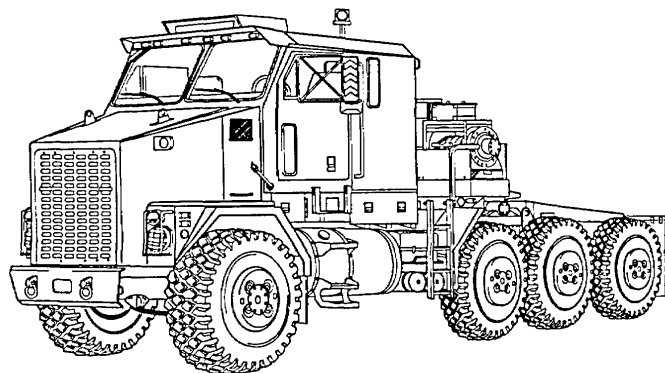


VOLUME NO. 2
GENERAL SUPPORTTECHNICAL MANUAL
DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCETRUCK, TRACTOR, M1070, 8 X 8,
HEAVY EQUIPMENT TRANSPORTER (HET)

NSN 2320-01-318-9902

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MARCH 1994

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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 1 September 1997

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DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE

TRUCK, TRACTOR, M1070, 8 X 8,
HEAVY EQUIPMENT TRANSPORTER (HET)
(NSN 2320-01-318-9902)
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22-101 and 22-102	22-101 thru 22-102.1/ (22-102.2 blank)		

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JOEL B. HUDSON
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03819

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DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

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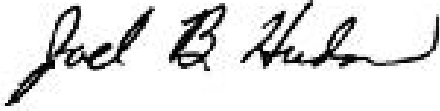
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*Acting Administrative Assistant to the
Secretary of the Army*
00331

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WARNING

Personnel hearing can be PERMANENTLY DAMAGED If exposed to constant high noise levels of 85 dB (A) or greater. Wear approved hearing protection devices when working in high noise level areas. Personnel exposed to high noise levels shall participate in a hearing conservation program in accordance with DA PAM 40-501. Hearing loss occurs gradually but becomes permanent over time.

WARNING**CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU**

Carbon monoxide is a colorless, odorless, DEADLY POISONOUS gas and when breathed deprives body of oxygen and causes SUFFOCATION. Breathing air with carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, a sleepy feeling, and coma. Permanent BRAIN DAMAGE or DEATH may result from severe exposure.

The following precautions MUST be followed to ensure personnel are safe whenever personnel heater or main or auxiliary engine is operated for any purpose.

- DO NOT operate personnel heater or engine of vehicle in enclosed area without adequate ventilation.
- DO NOT idle engine for long periods without ventilator blower operation. If tactical situation permits, open hatches.
- DO NOT drive any vehicle with inspection plates, cover plates, or engine compartment doors removed unless necessary for maintenance purposes.
- NEVER sleep in a vehicle when the heater is operating or the engine is idling.
- BE ALERT at all times during vehicle operation for exhaust odors or exposure symptoms. If either are present, IMMEDIATELY EVACUATE AND VENTILATE the area. Affected personnel treatment shall be: expose to fresh air; keep warm; DO NOT PERMIT PHYSICAL EXERCISE; If necessary, give artificial respiration as described in FM 21-11 and get medical attention.
- BE AWARE; neither the gas particulate filter unit nor field mask for nuclear, biological, and chemical protection will protect you from carbon monoxide poisoning.

THE BEST DEFENSE AGAINST CARBON MONOXIDE POISONING IS GOOD VENTILATION.

WARNING

- Wear eye protection and use care when replacing snap rings and retaining rings. Snap/retaining rings are under spring tension and can act as projectiles when released and may cause severe eye injury.
- Protective goggles must be worn when drilling. Failure to comply may result in injury to personnel.
- Always wear eye protection and protective clothing when handling glass. Failure to comply may result in injury.

WARNING

- Adhesive-sealants and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.
- General purpose cement can burn easily and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If cement gets on skin or clothing, wash immediately with soap and water.

WARNING

- Adhesive causes immediate bonding on contact with eyes, skin, or clothing and also gives off harmful vapors. Wear protective goggles and use in well-ventilated area. If adhesive gets in eyes, try to keep eyes open; flush eyes with water for 15 minutes and get immediate medical attention.
- On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

WARNING

- Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.
- Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- Steam cleaning creates hazardous noise levels and severe burn potential. Eye, skin, and ear protection is required. Failure to comply may result in injury to personnel.
- Face shield must be used by personnel operating spray gun. Failure to comply may result in injury to personnel.

WARNING

When servicing this vehicle, performing maintenance, or disposing of materials such as engine coolant, transmission fluid, lubricants, batteries, battery acid or CARC paint, consult your Unit/local hazardous waste disposal center or safety office for local regulatory guidance. If further information is needed, please contact the Army environmental hotline at 1-800-872-3845. Improper disposal of this material may result in damage to environment or injury to personnel.

WARNING

- Floor jack must be positioned on flat surface. Placing jack on uneven or soft surface could result in truck falling, causing serious injury or death to personnel.
- Jackstands must be positioned on flat surface, not more than 10 in. (25.4 cm) from wheels. Placing jackstands on uneven or soft surface could result in truck falling, causing serious injury or death to personnel.
- Do not work on any item supported only by jacks or hoist. Always use blocks or proper stands to support the item prior to any work. Equipment may fall and cause injury or death to personnel.
- To avoid personal injury, use hoist or get assistance when lifting components that weigh more than 50 lb (23 kg). Ensure all chains, hooks, slings, and lifting devices are in good condition and are of correct capacity.

WARNING

Observe the following precautions when working on or around engine/transmission components.

- Use guide straps or rope to guide engine/transmission assembly while lifting. Failure to comply may result in injury to personnel.
- Grade 8 screws must be used to support engine. Failure to comply may result in engine falling causing injury or death to personnel.
- Keep out from under heavy parts. Falling parts may result in serious injury to personnel.

WARNING

Observe the following precautions when working on or around engine/transmission components (cont).

- When working on a running engine, use caution around rotating parts. Tools, clothing, and hands may get caught causing serious injury or death to personnel.
- Ensure engine is cool before performing maintenance. Failure to comply may result in severe burns.
- Engine has many sharp edges. Use caution when using hand tools. Failure to comply may result in injury to personnel.

WARNING

Observe the following precautions when working on fuel system components.

- Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET OF VEHICLE.

WARNING

Observe the following precautions when working on or around exhaust system components.

- Ensure exhaust manifold and exhaust tube are cool before performing maintenance. Failure to comply may result in serious injury to personnel.

WARNING

Observe the following precautions when working on or around electrical system components.

- Remove rings, bracelets, watches, necklaces, and any other jewelry before working around HET Tractor. Jewelry can catch on equipment and cause injury or short across electrical circuit and cause severe burns or electrical shock. Batteries can explode from a spark.

Battery acid is harmful to skin and eyes. Always wear eye protection when working with batteries.

- Batteries produce explosive gases. Keep sparks and open flame away from batteries. Failure to comply may result in serious injury to personnel.
- Use extreme care when measuring voltage while engine is running. Rotating fan blade and hot engine parts may cause injury.

WARNING

Observe the following precautions when working on or around brake system components.

- Do not use brake drum that exceeds maximum wear specifications. Failure to comply may result in brake failure and serious injury or death.
- Brake shoes/drum may be coated with dust. Breathing dust may be harmful to personnel. Do not use compressed air to clean brake shoes/drum. Wear filter mask approved for use against dust.
- Left and right camshafts are different and not interchangeable. Using wrong camshaft may result in inoperative brakes and injury to personnel.

WARNING

Observe the following precautions when working on or around axle components.

- Axles are heavy. Keep hands and feet out from under axle. Failure to comply may result in injury or death to personnel.
- Differential assemblies are heavy. Stay clear of differential assembly when it is supported by lifting device. If differential falls, serious injury or death may result.
- Axle/suspension is heavy. Keep hands and feet out from under axle. Failure to comply may result in injury or death to personnel.
- Support axle with transmission lift. Secure axle to transmission lift with strap or chain. Failure to comply may result in serious injury to personnel.
- Keep hands clear of spring and axle housing when lowering axle. Failure to comply may result in serious injury to personnel.
- Keep fingers out of pin hole in spring brackets and spring eyes when removing spring pins. Failure to comply may result in injury to personnel.

WARNING

Observe the following precautions when working on or around cab and frame components.

- Cab weighs 2600 lb (1179 kg). Stay clear of cab when it is supported by lifting device. If cab falls, serious injury or death may result. Use 10 ft (3 m) guidelines to help guide cab during removal.
- Do not work on HET Tractor when supported only by jack or hoist. It may fall and cause severe injury or death.
- Ensure personnel are clear of lifting area. All personnel are within visual sight of each other and not within 15 ft (4.6 m) of cab when lifting is in process. Failure to comply may result in serious injury or death to personnel.
- Do not allow personnel to work between jackstands and cab or within designated danger zones while lifting device is supporting cab. Failure to comply may result in serious injury or death to personnel.
- Hood is not designed to be a work platform. Using hood as a work platform may result in injury or equipment damage.

WARNING

Observe the following precautions when working on or around fifth wheel.

- Rear of fifth wheel plate must be resting on angle stop before performing maintenance. Failure to comply may result in injury.

WARNING

Observe the following precautions when working on or around suspension system components.

- Keep hands clear of pin and spring when removing pin. Failure to comply may result in serious injury to personnel.
- Air suspension system may still be pressurized even though AIR PRESS gage reads 0 psi. Remove air line slowly to allow air to escape. Failure to comply may result in air line blowing off causing serious injury to personnel.
- Air suspension will drop when air line is removed. Stay clear of suspension. Failure to comply may result in serious injury to personnel.

WARNING

Observe the following precautions when working on or around winch system components.

- Driver's side and passenger's side winches are not interchangeable. Winch cable slot on drum is on gear end for driver's side winch and on motor end for passenger's side winch. Failure to install correct winch may result in injury to personnel and improper winch operation.
- Plug and valve cartridge locations determine if counterbalance valve is for driver or passenger side. Plug and valve cartridge must be in correct locations for driver and passenger side winch. Failure to comply may cause injury to personnel and result in reverse winch operation.
- Always wear heavy gloves when handling winch cable. Never let cable run through hands. Frayed cable can cut hands severely.
- Use care when removing cable from drum. End of cable can spring up causing injury to personnel.
- Output shaft is installed differently in winch drum depending on whether winch is for passenger or driver's side. For driver's side winch, splined end of output shaft must be on cutout end of winch drum. For passenger's winch, splined end of output shaft must be on end opposite cutout end of winch drum. Failure to comply may result in improper winding of cable and injury to personnel.

WARNING

Chemical Agent Resistant Coating (CARC) paint contains isocyanate (HDI) which is highly irritating to skin and respiratory system. High concentrations of HDI can produce symptoms of itching and reddening of skin, a burning sensation in throat and nose, and watering of the eyes. In extreme concentrations, HDI can cause cough, shortness of breath, pain during respiration, increased sputum production, and chest tightness. The following precautions must be taken whenever using CARC paint:

- DO NOT let skin or eyes come in contact with CARC paint. Always wear protective equipment (gloves, ventilation mask, safety goggles, etc.).
- NEVER weld or cut CARC-coated materials.
- DO NOT grind or sand painted equipment without high efficiency air purifying respirators in use.
- BE AWARE of CARC paint exposure symptoms; symptoms can occur a few days after initial exposure. Seek medical help immediately if symptoms are detected.

WARNING

After Nuclear, Biological, or Chemical (NBC) exposure of vehicle, all air filters shall be handled with extreme caution. Unprotected personnel may experience injury or death if residual toxic agents or radioactive material are present. If vehicle is exposed to chemical or biological agents, servicing personnel shall wear protective mask, hood, protective overgarments, and chemical protective gloves and boots in accordance with FM 3-4. All contaminated air filters shall be placed in double-lined plastic bags and moved swiftly to a segregation area away from the worksite. The same procedure applies for radioactive dust contamination. The Company NBC team should measure radiation prior to filter removal to determine extent of safety procedures required per the NBC Annex to the unit Standard Operating Procedures (SOP). The segregation area in which the contaminated air filters are temporarily stored shall be marked with appropriate NBC placards. Final disposal of contaminated air filters shall be in accordance with local SOP. Decontamination operation shall be in accordance with FM 3-5 and local SOP.

See FM 21-11 for additional first aid data.

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

TRUCK, TRACTOR, M1070, 8 X 8,
HEAVY EQUIPMENT TRANSPORTER (HET)
(NSN 2320-01-318-9902)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

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 the back of this manual direct to: Commander, U.S. Army Tank-Automotive and Armaments Command, ATTN: AMSTA-IM-OPIT, Warren, MI 48397-5000. A reply will be furnished to you.

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Section I. INTRODUCTION

19-1. INTRODUCTION

This chapter contains maintenance instructions for removal, installation, and repair of the engine at the General Support maintenance level. Some subassemblies and parts must be removed before the engine and components can be accessed. They are referenced to other paragraphs of this manual or TM 9-2320-360-20.

Section II. SERVICE UPON RECEIPT

19-2. GENERAL MAINTENANCE INSTRUCTIONS

a. Follow these maintenance instructions when removing and installing engine:

- (1) When unpacking items, remove packing material (for example: barrier paper, tape, plastic bags, and protective caps).
- (2) Cap or tape over engine inlets and exhaust ducts to prevent foreign objects from getting inside the engine. Keep dust, dirt, and other objects out of internal parts of the engine.

CAUTION

Do not use tape to close off fuel or oil openings. Adhesive surface of tape will mix with fuel or oil and will get in the engine lines.

- (3) Cap or tape over open tubes, hoses, fittings, and engine openings as soon as parts are taken off.
- (4) Use suitable container to catch oil and coolant when removing hoses, fittings, and plugs.
- (5) Handle and store removed engine components carefully.
- (6) Inspect parts as removed for breaks, dents, cracks, surface defects, or other obvious damage. Turn in bad parts. Set aside good parts for later use.

19-2. GENERAL MAINTENANCE INSTRUCTIONS (CONT)

- (7) When possible, replace gaskets, packings, and seals removed during repair work. Replace lockwire, lockwashers, and cotter pins at time of reassembly.
- (8) Replace broken, worn, or burned electrical wiring.
- (9) Replace broken, frayed, crimped, or soft flexible hoses. Replace stripped or damaged fittings. Replace entire connected flexible hoses if fittings are damaged.
- (10) Tag and mark shims, connectors, wires, valves, fittings, and mating ends of lines before disconnecting or removing. Identify similar parts to ensure correct assembly.
- (11) Use hoists, jacks, and other aids when lifting engine.

b. Follow these inspection instructions when removing and installing engine:

- (1) Inspect mounting surfaces and surfaces in contact with gaskets, seals, or machined surfaces. Look for burrs or scratches which might damage parts or seals upon installation. Remove any defects found.
- (2) Remove drain plugs from engine system components and inspect sediment sticking to plug. Grit or fine metal particles may indicate actual or potential component failure. A few fine particles are normal. This inspection will help to show defective parts before internal inspection of the components.
- (3) Inspect hose surfaces for broken or frayed fabric. Check for breaks caused by sharp kinks or contact with other parts of the vehicle. Inspect fitting threads for damage. Replace any defective parts. After assembly and during initial vehicle operation period, check for leaks. Inspect wiring harnesses for chafed or burned insulation. Inspect terminal connectors for loose connections and broken parts. Visually inspect castings and weldments for cracks.

Section III. MAINTENANCE PROCEDURES

19-3. ENGINE TO ENGINE STAND INSTALLATION/REMOVAL

This task covers:

- a. Installation
- b. Removal

c. Follow-On Maintenance

INITIAL SETUP**Equipment Conditions**

Sending units and attachments removed (TM 9-2320-360-20).

Starter removed (TM 9-2320-360-20).

150 amp circuit breakers removed (TM 9-2320-360-20).

24-volt (front) alternator/bracket removed (TM 9-2320-360-20).

Exhaust manifolds removed (para 3-23).

Air box drains removed (para 3-9).

Air box covers removed (para 3-8).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)

Plate, Adapter (Item 7, Appendix E)

Tools and Special Tools (Cont)

Sling Assemblies (2) (Item 160, Appendix E)

Stand, Engine (Item 181, Appendix E)

Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Compound, Sealing, Pipe Thread (Item 28, Appendix B)

Tags, Identification (Item 56, Appendix B)

Ties, Cable, Plastic (Item 60, Appendix B)

Lockwasher (Item 120, Appendix F)

Screws (13) (Item 275, Appendix F)

Personnel Required

Two

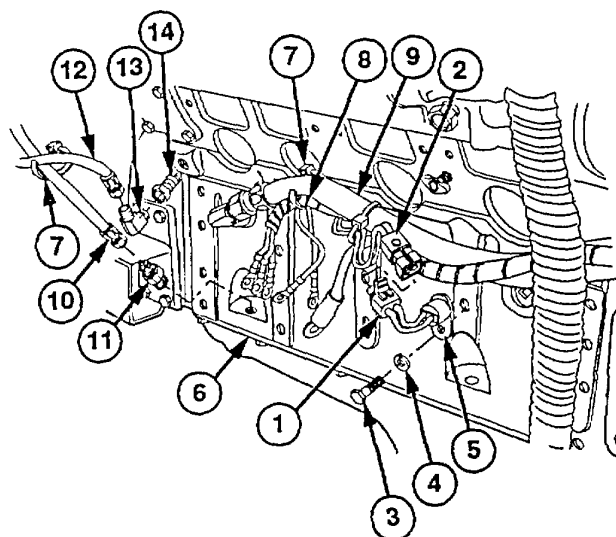
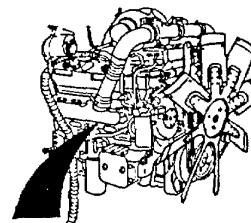
a. Installation

- (1) Remove electrical connector (1) from electrical connector (2).
- (2) Remove screw (3), lockwasher (4), and ether start temperature sensor (5) from engine assembly (6). Discard lockwasher.

NOTE

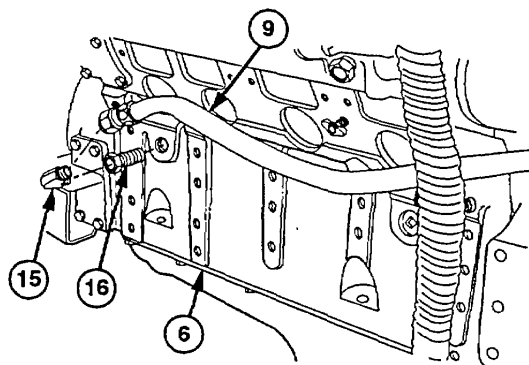
Location of plastic cable ties should be marked before removal.

- (3) Remove plastic cable tie (7) from engine wire harness (8) and hose no. 2630 (9).
- (4) Remove hose no. 2761 (10) from adapter (11).
- (5) Remove adapter (11) from engine assembly (6).
- (6) Remove plastic cable tie (7) from hose no. 27 (10) and hose no. 2682 (12).
- (7) Remove hose no. 2682 (12) from elbow (13).
- (8) Remove elbow (13) from adapter (14).
- (9) Remove adapter (14) from engine assembly (6).

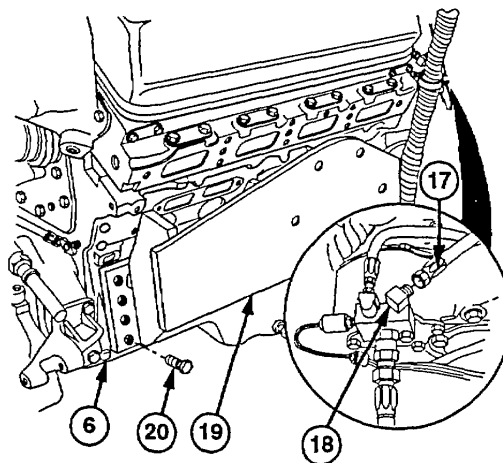


19-3. ENGINE TO ENGINE STAND INSTALLATION/REMOVAL (CONT)

- (10) Remove hose no. 2630 (9) from elbow (15).
- (11) Remove elbow (15) from adapter (16).
- (12) Remove adapter (16) from engine assembly (6).

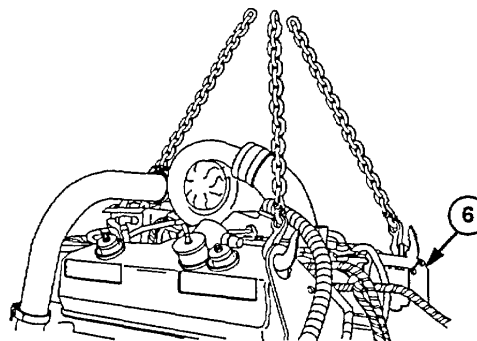


- (13) Remove fuel line (17) from elbow (18).
- (14) Install adapter plate (19) on engine assembly (6) with 13 screws (20) with aid of assistant.

**WARNING**

Engine assembly weighs 2605 lb (1182 kg). Stay clear of engine assembly when it is supported by lifting device. If engine falls, serious injury or death may result.

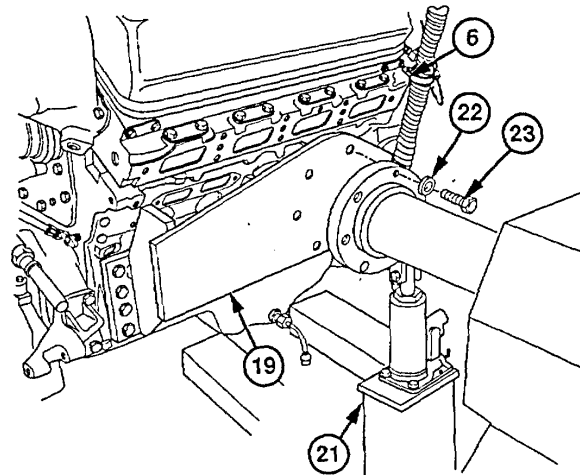
- (15) Install suitable lifting device on engine assembly (6).



WARNING

Stand clear of engine when supported by lifting device. Engine may fall and cause serious injury to personnel.

- (16) Mount engine assembly (6) and adapter plate (19) on engine stand (21) with six washers (22) and screws (23). Torque to 147 lb-ft (200 N m).
- (17) Remove lifting device from engine assembly (6).

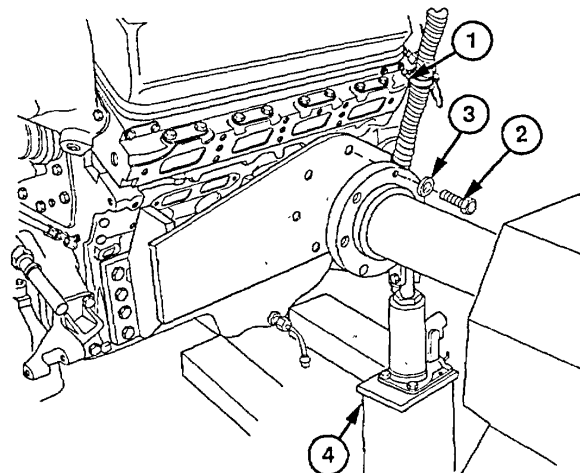
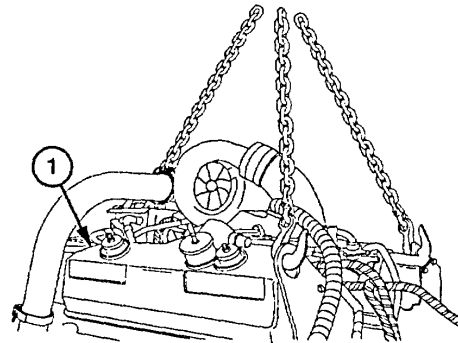
**b. Removal**

- (1) Install lifting device on engine assembly (1)

WARNING

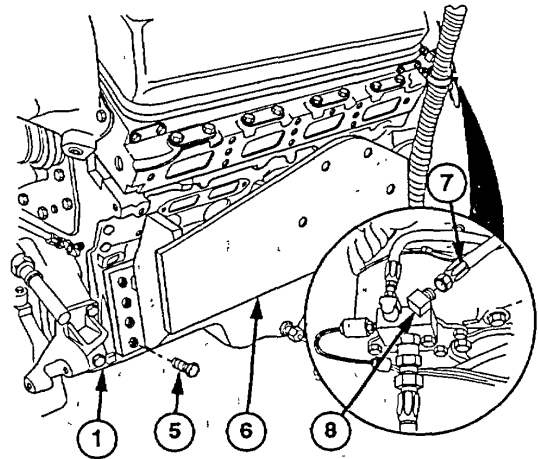
Stand clear of engine when supported by lifting device. Engine may fall and cause serious injury to personnel.

- (2) Support engine assembly (1) with lifting device.
- (3) Remove six screws (2), washers (3), and engine assembly (1) from engine stand (4).
- (4) Place engine assembly (1) on suitable supports.
- (5) Remove lifting device from engine assembly (1).



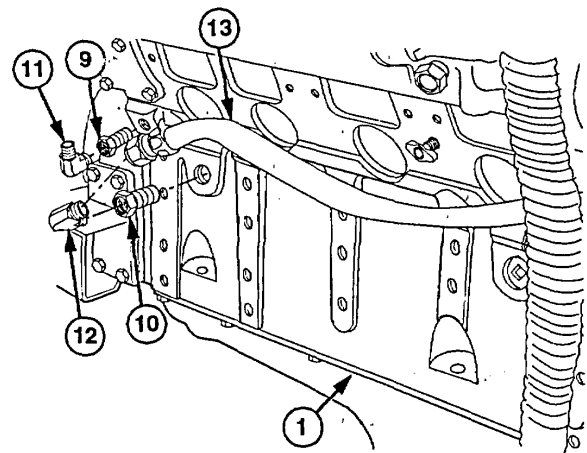
19-3. ENGINE TO ENGINE STAND INSTALLATION/REMOVAL (CONT)

- (6) Remove 13 screws (5) and adapter plate (6) from engine assembly (1).
- (7) Install fuel line (7) on elbow (8).

**WARNING**

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (8) Coat threads of two adapters (9 and 10) and elbows (11 and 12) with pipe thread sealing compound.
- (9) Install adapter (10) on engine assembly (1).
- (10) Install elbow (12) on adapter (10).
- (11) Install hose no. 2630 (13) on elbow (12).
- (12) Install adapter (9) on engine assembly (1).
- (13) Install elbow (11) on adapter (9).



- (14) Install hose no. 2682 (14) on elbow (11).

NOTE

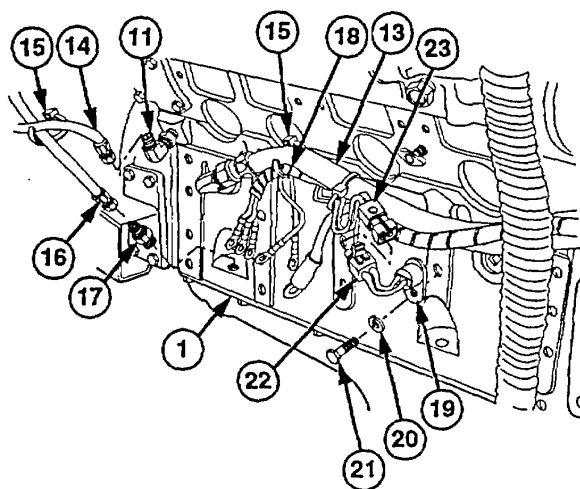
Plastic cable ties should be positioned in locations marked during removal.

- (15) Install plastic cable tie (15) on hose no. 2682 (14) and hose no. 2761 (16).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (16) Coat threads of adapter (17) with pipe thread sealing compound.
- (17) Install adapter (17) on engine assembly (1).
- (18) Install hose no. 2761 (16) on adapter (17).
- (19) Install plastic cable tie (15) on hose no. 2630 (13) and engine wire harness (18).
- (20) Install ether start temperature sensor (19) on engine assembly (1) with new lockwasher (20) and screw (21).
- (21) Install electrical connector (22) on electrical connector (23).



c. Follow-On Maintenance

- (1) Install air box covers (para 3-8).
- (2) Install air box drains (para 3-9).
- (3) Install exhaust manifolds (para 3-23).
- (4) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (5) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (6) Install starter (TM 9-2320-360-20).
- (7) Install sending units and attachments (TM 9-2320-360-20).

19-4. ENGINE BLOCK REPAIR

This task covers:

a. Disassembly	d. Testing
b. Cleaning/Inspection	e. Follow-On Maintenance
c. Assembly	
-

INITIAL SETUP
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 Electronic control module (ECM) removed (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 DDEC oil temperature sensor removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Fuel injector wire harnesses removed (para 4-3).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Oil cooler and housing removed (para 3-19).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Secondary fuel filter housing removed (para 4-13).
 Water pump removed (para 5-5).
 Vibration damper and front cover removed (para 3-15).
 Water pump drive gear removed (para 3-24).
 Crankshaft pulley removed (para 3-12).
 Crankshaft vibration damper removed (para 3-14).
 Turbocharger removed (para 4-11).
 Air inlet adapter removed (para 4-5).
 Fuel supply pump removed (para 4-4).
 Blower accessory drive hub removed (para 4-9).
 Tachometer drive gear removed (para 3-25).

Equipment Conditions (Cont)

Blower removed (para 4-6).
 Aftercooler removed (para 5-7).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 SRS/TRS sensor removed (para 3-7);
 Cylinder heads removed (para 3-10).
 Oil pan removed (para 3-20).
 Oil pressure regulator valve removed (para 3-22).
 Oil pressure relief valve removed (para 3-21).
 Crankshaft cover, front oil seal, and oil pump removed (para 19-14).
 Engine block breather tube removed (para 3-6).
 Flexplate assembly removed (para 3-1 7J).
 Flywheel housing removed (para 19-9).
 Blower drive support removed (para 4-8).
 Camshafts and end bearings removed (para 19-12).
 Idler gear removed (para 19-13).
 Rear end plate removed (para 19-6).
 Front end plate removed (para 19-5).
 Pistons, connecting rods, and liners removed (para 19-10).
 Main bearings and crankshaft removed (para 19-8).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Gage, Depth, Micrometer (Item 48, Appendix E)
 Gage, Dial, Cylinder Bore (Item 49, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Remover/installer, Core Plug Plug (Item 133, Appendix E)
 Remover/installer; Water Inlet Adapter, Aftercooler (Item 134, Appendix E)
 Sling Assemblies (2) (Item 160, Appendix E)
 Socket, Pipe Plug (Item 165, Appendix E)
 Testing Kit, Cylinder Block Pressure (Item 192, Appendix E)

19-4. ENGINE BLOCK REPAIR (CONT)

INITIAL SETUP (CONT)

Tools and Special Tools (Cont)

- Wrench Set, Socket, 3/4 In. Drive (Item 231, Appendix E)
- Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
- Wrench, Torque, 0-300 Lb-in. (Item 235, Appendix E)
- Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)
- Wrench, Torque, 0-75 Lb-in. (Item 237, Appendix E)

Materials/Parts

- Antifreeze, Permanent (Item 12, Appendix B)
- Compound, International, No. 2 (Item 21, Appendix B)

Materials/Parts (Cont)

- Compound, Sealing and Lubricating (Item 27, Appendix B)
- Compound, Sealing, Pipe Thread (Item 28, Appendix B)
- Oil, Lubricating (Item 45, Appendix B)
- Gaskets (8) (Item 27, Appendix F)
- Gasket (Item 34, Appendix F)
- Gasket (Item 38, Appendix F)
- Gasket (Item 48, Appendix F)
- Lockwashers (2) (Item 127, Appendix F)
- Seal Rings (34) (Item 258, Appendix F)
- Seal Rings (16) (Item 271, Appendix F)
- Shims, Head (4) (Item 322, Appendix F)

a. Disassembly

WARNING

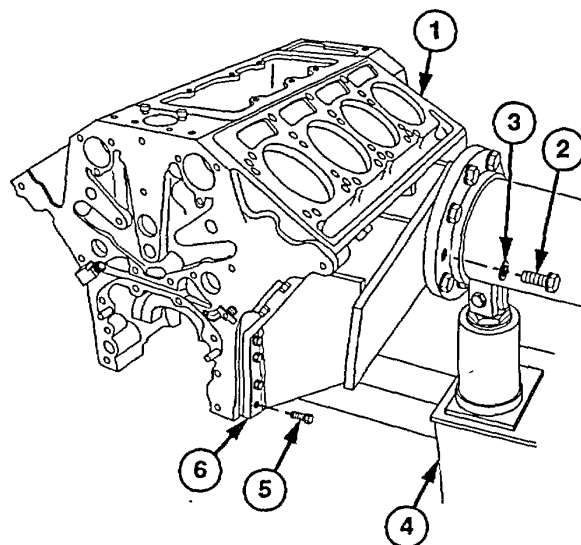
Engine has may sharp edges. Use caution when using hand tools. Failure to comply may result in injury to personnel.

- (1) Install lifting device on engine block (1).

WARNING

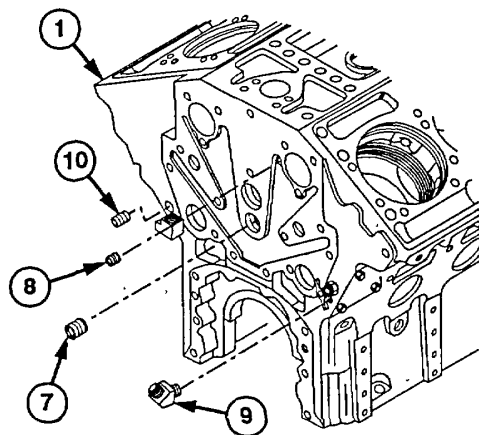
Engine weighs 2605 lb (1182 kg). Stand clear of engine when supported by lifting device. Engine may fall and cause serious injury or death to personnel.

- (2) Support engine block (1) with lifting device.
- (3) Remove six screws (2), washers (3), and engine block (1) from engine stand (4).
- (4) Place engine block (1) on floor.
- (5) Remove lifting device from engine block (1).
- (6) Remove 13 screws (5) and adapter plate (6) from engine block (1).



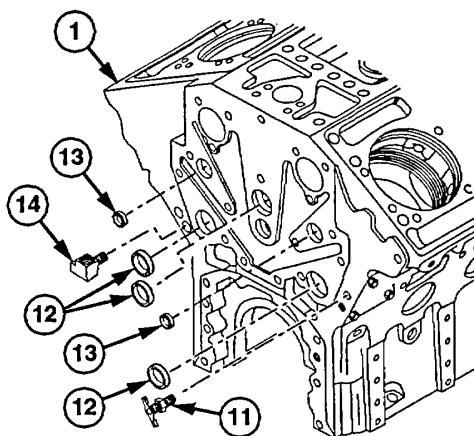
19-4. ENGINE BLOCK REPAIR (CONT)

- (7) Remove oil galley plugs (7 and 8), elbow (9), and plug (10) from front of engine block (1).



- (8) Remove drain cock (11) three plugs (12), and two plugs (13) from front of engine block (1).

- (9) Remove fitting (14) from front of engine block (1).



- (10) Remove oil galley plug (15) from rear of engine block (1).

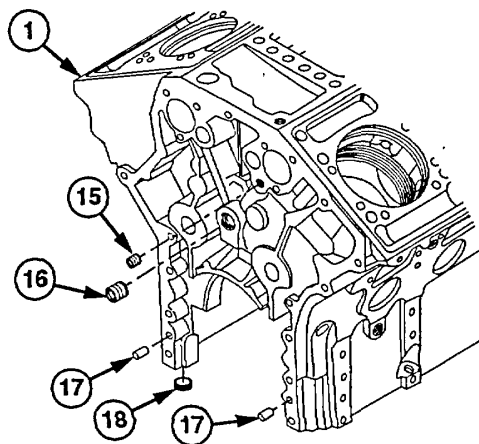
- (11) Remove oil galley plug (16) from rear of engine block (1).

NOTE

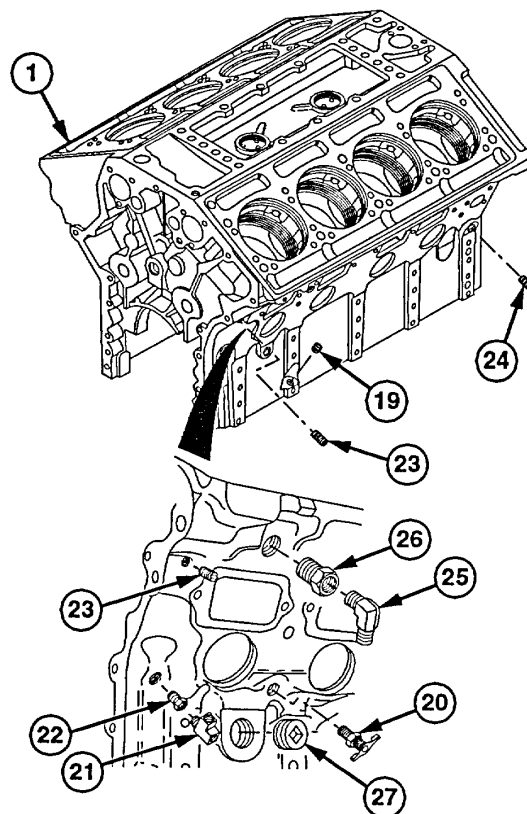
Do step (12) only if dowels are damaged. Do not remove dowels just to dean engine block.

- (12) Remove two dowels (17) from rear of engine block (1).

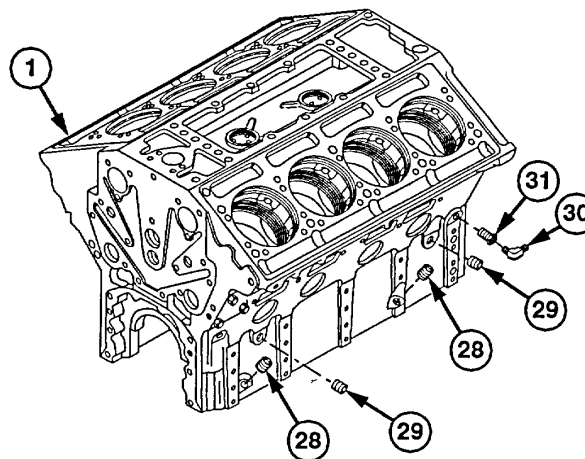
- (13) Remove two cup plugs (18) from bottom of engine block (1).



- (14) Remove plug (19) from right side of engine block (1).
- (15) Remove drain cock (20) from right side of engine block (1).
- (16) Remove elbow (21) and fitting (22) from right side of engine block (1).
- (17) Remove oil galley plugs (23 and 24) from side of engine block (1).
- (18) Remove elbow (25) and reducer bushing (26) from right side of engine block (1).
- (19) Remove plug (27) from right side of engine block (1).

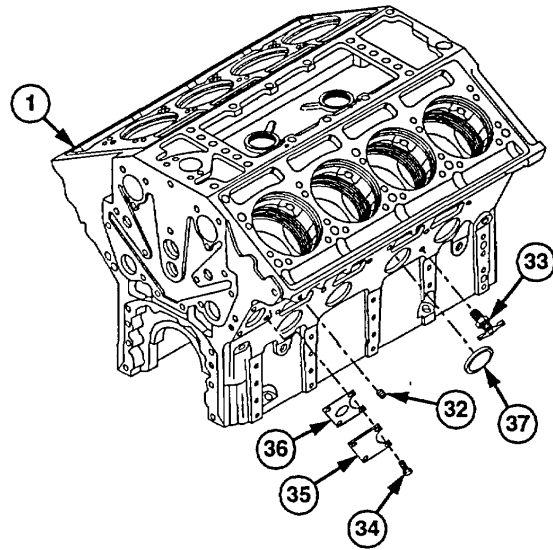


- (20) Remove two plugs (28) from left side of engine block (1).
- (21) Remove two plugs (29) from left side of engine block (1).
- (22) Remove elbow (30) and reducer bushing (31) from left side of engine block (1).

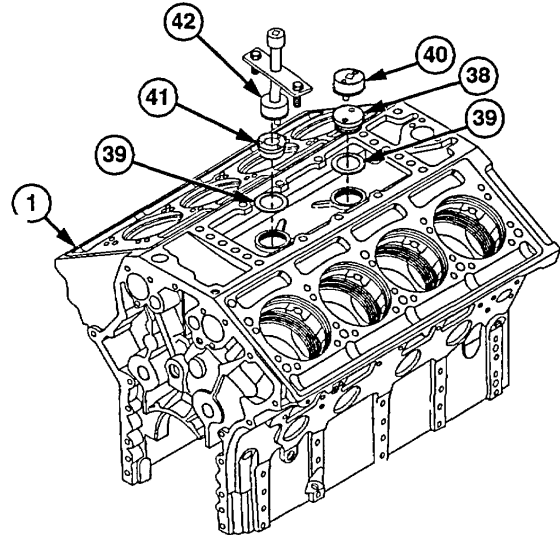


19-4. ENGINE BLOCK REPAIR (CONT)

- (23) Remove oil plug (32) from left side of engine block (1).
- (24) Remove drain cock (33) from left side of engine block (1).
- (25) Remove four screws (34), cover plate (35), and gasket (36) from left side of engine block (1). Discard gasket
- (26) Remove four expansion plugs (37) from both right and left sides of engine block (1).



- (27) Remove protective plug (38) and gasket (39) from top of engine block (1) using core plug remover (40). Discard gasket.
- (28) Remove aftercooler water inlet adapter (41) and gasket (39) from top of engine block (1) using aftercooler inlet adapter remover (42). Discard gasket.

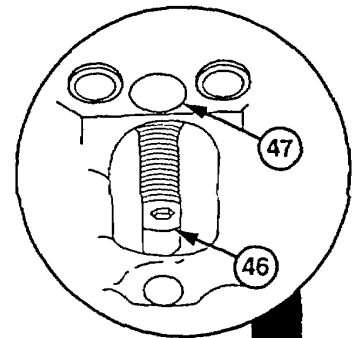
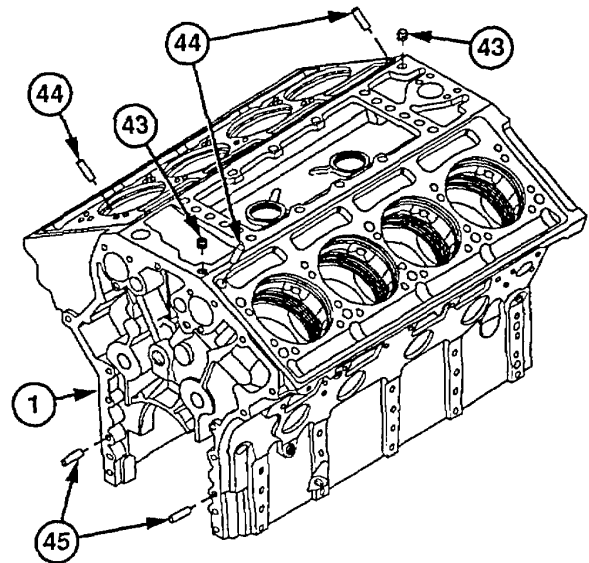


- (29) Remove two pipe plugs (43) from top of engine block (1).

NOTE

Do steps (30) thru (32) only if plugs and dowels are damaged. Do not remove just to clean engine block.

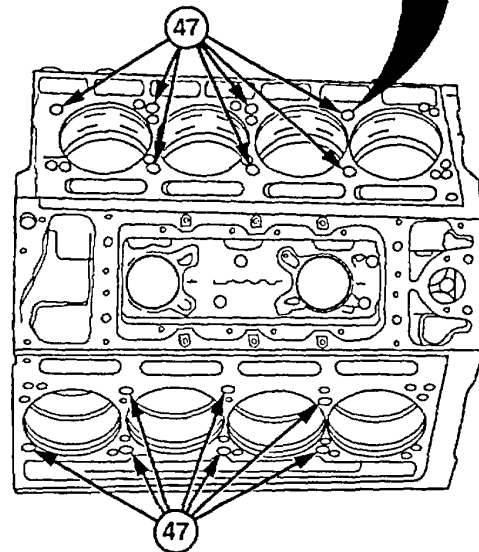
- (30) Remove three dowels (44) from top of engine block (1).
- (31) Remove two dowels (45) from front of engine block (1).



NOTE

Position of plugs must be marked before removal.

- (32) Remove 14 plugs (46) from bottom cylinder head screw holes (47).



19-4. ENGINE BLOCK REPAIR (CONT)**b. Cleaning/Inspection**

- (1) Scrape gasket material and sealant from engine block surfaces.

WARNING

High pressure steam may blow particles into eyes, may cause severe burns, and creates hazardous noise levels. Eye, skin, and hearing protection is required to prevent injury to personnel.

NOTE

Oil and water galleries in engine block must be thoroughly steam cleaned.

- (2) Steam clean engine block.

WARNING

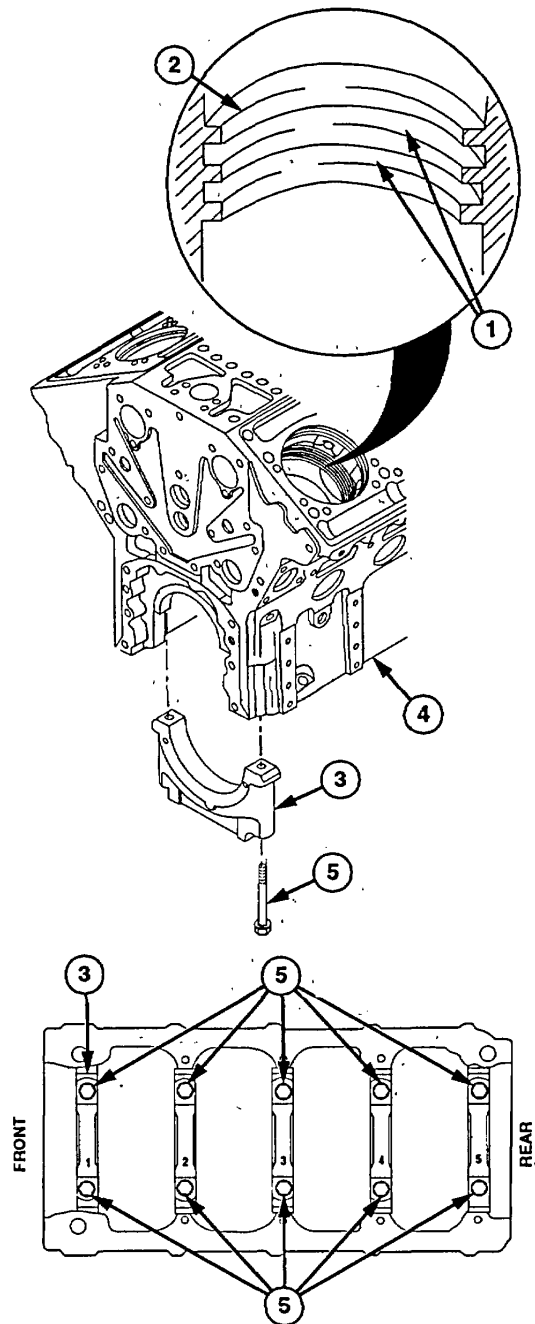
Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) Inspect grooves (1) and lands (2) for pitting and erosion.

NOTE

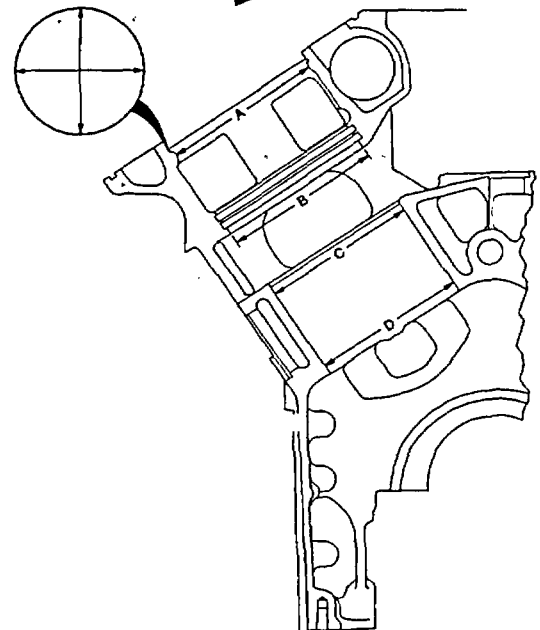
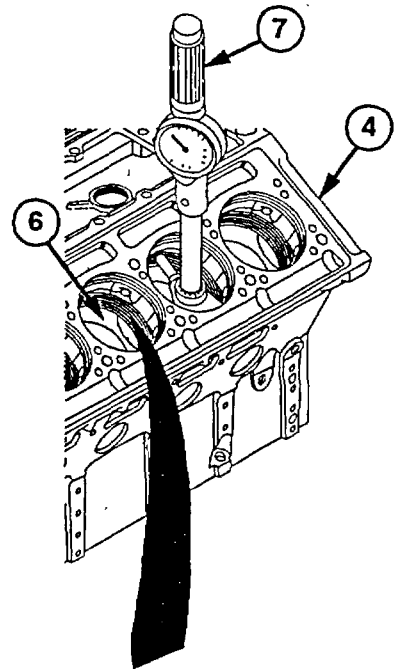
Main bearing caps must be installed in proper positions in engine block as marked during removal (para 19-8). Ensure caps are firmly seated in engine block and that main bearing shells are removed.

- (5) Install 5 main bearing caps (3) in bottom of engine block (4) with 10 screws (5). Torque to 20 lb-in. (2.3 N-m).
- (6) Seat caps (3) by striking with soft-faced hammer.
- (7) Tighten screws (5) to 50 lb-ft (68 N-m), then to 110 lb-ft (149 N-m), and then to 250 lb-ft (339 N-m).



NOTE

- All measurements should be made with engine block on floor, not in engine stand.
- All eight cylinders are measured the same. Follow steps (8) thru (11).



- (8) Measure cylinder bore (6) at position A using cylinder checking gage (7). Measurement cannot be greater than 5.3635 in. (136.23 mm).
- (9) Measure cylinder bore (6) at position B. Measurement cannot be greater than 5.3395 in. (135.62 mm).
- (10) Measure cylinder bore (6) at position C. Measurement cannot be greater than 5.2185 in. (132.55 mm).
- (11) Measure cylinder bore (6) at position D. Measurement cannot be greater than 5.2185 in. (132.55 mm).
- (12) Replace engine block (4) if any cylinder bore (6) is beyond limits listed above or if a sealing problem has occurred at position B. Also, the taper between C and D and out-of-roundness must not exceed 0.0010 in. (0.025 mm).
- (13) Measure flatness of engine block (4) crosswise between all cylinders using straight edge and feeler gage. If block (4) varies more than 0.003 in. (0.076 mm), replace engine block (4).
- (14) Measure flatness of engine block (4) contact surface lengthwise using straight edge and feeler gage. If block (4) varies more than 0.0070 in. (0.178 mm), replace engine block (4).

19-4. ENGINE BLOCK REPAIR (CONT)**NOTE**

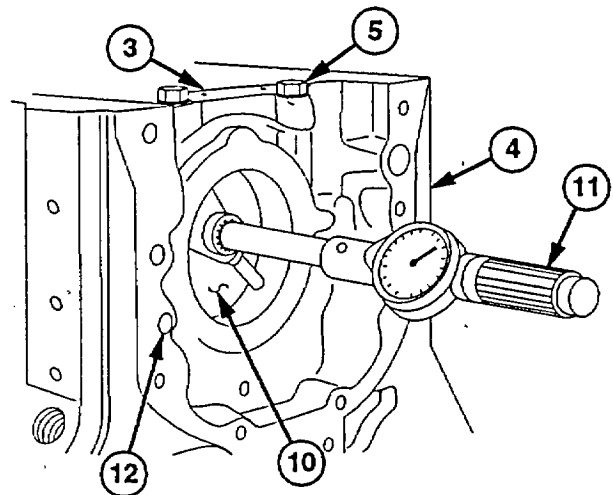
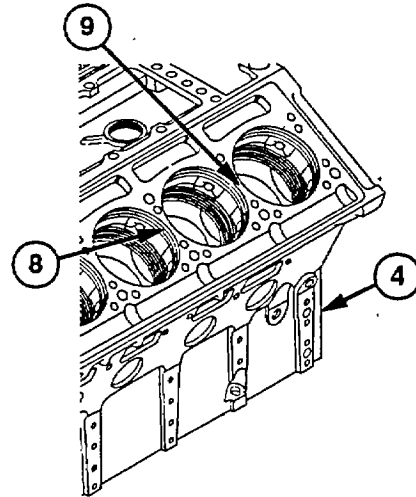
Cylinders may be counterbored to either of two depths.

- (15) Measure depth of counterbore (8) using depth gage. If depth is not between 0.4755 in. (12.13 mm) and 0.4770 in. (12.12 mm) or between 0.4905 in. (12.50 mm) and 0.4920 in. (12.50 mm) and cannot be brought into limits by installing cylinder liner insert, replace engine block (4).
- (16) If counterbore (8) varies more than 0.0015 in. (0.04 mm) around edge of cylinder, replace engine block (4).

NOTE

If two adjacent cylinders have different counterbore depth ranges measured in step (15) above, step (17) does not apply.

- (17) If difference between any one adjacent cylinder counterbore (8) measured at their closest point (9) is more than 0.0015 in. (0.04 mm), replace engine block (4).
- (18) Measure each main bearing bore (10) diameter with bore gage (11). If main bearing bore diameter is less than 4.812 in. (122.22 mm) or greater than 4.813 in. (122.25 mm) replace engine block (4).
- (19) Remove five main bearing caps (3) and screws (5) from engine block (4).
- (20) Inspect dowel holes (12) in engine block (4) for oversized holes or damage. Replace engine block if damaged or oversized.
- (21) Inspect threaded holes for stripped or crossed threads. Use a tap to clean threads.
- (22) Inspect machined surfaces for flatness, burrs, and scratches. If surfaces cannot be cleaned by lapping, replace engine block (4).



c. Assembly

WARNING

Sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid Injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

NOTE

There are 14 plugs, 7 in each cylinder bank. Apply small quantity of sealing and lubricating compound to thread and lubricating compound to thread area above plug. Do not let sealant get onto threads of cylinder head screws. Allow sealant to set for 12 hours before performing pressure check.

- (1) Coat threads of plugs (1) with sealing and lubricating compound.

NOTE

Top of plugs must be 1.9802.070 in. (5029-52.58 mm) below surface of engine block when installed.

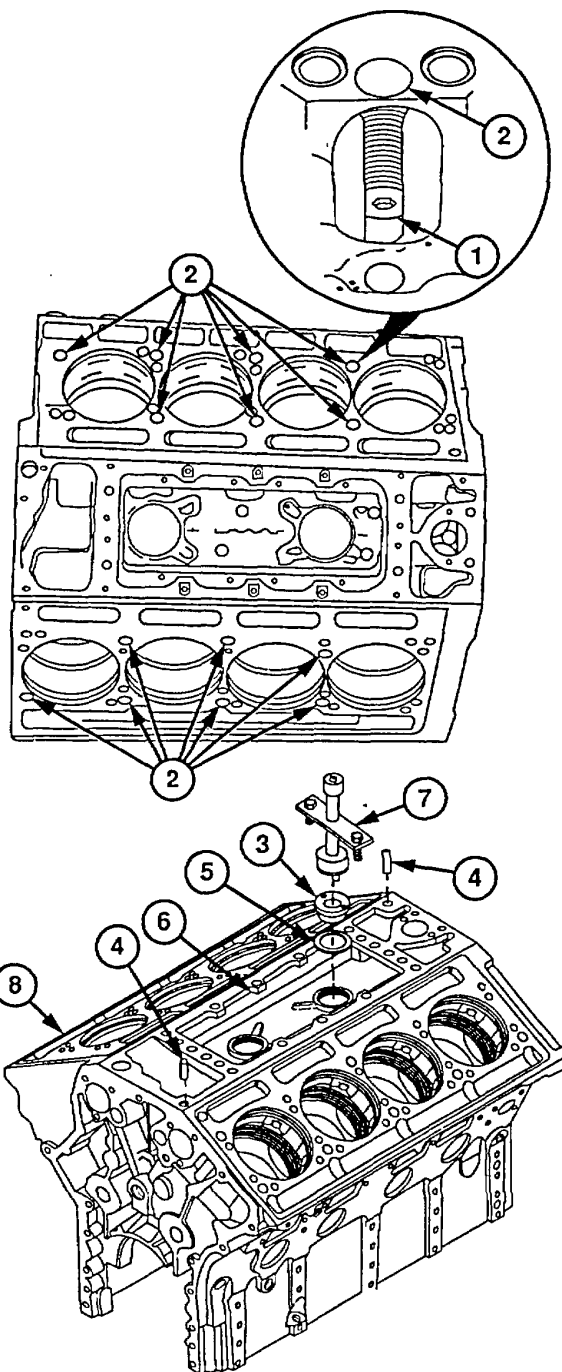
- (2) Install 14 plugs (1) in cylinder head screw holes (2).

- (3) Coat threads of protective plug (3) and pipe plugs (4) with pipe thread sealing compound.

- (4) Install new gasket (5) and protective plug (3) in air box (6) using core plug installer (7).

Torque to 230-270 lb-ft (312-366 N•m).

- (5) Install two pipe plugs (4) on top of engine block (8). Torque to 168-192 lb-in. (19-22 N•m).



19-4. ENGINE BLOCK REPAIR (CONT)**NOTE**

Do step (6) only if dowel pins were removed.

- (6) Install three dowel pins (9) in top of engine block (8) until flush with surface of engine block.

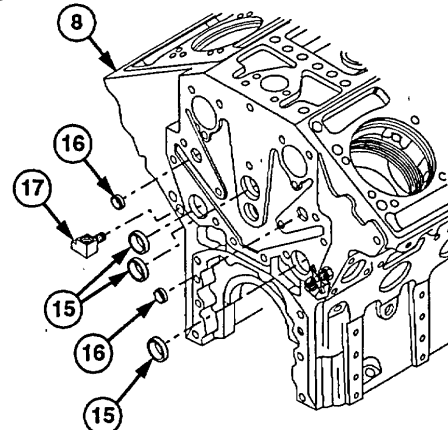
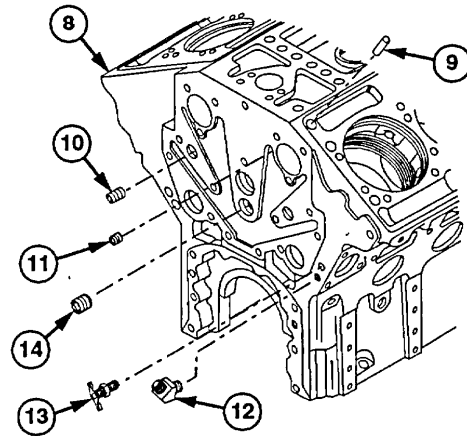
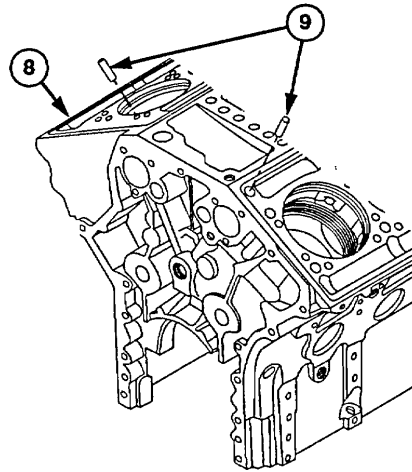
WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

NOTE

Front face views of engine block are shown.

- (7) Coat threads plugs (10 and 11), elbow (12), drain cock (13), plug (14), pipe plugs (15 and 16) and fitting (17) with pipe thread sealing compound.
- (8) Install plug (10) in front of engine block (8).
- (9) Install plug (11) in front of engine block (8).
- (10) Install elbow (12) in front of engine block (8).
- (11) Install drain cock (13) in front of engine block (8).
- (12) Install plug (14) in front of engine block (8). Torque to 168-192 lb-in. (19-22 N-m).
- (13) Install three plugs (15) in front of engine block (8).
- (14) Install two plugs (16) in front of engine block (8).
- (15) Install fitting (17) in front of engine block (8).



WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

NOTE

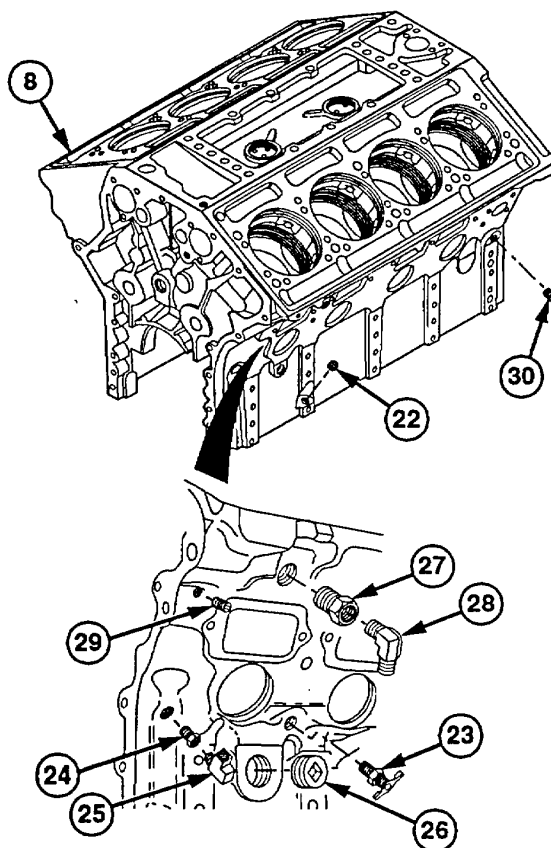
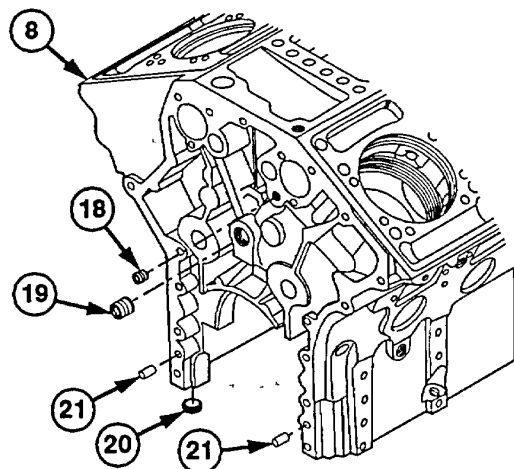
Rear face of engine block is shown.

- (16) Coat threads oil galley plugs (18 and 19) and two cup plugs (20) with pipe thread sealing compound.
- (17) Install oil galley plug (18) in rear of engine block (8).
- (18) Install oil galley plug (19) in rear of engine block (8).

NOTE

Do step (19) only if dowels were removed.

- (19) Install two dowels (21) in rear of engine block (8).
- (20) Install two cup plugs (20) in bottom of engine block (8).
- (21) Coat threads of plug (22), drain cock (23), fitting (24), elbow (25), plug (26), reducer bushing (27), elbow (28), and plugs (29 and 30) with pipe thread sealing compound.
- (22) Install plug (22) in right side of engine block (8).
- (23) Install drain cock (23) in right side of engine block (8).
- (24) Install fitting (24) in right side of engine block (8).
- (25) Install elbow (25) in fitting (24).
- (26) Install plug (26) in right side of engine block (8).
- (27) Install reducer bushing (27) in right side of engine block (8).
- (28) Install elbow (28) in reducer bushing (27).
- (29) Install oil galley plug (29) in right side of engine block (8).
- (30) Install pipe plug (30) in right side of engine block (8).

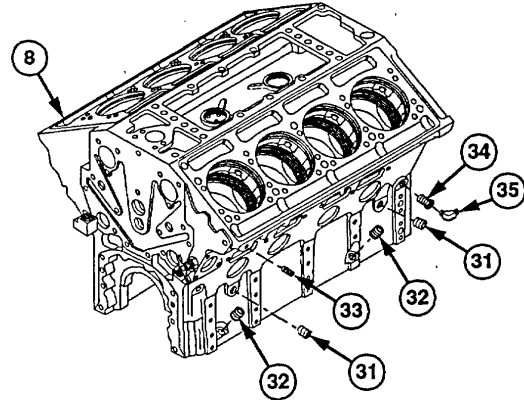


19-4. ENGINE BLOCK REPAIR (CONT)

(31) Install two plugs (31) in left side of engine block (8).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.



(32) Coat threads of plugs (32), oil plug (33), reducer bushing (34), and elbow (35) with pipe thread sealing compound.

(33) Install two plugs (32) in left side of engine block (8).

(34) Install oil plug (33) on left side of engine block (8).

(35) Install reducer bushing (34) in left side of engine block (8).

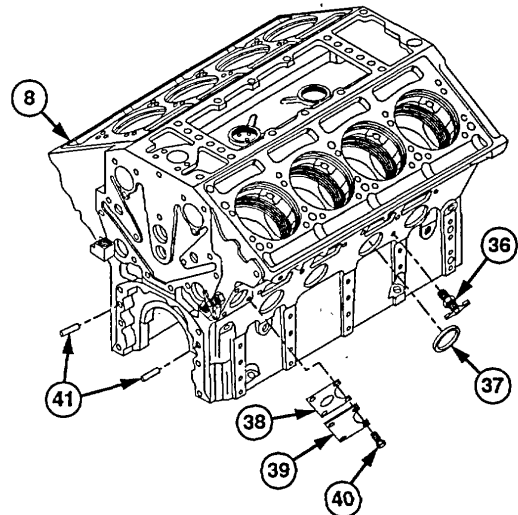
(36) Install elbow (35) in reducer bushing (34).

(37) Coat threads of drain cock (36) and expansion plugs (37) with pipe thread sealing compound.

(38) Install drain cock (36) in left side of engine block (8).

(39) Install four expansion plugs (37) on right and left sides of engine block (8).

(40) Install new gasket (38) and cover plate (39) on engine block (8) with four screws (40).

**NOTE**

Do step (41) only if dowels were removed.

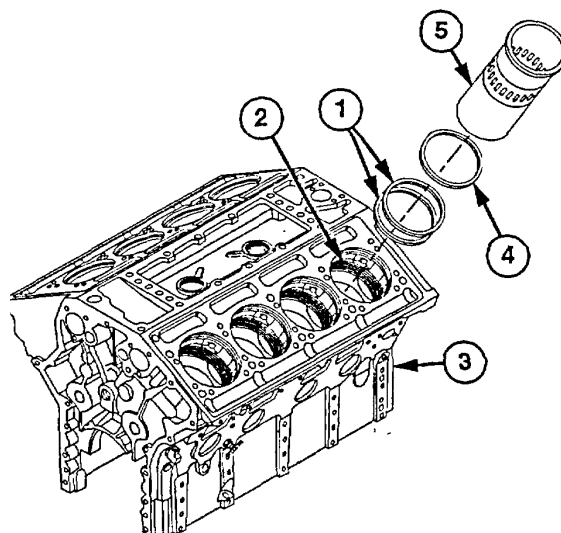
(41) Install two dowels (41) in front of engine block (8) until they stick out 0.375 in. (9.53 mm).

d. Testing

- (1) Coat two new seal rings (1) with lubricating oil.
- (2) Install two new seal rings (1) in grooves (2) of each cylinder of engine block (3).
- (3) Install cylinder insert (4) into each cylinder recess.

NOTE

It may be necessary to seat liners in engine block with soft-faced mallet.

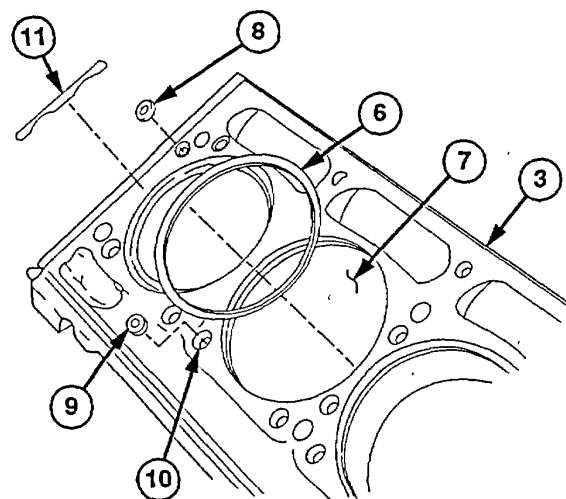


- (4) Install eight cylinder liners (5) in engine block (3).

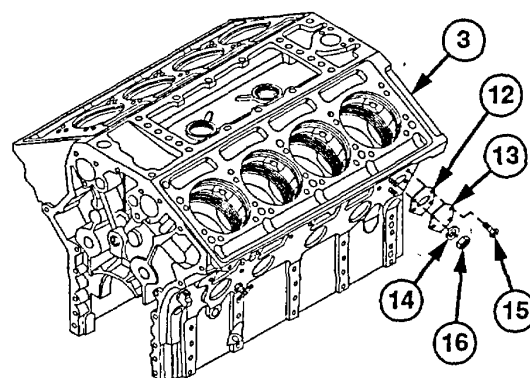
- (5) Install eight new compression gaskets (6) in cylinders (7).

- (6) Install 2 new oil hole seals (8) and 32 water hole seals (9) in 34 counterbored holes (10) in each side of engine block (3).

- (7) Install four shims (11) one at each end of cylinder head contact surface of each side of engine block (3).



- (8) Install gasket (12) and water inlet cover plate (13) on right side front of engine block (3) with two lockwashers (14), screws (15), and nuts (16).



19-4. ENGINE BLOCK REPAIR (CONT)

- (9) Install all 2 plates (17) from engine block test kit on right and left cylinder banks of engine block (3) with 20 spacers (18) and screws (19). Torque screws to 100 lb-ft (136 N•m).
- (10) Connect air line to fitting (20). Route air line from above engine block to prevent antifreeze solution from draining into hose.
- (11) Pour 1 gal (3.8 L) of antifreeze into engine block water jacket through hole for aftercooler water inlet adapter (21). Top off engine block water jacket with water.

WARNING

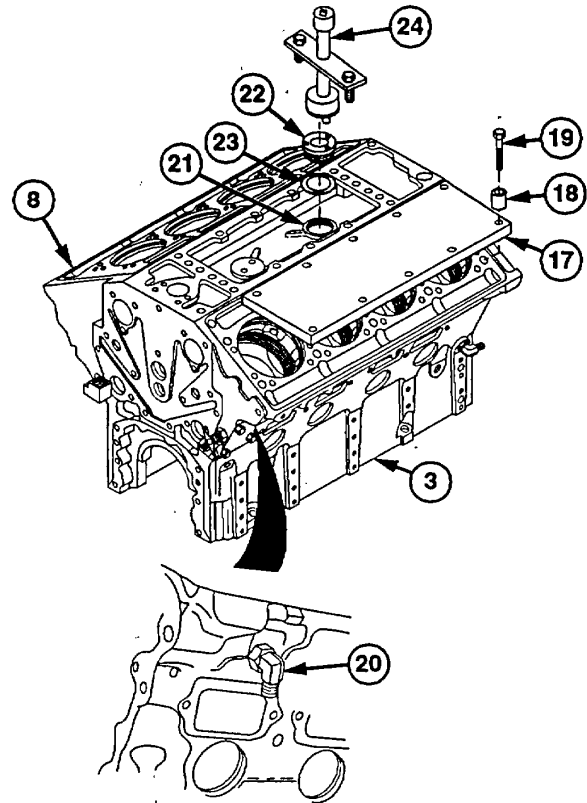
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid Injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (12) Coat threads of engine block pressure test core plug (22) with pipe thread sealing compound.
- (13) Install gasket (23) and engine block pressure test core plug (22) in hole for aftercooler water inlet adapter (21) using core plug remover/installer (24). Torque plug to 230-270 lb-ft (312-366 N•m).

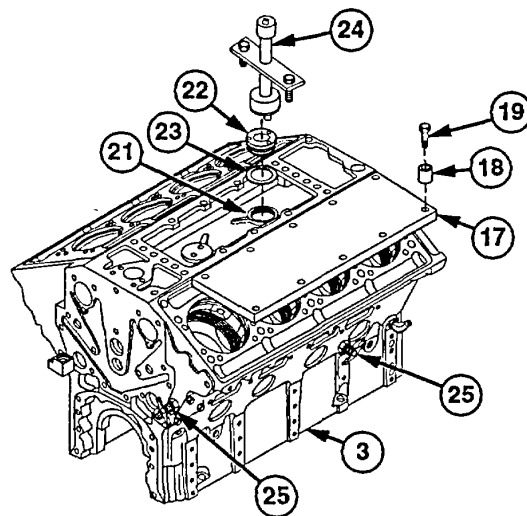
WARNING

Use care when using high air pressure. Ensure connections and seals are tight before applying pressure. High air pressure can blow out parts, hoses, or debris with force. Explosive force may cause Injury and damage equipment. Personal protective equipment will be used (goggles/shield, gloves, etc.).

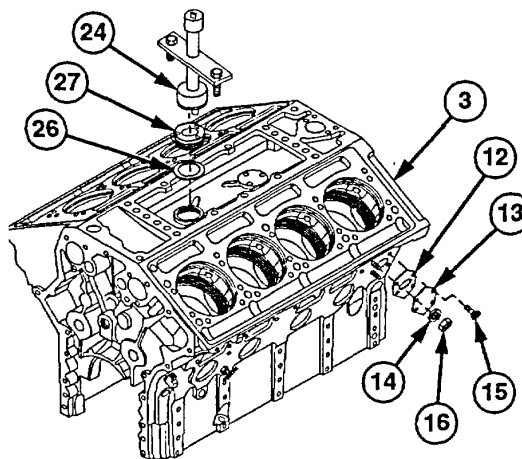
- (14) Apply 40 psi (276 kPa) pressure to engine block (3). Maintain pressure for at least 2 hours.
- (15) After test period, inspect engine block (3) for leaking antifreeze. If leaks are found in engine block (3), replace engine block.
- (16) Loosen air line from fitting (20) to allow air pressure to escape.
- (17) Remove air line from fitting (20).



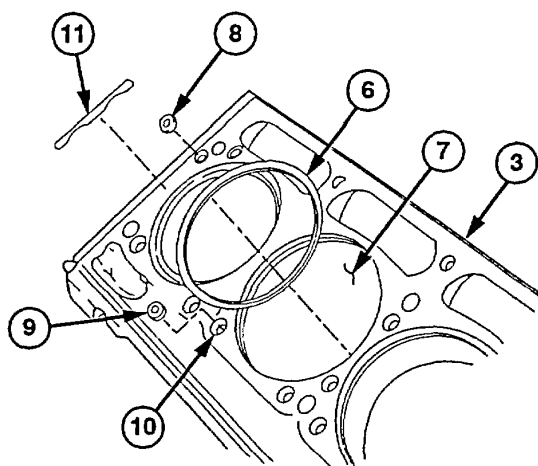
- (18) Open drain cocks (25) and drain antifreeze and water from engine block (3).
- (19) Remove 20 screws (19), spacers (18), and 2 plates (17) from engine block (3).
- (20) Remove engine block pressure test core plug (22) and gasket (23) from aftercooler water inlet adapter (21) using core plug remover/installer (24). Discard gasket.



- (21) Install new gasket (26) and aftercooler water inlet adapter (27) on engine block (3) using aftercooler water inlet adapter installer (24). Torque to 230-250 lb-ft (312-339 N•m).
- (22) Remove two screws (15), nuts (16), lockwashers (14), water inlet cover plate (13) and gasket (12) from right side of engine block (3). Discard lockwashers and gasket.



- (23) Remove eight compression gaskets (6) from cylinders (7). Discard gaskets.
- (24) Remove 4 shims (11), 2 oil hole seals (8) and 32 water hole seals (9) from 34 counterbored holes (10) on each side of engine block (3).

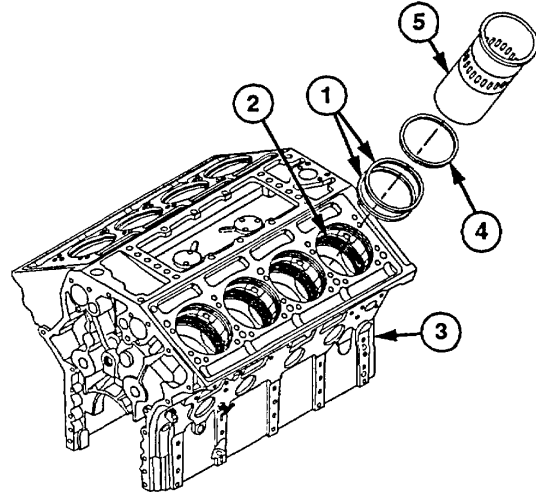


19-4. ENGINE BLOCK REPAIR (CONT)

- (25) Remove eight cylinder liners (5) from engine block (3).
- (26) Coat cylinder liners (5) with lubricating oil.
- (27) Remove cylinder liner inserts (4) from each cylinder recess.
- (28) Remove two seal rings (1) from grooves (2) of each cylinder of engine block (3).

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).



- (29) Dry engine block (3) with compressed air.
- (30) Coat engine block (3) machined surfaces with lubricating oil to prevent rust.
- (31) Install adapter plate (28) on engine block (3) with 13 screws (29) with aid of assistant.

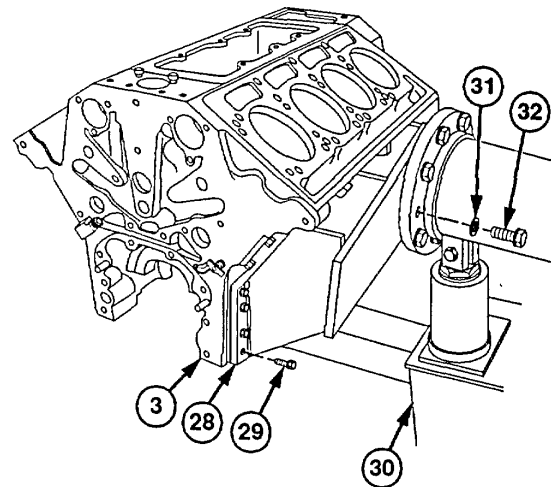
WARNING

Engine assembly weighs 2605 lb (1183 kg). Stay clear of engine assembly when it is supported by lifting device. If engine falls, serious injury or death may result.

- (32) Install suitable lifting device on engine block (3).

WARNING

Stand clear of engine when supported by lifting device. Engine may fall and cause serious injury to personnel.



- (33) Mount engine block (3) and adapter plate (28) on engine stand (30) with six washers (31) and screws (32). Torque to 147 lb-ft (199 N m).
- (34) Remove lifting device from engine block (3).

e. Follow-On Maintenance

- (1) Install main bearings and crankshaft (para 19-8).
- (2) Install pistons, connecting rods, and liners (para 19-10).
- (3) Install front end plate (para 19-5).
- (4) Install rear end plate (para 19-6).
- (5) Install idler gear (para 19-13).
- (6) Install camshafts and end bearings (para 19-12).
- (7) Install blower drive support (para 4-8).
- (8) Install flywheel housing (para 19-9).
- (9) Install flexplate assembly (para 3-17).
- (10) Install engine block breather tube (para 3-6).
- (11) Install crankshaft cover, front oil seal, and oil pump (para 19-14).
- (12) Install oil pressure relief valve (para 3-21).
- (13) Install oil pressure regulator valve (para 3-22).
- (14) Install oil pan (para 3-20).
- (15) Install cylinder heads (para 3-10).
- (16) Install SRSITRS sensor (para 3-7).
- (17) Install injectors (para 4-2).
- (18) Install rocker arms (para 3-18).
- (19) Install engine brake retarders (para 3-26).
- (20) Install engine brake retarder wire harnesses (para 6-16).
- (21) Install aftercooler (para 5-7).
- (22) Install blower (para 4-6).
- (23) Install tachometer drive gear (para 3-25).
- (24) Install blower accessory drive hub (para 4-9).
- (25) Install fuel supply pump (para 4-4).
- (26) Install air inlet adapter (para 4-5).
- (27) Install turbocharger (para 4-11).
- (28) Install crankshaft vibration damper (para 3-14).
- (29) Install crankshaft pulley (para 3-12).
- (30) Install water pump drive gear (para 3-24).
- (31) Install vibration damper and front cover (para 3-15).
- (32) Install water pump (para 5-5).
- (33) Install secondary fuel filter head (para 4-13).
- (34) Install right thermostat housing (para 5-4).
- (35) Install left thermostat housing (para 5-3).
- (36) Install oil cooler and housing (para 3-19).
- (37) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).

19-4. ENGINE BLOCK REPAIR (CONT)**e. Follow-On Maintenance (Cont)**

- (38) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (39) Install fuel injector wire harnesses (para 4-3).
- (40) Install rocker covers (TM 9-2320-360-20).
- (41) Install DDEC oil temperature sensor (TM 9-2320-360-20).
- (42) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (43) Install thermostats (TM 9-2320-360-20).
- (44) Install electronic control module (ECM) (TM 9-2320-360-20).
- (45) Install fan clutch (TM 9-2320-360-20).
- (46) Install fan belts (TM 9-2320-360-20).
- (47) Install fan (TM 9-2320-360-20).
- (48) Remove engine from engine stand (para 19-3).
- (49) Install air box covers (para 3-8).
- (50) Install air box drains (para 3-9).
- (51) Install exhaust manifolds (para 3-23).
- (52) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (53) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (54) Install starter (TM 9-2320-360-20).
- (55) Install sending units and attachments (TM 9-2320-360-20).

19-5. FRONT END PLATE REPAIR

This task covers

- a. Removal
- b. Installation
- c. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 Electronic control module (ECM) removed (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Fuel injector wire harnesses removed (para 4-3).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Secondary fuel filter head removed (para 4-13).
 Water pump removed (para 5-5).
 Vibration damper and front cover removed (para 3-15).

Equipment Conditions (Cont)

Water pump drive gear removed (para 3-24).
 Blower accessory drive hub removed (para 4-9).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 SRS/TRS sensor removed (para 3-7).
 Cylinder heads removed (para 3-10).
 Oil pan removed (para 3-20).
 Flexplate assembly removed (para 3-17).
 Flywheel housing removed (para 19-9).
 Camshafts and end bearings removed (para 19-12).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Grease, Automotive and Artillery (Item 32, Appendix B)
 Gasket (Item 42, Appendix F)
 Gasket (Item 52, Appendix F)
 Lockwashers (2) (Item 122, Appendix F)

19-5. FRONT END PLATE REPAIR (CONT)**a. Removal**

- (1) Remove five screws (1) from front end plate (2).
- (2) Remove two screws (3), and lockwashers (4), and front end plate (2) from engine block (5). Discard lockwashers.
- (3) Remove gasket (6) and gasket (7) from engine block (5). Discard gaskets.

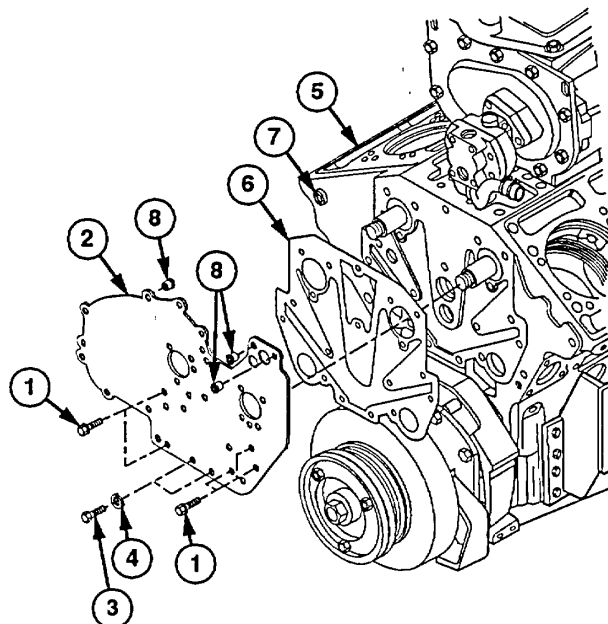
CAUTION

Support front end plate on flat, even surface when removing screw inserts to prevent warping or bending end plate.

NOTE

Do step (4) only if screw inserts are stripped.

- (4) Remove three screw inserts (8) from front end plate (2).

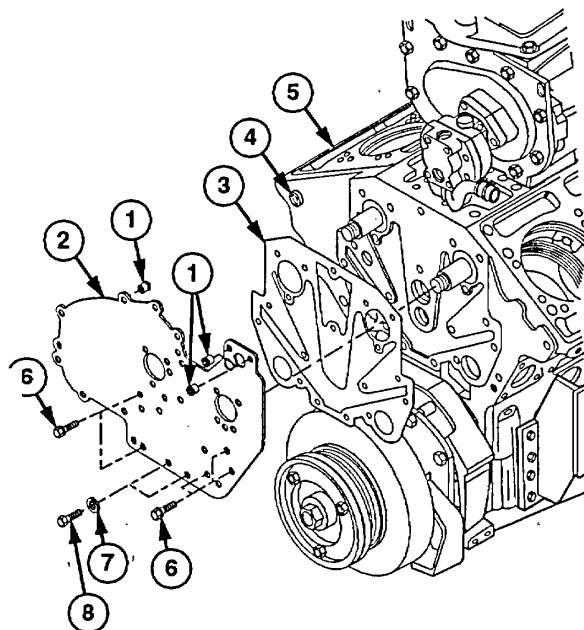
**b. Installation****CAUTION**

Support front end plate on flat, even surface when installing screw inserts to prevent warping or bending end plate.

NOTE

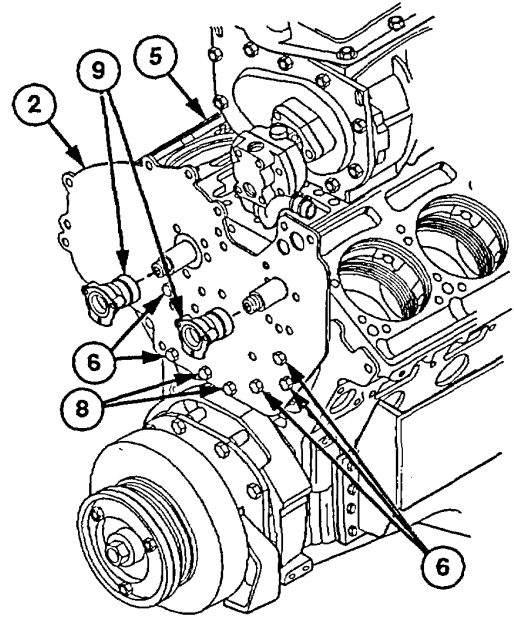
Do step (1) only if screw inserts were removed.

- (1) Install three screw inserts (1) in front end plate (2).
- (2) Coat new end plate gasket (3) with grease.
- (3) Install new gasket (3) and new gasket (4) on engine block (5).
- (4) Position front end plate (2) on engine block (5) with five screws (6). Do not tighten.
- (5) Position two new lockwashers (7) and screws (8) in front end plate (2). Do not tighten.



NOTE

- Camshaft end bearings are temporarily installed to align front plate.
- Holes in front end plate for camshaft end bearings are not the same size. Smaller hole is accurately machined for alignment purposes and is always located on right side of engine as viewed from the rear.



- (6) Install two camshaft end bearings (9) into front end plate (2) and engine block (5).
- (7) Tighten five screws (6) to 31-35 lb-ft (41-47 N•m).
- (8) Tighten two screws (8) to 71-75 lb-ft (96-102 N•m).
- (9) Remove two end bearings (9) from front end plate (2) and engine block (5).

c. Follow-On Maintenance

- (1) Install camshafts and end bearings (para 19-12).
- (2) Install flywheel housing (para 19-9).
- (3) Install flexplate assembly (para 3-17).
- (4) Install oil pan (para 3-20).
- (5) Install cylinder heads (para 3-10).
- (6) Install SRS/TRS sensor (para 3-7).
- (7) Install injectors (para 4-2).
- (8) Install rocker arms (para 3-18).
- (9) Install engine brake retarders (para 3-26).
- (10) Install engine brake retarder wire harnesses (para 6-16).
- (11) Install blower accessory drive hub (para 4-9).
- (12) Install water pump drive gear (para 3-24).
- (13) Install vibration damper and front cover (para 3-15).
- (14) Install water pump (para 5-5).
- (15) Install secondary fuel filter head (para 4-13).
- (16) Install right thermostat housing (para 5-4).
- (17) Install left thermostat housing (para 5-3).

19-5. FRONT END PLATE REPAIR (CONT)**c. Follow-On Maintenance (Cont)**

- (18) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).
- (19) Install 12-volt (rear) alternator (TM 9-2320-360-20).
- (20) Install fuel injector wire harnesses (para 4-3).
- (21) Install rocker covers (TM 9-2320-360-20).
- (22) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (23) Install thermostats (TM 9-2320-360-20).
- (24) Install electronic control module (ECM) (TM 9-2320-360-20).
- (25) Install fan clutch (TM 9-2320-360-20).
- (26) Install fan belts (TM 9-2320-360-20).
- (27) Install fan (TM 9-2320-360-20).
- (28) Remove engine from engine stand (para 19-3).
- (29) Install air box covers (para 3-8).
- (30) Install air box drains (para 3-9).
- (31) Install exhaust manifolds (para 3-23).
- (32) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (33) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (34) Install starter (TM 9-2320-360-20).
- (35) Install sending units and attachments (TM 9-2320-360-20).

19-6. REAR END PLATE REPAIR

This task covers

- a. Removal
- b. Installation
- c. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 Electronic control module (ECM) removed (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Fuel injector wire harnesses removed (para 4-3).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Secondary fuel filter head removed (para 4-13).
 Water pump removed (para 5-5).
 Vibration damper and front cover removed (para 3-15).
 Water pump drive gear removed (para 3-24).

Equipment Conditions (Cont)

Turbocharger removed (para 4-11).
 Air inlet adapter removed (para 4-5).
 Blower accessory drive hub removed (para 4-9).
 Blower removed (para 4-6).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 Cylinder heads removed (para 3-10).
 Oil pan removed (para 3-20).
 Flexplate assembly removed (para 3-17).
 Flywheel housing removed (para 19-9).
 Blower drive support removed (para 4-8).
 Camshafts and end bearings removed (para 19-12).
 Idler gear removed (para 19-13).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

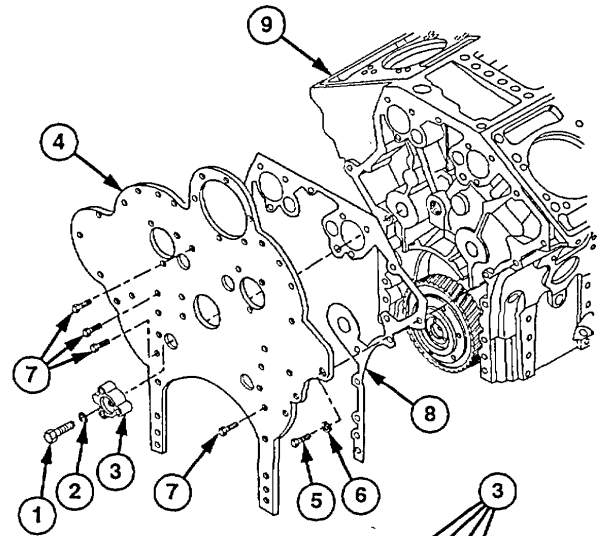
Materials/Parts

Grease, Automotive and Artillery (item 32, Appendix B)
 Gasket (Item 50, Appendix F)
 Lockwashers (2) (Item 106, Appendix F)

19-6. REAR END PLATE REPAIR (CONT)**a. Removal****NOTE**

Note position of special washer before removing from rear end plate.

- (1) Remove screw (1), special washer (2), and dummy hub (3) from rear end plate (4).
- (2) Remove screw (5) and lockwasher (6) from rear-end Slate (4). Discard lockwasher.
- (3) Remove four screws (7), end plate (4) and gasket (8) from engine block (9). Discard gasket.

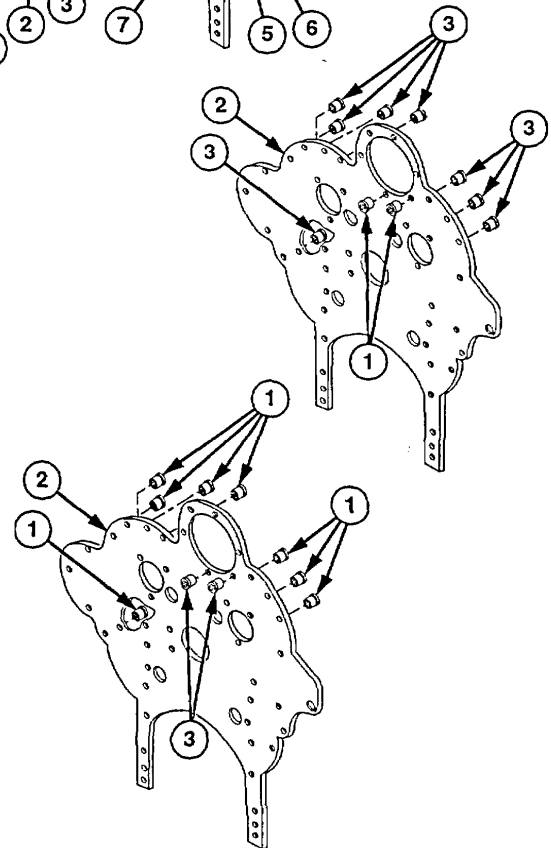
**b. Disassembly****CAUTION**

Support rear end plate on flat even surface when removing screw inserts to prevent warping or bending of end plate.

NOTE

Do steps (1) and (2) only if screw inserts are stripped.

- (1) Remove two screw inserts (1) from rear end plate (2).
- (2) Remove eight screw inserts (3) from rear end plate (2).

**c. Assembly****CAUTION**

Support rear end plate on flat even surface when installing screw inserts to prevent warping or bending end plate.

NOTE

Do steps (1) and (2) only if screw inserts were removed.

- (1) Press eight screw inserts (1) into back of rear end plate (2).
- (2) Press two screw inserts (3) into front of rear end plate (2).

d. Installation

- (1) Coat new gasket (1) with grease and Install over dowels (2) onto engine block (3).
- (2) Install rear end plate (4) on dowels (2).
- (3) Position four screws (5) on rear end plate (4). Do not tighten.
- (4) Position new lockwasher (6) and screw (7) on rear end plate (4). Do not tighten.

NOTE

Special washer is installed in same position as noted during removal.

- (5) Install special washer (8) on screw (9) with grooved side facing head of screw (9).

NOTE

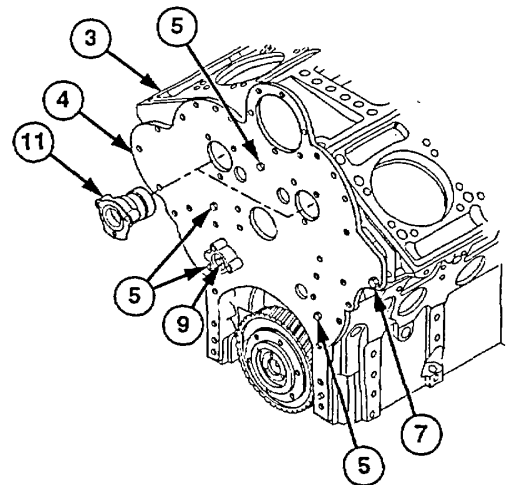
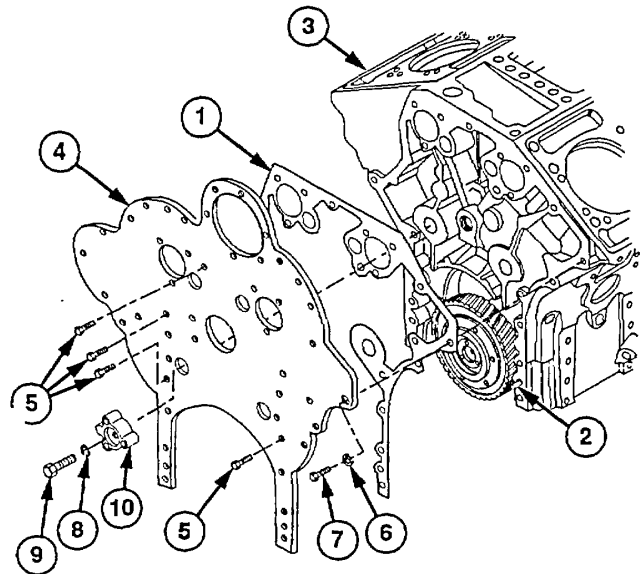
Align dowel in dummy hub with hole in rear end plate.

- (6) Install dummy hub (10), special washer (8), and screw (9) on rear end plate (4).

NOTE

- Camshaft end bearings are temporarily installed to align rear end plate.
- Holes in front and rear end plates for camshaft end bearings are not the same size. Smaller hole is accurately machined for alignment purposes and is always located on right side of engine as viewed from the rear.

- (7) Install two camshaft end bearings (11) in rear end plate (4) and engine block (3).
- (8) Tighten four screws (5) to 31-35 lb-f (41-47 N•m).
- (9) Tighten screw (7) to 103-110 lb-ft (140-149 N•m).
- (10) Tighten screw (9) to 90 lb-ft (122 N•m).
- (11) Remove two end bearings (11) from rear end plate (4) and engine block (3).

**e. Follow-On Maintenance**

- (1) Install Idler gear (para 19-13).
- (2) Install camshafts and end bearings (para 19-12).
- (3) Install blower drive support (para 4-8).

19-6. REAR END PLATE REPAIR (CONT)**e. Follow-On Maintenance (Cont)**

- (4) Install flywheel housing (para 19-9).
- (5) Install flexplate assembly (para 3-17).
- (6) Install oil pan (para 3-20).
- (7) Install cylinder heads (para 3-10).
- (8) Install injectors (para 4-2).
- (9) Install rocker arms (para 3-18).
- (10) Install engine brake retarders (para 3-26).
- (11) Install engine brake retarder wire harnesses (para 6-16).
- (12) Install blower (para 4-6).
- (13) Install blower accessory drive hub (para 4-9).
- (14) Install air inlet adapter (para 4-5).
- (15) Install turbocharger (para 4-11).
- (16) Install water pump drive gear (para 3-24).
- (17) Install vibration damper and front cover (para 3-15).
- (18) Install water pump (para 5-5).
- (19) Install secondary fuel filter head (para 4-13).
- (20) Install right thermostat housing (para 5-4).
- (21) Install left thermostat housing (para 5-3).
- (22) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).
- (23) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (24) Install fuel injector wire harnesses (para 4-3).
- (25) Install rocker covers (TM 9-2320-360-20).
- (26) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (27) Install thermostats (TM 9-2320-360-20).
- (28) Install electronic control module (ECM) (TM 9-2320-360-20).
- (29) Install fan clutch (TM 9-2320-360-20).
- (30) Install fan belts (TM 9-2320-360-20).
- (31) Install fan (TM 9-2320-360-20).
- (32) Remove engine from engine stand (para 19-3).
- (33) Install air box covers (para 3-8).
- (34) Install air box drains (para 3-9).
- (35) Install exhaust manifolds (para 3-23).
- (36) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (37) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (38) Install starter (TM 9-2320-360-20).
- (39) Install sending units and attachments (TM 9-2320-360-20).

19-7. CYLINDER HEAD REPAIR

This task covers:

- a. Disassembly
- b. Cleaning
- c. Pressure Testing
- d. Inspection
- e. Assembly
- f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Cylinder head on clean work surface.
Cam followers and push rods removed
(para 19-11).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Blocks, Wooden (Figure C-3, Appendix C)
Caliper Set, Micrometer (Item 15, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Compressor, Valve Spring (Item 25, Appendix E)
Extractor Set, Screw (Item 38, Appendix E)
Fixture, Test, Head (Item 44, Appendix E)
Gage, Depth, Micrometer (Item 48, Appendix E)
Gage Set, Telescoping (Item 56, Appendix E)
Grinding Kit, Valve Seat, Electric (Item 58, Appendix E)
Grinding Machine, Valve Face (Item 59, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Indicator, Dial (Item 73, Appendix E)
Installer, Bridge Guide (Item 76, Appendix E)
Installer, Valve Guide (Item 85, Appendix E)
Installer, Valve Seat Insert (Item 86, Appendix E)
Installer, Water Nozzle (Item 87, Appendix E)
Puller Assembly, Valve Seat (Item 121, Appendix E)
Reconditioning Set (Item 127, Appendix E) -
Remover Set, Valve Bridge Guide (Item 139, Appendix E)

Tools and Special Tools (Cont)

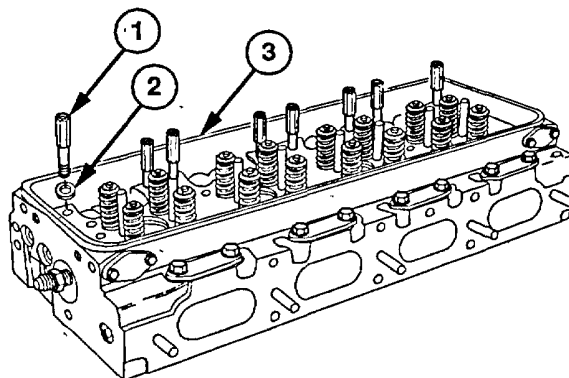
Remover, Broken Bridge Guide (Item 131, Appendix E)
Remover, Valve Guide (Item 143, Appendix E)
Socket, Deep Well, 9/16 in. (Item 164, Appendix E)
Tester, Spring (Item 190, Appendix E)
Threading Set, Screw (Item 193, Appendix E)
Wire Brush, Brass (Item 211, Appendix E)
Wrench, Torque, 0-600 Lb-Ft (item 233, Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Adhesive-Sealant (Item 9, Appendix B)
Chips, Soap (Item 15, Appendix B)
Compound, Sealing, Pipe Thread (Item 28, Appendix B)
Dye, Prussian Blue (Item 30, Appendix B)
Oil, Lubricating (Item 45, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)
Tape, Masking (Item 58, Appendix B)
Cap, Valve Spring (32) (Item 6, Appendix F)
Gaskets (8) (Item 14, Appendix F)
Gaskets (2) (Item 45, Appendix F)
Packing, Assortment (Item 156, Appendix F)
Seals, Valve Guide (32) (Item 320, Appendix F)
Washers, Pressure (8) (Item 337, Appendix F)

a. Disassembly

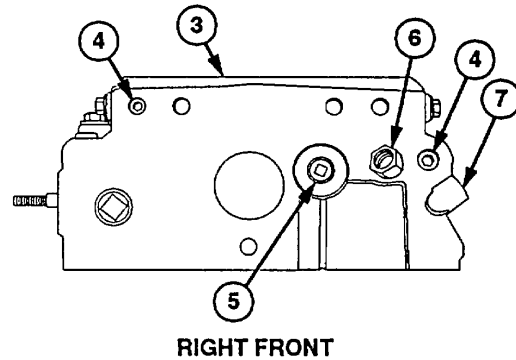
- (1) Remove eight connectors (1) and pressure washers (2) from cylinder head (3). Discard pressure washers.



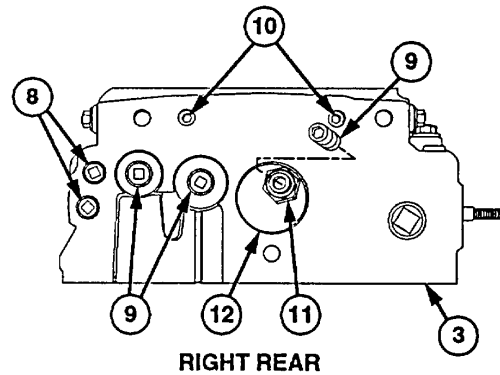
19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

- It may be necessary to drill plugs and remove with an easy out.
- Do steps (2) and (3) for right cylinder head only.
- Do steps (4) and (5) for left cylinder head only.

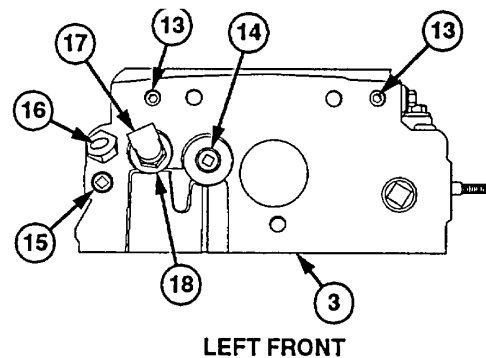
- (2) Remove two plugs (4), plug (5), elbow (6), and elbow (7) from front of cylinder head (3).



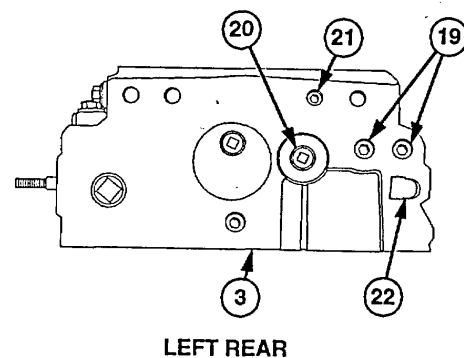
- (3) Remove two plugs (8), two plugs (9), two plugs (10), and fitting (11) from rear of cylinder head (3).
- (4) Install plug (9) in plug (12).



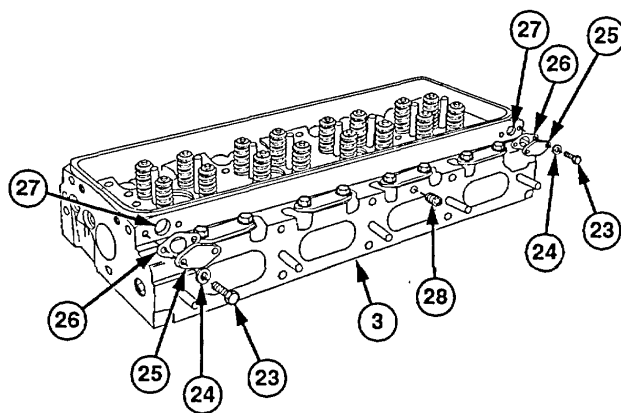
- (5) Remove two plugs (13), plug (14), plug (15), elbow (16), elbow (17), and adapter (18) from front of cylinder head (3)



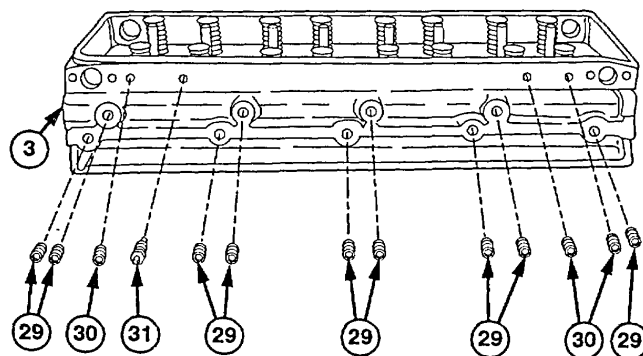
- (6) Remove two plugs (19), plug (20), plug (21), and elbow (22) from rear of cylinder head (3).



- (7) Remove four screws (23), washers (24), two cover plates (25), and two gaskets (26) from water inlet ports (27). Discard gaskets.
- (8) Remove fuse plug (28) from cylinder head (3).



- (9) Remove nine pipe plugs (29), three plugs (30), and engine brake wire harness connector (31) from cylinder head (3).



19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

Wooden block must cover all exhaust valves.

- (10) Turn cylinder head so valve springs (32) are up. Place cylinder head (3) on wooden block.
- (11) Install valve spring compressor (33) in one of rocker arm bracket screw holes (34).
- (12) Compress spring (32) and remove two valve spring locks (35). Discard valve spring locks.
- (13) Slowly release pressure on spring (32). Remove spring cap (36) and spring (32).

NOTE

Compressed air may ease removal of washers from valve guide.

- (14) Remove valve guide seal (37) and washer (38). Discard seal.
- (15) Repeat steps (11) thru (14) for each spring (32).
- (16) Remove valve spring compressor (33) from cylinder head (3).

NOTE

Secure valve stems with tape prior to rotating cylinder head to keep valves from falling out.

- (17) Slowly rotate cylinder head (3) on its side.

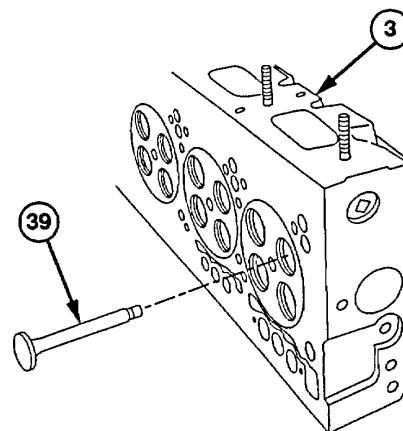
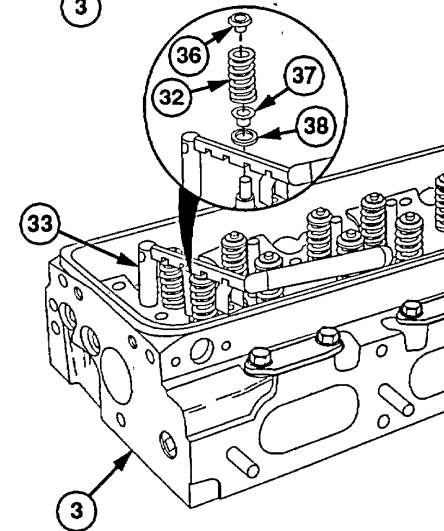
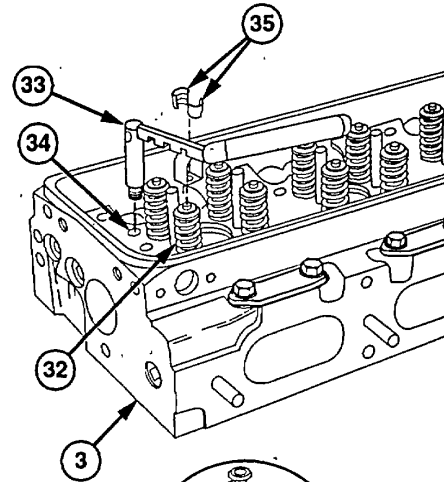
CAUTION

Valves must be installed in their original position. Failure to do so may result in poor seating and loss of engine performance.

NOTE

Tag all valves before removal.

- (18) Remove all valves (39) from cylinder head (3).



b. Cleaning

WARNING

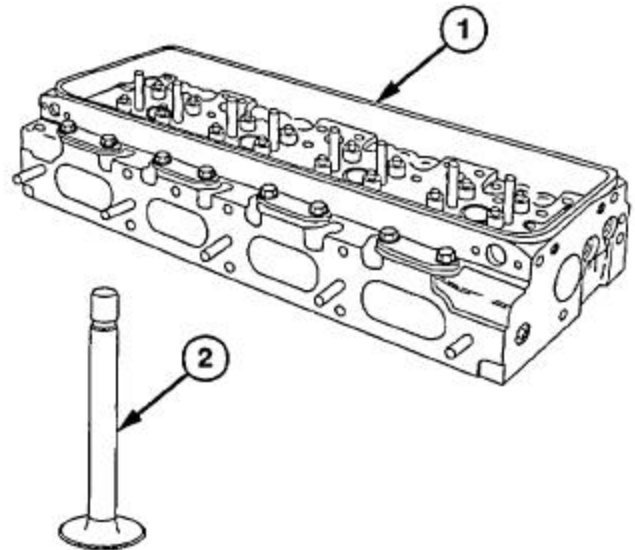
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-69°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean stripped cylinder head (1) with dry cleaning solvent.
- (2) Remove carbon from valves (2).

WARNING

Compressed air for cleaning purposes will not exceed 30 psi(207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Dry all parts with compressed air.

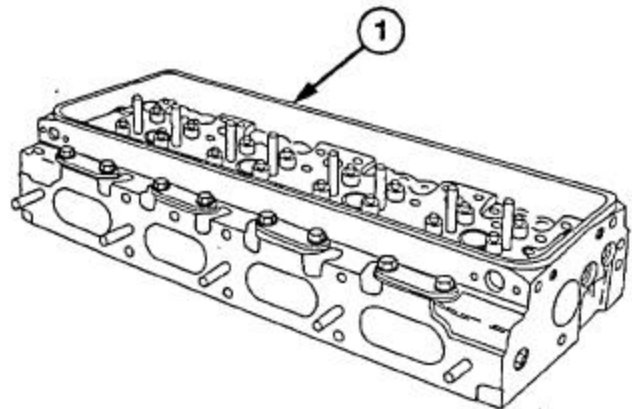


c. Pressure Testing

NOTE

Perform magnetic particle and fluorescent penetrant inspections before pressure testing to locate exterior cracks.

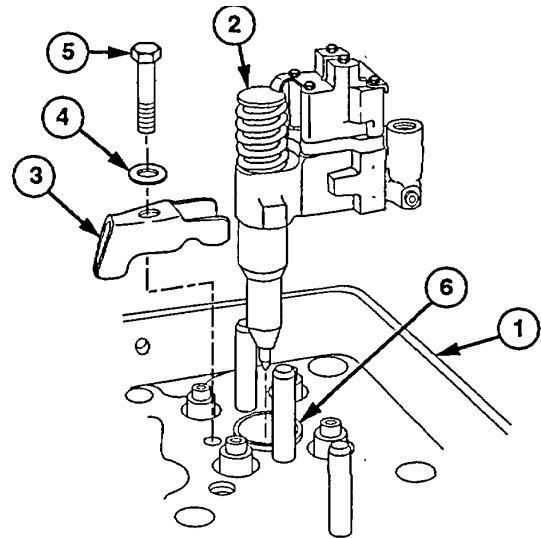
- (1) Replace cylinder head (1) if any cracks are detected.



19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

Cylinder head must be pressure tested before cylinder head repair.

- (2) Install four injectors (2), clamps (3), washers (4), and screws (5) in injector tubes (6). Torque to 240-300 lb-in. (27.1-33.9 N m).

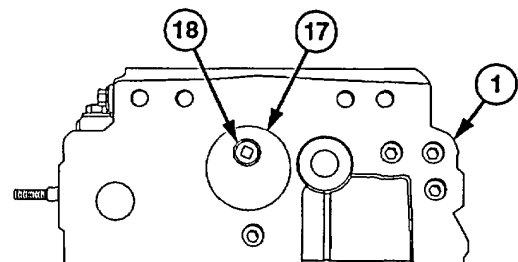
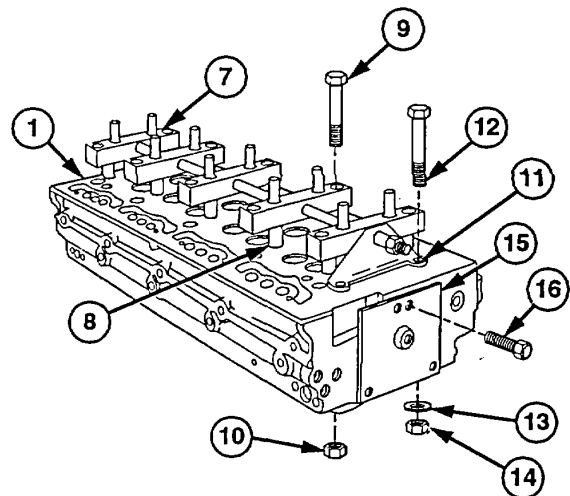


- (3) Position cylinder head (1) so bottom faces up.
 (4) Align test fixture (7) on bottom of cylinder head (1) so rubber stoppers cover water nozzles (8).

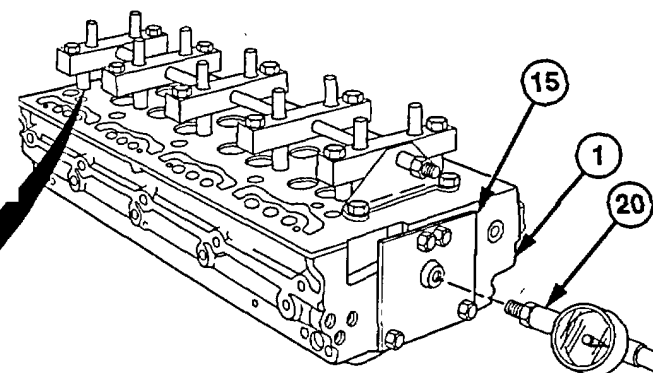
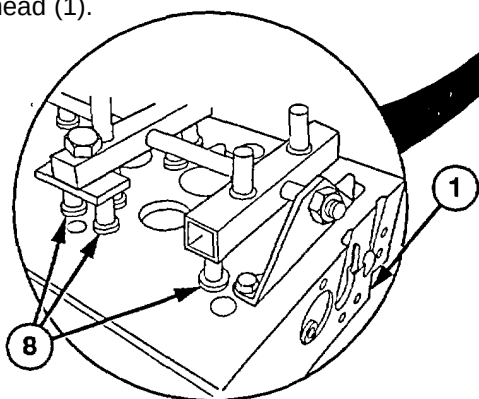
CAUTION

Do not overtighten hold-down cap screws. Rubber stopper could distort enough to seal off outer diameter of water nozzle. A leak would not be detected from outer diameter. Damage to equipment may result.

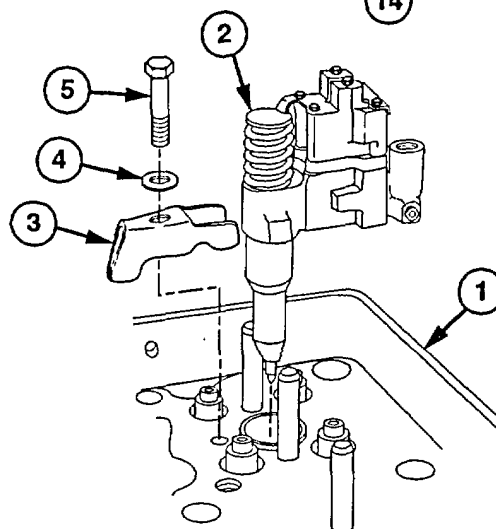
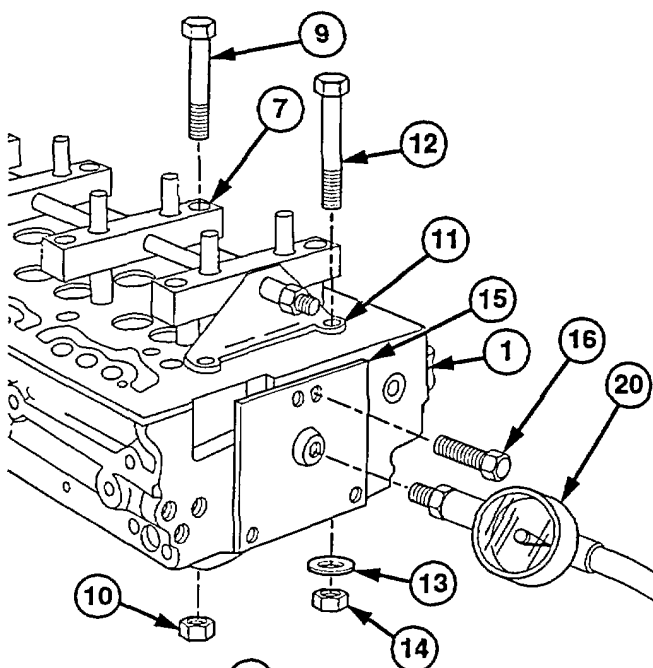
- (5) Install six screws (9) and nuts (10) on test fixture (7). Torque to 48-60 lb-in. (7-8 N m).
 (6) Install two tie down plates (11) on cylinder head (1) with four screws (12), washers (13), and nuts (14).
 (7) Install end plate (15) on thermostat end of cylinder head (1) with three screws (16).
 (8) Install rear plug (17) and pipe plug (18) in left rear of cylinder head (1).

**LEFT REAR**

- (9) Install air hose (20) on end plate (15) and apply 40 psi (276 kPa) to cylinder head (1).
- (10) Check for air leaks with soap solution around eight water nozzles (8) and bottom of cylinder head (1) with soap solution.
- (11) Check for air leaks with soap solution at top and bottom of injector tubes, oil galleys, exhaust ports, fuel manifolds, and top and bottom of cylinder head (1).



- (12) Slowly relieve air pressure and remove air supply.
- (13) Loosen air hose (20) from end plate (15) to allow air pressure to escape.
- (14) Remove air hose (20) from end plate (15).
- (15) Remove six nuts (10), screws (9), four screws (12), washers (13), nuts (14), two tie down plates (11), and test fixture (7) from cylinder head (1).
- (16) Remove three screws (16) and end plate (15) from cylinder head (1).
- (17) Remove four injectors (2), screws (5), washers (4), and clamps (3) from cylinder head (1).



WARNING

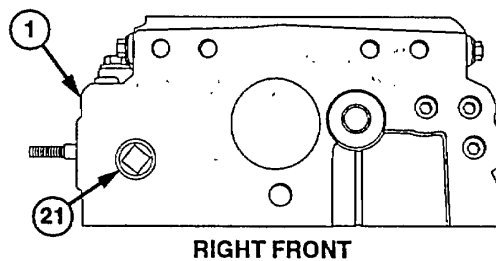
Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (18) Dry cylinder head (1) with compressed air.

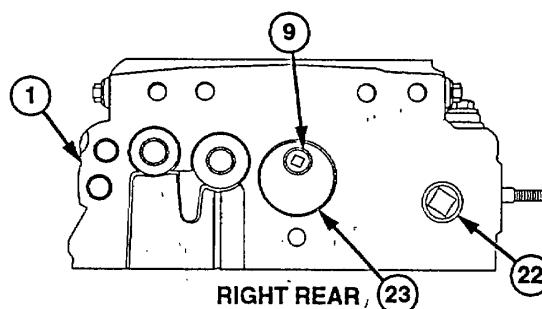
19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

- Do steps (19) and (20) for right cylinder head only.
- Do steps (21) and (22) for left cylinder head only.

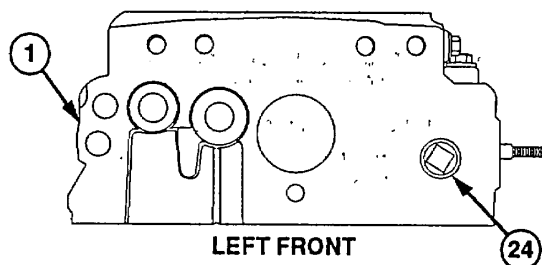
(19) Remove plug (21) from front of cylinder head (1).



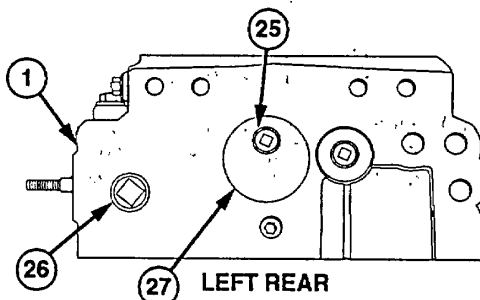
(20) Remove plug (22), plug (23), and plug (9) from rear of cylinder head (1).



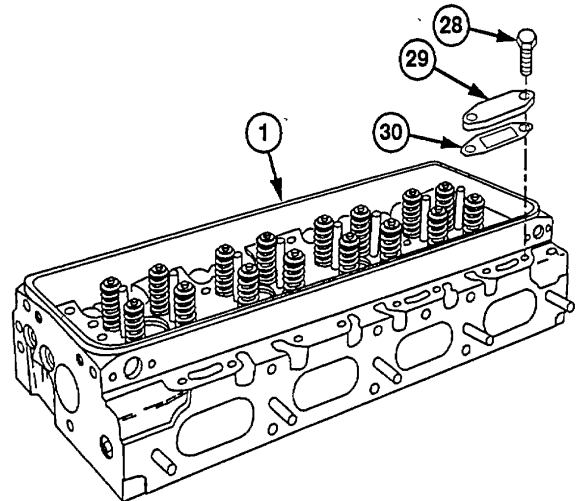
(21) Remove plug (24) from front of cylinder head (1).



(22) Remove plug (25), plug (26), and plug (27) from rear of cylinder head (1).



- (23) Remove eight screws (28), four covers (29), and gaskets (30) from top of cylinder head (1).



d. Inspection

NOTE

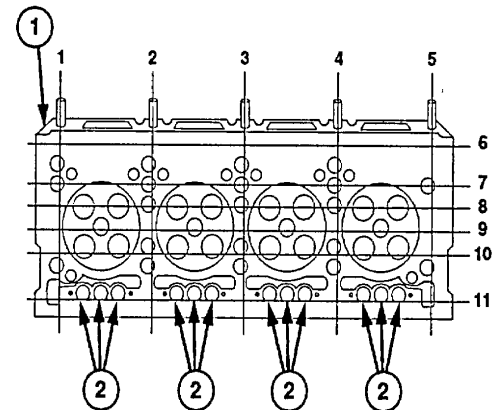
Maximum cylinder head warpage along lines 1 thru 5 is 0.004 in. (0.101 mm). Maximum warpage along lines 6 thru 11 is 0.008 in. (0.200 mm).

- (1) Inspect bottom of cylinder head (1) for warpage using straight edge and feeler gage.
- (2) Replace cylinder head (1) if warpage exceeds specifications.
- (3) Inspect cam follower bores (2) in cylinder head (1) for scoring or wear.
- (4) Clean light score marks on cam follower bores (2) using crocus cloth moistened with diesel fuel.

NOTE

Standard diameter of cam follower bore is between 1.062 in. (26.975 mm) and 1.063 (27.000 mm). Maximum bore diameter is 1.065 in. (27.051 mm).

- (5) Measure inside diameter of cam follower bores (2). Replace cylinder head (1) if any cam follower bore failed inspection.

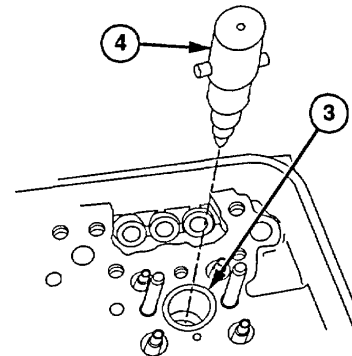


19-7. CYLINDER HEAD REPAIR (CONT)

- (6) Inspect injector tubes (3) for scoring, cracks, or damage.

NOTE

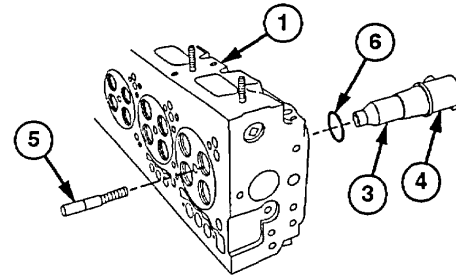
Do steps (7) thru (11) for any injector tubes that failed inspection or leaked during pressure testing.



- (7) Install injector tube installer (4) in injector tube (3).

- (8) Tap on pilot (5) to loosen injector tube (3).

- (9) Remove injector tube installer (4), injector tube (3), and pilot (5) from cylinder head (1). Discard injector tube.

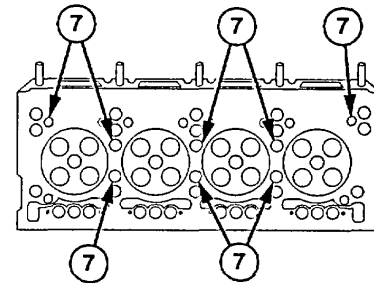


- (10) Remove and discard preformed packing (6).

- (11) Inspect eight water nozzles (7) for looseness or damage.

NOTE

Do steps (12) thru (17) for any water nozzles that failed inspection.



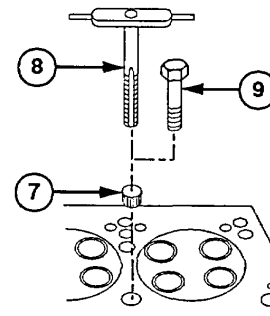
- (12) Insert tapping tool (8) into water nozzle (7).

- (13) Tap threads 0.5 in. (1.3 cm) deep in water nozzle (7).

- (14) Remove tapping tool (8).

- (15) Install screw (9) in threaded hole.

- (16) Pull on screw (9) to remove water nozzle (7).



- (17) Inspect valve guides (10) for cracks, chipping, scoring, or excessive wear.

NOTE

**Minimum inside diameter of valve guide is 0.3125 in. (7.938 mm).
Maximum inside diameter is 0.3140 in. (7.976 mm).**

- (18) Measure inside diameter of valve guides (10).

NOTE

Do steps (19) and (20) for any valve guide that failed inspection.

- (19) Support cylinder head (1) on two 3 in. (7.62 cm) high wooden blocks.

- (20) Drive valve guide (10) from bottom of cylinder head (1) using valve guide remover (11).

- (21) Inspect valve bridge guides (12) for cracks, chipping, scoring, or excessive wear.

NOTE

Do steps (22) thru (27) if valve bridge guides fail inspection.

- (22) File two notches (13) 1/16 in. (1.588 mm) deep in opposite sides of valve bridge guide (12) approximately 1-1/4 to 1-1/2 in. (31.75-38.11 mm) from top.

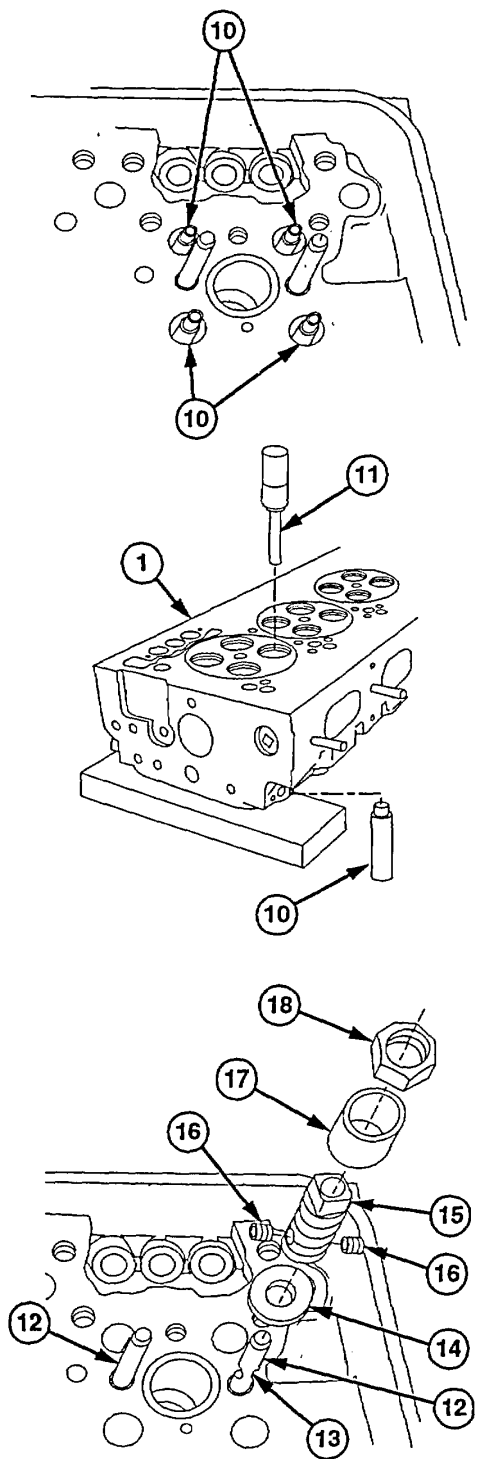
- (23) Place washer (14) over valve bridge guide (12).

- (24) Slide guide remover (15) over guide (12) and align setscrews (16) with notches (13) in guide (12).

- (25) Tighten setscrews (16).

- (26) Place spacer (17) over guide remover (15).

- (27) Thread nut (18) on guide remover (15) and turn clockwise to remove valve bridge guide (12) from cylinder head (1).



19-7. CYLINDER HEAD REPAIR (CONT)

- (28) Visually inspect valves (19) for cracks or bent valve stem.

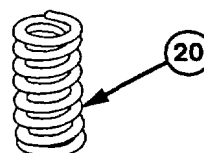
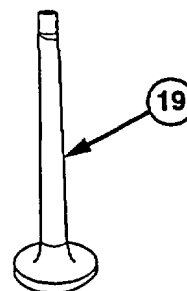
NOTE

Minimum diameter of valve stem is 0.309 in. (7.849 mm). Maximum diameter is 0.310 in. (7.874 mm).

- (29) Measure stem diameter of valves (19).
- (30) Replace any valve (19) that failed inspection.

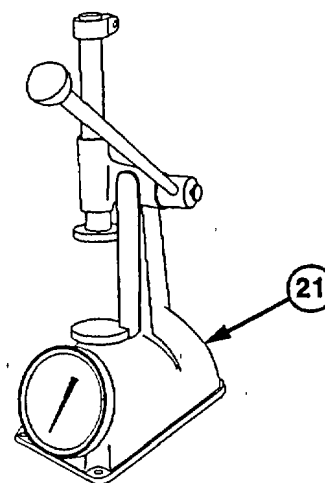
- (31) Visually inspect valves (19) for pitting or ridges on valve face. If pitting or ridges are found, valve must be refaced.

- (32) Inspect valve springs (20) for pit marks or cracks.

**NOTE**

Minimum spring load is 25 lb (11.35 kg) when spring is compressed to 1.80 in. (45.72 mm).

- (33) Test spring load of valve springs (20) using spring tester (21).
- (34) Replace valve springs (20) that fail inspection.



- (35) Inspect spring seats (22) and spring caps (23) for cracks or damage. Replace unserviceable parts.

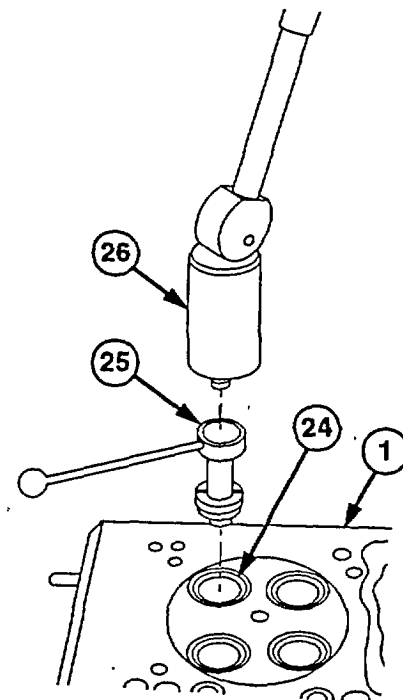


- (36) Inspect valve seat inserts (24) for excessive or uneven wear, pitting, or cracks.

NOTE

- Worn or pitted valve seat inserts that are not severely damaged may be repaired by refacing.
- Do steps (37) thru (39) to remove valve seat inserts that failed inspection and cannot be refaced.

- (37) Position collet (25) flush with bottom of valve seat insert (24).
- (38) Press handle (26) down and remove valve seat insert (24) from cylinder head (1).
- (39) Measure diameter of valve seat insert counterbore in cylinder head (1). Replace cylinder head (1) if measurement is not between 1.440 in. (36.576 mm) and 1.441 in. (36.601 mm).

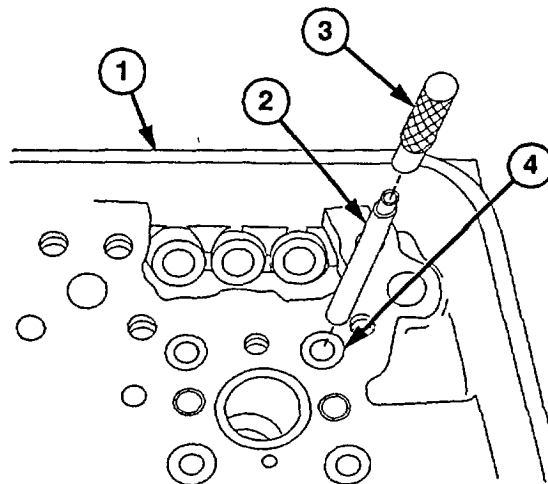


e. Assembly

NOTE

Do steps (1) thru (5) if valve guides were removed.

- (1) Place cylinder head (1) in press with top facing up.
- (2) Install internally threaded end of valve guide (2) in guide installer (3).
- (3) Position valve guide (2) squarely on guide bore (4) in cylinder head (1).
- (4) Press guide installer (3) gently to start valve guide (2) in straight.
- (5) Press valve guide (2) until guide installer (3) contacts bottom of counterbore in cylinder head (1).



19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

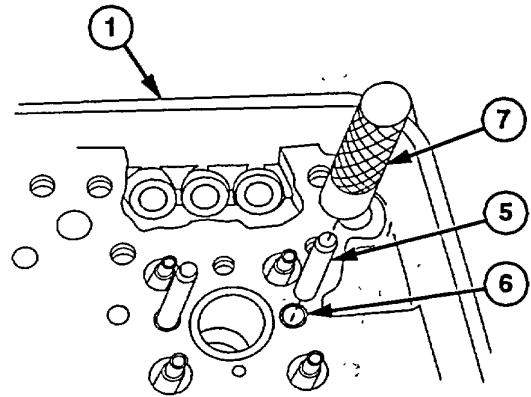
Do steps (6) thru (9) if valve bridge guides were removed.

- (6) Place cylinder head (1) in press with top facing up.

WARNING

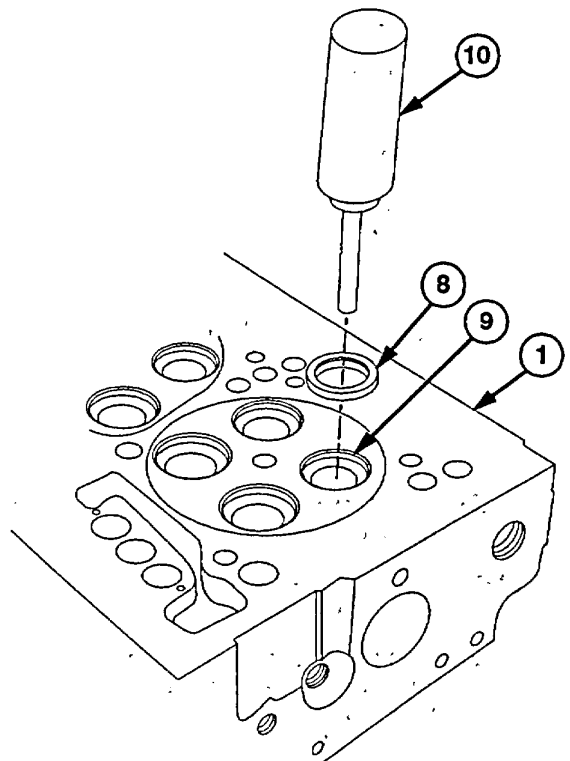
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (7) Coat undercut end of valve bridge guide (5) with adhesive-sealant.
- (8) Start undercut end of valve bridge guide (5) in bore (6) in cylinder head (1).
- (9) Position bridge guide installer (7) over valve bridge guide (5) and press guide until installer contacts cylinder head (1).

**NOTE**

Do steps (10) Thru (12) if valve seat insert was removed.

- (10) Place cylinder head (1) on wooden blocks with bottom facing up.
- (11) Place valve seat insert (8) in bore (9).
- (12) Drive valve seat insert (8) in bore (9) with valve insert installer (10) until seated in cylinder head (1).



NOTE

If new valves and valve seats are being used, do steps (20) thru (28) before continuing with step (13).

- (13) Lightly coat valve face (11) with Prussian blue dye.

NOTE

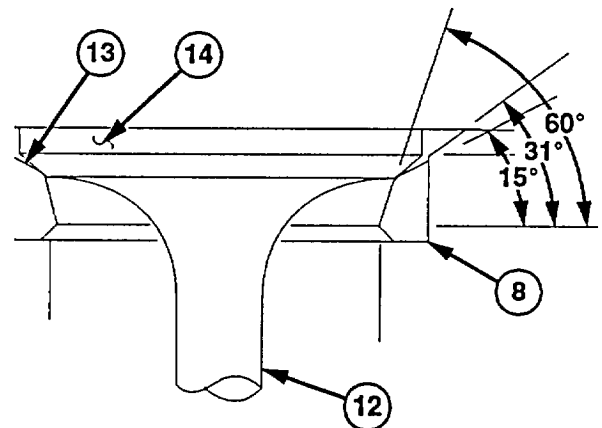
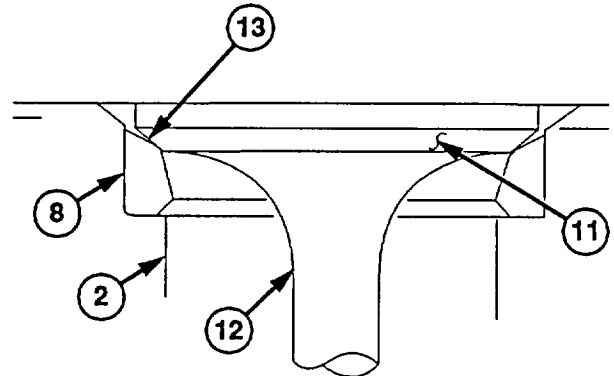
Do not rotate valve when performing steps (16) thru (19).

- (14) Lower stem of valve (12) into valve guide (2) and let valve (12) drop against valve seat insert (8).
- (15) Push up on stem of valve (12) until valve face (11) is about 1 in. (2.543 cm) above valve seat insert (8).
- (16) Release stem of valve (12) while applying downward pressure against head of valve (12) until valve face (11) makes contact with valve seat insert (8).
- (17) Repeat steps (15) and (16) several times to get good imprint in Prussian blue dye.
- (18) Remove valve (12) using care to avoid smearing Prussian dye.
- (19) Inspect contact surface (13). Imprint in Prussian blue dye should have an even seat mark all the way around the center of valve face (11).

NOTE

Do steps (20) thru (28) to reface valves and valve seat inserts if parts are new or pitted, or an uneven imprint was obtained.

- (20) Use 31 degree grinding wheel and grinder on valve seat insert (8).
- (21) Use 60 degree grinding wheel to open throat of valve seat insert (8).
- (22) Grind contact surface (13) of valve seat insert (8) with a 15 degree grinding wheel to narrow width of seat from 5/64 in. (1.984 mm) to 3/64 in. (1.91 mm).
- (23) Valve (12) must be refaced at a 30 degree angle. Valve head thickness (14) must be no less than 0.031 in. (0.79 mm).



19-7. CYLINDER HEAD REPAIR (CONT)**NOTE**

Head of valve must not protrude more than 0.006 in. (0.152 mm) above cylinder head or be recessed more than 0.023 in. (0.584 mm). If beyond limit, valve seat insert must be replaced.

- (24) Measure valve recess (15) when valve (12) is seated against valve seat insert (8).

- (25) Install gage block and dial indicator (16) in valve bore (9).

NOTE

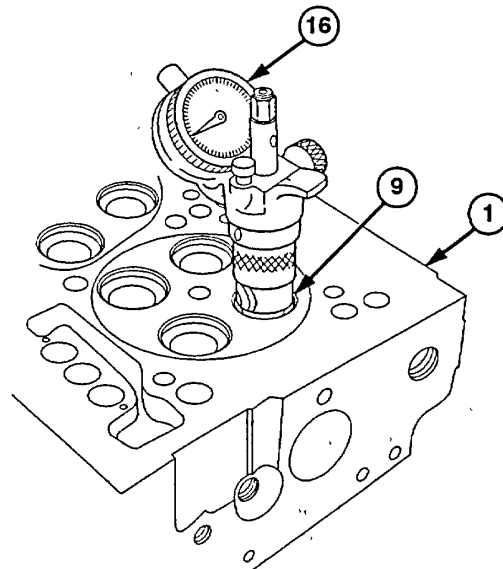
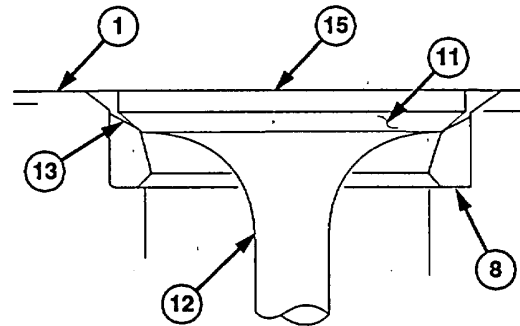
Runout must be measured to ensure valve is directly centered in valve guide. If measurement exceeds 0.002 in. (0.05 mm), check for bent valve guide before regrinding valve seat insert.

- (26) Rotate dial indicator (16) and observe runout

NOTE

Tag valves to aid in installation.

- (27) Recheck contact surface (13) between valve face (11) and valve seat insert (8) with Prussian blue dye. Do steps (13) thru (19).
- (28) Clean cylinder head (1) and valves (12) thoroughly.



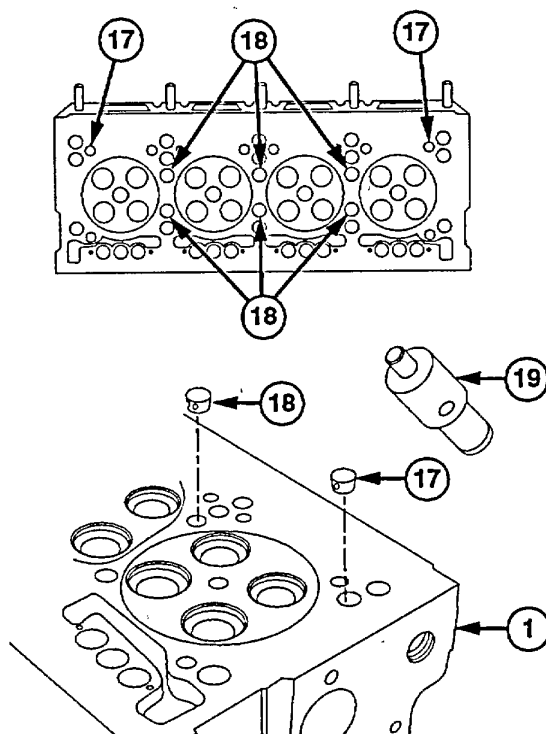
CAUTION

Water nozzles must be installed so holes are pointed toward cylinder. Failure to comply may result in improper coolant flow and engine overheating.

NOTE

- Do step (29) if water nozzles were removed.
- Ensure water nozzle fits tightly.
- Water nozzles must be flush or recessed less than 0.015 in. (0.38 mm) below cylinder head surface.
- End two water nozzles have one hole. Six water nozzles between cylinders have two holes.

- (29) Install water nozzle (17 or 18) into cylinder head (1) with nozzle holes facing in direction of arrows using water nozzle installer (19).

**NOTE**

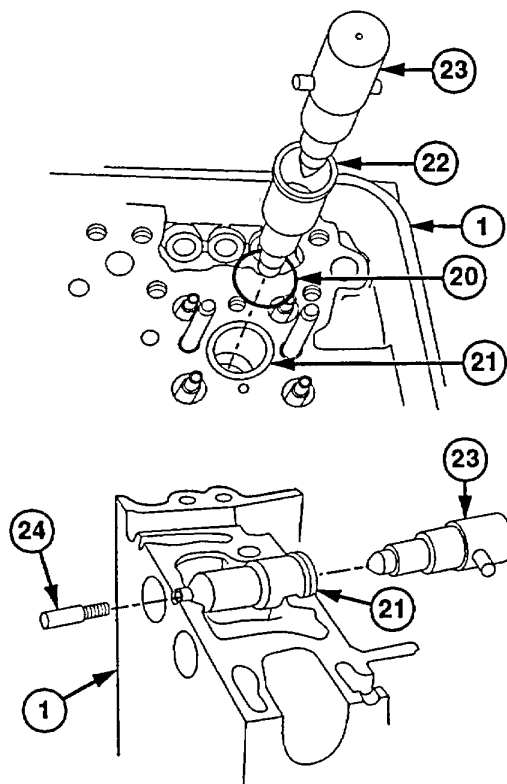
Do steps (30) thru (49) if injector tubes were removed.

- (30) Install new preformed packing (20) in counterbore (21) of cylinder head (1).
- (31) Install injector tube (22) in injector bore of cylinder head (1) using injector tube installer (23).
- (32) Install pilot (24) in bottom of injector tube installer (23).

NOTE

Tube flange at seal ring end may protrude 0.120 in. (3.048 mm) above cylinder head casting. Seal is formed when O-ring is pressed between head counterbore and outside diameter of injector tube. Tube flange is used to retain seal ring in head counterbore.

- (33) Drive injector tube (22) into bore (21) of cylinder head (1).



19-7. CYLINDER HEAD REPAIR (CONT)

- (34) Remove pilot (24) and install upsetting die (25) in injector tube Installer (23).
- (35) Tighten upsetting die (25) to 30 lb-ft (41 N•m) to flare lower end of injector tube (22).
- (36) Remove injector tube installer (23) and upsetting die (25).

NOTE

Reamer must be turned in clockwise direction only when inserting and withdrawing reamer. Movement in opposite direction will dull cutting edges.

- (37) Place few drops of lubricating oil on cutting edge of reamer (26) and carefully insert in injector tube (22).

CAUTION

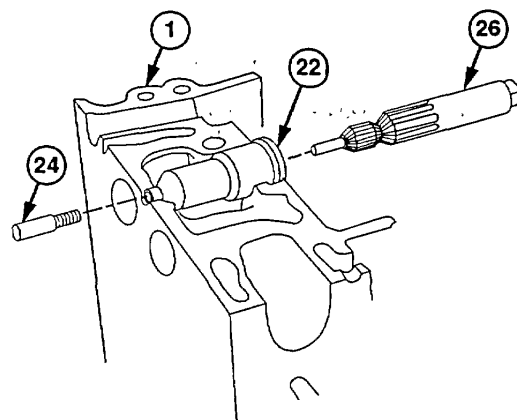
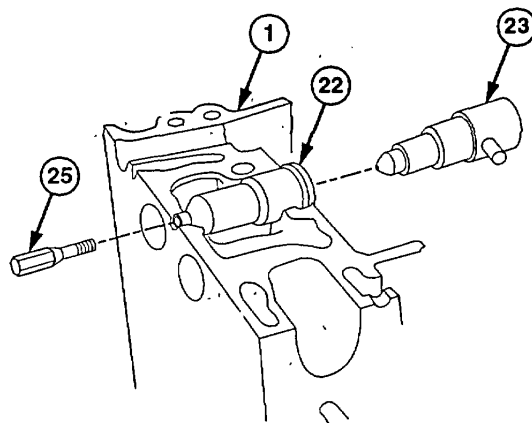
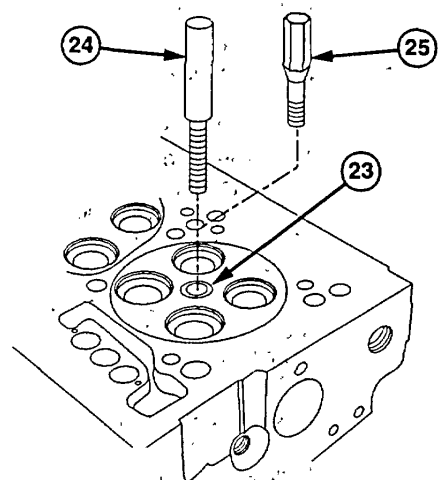
Ensure all metal chips and shavings are removed prior to each reaming operation. Failure to comply may result in damage to equipment.

- (38) Slowly turn reamer (26) clockwise, withdrawing frequently to remove chips. Continue cutting until shoulder of cutting edge on reamer (26) contacts injector tube (22).

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

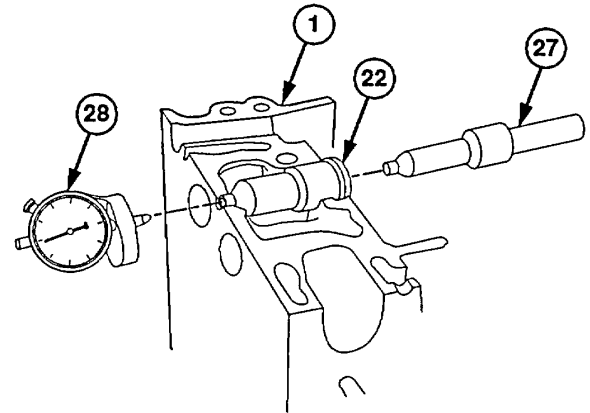
- (39) Clean out all metal chips with compressed air.
- (40) Install pilot (24) in reamer (26).
- (41) Place few drops of cutting oil on pilot (24).
- (42) Turn reamer (26) until lower end of injector tube (22) is flush with or up to 0.005 in. (0.127 mm) below finished surface on bottom of cylinder head (1).
- (43) Clean out all metal chips with compressed air.
- (44) Remove reamer (26) and pilot (24).



- (45) Install injector gage (27) in injector tube (22).
- (46) Zero sled gage dial indicator (28) on finished surface of cylinder head (1).

NOTE

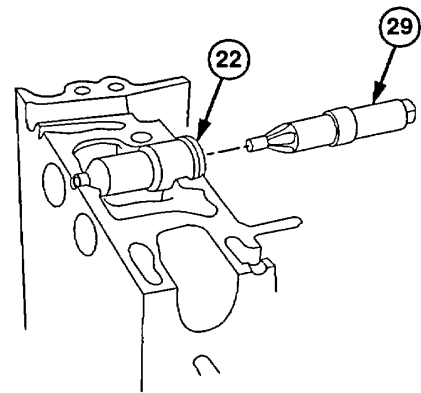
- Tip of Injector gage must be flush with or up to 0.014 in. (0.356 mm) above or below finished surface of cylinder head.
- If injector gage is more than 0.014 in. above cylinder head surface, replace injector tube.
- If injector gage is more than 0.014 in. below cylinder head surface, ream injector tube with nut reamer. Refer to step (48).



- (47) Hold Injector gage (27) in injector tube (22) and move sled gage dial Indicator (28) onto tip of injector gage (27). Note dial indicator reading and determine difference from zero reading. Remove sled gage dial indicator (28) and injector gage (27).

NOTE

- Do step (48) only if nut reaming is required.
- Remove a little metal at a time and recheck measurement when using nut reamer. Always clean out injector tube before taking a reading.



- (48) Remove excess stock from injector tube (22) using nut reamer (29).

19-7. CYLINDER HEAD REPAIR (CONT)

- (49) Install valves (12) in valve bores (9).

NOTE

- **Secure valve stems with tape prior to rotating cylinder head to keep valves from falling out.**
- **Wooden block must cover all exhaust valves.**

- (50) Place cylinder head (1) on wooden blocks with valve stems facing up.

- (51) Remove tape from valves (12).

- (52) Install washer (30), valve guide seal (31), spring (32), and spring cap (33).

- (53) Install spring compressor (34) in one of rocker shaft screw holes (35).

CAUTION

Compress spring only enough to permit installation of two-piece valve spring retainer. Compressing spring too far may result in damage to oil seal.

- (54) Apply pressure on spring compressor (34) and compress spring (32).

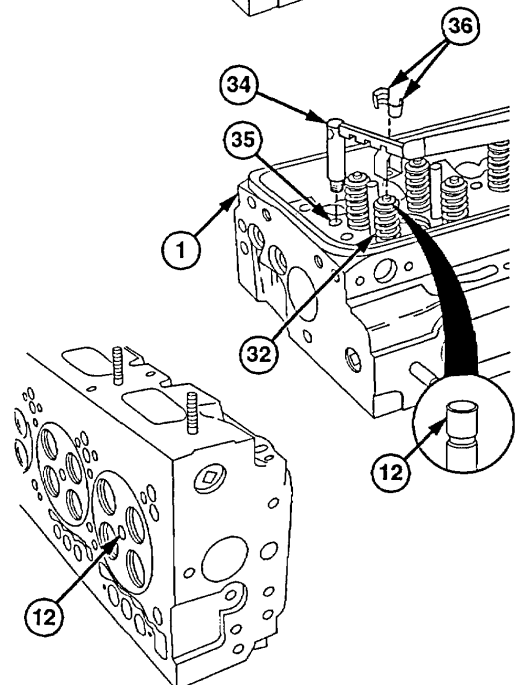
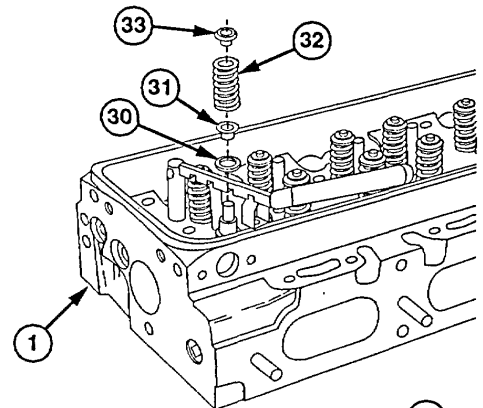
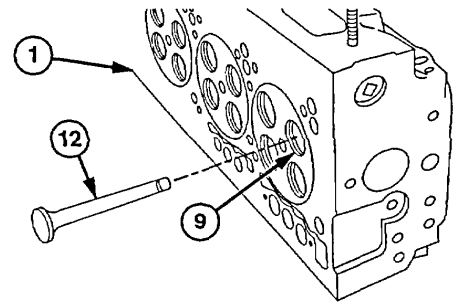
- (55) Install two valve spring locks (36) in groove at stem end of valve (12).

- (56) Slowly release pressure on spring (32), ensuring valve spring locks (36) are in place.

- (57) Remove spring compressor (34) from cylinder head (1).

- (58) Turn cylinder head (1) on its side when all valves (12) have been installed.

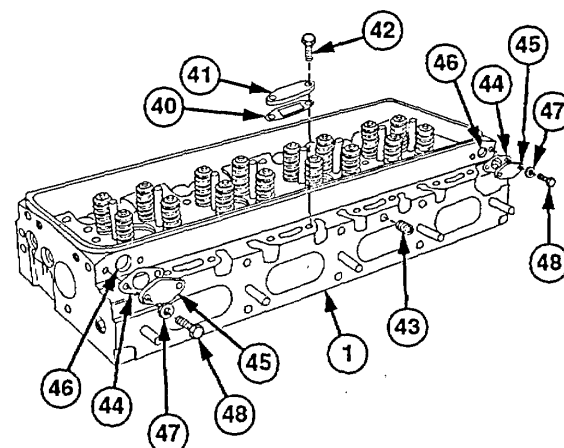
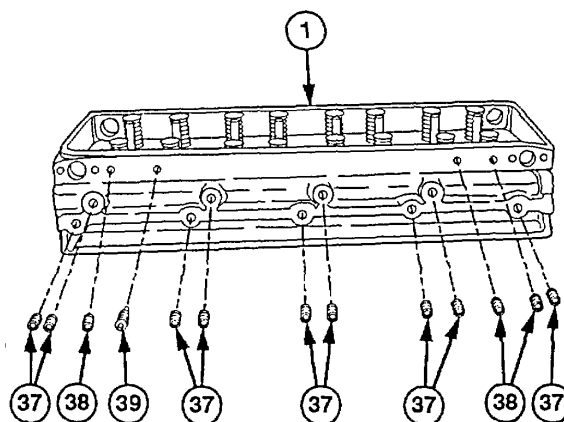
- (59) Tap stem end of each valve (12) with plastic hammer to seat valve spring locks (36).



WARNING

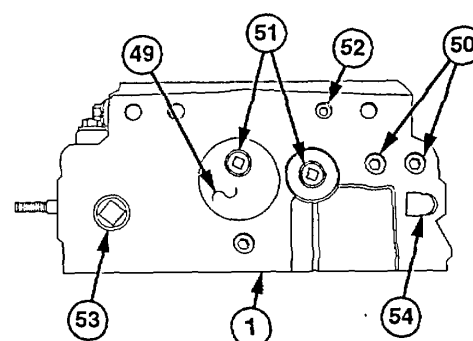
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (60) Coat threads of nine plugs (37) and three plugs (38) with pipe thread sealing compound.
- (61) Install nine pipe plugs (37) and three plugs (38) in cylinder head (1).
- (62) Install engine brake retarder wire harness connector (39) in cylinder head (1).
- (63) Install four new gaskets (40) and covers (41) on cylinder head (1) with screws (42).
- (64) Coat threads of fuse plug (43) with pipe thread sealing compound.
- (65) Install fuse plug (43) in cylinder head (1).
- (66) Install two new gaskets (44) and cover plates (45) on water inlet ports (46) with four washers (47) and screws (48).

**NOTE**

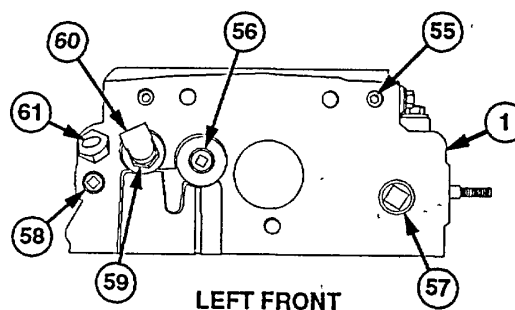
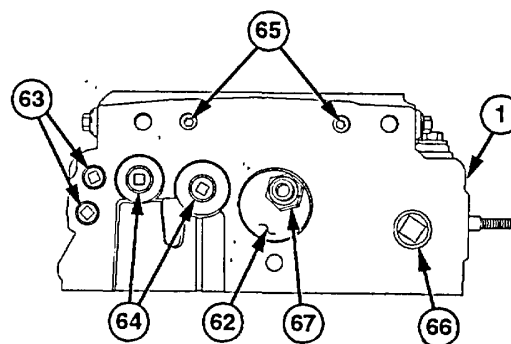
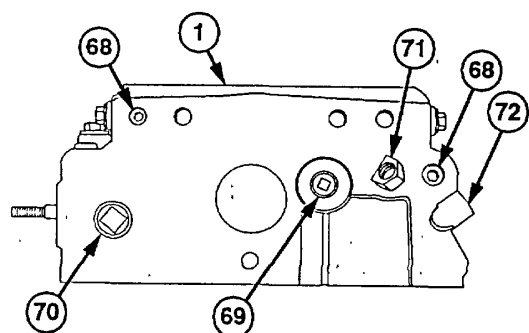
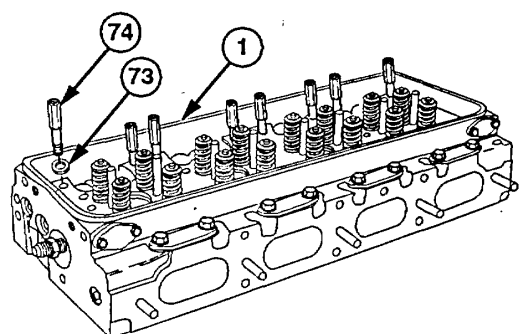
- Do steps (67) thru (72) for left cylinder head only.
- Do steps (73) thru (78) for right cylinder head only.

- (67) Install plug (49) in rear of cylinder head (1).
- (68) Coat threads of plugs (50 thru 53) and elbow (54) with pipe thread sealing compound.
- (69) Install two plugs (50), two plugs (51), plug (52), plug (53), and elbow (54) in rear of cylinder head (1).

**LEFT REAR**

19-7. CYLINDER HEAD REPAIR (CONT)**WARNING**

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

**LEFT FRONT****RIGHT REAR****RIGHT FRONT**

- (70) Coat threads of plugs (55 thru 58), adapter (59), elbow (60), and elbow (61) with pipe thread sealing compound.
- (71) Install two plugs (55), plug (56), plug (57), and plug (58) in front of cylinder head (1).
- (72) Install adapter (59), elbow (60), and elbow (61) in front of cylinder head (1).
- (73) Install plug (62) in rear of cylinder head (1).
- (74) Coat threads of plugs (63 thru 66) and fitting (67) with pipe thread sealing compound.
- (75) Install two plugs (63), two plugs (64), two plugs (65), plug (66), and fitting (67) in rear of cylinder head (1).
- (76) Coat threads of plugs (68 thru 70) and elbows (71 and 72) with pipe thread sealing compound.
- (77) Install two plugs (68), plug (69), and plug (70) in front of cylinder head (1).
- (78) Install elbow (71) and elbow (72) in front of cylinder head (1).
- (79) Install eight new pressure washers (73) and new connectors (74) in cylinder head (1). Torque to 40-45 lb-ft (102-115 N•m).

f. Follow-On Maintenance

Install cam followers and push rods (para 19-11).

19-8. MAIN BEARING AND CRANKSHAFT REPAIR

This task covers

a. Removal b. Cleaning/Inspection	c. installation d. Follow-On Maintenance
-

Initial Setup:
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 Electronic control module (ECM) removed (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Idler gear removed (para 19-13).
 Fuel injector wire harnesses removed (para 4-3).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Crankshaft pulley removed (para 3-12).
 Crankshaft vibration damper and cover removed (para 3-15).
 Blower accessory drive hub removed (para 4-9).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 Cylinder heads removed (para 3-10).

Equipment Conditions (Cont)

Oil pan removed (para 3-20).
 Oil pressure regulator valve removed (para 3-22).
 Oil pressure relief valve removed (para 3-21).
 Crankshaft cover, front oil seal, and oil pump removed (para 19-14).
 Flexplate assembly removed (para 3-17).
 Flywheel housing removed (para 19-9).
 Camshafts and end bearings removed (para 19-12).
 Pistons, connecting rods, and liners removed (para 19-10).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Caliper, Vernier, 0-6 In. (Item 16, Appendix E)
 Dial Indicator, Magnetic (Item 32, Appendix E)
 Remover, Bearing Shell (Figure C-10, Appendix C)
 Sling, Endless Strap (Item 161, Appendix E)
 Wrench Set, Socket, 3/4 In. (Item 231, Appendix E)
 Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
 Wrench, Torque, 0-150 Lb-In. (Item 234, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

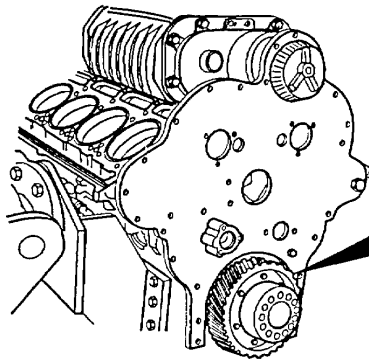
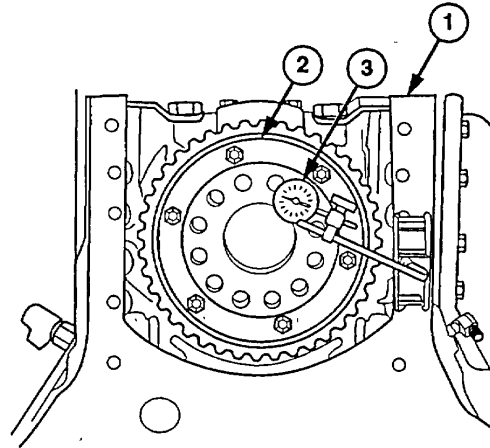
Compound, International, No. 2 (Item 21, Appendix B)
 Oil, Lubricating (Item 45, Appendix B)
 Plastigage (Item 50, Appendix B)
 Tags, Identification (Item 56, Appendix B)

Personnel Required

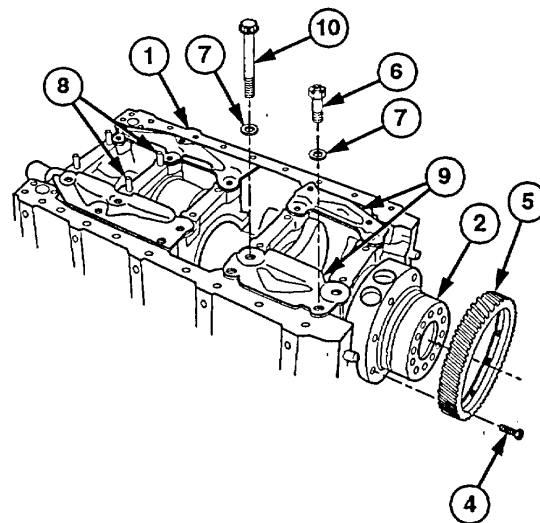
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19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)**a. Removal**

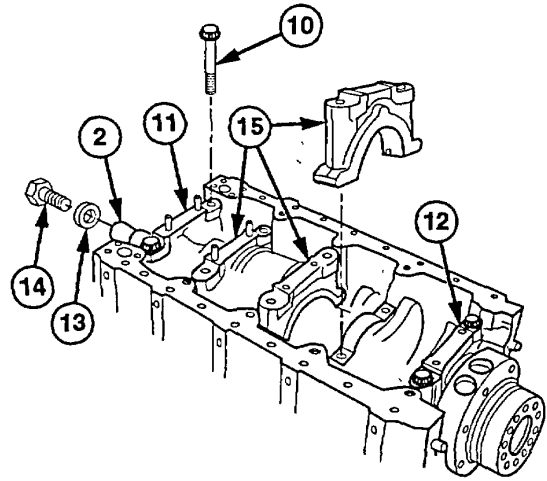
- (1) Rotate engine block (1) on engine stand so crankshaft (2) is up.
- (2) Install dial indicator (3) on engine block.
- (3) Adjust dial indicator (3) to zero while assistant pushes crankshaft (2) toward indicator with pry bar.
- (4) Remove pry bar and push crankshaft (2) in opposite direction. Note end play.



- (5) Remove six screws (4) and timing gear (5) from crankshaft (2).
- (6) Remove seven screws (6) and washers (7) from bearing cap stabilizers (8 and 9).
- (7) Remove 10 screws (10) and washers (7) from bearing cap stabilizers (8 and 9).
- (8) Remove four bearing cap stabilizers (8 and 9) from bottom of engine block (1).



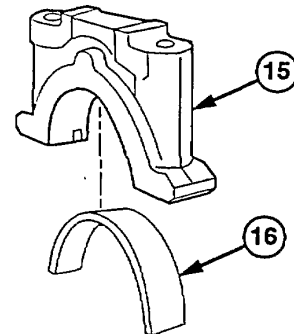
- (9) Install four screws (10) in front main bearing cap (11) and rear main bearing cap (12). Torque to 50 lb-ft (68 N•m).
- (10) Strike front main bearing cap (11) and rear main bearing cap (12) with soft-face hammer. Torque to 110 lb-ft (149 N•m).
- (11) Strike front main bearing cap (11) and rear main bearing cap (12) with soft-face hammer. Torque to 250 lb-ft (339 N•m).
- (12) Install spacer (13) and screw (14) on front of crankshaft (2).



NOTE

- Bearing caps are numbered 1 thru 5 for identification during installation.
- bearing shells are to be reused, tag and mark them for installation.

- (13) Remove three center bearing caps (15) from crankshaft (2).
- (14) Remove lower bearing shells (16) from three center bearing caps (15).



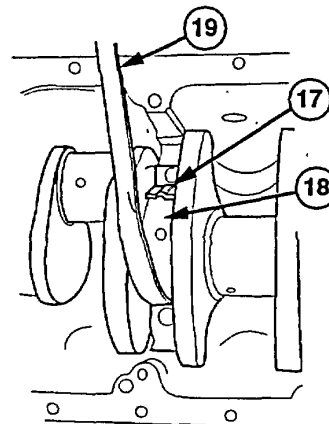
CAUTION

Bearings are notched on one side and only come out one way. Do not attempt to force bearing out incorrectly. Failure to comply may result in damage to equipment.

NOTE

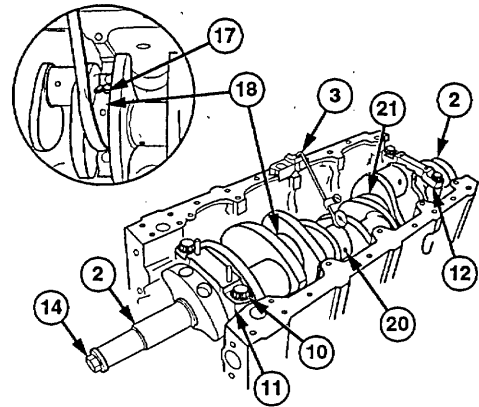
Turn crankshaft to aid in removing bearing shell from under bearing journal.

- (15) Push upper bearing shell (17) out from under crankshaft main bearing journal no. 2 (18) with bearing shell remover (19) while assistant turns screw (14) to turn crankshaft (2).

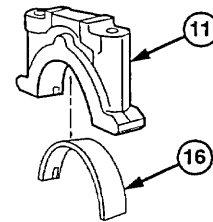


19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)

- (16) Repeat step (15) for crankshaft main bearing Journals no. 3 (20) and no. 4 (21).
- (17) Read runout of main bearing journals (18, 20, and 21) with dial indicator (3) while assistant turns screw (14) to turn crankshaft.
- (18) Maximum allowable runout for journals (18 and 21) is 0.002 in. (0.05 mm). Maximum allowable runout for journal (20) is 0.004 in. (0.10 mm).
- (19) Remove four screws (10) and two bearing caps (11 and 12) from crankshaft (2).



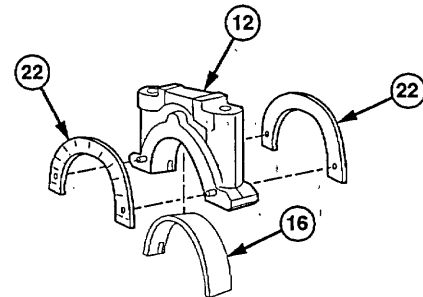
- (20) Remove lower bearing shell (17) from bearing cap (11).



NOTE

Tag and mark thrust bearing before removal.

- (21) Remove lower bearing shell (16) and two lower thrust bearings (22) from bearing cap (12).



CAUTION

Store crankshaft on end. Crankshaft may bend if stored on side.

- (22) Attach lifting device to crankshaft (2).

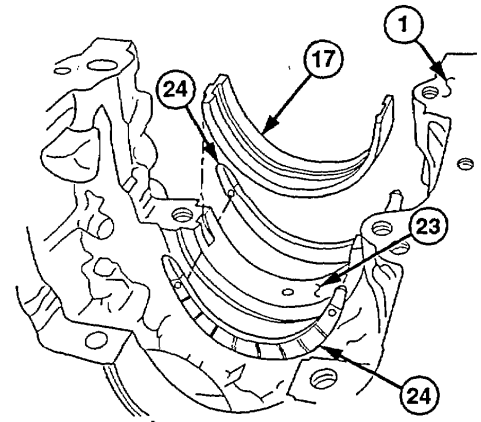
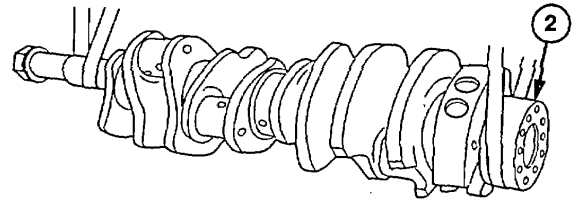
WARNING

Crankshaft weighs 185 lb (84 kg). Keep out from under crankshaft when it is supported by lifting device. If crankshaft falls, serious injury or death may result.

- (23) Guide crankshaft (2) while assistant operates lifting device to remove crankshaft.

- (24) Remove two remaining upper bearing shells (17) from bearing surfaces (23) at front and rear of engine block (1).

- (25) Remove two thrust bearings (24) from rear upper bearing surface (23).

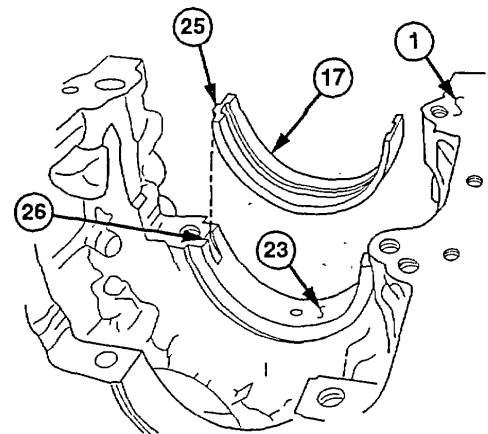
**CAUTION**

Upper bearing shells have a through slot for lubrication. Upper bearing shells are installed in cylinder block. Failure to comply will block off oil flow and damage to equipment may result.

NOTE

If runout measured during testing is not within limits, do steps (26) thru (36) to see if bearing shell caused crankshaft runout. (26) Align tab (25) on new upper bearing shell (17) with slot

- (26) on engine block rear main bearing surface (23).



19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)**NOTE**

Ensure both ends of bearing shell are flush with bearing cap mounting surfaces.

- (27) Install another new bearing shell (17) on bearing surface (23) at front of engine block (1).
- (28) Align tabs (27) with slots (28) and install two new bearing shells (16) on bearing caps (11 and 12). Make sure both ends of bearing shells are flush with bearing cap mounting surfaces (29).

NOTE

Grooved sides of thrust bearing point away from bearing cap.

- (29) Install two new thrust bearings (22) on rear main bearing cap (12).
- (30) Coat crankshaft front and rear main bearing journals (30) with oil.

WARNING

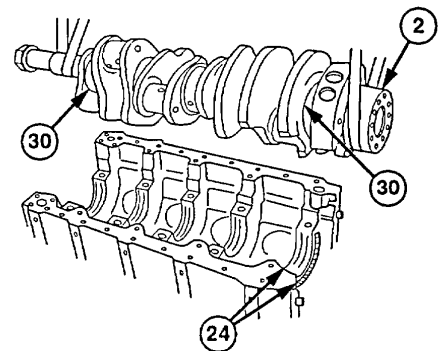
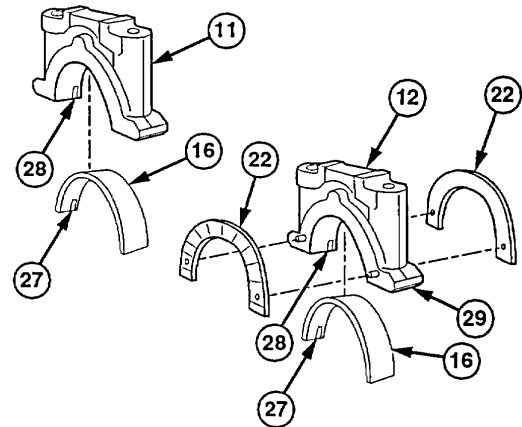
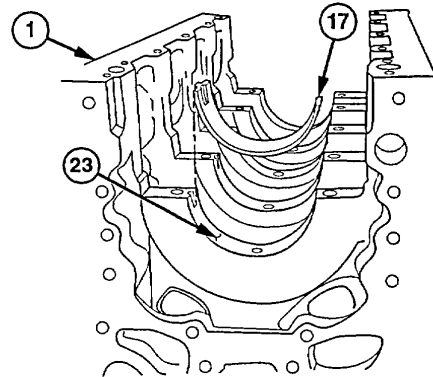
Crankshaft weighs 185 lb (84 kg). Keep out from under crankshaft when it is supported by lifting device. If crankshaft falls, serious injury or death may result.

- (31) Attach lifting device to crankshaft (2).
- (32) Guide crankshaft while assistant operates lifting device to install crankshaft (2).

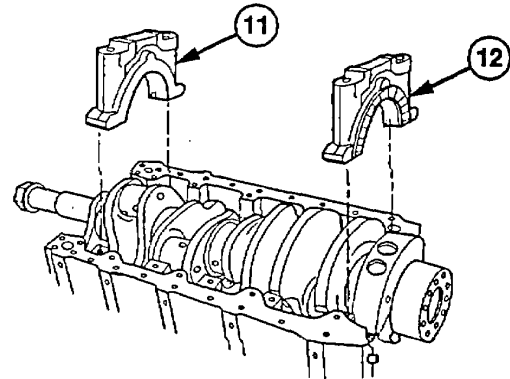
NOTE

Thrust bearings are installed only at bearing surface on rear of engine block.

- (33) Push crankshaft (2) to front and install new thrust bearing (24). Push crankshaft to rear and install other new thrust bearing (24).



- (34) Install two main bearing caps (11 and 12).
- (35) Do steps (9) thru (11).
- (36) Repeat steps (17) and (18). If crankshaft runout is still too high, replace crankshaft (2).
- (37) Do steps (19) thru (25).

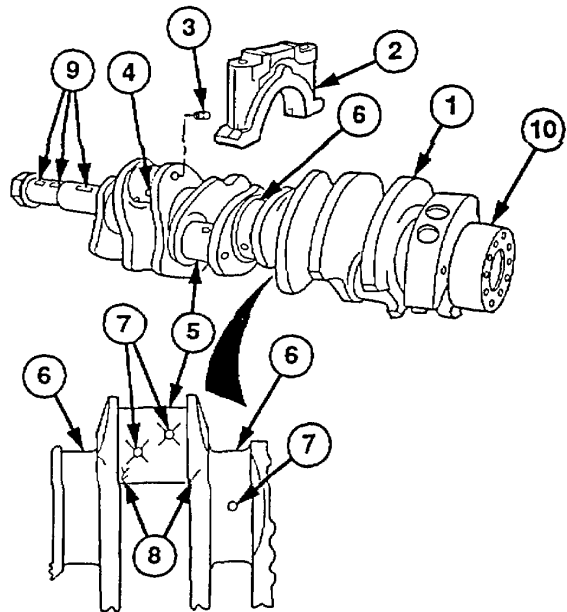


b. Cleaning/inspection

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep flame away from fuel and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET of vehicle.

- (1) Clean crankshaft (1) and bearing caps (2) with clean diesel fuel and a lint-free cloth.
- (2) Remove four plugs (3) from crankshaft (1).
- (3) Flush oil passages (4) in crankshaft (1) with stiff wire brush.
- (4) Install four plugs (3) on crankshaft (1). Torque to 120-144 lb-in. (13.6-16.3 N•m).
- (5) Visually inspect crankshaft (1) for signs of scoring, grooving, or overheating.
- (6) Inspect crankshaft connecting rod journals (5) and main bearing journals (6) for deep scratches. Replace crankshaft (1) if damaged.
- (7) Inspect connecting rod journals (5) and main bearing journals (6) for signs of cracks at journal oil holes (7) or joining points (8) of connecting rod journal (5) and main bearing journals (6). Replace crankshaft (1) if damaged.
- (8) Inspect crankshaft keyways (9) for signs of cracks or wear. Replace crankshaft (1) if damaged.
- (9) Inspect rear oil seal contact surface (10) for deep scratching. If scratches cannot be smoothed out with crocus cloth, replace crankshaft.



19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)

- (10) Inspect crankshaft rear main bearing thrust surfaces (11) for grooving. Replace crankshaft (1) if deep grooves are present in thrust surfaces.
- (11) Inspect timing gear (12) for chipped teeth. Replace if damaged.
- (12) Measure and note thickness of two lower thrust bearings (13).

NOTE

- Refer to table 19-1 for steps (13) thru (15).
- Refer to table 19-2 for steps (16) and (17).
- Refer to table 19-3 for steps (18) thru (21).

- (13) Measure diameter of five main bearing journals (14) at several different spots.
- (14) Measure diameter of four connecting rod journals (15) at different spots on each.
- (15) Replace crankshaft (1) if journals (14 and 15) are outside limits shown in table 19-1.
- (16) Measure width of connecting rod journals (15).
- (17) Replace crankshaft if journals (15) are outside limits shown on table 19-2.
- (18) Add together thickness of two lower thrust bearings measured in step (12).
- (19) Subtract total in step (18) from 0.244 in. (6.20 mm).
- (20) Subtract result in step (19) from crankshaft end play measured in removal, step (4).
- (21) Find amount of crankshaft end play from step (20) in table 19-3 and read what size thrust bearings to use.

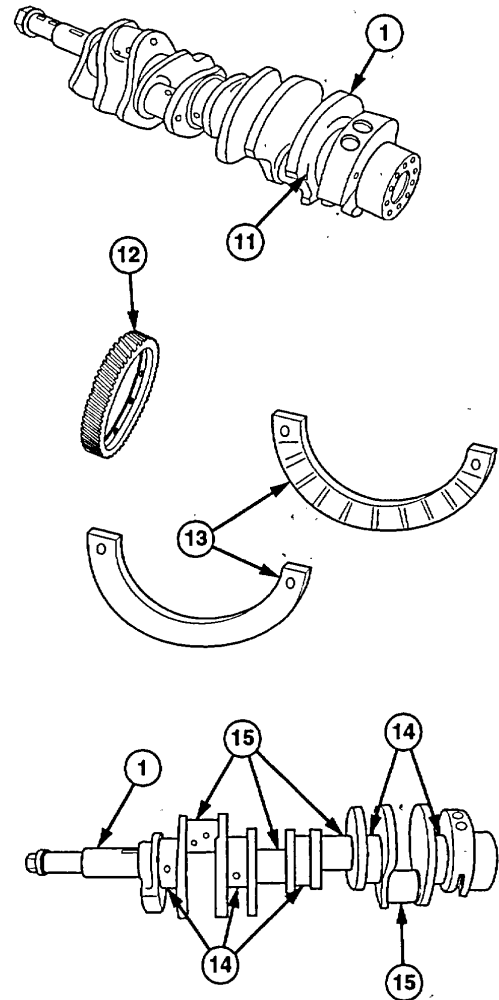


Table 19-1. Main Bearing and Connecting Rod Journal Diameter Specifications

Minimum Diameter:	
Main Bearing Journals (14)	4.4985 in. (114.25 mm)
Connecting Rod Journals (15)	2.9985 in. (76.15 mm)
Maximum Journal Out of Round	
All Journals.....	0.0005 in. (0.013 mm)
Maximum Taper	
All Journals	0.0040 in. (0.010 mm)

Table 19-2. Connecting Rod Journal Width Specifications

Maximum Width	
Connecting Rod Journals (15)	2.652 in. (67.36 mm)

Table 19-3. Crankshaft End Play Specifications

<u>Crankshaft end play found in step (20)</u>	<u>Use this size thrust bearing</u>
Less than 0.016 in. (0.41 mm);	Standard 0.122 in. (3.1 mm)
0.017-0.026 in. (0.43-0.66 mm)	Oversized 0.127 in. (3.23 mm)
0.027-0.036 in. (0.69-0.91 mm)	Oversized 0.132 in. (3.35 mm)
More than 0.36 in. (0.91 mm)	Replace crankshaft

19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)

c. Installation

CAUTION

Do not handle bearing shells and thrust bearings more than necessary for installation. Sweat from hands may damage bearing shells and thrust bearings.

NOTE

Bearing surfaces are numbered 1 thru 5 from front to rear of engine block. Repeat steps (1) and (2) for four other main bearing surfaces.

- (1) Align tab (1) on upper rear main bearing shell (2) with slot (3) on bearing surface of engine block (4).

CAUTION

Upper bearing shells have a through slot for lubrication. Upper bearing shells are installed in cylinder block. Failure to comply will block off oil flow and damage to equipment may result.

- (2) install shell (2) on bearing surface of engine block (4). Ensure both ends of shell are flush with bearing cap mounting surfaces (5).
- (3) Coat bearing shells (2) with oil after installation.
- (4) Coat five crankshaft main bearing journals (6) with oil.

WARNING

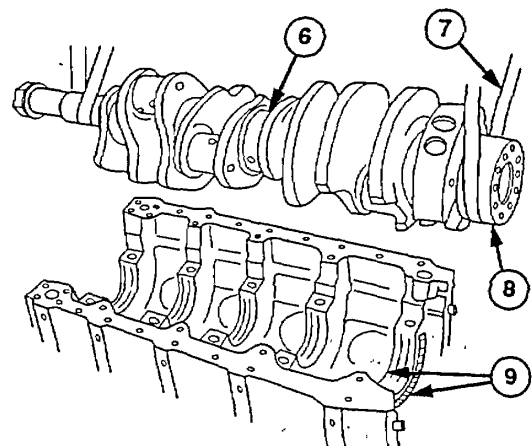
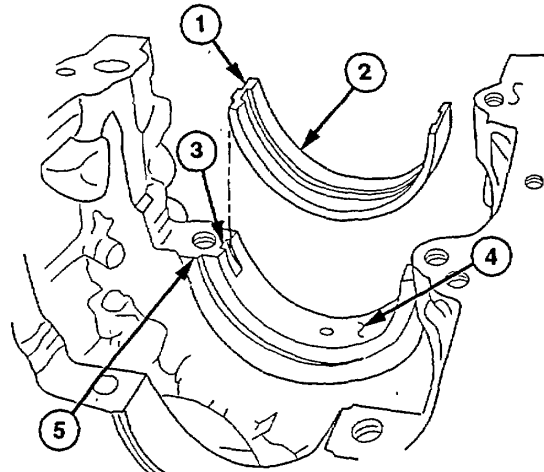
Crankshaft weighs 185 lb (84 kg). Keep out from under crankshaft when it is supported by lifting device. If crankshaft falls, serious injury or death may result.

- (5) Attach lifting device (7) to crankshaft (8).
- (6) Install crankshaft (8) while assistant operates lifting device.

NOTE

Install thrust bearing with grooved side toward crankshaft.

- (7) Push crankshaft (8) to front and install rear main thrust bearing (9). Push crankshaft (8) to rear and install other rear main thrust bearing (9).



- (8) Align tab (10) with slot (11) and install lower rear main bearing shell (12) in rear bearing cap (13). Ensure both ends of bearing shell are flush with rear bearing cap (13) mounting surfaces.

- (9) Install four other main bearing shells (10) on other main bearing caps (14 and 15).

NOTE

Install thrust bearing with grooved side away from bearing cap.

- (10) Install two lower thrust bearings (16) on rear bearing cap (13).

NOTE

Wipe oil from bearing shells and crankshaft main bearing journals before doing steps (11) thru (13).

- (11) Place strip of plastic gage (17) across width of bearing shell (12) 0.25 in. (6.35 mm) from center (18).
- (12) Do step (11) for four remaining bearing caps (14 and 15).

- (13) Position five bearing caps (13, 14, and 15) on bearing cap mounting surface (5).

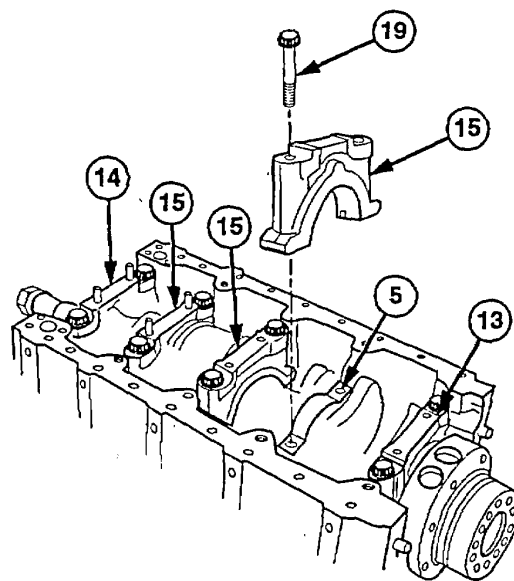
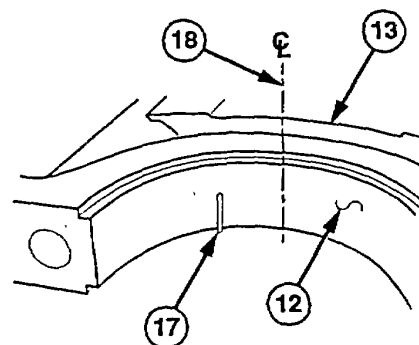
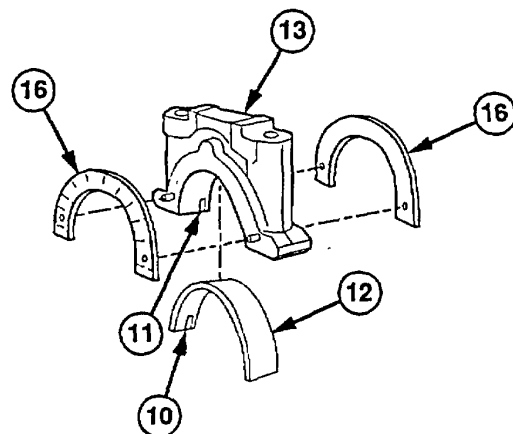
- (14) Strike bearing caps (13, 14, and 15) with soft-face hammer.

- (15) Install 10 screws (19) on bearing caps (13, 14, and 15). Torque to 50 lb-ft (68 N•m).

- (16) Strike bearing caps (13, 14, and 15) with soft-face hammer.

- (17) Tighten 10 screws (19) to 110 lb-ft (149 N•m) then to 230-240 lb-ft (312-325 N•m).

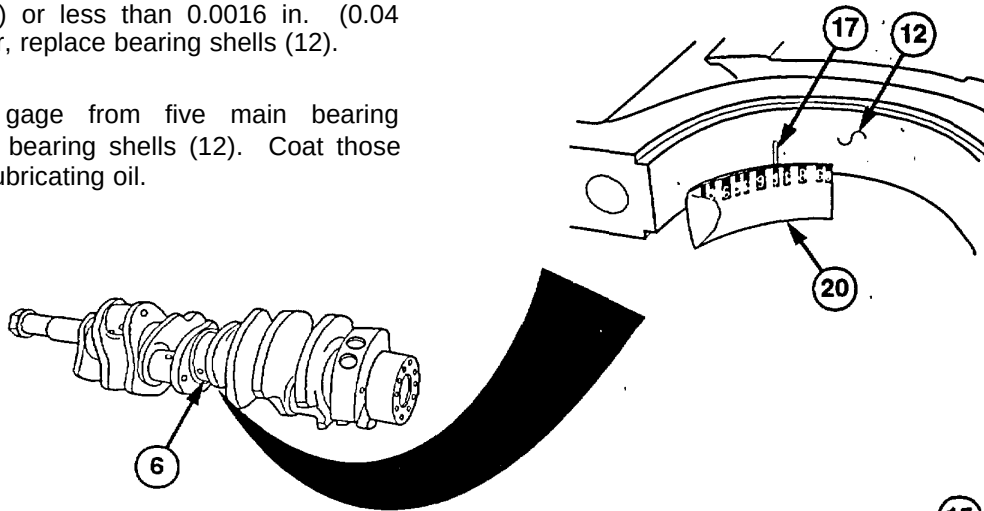
- (18) Remove 10 screws (19) and 5 bearing caps (13, 14, and 15).



19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)

- (19) Measure width of plastigage (17) with measuring strip (20). Width must be no more than 0.0051 in. (0.13 mm) or less than 0.0016 in. (0.04 mm). If greater, replace bearing shells (12).

- (20) Wipe plastic gage from five main bearing journals (6) or bearing shells (12). Coat those surfaces with lubricating oil.

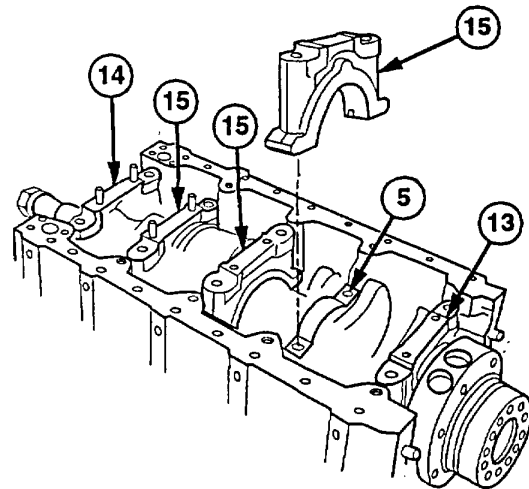


- (21) Install five bearing caps (13, 14, and 15) on bearing cap mounting surface (5).

- (22) Strike bearing caps (13, 14, and 15) with soft-face hammer.

- (23) Position four bearing cap stabilizers (21 and 22) on engine block (4).

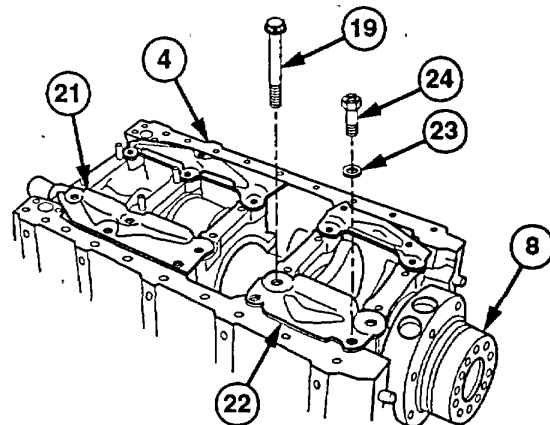
- (24) Install seven washers (23) and screws (24) on bearing cap stabilizers (21 and 22). Tighten screws finger tight.

**WARNING**

Sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

- (25) Coat threads of 10 screws (19) and surfaces of stabilizers (21 and 22) with small amount of sealing compound no. 2.

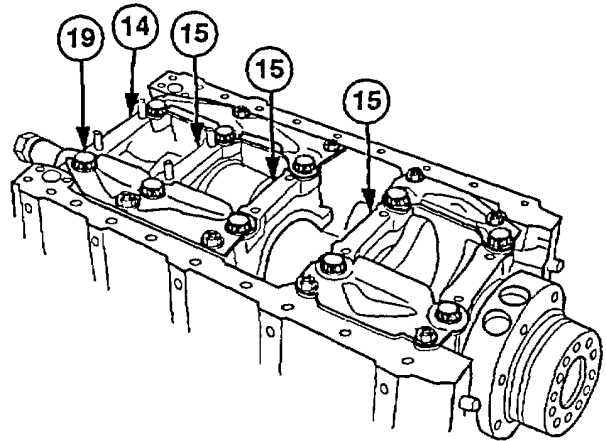
- (26) Install 10 screws (19) finger tight.



- (27) Strike bearing caps (14 and 15) with soft face-hammer.
- (28) Tighten eight screws (19) on four front bearing caps (14 and 15) to 40-50 lb-ft (54-X68 N•m) starting with middle two caps (15).
- (29) Strike bearing caps (14 and 15) with soft-face hammer and torque eight screws (19) to 110 lb-ft (149 N•m).

NOTE

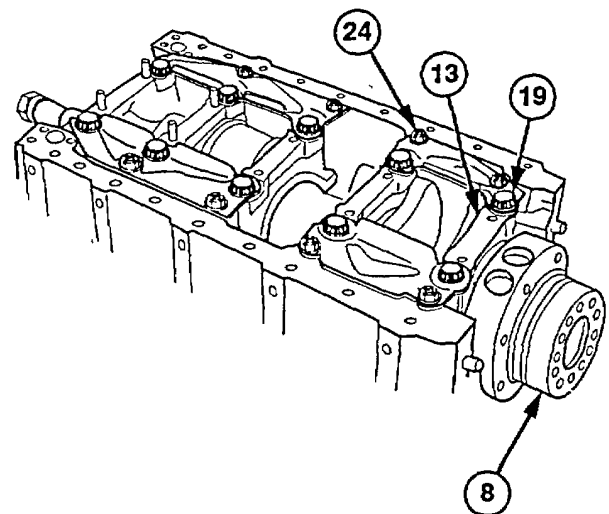
New bearing cap screws are tightened to 230-240 lb-ft (312-325 N•m).



- (30) Strike bearing caps (14 and 15) with soft-face hammer and torque eight screws (19) to 250-260 lb-ft (339-352 N•m).
- (31) Tighten two screws (19) on rear bearing cap (13) to 40-50 lb-ft (54-68 N•m).
- (32) Strike both ends of crankshaft (8) two or three blows with soft-face hammer.
- (33) Strike rear bearing cap (13) with soft-face hammer.
- (34) Tighten two screws (19) on rear bearing cap (13) to 110 lb-ft (149 N•m).
- (35) Strike rear bearing cap (13) with soft-face hammer.

NOTE

New bearing cap screws are tightened to 230-240 lb-ft (312-325 N•m).



- (36) Tighten two screws (19) on rear bearing cap (13) to 250-260 lb-ft (339-352 N•m).
- (37) Tighten seven screws (24) to 70-75 lb-ft (95-102 N•m).

NOTE

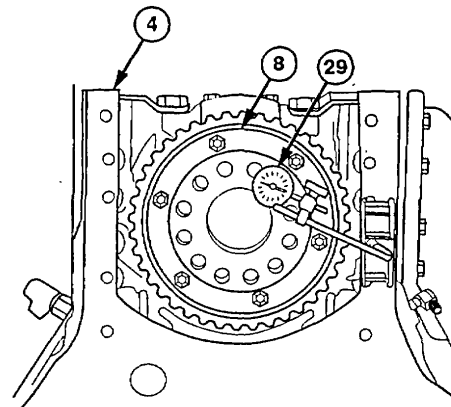
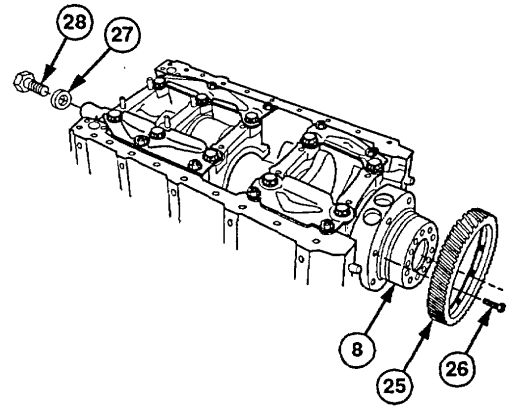
Crankshaft will turn freely if all bearings are properly installed.

- (38) Rotate crankshaft (8) to ensure it turns freely.

19-8. MAIN BEARING AND CRANKSHAFT REPAIR (CONT)**NOTE**

Align dowel pin on crankshaft with hole in gear.

- (39) Install timing gear (25) on crankshaft (8) with six screws (26).
- (40) Install spacer (27) and screw (28) on end of crankshaft (8).
- (41) Hold screw (28) while assistant torques six screws (26) to 40 lb-ft (54 N•m).
- (42) Remove screw (28) and spacer (27) from crankshaft (8).
- (43) Install dial indicator (29) on engine block (4).
- (44) Adjust dial indicator to zero while assistant pushes crankshaft (8) toward indicator (29) with pry bar.
- (45) Read end play while assistant pushes crankshaft away from dial indicator (29) with pry bar. Minimum end play is 0.004 in. (0.10 mm) and maximum end play is 0.018 in. (0.46). If end play is outside limits, replace crankshaft (8).

**d. Follow-On Maintenance**

- (1) Install pistons, connecting rods, and liners (para 19-10).
- (2) Install camshafts and end bearings (para 19-12).
- (3) Install flywheel housing (para 19-9).
- (4) Install flexplate assembly (para 3-17).
- (5) Install crankshaft cover, front oil seal, and oil pump (para 19-14).

d. Follow-On Maintenance (Cont)

- (6) Install oil pressure relief valve (para 3-21).
- (7) Install oil pressure regulator valve (para 3-22).
- (8) Install oil pan (para 3-20).
- (9) Install cylinder heads (para 3-10).
- (10) Install Injectors (para 4-2).
- (11) Install rocker arms (para 3-18).
- (12) Install engine brake retarders (para 3-26).
- (13) Install engine brake retarder wire harnesses (para 6-16).
- (14) Install blower accessory drive hub (para 4-9).
- (15) Install crankshaft vibration damper and cover (para 3-15).
- (16) Install crankshaft pulley (para 3-12).
- (17) Install right thermostat housing (para 5-4).
- (18) Install left thermostat housing (para 5-3).
- (19) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).
- (20) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (21) Install fuel Injector wire harnesses (para 4-3).
- (22) Install rocker covers (TM 9-2320-360-20).
- (23) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (24) Install thermostats (TM 9-2320-360-20).
- (25) Install electronic control module (ECM) (TM 9-2320-360-20).
- (26) Install fan clutch (TM 9-2320-360-20).
- (27) Install fan belts (TM 9-2320-360-20).
- (28) Install fan (TM 9-2320-360-20).
- (29) Remove engine from engine stand (para 19-3).
- (30) Install air box covers (para 3-8).
- (31) Install air box drains (para 3-9).
- (32) Install exhaust manifolds (para 3-23).
- (33) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (34) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (35) Install starter (TM 9-2320-360-20).
- (36) Install sending units and attachments (TM 9-2320-360-20).

19-9. FLYWHEEL HOUSING REPAIR

This task covers

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance
-

Initial Setup:
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Blower accessory drive hub removed (para 4-9).
 Oil pan removed (para 3-20).
 Flexplate assembly removed (para 3-17).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Eyes, Lifting (Figure C-12, Appendix C)
 Goggles, Industrial (Item 57, Appendix E)
 Guide Screws (4) (Item 61, Appendix E)
 Installer, Seal (Item 83, Appendix E)
 Sling, Endless Strap (Item 161, Appendix E)
 Wrench, Impact, Electric, 1 In. (Item 223, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
 Compound, Seating, Pipe Thread (Item 28, Appendix B)
 Grease, Automotive and Artillery (Item 32, Appendix B)
 Oil, Lubricating, (Item 45, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Gaskets (2) (Item 61, Appendix F)
 Gasket (Item 51, Appendix F)
 Lockwashers (6) (Item 121, Appendix F)
 Lockwashers (7) (Item 127, Appendix F)
 Screws (6) (Item 279, Appendix F)
 Screws (3) (Item 278, Appendix F)
 Seal, Oil (Item 317, Appendix F)
 Washer, Copper (Item 334, Appendix F)

Personnel Required

Two

a. Removal

NOTE

Tag and mark hoses before removal.

- (1) Remove two fuel hoses (1) from elbows (2) on fuel block (3).
- (2) Disconnect fuel pressure transducer (4) from STE/ICE engine wire harness (5).

NOTE

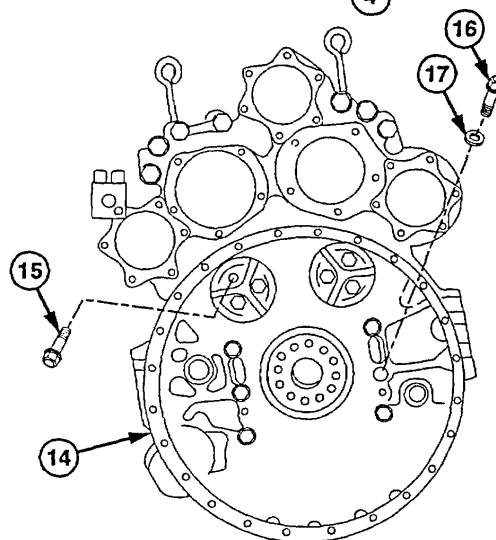
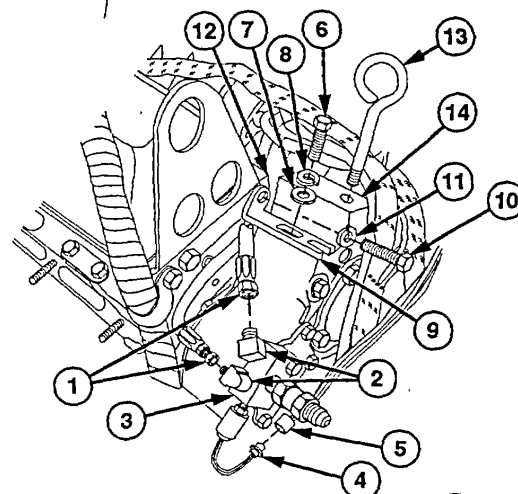
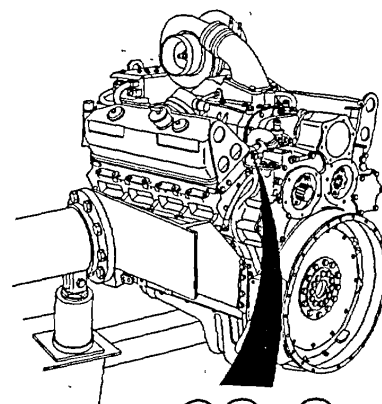
Left and right brackets are removed the same way. Left side is shown.

- (3) Remove four screws (6), washers (7), and lockwashers (8) from two brackets (9). Discard lockwashers.
- (4) Remove two screws (10), lockwashers (11), and brackets (9) from cylinder heads (12). Discard lockwashers.
- (5) Install two lifting eyes (13) on flywheel housing (14).
- (6) Support flywheel housing (14) with lifting device.

NOTE

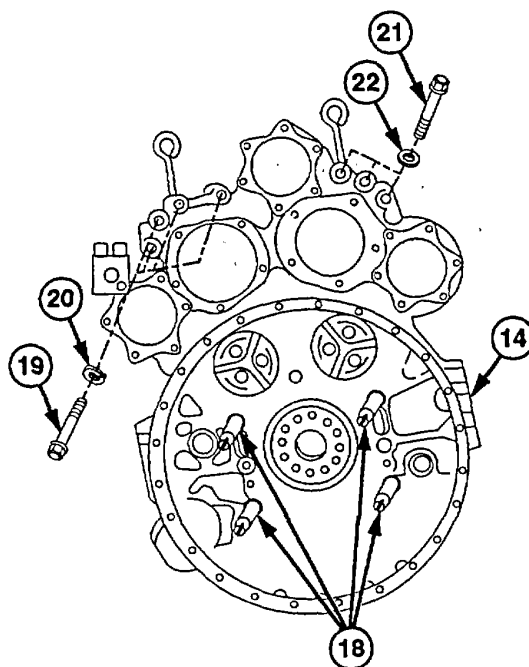
Tag and mark all screws before removal.

- (7) Remove six screws (15) from flywheel housing (14). Discard screws.
- (8) Remove six screws (16) and washers (17) from flywheel housing (14).

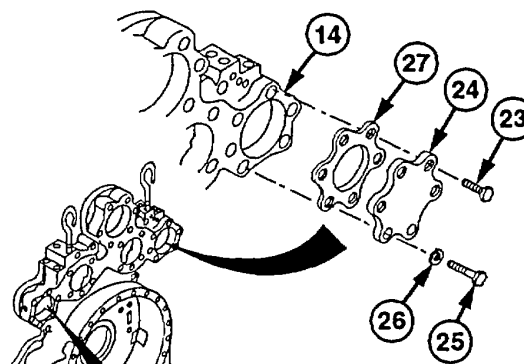


19-9. FLYWHEEL HOUSING REPAIR (CONT)

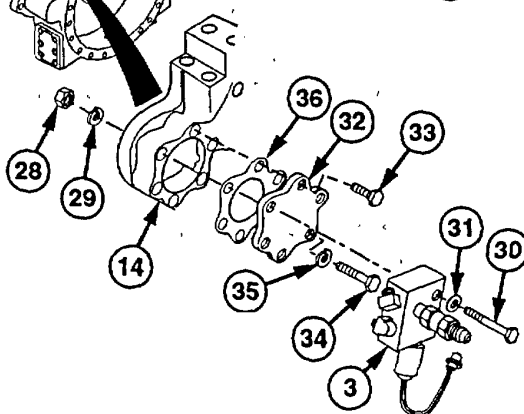
- (9) Install four guide screws (18) in flywheel housing (14).
- (10) Remove four screws (19) and lockwashers (20) from flywheel housing (14). Discard lockwashers.
- (11) Remove three screws (21) and washers (22) from flywheel housing (14). Discard screws.



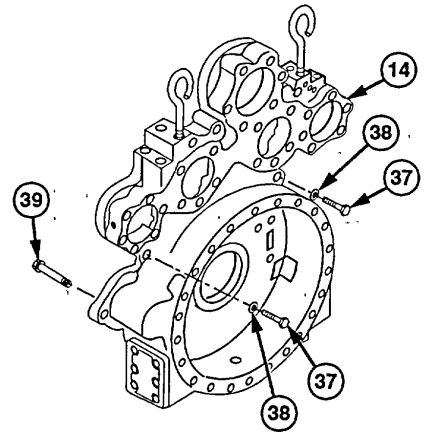
- (12) Remove five screws (23) from access cover (24).
- (13) Remove screw (25) and copper washer (26) from access cover (24). Discard copper washer.
- (14) Remove access cover (24) and gasket (27) from flywheel housing (14). Discard gasket.



