TECHNICAL MANUAL

INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL

TRUCK, FIREFIGHTING,

1000 GPM MULTIPURPOSE,

MODEL 2500L

NSN 4210-01-193-3621

Approved for public release; distribution is unlimited

H E A D Q U A R T E R S , D E P A R T M E N T O F T H E A R M Y
30 NOVEMBER ’1987

CHANGE
NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 7 APRIL 1992

Intermediate Direct Support and Intermediate General Support

Maintenance Manual

for

TRUCK, FIREFIGHTING,

1000 GPM MULTIPURPOSE, MODEL 2500L

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TM 5-4210-220-34, 30 November 1987 is changed as follows:

1 Remove and insert pages as indicated below. New or changed text material is indicated by a vertical bar in the margin. An illustration change is indicated by a miniature pointing hand.

Remove pages	Insert pages
1-1 and 1-2	1-1 and 1-2

2. Retain this sheet in front of manual for reference purposes.

By Order of the Secretary of the Army:

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General, United States Army
Chief of Staff

Official

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army

DISTRIBUTION:

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SAFETY WARNINGS

WARNING

(Compressed Air)
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

WARNING

(Low Voltage)
Death or serious injury could occur under certain conditions by "low voltage." Do not be mislead by this term. Treat "low voltage" with the same caution as "high voltage". Be sure that the equipment is unplugged/disconnected, and that circuit breakers are set to OFF and batteries are disconnected. Be sure the equipment is properly grounded. Always have another person standing by who is trained in electric shock first aid.

WARNING

(Hoisting)
Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the vehicle and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

WARNING

(Hoisting)
Injury to personnel or damage to equipment could occur from Improper hoisting. Hoist the load slowly to avoid tearing out lifting eye assemblies, slipping slings or load shift. Do not jerk the load or swing It from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

WARNING

(Physical Lifting)
Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job.

Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

SAFETY WARNINGS - Continued

WARNING

(P-D-680)
Dry cleaning solvent P-D-680 is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 deg. to 138 deg.

F (30 deg. to 59 deg. C).

WARNING

(Battery Handling)
Serious injury could occur from the careless handling or storage batteries or battery electrolyte (acid). If acid is splashed on the skin, wash the affected area immediately with plenty of clean water. If acid is splashed in the eyes, wash immediately with plenty of clean water and get medical attention.

WARNING

(Jump-Starting Engines)
Serious injury could occur if dead batteries are not boosted properly. Always wear eye protection. Keep sparks and flames away. Do not smoke. Keep away from dead batteries during starting procedure. Be sure both batteries have the same voltage and grounding and are filled with electrolyte (acid) Do not try to start if the acid is frozen. Connect ends of one cable to the positive (+) terminals of both batteries. Lay a damp cloth over the dead battery to prevent arcing when starting. Connect ends of the other cable to the negative (-) terminal of the good battery and to an engine bracket of dead engine away from dead battery or fuel system components. After dead engine has been started, remove cables in reverse order.

WARNING

(Exhaust Gases)
Carbon Monoxide (exhaust gas) is a colorless, odorless toxic gas. Prolonged inhalation may lead to coma, brain damage, or death. Never operate the main engine, or winterization system in an enclosed space without proper ventilation. FOR ARTIFICIAL RESPIRATION, REFER TO FM 21-11.

TECHNICAL MANUAL
No. 5-4210-220-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 30 November 1987

INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT MAINTENANCE MANUAL for **TRUCK, FIREFIGHTING, 1000 GPM MULTIPURPOSE, MODEL 2500L**

NSN 4210-01-193-3621

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. Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished to you.

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TABLE OF CONTENTS

HOW TO USE THIS MANUAL

ARRANGEMENT. This manual is divided into three chapters. The purpose of each chapter is listed below.

Chapter 1 INTRODUCTION. Provides users with information about standard data required in all manuals. It also familiarizes users with the truck and related equipment.

Chapter 2 DIRECT SUPPORT MAINTENANCE. Presents the necessary procedures and Instructions to maintain the truck at the direct support level.

Chapter 3 GENERAL SUPPORT MAINTENANCE. Presents the necessary procedures and Instructions to maintain the truck at the general support level.

EXPLANATION OF NUMBERING SYSTEM

Text. The information contained in this manual is numbered sequentially for easy access of data.

Example 2-1
First number (2) indicates the chapter.
Second number (1) indicates the paragraph numbers within chapter.

The symbols a. to z., (1) to (99), and (a) to (zz) indicate subparagraphs.

Page, Figure and Table Numbers. All are numbered sequentially within the chapter.

Example. 3-1 2
First number (3) indicates the chapter.
Second number (12) indicates the page number, figure number or table number within that chapter.

LOCATION OF NUMBERS

Text. Appear beside and to the left of related text

Page. Appear at the bottom right (odd no.) or the bottom left (even no.) of the page.

Figure. Appear directly below the related illustration.

Table. Appear directly above the related table.

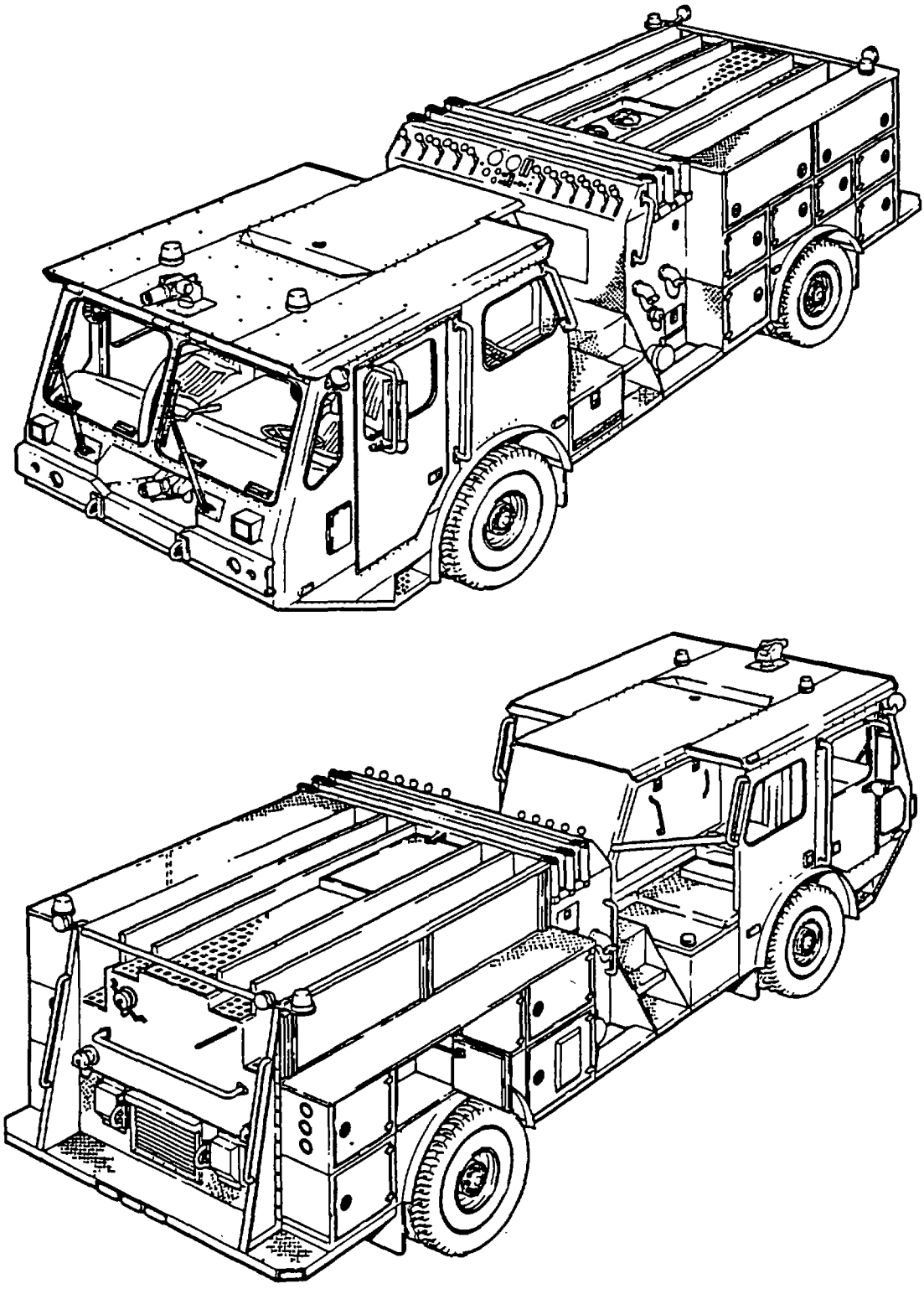

Figure 1-1. Model 2500L Firefighting Truck, NSN 4210-01-193-3621

CHAPTER 1

INTRODUCTION

SECTION I. GENERAL INFORMATION

1-1. SCOPE.

a. This manual provides detailed Direct Support and General Support maintenance instructions, and operator and unit maintenance instructions for the Model 2500L, 1000 GPM Multipurpose, Firefighting Truck NSN 4210-01-193-3621.

b. The Model 2500L firefighting truck is designed for aircraft crash, fire, and rescue operations. The truck is also capable of fighting ground and structural fires.

1-2. MAINTENANCE FORMS, RECORDS AND REPORTS. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA Pam 738-750, The Army Maintenance Management System (TAMMS).

1-3. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS. If your Model 2500L Firefighting Truck needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Quality Deficiency Report). Mail it to us at AMSTR-MOF, US Army Troop Support Command, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. We will send you a reply.

1-4. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE. The guidelines for destruction of army material to prevent enemy use will be those prescribed in TM 751-244-3.

1-5. PREPARATION FOR STORAGE OR SHIPMENT. The procedures and requirements covering preparation for storage or shipment will be those prescribed in Chapter 4. Section VI of manual TM 5-4210-220-12.

1-6. WARRANTY INFORMATION. The Model 2500L, 1000 GPM Multipurpose, Firefighting Trucks, are warranted by Amertek Inc. for 1 year. Refer to TB 5-4210-220-24 for specific component warranty information.

Warranty starts on date found in block 15, DA Form 2408-9, in the logbook. Report all defects in material or workmanship to your supervisor who will take appropriate action.

1-7. LIST OF ABBREVIATIONS. All abbreviations used in this manual conform to Military Standard MIL-STD-1 2 and Its amendments.

SECTION II. EQUIPMENT DESCRIPTION DATA

1-8. GENERAL

a. Chapter 1 of the Operator's and Organizational Maintenance Manual (TM 5-4210-220-12) contains an equipment data description.

b. Paragraph 1-8 details the equipment characteristics, capabilities and features.

c. Paragraph 1-9 describes and indicates the location of all major components.

d. Paragraph 1-10 lists equipment data for the truck.

e. Paragraph 1-11 contains a full description of the technical principles of operation of all systems within the truck.

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CHAPTER 2

INTERMEDIATE DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

2-1. COMMON TOOLS AND EQUIPMENT.

For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

Nomenclature	National/NATO Stock Number
Tool Kit, General Mechanic, Automotive	5180-00-177-7033
Tool Kit, Master Mechanic	5180-00-699-5273
Shop Equipment, Automotive Maintenance and Repair	4910-00-754-0650
Shop Equipment, General Purpose Repair	4940-287-4894
Shop Equipment, Automotive Maintenance and Repair	4910-00-754-0705

2-2. SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT.

For special tools, TMDE, and support equipment for repair at the Direct Support level of maintenance, refer to TM 5-4210-220-34P. Individual equipment requirements are covered in the specific equipment maintenance tasks.

2-3. REPAIR PARTS.

Repair parts for this equipment are listed in TM 5-4210-220-34P, Repair Parts and Special Tools List (RPSTL), covering Direct and General Support Maintenance for this equipment.

SECTION II. DIRECT SUPPORT TROUBLESHOOTING

2-4. GENERAL.

Troubleshooting at the Direct Support Maintenance Level requires you to locate any trouble as quickly as possible. Once the trouble is located, repair or replace the part if you are authorized to do so or determine if General Support Maintenance is required.

2-5. PROCEDURES.

Repairs by Direct Support maintenance are limited to those repairs in which neither the engine nor transmission requires removal. Before using the troubleshooting table, (see table 2-1) check your work order and talk to the Organizational level or operator, who may have checked the symptoms and ruled out certain faults prior to referring the unit to Direct Support.

2-6. SYMPTOM INDEX.

Refer to table 2-1, TROUBLESHOOTING under the number of the symptom in this index to determine the tests and corrective action required.

Table 2-1. DIRECT SUPPORT TROUBLESHOOTING

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

1a FIRE PUMP WILL NOT PRIME

Step 1. Check fiber wheel for wear

Replace fiber wheel as required, (para. 2-13).

Step 2. Check priming pump swings up and down.

a. Check and replace spring, If required, (para. 2-13).

b. Repair disengaging plunger assembly, (para. 2-13).

c. Repair priming pump fulcrum assembly, (para. 2-13).

Step 3. Carry out pressure test on pump (para. 2-13).

Replace any components that are leaking, (para. 2-13).

1b FIRE PUMP NOISY WHEN OPERATING

Step 1. Disconnect pump input drive shafts and rotate pump by hand. Check for failed bearings, indicated by noise or rough turning of shaft.

Repair pump as required, (para. 2-13).

Step 2. Rotate reducer gearbox input and output. Check for failed bearings or gears.

Repair gearbox as required, (para. 2-12).

1c PUMP LEAKING WATER WHILE PUMPING

Step 1. Check for water leak from hole in casing between impeller and drive housing.

Replace the impeller seal, (para. 2-13).

Step 2. Check If gasket or casing is leaking.

Replace gasket or leaking component, (para. 2-13).

Table 2-1. DIRECT SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

2a OIL LEAKING AT TRANSMISSION OUTPUT SHAFT

Step 1. Check for worn or damaged oil seal.

Replace seal (para. 2-19).

Step 2. Check for flange worn at seal.

Replace flange and seal, (para. 2-19).

3a ENGINE CRANKS BUT WILL NOT START, OR IS DIFFICULT TO START.

Step 1. Check stop solenoid energizes and stop rod extends when Ignition switched on

Replace stop solenoid, (para. 2-19.12).

Step 2. Check engine timing and valve clearances.

Retime exhaust valves and injectors as required, (para. 2-19.7).

Step 3. Check for low cylinder compression.

a. Regrind or replace exhaust valves, (para. 2-19.7).

b. Replace leaking cylinder head gasket, (para. 2-19.8).

c. Refer to General Support.

3b ENGINE RUNS ERRATICALLY OR STALLS FREQUENTLY

Step 1. Check fuel rack setting.

Reset fuel rack, (para. 2-19.6).

Step 2. Check for low cylinder compression.

a. Regrind or replace exhaust valves, (para. 2-19.7).

b. Replace leaking cylinder head gasket, (para. 2-19.8).

c. Refer to General Support

Step 3. Check governor.

Overhaul governor and check fuel rack for binding, (para. 2-19.12).

Step 4. Check injector spray tips.

Replace bad injectors, (para. 2-19.5).

Table 2-1. DIRECT SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION	
3c ENGINE HAS LOW POWER	
Step 1.	Check governor
	Overhaul governor and check fuel rack setting, (para. 2-19.12).
Step 2.	Check injector spray tips.
	Replace bad injectors, (para. 2-19.5).
Step 3.	Check engine timing and valve clearances
	a. Retime injectors, (para. 2-19.5).
	b. Adjust valve clearance as required (para. 2-19.7).
Step 4.	Check for low cylinder compression
	a. Regrind or replace exhaust valves, (para. 2-19.7).
	b. Replace leaking cylinder head gasket, (para. 2-19.8).
	c. Refer to General Support.
Step 5.	Check throttle linkage.
	Repair or replace throttle system, (para. 2-19.12).
3d ENGINE LOW OIL PRESSURE AT WORKING TEMPERATURE	
Step 1.	Check if oil intake screen blocked.
	Clean or replace oil intake screen, (para. 2-19.10).
Step 2.	Check for damaged oil pressure relief valve.
	Replace relief valve, (para. 2-19.10).
Step 3.	Check for damaged oil pressure regulator valve.
	Replace regulator valve, (para. 2-19.10).
Step 4	Check for leak in oil pump suction line
	Replace/repair oil pump suction line, (para. 2-19.10).
Step 5.	Check for damaged or worn oil pump.
	Replace oil pump, (para. 2-19.10).

Table 2-1. DIRECT SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

Step 6. Check for excessive wear of crankshaft bearings or major engine oil leak.

Refer to General Support.

3e OIL OR FUMES SEEN AT ROAD DRAFT TUBE

Check for low cylinder compression pressure.

If only one cylinder has low compression, remove head and replace head gaskets (para. 2-19.8). Otherwise, refer to General Support.

3f EXHAUST SMOKE BLACK

Step 1. Check engine timing.

Retime engine, (para. 2-20.5).

Step 2. Check for faulty injectors.

Replace injectors as required, (para. 2-20.5).

Step 3. Check for low cylinder compression.

a. Regrind or replace exhaust valves, (para. 2-20.7).

b. Replace leaking cylinder head gasket, (para. 2-20.8).

c. Refer to General Support.

3g EXHAUST SMOKE WHITE

Check for misfiring cylinders.

a. Replace injectors, (para. 2-20.5).

b Retime engine, (para. 2-20.5).

3h HIGH LUBRICATING OIL CONSUMPTION

Step 1. Check for gasket or seal leaks.

Replace as required.

Step 2 Check air compressor for excessive oil use (eg, oil in compressor discharge line).

a. Repair compressor as required. See TM 5-4210-220-12.

b. Refer to General Support.

Table 2-1. DIRECT SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION

Step 3. Check exhaust manifolds for oil.

a. Check and replace, If necessary, valve stems and guides (para. 2-19.7).

b. Refer to General Support.

Step 4. Pressure test the engine cooling system.

Replace oil cooler if leaking, (TM 5-4210-220-12).

Step 5. Check for low cylinder compression

a. Regrind or replace exhaust valves (para. 2-19.7).

b. Replace leaking cylinder head gasket (para. 2-19.8).

c. Refer to General Support.

3j ENGINE OVERHEATING

Step 1. Check fan and shutter operation.

Repair air lines, multistat, or shutter or fan actuator as required, (para. 2-16).

Step 2. Check thermostats.

Replace as required (TM 5-4210-220-12).

Step 3. Check radiator.

Replace core as required (2-16).

Step 4. Check for exhaust gases in radiator.

Replace cylinder head(s) (para. 2-19.8).

Step 5. Check water pump circulation and seals.

Repair as required (para. 2-19.9).

3k ENGINE WILL NOT REACH WORKING TEMPERATURE

Step 1. Check operation of shutter.

Replace components as required (para. 2-16).

Step 2. Check thermostats.

Replace as required (TM 5-4210-220-12).

SECTION III. DIRECT SUPPORT MAINTENANCE PROCEDURES

2-7. GENERAL MAINTENANCE PROCEDURES.

This paragraph describes general procedures that apply to all maintenance tasks detailed in this manual. To avoid repetition, these general procedures will not be repeated elsewhere in the manual.

2-7.1 General Removal and Disassembly Instructions.

a. Troubleshooting

Before removing any item, refer to the troubleshooting table. This ensures that faults are isolated to a particular component.

b. Cleanliness

Work areas must be kept clean. This avoids contamination of internal parts. This is especially true for areas where control valves, cylinders, or other hydraulic or air system parts are disassembled.

c. De-energize and Depressurize

Before removing any part of electrical, hydraulic, pneumatic, or foam systems ensure the system is not energized or pressurized (e.g. disconnect batteries or relieve all pressure from air system by opening drain valves). Ensure that all controls are in the OFF position before starting any removal procedure.

d. Preparation

Study the task description before disassembling or removing any item. This reduces job time as all tools and equipment will be available and procedures will have been noted.

e. Work Space

Ensure there is sufficient clearance to remove or disassemble a particular part. Disassemble adjacent parts as necessary to provide reasonable working clearance.

f. Lifting

Use a hoist, jack, or other aid when lifting heavy parts. Lifting devices should be positioned and attached to the part to remove all strain from mounting hardware before part is removed. Never work under a part which is supported only by a lifting device. Always support that part on maintenance trestles or other supports before starting work.

g. Lifting Truck

In certain cases it will be necessary to raise the truck so that all tires clear the ground. The following procedure describes a safe method of lifting the truck.

(1) Drain water tank to reduce truck weight.

(2) Park truck on level, hard surface. Position gear selector to N (neutral) and apply parking brakes

(3) Chock wheels of opposite axle.

(4) Place 10 ton hydraulic jack beneath differential. Raise the jack until tires clear the ground.

(5) Place maintenance trestles beneath axle, one on each side of differential. If truck is to be supported by frame, and tires still need to clear the ground, raise the truck high enough to compensate for leaf spring sag.

(6) Carefully lower truck onto maintenance trestles. Be sure maintenance trestles are adjusted to the same height and are of sufficient capacity to carry truck weight.

(7) Repeat steps 4 thru 6 to raise other axle.

h. Lowering The Truck

(1) Place 10 ton hydraulic jack beneath differential. Raise the jack until all weight is off maintenance trestles.

(2) Remove maintenance trestles from beneath axle (one on each side of differential).

(3) Carefully and slowly, lower jack until all weight is removed from jack. Immediately after truck is grounded, chock the wheels.

(4) Repeat step 1 thru 3 to lower other axle as necessary.

(5) Ensure gear selector is positioned to N (neutral) and parking brakes are applied, then remove all wheel chocks.

j. Identification

Identify all parts of similar shape with tags. This will make proper reassembly easier Be sure to identify ends of electric, hydraulic, and air lines as they are disconnected.

k. Salvage

Some assemblies that are removed, even though defective, shall be treated as valuable items. They may be rebuilt for future use.

I. Expendable Parts

Whenever possible, all gaskets, packings, and seals shall be discarded during removal or disassembly. Similarly, lockwire, lockwashers, cotter pins, and like items shall be discarded during disassembly. All should be replaced during assembly. When removing seals, gaskets, or packings, take care not to damage (e g. scratch) the sealing surfaces. If surfaces are damaged they must be repolished to give a good sealing surface.

m. Parts Protection

To prevent moisture and dirt from entering housings, lines, and other openings, apply protective covers after disassembly. Wrap all parts in clean paper or dip parts in rust preventive oil.

2-7.2 General Cleaning Instructions.

CAUTION

Do not use scrapers, wire brushes, abrasive wheels, or compounds when cleaning parts unless called for in detailed instructions. These procedures may alter size of machined surface and may weaken a stressed part.

a. Dry Cleaning Solvent

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Whenever dry cleaning solvent is recommended for cleaning, use item 10, Appendix B.

b. Mineral Spirits

WARNING

Mineral spirits are toxic to skin, eyes, and lungs. Skin and eye protection is required. Avoid prolonged or repeated contact. Good, general ventilation is normally adequate.

c. Gasoline, Diesel Fuel

WARNING

Never use gasoline or diesel fuel to clean parts.

d. Freon 113

WARNING

All freons are asphyxiants and are toxic to skin and eyes. Skin and eye protection is required. Use only in a well ventilated area. Freons are used to clean any parts that normally come in direct contact with hydraulic fluid.

e. Degreasing Machine

WARNING

1,1,1 Trichloroethane is toxic to skin, eyes and lungs. Skin and eye protection is required. Avoid prolonged or repeated contact. Good, general ventilation is normally adequate.

Heavy oil and grease may be removed with a degreasing machine filled with 1,1,1 Trichloroethane. All parts shall be dipped in rust preventive oil after removal from machine.

f. Baking Soda Solution

Truck battery exterior surfaces, terminals, and cable clamps should be cleaned with a weak solution of baking soda (item 5, Appendix B) and water. A bristle brush soaked in the solution may be used to remove caked dirt or corrosion products

g. Solvent Spray Gun

WARNING

Spray gun must be used in spray booth with filter and face shield for personnel since dry cleaning solvent (item 10, Appendix B) is toxic to skin, eyes and lungs. Avoid prolonged or repeated contact

h. Hot Water/Steam

Radiator cores should be cleaned with steam or hot water. If sediment within the core cannot be completely removed in this way, core will have to be boiled in a chemical bath. This bath is a strong solution of caustic soda and is available in a radiator repair shop

j. Pressure Wash

Painted surfaces (e g. truck body) shall be cleaned with a detergent solution and a pressure washer. Always rinse surface with clean water.

Although the truck body paint is very durable, certain solvents may damage the paint. Keep solvents away from painted surfaces. A pressure washer should be used to remove excessive road dirt, oil, and grease from exterior parts prior to dismantling.

k. Cleaning

Oil and fuel tanks should be flushed with steam for at least 24 hours before welding or repairing such tanks.

I. Ball and Roller Bearings

When cleaning ball or roller bearings, place them in a basket. Suspend the basket in a dry cleaning solvent, (item 10, Appendix B) preferably, overnight. If needed, use a brush to remove caked grease or chips. Avoid rotating the bearings until all solid particles are removed. When bearings are clean, spin them in a light lubricating oil (item 17, Appendix B) to remove solvent.

m. Rubber Parts

Do not clean preformed packings or other rubber parts in solvent. These parts should be wiped with a clean, dry, lint-free cloth

n. Electrical Components

Electrical components (e.g coils, switches) which use insulating materiels shall not be soaked or sprayed with cleaning solutions. Remove dirt with a clean, dry, lint-free cloth If necessary, moisten cloth with dry cleaning solvent (item 10, Appendix B).

p. Complex Components

Components that consist of a fabrication with passages and cavities should be checked thoroughly after cleaning. A thin flexible wire should be run through all passages to ensure they are not blocked. Individual passages may be cleaned using a pressure spray gun and dry cleaning solvent (item 10, Appendix B)

2-7.3 General Inspection Instructions.

a. Sealing Surfaces

Check all contact surfaces of gaskets, packings, or seals. Ensure there are no nicks, burrs, or scratches. These might damage new seals during assembly.

b. Ball and Roller Bearings

Check bearings for pitted balls, races, or separator. Bearings shall be rejected if any of the following are seen in the race load area:

(1) Cuts or grooves parallel to ball or roller rotation.

(2) Fatigue pits (not minor machine marks or scratches).

(3) Cracks found during magnetic particle inspection

(4) Serious abrasion of balls or rollers.

(5) Serious discoloration of any part of the bearing.

c. Drain Plugs

When removing drain plugs from transmission, engine, or axles, inspect the plug. A build-up of grit and/or fine metal particles may indicate part failure. A few fine particles are normal.

d. Tubing and Hoses

Check all hose surfaces for broken or frayed fabric. Check for breaks or weak points due to kinking or rubbing. Inspect metal tube lines for kinks or excessive corrosion. Inspect fitting threads or clamps for damage. Replace any faulty part. After assembly, check all disturbed joints for leaks.

e. Splines

Inspect shaft splines for wear. This will include pitting, peening or fatigue cracks. Perform magnetic particle inspection if needed.

f. Electrical Parts

Inspect all wiring for chaffed or burned insulation. Check all terminals for tightness Check all lamps for failure. Check for burns, or broken fittings or components

g. Gears

The following steps should be used to make a general visual inspection of all gears. Specific tests for particular gears, outlined in the text, should also be carried out. If any gear looks faulty, perform a surface temper and/or magnetic particle inspection.

(1) Normal Wear. Loss of metal from surface of teeth. Wear must not prevent gears from meshing or performing properly.

(2) Initial Pitting. This may occur when gears are first put into service. It may continue until high spots have been reduced. It will not affect contact surfaces. This pitting is not necessarily serious.

(3) Destructive Pitting. This pitting occurs after initial pitting, often at an increasing rate This type will destroy the contact area and reduce the load capacity of the gear. Rapid destruction will occur with use

(4) Abrasive Wear. This damage is caused by fine particles carried in the lubricant or embedded in gear tooth. This materiel may come from. Abrasives not removed during assembly. Sand or scale from castings. Impurities from oil or the environment. Bearing or gear tooth material.

(5) Scoring. Slight scoring, galling or other surface damage is seen as tears or scratches in the direction of sliding It starts in areas of highest stress and speed. This is usually at tip of teeth.

(6) Burning. Burning appears as discoloration, and causes loss of hardness of the metal. Burning is caused by any of the following: Gear Overload
Overspeed
Lack of Backlash
Too Little Lubrication
Wrong Lubrication
If discoloration can be wiped off, such marks can usually be traced to oil-burn stains which are not serious.

(7) Rolling. This damage usually occurs only on plastic gears. Rolling is when material is pushed out of shape but does not break off. It is usually caused by heavy, even loads and overheating.

h. Metal Parts

Visually inspect all castings and weldments for cracks. Parts that carry a great load should be Inspected by the magnetic particle method. Non-ferrous parts may be inspected by the fluorescent penetrant method

j. Magnetic Particle Inspection

This type of inspection can only be carried out on metals that can be magnetized. If in doubt check whether a magnet sticks to the surface. It should only be carried out If parts are not easily replaceable (cost or special order), or parts have been reworked or reground, or parts are subject to high stress. Magnetizing current depends on parts being magnetized. For solid section parts, current shall be 1000 amps per diameter - in. For variable diameter thickness, current shall be adjusted for diameter inspected. Parts shall be rejected if:

(1) Indications of non-metallic inclusions are present (foreign body - solid, liquid, or gaseous) and these are longer than one in, or indications are closer than 1/8 in. apart.

(2) Any evidence of cracks are seen

(3) Scattered short sharp bursts are seen. Bursts are caused by metals working at temperatures that weaken and break the material. Bursts are not usually seen until the metal is cut through to the burst area.

(4) Separate short wavy lines in the same general direction are seen. Flakes are caused by Improper cooling. They are not usually seen until the metal is cut through to the flake area.

(5) Fine, sharp, tightly packed lines are seen (grinding cracks). These are usually caused by a glazed grinding wheel. The wheel, instead of cutting the material, rubs and overheats the material The lines are thermal cracks similar to heat treat and hardening cracks.

k. Fluorescent Penetrant Inspection

This type of inspection can be carried out on any metal but is usually reserved for non-magnetic material (e.g. aluminum, stainless steel). The parts shall be warm prior to applying penetrant. The penetrant may be applied by dipping, painting or spraying. All surfaces to be examined shall be completely covered. Penetrant time for various metals is as follows:
Aluminum Alloy - no less than 20 minutes.
Magnesium Alloy - no less than 20 minutes.
Brass or Bronze - no less than 30 minutes.
Ferrous Alloys - no less than 30 minutes.
After applying penetrant, the surfaces will be cleaned with lukewarm water - less than 120 deg. F. (Cool water may be used, but cleaning time will be longer). Pressurized water spray may be used to shorten the washing cycle. The following methods may be used to develop the parts.

(1) Wet Developer Method Parts shall be completely covered in developer by spraying or dipping. Parts shall be dried and developed in a recirculating hot air drier for one half the penetration time.

(2) Dry Developer Method Parts must first be dried. The dry developer shall be spread on all surfaces by dusting or by dipping the part. Parts shall be developed for one half the penetration time.

(3) When no developer is used, drying and developing time shall be at least equal to penetration time to allow sufficient bleeding of penetrant from defects. If additional clarity is required during inspection dry developer may be applied by a hand powder bulb. Following development, the part shall be inspected under black light.

Any evidence of cracks is cause for rejection. After inspection the parts shall be cleaned with dry cleaning solvent (item 10, Appendix B) and covered with rust preventive oil.

m Lapping Procedures

(1) Clean the part with dry cleaning solvent (item 10, Appendix B) and dry with compressed air. Clean the lapping blocks with compressed air. Do not use a cloth or any other material for this purpose.

(2) Spread a good quality 600 grit dry lapping powder on one of the lapping blocks. Place the part to be lapped flat on the block and, using a figure eight motion, move it back and forth across the block. Do not press on the part, but use just enough pressure to keep the part flat on the block It Is Important that the part be kept flat on the block at all times

(3) After each four or five passes, clean the lapping powder from the part by drawing it across a clean piece of tissue placed on a flat surface and inspect the part. DO NOT LAP EXCESSIVELY.

(4) When the part is flat, wash it in dry cleaning solvent (item 10, Appendix B) and dry it with compressed air.

(5) Place the dry part on the second block. After applying lapping powder, move the part lightly across the block in a figure eight motion several times to give it a smooth finish. DO NOT LAP EXCESSIVELY. Wash the part in dry cleaning solvent (item 10, Appendix B) again, and dry It with compressed air

(6) Place the dry part on the third block Do not use lapping powder on this block. Keep the part flat and move it across the block several times, using the figure eight motion Lapping the dry part in this manner gives It the "mirror" finish required for perfect sealing.

(7) Wash the lapped part in dry cleaning solvent (item 10, Appendix B) and dry with compressed air.

2-7.4 General Repair/Assembly Instructions

a. Truck body

Chassis and exterior painted parts may be resurfaced where paint is damaged or parts have been repaired. Before resurfacing, scrape off loose and blistered paint. Clean area to be painted by sanding or buffing. Remove dust. During repair operations, protect bare steel surfaces from rusting with protective oil. Minor body dents may be removed by bumping with a soft-faced hammer while using a wooden block backing.

b. Welding

Welding and brazing may be used to repair cracks In steel parts (e.g. brackets, panels and light framework). Aluminum body panels may also be welded They should only be welded when replacement parts are not available. Do not weld or braze castings, moving parts, or parts under great stress, except in emergencies Refer to TM 9-237 for welding practices.

c. Hoses

Replace all broken, frayed, crimped or soft flexible hoses. Replace stripped or damaged fittings. When replacing hose clamps ensure hoses are not crimped

d. Hose Assemblies There are two different styles of hose assemblies. Described below are procedures for hose replacement.

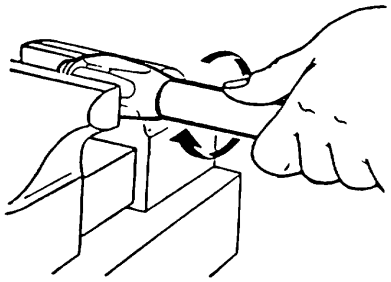
NOTE

If original hose route cannot be followed at time of replacement, find alternative route and measure for new hose length.

GENERAL PURPOSE - High Temperature; Hydraulic, Air and Fuel Application.

(1) Carefully examine both hose end fittings. Discard hose end fittings if any signs of damage are evident. Proceed to step 4 following to assemble new hose assembly using new hose end fittings

(2) If hose end fittings are to be reused, remove from old hose. Clamp socket in a vise. Remove nipple from hose and socket by unscrewing In a counterclockwise direction.



(3) Once nipple is removed, Invert hose and reclamp socket in vise Unscrew hose from socket by turning hose in a clockwise direction If hose is excessively long, socket removal is possible by clamping hose in vise and unscrewing socket from hose in clockwise direction.

(4) Using a cut-off saw or a fine tooth hacksaw cut new hose square to length.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards,,eye protection and other personal protective equipment..

(5) Using compressed air, blow out shavings from hose bore.

(6) Clamp socket in vise. Thread new hose into socket in a counterclockwise direction until it bottoms out. Then back out hose 1/4 turn.

(7) Using hydraulic oil (item 9, Appendix B), liberally lubricate nipple threads and inside of hose.

(8) Insert nipple into hose and socket and tighten in a clockwise direction. Leave 1/32 in. (1 mm) between nipple hex and socket.

(9) To prevent any contamination from new hose assembly, blow out hose assembly using compressed air. Rinse inside of hose with hot water. Do not allow water temperature to exceed 180 deg. F (82 deg. C). Using compressed air, blow out all water from hose assembly.

(10) If hose assembly is not going to be installed immediately after installing fittings, cap both ends to keep hose clean.

TEFLON HOSE - Medium Pressure (with Vacuum Service)

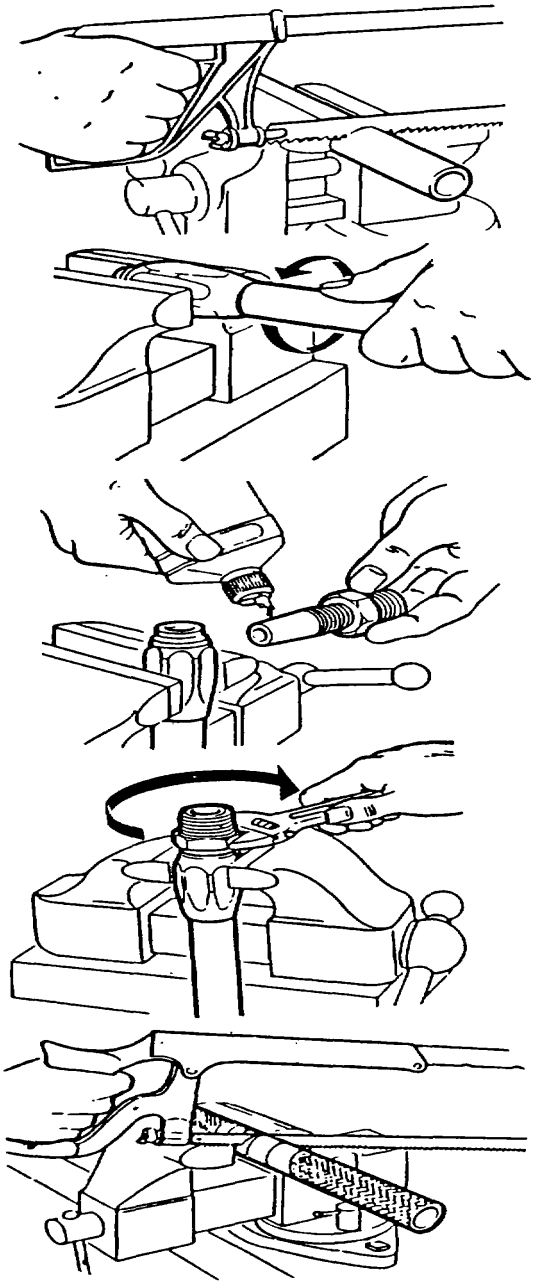
(1) Carefully examine both hose end fittings. Discard hose end fittings if any sign of damage is evident. Proceed to step 3 following, to assemble new hose assembly using new hose end fittings.

(2) If hose end fittings are to be reused, remove from old hose. Clamp socket in vise. Unscrew nipple (in a counterclockwise direction) and remove. Slide the socket away from the hose end by tapping on flat surface. Using pliers, pull the sleeve from hose.

NOTE

It is recommended that new sleeves be used when old fitting is reused.

(3) Wrap teflon hose with masking tape (item 18, Appendix B) at cutoff area Using a cutoff saw or a fine-tooth hacksaw, cut hose square to length. Remove all tape. Trim any extending wires flush with hose end, then remove hose material burrs.



WARNING

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(4) Using compressed air, blow out shavings from hose bore.

(5) Slip two sockets onto new hose. Ensure the sockets are back to back.

(6) Push a sleeve over the end of the tube and under the wire braid by hand. Position sleeve in hose by pushing the hose against a flat surface. Ensure the tube stock butts against the inside shoulder of the sleeve.

(7) Set the sleeve barbs into the Teflon tube by installing the end of the sleeve and tube over the nipple and then work the hose bore over the nipple as shown.

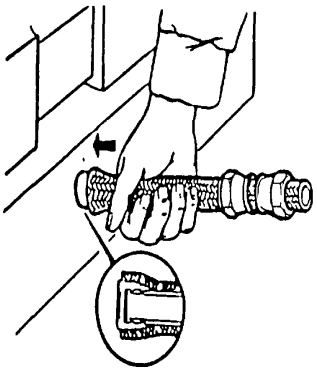
(8) Lubricate the nipple and socket threads with hydraulic fluid (item 9, Appendix B).

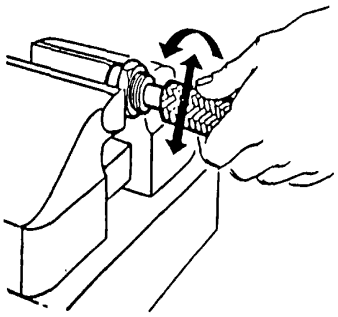
(9) Clamp the nipple hex in a vise. Push the hose over the nipple using a twisting action until seated against nipple clamper. Push socket forward and thread onto nipple handtight.

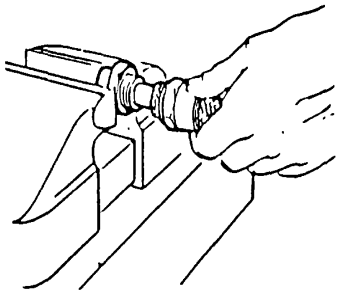
(10) Invert hose assembly and clamp socket in vise. Tighten nipple in a clockwise direction until 1/32 in. (1 mm) clearance between nipple and socket is achieved. Further tightening is acceptable if socket and nipple hexes are to be alined.

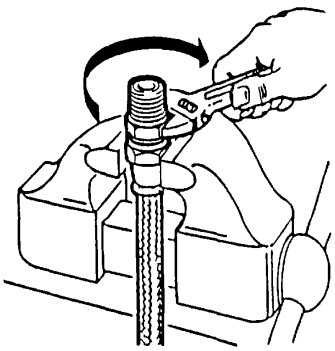
(11) To prevent any contamination from new hose assembly, blow out hose assembly using compressed air. Rinse inside of hose with hot water. Do not allow water temperature to exceed 180 deg. F (82 deg. C). Using compressed air, blow out all water from hose assembly.

(12) If new hose assembly is not going to be installed immediately after installing fittings, cap both ends to keep hose clean.









e. Fasteners

Replace any bolt, screw, nut, or fitting that has damaged threads. Inspect tapped holes for damage. If fitting cannot be retapped with next oversize screw or stud, chasing the threads with proper size tap or die may cure the problem.

f. Lockbolts

The lockbolt and collar type fasteners are used to secure the body panels on the truck

Always use the correct lockbolt when replacing equipment. Measure the width of all the various layers of metal. Add these together and use the lockbolt with the correct grip range.

NSN	VENDOR PART NO.	GRIP RANGE (INCHES)	HOLE SIZE
5306-01-245-0086	2801-06-03	0.1 25/0.250	.203
2590-01-244-6212	2801-06-04	0.187/0.312	.203
5306-01-244-6247	2801-06-05	0.250/0.375	.203
5306-01-245-0087	2801-06-06	0.312/0.437	.203
5306-01-244-6248	2801-06-08	0.437/0.562	.203

REMOVAL

(1) Using a hammer and a center punch, center punch the lockbolt head.

(2) Using a 13/64 in. drill bit and an electric drill, drill the lockbolt head until it is removed.

(3) Using a hammer and a pin punch, tap on lockbolt shank until it falls out.

INSTALLATION

(1) Set and clamp parts to be lockbolted in proper alinement. If holes are predrilled aline holes and clamp parts together.

(2) Drill 13/64 in. mounting holes as necessary.

(3) Insert lockbolt into prepared hole. Ensure the lockbolt is installed with the head facing the outside of the body.

(4) Install the lockbolt collar onto the lockbolt from the opposite side of body panel.

(5) Place nose of hand tool (Model 721) over the shank of the lockbolt and against the lockbolt collar.

(6) Squeeze hand tool levers together. As the tool pulls on the lockbolt shank, the sheets of metal are drawn together. The tool compresses the lockbolt collar Into the locking grooves and continues to pull on the lockbolt shank until lockbolt collar is completely compressed. The shank will break off at the neck. Discard the portion of the lockbolt shank that breaks away.

(7) Repeat steps 1 thru 6 until all necessary lockbolts are installed.

g. Insert Fasteners

There are two different sizes of Insert fasteners used on this truck Use the following table to determine size and NSN for either insert fastener.

NSN	VENDOR NO.	THREAD SIZE CLASS 2B	HOLE SIZE
5340-01-244-5052	9507-1012	10-32 UNF	0.290
5340-01-244-5053	9504-0816	1/4-20 UNC	0.375

REMOVAL

(1) Carefully drill out the old Insert fastener according to the hole size list chart.

(2) If hole size is oversize, install a patch over hole and re-drill to proper size, or install next size of insert fastener.

INSTALLATION

(1) Drill hole in the proper location.

(2) Install proper size adaptor on nut set hand tool (Model 249). Thread insert fastener onto adaptor of nut set hand tool

(3) Position insert fastener in hole and squeeze nut set hand tool levers together.

(4) Release pressure from levers, and unscrew adaptor from secured insert fastener

h. Rivets

There is only one size of countersunk rivet used on this truck.

REMOVAL

(1) Using a 13/64 m. twist drill and an electric drill, drill out the center of the rivet head

(2) Using a pin punch and a hammer tap rivet until It falls clear of hole.

INSTALLATION

(1) Set and clamp parts to be riveted in proper alinement. If holes were previously drilled, aline all holes.

(2) Drill 13/64 in. mounting holes as necessary

(3) Install anvil pin into rivet gun (Model 135).

(4) Install rivet into holes of panels to be attached.

(5) Squeeze rivet gun levers together. As anvil pin starts to pull through rivet, panels are drawn together until anvil pin snaps.

(6) Repeat steps 1 thru 5 until all necessary rivets are installed

j. Gaskets

Never reuse old gaskets except in an absolute emergency Always ensure correct gasket is being used as replacement by fitting dry.

k. Oil Seals

Install oil seals with lip seal facing the source of oil. Install by carefully applying an even force on the outer edge of the seal. If oil seals are to be installed over a keyed or splined shaft, use a guide.

This will prevent the sharp edges of the shaft damaging the lip seal. Make a guide by cutting and shaping very thin gage sheet metal over the splines. Make sure the edges are bent slightly inward to prevent these from damaging the seal.

I. Bearing Installation

To prevent personal injury or premature bearing failure when removing or installing bearing races, always exert force on the tight ring of the bearing.

To assist in bearing installation procedures it is acceptable to heat or cool bearing races. Outer bearing races can be cooled to reduce the race diameter. Place bearing In a deep freeze for about two hours prior to assembly. It is acceptable to leave bearing in deep grease for a longer period of time.

To avoid bearing failure, never heat a bearing using an open flame. Inner bearing races can be heated to increase the race diameter. An electrically-heated-type oil bath is recommended. Do not allow oil temperature to exceed 275 deg. F (135 deg. C). The preceding procedure can also be used to help during installation of gears on shafts. If accessible, shafts may be cooled to reduce outer diameter, and gears may be heated to increase inner diameter.

m. Lubrication

Lubricate bearings with the type of lubricant normally used before assembly (e.g. gear lube in gearbox bearing). This will provide lubrication during first run-in until system lubrication can reach bearings

n. Electrical Items

Replace broken, worn or burned electrical wiring with wire of the same carrying capacity. Always refer to tags and sketches made at removal.

p. Testing

Test operation of any system after installation or repair. Inspect for leaks, vibration, noise, misalinement or other problems. Recheck after a few hours of normal operation.

2-8 REAR STEP, TOW RINGS, AND HOSE REEL DOOR

2-8. REAR STEP, TOW RINGS, AND HOSE REEL DOOR.

This task covers
a. Removal
b. Installation
c. Repair

TOOLS
25, Appendix B Sealant
Shop Equipment, Automotive Maintenance and Repair, NSN-4910-00-754-0705

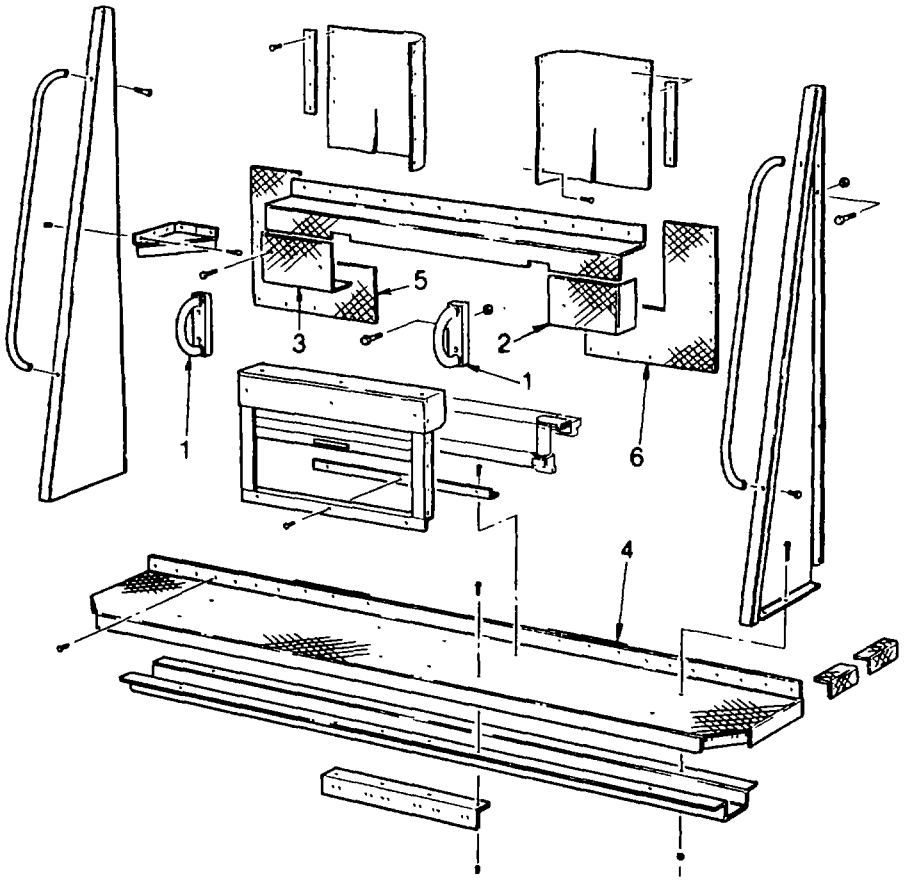
MATERIAL/PARTS

PERSONNEL REQUIRED - 2

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
All Air Tanks Drained

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves, and other suitable protective clothing.



2-8. REAR STEP, TOW RINGS, AND HOSE REEL DOOR - Continued

REMOVAL

NOTE

The rear step is not an assembly. Parts making up the group may be removed individually. For hose bed removal, remove only:

tow rings (1)
rear trim RH (2)
rear trim LH (3)
rear step (4)
mounting plate LH (5)
mounting plate RH (6)
detach heat retainers from door only
hose reel rollers will be removed when rear step and mounting plates are removed.

(1) If the step itself is to be removed, tag and disconnect the harness wires from the right rear lamps of the truck and pull harness back through the rear step.

(2) To pull harness clear, remove marker lamps and associated wires.

(3) All components may be removed individually. Use procedures in para. 2-7 to remove fasteners

INSTALLATION

(1) No particular order of assembly is required. Prior to installation of any part, coat mounting area of part with a 1/8 in. bead of sealant (item 25, Appendix B).

(2) Use procedures detailed in para. 2-7 for lockbolt and rivet installation.

(3) When all metal parts are attached, install wire harness through rear step support channel and up Into hose body rear boxes. Ensure all holes in body through which harness is drawn are fitted with suitable grommets

(4) Connect wires as tagged in step 1 of REMOVAL preceding.

(5) Install marker lamps.

(6) Test all lamps to ensure all wires are connected correctly.

REPAIR

(1) Minor body damage such as dents and bends, may be straightened using basic body repair tools.

(2) Chipped or damaged surface protection may be repaired by spot painting (para. 2-7).

(3) Severely damaged components must be replaced. When this is required use the REMOVAL and INSTALLATION procedures preceding to replace such panels

2-9. SIREN AND PA SYSTEM.

2-9. SIREN AND PA SYSTEM.

This task covers:

a. Removal
b. Installation
c. Repair

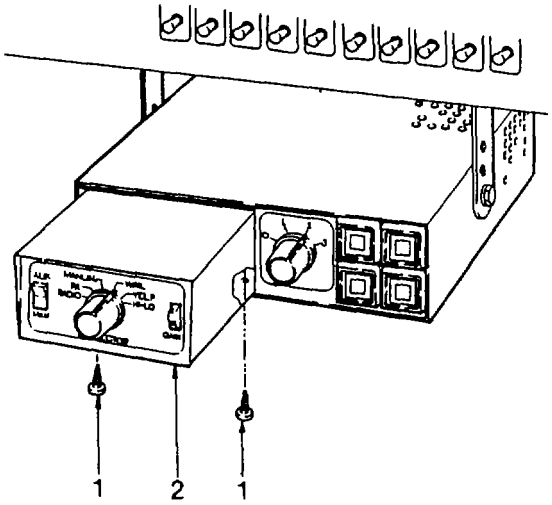
INITIAL SETUP:

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0650

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Engine Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)

REMOVAL

Remove screws (1) and pull siren module (2) out of chassis.



INSTALLATION

(1) Check that plugs on the back side of siren module and corresponding receptacles in chassis are securely installed. Secure attachment is necessary to ensure proper electrical contact when module is installed.

(2) Slide module (2) into place In chassis. Install and tighten screws (1).

REPAIR

Siren Module Repair

NOTE

Repair of the siren unit or module Is only done by electronic maintenance personnel at the intermediate level. The following repair procedure is limited to cover the siren module only as no functions are identified for the option control module .

(1) Only a limited number of components are replaceable in the siren module since components on the printed circuit boards are not considered individually replaceable. Use the illustrations and legends to identify the replaceable parts. For convenience, the parts are Identified by their circuit reference numbers.

CAUTION

Be careful when replacing and soldering small components. Heat easily damages integrated circuits, transistors, capacitors and circuit boards. Therefore, it is advisable to use long nose pliers or similar devices as a heat sink on component leads being soldered.

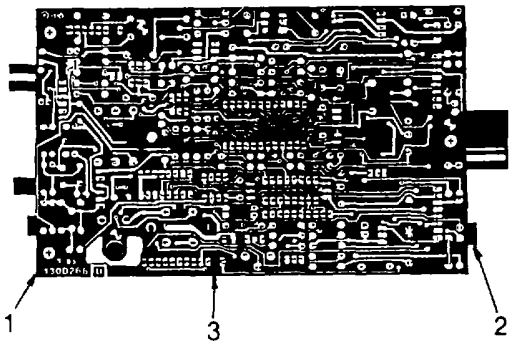
(2) When replacing the output amplifier transistors, Q301 and 0302, always ensure that they are replaced in a matched pair. Make sure that the wire insulators used with the transistors are replaced also. When installing new transistors use a heat sink compound on both sides of the mica insulators. Be sure the insulators are installed correctly, otherwise a short circuit may occur.

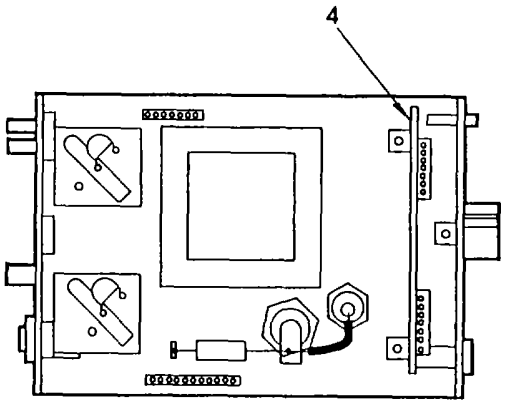
2-9. SIREN AND PA SYSTEM - Continued

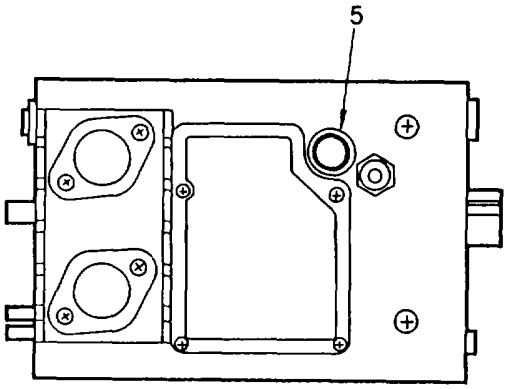
(3) When Q301 and Q302 are replaced, be sure to adjust the symmetry of the output waveform before returning the module to use. To do this, connect a 5.5 ohm, 200 watt dummy load across pins (5 and 6) of P301 in place of the speakers. Connect an oscilloscope across the dummy load and activate the Yelp signal. Adjust R158 on the main circuit board to obtain the best possible square wave.

1. Self Tapping Screw, No. 8 X 1/2 in.
2. Knob
3. Main Circuit Board
4. Front Circuit Board
5. Fuse Holder 342002

R301 Potentiometer, 10K Ohm
C301 Capacitor, 500 uF, 15 V, electrolytic
C302 Capacitor, .001 uF, 100 V, Disc
C303 Capacitor, .001 uF, 100 V, Disc
C304 Capacitor, .005 uF, 100 V, Disc
C305 Capacitor, .005 uF, 100 V, Disc
Q301 Transistor, NPN, Silicone 2N5885
Q302 Transistor, NPN, Silicone 2N5885
T301 Output Transformer
SW302 Slide Switch
F301 Fuse, 20 amp, 3AG
P301 Connector 8-pin
J302 Connector, 12-pin
J303 PCB Connector







(4) To remove the main circuit board remove the three screws that hold the board in the siren module. Disconnect the socket at the rear of the board and lift the board out of the module. When replacing the main circuit board, aline the socket at the rear so that the color dot on the socket is adjacent to the color dot on the circuit board. Also be sure that the two plugs on the front of the circuit board mate properly with sockets on the front circuit board.

(5) To remove the front circuit board, remove the main circuit board as described above. Loosen control knob set screws and slide the knobs from their control shafts. Remove the spanner nuts that hold the SELECTOR and the GAIN control to the front panel of the module. Remove the screw that holds the siren button bracket in place and lift out the circuit board.

(6) To test the main circuit board, the following tables list voltages and waveforms that appear on the integrated circuits and transistors when the SELECTOR switch is set to its various positions

2-9. SIREN AND PA SYSTEM - Continued

Abbreviations are used to describe the SELECTOR position. These abbreviations and their meanings are as follows:

R = RADIO
P= PA
M = MANUAL
W = WAIL
Y = YELP
H = HI-LO

When a waveform is present at a given point, the waveform is listed by a capital letter, its cycle rate and its peak-to-peak voltage. For example, the waveform at IC101-3 is listed as A/45-55, 1. Therefore, when an oscilloscope is connected to IC101-3, waveform A having a cycle rate of 45-55 cycles per minute (or Hz, if specified) and a nominal amplitude of 1 volt peak-to-peak (Var = varying) should be observed. All waveforms are illustrated subsequent to the tables.

IC101

SELECTOR Pin	**Position**	**Voltage or Waveform**
1	All	10.5 Vdc
2	H	10.5 Vdc
3, 4	H	A/45-55, 1
5	H	10 Vdc
6	H	10 Vdc
8	H	OV
11	Y	OV
12	Y	10.5 Vdc
13	H	10.5 Vdc
14	All	0.5 Vdc

1C102

Pin	**SELECTOR Position**	**Voltage or Waveform**
2, 6	W	B/10, 3
2, 6	Y	B/160-190, 3
2, 6	H	B/45-55, 3
3	w	A/109.8
3	Y	A/160-190, 9.8
3	H	A/45-55, 9.8
4	All	10.5 Vdc
5	All	7 Vdc
7	W	C/10, 7
7	Y	C/160-190, 7
7	H	C/45-55, 7
8	All	10.5 Vdc
2	M	1.9 Vdc
6	M	1.9 Vdc
7	M	OV

2-9. SIREN AND PA SYSTEM - Continued

IC103

1	W, Y	B/10, 2.8
2	H	10.5 Vdc
3	All	5.25 Vdc
5	W	B/10, 3
5	Y	B/160-190, 3
5	H	B/45-55, 3
6	All	2.7 Vdc
7	W, Y, H	9 0 Vdc, min.
7	M, P, R	0 5 Vdc
8	All	10.5 Vdc

IC104

2, 6	W, Y, H	C/1000-3000 Hz, Var.
3	W, Y, H	D/1000-3000 Hz, 9 8
4	All	10.5 Vdc
5	W	B/10, 3
5	Y	B/160-190, 3
5	H	A/45-55, 0 9
7	W, Y, H	E/1000, 2000 Hz. Var.
8	All	10.5 Vdc

IC105

Pin	**SELECTOR Position**	**Voltage or Waveform**
1	All	10.5 Vdc
3	All	OV
5	All	105 Vdc
6	All	10.5 Vdc
7	W, Y, H	OV
7	M, P, R	10.5 Vdc
10	W, Y, H	9 0 Vdc
10	M, P, R	0.5 Vdc
11	W, Y, H	9.0 Vdc
11	M, P, R	0.5 Vdc
12	All	1 0 Vdc max.
13	W, Y, H	D/1000-3000 Hz, 10
15	W, Y, H	A/500-1500 Hz, 10.5
16	All	10 5 Vdc

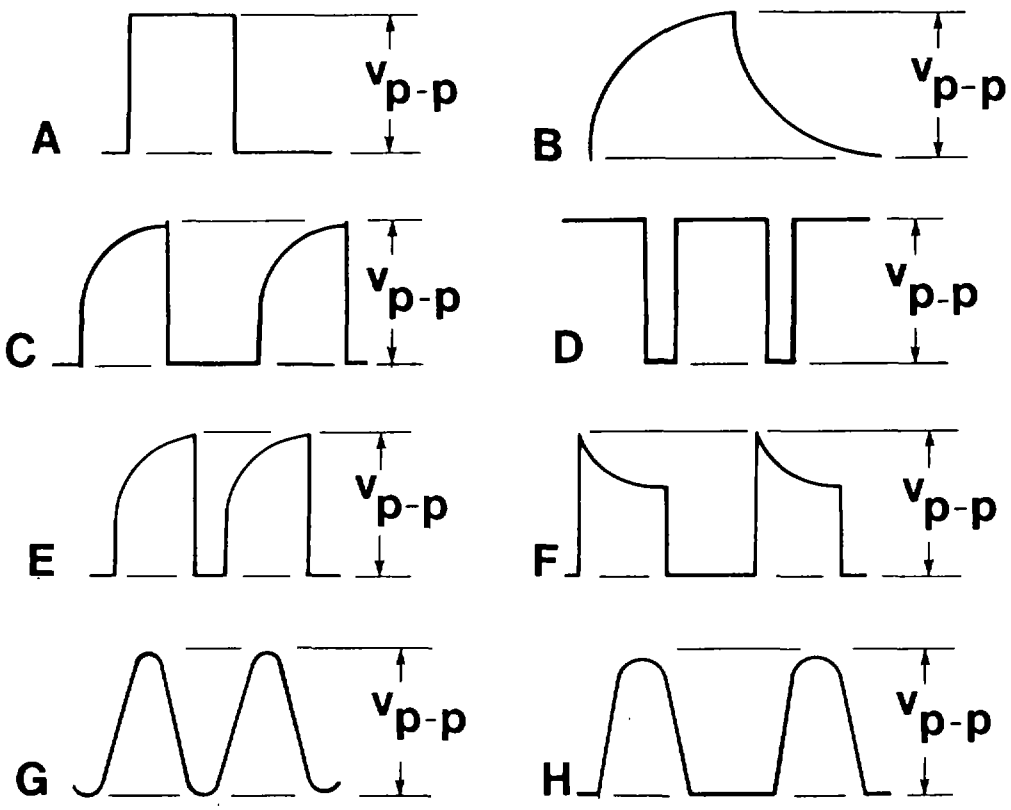
2-9. SIREN AND PA SYSTEM - Continued

Pin	IC106 SELECTOR Position	Voltage or Waveform
2	All	10.0 Vdc
3	All	OV
4	All	10.5 Vdc
5	All	7.0 Vdc
6	All	OV
7	All	OV
8	All	10.5 Vdc
	IC107	
1	All	6.3 Vdc
8	W, Y, H	F/500-1500 Hz, 10
8	P, R	G/1000 Hz, 1.8
14	All	13.6 Vdc
	Q101	
B, E	W	B/10, 3
B, E	Y	B/160-190, 3
B, E	H	B/45-55, 3
B, E	P, R	1.5 Vdc
B, E	M	1.9 Vdc
C	All	10.5 Vdc
	Q103	
B	All	11.0 Vdc
E	All	10.5 Vdc
C	All	13.6 Vdc
	Q106	
B	All	0.7 Vdc
E	All	OV
C	All	0.3 Vdc
	Q107	
B	All	12.9 Vdc
E	All	13.6 Vdc
C	All	13.5 Vdc

2-9. SIREN AND PA SYSTEM - Continued

Q108, 109

B	W, Y, H	A/500-1500 Hz, 30
B	P, R	G/1000 Hz, 5
E	W, Y, H	A/500-1500 Hz, 23
E	P, R	G/1000 Hz, 5
C	W, Y, H	A/500-1500 Hz, 1 5
C	P, R	H/1000 Hz, 0.8



2-10 PUMP BODY

2-10.1 Pump Body Assembly

2-10.2 Console Assembly

2-10. PUMP BODY.

2-10.1 Pump Body Assembly.

This task covers:

a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS

Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION

All Piping Drained (see TM 5-4210-220-12)
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Wheels Blocked
All Air Tanks Drained
Pump Body Heat Shield Removed (see TM 5-4210-220-12)
Radiator Drained (see LO 5-4210-220-12)
Winterization Heater Exhaust Removed (see TM 5-4210-220-12)
Winterization Heater and Supports Removed (see TM 5-4210-220-12)
Pump Body Heater Removed (see TM 5-4210-220-12)

MATERIALS/PARTS

101952 Pump Body
MS90725-172 Bolt
MS27183-21 Washer
100036 Washer
310591 Locknut

PERSONNEL REQUIRED - 2

WARNING

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid damaging components, slipping slings or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

NOTE

To remove and install the truck pump body, the workshop must be equipped with an overhead hoist or crane. The hoist or crane should have a lifting capacity of at least 1000 lb (454 kg) to height of at least 16 ft (4.9 m) from floor level.

REMOVAL

(1) Disconnect and remove hoses from cross-lay hose beds.

(2) Remove pump body access panels and unplug pump body wiring harness from engine harness and remove ties attaching harness to other wiring.

(3) Disconnect heater hose from hose reel blower. Drop hose through pump body.

2-10. PUMP BODY - Continued

(4) Tag and disconnect wires to hose reel blower.

(5) Remove all ties attaching water and air pressure lines and wiring to pump body components.

(6) Tag and remove pressure lines from water gages and air controls on structural panel Also detach pump tachometer drive cable.

(7) Remove throttle and stop controls for APU as detailed m TM 5-4210-220-12.

(8) Tag and remove auxiliary cooler hoses to control valve on structural panel.

(9) Tag and unplug foam and water tank level monitor harnesses.

(10) Tag and remove engine coolant hoses to auxiliary cooler.

(11) Disconnect tank fill and hose reel hoses from discharge manifold valves.

(12) Tag and remove foam hoses to metering valve .

(13) Remove victualic coupling and disconnect turret discharge pipe, rear discharge, 2 1/2 in. suction pipe and pump discharge from discharge and suction manifolds.

(14) Remove tie rod linkage from valve.

(15) Drill out and remove lockbolts (para. 2-7) attaching angles to each side of pump body. Remove both angles.

(16) Remove clamp that attaches 2 1/2 in. suction pipe to frame.

(17) Drain priming tank by opening small valve on pump primer.

(18) Disconnect priming reservoir hoses at priming tank.

(19) Detach winterization system fuel pump and filter and fuel lines from pump body.

(20) Detach PTO manual shutoff valve from left side of pump body. Do not remove hoses.

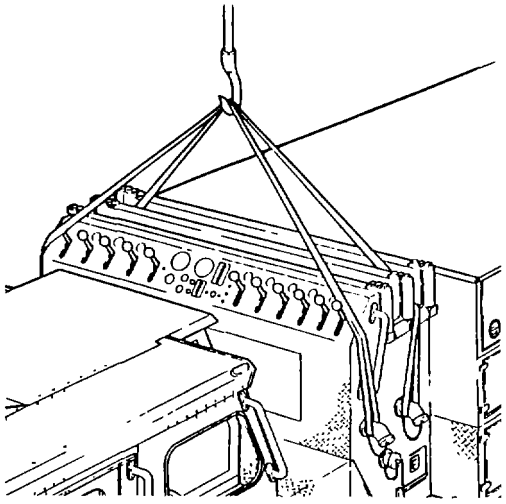
(21) Disconnect shop air connection at air drier.

(22) Position hoist over pump body and rig up lifting slings to body as shown.

(23) Remove four bolts and nuts attaching pump body to frame.

CAUTION

When hoisting, ease the pump body up slowly Be sure all air lines and hoses have been disconnected properly and the pump body does not interfere with chassis mounted components.



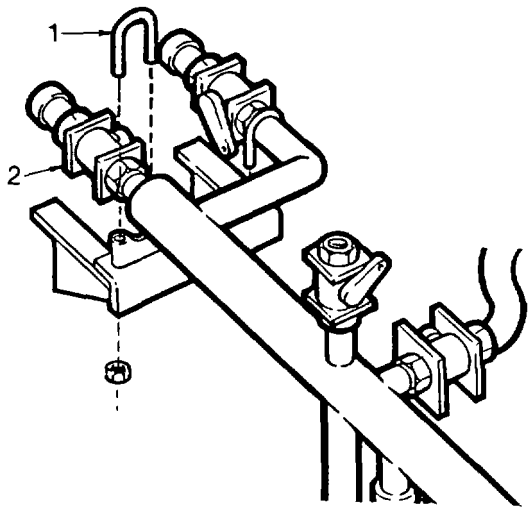
(24) Carefully lift pump body clear of truck frame and hose body and place it on the floor.

2-10. PUMP BODY - Continued

2-10.1 Pump Body Assembly - Continued

NOTE

If the pump body is removed and installed for the purpose of removing hose body or agent tanks, disregard steps (25 and 26) of this procedure and steps (1 and 2) of the installation procedure.



(25) Remove four clamps (1) attaching discharge piping to pump body.

(26) Disassemble valves (2) (see TM 5-4210-220-12) and remove discharge manifold, valves, and discharge pipes from pump body.

INSPECTION

(1) Ensure that new pump body is free of defects.

(2) Inspect structural control panel for damage and defects. Be sure wiring harness, and air and water lines are free of defects and properly secured to control panel components.

(3) If control panel is replaced be sure the new panel is wired and plumbed identically to the one removed.

(4) Inspect discharge manifold and attaching components. Ensure that all items are undamaged and free of defects.

INSTALLATION

(1) Position discharge manifold inside new pump body and assemble valves (2) (see TM 5-4210-220-12).

(2) Attach discharge manifold to pump body bracket using clamps (1).

(3) Attach lifting slings to pump body and hoist as in removal.

(4) Lift pump body onto truck carefully and aline mounting holes.

(5) Attach pump body to truck frame using four bolts and nuts. Remove lifting slings.

(6) Attach discharge manifold to pump discharge pipe using victualic coupling.

(7) Attach turret discharge pipe to manifold using victualic coupling.

(8) Thread hose reel heater hose up through body and attach to blower.

(9) Install PTO manual shutoff valve to left side of pump body. Install valve handle.

(10) Connect shop air line to air drier.

2-10. PUMP BODY - Continued

(11) Install winterization system fuel pump and filter to pump body.

(12) Reconnect priming reservoir hoses to priming tank. Ensure priming pump and priming tank drain valves are closed.

(13) Attach 2 1/2 in. suction pipe to frame with pipe clamp and install victaulic coupling to attach it to the suction manifold.

(14) Attach angles to each side of pump body using lockbolts as detailed In para 2-7

(15) Install tie rod linkage to valve.

(16) Reconnect foam hoses to metering valve as tagged.

(17) Reconnect tank fill and hose reel hoses to discharge manifold valves.

(18) Install engine coolant hoses to auxiliary cooler as tagged.

(19) Plug foam and water tank level monitors to harnesses as tagged.

(20) Connect auxiliary cooler hoses to control valve on structural panel as tagged.

(21) Reconnect throttle and stop controls for APU.

(22) Install all pressure lines to water gages and air controls on structural panel as tagged.

(23) Reconnect pump tachometer drive to structural panel.

(24) Install pump body heater and winterization heater as detailed in TM 5-4210-220-12

(25) Reconnect electrical wires to pump body and hose reel blowers.

(26) Plug pump body harness into chassis harness.

(27) Fill radiator and engine coolant system. Test operation of all pump body components before installing pump body heat shield.

REPAIR

a. Pump Body Repair

(1) Minor body damage, such as dents and bends, may be straightened using basic body repair tools.

(2) Chipped or otherwise damaged surface protection may be repaired by spot painting (see para. 2-7 GENERAL for applicable details).