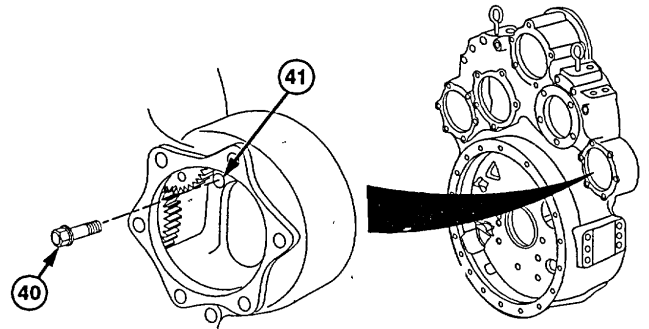
- (15) Remove three nuts (28), lockwashers (29), screws (30), washers (31), and fuel block (3) from access cover (32). Discard lockwashers.
- (16) Remove two screws (33), screw (34), and washer (35) from access cover (32).
- (17) Remove access cover (32) and gasket (36) from flywheel housing (14). Discard gasket.



- (18) Remove two screws (37) and washers (38) from flywheel housing (14).
- (19) Remove two screws (39) from rear of flywheel housing (14).



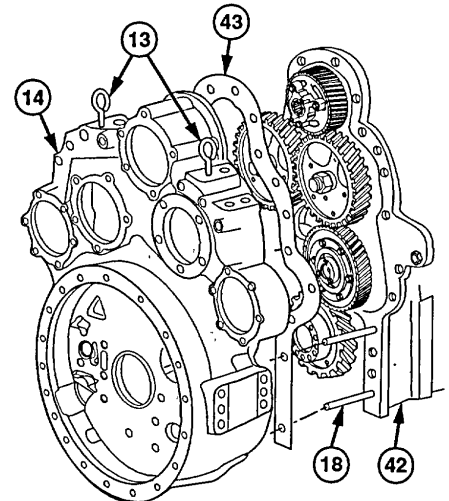
- (20) Remove screw (40) from access hole (41).



WARNING

Ensure lifting device is secured. Keep hands and feet out from under flywheel housing when removing from engine. Failing parts may cause serious injury to personnel.

- (21) Remove flywheel housing (14) from rear of engine block (42) and place on flat work surface, engine side up.
- (22) Remove gasket (43) from engine block (42) and flywheel housing (14). Discard gasket.
- (23) Remove four guide screws (18) from engine block (42).
- (24) Remove two lifting eyes (13) from flywheel housing (14).



19-9. FLYWHEEL HOUSING REPAIR (CONT)

J

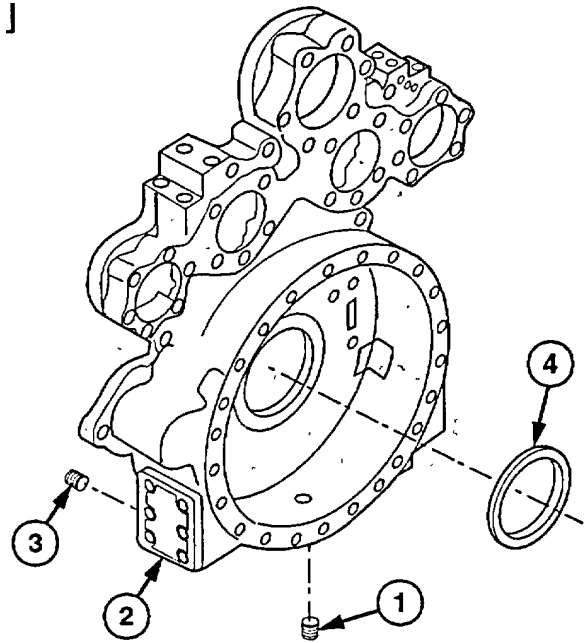
b. Disassembly

- (1) Remove pipe plug (1) from bottom of flywheel housing (2).
- (2) Remove pipe plug (3) from backside of flywheel housing (2).
- (3) Remove crankshaft rear oil seal (4) from flywheel housing (2). Discard oil seal.

c. Cleaning/Inspection**CAUTION**

Use care when scraping gasket material from machined surface of housing or housing will be damaged.

- (1) Scrape gasket material from housing.

**WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (2) Clean metal parts with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Dry metal parts with compressed air.
- (4) Inspect housing for cracks or other damage.

CAUTION

Crankshaft must be clean and smooth or oil seal lip will be damaged when flywheel housing is installed.

NOTE

Polishing motion should be clockwise around end of crankshaft.

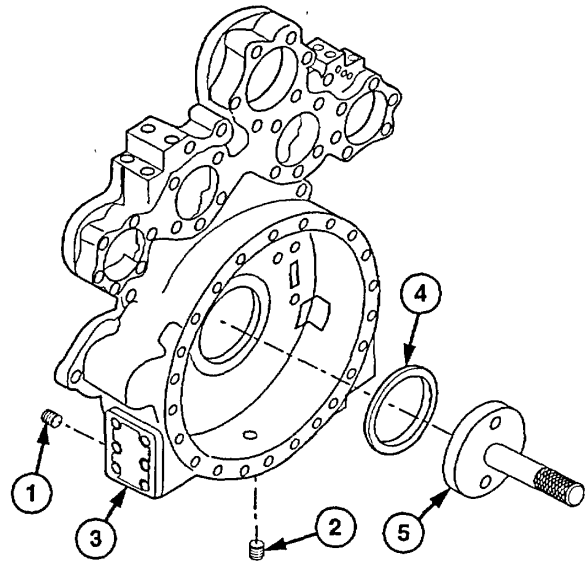
- (5) Polish end of crankshaft with crocus cloth wet with lubricating oil.
- (6) Replace all damaged parts.

d. Assembly

WARNING

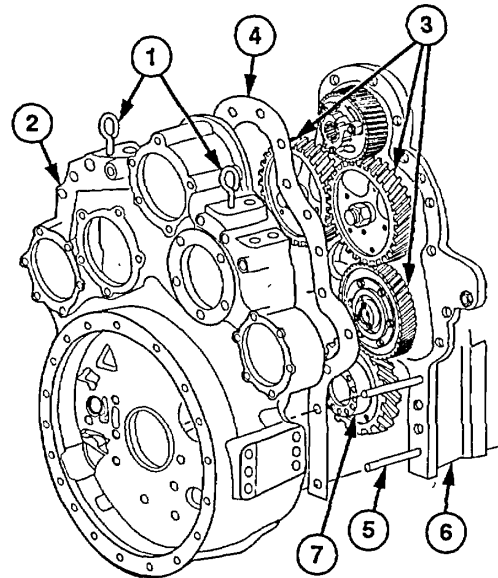
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (1) Coat threads of pipe plugs (1 and 2) with pipe thread sealing compound.
- (2) Install pipe plug (1) in backside of flywheel housing (3).
- (3) Install pipe plug (2) in bottom of flywheel housing (3).
- (4) Install oil seal (4) using seal installer (5).



e. Installation

- (1) Install two lifting eyes (1) in flywheel housing (2).
- (2) Coat gear train teeth (3) with lubricating oil.
- (3) Set flywheel housing (2), engine side up, on flat surface.
- (4) Coat engine side of flywheel housing (2) with grease.
- (5) Install new gasket (4) on engine side of flywheel housing (2).
- (6) Coat gasket (4) with grease.
- (7) Install four guide screws (5) in engine block (6).
- (8) Install lifting device while assistant positions flywheel housing (2) over crankshaft (7) and against engine block (6).



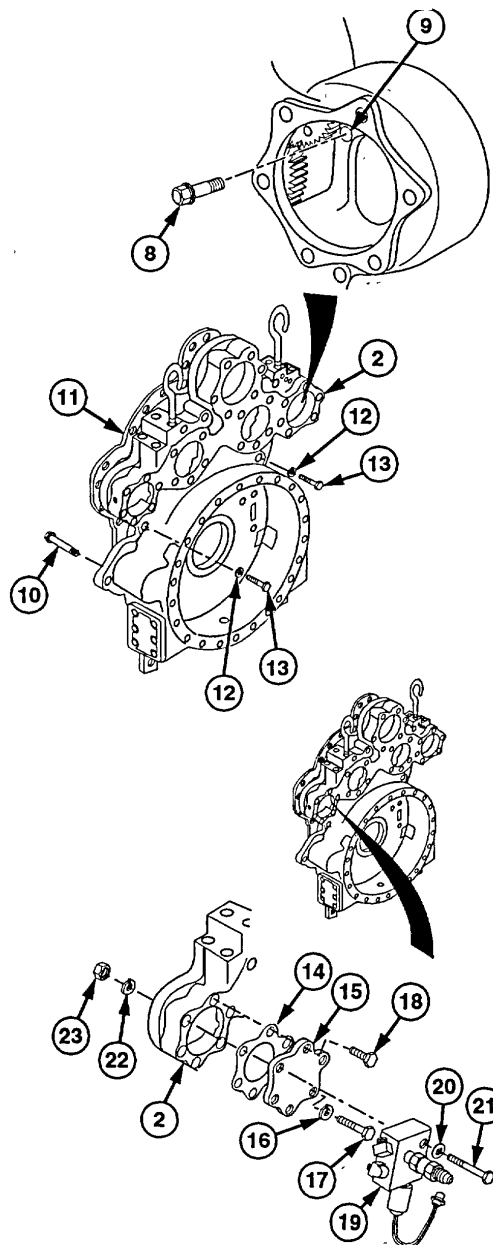
19-9. FLYWHEEL HOUSING REPAIR (CONT)**NOTE**

Do not tighten any screws until all are installed. All hardware is torqued at the end of the procedure.

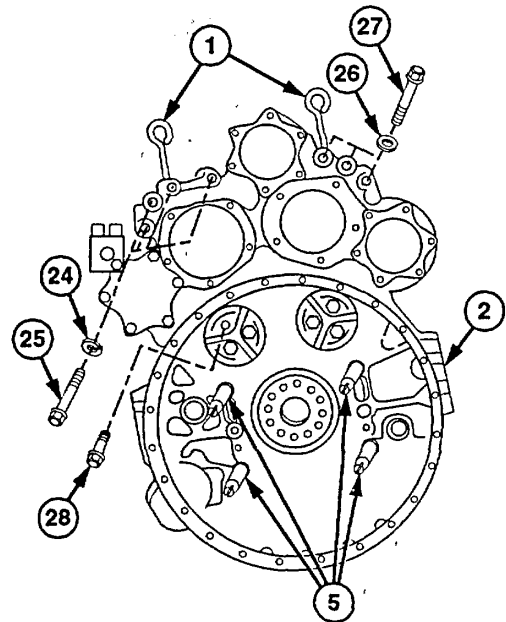
- (9) Install new screw (8) in access hole (9).

- (10) Install two screws (10) on engine rear cover plate (11) and flywheel housing (2).
 (11) Install two washers (12) and screws (13) on flywheel housing (2).

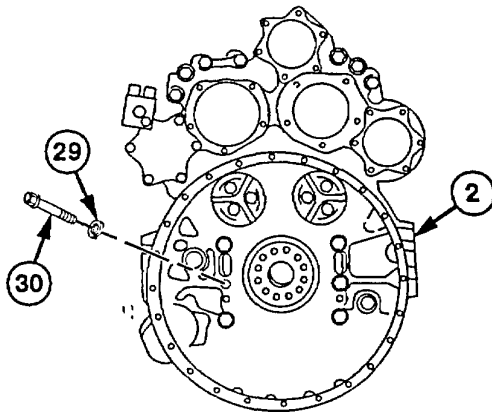
- (12) Coat new gasket (14) with grease.
 (13) Install new gasket (14) and access cover (15) on flywheel housing (2) with washer (16) and screw (17).
 (14) Install two screws (18) on flywheel housing (2).
 (15) Install fuel block (19) on flywheel housing (2) with three washers (20), screws (21), new lockwashers (22), and nuts (23).



- (16) Install four new lockwashers (24) and screws (25) in flywheel housing (2).
- (17) Install three washers (26) and new screws (27) in flywheel housing (2).
- (18) Install six new screws (28) in flywheel housing (2).
- (19) Remove lifting device from lifting eyes (1).
- (20) Remove two lifting eyes (1) from flywheel housing (2).
- (21) Remove four guide screws (5) from engine block (6).



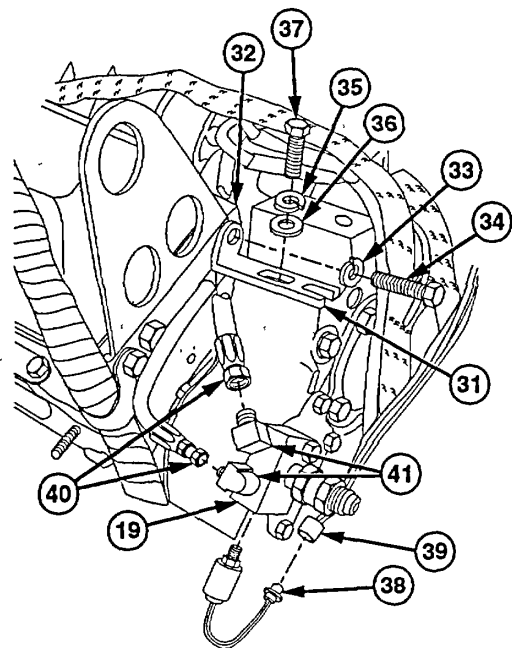
- (22) Install six washers (29) and screws (30) in flywheel housing (2).



NOTE

Left and right brackets are installed the same way. Left side is shown.

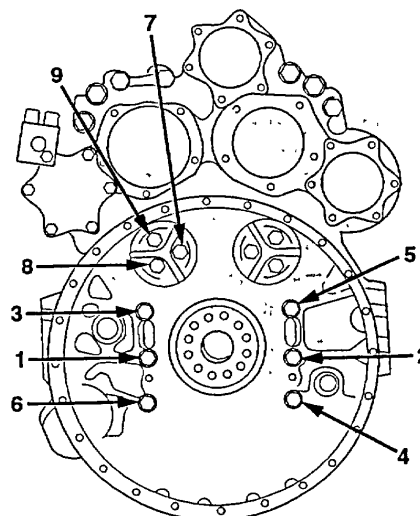
- (23) Install two brackets (31) on cylinder heads (32) with new lockwashers (33) and screws (34).
- (24) Install four new lockwashers (35), washers (36), and screws (37) on two brackets (31). Torque to 46 lb-ft (62 N m).
- (25) Install fuel pressure transducer (38) on STE/ICE engine wire harness (39).
- (26) Install two fuel hoses (40) on elbows (41) on fuel block (19).



19-9. FLYWHEEL HOUSING REPAIR (CONT)**NOTE**

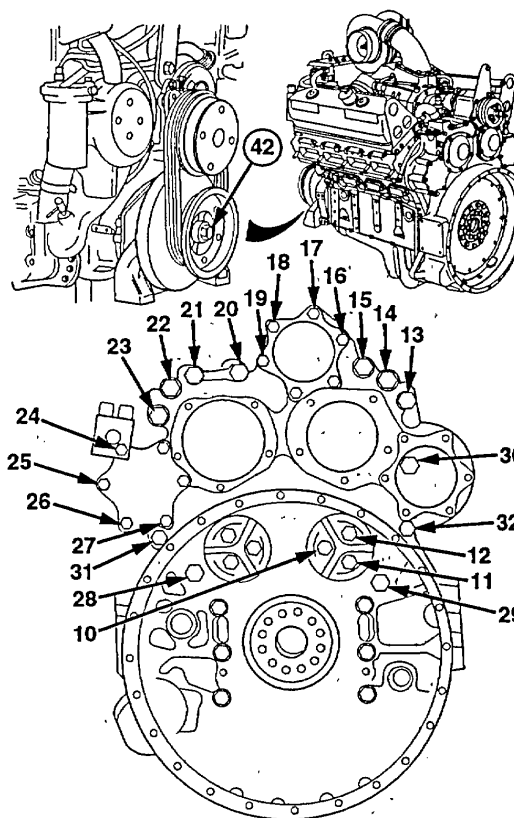
Screws are numbered to show tightening sequence. Tighten in order shown.

- (27) Tighten screws 1 thru 6 to 90-100 lb-ft (122-136 N•m).
- (28) Tighten screws 7 thru 9 to 40-45 lb-ft (54-61 N•m).

**CAUTION**

When using crankshaft front screw to bar over engine, always turn in clockwise direction. Turning over in counterclockwise direction may loosen screw and vibration damper. Serious damage to engine may result.

- (29) Turn crankshaft screw (42) clockwise, while assistant tightens screws 10 thru 12 to 40-45 lb-ft (54-61 N•m).



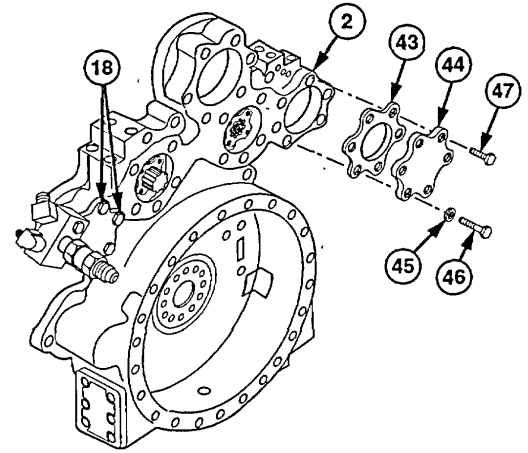
- (30) Tighten screws 13 thru 27 to 25-30 lb-ft (35-41 N•m).

NOTE

Screws were installed from front side of flywheel housing.

- (31) Tighten screws 28 and 29 to 40-45 lb-ft (54-61 N•m).
- (32) Tighten screw 30 to 30-35 lb-ft (41-47 N•m).
- (33) Tighten screws 31 and 32 to 137-147 lb-ft (186-200 N•m).

- (34) Coat new gasket (43) with grease.
- (35) Install new gasket (43), access cover (44), new copper washer (45), and screw (46) on flywheel housing (2). Do not tighten.
- (36) Install five screws (47) on access cover (44). Do not tighten.
- (37) Tighten six screws (46 and 47) to 25-30 lb-ft (35-41 N•m).
- (38) Tighten two screws (18) to 25-30 lb-ft (35-41 N•m).



f. Follow-On Maintenance

- (1) Install flexplate assembly (para 3-17).
- (2) Install oil pan (para 3-20).
- (3) Install blower accessory drive hub (para 4-9).
- (4) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (5) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (6) Remove engine from engine stand (para 19-3).
- (7) Install air box covers (para 3-8).
- (8) Install air box drains (para 3-9).
- (9) Install exhaust manifolds (para 3-23).
- (10) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (11) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (12) Install starter (TM 9-2320-360-20).
- (13) Install sending units and attachments (TM 9-2320-360-20).

19-10. PISTON, CONNECTING ROD, AND LINER REPAIR

This task covers:

a. Removal b. Disassembly c. Cleaning/Inspection	d. Assembly e. Installation f. Follow-On Maintenance

INITIAL SETUP:
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Electronic control module (ECM) remove (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Fuel injector wire harnesses removed (para 4-3).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 Cylinder heads removed (para 3-10).
 Oil pan removed (para 3-20).
 Bearing Shells (Item 2, Appendix F)
 Cylinder Kit (item 10, Appendix F)

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Clamp Set, Cylinder Liner Holddown (3) (Item 18, Appendix E)
 Compressor, Ring (Item 20, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Gage Set, Piston (Item 55, Appendix E)
 Gage, Cylinder Liner Depth (Item 47, Appendix E)
 Gage, Piston, Groove (Item 51, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Remover and Installer, Piston Ring (Item 135, Appendix E)
 Remover Assembly, Cylinder Liner (Item 130, Appendix E)
 Retainer Tool, Piston Pin (Item 144, Appendix E)
 Scale, Spring, 0-50 Lb (Item 145, Appendix E)
 Tester, Vacuum Gage Leak Detector Set (Item 191, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Compound, International, No. 2 (Item 21, Appendix B)
 Oil, Lubricating (Item 45, Appendix B)
 Rags (Item 51, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)

Personnel Required

Two

a. Removal

CAUTION

Do not rotate crankshaft in counterclockwise direction. Serious damage to engine may result.

NOTE

Repeat steps (1) thru (4) for each cylinder liner.

- (1) Move piston (1), by rotating camshaft screw (2) clockwise, so top is just above air inlet ports in cylinder liner (3).
- (2) Place clean rag on top of piston to catch carbon deposits as they are removed from cylinder liner (3).
- (3) Scrape carbon ridge from top of cylinder liner (3).
- (4) Remove rag and carbon residue from cylinder liner (3).

CAUTION

Do not use scribe or punch to mark piston, connecting rod, or cylinder head mounting surface. Leaks may result.

- (5) Turn engine block (4) upside down. Remove two nuts (5) from bearing cap screws (6).
- (6) Remove connecting rod bearing cap (7) with bearing shell (8). Discard bearing shell.

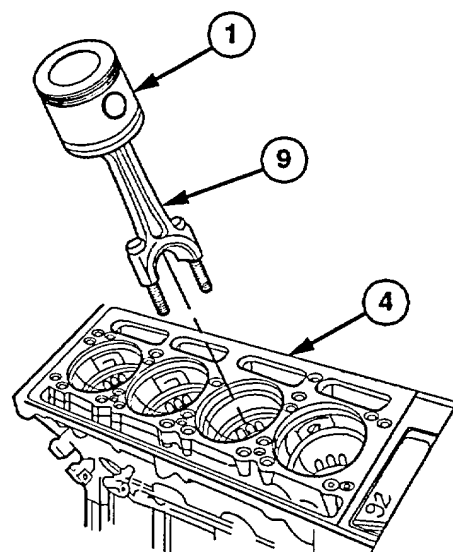
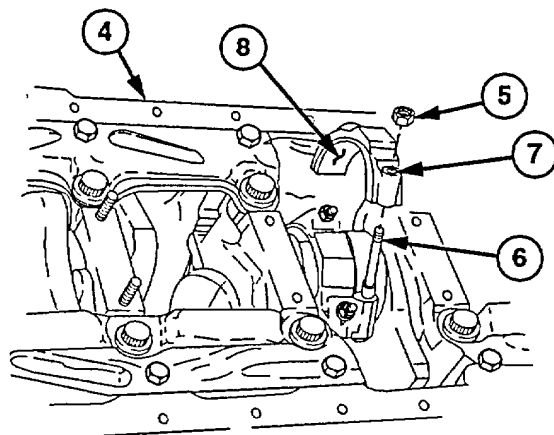
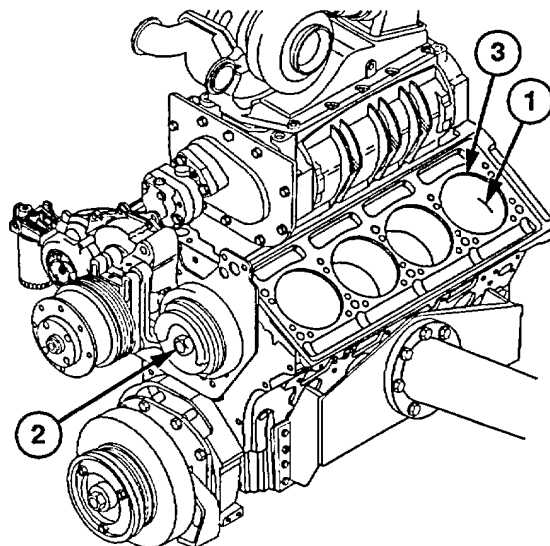
CAUTION

Ensure shoulder of connecting rod does not catch on lip of cylinder liner when removing piston with connecting rod.

NOTE

- It may be necessary to tap piston out of liner.
- Cylinder liner may come out with piston.

- (7) Push piston (1) and connecting rod (9) out through engine block (4) while assistant removes piston from engine block (4).



19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)

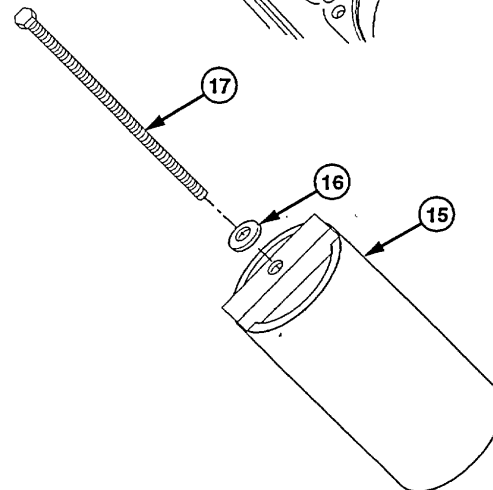
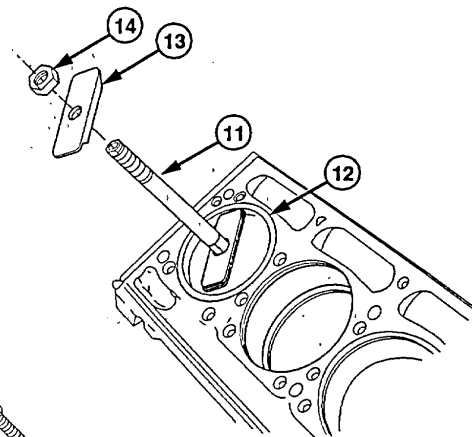
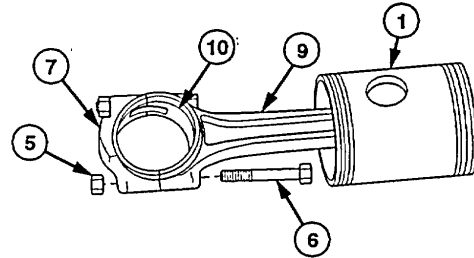
- (8) Discard bearing shell (10). Place bearing cap (7), and two nuts (5) back on two bearing cap screws (6) to keep matched parts together.
- (9) Remove seven remaining pistons (1) and connecting rods (9).
- (10) Turn engine so cylinder head bank is facing up.

NOTE

- If cylinder liners are being re-used, matchmark cylinder liner and engine block so the liner is installed in the same position in the block bore.
- Matchmark cylinder liner and engine block on side opposite camshaft.
- Crankshaft may have to be turned to allow for clearance of special tool.

- (11) Remove cylinder liner with tool set as follows:

- (a) Ease lower shoe and bolt assembly (11) down into liner (12). Place shoe on bottom edge of liner with flat on shoe parallel with crankshaft bore.
- (b) Hold lower shoe and bolt assembly (11) in pulling position. Place upper shoe (13) with flat in same position as lower shoe over threaded end of bolt. Thread nut (14) down on bolt assembly (11). Ensure pilots on both shoes are seated properly.
- (c) Place bridge assembly (15) (open end down) over upper shoe and against block.
- (d) With thrust bearing (16) on bolt (17), install bolt through bridge assembly (15) strap hole.
- (e) Thread bolt (17) into female threaded portion of bolt assembly (11).
- (f) Turn bolt (17) clockwise and withdraw liner (12) from block. Remove tool from liner.



NOTE

Tag liner insert noting cylinder number.

- (12) Remove cylinder liner insert (1B).
- (13) Remove two cylinder liner seal rings (19). Discard seal rings.

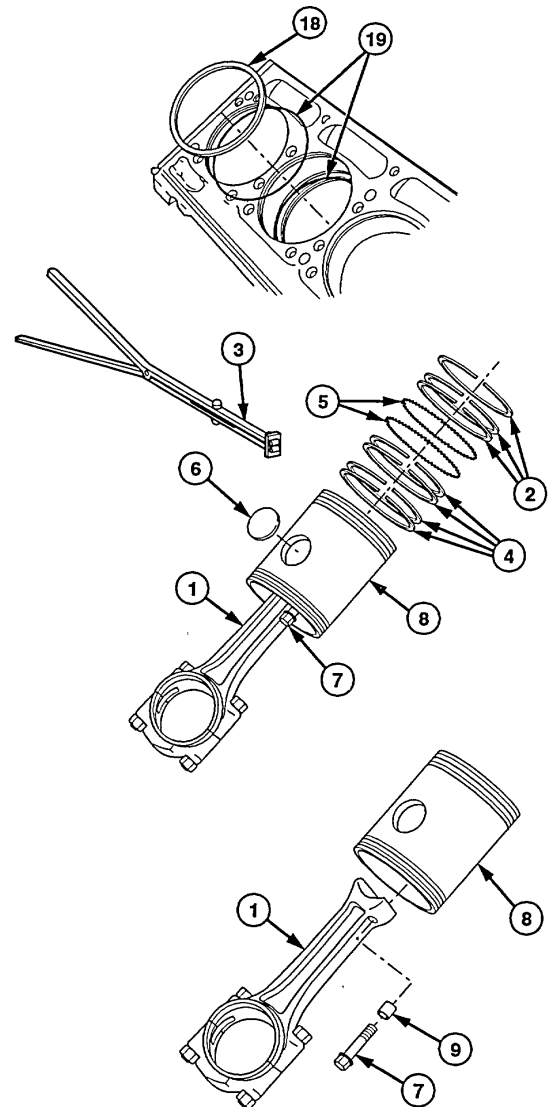
b. Disassembly

- (1) Place connecting rod (1) in soft-jawed vise.
- (2) Remove three upper piston rings (2) using piston ring remover and installer (3). Remove four lower piston rings (4) by hand. Discard all piston rings.
- (3) Remove oil ring expander (5) from each lower piston ring groove. Discard expander.
- (4) Punch hole in two piston pin retainers (6). Remove both retainers.
- (5) Loosen two screws (7) on connecting rod (1).
- (6) Remove connecting rod (1) and piston (8) from vise.

NOTE

Matchmark connecting rod and piston before removing connecting rod.

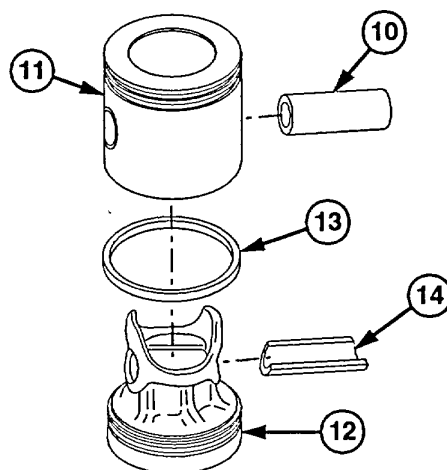
- (7) Remove two screws (7) and spacers (9) from connecting rod (1).
- (8) Remove connecting rod (1) from piston (8).



19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)**NOTE**

Matchmark piston pin, piston crown, piston skirt, and piston pin bearing before removal.

- (9) Remove piston pin (10) from piston skirt (11).
- (10) Separate piston crown (12) from piston skirt (11).
- (11) Remove rubber seal ring (13) from piston crown (12). Discard seal ring.
- (12) Remove piston pin bearing (14) from piston crown (12). Discard bearing.

**c. Cleaning/Inspection****WARNING**

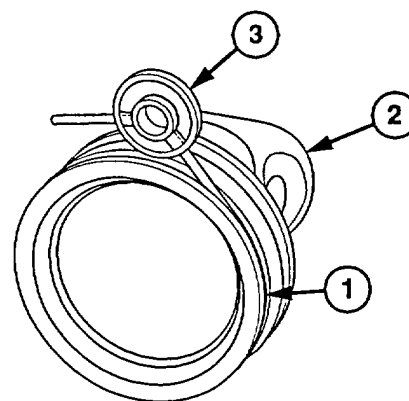
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean all metal parts with dry cleaning solvent.
- (2) Clean ring grooves and oil holes in pistons with paint brush and dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

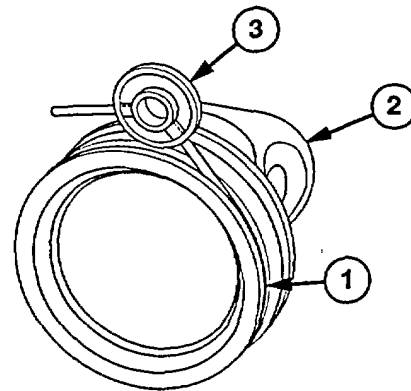
- (3) Dry parts with compressed air.
- (4) Inspect all parts for damage. Replace damaged parts.
- (5) Check fire ring groove (1) of piston crown (2) with piston groove gage tool (3).



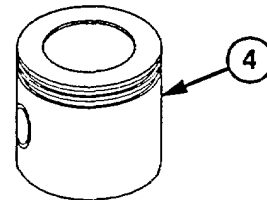
NOTE

Piston crown, bearing, and pin must be replaced as an assembly.

- (6) Slide NO-GO wire of piston groove gage tool (3) completely around groove (1). If wire is below flush at any one area, replace crown (2).
- (7) Slide GO wire of groove gage tool (3) completely around groove (1). Wire should be flush with or slightly higher than top edge of groove.



- (8) Measure diameter of piston skirt (4) and check for roundness using micrometer. Diameter must be between 4.8304 and 4.8314 in. (122.69 and 122.72 mm).

**NOTE**

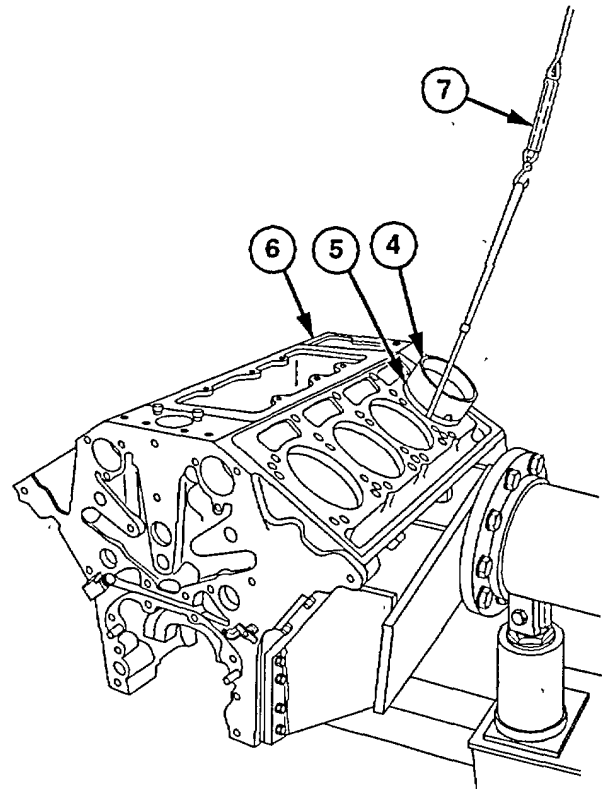
Piston skirt is installed upside down in liner.

- (9) With cylinder liner (5) installed on engine block (6), Install piston skirt (4) and feeler gage in liner (5) at same time. Have assistant attach piston gage set (7) and check clearance in four places 90 degrees apart.

NOTE

Feeler gage size is determined by amount of wear in piston skirt and liner.

- (10) Select largest feeler gage thickness that will require a pull of less than 6 lb (2.7 kg). Clearance will be 0.001 in. (0.25 mm) greater than feeler gage thickness when it is withdrawn with a pull of 6 lb (2.7 kg). Clearance must be between 0.007 and 0.011 in. (0.18 and 0.28 mm).

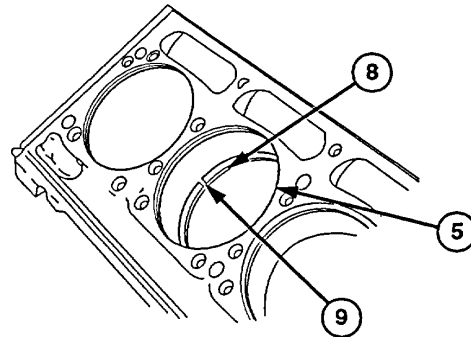


19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)

- (11) Insert new piston rings (8), one at a time inside cylinder liner (5) far enough to be in area of ring travel 2-3 in. (25-75 mm) deep. Use piston skirt to position ring parallel with top of cylinder liner.

NOTE

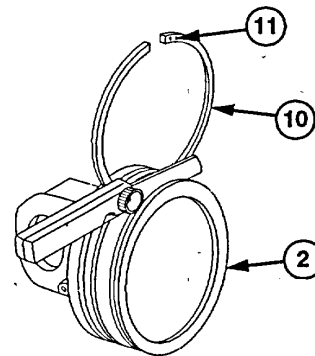
End of rings must be filed if gap is too small. File from outer surface to inner surface. Ends of rings must remain square.



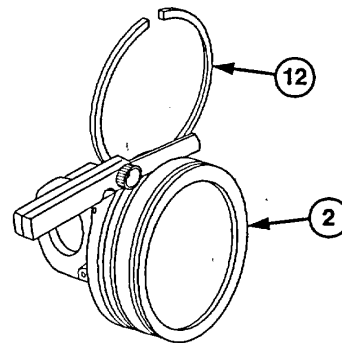
- (12) Measure ring gap (9) with feeler gage. Three compression rings should have a gap of 0.025-0.045 in. (0.63-1.1 mm). Two oil rings (upper slotted) should have a gap of 0.007-0.017 in. (0.18-0.43 mm). Two oil rings (lower) should have a gap of 0.010-0.025 in. (0.25-0.63 mm).

NOTE

- **Top ring has two punch marks on black side.**
- **Black side of ring faces top of piston.**

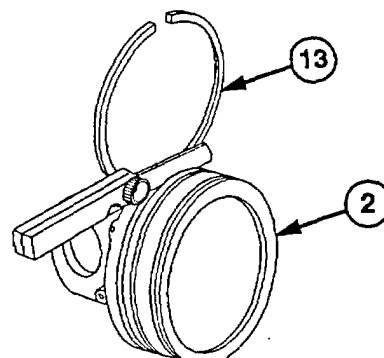


- (13) Install new top compression ring (10) with two punch marks (11) up on top groove of piston crown (2).
- (14) Measure clearance between compression ring (10) and groove; clearance should be 0.001-0.005 in. (0.025-0.13 mm). Remove top compression ring (10).



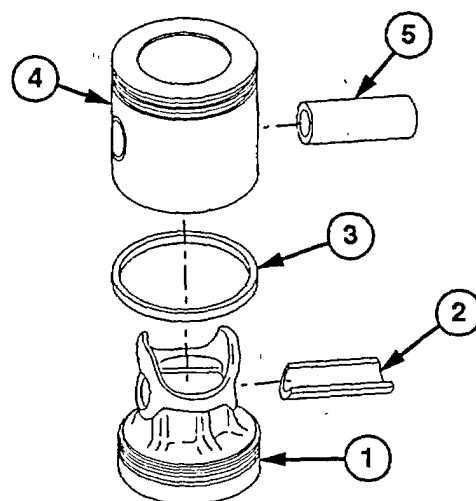
- (15) Insert new middle compression ring (12) in middle groove on piston crown (2); clearance should be 0.004-0.007 in. (0.10-0.18 mm).

- (16) Insert new lower compression ring (13) in lower groove on side of piston crown (2); clearance should be 0.004-0.007 in. (0.10-0.18 mm).



d. Assembly

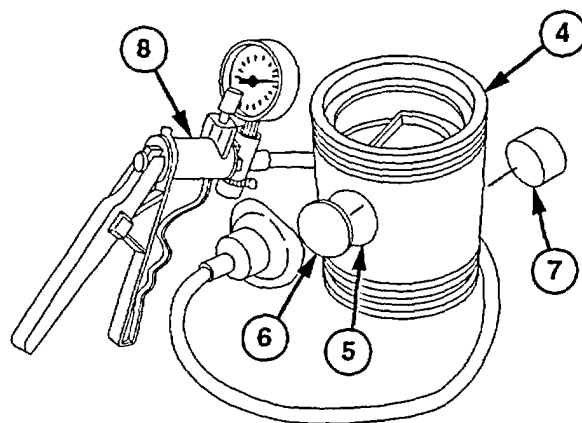
- (1) Place piston crown (1) top end down on work bench.
- (2) Install new piston pin bearing (2) in piston crown (1).
- (3) Coat new rubber seal ring (3) with lubricating oil.
- (4) Install rubber seal ring (3) on piston crown (1).
- (5) Push piston skirt (4) down into position on piston crown (1).
- (6) Coat piston pin (5) with lubricating oil.
- (7) Align hole in piston skirt (4) with hole in piston crown (1).
- (8) Install piston pin (5) with threaded holes toward bottom of piston skirt (4).
- (9) Place piston crown (1) and skirt (4) in soft-jawed vice.



NOTE

- Place domed end of retainer tool against retainer.
- Strike tool just hard enough to defect retainer and seat evenly in piston.

- (10) Install piston pin retainers (6) in piston skirt (4) at each side of piston pin (5) using piston pin retainer tool (7).
- (11) Use leak detector (8) to apply 10 in. (254 mm) of vacuum to each piston pin retainer (6). There should be no loss of pressure.
- (12) If loss of pressure occurs, repeat steps (10) and (11).
- (13) Remove piston crown (1) and skirt (4) from vise.



19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)

- (14) Install two spacers (9) on two screws (10).

WARNING

International no. 2 compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If no. 2 compound gets on skin or clothing, wash immediately with soap and water.

- (15) Coat threads and head contact surface of two screws (10) with international no. 2 compound.
 (16) Insert connecting rod (11) in piston skirt (4).
 (17) Install screws (10) finger tight.
 (18) Place connecting rod (11) in soft-jawed vise.
 (19) Tighten two screws (10) to 55-60 lb-ft (75-81 N•m).

NOTE

Replace piston rings in sets only.

- (20) Coat ring grooves in piston crown (1) and skirt (4) with lubricating oil.

NOTE

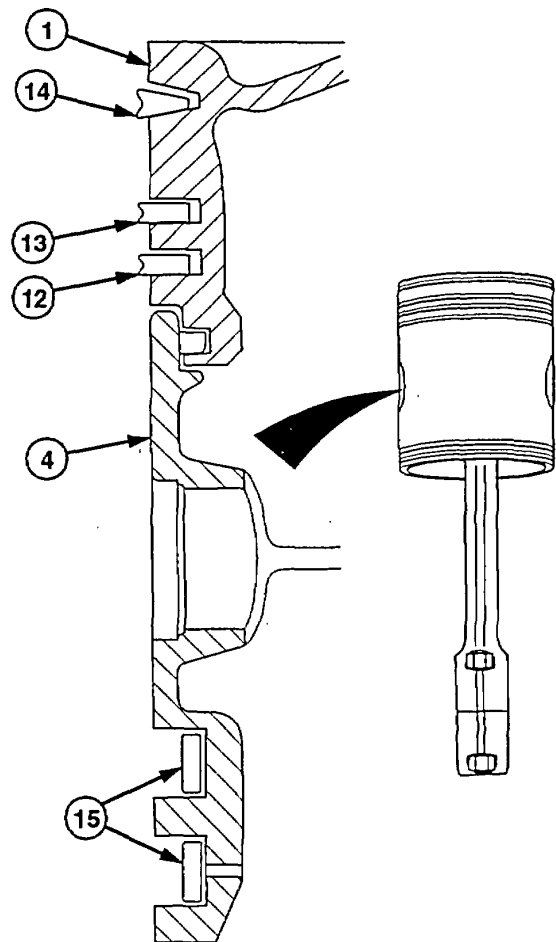
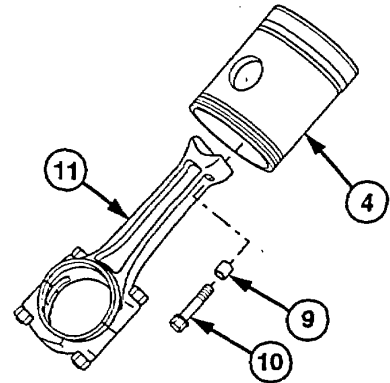
Position ring gaps 120 degrees apart around piston crown.

- (21) Install new lower piston ring (12) in bottom groove of piston crown (1).
 (22) Install new middle piston ring (13) in center groove of piston crown (1).

NOTE

- Black side of top ring faces top of piston.
- Top ring has two punch marks on black side.

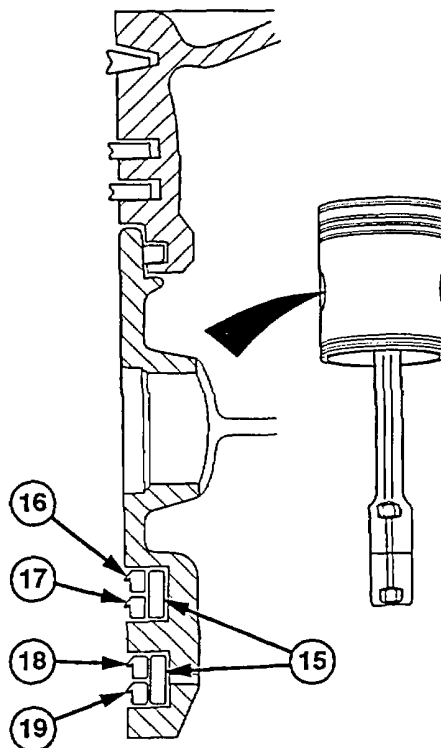
- (23) Install new top piston ring (14) (ring with beveled sides) in top groove of piston crown (1).
 (24) Install two new oil ring expanders (15) on piston skirt (4) with ends pointing up.
 (25) Remove piston from vise and place upside down on hard work surface.



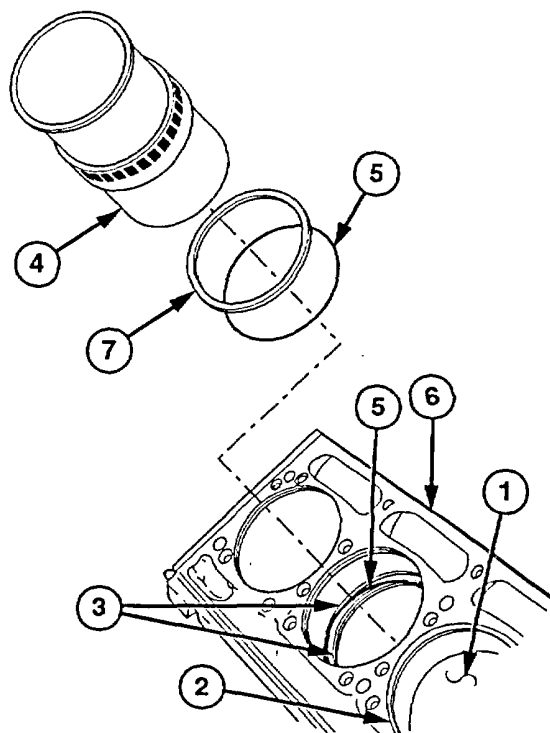
NOTE

- Install oil rings with beveled edge facing piston crown.
- Top oil ring has chrome beveled edge.
- Both lower oil rings have notches.

- (26) Install new chrome and orange oil ring (16) with gap positioned 180 degrees from gap in expander ring (15).
- (27) Install new black and orange oil ring (17) with gap positioned 90 degrees from gap in oil ring (16).
- (28) Install new oil ring (18) with notched side toward connecting rod and gap positioned 180 degrees from gap positioned in expander ring (15).
- (29) Install new oil ring (19) with notched side toward connecting rod and gap positioned 90 degrees from gap in oil ring (18).

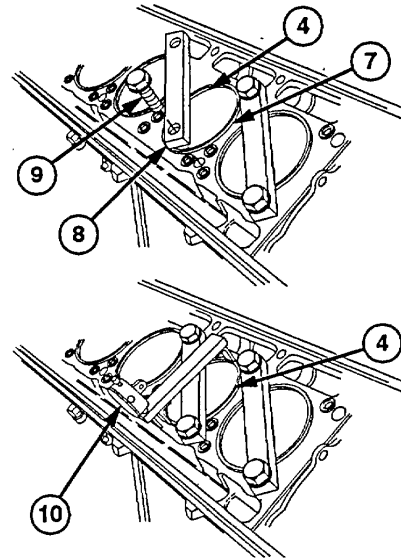
**e. Installation**

- (1) Wipe cylinder bore (1), counterbore (2), seal rings grooves (3), and cylinder liner (4) clean.
- (2) Install two new cylinder liner seal rings (5) in engine block (6).
- (3) Coat Inner surface of cylinder seal rings (5) with lubricating oil.
- (4) Install previously tagged liner insert (7) in counterbore (2) of engine block (6).
 - (a) Push cylinder liner (4) in cylinder block until liner flange rests on insert (7). Do not use excessive force to install liner. Liner should slide smoothly in place. Gently seat with soft-faced mallet.



19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)

- (b) Clamp liner (4) in place with hold down clamp (8) and two screws (9). Torque to 50 lb-ft (68 N•m).
- (c) Measure distance from top of liner (4) to top of block with cylinder liner depth gage (10). Liner flange must be 0.0418-0.0482 in. (1.06-1.22 mm) below surface of block. Even though all liners are within these specifications, there must not be over 0.0015 in. (0.038 mm) difference between two adjacent liners when measured along cylinder longitudinal centerline. If above limits are not met, install different thickness insert, install liner in another cylinder bore, and recheck or use new cylinder liner.
- (d) Remove screws (9), hold down clamp (8), and cylinder liner (4). Do not remove liner insert (7).

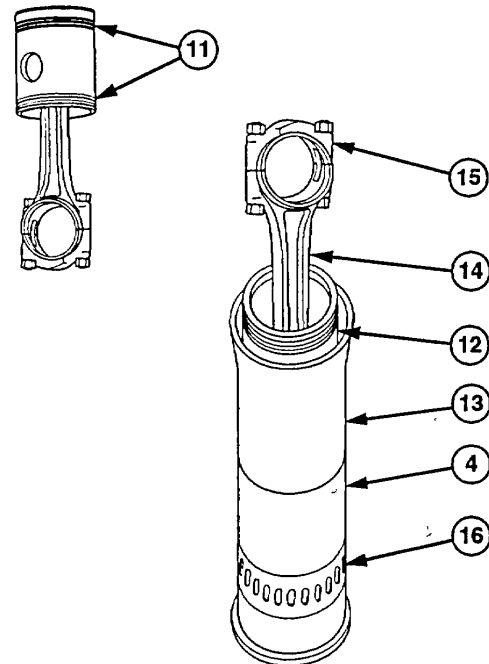


- (5) Coat piston rings (11) with lubricating oil.
- (6) Install piston (12) in ring compressor (13).
- (7) Coat inside of cylinder liner (4) with lubricating oil.
- (8) Hold cylinder liner (4) flange end down on wooden blocks. Place ring compressor (13) with piston and connecting rod (14) on cylinder liner (4).

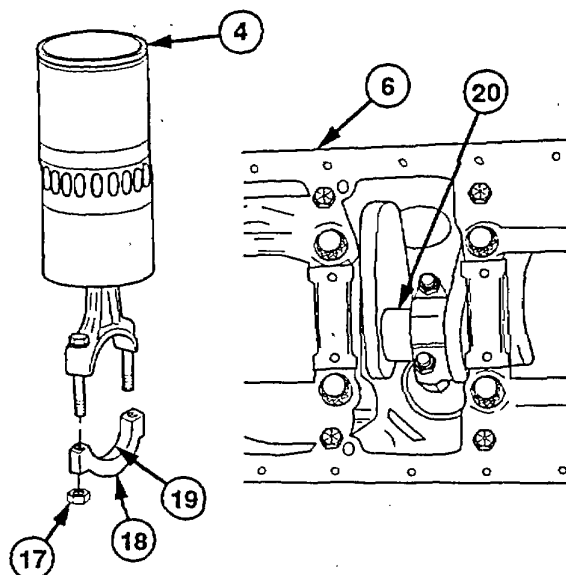
NOTE

Matchmarks align cylinder liner and engine block.

- (9) Align numbers on connecting rod (14) and rod bearing cap (15) with matchmark on cylinder liner (4).
- (10) Push piston into cylinder liner (4) until compression rings pass cylinder liner ports (16).
- (11) Remove ring compressor (13) from cylinder liner (4).



- (12) Remove two nuts (17), bearing cap (18), and bearing shell (19).
- (13) Coat new connecting rod bearing shell (19) with lubricating oil.
- (14) Position crankshaft connecting rod journal (20) of cylinder being worked on to bottom of its travel.
- (15) Coat journal (20) with lubricating oil.
- (16) Align matchmark on cylinder liner (4) and engine block (6).

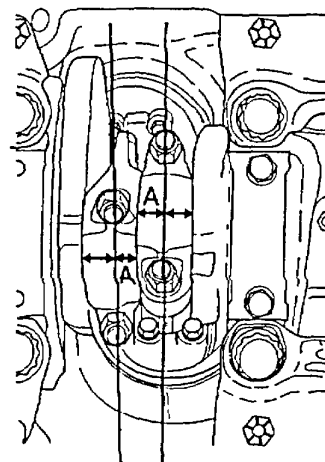


CAUTION

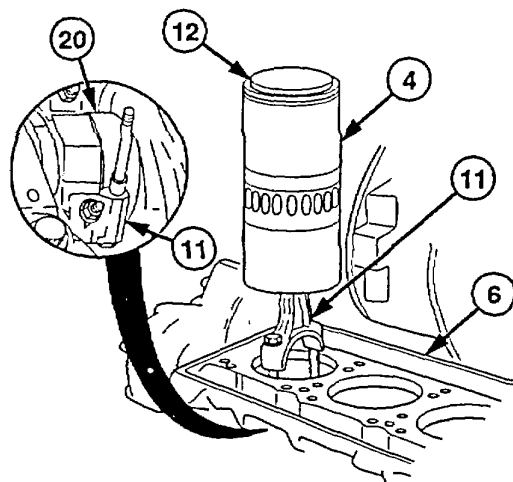
Distance from center of connecting rod bolts to edges of connecting rods are not equal. Narrow sides (A) of two connecting rods, on crankshaft journal, must face each other. Failure to comply will damage connecting rod.

NOTE

Pistons should be installed so that each crankshaft connecting rod journal has two pistons attached before moving to next crankshaft connecting rod journal.

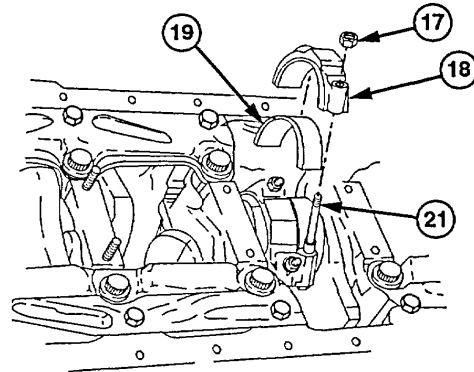


- (17) Slide cylinder liner (4) with piston (12) and connecting rod assembly (11) into engine block (6) while assistant guides connecting rod assembly over crankshaft journal (20).
- (18) Seat connecting rod (11) firmly on crankshaft journal (20).



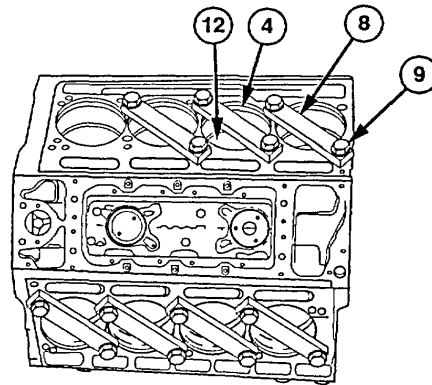
19-10. PISTON, CONNECTING ROD, AND LINER REPAIR (CONT)

- (19) Install cap (18) and new bearing shell (19) over two studs (21).
- (20) Install two nuts (17) on two studs (21). Torque to 60-70 lb-ft (81-95 N•m).

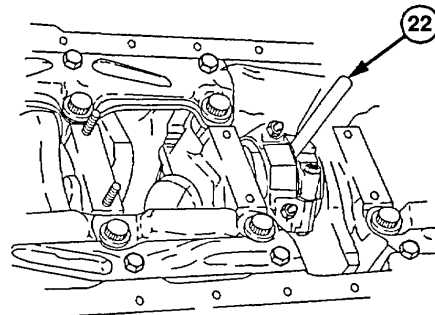
**NOTE**

Hold down clamps are installed over each piston and liner.

- (21) Install hold down clamp (8) over cylinder liner (4) with two screws (9).
- (22) Repeat steps (5) thru (21) for remaining pistons (12) and liners (4).
- (23) After all liners and pistons have been installed, remove screws (9) and hold down clamps (8).



- (24) Check that clearance between each connecting rod attached to same crankshaft journal is 0.008-0.016 in. (0.2-0.4 mm) using feeler gage (22).



f. Follow-On Maintenance

- (1) Install oil pan (para 3-20).
- (2) Install cylinder heads (para 3-10).
- (3) Install injectors (para 4-2).
- (4) Install rocker arms (para 3-18).
- (5) Install engine brake retarders (para 3-26).
- (6) Install engine brake retarder wire harnesses (para 6-16).
- (7) Install right thermostat housing (para 5-4).
- (8) Install left thermostat housing (para 5-3).
- (9) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).
- (10) Install fuel injector wire harnesses (para 4-3).
- (11) Install rocker covers (TM 9-2320-360-20).
- (12) Install thermostats (TM 9-2320-360-20).
- (13) Install electronic control module (ECM) (TM 9-2320-360-20).
- (14) Install fan belts (TM 9-2320-360-20).
- (15) Install fan (TM 9-2320-360-20).
- (16) Remove engine from engine stand (para 19-3).
- (17) Install air box covers (para 3-8).
- (18) Install air box drains (para 3-9).
- (19) Install exhaust manifolds (para 3-23).
- (20) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (21) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (22) Install starter (TM 9-2320-360-20).
- (23) Install sending units and attachments (TM 9-2320-360-20).

19-11. CAM FOLLOWER AND PUSH ROD REPAIR

This task covers:

a. Removal b. Cleaning/Inspection	c. Installation

INITIAL SETUP:
Equipment Conditions

Cylinder head on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Blocks, Wooden (Figure C-3, Appendix C)
 Caps, Vise Jaw (Item 17, Appendix E)
 Dial Indicator, Magnetic (Item 32, Appendix E)
 Gage, Feeler (Item 50, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Oil, Lubricating (Item 45, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Lockwashers (2) (Item 118, Appendix F)

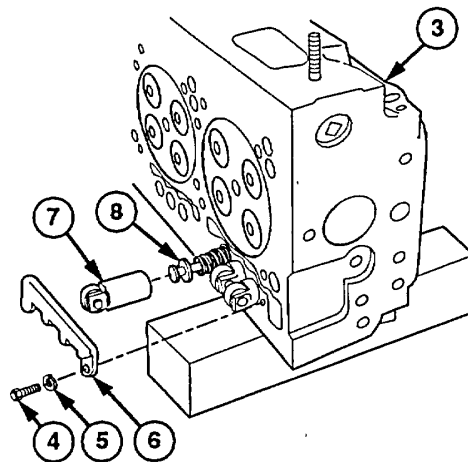
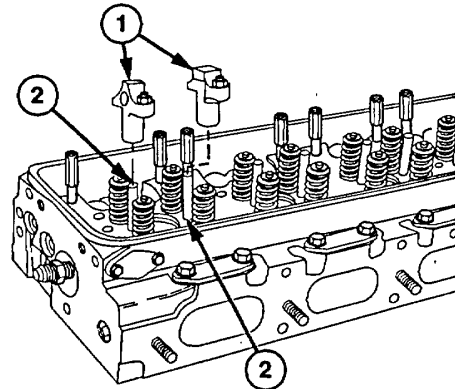
a. Removal

- (1) Remove exhaust valve bridges (1) from bridge guides (2).

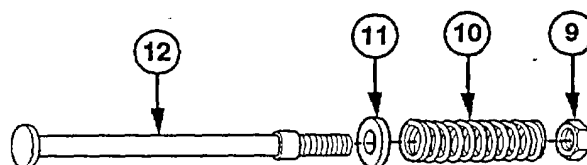
NOTE

- Tag cam follower and associated parts so they may be installed in original location.
- Cam followers are replaced the same way. Only one is shown.

- (2) Set cylinder head (3) on side on 1 in. (25 mm) wooden blocks.
- (3) Remove two screws (4) and lockwashers (5) from cam follower guide (6). Discard lockwashers.
- (4) Remove cam follower guide (6) from cylinder head (3).
- (5) Remove cam follower (7) and push rod assembly (8) from cylinder head (3) as one unit.
- (6) Remove cam follower (7) from push rod assembly (8).



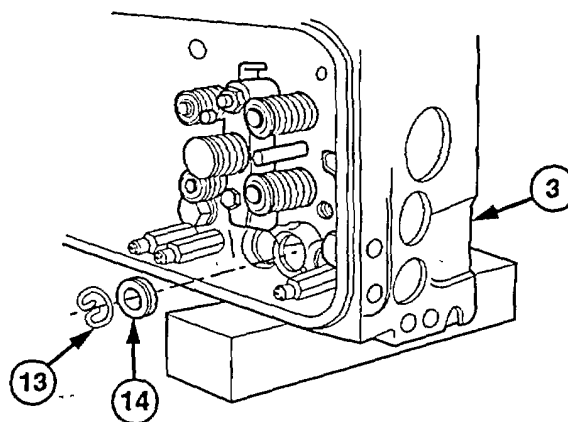
- (7) Remove locknut (9), spring (10), and lower spring seat (11) from push rod (12).



NOTE

Spring retainer must point in proper direction when installed. Mark direction of spring retainer before removal.

- (8) Remove spring retainer (13) from top side of cylinder head (3).
 (9) Remove upper spring seat (14) from cylinder head (3).



b. Cleaning/Inspection

WARNING

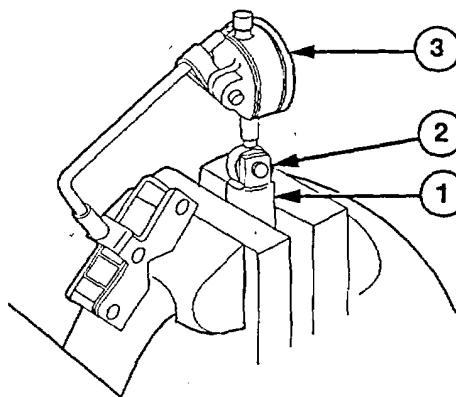
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean cam follower (1) with dry cleaning solvent.
 (2) Inspect cam follower (1) for damage.

CAUTION

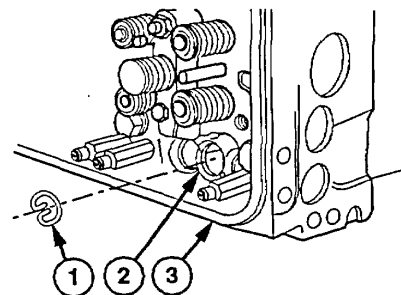
If clearance in step (3) is more than 0.023 in. (0.58 mm) or the clearance in step (4) is more than 0.010 in. (0.25 mm), go to disassembly. Damage to equipment may result.

- (3) Check side clearance between cam follower (1) and roller (2) to ensure it is not more than 0.023 in. (0.58 mm). If clearance is more than 0.023 in. (0.58 mm), go to disassembly.
 (4) Place cam follower (1) in soft-jawed vise on roller end of tube. Check for more than 0.010 in. (0.25 mm) pin-to-bushing clearance using dial indicator (3). If clearance is more than 0.010 in. (0.25 mm), replace cam follower.

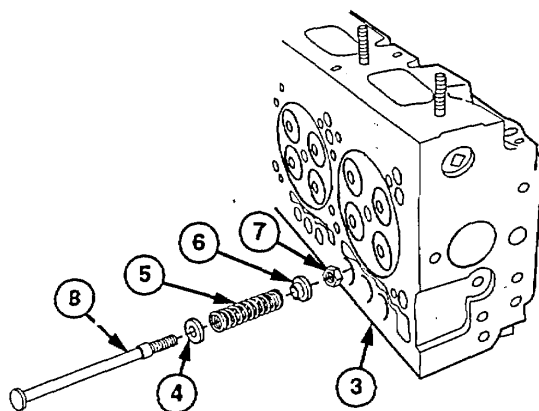


19-11. CAM FOLLOWER AND PUSH ROD REPAIR (CONT)**c. Installation**

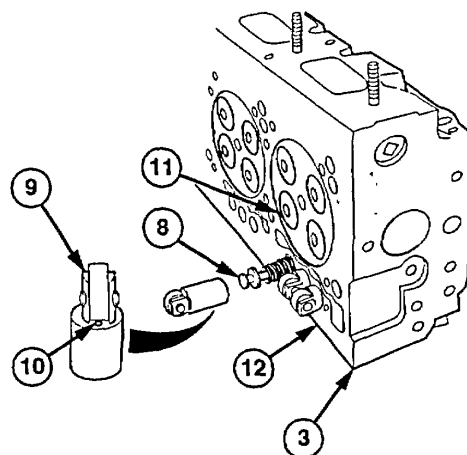
- (1) Install spring retainer (1) in top of cam follower bore (2) in cylinder head (3).



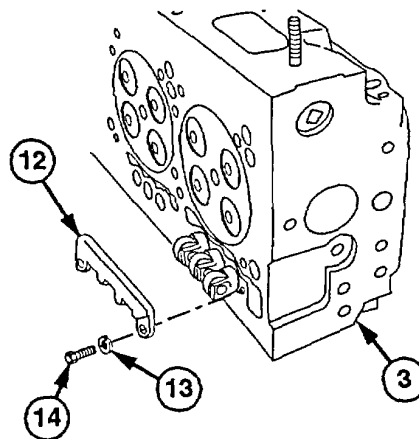
- (2) Install lower spring seat (4), spring (5), upper spring seat (6), and nut (7) on push rod (8).
- (3) Install push rod (8) in bottom of cylinder head (3).



- (4) Position cam follower (9) so oil hole (10) points away from exhaust valves (11).
- (5) Install cam follower (9) over push rod (8) and in cylinder head (3).
- (6) Install other push rods and cam followers in same manner.



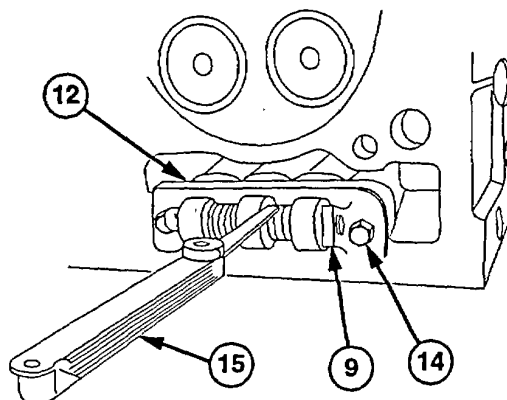
- (7) Install cam follower guide (12) on cylinder head (3) with two new lockwashers (13) and screws (14).
- (8) Tighten screws (14) to 180 lb-in. (20.3 N•m).



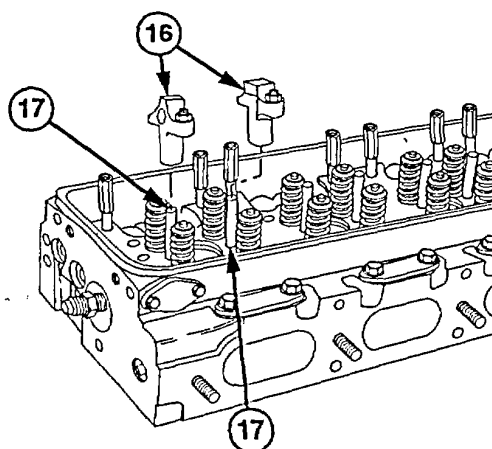
NOTE

There must be a minimum of 0.005 in. (0.13 mm) clearance between cam follower guide and cam follower.

- (9) Insert 0.005 in. (0.13 mm) feeler gage (15) between cam follower guide (12) and legs of cam followers (9).
- (10) If there is not enough clearance, loosen screws (14), move guide (12), and repeat step (9).



- (11) Install exhaust valve bridges (16) on bridge guides (17).



19-12. CAMSHAFT AND END BEARING REPAIR

This task covers

a. Removal b. Disassembly c. Cleaning/Inspection	d. Assembly e. Installation f. Follow-On Maintenance
-

Initial Setup:
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 Electronic control module (ECM) removed (TM 9-2320-360-20).
 Thermostats removed (TM 9-2320-360-20).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 Rocker covers removed (TM 9-2320-360-20).
 Fuel injector wire harnesses removed (para 4-3).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Left thermostat housing removed (para 5-3).
 Right thermostat housing removed (para 5-4).
 Secondary fuel filter housing removed (para 4-13).
 Water pump removed (para 5-5).
 Vibration damper and front cover removed (para 3-15).
 Water pump drive gear removed (para 3-24).
 Blower accessory drive hub removed (para 4-9).
 Engine brake retarder wire harnesses removed (para 6-16).
 Engine brake retarders removed (para 3-26).
 Rocker arms removed (para 3-18).
 Injectors removed (para 4-2).
 Cylinder heads removed (para 3-10).
 Oil pan removed (para 3-20).
 Flexplate assembly removed (para 3-17).
 Flywheel housing removed (para 19-9).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Dial Indicator, Magnetic (Item 32, Appendix E)
 Drill Set, Twist (Item 33, Appendix E)
 Drill, Electric, Portable (Item 34, Appendix E)
 Gage Set, Telescoping (Item 56, Appendix E)
 Gage, Feeler (Item 50, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Press, Hydraulic, 60-Ton (Item 116, Appendix E)
 Puller, Camshaft Gear (Item 123, Appendix E)
 Puller Kit, Mechanical, Slide Hammer (Item 125, Appendix E)
 Pulley Remover, Camshaft Gear and Water Pump (Item 136, Appendix E)
 Socket, Sockethead Screw, 114 in. (Item 171, Appendix E)
 V-blocks (Item 206, Appendix E)
 Wrench Set, Socket, 3/4 In. Drive (Item 231, Appendix E)
 Wrench Set, Socket, 3/8 In. Drive (Item 232, Appendix E)
 Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Adhesive-Sealant (Item 3, Appendix B)
 Grease, Automotive and Artillery (Item 32, Appendix B)
 Oil, Lubricating (Item 45, Appendix B)
 Rags (Item 51, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Gasket (Item 33, Appendix F).
 Lockwashers (6) (Item 140, Appendix F)
 Lockwasher (Item 141, Appendix F)
 Sea], Oil (Item 312, Appendix F)

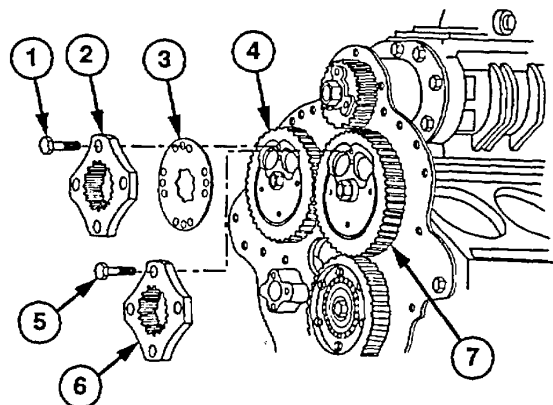
a. Removal

- (1) Remove four screws (1), adapter (2), and retainer (3) from left camshaft gear (4).
- (2) Remove four screws (5) and adapter (6) from right camshaft gear (7).

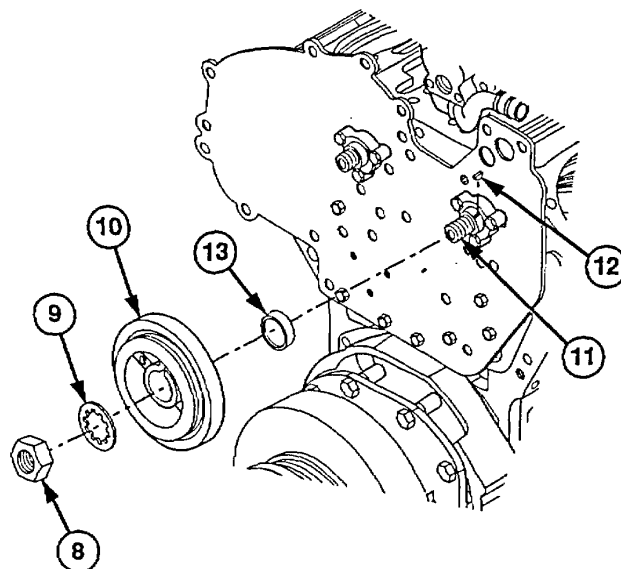
NOTE

Shop cloth is used between camshaft gears to prevent turning.

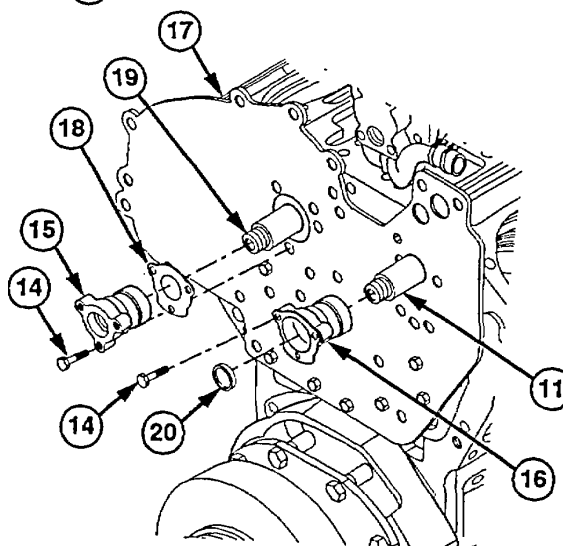
- (3) Place a clean shop cloth between gears (4 and 7).



- (4) Remove nut (8), lockwasher (9), and balance pulley (10) from front of camshaft (11). Discard lockwasher.
- (5) Remove woodruff key (12) and spacer (13) from end of left camshaft (11).



- (6) Remove six lock screws (14) from two end bearings (15 and 16) and engine block (17).
- (7) Remove end bearing (15) and gasket (18) from right camshaft (19).
- (8) Remove end bearing (16) from camshaft (11).
- (9) Remove oil seal (20) from end bearing (16). Discard seal.

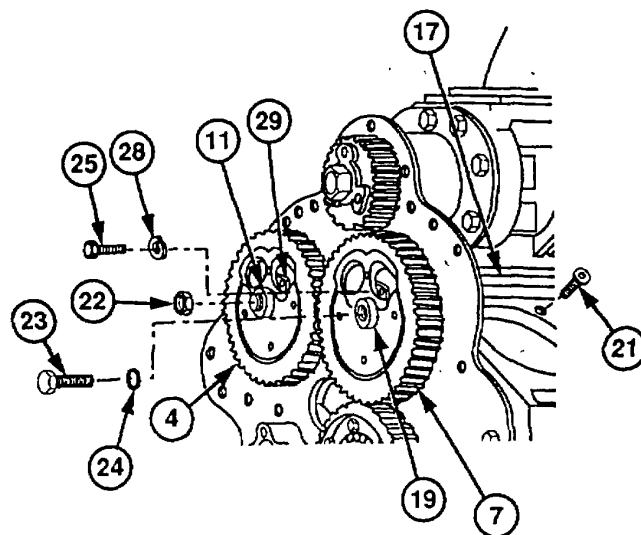


19-12. CAMSHAFT AND END BEARING REPAIR (CONT)

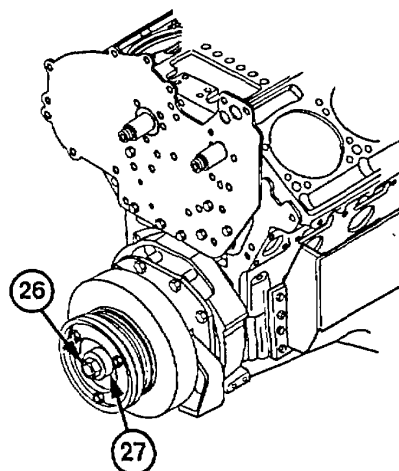
- (10) Remove six intermediate bearing lockscrews (21) from engine block (17).
- (11) Remove nut (22) from rear end of left camshaft (11).
- (12) Remove screw (23) and washer (24) from rear end of right camshaft (19).
- (13) Remove cloth from between gears.

CAUTION

When using front crankshaft capscrew to bar over engine, always turn in a clockwise direction. Turning over in a counterclockwise direction may loosen the capscrew and vibration damper. Serious damage to engine may result.



- (14) Turn gears (4 and 7) to reach rear end camshaft bearing screws (25) using screw (26) on front end of crankshaft (27).
- (15) Remove three camshaft rear end bearing screws (25) and lockwashers (28) from each rear camshaft bearing (29). Discard lockwashers.

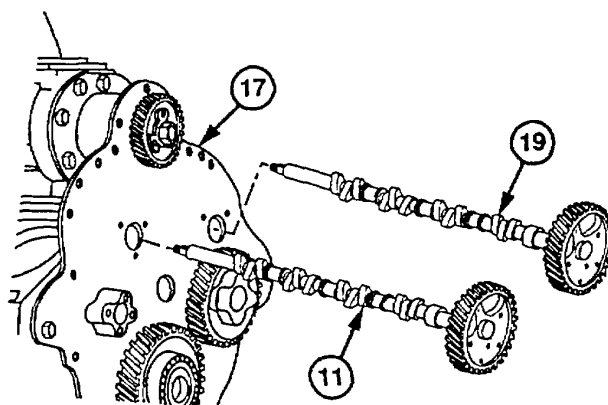
**CAUTION**

Use care when removing camshafts. Camshafts may be damaged by scraping or hitting engine block or hard surface.

NOTE

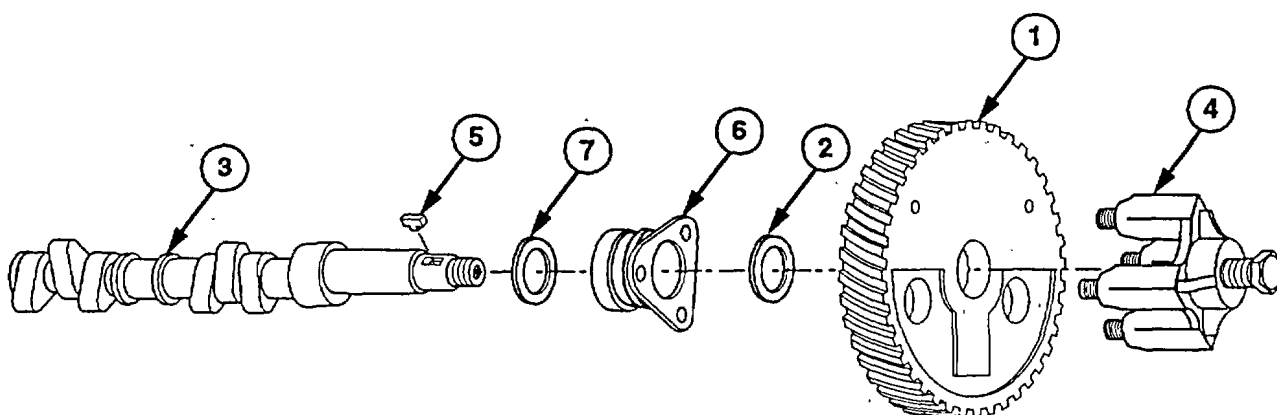
Tag and mark all parts to aid in assembly.

- (16) Remove two camshaft assemblies (11 and 19) from rear of engine block (17).



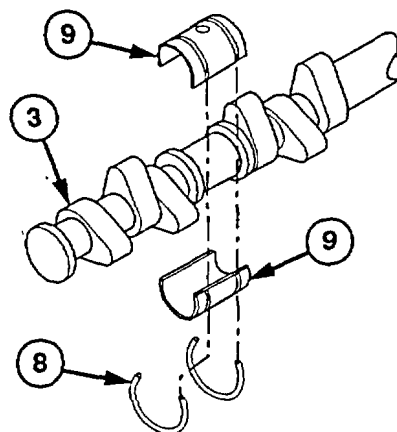
b. Disassembly

- (1) Remove gear (1) and thrust washer (2) from end of camshaft (3) using camshaft gear puller and remover (4).
- (2) Remove woodruff key (5) from end of camshaft (3).
- (3) Remove end bearing (6) and thrust washer (7) from end of camshaft (3).

**NOTE**

Tag and mark three camshaft bearings to aid in installation.

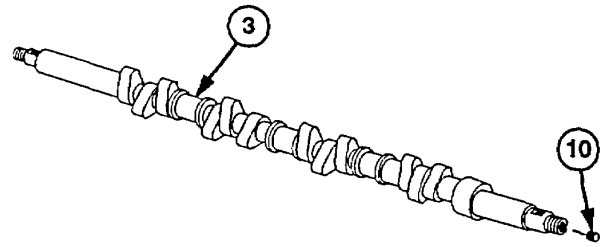
- (4) Remove six lock rings (8) and three camshaft Intermediate bearings (9) from camshaft (3).
- (5) Repeat steps (1) thru (4) for other camshaft.



19-12. CAMSHAFT AND END BEARING REPAIR (CONT)**NOTE**

There are two plugs in end of camshafts. All plugs are removed the same way.

- (6) Position camshaft (3) in soft-jawed vise.
- (7) Drill $31/64$ in. (8.3 mm) hole in center of plug (10).
- (8) Enlarge hole in plug (10) from $31/64$ to $1/4$ in. (8.3 to 6.4 mm).
- (9) Enlarge hole in plug (10) from $1/4$ to $5/16$ in. (6.4 to 7.9 mm).
- (10) Remove plug (10) from camshaft (3) using slide hammer.

**c. Cleaning/Inspection****WARNING**

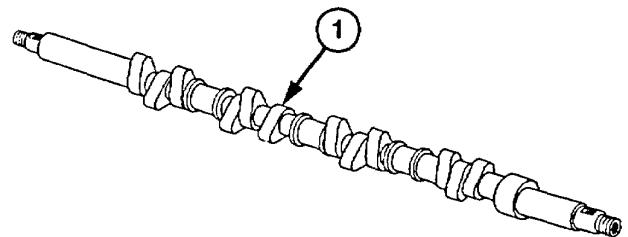
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean all camshaft parts with dry cleaning solvent

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

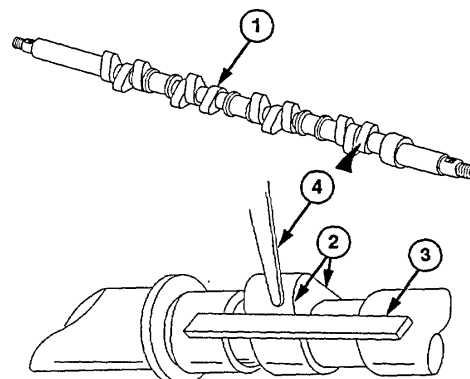
- (2) Dry parts with compressed air.
- (3) Inspect camshaft (1) for scratches or damage.
- (4) Damaged keyways may be filed smooth.
- (5) Threaded holes may be retapped.



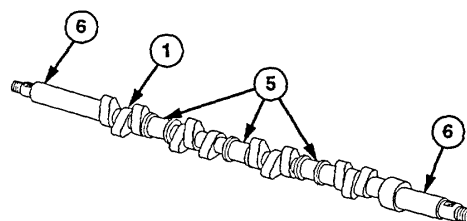
NOTE

Flat measurement must not exceed 0.003 in. (0.076 mm).

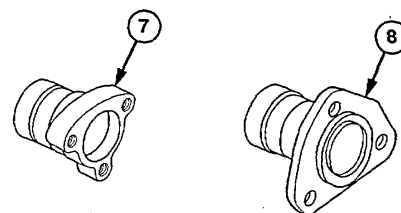
- (6) Measure flat spots (2) on 12 cam lobes using a straightedge (3) and 0.003 in. (0.076 mm) feeler gage (4). Replace camshaft if measurement exceeds 0.003 in. (0.076 mm).



- (7) Measure and record diameters of three bearing Journals (5). Replace camshaft (1) if any diameter is less than 1.4980 in. (38.049 mm).
- (8) Measure and record diameters of two end bearing journals (6). Replace camshaft (1) if any diameter is less than 1.4980 in. (38.049 mm).



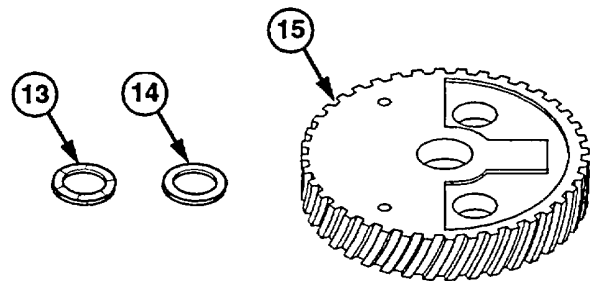
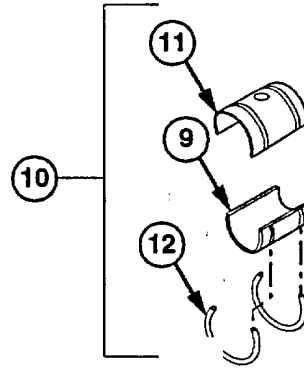
- (9) Measure and record inside diameter of four end bearing bushings (7 and 8).



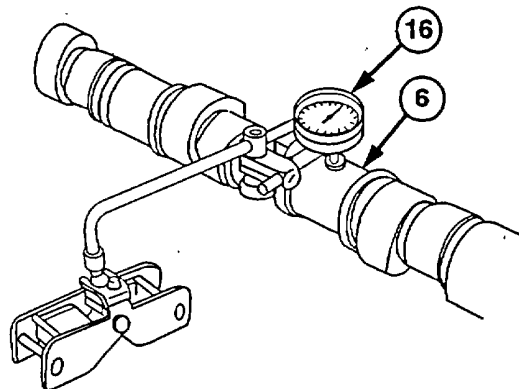
- (10) Take measurement recorded in step (8) and subtract it from measurement recorded in step (9). Total difference may not exceed 0.006 in. (0.15 mm).

19-12. CAMSHAFT AND END BEARING REPAIR (CONT)

- (11) Place lower half (9) of three intermediate bearings (10) together with top half (11).
- (12) Install six lock rings (12) over three intermediate bearings (10).
- (13) Measure and record inside diameter of three intermediate bearings (10).
- (14) Take measurement recorded in step (7) and subtract from measurement recorded in step (13).
- (15) Replace three intermediate bearings (10) if clearance exceeds 0.009 in. (0.23 mm).
- (16) Inspect spacers (13) and oil seal (14). Replace if damaged.
- (17) Inspect two camshaft gears (15) for worn or damaged teeth. Replace if damaged.



- (18) Place camshaft end bearing journals (6) in V blocks and use magnetic dial indicator (16) to check center bearing surface for runout. Runout should not exceed 0.002 in. (0.05 mm).
- (19) If runout exceeds 0.002 in. (0.05 mm), replace camshaft.
- (20) Repeat steps (1) thru (19) for other camshaft.



d. Assembly

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (1) Coat sides of two camshaft plugs (1) with adhesive-sealant.

NOTE

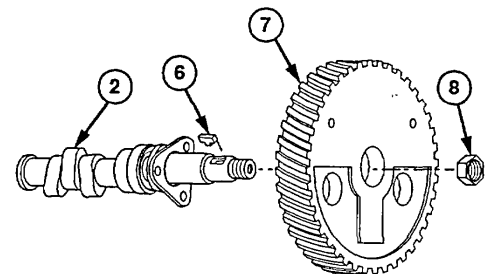
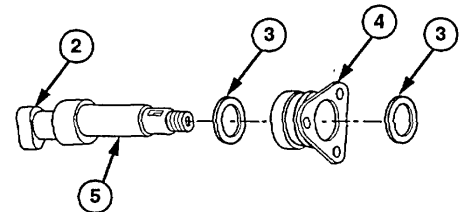
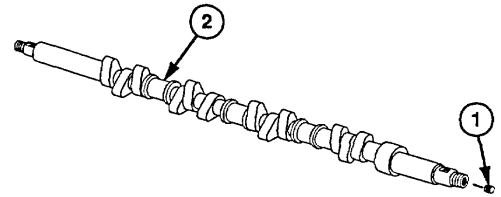
Camshaft plugs should be installed to a depth of 1.9402.060 in. (49.28-52.32 mm).

- (2) Install two plugs (1) in end of camshafts (2).

NOTE

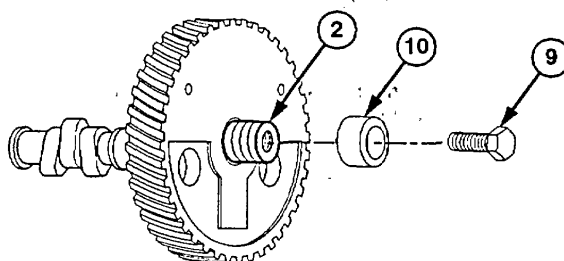
Steel faces of thrust washers are next to bearing.

- (3) Coat steel faces of two thrust washers (3) with grease.
- (4) Position thrust washer (3) against each end of camshaft rear end bearing (4).
- (5) Coat camshaft rear bearing Journal (5) with lubricating oil.
- (6) Install two thrust washers (3) and camshaft rear end bearing (4) on camshaft (2).
- (7) Install woodruff key (6) in keyway at rear of camshaft (2).
- (8) Align camshaft gear (7) with key (6).
- (9) Press gear (7) onto shoulder of camshaft (2).
- (10) Repeat steps (3) thru (9) for other camshaft.
- (11) Install nut (8) on left camshaft (2). Tighten finger tight.



19-12. CAMSHAFT AND END BEARING REPAIR (CONT)

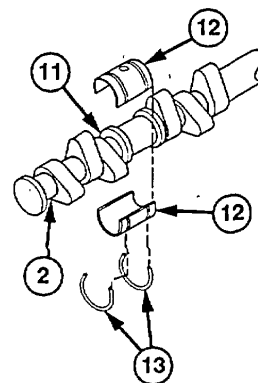
- (12) Install capscrew (9) and spacer (10) on right camshaft (2). Tighten finger tight.



- (13) Coat camshaft intermediate bearing journals (11) with lubricating oil.
- (14) Position 12 halves of intermediate bearing (12) on camshaft journals (11).

NOTE

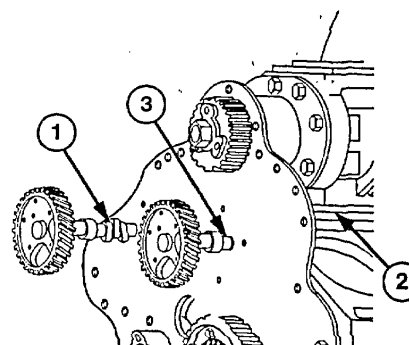
Bottom half of intermediate bearings do not have holes.



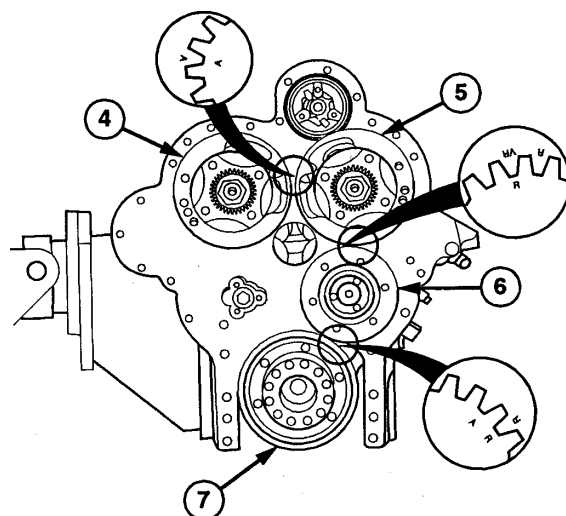
- (15) Install six lock rings (13) over bottom half of three intermediate bearings (12).
- (16) Repeat steps (13) thru (15) for other camshaft.

e. Installation

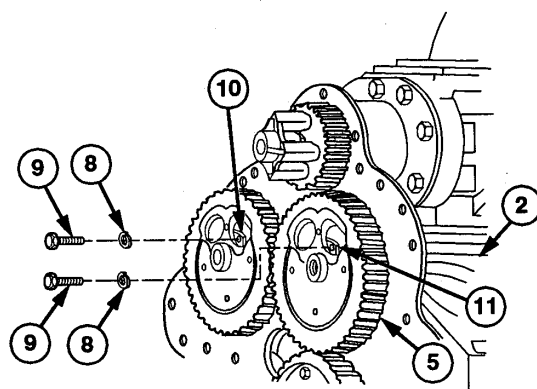
- (1) Install left camshaft (1) in engine block (2).
- (2) Install right camshaft (3) in engine block (2).



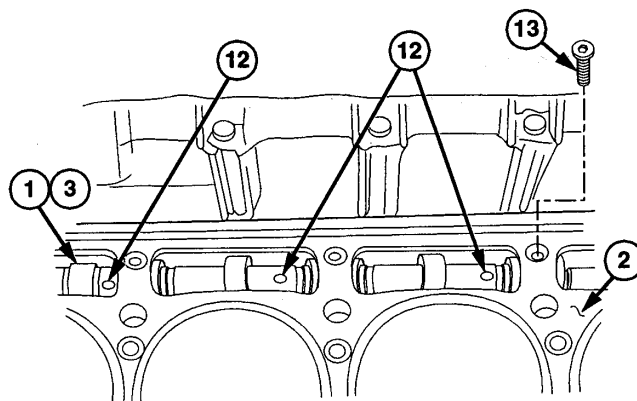
- (3) Align left camshaft gear (4), right camshaft gear (5), idler gear (6), and crankshaft timing gear (7) so timing marks on gears line up as shown.
- (4) Slide camshaft gears (4 and 5) in place until camshaft gears and idler gear (6) are fully meshed.
- (5) Check timing marks again to ensure gears (4, 5, 6, and 7) are aligned as shown.



- (6) Turn gear (5) to reach all rear end bearing screw holes.
- (7) Install three new lockwashers (8) and screws (9) on each camshaft rear end bearing (10 and 11) and engine block (2). Torque to 40 lb-ft (54 N•m).



- (8) Align holes in three Intermediate bearings (12) on right and left camshafts (1 and 3) with tapped holes in engine block (2).
- (9) Install six lock screws (13). Torque to 240 lb-in. (27.1 N•m).



19-12. CAMSHAFT AND END BEARING REPAIR (CONT)

- (10) Coat camshaft front end bearing journal (14) with clean engine oil.

NOTE

Gasket is on left side bearing only.

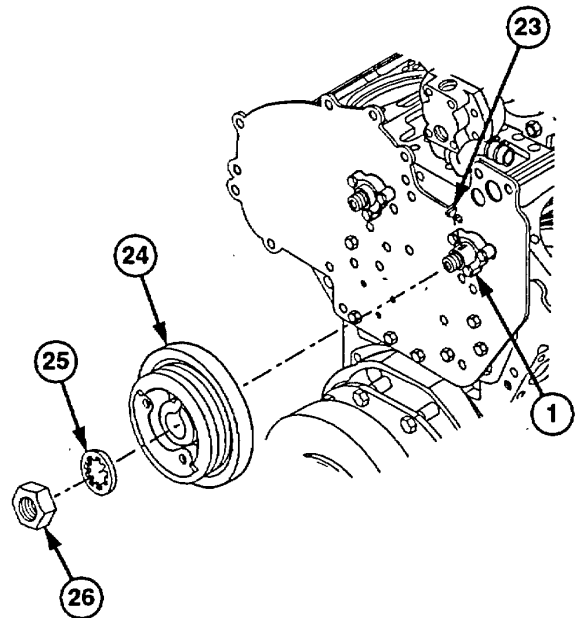
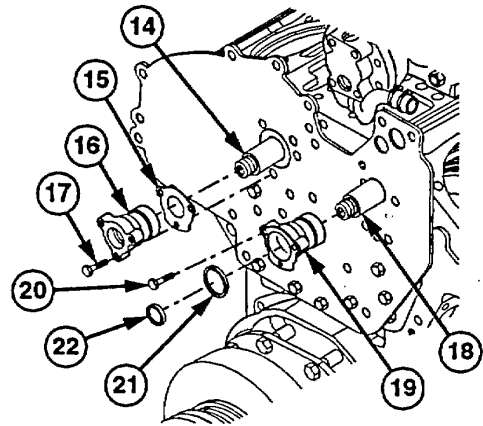
- (11) Install new gasket (15) and end' bearing (16) on journal (14) with three screws (17). Torque to 40 lb-ft (54 N•m).
- (12) Coat camshaft front end bearing journal (18) with clean engine oil.
- (13) Install end bearing (19) on journal (18) with three screws (20). Torque to 40 lb-ft (54 N•m).

NOTE

Spacers have polished outside diameters.

- (14) Install new oil seal (21) and spacer (22) on end bearing (19).

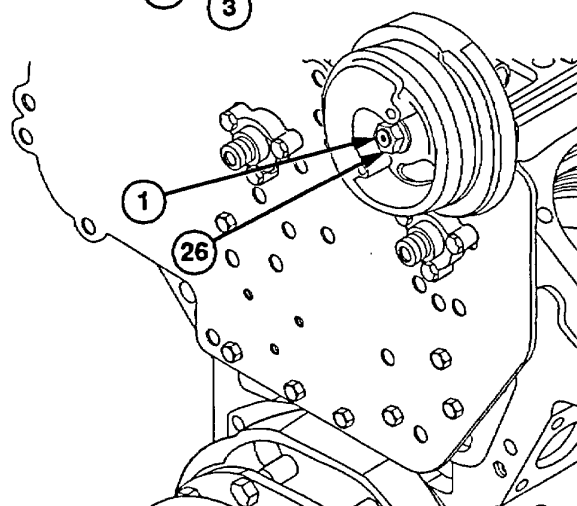
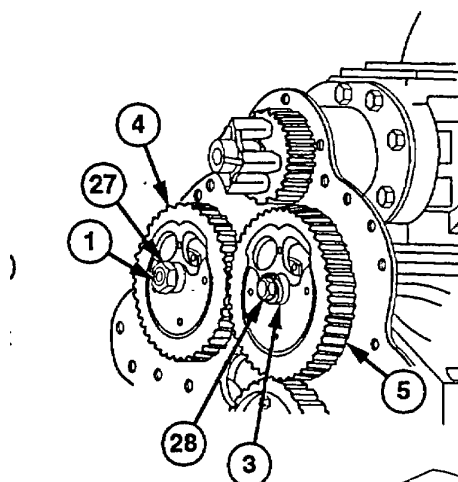
- (15) Install woodruff key (23) In camshaft (1).
- (16) Install pulley (24) on camshaft (1) with new lockwasher (25) and nut (26). Tighten finger tight.



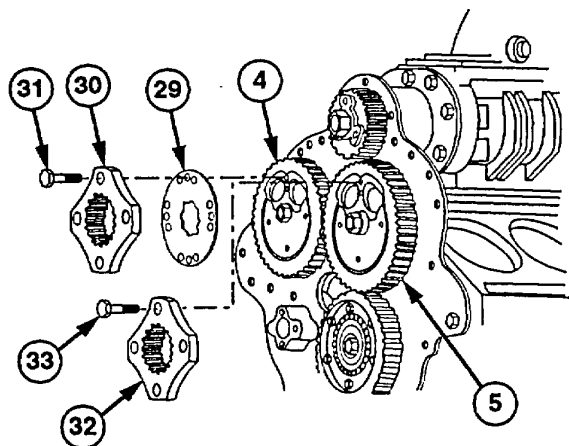
NOTE

Shop cloth is used between camshaft gears to prevent turning.

- (17) Place clean shop cloth between teeth of camshaft gears (4 and 5).
- (18) lighten nut (27) on rear end of camshaft (1 to 300 lb-ft (407 N•m).
- (19) Tighten screw (28) on rear end of camshaft (3) to 180-190 lb-ft (244-258 N•m).
- (20) Tighten nut (26) on front end of camshaft (1) to 300 lb-ft (407 N•m).



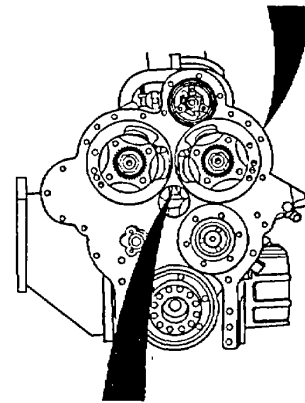
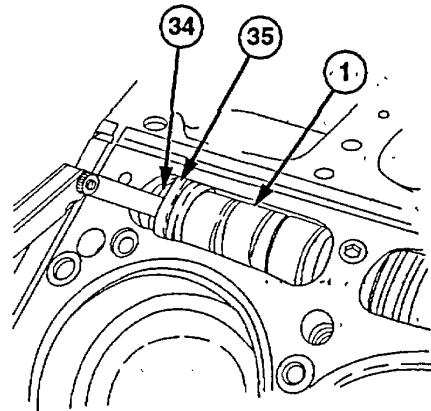
- (21) Install retainer (29) in mounting position on left camshaft gear (4).
- (22) Install adapter (30) In mounting position with four screws (31). Torque to 40 lb-ft (54 N•m).
- (23) Install adapter (32) on right camshaft gear (5) with four screws (33). Torque to 40 lb-ft (54 N•m).



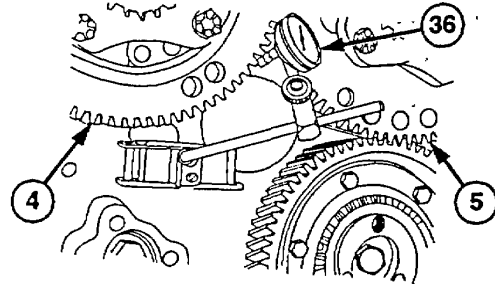
19-12. CAMSHAFT AND END BEARING REPAIR (CONT)**NOTE**

Camshaft may have to be gently pulled toward front of engine to check clearance.

- (24) Check clearance between thrust washer (34) and shoulder (35) of camshaft (1). If clearance is less than 0.003 in. (0.076 mm) or greater than 0.018 in. (0.46 mm), replace camshaft.



- (25) Check backlash between gears (4 and 5) using dial indicator (36). Minimum backlash is 0.002 in. (0.05 mm). Maximum backlash is 0.010 in. (0.0254 mm).

**f. Follow-On Maintenance**

- (1) Install flywheel housing (para 19-9).
- (2) Install flexplate assembly (para 3-17).
- (3) Install oil pan (para 3-20).
- (4) Install cylinder heads (para 3-10).
- (5) Install Injectors (para 4-2).
- (6) Install rocker arms (para 3-18).

f. Follow-On Maintenance (Cont)

- (7) Install engine brake retarders (para 3-26).
- (8) Install engine brake retarder wire harnesses (para 6-16).
- (9) Install blower accessory drive hub (para 4-9).
- (10) Install water pump drive gear (para 3-24).
- (11) Install vibration damper and front cover (para 3-15).
- (12) Install water pump (para 5-5).
- (13) Install secondary fuel filter housing (para 4-13).
- (14) Install right thermostat housing (para 5-4).
- (15) Install left thermostat housing (para 5-3).
- (16) Adjust valve clearance, engine brake retarder, and fuel injector timing (para 3-27).
- (17) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (18) Install fuel injector wire harnesses (para 4-3).
- (19) Install rocker covers (TM 9-2320-360-20).
- (20) Install DDEC oil pressure sensor (TM 9-2320-360-20).
- (21) Install thermostats (TM 9-2320-360-20).
- (22) Install electronic control module (ECM) (TM 9-2320-360-20).
- (23) Install fan clutch (TM 9-2320-360-20).
- (24) Install fan belts (TM 9-2320-360-20).
- (25) Install fan (TM 9-2320-360-20).
- (26) Remove engine from engine stand (para 19-3).
- (27) Install air box covers (para 3-8).
- (28) Install air box drains (para 3-9).
- (29) Install exhaust manifolds (para 3-23).
- (30) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (31) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (32) Install starter (TM 9-2320-360-20).
- (33) Install sending units and attachments (TM 9-2320-360-20).

19-13. IDLER GEAR REPAIR

This task covers:

a. Removal b. Disassembly c. Cleaning/Inspection	d. Assembly e. Installation f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 DDEC oil pressure sensor removed (TM 9-2320-360-20).
 12-volt (rear) alternator/bracket removed (TM 9-2320-360-20).
 Blower accessory drive hub removed (para 4-9).
 Oil pan removed (para 3-20).
 Flexplate assembly removed (para 3-17).
 Flywheel housing removed (para 19-9).

Tools and Special Tools

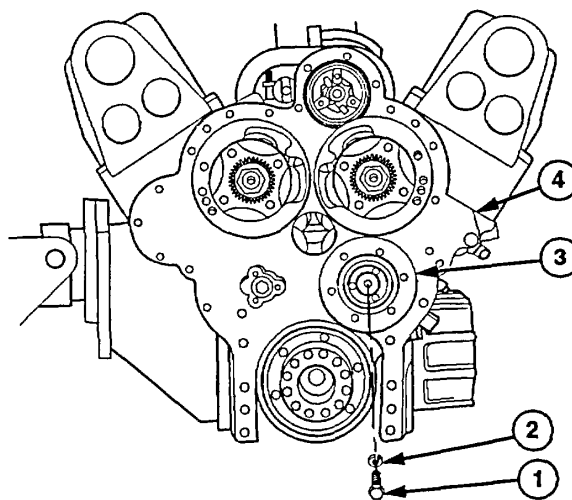
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caps, Vise Jaw (Item 17, Appendix E)
 Dial Indicator, Magnetic (Item 32, Appendix E)
 Holding Fixture, Idler Gear (Item 41, Appendix E)
 Scale, Spring (Item 145, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Oil, Lubricating (Item 45, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Ties, Cable, Plastic (Item 60, Appendix B)
 Screws, Nylon Patch (6) (Item 282, Appendix F)

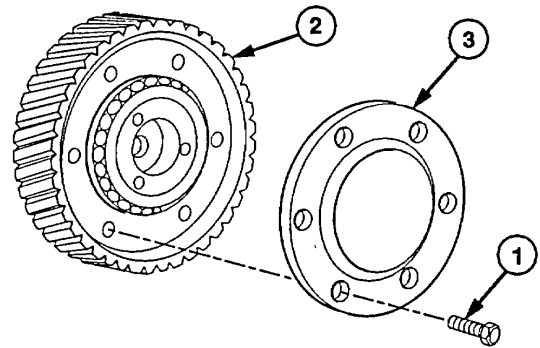
a. Removal

- (1) Remove screw (1) and special washer (2) from idler gear (3).
- (2) Remove idler gear assembly (3) from engine block (4).



b. Disassembly

- (1) Remove six screws (1) from idler gear assembly (2). Discard screws.
- (2) Remove retainer (3) from idler gear assembly (2).

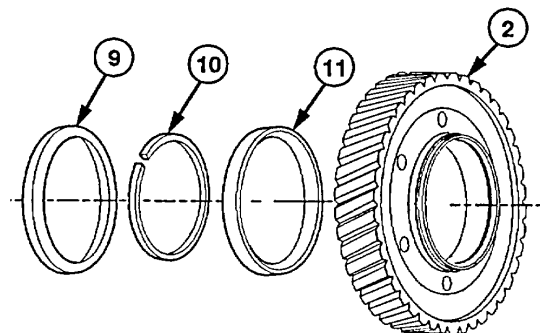
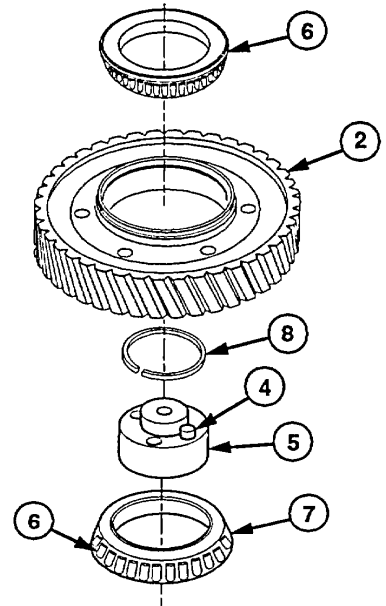
**NOTE**

- Mark parts of idler gear bearings if they will be used again. Do not scratch or damage bearings.
 - Support idler gear by bearing cone while in press.
- (3) Place Idler gear assembly (2) in press with hollow pin (4) facing down.

CAUTION

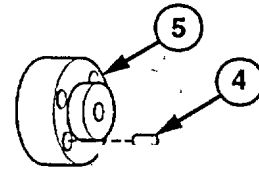
Idler gear assembly must be rotated during removal to prevent damage to bearing cones.

- (4) Rotate Idler gear assembly (2) while pressing idler gear hub (5) out of bearing cones (6 and 7).
- (5) Remove idler gear assembly (2) as one unit from the press.
- (6) Remove outer bearing cone (7), inner spacer ring (8), and inner bearing cone (6) from idler gear assembly (2).
- (7) Remove outer bearing cup (9), outer spacer ring (10), and inner bearing cup (11) from Idler gear assembly (2).



19-13. IDLER GEAR REPAIR (CONT)

- (8) Remove hollow pin (4) from idler gear hub (5).

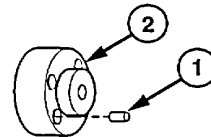
**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean idler gear and bearing parts with dry cleaning solvent.
- (2) Inspect bearing for scoring, pitting, or flat spots on rollers or cones.
- (3) Inspect bearing cups for scoring, pitting, and dents in bearing surface.
- (4) Examine gear teeth for scoring, pitting, and chips.
- (5) Replace all damaged parts.
- (6) Coat all parts with lubricating oil.

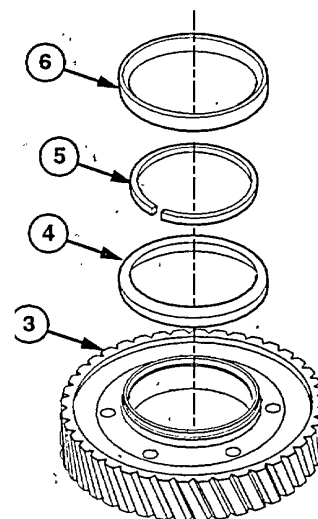
d. Assembly.

- (1) Install hollow pin (1) on idler gear hub (2).

**NOTE**

Bearing cones and cups are matched sets. If any part is unusable, all parts must be replaced.

- (2) Support idler gear (3), shoulder down, on bed of press.
- (3) Coat inner bearing cup (4) with lubricating oil. Insert inner bearing cup (4), numbered side up, in bore of gear (3).
- (4) Press inner bearing cup (4) to seat against shoulder of gear (3).
- (5) Install outer spacer ring (5) on inner bearing cup (4).
- (6) Coat bearing cup (6) with lubricating oil. Insert outer bearing cup (6), numbered side down, in bore of gear (3).
- (7) Press outer bearing cup (6) to seat against shoulder of gear (3).



- (8) Coat all parts with lubricating oil.
- (9) Position outer bearing cone (7), numbered side down, on bed of press.
- (10) Press idler gear hub (2) in outer bearing cone (7) until bottom of hub (2) is flush with bottom of cone (7).
- (11) Install inner spacer ring (8) on idler gear hub (2).
- (12) Position gap in spacer ring (8) on side opposite of oil hole in idler gear hub (2).
- (13) Support outer bearing cone (7) and idler gear hub (2).
- (14) Position idler gear assembly (3) on idler gear hub (2).
- (15) Position inner bearing cone (9) on idler gear assembly (3).

CAUTION

Turn gear while installing bearing cone on idler gear hub to prevent damage to bearing cups.

- (16) Turn idler gear assembly (3) while pressing inner bearing cone (9), numbered side up, over hub (2).
- (17) Hold hub (2) and turn gear assembly (3) to see if binding occurs.

NOTE

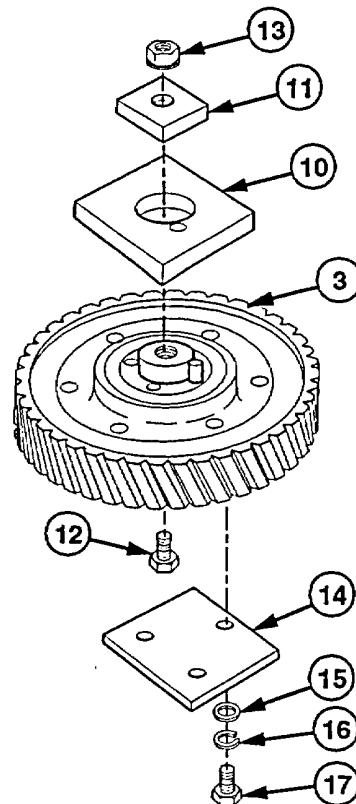
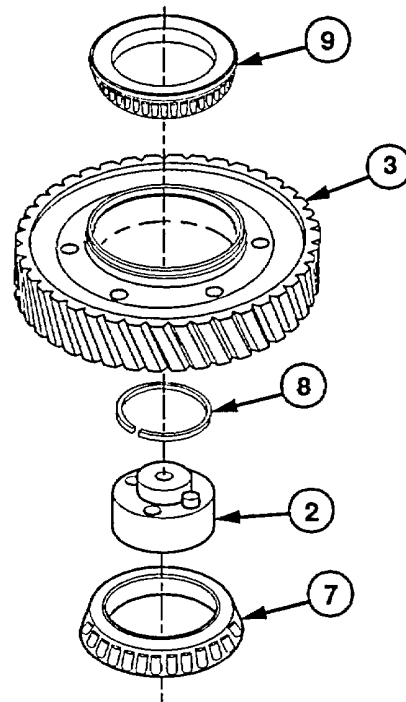
To check idler gear preload, do steps (18) thru (28).

- (18) Mount idler gear (3) in soft-jawed vise.

CAUTION

Hollow pin on idler gear hub must be aligned with hole in test fixture plate. Failure to comply may press pin into idler gear hub.

- (19) Mount two test fixture plates (10 and 11) on idler gear (3) with screw (12) and nut (13). Torque to 90 lb-ft (122 N•m).
- (20) Mount test fixture plate (14) on idler gear (3) with three washers (15), lockwashers (16), and screws (17). Torque to 40 lb-ft (54 N•m).

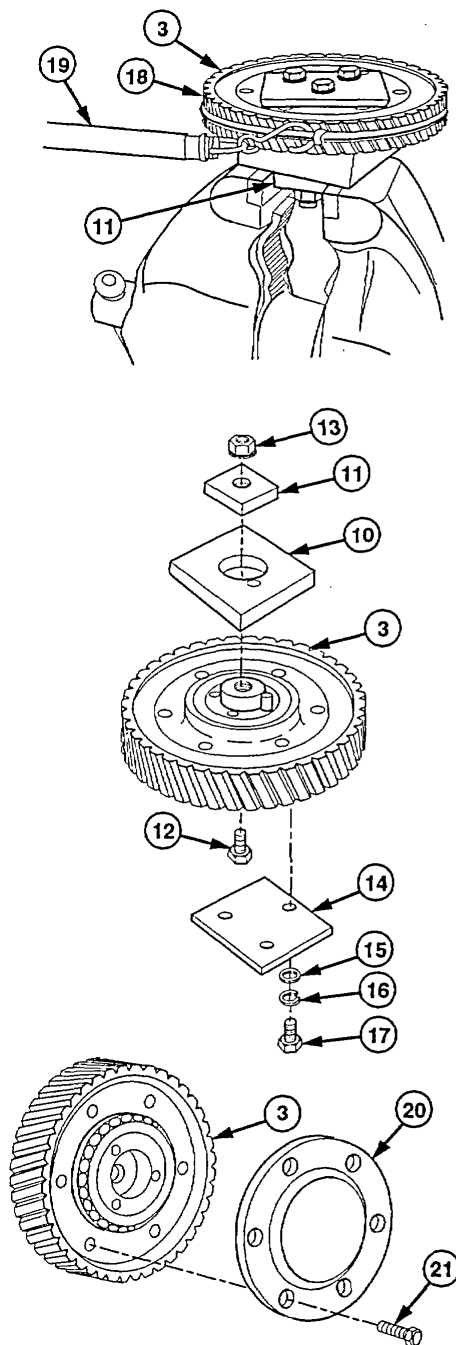


19-13. IDLER GEAR REPAIR (CONT)

- (21) Place plate (11) in jaws of vise.
- (22) Install two plastic ties (18) around outside edge of idler gear (3) and tighten.
- (23) Position spring gage (19) hook between tie strap and idler gear (3).

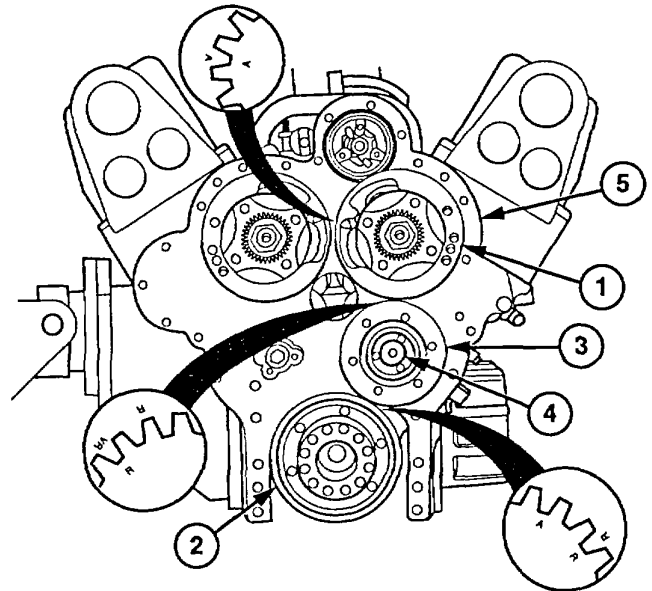
NOTE

- Pull to start gear moving must not be less than 0.5 lb (0.23 kg) or more than 4.0 lb (1.8 kg).
 - If scale reading is more than specified maximum, rollers are binding or improperly installed.
 - If scale reading is less than specified minimum, bearings are worn.
- (24) Pull spring gage (19) several times and record pull required to start gear (3) moving. Maximum difference between pulls is 2 lb, 11 oz (1.22 kg).
 - (25) Remove spring gage (19) and plastic ties (18) from idler gear (3).
 - (26) Remove three screws (17), lockwashers (16), washers (15), and test fixture plate (14).
 - (27) Place idler gear assembly (3) in soft-jawed vise.
 - (28) Remove nut (13), screw (12), and two test fixture plates (10 and 11).
 - (29) Remove idler gear assembly (3) from vise.
 - (30) Install retainer (20) on idler gear assembly (3) with six new nylon patch screws (21). Torque to 30 lb-ft (41 N•m).

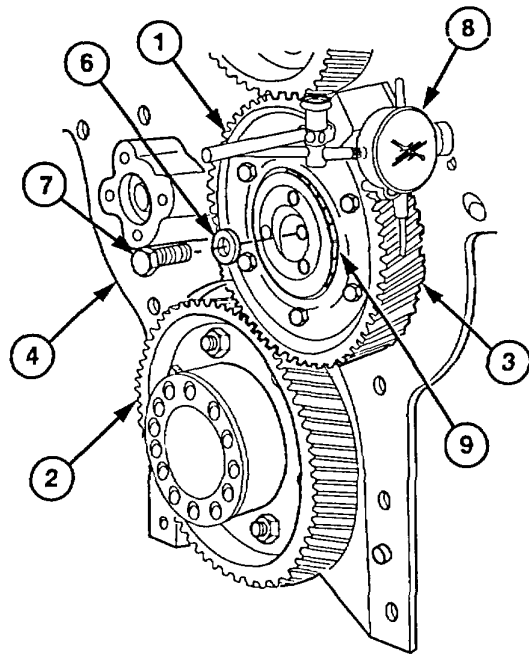


e. Installation

- (1) Align timing marks on camshaft gear (1) and crankshaft gear (2) with timing marks on idler gear (3).
- (2) Slide idler gear (3) in place until crankshaft gear (2) and camshaft gear (1) are fully meshed.
- (3) Rotate gear hub (4) so dowel in hub aligns with hole in end plate (5).
- (4) Tap hub (4) until it seats against end plate (5).
- (5) Check timing marks again to ensure gears (1, 2, and 3) are aligned as shown.
- (6) Install special washer (6) and screw (7) in idler gear (3). Torque to 90 lb-ft (122 N•m).
- (7) Mount dial indicator (8) on end plate (5) and check backlash between gears (1, 2, and 3). Minimum backlash is 0.002 in. (0.05 mm). Maximum backlash is 0.010 in. (0.25 mm).
- (8) Coat bearing (9) and idler gear (3) with lubricating oil.

**f. Follow-On Maintenance**

- (1) Install flywheel housing (para 19-9).
- (2) Install flexplate assembly (para 3-17).
- (3) Install oil pan (para 3-20).
- (4) Install blower accessory drive hub (para 4-9).
- (5) Install 12-volt (rear) alternator/bracket (TM 9-2320-360-20).
- (6) install DDEC oil pressure sensor (TM 9-2320-360-20).
- (7) Remove engine from engine stand (para 19-3).
- (8) Install air box covers (para 3-8).
- (9) Install air box drains (para 3-9).
- (10) Install exhaust manifolds (para 3-23).
- (11) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (12) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (13) Install starter (TM 9-2320-360-20).
- (14) Install sending units and attachments (TM 9-2320-360-20).



19-14. CRANKSHAFT COVER, FRONT OIL SEAL, AND OIL PUMP REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance
-

INITIAL SETUP
Equipment Conditions

Sending units and attachments removed (TM 9-2320-360-20).
 Starter removed (TM 9-2320-360-20).
 150 amp circuit breakers removed (TM 9-2320-360-20).
 24-volt (front) alternator/bracket removed (TM 9-2320-360-20).
 Exhaust manifolds removed (para 3-23).
 Air box drains removed (para 3-9).
 Air box covers removed (para 3-8).
 Engine mounted on engine stand (para 19-3).
 Fan removed (TM 9-2320-360-20).
 Fan belts removed (TM 9-2320-360-20).
 Fan clutch removed (TM 9-2320-360-20).
 24-volt (front) alternator adjusting strap removed (TM 9-2320-360-20).
 Crankshaft pulley removed (para 3-12).
 Crankshaft vibration damper removed (para 3-14).
 Oil pan removed (para 3-20).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer, 0-6 In. (Item 15, Appendix E)
 Caliper, Vernier, 0-6 In. (Item 16, Appendix E)

Tools and Special Tools (Cont)

Press, Hydraulic (Item 116, Appendix E)
 Seal Installer, Front Crankshaft (Item 156, Appendix E)
 Wrench Set, Socket, 3/8 In. Drive (Item 232, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

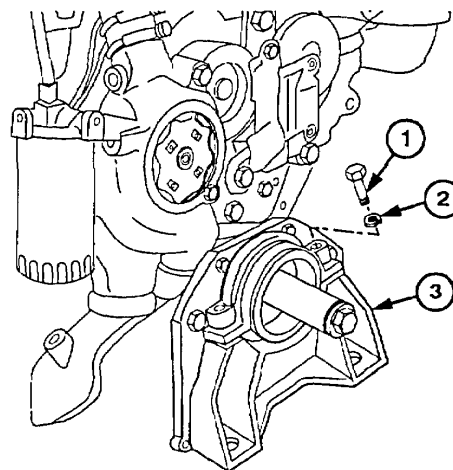
Materials/Parts

Grease, Automotive and Artillery (item 32, Appendix B)
 Oil, Lubricating (Item 45, Appendix B)
 Gasket (Item 41, Appendix F)
 Gasket (Item 56, Appendix F)
 Gasket (Item 32, Appendix F)
 Key (Item 72, Appendix F)
 Locknuts (2) (Item 97, Appendix F)
 Lockwashers (6) (Item 122, Appendix F)
 Lockwashers (4) (Item 127, Appendix F)
 Lockwashers (2) (Item 121, Appendix F)
 Screws, Self-Locking (8) (Item 280, Appendix F)
 Seal (Item 292, Appendix F)

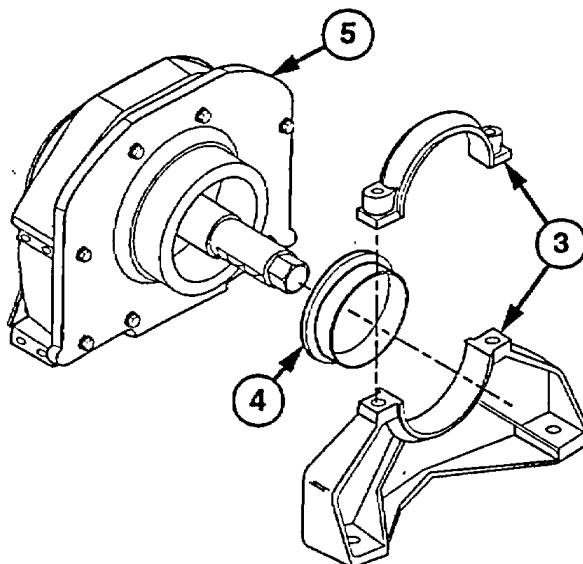
a. Removal
WARNING

Hold support when removing screws to prevent it from dropping. Failure to comply may result in Injury to personnel.

- (1) Remove two screws (1) and lockwashers (2) from support (3). Discard lockwashers.



- (2) Remove support (3) and ring (4) from trunnion (5).



- (3) Remove four screws (6) and lockwashers (7) from trunnion (5). Discard lockwashers.

- (4) Remove two screws (8) and lockwashers (9) from trunnion (5). Discard lockwashers.

- (5) Remove two screws (10) and lockwashers (11) from trunnion (5). Discard lockwashers.

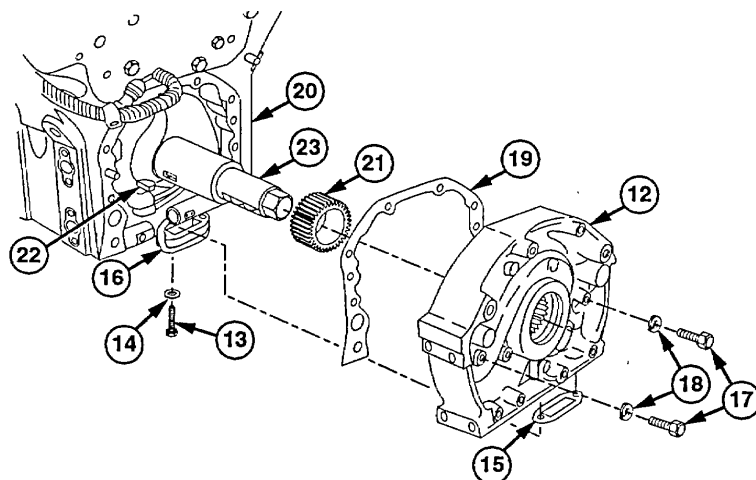
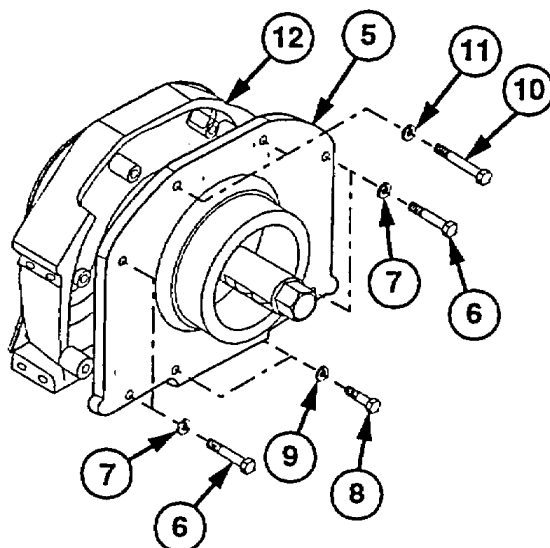
- (6) Remove trunnion (5) from crankshaft cover (12).

- (7) Remove two screws (13), washers (14), and gasket (15) from oil inlet pipe (16) on bottom of crankshaft cover (12). Discard gasket.

- (8) Remove two screws (17) and lockwashers (18) from inside crankshaft cover (12). Discard lockwashers.

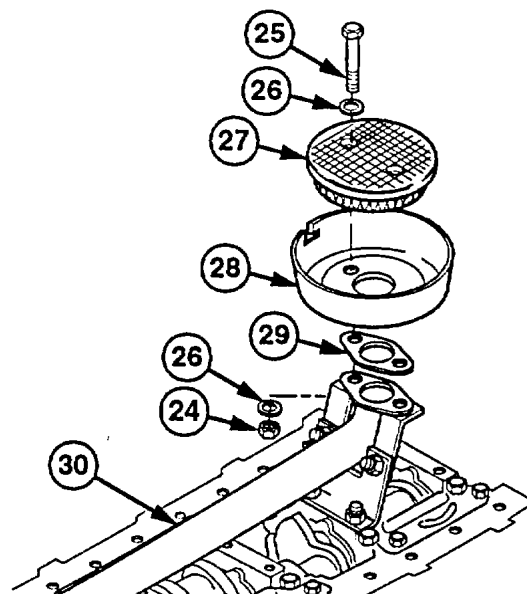
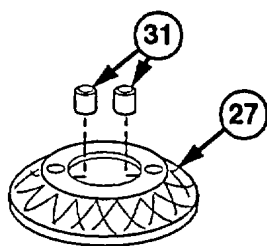
- (9) Remove crankshaft cover (12) and gasket (19) from engine block (20) and set on flat work surface with flat side facing up. Discard gasket.

- (10) Remove oil pump drive hub (21) and key (22) from crankshaft (23). Discard key.

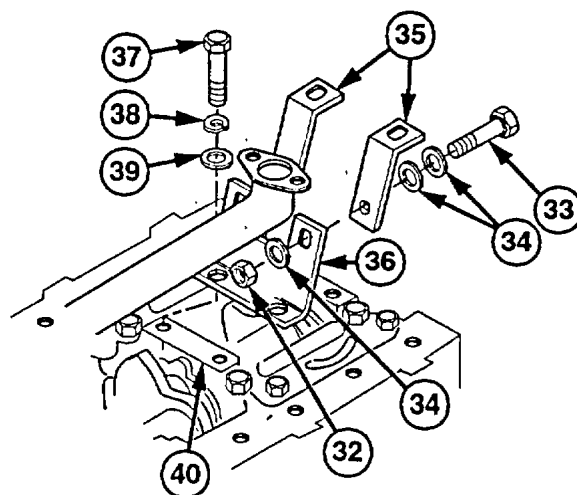


19-14. CRANKSHAFT COVER, FRONT OIL SEAL, AND OIL PUMP REPAIR (CONT)

- (11) Remove two nuts (24), screws (25), four washers (26), strainer (27), cover (28), and gasket (29) from oil inlet pipe assembly (30). Discard gasket
- (12) Remove two spacers (31) from screen (27).



- (13) Remove two locknuts (32), screws (33), six washers (34), and two brackets (35) from bracket (36). Discard locknuts.
- (14) Remove two screws (37), lockwashers (38), washers (39), and bracket (36) from cylinder block (40). Discard lockwashers.

**b. Disassembly****NOTE**

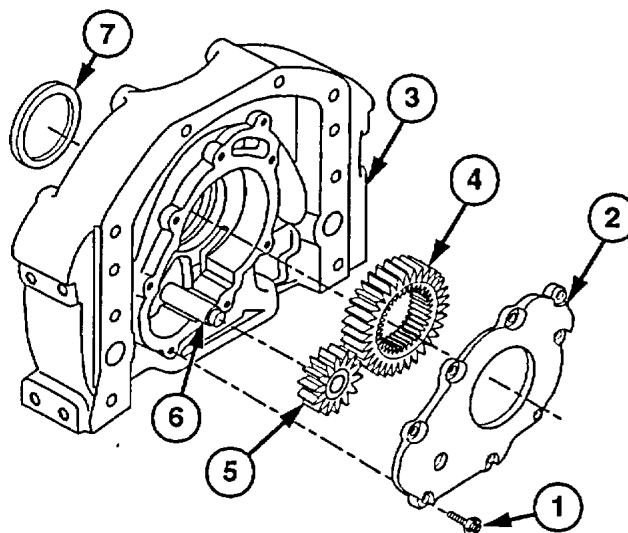
Oil pump is inside crankshaft cover.

- (1) Remove eight screws (1) and gear retaining plate
- (2) from rear of crankshaft cover (3). Discard screws.

NOTE

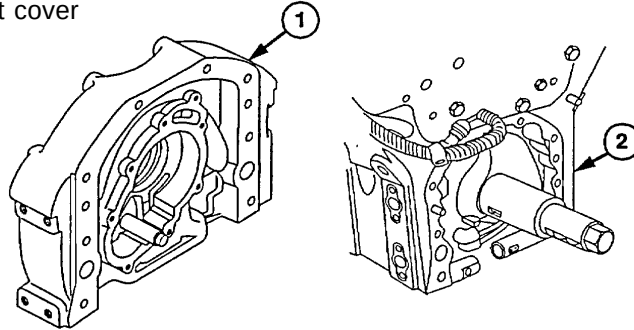
Shaft is removed only if it fails inspection.

- (2) Remove drive gear (4) and driven gear (5) from rear of crankshaft cover (3).
- (3) Remove shaft (6) from crankshaft cover (3).
- (4) Support outer face of crankshaft cover (3) on two wooden blocks.
- (5) Remove front seal (7) from front side of crankshaft cover (3). Discard seal.



c. Cleaning/Inspection

- (1) Remove old sealant from crankshaft cover (1) and engine block (2).



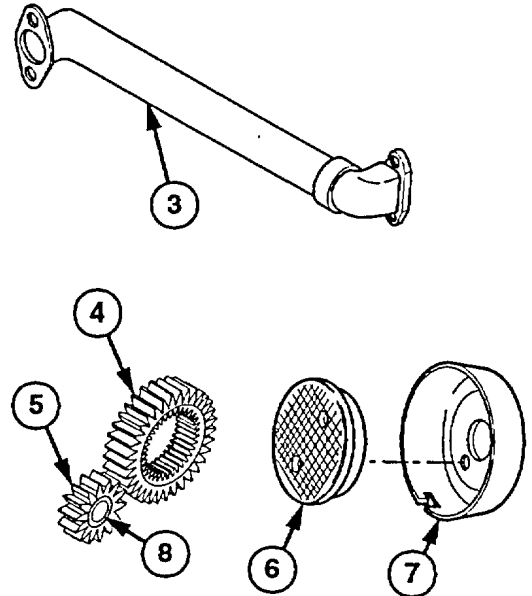
- (2) Clean gasket material from mounting surface of oil Inlet pipe assembly (3).

- (3) Clean drive and driven gears (4 and 5), screen (6), and cover (7) with diesel fuel.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) Dry parts with compressed air.
- (5) Inspect bushing (8) of driven gear (5) for wear. Replace bushing if clearance between bushing and shaft is more than 0.0035 in. (0.089 mm). If bushing is replaced, new clearance should be 0.001-0.0025 in. (0.25-0.064 mm).



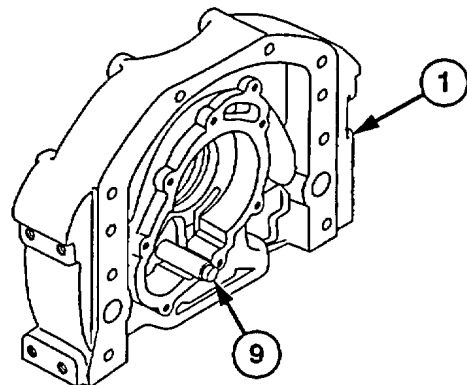
CAUTION

Failure to replace excessively worn gears will result in low oil pressure which may cause serious damage to engine.

NOTE

The drive and driven gear should be replaced as a set.

- (6) Inspect shaft (9), drive gear (4), driven gear (5), oil inlet pipe (3), cover (7), screen (6) and crankshaft cover (1) for damage or wear. Replace damaged parts.



19-14. CRANKSHAFT COVER, FRONT OIL SEAL, AND OIL PUMP REPAIR (CONT)**d. Assembly**

- (1) Lubricate shaft (1) and drive and driven gears (2 and 3) with oil.

NOTE

- If installing new shaft, do step (2).
- Shaft must be flush to 0.020 in. (0.51 mm) below finished face of crankshaft cover.

- (2) Press shaft (1) in crankshaft cover (4).
- (3) Install drive and driven gears (2 and 3) in rear side of crankshaft cover (4).

NOTE

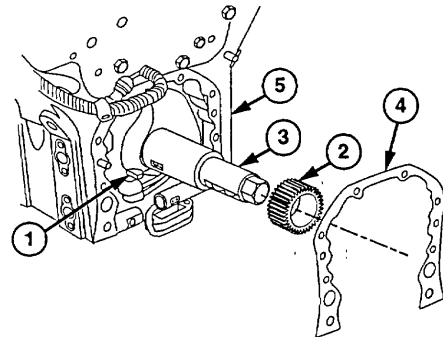
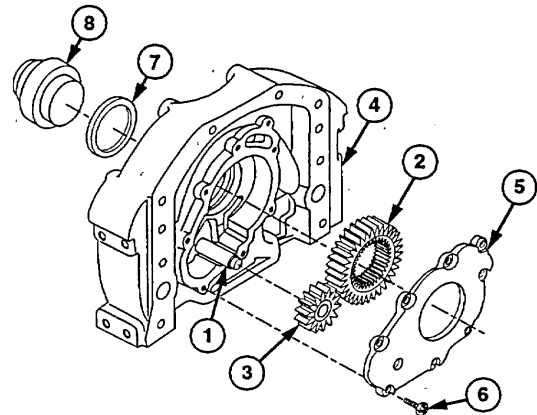
Self-locking screws must be used due to closeness of crankshaft.

- (4) Install gear retaining plate (5) on rear of crankshaft cover (4) with eight new screws (6). Torque to 156-204 lb-in. (18-23 N•m).
- (5) Coat sealing lip of new front seal (7) with oil.

NOTE

Sealing lips must face outside of front cover.

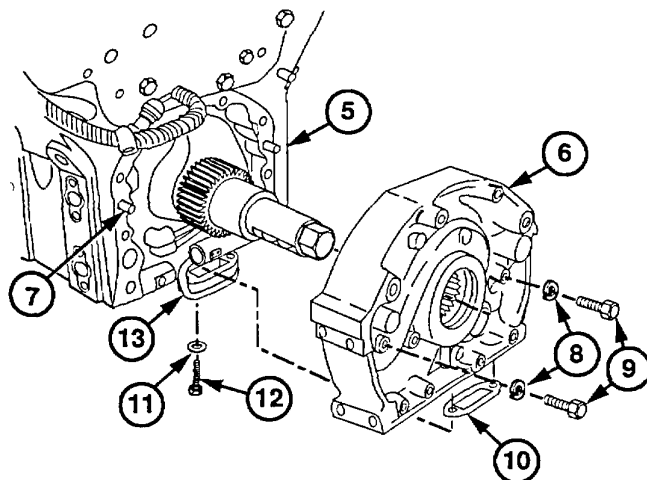
- (6) Install front seal (7) in front side of crankshaft cover (4) using seal installer (8).

**e. Installation****NOTE**

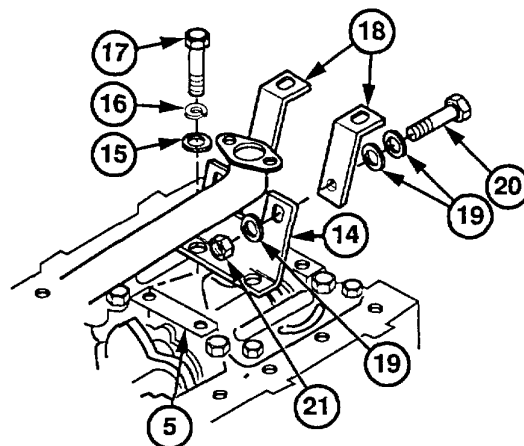
Bevel edge of oil pump drive hub faces rear of crankshaft.

- (1) Install new key (1) and oil pump drive hub (2) on crankshaft (3).
- (2) Coat new gasket (4) with grease and install on engine block (5).

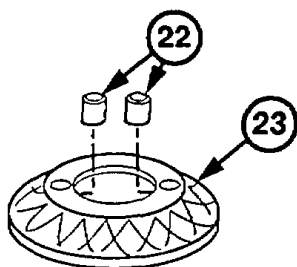
- (3) Install crankshaft cover (6) on engine block (5) and dowels (7).
- (4) Install two new lockwashers (8) and screws (9) in crankshaft cover (6). Torque to 80-90 lb-ft (108-122 N•m).
- (5) Install new gasket (10), two washers (11), and screws (12) to oil inlet pipe assembly (13) on bottom of crankshaft cover (6). Torque to 180-240 lb-in. (20.3-27.1 N•m).



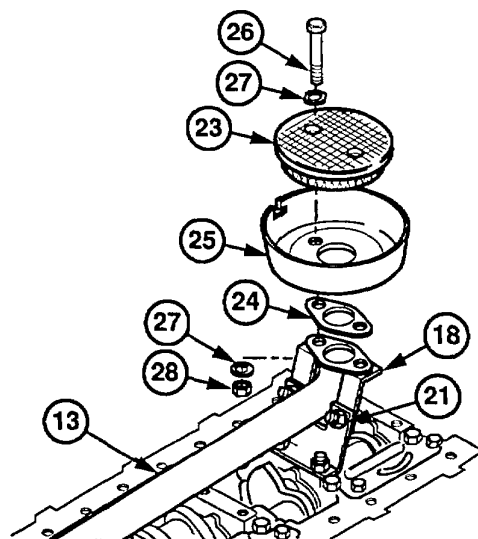
- (6) Install bracket (14) on engine block (5) with two washers (15), new lockwashers (16), and screws (17). Torque to 35 lb-ft (47 N•m).
- (7) Install two brackets (18) on bracket (14) with six washers (19), two screws (20), and new locknuts (21). Do not tighten.



- (8) Install two spacers (22) in strainer (23).

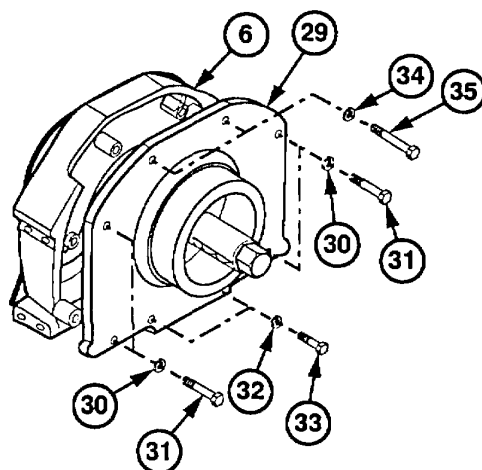


- (9) Install gasket (24), cover (25), and strainer (23) on oil inlet pipe assembly (13) and two brackets (18) with two screws (26), four washers (27), and nuts (28). Torque to 35 lb-ft (47 N•m).
- (10) Tighten two locknuts (21) to 35 lb-ft (47 N•m).

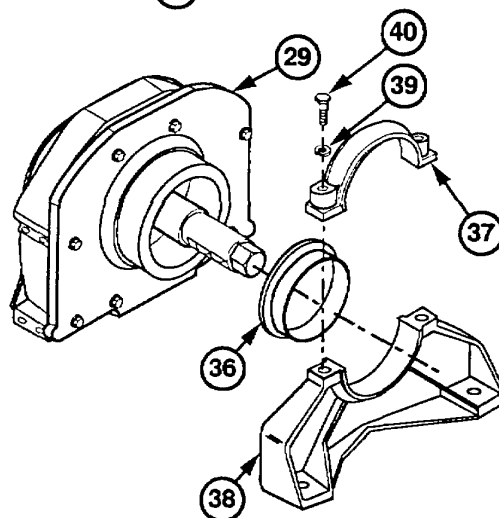


19-14. CRANKSHAFT COVER, FRONT OIL SEAL, AND OIL PUMP REPAIR (CONT)

- (11) Install trunnion (29) on crankshaft cover (6) with four new lockwashers (30), screws (31), two new lockwashers (32), screws (33), two new lockwashers (34) and screws (35).
- (12) Tighten screws (33 and 35) to 30-35 lb-ft (41-47 N•m).
- (13) Tighten screws (31) to 70-75 lb-ft (94-102 N•m).
- (14) Coat ring (36) with light coat of grease. Slide over trunnion (29).
- (15) Install top half of support (37) on support (38) with two new lockwashers (39) and screws (40). Torque to 45-50 lb-ft (61-67 N•m).

**f. Follow-On Maintenance**

- (1) Install oil pan (para 3-20).
- (1.1) Install crankshaft vibration damper (para 3-14).
- (2) Install crankshaft pulley (para 3-12).
- (3) Install 24-volt (front) alternator adjusting strap (TM 9-2320-360-20).
- (4) Install fan clutch (TM 9-2320-360-20).
- (5) Install fan belts (TM 9-2320-360-20).
- (6) Install fan (TM 9-2320-360-20).
- (7) Remove engine from engine stand (para 19-3).
- (8) Install air box covers (para 3-8).
- (9) Install air box drains (para 3-9).
- (10) Install exhaust manifolds (para 3-23).
- (11) Install 24-volt (front) alternator/bracket (TM 9-2320-360-20).
- (12) Install 150 amp circuit breakers (TM 9-2320-360-20).
- (13) Install starter (TM 9-2320-360-20).
- (14) Install sending units and attachments (TM 9-2320-360-20).



19-15. ENGINE BRAKE RETARDER REPAIR

This task covers

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

INITIAL SETUP**Equipment Conditions**

Engine brake retarder on dean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Compound, Sealing and Lubricating (Item 27, Appendix B)
Connector, Electrical, Butt (Item 29, Appendix B)
Oil, Lubricating (Item 45, Appendix B)
Tags, Identification (Item 56, Appendix B)

NOTE

Supply housing and drone housing are repaired in a similar manner. Solenoid is installed on supply housing and not on drone housing. Supply housing is shown.

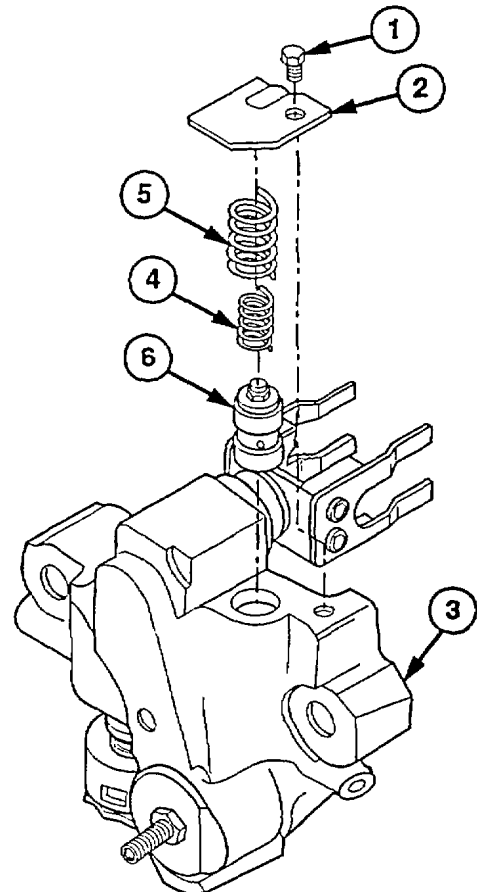
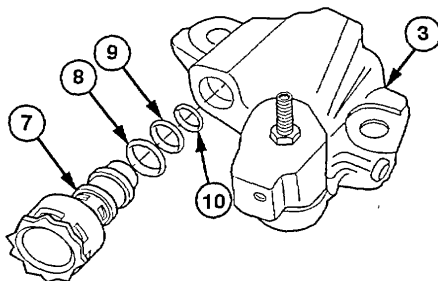
a. Disassembly

- (1) Remove screw (1) and cover (2) from housing (3).
- (2) Remove two springs (4 and 5) and spool (6) from housing (3).

NOTE

Do steps (3) thru (5) for supply housing only.

- (3) Remove solenoid valve (7) from housing (3).
- (4) Remove two seals (8 and 9) from solenoid valve (7).
- (5) Remove seal (10) from housing (3).



19-15. ENGINE BRAKE RETARDER REPAIR (CONT)**WARNING**

Slave piston is retained by spring under compression. Spring may be discharged and cause personal injury.

- (6) Turn housing (3) over. Use press to hold slave piston spring (11) and spring retainer (12) in place.

WARNING

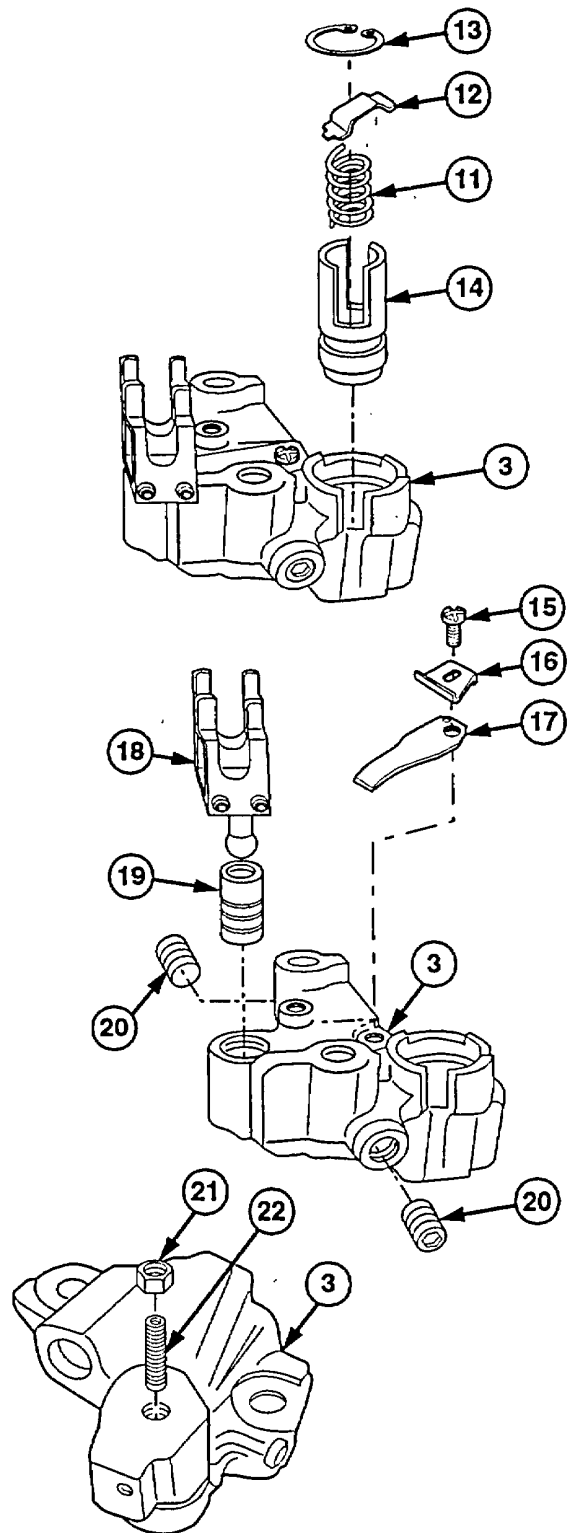
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (7) Remove retaining ring (13).
- (8) Slowly release force from spring retainer (12) and release slave piston spring (11).
- (9) Remove spring retainer (12), spring (11), and slave piston (14) from housing (3).
- (10) Remove screw (15), spring retainer (16), piston spring (17), and fork assembly (18) from housing (3).
- (11) Remove master piston (19).

NOTE

Mark location of pipe plugs before removal.

- (12) Remove two pipe plugs (20).
- (13) Turn housing over. Remove nut (21) and setscrew (22) from housing (3).



b. Cleaning/inspection

WARNING

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep flame away from fuel and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET of vehicle.

- (1) Clean housings and parts with diesel fuel.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry parts with compressed air.
- (3) Inspect all parts for damage. Replace damaged parts.

c. Assembly

- (1) Install two pipe plugs (1) in housing (2) in locations marked during removal.
- (2) Coat master piston (3) with lubricating oil.
- (3) Install master piston (3) and fork assembly (4) in bottom of housing (2).

WARNING

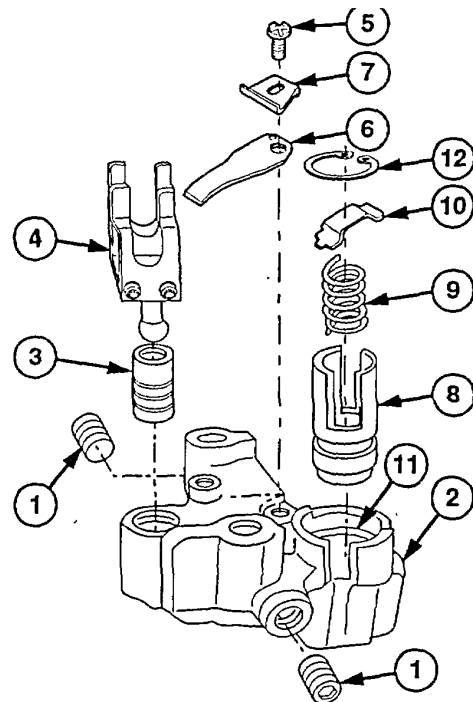
Sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

- (4) Coat screw (5) with sealing and lubricating compound. Install piston spring (6) with spring retainer (7) and screw (5).
- (5) Coat slave piston (8) and slave piston spring (9) with lubricating oil.
- (6) Install slave piston (8) and slave piston spring (9) in housing (2).
- (7) Align tab on spring retainer (10) with slot in housing (2).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (8) Press spring (9) and spring retainer (10) into housing (2), to just below retaining ring groove (11), and install retaining ring (12).



19-15. ENGINE BRAKE RETARDER REPAIR (CONT)**NOTE**

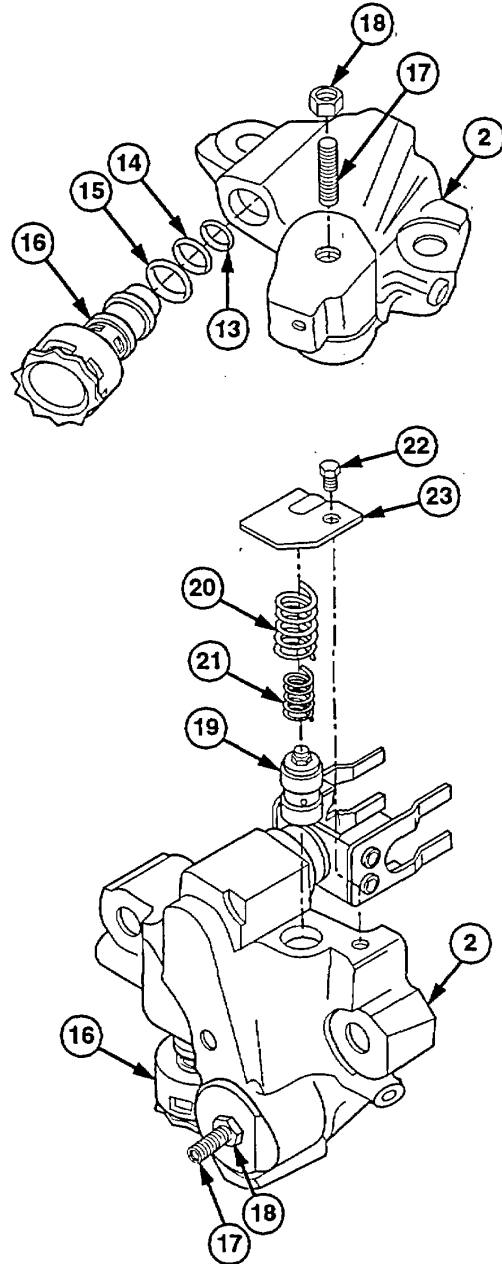
Do steps (9) thru (11) for supply housing only.

- (9) Coat seal (13) with oil and install in housing (2).
- (10) Coat two seals (14 and 15) with lubricating oil and install on solenoid valve (16).
- (11) Install solenoid valve (16) in supply housing (2). Torque to 50 lb-in. (5.5 N•m).
- (12) Install setscrew (17) in housing (2) with nut (18).
- (13) Coat spool (19) with lubricating oil. Install spool (19) and two springs (20 and 21) in housing (2).

WARNING

Sealing and lubricating compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

- (14) Coat screw (22) with sealing and lubricating compound. Install cover (23) on housing (2) with screw (22).



CHAPTER 20
FUEL SYSTEM MAINTENANCE

Contents	Para	Page
Introduction	20-1	20-1
Blower Repair	20-2	20-2
Turbocharger Repair	20-3	20-17

Section I. INTRODUCTION

20-1. INTRODUCTION

This chapter contains Instructions for repair of fuel system components at the General Support maintenance level. These components must be removed from the HET Tractor before they can be repaired. The removal procedures are referenced to chapter 4.

Section II. MAINTENANCE PROCEDURES

20-2. BLOWER REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/Inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Blower on clean work surface.

Tools and Special Tools

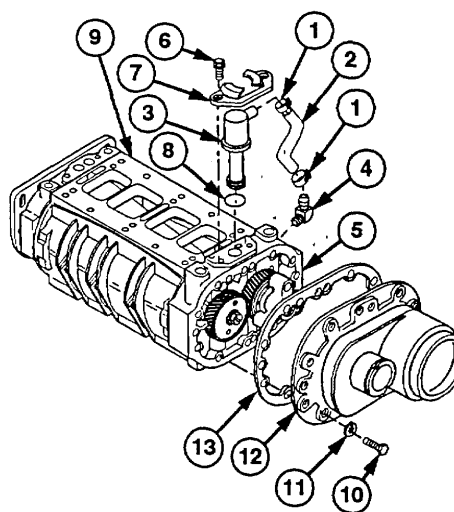
Tool Kit, Genl Mech (Item 202, Appendix E)
 Tool Set, Blower Service (Item 204, Appendix E)
 Blocks, Wooden (Figure C-3, Appendix C)
 Compressor Unit, Air (Item 24, Appendix E)
 Gage, Feeler (Item 50, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Screws, Cap, Hex, 5/16-18 x 2 In. (4)
 (Item 147, Appendix E)
 Screws, Cap, Hex, 114-20 x 1-1/4 In. (5)
 (Item 151, Appendix E)
 Screws, 5/16-18 x 2-1/4 In. (4) (Item 148,
 Appendix E)
 Washers, Fiat, 5/16 In. (8) (Item 210,
 Appendix E)
 Wrench Set, Impact (Item 228, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236,
 Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235,
 Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
 Compound, Gasket Forming (Item 19,
 Appendix B)
 Grease, Automotive and Artillery (Item 32,
 Appendix B)
 Oil, Lubricating (Item 47, Appendix B)
 Rags (Item 51, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Gasket (Item 46, Appendix F)
 Gasket (Item 66, Appendix F)
 Lockwashers (19) (Item 119, Appendix F)
 Overhaul Kit, Blower (Item 153, Appendix F)
 Packing, Preformed (Item 195, Appendix F)
 Washer, Key (Item 335, Appendix F)

a. Disassembly

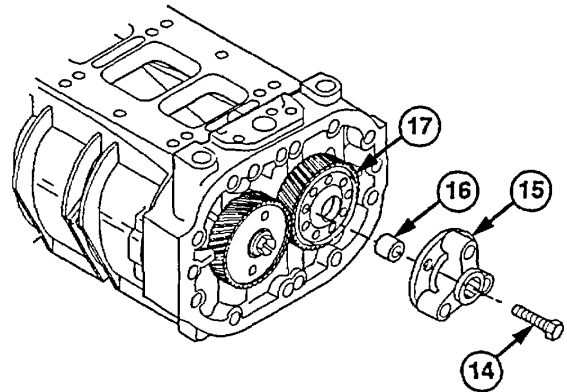
- (1) Remove two dampers (1) and hose (2) from blower bypass valve (3) and elbow (4).
- (2) Remove elbow (4) from rear end plate (5).
- (3) Remove two screws (6), clamp (7), blower bypass valve (3), and preformed packing (8) from blower (9). Discard preformed packing.
- (4) Remove nine screws (10), lockwashers (11), rear end plate cover (12), and gasket (13) from rear end plate (5).; Discard lockwashers and gasket.



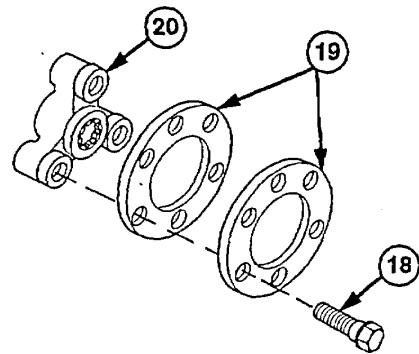
NOTE

Clean shop towel should be placed between blower rotors to keep gears from turning.

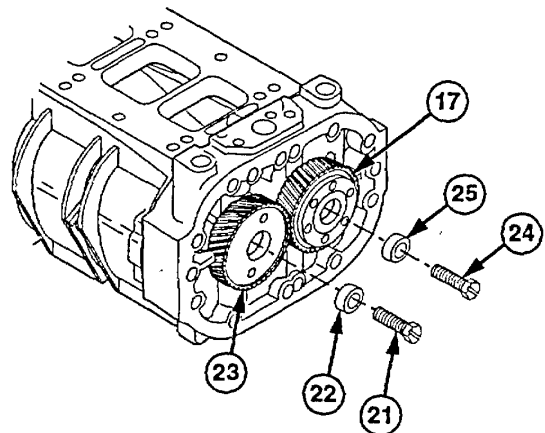
- (5) Remove three screws (14), coupling assembly (15), and three spacers (16) from timing gear (17).



- (6) Place coupling assembly (15) in soft-jawed vise.
- (7) Remove three screws (18) and two spring plates (19) from coupling (20).
- (8) Remove coupling (20) from vise.



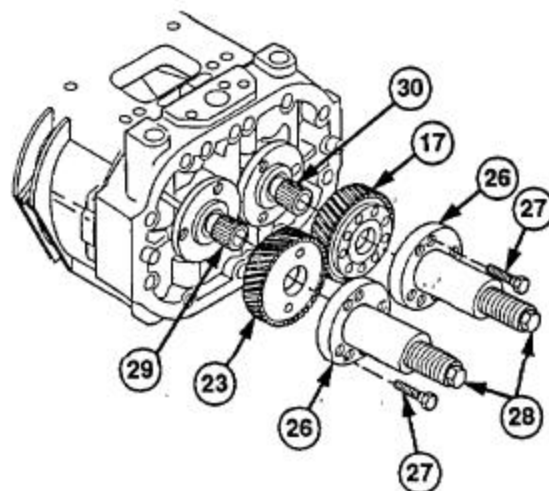
- (9) Remove screw (21) and spacer (22) from left timing gear (23).
- (10) Remove screw (24) and spacer (25) from right timing gear (17).



20-2. BLOWER REPAIR (CONT)**NOTE**

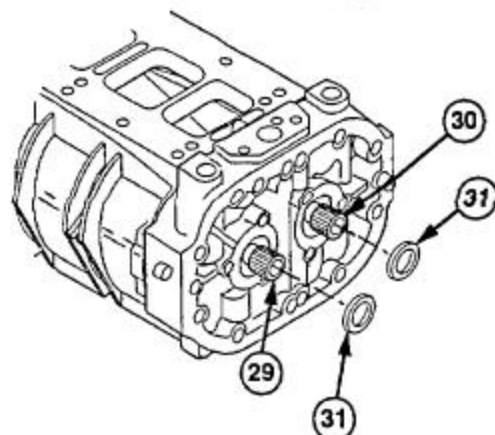
- Five 5/16 in.-24 x 1-1/2 in. (38 mm) screws can be used to align tapped holes in gears on rear end plate.
- Matchmarks on rotor and timing gear must be aligned for proper operation.

- (11) Install puller tool (26) on left timing gear (23) with two screws (27).
- (12) Install puller tool (26) on right timing gear (17) with three screws (27).

**CAUTION**

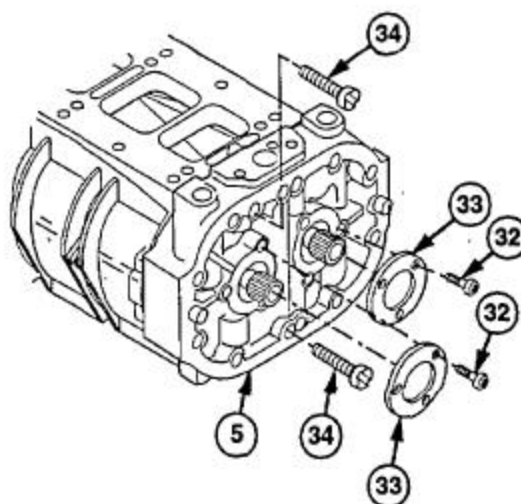
Puller screws must be tightened evenly during removal of timing gears. Failure to comply may result in damage to gears.

- (13) Tighten two screws (28) evenly and remove gears (17 and 23) from rotors (29 and 30).
- (14) Remove screws (27) and puller tools (26) from gears (17 and 23).

**NOTE**

Spacers should be tagged and marked before removal.

- (15) Remove two spacers (31) from two rotors (29 and 30).
- (16) Remove six screws (32) and two flat bearing retainers (33) from rear end plate (5).
- (17) Remove two screws (34) from rear end plate (5).



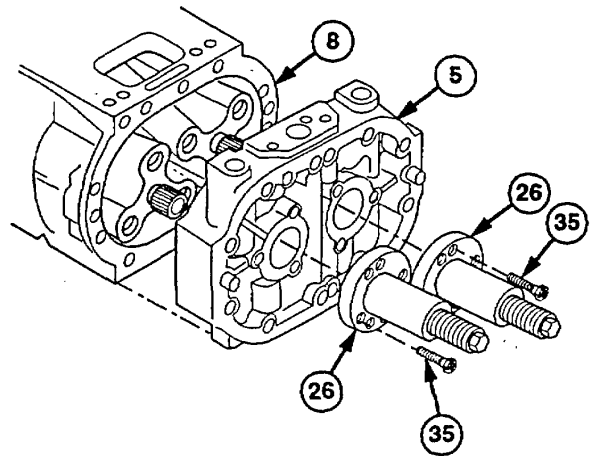
CAUTION

Screws should be threaded all the way into tapped holes of end plate. Failure to comply may result in damage to end plate.

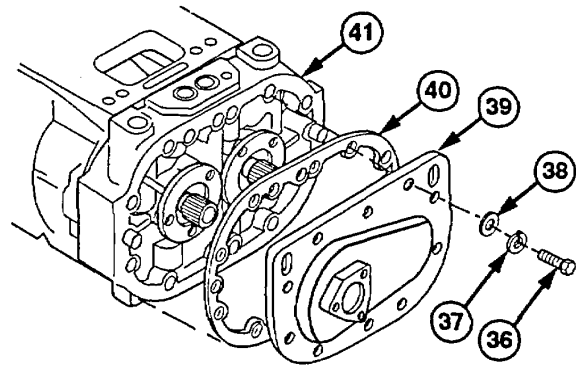
NOTE

Six puller screws must be 1/4 in.-20 x 1-1/4 in. (32 mm) or longer.

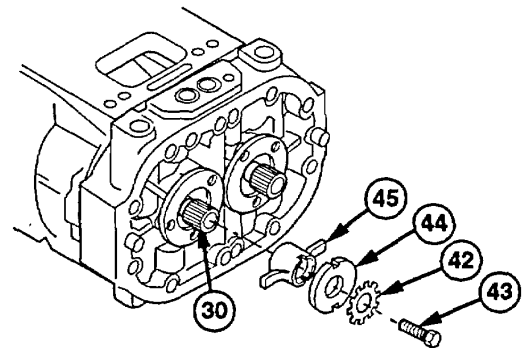
- (18) Install six screws (35) and align two puller tools (26) on rear end plate (5).
- (19) Turn both puller tools (26) evenly and remove rear end plate (5) from blower (8).
- (20) Remove puller tools from rear end plate (5).



- (21) Remove 10 screws (36), lockwashers (37), and washers (38) from front end cover (39). Discard lockwashers.
- (22) Remove front end cover (39) and gasket (40) from front end plate (41). Discard gasket.



- (23) Bend tangs of key washer (42) flat.
- (24) Remove screw (43), key washer (42), fuel pump disk (44), and coupling spacer (45) from rotor (30). Discard lockwasher.



20-2. BLOWER REPAIR (CONT)**NOTE**

Front and rear end plates should be matchmarked with blower housing before removal.

- (25) Remove six screws (46) and two deflectors (47) from front end plate (41).
- (26) Remove two screws (48) from front end plate (41).
- (27) Repeat steps (17) thru (19) to remove front end plate (41).

CAUTION

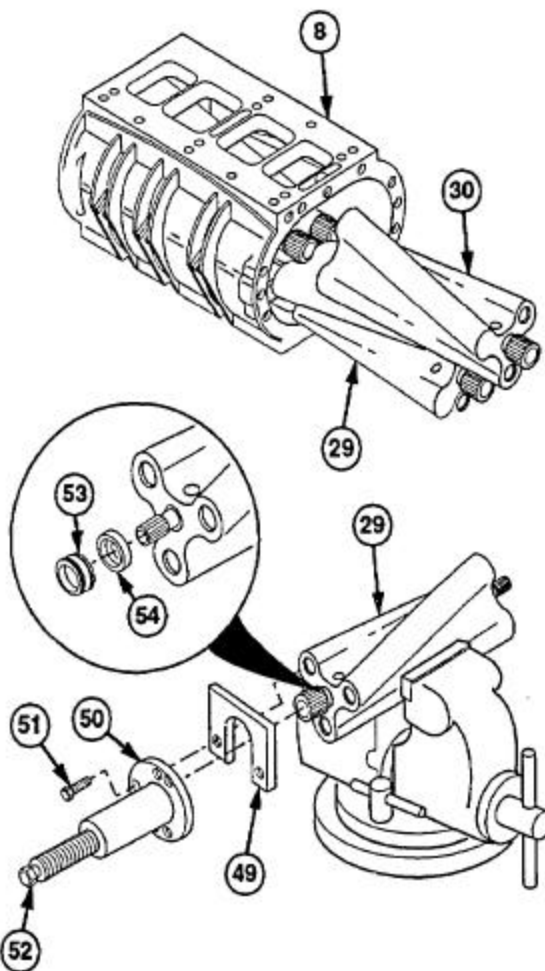
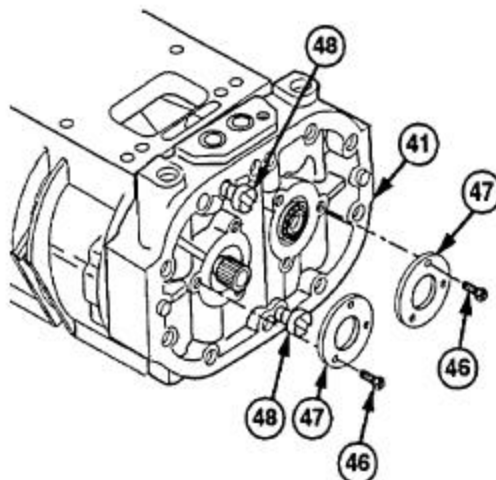
Rotors should be handled with care to avoid scratching surfaces. Failure to comply may result in damage to rotors.

NOTE

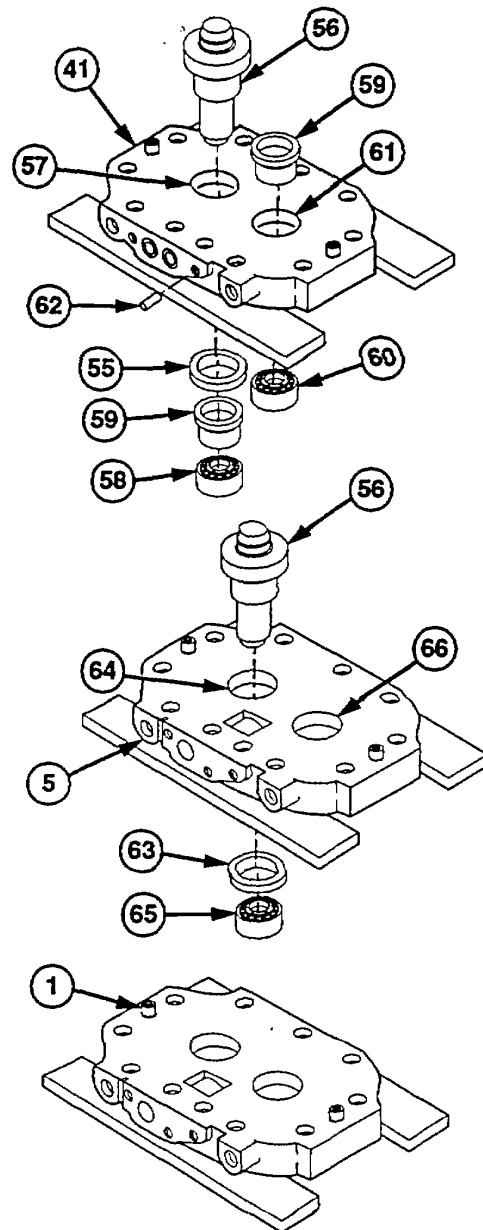
- Shop towel must be removed before removing rotors from blower.
- Tag and mark left and right rotors before removal.

- (28) Matchmark rotors (29 and 30) before removing.
- (29) Remove rotors (29 and 30) from blower (8).

- (30) Clamp lobe of left rotor (29) in soft-jawed vise.
- (31) Install adapter (49) on left rotor (29).
- (32) Install puller tool (50) on adapter (49) with two screws (51).
- (33) Turn puller screw (52) and remove bearing collar (53) from left rotor (29).
- (34) Remove and discard oil seal (54) from left rotor (29).



- (35) Place front end plate (41) on wooden blocks with seal (55) up.
- (36) Place long end of remover and Installer tool (56) in right bore (57), through seal (55), and into roller bearing (58).
- (37) Remove roller bearing (58), collar (59), and seal (55) from right bore (57). Discard seal.
- (38) Install collar (59) in left roller bearing (60) for support.
- (39) Install long end of remover and installer tool (56) in left bore (61) of front end plate (41) through roller bearing (60).
- (40) Remove roller bearing (60) from left bore (61).
- (41) Remove two plugs (62) from front end plate (41).
- (42) Place rear end plate (5) on wooden blocks with seal (63) up.
- (43) Install long end of remover and installer tool (56) in bore (64), through seal (63), and into ball bearing (65).
- (44) Remove ball bearing (65) and seal (63) from bore (64).
- (45) Repeat steps (42) thru (44) for remaining bore (66).



b. Cleaning/Inspection

- (1) Inspect dowel pins (1) for breakage or damage. Replace if broken or damaged.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean metal parts in dry cleaning solvent.

20-2. BLOWER REPAIR (CONT)**WARNING**

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Dry all metal parts, except bearings, with compressed air. Allow bearings to air dry.
- (4) Inspect roller and ball bearings for corrosion, scoring, pitting, or other damage.
- (5) Inspect both timing gears at teeth and bore splines for chips or nicks.
- (6) Inspect oil holes. If clogged, clean with dry cleaning solvent.
- (7) Inspect all finished surfaces for burrs and scoring. Clean with crocus cloth.

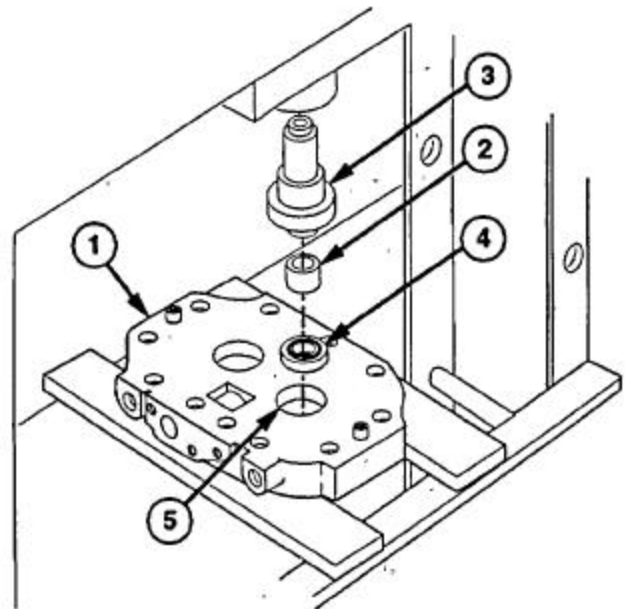
c. Assembly

- (1) Place rear end plate (1) on wooden blocks with inner surface up.
- (2) Install seal protector (2) on remover and installer tool (3).

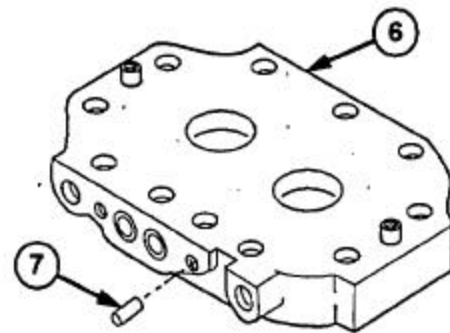
CAUTION

Double-lipped oil seal must be installed dry. Do not apply oil to seal when installing. Oil will damage protective coating of seal.

- (3) Install new double-lipped oil seal (4), number side up, on tool. Press new oil seal (4) in bore (5) until tool contacts rear end plate (1).



- (4) Repeat steps (1) thru (3) to install remaining seal in rear end plate (1) and two seals (4) in front end plate (6).
- (5) Install two pipe plugs (7) on front end plate (6).



- (6) Place front end plate (6) on wooden blocks with inner surface up.
- (7) Install seal protectors (2), tapered edge down, on rotors (8 and 9).

NOTE

- Seal protectors will drive out plastic sleeve in seal. Discard sleeve.
- When properly installed, externally splined ends of rotors will be up, and rotor end with internal spline will be in right side of front end plate.

- (8) Align matchmarks made during removal and install rotors (8 and 9) in bores (5). Work rotors (8 and 9) until they contact front end plate (6).

CAUTION

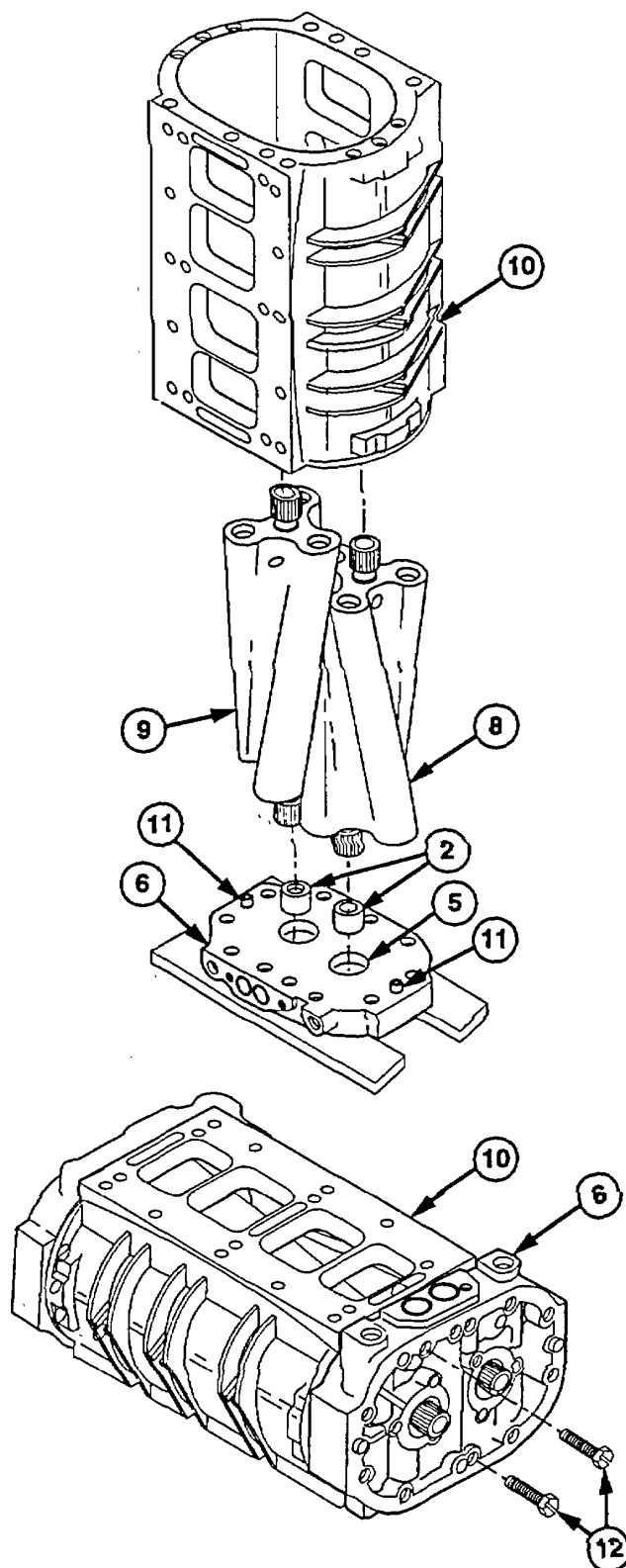
Do not let gasket forming compound protrude into blower housing. Failure to comply may result in engine damage.

- (9) Lightly coat mating surfaces of blower (10) and front end plate (6) with gasket forming compound.

NOTE

Matchmarks made during removal should be aligned.

- (10) Install blower (10) over rotors (8 and 9) until it contacts dowel pins (11) in front end plate (6).
- (11) Align dowel pins (11) with holes in blower (10) and push blower tight against front end plate (B). Tap blower (10) with soft-faced hammer if necessary.
- (12) Move blower (10) to work surface while firmly holding front end plate (6) against blower (10). Position bottom down.
- (13) Install two screws (12) through front end plate (6) and blower (10).



20-2. BLOWER REPAIR (CONT)

- (14) Stand blower(10) up on wooden blocks.

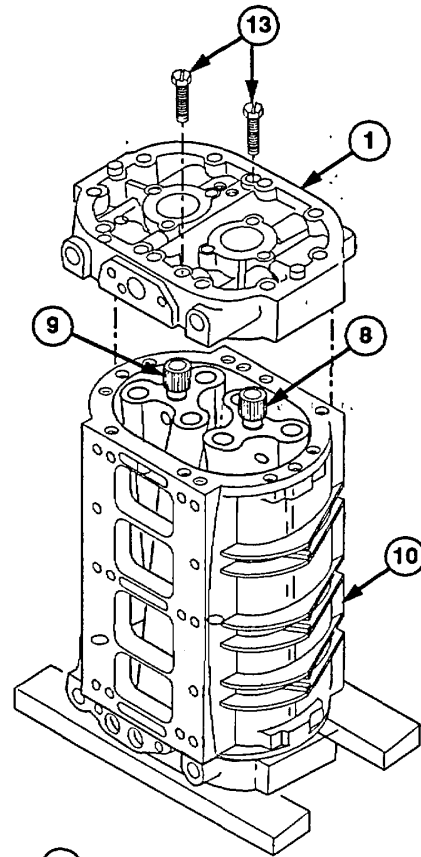
CAUTION

Do not apply oil to seals or rotor shafts. Damage to seals will result.

NOTE

Seal protectors will drive out plastic sleeve in seal. Discard sleeve.

- (15) Align matchmarks and install rear end plate (1) on blower (10).
 (16) Install two screws (13) through rear end plate (1) and blower (10).



- (17) Coat two ball bearings (14) with lubricating oil.

CAUTION

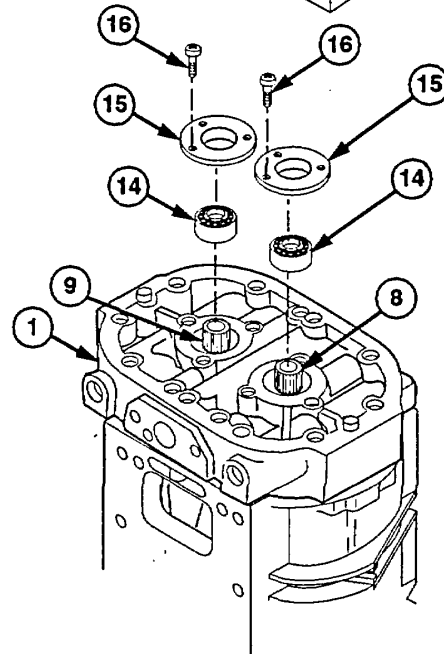
Bearings must rest flat on rotors. Failure to comply may result in damage to splines.

- (18) Install ball bearings (14), numbered end up, on rotors (8 and 9) and in rear plate (1).

NOTE

- **Bearing retainers should be installed with chamfered side of holes up.**
- **Rear bearing retainers are flat.**

- (19) Install two bearing retainers (15) on rear end plate (1) with six screws (16). Torque to 84-108 lb-in. (9.5-12.2 N•m).



- (20) Turn blower (10) over on wooden blocks so front end plate (6) faces up.
- (21) Install two bearing collars (17) on rotors (8 and 9).
- (22) Coat two roller bearings (18) with lubricating oil.
- (23) Install roller bearings (18) over rotors (8 and 9) and in front end plate (6).

NOTE

Flanges on reflectors face front end plate.

- (24) Install two reflectors (19) on front end plate (6) with six screws (20). Torque to 84-108 lb-in. (9.5-12.2 N•m).

WARNING

Do not place fingers between rotors. Turning rotors may cause serious injury.

- (25) Position blower (10) bottom down with rear end plate (1) facing you.

NOTE

Timing mark (located at flat spot) in end of each rotor shaft will aid in aligning rotors and gears.

- (26) Set rotors (8 and 9) so that flat spots on splines are in line with each other and facing left.

NOTE

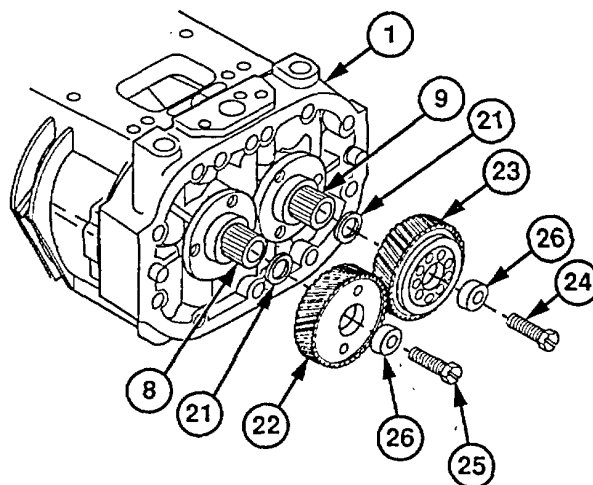
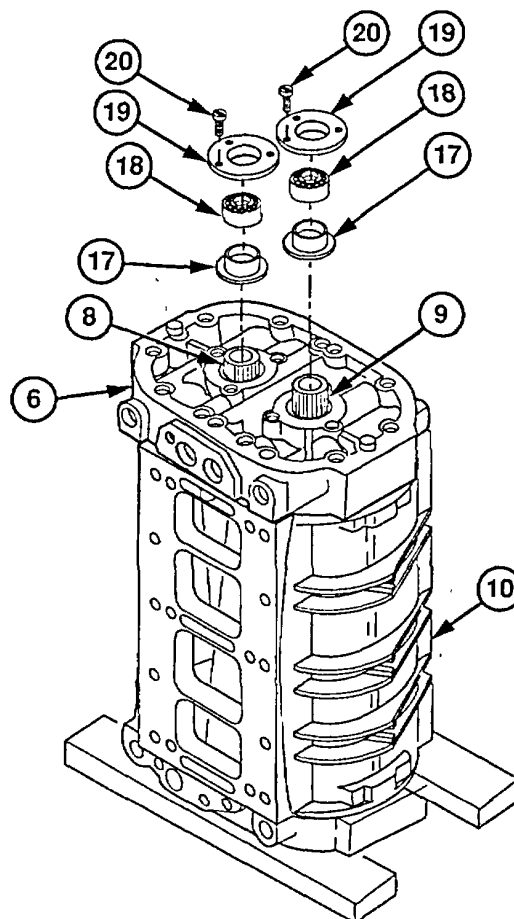
Folded shop towel should be placed between rotor lobes to keep rotors from turning.

- (27) Install two spacers (21) on two rotors (8 and 9).
- (28) Coat splines of rotors (8 and 9) with lubricating oil.
- (29) Install both timing gears (22 and 23) on rotors (8 and 9) at the same time so that flat spots in gear splines align with flat spots in rotor splines.
- (30) Coat screws (24 and 25) with lubricating oil.
- (31) Install two spacers (26) and screws (24 and 25) in timing gears (22 and 23).

NOTE

Screws must be tightened evenly to draw both timing gears tight.

- (32) Tighten screws (24 and 25) to 110 lb-ft (149 N•m).



20-2. BLOWER REPAIR (CONT)

- (33) Install four washers (27) and four 5/16 x 2 in. screws (28) in front end plate (6). Torque to 180 lb-in. (20.3 N•m).
- (34) Install four washers (29) and four 5/16 x 2-1/4 in. screws (30) in rear end plate (1). Torque to 180 lb-in. (20.3 N•m).
- (35) Position blower (10) on side.

NOTE

- Shop cloth must be removed before timing rotors and setting clearances.
- Clearance between rotor lobes should be 0.013 in. (3.3 mm). Clearance is adjusted by installing shims between gears and bearings to move timing gears in or out.
- Minimum clearances are listed for feeler gage measurements.
- Six checks must be made on both air inlet and air outlet sides to determine clearance between rotors.
- Checks are made 1 in. (25.4 mm) from end of blower. Both ends must be checked.

- (36) Place 0.013 in. (3.3 mm) feeler gage between rotor lobes (31 and 32).

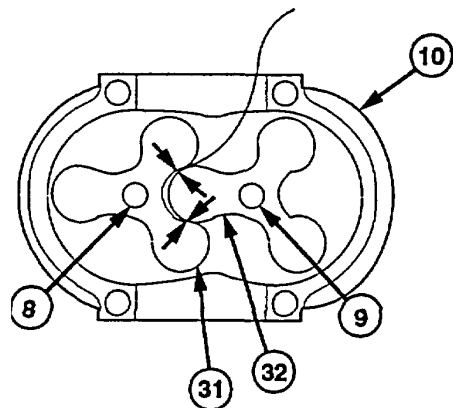
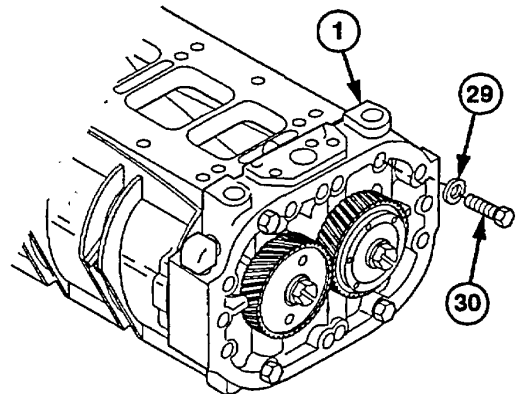
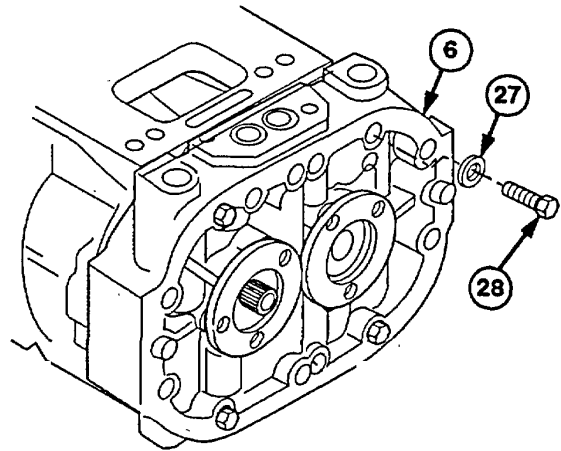
CAUTION

Do not force feeler gage between rotors. Failure to comply may result in damage to equipment.

NOTE

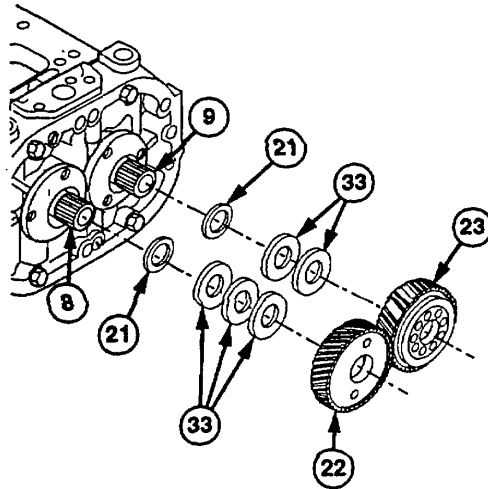
If feeler gage cannot be inserted between rotors, go to step (40).

- (37) Rotate rotors (8 and 9) to position feeler gage between rotor lobes (31 and 32).
- (38) Remove feeler gage from between rotor lobes (31 and 32).
- (39) Repeat steps (36) thru (38) until checks have been made on each lobe of rotors (8 and 9) from both inlet and outlet sides of blower (10).



NOTE

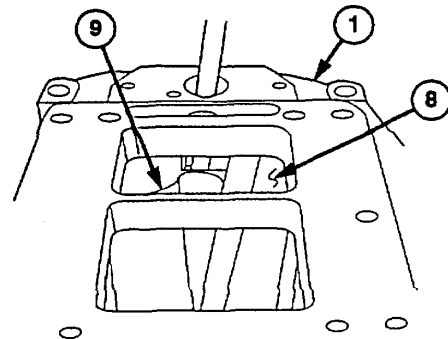
- If clearance is correct, go to step (45).
- To change gap between rotor lobes by 0.001 in. (0.025 mm), add or remove 0.003 in. (0.076 mm) shim.
- Placing shims behind right-side gear on gear end will turn right-hand rotor counterclockwise.
- Placing shims behind left-side gear on gear end will turn left-hand rotor clockwise.



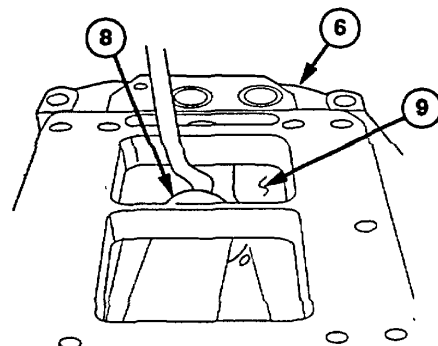
- (40) If clearance is not correct, determine amount of movement required to obtain correct clearance.
- (41) Remove gears (para 20-2a, steps (9) thru (14)).
- (42) Add shims (33) between gears (22 or 23) and spacers (21) to obtain correct clearance.
- (43) Repeat steps (29) thru (32) and (36) thru (40).
- (44) If correct clearance cannot be obtained using shims, replace rotor (8 or 9).

NOTE

There are 12 measurements for checking clearance between rotor lobes and end plates, 6 for front end plate and 6 for rear end plate.



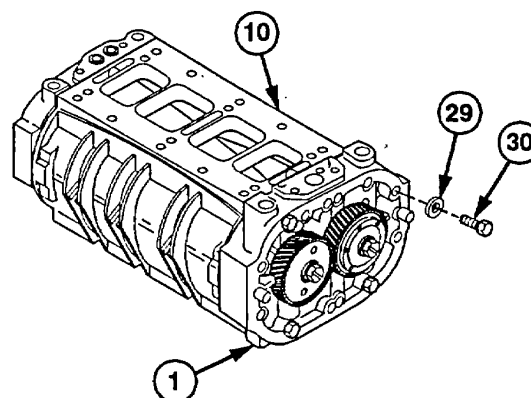
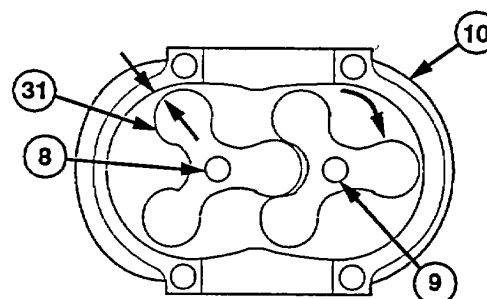
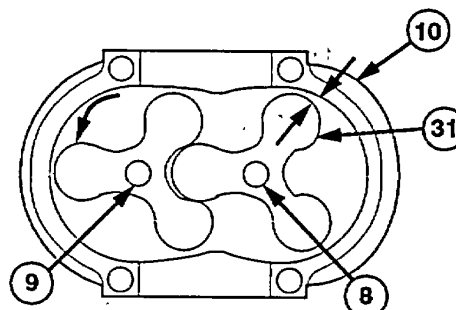
- (45) Place 0.007 in. (0.178 mm) feeler gage between one lobe of rotor (9) and rear end plate (1).
- (46) Repeat step (45) for other two lobes of rotor (9) and three lobes of rotor (8).
- (47) If clearance is not correct, replace rear end plate (1).
- (48) Place 0.019 in. (0.48 mm) feeler gage between one lobe of rotor (8) and front end plate (6).
- (49) Repeat step (48) for other two lobes of rotor (8) and three lobes of rotor (9).
- (50) If clearance is not correct, replace front end plate (6).



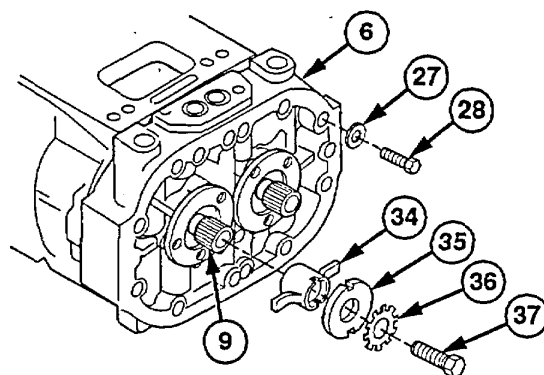
20-2. BLOWER REPAIR (CONT)**NOTE**

There are 12 measurements for checking clearance between rotor lobes and housing, 6 from air inlet side and 6 from air outlet side.

- (51) Place 0.0015 in. (0.38 mm) feeler gage between one lobe of rotor (8) and housing of blower (10).
- (52) Rotate rotors and position gage between one rotor lobe (31) and housing of blower (10).
- (53) Remove feeler gage from between rotor (8) and housing of blower (10).
- (54) Repeat steps (51) thru (53) for other two lobes of rotor (8) and three lobes of rotor (9).
- (55) If clearance is not correct, replace housing of blower (10).
- (56) Position blower (10) so air outlet side is facing up.
- (57) Place 0.005 in. (0.13 mm) feeler gage between one lobe of rotor (8) and housing of blower (10).
- (58) Rotate rotors to position feeler gage between one rotor lobe (31) and housing of blower (10).
- (59) Remove feeler gage from between rotor (8) and housing of blower (10).
- (60) Repeat steps (56) thru (59) for other two lobes of rotor (8) and three lobes of rotor (9).
- (61) If clearance is not correct, replace basic blower (10).
- (62) Position blower (10) with air inlet side up.
- (63) Remove four screws (30) and washers (29) from rear end plate (1).



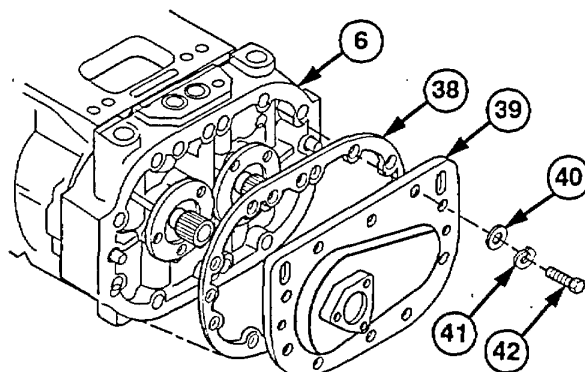
- (64) Remove four screws (28) and washers (27) from front end plate (6).
- (65) Install coupling spacer (34) on rotor (9) at front end plate (6).
- (66) Position fuel pump disk (35), new keywasher (36), and screw (37) on rotor (9).
- (67) Bend one tang of keywasher (36) into slot on fuel pump disk (35).
- (68) Tighten screw (37) on rotor (9) to 65 lb-ft (88 N•m).
- (69) Bend two tangs of keywasher (36) around head of screw (37).



NOTE

Front cover screws are shorter than rear cover screws.

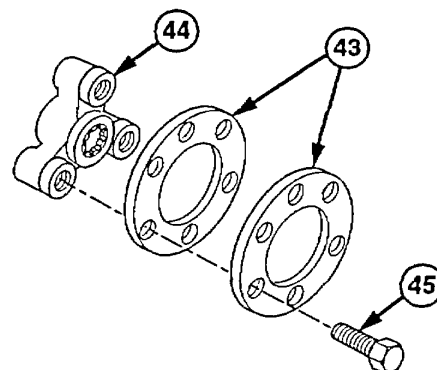
- (70) Install new gasket (38) and front cover (39) on front end plate (6) with 10 washers (40), new lockwashers (41), and screws (42). Torque to 156-204 lb-in. (17.6-23.0 N•m).



NOTE

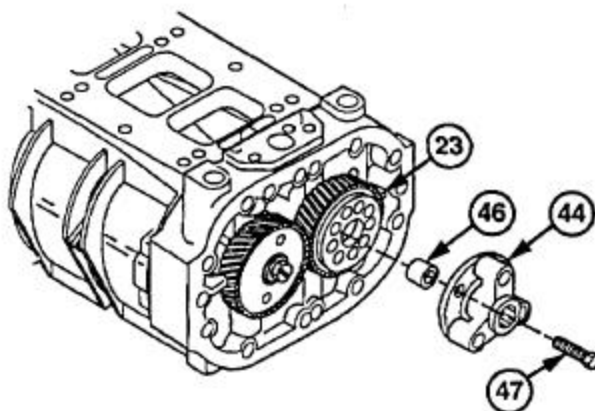
When properly positioned, spring plates will mount on machined side of coupling.

- (71) Position two spring plates (43) on coupling (44) with three screws (45). Do not tighten.
- (72) Place coupling (44) in soft-jawed vise. Tighten screws (45) to 30 lb-ft (41 N•m).



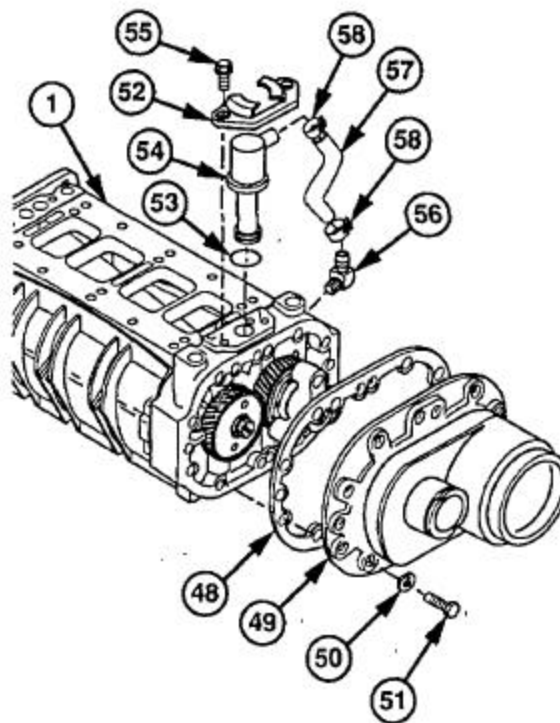
20-2. BLOWER REPAIR (CONT)

- (73) Install three spacers (46) and coupling (44) on timing gear (23) with three screws (47). Torque to 30 lb-ft (41 N•m).

**NOTE**

Shop cloth must be removed before installing rear cover.

- (74) Install new gasket (48) and rear cover (49) on rear end plate (1) with nine new lockwashers (50) and screws (51). Torque to 180 lb-in. (20.3 N•m).
- (75) Install bracket (52), preformed packing (53), and blower bypass valve (54) on rear end plate (1) with two screws (55).
- (76) Install elbow (56) on rear end plate (1).
- (77) Install hose (57) on blower bypass valve (54) and elbow (56) with two clamps (58).



20-3. TURBOCHARGER REPAIR

This task covers:

- a. Disassembly
 - b. Cleaning/inspection
 - c. Assembly
-

INITIAL SETUP
Equipment Conditions

Turbocharger on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Dial Indicator, Magnetic (Item 32, Appendix E)
 Gage Set, Telescoping (Item 56, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Hammer, Soft-Faced (Item 63, Appendix E)
 Holding Fixture, Turbocharger (Item 71, Appendix E)
 Pliers, Retaining Ring (Item 105, Appendix E)
 Pliers, Retaining Ring (Item 108, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Compound, Antiseize (Item 18, Appendix B)
 Grease, Automotive and Artillery (Item 32, Appendix B)
 Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Locknut (Item 99, Appendix F)
 Rings, Retaining (3) (Item 242, Appendix F)
 Ring, Retaining (Item 241, Appendix F)
 Rings, Seal, Metal (2) (Item 259, Appendix F)
 Ring, Seal (Item 260, Appendix F)

Personnel Required

Two

a. Disassembly
CAUTION

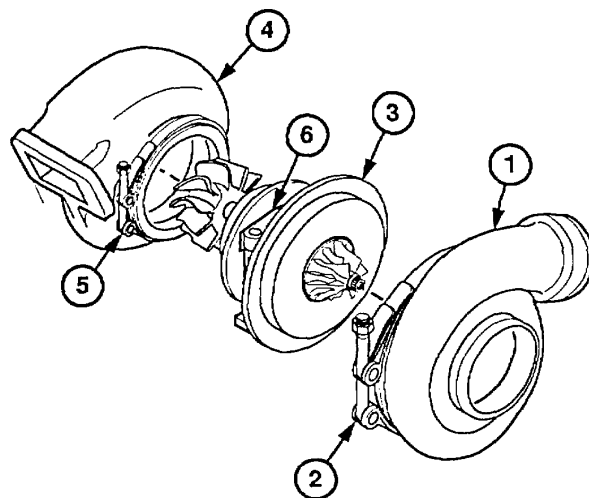
Do not attempt to remove guard assembly from compressor housing. Damage to guard or housing will result.

- (1) Mark compressor housing (1), coupling (2), and compressor backplate (3) before removing.
- (2) Mark turbine housing (4), coupling (5), and center housing (6) before removing.

WARNING

Fins on Impeller and shaft are very sharp. Use care when removing. Failure to comply may result in injury to personnel.

- (3) Loosen coupling (2) and remove compressor housing (1) and coupling (2) from center housing (6).
- (4) Loosen coupling (5) and remove center housing (6) and coupling (5) from turbine housing (4).



20-3. TURBOCHARGER REPAIR (CONT)

- (5) Install turbine wheel (7) in holding fixture (8).
- (6) Remove locknut (9) from shaft (10) with aid of assistant. Discard locknut.
- (7) Tap shaft (10) with soft-faced hammer while assistant holds center housing (6) up approximately 1 in. (25.4 mm) above holding fixture (8) to loosen impeller (11).

CAUTION

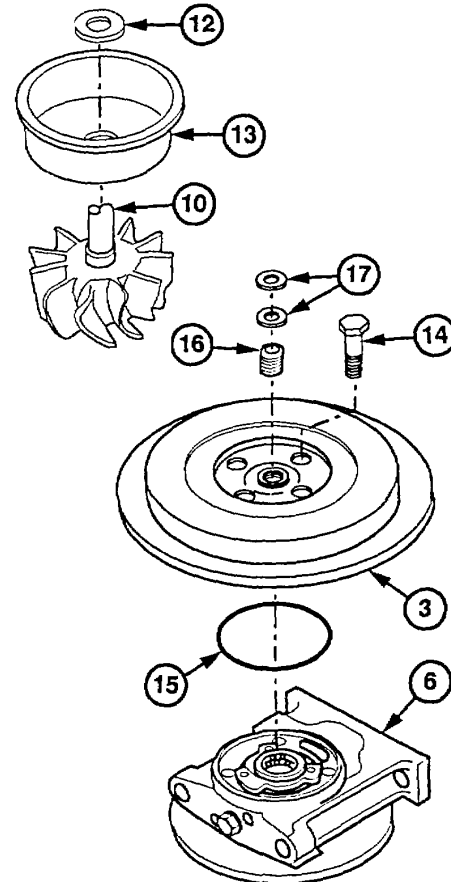
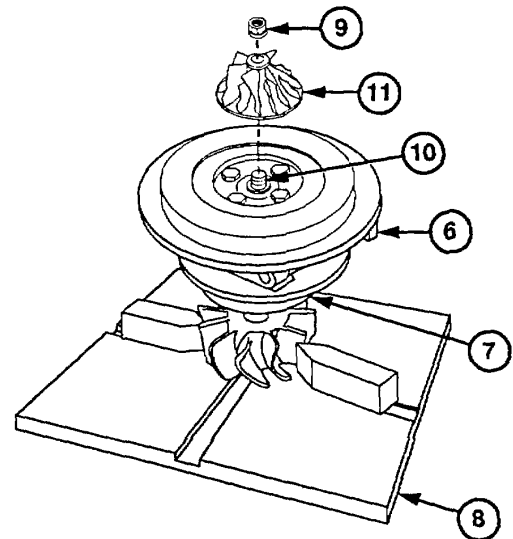
Do not pry off impeller. Damage to impeller may result.

- (8) Remove impeller (11) from shaft (10).
- (9) Remove center housing (6) from shaft (10).

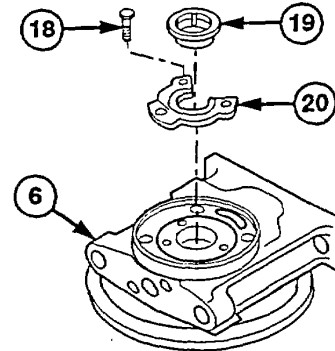
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (10) Remove retaining ring (12) from shaft (10). Discard retaining ring.
- (11) Remove turbine wheel shroud (13) from turbo wheel shaft (10).
- (12) Remove four screws (14) and backplate (3) from center housing (6).
- (13) Remove seal ring (15) from center housing (6). Discard seal ring.
- (14) Remove thrust spacer (16) from backplate (3).
- (15) Remove two metal seal rings (17) from thrust spacer (16). Discard seal rings.



- (16) Remove three screws (18) from center housing (6).
- (17) Remove thrust collar (19) and thrust collar retainer (20) from center housing (6).

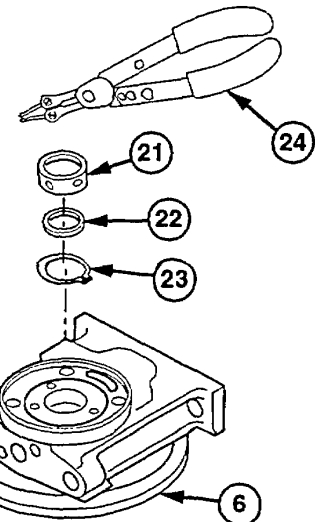


- (18) Remove bearing (21) and washer (22) from center housing (6).

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

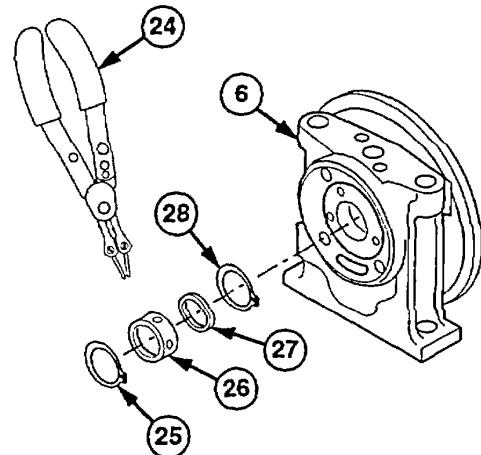
- (19) Remove retaining ring (23) from center housing (6) using retaining ring pliers (Item 105, Appendix E) (24). Discard retaining ring.



- (20) Remove retaining ring (25) and bearing (26) from center housing (6) using retaining ring pliers (24). Discard retaining ring.

- (21) Remove thrust washer (27) from center housing (6).

- (22) Remove retaining ring (28) from center housing (6) using retaining ring pliers (24). Discard retaining ring.



20-3. TURBOCHARGER REPAIR (CONT)**b. Cleaning/Inspection****WARNING**

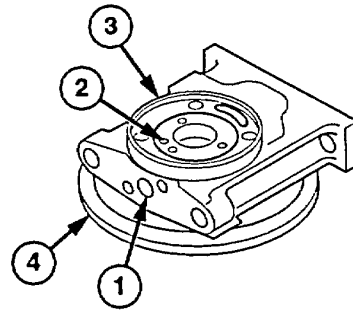
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Soak metal parts in dry cleaning solvent for 25 minutes.

CAUTION

Do not clean turbocharger parts with steel bristle brush. Damage to equipment may result.

- (2) Clean parts with stiff bristle brush.
- (3) Clean oil passages (1, 2, and 3) in center housing (4) and oil passages (5 and 6) in backplate (7).

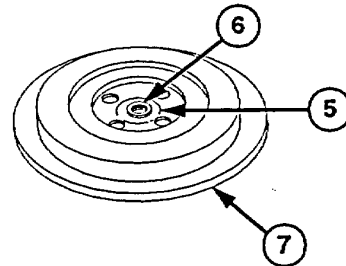
**WARNING**

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

CAUTION

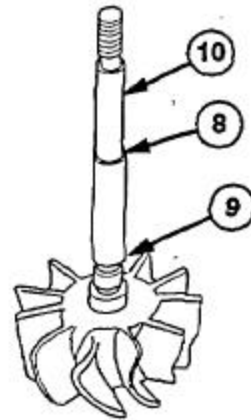
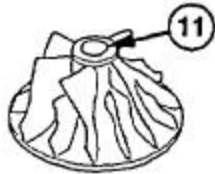
Do not use compressed air on bearings. Allow bearings to air dry. Compressed air may cause damage to bearings.

- (4) Dry metal parts, except bearings, with compressed air. Allow bearings to dry.
- (5) Inspect turbocharger for nicks, cuts, scratches, scoring, or other damage.
- (6) Inspect screw threads for stripping or cross-threading.



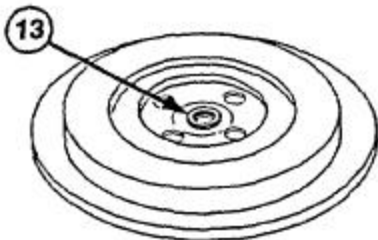
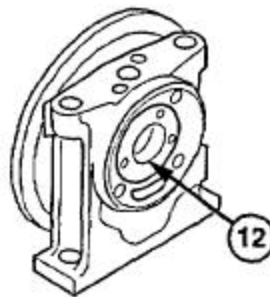
- (7) Measure diameters of turbo wheel shaft journals (8 and 9) on shaft (10). Journal diameters must be 0.6250-0.6254 in. (15.875-15.885 mm).

- (8) Measure inside diameter of bore (11). Inside diameter of bore (11) must not be greater than 0.3749 in. (9.522 mm).



- (9) Measure inside diameter of center housing (12). Inside diameter of center housing (12) must not be greater than 0.9842 in. (24.999 mm).

- (10) Measure seal bore (13). Seal bore (13) must not be greater than 0.6895 in. (17.513 mm).

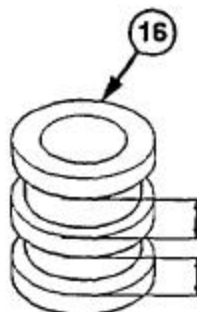
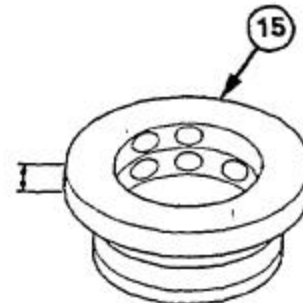
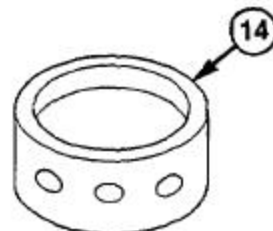


- (11) Measure inside diameter of bearing (14). Bearing (14) inside diameter must not be greater than 0.9842 in. (24.999 mm).

- (12) Measure thrust collar thickness (15). Thrust collar (15) thickness must not be less than 0.2970 in. (7.543 mm). Thrust collar bore inside diameter must not be greater than 0.3778 in. (9.596 mm).

- (13) Measure ring groove width. Ring groove width will not be greater than 0.0715 in. (1.816 mm). Thrust spacer (16) outside diameter must not be less than 0.6705 in. (17.030 mm).

- (14) Replace damaged parts or parts that do not meet specifications.



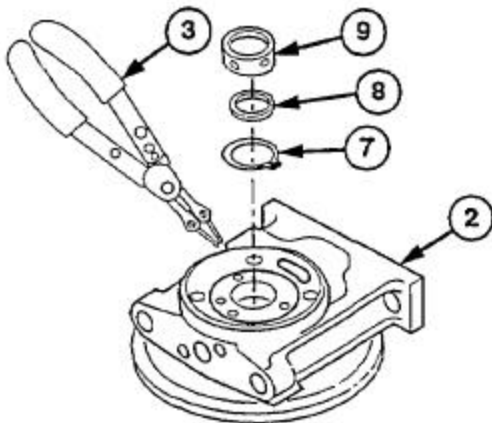
20-3. TURBOCHARGER REPAIR (CONT)

c. Assembly

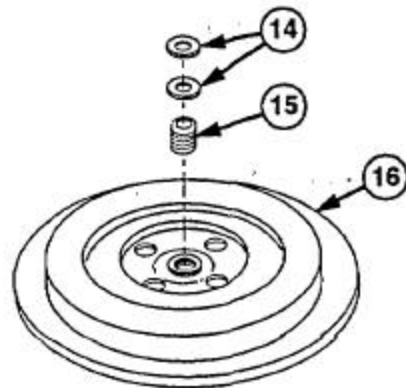
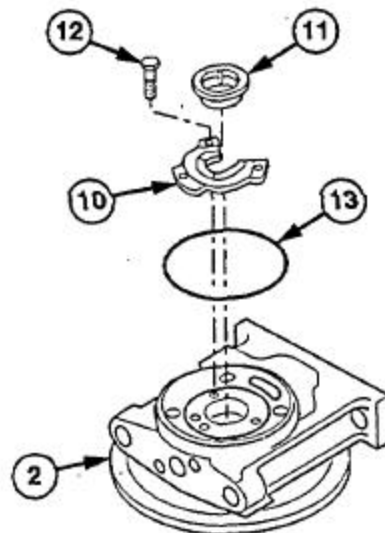
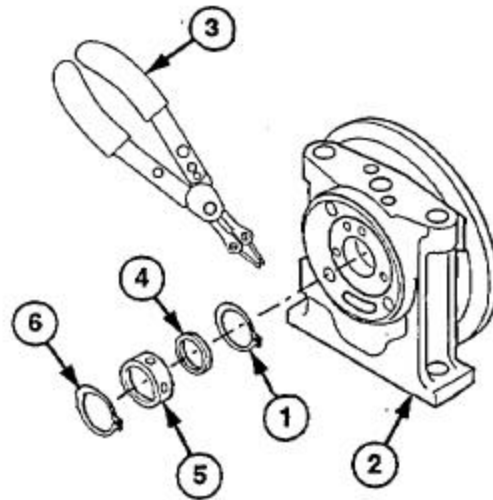
WARNING

Wear protective goggles and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (1) Install retaining ring (1) in center housing (2) using retaining ring pliers (Item 105, Appendix E) (3).
- (2) Install thrust washer (4), bearing (5), and retaining ring (6) in turbine side of center housing (2) using retaining ring pliers (3).
- (3) Install retaining ring (7), thrust washer (8), and bearing (9) in center housing (2) using retaining ring pliers (3).



- (4) Install thrust collar retainer (10) on thrust collar (11) with oil groove facing housing (2).
- (5) Install thrust collar retainer (10) and thrust collar (11) in center housing (2) with three screws (12). Torque to 80-100 lb-in. (9.0-11.3 N•m).
- (6) Install new seal ring (13) in center housing (2).
- (7) Install two new metal seal rings (14) on thrust spacer (15).
- (8) Install thrust spacer (15) in backplate (16).

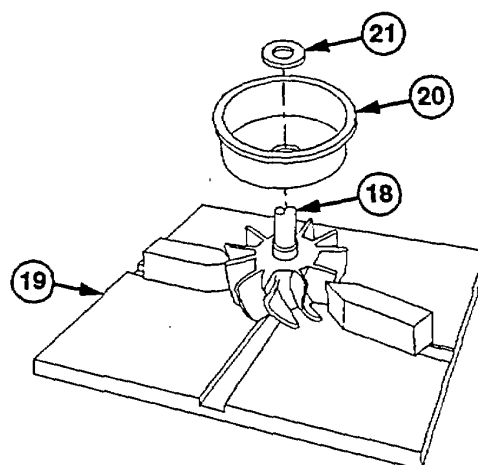
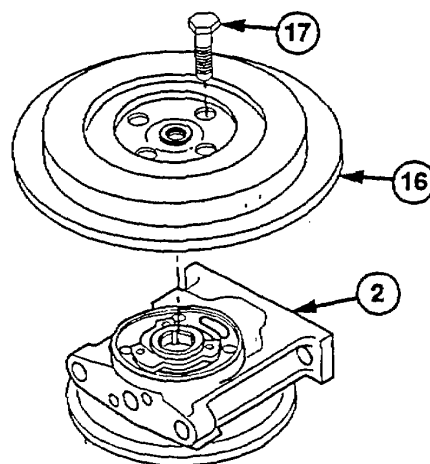


- (9) Install backplate (16) on center housing (2), aligning marks made during disassembly.
- (10) Install four screws (17) in backplate (18). Torque to 80-100 lb-in. (9.0-11.3 N•m).
- (11) Position turbo wheel shaft (18) in holding fixture (19).
- (12) Install turbine wheel shroud (20) on turbo wheel shaft (18).

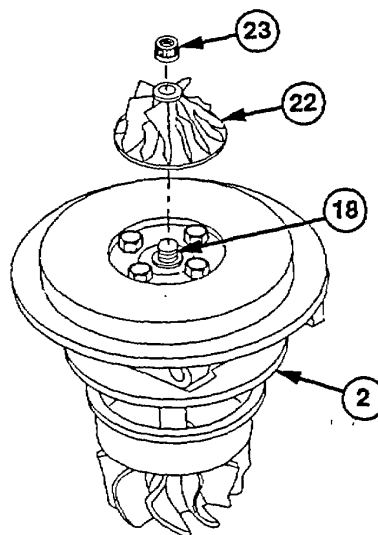
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (13) Coat lower piston ring groove with grease. Install new retaining ring (21) in groove.
- (14) Install center housing (2) on turbo wheel shaft (18).



- (15) Install impeller (22) on shaft (18).
- (16) Position new locknut (23) on shaft (18).
- (17) Tighten locknut (23) to 135 lb-in. (14.9 N•m) with aid of assistant.
- (18) Remove locknut (23) from shaft (18) with aid of assistant.
- (19) Inspect locknut (23) and impeller (22) for scratches. Ensure both contact surfaces are clean and smooth. Replace damaged parts.
- (20) Coat threads of shaft (18) and base of locknut (23) with lubricating oil.
- (21) Position locknut (23) on shaft (18). Torque to 35-55 lb-in. (4.0-6.2 N•m) with aid of assistant. Tighten 1/4 turn more.



20-3. TURBOCHARGER REPAIR (CONT)

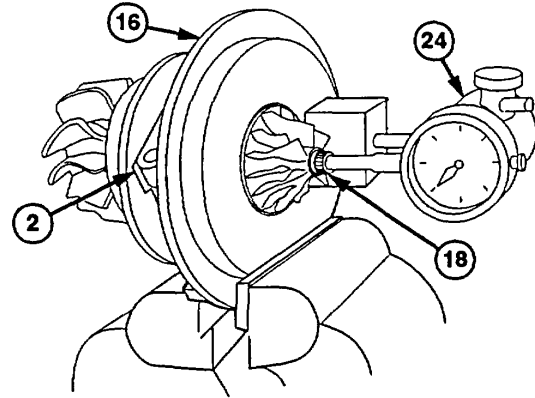
- (22) Place backplate (16) in soft-jawed vise.

NOTE

If reading is not 0.003-0.010 in. (0.08-0.25 mm), remove indicator and repeat steps (17) thru (23).

- (23) Check thrust float with dial indicator (24). Move shaft (18) back and forth in center housing (2). Reading should be 0.003-0.010 in. (0.08-0.25 mm).

- (24) Remove backplate (16) from soft-jawed vise.

**NOTE**

Matchmarks on center housing, coupling, and turbine housing should be aligned.

- (25) Install turbine wheel assembly (25) and coupling (26) on turbine housing (27).

- (26) Coat threads of coupling screw (28) with antiseize compound.

CAUTION

Do not tighten coupling until aligned with turbine housing. If parts are not aligned, turbocharger will be damaged.

- (27) Install new locknut (29) on coupling screw (28). Torque to 160 lb-in. (18.1 N•m).

- (28) Loosen locknut (29) to 50 lb-in. (6 N•m).

- (29) Tighten locknut (29) to 165 lb-in. (18.9 N•m).

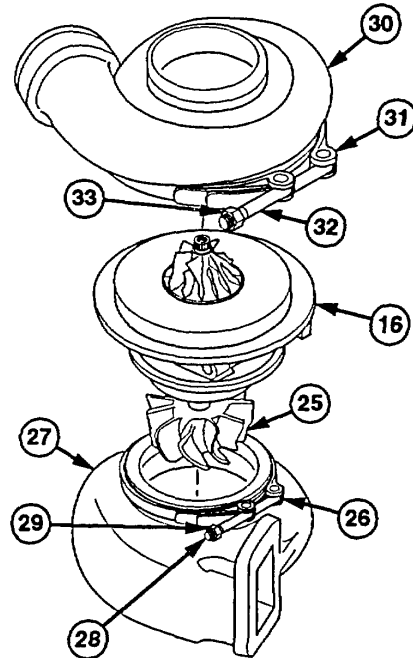
NOTE

Matchmarks on compressor housing, coupling, and turbine housing should be aligned.

- (30) Install compressor housing (30) and coupling (31) on backplate (16).

- (31) Coat threads of coupling screw (32) with lubricating oil.

- (32) Install new locknut (33) on coupling screw (32). Torque to 110-130 lb-in. (12.4-14.7 N•m).



- (33) Position dial Indicator (23) on compressor housing (30).

CAUTION

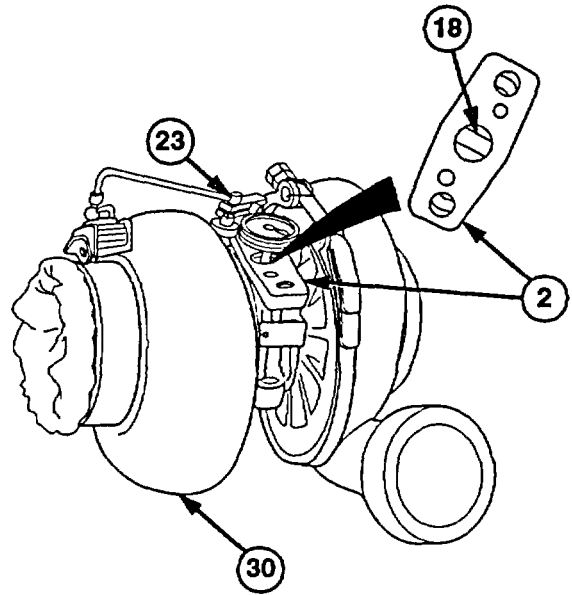
Do not allow sides of extension rod to touch sides of center housing. Inaccurate reading may result in poor fit and damage to turbocharger.

- (34) Install extension rod of dial indicator (23) in oil drain hole in center housing (2) so that rod is against turbo wheel shaft (18).

NOTE

If fit of shaft is not within limits, disassemble and inspect turbocharger.

- (35) Move shaft (18) up and down. Shaft must not move more than 0.0070 in. (0.178 mm) or less than 0.003 in. (0.076 mm).



CHAPTER 21
COOLING SYSTEM MAINTENANCE

Contents	Para	Page
Introduction	21-1	21-1
Water Pump Repair	21-2	21-2

Section I. INTRODUCTION

21-1. INTRODUCTION

This chapter contains instructions for repair of the water pump at the General Support maintenance level.

Section II. MAINTENANCE PROCEDURES

21-2. WATER PUMP REPAIR

This task covers

- a. Disassembly
- b. Cleaning/Inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Water pump on clean work surface.

Tools and Specials Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Adapter, Impeller, Slip Test (Item 1, Appendix E)
 Gage, Feeler (Item 50, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Handle, Drive (Item 65, Appendix E)
 Installer, Oil Seal (Item 80, Appendix E)
 Installer, Water Pump Drive Gear (Item 88, Appendix E)
 Installer, Water Pump Seal (Item 89, Appendix E)
 Pliers, Retaining Ring (Item 108, Appendix E)
 Pliers, Retaining Ring (Item 110, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical, Gear and Brg (Item 124, Appendix E)

Tools and Specials Tools (Cont)

Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Adhesive-Sealant (Item 7, Appendix B)
 Compound, International No. 2 (Item 21, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28, Appendix B)
 Oil, Lubricating (Item 45, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Repair Kit, Water Pump (Item 230, Appendix F)
 Ring, Retaining (Item 244, Appendix F)

Personnel Required

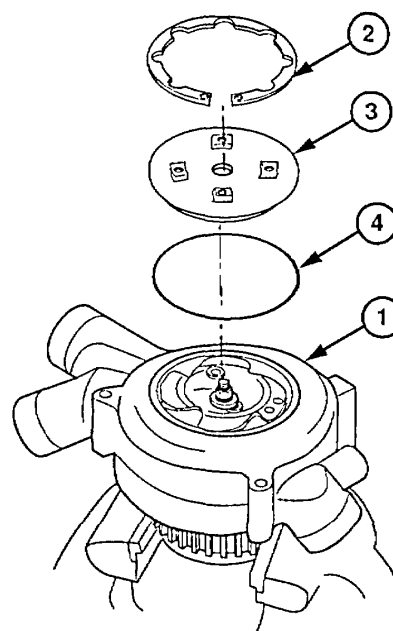
Two

a. Disassembly

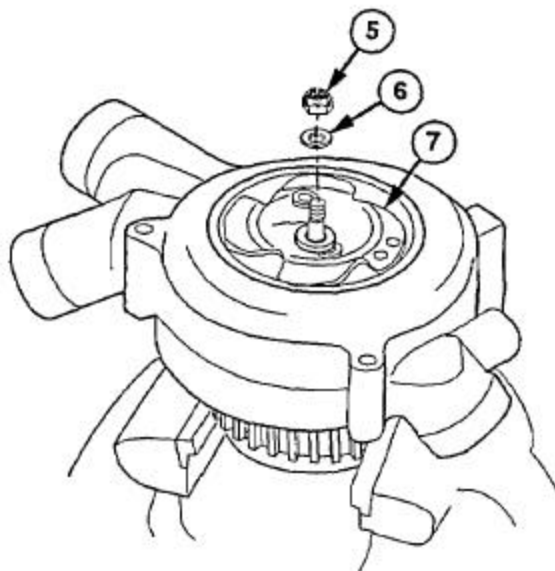
- (1) Place water pump (1) gear-side down in soft-jawed vise.

WARNING

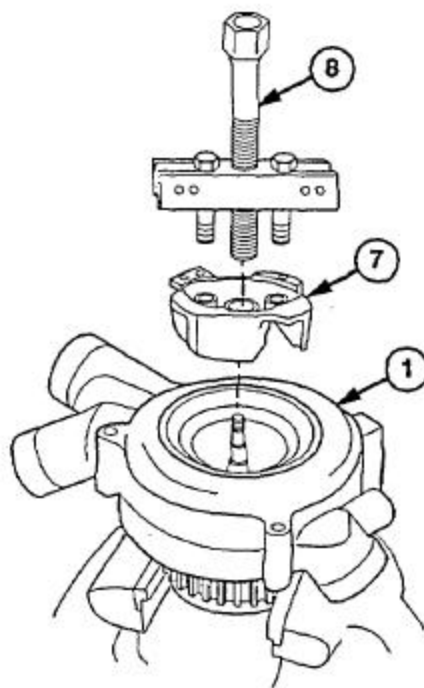
- **Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released and may cause severe eye injury.**
 - **Due to size and tension of retaining ring in step (2), ensure suitable retaining ring pliers are used for safety. Press a hammer against pump cover to help prevent injury should retaining ring slip off pliers.**
- (2) Remove retaining ring (2), access cover (3), and seal ring (4) using retaining ring pliers. Discard retaining ring and seal ring.



- (3) Remove locknut (5) and washer (6) from impeller (7). Discard locknut.



- (4) Remove impeller (7) from water pump (1) with puller (8).



- (5) Rotate water pump (1) so gear side faces up.

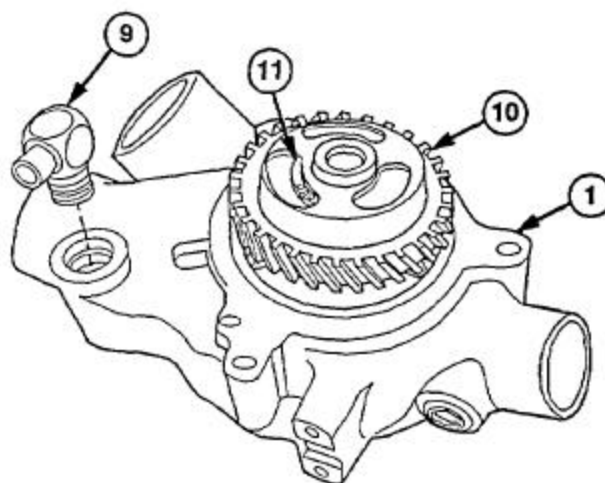
- (6) Remove elbow (9) from water pump (1).

- (7) Turn gear (10) until ends of lock ring (11) can be seen.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released and may cause severe eye injury.

- (8) Remove lock ring (11) from groove in water pump (1).



21-2. WATER PUMP REPAIR (CONT)

- (9) Press gear (10) and shaft assembly (12) from water pump (1).

NOTE

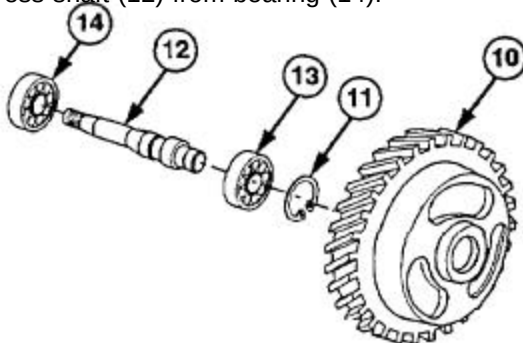
Do steps (10) and (11) if gear fails inspection.

- (10) Press shaft (12) from gear (10).
 (11) Remove lock ring (11) from shaft (12).

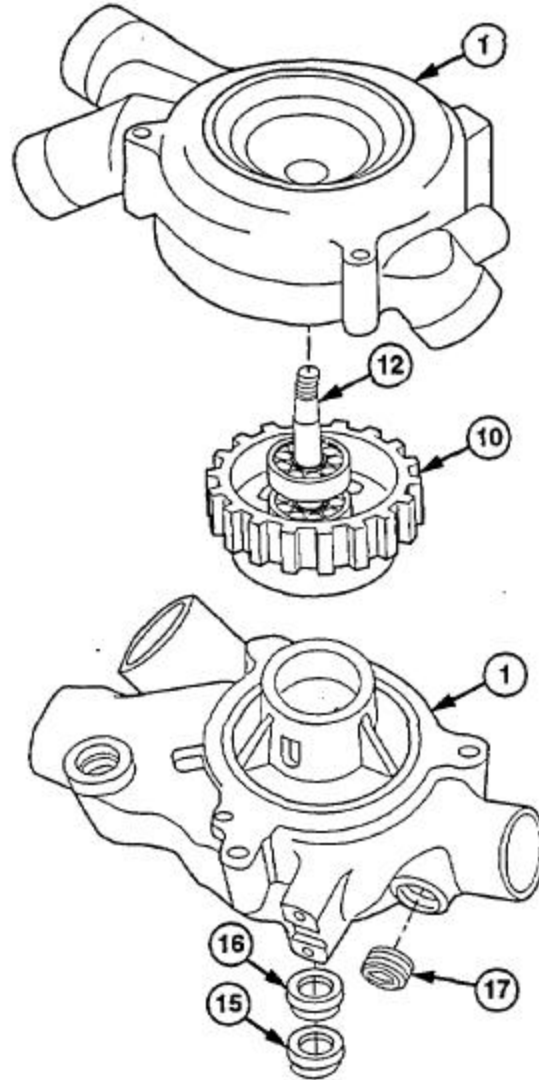
NOTE

Do steps (12) and (13) if bearings fail inspection.

- (12) Press shaft (12) from bearing (13).
 (13) Press shaft (12) from bearing (14).



- (14) Tap water seal (15) from water pump (1).
 (15) Tap oil seal (16) from water pump (1).
 (16) Remove plug (17) from water pump (1).

**b. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean all metal parts with dry cleaning solvent.
- (2) Inspect passages of housing for obstructions, deposits, and cracks. Clean out any obstructions or deposits. Replace housing if cracked.
- (3) Inspect bearings for damage and rough turning. Replace both bearings if either bearing is damaged.
- (4) Inspect gear for worn, chipped, or missing teeth.

c. Assembly

NOTE

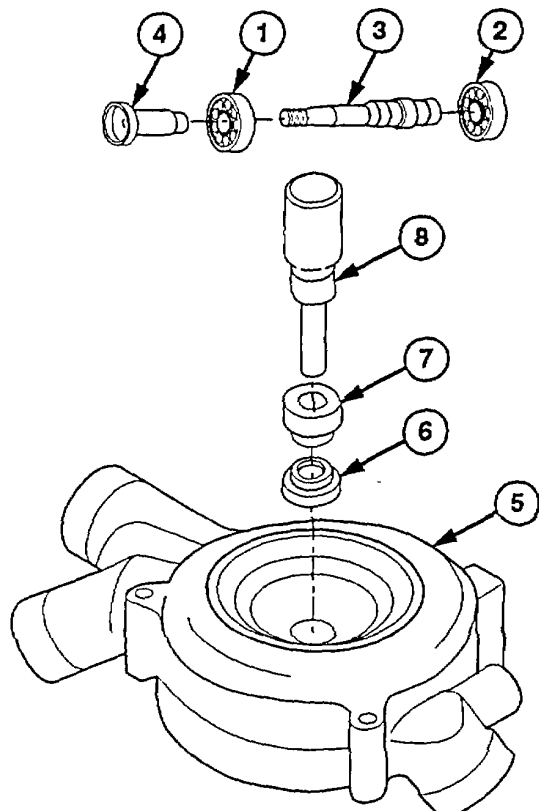
- Do steps (1) thru (3) if bearings were removed during disassembly.
- Bearings are installed with numbered side of one bearing facing numbered side of other bearing.

- (1) Lubricate bearings (1 and 2) and shaft (3) with oil.

CAUTION

Apply pressure to inside bearing races only. Failure to comply may damage bearings.

- (2) Press shaft (3), threaded end down, into small bearing (2) using water pump drive gear installer (4) to support bearing.
- (3) Press shaft (3), threaded end up, into large bearing (1) using water pump drive gear installer (4) to support bearing.
- (4) Place water pump (5) gear-side down on clean work surface.
- (5) Install new oil seal (6), lip facing down, in water pump (5) using oil seal installer (7) and drive handle (8).

**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (6) Coat outside of new water seal (9) with adhesive-sealant.
- (7) Position new water seal, (9), small side facing up, in water pump (5).

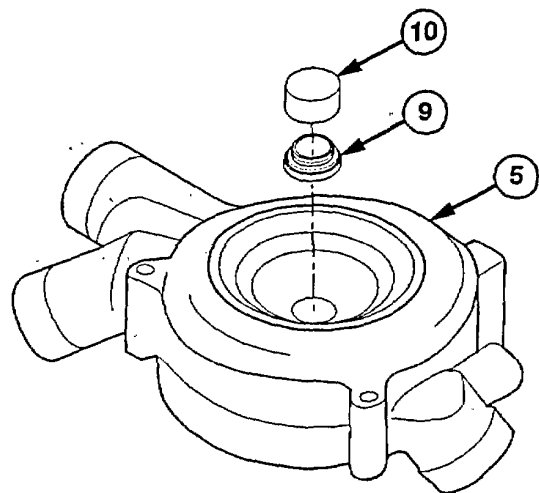
CAUTION

Water pump seal installer must be used to install water seal to correct height. Failure to comply may result in damage to equipment.

NOTE

Excess sealant should be wiped from water seal.

- (8) Install new water seal (9) in water pump (5) using water pump seal installer (10).



21-2. WATER PUMP REPAIR (CONT)**WARNING**

When Installing shaft assembly, ensure shaft assembly is installed straight into pump body or damage to shaft assembly and pump body may result.

- (9) Install shaft assembly (3) into water pump (5) by pressing on outer race of larger bearing (1).
- (10) Install lock ring (11) in water pump (5) to secure shaft assembly (3).

WARNING

Gear must be installed straight onto shaft or gear will be damaged.

NOTE

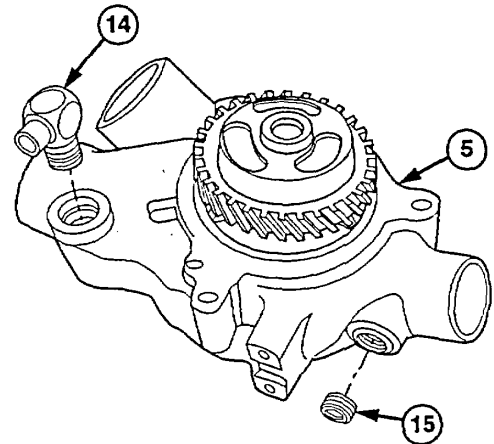
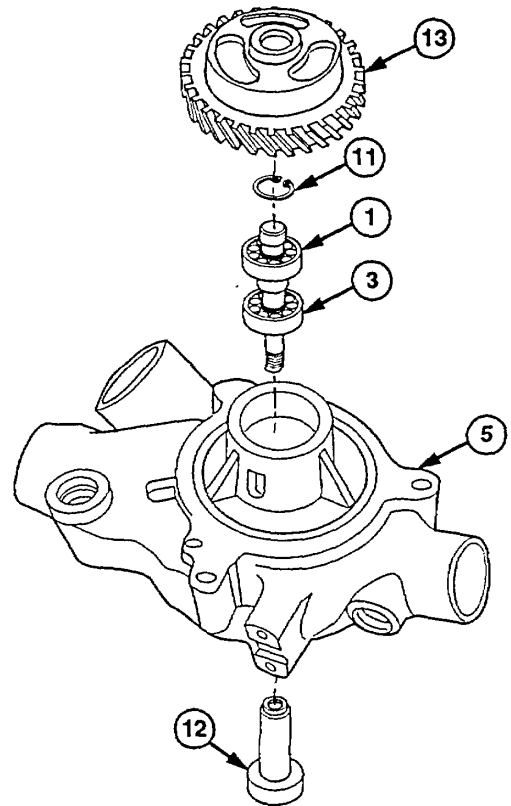
Do step (11) if gear was removed during disassembly.

- (11) Press gear (13) onto shaft assembly (3) using water pump drive gear installer (12) to support shaft assembly from beneath.

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (12) Coat threads of elbow (14) with pipe thread sealing compound and install elbow (14) in water pump (5).
- (13) Coat threads of plug (15) with pipe thread sealing compound and install plug (15) on water pump (5).



- (14) Coat threads of shaft (3) with compound no. 2.
- (15) Place gear (13) in soft-Jawed vise.
- (16) Install impeller (16) on shaft (3) with washer (17) and new locknut (18). Torque to 35-40 lb-ft (47-54 N•m).

NOTE

Steps (17) thru (21) measure slip torque of gear.

- (17) Scribe a line across gear (13) and shaft (3).
- (18) Scribe a second line across impeller (16), locknut (18), and shaft (3).
- (19) Install adapter (19) on torque wrench (20).
- (20) Insert adapter dowel pins (21) in impeller puller holes (22) and apply torque of 80 lb-ft (108 N•m). Check assembly for slippage while applying torque.

NOTE

If slippage was felt, examine scribed marks to determine if gear or impeller slipped and do step (21). Otherwise go to step (22).

- (21) Replace shaft (3) and component that slipped (13 or 16). Repeat steps (17) thru (20).
- (22) Insert 0.015 in. (0.38 mm) feeler gage (23) through water outlet opening between impeller (16) and inside wall (24) of water pump (5).

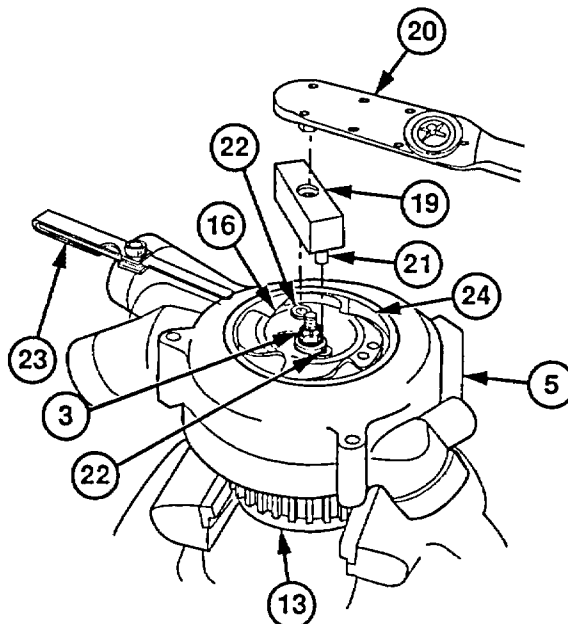
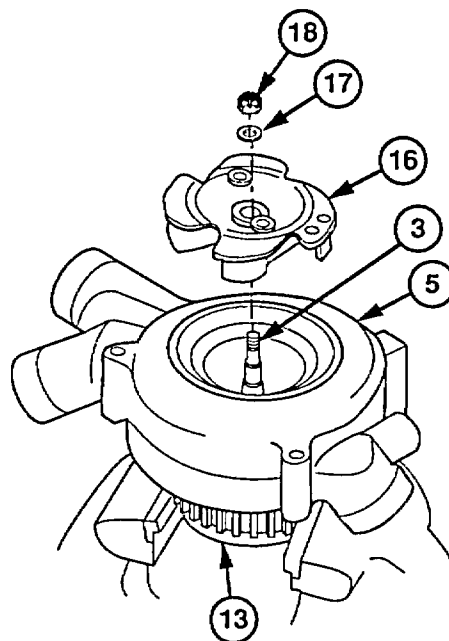
NOTE

If clearance in step (23) is wrong, repeat para 21-2a and 21-2b.

- (23) Turn impeller (16) while holding feeler gage (23) in position to check clearance between all blades of impeller (16) and inside wall of water pump (5).
- (24) Remove gear (13) from vise.

NOTE

Retaining ring, access cover, and seal ring are installed in para 5-5.



CHAPTER 22

TRANSMISSION MAINTENANCE

Contents	Para	Page
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Section I. INTRODUCTION

22-1. INTRODUCTION

This chapter contains instructions for replacement and repair of transmission components at the General Support maintenance level. Some parts must be removed before transmission parts can be accessed. They are referenced to other paragraphs of this manual or TM 9-2320-360-20.

Section II. SERVICE AND INSPECTION

22-2. GENERAL MAINTENANCE INSTRUCTIONS

- a. Maintenance.** Follow these basic instructions when working on the transmission.
 - (1) Handle transmission parts carefully to prevent nicking, scratching, or denting. Internal parts of transmission have close operating tolerances. They may bind if parts are damaged. Some parts rely upon a smooth surface to create a seal. They may leak if surfaces are scratched.
 - (2) Do not use metal tools when working on internal parts of transmission or when removing gaskets or packing. Use a pointed wooden dowel to remove packing from grooves. Use wooden or plastic scrapers on gasket surfaces.
- b. Cleaning.** Follow these cleaning instructions when working on the transmission.
 - (1) All parts must be clean to permit proper inspection of subassemblies and parts. Ensure that no debris or foreign material enters the transmission when working on internal parts.

22-2. GENERAL MAINTENANCE INSTRUCTIONS (CONT)**WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-69°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

CAUTION

DO NOT use caustic soda solution in place of steam cleaning method. Use only dry cleaning solvent to clean friction-faced dutch plates.

- (2) Thoroughly clean metal transmission parts, except bearings and friction-faced clutch plates, with dry cleaning solvent (Item 54, Appendix B) or by steam cleaning method.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Drip-dry and air-dry bearings, then oil (Item 44, Appendix B). Dry other parts with compressed air. Oil steam-cleaned parts immediately after drying to prevent rust.
- (4) Clean oil passages by working a piece of soft wire back and forth through them. Flush with dry cleaning solvent (Item 54, Appendix B). Dry with compressed air.

c. Inspection. Follow these inspection instructions when working on the transmission.

- (1) Inspect surfaces which contact gaskets, packing, or seals. Ensure there are no nicks, burrs, or scratches. Remove or correct any defect with crocus cloth (Item 16, Appendix B) before assembly.
- (2) Inspect bores for wear, scratches, grooves, burrs, or dirt. Remove scratches and burrs with crocus cloth (Item 16, Appendix B) and clean. Remove foreign matter from bores and clean. Replace deeply scratched, grooved, and excessively worn parts.
- (3) Inspect housing and other cast metal parts for cracks. Replace cracked parts as necessary.
- (4) Inspect gears for scuffed, nicked, burred, worn, or broken teeth. If defect cannot be corrected with soft stone, replace damaged gear.
- (5) Inspect thrust face of gears for scoring, scratches, or burrs. If defects are found, remove with soft stone. If defects cannot be removed, replace gears as necessary.
- (6) Inspect splined parts for stripped, twisted, chipped, or burred splines. Remove burrs with soft stone and replace parts if other defects are found. Spline wear is not considered defective except when it affects tightness of the assembly.
- (7) Inspect retaining rings for nicks, distortion, or looseness. Replace retaining rings if loose or damaged.
- (8) Inspect springs for signs of overheating, permanent set, or wear due to rubbing of adjacent parts. Replace springs if damage is found.
- (9) Inspect friction-faced dutch plates and steel dutch plates for burrs, scoring, excessive wear, distortion, embedded metal, galling, cracks, and damaged teeth or tangs. Remove burrs and minor surface defects with soft stone. If other than minor surface defects are found, replace clutch plates.

Section III. MAINTENANCE PROCEDURES

22-3. TRANSMISSION TO TRANSMISSION STAND INSTALLATION/REMOVAL

This task covers

- a. Installation
- b. Removal
- c. Follow-On Maintenance

Initial Setup:

Equipment Conditions

Transmission removed from container (para 7-3).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Fixture, Transmission Holding (Item 45, Appendix E)
 Sling Assemblies (2) (Item 160, Appendix E)
 Stand, Engine (Item 181, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Compound, Sealing, Pipe Thread (Item 28, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Gasket (Item 25, Appendix F)
 Kit, Mounting Parts (Item 145, Appendix F)
 Locknuts (7) (Item 86, Appendix F)
 Lockwashers (4) (Item 122, Appendix F)
 Screws (4) (Item 276, Appendix F)
 Screws (4) (Item 277, Appendix F)

Personnel Required

Two

a. Installation

- (1) Remove breather (1) from reducer (2).
- (2) Remove reducer (2) from transmission (3).

NOTE

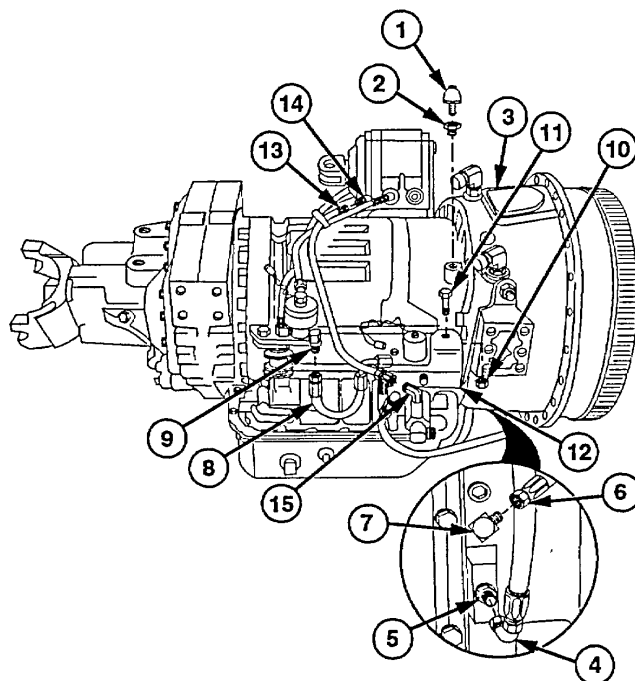
Tag and mark hoses before removal.

- (3) Remove hose no. 2672 (4) from adapter (5).
- (4) Remove hose no. 2646 (6) from elbow (7).
- (5) Remove hose no. 2851 (8) from screen adapter (9).

NOTE

Transmission lockup solenoid and hoses no. 2672, 2646, and 2851 are removed with bracket.

- (6) Remove locknut (10), screw (11), and bracket (12) from transmission (3). Discard locknut.
- (7) Remove hose no. 2852 (13) from elbow (14) and elbow (15).



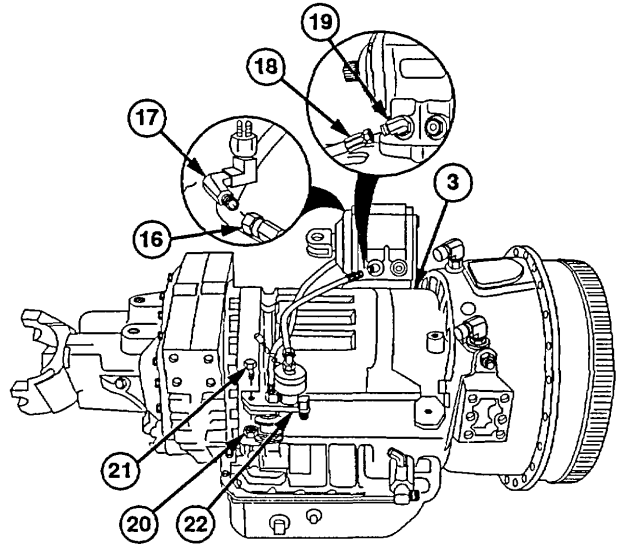
22-3. TRANSMISSION TO TRANSMISSION STAND INSTALLATION/REMOVAL (CONT)

- (8) Remove hose no. 2933 (16) from elbow (17).
- (9) Remove hose no. 2934 (18) from elbow (19).

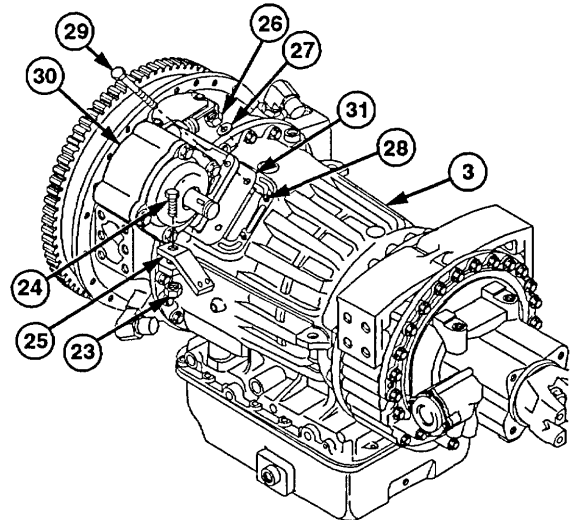
NOTE

PTO solenoid and hoses no. 2852, 2933, and 2934 are removed with bracket.

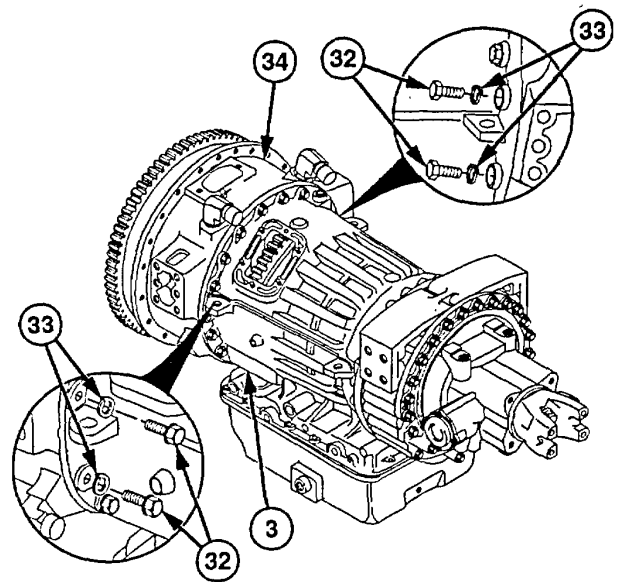
- (10) Remove locknut (20), screw (21), and bracket (22) from transmission (3). Discard locknut.



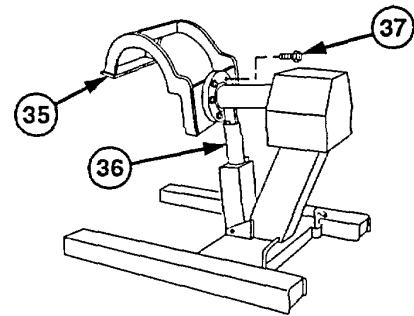
- (11) Remove locknut (23), screw (24), and bracket (25) from transmission (3). Discard locknut.
- (12) Remove five nuts (26) and copper washers (27) from studs (28). Discard copper washers.
- (13) Remove screw (29) from PTO (30) and transmission (3).
- (14) Remove PTO (30) and gasket (31) from transmission (3). Discard gasket.



- (15) Remove four screws (32) and lockwashers (33) from torque converter housing (34) and transmission (3). Discard lockwashers.



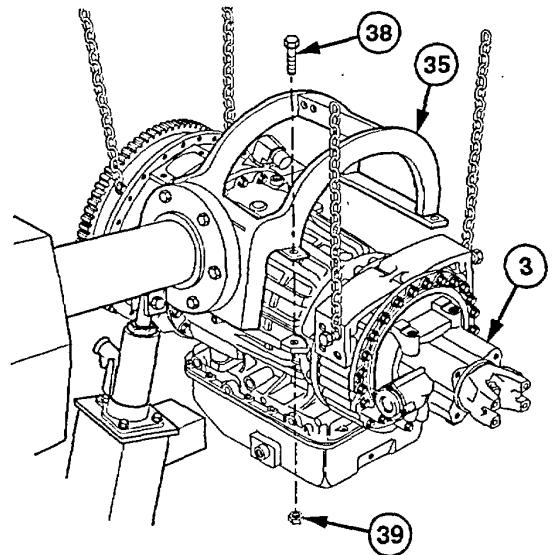
- (16) Install transmission holding fixture (35) on engine stand (36) with four screws (37).



WARNING

Transmission weighs approximately 1125 lb (510 kg). Use caution when lifting transmission. Failure to comply may result in serious injury or death to personnel.

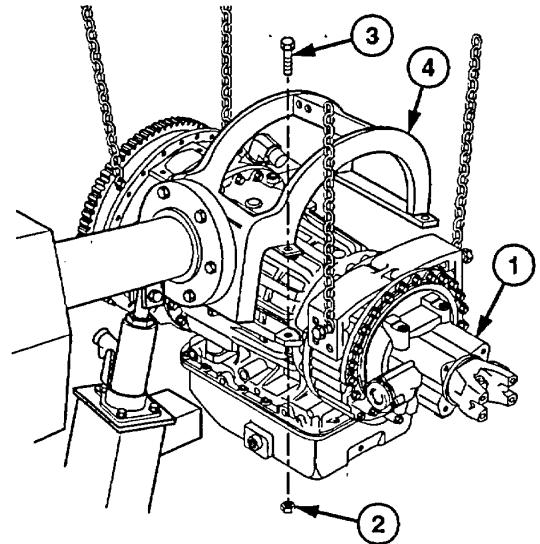
- (17) Install lifting device on transmission (3).
 (18) Position holding fixture (35) over transmission (3) while assistant supports transmission with lifting device.
 (19) Install holding fixture (35) on transmission with four screws (38) and locknuts (39).
 (20) Remove lifting device from transmission (3).



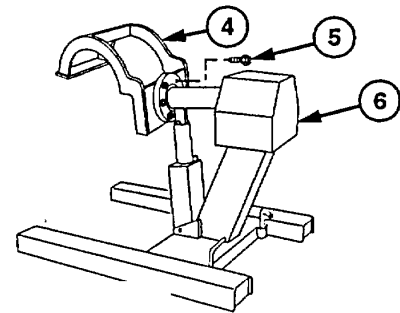
22-3. TRANSMISSION TO TRANSMISSION STAND INSTALLATION/REMOVAL (CONT)**b. Removal****WARNING**

Transmission weighs approximately 1125 lb (510 kg). Use caution when lifting transmission. Failure to comply may result in serious injury or death to personnel.

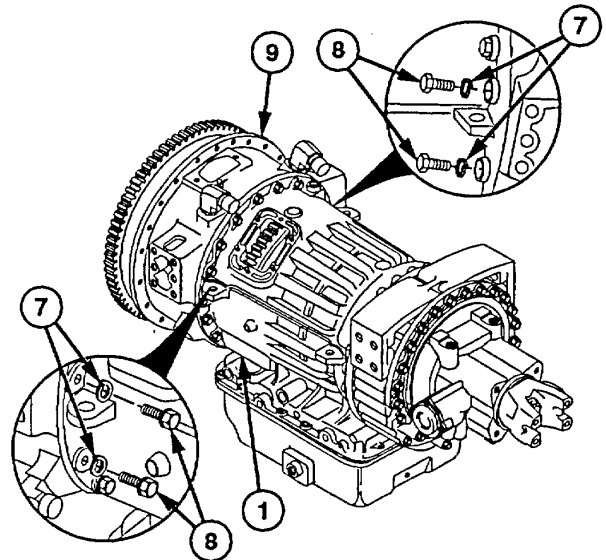
- (1) Install lifting device on transmission (1).
- (2) Remove four locknuts (2) and screws (3) from holding fixture (4) and transmission (1) while assistant supports transmission with lifting device.
- (3) Place transmission (1) on hard, level surface and remove lifting device.



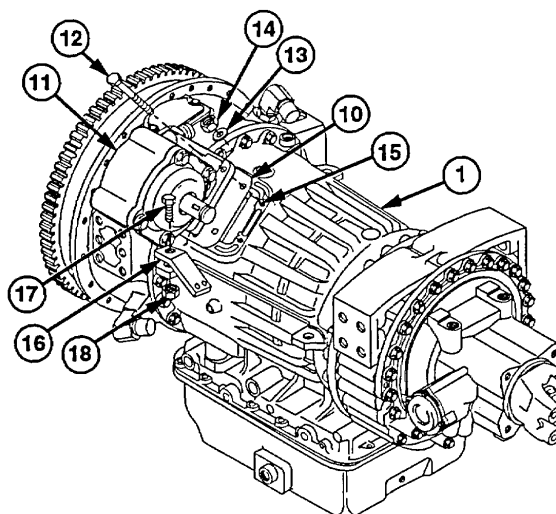
- (4) Remove four screws (5) and holding fixture (4) from engine stand (6).



- (5) Install four new lockwashers (7) and screws (8) in transmission (1) and torque converter housing (9). Torque to 67-80 lb-ft (91-108 N•m).



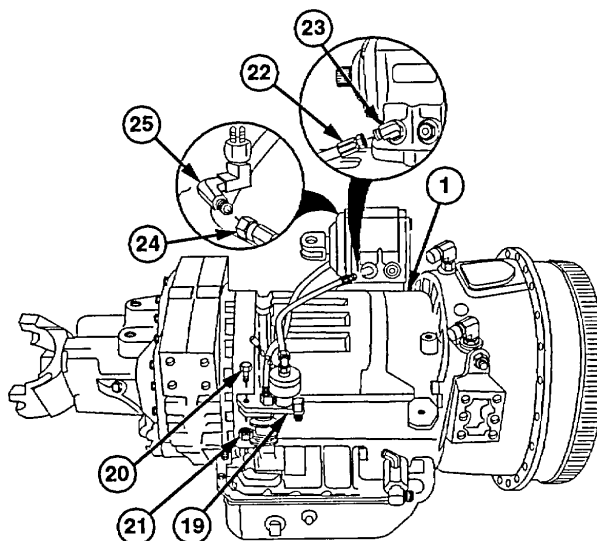
- (6) Install new gasket (10) and PTO (11) on transmission (1).
- (7) Install screw (12) in PTO (11) and transmission (1).
- (8) Install five new washers (13) and nuts (14) on studs (15).
- (9) Install bracket (16) on transmission (1) with screw (17) and new locknut (18).



NOTE

PTO solenoid and hoses no. 2852, 2933, and 2934 are installed with bracket.

- (10) Install bracket (19) on transmission (1) with screw (20) and new locknut (21).
- (11) Install hose no. 2934 (22) on elbow (23).
- (12) Install hose no. 2933 (24) on elbow (25).



22-3. TRANSMISSION TO TRANSMISSION STAND INSTALLATION/REMOVAL (CONT)

- (13) Install hose no. 2852 (26) on elbow (27) and elbow (28).

NOTE

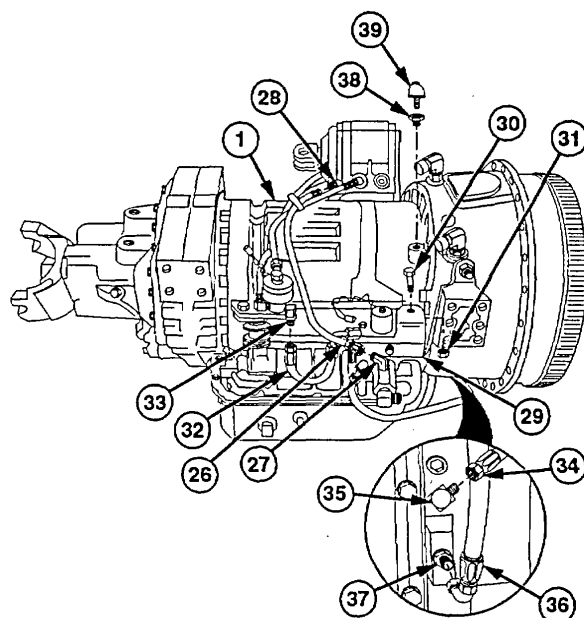
Transmission lockup solenoid and hoses no. 2672, 2646, and 2851 are installed with bracket.

- (14) Install bracket (29) on transmission (1) with screw (30) and new locknut (31).
 (15) Install hose no. 2851 (32) on elbow (33).
 (16) Install hose no. 2646 (34) on elbow (35).
 (17) Install hose no. 2672 (36) on adapter (37).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (18) Coat threads of reducer (38) and breather (39) with pipe thread sealing compound.
 (19) Install reducer (38) on transmission (1).
 (20) Install breather (39) on reducer (38).

**c. Follow-On Maintenance**

Install transmission in container (para 7-3).

22-4. FLYWHEEL ASSEMBLY/LOCKUP CLUTCH REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Transmission mounted on stand (para 22-3).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Bracket, Lifting, Flywheel (Item 12, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Pan, Oil Drain (Item 102, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

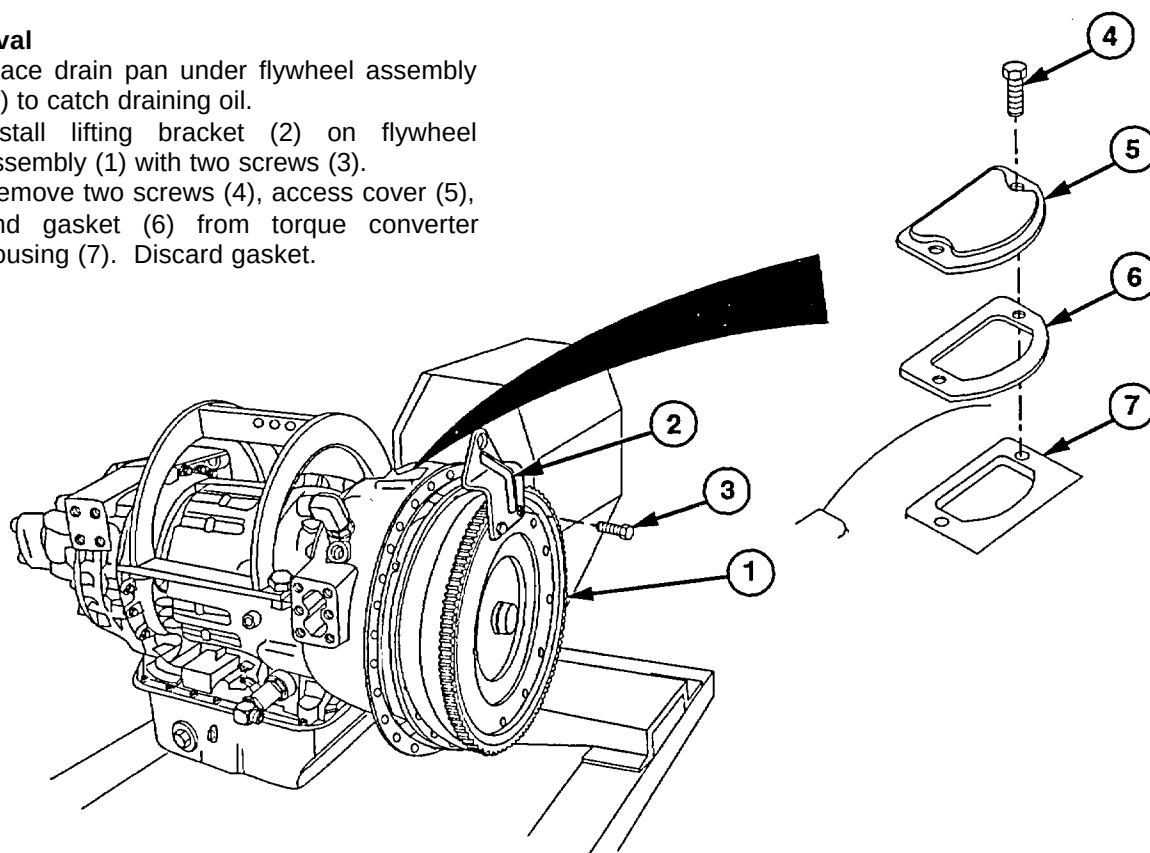
Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Gasket (Item 58, Appendix F)
 Lockwashers (30) (Item 143, Appendix F)
 Ring, Seal (Item 252, Appendix F)
 Ring, Seal (Item 261, Appendix F)
 Ring, Seal (Item 262, Appendix F)
 Ring, Seal (Item 269, Appendix F)

Personnel Required

Two

a. Removal

- (1) Place drain pan under flywheel assembly (1) to catch draining oil.
- (2) Install lifting bracket (2) on flywheel assembly (1) with two screws (3).
- (3) Remove two screws (4), access cover (5), and gasket (6) from torque converter housing (7). Discard gasket.



22-4. FLYWHEEL ASSEMBLY/LOCKUP CLUTCH REPAIR (CONT)

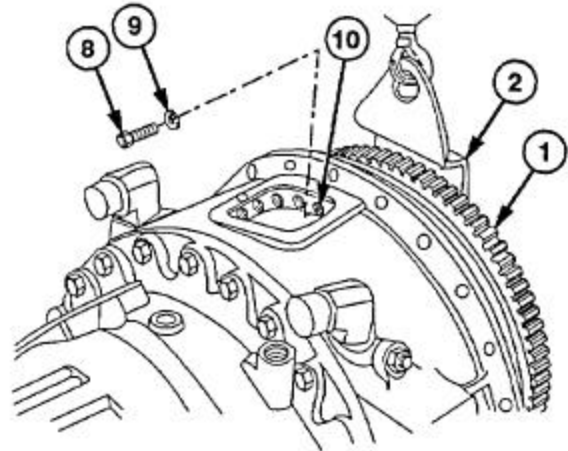
WARNING

Leave one screw in place behind lifting bracket. Screw is intended to secure flywheel assembly until lifting device is in place. Failure to comply may result in serious injury to personnel and damage to equipment.

NOTE

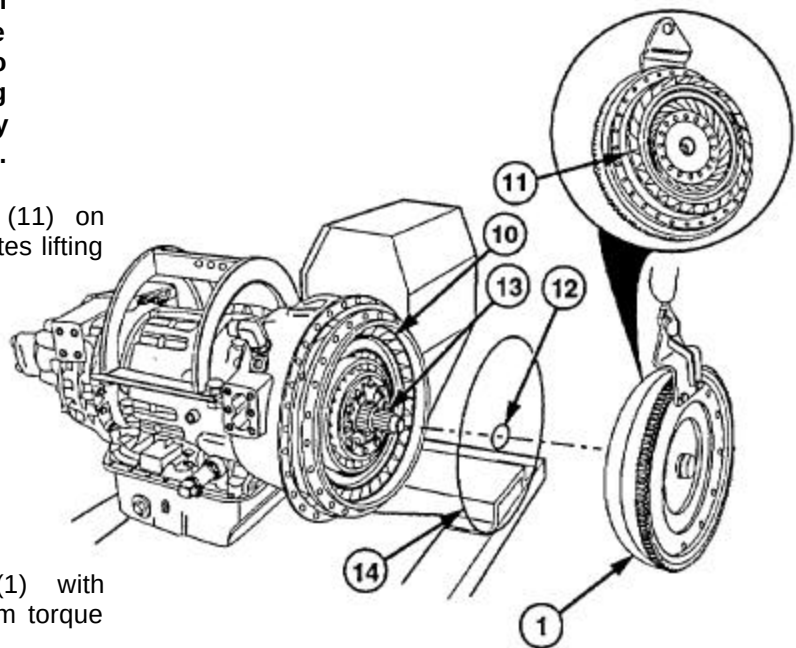
Use flywheel lifting bracket to turn flywheel for access to screws inside torque converter housing.

- (4) Remove 29 of 30 screws (8) and lockwashers (9) from torque converter pump (10) and flywheel assembly (1) with aid of assistant. Discard lockwashers.
- (5) Install lifting device on lifting bracket (2).
- (6) Raise lifting device until it supports weight of flywheel assembly (1).
- (7) Remove remaining screw (8) and lockwasher (9) from flywheel assembly (1). Discard lockwasher.

**CAUTION**

Torque converter turbine may be removed with flywheel or remain in transmission. Ensure that torque converter turbine is supported to prevent it from falling when removing flywheel. Failure to comply may result in damage to converter turbine.

- (8) Hold torque converter turbine (11) on flywheel (1) while assistant operates lifting device.



- (9) Remove flywheel assembly (1) with torque converter turbine (11) from torque converter pump (10).
- (10) Remove seal ring (12) from turbine shaft (13). Discard seal ring.
- (11) Remove seal ring (14) from torque converter pump (10). Discard seal ring.

NOTE

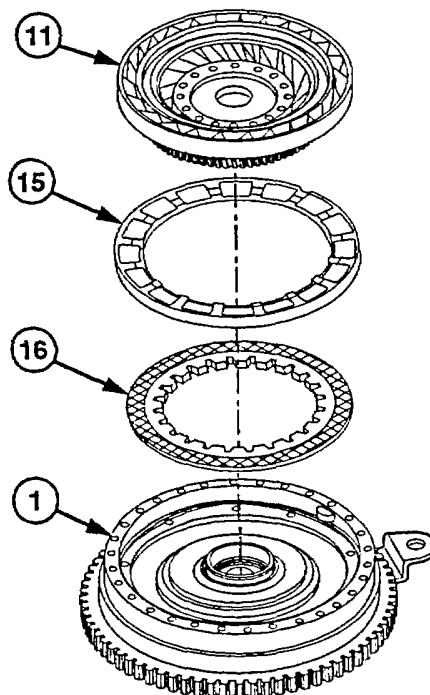
If torque converter turbine remains in transmission, go to step (14).

- (12) Position flywheel assembly (1) on level surface so torque converter turbine (1) faces up.

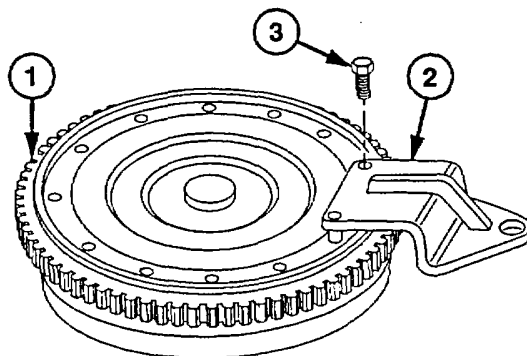
CAUTION

Pry up evenly to remove torque converter turbine from flywheel. Use shop towels at two pry points to prevent scoring or other damage to torque converter turbine or flywheel.

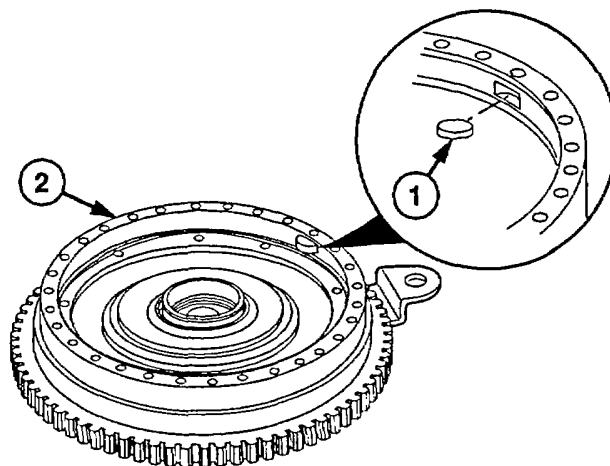
- (13) Remove torque converter turbine (11) from flywheel assembly (1).
 (14) Remove backplate (15) and lockup clutch plate (16) from flywheel (1).



- (15) Turn flywheel assembly (1) over so screws (3) face up.
 (16) Remove two screws (3) and lifting bracket (2) from flywheel assembly (1).

**b. Disassembly**

- (1) Remove two keys (1) from flywheel (2).



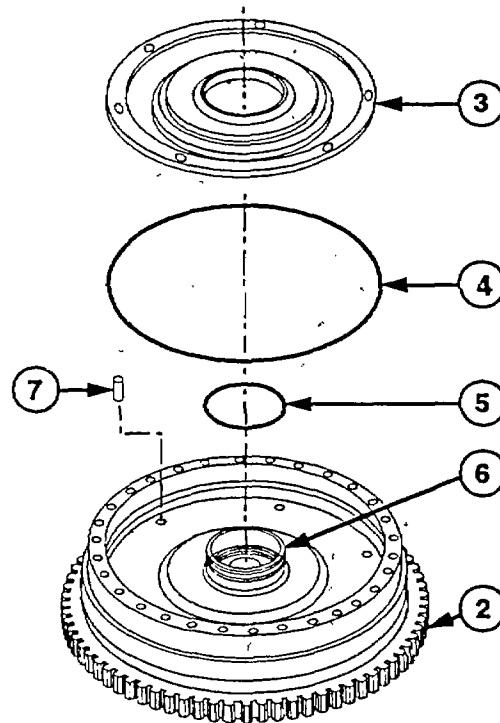
22-4. FLYWHEEL ASSEMBLY/LOCKUP CLUTCH REPAIR (CONT)

- (2) Place wooden blocks on ground.
- (3) Position flywheel (2) on blocks with piston (3) facing down.
- (4) Lift flywheel (2) 12 in. (30 cm) with aid of assistant. Drop flywheel (2) on wooden blocks to free piston (3). Remove piston (3).
- (5) Remove seal ring (4) from outer groove in piston (3). Discard seal ring.
- (6) Remove seal ring (5) from outer groove in flywheel hub (6). Discard seal ring.

NOTE

Do step (7) if pins fail inspection.

- (7) Remove six pins (7) from flywheel (2).

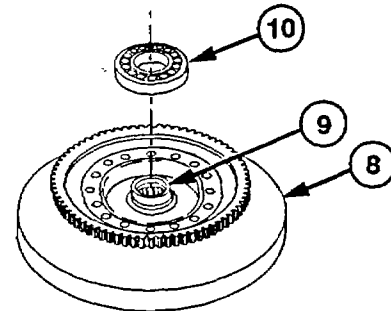


- (8) Set torque converter turbine (8) on level surface with bearing shaft (9) facing up.

NOTE

Bearing may stay in bore of flywheel.

- (9) Remove bearing (10) from bearing shaft (9) while assistant holds down torque converter housing (8).

**c. Cleaning/Inspection****WARNING**

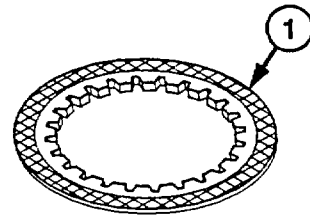
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean all metal parts with dry cleaning solvent

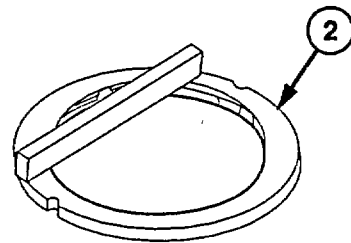
WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

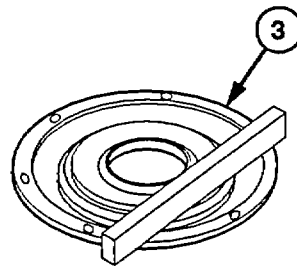
- (2) Dry all parts, except for bearings, with compressed air.
- (3) Inspect all parts for damage. Replace all damaged parts.
- (4) Measure thickness of lockup clutch plate (1). Replace if less than 0.19 in. (4.83 mm) thick.



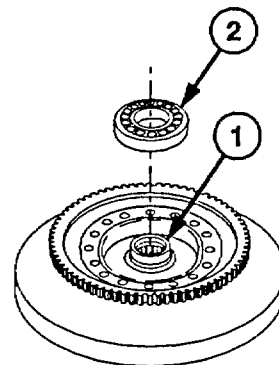
- (5) Place straight edge on backplate (2) and insert feeler gage. Measure gap between straight edge and backplate. If feeler gage larger than 0.010 in. (0.25 mm) will fit under straight edge, replace backplate.



- (6) Place straight edge on piston (3) and insert feeler gage. Measure gap between straight edge and piston. If feeler gage larger than 0.010 in. (0.25 mm) will fit under straight edge, replace piston.

**d. Assembly**

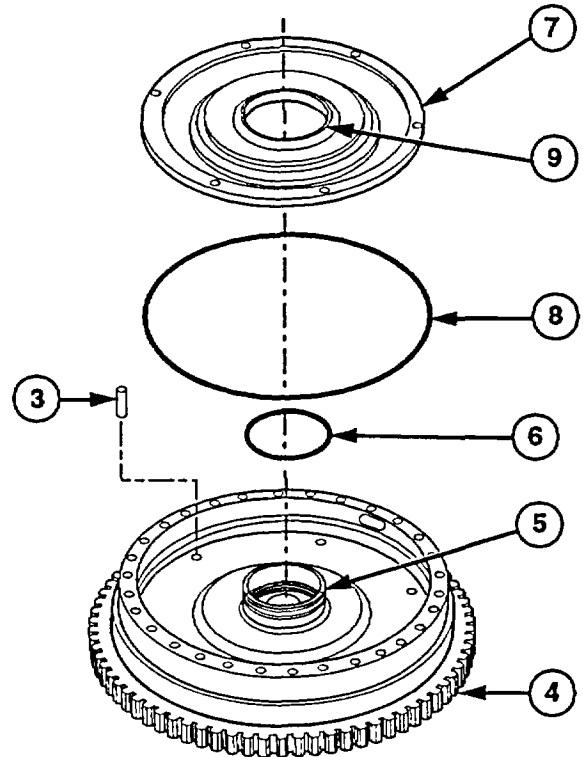
- (1) Coat bearing shaft (1) and bearing (2) with lubricating oil.
- (2) Position bearing (2) on bearing shaft (1) and press bearing on shaft.



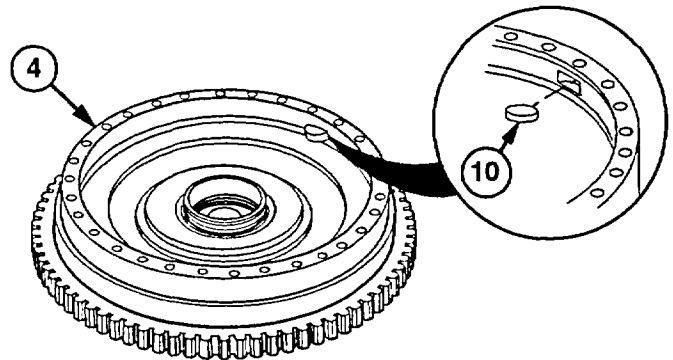
22-4. FLYWHEEL ASSEMBLY/LOCKUP CLUTCH REPAIR (CONT)**NOTE**

- Do step (3) only if pins were removed.
- Pins should be installed so 0.330-0.320 in. (8.38-8.13 mm) remains above surface.

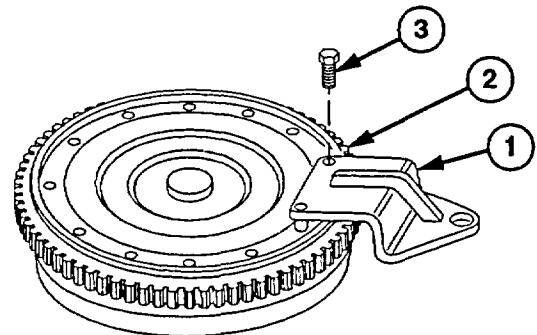
- (3) Install six pins (3) in flywheel (4).
- (4) Coat outside of hub (5) and new seal ring (6) with lubricating oil.
- (5) Install new seal ring (6) on hub (5).
- (6) Coat outer groove of piston (7) and new seal ring (8) with lubricating oil.
- (7) Install new seal ring (B) on groove of piston (7).
- (8) Coat inner hub (9) of piston (7) and piston seal surface of flywheel (4) with lubricating oil.
- (9) Position piston (7) on flywheel (4) and align six holes with six pins (3) on flywheel (4). Seat piston (7) firmly on pins.



- (10) Install two keys (10) in flywheel (4).

**e. Installation**

- (1) Install lifting bracket (1) on flywheel assembly (2) with two screws (3).

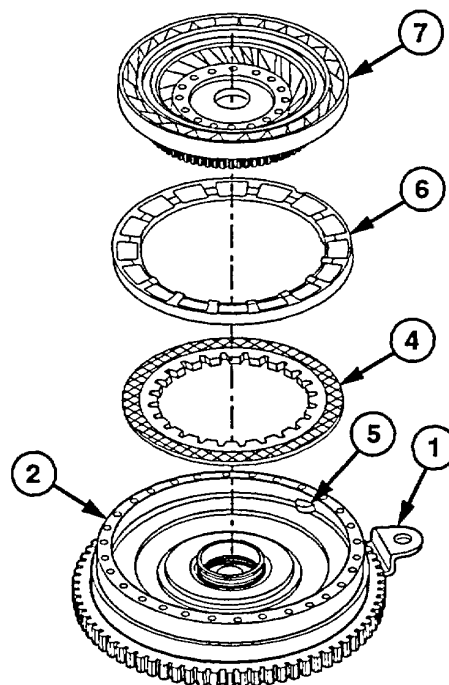


- (2) Turn flywheel assembly (2) over so bracket (1) faces down.
- (3) Soak clutch plate (4) in lubricating oil for 3 minutes and install on flywheel (2).
- (4) Align notches with keys (5) and install backplate (6) in flywheel (2).

CAUTION

Gear on torque converter turbine must be lined up with teeth of lockup clutch plate. Damage to lockup clutch may result.

- (5) Install torque converter turbine (7) on flywheel (2).

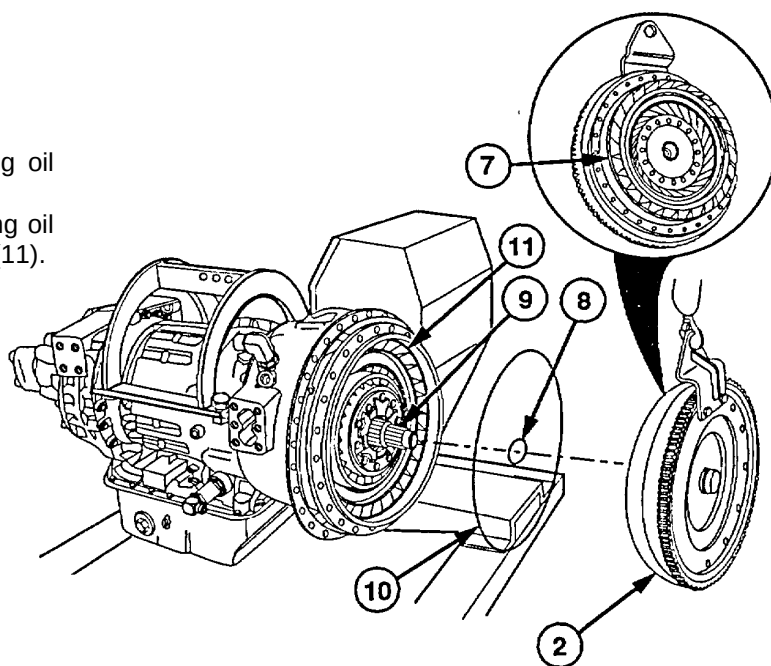


- (6) Coat new seal ring (8) with lubricating oil and install on turbine shaft (9).
- (7) Coat new seal ring (10) with lubricating oil and install on torque converter pump (11).

CAUTION

Support torque converter turbine during installation. Damage to equipment may result.

- (8) Hold torque converter turbine (7) on flywheel assembly (2) while assistant operates lifting device. Position flywheel assembly (2) on torque converter pump (11) and align holes.



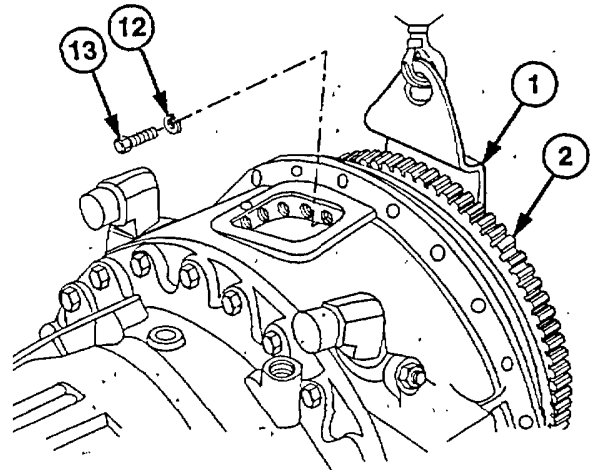
22-4. FLYWHEEL ASSEMBLY/LOCKUP CLUTCH REPAIR (CONT)

- (9) Install lockwasher (12) and screw (13) on flywheel assembly (2) and remove lifting device from lifting bracket (1).

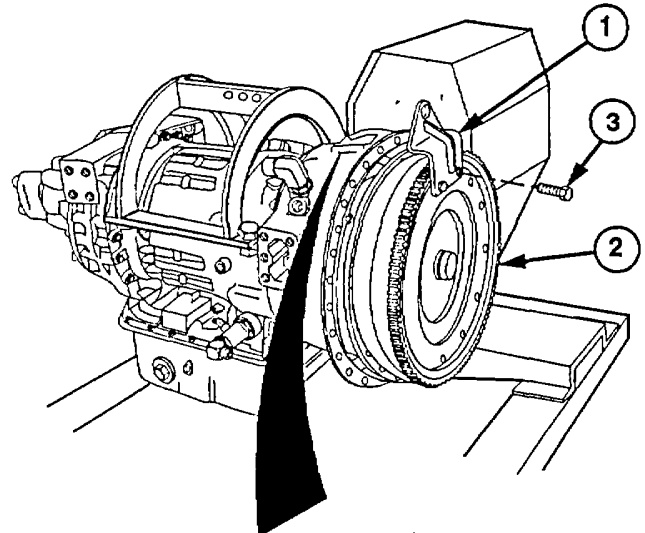
NOTE

Lifting bracket is used to turn flywheel for access to screw holes inside torque converter housing.

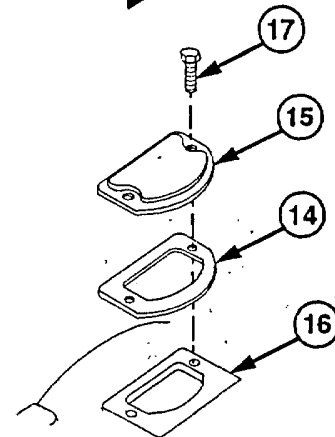
- (10) Loosely install 29 new lockwashers (12) and screws (13) on flywheel assembly (2).
 (11) Tighten 30 screws (13) to 41-49 lb-ft (56-66 N•m).



- (12) Remove two screws (3) and lifting bracket (1) from flywheel assembly (2).



- (13) Install new gasket (14) and access cover (15) on torque converter housing (16) with two screws (17). Torque to 25-30 lb-ft (34-41 N•m).

**f. Follow-On Maintenance**

Remove transmission from stand (para 22-3).

22-5. TORQUE CONVERTER STATOR REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Flywheel assembly removed (para 22-4).

Materials/Parts

Oil, Lubricating (Item 44, Appendix B)

Solvent, Dry Cleaning (Item 54, Appendix B)

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)

Compressor Unit, Air (Item 24, Appendix E)

Goggles, Industrial (Item 57, Appendix E)

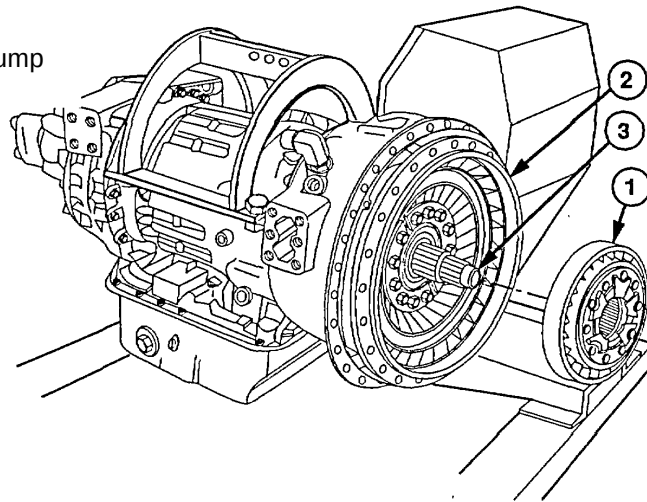
Holder, Stator Roller (Item 70, Appendix E)

a. Removal

NOTE

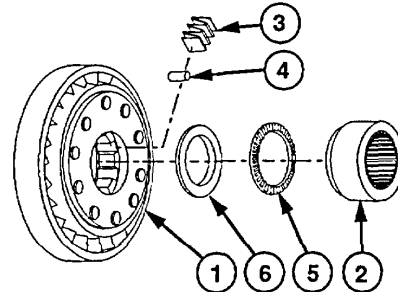
Bearings, springs, and roller race may fall out when stator is removed.

Remove stator (1) from torque converter pump (2) and shaft (3).



b. Disassembly

- (1) Hold rim of stator (1) on work surface.
- (2) Turning roller race (2) clockwise, slowly remove from stator (1).
- (3) Remove 10 roller springs (3) and 10 rollers (4) from stator (1).
- (4) Remove thrust bearing (5) and thrust bearing race (6) from stator (1).



22-5. TORQUE CONVERTER STATOR REPAIR (CONT)**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean parts in dry cleaning solvent.

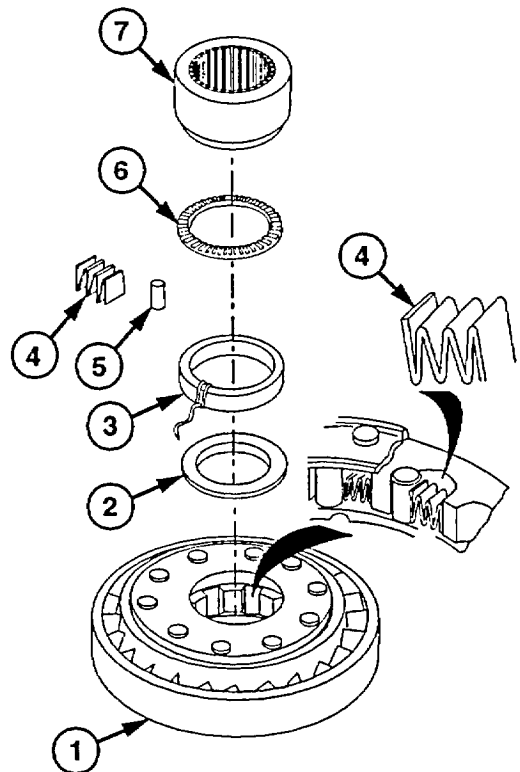
WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, and gloves).

- (2) Dry parts, except bearings, with compressed air.
- (3) Inspect parts for cracks, chipping, and warping. If damage is found, replace parts.
- (4) Coat parts with oil prior to assembly.

d. Assembly

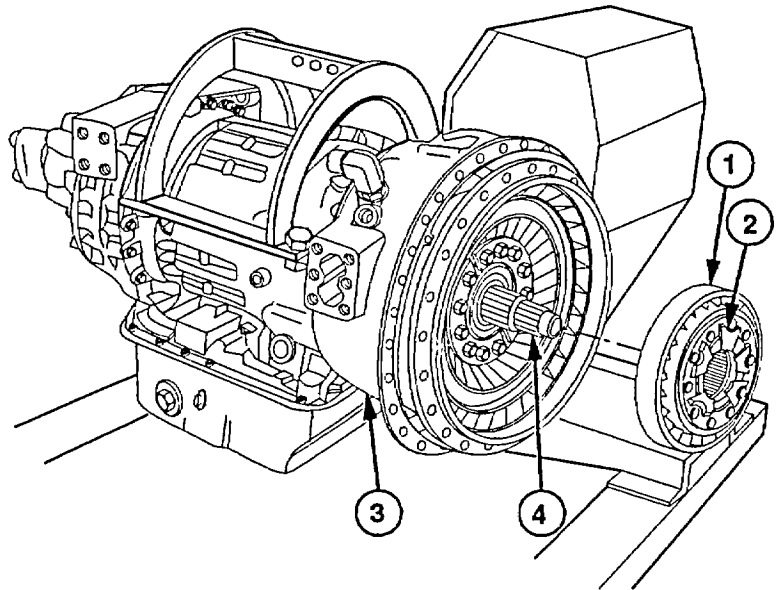
- (1) Position stator (1) on work surface rear side up.
- (2) Install thrust bearing race (2) in rear side of stator (1).
- (3) Insert roller holder tool (3) in stator (1) against thrust bearing race (2) with string hanging out bottom.
- (4) Install 10 roller springs (4) and rollers (5) in cam pockets on stator (1).
- (5) Install thrust bearing (6) on roller holder tool (3).
- (6) Install roller race (7) in stator (1) until it contacts thrust bearing (6).
- (7) Remove roller holder tool (3) from stator (1) by pulling attached string.
- (8) Push roller race (7) in while turning clockwise until thrust bearing (6) seats on thrust bearing race (2).



e. Installation**CAUTION**

- Keep outer face of stator down to prevent roller race, bearings, and springs from falling out.
- Stator must turn freely in clockwise direction and lockup in counterclockwise direction. Failure to ensure this may result in improper operation and damage to equipment.

- (1) Hold stator (1) with thrust pads (2) away from transmission (3).
- (2) Install stator (1) on shaft (4). Check that stator turns freely in clockwise direction and locks up in counterclockwise direction.

**f. Follow-On Maintenance**

Install flywheel assembly (para 22-4).

22-6. TORQUE CONVERTER PUMP REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Torque converter stator removed (para 22-5).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Puller, Bridge (Item 122, Appendix E)
 Bolts, Puller (2) (Item 10, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Handle, Driver (Item 67, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Remover/installer, Converter Pump Snap
 Ring (Item 132, Appendix E)
 Screw, Forcing (Item 152, Appendix E)
 Sleeve, Puller (Item 159, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Lockstrips (6) (Item 105, Appendix F)
 Ring, Retaining (Item 243, Appendix F)
 Rings, Seal (Item 252, Appendix F)
 Rings, Seal (Item 254, Appendix F)

Personnel Required

Two

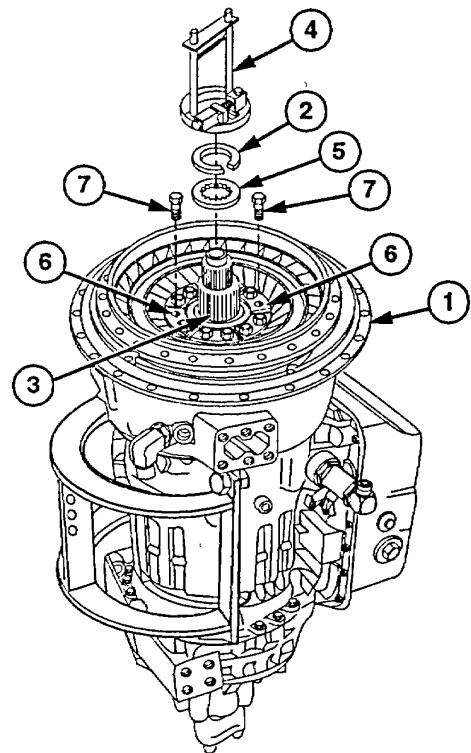
a. Removal

- (1) Turn transmission assembly so torque converter housing (1) faces up.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

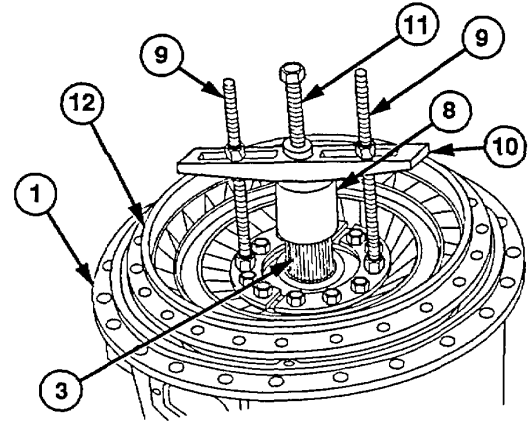
- (2) Remove retaining ring (2) from ground sleeve (3) with snap ring remover/installer (4). Remove spacer (5). Discard retaining ring.
- (3) Bend corners of two lockstrips (6) away from heads of two opposing screws (7). Remove two screws with aid of assistant.



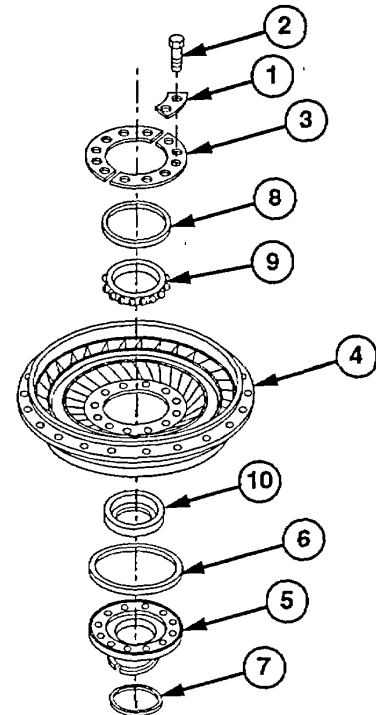
CAUTION

Failure to use sleeve when tightening puller may damage transmission assembly.

- (4) Install sleeve (8), two puller bolts (9), puller bridge (10), and forcing screw (11) on pump (12).
- (5) Tighten forcing screw (11) to separate pump (12) from ground sleeve (3).
- (6) Remove forcing screw (11), puller bridge (10), two puller bolts (9), and sleeve (8) from pump (12).
- (7) Remove pump (12) from torque converter housing (1) and set on level surface.

**b. Disassembly**

- (1) Bend remaining corners of 6 lockstrips (1) away from heads of 10 screws (2).
- (2) Remove 10 screws (2), 6 lockstrips (1), and 2 bearing retainers (3) from torque converter pump (4). Discard lockstrips.
- (3) Remove torque converter hub (5) from pump (4).
- (4) Remove two seal rings (6 and 7) from hub (5). Discard seal rings.
- (5) Remove outer race (8) and bearing (9) from pump (4).
- (6) Remove inner race (10) from pump (4).

**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

22-6. TORQUE CONVERTER PUMP REPAIR (CONT)**WARNING**

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, and gloves).

- (2) Dry metal parts, except bearings, with compressed air.
- (3) Inspect parts for damage.
- (4) Replace damaged parts.
- (5) Coat parts with lubricating oil.

d. Assembly

- (1) Coat new seal ring (1) with lubricating oil and install on torque converter pump hub (2).

CAUTION

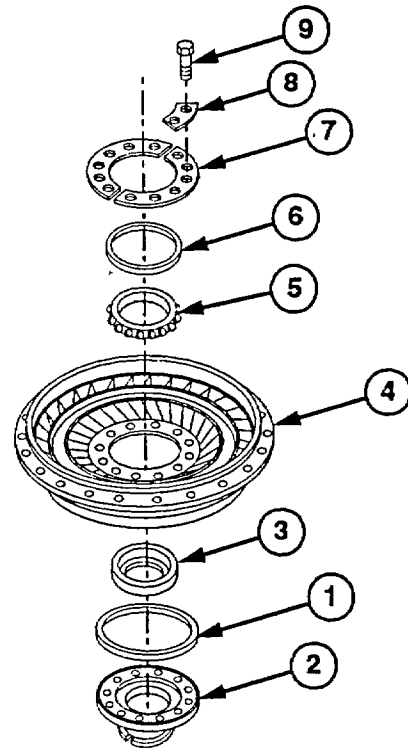
Ensure that two bearing races have the same serial number.

- (2) Install inner race (3) on hub (2).
- (3) Install hub (2) on torque converter pump (4).

CAUTION

Bearing must be kept clean during installation. Keep bearing wrapped until bearing is installed. Set bearing on clean, lint-free paper and never on dirty surface.

- (4) Install bearing (5) in inner race (3).
- (5) Install outer race (6) over bearing (5).
- (6) Install two bearing retainers (7) in groove on outer race (6).
- (7) Position 6 new lockstrips (8) and 12 screws (9). Snug the screws at 12, 6, 3, and 9 o'clock positions. Snug the remaining screws finger tight.
- (8) Tighten the four screws in the same manner (12, 6, 3, and 9 o'clock) 35-40 lb ft (47-54 N•m). Tighten the remaining eight screws 35-40 lb ft (47-54 N•m) with aid of assistant.
- (9) Bend corners of lockstrips (8) against heads of screws (9).

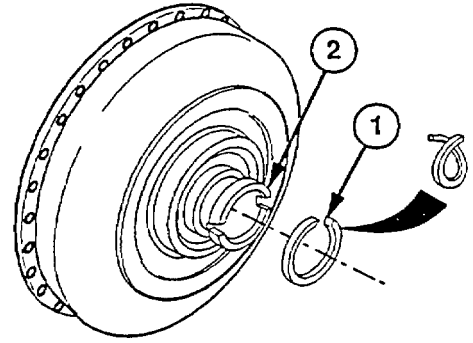


e. Installation

CAUTION

Keep seal ring sealed in package until ready to use so seal ring does not change shape.

- (1) Compress new seal ring (1) to one-half diameter and hold for at least 10 seconds.
- (2) Install new seal ring (1) in groove on torque converter pump hub (2).



CAUTION

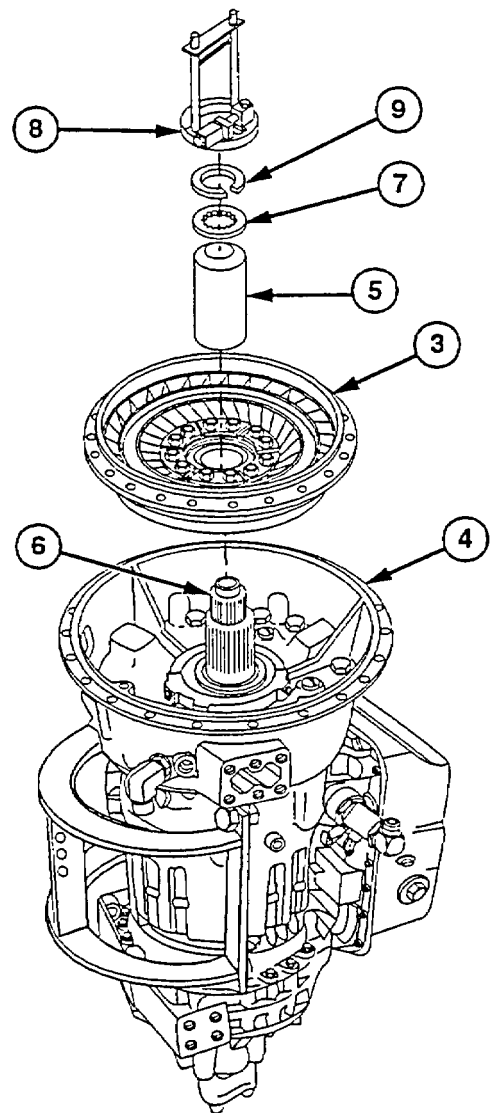
Make sure tangs of converter hub engage properly in transmission pump. Failure to comply may result in damage to equipment.

- (3) Install torque converter pump (3) in torque converter housing (4).
- (4) Position driver handle tool (5) around ground sleeve (6) and on pump (3). Drive pump down until seated.
- (5) Remove driver handle tool (5).
- (6) Install spacer (7) over ground sleeve (6) and in pump (3).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (7) Using snap ring remover/installer (8), install retaining ring (9) on ground sleeve (6).
- (8) Coat pump (3) and area around hub (2) with lubricating oil.



f. Follow-On Maintenance

Install torque converter stator (para 22-5).

22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Torque converter pump removed (para 22-6).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Compressor, Spring (Item 23, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Eyes, Lifting (Item 40, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Hammer, Slide (Item 64.1, Appendix E)
 Handle, Driver (Item 66, Appendix E)
 Installer, Front Support Needle Bearing (Item 78, Appendix E)
 Guide Pin Set (Item 60, Appendix E)
 Puller Kit, Mechanical Slide Hammer (Item 125, Appendix E)
 Remover Tool, Bearing (Item 142, Appendix E)
 Remover, Valve Pin (Item 143.1, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

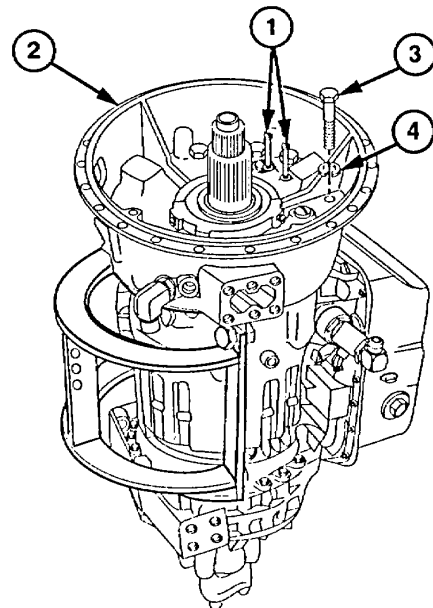
Compound, Sealing, Pipe, Pipe Thread (Item 28, Appendix B)
 Oil, Lubricating (Item 44, Appendix B)
 Sealant, Adhesive, Silicone (Item 2, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Gasket (Item 21, Appendix F)
 Lockwashers (14) (Item 122, Appendix F)
 Ring, Retaining (Item 247, Appendix F)
 Ring, Retaining (Item 246, Appendix F)
 Ring, Retaining (Item 238, Appendix F)
 Rings, Seal (2) (Item 273, Appendix F)
 Ring, Seal (Item 263, Appendix F)
 Seal, Oil (Item 308, Appendix F)

Personnel Required

Two

a. Removal

- (1) Loosen two screws (1) inside torque converter housing (2).
- (2) Remove seven screws (3) and lockwashers (4) from inside torque converter housing (2). Discard lockwashers.

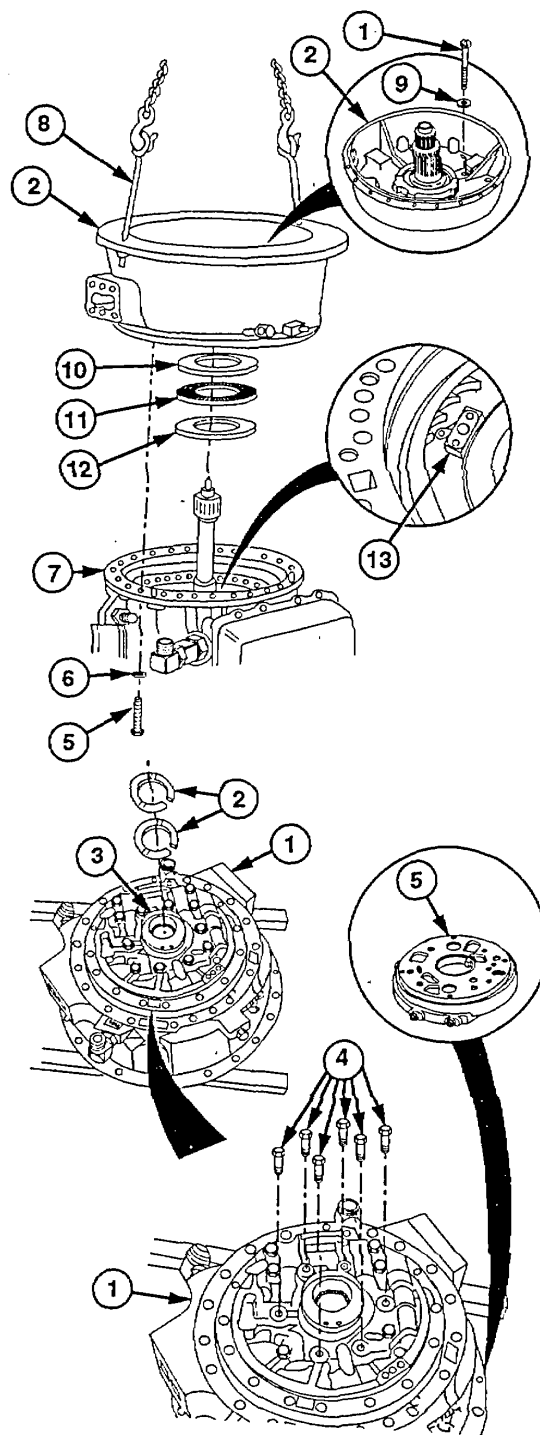


- (3) Remove seven screws (5) and lockwashers (6) holding torque converter housing (2) to transmission housing (7). Discard lockwashers.
- (4) Install two lifting eyes (8) on torque converter housing (2).
- (5) Install lifting device to lifting eyes (8).

CAUTION

Do step (6) before removing torque converter housing. Pitot collector will be damaged if step (6) is not performed.

- (6) Remove two screws (1) and washers (9) from torque converter housing (2).
- (7) Remove torque converter housing (2) while assistant operates lifting device.
- (8) Remove bearing race (10), roller bearing (11), and bearing race (12).
- (9) Remove pitot collector (13) from transmission housing (7).



b. Disassembly

- (1) Turn torque converter housing (1) over and place on wooden blocks with aid of assistant.
- (2) Remove two seal rings (2) from support hub (3). Discard seal rings.

CAUTION

When screws are removed, oil pump will fall. Ensure that assistant supports oil pump to prevent damage.

- (3) Remove six screws (4) and oil pump (5) from torque converter housing (1) while assistant supports oil pump.

22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)

- (4) Remove outer seal ring (6) from backplate (7). Discard seal ring.
- (5) Remove screw (8) and backplate (7) from oil pump (5).
- (6) Remove drive gear (9) from oil pump (5).
- (7) Remove two driven gears (10) from oil pump shafts (11).

NOTE

Do step (8) only if bearings are damaged.

- (8) Remove bearings (12) from driven gears (10).
- (9) Set oil pump (5) on rim and remove oil seal (13). Discard seal.
- (10) Remove three plugs (14) from oil pump (5).
- (11) Remove elbow (15) from torque converter housing (1).

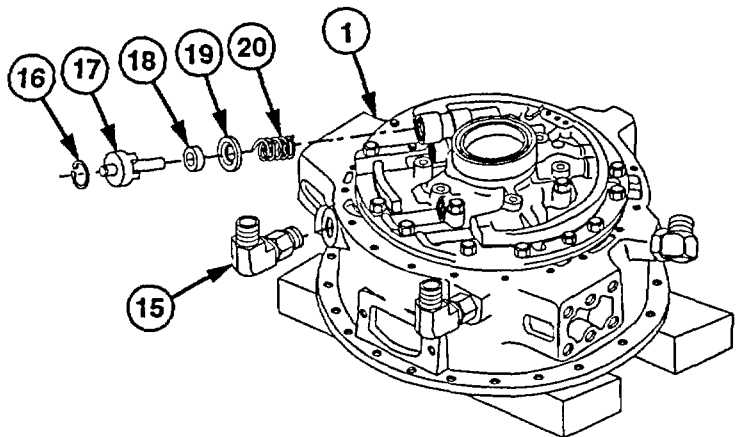
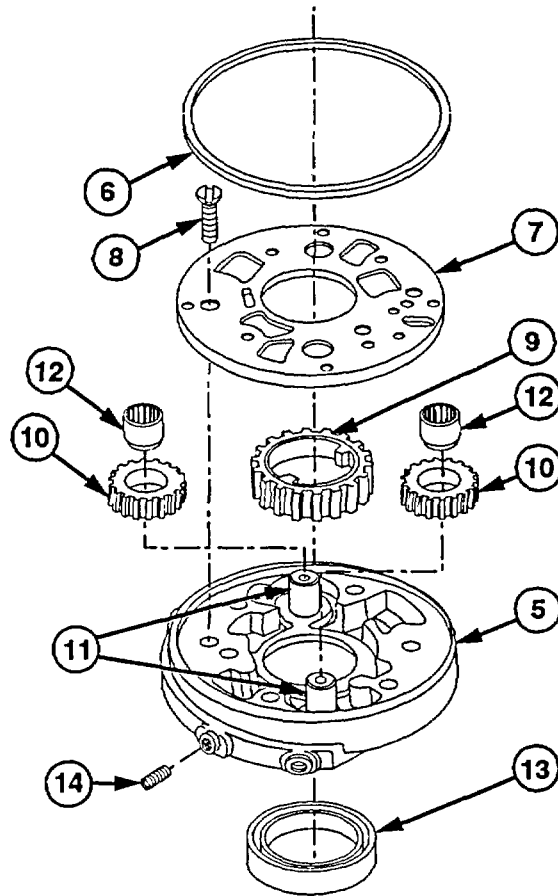
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Tag and mark all parts.

- (12) Slowly remove retaining ring (16) while assistant pushes support assembly (17). Discard retaining ring.
- (13) Remove support assembly (17), valve seat (18), converter bypass valve (19), and spring (20).



- (14) Remove two screws (21). Install spring compressor tool (22).

WARNING

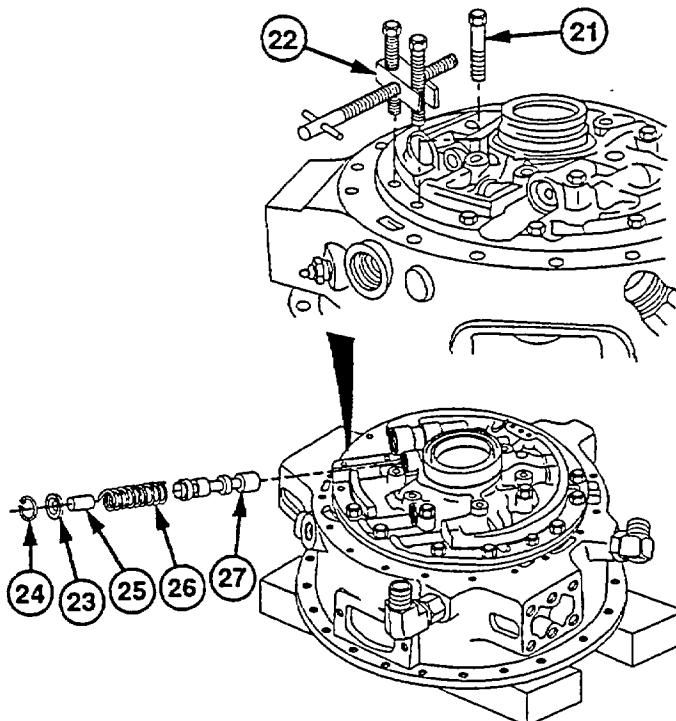
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (15) Push in washer (23) and remove retaining ring (24). Discard retaining ring.

CAUTION

Keep valve clean and free from nicks and burrs. Failure to comply will result in difficulty in assembly.

- (16) Remove washer (23), valve stop (25), valve spring (26), and lockup shift valve (27).

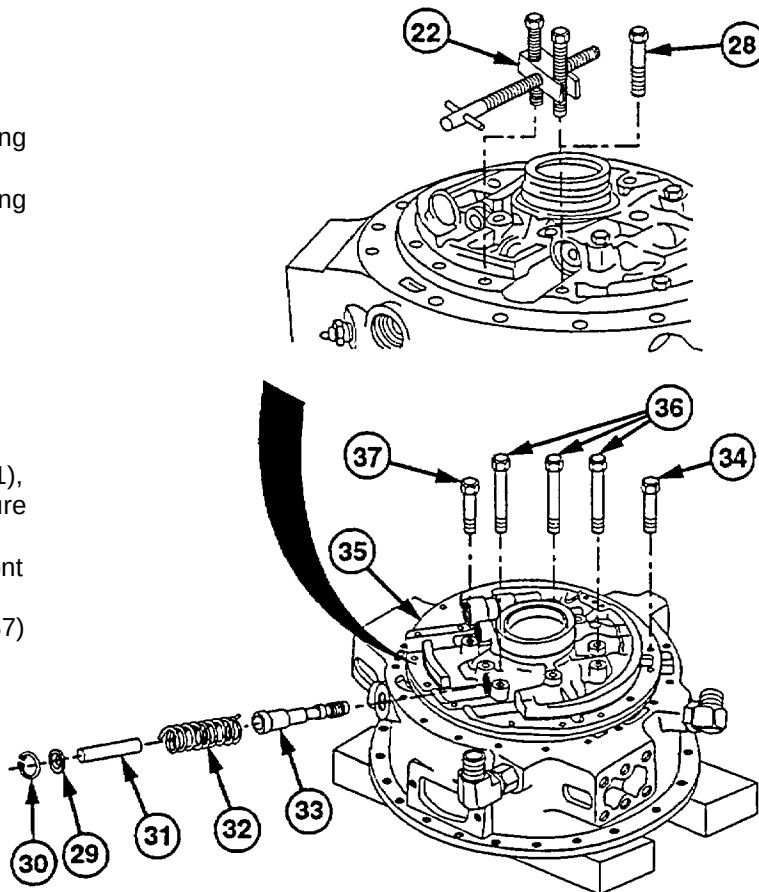


- (17) Remove two screws (28). Install spring compressor tool (22).
 (18) Push in washer (29) and remove retaining ring (30). Discard retaining ring.

CAUTION

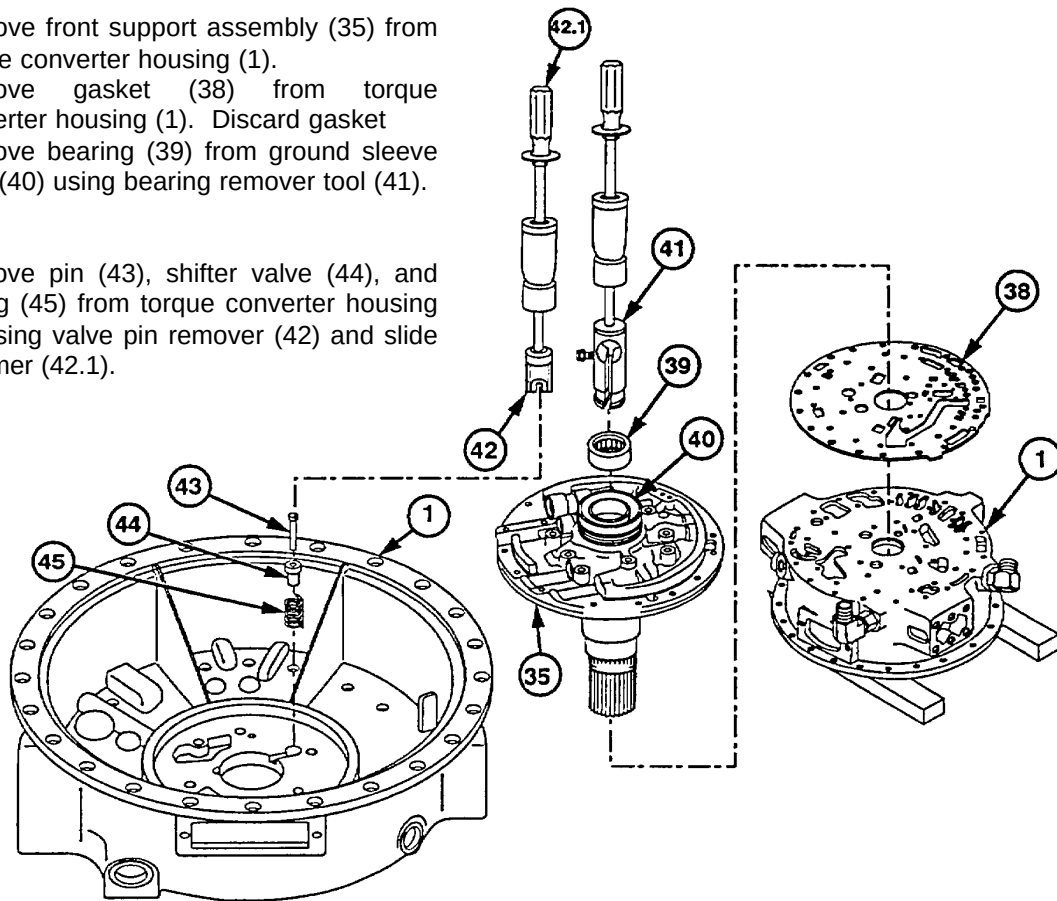
Keep valve clean and free from nicks and burrs. Failure to comply will result in difficulty in assembly.

- (19) Remove washer (29), valve stop (31), valve spring (32), and main pressure regulator valve (33).
 (20) Remove 11 screws (34) from front support assembly (35).
 (21) Remove three screws (36) and screw (37) from front support assembly (35).



22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)

- (22) Remove front support assembly (35) from torque converter housing (1).
- (23) Remove gasket (38) from torque converter housing (1). Discard gasket
- (24) Remove bearing (39) from ground sleeve bore (40) using bearing remover tool (41).
- (25) Remove pin (43), shifter valve (44), and spring (45) from torque converter housing (1) using valve pin remover (42) and slide hammer (42.1).

**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

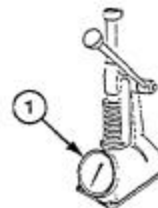
- (1) Clean metal parts with dry cleaning solvent and inspect for damage.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.

- (3) Measure spring lengths using spring tester (1). Converter bypass valve spring, lockup shift valve spring, and main pressure regulator valve spring must be replaced if load-height specifications, listed in table 22-1, are not met.



- (4) Inspect two oil pump shafts (2). Replace oil pump assembly if shafts are worn or damaged.

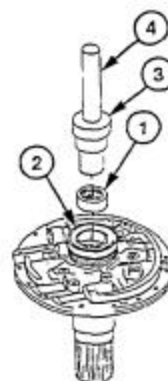


Table 22-1. Valve Spring Load-Height Specifications

Spring	Length Without Load	Length Under Load	Load
Converter bypass valve	2.65 in. (67.3 mm)	1.62 in. (41.2 mm)	21 to 23 lb (9.6 to 10.4 kg)
Lockup shift valve	3.33 in. (84.6 mm)	1.8 in. (45.7 mm)	24 to 25.5 lb (10 to 10.9 kg)
Main regulator valve	3.94 in. (100.1 mm)	2.64 in. (67.1 mm)	82 to 87 lb (37.2 to 39.4 kg)

d. Assembly

- (1) install bearing (1) in ground sleeve bore (2) using bearing installer tool (3) and driver handle (4).



22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)

- (2) Set torque converter housing (5) on wooden blocks.

NOTE

Pin is properly installed when its head is 0.300 in. (7.62 mm) above housing surface.

- (3) Install spring (6), shifter valve (7), and pin (8) on torque converter housing (5).

- (4) Install new gasket (9) on torque converter housing (5).

- (5) Align holes and install front support assembly (10) on torque converter housing (5).

- (6) Install three screws (11) in front support assembly (10). Torque to 36-43 lb-ft (49-58 N•m).

- (7) Install 11 screws (12) in front support assembly (10). Torque to 36-43 lb-ft (49-58 N•m).

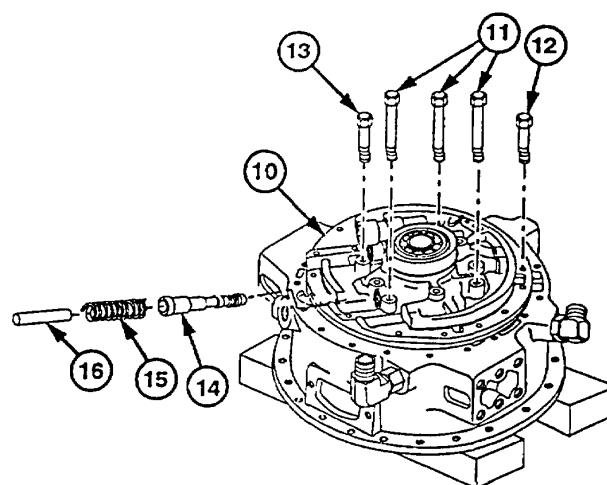
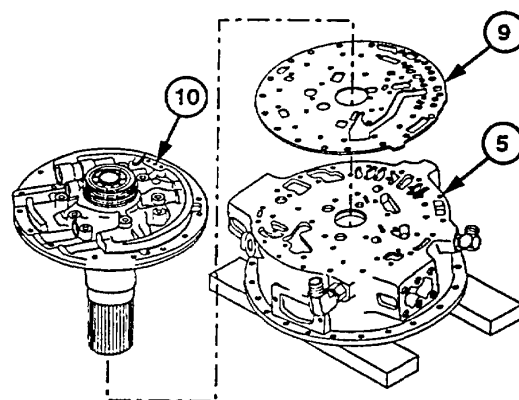
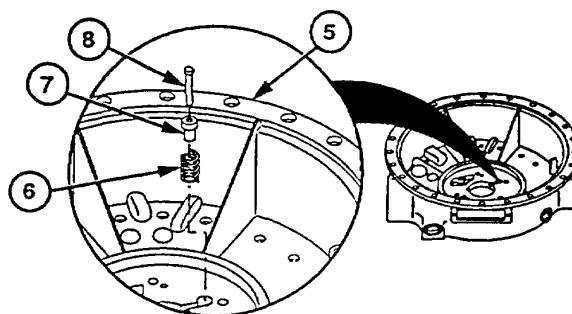
- (8) Install screw (13) in front support assembly (10). Torque to 36-43 lb-ft (49-58 N•m).

CAUTION

Keep valve clean and free from nicks and burrs. Failure to comply will result in difficulty in assembly.

- (9) Install main pressure regulator valve (14) small end first in front support assembly (10).

- (10) Install main pressure regulator valve spring (15) and valve stop (16) in front support assembly (10).



- (11) Install spring compressor tool (17) on front support assembly (10).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

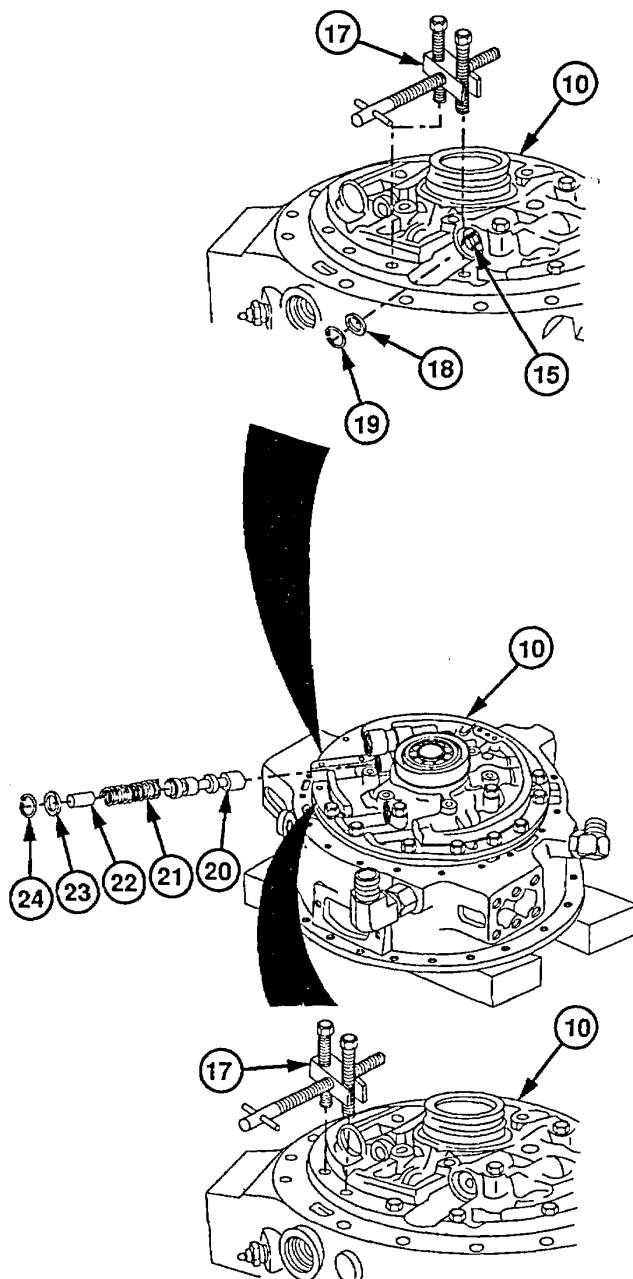
- (12) Install washer (18) and retaining ring (19) on main pressure regulator valve spring (15).
- (13) Remove spring compressor tool (17) from front support assembly (10).

CAUTION

Keep valve clean and free from nicks and burrs. Failure to comply will result in difficulty in assembly.

- (14) Install lockup shift valve (20) small end first in front support assembly (10).
- (15) Install valve spring (21) and valve stop (22) in front support assembly (10).

- (16) Install spring compressor tool (17) on front support assembly (10).
- (17) Install washer (23) and new retaining ring (24) on valve spring (21).
- (18) Remove spring compressor tool (17) from front support assembly (10).



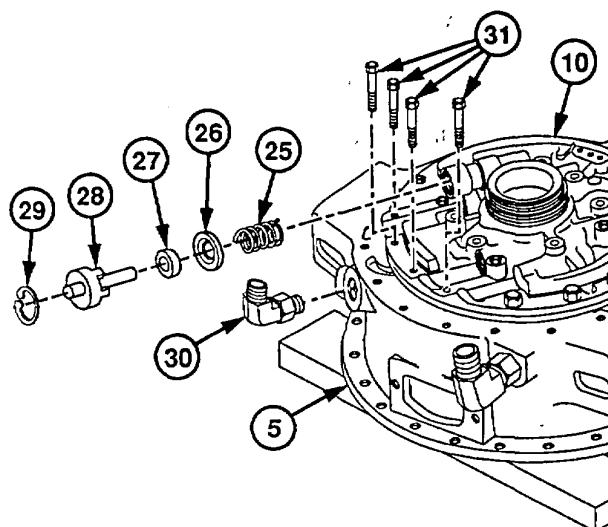
22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)

- (19) Install Spring (25), converter bypass valve (26), valve seat (27), and support assembly (28) in front support assembly (10).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (20) Install new retaining ring (29) while assistant pushes against front support assembly (10).
- (21) Install elbow (30) on torque converter housing (5).
- (22) Install four remaining screws (31) in front support assembly (10). Torque to 36-43 lb-ft (49-58 N•m).

**WARNING**

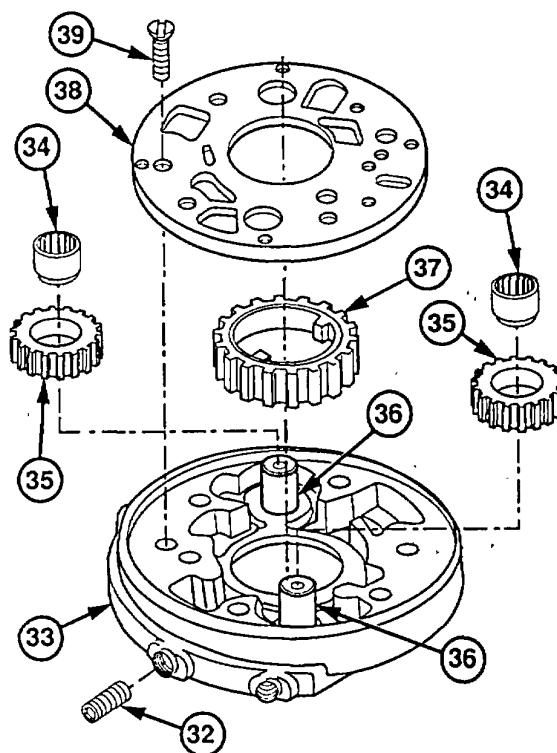
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (23) Coat threads of three plugs (32) with pipe thread sealing compound.
- (24) Install three plugs (32) on pump (33).

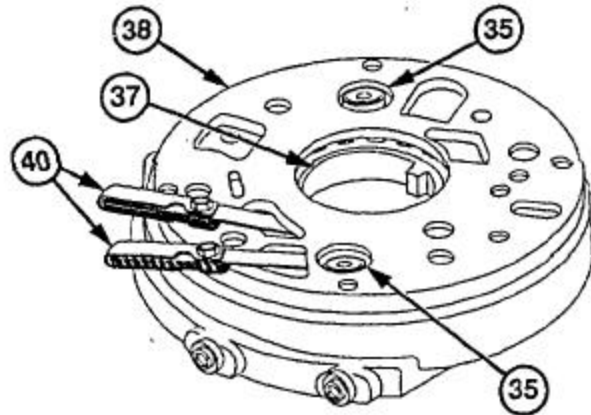
NOTE

Do step (25) only if bearings were removed.

- (25) Install two new bearings (34) in two driven gears (35).
- (26) Install two driven gears (35) on shafts (36).
- (27) Install drive gear (37) in oil pump (33).
- (28) Install backplate (38) on pump (33) with screw (39). Torque to 120-180 lb-in. (13.6-20.3 N•m).



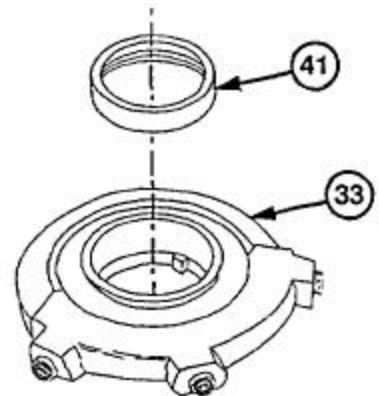
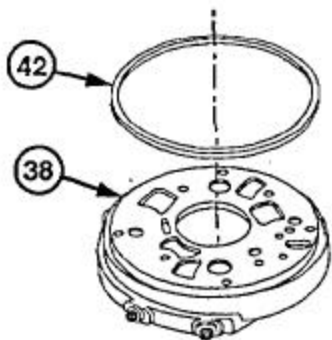
- (29) Check clearance between backplate (38), drive gear (37), and two driven gears (35) using feeler gages (40). Maximum clearance is 0.006 in. (0.15 mm). If clearance is more than 0.006 in. (0.15 mm), replace oil pump.



- (30) Turn oil pump (33) over.

- (31) Coat rubber lip of new seal (41) with lubricating oil and install seal in pump (33).

- (32) Coat new outer seal ring (42) with lubricating oil and install on backplate (38).

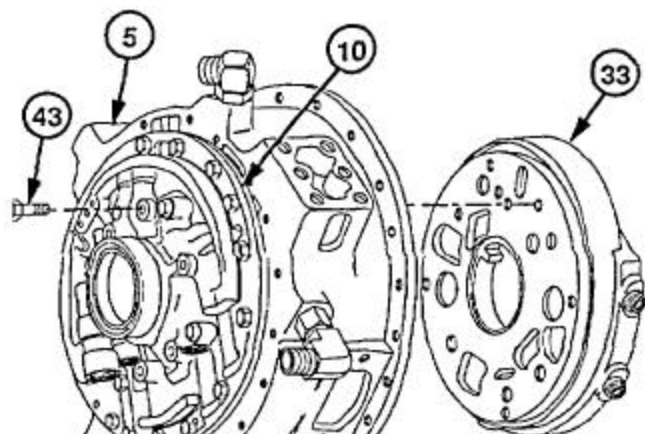


- (33) Turn torque converter housing (5) on side with aid of assistant.

- (34) Install oil pump (33) on torque converter housing (5) while assistant holds torque converter housing (5).

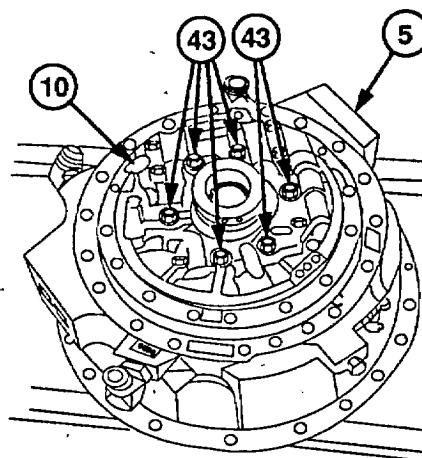
- (35) Align screw holes in oil pump (33) with holes on front support (10).

- (36) Install six screws (43) in front support (10) and oil pump (33) with aid of assistant.



22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)

- (37) Set torque converter (5) on wooden blocks with front support (10) facing up with aid of assistant.
- (38) Tighten six screws (43) to 35-45 lb-ft (47-61 N•m).

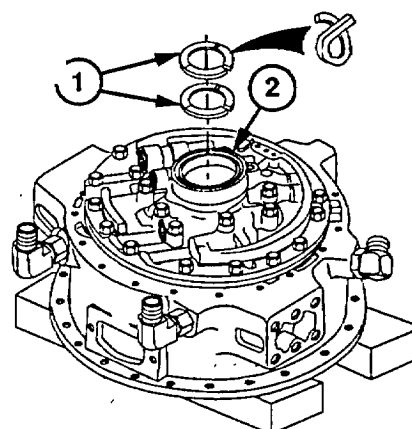


e. Installation

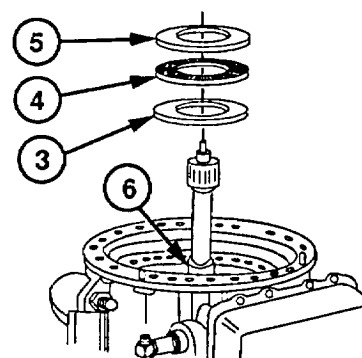
CAUTION

Keep seal rings seated in package until ready to use to keep from being damaged.

- (1) Compress two new seal rings (1) to one-half diameter and hold for 10 seconds.
- (2) Install two new seal rings (1) in grooves of support hub (2).



- (3) Install bearing race (3), roller bearing (4), and bearing race (5) on inner bore (6).



- (4) Turn torque converter housing (7) over so support hub (2) faces down.

NOTE

Guide screws are installed in side of pitot collector with one hole in center.

- (5) Install two guide screws (8) in pitot collector (9).
- (6) Position pitot collector (9) on forward clutch housing (10) with tube under pitot collector ring (11).
- (7) Install lifting eyes (12) and lifting device on torque converter housing (7).
- (8) Position torque converter housing (7) over transmission housing (13) while assistant operates lifting device.
- (9) Align two pitot collector guide screws (8) with two small holes in torque converter housing (7) while assistant operates lifting device.

CAUTION

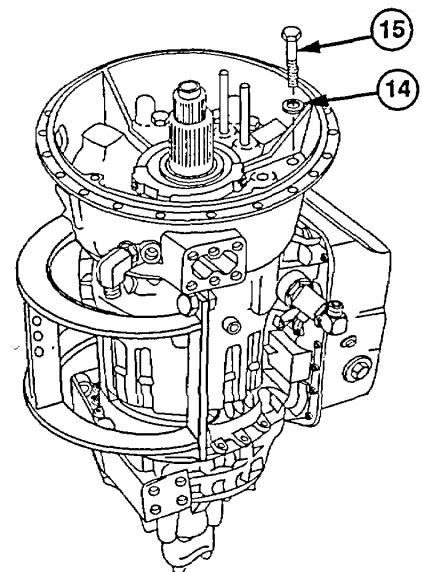
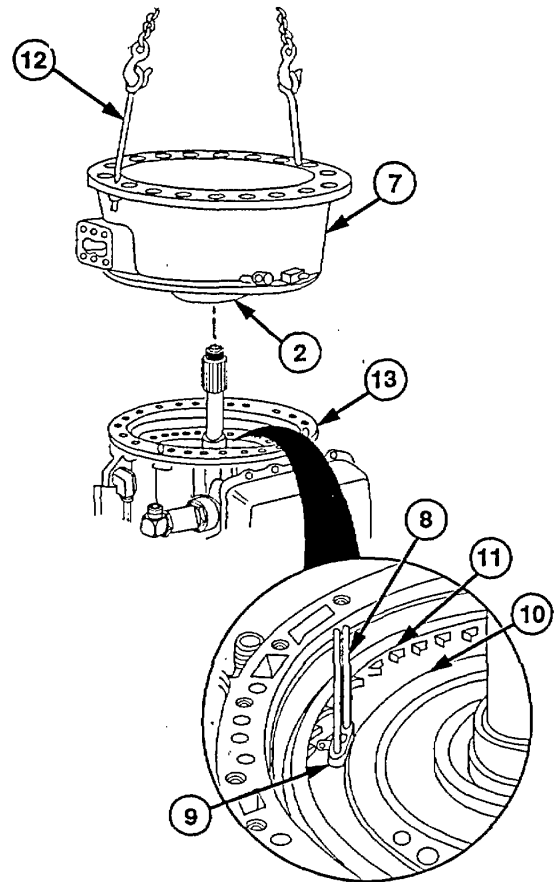
Take care not to damage pitot tube and seal rings when installing torque converter housing.

- (10) Install torque converter housing (7) on transmission housing (13).
- (11) Remove lifting device and lifting eyes (12).

NOTE

Move pitot collector guide screws up and down to check that pitot tube is free.

- (12) Install seven new lockwashers (14) and screws (15). Torque to 67-80 lb-ft (90-108 Nm)



22-7. TORQUE CONVERTER HOUSING/FRONT SUPPORT REPAIR (CONT)**NOTE**

If transmission is mounted in stand, it may only be possible to install 7 of 11 washers (16) and screws (17). The remaining four screws will be installed when transmission is removed from stand.

- (13) Install seven new lockwashers (16) and screws (17) holding torque converter housing (7) to transmission housing (13). Torque to 67-80 lb-ft (90-108 N•m).

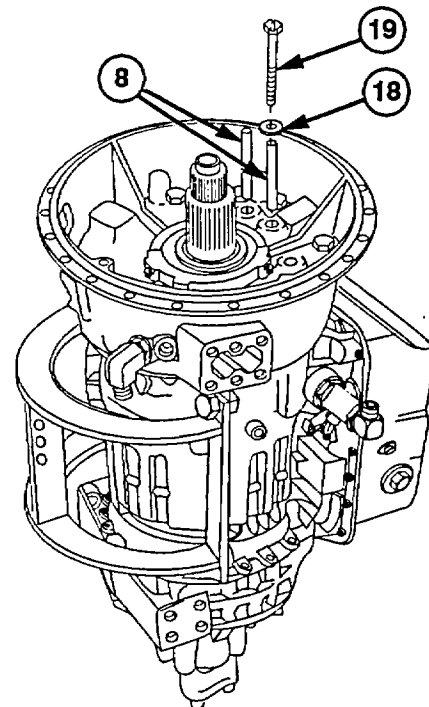
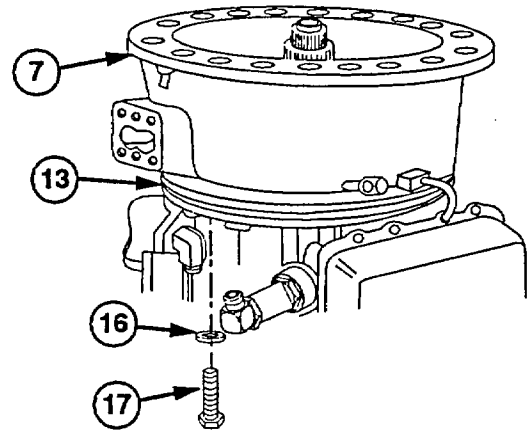
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (14) Apply small amount of silicone adhesive-sealant to two washers (18) and screws (19).
- (15) Remove one pitot collector guide screw (8) and pull up on other pitot collector guide screw (8); position washer (18) and screw (19). Tighten screw until snug.
- (16) Remove other pitot collector guide screw (8) and position washer (18) and screw (19). Tighten screw until snug.
- (17) Tighten two screws (19) to 38-48 lb-in. (4.3-5.4 N•m).

f. Follow-On Maintenance

Install torque converter pump (para 22-6).



22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR

This task covers

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

Initial Setup:

Equipment Conditions

- Torque converter housing removed (para 22-7).
- Main control valve removed (para 22-14).

Tools and Special Tools

- Tool Kit, Gent Mech (Item 202, Appendix E)
- Caliper Set, Micrometer (Item 15, Appendix E)
- Compressor Set, Clutch Spring (Item 22, Appendix E)
- Compressor Unit, Air (Item 24, Appendix E)
- Alignment Tool, Fifth Clutch (Item 9, Appendix E)
- Fixture, PTO Gear Removal (Item 43, Appendix E)
- Gage, Depth, Micrometer (Item 48, Appendix E)
- Goggles, Industrials (Item 57, Appendix E)
- Heater, Gun Type (2) (Item 68, Appendix E)

Tools and Special Tools (Cont)

- Installer and Staking Set, Collector Ring (Item 84, Appendix E)
- Press, Hydraulic (Item 116, Appendix E)
- Protector, Forward Clutch Piston Inner Seal (Item 118, Appendix E)
- Stock, Shim (Figure C-7, Appendix C)
- Tool, Lifting (Item 198, Appendix E)

Materials/Parts

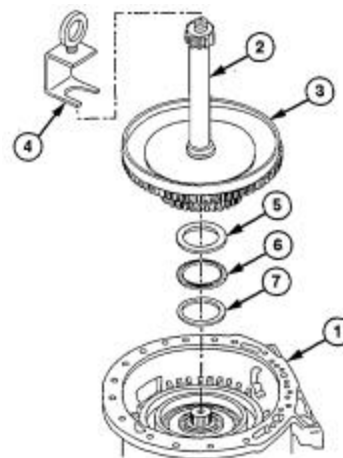
- Compound, Retaining (Item 22, Appendix B)
- Oil, Lubricating (Item 44, Appendix B)
- Solvent, Dry Cleaning (Item 54, Appendix B)
- Tape, Insulation, Electrical (Item 57, Appendix B)
- Rings, Seal (2) (Item 253, Appendix F)
- Ring, Seal (Item 264, Appendix F)
- Ring, Seal (Item 267, Appendix F)

Personnel Required

Two

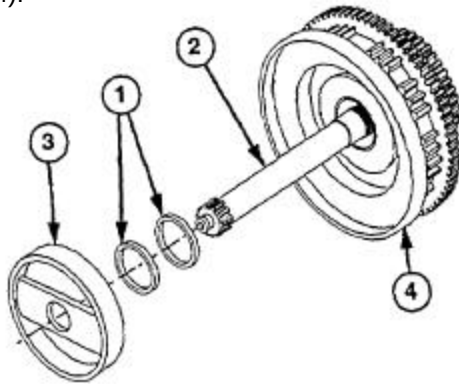
a. Removal

- (1) Turn transmission (1) in stand so that turbine shaft (2) is pointing up.
- (2) Remove turbine shaft (2) and forward clutch assembly (3) using lifting tool (4).
- (3) Remove outer race (5), roller bearing (6), and inner race (7).
- (4) Place forward clutch assembly (3) in clean area.



22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR (CONT)**b. Disassembly**

- (1) Remove two seal rings (1) from turbine shaft (2). Discard seal rings.
- (2) Place collector ring installer (3) on forward clutch assembly (4).

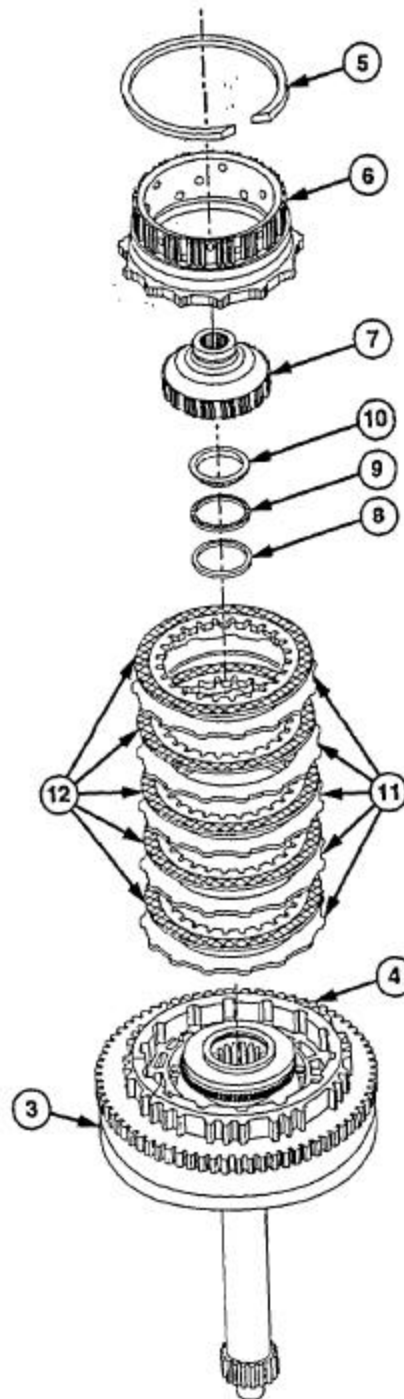


- (3) Place forward clutch assembly (4) and collector ring installer (3) in hydraulic press with shaft down.

CAUTION

Use wooden or plastic dowels to remove retaining rings. Using screwdrivers may damage transmission housing.

- (4) Remove large inner retaining ring (5) from forward clutch assembly (4).
- (5) Remove fifth clutch driving hub (6) from forward clutch assembly (4).
- (6) Remove forward clutch driving hub (7), inner race (8), bearing (9), and outer race (10) from forward clutch assembly (4).
- (7) Remove five steel plates (11) and five friction plates (12) from forward clutch assembly (4).



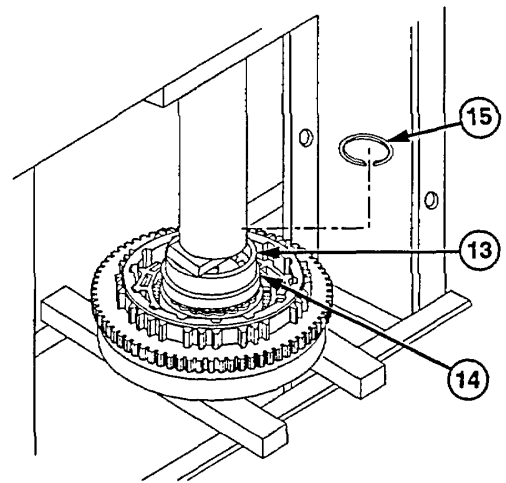
NOTE

Ensure gap in retaining ring faces you.

- (8) Install clutch spring compressor (13) on spring retainer (14).

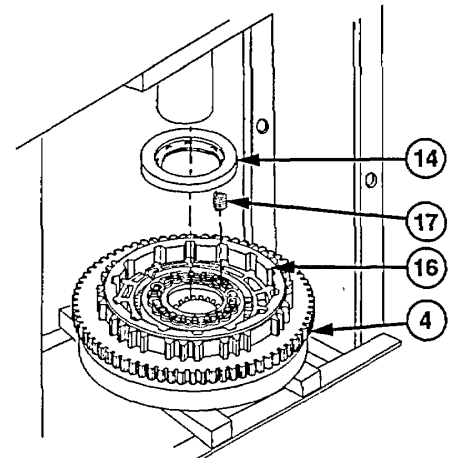
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.



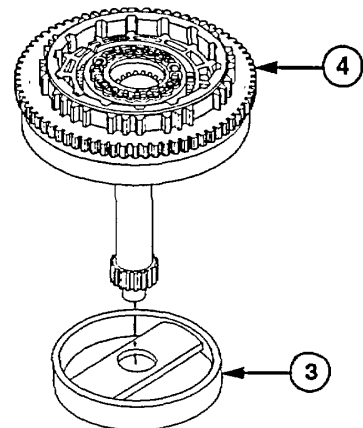
- (9) Compress spring retainer (14) with clutch spring compressor (13). Remove retaining ring (15).

- (10) Release pressure from spring retainer (14) and remove clutch spring compressor (13).



- (11) Remove spring retainer (14) from forward clutch piston (16).

- (12) Remove 20 piston return springs (17) from forward clutch piston (16).

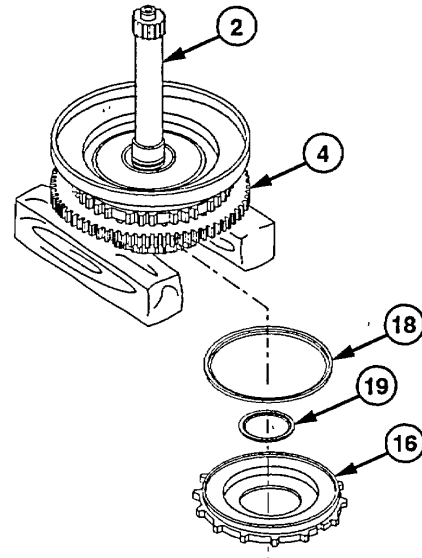


- (13) Remove forward clutch assembly (4) from press.

- (14) Remove collector ring installer (3) from forward clutch assembly (4).

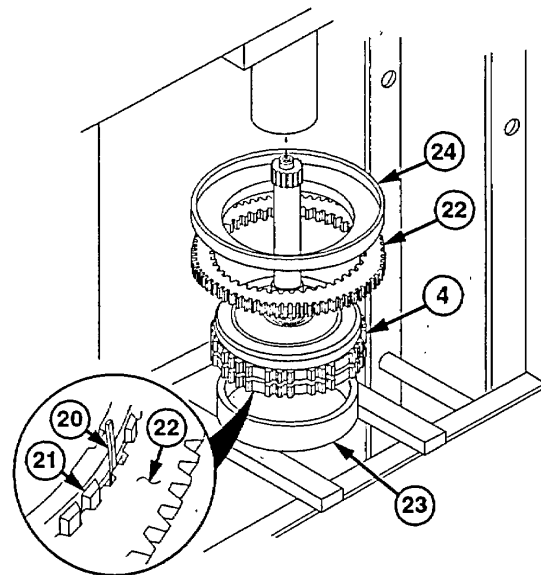
22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR (CONT)

- (15) Place wooden blocks on ground.
- (16) Position forward clutch assembly (4) on blocks with turbine shaft (2) facing up.
- (17) Lift forward clutch assembly (4) 12 in. (30 cm) with aid of assistant. Drop clutch assembly (4) on wooden blocks to free forward clutch piston (16). Remove piston (16) from clutch assembly (4).
- (18) Remove inner seal ring (18) and outer seal ring (19) from forward clutch piston (16). Discard seal rings.

**NOTE**

Do steps (19) thru (22) if PTO gear has missing or damaged teeth or if pitot collector ring is damaged or distorted. Otherwise, go to para 22-8c.

- (19) Install shim stock (20) in gap between retaining ring (21) and teeth of PTO gear
- (22) Push retaining ring in forward clutch assembly (4) and put shim stock every 3 in. (76 mm) around forward clutch assembly. (20) Secure shim stock (20) in place with electrical tape.
- (21) Place PTO gear removal fixture (23) in press. Install forward clutch assembly (4) on PTO gear removal fixture (23) with shaft pointing up.
- (22) Press forward clutch assembly (4) out of PTO gear (22). Remove PTO gear (22), forward clutch assembly (4), pitot collector ring (24), and PTO gear removal fixture (23) from press.



c. Cleaning/inspection

WARNING

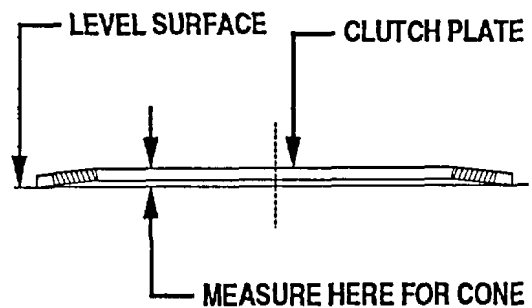
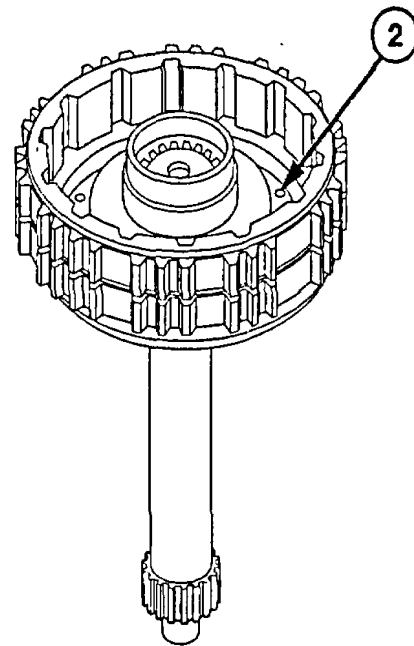
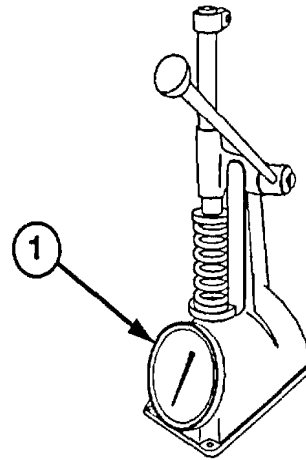
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with Water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.
- (2) Turbine shaft is pressed in forward clutch housing and should be tight. Replace forward clutch housing if there is any up and down movement.
- (3) Measure piston release spring lengths using spring tester (1). Replace all 20 piston release springs if any 3 do not meet the following load-height requirements:
 - (a) Length without load: 1.25 in. (31.8 mm)
 - (b) Length under load: 0.88 in. (22.4 mm) with load of 17.9-18.9 lb (8.13-8.58 kg).
- (4) Clean ball pockets (2) with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (5) Inspect balls for freedom of movement and proper staking. Replace balls if damaged.
- (6) Dry pockets with compressed air. Apply lubricating oil around area of ball pockets (2).
- (7) Measure individual clutch plate thickness by measuring amount of cone. The amount of cone is the distance between the inside diameter and level surface.
 - (a) Steel clutch plate:
Minimum thickness 0.0993 in. (2.522 mm)
 - (b) Friction plate:
Minimum thickness 0.090 in. (2.29 mm)
 - (c) Clutch driving hub (plate contact area):
Minimum thickness 0.390 in. (9.91 mm)



22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR (CONT)**d. Assembly****NOTE**

Do step (1) only if balls were removed.

- (1) Install eight balls (1) in ball pockets (2). Stake forward clutch assembly (3) housing to retain balls.

NOTE

If collector ring and PTO gear were not removed, go to step (10).

- (2) Position forward clutch assembly (3) on work table with shaft pointing down.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (3) Install retaining ring (4) in groove (5) on outside of forward clutch assembly (3).

WARNING

Wear heat-resistant gloves to prevent burning hands when handling hot PTO gear. Failure to comply may result in severe injury.

CAUTION

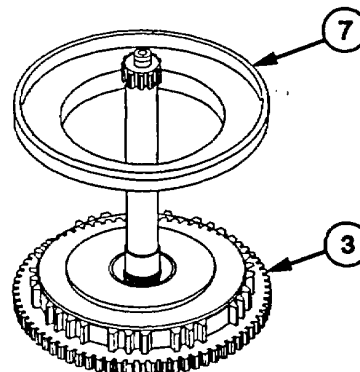
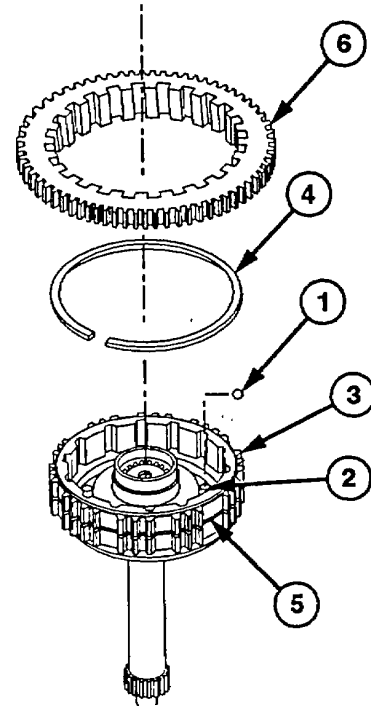
PTO gear must be heated for 20-30 minutes to allow it to fit over forward clutch assembly. Failure to heat PTO gear will result in damage to components.

- (4) Heat PTO gear (6) with two heater guns with aid of assistant.

NOTE

- PTO gear must be installed with chamfered inside diameter first.
- When properly installed, retaining ring should move freely in groove.

- (5) Carefully place PTO gear (6) on forward clutch assembly (3) until retaining ring (4) expands into PTO gear (6) groove.
- (6) Coat collar of oil collector ring (7) with retaining compound and place on forward clutch assembly (3).

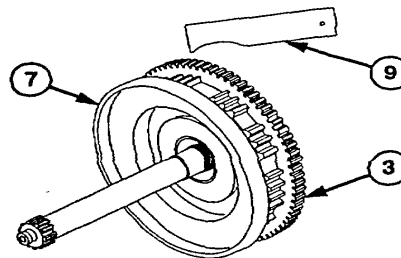
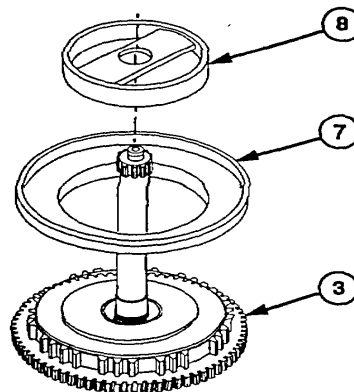
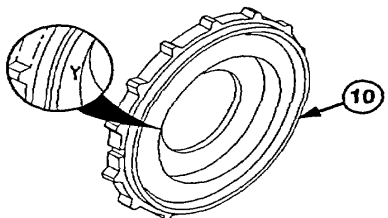


- (7) Install collector ring installer (8) on oil collector ring (7).

- (8) Using staking tool (9), bend edge of oil collector ring (7) in groove in forward clutch assembly (3) while assistant supports forward clutch assembly on edge. Ensure oil collector ring (7) does not touch work surface.

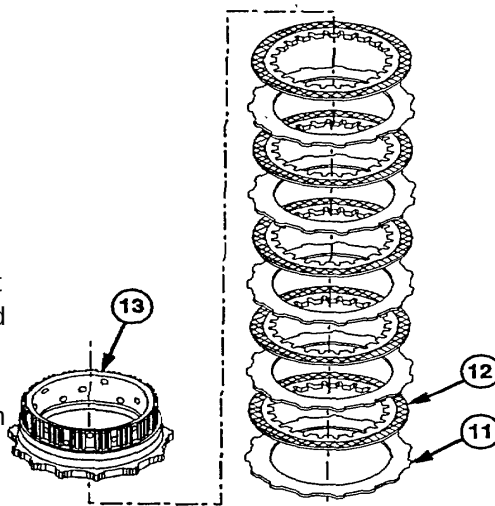
- (9) Remove collector ring installer (8) from oil collector ring (7).

- (10) Look at bottom of forward clutch piston (10); note whether forward clutch piston is labeled X,Y, or Z.



- (11) Stack 10 clutch plates (11 and 12) on flat surface of press starting with steel plate (11) and alternating with friction plate (12).

- (12) Place fifth clutch driving hub (13) on clutch plates (11 and 12).



22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR (CONT)

- (13) Apply pressure to clutch pack (14) to steady it.
- (14) Press evenly on fifth clutch driving hub (13) with 100 psi (689.5 kPa).

NOTE

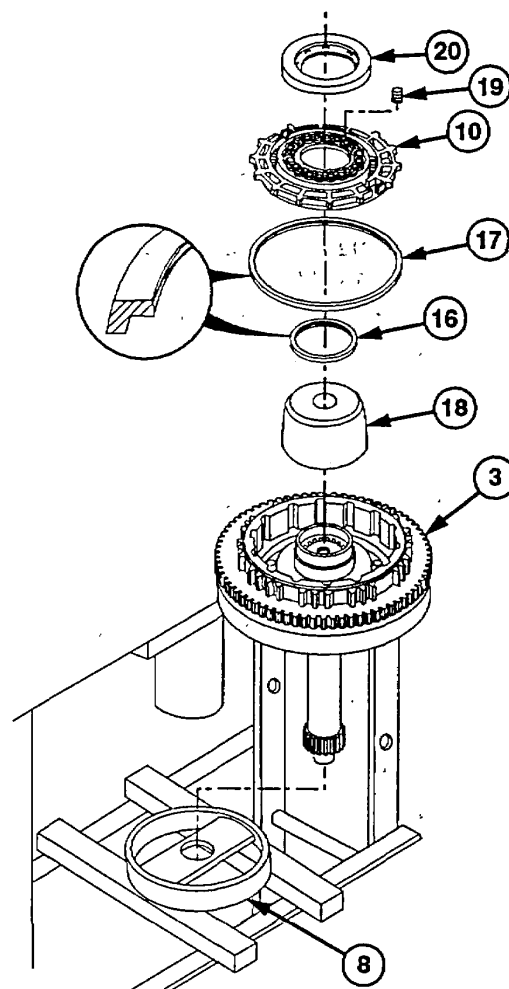
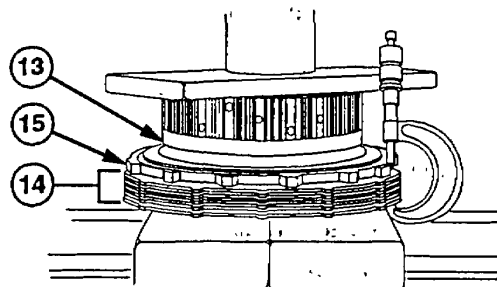
Forward clutch piston (10) must be a Z piston if clutch pack clearance is 1.4152-1.4415 in. (35.956-36.614 mm). Forward clutch piston must be a Y piston if clutch pack clearance is 1.3882-1.4148 in. (35.260-35.935 mm). Forward clutch piston must be an X piston if clutch pack clearance is 1.3615-1.3878 in. (34.582-35.230 mm).

- (15) Measure distance from base of clutch pack (14) to machined surface (15) of hub (13) to get clutch pack clearance.
- (16) Replace clutch plates (11 and 12) as needed to ensure proper clutch pack thickness.
- (17) Remove clutch pack (14) and fifth clutch driving hub (13) from press.
- (18) Install collector ring installer (8) on forward clutch assembly (3).
- (19) Position forward clutch assembly (3) with shaft down on hydraulic press.
- (20) Coat two new seal rings (16 and 17) with lubricating oil.

NOTE

Lip of piston seal rings face down on piston.

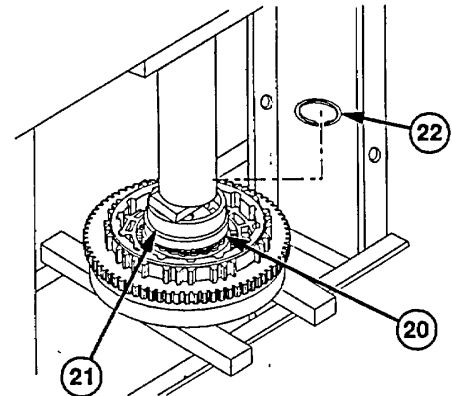
- (21) Install seal ring (16) and seal ring (17) on forward clutch piston (10).
- (22) Install inner hub seal protector (18) over inner hub of forward clutch assembly (3).
- (23) Install forward clutch piston (10) over seal protector (18). Carefully work forward clutch piston (10) completely down until seated.
- (24) Remove inner hub seal protector (18).
- (25) Install 20 piston release springs (19) on forward clutch piston (10).
- (26) Install piston release spring retainer (20) on piston release springs (19).



WARNING

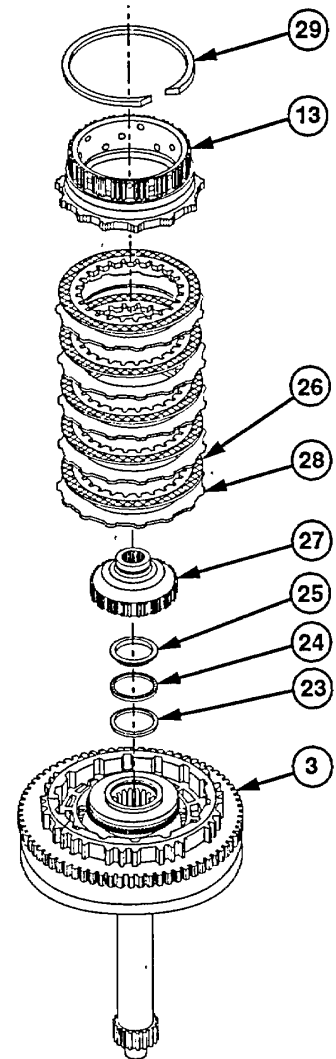
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (27) Compress spring retainer (20) with clutch spring compressor tool (21) and hydraulic press. Install retaining ring (22).
- (28) Release pressure from spring retainer (20) and remove clutch spring compressor tool (21).

**NOTE**

Install bearing race with cupped side down.

- (29) Install outer race (23) on small hub of forward clutch assembly (3).
- (30) Install thrust bearing (24) on outer race (23).
- (31) Coat inner race (25) with lubricating oil and install on thrust bearing (24).
- (32) Soak five friction plates (26) in clean lubricating oil for 2 minutes.
- (33) Install forward clutch driving hub (27) on forward clutch assembly (3).
- (34) Install five steel plates (28) and five friction plates (26), starting with steel plate (28) and alternating with friction plate (26).
- (35) Install fifth clutch driving hub (13) on forward clutch assembly (3).
- (36) Install large inner retaining ring (29) on forward clutch assembly (3).
- (37) Remove forward clutch assembly (3) from press.



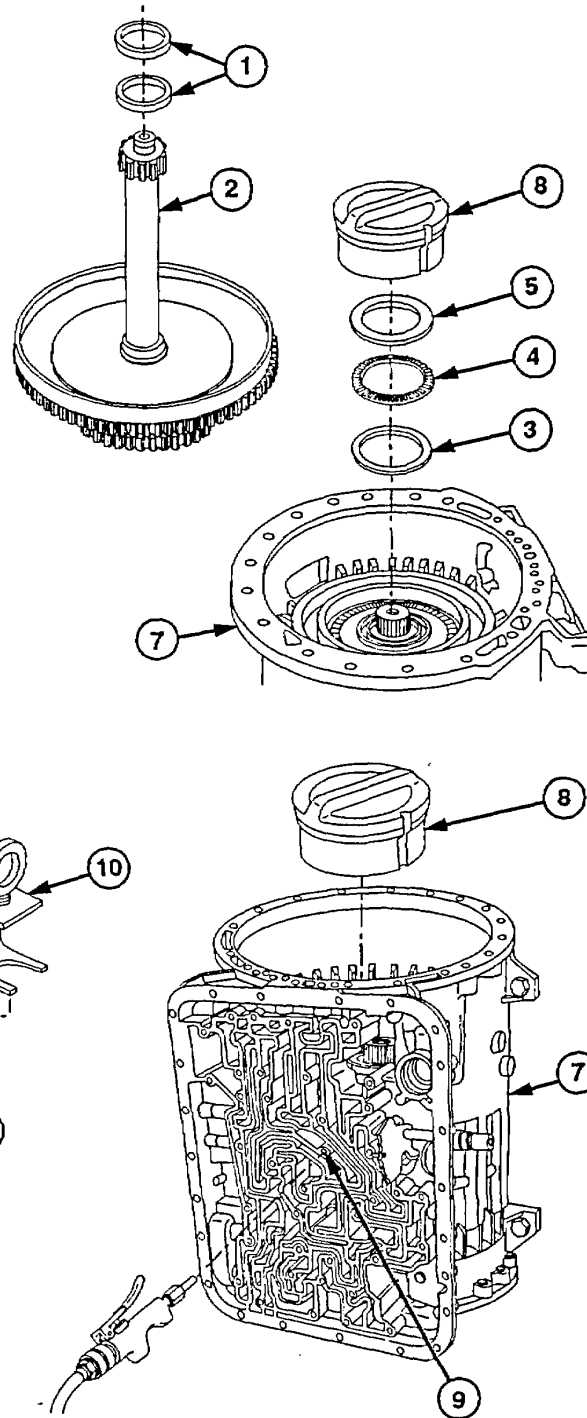
22-8. FORWARD CLUTCH AND TURBINE SHAFT REPAIR (CONT)**e. Installation**

- (1) Install two new seal rings (1) on turbine shaft (2).
- (2) Install outer race (3), roller bearing (4), and inner race (5) on fifth clutch assembly (6) in transmission housing (7).
- (3) Install fifth clutch alignment fixture (8) on fifth clutch assembly (6).

WARNING

Compressed air used to lockup fifth clutch plate will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) Apply air pressure to port (9) to lock up fifth clutch plates.
- (5) Remove fifth clutch alignment fixture (8) and install forward clutch assembly (6) in transmission housing (7) using lifting tool (10) while assistant holds air pressure in fifth clutch assembly (6).
- (6) Have assistant stop air pressure when forward clutch assembly (2) is fully seated in transmission housing (7).

**f. Follow-On Maintenance**

- (1) Install torque converter housing (para 22-7).
- (2) Install main control valve body (para 22-14).

22-9. FIFTH CLUTCH REPAIR

This task covers

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance
-

Initial Setup:

Equipment Conditions

Forward clutch and turbine shaft removed
(para 22-8).

Tools and Special Tools

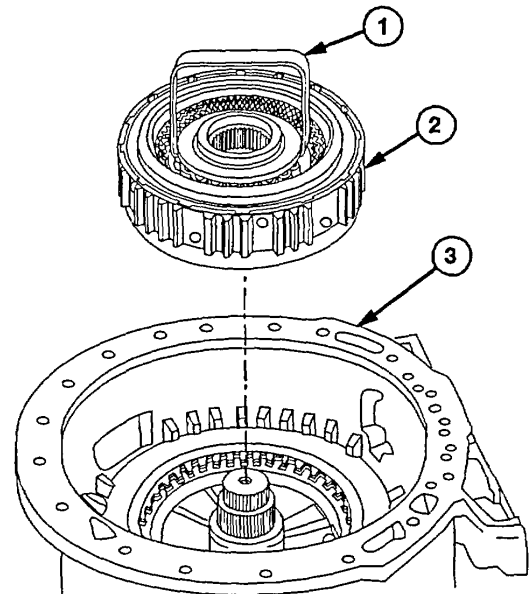
Tool Kit, Gent Mech (Item 202, Appendix E)
Bracket, Lifting (Item 11, Appendix E)
Compressor, Clutch Spring (Item 22,
Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Gage, Clearance (Item 46, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Spring Tester (Item 190, Appendix E)

Materials/Parts

Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Ring, Seal (Item 264, Appendix F)
Ring, Seal (Item 267, Appendix F)

a. Removal

Attach lifting bracket (1) to fifth clutch assembly (2) and
remove clutch from transmission housing (3).



22-9. FIFTH CLUTCH REPAIR (CONT)**b. Disassembly**

- (1) Remove thrust bearing race (1) from rear hub of clutch housing (2).

WARNING

Wear eye protection and use care when removing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

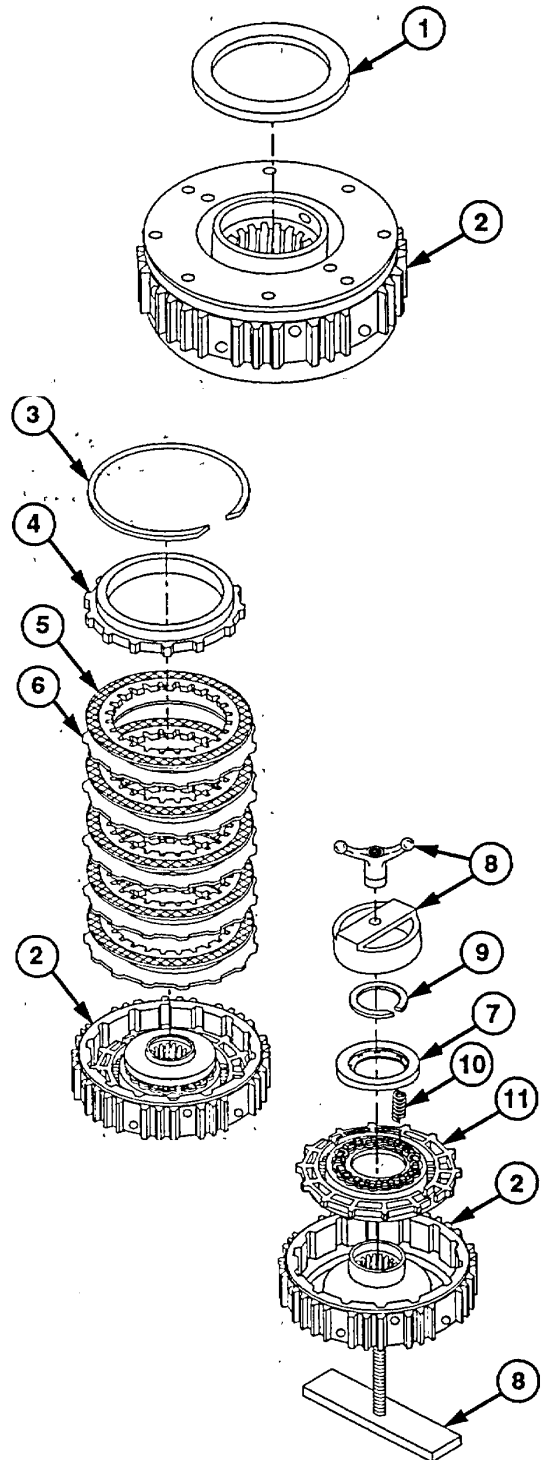
- (2) Remove snap ring (3) and backplate (4) from clutch housing (2).
- (3) Remove five friction plates (5) and five steel plates (6) from clutch housing (2).

- (4) Compress spring retainer (7) with clutch spring compressor tool (8) until it is clear of snap ring (9). Remove snap ring.

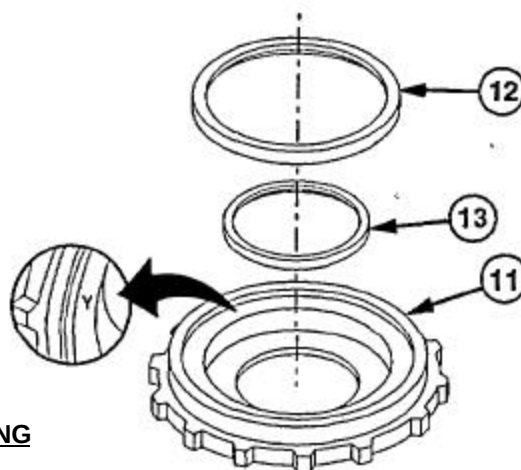
- (5) Remove spring compressor tool (8) from clutch housing (2).

- (6) Remove spring retainer (7) and 20 piston return springs (10) from piston (11).

- (7) Remove piston (11) from clutch housing (2).



- (8) Turn piston (11) over. Remove seal rings (12 and 13) from piston (11). Discard seal rings.
- (9) Record piston identification letter (X, Y, or Z) found on bottom side of piston (11).



c. Cleaning/inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

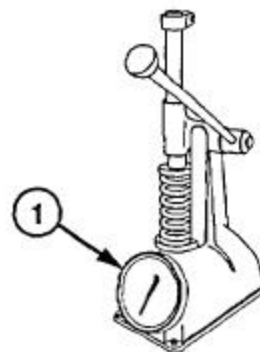
- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

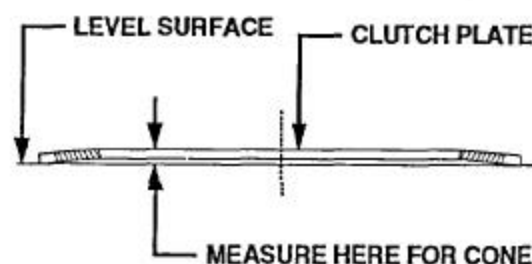
- (2) Dry metal parts with compressed air.
- (3) Measure piston release spring lengths using spring tester (1). Replace piston release springs if any 3 of each set of 20 do not meet the following load-height requirements:

- (a) Length without load must be at least 1.25 in. (31.8 mm).
- (b) Length under load must be at least 0.88 in. (22.4 mm) with a load of 17.9-18.9 lb (8.1-8.6 kg)



- (4) Measure individual clutch plate thickness by measuring amount of cone. The amount of cone is the distance between the inside diameter and level surface.

- (a) Friction plate: Minimum thickness 0.0993 in. (2.522 mm)
- (b) Steel clutch plate: Minimum thickness 0.090 in. (2.29 mm)
- (c) Backplate: Minimum thickness 0.390 in. (9.91 mm)



22-9. FIFTH CLUTCH REPAIR (CONT).**NOTE**

Staking must withstand a 30 lb (133 N) load applied through the bleed hole.

- (5) Inspect eight balls (2) for freedom of movement and proper staking. Replace balls if damaged.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (6) Clean eight ball pockets (3) with dry cleaning solvent.

WARNING

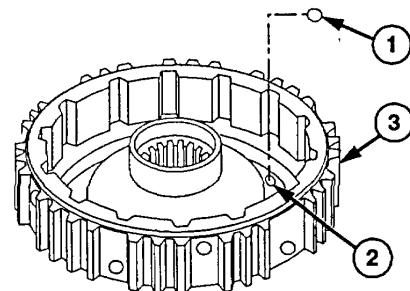
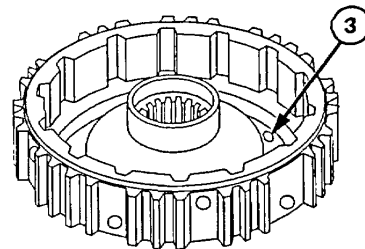
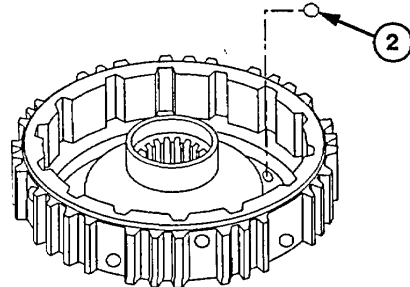
Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (7) Dry ball pockets (3) with compressed air.
(8) Apply lubricating oil around area of ball pockets (3).

d. Assembly**NOTE**

Do step (1) only if balls were removed.

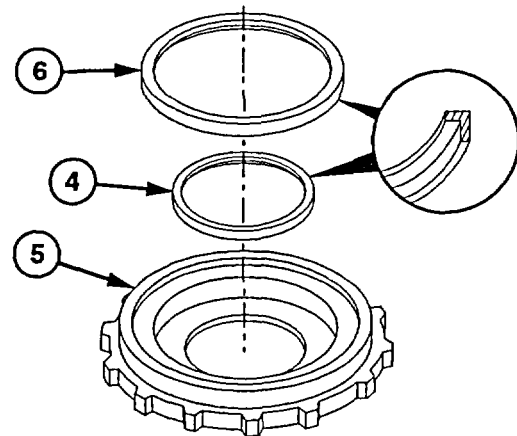
- (1) Install eight balls (1) in ball pockets (2). Stake clutch housing (3) to retain balls.



NOTE

Lip of piston seal rings faces bottom of piston cavity.

- (2) Lubricate and install new seal rings (4 and 5) in grooves in piston (6).



- (3) Install piston (6), spring bosses up, in clutch housing (3).

- (4) Soak five friction plates (7) in clean lubricating oil for 2 minutes.

NOTE

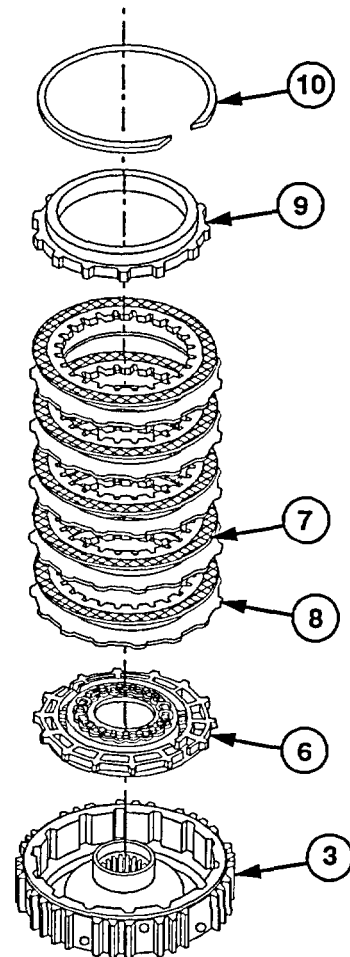
If new piston is used, make sure identification letter (X, Y, or Z) matches letter on old piston.

- (5) Install five steel plates (8) and five friction plates (7) starting with steel plate (8) and alternating with friction plate (7).

WARNING

Wear eye protection and use care when removing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (6) Install backplate (9) and snap ring (10) in clutch housing (3).



22-9. FIFTH CLUTCH REPAIR (CONT)**NOTE**

Clearance is satisfactory when thinner portion of gage will pass between backplate and clutch plates; the thicker portion of the gage will not.

- (7) Hold backplate (9) firmly against snap ring (10). Insert gage and check clearance between backplate and clutch pack (11). Clearance should be 0.80-0.120 in. (2.03-3.04 mm). If measurement is incorrect, replace clutch plates as needed.
- (8) Install bottom half of clutch spring compressor tool (12) under clutch housing (3).
- (9) Install 20 piston return springs (13) on piston (6).
- (10) Install spring retainer (14) outer lip down on 20 piston return springs (13).

WARNING

Wear eye protection and use care when installing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

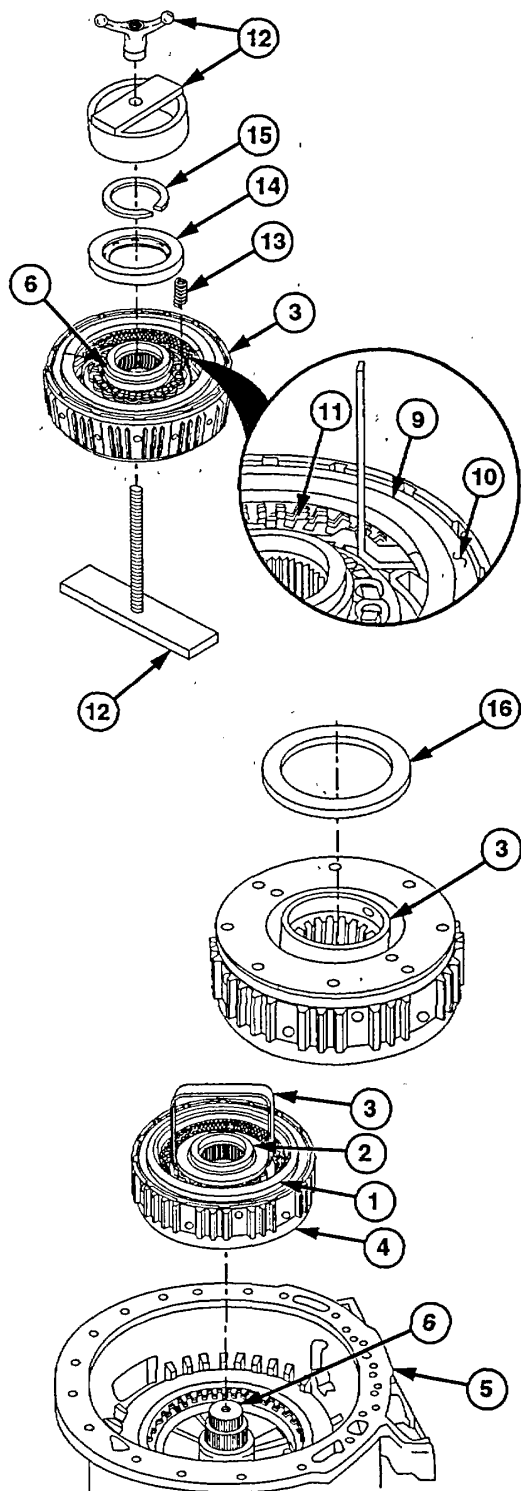
- (11) Install clutch spring compressor tool (12) and press on spring retainer (14) until snap ring groove on clutch hub is visible. Install snap ring (15).
- (12) Lubricate and install thrust bearing race (16) on rear hub of clutch housing (3).

e. Installation

- (1) Ensure thrust bearing race (1) is in place on the rear hub of clutch housing (2).
- (2) Attach lifting bracket (3) to fifth clutch assembly (4) and install fifth clutch into transmission (5).
- (3) Engage internal splines with splines on center sun gear shaft (6).

f. Follow-On Maintenance

Install fourth clutch (para 22-10).



22-10. FOURTH CLUTCH REPAIR

This task covers:

a. Removal	c. Installation
b. Cleaning/Inspection	d. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Fifth clutch removed (para 22-9).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Gage, Depth, Micrometer (Item 48, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)

Materials/Parts

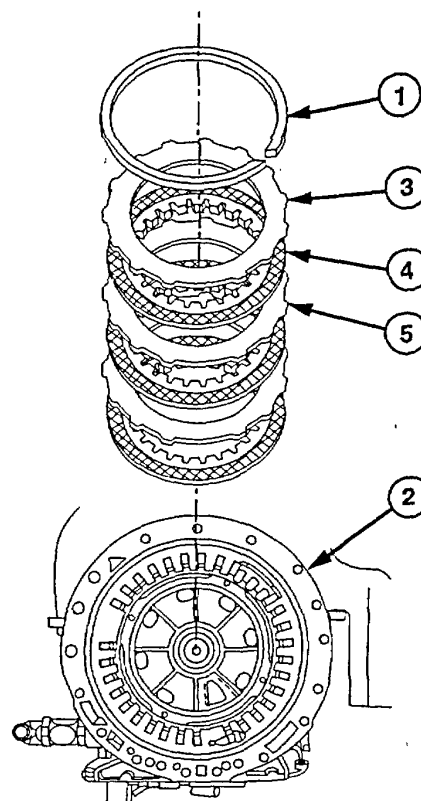
Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)

a. Removal

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (1) Remove retaining ring (1) from transmission housing (2).
- (2) Remove backplate (3) from transmission housing (2).
- (3) Remove four friction plates (4) and four steel plates (5) from transmission housing (2).



22-10. FOURTH CLUTCH REPAIR (CONT)**b. Cleaning/inspection.****WARNING**

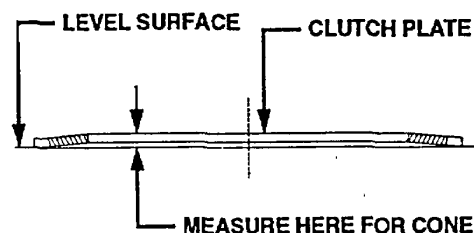
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.
- (3) Inspect friction clutch plates (internal splined plates) for embedded metal particles, severely pitted faces, loose fittings, excessive wear, cracks, distortion, and damaged spline teeth. Replace clutch plates if any other defects are found.
- (4) Inspect steel clutch plates (external-tanged plates) for burrs, scoring, embedded metal particles, severely pitted faces, galling, excessive wear, cracks, and distortion. Remove burrs and minor surface defects using soft stone. Replace clutch plates which have any other defects.
- (5) Measure individual clutch plate thickness by measuring amount of cone. The amount of cone is the distance between the inside diameter and level surface.
 - (a) Steel clutch plate (color-coded red):
Minimum thickness 0.0933 in. (2.37 mm)
Maximum cone 0.013 in. (0.33 mm)
 - (b) Steel clutch plate (color-coded green):
Minimum thickness 0.1161 in. (2.949 mm)
Maximum cone 0.013 in. (0.33 mm)
 - (c) Friction plate: Minimum thickness 0.1347 in. (3.420 mm) Maximum depth of oil grooves 0.008 in. (0.20 mm)
 - (d) Backplate minimum thickness 0.490 in. (12.45 mm)



c. Installation

NOTE

Do step (1) only if center support was not removed.

- (1) Install fifth clutch assembly (para 22-9).
- (2) Soak friction plates (1) in clean lubricating oil for 2 minutes.

NOTE

Thick steel plates (color-coded green) must be installed on bottom of stack.

- (3) Install steel plate (2) (color-coded green) with gap (3) facing as shown.

NOTE

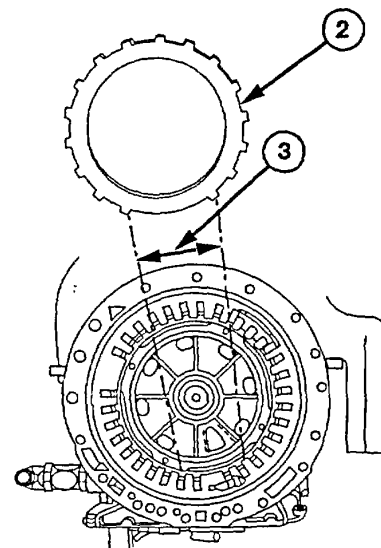
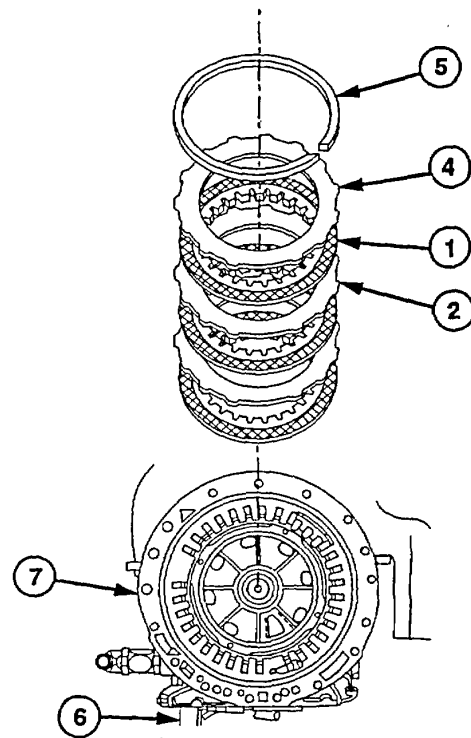
All steel plates and backplate must align with gap noted in step (3).

- (4) Install four friction plates (1) and three steel plates (2), starting with friction plate (1) and alternating with steel plate (2).
- (5) Install backplate (4).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (6) Install retaining ring (5) with gap opposite oil pan side (6) of transmission housing (7).



d. Follow-On Maintenance

Install forward clutch assembly and turbine shaft (para 22-8).

22-11. LOCKUP CUTOFF VALVE BODY REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Internal filter element removed (para 7-7).
Transmission installed on stand (para 22-3).

Tools and Special Tools

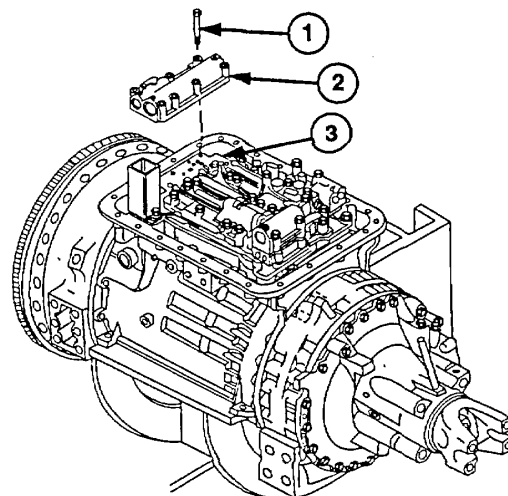
Tool Kit, Genl Mech (Item 202, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)

a. Removal

Remove eight screws (1) and lockup cutoff valve (2) from main control valve (3).

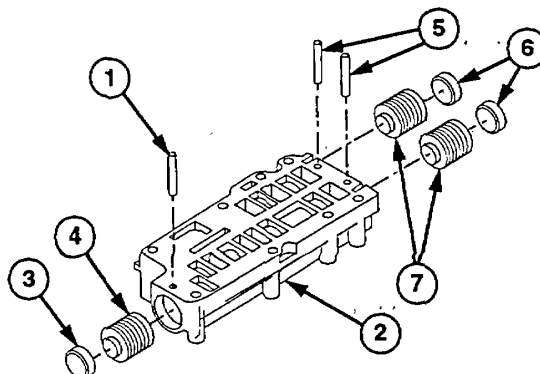


b. Disassembly

NOTE

Tag and mark all parts.

- (1) Remove retainer pin (1) from lockup cutoff valve (2).
- (2) Remove valve plug (3) and valve (4) from lockup cutoff valve (2).
- (3) Remove two retainer pins (5) from lockup cutoff valve (2).
- (4) Remove two valve plugs (6) and valves (7) from lockup cutoff valve (2).



c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean motor parts with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.
- (3) Inspect valve body and valves for nicks, burrs, and scratches. If defects are found, remove with crocus cloth.
- (4) Coat parts with lubricating oil.

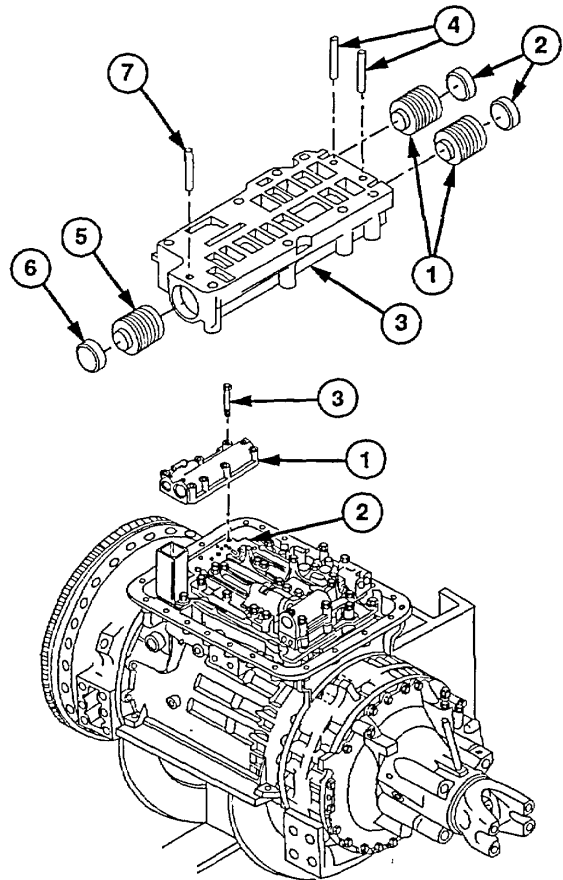
d. Assembly

- (1) Install two valves (1) and valve plugs (2) in lockup cutoff valve (3).

CAUTION

Retaining pins must be flush with bottom of lockup cutoff valve. Failure to comply may result in damage to equipment.

- (2) Install two retaining pins (4) in lockup cutoff valve (3).
- (3) Install valve (5), valve plug (6), and retaining pin (7) in lockup cutoff valve (3).



e. Installation

Position lockup cutoff valve (1) on main control valve (2) and install eight screws (3). Torque to 96-144 lb-in. (10.8-16.3 N•m).

f. Follow-On Maintenance

Install internal filter element (para 7-7).

22-12. TRIMMER VALVE REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Internal filter element removed (para 7-7).

Tools and Special Tools

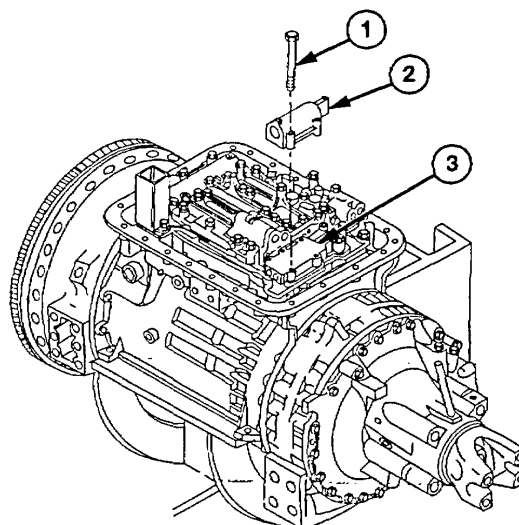
Tool Kit, Genl Mech (Item 202, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)

a. Removal

Remove six screws (1) and trimmer valve (2) from main control valve (3).

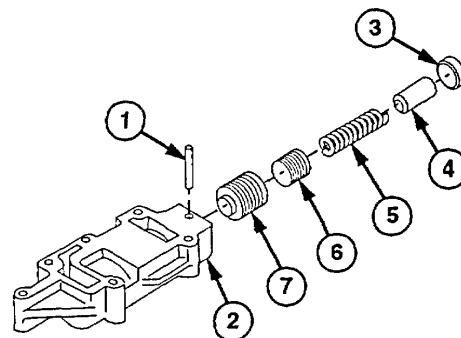


b. Disassembly

WARNING

Spring behind stop is under tension.
To prevent injury, use care when removing retaining pin.

- (1) Remove retaining pin (1) from trimmer valve (2).
- (2) Remove valve plug (3), stop (4), spring (5), plug (6), and valve (7) from trimmer valve (2).



c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-80 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.
- (3) Inspect valve body and valve for nicks, burrs, and scratches. If defects are found, remove with crocus cloth.
- (4) Coat parts with lubricating oil after cleaning.

d. Assembly

- (1) Install valve (1), plug (2), spring (3), stop (4), and valve plug (5) in trimmer valve (6).

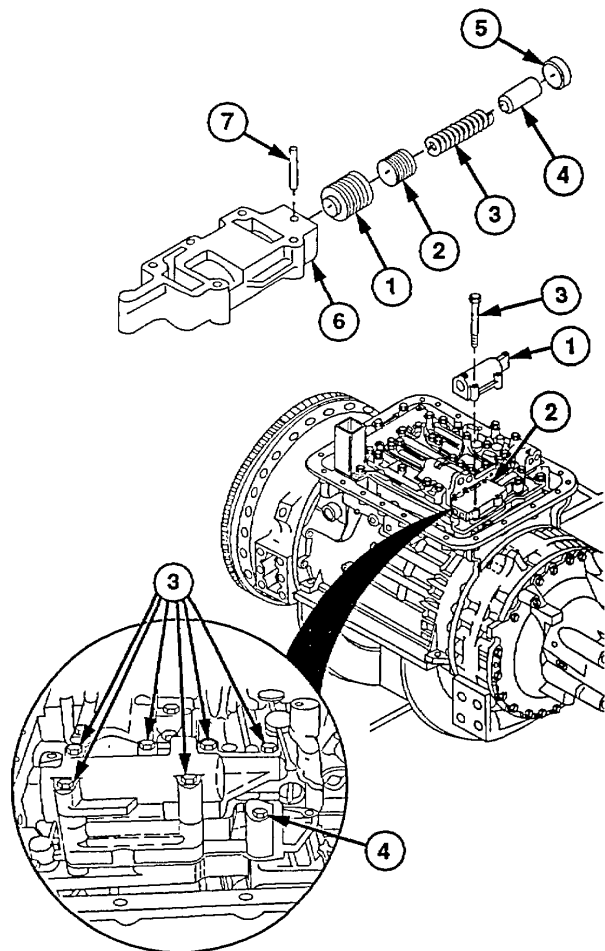
CAUTION

Retaining pin must be flush with bottom of trimmer valve. Failure to comply may result in damage to equipment.

- (2) Install retaining pin (7) in trimmer valve (6).

e. Installation

- (1) Install trimmer valve (1) on main control valve (2) with six screws (3).
- (2) Tighten six screws (3) and screw (4) to 96-144 lb-in. (10.8-16.3 N•m).



f. Follow-On Maintenance

Install internal filter element (para 7-7).

22-13. FIRST SHIFT VALVE REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

- Trimmer valve removed (para 22-12).
- Transmission installed on stand (para 22-3).

Tools and Special Tools

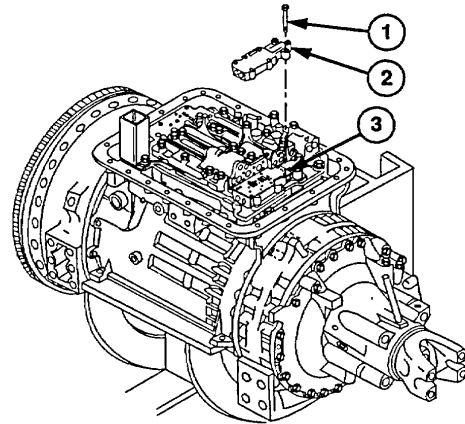
- Tool Kit, Genl Mech (Item 202, Appendix E)
- Compressor Unit, Air (Item 24, Appendix E)
- Goggles, Industrial (Item 57, Appendix E)

Materials/Parts

- Cloth, Crocus (Item 16, Appendix B)
- Oil, Lubricating (Item 44, Appendix B)
- Solvent, Dry cleaning (Item 54, Appendix B)

a. Removal

Remove screw (1) and first shift valve (2) from main control valve (3).



b. Disassembly

WARNING

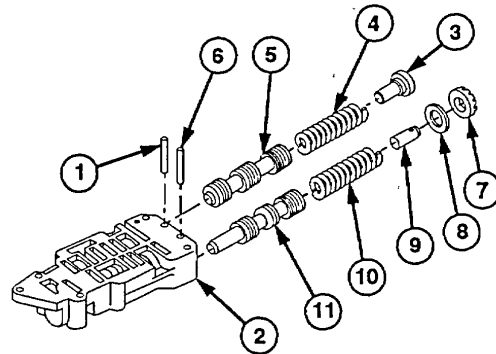
Springs are under tension. To prevent injury, use care when removing retaining pin.

- (1) Remove retaining pin (1) from first shift valve (2).
- (2) Remove valve plug (3), spring (4), and valve (5) from first shift valve (2).

CAUTION

Mark position of adjusting ring before removal. Damage to transmission may result if not assembled to same notch.

- (3) Remove retaining pin (6) from first shift valve (2).
- (4) Remove adjusting ring (7), washer (8), stop (9), spring (10), and valve (11) from first shift valve (2).



c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.
- (3) Inspect valve body and valve for nicks, burrs, and scratches. If defects are found, remove with crocus cloth.
- (4) Coat parts with lubricating oil.

d. Assembly

CAUTION

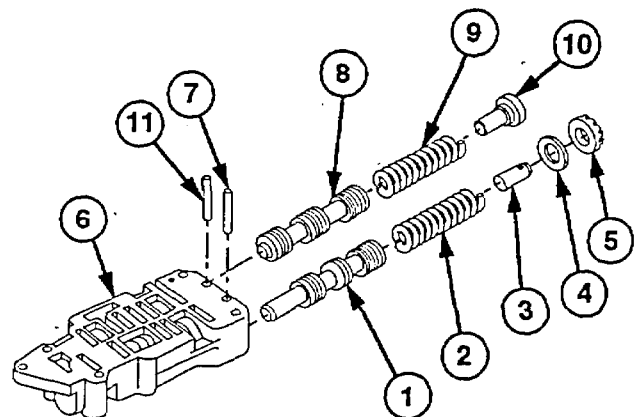
Install adjusting ring in position marked during removal. Damage to transmission may result if not assembled to same notch.

- (1) Install valve (1), spring (2), stop (3), washer (4), and adjusting ring (5) in first shift valve (6).

CAUTION

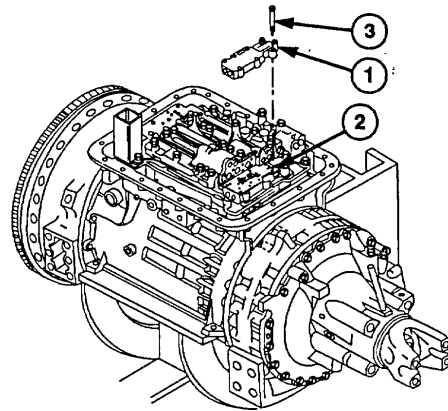
Retaining pins must be flush with bottom of first shift valve. Failure to comply may result in damage to equipment.

- (2) Install retaining pin (7) far enough in first shift valve (6) to hold adjusting ring (5) in place.
- (3) Position stop (3) in first shift valve (6) and fully seat retaining pin (7).
- (4) Install valve (8), spring (9), and valve plug (10) in first shift valve (6).
- (5) Install retaining pin (11) in first shift valve (6).



22-13. FIRST SHIFT VALVE REPAIR (CONT)**e. Installation**

Position first shift valve (1) on main control valve (2) and install screw (3). Do not tighten.

**f. Follow-On Maintenance**

Install trimmer valve (para 22-12).

22-14. MAIN CONTROL VALVE REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Transmission Installed on stand
(para 22-3).
Transmission external modulator
removed (TM 9-2320-360-20).
Lockup cutoff valve body removed
(para 22-11).
Trimmer valve removed (para 22-12).
First shift valve removed (para 22-13).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Spring Tester (Item 190, Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235,
Appendix E)

Materials/Parts

Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)

Personnel Required

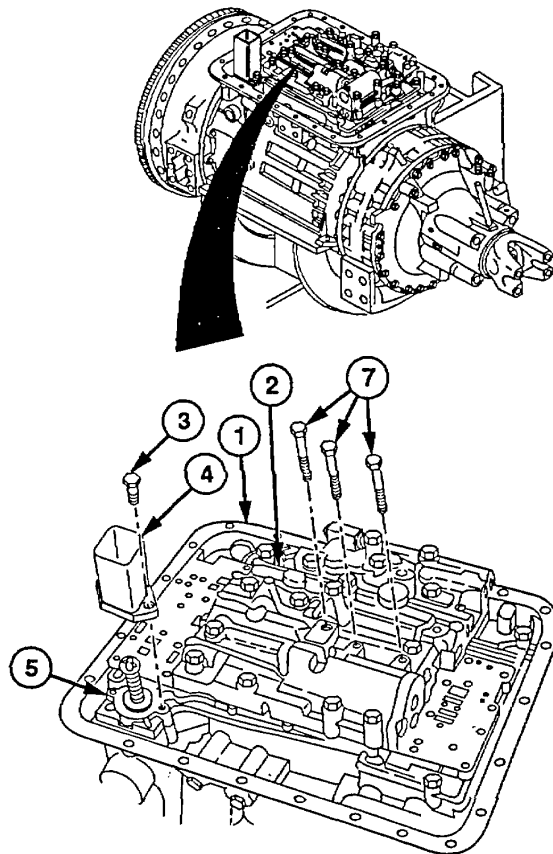
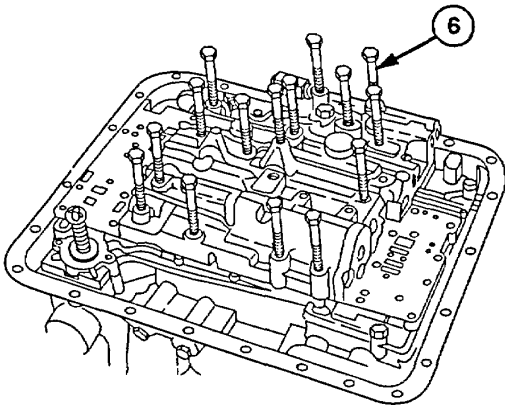
Two

a. Removal

CAUTION

Ensure forward clutch is secured
before turning transmission in stand.
Clutch may fall out and become
damaged.

- (1) Turn transmission (1) to access main control valve (2).
- (2) Remove two screws (3) and oil baffle (4) from separator plate (5).
- (3) Remove 15 screws (6) and 3 long screws (7) from main control valve (2).



22-14. MAIN CONTROL VALVE REPAIR (CONT)

- (4) Remove screw (8) and selector detent assembly (9) from main control valve (2).
- (5) Remove two screws (10) and washers (11) from main control valve (2).

CAUTION

Ensure selector valve is secured before removing control valve, otherwise it could fall out and become damaged.

- (6) Remove main control valve (2) from transmission (1) while holding selector valve (12).
- (7) Place main control valve (2) on flat work surface bottom up.

b. Disassembly

- (1) Remove three screws (1) from modulator valve body (2).
- (2) Remove modulator valve body (2) while holding oil transfer plate (3) and separator plate (4) together on control valve body (5).

WARNING

All valves are under spring tension. Release springs slowly to avoid personal injury.

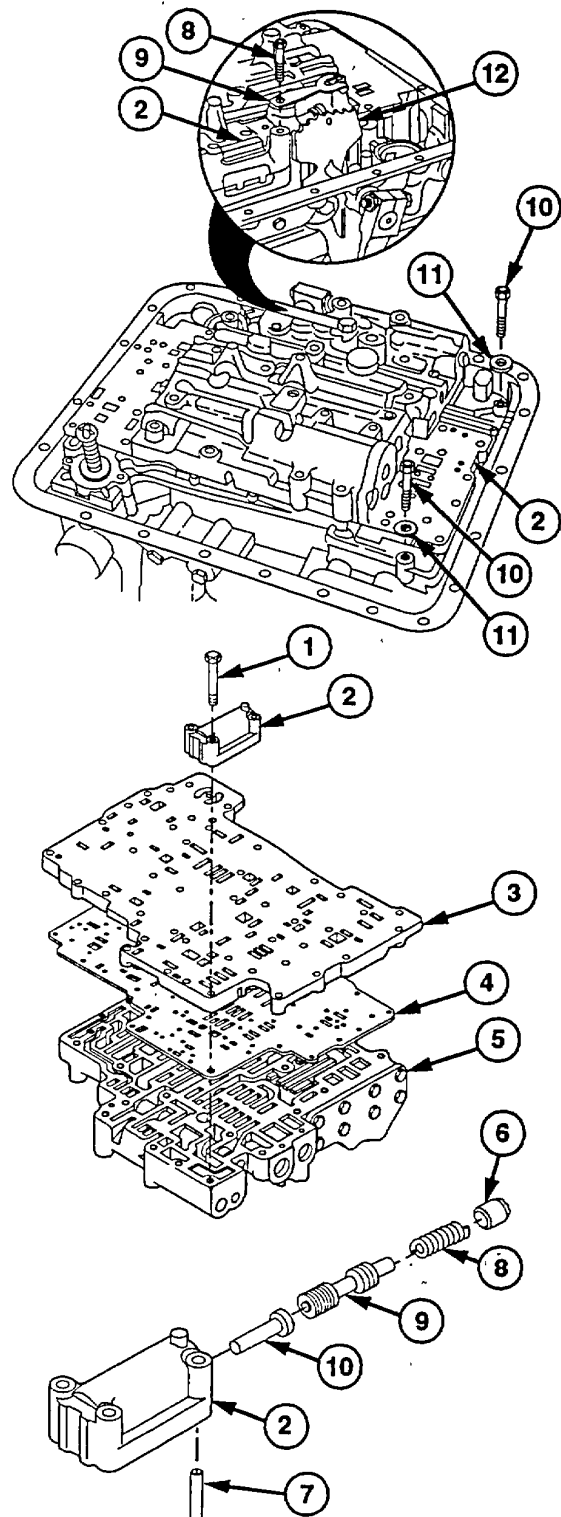
CAUTION

- Do not use magnets to remove valve bodies. Magnetized valve bodies may not work properly.
- Mark positions of adjusting rings before removal. Improper shifting and possible damage to transmission may result if not assembled to same notch.

NOTE

Tag and mark all parts after removing.

- (3) Press adjusting ring (6) inward and remove retaining pin (7) from modulator valve body (2).
- (4) Remove adjusting ring (6), spring (8), modulator valve (9), and valve actuator pin (10) from modulator valve body (2).



- (5) Hold oil transfer plate (3) and separator plate (4) together and remove from control valve body (5).

CAUTION

Ensure transfer plate and separator plate do not separate before turning over.

- (6) Turn oil transfer plate (3) and separator plate (4) over with separator plate up. Place on flat work surface.

CAUTION

Ensure transfer plate is face up on work surface before separator plate is removed. Failure to do so will allow check balls to fall from control valve.

- (7) Lift separator plate (4) from oil transfer plate (3).