(3) If severely damaged, replace pump body as detailed in REMOVAL and INSTALLATION preceding.

2-10. PUMP BODY.

2-10.2 Console Assembly.

This task covers:

a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS

Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION

Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
All Air Tanks Drained.
Structural Control Panel Removed (see TM 5-4210-220-12)
Valve Levers Removed (see TM 5-4210-220-12)
Hose Rollers Removed (see TM 5-4210-220-12)

MATERIALS/PARTS

101561 Console and Hose Bed Assy
MS90725-6 Screw, 1/4-20x1/2", Hex
MS51922-1 Locknut 1/4-20
2667-06 Lockbolt Collar
2801-06-04 Lockbolt
2801-06-05 Lockbolt

PERSONNEL REQUIRED - 2

REMOVAL

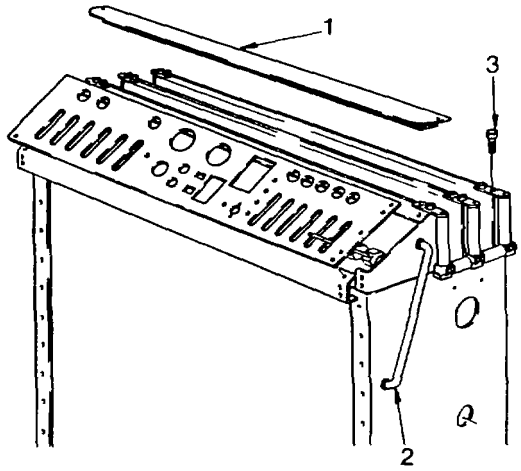
(1) Disconnect and remove hoses from cross-lay hose beds.

(2) Remove panel light bar (1) from console.

(3) Remove handrails (2) - two screws each.

(4) Drill out lockbolts (3) on each side of the console assembly.

(5) Remove nuts and bolts attaching valve lever assembly and console assembly to front of pump body.



INSPECTION

(1) Inspect control lever banks, and if necessary, repair as detailed in TM 5-4210-220-12.

(2) Inspect hose rollers. If necessary, repair or replace components as detailed in TM 5-4210-220-12.

(3) Make sure new console is undamaged and free of defects.

2-10. PUMP BODY - Continued

INSTALLATION

(1) Place console without control panel and light bar on the pump body.

(2) Attach console by installing 14 lockbolts. See para 2-7 GENERAL for details of lockbolt installation.

(3) Install valve lever banks and connect levers to tie rod linkages inside pump body (see TM 5-4210-220-12).

(4) Install panel light bar

(5) Install hose rollers to both sides of body (see TM 5-4210-220-12).

(6) Install handrails.

(7) Install structural control panel (see TM 5-4210-220-12).

REPAIR

a. Console Assembly Repair

(1) Minor damage to console sides and hose beds may be repaired without replacement of components. Small dents and bends may be straightened using basic body repair tools.

(2) Chipped or otherwise damaged surface protection may be repaired by spot painting, see para. 2-7 GENERAL for applicable instructions.

(3) If severely damaged, replace console assembly as detailed In REMOVAL and INSTALLATION preceding.

2-11 HOSE BODY

2-11.1 Hose Body Assembly

2-11.2 Manhole Cover and Panels

2-11.3 Compartment Boxes

2-11. HOSE BODY.

2-11.1 Hose Body Assembly.

This task covers:

a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
All Piping Drained (see TM 5-4210-220-12)
Water Tank Drained (see TM 5-4210-220-12)
Foam Tank Drained (see TM 5-4210-220-12)
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-10)
Wheels Blocked
All Air Tanks Drained
Radiator Drained (see LO 5-4210-200-12)
Pump Body Heat Shield Removed (see TM 5-4210-220-12)
Hose Body Heat Shield Removed (see TM 5-4210-220-12)
Hose Reel Blower Removed (see TM 5-4210-220-12)
Winterization Heater Exhaust Removed (see TM 5-4210-220-12)
Winterization Heater and Supports Removed (see TM 5-4210-220-12)
Pump Body Heater Removed (see TM 5-4210-220-12)
Auxiliary Power unit Removed (see TM 5-4210-200-12)
APU Fuel Lines and Exhaust Removed (see TM 5-4210-220-12)
110-Vac Inverter And Harness Removed (see TM 5-4210-220-12)
Rear Step and Tow Rings Removed (see para. 2-8)
Pump Body Removed (see para. 2-10.1)

MATERIALS/PARTS
11, Appendix B Electrical Tape
22, Appendix B Pipe Sealant
25, Appendix B Sealant
101569 Hose Body
310591 Locknut
MS90725-172 Capscrew

PERSONNEL REQUIRED - 2

WARNING

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting eye assemblies, slipping slings or load shift. Do not jerk the load or swing it from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

NOTE

To remove and install the truck hose body, the workshop must be equipped with an overhead hoist or crane. The hoist or crane should have a lifting capacity of at least 2000 lb (907 kg) to a height of at least 16 ft (4.9 m) from floor level

For removal, inspection, and installation of hose body fasteners, refer to para. 2-7.

Apply 1/8 in. (3 mm) bead of sealant (item 25, Appendix B) to all metal mating surfaces prior to installation.

2-11. HOSE BODY - Continued

REMOVAL

(1) Remove all auxiliary equipment from hose body compartments and equipment attached to the outer body.

(2) Remove all hoses and equipment from main hose beds.

(3) Remove auxiliary engine cooler from hose body front panel.

(4) Remove hose reel cover from underside of truck

(5) Remove victualic couplings (see TM 5-4210-220-1 2) from rear suction piping and rear discharge piping. Loosen and remove support clamps from rear piping. Carefully remove rear suction and discharge piping by pulling them through the hose body rear panel.

(6) Disconnect the hose body wiring from the main wiring harness by separating the plugs located underneath the pump body assembly. Remove all wire supports and ties attaching wiring harness to frame or chassis components.

(7) Disconnect the hose body ground strap at the frame.

(8) Remove plug, swivel adapter, and nipple from the automatic tank fill valve, located in rear of water tank.

(9) Disconnect wiring from water tank and foam tank level gages and sending units Pull wiring through hose body front panel and remove from truck.

(10) Raise hinged steps (one on both sides of truck) and lock in vertical position by engaging step grating into step locks which are attached to compartment boxes

(11) Remove eight locknuts and snubbing washers from hose body mounting capscrews. Four are located at the front of the hose body mount and four are located at the rear of the hose body.

(12) Attach a lifting sling to the hose body.

(13) Carefully lift hose body from truck. Lift hose body slowly while frequently checking to ensure all components have been disconnected and that all hoses, wiring and linkage will not obstruct removal. Tank fill hose will have to be fed through opening in hose body front panel.

(14) Lower hose body assembly and support with maintenance trestles positioned below hose body mounts. Make sure the hose body is level and stable. Make sure the splash guards clear the ground. This will eliminate compartment box damage and allow repair.

(15) Remove load washers from vibration isolator on hose body mount and retain for installation.

INSPECTION

(1) Inspect new hose body for any type of defects. Report any major damage.

(2) Make sure all components of hose body assembly are secured properly.

2-11. HOSE BODY - Continued

2-11.1 Hose Body Assembly - Continued

(3) Transfer wiring, lighting and trim components as necessary. Make sure to install all components in the same position as before removal.

(4) Inspect all fasteners as detailed in para. 2-7. Replace parts as necessary.

(5) Inspect vibration isolators in frame and replace if any wear or damage is visible. Do not use petroleum base products as a lubricant during installation.

INSTALLATION

(1) Secure load washer to vibration isolator using electrical tape (item 11, Appendix B). This will hold load washer during installation.

(2) Attach a lifting sling to the hose body.

(3) Carefully lift hose body from repair stand. Lift hose body high enough to clear water/foam tank and support over truck frame

(4) Thread foam and water tank level gage wiring harness and tank fill hose through front plate of hose body and attach to tank.

(5) Carefully lower hose body onto truck frame. Frequently check that all hoses, wiring or linkages are out of the way and not obstructing installation. Make sure to feed tank fill hose and wiring through hose body front panel. When hose body is approximately 1 foot (300 mm) from frame, check fire pump and ensure fire pump does not hinder hose body lowering.

(6) When hose body mount is about to contact the load washers, aline mounting holes with pry bar. Carefully lower hose body remainder of travel and secure using eight capscrews, washers, snubbing washers and locknuts.

(7) Connect hose body ground strap.

(8) Reconnect hose body wiring. The main wiring plug is located on left hand frame rail, directly below pump body.

(9) Install auxiliary engine cooler on hose body front panel.

(10) Install pump body as detailed in para. 2-10.1.

(11) Carefully install rear suction and discharge piping through hose body rear panel. Guide piping along frame rails and attach to appropriate manifold (suction/discharge) using victualic coupling (see TM 5-4210-220-12). Attach suction and discharge piping clamps to frame rails.

(12) Install hose reel cover to underside of truck.

(13) Install hose reel blower, APU, 110-Vac inverter and harness, as detailed in TM 5-4210-220-12.

(14) Install nipple, swivel adapter, and plug through hose body rear panel and into automatic tank fill valve, Apply pipe sealant (item 22, Appendix B) to all male pipe threads prior to installation.

2-11. HOSE BODY - Continued

(15) Lower hinged step from step lock and inspect contact area on pump body angle.

(16) Install all hoses in to proper hose bed

(17) Install all auxiliary equipment into appropriate compartments.

(18) Tie or support all hoses, wiring and linkages so they will not be damaged during normal operation.

(19) Install heat shields (see TM 5-4210-220-12).

(20) Refill radiator and winterization heater system as detailed in LO 5-4210-220-12 Start APU, bleed system and check for leaks. Tighten/remake connections as required

(21) Fill water and foam tank to 'FULL' level as detailed in TM 5-4210-220-12. Inspect for leaks Tighten/remake connections as necessary.

(22) Refer to TM 5-4210-220-12 to ensure all components are operating correctly

REPAIR

a. Grab Handle Repair

NOTE

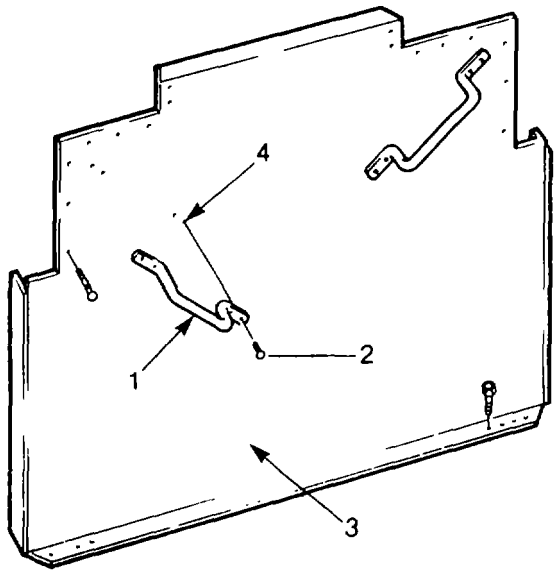
Grab handle repair is limited to replacement of grab handle, machine screws, or insert fasteners.

(1) To remove grab handle (1), remove four machine screws (2). Separate grab handle from rear panel (3)

(2) Inspect machine screws (2) and insert fasteners (4) as detailed In para. 2-7. Replace parts as necessary.

(3) To Install grab handle (1), lift into position and aline mounting holes with insert fasteners (4).

(4) Install machine screws (2) and tighten firmly.



2-11. HOSE BODY - Continued

2-11.1 Hose Body Assembly - Continued

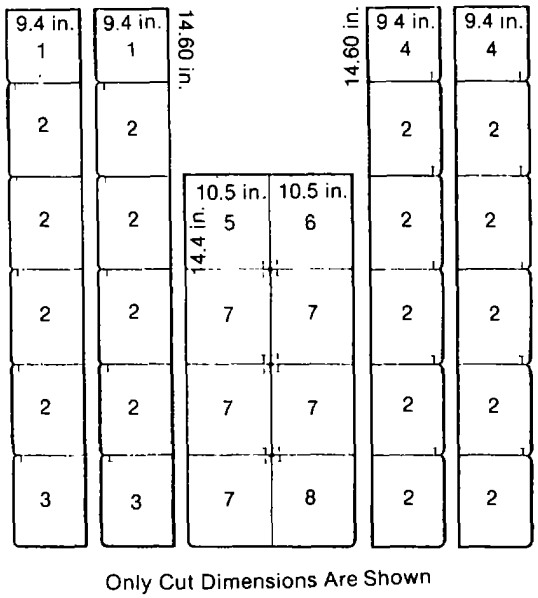
b. Hose Bed Matting Repair

NOTE

Repair to tiles is limited to replacement of any that are damaged. Tiles are originally 19.38 in. square (49.23 cm square). Remove all hoses from appropriate hose bed prior to replacing tiles. Before cutting tiles, determine position and orientation. This will ensure that all tiles will interlock when installed.

(1) Cut tiles with hacksaw. Use the illustration to obtain measurements and orientation.

(2) Install new tile.



Only Cut Dimensions Are Shown

c. Compartment Drain

NOTE

There are four compartment drains on hose body assembly, one in each lower compartment box floor.

Repair to compartment drains includes replacement of dust valve, gear clamp or drain adaptor.

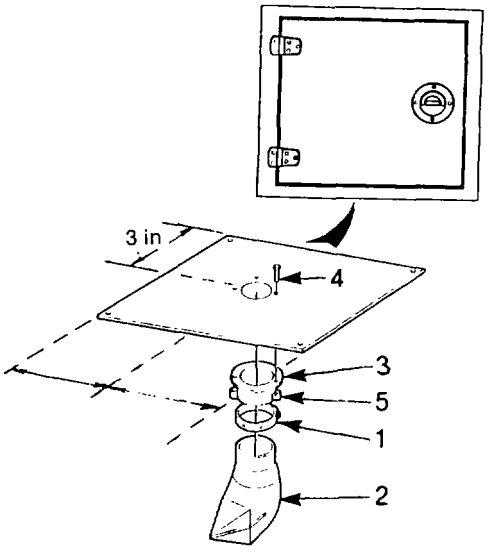
(1) Remove gear clamp (1) and dust valve (2) from drain adaptor (3).

(2) Inspect gear clamp, dust valve and drain adaptor for damage. Replace parts as necessary.

(3) To remove drain adaptor (3) remove lockbolts (4) and lockbolt collars (5) as detailed in para. 2-7.

(4) Apply sealant (item 25, Appendix B) to perimeter of drain adaptor prior to installation.

(5) Secure new drain adaptor (3) to compartment box using lockbolts (4) and lockbolt collars (5). Refer to para. 2-7 for lockbolt installation.



NOTE

If compartment box is new, position drain adaptor (3) as shown. Drill 1 in. (2.54 cm) hole. **2-46**

(6) Install dust valve (2) onto drain adaptor (3) and secure using gear clamp (1). Tighten gear clamp firmly.

2-11. HOSE BODY - Continued

d. Splash Guard Repair **Error! Not a valid filename.**

NOTE

Splash guard repair is limited to replacement of rubber sheet (3), fasteners (1, 2), or plate (4).

The procedure below may be used to repair any splash guard.

(1) Remove locknuts (2) and capscrews (1) that retain splash guard (3) and plate (4) to compartment box (5). Gain access to locknut from inside compartment box.

(2) Separate plate (4) and splash guard (3) from compartment box.

(3) Inspect capscrew as detailed in para 2-7. Discard locknuts.

(4) Inspect splash guard (3) for torn mounting holes or gashes in rubber. Replace as necessary.

NOTE

If new splash guard is to be installed, use plate (4) as a template to drill mounting holes. Aline upper edge of plate with upper edge of splash guard. Drill mounting holes to 17/64 in. (6 75 mm).

(5) Lift splash guard (3) and plate (4) into position. Aline mounting holes and install four capscrews (1) and locknuts (2). Tighten locknuts to 7 ft lb (10 Nm).

e. Fender Repair

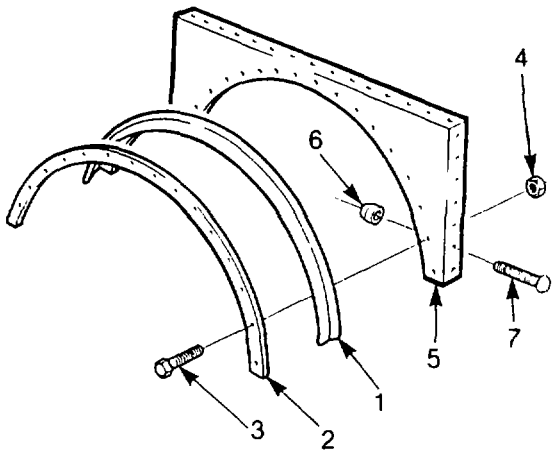
NOTE

Fender repair is limited to replacement of failed components. The procedure below may be used to replace any fender.

(1) To remove rubber fender (1), remove 19 capscrews (3) and locknuts (4). Discard locknuts.

(2) Separate the fender plate (2) and rubber fender (1) from fender skirt (5).

(3) inspect capscrews as detailed in para. 2-7.



(4) Examine fender plate (2) for oversized mounting holes or cracks. Replace as necessary.

(5) Examine fender skirt (5) for damage such as dents, oversized holes, or cracks Replace as necessary.

2-11. HOSE BODY - Continued

2-11.1 Hose Body Assembly - Continued

(6) If fender skirt (5) needs to be replaced, remove lockbolt (7) and lockbolt collar (6), see para. 2-7.

(7) Apply a 1/8 in. (3 mm) bead of sealant (item 25, Appendix B) on fender skirt and compartment box mating surface.

(8) To install fender skirt (5), lift into position between compartment boxes. Install new lockbolts as detailed in para. 2-7.

(9) To install new rubber fender either use fender plate (2) or fender skirt (5) as a template to mark out mounting holes. Drill 19 mounting holes to 17/64 In. (6.75 mm).

(10) Aline new fender (1) and fender plate (2) with fender skirt (5). Install 19 capscrews (3) and locknuts (4). Torque locknuts to 7 ft lb (10 Nm).

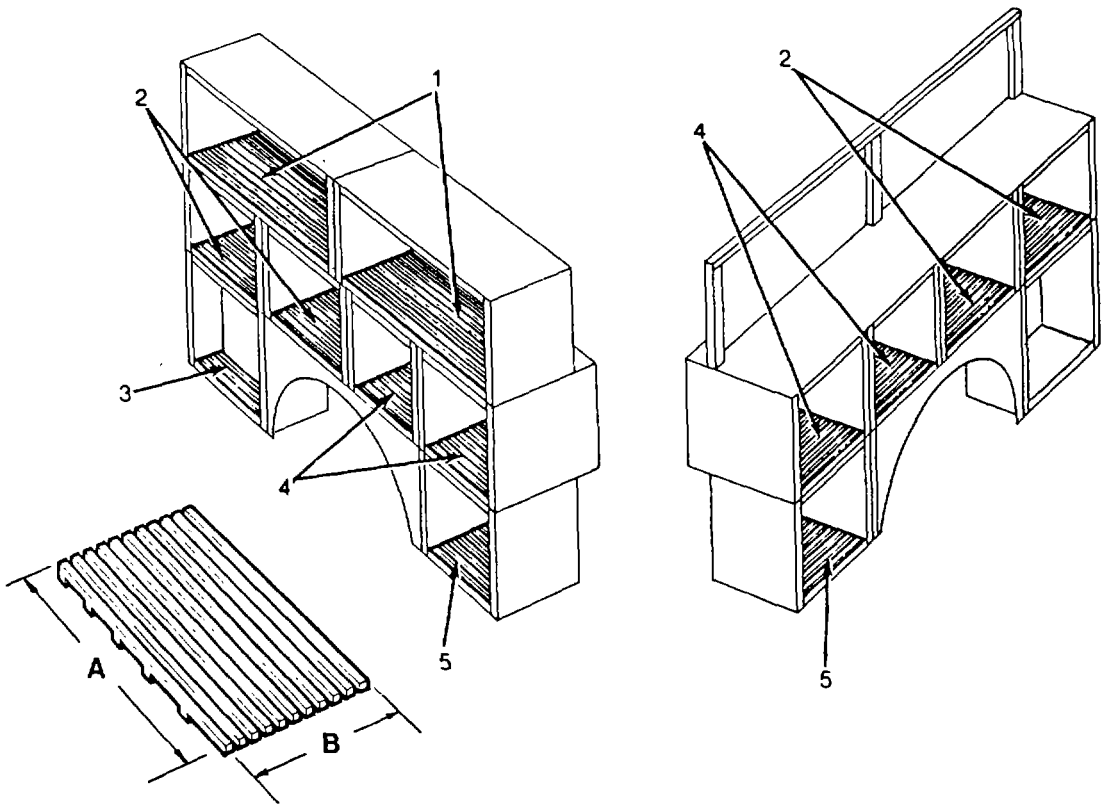
f. Compartment Matting Repair

NOTE

There is no compartment matting repair. If any compartment matting is damaged or missing replace it with new.

(1) Remove all equipment from compartment box, and remove damaged compartment matting.

(2) Cut desired size of compartment matting from matting roll. Use following illustration and legend to determine size needed for a specific compartment box.



2-11. HOSE BODY - Continued

COMPARTMENT NUMBERS	Qty.	DIMENSIONS A - in. (cm)	B - in. (cm)
1	2	55 75 (141.6)	13.75 (34.9)
2	4	29.75 (75.6)	21 75 (55.2)
3	1	29.75 (75.6)	9 75 (24.7)
4	4	25 75 (65.4)	21 75 (55.2)
5	2	25.75 (65.4)	13.75 (34.9)

g. Rear Light Bracket Repair

(1) Remove rear beacon (1) from rear light bracket (2) (see TM 5-4210-220-12).

(2) Remove locknut (4) and capscrew (3) that retain rear light bracket (2) to stanchion (5).

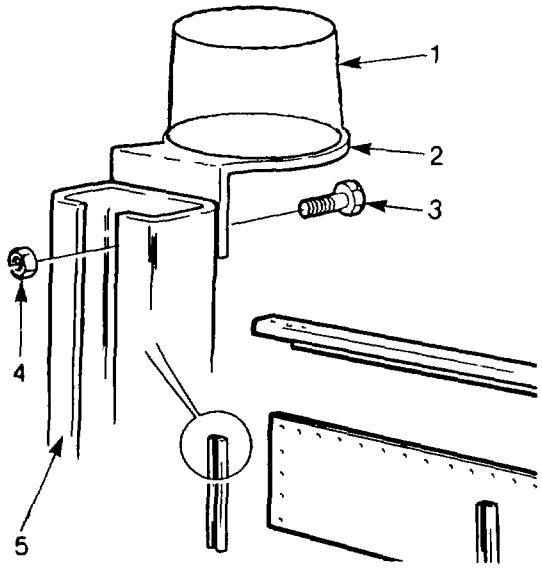
(3) Examine stanchion (5) for bends or oversized mounting holes. Replace as necessary.

(4) Repair dented or twisted rear light bracket (2) using basic body repair tools. Replace rear light bracket if damage is excessive.

(5) To install rear light bracket, aline mounting holes as shown.

(6) Install capscrew (3) and locknut (4) and tighten to 7 ft lb (10 Nm).

(7) Install rear beacon (1) as detailed in TM 5-4210-220-12.



h Grab Rail Repair

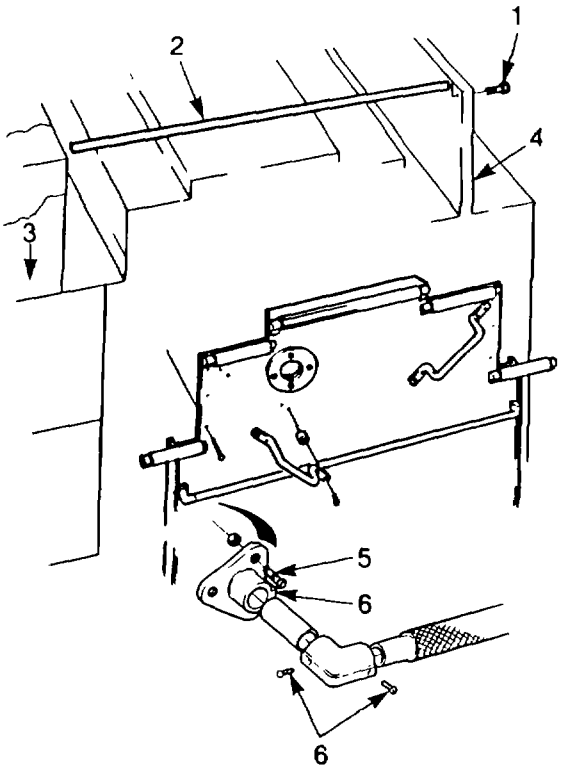
NOTE

There are two grab rails, one mounted to top of dividers, and one mounted on rear panel.

To remove top rail refer to steps 1 thru 6; to remove lower grab rail, refer to steps 7 thru 12.

(1) Remove all auxiliary equipment from compartment box (3).

(2) Remove grab rail (2) from between compartment box (3) and upper panel (4) by removing two capscrews (1). Gain access to left hand capscrew from inside compartment box.



2-11. HOSE BODY - Continued

2-11.1 Hose Body Assembly - Continued

(3) Inspect compartment box rear and upper panel for oversized or cracked grab rail mounting holes. Replace panels or use oversized washers, or rivet a reinforcing patch to the panel as required.

(4) Examine grab rail (2) for dents, bends, or stripped threaded holes. Grab rail length should be 65.6 in. (166.7 cm).

(5) If grab rail is bent, straighten in a press. If threaded holes are stripped, drill and tap to next highest size. Replace grab rail if damage is excessive.

(6) To install grab rail (2), lift into position between the compartment box (3) and upper panel (4). Secure grab rail using capscrews (1). Tighten capscrews to 17 ft lb (23 Nm).

(7) To remove lower grab rail, support rail and remove screws (5) from one side. Remove set screw (6) and slide off bracket. Remove rail from other bracket by removing set screws (6).

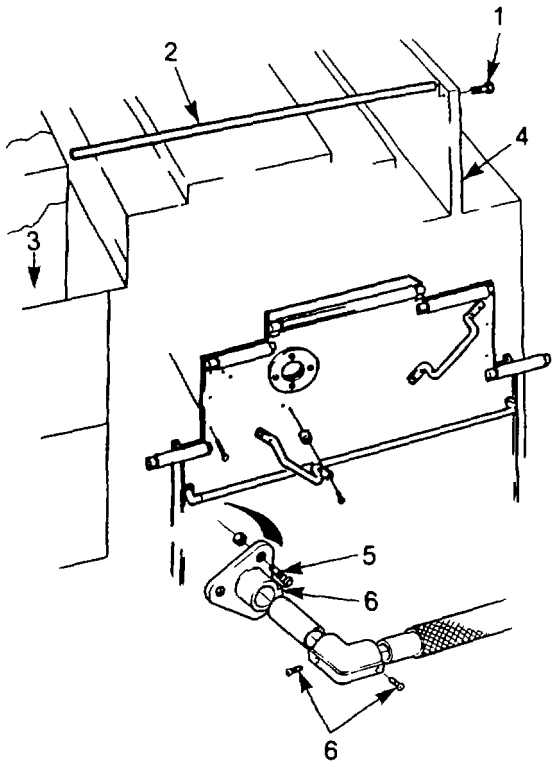
(8) Remove second bracket if required.

(9) Inspect rail and covering. Covering is a cut length of pressure hose. Remove old cover and replace as required. Glue to pipe using sealant (item 25, Appendix B).

(10) Install one bracket. Push rail into position and slide second bracket into position on other end of rail.

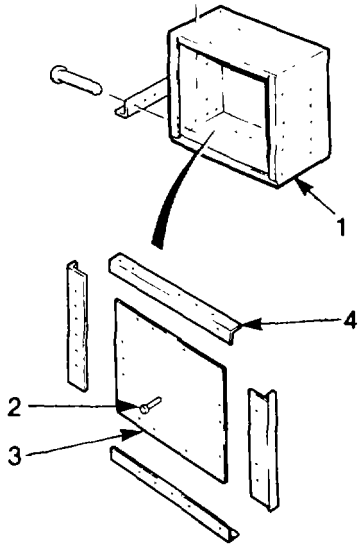
(11) Secure second bracket with screws (5). Tighten all screws securely.

(12) Tighten set screws (6) securely.



2-11. HOSE BODY - Continued

j. Box Rear Plate Repair



NOTE

There is only one removable box rear plate. It is located on the left, front, lower compartment box. This plate, when removed, allows access to fire pump.

(1) Remove all auxiliary equipment from left, front, lower compartment box (1).

(2) Remove fasteners 12) that retain box rear plate (3) to the mounting angles (4). Remove box rear plate from compartment box.

(3) Examine fasteners and as detailed in para 2-7. Replace parts as necessary.

(4) Inspect box rear plate for oversized mounting holes, cracks or dents. Repair dents using basic body repair tools. Replace box rear plate if damage is excessive.

(5) Apply 1/8 In. (3 mm) bead of sealant (item 25, Appendix B) on angle faces (4).

(6) Install box rear plate (3) into left, front, lower compartment box and secure to mounting angles (4) using fasteners (2). Tighten capscrews firmly.

(7) Replace all auxiliary equipment into compartment box

k. Door Seal Repair

NOTE

All compartment boxes have door seals. This procedure describes seal repair for one compartment box.

(1) To remove door seal (1), grasp outer surface of seal and pull away from compartment box (2) lip.

(2) Inspect rubber for cuts, crack, or deterioration.

(3) Examine seal (1) for expansion. Expansion may be caused by a corroded wire carrier. Replace seal if any defects are noticed.

(4) Install door seal (1) onto compartment box (2) lip as shown. Make sure-all corners are cut to 45 deg. angles. Once all seals are properly cut, apply vulcanizer (item 33, Appendix B) to seal corners

2-11. HOSE BODY - Continued

2-11.1 Hose Body Assembly - Continued

m. Compartment Lamp Bracket Repair

NOTE

There are fourteen compartment lamp brackets; seven are left hand brackets.

Repair procedures will be the same for all fourteen brackets.

(1) If hose body is still mounted on truck, disconnect batteries, see TM 5-4210-220-12.

(2) If necessary, remove all auxiliary equipment from compartment box.

(3) Remove compartment lamp bracket (8) from compartment box (4), by removing two capscrews (1) and locknuts (2). Discard locknuts.

(4) If bracket (8) needs to be straightened or replaced remove lamp assembly (12) as detailed in TM 5-4210-220-12.

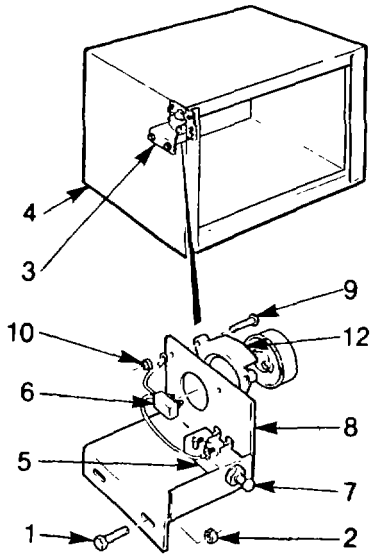
(5) Remove switch (5) from bracket (8) by removing nut (7).

(6) Straighten bent or dented bracket (8) using basic body repair tools.

(7) If damage is excessive, replace bracket (8).

(8) Install switch (5) into bracket (8). Thread nut (7) onto switch stem and tighten firmly. Make sure electrical connections are not contacting bracket (ground).

(9) Install compartment lamp assembly (12) onto bracket (8) as detailed in TM 5-4210-220-12.



(10) Attach compartment lamp bracket to compartment box (4) using two capscrews (1) and new locknuts (2). Do not tighten.

(11) Adjust compartment lamp bracket so that when compartment door is closed, inner panel depresses switch plunger and light shuts off.

n. Stiffener

NOTE

There are two box stiffeners used on the left hand compartment box assembly.

This instruction assumes the hose body is being rebuilt with new compartments and compartment top.

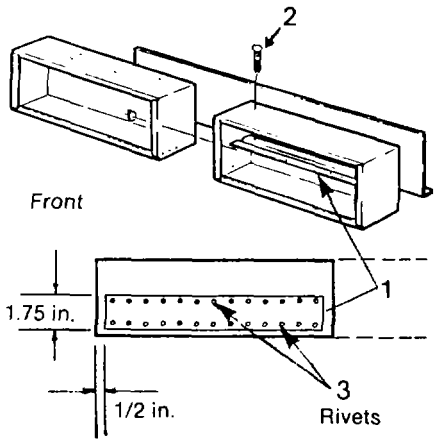
2-11. HOSE BODY - Continued

(1) To remove the stiffeners (1) remove the lockbolts (2) and rivets (3) that retain the stiffener and compartment top and to the upper compartment boxes, see para. 2-7. Each stiffener has two rivets (3) that retain it in position while hose body is being painted.

(2) Inspect stiffener for oversized mounting holes, cracks or bends. Replace as necessary.

(3) To install stiffener, position on compartment box top as shown.

(4) Install two rivets from outside of compartment box. These two rivets will retain stiffener to hose body during painting.



(5) Install compartment top as detailed in para. 2-11.3a.

(6) Using stiffener as a template, drill mounting holes through compartment top or compartment box as necessary.

(7) Install stiffener with lockbolts as detailed In para. 2-7.

p. Partitions.

NOTE

There are four partitions used on this hose bed assembly. Two methods of *installation can be* used. To remove inboard partitions, remove lockbolts that retain the inboard partitions to the manhole panels.

(1) To remove partition assembly, remove the rivets that retain the cover (2) to the hose bed (3).

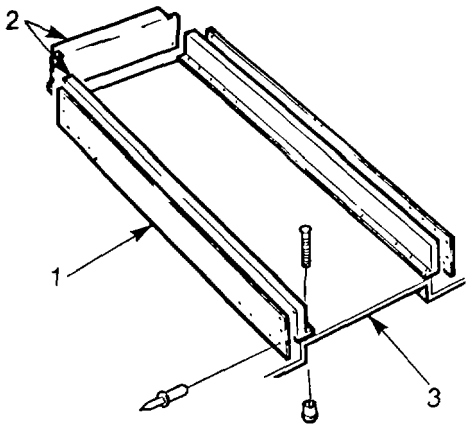
(2) Remove the lockbolts that retain the partition (1) to the hose bed (3) (para. 2-7).

(3) To separate the cover (2) from the partition (1) remove remaining rivets.

(4) Inspect all mounting holes for cracks, oversized holes, or dents.

(5) Minor bends or dents can be repaired using basic body repair tools. NOTE If either inboard partition assembly is to be replaced, leave cover (2) off. First attach side manhole cover, rear manhole cover and partition together. Then install cover (2), using rivets (para. 2-7).

(6) Position partition on hose bed, aline mounting holes and attach to hose bed using lockbolts, (para. 2-7). If hose bed is new, use partition as a drill template



(7) Attach cover to partition using rivets (para. 2-7). If hose bed is new, use cover as a template

2-11. HOSE BODY - Continued

2-11.2 Manhole Cover and Panels.

This task covers:

a. Removal
b. Inspection
c. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
1604-0615 Rivet

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)

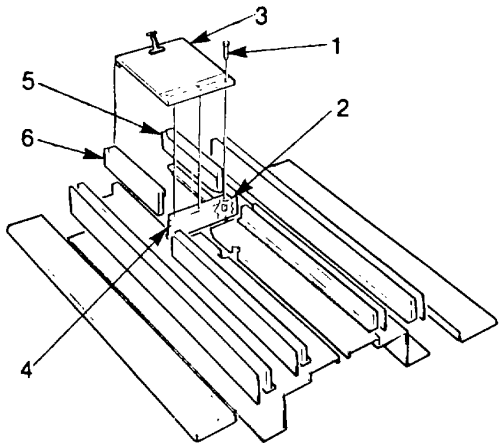
MATERIALS/PARTS
25, Appendix B Sealant
2801-06 Lockbolt
2667-06 Lockbolt Collar

100080 Rear Manhole Panel
100078 Left Manhole Panel
100079 Right Manhole Panel

NOTE

For lockbolt and collar removal/installation refer to para. 2-7. Apply 1/8 in. (3 mm) bead of sealant (item 25, Appendix B) to all metal mating surfaces, prior to installation.

REMOVAL



(1) Remove the machine screws (1), and locknuts (2) that retain the manhole cover (3) to the rear manhole panel (4). Unfasten manhole cover strap and remove manhole cover

(2) Remove six lockbolts that retain the rear manhole panel (4) to the left and right manhole panels (6 and 5), and inboard partitions.

(3) Remove six lockbolts that retain rear manhole panel (4) to the hose bed.

(4) Remove 11 lockbolts that retain the left hand manhole panel (6) to the hose bed and hose body front panel.

(5) Remove 11 lockbolts that retain the right hand manhole panel (5) to the hose bed and hose body front panel.

(6) Separate manhole panel assembly from hose bed. It will be necessary to crack or remove insulation adhering to inner surface of manhole panels.

INSPECTION

Inspect all mounting holes for oversize or cracks. Some oversized holes can be repaired by installing a washer during lockbolt installation. The washer will cover the hole and strengthen the joint.

2-11. HOSE BODY - Continued

[INSTALLATIONI

NOTE

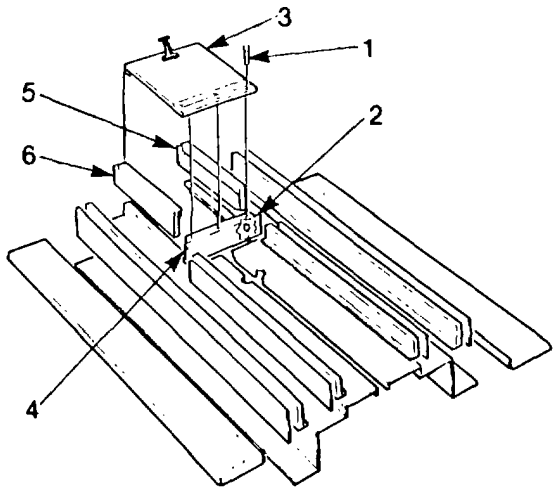
Apply 1/8 in. (3 mm) bead of sealant (item 25, Appendix B) to manhole panel mating surfaces, prior to installation

(1) For original equipment installation, partition covers must be removed from inboard partition assembly. To remove partition cover, remove 23 rivets. This will allow ample room for lockbolt installation. An alternate method would require the installation of six insert fasteners (three in each inboard partition). This method will use machine screws to retain the left and right manhole panels (6 and 5) and rear manhole panel (4) to the inboard partitions.

(2) Position rear manhole panel (4) and secure to hose bed using lockbolts. If hose bed is new, use rear manhole panel as template to drill mounting holes.

(3) Position left and right manhole panels (6 and 5) and secure to hose bed using lockbolts If hose bed is new, use left and right manhole panels as templates to drill mounting holes.

(4) Attach left and right manhole panels (6 and 5) to hose body front panel using lockbolts. If hose body front panel is new, use left and right manhole panels as templates to drill mounting holes.



(5) If rear manhole panel (4) is new, drill mounting hole using left and right manhole panel (6 and 5) as a template. Carefully drill rear manhole panel so as not to drill new holes in partition.

(6) Install lockbolts that attach the left manhole panel (6), rear manhole panel (4), and left inboard partition together.

(7) Install lockbolts that attach the right manhole panel (5), rear manhole panel (4), and the right inboard partition together

(8) Position manhole cover (3) on manhole panels. *Aline* hinge holes with holes *in rear manhole* panel. If rear manhole panel is new use hinge as template.

(9) Attach partition covers to partitions using rivets.

(10) Raise and lower manhole cover a couple of times to make sure it operates freely. Lower manhole cover, and fasten cover strap to strap lock.

2-11. HOSE BODY - Continued

2-11.3 Compartment Boxes.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705Personnel Required - 2

MATERIALS/PART
25, Appendix B Sealant

EQUIPMENT CONDITION
Hose Body Removed From Truck (see para. 2-11.1)

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

NOTE

For removal, inspection, and installation of hose body fasteners, refer to para. 2-7.

Apply 1/8 in. (3 mm) bead of sealant (item 25, Appendix B) to all metal mating surfaces prior to installation.

Lower compartment boxes can be replaced with hose body mounted on truck.

If hose body is repaired while mounted on truck, main engine and APU must be shutdown, batteries disconnected, and auxiliary equipment removed from compartment box (see TM 5-4210-220-12). Remove wire harness from compartment box that is to be repaired. Remove appropriate fasteners and separate compartment box from compartment assembly.

If a number of compartment boxes need replacement, disassemble hose body assembly into six subassemblies. These six subassemblies are listed below In order of removal:

Compartment Tops
Hose bed (including partitions)
Front Panel Assembly
Rear Panel Assembly
RH Compartment Assembly
LH Compartment Assembly

2-11. HOSE BODY - Continued

REPAIR

NOTE

Repair consists of component replacement.

a. Compartment Top Repair

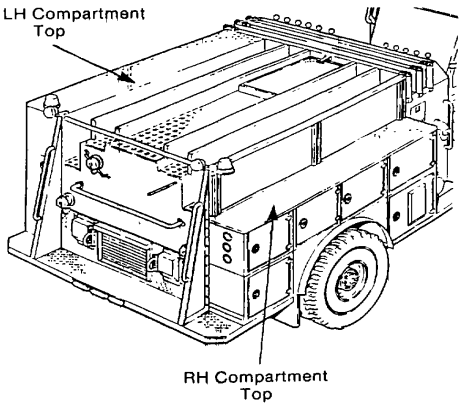
(1) To remove left hand compartment top from compartment assembly, remove all lockbolts.

(2) To remove right hand compartment top from compartment assembly, remove all lockbolts.

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces prior to installation.

Install compartment top only after all panels have been painted If compartment boxes are new, use compartment top as a template to drill mounting holes.



(3) Secure left hand compartment top to compartment assembly using lockbolts,

(4) Secure right hand compartmert top to compartment assembly using lockbolts.

b. Hose Bed Repair

NOTE

Remove hose bed as a complete assembly. If other repairs are necessary, remove components as necessary.

(1) Remove manhole fastener attaching left and right panels to the front panel assembly.

(2) Remove lockbolts and collars (1) around the perimeter of the hose bed. The hose bed is attached to front and rear panels, and the left and right compartment tops.

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

(3) Attach a suitable sling to hose bed assembly and lift from compartment assembly.

(4) To install hose bed, make sure fasteners securing hose bed halves are in position and tight.

2-11. HOSE BODY - Continued

2-11.3 Compartment Boxes - Continued

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces, prior to installation.

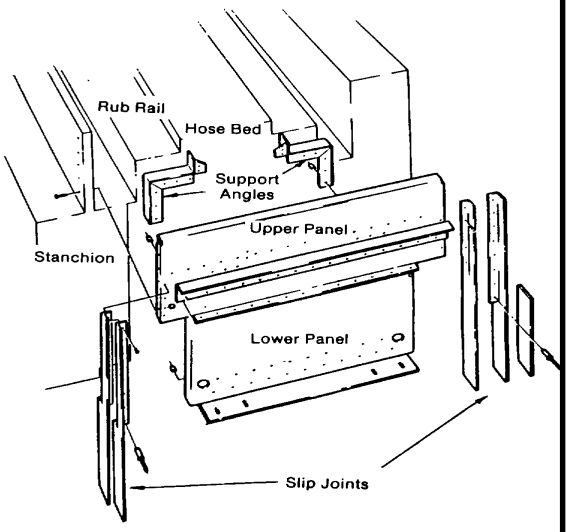
(5) Attach sling to hose bed assembly. Lift hose bed assembly and lower onto compartment boxes. The front and rear panel assembly must be in place and attached; see c. and d. following.

(6) Attach hose bed assembly to left and right compartment tops, and front and rear panels using lockbolts and collars. If compartment boxes are new, use hose bed as a drill template. If front or rear panel supporting angles are new, use hose bed as a drill template.

c. Front Panel Assembly Repair

NOTE

Remove front panel assembly as a complete unit. If front panel assembly requires repair, remove components as necessary. If hose bed has been removed prior to front panel assembly removal, the lockbolts that secure the hose bed to the support angles have already been removed.



(1) Remove lockbolts that attach upper and lower panels to the left and right compartment boxes. Remove lockbolts that attach the upper panel to the stanchion on the right hand side.

(2) Remove lockbolts that retain the slip joints to the upper panel. This will leave slip joint attached to compartment box.

(3) Separate front panel from compartment assemblies.

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces, prior to installation.

(4) To install front panel assembly make sure all fasteners are in position and tight.

(5) Lift front panel assembly so that it is positioned between compartment sides, and level with rub rail. Make sure front panel angles will mate with hose bed.

(6) Secure front panel assembly to left and right hand compartments using lockbolts.

2-11. HOSE BODY - Continued

(7) Attach slip joints to upper panel using lockbolts.

(8) Install lockbolts that secure upper panel to the stanchion on the right hand side.

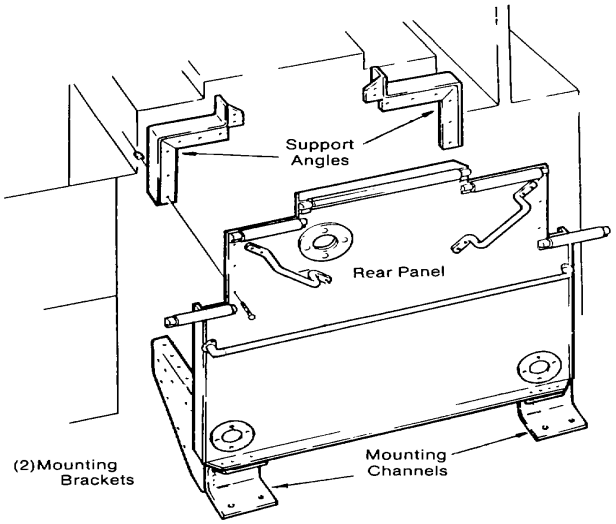
(9) If hose bed is in position, install lockbolts to secure hose bed to support angles.

d. Rear Panel Assembly Repair

NOTE

Remove rear panel assembly as a complete unit. If rear panel assembly requires repair, remove components as necessary.

If hose bed has been removed prior to front panel assembly removal, the lockbolts that secure the hose bed to the support angles have already been removed.



(1) Remove lockbolts and collars that retain the left and right hand mounting brackets to the back of lower compartments.

(2) Remove lockbolts that secure the rear panel to the left and right compartments.

(3) Separate rear panel from compartment assemblies.

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces, prior to installation.

(4) To install rear panel assembly make sure mounting channels are securely attached to mounting brackets and rear panel. Ensure support angles are also secured to rear panel.

(5) Lift rear panel assembly so that it is positioned between compartment sides and level with hose bed. Make sure the rear panel support angles just touch hose bed.

(6) Secure the rear panel assembly to the left and right hand compartment boxes using lockbolts. If rear panel is new, use compartment rear panels as a drill template.

(7) Attach left and right mounting brackets to compartment rear panels using lockbolts.

(8) If hose bed is in position, install lockbolts to secure hose bed to rear panel support angles.

2-11. HOSE BODY - Continued

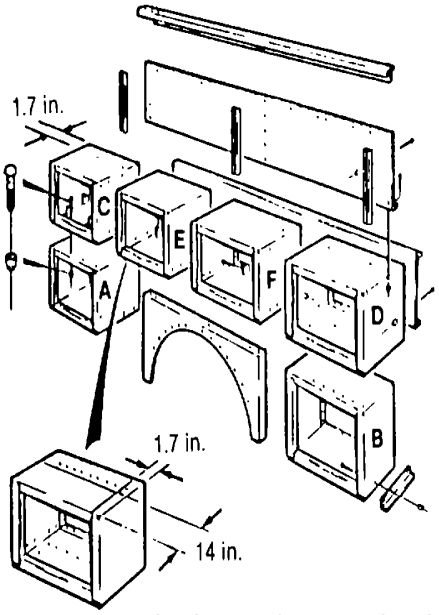
2-11.3 Compartment Boxes - Continued

e. Right-Hand Compartment Assembly Repair

NOTE

To disassemble the right hand compartment assembly, it must first be separated from the hose body assembly. To separate the right hand compartment assembly remove the following subassemblies

Compartment Tops (see a. preceding) Hose Bed (see b. preceding) Front Panel Assembly (see c. preceding) Rear Panel Assembly (see d. preceding)



(1) Separate the upper panel from the compartment boxes by removing lockbolts.

(2) Separate the lower panel from the compartment boxes by removing lockbolts.

(3) Remove lockbolts that retain the box assemblies as a group. Separate the boxes from each other by removing lockbolts. Using illustration, remove compartment boxes in alphabetical order. Do not remove rivets because they hold the compartment panels together.

(4) Replace fender skirt as necessary, see para. 2-11.1.

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces prior to installation.

(5) To assemble the right-hand compartment assembly, attach four center boxes (C, E, F, D) as shown. Make sure boxes are in correct order and that the tops are level. Lockbolt boxes together.

(6) Measure and scribe a vertical line 1.7 in. (4.3 cm) as shown on compartment (C) rear panel.

Position lower panel so that it is level with compartment boxes and adjacent to scribe mark.

(7) Secure lower panel in this position using lockbolts. If lower panel is new, use holes in compartment rear panels as drill templates.

(8) Aline compartment (A) beneath compartment (C) and attach using proper lockbolts. Replace splash guard, see para. 2-11.1.

(9) Install fender skirt under boxes (E and F). Secure fender skirt to compartment boxes (A, E, and F) using lockbolts. If compartment boxes are new, use fender skirt as a drill template.

(10) Aline compartment (B) beneath compartment (D) and attach using lockbolts. If compartment (B) is new, replace main body angle. Fasten to compartment using lockbolts.

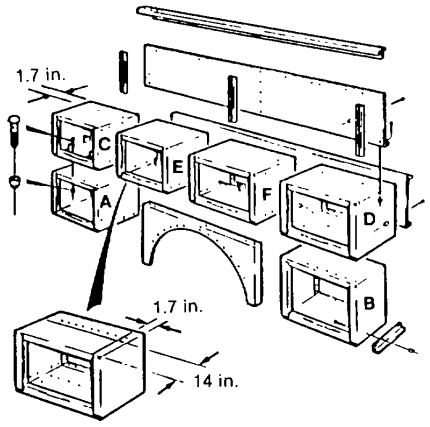
2-11. HOSE BODY - Continued

(11) To install upper panel onto new compartment boxes, measure and scribe the following dimensions as shown. Measure 1.7 in. (4.3 cm) from the forward most edge of compartment box (D). Measure in 14 in. (35.6 cm) from the outer face of each compartment box (C, E, F, and D).

(12) Position upper panel so that it is adjacent to scribe marks. Make sure upper panel is inboard of scribe marks. Secure upper panel to compartment boxes using lockbolts. If compartment boxes are new, use upper panel as a drill template.

(13) Attach fender skirt to compartment box (B) using lockbolts.

(14) If all repairs are completed, reassemble hose body by attaching the following subassemblies
- Rear Panel Assembly (see d. preceding)
- Front Panel Assembly (see c. preceding)
- Hose bed (see b. preceding)
- Compartment Tops (see a. preceding)



f. Left Hand Compartment Assembly Repair

NOTE

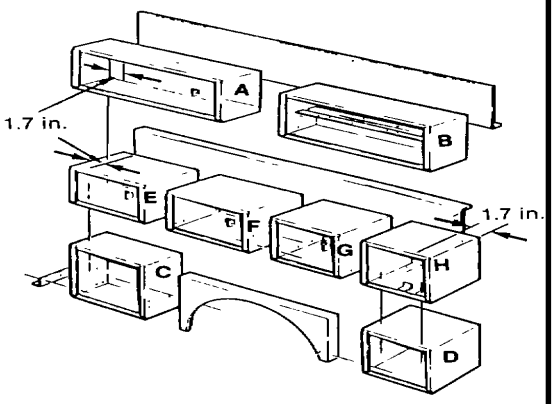
To disassemble the left hand side compartment assembly, it must first be separated from the hose body assembly. To separate the left hand compartment assembly remove the following subassemblies Compartment Tops (see a. preceding)
Hose bed (see b. preceding)
Front Panel Assembly (see c. preceding)
Rear Panel Assembly (see d. preceding)

(1) Separate the upper panel from the compartment boxes by removing lockbolts.

(2) Separate the lower panel from the compartment boxes by removing lockbolts.

(3) Remove lockbolts that retain the box assemblies as a group. Separate the boxes from each other by removing lockbolts. Using illustration, remove compartment boxes following alphabetical order.

Do not remove rivets because they hold the compartment panels together.



(4) Replace fender skirt as necessary, see para. 2-11.1.

NOTE

Apply sealant (item 25, Appendix B) to all metal mating surfaces prior to installation.

2-11. HOSE BODY - Continued

2-11.3 Compartment Boxes - Continued

(5) To assemble the left hand compartment assembly, attach four center boxes (E, F, G, H) as shown. Make sure boxes are in correct order and that the tops are level. Lockbolt boxes together.

(6) Measure and scribe a vertical line 1.7 in. (4.3 cm) as shown on compartment (H) rear panel.

Position lower panel so that it is level with compartment boxes and adjacent to scribe mark.

(7) Secure lower panel in this position using lockbolts. If the lower panel is new, use holes in compartment rear panels as drill templates.

(8) Aline compartment (D) beneath compartment (H) and attach using lockbolts. Replace splash guard, see para. 2-11.1.

(9) Install fender skirt under boxes (F and G). Secure fender skirt to compartment boxes (D, F, and G) using lockbolts. If compartment boxes are new, use fender skirt as a drill template.

(10) Aline compartment box (C) beneath compartment box (E) and attach using lockbolts. If compartment box (C) is new, replace main body angle. Fasten to compartment using lockbolts.

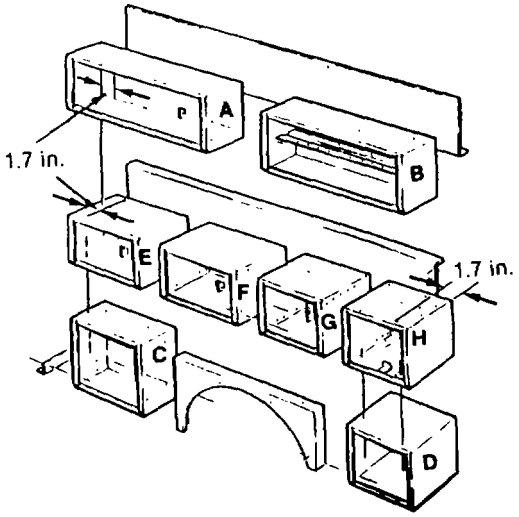
(11) Position compartment box (A and B) onto compartment boxes (E, F, G, and H). Make sure all outer surfaces are flush, then lockbolt boxes together. If compartment boxes (A and B) are new, replace stiffener, see para. 2-11.1.

(12) To install upper panel, measure in 1.7 in. (4.3 cm) from the forward most edge of compartment boxes (E and A). Support upper panel on lower panel and adjacent to scribe mark.

(13) Secure upper panel to compartment boxes using lockbolts.

(14) Attach fender skirt to compartment box (C) using lockbolts.

(15) If all repairs are completed, reassemble hose body by attaching the following subassemblies;
Rear Panel Assembly (see d. preceding)
Front Panel Assembly (see c. preceding)
Hose Bed (see b. preceding)
Compartment Tops (see a. preceding).,



2-12. PUMP DRIVE AND PTO

2-12.1 Power Take Off Unit

2-12.2 PTO To Reducer Gear Drive Shaft

2-12.3 Reducer Gear To Pump Drive Shaft

2-12.4 Reducer Gearbox

2-12. PUMP DRIVE AND PTO.

2-12.1 Power Take Off Unit.

This task covers a. Repair
b. Overhaul

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
9, Appendix D Dummy Shaft

EQUIPMENT CONDITION
PTO Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
13, Appendix B Emery Cloth
21, Appendix B Petroleum Jelly
22, Appendix B Dexron
28-P-35 Oil Seal
22-P-25-2 Gasket, Bearing Cover
28-P-119 Oil Seal

CAUTION

To prevent personal injury or premature bearing failure when removing or installing bearing races, never exert force through the balls or rollers.

REPAIR

NOTE

Repair to the power take off unit (PTO) is limited to replacement of the bearing cap seal and gasket, and the bearing cover seal and gasket.

Repair may be made without removing PTO from truck. If not removed from truck, the main engine and APU must be shutdown, the batteries disconnected and the pump body heat shield removed as detailed in TM 5-4210-220-12.

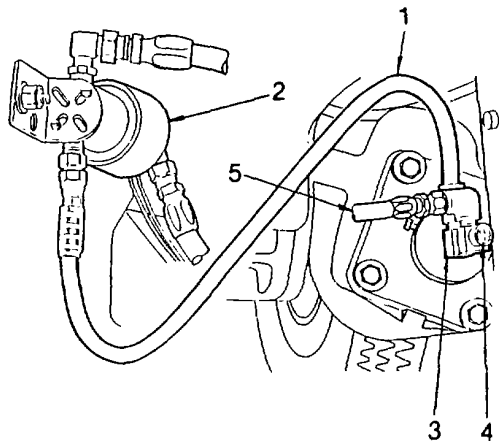
a. Bearing Cap Seal Replacement

(1) Remove the torque converter housing drain plug and drain transmission fluid into a clean pan. During cold weather, run engine until transmission oil is warm.

(2) Remove the high pressure line (1) from the solenoid valve (2) and PTO housing street tee (3). It will be necessary to disconnect the high pressure line at the solenoid valve first.

(3) Remove the dump line (5) from the PTO, and cover the hose end.

(4) Tag and remove wiring from pressure switch (4).

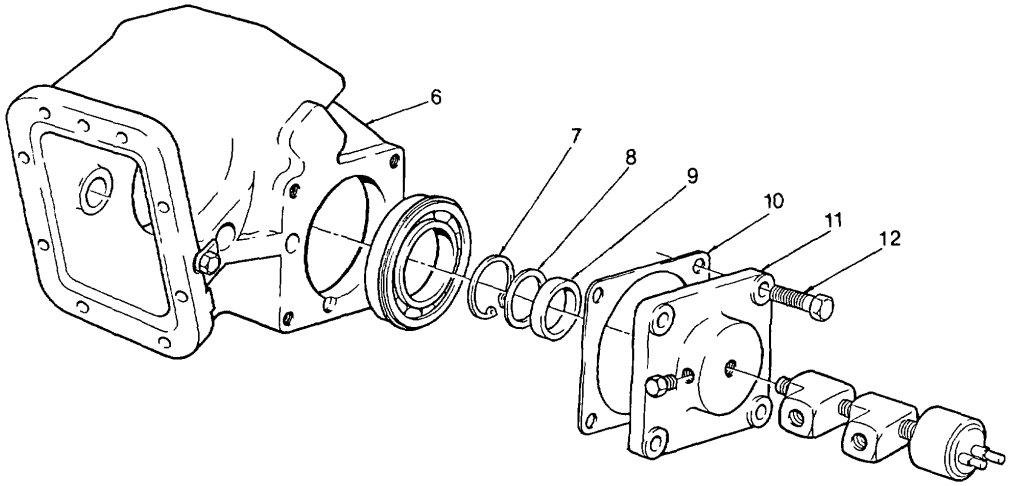


2-12. PUMP DRIVE AND PTO - Continued

(5) Remove bearing cap (11) from PTO housing (6) by removing capscrews (12). Remove and discard gasket (10)

(6) Remove retaining ring (7), back-up plate (8) and seal (9) from bearing cap (11). Discard seal.

(7) Inspect seal bore in the bearing cap for nicks or burrs. Remove with emery cloth (Item 13, Appendix B). If damage is severe, replace cap.



(8) Inspect bearing cap for warping or cracks. Replace as necessary.

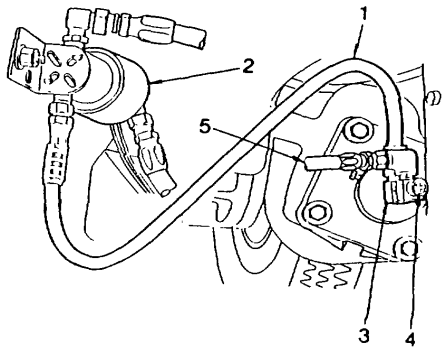
(9) Lubricate new seal (9) using automatic transmission fluid (item 9, Appendix B) and install into bearing cap (11); lip facing cap.

(10) Install back-up plate (8) and lock into position with retaining ring (7).

(11) Aline one new bearing cover gasket (10) with bearing cap (11) and attach to PTO housing (6) using capscrews (12). Torque capscrews to 90 ft lb (122 Nm).

(12) Reattach high pressure line (1) and dump line (5) onto PTO housing street tees (3). Install high pressure line (1) on solenoid valve (2).

(13) Reconnect wires to the pressure switch (4). Be sure they are Installed as noted in step 4 preceding.



2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued

(14) Fill transmission with automatic transmission fluid (item 9, Appendix B) as detailed in Lube Order, LO 5-4210-220-12.

(15) Reconnect batteries, start truck and operate PTO. Visually check for oil leaks. Tighten/remake any leaking connections.

b. Bearing Cover Seal Replacement

(1) Remove the torque converter housing drain plug and drain transmission fluid into a clean pan. During cold weather, run transmission until oil Is warm.

(2) Remove PTO to reducer gear drive shaft (see TM 5-4210-220-12).

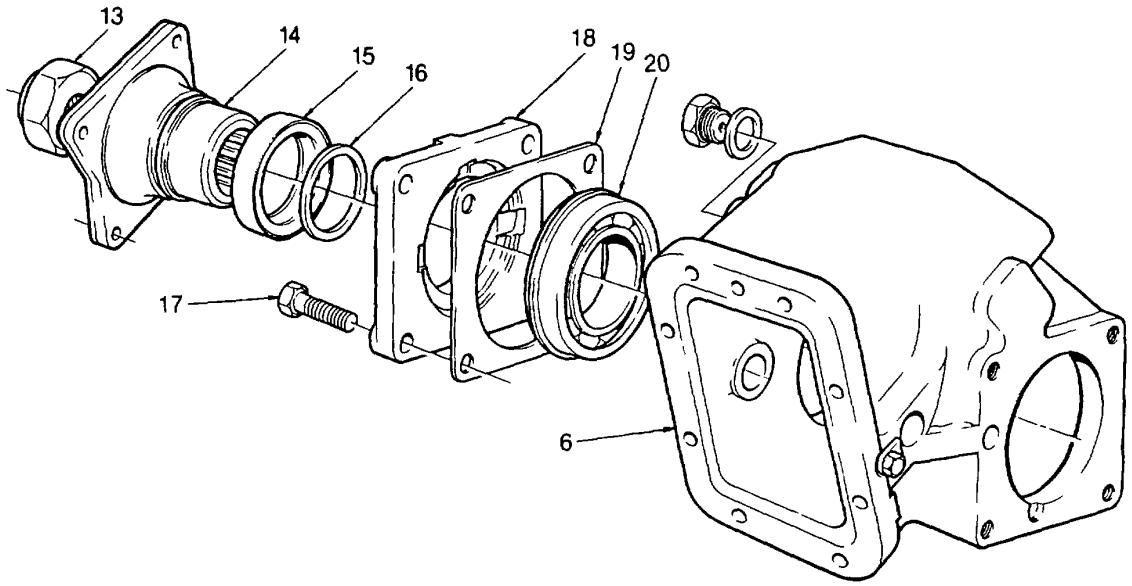
(3) Remove nut (13) and companion flange (14) from drive shaft. A mechanical puller may be used to remove companion flange.

(4) Remove bearing cover (18) from PTO housing (6) by removing capscrews (17). Remove and discard gasket (19).

(5) Remove seal (15) from bearing cover (18). Discard seal.

(6) Inspect seal bore in bearing cover (18) for nicks or burrs. Remove with emery cloth (item 13, Appendix B). If damage is severe, replace bearing cover.

(7) Inspect bearing cover for warps or cracks.



(8) Inspect companion flange seal area for corrosion or wear rings. Replace if necessary.

(9) Lubricate new seal using automatic transmission fluid (item 9, Appendix B) and install into bearing cover (18). Make sure the sealing lip faces the bearing (20).

2-12. PUMP DRIVE AND PTO - Continued

(10) Aline one new bearing cover gasket (19) with bearing cover (18) and attach to PTO housing (6) using capscrews (17). Torque capscrews evenly to 90 ft lb (122 Nm).

(11) Make sure the spacer (16) is positioned between bearing (20) and companion flange (14). Slide companion flange onto drive shaft. Thread nut (13) onto drive shaft and torque to 80 ft lb (108 Nm).

(12) Fill transmission with automatic transmission fluid (Item 9, Appendix B) as detailed in Lube Order, LO 5-4210-220-12.

(13) Install PTO to reducer gear drive shaft (see TM 5-4210-220-12).

(14) Reconnect batteries, start truck and operate PTO. Visually check for oil leaks. Tighten/remake any leaking connections.

OVERHAUL

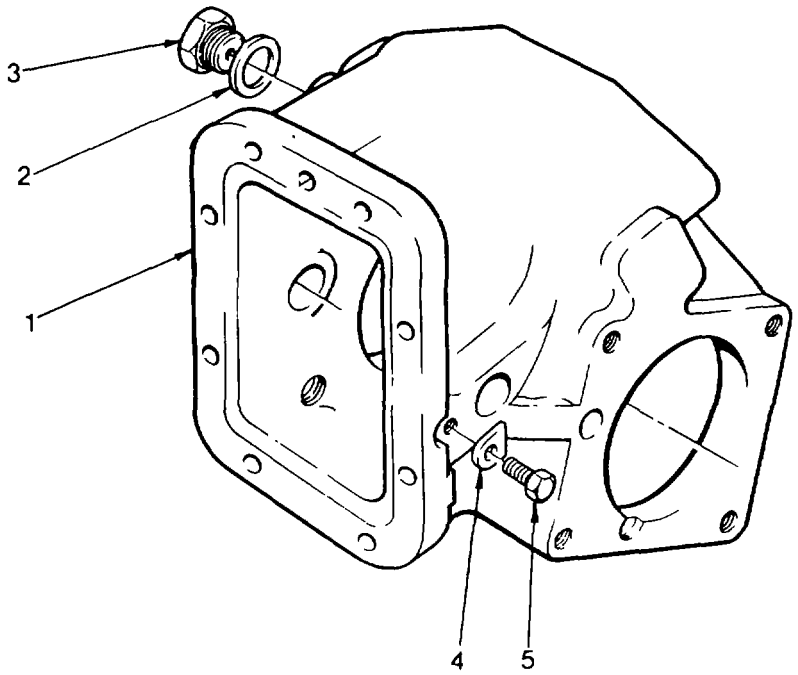
NOTE

Replacement of gaskets, seals, and bearings is strongly recommended if PTO is completely disassembled.

a. Disassembly

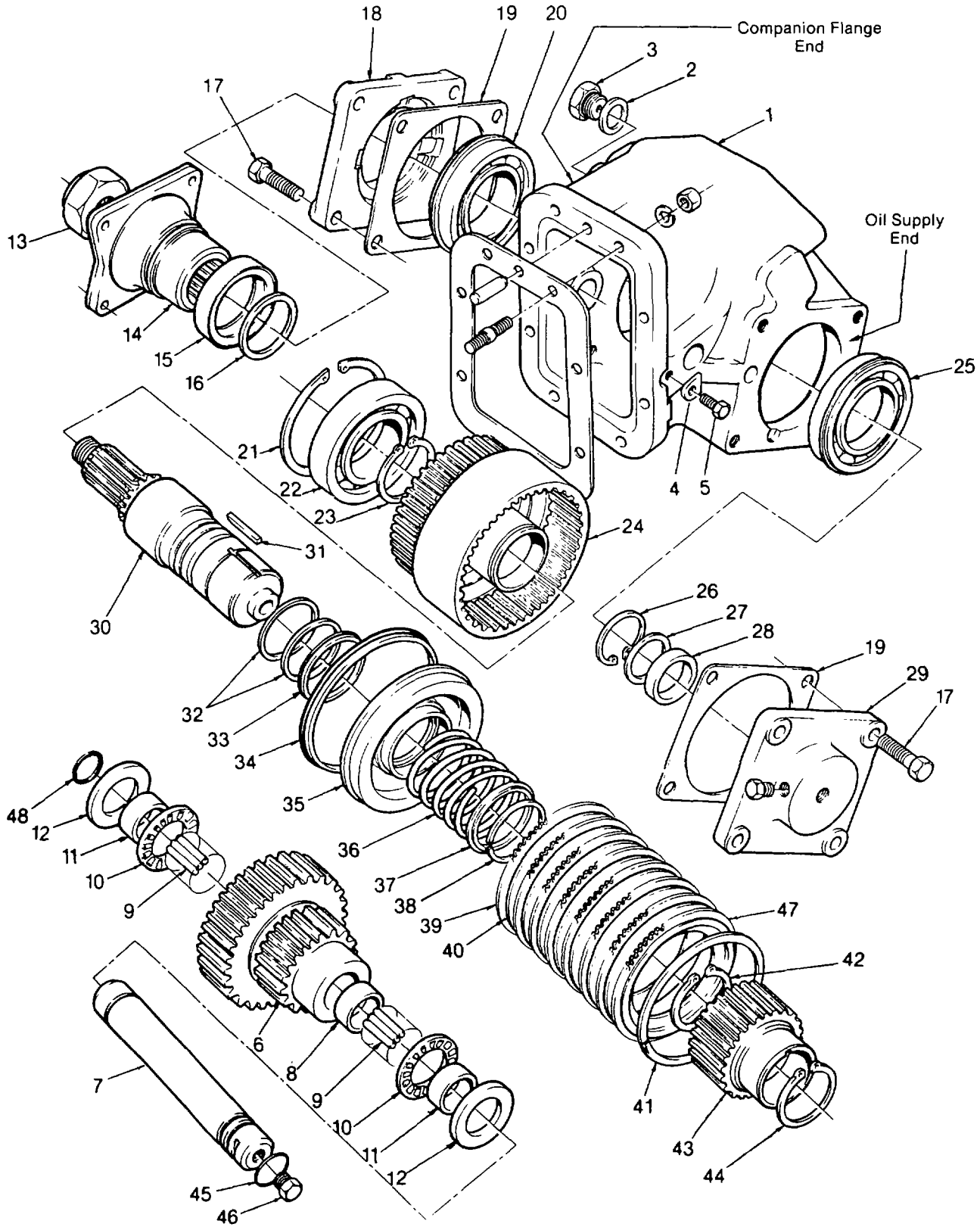
(1) Remove inspection plug (3) and gasket (2) from the PTO housing (1).

(2) Remove capscrews (5) and retaining plate (4).



2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued



2-12. PUMP DRIVE AND PTO - Continued

NOTE

There are a number of parts on the idler shaft that may fall out once the idler shaft is removed. Position PTO so parts do not fall out.

(3) Supporting to PTO housing (1), oil supply end up, on a hydraulic press bed, press the idler shaft (7) from the housing using a ram adapter about 7/8 X 7.5 in. Do not allow idler shaft to drop to the ground because damage to the idler shaft may occur.

(4) Remove ram adapter from PTO housing (1).

(5) Remove cluster gear (6) and place on clean workbench. During removal, hold the cluster gear in a horizontal position so that the needle bearings (9) and spacer (8) do not fall out.

(6) Remove needle bearings (9) and spacer (8) from cluster gear (6).

(7) Remove thrust race (12), needle bearing spacers (11) and thrust bearing (10) from housing (or bench top).

(8) Remove the O-ring (45) from the idler shaft (7) and discard O-ring. Remove the O-ring (48) from the PTO housing (1) and discard O-ring.

(9) Remove nut (13), companion flange (14) and spacer (16) from the drive shaft (30). A mechanical puller may be used to remove companion flange.

(10) Remove bearing cover (18) and gasket (19) by removing four capscrews (17).

(11) Remove seal (15) from bearing cover (18) and discard seal.

(12) Remove bearing cap (29) and gasket (19) by removing four capscrews (17).

(13) Remove the retaining ring (26), back-up plate (27), and seal (28) from the bearing cap (29).

(14) Attach the yoke of a puller to the oil supply end of PTO housing. Tighten pressure screw into oil supply end of drive shaft (30). Continue to tighten pressure screw until bearing (20) is pushed from PTO housing via the drive shaft. Remove mechanical puller from oil supply end of PTO housing. Using an outside three jaw puller, remove bearing (20) from shaft (30). Make sure the jaws of the puller contact the inner race of the bearing..

(15) Remove bearing (25) using an inside three jaw puller on a slide hammer. Make sure the jaws of the puller are contacting the outer race of the bearing.

(16) Remove lock ring (44) from drive shaft (30) and pull internal drive gear (43) from drive shaft.

(17) Remove lock ring (42) and key (31) from drive shaft (30).

(18) Remove lock ring (21) from spider gear assembly (24) (19) Position PTO housing (1) so that spider gear assembly (24) is resting internally on the companion flange end of PTO housing.

2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued

(20) Reattach mechanical puller kit to the oil supply end of the PTO housing (1). Tighten pressure screw into oil supply end of drive shaft (30). Continue to tighten pressure screw until drive shaft is free of spider gear assembly (24).

(21) Remove drive shaft (30) from PTO housing (1). Bearings (20 and 22) are still mounted on the drive shaft.

(22) Carefully maneuver spider gear assembly (24) from PTO housing (1).

(23) Disassemble the spider gear assembly (24) following the procedures listed below.

(24) Remove lock ring (41). Pull clutch stop spacer (47), opposing clutch discs (39), and bronze clutch discs (40) from the spider gear assembly (24).

(25) Compress spring (36) using arbor press. Remove lock ring (38), spring retainer (37), and spring (36).

WARNING

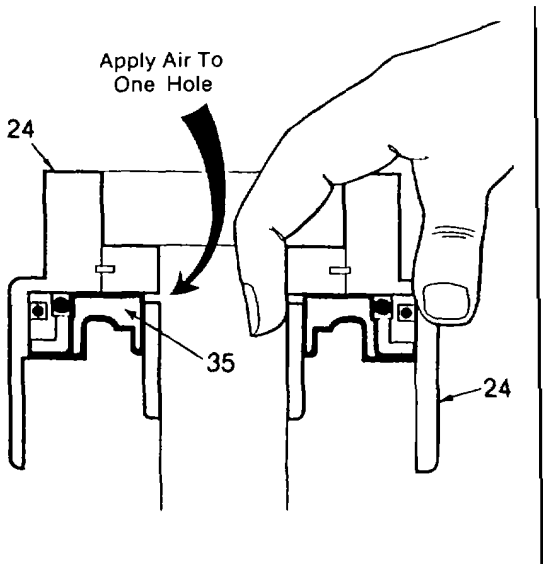
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(26) Position spider gear assembly (24) on a cloth on workbench as shown. Remove piston (35) by applying compressed air to one of the clutch oil passages in the spider gear assembly. Plug the remaining hole with index finger.

(27) Remove inner and outer block vee rings (33 and 34) from the piston (35).

(28) Inspect bearings (20 and 22) as detailed in para. 2-7.

(29) If necessary, press damaged bearings (20 and 22) from drive shaft (30) if any damage is evident. To remove bearing (20) it will be necessary to remove lock ring (23) from drive shaft.

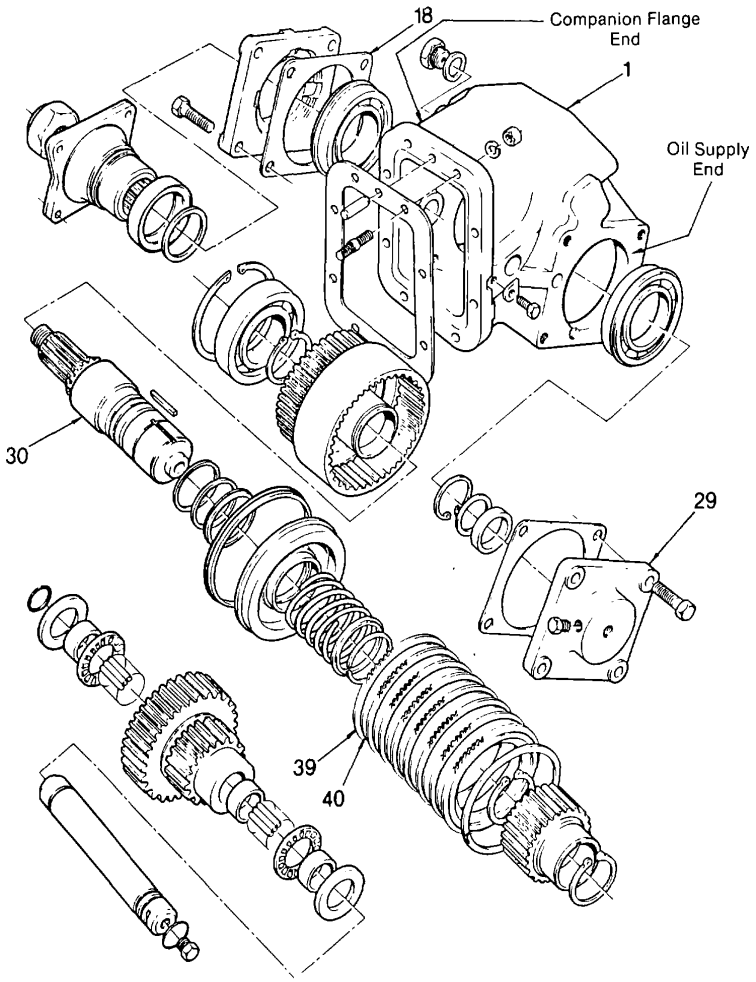


b. Inspection (1) Discard all O-rings, seals, and gaskets

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

2-12. PUMP DRIVE AND PTO - Continued



(2) Wash all PTO components using dry cleaning solvent (item 10, Appendix B) except for opposing clutch discs and bronze clutch discs.

WARNING

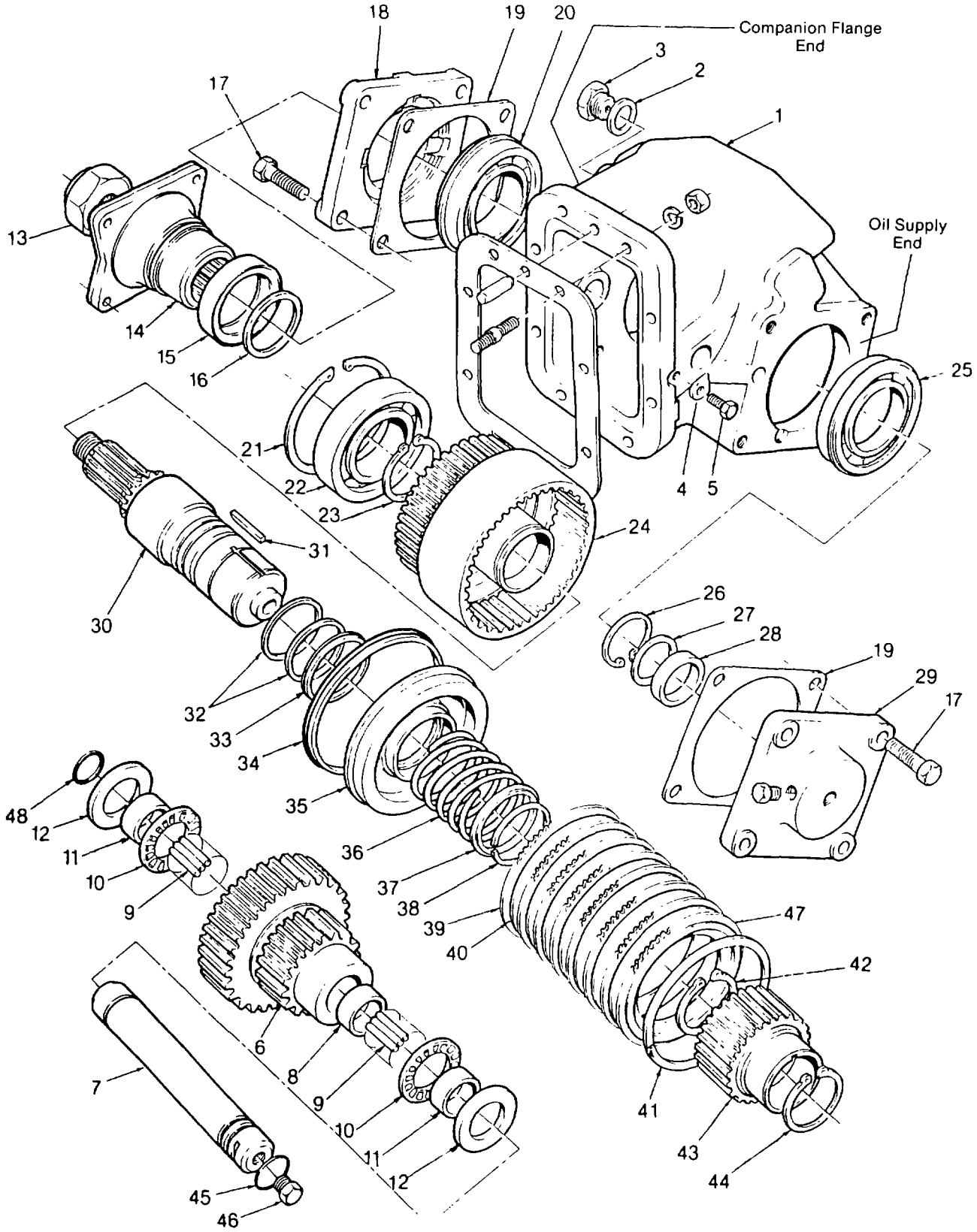
Death or serious injury could occur if compressed air is directed against the skin Do not use compress air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(3) Dry all components using compressed air. Wipe opposing clutch discs (39) and bronze clutch discs (40) using a clean, dry, lint-free cloth.

(4) Inspect housing (1) for cracks, stripped threaded holes, oblong bearing and shaft holes or warped mating surfaces.

2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued



2-12. PUMP DRIVE AND PTO - Continued

(5) Inspect clutch discs (39 and 40). Discard any that show signs of overheating. Using a vernier caliper, measure the thickness of each clutch disc. Discard any that do not fall within specification listed below.

#	Item	ThicknessTolerances
39	Opposing Clutch Disc	.068 .070 in. (1.73 1.78 mm)
40	Bronze Clutch Disc	0605 .063 In. (1.54 1.6 mm)

(6) Inspect bearings, shafts, and gears as detailed in para 2-7. Make sure oil passage in drive shaft (30) is not clogged.

(7) Inspect companion flange splines, seal area, and mounting flange.

(8) Inspect bearing covers (18 and 29) for cracks, warping or any other damage that may cause oil leaks.

c. Assembly

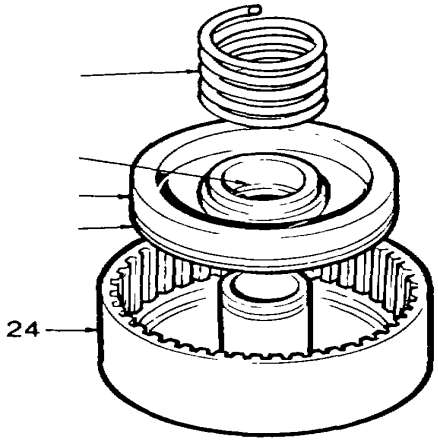
NOTE

Lubricate seals and bearings using petroleum jelly (item 21, Appendix B) prior to assembly.

(1) Assemble spider gear assembly as detailed in the following steps.

(2) Lubricate block vee rings (33 and 34) using petroleum jelly (item 21, Appendix B) and install onto piston (35). Make sure the sealing lips of the block vee rings are facing away from the spring seat.

(3) Install piston assembly (35) into spider gear assembly (24). Use extreme care so as not to damage the block vee rings (33 and 34) during installation. Twist piston assembly into spider gear assembly to ensure piston is fully seated.



(4) Install spring (36) into spring seat of piston (35).

(5) Install retainer (37) onto spring (36) and compress using hand pressure. Lock into position using lock ring (38).

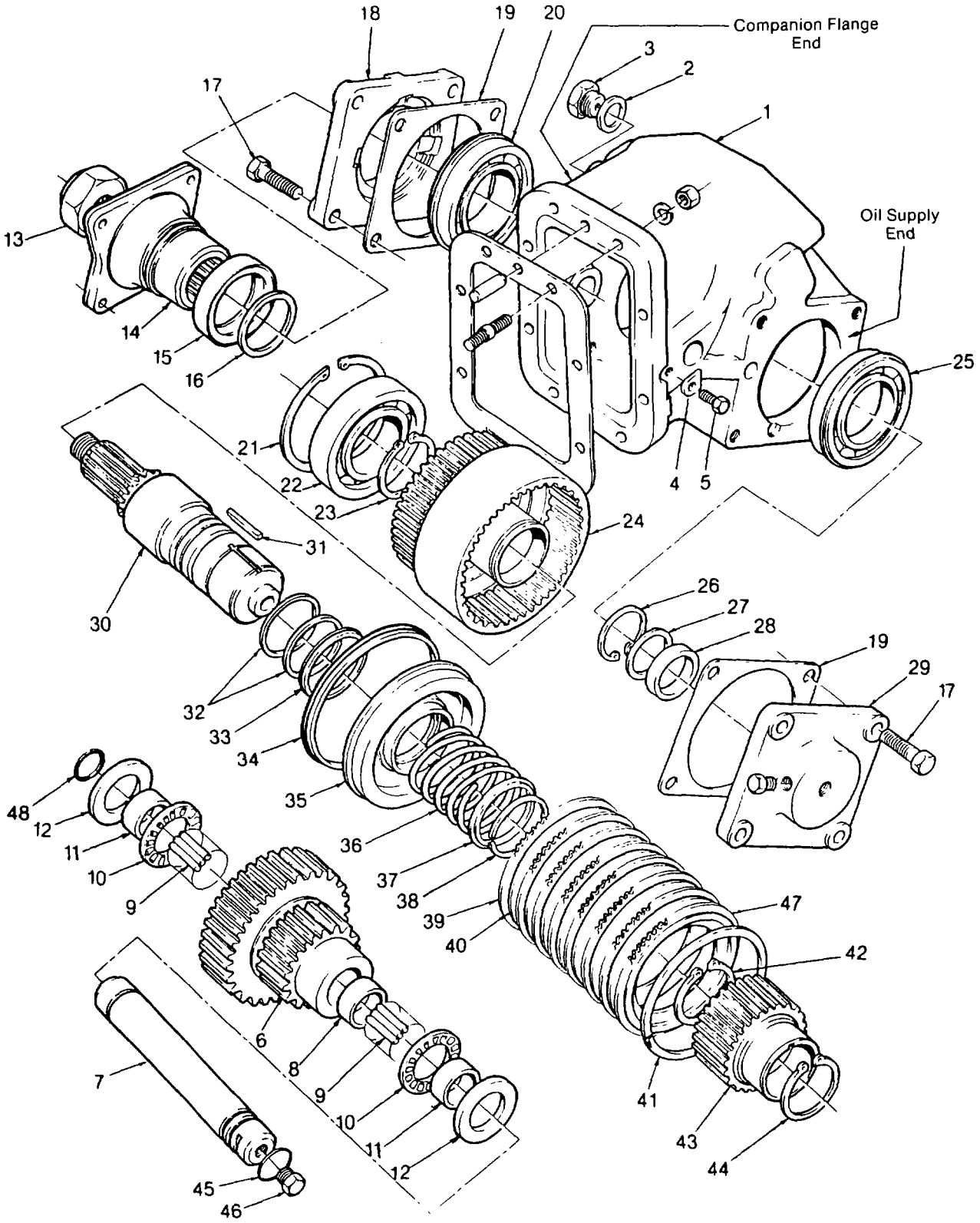
(6) Install one opposing clutch disc (39) and then install one bronze clutch disc (40). Continue to install clutch discs in this staggered manner until all 14 clutch discs are installed. Make sure a bronze clutch disc is installed last.

(7) Install clutch stop spacer (47) and lock into position using lock ring (41). Set assembled spider gear assembly (24) aside.

(8) Press bearing (22) onto drive shaft (30). Make sure bearing is fully seated against mounting shoulder. Lock bearing into position by installing lock ring (23).

2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued



2-12. PUMP DRIVE AND PTO - Continued

(9) Lubricate two piston rings (32) using petroleum jelly (item 21, Appendix B) and install on drive shaft (30).

(10) Install spider gear assembly (24) into PTO housing (1) and aline the drive shaft hole with the housing. Position housing on press bed so that it is resting on the oil supply end.

(11) Carefully slide drive shaft (30) into spider gear assembly (24).

(12) Lubricate bearing (22) outer race with petroleum jelly (item 21, Appendix B) and press bearing into spider gear assembly (24). Lock into position using lock ring (21). Make sure drive shaft (30) has enough clearance between press bed while bearing (22) Is pressed into position.

(13) With drive shaft (30) protruding through PTO housing oil supply end (1), install lock ring (42) and key (31) onto drive shaft.

(14) Carefully install internal drive gear (43) into spider gear assembly (24). Make sure internal drive gear meshes with the teeth of the bronze clutch discs (40). Lock in position using lock ring (44).

(15) Lubricate bearing (25) inner and outer races with petroleum jelly (item 21, Appendix B). Carefully press bearing onto internal drive gear (43) until it contacts gear shoulder.

(16) Invert PTO housing (1) so that it is resting on the companion flanged end. Carefully press bearing (25) outer race into PTO housing. Stop pressing once the snap ring on the outer race of the bearing contacts the PTO housing.

(17) Install seal (28), back-up plate (27) and snap ring (26) into bearing cap (29).

(18) Aline gasket (19) with bearing cap (29) and attach to PTO housing (1) using four capscrews (17). Evenly torque capscrews to 90 ft lb (122 Nm).

(19) Lubricate bearing (20) inner race using petroleum jelly (item 21, Appendix B) and install onto companion flange end of the drive shaft (30). Use a soft drift and a hammer to install bearing.

(20) Lubricate seal (15) with petroleum jelly (item 21, Appendix B) and install into bearing cover (18).

(21) Aline gasket (19) with bearing cover (18) and attach to PTO housing using four capscrews (17). Evenly torque capscrews to 90 ft lb (122 Nm).

(22) Install spacer (16) onto drive shaft (30). Install companion flange (14) and secure to drive shaft using nut (13).

(23) Clamp companion flange (14) in a vise and torque nut (13) to 80 ft lb (108 Nm).

(24) Make sure drive shaft (30) rotates freely and that drive shaft end play does not exceed .006 in. (0.15 mm).

(25) Lubricate O-ring (45) with petroleum jelly (item 21, Appendix B) and install onto idler shaft (7).

2-12. PUMP DRIVE AND PTO - Continued

2-12.1 Power Take Off Unit - Continued

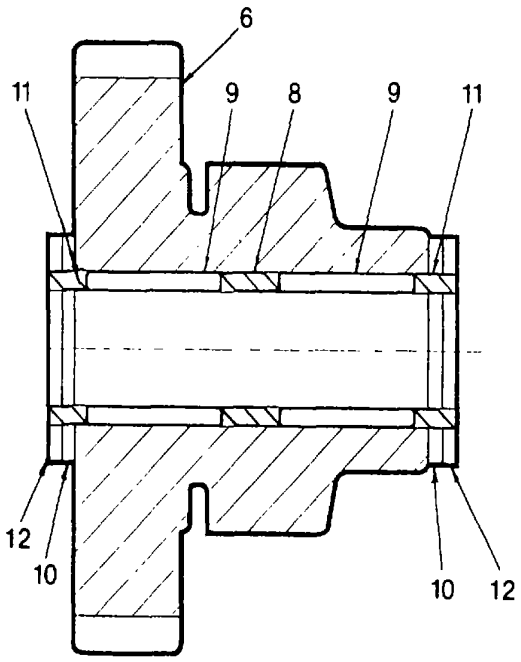
(26) Lubricate O-ring (48) with petroleum jelly (item 21, Appendix B) and install into idler shaft hole groove. Groove is located in companion flanged end of PTO housing (1).

(27) Clamp cluster gear (6) in a vise. Use soft jaws to eliminate the possibility of damage.

(28) Lubricate spacer (8) with petroleum jelly (item 21, Appendix B) and install into cluster gear (6).

(29) Apply approximately a 1/8 in. thick film of petroleum jelly (item 21, Appendix B) to the inner bore of the cluster gear (6).

(30) Carefully install needle bearings (9), one by one, until all 21 needle bearings are Installed. Repeat this procedure for the second set of 21 needle bearings on the opposite side of the spacer (8).



(31) Install spacers (11) into each end of the cluster gear (6).

(32) Slide dummy shaft (9, Appendix D) into cluster gear (6) to hold all components in position.

(33) Install one thrust bearing (10) and one thrust race (12) onto each end of the dummy shaft.

(34) Carefully install the cluster gear assembly (6) in the PTO housing (1). Mesh the small gear of the cluster gear with the gear on the spider gear assembly (24). Aline the dummy shaft with the idler shaft hole.

(35) Lubricate idler shaft (7) using petroleum jelly (item 21, Appendix B) and position over the idler shaft hole on the oil supply end of the PTO housing (1). Make sure to aline the retainer plate slot with the position of the retainer plate (4).

(36) Carefully press idler shaft (7) into idler shaft hole of PTO housing (1). Stop once the retainer plate (4) can be installed into the groove of the idler shaft (7).

(37) Position retainer plate (4) in groove on idler shaft (7) and attach to PTO housing using capscrew (5). Torque capscrew to 16 ft lb (22 Nm).

(38) Install inspection plug'(3) and gasket (2) into PTO housing (1) and torque to 50 ft lb (68 Nm).

(9) Make sure the cluster gear (6) rotates freely, and clearance does not exceed .020 in. (0.5 mm). If clearance exceeds previous figure replace thrust races (12), reassemble and recheck clearance.

(40) Install power take off unit as detailed in TM 5-4210-220-12.

2-12. PUMP DRIVE AND PTO - Continued

2-12.2 PTO to Reducer Gear Drive Shaft.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

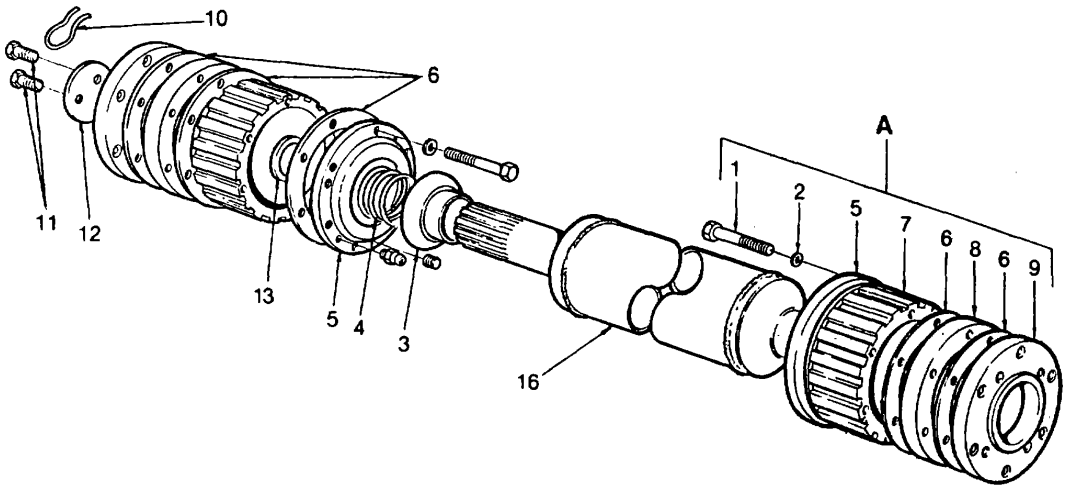
EQUIPMENT CONDITION
PTO to Reducer Gearbox Drive Shaft Removed
(see TM 5-4210-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
14, Appendix B Gasket Eliminator
16, Appendix B Grease
29, Appendix B Threadlock Liquid
E3-81-59 Gasket

NOTE

PTO to reducer gear drive shaft repair is limited to replacement of the disc joints.

If drive shaft tube or splined section is damaged in any way replace the complete drive shaft assembly, including the disc joints.



REPAIR

NOTE

The disc joints are not repairable. If a disc joint is worn or damaged, replace it.

Both disc joints are similar. One is locked to the drive shaft whereas the other is a slipping disc joint. Procedures below refer to either disc joint except where noted.

(1) Pull slipping disc joint assembly (A) from drive shaft (16).

2-12. PUMP DRIVE AND PTO - Continued

(2) Remove capscrews (1), lockwashers (2), and separate the spacer plates (8 and 9), and gaskets (6) from disc joint (7).

(3) For slipping disc joint only, separate the disc joint (7) from the wiper (5) and mechanical seal (3).

(4) For locking disc joint only cut and remove safety wire (10). Remove capscrews (11) and retainer (12).

(5) For locking disc joint only, slide the disc joint from drive shaft. Remove the snap ring (13) and pull mechanical seal (3), spring (4), and wiper (5) from drive shaft (16).

(6) Remove all gaskets (6) from disc joint assemblies and discard.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(7) Wash spacer plates, mechanical seal, wiper, spring, drive shaft splines, and fasteners using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur If compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(8) After washing, dry components using compressed air.

(9) Inspect space plates and wiper for cracks, warped mating surfaces or corrosion. Replace as necessary.

(10) Inspect mechanical seal for corrosion, wear, or dents. Replace as necessary.

(11) Test grease fitting by pumping grease (item 16, Appendix B) through fitting. If blocked, replace fitting.

(12) Inspect drive shaft tube and splined section for dents, cracks, or worn splines. If damage is evident, replace complete drive shaft assembly (including both disc joints).

NOTE

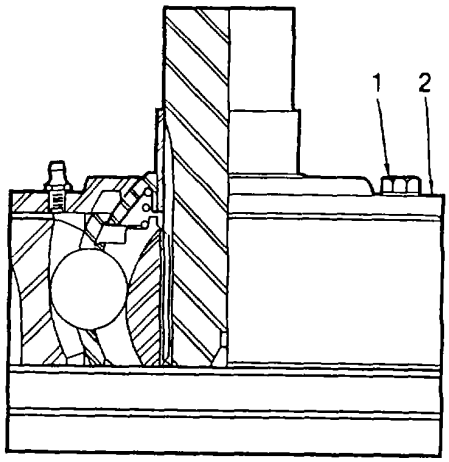
Keep work area clean to avoid the possibility of contamination of the disc joint.

2-12. PUMP DRIVE AND PTO - Continued

2-12.2 PTO To Reducer Gear Drive Shaft - Continued

(13) Stack disc joint components on bench as shown. Aline capscrew holes.

(14) For slipping disc joint only, install washers (2) onto capscrews (1) and apply threadlock liquid (item 29, Appendix B) to threads. Install capscrews and tighten to 95 ft lb (130 Nm). Go to step 23.



(15) For locking disc joint only, carry out steps 16 thru 22. Assembly is easier if drive shaft is in a vertical position.

(16) Install wiper (5), mechanical seal (3), and snap ring (13) onto splined shaft.

(17) Install spring (4) and one gasket (6). Aline shaft splines with disc joint (7) and install.

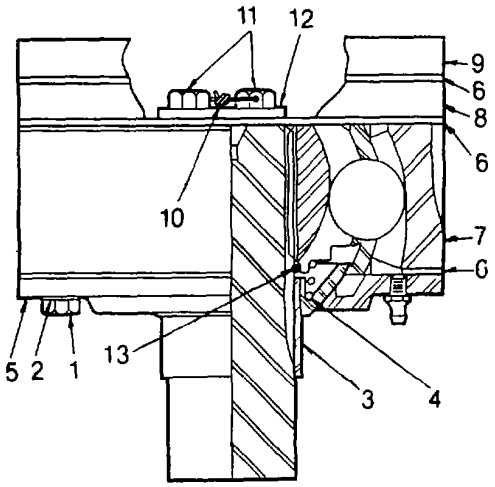
(18) Apply threadlock liquid (item 29, Appendix B) to capscrews (11).

(19) Attach retainer (12) to shaft using capscrews (11). Tighten capscrews to 40 ft lb (54 Nm).

(20) Install safety wire (10) into capscrew heads.

(21) Install gasket (6), spacer plate (8), gasket (6), and spacer plate (9) onto disc joint. Aline all capscrew holes.

(22) Install washers (2) onto capscrews (1) and apply threadlock liquid (item 29, Appendix B) to threads. Install capscrevvs (1) and tighten to 95 ft lb (130 Nm).



(23) Aline slipping disc joint assembly with splined shaft a

(24) Refer to Lube Order LO 5-4210-220-12, for lubrication instructions.

2-12. PUMP DRIVE AND PTO - Continued

2-12.3 Reducer Gear to Pump Drive Shaft.

This task covers Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
16, Appendix B Grease

EQUIPMENT CONDITION
Reducer Gear to Pump Drive Shaft Removed (see TM 5-4210-220-12)

REPAIR

NOTE

Reducer gear to pump drive shaft repair is limited to replacement of universal joints.

If drive shaft slip joint or tight end are damaged in any way, replace the complete drive shaft assembly including the universal joints.

(1) Mark slip joint (1) position before separating to ensure alinement of components during assembly.

(2) Unscrew dust cap (3) from slip joint (1) and separate slip joint (1) from tight end (2).

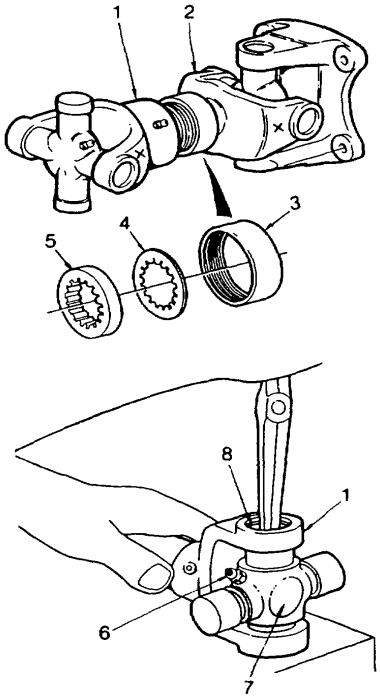
(3) Remove the cork washer (5), steel washer (4), and dust cap (3) from the tight end (2).

(4) Wipe excess grease from tight end (2), and slip joint (1), and inspect splines for damage such as wear, pitting, rolling, peening and fatigue cracks.

(5) Evidence of damage of any kind is cause for rejection. Replace complete drive shaft assembly. If no damage is found, continue with step 6.

(6) Remove grease fittings (6) from cross (7).

(7) Remove two snap rings (8) from tight end (1).



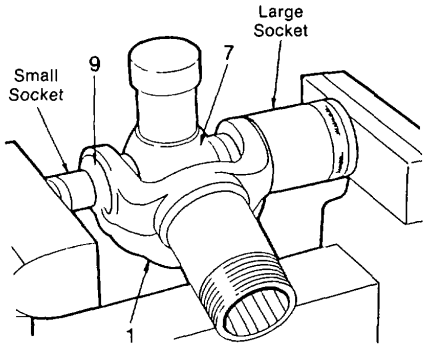
NOTE

Universal joint removal procedure will be similar for both the slip joint yoke (1) or the tight end yoke (2) except the tight end yoke also has a flanged yoke. This means that for tight end universal joint removal the following procedure will be carried out twice.

2-12. PUMP DRIVE AND PTO - Continued

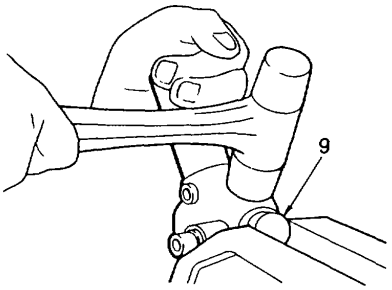
(8) Press the bearing caps (9) from the yoke using the following procedures.

(9) Position the slip joint yoke (1) between a large socket and a small socket, and between the vise jaws as shown.



(10) Close the vise. As the vise is closed, the small socket will force the bearing cap (9) into the cross (7) and in turn, the cross will force the opposite bearing cap into the large socket.

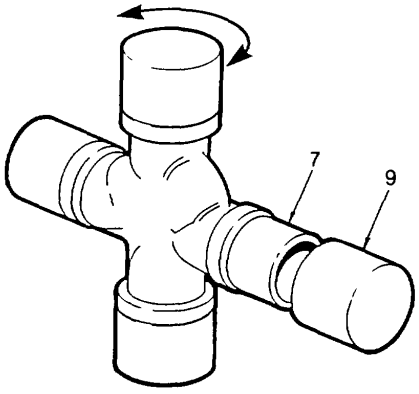
(11) The cross (7) travel is not enough to allow bearing cap (9) to be completely removed. Grasp the protruding bearing cap (9) in a vise. Strike yoke as shown using a soft faced hammer to completely remove bearing cap.



(12) Remove opposite bearing cap similar to steps 9 thru 11 preceding.

(13) Carefully maneuver the cross (7) from between the yoke lugs.

(14) Remove the universal joint from between the tight end yoke (2) and the flanged yoke (11) following steps 8 thru 13 preceding. This procedure will have to be carried out twice for complete removal.



(15) Visually inspect exposed universal joint cross (7) journals and needle bearings in bearing caps (9). Look for defects caused by lack of lubrication, and physical damage. If corrosion, pitting, unusual wear or missing needle bearings is evident, the complete universal joint kit must be replaced. If no damage is evident, continue inspecting.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

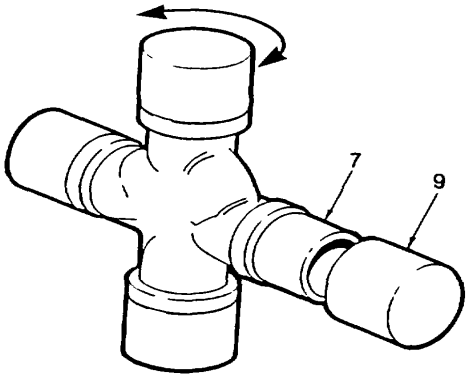
2-12. PUMP DRIVE AND PTO - Continued

2-12.3 Reducer Gear To Pump Drive Shaft - Continued

(16) Using dry cleaning solvent (item 10, Appendix B), wash universal joint cross (7) and bearing caps (9).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.



(17) Dry components using compressed air. Blow out grease passages in the cross (7).

(18) Apply a small amount of grease (Item 16, Appendix B) to each bearing cap needle bearing.

(19) Install and test bearing cap (9) on cross (7) journals as shown. The movement must be smooth and resistance free.

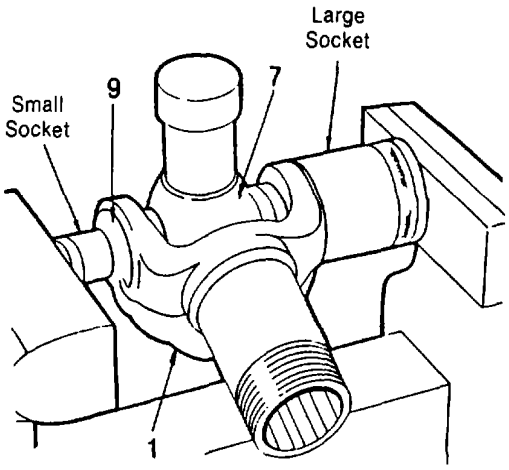
(20) If any one component fails testing, the complete universal joint must be replaced.

NOTE

Universal joint installation procedures will be similar for both the slip joint yoke (1) or the tight end yoke (2) except the tight end yoke also has a flanged yoke. This means that for tight end universal joint installation the following procedure will have to be carried out twice.

(21) Tilt the cross (7) and install one journal into slip joint yoke hole.

(22) Allow one journal of the cross (7) to protrude through the yoke hole. Install a bearing cap (9) onto the protruding cross journal and press in handtight.



(23) Use shop vise as a press. Place the slip joint yoke (1) between the vise jaws and begin to close the vise. Continue to tighten the vise until the bearing cap (9) is flush with the yoke lug.

(24) Allow the opposite arm of the cross (7) to protrude through the other slip joint yoke hole. Install a bearing cap (9) onto the protruding cross journal and press in handtight.

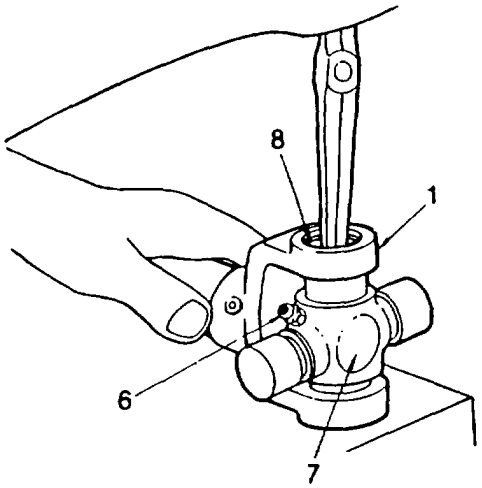
2-12. PUMP DRIVE AND PTO - Continued

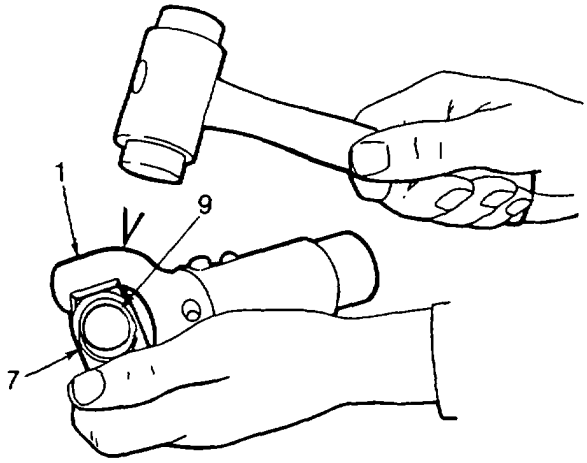
(25) Use shop vise as a press. Place the slip joint yoke between the vise jaws and begin to close the vise. Continue to tighten the vise until the second bearing cap (9) is flush with the yoke lug.

(26) Open the shop vise to accommodate the slip joint yoke (1), a large socket and a small socket as shown. Tighten the vise until the small socket has forced the bearing cap (9) into the yoke enough to install one snap ring (8).

(27) Remove from vise and install snap ring (8) into groove.

(28) Rotate the shaft 1/2 turn and install second snap ring (8) similarly to steps 26 and 27 preceding.





(29) Center the cross (7) in the slip joint yoke (1) by striking the yoke with a soft faced hammer as shown. Support the free bearing caps (9).

(30) Install grease fitting (6) into cross (7). Lubricate drive shaft after shaft has been installed in truck.

(31) Install universal joint between the tight end yoke (2) and the flanged yoke (11) following steps 21 thru 30 preceding. This procedure will have to be carried out twice for complete installation.

2-12. PUMP DRIVE AND PTO - Continued

2-12.4 Reducer Gearbox.

This task covers a. Repair
b. Overhaul

TOOLS MATERIALS/PARTS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

10, Appendix B Dry Cleaning Solvent
13, Appendix B Emery Cloth
22, Appendix B Pipe Sealant
29, Appendix B Threadlock Liquid
02-23-01262-200 Repair Kit

EQUIPMENT CONDITION
Reducer Gearbox Removed
(see TM 5-4210-220-12)

NOTE

Keep work area as clean as possible to prevent contamination of components.

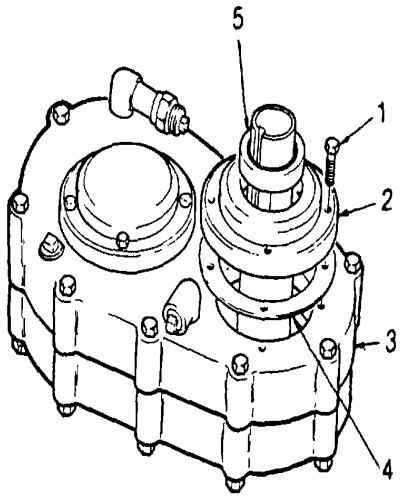
REPAIR

NOTE

Reducer gearbox repair consists of replacement of leaking seals and gaskets and shaft end play adjustment.

There are two types of caps on the gearbox, an open cap through which shaft protrudes and a closed cap.

If an open cap is removed it is recommended that the oil seal be replaced.



(1) Measure shaft end play prior to the removal of cap and record these readings. If end plate exceeds .005 in. (0.127 mm) this indicates bearing wear.

(2) If unit is full of oil, drain it into a clean drain pan. Install drain plug and tighten.

(3) Remove four capscrews (1) that retain the cap (2) to the housing (3).

(4) Remove cap (2) from housing (3). The cap may be loosened from the housing, by lightly tapping on the corner of the cap. Never pry caps off because damage may result.

(5) Inspect bearing cone and caps for damage as described in para. 2-7. If damage is evident refer to OVERHAUL following. If there is no bearing damage proceed to step 6.

(6) Remove cap gaskets (4) using a putty knife. If possible count and record the number of gaskets removed.

2-12. PUMP DRIVE AND PTO - Continued

(7) Inspect capscrews (1) and housing (3) threads. Replace capscrews as necessary.

(8) If working on an open cap (2) remove the oil seal (5).

(9) Clean the cap (2) and housing (3) gasket area.

(10) Install new gaskets (4) onto cap (2). Be sure to install the same number of gaskets as recorded in step (6) preceding. If unsure about the number of gaskets Install three gaskets under one cap. Do not apply gasket glue.

(11) Aline cap, gaskets, and housing screw holes and attach cap (2) to housing (3) using capscrews (1). Torque capscrews (1) evenly to 28 ft lb (38 Nm). While tightening the capscrews, rotate the respective shaft and stop tightening at the first sign of binding or resistance.

NOTE

Shaft end play is adjusted by adding or deleting cap gaskets (4) until the shaft rotates freely, with no end play.

(12) If end play is evident remove one gasket at a time and repeat step 10 and 11 preceding.

(13) If shaft is binding, add one gasket at a time and repeat step 10 and 11 preceding.

(14) When end play is correct, remove and clean capscrews (1) and housing threaded holes.

(15) Apply threadlock liquid (item 29, Appendix B) to capscrew (1) and reinstall into housing.

(16) Evenly torque capscrews (1) to 28 ft lb (38 Nm) Rotate respective shaft while tightening to ensure bearings do not bind.

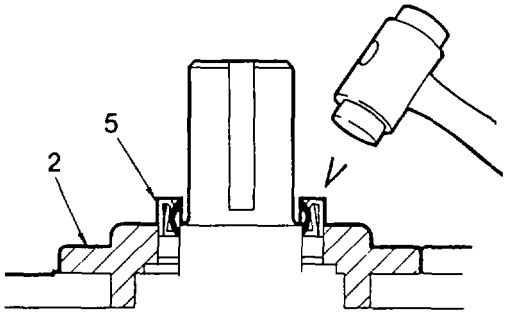
CAUTION

To avoid seal damage during installation, cover the shaft keyway with paper or cellophane tape before sliding the seal onto the shaft.

(17) Cover shaft keyway using cellophane tape to avoid seal damage during installation.

(18) Install seal (5) onto shaft. Make sure the spring loaded lip of the seal is facing the reducer gear box.

(19) Using a soft faced hammer, carefully tap seal (5) into cap (2). Stagger the tapping over the circumference to ensure seal is installed evenly.



(20) Install gearbox in truck as detailed in TM 5-4210-220-12.

2-12. PUMP DRIVE AND PTO - Continued

2-12.4 Reducer Gearbox - Continued

OVERHAUL

(1) Remove the capscrews (1) and locknuts (2) that retain the housing halves (3 and 4) together.

(2) Position housing halves (3 and 4) so they are in a horizontal position and lift off the upper housing half (3). Be sure to leave the high speed shaft (5) assembly and low speed shaft (6) assembly in the lower housing half (4).

(3) Lift out the high , speed shaft (5) assembly and low speed shaft (6) assembly' from the lower housing half (4).

(4) Mark the position of each cap (7 and 8) In relation to the housing half to which they are attached.

(5) Remove the capscrews (18) that retain the open caps (8) and closed caps (7) to the housing halves (3 and 4).

(6) Inspect gears (11 and 12) and bearings (14) following procedures outlined in para. 2-7. If any damage is evident disassemble shaft assembly as detailed in steps 7 thru 11 following. If bearings and gears are in good condition proceed to step 12.

CAUTION

Do not attempt to remove both bearing cones and gear off the shaft at the same time; one bearing cone will lodge against the key located under the gear.

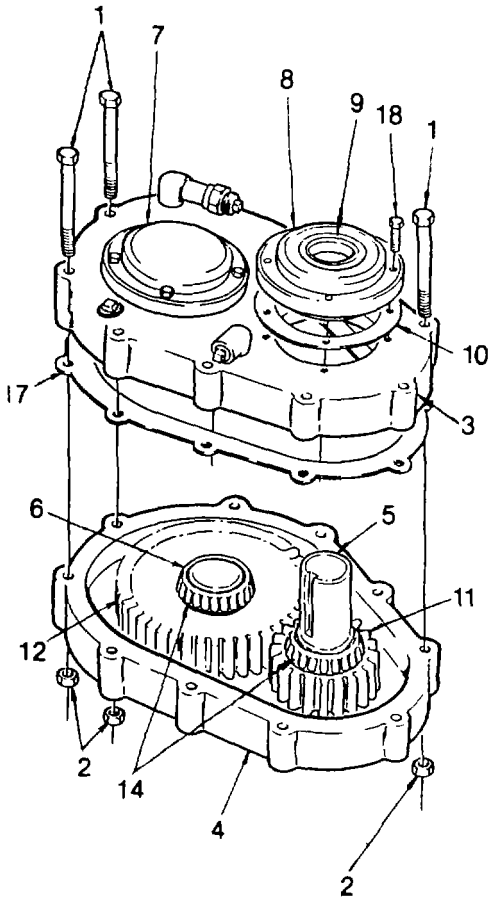
NOTE

If one gear is damaged and is going to be replaced, it is recommended that the complete gear set be replaced. Both shafts are similar. Use following procedures for both shafts. Low speed shaft has spacers between bearings and gear.

(7) Position shaft assembly (5) on a press bed with the drive end of the shaft pointing up as shown.

(8) Press shaft until it is removed from gear (11) and upper bearing (14). Do not allow the shaft to drop to the floor because damage may result.

(9) Invert the shaft and position the inner race of the bearing (14) on the press bed.


1
7
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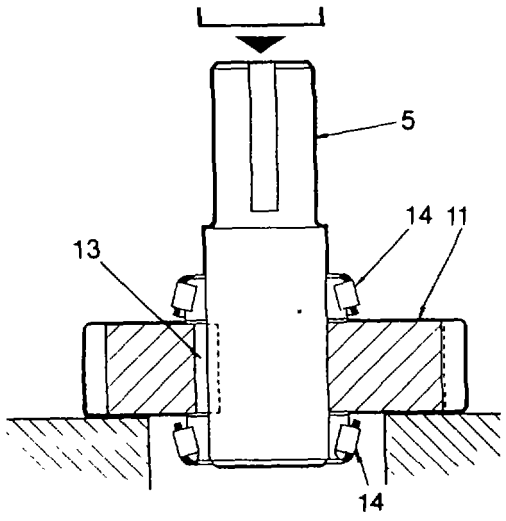
2


5
14
11
13
14

2-12. PUMP DRIVE AND PTO - Continued

(10) Press shaft until it is removed from lower bearing (14).

(11) Remove the key (13) from the shaft, only if It is damaged and needs to be replaced.

(12) Remove the seals (9) from the open caps (8).

(13) Remove bearing cups from the open caps (using a hammer and a punch), and from the closed cap (using a pair of pry bars).

NOTE

If the bearings are damaged, the bearing cone and cup should be replaced as a pair.

(14) Remove all old gaskets using a putty knife.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 148 deg. F (30 to 59 deg. C).

(15) Wash all reducer gear components using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(16) Dry all components using compressed air. Do not allow bearings to spin while drying.
(17) Inspect gears, shafts, bearing cones, and caps following procedures outlined in para. 2-7. Small imperfections in a shaft may be removed using emery cloth (item 13, Appendix B). Polish the shaft in a circumferential direction.
(18) Inspect open caps, closed caps, and housing halves for cracks stripped mounting holes or warped mating surfaces. Repair or replace as necessary.
(19) If disassembled, assemble both shafts as detailed in steps 20 thru 25. Both shafts are similar except low speed shaft has a spacer between each bearing and the gear.

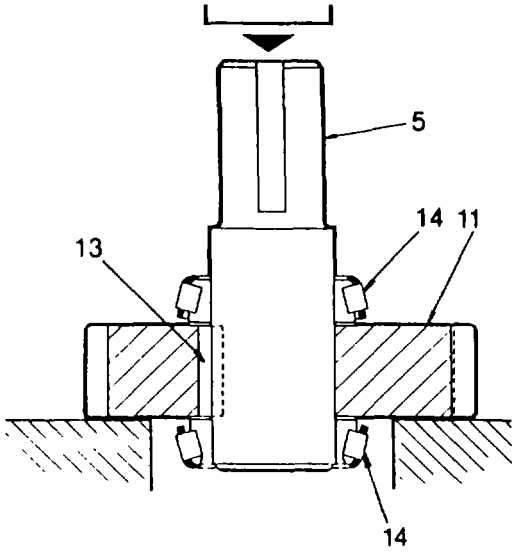
CAUTION

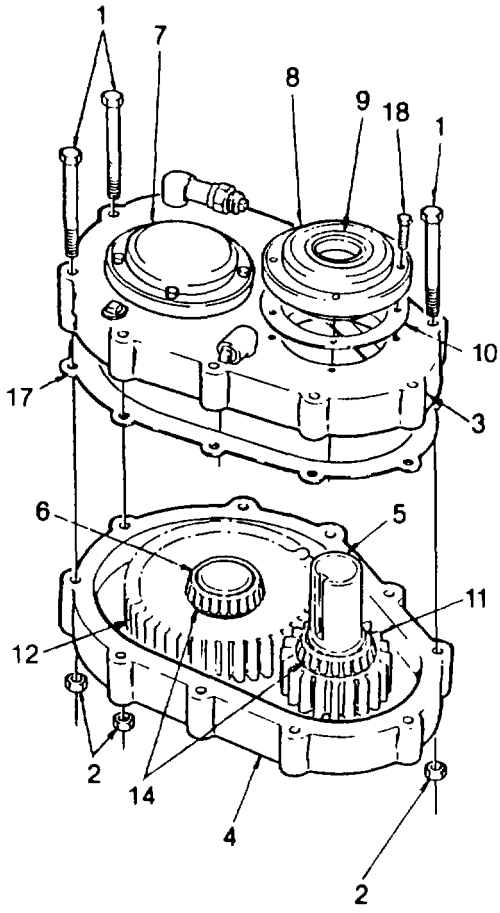
Do not attempt to press more than one part onto the shaft at a time.

2-12. PUMP DRIVE AND PTO - Continued

2-12.4 Reducer Gearbox - Continued

(20) Install the key (13) in shaft (5) key seat.
(21) Position the gear (11) on the press bed.
(22) Support the shaft (5) over the gear (11). Be sure the drive end of the shaft is up, the shaft is centered and the key (13) is alined with the keyway in the gear.
(23) Press shaft (5) into high speed gear (11). Be sure the gear is centered over the key (13) so that when the bearings (14) are installed they butt against the gear and not the key.
(24) Press bearing cone (14) onto shaft (5) until it contacts the gear (11). When installing bearing cone, apply pressure to inner race. (For low speed shaft only, install spacer between gear and bearing).
(25) Invert shaft assembly and press other bearing cone (14) onto opposite end of shaft (5) until it contacts the gear (11). When installing bearing cone, apply pressure to inner race. (For low speed shaft only, Install spacer between gear and bearing.)
(26) If disassembled, press bearing cups into the open caps (8) and closed caps (7). Make sure the cap bore is free of dirt so the cups will seat squarely. Do not install seals at this time.
(27) Attach one open cap (8) and one closed cap (7) to the lower housing half (4) using capscrews (18). Be sure to install three gaskets (10) under each cap. Tighten capscrews evenly to 28 ft lb (38 Nm).
(28) Position low speed shaft assembly (6) and high speed shaft assembly (5) in the lower housing half (4). Rotate the shafts by hand to mesh the helical gears.
(29) Position new gasket (17) on lower housing half (4) and carefully lower the upper housing half (3) onto the lower housing half (4).





2-12. PUMP DRIVE AND PTO - Continued

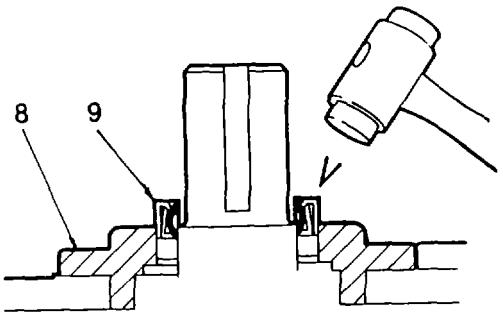
(30) Install capscrews (1) through the housing halves. Apply threadlock liquid (item 13, Appendix B) to the threads. Install nuts (2) and torque evenly. Tighten 5/16 - 18 capscrews to 15 ft lb (22 Nm). Tighten 3/8 - 16 capscrews to 28 ft lb (38 Nm).
(31) Attach one open cap (8) and one closed cap (7) to the upper housing half using capscrews (18) Be sure to install three gaskets (10) under each cap.
(32) Torque capscrews (18) evenly to 28 ft lb (38 Nm). While tightening the capscrews, rotate the respective shaft and stop tightening at the first sign of binding or resistance.

NOTE

Shaft end play is adjusted by adding or deleting cap gaskets (10) until the shaft rotates freely, with no end play. The gears will remain closer to center if the number of gaskets on each cap does not vary by more than one.

(33) Adjust high speed shaft bearing clearance. If end play is evident remove one gasket at a time and repeat step 32. If shaft Is binding, add one gasket at a time and repeat step 32.
(34) When shaft end play Is adjusted and shaft rotates freely, remove four capscrews (18) from open cap (8).
(35) Clean capscrews (18) and housing threaded holes and apply threadlock liquid (item 13, Appendix B) to capscrews (18). Reinstall in housing and evenly torque capscrews (18) to 28 ft lb (38 Nm). Rotate respective shaft while tightening to ensure bearings do not bind.
(36) Remove capscrews (18) from closed cap (7) then repeat step 35 preceding.
(37) Adjust low speed shaft bearing clearance similar to steps 33 thru 36 preceding.
(38) Cover the high speed shaft keyway using cellophane tape to avoid seal damage during installation.

(39) Slide seal (9) onto shaft. Make sure the spring loaded lip of the seal is facing the reducer gearbox.
(40) Using a soft faced hammer, carefully tap seal (9) into open cap (8). Stagger the tapping over the circumference to ensure seal is installed evenly.
(41) Repeat step 38 thru 40 to install the low speed shaft seal.
(42) Apply pipe sealant (Item 22, Appendix B) to the fill tube, vent, and drain plug and install.
(43) Install gearbox on truck as detailed in TM 5-4210-220-12.,



2-13 FIRE PUMP

2-13. FIRE PUMP.

2-13.1 Primer Suction Pipe.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5-4210-220-12)
Pump Access Panels Removed

REPAIR

(1) Remove primer suction pipe (1) by removing banjo bolt (5) and loosening pipe clamps (3).

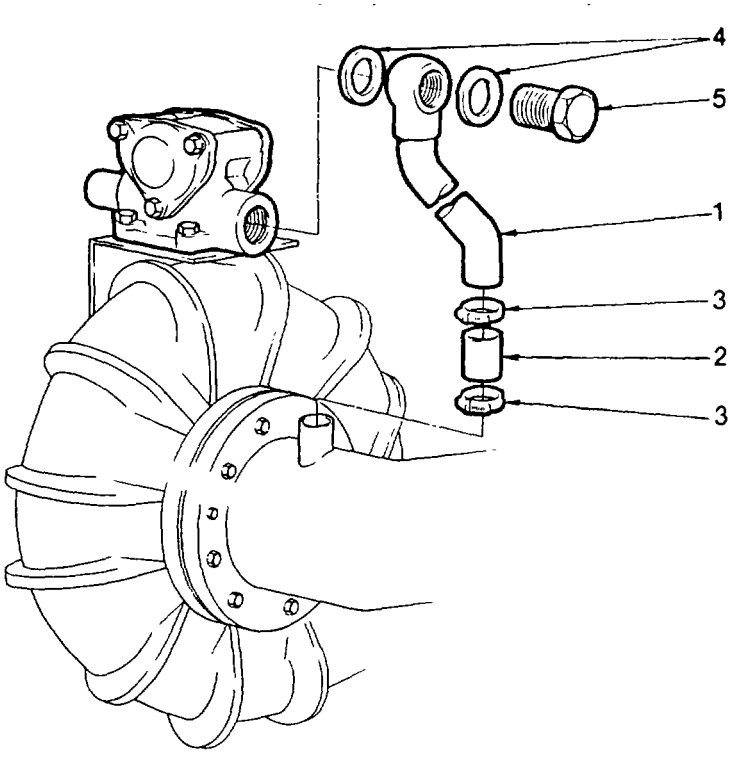
(2) Remove all fittings. Check pipe (1) and hose (2) for leaks. Replace as required.

(3) Make sure all mating surfaces for seal washers (4) are free of dirt or corrosion. Clean mating surfaces using emery cloth (item 13, Appendix B). Excessive corrosion will require replacement of primer suction pipe (1).

(4) Coat threads of all fittings with pipe sealant (item 22, Appendix B).

(5) Replace pipe and hose Tighten banjo bolt (5) securely. Ensure hose clamps (3) are tight.

(6) After repairs have been made, test fire pump as detailed in para. 2-13.14.



2-13. FIRE PUMP - Continued

2-13.2 Wearing Ring.

This task covers Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

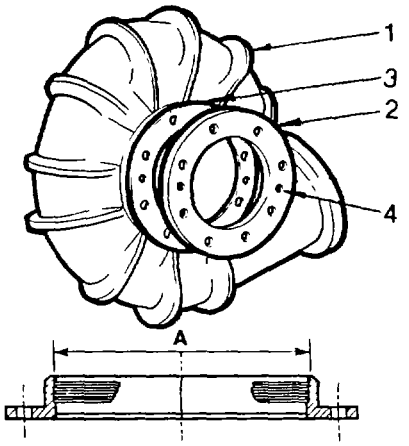
EQUIPMENT CONDITION
Water Tank Drained (see TM 5-4210-220-12)
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Heat Shields Removed (see TM 5-4210-220-12)
Pump Suction Pipe Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
21, Appendix B Petroleum Jelly
UFP 5351/1 Suction Tube Gasket

REPAIR

(1) Remove wearing ring (2) using two M10 x 1.5 flat-ended capscrews. Thread the two flat-ended capscrews into the two tapped holes (4).
(2) Tighten two capscrews evenly and remove wearing ring (2) from volute body (1).
(3) Remove and discard gasket (3).
(4) Examine volute body (1) and wearing ring (2) for cracks, corrosion, or warped flanges. Replace as necessary.

(5) Measure the internal diameter (A) of the wearing ring (2) in several places. If dimension (A) exceeds 7.025 in. (178.43 mm) at any of several points, the wearing ring must be replaced. If the wearing ring is to be replaced, it is recommended that the impeller wearing diameter is also measured. See para. 2-13.4 for procedure.
(6) To install wearing ring (2), apply a continuous bead of petroleum jelly (item 21, Appendix B) to both sides of new gasket (3).
(7) Aline mounting holes in gasket (3) with holes in wearing ring (2). Allow gasket to stick to wearing ring.



(8) Attach wearing ring (2) to volute body (1) using eight capscrews (M12 x 1.75 x 25 mm L). Tighten capscrews to 90 ft lb (122 Nm). Make sure wearing ring is fitted with its sleeve towards the volute body (1).
(9) Measure radial clearance between the impeller and wearing ring. The minimum clearance allowed is .006 in. (0.15 mm).
(10) Remove capscrews and replace suction pipe (see TM 5-4210-220-12).
(11) After repairs have been made, test fire pump as detailed in para. 2-13.14.

2-13. FIRE PUMP - Continued

2-13.3 Volute Body.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

MATERIALS/PARTS
21, Appendix B Petroleum Jelly
UFP 2295/2 Gasket

EQUIPMENT CONDITION
Fire Pump Removed for Truck
(see TM 5-4210-220-12)

CAUTION

Pump is made of aluminum alloy. Sealing surface will be damaged if pry bars or wedges are used to disassemble components. When reassembling, do not force components into position or use fasteners to bring parts together.

REPAIR

NOTE

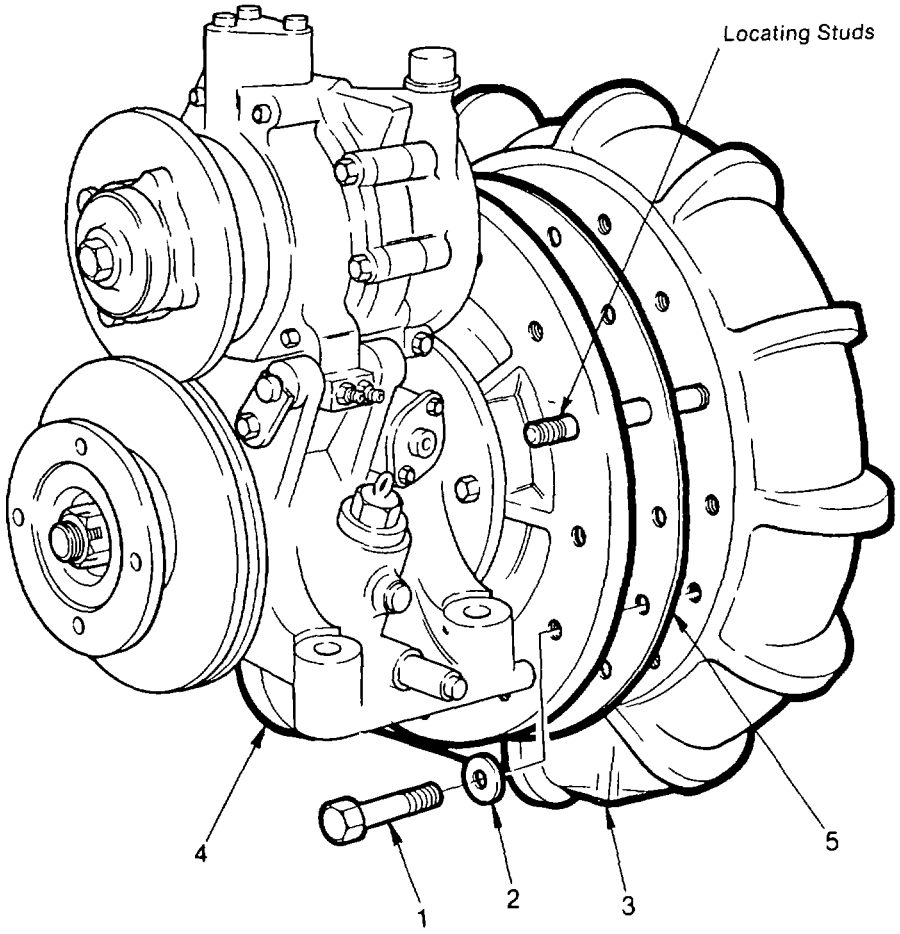
The volute body can be removed from the fire pump without removing the wearing ring.

The following procedure describes volute body removal as a complete sub-assembly. This will allow direct access to the impeller, pump head, carbon seal assembly, and bearing housing.

(1) Remove primer valve as detailed in para. 2-13.10.
(2) Remove 16 capscrews (1) and seal washers (2) securing the volute body (3) to the pump head (4). Remove volute body and gasket (5). Discard gasket.
(3) Inspect seal washers for deterioration of rubber face. Replace as necessary.
(4) Inspect volute body (3) and pump head (4) for cracks, corrosion or warped flanges. Replace as necessary. Remove old gasket and clean surface.
(5) Install a locating stud in the volute body (3) as shown. This will help to aline volute body during installation.
(6) Apply a continuous bead of petroleum jelly (item 21, Appendix B) to both sides of new gasket (5).
(7) Aline gasket (5) with locating stud and stick to volute body (3) flange.
(8) Aline volute body (3) with pump head (4) and bring together.

2-13. FIRE PUMP - Continued

(9) Install 16 capscrews (1) and seal washers (2) to secure volute body (3) to the pump head (4). Make sure rubber side of seal washer faces pump head. Make sure priming valve bracket is installed in proper location. Tighten capscrews evenly to 210 ft lb (285 Nm)
(10) Install primer valve as detailed in para. 2-13.10.
(11) After fire pump has been repaired, test pump as detailed in para 2-13.14.



2-13. FIRE PUMP - Continued

2-13.4 Impeller.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

MATERIALS/PARTS
MS178/69 Cotter Pin

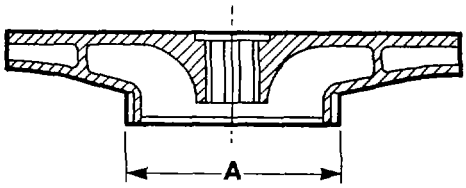
EQUIPMENT CONDITION
Fire Pump Removed from Truck
(see TM 5-4210-220-12)
Volute Body Removed (see para. 2-13.3)

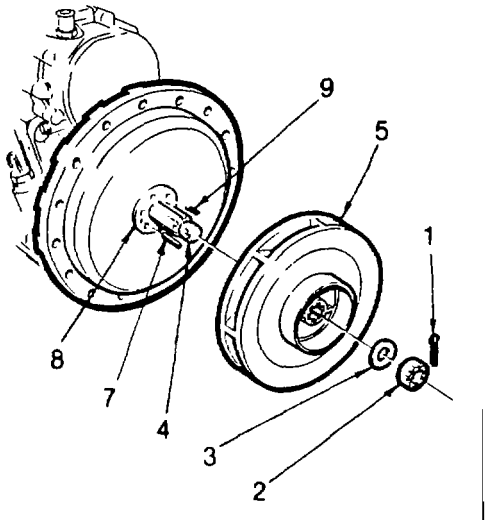
CAUTION

Pump is made of aluminum alloy. Sealing surfaces will be damaged if pry bars or wedges are used to disassemble components. When reassembling, do not force components into position or use fastener to bring parts together.

REPAIR

(1) Measure the wearing diameter of the impeller in several places. If dimension (A) is less than 6.975 in. (177.17 mm) at any of the several points the impeller must be replaced. If the impeller is to be replaced, it is recommended that the wearing ring diameter also be measured. See para. 2-13.2 for procedure.
(2) Remove the cotter pin (1), nut (2) and washer (3). It will be necessary to hold the drive flange at opposite end of pump shaft (4) while removing nut (2).
(3) Remove impeller (5) from splined shaft (4).
(4) To install, ensure the carbon seal springs (9) are in place.
(5) Carefully slide impeller (5) onto pump shaft (4). Make sure to aline the roll pin (7) in the impeller with the hole in the spring seat (8).
(6) Install washer (3) onto pump shaft (4). Thread nut (2) onto pump shaft and tighten firmly. Aline slotted nut with shaft hole and install new cotter pin (1). Bend cotter pin legs over the nut and toward impeller (5).
(7) Install volute body as detailed in para. 2-13.3 preceding.





2-13. FIRE PUMP - Continued

2-13.5 Carbon Seal and Seating Assembly.

This task covers Repair

TOOLS MATERIALS/PARTS

Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

UFP 2301 O-ring
UMP 9370 O-ring
UMP 9413 O-ring

EQUIPMENT CONDITION

Fire Pump Removed from Truck (see TM 5-4210-220-12)
Volute Body Removed (see para. 2-13.3)
Impeller Removed (see para. 2-13.4)

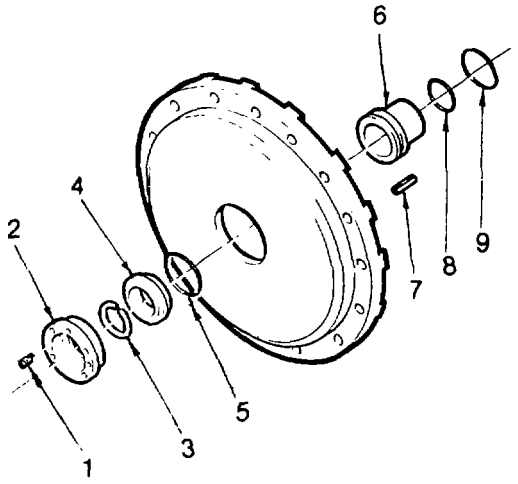
CAUTION

Pump is made of aluminum alloy. Sealing surfaces will be damaged if pry bars or wedges are used to disassemble components. When reassembling, do not force components into position or use fasteners to brings parts together.

REPAIR

NOTE

If water leakage is noticed dripping out of the drain hole in the pump head, carefully examine three O-rings, and carbon seal. Replace parts as necessary.



(1) Pull the carbon seal seating ring (2), sleeve (6) and six springs (1) from pump shaft.
(2) Remove and examine carbon seal (4), and O-ring (5). If carbon seal face is scored, it should be replaced along with the seating ring (2). Replace O-ring (5).
(3) To replace the O-ring (9), remove circlip (3) and seating ring (2) from the sleeve (6). Use extreme care to avoid scratching the face of the seating ring.
(4) Remove O-ring (8) from the inside of the sleeve (6). Replace with new.
(5) Install new O-ring (9) onto sleeve (6), followed by seating ring (2). Lock into position with circlip (3).
(6) Install carbon seal (4) and O-ring (5) in pump head seal housing.
(7) Install carbon seal on the pump shaft and push fully home.

2-13. FIRE PUMP - Continued

(8) Install six springs (1) into the seating ring holes, and slide complete assembly onto the pump shaft.
(9) Install impeller as detailed in para. 2-13.4.
(10) Install volute body as detailed in para. 2-13.3.
(11) After repairs have been made, test fire pump as detailed in para. 2-13.14.

2-13. FIRE PUMP - Continued

2-13.6 Pump Head.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

EQUIPMENT CONDITION
Fire Pump Removed from Truck
(see TM 5-4210-220-12)
Volute Body Removed
(see para. 2-13.3)
Impeller Removed
(see para. 2-13.4)
Carbon Seal and Sealing Assembly Removed
(see para. 2-13.5)

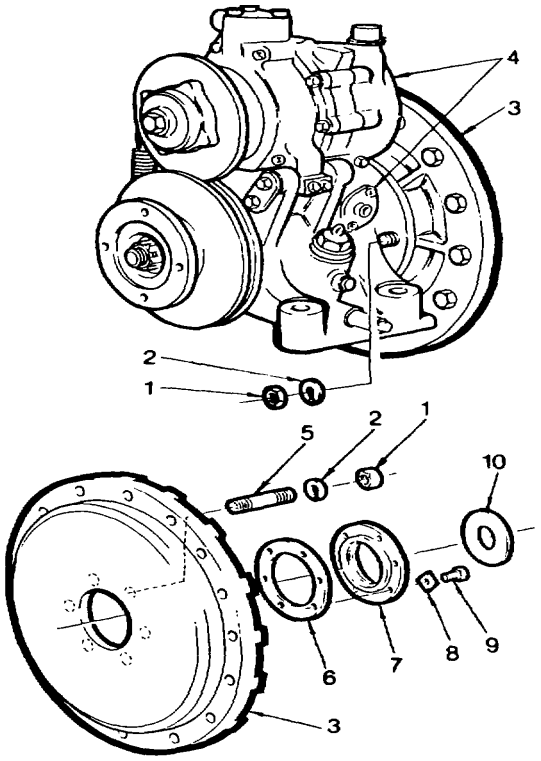
MATERIALS/PARTS
UMP 6538 Gasket

CAUTION

Pump is made of aluminum alloy. Sealing surfaces will be damaged if pry bars or wedges are used to disassemble components. When reassembling, do not force components into position or use fasteners to bring parts together.

REPAIR

(1) Use a marker to mark the pump head and housing for easier installment.
(2) Remove the six nuts (1) and lockwashers (2) that retain the pump head (3) to the bearing housing (4).
(3) Remove the disengaging plunger pipe. See para. 2-13.11 steps 4 and 6.
(4) Using a soft faced hammer, progressively tap around the circumference of the pump head (3) until it separates from the bearing housing (4).
(5) Examine pump head (3) and bearing housing (4) for cracks, excessive corrosion, or warped mating surfaces. Replace as necessary.
(6) To remove the seal housing (7), remove the six capscrews (9) and washers (8).
(7) Separate seal housing (7) from pump head (3). Remove and discard gasket (6).
(8) Remove water flinger (10) from pump shaft.
(9) To assemble pump head, first install the water flinger (10).
(10) Install new gasket (6) onto seal housing (7).