CAUTION

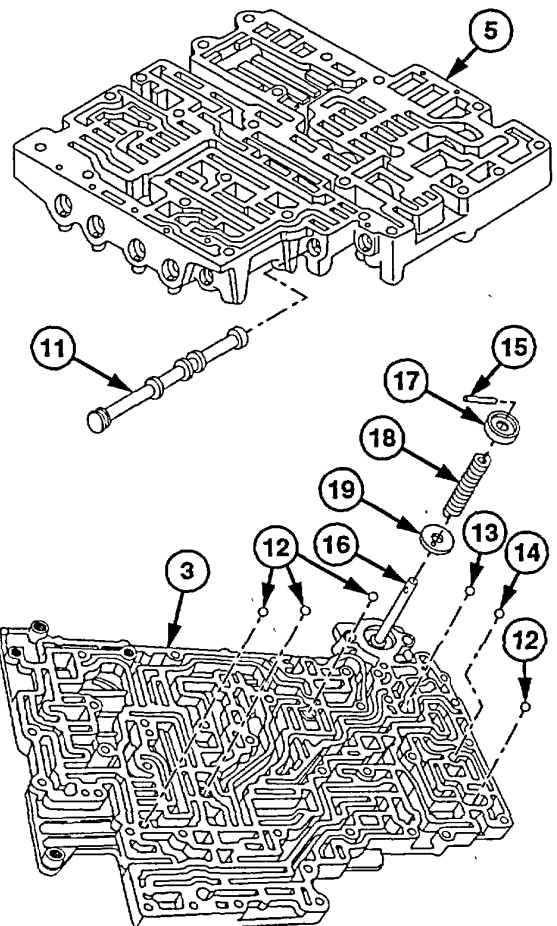
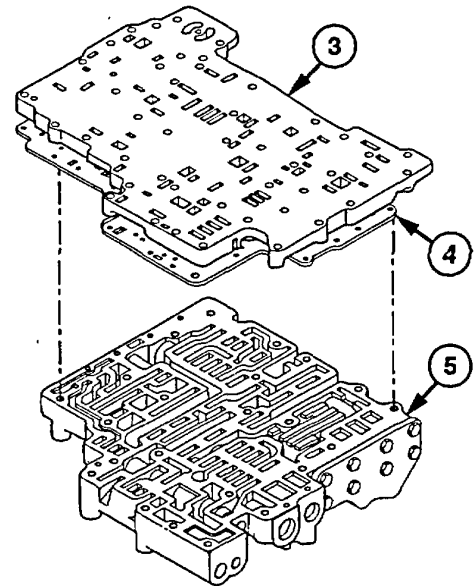
Do not drop selector valve. Tip may break off and valve will become unserviceable.

- (8) Remove selector valve (11) from control valve body (5).

CAUTION

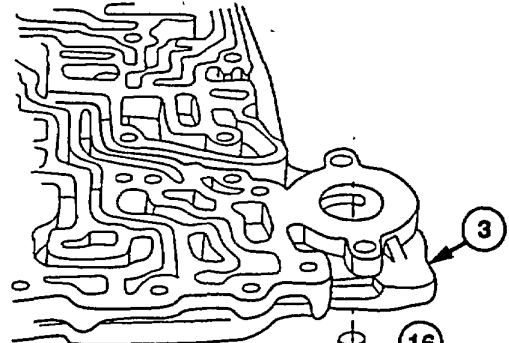
Record and identify check balls by size, color, and location. Failure to comply may result in equipment damage.

- (9) Remove four 1/4 in. check balls (12) from oil transfer plate (3).
- (10) Remove 3/8 in. check ball (13) and 5/16 in. check ball (14) from oil transfer plate (3).
- (11) Remove retaining pin (15) from check valve pin (16) while assistant presses down on cup washer (17).
- (12) Remove cup washer (17), spring (18), and lubrication check valve (19) from oil transfer plate (3).



22-14. MAIN CONTROL VALVE REPAIR (CONT)

- (13) Remove check valve pin (16) from bottom of oil transfer plate (3).



- (14) Remove priority valve (20), spring (21), and valve stop (22) from port (23).

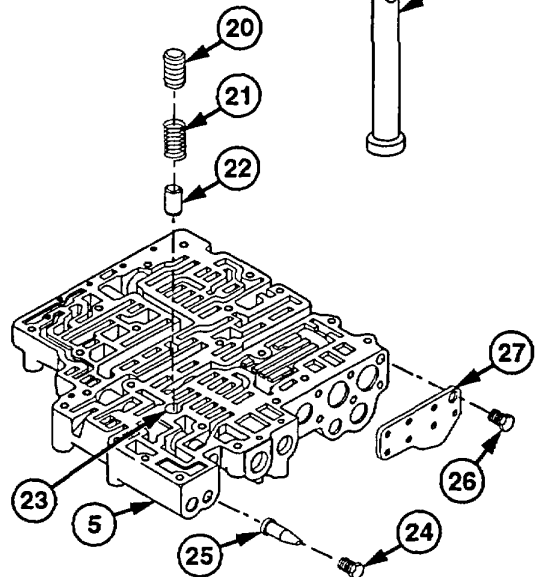
- (15) Remove plug (24) and governor screen assembly (25) from control valve body (5).

- (16) Remove six of eight screws (26) from trimmer valve cover (27).

WARNING

**All valves are under spring tension.
Release springs slowly to avoid
personal injury.**

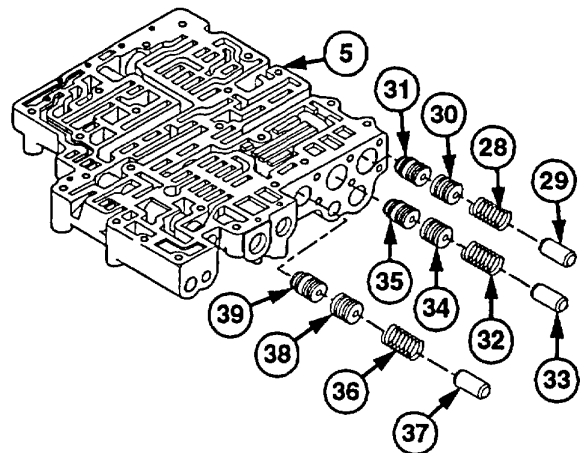
- (17) Slowly remove last two screws (26) evenly while holding down trimmer valve cover (27). Remove trimmer valve cover.



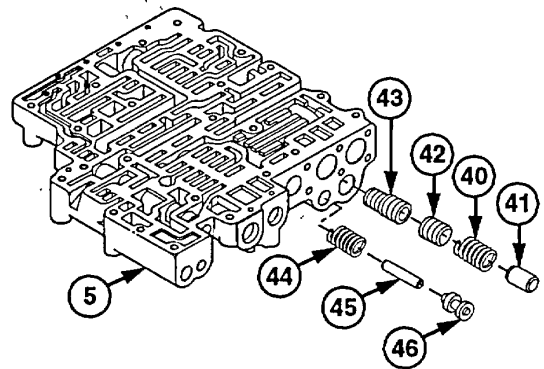
- (18) Remove spring (28), valve stop (29), trimmer plug (30), and fourth clutch trimmer valve (31) from control valve body (5).

- (19) Remove spring (32), valve stop (33), plug (34), and third clutch trimmer valve (35) from control valve body (5).

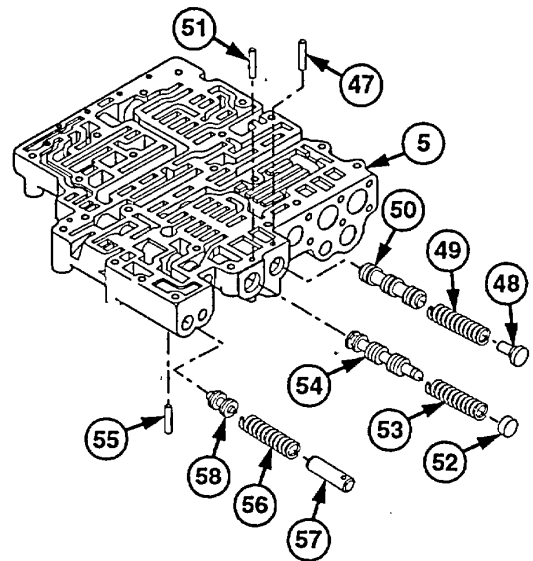
- (20) Remove spring (36), valve stop (37), plug (38), and fifth clutch trimmer valve (39).



- (21) Remove spring (40), valve stop (41), plug (42), and second clutch trimmer valve (43) from control valve body (5).
- (22) Remove spring (44), valve stop (45), and accumulator valve (46) from control valve body (5).



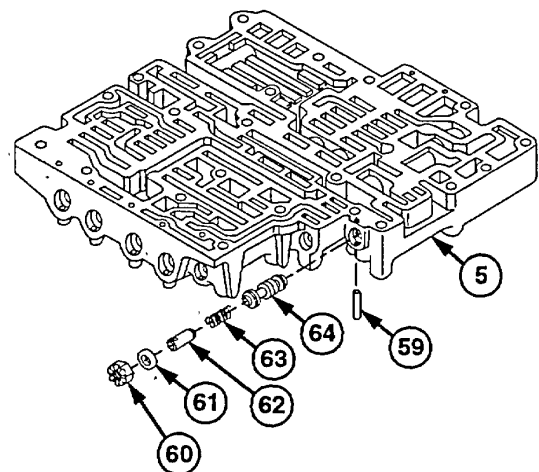
- (23) Remove retainer pin (47), spring spacer (48), spring (49), and three-four relay valve (50) from control valve body (5).
- (24) Remove retaining pin (51), valve stop (52), spring (53), and two-three relay valve (54) from control valve body (5).
- (25) Remove retaining pin (55), spring (56), valve stop (57), and governor accumulator valve (58) from control valve body (5).



CAUTION

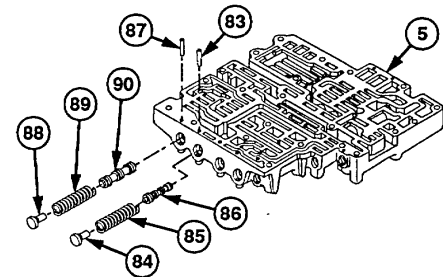
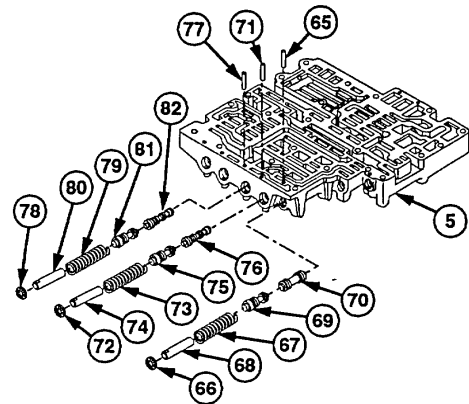
Mark position of adjusting ring before removal. Improper shifting and possible damage to transmission may result if not assembled to same notch.

- (26) Remove retaining pin (59), adjusting ring (60), washer (61), valve stop (62), valve spring (63), and hold regulator valve (64) from control valve body (5).



22-14. MAIN CONTROL VALVE REPAIR (CONT)

- (27) Remove retaining pin (65), adjusting ring (66), valve spring (67), valve stop (68), two-three shift modulator valve (69), and two-three shift signal valve (70) from control valve body (5).
- (28) Remove retaining pin (71), adjusting ring (72), valve spring (73), valve stop (74), three-four shift modulator valve (75), and three-four shift signal valve (76) from control valve body (5).
- (29) Remove retaining pin (77), adjusting ring (78), spring (79), valve stop (80), four-five modulator shift valve (81), and four-five shift signal valve (82) from control valve body (5).
- (30) Remove retaining pin (83), valve stop (84), valve spring (85), and four-five relay valve (86) from control valve body (5).
- (31) Remove retaining pin (87), valve stop (88), valve spring (89), and trimmer regulator valve (90) from control valve body (5).

**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.
- (2) Inspect valves, valve stops, and plugs for damage. Replace damaged parts.
- (3) Inspect bores and surfaces of control valve body for damage.
- (4) Measure spring lengths using spring tester (1). Replace springs which do not meet load-length specifications listed in table 22-2.

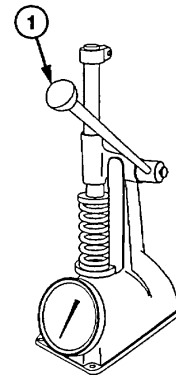
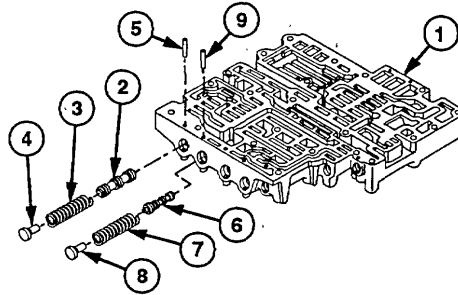


Table 22-2. Spring Load-Length Specifications

	Length Without Load in. (mm)	Length Under Load in. (mm)	Load lb (kg)	Assembly Text Reference	
				Step No.	Callout No.
Trimmer regulator valve spring	1.37 (34.8)	0.89 (22.6)	2.43-2.69 (10.8-11.9)	(2)	(3)
Four-five shift relay valve spring	2.18 (55.4)	1.20 (30.5)	16.20-19.80 (72.1-88.1)	(4)	(7)
Four-five shift signal valve spring	2.69 (68.3)	1.15 (29.2)	8.9-9.6 (39.6-42.7)	(6)	(12)
Three-four shift signal valve spring	2.37 (60.2)	1.15 (29.2)	11.0-11.5 (48.9-51.2)	(9)	(18)
Two-three shift signal valve spring	2.98 (75.7)	1.15 (29.20)	10.6-11.4 (47.2-50.7)	(12)	(24)
Hold regulator valve spring	1.91 (48.5)	1.15 (29.2)	7.46-7.76 (33.2-34.5)	(16)	(30)
Governor accumulator valve spring	1.83 (46.5)	0.70 (17.8)	11.6-12.8 (51.6-56.9)	(19)	(36)
Two-three relay valve spring	1.52 (38.6)	1.10 (27.9)	7.2-8.8 (32.03-39.14)	(21)	(40)
Three-four relay valve spring	2.18 (55.4)	1.94 (49.3)	29.0-35.0 (129.0-155.7)	(23)	(44)
Accumulator valve spring	2.77 (70.4)	1.49 (37.8)	11.6-12.8 (51.6-56.9)	(25)	(47)
Second clutch trimmer valve spring	2.38 (60.5)	1.94 (49.3)	29.0-35.0 (129.0-155.7)	(26)	(52)
Fifth clutch trimmer valve spring	2.38 (60.5)	1.94 (49.3)	29.0-35.0 (129.0-155.7)	(27)	(56)
Third clutch trimmer valve spring	2.38 (60.5)	1.94 (49.3)	29.0-35.0 (129.0-155.7)	(28)	(60)
Fourth clutch trimmer valve spring	2.16 (54.9)	1.94 (49.3)	12.2-14.8 (54.3-65.8)	(29)	(64)
Priority valve spring	1.17 (29.7)	0.94 (23.9)	8.15-9.25 (36.3-41.2)	(32)	(70)
Lubrication check valve spring	2.45 (62.2)	1.97 (50.0)	39.41-48.21 (175.3-214.4)	(33)	(76)
Modulator valve spring	1.47 (37.3)	0.80 (20.3)	11.9-13.1 (52.9-58.3)	(40)	(86)

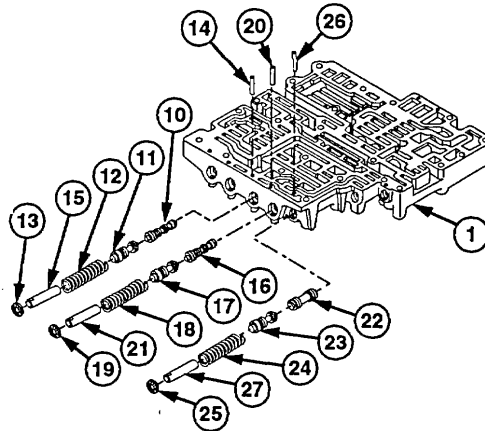
22-14. MAIN CONTROL VALVE REPAIR (CONT)**d. Assembly**

- (1) Place control valve body (1) on dean work surface flat side up.
- (2) Install trimmer regulator valve (2), valve spring (3), and valve stop (4) in control valve body (1).
- (3) Press valve stop (4) and insert retaining pin (5) in control valve body (1).
- (4) Install four-five shift relay valve (6), valve spring (7), and valve stop (8) in control valve body (1).
- (5) Press valve stop (8) and insert retaining pin (9) in control valve body (1).

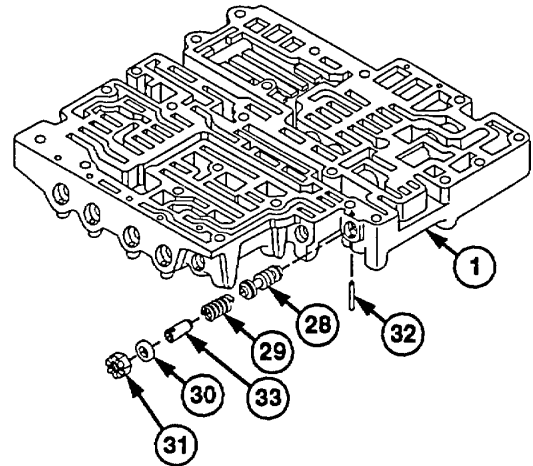
**CAUTION**

Install adjusting rings in positions marked during removal. Improper shifting and possible damage to transmission may result if not assembled to same notch.

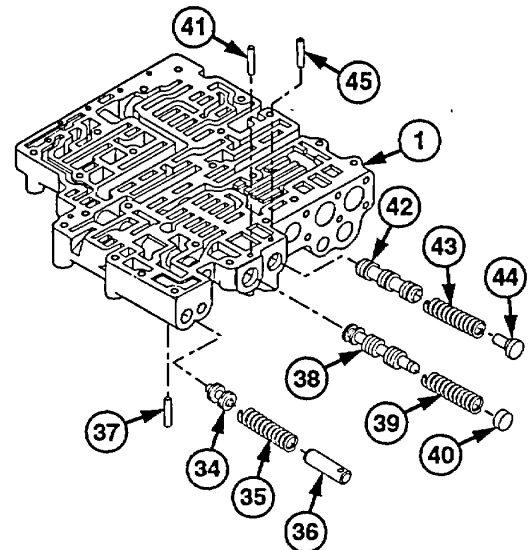
- (6) Install four-five shift signal valve (10), four-five shift modulator valve (11), spring (12), and adjusting ring (13) in control valve body (1).
- (7) Press adjusting ring (13) and insert retaining pin (14) in control valve body (1) far enough to hold adjusting ring in place.
- (8) Install valve stop (15) in control valve body (1). Install retaining pin (14) through hole in valve stop (15).
- (9) Install three-four shift signal valve (16), three-four shift modulator valve (17), valve spring (18), and adjusting ring (19) in control valve body (1).
- (10) Press adjusting ring (19) and insert retaining pin (20) in control valve body (1) far enough to hold adjusting ring in place.
- (11) Install valve stop (21) in control valve body (1). Install retaining pin (20) through hole in valve stop (21).
- (12) Install two-three shift signal valve (22), two-three shift modulator valve (23), valve spring (24), and adjusting ring (25) in control valve body (1).
- (13) Press adjusting ring (25) and insert retaining pin (26) in control valve body (1) far enough to hold adjusting ring in place.
- (14) Install valve stop (27) in control valve body (1). Install retaining pin (26) through hole in valve stop (27).



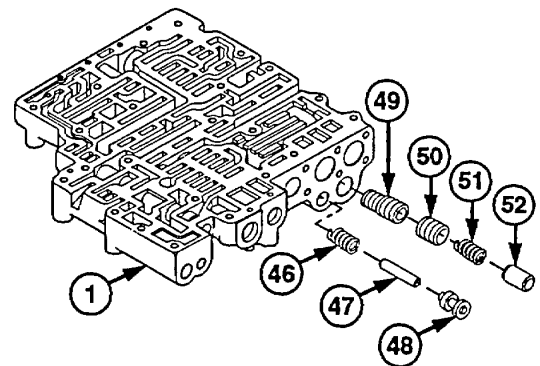
- (15) Install hold regulator valve (28), valve spring (29), washer (30), and adjusting ring (31) in control valve body (1).
- (16) Press adjusting ring (31) and insert retaining pin (32) in control valve body (1) far enough to hold adjusting ring in place.
- (17) Install valve stop (33) in control valve body (1). Install retaining pin (32) through hole in valve stop (33).



- (18) Install governor accumulator valve (34) and spring (35) in control valve body (1).
- (19) Install valve stop (36) in control valve body (1). Install retaining pin (37) through hole in valve stop (36).
- (20) Install two-three relay valve (38) and spring (39) in control valve body (1).
- (21) Install valve stop (40) in control valve body (1). Install retaining pin (41) through hole in valve stop (40).
- (22) Install three-four relay valve (42) and spring (43) in control valve body (1).
- (23) Install spring spacer (44) in control valve body (1). Install retaining pin (45) through hole in spring spacer (44).



- (24) Install spring (46), valve stop (47), and accumulator valve (48) in control valve body (1).
- (25) Install second clutch trimmer valve (49), plug (50), spring (51), and valve stop (52) in control valve body (1).



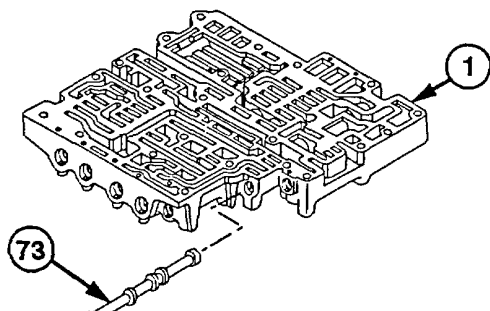
22-14. MAIN CONTROL VALVE REPAIR (CONT)

- (26) Install fifth clutch trimmer valve (53), plug (54), spring (55), and valve stop (56) in control valve body (1).
- (27) Install third clutch trimmer valve (57), plug (58), spring (59), and valve stop (60) in control valve body (1).
- (28) Install fourth clutch trimmer valve (61), trimmer plug (62), spring (63), and valve stop (64) in control valve body (1).
- (29) Install governor screen assembly (65) and plug (66) in control valve body (1).
- (30) Install trimmer valve cover (67) and eight screws (68) in control valve body (1) while pressing on springs. Torque to 96-144 lb-in. (10.8-16.3 N m).
- (31) Install spring (69), valve stop (70), and priority valve (71) in port (72).

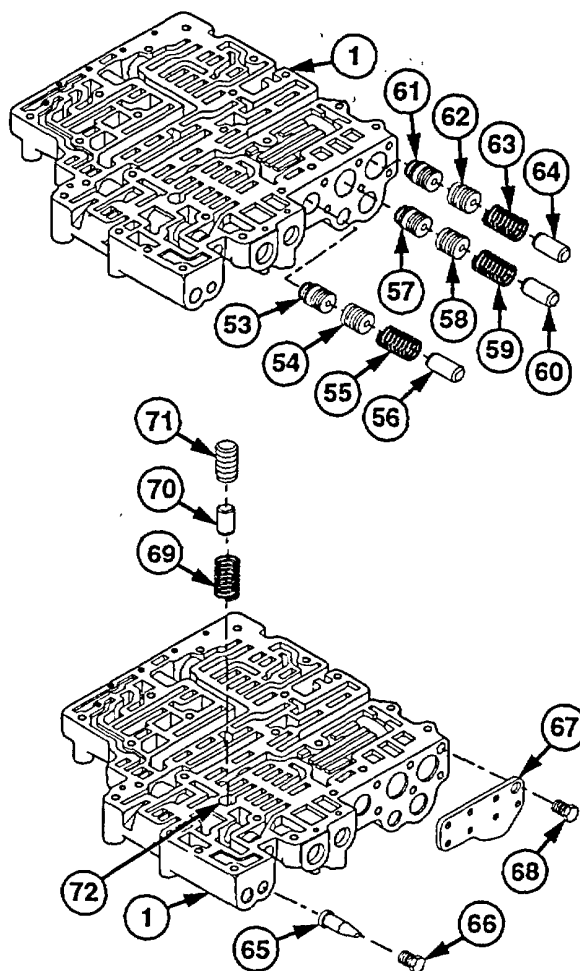
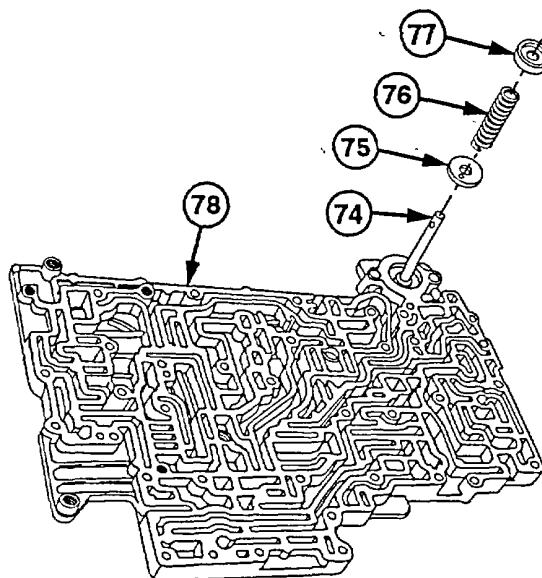
CAUTION

Do not drop selector valve. Tip may break off and valve will become nonserviceable.

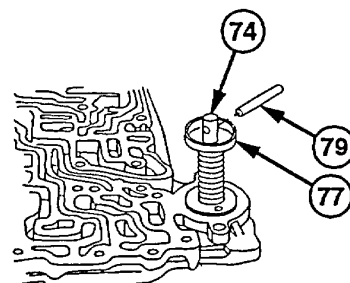
- (32) Install selector valve (73) in control valve body (1).



- (33) Install check valve pin (74), lubrication check valve (75), spring (76), and spring cup washer (77) in oil transfer plate (78).

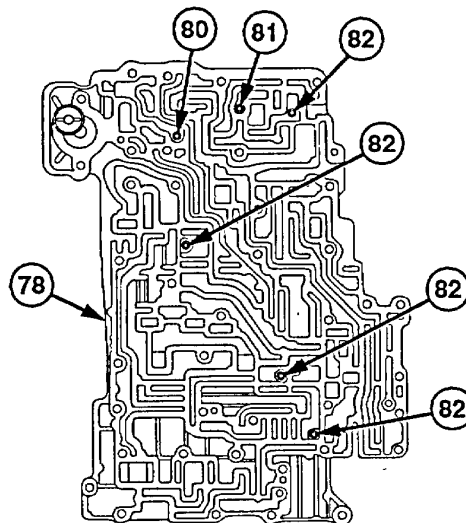


- (34) Install retaining pin (79) in check valve pin (74) while assistant presses down on spring cup washer (77).



- (35) Install 5/16 in. check ball (80) and 3/8 in. check ball (81) in oil transfer plate (78).

- (36) Install four 1/4 in. check balls (82) in oil transfer plate (78).



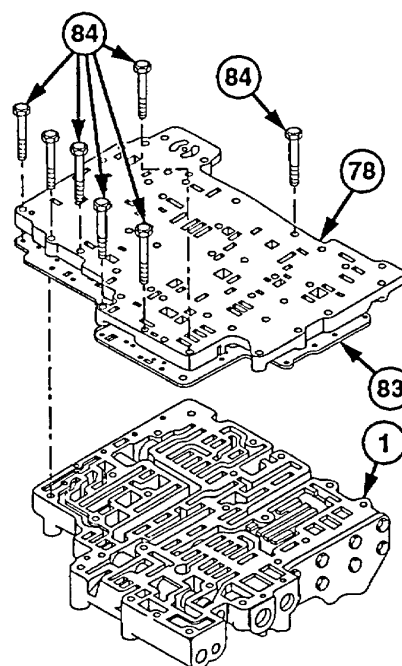
- (37) Slide separator plate (83) on oil transfer plate (78).

- (38) Hold separator plate (83) and oil transfer plate (78) together, turn plates over, and place on control valve body (1).

NOTE

Screws are used to align holes in plates and control valve body.

- (39) Insert six screws (84) through oil transfer plate (78), separator plate (83), and control valve body (1).



22-14. MAIN CONTROL VALVE REPAIR (CONT)**CAUTION**

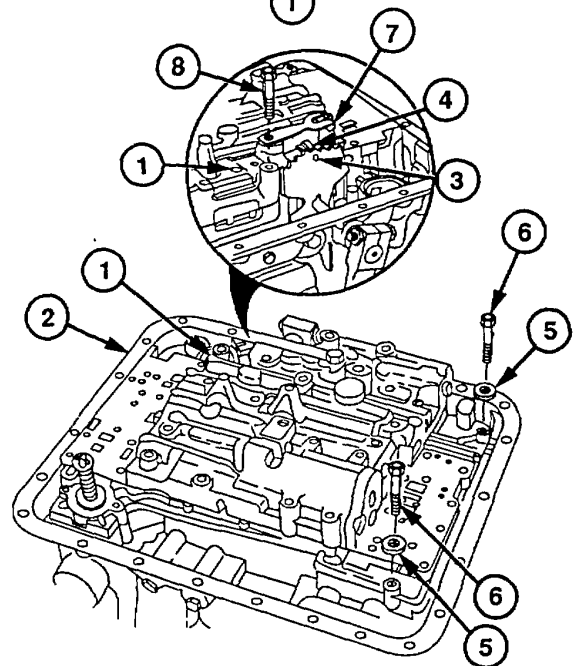
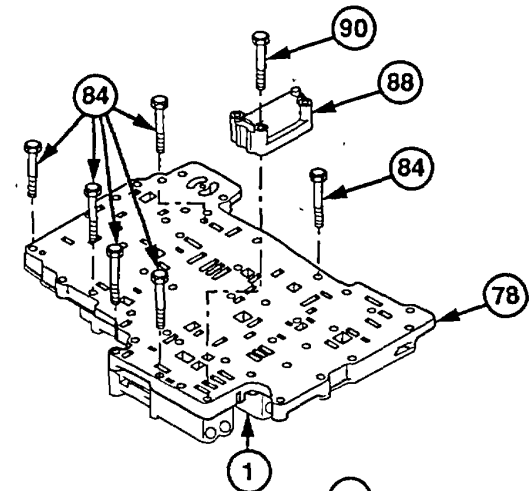
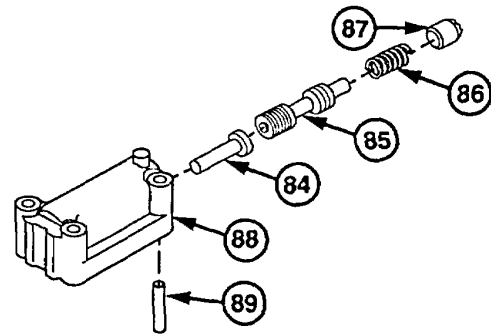
Install adjusting ring in position marked during removal. Damage to transmission may result if not assembled to same notch.

(40) Install actuator pin (84), modulator valve (85), spring (86), and adjusting ring (87) in modulator valve body (88).

(41) Press adjusting ring (87) and insert retaining pin (89) in modulator valve body (88).

(42) Place modulator valve body (88) on oil transfer plate (78) and install three screws (90). Torque to 96-144 lb-in. (10.8-16.3 N•m).

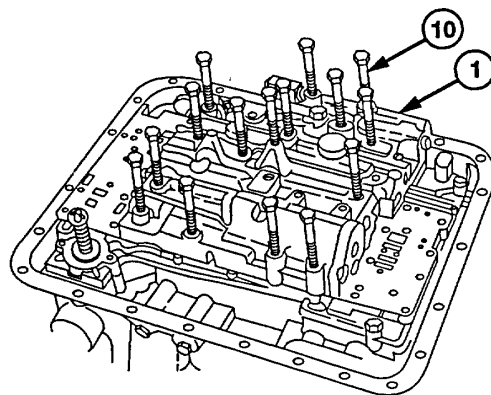
(43) Remove six screws (84) from oil transfer plate (78) and control valve body (1).

**e. Installation**

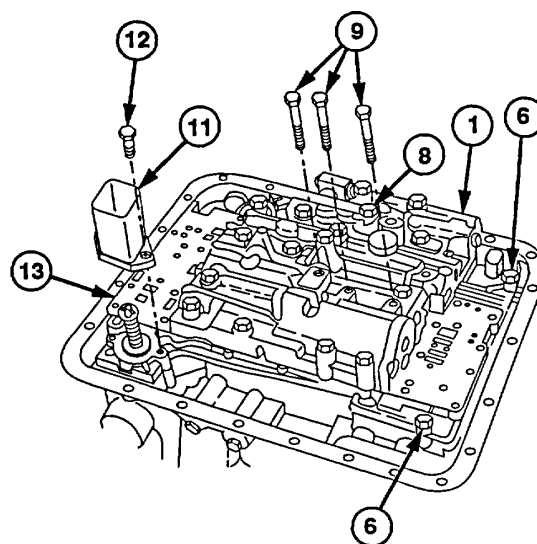
(1) Install control valve body (1) in transmission housing (2) making sure shift rack pin (3) engages slot on selector valve (4).

(2) Install two washers (5) and screws (6) on control valve body (1).

(3) Install selector detent assembly (7) and screw (8) on control valve body (1).



- (4) Install 3 long screws (9) and 15 screws (10) on control valve body (1).
- (5) Install oil baffle (11) and two screws (12) on separator plate (13).
- (6) Tighten screws (6, 8, 9, 10, and 12) to 108-132 lb-in. (12.2-14.9 N•m).



f. Follow-On Maintenance

- (1) Install first shift clutch valve (para 22-13).
- (2) Install trimmer valve (para 22-12).
- (3) Install lockup cutoff valve (para 22-11).

22-15. CENTER SUPPORT REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/inspection	f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

- Fourth clutch removed (para 22-10).
- Control valve removed (para 22-14).

Tools and Special Tools

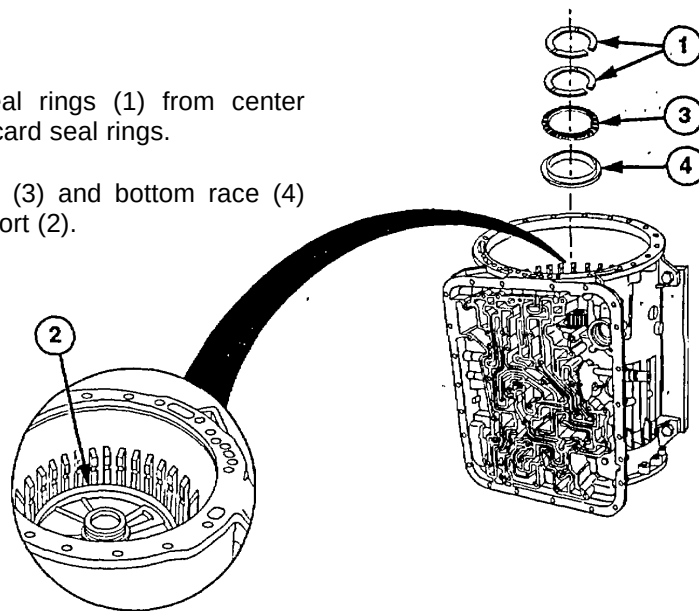
- Tool Kit, Gent Mech (Item 202, Appendix E)
- Compressor Unit, Air (Item 24, Appendix E)
- Compressor Set, Center Support (Item 21, Appendix E)
- Gage, Seal Ring Groove (Item 53, Appendix E)
- Goggles, Industrial (Item 57, Appendix E)
- Bracket, Lifting (Item 11, Appendix E)
- Heater, Gun Type (Item 68, Appendix E)
- Press, Hydraulic (Item 116, Appendix E)
- Swaging Tool (Item 186, Appendix E)
- Tester, Spring (Item 190, Appendix E)
- Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

- Oil, Lubricating (Item 44, Appendix B)
- Solvent, Dry Cleaning (Item 54, Appendix B)
- Ring Kit, Seal, Buttjoint (Item 273, Appendix F)
- Rings, Seal (2) (Item 265, Appendix F)
- Rings, Seal (2) (Item 250, Appendix F)
- Screw, Anchor (Item 281, Appendix F)
- Washers, Retaining (8) (item 338, Appendix F)
- Washer (Item 332, Appendix F)

a. Removal

- (1) Remove two seal rings (1) from center support (2). Discard seal rings.
- (2) Remove bearing (3) and bottom race (4) from center support (2).



- (3) Remove center support anchor screw (5) and washer (6) from transmission (7). Discard screw and washer.

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (4) Remove retaining ring (8) from transmission (7).
- (5) Install center support lifting bracket (9) into the seal ring grooves on the center support hub (10).

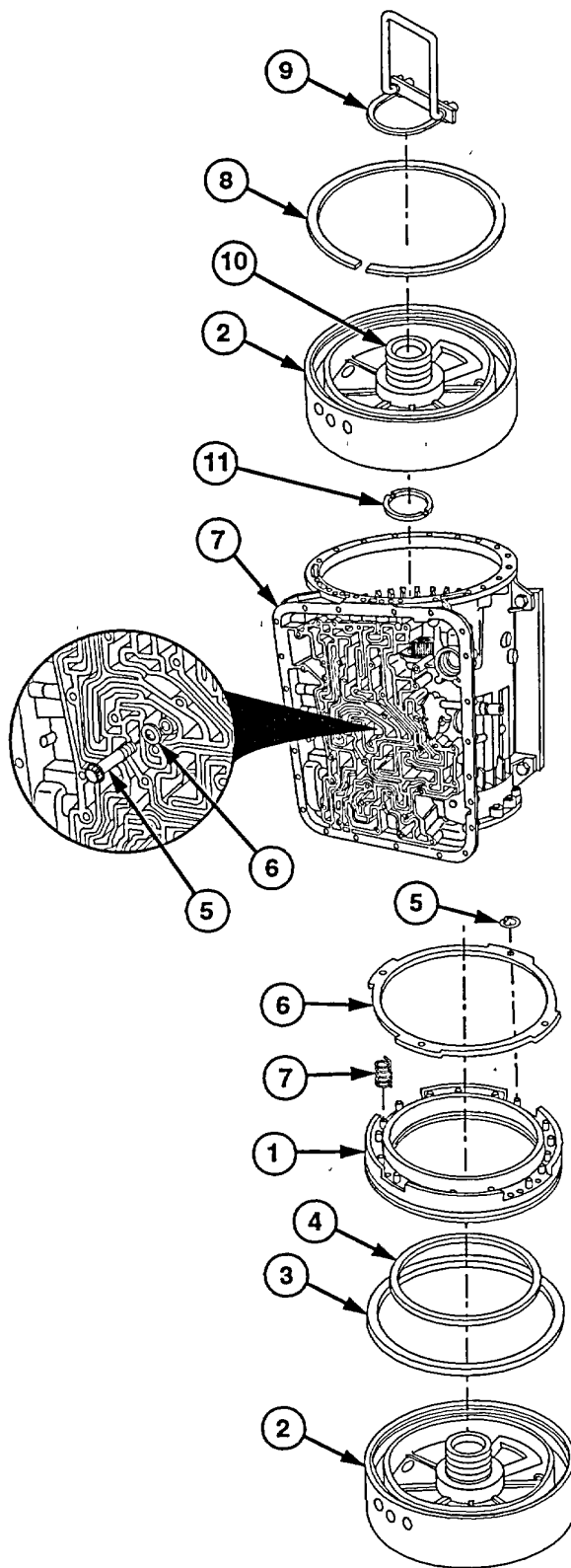
NOTE

- Center support housing is fitted to transmission housing with very little clearance and may bind if transmission housing is cold. Heat transmission housing with heat lamp or warm current of air.
- If center support housing starts upward and begins to bind, tap center support housing downward and lift again.

- (6) Lifting straight up, remove center support (2) from transmission (7).
- (7) Set center support (2) on flat work surface.
- (8) Remove thrust washer (11) from transmission (7).
- (9) Remove lifting bracket (9) from center support hub (10).

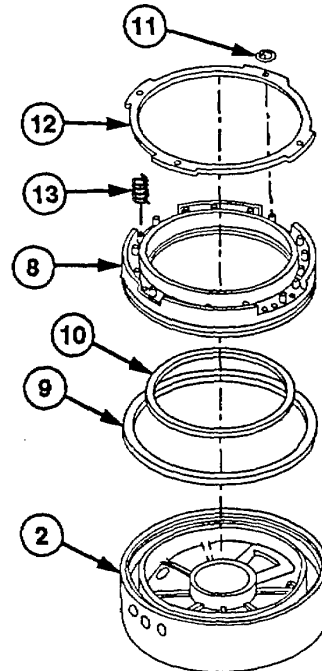
b. Disassembly

- (1) Remove fourth clutch piston (1) from center support housing (2).
- (2) Remove outer seal ring (3) and inner seal ring (4) from fourth clutch piston (1).
- (3) Cut and remove four retaining washers (5). Discard retaining washers.
- (4) Remove clutch ring (6) from fourth clutch piston (1).
- (5) Remove 20 springs (7) from fourth clutch piston (1).



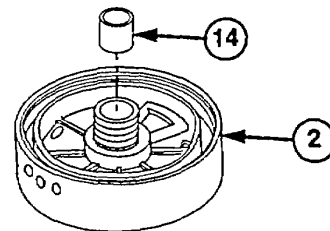
22-15. CENTER SUPPORT REPAIR (CONT)

- (6) Turn center support housing (2) over.
- (7) Remove third clutch piston (8) from center support housing (2).
- (8) Remove outer seal ring (9) and inner seal ring (10) from third clutch piston (8).
- (9) Cut and remove four retaining washers (11). Discard retaining washers.
- (10) Remove clutch ring (12) from third clutch piston (8).
- (11) Remove 20 springs (13) from third clutch piston (8).
- (12) Turn center support housing (2) over.

**NOTE**

Do step (13) only if replacing bushing.

- (13) Collapse bushing (14) at seam and remove from center support housing (2) using a chisel.

**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.

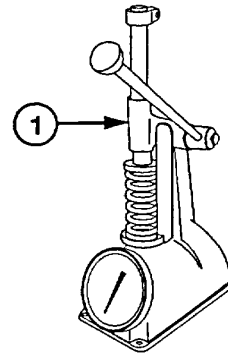
WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

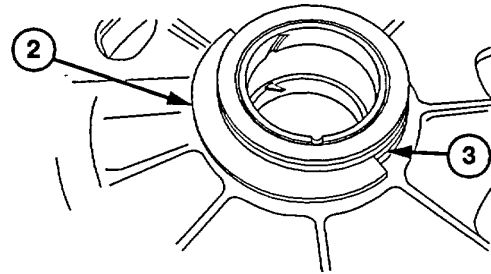
- (2) Dry metal parts using compressed air.

- (3) Measure piston release spring lengths using spring tester (1). Replace piston release springs if any three of each set do not meet the following load-height requirements:

- (a) Length without load must be at least 1.29 in. (32.7 mm).
- (b) Length under load must be at least 0.82 in (20.8 mm) with load of 4.3-5.7 lb (2-2.6 kg).
- (c) Measure thrust washer thickness. Thickness must be no less than 0.091 in. (2.31 mm).



- (4) Insert seal ring groove gage (2) into groove (3) on center support. Rotate gage around hub. If the gage does not rotate freely, the support is damaged and should be replaced. Repeat the check on the other seal ring groove.



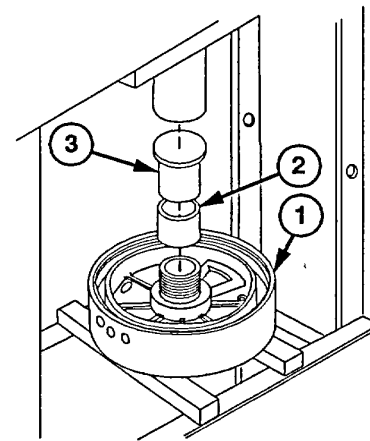
d. Assembly

- (1) Place center support (1) on press, hub side up.

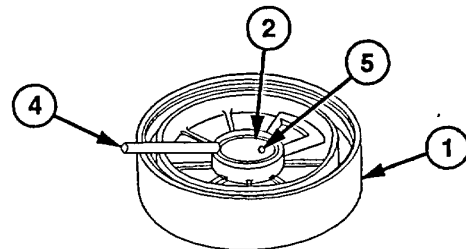
NOTE

Oil hole in prebored bushing must align with oil hole in center hub.

- (2) Install prebored bushing (2) in hub with installer (3).

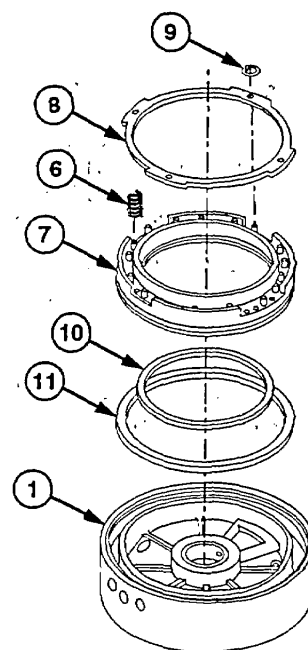


- (3) Remove center support (1) from press and place on flat work surface hub side up.
- (4) Use swaging tool (4) to swage bushing (2) by staking edges of oil hole (5).

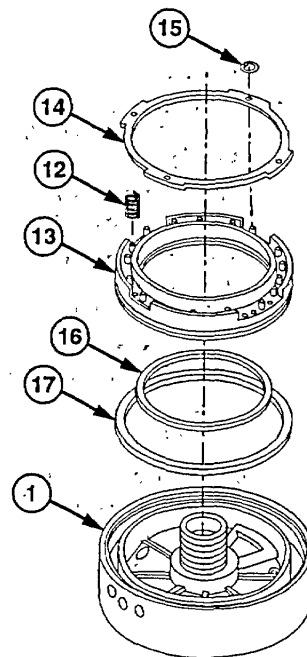


22-15. CENTER SUPPORT REPAIR (CONT)

- (5) Install 20 springs (6) in third clutch piston (7).
- (6) Install clutch ring (8) on third clutch piston (7).
- (7) Install four new retaining washers (9) while applying pressure to clutch ring (8).
- (8) Coat seal rings (10 and 11) with lubricating oil.
- (9) Install inner seal ring (10) and outer seal ring (11) in third clutch piston (7).
- (10) Install third clutch piston (7) in center support (1).



- (11) Turn center support (1) over on opposite side.
- (12) Install 20 springs (12) in fourth clutch piston (13).
- (13) Install clutch ring (14) in fourth clutch piston (13).
- (14) Install four new retaining washers (15) while applying pressure to clutch ring (14).
- (15) Apply lubricating oil to seal rings (16 and 17).
- (16) Install inner seal ring (16) and outer seal ring (17) in fourth clutch piston (13).
- (17) Install fourth clutch piston (13) on center support (1).



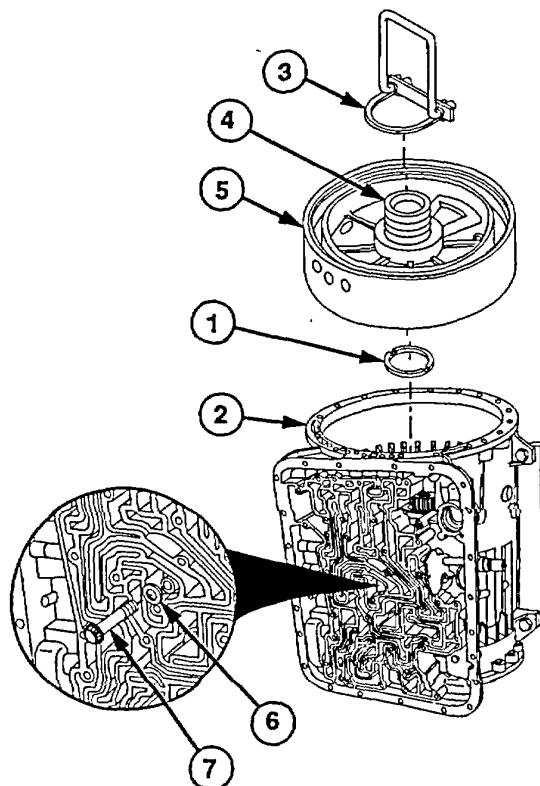
e. Installation

- (1) Install thrust washer (1) in transmission (2).
- (2) Install lifting bracket (3) on center support hub (4).

NOTE

Ensure tapped hole on center support housing is aligned with hole in transmission housing.

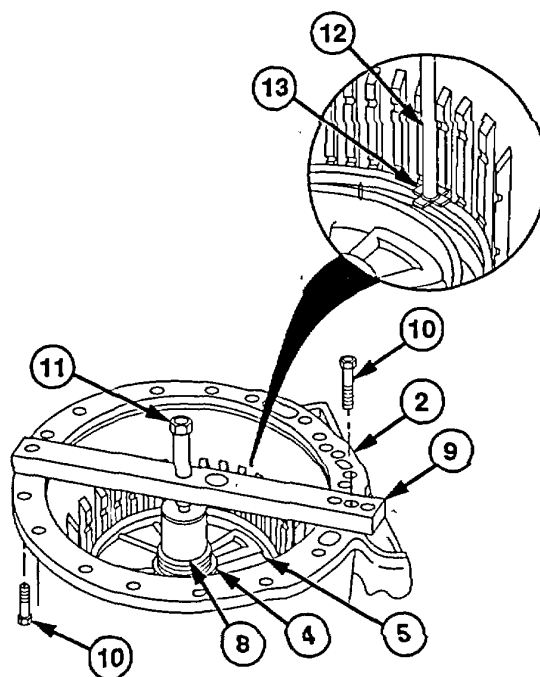
- (3) Lower center support (5) into transmission (2).
- (4) Position washer (6) and anchor screw (7) in transmission (2) and center support (5). Do not tighten.
- (5) Remove lifting bracket (3) from center support hub (4).



- (6) Install compressor sleeve (8) on hub (4) of center support (5). Place compressor bar (9) across transmission (2). Install two screws (10).
- (7) Tighten compressor screw (11) to 60 lb-in. (6.8 N•m) to compress center support (5).

- (8) Using retaining ring gage (12), measure retaining ring opening with each of four lugs (13). This will determine retaining ring size.

- (a) Blue color-coded ring is 0.1480.150 in. (3.76 to 3.81 mm thick).
- (b) Yellow color-coded ring is 0.1520.154 in. (3.86-3.91 mm) thick.
- (c) White color-coded ring is 0.1550.157 in. (3.94-3.99 mm) thick.
- (d) Red color-coded ring is 0.1580.160 in. (4.01-4.06 mm) thick.



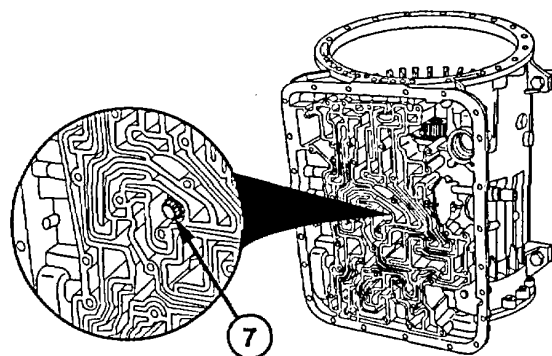
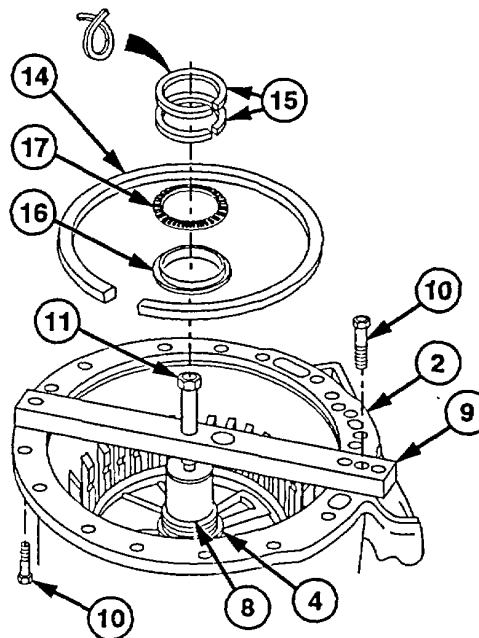
22-15. CENTER SUPPORT REPAIR (CONT)**NOTE**

Ensure split in retaining ring faces opposite oil pan.

- (9) Install retaining ring (14) that has same color code as lug on gage.
- (10) Ease tension on compressor screw (11) and remove two screws (10) from transmission housing (2).
- (11) Remove compressor bar (9) and compressor sleeve (8) from transmission housing (2).
- (12) Fold new seal rings (15) in half and hold for 10 seconds.
- (13) Install bottom race (16) and bearing (17) on hub (4).
- (14) Install two new seal rings (15) in center support hub (4).
- (15) Tighten center support anchor screw (7) to 45 lb-ft (61 N•m).

f. Follow-On Maintenance

Install fifth clutch (para 22-9).



22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance
-

INITIAL SETUP
Equipment Conditions

Center support removed (para 22-15).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Bracket, Lifting, Main Shaft (Item 13, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Drill, Electric, Portable, 1/4 In. (Item 34, Appendix E)
 Drill, Electric, Portable, 1/2 In. (Item 35, Appendix E)
 Drill, Twist, 5/8 In. (Item 36, Appendix E)
 Gage Set, Telescoping (Item 56, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Installer, Bushing (Item 77, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Reamer Set, Sun Gear Bushing (Item 126, Appendix E)
 Swaging Tool, Sun Gear (Item 187, Appendix E)
 Lifting Tool, Rear Planetary (Item 97, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)

Materials/Parts

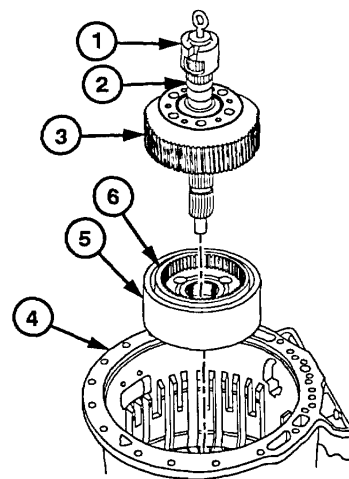
Compound, Sealing, Lubricating (Item 23, Appendix B)
 Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tag, Identification (Item 56, Appendix B)
 Pin, Spring (2) (Item 227, Appendix F)
 Spindles (6) (Item 328, Appendix F)
 Spindles (4) (item 327, Appendix F)
 Washers, Thrust (12) (Item 339, Appendix F)
 Washer, Thrust (Item 340, Appendix F)
 Washers, Thrust (8) (Item 341, Appendix F)
 Washer, Thrust (Item 342, Appendix F)
 Washer, Thrust (Item 343, Appendix F)

Personnel Required

Two

a. Removal

- (1) Install lifting bracket (1) on main shaft (2).
- (2) Remove front planetary carrier assembly (3) from transmission housing (4) while assistant operates lifting device.
- (3) Remove lifting bracket (1) from main shaft (2).
- (4) Lift planetary connecting drum (5) and front planetary ring gear (6) from transmission housing (4).



22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Backing plate is color-coded green and thicker than six steel plates.

- (5) Remove retaining ring (7), backing plate (8), six friction plates (9), and six steel plates (10) from transmission housing (4). Tie third clutch plates together and identify the pack.

- (6) Lift center planetary ring gear (11) and rear sun gear (12) from transmission housing (4).

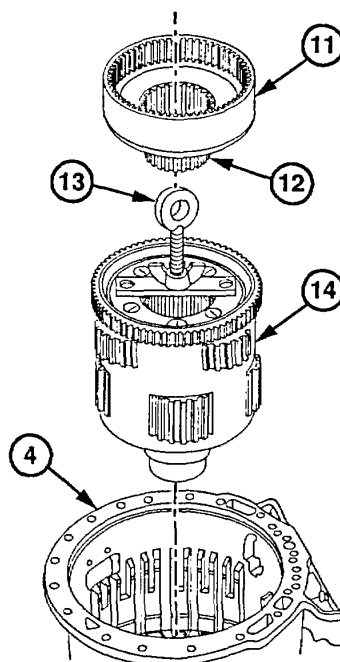
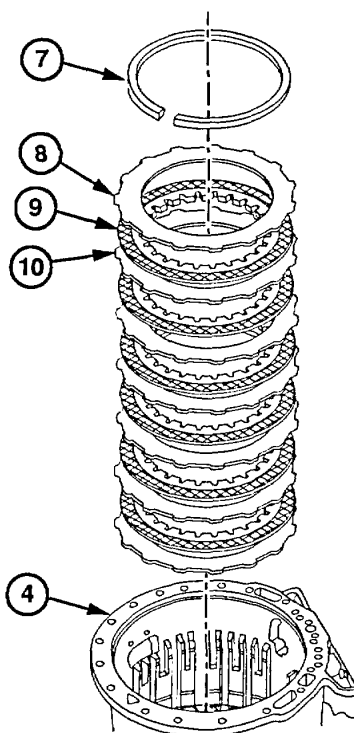
WARNING

Do not lift the rear planetary assembly by the ball bearing on the rear end. The bearing may come off and the heavy planetary may fall. Failure to comply with this warning may result in personal injury or damage to equipment.

CAUTION

Output shaft yoke must be turned while lifting rear planetary carrier assembly out of transmission housing. Failure to comply will not allow rear carrier assembly to be removed and may cause equipment damage.

- (7) Install lifting tool (13) on rear planetary carrier assembly (14) and lift assembly from transmission housing (4) with suitable lifting device.
- (8) Place rear planetary carrier assembly on flat work surface. Remove lifting tool (13).



b. Disassembly
Gear Unit and Main Shaft

- (1) Remove center sun gear shaft (1) and main shaft (2) from front carrier assembly (3).
- (2) Remove center sun gear shaft (1) from main shaft (2).
- (3) Remove thrust washer (4) from base of main shaft (2). Discard thrust washer.

NOTE

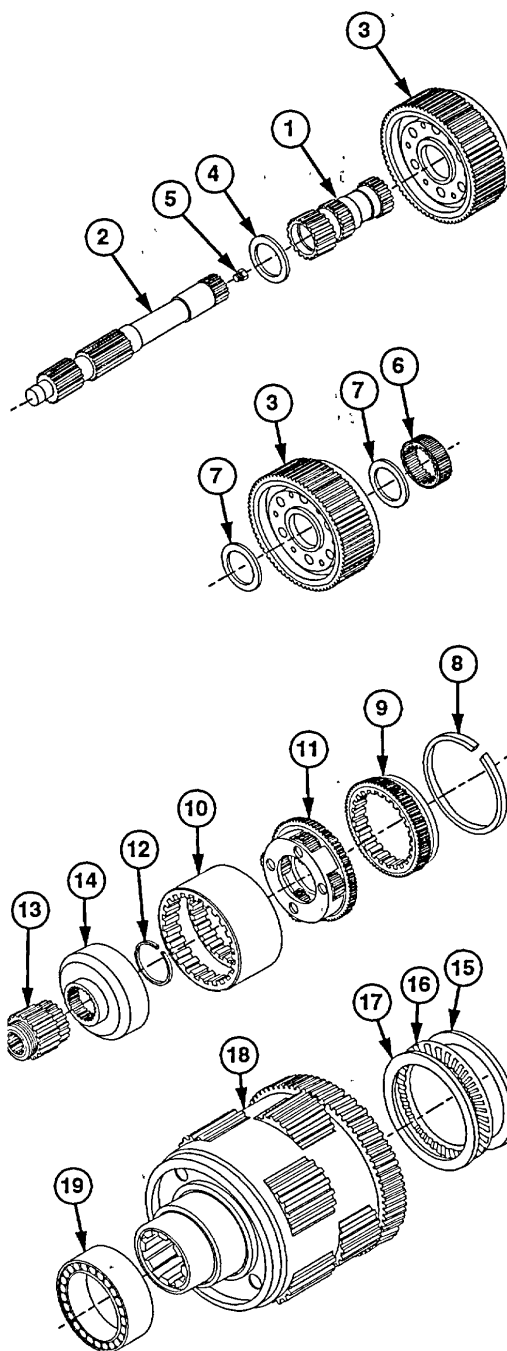
Remove lube orifice plug only if required.

- (4) Remove lube orifice plug (5) from main shaft (2).
- (5) Remove front sun gear (6) from front carrier assembly (3).
- (6) Remove two thrust washers (7) from front carrier assembly (3). Discard thrust washers.

WARNING

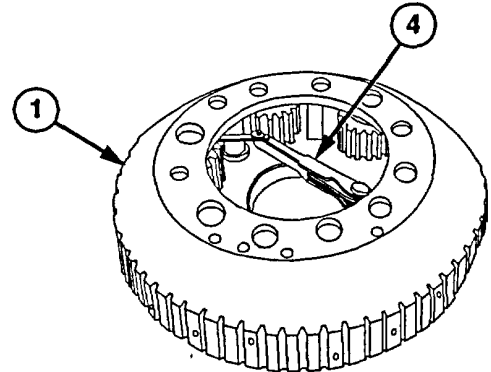
Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (7) Remove retaining ring (8) and front ring gear (9) from planetary connecting drum (10).
- (8) Remove center carrier assembly (11) from connecting drum (10).
- (9) Remove snap ring (12) from rear sun gear (13) and center ring gear (14).
- (10) Remove rear sun gear (13) from center ring gear (14).
- (11) Remove bearing race (15), bearing (16), and bearing race (17) from rear carrier assembly (18).
- (12) Remove bearing (19) from rear carrier assembly (18).



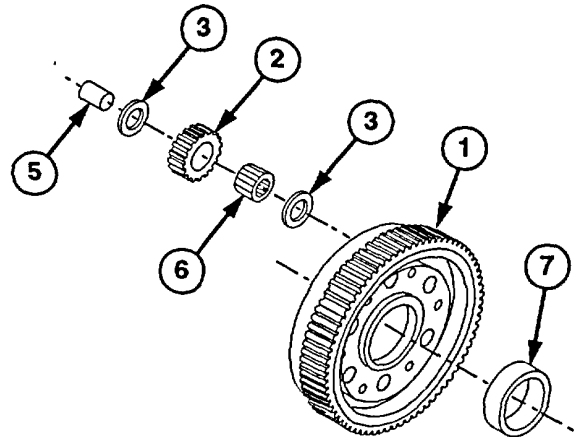
22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)**Front Carrier**

- (1) Place front carrier assembly (1) on flat work surface.
- (2) Inspect front carrier assembly (1) for excessive wear, damage, or heavy metal contamination.
- (3) Check end play of pinions (2). With thrust washer (3) held flat, insert feeler gage (4) between front carrier assembly (1) and thrust washer (3). End play must be within 0.008-0.031 in. (0.21-0.78 mm).

**NOTE**

Do steps (4) thru (10) only if end play is not within specifications.

- (4) Drill away staked ends of six spindles (5) using 5/8 in. (16 mm) bit.
- (5) Place front carrier assembly (1) in press.
- (6) Press six spindles (5) from front carrier assembly (1). Discard spindles.
- (7) Remove front carrier assembly (1) from press.
- (8) Remove 6 pinions (2) and 12 thrust washers (3) from front carrier assembly (1).
- (9) Remove six roller bearings (6) from pinions (2).

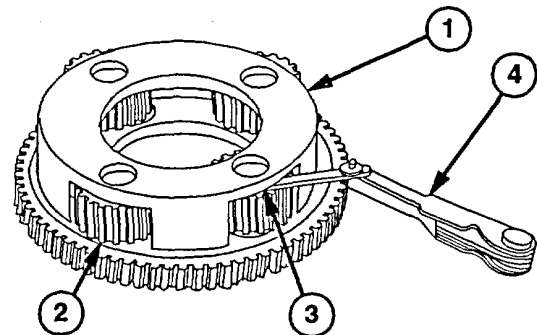
**NOTE**

Do step (10) only if bushing fails inspection.

- (10) Remove bushing (7) from front carrier assembly (1).

Center Carrier

- (1) Place center carrier assembly (1) on flat work surface.
- (2) Inspect center carrier assembly (1) for excessive wear, damage, or heavy metal contamination.
- (3) Check end play of spur gears (2). With thrust washer (3) held flat, insert feeler gage (4) between center carrier assembly (1) and thrust washer (3). End play must be within 0.008-0.031 in. (0.21-0.78 mm).



NOTE

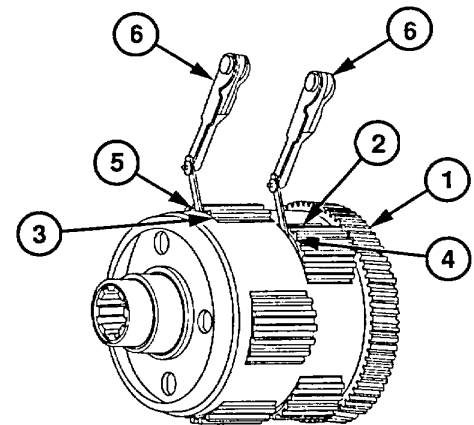
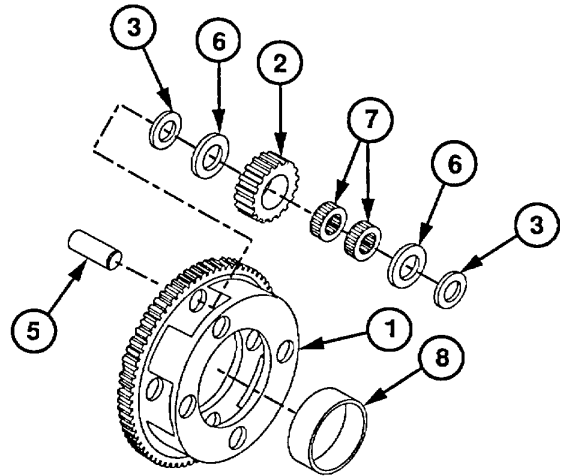
Do steps (4) thru (10) only if end play is not within specifications.

- (4) Drill away staked ends of four spindles (5) using 5/8 in. (16 mm) bit.
- (5) Place center carrier assembly (1) in press.
- (6) Press four spindles (5) from center carrier assembly (1). Discard spindles.
- (7) Remove front carrier assembly (1) from press.

NOTE

Some transmissions will have a single graphite filled polyamide thrust washer in place of the combination of bronze and steel thrust washers.

- (8) Remove four spur gears (2), eight bronze thrust washers (3), and eight steel thrust washers (6) from center carrier assembly (1).
- (9) Remove eight roller bearings (7) from pinions (2).
- (10) Remove bushing (8) from center carrier assembly (1).

**Rear Carrier**

- (1) Place rear carrier assembly (1) on flat work surface with splined hub up.
- (2) Inspect rear carrier assembly (1) for excessive wear, damage, or heavy metal contamination.
- (3) Check end play of pinions (2 and 3). With thrust washer (4 and 5) held flat, insert feeler gage (6) between rear carrier assembly (1) and thrust washers (4 and 5). End play must be within 0.008-0.031 in. (0.21-0.78 mm).

22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)**WARNING**

Wear eye protection and use care when installing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

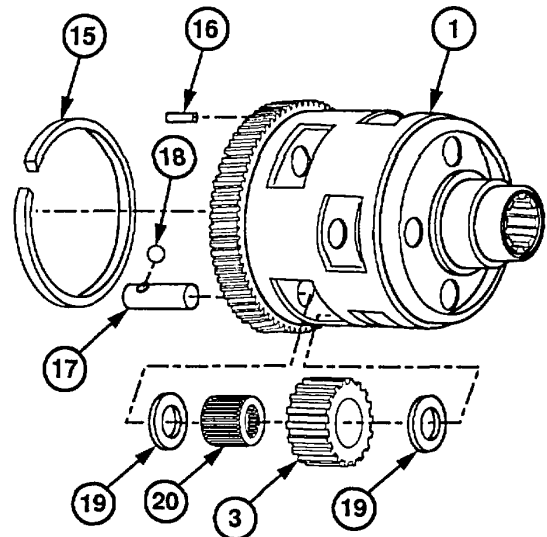
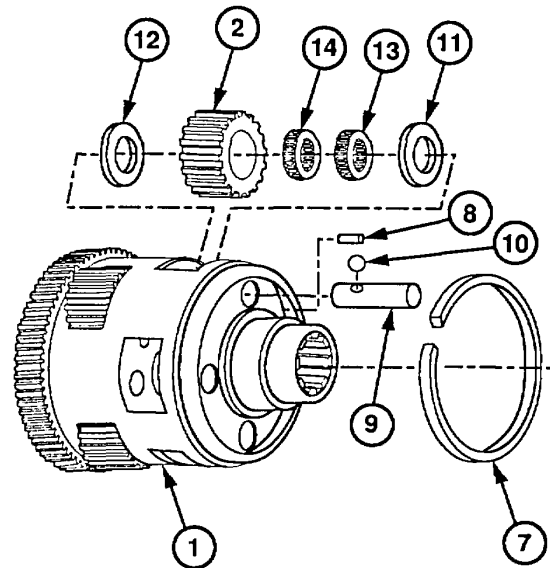
Do steps (4) thru (16) only if end play is not within specifications.

- (4) Remove snap ring (7) from rear carrier assembly (1).
- (5) Remove spring pin (8) from rear carrier assembly (1).
- (6) Place rear carrier assembly (1) in press with splined hub down.

NOTE

Balls may fall when pressing spindles. Catch balls to prevent losing them.

- (7) Press four spindles (9) with locking balls (10) from rear carrier assembly (1) using soft drift.
- (8) Remove four pinions (2), washers (11), and washers (12) from rear carrier assembly (1).
- (9) Remove four bearings (13) and bearings (14) from pinions (2).
- (10) Remove snap ring (15) from rear carrier assembly (1).
- (11) Remove spring pin (16) from rear carrier assembly (1).
- (12) Turn rear carrier assembly (1) over in press.
- (13) Press four spindles (17) with locking balls (18) from rear carrier assembly (1) using soft drift.
- (14) Remove four pinions (3) and eight washers (19) from rear carrier assembly (1).
- (15) Remove four bearings (20) from pinions (3).
- (16) Remove rear carrier assembly (1) from press.



c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-69°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

WARNING

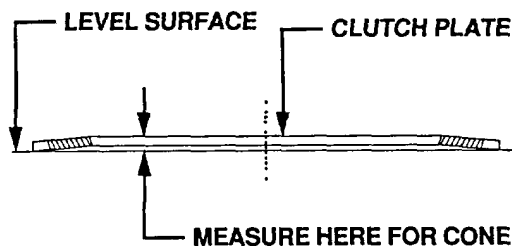
Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry metal parts with compressed air.

NOTE

All planetary gears in a carrier assembly are replaced as a set.

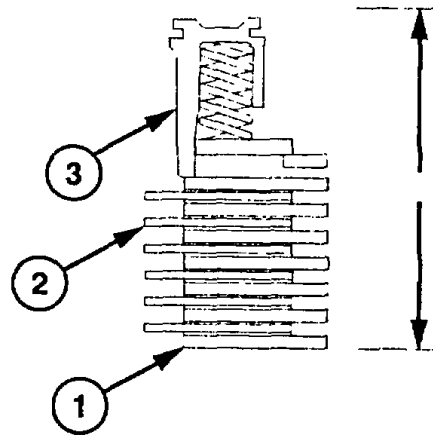
- (3) Inspect parts for damage. Replace damaged parts.
- (4) Inspect friction clutch plates (internal splined plates) for embedded metal particles, severely pitted faces, loose fittings, excessive wear, cracks, distortion, and damaged spline teeth. Replace clutch plates if any other defects are found.
- (5) Inspect steel clutch plates (external-tanged plates) for burrs, scoring, embedded metal particles, severely pitted faces, galling, excessive wear, cracks, and distortion. Remove burrs and minor surface defects using soft stone. Replace clutch plates which have any other defects.
- (6) Measure individual clutch plate thickness and cone. The amount of cone is the distance between the inside diameter and level surface.



- (a) Steel clutch plate (color-coded red): Minimum thickness 0.0933 in. (2.37 mm) Maximum cone 0.013 in. (0.33 mm)
- (b) Steel clutch plate (color-coded green): Minimum thickness 0.1161 in. (2.949 mm) Maximum cone 0.013 in. (0.33 mm)
- (c) Friction plate: Minimum thickness 0.1347 in. (3.420 mm) Maximum depth of oil grooves 0.008 in. (0.20 mm)

22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)

- (6.1) Stack eight steel plates (1) and seven friction plates (2) on flat surface of suitable hydraulic press, starting with a steel plate and alternating with a friction plate.
- (6.2) Place third clutch piston (3) on top of clutch plates (1 and 2).
- (6.3) Press evenly on third clutch piston (3) with 100 psi load.
- (6.4) Measure distance from base of clutch plates (1 and 2) to top of third clutch piston (3).
- (6.5) From Table 22-3, select the proper steel plate combination to obtain 3.20143.1794 in. (81.3280.76 mm) height. Tie these parts together and tag for subsequent assembly.

**Table 22-3. Third Clutch Pack Height**

FROM	TO	PLATE 6834488	PLATE 6834720
3.2280	3.2147	ADD 2	REMOVE 2
3.2147	3.2014	ADD 1	REMOVE 1
3.2014	3.1794	-	-
3.1794	3.1661	REMOVE 1	ADD 1
3.1661	3.1528	REMOVE 2	ADD 2

NOTE

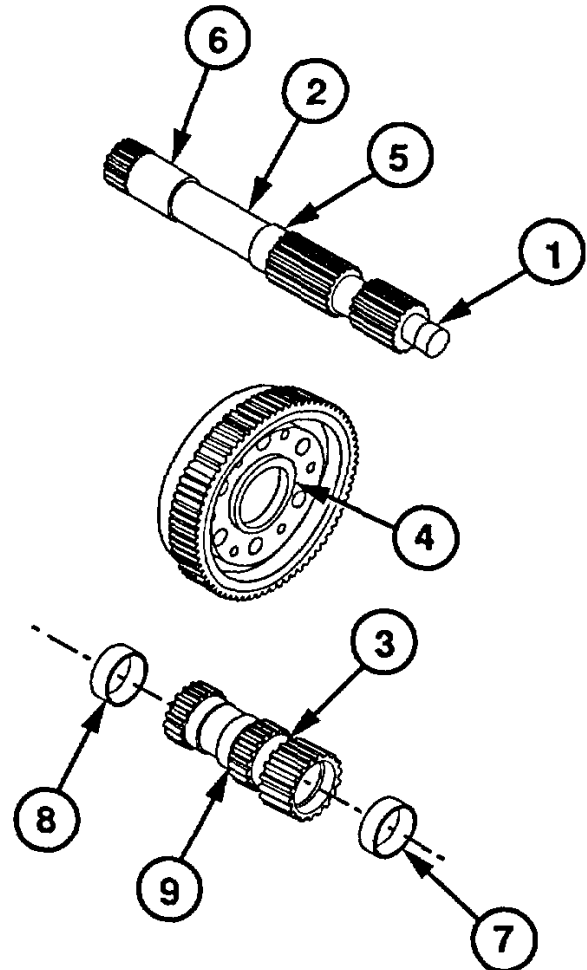
Shaft bushing surface measurement will be used in paragraph 22-17 to find output shaft bushing clearance.

- (7) Measure and note diameter of shaft bushing surface (1) of main shaft (2).
- (8) Measure diameter of front carrier bushing surface (3).
- (9) Measure inside diameter of bushing (4).
- (10) If bushing (4) to front carrier bushing surface (3) clearance is greater than 0.0072 in. (0.18 mm), replace bushing.
- (10.1) Inspect surface finish of bearing surfaces (5 and 6) on main shaft (2). Replace main shaft if any defects are found.
- (11) Measure diameter of bushing surfaces (5 and 6) on main shaft.
- (12) Measure inside diameter of bushings (7 and 8) in sun gear shaft (9).

NOTE

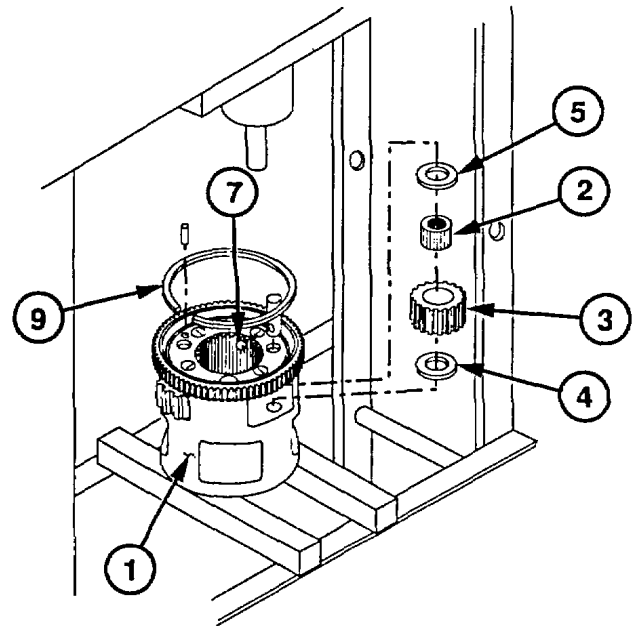
Bushings can be easily removed once collapsed. Use of a small punch thru the swaging hole will collapse the forward bushing. A small chisel between the shaft and the bushing outside edge can be used to collapse the rear bushing.

- (13) If clearance between bushings (7 and 8) and shaft bushing surfaces (2 and 5) is more than 0.0064 in. (0.16 mm), remove bushings.
- (14) Inspect both ends of sun gear shaft (9) for spline damage and cracks. Inspect shaft inside diameter for scoring and metal transfer. Replace sun gear shaft if any defects are found.



22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)**d. Assembly****Rear Carrier**

- (1) Position rear carrier assembly (1) in press.
- (2) Install bearing (2) in pinion (3).
- (3) Place new thrust washers (4 and 5) on opposite ends of pinion (3).
- (4) Place pinion (3) with bearing (2) and washers (4 and 5) in slot at splined end of carrier (1).
- (5) Insert spindle (6) with locking ball (7) in bore through washers, pinion, and bearings. Align locking ball with slot in carrier (1) and press spindle until it seats.
- (6) Repeat steps (1) thru (5) to install remaining three spindles and associated parts.
- (7) Press new spring pin (8) in hole 0.330-0.370 in. (8.38-9.40 mm) above the face of carrier.

**WARNING**

Wear eye protection and use care when installing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (8) Install spindle retaining snap ring (9) in groove in carrier (1).

- (9) Turn rear carrier assembly (1) over in press.

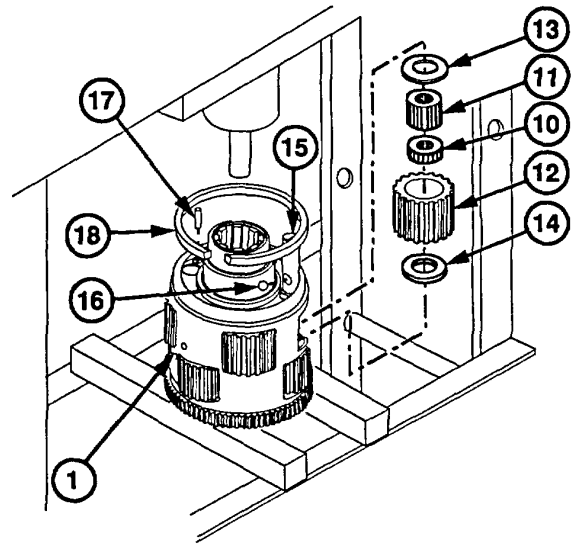
CAUTION

Short bearing must be toward front end of carrier to align with lubrication holes in spindle pin.

NOTE

Bearings (10 and 11) are different, thrust washers (13 and 14) are the same.

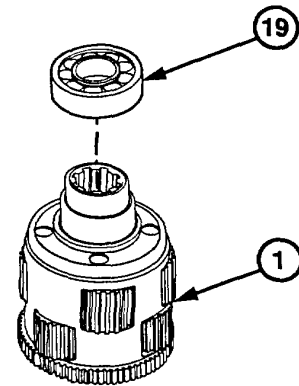
- (10) Install bearing (10) and bearing (11) in pinion (12).
- (11) Place new thrust washers (13 and 14) on ends of pinion (12).
- (12) Place pinion (12) with washers (13 and 14) and bearings (10 and 11) in their location in slot at rear end of carrier (1).
- (13) Insert spindle (15) with locking ball (16) in bore through washers, pinion, and bearings. Align locking ball with slot in carrier (1) and press spindle until it seats.
- (14) Repeat steps (9) thru (13) to install remaining three spindles and associated parts.
- (15) Press new spring pin (17) in hole 0.330-0.370 in. (8.38-9.40 mm) above the face of carrier.



WARNING

Wear eye protection and use care when installing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (16) Install spindle retaining snap ring (18) in groove in carrier (1).
- (17) Install bearing (19) on rear carrier assembly (1).



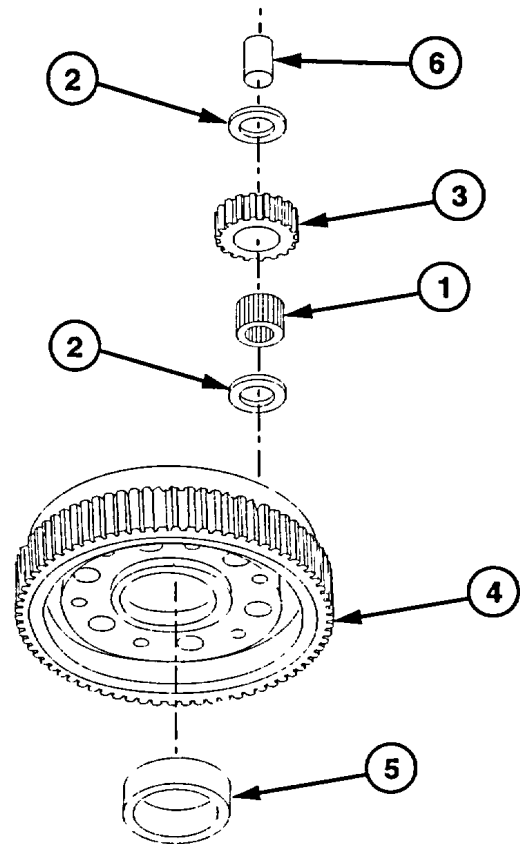
22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)**Front Carrier**

- (1) Coat four roller bearings (1) and eight new black thrust washers (2) with lubricating oil.
- (2) Install thrust washer (2) on each end of four pinions (3).

NOTE

Do step (3) only if bushing was removed.

- (3) Position front carrier assembly (4) rear end up. Install bushing (5).
- (4) Install two thrust washers (2), roller bearing (1), and pinion (3) in front carrier assembly (4), aligning loading pins with pin bores in carrier (4).
- (5) Press spindles (6) in carrier until both ends of spindle are equal.
- (6) Repeat steps (4) and (5) for other five pinions.
- (7) Remove carrier (4) from press and stake both ends of spindles (6) in four places.

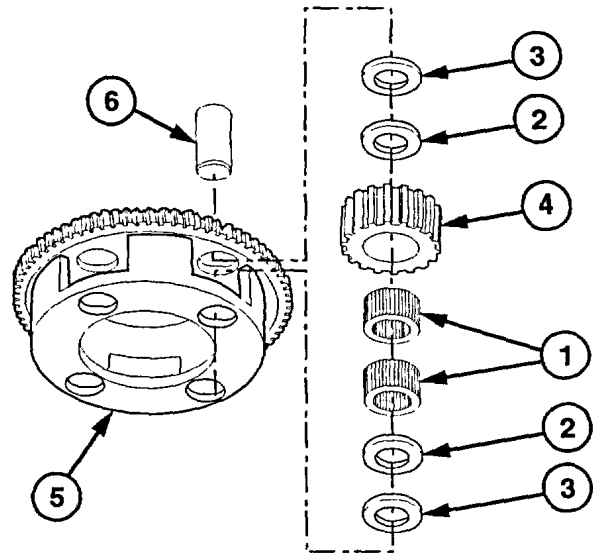


Center Carrier

NOTE

Some transmissions and service parts will have a single graphite filled polyamide thrust washer in place of the combination of bronze and steel thrust washers.

- (1) Coat eight roller bearings (1), new steel thrust washers (2), and new bronze thrust washers (3) with lubricating oil.
- (2) Install steel thrust washer (2) on each end of four spur gears (4).
- (3) Install bronze thrust washer (3) on each steel thrust washer (2).
- (4) Position center carrier (5) front end up. Install thrust washers (2 and 3), two roller bearings (1), and spur gear (4) in center carrier assembly, aligning loading pins with pin bores in carrier (5).
- (5) Press spindles (6) in carrier until both ends of spindle are equal.
- (6) Repeat steps (4) and (5) for other three pinions.
- (7) Remove carrier (5) from press and stake both ends of spindles (6) in four places.



WARNING

Sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

- (8) Coat bushings (13 and 14) with sealing compound.
- (9) Position bushing (13) at bore of small end of sun gear shaft (15). Align interlock split so bushing is more than 45 degrees from swaging hole in sun gear shaft.
- (10) Press in bushing (13) using end of bushing installer tool (16) marked 0.360.
- (11) Install bushing (14) in larger end of sun gear shaft (15) using end of bushing installer tool (16) marked 0260. Align interlock split so bushing is more than 45 degrees from swaging hole in sun gear shaft.
- (12) Push both bushings (13 and 14) in swaging holes of sun gear shaft assembly (15) using swaging tool (17).

NOTE

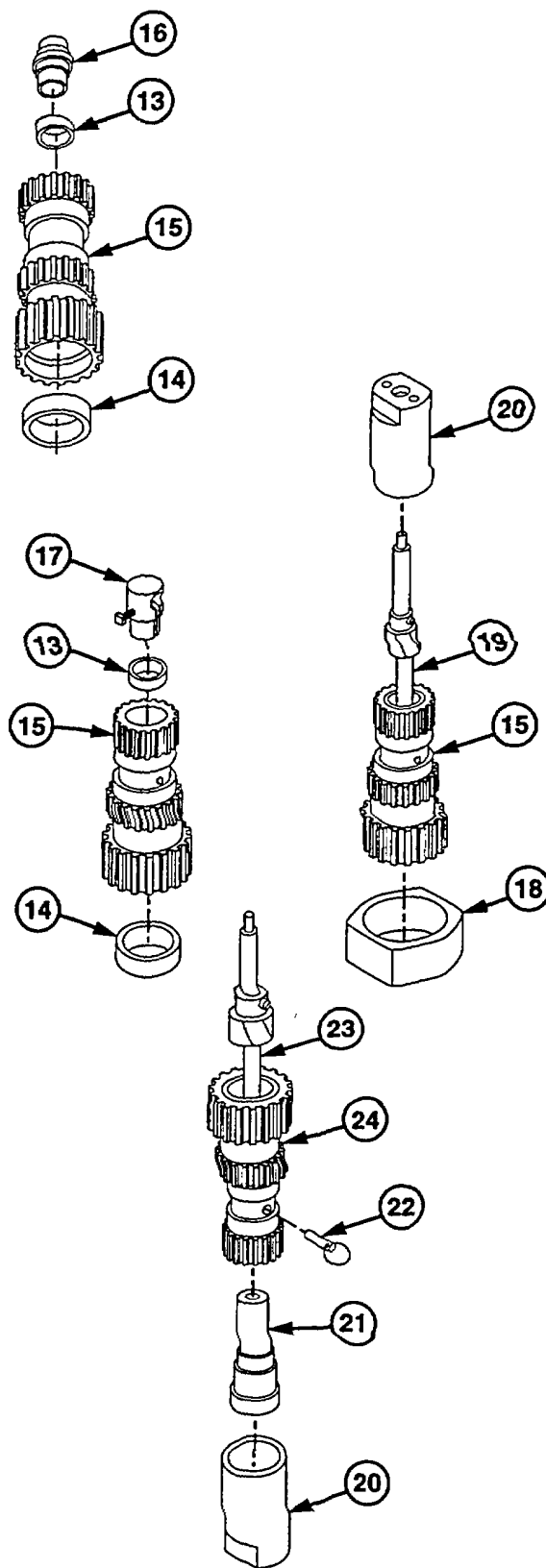
Bushing PN 6835323 requires machining before final assembly, continue with step (13). Bushing PN 29506041 is pre-bored and does not require machining, continue with Gear Unit and Main Shaft assembly.

- (13) Clamp holding fixture (18) in vise. Set sun gear shaft (15) in holding fixture with small end up. Position sun gear bushing reamer (19) and pilot tool (20) in sun gear shaft (15).

CAUTION

Keep reamer rotating at full drill speed when pulling back through bushing. If reamer is not rotating at full drill speed, bushing could be damaged.

- (14) Machine bushing at approximately 75 to 150 rpm while adding oil through either hole on top of pilot tool (20) using 1/2 in. (13 mm) electric drill.
- (15) Clamp pilot tool (20) in vise. Insert bushing pilot tool (21) in small end of sun gear shaft (15) and hold with locking pin (22). Position bushing pilot tool (21) in pilot tool (20), and position reamer and shaft assembly (23) in sun gear shaft.



22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)

- (16) Engage shaft of reamer and shaft assembly (23) with pilot tool (20).
- (17) Machine bushing at approximately 75 to 150, rpm while adding lubricating oil in bore at sides of sun gear shaft (15) using 1/2 in. (13 mm) electric drill.
- (18) Check inner diameter of bushings for runout. Runout must not exceed 0.002 in. (0.05 mm) total indicator reading. Surface finish should be 30 microinch (0.762 micrometer).
- (19) Thoroughly clean sun gear shaft (15) of chips and debris.

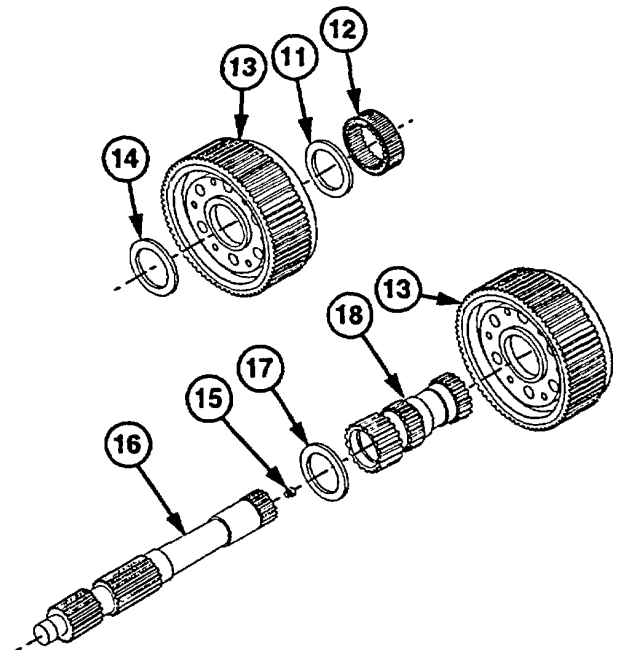
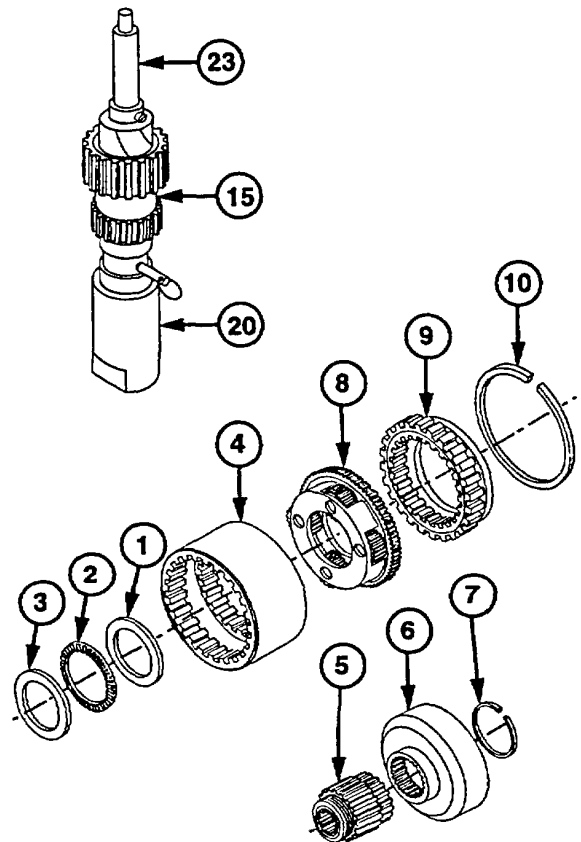
Gear Unit and Main Shaft

- (1) Install larger bearing race (1), bearing (2), and smaller bearing race (3) in connecting drum (4).

WARNING

Wear eye protection and use care when installing snap rings. Snap rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (2) Install rear sun gear (5) on center ring gear (6) and install snap ring (7).
- (3) Install center carrier assembly (8) in connecting drum (4).
- (4) Install front ring gear (9) and retaining ring (10) in connecting drum (4).
- (5) Install thrust washer (11) and front sun gear (12) on front carrier assembly (13).
- (6) Coat thrust washer (14) with grease and install on front carrier assembly (13).
- (7) Install lube orifice plug (15) on large end of main shaft (16).
- (8) Install thrust washer (17) on base of main shaft (16).
- (9) Install center sun gear shaft (18) on main shaft (16).
- (10) Install center sun gear (18) and main shaft (16) on front carrier assembly (13).

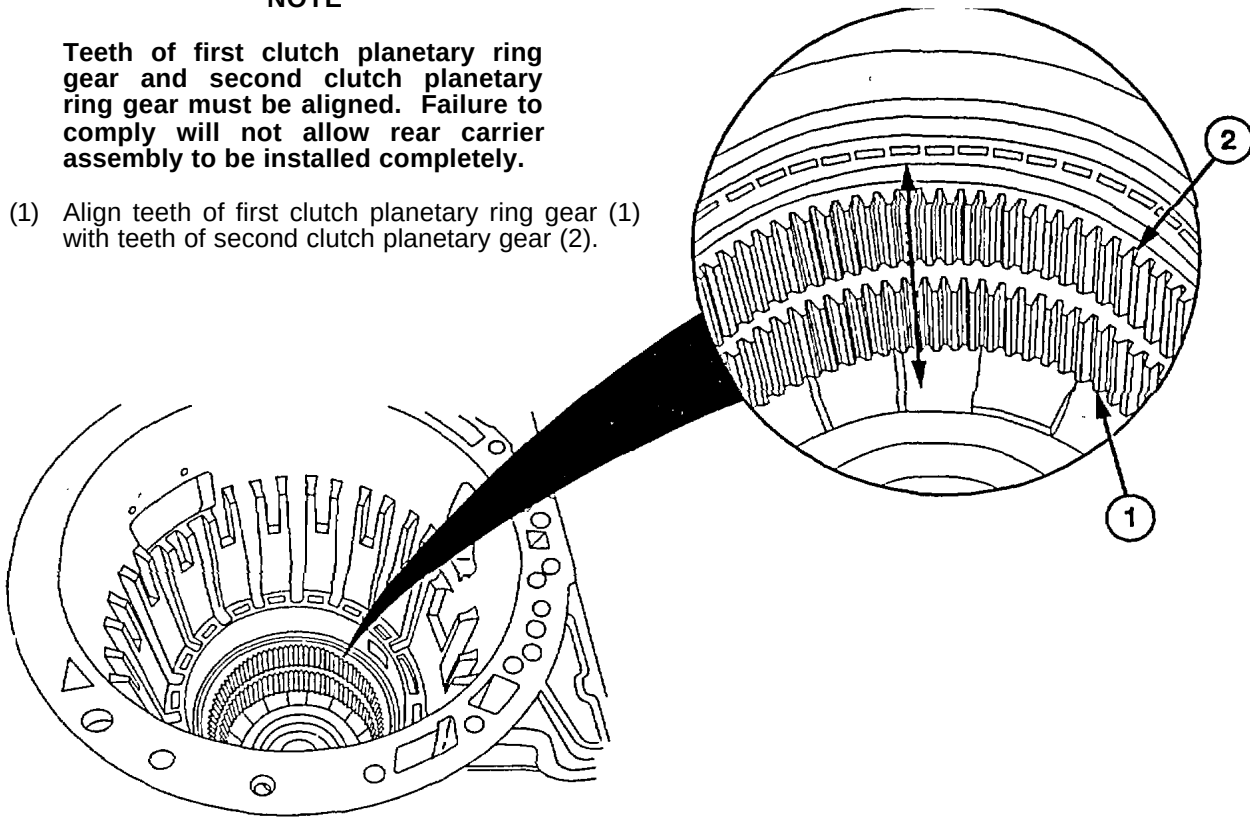


e. Installation

NOTE

Teeth of first clutch planetary ring gear and second clutch planetary ring gear must be aligned. Failure to comply will not allow rear carrier assembly to be installed completely.

- (1) Align teeth of first clutch planetary ring gear (1) with teeth of second clutch planetary gear (2).

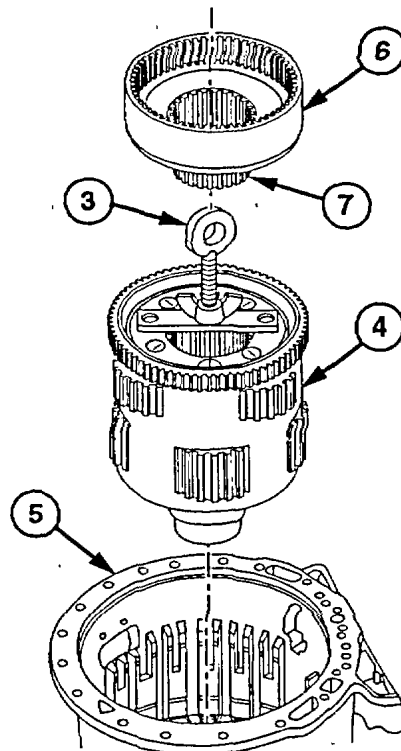
**WARNING**

Planetary is heavy. Do not lift rear planetary assembly by ball bearing on rear end. Bearing may come off causing planetary to fall. Failure to comply may result in personnel injury or damage to equipment.

NOTE

Output shaft yoke must be turned while lowering rear planetary carrier assembly into first clutch planetary ring gear. Failure to comply will not allow rear carrier assembly to be installed completely.

- (2) Install lifting tool (3) on rear carrier assembly (4) and install in transmission housing (5) with suitable lifting device. Remove lifting tool from rear carrier assembly.
- (3) Install center planetary ring gear (6) and rear sun gear (7) in transmission housing (5).



22-16. PLANETARY GEARING, SHAFTS, AND THIRD CLUTCH REPAIR (CONT)

- (4) Install six steel plates (8) and six friction plates (9) in transmission housing (5).

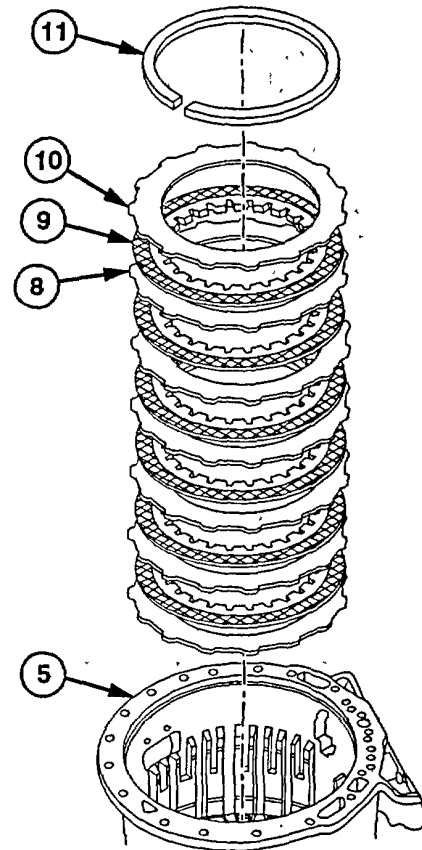
WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

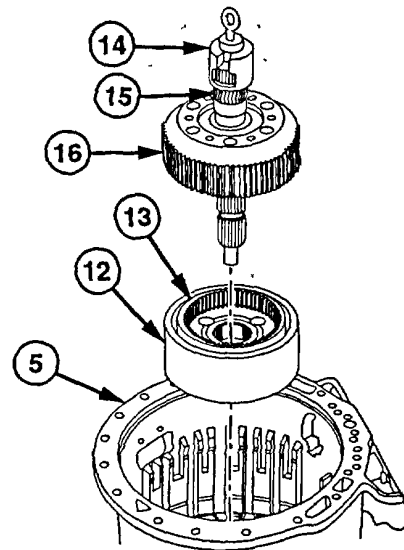
NOTE

Backing plate is color-coded green and thicker than six steel plates.

- (5) Install backing plate (10) and retaining ring (11) in transmission housing (5).



- (6) Install planetary connecting drum (12) and front planetary ring gear (13) in transmission housing (5).
- (7) Install lifting bracket (14) on main shaft (15).
- (8) Install front planetary carrier assembly (16) in transmission housing (5) while assistant operates lifting device.
- (9) Remove lifting bracket (14) from main shaft (15).

**f. Follow-On Maintenance**

Install center support (para 22-15).

22-17. REAR COVER AND FIRST CLUTCH REPAIR

This task covers:

- a. Removal
- b. Disassembly
- c. Cleaning/inspection
- d. Assembly
- e. Installation
- f. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

- Governor removed (para 7-6).
- Planetary gears removed (para 22-16).

Tools and Special Tools

- Tool Kit, Genl Mech (Item 202, Appendix E)
- Blocks, Wooden (Figure C-3, Appendix C)
- Caliper Set, Micrometer (item 15, Appendix E)
- Compressor Set, Clutch Spring (Item 22, Appendix E)
- Goggles, Industrial (Item 57, Appendix E)
- Handle, Driver (Item 66, Appendix E)
- Handle, Driver (Item 67, Appendix E)
- Installer, Bearing (Item 75, Appendix E)
- Installer, Oil Seal Output (Item 81, Appendix E)
- Installer, Output Shaft Bearing (Item 82, Appendix E)
- Multiplier, Torque (Item 99, Appendix E)
- Protector, Seal (Item 119, Appendix E)
- Sling, Endless Strap (Item 161, Appendix E)
- Socket, 3-1/8 In. (Item 162, Appendix E)
- Tester, Spring (item 190, Appendix E)

Tools and Special Tools (Cont)

- Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
- Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

- Compound, Retaining (Item 22, Appendix B)
- Compound, Sealing, Pipe Thread (Item 28, Appendix B)
- Grease, High Temperature (Item 34.1, Appendix B)
- Oil, Lubricating (Item 44, Appendix B)
- Solvent, Dry Cleaning (Item 54, Appendix B)
- Gasket (Item 59, Appendix F)
- Lockwashers (24) (Item 122, Appendix F)
- Nut (Item 148, Appendix F)
- Ring, Seal (Item 266, Appendix F)
- Ring, Seal (Item 268, Appendix F)
- Seal, Oil (Item 315, Appendix F)

Personnel Required

Two

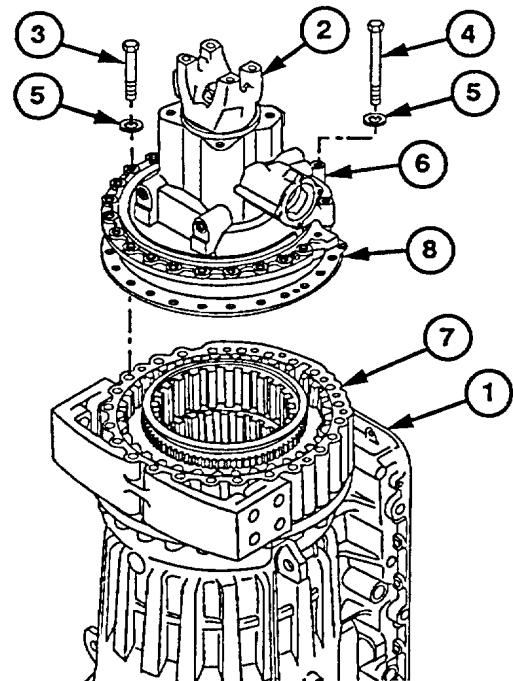
a. Removal

- (1) Position transmission assembly (1) so yoke (2) is pointing up.
- (2) Remove 21 screws (3), 3 screws (4), and 24 lockwashers (5) from rear cover (6) and adapter housing (7). Discard lockwashers.
- (3) install lifting device on yoke (2).
- (4) Remove and guide rear cover (6) away from adapter housing (7) while assistant operates lifting device.
- (5) Place rear cover (6) on clean work surface.
- (6) Remove lifting device from yoke (2).

NOTE

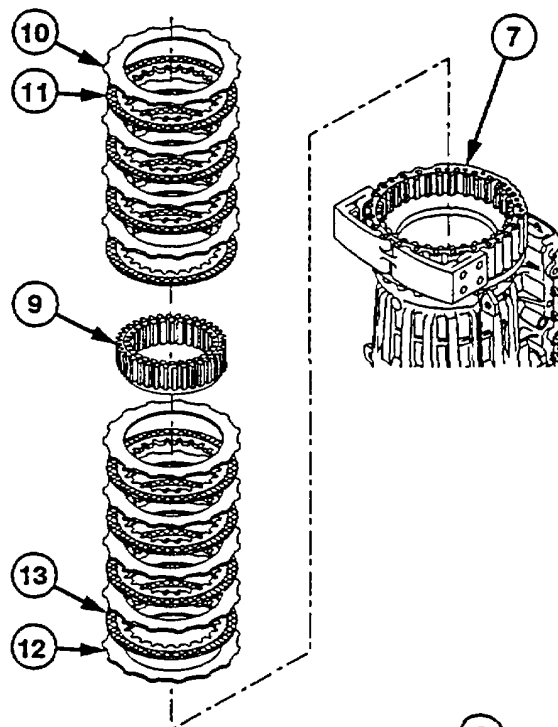
Gasket may stay on rear cover or adapter housing.

- (7) Remove gasket (8) from either rear cover (6) or adapter housing (7). Discard gasket.

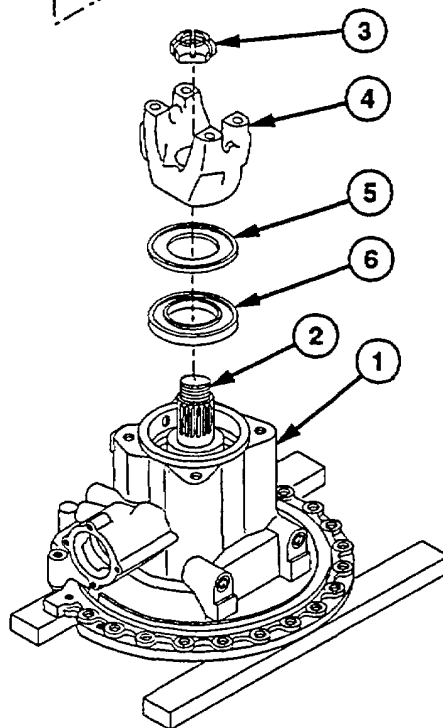


22-17. REAR COVER AND FIRST CLUTCH REPAIR (CONT)

- (8) Remove ring gear (9) with four steel plates (10) and four friction plates (11) from adapter housing (7).
- (9) Remove five steel plates (12) and four friction plates (13) from adapter housing (7).

**b. Disassembly**

- (1) Position rear cover (1) on wooden blocks so output shaft (2) is pointing up.
- (2) Remove nut (3) and yoke (4) from output shaft (2). Discard nut (3). Remove dust shield (5) and oil seal (6) from rear cover (1). Discard oil seal.



WARNING

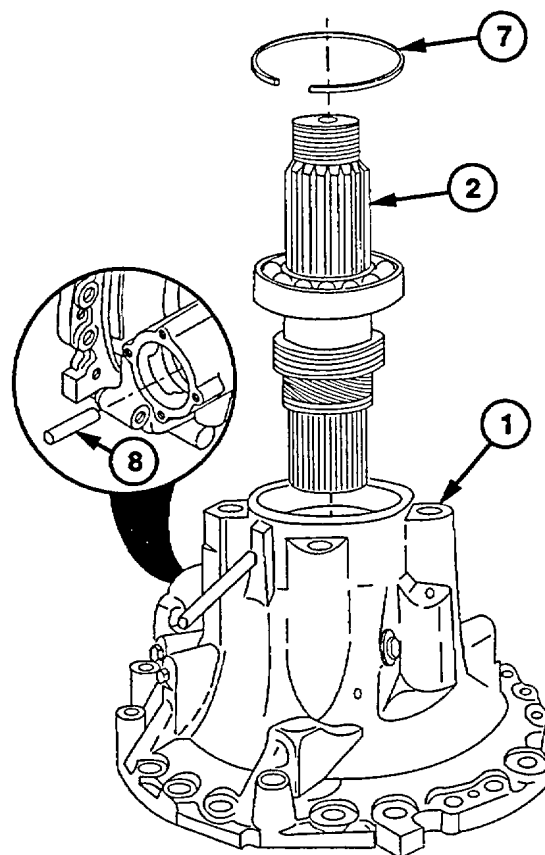
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (4) Remove retaining ring (7) from rear cover (1).
- (5) Remove output shaft (2) from rear cover (1).

NOTE

Do step (6) only if governor support pin is damaged.

- (6) Remove governor support pin (8) from rear cover (1).

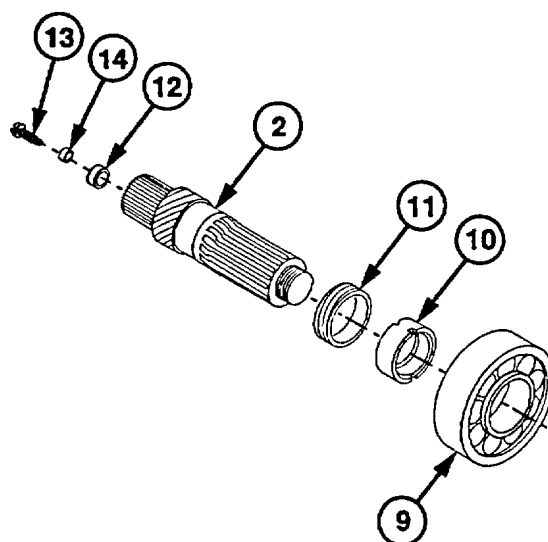


- (7) Press output shaft (2) from bearing (9).
- (8) Remove spacer (10) and speedometer drive gear (11) from output shaft (2).

NOTE

Transmissions with a serial number lower than 251017042 have a roller bearing; serial numbers of 251017042 or higher have a bushing. Both shaft assemblies are completely interchangeable.

- (9) Remove roller bearing (12) from output shaft (2).
- (10) Thread long screw (13) into small orifice plug (14). Pry up on screw to remove plug.



22-17. REAR COVER AND FIRST CLUTCH REPAIR (CONT)

- (11) Position rear cover (1) flange side up. Use wooden block for support.
- (12) Install clutch spring compressor tool (15) in rear cover (1).

WARNING

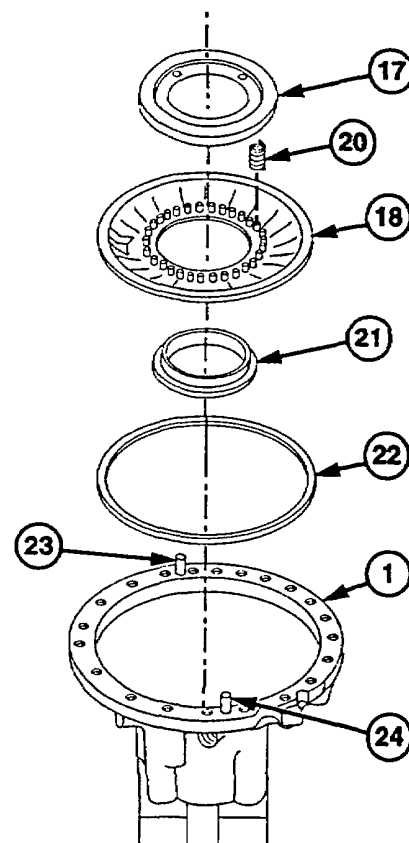
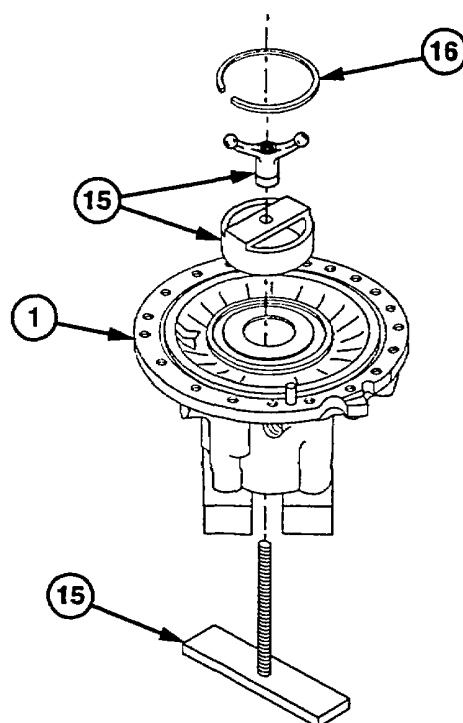
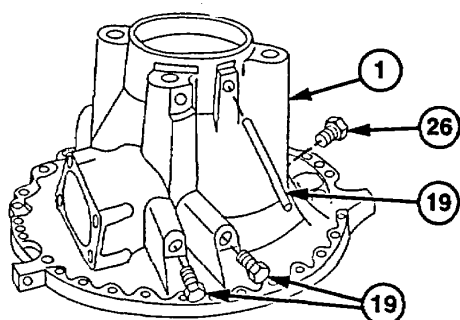
Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (13) Compress clutch spring compressor tool and remove large external retaining ring (16) from rear cover (1).
- (14) Remove clutch spring compressor tool (15) from rear cover (1).
- (15) Remove piston spring retainer (17) from first clutch piston (18).
- (16) Remove vent tube (19) from rear cover (1).
- (17) Remove 30 piston release springs (20) from first clutch piston (18).
- (18) Remove first clutch piston (18) from rear cover (1).
- (19) Remove inner seal ring (21) and outer seal ring (22) from rear cover (1). Discard seal rings.

NOTE

Do step (20) only if dowel pins are damaged.

- (20) Remove dowel pins (23 and 24) from rear cover (1).
- (21) Remove two small plugs (25) and large plug (26) from rear cover (1).



c. Cleaning/Inspection

WARNING

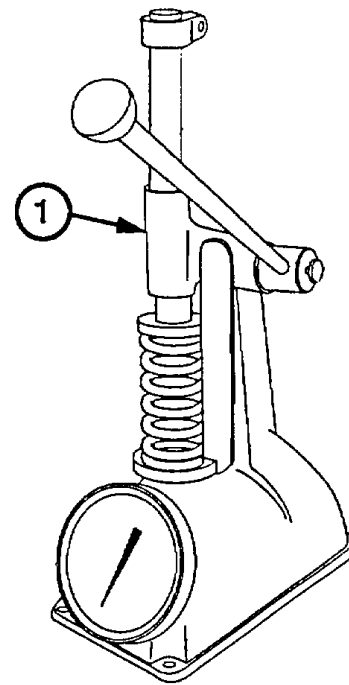
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.
- (2) Inspect all parts for burrs, scratches, and pitting. Remove defects.
- (3) Inspect all parts for missing or broken splines or teeth. Replace all damaged parts.

NOTE

Do step (4) for piston release springs coded light blue. Do step (5) for piston release springs coded light green.

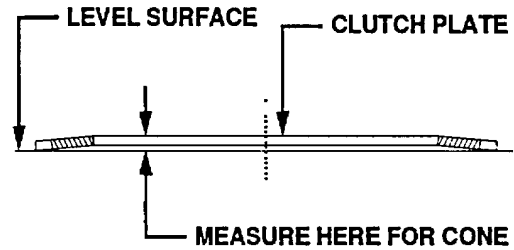
- (4) Measure piston release spring lengths using spring tester (1). Replace piston release springs if any three of each set do not meet the following load-height requirements:
 - (a) Length without load must be at least 1.31 in. (33.3 mm).
 - (b) Length under load must be at least 0.90 in. (22.9 mm) with a load of 26-28 lb (11.8-12.7 kg).
- (5) Measure piston release spring lengths using spring tester (1). Replace piston release springs if any three of each set do not meet the following load-height requirements:
 - (a) Length without load must be at least 1.29 in. (32.7 mm).
 - (b) Length under load must be at least 0.82 in. (20.8 mm) with a load of 4.3-5.7 lb (2-2.6 kg).



22-17. REAR COVER AND FIRST CLUTCH REPAIR (CONT)

(5.1) Measure individual clutch plate thickness and cone. The amount of cone is the distance between the inside diameter and a level surface.

- (a) Steel clutch plate (color-coded red):
Minimum thickness 0.0933 in.
(2.522 mm) Maximum cone 0.013
in. (0.33 mm)
- (b) Steel clutch plate (color-coded
green): Minimum thickness 0.1161
in. (2.948 mm) Maximum cone
0.013 in. (0.33 mm)
- (c) Friction plate: Minimum thickness
0.1347 in. (3.420 mm) Maximum
depth of oil grooves 0.008 in. (0.20
mm)



- (6) Stack nine steel plates (2) and eight friction plates (3) on flat surface of suitable hydraulic press, starting with steel plate and alternating with friction plate.
- (7) Place first clutch piston (4) on top of clutch plates (2 and 3).
- (8) Press evenly on first clutch piston (4) with 100 psi load.
- (9) Measure distance from base of clutch plates (2 and 3) to thrust pad (5).
- (10) From Table 22-4, select the proper steel plate combination to obtain 3.0964-3.0744 in. (78.65-78.09 mm) height (6). Tie these parts together and tag for subsequent assembly.

NOTE

There are two thickness' of steel plates.

- (11) Measure thickness of one tang (7) on each of seven steel plates (2). Thin plates should measure 0.096-0.103 in. (2.44-2.62 mm). Thick plates should measure 0.116-0.123 in. (2.95-3.12 mm).
- (12) Replace friction plate if thickness is less than 0.1347 in. (3.421 mm).
- (13) Repeat steps (4) thru (10) to recheck first clutch thickness.
- (14) Check friction plate for presence of oil grooves.
- (15) Remove first clutch piston (4), steel plates (2), and friction plates (3) from press.

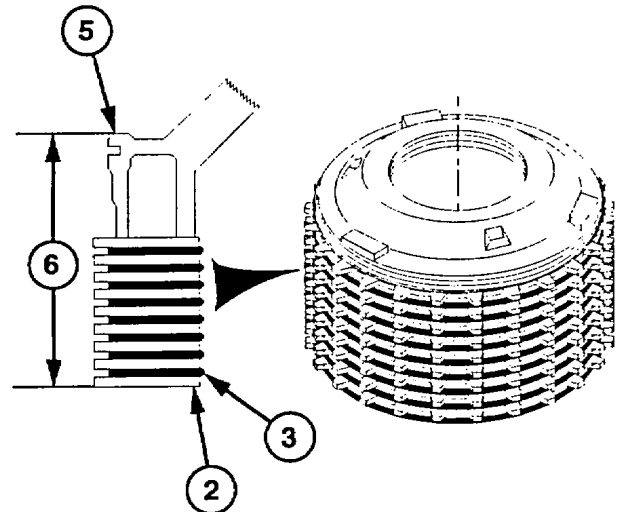
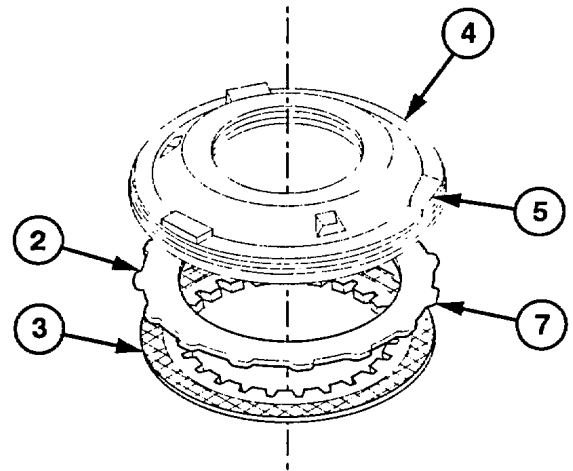


Table 22-4. First Clutch Pack Height

FROM	TO	PLATE 23047771	PLATE 23047772
3.1363	3.1230	ADD 3	REMOVE 3
3.1230	3.1097	ADD 2	REMOVE 2
3.1097	3.0964	ADD 1	REMOVE 1
3.0964	3.0744	-	-
3.0744	3.0611	REMOVE 1	ADD 1
3.0611	3.0478	REMOVE 2	ADD 2
3.0478	3.0345	REMOVE 3	ADD 3

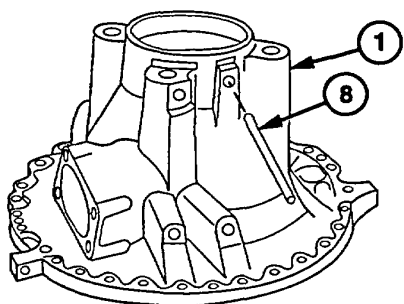
d. Assembly

- (1) Position rear cover (1) flange side up. Use wooden block for support.
- (2) Coat new inner seal ring (2) and new outer seal ring (3) with lubricating oil.
- (3) Install new inner seal ring (2) and new outer seal ring (3) on first clutch piston (4) with lips facing down.
- (4) Install first clutch piston (4) in rear cover (1) using seal protector (5).

NOTE

Do step (5) only if dowel pins were removed.

- (5) Install two dowel pins (6 and 7) in rear cover (1).
- (6) Install vent tube (8) on rear cover (1).

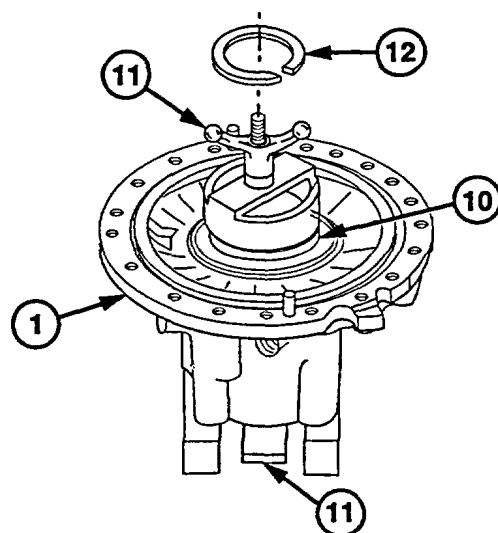
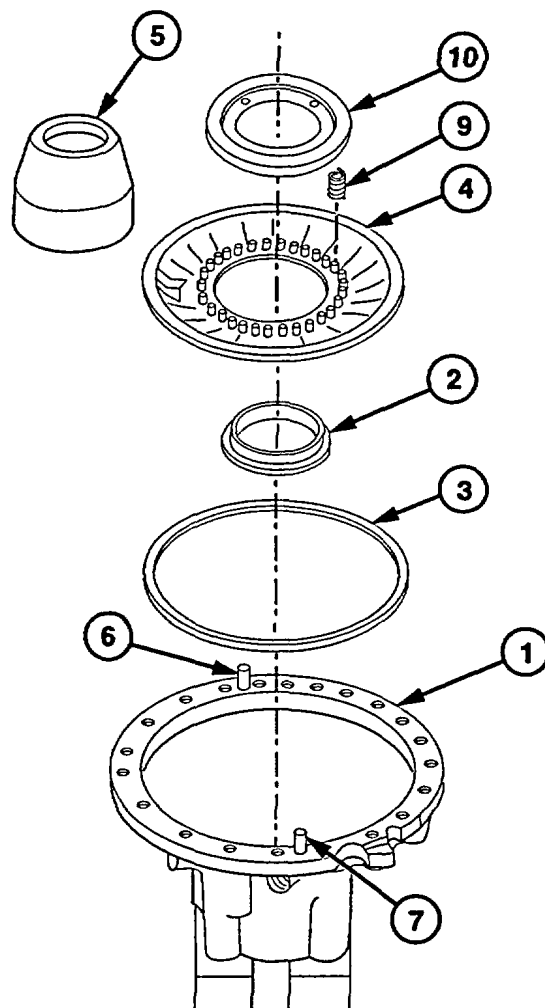


- (7) Install 30 piston release springs (9) in first clutch piston (4).
- (8) Install piston spring retainer (10) on piston release springs (9).
- (9) Push down on piston spring retainer (10) and piston release springs (9) using clutch spring compressor tool (11). Press until retaining ring groove in rear cover (1) is cleared.

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (10) Install retaining ring (12). Remove clutch spring compressor tool (11).



22-17. REAR COVER AND FIRST CLUTCH REPAIR (CONT)

- (11) Position rear cover (1) on side with governor support pin access hole facing down. Use wooden block for support.

- (12) Install orifice plug (13) in output shaft (14).

CAUTION

A roller bearing must be pressed back into a shaft that had a bearing, and a bushing must be pressed back into a shaft that had a bushing.

- (13) Coat output shaft roller bearing (15) with retaining compound.

- (14) Install output shaft roller bearing (15) in output shaft (14) using output shaft roller bearing installer tool (16) and driver handle (Item 66, Appendix E) (17).

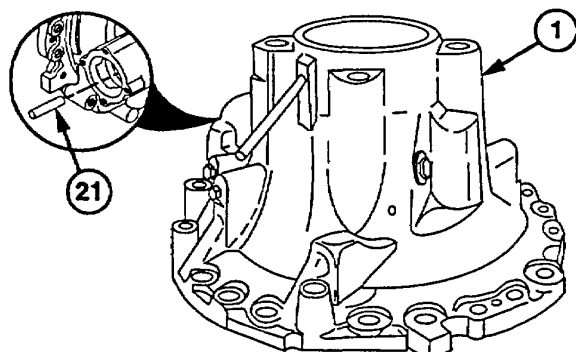
- (15) Install speedometer drive gear (18) and spacer (19) on output shaft (14).

- (16) Press bearing (20) on output shaft (14).

NOTE

Do step (17) only if governor support pin was removed.

- (17) Install governor support pin (21) in rear cover (1) if removed.



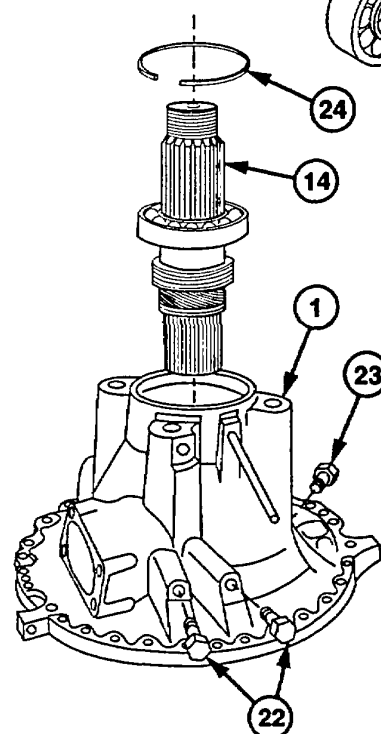
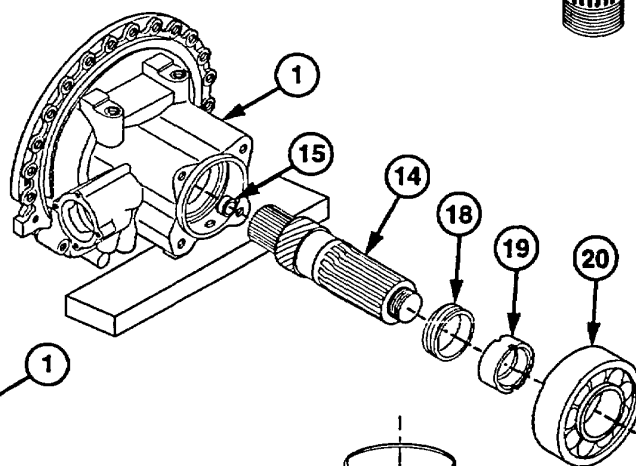
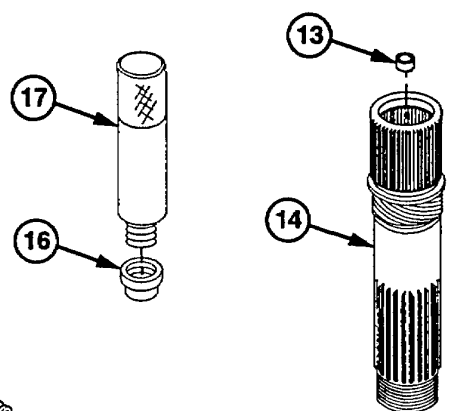
- (18) Coat threads of two small plugs (22) and install in rear cover (1).

- (19) Install large plug (23) in rear cover (1).

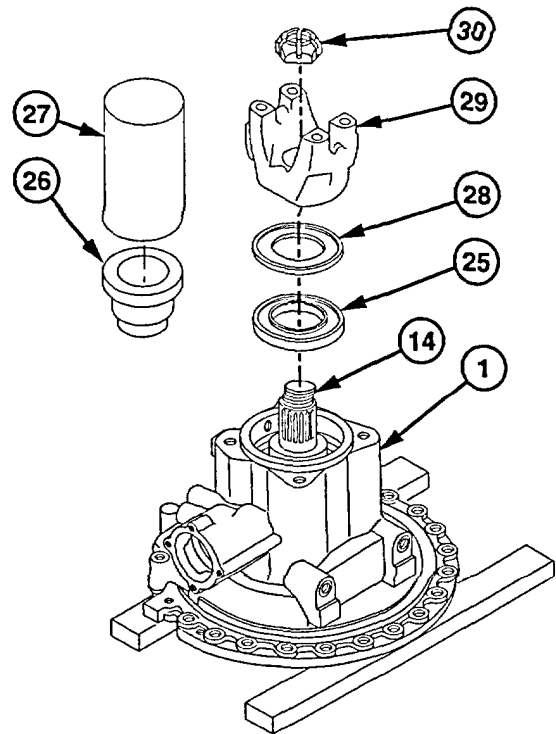
WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (20) Install output shaft (14) and retaining ring (24) in rear cover (1).

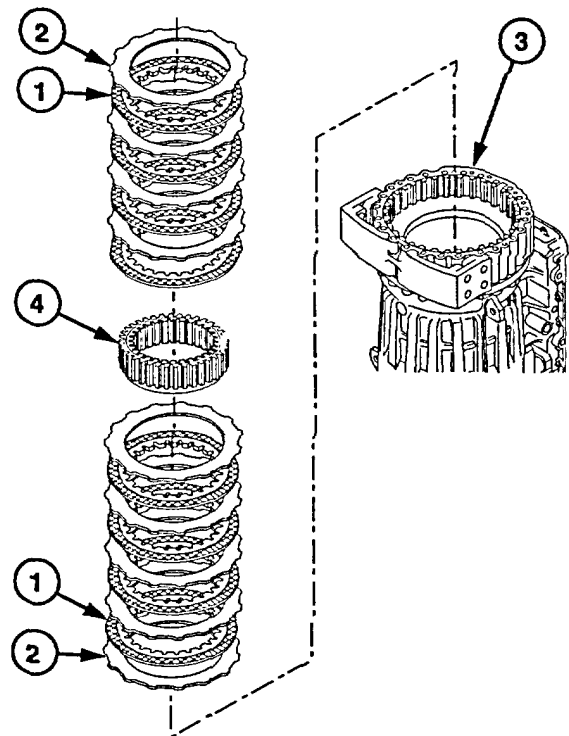


- (21) Position rear cover (1) flange side down.
- (22) Install new oil seal (25) with seal lip facing rear cover (1) using oil seal installer (26) and driver handle (Item 67, Appendix E) (27).
- (23) Install dust shield (28) in rear cover (1), flat side first, so rear edge of shield is flush with surface of rear cover.
- (23.1) Coat inner surface of oil seal (25) with high temperature grease.
- (24) Install yoke (29) on output shaft (14).
- (25) Coat threads of output shaft (14) and new retainer nut (30) with lubricating oil.
- (26) Install new retainer nut (30) on output shaft (14). Torque to 600-800 lb-ft (814-1085 N•m).



e. Installation

- (1) Soak eight friction plates (1) in clean lubricating oil for at least 2 minutes.
- (2) Install nine clutch plates (1 and 2) in adapter housing (3), starting with steel plate (2) and alternating with friction plate (1).
- (3) Install rear planetary ring gear (4) in adapter housing (3).
- (4) Install remaining clutch plates starting with friction plates (1).



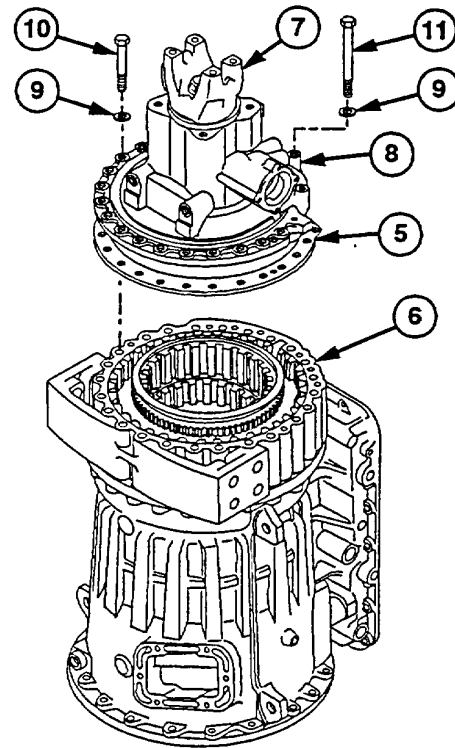
22-17. REAR COVER AND FIRST CLUTCH REPAIR (CONT)

- (5) Position new gasket (5) on transmission assembly (6) and align holes.
- (6) Install lifting device to yoke (7).

NOTE

There are two different size dowel pins on screw flange face of rear cover to help align cover with transmission.

- (7) Lift rear cover (8) and position over transmission assembly (6) while assistant operate lifting device. Align holes in transmission assembly and rear cover.
- (8) Install 24 new lockwashers (9), 21 screws (10), and 3 screws (11). Torque to 67-80 lb-ft (91-108 N•m).

**f. Follow-On Maintenance**

- (1) Install planetary gears (para 22-16).
- (2) Install governor (para 7-6).

22-18. ADAPTER HOUSING AND SECOND CLUTCH REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP**Equipment Conditions**

Rear cover and first clutch removed
(para 22-17).

Tools and Special Tools

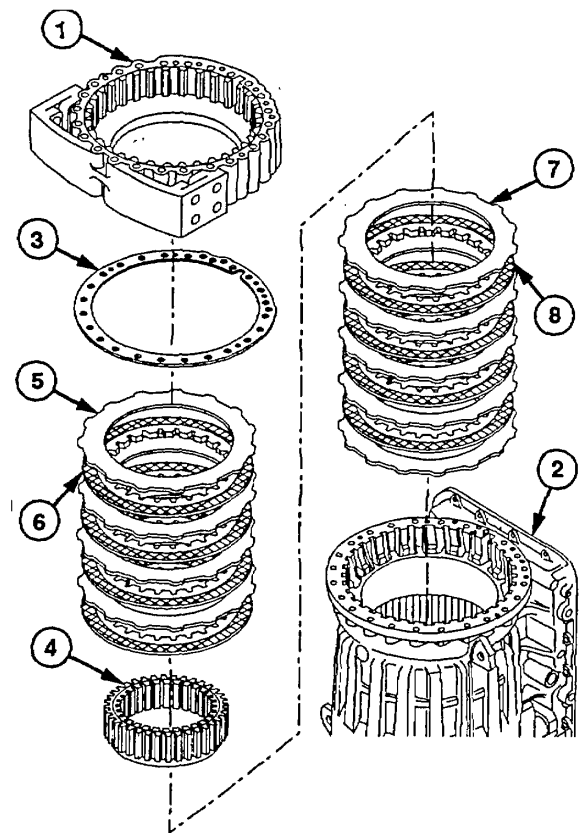
Tool Kit, Genl Mech (Item 202, Appendix E)
Caliper Set,-Micrometer item 15, Appendix E)
Spring Tester (Item 190, Appendix E)

Materials/Parts

Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Gasket (Item 59, Appendix F)
Ring, Seal (Item 251, Appendix F)
Ring, Seal (Item 265, Appendix F)

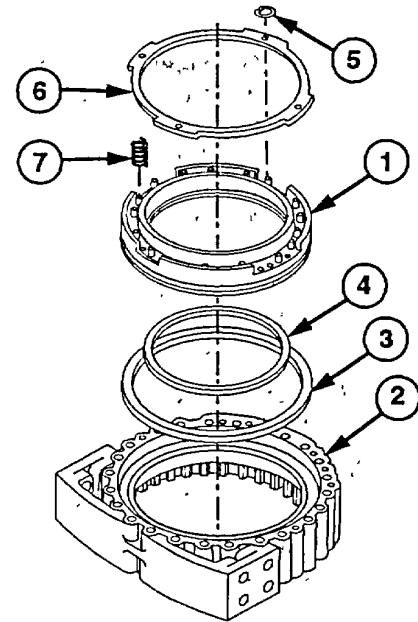
a. Removal

- (1) Remove adapter housing (1) from transmission housing (2).
- (2) Place adapter housing (1) on flat work surface with piston side up.
- (3) Remove gasket (3) from transmission housing (2).
- (4) Remove rear planetary ring gear (4) with four steel plates (5) and four friction plates (6) from transmission housing (2).
- (5) Remove four steel plates (5), four friction plates (6) from rear planetary ring gear (4).
- (6) Remove five steel plates (7) and four friction plates (8) from transmission housing (2).
- (7) Tie the second clutch plates together and identify the pack.

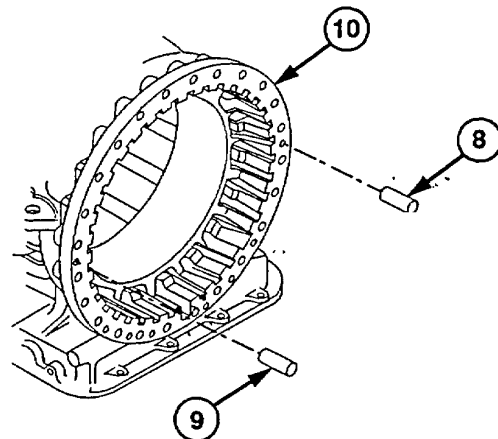


22-18. ADAPTER HOUSING AND SECOND CLUTCH REPAIR (CONT)**b. Disassembly**

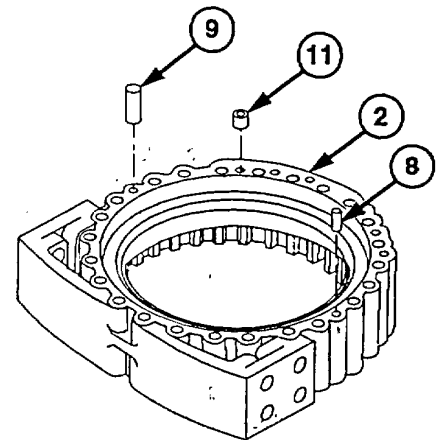
- (1) Remove second clutch piston (1) from bottom of adapter housing (2).
- (2) Remove outer seal ring (3) and inner seal ring (4) from second clutch piston (1).
- (3) Cut and remove four retaining washers (5). Discard retaining washers.
- (4) Remove clutch ring (6) from second clutch assembly (1).
- (5) Remove 28 springs (7) from second clutch piston (1).

**NOTE**

- Remove dowel pins and lube plugs only if required.
 - Dowel pins may have remained in transmission housing during removal of adapter housing. If so, go to step (6). If not, go to step (7).
- (6) Remove dowel pins (8 and 9) from transmission housing (10).



- (7) Remove lube plug (11) from adapter housing (2).
- (8) Remove dowel pins (8 and 9) from adapter housing (2).

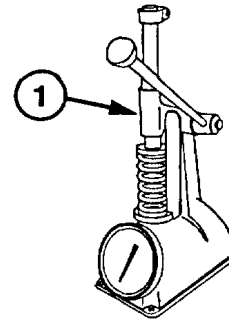


c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

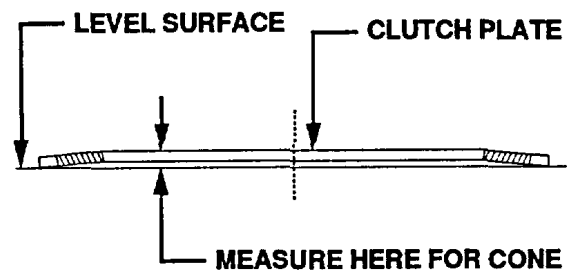
- (1) Clean metal parts with dry cleaning solvent and inspect for damage. Replace damaged parts.
- (2) Inspect all parts for burrs, scratches, and pitting. Remove defects.
- (3) Inspect all parts for missing or broken splines or teeth. Replace all damaged parts.
- (4) Measure piston release spring lengths using spring tester (1). Replace piston release springs if any three of each set do not meet the following load-height requirements:



- (a) Length without load must be at least 1.29 in. (32.7 mm).
- (b) Length under load must be at least 0.82 in. (20.8 mm) with a load of 4.3-5.7 lb (2-2.6 kg).

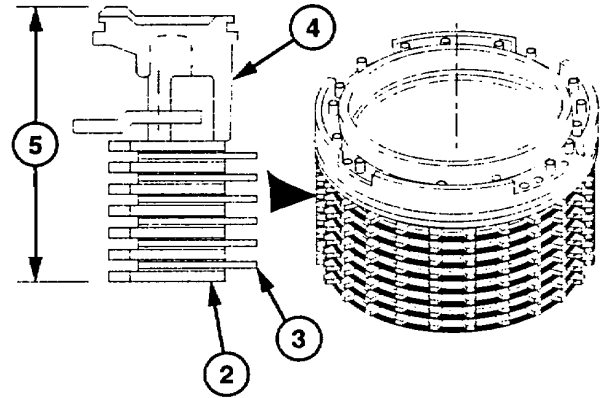
- (4.1) Measure individual clutch plate thickness and cone. The amount of cone is the distance between the inside diameter and a level surface.

- (a) Steel clutch plate (color-coded red): Minimum thickness 0.0933 in. (2.522 mm) Maximum cone 0.013 in. (0.33 mm)
- (b) Steel clutch plate (color-coded green): Minimum thickness 0.1161 in. (2.948 mm) Maximum cone 0.013 in. (0.33 mm)
- (c) Friction plate: Minimum thickness 0.1347 in. (3.420 mm) Maximum depth of oil grooves 0.008 in. (0.20 mm)



22-18. ADAPTER HOUSING AND SECOND CLUTCH REPAIR (CONT)

- (5) Stack nine steel plates (2) and eight friction plates (3) on flat surface of suitable hydraulic press, starting with steel plate (2) and alternating with friction plate (3).
- (6) Place second clutch piston (4) on top of clutch plates (2 and 3).
- (7) Press evenly on second clutch piston (4) with 100 psi load.
- (8) Measure distance from base of clutch plates (2 and 3) to top of piston (4).
- (9) From Table 22-5, select the proper steel plate combination to obtain 3.6064-3.5844 in. (91.60-91.04 mm) height. Tie these parts together and tag for subsequent assembly.

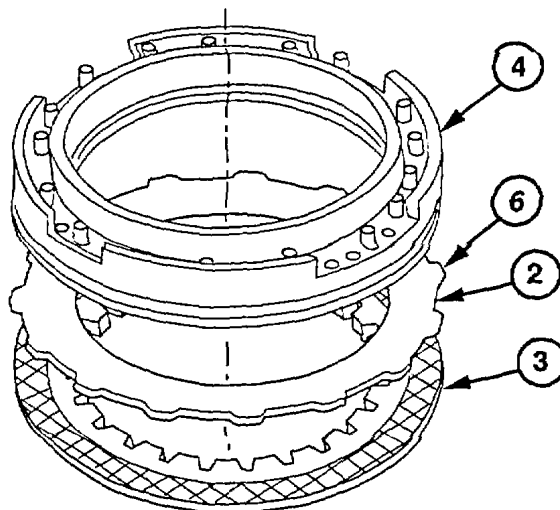
**Table 22-5. Second Clutch Pack Height**

FROM	TO	PLATE 23047771	PLATE 23047772
3.6463	3.6330	ADD 3	REMOVE 3
3.6330	3.6197	ADD 2	REMOVE 2
3.6197	3.6064	ADD 1	REMOVE 1
3.6064	3.5844	-	-
3.5844	3.5711	REMOVE 1	ADD 1
3.5711	3.5578	REMOVE 2	ADD 2
3.5578	3.5445	REMOVE 3	ADD 3

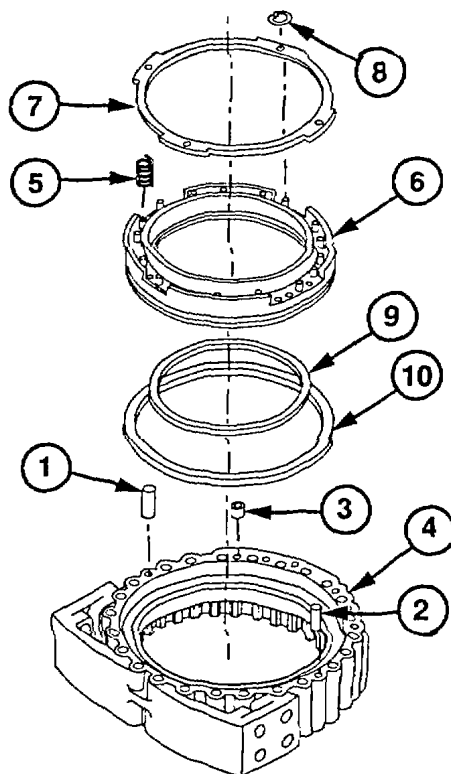
NOTE

There are two thickness' of steel plates.

- (10) Measure thickness of one tang (6) on each of seven steel plates (2). Thin plates should measure 0.096-0.103 in. (2.44-2.62 mm). Thick plates should measure 0.116-0.123 in. (2.95-3.12 mm).
- (11) Replace friction plate thickness is less than 0.1347 in. (3.420 mm)
- (12) Repeat steps (6) thru (8) to recheck second clutch thickness.
- (13) Check friction plate for presence of oil grooves.
- (14) Remove second clutch piston (4), steel plates (2), and friction plates (3) from press.

**d. Assembly**

- (1) Install dowel pins (1 and 2) and lube plug (3) in adapter housing (4).
- (2) Install 28 springs (5) in clutch piston (6).
- (3) Install clutch ring (7) on clutch piston (6).
- (4) Install four new retaining washers (8) while applying pressure to clutch ring (7).
- (5) Coat seal rings (9 and 10) with lubricating oil.
- (6) Install inner seal ring (9) and outer seal ring (10) in clutch piston (6).
- (7) Install clutch piston (6) in adapter housing (4).



e. Installation

- (1) Soak eight friction plates (1) in oil for 2 minutes.

NOTE

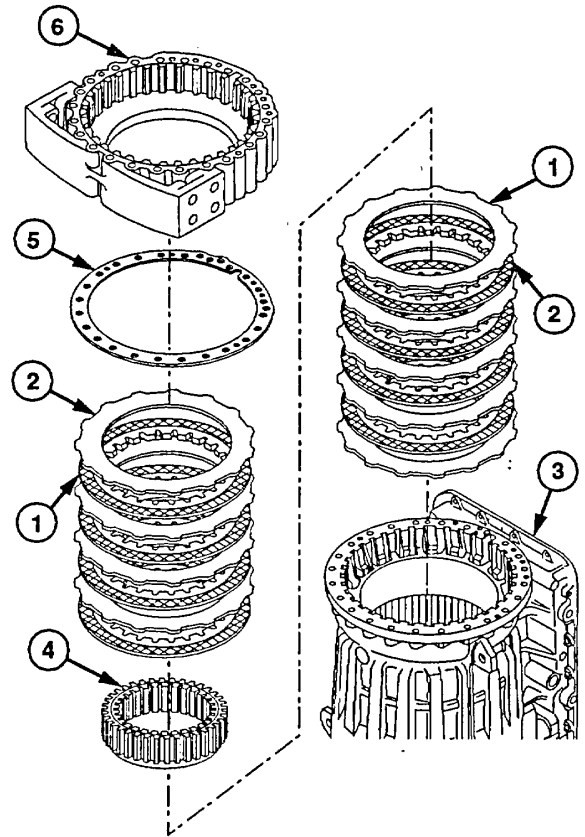
Aligning the splines in the friction plates during installation will allow for simple installation of the rear planetary ring gear.

- (2) Install nine clutch plates (1 and 2) in transmission housing (3), starting with steel plate (2) and alternating with friction plate (1). Align the splines on the friction plates.
- (3) Install rear planetary ring gear (4) in clutch plates (2).
- (4) Install remaining clutch plates (1 and 2) in transmission housing, starting with friction plate (1) and alternating with steel plate (2).
- (5) Lightly coat one side of gasket (5) with grease and set gasket on transmission housing (3) with greased side of gasket down.

NOTE

Adapter housing is installed with clutch piston side facing transmission housing.

- (6) Position adapter housing (6) on transmission housing (3).

**f. Follow-On Maintenance**

Install rear cover and first clutch (para 22-17).

22-19. TRANSMISSION HOUSING REPAIR

This task covers:

a. Removal	c. Assembly
b. Cleaning/inspection	d. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Adapter housing and second clutch removed (para 22-18).

Tools and Special Tools

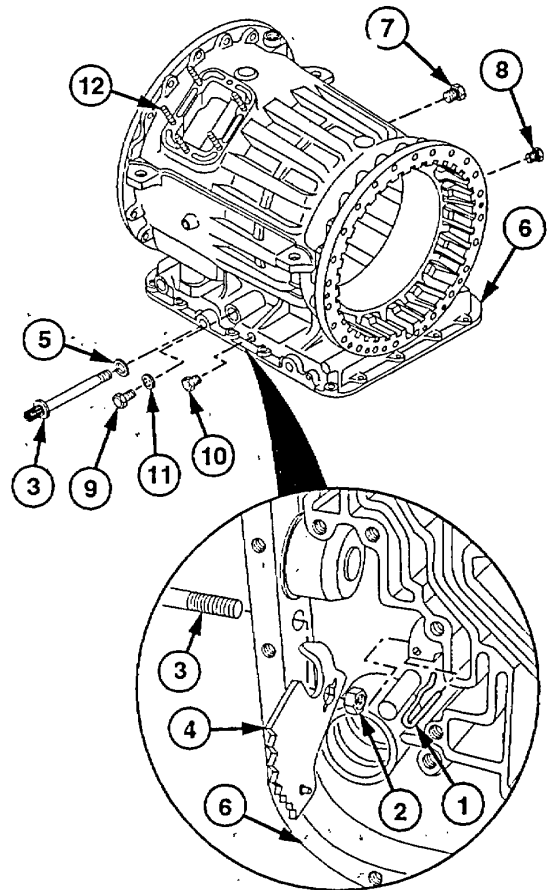
Tool Kit, Genl Mech (Item 202, Appendix E)
 Installer, Manual Shaft Oil Seal (Item 79, Appendix E)
 Remover/Setter, Stud (Item 138, Appendix E)
 Wrench, Torque, 0-300 Lb-in (Item 235, Appendix E)

Materials/Parts

Solvent, Dry Cleaning (Item 54, Appendix B)
 Compound, Sealing, Lubricating (Item 23, Appendix B)
 Locknut (Item 90, Appendix F)
 Pin, Retaining (Item 225, Appendix F)
 Seal, Oil (Item 307, Appendix F)
 Washer (Item 333, Appendix F)

a. Removal

- (1) Remove retainer pin (1) and loosen locknut (2) from manual shaft (3). Discard cotter pin.
- (2) Hold lever (4) and locknut (2) with one hand and remove manual shaft (3) by pulling shaft through oil seal (5).
- (3) Remove lever (4) and locknut (2) from transmission housing (6). Discard locknut.
- (4) Remove manual shaft oil seal (5) from transmission housing (6). Discard seal.
- (5) Remove fifth clutch pressure tap plug (7) from transmission housing (6).
- (6) Remove plugs (8, 9, and 10) and washer (11) from transmission housing (6).
- (7) Remove five studs (12) from transmission housing (6).



b. Cleaning/inspection

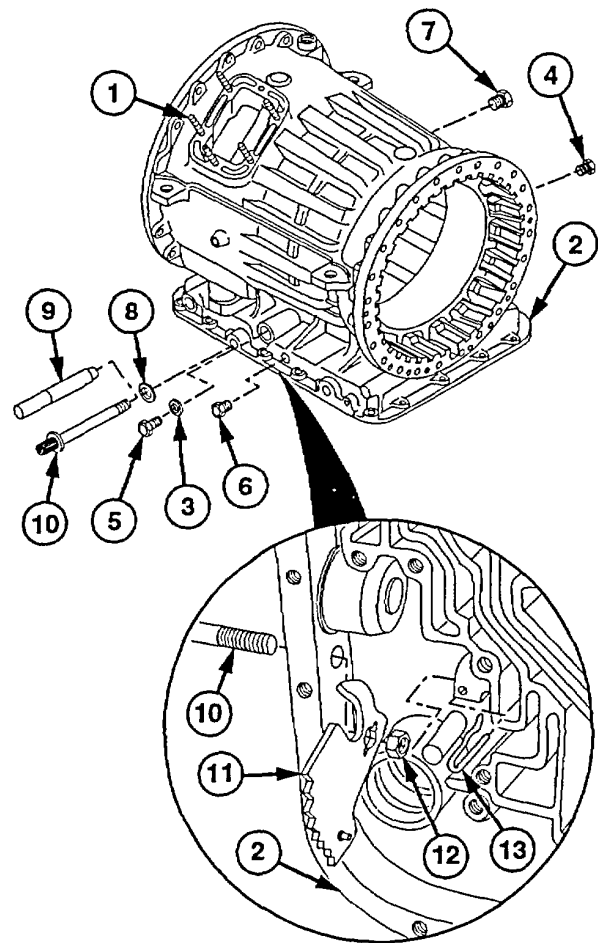
WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean transmission housing and metal parts with dry cleaning solvent.
- (2) inspect parts for damage. Replace damaged parts.
- (3) If signs of damage to transmission housing are noted, replace transmission housing.

c. Assembly

- (1) Install five studs (1) on transmission housing (2).
- (2) Install washer (3) and plugs (4, 5, and 6) on transmission housing (2).
- (3) Install fifth clutch pressure tap plug (7) from transmission housing (2).
- (4) Coat outside of new oil seal (8) with sealing and lubricating compound and install oil seal in transmission using manual shaft oil seal installer (9).
- (5) insert manual shaft (10) halfway by pushing shaft through oil seal (8) in transmission housing (2).
- (6) Position lever (11) in transmission housing (2) and install new locknut (12) on manual shaft (10). Fully seat shaft (10) and tighten locknut to 180-240 lb-in. (21-27 N•m).
- (7) Install new retainer pin (13) on manual shaft (10) by inserting straight side of pin in hole and curve over shaft.



d. Follow-On Maintenance

Install adapter housing and second clutch (para 22-18).

CHAPTER 23
TRANSFER CASE MAINTENANCE

Contents	Para	Page
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Transfer Case Repair.....	23-2	23-2
Lubrication Pump Repair.....	23-3	23-36

Section I. INTRODUCTION

23-1. INTRODUCTION

This chapter contains instructions for replacement and repair of the transfer case and components at the General Support maintenance level. Some parts must be removed before the transfer case components can be accessed. They are referenced to other paragraphs of this manual or in TM 9-2320-360-20. The HET transfer case is supplied as a dressed assembly including input and output yokes.

Section II. MAINTENANCE PROCEDURES

23-2. TRANSFER CASE REPAIR

This task covers:

a. Disassembly b. Cleaning/inspection	c. Assembly d. Follow-On Maintenance
-

INITIAL SETUP

Equipment Conditions

- Breather removed (TM 9-2320-360-20).
- Lockout shift chamber removed (TM 9-2320-360-20).
- Lubrication pump removed (para 8-7).

Tools and Special Tools

- Tool Kit, Genl Mech (Item 202, Appendix E)
- Adapter Kit, Transfer Case (Item 6.1, Appendix E)
- Adapter Tool, Transfer Case End Play (Item 8, Appendix E)
- Compressor Unit, Air (Item 24, Appendix E)
- Dial indicator, Magnetic (Item 32, Appendix E)
- Fixture, Transmission Holding (Item 45, Appendix E)
- Goggles, industrial (Item 57, Appendix E)
- Hammer, Soft-Faced (Item 63, Appendix E)
- Holder, Yoke (Figure C-15, Appendix C)
- Lifting Tool, Rear Planetary (Item 97, Appendix E)
- Press, Hydraulic (Item 116, Appendix E)
- Puller Kit, Mechanical, Gear and Brg (Item 124, Appendix E)
- Shaft, Dummy, Transfer Case (Item 158, Appendix E)
- Sling, Endless Strap (Item 161, Appendix E)
- Socket, Sockethead Screw, 3/8 in. (Item 172.1, Appendix E)
- Stand, Engine (Item 181, Appendix E)
- Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

- Adhesive-Sealant, Silicone (Item 2, Appendix B)
- Adhesive-Sealant (Item 3, Appendix B)
- Adhesive-Sealant (Item 5, Appendix B)
- Adhesive-Sealant (Item 6, Appendix B)
- Cloth, Crocus (Item 16, Appendix B)
- Compound, Sealing (Item 25, Appendix B)
- Compound, Sealing, Pipe Thread (Item 28, Appendix B)
- Grease, General Purpose, Lithium Base (Item 34, Appendix B)
- Lockwire (Item 36, Appendix B)
- Oil, Lubricating (Item 48, Appendix B)
- Solvent, Dry Cleaning (Item 54, Appendix B)
- Tags, Identification (Item 56, Appendix B)
- Tape, Masking (Item 58, Appendix B)
- Lockwashers (36) (Item 122, Appendix F)
- Lockwashers (2) (Item 119, Appendix F)
- Ring, Piston, Teflon (Item 274, Appendix F)
- Seal (Item 286, Appendix F)
- Seal (Item 309, Appendix F)
- Seal (Item 310, Appendix F)

Personnel Required

Two

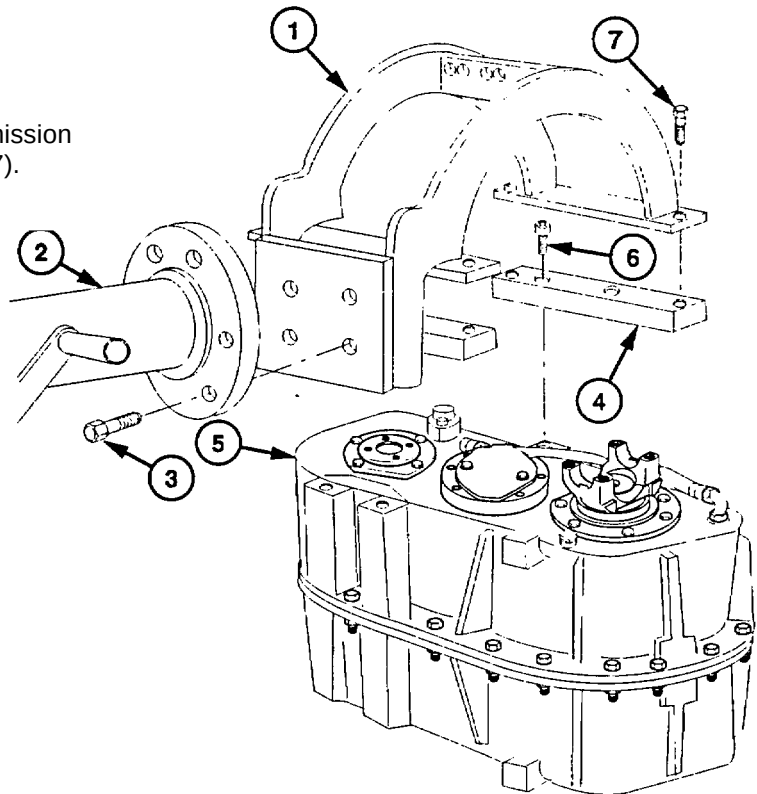
a. Disassembly

- (1) Install transmission holding fixture (1) on engine stand (2) with four screws (3).
- (2) Install two adapters (4) on rear transfer case housing (5) with four screws (6).

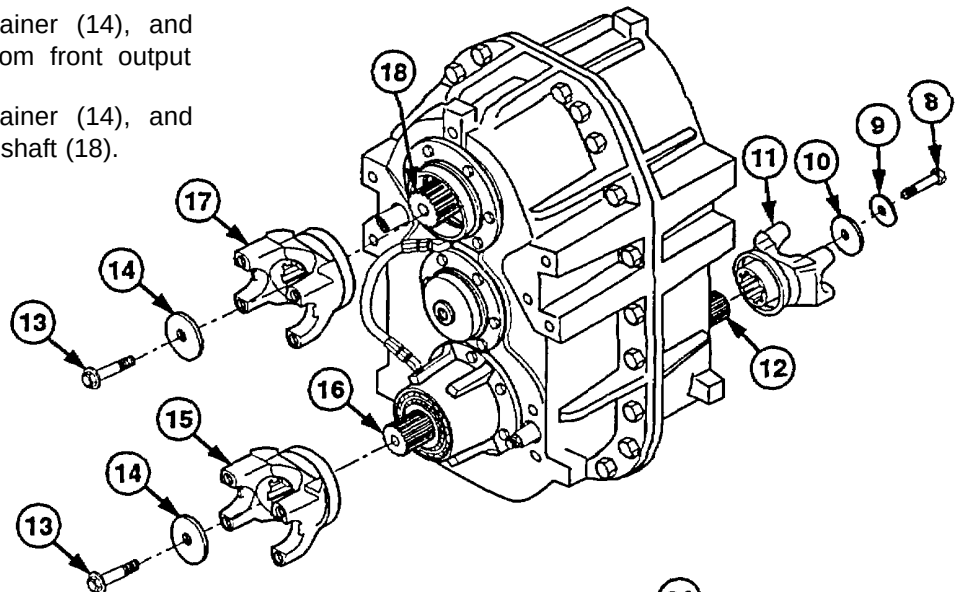
WARNING

Transfer case weighs 965 lb (438 kg). Stay clear of transfer case when supported by lifting device. Transfer case may fall and cause serious injury to personnel.

- (3) Install two adapters (4) on transmission holding fixture (1) with four screws (7).
- (4) Deleted.



- (5) Remove screw (8), washer (9), retainer (10), and rear output yoke (11) from rear output shaft (12).
- (6) Remove screw (13), retainer (14), and front output yoke (15) from front output shaft (16).
- (7) Remove screw (13), retainer (14), and input yoke (17) from input shaft (18).

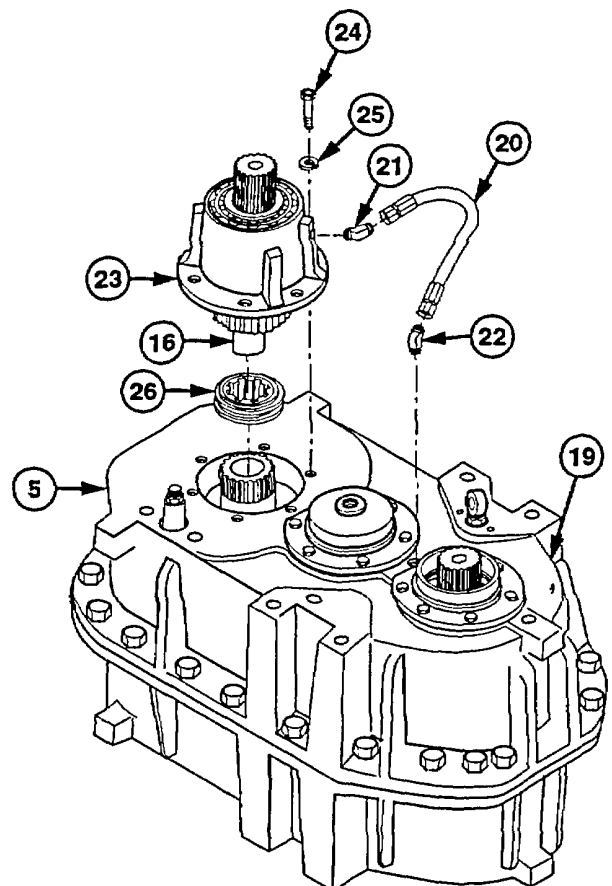


- (8) Position transfer case front half (19) up.
- (9) Remove hose (20) from elbows (21 and 22).
- (10) Remove elbow (22) from transfer case front half (19).
- (11) Remove elbow (21) from lower front bearing cap (23).
- (12) Remove six screws (24) and lockwashers (25) from lower front bearing cap (23). Discard lockwashers.
- (13) Remove lower front bearing cap (23) with front output shaft (16) from transfer case front half (19).

NOTE

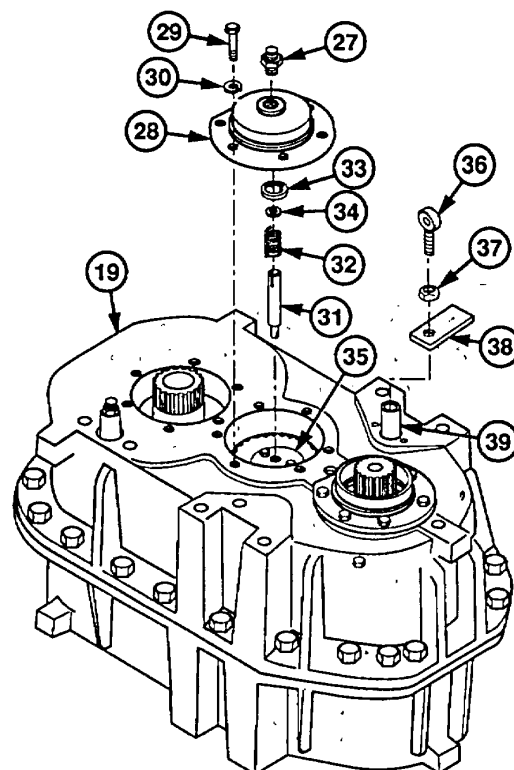
- Note location of groove in clutch collar before removing.
- Lift on fork assembly to remove clutch collar.

- (14) Remove clutch collar (26) from transfer case (5).

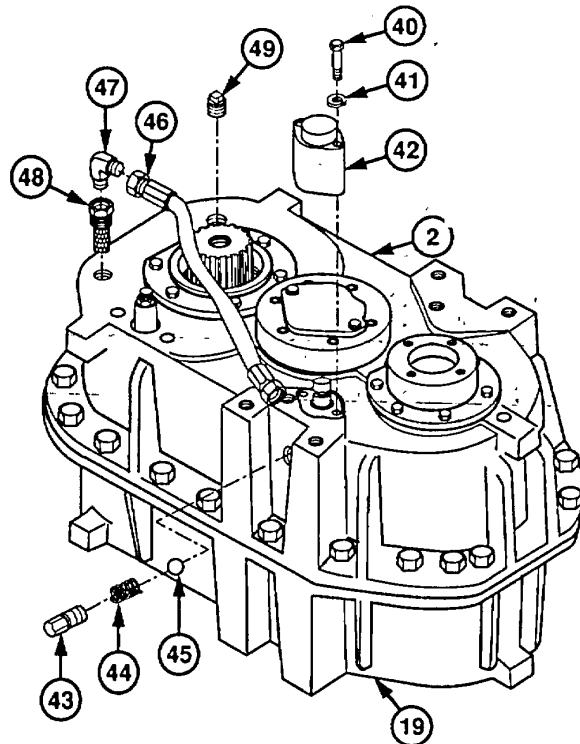


23-2. TRANSFER CASE REPAIR (CONT)

- (15) Remove reducer (27) from end cap (28).
- (16) Remove six screws (29), lockwashers (30), and end cap (28) from transfer case front half (19). Discard lockwashers.
- (17) Remove speedometer drive shaft (31), spring (32), thrust bearing (33), and thrust washer (34) from shaft retaining plate (35).
- (18) Remove shifter rod end (36), jam nut (37), and actuator plate (38) from upper shift rod (39).



- (19) Position transfer case rear half (2) facing up.
- (20) Remove two screws (40), lockwashers (41), and cover (42) from transfer case rear half (2). Discard lockwashers.
- (21) Remove plug (43), outer spring (44), and outer ball (45) from transfer case rear half (2).
- (22) Remove lube pump oil hose (46) and elbow (47) from adapter strainer (48).
- (23) Remove adapter strainer (48) from transfer case rear half (2).
- (24) Remove plug (49) from transfer case rear half (2).



- (25) Turn transfer case front half (19) up.
- (26) Remove 20 screws (50) from transfer case front half (19).
- (27) Install two screws (50) in transfer case rear half jackscrew holes (51) next to dowels (52).
- (28) Tighten two screws (50) alternately to force transfer case front half (19) with dowels (52) from rear half (2).

WARNING

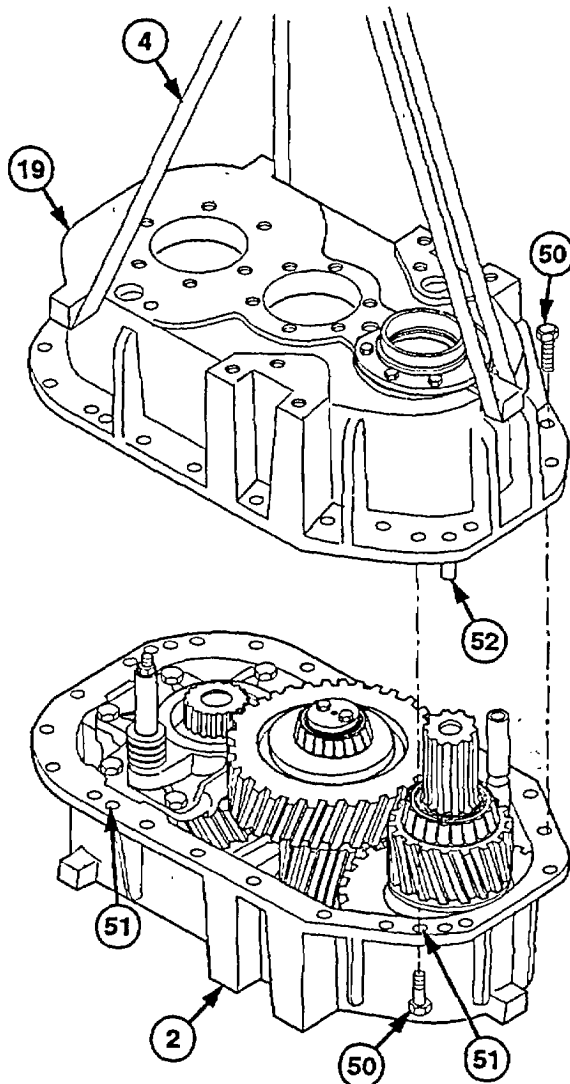
Transfer case front half weighs 200 lb (91 kg). Stay clear of transfer case front half when supported by lifting device. Transfer case front half may fall and cause serious injury to personnel.

- (29) Attach three straps (4) to transfer case front half (19).

CAUTION

Lift transfer case front half straight up to prevent possible damage to shift rod.

- (30) Lift transfer case front half (19) from rear half (2) while assistant operates suitable lifting device. Place on flat surface.
- (31) Remove two screws (50) from transfer case rear half (2).



23-2. TRANSFER CASE REPAIR (CONT)

- (32) Place clean shop rag between center shaft assembly (53) and input shaft assembly (54).
- (33) Remove two screws (55) and retainer plate (56) from end of center shaft assembly (53).
- (34) Remove shop rag.
- (35) Install lifting eye (57) on center shaft assembly (53).

WARNING

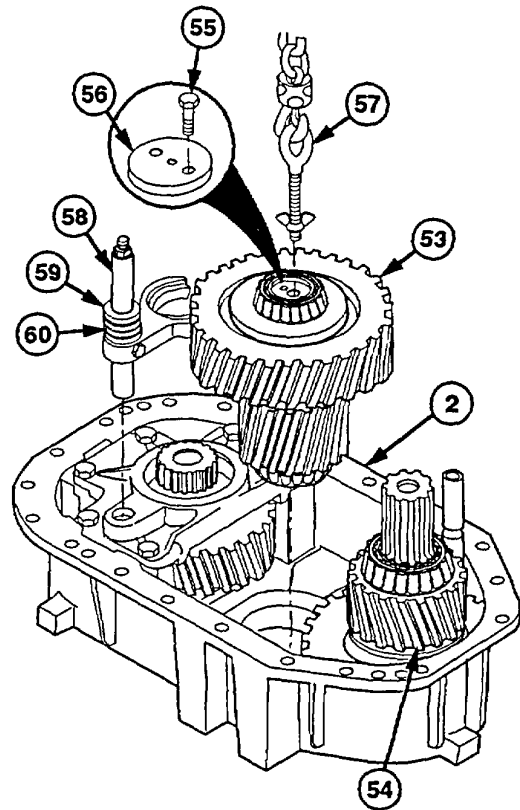
Center shaft weighs 140 lb (64 kg). Stay clear of center shaft when supported by lifting device. Center shaft may fall and cause serious injury to personnel.

- (36) Remove center shaft assembly (53) from transfer case rear half (2) while assistant operates suitable lifting device.

NOTE

Check that eight spring disks and spacer are removed with lower shift rod.

- (37) Remove lower shift fork assembly (58) with spacer (59) and eight spring disks (60) from transfer case rear half (2).



- (38) Install lifting eye (57) in input shaft assembly (54).

WARNING

Input shaft weighs 110 lb (50 kg). Stay clear of input shaft when supported by lifting device. Input shaft may fall and cause serious injury to personnel.

NOTE

- Inner detent ball will fall out of bottom of transfer case rear half when upper shift rod is removed.
- Fork assembly and shaft assembly must be removed simultaneously to prevent binding.
- Spacers are different in length. Mark for proper assembly.

- (39) Remove input shaft assembly (54), upper shift fork assembly (61), and two spacers (62) and (63) from transfer case rear half (2) while assistant operates suitable lifting device.
- (40) Remove inner spring (64) from transfer case rear half (2).
- (41) Remove six screws (65) and washers (66) from transfer case rear half (2).
- (42) Using soft-faced hammer, remove bearing support (67) from transfer case rear half (2).

WARNING

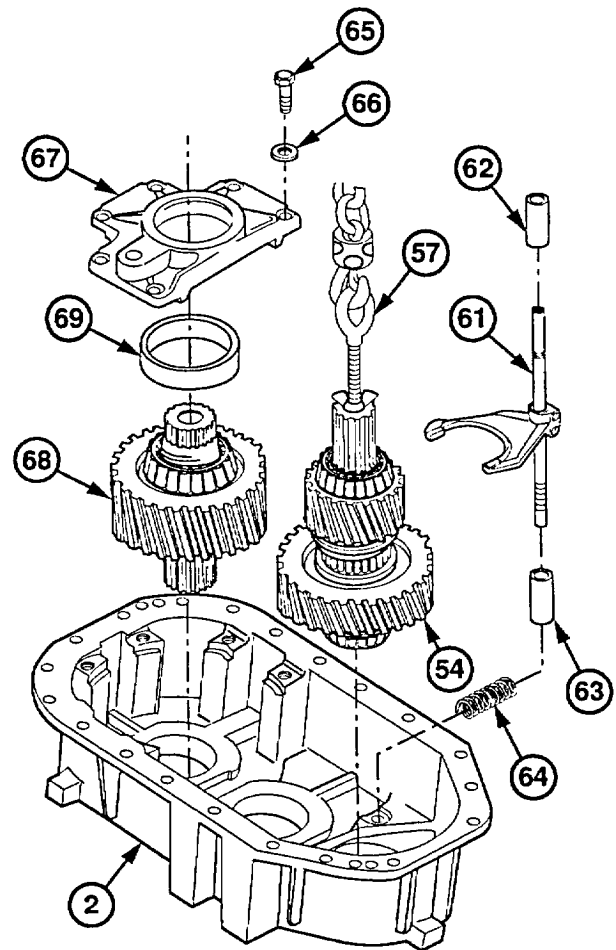
Lower rear output shaft weighs 110 lb (50 kg). Stay clear of output shaft when supported by lifting device. Lower rear output shaft may fall and cause serious injury to personnel.

- (43) Remove lower rear output shaft assembly (68) from transfer case rear half (2).

NOTE

Do step (44) if bearing or race fail inspection.

- (44) Remove outer race (69) from bearing support (67).



23-2. TRANSFER CASE REPAIR (CONT)

- (45) Turn transfer case rear half (2) so outside surface faces up.

NOTE

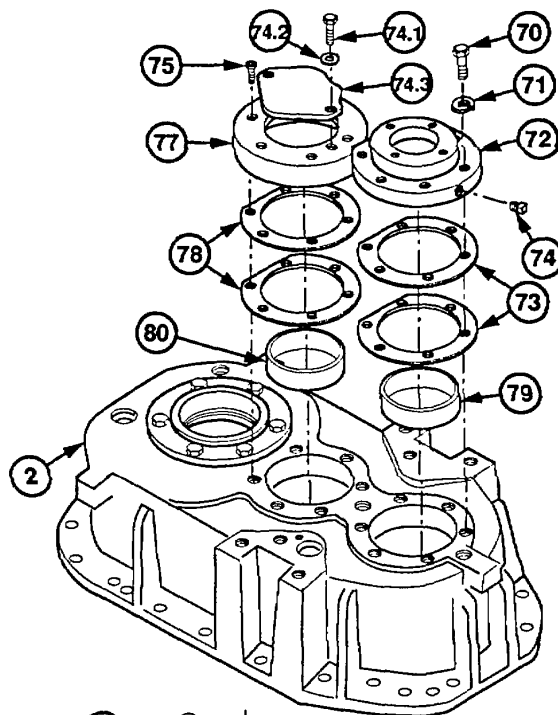
Tag and mark shims before removal.

- (46) Remove six screws (70), lockwashers (71), upper end cap (72), and shims (73) from transfer case rear half (2). Discard lockwashers.
- (47) Remove plug (74) from upper end cap (72).
- (47.1) Remove two screws (74.1), washers (74.2), and cover plate (74.3) from adapter end plate (77).
- (48) Remove six screws (75), adapter end plate (77), and shims (78) from transfer case rear half (2).

NOTE

Do step (49) if bearings or races fail inspection.

- (49) Remove two outer races (79 and 80) from transfer case rear half (2).

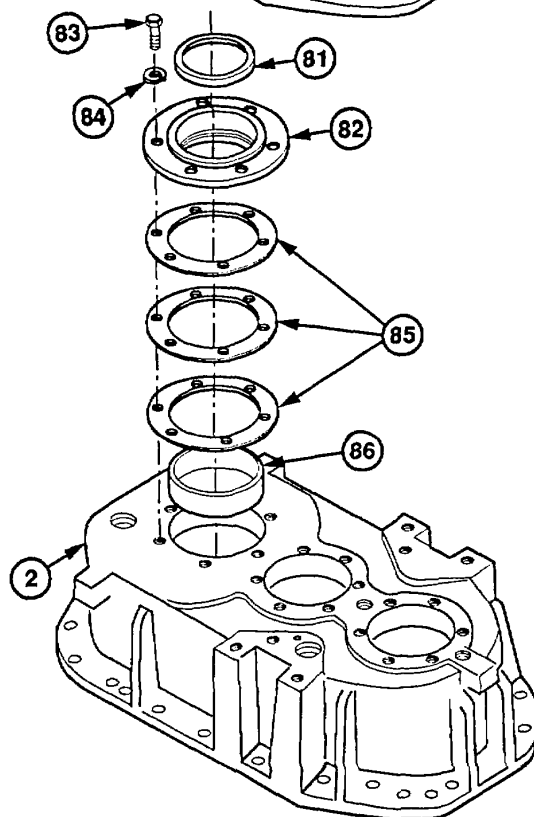


- (50) Remove seal (81) from lower end cap (82). Discard seal.
- (51) Remove six screws (83), lockwashers (84), lower end cap (82), and shims (85) from transfer case rear half (2).

NOTE

Do step (52) if bearings or races fail inspection.

- (52) Remove outer race (86) from transfer case rear half (2).



NOTE

Inner bearing races may fall out.

- (53) Turn transfer case front half (19) so outside surface faces up.
- (54) Remove seal (87) from upper end cap (88). Discard seal.
- (55) Remove six screws (89), lockwashers (90), and upper end cap (88) from transfer case front half (19). Discard lockwashers.

NOTE

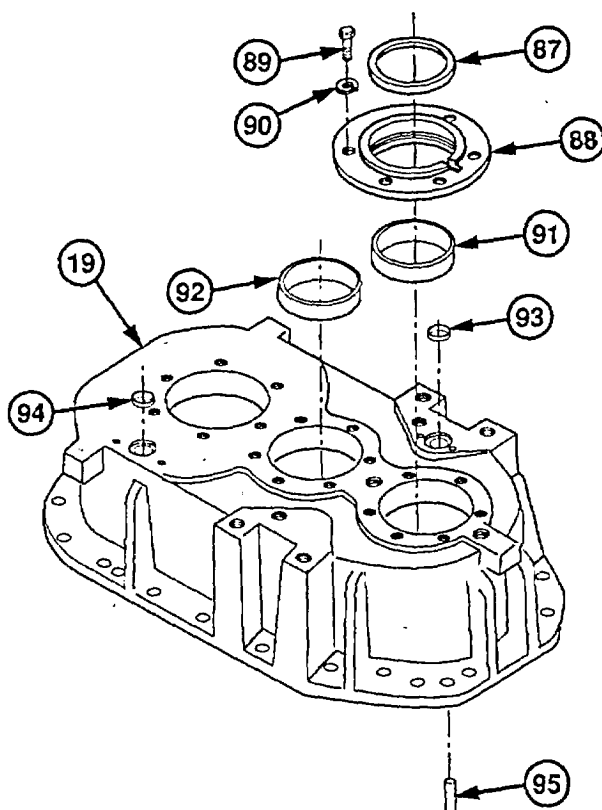
Do step (56) if bearings or races fail inspection.

- (56) Remove two outer races (91 and 92) from transfer case front half (19).
- (57) Remove seal (93) from transfer case front half (19). Discard seal.
- (58) Remove pilot ring (94) from transfer case front half (19).

NOTE

Do step (59) if dowel pins fail inspection.

- (59) Remove two dowel pins (95) from transfer case front half (19).

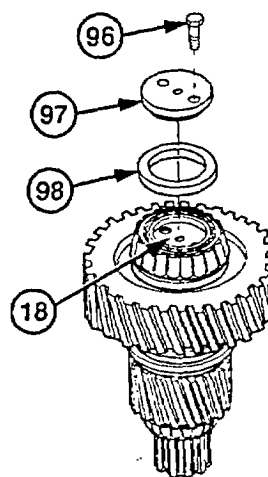
**WARNING**

Input shaft weighs 110 lb (50 kg). Stay clear of input shaft when supported by lifting device. Input shaft may fall and cause serious injury to personnel.

NOTE

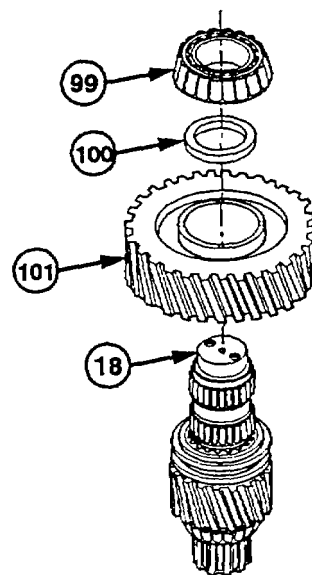
Yoke may be used to hold shaft when removing screws.

- (60) Remove two screws (96), pump drive plate (97), and teflon piston ring (98) from input shaft (18). Discard teflon piston ring.

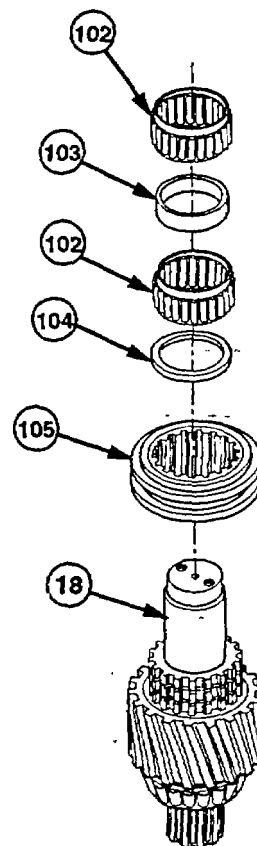


23-2. TRANSFER CASE REPAIR (CONT)

- (61) Remove bearing (99), spacer (100), and large gear (101) from input shaft (18) using puller.



- (62) Remove two needle bearings (102), spacer (103), and spacer (104) from input shaft (18).
- (63) Remove shift collar (105) from input shaft (18).

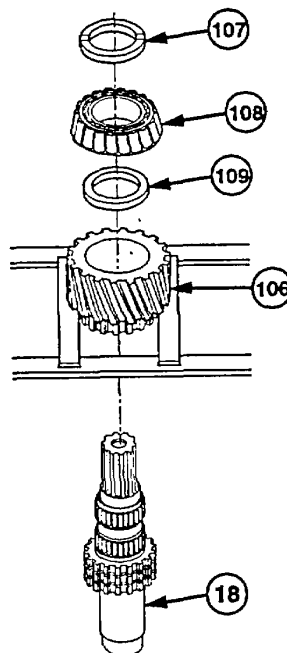


- (64) Position input shaft (18) in press and support by small gear (106).

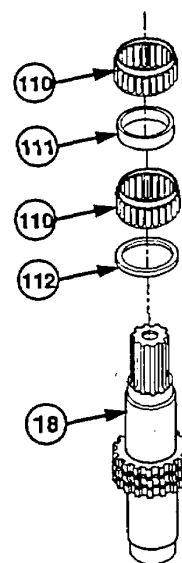
CAUTION

Properly support shaft during removal. Shaft may drop suddenly. Failure to comply may result in damage to equipment.

- (65) Press top input shaft (18) out of spacer (107), bearing (108), spacer (109), and gear (106).



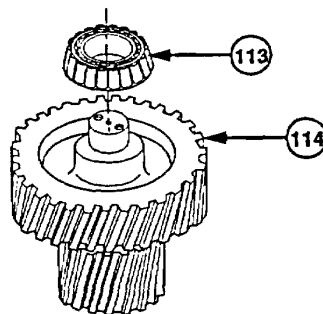
- (66) Remove two needle bearings (110) and spacer (111) from input shaft (18).
 (67) Remove spacer (112) from input shaft (18).



WARNING

Center shaft weighs 140 lb (64 kg). Stay clear of center shaft when supported by lifting device. Center shaft may fall and cause serious injury to personnel.

- (68) Remove bearing cone (113) from center shaft (114).



23-2. TRANSFER CASE REPAIR (CONT)

- (69) Turn center shaft (114) over so that smaller gear is up.
- (69.1) Remove two screws (114.1) and drive coupling (114.2) from center shaft (114).
- (70) Remove bearing cone (115) from center shaft (114).

WARNING

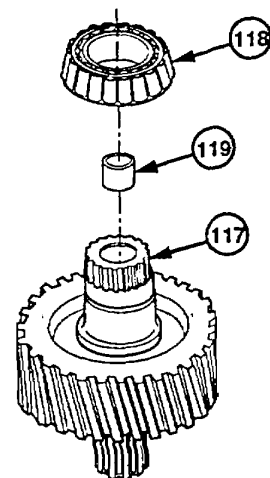
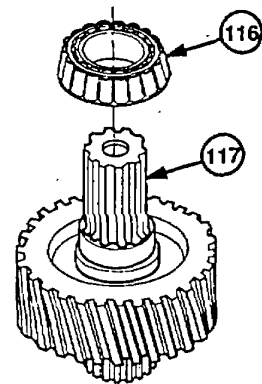
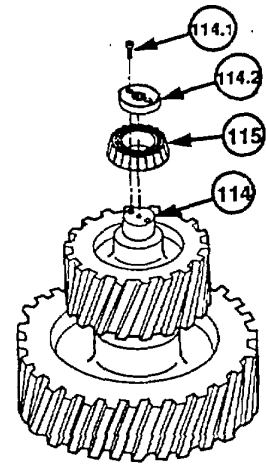
Lower rear output shaft weighs 110 lb (50 kg). Stay clear of input shaft when supported by lifting device. Lower rear output shaft may fall and cause serious injury to personnel.

NOTE

Perform disassembly if bearings or bushing fail inspection.

- (71) Remove bearing cone (116) from shaft assembly (117).

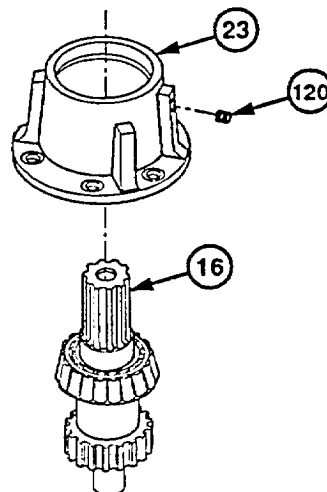
- (72) Turn rear output shaft (117) over.
- (73) Remove bearing cone (118) from rear output shaft assembly (117).
- (74) Remove bushing (119) from rear output shaft (117).



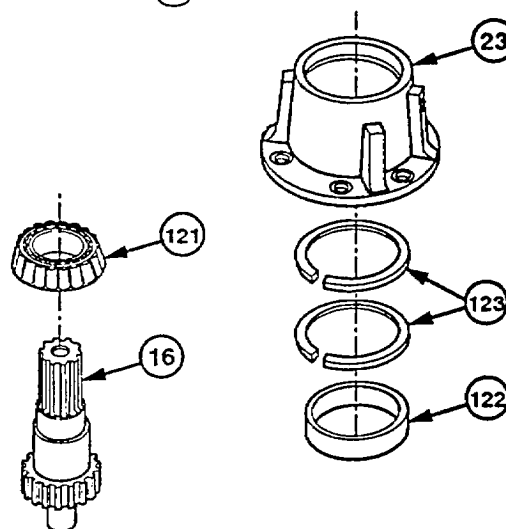
NOTE

Mark plug location for ease of assembly.

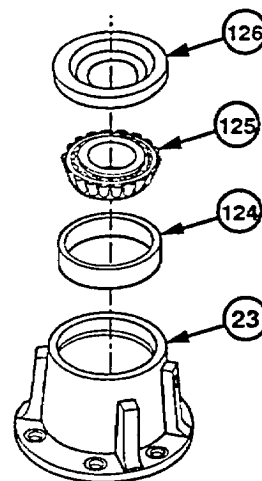
- (75) Remove plug (120) from lower front bearing cap (23).
- (76) Place bearing cap (23) in press. Press front output shaft (16) from lower front bearing cap (23).



- (77) Remove bearing cone (121) from front output shaft (16).
- (78) Remove bearing cup (122) from lower front bearing cap (23).
- (79) Remove two spacers (123) from lower front bearing cap (23).

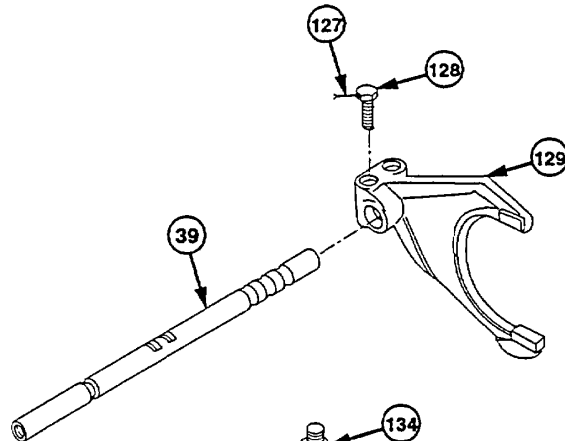


- (80) Press outer race (124), bearing (125), and seal (126) from lower front bearing cap (23). Discard seal.

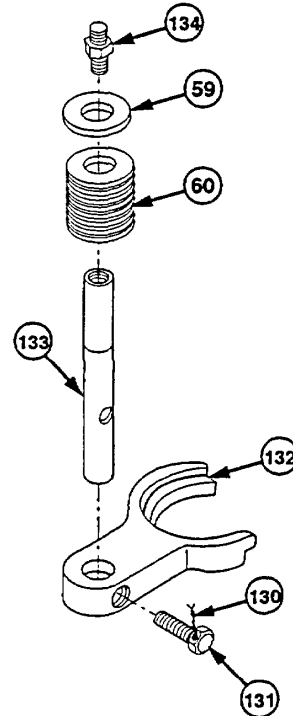


23-2. TRANSFER CASE REPAIR (CONT)

- (81) Cut lockwire (127) holding two screws (128).
- (82) Remove two screws (128) and upper shift rod (39) from fork (129).



- (83) Remove spacer (59) and eight spring disks (60).
- (84) Cut lockwire (130) holding screw (131).
- (85) Remove screw (131) from fork (132).
- (86) Slide shift rod (133) from fork (132).
- (87) Remove stud (134) from lower shift rod (133).

**b. Cleaning/inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-54°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean all metal parts with dry cleaning solvent.
- (2) Clean all sealing surfaces.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Dry all parts, except bearings, with compressed air. Allow bearings to air dry.
- (4) Inspect bearings for corrosion, scoring, pitting, or other damage.
- (5) Inspect all machined surfaces for nicks, burrs, or scratches. Remove defects with crocus cloth.
- (6) Inspect both case halves for cracks or damage.
- (7) Inspect all threads for peeled or crossed condition.
- (8) Replace all oil seals and damaged parts.

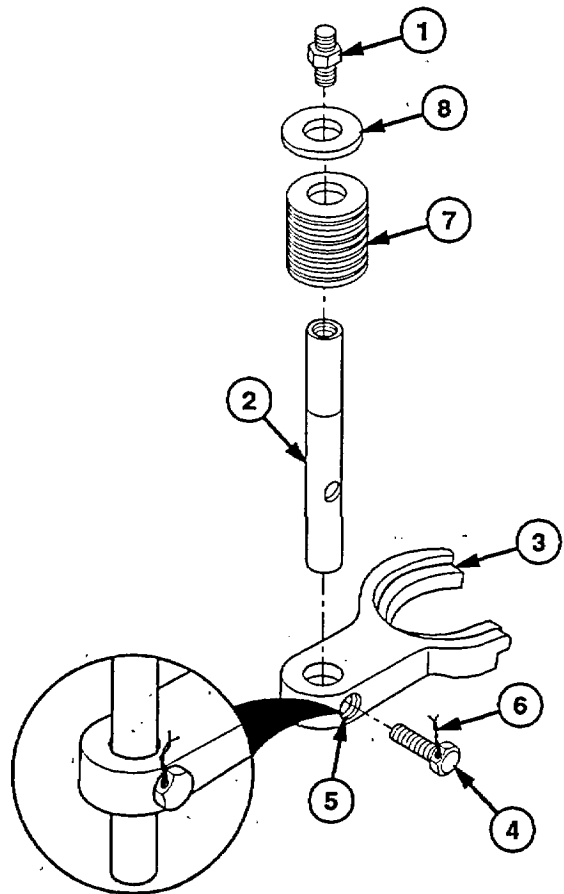
c. Assembly

- (1) Coat threads of stud (1) with grease.
- (2) Install stud (1) in shift rod (2). Torque to 15 lb-ft (20 N•m).
- (3) Slide shift rod (2) in fork (3).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (4) Coat threads of screw (4) with adhesive-sealant (Item 6, Appendix B).
- (5) Align holes (5) in fork (3) and shift rod (2) and install screw (4). Torque to 40 lb-ft (54 N•m).
- (6) Secure screw (4) with lockwire (6).
- (7) Install eight spring disks (7), alternating concaved surfaces, in pairs, and spacer (8) on shift rod (2).



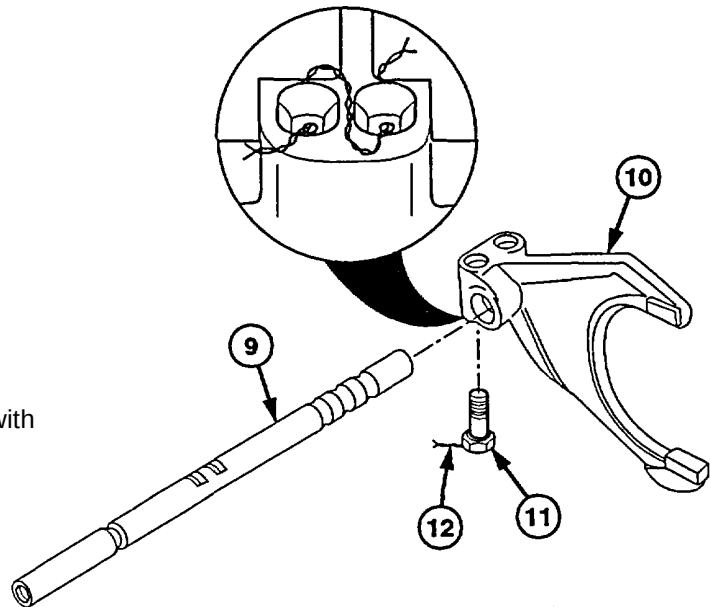
23-2. TRANSFER CASE REPAIR (CONT)

- (8) Slide shift rod (9) on fork (10).

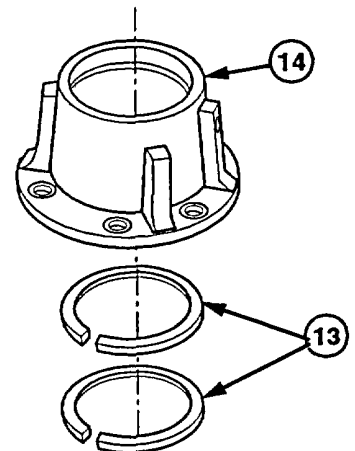
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

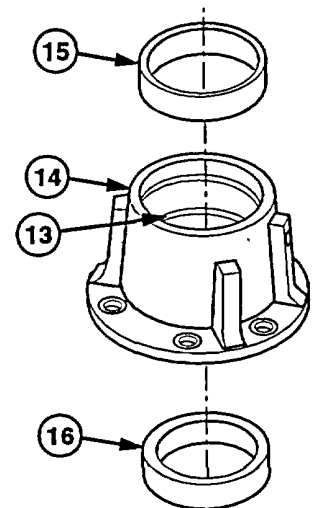
- (9) Coat threads of two screws (11) with adhesive-sealant (Item 6, Appendix B).



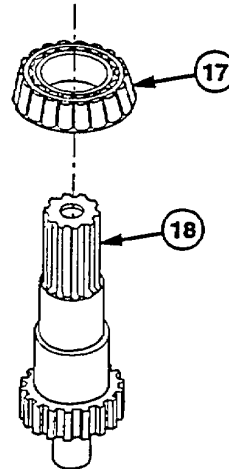
- (10) Install two screws (11) on fork (10). Torque to 40 lb-ft (54 N•m).
- (11) Secure two screws (11) together with lockwire (12).
- (12) Install two spacers (13) in bearing cap (14).



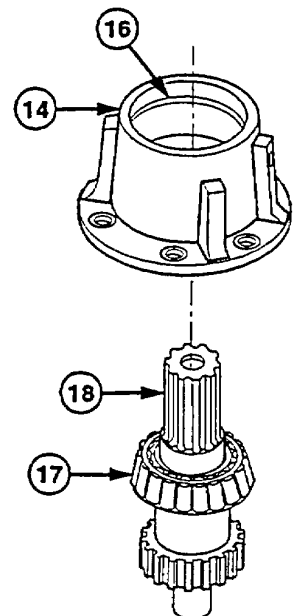
- (13) Press bearing cup (15) and bearing cup (16) in bearing cap (14). Seat against spacers (13).



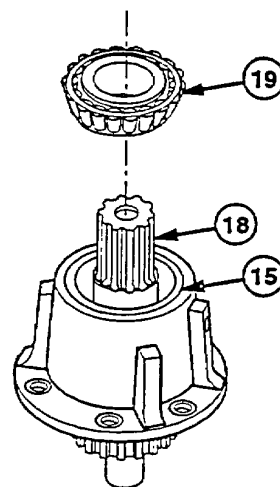
- (14) Place inner bearing cone (17) on spline end of output shaft (18). Press to seat against shoulder of shaft.



- (15) Install bearing cap (14) on splined end of output shaft (18) until inner bearing cone (17) is firmly seated in bearing cup (16).



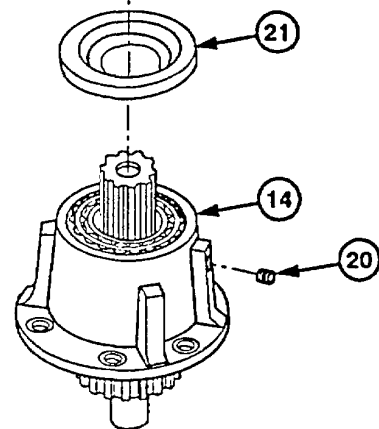
- (16) Place outer bearing cone (19) on spline end of output shaft (18).
 (17) Press to seat outer bearing cone (19) in bearing cup (15).



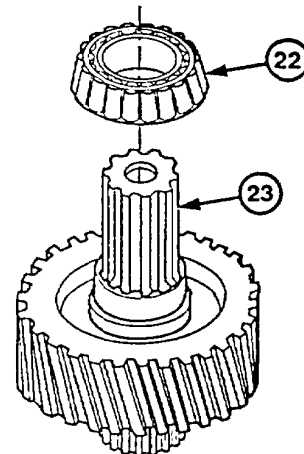
23-2. TRANSFER CASE REPAIR (CONT)**WARNING**

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

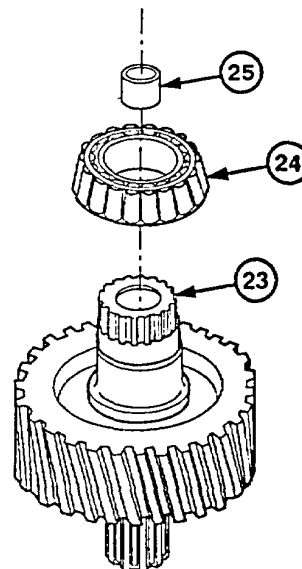
- (18) Coat threads of plug (20) with pipe thread sealing compound. Install plug in bearing cap (14).
- (19) Install new seal (21) on bearing cap (14).



- (20) Press bearing cone (22) on lower rear output shaft (23).
- (21) Coat bearing cone (22) with grease.



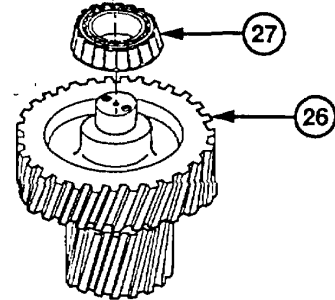
- (22) Turn lower rear output shaft (23) over.
- (23) Press bearing cone (24) on lower rear output shaft (23).
- (24) Coat bearing cone (24) with grease.
- (25) Install bushing (25) in lower rear output shaft (23).



WARNING

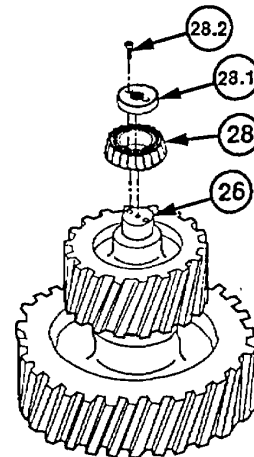
Center shaft weighs 140 lb (64 kg). Stay clear of center shaft when supported by lifting device. Center shaft may fall and cause serious injury to personnel.

- (26) Place center shaft (26) in press with large gear up using lifting device.
- (27) Press bearing cone (27) on center shaft (26).
- (28) Turn center shaft (26) over in press so that smaller gear is up.
- (29) Install bearing cone (28).

**WARNING**

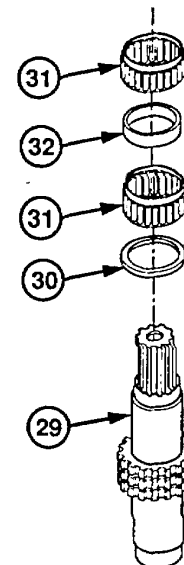
Adhesive sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (29.1) Coat threads of two screw holes in center shaft (26) with adhesive-sealant (item 6, Appendix B).
- (29.2) Install drive coupling 128.1 on center shaft (26) with two screws (28.2). Torque to 40 lb-ft (54 N•m).
- (30) Remove center shaft (26) from press with lifting device.

**WARNING**

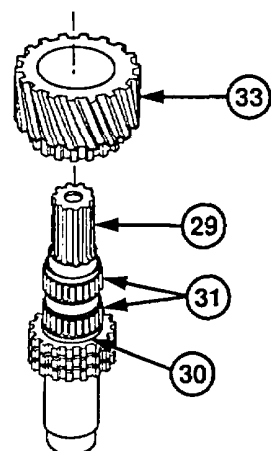
Input shaft weighs 110 lb (50 kg). Stay clear of input shaft when supported by lifting device. Input shaft may fall and cause serious injury to personnel.

- (31) Place top input shaft (29) in press so spline end is up.
- (32) Install spacer (30), needle bearing (31), spacer (32), and needle bearing (31).

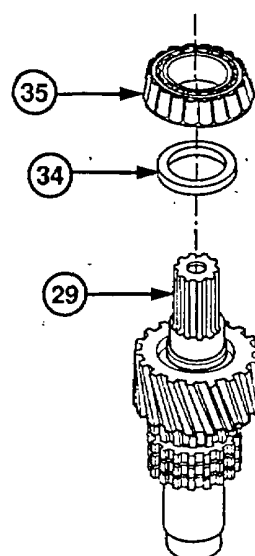


23-2. TRANSFER CASE REPAIR (CONT)

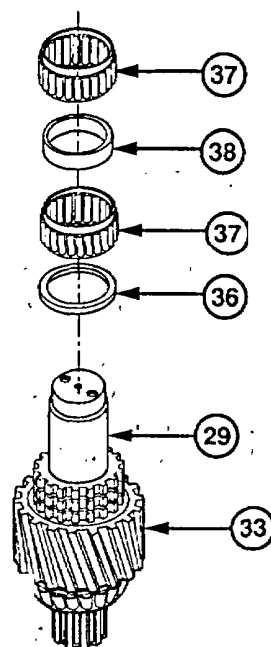
- (33) Coat two needle bearings (31) with grease.
- (34) Install gear (33) with small teeth down on top input shaft (29). Seat against spacer (30).



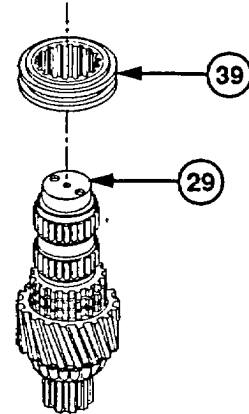
- (35) Install spacer (34) on top input shaft (29).
- (36) Press bearing (35) to seat against spacer (34).



- (37) Turn top input shaft (29) over and support gear (33).
- (38) Install spacer (36), needle bearing (37), spacer (38), and needle bearing (37).



- (39) Install shift collar (39) with larger taper up on input shaft (29).

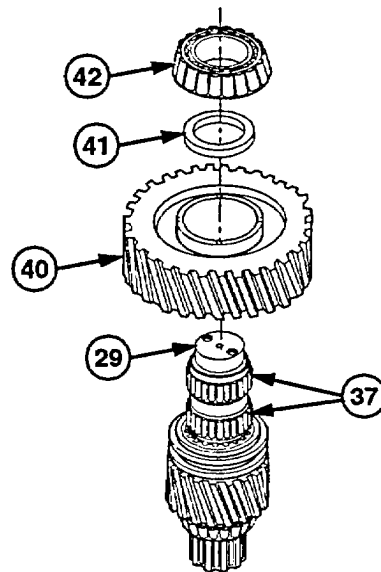


- (40) Coat two needle bearings (37) with grease.
 (41) Install large gear (40) over top input shaft (29) with collar gears facing down.
 (42) Install spacer (41) over top input shaft (29).

NOTE

Yoke may be used to hold shaft when installing screws.

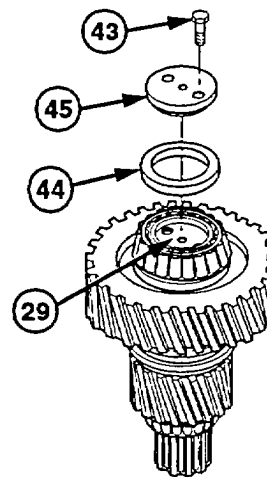
- (43) Press bearing (42) to seat against spacer (41).



WARNING

Adhesive sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (44) Coat threads of two screws (43) with adhesive-sealant (Item 5, Appendix B).
 (45) Install new piston ring (44) and pump drive plate (45) on input shaft (29) with screws (43). Torque to 60 lb-ft (81 N•m).



23-2. TRANSFER CASE REPAIR (CONT)**NOTE**

Only the shims removed during disassembly are installed at this time.

- (46) Install center shims (46) and adapter end plate (47) in transfer case rear half (48) with six screws (50). Torque to 60 lb-ft (81 N•m).

NOTE

Align oil port on bearing housing with port on transfer case rear half.

- (47) Install upper shims (51) and bearing housing (52) in transfer case rear half (48) with six lockwashers (53) and screws (54). Torque to 60 lb-ft (81 N•m).

WARNING

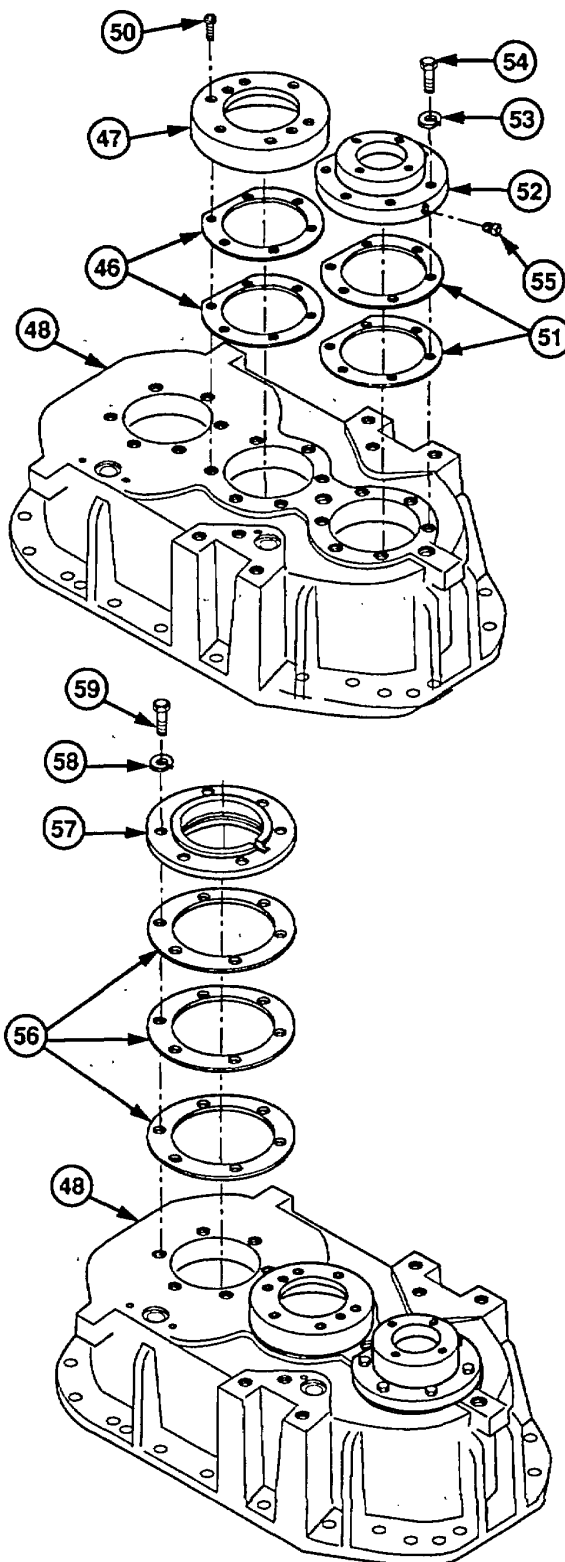
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (48) Coat threads of plug (55) with pipe thread sealing compound.
(49) Install plug (55) in bearing housing (52)..