2-13. FIRE PUMP - Continued

(11) Aline mounting holes in seal housing (7) with holes in pump head (3). Install washers (8) onto capscrews (9) and thread into holes. Torque to 12 ft lb (16 Nm).

(12) To install pump head (3) onto bearing housing (4), aline studs (5) with mounting holes in bearing housing and slide into place.
(13) Install lockwashers (2) and nuts (1) fingertight. Torque nuts to 44 ft lb (60 Nm).
(14) Install carbon seal seating ring assembly as detailed in para. 2-13.5 preceding.
(15) Install impeller as detailed in para. 2-13.4.
(16) Install volute body as detailed in para. 2-13.3.
(17) After repairs have been made, test fire pump as detailed in para. 2-13.14.

2-13. FIRE PUMP - Continued

2-13.7 Water Ring Primer.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

EQUIPMENT CONDITION
Fire Pump Removed from Truck
(see TM 5-4210-220-12)

MATERIALS/PARTS
3, Appendix B Antiseize Compound
21, Appendix B Petroleum Jelly
WRP 7953 Gasket
WRP 7954 Gasket
WRP 7985 Seal

WARNING

To prevent personal injury or premature bearing failure when removing or installing bearing races, always exert force on the tight ring of the bearing.

CAUTION

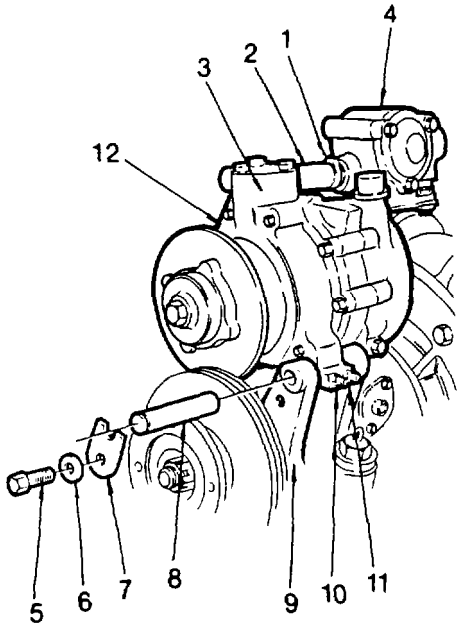
Pump is made of aluminum alloy. Sealing surfaces will be damaged if pry bars or wedges are used to disassemble components. When reassembling, do not force components into position or use fasteners to bring parts together.

REPAIR

NOTE
Water ring primer can be removed from fire pump with the fire pump still mounted in the truck.

If fire pump is not removed from truck, the main engine and APU must be shutdown, the batteries disconnected, heat shields removed, and the pump access panels removed as detailed in TM 5-4210-220-12. The procedure listed below describes water ring primer repair with the pump removed.

(1) To remove the water ring primer, loosen gear clamps (1) and remove priming hose (2) from primer.
(2) Disconnect and remove priming return spring from back of primer.
(3) Remove capscrew (5), lockwashers (6) and locking plate (7).
(4) Loosen the two locknuts (10) and two setscrews (11).
(5) While supporting the water ring primer assembly (12), tap the fulcrum pin (8) out of bearing housing (9). Lift the water ring primer assembly from bearing housing and place on workbench.



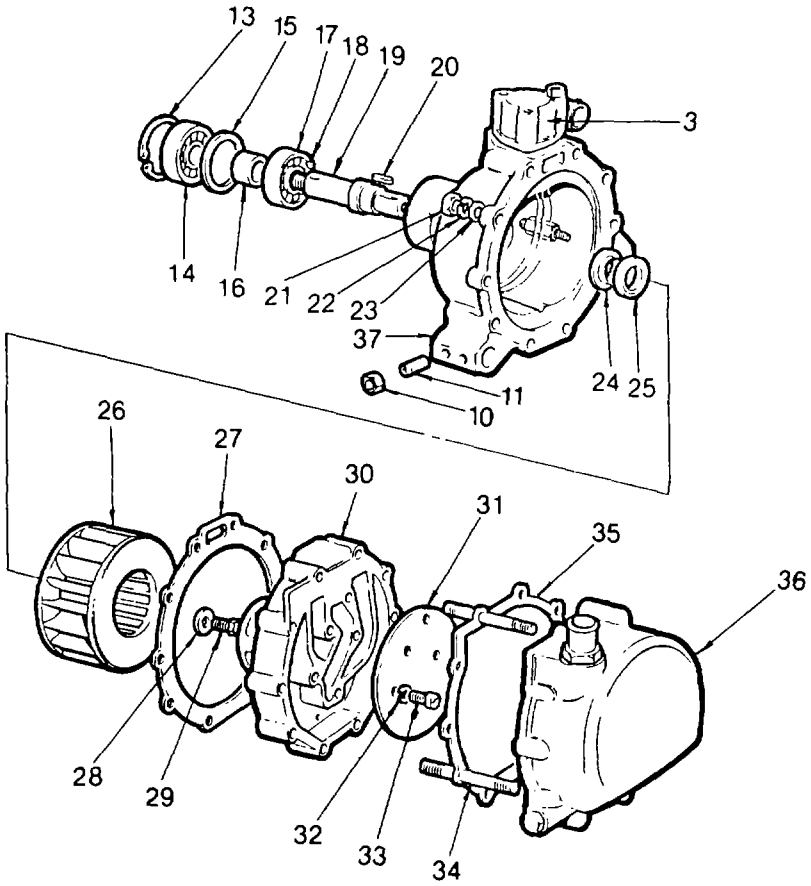
2-13. FIRE PUMP - Continued

(6) Remove fiber driving wheel as detailed in para. 2-13.8.

(7) Repair non-return valve as detailed in para. 2-13.9 as required.

(8) Remove the ten nuts (21), lockwashers (22), and flat washers (23) from the studs (34) in the primer body (36).

(9) Separate the primer housing (37) and primer body (36) from the suction and delivery cover (30). The shaft, bearings, and impeller are still attached to the primer bearing housing.
(10) Remove and discard gaskets (27 and 35).
(11) Examine studs (34) and replace as necessary. There are four different stud lengths, identify length and location of stud before removing.
(12) Carefully examine the impeller (26) inner diameter, and the corresponding outer diameter of the suction and delivery cover (30) for excessive scoring or wear.
(13) If the suction and delivery cover (30) needs to be replaced, remove the cover plate (31) by removing the self-locking screws (33) and washers (32).
(14) If the impeller (26) needs to be replaced, remove impeller retaining screw (29), washer (28), and pull impeller from shaft (19). If any resistance is encountered pulling the impeller, it may be levered out of the primer bearing housing (37).
(15) Remove the circlip (13).



2-13. FIRE PUMP - Continued

2-13.7 Water Ring Primer - Continued

(16) Carefully tap impeller end of primer shaft (19) until the primer shaft and bearings are clear of primer bearing housing (37). Make sure to use a soft faced hammer.

(17) Inspect ball bearings (14 and 17) as detailed in para. 2-7.

CAUTION

To prevent personal injury or premature bearing failure when removing or installing bearing races, always exert force on the tight ring of the bearing.

(18) Press bearings (14, 17) from primer shaft (19) if evidence of damage or wear is noticed.

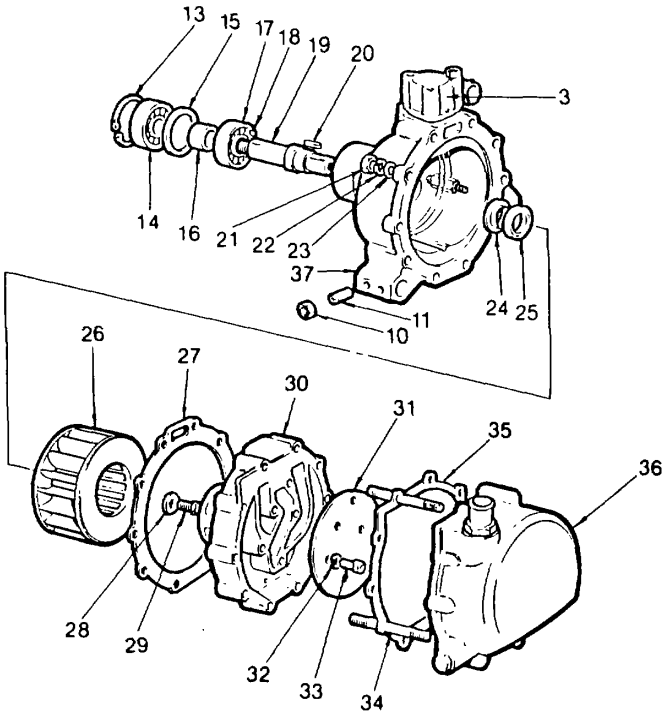
(19) Push the seal (25) and back-up washer (24) towards the impeller cavity and remove from the bearing housing (37).

(20) Remove all gasket material or corrosion from all mating surfaces.

(21) Install back-up washer (24), and primer shaft seal (25) into primer bearing housing (37) from the impeller cavity side. Ensure the lip on the back-up washer and the open end of seal face are mounted toward the impeller.

CAUTION

To prevent personal injury or premature bearing failure when removing or installing bearing races, always exert force on the tight ring of the bearing.



2-13. FIRE PUMP - Continued

(22) Press bearing (17) onto primer shaft. Bearing may be cooled in freezer prior to bearing installation.
(23) Install assembled primer shaft (19) into primer housing (37). Enter primer housing from fiber driving wheel end. Use care so as not to damage seal (25).
(24) Slide bearing spacer (16) onto primer shaft (19) until it contacts inner race of bearing (17).
(25) Install bearing location ring (15) into primer bearing housing (37). Make sure it is fully seated in housing.
(26) Install bearing (14) onto primer shaft (19) and into primer bearing housing (37). During installation of bearing, exert force on both the inner and outer race to prevent bearing damage.
(27) Install circlip (13) into primer bearing housing (37).
(28) Install key (20) into primer shaft (19).
(29) Aline impeller (26) with key (20) and slide onto primer shaft (19).
(30) Install capscrew (29) and flat washer (28) to retain impeller (26). Tighten capscrew to 12 ft lb (16 Nm).
(31) Spin impeller and make sure shaft rotates freely and quietly.
(32) If suction and delivery cover (30) or cover plate (31) was replaced it is necessary to apply gasket eliminator (item 14, Appendix B) to the mating surface. Fasten cover plate on suction and delivery cover using self-locking screws (33) and washers (32). Torque screws to 12 ft lb (16 Nm).
(33) Lay primer body (36) so studs (34) point upwards. Install gasket (35), suction and delivery cover (30), gasket (27), and primer bearing housing (37) onto studs. Secure parts using flat washers (23), lockwashers (22), and nuts (21). Torque nuts evenly to 24 ft lb (33 Nm).
(34) If repaired, install non-return valve as detailed in para. 2-13.9 following.
(35) Install fiber driving wheel as detailed in para. 2-13.8 following.
(36) Position water ring primer assembly (12) on bearing housing (9).
(37) Apply antiseize compound (item 3, Appendix B) to fulcrum pin (8). Aline fulcrum pin holes, then slide fulcrum pin into bearing housing. Ensure the locking plate groove is on the pulley end of pump, and the fulcrum pin Is installed in a different position as was originally so that the setscrews (11) bear on a different part of the shaft.
(38) Lock fulcrum pin (8) to bearing housing (9) using locking plate (7), capscrew (5) and lockwasher (6). Torque capscrew to 24 ft lb (33 Nm).
(39) Move water ring primer (12) on fulcrum pin (8) until both sides of fiber wheel bear equally on the sides of the pump driving pulley groove.

2-13. FIRE PUMP - Continued

2-13.7 Water Ring Primer - Continued

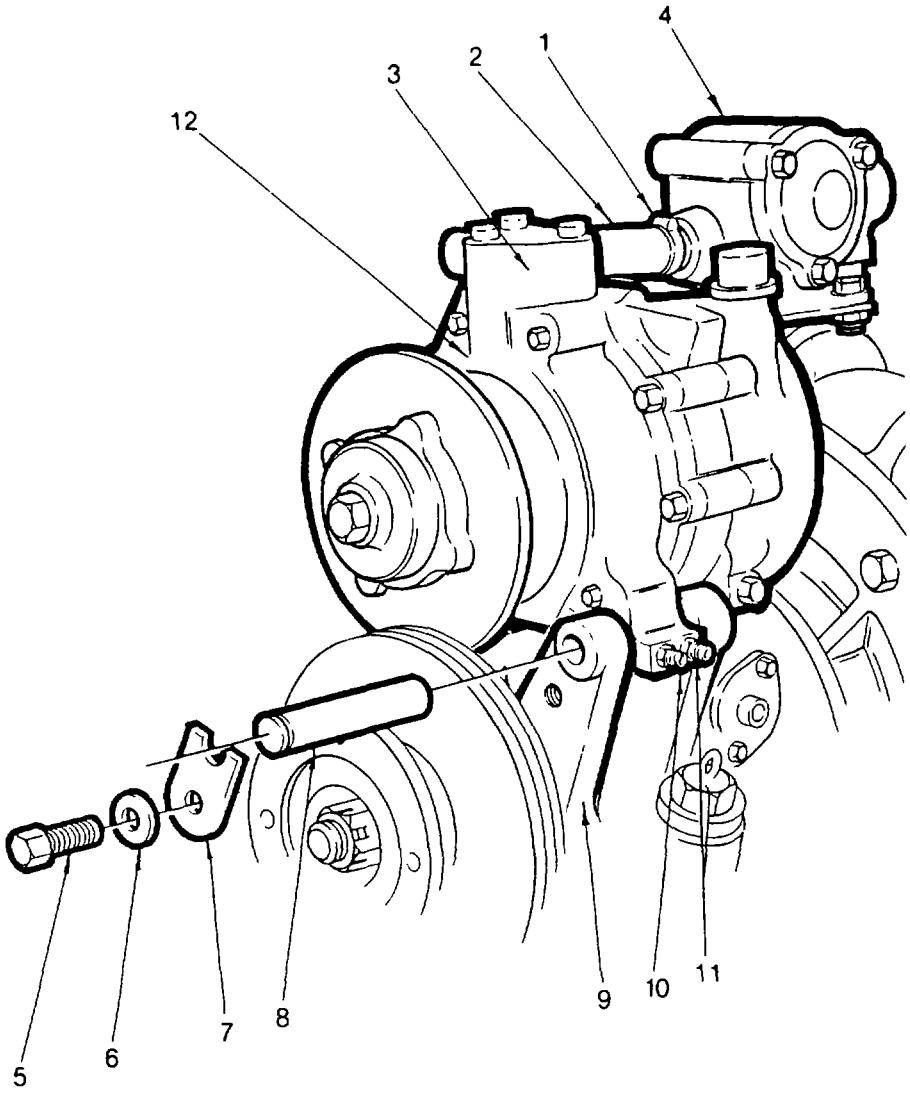
(40) Tighten setscrews (10) firmly, and lock into position with locknuts (11). Torque locknuts to 24 ft lb (33 Nm).

(41) Install and attach primer return spring.

(42) Install priming hose (2) and fasten to suction elbow (3) and priming valve (4) using gear clamps (1).

(43) Check adjustment of disengaging unit as detailed in para. 2-13.11.

(44) Test fire pump as detailed in para. 2-13.14.



2-13. FIRE PUMP - Continued

2-13.8 Fiber Driving Wheel.

This task covers Repair

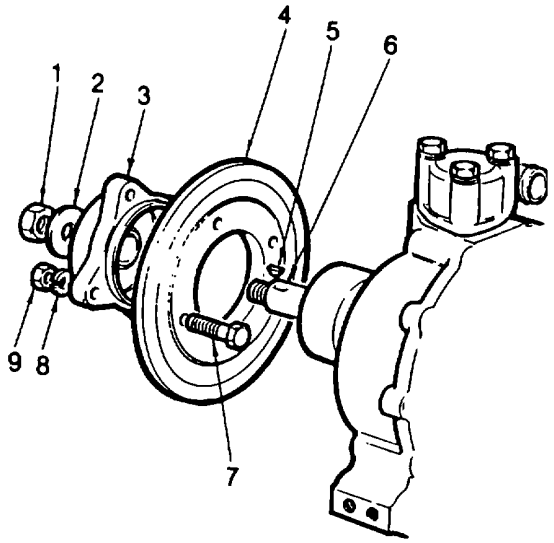
TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

MATERIALS/PARTS
WRP 7938 Tab Washer
UMP 7915 Fiber Wheel

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown
(see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5-4210-220-12)
Pump Access Panels Removed

REPAIR

(1) Using a block of wood, wedge it between water ring primer and bearing housing to disengage fiber wheel from drive pulley.
(2) Straighten the tab washer (2) and remove nut (1).
(3) Pull center piece (3) from primer shaft (6).
(4) Remove woodruff key (5) from primer shaft (6).
(5) Remove the fiber driving wheel (4) from the center piece (3) by removing nuts (9), lockwashers (8) and capscrews (7).
(6) Inspect center piece (3) for cracks, warped flanges, or oblong shaft hole. Replace as necessary.
(7) Attach the fiber driving wheel (4) to the center piece (3) using capscrews (7) lockwashers (8) and nuts (9) Torque nuts evenly to 12 ft lb (16 Nm).
(8) Install woodruff key (5) into primer shaft (6).
(9) Aline center piece (3) key slot with woodruff key (5), then slide onto the primer shaft (6).



(10) Install new tab washer (2) and nut (1) onto primer shaft (6). Tighten nut to 44 ft lb (60 Nm).
(11) Bend tab washer (2) onto one nut flat.
(12) Adjust water ring primer to drive pulley as detailed in step 39 and 40 in para. 2-13.7. If adjustment is necessary loosen locknuts and setscrews on fulcrum prior to adjusting. (13) Check disengaging unit to primer adjusting screw clearance as detailed in step 28 of para. 2-13.11.

2-13. FIRE PUMP - Continued

2-13.9 Non-Return Valve.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

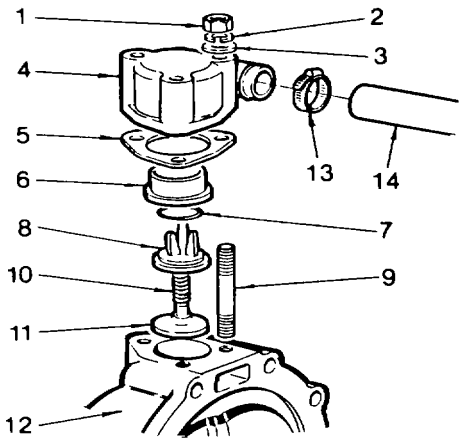
MATERIALS/PARTS
27, Appendix B Silicone Grease
WRP 7973 Gasket
WRP 7993 O-ring

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown
(see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5-4210-220-12)
Pump Access Panels Removed

REPAIR

(1) Loosen hose clamp (13) and pull hose (14) from non-return valve.

(2) To disassemble the non return valve assembly, remove the three nuts (1), lockwashers (2), and flatwashers (3).
(3) Remove the body (4) from mounting studs (9). Remove gasket (5) and discard.
(4) Pull non-return valve (8), spring (10), and spring retainer (11) from primer bearing housing (12).
(5) Remove O-ring (7) from non return valve and discard.
(6) Examine body (4) and valve sleeve (6) for cracks, corrosion or warped mounting flange.



(7) Lubricate new O-ring (7) using silicone grease (item 27, Appendix B) and install O-ring onto non-return valve (8).
(8) Install spring retainer (11), spring (10), and non-return valve (8) into the primer bearing housing (12).
(9) Install new gasket (5), valve sleeve and body (4) onto studs (9).
(10) Install three flatwashers (3), lockwashers (2) and nuts (1) onto studs (9). Torque nuts to 24 ft lb (33 Nm).
(11) Test fire pump as detailed in para. 2-13.14.

2-13.10 Priming Valve Repair.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705
1334 Gasket

EQUIPMENT CONDITION
Fire Pump Removed from Truck
(see TM 5-4210-220-12)

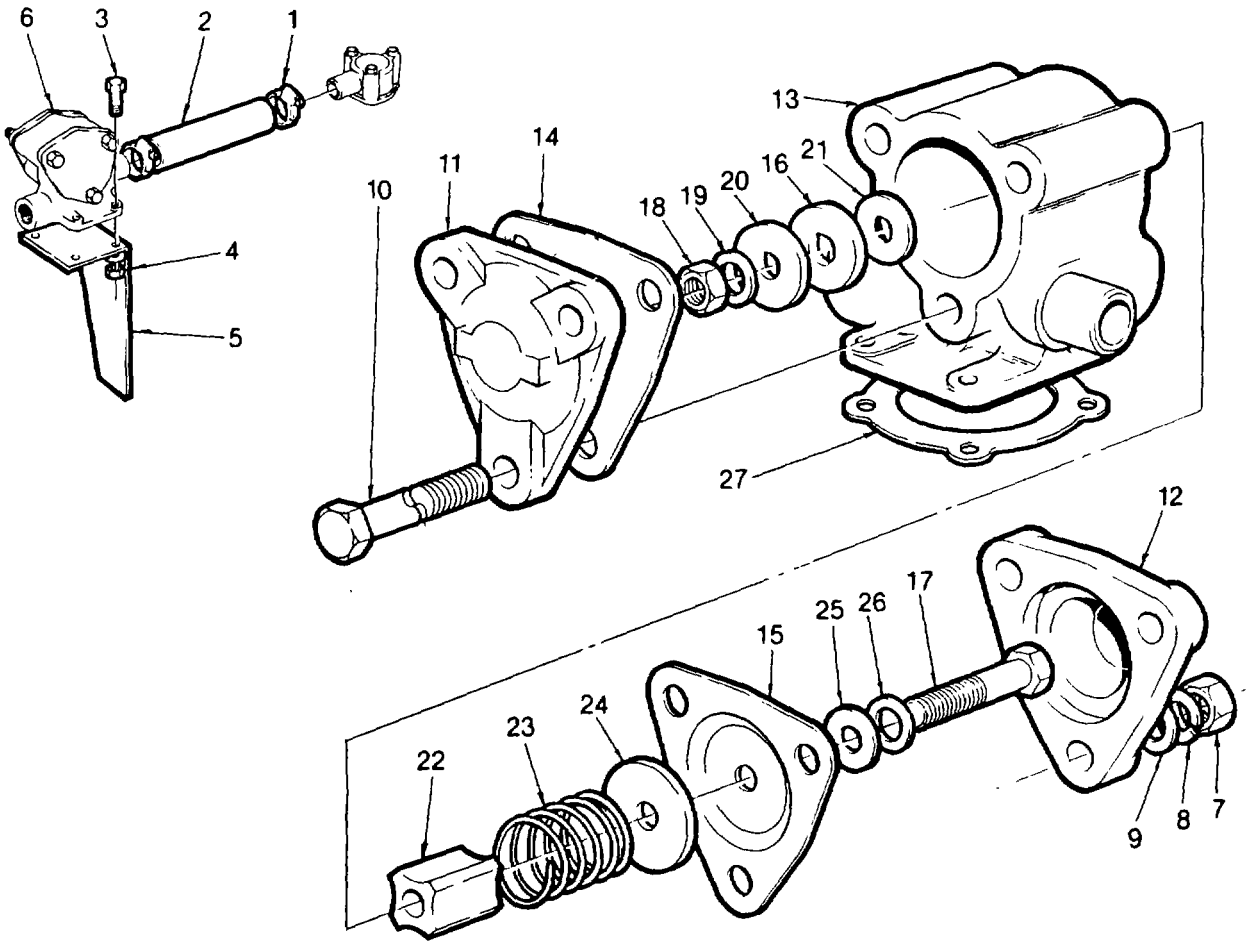
MATERIALS/PARTS
14, Appendix B Gasket Eliminator
UFP 6489 Diaphragm
MS 141/5 Locknut

UFP 6490 Gasket

REPAIR

NOTE

Priming valve may be examined while fire pump is mounted in truck. If not removed from truck, the main engine and APU must be shutdown, the batteries disconnected, and the pump access panels removed (see TM 5-4210-220-12).



2-13. FIRE PUMP - Continued

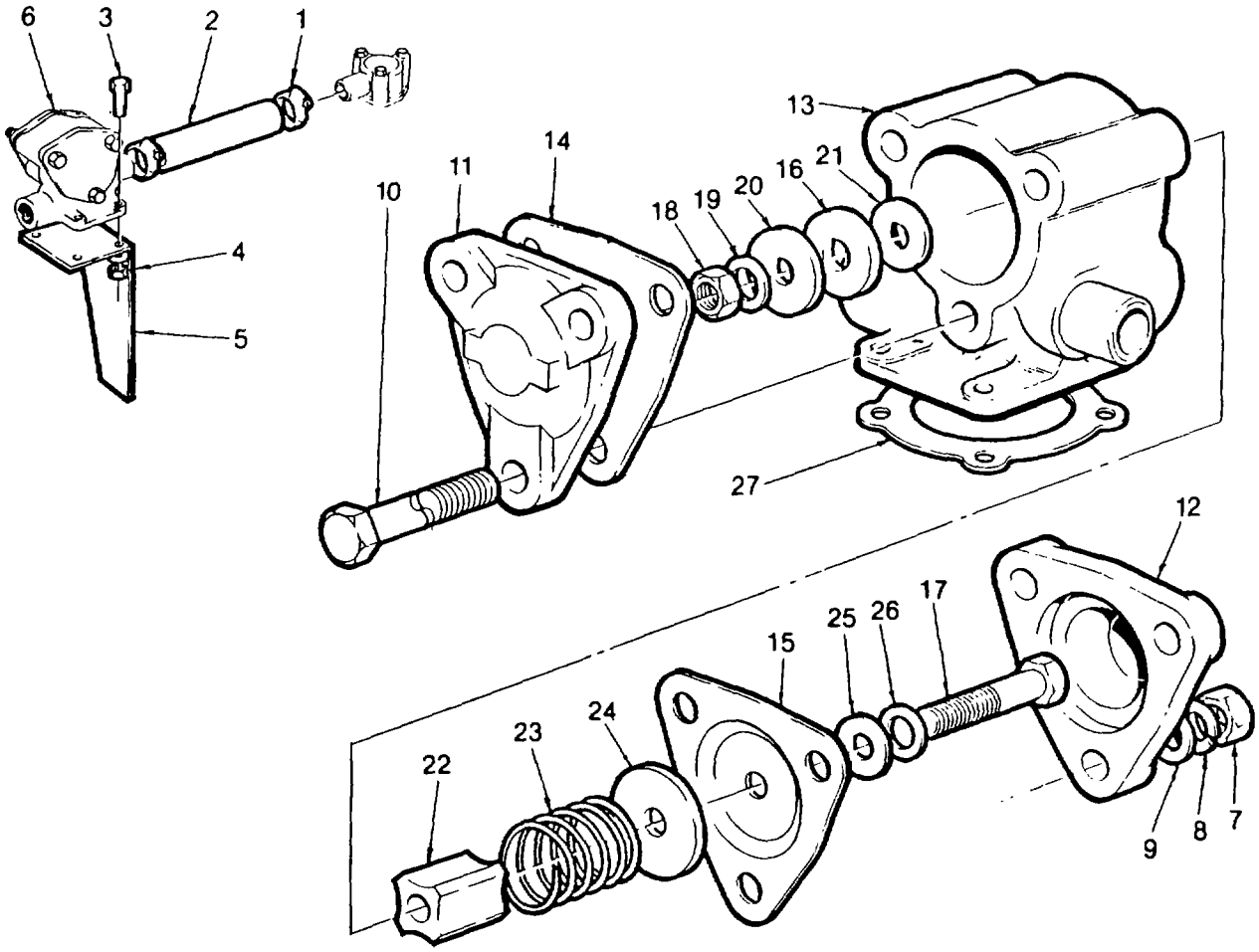
The procedure below describes priming valve repair with the pump removed.

(1) Remove primer suction pipe as detailed in para. 2-13.1.
(2) Loosen gear clamps (1) and remove hose (2).
(3) Remove four capscrews (3) and nuts (4). Remove priming valve (6) from bracket (5).
(4) To disassemble the priming valve, unscrew the three nuts (7), lockwashers (8), flatwasher (9), and capscrews (10).
(5) Carefully separate the end plates I11 and 12) from body (13). Remove gasket (14) and discard.
(6) With end cover (12) removed, examine diaphragm (15) for deterioration or cracks.
(7) If diaphragm (15) is damaged, it can be replaced when seal washer (16) is inspected.
(8) To remove seal washer (16), support capscrew (17) and remove self-locking nut (18). Remove bonded seal (19), washer (20), seal washer (16) and washer (21).
(9) Pull remaining components through body (13). Remove spacer (12), spring (23), diaphragm plate (24) and diaphragm (15) from capscrew (17). Slide washer (25) and bonded seal (26) from capscrew (17).
(10) Examine the seal washer (21) and valve seat for contamination. Replace seal washer as necessary.
(11) Inspect end plates (11 and 12) for cracks, corrosion or warped flanges. Clean end plates (11 and 12) and body (13) mating surfaces.
(12) Examine hose connections for excessive contamination or cracks. Replace body as necessary.
(13) To assemble, slide bonded seal (26) and washer (25) onto capscrew (17).
(14) Install new diaphragm (15) on capscrew (17). Install diaphragm plate (24), spacer (22), and spring (23) onto capscrew (17).
(15) Install partial assembly into body (13). Make sure the spring (23) contacts the seat in the body.
(16) Install washer (21), seal washer (16), washer (20), bonded seal (19) and new locknut (118).Torque locknut to 44 ft lb (60 Nm).
(17) Apply gasket eliminator (item 14, Appendix B) to both faces of gasket (14).
(18) Aline end plate (11), gasket (14), body (13), diaphragm (15), and end plate (12).
(19) Install three capscrews (10) through end plates (11 and 12) and valve body (13). Install flatwashers (9), lockwashers (8) and nuts (7) onto capscrews (10). Torque nuts (7) evenly to 44 ft lb (60 Nm).

2-13. FIRE PUMP - Continued

2-13.10 Priming Valve Repair - Continued

(20) Install priming valve (6) and gasket (27) onto bracket (5) and aline mounting holes.
(21) Install capscrews (3) and nuts (4) and tighten firmly.
(22) Install hose (2) and attach using clamps (1).
(23) Install primer suction pipe as detailed in para. 2-13.1.
(24) After repairs have been made, test fire pump as detailed in para. 2-13.14.



2-13. FIRE PUMP - Continued

2-13.11 Disengaging Unit.

This task covers Repair

TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705

MATERIALS/PARTS
22, Appendix B Pipe Sealant
UFP 2290 O-ring
UFP 5954 Diaphragm

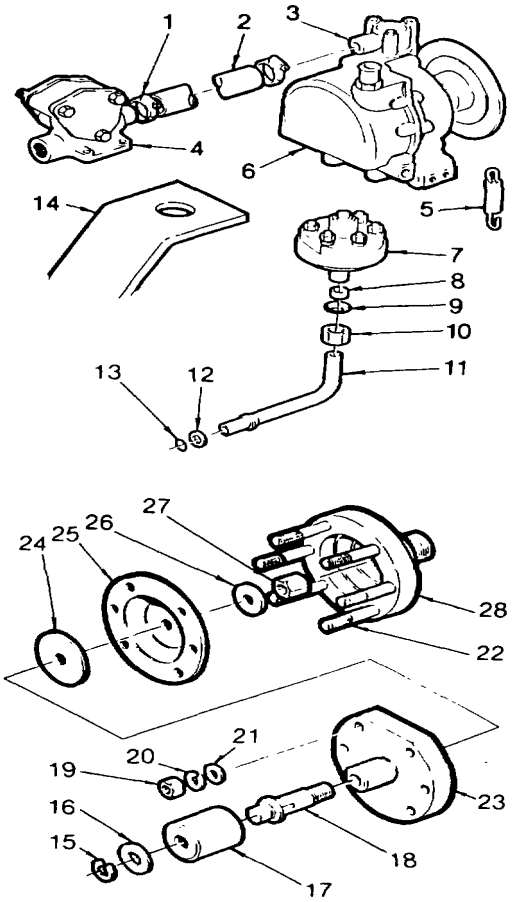
EQUIPMENT CONDITION
Fire Pump Removed from Truck
(see TM 5-4210-220-12)

REPAIR

NOTE

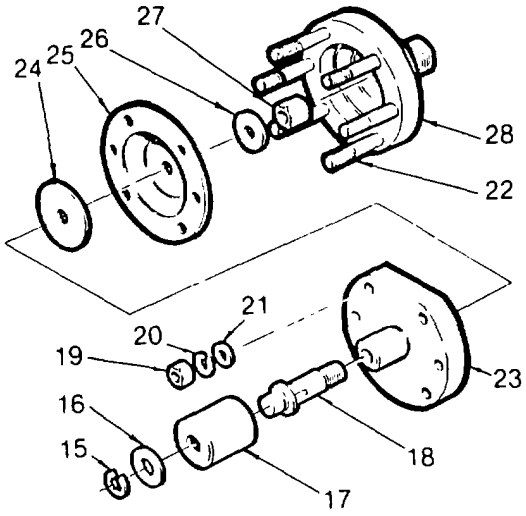
If disengaging unit diaphragm is damaged, water will be seen dripping from disengaging unit upper flange.

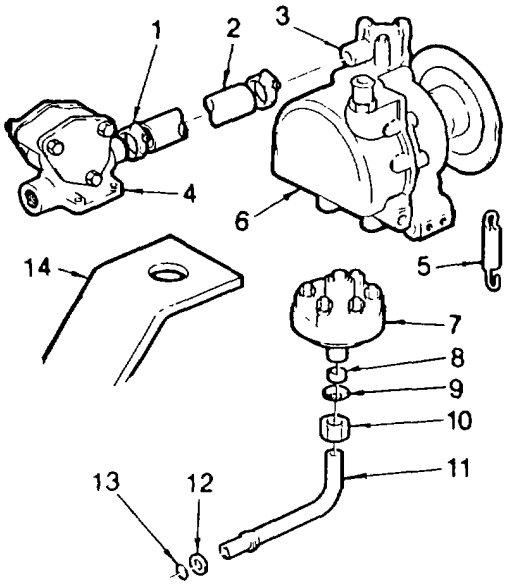
(1) Loosen gear clamps (1) and remove hose (2) from between suction elbow (3) and priming valve (4).
(2) Disconnect and remove priming return spring (5).
(3) Swing the water ring primer (6) upwards, and allow it to hang by the fulcrum pin on the front of the pump.
(4) Disconnect the union nut (10) on the under side of the disengaging unit (7).
(5) Unscrew the disengaging unit (7) from the bearing housing.
(6) Remove lift-off pipe (11) if necessary. If lift-off pipe is removed, pull washer (12) and O-ring (13) from pump body. Replace O-ring (13).
(7) To disassemble disengaging unit, first remove circlip (15) and washer (16). Pull plastic cap (17) from diaphragm cover (23).
(8) Remove six nuts (19), lockwashers (20) and flatwashers (21).
(9) Separate the diaphragm cover (23) from the diaphragm housing (28).



2-13. FIRE PUMP - Continued

(10) Examine diaphragm(25) for splits, or deterioration.
(11) Remove damaged diaphragm (25) from plunger (18) by removing nut (27) and washer (26). Make sure to remove diaphragm plate (24), located on diaphragm cover (23) end of plunger. Pull plunger from diaphragm cover.
(12) Inspect diaphragm cover and housing for cracks, excessive corrosion, or warped mating surfaces.
(13) Inspect diaphragm housing for stripped threaded holes, and stripped water connection threads.
(14) Inspect diaphragm cover for oblong plunger hole.
(15) Examine plunger for excessive wear or corrosion.
(16) Evidence of damage of any kind is cause for rejection. Replace component or assembly as required.
(17) Install plunger (18) into diaphragm cover (23).
(18) Slide diaphragm plate (24) onto plunger (18).
(19) Install new diaphragm (25) and washer (26). Apply a thin coating of pipe sealant (item 22, Appendix B) to plunger threads. Thread nut (27) onto plunger and tighten to 24 ft lb (33 Nm).
(20) Aline diaphragm (25) and diaphragm cover (23) mounting holes. Carefully slide diaphragm onto diaphragm housing studs (22). Secure diaphragm cover to diaphragm housing using flat washers (21), lockwashers (20), and nuts (19). Torque nuts to 24 ft lb (33 Nm).
(21) Position plastic cap (17) and washer (16) on diaphragm cover (23) and lock in position with circlip (15).
(22) Thread disengaging unit (7) into bracket (14).
(23) Install washer (12) and new O-ring (13) onto lift-off pipe (11). Position lift-off pipe in pump head pressure socket.

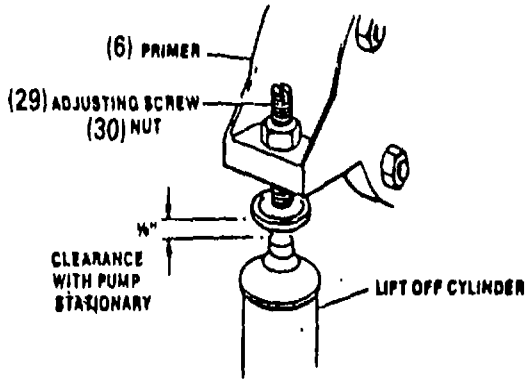




2-13. FIRE PUMP - Continued

2-13.11 Disengaging Unit - Continued

(24) Attach the union nut (10) to base of disengaging unit and tighten firmly.
(25) Swing the water ring primer (6) back to normal operating position. Allow the fiber driving wheel to rest in pump driving pulley groove.
(26) Re-attach the priming return spring (5).
(27) Install hose (2) and secure using clamps (1). Tighten clamps firmly.
(28) Check disengaging unit to water ring primer clearance as shown. To adjust, loosen jam nut (30) and adjust screw (29) until 1/8 in. (3.18 mm) clearance is achieved. Tighten jam nut firmly once adjustment is made.
(29) Test fire pump as detailed in par3. 2-13.14.



2-13. FIRE PUMP - Continued

2-13.12 Revolution Counter Repair.

This task covers

a. Removal
b. Inspection
c. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Pump Access Panels Removed

MATERIALS/PARTS
16, Appendix B Grease
1312 Thrust button

REMOVAL

(1) Remove cable end (9) from revolution counter drive housing (4).
(2) Remove two capscrews (1), lockwashers (2), and flat washers (3).
(3) Pull revolution counter drive housing (4) and pinion (5) from bearing housing (8). Make sure thrust button (6) is removed with revolution counter drive pinion.

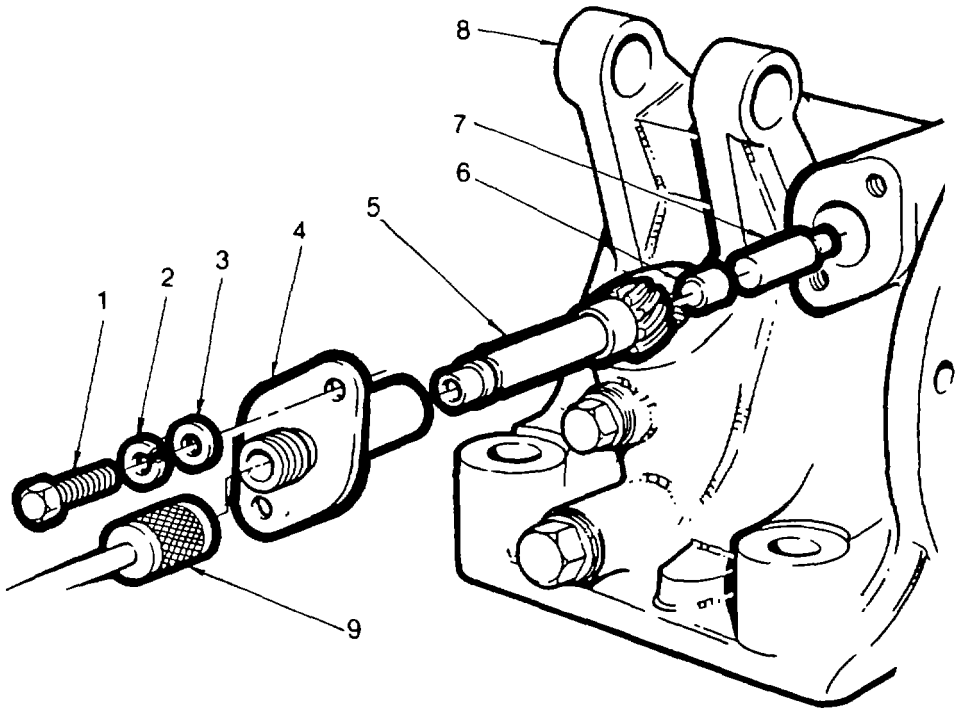
INSPECTION

(1) Inspect revolution counter drive housing for cracks or corrosion that may cause a lubricant leak.
(2) Inspect revolution counter drive pinion for worn or damaged gear, corrosion or wear.
(3) Discard thrust button whenever revolution counter drive pinion Is replaced.

INSTALLATION

(1) Slide revolution counter drive pinion (5) into revolution counter drive housing (4).
(2) Apply grease (item 16, Appendix B) to thrust button (6) and install into recess in revolution counter drive pinion (5). Support pin (7) is pressed into the inner wall of bearing housing (8).
(3) Install revolution counter drive assembly into bearing housing (8). Aline mounting holes and secure revolution counter drive housing (4) to bearing housing using flatwashers (3), lockwashers (2) and capscrews (1).
(4) Tighten capscrews to 24 ft lb (33 Nm).
(5) Attach cable end (9) to revolution counter drive housing (4).

12-13. FIRE PUMP - Continued



2-13. FIRE PUMP - Continued

2-13.13 Bearing Housing Repair.

This task covers

a. Disassembly
b. Inspection
c. Assembly

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
1, Appendix D Extractor Tool Assembly
2, Appendix D Bearing Removal Tool
3, Appendix D Pump Shaft Support Fixture
4, Appendix D Thread Protector Tool
5, Appendix D Bearing Installation Tool
8, Appendix D Bearing Installing Tool

EQUIPMENT CONDITION
Fire Pump Removed from Truck (see TM 5-4210-220-12)
Water Ring Primer Removed (see para. 2-13.7)
Volute Body Removed (see para. 2-13.3)
Impeller Removed (see para. 2-13.4)
Pump Head Removed (see para. 2-13.6)
Revolution Counter Removed (see para. 2-13.12)

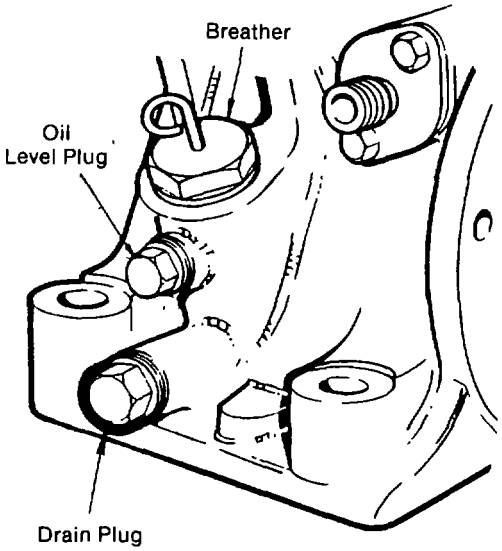
MATERIAL/PARTS
10, Appendix B Dry Cleaning Solvent
13, Appendix B Emery Cloth
15, Appendix B Gear Oil
16, Appendix B Grease
29, Appendix B Threadlock Liquid
MS178/69 Cotter Pin
UMP 9392 Gasket
UMP 9700 O-ring
UFP 2609 Tab Washer
UMP 9392 Gasket
UMP 9392 Gasket
UMP 9404 Seal
UMP 9395 Seal

DISASSEMBLY

CAUTION

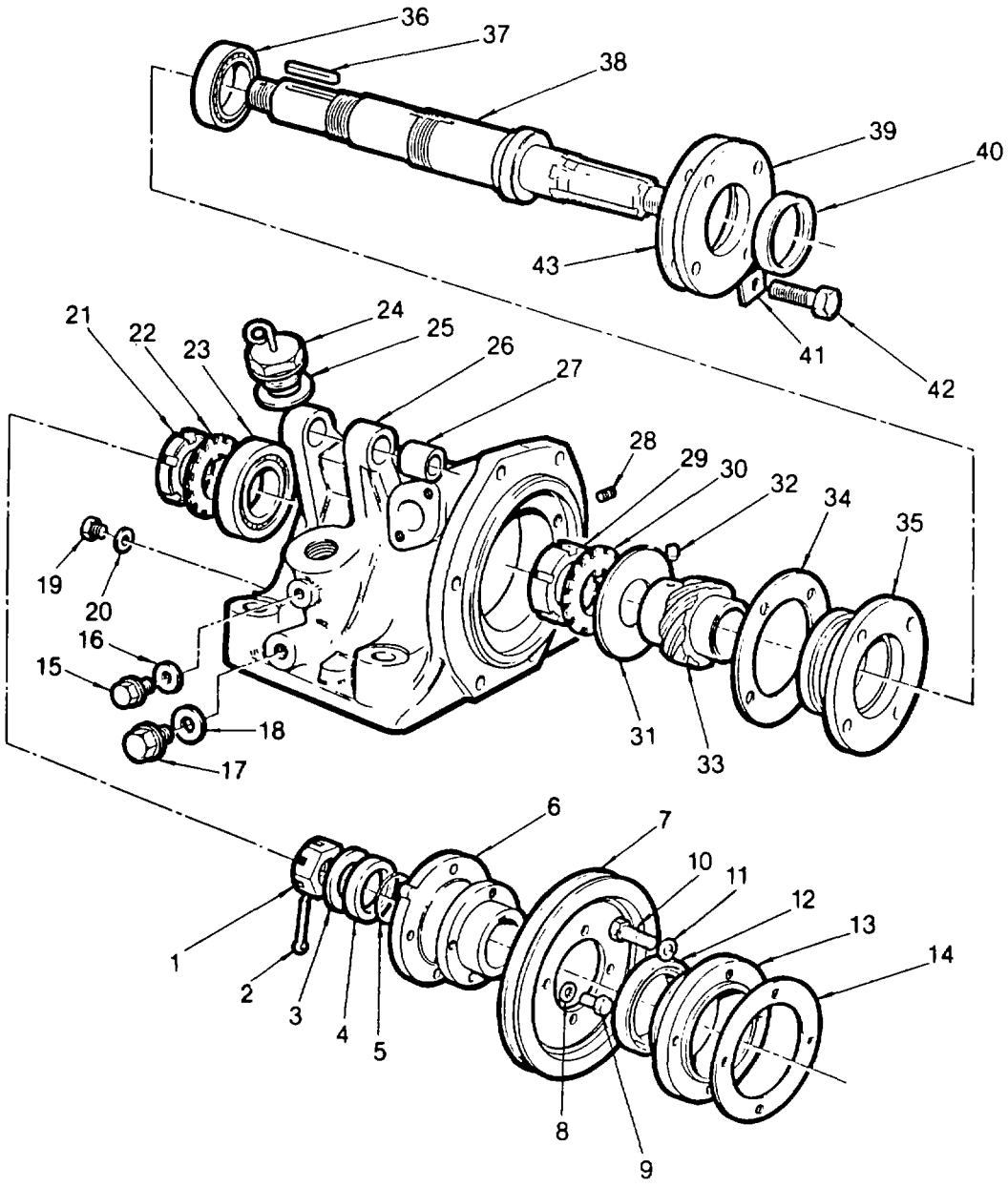
Damage to shaft sealing surfaces will warrant replacement of pump shaft. Do not scratch or mark sealing surfaces.

(1) Remove bearing housing drain plug from bearing housing and drain oil.
(2) Remove the cotter pin (2) securing the slotted nut (1) on the drive flange end of the pump shaft (38).
(3) Place pump shaft support fixture (3, Appendix D) over the impeller shaft splines. While holding pump shaft support fixture, remove nut (1) and washer (3).



(4) Remove the pulley and flange assembly from pump shaft (38). Separate pulley (7) from drive flange (6) by removing capscrews (9) and lockwashers (8). Remove O-ring (5) from seal mounting (4).
(5) Remove key (37) from pump shaft (38).

2-13. FIRE PUMP - Continued



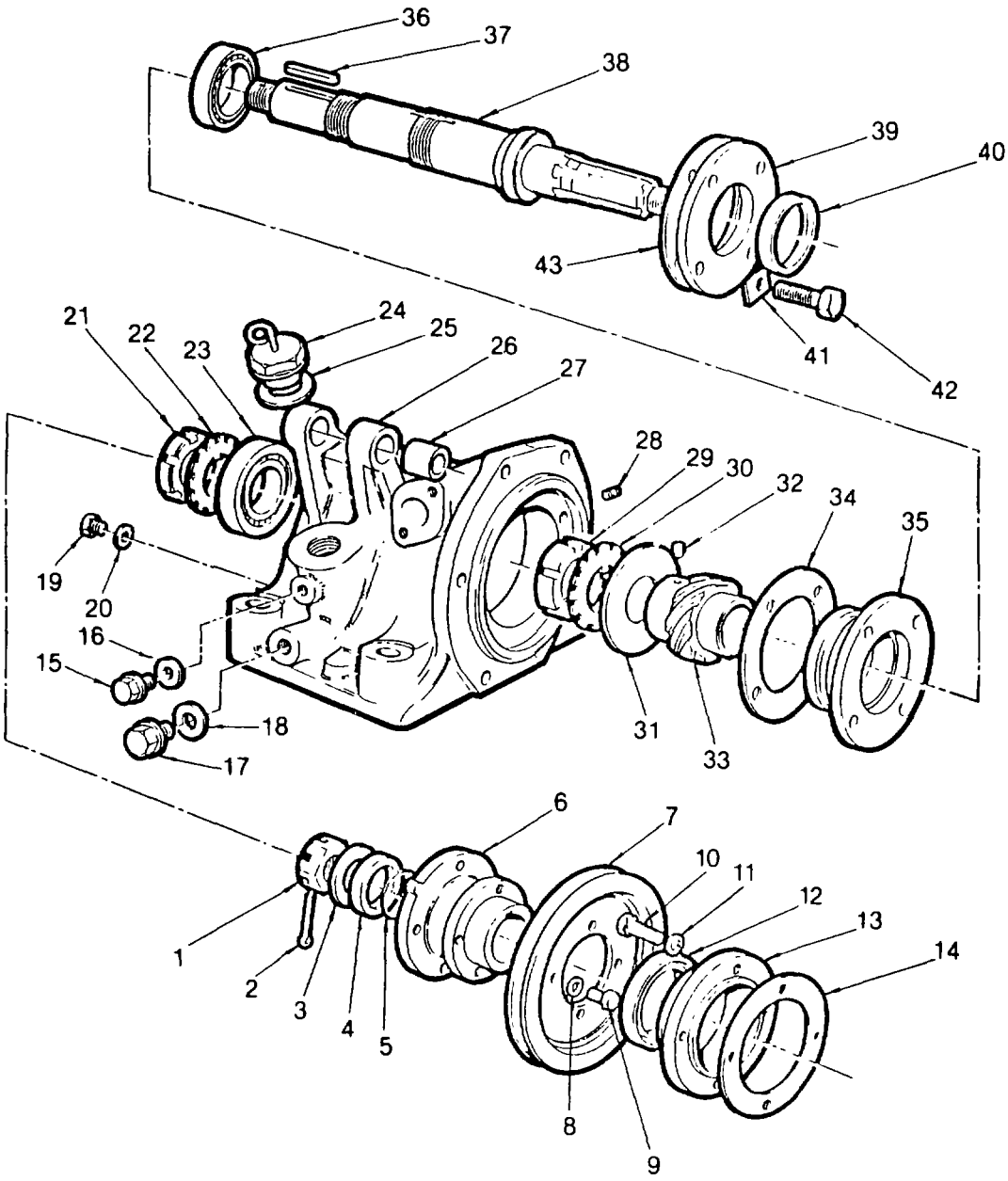
(6) Remove the four capscrews (10) and lockwashers (11) that retain the seal housing (13) to the bearing housing (26). Using two of the capscrews removed, insert them into threaded extractor holes. Tighten evenly until the seal housing is removed. Remove gasket (14) and discard.

(7) Straighten tab washers (41). Remove seal housing (43) by removing capscrews (42). Remove seal (40) from seal housing if seal shows signs of damage or leakage.

(8) Straighten the lock tab on the tab washer (22). Place pump shaft support fixture (3, Appendix D) over the impeller shaft splines. While holding pump shaft support fixture, remove locknut (21). Slide locknut and tab washer from pump shaft (38).

2-13. FIRE PUMP - Continued

2-13.13 Bearing Housing Repair - Continued



(9) Place thread protector tool (4, Appendix D) over the threaded section at the drive flange end of the pump shaft (38).

(10) Position the extractor tool assembly (1, Appendix D) over the drive flange end of pump shaft (38). Secure extractor tool assembly to bearing housing (26) using four capscrews (10) and tighten firmly.

(11) Tighten pressure screw of extractor tool assembly (1, Appendix D) until the pump shaft (38) moves clear of bearing (23) in the bearing housing (26).

2-13. FIRE PUMP - Continued

(12) Remove the extractor tool assembly (1, Appendix D) and the thread protector tool (4, Appendix D).

(13) Pull the shaft assembly (38) from the bearing housing (26), and remove tapered roller bearing (23) from the opposite end of bearing housing. Make sure shaft is square to bearing housing during removal. Use care so as not to damage oil finger (30) and revolution counter gear (33) during shaft removal.

(14) Install the pump shaft support fixture (3, Appendix D) horizontally in a vise. Lower the shaft into the pump shaft support fixture engaging the splines on the shaft with the splines in the tool.

(15) Straighten the tab washer (30). Remove locknut (29), tab washer (30) and oil finger (31) from pump shaft (38).

(16) Loosen the setscrew (32) from the revolution counter gear flange, and slide revolution counter gear (33) from shaft (38).

(17) Separate the front seal housing (43) from the front bearing mount (35). Avoid burrs or scratches to either face during separation. Remove burrs or scratches using emery cloth (item 16, Appendix B) prior to reassembly.

(18) Lift the front bearing mount (35) from shaft (38).

(19) Remove pump shaft from pump shaft support fixture (3, Appendix D).

(20) To remove bearing (36), first install thread protector tool (4, Appendix D) on the drive flange end of the pump shaft (38). Position pump shaft vertically allowing thread protector tool to rest on flat bench top.

(21) While supporting pump shaft vertically, position bearing removing tool (2, Appendix D) over the shaft. Make sure bearing removing tool rests on inner race of bearing.

CAUTION

Damage to shaft sealing surfaces will warrant replacement of pump shaft. Do not scratch or mark sealing surfaces.

(22) Carefully but firmly tap the bearing removal tool (2, Appendix D) until the bearing (36) is free of shaft (38).

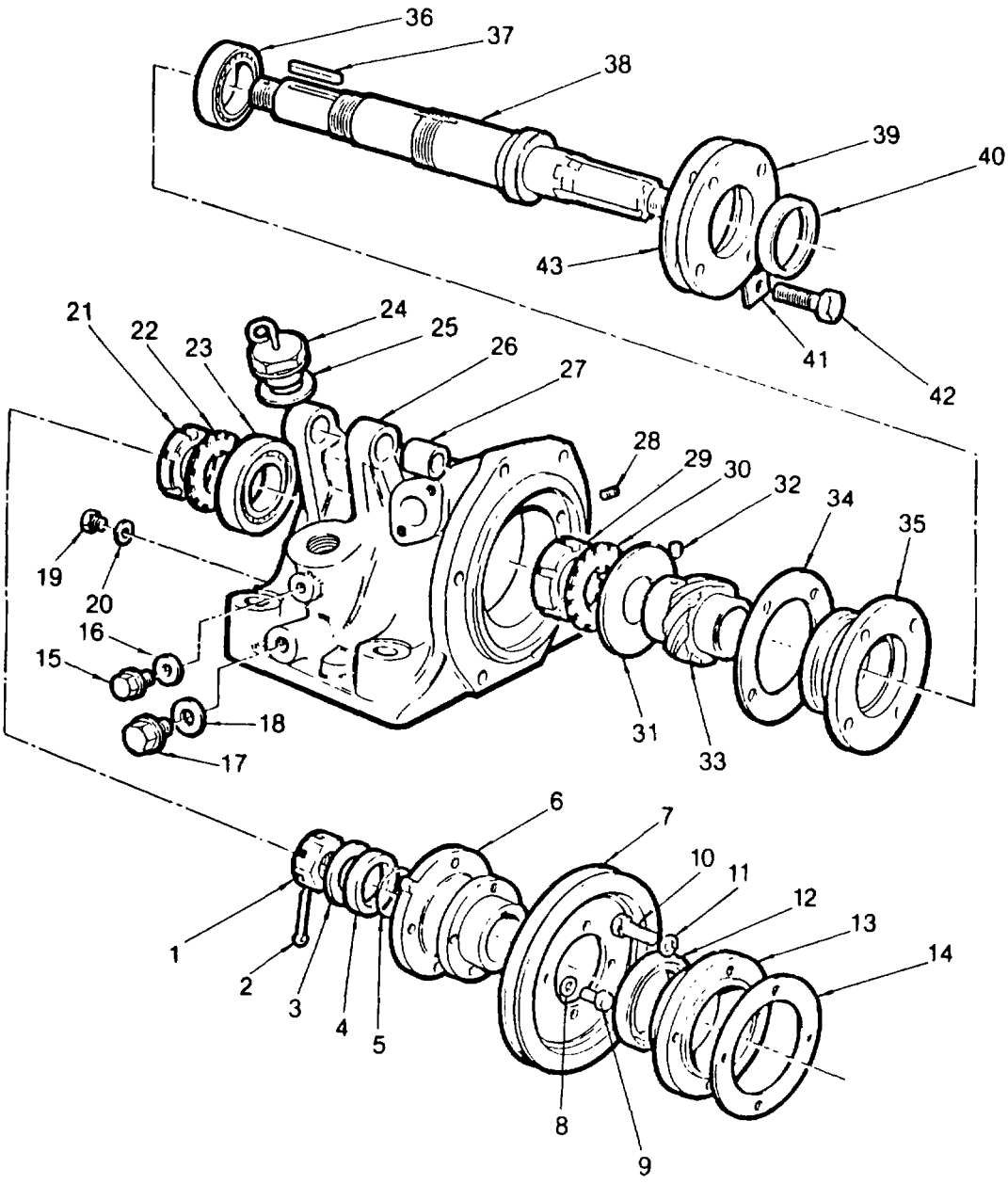
INSPECTION

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

2-13. FIRE PUMP - Continued

2-13.13 Bearing Housing Repair - Continued



(1) Wash all components using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

2-13. FIRE PUMP - Continued

(2) After washing, dry all components using compressed air. Do not allow bearings to spin while drying with compressed air.

(3) Inspect bearing housing for cracks, stripped threads, or warped mating surfaces.

(4) Inspect bearings as detailed in para. 2-7. If tapered bearing is damaged, replace the bearing and outer race as a pair.

(5) Examine pump shaft for nicks, scratches, damaged splines, damaged threads or corrosion.

(6) Examine bearing mount and seal housings for cracks, corrosion or warped mating surfaces.

(7) Replace all gaskets and seals.

(8) Inspect locknuts for damaged threads.

(9) Inspect tab washer for missing tabs or wear.

(10) Inspect fulcrum pin bushings and fulcrum pin for wear or corrosion.

(11) Evidence of damage of any kind is cause for rejection. Replace components or assembly as required.

ASSEMBLY

CAUTION

Damage to shaft sealing surfaces will warrant replacement of pump shaft. Do not scratch or mark sealing surfaces.

(1) To install bearing (36) onto shaft (38), position thread protector tool (4, Appendix D) onto impeller end of pump shaft (38).

(2) Hold the pump shaft vertically, splined end downwards, resting on the thread protector tool (4, Appendix D).

(3) Make sure bearing surface is clean, otherwise bearing may not fit squarely on shaft. Apply a light coating of grease (item 16, Appendix B) to the bearing surface.

(4) Slide the bearing (36) down the pump shaft (38) with its narrow face upmost. Using bearing installing tool (8, Appendix D), tap top of tool with hammer until beating is fully seated against pump shaft shoulder. Remove bearing installing tool.

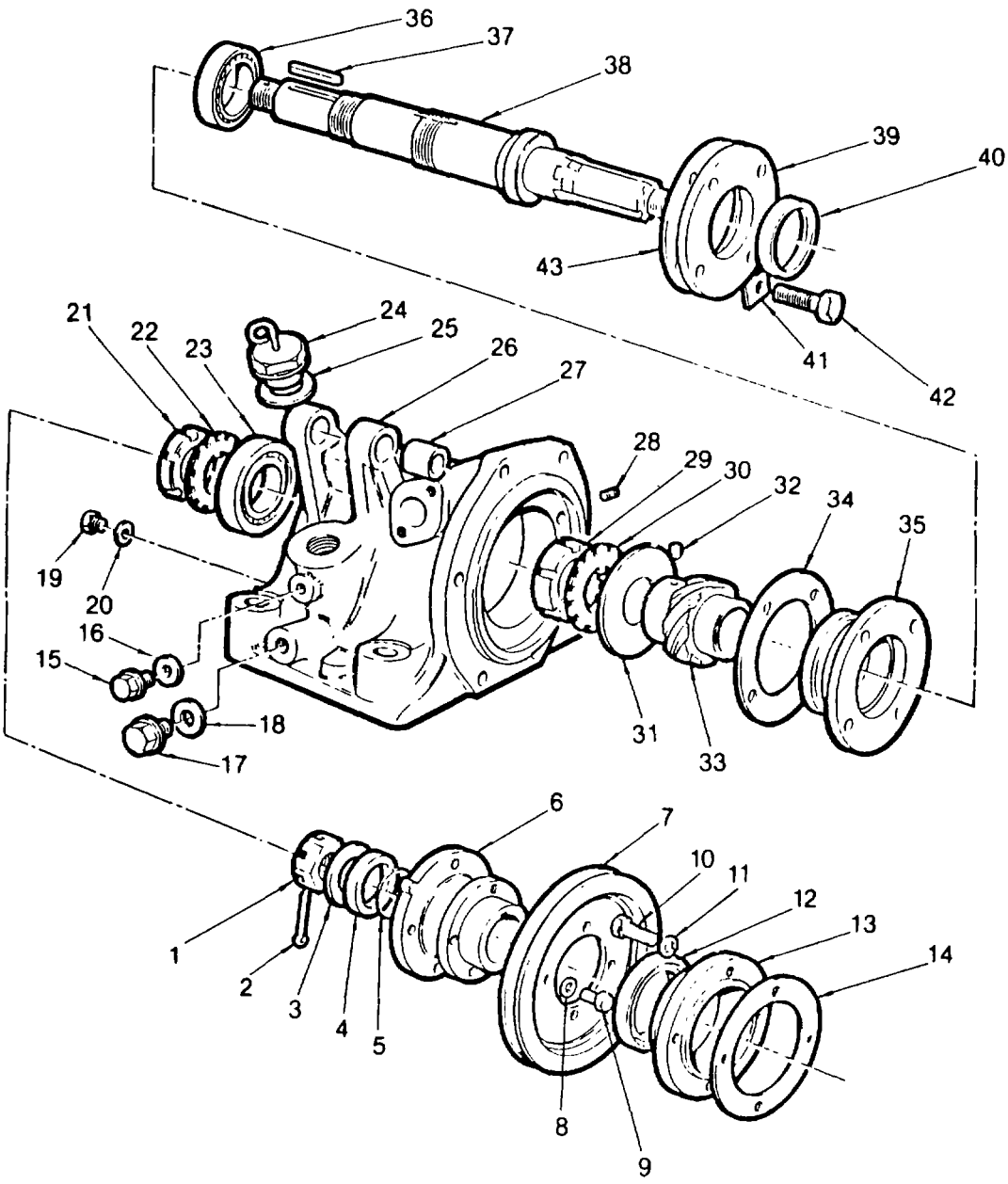
(5) If bearing (36) was replaced, it will be necessary to press outer race from bearing mount (35) and replace outer race.

(6) If bearing (23) requires replacement, remove bearing outer race from bearing housing (26) and replace with new outer race.

(7) Slide bearing mount (35) and new gaskets (34 and 39), one on each side, onto pump shaft (38). Allow bearing mount to rest on bearing (36). Make sure gaskets do not cover the oil drain area on the facing of the bearing mount. If necessary, cut a small section of the gasket away.

2-13. FIRE PUMP - Continued

2-13.13 Bearing Housing Repair - Continued



(8) Slide revolution counter gear (33) onto shaft (38). Make sure the socket screw hole is at the upper end.

(9) Rotate revolution counter gear (33) until the socket screw hole alines with groove in pump shaft (38).

(10) Install socket screw (32) into revolution counter gear flange. Do not fully tighten.

(11) Slide oil finger (31) onto pump shaft (38) up to the revolution counter gear flange.

2-13. FIRE PUMP - Continued

(12) Slide tab waster (30) onto pump shaft (38) with the curve of the base facing upwards. Make sure the single center tab on tab washer is fully engaged with pump shaft groove.

(13) Slide locknut (29) down pump shaft (38). Make sure chamfered side of locknut faces tab washer (30). Thread locknut onto pump shaft threads, handtight.

(14) Position pump shaft support fixture (3, Appendix D) horizontally in a vise. Lower pump shaft into the pump shaft support fixture, engaging the impeller splines with the splines in the tool.

(15) Using a spanner wrench tighten locknut (29) firmly. Tap one lock tab on the tab washer (30) into groove on locknut.

(16) Remove socket screw (32) from revolution counter gear (33). Apply threadlock liquid (item 29, Appendix B) to socket screw. Install into revolution counter gear and tighten firmly. Make sure socket screw enters the pump shaft groove.

(17) Remove gaskets (34 and 39) from pump shaft. Apply gasket eliminator to both sides of each gasket.

(18) Slide gaskets (34 and 39) into position on bearing mount (35). Make sure gaskets do not cover the oil drain area on the facing of the bearing mount.

(19) Carefully slide pump shaft assembly into bearing housing (26) from the impeller end. Make sure the oil drain cut away on the bearing mount (35) is alined with three oil drain holes located in the bottom of the bearing housing.

(20) Apply a thin coating of gear oil (item 15, Appendix B) to the oil seal face of the pump shaft (38).

(21) Install new seal (40) into seal housing (43). Make sure the seal lip faces inwards towards the spigot in the bearing housing (26).

(22) Slide seal housing (43) over pump shaft (38) and up to bearing mount. Make sure mounting holes are alined with gasket (39) and bearing mount (35).

(23) Secure the seal housing (43) to the bearing housing (26) using four capscrews (42) and new tab washers (41). Tighten four capscrews to 24 ft lb (33 Nm). Make sure tab washer contacts the outer rim of the seal housing and a flat on the capscrew heads.

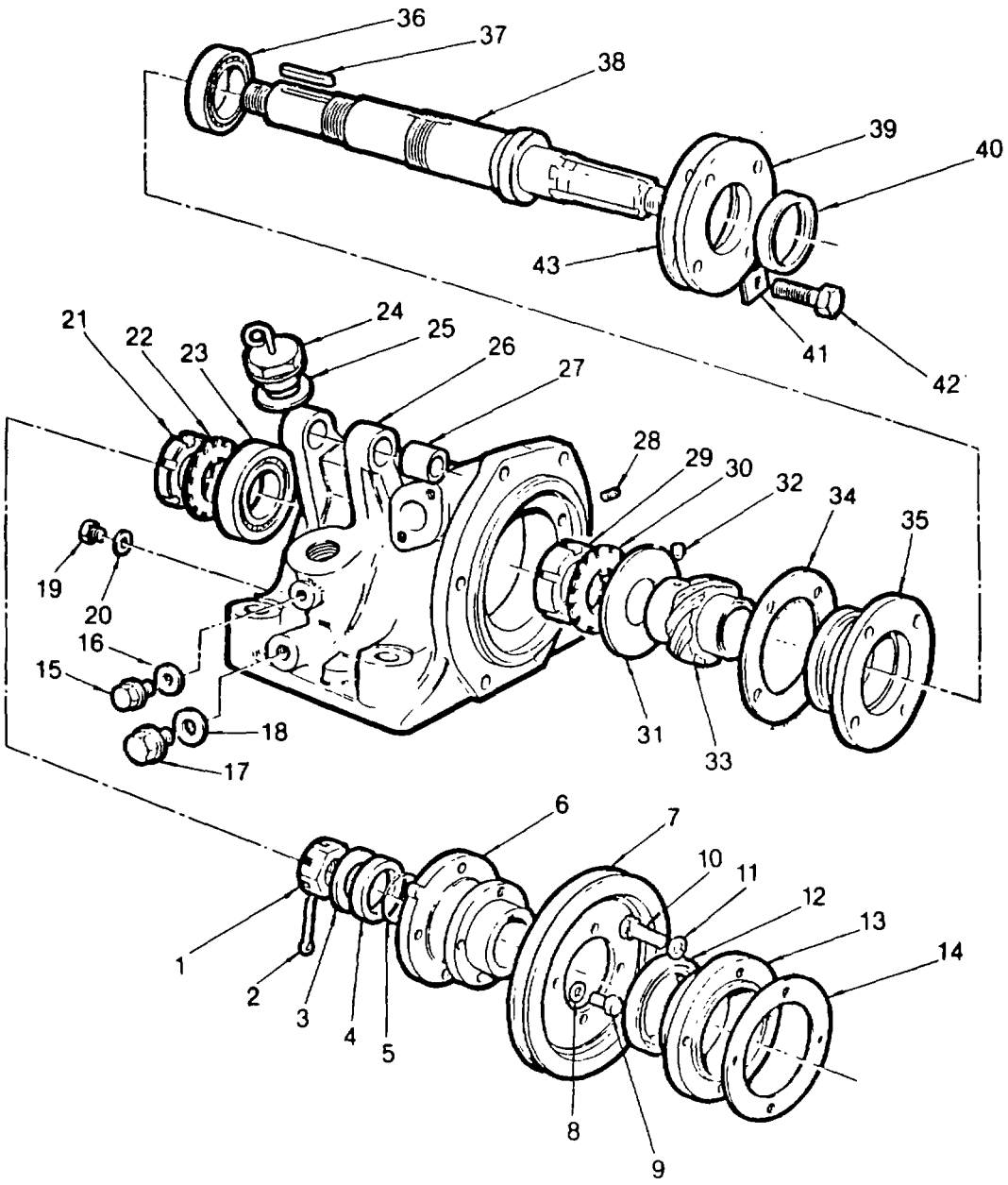
(24) Apply grease (item 16, Appendix B) to pump shaft bearing seat and to the inner diameter of the bearing (23).

(25) Fit bearing (23) onto bearing installing tool (5, Appendix D), and slide onto pump shaft (38). Make sure narrow face of bearing is installed first.

(26) Next install tab washer (22) and locknut (21) and tighten using a spanner wrench. It will be necessary to attach pump shaft support fixture (3, Appendix D) to pump shaft impeller end to prevent shaft rotation while tightening locknut (21). Remove locknut, washer, and bearing installing tool (5, Appendix D) from pump shaft once bearing (23) is installed.

2-13. FIRE PUMP - Continued

2-13.13 Bearing Housing Repair - Continued



(27) To adjust bearing axial clearance, mount bearing housing (26) in a large vise so pump shaft is in a vertical position.

(28) Install tab washer (22) and locknut (21) onto pump shaft (38).

(29) Attach a dial indicator to the upper end of the pump shaft and using a piece of wood, lever the lower end of the pump shaft up and down.

2-13. FIRE PUMP - Continued

(30) Adjust bearing clearance to 0.002 in. (0.05 mm) by turning locknut (21). Once bearing clearance is adjusted, bend lock tab into one of the lock ring slots. Remove dial indicator.

(31) Install new seal (12) into seal housing (13) Make sure lip of seal faces inwards.

(32) Apply gasket eliminator (item 14, Appendix B) to both sides of gasket (14). Aline gasket with seal housing (13).

(33) Attach seal housing (13) to bearing housing (26) using capscrews (10) and lockwashers (11). Torque capscrews to 24 ft lb (33 Nm).

(34) Install key (37) into pump shaft keyway.

(35) Assemble pulley and flange assembly. Install O-ring (5) into seal mounting (4). Attach pulley (7) to drive flange (6) using capscrew (9) and lockwashers (8). Torque capscrews to 24 ft lb (33 Nm).

(36) Apply gear oil (item 15, Appendix B) to sealing surface of drive flange (6) and pump shaft end. Slide pulley and flange assembly onto shaft (38).

(37) Install washer (3) and slotted nut (1) and tighten firmly. It will be necessary to hold shaft while tightening slotted nut, using pump shaft support fixture (3, Appendix D).

(38) Install new cotter pin (2) through slotted nut (1). Bend cotter pin legs; one over nut, one over shaft. Cut cotter pin legs as necessary.

(39) Install revolution counter pinion as detailed in para. 2-13.12.

(40) Install pump head as detailed in para. 2-13.6.

(41) Install impeller as detailed in para. 2-13.4.

(42) Install volute body as detailed in para. 2-13.3.

(43) Install water ring primer as detailed in para. 2-13.7.

(44) Fill bearing housing with lubricant as detailed in Lube Order LO 5-4210-220-12.

(45) Test fire pump as detailed in para. 2-13.14.

2-13. FIRE PUMP - Continued

2-13.14 Fire Pump Tests.

This task covers: Test

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
6, Appendix D Discharge Blanking Plate
7, Appendix D Suction Blanking Tool

MATERIALS/PARTS
14, Appendix B Gasket Eliminator

EQUIPMENT CONDITION
Suction Tee Removed (see TM 5-4210-220-12)
Discharge Elbow Removed (see TM 5-4210-220-12)
Fire Pump Mounted in Truck
Primer Hoses Attached
Priming Reservoir Full

NOTE

If fire pump is not removed from truck, disregard equipment condition 1 (Suction Tee Removed) and 2 (Discharge Elbow Removed). Reattach fire pump as detailed in TM 5-4210-220-12 and test fire pump as detailed in a. following.

The following repair sections will require testing as detailed in procedure a. following.

2-13.1 Primer Suction Pipe
2-13.2 Wearing Ring
2-13.8 Fiber Driving Wheel
2-13.9 Non-return Valve
2-13.10 Priming Valve Repair
2-13.11 Disengaging Unit
2-13.12 Revolution Counter

The following repair section will require testing as detailed in procedure b. following.

2-13.3 Volute Body
2-13.4 Impeller
2-13.5 Carbon Seal and Seating Ring
2-13.6 Pump Head
2-13.7 Water Ring Primer
2-13.13 Bearing Housing

TEST

a. Draft Test

NOTE

This test will require a drafting water source. A pond or reservoir will provide a sufficient water supply providing it is about four feet deep.

(1) Make sure tank valve is closed.

2-13. FIRE PUMP - Continued

(2) Attach six in suction hoses to suction adapter. Make sure suction screen is well below water surface.

(3) Start truck and engage fire pump. Fire pump should be primed within 30 seconds.

(4) If fire pump will not prime, shutdown pump and main engine immediately and refer to test procedures in b. following.

b. Vacuum Test

NOTE

It will be necessary to remove suction tee and discharge elbow (see TM 5-4210-220-12) from truck if b. Vacuum Testing is required

(1) Apply gasket eliminator (item 14, Appendix B) to the suction (wearing ring) and discharge flanges.

(2) Secure the discharge blanking plate (6, Appendix D) to the discharge flange and secure the suction blanking tool (7, Appendix D) to the (wearing ring) using the pump fasteners.

(3) Attach priming suction pipe to suction blanking tool (7, Appendix D) and priming valve

(4) Attach vacuum gage to suction blanking tool (7, Appendix D).

(5) Start truck and engage PTO. Run engine at approximately 1200 rpm while watching vacuum gage.

(6) Stop the pump once 24 in. Hg is obtained. The fire pump should maintain this vacuum for at least 15 seconds. If the fire pump will not hold this vacuum, the fire pump has a leak Pressure test should be carried out as detailed in c. following. If pump maintains 24 in. Hg for 15 seconds proceed to step 9.

(7) If the pump does not reach a vacuum of 24 in. Hg, but will hold lower vacuum, the priming system is at fault. Check the following: Make sure fiber driving wheel is engaged with pump pulley and spins without slipping. Make sure primer reservoir is filled with antifreeze (item 2, Appendix B). Examine the primer seal drain hole for evidence of leakage. If leakage is found, replace seal as detailed in (para. 2-13.7).

(8) If the pump does not reach a vacuum of 24 in. Hg, and will not maintain what vacuum it does create, there is a leak and possibly a fault in the priming system. Pressure test fire pump as detailed in c. following.

(9) Once fire pump tests have been completed and are within specifications, remove discharge blanking plate (6, Appendix D) and suction blanking tool (7, Appendix D).

(10) Reinstall discharge elbow and suction tee (see TM 5-4210-220-12).

2-13. FIRE PUMP - Continued

2-13.14 Fire Pump Tests - Continued

c. Pressure Test

NOTE

This test should only be carried out if the pump will not hold vacuum with blanking tools (6, 7 Appendix D) in place. Perform following test to trace possible leaks that are responsible for the vacuum leaks

(1) Apply 50 to 100 psi water pressure to the volute body through suction blanking tool (7, Appendix D).

(2) Check for water leaks around fire pump. Refer to appropriate repair section to rectify water leak.

(3) If no leaks are found, the vacuum leak must be in line from the water ring primer to the priming valve. Check for the following: Priming valve sealing washer damaged; see para. 2-13.10. Water ring primer non-return valve damaged; see para. 2-13.9. Rubber hose between priming valve and non return valve. Replace hose as required.

2-14 FOAM TANK

2-14. FOAM TANK.

This task covers: a. Replacement
b. Repair

TOOLS
Shop Equipment, Automotive Maintenance And Repair, NSN 4910-00-754-0705
Hose Body Removed (see para. 2-11.1 Hose

EQUIPMENT CONDITION
Foam and Water Tanks Drained
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Pump Body and Hose Body Heat Shields Removed (see TM 5-4210-220-12)

Wheels Blocked
All Air Tanks Drained
Pump Body Removed (see para. 2-10.1 Pump Body)

Body)

MATERIALS/PARTS
22, Appendix B Pipe Sealant
310697 Foam Tank
310591 Locknut

PERSONNEL REQUIRED - 2

REPLACEMENT

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

NOTE

To remove and install foam tank, overhead lifting equipment is required. Equipment used for removal of hose and pump bodies is suitable. See para. 2-10.1.

(1) Crimp winterization heater hoses (1) to avoid loss of engine coolant and remove hoses from foam tank.

(2) Remove vent hose (2).

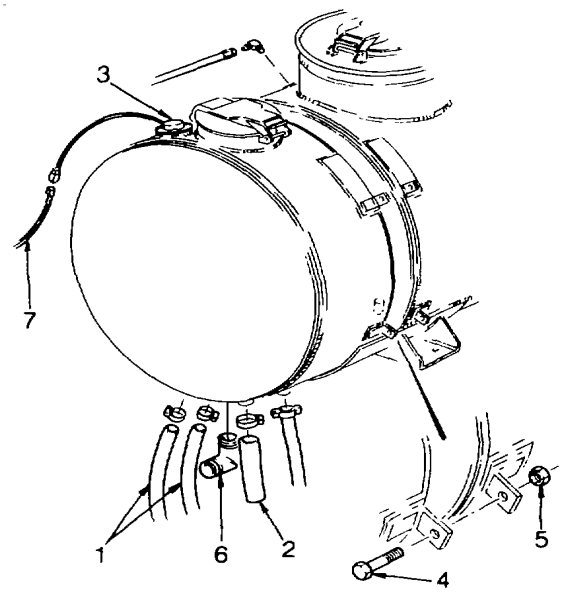
(3) Remove level sensor (3) and extension cable (7).

(4) Remove foam tank outlet elbow (6).

(5) Position lifting equipment over foam tank and rig up a lifting sling to tank and' hoist.

(6) Remove capscrews and nuts (4) and (5) attaching foam tank to water tank.

(7) Lift foam tank off the truck, and place and support it on the floor. Remove lifting gear.



2-14. FOAM TANK - Continued

(8) Inspect new tank for shipping damage. Remove any loose debris or foreign material from inside the tank.

(9) Rig up lifting sling to tank and overhead lifting equipment.

(10) Lift foam tank and aline it with water tank on truck.

(11) Assemble foam and water tanks using capscrews and nuts (4) and (5). Tighten nuts to 150 ft lb (205 Nm).

(12) Apply pipe sealant (Item 22, Appendix B) to elbow (6) and install it in the tank.

(13) Install level sensor (3) and extension cable (7).

(14) Install winterization hoses (1) and vent hose (2). Remove crimps from winterization hoses.

REPAIR

a. Foam Tank Repair

NOTE

Unless repair site is accessible from underneath the truck (heat shield removed (see TM 5-4210-220-12)), the foam tank must be removed as detailed in REPLACEMENT procedure.

(1) Foam tank leaks may be repaired by welding, see TM 9-237, after tank insulation is removed from the area to be repaired.

(2) To replace foam tank outlet elbow (1), disconnect foam piping at elbow, see TM 5-4210-220-12, and unscrew elbow from tank.

(3) Apply pipe sealant (item 22, Appendix B) to new elbow and install In foam tank.

2-15 WATER TANK ASSEMBLY

2-15. WATER TANK ASSEMBLY.

2-15.1 Water Tank.

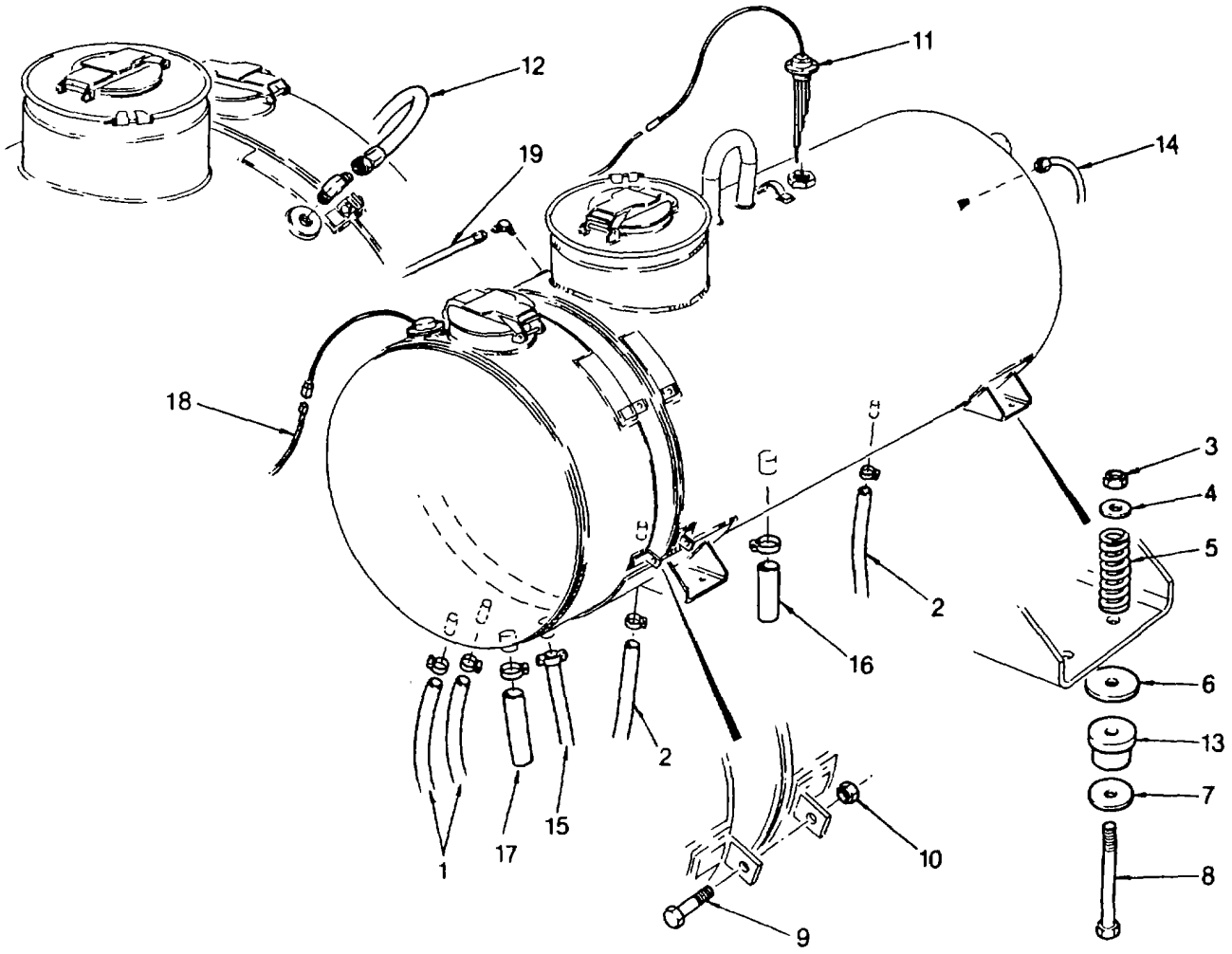
This task covers: a. Replacement
b. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Foam And Water Tanks Drained
Main Engine Shutdown (see TM 5-410-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Wheels Blocked
All Air Tanks Drained
Hose Body And Pump Body Heat Shields Removed (see TM 5-4210-220-12)
Pump Body Removed (see para. 2-10 Pump Body)
Hose Body Removed (see para. 2-11 Hose Body)

MATERIALS/PARTS
101985 Water Tank
310591 Locknut 5/8-11

PERSONNEL REQUIRED - 2



2-15. WATER TANK ASSEMBLY - Continued

REPLACEMENT

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves, and other suitable protective clothing.

NOTE

To remove and install the water tank, overhead lifting equipment is required. Equipment used for removal of hose and pump bodies is suitable, see para. 2-10.1. Remove water and foam tanks as a single unit.

(1) Crimp winterization hoses (1 and 2) to avoid loss of engine coolant and remove the hoses from foam and water tanks.

(2) Remove water tank fill hose (12).

(3) At the rear of the water tank disconnect tank fill valve control air line (14).

(4) Remove pump suction pipe between tank and tank valve. Refer to TM 5-4210-220-12.

(5) Remove foam tank outlet piping (15).

(6) Position lifting equipment above water tank and attach slings to tank lifting eye and around water tank as necessary.

(7) Remove overflow hose (16) from water tank.

(8) Remove overflow hose (17) from foam tank.

(9) Remove extension cables (18 and 19) from foam and water tank level sensors.

(10) From each of the four tank mounts remove locknuts (3) washers (4), spring (5), snubber washers (7), and capscrews (8).

(11) Lift foam and water tanks off the truck. Place and support them on the floor.

(12) Remove capscrews and locknuts (9 and 10). Remove foam tank from water tank.

(13) Remove water level sensor (11).

(14) Examine new water tank for shipping damage. Remove any debris or foreign material from inside the tank.

(15) Line up foam tank and new water tank. Assemble tanks using capscrews (9) and new locknuts (10). Tighten nuts to 150 ft lb (205 Nm)

2-15. WATER TANK ASSEMBLY - Continued

2-15.1 Water Tank - Continued

(16) Install water level sensor (11)

(17) Inspect old vibration isolators (13) and replace if required. Place washers (6) on top of vibration isolators.

(18) Attach lifting equipment to water tank and lift the tanks onto the truck frame.

(19) Aline mounting holes in tank brackets with holes in vibration isolators and washers (6) and install attaching hardware, items (3 thru 5, 7, and 8).

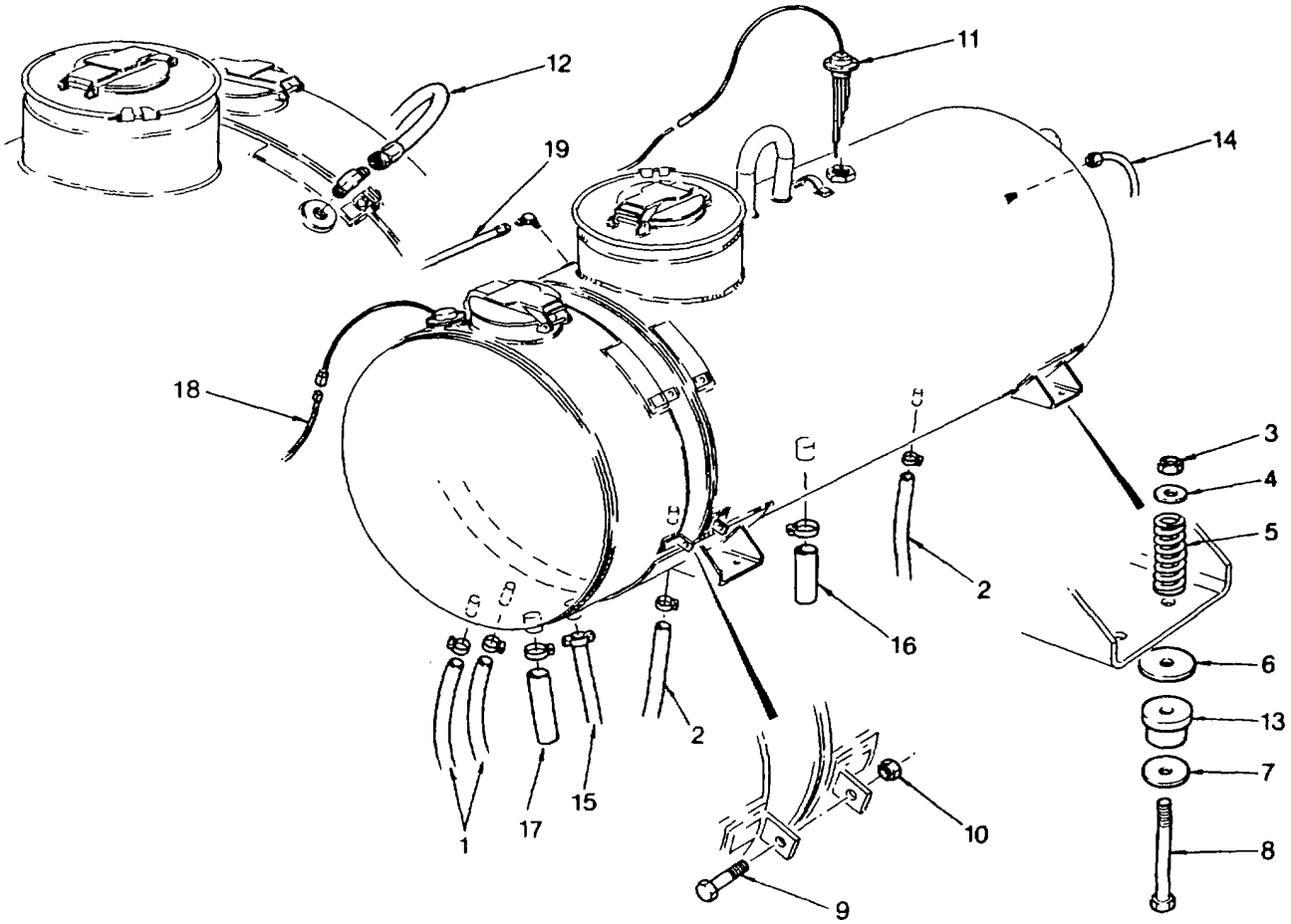
(20) Tighten nuts (3) until springs (5) are compressed to a length of 3.0 In. (76 mm). This will provide a spring pre-load of approximately 370 lbs.

(21) Install winterization hoses (1 and 2) and remove crimps.

(22) Connect tank fill valve control air line (14) to fitting on rear face of water tank.

(23) Install water tank fill hose (12).

(24) Attach outlet piping (15) to foam tank.



2-15. WATER TANK ASSEMBLY - Continued

(25) Attach overflow hoses (16 and 17) to water and foam tanks.

(26) Reconnect pump suction pipe between tank valve and tank. Refer to Water Piping Replacement in TM 5-4210-220-12.

(27) Connect extension cables (18 and 19) to water and foam tank sensor cables.

REPAIR

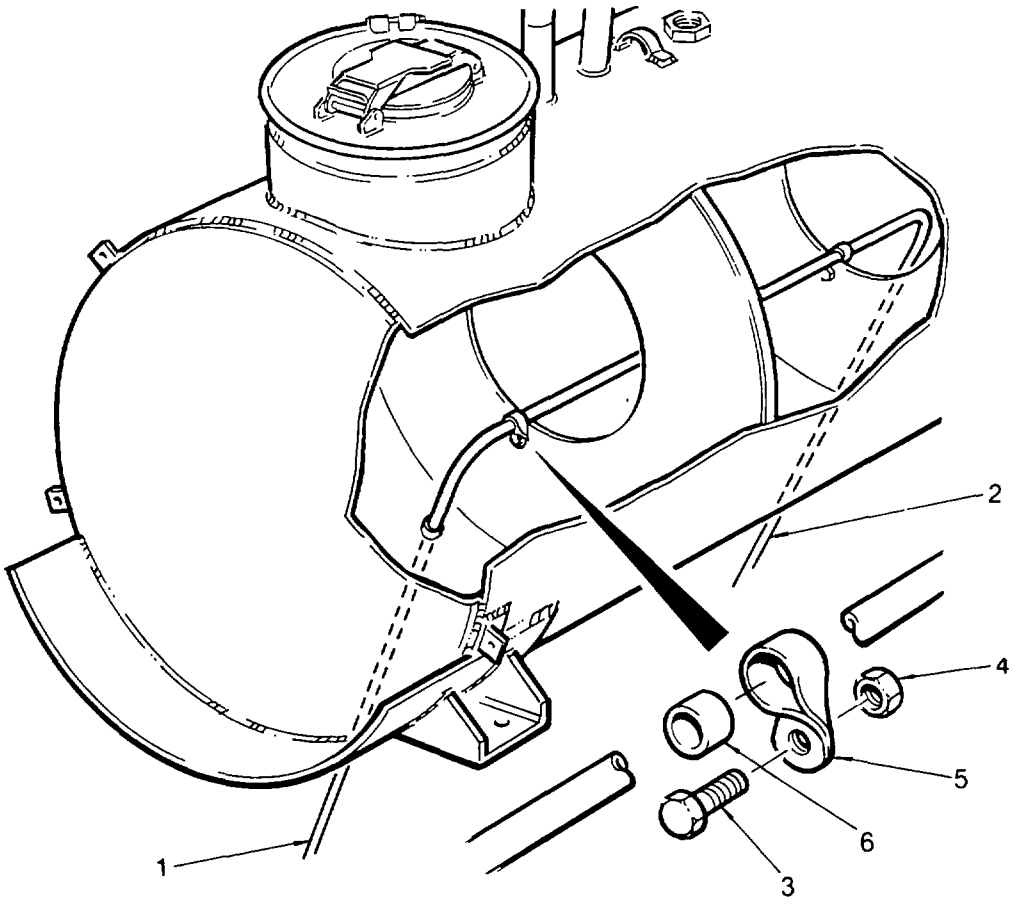
a. Water Tank Repair

NOTE

Water tank, pump body, and hose body remain installed on truck. Water tank empty of water.

Leaks in the water tank due to cracks or minor damage may be repaired by welding (see TM 9-237). Virtually all repairs can be carried out from inside the tank unless the area to be repaired is too large or too difficult to manage. In such cases, remove the tank as detailed under REPLACEMENT and carry out repair from the outside.

b. Winterization Heater Coil Repair



2-15. WATER TANK ASSEMBLY - Continued

2-15.1 Water Tank - Continued

NOTE

Water tank, pump body, and hose body remain installed on truck. Water tank empty of water.

Hose body heat shield removed (see TM 5-4210-220-12).

(1) Crimp winterization hoses to prevent loss of engine coolant.

(2) Inside the tank remove screws (3), nuts (4), clamp (5), and filler (6).

(3) Unscrew heater coil fitting from tank couplings and remove heater coil.

(4) Examine heater coil and determine extent of damage or failure.

(5) Provided the coil material is sound, minor leaks or damage may be repaired by hard soldering pinhole leaks or by cutting the coil on both sides of the failed area. Reconnect the coil pieces using a 3/4 in. i.d. copper coupling, and hard solder (see TM 9-237).

(6) If damage to the coil is extensive the complete coil as well as the coil fittings must be replaced.

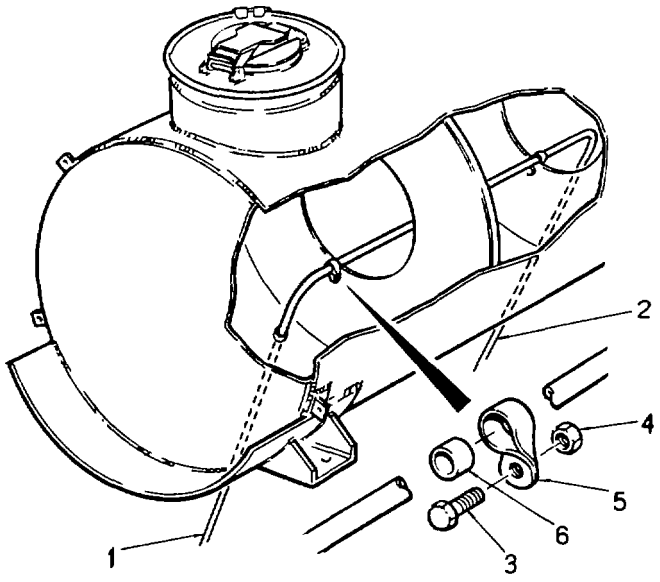
(7) Apply pipe sealant to thread of coil fitting and install coil in tank. Be sure fittings are tightened firmly.

(8) Attach coil to tank baffles using clamp fillers (6), clamps (5), screws (3) and nuts (4). Tighten nut firmly.

(9) Remove crimps from winterization hoses (1 and 2).

(10) Inspect coil and coil connections for leaks by circulating engine coolant (see TM 5-4210-220-12).

(11) Top up engine coolant in radiator as required.



2-15. WATER TANK ASSEMBLY - Continued

2-15.2 Water Tank Piping.

This task covers: Replacement

TOOLS
Tool Kit, General Mechanic, Automotive,
NSN 5180-00-177-7033
Hose Body Removed (see para. 2-11, Hose Body)
Pump Body And Hose Bed
Heat Shields Removed (see TM 5-4210-220-12)
Pump Body Removed (see para. 2-10, Pump Body)

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
All Air Tanks Drained

MATERIALS/PARTS
22, Appendix B Pipe Sealant
FC-300-24 Hose
411-243 Straight Swivel Fitting

REPLACEMENT

NOTE

The supply end of tank fill hose (1) connects to pump discharge manifold (see TM 5-4210-220-12). Hose is disconnected at manifold prior to removal of pump and hose bodies.

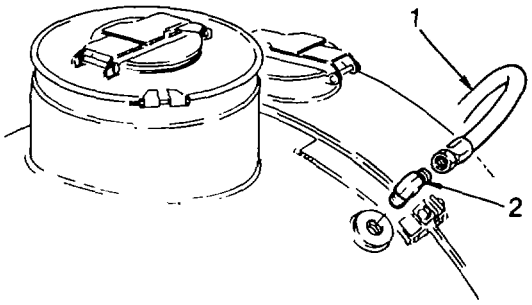
(1) Disconnect tank fill hose (1) from elbow fitting (2).

(2) Replace, complete hose assembly; manufacture new hose as detailed in para. 2-7.

(3) Inspect thread on elbow fitting (2); if damaged, replace fitting.

(4) Apply pipe sealant (item 22, Appendix B) to all pipe threads prior to installation.

(5) Install fill hose (1) to tank fitting (2) and tighten securely.



2-15. WATER TANK ASSEMBLY - Continued

2-15.3 Tank Rear Fill Valve.

This task covers: a. Replacement
b. Repair

TOOLS
Tool Kit, -General Mechanic, Automotive,
NSN 5180-00-177-7033
(see TM 5-4210-220-12)

All Air Tanks Drained
(see TM 5-4210-220-12)
Water Tank Drained

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5-4210-220-12)

MATERIALS/PARTS
14, Appendix B Gasket Eliminator
22, Appendix B Pipe Sealant
FIG 113-2.5 Automatic Tank Fill Valve
310591 Locknut, 5/8-11

PERSONNEL REQUIRED - 2

REPLACEMENT

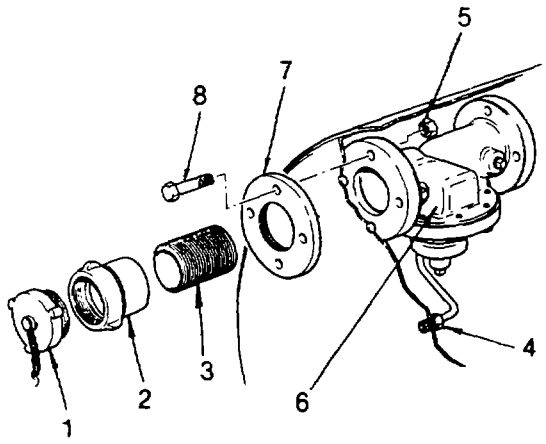
(1) From the rear of the truck remove cap (1), swivel adaptor (2), and nipple (3).

(2) From inside the tank, disconnect air line fitting (4).

(3) While supporting valve (6) from the inside and the flange (7) and capscrews (8) from the outside, remove nuts (5).

NOTE

Flange (7) cannot be removed from the space between hose body and tank without removing the hose body. Therefore, when the valve is removed, the flange, attached to tank with gasket eliminator,



together with capscrews (8) should be left in place and supported until new valve is installed.

(4) Remove valve from tank and support flange (7) to keep it in place and sealed to tank wall.

(5) If seal between tank and flange (7) is broken, clean flange and tank surface. When ready to install new valve (6) apply gasket eliminator (item 14, Appendix B) to mating surface of flange (7) and reinstall it together with capscrews (8).

(6) Inspect new valve for shipping damage and apply gasket eliminator (item 14, Appendix B) on flange to mate with tank. The directional flow arrow on valve body should point toward tank cavity.

(7) Apply gasket eliminator (item 14, Appendix B) to capscrews (8) where these protrude tank wall. Install valve (6) on capscrews. Install and tighten nuts (5) to 135 ft lb (180 Nm).

12-15. WATER TANK ASSEMBLY - Continued

(8) Install air line fitting (4) to tank nipple and tighten firmly.

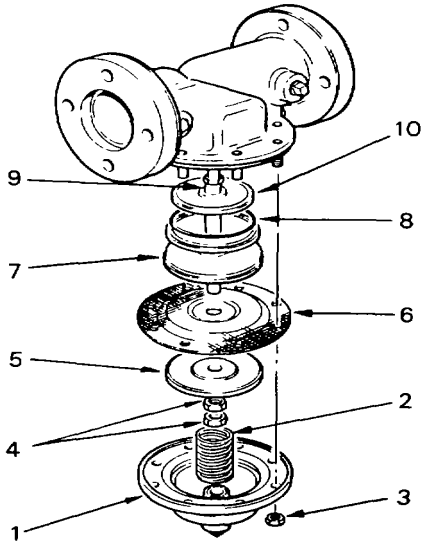
(9) Apply pipe sealant (Item 22, Appendix B) to thread of nipple (3). Install nipple, swivel adaptor (2), and cap (1).

REPAIR

a. Valve Seal and Diaphragm Repair

NOTE

Valve may be repaired while installed in tank.



(1) Remove nuts (3), valve cover (1) and spring (2).

(2) Carefully remove diaphragm and stem assembly.

(3) Hold valve stem (9) and remove nuts (4) attaching diaphragm washer (5), diaphragm (6), O-ring retainer (7), O-ring (8), and O-ring washer (10). Separate all items.

(4) Inspect individual parts; if any components other than O-ring (8) and diaphragm (6) show signs of extensive wear or damage, the complete valve must be replaced, see REPLACEMENT preceding.

(5) Replace items (6 and 8) and assemble valve stem (9), O-ring washer (10), O-ring (8), O-ring retainer (7), diaphragm (6), and diaphragm washer (5) in this order. Install and tighten nuts (4).

(6) Install valve stem and diaphragm assembly to valve body, and install spring (2) and cover (1).

(7) Install nuts (3) and tighten in a diametrical pattern. Be sure nuts are tightened firmly and uniformly.

2-16 RADIATOR CORE

2-16. RADIATOR CORE.

This task covers: a. Removal
b. Installation
c. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Radiator Removed from Truck (see TM 5-4210-220-12)
Shutter Removed from Radiator (see TM 5-4210-220-12)

MATERIALS/PARTS
1100-6317-00 Radiator Core
284-6317-00 Radiator Core Gasket

PERSONNEL REQUIRED - 2

WARNING

Engine coolant can cause severe burns. Allow engine to cool before attempting to maintain the radiator.

REMOVAL

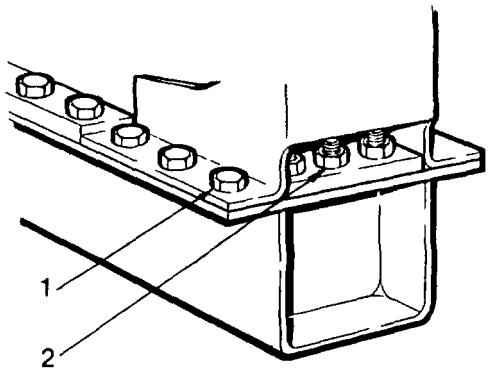
(1) Remove all capscrews (1) and nuts (2) from one reservoir.

(2) Carefully pry strengthening bars off flanges.

(3) Carefully pry reservoir from core.

(4) Remove other reservoir similarly.

(5) Lift sides away from core.



INSTALLATION

(1) Clean old gasket material from flanges of equipment that is to be reused. Use scraper or wire brush to ensure all cork material is removed.

(2) Install gasket on reservoir.

WARNING

Serious injury could occur If heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

2-16. RADIATOR CORE - Continued

(3) Lift core onto reservoir and ensure holes line up. Push four capscrews through holes to ensure alinement.

(4) Lift side member into place and aline with reservoir. Install capscrews and nuts handtight

(5) Lift second side member into place and install its capscrews and nuts handtight.

(6) Install second gasket on top of core and aline second reservoir to gasket and core.

(7) Install all capscrews and nuts handtight. Ensure the strengthening ribs are installed on the core side of the flanges.

(8) Tighten capscrews in sequenced steps around each flange until the gasket thickness reduces from its original 0.090 in. (2.29 mm) to 0.060 in. (1.52 mm). This is equivalent to 1/2 turn of capscrew from handtight.

(9) Pressure test the radiator as detailed in REPAIR following.

REPAIR

(1) Determine location of leak either by inspection or by pressurizing the radiator with air and submersing radiator in water.

(2) A leak in either the bottom or upper reservoirs can be repaired by welding (see TM 9-237).

(3) A leak in the core can be repaired either by plugging a tube or by replacing the core. For core replacement, see REMOVAL and INSTALLATION preceding.

(4) A leak on either core to reservoir flange requires the gasket to be replaced. See REMOVAL and INSTALLATION preceding.

(5) To plug a tube, refer to instructions following.

(6) If the tube is on the outside of the radiator, the tube should be cut out of the radiator, ensuring there is a 1 in. (2.5 cm) stub left. Each stub should be crimped over and hard soldered (see TM 9-237).

(7) If an outside tube is leaking within 1 in. (2.5 cm) of the reservoir, or an inner tube is leaking, that tube should be plugged with suitable pieces of copper hard soldered to each end of the tube. To do this the radiator reservoirs must first be removed. Refer to REMOVAL following.

(8) When the tube is repaired, the radiator must be tested as in step 1 preceding.,

2-17 FUEL TANK

2-153

2-17. FUEL TANK.

This task covers: Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705 (see TM 5-4210-220-12)

EQUIPMENT CONDITION
Fuel Tank Removed From Truck (see TM 5-4210-220-12)
Fuel Priming Pump Removed From Tank

WARNING

Diesel fuel is flammable. Diesel tank must be steamed out before any repair is attempted.

NOTE

Fuel tank is fabricated from 0 188 in. and 0.125 in. 5052 H32 aluminum.

REPAIR

(1) Remove breather from fuel tank. Blank the flange openings with a temporary cap.

(2) Steam fuel tank for at least 8 hours at a pressure of at least 5 psi (35 kPa).

WARNING

Personal injury may be sustained from rupture of the tank if it is over-pressurized. Do not apply more than 12 psi (85 kPa) air pressure when testing.

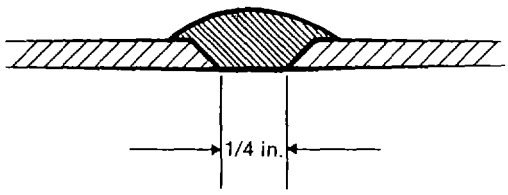
(3) Inspect fuel tank for leaks and determine exact location. If the leak is small, pressurizing the tank with 1 - 2 psi (7 - 14 kPa) air may help to find the leak. Brush a soap solution on outside of tank. Bubbles indicate location of leak.

(4) Only small leaks should be repaired. Any split or puncture creating a hole or crack more than 2 in. (5 cm) long should not be repaired. Replace the tank as detailed in TM 5-4210-220-12.

(5) To weld any holes, see TM 9-237.

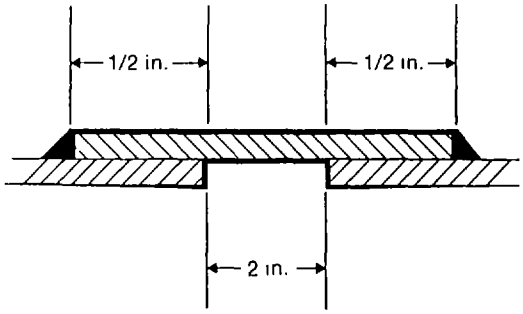
(6) The following types of welds may be attempted.

(a) Small hole leaks (less than 1/4 in. (6 mm)): Clean out hole using file or countersinking bit. Roughen up area around the hole. Fill hole with welding rod and extend weld out at least 1/8 in. (3 mm) to surrounding area. Do not level weld.

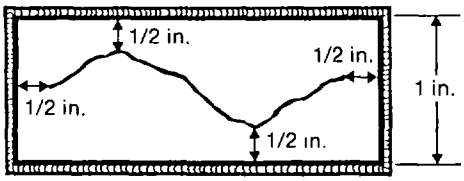


1 2-17. FUEL TANK - Continued

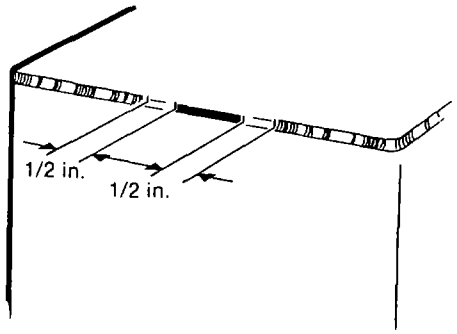
(b) Large hole leaks (1/4 2 in. (6-50 mm). Roughen up area around hole using sandpaper or file. Smooth edges of hole using a round file. Install a patch of aluminum at least 1/2 in (12 mm) bigger than the hole. Lap weld the patch to the outside of the tank.



(c) Cracks in flat area: Roughen up area around crack using sandpaper or file. Install a patch of Aluminum which is at least 1 in. (25 mm) wide and at least 1/2 In. (12 mm) longer than the crack. Butt weld the patch to the outside of the tank.



(d) Cracks in weld: Grind out filler material in the area of the crack. Extend crack at least 1/2 In (12 mm) into adjoining weld. Smooth edges of the weld area with a file and remake the joint.



(7) When the weld is complete seal all openings in the tank.

(8) Connect a regulated air supply with gage to one opening.

2-17. FUEL TANK - Continued

WARNING

Personal injury may be sustained from rupture of the tank if It is over-pressurized. Do not apply more than 12 psi (85 kPa) air pressure when testing.

(9) Pressurize tank to 12 psi (85 kPa) and isolate air supply. Check tank for leaks using soap solution. Maintain tank at 12 psi for at least 1/2 hour to ensure strength of new weld.

(10) Remove air supply and all testing blanks. Replace tank in truck as detailed in TM 5-4210-220-12.

2-18. TRANSMISSION

2-18. TRANSMISSION.

2-18.1 Transmission Output Shaft Seal.

This task covers: Replacement

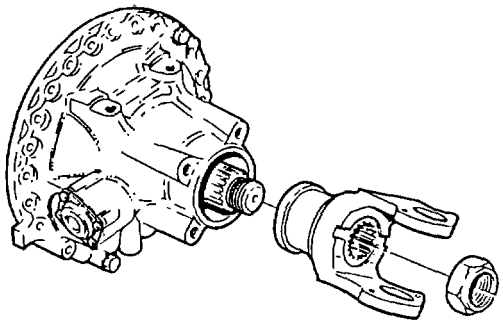
TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705
J24171 Seal Removal Tool
J24202 Seal Installer
J24198 Dust Shield Installer

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5 4210-220-12)
Heat Shields Removed
(see TM 5 4210-220-12)
Driveshaft Removed - Transmission To Rear Axle
(see TM 5 4210-220-12)

MATERIALS/PARTS
9, Appendix B Dexron II
16, Appendix B Grease
26, Appendix B Seal Retainer

PERSONNEL REQUIRED - 1

REPLACEMENT



(1) rain transmission oil into suitable clean containers by removing transmission pan plug.

(2) Check the number of notches that have been cut into the wrenching flats of the yoke retaining nut. If there are five notches, remove the nut and throw it away.

(3) If there are less than five notches, or none at all, remove all dirt and any burrs from the exposed shaft threads. Loosen the nut until there is approximately 1/16 in. (1.6 mm) gap between the nut and flange.

(4) Check the running torque while removing the nut. The nut can be reused only if it meets the following requirements: The first time (no notches) the nut is removed the running torque must be at least 400 in. lb (45 Nm). Each additional time (one to four notches) the nut is removed the running torque must be at least 300 in. lb (34 Nm).

(5) Each time the nut is removed, deeply scribe one of the wrenching flats. This method of marking the nut will indicate how many times the nut has been used.

(6) Remove the output yoke.

2-18. TRANSMISSION - Continued

(7) Using tool J2z4171 remove dust shield and oil seal from rear cover (output end of transmission).

(8) Inspect transmission output shaft bearing in rear cover. If faulty, refer to General Support for complete transmission overhaul.

(9) Install oil seal, spring-loaded lip first, using installer J24202-1A (1) and driver handle J24202-4 (2). Push in until the rear of the seal (3) is 0.60 - 0.70 in. (15 - 18 mm) below the surface of the rear cover.

(10) Coat the outer circumference of the dust shield (5) with seal retainer (item 26, Appendix B). Install the shield, flat side first, into the rear cover using installer J24198 (4). The rear edge of the shield must be flush with the rear surface of the cover.

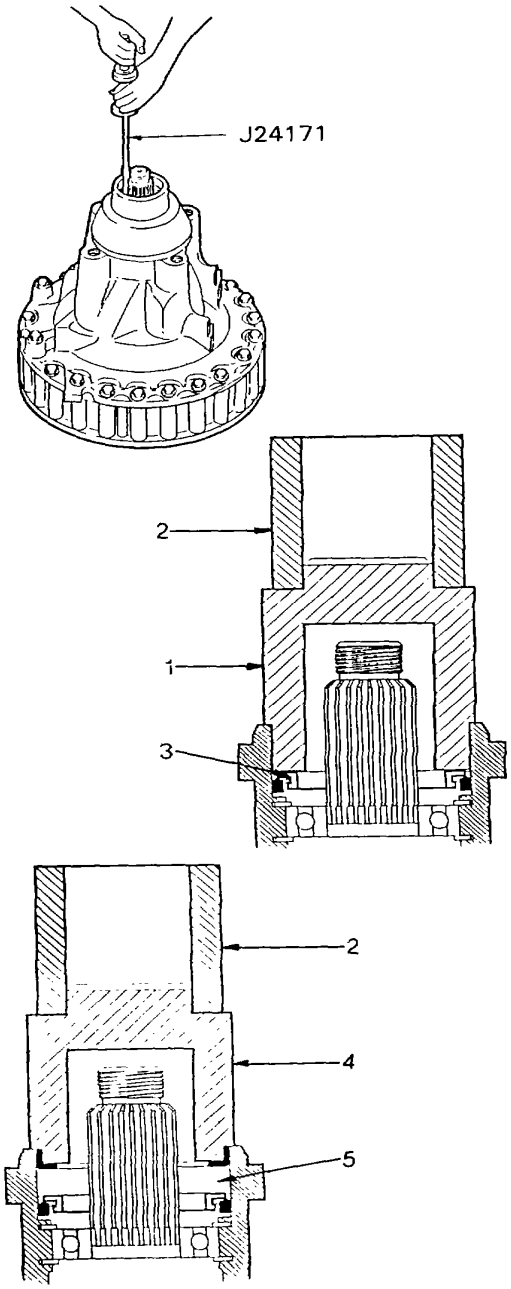
(11) Coat the threads of the retaining nut with grease (item 16, Appendix B). Retain yoke with holder bar and tighten yoke retaining nut to 600 - 800 ft lb (814 - 1085 Nm).

(12) Replace transmission drain plug and refill transmission with Dexron (item 9, Appendix B)

(13) Check transmission oil level while the vehicle is on level ground and the parking brake applied. Fill to the COLD RUN band.

(14) Start engine and shift the transmission through all drive ranges to fill the clutch cavities and oil passages. Shift to neutral.

(15) When transmission reaches working temperature check oil level. Top up until oil is in the HOT RUN band as marked on the dipstick



2-18. TRANSMISSION - Continued

2-18.2 Modulator Valve.

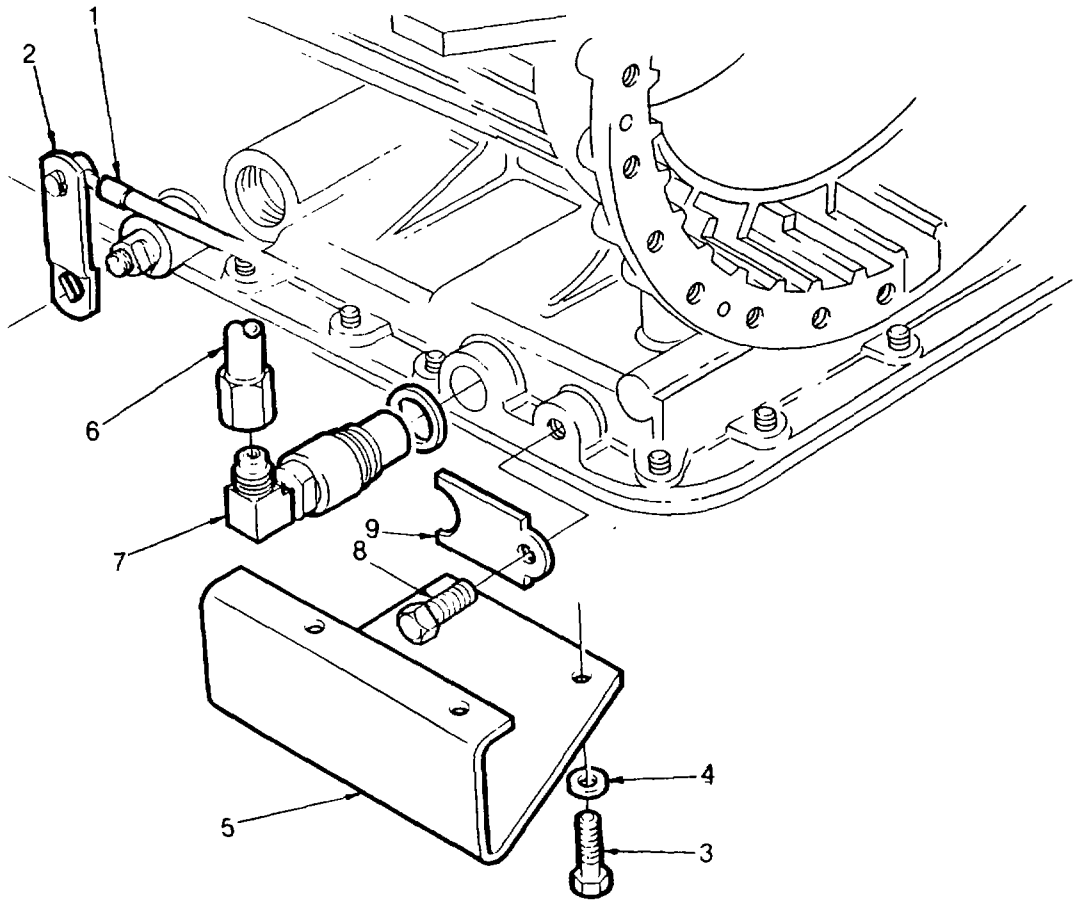
This task covers Replacement

TOOLS
Tool Kit, Master Mechanics,
NSN 5180-00-699-5273
(see TM 5-4210-220-12)

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5 4210-200-12)
APU Shutdown
(see TM 5-4210-220-12)
4-469-F-04X02 Elbow
Batteries Disconnected
(see TM 5-4210-220-12)
Center Heat Shield Removed

MATERIALS/PARTS
9, Appendix B Dexron II
21, Appendix B Petroleum Jelly
117830WM775B Transmission Modulator

PERSONNEL REQUIRED - 1



2-18. TRANSMISSION - Continued

REPLACEMENT

(1) Disconnect transmission shift cable (1) from shift lever (2). Remove two 5/16 bolts (3) and spacers (4) attaching shift cable anchor bracket (5) to transmission. Move bracket and cable out of the way.

(2) Remove air line (6) to modulator valve assembly (7).

(3) Place suitable container under transmission to catch any oil leakage.

(4) Lubricate O-ring on replacement modulator with petroleum jelly (item 21, Appendix B).

(5) Remove 5/16 bolt (8) securing modulator retainer (9). Remove bolt and retainer.

(6) Pry out original modulator and replace with new modulator valve assembly. Secure in position with retainer (9) and bolt (8).

(7) Reconnect air line (6) to modulator.

(8) Replace shift control cable mounting bracket (5) and pivot pin.

(9) Check and add transmission fluid (item 9, Appendix B) as detailed in LO 5-4210-220-12.

2-18. TRANSMISSION - Continued

2-18.3 Governor Assembly.

This task covers Replacement

TOOLS
Tool Kit, Master Mechanic,
NSN 5190-00-699-5273

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Pump Body Heat Shield Removed
(see TM 5-4210-220-12)

MATERIALS/PARTS
688 5571 Governor Assembly
23018625 Gasket

PERSONNEL REQUIRED - 1

REPLACEMENT

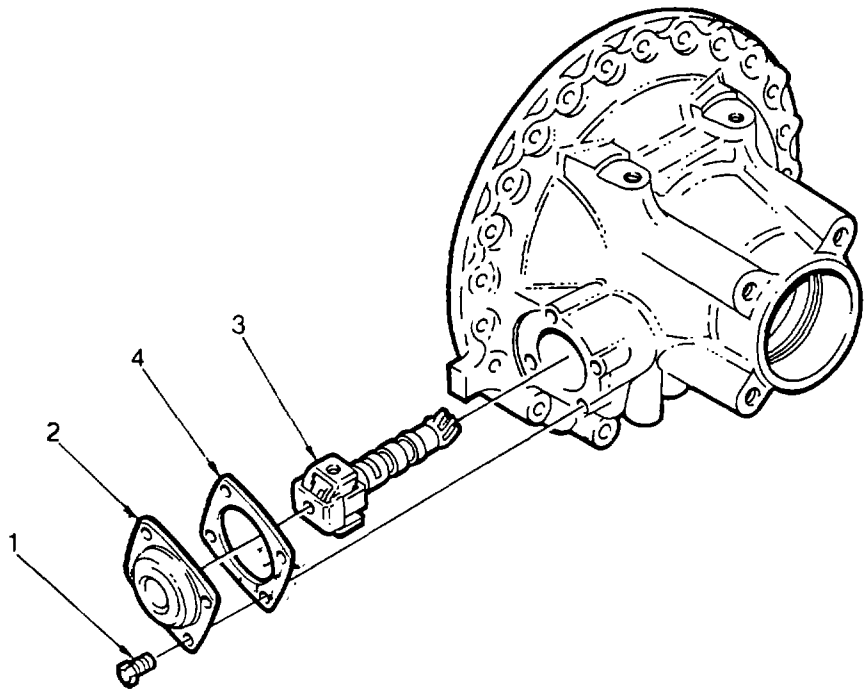
(1) Remove four 5/16 in. bolts (1) attaching governor cover (2).

(2) Remove cover gasket (4) and clean mating surfaces.

(3) Remove governor assembly rotating clockwise while removing.

(4) Install new governor assembly (3), cover gasket (4) and cover (2).

(5) Tighten bolts to 20 ft lb (27 Nm)



2-19 ENGINE

2-19. ENGINE.

2-19.1 Exhaust Manifold.

This task covers
a. Removal
b. Inspection
c. Installation

TOOLS
Tool Kit, Master Mechanic,
NSN 5180-00-699-5273

EQUIPMENT CONDITION
Main Engine Shutdown
(see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected
(see TM 5-4210-220-12)
Both Engine Compartment Covers Removed
(see TM 5-4210-220-12)

MATERIALS/PARTS
20, Appendix B Penetrating Oil
5122866 Exhaust Manifold Gasket
5101435 Left Exhaust Manifold
5101436 Right Exhaust Manifold

WARNING

Exhaust parts can be hot enough to cause severe burns if touched. Allow exhaust system to cool before servicing.

NOTE

If components are excessively corroded, apply penetrating oil (item 20, Appendix B) to ease disassembly.

REMOVAL

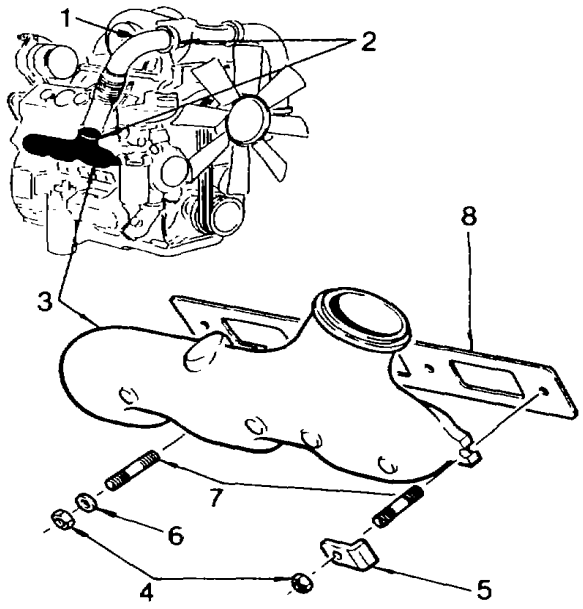
(1) Remove the right exhaust manifold to turbocharger pipe (1) by loosening and removing the seal clamps (2).

(2) While supporting the right exhaust manifold (3) remove the four nuts (4). Remove the two hold-down crabs (5) and bevel washers (6) from the exhaust manifold studs (7).

(3) Slide the right exhaust manifold from the studs and lift from engine compartment.

(4) Remove and discard the exhaust manifold gasket (8).

(5) Remove the left exhaust manifold similarly to steps 1 thru 4 preceding.



2-19. ENGINE - Continued

INSPECTION

(1) Remove all loose scale and carbon that may have accumulated on the internal walls of the exhaust manifold. This is especially important on turbocharged engines because loose scale or carbon could enter and damage the turbocharger.

(2) Examine the exhaust manifold studs for damage or wear, and replace as necessary. Tighten new studs to 35 ft lb (47.5 Nm).

(3) Make sure all gasket material is removed from cylinder head and exhaust manifold mating surface.

(4) If installing old manifold, make sure it is not cracked or warped.

INSTALLATION

NOTE

Ensure manifold interior is free from scale and carbon. This will eliminate the possibility of turbocharger damage.

(1) Place new gasket (8) over studs and up against the cylinder head.

NOTE

When installing the metal clad exhaust manifold gasket(s) be sure the crimped side of the gasket faces the cylinder head.

(2) Lift right exhaust manifold (3) into engine compartment. Position the manifold over the studs (7) and against the exhaust manifold gasket (8).

(3) Install the hold-down crabs (5), bevel washers (6), and nuts (4) on the studs (7), and draw the exhaust manifold up against the gasket. Set the bevel washers in position so that outer diameter will rest on the manifold and the crown at the center is next to the nut. Tighten the exhaust manifold stud nuts (4) from the center of the exhaust manifold outward, alternating toward either end. Torque the nuts to 35 ft lb (47 Nm).

(4) Install the right exhaust manifold to the turbocharger pipe (1) into position, and secure using seal clamps (2). Do not allow exhaust piping to impose excessive loads on turbocharger. Tighten seal clamps firmly.

(5) Install the left exhaust manifold similarly to steps 1 thru 4 preceding.

2-19. ENGINE - Continued

2-19.2 Accessory Drive.

This task covers
a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J33001 Alinement Tool

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Compartment Covers Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
5131329 Steering Pump Drive Gasket
5104507 Alternator Gasket

NOTE

A single accessory drive is installed on the front left-hand side of the engine. Three accessory drives are installed on the rear of the engine; two are pulley drives and one is direct drive. Repair of the accessory drive consists of replacing components of the drive which have failed. Dismantle drive system only as far as required to remove the failed component.

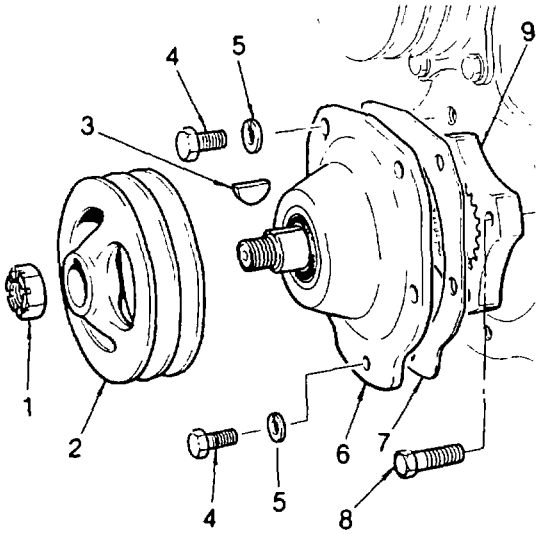
REMOVAL

a. Front Accessory Drive Removal

NOTE

This accessory drive pulley is not utilized on this truck. The front accessory drive is camshaft mounted (refer to General Support for removal).

b. Steering Pump Drive Removal
(1) Remove steering pump and associated mounting brackets (see TM 5-4210-220-12).
(2) Remove pulley nut (1).
(3) Remove pulley (2) using a puller. (Pulley has threaded holes to attach puller.)
(4) Remove pulley key (3).
(5) Remove bolts (4) and lockwashers (5). Lift off retainer (6). Remove and discard gasket (7).
(6) Place a clean lintless cloth in the housing opening (under the accessory drive plate or drive hub) to prevent bolts from accidentally falling into the gear train. Then remove the four shoulder bolts (8) and withdraw the accessory drive plate (9).



2-19. ENGINE - Continued

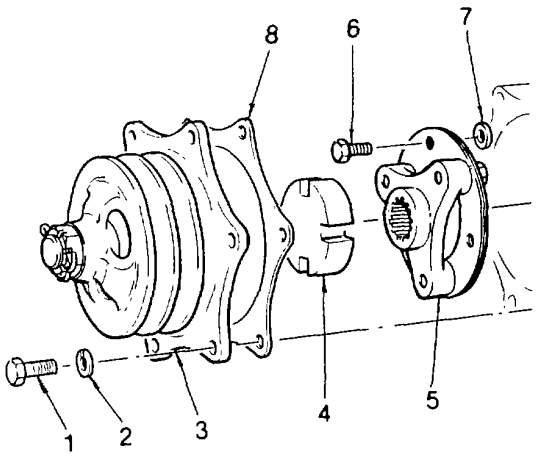
c. Alternator Drive Removal

(1) Remove alternator and associated mounting brackets (see TM 5-4210-220-12).

(2) Remove the bolts (1) and lockwashers (2) and carefully withdraw the pulley assembly (3), drive coupling (4) and gasket (8).

(3) Remove the blower drive shaft retaining ring. Thread a No. 10-32 screw in the tapped hole and withdraw the blower drive shaft. Remove the screw used to withdraw the shaft.

(4) If necessary unscrew the three bolts and withdraw the drive hub assembly (5). Use extreme care so as not to drop spacers (7) into gear train.



(5) Discard the spacers and bolts. When installing drive hub assembly use new type bolts.

d. Rear Accessory Drive Assembly (Direct Drive) Removal

NOTE

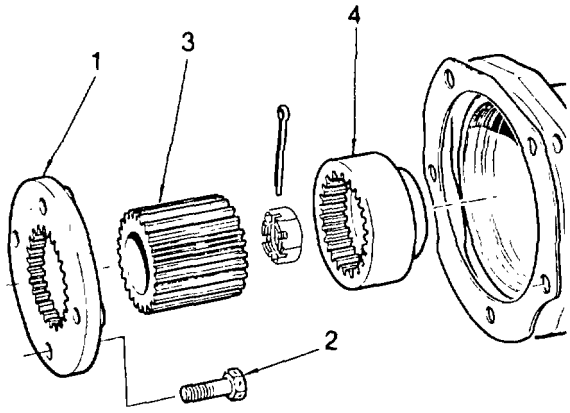
A single direct-drive assembly is installed. It is used to drive the air compressor.

(1) Remove air compressor as detailed in TM 5-4210-220-12.

(2) Remove the drive coupling (3) out of the flywheel housing opening. (Drive hub (4) is retained with air compressor.)

(3) Place a clean, lintless cloth in the flywheel housing opening (under the accessory drive plate) to prevent bolts from accidentally falling into the gear train.

(4) Remove the four bolts (2) and withdraw the drive plate (1).



2-19. ENGINE - Continued

2-19.2 Accessory Drive - Continued

INSPECTION

NOTE

This procedure may be used for any accessory drive.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm^2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

(1) Clean all of the parts with dry cleaning solvent (item 10, Appendix B) and dry them with compressed air.

(2) Check the teeth on the drive coupling or drive plate and the drive shaft for wear. Replace any parts which are worn excessively.

(3) Rotate drive shaft, and move up and down to check for bearing wear. Replace bearing as detailed in REPAIR following if bearing is excessively worn.

(4) Inspect the oil seal. If there is any sign of oil leaks, replace oil seal as detailed in REPAIR following.

(5) For flexplate drives, inspect flexplates for signs of warp or twist. Replace as required.

INSTALLATION

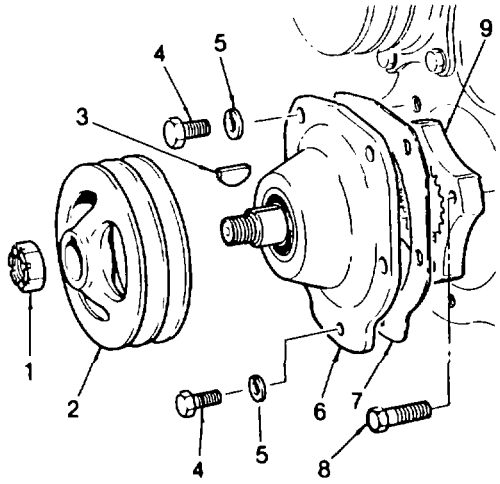
a. Front Accessory Drive Installation

NOTE

This accessory drive is not utilized on this truck. The front accessory drive is camshaft mounted (refer to General Support for installation).

2-19. ENGINE - Continued

b. Steering Pump Drive Installation



(1) Install drive plate (9) in engine and secure with bolts (8). Torque to 30 ft lb (41 Nm). Remove cloth from housing opening.

(2) Affix a new gasket (7) to the mounting flange on the retainer (6).

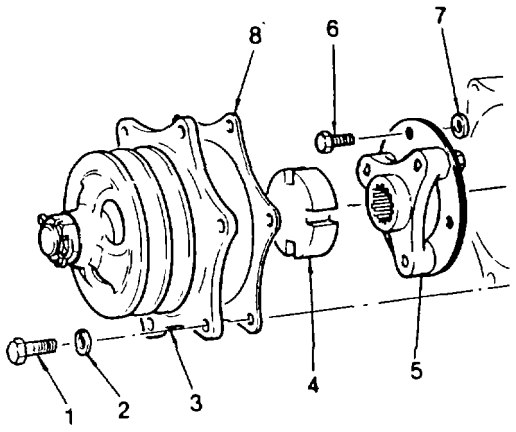
(3) Position the retainer and shaft assembly against the housing. Rotate the shaft slightly, if necessary, to permit the teeth of the shaft to mesh with the teeth in the accessory drive plate. Secure the retainer to the housing with five bolts (4) and lockwashers (5). Tighten the bolts to 30 ft lb (41 Nm).

(4) Install the key (3) in the shaft. Then start the pulley (2) on the shaft and tap it into place.

(5) Install the retaining nut (1) and tighten to 120 ft lb (163 Nm).

(6) Mount the steering pump as detailed in TM 5-4210-220-12.

c. Alternator Drive Installation



(1) Install the drive hub assembly (5) on the blower drive gear using new bolts (6) and spacers (7).

(2) Slip the snap ring over the notched end of tool J33001 and thread the blower drive shaft onto the end of the tools.

(3) Install the shaft and position the blower so the shaft can be removed and installed.

(4) Remove the shaft and rotate the blower in 90 deg. Increments reinserting the shaft and repositioning blower as necessary. Check alinement for the full 360 deg. rotation of the blower.

(5) Insert the drive shaft in the position of least drag and install the snap ring. The notch in the tool provides sufficient clearance for installation of the snap ring with needle nose pliers.

(6) Place a new gasket (8) on the mounting flange of the accessory drive housing.

(7) Place the slotted drive coupling (4) on the hub of the accessory drive assembly. Aline the slots in the coupling with the lugs on the drive hub which is attached to the blower drive gear and carefully position the accessory drive against the flywheel housing.

(8) Secure the accessory drive assembly (3) to the flywheel housing with bolts (1) and lockwashers (2).

(9) Mount the alternator and associated mounting brackets to the engine as detailed in TM 5-4210-220-12.

2-19. ENGINE - Continued

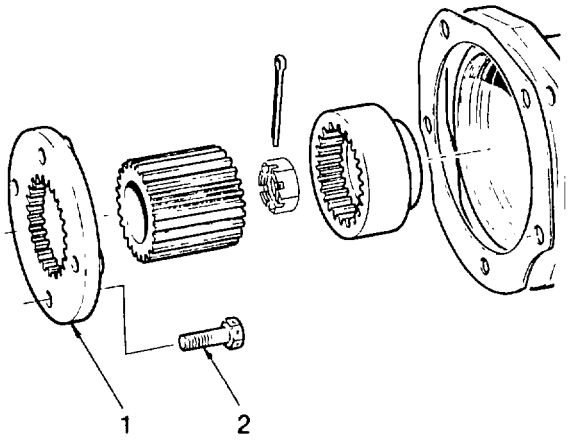
2-19.2 Accessory Drive - Continued

d. Rear Accessory Drive Assembly(direct-drive) Installation

(1) Aline the bolt holes in the accessory drive plate (1) with the tapped holes In the camshaft gear.

(2) Secure the drive plate with the four special shoulder bolts (2). Tighten the bolts to 45 ft lb (61 Nm).

(3) Install the air compressor as detailed in TM 5-4210-220-12.



REPAIR

a. Steering Pump Drive Repair

NOTE

Drive unit removed from engine.

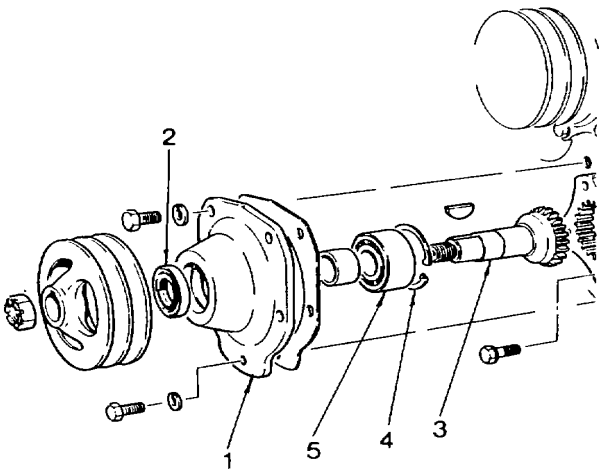
(1) Using a press, push drive shaft (3) out of retainer (1)

(2) Remove snap ring (4) and pull bearing (5) out of retainer.

(3) Pull oil seal (2) out of retainer Discard oil seal.

(4) Place the accessory drive retainer on a bench, with the mounting flange side up. Lubricate the outside diameter of the bearing (5) with oil (item 17, Appendix B). Press or tap It (with the protruding face of the inner race facing toward the retainer) straight in until It contacts the shoulder in the retainer. Then install the snap ring (4).

(5) Turn the retainer over and coat the oil seal recess with silicone sealant (item 28, Appendix B). Press a new oil seal into the bore of the retainer with the lip of the seal facing the bearing. Wipe any excess sealant from the retainer.



(6) Turn the retainer over again, bearing side up. Lubricate the drive shaft and press it in the bearing until the shoulder on the shaft contacts the bearing.

(7) Install the drive unit as detailed in INSTALLATION preceding.

2-19. ENGINE - Continued

b. Alternator Drive Repair

NOTE

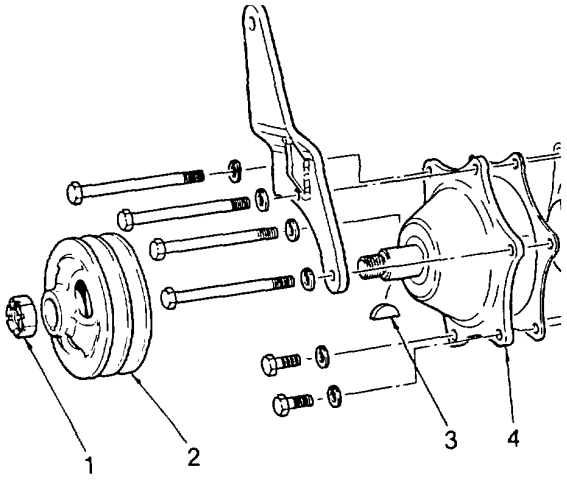
Drive unit removed from engine. Only repair parts are the retainer assembly and the pulley. If bearing or seal has failed remove pulley from retainer and replace retainer.

(1) Remove pulley retaining nut (1) and pull pulley (2) from shaft.

(2) Remove key (3).

(3) Replace failed component and attach pulley (2) and retainer (4) together with key (3) and nut (1).

(4) Install drive unit on engine as detailed in INSTALLATION preceding.



2-19. ENGINE - Continued

2-19.3 Rocker Cover.

This task covers a. Removal
b Installation

TOOLS
Tool Kit, General Mechanic, Automotive,
NSN 5180-00-177-7033

MATERIALS/PARTS
17, Appendix B Engine Oil
5149510 Rocker Cover Gasket

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Covers Removed
(see TM 5-4210-220-12)

NOTE

Two similar rocker covers are Installed, one on the left bank cylinder head and the other on the right. The instructions below may be used for either cover.

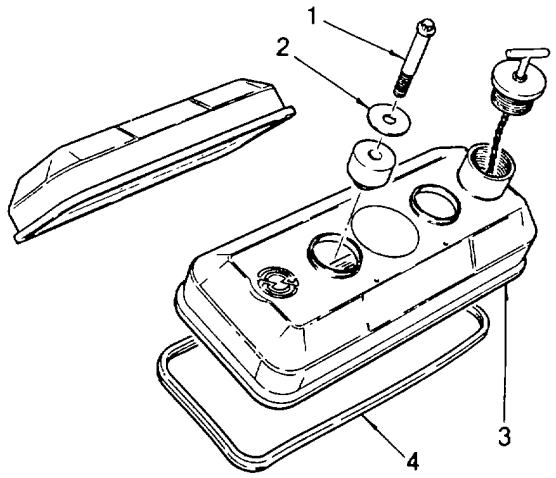
REMOVAL

(1) For right hand rocker cover removal only, remove exhaust elbow from turbocharger as detailed in TM 5-4210-220-12.