NOTE

Only the shims removed during disassembly are installed at this time.

- (50) Install shims (56) and lower end cap (57) in transfer case rear half (48) with six new lockwashers (58) and screws (59). Torque to 60 lb-ft (81 N•m).
(51) Turn transfer case rear half (48) over.



- (52) Coat lower bearing outer race (60) with grease.
- (53) Install lower bearing outer race (60) in transfer case rear half (48).

WARNING

Be careful not to trap hands between gear assembly and transfer case. Injury to personnel may result.

- (54) Install rear output shaft assembly (61) in transfer case rear half (48) through lower bearing outer race (60).
- (55) Coat upper bearing race (62) with grease.

NOTE

Do step (56) if bearing race was removed.

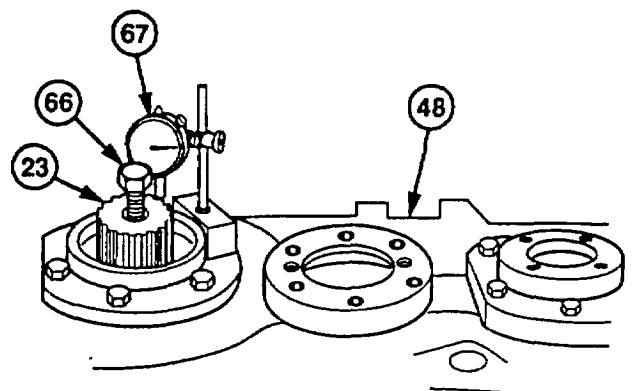
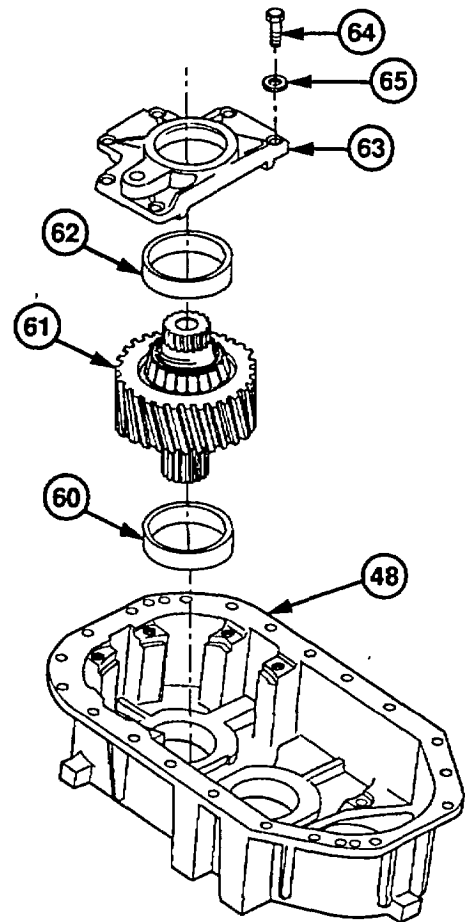
- (56) Install upper bearing outer race (62) in bearing retaining plate (63).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (57) Coat threads of six screws (64) with adhesive-sealant (Item 6, Appendix B).
- (58) Install bearing retaining plate (63) on transfer case rear half (48) with six washers (65) and screws (64). Torque to 88 lb-ft (119 N•m).

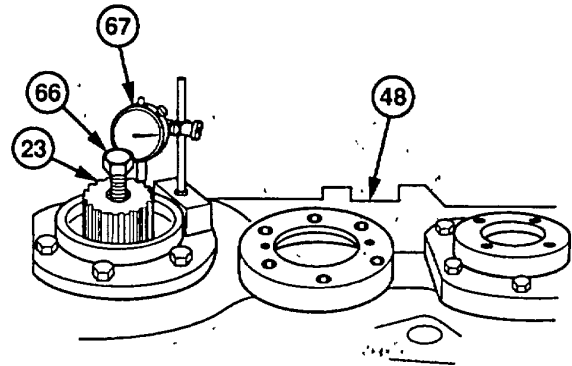
- (59) Turn transfer case rear half (48) over so outside surface faces up.
- (60) Install screw (66) in lower rear output shaft (23).
- (61) Lightly tap down on lower rear output shaft (23) to seat bearings.
- (62) Install dial indicator (67) on rear output shaft (23).
- (63) Pry up on screw (66).



23-2. TRANSFER CASE REPAIR (CONT)**NOTE**

End play must be 0.003-0.006 in. (0.076-0.15 mm). If end play is less than 0.003 in. (0.076 mm), shims must be added. If end play is greater than 0.006 in. (0.15 mm), shims must be removed.

- (64) Check and record end play measured on dial indicator (67).
- (65) Remove screw (66) and dial indicator (67) from lower rear output shaft (23).



- (66) Remove six screws (59), lockwashers (58), lower end cap (57), and shims (56) from transfer case rear half (48). Discard lockwashers.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (67) Coat shims (56) and screws (59) with adhesive-sealant (Item 6, Appendix B).

NOTE

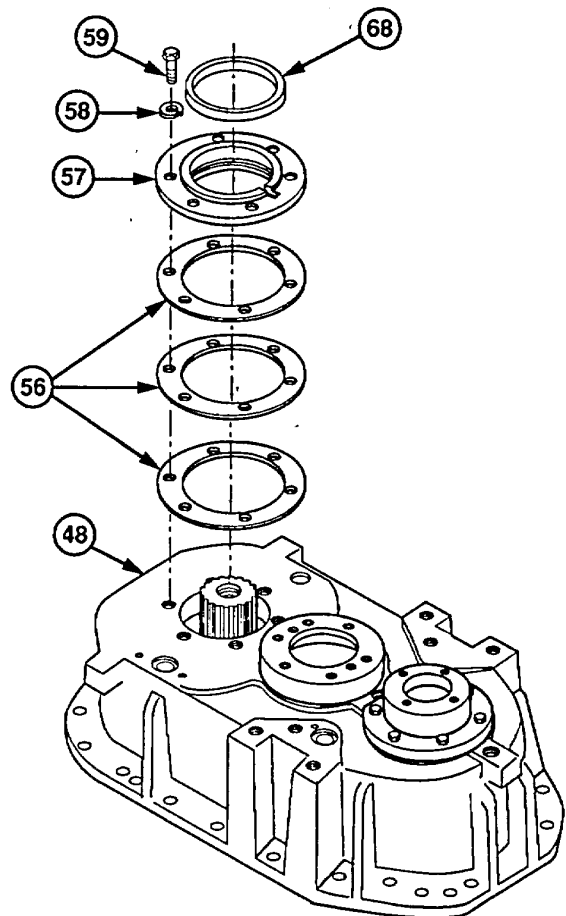
The number of shims installed is amount required to obtain correct end play.

- (68) Install shims (56) and lower end cap (57) on transfer case rear half (48) with six new lockwashers (58) and screws (59). Torque to 60 lb-ft (81 N•m).

NOTE

Seal is installed with numbered side out.

- (69) Install new seal (68) in lower end cap (57).



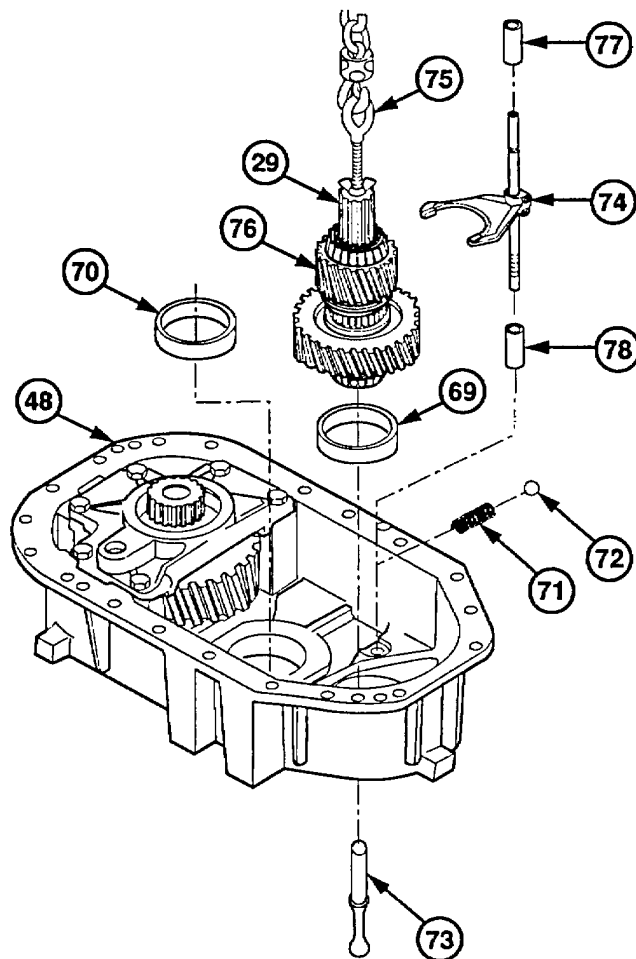
- (70) Install top bearing race (69) and center bearing race (70) in transfer case rear half (48).
- (71) Install spring (71) and ball (72) in transfer case rear half (48). Hold spring and ball in place with dummy shaft (73).
- (72) Coat shaft of upper shift fork assembly (74) with grease.
- (73) Install lifting eye (75) in top input shaft (29).

WARNING

Input shaft weighs 110 lb (50 kg). Stay clear of Input shaft when supported by lifting device. Input shaft may fall and cause serious injury to personnel.

NOTE

- End of fork shift rod with threaded hole must face up.
 - Shift fork will push dummy shaft out during assembly.
 - The cutoff part of fork faces center shaft.
 - Fork assembly and shaft assembly must be installed simultaneously to prevent binding.
- (74) Install top input shaft assembly (76), shift fork (74), and two spacers (77 and 78) in transfer case rear half (48) while assistant operates lifting device.
 - (75) Remove lifting eye (75) from top input shaft (29).



23-2. TRANSFER CASE REPAIR (CONT)

- (76) Install lifting eye (75) in center shaft (26).

WARNING

Center shaft weighs 140 lb (64 kg). Stay clear of center shaft when supported by lifting device. Center shaft may fall and cause serious injury to personnel.

- (77) install center shaft assembly (79) in transfer case rear half (48) while assistant operates lifting device.
 (78) Remove lifting eye (75) from center shaft (26).

WARNING

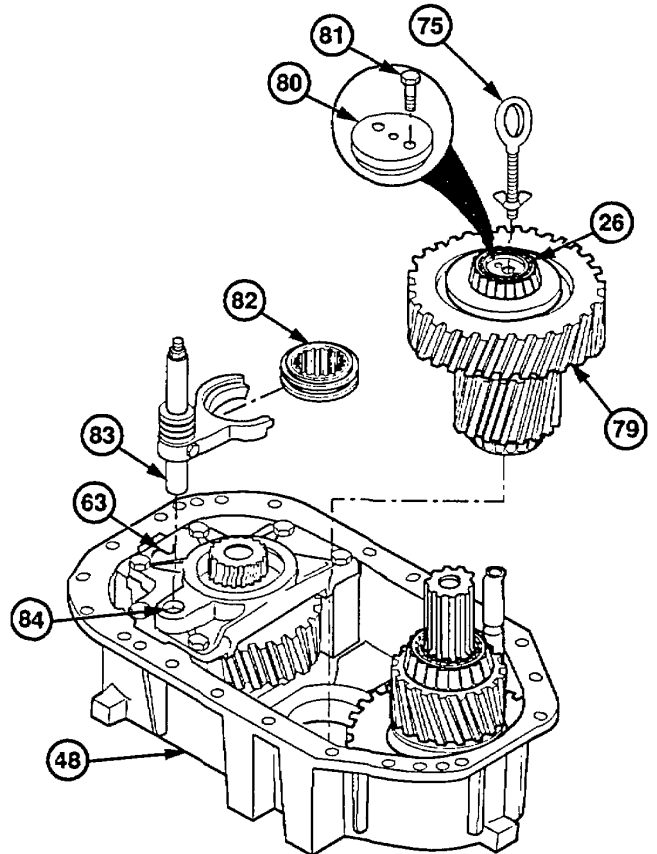
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (79) Coat holes in retainer plate (80) and two screws (81) with adhesive-sealant (Item 6, Appendix B).
 (80) Install retainer plate (80) on center shaft (26) with two screws (81). Torque to 40 lb-ft (54 N•m).

NOTE

Lip on collar should face top of case.

- (81) Install collar (82) on lower fork assembly (83).
 (82) Coat hole (84) in bearing retaining plate (63) and shaft of lower shift fork assembly (83) with grease.
 (83) Install lower shift fork assembly (83) in bearing retaining plate (63).



- (84) Coat shafts of upper shift fork assembly (74) and lower shift fork assembly (83) with grease.
- (85) Coat bushing (25), hole in bearing retaining plate (63), and bearing cone (24) with grease.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (86) Coat inner edge of flange on transfer case rear half (48), just inside holes, with adhesive-sealant (Item 3, Appendix B).

NOTE

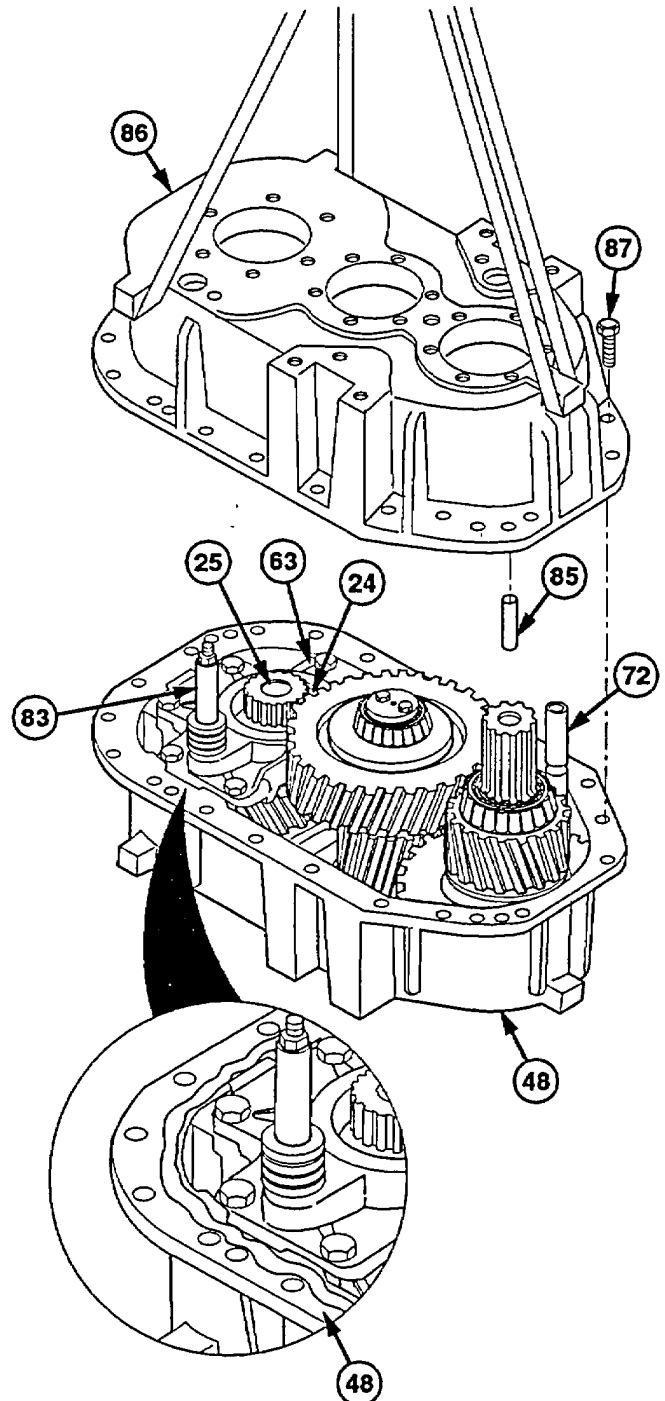
Do step (87) if dowel pins were removed.

- (87) Install two dowel pins (85) on transfer case front half (86).

CAUTION

Lower transfer case front half straight down to prevent possible damage to shift rod.

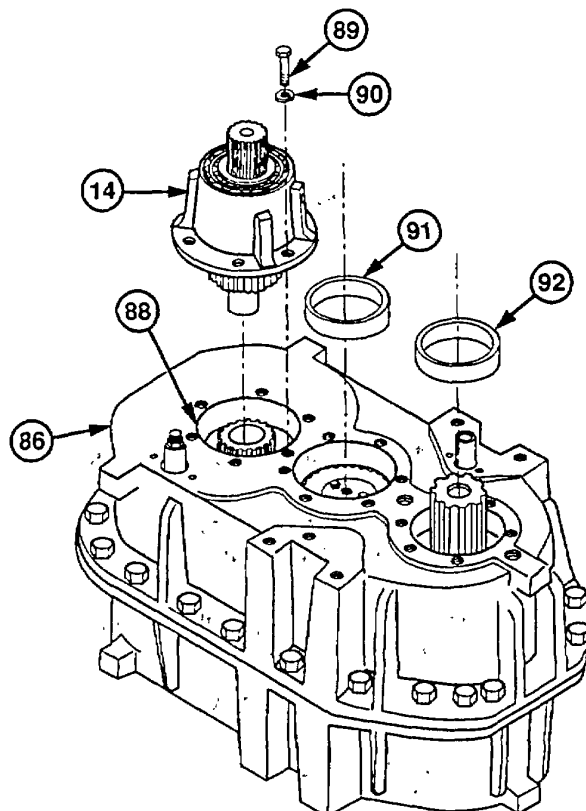
- (88) Lower transfer case front half (86) onto transfer case rear half (48) while aligning dowel pins (85) while assistant operates suitable lifting device.
- (89) Coat threads of screws (87) with adhesive-sealant (Item 6, Appendix B).
- (90) Install 20 screws (87) in housing. Torque to 88 lb-ft (119 N•m).



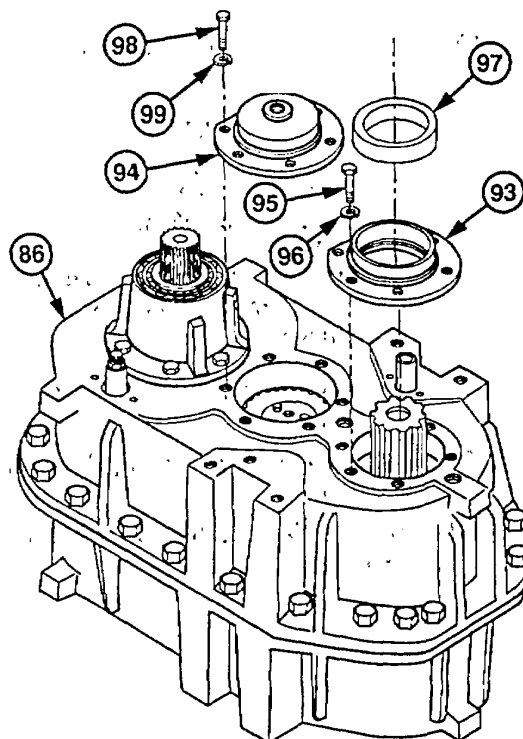
23-2. TRANSFER CASE REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (91) Coat area in and around lower opening (88) with adhesive-sealant (Item 3, Appendix B).
- (92) Coat threads of screws (89) with adhesive-sealant (Item 6, Appendix B).
- (93) Install bearing cap (14) on transfer case front half (86) with new lockwashers (90) and screws (89). Torque to 60 lb-ft (81 N•m).
- (94) Install bearing races (91 and 92) in transfer case front half (86).



- (95) Coat mating surfaces of upper end cap (93) and end cap (94) with adhesive-sealant (Item 3, Appendix B).
- (96) Coat threads of screws (95) with adhesive-sealant (Item 6, Appendix B).
- (97) Install upper end cap (93) on transfer case front half (86) with six new lockwashers (96) and screws (95). Torque to 60 lb-ft (81 N•m).

**NOTE**

Seal is installed with numbered side up.

- (98) Install new seal (97) in upper end cap (93).
- (99) Coat threads of screws (98) with adhesive-sealant (Item 6, Appendix B).
- (100) Install end cap (94) on transfer case front half (86) with six new lockwashers (99) and screws (98). Torque to 60 lb-ft (81 N•m).

- (101) Install end play adapter (100) in center hole (101) of end cap (94).

- (102) Turn transfer case (102) over so rear half (48) faces up.

- (103) Lightly tap down on center shaft (26) through hole (103) in adapter end plate (47) to seat bearings.

- (104) Install dial indicator (67) through hole (103) in adapter end plate (47).

CAUTION

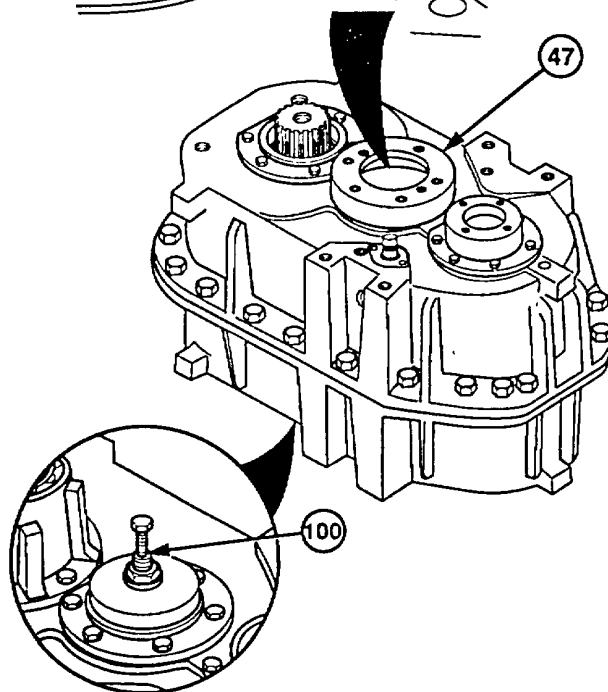
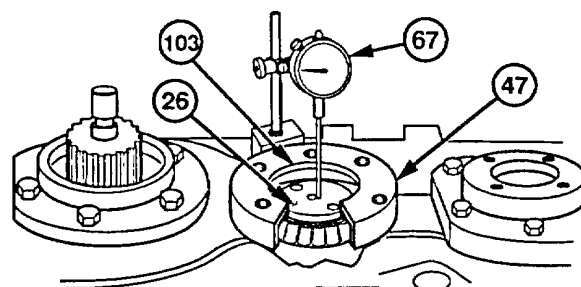
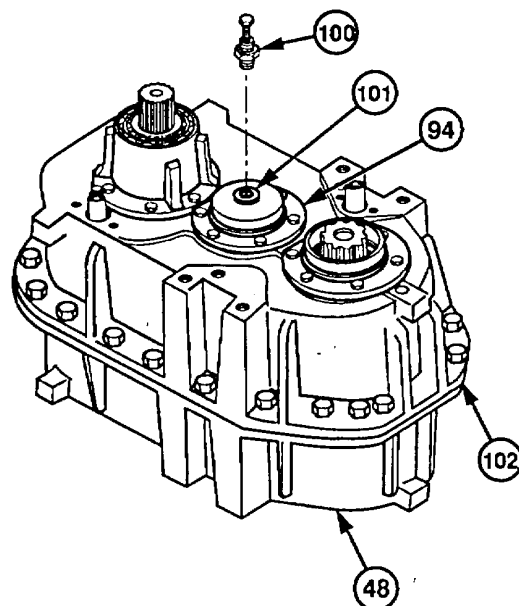
Do not overtighten end play adapter screw. Damage to center shaft end plate may result.

- (105) Turn end play adapter screw (100) clockwise until tight.

NOTE

End play must be 0.003-0.006 in. (0.076-0.15 mm). If end play is less than 0.003 in. (0.076 mm), shims must be added. If end play is greater than 0.006 in. (0.15 mm), shims must be removed.

- (106) Check and record end play measured on dial indicator (67).
- (107) Remove end play adapter (100) from end cap (94).
- (108) Remove dial indicator (67) from adapter end plate (47).



23-2. TRANSFER CASE REPAIR (CONT)

- (109) Remove six screws (50), adapter end plate (47), and shims (46) from rear half (48). Discard lockwashers.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (110) Coat shims (46) and screws (50) with adhesive-sealant (Item 6, Appendix B).

NOTE

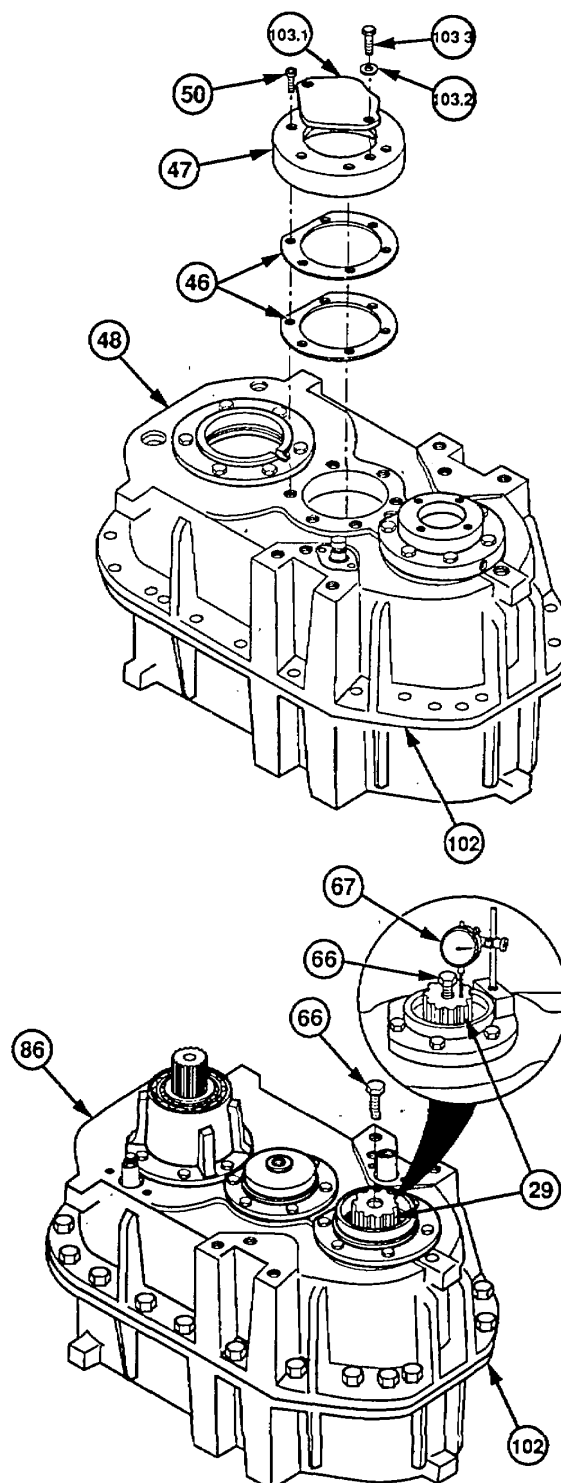
The number of shims installed is amount required to obtain correct end play.

- (111) Install shims (46) and adapter end plate (47) on rear half (48) with six screws (50). Torque to 60 lb-ft (81 N•m).
- (111.1) Install cover plate (103.1) on adapter end plate (47) with two washers (103.2) and screws (103.3).
- (112) Turn transfer case (102) over so front half (86) faces up.
- (113) Install screw (66) in front input shaft (29).
- (114) Lightly tap down on front input shaft (29) to seat bearings.
- (115) Install dial indicator (67) on front input shaft (29).
- (116) Pry up on screw (66) on front input shaft (29).

NOTE

End play must be 0.003-0.006 in. (0.076-0.15 mm). If end play is less than 0.003 in (0.076 mm), shims must be added. If end play is greater than 0.006 in. (0.15 mm), shims must be removed.

- (117) Check and record end play measured on dial indicator (67).
- (118) Remove screw (66) and dial indicator (67) from front input shaft (29).



NOTE

If end play is within specifications, go to step (123). If not, go to step (119).

- (119) Turn transfer case (102) over so rear half (48) faces up.
- (120) Remove six screws (54), lockwashers (53), bearing housing (52), and shims (51) from rear half (48). Discard lockwasher.

WARNING

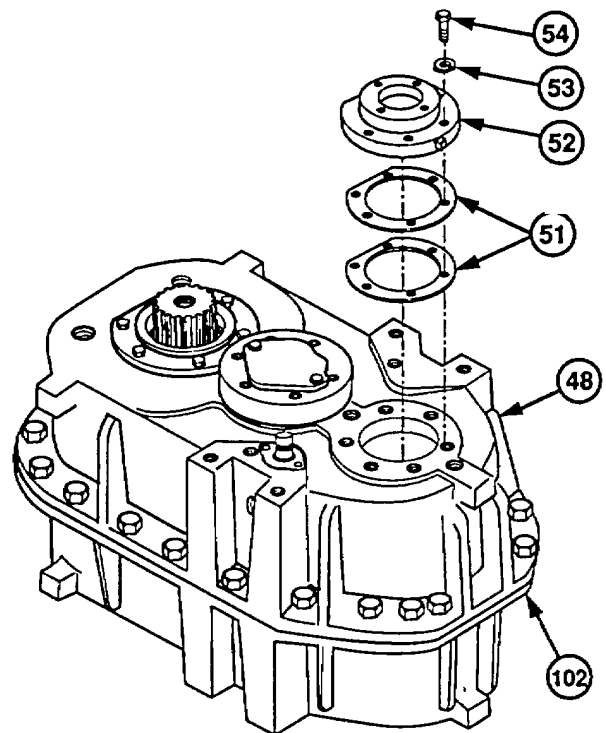
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (121) Coat shims (51) and screws (54) with adhesive-sealant (item 6, Appendix B).

NOTE

The number of shims installed is amount required to obtain correct end play.

- (122) Install shims (51) and bearing housing (52) on rear half (48) with six new lockwashers (53) and screws (54). Torque to 60 lb-ft (81 N•m).



23-2. TRANSFER CASE REPAIR (CONT)**WARNING**

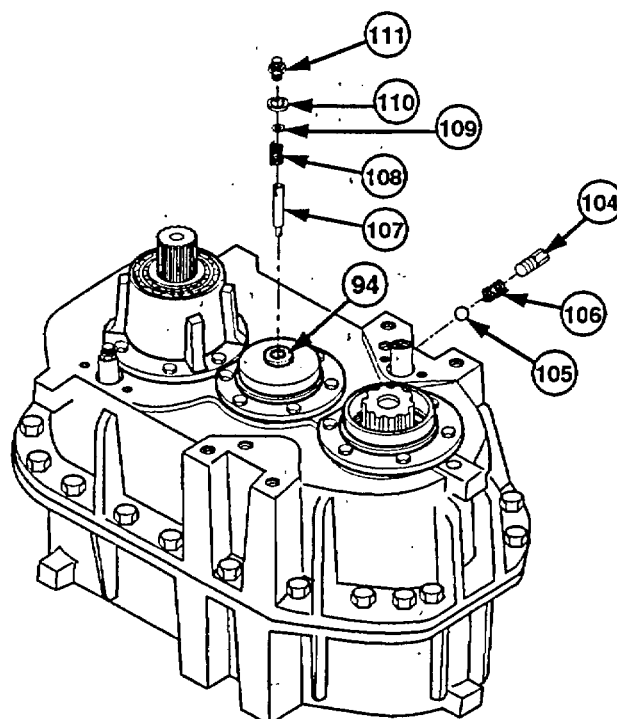
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (123) Coat threads of plug (104) with pipe thread sealing compound.
- (124) Install detent ball (105), spring (106), and plug (104) in transfer case front half (86).
- (125) Install speedo drive shaft (107), spring (108), thrust washer (109), and thrust bearing (110) through end cap (94).
- (126) Install reducer (111) in end cap (94).

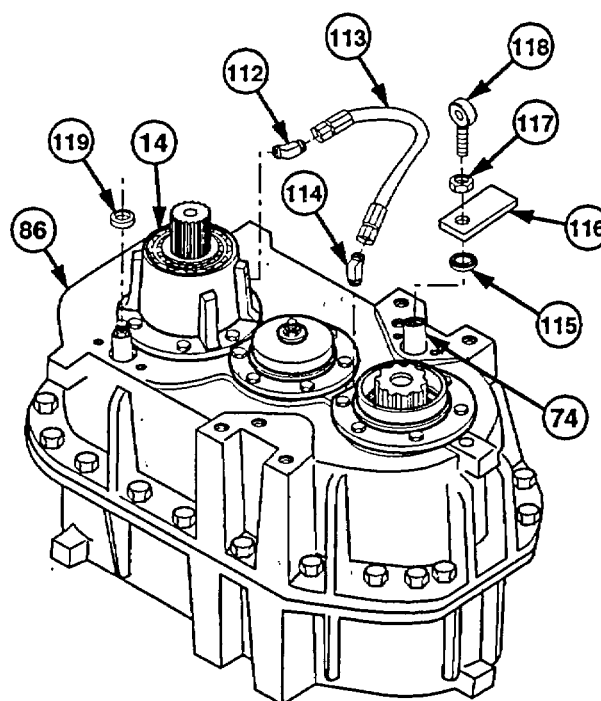
NOTE

Speedo drive shaft may fall out if not retained.

- (127) Install tape on reducer (111) to retain speedo drive shaft (107).



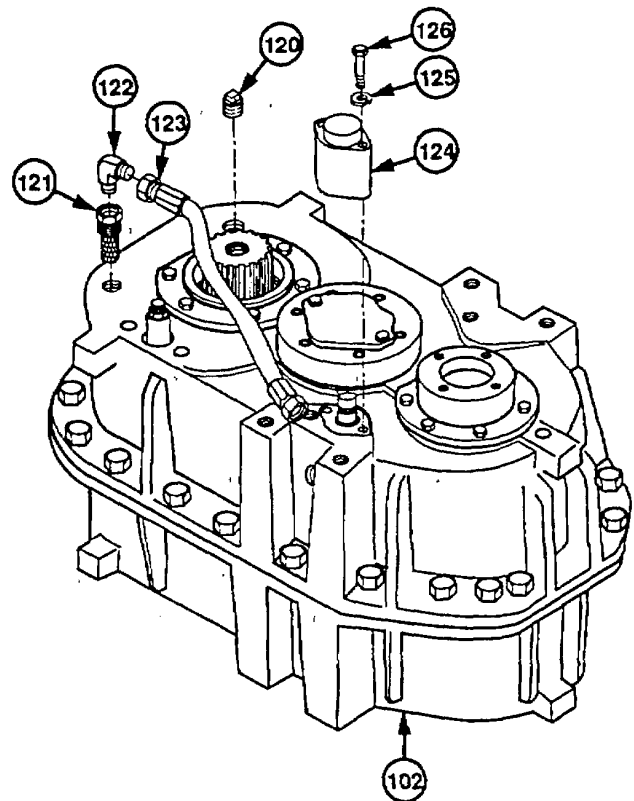
- (128) Install elbow (112) and hose (113) on bearing cap (14).
- (129) Install elbow (114) and hose (113) on transfer case front half (86).
- (130) Install seal (115), actuator plate (116), jam nut (117), and shift rod end (118) on upper shift rod (74).
- (131) Install pilot ring (119) in transfer case front half (86).



- (132) Turn transfer case (102) over so rear half (48) faces up.

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

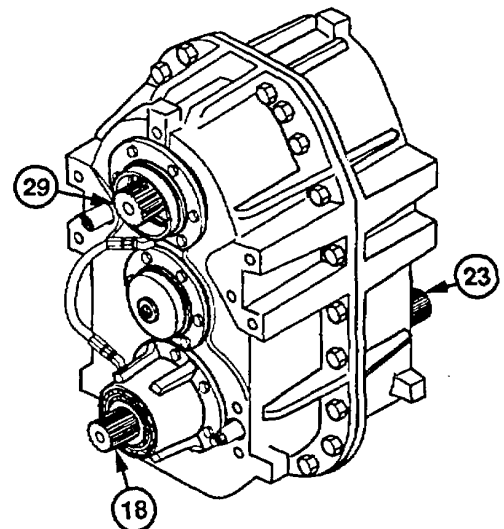


- (133) Coat threads of plug (120), strainer (121), and elbow (122) with pipe thread sealing compound.
- (134) Install plug (120) in transfer case rear half (48).
- (135) Install adapter strainer (121), elbow (122), and lube pump oil supply hose (123) on transfer case rear half (48).
- (136) Install shift cover (124) on transfer case rear half (48) with new lockwashers (125) and screws (126).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

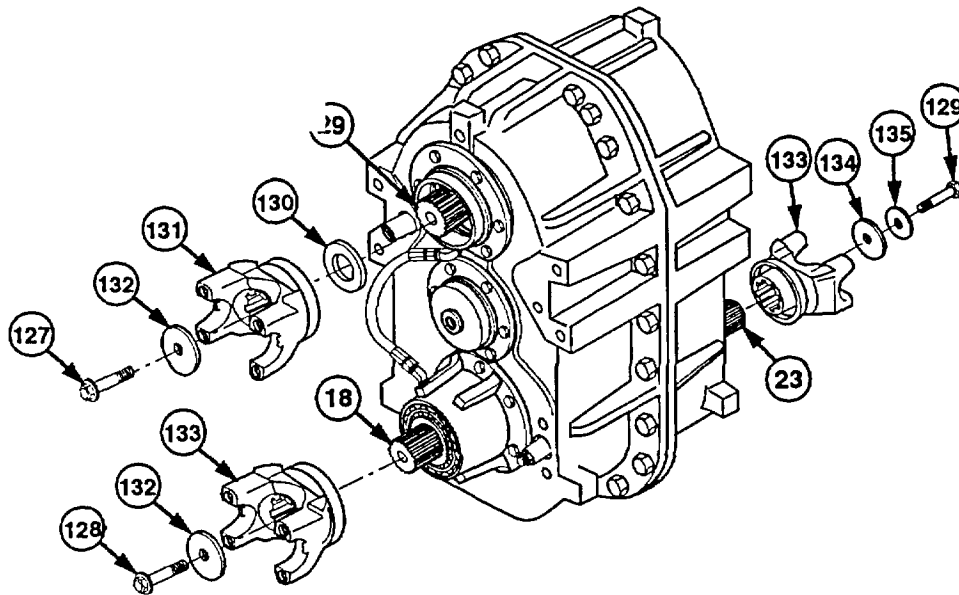
- (137) Coat ends and splines of shaft (18), shaft (23), and shaft (29) with silicone adhesive-sealant.



23-2. TRANSFER CASE REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (138) Coat threads of three screws (127, 128, and 129) with adhesive-sealant (Item 5, Appendix B).
- (139) Install spacer (130), input yoke (131), retainer (132), and screw (127) on input shaft (29). Torque to 375 lb-ft (508 N•m).
- (140) Install front output yoke (133), retainer (132), and screw (128) on front output shaft (18). Torque to 375 lb-ft (508 N•m).
- (141) Install rear output yoke (133), retainer (134), washer (135), and screw (129) on rear output shaft (23). Torque to 308 lb-ft (418 N•m).

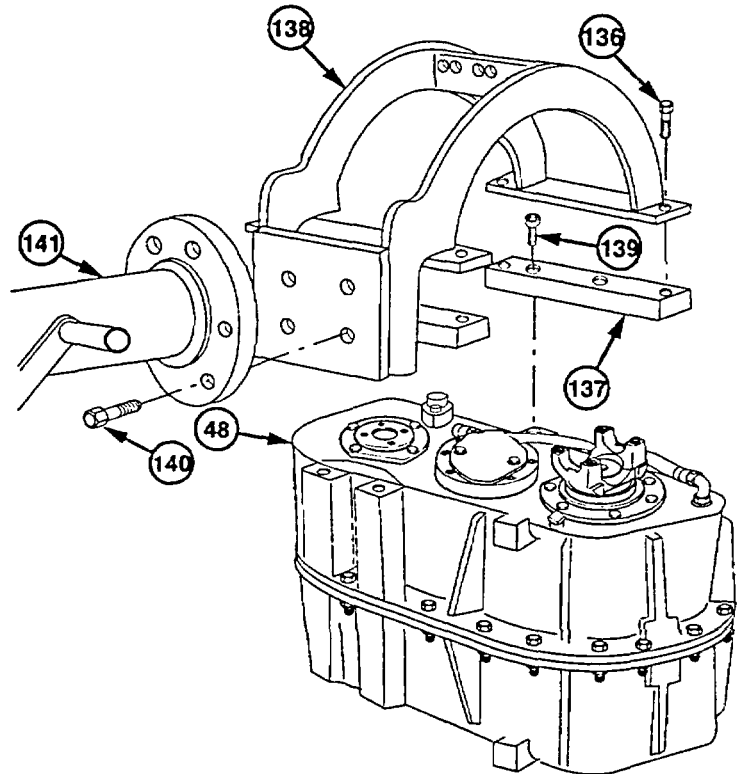


(142) Deleted.

WARNING

Transfer case weighs 965 lb (438 kg). Stay clear of transfer case when supported by lifting device. Transfer case may fall and cause serious injury to personnel.

- (143) Remove four screws (136) and two adapters (137) from transmission holding fixture (138).
- (144) Remove four screws (139) and two adapters (137) from rear transfer case housing (48).
- (145) Remove four screws (140) and transmission holding fixture (138) from engine stand (141).



d. Follow-On Maintenance

- (1) Install breather (TM 9-2320-360-20).
- (2) Install lockout shift chamber (TM 9-2320-360-20)
- (3) Install lubrication pump (para 8-7).

23-3. LUBRICATION PUMP REPAIR

This task covers

- a. Disassembly
- b. Cleaning/Inspection

c. Assembly

Initial Setup:

Equipment Conditions

Lubrication pump on clean work surface

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)

Materials/Parts

Grease, Automotive and Artillery (Item 32, Appendix B)

Paper, Abrasive, Garnet (Item 49, Appendix B)

Solvent, Dry Cleaning (item 54, Appendix B)

Packings, Preformed (2) (Item 173, Appendix F)

Seal (Item 290, Appendix F)

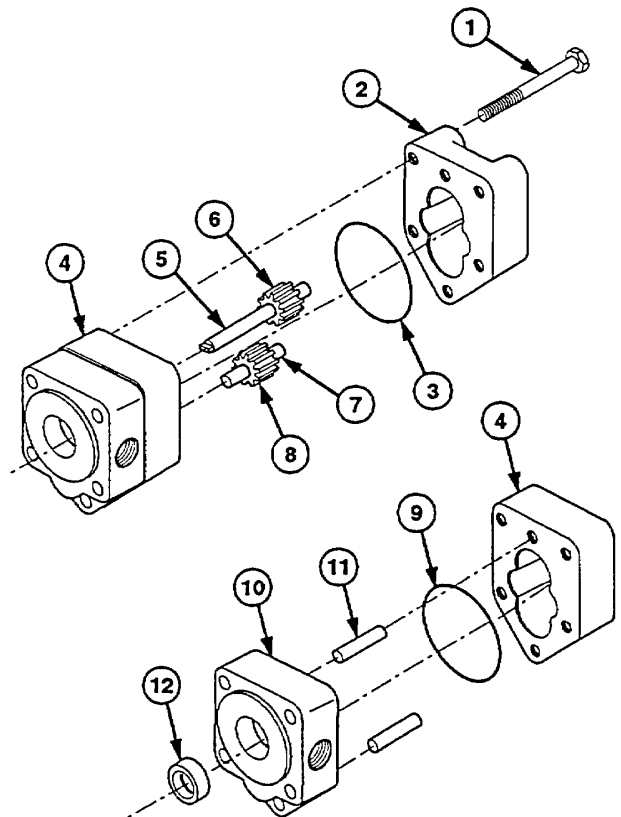
a. Disassembly

NOTE

Alignment sleeves may come out with head.

- (1) Remove two screws (1), head (2), and preformed packing (3) from casing (4). Discard preformed packing.
- (2) Remove shaft (5) with gear (6) from casing (4).
- (3) Remove shaft (7) with gear (8) from casing (4).

- (4) Remove casing (4) and preformed packing (9) from end plate (10). Discard preformed packing.
- (5) Remove two alignment sleeves (11) from end plate (10).
- (6) Remove seal (12) from end plate (10). Discard seal.



b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean all metal parts with dry cleaning solvent.
- (2) Inspect all parts for wear or damage.
- (3) Replace all worn or damaged parts.

c. Assembly

NOTE

Install seal with lip away from bracket.

- (1) Coat new seal (1) with grease and install in end plate (2).
- (2) Install two alignment sleeves (3) in end plate (2).
- (3) Install new preformed packing (4) on casing (5).

NOTE

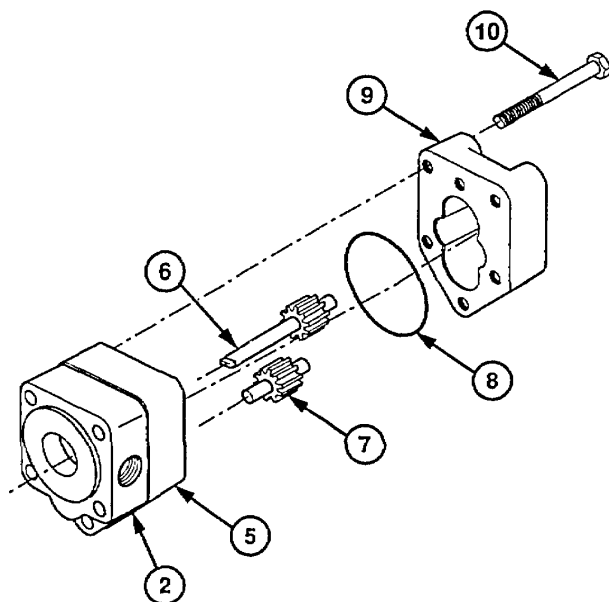
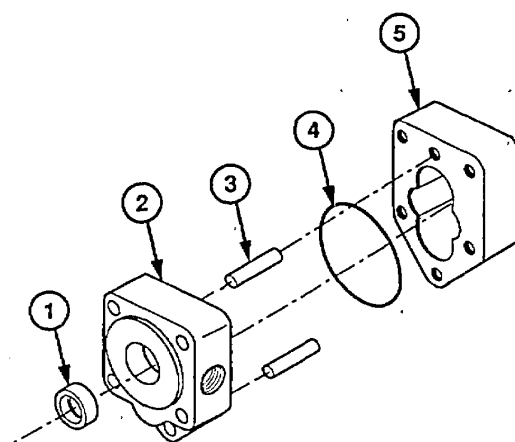
Install casing with preformed packing facing bracket.

- (4) Install casing (5) in end plate (2).
- (5) Install shaft (6) in casing (5) and end plate (2) until end of shaft extends 1-5/8 in. (41.3 mm).
- (6) Install shaft (7) in casing (5) and end plate (2).
- (7) Coat new preformed packing (8) with grease and install on head (9).
- (8) Align screw holes in head (9) with sleeves (3).

NOTE

Install head with preformed packing facing casing.

- (9) Install head (9) on casing (5) and end plate (2) with two screws (10).



CHAPTER 24
FRONT AXLE MAINTENANCE

Contents	Para	Page
Introduction	24-1	24-1
Axle No. 1 Differential Repair	24-2	24-2

Section I. INTRODUCTION

24-1. INTRODUCTION

This chapter contains maintenance instructions for repair of axle no. 1 at the General Support maintenance level. Some subassemblies and parts must be removed before axle components can be accessed. They are referenced to other paragraphs of this manual.

Section II. MAINTENANCE PROCEDURES

24-2. AXLE NO. 1 DIFFERENTIAL REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-On Maintenance

INITIAL SETUP:
Equipment Conditions

Pivot, spindle, and axle shaft
removed (para 9-4).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Holder, Yoke (Figure C-15, Appendix C)
Gage, Preload, Differential Carrier
(Figure C-16, Appendix C)
Installer, Bearing Cone (Figure C-20,
Appendix C)
Adapter, Differential Maintenance (Item 0.1,
Appendix E)
Dial Indicator, Magnetic (Item 32,
Appendix E)
Indicator, Dial (Item 74, Appendix E)
Multiplier, Torque (Item 99, Appendix E)
Press, Hydraulic (Item 116, Appendix E)
Sling, Endless Strap (Item 161, Appendix E)
Socket, 55 mm (Item 163.1, Appendix E)
Stand, Engine (Item 181, Appendix E)
Stand, Maintenance, Automotive Axle
(Item 182, Appendix E)
Wrench Set, Socket, 1 In. Drive (Item 230,
Appendix E)
Wrench Set, Socket, 3/8 In. Drive (Item 232,
Appendix E)
Wrench, Torque, 0-600 Lb-Ft (Item 233,
Appendix E)
Wrench, Torque, 0-150 Lb-In (Item 234,
Appendix E)
Wrench, Torque, 0-300 Lb-in. (Item 235,
Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236,
Appendix E)

Materials/Parts

Adhesive-Sealant, Silicone (Item 2, Appendix B)
Adhesive-Sealant (Item 6, Appendix B)
Cloth, Crocus (Item 16, Appendix B)
Compound, Sealing, Pipe Thread
(Item 28, Appendix B)
Dye, Prussian Blue (Item 30, Appendix B)
Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)
Locknuts (3) (Item 82, Appendix F)
Nut (Item 150, Appendix F)
Seal, Oil (Item 305, Appendix F)

Personnel Required

Two

a. Removal

NOTE

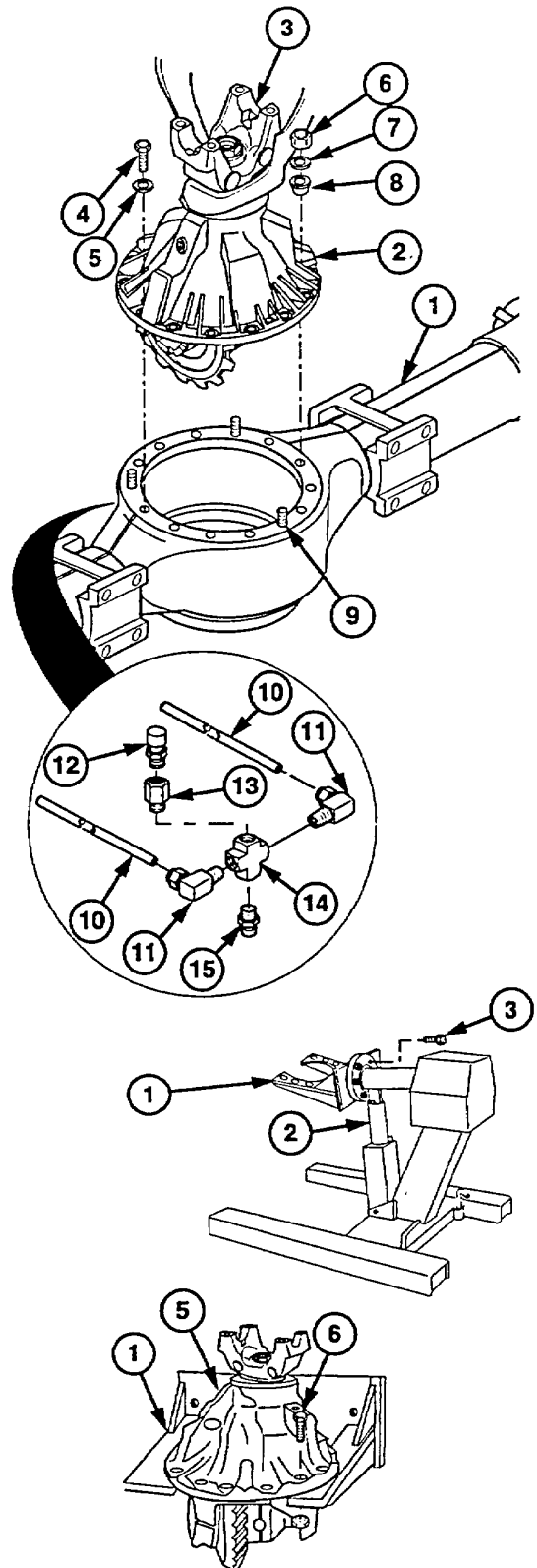
Matchmark differential and axle housing.

- (1) Position axle (1) with differential assembly
- (2) pointing up.
- (2) Attach lifting device to yoke (3).
- (3) Remove 11 screws (4) and washers (5) from differential assembly (2).
- (4) Remove three locknuts (6), washers (7), and taper dowels (8) from studs (9). Discard locknuts.

WARNING

Differential assembly weighs approximately 260 lb (118 kg). Stay clear of differential assembly when it is supported by lifting device. If differential falls, serious injury or death may result.

- (5) Lift differential assembly (2) from axle housing (1) while assistant operates lifting device.
- (6) Remove two breather hoses (10) from elbows (11).
- (7) Remove breather (12) and adapter (13) from tee (14).
- (8) Remove tee (14) and adapter (15) from axle housing (1).
- (9) Remove two elbows (11) from tee (14).



b. Disassembly

- (1) Install adapter (1) on stand (2) with six screws (3).
- (2) Install differential assembly (5) on adapter (1) with six screws (6).
- (3) Remove lifting device from differential assembly (5).

24-2. AXLE NO. 1 DIFFERENTIAL REPAIR (CONT)

- (4) Position differential assembly (5) so pinion shaft (8) points down.
- (5) Check backlash of differential (9) to pinion shaft (8).
- (6) Hold yoke (10) so that pinion gear (11) does not move.

NOTE

Do not allow pinion gear to turn while doing steps (7) thru (9).

- (7) Turn differential (9) counterclockwise until it stops to take up backlash.

NOTE

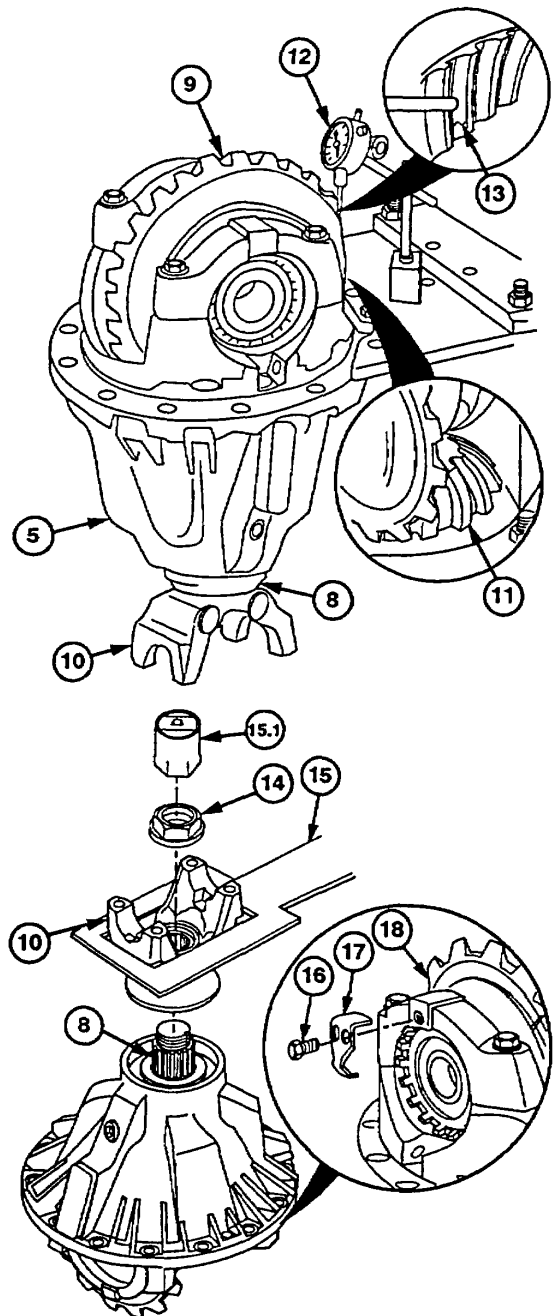
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (8) Install dial indicator (12) on face of differential gear tooth (13).
- (9) Turn differential (9) clockwise until it stops.

NOTE

Backlash should be 0.010-0.016 in. (25-41 mm). To increase backlash, reduce thickness of shims installed in carrier housing. To decrease backlash, increase thickness of shims.

- (10) Record differential (9) to pinion shaft (8) backlash measured on dial indicator (12).
- (11) Unstake nut (14) on yoke (10).
- (12) Position yoke holder (15) on yoke (10).
- (13) Remove nut (14) and yoke (10) from pinion shaft (8) using yoke holder (15) and socket (15.1) with aid of assistant.
- (14) Remove screw (16) and nut lock plate (17) from bearing cap (18).



- (15) Remove four screws (19) from two bearing caps (18).
- (16) Remove two bearing caps (18) and adjusting nut (20) from differential housing (21).
- (17) Lift differential (9) from housing (21) with the aid of assistant. Place on work surface.

NOTE

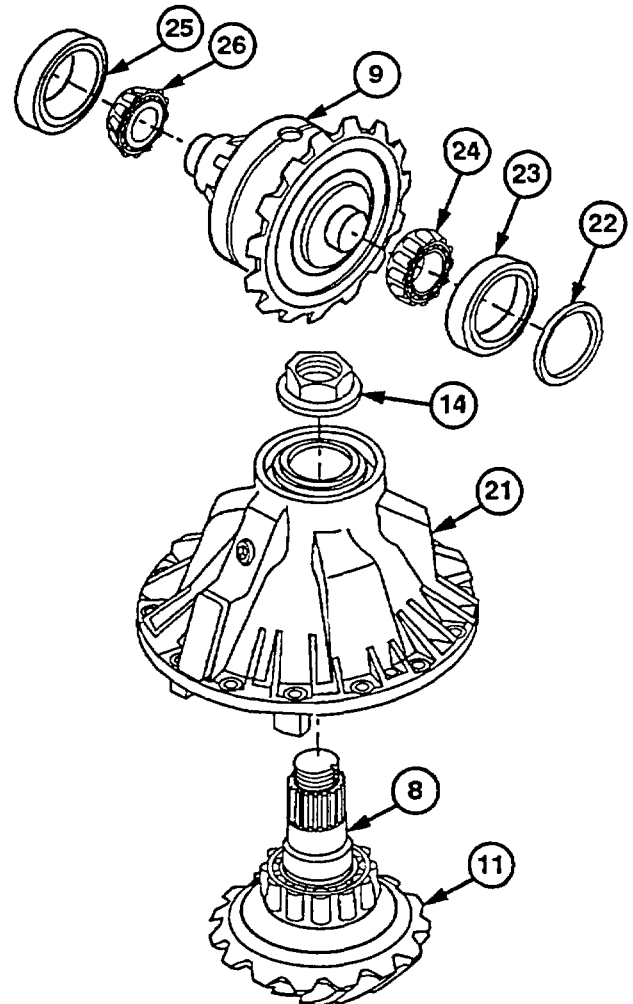
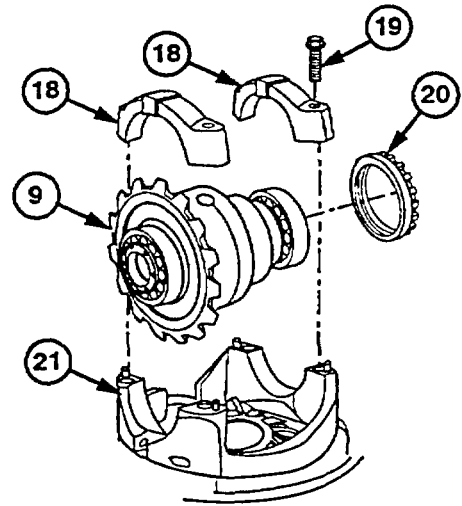
- Remove taper bearings only if they fail inspection.
- To remove taper bearing from gear side of differential, first remove cage and rollers from under race. Then pry inner race high enough to install puller.
- Tag and mark shims before removal.

- (18) Remove adjusting shim (22), taper race (23), and taper bearing (24) from gear side of differential (9).
- (19) Remove taper race (25) and taper bearing (26) from other side of differential (9).

CAUTION

During removal of pinion gear, do not allow gear teeth to engage with the inside of the housing and cover assembly. Damage to equipment may result.

- (20) Install nut (14) loosely on end of pinion shaft (8).
- (21) Remove pinion gear (11) from housing (21) while assistant supports pinion gear (11).
- (22) Remove and discard nut (14).



24-2. AXLE NO. 1 DIFFERENTIAL REPAIR (CONT)

- (23) Remove pinion seal (27), taper bearing (28), and taper race (29) from housing (21). Discard pinion seal.

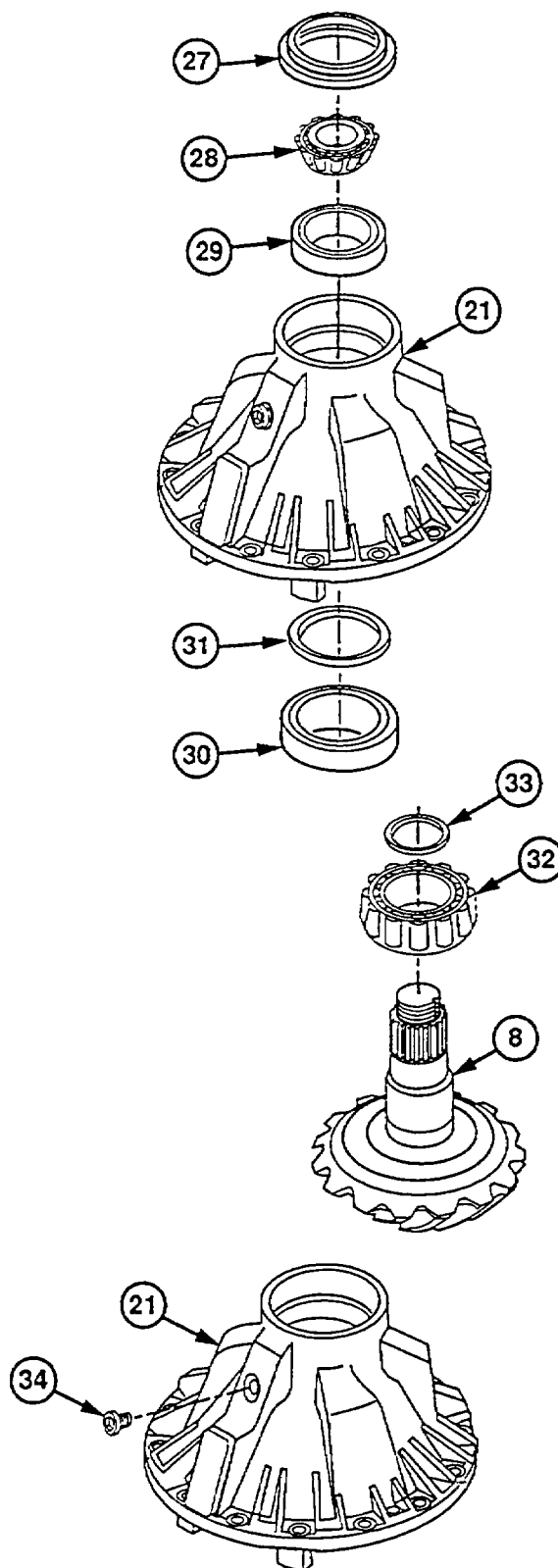
NOTE

Tag and mark shims before removal.

- (24) Remove taper race (30) and shim (31) from housing (21).

- (25) Remove taper bearing (32) and shim (33) from pinion shaft (8).

- (26) Remove filler plug (34) from housing (21).



c. Cleaning/inspection

- (1) Clean old gasket material from housing and/or caps.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean sealant residue from threaded holes with dry cleaning solvent.

CAUTION

Wash machined parts separately to avoid damage from parts bumping together.

- (3) Wash metal parts in dry cleaning solvent.

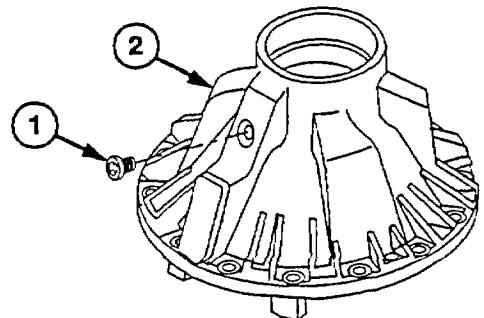
WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) Dry parts, except bearings, with compressed air. Allow bearings to air dry.
- (5) Remove small nicks or burrs with crocus cloth.
- (6) Coat parts with light coat of lubricating oil.
- (7) Inspect housing and caps for damage.
- (8) Inspect all parts and bearings with machined surfaces for deep scratches or wear grooves.
- (9) Replace damaged parts.

d. Assembly

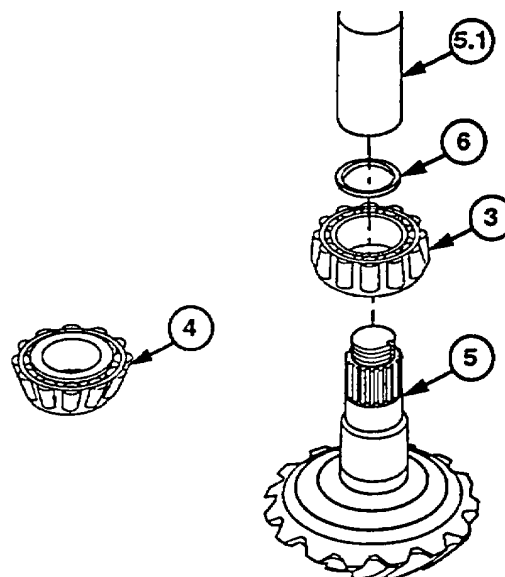
- (1) Install filler plug (1) in differential housing (2).



24-2. AXLE NO. 1 DIFFERENTIAL REPAIR (CONT)**NOTE**

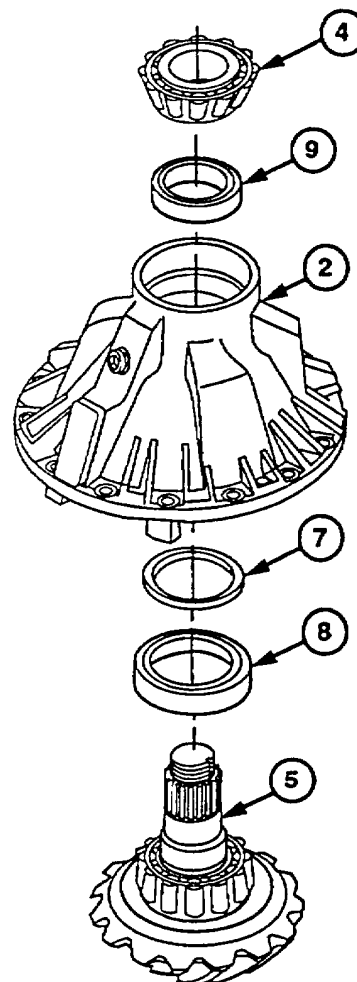
If installing new gear set, record size of pinion gear (engraved on pinion end). Compare dimension with new gear set. If new size is larger, pinion gear shims will be thinner.

- (2) Coat bearings (3 and 4) with lubricating oil.
- (3) Press taper bearing (3) on pinion shaft (5) using pinion bearing cone installer (5.1).
- (3.1) Install shim (6) over end of pinion shaft (5).

**NOTE**

If small shim thickness is increased or decreased, large shim must be changed accordingly.

- (4) Install shim (7) and taper race (8) in housing (2) until fully seated.
- (5) Install pinion shaft (5) through housing (2).
- (6) Install taper race (9) and taper bearing (4) on pinion shaft (5) while assistant supports pinion shaft (5).



WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (7) Coat new pinion seal (10) outer edge with adhesive-sealant.

NOTE

Pinion seal is installed properly when top of seal is 1/16 in. (1.59 mm) below surface of housing.

- (8) Install new pinion seal (10) in housing (2).

WARNING

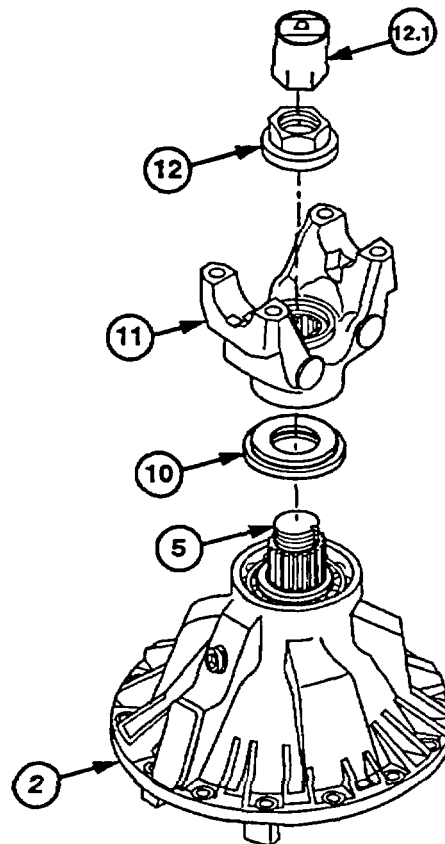
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (9) Coat splines of pinion shaft (5) with silicone adhesive-sealant.
 (10) Coat threads of pinion shaft (5) with adhesive-sealant.

NOTE

Yoke should be positioned so large openings of yoke align with notches of pinion shaft. This will ease staking of nut.

- (11) Install yoke (11) and new nut (12) on pinion shaft (5) using socket (12.1). Torque to 486-572 lb-ft (659-775 N•m).
 (12) Bend edge of nut (12) into notches of pinion shaft (5).
 (13) Check pinion preload by turning nut (12) with torque wrench. Torque should be 38-48 lb-in. (4.31-5.44 N•m).



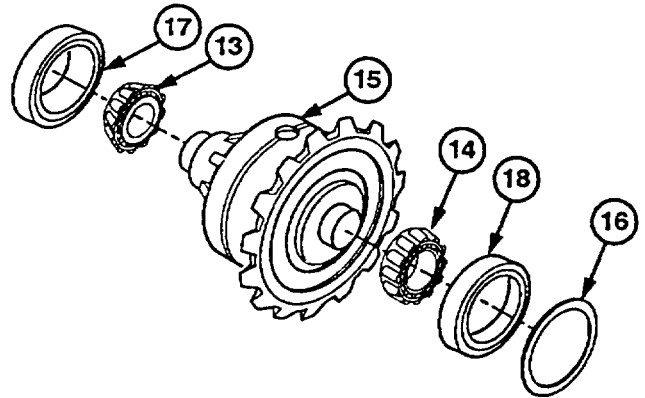
24-2. AXLE NO. 1 DIFFERENTIAL REPAIR (CONT)

- (14) Install taper bearings (13 and 14) on differential gear (15).

NOTE

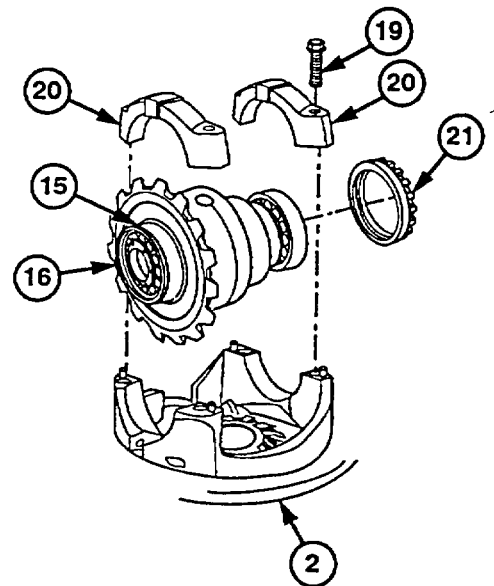
If thickness of pinion gear shims increased, differential shim must be decreased by same amount. If thickness of pinion gear shims decreased, differential shim must be increased by same amount. Refer to TM 9-2320-360-34P for proper identification of parts.

- (15) Measure thickness of shim (16) and change thickness if necessary.
 (16) Install differential gear (15), bearing races (17 and 18), and shim (16) in differential housing (2).

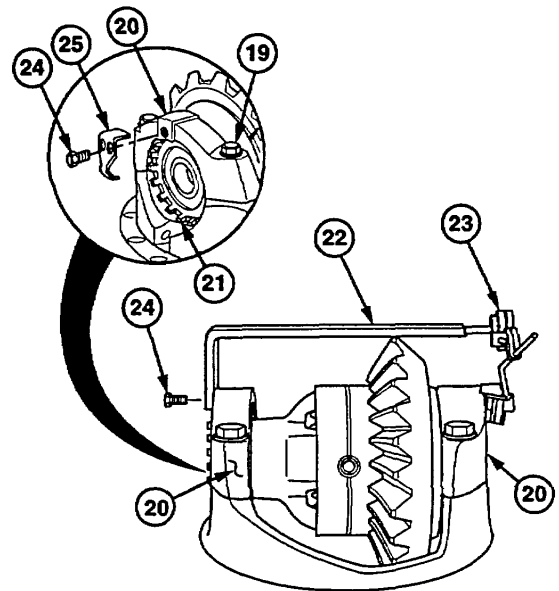
**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (17) Coat threads of capscrews (19) with adhesive-sealant.
 (18) Install two bearing caps (20) on housing (2) with four capscrews (19). Torque to 25 lb-in. (2.82 N•m).
 (19) Install adjusting nut (21) in bearing cap (20).



- (20) Install differential carrier preload gage (22) on bearing cap (20) with screw (24).
- (20.1) Position magnetic base of dial indicator (23) on bearing cap (20).
- (20.2) Position probe of dial indicator (23) on differential carrier preload gage (22).
- (20.3) Zero dial indicator (23).
- (21) Tighten adjusting nut (21) until bearing caps (20) expand 0.013-0.017 in. (.33-.43 mm).
- (21.1) Remove screw (24), differential carrier preload gage (22) and dial indicator (23) from bearing caps (20).
- (22) Tighten capscrews (19) to 125 lb-ft (169 N•m).
- (23) Coat capscrew (24) with adhesive-sealant.
- (24) Install capscrew (24) in lockplate (25) and bearing cap (20). Torque to 132-216 lb-in. (14.9-24.4 N•m).
- (25) Check backlash of differential (15) to pinion shaft (5).
- (26) Hold yoke (11) so that pinion gear (26) does not move.



NOTE

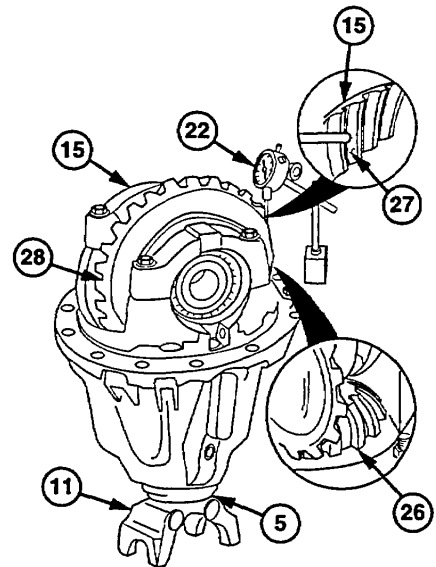
Do not allow pinion gear to turn while doing steps (27) thru (29).

- (27) Turn differential (15) counterclockwise until it stops to take up backlash.

NOTE

Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (28) Install dial indicator (22) on face of differential gear tooth (27).
- (29) Turn differential (15) clockwise until it stops.



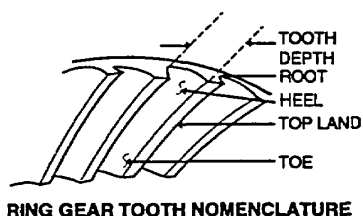
NOTE

Backlash should be 0.010-0.013 in. (0.25-0.33 mm). To increase backlash, reduce thickness of shim. To decrease backlash, increase thickness of shim.

- (30) Record differential (15) to pinion shaft (5) backlash measured on dial indicator (22).

24-2. AXLE NO. 1 DIFFERENTIAL REPAIR (CONT)

- (31) Coat gear teeth of ring gear (28) with prussian blue dye. Check for correct pattern by rotation. Remove and adjust shims as necessary.

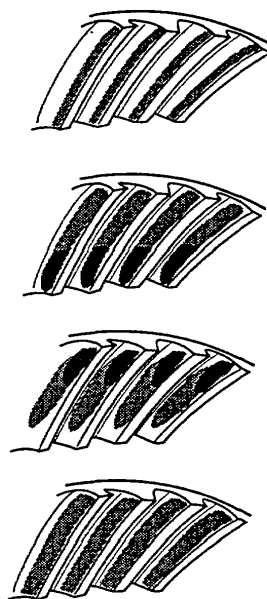
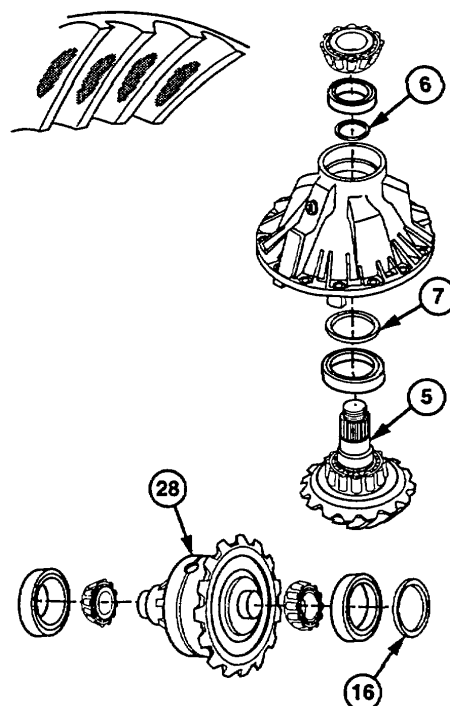


RING GEAR TOOTH NOMENCLATURE

NOTE

Any time pinion depth is changed, backlash may change. Check and adjust backlash as needed. A correct pattern is clear of toe and centers evenly along width of face between top land and root. Length and shape of pattern may vary and is acceptable as long as pattern does not run off tooth at any point.

- (32) Move ring gear (28) away from pinion shaft (5) by using a thinner shim (16) and thicker shims (6) and (7) if pattern is too close to top of tooth.
- (33) Move ring gear (28) away from pinion shaft (5) by using a thinner shim (16) and thicker shims (6) and (7) if pattern is too close or off tooth root.
- (34) Move ring gear (28) toward pinion shaft (5) by using a thicker shim (16) and thinner shims (6) and (7) if pattern is too close or off tooth heel.
- (35) Move ring gear (28) toward pinion shaft (5) by using a thicker shim (16) and thinner shims (6) and (7) if pattern is too close to bottom of tooth.

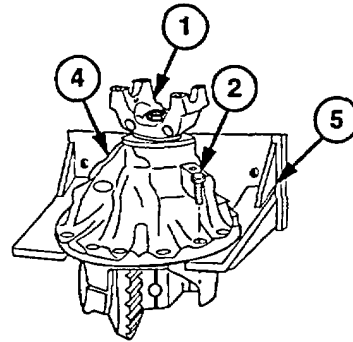


e. Installation

- (1) Attach lifting device to yoke (1).
- (2) Remove six screws (2) and differential assembly (4) from adapter (5).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.



- (3) Coat around mounting flange of differential assembly (4) with silicone adhesive-sealant.

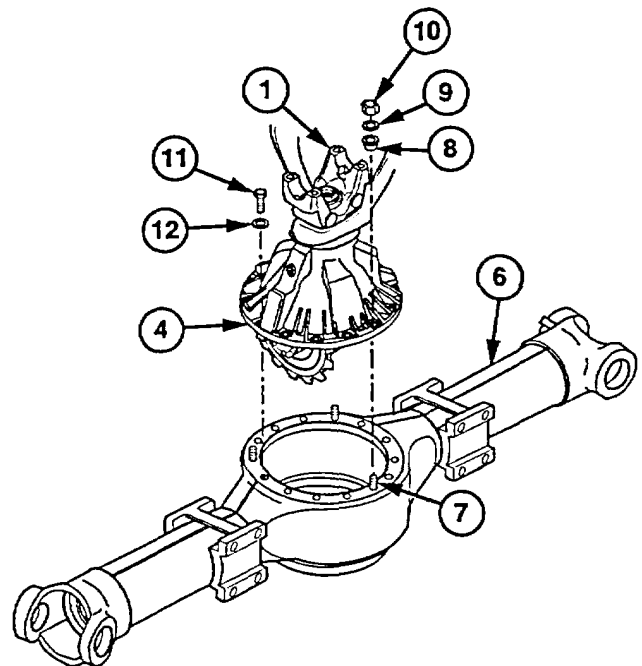
WARNING

Differential assembly weighs approximately 260 lb (118 kg). Stay clear of differential assembly when it is supported by lifting device. If differential falls, serious injury or death may result.

- (4) Install differential assembly (4) on axle housing (6) while assistant operates lifting device.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

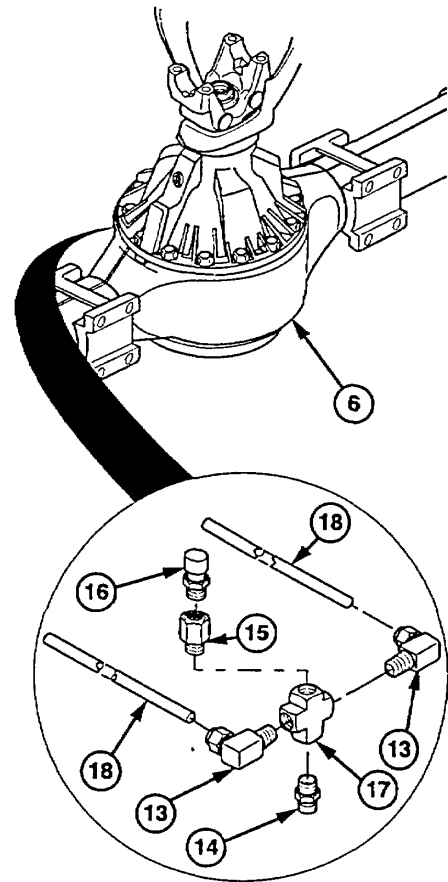


- (5) Coat three studs (7) with adhesive-sealant. Install three taper dowels (8), washers (9) and nuts (10) on studs (7). Torque to 140-152 lb-ft (190-206 N•m).
- (6) Coat 11 screws (11) with adhesive-sealant. Install washers (12) and screws (11) in differential assembly (4). Torque to 140-152 lb-ft (190-206 N•m).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (7) Coat threads of two elbows (13), adapter (14), adapter (15), and breather (16) with pipe thread sealing compound.
- (8) Install two elbows (13) on tee (17).
- (9) Install tee (17) and adapter (14) in axle housing (6).
- (10) Install adapter (15) and breather (16) on tee (17).
- (11) Install two breather hoses (18) on elbows (13).

**f. Follow-On Maintenance**

Install axle shafts, pivots, and spindles (para 9-4).

CHAPTER 25
REAR AXLES MAINTENANCE

Contents	Para	Page
Introduction	25-1	25-1
Axle No. 2 Differential Repair	25-2	25-2
Axle No. 3 Differential Repair	25-3	25-35
Axle No. 4 Differential Repair	25-4	25-57

Section I. INTRODUCTION

25-1. INTRODUCTION

This chapter contains maintenance instructions for repair of axle no. 2, axle no. 3, and axle no. 4 at the General Support maintenance level. Some subassemblies and parts must be removed before axle components can be removed. They are referenced to other paragraphs of this manual.

Section II. MAINTENANCE PROCEDURES

25-2. AXLE NO. 2 DIFFERENTIAL REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-on Maintenance
-

INITIAL SETUP**Equipment Conditions**

Oil drained from differential assembly
(LO 9-2320-360-12).
Axle manifold removed (TM 9-2320-360-20).
Brake chambers removed
(TM 9-2320-360-20).
Axle shafts removed (para 10-8).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Blocks, Wooden (Figure C-3, Appendix C)
Extractor, Jet (Figure C-11, Appendix C)
Holder, Yoke (Figure C-15, Appendix C)
Gage, Preload, Differential Carrier
Figure C-16, Appendix C)
Installer, Bearing Cone (Figure C-20,
Appendix C)
Adapter, Differential Maintenance
(Item 0.1, Appendix E)
Caliper Set, Micrometer (Item 15, Appendix E)
Crowbar (Item 30, Appendix E)
Dial Indicator, Magnetic (Item 32,
Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Multiplier, Torque (Item 99, Appendix E)
Press, Hydraulic (Item 116, Appendix E)
Puller Kit, Mechanical, Gear and Brg
(Item 124, Appendix E)
Remover/Setter, Stud (Item 137, Appendix E)
Sling, Endless Strap (Item 161, Appendix E)
Socket, 63 mm (Item 163.2, Appendix E)
Socket, Sockethead Screw, 10 mm
(Item 175, Appendix E)
Socket, Spanner (Item 176, Appendix E)
Socket, Spanner (Item 177, Appendix E)
Socket, Spanner (Item 178, Appendix E)
Stand, Engine (Item 181, Appendix E)
Stand, Maintenance, Automotive Axle
(Item 182, Appendix E)
Wrench Set, Socket, 1 In. Drive (Item 230,
Appendix E)
Wrench Set, Socket, 3/4 In. Drive (Item 231,
Appendix E)

Tools and Special Tools (Cont)

Wrench Set, Socket, 3/8 In. Drive (Item 232,
Appendix E)
Wrench, Torque, 600 Lb-Ft (Item 233,
Appendix E)
Wrench, Torque, 150 Lb-In. (Item 234,
Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235,
Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236,
Appendix E)

Materials/Parts

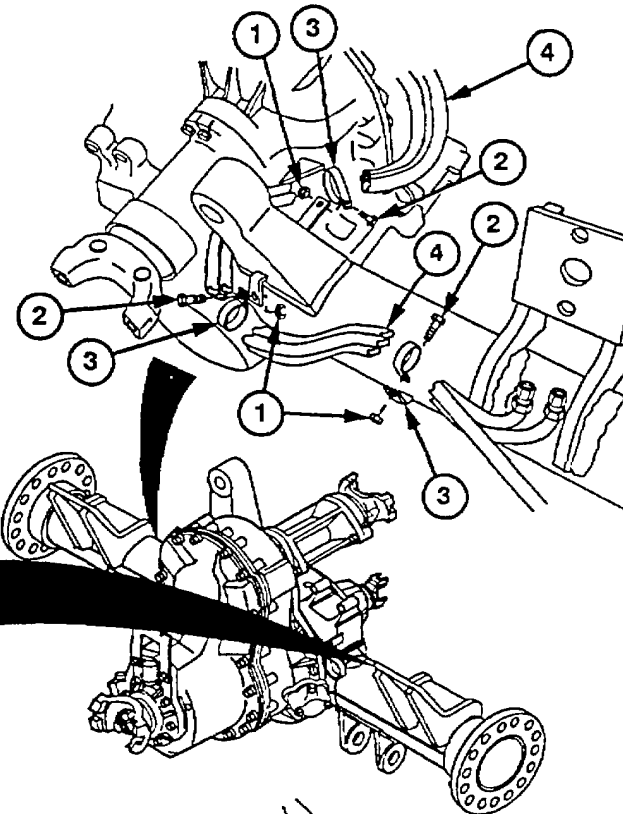
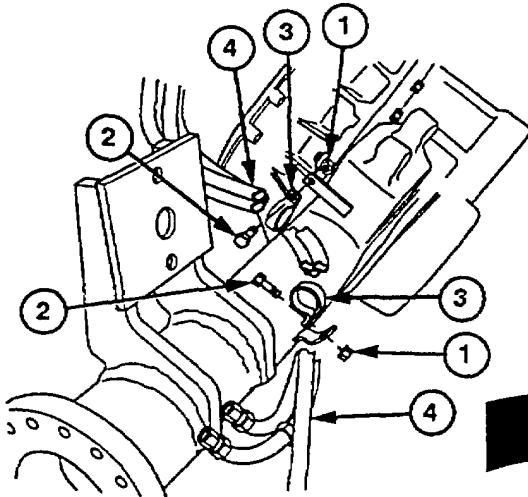
Adhesive-Sealant, Silicone (Item 2,
Appendix B)
Adhesive-Sealant (Item 3, Appendix B)
Adhesive-Sealant (Item 4, Appendix B)
Adhesive-Sealant (Item 6, Appendix B)
Cloth, Crocus (Item 16, Appendix B)
Compound, Sealing, Pipe Thread
(Item 28, Appendix B)
Dye, Prussian Blue (Item 30, Appendix B)
Grease, Ball Bearing (Item 33, Appendix B)
Oil, Lubricating (Item 48, Appendix B)
Rags (Item 51, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)
Locknuts (14) (Item 82, Appendix F)
Locknuts (5) (Item 96, Appendix F)
Nuts (2) (Item 149, Appendix F)
Nut (Item 146, Appendix F)
Packings, Preformed (Item 166, Appendix F)
Packing, Preformed (Item 174, Appendix F)
Seals, Oil (2) (Item 305, Appendix F)

Personnel Required

Two

a. Removal

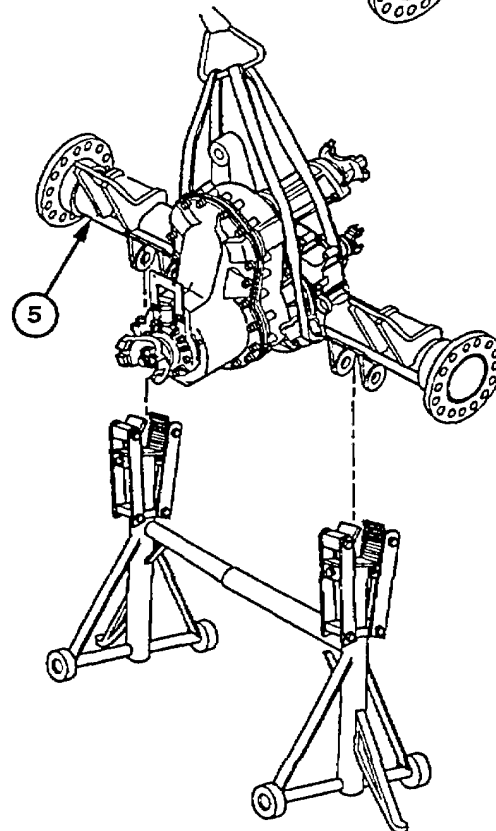
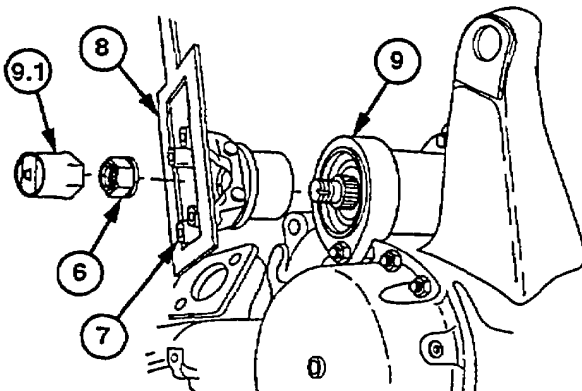
- (1) Remove five locknuts (1), screws (2), cushion clips (3), and six hoses (4) from axle housing (5). Discard locknuts.



WARNING

Axle weighs 2160 lb (981 kg). Use caution when lifting or moving axle. Failure to do so may result in serious injury or death to personnel.

- (2) Attach suitable lifting device to axle housing (5) and install in axle stand with aid of assistant.
- (3) Unstake nut (6) on output yoke (7).
- (4) Position yoke holder (8) on yoke (7).
- (5) Remove nut (6) and output yoke (7) from output housing (9) using socket (9.1) with aid of assistant. Discard nut.



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (6) Remove nut (10) from output housing (9).
- (7) Remove seal (11) from output housing (9).
- (8) Remove spanner nut (12) from output housing (9) using socket (13).
- (9) Remove seven screws (14), clip (15), and rear output housing (9) from differential assembly (16).
- (10) Remove four locknuts (17) and washers (18) from axle housing (5).

WARNING

Axle weighs 2160 lb (980 kg). Use caution when lifting or moving axle. Failure to do so may result in serious injury or death to personnel.

- (11) Position axle housing (5) in stand so input yoke (19) is pointing up.

WARNING

Differential assembly weighs approximately 950 lb (431 kg). Use caution while lifting or moving differential assembly. Failure to do so may result in serious injury to personnel.

- (12) Attach three lifting straps to differential assembly (16).

NOTE

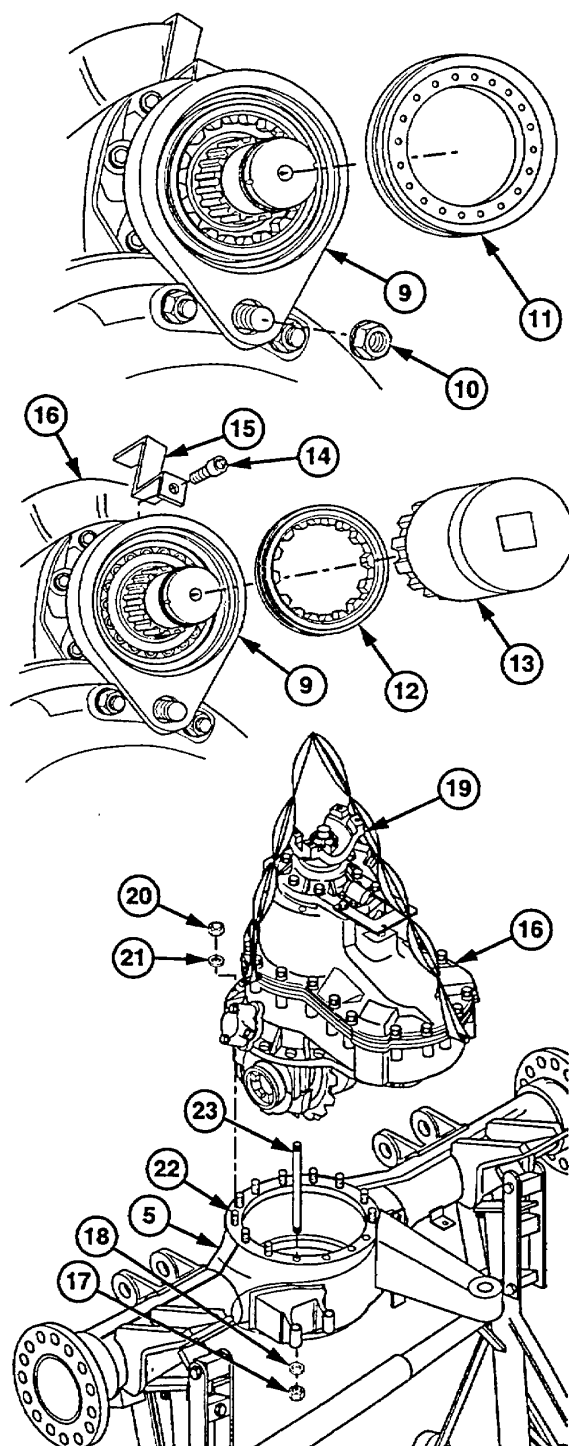
Studs may come out of housing rather than nuts from studs.

- (13) Remove 10 locknuts (20) and washers (21) from studs (22). Discard locknuts.
- (14) Separate differential assembly (16) from axle housing (5) while assistant operates lifting device.

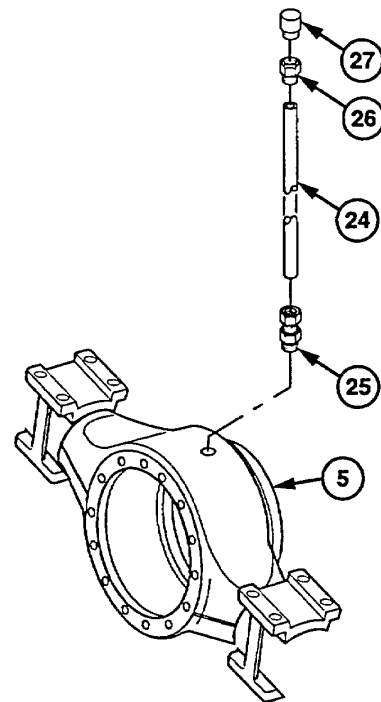
NOTE

Studs may come out of housing rather than nuts from studs.

- (15) Remove four studs (23) from differential assembly (16).



- (16) Remove breather hose (24) from adapter (25).
- (17) Remove adapter (25) from axle housing (5).
- (18) Remove breather hose (24) from adapter (26).
- (19) Remove breather (27) from adapter (26).



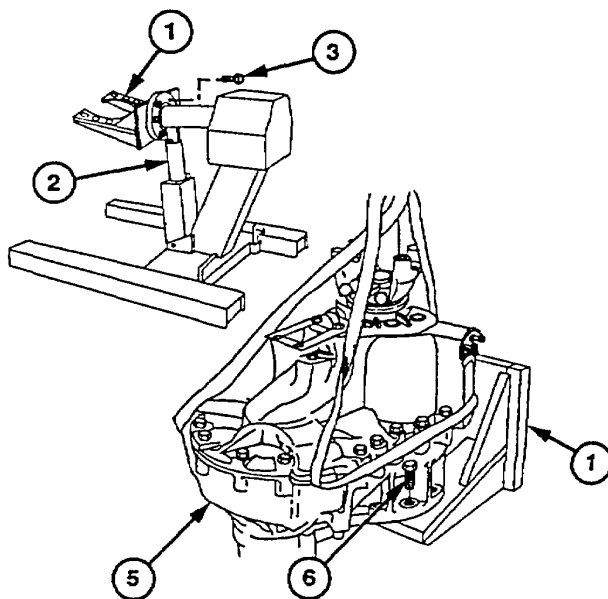
b. Disassembly

- (1) Install adapter (1) on stand (2) with six screws (3).

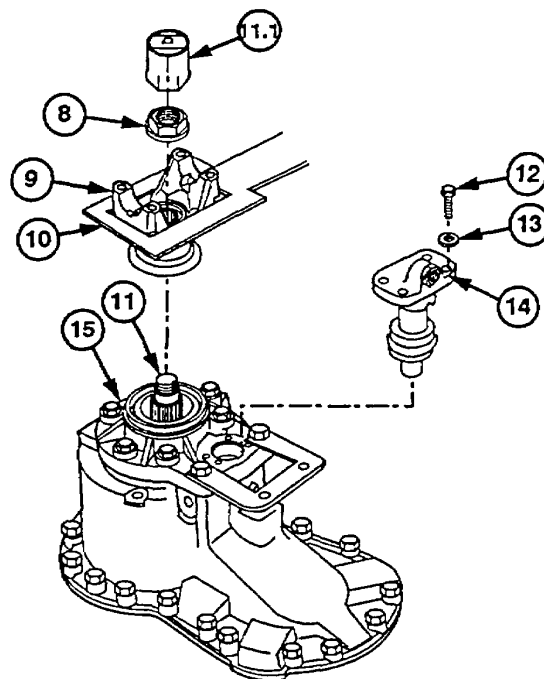
WARNING

Differential assembly weighs 950 lb (431 kg). Use caution while lifting or moving differential assembly. Failure to do so may result in serious injury to personnel.

- (2) Install differential assembly (5) on adapter (1) with six screws (6).



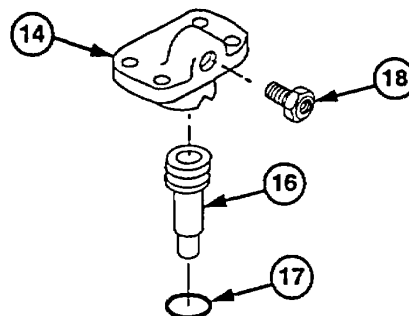
- (3) Unstake nut (B) on yoke (9).
- (4) Position differential assembly (5) with input yoke (9) pointing up.
- (5) Position yoke holder (10) on yoke (9).
- (6) Remove nut (8), yoke holder (10), and input yoke (9) from input shaft (11) using socket (11.1) with aid of assistant. Discard nut.
- (7) Remove four screws (12) and washers (13) from cover (14).
- (8) Remove cover (14) from front housing cover (15).



NOTE

Piston pin may stay in cover or housing cover.

- (9) Remove piston pin (16) from cover (14) or housing cover (15).
- (10) Remove preformed packing (17) from piston pin (16). Discard preformed packing.
- (11) Remove fitting (18) from cover (14).



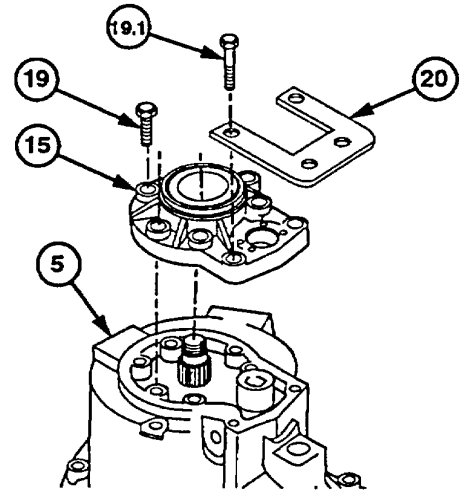
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (12) Remove six screws (19), two screws (19.1), and manifold bracket (20) from front housing cover (15).

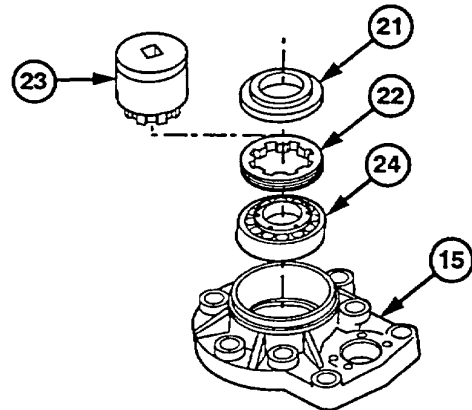
NOTE

Cover is removed by lifting up on cover while assistant taps on input shaft.

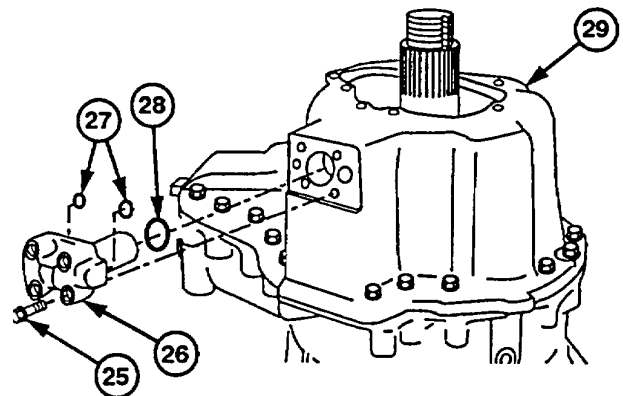
- (13) Remove front housing cover (15) from differential assembly (5) using puller.



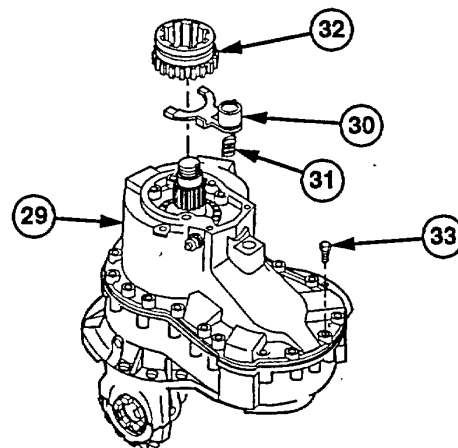
- (14) Remove oil seal (21) from front housing cover (15). Discard oil seal.
- (15) Remove seal cage nut (22) from front housing cover (15) using socket (23).
- (16) Remove bearing (24) from front housing cover (15).



- (17) Remove four screws (25) from pump assembly (26).
- (18) Remove pump assembly (26), two preformed packings (27), and preformed packing (28) from front housing (29). Discard preformed packings.



- (19) Remove fork (30), spring (31), and pinion (32) from front housing (29).
- (20) Remove 20 screws (33) from front housing (29).

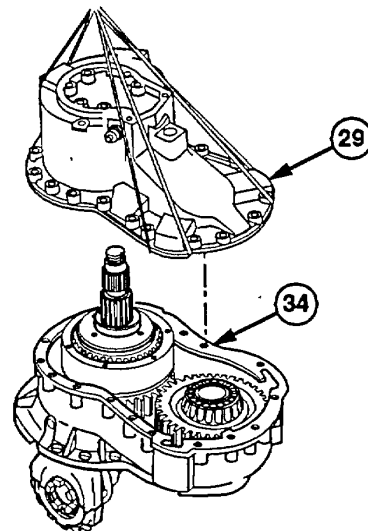


- (21) Attach lifting device and lifting strap to front housing (29).

WARNING

Front housing weighs 85 lb (39 kg). Keep clear of front housing during separation from carrier assembly. Failure to comply may result in Injury to personnel.

- (22) Separate front housing (29) from carrier housing (34).
- (23) Remove lifting device and lifting strap from front housing (29).

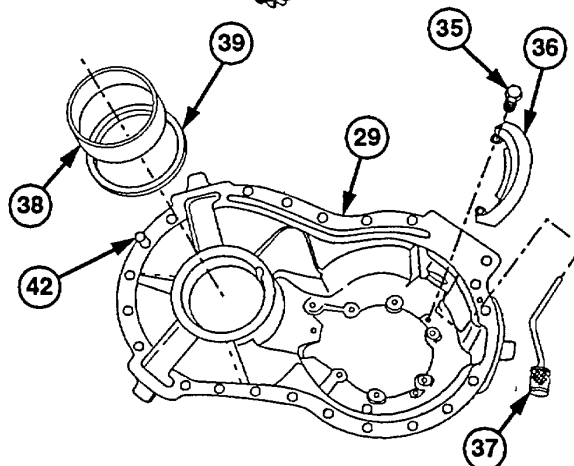


- (24) Remove two screws (35), deflector (36), and pipe (37) from front housing (29).

NOTE

Tag shim before removal.

- (25) Remove bearing race (38) and shim (39) from front housing (29).



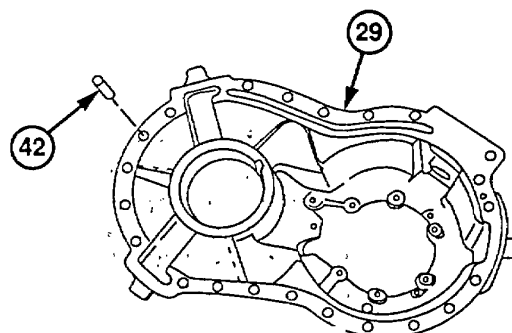
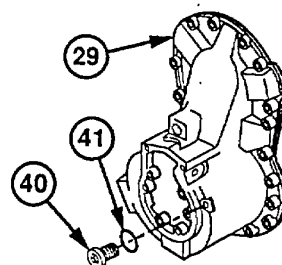
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (26) Remove plug (40) and preformed (41) from front housing (29). Discard preformed packing.

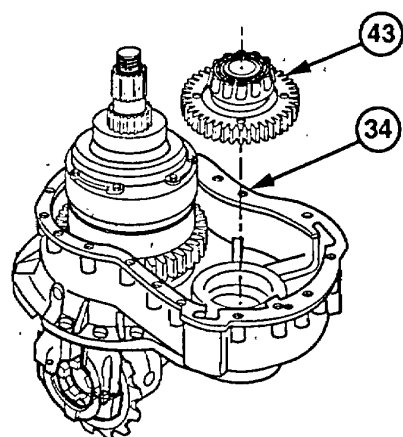
NOTE

Do step (27) only if dowels fail inspection.

- (27) Remove two dowels (42) from front housing (29).

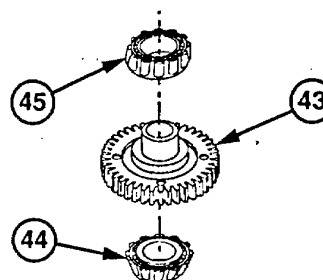


- (28) Remove pinion (43) from carrier housing (34) with aid of assistant.

**NOTE**

Do steps (29) and (30) only if bearings fail inspection.

- (29) Remove bearing (44) from pinion (43).
 (30) Turn pinion (43) over. Remove bearing (45) from pinion (43).



- (31) Remove six screws (46) and three plates (47) from ring and pinion assembly (48).
- (32) Remove ring gear carrier (49) from gear carrier assembly (50).
- (33) Remove input shaft (11) and gear carrier assembly (50) from carrier housing (34).

WARNING

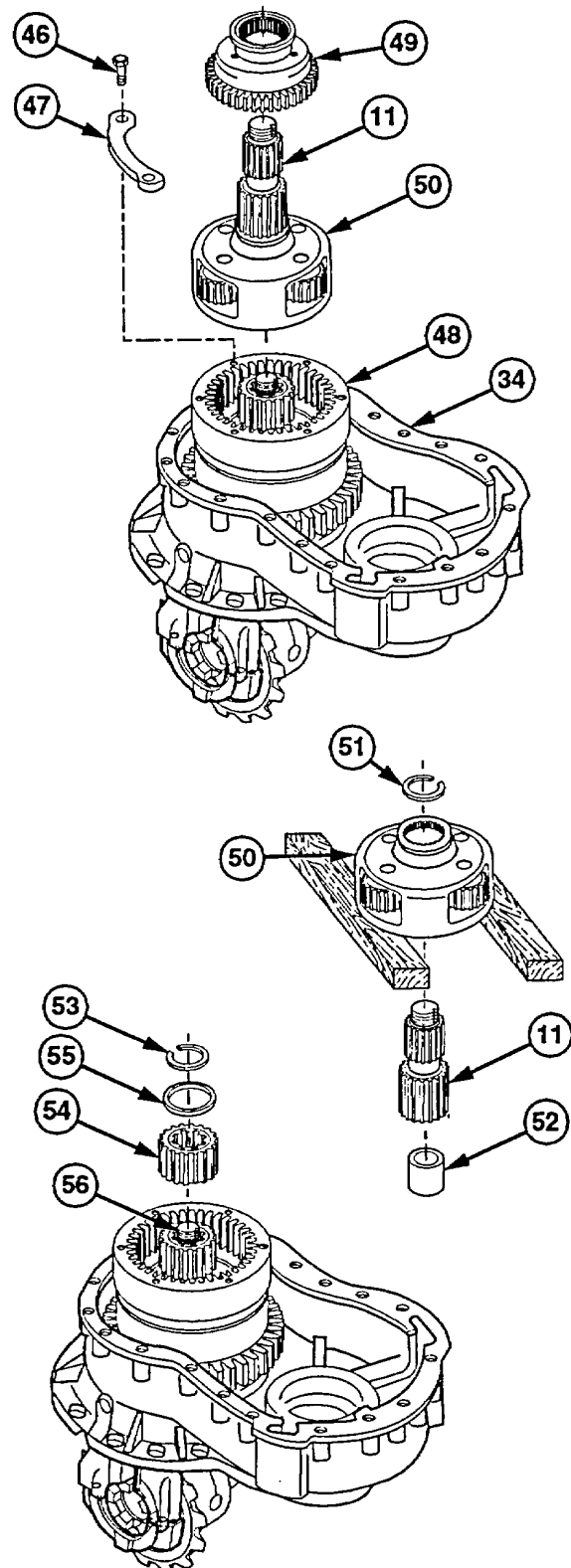
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye Injury.

- (34) Remove retaining ring (51) from input shaft (11).
- (35) Place gear carrier assembly (50) on wooden blocks.
- (36) Remove gear carrier assembly (50) from input shaft (11) using soft-faced hammer.

NOTE

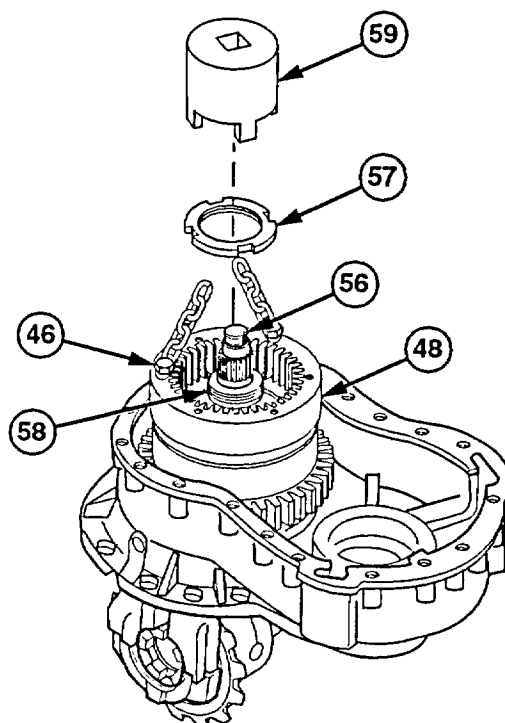
Do step (37) only if sleeve fails inspection.

- (37) Remove sleeve (52) from Input shaft (11).
- (38) Remove retaining ring (53) from sun gear (54).
- (39) Remove washer (55) and sun gear (54) from pinion shaft (56).



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (40) Unstake inner edge of nut (57) away from bearing cover (58).
- (41) Remove nut (57) from bearing cover (58) using spanner nut socket (59) and torque multiplier with aid of assistant. Discard nut.
- (42) Attach lifting device to ring and pinion assembly (48) with two screws (46).
- (43) Remove ring and pinion assembly (48) from bearing cover (58) while assistant operates lifting device.
- (44) Remove lifting device and screws (46) from ring and pinion assembly (48) with aid of assistant.



- (45) Remove deflector (60) from ring and pinion assembly (48).

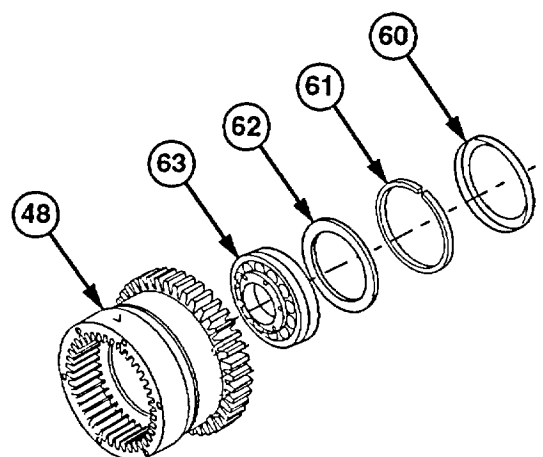
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Tag and mark shim before removal.

- (46) Remove retaining ring (61) and shim (62) from ring and pinion assembly (48).
- (47) Press bearing (63) from ring and pinion assembly (48).



- (48) Rotate carrier housing (34) so pinion shaft (56) is pointing down.

NOTE
Backlash should be 0.0100.013 in.(025-0.33 mm).

- (49) Check backlash of differential (64) to pinion shaft (56).
(50) Hold pinion shaft (56) so pinion gear (65) does not move.

NOTE
Do not allow pinion gear to turn while doing steps (51) thru (53).

- (51) Turn differential (64) counterclockwise until it stops to take up backlash.

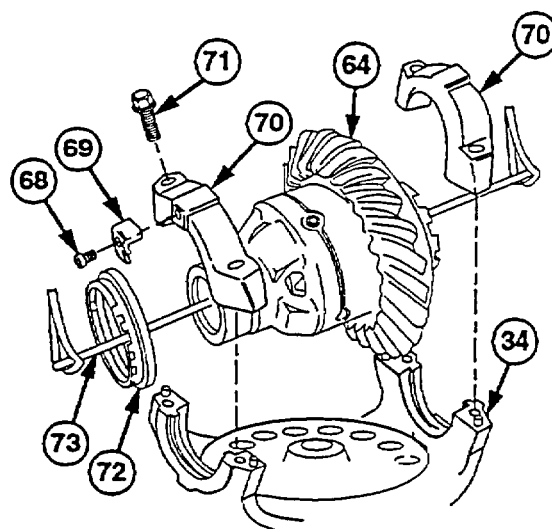
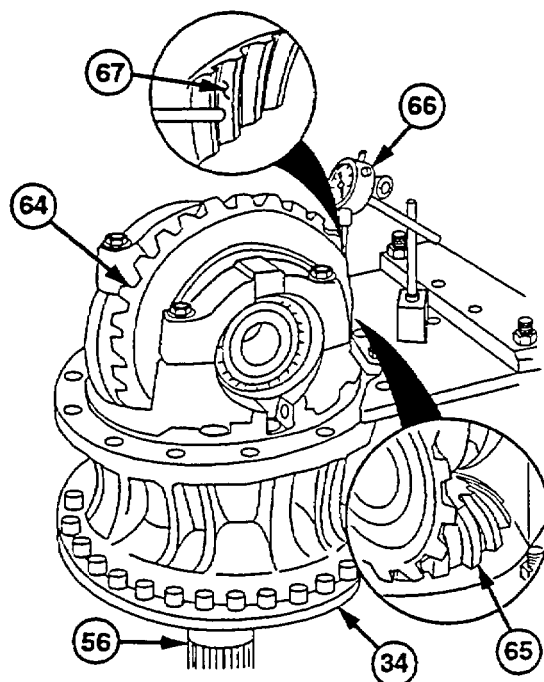
NOTE
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (52) Install dial indicator (66) on face of differential gear tooth (67).
(53) Turn differential (64) clockwise until it stops.
(54) Record differential (64) to pinion shaft (56) backlash measured on dial indicator (66).

- (55) Remove screw (68) and nut lock plate (69) from bearing cap (70).
(56) Remove four screws (71) from bearing caps (70).
(57) Remove two bearing caps (70) from carrier housing (34).
(58) Remove adjusting nut (72) from differential (64).
(59) Install crowbar (73) through differential (64).
(60) Install strap on crowbar (73).

WARNING
Differential is heavy and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (61) Remove differential (64) from carrier housing (34) with aid of assistant.
(62) Remove crowbar (73) and strap.



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)**NOTE**

Do step (63) only if dowels fail inspection.

(63) Remove four dowels (74) from carrier housing (34).

(64) Remove shim (75) and taper races (76) from differential (64).

NOTE

- Remove taper bearings only if they fail inspection.

- To remove taper bearing from gear side of differential, first remove cage and rollers from inner race. Then pry inner race up high enough to install puller.

(65) Remove bearing (77) from differential (64) using puller.

(66) Remove bearing (78) from differential (64) using puller.

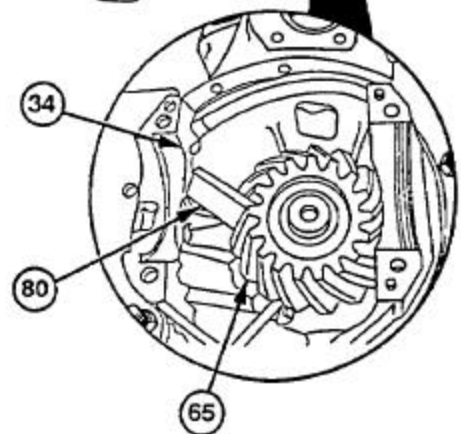
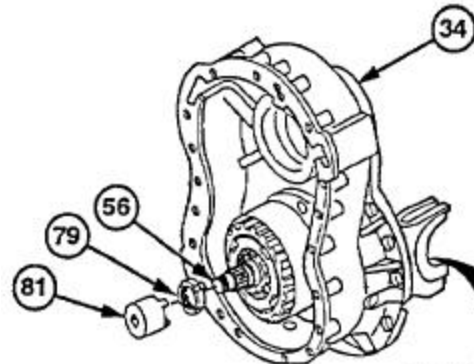
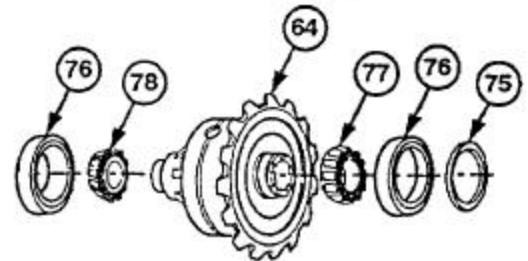
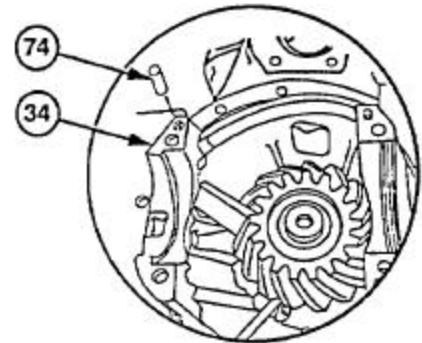
(67) Rotate carrier housing (34) so pinion shaft (56) is parallel to floor.

(68) Unstake inner edge of nut (79) away from pinion shaft (56).

(69) Position jet extractor (80) between teeth of pinion gear (65) and housing (34) with aid of assistant.

(70) Remove nut (79) from pinion shaft (56) using spanner nut socket (81) and torque multiplier with aid of assistant. Discard nut.

(71) Remove jet extractor (80) from housing (34).

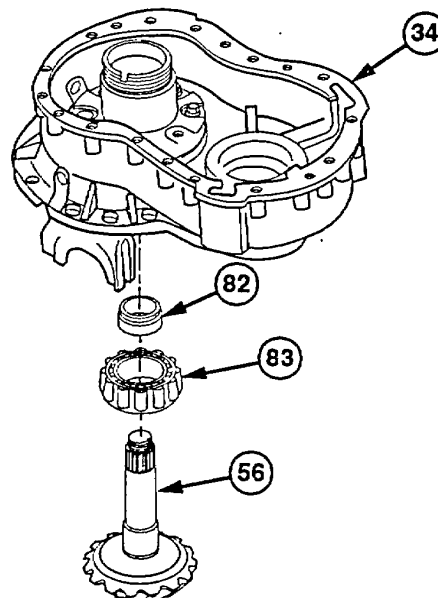


- (72) Rotate carrier housing (34) so pinion shaft (56) is pointing up.

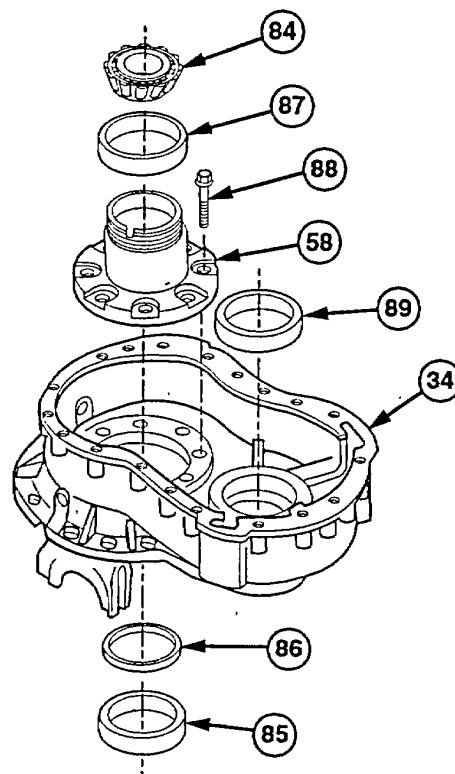
CAUTION

Ensure assistant supports pinion shaft during removal. Failure to comply may result in damage to equipment.

- (73) Drive pinion shaft (56) through carrier housing (34) while assistant supports pinion shaft (56).
- (74) Remove spacer (82) and taper bearing (83) from pinion shaft (56).



- (75) Remove taper bearing (84) from bearing cover (58).
- (76) Remove taper race (85), shim (86), and taper race (87) from bearing cover (58).
- (77) Remove eight screws (88) from bearing cover (58).
- (78) Remove bearing cover (58) from carrier housing (34).
- (79) Remove taper race (89) from carrier housing (34).



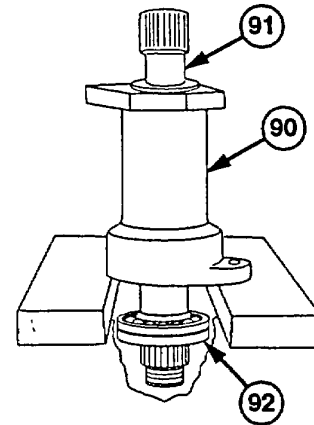
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (80) Position output housing (90) in press with long end of shaft facing up.

CAUTION

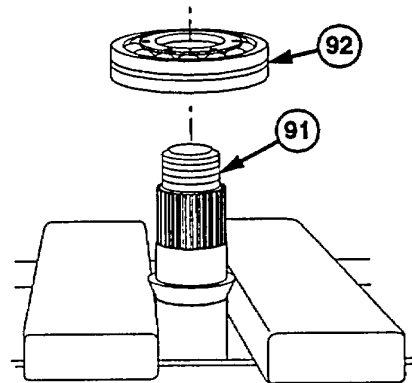
Ensure shaft does not drop to floor. Failure to comply may result in damage to equipment.

- (81) Press output shaft (91) with bearing (92) from output housing (90).



- (82) Position output shaft (91) in press.

- (83) Press output shaft (91) from bearing (92).

**c. Cleaning/Inspection**

- (1) Clean old gasket material from housing and/or caps.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean sealant residue from threaded holes with dry cleaning solvent.

CAUTION

Wash machined parts separately to avoid damage from parts bumping together.

- (3) Wash parts in dry cleaning solvent.

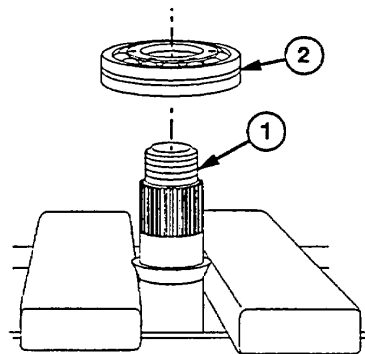
WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

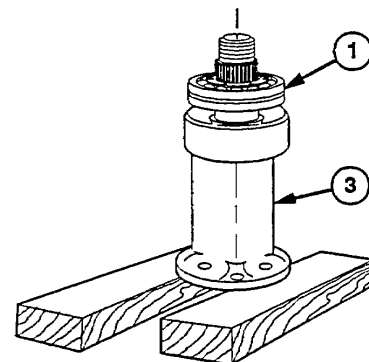
- (4) Dry all parts, except bearings, with compressed air. Allow bearings to air dry.
- (5) Remove all small nicks or burrs with crocus cloth.
- (6) Coat all parts with lubricating oil.
- (7) Inspect housing and caps for damage.
- (8) Inspect all parts and bearings with machined surfaces for deep scratches or wear grooves.
- (9) Replace damaged parts.

d. Assembly

- (1) Position output shaft (1) and bearing (2) in press.
- (2) Press bearing (2) on output shaft (1). Remove from press.



- (3) Install output housing (3) and output shaft (1) in press with aid of assistant
- (4) Press output housing (3) on output shaft (1). Remove from press.



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (5) Coat threads of eight screws (4) with adhesive-sealant (Item 6, Appendix B).
- (6) Install bearing cover (5) on carrier housing (6) with eight screws (4). Torque to 80 lb-ft (108 N•m).
- (7) Position carrier housing (6) so rear faces up.
- (8) Install taper race (7) in carrier housing (6).

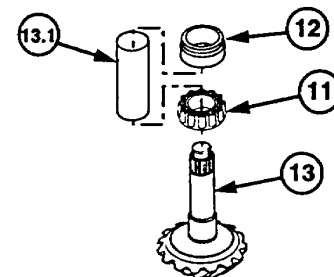
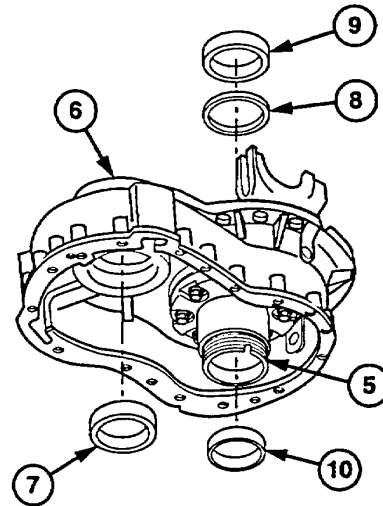
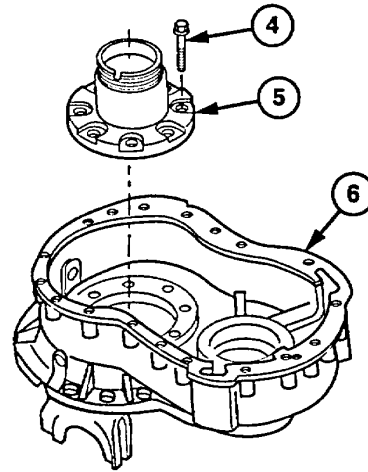
NOTE

- If same pinion and differential are being reused, same shim may be used.
- If new pinion and differential are being used, shim thickness is determined by comparing dimension engraved on new pinion with dimension on old pinion. If dimension is larger, shim must be reduced by difference. If dimension is smaller, shim must be increased by difference.

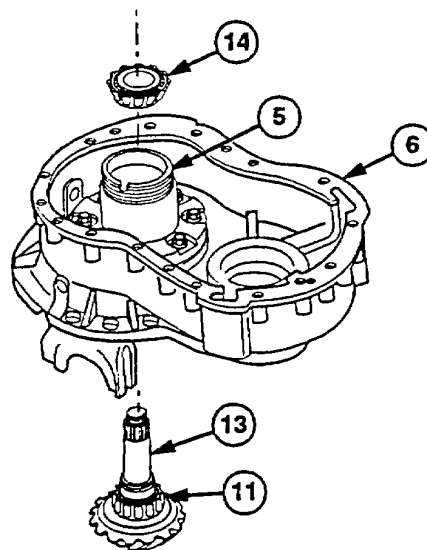
- (9) Install shim kit (8), taper race (9), and taper race (10) in bearing cover (5).

- (10) Install taper bearing (11) on pinion shaft (13) using pinion bearing cone installer (13.1).

- (10.1) Install spacer (12) on pinion shaft (13).



- (11) Rotate carrier housing (6) so bearing cover (5) bore is parallel to ground.
- (12) Coat taper bearing (11) with lubricating oil.
- (13) Install pinion shaft (13) in carrier housing (6).
- (14) Install taper bearing (14) on pinion shaft (13) while assistant supports pinion shaft (13).

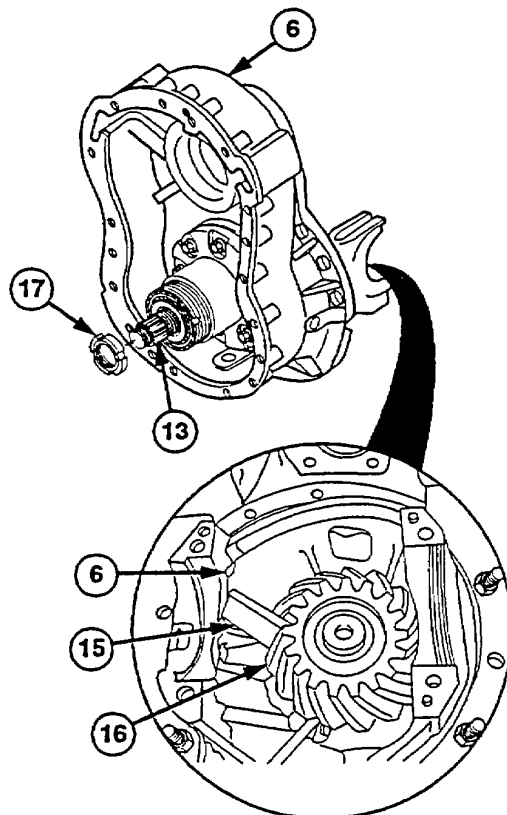


- (15) Position carrier housing (6) so pinion shaft (13) is parallel to floor.
- (16) Position jet extractor (15) between housing (6) and teeth on pinion gear (16) with aid of assistant.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If sealing compound gets on skin or clothing, wash immediately with soap and water.

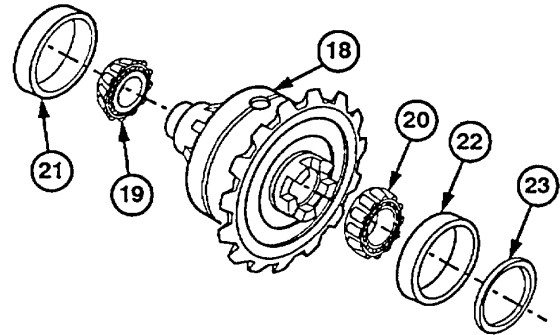
- (17) Coat new nut (17) with adhesive-sealant (Item 4, Appendix B).
- (18) Install new nut (17) on pinion shaft (13) flat side first.
- (19) Tighten nut (17) to 528-564 lb-ft (716-765 N•m).
- (20) Stake edge of nut (17) in notches in pinion shaft (13).
- (21) Remove jet extractor (15) from housing (6).



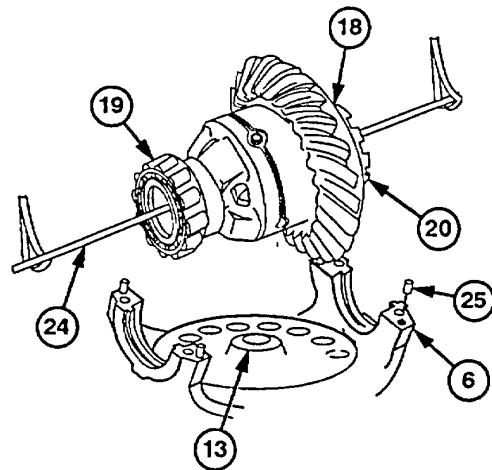
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)**WARNING**

Differential is heavy and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (22) Install differential (18) in press.
- (23) Press bearing (19) on differential (18).
- (24) Turn differential (18) over in press.
- (25) Press bearing (20) on differential (18).
- (26) Remove differential (18) from press.
- (27) Install taper races (21 and 22) on bearings (19 and 20).
- (28) Position shim (23) on gear end of differential (18).



- (29) Install crowbar (24) through differential (18).
- (30) Install strap on crowbar (24).
- (31) Coat taper bearings (19 and 20) with lubricating oil.
- (32) Position carrier housing (6) with pinion shaft (13) down.

**NOTE**

Do step (33) if dowels were removed.

- (33) Install four dowels (25) in carrier housing (6).
- (34) Install differential (18) in carrier housing (6) with aid of assistant.
- (35) Remove strap and crowbar (24) from differential (18).

WARNING

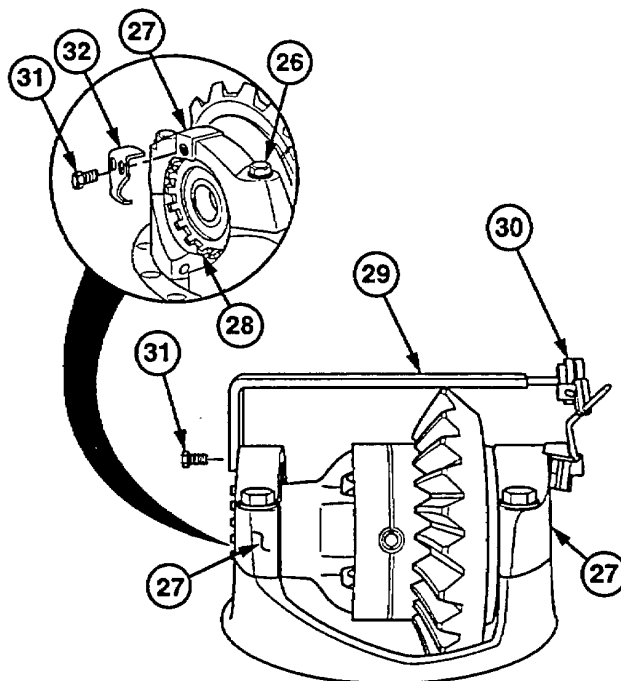
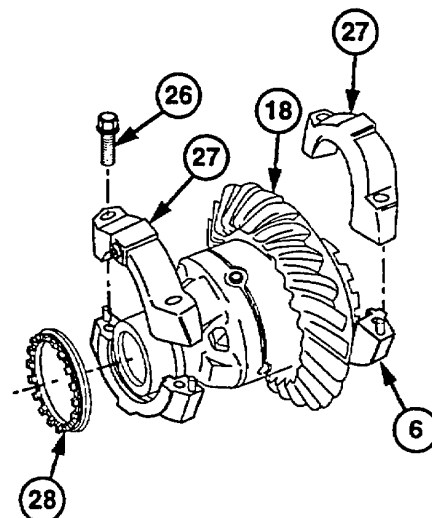
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (36) Coat four screws (26) with adhesive-sealant (Item 3, Appendix B).
- (37) Install two bearing caps (27) on carrier housing (6) with four screws (26). Torque to 25 lb-in. (2.83 N•m).
- (38) Install adjusting nut (28) on differential (18).
- (39) Install differential carrier preload gage (29) on bearing cap (27) with screw (31).
- (39.1) Position magnetic base of dial indicator (30) on bearing cap (27).
- (39.2) Position probe of dial indicator (30) on differential carrier preload gage (29).
- (39.3) Zero dial indicator (30).
- (39.4) Tighten adjusting nut (28) until bearing caps (27) expand 0.013-0.018 in. (.33-.46 mm).
- (39.5) Remove screw (31), differential carrier preload gage (29) and dial indicator (30) from bearing caps (27).
- (40) Tighten screws (26) to 123-138 lb-ft (167-187 N•m).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (41) Coat screw (31) with adhesive-sealant (Item 6, Appendix B).
- (42) Install nut lock plate (32) on bearing cap (27) with screw (31). Torque to 132-216 lb-in. (14.9-24.4 N•m).



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

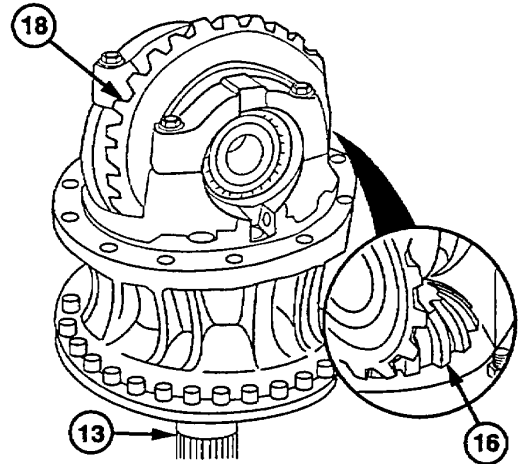
(43) Check backlash of differential (18) to pinion shaft (13).

(44) Hold pinion shaft (13) so pinion gear (16) does not move.

NOTE

Do not allow pinion gear to turn while doing steps (45) thru (47).

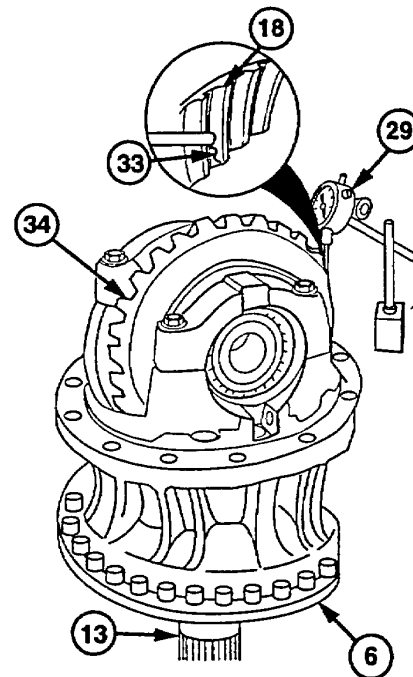
(45) Turn differential (18) counterclockwise until it stops to take up backlash.

**NOTE**

Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

(46) Install dial indicator (29) on face of differential gear tooth (33).

(47) Turn differential (18) clockwise until it stops.

**NOTE**

Backlash should be 0.0100.013 in. (0.25-0.33 mm). To increase backlash, reduce thickness of shim. To decrease backlash, increase thickness of shim.

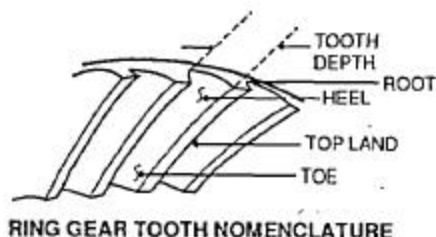
(48) Record differential (18) to pinion shaft (13) backlash measured on dial indicator (29).

(49) Rotate carrier housing (6) so pinion shaft (13) faces down.

NOTE

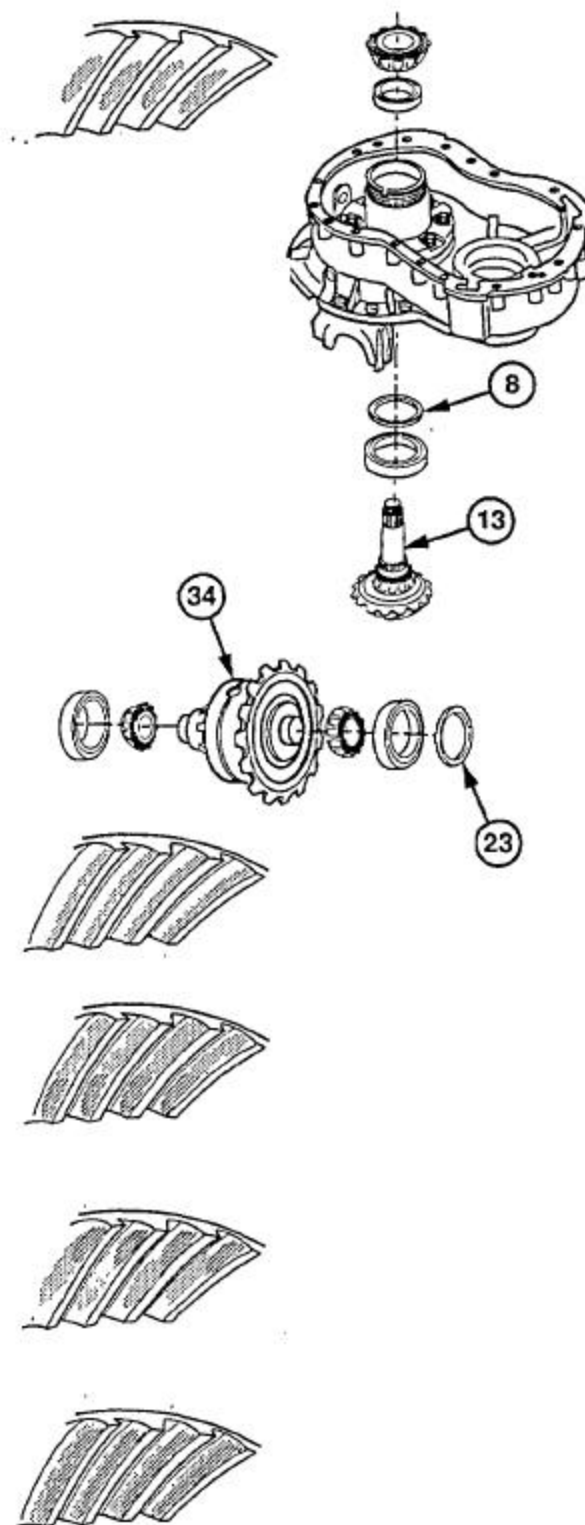
Do steps (50) thru (54) to adjust tooth contact pattern.

- (50) Coat gear teeth of differential gear (34) with prussian blue dye. Check for correct pattern of rotation. If needed, remove and adjust shims as required. A correct pattern is clear of toe and centers evenly along width of face between top land and root. Length and shape of pattern may vary and is acceptable as long as pattern does not run off tooth at any point.

**NOTE**

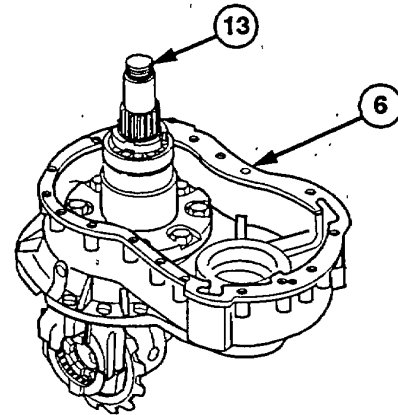
Any time pinion depth is changed, backlash may change. Check and adjust backlash as needed.

- (51) Move differential gear (34) away from pinion shaft (13) by using a thinner shim (23) and thicker shim (8) if pattern is too close to top of tooth.
- (52) Move differential gear (34) away from pinion shaft (13) by using thinner shim (23) and thicker shim (8) if pattern is too close or off tooth root.
- (53) Move differential gear (34) toward pinion shaft (13) by using thicker shim (23) and thinner shim (8) if pattern is too dose or off tooth heel.
- (54) Move differential gear (34) toward pinion shaft (13) by using thicker shim (23) and thinner shim (8) if pattern is too close to bottom of tooth.



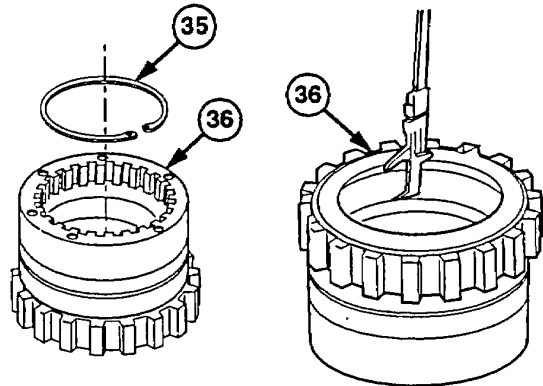
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (55) Rotate carrier housing (6) so pinion shaft (13) is pointing up.

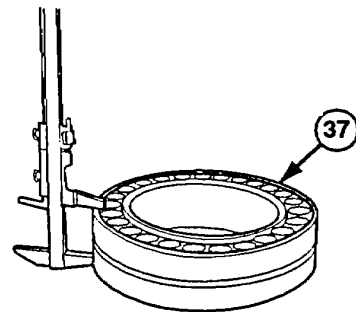
**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

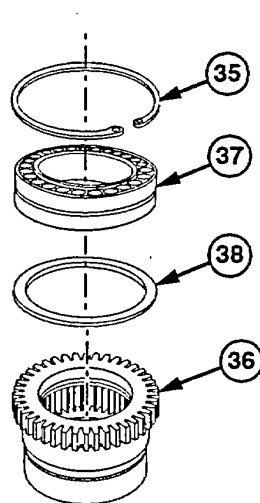
- (56) Install retaining ring (35) in ring and pinion assembly (36).
- (57) Measure and record distance C between bottom of retaining ring (35) and shim land on ring and pinion assembly (36).



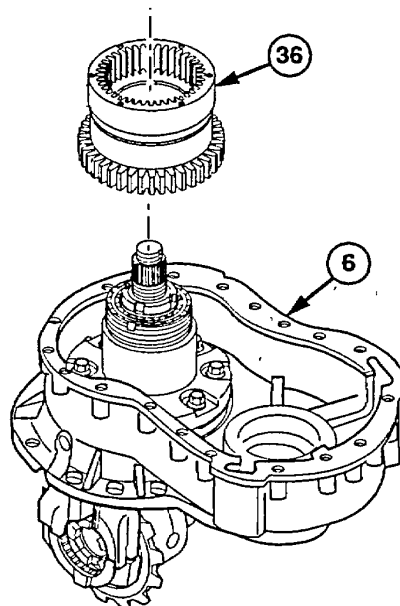
- (58) Measure and record width D of bearing (37).



- (59) Calculate shim (38) thickness by subtracting distance C from width D. Shim thickness $D - C + 0.004$ in. (0.10 mm).
- (60) Remove retaining ring (35) from ring and pinion assembly (36).
- (61) Press bearing (37) in ring and pinion assembly (36).
- (62) Install shim (38) and retaining ring (35) in ring and pinion assembly (36).
- (63) Coat bearing (37) with lubricating oil.



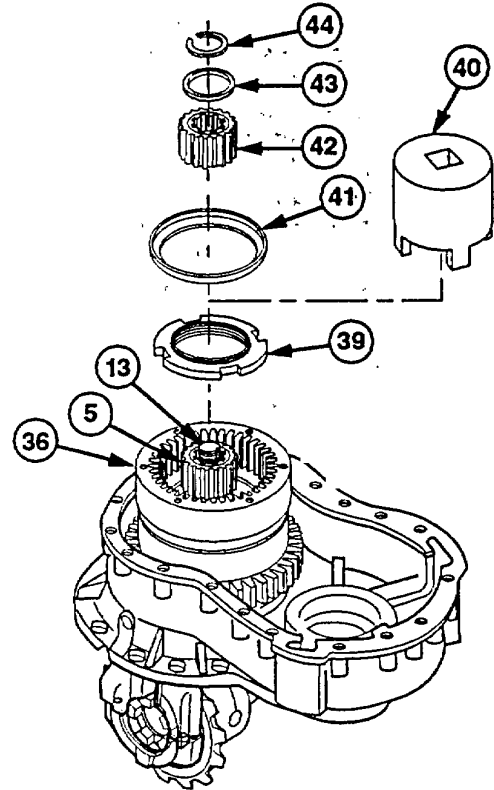
- (64) Install ring and pinion assembly (36) in carrier housing (6) with aid of assistant.



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (65) Coat new nut (39) with adhesive-sealant (Item 6, Appendix B).
- (66) Install new nut (39) using spanner nut socket (40). Torque to 325-362 lb-ft (441-491 N•m).
- (67) Stake edge of nut (39) in notches of bearing cover (5).
- (68) Install deflector (41) in ring and pinion assembly (36).
- (69) Install sun gear (42) on pinion shaft (13) flat side first.
- (70) Install washer (43) on sun gear (42).

**WARNING**

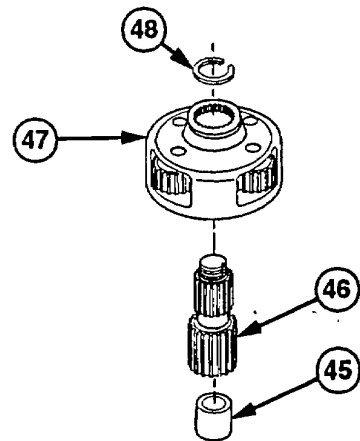
Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (71) Install retaining ring (44) on pinion shaft (13).
- (72) Coat end of pinion shaft (13) with grease.

NOTE

Do step (73) if spacer was removed.

- (73) Install spacer (45) on input shaft (46).
- (74) Install gear carrier (47) on input shaft (46).
- (75) Install retaining ring (48) on input shaft (46).

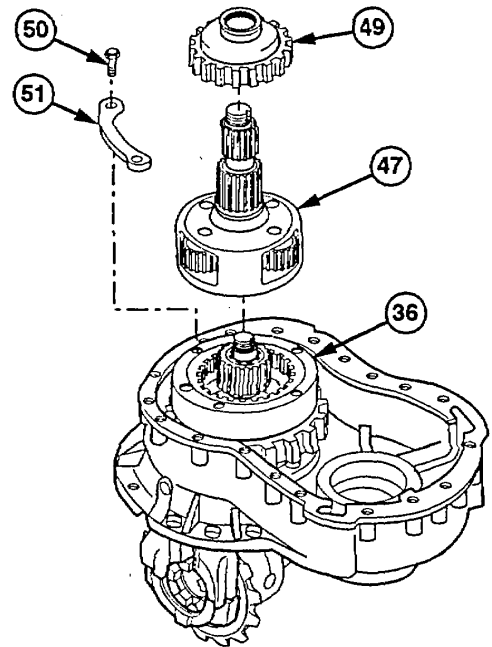


- (76) Install gear carrier (47) in ring and pinion assembly (36).
- (77) Install ring gear carrier (49) on gear carrier (47).

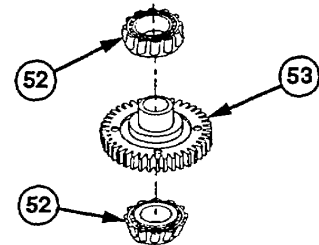
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

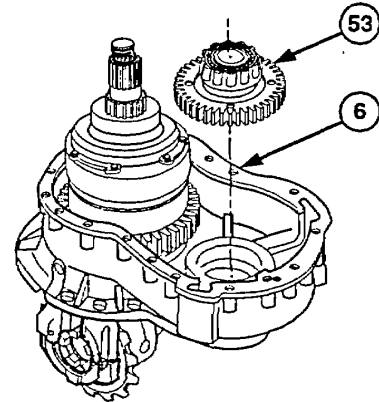
- (78) Coat threads of six screws (50) with adhesive-sealant (Item 6, Appendix B).
- (79) Install three plates (51) on ring and pinion assembly (36) with six screws (50). Torque to 120 lb-in. (13.6 N•m).



- (80) Press two bearings (52) on pinion (53).
- (81) Coat bearings (52) with lubricating oil.



- (82) Install pinion (53) in carrier housing (6) with aid of assistant.



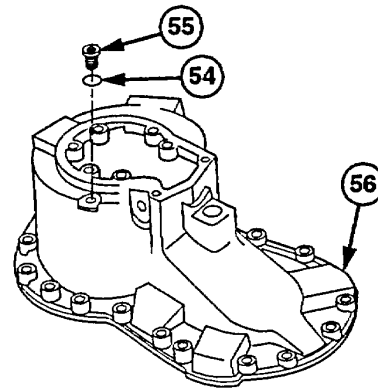
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (83) Install new preformed packing (54) and plug (55) in front housing (56).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (84) Fill plug (55) slot with silicone adhesive-sealant.

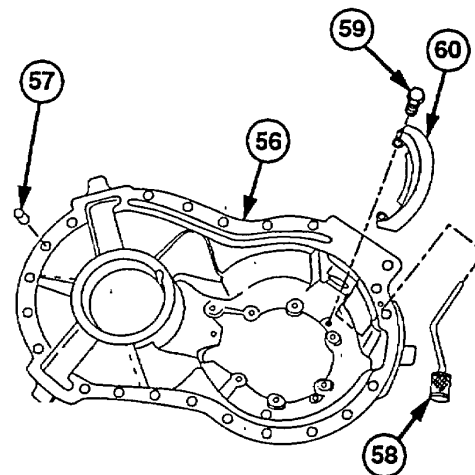
**NOTE**

Do step (85) if dowels were removed.

- (85) Install two dowels (57) in front housing (56).
- (86) Coat end of pipe (58) with silicone adhesive-sealant.

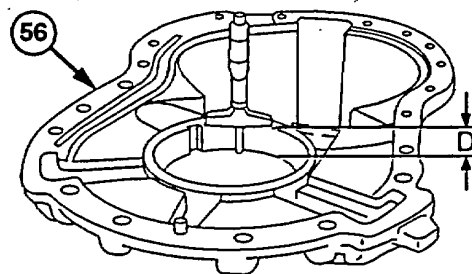
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

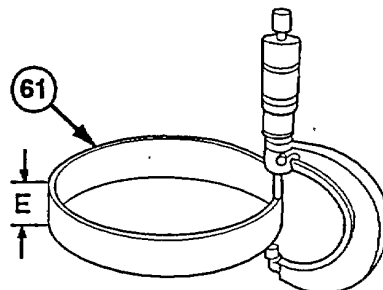


- (87) Coat threads of two screws (59) with adhesive-sealant (Item 6, Appendix B).
- (88) Install pipe (58), deflector (60), and two screws (59) in front housing (56). Torque to 78 lb-in. (8.8 N•m).

- (89) Measure and record distance D between top and bottom of bearing surface in front housing (56).

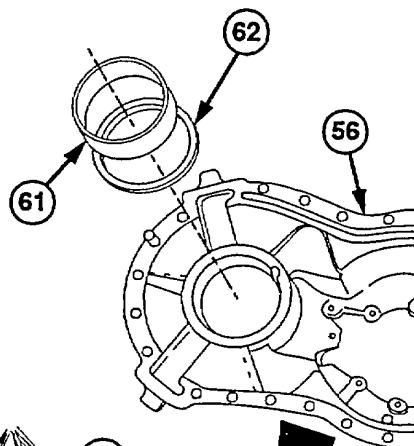


- (90) Measure and record distance E, height of bearing race (61).



- (91) Calculate shim (62) thickness by subtracting distance E from D. Shim thickness D E.

- (92) Install shim (62) and bearing race (61) in front housing (56).



WARNING
 Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (93) Coat mating surface of carrier housing (6) with adhesive-sealant (Item 4, Appendix B).

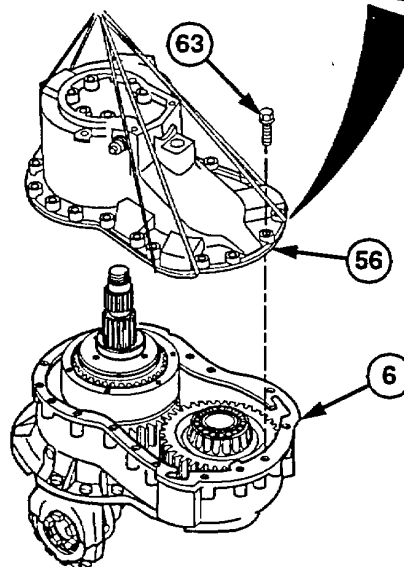
- (94) Attaching lifting strap and lifting device to front housing (56).

- (95) Coat threads of 20 screws (63) with adhesive-sealant.

- (96) Lower front housing (56) on carrier assembly while assistant operates lifting device.

- (97) Remove lifting device and strap from front housing (56).

- (98) Install 20 screws (63) in front housing (56). Torque to 80 lb-ft (108 N•m).



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

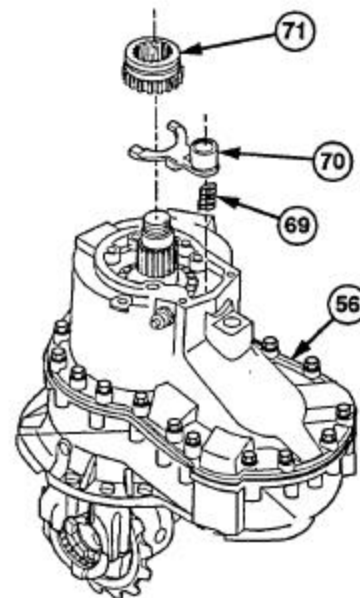
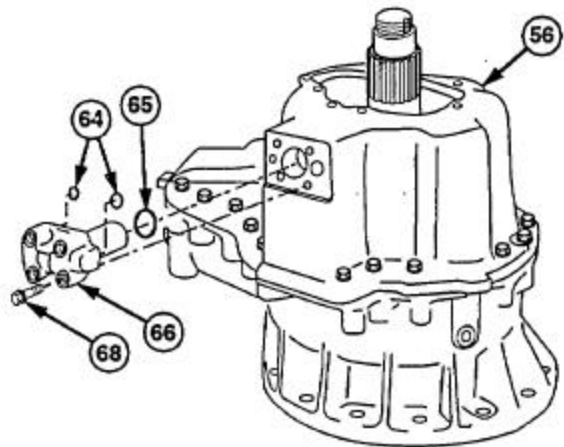
- (99) Install two new preformed packings (64) and new preformed packing (65) on pump assembly (66).
- (100) Coat preformed packings (67) with lubricating oil.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (101) Coat mounting surface of pump (66) with adhesive-sealant (item 4, Appendix B).
- (102) Coat threads of screws (68) with adhesive-sealant (Item 6, Appendix B).
- (103) Install pump assembly (66) on front housing (56) with four screws (68). Torque to 29 lb-ft (39 N•m).

- (104) Install spring (69), fork (70), and pinion (71) in front housing (56).



WARNING

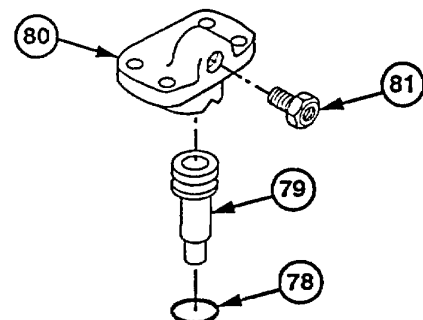
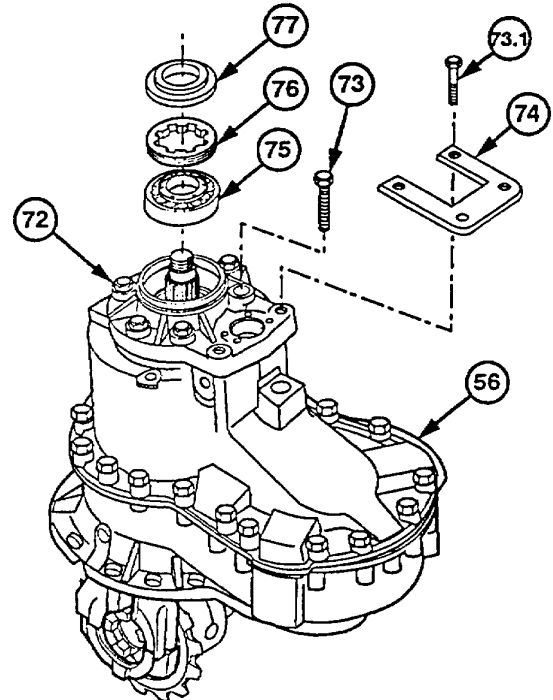
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (105) Coat mating surface of front housing cover (72) with adhesive-sealant (Item 4, Appendix B).
- (106) Coat threads of six screws (73) and two screws (73.1) with adhesive-sealant (Item 6, Appendix B).
- (107) Install front housing cover (72) and manifold bracket (74) on front housing (56) with six screws (73) and two screws (73.1). Torque to 46 lb-ft (62 N•m).
- (108) Install bearing (75) in front housing cover (72).
- (109) Coat bearing (75) with lubricating oil.
- (110) Coat seal cage nut (76) with adhesive-sealant (Item 6, Appendix B).
- (111) Install seal cage nut (76) in front housing cover (72). Torque to 217-253 lb-ft (294-343 N•m).

NOTE

Oil seal is installed properly when top surface of seal is 1/16 in. (1.59 mm) below housing.

- (112) Install new oil seal (77) in front housing cover (72).
- (113) Install new preformed packing (78) on piston pin (79).
- (114) Install piston pin (79) in cover (80).
- (115) Install fitting (81) in cover (80).



25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (116) Coat mating surface of cover (82) with adhesive-sealant (Item 4, Appendix B).
- (117) Coat threads of screws (83) with adhesive-sealant (Item 6, Appendix B).
- (118) Install cover (82) on front housing cover (72) with four washers (84) and screws (83). Torque to 29 lb-ft (39 N•m).

WARNING

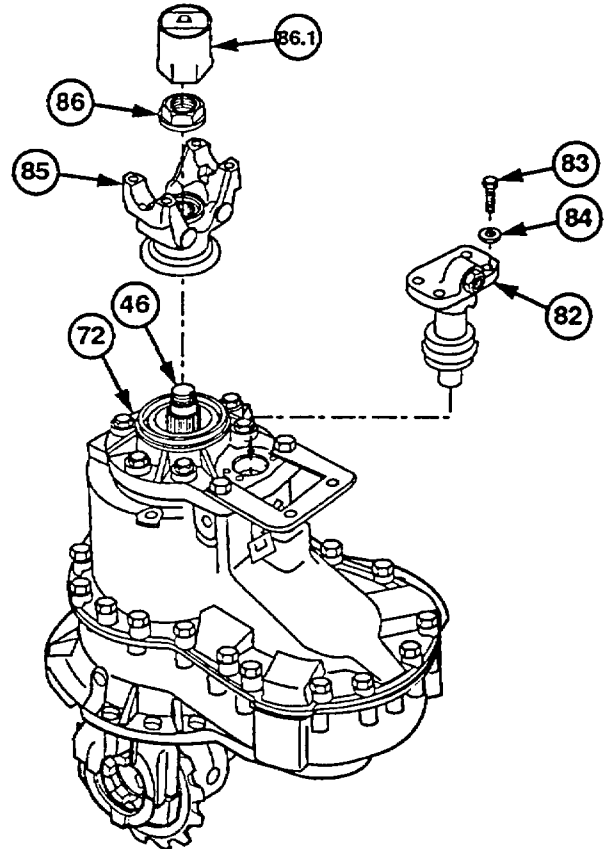
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (119) Coat splines of shaft (46) with silicone adhesive-sealant.
- (120) Coat threads of shaft (46) with adhesive-sealant

NOTE

Large openings of yoke must align with notches in input shaft to ease staking of nut.

- (121) Install input yoke (85) on input shaft (46) with new nut (86) using socket (86.1). Torque to 680-796 lb-ft (922-1079 N•m).
- (122) Stake edge of new nut (86) in notches of input shaft (46).



e. Installation

- (1) Attach suitable lifting device to differential assembly (1).
- (2) Remove six screws (2) and differential assembly (1) from adapter (4).

WARNING

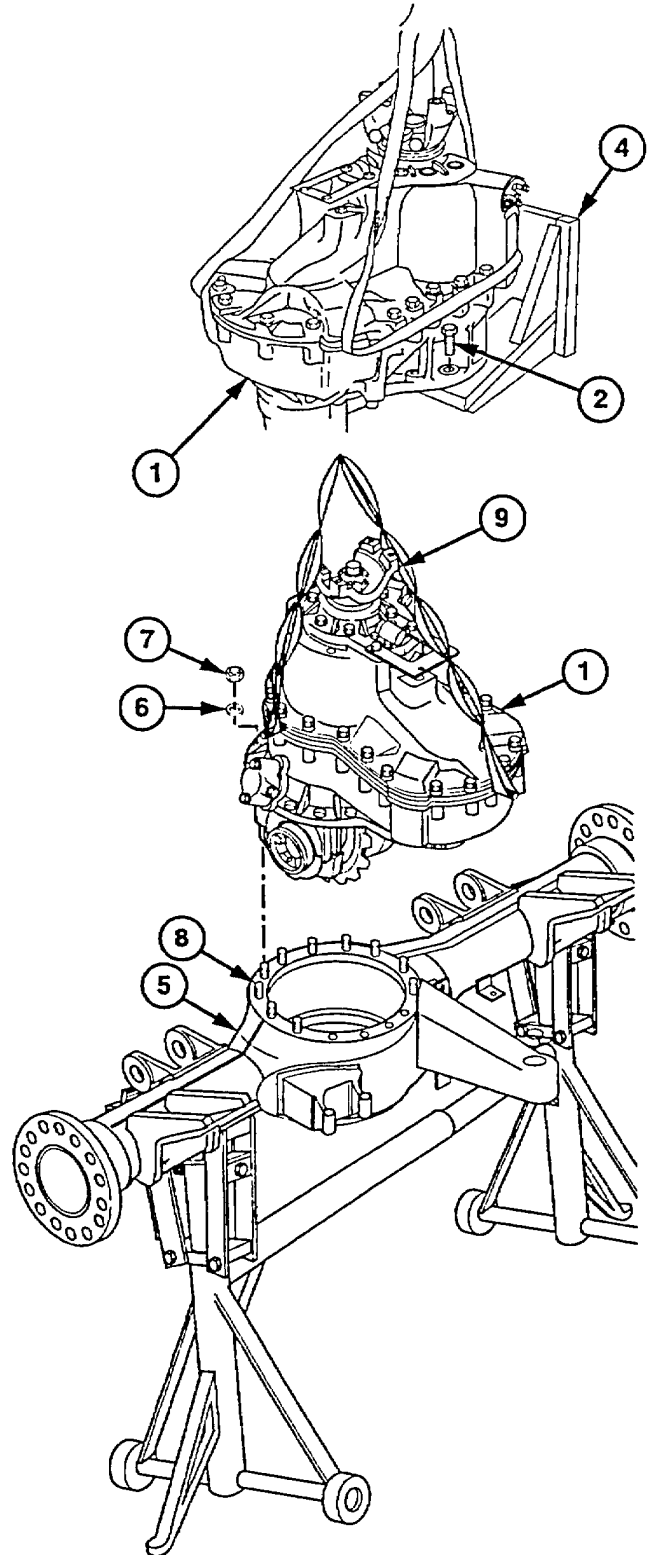
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (3) Coat mating surface of axle housing (5) with silicone adhesive-sealant.

WARNING

Differential weighs 950 lb (431 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (4) Install differential assembly (1) in axle housing (5) while assistant operates lifting device.
- (5) Install 10 washers (6) and new locknuts (7) on studs (8). Torque to 190-206 lb-ft (140-152 N•m).
- (6) Position axle housing (5) so input yoke (9) is parallel to floor.

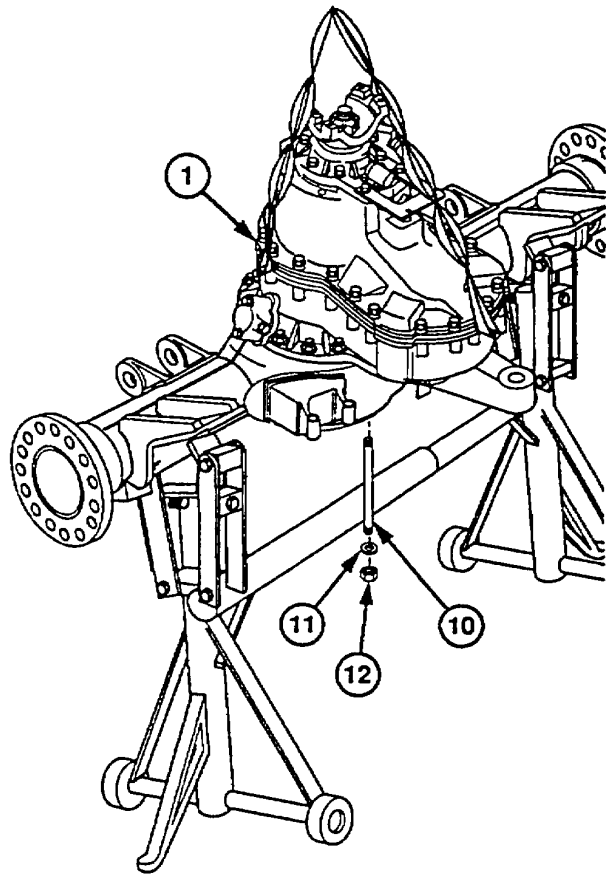


25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

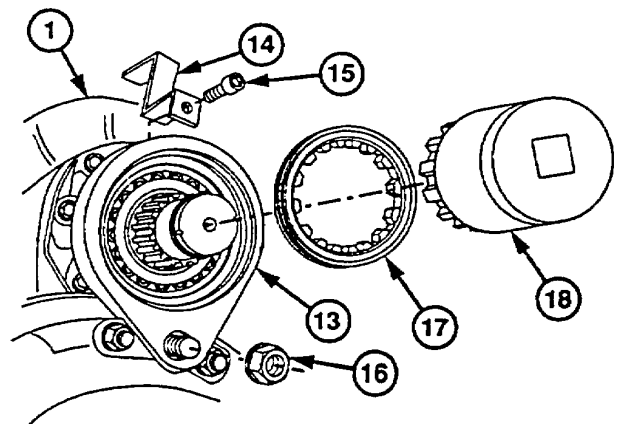
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (7) Coat four studs (10) with adhesive-sealant (Item 6, Appendix B).
- (8) Install four studs (10) in differential assembly (1). Torque to 76 lb-ft (103 N•m).
- (9) Install four washers (11) and nuts (12) on studs (10). Torque to 117-137 lb-ft (159-186 N•m).
- (10) Remove lifting device and lifting straps.



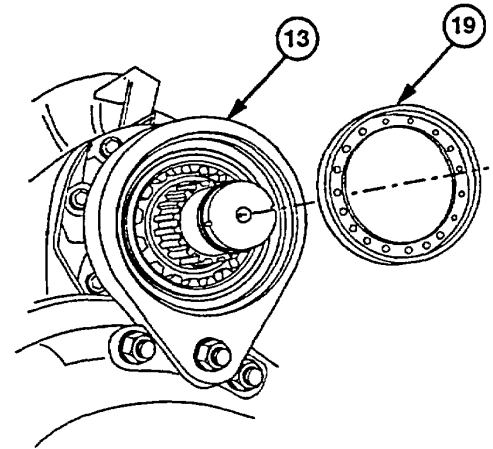
- (11) Coat mounting surface of rear section of output housing (13) with adhesive-sealant (Item 4, Appendix B).
- (12) Install output housing (13) and dip (14) on differential assembly (1) with seven screws (15). Torque to 61-80 lb-ft (83-108 N•m).
- (13) Install nut (16) on output housing (13). Torque to 145 lb-ft (197 N•m).
- (14) Coat threads of spanner nut (17) with adhesive-sealant (item 6, Appendix B).
- (15) Install spanner nut (17) on output housing (13) using socket (18). Torque to 210-230 lb-ft (285-312 N•m).



NOTE

Oil seal is installed properly when top surface of seal is 1/16 in. (1.59 mm) below housing.

- (16) Install new oil seal (19) on output housing (13).

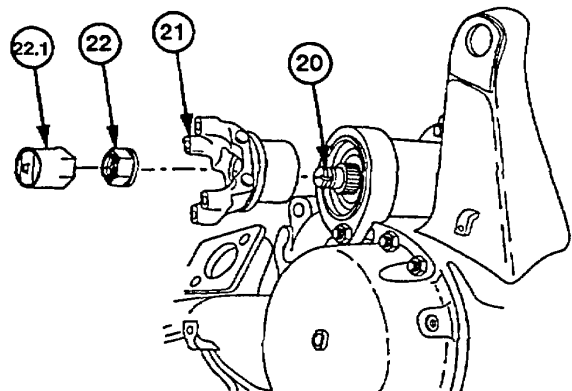
**WARNING**

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (17) Coat splines of output shaft (20) with silicone adhesive-sealant.
 (18) Coat threads of output shaft (20) with silicone adhesive-sealant.

NOTE

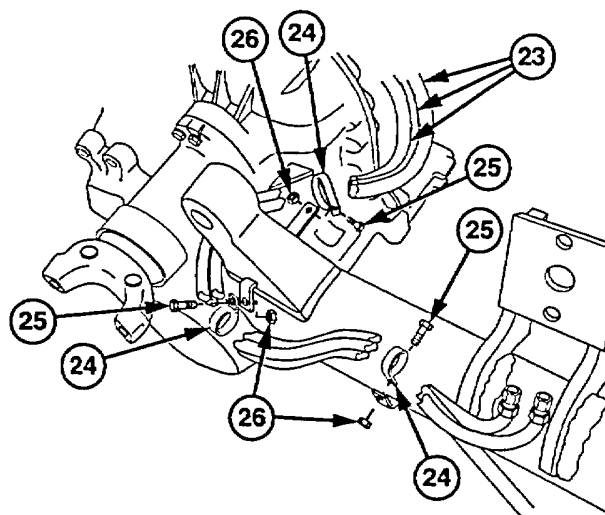
Large openings of yoke must align with notches in input shaft to ease staking of nut



- (19) Install output yoke (21) and new nut (22) on output shaft (20) using socket (22.1).
 (20) Tighten nut (22) to 486-572 lb-ft (659-775 N•m).
 (21) Stake edges of nut (22) in notches of shaft (20).

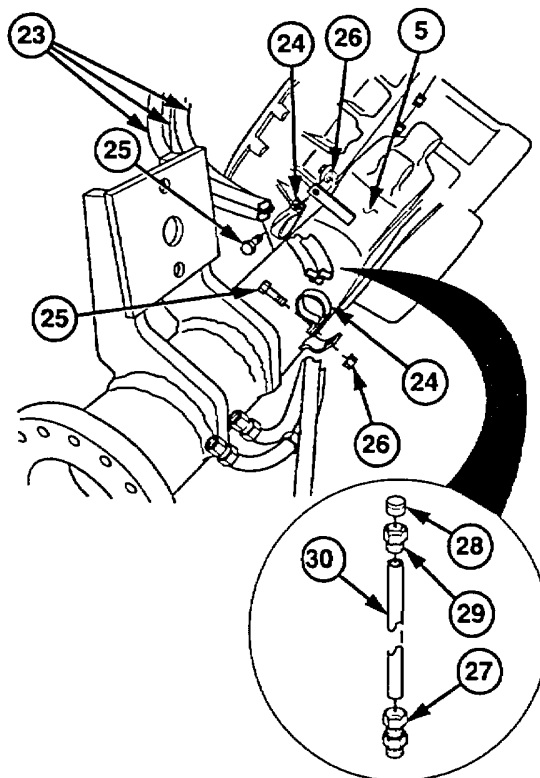
25-2. AXLE NO. 2 DIFFERENTIAL REPAIR (CONT)

- (22) Install six hoses (23) on axle housing (5) with five clips (24), screws (25), and new locknuts (26).

**WARNING**

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (23) Coat threads of adapter (27) and breather (28) with pipe thread sealing compound.
 (24) Install breather (28) in adapter (29).
 (25) Install breather hose (30) on adapter (29).
 (26) Install adapter (27) on axle housing (5).
 (27) Install breather hose (30) on adapter (27).

**e. Follow-On Maintenance**

- (1) Install axle shafts (para 10-8).
- (2) Install brake chambers (TM 9-2320-360-20).
- (3) Install axle manifolds (TM 9-2320-360-20).

25-3. AXLE NO. 3 DIFFERENTIAL REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/Inspection	f. Follow-on Maintenance
-

Initial Setup:
Equipment Conditions

Oil drained from differential
(LO 9-2320-360-12).
Axle manifold removed (TM 9-2320-360-20).
Brake chambers removed
(TM 9-2320-360-20).
Axle shafts removed (para 10-8).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Eyes, Lifting (2) (Figure C-8, Appendix C)
Extractor, Jet (Figure C-11, Appendix C)
Holder, Yoke (Figure C-15, Appendix C)
Gage, Preload, Differential Carrier
(Figure C-16, Appendix C)
Installer, Bearing Cone (Figure C-20,
Appendix C)
Installer, Bearing Cone (Figure C-21,
Appendix C)
Adapter, Differential Maintenance
(Item 0.1, Appendix E)
Adapter, 3/4 Female -1 In. Male (Item 6,
Appendix E)
Caliper Set, Micrometer (Item 15, Appendix E)
Compressor, Air Unit (Item 24, Appendix E)
Crowbar (Item 30, Appendix E)
Dial Indicator, Magnetic (Item 32, Appendix E)
Gage, Depth, Micrometer (Item 48,
Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Multiplier, Torque (Item 99, Appendix E)
Press, Hydraulic (Item 116, Appendix E)
Puller Kit, Mechanical, Gear and Brg (Item 124,
Appendix E)
Remover, Setter, Stud (Item 137, Appendix E)
Socket, 63 mm (Item 163.2, Appendix E)
Stand, Engine (Item 181, Appendix E)

Tools and Special Tools (Cont)

Stand, Maintenance, Differential/Transfer
Case (Item 183, Appendix E)
Wrench Set, Socket, 1 In. Drive (Item 230,
Appendix E)
Wrench Set, Socket, 3/8 In. Drive (Item 232,
Appendix E)
Wrench, Torque, 0-600 Lb-Ft (Item 233,
Appendix E)
Wrench, Torque, 0-150 Lb-in. (Item 234,
Appendix E)
Wrench, Torque, 0-300 Lb-in. (Item 235,
Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236,
Appendix E)

Materials/Parts

Adhesive-Sealant, Silicone (Item 2, Appendix B)
Adhesive-Sealant (Item 3, Appendix B)
Adhesive-Sealant (Item 4, Appendix B)
Adhesive-Sealant (Item 6, Appendix B)
Compound, Sealing, Pipe Thread
(Item 28, Appendix B)
Dye, Prussian Blue (Item 30, Appendix B)
Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Locknuts (2) (Item 82, Appendix F)
Nuts, Adjusting (2) (Item 149, Appendix F)
Nut, Adjusting (Item 150, Appendix F)
Packing, Preformed (Item 166, Appendix F)
Packing, Preformed (Item 167, Appendix F)
Seals, Oil (2) (Item 305, Appendix F)

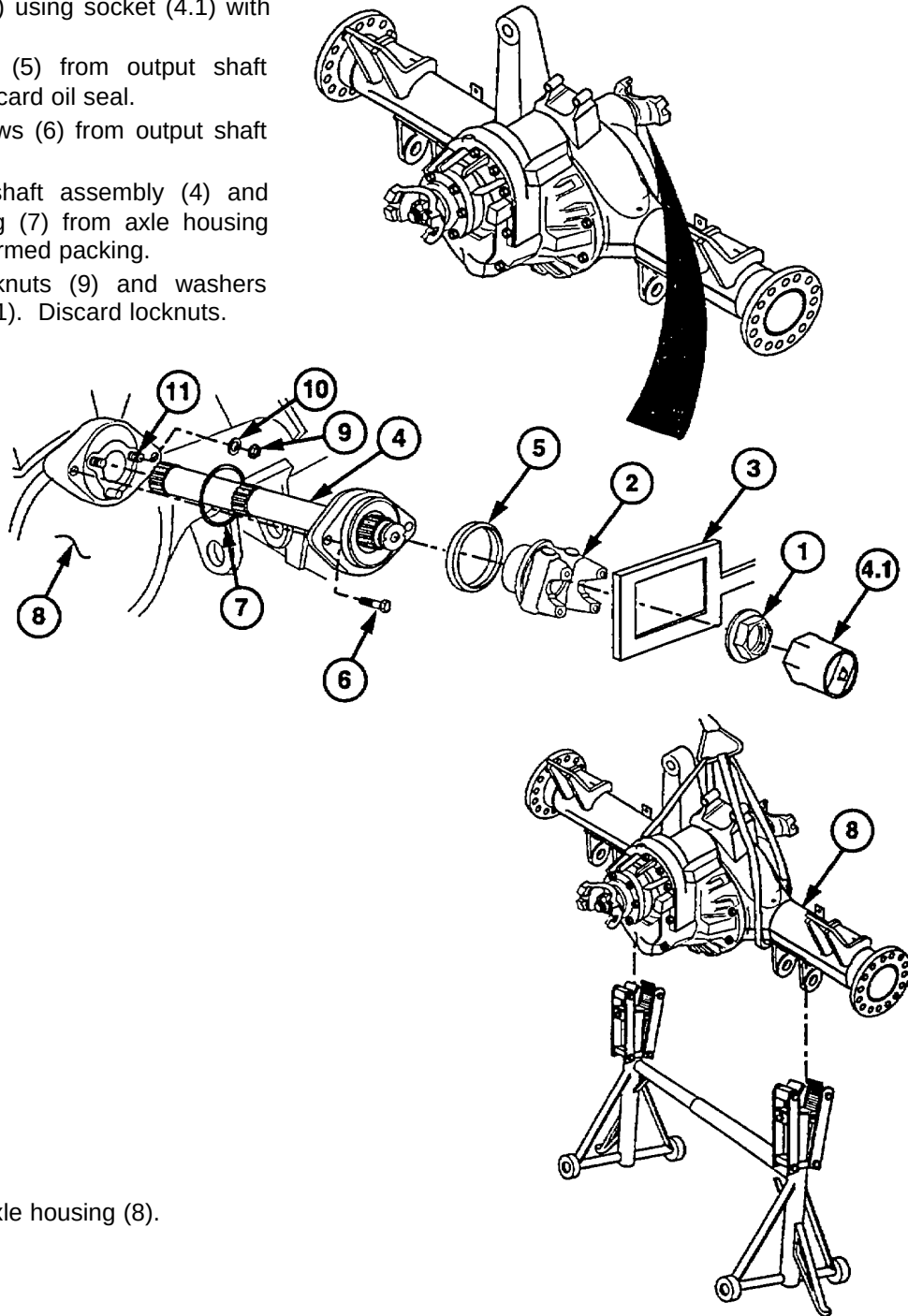
Personnel Required

Two

25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

a. Removal

- (1) Unstake nut (1) on yoke (2).
- (2) Position yoke holder (3) on yoke (2).
- (3) Remove nut (1) and yoke (2) from output shaft assembly (4) using socket (4.1) with aid of assistant.
- (4) Remove oil seal (5) from output shaft assembly (4). Discard oil seal.
- (5) Remove two screws (6) from output shaft assembly (4).
- (6) Remove output shaft assembly (4) and preformed packing (7) from axle housing (8). Discard preformed packing.
- (7) Remove two locknuts (9) and washers (10) from studs (11). Discard locknuts.



- (8) Attach lifting device to axle housing (8).

WARNING

Axle weighs approximately 1927 lb (875 kg). Use caution when lifting or moving axle. Failure to do so may result in serious injury or death to personnel.

- (9) Position axle housing (8) in axle stand with input shaft (12) pointing up.
- (10) Remove two screws (13) from differential carrier (14) and install lifting eyes (15).
- (11) Attach lifting device to lifting eyes (15).

WARNING

Differential weighs approximately 750 lb (341 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

CAUTION

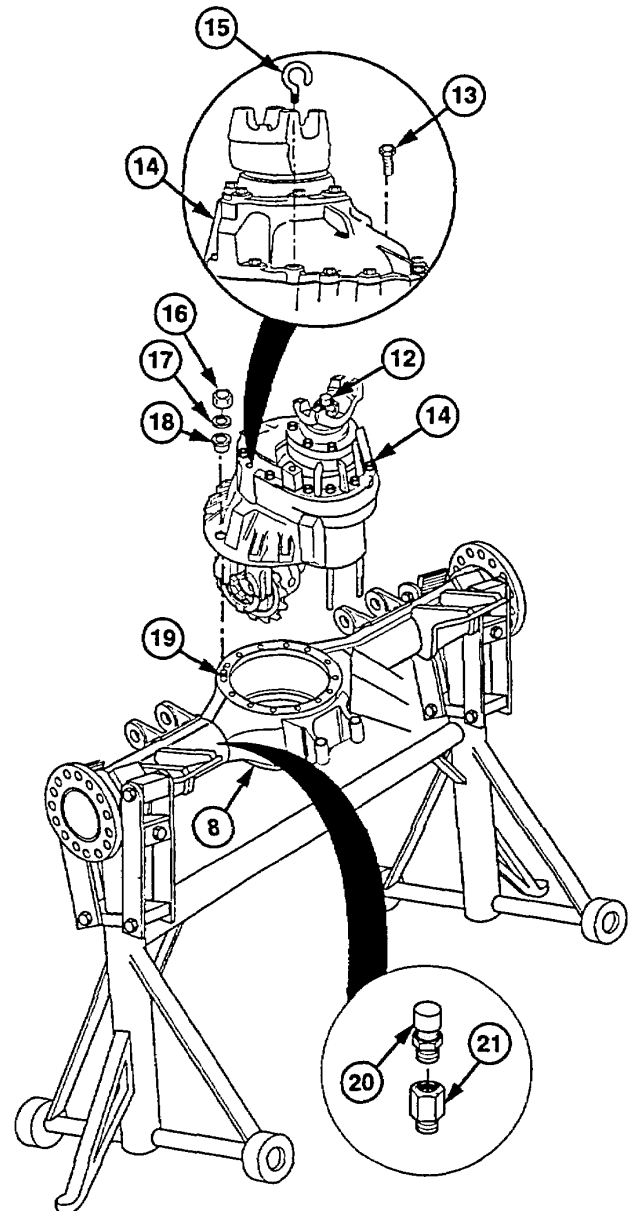
Lift carrier straight out of axle housing. Failure to comply may result in binding and damage to studs.

- (12) Remove 12 nuts (16), washers (17), and 10 taper rings (18) from studs (19).
- (13) Remove differential carrier (14) from axle housing (8) while assistant operates lifting device.

NOTE

Do step (14) only if studs fail inspection.

- (14) Remove 12 studs (19) from axle housing (8).
- (15) Remove breather (20) and adapter (21) from axle housing (8).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)**b. Disassembly****WARNING**

Differential weighs approximately 750 lb (341 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (1) Install adapter (1) on stand (2) with six screws (3).
- (2) Install differential assembly (5) on adapter (1) with six screws (6).
- (3) Remove two lifting eyes (8) from differential assembly (5).

- (4) Unstake nut (9) on yoke (10).
- (5) Position rear housing (11) with input shaft (12) pointing up.
- (6) Position yoke holder (13) on yoke (10).
- (7) Remove nut (9), yoke holder, and input yoke (10) from input shaft (12) using socket (13.1) with aid of assistant. Discard nut.
- (8) Remove input shaft seal (14) from seal cover (15). Discard seal.

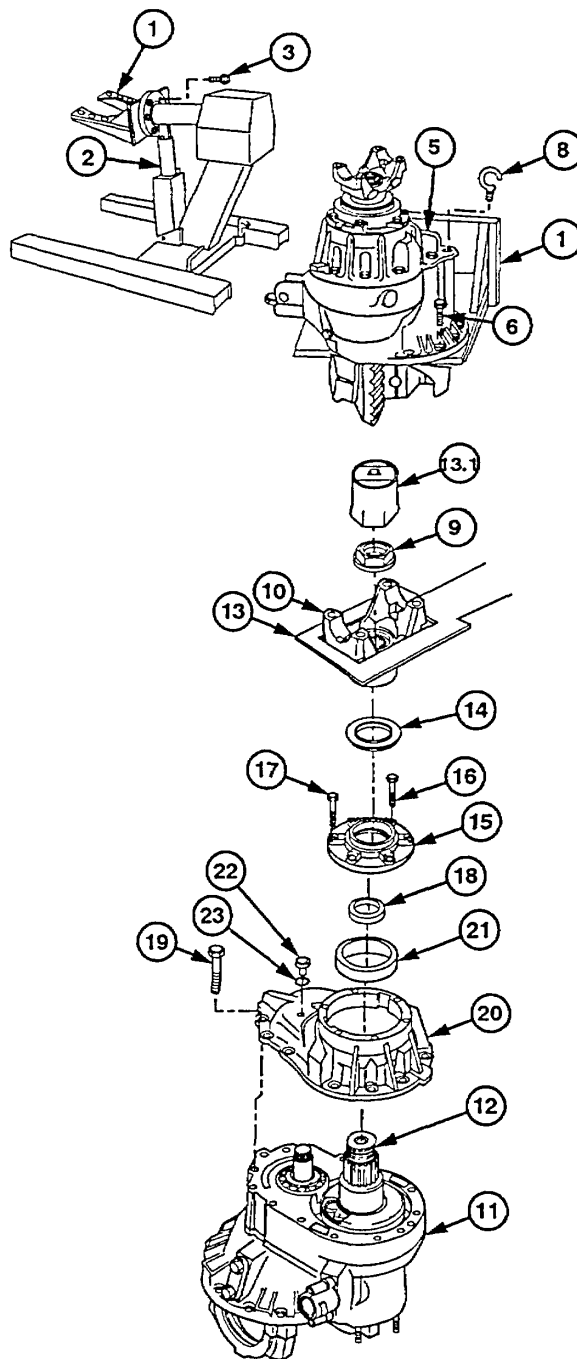
NOTE**Tag and mark shim.**

- (9) Remove five screws (16), screw (17), seal cover (15), and shim (18) from rear housing (11). Discard seal.
- (10) Remove 13 screws (19) from front housing (20).

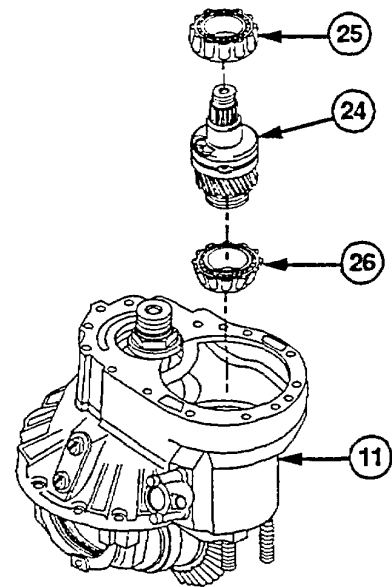
NOTE

It may be necessary to loosen housing by striking with rubber mallet

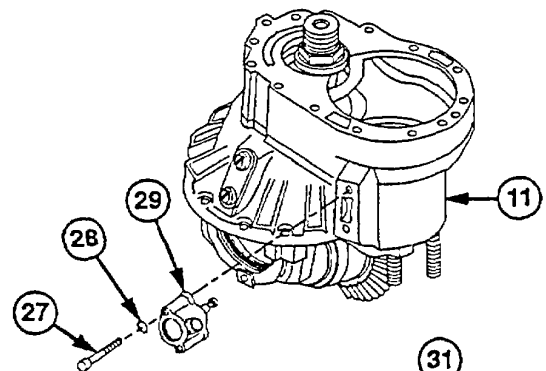
- (11) Remove front housing (20) from rear housing (11).
- (12) Remove taper bearing race (21) from front housing (20).
- (13) Remove plug (22) and preformed packing (23) from front housing (20). Discard preformed packing.



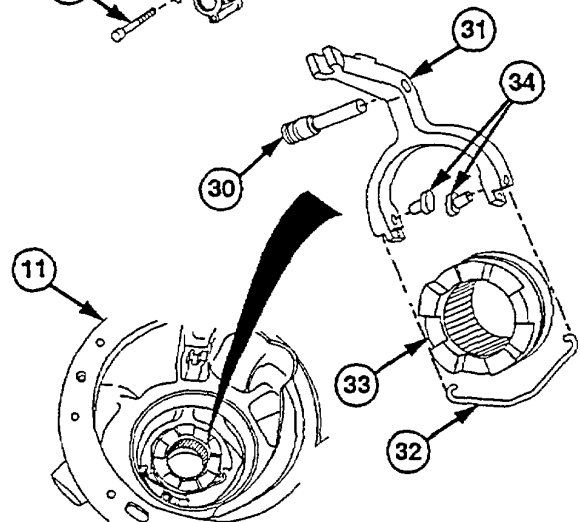
- (14) Remove split torque differential (24) from rear housing (11).
- (15) Remove two taper bearings (25 and 26) from split torque differential (24).



- (16) Remove two screws (27), washers (28), and differential lock actuating cylinder (29) from rear housing (11).



- (17) Remove pin (30) and fork (31) from rear housing (11).
- (18) Remove retaining dip (32), clutch gear (33), and two shift dogs (34) from fork (31).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

- (19) Position rear housing (11) so pinion shaft (35) points down.
- (20) Check backlash of differential (36) to pinion shaft (35).
- (21) Hold pinion shaft (35) so pinion gear (37) does not move.

NOTE

Do not allow pinion gear to turn while doing steps (22) thru (24).

- (22) Turn differential (36) counterclockwise until it stops to take up backlash.

NOTE

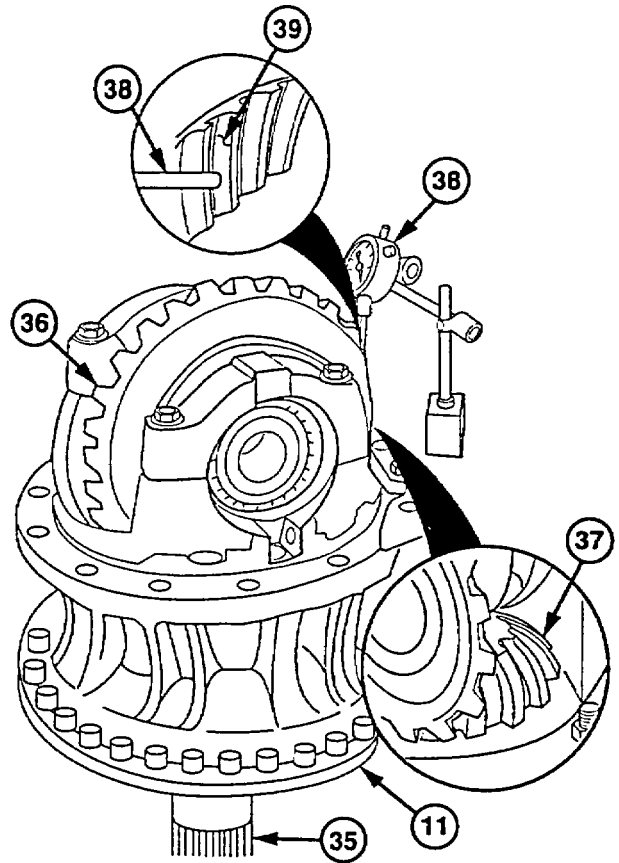
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (23) Install dial indicator (38) on face of differential gear tooth (39).
- (24) Turn differential (36) clockwise until it stops.

NOTE

Backlash should be 0.010-0.016 in. (25-41 mm). To increase backlash, reduce thickness of shims installed in carrier housing. To decrease backlash, increase thickness of shims.

- (25) Record differential (36) to pinion shaft (35) backlash measured on dial indicator (38).



- (26) Remove two studs (39) from rear housing (11).
- (27) Remove screw (40) and lockplate (41) from bearing cap (42).
- (28) Remove four capscrews (43), bearing caps (42), and adjusting nut (44) from housing (11).
- (29) Install crowbar (45) through differential (36).
- (30) install strap on crowbar (45).

WARNING

Differential weighs approximately 750 lb (341 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (31) Remove shim (46), differential (36), and races (47) with aid of assistant.
- (32) Remove crowbar (45), strap, shim (46), and two races (47) from differential (36).

NOTE

Do step (33) only if dowels fail inspection.

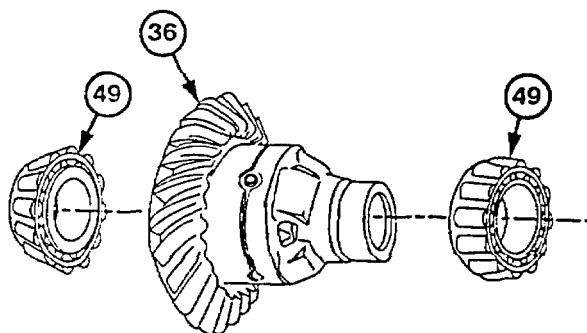
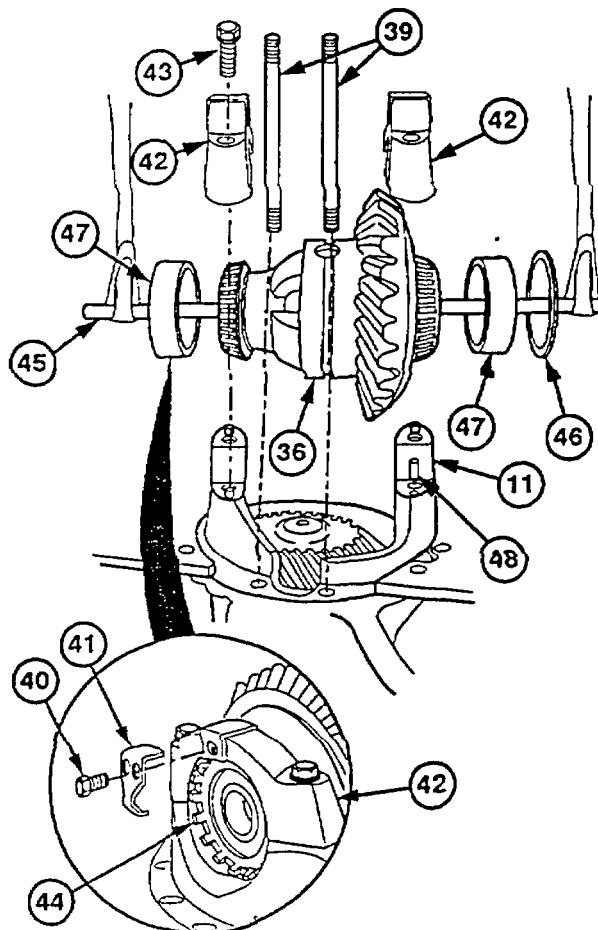
- (33) Remove four dowels (48) from rear housing (11).

NOTE

- Remove taper bearings only if they fail inspection.

- To remove taper bearing from gear side of differential, first remove cage and rollers from inner race. Then pry inner race up high enough to install puller.

- (34) Remove taper bearings (49) from differential (36) using puller.



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

- (35) Position rear housing (11) so pinion shaft (35) points up.
- (36) Unstake pinion nut (50) on pinion shaft (35).
- (37) Position jet extractor (51) between teeth of pinion gear (37) and housing (11) with aid of assistant.
- (38) Remove pinion nut (50) from pinion shaft (35).
- (39) Remove jet extractor (51) from housing (11).

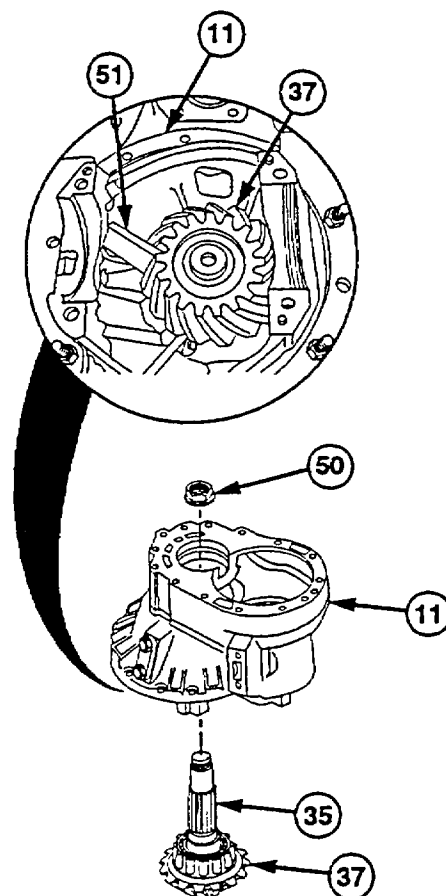
CAUTION

During removal of pinion gear, do not allow gear teeth to hit inside of housing. Damage to equipment may result.

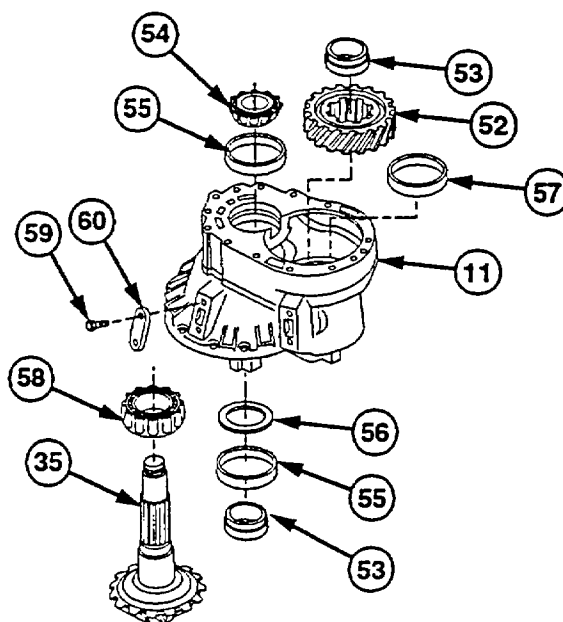
NOTE

Step down gear and spacers may come out with pinion gear or stay in housing.

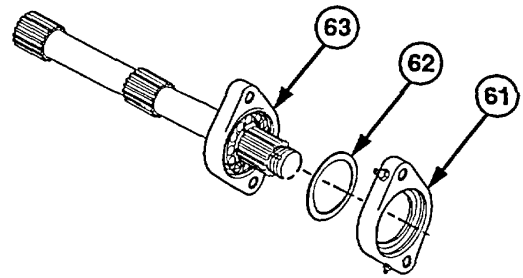
- (40) Remove pinion gear (35) from rear housing (11).



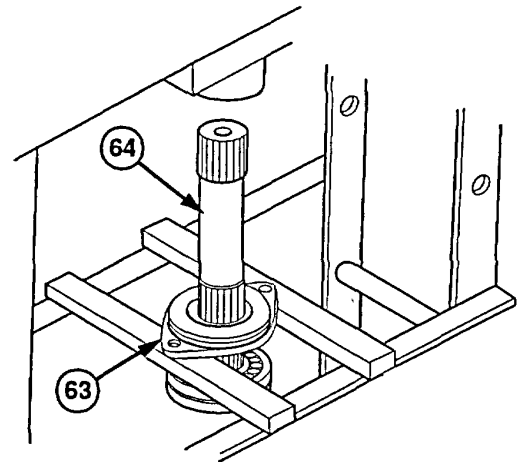
- (41) Remove step down gear (52) and two spacers (53) from pinion shaft (35) or inside rear housing (11).
- (42) Remove taper bearing (54), two taper races (55), and shim (56) from rear housing (11).
- (43) Remove taper race (57) from rear housing (11).
- (44) Remove taper bearing (58) from pinion shaft (35).
- (45) Remove two screws (59) and cover plate (60) from rear housing (11).



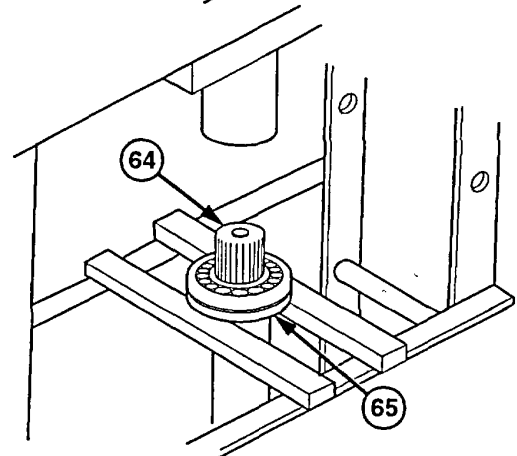
- (46) Separate and remove cover (61) and shim (62) from output housing (63).



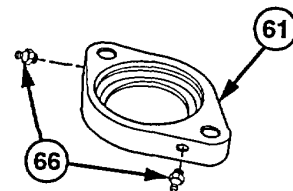
- (47) Place shaft (64) in press with output housing (63) at bottom. Press shaft (64) from housing (63).



- (48) Turn shaft (64) over. Press bearing (65) off shaft (64).



- (49) Remove two grease fittings (66) from cover (61).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

c. Cleaning/inspection

- (1) Remove sealant from housing mating surfaces.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean all metal parts with dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (3) Dry all parts, except bearings, with compressed air. Allow bearings to air dry.
- (4) Inspect bearings for abnormal wear or chipping.
- (5) Remove residual adhesive-sealant from screws and threaded holes.
- (6) Remove burrs from seal bores.
- (7) Inspect all parts for other damage. Replace damaged parts.
- (8) Inspect differential housing studs for bending or damaged threads.

d. Assembly

WARNING

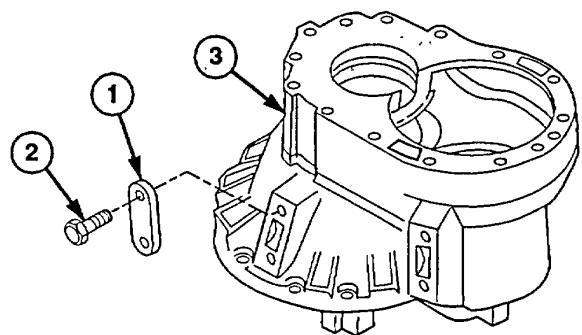
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (1) Coat mating surface of cover plate (1) with silicone adhesive-sealant.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

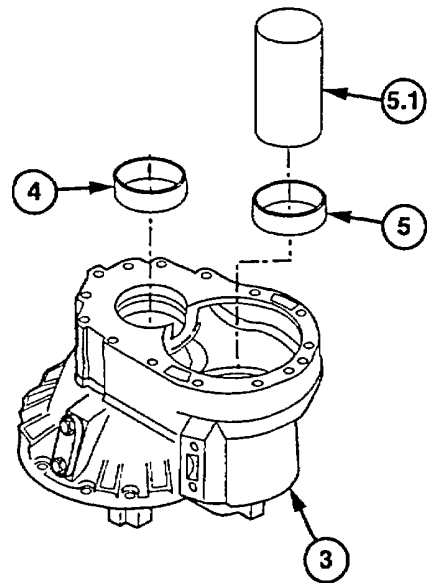
- (2) Coat threads of two screws (2) with adhesive-sealant (Item 6, Appendix B).
- (3) Install cover plate (1) on rear housing (3) with two screws (2). Torque to 47 lb-ft (65 N•m).



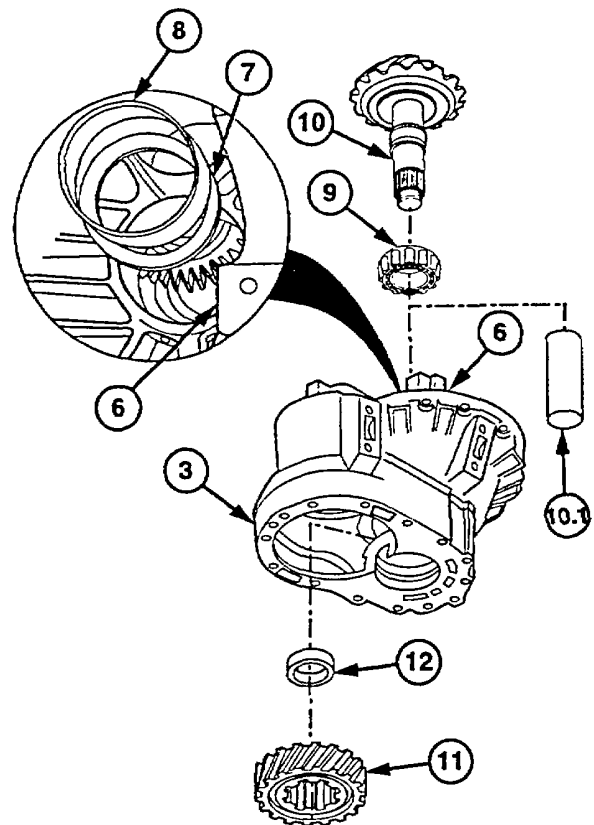
NOTE

If installing new gear set, compare dimension marked on new pinion head of pinion gear with dimension on original pinion gear. If dimension is bigger, pinion gear shim will be thinner. If dimension is smaller, pinion gear shim will be thicker.

- (4) Install taper race (4) in rear housing (3).
- (4.1) Install taper race (5) in rear housing (3) using power divider bearing cone installer (5.1).



- (5) Position housing (3) so differential cradle (6) faces up.
- (6) Install shim (7) and taper race (8) in housing (3).
- (7) Install taper bearing (9) on pinion shaft (10) using pinion bearing cone installer (10.1).
- (8) Coat taper bearing (9) with lubricating oil.
- (9) Install drop gear (11) and spacer (12) in rear housing (3).
- (10) Install pinion shaft (10) in rear housing (3) thru drop gear (11) and spacer (12).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

- (11) Position rear housing (3) so pinion shaft (10) is parallel to floor.
- (12) Install spacer (13) and taper bearing (14) on pinion shaft (10) while assistant supports pinion shaft (10).
- (13) Position jet extractor (15) between gear tooth on pinion gear (16) and housing (3) with aid of assistant
- (14) Install new pinion nut (17) on pinion shaft (10). Torque to 543-572 lb-ft (736-776 N•m).
- (15) Stake edges of nut (17) in notches of shaft (10).
- (16) Remove jet extractor (15) from housing (3).

NOTE

Assembled pinion gear should rotate with 38-47 lb-in. (4.45.4 N·m) of torque. Repeat assembly steps (4) thru (14) if over these limits.