(2) Clean the rocker cover and engine around the cover.

(3) Loosen both cover bolts (1) and washers {2).

(4) Lift up rocker cover (3), and remove gasket (4). Clean gasket groove in rocker cover.



INSTALLATION

(1) Press the stem side of the T-shape gasket (4) down into the groove at the four corners of the cover. Press the remainder of the gasket into place in the groove. Do not put oil on gasket or in the groove.

(2) Lubricate the flat face of the gasket and the cylinder head rail with engine oil (item 17, Appendix B).

(3) Place the rocker cover (3) flat down on the cylinder head, install bolts (1) and washers (2). Tighten bolts (1) to 1 5 ft lb (20 Nm).

(4) Reclamp exhaust elbow to turbocharger, if removed.

2-19. ENGINE - Continued

2-19.4 Rocker Arms, Cam Follower, and Push Rods.

This task covers
a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Tool Kit, General Mechanic, Automotive, NSN 5180-00-177-7033
J8932-01 Fuel Line Nut Wrench
J3092-01 Push Rod Remover/Installer
J22738-02 Spring Tester
J22582 Engine Barring Tool

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Covers Removed (see TM 5-4210-220-12)
Both Rocker Covers Removed (see para. 2-19.3)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
15, Appendix B Gear Oil
17, Appendix B Engine Oil
5149510 Rocker Cover Gasket

NOTE

Cylinder head need not be removed to carry out this task. The following REMOVAL instructions assume cylinder head is not removed.

REMOVAL

(1) Tag and remove the fuel pipes from the injector and fuel connectors.

NOTE

Immediately after removing the fuel pipes, cover the injector fuel inlet and outlet openings with shipping caps to prevent dirt or foreign material from entering.

(2) Turn the crankshaft with J22582, or crank the engine with starting motor, to bring the injector and valve rocker arms in line horizontally.

NOTE

Do not bar the crankshaft in a left-hand direction of rotation with a wrench or barring tool on the crankshaft bolt, because the bolt may loosen.

(3) Remove the two bolts which secure the rocker arm shaft brackets to the cylinder head. Remove the brackets and shaft.

NOTE

When removing the rocker arm shaft, fold the three rocker arms back just far enough so the shaft can be removed. Do not force the rocker arms all the way back with the shaft in place as this may impose a load that could bend the push rods.

2-19. ENGINE - Continued

(4) Loosen the locknuts at the upper ends of the push rods, next to the devises, and unscrew the rocker arms from the push rods.

NOTE

If the rocker arms and shafts from two or more cylinders are to be removed, tag them so they may be reinstalled In their original positions.

(5) When removing the cam followers and associated parts, tag them so they may be reinstalled in their original location.

(6) Install remover J3092-01, flat washer, and the locknut on the push rod, with the lower end of the tool resting on the upper spring seat.

(7) Thread the nut down to compress the spring.

(8) Remove the spring seat retainer from the groove in the cylinder head.

(9) Unscrew the locknut to release the spring Then remove the nut, flat washer, and tool from the push rod.

(10) Pull the push rod, spring, spring seats, and cam follower out of the cylinder head.

INSPECTION

(1) Clean the cam followers and wash with engine oil (item 17, Appendix B).

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(2) Wash all other components in dry cleaning solvent (item 10, Appendix B) and dry with compressed air. Use a small wire to clean out the drilled od passages in the rocker arms and rocker shaft bolts.

(3) Inspect the rocker arm shaft and rocker arm bushings for wear. A maximum shaft to bushing clearance of 0.004 in. (0.10 mm) is allowable with used parts. Service replacement bushings must be reamed to size after installation.

(4) Inspect the rocker arms for galling or wear on the pallets (valve or Injector contact surfaces) If worn, the surface may be refaced up to a maximum of 0.010 in. (0.25 mm). However, proceed with caution when surface grinding to avoid overheating the rocker arm. Maintain the radius and finish as close to the original surface as possible. Also inspect the valve bridges for wear.

2-19. ENGINE - Continued

2-19.4 Rocker Arms, Cam Follower, And Push Rods - Continued

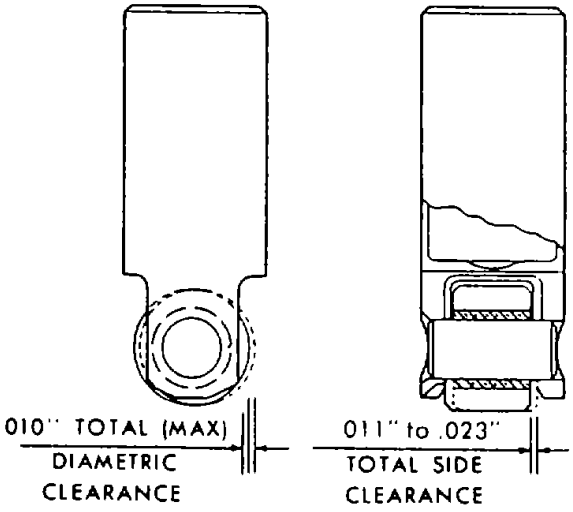
(5) Inspect the rocker arm shaft brackets for cracks.

(6) Examine the cam follower rollers for scoring, pitting or flat spots. The rollers must turn freely on their pins.

(7) Measure diametric clearance and side clearance as shown. Replace roller and pin if clearances are exceeded (see REPAIR following).

(8) Examine the camshaft lobes for scoring, pitting or flat spots. If camshaft requires repair, refer to General Support.

(9) Measure the cam follower bores in the cylinder head with a telescope gage and micrometer and record the readings.



(10) Measure the diameter of the cam followers with a micrometer. Record the readings and compare the readings of the followers and bores to determine the cam follower-to-bore clearances. Maximum clearance should be 0.005 in. (0.13 mm).

(11) If the push rod is broken or damaged, the rocker arm should be suspect. Any wear or excessive movement in the rocker arm or clevis can put a side load on the push rod, resulting in fracture or damage.

(12) Inspect the rocker arm for signs of wear or cracking. If wear or excessive movement of the rocker arm or clevis is noted, replace the rocker arm.

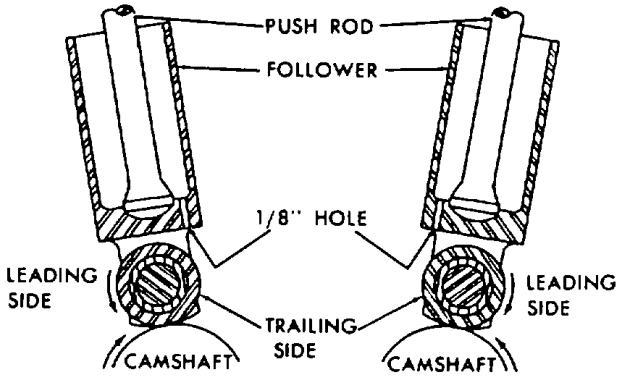
(13) Inspect the push rods and spring seats for wear. The push rods have milled wrench flats and a bright "turned" finish and the lower spring seats are serrated along the push rod contact surfaces.

(14) Examine the cam follower springs for wear or damage and check the spring load. Replace a spring when a load of less than 250 lb (113 kg) will compress it to a length of 2.1406 in. (54.371 mm). Use spring tester J22738-02 to check the spring load.

INSTALLATION

(1) Before cam followers are installed, immerse them in clean engine oil (item 17, Appendix B) heated to 100 - 125 deg. F (38 - 52 deg. C) for at least one hour. Rotate rollers regularly to ensure bushing is purged of air.

(2) Install cam followers and push rods in their original locations as noted in REMOVAL preceding.



(3) Note the oil hole In the bottom of the cam the follower. With the oil hole directed away from exhaust valves, slide the cam follower in position in the cylinder head.

2-19. ENGINE - Continued

(4) Assemble the serrated lower spring seat (11), spring (10), and upper spring seat (9), on the push rod (12).

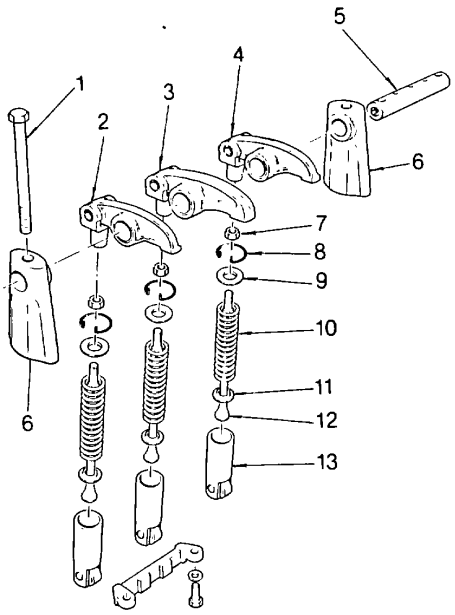
(5) Place a flat washer over the upper spring seat and start the locknut (7) on the push rod. Place tool J3092-02 on the push rod between the washer and the upper spring seat and place the push rod assembly in the cam follower (13).

(6) Thread the locknut (7) on the push rod until the spring Is compressed sufficiently to permit the spring retainer (8) to be installed.

(7) Install the retainer (8) with the tangs facing the notch in the cylinder head.

(8) Remove the nut, flat washer, and tool. Then reinstall the locknut (7) and thread It as far as possible on the push rod (12).

(9) The injector rocker arm (3) is slightly different from the exhaust valve rocker arms (2 and 4), the boss for the shaft on the left and right-hand valve rocker arms is longer on one side. The extended boss of each valve rocker arm must face toward the injector rocker arm. The exhaust valve rocker arms also have a flat spot beneath the rocker shaft hole to ensure clearance with the valve bridge



NOTE

If the rocker arm is damaged or breaks, the push rod should always be changed when the new rocker arm is installed.

(10) Thread each rocker arm on its push rod (12) until the end of the push rod Is flush with or above the inner side of the clevis yoke This will provide sufficient initial clearance between the exhaust valve and the piston when the crankshaft is turned during the valve clearance adjustment procedure

(11) If removed, install cylinder head on the engine, see para. 2-19.8.

(12) Lubricate the valve bridge guides with gear oil (item 15, Appendix B) and position the valve bridges in place on the guides. Refer to para. 2-19.7 and adjust the valve bridges.

(13) If removed, install the fuel injectors. See para. 2-19.5

(14) Apply clean engine oil (item 17, Appendix B) to the rocker arm shaft (5) and slide the shaft through the rocker arms. Then place a bracket (6) over each end of the shaft with the finished face of the bracket next to the rocker arm.

(15) Insert the rocker arm bracket bolts (1) through the brackets (6) and the shaft (5). Tighten the bolts to 90 ft lb (122 Nm).

2-19. ENGINE - Continued

(16) Aline the fuel pipes and connect them to the injectors and fuel connectors. Tighten the fuel pipe nuts to 12 ft lb (16 Nm) torque using socket J8932-01.

NOTE

Do not bend the fuel pipes and do not exceed the specified torque. Excessive tightening will twist or fracture the flared ends of the fuel pipes and result in leaks. Lubricating oil diluted by fuel oil can cause serious damage to the engine bearings.

(17) Fill the cooling system if It was drained.

(18) Adjust the exhaust valve clearance see para. 2-19.7 and time the injectors see para. 2-19.5.

(19) Replace rocker covers see para. 2-19.3.

REPAIR

NOTE

Repair of all components except cam follower consists of replacement of failed components as detailed in INSPECTION preceding.

Cam Follower Repair

CAUTION

Do not attempt to bore out the legs of a standard cam follower for an oversize pin. Use tool J33421 for cam follower roller replacement.

(1) Pull the adjustable sliding support out against its stop on tool J33421.

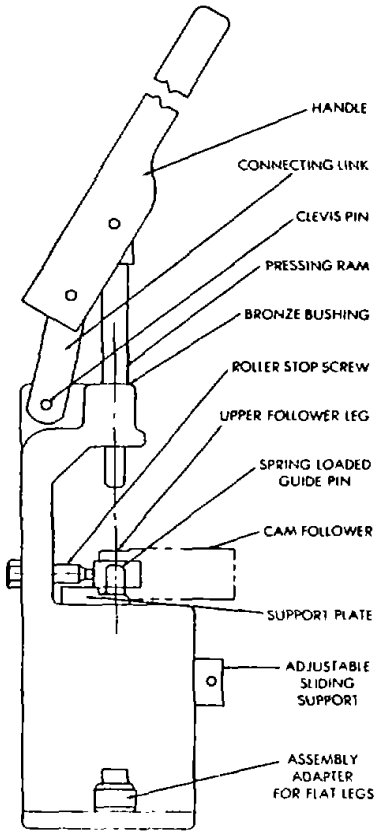
(2) Place the cam follower with follower pin resting on the spring loaded guide pin in the fixture.

(3) Push the follower down until the lower leg engages th slot in the support plate. This supports the roller whic in turn supports the upper follower leg.

(4) Push the follower in until contact is made with the roller stop screw. This should put the roller pin in alinement with the pressing ram.

(5) Lower the handle to put pressure on the roller pin.

(6) Push the adjustable sliding support in until resistance is felt. This causes the lower follower leg to be supported.



2-19. ENGINE - Continued

(7) Press the pin from the cam follower.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(8) Before installing the new roller and pin, remove the preservative by washing the parts with dry cleaning solvent (item 10, Appendix B). Wipe dry Do not use fuel oil. After washing the parts, lubricate the roller and pin with engine oil (item 17, Appendix B).

(9) Pull the adjustable sliding support out arid position the cam follower in the fixture (roller in place) as in steps 2 thru 4 preceding.

(10) When assembling the cam follower with flats on the outside of the legs, push adaptor J33421-3 onto the pressing ram to limit depth of the press to the correct dimension. When pressing the pin into the follower with rounded legs, depth of the press is determined by the operator. Adapter J33421-3 has a spring-loaded plunger in the setscrew and does not normally require any adjustment.

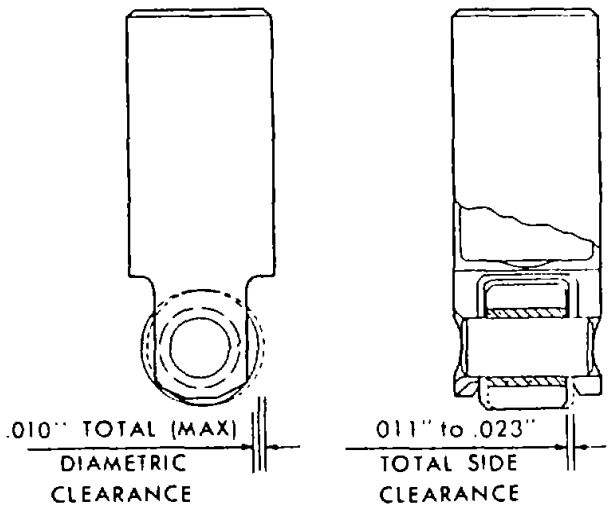
(11) Aline the pin over the follower leg, lower handle and place pressure on the pin.

(12) To support the lower follower leg, push the adjustable sliding support in until resistance is felt.

(13) Press the pin into place.

(14) Remove the cam follower from the fixture and check the side clearance. The clearance must be 0011 - 0.023 in. (0.28 - 0.58 mm).

(15) Install cam follower as detailed in INSTALLATION preceding.



2-19. ENGINE - Continued

2-19.5 Injectors.

This task covers
a. Adjustment
b. Removal
c. Inspection
d. Installation
e. Test
f. Repair

TOOLS
Shop Equipment, Automotive Maintenance And Repair, NSN 4910-00-754-0705
J22582 Engine Barring Tool
J1242 Injector Timing Gage
J22525 Injector Tube Service Tool Set
J8932-01 Fuel Pipe Socket
J22396 Injector Holding Fixture
J23010 Injector Tester
J22640 Injector Auxiliary Tester
J26400 Injector Test Oil
J22410 Injector Calibrator
J9462-02 Injector Needle Valve Lift Gage

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (TM 5-4210-220-12)
Batteries Disconnected (TM 5-4210-220-12)
Both Engine Compartment Covers Removed (TM 5-4210-220-12)
Rocker Cover(s) Removed (see para. 2-19.3)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
5149510 Rocker Cover Gasket

WARNING

JP-4 is a highly volatile fuel. Extraordinary care must be taken when servicing components that use this fuel. The truck shall be grounded to an approved grounding point if it contains JP-4.

ADJUSTMENT

(1) Adjust exhaust valve clearance as detailed in para. 2-19.7.

(2) Place the governor speed control lever in the idle speed position. If a stop lever is provided, secure it in the stop position.

(3) Rotate the crankshaft, with the starting motor or with engine barring tool J22582, until the exhaust valves are fully depressed on the particular cylinder to be timed.

NOTE

If a wrench is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction or rotation or the bolt may loosen.

(4) Place the small end of the injector timing gage J1242 in the hole provided in the top of the Injector body with the flat of the gage toward the injector follower.

(5) Loosen the injector rocker arm push rod lock nut.

2-19. ENGINE - Continued

(6) Turn the push rod and adjust the injector rocker arm until the extended part of the gage will just pass over the top of the Injector follower.

(7) Hold the push rod and tighten the lock nut. Check the adjustment and, if necessary, re-adjust the push rod.

(8) Time the remaining injectors In the same manner as outlined above.

(9) If no further engine tune-up is required, Install the valve rocker covers, using new gaskets.

REMOVAL

NOTE

This Instruction is written for one fuel injector; repeat the following instructions for each injector.

(1) Remove the fuel pipes from both the injector and fuel connectors. Cover/protect caps on injector, fuel pipe and fuel connectors with shipping caps to prevent entry of dirt or foreign material.

(2) Crank the engine to bring the outer ends of the push rods of the injector and valve rocker arms in line horizontally.

(3) Remove the two rocker shaft bracket bolts and swing the rocker arms away from the injector and valves.

(4) Remove the Injector clamp bolt, special washer and clamp.

(5) Loosen the inner and outer adjusting screws (certain engines have only one adjusting screw and locknut) on the injector rack control lever and slide the lever away from the injector.

(6) Lift the injector from its seat in the cylinder head.

(7) Cover the injector hole in the cylinder head to keep foreign material out.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur If compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(8) Clean the exterior of the injector with clean dry solvent (item 10, Appendix B) and dry it with compressed air.

2-19. ENGINE - Continued

2-19.5 Injectors - Continued

INSPECTION

(1) Inspect injector for external damage; cracked or damaged follower, or body; uneven movement of control rack etc.

(2) Perform tests on injector as detailed in TEST following. If the injector is to be replaced, check new injector has passed all tests detailed in TEST following before installing in truck.

(3) Inspect the beveled seat of the injector tube in the cylinder head. Remove any carbon deposits with reamer J5286-9. Use care to remove only the carbon so that the proper clearance between the injector body and the cylinder head is maintained. Pack the flutes of the reamer with grease to retain the carbon removed from the tube. If the injector tube is leaking refer to Injector Tube Repair following.

INSTALLATION

(1) Fill the injector with clean fuel oil be adding fuel to the inlet filter cap until it runs out of the outlet filter cap.

(2) Insert injector into the injector tube with the dowel pin in the injector body alined with the locating hole in the cylinder head.

(3) Slide over the injector control rack lever so that it registers with the injector rack.

(4) Install the injector clamp, special washer (with curved side toward injector clamp), and bolt. Tighten bolt to 25 ft lb (34 Nm) while operating the control rack. Do not overtighten the bolt. Make sure the clamp does not interfere with the injector follower spring or the exhaust valve springs.

(5) Move the rocker arm assembly into position and secure the rocker arm assembly to the cylinder head by tightening the bolts to 100 ft lb (136 Nm).

(6) Remove the shipping caps and install the fuel pipes. Use socket J8932-01 to tighten the connections to 15 ft lb (20 Nm). Do not bend the fuel pipes or overtighten the nuts.

(7) Adjust the valve clearance as detailed in para. 2-19.7 and adjust the injector timing as detailed in ADJUSTMENT preceding.

TEST

NOTE

Injector removed from truck, see REMOVAL preceding.

WARNING

JP-4 is a highly volatile fuel. Extraordinary care must be taken when servicing components that use this fuel. The truck shall be grounded to an approved grounding point if it contains JP-4.

2-19. ENGINE - Continued

The fuel spray from an injector can penetrate the skin. Fuel which enters the blood stream can cause a serious infection. Follow instructions carefully and use proper equipment to test an Injector. All tests must be performed using injector test oil J26400. To fully test an injector, all the following tests should be carried out.

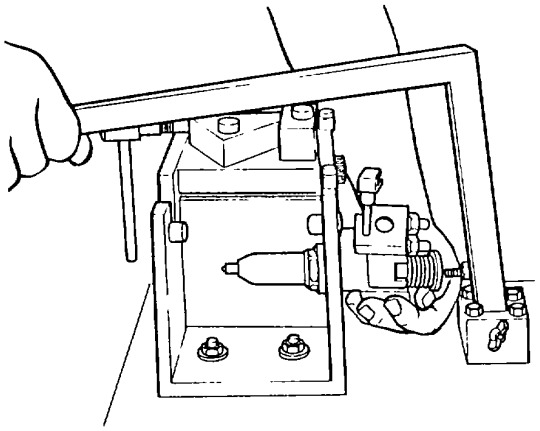
a. Injector Control Rack And Plunger Test

(1) Place Injector in holding fixture J22396 as shown.

(2) Place handle on top of injector follower. Adjust contact screw in handle so it rests at center of follower, when the follower spring is compressed.

(3) Push up control rack on the injector to the no-fuel position. Push handle down to depress follower fully.

(4) Release pressure on handle slowly, while moving control rack up and down. The control rack should fall each time under gravity.



(5) If the control rack is stiff, loosen the injector nut, turn the tip and retighten. Repeat until rack is free. If the rack isn't free change the Injector nut as detailed in REPAIR following.

b. Visual Inspection Of Plunger

NOTE

This test need not be carried out if a reassembled injector is being tested.

(1) Support the injector, follower end up, in holding fixture J22396.

(2) Compress the follower spring by hand. Raise spring above the stop pin with a screwdriver and withdraw the pin. Allow the spring to rise gradually.

(3) Remove injector from holding fixture. Turn upside down and catch the spring, follower and plunger as they drop out.

(4) Inspect the plunger. If the plunger is chipped, worn, or scratched especially in the helix area, replace the plunger and bushing.

(5) Reinstall the plunger, follower, and spring.

c. Injector Operation Tests

(1) Install injector in tester J23010 or similar model. Ensure correct clamping head is used. Follow tool instructions with extreme care to ensure mounting is correct.

2-19. ENGINE - Continued

2-19.5 Injectors - Continued

(2) Follow the test equipment manufacturers recommended test procedures and perform the

- Injector Throughput Test
- Injector High Pressure Test
- Injector Pressure Holding Test

d. Fuel Output Test

(1) To check the fuel output, mount the injector in tester J22410 or similar model tester. Ensure the inlet and outlet fuel lines are connected properly. If not the dirt on the inlet filter may be backwashed through the injector. Be sure to install the injector exactly as the tool instructions detail.

e. Needle Valve Tip Test

(1) Using auxiliary tester J22640 and test J23010 or similar type equipment, perform needle valve tip test following the tool manufacturers instructions

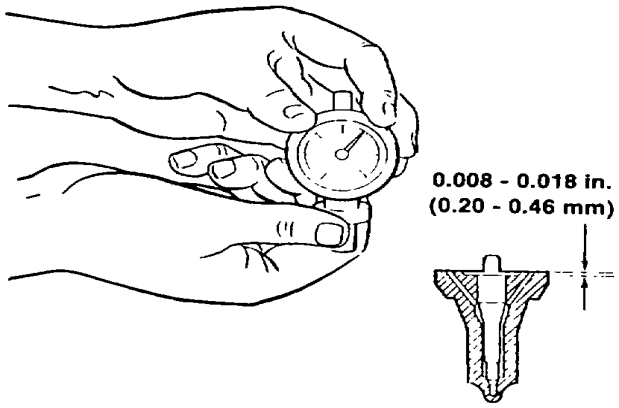
f. Needle Valve Lift Test

(1) Place tool J9462-02 plunger on a flat surface and zero the gage.

(2) Place the needle valve in the spray tip.

(3) Insert the quill of the needle valve in the hole of the plunger of tool J9462-02.

(4) Hold the spray tip land tight against the gage. The dial should read 0.008 - 0.018 in. (0.20 -0.46 mm).



(5) If it is greater than 0.018 in. (0.45 mm) replace the needle valve and tip. If it is less than 0.008 in. (0.20 mm) inspect spray tip seat or needle valve for foreign material. If the lift is satisfactory, test g. failed because of a weak spring. Repeat test g. with a new spring or new spray tip assembly depending which failed.

REPAIR

NOTE

Injector must be removed from truck. Before any repair can be carried out the injector must be disassembled.

a. Disassembly Prior To Repair

(1) Clamp injector in injector holding fixture J22396.

(2) Remove filter caps (3), gaskets (2), and filter (1). Discard the filter (inlet side only) and gaskets.

2-19. ENGINE - Continued

(3) Raise the follower spring (6) with a screwdriver above the lower land. Hold one hand on the follower (4) and extract the stop pin (7). Allow the spring to rise gradually.

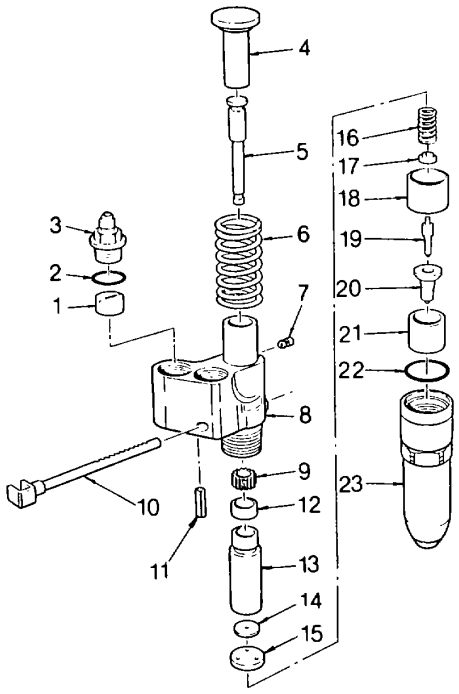
(4) Remove the follower (4), follower spring (6), and plunger (5) as an assembly

(5) Invert the injector on the holding fixture and loosen the injector nut (23) using tool J4983-01.

(6) Lift the nut straight up, taking care not to dislodge the spray tip and valve parts.

(7) Remove the spray tip (20) and valve parts (19, 18, 17, 16, 15, 14) from the bushing and place in a clean receptacle If the spray tip is lodged in the nut, support nut on a wooden block and drive the tip down through the nut using punch J1291-02 and a hammer.

(8) Lift off the spill deflector (21) and then lift bushing (13) straight out of body (8).



(9) Remove the injector body from the holding fixture, invert and catch the gear retainer (12) and gear (9) as they fall out of the body.

(10) Withdraw the injector control rack (10) from the body (8). Remove the seal ring (22) from the body.

b. Inspect and Repair

NOTE

Most injector problems are the result of dirt particles. A clean work area is essential for parts cleaning and inspection.

WARNING

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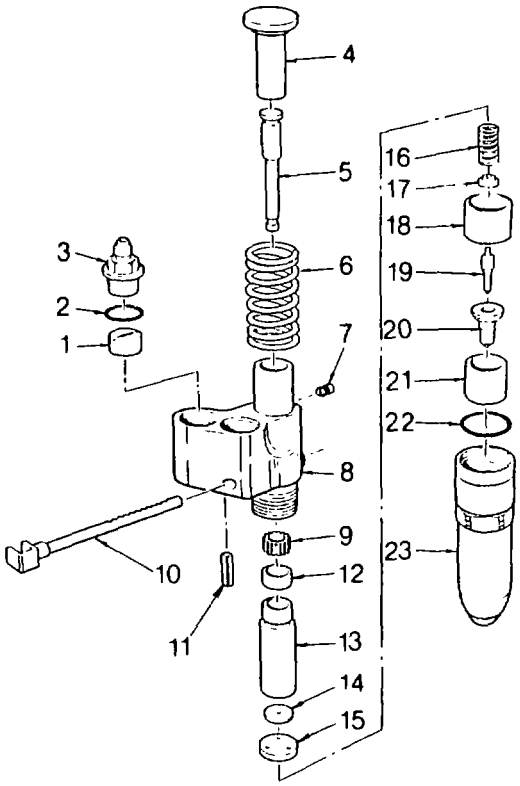
2-19. ENGINE - Continued

2-19.5 Injectors - Continued

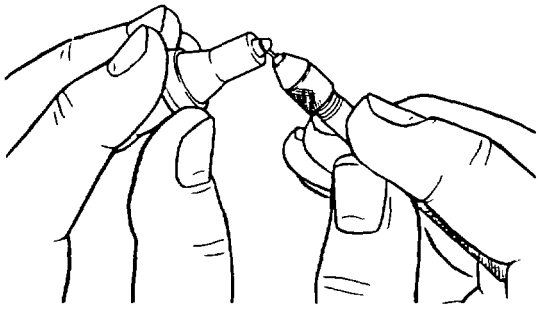
(1) Wash all components In dry cleaning solvent (item 10, Appendix B). Discard filter (1) and seal ring (22). Dry all parts with compressed air. Clean out all passages and drilled holes.

(2) If there is carbon in the spray tip (20) soak in methyl ethyl ketone (item 19, Appendix B) for 15 minutes. Clean the spray tip with tool J24838. Be careful not to push too far and contact the needle valve seat in the end of the tip.



(3) Clean the spray tip orifices with pin vise J4298-1 and wire J21461-01 (0.006 in.). Before using the wire, hone the end until free of burrs; taper the end with stone J8170. Allow wire to extend 1/8 in. beyond pin vise.

(4) Buff the exterior of the spray tip with a brass wire buffing wheel J7944. Hold the spray tip with tool J24838. Lightly buff the tip end.



(5) Clean and brush all passages in the body using fuel hole brush J8152, and rack hole brush J8150.

(6) Insert reamer J21089 into the injector body turning in a clockwise direction a few turns. Check reamer contacts entire face of inner ring. Repeat as required.

(7) Clean up opposite end of the ring by inserting reamer J21089 in the other end of the body and repeating step 6.

(8) Insert a straight fluted 0.375 in. reamer inside the ring bore of the injector body and rotate clockwise to remove any burrs in the ring. Wash and blow dry the injector body.

(9) Carefully insert carbon remover J9418-5 into injector nut. Turn in clockwise direction a few turns. Remove reamer rotating clockwise. Use care to minimize removing metal or setting up burrs on the spray tip seat. Remove only enough metal to produce a clean uniform seat. Replace the nut if it is severely damaged.

2-19. ENGINE - Continued

(10) Be very careful with the plunger (5). After cleaning do not touch the plunger surfaces with your fingers Check for sharp edges on that portion that rides In the gear Remove edges with 500 grit stone.

(11) Check bushing (13) bleed hole (on side) is not plugged. Keep the bushing (13) and plunger (5) together as these are mated parts. Slip plunger into bushing Check for free movement. Replace both components If required

(12) Inspect teeth on the control rack (10) and control rack gear (9). Check for excessive wear or damage to the teeth

(13) Check for excessive wear of the bore of the gear (9) and the gear retainer (12). Both should be a snug fit on the flats of the plunger.

(14) Inspect the injector follower (4) for wear. If the face requires refinishing, this must be flat ground. The distance between face and plunger slot must never be less than 1.645 in. otherwise injector timing will be incorrect. New followers are 1.647 + 0.002 in. (41.83 + 0.05 mm).

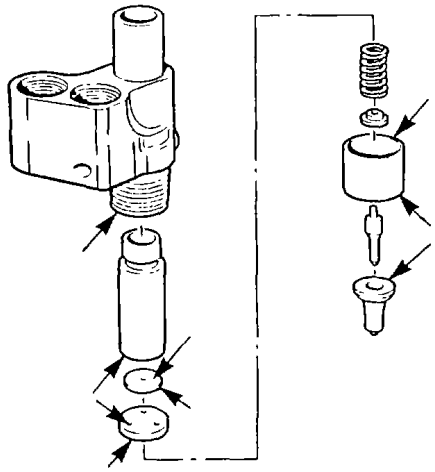
(15) Inspect both ends of spill deflector (21) for burrs. Remove with 500 grit stone.

(16) Inspect follower spring (6) for usual defects. Check spring with tester J22738-02. Spring free length is 1.504 in. (38.20 mm). Spring wire diameter is 0 142 in. (3.61 mm). A load of 70 lb (31.8 kg) should compress spring to 1.028 in. (26.11 mm) or greater. Replace spring if any specification is not satisfied or spring is cracked, broken, or badly corroded.

(17) Check the seal ring area on the Injector body for burrs or scratches. Discard injector body (8) if evidence of damage is found. Check surface which contacts the injector bushing similarly. Replace any loose injector body plugs or dowel pin.

(18) Examine the spray tip seating surface of the injector nut and spray tip for nicks, burrs, erosion or brinelling, Reseat the surface or replace the nut or tip If severely damaged.

(19) Inspect valve spring (16) and replace if worn or broken.



(20) Inspect the sealing surfaces shown with a magnifying glass. Check for burrs, nicks, erosion, cracks, chipping or excessive wear. Replace any component failing inspection.

(21) Examine needle valve seating area in the spray tip for wear or damage or foreign material. Polish the seat area with polishing stick J22964. Coat the taper end of stick with compound J23038 and insert directly into center of spray tip until it bottoms. Rotate the stick 6 to 12 times applying light pressure.

Ensure the tapered surfaces higher up in the spray tip are not contaminated with the 2-187 compound. After lapping, wash seat with dry cleaning solvent (item 10, Appendix B). Carry out the needle valve tip test detailed in TEST preceding.

2-19. ENGINE - Continued

2-19.5 Injectors - Continued

c. Assembly After Repair

NOTE

Use an extremely clean bench to work on and to place parts during assembly. Be sure all injector parts, both new and used, are spotlessly clean. Always use new filters and gaskets when assembling an injector.

(1) Install a new filter (1), dimple end down, slotted end up in the inlet cavity of the injector body. No filter is required on the outlet side.

(2) Place a new gasket (2) on each filter cap (3). Lubricate the threads with test oil and install in the body (8). Tighten the caps to 75 ft lb (102 Nm).

(3) Purge the filter after installation by directing compressed air through the inlet filter cap.

(4) Install clean shipping cap on each filter cap to prevent dirt entering.

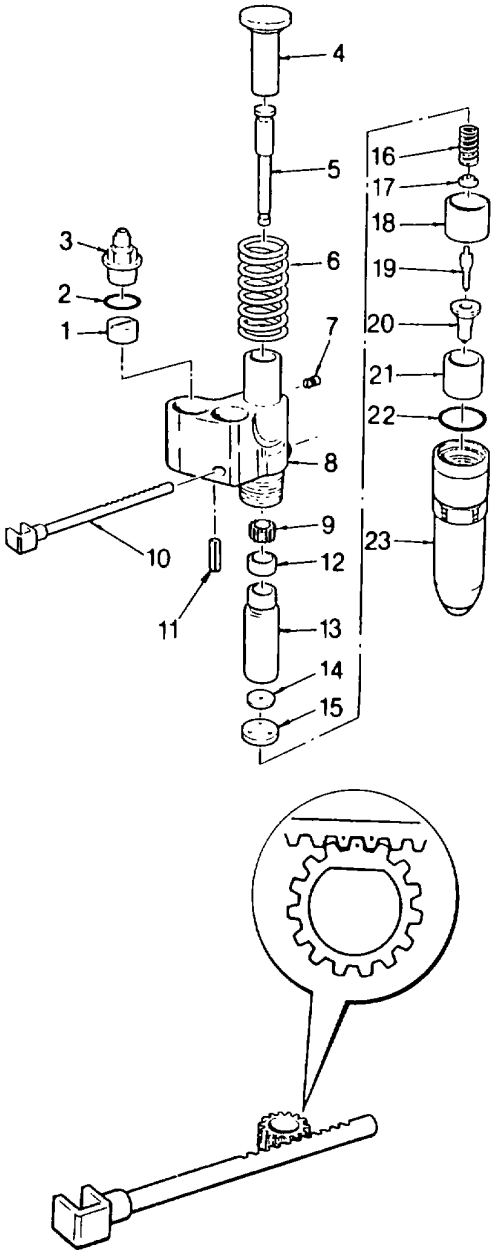
(5) Note the drill spot marks on the control rack (10) and gear (9).

(6) Hold the injector body (8) bottom end up and slide the rack (10) through the hole in the body. Push rack first through hole directly above inlet filter cap. Look into the body bore until drill marks can be seen. Place the gear (9) in the injector body so that the marked tooth is engaged between the two marked teeth of the rack.

(7) Place gear retainer (12) on top of gear (9).

(8) Aline the locating pin in the bushing (13) with the slot in the injector body (8). Slide end of bushing into place.

(9) Support the injector body (8), bottom end up in holding fixture J22396.



(10) Place a new seal (22) and seal protector J29197 in a container with a small amount of test oil J26400

(11) Place the lubricated seal protector J29197 over the threads of the injector body (8). Place the seal (22) over the nose of the protector. Slide the seal down the protector onto the shoulder of the injector body. Do not allow the seal to roll or twist.

(12) Remove the protector.

2-19. ENGINE - Continued

(13) Install the spill deflector (18) over the barrel of the bushing (13).

(14) Place the check valve (14) centrally on top of the bushing

(15) Place the check valve cage (15) over the check valve (14) and against the bushing (13).

(16) Insert the spring seat (17) in the valve spring (16). Insert this assembly into the spring cap (18), spring seat first.

(17) Insert the needle valve (19), taper end down, into the spray tip (20).

(18) Place the spring assembly on ;op of the check valve cage, spring end down. Place the spray tip assembly on top of the spring assembly; the quill end of the needle valve in the hole in the spring cage

(19) Lubricate the threads of the injector nut (23) with test oil J26400. Carefully lower the injector nut over the injector assembly. Thread the nut onto the injector body by hand. Rotate the spray tip as the nut is being threaded. Tighten nut by hand. When as tight as possible, the spray tip should be impossible to turn by hand.

(20) Use socket J4983-01 and a torque wrench to tighten the injector nut to 75 ft lb (115 Nm).

(21) Check the area between nut and body. The seal must not be extruded out of the body; replace seal and reassemble using a new nut (23).

(22) Slide the head of the plunger (5) into the follower (4).

(23) Invert the Injector in the holding fixture J22396.

(24) Push the injector control rack all the way In. Place the follower spring (6) on the injector body (8).

(25) Place the stop pin (7) on the injector body so that the follower spring rests on the narrow flange of the stop pin.

(26) Aline the slot in the follower (4) with the stop pin hole in the injector body.

(27) Aline the flat side of the plunger with the slot in the follower.

(28) Insert the free end of the plunger into the Injector body top. The plunger follower assembly should go all the way into the body until the follower rests on top of the spring. Ensure none of the components are rotated in this process. Do not force the plunger. Withdraw and aline If required.

(29) Press down on the follower, and at the same time, press the stop pin (7) into the hole in the body. When in place the spring will hold the stop pin in position.

(30) Release the follower slowly to check everything is held in place correctly.

(31) Place the Injector in the concentricity gage J5119 and adjust dial indicator to zero.

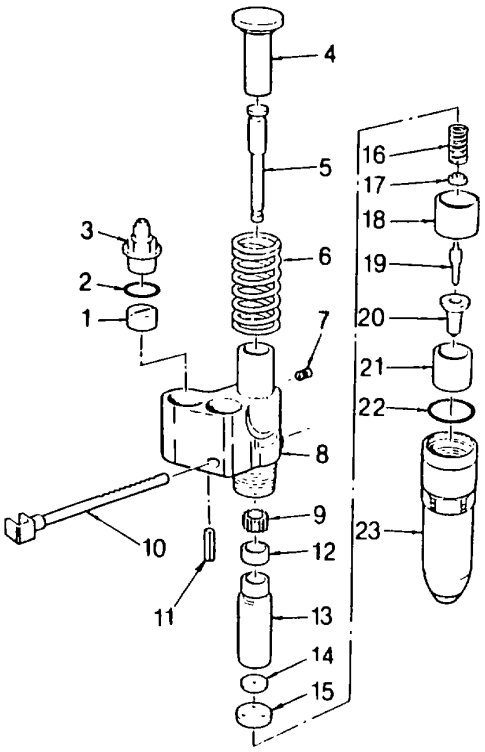
2-19. ENGINE - Continued

2-19.5 Injectors - Continued

(32) Rotate the Injector one complete turn and note the total runout on the dial.

(33) If total runout exceeds 0.008 in. (0.20 mm) remove the injector from the gage. Loosen the injector nut, recenter the spray tip by rotating. Then retighten nut to 75 ft lb (115 Nm) and repeat the concentricity test. If the spray tip cannot be repositioned, rebuild the injector with a new nut.

(34) Perform tests a, c, and d detailed in TEST preceding. The injector must pass all tests prior to service. If it fails, repeat all disassembly, inspection, and assembly instructions.



d. Fuel Injector Tube Repair

NOTE

Injector tube cannot be repaired. If the tube leaks it should be replaced. Cylinder head must be removed to carry out this task.

(1) Remove cylinder head as detailed In para. 2-19-8.

(2) Place the injector tube installer J5286-4B in the injector tube. Insert the pilot J5286-5 through the small opening of the injector tube. Thread the pilot onto the installer. Handtighten the pilot.

(3) Tap on the end of the pilot to loosen the injector tube then lift tube, installer, and pilot out of the cylinder head.

(4) Discard the tube and seal.

(5) Thoroughly clean the injector tube holes in the cylinder head to remove dirt, burrs, or foreign material.

(6) Carefully remove burrs and foreign material. Do not not scratch or dent the sealing surfaces.

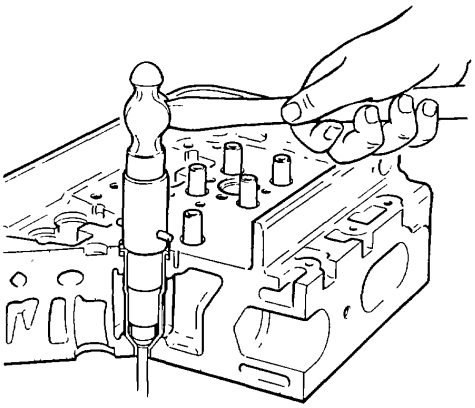
NOTE

Any cylinder head resurfacing must be done prior to injector tube installation.

(7) Lubricate the new injector tube seal with engine oil (item 17, Appendix B). Place in top counterbore of cylinder head.

2-19. ENGINE - Continued

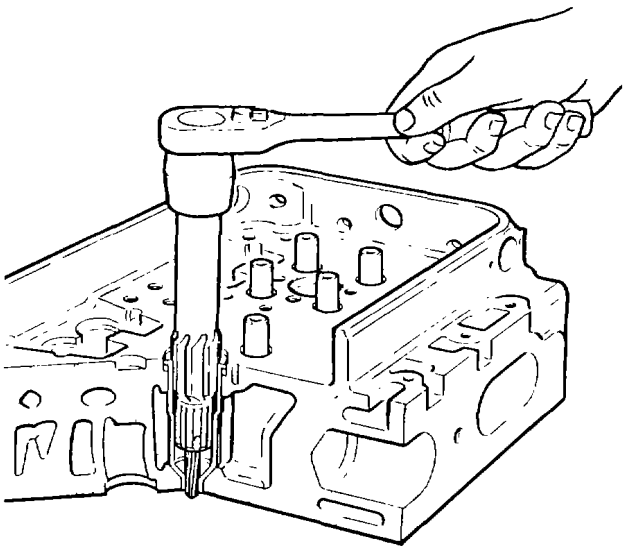
(8) Place installer J5286-4B in new injector tube. Insert the pilot J5286-5 through the small opening of the injector tube. Thread pilot onto installer and handtighten.



(9) Slip injector tube and installer assembly into cylinder head. Drive carefully into place. The injector tube upper flange is used to retain seal. The seal is accomplished between head counterbore (inner diameter) and outside diameter of tube.

(10) Turn cylinder head upside down. Remove pilot J5286-5.

(11) Thread flaring dye J5286-6 onto tapped end of installer J5286-4B.



(12) Using socket and torque wrench apply 30 ft lb (41 Nm) torque to the flaring dye.

(13) Remove all tools from injector tube.

(14) Turn cylinder head right side up and clean injector tube.

(15) Place a few drops of cutting oil (item 8, Appendix B) on reamer J22525-1. Insert reamer carefully into injector tube.

(16) Turn the reamer clockwise. Withdraw every 2 turns to remove chips. Keep cutting until shoulder of reamer contacts the Injector tube. Withdraw reamer and clean injector tube.

(17) Turn cylinder head upside down and place a few drops of cutting oil (item 8, Appendix B) on cutting tool J5286-8. Insert carefully into small hole of injector tube.

(18) Remove excess stock from lower end of tube so tube is flush to 0.005 in. (0.13 mm) below the finished surface of the cylinder head Withdraw cutting tool J5886-8. Clean injector tube.

(19) Insert gage tool J25521 into injector tube. Zero the sled dial indicator J22273 on lower face of cylinder head.

(20) Slide sled dial indicator so its pointer contacts the gage tool. Hold gage tool firmly in injector tube. Dial should read 0 + 0.014 in. (0 + 0.36 mm).

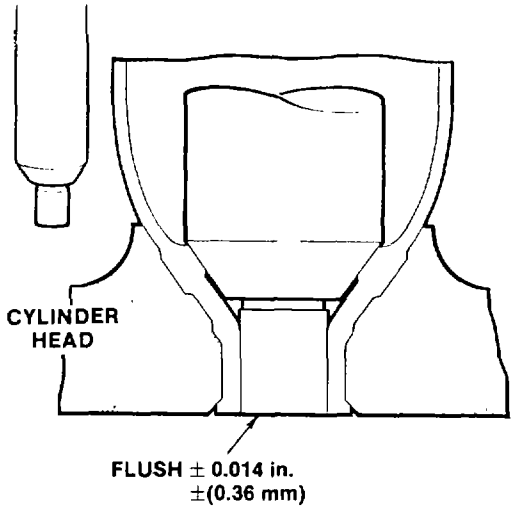
(21) Place a few drops of cutting oil on the bevel seat of the tube Carefully lower reamer J5286-9 into injector tube until it contacts the bevel seat.

2-19. ENGINE - Continued

2-19.5 Injectors - Continued

(22) Make a trial cut by turning the reamer steadily without applying downward force. Remove the reamer. Blow out any chips and look at the bevel seat. Note which portion of the seat has been cut (shiny).

(23) Lower the reamer again and resume cutting. Proceed in 2 turn operations, removing chips each time. When the gage tool is flush to -0.014 in. (0.36 mm) with the lower face of the cylinder head, stop cutting. (For checking, repeat steps 19 and 20 preceding).



WARNING

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Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment. (24) Wash the interior of the injector tube with dry cleaning solvent (item 10, Appendix B) and dry with compressed air.

2-19. ENGINE - Continued

2-19.6 Injector Controls.

This task covers: a. Adjustment
b. Removal
c. Installation
d. Repair

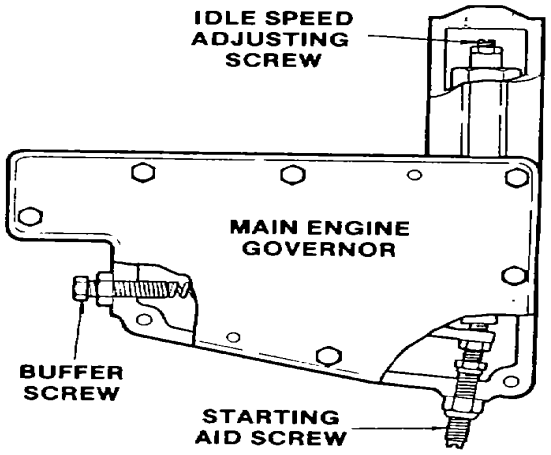
TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J23190 Injector Rack Gage
J25560 Injector Rack Gage
J25558 Throttle Delay Pin Gage

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Covers Removed (see TM 5-4210-220-12)
Both Rocker Covers Removed (see para. 2-19.3)

MATERIALS/PARTS
17, Appendix B Engine Oil
5149510 Rocker Cover Gasket

ADJUSTMENT

Before adjusting injector controls, be sure exhaust valves have correct clearance, injectors have been timed, and governor gap has been set up.



(1) Disconnect foot throttle and pump governor from main engine governor as detailed in para. 2-19.12.

(2) Turn the governor idle speed adjusting screw (1) until 1/2 In. (13 mm) of threads project from the locknut when the nut is against the high speed plunger.

(3) Back out the buffer screw about 5/8 in. (16 mm).

(4) Loosen the throttle delay U-bolt (1) on the right bank until the fuel rack rotates freely.

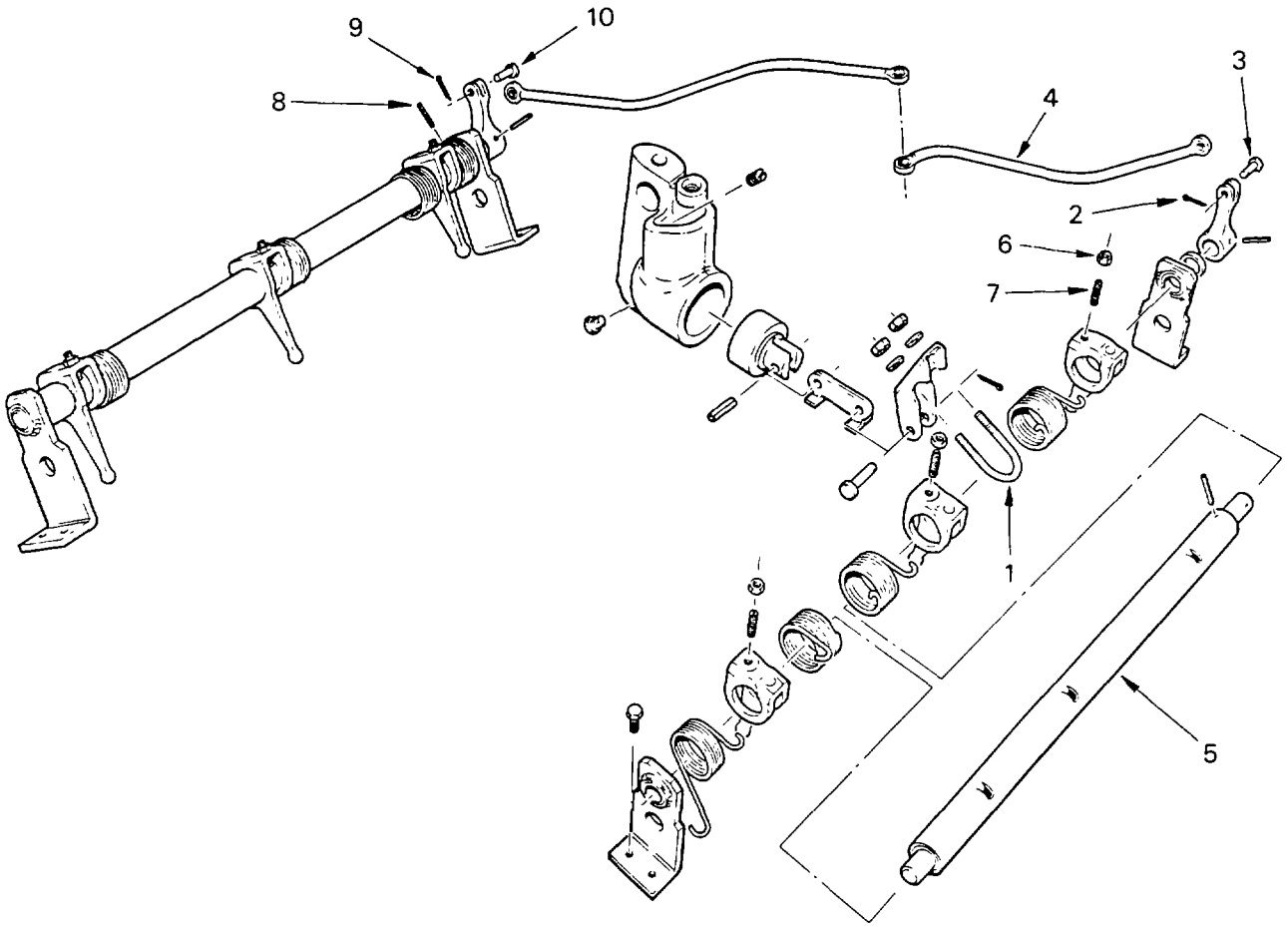
(5) Remove the split pin (2) and clevis pin (3) from the right hand fuel rod (4) and injector control tube lever (5).

(6) Loosen all the rack control lever adjusting screws (7) and locknuts (6).

(7) Move the speed control lever to the maximum speed position with light finger pressure.

(8) Tighten the adjusting screw (8) of No. 1 cylinder left bank (No. 1 L) until the injector rack clevis is seen to roll up, or the effort to turn the screwdriver increases Tighten the screw another 1/8 turn and lock in place with the locknut.

2-19. ENGINE - Continued



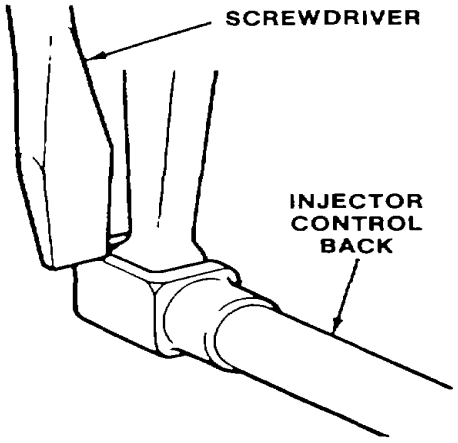
(9) Check the torque by pushing down on the injector rack with the tip of a screwdriver. The rack should swivel freely about it's axis, when released it should spring back upward

(10) Remove the split pin (9) and the clevis pin (10) from the left hand fuel rod and injector control tube lever

(11) Install the clevis pin (3) and split pin (2) to connect the right hand fuel rod and injector control tube lever.

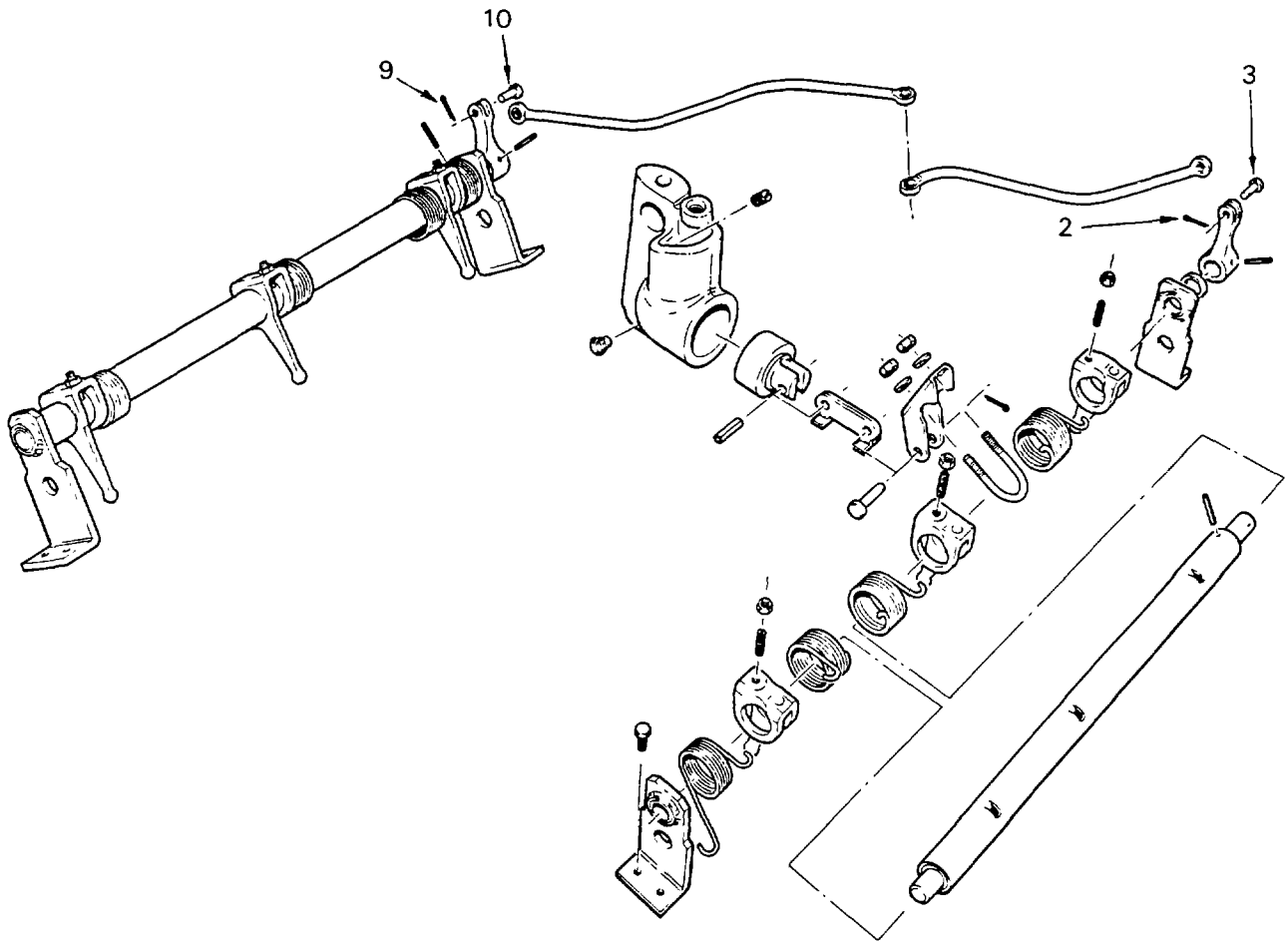
(12) Repeat steps 7 thru 9 for the No. 1 R injector control rack lever.

(13) Do not alter No. 1L and No. 1R settings once completed.



2-19. ENGINE - Continued

2-19.6 Injector Controls - Continued



(14) Remove spring pin (2) and clevis pin (3) from right hand fuel rod and injector control tube lever.

(15) Hold the left hand injector control tube lever in the full-fuel position and adjust all left-hand control rack levers as In steps 8 and 9.

(16) Repeat step 15 for the right hand control rack levers, setting these against No. 1R.

(17) When all are adjusted, check each one is free to move as detailed in step 9.

(18) Insert clevis pins (3 and 10) into the fuel rod and injector control tube levers and install split pins (2 and 9)

2-19. ENGINE - Continued

(19) Turn the idle speed adjusting screw in until it project 3/16 in. (4.8 mm) from the locknut.

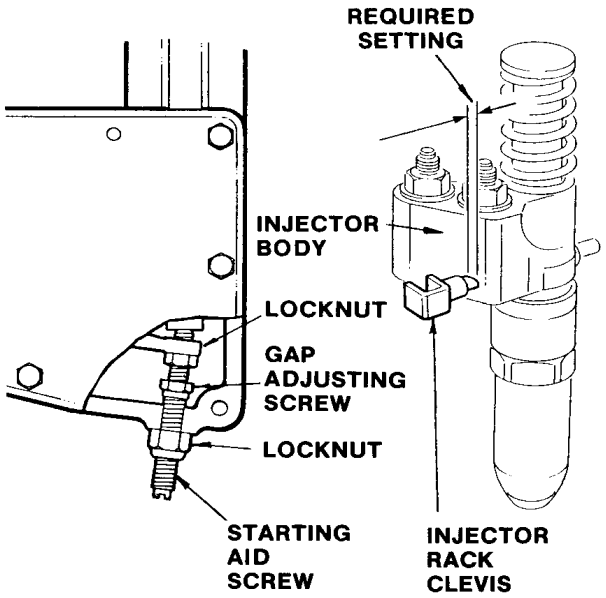
(20) Place the governor stop lever in the run position and the speed control lever in the idle position.

(21) Adjust the starting aid screw until the gage J23190 exactly fits the gap

(22) Retighten starting aid screw locknut.

(23) Recheck the gap after moving speed control lever to maximum speed and back to idle a few times. Adjust starting aid screw as required.

(24) Fill the throttle delay reservoir (detent in top of mechanism) with engine oil (item 17, Appendix B).

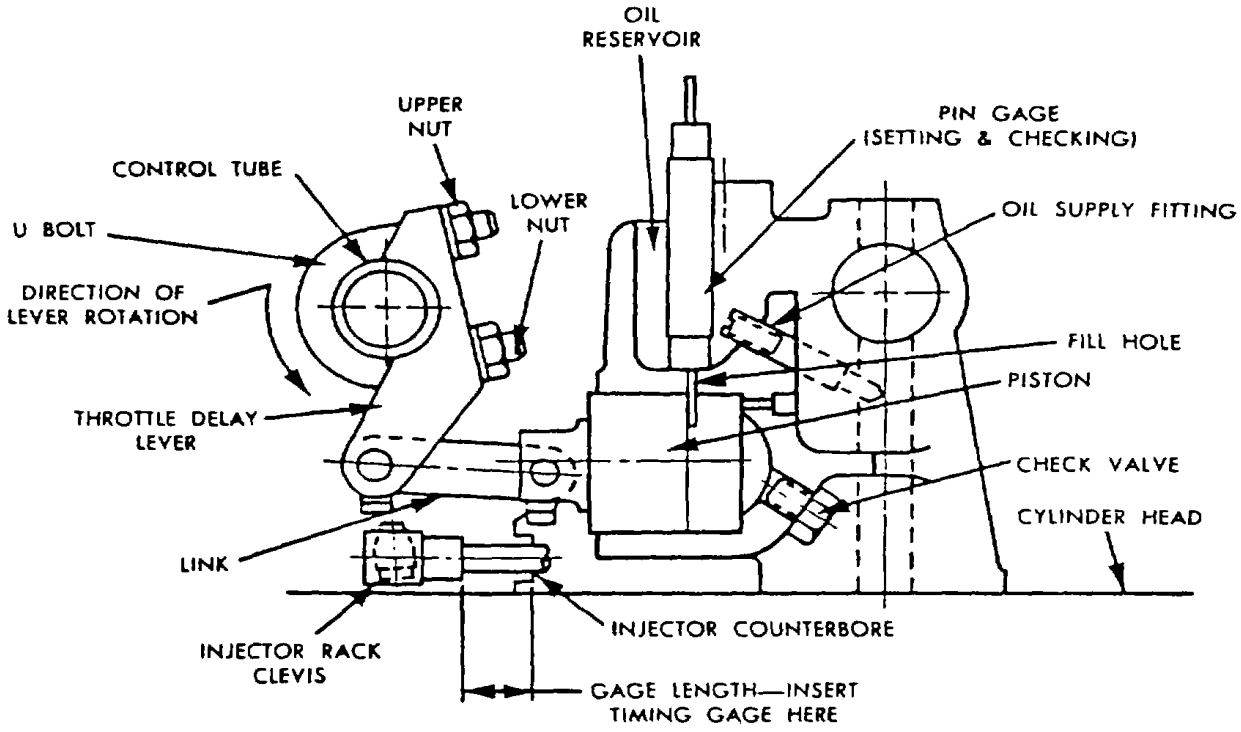


(25) Insert the rack gage J25560 on the rack between No. 2R injector body and the shoulder on the injector rack clevis.

(26) Hold the governor throttle lever in the maximum position.

(27) Insert pin gage J25558 with the green 0.069 in. (1.75 mm) end in the cylinder fill hole as shown. Use the hole to the rear of the engine.

(28) Rotate the throttle delay lever in the direction shown until further movement is limited by the piston contacting the gage.



2-19. ENGINE - Continued

2-19.6 Injector Controls - Continued

(29) Tighten the U-bolt while exerting a slight pressure on the lever **In** the direction of rotation.

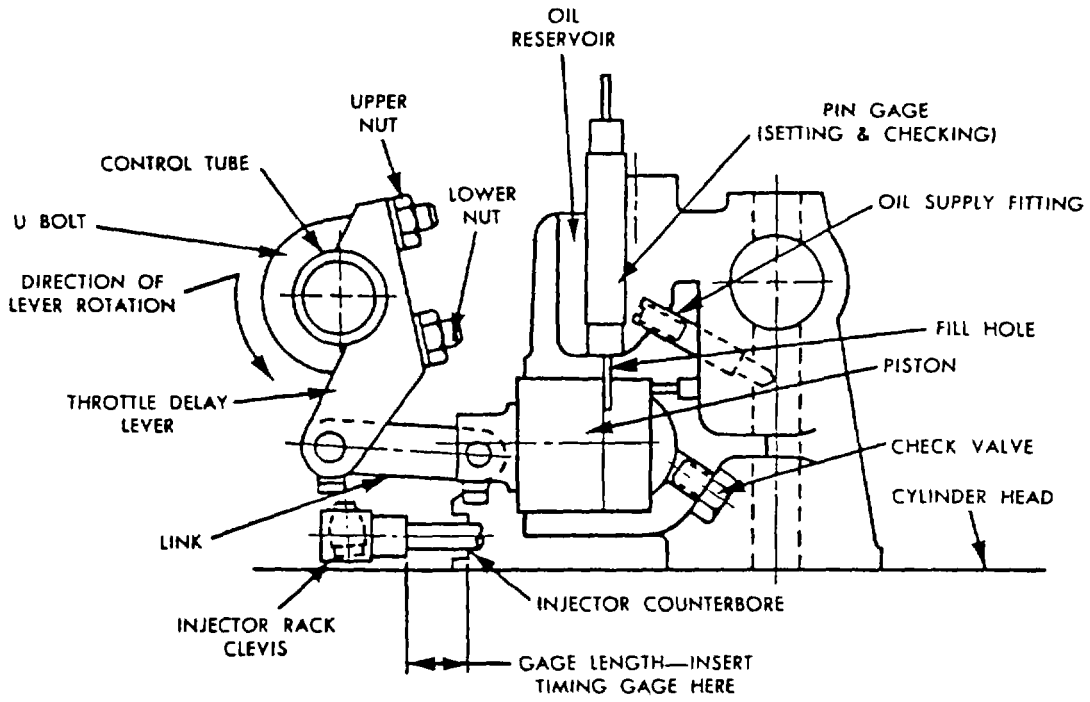
(30) Remove pin gage and reinsert green end. If it enters with no resistance tighten lower U-bolt nut.

(31) Insert the red end of the gage. If it enters to full depth tighten upper U-bolt nut. This end should not enter without moving the injector racks toward the no-fuel position.

(32) Remove pin gage and timing gage.

(33) Move the control tube assembly between the no-fuel and full-fuel position to make sure there is no bind.

(34) Adjust governor maximum no-load speed and idle speed as detailed in para 2-19.13.



REMOVAL

(1) Remove U-bolt (4) securing throttle delay actuator to the right-hand injector control tube assembly.

(2) Remove cotter pin (3) and clevis pin (2), securing each fuel rod (1) to the injector control tube.

(3) Remove the bolts (5) from all brackets (6).

(4) Disengage the rack levers from the injector control racks and lift each control tube assembly from the cylinder head

2-19. ENGINE - Continued

INSTALLATION

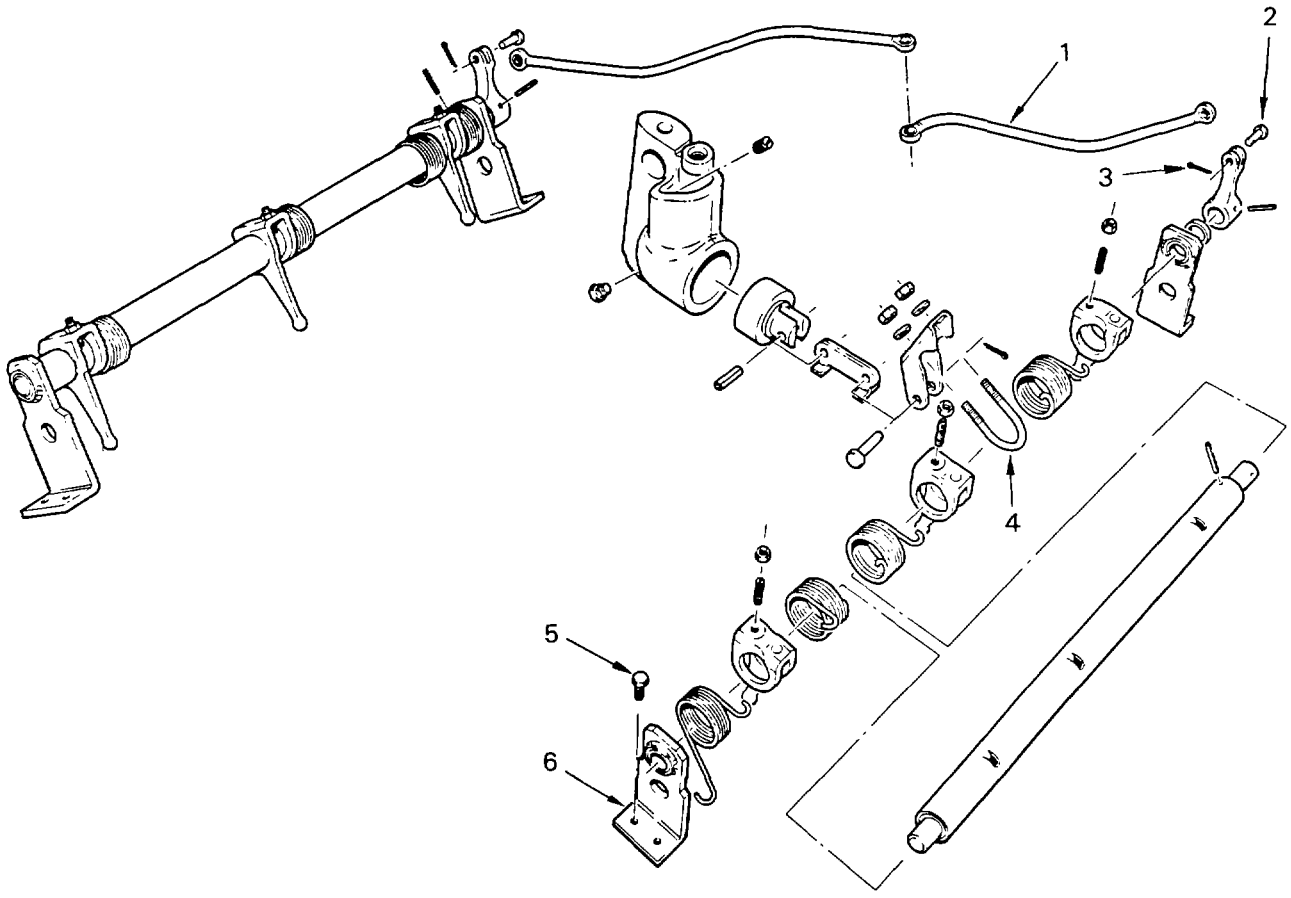
(1) Engage the injector rack control levers with the injector control racks and aline brackets (6) with the mounting holes on the cylinder head.

(2) Install bolts (5) at each bracket (6) and tighten to 12 ft lb (16 Nm).

(3) Check the control tube is free to move **In** the brackets. Tap the control tube gently, if necessary, to aline the bearings in the brackets.

(4) Connect the fuel rods (1) to the injector tube levers with clevis pins (2) and new cotter pin (3).

(5) Adjust the fuel rack as detailed in ADJUSTMENT preceding.



2-19. ENGINE - Continued

2-19.6 Injector Controls - Continued

REPAIR

NOTE

The injector control tube, one mounting bracket, a spacer and an injector control tube lever are available as a service assembly. When any part of this assembly requires replacing, the complete service assembly should be replaced. (Items 1 - 6 on the illustration).

Similar procedures apply to both control tube assemblies except as noted. To repair, control tube assembly must be removed from cylinder head.

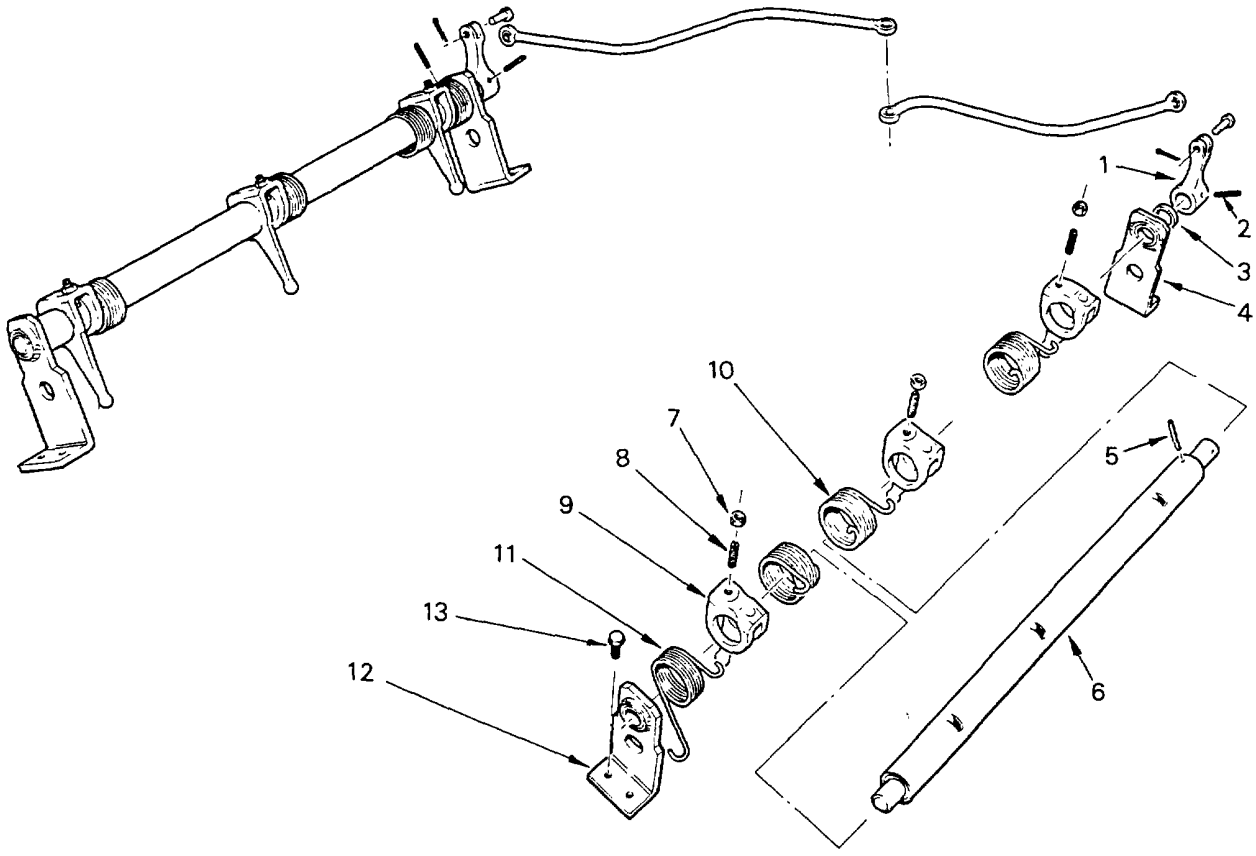
(1) On right hand tube, disconnect spring (11) and remove bracket (12) from control tube. On left hand tube, remove bracket only.

(2) Loosen the adjusting screws (8) and locknuts (7) on each Injector rack control lever.

(3) Disconnect the yield springs (10) from each rack lever and roll the other end of the spring out of the notch on the control tube.

(4) On left hand tube, disconnect spring (11) from the front bracket.

(5) Slide springs (10 and 11) and rack levers from the control tube.



2-19. ENGINE - Continued

WARNING

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(6) Wash all parts in dry cleaning solvent (item 10, Appendix B) and dry with compressed air.

(7) Examine all components for excessive wear cracks or damage and replace as required. Examine bearings in each bracket as detailed in para. 2-7 and replace bracket and bearing assembly as required.

(8) Examine the yield and return springs and replace if worn or fractured.

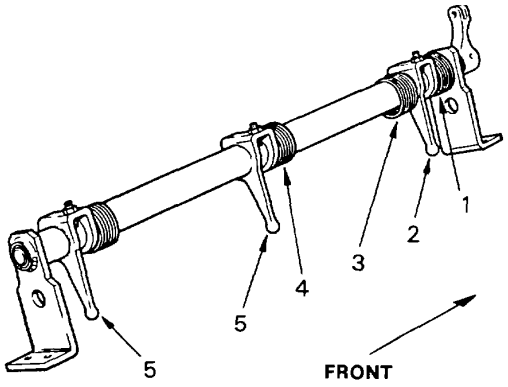
(9) For left bank cylinder head carry out steps 10 thru 15 and 21. For right bank cylinder head carry out steps 16 thru 21.

(10) Install the return spring (1) on the control tube and against the front bracket.

(11) Install a rack control lever (2) with the lever towards the rear bracket, and the odd (left hand helix) yield spring (3).

(12) Install the right hand helix yield spring (4) and rack control levers (5) with the levers facing the rear bracket.

(13) Attach the curled end of the yield springs to the rack control lever and roll the yield springs into the notch or slots.



(14) Turn the adjusting screws and locknuts into the slots only far enough to position the levers on the control tube.

(15) Attach the curled end of the control tube return spring to the rack control lever and the extended end of the spring behind the front bracket.

(16) Install the rack control levers (1) with the levers towards the front bracket and the right hand helix yield spring (2).

(17) Install the left hand helix yield spring (3) and the rack control lever (4) with the lever towards the front bracket.

(18) Attach the curled end of the yield springs to the rack control levers and roll the springs into the notch (left hand helix spring) and the slots (right hand helix springs) in the control tube.

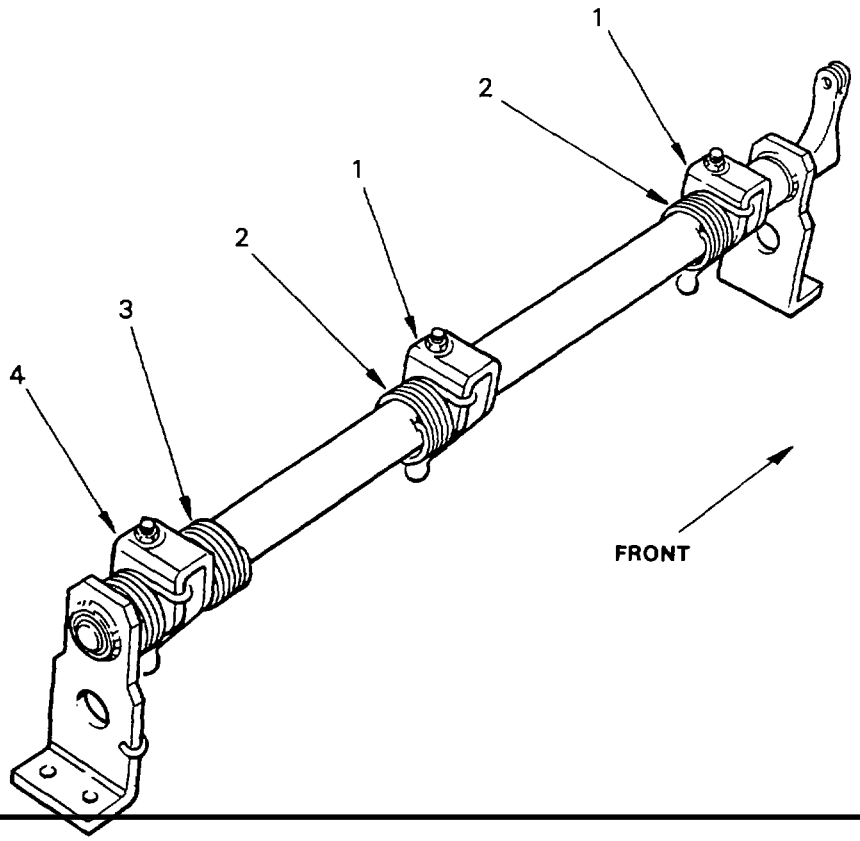
2-19. ENGINE - Continued

2-19.6 Injector Controls - Continued

(19) Turn the adjusting screws and locknuts into the slots only far enough to position the levers on the control tube.

(20) Install the control tube return spring and rear bracket on the control tube. Attach the curled end of the return spring to the rack and the extended end of the spring behind the rear bracket.

(21) Install control racks as detailed in INSTALLATION preceding.



2-19. ENGINE - Continued

2-19.7 Exhaust Valves.

This task covers:
a. Adjustment
b. Removal
c. Inspection
d. Installation
e. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J22582 Engine Barring Tool
J7455 Valve/Spring Removal Tool
J9708-01 Feeler Gage
J22738-02 Spring Tester
J5437 Valve Guide Brush
J8932-01 Fuel Pipe Socket
J25076-B Spring Checking Gage
8921209 Exhaust Valve Guide Seal

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (TM 5-4210-220-12)
LH and RH Engine Covers Removed (see TM 5-4210-220-12)
Top Exhaust System Elbow Removed (see TM 5-4210-220-12)
Both Rocker Covers Removed (see para. 2-19.3)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
15, Appendix B Gear Oil
17, Appendix B Engine Oil
18, Appendix B Masking Tape
5149510 Rocker Cover Gasket
5147347 Exhaust Valve Spring
5149041 Exhaust Valve Kit

PERSONNEL REQUIRED - 2

ADJUSTMENT

NOTE
This is the first task in any tune-up.

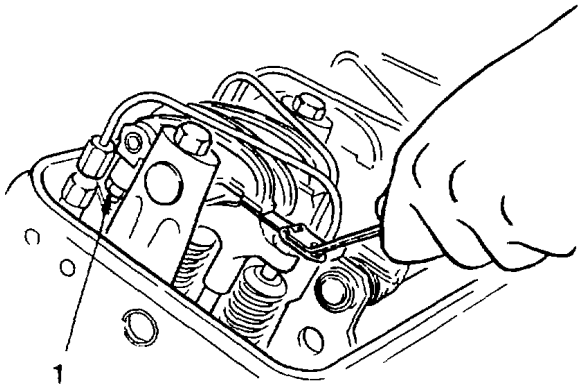
Exhaust valve bridge is adjusted during valve installation; the push rod only is adjusted after the engine is rebuilt. Rocker must be removed as detailed in para. 2-19.3.

(1) Cover any drain cavities in cylinder head to prevent foreign material entering.

(2) Allow engine to cool completely; must be less than 100 deg. F (38 deg. C).

(3) Ensure governor speed control lever is in the idle position and stop lever is in the stop position. This is the normal setting when engine is shutdown.

(4) Remove starter motor and install barring tool J22582 (see TM 5-4210-220-12 for starter motor removal) or barr engine using starter motor or wrench on the crankshaft pulley bolt (if using wrench, do not rotate engine in left-hand direction because this may loosen the bolt).



2-19. ENGINE - Continued

(5) Barr engine until the injector follower on No. 1L cylinder is fully depressed.

(6) Loosen the exhaust valve rocker arm push rod locknut (1).

(7) Place a 0.016 + 0.004 in (0.41 + 0.01 mm) feeler gage (Tool J9708-01) between the valve bridge and the valve rocker arm pallet as shown.

(8) Adjust the push rod to obtain a smooth pull on the feeler gage.

(9) Remove the feeler gage. While holding the adjusting nut with one wrench, tighten the locknut with a second wrench.

(10) Recheck the clearance. A 0.15 in. (0.38 mm) gage will pass freely between the valve bridge , and the rocker arm pallet. A 0.17 in. (0.43 mm) feeler gage will not pass through.

(11) Readjust push rod, if required.

(12) Adjust and check all exhaust valves in the same manner. If carried out in the following order, all valves can be checked in one engine revolution: 1L, 3R. 3L, 2R, 2L, 1R.

(13) Replace rocker covers temporarily.

(14) Run engine to normal operating temperature and check exhaust valve clearance with a 0.013 in. (0.33 mm) gage. This should pass freely between the valve bridge and the rocker arm whereas a 0.015 in. (0.38 mm) gage will not. It is essential that the engine remain at or very close to normal operating temperature when carrying out these checks.

(15) Readjust push rods as required.

(16) When complete, check the fuel injector timing as detailed in para. 2-19.5.

REMOVAL

a. Exhaust Valve Spring Removal

NOTE

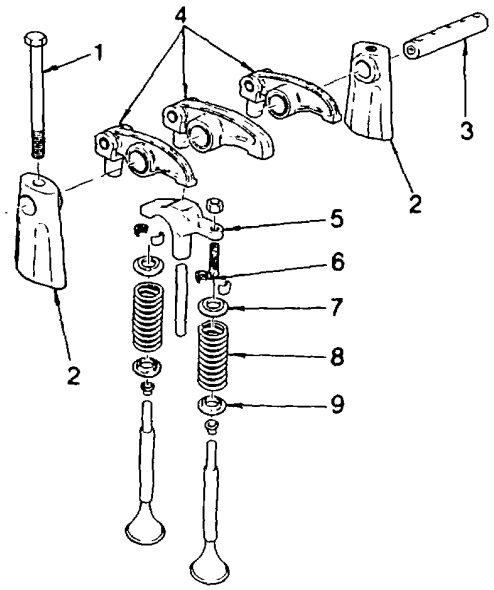
This may be removed with the cylinder head installed. For valve and spring removal with head removed, see b. following. This procedure is for one spring; repeat for all springs on each head, as required.

(1) Remove starter motor and install barring tool J22582 (see TM 5-4210-220-12 for starter motor removal) or barr engine using starter motor or wrench on the crankshaft pulley bolt. (If using wrench, do not rotate engine in left-hand direction because this may loosen the bolt).

(2) Barr the engine to bring the valve and injector arms in line horizontally on the relevant cylinder.

2-19. ENGINE - Continued

2-19.7 Exhaust Valves - Continued



(3) Tag and remove the injector fuel pipes from the injector and fuel connectors.

(4) Cover each injector opening and the fuel pipe openings with shipping caps to prevent the entry of foreign material.

(5) Remove the two bolts (1) holding the rocker arm shaft brackets (2) to the cylinder head. Then remove the brackets and shaft (3)

(6) Flip over the rocker arms (4) and lift off the exhaust valve bridge (5).

(7) Remove the cylinder block air box cover so that piston travel may be observed, then turn the crankshaft until the piston is at the top of its stroke.

(8) Thread the valve spring compressor adaptor J7455 into the rocker arm bracket bolt hole in the cylinder head. Compress the valve spring and remove the two-piece tapered valve lock (6).

(9) Release the tool and remove the spring cap (7), valve spring (8), and spring seat (9).

b. Exhaust Valve Removal

NOTE

Cylinder head must be removed, see para. 2-19.8. The following instruction may be used for the right hand or left hand cylinder head.

(1) Support the cylinder head on 2 in. thick wood blocks to keep the cam followers clear of the bench. Be careful not to damage or scratch the seal area around the intermediate water nozzles.

(2) Remove the fuel pipes from the injector and fuel connectors. Cover the fuel pipe and injector openings with shipping caps to prevent entry of foreign material.

(3) Remove the two bolts (1) holding the rocker arm shaft brackets (2) to the cylinder head. Remove the brackets (2) and shaft (3).

(4) Remove the fuel injectors as detailed in para. 2-19.5.

(5) Flip over the rocker arms (4), and lift off the exhaust valve guide bridge (5).

(6) Place a block of wood under the cylinder head to support the exhaust valve being removed.

(7) Thread the valve spring compressor J7455 into the rocker arm bracket bolt hole in the cylinder head.

2-19. ENGINE - Continued

(8) Compress the valve spring and remove the two piece tapered valve lock (6).

(9) Release the tool and remove the spring cap (7), valve spring (8) and spring seat (9). Repeat steps 6 thru 9 for each valve, as required.

(10) Turn the cylinder head over using care to keep the valves from falling out of the head.

(11) If the valves are to be reused, number each valve to facilitate reinstallation in the same location. Withdraw the valves from the cylinder head.

(12) Remove the cam followers and push rod assemblies as required. See para. 2-19.4.

INSPECTION

WARNING

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Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(1) Clean the springs with dry cleaning solvent (item 10, Appendix B) and dry them with compressed air. Inspect springs for pitting or fractures. Replace any damaged spring.

(2) Install each spring in spring tester J22738-02. Replace any spring which compresses to less than 1.80 in. (45.7 mm) with a load of 25 lb (11.3 kg).

(3) Inspect the valve spring seats and caps for wear. Replace if worn.

(4) Examine the contact surfaces of the exhaust valve bridge guides, bridges and adjusting screws for wear and galling. Replace excessively worn components.

(5) Inspect valve face and seats. Black carbon deposits on the face could indicate blow-by due to a faulty seat. Deposits extending from the seats to the valve guides may result from cold operation due to light loads or using of too heavy a grade of fuel.

(6) Rusty brown valve heads with carbon deposits forming narrow collars near the valve guides is evidence of high temperature due to overloads, inadequate cooling or improper timing.

(7) Clean the valve stems. Inspect for scuff marks or scratches. The valve faces must be free from ridges, cracks or pitting. If necessary reface the valves or install new valves. If valve heads are warped, replace the valves.

(8) If there is evidence of engine oil running down the exhaust valve stem into the exhaust chamber, creating a high oil consumption condition, replace the valve guide oil seals (see INSTALLATION following).

2-19. ENGINE - Continued

2-19.7 Exhaust Valves - Continued

(9) Clean the inside of the valve guides with brush J5437 to remove all gum and carbon deposits from the guides. Check the spiral grooves are clean.

(10) Inspect the valve guides for fractures, chipping, scoring, or excessive wear. Measure the valve guide inside diameter with a pin gage or inside micrometer.

(11) Measure the outside diameter of the valve stems with a micrometer. If the clearance exceeds 0.005 in. (0.13 mm), replace valve guides as detailed in REPAIR following.

(12) Inspect the valve seat inserts for excessive wear, pitting, cracking or an improper seat angle. The proper angle for the seating face of the valve is 30 deg., and the angle for the insert is 31 deg. If a valve seat has been reground to such an extent that the grinding wheel contacts the cylinder head, install a new insert.

(13) Check the contact area between the valve and valve seat by applying a light coat of Prussian Blue or similar paste onto the valve seat.

(14) Bounce the valve on the insert and check there is a line of contact around the whole seat. If not or the line is wavy repair the seats as detailed in REPAIR following.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(15) Wash all components with dry cleaning solvent. Be sure all contaminants are removed.

INSTALLATION

(1) Check valve guides are totally clean. Lubricate the valve stems with gear oil (item 15, Appendix B) and slide the valves into the guides. Be sure valves are installed in same location as noted in step 12 of REMOVAL preceding.

(2) Hold the valves in place with a piece of masking tape (item 18, Appendix B) and turn cylinder head over. Place a board beneath the valves to hold them in place.

(3) Install valve spring seats (9).

(4) If new oil seals (10) are being installed, place the plastic seal installation cap on the end of the valve stem. If the cap extends more than 1/16 in. (1.6 mm) below the groove on the valve stem, remove cap and cut off excess length.

(5) Lubricate the installation cap with gear oil (item 15, Appendix B) and start the seal carefully over the valve stem. Push the seal down slowly until the seal rests on top of the valve guide. Remove the installation cap.

(6) Install the valve springs (8) over the guide and place spring caps (7) on top of spring.

2-19. ENGINE - Continued

(7) Thread the valve spring compressor J7455 into one of the rocker shaft bolt holes in the cylinder head.

CAUTION

Compress the valve spring only sufficiently to install the locks. Excessive compression could damage stem oil seals (10).

(8) Apply pressure to the tool arm to compress the spring. Install the two-piece taper valve lock (6).

(9) Give the end of the valve stem a sharp tap with a plastic hammer to seat the *locks.*

(10) Using spring checking gage J25076-B, note the gage reading the moment the exhaust valve starts to open. The minimum pressure must not be less than 20 lb (9.1 kg).

(11) Repeat for all valves.

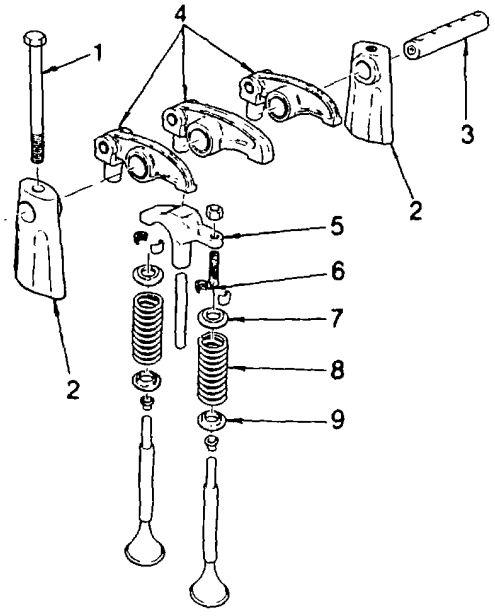
(12) When complete install the injector rocker arms, and push rods. Install the cylinder head on the engine as detailed in para. 2-19.8.

(13) Place the valve bridge (5) in a vise and loosen the locknut on the bridge adjusting screw.

(14) Install the valve bridge on the valve bridge guide (11).

(15) While firmly pressing straight down on the pallet surface of the valve bridge, turn the adjusting screw clockwise until it just touches the valve stem.

(16) Turn the screw an additional 1/8 to 1/4 turn clockwise and tighten the locknut fingertight.



CAUTION

To avoid bending the bridge guide or rear valve stem, never loosen or tighten the locknut with the bridge on the engine.

(17) Remove the valve bridge, install in a vise and while holding the screw tighten the locknut to 25 ft lb (34 Nm).

(18) Lubricate the valve bridge and guide with engine oil (item 17, Appendix B) and install bridge on the guide.

(19) Place a 0.0015 in. (0.038 mm) (feeler gage under each end of the valve bridge. While pressing down firmly on the pallet surface, both feeler gages must be tight. If not tight, readjust screw.

(20) Adjust all bridges similarly.

2-19. ENGINE - Continued

2-19.7 Exhaust Valves - Continued

(21) Swing the rocker arm assembly into position making sure the valve bridges are properly positioned on the rear valve stems. This precaution is necessary to prevent valve damage due to mislocated valve bridges.

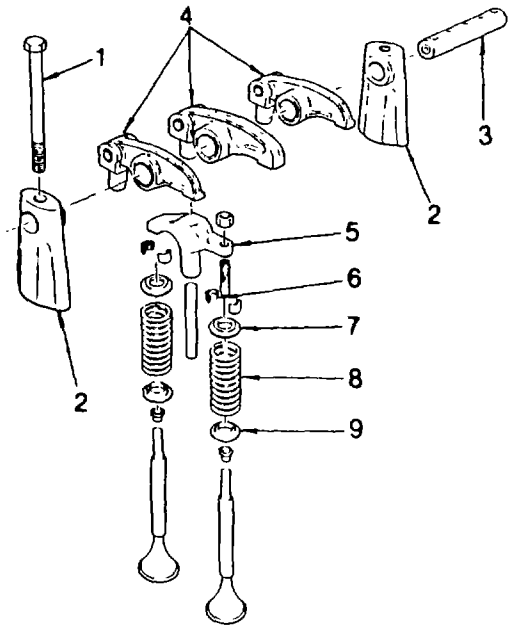
(22) Install the rocker arm shaft brackets (2) and shaft (3).

(23) Install the two bolts (1) holding the brackets to the cylinder head and tighten to 100 ft lb (136 Nm).

(24) Install the fuel pipes between the injectors and fuel connectors. Be sure all shipping caps are removed prior to installation.

(25) Fill the cooling system.

(26) Check the exhaust valve clearance as detailed in ADJUSTMENT preceding.



REPAIR

a. Exhaust Valve Guide Repair

NOTE

The valve guides cannot be repaired; if the valve stem to guide clearance is excessive, replace the valve guide as detailed following.

(1) Pull out the valve guide oil seal and discard.

(2) Support the cylinder head, bottom side up, on 2 in. (50 mm) thick wood blocks.

(3) Using tool J6569 and a hammer, drive the valve guide out from the cylinder head.

(4) Place the cylinder head right side up on an arbor press.

(5) Install the internally threaded end of the valve guide in the installing tool J21520.

(6) Position the guide squarely in the bore in the cylinder head and press the tool J21520 gently to start the guide.

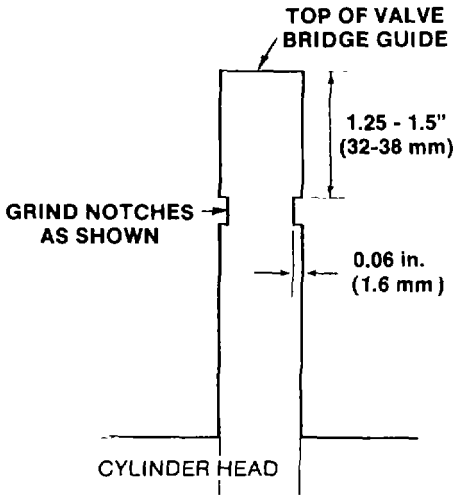
(7) Press the guide in until the tool contacts the cylinder head. The tool installs the guide 0.670 - 0.710 in. (17 - 18 mm) above the top of the cylinder head.

2-19. ENGINE - Continued

b. Exhaust Valve Bridge Guide Repair

NOTE

The valve bridge guide cannot be repaired, replace as detailed following. If the guide is broken refer to instructions 6 thru 9 following.



(1) File or grind two diametrically opposite notches 0.06 in. (1.6 mm) deep in the side of the guide approximately 1.25 1.5 in. (32 38 mm) from the upper end.

(2) Place spacer J7091-3 over the guide.

(3) Slide guide remover J7091-5 over the guide and aline the set screws with the notches in the guide. Tighten the set screws firmly.

(4) Place spacer J7091-4 over the guide remover and thread the nut on the remover. Turn it clockwise to withdraw the guide from the head.

(5) For installation of a valve bridge guide refer to step 10 following.

(6) To remove a broken exhaust valve bridge guide, drill a hole approximately 0.5 in. (13 mm) deep in the end of the guide with a # 3, 0.213 in. (5.41 mm) drill bit.

(7) Tap the guide with 1/4 in. - 28 bottoming tap.

(8) Thread remover J7453 into the guide and attach slide hammer J2619-01 to the tool.

(9) One or two sharp blows with the puller weight will remove the broken guide.

(10) Apply retaining compound (item 23, Appendix B) to the undercut end of the new valve bridge guide.

(11) Start the guide straight into the cylinder head.

(12) Place installer J7482 over the guide and drive it into place. The installer will properly position the guide to the correct height in the cylinder head.

c. Valve Seat Insert Repair

(1) Turn cylinder head bottom side up and support on wooden blocks.

(2) Use the cam operated valve insert puller J23479-35 and collet J23479-33 to remove the insert from the head.

(3) Clean the valve insert counter bore and the new valve seat insert.

2-19. ENGINE - Continued

2-19.7 Exhaust Valves - Continued

(4) Check the dimensions of the counterbore. Diameter should be 1.440 1.441 in. (36.58 36.60 mm) and a depth of 0.3395 0.3505 in. (8.623 8.903 mm). The counter bores should be concentric with the valve guide within 0.002 in. (0.051 mm). If necessary use a valve seat insert which is 0.010 in. (0.25 mm) oversize on the outer diameter.

(5) Immerse cylinder head for 30 minutes in a hot water both at 200 deg. F (93 deg. C).

(6) Rest the cylinder head, bottom side up, on a bench and place a new insert in the counter bore. Check valve seat side is up.

(7) Quickly, to avoid the insert heating up, drive the insert in place with tool J24357, until it seats solidly in the cylinder.

(8) Grind the valve and check for concentricity as detailed in d following.

d. Exhaust Valve And Valve Seat Regrind

NOTE

An exhaust valve may be refaced if necessary. However, to provide sufficient strength and spring tension, the edge of the valve at the valve head must not be less than 0.031 in. (0.78 mm) inch thickness after refacing.

When a new valve seat insert is installed or an old insert is reconditioned, using grinding set J7040 with adaptor set J24566.

CAUTION

Do not permit any grinding wheel to contact the cylinder head. If the wheel will contact the head, install a new insert.

(1) Install a 31 deg. grinding wheel on the grinding tool and dress the valve seat insert.

(2) Open the throat of the insert with the 60 deg. grinding wheel.

(3) Grind the top surface of the insert with a 15 deg. grinding wheel to narrow the width of the seat.

(4) Adjust the center of the 31 deg. face with the 15 and 60 deg. grinding wheels as required.

(5) Clean the valve seat and ensure it is dry.

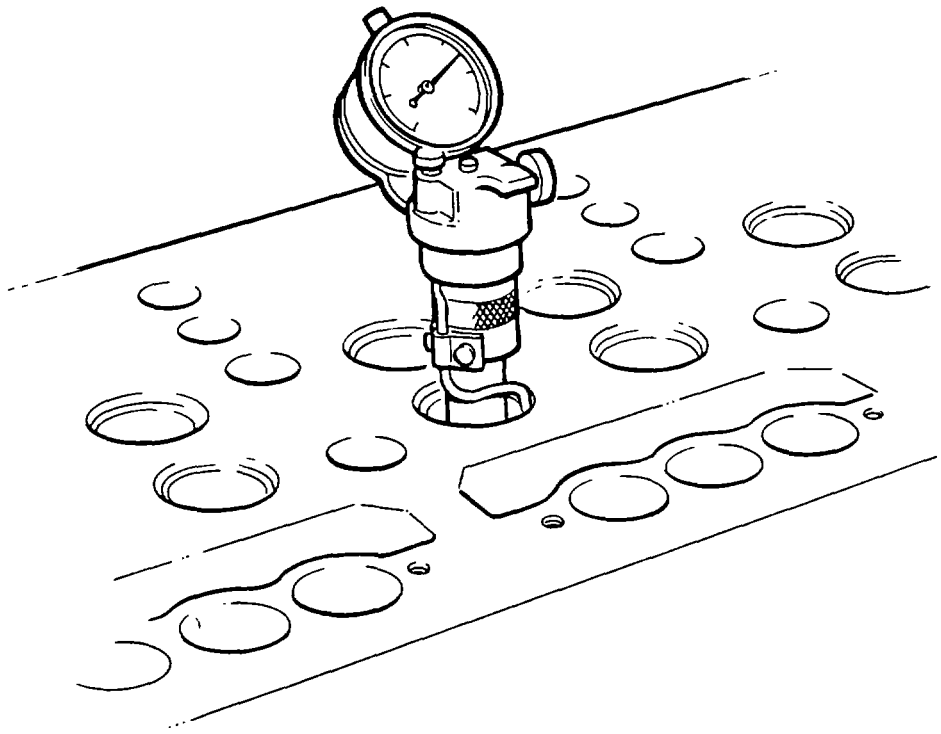
(6) Set dial indicator J8165-2 in position shown and rotate it to determine the concentricity of the valve seat insert relative to the valve guide. If total runout is exceeded, check for a bent or worn valve guide before regrinding the seat. Valve seat runout should be less than 0.0020 in. (0.051 mm).

(7) After completion of grinding, apply a thin coat of Prussian blue to the seat insert.

(8) Bounce the valve in the insert; do not rotate. Check the area of contact. If necessary reface the valve itself.

(9) Use valve refacing equipment, and grind valve face to 30 deg. Keep dimensions within tolerances shown.,

2-19. ENGINE - Continued



2-19. ENGINE.

2-19.8 Cylinder Head.

This task covers:
a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J22062-01 Cylinder Head Lifting Tool
J3172 Feeler Gage
J24565-02 Piston Liner Clamp
J24898 Depth Gage
J24748 Guide Studs

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-420-220-12)
Engine Coolant Drained (see TM 5-420-220-12)
LH and RH Engine Covers Removed (see TM 5-4210-220-12)
Exhaust System Top Elbow Removed (see TM 5-420-220-12)
Exhaust Manifolds Removed (see para. 2-19.1)
Fuel Lines To And From Cylinder Head Removed (see TM 5-420-220-12)
LH and RH. Thermostat Housings Removed (see TM 5-4210-220-12)
Fuel Shutdown Plate Removed (see para. 2-19.13)
Mechanical Governor Top Cover Removed (see para. 2-19.13)
Fuel Rods Removed From Governor (see para. 2-19.13)
Fuel Injector Controls Removed (see para. 2-19.6)
Rocker Cover Removed (see para. 2-19.3)

MATERIALS/PARTS
4, Appendix B Antiseize Compound
10, Appendix B Dry Cleaning Solvent
22, Appendix B Pipe Sealant
29, Appendix B Threadlock Liquid
5149510 Rocker Cover Gasket
5199673 Cylinder Head Gasket Set

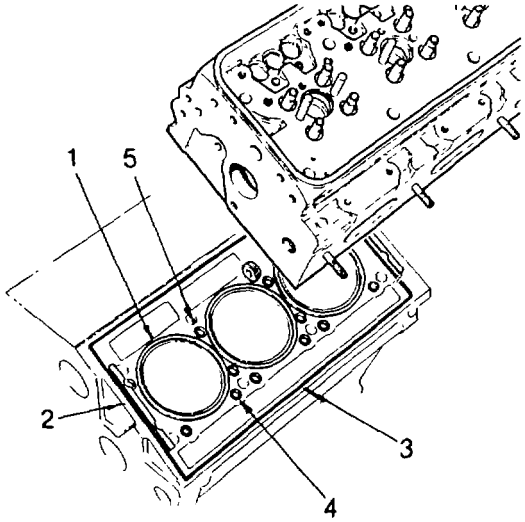
PERSONNEL REQUIRED - 2

REMOVAL

(1) If the cylinder head is to be disassembled for reconditioning of the exhaust valves and seats, or for complete overhaul, or replacement, remove the fuel pipes and injectors as detailed in para. 2-19.5.

(2) Check and note the torque on the cylinder head bolts. Examination of compression gaskets and seals after head removal together with these torque values may reveal the causes of any cylinder head problems.

(3) Attach cylinder head lifting tool J22062-01 to the head being removed.



(4) Starting at the end of the head and working diametrically, progressively loosen all bolts and washers and remove from head.

(5) Lift head carefully from block. Do not lay it flat bottom side down or drag it bottom side down. Lay it on 2 in. (50 mm) wood blocks to protect the cam followers and injector spray tips.

(6) Remove and discard the cylinder head compression gaskets (1), support shims (2), oil seals (3 and 4), and water seals (5).

(7) Drain the lubricating oil from the engine. Draining at this time will ensure any coolant that may have contaminated the oil when the head(s) were removed is drained with the oil.

INSPECTION

NOTE

If a service replacement head is to be installed, clean off all rust preventative compound before installing the pipe plugs. Immerse the head in a bath of dry cleaning solvent (item 10, Appendix B) and scrub with a bristle brush. Clean all passages using brush J8152 with an attached brass rod extension handle.

A service replacement cylinder head includes the exhaust valve guides, valve seat inserts, water nozzles, injector tubes, pilot sleeves, valve bridge guides, valve spring seats and all necessary plugs, shims, studs, cover plates, gaskets, lockwashers, and nuts. If complete disassembly of the cylinder head is necessary, remove the exhaust valves and injectors as detailed in para. 2-19.7 and para. 2-19.5 respectively.

(1) Steam clean the cylinder head; if the water passages are heavily coated with scale, remove all components including all pipe plugs, injector tubes and water nozzles and place head in an acid pickling bath until all scale is removed.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

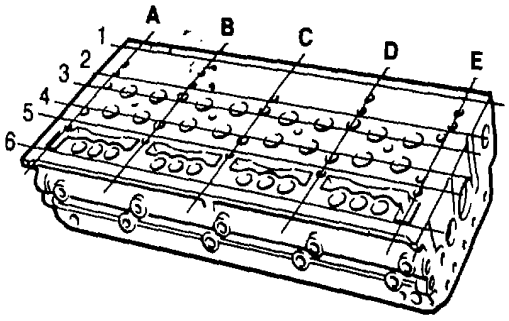
(2) Clean the cylinder head components with dry cleaning solvent (item 10, Appendix B) and dry with compressed air.

(3) Before a cylinder head can be reused, it must be inspected for cracks. Refer to para. 2-7 for magnetic particle and fluorescent and non-fluorescent methods. The head can also be checked by carrying out a pressure test with tool J28454.

2-19. ENGINE - Continued

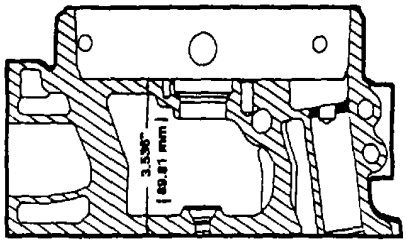
2-19.8 Cylinder Head - Continued

(4) Using a heavy accurate straight edge and feeler gage J3172, check for longitudinal and transverse warpage of the head as shown. The maximum longitudinal warpage allowable is 0.0055 in. (0.140 mm); the maximum transverse warpage allowable is 0.0040 in. (0.102 mm).



CAUTION

To prevent failure of an engine when rebuilt, do not remove more metal from the fire deck of any cylinder head below the minimum distance of 3.536 in. (89.81 mm).



(5) The cylinder head may be refaced provided the injector tubes are removed prior to machining. The water nozzles may remain in the head.

(6) After refacing the head, the protrusion of valve seat inserts (2-19.7), exhaust valves (2-19.7), injector tubes (2-19.5) injector spray tip spray tips (2-19.5), and push rods (2-19.4) must be checked and corrected. The water nozzle bores must also be deburred.

(7) Inspect the exhaust valve seat inserts and the valve guides as detailed in 2-19.7.

(8) Inspect the cam follower bores in the cylinder head for scoring or wear. Light score marks may be cleaned up with emery cloth (item 13, Appendix B).

(9) Measure the diameter of the cam followers with a micrometer and compare with similar readings for each bore. The follower cylinder head clearance must not exceed 0.006 in. (0.15 mm) with used parts. If the bores are excessively worn or scored replace the cylinder head.

(10) Check the water hole nozzles for looseness. Replace nozzles if loose as detailed in REPAIR following.

(11) Replace broken or damaged studs. Apply threadlock liquid (item 29, Appendix B) to the new studs. Install and torque to 40 ft lb (54 Nm).

(12) Inspect the pilot sleeves in the cylinder head bolt holes at each end of the head on the camshaft side. Replace any damaged or loose sleeves using an arbor press (these sleeves are installed to provide a close fit for the cylinder head bolts used when installing the head on the engine).

(13) If injectors are removed, remove all cylinder head to-fuel pipe connectors and inspect for damaged threads. Remove all seals and discard.

(14) Coat all plugs that were removed cleaning for with pipe sealant (item Appendix B) and install. Tighten to the following torques.

NPT Size	Recommended Torque	
1/8-27	12 ft lb	(16 Nm)
1/4-18	16 ft lb	(22 Nm)
3/8-18	22 ft lb	(30 Nm)
1/2-14	27 ft lb	(37 Nm)
3/4-14	37 ft lb	(50 Nm)

2-19. ENGINE - Continued

Be sure all headless plugs are flush to 0.0625 in. (1.6 mm) below the surface of the cylinder head. A 3/8 in. socket head plLG is installed about 1 in. (25 mm) away from the 2 in. plug on the push rod side. This plug must not protrude more than 0.0625 in. (1.6 mm) from the block and a 0.2188 in. (5.56 mm) rod placed in the vertical fee hole must pass the inner face of the plug.

(15) If removed, install the exhaust valves and seats, as detailed in para. 2-19.7.

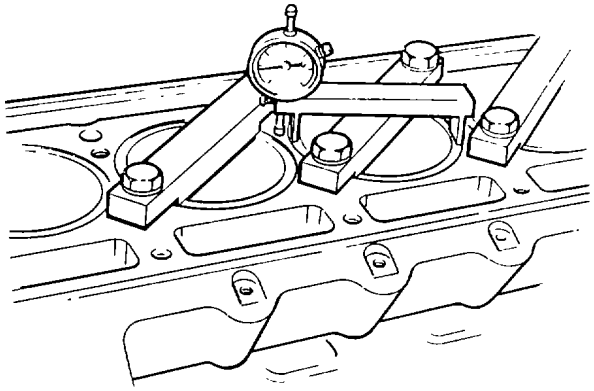
(16) If removed, install the rocker arms, cam followers, and push rods as detailed in para. 2-19.4.

(17) If removed, replace all cylinder head-to-fuel pipe connector seals. Install all connectors and tighten to 45 ft lb (61 Nm).

INSTALLATION

(1) Check the cylinder liner flange heights with respect to the cylinder block using hold down clamp J24565-02 and depth gage J24898.

(2) The liner flange must be 0.0418 0.0482 in. (1.0621 1.224 mm) below the surface of the block. The difference in height between two adjacent cylinders must not exceed 0.015 in. (0.38 mm). If these limitations are not satisfied refer to General Support for repair.



(3) Be sure piston crowns are clean and free of foreign material.

(4) Be sure each push rod is threaded into its clevis until the end of the push rod projects through the clevis.

(5) Be sure all cylinder block and cylinder head gasket surfaces, counterbores, and seal grooves are free of foreign material and are clean.

(6) Be sure there are no burrs or sharp edges in the head or block counterbores.

(7) Inspect the cylinder head bolt holes in the block and remove any water, oil or other foreign material. Check for any damaged threads.

CAUTION

The 2.00 in. diameter cup plug (thermostat housing end) in a new service head must be removed prior to installation to prevent blocking the coolant flow out of the head.

(8) Install a new compression gasket on top of each cylinder liner.

(9) Remove the adhesive paper, and place the support shims, adhesive side down in position at each end of the cylinder block. The scallop in the shim placed at the rear of the block must be at the oil supply hole.

2-19. ENGINE - Continued

2-19.8 Cylinder Head - Continued

(10) Place new seal rings in the counter bores of the water and oil holes in the cylinder block (13 rings altogether).

(11) Install a new oil seal in the groove around the perimeter of the cylinder block with the colored stripe facing away from the cylinder bores. Be sure seal lays flat in the groove and is not twisted or stretched when installed.

(12) Install guide studs J24748 in the two outboard bolt holes in the cylinder block.

(13) Attach lifting tool J22062-01 to the cylinder head, if convenient, then position head above the cylinder head.

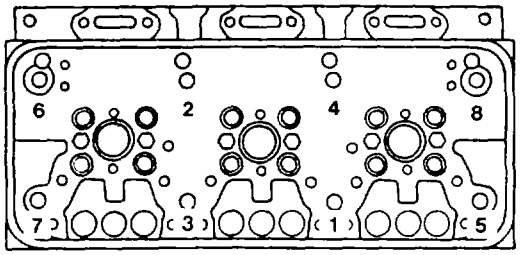
(14) Make final visual check to be sure all seals, gaskets, and shims are in place.

(15) Wipe the bottom of the head clean and lower head over guide studs onto the surface of the block.

(16) Apply a small amount of antiseize compound (item 4, Appendix B) to the threads and to the underside of each cylinder head bolt head.

(17) Install bolts on the cam shaft side first to take up the tension on the push rod springs. Remove the guide studs and lifting fixture and install all remaining bolts. Tighten all bolts to 20 ft lb (27 Nm).

(18) Tighten the bolts in 50 ft lb (68 Nm) increments in the sequence shown until all bolts are at 240 ft lb (325 Nm). Hold the tension for 2 3 seconds to allow bolt to move under this torque.



REPAIR

a. Water Nozzle Repair

NOTE

Replace the nozzles if they are loose in the cylinder head. If the engine has overheated, replace all nozzles.

(1) Pry out the old water nozzles.

(2) Be sure the water inlet ports in the cylinder head are clean and free of scale. Use a soft bristle brush to clean the holes. Do not use a drill bit as the holes are reamed for fit.

(3) Place cylinder head on an arbor press, fire deck side up. Be sure bottom side of head is supported on its rim to prevent damage to valve guides etc.

(4) Aline new nozzle in hole and using a suitable arbor, press into position.

(5) Check nozzles are recessed from flush to 0.015 in. (0.38 mm) below the fire deck.

2-19.9 Water Pump.

This task covers:
a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Engine Compartment Covers Removed (see TM 5-4210-220-12)
Main Engine Fuel Filter Assembly Removed (see TM 5-4210-220-12)
Engine Coolant Drained

MATERIALS/PARTS
16, Appendix B Grease
22, Appendix B Pipe Sealant
5103544 Seal Ring (Pump to Engine)

WARNING

Engine coolant can cause serious burns or scalds. Allow engine to cool before removing the water pump.

REMOVAL

(1) Loosen hose clamps and remove hose (1) between thermostat cover (2) and water pump housing (3).

(2) Loosen hose clamps and remove hose (4) between radiator pipe (5) and water pump housing (3).

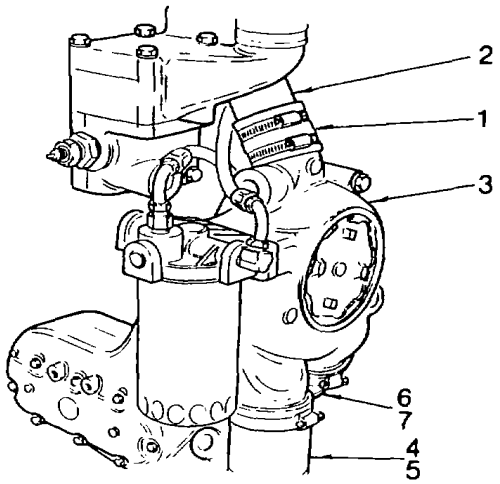
(3) Loosen hose clamps and remove hose (6) between oil cooler pipe (7) and water pump housing (3).

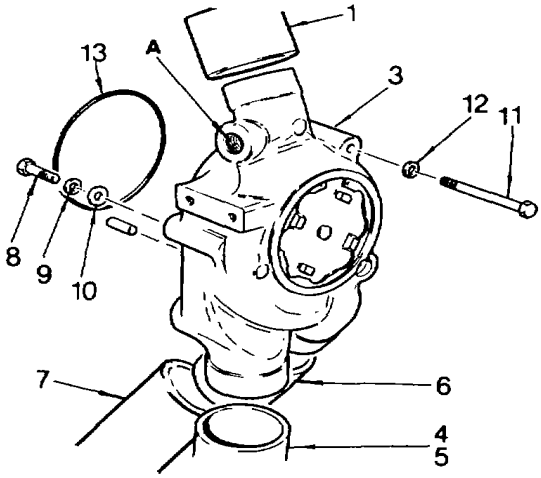
(4) Remove capscrew (8), lockwasher (9), and flat washer (10) from the rear side of the water pump housing.

(5) Loosen the clamps and tag and remove the two 3/4 in. hoses from the winterization valve block that are attached to the water pump housing at port (A).

(6) Remove the two front capscrews (11) and lockwasher (12). Use extreme care to prevent damage to the gear teeth when disengaging the pump gear from the water pump drive.

(7) Remove seal ring (13) and discard.





2-19. ENGINE - Continued

INSPECTION

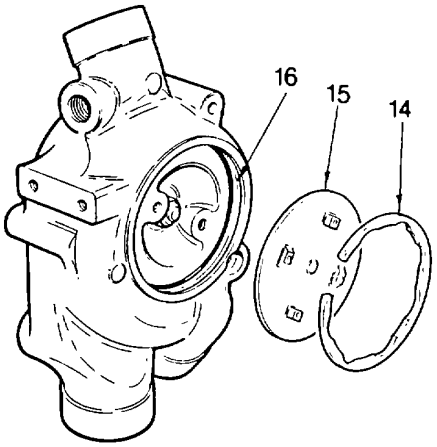
(1) Inspect winterization valve block on water pump housing and inspect the valves. Check seats are clean and valves operate smoothly. Replace any valves failing inspection.

(2) If a new water pump is to be installed, remove valve block from old housing and install on new housing. Coat threads with pipe sealant (item 22, Appendix B) prior to installation.

(3) Mount pump drive gear in a soft jawed vise.

(4) Using snap ring pliers, remove snap ring (14).

(5) Lift off pump cover (15). Do not remove seal ring (16).



(6) Remove water pump from vise and rotate impeller by hand. Check for any looseness in the bearing. Repair as required. See REPAIR following.

(7) If required, check impeller for build up of contaminants or foreign material. Remove impeller and repair as detailed in REPAIR following.

INSTALLATION

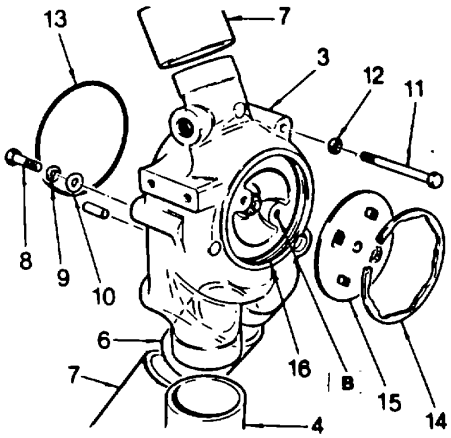
(1) Install seal ring (13) on pump body. Use grease (item 16, Appendix B) to hold in position.

(2) Mount pump on the engine. Be sure pump meshes with front right-hand camshaft gear and dowel pin engages in front engine plate hole.

(3) Install and tighten mounting bolts (11) and washers (1 2).

(4) Install and tighten mounting bolt (8), washer (10), and lockwasher (9).

(5) Install a bolt in the impeller puller holes (B) and measure the backlash with a dial indicator. Rear backlash should be 0.001 0.006 in. (0.025 0.15 mm).



(6) Adjust backlash to these limits by loosening bolts (8 and 11) and pivoting pump either clockwise or counterclockwise.

(7) Retighten mounting bolts to 50 ft lb (68 Nm).

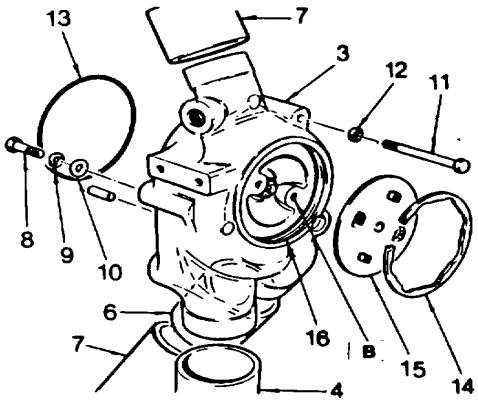
(8) Install pump cover (15) on water pump housing. Be careful not to damage front seal ring (16) in housing.

2-19. ENGINE - Continued

2-19.9 Water Pump - Continued

(9) While pushing on pump cover (15), install snap ring (14). Be sure it seats in the groove.

(10) Install winterization hoses to valve block as tagged in step 5 of REMOVAL preceding. Tighten clamps securely.



(11) Install hose (6) between oil cooler pipe (7) and water pump housing (3). Tighten hose clamp securely.

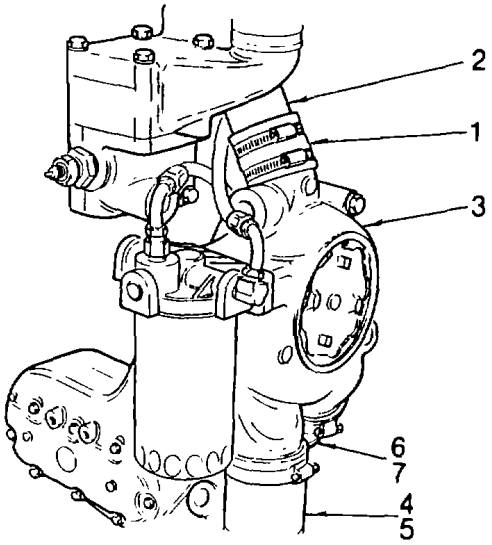
(12) Install hose (4) between radiator pipe (5), and water pump housing (3). Tighten hose clamps securely.

(13) Install hose (1) between thermostat cover (2) and water pump housing (3). Tighten hose clamps securely.

(14) Refill radiator, start main engine and check for leaks. Tighten/remake connections as required.

(15) Stop engine after 2 minutes and top up radiator again.

(16) Restart engine and allow It t**o** reach full working temperature. Watch for leaks as pressure builds. Stop engine if leak is detected and repair.



(17) When engine has run at full operating temperature for 5 minutes shutdown and allow to cool. Recheck radiator level.

REPAIR

NOTE

Water pump must be removed from truck. See REMOVAL preceding. Water pump can be repaired using one of three methods:

a. Replacing seals and individual components as required, and repairing impeller (Use kit 5197279).

b. Replacing impeller assembly, which has new insert installed, and replacing seals and individual components as required (Use kit 5197279 plus impeller 5101168).

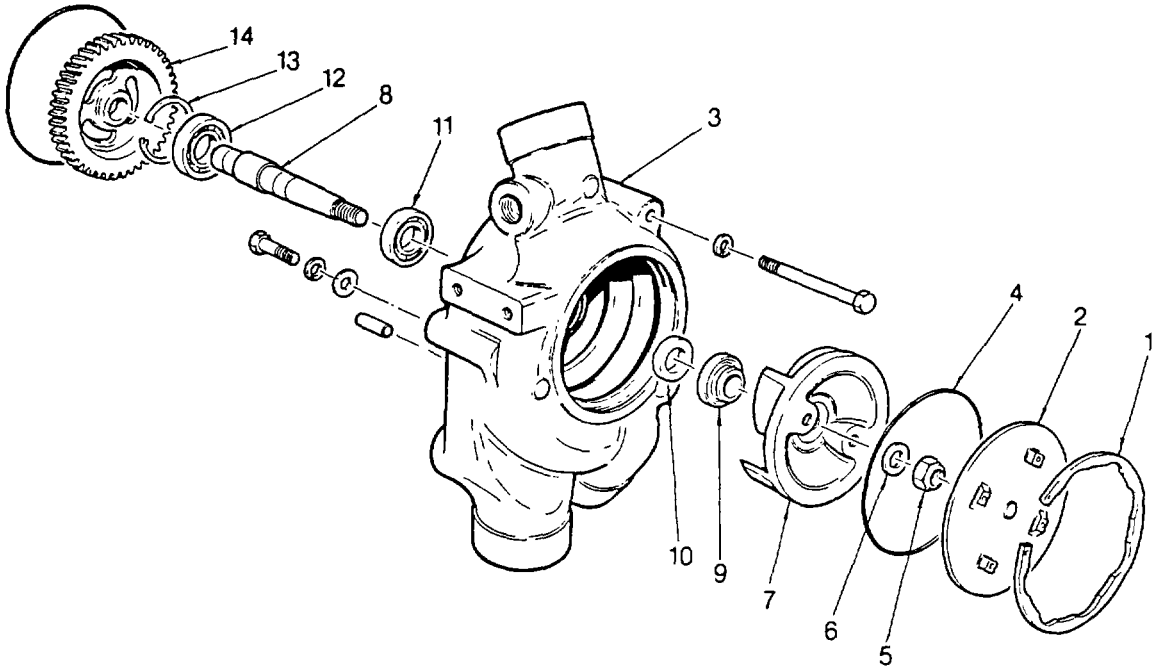
c. Replacing all internal pump parts using reconditioning kit 5149407.

2-19. ENGINE - Continued

(1) Clean water pump, if necessary with pressure hose to remove both internal and external dirt and grime.

(2) Position water pump drive gear in soft jawed vise.

(3) Using snap ring pliers, remove snap ring (1) retaining pump cover (2) to water pump housing. (3). Remove pump cover. Do not remove seal ring (4) at this time.



(4) Remove impeller locknut (5) and washer (6).

(5) Using puller J24420-A, remove impeller (7) from shaft assembly (8).

(6) Place pump assembly on workbench with drive gear upwards. Turn pump drive gear (14) so one of the slots in the drive gear is over the ends of bearing retaining ring (13).

(7) Insert pliers J4646 into slot and remove ring (13) from groove.

(8) Press shaft bearings and pump gear assembly out of pump body.

(9) Place gear (14) on bed of press with the shaft extending downward. Using a suitable sized arbor shaft, press shaft (8) out of gear.

(10) Support shaft assembly on the inner race of the larger bearing (12) with threaded end down. Place flat stock between hydraulic ram and shaft. Press pump shaft out of large bearing.

(11) Invert shaft and support it on the inner race of the small bearing (11). Press shaft (8) from bearing.

(12) Use channel lock pliers to grasp the metal flange around the upper portion of seal (9), and twist it to break the seal and boot away from the outside case of the water seal.

2-19. ENGINE - Continued

2-19.9 Water Pump - Continued

(13) Remove and discard the cover seal ring (4).

(14) Push the oil seal (10) out of pump body (3).

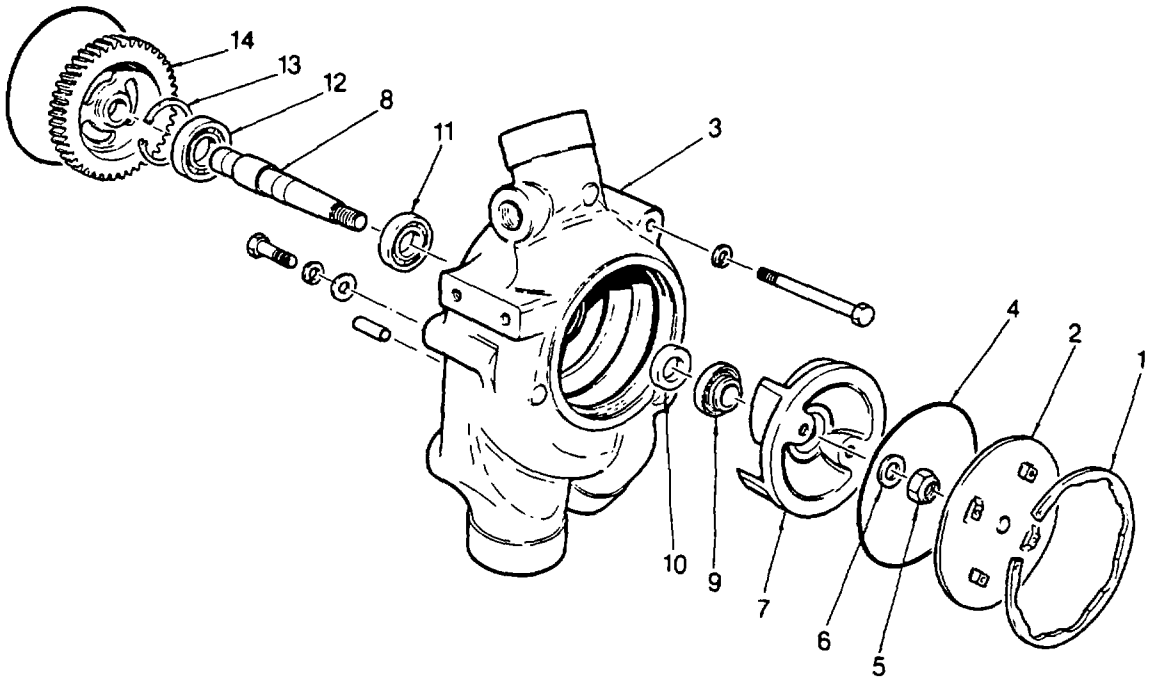
NOTE

New seals and a new ceramic impeller insert must be used each time a water pump is repaired.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.



(15) Wash all parts in dry cleaning solvent (item 10, Appendix B) and dry with compressed air. Inspect and replace damaged or worn parts.

(16) Make sure "Y" drain passage in housing is clear of any obstructions.

(17) Examine bearings for corrosion, pitting and freedom of movement. Replace bearings if any found faulty. Always replace both bearings.

2-19. ENGINE - Continued

(18) Lubricate bearing bores and shaft bearing surfaces with engine oil (item 17, Appendix B).

(19) Press bearings (11 and 12) on shaft using J25257 gear and bearing installer. Press only on the inner races during installation.

(20) Support pump body (3) on press bed with cover side down. Press shaft and bearing assembly in place by applying pressure on the outer race of the large bearing (12).

(21) Install bearing retaining ring (13).

(22) Inspect water pump driven gear for damaged teeth. Replace as required.

(23) Inspect water pump drive gear or engine for possible related failure. Refer to General Support Level if repair is necessary to drive gear.

(24) Position gear installer J25257 on impeller end of shaft (8). Press gear (14) on shaft so it is flush with end of shaft.

(25) Apply film of engine oil (item 17, Appendix B) to sealing areas of oil seal (10) and shaft (8). Install seal with spring loaded tip towards bearing in pump housing (3). Press or tap seal flush with water seal counter-bore using suitable installing sleeve.

(26) Apply a light coat of seal retainer (item 26, Appendix B) on outside diameter of water seal (9). Install seal in the pump body housing (3) with a sleeve large enough to fit around the seal case and resting on the brass lip. Press seal into position.

(27) Inspect water pump impeller (7) for erosion and excessive wear.

(28) If impeller is reused, the ceramic impeller insert must be replaced. If new impeller is to be installed proceed to step 36.

(29) Bake impeller assembly at 500 deg. F (260 deg. C) for one hour. Remove insert while adhesive is hot. Allow impeller to cool. Clean the insert area with buffing wheel to remove old adhesive and oxide build up.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(30) Clean with dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protection equipment.

2-19. ENGINE - Continued

2-19.9 Water Pump - Continued

(31) Clean parts with compressed air.

(32) Place the adhesive washer in the impeller bond area with the ceramic insert on top.

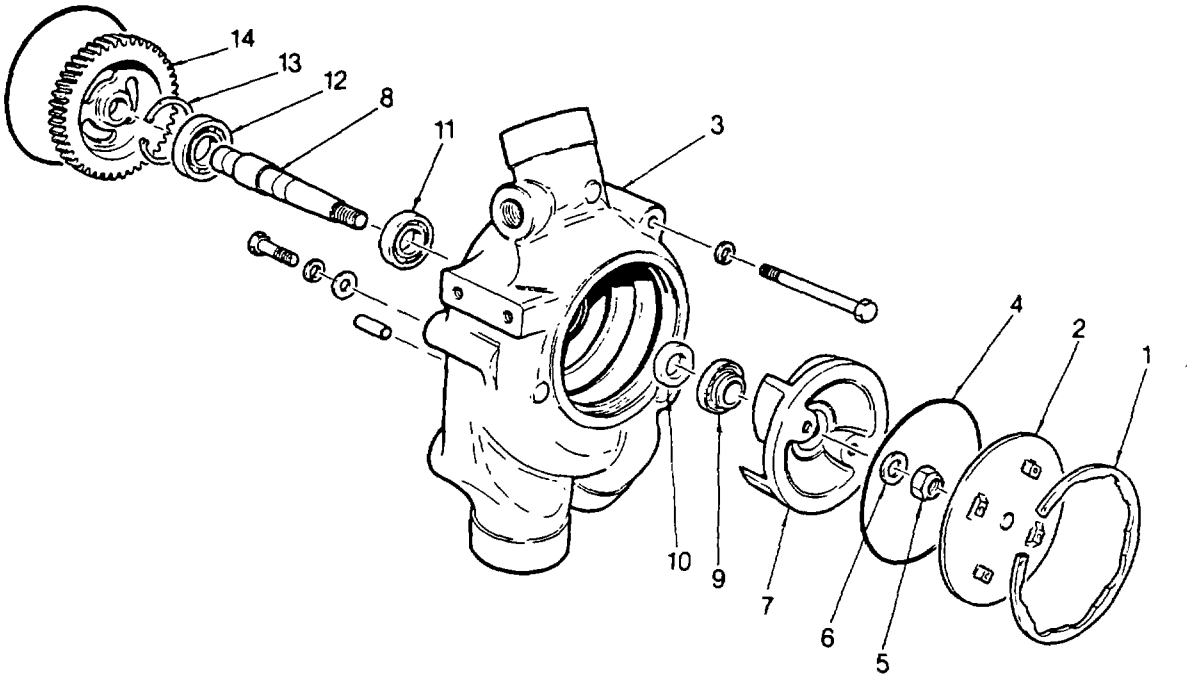
(33) Clamp ceramic insert and impeller together with 3/8 in. bolt, nut and two flat washers. Tighten to 10 ft lb (14 Nm).

(34) Place impeller assembly in level position, insert upwards, in an oven preheated to 350 deg. F (177 deg. C) for one hour to cure adhesive.

(35) Cool impeller to room temperature.

(36) Make sure mating surfaces of water seal and the ceramic insert in impeller are free of dirt or oil film.

(37) Apply small amount of anti-seize compound (item 4, Appendix B) to the threads of the pump shaft (8).



(38) Place impeller (7), washer (6), and new locknut (5) on shaft.

(39) Hold the pump gear securely in a brass jawed vise. Draw impeller down on tapered shaft with locknut. Tighten nut to 40 ft lb (54 Nm).

(40) Scribe a line across impeller, nut, and shaft.

(41) Scribe a line across water pump, gear, and shaft.

(42) Using adapter J33765 inserted into impeller puller holes, apply a torque of 80 ft lb (108 Nm) to the impeller.

2-19. ENGINE - Continued

(43) Slippage of impeller or gear should not occur at this torque.

(44) If slippage is felt, remove pump assembly from vise and examine the scribe marks. Determine whether the gear or impeller turned on shaft. In either case, the shaft must be replaced along with the component that turned.

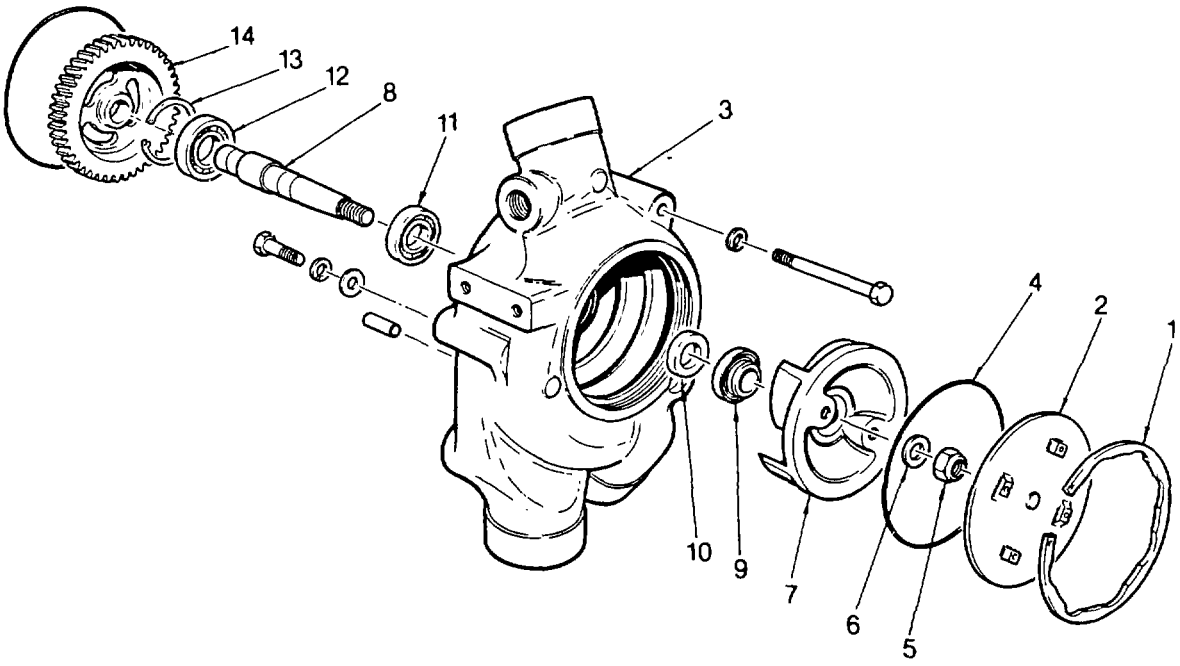
(45) After replacing necessary parts, retest the water pump assembly for slippage

(46) Insert a feeler gage into the water outlet opening of the pump. The clearance between the impeller and the pump body must be a minimum of 0.015 in. (0.38 mm). Repair or replace pump assembly to obtain desired clearance.

(47) If pump is to be stored after rebuild, carry out steps 48 and 49. If it is to be installed on the engine, see INSTALLATION preceding.

(48) Install new cover seal ring using grease (item 16, Appendix B) in groove and on seal ring.

(49) Install cover securely in place with snap ring.



2-19. ENGINE - Continued

2-19.10 Oil Pump

This task covers a. Removal
b. Installation
c. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J24420-A Puller
J9783 Front Oil Seal Installer
J22425A Front Oil Seal Expander

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-00220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Front Heat Shield Removed (see TM 5-4210-220-12)
Fan Removed From Hub (see TM 5-4210-220-12)
Drive Belts Removed (see TM 5-4210-220-12)
Oil Pan Removed (see para. 2-19.11)

MATERIALS/PARTS
17, Appendix B Engine Oil
32, Appendix B Vegetable Shortening
5121714 Front Cover Gasket
5117230 Oil Pan Gasket
5117269 Pressure Regulator Gasket
5117269 Pressure Relief Valve Gasket
5115454 Crankshaft Oil Seal

WARNING

To reduce the risk of personal injury when barring over or "bumping" the starter while performing an engine tune-up, personnel should keep their hands and clothing away from the moving parts of the engine as there is a remote possibility the engine could start.

REMOVAL

NOTE

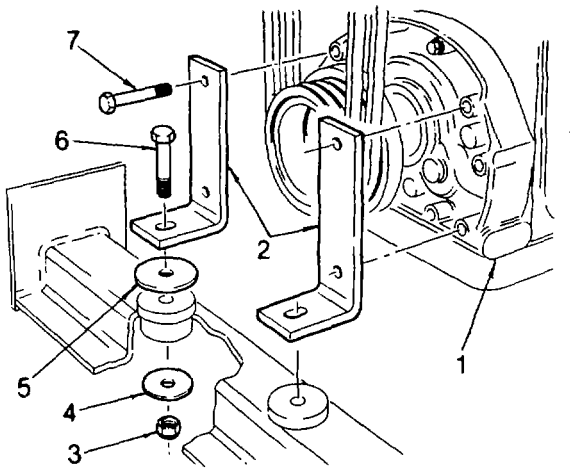
Whenever the oil pump is removed for service, also remove and inspect the oil pressure regulator and oil pressure relief valves.

(1) Support the main engine (1) by one of the following methods.

(a) Remove engine canopy (see TM 5-4210-220-12). Use an overhead crane to support engine weight before removing front engine mounts.

(b) Using a floor jack and a block of wood, support the weight of the engine on front of the cylinder block. Position maintenance trestles, on either side of the cylinder block before removing engine mounts.

(2) Remove engine mount nuts (3), washers (4), and capscrews (6).



2-19. ENGINE - Continued

WARNING

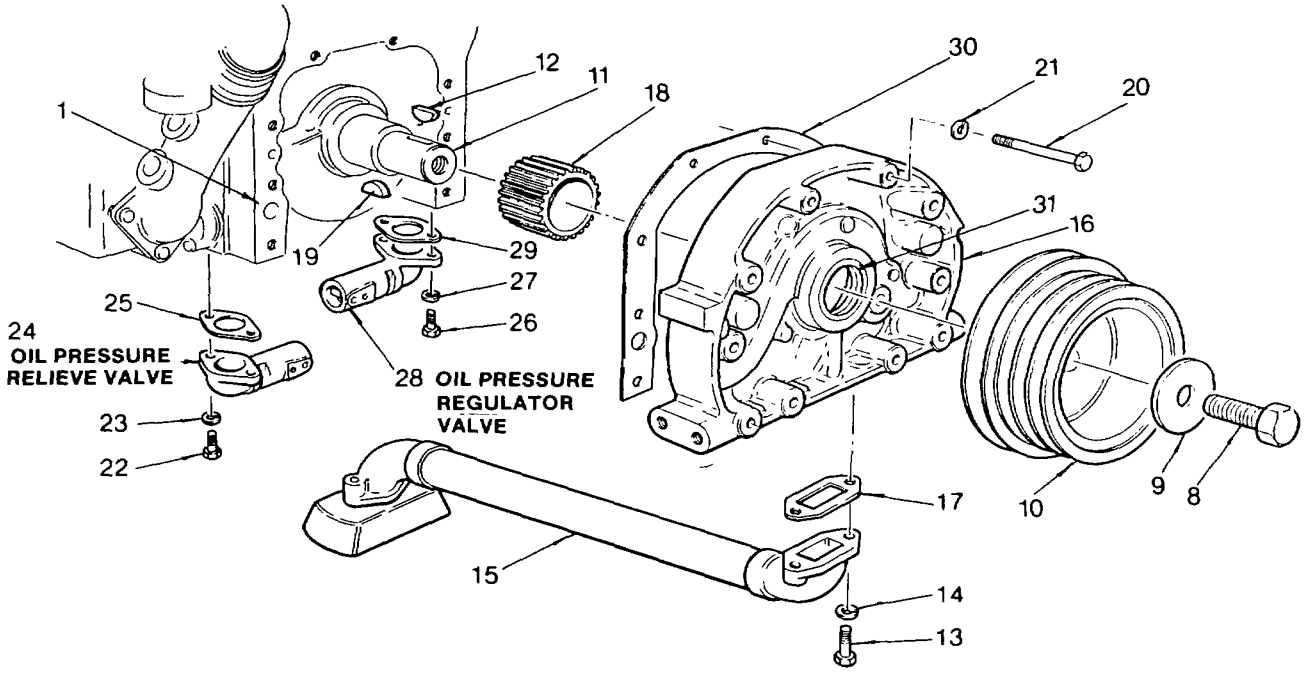
Ensure engine is properly supported before removing the front engine mounts (2).