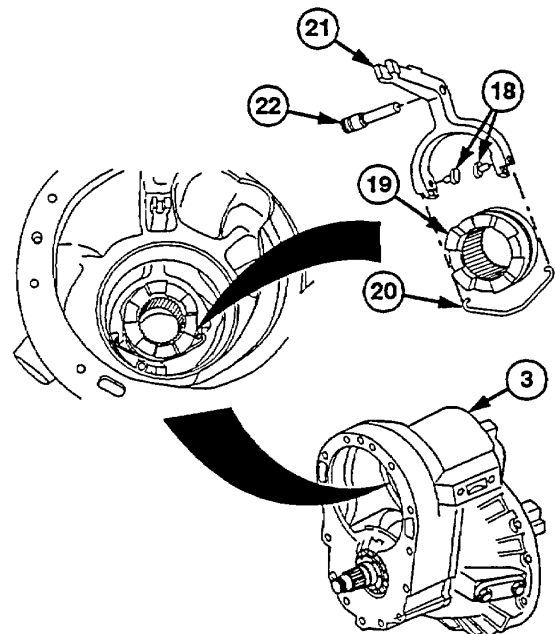
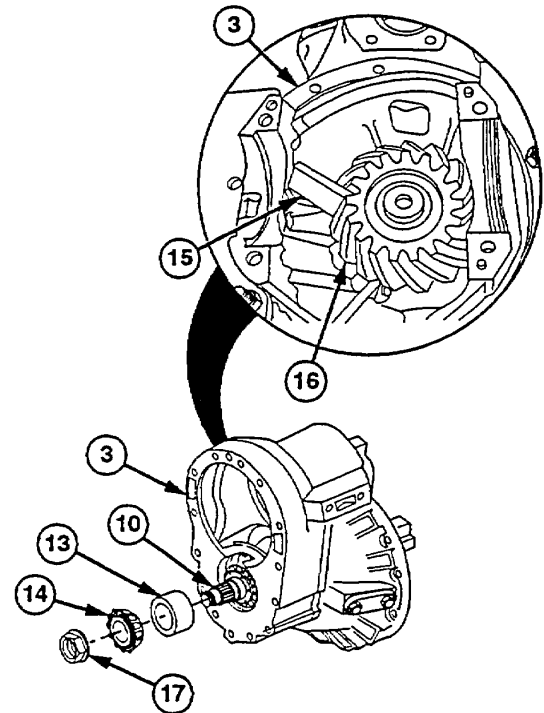
- (17) Check rolling resistance of assembled gear by turning pinion nut (17).

- (18) Install two shift dogs (18), dutch gear (19), and retaining dip (20) on fork (21).
- (19) Install assembled fork (21) and pin (22) in rear housing (3).
- (20) Lock pin (22) in place by staking three points.

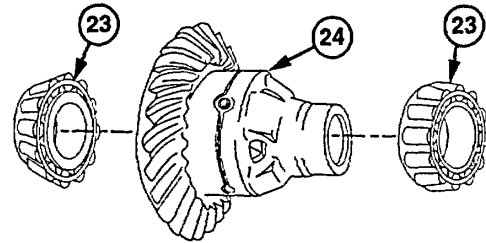
WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (21) Coat pin (22) area with layer of silicone adhesive-sealant.



- (22) Install two taper bearings (23) on differential (24).
- (23) Coat taper bearings (23) with lubricating oil.



- (24) Position rear housing (3) so pinion shaft (10) points down.

NOTE

Do step (25) if dowels were removed.

- (25) Install four dowels (25) on rear housing (3).

WARNING

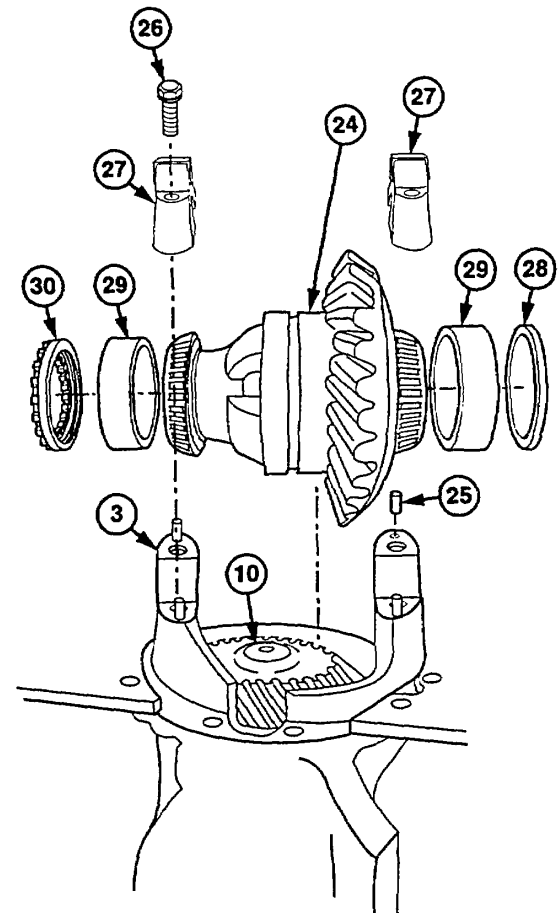
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (26) Coat threads of four screws (26) with adhesive-sealant (Item 4, Appendix B).

NOTE

If pinion gear shims were increased in thickness, differential bearings must be decreased by same amount. If pinion gear shims were decreased in thickness, differential bearings must be increased by same amount.

- (27) Install differential (24), bearing caps (27), shim (28), and races (29) on rear housing (3) with four screws (26). Torque to 25 lb-in. (2.8 N•m).
- (28) Position adjusting nut (30) in rear housing (3).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

- (29) Install differential carrier preload gage (31) on bearing cap (27) with screw (35).
- (29.1) Position magnetic base of dial indicator (32) on bearing cap (27).
- (29.2) Position probe of dial indicator (32) on differential carrier preload gage (31).
- (29.3) Zero dial indicator (32).
- (30) Tighten adjusting nut (30) until bearing caps (27) expand 0.014-0.018 in. (.36-.46 mm).
- (30.1) Remove screw (35), differential carrier preload gage (31) and dial indicator (32) from bearing caps (27).
- (31) Tighten screws (26) on bearing caps (27) to 120-137 lb-ft (163-186 N•m).
- (32) Check backlash of differential (24) to pinion shaft (10).
- (33) Hold pinion shaft (10) so pinion gear (16) does not move.

NOTE

Do not allow pinion gear to turn while doing steps (33) thru (35).

- (34) Turn differential (24) counterclockwise until it stops to take up backlash.

NOTE

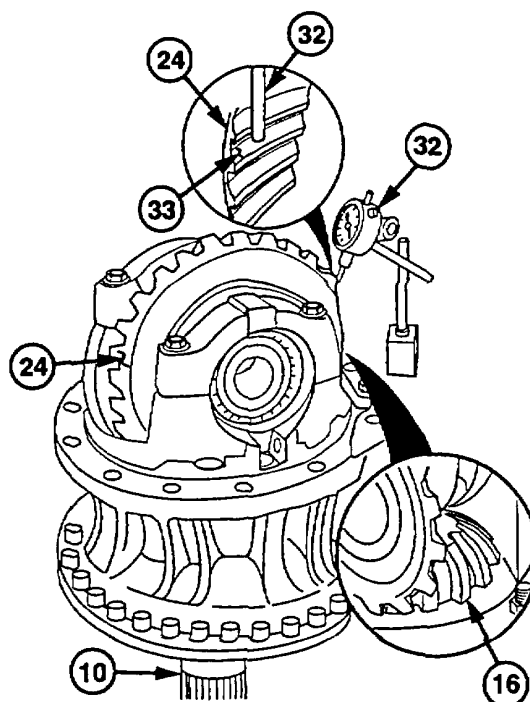
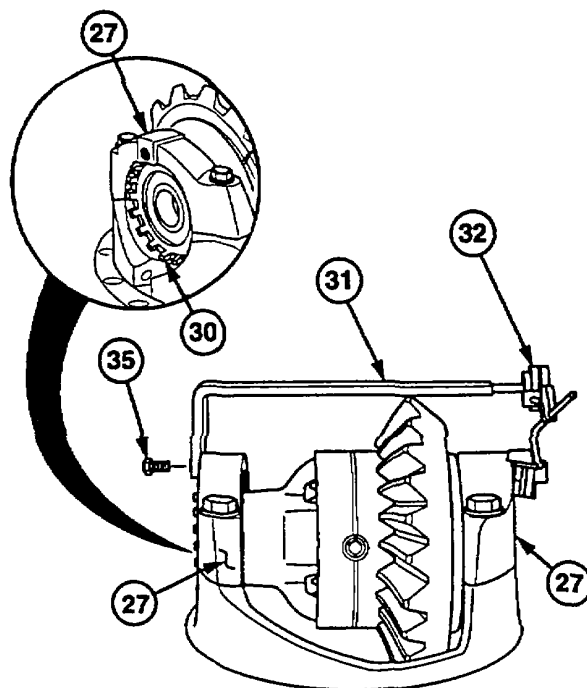
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (35) Install dial indicator (32) on face of differential gear tooth (33).
- (36) Turn differential (24) clockwise until it stops.

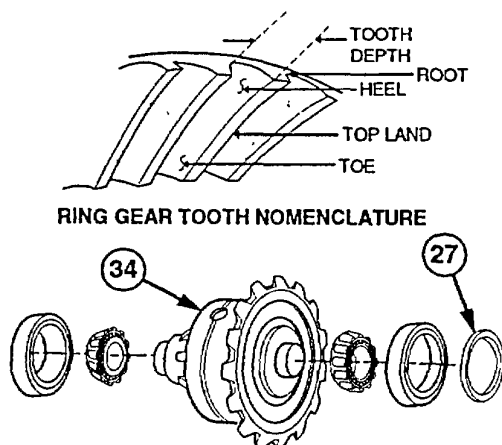
NOTE

Backlash should be 0.0100-0.016 in. (25-41 mm). To increase backlash, reduce thickness of shims installed in carrier housing. To decrease backlash, increase thickness of shims.

- (37) Record differential (24) to pinion shaft (10) backlash measured on dial indicator (32).



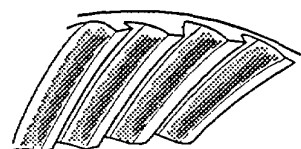
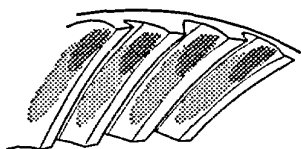
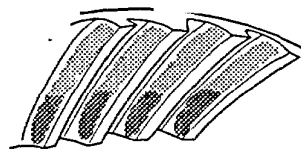
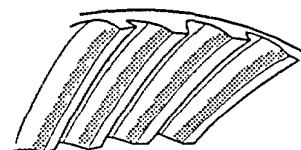
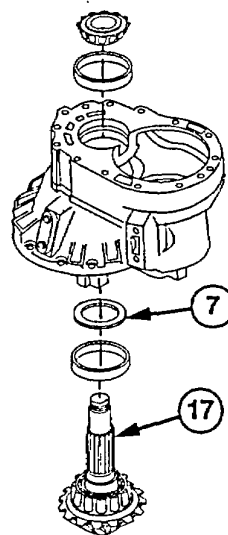
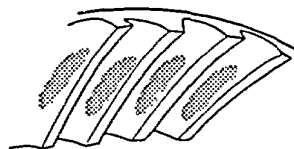
- (38) Coat gear teeth of ring gear (34) with prussian blue dye. Check for correct pattern of rotation. If needed, remove and adjust shims as required. A correct pattern is clear of toe and centers evenly along width of face between top land and root. Length and shape of pattern may vary and is acceptable as long as pattern does not run off tooth at any point.



NOTE

Any time pinion depth is changed, backlash may change. Check and adjust backlash as needed.

- (39) Move ring gear (34) away from pinion gear (17) by using a thinner shim (27) and thicker shim (7) if pattern is too close to top of tooth.
- (40) Move ring gear (34) away from pinion gear (17) by using a thinner shim (27) and thicker shim (7) if pattern is too close or off tooth root.
- (41) Move ring gear (34) toward pinion gear (17) by using a thicker shim (27) and thinner shim (7) if pattern is too close or off tooth heel.
- (42) Move ring gear (34) toward pinion gear (17) by using a thicker shim (27) and thinner shim (7) if pattern is too close to bottom of tooth.



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

WARNING

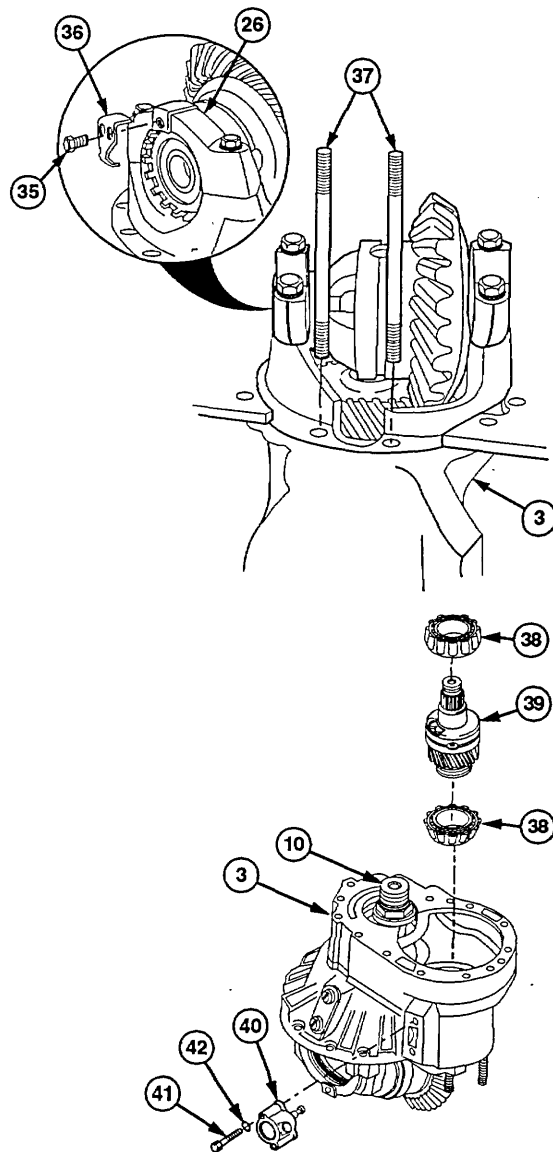
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (43) Coat threads of screw (35) with adhesive sealant (Item 6, Appendix B).
- (44) Install lock plate (36) on bearing cap (26) with screw (35). Torque to 132-216 lb-in. (15-24 N•m).
- (45) Coat two studs (37) with adhesive-sealant (Item 6, Appendix B).
- (46) Install two studs (37) in rear housing (3). Torque to 76 lb-ft (103 N•m).
- (47) Rotate rear housing (3) so pinion shaft (10) points up.
- (48) Install two bearing cones (38) on split torque differential (39).
- (49) Install split torque differential (39) in rear housing (3).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

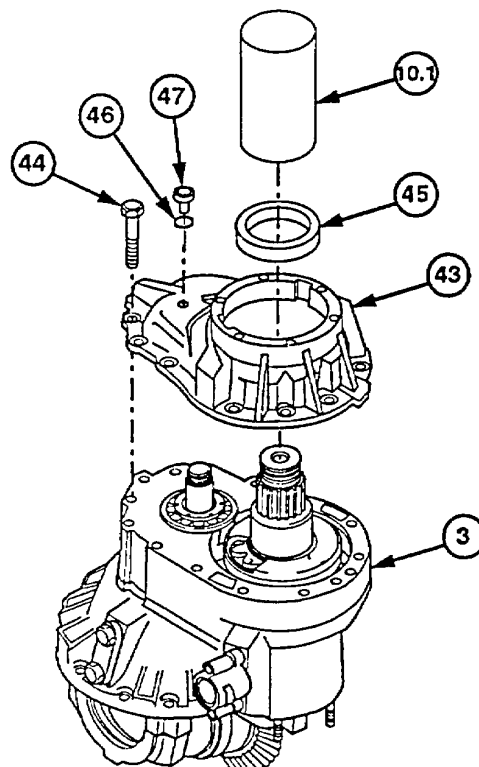
- (50) Coat mating surface of differential lock actuating cylinder (40) with silicone adhesive-sealant.
- (51) Coat threads of two screws (41) with adhesive-sealant (Item 6, Appendix B).
- (52) Install differential lock actuating cylinder (40) on rear housing (3) with two washers (42) and screws (41). Torque to 47 lb-ft (64 N•m).



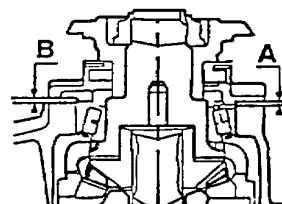
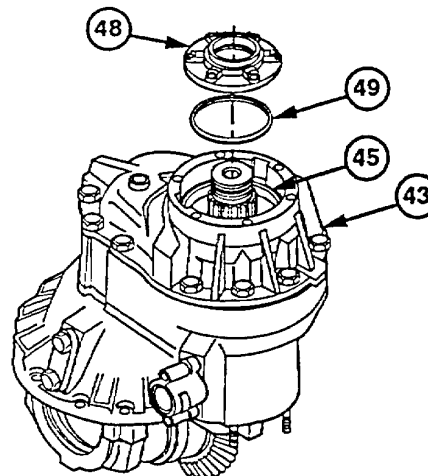
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (53) Coat rear housing (3) sealing surface with adhesive-sealant (Item 3, Appendix B).
- (54) Install front housing (43) on rear housing (3).
- (55) Coat 13 screws (44) with adhesive-sealant.
- (56) Install screws (44) in front housing (43). Torque to 44 lb-ft (60 N•m).
- (57) Install taper race (45) in front housing (43) using power divider bearing cone installer (10.1).
- (58) Install new preformed packing (46) and drain plug (47) in front housing (43).



- (59) Measure and record distance A on raised portion of bottom seal cover (48).
- (60) Measure and record distance B between face of front housing (43) and taper race (45).
- (61) Calculate shim (49) thickness by subtracting distance A from B. Shim thickness is $B - A \pm 0.002$ in. (0.05 mm).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)**WARNING**

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (62) Coat front housing (43) sealing surface with silicone adhesive-sealant.

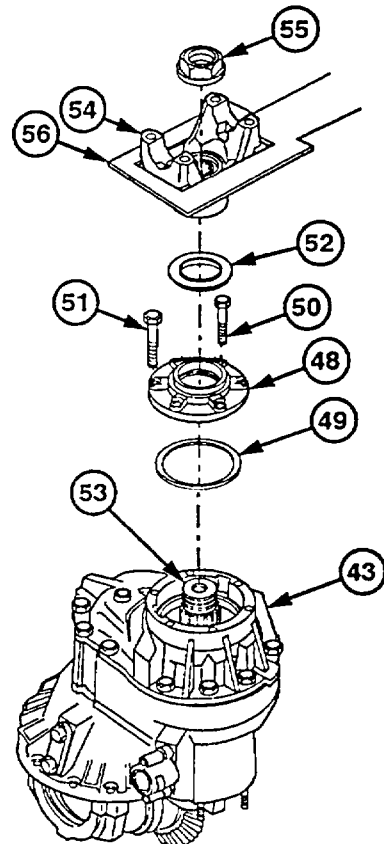
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

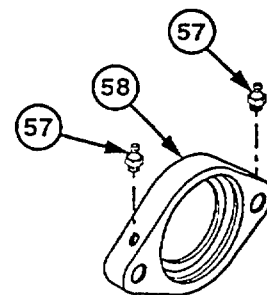
- (63) Coat threads of five screws (50) and screw (51) with adhesive-sealant (Item 6, Appendix B).
- (64) Install shim (49) and seal cover (48) on front housing (43) with five screws (50) and screw (51). Torque screws (50) to 44 lb-ft (60 N•m) and screw (51) to 56 lb-ft (104 N•m).

NOTE

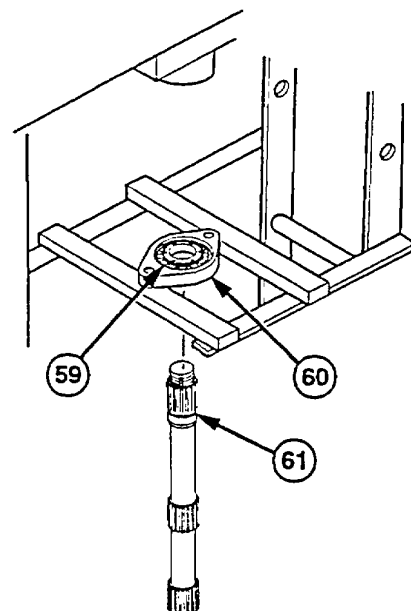
Oil seal is installed properly when top surface of seal is 1/16 in. (1.59 mm) below cover.



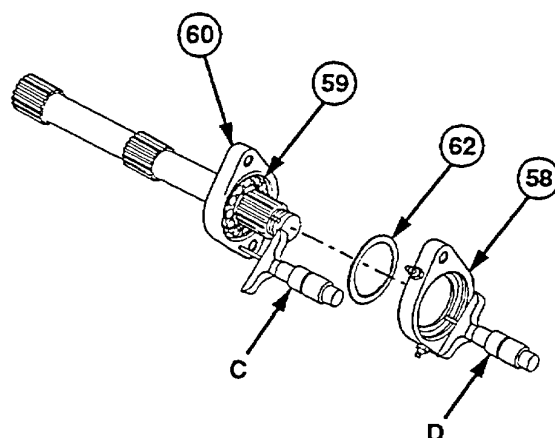
- (65) Install new yoke seal (52) in seal cover (48).
- (66) Coat splines of input shaft (53) with silicone adhesive-sealant.
- (67) Install yoke (54) and new pinion nut (55) on input shaft (53) using socket (55.1). Torque to 680-796 lb-ft (922-1079 N•m) using yoke holder (56) with aid of assistant.
- (68) Stake edges of new nut (55) in notches of shaft (53).
- (69) Install two grease fittings (57) on cover (58).



- (70) Press bearing (59) in output housing (60).
- (71) Press shaft (61) on bearing (59).



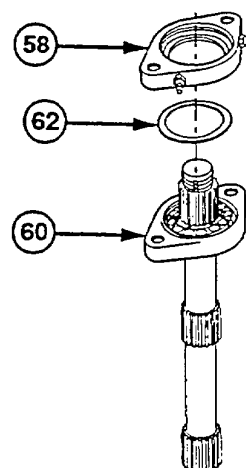
- (72) Measure distance C between machine surface of output housing (60) and top of bearing (59).
- (73) Measure distance D between machine surface and bottom of first land in cover (58).
- (74) Calculate shim thickness (62) by subtracting distance C from distance D. Shim thickness = DC.



WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (75) Coat mating surface of cover (58) with silicone adhesive-sealant
- (76) Install shim (62) and cover (58) and on housing (60).



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

e. Installation

- (1) Remove two screws (1) from differential assembly (2).
- (2) Install two lifting eyes (3) in differential assembly (2).
- (3) Attach lifting device to lifting eyes (3).
- (4) Remove six screws (4) and differential assembly (2) from adapter (6).

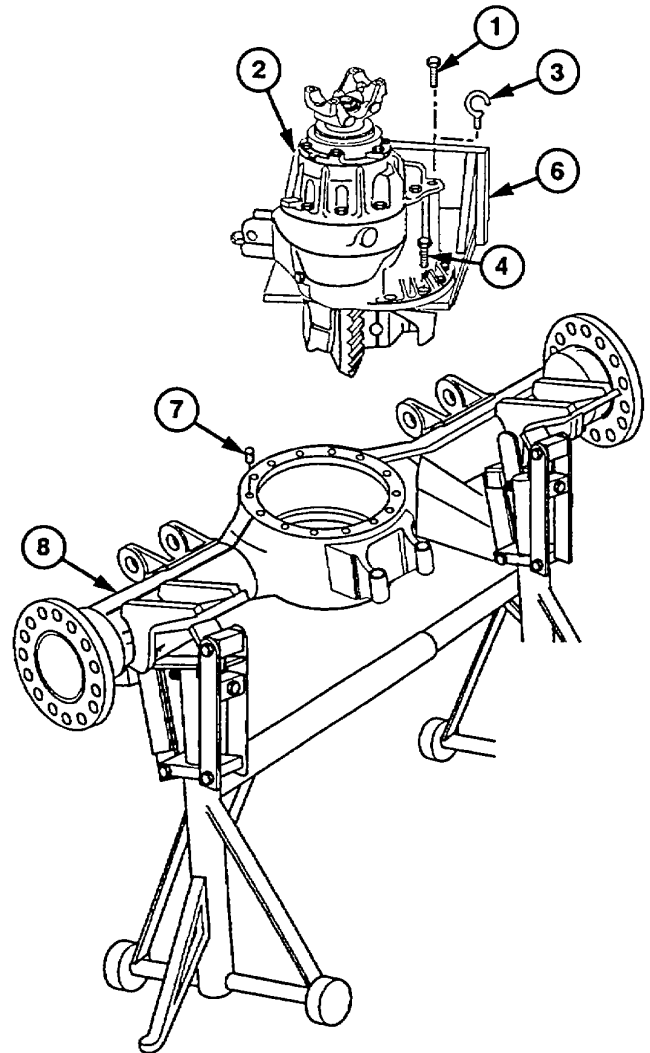
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

NOTE

Do steps (5) and (6) only if studs were removed.

- (5) Coat threads of 12 studs (7) with adhesive-sealant (Item 6, Appendix B).
- (6) Install 12 studs (7) in axle housing (8).



WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (7) Coat contact surface of differential assembly (2) with silicone adhesive-sealant.

WARNING

Differential weighs approximately 750 lb (341 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

CAUTION

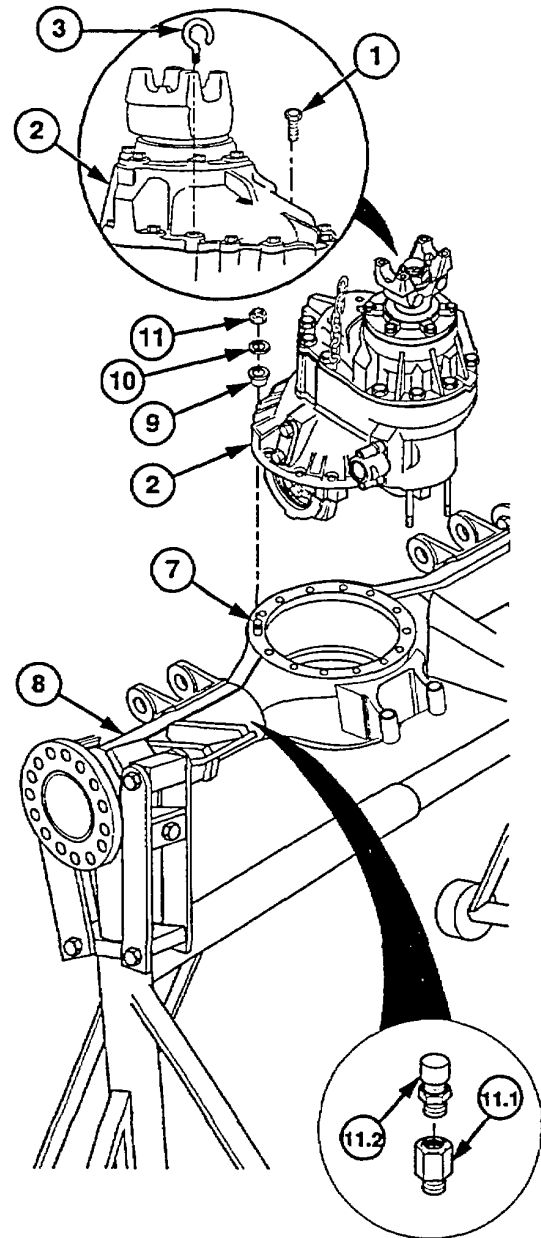
Lower carrier straight into axle housing. Failure to comply may result in binding and damage to studs.

- (8) Install differential assembly (2) on axle housing (8) while assistant operates lifting device.
- (9) Install 10 taper rings (9) on studs (7).
- (10) Install 12 washers (10) and locknuts (11) on studs (7). Torque to 140-152 lb-ft (191-206 Nm).
- (11) Remove two lifting eyes (3) and lifting device from differential assembly (2).
- (12) Install two screws (1) in differential assembly (2).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (12.1) Coat adapter (11.1) and breather (11.2) with pipe thread compound.
- (12.2) Install adapter (11.1) and breather (11.2) on axle housing (8).

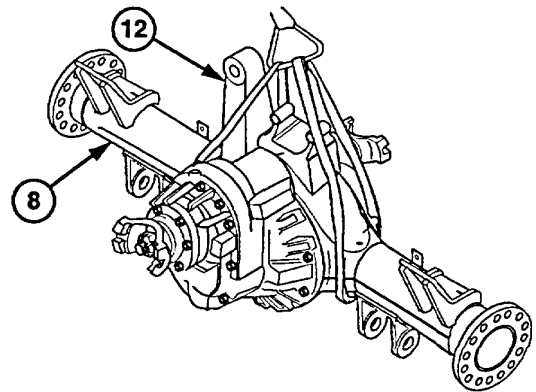


- (13) Attach lifting device to axle housing (8)

WARNING

Axle weighs approximately 1927 lb (875 kg). Use caution when lifting or moving axle. Failure to do so may result in serious injury or death to personnel.

- (14) Position axle housing (8) so torque rod bracket (12) is pointing up



25-3. AXLE NO. 3 DIFFERENTIAL REPAIR (CONT)

- (15) Install two washers (13) and new locknuts (14) on studs (15).
- (16) Install output shaft assembly (16) and new preformed packing (17) on differential assembly (2).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive sealant gets on skin or clothing, wash immediately with soap and water.

- (17) Coat threads of two screws (18) with adhesive-sealant (Item 6, Appendix B).
- (18) Install two screws (18) on output shaft assembly (16). Torque to 90 lb-ft (122 N•m).

NOTE

Oil seal is installed properly when top surface of seal is 1/16 in. (1.59 mm) below cover.

- (19) Install new oil seal (19) on output shaft assembly (16).

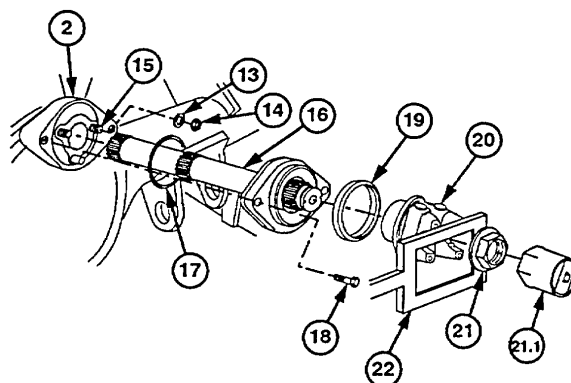
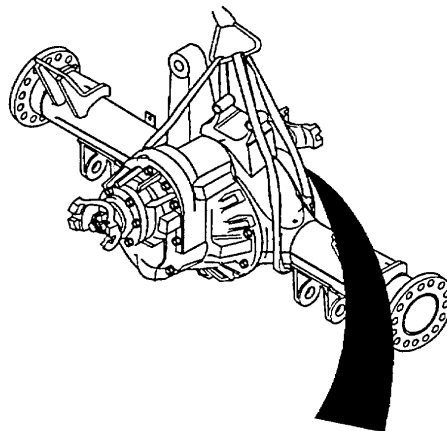
WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (20) Coat splines of output shaft assembly (16) with silicone adhesive-sealant
- (21) Install yoke (20) on output shaft assembly (16) with nut (21) using socket (21.1). Torque to 486-572 lb-ft (659-775 N•m) using yoke holder (22) with aid of assistant.
- (22) Stake nut (21) in notches of output shaft assembly (16).

f. Follow-On Maintenance

- (1) Install axle shafts (para 10-8).
- (2) Install axle manifold (TM 9-2320-360-20).
- (3) Install brake chambers (TM 9-2320-360-20).



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR

This task covers:

a. Removal	d. Assembly
b. Disassembly	e. Installation
c. Cleaning/inspection	f. Follow-on Maintenance

INITIAL SETUP

Equipment Conditions

Pivot, spindle, and axle shafts removed (para 10-7).
Axle no. 4 manifold removed (TM 9-2320-360-20).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Holder, Yoke (Figure C-15, Appendix C)
Gage, Preload, Differential Carrier (Figure C-16, Appendix C)
Installer, Bearing Cone (Figure C-20, Appendix C)
Adapter, Differential Maintenance (Item 0.1, Appendix E)
Dial Indicator, Magnetic (Item 32, Appendix E)
Multiplier, Torque (Item 99, Appendix E)
Press, Hydraulic (Item 116, Appendix E)
Socket, 55 mm (Item 163.1, Appendix E)
Stand, Engine (Item 181, Appendix E)
Stand, Maintenance, Automotive Axle (Item 182, Appendix E)
Wrench Set, Socket, 1 In. Drive (Item 230, Appendix E)
Wrench Set, Socket, 3/4 In. Drive (Item 231, Appendix E)
Wrench Set, Socket, 3/8 In. Drive (Item 232, Appendix E)
Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
Wrench, Torque, 0-150 Lb-In. (Item 234, Appendix E)
Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Adhesive-Sealant (Item 4, Appendix B)
Adhesive-Sealant (Item 6, Appendix B)
Adhesive-Sealant, Silicone (Item 2, Appendix B)
Cloth, Crocus (Item 16, Appendix B)
Compound, Sealing, Pipe Thread (Item 28, Appendix B)
Dye, Prussian Blue (Item 30, Appendix B)
Oil, Lubricating (Item 44, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Tags, Identification (Item 56, Appendix B)
Ties, Cable, Plastic (Item 60, Appendix B)
Locknuts (3) (Item B2, Appendix F)
Nut (Item 150, Appendix F)
Seal, Pinion (Item 305, Appendix F)

Personnel Required

Two

25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)

a. Removal

NOTE

Location of plastic cable ties should be marked before removal.

- (1) Remove plastic cable ties (1) from hoses no. 2109 (2), no. 2140 (3), no. 2018 (4), and breather hose (5).
- (2) Remove hose no. 2109 (2) from fitting (6).
- (3) Remove hose no. 2140 (3) from fitting (7).
- (4) Remove hose no. 2018 (4) from fitting (8).

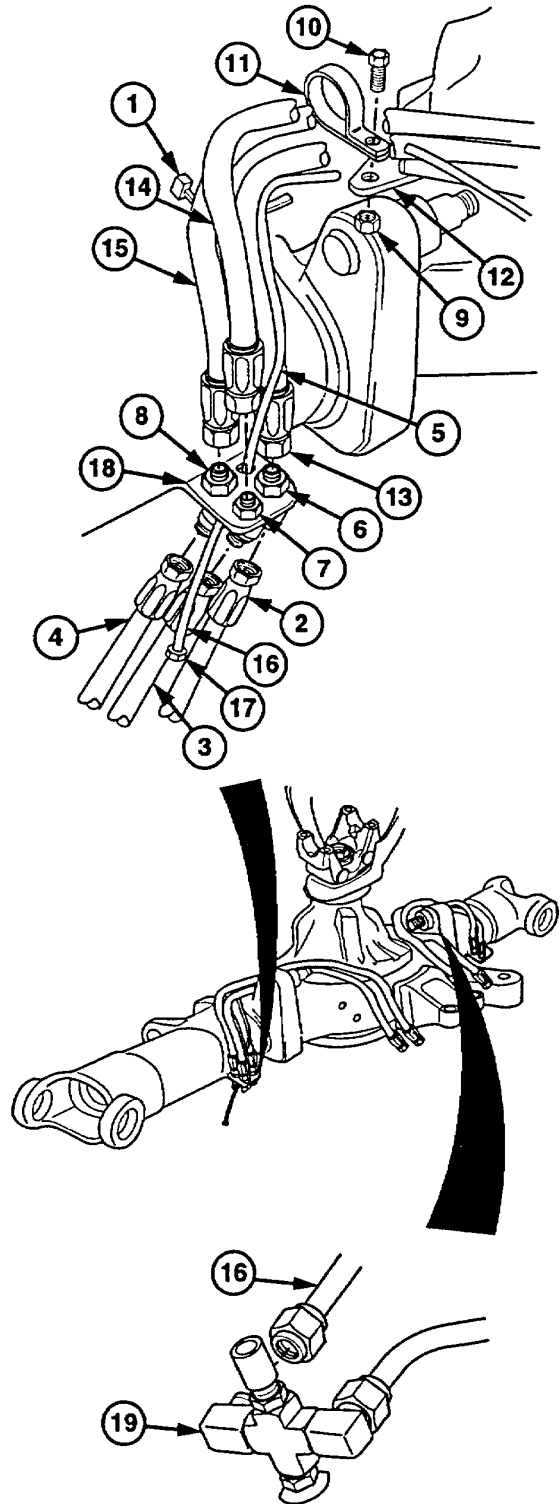
- (5) Remove locknut (9), screw (10), and cushion clip (11) from standoff bracket (12) and four hoses (13, 14, 15, and 5). Discard locknut (6). Remove hose no. 2109 (13) from fitting (6).
- (7) Remove hose no. 2140 (14) from fitting (7).
- (8) Remove hose no. 2018 (15) from fitting (8).

NOTE

- Fitting must be removed to remove breather hose from bracket

- Cut hose directly behind fitting.

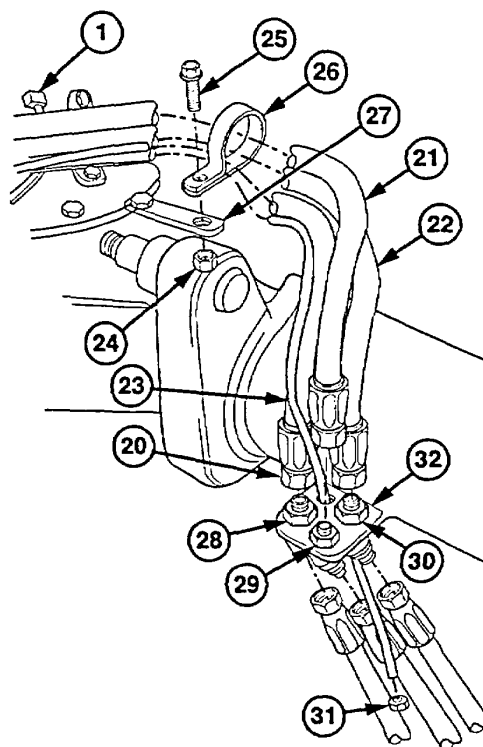
- (9) Cut breather hose (16) and remove fitting (17).
- (10) Remove breather hose (16) from bracket (18).
- (11) Remove breather hose (16) from elbow (19).



NOTE

Location of plastic cable ties should be marked before removal.

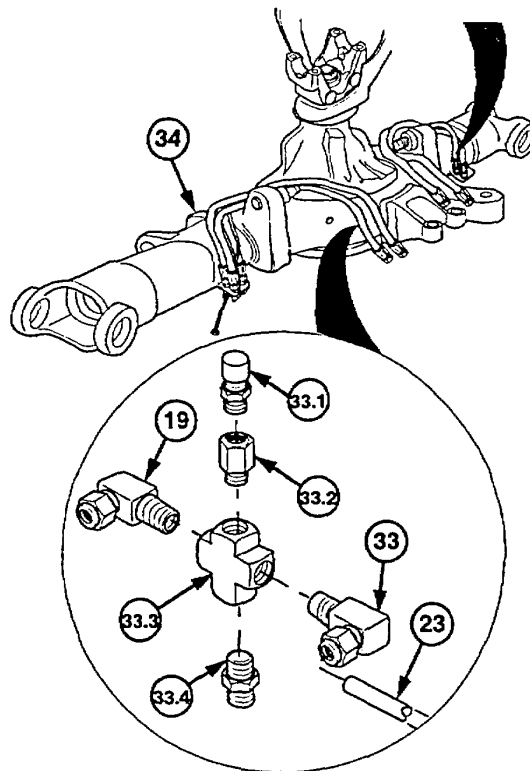
- (12) Remove plastic cable tie (1) from hoses no. 2873 (20), no. 2141 (21), no. 2016 (22), and breather hose (23).
- (13) Remove locknut (24), screw (25), and cushion clip (26) from standoff bracket (27) and four hoses (20, 21, 22, and 23). Discard locknut.
- (14) Remove hose no. 2873 (20) from fitting (28).
- (15) Remove hose no. 2141 (21) from fitting (29).
- (16) Remove hose no. 2016 (22) from fitting (30).

**NOTE**

Fitting must be removed to remove breather hose from bracket.

Cut hose directly behind fitting.

- (17) Cut breather hose (23) and remove fitting (31).
- (18) Remove breather hose (23) from bracket (32).
- (19) Remove breather hose (23) from elbow (33).
- (19.1) Remove breather (33.1) and adapter (33.2) from tee (33.3).
- (19.2) Remove tee (33.3) and adapter (33.4) from axle housing (34).
- (19.3) Remove elbow (19) and elbow (33) from tee (33.3).



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)

- (20) Attach lifting device to axle housing (34).

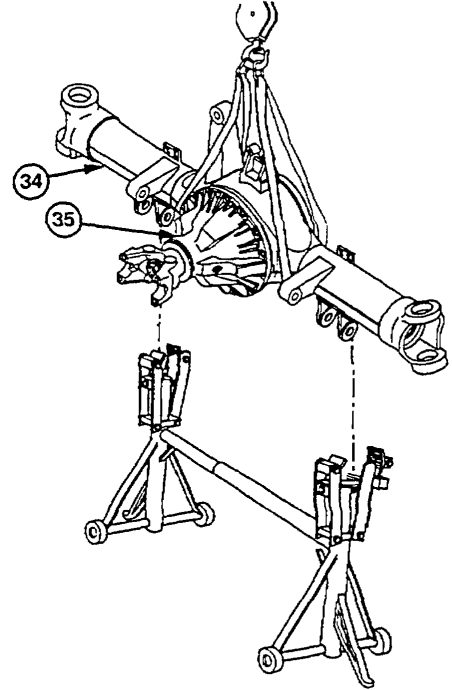
WARNING

Axle weighs approximately 2040 lb (926 kg). Use caution when lifting or moving axle. Failure to do so may result in serious injury or death to personnel.

NOTE

Matchmark differential and axle housing.

- (21) Position axle housing (34) in axle stand with differential assembly (35) pointing up.

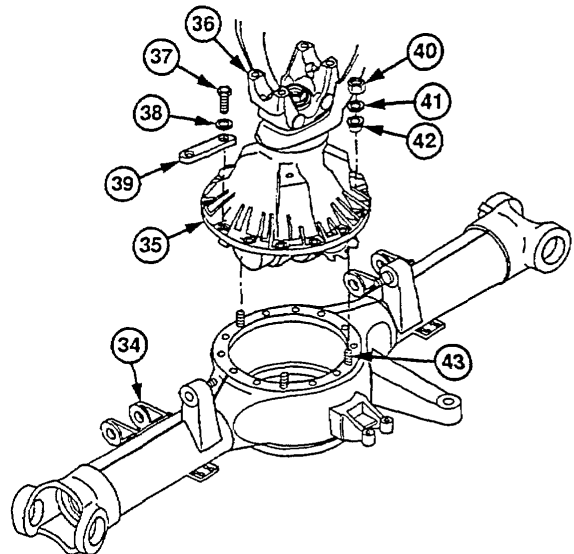


- (22) Attach lifting device to yoke (36).
- (23) Remove 11 screws (37), washers (38), and two brackets (39) from differential assembly (35).
- (24) Remove three locknuts (40), washers (41), and taper dowels (42) from studs (43). Discard locknuts.

WARNING

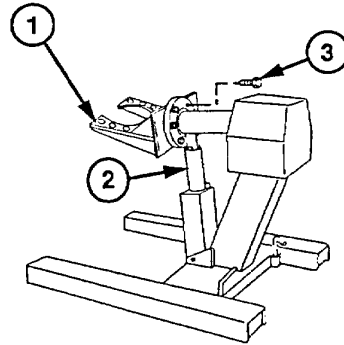
Differential weighs approximately 260 lb (118 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (25) Lift differential assembly (35) from axle housing (34) while assistant operates lifting device.

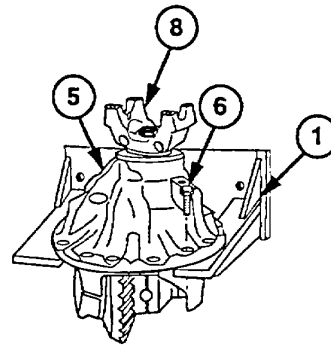


b. Disassembly

- (1) Install adapter (1) on stand (2) with six screws (3).
- (2) Install differential assembly (5) on adapter (1) with six screws (6).
- (3) Remove lifting device from yoke (B).



- (4) Position differential assembly (5) so pinion shaft (9) points down.
- (5) Check backlash of differential (10) to pinion shaft (9).
- (6) Hold yoke (8) so pinion gear (11) does not move.

**NOTE**

Do not allow pinion gear to turn while doing steps (7) thru (9).

- (7) Turn differential (10) counterclockwise until it stops to take up backlash.

NOTE

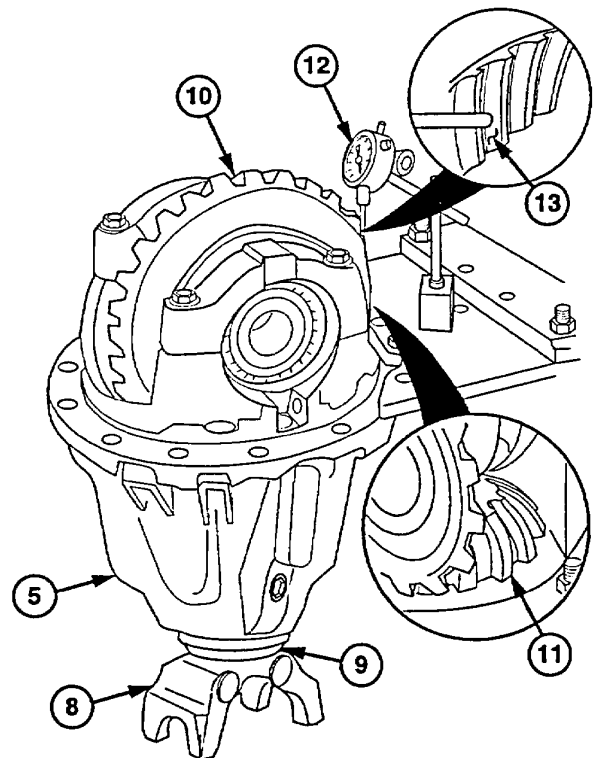
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (8) Install dial indicator (12) on face of differential gear tooth (13).
- (9) Turn differential (10) clockwise until it stops.

NOTE

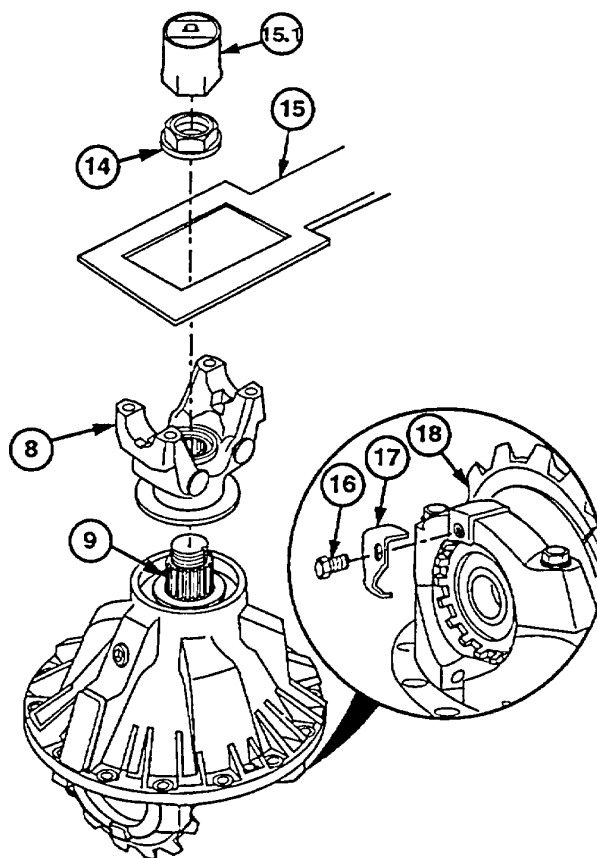
Backlash should be 0.008-0.011 in. (0.003-0.004 mm). To increase backlash, reduce thickness of shims installed in carrier housing. To decrease backlash, increase thickness of shims.

- (10) Record differential (10) to pinion shaft (9) backlash measured on dial indicator (12).

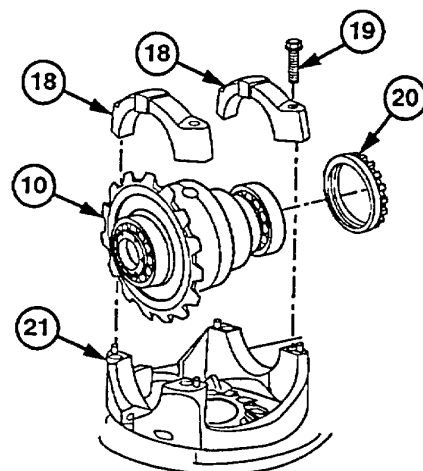


25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)

- (11) Unstake nut (14) on yoke (8).
- (12) Position yoke holder (15) on yoke (8).
- (13) Remove nut (14), yoke (8), and yoke holder (15) from pinion shaft (9) using socket (15.1) with aid of assistant.
- (14) Remove screw (16) and nut lock plate (17) from bearing cap (18).



- (15) Remove four screws (19) from two bearing caps (18).
- (16) Remove two bearing caps (18) and adjusting nut (20) from housing (21).
- (17) Lift differential (10) from housing (21) with the aid of assistant.



NOTE

- Remove taper bearings only if they fail inspection.
- To remove taper bearing from gear side of differential, first remove cage and rollers from inner race. Then pry inner race up high enough to install puller.
- Tag and mark shims before removal.

- (18) Remove adjusting shim (22), taper race (23), and taper bearing (24) from gear side of differential (10).
- (19) Remove taper race (25) and taper bearing (26) from other side of differential (10).

CAUTION

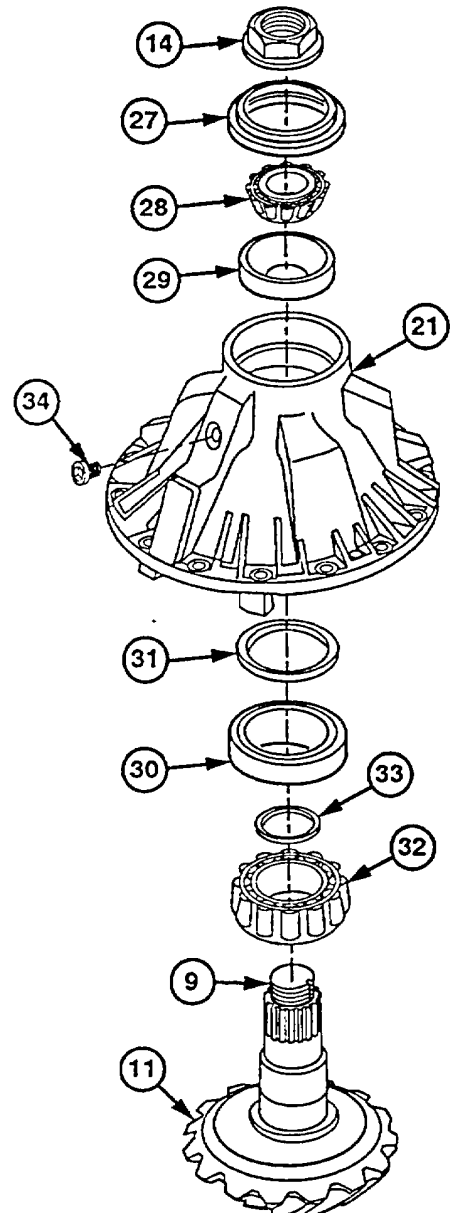
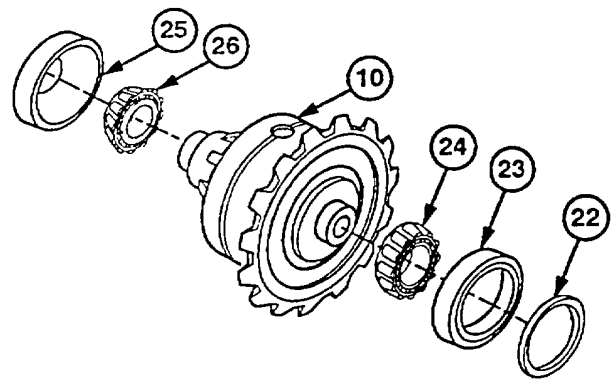
During removal of pinion gear, do not allow gear teeth to hit the inside of the housing and cover assembly. Damage to equipment may result.

- (20) Install nut (14) loosely on end of pinion shaft (9).
- (21) Remove pinion gear (11) from housing (21) while assistant supports pinion gear (11).
- (22) Remove and discard nut (14).
- (23) Remove pinion seal (27), taper bearing (28), and taper race (29) from housing (21). Discard pinion seal.

NOTE

Tag and mark shims before removal.

- (24) Remove taper race (30) and shim (31) from housing (21).
- (25) Remove taper bearing (32) and shim (33) from pinion shaft (9).
- (26) Remove filler plug (34) from housing (21).



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)**c. Cleaning/inspection**

- (1) Clean old gasket material from housing and/or caps.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean sealant residue from threaded holes with dry cleaning solvent

CAUTION

Wash machined parts separately to avoid damage from parts bumping together.

- (3) Wash metal parts in dry cleaning solvent.

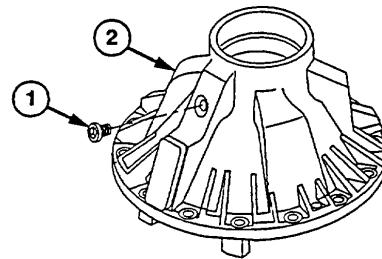
WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) Dry parts, except bearings, with compressed air. Allow bearings to air dry.
- (5) Remove small nicks or burrs with crocus cloth.
- (6) Coat parts with light coat of lubricating oil.
- (7) Inspect housing and caps for damage.
- (8) Inspect all parts and bearings with machined surfaces for deep scratches or wear grooves.
- (9) Replace damaged parts.

d. Assembly

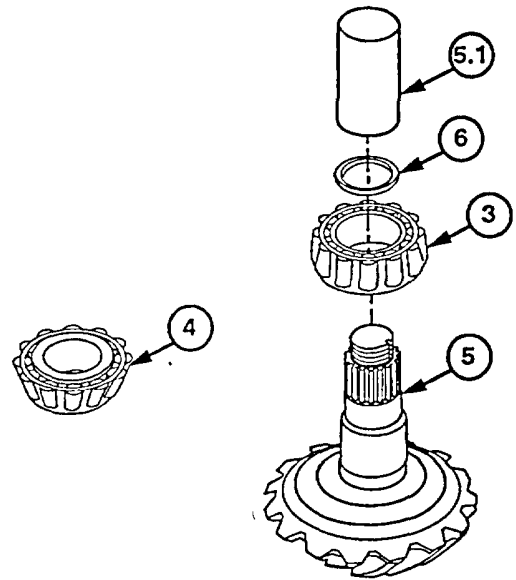
- (1) Install filler plug (1) in differential housing (2).



NOTE

If installing new gear set, record size of pinion gear (engraved on pinion end). Compare dimension with new gear set. If new size is larger, pinion gear shims will be thinner.

- (2) Coat bearings (3 and 4) with lubricating oil.
- (3) Press taper bearing (3) on pinion shaft (5) using pinion bearing cone installer (5.1)
- (3.1) Install shim (6) over end of pinion shaft (5).

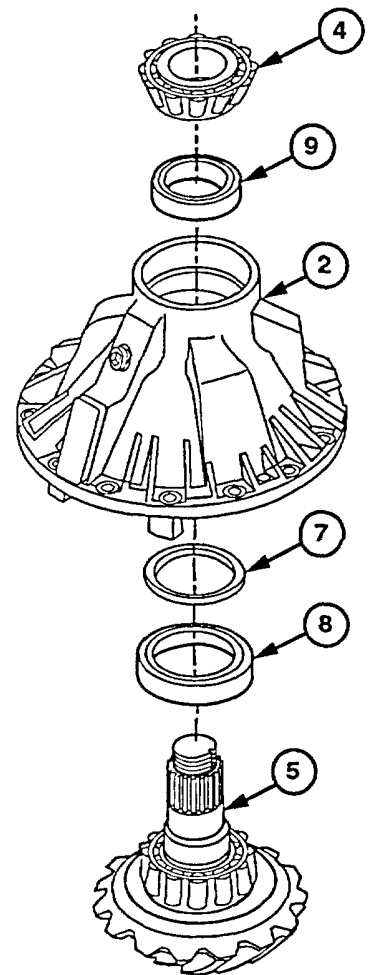


- (4) Install shim (7) and taper race (8) in housing (2) until fully seated.

NOTE

If small shim thickness is increased or decreased, large shim must be changed accordingly.

- (5) Install pinion shaft (5) through housing (2).
- (6) Install taper race (9) and taper bearing (4) on pinion shaft (5) while assistant supports pinion shaft (5).



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (7) Coat outer edge of new pinion seal (10) with silicone adhesive-sealant.

NOTE

Pinion seal is installed properly when top surface of seal is 1/16 in. (1.59 mm) below housing.

- (8) Install new pinion seal (10) in housing (2).
(9) Coat splines of pinion shaft (5) with silicone adhesive-sealant.

NOTE

Large openings of yoke must align with notches in input shaft to ease staking of nut.

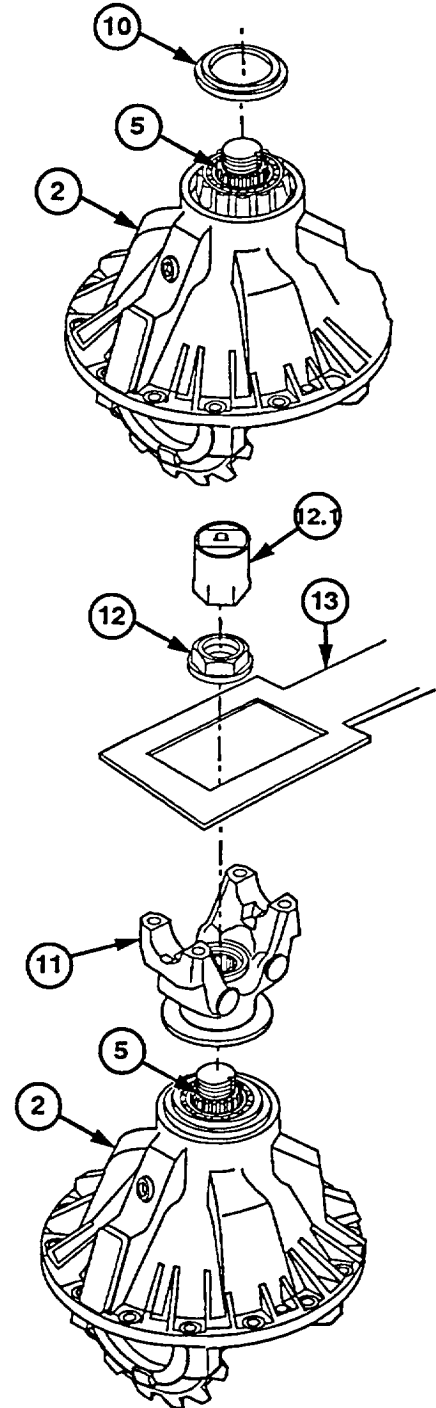
- (10) Install yoke (11) and new nut (12) on pinion shaft (5) using socket (12.1). Torque to 486-572 lb-ft (659-775 N•m) using yoke holder (13) with aid of assistant.

- (11) Stake edge of nut (12) in notches of pinion shaft (5).

NOTE

Pinion gear should rotate with 38-48 lb-in. (4.4-5.4 N•m) of torque. Repeat steps (1) thru (11) if over these limits.

- (12) Check pinion preload by turning nut (12) with torque wrench.



- (13) Install taper bearings (14 and 15) on differential (16).

NOTE

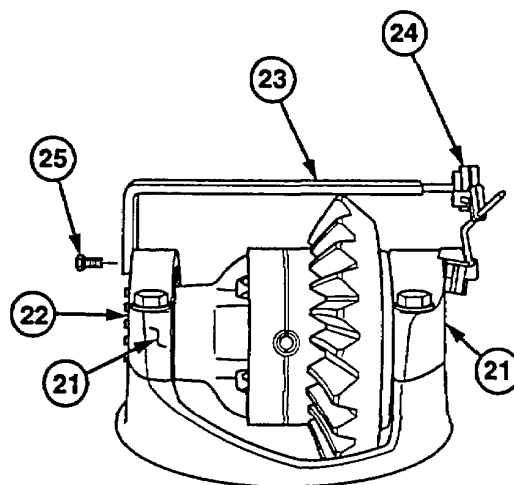
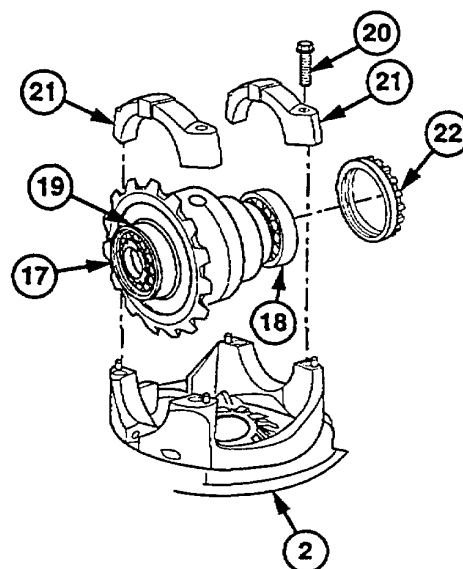
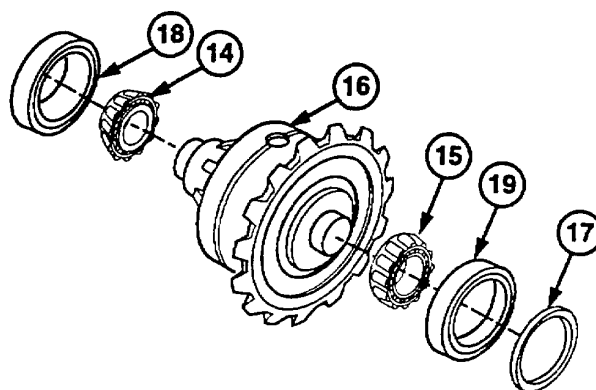
If thickness of pinion gear shims increased, differential shim must be decreased by same amount. If thickness of pinion gear shims decreased, differential shim must be increased by same amount. Refer to TM 9-2320-360-34P for proper identification of parts.

- (14) Measure thickness of shim (17) and change thickness if necessary.
- (15) Install differential (16), bearing races (18 and 19), and shim (17) in differential housing (2).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (16) Coat threads of capscrews (20) with adhesive-sealant (Item 4, Appendix B).
- (17) Install two bearing caps (21) on housing (2) with four capscrews (20). Torque to 25 lb-in. (2.82 N•m).
- (18) Install adjusting nut (22) in bearing cap (21).
- (19) Install differential carrier preload gage (23) on bearing cap (21) with screw (25).
- (19.1) Position magnetic base of dial indicator (24) on bearing cap (21).
- (19.2) Position probe of dial indicator (24) on differential carrier preload gage (23).
- (19.3) Zero dial indicator (24).
- (20) Tighten adjusting nut (22) until bearing caps (21) expand 0.013-0.017 in. (.33-.43 mm).
- (20.1) Remove screw (25), differential carrier preload gage (23) and dial indicator (24) from bearing caps (21).
- (21) Tighten capscrews (20) to 125 lb-ft (169 N•m).



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (22) Coat capscrew (25) with adhesive-sealant (Item 6, Appendix B).
- (23) Install capscrew (25) in lockplate (26) and bearing cap (21). Torque to 11-18 lb-ft (15-24 N•m).
- (24) Check backlash of differential (16) to pinion shaft (5).
- (25) Hold yoke (11) so pinion gear (27) does not move.

NOTE

Do not allow pinion gear to turn while doing steps (27) thru (29).

- (26) Turn differential (16) counterclockwise until it stops to take up backlash.

NOTE

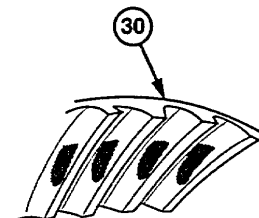
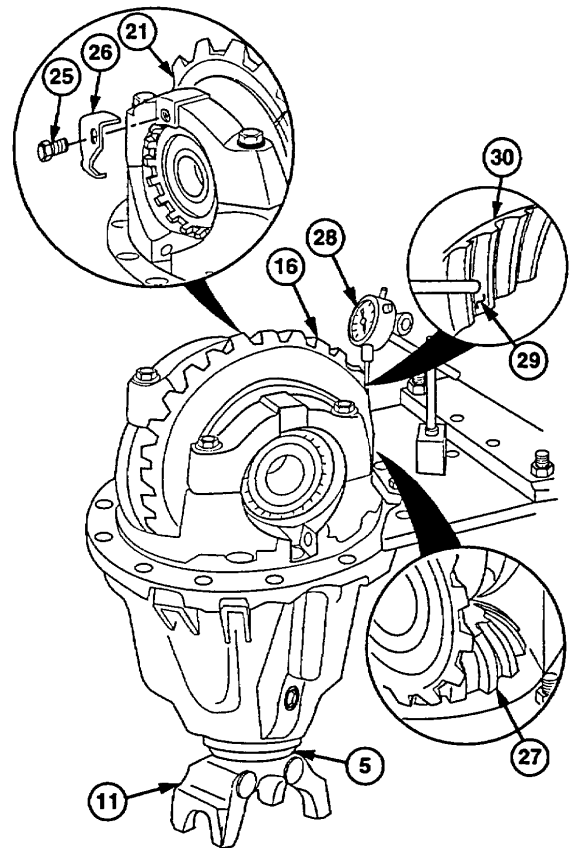
Shaft from dial indicator must be at right (90°) angle to face of tooth when in contact.

- (27) Install dial indicator (28) on face of differential gear tooth (29).
- (28) Turn differential (16) clockwise until it stops.

NOTE

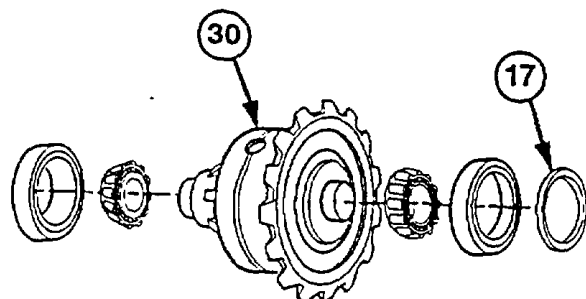
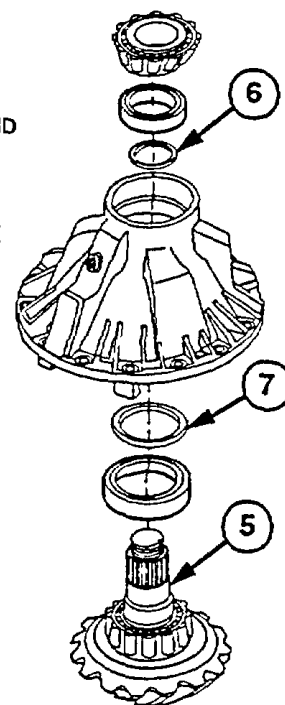
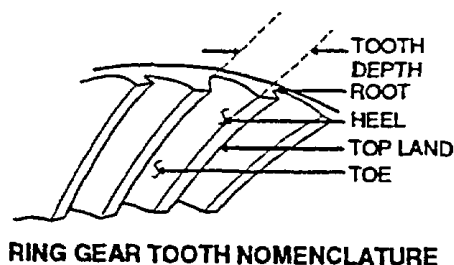
Backlash should be 0.008-0.011 in. (0.003-0.004 mm). To increase backlash, reduce thickness of shim. To decrease backlash, increase thickness of shim.

- (29) Record differential (16) to pinion shaft (5) backlash measured on dial indicator (28).
- (30) Coat gear teeth of ring gear (30) with prussian blue dye. Check for correct pattern by rotation. Remove and adjust shims as necessary.

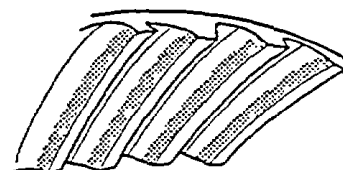


NOTE

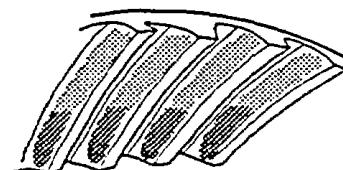
Any time pinion depth is changed, backlash may change. Check and adjust backlash as needed. A correct pattern is clear of toe and centers evenly along width of face between top land and root. Length and shape of pattern may vary and is acceptable as long as pattern does not run off tooth at any point.



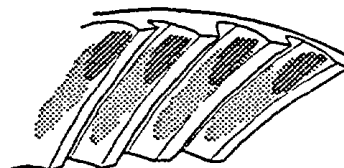
- (31) Move ring gear (30) away from pinion shaft (5) by using a thinner shim (17) and thicker shims (6) and (7) if pattern is too close to top of tooth.



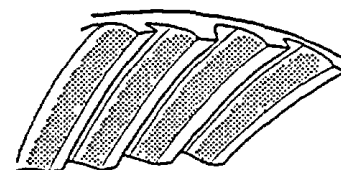
- (32) Move ring gear (30) away from pinion shaft (5) by using a thinner shim (17) and thicker shims (6) and (7) if pattern is too close or off tooth root.



- (33) Move ring gear (30) toward pinion shaft (5) by using a thicker shim (17) and thinner shims (6) and (7) if pattern is too close or off tooth heel.



- (34) Move ring gear (30) toward pinion shaft (5) by using a thicker shim (17) and thinner shims (6) and (7) if pattern is too close to bottom of tooth.



25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)**e. Installation**

- (1) Attach lifting device to yoke (1).
- (2) Remove six screws (2) and differential assembly (4) from adapter (5).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (3) Coat around mounting flange of differential assembly (4) with silicone adhesive-sealant.

WARNING

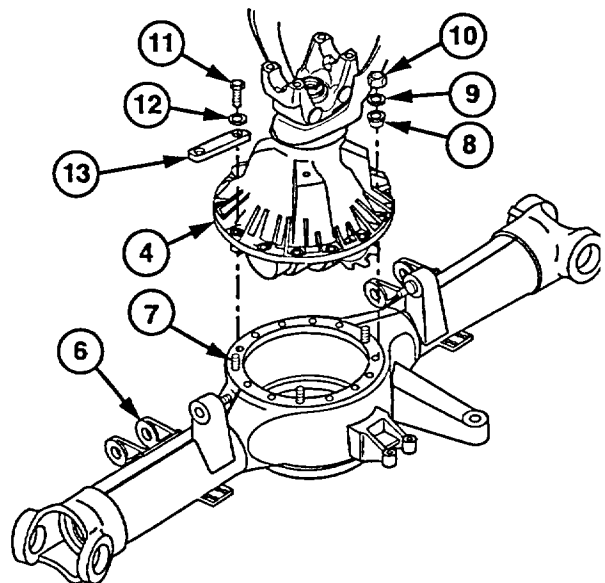
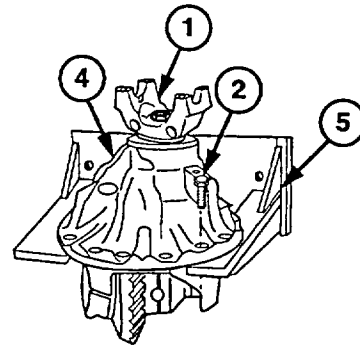
Differential weighs approximately 260 lb (118 kg) and requires the aid of assistant to move or lift it. Failure to use caution may result in injury to personnel.

- (4) Install differential assembly (4) on axle housing (6) while assistant operates lifting device.
- (5) Coat three studs (7) with silicone adhesive-sealant (6) Install three taper dowels (8), washers (9), and nuts (10) on studs (7). Torque to 140-152 lb-ft (190-206 N•m).

WARNING

Adhesive-sealant may burn or give off harmful vapors. It is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

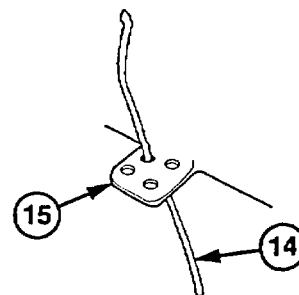
- (7) Coat 11 screws (11) with adhesive-sealant (Item 6, Appendix B).
- (8) Install washers (12), screws (11), and two standoff brackets (13) in differential assembly (4). Torque to 140-152 lb-ft (190-206 N•m).



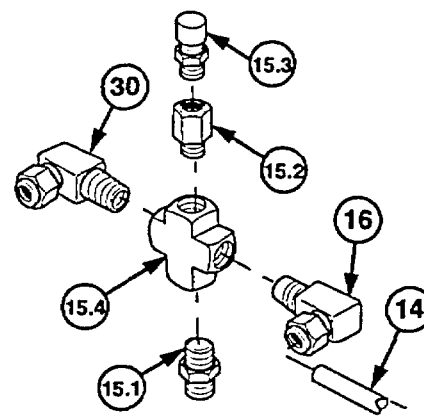
- (9) Route breather hose (14) through bracket (15).

WARNING

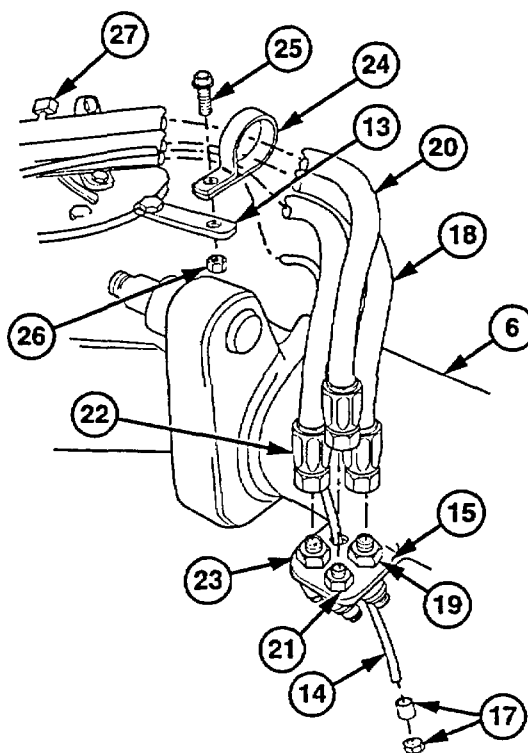
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.



- (9.1) Coat threads of elbow (16), elbow (30), adapter (15.1), adapter (15.2), and breather (15.3).
- (9.2) Install elbow (16) and elbow (30) on tee (15.4).
- (9.3) Install tee (15.4) and adapter (15.1) in axle housing (6).
- (9.4) Install adapter (15.2) and breather (15.3) on tee (15.4).



- (10) Install breather hose (14) on elbow (16).
- (11) Install fitting (17) on breather hose (14).
- (12) Install hose no. 2016 (18) on fitting (19).
- (13) Install hose no. 2141 (20) on fitting (21).
- (14) Install hose no. 2873 (22) on fitting (23).
- (15) Install four hoses (14, 18, 20, and 22) on standoff bracket (13) with cushion clip (24), screw (25), and new locknut (26).



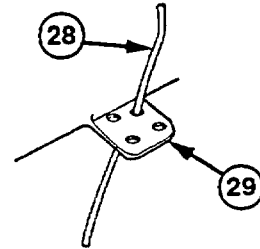
NOTE

Plastic cable ties should be positioned in locations marked during removal.

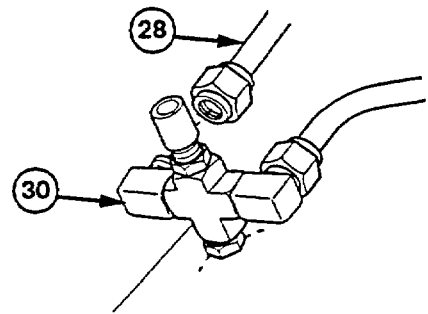
- (16) Secure hoses no. 2873 (22), no. 2141 (20), no. 2016 (18), and breather hose (14) with plastic cable ties (27) as required.

25-4. AXLE NO. 4 DIFFERENTIAL REPAIR (CONT)

- (17) Route breather hose (28) through bracket (29).



- (18) Install breather hose (28) on elbow (30).

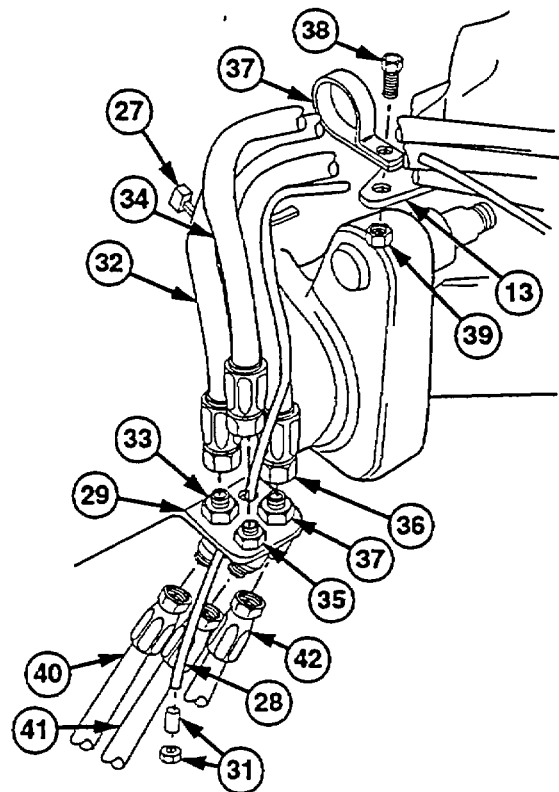


- (19) Install fitting (31) on breather hose (28).
 (20) Install hose no. 2018 (32) on fitting (33).
 (21) Install hose no. 2140 (34) on fitting (35).
 (22) Install hose no. 2109 (36) on fitting (37).
 (23) Install four hoses (28, 32, 34, and 36) on standoff bracket (13) with cushion clip (37), screw (38), and new locknut (39).

NOTE

Plastic cable ties should be positioned in locations marked during removal.

- (24) Secure hoses no. 2018 (32), no. 2140 (34), no. 2109 (36), and breather hose (28) with plastic cable ties (27) as required.
 (25) Install hose no. 2018 (40) on fitting (33).
 (26) Install hose no. 2140 (41) on fitting (35).
 (27) Install hose no. 2109 (42) on fitting (37).

**f. Follow-On Maintenance**

- (1) Install pivot, spindle, and axle shafts (para 10-7).
 (2) Install no. 4 axle manifold (TM 9-2320-360-20)

CHAPTER 26
BRAKE SYSTEM MAINTENANCE

Contents	Para	Page
Introduction	26-1	26-1
Air Compressor Repair	26-2	26-2

Section I. INTRODUCTION

26-1. INTRODUCTION

This chapter contains maintenance instructions for repair of the brake system at the General Support maintenance level. Some subassemblies and parts must be removed before components can be removed. They are referenced to other paragraphs of this manual.

Section II. MAINTENANCE PROCEDURES

26-2. AIR COMPRESSOR REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Air compressor on clean work surface.

Tools and Special Tools

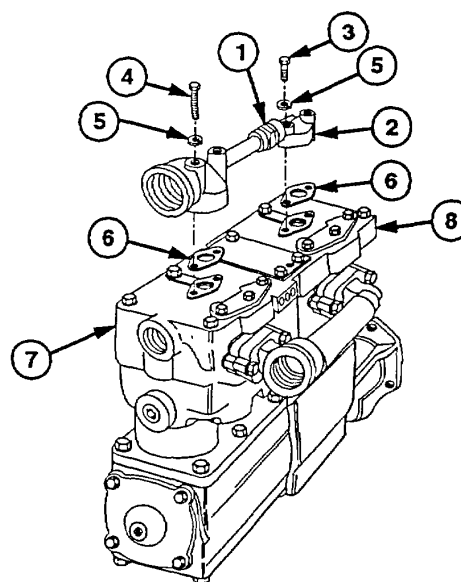
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Compressor, Piston Ring (Item 19, Appendix E)
 Gage Set, Telescoping (Item 56, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Puller Kit, Mechanical, Gear and Brg (Item 124, Appendix E)
 Remover and Installer, Piston Ring (Item 135, Appendix E)
 Wrench, Crow's Foot, 1/2 In. (Item 221, Appendix E)
 Wrench, Crow's Foot, 9/16 In. (Item 218, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

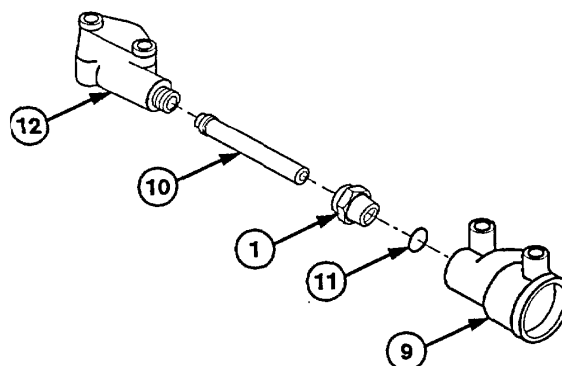
Oil, Lubricating (Item 46, Appendix B)
 Plastigage (Item 50, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Parts Kit, Compressor (Item 209, Appendix F)
 Parts Kit (Item 202, Appendix F)
 Parts Kit (Item 203, Appendix F)
 Parts Kit (Item 204, Appendix F)
 Parts Kit (Item 205, Appendix F)
 Parts Kit (Item 206, Appendix F)

a. Disassembly

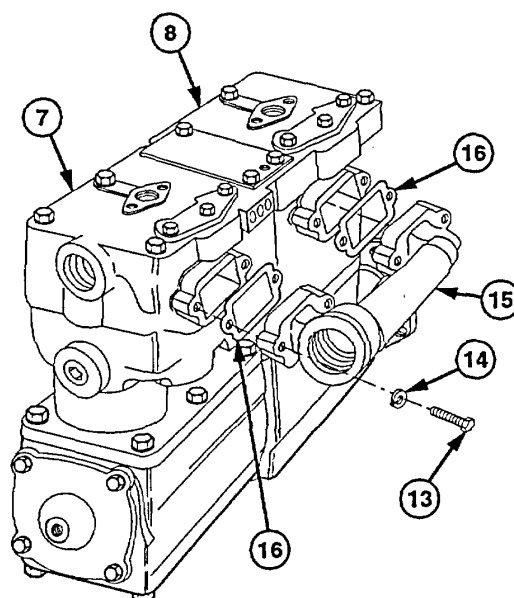
- (1) Loosen nut (1) on discharge manifold assembly (2).
- (2) Remove two screws (3), screws (4), four lockwashers (5), discharge manifold assembly (2), and two gaskets (6) from cylinder heads (7 and 8). Discard lockwashers and gaskets.



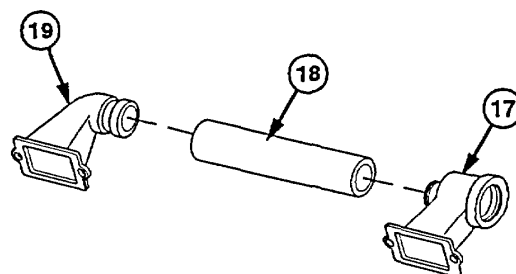
- (3) Remove discharge manifold (9) from tube (10).
- (4) Remove preformed packing (11) from discharge manifold (9). Discard preformed packing.
- (5) Remove nut (1) from discharge manifold (12).
- (6) Remove tube (10) from discharge manifold (12).



- (7) Remove four screws (13), lockwashers (14), intake manifold assembly (15), and two gaskets (16) from two cylinder heads (7 and 8). Discard lockwashers and gaskets.

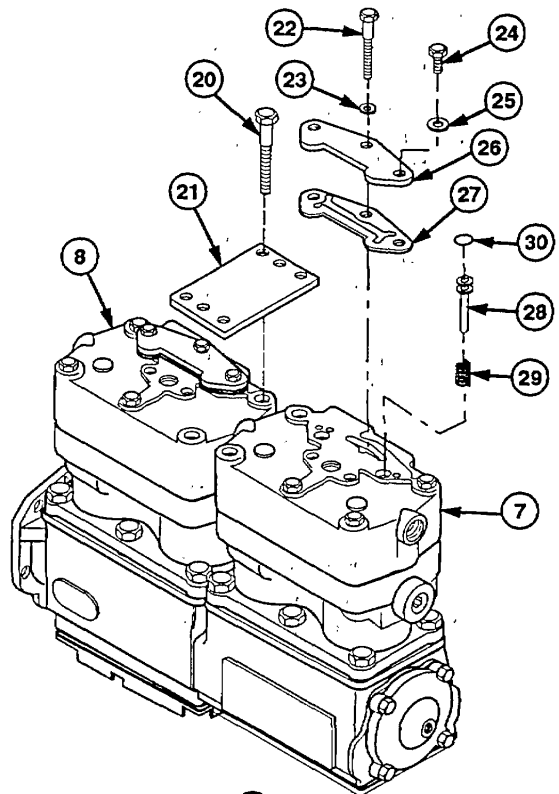


- (8) Remove intake manifold (17) from hose (18).
- (9) Remove intake manifold (19) from hose (18).

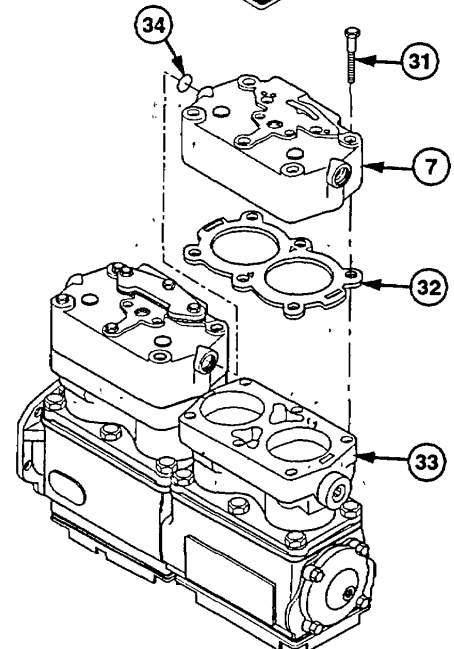


26-2. AIR COMPRESSOR REPAIR (CONT)

- (10) Remove four screws (20) and connecting plate (21) from two cylinder heads (7 and 8).
- (11) Remove screw (22), washer (23), two screws (24), washers (25), unloader cover (26), and gasket (27) from cylinder head (7). Discard gasket.
- (12) Remove two unloader pins (28), and springs (29) from cylinder head (7).
- (13) Remove two preformed packings (30) from unloader pins (28). Discard preformed packings.



- (14) Remove remaining three screws (31) from cylinder head (7).
- (15) Remove cylinder head (7) and gasket (32) from cylinder block (33). Discard gasket.
- (16) Remove preformed packing (34) from cylinder head (7). Discard preformed packing.
- (17) Repeat steps (11) thru (15) for remaining cylinder head (8).



(18) Remove six screws (35), lockwashers (36), plate (37), and gasket (38) from crankcase assembly (39). Discard lockwashers and gasket.

(19) Remove four screws (40), lockwashers (41), plate (42), and gasket (43) from crankcase assembly (39). Discard lockwashers and gasket.

NOTE

Rotate crankshaft to gain access to connecting rod screws.

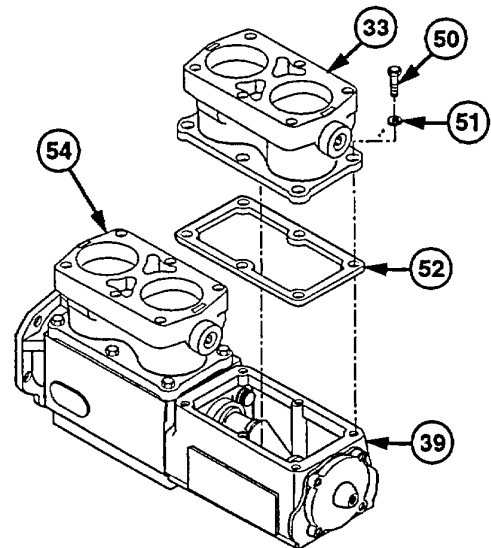
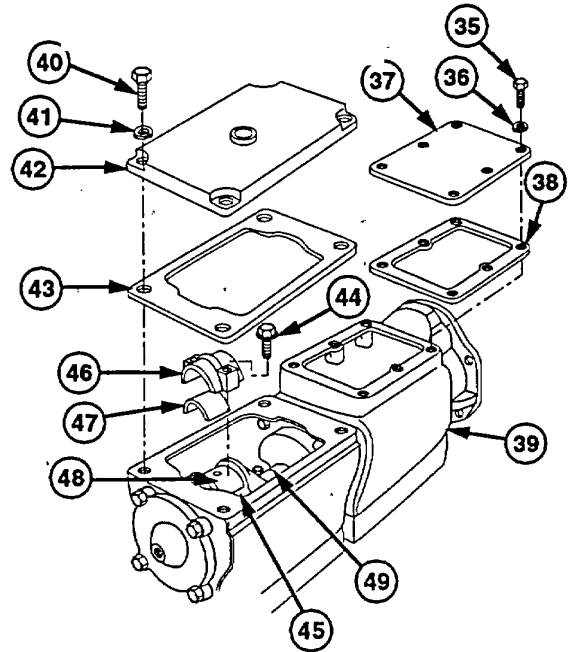
(20) Remove two screws (44) from connecting rod (45) and connecting rod cap (46).

NOTE

Matchmark caps and connecting rods before removing caps.

(21) Remove connecting rod cap (46) and bearing half (47) from crankshaft (48).

(22) Repeat steps (20) and (21) for remaining three piston and rod assemblies (49).



NOTE

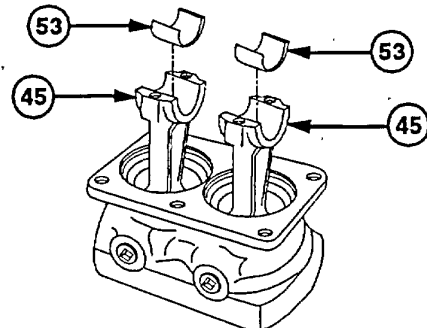
Matchmark cylinder block and crankcase assembly.

(23) Remove six screws (50) and lockwashers (51) from cylinder block (33). Discard lockwashers.

(24) Remove cylinder block (33) and gasket (52) from crankcase assembly (39). Discard gasket.

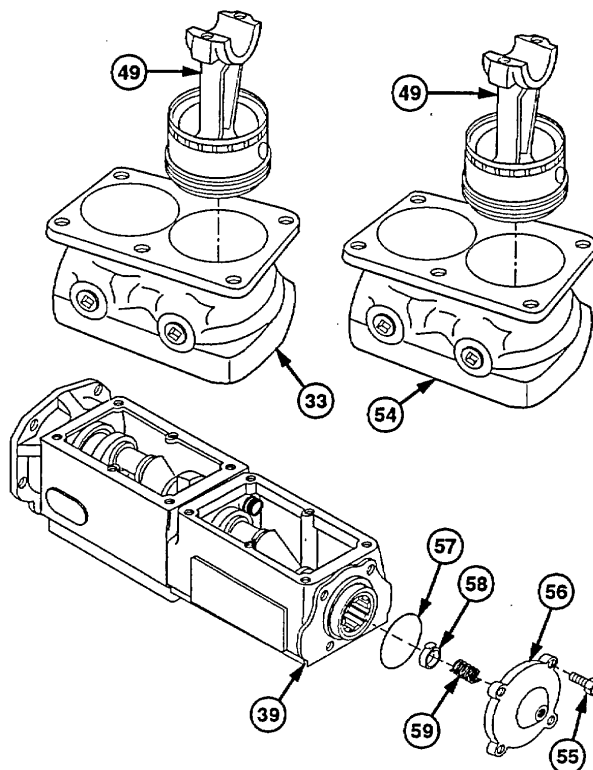
(25) Remove two bearing halves (53) from connecting rods (45).

(26) Repeat steps (23) thru (25) for remaining cylinder block (54).



26-2. AIR COMPRESSOR REPAIR (CONT)

- (27) Push four piston and rod assemblies (49) out through bottom of two cylinder blocks (33 and 54).



- (28) Remove four screws (55) and bearing end cover (56) from crankcase assembly (39).

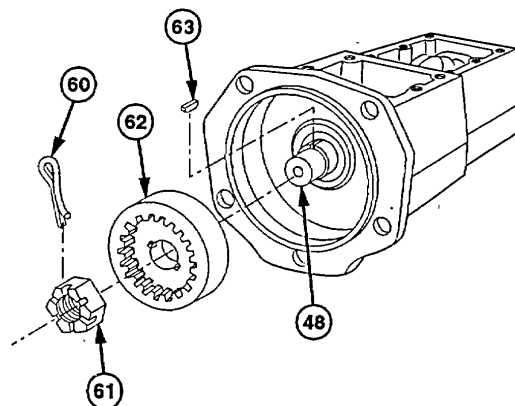
- (29) Remove preformed packing (57) from bearing end cover (56). Discard preformed packing.

- (30) Remove oil flow regulator (58) and spring (59) from bearing end cover (56).

- (31) Remove cotter pin (60) from nut (61). Discard cotter pin.

- (32) Remove nut (61) and drive coupling (62) from crankshaft (48).

- (33) Remove key (63) from crankshaft (48).



b. Cleaning/Inspection

WARNING

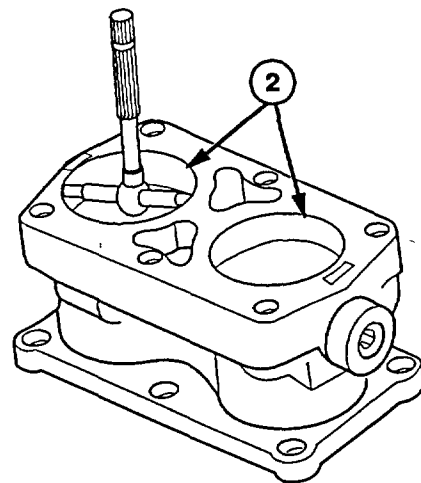
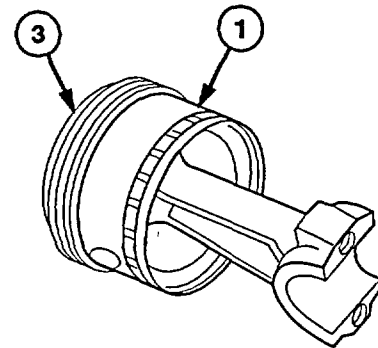
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated area. Avoid contact with skin, eyes, and clothing, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

WARNING

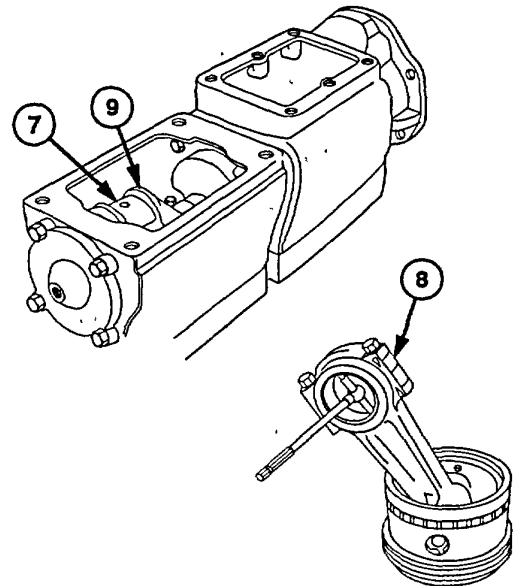
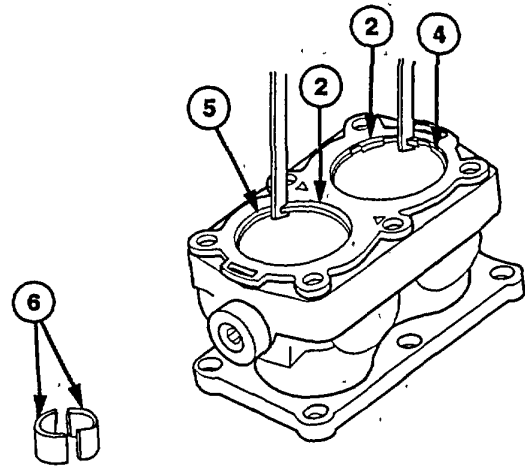
Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry parts with compressed air.
- (3) Clean carbon deposits from cylinder head interior surfaces, piston crowns, and piston ring grooves.
- (4) Clean interior air and water passageways and blow out with compressed air.
- (5) Remove gasket material from gasket mating surfaces.
- (6) Inspect cylinder heads, cylinder blocks, and crankcase assembly for cracks and damaged threads. Gasket surfaces must be free of nicks and gouges.
- (7) Inspect intake and exhaust valves for wear grooves, cracks, or pits.
- (8) Inspect pistons for scoring, cracks, or other damage.
- (9) Measure piston (1) outside diameter. Measure cylinder bore (2) inside diameter using telescoping gage. Piston (1) to bore (2) clearance should not exceed 0.008 in. (0.20 mm). Replace pistons and cylinder block if clearance is exceeded.
- (10) Inspect cylinder bores for scratches, scoring, and pitting.
- (11) Inspect bores (2) for out-of-round or taper. Bores (2) must not be out-of-round more than 0.0005 in. (0.013 mm). Bores (2) must not taper more than 0.001 in. (0.025 mm) from top to bottom of bore. Replace cylinder block if limits are exceeded.
- (12) Inspect piston rings for cracks or wear. Clearance between rings (3) and piston (1) grooves must not exceed 0.0045 in. (0.114 mm).



26-2. AIR COMPRESSOR REPAIR (CONT)

- (13) Position compression ring (4) in cylinder bore (2) and measure end gap clearance. Replace rings if clearance exceeds 0.017 in. (0.43 mm).
- (14) Position oil ring (5) in cylinder bore (2) and measure end gap clearance. Replace rings if clearance exceeds 0.055 in. (1.40 mm).
- (15) Inspect connecting rod bearings (6) for scoring, pitting, or visible wear. Clearance between bearings (6) and crankshaft journals (7) must be 0.005-0.0021 in. (0.053-0.127 mm) after assembly. Replace bearings if clearance is exceeded.
- (16) Measure distance between side of connecting rod bearing cap (8) and crankshaft (9). Clearance must not exceed 0.010 in. (0.254 mm) after assembly. Replace connecting rod if clearance is exceeded.
- (17) Check ball bearings for worn or damaged balls; rotate bearings by hand to detect roughness. Replace crankcase assembly if wear, roughness, or damage is evident.
- (18) Coat parts with lubricating oil.

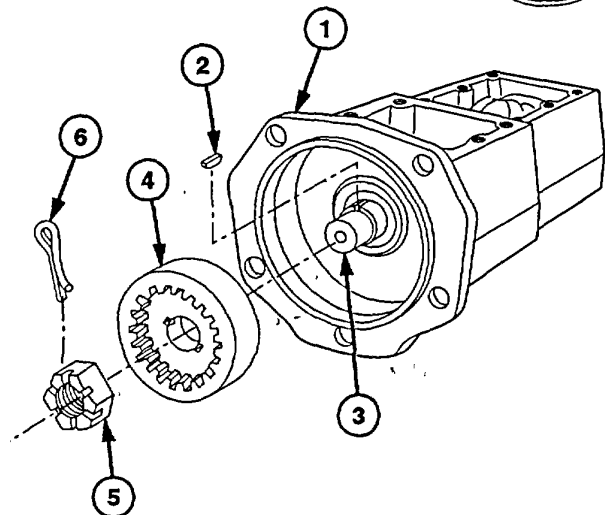
**c. Assembly**

- (1) Position crankcase assembly (1) in vise.
- (2) Install key (2) in crankshaft (3).

NOTE

When proper torque is reached, continue to tighten until slot in nut aligns with hole in crankshaft for cotter pin.

- (3) Install drive coupling (4) and nut (5) on crankshaft (3). Torque to 80 lb-ft (108 N-m).
- (4) Install new cotter pin (6) through nut (5) and crankshaft (3).



- (5) Install spring (7) and oil flow regulator (8) in bearing end cover (9).
- (6) Install new preformed packing (10) in bearing end cover (9).

NOTE

When properly installed, tab on oil flow regulator should be up.

- (7) Install bearing end cover (9) on crankcase assembly (1) with four screws (11).
- (8) Coat cylinder walls (12) and piston and rod assemblies (13) with lubricating oil.
- (9) Install four piston and rod assemblies (13) in two cylinder blocks (14 and 15) using piston ring compressor (16).

NOTE

Locating tabs on bearing halves must insert in locating notches in connecting rods.

- (10) Install two bearing halves (17) on connecting rods (18).
- (11) Coat two bearing halves (17) with lubricating oil.

NOTE

Cylinder block should be installed on crankcase as marked during removal.

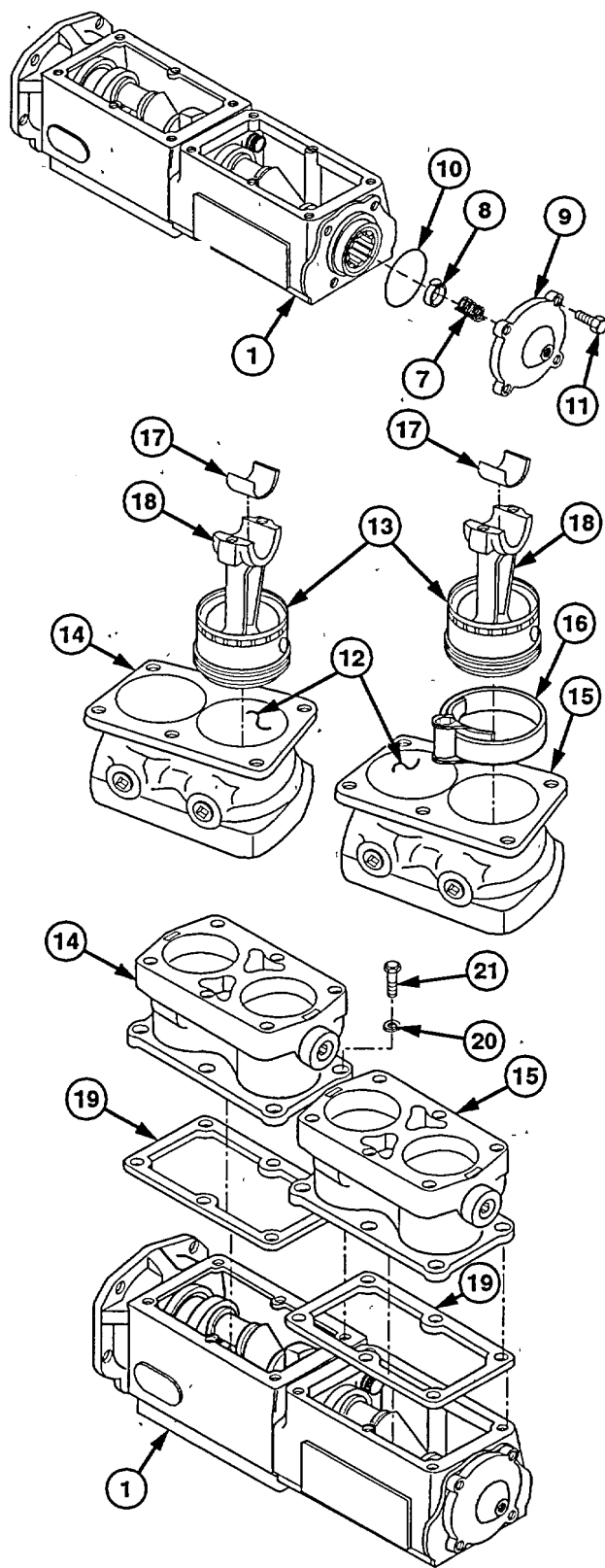
- (12) Install new gasket (19) and cylinder block (14) on crankcase assembly (1).

NOTE

- Two center screws should be tightened to 96 lb-in. (11 N•m).
- Four outer screws then should be tightened to 96 lb-in. (11 N•m).
- Two center screws then should be tightened to 27-33 lb-ft (37-45 N•m).
- Four outer screws then should be tightened to 27-33 lb-ft (37-45 N•m).

- (13) Install six new lockwashers (20) and screws (21) on cylinder block (14). Torque to 27-33 lb-ft (37-45 N•m).

- (14) Repeat steps (10) thru (13) for cylinder block (15).

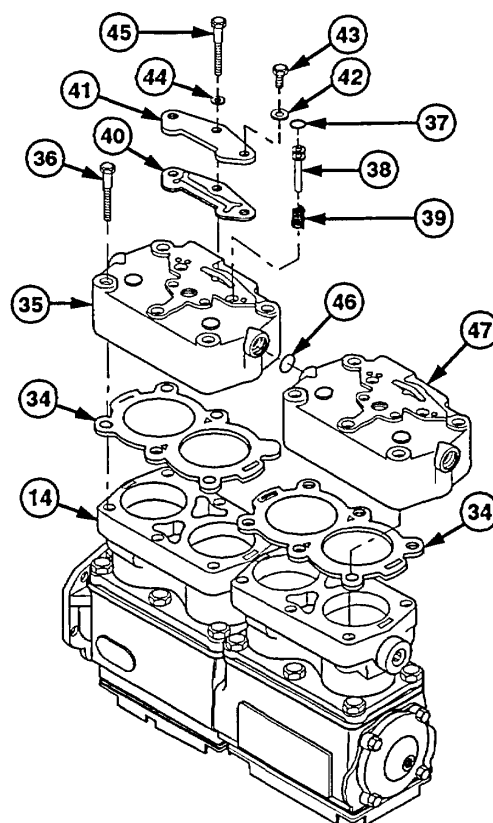
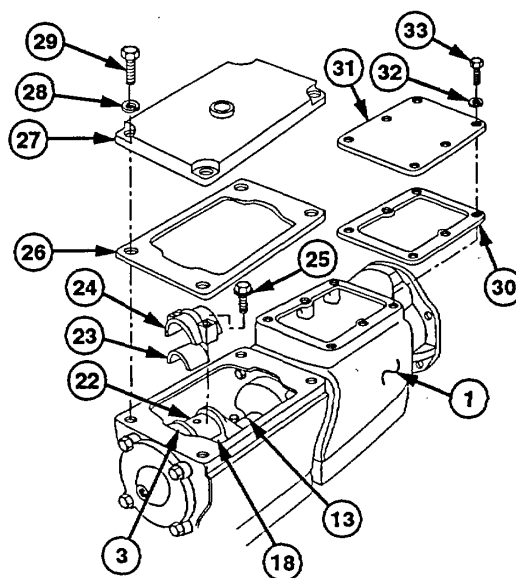


26-2. AIR COMPRESSOR REPAIR (CONT)

- (15) Coat connecting rod journal (22) on crankshaft (3) with lubricating oil.
- (16) Position connecting rod (18) on crankshaft (3).

NOTE

- Locating tab on bearing half must insert in locating notch in connecting rod cap. Align arrows on connecting rod and cap.
 - Rotate crankshaft to gain access to connecting rod screws.
- (17) Install bearing half (23) and connecting rod cap (24) on crankshaft (3).
 - (18) Install two screws (25) in connecting rod cap (24) and connecting rod (18). Torque to 105-135 lb-in. (11.9-15.3 N•m).
 - (19) Repeat steps (15) thru (18) for three remaining piston and rod assemblies (13).
 - (20) Install new gasket (26) and plate (27) on crankcase assembly (1) with four new lockwashers (28) and screws (29). Torque to 110-150 lb-in. (12.4-17 N•m).
 - (21) Install new gasket (30) and plate (31) on crankcase assembly (1) with six new lockwashers (32) and screws (33). Torque to 110-150 lb-in. (12.4-17 N•m).
 - (22) Position new gasket (34) and cylinder head (35) on cylinder block (14) with three screws (36). Do not tighten screws.
 - (23) Install two new preformed packings (37) on unloader pins (38).
 - (24) Install two springs (39) and unloader pins (38) in cylinder head (35).
 - (25) Install new gasket (40) and unloader cover (41) on cylinder head (35) with two washers (42) and screws (43). Torque to 10 lb-in. (1.13 N•m).
 - (26) Position washer (44) and screw (45) on cylinder head (35). Do not tighten screw.
 - (27) Install new preformed packing (46) on cylinder head (47).
 - (28) Repeat steps (21) thru (26) for remaining cylinder head (47).

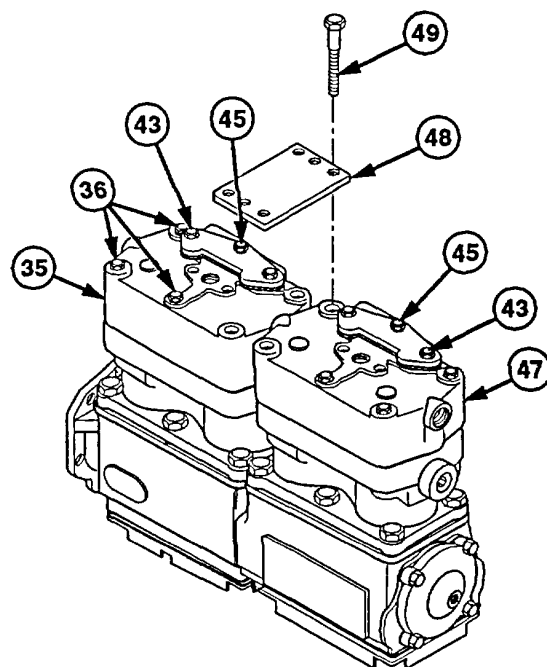


- (29) Position connecting plate (48) on two cylinder heads (35 and 47) with four screws (49). Do not tighten screws.

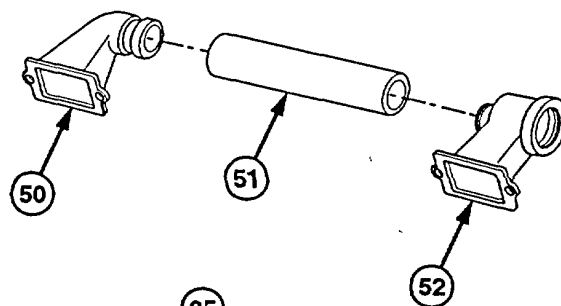
CAUTION

Head screws must be tightened in the following order. Damage to equipment may result.

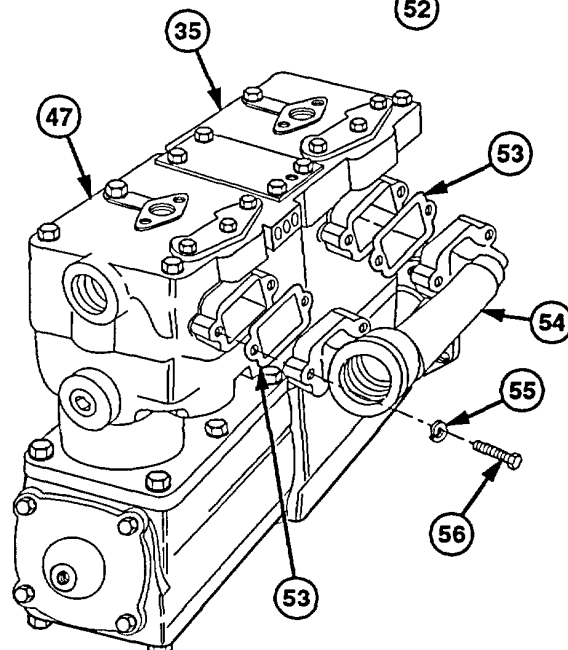
- (30) Tighten three screws (36), screw (45), and two screws (49) on cylinder head (35) to 18-22 lb-ft (24.4-30 N•m). Retighten to 27-33 lb-ft (37-45 N•m) in same order.
- (31) Tighten two screws (43) to 100-150 lb-in. (11.3-17.0 N•m).
- (32) Repeat steps (29) and (30) for cylinder head (47).



- (33) Install intake manifold (50) on hose (51).
- (34) Install intake manifold (52) on hose (51).

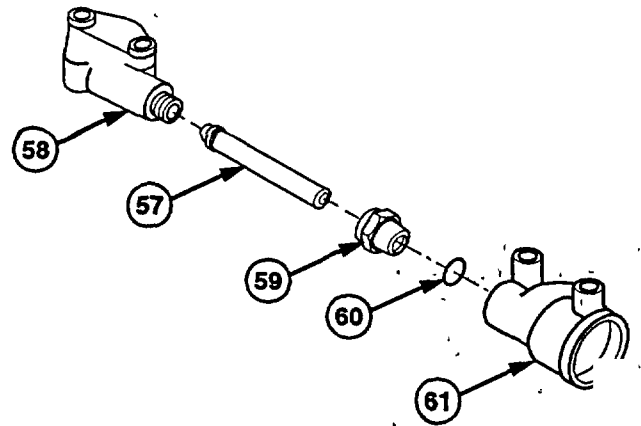


- (35) Install two new gaskets (53) and intake manifold assembly (54) on two cylinder heads (35 and 47) with four new lockwashers (55) and screws (56). Torque to 110-150 lb-in. (12.4-17.0 N•m).

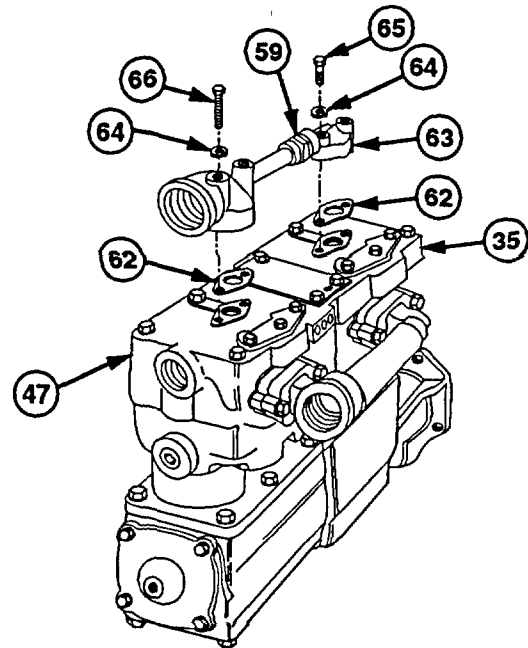


26-2. AIR COMPRESSOR REPAIR (CONT)

- (36) Install tube (57) in discharge manifold (58).
- (37) Install nut (59) on discharge manifold (58). Do not tighten.
- (38) Install new preformed packing (60) in discharge manifold (61).
- (39) Install discharge manifold (61) on tube (57).



- (40) Install two new gaskets (62) and discharge manifold assembly (63) on two cylinder heads (35 and 47) with four new lockwashers (64), two screws (65), and screws (66). Torque to 110-150 lb-in (12.4-17.0 N•m).
- (41) Tighten nut (59) on discharge manifold assembly (63).



CHAPTER 27
STEERING SYSTEM MAINTENANCE

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Section I. INTRODUCTION

27-1. INTRODUCTION

This chapter contains instructions for repair of steering system components at the General Support maintenance level.

Section II. MAINTENANCE PROCEDURES

27-2. STEERING PUMP REPAIR

This task covers:

Disassembly
Cleaning/Inspection

Assembly

INITIAL SETUP

Equipment Conditions

Steering pump on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Caliper Set, Micrometer (Item 15, Appendix E)
Caps, Vise Jaw (Item 17, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Nut, 5/8 In. (Item 101, Appendix E)
Pliers, Retaining Ring (Item 108, Appendix E)
Press, Hydraulic (item 116, Appendix E)
Puller Kit, Mechanical, Gear and Brg
(Item 124, Appendix E)
Screw, 5/8 x 4-1/2 In. (Item 149, Appendix E)
Socket, Power Steering (item 166, Appendix E)
Vise, Machinist's (Item 207, Appendix E)
Washers, Fiat, 5/8 In. (4) (Item 209, Appendix E)
Wrench Set, Socket, 3/4 In. Drive (Item 231, Appendix E)
Wrench, Torque, 0-300 Lb-in. (Item 235, Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

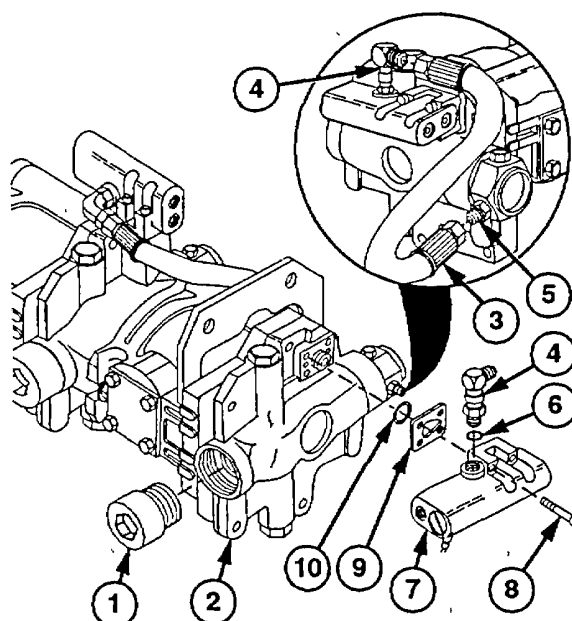
Adhesive-Sealant (Item 5, Appendix B)
Tape, Plastic (Item 59, Appendix B)
Gaskets (2) (Item 24, Appendix F)
Gaskets (2) (Item 26, Appendix F)
Packings, Preformed (8) (Item 169, Appendix F)
Packings, Preformed (4) (Item 172, Appendix F)
Packings, Preformed (2) (Item 170, Appendix F)
Packings, Preformed (2) (Item 171, Appendix F)
Packings, Preformed (2) (Item 184, Appendix F)
Packings, Preformed (2) (Item 187, Appendix F)
Packing, Preformed (Item 185, Appendix F)
Rings, Retaining (2) (Item 234, Appendix F)
Seals, Oil (2) (Item 311, Appendix F)

NOTE

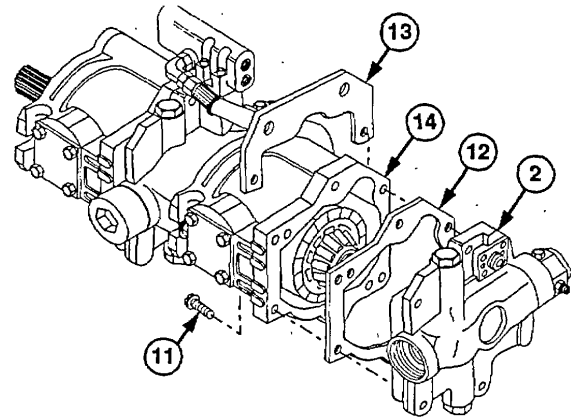
Steering pump consists of two similar housings.

a. Rear Housing Disassembly

- (1) Remove shipping plug (1) from valve block (2).
- (2) Remove hose (3) from elbow (4).
- (3) Remove hose (3) from fitting (5).
- (4) Remove elbow (4) and preformed packing (6) from compensator body (7). Discard preformed packing.
- (5) Remove four screws (8), compensator body (7), gasket (9), and preformed packing (10) from valve block (2). Discard preformed packing and gasket.



- (6) Remove six screws (11), valve block (2), gasket (12), and bracket (13) from pump housing (14). Discard gasket.



- (7) Remove wafer plate (15), pin (16), and piston (17) from valve block (2).

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (8) Remove retaining ring (18), rod (19), and preformed packing (20) from valve block (2). Discard preformed packing.

NOTE

Do step (9) if valve fails inspection.

- (9) Remove seat (21), valve (22), and spring (23) from valve block (2).

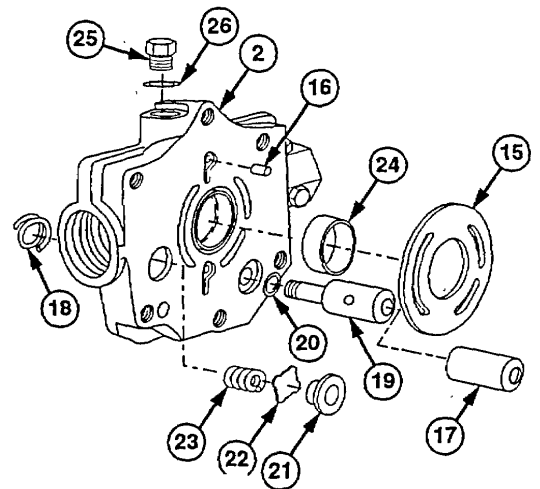
- (10) Position valve block (2) in soft-jawed vise.

NOTE

When removing bearing cup, frequently reposition slide hammer hook.

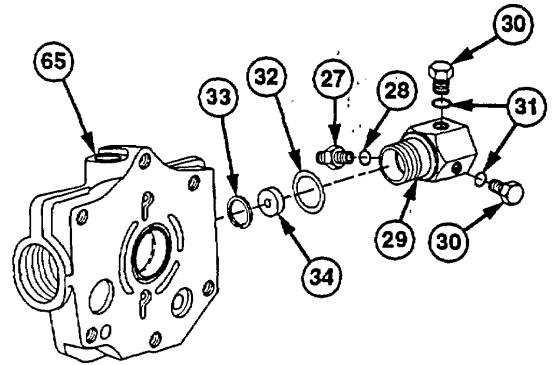
- (11) Remove bearing cup (24) from valve block (2).

- (12) Remove plug (25) and preformed packing (26) from valve block (2). Discard preformed packing.



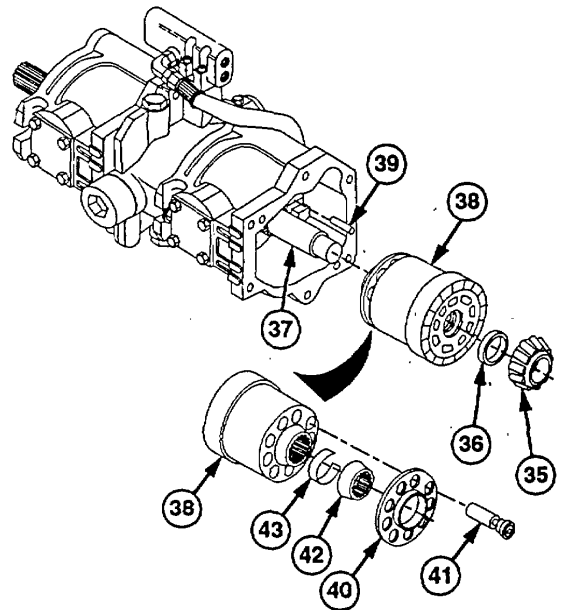
27-2. STEERING PUMP REPAIR (CONT)

- (13) Remove fitting (27) and preformed packing (28) from adapter (29). Discard preformed packing.
- (14) Remove two plugs (30) and preformed packings (31) from adapter (29). Discard preformed packings.
- (15) Remove adapter (29) and preformed packing (32) from valve block (2). Discard preformed packing.

**WARNING**

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (16) Remove retaining ring (33) from adapter (29).
- (17) Remove orifice plug (34) from adapter (29).
- (18) Remove bearing (35) and spacer (36) from shaft (37).
- (19) Remove cylinder block (38) and three pins (39) from shaft (37).
- (20) Remove shoe plate (40), nine pistons (41), and spherical washer (42) from cylinder block (38).
- (21) Remove pin retainer (43) from cylinder block (38).



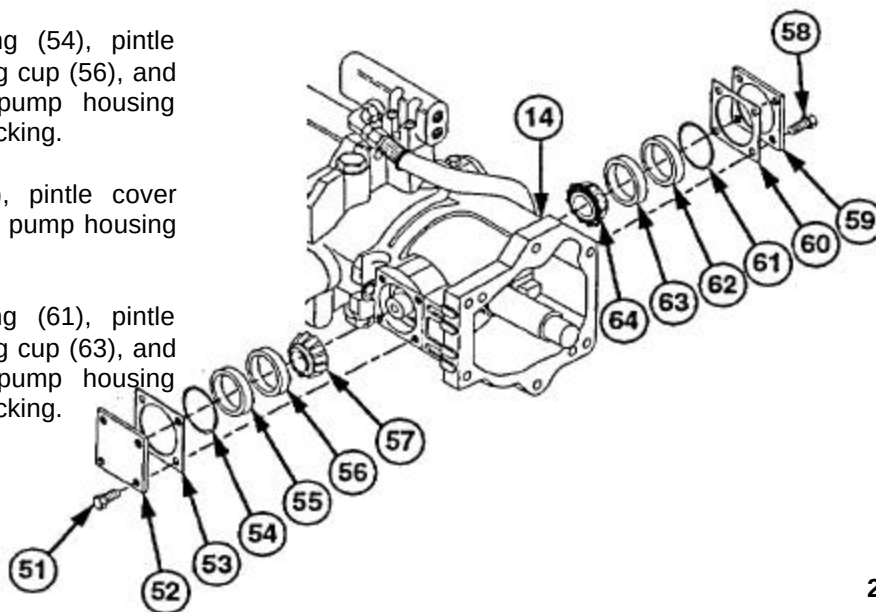
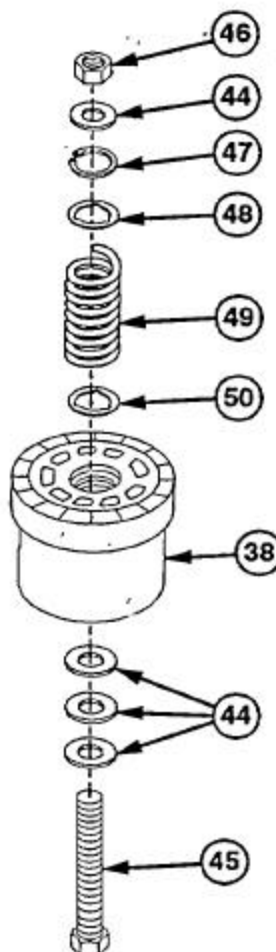
WARNING

Cylinder block spring must be held by screw, washers, and nut before removing retaining ring. Spring and retaining ring are under high tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

CAUTION

Do not clamp on flat surface of cylinder block. Failure to comply may result in damage to machined surface.

- (22) Position cylinder block (38) in soft-jawed vise.
- (23) Position four washers (44), screw (45), and nut (46) through cylinder block (38).
- (24) Tighten nut (46) and remove retaining ring (47).
- (25) Loosen nut (46) to relieve spring tension.
- (26) Remove nut (46), four washers (44) and screw (45) from cylinder block (38).
- (27) Remove spring washer (48), spring (49), and spring washer (50), from cylinder block (38).
- (28) Remove four screws (51), pintle cover (52), and shim kit (53) from pump housing (14).
- (29) Remove preformed packing (54), pintle bearing spacer (55), bearing cup (56), and bearing cone (57) from pump housing (14). Discard preformed packing.
- (30) Remove four screws (58), pintle cover (59), and shim kit (60) from pump housing (14).
- (31) Remove preformed packing (61), pintle bearing spacer (62), bearing cup (63), and bearing cone (64) from pump housing (14). Discard preformed packing.



27-2. STEERING PUMP REPAIR (CONT)

(32) Remove shaft (65), yoke (66), and bearing (67) from pump housing (14).

(33) Remove seat (68) and spring (69) from pump housing (14).

NOTE

Do Step (34) if seat fails inspection.

(34) Remove seat (70) and roll pin (71) from yoke (66).

NOTE

Do steps (35) and (36) if bearing fails inspection.

(35) Position shaft (65) in press with wide edge of bearing (67) down.

(36) Press bearing (67) from shaft (65).

(37) Remove two screws (72), washers (73), pump housing (14), coupler (74), and preformed packing (75) from pump housing (76). Discard preformed packing.

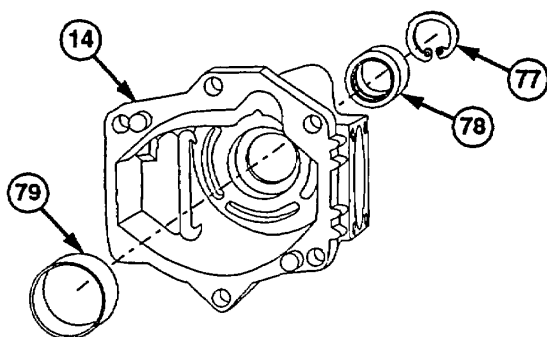
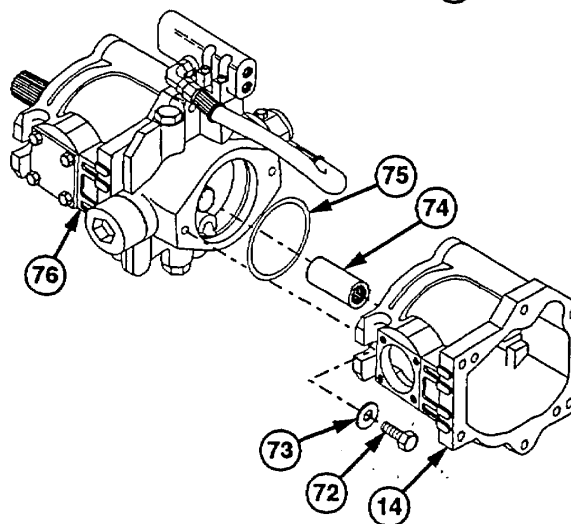
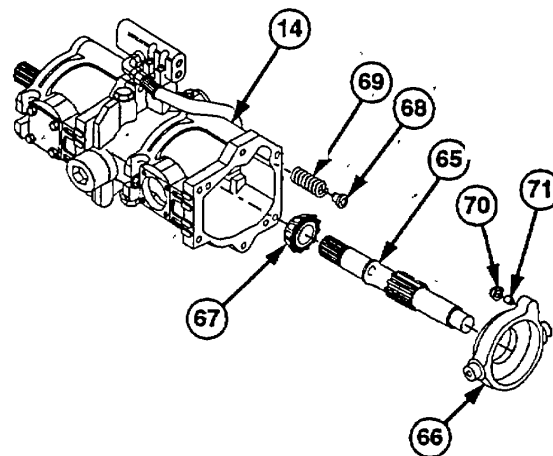
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

(38) Remove retaining ring (77) from housing (14). Discard retaining ring.

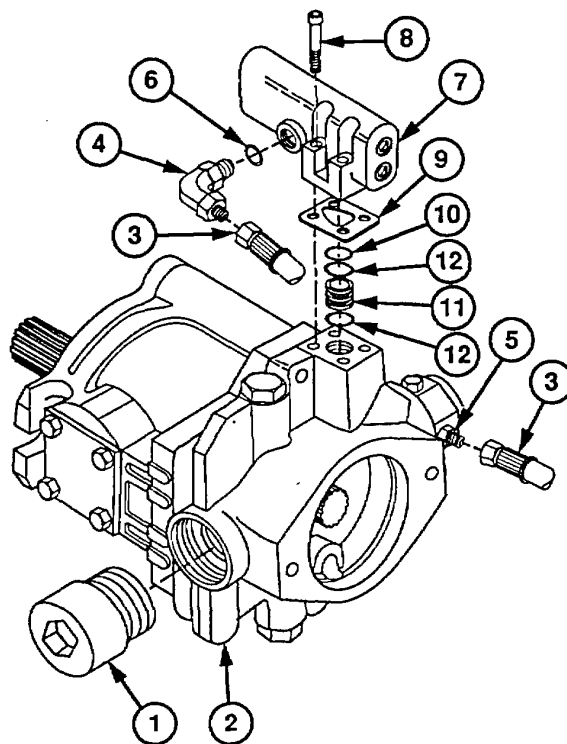
(39) Remove seal (78) from housing (14). Discard seal.

(40) Remove bearing race (79) from housing (14).

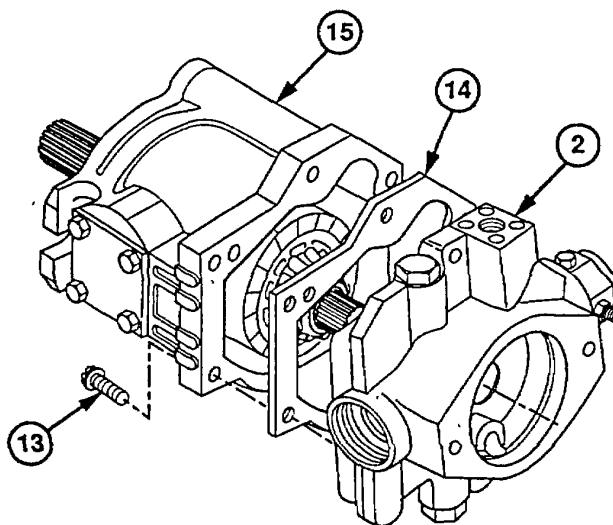


b. Front Housing Disassembly

- (1) Remove shipping plug (1) from valve block (2).
- (2) Remove hose (3) from elbow (4).
- (3) Remove hose (3) from fitting (5).
- (4) Remove elbow (4) and preformed packing (6) from compensator body (7). Discard preformed packing and gasket.
- (5) Remove four screws (8), compensator body (7), gasket (9), preformed packing (10), spool (11) and two preformed packings (12) from valve block (2). Discard preformed packings and gasket.



- (6) Remove six screws (13), valve block (2), and gasket (14) from pump housing (15). Discard gasket.



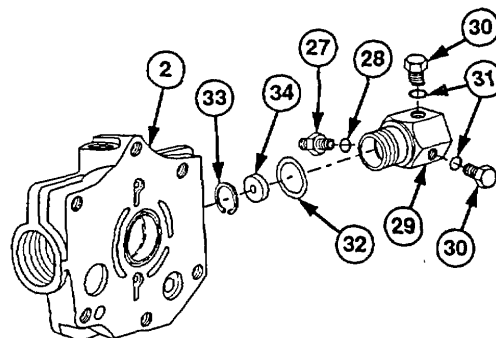
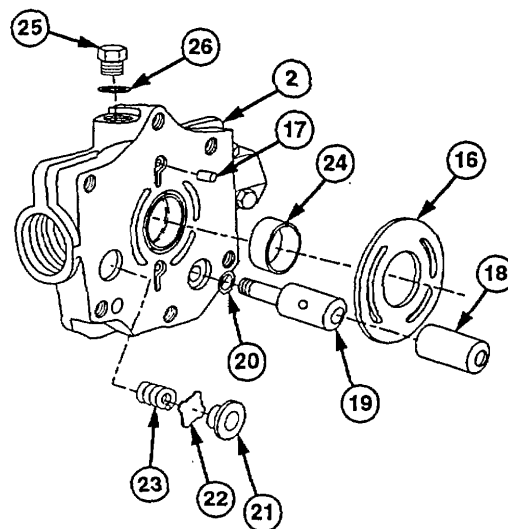
27-2. STEERING PUMP REPAIR (CONT)

- (7) Remove wafer plate (16), pin (17), and piston (18) from valve block (2).
- (8) Remove rod (19) and preformed packing (20) from valve block (2). Discard preformed packing.

NOTE

Do step (9) if valve fails inspection.

- (9) Remove seat (21), valve (22), and spring (23) from valve block (2).
- (10) Position valve block (2) in soft-jawed vise.
- (11) Remove bearing cup (24) from valve block (2).
- (12) Remove plug (25) and preformed packing (26) from valve block (2). Discard preformed packing.
- (13) Remove fitting (27) and preformed packing (28) from adapter (29). Discard preformed packing.
- (14) Remove two plugs (30) and preformed packings (31) from adapter (29). Discard preformed packings.
- (15) Remove adapter (29) and preformed packing (32) from valve block (2). Discard preformed packing.

**WARNING**

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (16) Remove retaining ring (33) from adapter (29).
- (17) Remove orifice plug (34) from adapter (29).

- (18) Remove bearing (35) and spacer (36) from shaft (37).
- (19) Remove cylinder block (38) and three pins (39) from shaft (37).
- (20) Remove shoe plate (40), nine pistons (41), and spherical washer (42) from cylinder block (38).
- (21) Remove pin retainer (43) from cylinder block (38).

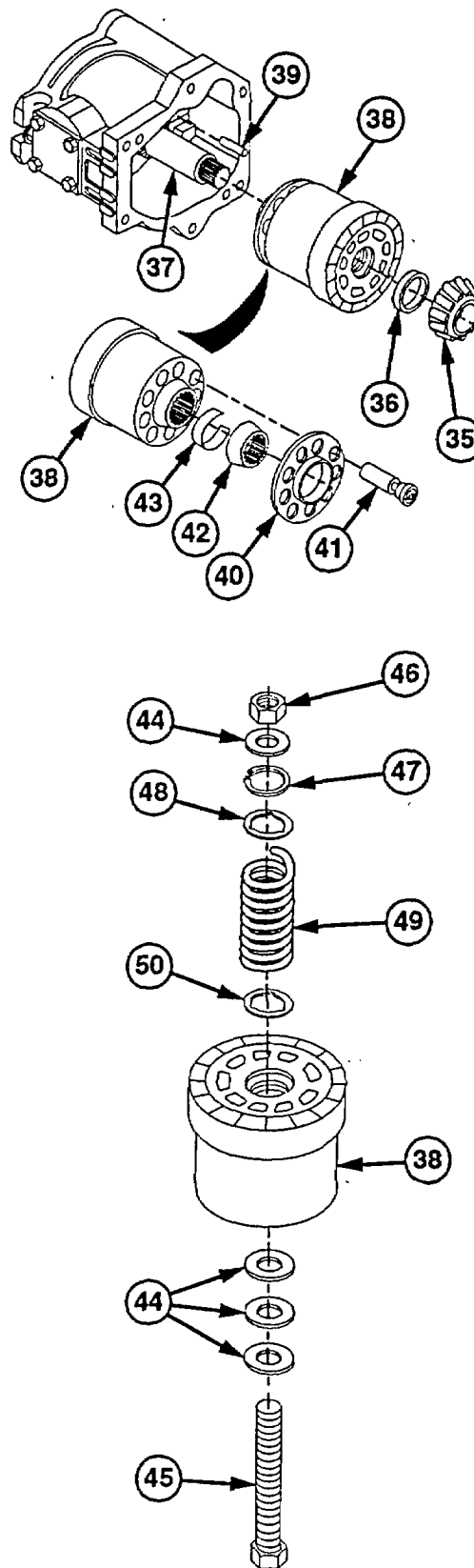
WARNING

Cylinder block spring must be held by screw, washers, and nut before removing retaining ring. Spring and retaining ring are under high tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

CAUTION

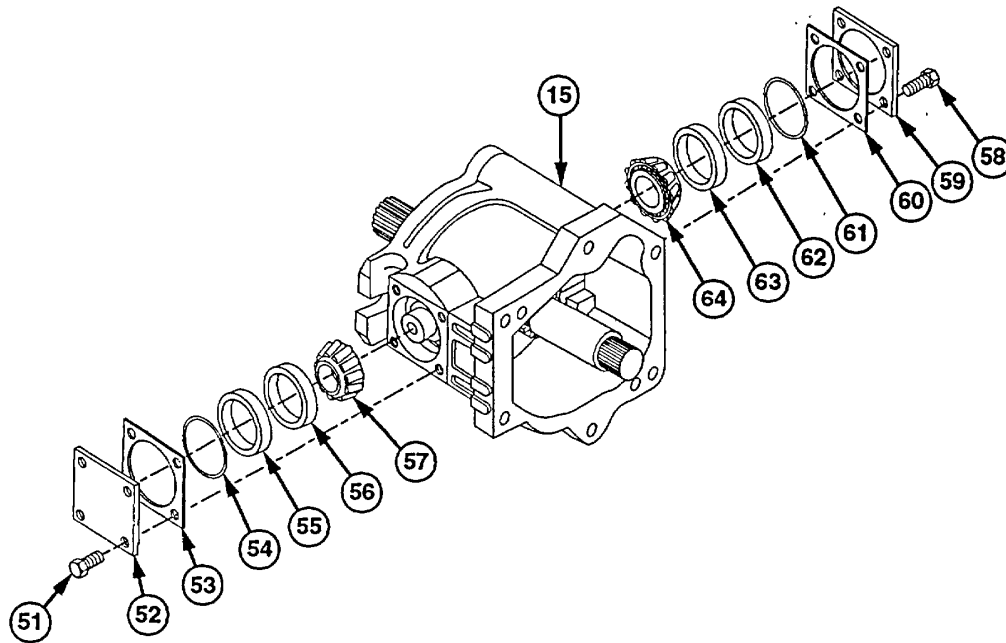
Do not clamp on flat surface of cylinder block. Failure to comply may result in damage to machined surface.

- (22) Position cylinder block (38) in soft-Jawed vise.
- (23) Install four washers (44), screw (45), and nut (46) through cylinder block (38).
- (24) Tighten nut (46) and remove retaining ring (47).
- (25) Loosen nut (46) to relieve spring tension.
- (26) Remove nut (46), screw (45), and four washers (44) from cylinder block (38).
- (27) Remove spring washer (48), spring (49), and spring washer (50) from cylinder block (38).



27-2. STEERING PUMP REPAIR (CONT)

- (28) Remove four screws (51), pintle cover (52), and shim kit (53) from pump housing (15).
- (29) Remove preformed packing (54), pintle bearing spacer (55), bearing cup (56) and bearing cone (57) from pump housing (15). Discard preformed packing.
- (30) Remove four screws (58), pintle cover (59), and shim kit (60) from pump housing (15).
- (31) Remove preformed packing (61), pintle bearing spacer (62), bearing cup (63) and bearing cone (64) from pump housing (15). Discard preformed packing.



- (32) Remove shaft (65), yoke (66), and bearing (67) from pump housing (15).
- (33) Remove seat (68) and spring (69) from pump housing (15).

NOTE

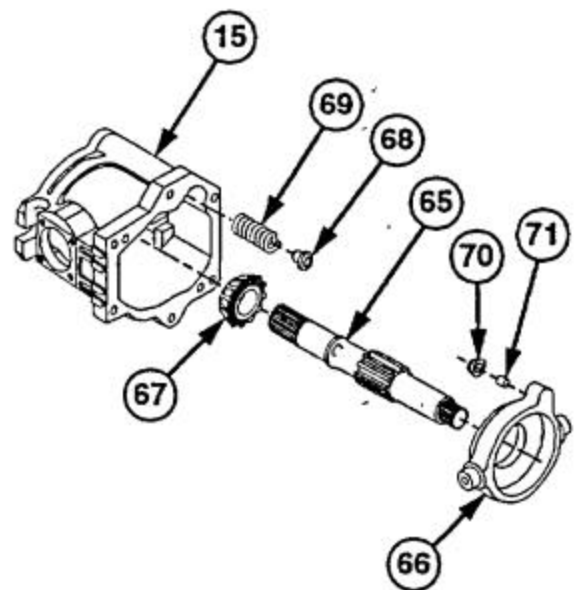
Do step (34) if seat fails inspection.

- (34) Remove seat (70) and rollpin (71) from yoke (66).

NOTE

Do steps (35) and (36) if bearing fails inspection.

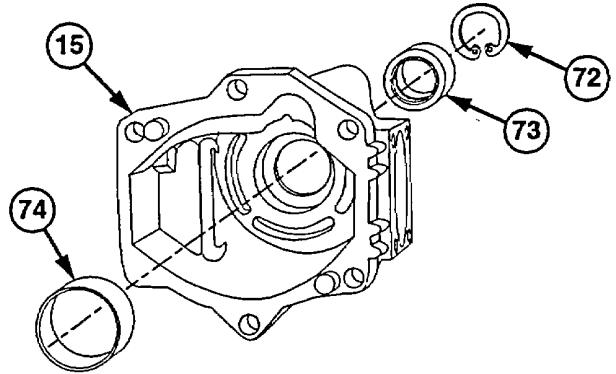
- (35) Position shaft (65) in press with wide edge of bearing (67) down.
- (36) Press bearing (67) from shaft (65).



WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (37) Remove retaining ring (72) from housing (15). Discard retaining ring.
- (38) Remove seal (73) from housing (15). Discard seal.
- (39) Remove bearing race (74) from housing (15).

**c. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts in dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

CAUTION

Bearings must be air dried or damage to bearing will result.

- (2) Dry parts, except bearings, with compressed air.
- (3) Inspect parts for damage. Replace non-serviceable damaged parts. Remove all burrs with crocus cloth.
- (4) Inspect face of wafer plate for wear, scratches, and fractures.
- (5) Inspect springs for wear and check that ends are parallel. Replace warped or worn springs.
- (6) Inspect yoke face for wear, roughness, and scoring.
- (7) Inspect shaft for wear, chipped splines, and burrs.

NOTE

Wobble shoe plate to ensure that each piston is free within its bore in the cylinder block

- (8) Check cylinder block bore for excessive wear. Piston should be close fit but slide in and out easily. If binding exists, clean and lubricate block and piston with clean hydraulic fluid. If binding persists, replace cylinder block.

27-2. STEERING PUMP REPAIR (CONT)

- (9) Check for excessive end play between piston and shoe.

NOTE

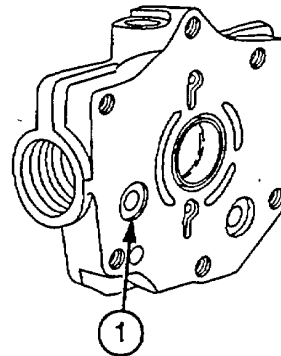
Piston faces' thickness dimensions must within 0.001 in. (0.025 mm) of each other.

- (10) Measure thickness of nine piston faces.

NOTE

Pins, bearings, and races are replaced in sets. If one is defective, replace both.

- (11) Inspect pins for equal length and bent condition. Replace if damaged.
- (12) Remove burrs from pin retainer
- (13) Inspect bearings for scoring, pitting, and roughness when turned in race. Replace if damaged.
- (14) Inspect bearing spacers for burrs.
- (15) Press in check valve (1). Valve should return and hold firm against seat. Replace if damaged.
- (16) Inspect spherical washer for burrs, wear, and scratches due to pin breakage.

**d. Front Housing Assembly****CAUTION**

Use plastic tape on shaft to prevent damage to seal when installing.

NOTE

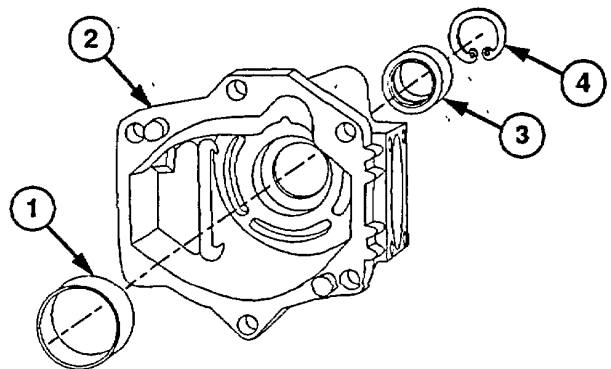
Bearing race is installed with narrow side to inside of housing.

- (1) Install bearing race (1) in pump housing (2).
- (2) Install seal (3) in pump housing (2).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (3) Install retaining ring (4) in pump housing (2).



- (4) Position bearing (5) in press with narrow side down.
- (5) Press shaft (6) into bearing (5).

NOTE

Do step (6) if seat and roll pin were removed.

- (6) Install roll pin (7) and seat (8) on yoke (9).
- (7) Install spring (10) and seat (11) in pump housing (2).
- (8) Install yoke (9) and shaft (6) in pump housing (2).

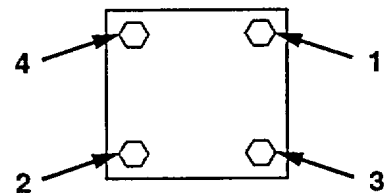
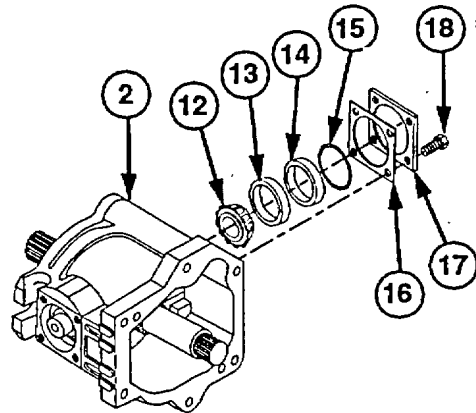
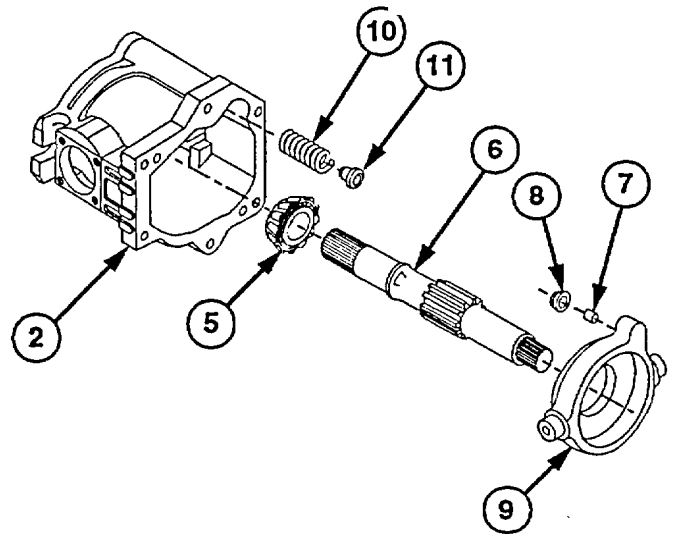
NOTE

- When properly assembled, yoke should be stiff, but loose enough to be moved by hand.
 - If yoke is too tight in housing, add or remove shims until correct preload is obtained.
- (9) Install bearing cone (12), bearing cup (13), bearing spacer (14), and preformed packing (15) in pump housing (2).

NOTE

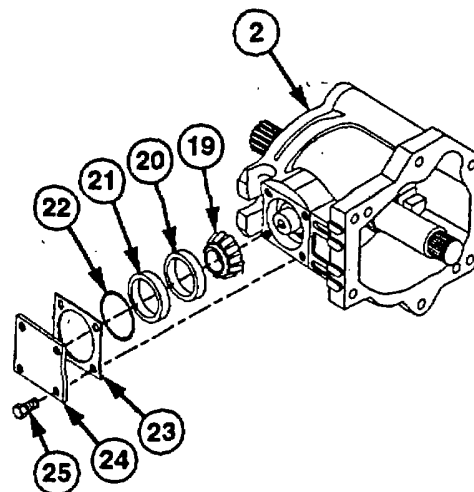
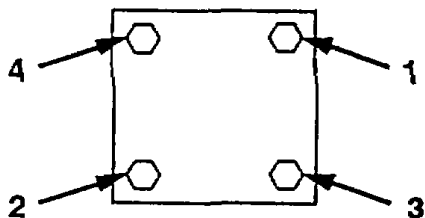
- Shims must be adjusted only if new bearings are installed.
- If shim thickness is greater than 0.02 in., another shim must be added to opposite side of yoke to reduce total shim thickness to less than 0.02 in. Shim thickness at either pintle must not exceed 0.02 in.

- (10) Install shim kit (16) and pintle cover (17) on pump housing (2) with four screws (18). Cross-tighten to 175-185 lb-in. (237-251 N•m).



27-2. STEERING PUMP REPAIR (CONT)

- (11) Install bearing cone (19), bearing cup (20), bearing spacer (21), and new preformed packing (22) in pump housing (2).
- (12) Install shim kit (23) and pintle cover (24) on pump housing (2) with four screws (25). Cross-tighten to 175-185 lb-in. (237-251 N•m).



- (13) Install spring washer (26), spring (27), and spring washer (28) in cylinder block (29).
- (14) Position four washers (30), screw (31), and nut (32) through cylinder block (29).

NOTE

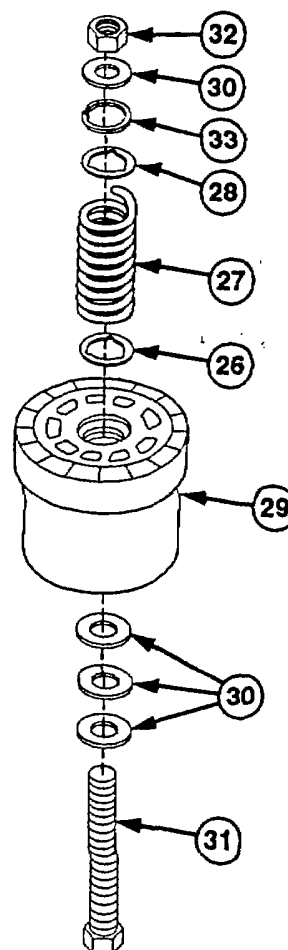
Tighten nut only enough to install retaining ring.

- (15) Tighten nut (32) to compress spring (27).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (16) Install retaining ring (33) in cylinder block (29).
- (17) Remove nut (32), screw (31), and four washers (30).



NOTE

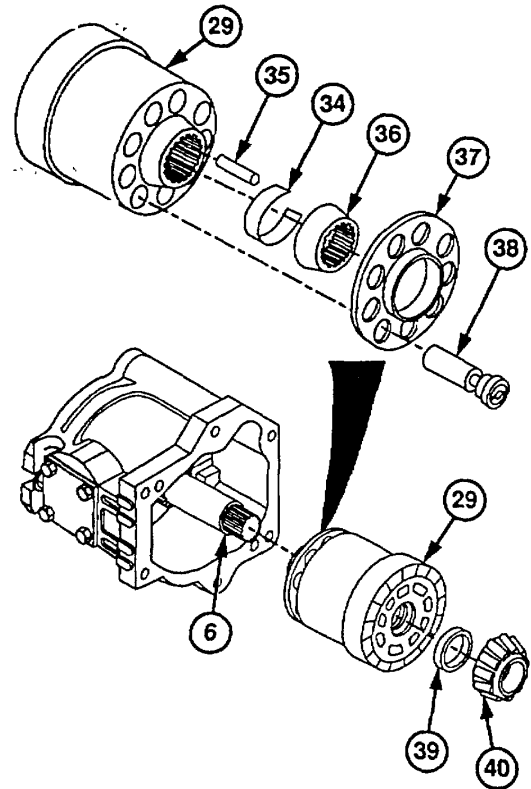
Pin retainer must be installed 0.25 in. (6.4 mm) below surface.

- (18) Install pin retainer (34) in cylinder block (29).

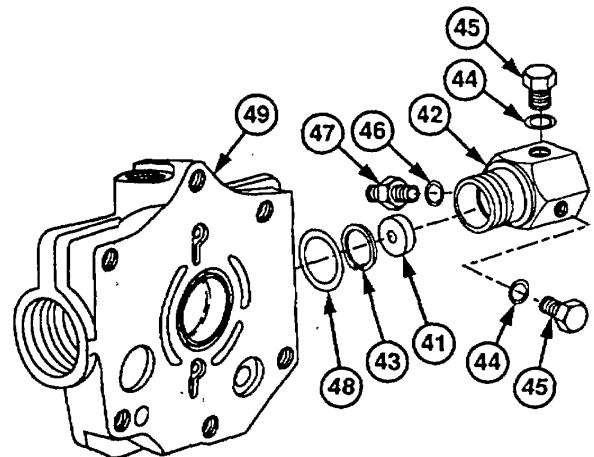
NOTE

Pins must be installed in cylinder block until they bottom against spring washer.

- (19) Install three pins (35) in cylinder block (29).
- (20) Position spherical washer (36) on top of three pins (35).
- (21) Install shoe plate (37) with nine pistons (38) over spherical washer (36) and into cylinder block (29).
- (22) Install cylinder block (29) on shaft (6), (23) Install bearing spacer (39) and bearing (40) on shaft (6).



- (24) Install orifice plug (41) in adapter (42) with new retaining ring (43).
- (25) Install two new preformed packings (44) and plugs (45) on adapter (42).
- (26) Install new preformed packing (46) and fitting (47) on adapter (42).
- (27) Install new preformed packing (48) and adapter (42) on valve block (49).



27-2. STEERING PUMP REPAIR (CONT)

- (28) install new preformed packing (50) and plug (51) in valve block (49).

NOTE

- Do step (29) if seat, valve, and spring were removed.
- When properly installed, seat should be flush with face of valve block.

- (29) Install spring (52), valve (53), and seat (54) in valve block (49).

- (30) Install bearing cup (55) in valve block (49).

- (31) Install new preformed packing (56) on rod (57).

WARNING

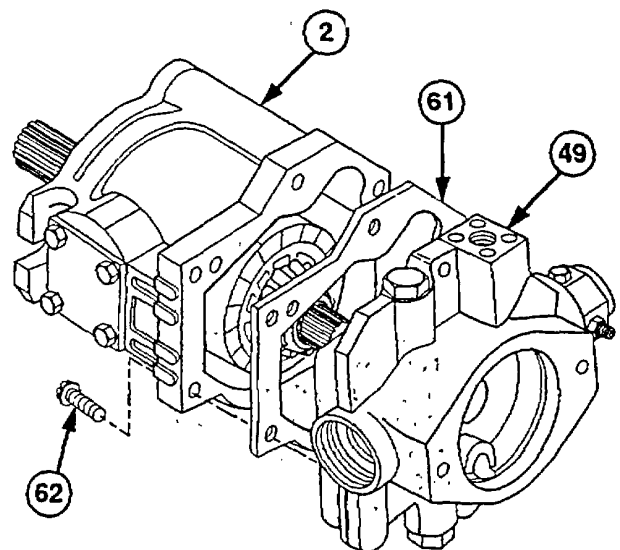
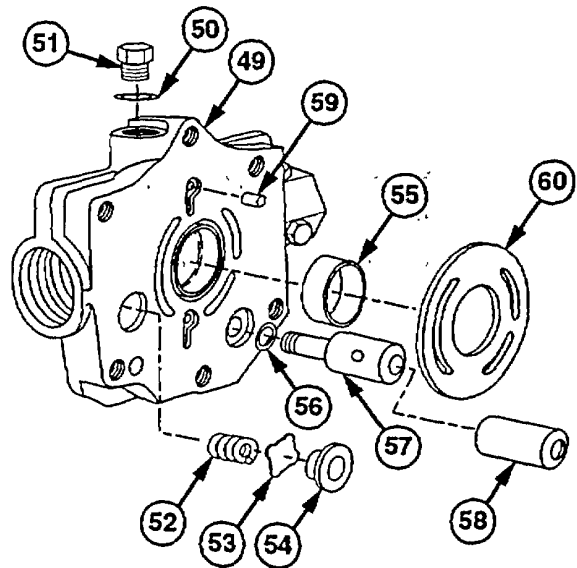
Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (32) Coat threads of rod (57) with adhesive-sealant.

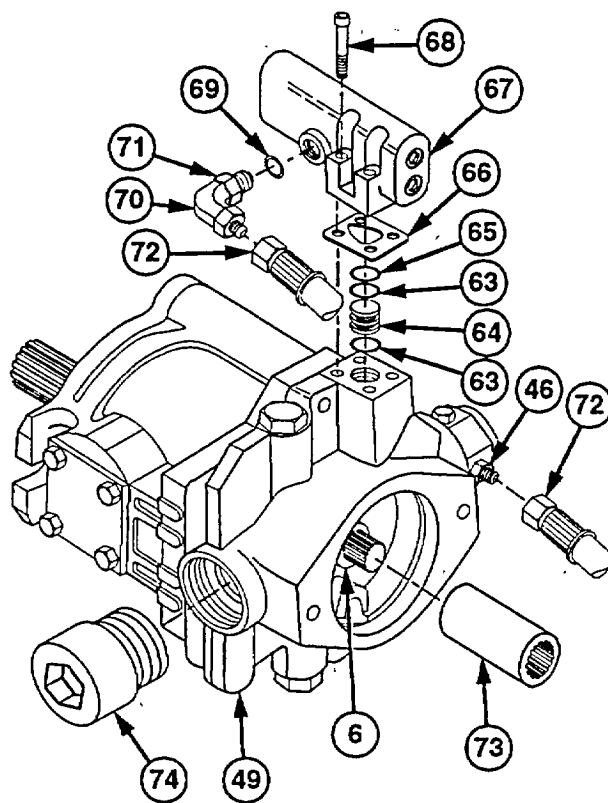
- (33) Install rod (57) and new preformed packing (56) in valve block (49).

- (34) Install piston (58), pin (59), and wafer plate (60) on valve block (49).

- (35) Install new gasket (61) and valve block (49) on pump housing (2) with six screws (62). Torque to 23-26 lb-ft (31-35 N•m).



- (36) Install two new preformed packings (63) and spool (64) in valve block (49).
- (37) Install new preformed packing (65), new gasket (66), and compensator (67) on valve block (49) with four screws (68). Torque to 60-70 lb-in. (6.8-7.9 N•m)
- (38) Install new preformed packing (69) and elbow (70) on compensator (67). Tighten jam nut (71).
- (39) Install hose (72) on fitting (46) on valve block (49).
- (40) Install hose (72) on elbow (70).
- (41) Install coupling (73) on shaft (6).
- (42) Install shipping plug (74) in valve block (49).



e. Rear Housing Assembly

NOTE

Bearing race is installed with narrow side to inside housing.

- (1) Install bearing race (1) in pump housing (2).

NOTE

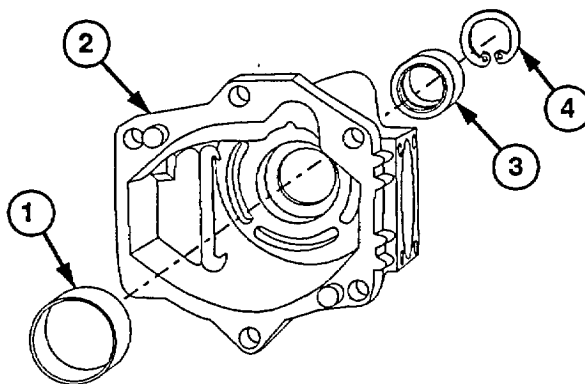
Seal is installed with numbered side out.

- (2) Install seal (3) in pump housing (2).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (3) Install retaining ring (4) in pump housing (2).



27-2. STEERING PUMP REPAIR (CONT)

- (4) Install new preformed packing (5) and pump housing (2) on valve block (6) with two washers (7) and screws (8).

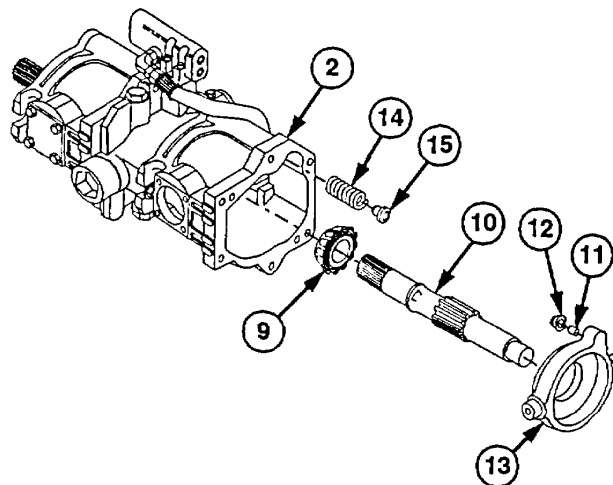
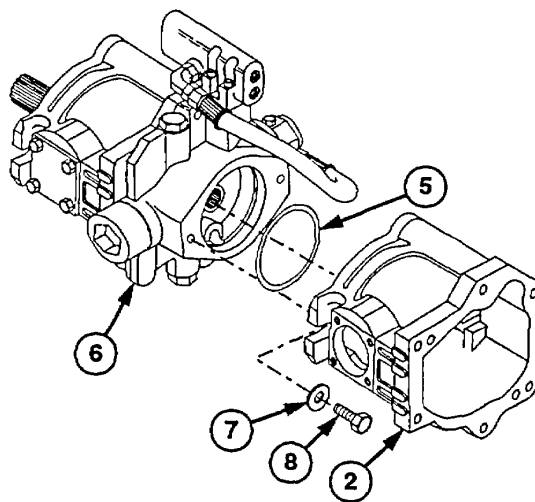
- (5) Position bearing (9) in press with narrow side down.

- (6) Press shaft (10) into bearing (9).

NOTE

Do step (7) if seat and roll pin were removed.

- (7) Install roll pin (11) and seat (12) on yoke (13).
- (8) Install spring (14) and seat (15) in pump housing (2).
- (9) Install yoke (13) and shaft (10) in pump housing (2).



NOTE

- When properly assembled, yoke should be stiff, but loose enough to be moved by hand.
- If yoke is too tight in housing, add or remove shims until correct preload is obtained.

- (10) Install bearing cone (16), bearing cup (17), bearing spacer (18), and preformed packing (19) in pump housing (2).

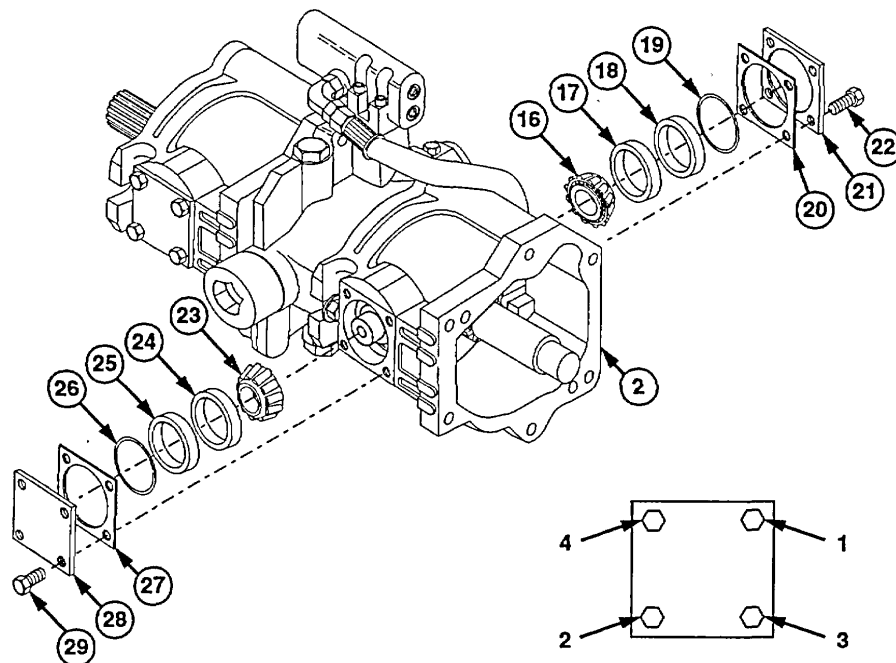
NOTE

- Shims must be adjusted only if new bearings are installed.
- If shim thickness is greater than 0.02 in., another shim must be added to opposite side of yoke to reduce total shim thickness to less than 0.02 in. Shim thickness at either pintle must not exceed 0.02 in.

- (11) Install shim kit (20) and pintle cover (21) on pump housing (2) with four screws (22). Cross-tighten to 175-185 lb-in. (237-251 N•m).

- (12) Install bearing cone (23), bearing cup (24), bearing spacer (25), and new preformed packing (26) in pump housing (2).

- (13) Install shim kit (27) and pintle cover (28) on pump housing (2) with four screws (29). Cross-tighten to 175-185 lb-in. (237-251 N•m).



27-2. STEERING PUMP REPAIR (CONT)

- (14) Install spring washer (30), spring (31), and spring washer (32) in cylinder block (33).
- (15) Position four washers (34), screw (35), and nut (36) through cylinder block (33).

NOTE

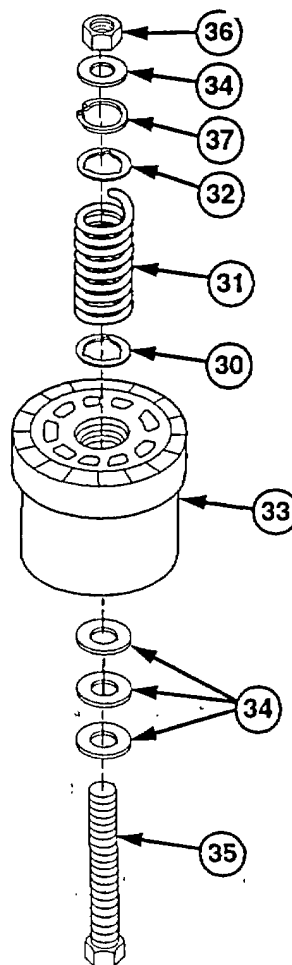
Tighten nut only enough to install retaining ring.

- (16) Tighten nut (36) to compress spring (31).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (17) Install retaining ring (37) in cylinder block (33).
- (18) Remove nut (36), screw (35), and four washers (34) from cylinder block (33).

**NOTE**

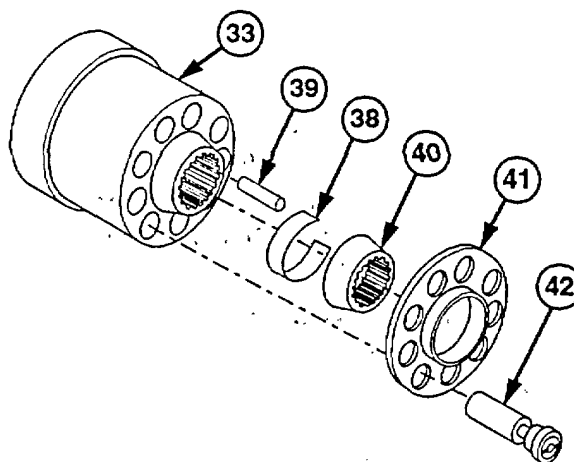
Pin retainer must be installed 0.25 in. (6.4 mm) below surface.

- (19) Install pin retainer (38) in cylinder block (33).

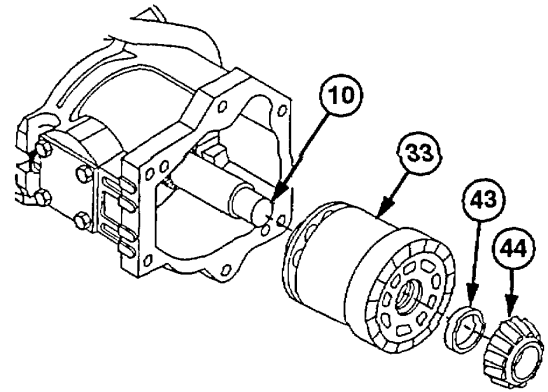
NOTE

Pins must be installed in cylinder block until they bottom against spring washer.

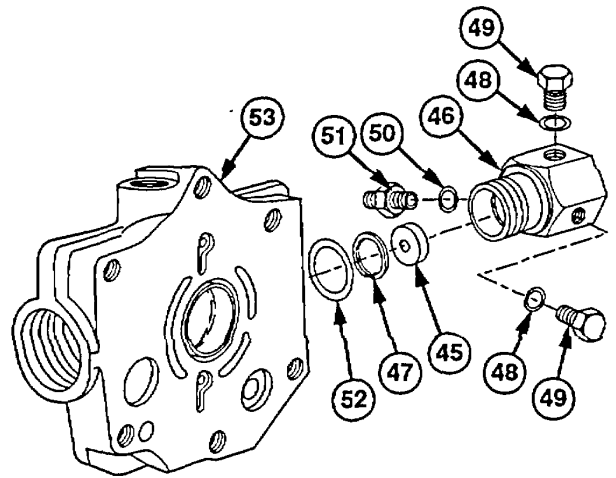
- (20) Install three pins (39) in cylinder block (33).
- (21) Position spherical washer (40) on top of three pins (39).
- (22) Install shoe plate (41) with nine pistons (42) over spherical washer (40) and into cylinder block (33).



- (23) Install cylinder block (33) on shaft (10).
- (24) Install bearing spacer (43) and bearing (44) on shaft (10).



- (25) Install orifice plug (45) in adapter (46) with new retaining ring (47).
- (26) Install two new preformed packings (48) and plugs (49) on adapter (46).
- (27) Install new preformed packing (50) and fitting (51) on adapter (46).
- (28) Install new preformed packing (52) and adapter (46) on valve block (53).

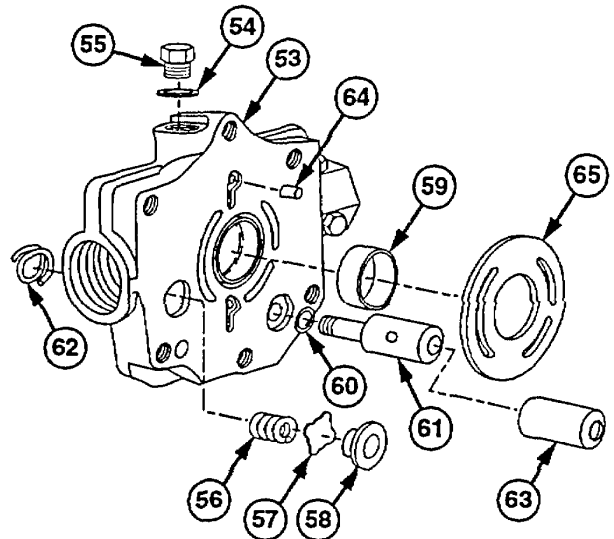


- (29) Install new preformed packing (54) and plug (55) in valve block (53).

NOTE

- Do step (30) if seat, valve, and spring were removed.
- When properly installed, seat should be flush with face of valve block.

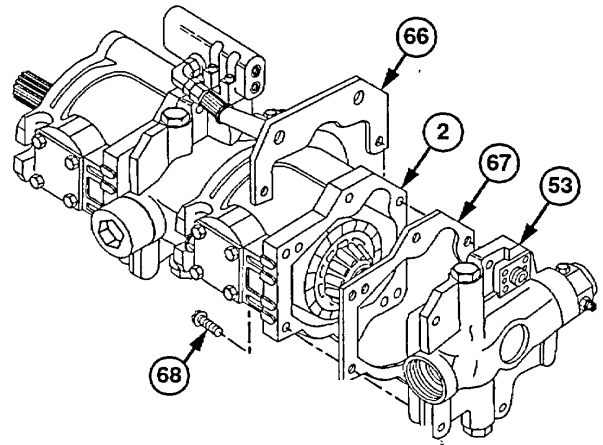
- (30) Install spring (56), valve (57), and seat (58) in valve block (53).
- (31) Install bearing cup (59) in valve block (53).
- (32) Install new preformed packing (60) and rod (61) in valve block (53).
- (33) Install new retaining ring (62) on rod (61).



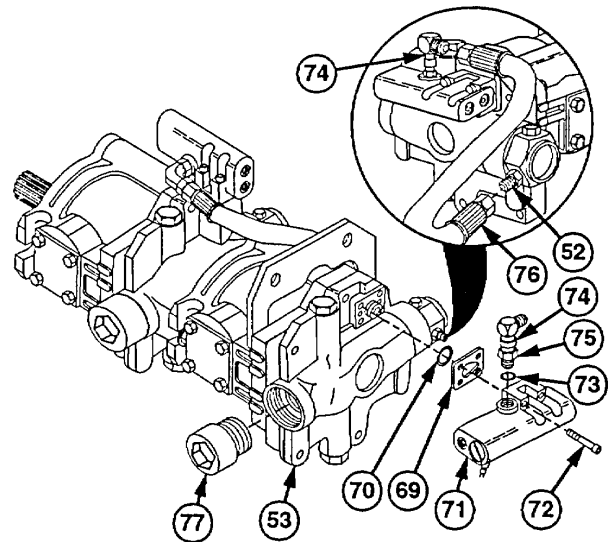
- (34) Install piston (63), pin (64), and wafer plate (65) on valve block (53).

27-2. STEERING PUMP REPAIR (CONT)

- (35) Install bracket (66), new gasket (67), and valve block (53) on pump housing (2) with six screws (68). Torque to 23-26 lb-ft (31-35 N•m).



- (36) Install new gasket (69), new preformed packing (70), and compensator (71) on valve block (53) with four screws (72). Torque to 60-70 lb-in. (6.8-7.9 N•m).



- (37) Install new preformed packing (73) and elbow (74) on compensator (71). Tighten jam nut (75).
- (38) Install hose (76) on fitting (52) on valve block (53).
- (39) Install hose (76) on elbow (74).
- (40) Install shipping plug (77) in valve block (53).

27-2.1. AUXILIARY STEERING PUMP REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Auxiliary steering pump on clean work surface.

Tools and Special Tools

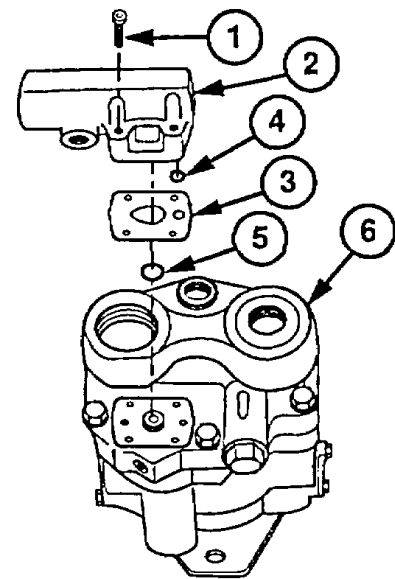
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Caps, Vise Jaw (Item 17, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Nut, 1/2 in. (Item 100.1, Appendix E)
 Pliers, Retaining Ring (Item 108, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical (Item 124, Appendix E)
 Screw, 1/2 x 3 1/2 in. (Item 148.1, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Washers, 1/2 in. (2) (Item 208.1, Appendix E)
 Wrench, Torque, 0-300 Lb-in. (Item 235, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Piston Rod Kit (item 227.1, Appendix F)
 Rotating Group Kit (item 274.1, Appendix F)
 Seal Kit (Item 296.1, Appendix F)
 Shaft Bearing Kit (Item 321.1, Appendix F)
 Yoke Bearing Kit (Item 347, Appendix F)

a. Disassembly

- (1) Remove four screws (1), compensator body (2), gasket (3), preformed packing (4), and preformed packing (5) from valve block (6). Discard gasket and preformed packings.



27-2.1. AUXILIARY STEERING PUMP REPAIR (CONT)

- (2) Remove five screws (7), valve block (6), and gasket (8) from pump housing (9). Discard gasket.
- (3) Remove wafer plate (10) and piston (11) from valve block (6).

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (4) Remove retaining ring (12) and rod (13) from valve block (6).

NOTE

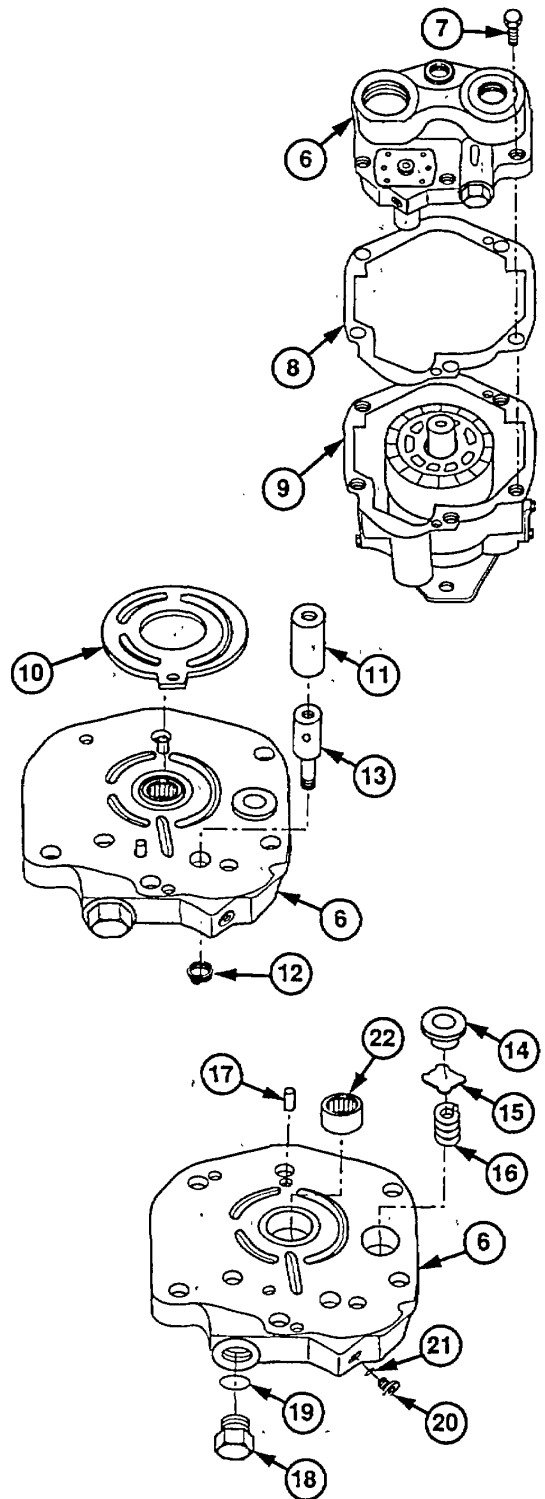
Do step (5) if valve fails inspection.

- (5) Remove seat (14), valve (15), and spring (16) from valve block (6).
- (6) Remove two pins (17) from valve block (6).
- (7) Remove plug (18) and preformed packing (19) from valve block (6). Discard preformed packing.
- (8) Remove plug (20) and preformed packing (21) from valve block (6). Discard preformed packing.
- (9) Position valve block (6) in soft jawed vice.

NOTE

When removing bearing, frequently reposition slide hammer hook.

- (10) Remove bearing (22) from valve block (6).



- (11) Remove cylinder block (23) and three pins (24) from shaft (25).
- (12) Remove shoe plate (26), nine pistons (27), and spherical washer (28) from cylinder block (23).
- (13) Remove pin retainer (29) from cylinder block (23).

WARNING

Cylinder block spring must be held by screw, washer, and nut before removing retaining ring. Spring and retaining ring are under high tension and can act as projectiles when released. Failure to comply may result in injury to personnel.

CAUTION

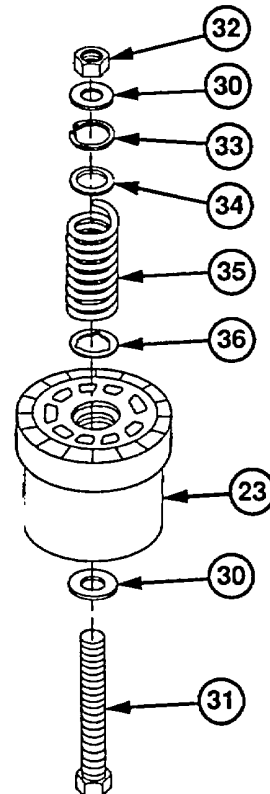
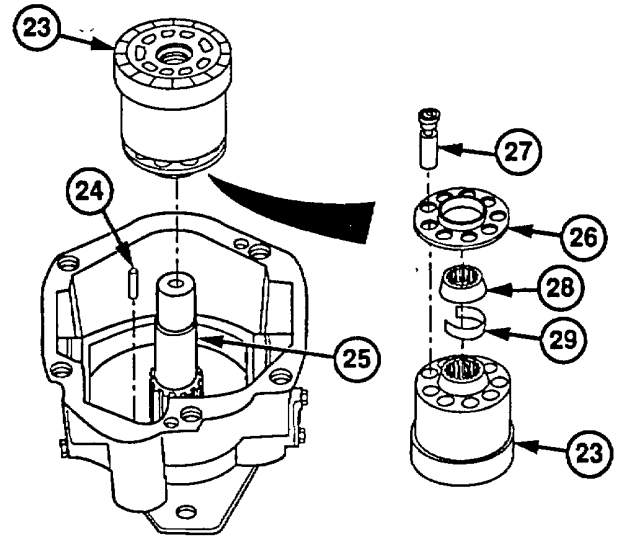
Do not clamp on flat surface of cylinder block. Failure to comply may result in damage to machine surface.

- (14) Position cylinder block (23) in soft-jawed vice.
- (15) Position two washers (30), screw (31), and nut (32) through cylinder block (23).

NOTE

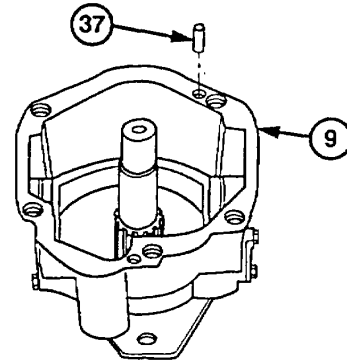
Spring must be compressed to allow retaining ring to be removed.

- (16) Tighten nut (32) and remove retaining ring (33).
- (17) Loosen nut (32) to relieve spring tension.
- (18) Remove nut (32), two washers (30), and screw (31) from cylinder block (23).
- (19) Remove spring washer (34), spring (35), and spring washer (36) from cylinder block (23).



27-2.1. AUXILIARY STEERING PUMP REPAIR (CONT)

- (20) Remove two pins (37) from pump housing (9).

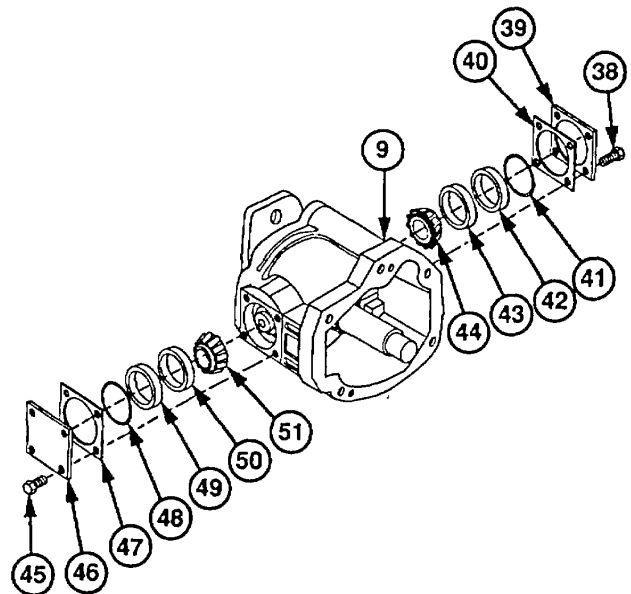


- (21) Remove four screws (38), pintle cover (39), and shim kit (40) from pump housing (9). Discard shim kit.

- (22) Remove preformed packing (41), pintle bearing spacer (42), bearing cup (43), and bearing cone (44) from pump housing (9). Discard preformed packing.

- (23) Remove four screws (45), pintle cover (46), and shim kit (47) from pump housing (9). Discard shim kit.

- (24) Remove preformed packing (48), pintle bearing spacer (49), bearing cup (50), and bearing cone (51) from pump housing (9). Discard preformed packing.



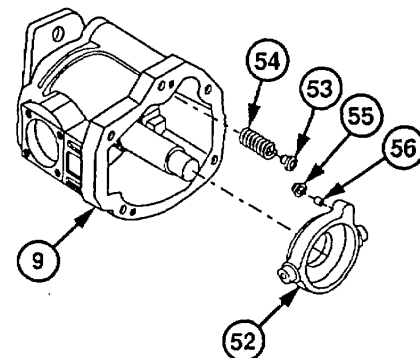
- (25) Remove yoke (52) from housing (9).

- (26) Remove seat (53) and spring (54) from pump housing (9).

NOTE

Do step (27) if seat fails inspection.

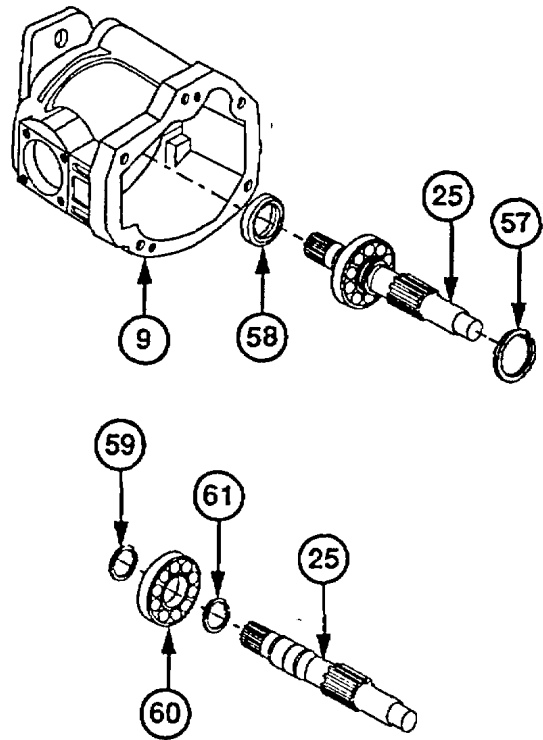
- (27) Remove seat (55) and roll pin (56) from yoke (52).



WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (28) Remove retaining ring (57) and shaft (25) from pump housing (9).
- (29) Remove seal (58) from pump housing (9). Discard seal.
- (30) Remove retaining ring (59) from shaft (25).
- (31) Position shaft (25) on press with long end of shaft (25) facing down.
- (32) Press shaft (25) from bearing (60).
- (33) Remove retaining ring (61) from shaft (25).

**b. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while using cleaning solvent, get fresh air Immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid Immediately.

- (1) Clean metal parts in dry cleaning solvent

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

CAUTION

Bearing must be air dried or damage to bearing cone will result.

- (2) Dry parts, except bearing cones, with compressed air.
- (3) Inspect parts for damage. Replace non-serviceable damaged parts. Remove all burrs with crocus cloth.
- (4) Inspect face of wafer plate for wear, scratches, and fractures.
- (5) Inspect springs for wear and check that ends are parallel. Replace warped or worn springs.

27-2.1. AUXILIARY STEERING PUMP REPAIR (CONT)

- (6) Inspect yoke face for wear, roughness, and scoring.
- (7) Inspect shaft for wear, roughness, and scoring.

NOTE

Wobble shoe plate to ensure that each piston is free within its bore in the cylinder block.

- (8) Check cylinder block bore for excessive wear. Piston should be close fit but slide in and out easily. If binding exists, clean and lubricate block and piston with clean hydraulic fluid. If binding persists, replace cylinder block.
- (9) Check for end play between piston and shoe.

NOTE

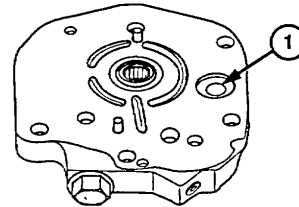
Piston face thickness dimensions must be within 0.001 in. (0.025 mm) of each other.

- (10) Measure thickness of nine piston faces.

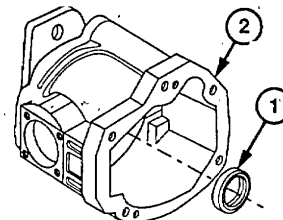
NOTE

Pins, bearings, and races are replaced in sets. If one is defective, replace both.

- (11) Inspect pins for equal length and bent condition. Replace if damaged.
- (12) Remove burrs from pin retainer.
- (13) Inspect bearings for scoring, pitting, and roughness when turned in race. Replace if: damaged.
- (14) Inspect bearing spacers for burrs.
- (15) Press in check valve (1). Valve should return and hold firm against seat. Replace if damaged.
- (16) Inspect spherical washer for burrs, wear, and scratches due to pin breakage.

**c. Assembly**

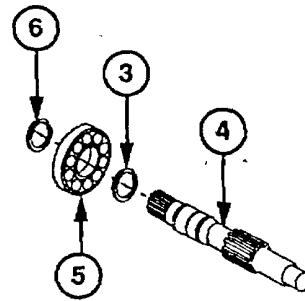
- (1) Install new seal (1) in pump housing (2).



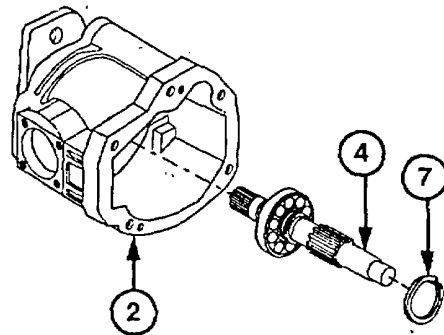
WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (2) Install new retaining ring (3) on shaft (4).
- (3) Position bearing (5) on press.
- (4) Press shaft (4) on bearing (5) until bearing (5) contacts retaining ring (3).
- (5) Install new retaining ring (6) on shaft (4).

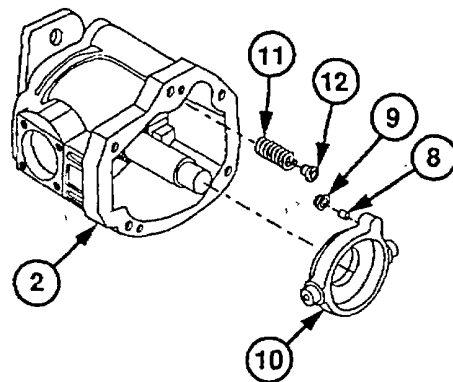


- (6) Install shaft (4) and new retaining ring (7) on pump housing (2).

**NOTE**

Do step (7) if roll pin and seat were removed.

- (7) Install roll pin (8) and seat (9) on yoke (10).
- (8) Install spring (11) and seat (12) in pump housing (2).
- (9) Install yoke (10) in pump housing (2).



27-2.1. AUXILIARY STEERING PUMP REPAIR (CONT)**NOTE**

- When properly assembled, yoke should be stiff, but loose enough to be moved by hand.
- If yoke is too tight in pump housing, add or remove shims until correct preload is obtained.

- (10) Install bearing cone (13), bearing cup (14), bearing spacer (15), and new preformed packing (16) in pump housing (2).

NOTE

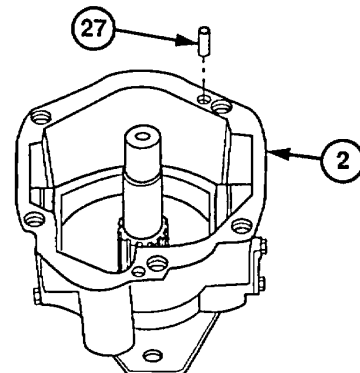
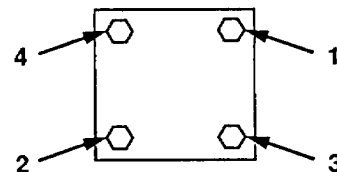
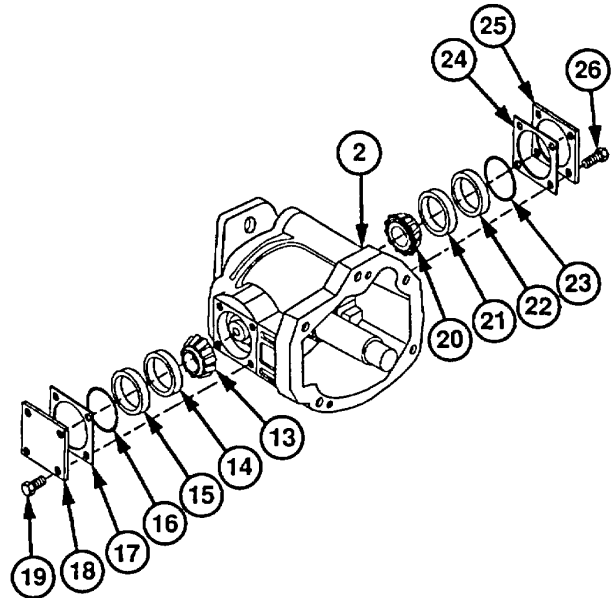
- Shims must be adjusted only if new bearings are installed.
- If shim thickness is greater than 0.02 in. (0.508 mm), another shim must be added to opposite side of yoke to reduce total shim thickness to less than 0.02 in. Shim thickness at either pintle must not exceed 0.02 in. (0.508 mm).

- (11) Install shim kit (17) and pintle cover (18) on pump housing (2) with four screws (19). Cross-tighten to 175-185 lb-in. (237-251 N•m)

- (12) Install bearing cone (20), bearing cup (21), bearing spacer (22), and new preformed packing (23) in pump housing (2).

- (13) Install shim kit (24) and pintle cover (25) on pump housing (2) with four screws (26). Cross-tighten to 175-185 lb-in. (237-251 N•m).

- (14) Install two pins (27) in pump housing (2).



(15) Install spring washer (28), spring (29), and spring washer (30) in cylinder block (31).

(16) Position two washers (32), screw (33), and nut (34) in cylinder block (31).

NOTE

Nut should be tightened only enough to install retaining ring.

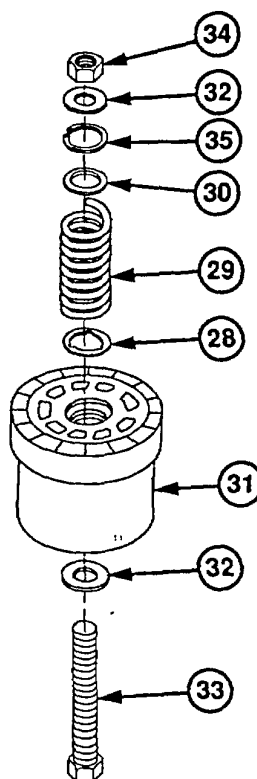
(17) Tighten nut (34) to compress spring (29).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

(18) Install retaining ring (35) in cylinder block (31).

(19) Remove nut (34), screw (33), and two washers (32) from cylinder block (31).



NOTE

Pin retainer must be installed 0.25 in. (6045 mm) below surface.

(20) Install pin retainer (36) in cylinder block (31).

NOTE

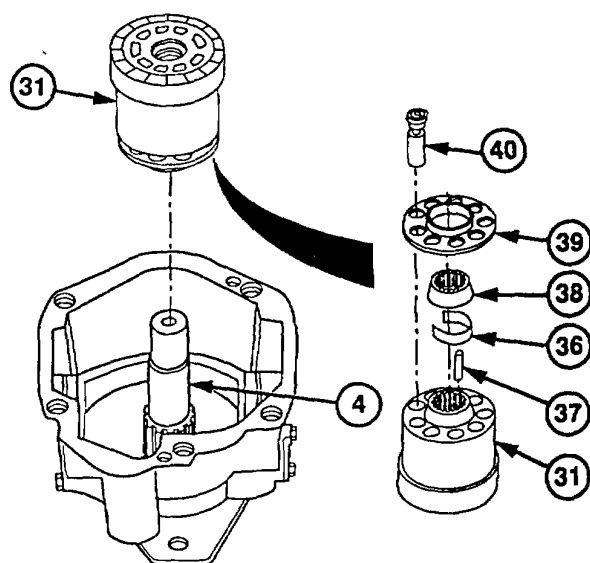
Pins must be installed in cylinder block until they contact spring washer.

(21) Install three pins (37) in cylinder block (31).

(22) Position spherical washer (38) on top of three pins (37).

(23) Install shoe plate (39) with nine pistons (40) over spherical washer (38) and into cylinder block (31).

(24) Install cylinder block (31) on shaft (4).



27-2.1. AUXILIARY STEERING PUMP REPAIR (CONT)

- (25) Install new preformed packing (41) and plug (42) in valve block (43).
- (26) Install new preformed packing (44) and plug (45) in valve block (43).
- (27) Install bearing (46) in valve block (43).
- (28) Install two pins (47) in valve block (43).

NOTE

- Do step (29) if seat, valve, and spring were removed.
- When properly installed, seat should be flush with face of valve block.

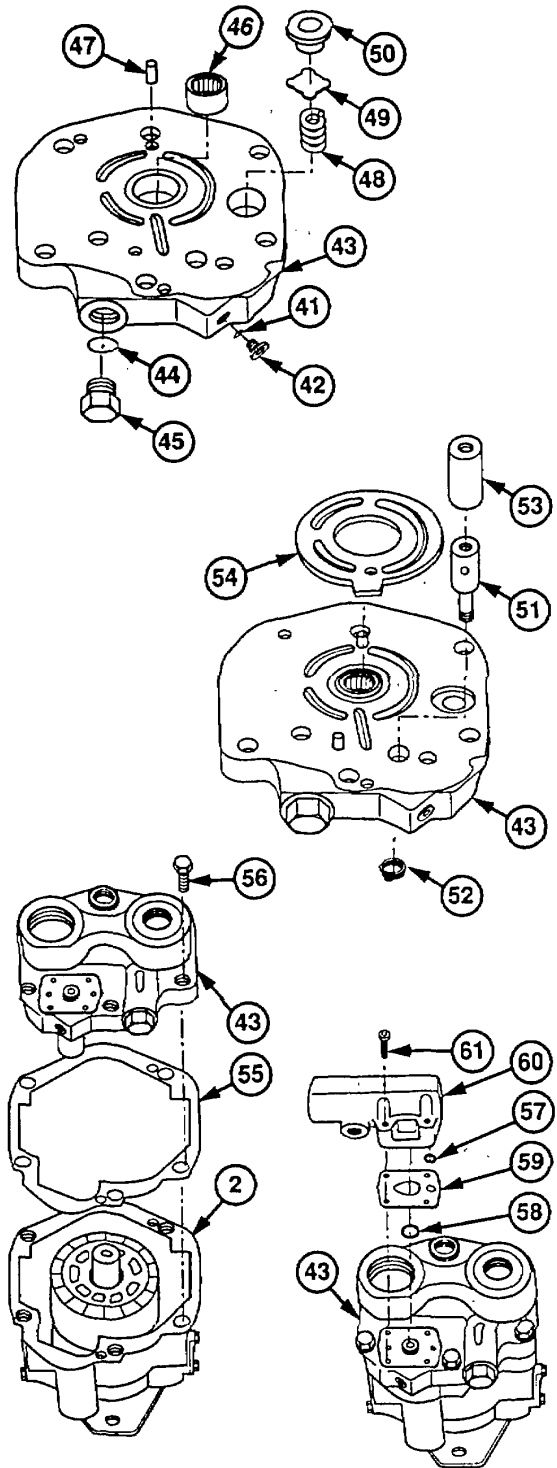
- (29) Install spring (48), valve (49), and seat (50) in valve block (43).

- (30) Install rod (51) and retaining ring (52) on valve block (43).

- (31) Install piston (53) and wafer plate (54) on valve block (43).

- (32) Install new gasket (55) and valve block (43) on pump housing (2) with five screws (56). Torque to 23-26 lb-ft (31-35 N•m).

- (33) Install new preformed packing (57), new preformed packing (58), gasket (59), and compensator body (60) on valve block (43) with four screws (61).



27-3. FRONT STEERING GEAR REPAIR

This task covers

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

Initial Setup:

Equipment Conditions

Steering gear on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Drill Set, Twist (Item 33, Appendix E)
 Drill, Electric, Portable, 14 In. (Item 34, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Hammer, Soft-Faced (Item 63, Appendix E)
 Pan, Oil Drain (Item 102, Appendix E)
 Puller Kit, Mechanical, Slide Hammer (Item 125, Appendix E)
 Wrench Set, Socket 3/4 in. Drive (Item 231, Appendix E)
 Wrench, Torque, 0-600 Lb-Ft (Item 233, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

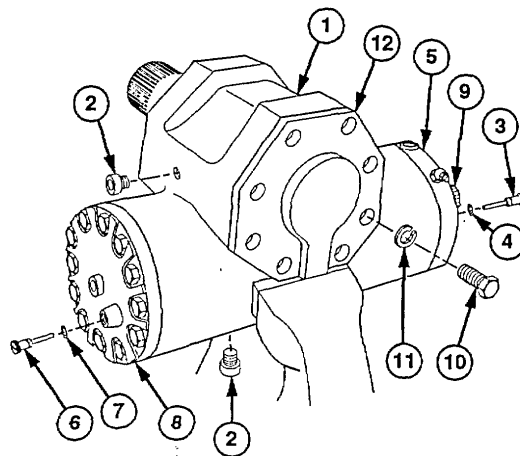
Cloth, Crocus (Item 16, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28, Appendix B)
 Oil, Hydraulic (Item 39, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Gasket/Seal Kit (Item 71, Appendix F)
 Lockwashers (24) (Item 127, Appendix F)
 Lockwashers (8) (Item 106, Appendix F)
 Pin, Roll (Item 226, Appendix F)
 Seal, Quad Ring (Item 319, Appendix F)

NOTE

Front and rear steering gears are assembled differently. Parts are not interchangeable.

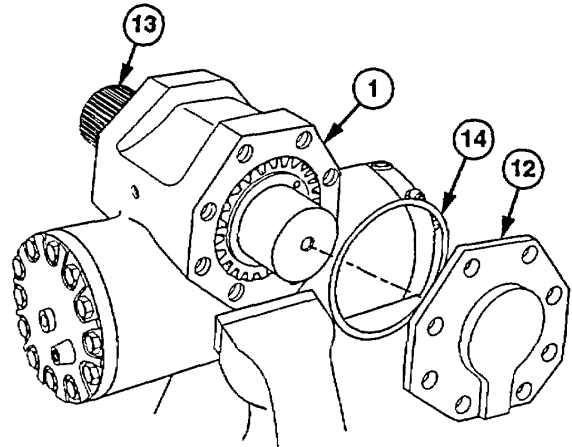
a. Disassembly

- (1) Position housing (1) in vise.
- (2) Remove two plugs (2) from housing (1).
- (3) Remove relief valve (3) and preformed packing (4) from bearing cap (5). Discard preformed packing.
- (4) Remove relief valve (6) and preformed packing (7) from cylinder head (8). Discard preformed packing.
- (5) Position drain pan under housing (1).
- (6) Turn actuating shaft (9) fully clockwise then fully counterclockwise to drain oil through relief valve holes.
- (7) Remove eight screws (10) and lockwashers (11) from pinion gear cover (12). Discard lockwashers.



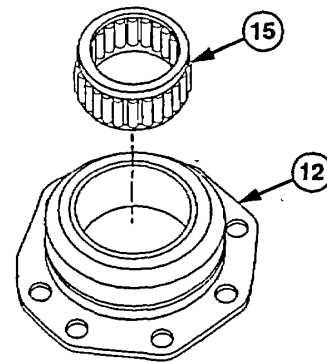
27-3. FRONT STEERING GEAR REPAIR (CONT.).

- (8) Remove paint/foreign matter from output shaft (13) with crocus cloth.
- (9) Using a soft-faced hammer, tap end of output shaft (13) to loosen cover (12).
- (10) Remove cover (12) and preformed packing (14) from housing (1). Discard preformed packing.



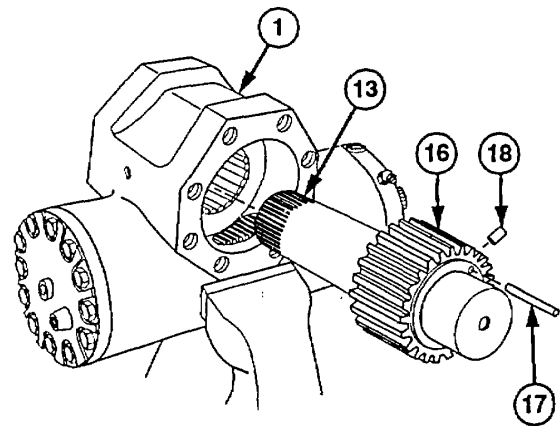
NOTE
Do step (11) if bearing fails inspection.

- (11) Remove bearing (15) from cover (12).
- (12) Remove output shaft (13) and pinion gear (16) from housing (1).



NOTE
- Do not separate pinion gear from output shaft unless one of them must be replaced.
- Do steps (13) thru (15) if replacing pinion gear or shaft.

- (13) Remove roll pin (17) from pinion gear (16). Discard roll pin.
- (14) Using 3/8 in. (9.5 mm) bit, drill retaining pin (18) from pinion gear (16) and output shaft (13).
- (15) Remove pinion gear (16) from output shaft (13).



- (16) Remove plug (19) from cylinder head (8).
- (17) Remove 12 screws (20) and lockwashers (21) from cylinder head (8). Discard lockwashers.
- (18) Remove cylinder head (8) and preformed packing (22) from housing (1). Discard preformed packing.
- (19) Remove plug (23) and grease fitting (24) from bearing cap (5).
- (20) Remove 12 screws (25) and lockwashers (26) from bearing cap (5). Discard lockwashers.

NOTE

Bearing cap is removed from housing by turning input shaft counterclockwise out of piston. (21) Remove bearing cap (5) and preformed packing (27) from housing (1). Discard preformed packing.

NOTE

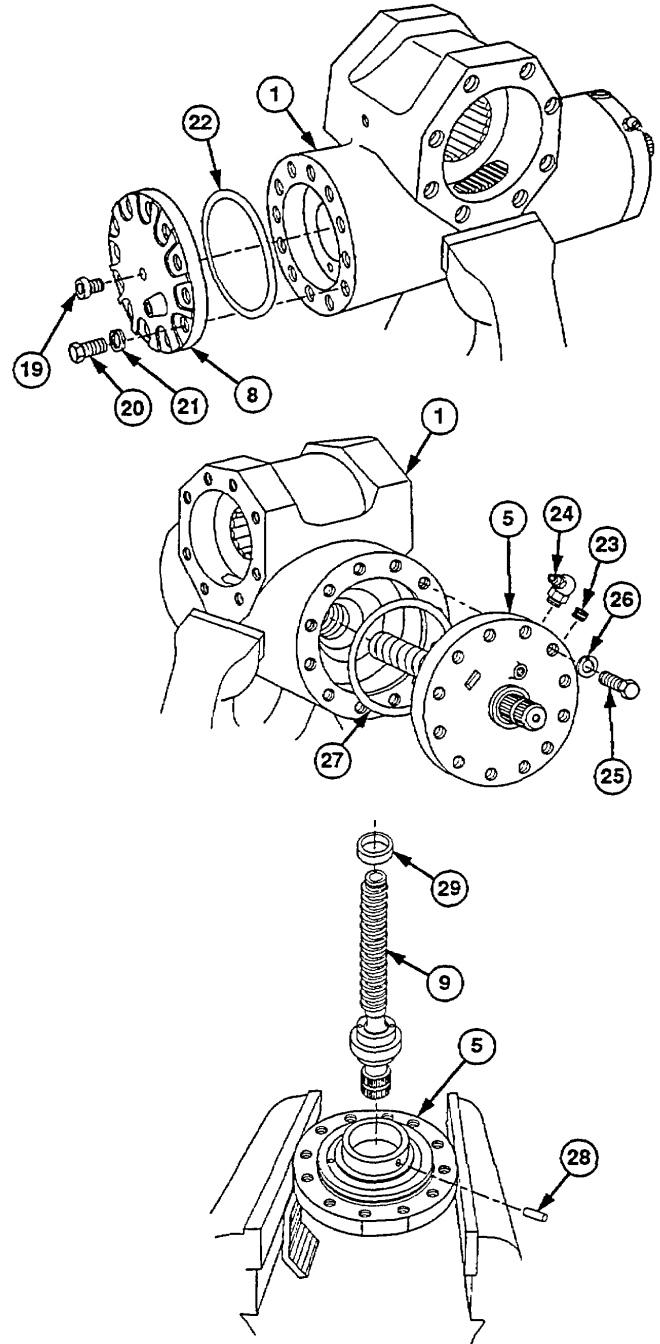
Do steps (22) thru (29) if replacing seals or actuating shaft.

- (22) Position bearing cap (5) in soft-jawed vise with actuating shaft (9) up.
- (23) Using 5/64 in. (2 mm) bit, drill retaining pin (28) from bearing cap (5).
- (24) Remove bearing retainer (29) from bearing cap (5).

NOTE

Do not separate bearing from actuating shaft. They are replaced as an assembly.

- (25) Remove actuating shaft (9) from bearing cap (5).



27-3. FRONT STEERING GEAR REPAIR (CONT).

- (26) Position bearing cap (5) in vise with outside of bearing cap up.
- (27) Remove seal (30) and seal (31) from bearing cap (5).

NOTE

- High-pressure seal must be removed by pressing from outside of bearing cap.
- Some steering gears do not have backup washer.

- (28) Remove high-pressure seal (32) and backup washer (32.1) from bearing cap (5). Discard seal and washer.
- (29) Remove bearing cap (5) from vise.

NOTE

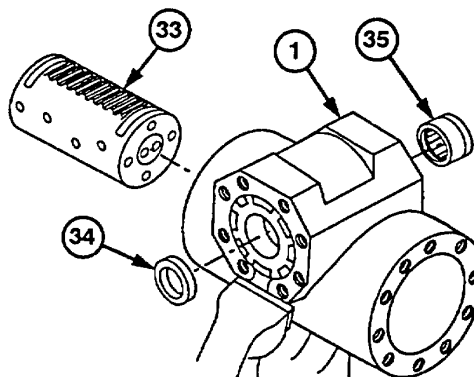
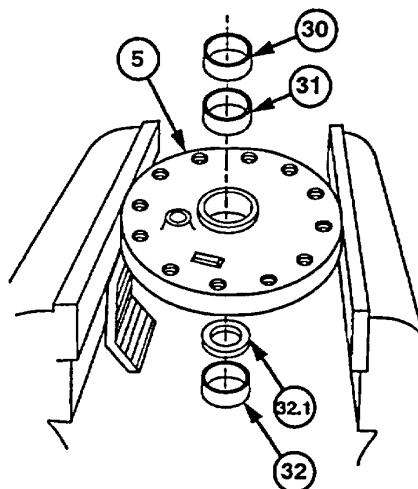
Do not disassemble piston. It must be replaced as an assembly.

- (30) Remove piston (33) from housing (1).
- (31) Remove quad ring seal (34) from housing (1). Discard quad ring seal.

NOTE

Do step (32) if bearing fails inspection.

- (32) Remove bearing (35) from housing (1).

**b. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated area. Avoid contact with skin, eyes, and clothing, and don't breathe vapors. DO NOT use near open flame or excessive heat. the flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts in dry cleaning solvent.
- (2) Inspect parts for damage, cracks, breaks, or deterioration.
- (3) Inspect parts with machined surfaces for deep scratches.
- (4) Remove small nicks or burrs with crocus cloth.
- (5) Coat internal parts with light coating of hydraulic fluid.
- (6) Replace unserviceable parts.

c. Assembly

- (1) Lubricate new quad ring seal (1) with hydraulic oil and install in housing (2).

NOTE

- Do step (2) if bearing was removed.
- Bearing must be pressed in until flush with inside surface of housing.

- (2) Install bearing (3) in housing (2).

NOTE

Do steps (3) thru (12) if seals or actuating shaft were removed.

- (3) Position bearing cap (4) in vise with inside surface up.

CAUTION

Seals must be evenly pressed in bearing cap. Failure to comply may result in damage to seals.

NOTE

- High-pressure seals must be installed by pressing from inside of bearing cap to outside.
- Backup washer must be installed on all steering gears.

- (4) Install new backup washer (4.1) and new high-pressure seal (5) in bearing cap (4) until it rests against shoulder.

- (5) Lubricate high-pressure seal (5) with hydraulic oil.

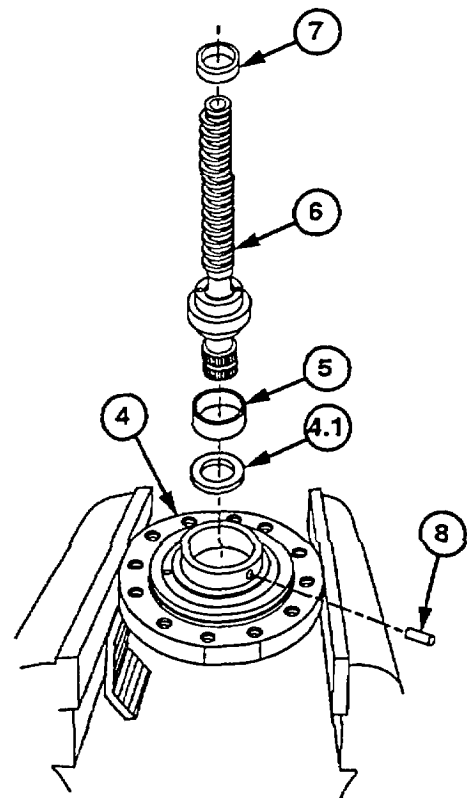
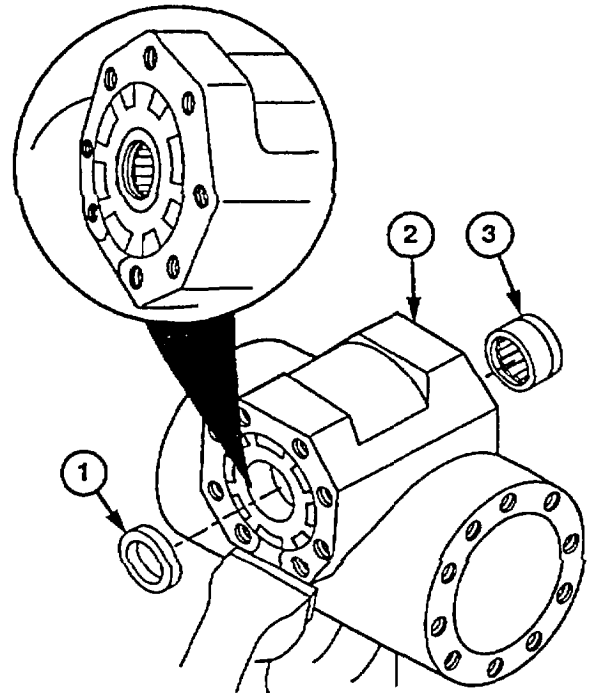
- (6) Press actuating shaft (6) into bearing cap (4).

NOTE

Bearing retainer should be tightened securely to prevent actuating shaft end play.

- (7) Install bearing retainer (7) on bearing cap (4).

- (8) Install new retaining pin (8) in bearing cap (4).



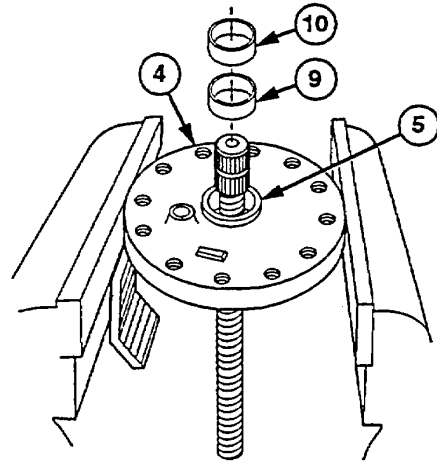
27-3. FRONT STEERING GEAR REPAIR (CONT)

- (9) Position bearing cap (4) in vise with outside surface facing up.

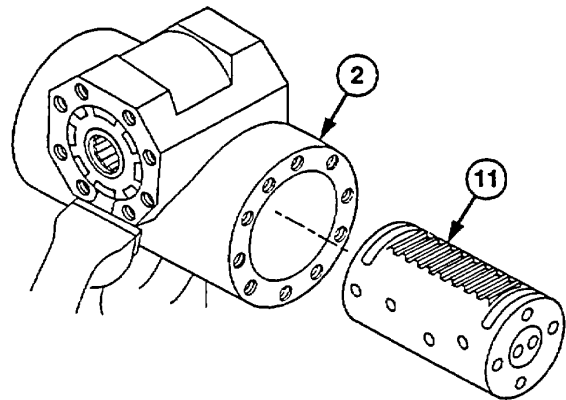
NOTE

Seals are installed lip-side out.

- (10) Install new seal (9) in bearing cap (4) until it rests against high-pressure seal (5).
- (11) Install new seal (10) in bearing cap (4) until flush with face of bearing cap (4).
- (12) Remove bearing cap (4) from vise.

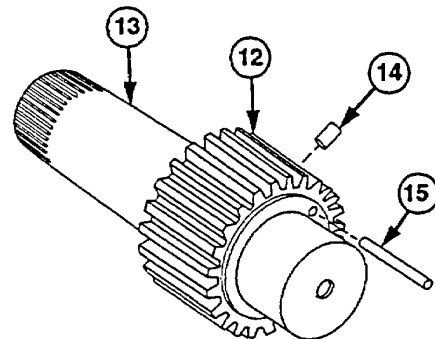


- (13) Lubricate piston (11) with hydraulic oil and install in housing (2).

**NOTE**

Do steps (14) thru (16) if pinion gear or shaft was removed.

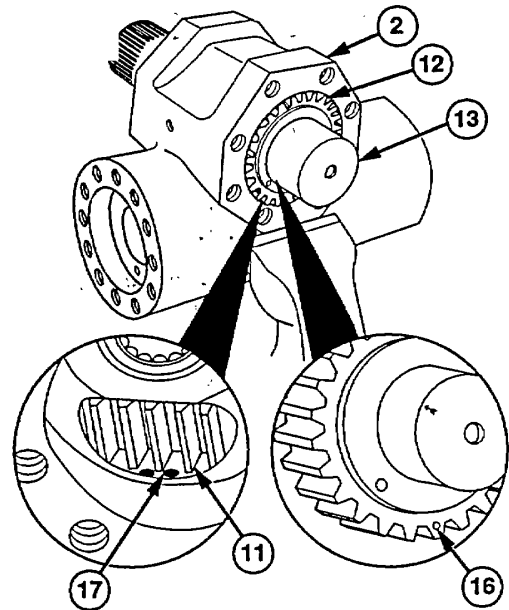
- (14) Position pinion gear (12) on output shaft (13).
- (15) Install retaining pin (14) through hole in pinion gear (12) into slot on output shaft (13).
- (16) Install roll pin (15) in pinion gear (12).



WARNING

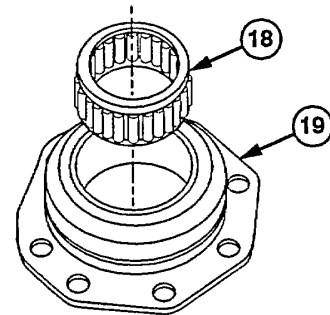
Timing marks on piston and pinion must be properly aligned. Failure to comply will cause steering gear to fail and loss of vehicle control which may cause serious injury or death to personnel.

- (17) Center timing mark (16) on pinion gear (12) between timing marks (17) on piston (11) and install output shaft (13) in housing (2).

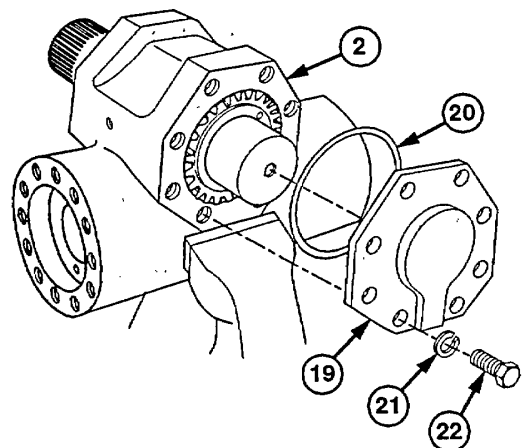
**NOTE**

- Do step (18) if bearing was removed during disassembly.
- Bearing must be pressed in until flush with face of cover.

- (18) Install bearing (18) in cover (19).



- (19) Lubricate new preformed packing (20) with hydraulic oil and install on cover (19).
- (20) Install cover (19) on housing (2) with eight new lockwashers (21) and screws (22). Torque to 170-180 lb-ft (231-244 N•m)



27-3. FRONT STEERING GEAR REPAIR (CONT)

- (21) Lubricate new preformed packing (23) with hydraulic oil and install on cylinder head (24).
- (22) Align relief valve hole (25) on cylinder head
- (24) with relief valve hole (26) in piston (11).

NOTE

Screws for cylinder head are shorter than screws for bearing cap.

- (23) Install cylinder head (24) on housing (2) with 12 new lockwashers (27) and screws (28). Torque to 35-45 lb-ft (48-61 N•m).

WARNING

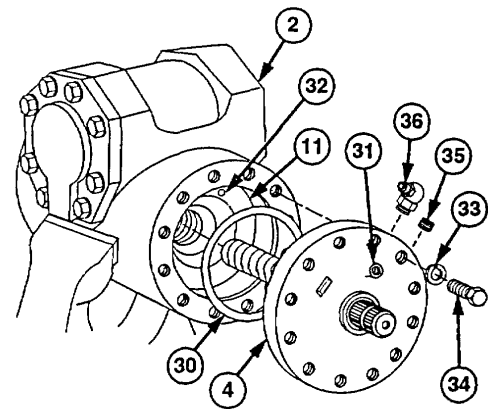
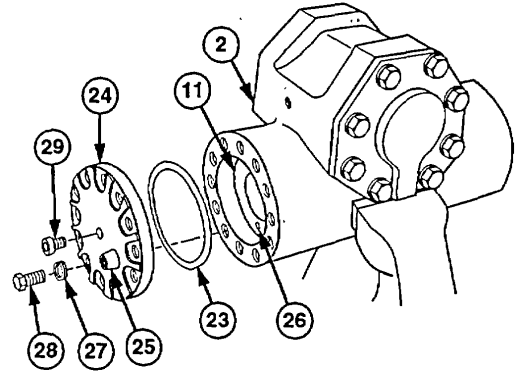
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (24) Coat threads of plug (29) with pipe thread sealing compound.
- (25) Install plug (29) in cylinder head (24).
- (26) Lubricate new preformed packing (30) with hydraulic oil and install on bearing cap (4).

NOTE

Bearing cap is installed on housing by turning actuating shaft clockwise into piston.

- (27) Install bearing cap (4) on housing (2).
- (28) Align relief valve hole (31) in bearing cap (4) with relief valve hole (32) in piston (11).
- (29) Install bearing cap (4) on housing (2) with 12 new lockwashers (33) and screws (34). Tighten to 35-45 lb-ft (47-61 N•m) torque.
- (30) Coat threads of plug (35) with pipe thread sealing compound.
- (31) Install plug (35) in bearing cap (4).
- (32) Install grease fitting (36) in bearing cap (4).



NOTE

Relief valves have different lengths. Shorter relief valve goes in cylinder head.

- (33) Lubricate new preformed packing (37) with hydraulic oil and install on relief valve (38).

NOTE

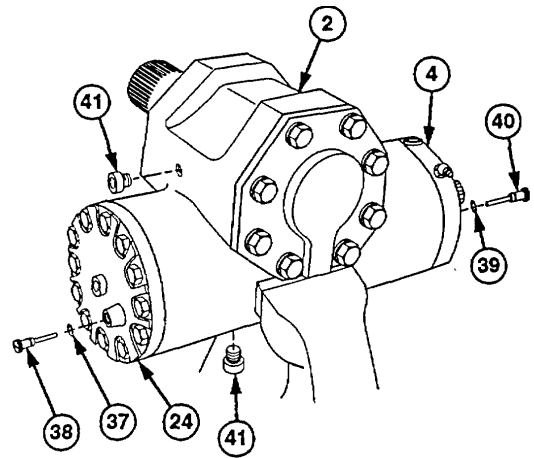
Relief valve must be installed until head is flush with outside face of cylinder head.

- (34) Install relief valve (38) in cylinder head (24).
- (35) Lubricate new preformed packing (39) with hydraulic oil and Install on relief valve (40).

NOTE

Relief valve must be installed until head is flush with outside face of bearing cap.

- (36) Install relief valve (40) in bearing cap (4).
- (37) Install two plugs (41) in housing (2).
- (38) Remove housing (2) from vise.



27-4. REAR STEERING GEAR REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/ Inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Steering gear on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Drill Set, Twist (Item 33, Appendix E)
 Drill, Electric, Portable, 1/4 in. (Item 34, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Hammer, Soft-Faced (Item 63, Appendix E)
 Pan, Oil Drain (Item 102, Appendix E)
 Puller Kit, Mechanical, Slide Hammer (Item 125, Appendix E)
 Wrench Set, Socket 3/4 in. Drive (Item 231, Appendix E)
 Wrench, Torque, 0-600 Lb-Ft (item 233, Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

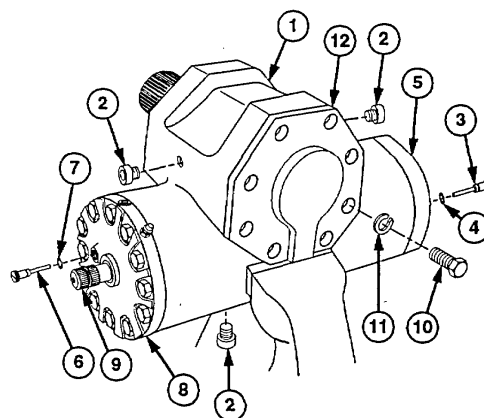
Cloth, Crocus (Item 16, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28, Appendix B)
 Oil, Hydraulic (Item 39, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Gasket/Seal Kit (Item 71, Appendix F)
 Lockwashers (24) (Item 127, Appendix F)
 Lockwashers (8) (Item 106, Appendix F)
 Pin, Roll (Item 226, Appendix F)
 Seal, Quad Ring (Item 319, Appendix F)

NOTE

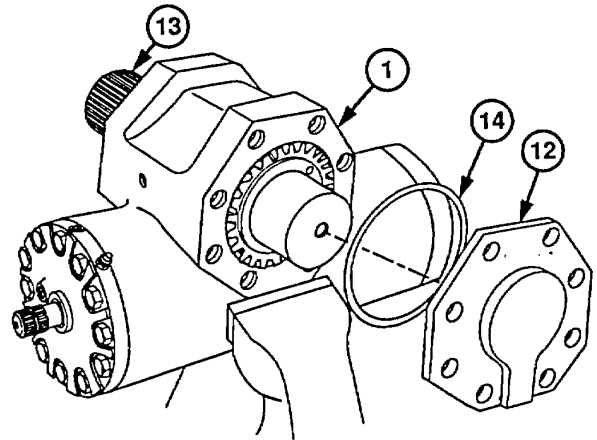
Front and rear steering gears are assembled differently. Parts are not interchangeable.

a. Disassembly

- (1) Position housing (1) in vise.
- (2) Remove three plugs (2) from housing (1).
- (3) Remove relief valve (3) and preformed packing (4) from bearing cap (5). Discard preformed packing.
- (4) Remove relief valve (6) and preformed packing (7) from cylinder head (8). Discard preformed packing.
- (5) Position drain pan under housing (1).
- (6) Turn actuating shaft (9) fully clockwise then fully counterclockwise to drain oil through relief valve holes.
- (7) Remove eight screws (10) and lockwashers (11) from pinion gear cover (12). Discard lockwashers.



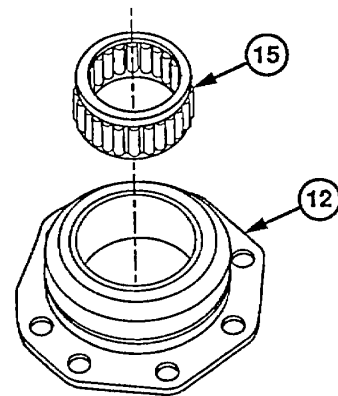
- (8) Remove paint/foreign matter from output shaft (13) with crocus cloth.
- (9) Using a soft-faced hammer, tap end of output shaft (13) to loosen cover (12).
- (10) Remove cover (12) and preformed packing (14) from housing (1). Discard preformed packing.



NOTE

Do step (11) if bearing fails inspection.

- (11) Remove bearing (15) from cover (12).

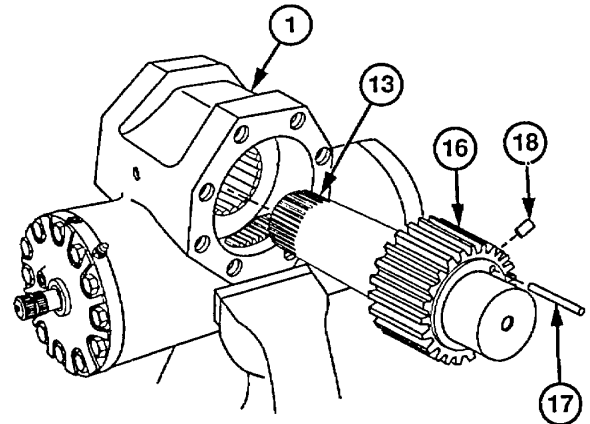


- (12) Remove output shaft (13) and pinion gear (16) from housing (1).

NOTE

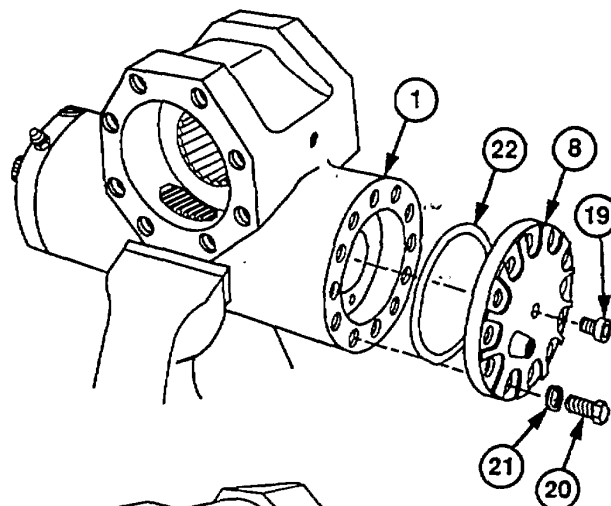
- Do not separate pinion gear from output shaft unless one of them must be replaced.
- Do steps (13) thru (15) if replacing pinion gear or shaft.

- (13) Remove roll pin (17) from pinion gear (16). Discard roll pin.
- (14) Using 3/8 in. (9.5 mm) bit, drill retaining pin (18) from pinion gear (16) and output shaft (13).
- (15) Remove pinion gear (16) from output shaft (13).

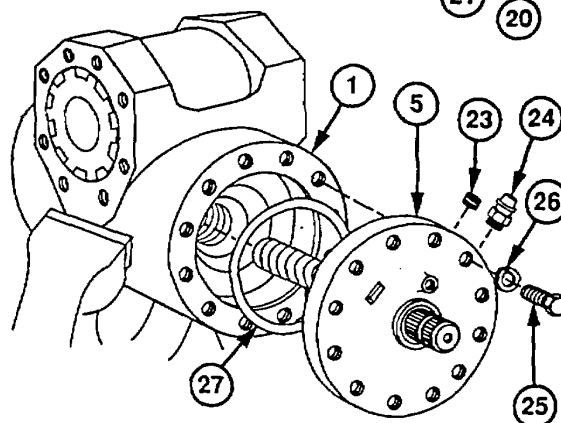


27-4. REAR STEERING GEAR REPAIR (CONT)

- (16) Remove plug (19) from cylinder head (B).
- (17) Remove 12 screws (20) and lockwashers (21) from cylinder head (8). Discard lockwashers.
- (18) Remove cylinder head (B) and preformed packing (22) from housing (1). Discard preformed packing.



- (19) Remove plug (23) and grease fitting (24) from bearing cap (5).
- (20) Remove 12 screws (25) and lockwashers (26) from bearing cap (5). Discard lockwashers.

**NOTE**

Bearing cap is removed from housing by turning input shaft clockwise out of piston.

- (21) Remove bearing cap (5) and preformed packing (27) from housing (1). Discard preformed packing.

NOTE

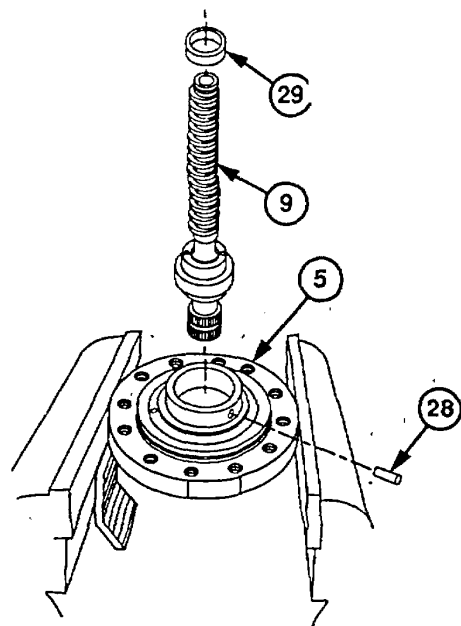
Do steps (22) thru (29) if replacing seals or actuating shaft.

- (22) Position bearing cap (5) in soft-jawed vise with actuating shaft (9) up.
- (23) Using 5/64 in. (2 mm) bit, drill retaining pin (28) from bearing cap (5).
- (24) Remove bearing retainer (29) from bearing cap (5).

NOTE

Do not separate bearing from actuating shaft. They are replaced as an assembly.

- (25) Remove actuating shaft (9) from bearing cap (5).

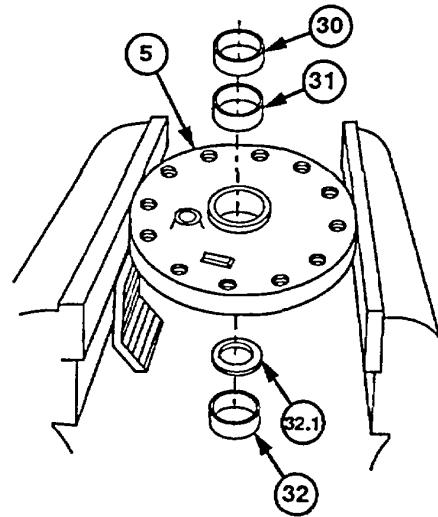


- (26) Position bearing cap (5) in vise with outside of bearing cap up.
- (27) Remove seal (30) and seal (31) from bearing cap (5).

NOTE

- High-pressure seal must be removed by pressing from outside of bearing cap.
- Some steering gears do not have backup washer.

- (28) Remove high-pressure seal (32) and backup washer (32.1) from bearing cap (5). Discard seal and washer.
- (29) Remove bearing cap (5) from vise.

**NOTE**

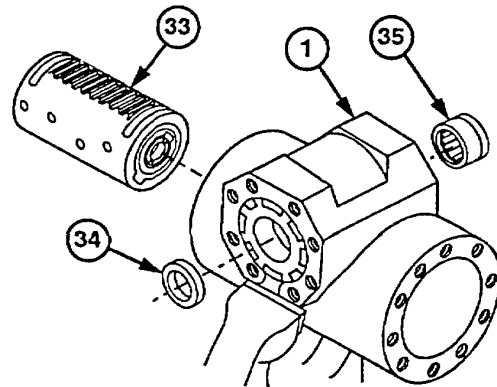
Do not disassemble piston. It must be replaced as an assembly.

- (30) Remove piston (33) from housing (1).
- (31) Remove quad ring seal (34) from housing (1). Discard quad ring seal.

NOTE

Do step (32) if bearing fails inspection.

- (32) Remove bearing (35) from housing (1).

**b. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated area. Avoid contact with skin, eyes, and clothing, and don't breath vapors. DO NOT use near open flame or excessive heat. the flash point is 100-38°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts in dry cleaning solvent.
- (2) Inspect parts for damage, cracks, breaks, or deterioration.
- (3) Inspect parts with machined surfaces for deep scratches.
- (4) Remove small nicks or burrs with crocus cloth.
- (5) Coat internal parts with light coating of hydraulic fluid.
- (6) Replace unserviceable parts.

27-4. REAR STEERING GEAR REPAIR (CONT)**c. Assembly**

- (1) Lubricate new quad ring seal (1) with hydraulic oil and install in housing (2).

NOTE

- Do step (2) if bearing was removed.
- Bearing must be pressed in until flush with inside surface of housing.

- (2) Install bearing (3) in housing (2).

NOTE

Do steps (3) thru (12) if seals or actuating shaft were removed.

- (3) Position bearing cap (4) in vise with inside surface up.

CAUTION

Seals must be evenly pressed in bearing cap. Failure to comply may result in damage to seals.

NOTE

- High-pressure seals must be installed by pressing from inside of bearing cap to outside.
- Backup washer must be installed on all steering gears.

- (4) Install new backup washer (4.1) and new high-pressure seal (5) in bearing cap (4) until it rests against shoulder.

- (5) Lubricate high-pressure seal (5) with hydraulic oil.

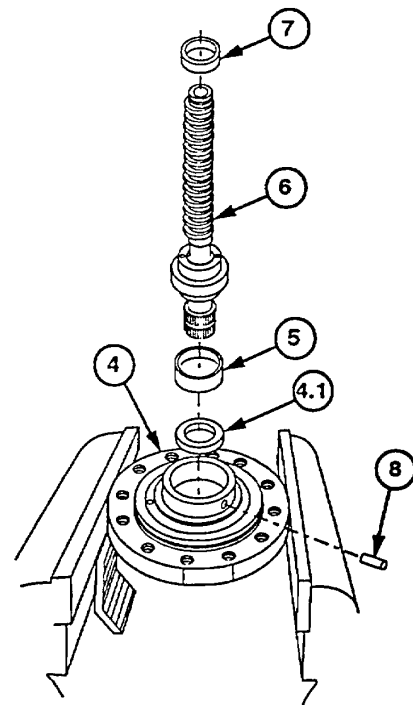
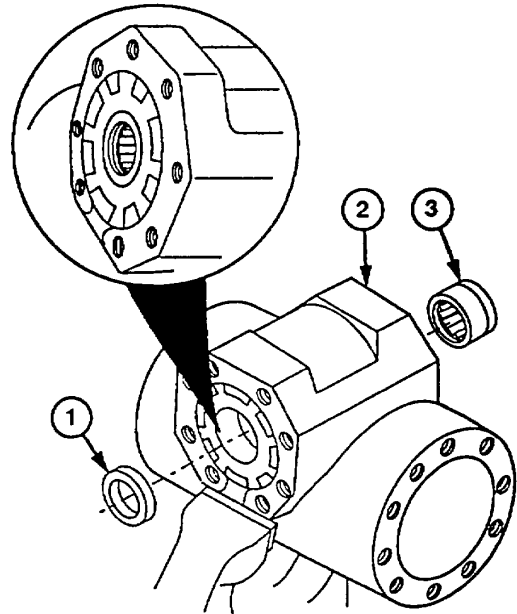
- (6) Press actuating shaft (6) into bearing cap (4).

NOTE

Bearing retainer should be tightened securely to prevent actuating shaft end play.

- (7) Install bearing retainer (7) on bearing cap (4).

- (8) Install new retaining pin (8) in bearing cap (4).

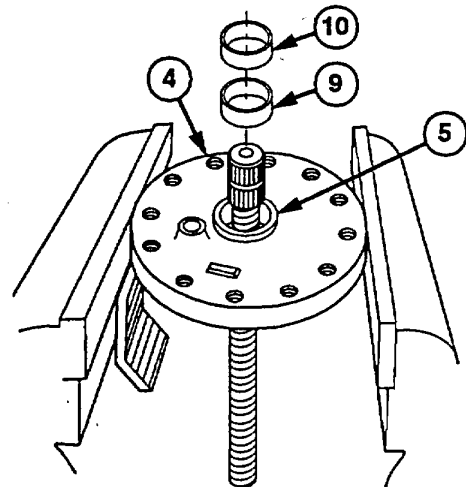


- (9) Position bearing cap (4) in vise with outside surface facing up.

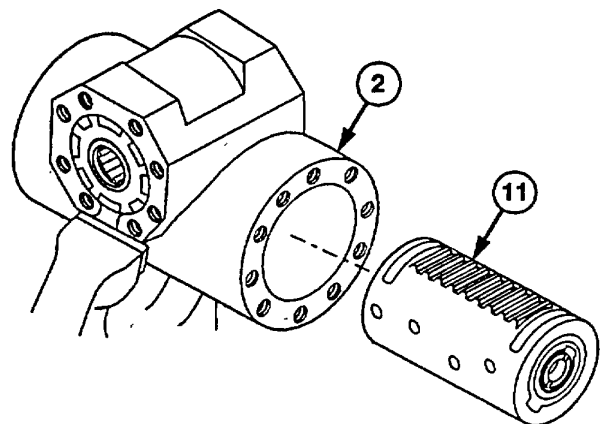
NOTE

Seals are Installed lip-side out.

- (10) Install new seal (9) in bearing cap (4) until it rests against high-pressure seal (5).
- (11) Install new seal (10) in bearing cap (4) until flush with face of bearing cap (4).
- (12) Remove bearing cap (4) from vise.



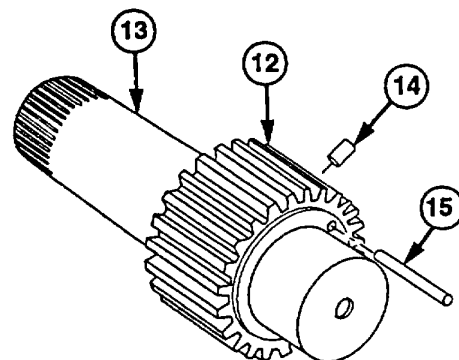
- (13) Lubricate piston (11) with hydraulic oil and install in housing (2).



NOTE

Do steps (14) thru (16) if pinion gear or shaft was removed.

- (14) Position pinion gear (12) on output shaft (13).
- (15) Install retaining pin (14) through hole in pinion gear (12) into slot on output shaft (13).
- (16) Install roll pin (15) in pinion gear (12).

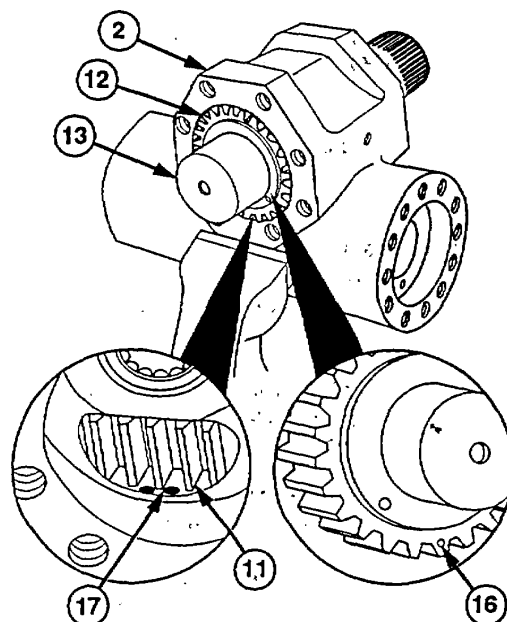


27-4. REAR STEERING GEAR REPAIR (CONT)

WARNING

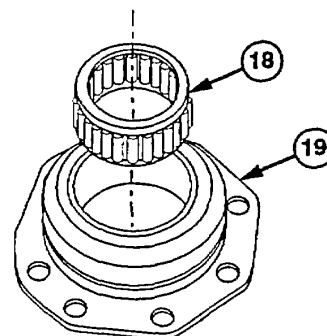
Timing marks on piston and pinion must be properly aligned. Failure to comply will cause steering gear to fall and loss of vehicle control which may cause serious injury or death to personnel.

- (17) Center timing mark (16) on pinion gear (12) between timing marks (17) on piston (11) and install output shaft (13) in housing (2).

**NOTE**

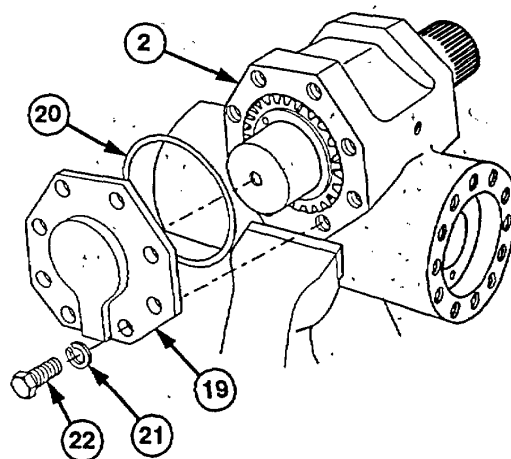
- Do step (18) if bearing was removed during disassembly.
- Bearing must be pressed in until flush with face of cover.

- (18) Install bearing (18) in cover (19).



- (19) Lubricate new preformed packing (20) with hydraulic oil and install on cover (19).

- (20) Install cover (19) on housing (2) with eight new lockwashers (21) and screws (22). Tighten to 170-180 lb-ft (231-244 N•m)



- (21) Lubricate new preformed packing (23) with hydraulic oil and Install on cylinder head (24).
- (22) Align relief valve hole (25) on cylinder head
- (24) with relief valve hole (26) in piston (11).

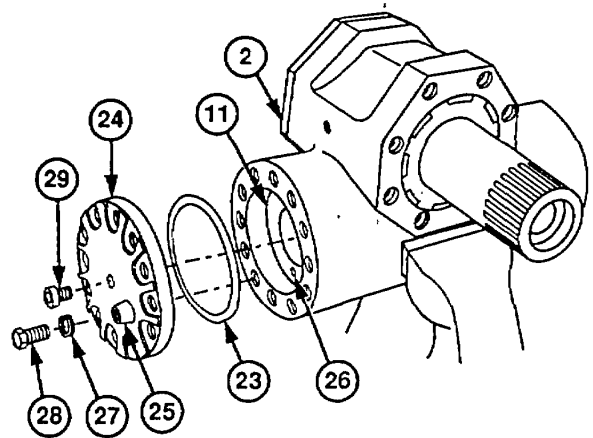
NOTE

Screws for cylinder head are shorter than screws for bearing cap.

- (23) Install cylinder head (24) on housing (2) with 12 new lockwashers (27) and screws (28). Torque to 35-45 lb-ft (48-61 N•m).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

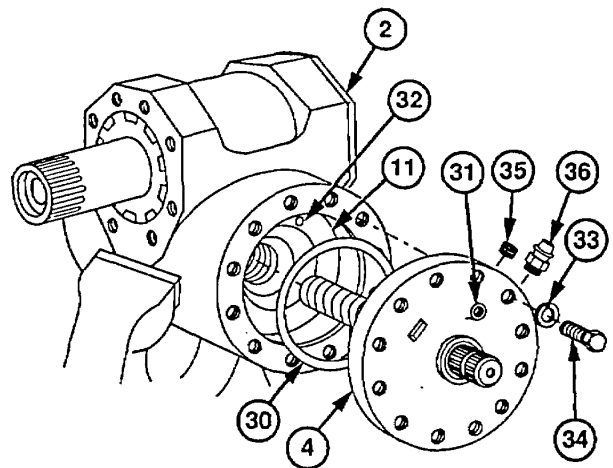


- (24) Coat threads of plug (29) with pipe thread sealing compound.
- (25) Install plug (29) in cylinder head (24).
- (26) Lubricate new preformed packing (30) with hydraulic oil and Install on bearing cap (4).

NOTE

Bearing cap is installed on housing by turning actuating shaft counterclockwise into piston.

- (27) Install bearing cap (4) on housing (2).
- (28) Align relief valve hole (31) in bearing cap (4) with relief valve hole (32) in piston (11).
- (29) Install bearing cap (4) on housing (2) with 12 new lockwashers (33) and screws (34). Tighten to 35-45 lb-ft (47-61 N•m).
- (30) Coat threads of plug (35) with pipe thread sealing compound.
- (31) Install plug (35) in bearing cap (4).
- (32) Install grease fitting (36) in bearing cap (4).



27-4. REAR STEERING GEAR REPAIR (CONT)**NOTE**

Relief valves have different lengths.
Shorter relief valve goes in cylinder head.

- (33) Lubricate new preformed packing (37) with hydraulic oil and install on relief valve (38).

NOTE

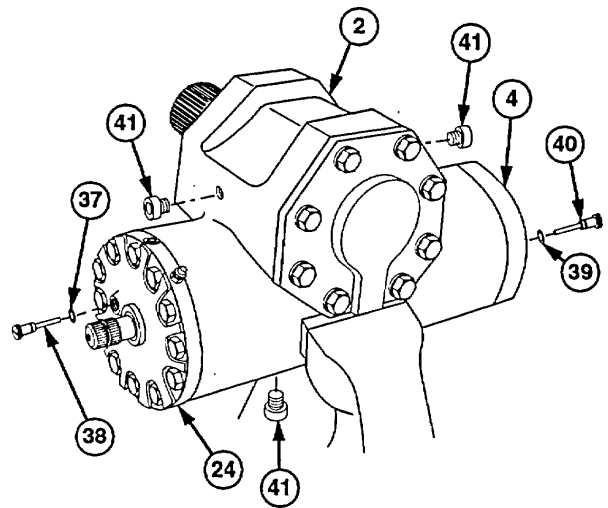
Relief valve must be installed until head is flush with outside face of cylinder head.

- (34) Install relief valve (38) in cylinder head (24).
- (35) Lubricate new preformed packing (39) with hydraulic oil and install on relief valve (40).

NOTE

Relief valve must be installed until head is flush with outside face of bearing cap.

- (36) Install relief valve (40) in bearing cap (4).
- (37) Install three plugs (41) in housing (2).
- (38) Remove housing (2) from vise.



27-5. TEE GEAR BOX REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Tee gear box on clean work surface.

Tools and Special Tools

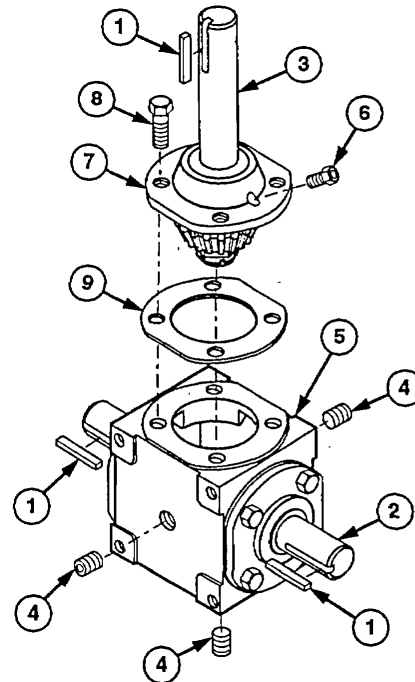
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caps, Vise Jaw (Item 17, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Pan, Drain Oil (Item 102, Appendix E)
 Pliers, Retaining Ring (Item 111, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical, Slide Hammer
 (Item 125, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235, Appendix E)

Materials/Parts

Adhesive-Sealant (Item 6, Appendix B)
 Cloth, Crocus (Item 16, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28, Appendix B)
 Grease, General Purpose, Lithium Base (Item 34, Appendix B),
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Repair Kit, Gear Box (Item 229, Appendix F)

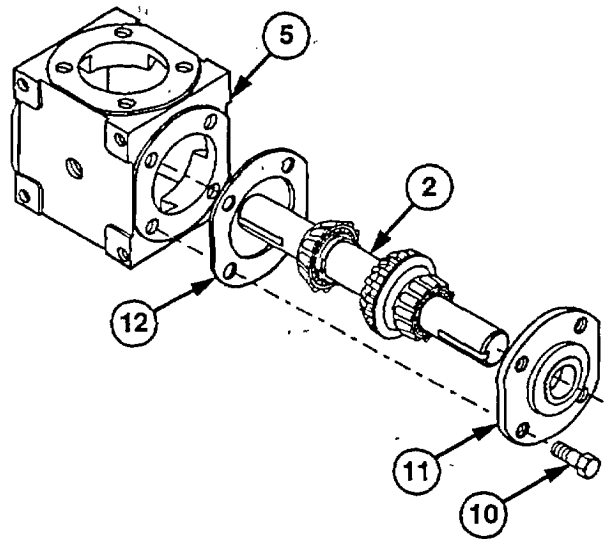
a. Disassembly

- (1) Remove three keys (1) from output shaft (2) and pinion shaft (3).
- (2) Remove three pipe plugs (4) from housing (5).
- (3) Remove vent (6) from pinion end plate (7).
- (4) Remove four screws (8), pinion end plate (7), gasket (9), and pinion shaft (3) from housing (5). Discard gasket.

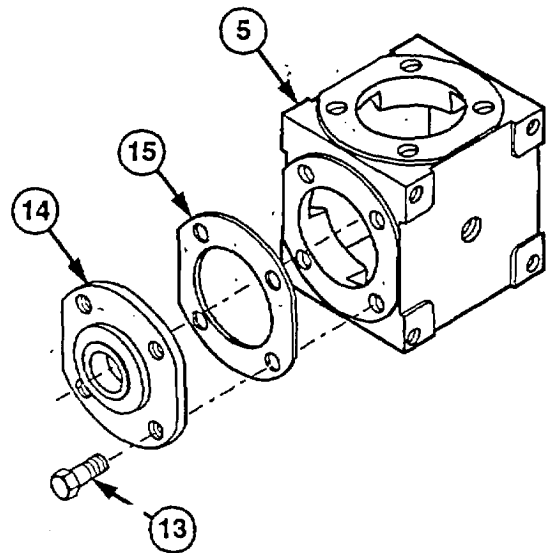


27-5. TEE GEAR BOX REPAIR (CONT)

- (5) Remove four screws (10), front output end plate (11), gasket (12), and output shaft (2) from housing (5). Discard gasket
- (6) Remove front output end plate (11) from output shaft (2).



- (7) Remove four screws (13), rear output end plate (14), and gasket (15) from housing (5). Discard gasket

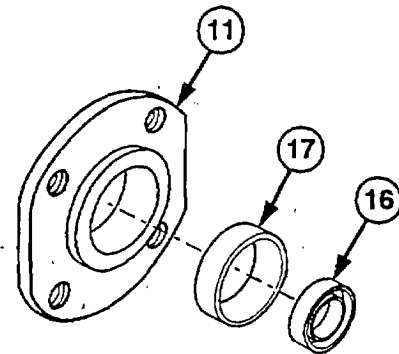


- (8) Remove oil seal (16) from front output end plate (11). Discard oil seal.
- (9) Position front output end plate (11) in vise outside surface up.

NOTE

Bearing cups and cones are matched sets. They should be kept together.

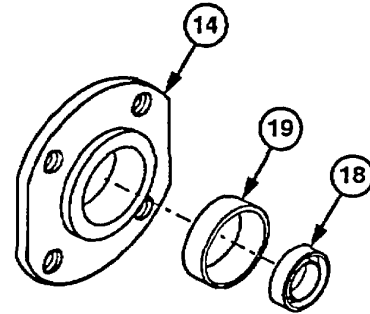
- (10) Remove bearing cup (17) from front output end plate (11).
- (11) Remove front output end plate (11) from vise.



- (12) Remove oil seal (18) from rear output end plate (14). Discard oil seal.
- (13) Position rear output end plate (14) in vise outside surface up.
- (14) Remove bearing cup (19) from rear output end plate (14).
- (15) Remove rear output end plate (14) from vise.

NOTE

Some tee boxes have machined shoulder on shaft and no retaining rings. Skip steps (16) and (19) if no retaining rings are present on shaft.

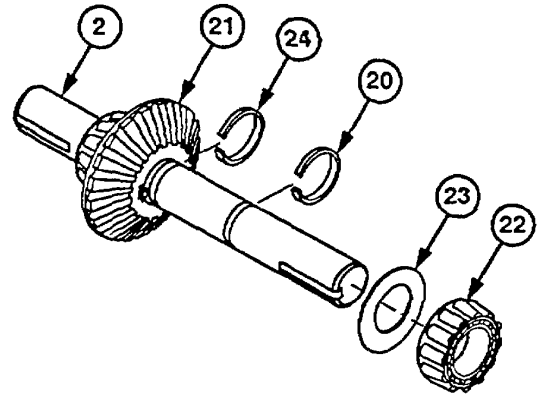


- (16) Remove retaining ring (20) from locking position and slide toward gear (21) on output shaft (2).
- (17) Position output shaft (2) gear side down in suitable press.

CAUTION

Protect shaft from striking floor while pressing bearing and spacer. Failure to comply may result in damage to output shaft.

- (18) Press bearing (22) and spacer (23) from output shaft (2).

**WARNING**

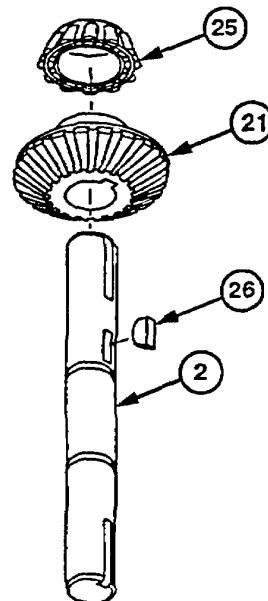
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (19) Remove two retaining rings (20 and 24) from output shaft (2). Discard retaining rings.
- (20) Position output shaft (2) gear side up in suitable press.

CAUTION

Protect shaft from striking floor while pressing bearing and gear. Failure to comply may result in damage to output shaft.

- (21) Press bearing (25) and gear (21) from output shaft (2).
- (22) Remove woodruff key (26) from output shaft (2).



27-5. TEE GEAR BOX REPAIR (CONT)

- (23) Remove locknut (27) from pinion shaft (3). Discard locknut.

- (24) Position pinion shaft (3) gear side up in suitable press.

CAUTION

Protect shaft from striking floor while pressing gear from shaft. Failure to comply may result in damage to shaft.

- (25) Press pinion gear (28) from pinion shaft (3).

- (26) Remove woodruff key (29) from pinion shaft (3).

- (27) Position pinion end plate (7) with pinion shaft (3) threaded end up in suitable press.

CAUTION

Protect shaft from striking floor while pressing from pinion end plate. Failure to comply may result in damage to pinion shaft.

- (28) Press pinion shaft (3), bearing cone (30), and oil seal (31) from pinion end plate (7). Discard oil seal.

- (29) Position pinion shaft (3) threaded end up in suitable press.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

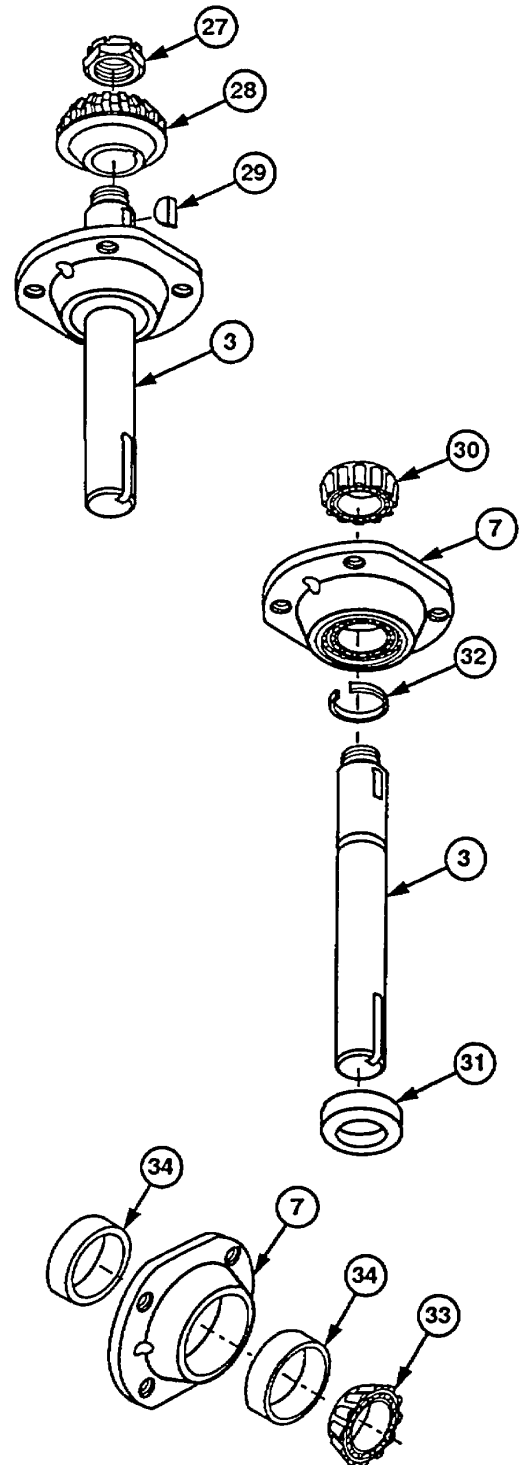
NOTE

Some tee boxes have machined shoulder on shaft and no retaining rings. Skip steps (30) if no retaining ring is present on shaft.

- (30) Remove retaining ring (32) from pinion shaft (3). Discard retaining ring.

- (31) Press outer bearing cone (30) from pinion shaft (3).

- (32) Remove inner bearing cone (33) and two bearing cups (34) from pinion end plate (7).



b. Cleaning/inspection

- (1) Remove remaining lithium grease from housing.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated area. Avoid contact with skin, eyes, and clothing, and don't breath vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

CAUTION

Do not wash machined parts together to avoid damage from parts bumping together.

- (2) Wash metal parts in dry cleaning solvent.
- (3) Clean sealant residue from threaded holes with dry cleaning solvent.

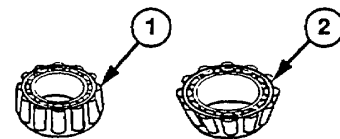
CAUTION

Dirt and foreign material in steering system will cause damage and steering problems.

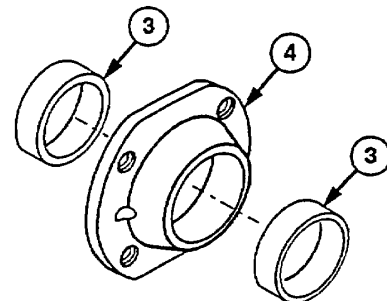
- (4) Clean old gasket material from housing and/or plates
- (5) Inspect parts for damage, cracks, breaks, or deterioration.
- (6) Inspect parts with machined surfaces for deep scratches.
- (7) Remove small nicks or burrs with crocus cloth.
- (8) Coat internal parts with light coating of lithium grease.
- (9) Replace unserviceable parts.

c. Assembly

- (1) Coat two bearing cones (1 and 2) with grease.



- (2) Install two bearing cups (3) in pinion end plate (4).



27-5. TEE GEAR BOX REPAIR (CONT)**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Skip step (3) if shaft has machined shoulder instead of retaining ring.

- (3) Install new retaining ring (5) on pinion shaft (6).
- (4) Position outer bearing cone (1) small side down on suitable press.
- (5) Press pinion shaft (6) threaded end down into outer bearing cone (1).

NOTE

Support inner bearing cone on press.

- (6) Position inner bearing cone (2) and pinion end plate (4) inner side down on suitable press.
- (7) Press pinion shaft (6) threaded end down into pinion end plate (4) and inner bearing cone (2).
- (8) Install woodruff key (7) in pinion shaft (6).
- (9) Position pinion gear (8) toothed side down on press.

CAUTION

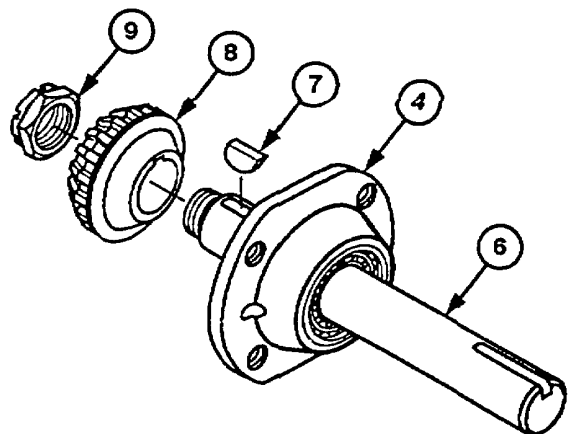
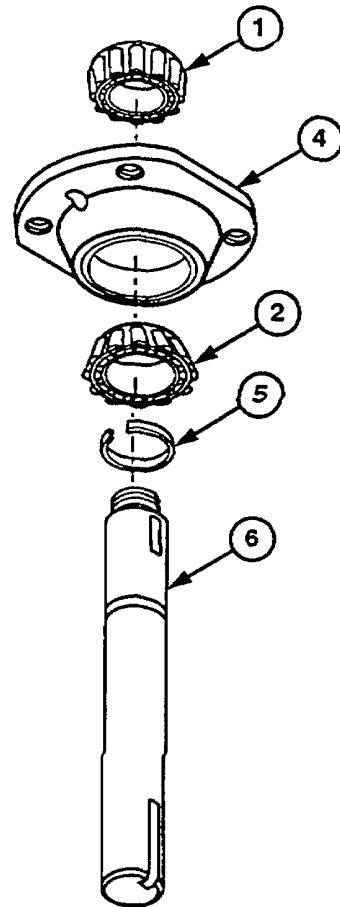
Do not bottom out pinion end plate on inner bearing cup when installing. Failure to comply may result in improper bearing adjustment.

- (10) Align slot in gear (8) with woodruff key (7) and press pinion shaft (6) into gear (8).
- (11) Position pinion shaft (6) in soft-jawed vise.

NOTE

When properly adjusted, pinion end plate should rotate freely on shaft, with no noticeable end play.

- (12) Install locknut (9) on pinion shaft (6).
- (13) Remove pinion shaft (6) from vise.



- (14) Position pinion end plate (4) in vise.

NOTE

Sharply striking end of pinion shaft and locknut with rubber mallet will enable bearings to rotate freely with no end play.

- (15) Strike end of pinion shaft (6) and locknut (9).
(16) Remove pinion end plate (4) from vise.

CAUTION

Seal must be evenly pressed in end plate. Failure to comply may result in damage to seal.

- (17) Install new oil seal (10) on pinion shaft (6) and pinion end plate (4).

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

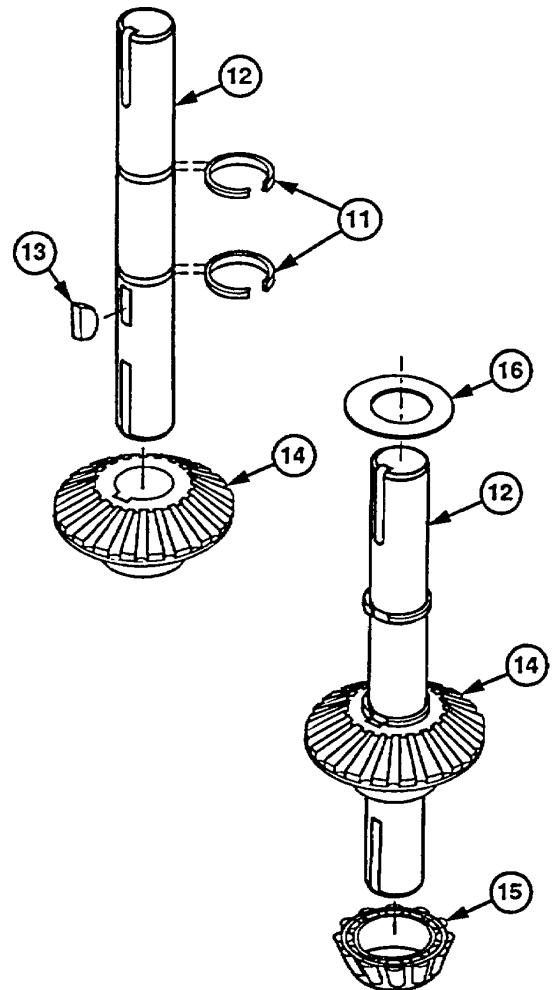
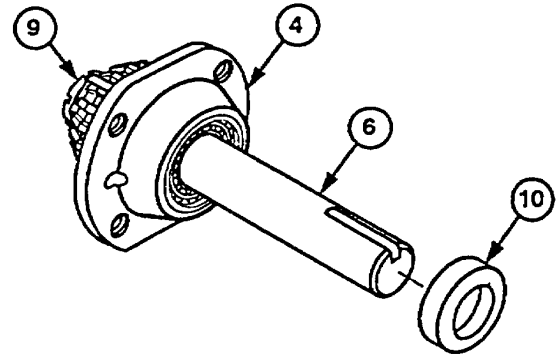
Skip step (18) if shaft has machined shoulder instead of retaining ring.

- (18) Install two new retaining rings (11) on output shaft (12).
(19) Install woodruff key (13) on output shaft (12).
(20) Position gear (14) toothed side up on suitable press.
(21) Align slot in gear (14) with woodruff key (13) and install output shaft (12) in gear (14).
(22) Position bearing cone (15) small side down on press.

NOTE

Bearing cone must be pressed on output shaft until it contacts gear.

- (23) Press output shaft (12) into bearing cone (15).
(24) Install spacer (16) on output shaft (12).



27-5. TEE GEAR BOX REPAIR (CONT)**NOTE**

Bearing cone should be positioned with small side down.

- (25) Position bearing cone (17) small side down on press.

NOTE

Bearing cone must be pressed on output shaft until it contacts spacer and retaining ring.

- (26) Press output shaft (12) into bearing cone (17).
- (27) Install bearing cup (18) in rear output end plate (19).

CAUTION

Seal must be evenly pressed in end plate. Failure to comply may result in damage to seal.

- (28) Install new oil seal (20) in rear output end plate (19).
- (29) Install bearing cup (21) in front output end plate (22).
- (30) Install new oil seal (23) in front output end plate (22).
- (31) Coat two bearing cones (15 and 17) and bearing cups (18 and 21) with grease.

WARNING

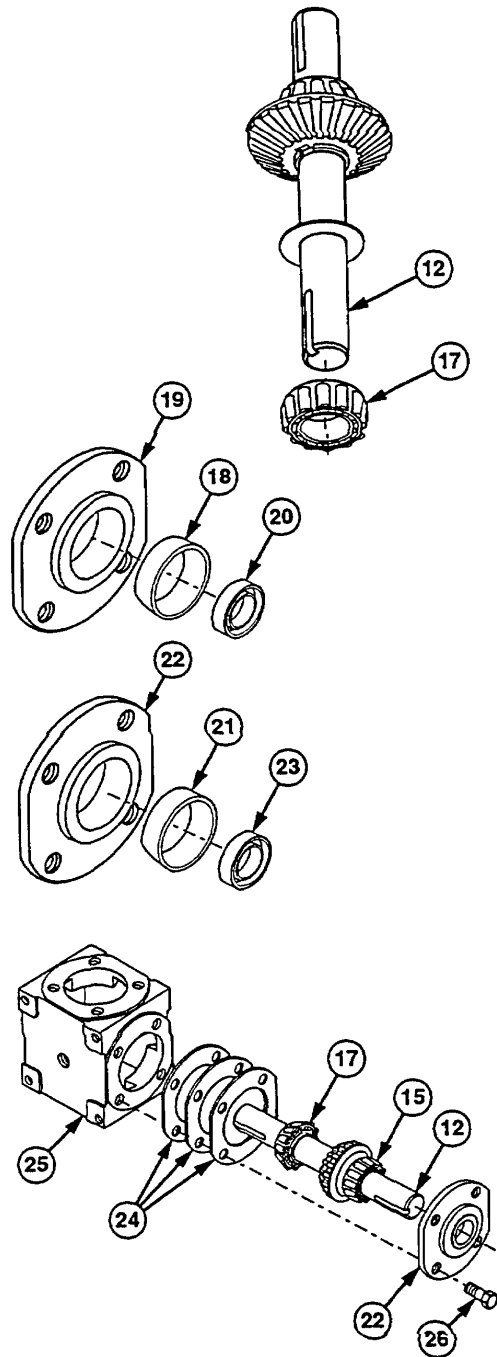
Output end plates will fit either end of housing. Output end plates and output shaft must be installed correctly. Failure to comply will cause steering gear to operate backwards, which may cause serious injury or death.

- (32) Install three new gaskets (24) and front output end plate (22) on housing (25) with four screws (26).

CAUTION

Gear end must be installed first. Failure to comply will result in backward gear operation.

- (33) Install output shaft (12) gear end first in housing (25).



- (34) Install three new gaskets (24) and rear output end plate (19) on housing (25) with four screws (27).

NOTE

Bearings are adjusted by removing gaskets until bearings bind, then adding one gasket at a time until shaft rotates freely with no end play. Number of gaskets on each end should not vary from other end by more than one.

- (35) Remove gaskets (24), one at a time, from front output end plate (22) and rear output end plate (19) until bearing cones (15 and 17) just bind when turning output shaft (12) by hand.
- (36) Add gaskets (24), one at a time, to front output end plate (22) then rear output end plate (19) until output shaft (12) rotates freely with no end play.

NOTE

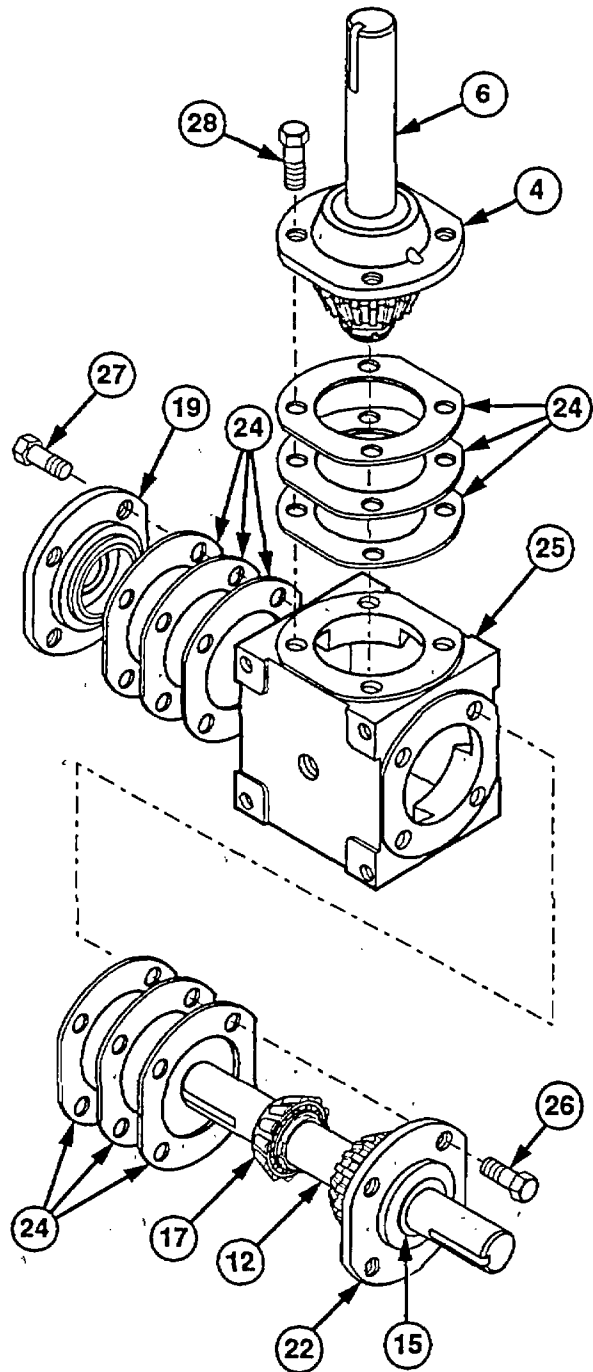
All keyways should face the mounting side of Tee box when properly assembled. Gear teeth should mesh as parts are assembled.

- (37) Align keyways in output shaft (12) and pinion shaft (6) and Install three new gaskets (24) and pinion end plate (4) on housing (25) with four screws (28).
- (38) Move gaskets (24), one at a time, from front output end plate (22) to rear output end plate (19) until pinion shaft (6) and output shaft (12) rotate freely with no backlash.

NOTE

To properly adjust backlash, two gaskets must be moved from front output end plate to rear output end plate. If there are not enough gaskets at rear output end plate to move to front output end plate, further gear adjustment must be made by removing two gaskets from between pinion end plate and housing and repeating steps (32) through (38).

- (39) Move two gaskets (24) from rear output end plate (19) to front output end plate (22).



27-5. TEE GEAR BOX REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid Injury or death, keep away from open fire and use in well-ventilated areas. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

NOTE

Remove and install each end plate screw separately to ensure gear adjustment.

- (40) Remove four screws (26 and 27) separately from end plates (19 and 22) and housing (25); coat threads with adhesive-sealant and install. Torque to 17 lb-ft (23 N•m).

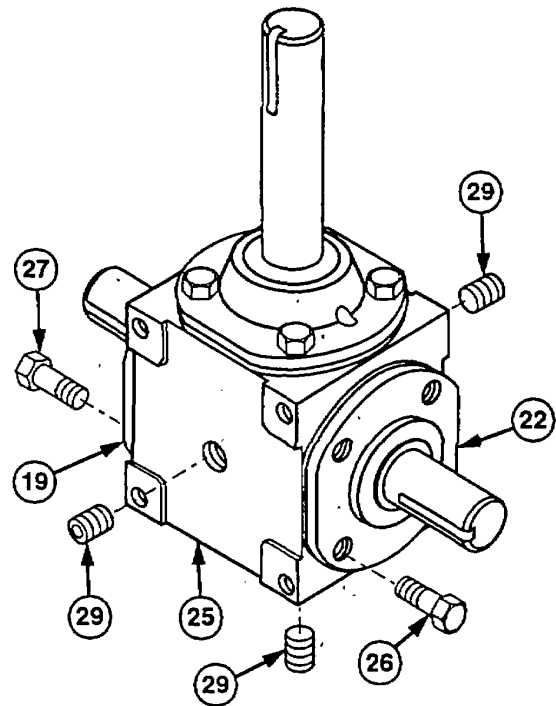
WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

CAUTION

Use pipe thread sealing compound sparingly, only on pipe threads. Do not apply compound at hose connections. Failure to comply may result in component damage.

- (41) Coat threads of three plugs (29) with pipe thread sealing compound.
- (42) Install three plugs (29) in housing (25).



- (43) Remove four screws (28), pinion end plate (4), and three gaskets (24) from housing (25).

NOTE

Two-thirds is approximately 0.25 in. (6 mm) above shaft.

- (44) Fill housing (25) two-thirds full with lithium grease.

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (45) Coat threads of four screws (28) with adhesive-sealant.

NOTE

All keyways should face mounting side of tee box when properly assembled. Gear teeth should mesh as parts are assembled.

- (46) Align keyways in output shaft (12) and pinion shaft (6) and install three new gaskets (24) and pinion end plate (4) on housing (25) with four screws (28).

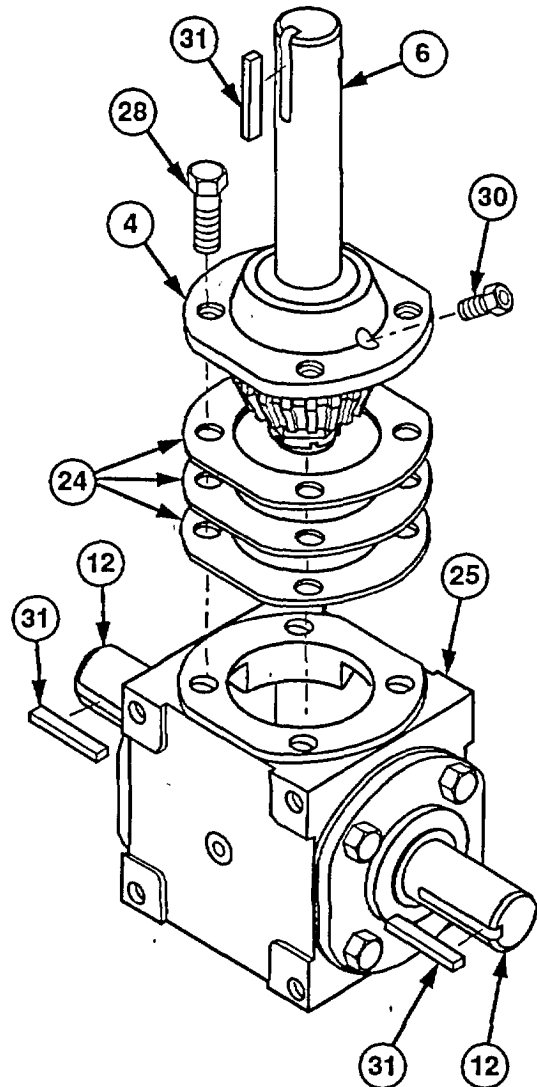
WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well ventilated areas. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

CAUTION

Use pipe thread sealing compound sparingly, only on pipe threads. Do not apply compound at hose connections. Failure to comply may result in component damage.

- (47) Coat threads of vent (30) with pipe thread sealing compound and install in pinion end plate (4).
- (48) Install three keys (31) on output shaft (12) and pinion shaft (6).



27-6. GEAR REDUCER REPAIR

This task covers:

a. Disassembly	c. Assembly
b. Cleaning/Inspection	d. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Gear reducer removed (TM 9-2320-360-20).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Pan, Oil Drain (Item 102, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical (Item 124, Appendix E)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Tags, Identification (Item 56, Appendix B)
 Repair Kit (Item 228.1, Appendix F)

Materials/Parts

Adhesive-Sealant (Item 3, Appendix B)
 Adhesive-Sealant (Item 6, Appendix B)
 Adhesive-Sealant, Permatex No. 1
 (Item 9, Appendix B)
 Cloth, Crocus (Item 16, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28,
 Appendix B)

a. Disassembly

NOTE

Tag and mark housing before disassembly.

- (1) Position drain pan under gear reducer (1).

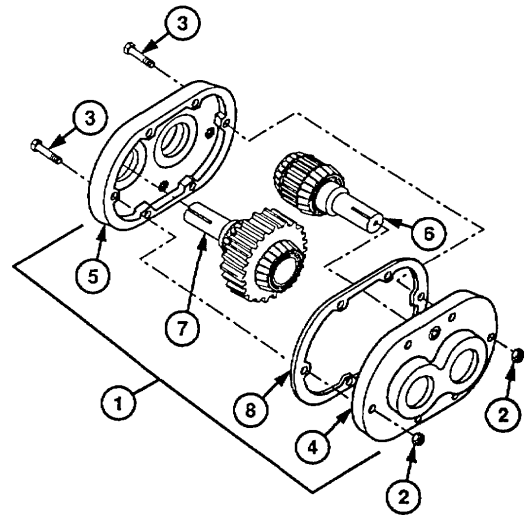
CAUTION

During separation of housing, do not allow gears to fall. Damage to equipment may result.

NOTE

Output housing has three pipe plugs,
 Input housing has one pipe plug.

- (2) Remove two nuts (2), screws (3), and input housing (4) from output housing (5).
- (3) Remove input shaft (6) from input housing (4).
- (4) Remove output shaft (7) from output housing (5).
- (5) Remove gasket(s) (8) from housing (4 or 5). Discard gasket(s).



- (6) Remove plug (9) from input housing (4).
- (7) Remove three plugs (10) from output housing (5).

NOTE

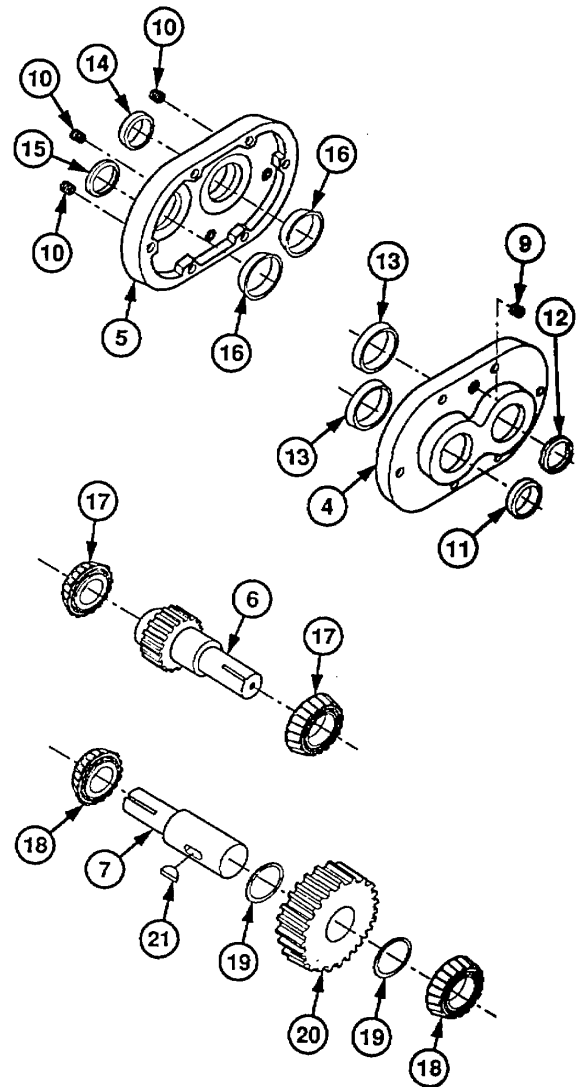
Mark location of oil seal and plug before removing to aid in installation.

- (8) Remove plug (11), oil seal (12) and two bearing cups (13) from input housing (4). Discard oil seal.
- (9) Remove plug (14), oil seal (15), and two bearing cups (16) from output housing (5). Discard oil seal.
- (10) Remove two bearing cones (17) from input shaft (6).
- (11) Remove two bearing cones (18) and shims (19) from output shaft (7).
- (12) Position output shaft (7), gear (20) side up, in suitable press.

CAUTION

Protect output shaft from striking floor while pressing from gear. Failure to comply may result in damage to output shaft.

- (13) Press output shaft (7) from gear (20).
- (14) Remove key (21) from output shaft (7).



b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use solvent only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If solvent contacts eyes, wash eyes with water and get medical aid immediately.

- (1) Clean metal parts in dry cleaning solvent.

27-6. GEAR REDUCER REPAIR (CONT)**WARNING**

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

CAUTION

Bearing cones must be air dried or damage to bearing cone will result.

- (2) Dry parts, except bearing cones, with compressed air.
- (3) Clean old gasket material from housing.
- (4) Inspect parts for damage. Replace nonserviceable damaged parts. Remove all burrs with crocus cloth.

c. Assembly

- (1) Install key (1) on output shaft (2).
- (2) Position gear (3) on press.

CAUTION

Gears must be centered over key when installed or damage to equipment may result.

- (3) Align slot on gear (3) with key (1) and press output shaft (2) into gear (3).
- (4) Position bearing cone (4) small side down on press.
- (5) Install shim (5) on output shaft (2).

NOTE

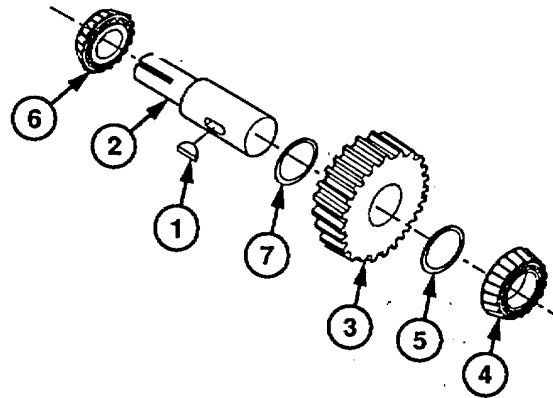
Bearing cone must be pressed on output shaft until it contacts gear.

- (6) Press output shaft (2) into bearing cone (4).
- (7) Position bearing cone (6) small side down on press.
- (8) Install shim (7) on output shaft (2).

NOTE

Bearing cone must be pressed on output shaft until it contacts gear.

- (9) Press output shaft (2) into bearing cone (6).

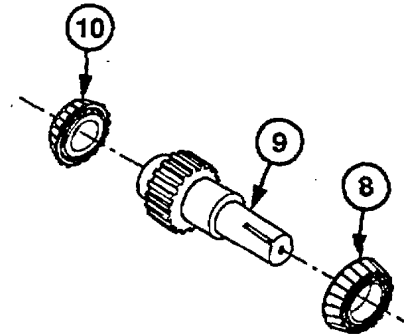


- (10) Position bearing cone (8) small side down on press.

NOTE

Bearing cone must be pressed on output shaft until it contacts gear.

- (11) Press input shaft (9) into bearing cone (8).
 (12) Position bearing cone (10) small side down on press.



NOTE

Bearing cone must be pressed on output shaft until it contacts gear.

- (13) Press input shaft (9) into bearing cone (10).

WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

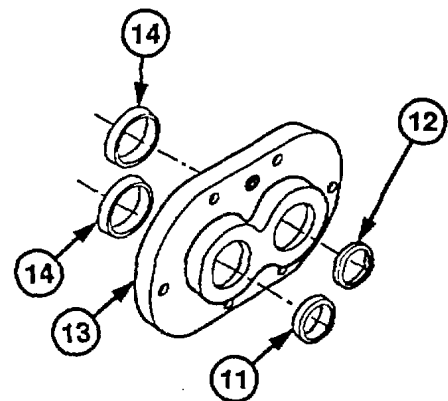
CAUTION

Oil seal must be evenly pressed into housing. Failure to comply may result in damage to oil seal.

NOTE

Plug and oil seal must be installed in places marked during removal.

- (14) Coat plug (11) with adhesive-sealant (Item 9, Appendix B).
 (15) Install plug (11) and new oil seal (12) in input housing (13).
 (16) Install two bearing cups (14) in input housing (13).



27-6. GEAR REDUCER REPAIR (CONT)**WARNING**

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

CAUTION

Oil seal must be evenly pressed into housing. Failure to comply may result in damage to oil seal.

NOTE

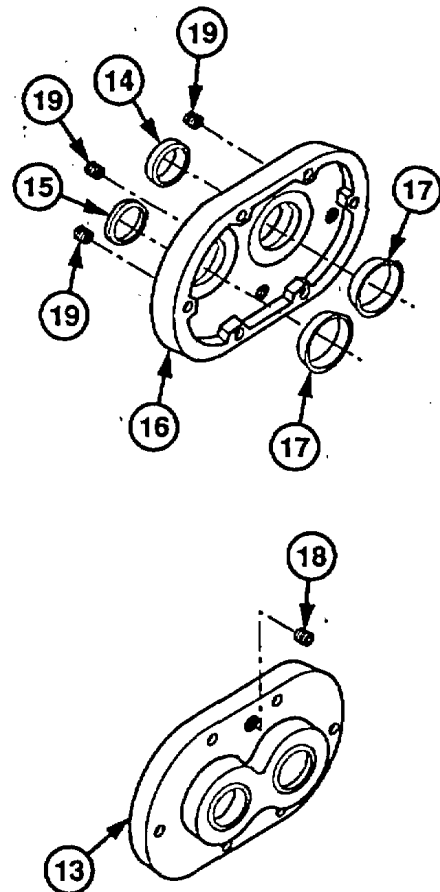
Plug and oil seal must be installed in places marked during removal.

- (17) Coat plug (14) with adhesive-sealant (Item 9, Appendix B).
- (18) Install plug (14) and new oil seal (15) in output housing (16).
- (19) Install two bearing cups (17) in output housing (16).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated areas. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (20) Coat threads of plug (18) and three plugs (19) with pipe thread sealing compound.
- (21) Install plug (18) in input housing (13).
- (22) Install three plugs (19) in output housing (16).



- (23) Install input shaft (9) in input housing (13).
- (24) Install output shaft (2) in output housing (16).
- (25) Install four new gaskets (20) and input housing (13) on output housing (16) with two screws (21) and nuts (22).

NOTE

Bearings are adjusted by removing gaskets until bearings bind, then adding one gasket at a time until shafts rotate freely and with no end play.

- (26) Remove gaskets (20), one at a time, from housings (13 and 16) until bearing cones just bind.
- (27) Install gaskets (20), one at a time, on housings (13 and 16) until shafts (2 and 9) rotate freely with no end play.
- (28) Remove two nuts (22) and separate housings (13 and 16).

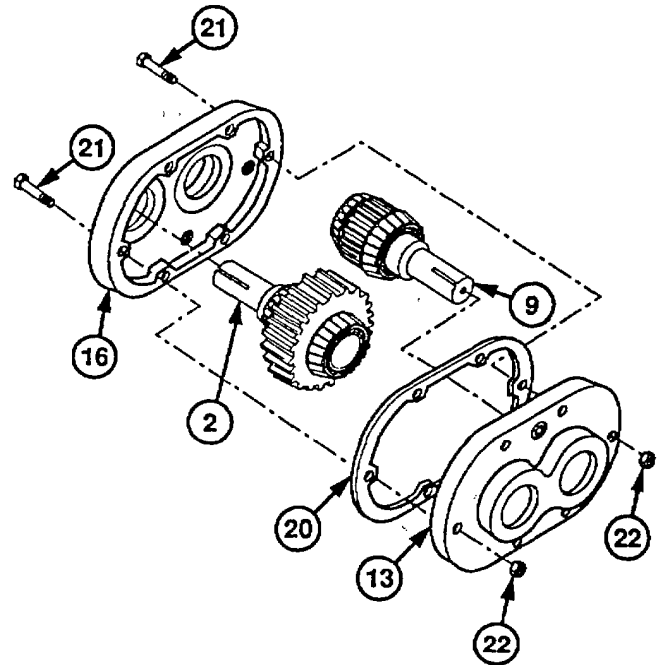
WARNING

Adhesive-sealant can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (29) Coat gaskets (20) and housings (13 and 16) with adhesive-sealant (Item 3, Appendix B).
- (30) Coat threads of screws (21) with adhesive-sealant (Item 6, Appendix B).
- (31) Assemble gaskets (20) and housings (13 and 16) with two nuts (22).

d. Follow-On Maintenance

Fill gear reducer with oil (LO 9-2320-360-12)



CHAPTER 28
WINCHES MAINTENANCE

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28-1. INTRODUCTION

This chapter contains instructions for repair of winch components at the General Support maintenance level.

28-2. WINCH REPAIR

This task covers:

a. Disassembly	c. Assembly
b. Cleaning/Inspection	d. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Winch drained of lubricant
(TM 9-2320-360-20).

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Press, Hydraulic (Item 116, Appendix E)
Pliers, Retaining Ring (Item 107, Appendix E)
Rods, Threaded (2) (Figure C-14, Appendix C)
Screws, Guide (2) (Figure C-4, Appendix C)
Sling Assemblies (2) (Item 160, Appendix E)
Sling, Endless Strap (Item 161, Appendix E)
Wrench, Torque, 0-300 Lb-in. (Item 235, Appendix E)
Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

Materials/Parts

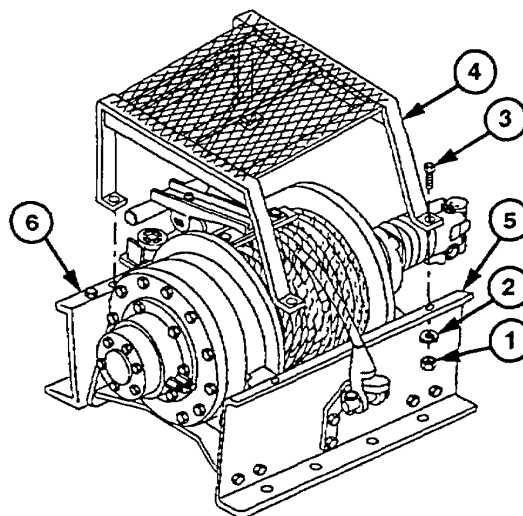
Adhesive-Sealant, Silicone (Item 2, Appendix B)
Adhesive-Sealant (Item 10.1, Appendix B)
Compound Sealing, Pipe Thread (Item 28, Appendix B)
Oil, Lubricating (Item 41, Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Brake Seal Kit (item 297, Appendix F)
Locknuts (2) (Item 93, Appendix F)
Lockwashers (31) (Item 120, Appendix F)
Lockwashers (18) (Item 124, Appendix F)
Lockwashers (6) (Item 121, Appendix F)
Lockwashers (2) (Item 122, Appendix F)
Lockwashers (2) (item 129, Appendix F)
Lockwashers (2) (Item 130, Appendix F)
Service Kit, Winch (Item 231, Appendix F)

Personnel Required

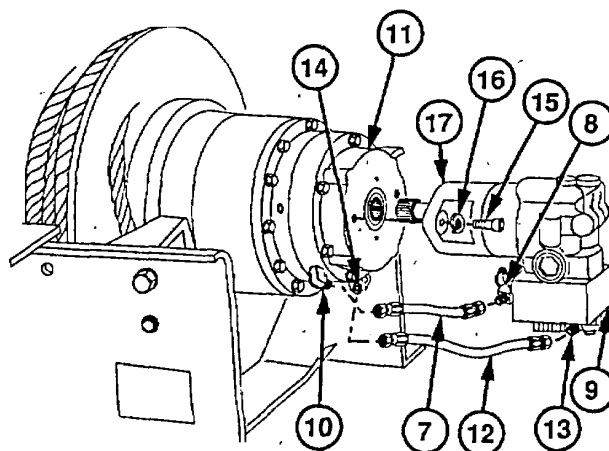
Two

a. Disassembly

- (1) Remove four nuts (1), lockwashers (2), screws (3), and cable guard (4) from winch side supports (5 and 6). Discard lockwashers.



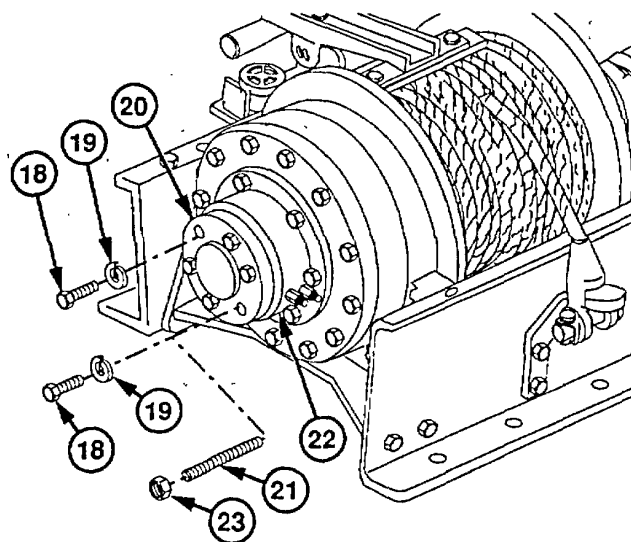
- (2) Remove hose (7) from fitting (8) on valve solenoid (9).
- (3) Remove hose (7) from elbow (10) on brake housing (11).
- (4) Remove hose (12) from elbow (13) on valve solenoid (9).
- (5) Remove hose (12) from elbow (14) on brake housing (11).
- (6) Remove two screws (15), lockwashers (16), and drive motor (17) from brake housing (11). Discard lockwashers.



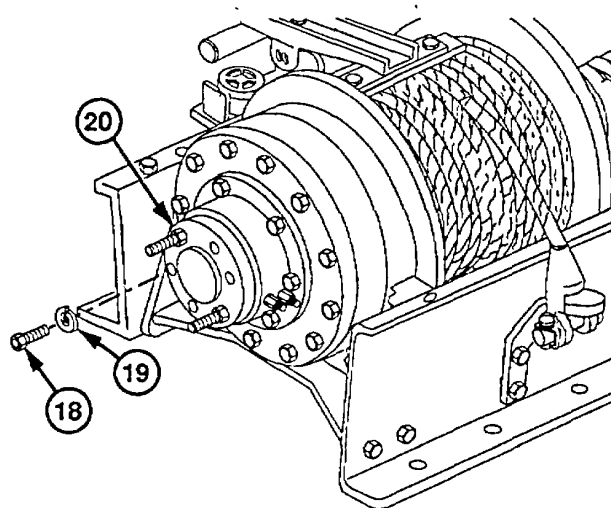
NOTE

Right and left sides are disassembled the same way. Left side is shown.

- (7) Remove two opposite screws (18) and lockwashers (19) from clutch end cover (20). Discard lockwashers.
- (8) Install two threaded rods (21) in clutch end cover (20) and clutch adapter (22).
- (9) Install two nuts (23) on threaded rods (21). Tighten nuts until they contact clutch end cover (20).



- (10) Remove four remaining screws (18) and lockwashers (19) from clutch end cover (20). Discard lockwashers.



28-2. WINCH REPAIR (CONT)**WARNING**

Clutch end cover is under spring pressure. Loosen nuts slowly and evenly until spring brace is relieved. Failure to do so may cause injury to personnel.

- (11) Loosen two nuts (23) on threaded rods (21) and remove clutch end cover (20) from clutch adapter (22).
- (12) Remove two nuts (23) and clutch end cover (20) from two threaded rods (21).
- (13) Remove two threaded rods (21) from clutch adapter (22).
- (14) Remove preformed packing (24) from clutch end cover (20). Discard preformed packing.
- (15) Remove spring (25) from clutch adapter (22).

NOTE

Bearing may stay on shaft or in clutch end cover.

- (16) Remove bearing (26) from shaft (27).
- (17) Remove thrust ring (28) from clutch drive gear (29).

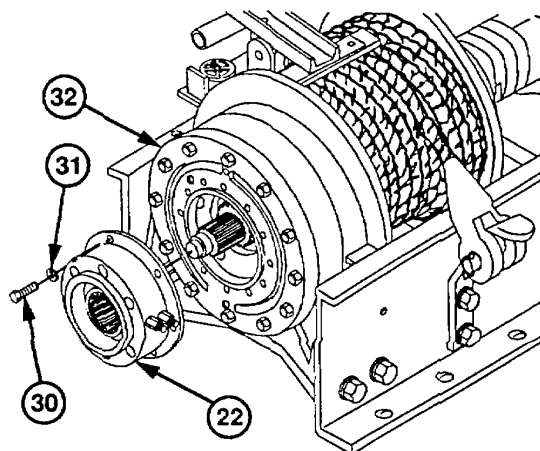
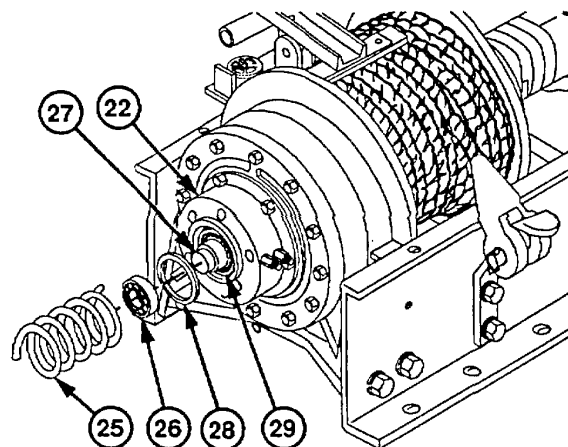
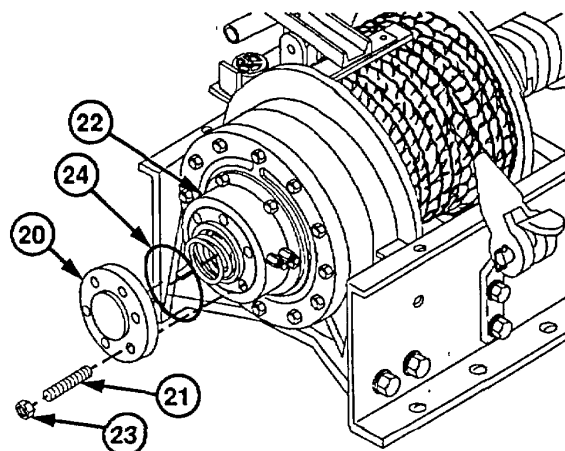
WARNING

Clutch drive gear and piston may separate from clutch adapter causing injury to personnel.

NOTE

Location of air fittings on clutch adapter should be marked on planetary adapter cover before removal.

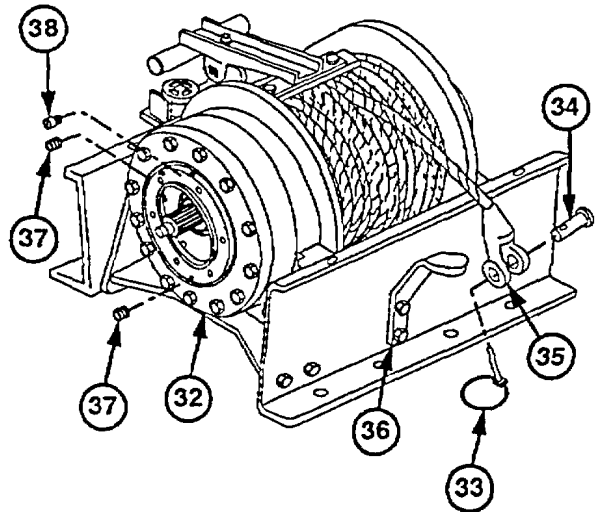
- (18) Remove six screws (30), lockwashers (31), and clutch adapter (22) from planetary adapter cover (32). Discard lockwashers.



NOTE

- Tension on cable must be released if clutch drive gear is stuck on input shaft.
- Do steps (19) thru (21) if clutch drive gear is stuck on input shaft.

- (19) Remove pin (33) from pin (34).
- (20) Remove pin (34) from cable clevis (35).
- (21) Remove cable clevis (35) from cable clamp (36).
- (22) Remove two plugs (37) and vent (38) from planetary adapter cover (32).

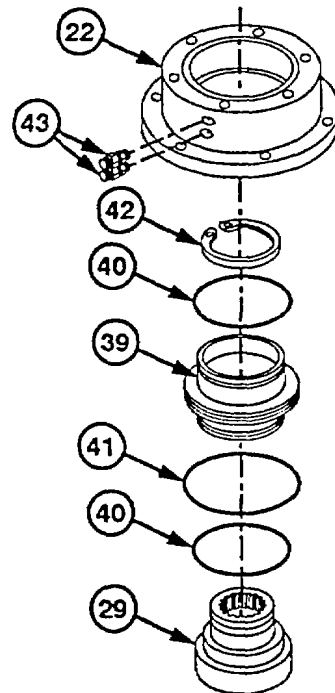


- (23) Remove piston (39) with clutch drive gear (29) from clutch adapter (22).
- (24) Remove two preformed packings (40) and preformed packing (41) from piston (39). Discard preformed packings.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (25) Remove retaining ring (42) from clutch drive gear (29). Discard retaining ring.
- (26) Remove piston (39) from clutch drive gear (29).
- (27) Remove two tube fittings (43) from clutch adapter (22).



28-2. WINCH REPAIR (CONT)

- (28) Loosen 12 screws (44) on planetary adapter cover (32).
- (29) Remove two screws (44) and lockwashers (45) at the 6 and 12 o'clock positions from planetary adapter cover (32). Discard lockwashers.
- (30) Install two guide screws (46) through planetary adapter cover (32) and ring gear (47) and into gear end support (48).

WARNING

Support planetary adapter cover to prevent personnel injury.

- (31) Remove 10 remaining screws (44) and lockwashers (45) from planetary adapter cover (32). Discard lockwashers.
- (32) Slide planetary adapter cover (32) off guide screws (46) and remove from ring gear (47).

WARNING

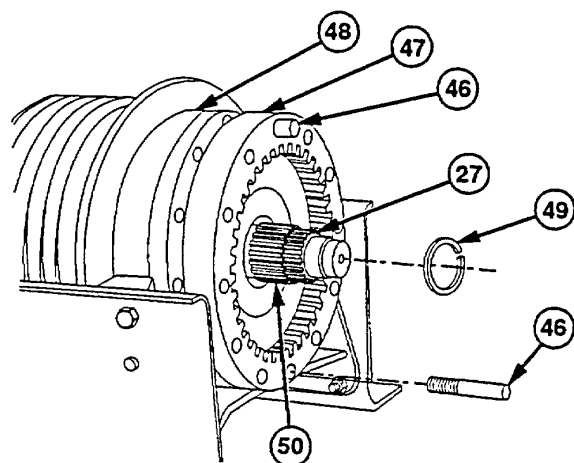
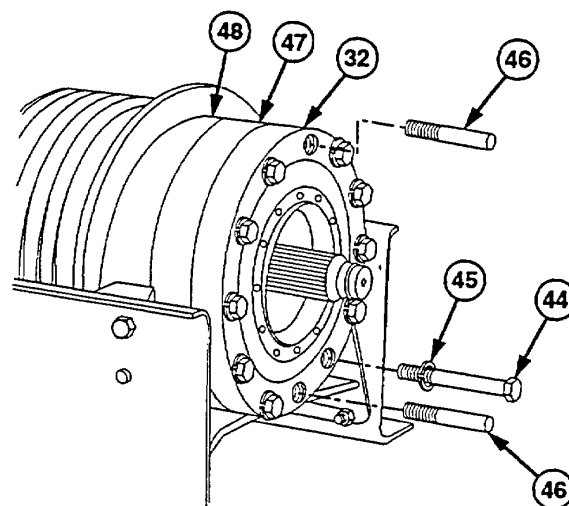
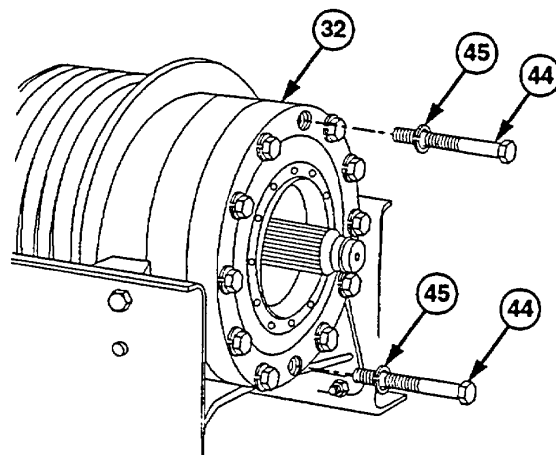
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (33) Remove retaining ring (49) and clutch sun gear (50) from input shaft (27). Discard retaining ring.
- (34) Remove two guide screws (46) from ring gear (47) and gear end support (48).

WARNING

Ring gear weighs approximately 62 lb (28 kg). Keep out from under ring gear. Failure to comply may result in serious injury or death to personnel.

- (35) Remove ring gear (47) from gear end support (48).



NOTE

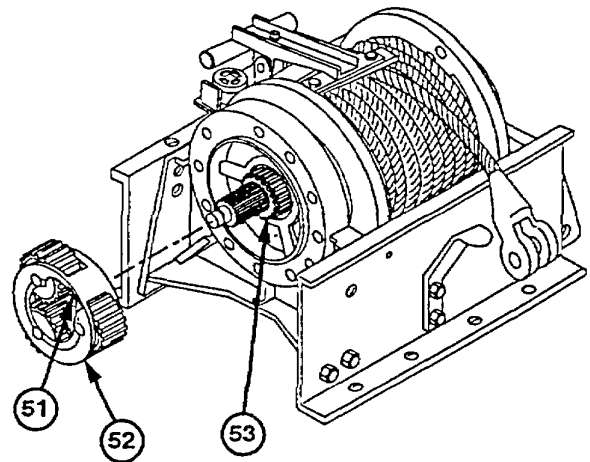
Retaining ring is held captive inside planetary carrier.

- (36) Expand retaining ring (51) enough to disengage planetary carrier (52) from end of output shaft (53).

WARNING

Planetary carrier weighs approximately 100 lb (45 kg). Keep out from under planetary carrier. Failure to comply may result in serious injury or death to personnel.

- (37) Remove planetary carrier (52) from end of output shaft (53) with aid of assistant.

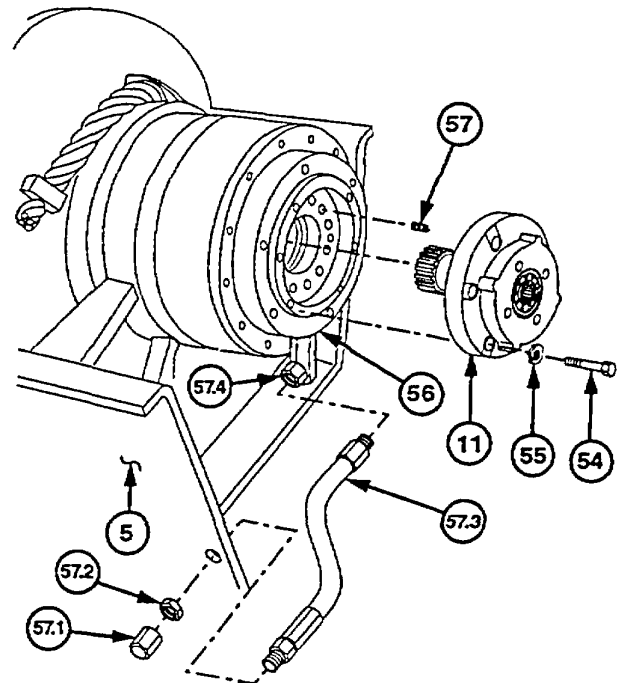
**WARNING**

Outer brake housing is under 3500 lb (1589 kg) of spring pressure. Loosen six screws slowly and evenly until spring force is relieved. Failure to comply may result in serious injury to personnel.

NOTE

Steps (38) thru (66) are performed on motor end of winch.

- (38) Remove six screws (54), lockwashers (55) and brake housing (11) from brake adapter (56). Discard lockwashers.
- (39) Remove 12 compression springs (57) from brake adapter (56).
- (39.1) Remove drain cap (57.1), nut (57.2), and hose (57.3) from side support (5).
- (39.2) Remove hose (57.3) from elbow (57.4).



28-2. WINCH REPAIR (CONT)**NOTE**

Sun gear may stay in carrier in brake adapter.

- (40) Remove sun gear (58) from brake shaft (59).

NOTE

Brake shaft may have to be tapped out of brake piston.

- (41) Remove brake shaft (59) from brake piston (60).
 (42) Remove bearing (61) from brake shaft (59).

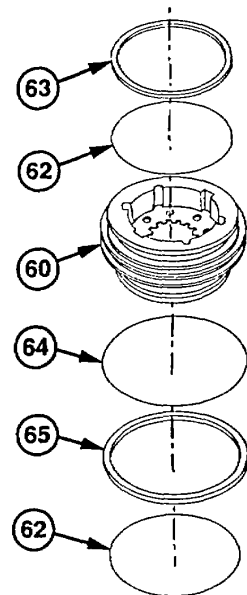
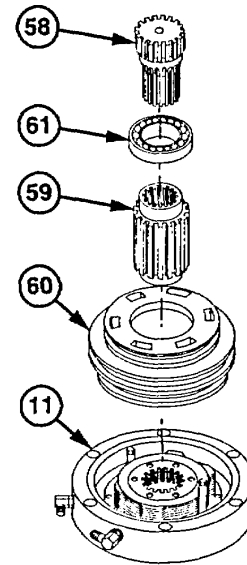
CAUTION

Carefully pry brake piston from brake housing. Failure to comply may result in damage to brake piston.

NOTE

Place brake housing assembly on work surface, piston side up.

- (43) Remove brake piston (60) from brake housing (11).



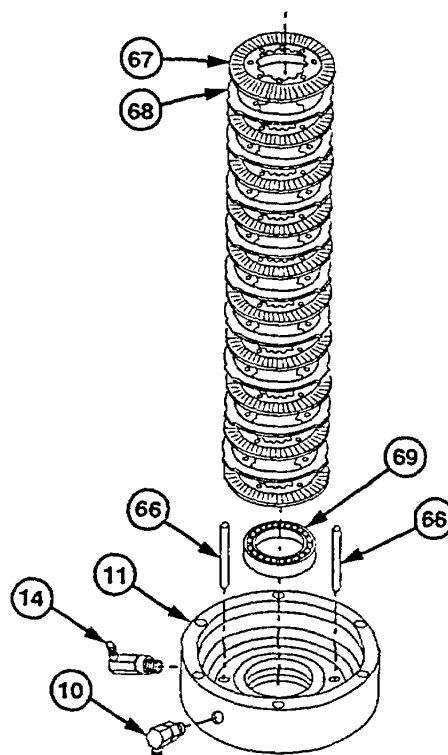
- (44) Remove two preformed packings (62) and backup ring (63) from brake piston (60). Discard preformed packings.
 (45) Remove preformed packing (64) and backup ring (65) from brake piston (60). Discard preformed packing.

- (46) Remove two dowel pins (66) from brake housing (11).

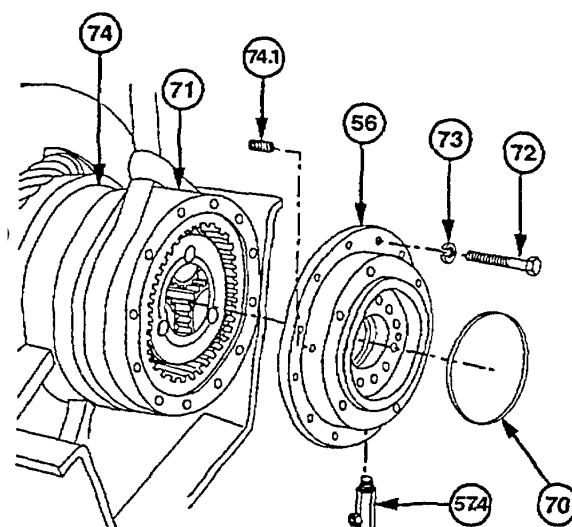
NOTE

Mark order of plates to aid in assembly.

- (47) Remove 10 friction disk plates (67) and 9 drive plates (68) from brake housing (11).
- (48) Remove bearing (69) from brake housing (11).
- (49) Remove two elbows (10 and 14) from brake housing (11).



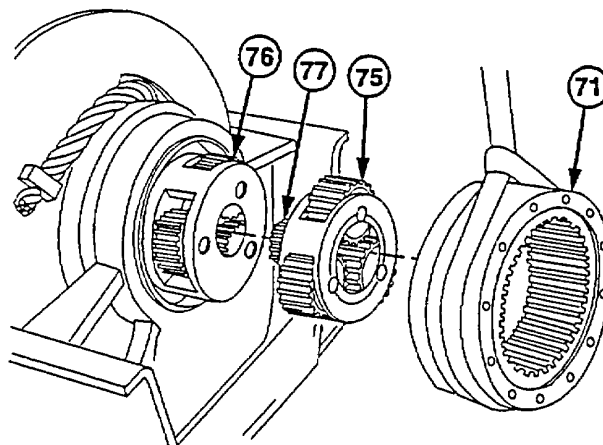
- (50) Remove preformed packing (70) from brake adapter (56). Discard preformed packing.
- (51) Attach suitable lifting device to ring gear (71) for support.
- (52) Remove 12 screws (72) and lockwashers (73) from brake adapter (56), ring gear (71), and motor end support (74). Discard lockwashers.
- (53) Remove brake adapter (56) from ring gear (71).
- (53.1) Remove elbow (57.4) from brake adapter (5.6).
- (53.2) Remove plug (74.1) from brake adapter (56).



28-2. WINCH REPAIR (CONT)**WARNING**

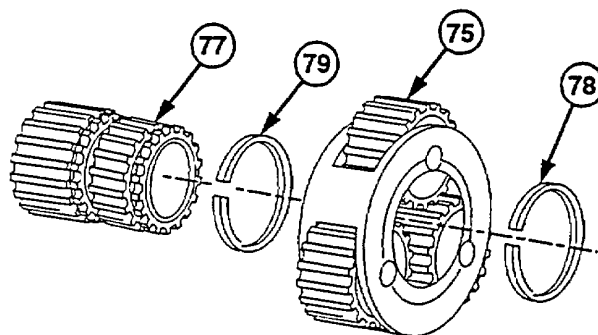
Ring gear weighs approximately 62 lb (28 kg). Keep out from under ring gear. Failure to comply may result in serious injury or death to personnel.

- (54) Place hand on planetary carrier (75) to keep in place. Remove ring gear (71) from planetary carriers (75 and 76).
- (55) Remove planetary carrier (75) and sun gear (77) from planetary carrier (76).

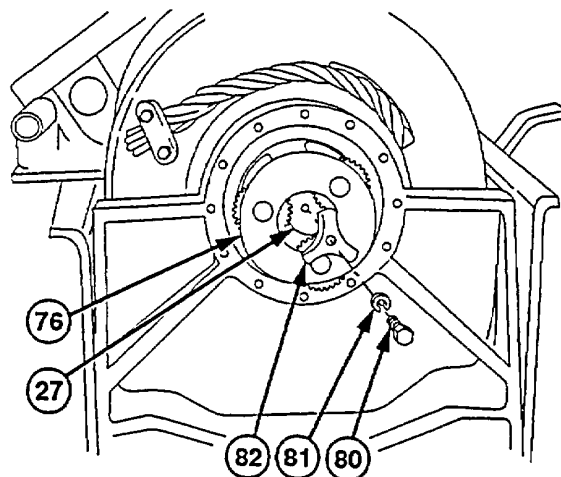
**WARNING**

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

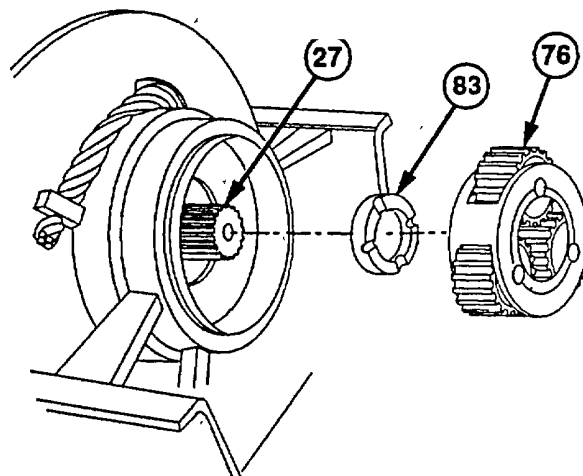
- (56) Remove retaining ring (78) from sun gear (77). Discard retaining ring.
- (57) Remove sun gear (77) from planetary carrier (75).
- (58) Remove retaining ring (79) from sun gear (77). Discard retaining ring.



- (59) Remove screw (80), lockwasher (81), and retainer plate (82) from planetary carrier (76) and input shaft (27). Discard lockwasher.



- (60) Remove planetary carrier (76) from input shaft (27).
- (61) Remove bronze thrust bearing (83) from input shaft (27).



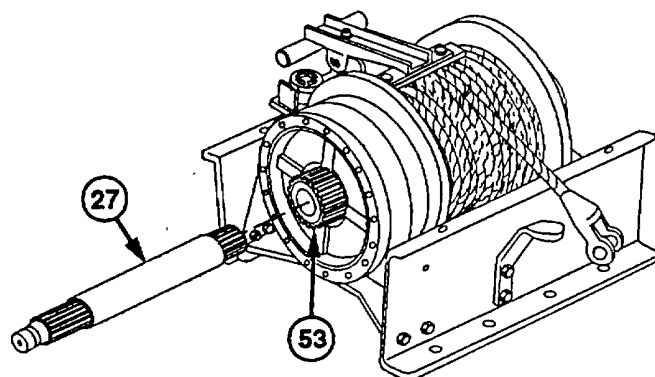
- (62) Remove Input shaft (27) from output shaft (53).

WARNING

Always wear heavy gloves when handling winch cable. Never let cable run through hands. Frayed cable can cut hands severely.

NOTE

If cable is still on winch drum, do steps (63) thru (65).

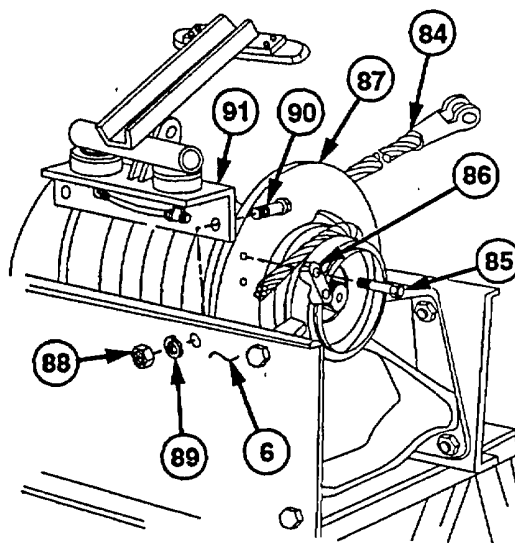


- (63) Wind out winch cable (84).
- (64) Remove two screws (85) and clamp (86) from winch drum (87).

WARNING

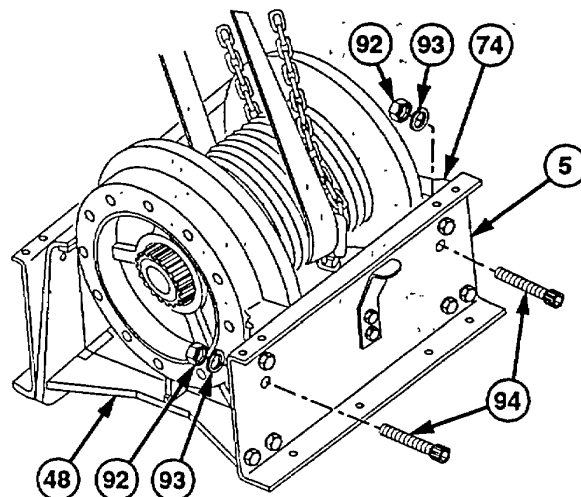
Use care when removing cable from drum. End of cable can spring up causing injury to personnel.

- (65) Remove winch cable (84) from winch drum (87).
- (66) Remove two nuts (88), lockwashers (89), screw (90), and cable hold down assembly (91) from winch side support (6). Discard lockwashers.



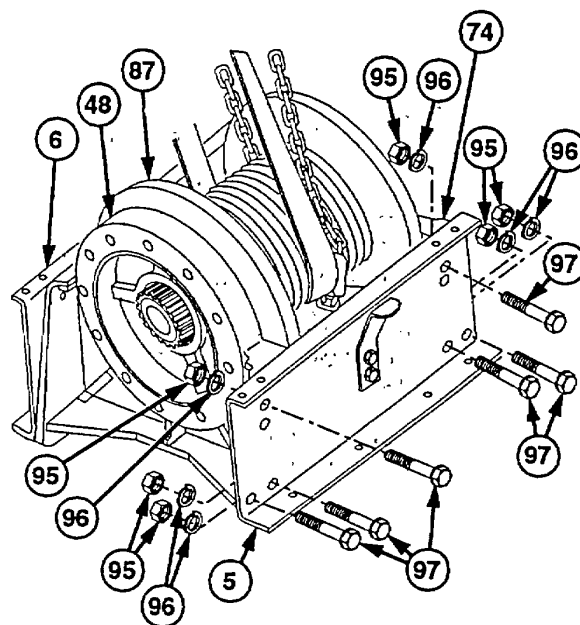
28-2. WINCH REPAIR (CONT)

- (67) Remove two nuts (92), lockwashers (93), and screws (94) from winch side support (5) and end supports (48 and 74). Discard lockwashers.

**WARNING**

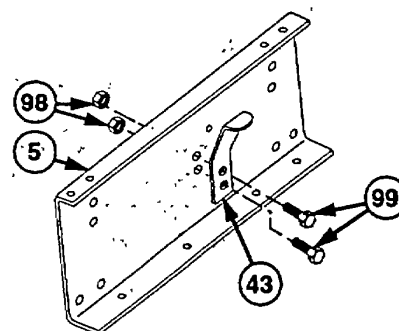
Winch drum weighs 450 lb (204 kg). Keep out from under winch drum. Failure to comply may result in injury or death to personnel.

- (68) Attach suitable lifting device to winch drum (87) and end supports (48 and 74).
- (69) Remove six nuts (95), lockwashers (96), and screws (97) from winch side support (5) and end supports (48 and 74). Discard lockwashers.
- (70) Remove side support (5) from end supports (48 and 74).
- (71) Repeat steps (67), (69), and (70) for remaining side support (6).

**NOTE**

Right and left side winch cable clamps are removed the same way. Left side is shown.

- (72) Remove two locknuts (98), screws (99), and cable clamp (43) from side support (5). Discard locknuts.



- (73) Support winch drum (87) with wooden blocks.
- (74) Attach lifting device to gear end support (48).

WARNING

Gear end support weighs 125 lb (57 kg). Keep out from under gear end support. Failure to comply may result in injury or death to personnel.

- (75) Remove gear end support (48) from output shaft (53) using lifting device.
- (76) Remove seal ring (100) from gear end support (48). Discard seal ring.

NOTE

Do step (77) if bushings fail inspection.

- (77) Press bronze bushing (101) and bronze bushing (102) from gear end support (48).

WARNING

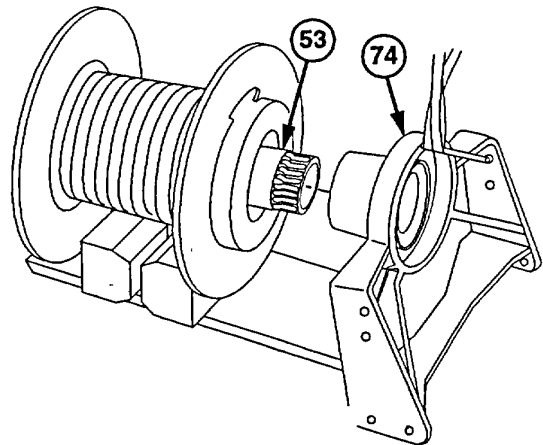
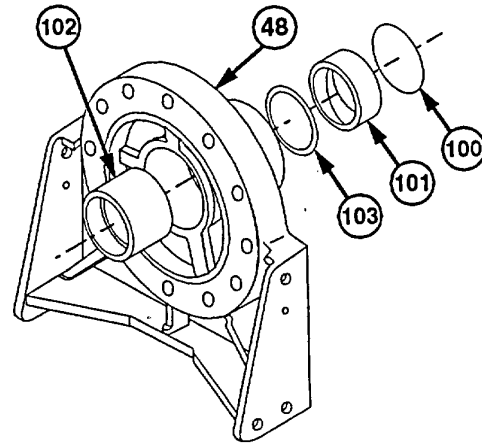
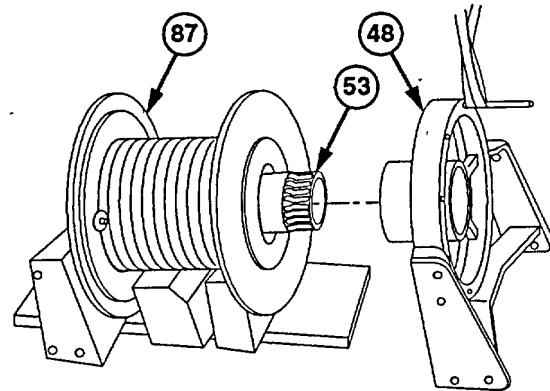
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (78) Remove retaining ring (103) from gear end support (48). Discard retaining ring.
- (79) Attach lifting device to motor end support (74).

WARNING

Motor end support weighs 125 lb (57 kg). Keep out from under motor end support. Failure to comply may result in injury or death to personnel.

- (80) Remove motor end support (74) from output shaft (53) using lifting device.



28-2. WINCH REPAIR (CONT)

- (81) Remove seal ring (104) from motor end support (74). Discard seal ring.

NOTE

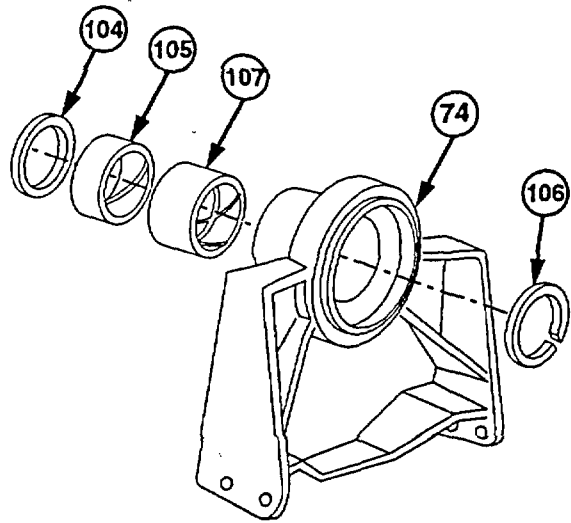
Do steps (82) and (84) if bushings fail inspection.

- (82) Press small bushing (105) from motor end support (74).

WARNING

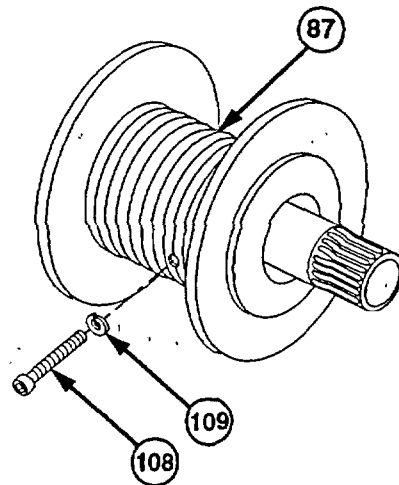
Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (83) Remove retaining ring (106) from motor end support (74). Discard retaining ring.
- (84) Press large bushing (107) from motor end support (74).

**WARNING**

Winch drum weighs 450 lb (204 kg). Keep out from under winch drum. Failure to comply may result in injury or death to personnel.

- (85) Lower winch drum (87) to ground and remove lifting device.
- (86) Remove two screws (108) and lockwashers (109) from winch drum (87). Discard lockwashers.



NOTE

Location of splined end of output shaft is reversed on passenger and driver's side winches. For proper assembly, note which end of drum splines are on.

- (87) Slide output shaft (53) with drum keys (110) out of winch drum (87).

NOTE

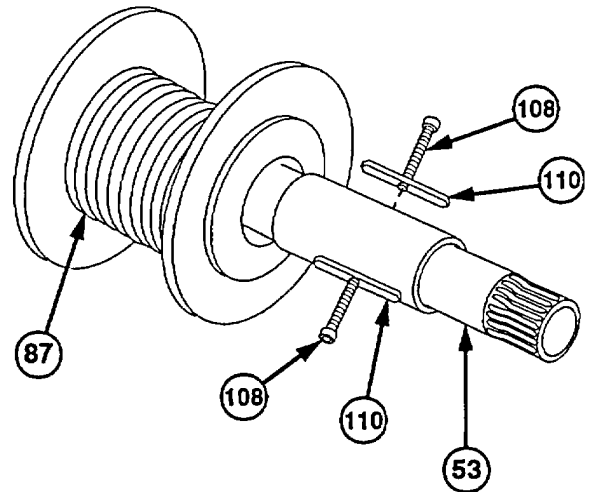
Drum keys are removed using the screws removed in step (86).

- (88) Install two screws (108) into drum keys (110).

NOTE

Turn screws until drum keys are removed.

- (89) Remove drum keys (110) from output shaft (53).

**b. Cleaning/Inspection****WARNING**

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact is made with eyes, wash your eyes with water and get medical aid immediately.

- (1) Clean all parts in dry cleaning solvent.

WARNING

Compressed air for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (2) Dry all parts, except bearings, with compressed air. Allow bearings to air dry.
- (3) Inspect parts for damage. Replace all damaged parts.
- (4) Inspect brake housing and brake adapter seal surfaces for nicks or scratches. Replace if damaged.
- (5) Inspect inner spline of brake shaft for damage. Replace shaft if worn, pitted, spalled, or if flaking exists on more than 3/8 in. (10 mm) of tooth surface. Inspect outer teeth for damage that will not allow drive plates to slip freely.
- (6) Inspect outside diameters of brake piston. Replace only if outside diameters are damaged to affect assembly fit or will not provide support for preformed packings or backup rings.

28-2. WINCH REPAIR (CONT)

- (7) Inspect disk friction plates for broken or damaged sintered bronze faces. Measure thickness of plate. Replace if damaged, warped, bent, or if overall thickness is less than 0.080 in. (2.03 mm).
- (8) Inspect drive plates for bent or warped surface and freedom of movement on brake shaft. Measure thickness of plate. Replace if damaged, warped or if thickness is 0.055 in. (1.40 mm) or less.
- (9) Compress spring to 3/4 in. (19.05 mm) and release. Measure length of spring. Spring must return to 1 in. (25.4 mm) free length. Replace spring if it does not return to 1 in. (25.4 mm) free length.
- (10) Measure thickness of thrust bearing. Replace thrust bearing if pitted or if worn to less than 0.230 in. (5.84 mm).
- (11) Inspect ball bearings and races for damage. Replace galled or pitted races and ball bearings or ball bearings that do not rotate freely in inner and outer races.
- (12) Inspect primary and secondary carrier assembly gear teeth and bearings. Replace assembly if teeth are worn, pitted, or galled or if bearings have failed.
- (13) Inspect sun gear, clutch sun gear, and secondary sun gear for damage. Replace any gear if teeth faces are worn, galled, pitted, or broken or if flaking has occurred on more than 10% of any tooth surface.
- (14) Inspect bronze bearings for damage. Replace if bearing surface is spalled, pitted, or if inner diameter is out of round.
- (15) Inspect ring gears for damage. Replace ring gear if teeth faces are galled, pitted, spalled, or broken or if flaking has occurred on more than 10% of any tooth surface.
- (16) Inspect planetary carrier assembly for damage. Replace assembly if gears will not rotate freely or if teeth faces are worn, galled, pitted, or broken or if flaking has occurred on more than 10% of any tooth surface.
- (17) Inspect output shaft for damage. Replace output shaft if journals for bronze bearings are worn to less than 4.490 in. (114.05 mm) diameter, are galled or scarred enough to damage bearing, or if tooth faces are worn, galled, pitted, or broken over 10% of any tooth surface.
- (18) Inspect relief vent for damage. Replace if spring loaded poppet does not operate freely.
- (19) Inspect input shaft for damage. Replace input shaft if splines are damaged to extent that sun gear will not slide freely or if spline teeth are worn, galled, pitted, broken, or if flaking has occurred on more than 10% of any tooth surface.
- (20) Inspect clutch adapter seal bores for nicks and scratches. Replace if damaged.
- (21) Inspect clutch drive gear spline teeth for galling, pitting, breakage, and flaking over 10% of any tooth surface. Replace if damaged.
- (22) Inspect thrust ring for cracks, pitting, galling, and breakage. Replace if damaged.

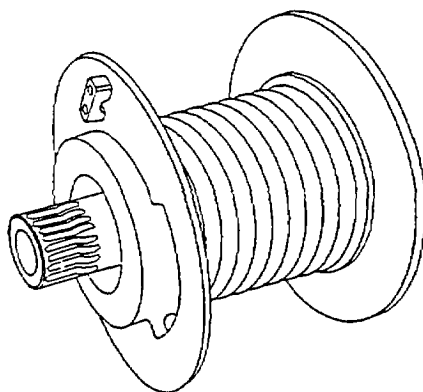
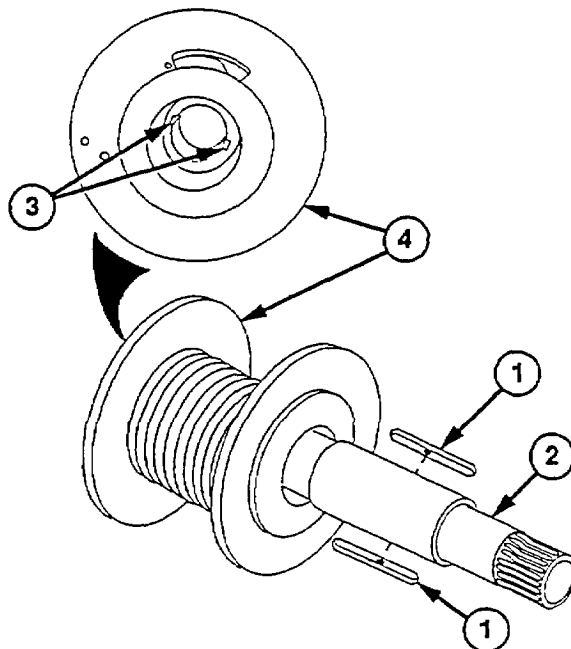
c. Assembly

- (1) Install two keys (1) in keyways on output shaft (2).

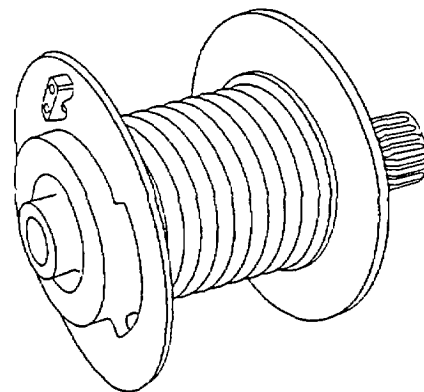
WARNING

Output shaft is installed differently in winch drum depending on whether winch is for passenger or driver's side. For driver's side winch, splined end of output shaft must be on cutout end of winch drum. For passenger's winch, splined end of output shaft must be on end opposite cutout end of winch drum. Failure to comply may result in improper winding of cable and injury to personnel.

- (2) Align keys (1) with keyways (3) in winch drum (4) and install output shaft (2) in drum.



DRIVER'S SIDE WINCH DRUM

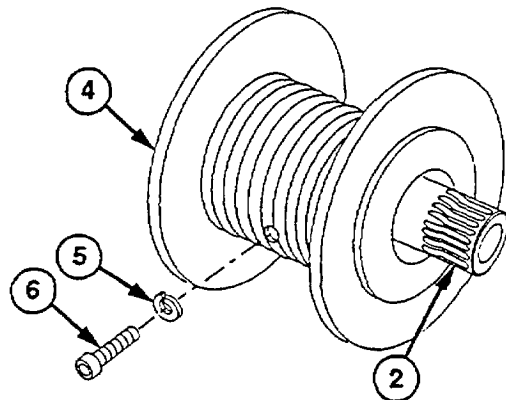


PASSENGER'S SIDE WINCH DRUM

NOTE

Holes in drum must align with holes in output shaft.

- (3) Install two new lockwashers (5) and screws (6) in winch drum (4) and output shaft (2).



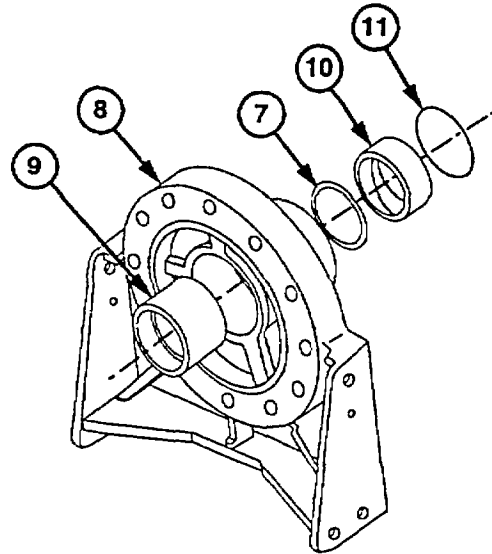
28-2. WINCH REPAIR (CONT)**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Right and left sides are assembled the same way. Left side is shown.

- (4) Install new retaining ring (7) in gear end support (8).

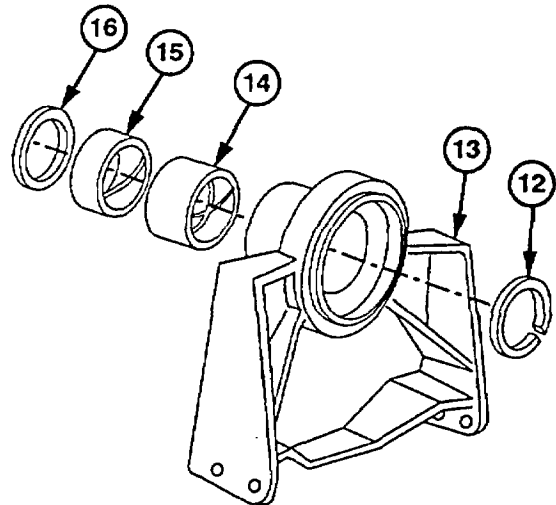
**WARNING**

Adhesive-sealant may burn or give off harmful vapors. It is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

NOTE

Do steps (4.1) thru (6) if bushings failed inspection.

- (4.1) Coat outside face of bushing (9) and bushing (10) with adhesive-sealant (Item 10.1, Appendix B).
 (5) Install large bushing (9) in gear end support (8).
 (6) Install small bushing (10) in gear end support (8).
 (7) Install new seal ring (11) in gear end support (8).
 (8) Install new retaining ring (12) in motor end support (13).

**NOTE**

Do steps (8.1) thru (10) if bushings failed inspection.

- (8.1) Coat outside face of bushing (14) and bushing (15) with adhesive-sealant (Item 10.1, Appendix B).
 (9) Install large bushing (14) in motor end support (13).
 (10) Install small bushing (15) in motor end support (13).
 (11) Install new seal ring (16) in motor end support (13).

WARNING

Winch drum weighs 450 lb (204 kg).
Keep out from under winch drum.
Failure to comply may result in injury
or death to personnel.

- (12) Attach suitable lifting device to winch drum (4).
- (13) Raise winch drum (4) and support on blocks to allow installation of end supports (8 and 13).
- (14) Attach lifting device to gear end support (8).

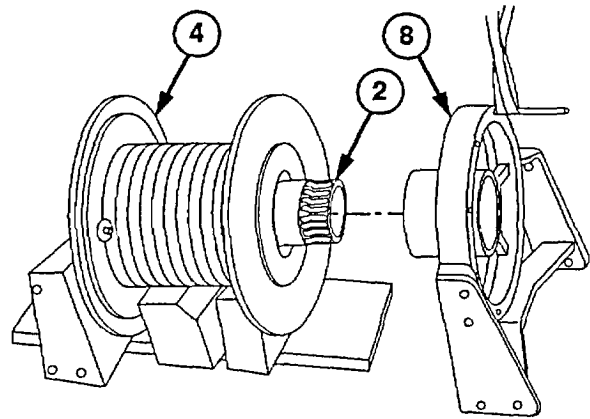
WARNING

Gear end support weighs 125 lb (57 kg). Keep out from under motor end support. Failure to comply may result in injury or death to personnel.

NOTE

Gear end support is installed on splined end of output shaft.

- (15) Install gear end support (8) on output shaft (2) while assistant operates lifting device.

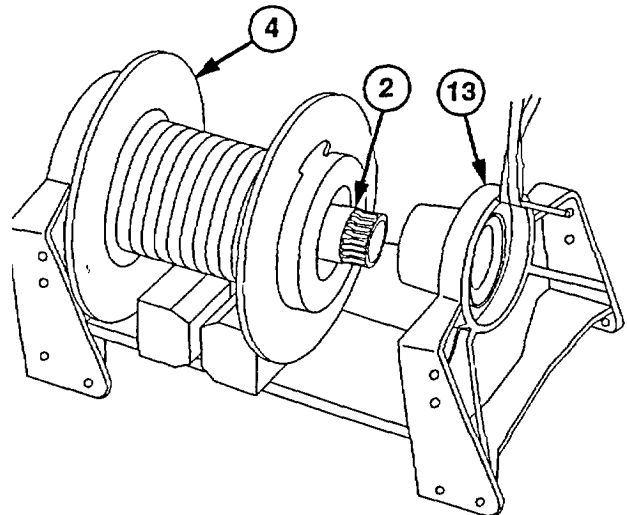


- (16) Attach lifting device to motor end support (13).

WARNING

Motor end support weighs 125 lb (57 kg). Keep out from under motor end support. Failure to comply may result in injury or death to personnel.

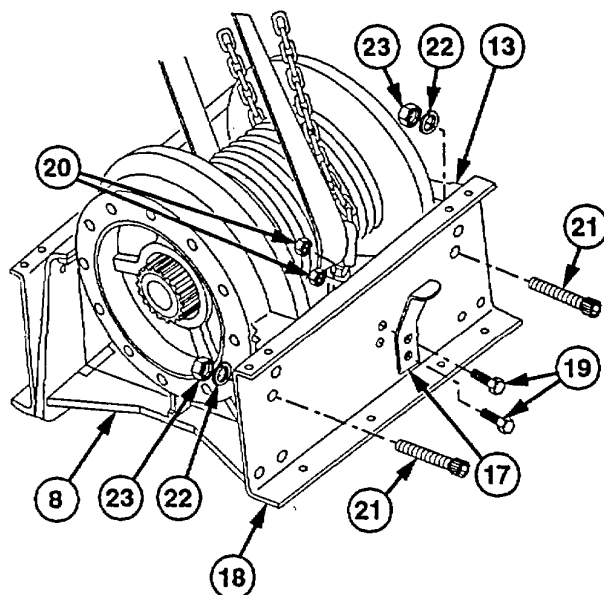
- (17) Install motor end support (13) on output shaft (2) while assistant operates lifting device.



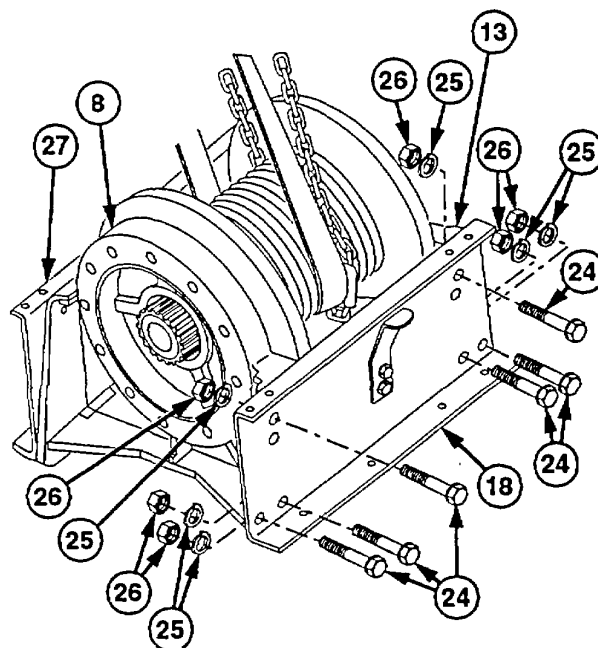
28-2. WINCH REPAIR (CONT)**NOTE**

Right and left side cable dampers are installed the same way. Left side is shown.

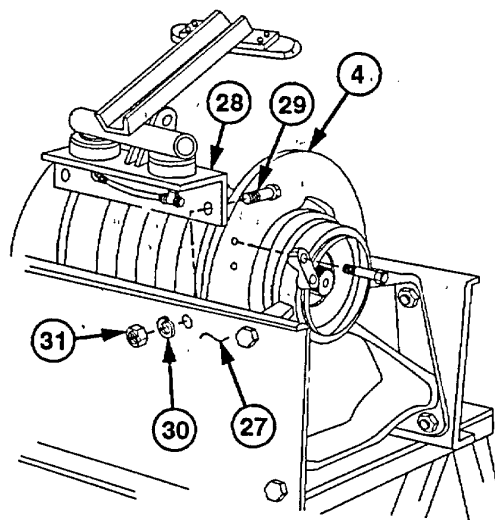
- (18) Install cable clamp (17) on side support (18) with two screws (19) and new locknuts (20). Torque to 200 lb-ft (271 N•m).
- (19) Install side support (18) on end supports (8 and 13) with two screws (21), new lockwashers (22), and nuts (23). Do not tighten.



- (20) Install six screws (24), new lockwashers (25), and nuts (26) on side support (18).
- (21) Tighten two nuts (23) and six nuts (26) to 200 lb-ft (271 N•m).
- (22) Repeat steps (19) thru (21) for remaining side support (27).



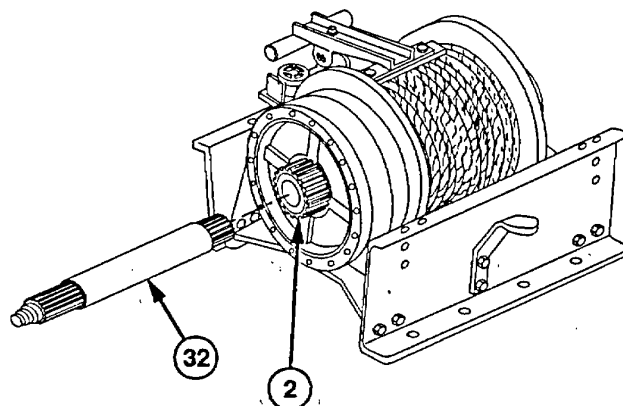
- (23) Install cable hold down assembly (28) on winch side support (27) with two screws (29), new lockwashers (30), and nuts (31).



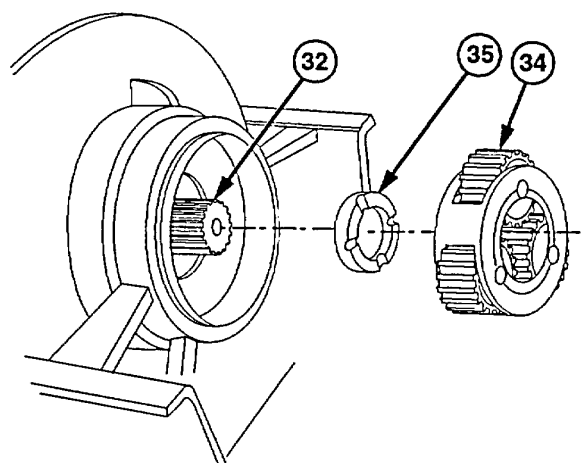
NOTE

Input shaft is installed from gear end support. Threaded hole in end of input shaft must be at motor end of drum.

- (24) Install Input shaft (32) in output shaft (2).

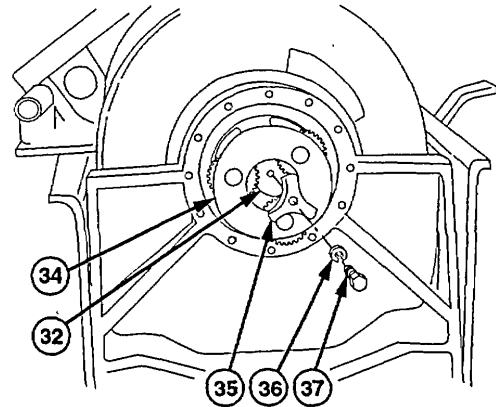


- (25) Install bronze thrust bearing (35) on input shaft (32).
 (26) Install planetary carrier (34) on input shaft (32).

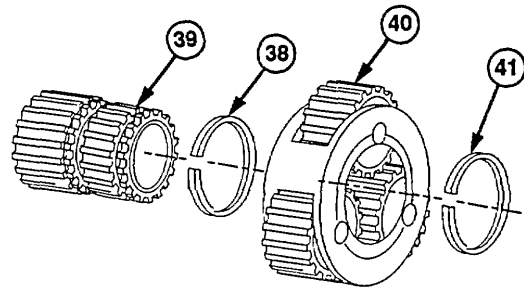


28-2. WINCH REPAIR (CONT)

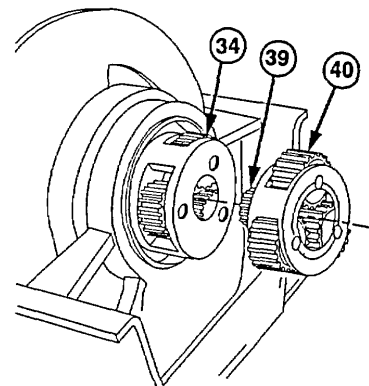
- (27) Install retainer plate (35) on planetary carrier (34) and input shaft (32) with new lockwasher (36) and screw (37). Torque to 276 lb-in. (31.2 N•m).

**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.



- (28) Install new retaining ring (38) on sun gear (39).
 (29) Install sun gear (39) in planetary carrier (40).
 (30) Insert new retaining ring (41) into planetary carrier (40) and install on end of sun gear (39).
 (31) Slide planetary carrier (40) with sun gear (39) into planetary carrier (34).



WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (32) Coat both sides of ring gear (42) with silicone adhesive-sealant.

WARNING

Ring gear weighs 62 lb (28 kg). Keep out from under ring gear. Failure to comply may result in injury or death to personnel.

NOTE

If gap exists between ring gear and motor end support, reverse ring gear.

- (33) Install ring gear (42) on planetary carriers (40 and 34).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (33.1) Coat threads of plug (42.1) and elbow (42.2) with pipe thread sealing compound.
 (33.2) Install plug (42.1) in brake adapter (43).
 (33.3) Install elbow (42.2) in brake adapter (43).

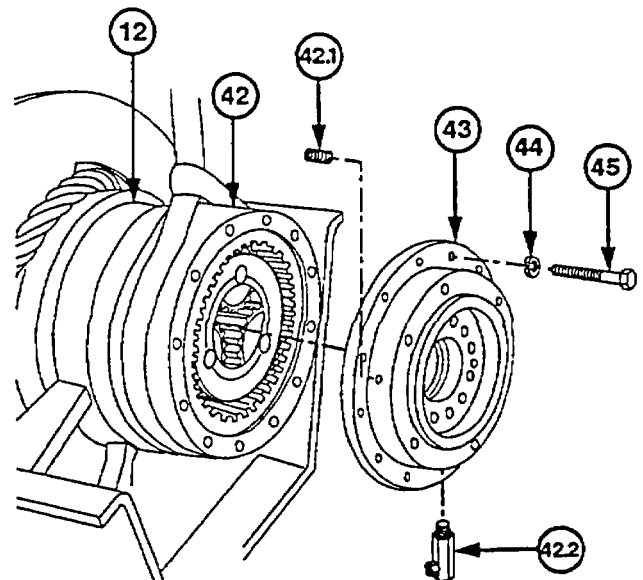
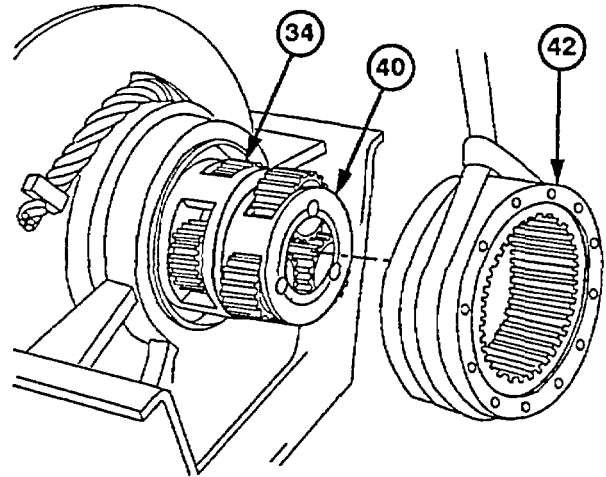
WARNING

Support brake adapter while installing to prevent injury to personnel.

NOTE

Holes for fittings in brake adapter must be in the 5 o'clock and 7 o'clock positions.

- (34) Align holes and install brake adapter (43) on ring gear (42).
 (35) Install brake adapter (43) and ring gear (42) on motor end support (12) with 12 new lockwashers (44) and screws (45). Torque to 35 lb-ft (47.5 N•m).



28-2. WINCH REPAIR (CONT)**WARNING**

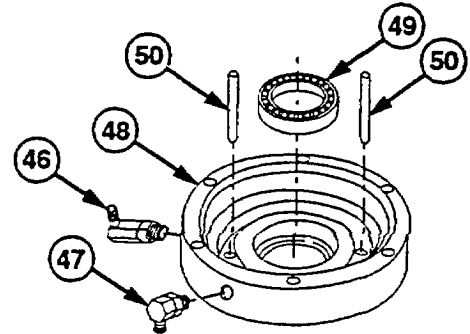
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (36) Coat threads of two elbows (46 and 47) with pipe thread sealing compound.

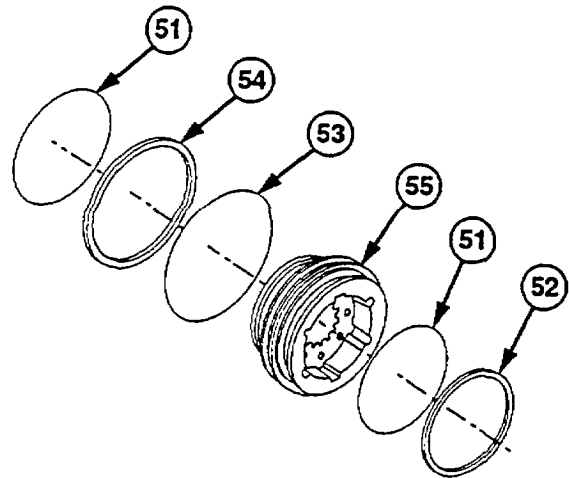
NOTE

Elbow hose connections must face each other.

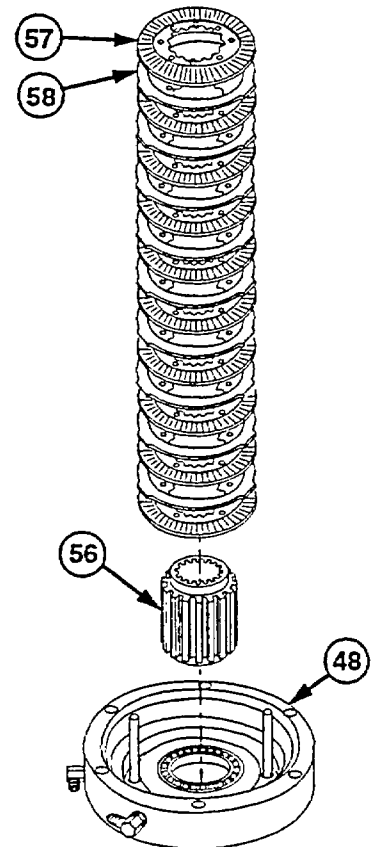
- (37) Install elbow (46) and elbow (47) in brake housing (48).
 (38) Install bearing (49) and two dowel pins (50) in brake housing (48).



- (39) Install two new preformed packings (51), backup ring (52), new preformed packing (53), and backup ring (54) on brake piston (55).



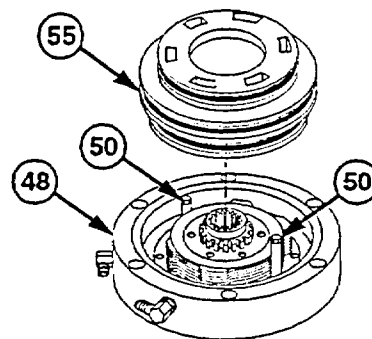
- (40) Install brake shaft (56) in brake housing (48).
- (41) Install 10 friction disk plates (57) and 9 drive plates (58) on brake shaft (56).



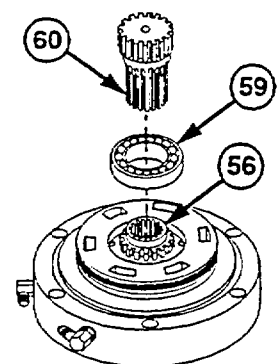
NOTE

Ensure proper alignment and seating of brake piston to brake housing.

- (42) Align dowel pins (50) and install brake piston (55) in brake housing (48).

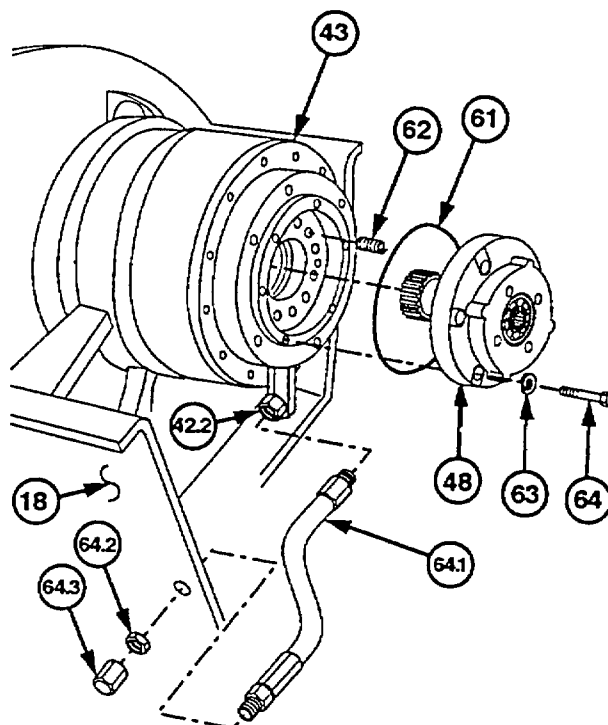


- (43) Install bearing (59) on brake shaft (56).
- (44) Install sun gear (60) in brake shaft (56).



28-2. WINCH REPAIR (CONT)

- (45) Install preformed packing (61) and 12 compression springs (62) on brake adapter (43).
- (46) Install brake housing (48) on brake adapter (43) with six new lockwashers (63) and screws (64). Torque to 55 lb-ft (74.6 N•m).
- (46.1) Install hose (64.1) on elbow (42.2).
- (46.2) Install hose (64.1) on side support (18) with nut (64.2).
- (46.3) Install drain cap (64.3) on hose (64.1).

**WARNING**

Planetary carrier weighs 100 lb (45 kg). Keep out from under planetary carrier. Failure to comply may result in injury or death to personnel.

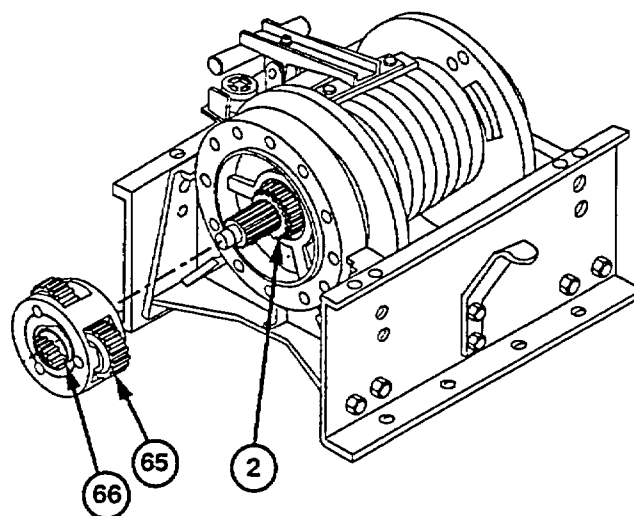
- (47) Install planetary carrier (65) on output shaft (2) with aid of assistant.

WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Retaining ring is located inside planetary carrier.



- (48) Install retaining ring (66) on end of output shaft (2).

- (49) Install two guide screws (67) at opposite positions in gear end support (8).

WARNING

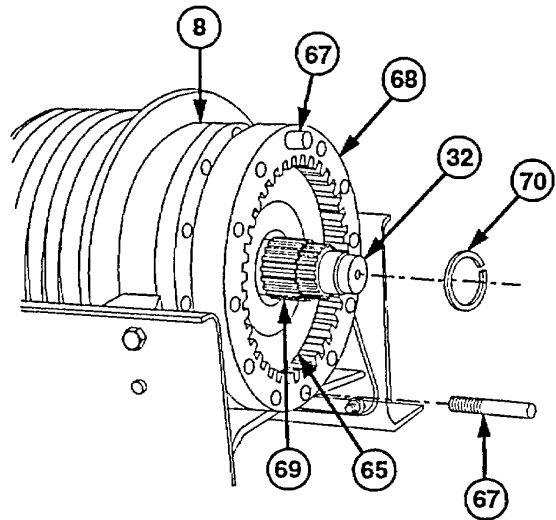
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (50) Coat both sides of ring gear (68) with silicone adhesive-sealant.

WARNING

Ring gear weighs 62 lb (28 kg). Keep out from under ring gear. Failure to comply may result in injury or death to personnel.

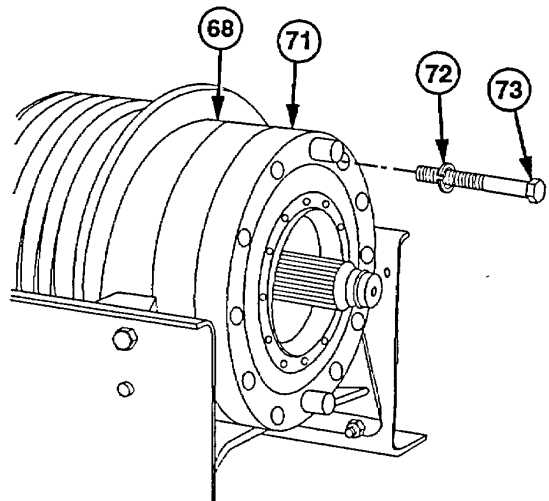
- (51) Align marks made during disassembly and install ring gear (68) on planetary carrier (65) and gear end support (8).
 (52) Install clutch sun gear (69) on input shaft (32).
 (53) Install new retaining ring (70) on input shaft (32).



NOTE

Breather hole and drain hole must be in the 12 o'clock and 6 o'clock positions.

- (54) Install planetary adapter cover (71) on ring gear (68) with 10 new lockwashers (72) and screws (73). Do not tighten.



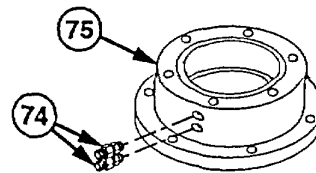
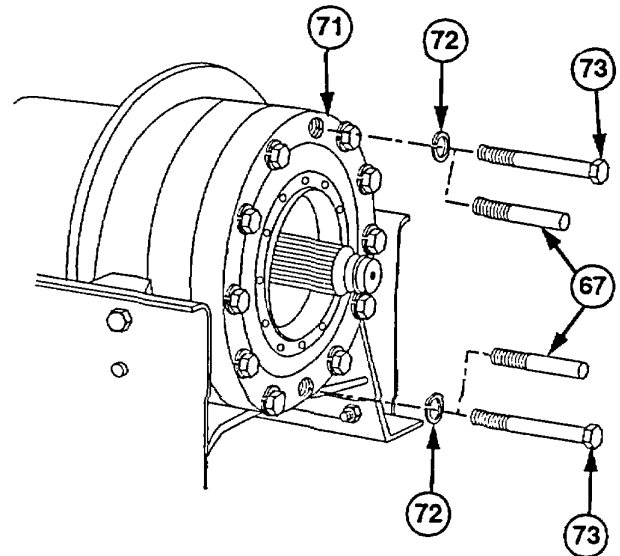
28-2. WINCH REPAIR (CONT)

- (55) Remove two guide screws (67) from planetary adapter cover (71) and install two new lockwashers (72) and remaining screws (73).
- (56) Tighten 12 screws (73) to 200 lb-ft (271 N•m).

WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (57) Coat two tube fittings (74) with pipe thread sealing compound and install in clutch adapter (75).

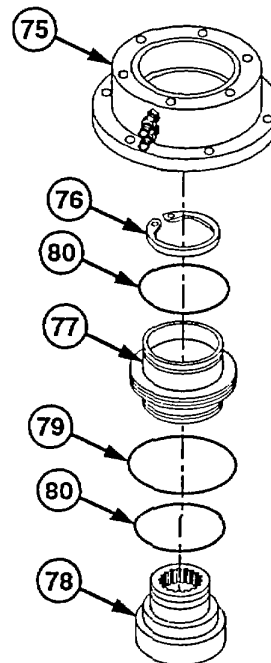
**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

NOTE

Clutch drive gear is secured to input shaft with retaining ring.

- (58) Install new retaining ring (76) and piston (77) on clutch drive gear (78).
- (59) Install new preformed packing (79) and two new preformed packings (80) on piston (77). Coat piston with oil.
- (60) Install piston (77) on clutch adapter (75).



WARNING

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (61) Coat two plugs (81) and vent (82) with pipe thread sealing compound and install in planetary adapter cover (71).

WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

NOTE

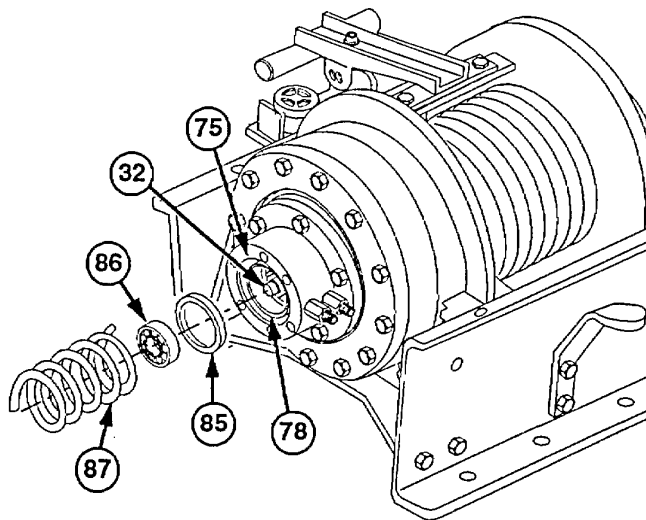
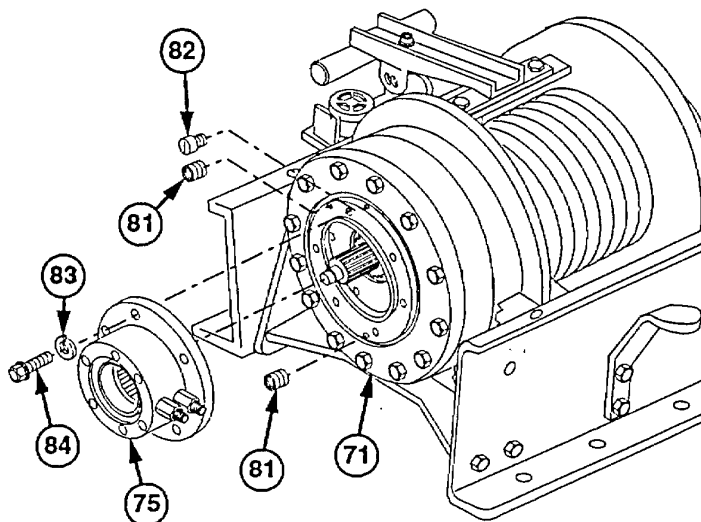
Clutch adapter should be positioned on planetary adapter cover as marked during removal.

- (62) Coat mating surfaces of planetary adapter cover (71) and clutch adapter (75) with silicone adhesive-sealant.
- (63) Install clutch adapter (75) on planetary adapter cover (71) with six new lockwashers (83) and screws (84). Torque to 276 lb-in. (31.2 N•m).

NOTE

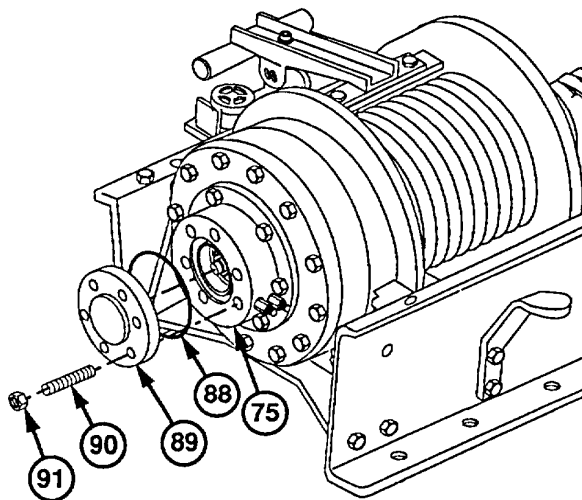
Flat surface of thrust ring faces out.

- (64) Install thrust ring (85) on clutch drive gear (78).
- (65) Install bearing (86) on shaft (32).
- (66) Install spring (87) on clutch adapter (75).

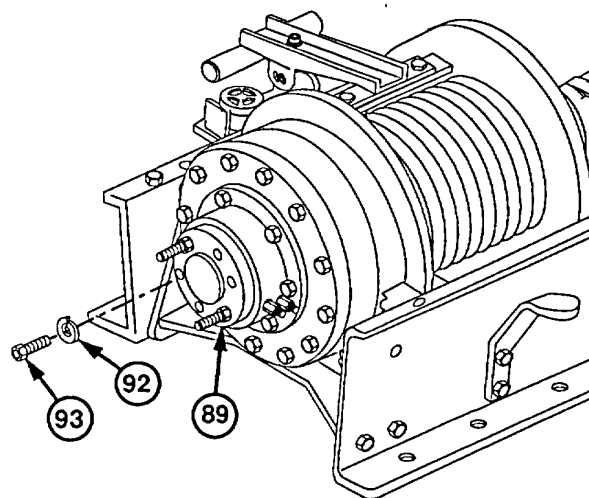


28-2. WINCH REPAIR (CONT)

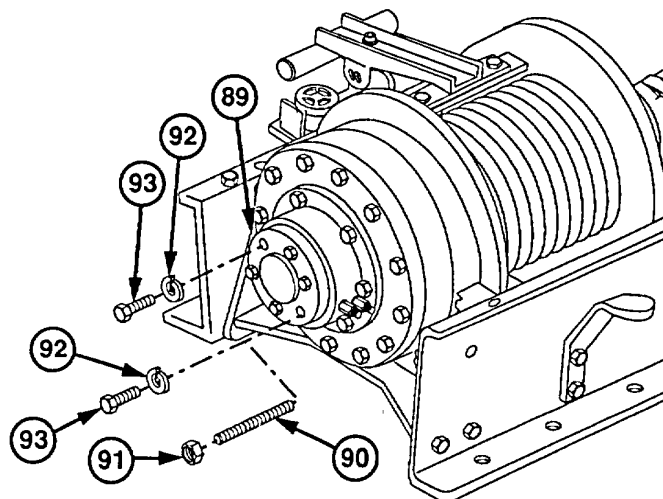
- (67) Install new preformed packing (88) on clutch end cover (89).
- (68) Install two threaded rods (90) on opposite ends of clutch adapter (75).
- (69) Install clutch end cover (89) on threaded rods (90).
- (70) Install two nuts (91) on threaded rods (90). Tighten until mating surfaces of clutch end cover (89) and clutch adapter (75) meet.



- (71) Install four new lockwashers (92) and screws (93) on clutch end cover (89).



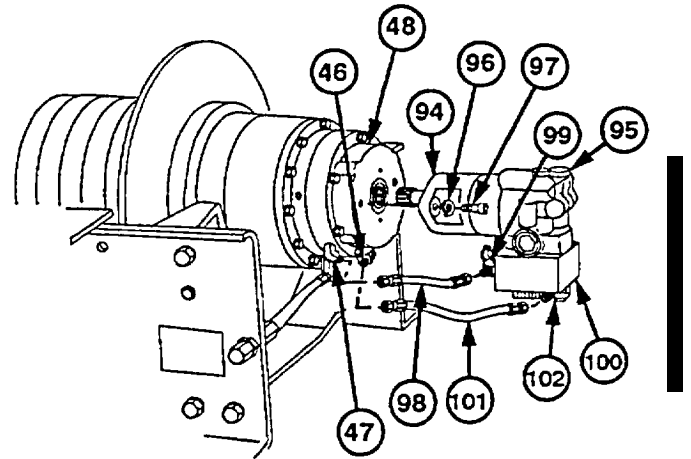
- (72) Remove two nuts (91) and threaded rods (90) from clutch end cover (89).
- (73) Install two new lockwashers (92) and screws (93) on clutch end cover (89).
- (74) Tighten six screws (93) to 35 lb-ft (47.5 N•m).



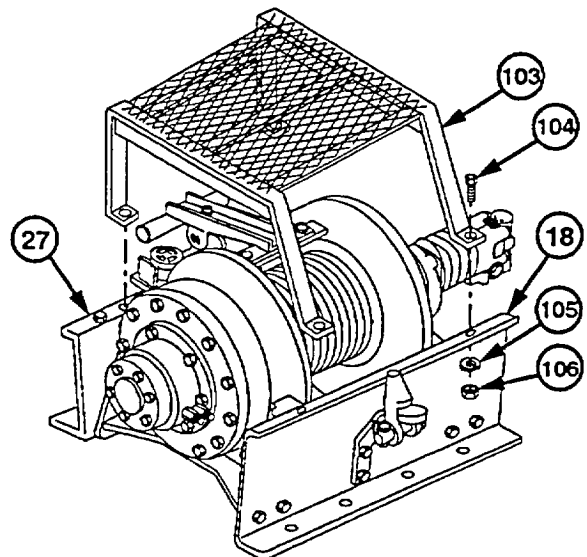
WARNING

On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (75) Lightly coat edge of bearing housing (94) on drive motor (95) with thin layer of silicone adhesive-sealant.
- (76) Install drive motor (95) on brake housing (48) with two new lockwashers (96) and screws (97).
- (77) Install hose (98) on elbow (47) on brake housing (48).
- (78) Install hose (98) on elbow (99) on valve solenoid (100).
- (79) Install hose (101) on elbow (46) on brake housing (48).
- (80) Install hose (101) on fitting (102) on valve solenoid (100).



- (81) Install cable guard (103) on winch side supports (18 and 27) with four screws (104), new lockwashers (105), and nuts (106).

**d. Follow-On Maintenance**

Fill winch with lubricant (LO 9-2320-360-12).

28-3. DRIVE MOTOR REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/Inspection
- c. Assembly

INITIAL SETUP

Equipment Conditions

Drive motor on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
 Caps, Vise Jaw (Item 17, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical, Slide Hammer
 (Item 125, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235,
 Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (Item 236,
 Appendix E)

Materials/Parts

Cloth, Crocus (Item 16, Appendix B)
 Jelly, Petroleum (Item 35, Appendix B)
 Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Seal Kit (Item 296, Appendix F)

a. Disassembly

CAUTION

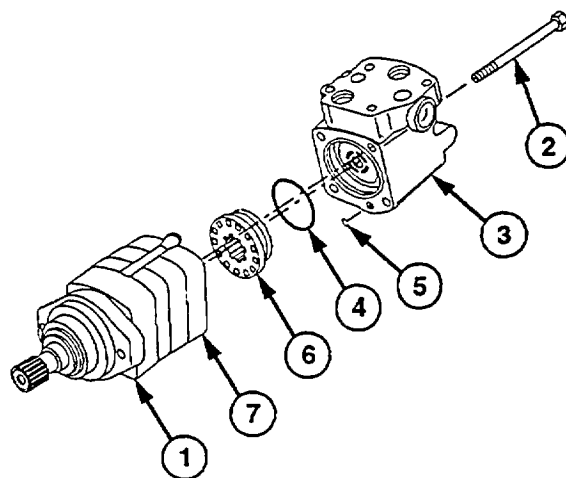
Clamp drive motor in soft-jawed vise by mounting flange only. Clamping drive motor in any other location will cause damage. Excessive clamping will cause damage to drive motor.

- (1) Position drive motor (1) in soft-jawed vise output shaft down.
- (2) Remove four screws (2) from drive motor (1).

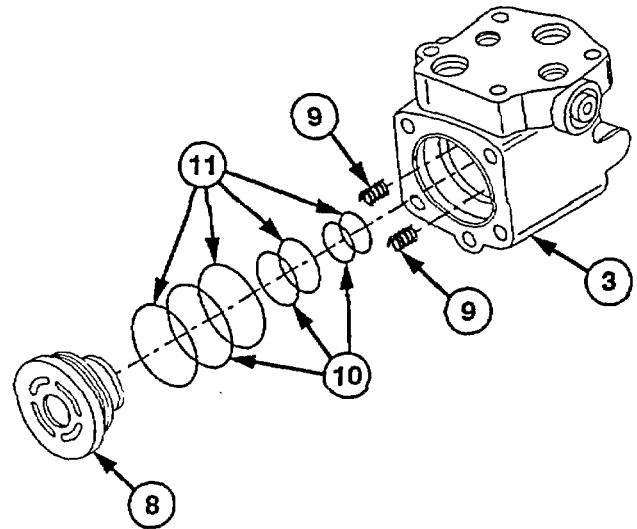
NOTE

Drive motor is made up of several sections. Only valve housing should be removed in step (3).

- (3) Carefully lift valve housing (3) straight up to remove from drive motor (1).
- (4) Remove seal (4) and preformed packing (5) from valve housing (3). Discard seal and preformed packing.
- (5) Remove valve (6) from valve plate (7).



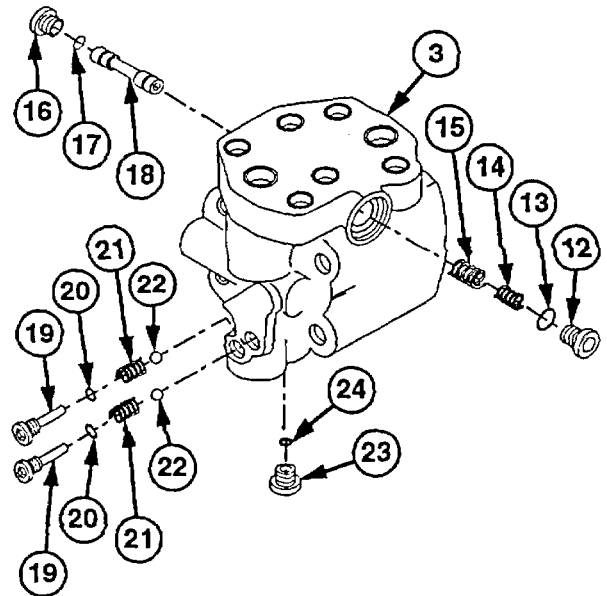
- (6) Remove balance ring (8) and two balance ring springs (9) from valve housing (3).
- (7) Remove three preformed packings (10) and four backup rings (11) from balance ring (8). Discard preformed packings and backup rings.



WARNING

Control spool springs are compressed under plugs. Remove carefully to prevent injury to personnel.

- (8) Remove control spool plug (12), preformed packing (13), spring (14), and spring (15) from valve housing (3). Discard preformed packing.
- (9) Remove control spool plug (16) and preformed packing (17) from valve housing (3). Discard preformed packing.
- (10) Remove control spool (18) from valve housing (3).
- (11) Remove two check ball plugs (19) and preformed packings (20) from valve housing (3). Discard preformed packings.
- (12) Remove two springs (21) and check balls (22) from valve housing (3).
- (13) Remove case drain plug (23) and preformed packing (24) from valve housing (3). Discard preformed packing.



28-3. DRIVE MOTOR REPAIR (CONT)

- (14) Remove valve plate (7) from geroler assembly (25).
- (15) Remove seal (26) from valve plate (7). Discard seal.
- (16) Remove valve drive (27) from geroler assembly (25).

NOTE

Star and rollers may come out of geroler assembly.

- (17) Remove geroler assembly (25) from wear plate (28).
- (18) Remove drive (29) from shaft and bearing assembly (30).
- (19) Remove wear plate (28) from bearing housing (31).
- (20) Remove seal (32) and shaft face seal (33) from wear plate (28). Discard seals.
- (21) Remove seal (34) from bearing housing (31). Discard seal.

NOTE

If shaft or bearings are damaged, replace complete assembly.

- (22) Press shaft and bearing assembly (30) from bearing housing (31).

CAUTION

Be careful not to damage seal seats.

- (23) Remove shaft seal (35), backup ring (36), and dust seal (37) from bearing housing (31). Discard ring and seals.

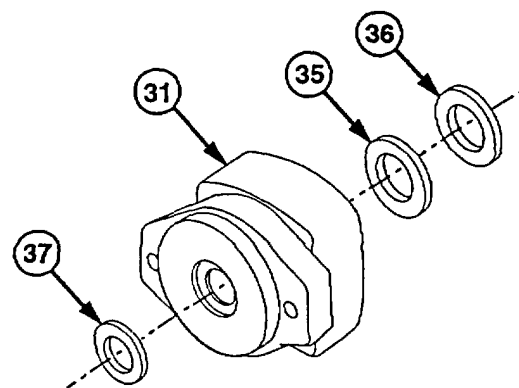
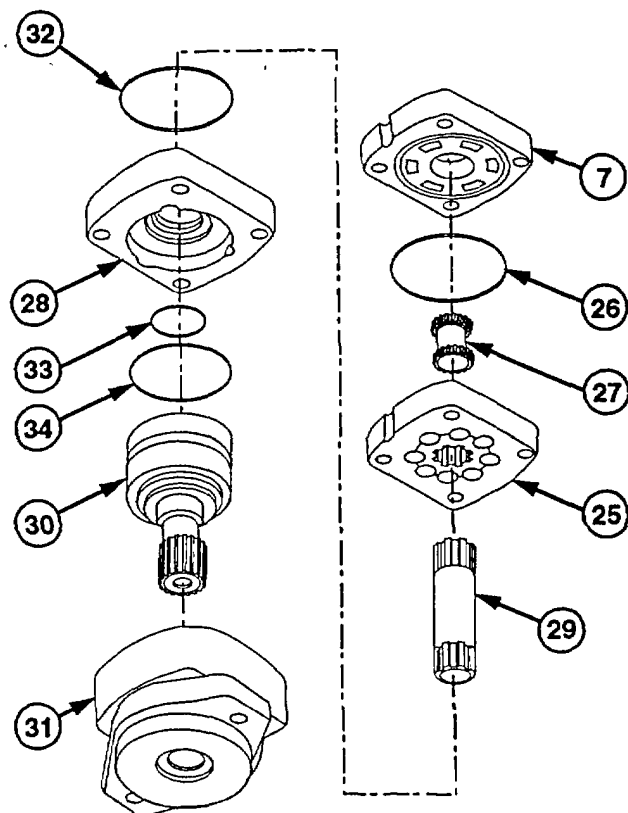
b. Cleaning/Inspection

- (1) Use wire brush to remove dirt and debris from motor exterior.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. DO NOT use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (2) Clean metal parts in dry cleaning solvent.



WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, and gloves).

- (3) Dry parts, except bearings, with compressed air.
- (4) Check chamfered area of output shaft. Use crocus cloth to remove any nicks, burrs, or sharp edges that could damage shaft during assembly.
- (5) Inspect parts for scratches, burrs, nicks, or sharp edges. If defects are found, remove with crocus cloth. If damage cannot be corrected, replace defective parts.

c. Assembly

- (1) Install new dust seal (1) into outer bore of bearing housing (2) with lip facing out.
- (2) Install backup ring (3) into inner bore of bearing housing (2).
- (3) Using shaft seal installation tool, press shaft seal (4) into inner bore over backup ring (3).

CAUTION

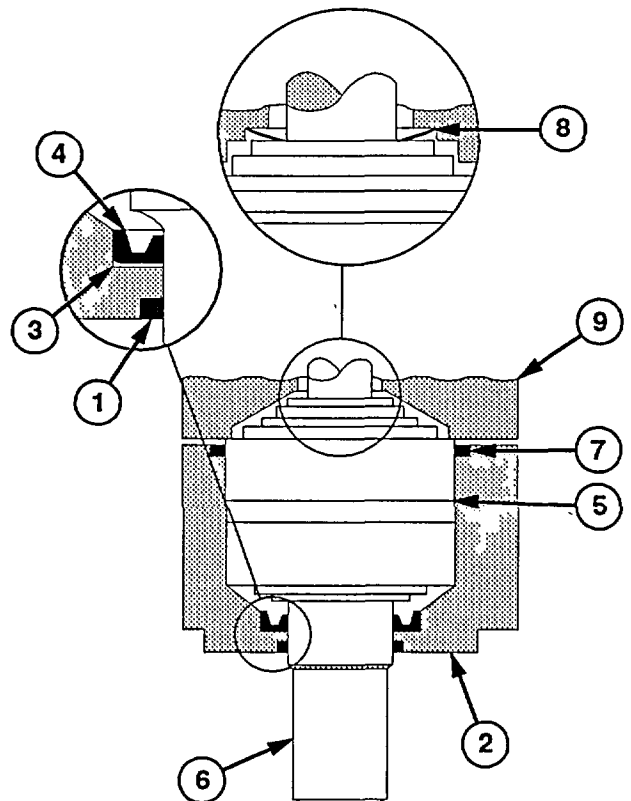
Use protective bullet when installing shaft to prevent damage to seals.

- (4) Coat inner edge of dust seal (1) and shaft seal (4) with petroleum jelly.
- (5) Press shaft and bearing assembly (5) into bearing housing (2).

CAUTION

Clamp bearing housing in soft-jawed vise by mounting flange only. Clamping bearing housing in any other location will cause damage. Excessive clamping will cause damage to drive motor.

- (6) Clamp bearing housing (2) in soft-jawed vise.
- (7) Pour small amount of clean lubricating oil into bearing housing (2) and output shaft (6).
- (8) Coat seal (7) with petroleum jelly and install in groove in bearing housing (2).
- (9) Install shaft face seal (8) in wear plate (9).



28-3. DRIVE MOTOR REPAIR (CONT)

- (10) install wear plate (9) on bearing housing (2).
- (11) Coat seal (10) with petroleum jelly and install in groove in wear plate (9).
- (12) Insert drive (11) into bearing housing (2).

NOTE

Star and rollers must be in place when installing geroler assembly.

- (13) Install geroler assembly (12) on wear plate (9).

NOTE

The direction output shaft rotates is determined by timing.

- (14) Locate largest opening pocket in geroler assembly (12). Mark its position.

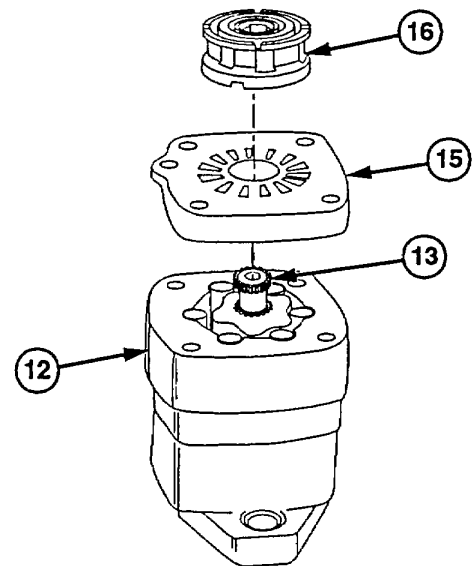
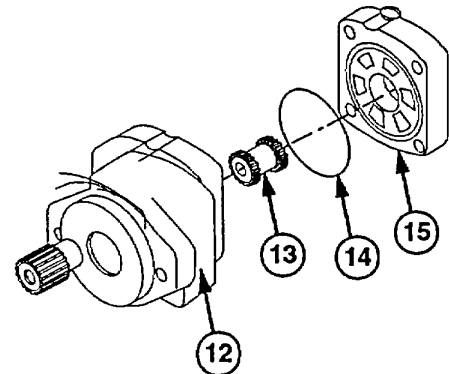
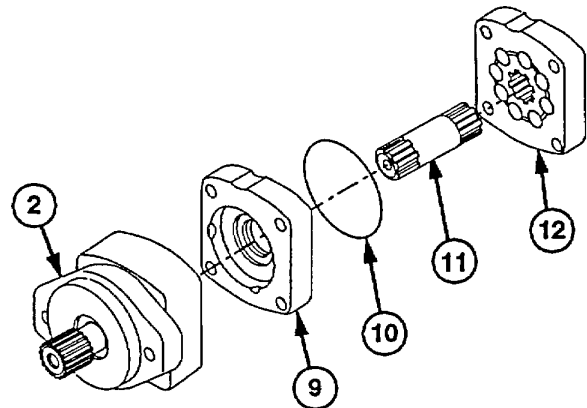
- (15) install valve drive (13) in geroler assembly (12).
- (16) Coat seal (14) with petroleum jelly and install in groove in valve plate (15).
- (17) Align scribe marks and install valve plate (15) on geroler assembly (12).
- (18) Locate open slot in valve plate (15) that is in line with largest open pocket in geroler assembly (12).

- (19) Align any side opening in valve (16) with open slot in valve plate (15) that is over largest open pocket in geroler assembly (12).

NOTE

Valve will fall into place and rest flat on valve plate when properly seated.

- (20) Engage valve (16) with valve drive (13) by rotating it clockwise until spline teeth mesh (1/2 spline tooth).

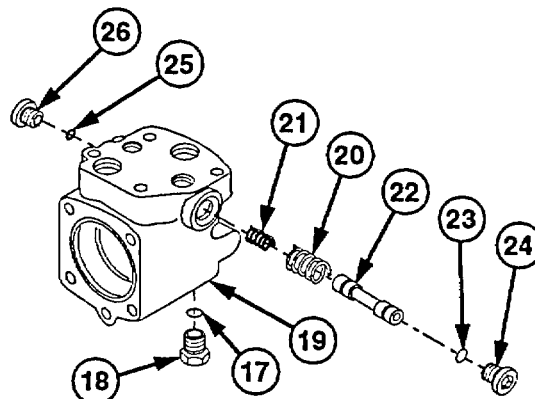


- (21) Install new preformed packing (17) on case drain plug (18).
- (22) Install case drain plug (18) in valve housing (19). Torque to 40-60 lb-in. (4.5-6.8 N•m).
- (23) Install springs (20 and 21) in control spool (22).

NOTE

Valve housing should be positioned with opening facing you.

- (24) Install control spool (22) with springs (20 and 21) in right port of valve housing (19).
- (25) Install new preformed packing (23) on control spool plug (24).
- (26) Install control spool plug (24) in valve housing (19).
- (27) Install new preformed packing (25) on control spool plug (26).



NOTE

Compress springs to install second plug.

- (28) Install control spool plug (26) in valve housing (19).
- (29) Tighten control spool plugs (24 and 26) to 38-46 lb-ft (51-62 N•m).
- (30) Install three new preformed packings (27) and four new backup rings (28) on balance ring (29).

NOTE

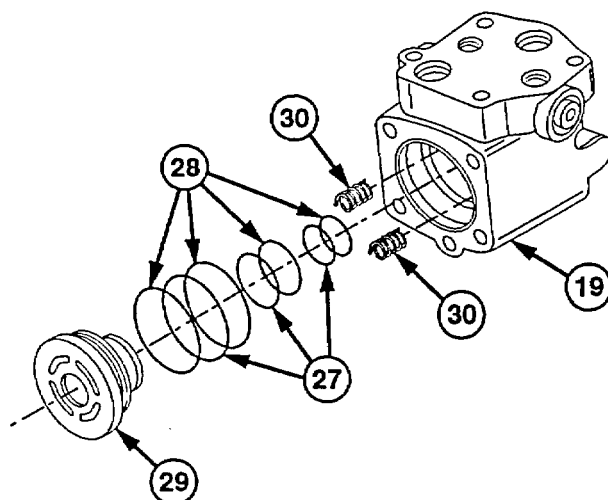
Balance ring springs may be installed in any two holes that are directly across from each other.

- (31) Install two balance ring springs (30) in holes in valve housing (19).
- (32) Coat preformed packings (27) and backup rings (28) with petroleum jelly.

NOTE

Ensure two index pins are properly seated in balance ring before installation.

- (33) Align two index pins with two remaining holes in valve housing (19) and install balance ring (29). Push balance ring (29) into valve housing (19) until it just touches springs (30).



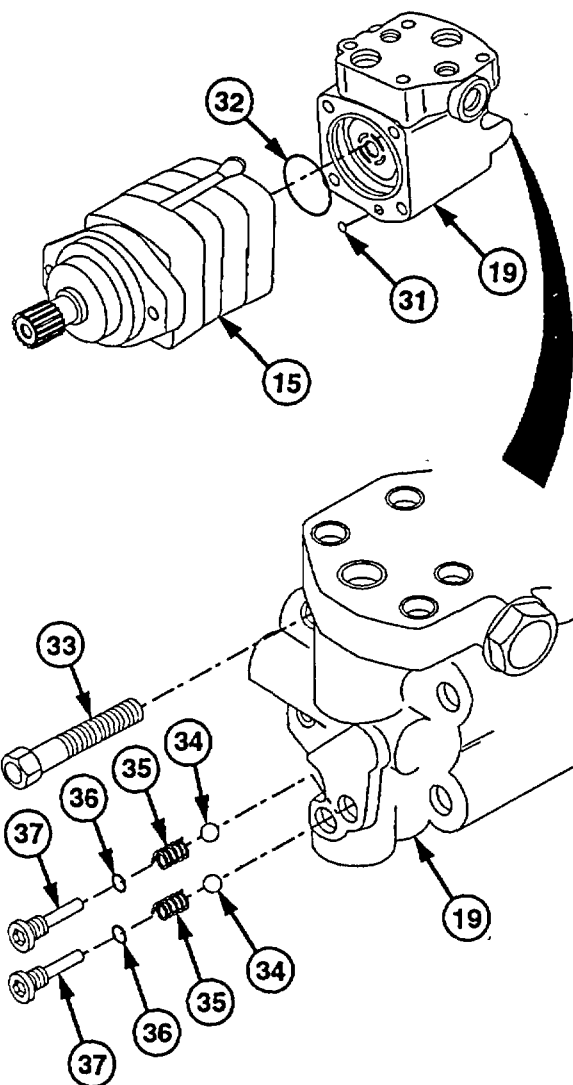
28-3. DRIVE MOTOR REPAIR (CONT)

- (34) Coat seal (31) with petroleum jelly.
- (35) Install seal (31) and preformed packing (32) in grooves in valve housing (19).

NOTE

There is a gap between valve housing and valve plate. This gap will close when screws are tightened.

- (36) Install valve housing (19) on valve plate (15).
- (37) Install four screws (33) in valve housing (19). Torque in a crisscross pattern to 38-46 lb-ft (51-62 N•m).
- (38) Install two check balls (34) and springs (35) in valve housing (19).
- (39) Install new preformed packings (36) on two check ball plugs (37).
- (40) Install plugs (37) in valve housing (19). Torque to 40-60 lb-in. (4.5-6.8 N•m).



28-4. HYDRAULIC PUMP REPAIR

This task covers:

a. Disassembly	c. Assembly
b. Cleaning/Inspection	

INITIAL SETUP

Equipment Conditions

Hydraulic pump on clean work surface.

Tools and Special Tools

Tool Kit, Genl Mech (Item 202, Appendix E)
Compressor Unit, Air (Item 24, Appendix E)
Goggles, Industrial (Item 57, Appendix E)
Puller Kit, Mechanical, Slide Hammer
(Item 125, Appendix E)
Wrench, Torque, 0-600 Lb-Ft (Item 233,
Appendix E)

Materials/Parts

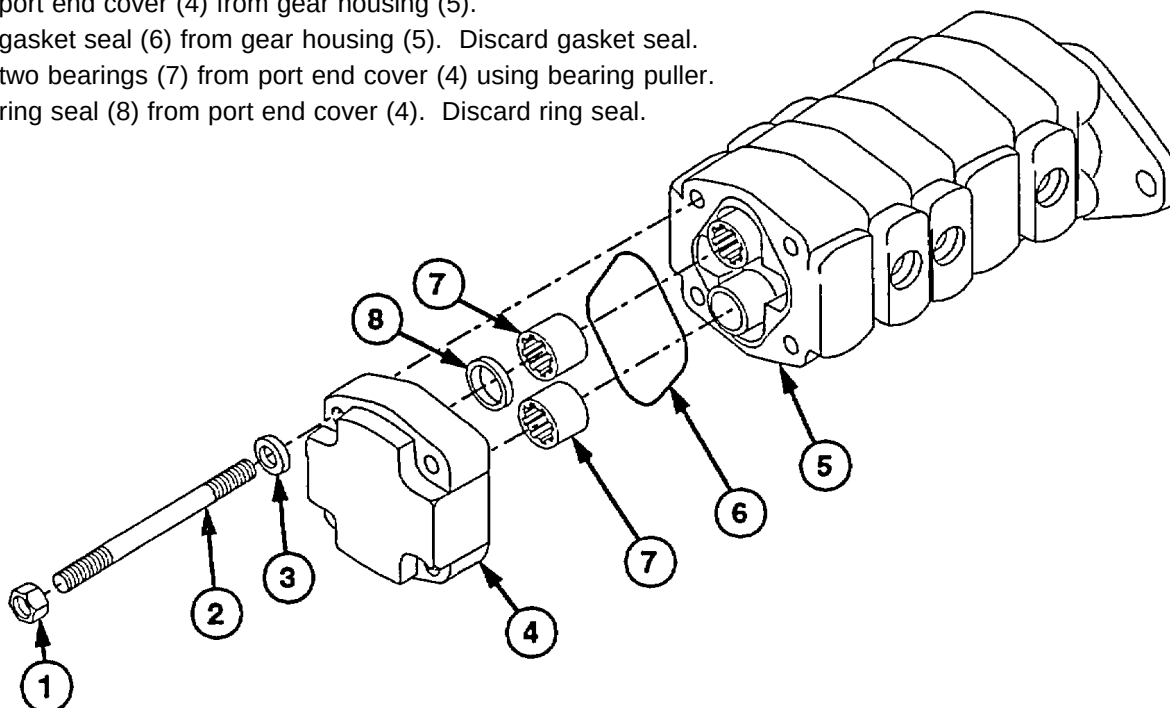
Adhesive-Sealant, Silicone (Item 2, Appendix B)
Grease, Automotive and Artillery (Item 32,
Appendix B)
Solvent, Dry Cleaning (Item 54, Appendix B)
Bearing, Ball (Item 1, Appendix F)
Ring, Retaining (Item 240, Appendix F)
Seals, Gasket (6) (Item 294, Appendix F)
Seals, Pocket (36) (Item 318, Appendix F)
Seals, Ring (6) (Item 255, Appendix F)
Seal, Lip (Item 303, Appendix F)

a. Disassembly

NOTE

- Leaving two studs in place will aid in disassembly.
- When pump is disassembled, housings look the same. Mark and number housings.

- (1) Remove four nuts (1), two long studs (2), and washers (3) from port end cover (4).
- (2) Remove port end cover (4) from gear housing (5).
- (3) Remove gasket seal (6) from gear housing (5). Discard gasket seal.
- (4) Remove two bearings (7) from port end cover (4) using bearing puller.
- (5) Remove ring seal (8) from port end cover (4). Discard ring seal.



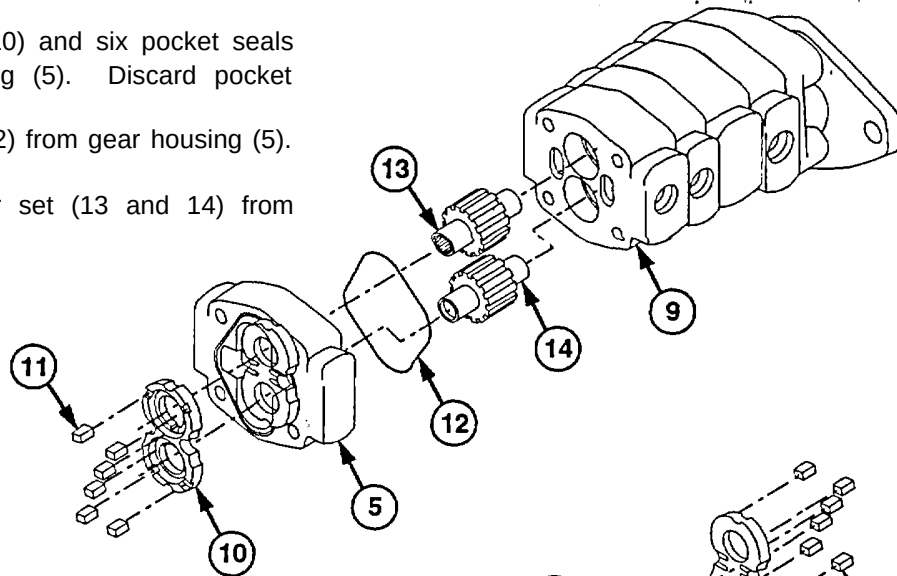
28-4. HYDRAULIC PUMP REPAIR (CONT)

- (6) Remove gear housing (5) from bearing carrier (9).

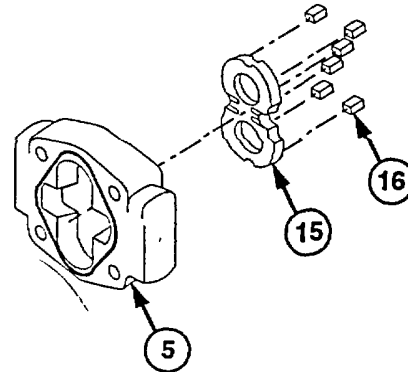
NOTE

Thrust plate may stay on port end cover or gear housing.

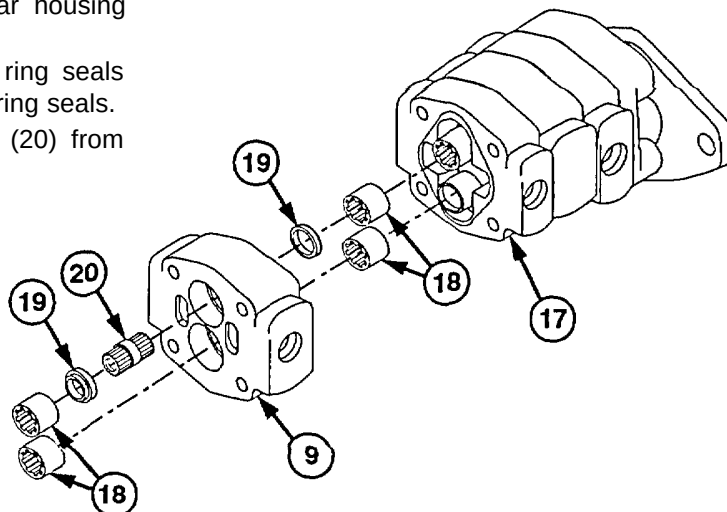
- (7) Remove thrust plate (10) and six pocket seals (11) from gear housing (5). Discard pocket seals.
- (8) Remove gasket seal (12) from gear housing (5). Discard gasket seal.
- (9) Remove matched gear set (13 and 14) from bearing carrier (9).



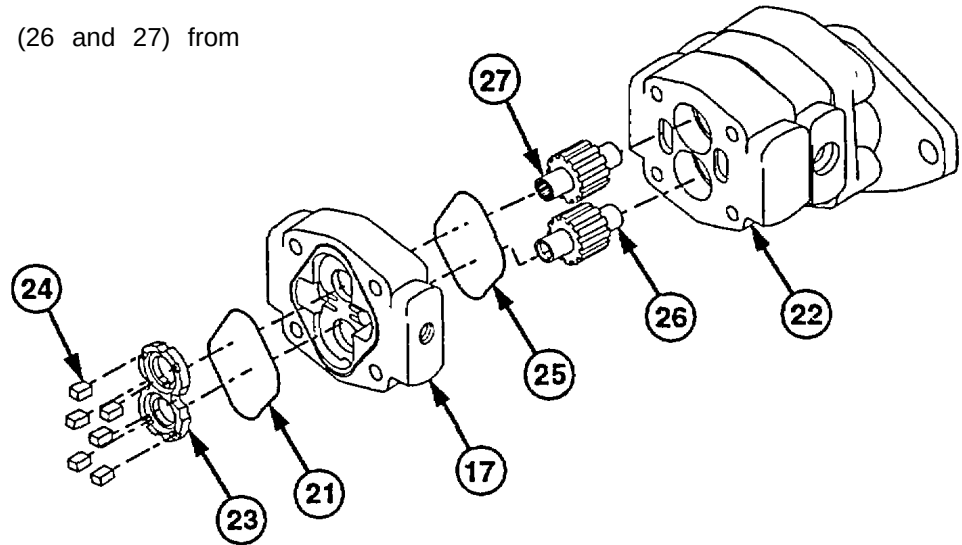
- (10) Remove thrust plate (15) and six pocket seals (16) from gear housing (5). Discard pocket seals.



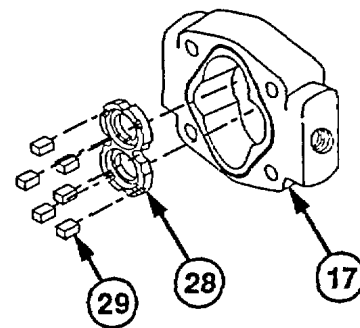
- (11) Remove bearing carrier (9) from gear housing (17).
- (12) Remove four bearings (18) and two ring seals (19) from bearing carrier (9). Discard ring seals.
- (13) Remove drive gear connecting shaft (20) from bearing carrier (9).



- (14) Remove gasket seal (21) from gear housing (17). Discard gasket seal.
- (15) Remove gear housing (17) from bearing carrier (22).
- (16) Remove thrust plate (23) and six pocket seals (24) from gear housing (17). Discard pocket seals.
- (17) Remove gasket seal (25) from gear housing (17). Discard gasket seal.
- (18) Remove matched gear set (26 and 27) from gear housing (17).

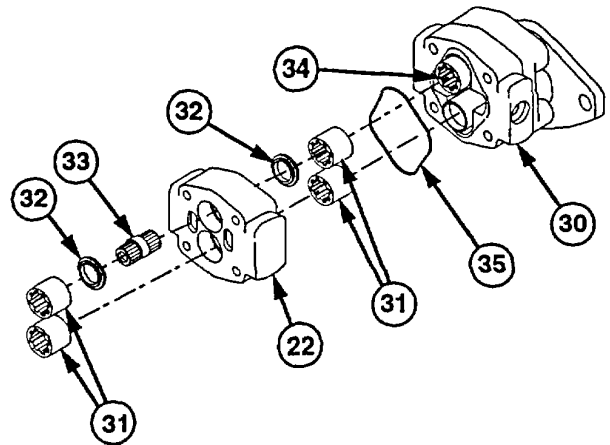


- (19) Remove thrust plate (28) and six pocket seals (29) from gear housing (17). Discard pocket seals.

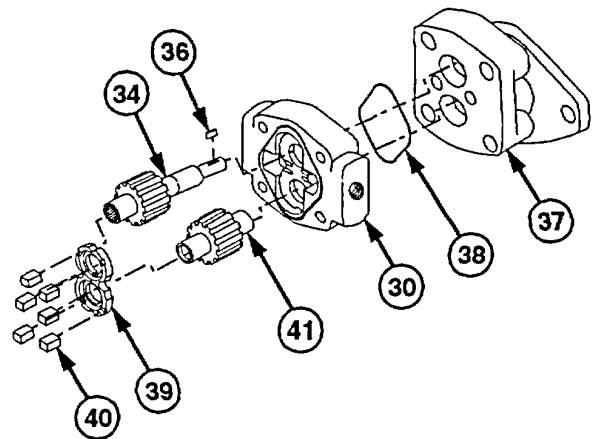


28-4. HYDRAULIC PUMP REPAIR (CONT)

- (20) Remove bearing carrier (22) from gear housing (30).
- (21) Remove four bearings (31) and two ring seals (32) from bearing carrier (22).
- (22) Remove drive gear connecting shaft (33) from driven gear (34).
- (23) Remove gasket seal (35) from gear housing (30). Discard gasket seal.

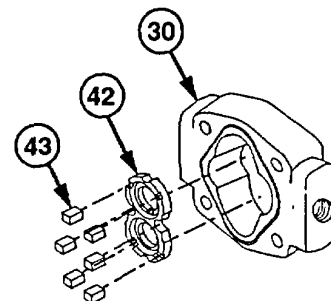


- (24) Remove key (36) from driven gear (34).
- (25) Remove gear housing (30) from shaft end cover (37).
- (26) Remove gasket seal (38) from gear housing (30). Discard gasket seal.
- (27) Remove thrust plate (39) and six pocket seals (40) from gear housing (30). Discard pocket seals.
- (28) Remove gears (34 and 41) from gear housing (30).

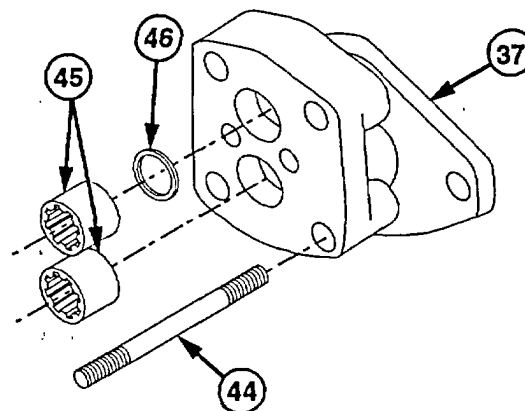
**NOTE**

Thrust plate may stay on cover or gear housing.

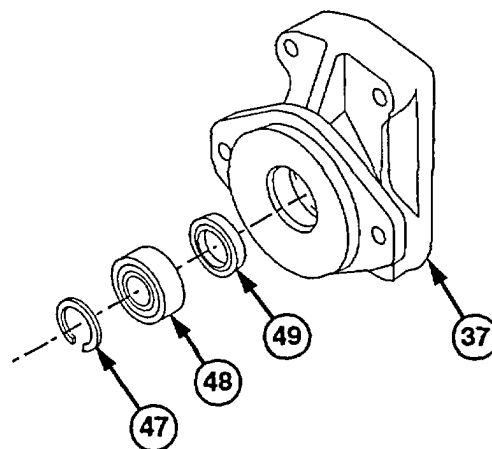
- (29) Remove thrust plate (42) and six pocket seals (43) from gear housing (30). Discard pocket seals.



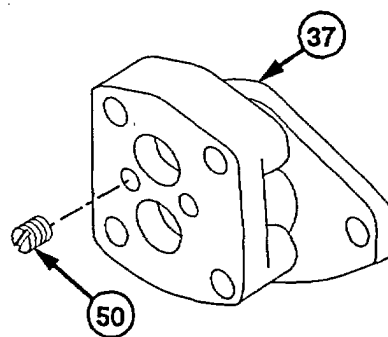
- (30) Remove two studs (44) from shaft end cover (37).
- (31) Remove two bearings (45) and ring seal (46) from shaft end cover (37). Discard ring seal.



- (32) Remove retaining ring (47) from back of shaft end cover (37). Discard retaining ring.
- (33) Remove seated bearing (48) from shaft end cover (37). Discard sealed bearing.
- (34) Remove seal (49) from shaft end cover (37). Discard seal.



- (35) Remove plug (50) from shaft end cover (37).



b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts in dry cleaning solvent.

28-4. HYDRAULIC PUMP REPAIR (CONT)**WARNING**

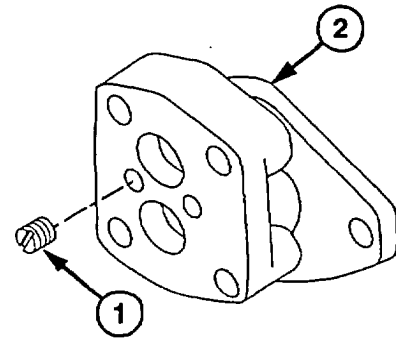
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, and gloves).

- (2) Dry parts, except bearings, with compressed air.
- (3) Inspect parts for cracks, chipping, and warping. If damage is found, replace parts:

c. Assembly**NOTE**

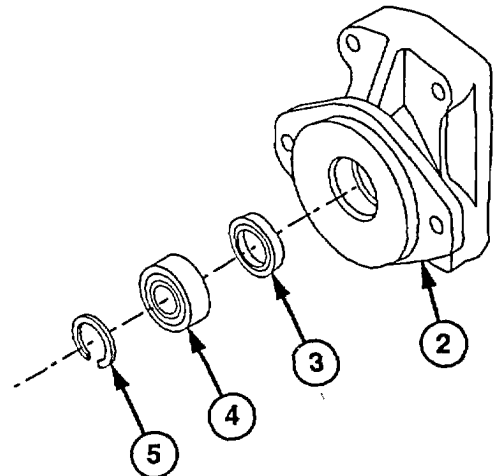
Ensure directional plug is in correct hole as shown.

- (1) Install plug (1) in shaft end cover (2).

**WARNING**

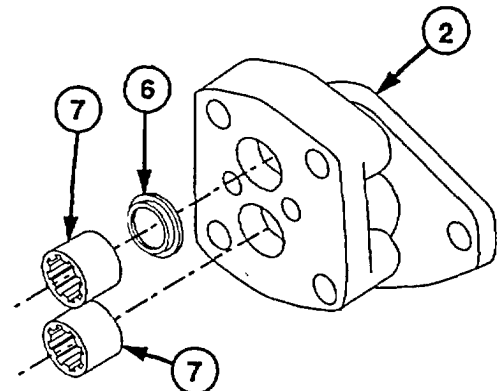
On direct contact, uncured silicone sealant irritates eyes. In case of contact, flush eyes with water and seek medical attention. In case of skin contact, wipe off and flush with water.

- (2) Coat outside edge of new seal (3) with silicone adhesive-sealant.
- (3) Install new seal (3) metal side up in back of shaft end cover (2).
- (4) Install new sealed bearing (4) in back of shaft end cover (2).
- (5) Install new retaining ring (5) in back of shaft end cover (2).

**NOTE**

Notched side of ring seals face bearings.

- (6) Install new ring seal (6) in shaft end cover (2).
- (7) Install two bearings (7) in shaft end cover (2).

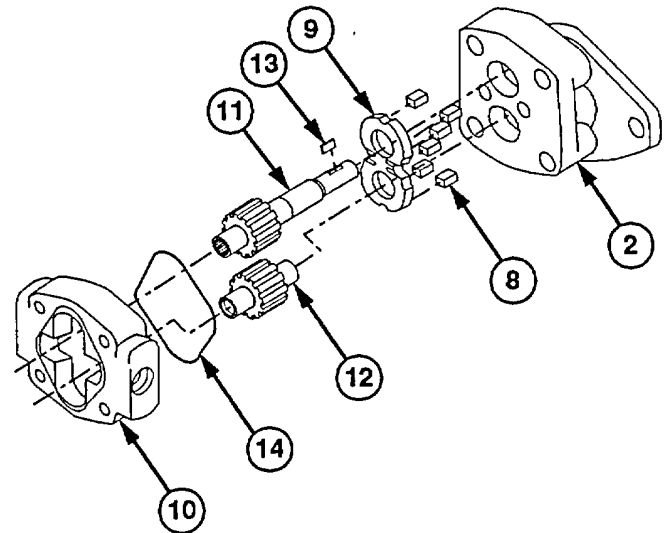


- (8) Coat six new pocket seals (8) thoroughly with grease.
- (9) Install pocket seals (8) in thrust plate (9).
- (10) Install thrust plate (9) in gear housing (10).
- (11) Install driven gear (11) and gear (12) in housing (10).
- (12) Install key (13) into driven gear (11).
- (13) Install new gasket seal (14) in groove in gear housing (10).

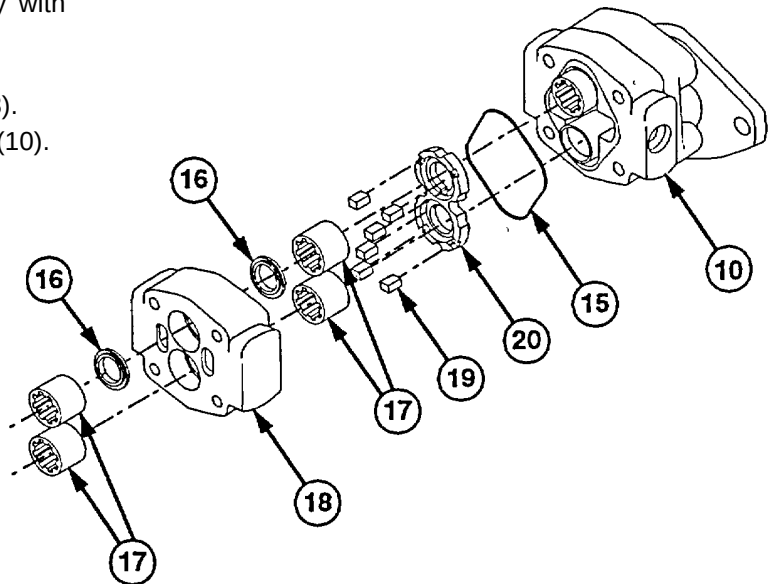
NOTE

Marks made during disassembly should be aligned before assembly.

- (14) Install gear housing (10), over gears (11 and 12), on shaft end cover (2).

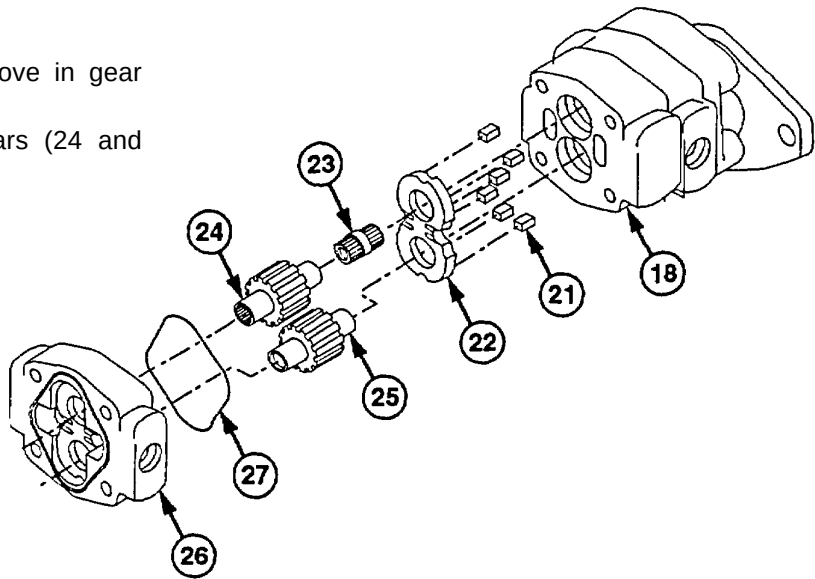


- (15) Install new gasket seal (15) in groove in gear housing (10).
- (16) Install two new ring seals (16) and four bearings (17) in bearing carrier (18).
- (17) Coat six new pocket seals (19) thoroughly with grease.
- (18) Install pocket seals (19) in thrust plate (20).
- (19) Install thrust plate (20) in bearing carrier (18).
- (20) Install bearing carrier (18) on gear housing (10).

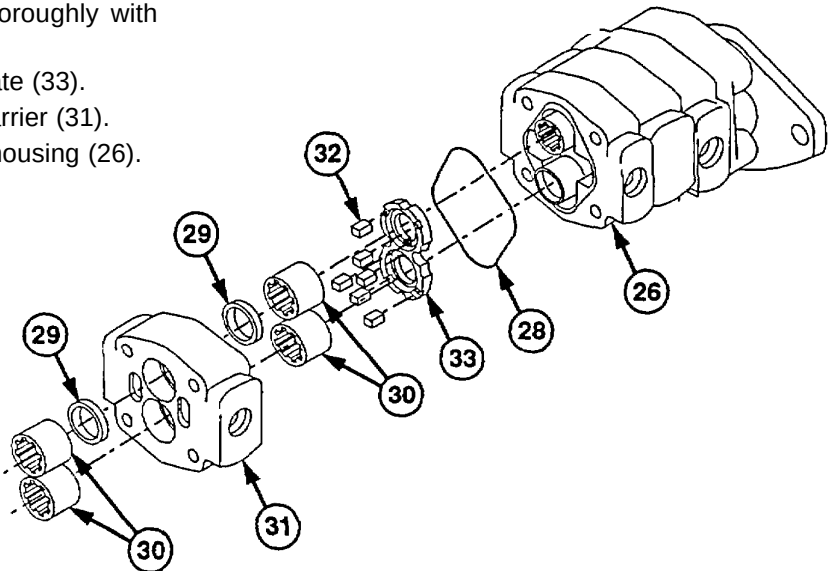


28-4. HYDRAULIC PUMP REPAIR (CONT)

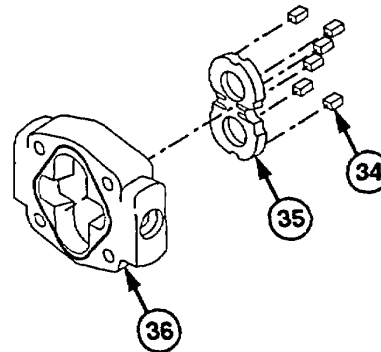
- (21) Coat six new pocket seals (21) thoroughly with grease.
- (22) Install pocket seals (21) in thrust plate (22).
- (23) Install thrust plate (22) in bearing carrier (18).
- (24) Install drive gear connecting shaft (23) in bearing carrier (18).
- (25) Install gear (24) on drive gear connecting shaft (23).
- (26) Install gear (25) in gear housing (26).
- (27) Install new gasket seal (27) in groove in gear housing (26).
- (28) Install gear housing (26), over gears (24 and 25), on bearing carrier (18).



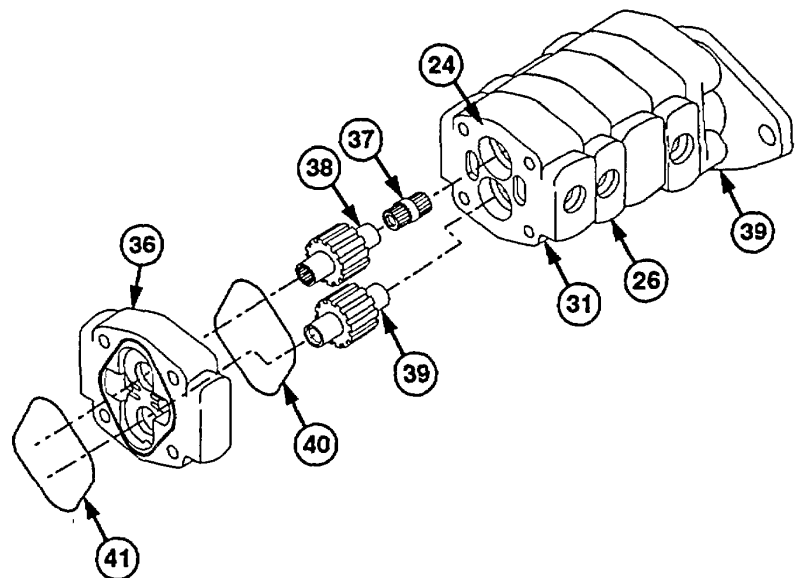
- (29) Install new gasket seal (28) in groove in gear housing (26).
- (30) Install two new ring seals (29) and four bearings (30) in bearing carrier (31).
- (31) Coat six new pocket seals (32) thoroughly with grease.
- (32) Install pocket seals (32) in thrust plate (33).
- (33) Install thrust plate (33) in bearing carrier (31).
- (34) Install bearing carrier (31) on gear housing (26).



- (35) Coat six new pocket seals (34) thoroughly with grease.
- (36) Install pocket seals (34) in thrust plate (35).
- (37) Install thrust plate (35) in gear housing (36).

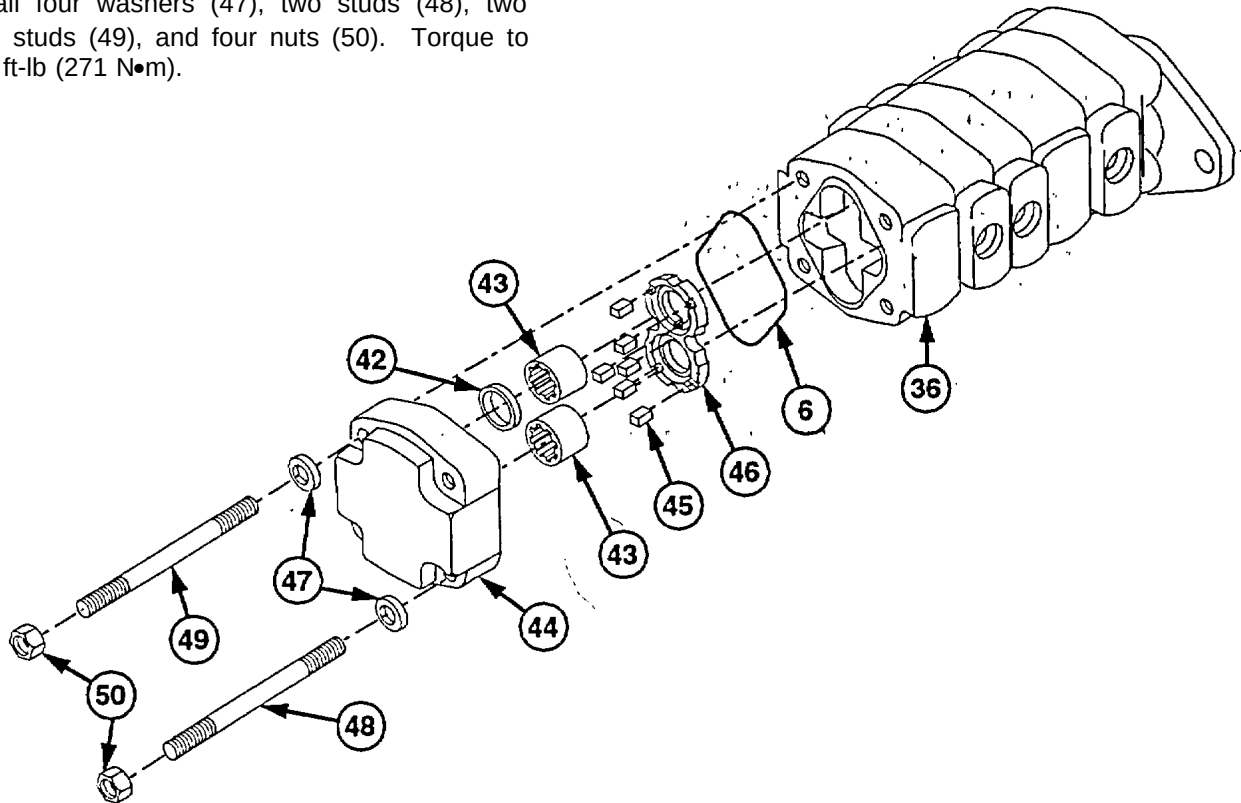


- (38) Install drive gear connecting shaft (37) in driven gear (24).
- (39) Install gear (38) on drive gear connecting shaft (37).
- (40) Install gear (39) in gear housing (36).
- (41) Install new gasket seal (40) in groove in gear housing (36).
- (42) Install gear housing (36), over gears (38 and 39), on bearing carrier (31).
- (43) Install new gasket seal (41) in groove in gear housing (36).



28-4. HYDRAULIC PUMP REPAIR (CONT)

- (44) Install new ring seal (42) and two bearings (43) in port end cover (44).
- (45) Coat six new pocket seals (45) thoroughly with grease.
- (46) Install pocket seals (45) in thrust plate (46).
- (47) Install thrust plate (46) in port end cover (44).
- (48) Install port end cover (44) on gear housing (36).
- (49) Install four washers (47), two studs (48), two long studs (49), and four nuts (50). Torque to 200 ft-lb (271 N•m).



28-5. AUXILIARY WINCH REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/Inspection
- c. Assembly

INITIAL SETUP**Equipment Conditions**

Auxiliary winch on clean work surface.

Tools and Special Tools

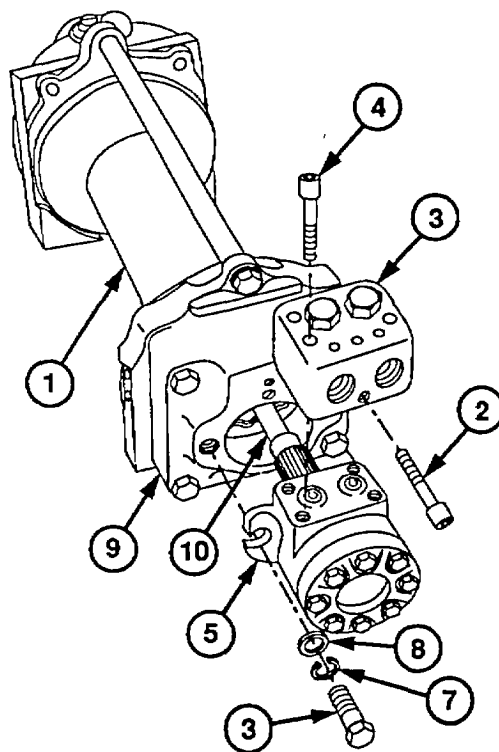
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caliper Set, Micrometer (Item 15, Appendix E)
 Compressor Unit, Air (Item 24, Appendix E)
 Gage Set, Telescoping (Item 56, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Pan, Oil Drain (Item 102, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Socket, Sockethead Screw, 3/16 In.
 (Item 172, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235,
 Appendix E)
 Wrench, Torque, 0-175 Lb-Ft (item 236,
 Appendix E)

Materials/Parts

Compound, Sealing, Pipe Thread (Item 28,
 Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Lockwashers (6) (Item 119, Appendix F)
 Lockwashers (7) (Item 122, Appendix F)
 Lockwasher (1) (Item 111, Appendix F)
 Lockwasher (Item 118, Appendix F)
 Lockwasher (Item 120, Appendix F)
 Repair Kit, Winch (Item 232, Appendix F)
 Service Kit, Winch (Item 321, Appendix F)

a. Disassembly

- (1) Place auxiliary winch (1) on clean work surface.
- (2) Remove screw (2) from counterbalance valve (3).
- (3) Remove four screws (4) and counterbalance valve (3) from auxiliary winch drive motor (5).
- (4) Remove two screws (6), lockwashers (7), and washers (8) from brake housing assembly (9). Discard lockwashers.
- (5) Remove auxiliary winch drive motor (5) with input shaft (10) from brake housing assembly (9).



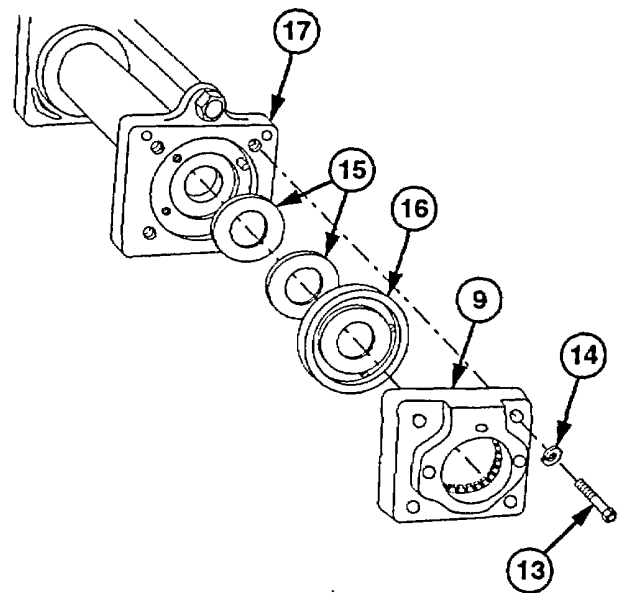
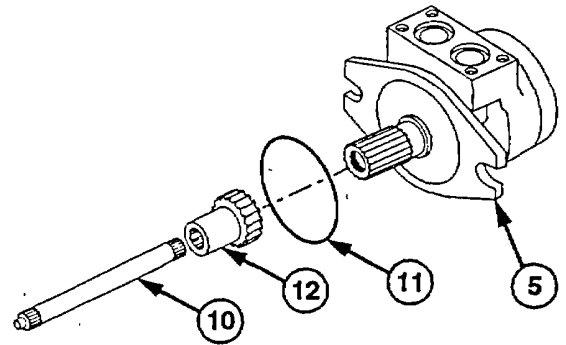
28-5. AUXILIARY WINCH REPAIR (CONT)

- (6) Remove preformed packing (11) from drive motor (5). Discard preformed packing.
- (7) Remove input shaft (10) from drive motor (5).
- (8) Remove brake shaft (12) from input shaft (10).

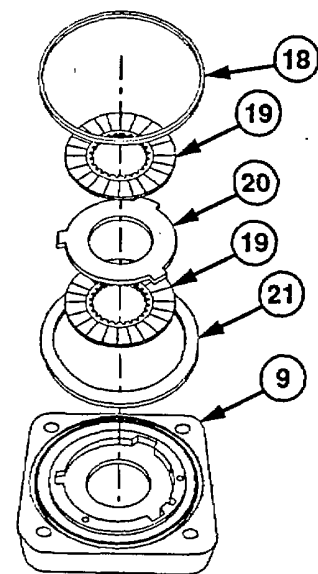
WARNING

Loosen capscrews evenly until spring pressure is completely relieved. Failure to do so may result in injury to personnel.

- (9) Remove four screws (13) and lockwashers (14) from brake housing assembly (9). Discard lockwashers.
- (10) Remove brake housing assembly (9) with two springs (15) and thrust plate (16) from end support (17).



- (11) Remove preformed packing (18) from housing (9).
- (12) Remove two friction disc plates (19) and steel brake drive plates (20) from housing (9).
- (13) Remove seal (21) from housing (9). Discard seal.



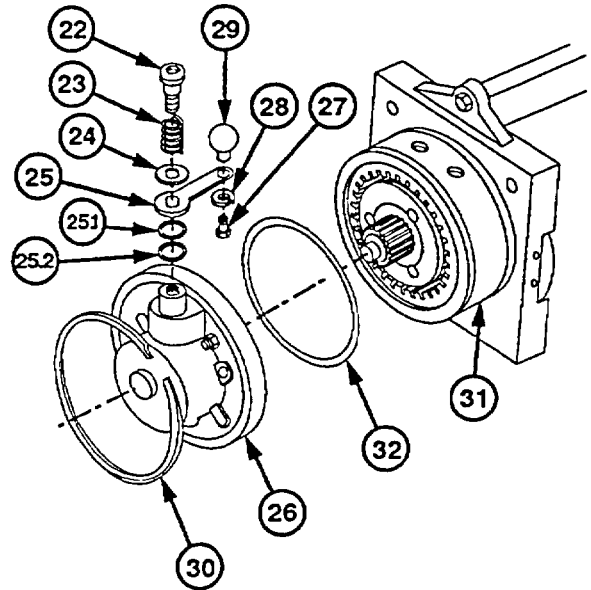
WARNING

Screw is under spring tension. Remove screw slowly to relieve tension and prevent serious injury.

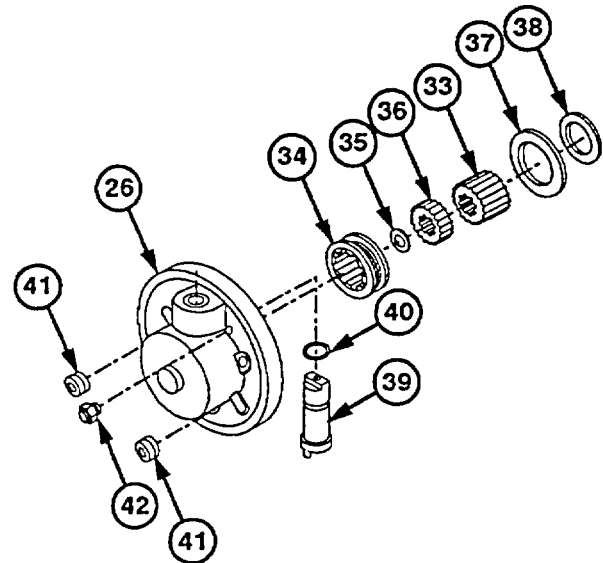
- (14) Remove sockethead screw (22), spring (23), washer (24), and shifter arm (25) from end cover (26).
- (14.1) Remove preformed packing (25.1) and preformed packing (25.2) from end cover (26). Discard preformed packings.
- (15) Remove sockethead screw (27), lockwasher (28), and knob (29) from shifter arm (25). Discard lockwashers.

WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.



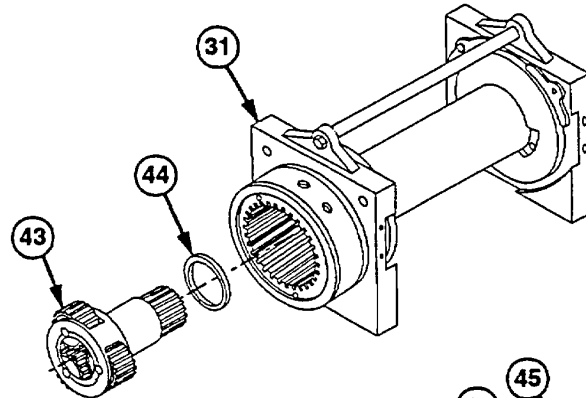
- (16) Remove retaining ring (30) from ring gear (31).
- (17) Remove end cover (26) from ring gear (31).
- (18) Remove preformed packing (32) from end cover (26). Discard preformed packing.



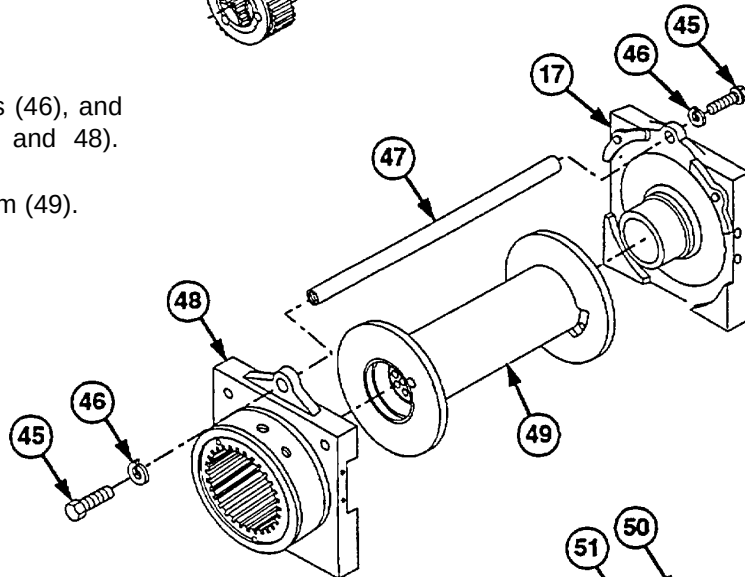
- (19) Remove sun gear (33) from drive coupling (34).
- (20) Remove washer (35), drive gear (36), thrust washer support (37), and thrust washer (38) from end cover (26).
- (21) Remove drive coupling (34) from end cover (26).
- (22) Remove shifter shaft (39) from end cover (26).
- (23) Remove preformed packing (40) from shifter shaft (39). Discard preformed packing.
- (24) Remove two plugs (41) and breather (42) from end cover (26).

28-5. AUXILIARY WINCH REPAIR (CONT)

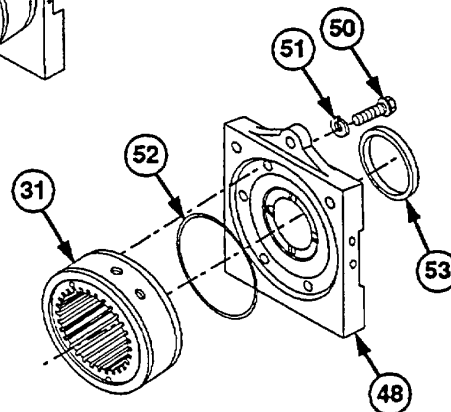
- (25) Remove secondary carrier assembly (43) and thrust washer (44) from ring gear (31).
- (26) Remove thrust washer (44) from secondary carrier assembly (43).



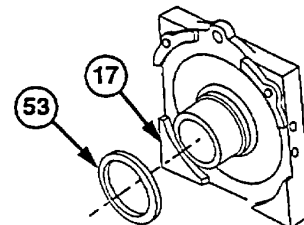
- (27) Remove two screws (45), lockwashers (46), and tie bar (47) from end supports (17 and 48). Discard lockwashers.
- (28) Pry end supports (17 and 48) from drum (49).



- (29) Remove six screws (50) and lockwashers (51) from end support (48) and ring gear (31). Discard lockwashers.
- (30) Remove ring gear (31) and preformed packing (52) from end support (48). Discard preformed packing.



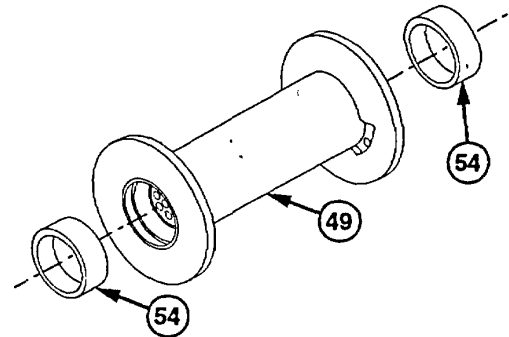
- (31) Remove two seal rings (53) from end supports (17 and 48). Discard seal rings.



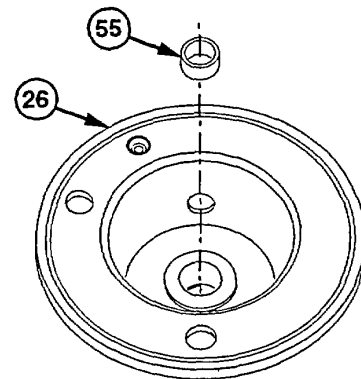
NOTE

Do steps (32 and 33) only if bearings or bushings fail inspection.

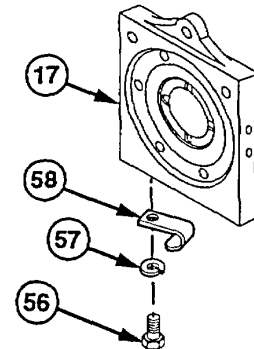
- (32) Remove two bronze bearings (54) from drum (49).



- (33) Remove bronze bushing (55) from end cover (26).



- (34) Remove screw (56), lockwasher (57), and cable hook (58) from end support (17). Discard lockwasher.



b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.

28-5. AUXILIARY WINCH REPAIR (CONT)

WARNING

Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles, shield, and gloves).

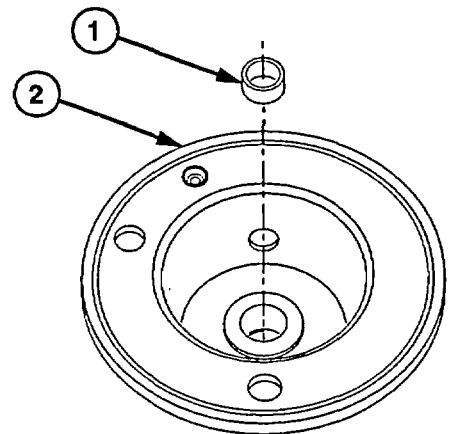
- (2) Dry parts with compressed air.
- (3) Clean all sealing surfaces.
- (4) Inspect machined surfaces for damage.
- (5) Replace oil seals and damaged parts.
- (6) Inspect bushing and bearings for pitting, roundness, and for inside diameter larger than 5/8 in. (16 mm).
- (7) Replace bushing or bearings if pitted, out of round, or smaller than 5/8 in. (16 mm).

c. Assembly

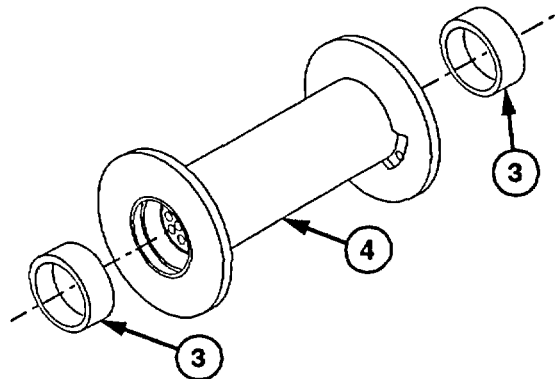
NOTE

Do steps (1) and (2) if bushing and bearings were removed.

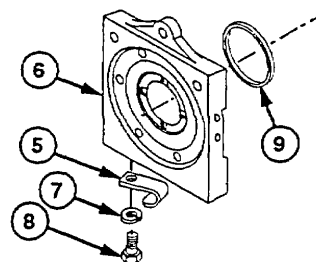
- (1) Press bronze bushing (1) into end cover (2).



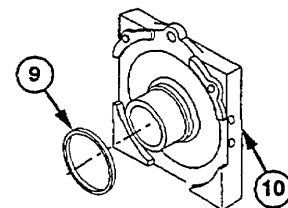
- (2) Press two bronze bearings (3) into ends of drum (4).



- (3) Install cable hook (5) on end support (6) with new lockwasher (7) and screw (8).



- (4) Install two new seal rings (9) on end supports (6 and 10).

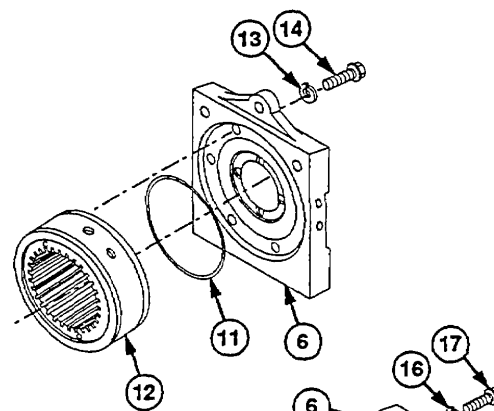


- (5) Install new preformed packing (11) in end support (6).

NOTE

When installing ring gear, ensure that hole on ring gear for manual kickout shifter arm is at top and aligns with tie bar.

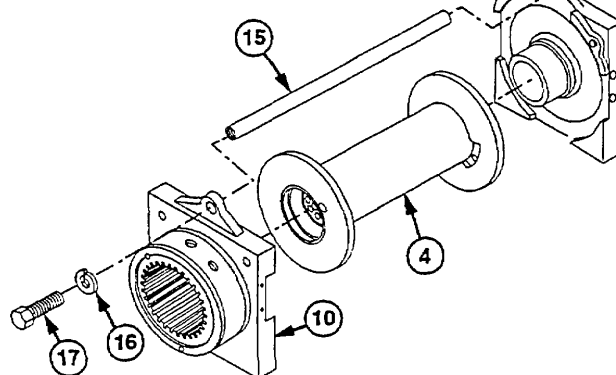
- (6) Align holes in ring gear (12) with holes in end support (6) and install ring gear (12) on end support (6).
- (7) Install six new lockwashers (13) and screws (14) on end support (6) and ring gear (12).



NOTE

Cable hold down side of drum goes toward motor end of support.

- (8) Install end supports (6 and 10) on drum (4).
- (9) Install tie bar (15) on end supports (6 and 10) with two new lockwashers (16) and screws (17). Torque to 50 lb-ft (68 N•m).



28-5. AUXILIARY WINCH REPAIR (CONT)

- (10) Install thrust washer (18) on shaft portion of secondary carrier assembly (19).
- (11) Install secondary carrier assembly (19), shaft first, on ring gear (12) until flush.

NOTE

Sun gear is installed with beveled teeth out.

- (12) Install sun gear (20) in secondary carrier assembly (19).
- (13) Install new preformed packing (21) on shifter shaft (22).
- (14) Install shifter shaft (22) in end cover (2).
- (15) Install knob (23) on shifter arm (24) with new lockwasher (25) and screw (26).
- (15.1) Install new preformed packing (26.1) and new preformed packing (26.2) on end cover (2).

WARNING

Spring is under pressure when compressed. Use care when installing to prevent serious injury.

NOTE

Arrow on shifter shaft should point in same direction as shifter arm.

- (16) Install shifter arm (24) on shifter shaft (22) with washer (27), spring (28), and sockethead screw (29).
- (17) Install new preformed packing (30) on end cover (2).

NOTE

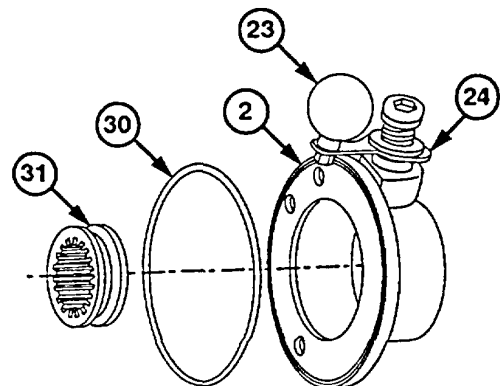
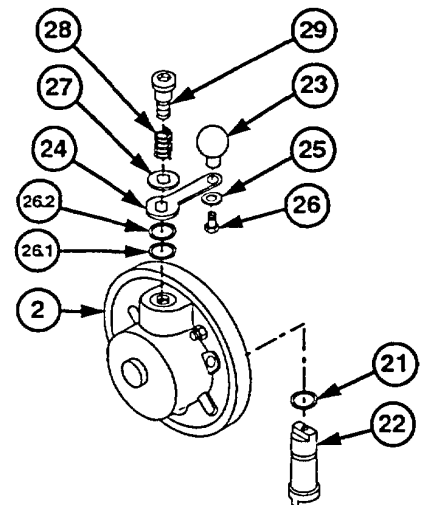
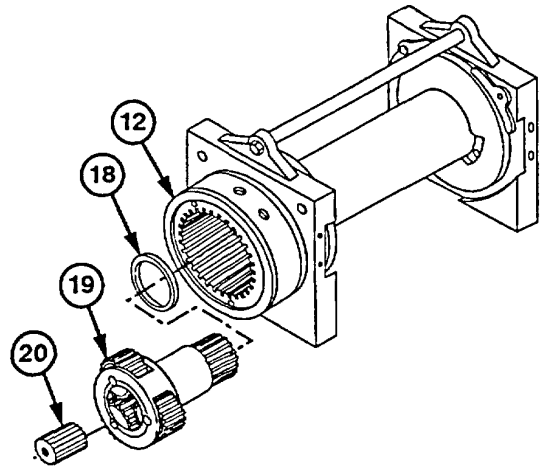
Ensure groove around drive coupling engages boss on shifter shaft.

- (18) Install drive coupling (31) in end cover (2).

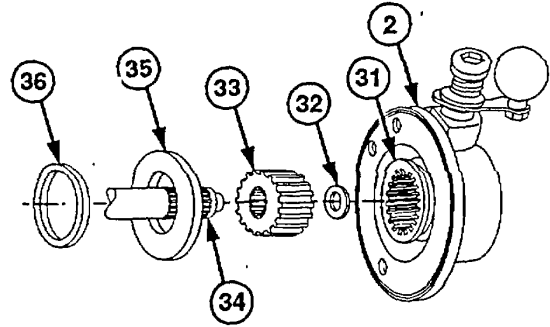
NOTE

Shifter arm must be turned so drive coupling lays flat in end cover.

- (19) Turn shifter arm (24) 180 degrees so knob (23) faces outside end cover (2).



- (20) Install thrust washer (32) and drive gear (33) in drive coupling (31).
- (21) Install input shaft (34), small end first, in drive gear (33) and end cover (2).
- (22) Install thrust washer support (35) and thrust washer (36) on end cover (2).

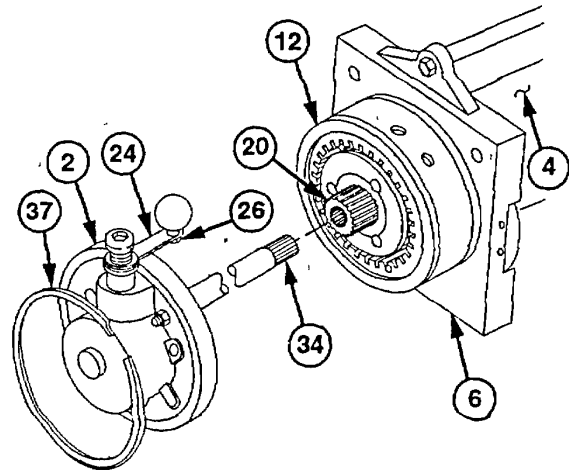


- (23) Install input shaft (34) through sun gear (20) and drum (4).
- (24) Install end cover (2) on end support (6).

NOTE

Shifter arm must align with hole in ring gear and tie bar.

- (25) Turn shifter arm (24) so screw (26) locks in hole in ring gear (12).



WARNING

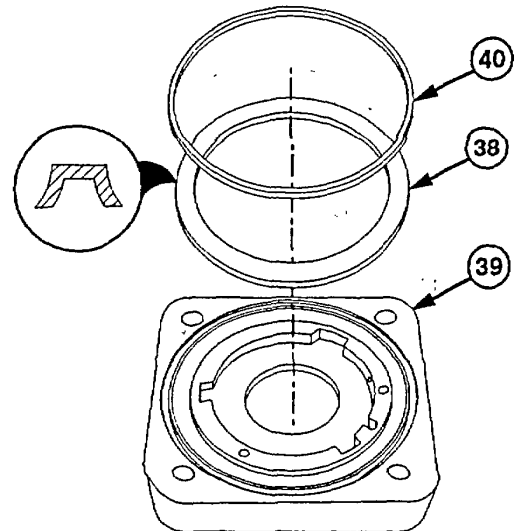
Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (26) Install retaining ring (37) on ring gear (12).

NOTE

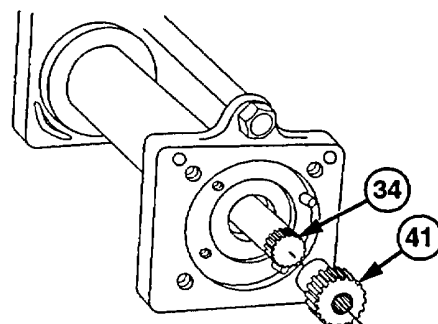
- Open side of seal faces brake housing.
- Seal is installed 2 in. (50 mm) at a time. Start with outer edge, then move to inner edge until seal is installed flush with housing.

- (27) Install seal (38) in brake housing (39).
- (28) Install new preformed packing (40) in brake housing (39).



28-5. AUXILIARY WINCH REPAIR (CONT)

- (29) Install brake shaft (41) over end of input shaft (34).

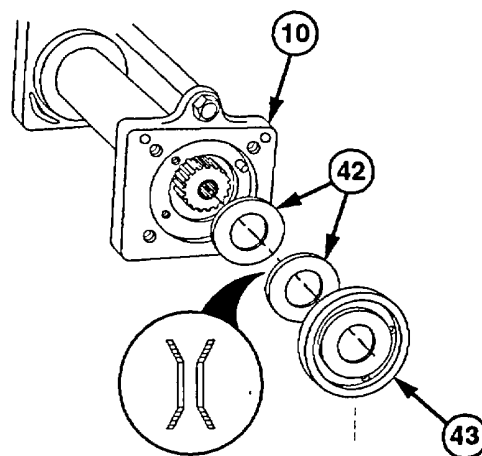
**CAUTION**

Springs must be centered in end support. Position auxiliary winch so brake shaft points up. Failure to comply may cause springs to bind when brake housing is installed.

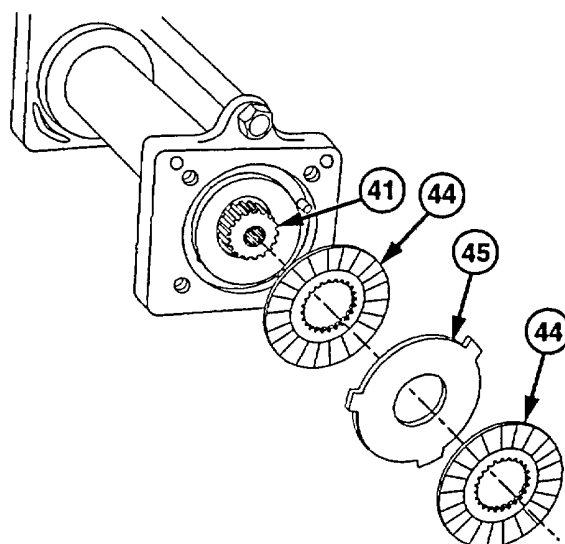
NOTE

- Springs must be installed so outside edges do not touch.
- Grooved side of thrust plate faces out.

- (30) Install two springs (42) and thrust plate (43) in end support (10).



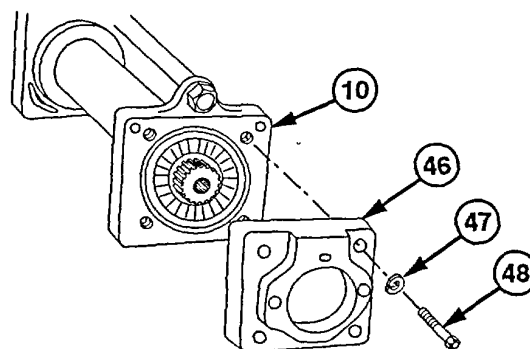
- (31) Install two friction disc plates (44) and steel brake drive plate (45) on brake shaft (41).



NOTE

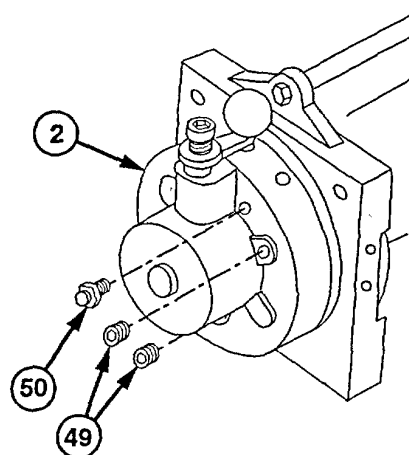
- Notches in brake housing must align with tabs on steel drive plate.
- Holes in brake housing must align with dowels in end support.
- Screws should be tightened evenly to uniformly compress spring.

- (32) Install brake housing (46) on end support (10) with four new lockwashers (47) and screws (48). Torque to 45-55 lb-ft (61-75 N•m).

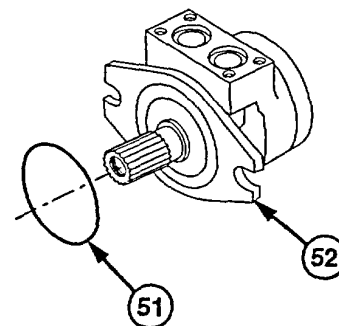
**WARNING**

Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (33) Coat threads of two plugs (49) and breather (50) with pipe thread sealing compound.
- (34) Install two plugs (49) and breather (50) on end cover (2).

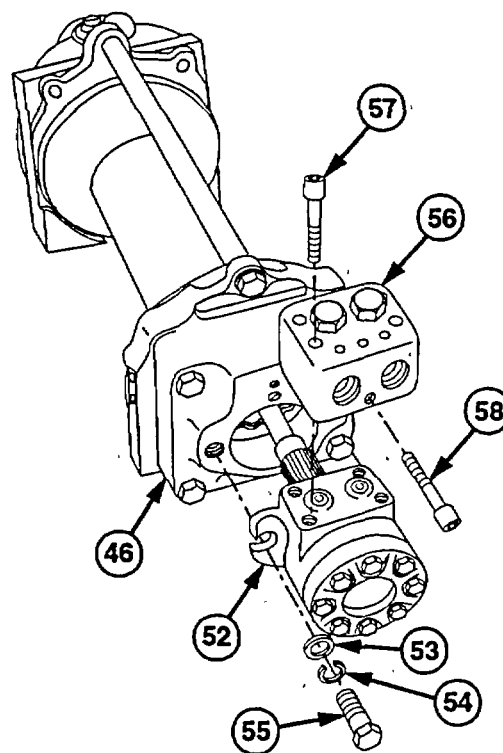


- (35) Install new preformed packing (51) on auxiliary winch drive motor (52).



28-5. AUXILIARY WINCH REPAIR (CONT)

- (36) Position auxiliary winch drive motor (52) on brake housing (46) with two washers (53), new lockwashers (54), and screws (55).
- (37) Install counterbalance valve (56) on auxiliary winch drive motor (52) with four screws (57).
- (38) Install screw (58) on counterbalance valve (56).



28-6. POWER TAKEOFF REPAIR

This task covers:

a. Disassembly	c. Assembly
b. Cleaning/Inspection	d. Follow-On Maintenance

INITIAL SETUP

Equipment Conditions

Power takeoff removed (para 17-12).

Tools and Special Tools

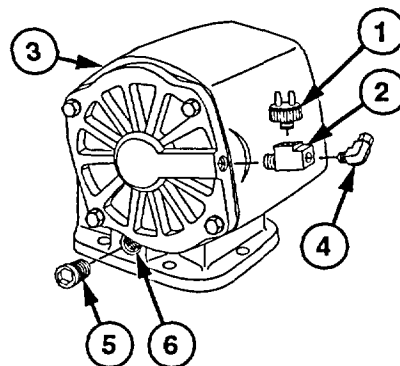
Tool Kit, Genl Mech (Item 202, Appendix E)
 Caps, Vise Jaw (Item 17, Appendix E)
 Goggles, Industrial (Item 57, Appendix E)
 Pliers, Retaining Ring (Item 106, Appendix E)
 Press, Hydraulic (Item 116, Appendix E)
 Puller Kit, Mechanical, Gear and Brg
 (Item 124, Appendix E)
 Socket, Sockethead Screw, 1/8 In,
 (Item 170, Appendix E)
 Vise, Machinist's (Item 207, Appendix E)
 Wrench, Torque, 0-300 Lb-In. (Item 235,
 Appendix E)

Materials/Parts

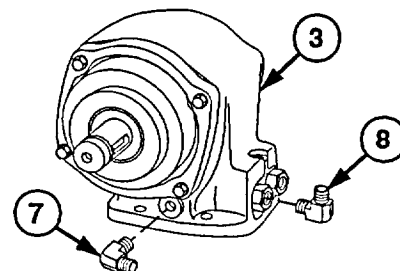
Adhesive-Sealant (Item 6, Appendix B)
 Compound, Sealing, Pipe Thread (Item 28,
 Appendix B)
 Grease, Automotive and Artillery, (item 32,
 Appendix B)
 Oil, Lubricating (Item 44, Appendix B)
 Solvent, Dry Cleaning (Item 54, Appendix B)
 Parts Kit, Clutch (Item 208, Appendix F)
 Parts Kit, Linear (Item 210, Appendix F)

a. Disassembly

- (1) Remove switch (1) from reducer (2).
- (2) Remove reducer (2) from power takeoff (PTO) housing (3). Discard preformed packings.
- (3) Remove elbow (4) from reducer (2).
- (4) Remove plug (5) from idler shaft (6).

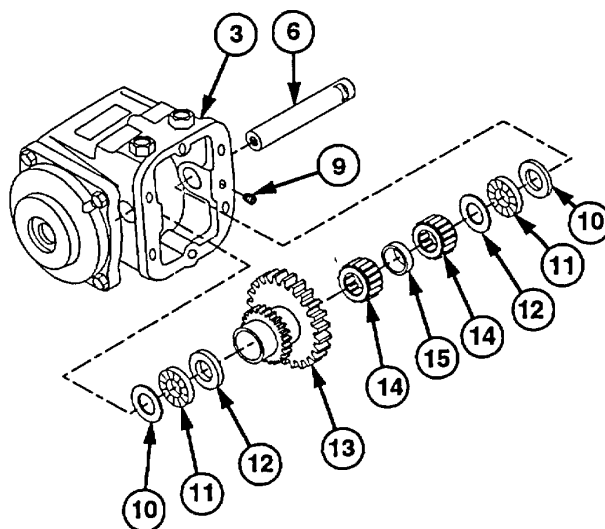


- (5) Remove elbows (7 and 8) from PTO housing (3).



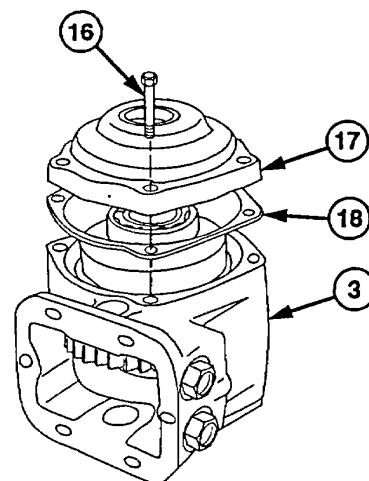
28-6. POWER TAKEOFF REPAIR (CONT)

- (6) Remove setscrew (9) from PTO housing (3).
- (7) Tap idler shaft (6) out of PTO housing (3).
- (8) Remove two thick thrust races (10), needle thrust bearings (11), thin thrust races (12), and input gear (13) from PTO housing (3).
- (9) Remove two needle bearings (14) and spacer (15) from input gear (13).

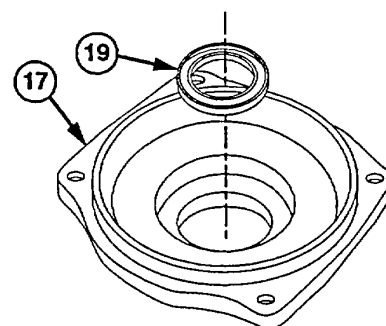
**NOTE**

Output shaft may remain in PTO housing or come out with open-end bearing cover.

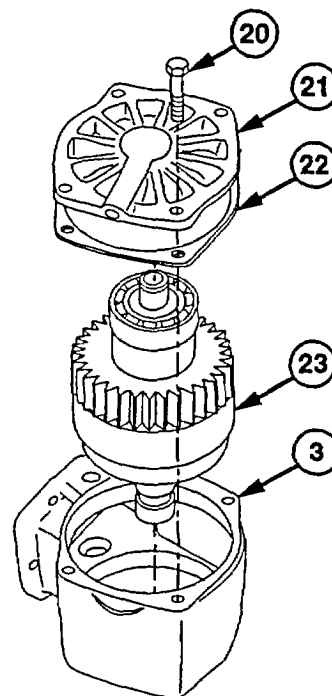
- (10) Remove four screws (16), open-end bearing cover (17), and gasket (18) from PTO housing (3). Discard gasket



- (11) Remove oil seal (19) from open-end bearing cover (17). Discard oil seal.



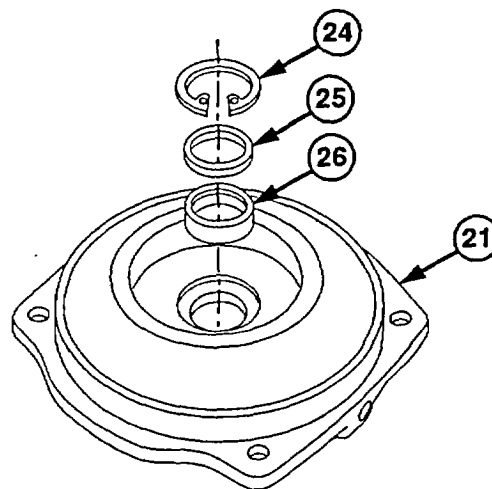
- (12) Remove four screws (20), closed-end bearing cover (21), bearing cover gasket (22), and output shaft (23) from PTO housing (3). Discard gasket.



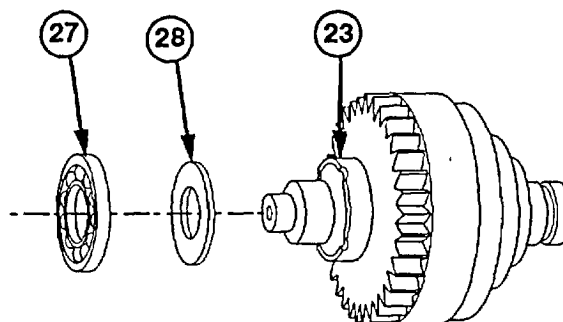
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (13) Remove retaining ring (24) and backup plate (25) from closed-end bearing cover (21). Discard retaining ring.
- (14) Remove oil seal (26) from closed-end bearing cover (21). Discard oil seal.

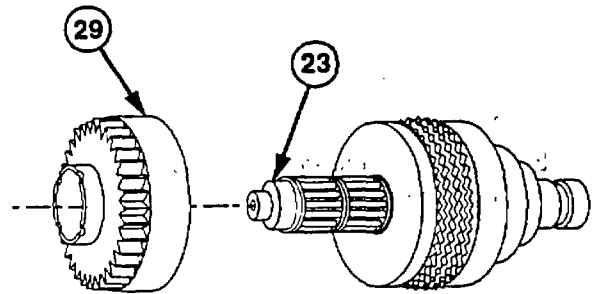


- (15) Press ball bearing (27) and thrust washer (28) from output shaft (23).

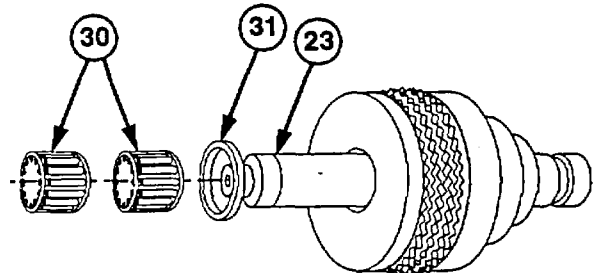


28-6. POWER TAKEOFF REPAIR (CONT)

- (16) Remove output gear (29) from output shaft (23).



- (17) Remove two roller bearings (30) and thrust washer (31) from output shaft (23).



- (18) Press ball bearing (32) from output shaft (23).

WARNING

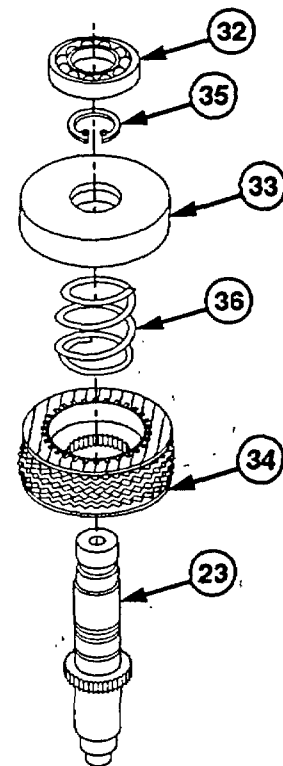
Clutch backup cylinder is under spring pressure. It must be clamped in vise to avoid sudden release of parts. Failure to comply may cause injury to personnel.

- (19) Position clutch backup cylinder (33) and inner clutch gear (34) in vise.

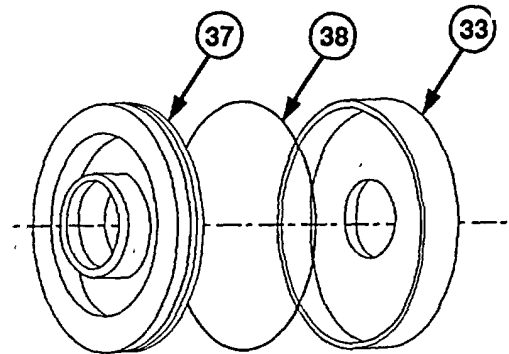
WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

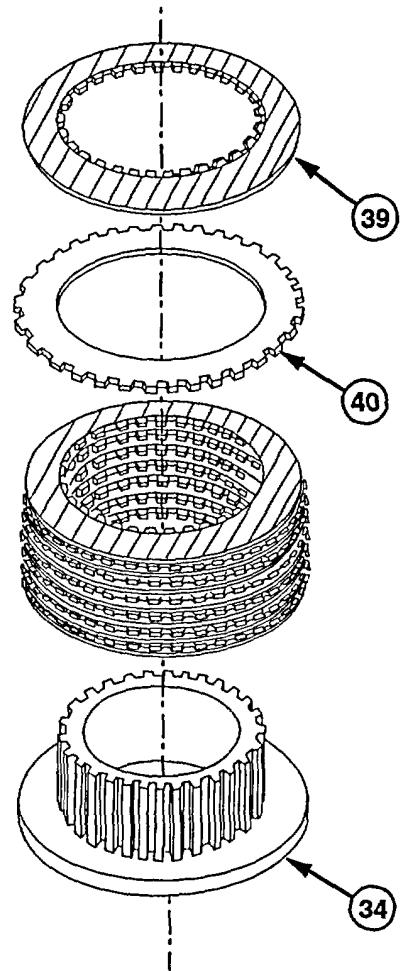
- (20) Remove retaining ring (35) from output shaft (23). Discard retaining ring.
- (21) Remove clutch backup cylinder (33), clutch spring (36), and inner clutch gear (34) from output shaft (23).



- (22) Remove piston (37) from clutch backup cylinder (33).
- (23) Remove preformed packing (38) from piston (37). Discard preformed packing.



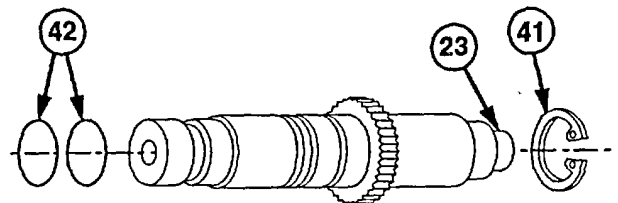
- (24) Remove eight friction discs (39) and seven clutch plates (40) from inner clutch gear (34).



WARNING

Wear eye protection and use care when removing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (25) Remove retaining ring (41) and two preformed packings (42) from output shaft (23). Discard retaining ring and preformed packings.



28-6. POWER TAKEOFF REPAIR (CONT)**b. Cleaning/Inspection****WARNING**

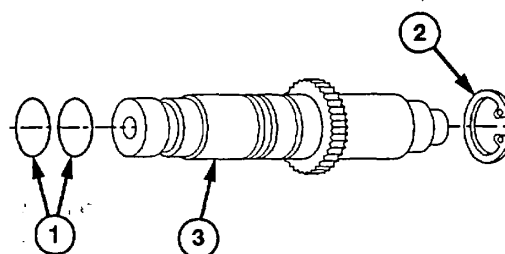
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes, and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

- (1) Clean metal parts with dry cleaning solvent.
- (2) Inspect friction discs for wear. If oil grooves are not visible on any portion of any friction disc, replace all friction discs.
- (3) Inspect clutch spring for breaks or discoloration. Replace spring if broken or discolored.
- (4) Inspect idler shaft, output shaft, and thrust washers for nicks, burrs, grooves, warps, bends, or other damage. If nicks, burrs, or grooves cannot be removed with emery cloth, replace part.
- (5) Inspect remaining parts for damage. Replace damaged parts.
- (6) Coat parts with lubricating oil.

c. Assembly**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

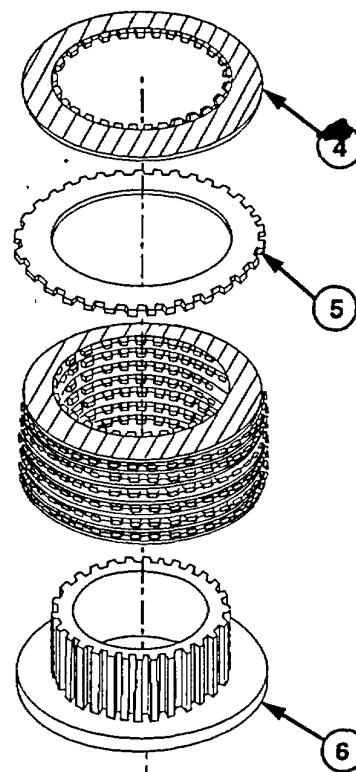
- (1) Install two new preformed packings (1) and new retaining ring (2) on output shaft (3).



NOTE

Discs and plates should be installed alternately starting with friction plates.

- (2) Install eight friction discs (4) and seven clutch plates (5) on Inner clutch gear (6).

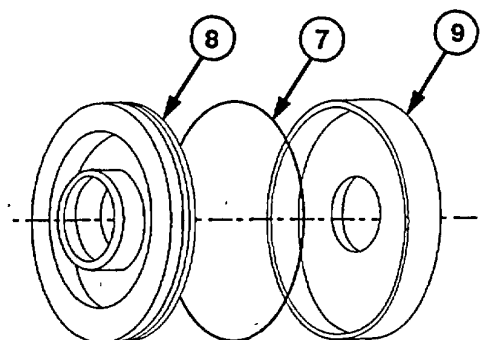


- (3) Coat new preformed packing (7) with lubricating oil.

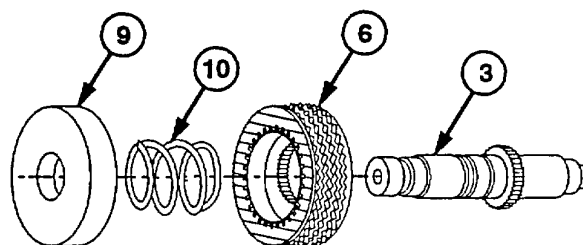
NOTE

Lip on seal faces narrow edge on piston.

- (4) Install new preformed packing (7) on clutch piston (8).
 (5) Install clutch piston (8) in backup cylinder (9).



- (6) Position inner clutch gear (6), clutch spring (10), and backup cylinder (9) on output shaft (3).
 (7) Position inner clutch gear (6) and backup cylinder (9) in vise.
 (8) Tighten vise to compress spring (10).



28-6. POWER TAKEOFF REPAIR (CONT)**WARNING**

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (9) Install new retaining ring (11) on output shaft (3) to secure backup cylinder (9).

NOTE

Assembly should be supported in press by shaft.

- (10) Position output shaft (3) in press with keyway end up.
 (11) Press ball bearing (12) on output shaft (3) until seated.

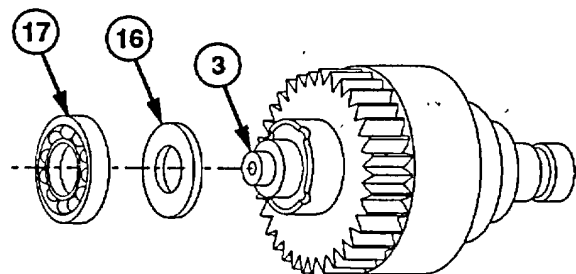
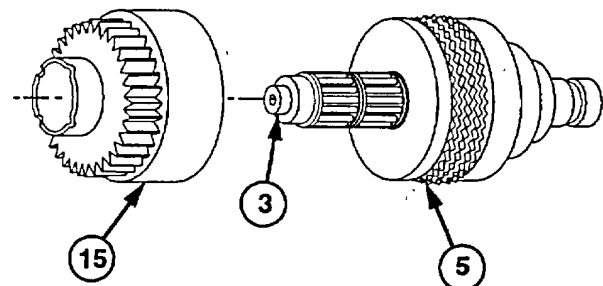
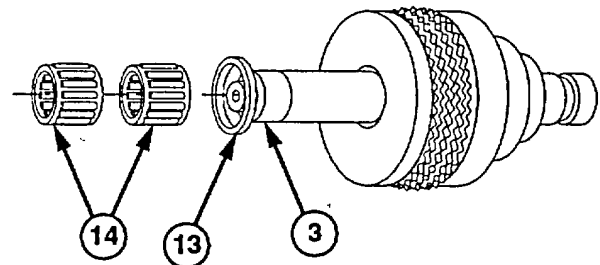
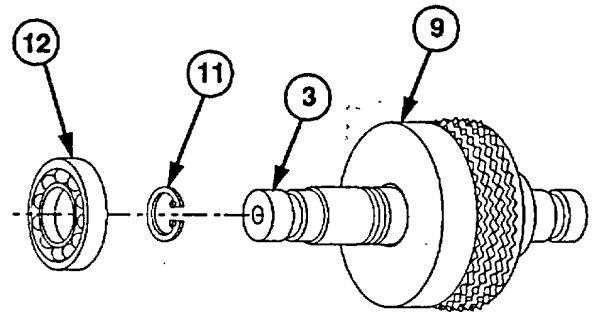
- (12) Install thrust washer (13) and two roller bearings (14) on output shaft (3).

- (13) Align splines on clutch plates (5) with splines in output gear (15).
 (14) Install output gear (15) on output shaft (3).

NOTE

Assembly should be supported in press by shaft.

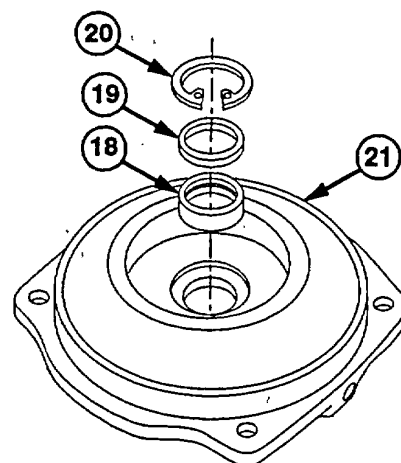
- (15) Position output shaft (3) in press with keyway end down.
 (16) Press thrustwasher (16) and ball bearing (17) on output shaft (3) until seated.



WARNING

Wear eye protection and use care when installing retaining rings. Retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (17) Install new oil seal (18), backup plate (19), and new retaining ring (20) in closed-end bearing cover (21).

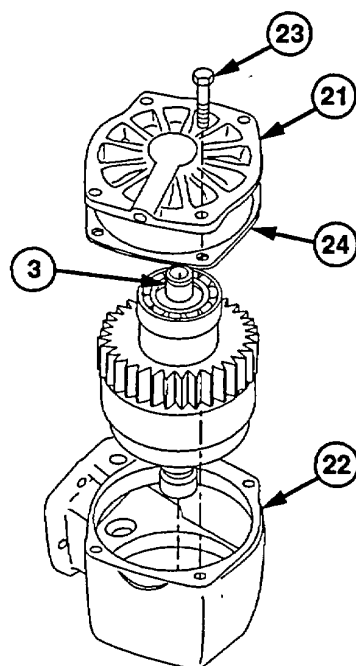


- (18) Lightly coat mounting surface of PTO housing (22) with grease.

WARNING

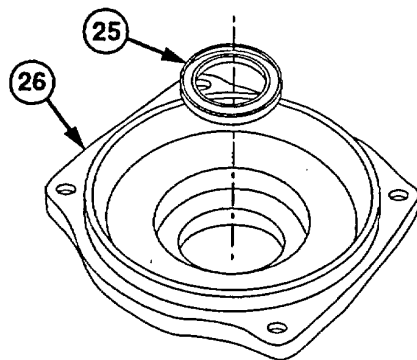
Adhesive-sealant may burn or give off harmful vapors. It is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (19) Coat threads of four screws (23) with adhesive-sealant.
 (20) Install new gasket (24), closed-end bearing cover (21), and output shaft (3) on PTO housing (22) with four screws (23). Torque to 214-240 lb-in. (23-27.1 N·m).
 (21) Install output shaft (3) on closed-end bearing cover (21).

**NOTE**

Lip on seal faces bearing cover.

- (22) Install new oil seal (25) in open-end bearing cover (26) until flush with outside surface.



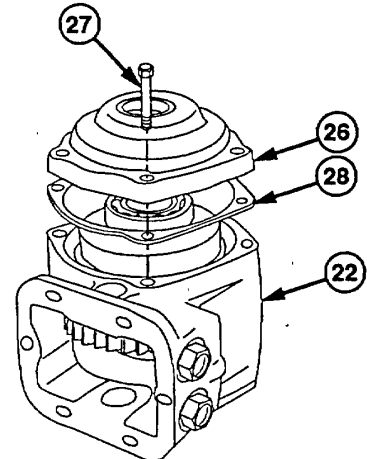
28-6. POWER TAKEOFF REPAIR (CONT)

- (23) Lightly coat mounting surface of PTO housing (22) with grease.

WARNING

Adhesive-sealant may burn or give off harmful vapors. It is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If adhesive-sealant gets on skin or clothing, wash immediately with soap and water.

- (24) Coat threads of four screws (27) with adhesive-sealant
- (25) Install new gasket (28) and open-end bearing cover (26) on PTO housing (22) with four screws (27). Torque to 214-240 lb-in. (23-27.1 N•m).
- (26) Install needle bearing (29), bearing spacer (30), and needle bearing (29) in input gear (31).
- (27) Align flat spot on idler shaft (32) with setscrew hole (33).

**NOTE**

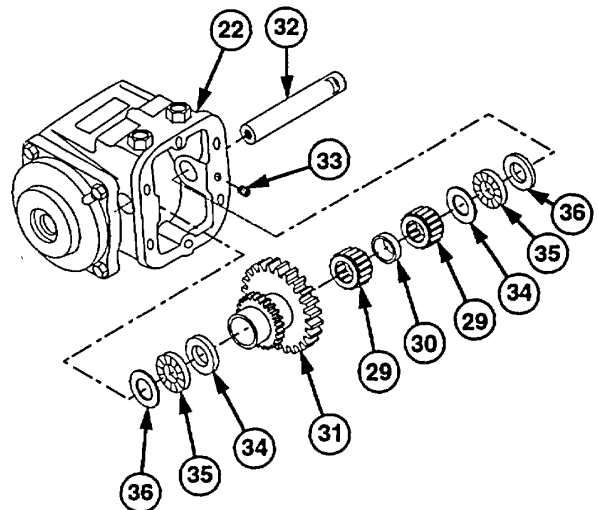
Slot on idler gear should face out.

- (28) Press Idler shaft (32) in PTO housing (22) until 0.25 in. (6 mm) shows in opening on PTO housing (22).
- (29) Install thin thrust race (34), thrust bearing (35), and thick thrust race (36) on idler shaft (32).

NOTE

Leave space to install thrust races and thrust bearing.

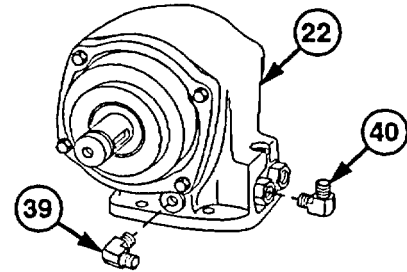
- (30) Install input gear (31) on idler shaft (32). Press idler shaft through input gear (31).
- (31) Install thin thrust race (34), thrust bearing (35), and thick thrust race (36) under input gear (31).
- (32) Install idler shaft (32) completely in PTO housing (22).
- (33) Coat threads of setscrew (37) with adhesive-sealant and install in PTO housing (22). Torque to 30 lb-in. (3.4 N•m).



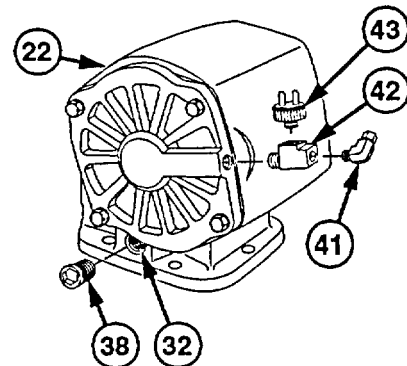
WARNING

Pipe thread sealing compound may burn or give off harmful vapors. It is harmful to skin and clothing. To avoid injury or death, keep away from open flame and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (34) Coat threads of plug (38), elbows (39 thru 41), reducer (42), and switch (43) with pipe thread sealing compound.
- (35) Install plug (38) on idler shaft (32).
- (36) Install elbows (39 and 40) on housing (22).



- (37) Install reducer (42) on housing (22).
- (38) Install switch (43) in reducer (42).
- (39) Install elbow (41) on reducer (42).

**d. Follow-On Maintenance**

Install power takeoff (para 17-12).

CHAPTER 29
STORAGE CONTAINER MAINTENANCE

Contents	Para	Page
Introduction	29-1	29-1
Shipping and Storage Containers, Engine, Transmission, and Transfer Case Repair	29-2	29-2

29-1. INTRODUCTION

This chapter contains instructions for repair of storage container components at the General Support maintenance level.

29-2. SHIPPING AND STORAGE CONTAINERS, ENGINE, TRANSMISSION, AND TRANSFER CASE REPAIR

This task covers:

- a. Disassembly
- b. Cleaning/inspection
- c. Assembly

INITIAL SETUP**Equipment Conditions**

- Engine removed from container (para 3-4).
- Transmission removed from container (para 7-3).
- Transfer case removed from container (para 8-2).

Materials/Parts

- Compound, Sealing, Pipe Thread (Item 28, Appendix B)
- Lockwashers (60) (Item 122, Appendix F)

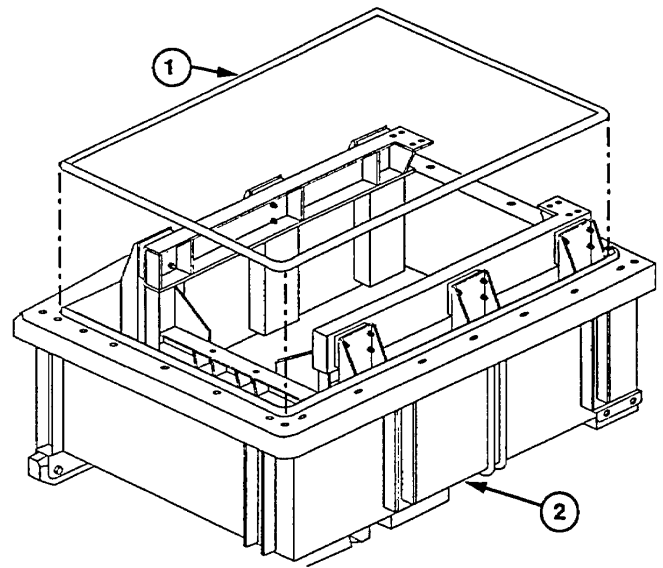
Tools and Special Tools

- Tool Kit, Genl Mech (Item 202, Appendix E)
- Wrench, Torque, 0-175 Lb-Ft (Item 236, Appendix E)

a. Disassembly**NOTE**

All three containers are repaired in a similar manner. Engine container is shown throughout the task.

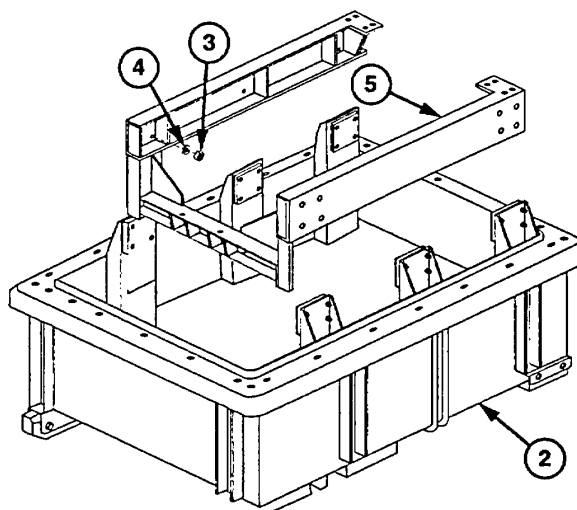
- (1) Remove seal (1) from lower container (2).



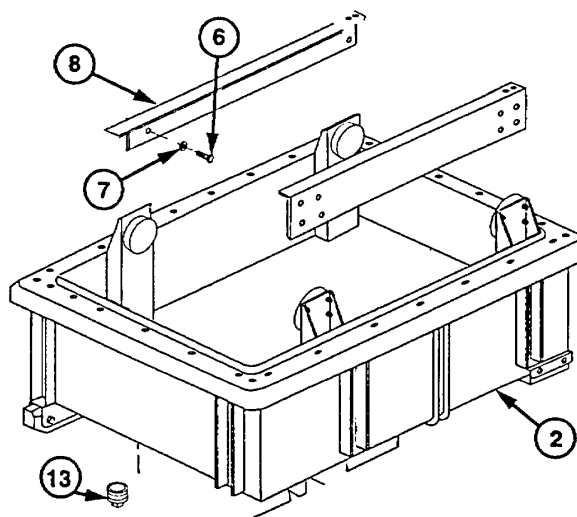
NOTE

- Do step (2) for engine container; do step (3) for transmission and transfer case containers.
- Position of inner frame(s) should be marked before removal.

- (2) Remove 24 nuts (3), lockwashers (4) and inner frame (5) from lower container (2). Discard lockwashers.

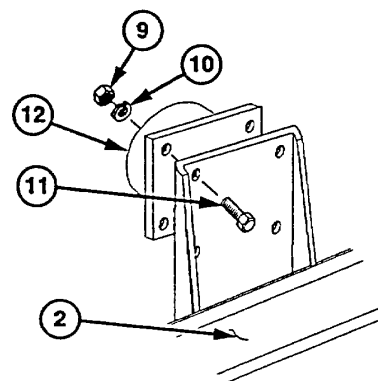


- (3) Remove four screws (6), lockwashers (7) and inner frame (8) from lower container (2). Discard lockwashers.

**NOTE**

All shear mounts are similar except for shape.

- (4) Remove four nuts (9), lockwashers (10), screws (11), and shear mount (12) from lower container (2). Discard lockwashers.
- (5) Remove plug (13) from lower container (2).

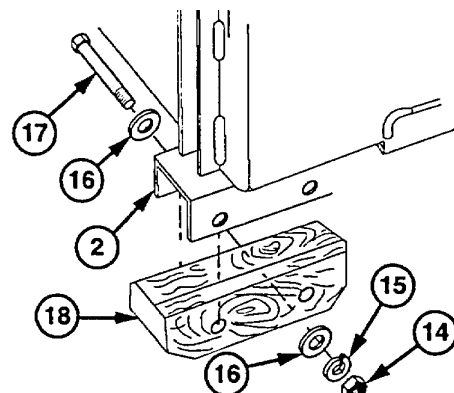


29-2. SHIPPING AND STORAGE CONTAINERS, ENGINE, TRANSMISSION, AND TRANSFER CASE REPAIR (CONT).

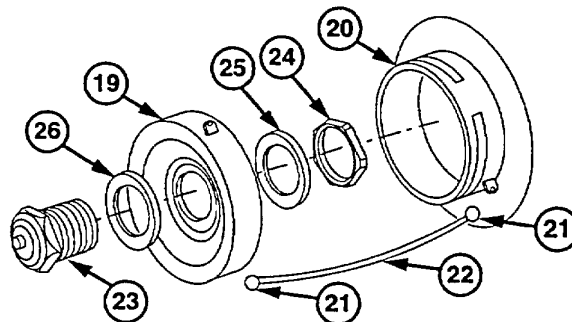
NOTE

Skid legs on engine and transmission containers do not have flat washers.

- (6) Remove two nuts (14), lockwashers (15), four washers (16), two screws (17) and skid leg (18) from lower container (2).



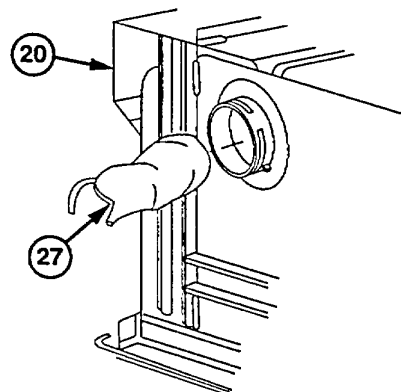
- (7) Remove cover (19) from upper container (20).
- (8) Remove two end balls (21) and cable (22) from upper container (20) and cover (19).
- (9) Remove valve (23), nut (24), washer (25), and gasket (26) from cover (19).



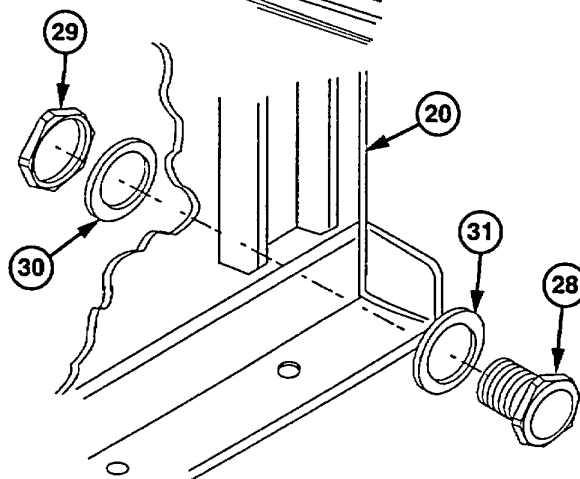
NOTE

Number of dehumidification bags may vary due to amount of units per bag.

- (10) Remove 128 units of desiccant (8 to 16 bags) (27) from upper container (20).



- (11) Remove humidity indicator (28), nut (29), washer (30), and gasket (31) from upper container (20).

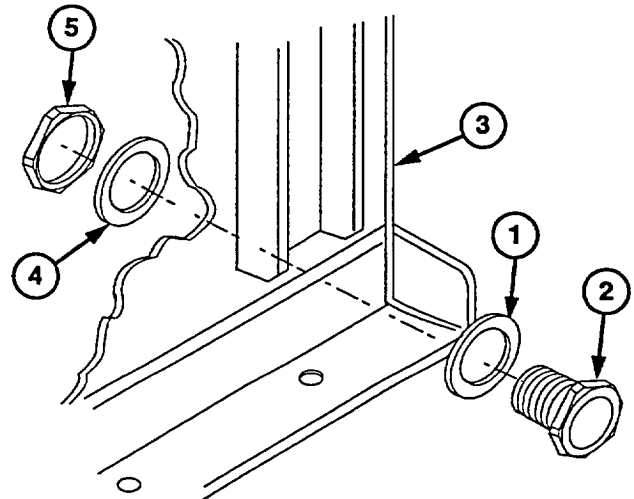


b. Cleaning/Inspection

- (1) Clean interior and exterior surfaces of container. Use any process or combination of processes which will accomplish through cleaning without damage to container.
- (2) Clean all desiccant port covers/assemblies removed from container.
- (3) Remove paint scale and rust.
- (4) Check interior and exterior of container for dents, cracks, defective welds and other defects. Dents approximately .75 in. (1.9 cm) or less deep that do not penetrate skin or weaken structure are acceptable and are not considered defects.
- (5) Check inner frame for bends and cracks.
- (6) Check mounting brackets for bends and cracks.
- (7) Check wire basket for defective tack welds.
- (8) Check desiccant port covers/assemblies for damage and reusability.
- (9) Check vibration dampener mounts for defects, such as cracking, tearing or evidence of separation of bonding between metal and elastomer, which may affect the function of the mount.
- (10) Inspect skids while on container for weakness and wear.
- (11) Inspect installation decal for cracks, tears, illegibility and failure of adhesion.

c. Assembly

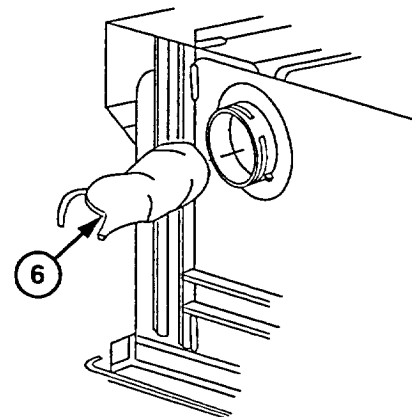
- (1) Install gasket (1) and humidity indicator (2) on upper container (3) with washer (4) and nut (5).



NOTE

Desiccant comes in bags of eight units each or 16 units each. The minimum units for engine is 128 units, transmission and transfer case is 48 units.

- (2) Install appropriate units of desiccant (8 to 16 bags) (6).



29-2. SHIPPING AND STORAGE CONTAINERS, ENGINE, TRANSMISSION, AND TRANSFER CASE REPAIR (CONT).

- (3) Install gasket (7) and valve (8) in cover (9) with washer (10) and nut (11).
- (4) Install cover (9) on upper container (5) with cable (12) and two balls (13).

NOTE

Skid legs on engine and transmission containers do not have flat washers.

- (5) Install skid leg (14) on lower container (15) with two screws (16), four washers (17), two new lockwashers (18), and nuts (19). Torque to 31-37 lb-ft (42-50 N•m).

WARNING

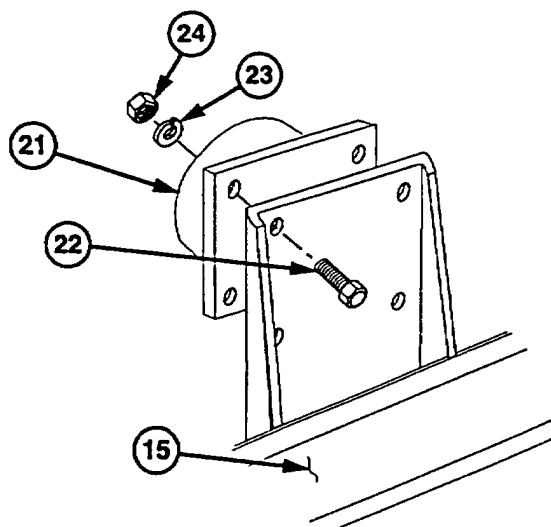
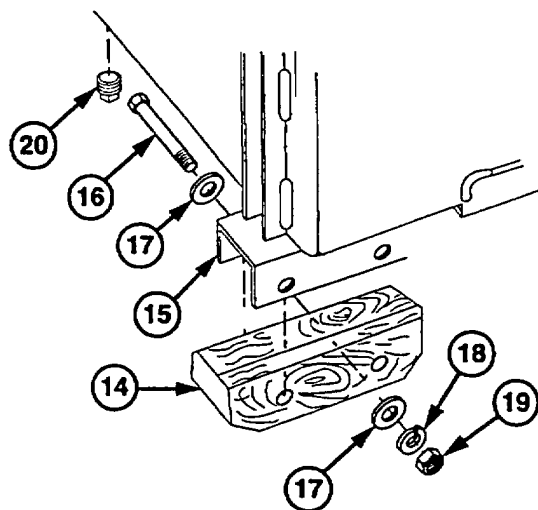
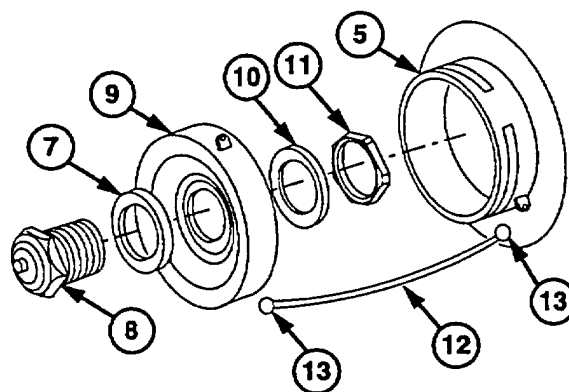
Pipe thread sealing compound can burn easily, can give off harmful vapors, and is harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in well-ventilated area. If pipe thread sealing compound gets on skin or clothing, wash immediately with soap and water.

- (6) Coat threads of pipe plug (20) with pipe thread compound and install in lower container (15).

NOTE

All shear mounts are similar except for shape.

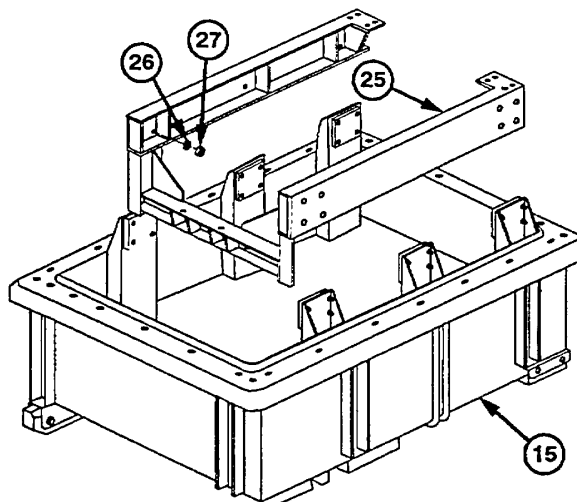
- (7) Install shear mount (21) on lower container (15) with four screws (22), new lockwashers (23) and nuts (24).



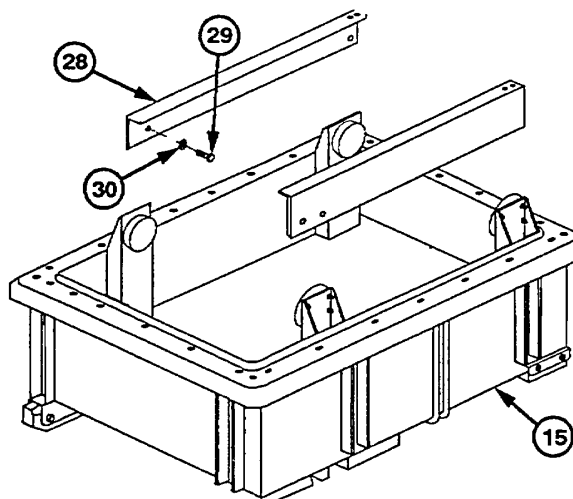
NOTE

Do step (8) for engine container, do step (9) for transmission and transfer case containers.

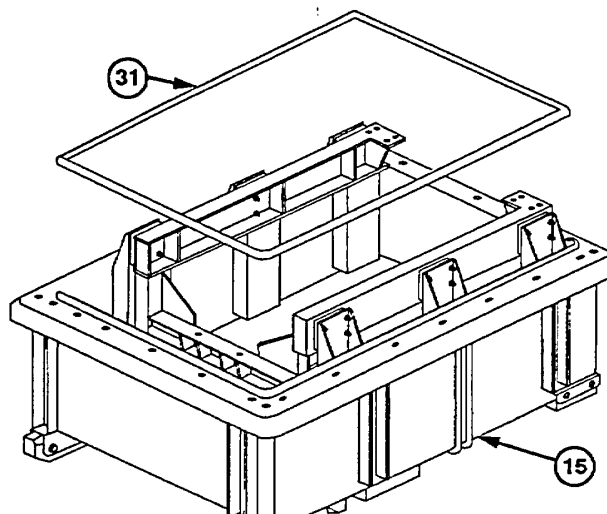
- (8) Install inner frame (25) in lower container (15) with 24 new lockwashers (26) and nuts (27).



- (9) Install inner frame (28) with four screws (29) and new lockwashers (30).



- (10) Install seal (31) on lower container (15).



APPENDIX A REFERENCES

A-1. SCOPE

This appendix lists all forms, field manuals, technical manuals, and other publications referenced in this manual.

A-2. PUBLICATIONS INDEX

The following index should be consulted frequently for latest changes or revisions and for new publications relating to material covered in this technical manuals.

Consolidated Index of Army Publications and Blank Forms DA Pam 25-30

A-3. FORMS

The following forms pertain to this manual. See DA Pam 25-30 for index of blank forms. See DA Pam 738-750, The Army Maintenance Management System (TAMMS), for instructions on the use of maintenance forms pertaining to this material.

Field Organizations Unit Status Report AR 220-1
 Recommended Changes to DA Publications and Blank Forms DA Form 2028
 Recommended Changes to Equipment Technical Publications DA Form 2028-2
 Equipment Inspection and Maintenance Worksheet DA Form 2404
 Maintenance Request DA Form 2407
 Equipment Control Record DA Form 2408-9
 Quality Deficiency Report (Category II) SF 368

A-4. OTHER PUBLICATIONS

The following publications contain information pertinent to the HET Tractor and associated equipment.

a. Department of Army Pamphlets

The Army Maintenance Management System (TAMMS) DA Pam 738-750

b. Field Manuals

Nuclear, Biological, and Chemical (NBC) Protection FM 3-4
 Nuclear, Biological, and Chemical (NBC) Decontamination FM 3-5
 First Aid for Soldiers FM 21-11
 Nuclear, Biological, and Chemical (NBC) Defense FM 21-40

c. Lubrication Order

Lubrication Order for Truck, Tractor, M1070, 8 x 8,
 Heavy Equipment Transporter LO 9-2320-360-12

d. Technical Bulletins

Pre-Embarkation Requirements TB 9-2300-281-35
 Warranty Technical Bulletin for Truck, Tractor, M1070, 8 x 8,
 Heavy Equipment Transporter TB 9-2320-360-14
 Equipment Improvement Report and Maintenance Digest: TACOM Equipment TB 43-001-39
 Cooling Systems: Tactical Vehicles TB 750-254

A-4. OTHER PUBLICATIONS (CONT)**e. Technical Manuals**

Chemical, Biological, and Radiological (CBR) Decontamination	TM 3-220
Operator's Manual for Truck, Tractor, M1070, 8 x 8, Heavy Equipment Transporter	TM 9-2320-360-10
Hand Receipt Manual for Truck, Tractor, M1070, 8 x 8, Heavy Equipment Transporter	TM 9-2320-360-10-HR
Unit Maintenance Manual for Truck, Tractor, M1070, 8 x 8, Heavy Equipment Transporter	TM 9-2320-360-20
Unit Maintenance Repair Parts and Special Tools List for Truck, Tractor, M1070, 8 x 8, Heavy Equipment Transporter	TM 9-2320-360-20P
Direct Support and General Support Repair Parts and Special Tools List for Truck, Tractor, M1070, 8 x 8, Heavy Equipment Transporter	TM 9-2320-360-34P
Equipment Improvement Report and Maintenance Summary	TM 43-1043
Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use	TM 750-244-6

APPENDIX B EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

B-1. SCOPE

This appendix lists expendable and durable items that you will need to operate and maintain the HET Tractor. This listing is for information only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-790, Expendable/Durable Items (except medical, class V repair parts, and heraldic items), or CTA 8-100, Army Medical Department Expendable/Durable Items.

B-2. EXPLANATION OF COLUMNS

a. Column (1)- Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the item, e.g., "Oil, Lubricating (Item 42, Appendix B)."

b. Column (2) - Level. This column identifies the lowest level of maintenance that requires the item.

c. Column (3) - National Stock Number. This is the national stock number assigned to the item which you can use to requisition it.

d. Column (4) - Item Name, Description, Commercial and Government Entity Code (CAGEC), and Part Number. This provides the other information you need to identify the item.

e. Column (5)- Unit of Measure. This code shows the physical measurement or count of an item, such as gallon, dozen, gross, etc.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	O	8040-00-273-8717	Adhesive (81348) MMM-A-121	pt
2	O	8040-00-843-0802	Adhesive-Sealant, Silicone, RTV, General Purpose (MIL-A-46106A) (01139) 108	oz
2.1	F		Adhesive-Sealant (05972) 510	ml
3	O	5330-01-325-6993	Adhesive-Sealant (05972) 515	ml
4	F		Adhesive-Sealant (51517) 518	ml
5	O	8030-00-148-9833	Adhesive-Sealant (MIL-S-46163) (05972) 271	ml
6	O	8040-01-250-3969	Adhesive-Sealant (05972) 242	ml
7	F		Adhesive-Sealant (05972) 290	ml
7.1	H		Adhesive-Sealant (05972) 601	ml

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST (CONT)

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
8	F		Adhesive-Sealant (05972) 680	ml
9	F		Adhesive-Sealant, Permatex No. 1	ml
10	F		Adhesive-Sealant, Permatex No. 2	ml
10.1	F		Adhesive-Spray (04963) 77	oz
11	C	8040-00-938-6860	17 oz. can	
			Antifreeze, Arctic Type (MIL-A-11755) (81349)	
		6850-00-243-1992	1 gal can	gl
		6850-00-174-1806	55 gal drum	gl
12	C	6850-00-181-7940	Antifreeze, Permanent, Glycol, Inhibited (MIL-A-46153) (81349)	gl
13	F		Caps, Shipping and Sealing	
14	O		Cement, General Purpose, Synthetic Base (MIL-A-4003) (81349)	
15	C	7930-00-634-3935	Chips, Soap (81348) P-S-579	
16	F		Cloth, Crocus	
17	F		Clips, Wire (45152) 27886AX	
18	O	8030-00-597-5367	Compound, Antiseize, High Temperature (MIL-A-907) 2-1/2 lb can	lb
19	F		Compound, Gasket-Forming	
20	F	5970-00-166-5697	Compound, Insulating, Electrical, Embedding (MIL-C-47233)	
21	F		Compound, International, No. 2 (72582) 5198563	
22	F		Compound, Retaining (MIL-R-46082)	
		8030-00-181-7603	50 cc	cc
		8030-00-181-7529	250 cc	cc
22.1			Compound, Sealing (MIL-S-45180C) Type III (7A756) Permatex 3D	pt
23	F		Compound, Sealing, Lubricating, Wicking, Thread- Locking, Anaerobic, Single Component (MIL-S-46163), Type I, Grade K	

**Section II. EXPENDABLE/DURABLE SUPPLIES AND
MATERIALS LIST (CONT)**

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
24	F		Compound, Sealing, Lubricating, Wicking, Thread-Locking, Anaerobic, Single Component (MIL-S-46163), Type I, Grade	
25	F		Compound, Sealing, Lubricating, Wicking, Thread-Locking, Anaerobic, Single Component (MIL-S-46163), Type II, Grade N	
26	F		Compound, Sealing, Lubricating, Wicking, Thread-Locking, Anaerobic, Single Component (MIL-S-46163), Type II, Grade O	
27	F		Compound, Sealing and Lubricating	
28	O	8030-01-166-0675	Compound, Sealing, Pipe Thread (05972) 567 50 ml 250 ml	ml ml
29	F		Connector, Electrical, Butt (34072) 04618	ea
30	F		Dye, Prussian Blue	
31	O	9150-00-223-4004	Grease, Anticorrosion (Molybdenum) (MIL-G-21164) (81349)	lb
32	C	9150-00-065-0029	Grease, Automotive and Artillery (GAA) (MIL-G-10924) (81349) 2-1/4 oz tube	oz
		9150-00-935-1017	14 oz cartridge	oz
		9150-00-190-0904	1 lb can	lb
		9150-00-190-0905	5 lb can	lb
		9150-00-190-0907	35 lb can	
33	F		Grease, Ball Bearing	
34	F	9150-01-091-9336	Grease, General Purpose, Lithium Base	
34.1	F	9150-01-145-1259	Grease, High Temperature DOD-G-85733 (81349)	qt
35	F		Jelly, Petroleum	
36	F	9505-00-191-3680	Lockwire	
37	C		Oil, Fuel, Diesel, DF-1, Winter (W-F-800) (81348)	
		9140-00-286-5286	Bulk	gl
		9140-00-286-5287	5 gal can	gl
		9140-00-286-5288	55 gal drum, 16 gage	gl
		9140-00-286-5289	55 gal drum, 18 gage	gl

**Section II. EXPENDABLE/DURABLE SUPPLIES AND
MATERIALS LIST (CONT)**

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
38	C	9140-00-286-5294 9140-00-286-5295 9140-00-286-5296 9140-00-286-5297	Oil, Fuel, Diesel, DF-2, Regular (W-F-800) (81348) Bulk 5 gal can 55 gal drum, 16 gage 55 gal drum, 18 gage	gl gl gl gl
39	F		Oil, Hydraulic	
40	C	9150-01-035-5390 9150-01-035-5391	Oil, Lubricating Gear, GO 75 (MIL-L-2105C) 1 qt can 5 gal drum	qt gl
41	C	9150-01-035-5392 9150-01-035-5393 9150-01-035-5394	Oil, Lubricating Gear, GO 80/90 (MIL-L-2105C) 1 qt can 5 gal drum 55 gal drum	qt gl gl
42	O	9150-00-402-4478 9150-00-402-2372 9150-00-491-7197	Oil, Lubricating OEA ICE, Subzero (MIL-L-46167) 1 qt can 5 gal drum 55 gal drum, 16 gage	qt gl gl
43	O	9150-01-152-4117 9150-01-152-4118 9150-01-152-4119	Oil, Lubricating 15W/40 (MIL-L-2104) 1 qt can 5 gal drum 55 gal drum	qt gl gl
44	C	9150-00-189-6727 9150-00-186-6668 9150-00-191-2772	Oil, Lubricating, OE/HDO 10 (MIL-L-2104) 1 qt can 5 gal drum 55 gal drum, 16 gage 55 gal drum, 18 gage	qt gl gl gl
45	F		Oil, Lubricating, OE/HDO 15 (MIL-L-2104) 1 qt can	qt
46	C	9150-00-186-6681 9150-00-188-9858 9150-00-265-9436 9150-00-189-6729	Oil, Lubricating, OE/HDO 30 (SAE 30) (MIL-L-2104) 1 qt can 5 gal drum 55 gal drum, 16 gage 55 gal drum, 18 gage	qt gl gl gl
47	C	9150-00-189-6730 9150-00-188-9862 9150-00-405-2987	Oil, Lubricating, OE/HDO 40 (MIL-L-2104) 1 qt can 5 gal drum 55 gal drum, 16 gage	qt gl gl

**Section II. EXPENDABLE/DURABLE SUPPLIES AND
MATERIALS LIST (CONT)**

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
48	F		Oil, Lubricating, OE/HDO 50 (MIL-L-2104) 1 qt can 5 gal drum 55 gal drum, 16 gage	qt gal gal
49	F	5350-00-186-8818	Paper, Abrasive, Garnet, P-P-121	
50	F		Plastigage	
51	O	7920-00-205-1711	Rags, Wiping, Cotton and Cotton-Synthetic (A-A-531)	lb
52	F	2090-00-372-6064	Repair Kit, Glass Reinforced Plastic Laminate	ea
53	F		Rope, 50 ft	ft
54	C	6850-00-664-5685 6850-00-281-1985	Solvent, Dry Cleaning SD (P-D-680) 1 qt can 1 gal can	qt gal
55	F		Spray, Adhesive	
56	O	8135-00-178-9200	Tags, Identification (MIL-T-12755) pk/1000	mx
57	O	5970-00-644-3167	Tape, Insulation, Electrical (MIL-T-50886)	ft
58	F		Tape, Masking, A-A-883	ft
59	F		Tape, Plastic	ft
60	O	5975-01-273-8133	Ties, Cable, Plastic (96906) MS3367 (MIL-S-29190)	

APPENDIX C

ILLUSTRATED LIST OF MANUFACTURED ITEMS

Section I. INTRODUCTION

This appendix includes complete instructions for making items authorized to be manufactured or fabricated at the direct support and general support maintenance levels.

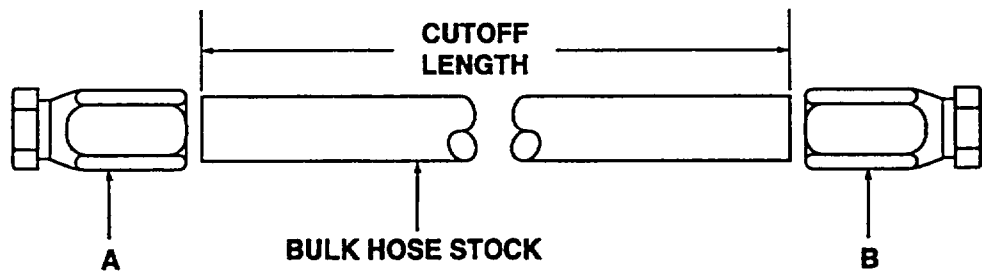
A part number index in alphanumeric order is provided for cross-referencing the part number of the item to be manufactured to the figure which covers fabrication criteria.

All bulk materials needed for manufacture of an item are listed by part number or specification number in a tabular list on the illustration.

Section II. MANUFACTURED ITEMS PART NUMBER INDEX

PART NO.	DESCRIPTION	FIGURE NO.
1525-6	HOSE ASSEMBLY	C-1
2BG623	REMOVER, BEARING SHELL	C-10
2BH944	EYES, LIFTING (1/2 IN.)	C-8
2HD798	YOKE HOLDER	C-15
2SK742	FIXTURE, TURBOCHARGER HOLDING	C-17
25806AX9	WIRE, SAFETY	C-2
	ADAPTER, CONSTANT VELOCITY U-JOINT BEARING	
	CAP REMOVAL TOOL	C-19
	BEARING CONE INSTALLER, POWER DIVIDER	C-21
	CONE INSTALLER, PINION BEARING	C-20
	BLOCKS, WOODEN	C-3
	EYE, LIFTING (10 MM)	C-9
	FIXTURE, IDLER GEAR HOLDING	C-18
	GUIDE SCREWS	C-4
	HOOK, WIRE	C-6
	JET EXTRACTOR	C-11
	PLATE, STEEL, 3/16 IN.	C-12
	PLATE, STEEL, 1/16 IN.	C-13
	PLYWOOD	C-5
	PRELOAD GAGE, DIFFERENTIAL CARRIER	C-16
	SHIM	C-7
	TEMPLATE, STEERING RADIUS	C-22
	THREADED ROD (3/8 IN.)	C-14

Section III. MANUFACTURED ITEMS ILLUSTRATIONS

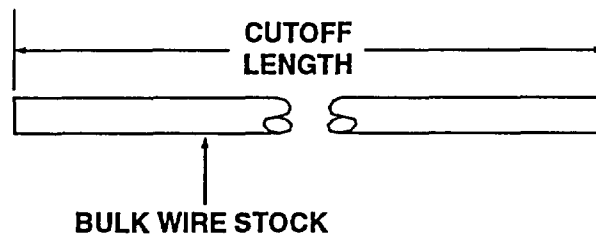


- (1) Fabricate from bulk hose stock listed in table C-1.
- (2) Using fine-toothed hacksaw, cut hose to length required in table C-1.
- (2.1) Clean debris from inside hose and around hose end.
- (3) Place fitting A in vise and screw hose counterclockwise until hose bottoms in fitting. Back off one quarter turn.
- (4) Place fitting B in vise and screw hose counterclockwise until hose bottoms. Back off one-quarter turn.

Figure C-1. Hose Assembly

Table C-1. Hose Assembly

HOSE ASSY PN	BULK HOSE PN	CUTOFF LENGTH IN. (CM)	FITTING A	FITTING B
1525-6	FS332-6	12 (30)	ADAPTER 5113191	ADAPTER 5113191

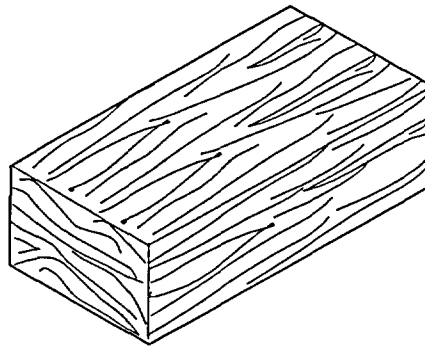


- (5) Fabricate from bulk wire stock listed in table C-2.
- (6) Using wire cutters, cut to required length.

Figure C-2. Safety Wire

Table C-2. Safety Wire

HARNESS ASSY PN	BULK WIRE PN	CUTOFF LENGTH IN.(MM)
25806AX9	MS20995-S41	9 (229)

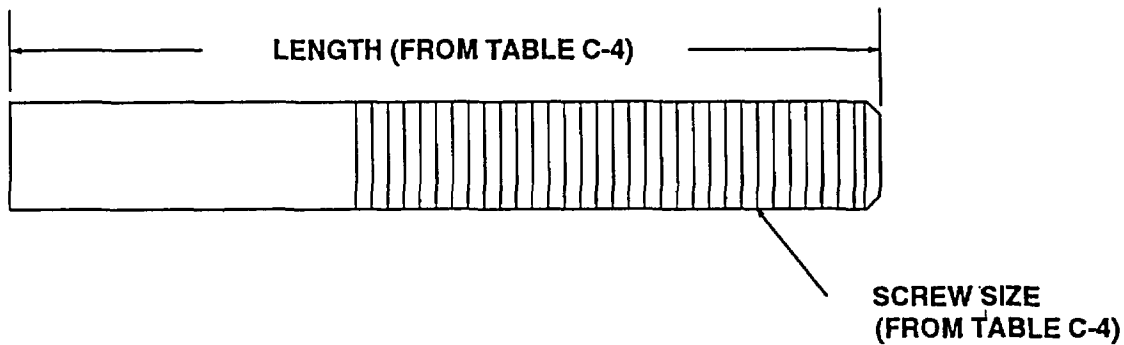


- (1) Fabricate from MML751 lumber stock
- (2) Using saw and standard planing machine, cut stock to size required in table C-3.

Figure C-3. Wooden Blocks

Table C-3. Wooden Blocks

PARAGRAPH NO.	FINISHED DIMENSIONS OF BLOCK IN. (CM)
3-10, 4-4,19-11, 20-2	1-1/2 x 1-1/2 x 12 (3.8 x 3.8 x 30)
5-6	2x4x9 (5x 10 x 23)
14-9	4 x 4 x 24 (10 x 10 x 61)
14-11	2 x 4 x 14.5 (5 x 10 x 37)
	2 x 4 x 16.5 (5 x 10 x 42)
	2x4x21 (5x10x53)
19-7	1-1/2 x 3-1/2 x 24 (3.8 x 9 x 61)
22-17	3-1/2 x 3-1/2 x 12 (9 x 9 x 30)
25-2	1-1/2 x 3-1/2 x 12 (3.8 x 9 x 30)

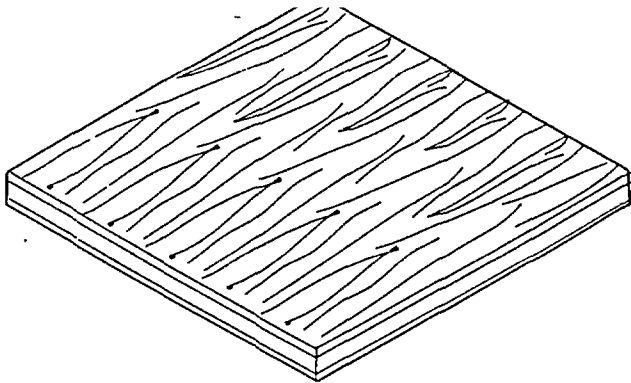


- (1) Fabricate from grade 5 screw of lengths shown in table C-4.
- (2) Using hacksaw, cut off screw head.
- (3) Using file or grinder, remove any sharp edges.
- (4) All dimensions are in inches (millimeters)

Figure C-4. Guide Screws

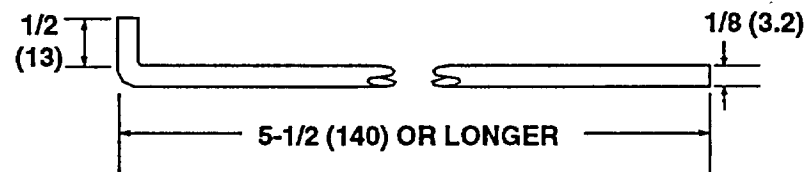
Table C-4. Guide Screws

PARAGRAPH	SCREW SIZE	LENGTH IN. (MM)
11-6	1/2-13	2-3/8 (60)
13-7	1/2-13	2-1/2 (64)
28-2	3/4-10	6-1/2 (165)



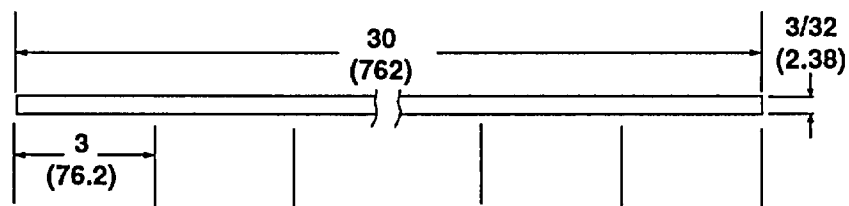
- (1) Fabricate from 48 x 72 x 3/4 in. exterior grade plywood.
- (2) Using saw, cut to 48 x 29 x 3/4 in. (122 x 73.6 x 1.9 cm).

Figure C-5. Plywood



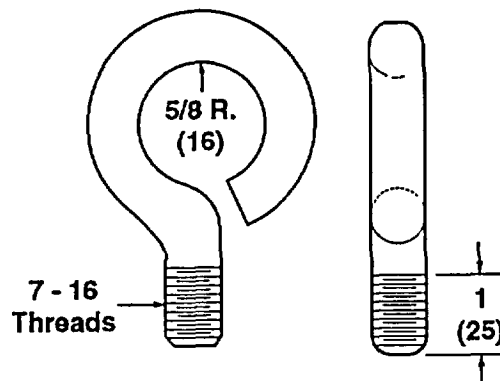
- (1) Fabricate from 1/8 in. (3.2 mm) diameter steel welding rod or equivalent stiff wire.
- (2) Using cutting pliers, cut welding rod to 6 in. (150 mm) length or longer.
- (3) Using machinist's vise, bend 112 in. (13 mm) length of rod 90 degrees.
- (4) All dimensions are in inches (millimeters).

Figure C-6. Wire Hook



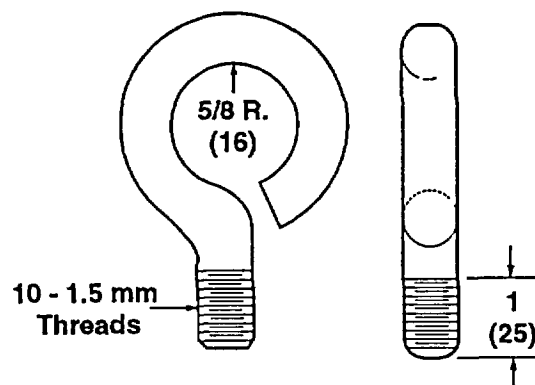
- (1) Fabricate from flat shim stock 0.02 x 3/32 x 30 in. (0.5 x 2.38 x 762 mm).
- (2) Cut shim stock into ten 3 in. (76.2 mm) pieces.
- (3) All dimensions are in inches (millimeters).

Figure C-7. Shims



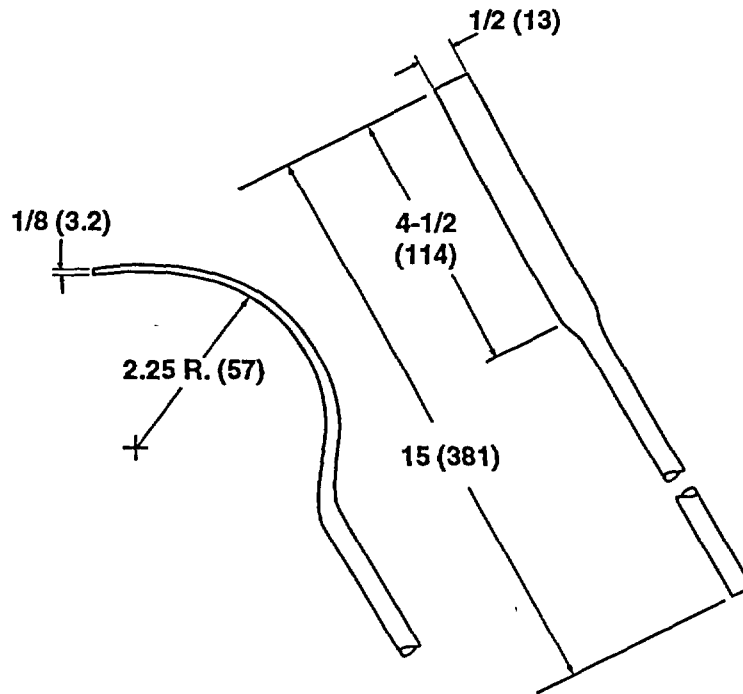
- (1) Fabricate from 1/2 x 6 in. (13 x 152 mm) cold rolled steel.
- (2) Thread size is 7-16x1 in. (25 mm) long.
- (3) Heat unthreaded end and bend over 1-1/4 (32 mm) diameter rod.
- (4) All dimensions are inches (millimeters).

Figure C-8. Lifting Eyes (PN 2BH944)



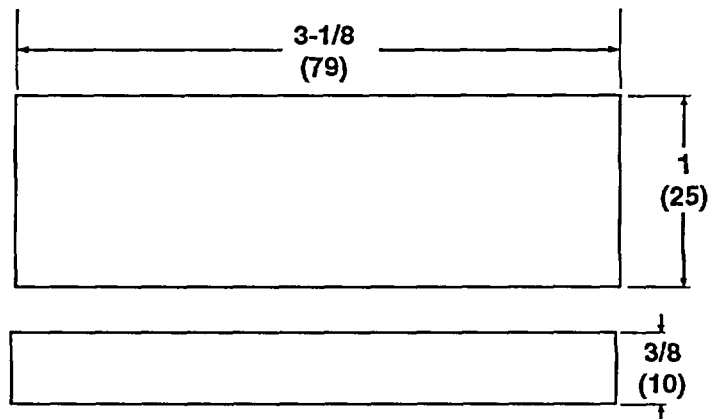
- (1) Fabricate from 1/2 x 6 in. (13 x 152 mm) cold rolled steel.
- (2) Thread size is 10-1.5 x 25 mm (1 in.) long.
- (3) Heat unthreaded end and bend over 1-1/4 (32 mm) diameter rod.
- (4) All unlabeled dimensions are inches (millimeters).

Figure C-9. Lifting Eye (10 mm)



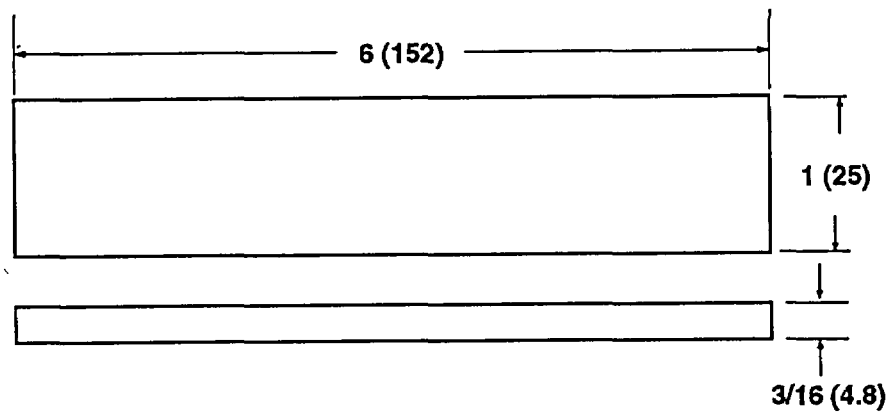
- (1) Fabricate from 3/8 in. (9.5 mm) diameter cold rolled steel.
- (2) Heat and flatten 4-1/2 in. (114 mm) length of round stock until end is 1/8 x 1/2 x 4-1/2 in. (3.2 x 13 x 114 mm).
- (3) All dimensions are in inches (millimeters).

Figure C-10. Bearing Shell Remover (PN 2BG623)



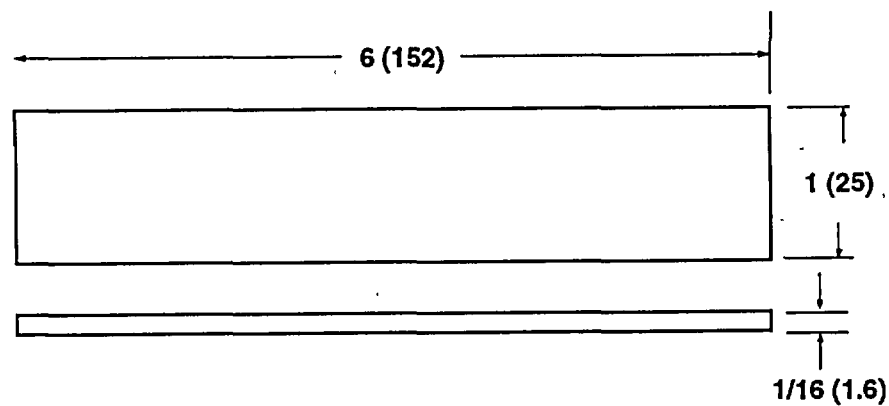
- (1) Fabricate from 3/8 in. (10 mm) thick mild steel stock.
- (2) Using hacksaw, cut steel stock to dimensions shown.
- (3) Using file or grinder, remove any sharp edges.
- (4) All dimensions are in inches (millimeters).

Figure C-11. Jet Extractor



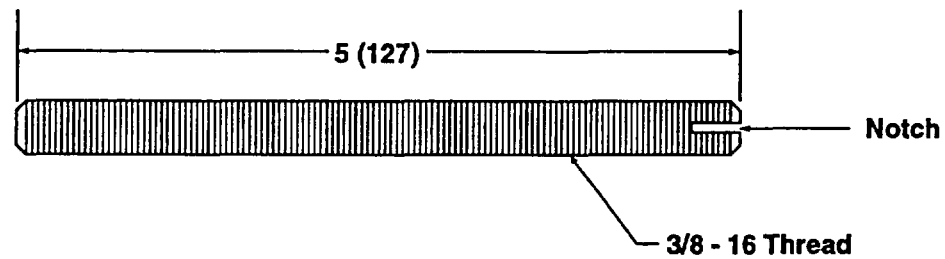
- (1) Fabricate from 3/16 x 1x6 in. (4.8 x 25 x 152 mm) or longer flat steel stock.
- (2) Using hacksaw, cut steel stock to 6 in. (152 mm) length.
- (3) Using file or grinder, remove any sharp edges.
- (4) All dimensions are in inches (millimeters).

Figure C-12. 3/16-Inch Steel Plate



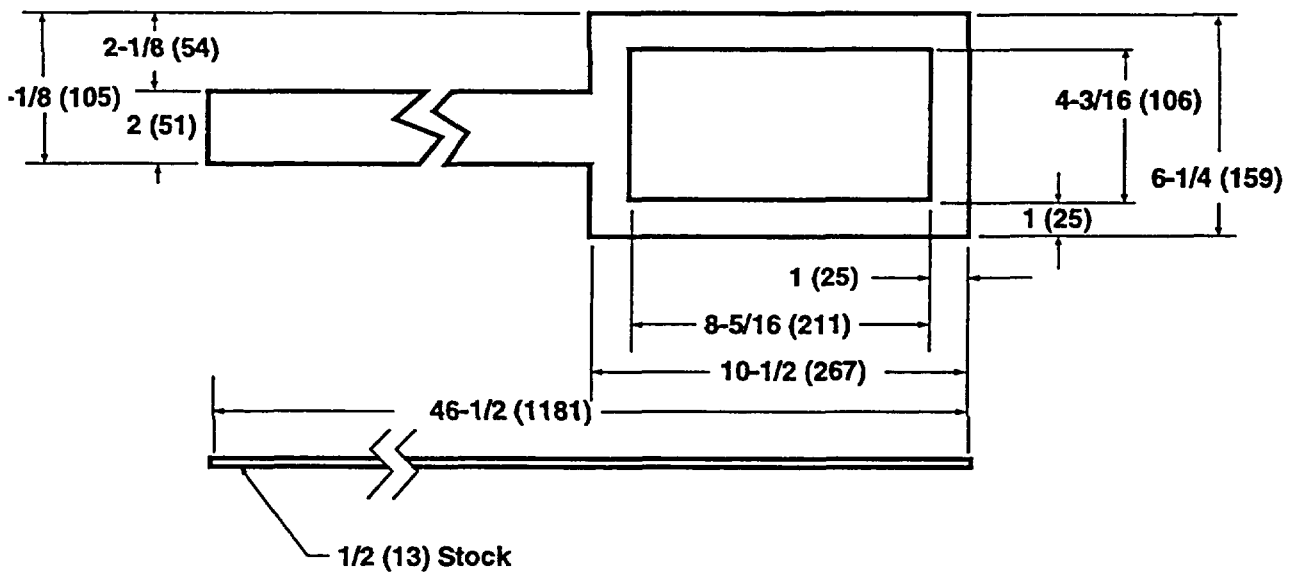
- (1) Fabricate from 1/16 x 1 x 6 in. (1.6 x 25 x 152 mm) or longer flat steel stock.
- (2) Using hacksaw, cut steel stock to 6 in. (152 mm) length.
- (3) Using file or grinder, remove any sharp edges.
- (4) All dimensions are in inches (millimeters).

Figure C-13. 1/16-Inch Steel Plate



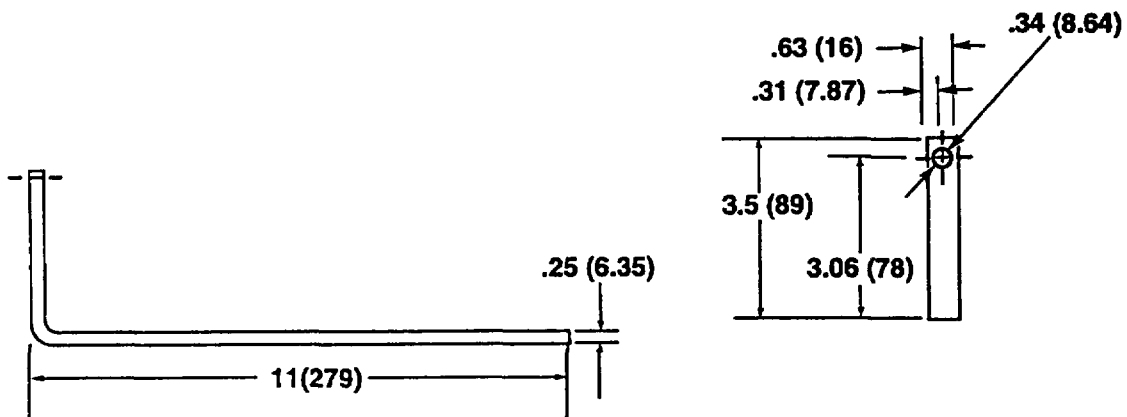
- (1) Fabricate from 3/8 in. -16 threaded steel rod.
- (2) Using hacksaw, cut rod to 5 in. (127 mm) length.
- (3) Using file or grinder, remove any sharp edges.
- (4) Using hacksaw, cut screwdriver-size notch in one end of rod.
- (5) All dimensions are in inches (millimeters).

Figure C-14. Threaded Rod (318 inch)



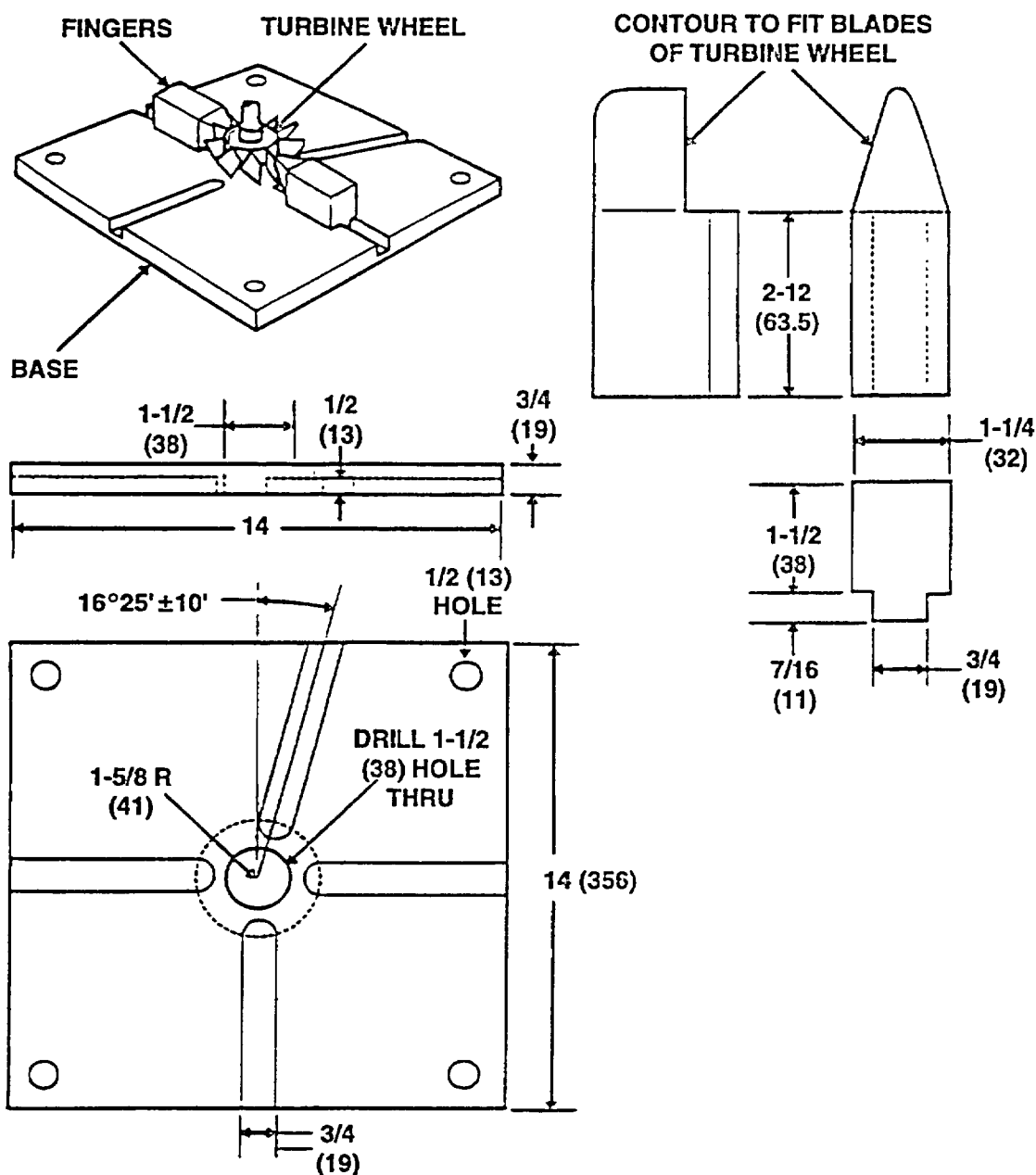
- (1) Fabricate from 1/2 in. (13 mm) thick mild steel stock.
- (2) Using torch, cut steel stock to dimensions shown.
- (3) Using grinder, remove rough edges.
- (4) All dimensions are in inches (millimeters).

Figure C-15. Yoke Holder (PN 2HD798)



- (1) Fabricate from 1/4 in. (6 mm) thick, 1/2 in. (13 mm) wide, mild steel stock.
- (2) Using hacksaw, cut steel stock to 14 1/2 in. (36.8 cm).
- (3) Using machinist's vise, bend steel stock 90° where indicated.
- (4) Drill .344 in. (8.73 mm) hole where indicated.
- (5) Using file or grinder, remove any sharp edges.
- (6) All dimensions are in inches (millimeters).

Figure C-16. Differential Carrier Preload Gage.



- (1) Fabricate from 3/4 in. (19 mm) exterior grade plywood.
- (2) Drill 1-1/2 in. (38 mm) diameter hole in center of base.
- (3) Drill four 1/2 in. (13 mm) diameter holes in corners of base.
- (4) Draw a circle with a 1-5/8 in. (41 mm) radius.
- (5) Route four 1/2 x 3/4 in. (13 x 38 mm) slots in base into circle as shown.
- (6) Fabricate two 1-15/16 x 2-1/2 x 1-1/4 in. (49 x 63.5 x 32 mm) fingers from plywood.
- (7) Grind bottom of fingers 23/32 in. (18 mm) wide and 7/16 in. (11 mm) high. Contour front surface of fingers to fit turbine wheel blades.
- (8) All dimensions are in inches (millimeters).

Figure C-17. Turbocharger Holding Fixture (PN 2SK742)

NOTE

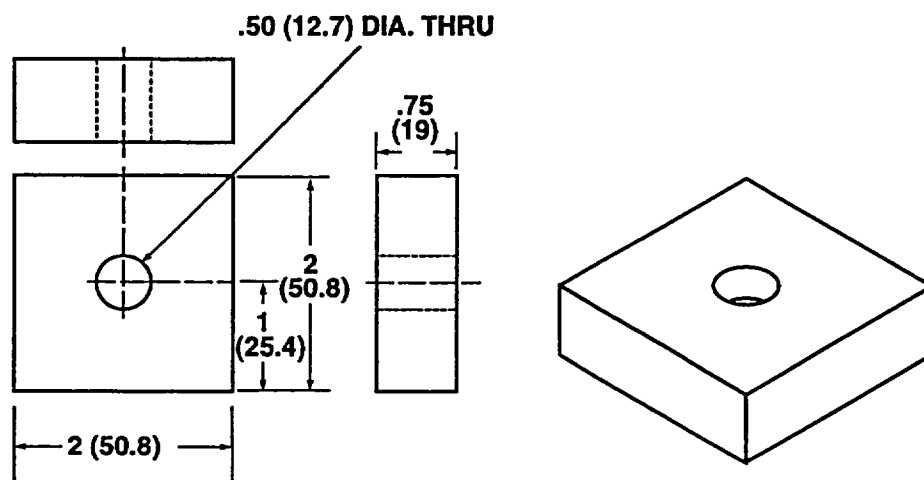
Required stock:

Mild steel plate, 0.75 x 6.13 x 4 in. (19 x 156 x 102 mm)

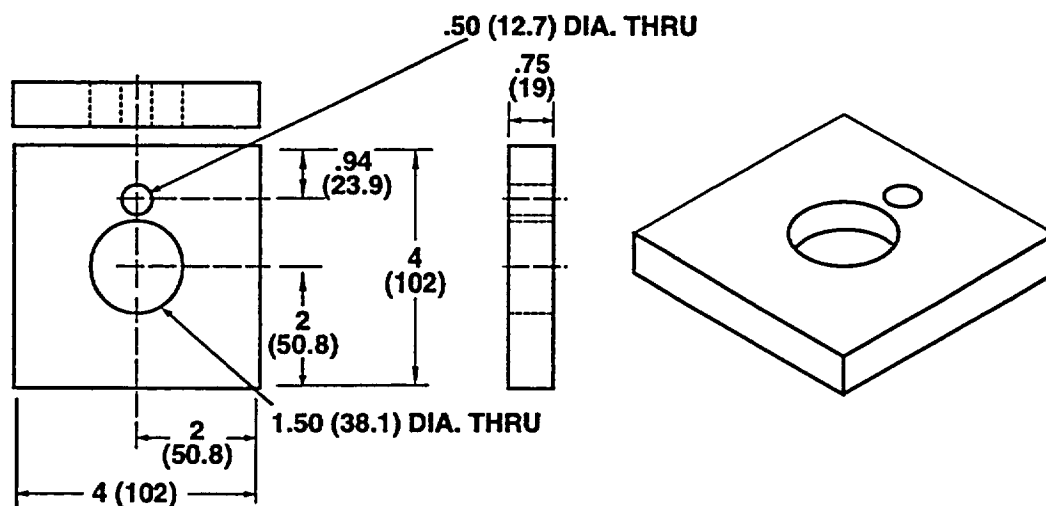
Mild steel plate, 0.25 x 4 x 4 in. (6.35 x 102 x 102 mm)

Nut, 3/8-16 (MS51967-8)

Bolt, 3/8-16 x 3-1/4 (MS90725-71)

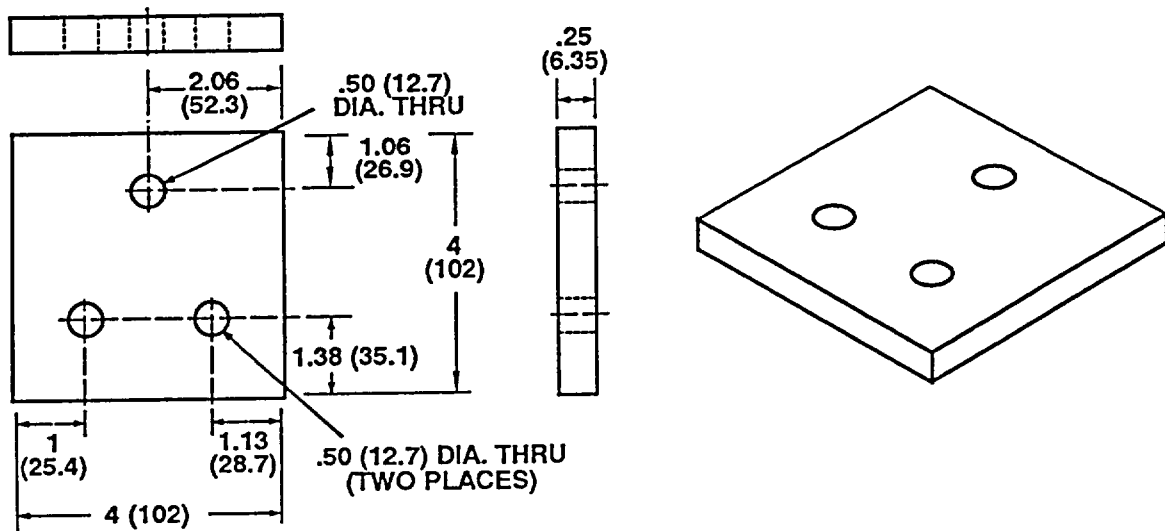


- (1) Cut 0.75 x 2 x 2 in. (19 x 50.8 x 50.8 mm) steel plate.
- (2) Drill 0.50 in. (12.7 mm) hole through center of steel plate.
- (3) All dimensions are inches (millimeters).



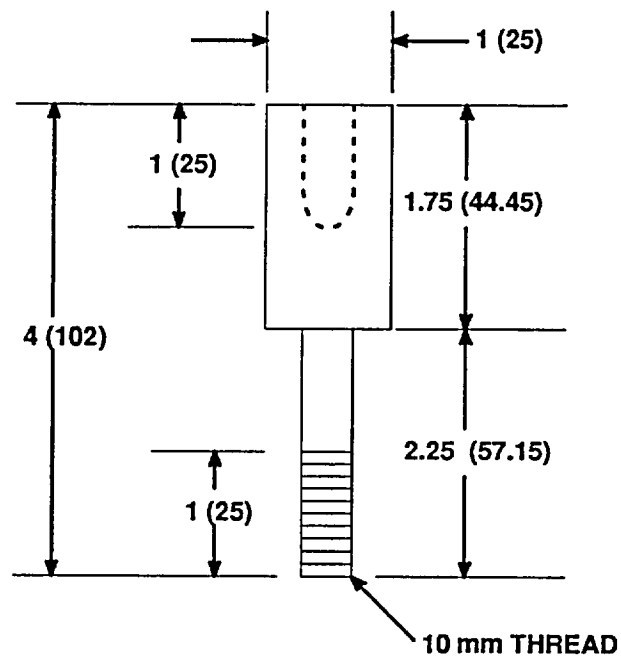
- (4) Cut 0.75 x 4 x 4 in. (19 x 102 x 102 mm) steel plate.
- (5) Drill 1.50 in. (38.1 mm) hole through center of steel plate.
- (6) Drill 0.50 in. (12.7 mm) hole in steel plate.
- (7) All dimensions are inches (millimeters).

Figure C-18. Idler Gear Holding Fixture



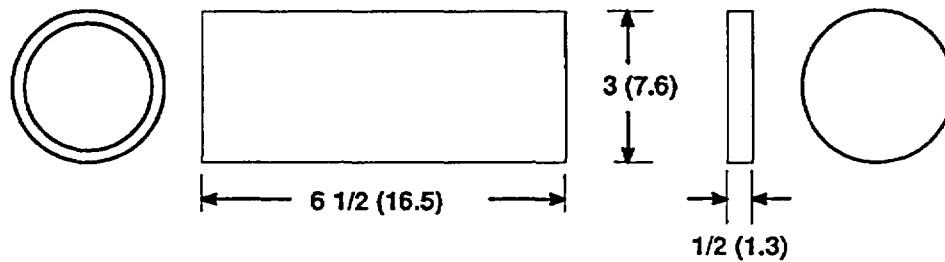
- (8) Cut 0.25 x 4 x 4 in. (6.35 x 102 x 102 mm) steel plate.
- (9) Drill three 0.50 in. (12.7 mm) holes through center of steel plate.
- (10) All dimensions are inches (millimeters).
- (11) Assemble parts using 3/8-16 x 3-1/4 in. bolt and 3/8-16 nut.

Figure C-18. Idler Gear Holding Fixture (Cont)



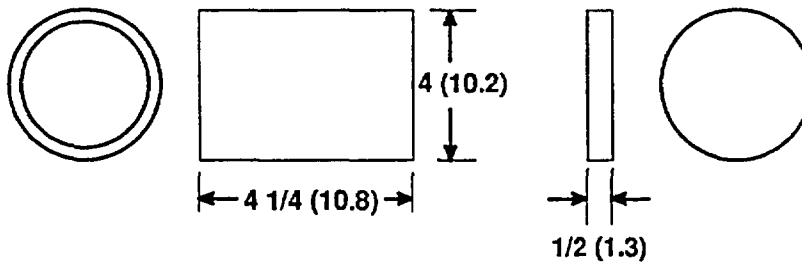
- (1) Fabricate from 1 in. (25 mm) mild steel round stock; 4 in. (102 mm) long.
- (2) Turn down 2.1/4 in. (57.15 mm) to .39 in. (10mm).
- (3) Tap 1 in. (25mm) of 10 mm diameter shaft with 10 mm by 1 in. (25 mm) threads.
- (4) Drill 5/8 in. (16 mm) hole 1 in. (25 mm) deep in 1 in. (25 mm) end.
- (5) Tap 1 in. (25 mm) of 3/4 in. by 16 diameter hole in 1 in. (25 mm) end.
- (6) All dimensions are in inches (millimeters).

Figure C-19. Adapter, Constant Velocity U-Joint Bearing Cap Removal Tool



- (1) Fabricate from 3 in. (7.6 cm) OD steel tube.
- (2) Using hacksaw, cut tubing to 6 1/2 in. (16.5 cm) in length.
- (3) Cut 3 in. (7.6 cm) diameter circle from 1/2 in. (1.3 cm) steel plate.
- (4) Weld steel plate on one end of steel tube.
- (5) Using file or grinder, remove any sharp edges.
- (6) All dimensions are in inches (centimeters).

Figure C-20. Pinion Bearing Cone Installer (PN 2HE491)

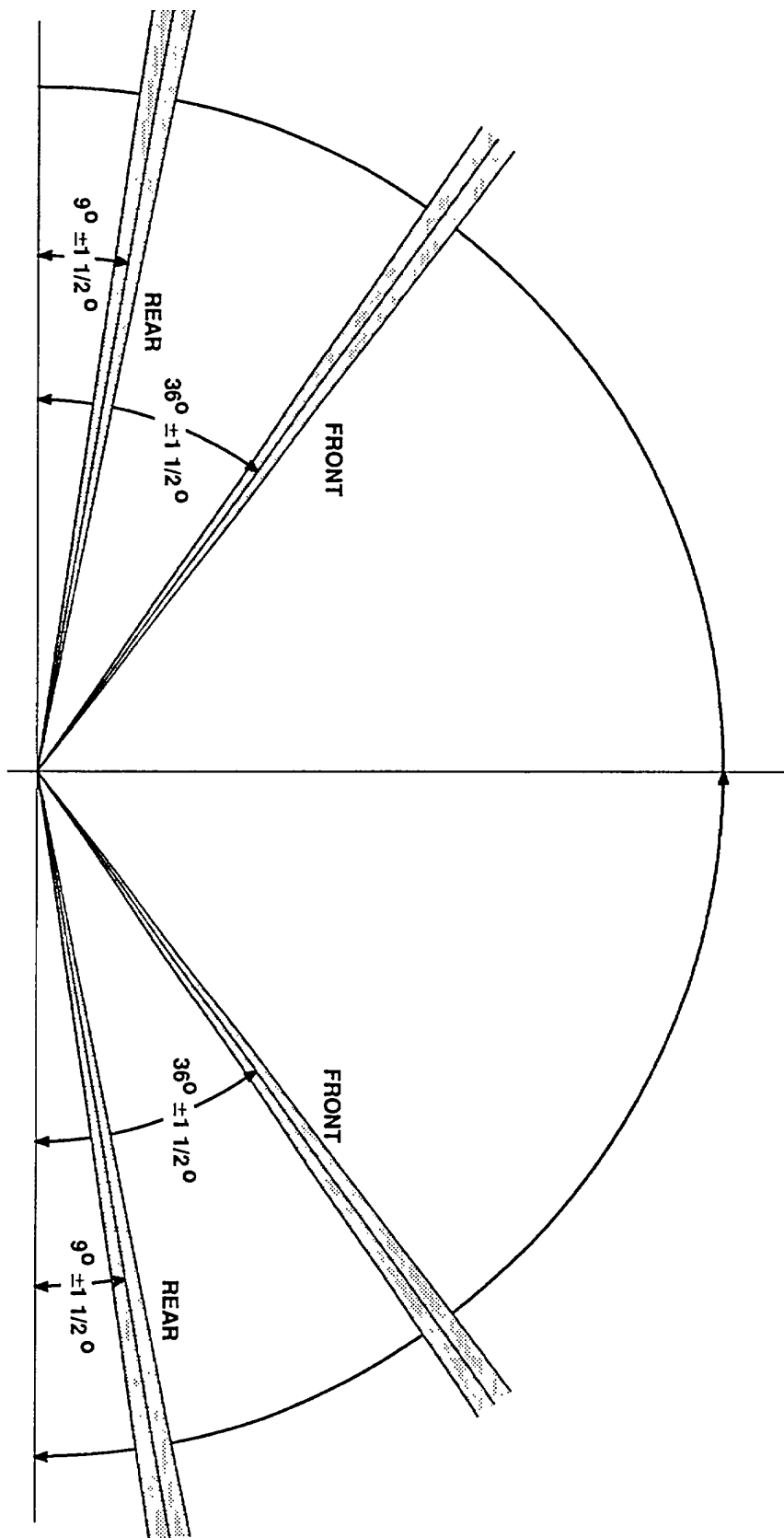


- (1) Fabricate from 4 in. (10.2 cm) OD steel tube.
- (2) Using hacksaw, cut tubing to 4 1/4 in. (10.8 cm) in length.
- (3) Cut 4 in. (10.2 cm) diameter circle from 1/2 in. (1.3 cm) steel plate.
- (4) Weld steel plate on one end of steel tube.
- (5) Using file or grinder, remove any sharp edges.
- (6) All dimensions are in inches (centimeters).

Figure C-21. Power Divider Bearing Cone Installer (PN 2HE497)

- (1) Fabricate from 1/8 in. (3.2 mm) aluminum plate.
- (2) Cut aluminum plate to 11 X 17 in. (28 X 43 cm).
- (3) Using file or grinder, remove any sharp edges.
- (4) Using punch or awl, scribe a line 3/4 in. (1.9 cm) from bottom of plate.
- (5) Scribe second line 90 degrees from first line, 8 1/2 in. (22 cm) from edge of plate (6) Using compass, scribe lines at 7 1/2 degrees, 10 1/2 degrees, 34 1/2 degrees and 37 1/2 degrees from line made in step (4).
- (7) Repeat step (6) for other side of template.
- (8) Using letter punches, identify the 34 1/2 and 37 1/2 degree lines as "FRONT" and the 7 1/2 and 10 1/2 degree lines and "REAR".

Figure C-22. Steering Radius Template



APPENDIX D TORQUE VALUES

D-1. GENERAL

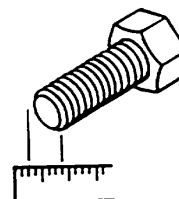
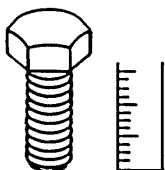
This appendix provides general torque limits for screws used on the HET Tractor. Special torque limits are shown in the maintenance procedures for applicable components. Use the general torque limits given in this appendix when specific torque limits are not given in the maintenance procedure. These general torque limits cannot be applied to screws that retain rubber components. The rubber components will be damaged before the torque limit is reached. If a special torque limit is not given in the maintenance instruction, tighten the screw or nut until it touches the metal bracket, then tighten it one more turn.

D-2. TORQUE LIMITS

Table D-1 lists dry torque limits. Dry torque limits are used on screws that do not have lubricants applied to the threads. Table D-2 lists wet torque limits. Wet torque limits are used on screws that have high pressure lubricants applied to the threads. Table D-3 lists dry torque limits for metric screws. Table D-4 lists wet torque limits for flange nuts.

D-3. USE OF TORQUE TABLES

- (1) Measure the diameter of the screw you are installing.
- (2) Count the number of threads per inch.



- (3) Under the heading DIAMETER look down the column until you find the diameter of the screw. (There are usually two lines beginning with the same diameter.)

NOTE

Step (4) is not required for metric screws.

- (4) Under the heading THREADS PER INCH, find the number of threads per inch that matches the * number you counted in step (2).
- (5) To find the grade of the screw, match the markings on the head to the correct picture under CAPSCREW HEAD MARKINGS on the torque table.
- (6) Look down the column under the picture you found in step (5) until you find the torque limit (lb-ft or N•m) for the diameter and threads per inch of the screw.

Table D-1. Torque Limits for Dry Fasteners

			CAPSCREW HEAD MARKINGS							
			 SAE GRADE NO. 2	 SAE GRADE NO. 5	 SAE GRADE NO. 6 OR 7	 SAE GRADE NO. 8				
NOTE Manufacturer's marks may vary. These are all SAE Grade 5.										
DIAMETER		THREADS PER INCH	TORQUE							
IN.	MM		LB-FT	N•M	LB-FT	N•M	LB-FT	N•M	LB-FT	N•M
1/4	6.35	20	5	7	8	11	10	14	12	16
1/4	6.35	28	6	9	10	14	12	16	14	19
5/16	7.94	18	11	15	17	23	21	28	25	34
5/16	7.94	24	12	16	19	26	24	33	25	34
3/8	9.53	16	20	27	30	41	40	54	45	61
3/8	9.53	24	23	31	35	47	45	61	50	68
7/16	11.1	14	30	41	50	68	60	81	70	95
7/16		20	35	47	55	75	70	95	80	108
1/2	12.70	13	50	68	75	102	95	129	110	149
1/2		20	55	75	90	122	100	136	120	163
9/16	14.29	12	65	88	110	149	135	183	150	203
9/16		18	75	102	120	163	150	203	170	231
5/8	15.88	11	90	122	150	203	190	258	220	298
5/8		18	100	136	180	244	210	285	240	325
3/4	19.05	10	160	217	260	353	320	434	380	515
3/4		16	180	244	300	407	360	488	420	597
7/8	22.23	9	140	190	400	542	520	705	600	814
7/8		14	155	210	440	597	580	786	660	895
1	25.40	8	220	298	580	786	800	1085	900	1220
1		12	240	325	640	868	860	1166	1000	1356
1-1/8	25.58	7	300	407	800	1085	1120	1519	1280	1736
1-1/8		12	340	461	880	1193	1260	1709	1440	1953
1-1/4	31.75	7	420	570	1120	1519	1580	2142	1820	2468
1-1/4		12	460	624	1240	1681	1760	2387	2000	2712
1-3/8	34.93	6	560	759	1460	1980	2080	2820	2380	3227
1-3/8		12	640	868	1680	2278	2380	3227	2720	3688
1-1/2	38.10	6	740	1003	1940	2631	2780	3770	3160	4285
1-1/2		12	840	1139	2200	2983	3100	4204	3560	4827

Table D-2. Torque Limits for Wet Fasteners

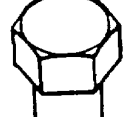
			CAPSCREW HEAD MARKINGS							
										
NOTE Manufacturer's marks may vary. These are all SAE Grade 5.			SAE GRADE NO. 2		SAE GRADE NO. 5		SAE GRADE NO. 6 OR 7		SAE GRADE NO. 8	
DIAMETER		THREADS PER INCH	TORQUE							
IN.	MM		LB-FT	N•M	LB-FT	N•M	LB-FT	N•M	LB-FT	N•M
1/4	6.35	20	5	7	8	11	10	14	12	16
1/4	6.35	20	4	6	6	8	8	11	9	12
1/4	6.35	28	5	7	7	9	9	12	10	14
5/16	7.94	18	8	11	13	18	16	22	18	24
5/16	7.94	24	9	12	14	19	18	24	20	27
3/8	9.53	16	15	20	23	31	30	41	35	47
3/8	9.53	24	17	23	25	34	30	41	35	47
7/16	11.11	14	24	33	35	47	45	61	55	75
7/16		20	25	34	40	54	50	68	60	81
1/2	12.70	13	35	47	55	75	70	95	80	108
1/2		20	40	54	65	88	80	108	90	122
9/16	14.29	12	50	68	80	108	100	136	110	149
9/16		18	55	75	90	122	110	149	130	176
5/8	15.88	11	70	95	110	149	140	190	170	231
5/8		18	80	108	130	176	160	217	180	244
3/4	19.05	10	120	163	200	271	240	325	280	380
3/4		16	140	190	220	298	280	380	320	434
7/8	22.23	9	110	149	300	407	400	542	460	624
7/8		14	120	163	320	434	440	597	500	678
1	25.40	8	160	217	440	597	600	814	680	922
1		12	170	231	480	651	660	895	740	1003
1-1/8	25.58	7	220	298	600	814	840	1139	960	1302
1-1/8		12	260	353	660	895	940	1275	1080	1464
1-1/4	31.75	7	320	434	840	1139	1100	1492	1360	1844
1-1/4		12	360	488	920	1248	1320	1790	1500	2034
1-3/8	34.93	6	420	570	1100	1492	1560	2115	1780	2414
1-3/8		12	460	624	1260	1709	1780	2414	2040	2766
1-1/2	38.10	6	560	760	1460	1980	2080	2820	2360	3200
1-1/2		12	620	841	1640	2224	2320	3146	2660	3607

Table D-3. Torque Limits for Dry Metric Fasteners

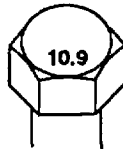
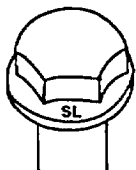
		CAPSCREW HEAD MARKINGS					
		 METRIC GRADE 8.8		 METRIC GRADE 10.9		 METRIC GRADE 12.9	
DIAMETER		TORQUE					
IN.	MM	LB-FT	N-M	LB-FT	N-M	LB-FT	N-M
0.157	4	2	3	3	4	4	5
0.197	5	4	5	6	8	7	9
0.237	6	7	9	10	14	11	15
0.276	7	11	15	16	22	20	27
0.315	8	18	24	25	34	29	39
0.394	10	32	43	47	64	58	79
0.473	12	58	79	83	113	100	136
0.552	14	94	127	133	180	159	216
0.630	16	144	195	196	266	235	319
0.709	18	190	258	269	365	323	438
0.788	20	260	353	366	496	440	597
0.867	22	368	499	520	705	678	919
0.946	24	470	637	664	900	794	1077
1.064	27	707	959	996	1351	1235	1675
1.182	30	967	1311	1357	1840	1630	2210

Table D-4. Torque Limits for Wet Flange Nuts

DIAMETER		THREADS PER INCH	TORQUE	
IN.	MM		LB-FT	N-M
1/4	6.35	20	15	20
5/16	7.94	18	25	34
3/8	9.65	16	45	61
1/2	12.70	13	110	149
5/8	15.75	11	210	285
3/4	19.05	10	375	508

**SPIRALOCK FLANGE
NUT MARKINGS
GRADE 8**


**APPENDIX E
COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

Section I. INTRODUCTION

E-1. INTRODUCTION

This appendix lists common tools, supplements, and special tools/fixtures that are required for maintenance tasks performed at the organizational maintenance level.

E-2. EXPLANATION OF COLUMNS

- a. Column (1) - Item Number.** This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the item, e.g., "Adapter Tool, Transfer Case End Play (Item 8, Appendix E)."
- b. Column (2) - Item Name.** This column contains the nomenclature for the item.
- c. Column (3) - National Stock Number.** This is the national stock number assigned to the item which you can use to requisition it
- d. Column (4)- Part Number.** This provides the Government, manufacturer, or vendor part number for the item.
- e. Column (5) - Reference.** This column contains the shop catalog (SC), technical manual, or other publication which provides an illustration and description of the item, or lists whether the item is fabricated.

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
0.1	ADAPTER, DIFFERENTIAL MAINTENANCE STAND		J39929	TM 9-2320-360-34P
1	TEST	5935-01-297-2481	J33765	TM 9-2320-360-34P
2	ADAPTER, RADIATOR	4910-01-170-4929	J29003-A	TM 9-2320-360-34P
3	1/2 IN. FEMALE - 3/4 IN. MALE			SC 4910-95-A31
4	ADAPTER, SOCKET WRENCH, 3/4 IN. FEMALE - 1/2 IN. MALE	5120-00-227-8088		
5	ADAPTER, SOCKET WRENCH, 1/2 IN. FEMALE - 3/8 IN. MALE	5120-00-240-8702		SC 4910-95-A31
6	ADAPTER, SOCKET WRENCH, 3/4 IN. FEMALE - 1 IN. MALE	5120-00-227-8104		
6.1	ADAPTER KIT, TRANSFER CASE		J39911	TM 9-2320-360-34P
7	ADAPTER PLATE, ENGINE STAND	4910-00-146-9624	J33850	TM 9-2320-360-34P
8	ADAPTER TOOL, TRANSFER CASE END PLAY		1976890U	TM 9-2320-360-34P
9	ALIGNMENT TOOL, FIFTH CLUTCH	5120-01-115-1161	J24221	TM 9-2320-360-34P
9.1	BIT SET, SCREWDRIVER	5120-01-170-4454		SC 4910-95-CL-A72
10	BOLTS, PULLER	5120-01-185-6811	J26901-A	TM 9-2320-360-34P
11	BRACKET, LIFTING	5120-01-115-1159	J24209	TM 9-2320-360-34P
12	BRACKET, LIFTING, FLYWHEEL	5120-01-116-6049	J24365	TM 9-2320-360-34P
13	BRACKET, LIFTING, MAIN SHAFT	5120-01-115-1157	J24196	
14	BRUSH, WIRE	7920-00-291-5815	8078883	SC4910-95-A31
15	CALIPER SET, MICROMETER, 0-6 IN.	5210-00-554-7134	GGG-C-105	SC 4910-95-A63
16	CALIPER, VERNIER, 0-6 IN.	5210-01-113-1548	6240	SC 4910-95-A31
17	CAPS, VISE JAW (4 IN. BRASS OR COPPER)	5120-00-221-1506	404-4	SC 4910-95-A31
18	CLAMP SET, CYLINDER LINER HOLDDOWN	4910-01-158-3984	J24565-02	TM 9-2320-360-34P

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	ITEM NAME	NATIONAL STOCK NUMBER	PART NUMBER	REFERENCE
19	COMPRESSOR, PISTON RING		RCL30	TM 9-2320-360-34P
20	COMPRESSOR, RING	5120-00-223-8848		SC 4910-95-A63
21	COMPRESSOR SET, CENTER SUPPORT	4310-01-247-7126	J24208-D	TM 9-2320-360-34P
22	COMPRESSOR SET, CLUTCH SPRING	5120-01-048-3129	J24204	TM 9-2320-360-34P
23	COMPRESSOR, SPRING	5120-01-048-2160	J24219	TM 9-2320-360-34P
24	COMPRESSOR UNIT, AIR	4310-00-542-4566	MIL-C-52980	SC 4910-95-CL-A31
25	COMPRESSOR, VALVE SPRING	5120-00-733-8888	J7455-A	TM 9-2320-360-34P
25.1	CONTACT TEST SET			
26	COVER, KING PIN PRELOAD		2HE225	TM 9-2320-360-34P
27	CRIMPER, TERMINAL		J35123	TM 9-2320-360-34P
28	CRIMPER, TERMINAL		J35606	TM 9-2320-360-34P
29	CRIMPER, TERMINAL		J35688	TM 9-2320-360-34P
30	CROWBAR	5120-00-224-1390		SC 4910-95-CL-A72
31	DELETED			
32	DIAL INDICATOR, MAGNETIC	5120-00-402-9619	J7872	TM 9-2320-360-34P
33	DRILLSET, TWIST, 1/16-1/2 IN. - BY 64THS	5133-00-293-0983	800434	SC4910-95-A31
34	DRILL, ELECTRIC, PORTABLE, 1/4 IN.	5130-00-889-8993	1070	SC 4910-95-A31
35	DRILL, ELECTRIC, PORTABLE, 1/2 IN.	5130-00-204-2718		SC 4910-95-CL-A02
36	DRILL, TWIST, 5/8 IN.	5133-00-228-1327	10040	SC 4910-95-A31
37	EXPANDER, SEAL	5120-00-336-0445	J4239	TM 9-2320-360-34P
38	EXTRACTOR SET, SCREW	5120-00-610-1888	A-A-283 SZ1-9	SC 4910-95-A31
39	EXTRACTOR, KING PIN		2HE226	TM 9-2320-360-34P
40	EYE, LIFTING		2BH944	Appendix C, Fig. C-4
41	FIXTURE, HOLDING, IDLER GEAR	5180-01-167-4285	2SK900	Appendix C, Fig. C-18
42	FIXTURE, LIFTING	4910-00-456-7620	J22062-01	TM 9-2320-360-34P

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1)	(2)	(3)	(4)	(5)
ITEM NUMBER	ITEM NAME	NATIONAL STOCK NUMBER	PART NUMBER	REFERENCE
43	FIXTURE, PTO GEAR REMOVER	4910-01-158-3969	J26899	TM 9-2320-360-34P
44	FIXTURE, TEST, HEAD	4910-01-158-3985	J28454	TM 9-2320-360-34P
45	FIXTURE, TRANSMISSION HOLDING	5120-01-115-1165	J24310	TM 9-2320-360-34P
45.1	MICROMETER	5210-00-861-9117	8500-50	
46	GAGE, CLEARANCE	5120-01-048-2161	J24192	TM 9-2320-360-34P
47	DEPTH	5120-01-093-3710	J24898	TM 9-2320-360-34P
48	GAGE, DEPTH, MICROMETER	5210-00-619-4045	445BZ-6RL	SC 3470-95-CL-A02
49	GAGE, DIAL, CYLINDER BORE	5120-01-070-4543	J5347-B	TM 9-2320-360-34P
50	GAGE, FEELER	5210-00-267-3095	667	SC4910-95-A31
51	GAGE, PISTON GROOVE	5120-01-028-1109	J24599	TM 9-2320-360-34P
52	DELETED			
53	GAGE, SEAL RING GROOVE	5120-01-133-6888	J29198-3	TM 9-2320-360-34P
54	COMPRESSION	4910-01-148-1236	J7334-E	TM 9-2320-360-34P
55	GAGE SET, PISTON FEELER	5210-00-116-1631	J5438-01	TM 9-2320-360-34P
56	GAGE SET, TELESCOPING	5210-00-473-9350	GGG-G-17	SC 4910-95-A63
57	GOGGLES, INDUSTRIAL	4940-00-269-7912	A-A-1814	SC 4910-95-CL-A31
58	GRINDING KIT, VALVE SEAT, ELECTRIC	4910-00-473-6437	1750	SC 4910-95-CL-A63
59	GRINDING MACHINE, VALVE FACE	4910-00-540-4679	K403CM	SC 4910-95-CL-A63
60	GUIDE PIN SET		J24315	TM 9-2320-360-34P
61	GUIDE SCREWS	5120-00-629-9781	J1927-01	TM 9-2320-360-34P
62	GUIDE SLEEVE		2HE234	TM 9-2320-360-34P
63	HAMMER, HAND: NONSPARKING (SOFT-FACED)	5120-01-065-2211	57-534	SC 4910-95-A31

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
64	HAMMER, SLIDE	5120-01-355-3010	2HE227	TM 9-2320-360-34P
64.1	HAMMER, SLIDE TYPE	5120-01-112-2165	J6125-1B	TM 9-2320-360-34P
65	HANDLE, INSTALLER	5120-00-977-5578	J7079-2	TM 9-2320-360-34P
66	HANDLE, DRIVER	5120-00-677-2259	J8092	TM 9-2320-360-34P
67	HANDLE, DRIVER	5129-01-054-4048	J24202-4	TM 9-2320-360-34P
68	HEATER, GUN TYPE	4940-00-561-1002	500A	SC 4910-95-A31
69	HOIST, HAND OPERATED	1730-00-906-1352		TM 9-2320-360-10
70	HOLDER, STATOR ROLLER	5120-01-115-1185	J24218-2	TM 9-2320-360-34P
71	HOLDING FIXTURE, TURBOCHARGER		2SK742	Appendix C, Fig. C-8
72	HYDRAULIC TEST KIT		3SK867	TM 9-2320-360-34P
73	INDICATOR, DIAL	4910-00-779-7103	J8165-2	TM 9-2320-360-34P
74	INDICATOR, DIAL	5120-00-794-9178	J5959-01	SC 4910-95-CL-A31
75	INSTALLER, BEARING		J24447	TM 9-2320-360-34P
76	INSTALLER, BRIDGE GUIDE	5120-00-999-8616	J7482	TM 9-2320-360-34P
77	INSTALLER, BUSHING	4910-01-158-3986	J24201	TM 9-2320-360-34P
78	INSTALLER, FRONT SUPPORT NEEDLE BEARING	5120-01-115-1160	J24197	TM 9-2320-360-34P
79	INSTALLER, MANUAL SHAFT OIL SEAL	5120-01-115-1161	J26282	TM 9-2320-360-34P
80	INSTALLER, OIL SEAL	5120-00-937-7267	J8501	TM 9-2320-360-34P
81	INSTALLER, OIL SEAL, OUTPUT	5120-01-054-4042	J24202-1A	TM 9-2320-360-34P
82	INSTALLER, OUTPUT SHAFT BEARING	5120-01-158-3946	J25562	TM 9-2320-360-34P
83	INSTALLER, SEAL	4910-01-176-4230	J21112-B	TM 9-2320-360-34P
84	INSTALLER AND STAKING SET, COLLECTOR RING	5120-00-048-3124	J24200	TM 9-2320-360-34P
85	INSTALLER, VALVE GUIDE	5120-00-999-8617	J21520	TM 9-2320-360-34P

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
86	INSTALLER, VALVE SEAT INSERT	5120-01-048-3118	J24357	TM 9-2320-360-34P
87	INSTALLER, WATER NOZZLE	5120-01-048-3119	J24857-A	TM 9-2320-360-34P
88	INSTALLER, WATER PUMP DRIVE GEAR	5120-00-033-8902	J25257	TM 9-2320-360-34P
89	INSTALLER, WATER PUMP SEAL		J38858	TM 9-2320-360-34P
90	JACK, FLOOR (DOLLY TYPE), 10-TON	4910-00-289-7233	93660	SC 4910-95-A31
91	JACK, HYDRAULIC, 12 TON	5120-00-224-7330	5025209-111-10	SC 4910-95-A31
92	JACK KIT, HYDRAULIC HAND	5120-00-595-8387	A-A-312	SC 4910-95-A31
93	JACKSTAND, 7-TON	4910-00-251-8013	306	SC 4910-95-A31
94	LATHE, BRAKE DRUM	4910-01-028-9849	4100	SC 4910-95-A31
95	LIFT, TRANSMISSION AND DIFFERENTIAL	4910-00-585-3622	9037-20BM	SC 4910-95-A62
96	LIFTING BRACKET	5120-01-116-6048	J24195	TM 9-2320-360-34P
97	LIFTING TOOL, REAR PLANETARY		J24408-A	TM 9-2320-360-34P
98	MULTIMETER	6625-01-139-2512	T00377	SC 4910-95-A31
99	MULTIPLIER, TORQUE	5120-01-122-9393	GA185	SC 4910-95-A31
100	NUT, 1/4 IN.		MS51967-2	
100.1	NUT, 1/2 IN.		MS51967-14	
101	NUT, 5/8 IN.	5310-00-763-8920	MS51967-20	
102	PAN, OIL DRAIN	4910-00-387-9592	450	SC 4910-95-A31
103	DELETED			
104	DELETED			
105	PLIERS, RETAINING RING		J28507	TM 9-2320-360-34P
106	PLIERS, RETAINING RING	5120-00-288-9717	176L129P8	SC4910-95-A31
107	PLIERS, RETAINING RING	5120-00-293-0046		SC 4910-95-A31

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
108	PLIERS, RETAINING RING	5120-00-293-0048	0100	SC 4910-95-A31
109	PLIERS, RETAINING RING	5120-00-293-0049		SC 4910-95-A31
110	PLIERS, RETAINING RING	5120-00-293-0186	J6843-01	SC 4910-95-A31
111	PLIERS, RETAINING RING	5120-00-595-9551	407	SC 4910-95-A31
112	PLIERS, RETAINING RING	5120-00-595-9552		SC 4910-95-A31
112.1	PLUG		FF9767-08S	
113	PLUG PIPE, 1/2 IN.	4730-01-318-6246	219P-8	TM 9-2320-360-34P
114	PLUG PIPE, 1/4 IN.	4730-01-082-1017	444693	TM 9-2320-360-34P
115	PLUG SET, RADIATOR	4910-00-273-3660	2005S-S	SC 4910-95-CL-A76
115.1	PLUMB BOB	5120-00-234-8949	GGG-P-501	
116	PRESS, HYDRAULIC, 60-TON	3444-00-449-7295	26A49	SC 4910-95-A31
117	PRESSURE TESTER, RADIATOR	4910-01-170-4928	J24460-01	TM 9-2320-360-34P
118	PROTECTOR, FORWARD CLUTCH PISTON INNER SEAL	5120-01-048-2157	J24216-01	TM 9-2320-360-34P
119	PROTECTOR, SEAL	5120-00-048-2156	J24210	TM 9-2320-360-34P
120	PULLER, 3-LEG	5120-00-740-3345	J4871	TM 9-2320-360-34P
121	PULLER ASSEMBLY, VALVE SEAT		J23479-492	TM 9-2320-360-34P
122	PULLER, BRIDGE	5120-01-143-4492	J8433-1	TM 9-2320-360-34P
123	PULLER, CAMSHAFT GEAR	5120-00-219-8397	J1902-B	TM 9-2320-360-34P
124	PULLER KIT, MECHANICAL, GEAR AND BRG	5180-00-423-1596	PE12	SC 4910-95-A31
125	PULLER KIT, MECHANICAL, SLIDE HAMMER	5180-00-313-9496	1178	SC 4910-95-A62
126	REAMER SET, SUN GEAR BUSHING	5110-01-150-9755	J28489	TM 9-2320-360-34P
127	RECONDITIONING SET, INJECTOR TUBE	2910-01-146-9616	J22525-B	TM 9-2320-360-34P
128	RELINER, BRAKE AND CLUTCH	4910-00-173-5310	MILR13495	SC4910-95-A31

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
129	REMOVAL TOOL, FILTER	5120-00-865-0933		SC 4910-95-CL-A72
130	REMOVER ASSEMBLY, CYLINDER LINER	4910-01-158-3892	J24563-A	TM 9-2320-360-34P
131	REMOVER, BROKEN BRIDGE GUIDE	5120-00-999-8615	J7453	TM 9-2320-360-34P
132	REMOVER/INSTALLER, CONVERTER PUMP SNAP RING	4110-01-158-3996	J26598-A	TM 9-2320-360-34P
133	REMOVER/INSTALLER, CORE PLUG	5120-01-130-8864	J23019	TM 9-2320-360-34P
134	REMOVER/INSTALLER, WATER INLET ADAPTER	5120-01-048-2180	J25275	TM 9-2320-360-34P
135	REMOVER AND INSTALLER, PISTON RING	5120-00-494-1846	7950177	TM 9-2320-360-34P
136	REMOVER, PULLEY, CAM GEAR AND WATER PUMP	5120-00-733-8890	J7932	TM 9-2320-360-34P
137	REMOVER/SETTER, STUD	5120-00-293-0050		SC 4910-95-A31
138	REMOVER/SETTER, STUD, 1/4 IN., 1/2 IN. DRIVE	5120-00-596-0980		SC 4910-95-A31
139	REMOVER SET, VALVE BRIDGE GUIDE	5120-00-999-8614	J7091-01	TM 9-2320-360-34P
140	REMOVER, TERMINAL		J35689-A	TM 9-2320-360-34P
141	REMOVER, TERMINAL		J33095	TM 9-2320-360-34P
142	REMOVER TOOL, BEARING	5120-01-117-2523	J28557	
143	REMOVER, VALVE GUIDE	5120-00-733-8880	10919987	
143.1	REMOVER, VALVE PIN	5120-01-048-3128	J24412-2	TM 9-2320-360-34P
144	RETAINER TOOL, PISTON PIN	5120-00-127-7757	J23762-A	TM 9-2320-360-34P
145	SCALE, SPRING, 0-50 LB	6670-00-254-4634	AAA-S-133	SC 4910-95-CL-A74
146	SCREW, 114 IN. X 3 IN.		MS90728-18	
147	SCREW, 5/16-18 X 2 N.		MS90728-44	
148	SCREW, 5/16-18 x 2-1/4 IN.		MS90728-40	

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
148.1	SCREW, 1/2 IN. X 3-1/2 IN.		MS90728-121	
149	SCREW, 5/8 IN. X 4-1/2 IN.	5305-00-724-7264	MS90728-174	
150	SCREW, CAP, HEX, 5/8 IN. X 4 IN.	5305-00-724-7254	MS90728-172	
151	SCREW, CAP, HEX, 1/4-20 X 1-1/4 IN.	5305-00-068-0509	MS90728-10	
152	SCREW, FORCING	5305-01-142-9397	J22214-4	TM 9-2320-360-34P
153	SCREW, SHEET METAL, NO. 8 X 1 IN.		MS51850-48	
154	SEAL DRIVER, CTI		2HE232	TM 9-2320-360-34P
155	SEAL DRIVER, CTI		2HE233	TM 9-2320-360-34P
156	SEAL INSTALLER, FRONT CRANKSHAFT	5120-00-936-4377	J9783	TM 9-2320-360-34P
157	SET, CYLINDER HEAD GUIDE STUD	4910-01-162-3630	J24748	TM 9-2320-360-34P
158	SHAFT, DUMMY, TRANSFER CASE		1975300	TM 9-2320-360-34P
159	SLEEVE, PULLER	4910-01-162-3633	J25007-4	TM 9-2320-360-34P
160	SLING ASSEMBLY	3940-01-209-6008		TM 9-2320-360-10
161	SLING, ENDLESS STRAP	3940-00-675-5002		TM 9-2320-360-10
162	SOCKET, 3-1/8 IN., 1-1/2 IN. DRIVE	5130-00-234-1890	IM1005	SC 4910-95-A31
163	SOCKET, 33 MM, 3/4 IN. DRIVE		07533M	TM 9-2320-360-34P
163.1	SOCKET, 55 MM		J39938	TM 9-2320-360-34P
163.2	SOCKET, 63 MM		J39939	TM 9-2320-360-34P
164	SOCKET, DEEP WELL, 9/16 IN., 1/2 IN. DRIVE	5120-00-243-7348	A-A-1394	SC 4910-95-A31
165	SOCKET, PIPE PLUG		PPM408	TM 9-2320-360-34P
166	SOCKET, POWER STEERING		E12-V	TM 9-2320-360-34P

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
167	SOCKET SET, DEEP WELL, 12- POINT, 1/2 IN. DRIVE	5120-00-596-8622		SC 4940-95-CL-B20
168	SOCKET, SOCKETHEAD, 3/4 IN., 1/2 IN. DRIVE	5120-01-024-0168	LAW124A	TM 9-2320-360-34P
169	SOCKET, SOCKETHEAD SCREW, 1/2 IN., 1/2 IN. DRIVE	5120-00-243-1676	172396PC5	
170	SOCKET, SOCKETHEAD SCREW, 1/8 IN., 3/8 IN. DRIVE	5120-00-516-4979	4080-08	
171	SOCKET, SOCKETHEAD SCREW, 1/4 IN., 1/2 IN. DRIVE	5120-00-596-8508		SC 4910-95-A31
172	SOCKET, SOCKETHEAD SCREW, 3/16 IN., 3/8 IN. DRIVE	5120-00-683-8597	4080-12	SC 4910-95-A31
172.1	SOCKET, SOCKETHEAD SCREW, 3/8 IN., 3/8 IN. DRIVE	5120-00-596-1199		SC 4910-95-A31
173	SOCKET, SOCKETHEAD SCREW, 14 MM, 1/2 IN. DRIVE	5120-01-079-8033	SAM14A	SC 4910-95-A31
174	SOCKET, SOCKETHEAD SCREW, 12 MM, 1/2 IN. DRIVE	5120-01-104-5346	SAM12A	SC 4910-95-A31
175	SOCKET, SOCKETHEAD SCREW, 10 MM, 1/2 IN. DRIVE	5320-01-104-5345		SC 4910-95-A31
176	SOCKET, SPANNER		2HE229	TM 9-2320-360-34P
177	SOCKET, SPANNER		2HE230	TM 9-2320-360-34P
178	SOCKET, SPANNER		2HE231	TM 9-2320-360-34P
179	SOCKET, SPANNER		2HE228	TM 9-2320-360-34P
180	SQUARE, COMBINATION, PROTRACTOR HEAD	5210-00-540-3513	GGGS656	SC 3470-95-CL-A02
181	STAND, ENGINE	4910-00-808-3372	J29109	TM 9-2320-360-34P
182	STAND, MAINTENANCE, AUTOMOTIVE AXLE	4910-00-241-3329		SC 4910-95-A63
183	DELETED			
184	STE/ICE-R	4910-01-222-6589	12259266	
185	STRAIGHT EDGE	6675-00-224-8807		SC 4910-95-A63
186	SWAGING TOOL	4910-01-158-3971	J28525	TM 9-2320-360-34P

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
187	SWAGING TOOL, SUN GEAR	4910-01-158-3970	J26997-A	TM 9-2320-360-34P
188	TAPE, MEASURING, 50 FT	5210-00-234-6745	GGG-T-106	SC 4910-95-A31
189	TAPE, MEASURING, 12 FT	5210-00-287-3335		SC 3470-95-CL-A02
190	TESTER, SPRING	6635-01-170-5001	J29196	TM 9-2320-360-34P
191	TESTER, VACUUM GAGE, LEAK DETECTOR SET	6685-01-061-4253	J-23987-B	TM 9-2320-360-34P
192	TESTING KIT, CYLINDER BLOCK PRESSURE	5180-01-252-9800	2SK737	TM 9-2320-360-34P
193	THREADING SET, SCREW, NC THREAD	5120-00-448-2362	GGG-T-330	SC 4910-95-A31
194	GAGE, INJECTOR, 1.520 IN.	5220-01-348-1638	J25502	TM 9-2320-360-34P
195	TOOL, ALIGNMENT, BLOWER SHAFT	4910-01-158-3991	J33001	TM 9-2320-360-34P
196	TOOL, ALIGNMENT, SRS/TRS	5120-01-343-1001	J34729	TM 9-2320-360-34P
196.1	TOOL, ALIGNMENT, SRS/TRS	5120-01-343-1001	J39815	TM 9-2320-360-34P
197	TOOL, CRANK POSITION TIMING		J34930-A	TM 9-2320-360-34P
198	TOOL, LIFTING	5120-01-159-1736	J33079	TM 9-2320-360-34P
199	TOOL KIT, AUTOMOTIVE FUEL AND ELECTRICAL SYSTEM REPAIR	5180-00-754-0655		SC 5180-95-CL-B08
200	TOOL KIT, BODY AND FENDER REPAIR	5180-00-754-0063		SC 5180-90-CL-N34
201	TOOL KIT, ELECTRICAL REPAIR	5180-00-876-9336	7550526	SC 4910-95-A31
202	TOOL KIT, GENERAL MECHANICS	5180-00-177-7033	SC5180-90-CL- N26	SC 5180-90-CL-N26
203	TOOL KIT, FAN CLUTCH OVERHAUL	4910-01-163-1340	3-462-902-24460	TM 9-2320-360-34P
204	TOOL SET, BLOWER SERVICE	5180-00-936-4376	J6270-G	TM 9-2320-360-34P
205	TOOL SET, FUEL PUMP	5180-00-219-8407	J1508-E	TM 9-2320-360-34P
206	V-BLOCKS	3460-00-725-5076	AA51150TY2S TASZ2	SC 4910-95-A63

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
207	WISE, MACHINISTS, 4 IN. JAW, 6 IN. OPENING	5120-00-239-1439	504M2	SC 4910-95-A31
208	WASHER, FLAT, 1/4 IN.		MS23183-48	
208.1	WASHER, FLAT, 1/2 IN.		MS27183-17	
209	WASHER, FLAT, 5/8 IN.	5310-00-003-9174	MS27183-21	
210	WASHER, FLAT, 5/16 IN.	5310-00-081-4219	MS27183-12	
211	WIRE BRUSH, BRASS	5130-00-937-7281	J7944	TM 9-2320-360-34P
212	WIRE TWISTER, PLIER	5130-00-542-4171		SC 4910-95-A31
212.1	WRENCH, ADJUSTABLE, AUTOMOBILE	5120-00-264-3793	WA615	SC 4910-95-A31
213	WRENCH, COMBINATION, 1-3/8 IN.	5120-00-277-8833	1244	SC 4910-95-A31
214	WRENCH, COMBINATION, 1-1/2 IN.	5120-00-277-8834	A-A-1358	SC 4910-95-A31
215	WRENCH, COMBINATION, 1-1/4 IN.	5120-00-228-9517	1173	SC 4910-95-A31
216	WRENCH, COMBINATION, 1-5/16 IN.	5120-00-228-9518	1174	SC 4910-95-A31
217	WRENCH, COMBINATION, 2 IN.	5120-01-957-3115	CL64	TM 9-2320-360-34P
218	WRENCH, CROW'S FOOT, 9/16 IN., 3/8 IN. DRIVE	5120-00-222-7975		SC 4910-95-A31
219	WRENCH, CROW'S FOOT, 3/4 IN., 3/8 IN. DRIVE	5120-00-189-7898		SC 4910-95-A31
220	WRENCH, CROWS FOOT, 5/8 IN., 3/8 IN. DRIVE	5120-00-224-7288	A1650-013	SC 4910-95-A31
221	WRENCH, CROW'S FOOT, 1/2 IN., 3/8 IN. DRIVE	5120-01-114-4933		SC 4910-95-A31
222	WRENCH, FUEL LINE NUT, 1/2 IN. DRIVE	5120-00-019-5232	J8932-B	TM 9-2320-360-34P
223	WRENCH, IMPACT, ELECTRIC, 1 IN.	5120-00-889-9020		SC 4910-95-A62
224	WRENCH, OPEN-END, 1-5/8 IN. & 1-13/16 IN.	5120-00-081-9099	ANSI B107.6	SC 4910-95-A31

**Section II. COMMON TOOLS, SUPPLEMENTS, AND
SPECIAL TOOLS/FIXTURES LIST**

(1) ITEM NUMBER	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER	(4) PART NUMBER	(5) REFERENCE
225	WRENCH, OPEN-END, 1-7/8 IN. & 1-11/16 IN.	5120-00-081-9100	ANSI B107.6	SC 4910-95-A31
226	WRENCH, OPEN-END, 1 IN. & 1-1/8 IN.	5120-00-187-7133		SC 4910-95-A31
227	WRENCH, OPEN-END, 15/16 IN. & 1-1/16 IN.	5120-00-277-2693		SC 4910-95-A31
228	WRENCH SET, IMPACT	5130-00-221-0607	WW650	SC 4910-95-A31
229	WRENCH SET, LINE	5120-00-985-9866		SC 4910-95-A31
230	WRENCH SET, SOCKET, 1 IN. DRIVE	5120-00-081-2309	A-A-1392	SC 4910-95-A31
231	WRENCH SET, SOCKET, 3/4 IN. DRIVE	5120-00-204-1999	GGG-W-641	SC 4910-95-A31
232	WRENCH SET, SOCKET, 3/8 IN. DRIVE	5120-00-322-6231	51200017510	SC 4910-95-A31
233	WRENCH, TORQUE, 0-600 LB-FT, 3/4 IN. DRIVE	5120-00-221-7983	TE602A	SC 4910-95-A31
234	WRENCH, TORQUE, 0-150 LB-IN, 3/8 IN. DRIVE	5120-00-230-6380	TE-12A	SC 4910-95-A31
235	WRENCH, TORQUE, 0-300 LB-IN, 1/2 IN. DRIVE	5120-00-247-2536	F3001	SC 4910-95-A31
236	WRENCH, TORQUE, 0-175 LB-FT, 1/2 IN. DRIVE	5120-00-640-6364	A-A-2411	SC 4910-95-A31
237	WRENCH, TORQUE, 0-75 LB-IN, 1/4 IN. DRIVE	5120-01-112-9532	TQSC6A	SC 4910-95-A31
238	WRENCH, TORQUE, CLICK-TYPE, 15-100 LB-FT, 3/8 IN. DRIVE		QJR2100E	TM 9-2320-360-34P
239	WRENCH, TORQUE, CLICK-TYPE, 30-250 LB-FT, 1/2 IN. DRIVE		QJR3250A	TM 9-2320-360-34P
240	WRENCH, WHEEL BEARING ADJUSTING NUT, 3-1/2 IN.	5120-01-144-5322	AS1910	SC 4910-95-CL-A74

APPENDIX F MANDATORY REPLACEMENT PARTS

Section I. INTRODUCTION

F-1. SCOPE

This appendix lists mandatory replacement parts you will need to maintain the HET Tractor.

F-2. EXPLANATION OF COLUMNS

- a. Column (1) - Item Number. This number is assigned to each entry in the listing and is referenced in the Initial Setup of the applicable task under Materials/Parts.
- b. Column (2)- Nomenclature. Name or identification of the part.
- c. Column (3) - Part Number. The manufacturer's part number.
- d. Column (4)- National Stock Number. The National stock number of the part.

Section II. MANDATORY REPLACEMENT PARTS LIST

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
1	BEARING, BALL	391 0381 040	3110-01-284-1460
2	BEARING SHELL	23501025	3120-01-336-3064
3	BOLT KIT, BEAM HANGER	A-11784	
4	BOLT KIT, BUSHING	A-5332	5306-01-344-7993
5	BUSHING	XB-02949	
6	CAP, VALVE SPRING	5111337	2815-00-529-8193
7	CLAMP	5137620	5340-01-114-5623
8	CLAMP	5143999	4730-00-080-5799
9	CONNECTOR	23500514	2990-01-298-9350
9.1	CROSS	V75750400	2520-01-352-9164
10	CYLINDER KIT	23503830	2590-01-361-8202
11	FASTENER, RATCHET	PC47516	5305-01-222-4344
12	FILTER, FUEL	25010778	2910-01-022-8183
13	FUEL PIPE, JUMPER	8928632	
14	GASKET	D346-177	5330-00-364-3550
15	GASKET	MS52000-3	5330-00-939-0666
16	GASKET	0601-38260	5330-01-352-7495

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
17	GASKET	14079550	5330-00-107-3925
18	GASKET	2DD219	
19	GASKET	23016681	5330-01-328-7635
20	GASKET	23018625	5330-01-243-5148
21	GASKET	23046658	
22	GASKET	23501587	5330-01-058-0587
23	GASKET	23502937	5330-01-353-9547
24	GASKET	244956	
25	GASKET	328951-6X	5330-00-781-7774
26	GASKET	423617	5330-01-336-8786
27	GASKET	5100404	5330-01-054-2398
28	GASKET	5100638	5330-01-058-0586
29	GASKET	5104081	5330-01-078-7186
30	GASKET	23515145	5330-01-079-9963
31	GASKET	5104507	
32	GASKET	5117242	5330-00-911-4628
33	GASKET	5117243	5330-00-735-4289
34	GASKET	5117254	5330-00-745-7831
35	GASKET	5117269	5330-00-735-4291
36	GASKET	5117332	5330-00-725-2301
37	GASKET	5117535	5330-00-844-2907
38	GASKET	5117734	5330-00-745-7776
39	GASKET	5117993	5330-00-973-1415
40	GASKET	5120224	5330-00-862-6929
41	GASKET	5121714	5330-00-745-7669
42	GASKET	5121835	5330-00-847-4967
43	GASKET	5123570	5330-00-915-2835
44	GASKET	5123638	5330-00-862-6934

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
45	GASKET	5123812	5330-00-892-1764
46	GASKET	5126499	5330-00-736-0228
47	GASKET	5136678	5330-00-198-7953
47.1	GASKET	5137721	
48	GASKET	5138659	5330-00-769-48B2
49	GASKET	23513520	5330-00-915-4511
50	GASKET	5144874	5330-01-348-3331
51	GASKET	5144875	5330-01-058-0584
52	GASKET	5144901	5330-01-054-2399
53	GASKET	5145581	
54	GASKET	5148810	5330-01-058-0585
55	GASKET	5161003	5330-00-599-5577
56	GASKET	5167380	5330-00-641-4504
57	GASKET	60598	5310-00-663-7617
58	GASKET	6750186	5330-00-537-2388
59	GASKET	6839213	5330-01-049-0552
60	GASKET	79031	5330-01-078-2825
61	GASKET	8922442	8030-01-338-7640
62	GASKET	8923492	5330-01-037-4129
63	GASKET	8923512	5330-01-206-3264
64	GASKET	8923791	5330-01-088-5982
65	GASKET	8923792	5330-01-206-3265
66	GASKET	8924266	5330-01-270-1161
67	GASKET	8925778	5330-01-247-2474
68	GASKET	23511304	5330-00-758-2863
69	GASKET	97706	5330-01-078-2826
70	GASKET, FUEL PUMP TO ENGINE	5150193	5330-00-212-6290
71	GASKET/SEAL KIT	5518191	5330-01-329-2074
72	KEY	8928545	5315-01-304-9174

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
73	KEYWASHER	8926285	5310-01-233-1338
74	LINING, BRAKE	N2000J1466	2530-01-342-2980
75	LOCKNUT	AN365-1024A	5310-00-208-1918
76	LOCKNUT	MS21045-7	5310-00-274-9364
77	LOCKNUT	MS35691-93	5310-00-997-6903
78	LOCKNUT	MS51922-21	5310-00-959-1488
79	LOCKNUT	TLA-3410-S-GRC	5310-00-269-6340
80	LOCKNUT	TLA-3816-S-GRC	5310-01-222-9097
80.1	LOCKNUT	TLA-5811-GRC	5310-01-082-6166
81	LOCKNUT	T893R	5310-01-288-1116
82	LOCKNUT	V75502830	5310-01-344-6738
83	LOCKNUT	V75503336	5310-01-344-6740
84	LOCKNUT	XB-FW-25	5310-01-199-3419
85	LOCKNUT	XB-HNH-58-C	5310-01-199-9463
86	LOCKNUT	110310A	5310-01-159-8178
87	LOCKNUT	110311A	5310-01-111-0645
88	LOCKNUT	110312A	5310-01-150-5918
89	LOCKNUT	115307A	5310-01-151-1036
90	LOCKNUT	117212	5310-00-568-6077
91	LOCKNUT	1244954-2	5310-00-074-1387
92	LOCKNUT	1333510	5310-01-340-5671
93	LOCKNUT	1488-G	5310-01-358-3664
94	LOCKNUT	1571850	5310-01-288-5096
95	LOCKNUT	1598030	5310-01-342-8595
96	LOCKNUT	1600460	5310-01-346-9445
97	LOCKNUT	192481	5310-01-058-3353
98	LOCKNUT	26175	5310-00-429-3127
99	LOCKNUT	5149163	2835-01-015-5419
100	LOCKNUT	76985	5310-00-432-3959
101	LOCKNUT	79024	5310-01-077-9437

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
102	LOCKNUT	8925752	5310-01-268-6783
103	LOCKNUT	9004-94	
104	LOCK PLATE	57022	5340-01-127-5636
105	LOCKSTRIP	6880899	5340-01-056-0037
106	LOCKWASHER	L58	5310-00-820-6653
107	LOCKWASHER	MS27183-15	5310-00-809-4061
108	LOCKWASHER	MS27183-17	5310-00-809-5997
109	LOCKWASHER	MS27183-21	
110	LOCKWASHER	MS35333-42	
111	LOCKWASHER	MS35333-44	5310-00-194-1483
112	LOCKWASHER	MS35335-31	
113	LOCKWASHER	MS35338-100	
114	LOCKWASHER	MS35338-103	
115	LOCKWASHER	MS35338-41	5310-00-045-4007
116	LOCKWASHER	MS35338-42	5310-00-045-3299
117	LOCKWASHER	MS35338-43	5310-00-045-3296
118	LOCKWASHER	MS35338-44	5310-00-582-5965
119	LOCKWASHER	MS35338-45	5310-00-407-5966
120	LOCKWASHER	MS35338-46	5310-00-637-9541
121	LOCKWASHER	MS35338-47	5310-00-209-0965
122	LOCKWASHER	MS35338-48	5310-00-584-5272
123	LOCKWASHER	MS35338-49	5310-00-167-0860
124	LOCKWASHER	MS35338-51	5310-01-584-7888
125	LOCKWASHER	MS35338-52	5310-00-754-2005
126	LOCKWASHER	MS35338-63	5310-00-582-5965
127	LOCKWASHER	MS35338-8	5310-00-261-7340
128	LOCKWASHER	MS45904-60	5310-00-080-9786
129	LOCKWASHER	MS51848-12	5310-00-688-2195
130	LOCKWASHER	MS51848-14	5310-00-171-1735

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
131	LOCKWASHER	NWA18	5310-01-344-8254
132	LOCKWASHER	SA-1600-4	
133	LOCKWASHER	1484FX	5310-01-354-9949
134	LOCKWASHER	103323	
135	LOCKWASHER	1613	
136	LOCKWASHER	237757	5305-01-133-7193
137	LOCKWASHER	2434	5310-00-775-5139
138	LOCKWASHER	2523	5310-00-775-5182
139	LOCKWASHER	3231	5310-00-032-1814
140	LOCKWASHER	5141367	5310-01-340-3936
141	LOCKWASHER	5177769	5310-00-209-1543
142	LOCKWASHER	5584	5310-00-775-5125
143	LOCKWASHER	6769636	5310-00-776-7670
144	LOCKWASHER	78328	5310-00-172-1991
145	MOUNTING PARTS KIT	328170-101X	
146	NUT	V75503561	5310-01-344-6313
147	NUT	V88350222	5310-01-345-5495
148	NUT	6772182	
149	NUT, ADJUSTING	V75502102	5310-01-344-6280
150	NUT, ADJUSTING	V88140038	5310-01-344-6279
151	NUT, NYLON	97-4196-1	
152	NUT, TRISTOP	V75503716	5310-01-357-3768
153	OVERHAUL KIT, BLOWER	23514202	2990-01-136-7514
154	OVERHAUL KIT, CYLINDER HEAD	5199674	5330-01-053-1845
155	OVERHAUL KIT, FAN CLUTCH	3-34867	2930-01-K49-9523
156	PACKING, PREFORMED	8925981	5330-01-207-7789
157	PACKING, PREFORMED	FF9446-12	5330-01-115-8226
158	PACKING, PREFORMED	FF9446-14	5330-01-269-8580
159	PACKING, PREFORMED	FF9446-10	

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
160	PACKING, PREFORMED	FF9446-16	5330-01-115-8225
160.1	PACKING, PREFORMED	FF9446-18	
161	PACKING, PREFORMED	FF9446-25	5330-01-269-6152
162	PACKING, PREFORMED	FF9449-16	5330-01-115-8225
163	PACKING, PREFORMED	FF9449-18	5310-01-092-5503
164	PACKING, PREFORMED	FF9449-21	5330-01-269-4323
165	PACKING, PREFORMED	FF9449-25	5330-01-269-6152
166	PACKING, PREFORMED	V75500858	5330-01-350-6007
167	PACKING, PREFORMED	V75502787	5330-01-354-4160
168	PACKING, PREFORMED	Z053095777	5330-01-304-3453
169	PACKING, PREFORMED	154126	5330-00-123-2827
170	PACKING, PREFORMED	154130	5330-01-337-0851
171	PACKING, PREFORMED	154132	5330-00-935-6018
172	PACKING, PREFORMED	174140	5330-01-337-0850
173	PACKING, PREFORMED	2AL343	5330-01-145-4573
174	PACKING, PREFORMED	2-219N674-70	5330-00-013-7784
175	PACKING, PREFORMED	2-27153	5330-01-334-1602
176	PACKING, PREFORMED	22617-10	5330-01-040-4772
177	PACKING, PREFORMED	22617-12	5330-00-228-7196
178	PACKING, PREFORMED	22617-14	
179	PACKING, PREFORMED	22617-16	5330-01-168-0885
180	PACKING, PREFORMED	22617-2	
181	PACKING, PREFORMED	22617-20	5330-01-168-1802
181.1	PACKING, PREFORMED	22617-24	
182	PACKING, PREFORMED	22617-4	
182.1	PACKING, PREFORMED	22617-6	
183	PACKING, PREFORMED	22617-8	5330-01-244-2273
184	PACKING, PREFORMED	262331	
185	PACKING, PREFORMED	375422	5330-01-336-8770

Section II. MANDATORY REPLACEMENT PARTS LIST (CONT)

(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
186	PACKING, PREFORMED	3-924N552-90	5330-01-038-3074
187	PACKING, PREFORMED	427682	
188	PACKING, PREFORMED	5101138	5330-01-062-0942
189	PACKING, PREFORMED	5101419	5330-01-164-0344
190	PACKING, PREFORMED	5104978	5330-01-163-8179
191	PACKING, PREFORMED	6830007	5330-01-049-0547
192	PACKING, PREFORMED	71038	5330-00-633-6818
193	PACKING, PREFORMED	71040	5330-01-012-2722
194	PACKING, PREFORMED	71041	5330-00-633-6827
194.1	PACKING, PREFORMED	853181952	
195	PACKING, PREFORMED	8923959	5330-00-166-1020
196	PACKING, PREFORMED	9600-G	5330-01-351-2728
197	PACKING, PREFORMED	9605-G	5330-01-113-2084
198	PACKING, PREFORMED	9705-G	5330-01-351-2726
199	PACKING, PREFORMED	9817-2	5330-01-351-2727
200	PACKING, PREFORMED	9964-G	5330-01-114-9226
201	PACKING, PREFORMED	9972-G	5330-01-131-7062
202	PARTS KIT	RNT-26-C	
203	PARTS KIT	RNT-26-EG	
204	PARTS KIT	RNT-26-H	
205	PARTS KIT	SN-3711-AL	
206	PARTS KIT	SN-3711-T	
207	PARTS KIT, AIR FLOW	289352	2530-01-134-1834
208	PARTS KIT, CLUTCH	328970X	2520-01-325-3336
209	PARTS KIT, COMPRESSOR	RNT26A	4310-01-231-2807
210	PARTS KIT, LINEAR	328971X	3040-01-221-8889
211	PIN	274889	5315-00-823-4333
212	PIN	5106909	5315-01-089-6864
213	PIN	5175641	5315-00-829-0381

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(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
214	PIN, COTTER	MS24665-291	5315-00-019-0777
215	PIN, COTTER	MS24665-267	
216	PIN, COTTER	MS24665-283	5315-00-842-3044
217	PIN, COTTER	MS24665-291	
218	PIN, COTTER	MS24665-353	5315-00-839-5822
219	PIN, COTTER	MS24665-360	5315-00-298-1499
220	PIN, COTTER	MS24665-493	5315-00-018-7988
221	PIN, COTTER	MS24665-624	5315-00-059-0217
222	PIN, COTTER	MS24665-625	5315-00-209-7273
223	PIN, COTTER	MS24665-627	5315-00-013-7308
224	PIN, COTTER	MS24665-683	5315-00-234-1673
225	PIN, RETAINING	6831774	5315-00-108-1112
226	PIN, ROLL	2451151	5315-01-162-4130
227	PIN, SPRING	456299	5315-01-297-7378
227.1	PISTON AND ROD KIT	882957	
228	PLUG	5151272	5340-00-841-9141
228.1	REPAIR KIT	0223-01251-022	
229	REPAIR KIT, GEARBOX	02-23-01260-150	3010-01-102-2040
230	REPAIR KIT, WATER PUMP	5149407	2930-01-143-1352
231	REPAIR KIT, WINCH	9426-G	5330-01-356-5147
232	REPAIR KIT, WINCH	9443-G	
233	RETAINING KIT, PITMAN ARM	1790632K	2530-01-340-4080
234	RING, RETAINING	MS16625-1175	5365-00-804-5827
235	RING, RETAINING	2-21267	5365-01-151-5087
236	RING, RETAINING	2-21272	5365-01-151-4985
237	RING, RETAINING	2-25578	5360-01-336-6734
238	RING, RETAINING	274613	5365-00-349-8518
239	RING, RETAINING	3359-G	5365-01-350-6035
240	RING, RETAINING	3912686063	5365-00-768-8563

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(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
241	RING, RETAINING	5149154	5365-01-015-5414
242	RING, RETAINING	5198049	5365-00-930-3257
243	RING, RETAINING	6758779	5365-00-582-2641
244	RING, RETAINING	8922407	5365-01-166-6633
245	RING, RETAINING	8922605	5365-01-173-3437
246	RING, RETAINING	9414876	5365-01-084-5352
247	RING, RETAINING	9420905	5365-01-084-5353
248	RING, SEAL	001332	5330-01-173-6825
249	RING, SEAL	23503769	5330-00-166-8396
250	RING, SEAL	23011454	5365-01-084-5258
251	RING, SEAL	23011455	2520-01-149-3273
252	RING, SEAL	23014631	5330-01-173-3413
253	RING, SEAL	23019652	5330-01-247-8519
254	RING, SEAL	23045519	5330-01-280-7491
255	RING, SEAL	3912585006	5330-01-212-2222
256	RING, SEAL	5101160	5330-01-058-0281
257	RING, SEAL	5103544	5330-01-088-6596
258	RING, SEAL	5148502	5365-01-062-0943
259	RING, SEAL	5197583	5330-00-930-3254
260	RING, SEAL	5198936	5365-01-016-0443
261	RING, SEAL	6758740	5330-00-582-0456
262	RING, SEAL	6770492	5330-00-999-3760
263	RING, SEAL	6772321	5330-00-999-3754
264	RING, SEAL	6833980	5330-01-236-1753
265	RING, SEAL	6834542	5330-01-088-5847
266	RING, SEAL	6836796	5330-01-336-6709
267	RING, SEAL	6836799	5330-01-145-0697
268	RING, SEAL	6836800	5330-01-336-2998
269	RING, SEAL	6880389	5330-01-141-9579

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(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
270	RING, SEAL	8922140	5330-00-764-1659
271	RING, SEAL	8927189	5330-01-054-2267
272	RING, SEAL	8928676	5330-01-346-0486
273	RING KIT, SEAL, BUTT JOINT	23014441	5330-01-087-6849
274	RING, TEFLON, PISTON	T-560-0330-001	3040-01-341-2340
274.1	ROTATING GROUP KIT	882954	
275	SCREW	MS90725-61	
276	SCREW	MS90728-172	
277	SCREW	115217A	5306-01-156-5429
278	SCREW	5121466	5306-00-894-2381
279	SCREW	8927581	5305-01-242-1783
280	SCREW	9409011	5306-00-940-9011
281	SCREW, ANCHOR	23045343	5306-01-245-9837
282	SCREW, NYLON PATCH	5103534	5306-01-078-4981
283	SCREW, NYLON PATCH	8925603	5306-01-297-6987
284	SCREW, SELF-LOCKING	5101196	5306-01-120-3659
285	SCREW, SELF-LOCKING	9431456	5306-01-147-1202
286	SEAL	A11507	4330-00-846-8177
287	SEAL	NA1205V1 556	5330-01-344-0636
288	SEAL	N1779J1024	5330-01-345-4721
289	SEAL	V75503661	5330-01-344-0637
290	SEAL	2AG460	5330-01-328-6014
291	SEAL	5102098	5330-01-058-5220
292	SEAL	8922045	5330-01-K49-9394
293	SEAL, CTI	V88900213	5330-01-342-7860
294	SEAL, GASKET	3912884019	5330-01-340-8159
295	SEALING KIT	V88510253	5330-01-345-0157
295.1	SEAL KIT	SK-10-2	
295.2	SEAL KIT	SK2-10V-4	

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(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
296	SEAL KIT	61267	5330-01-355-3582
296.1	SEAL KIT	882955	
297	SEAL KIT, BRAKE	9868-G	5330-01-230-3723
298	SEAL KIT, CARTRIDGE VALVE	9692-G	5330-01-169-0769
299	SEAL KIT, PLUG	70035-G	4820-01-351-5840
300	SEAL KIT, PLUG	9432-G	5340-01-344-8463
301	SEAL KIT, SOLENOID VALVE	SV08-31	4810-01-356-4018
302	SEAL KIT, VALVE CARTRIDGE	9638-G	5330-01-346-1534
303	SEAL, LIP	3912883058	5330-01-298-3042
304	SEAL, OIL	G13824	5330-00-725-1511
305	SEAL, OIL	V75503484	5330-01-344-8263
306	SEAL, OIL	V75503486	5330-01-344-8935
307	SEAL, OIL	23010610	2840-01-141-9503
308	SEAL, OIL	23016947	5330-01-245-0159
309	SEAL, OIL	415023-SSR	5330-01-340-9882
310	SEAL, OIL	415304	5330-01-033-2697
311	SEAL, OIL	471965	5330-01-336-8738
312	SEAL, OIL	23516871	
313	SEAL, OIL	5107223	5330-01-083-3063
314	SEAL, OIL	23512418	5330-00-961-9801
315	SEAL, OIL	6773311	5330-00-999-3752
316	SEAL, OIL	71246	5330-01-187-3640
317	SEAL, OIL	8929750	5330-01-324-0437
318	SEAL, POCKET	3912882086	5330-00-809-1052
319	SEAL, QUAD RING	2369031	5330-01-K49-9511
320	SEAL, VALVE GUIDE	8921209	5330-00-992-0695
321	SERVICE KIT	9427-G	2590-01-344-5749
321.1	SHAFT BEARING KIT	882956	
322	SHIM	5100703	5365-01-082-1972
322.1	SHIM KIT	V86010048	5310-01-345-2637

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(1) ITEM NO.	(2) NOMENCLATURE	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER
323	SNAP CLIP	H360-4-2	5340-01-151-8391
324	SNAP CLIP	H360-6-2	5340-01-224-8368
324.1	SNAP CLIP	H360-13-12	
324.2	SNAP CLIP	H360K2593	
325	SOCKET, CONTACT	1203 4051	5940-01-342-0712
326	SPACER	59808BX	5365-01-156-0026
327	SPINDLE	12267808	5315-01-091-0784
328	SPINDLE	6831679	5315-01-112-8641
329	TERMINAL	12084563	5999-01-321-1925
330	TERMINAL	12089305	5999-01-319-7394
331	U-BOLT ASSEMBLY	2-94-28X	5306-00-097-9701
332	WASHER	23013841	5310-01-245-9859
333	WASHER	6839761	5310-01-084-1768
333.1	WASHER, COPPER SEAL	23513842	
334	WASHER, COPPER	5152148	
335	WASHER, KEY	7520854	5310-00-264-1888
336	WASHER, LOCKING	V88350241	5310-01-346-0138
337	WASHERS, PRESSURE	5125108	5310-00-785-3961
338	WASHER, RETAINING	3909063	5310-01-143-0542
339	WASHER, THRUST	23047365	3120-01-318-2070
340	WASHER, THRUST	6835321	3120-01-084-4607
341	WASHER, THRUST	29519114	
342	WASHER, THRUST	6881352	3120-01-056-2112
343	WASHER, THRUST	6881638	3120-01-053-1819
344	deleted		
345	WIRE SEAL	12010293	5975-01-226-8078
346	WIRE SEAL	12015323	5975-01-310-5011
347	YOKE BEARING KIT	923987	

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By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

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IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

Your mailing address

DATE SENT

Date you fill out this form

PUBLICATION NUMBER

TM X-XXXX-XXX-XX

PUBLICATION DATE

Date of TM

PUBLICATION TITLE

Title of TM

BE EXACT PIN-POINT WHERE IT IS

PAGE
NO

PARA-
GRAPH

FIGURE
NO

TABLE
NO

3

2

109

51

2-8

2-1

12

1-6a

IN THIS SPACE TELL WHAT IS WRONG
AND WHAT SHOULD BE DONE ABOUT IT:

Item 10. Change illustration. Reason: Tube end
shown assembled on wrong side of lever cam.

Item 3. The NSN and P/N are not listed on the
AMDF nor the MCRL. Request correct NSN
and P/N be furnished.

Preventive Maintenance Checks and Services.
Item 7 under "Items to be inspected" should
be changed to read as follows: Firing
linkage and firing mechanism pawl.

Since there are both 20- and 30- round
magazines for this rifle, data on both
should be listed.

SAMPLE

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER

SGT JOHN SMITH
Motor Pool SGT

SIGN HERE

SGT John Smith

DA FORM 2028-2
1 JUL 79

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

SAMPLE

FILL IN YOUR
UNIT'S ADDRESS

FOLD BACK

DEPARTMENT OF THE ARMY

TEAR ALONG PERFORATED LINE

Commander
US Army Tank-Automotive Command
ATTN: AMSTA-MB
Warren, Michigan 48397-5000

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

 THEN... JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT. FOLD IT AND DROP IT IN THE MAIL!		SOMETHING WRONG		WITH THIS PUBLICATION?	
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PUBLICATION NUMBER TM 9-2320-360-34-2				PUBLICATION DATE 31 March 1994	
PUBLICATION TITLE DS/GS Maintenance Manual, Truck, Tractor, Heavy Equipment Transporter (HET)				DATE SENT	
BE EXACT. PIN-POINT WHERE IT IS				IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:	
PAGE NO	PARA- GRAPH	FIGURE NO	TABLE NO		
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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 =

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces
 320 Fahrenheit is equivalent to 0° Celsius

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

$5/9 (^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212° Fahrenheit is equivalent to 100° Celsius
 90° Fahrenheit is equivalent to 32.2° Celsius
 $9/5 (^{\circ}\text{C} + 32) = ^{\circ}\text{F}$

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
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
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.195
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