(3) Remove capscrews (7) and remove both front engine mounts (2) and washers (5).

(4) Remove the pulley retaining bolt (8) and washer (9).

(5 Using tapped holes in pulley (10), attach mechanical puller J24420A using correct size bolts. Tighten the pressure screw into the end of the crankshaft and remove the pulley. When using a puller, follow tool manufacturers recommendations.

(6) Remove key (12) from crankshaft (11).



(7) Remove the bolts (13), and lockwashers (14) that secure the oil inlet pipe and screen assembly (15) to the crankshaft front cover (16). Remove and discard gasket (17).

(8) Remove crankshaft front cover mounting capscrews (20), and lockwashers (21).

(9) Strike the edges of the crankshaft cover (16) alternately on each side with a soft faced hammer to free it from the cylinder block dowel pins. Then pull the cover straight off the end of the crankshaft (11).

(10) Remove and discard gasket (30).

(11) Remove drive hub (18), and key (19), from crankshaft (11).

(12) Inspect and repair oil pump as detailed in REPAIR following.

2-19. ENGINE - Continued

2-19.10 Oil Pump - Continued

NOTE

To remove the oil pressure relief valve body (24) carry out steps 13 thru 15.

(13) Remove the two relief valve to cylinder block capscrews (22) and washers (23).

(14) Using a soft faced hammer, lightly tap the relief valve body (24) to loosen it from the gasket (25) and cylinder block.

(15) Remove relief valve assembly (24). Remove and discard gasket (25).

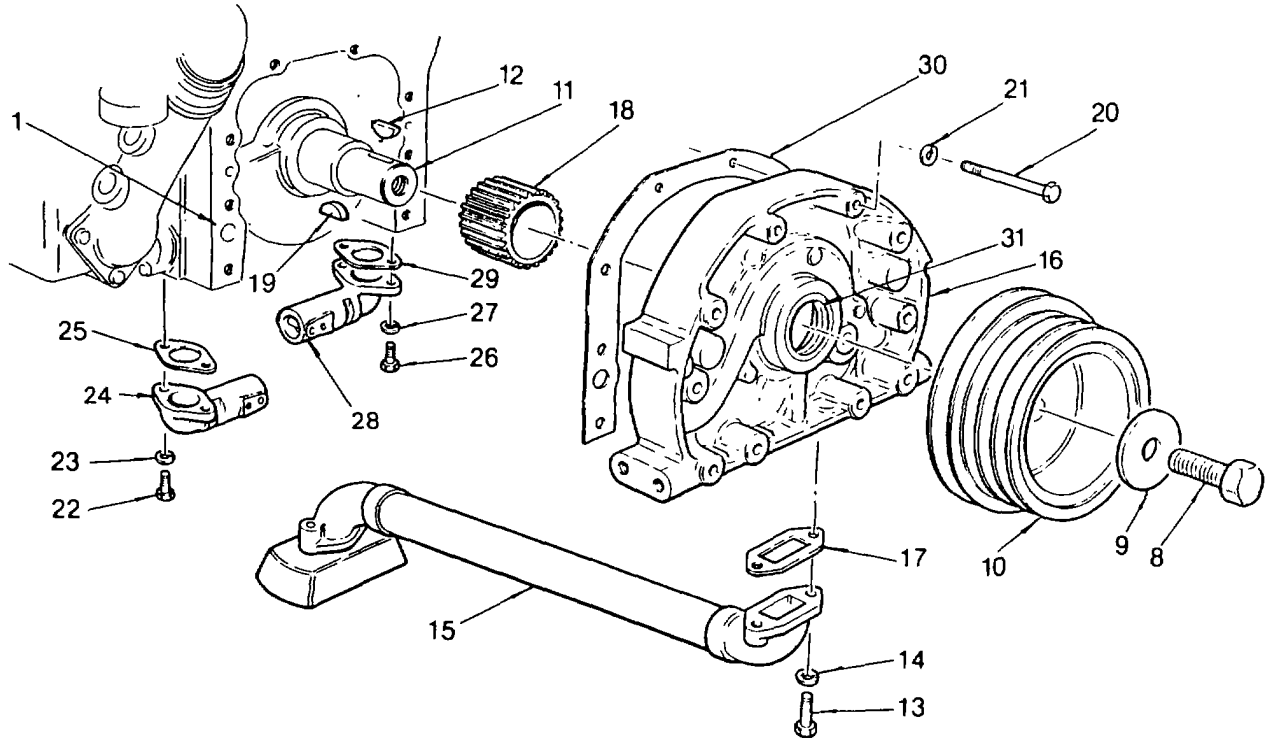
NOTE

To remove the oil pressure regulator valve body (28) carry out steps 16 thru 18.

(16) Remove the two regulator-to-cylinder block capscrews (26) and washers (27).

(17) Using a soft faced hammer, lightly tap the regulator body (28) to loosen it from the gasket (29) and cylinder block.

(18) Remove the oil pressure regulator (28). Remove and discard gasket (29).



2-19. ENGINE - Continued

INSTALLATION

CAUTION

The oil pressure regulator and the oil pressure relief valve are similar in shape. The only difference between the two valves is the location of the seat retaining pin which changes valve opening pressure. Serious engine damage could result if valves are not installed in the correct position.

NOTE

To install the oil pressure relief valve (24), carry out steps 1 and 2.

(1) Ensure all gasket material is removed from cylinder block (1) and the relief valve body (24).

WARNING

When installing the relief valve assembly in an aluminum housing, use a 3/8 in. plain washer on the capscrews and make sure the washers are against the aluminum housing.

(2) Affix a new gasket (25) to the relief valve body (24) and secure to the cylinder block with capscrew (22) and washers (23). Tighten capscrews to 28 ft lb (38 Nm).

NOTE

To install the oil pressure regulator valve (28) carry out steps 3 and 4.

(3) Ensure all gasket material is removed from cylinder block (1) and the regulator body (28).

WARNING

When installing the regulator valve assembly in an aluminum housing, use a 3/8 in. Plain washer on the capscrews and make sure the washers are against the aluminum housing.

(4) Affix a new gasket (29) to the regulator body (28) and secure to the cylinder block with capscrews (26) and washers (27). Tighten the capscrews to 28 ft lb (38 Nm).

(5) Install the key (19) into the crankshaft (11) and then slide the oil pump drive gear (18) into position on the crankshaft.

(6) Affix a new gasket (30) to the inner face of the cover (16).

(7) Coat the lip of the oil seal (31) with vegetable shortening (item 32, Appendix B).

(8) Install the front cover (16) using oil seal expander J22425A to pilot the oil seal over the crankshaft (11). Position the cover over the crankshaft and up against the cylinder block. Remove the oil seal expander.

2-19. ENGINE - Continued

2-19.10 Oil Pump - Continued

(9) Install the cover attaching capscrews (20), and lockwashers (21). Tighten the 3/8 - 16 capscrews to 28 ft lb (38 Nm) and tighten the 1/2 - 13 capscrews to 80 ft lb (108 Nm).

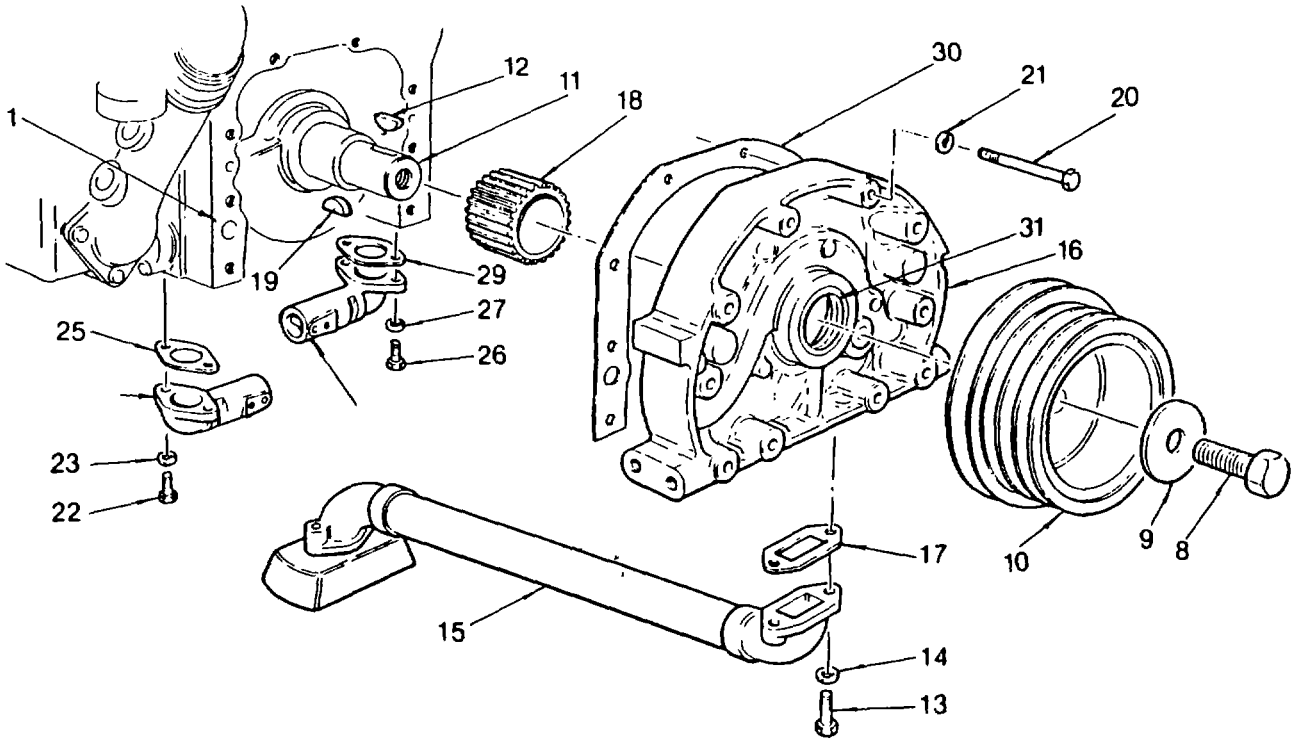
(10 Affix a new gasket (17) to the flange on the oil pump inlet tube (15). Attach tube to the bottom of the crankshaft cover (16) using capscrews (13), and lockwasher (14). Tighten capscrews to 28 ft lb (38 Nm).

(11) Install key (12) into crankshaft (11).

(12) Lubricate the end of the crankshaft (11) and the crankshaft pulley (10) using engine oil (item 17, Appendix B).

(13) Slide the crankshaft pulley (10) on the crankshaft (11).

(14) Place the washer (9) over the pulley retaining bolt (8) and thread the bolt into the end of the crankshaft fingertight.



(15) Attach the front engine supports (2) to the crankshaft front cover using capscrews (7).

(16) Aline snubbing washer (5) with left hand vibration isolator and install capscrew (6), and similarly the right hand side.

(17) Install washers (4), and nuts (3) onto both capscrews (6).

(18) Tighten engine mount-to-cover capscrews (7) to 80 ft lb (108 Nm).

(19) Remove all engine supports, and allow engine weight to rest on cross member.

2-19. ENGINE - Continued

(20) Tighten the engine mount-to-frame cross member capscrews (6) to 135 ft lb (180 Nm).

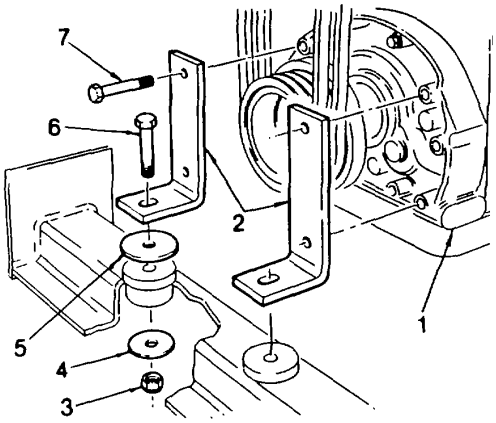
(21) Tighten the crankshaft bolt to 180 ft lb (244 Nm).

(22) Strike the end of the bolt with a sharp blow using a 2 lb lead hammer.

(23) Tighten the crankshaftbolt to 300 ft lb (407 Nm).

(24) Strike the bolt again, with a sharp blow using a 2 lb lead hammer.

(25) Retighten the crankshaft bolt to 290 - 310 ft lb (393 - 421 Nm). Do not strike the bolt after the final torque has been applied.



CAUTION

The hex head of the crankshaft bolt may be used to bar, or turn, the crankshaft. However, the barring operation should always be performed in a clockwise direction. It is very important to make certain that the bolt has not been loosened during the barring operation. Otherwise, serious engine damage may result if the or pulley is not securely fastened to the crankshaft.

(26) Install oil pan as detailed in para. 2-19.11.

(27) Install fan and drive belts, see TM 5-4210-220-12.

(28) Install engine oil into crankcase, see LO 5-4210-220-12.

(29) Start and run engine until it reaches operating temperature. Check for oil or coolant leaks, rattles or vibrations and correct as necessary.

REPAIR

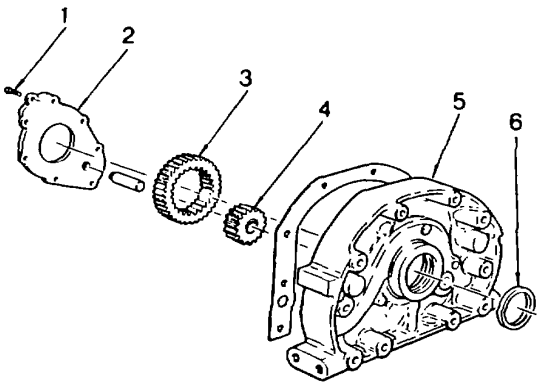
a. Oil Pump Repair

(1) Remove the self-locking capscrews (1) that secure the oil pump gear retaining plate (2) to the crankshaft front cover (5). Separate the retaining plate from the front cover.

(2) Remove the oil pump drive gear (3), and driven gear (4) from the crankshaft front cover (5).

(3) Support the outer face of the crankshaft cover (5).

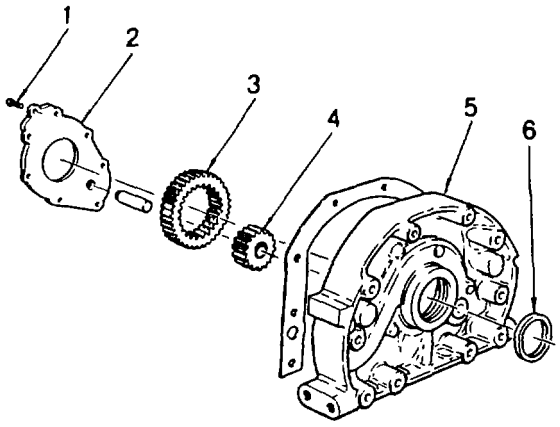
(4) Using a hammer and a punch, drive the oil seal (6) out of the crankshaft front cover.



2-19. ENGINE - Continued

2-19.10 Oil Pump - Continued

(5) Remove the screen and cover from the oil inlet pipe assembly.



WARNING

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(6) Wash all the oil pump components using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(7) Dry all components using compressed air.

(8) Examine the oil pump gear cavity in the crankshaft front cover. Replace the cover if the surfaces are worn or scored excessively.

(9) Replace the driven gear shaft if it is worn or scored excessively. When a new shaft is pressed in place, the shoulder on the shaft must be flush to 0.020 in. (0.508 mm) below the finished face of the crankshaft front cover.

(10) The clearance between the driven gear bushing and the shaft is 0.0010 in. (0.025 mm) to 0.0025 in. (0.064 mm) when new parts are used, or a maximum of 0.0035 in. (0.089 mm) with used parts.

(11) Inspect the teeth on the oil pump gears and the pump drive hub. Also, examine the bushing in the driven gear for wear. The bushing is not serviced separately. Therefore, if the bushing is worn, it will be necessary to replace both the drive and driven gears as they are only serviced as a set. The use of excessively worn gears will result in low oil pressure which may cause serious damage throughout the engine.

(12) Inspect the inner face of the oil pump gear retaining plate. Replace the retaining plate if it is scored or worn.

(13) Reassemble the screen, cover, and oil intake pipe.

(14) Drive a new 6il seal (6) into the crankshaft front cover (5) using tool J9783 and a hammer. The tool is designed to drive only on the outer edge of the seal casing to prevent seal damage.

2-19. ENGINE - Continued

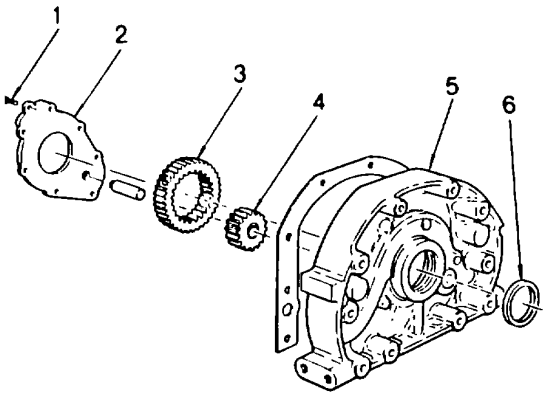
(15) Lubricate the oil pump gears (3 and 4) and the driven gear shaft with engine oil (item 17, Appendix B).

(16) Install the oil pump gears (3 and 4).

NOTE

The manufacturers self-locking capscrews must be used due to the close clearance between the oil pump and the crankshaft.

(17) Install the gear retaining plate (2) and secure it to the crankshaft front cover (5) using the self-locking capscrews (1). Tighten the capscrews (1) to 17 ft lb (23 Nm).



b. Regulator/Relief Valve Repair

NOTE

The oil pressure regulator and oil pressure relief valve both have all the same parts. The only difference between the two valves is the location of the retaining pin (5); pin location changes the valve opening pressures. Ensure to position pin in correct hole during valve assembly.

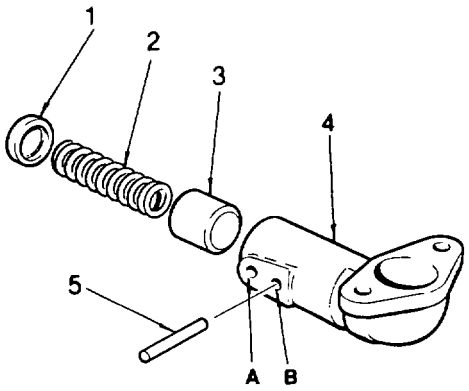
(1) Clamp the body (4) in the soft jaws of a vise.

(2) Remove the spring seat retaining pin (5) from the valve body (4).

(3) Remove the spring seat (1), spring (2), and valve (3) from the valve body (4).

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 - 59 deg. C).



PIN LOCATION
A - PRESSURE REGULATOR
B - PRESSURE RELIEF VALVE

(4) Wash all components using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air Is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

2-19. ENGINE - Continued

2-19.10 Oil Pump - Continued

(5) Dry all components using compressed air.

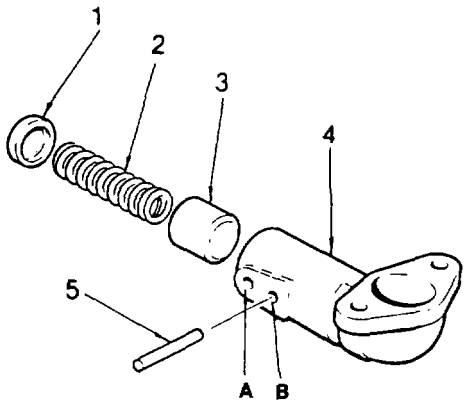
(6) Inspect all parts for wear, corrosion or damage.

(7) Check spring (2) for pitting or fractures. Remove light corrosion from valve (3) using crocus cloth (item 7, Appendix B). The valve (3) must slide freely in the valve body (4). Replace parts as necessary.

(8) Replace complete valve assembly if valve body (4) is damaged beyond repair.

(9) Clamp the cleaned body (4) in the soft jaws of a vise.

(10) Apply engine oil (item 17, Appendix B) to the outer face of the valve (3) and slide It into the body (4), closed end first.



PIN LOCATION
A—Pressure Regulator
B—Pressure Relief Valve

NOTE

It is important that the retaining pin (5) be positioned correctly so the proper valve opening pressure will be obtained.

(11) Each valve body has two retaining pin holes. Install the retaining pin (5) in the outer most hole for the regulator valve, and install the retaining pin (5) in the inner hole (B) for oil pump relief valve.

(12) Insert the spring (2) in the valve (3) and install spring seat (1). While compressing the spring install the retaining pin (5) behind the spring seat. Press the pin flush to 0.010 in. (0.25 mm) below the valve body surface.

2-19. ENGINE - Continued

2-19.11 Oil Pan

This task covers a. Removal
b. Installation

TOOLS
Tool Kit, Master Mechanic,
NSN 5180-00-699-5273

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-200-12)
Batteries Disconnected (see TM 5-4210-220-12)
Right Engine Compartment Cover Removed
(see TM 5-4210-220-12)
Front Heat Shield Removed
(see TM 5-4210-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil
29, Appendix B Threadlock Liquid
5117230 Oil Pan Gasket
5125668 Oil Pan

REMOVAL

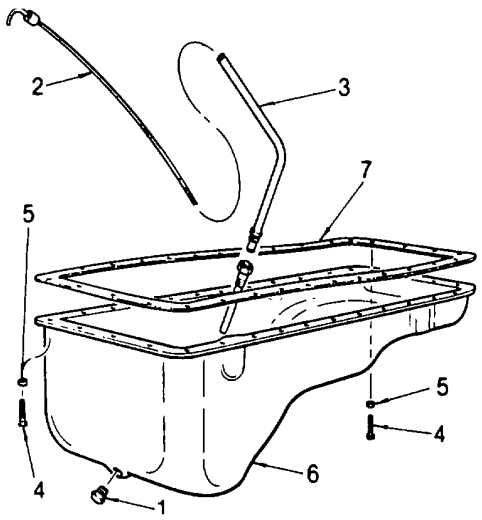
(1) Remove the drain plug (1), and drain the engine oil into a suitable container.

(2) Remove the dipstick (2) from dipstick tube (3).

(3) Remove the capscrews (4) and lockwashers (5).

(4) Support the oil pan (6) and using a soft faced hammer, tap the oil pan to loosen it from the cylinder block.

(5) Lower the oil pan from the cylinder block, being careful not to damage the oil pump piping and inlet screen.



(6) Remove gasket (7) and discard. Ensure all gasket material is removed from cylinder block.

INSTALLATION

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(1) Wash the oil pan and fasteners using dry cleaning solvent (item 10, Appendix B).

2-19. ENGINE - Continued

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(2) Dry the oil pan and fasteners using compressed air.

(3) Make sure that all gasket material is removed from the oil pan mating surface. Once the oil pan is clean, examine the oil pan for dents or cracks. Check for misalined flanges or raised surfaces surrounding the bolt holes by placing the oil pan on a large flat surface. Replace pan as necessary.

(4) Position a new gasket (7), on oil pan (6).

NOTE

The current oil pan capscrews are coated with a locking material. Apply a drop or two of threadlock liquid (item 29, Appendix B) to the threads of the capscrews at reassembly.

(5) Carefully raise the oil pan (6) until it contacts the cylinder block, then install the capscrews (4) and lockwashers (5) fingertight.

(6) Starting with the center capscrew on each side and working alternately toward each end of the pan, tighten the capscrews (4) to 20 ft lb (27 Nm).

(7) Install and tighten the drain plug (1) to 30 ft lb (40.7 Nm).

(8) Fill the oil pan with new engine oil (item 17, Appendix B), up to the full mark on the dipstick (2).

(9) Start and run the engine for a short period of time and check for oil leaks.

(10) Stop the engine and after about twenty minutes recheck the oil level. Add engine oil as necessary to bring the oil level to the full mark.

2-19. ENGINE - Continued

2-19.12 Throttle, Fuel Shutdown, And Fire Pump Governor.

This task covers a. Adjustment
b. Replacement

TOOLS
Tool Kit, General Mechanic, Automotive,
NSN 5180-00-177-7033

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
LH Engine Compartment Cover Removed
(see TM 5-4210-220-12)

MATERIALS/PARTS
22, Appendix B Pipe Sealant
117907 Throttle Cylinder
1030-39540-01 Fuel Shutdown
101812 Fire Pump Governor
5149510 Rocker Cover Gasket

PERSONNEL REQUIRED - 2

NOTE

The following instructions may be used to install the above controls on a new engine or to replace components on a used engine.

ADJUSTMENT

a. Fuel Shutdown Adjustment

NOTE

Engine must be shutdown and both rocker covers removed, (see para. 2-19.3).

Exhaust valve clearance, injector timing, mechanical governor, and Injector control racks must be set before adjusting the stop control.

CAUTION

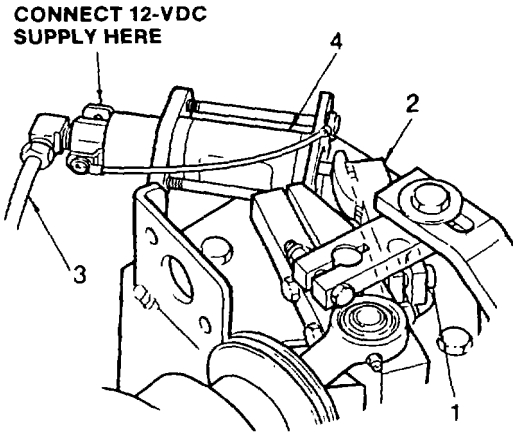
This instruction must be carried out every time the engine is repaired. This one system is used to assure a positive engine shutdown.

(1) Ensure air tanks are pressurized. If no air, pressurize using shop connection on left side of pump body. Check all air tanks are at 100 psi (690 kPa).

(2) Loosen screw (1) and remove operating arm (2) from governor shaft.

(3) Check air line (3) is connected to solenoid (4).

(4) Connect a temporary 12-Vdc electrical supply to solenoid (4).



2-19. ENGINE - Continued

(5) Be sure that 'when electrical connection is made, air is exhausted from the solenoid and the plunger retracts.

(6) Be sure that when 12-Vdc supply is removed, the plunger extends. Replace whole assembly if plunger fails. See REPLACEMENT following.

(7) Reconnect electrical supply to place solenoid in engine run position, cylinder retracted.

(8) Install arm (2) and aline it with the plunger ensuring it rests against the plunger. Tighten screw (1) firmly.

(9) Disconnect electrical supply, and check all fuel injectors are in the no-fuel position (injector control rack fully withdrawn).

(10) Adjust arm (2) as required. The Injector racks must be fully withdrawn and checked to go to that position whenever the engine ignition is set to OFF.

b. Foot Throttle Chamber Adjustment

NOTE

Engine must be shutdown.

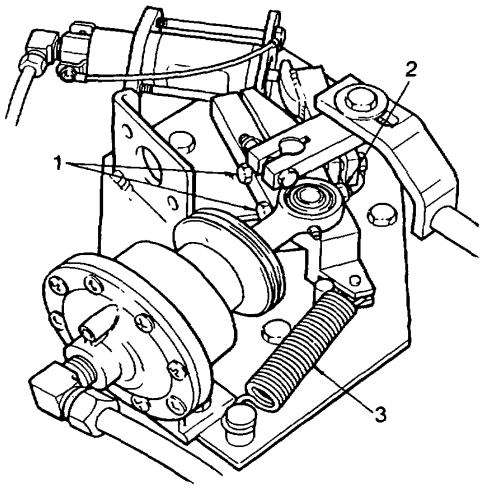
Exhaust valve clearance, injector timing, mechanical governor and injector control racks must be set before adjusting the throttle.

(1) Ensure air tanks are pressurized. If no air, pressurize using shop connection on left side of pump body. Check all air tanks are at 100 psi (690 kPa).

(2) Check screws (1) and nuts (2) on throttle arm are loose.

(3) Press and release foot throttle in cab a few times and ensure throttle chamber rod moves freely. Check spring (3) is connected and pulls throttle arm promptly back when throttle pedal is released.

(4) With engine shut down, release foot throttle in cab.



(5) Tighten clamp screws (1) and nuts (2).

(6) Depress foot throttle up and down a few times to check operation of the foot throttle and the governor speed shaft.

(7) With the foot throttle depressed, and the rocker covers removed, see para. 2-19.3, check that fuel injectors are in the full-fuel position (injector control rack fully in).

2-19. ENGINE - Continued

2-19.12 Throttle, Fuel Shutdown, And Fire Pump Governor - Continued

c. Pump Governor Adjustment.

NOTE

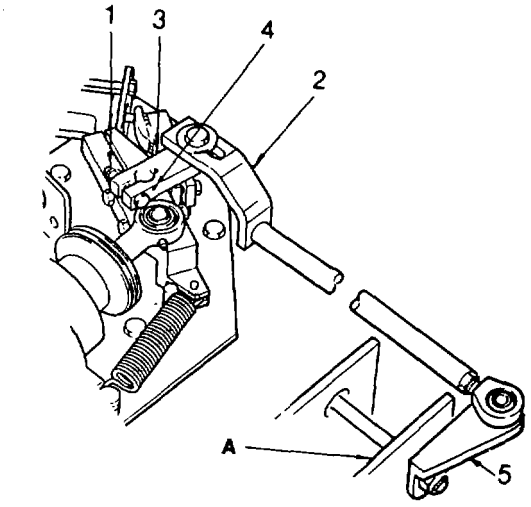
Mechanical Governor, fuel shutdown and foot throttle chamber must be adjusted and the engine idle and maximum rpm must be set prior to carrying out pump governor adjust.

(1) Be sure pump governor has been installed as in REPLACEMENT following. This procedure ensures the assembly itself is adjusted correctly.

(2) With engine shutdown, rotate pump governor arm (3) counterclockwise until the pivot bolt is against the outer end of the slot of the pump governor link (4).

(3) Be sure bracket (5) on pump governor shaft is held to the left near bracket (A) and then tighten locking nut and bolt (1 and 2) on the pump governor arm.

(4) Start main engine and start fire pump in structural mode. Be sure pump is flooded. Using hand throttle on structural control panel adjust engine speed so that pump pressure increases to 150 psi (1034 kPa). Be sure pump pressure is stable. Open various discharges and check pump pressure restabilizes to this pressure. Shut pump down.



(5) Set pump to CFR mode and start pump. Switch on governor and check pump pressure increase to 250 psi (1720 kPa). If pressure exceeds 280 psi (1930 kPa) switch off pump governor immediately. Reduce pressure as detailed in following steps.

(6) With pump pressure stabilized, adjust pressure to 250 psi (1720 kPa) using air control valve mounted on service brake plate.

(7) Open bumper turret and roof turret in turn and check pressure restabilizes to 250 psi (1720 kPa) after each operation.

REPLACEMENT

a. Fuel Shutdown Replacement

NOTE

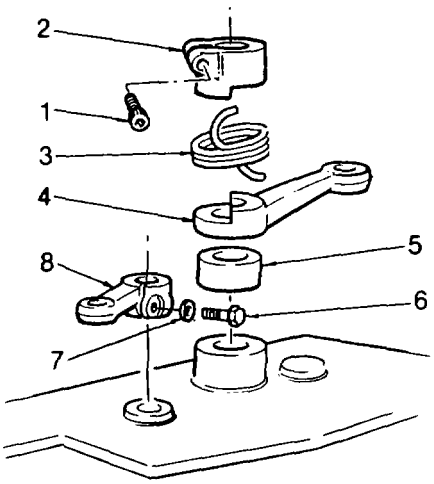
If a new engine is being prepared for installation carry out all instructions.

If the fuel shutdown is being removed and installed on engine(s) already in service start at instruction 3.

2-19. ENGINE - Continued

(1) On new engine, loosen screw (1) and remove locking ring (2), spring (3), arm (4), and bushing (5) from governor speed shaft.

(2) On new engine, loosen screw (6) and remove fuel shutdown arm assembly (8) from governor shutdown shaft.

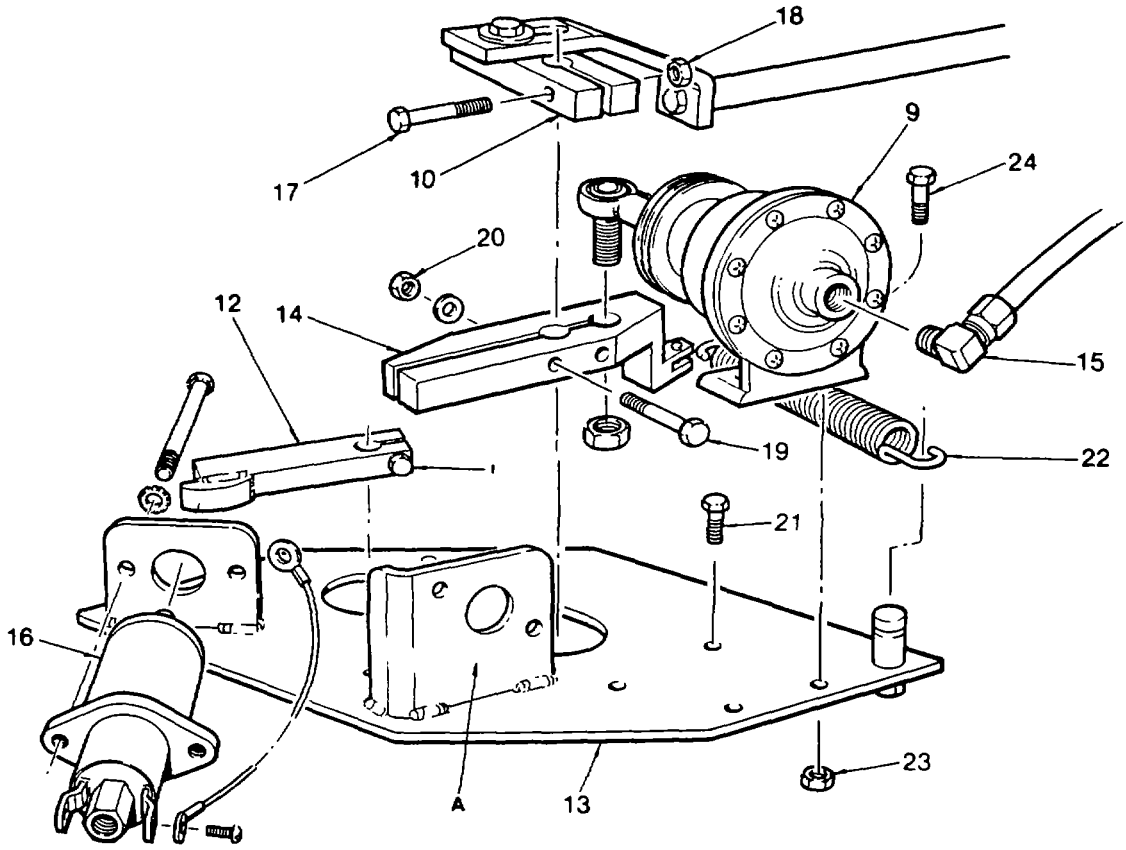


(3) Tag and disconnect wire to solenoid on old engine.

(4) Tag and remove air lines from solenoid and from air cylinder.

(5) Loosen screw (11) on stop control arm (12) and pull control arm from governor.

(6) Loosen screw (17), and nut (18), and remove pump governor arm (10) from speed shaft.



2-19. ENGINE - Continued

2-19.12 Throttle, Fuel Shutdown, And Fire Pump Governor - Continued

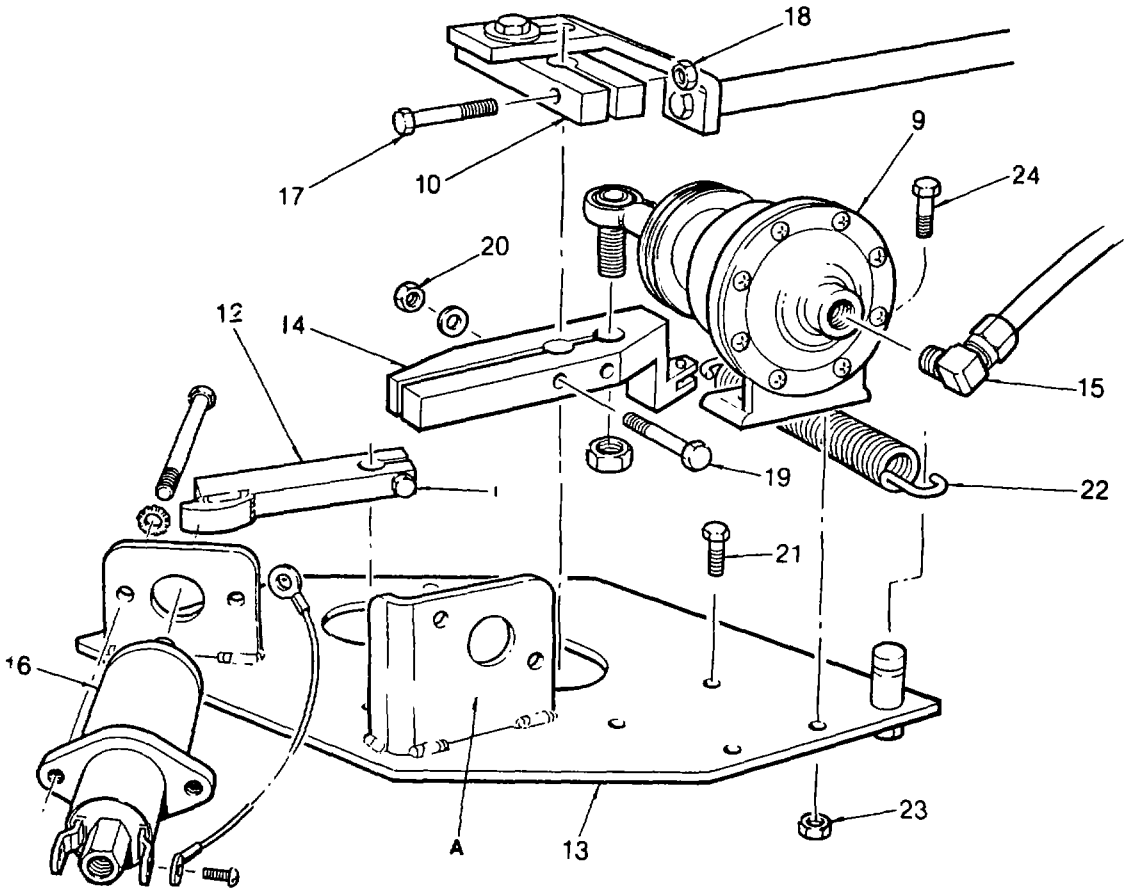
(7) Loosen screws (19), and nuts (20) until throttle arm (14) is loose.

(8) Remove screws (21) and lift plate (13) from engine.

(9) If a new shutdown plate is being installed, carry out instructions 10 thru 12. If the old plate is being installed on an old engine go to step 13.

(10) Remove second solenoid mounted on plate (A) from new shutdown plate (13).

(11) Remove throttle spring (22). Remove nuts (23) and bolts (24) and lift throttle cylinder and speed arm assembly from old plate.



(12) Install throttle cylinder (9) and new plate (13) using nuts (23) and bolts (24). Install throttle spring (22).

(13) Aline throttle speed arm (14) with governor shaft and install shutdown plate on governor. Remove screws from governor top plate as required.

(14) Install pump governor arm (10) over governor speed shaft. Do not tighten the retaining screws.

(15) Install stop control arm (12) on stop shaft. Do not tighten the retaining screws.

2-19. ENGINE - Continued

(16) Coat threads of fittings (15) with pipe sealant (item 22, Appendix B) and install air lines, as tagged, to stop solenoid (16) and throttle air chamber (9).

(17) Connect wire to solenoid.

(18) Adjust fuel shutdown, throttle cylinder and pump governor as detailed in ADJUSTMENT preceding.

b. Throttle Air Chamber Replacement

NOTE

When removing and Installing an air cylinder on an old engine, or transferring it between two engines, it is removed with the fuel shutdown plate - see Fuel Shutdown Replacement preceding If an air chamber is to be replaced use following instruction. A new chamber comes ready mounted onto a plate.

(1) Remove return spring mounted to arm (5).

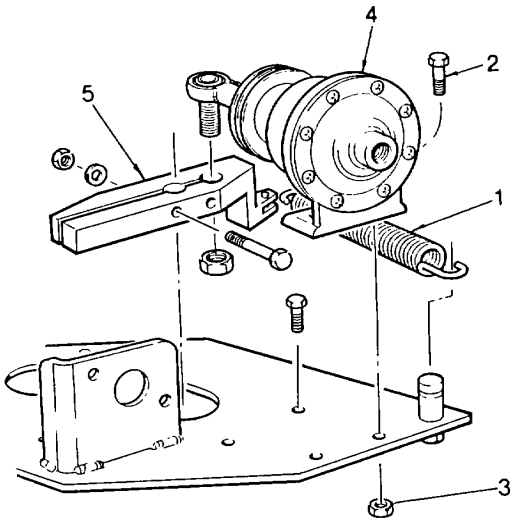
(2) Remove screws (2), and nuts (3) and lift chamber assembly (14) from plate. Discard the plate.

(3) Remove spring (1) from old plate.

(4) Remove air line from old air chamber.

(5) Remove chamber assembly from old plate by removing mounting screws and nuts.

(6) Aline arm (5) on governor shaft and mount new chamber on existing shutdown plate using screws (2) and



(7) Install spring (1) between plate post and arm (5).

(8) oat threads of pipe fitting with pipe sealant (Item 22, Appendix B) and install throttle hose to air chamber.

(9) Adjust throttle as detailed in ADJUSTMENT preceding.

c. Pump Governor Replacement

NOTE

There are no repairable parts on the pump governor. This instruction can be used either to install a pump governor on a new engine or to remove and install a new or old pump governor on an old engine.

(1) Loosen nut (2), and screw (1) and lift off pump governor lever (3) from governor speed shaft.

2-19. ENGINE - Continued

2-19.12 Throttle, Fuel Shutdown, And Fire Pump Governor - Continued

(2) Tag and remove water and air lines at connections (4 and 5).

(3) Tag and remove ground wire from fuel water separator.

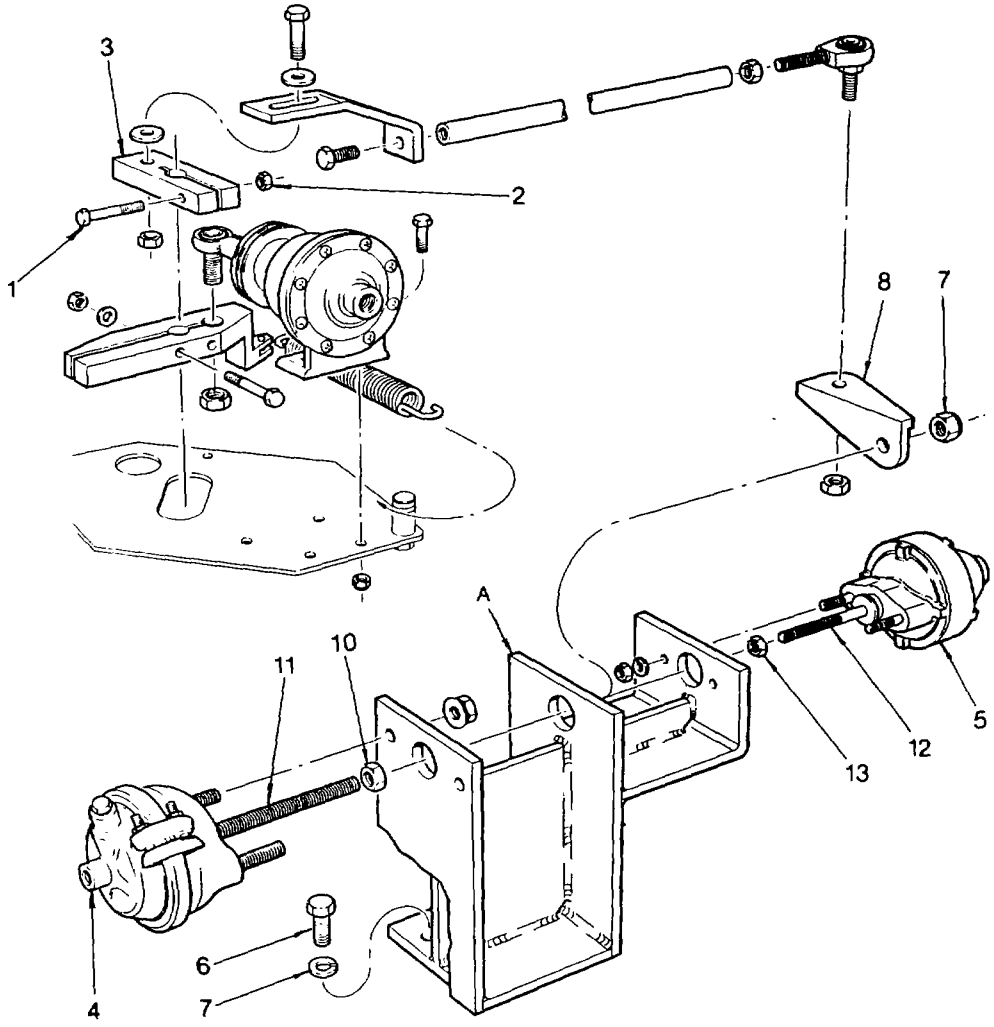
(4) Remove bolts (6), and washers (7) and lift pump governor from engine.

(5) Assemble pump governor as shown. Be sure bracket (8) is installed on the end of the air side control rod so that the threads of rod (11) are just seen out of nut (9).

(6) Be sure bracket (8) is held firmly in place with nuts (9 and 10).

(7) While holding bracket (8) up against left-hand bracket (A) back off nut (13) and rotate shaft (12) until diaphragm in water chamber bottoms out. Lock control rod nut (13) against end of rod (11).

(8) Aline assembly on engine and install screws (6) and washers (7). Tighten securely.



2-19. ENGINE - Continued

(9) Coat threads with pipe sealant (item 22, Appendix B) and install air line into connection (4) and water line into connection (5).

(10) Aline pump governor lever (3) on mechanical governor speed shaft and slide into position. Do not tighten bolt (1).

(11) Install ground wire from water/fuel separator to mounting bracket.

(12) Adjust pump governor as detailed in ADJUSTMENT preceding.

2-19. ENGINE - Continued

2-19.13 Mechanical Governor.

This task covers
a. Adjustment
b. Removal
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0650 (see TM 5-4210-220-12)

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Engine Coolant Drained (see TM 5-4210-220-12)
Turbocharger Exhaust Elbow Removed (see TM 5-4210-220-12)
Both Rocker Covers Removed (see para. 2-19.3)
Engine Stop Solenoid and Throttle Plate Removed (see para. 2-19.12)
Engine Fuel Pump Removed
Engine Thermostat Crossheader Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
21, Appendix B Petroleum Jelly
5123812 Blower/Governor Gasket
8924869 Blower Cover Gasket
8921497 Governor
8922593 High Speed Cover Gasket
5149510 Rocker Cover Gasket
5150193 Fuel Pump Gasket

PERSONNEL REQUIRED - 2

ADJUSTMENT

NOTE

Be sure exhaust valves are adjusted as detailed in para. 2-19.7. Be sure the fuel injectors have been timed as detailed in para. 2-19.5.

Engine coolant and thermostats Installed on engine.

(1) Remove engine fan as detailed in TM 5-4210-220-12 as adjustment requires the engine to be running and the adjustment of screws on the governor that are close to the fan blades.

(2) Be sure the foot throttle is in the up position.

(3) Be sure the cab mode switch is set to CFR and the governor switch is set to OFF.

(4) Remove the rocker cover on both cylinder heads as detailed in para. 2-19.3.

CAUTION

Never start an engine if there is any doubt that the stop control lever will not shut off fuel to the engine. An engine runaway could destroy the engine.

(5) Operate the governor stop lever, in a too and fro motion. Be sure the injector racks move to the full out position when the stop lever Is rotated clockwise.

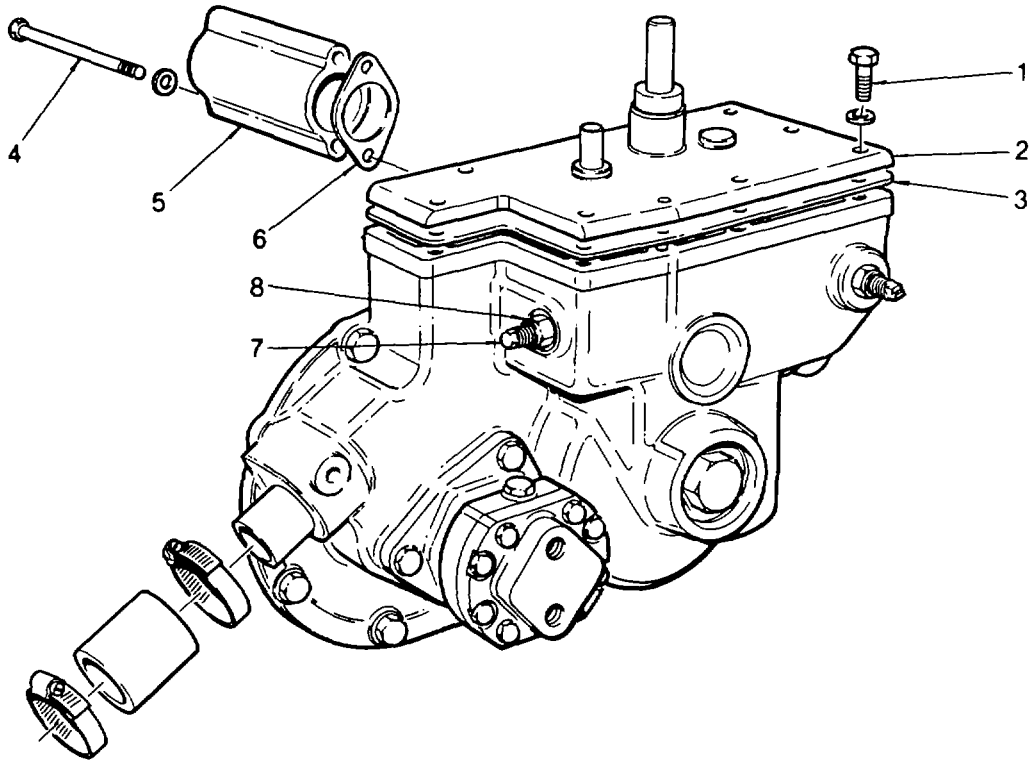
(6) Carry out fuel rod adjustment as detailed in para. 2-19.6 if the injector levers do not pull out.

2-19. ENGINE - Continued

(7) Remove the engine stop solenoid and foot throttle plate as detailed in para. 2-19.12.

(8) Remove screws (4) and lift off high speed spring retainer cover (5). Remove and discard gasket (6).

(9) Back out the buffer screw (7) until it extends approximately 5/8 in. (17 mm) from the locknut (8).

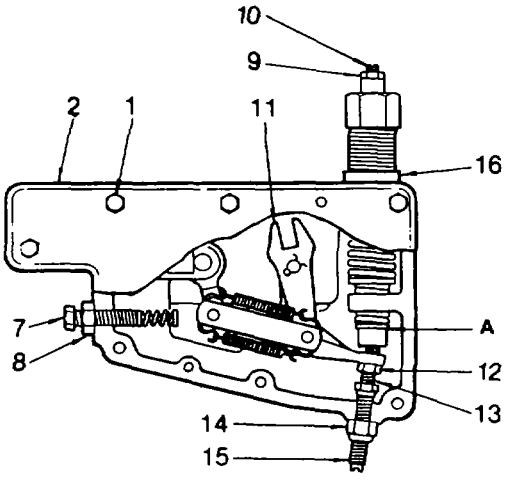


(10) Start engine and loosen the idle speed adjusting screw locknut (9). Adjust the idle screw (10) until the engine is idling at 600 rpm.

(11) Remove screws (1) and lift off governor cover (2). Remove and discard gasket (3). The stop and speed control shafts will remain attached to the cover.

(12) Restart the engine and manually operate the differential lever (11) until the engine is running between 1100 and 1300 rpm. Do not overspeed the engine.

(13) With a feeler gage, check the gap (A) between the high-speed spring plunger and the low-speed spring cap. Gap should be 0.002 0.004 in. (0.05 - 0.10 mm).



2-19. ENGINE - Continued

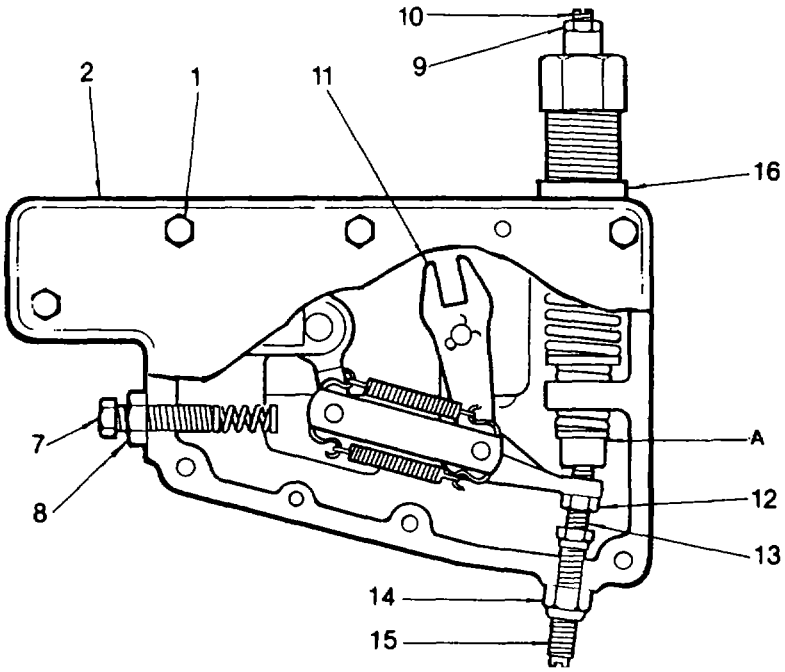
2-19.13 Mechanical Governor - Continued

(14) If adjustment is required stop the engine and the back off starting aid screw (15) and locknut (14). Loosen locknut (12) and adjust gap via screw (13).

(15) Recheck the gap with the engine operating at 1100 - 1300 rpm. Readjust as required.

(16) Stop the engine and using a new gasket , install the governor cover with screws . Be sure the pin in the speed control shaft aligns with the slot in the differential lever (11). Be sure the dowel pins in the housing aline with the holes in the cover.

(17) Adjust the position of the injector rack control levers as detailed in para. 2-19.6. Adjust the starting aid screw as detailed in para. 2-19.6.



(18) Remove the governor cover and recheck the running gap as detailed in steps 13 thru 16.

(19) Loosen the spring retainer locknut (16) and back off the high speed spring retainer at 5 turns.

(20) Start the engine and allow it to reach normal operating temperature.

(21) With no load on the engine, rotate the speed control shaft fully counterclockwise to the maximum speed position.

(22) Turn the high speed spring retainer until the engine is operating at 2250 rpm.

(23) Holding the high speed spring retainer, tighten the locknut (16).

(24) With the engine running at normal operating temperature, and the buffer screw (7) backed out, turn the idle speed adjusting screw (10) until the engine operates at 575 rpm.

(25) If the engine rolls use the buffer screw to hold the engine at speed. Once 575 rpm is set, back-out the buffer screw 0.63 in. (17 mrn).

2-19. ENGINE - Continued

(26) Holding the idle screw (10) tighten the locknut (9).

(27) Install the high speed spring retainer cover and tighten the two bolts.

(28) With the engine running at normal operating temperature, turn the buffer screw (7) in until it just contacts the differential lever and eliminates engine roll. Do not increase engine idle speed more than 15 rpm.

(29) Recheck the maximum no-load speed as detailed in step 21.

(30) If maximum no-load speed has increased more than 25 rpm, back off the buffer screw until speed increase is less than 25 rpm.

(31) Hold the buffer screw (7) and tighten the locknut (8).

(32) Install the engine stop solenoid and foot throttle plate as detailed in para. 2-19.12.

(33) Replace fan assembly as detailed in TM 5-4210-220-12.

REMOVAL

WARNING

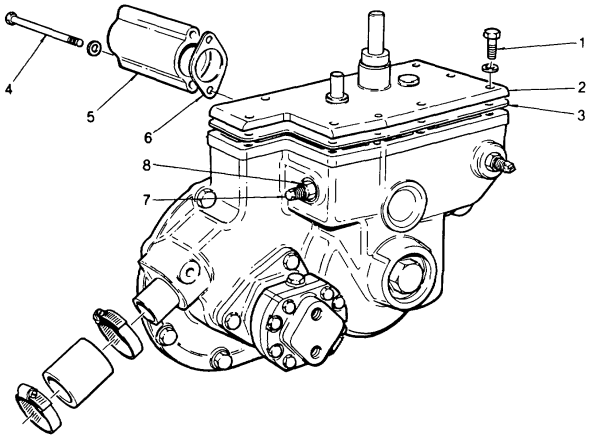
JP-4 is a highly volatile fuel. Extraordinary care must be taken when servicing components that use this fuel. The truck shall be grounded to an approved grounding point if it contains JP-4.

(1) Remove the eight screws (1) and lift off the governor cover (2). Remove and discard gasket (3). The stop and speed control shafts will remain attached to the cover.

(2) Remove the right bank fuel rod by removing the screw type pin, in the control link operating lever, and the clevis pin in the control tube lever.

(3) Withdraw the fuel rod from the governor.

(4) Remove the left bank fuel rod by removing the clevis pin in the control tube lever and lift the connecting pin up out of the control link operating lever 3/4 in. (19 mm).



(5) Withdraw the left fuel rod from the governor.

(6) Tag and remove the crossover fuel lines attached to each cylinder head.

(7) Loosen the hose clamps (4) on the fuel rod cover tube hoses (5). Slide each hose and clamp up the tube on the governor housing (6).

2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

(8) Note the location of the two copper, one plain, and eight lockwashers on the governor to blower bolts.

(9) Remove the 10 bolts and washers securing the governor and fuel pump assembly to the blower.

(10) Tap the sides of the governor housing lightly with a plastic hammer, and pull the governor straight out from the dowels on the blower end plate.

(11) Remove and discard the governor-to-blower gasket.

INSTALLATION

WARNING

JP-4 is a highly volatile fuel. Extraordinary care must be taken when servicing components that use this fuel. The truck shall be grounded to an approved grounding point if it contains JP-4.

(1) If removed, place a fuel rod cover tube hose (5) and clamp (4) on each fuel rod cover tube on each side of the governor housing (6).

(2) Place a new gasket on the forward face of the blower end plate. Hold in place with petroleum jelly (item 21, Appendix B).

(3) Push the governor over the dowels in the blower end plate and against the gasket.

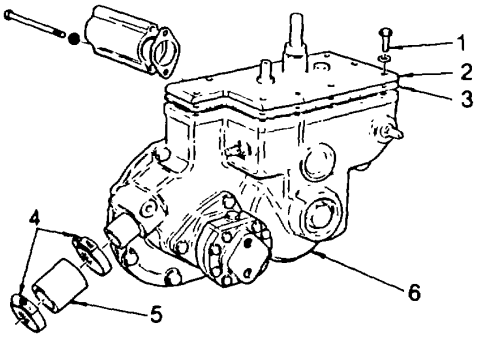
(4) Install the bolts, lockwashers, copper washers, and plain washers as shown. Tighten all bolts to 17 ft lb (23 Nm).

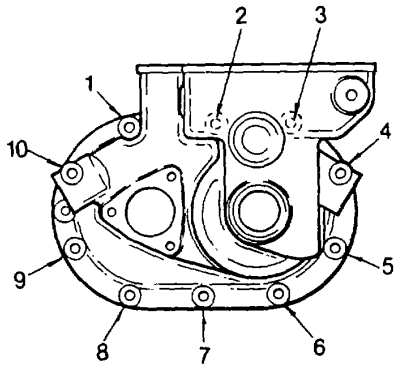
(5) Slide each fuel rod cover tube hose (5) down on the cover tube on the cylinder head and tighten the hose clamps (4).

(6) Install the crossover fuel line to each cylinder head.

(7) Insert the lower end of the left bank fuel rod down through the top of the governor housing and through the fuel rod cover tubes to the injector control tube lever.

(8) Raise the connecting pin (9) up. Insert the end of the fuel rod (10) between the two bosses (B) on the lever (11) and insert the pin through the fuel rod and into the lower boss.





Bolt Size:	Washer:	Position:
5/16" .18 x 5-1/4"	Copper	4
5/16" .18 x 4"	Copper	10
5/16" .18 x 3-3/4"	Lock and Plain	1
5/16" .18 x 2-1/4"	Lock	2-3-5-6-7-8-9

2-19. ENGINE - Continued

(9) Connect the opposite end of the fuel rod to the left bank injector control tube lever with a clevis pin and cotter pin.

(10) Insert the lower end of the right bank fuel rod down through the top of the governor housing and through the fuel rod cover tube to the injector control tube lever.

(11) Remove the short screw pin (8) from the control link operating lever. Insert the end of the fuel rod (22) between the two bosses (A) on the lever (11).

(12) Install the screw pin (8).

(13) Connect the opposite end of the fuel rod to the right bank injector control tube lever with a clevis pin and cotter pin.

(14) Affix a new gasket to the top of the governor housing.

(15) Place the governor cover on the governor housing (6) with the pin in the speed control shaft aligned with the slot in the differential lever (12).

(16) Be sure the dowel pins in the housing locate in the cover and attach cover with screws.

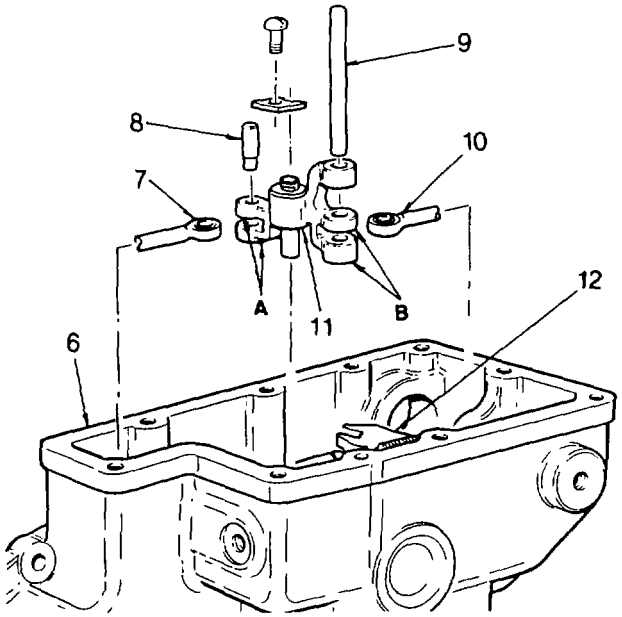
NOTE

The short screw with the drilled head goes in the corner hole next to the high speed spring retainer housing.

(17) Install fuel pump and hoses as detailed in TM 5-4210-220-12.

(18) Install the thermostat cross header as detailed in TM 5-4210-220-12.

(19) Adjust the governor as detailed in ADJUSTMENT preceding.



2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

REPAIR

a. Speed Control Shaft Repair

NOTE

This can be repaired with governor on engine.

(1) Remove stop solenoid and throttle plate as detailed in para. 2-19.12.

(2) Remove screws (1) from cover (2), and pull cover from housing. Remove and discard gasket (3).

(3) Remove snap ring (4), the two seal ring retainer washers (5 and 6) and the seal ring (7) from the shaft (9).

(4) Withdraw shaft (9) from lower end of cover.

(5) Inspect bearings and shaft. If bearings require replacement see steps 6 thru 15. If only the shaft requires replacement go to step 16.

(6) For bearing removal, remove stop shaft (10) as detailed in Stop Control Shaft Repair following.

(7) Place the inner face of the cover over the bed opening on an arbor press.

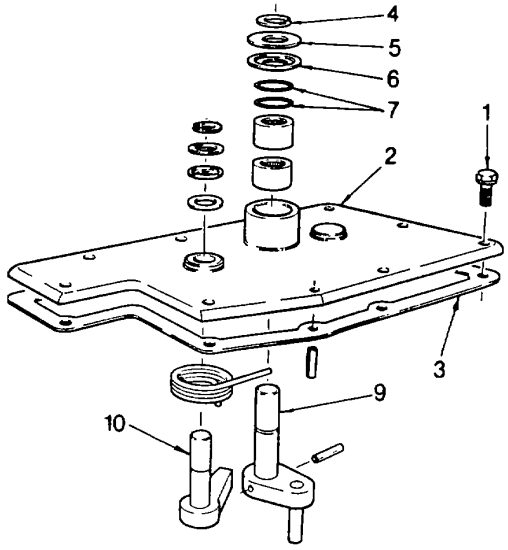
(8) Place remover J21967-01 on top of bearing and under the ram of the press.

(9) Press both bearings out of the cover.

(10) Lubricate the outside diameter of one of the new bearings with engine oil (item 17, Appendix B).

(11) Start the bearing, number side up, into the top face of the cover.

(12) Press into position using a press and tool J21068.



(13) Place the cover, inner side up on the press and lubricate the second bearing with engine oil (item 17, Appendix B).

(14) Start the bearing, numbered side up, and press into positions as per the first bearing, but using the other end of the installer, ie. this bearing remains flush with the face of the boss.

(15) Install stop lever as detailed in Stop Control Shaft Repair following.

(16) Lubricate the speed control shaft bearings with grease (item 16, Appendix B). Insert the speed control shaft (9) through the bearings.

2-19. ENGINE - Continued

(17) Place a new seal ring (7) over the shaft and push it down into the bearing bore against the bearing.

(18) Install the two seal ring washers (5 and 6) and install the snap ring (4) into the groove in the shaft.

(19) Adjust the governor as detailed in ADJUSTMENT preceding.

(20) Install the cover (2) on the housing with a new gasket (3). Retain with screws (1).

(21) Install stop solenoid and throttle plate as detailed in para. 2-19.12.

b. Stop Solenoid Shaft Repair

NOTE

This can be repaired with governor on engine. The stop solenoid shaft bushing is not serviced; replace top cover if bushing worn.

(1) Carry out steps 1 thru 4 of Speed Control Shaft Repair, a. preceding.

(2) Remove snap ring (11), the two seal ring retainer washers (12 and 13) and the seal ring (14) from the shaft (10).

(3) Discard the seal ring.

(4) Carefully withdraw shaft (10) and retain the spring (15).

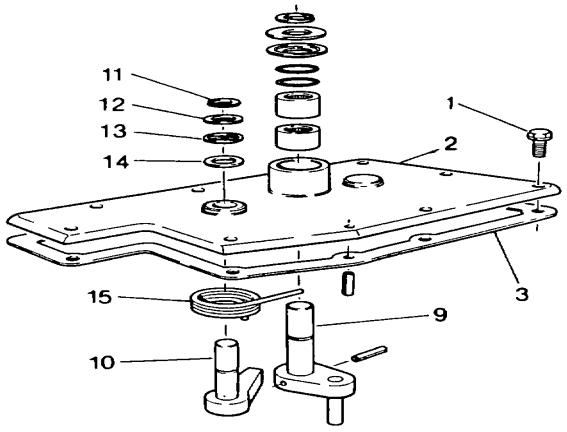
(5) Inspect the spring for wear. Replace as required.

(6) Inspect the play between the shaft (10) and the bushing in the cover (2).

(7) If there is too much play, replace the shaft and check for play. If play is still excessive, replace the cover (2).

(8) Lubricate the stop lever shaft with grease (item 16, Appendix B).

(9) Place the return spring (15) over the boss on the inner face of the cover.



(10) Insert the shaft (10) part way into the bushing and hook the end of the return spring over the lever. Then push the shaft up into the cover.

(11) Position the end of the lever on the right side of the step pin.

(12) Place a new seal ring (14) over the shaft and push it down into the bore, against the bushing.

(13) Install the two seal ring retainer washers (12 and 13) and install the snap ring (11) into the groove on the shaft.

(14) Carry out steps 16 thru 20 of Speed Control Shaft Repair, a. preceding.

2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

c. High and Low Speed Spring Repair

NOTE

This can be repaired with governor on engine.

(1) Remove the stop solenoid and throttle plate as detailed in para. 2-19.12.

(2) Remove screws (1) from cover (2) and pull cover from housing. Remove and discard gasket (3).

(3) Remove the two bolts (4) and copper washers (5).

(4) Remove the housing (6) and gasket (7). Discard the gasket.

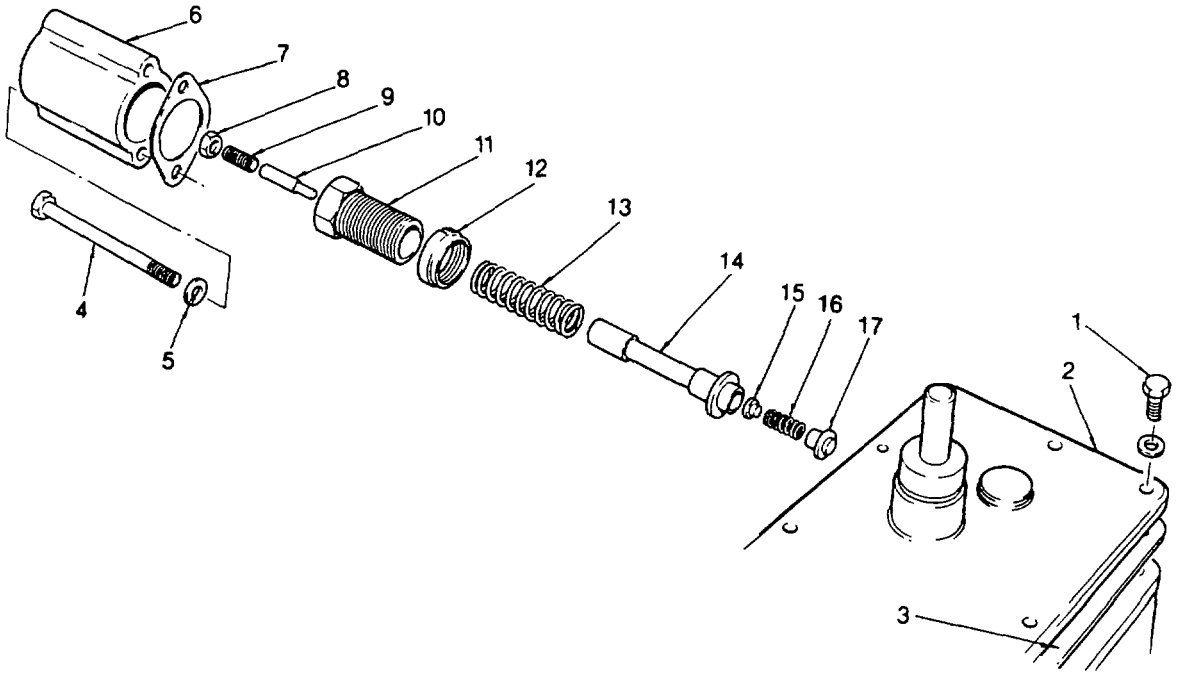
(5) Loosen the high speed spring retainer locknut (12) with spanner wrench.

(6) Holding the flats of the spring retainer (11) turn it out of the housing and carefully withdraw the low and high speed spring assembly from the governor.

(7) Remove the low speed spring cap (17), spring (16), and spring seat (15) from the plunger (14).

(8) Depress the high speed spring (13) by hand and remove the idle speed adjusting locknut (8).

(9) Remove the high speed spring retainer (11), high speed spring (13), idle speed adjusting screw (9), and adjusting pin (10) from the high speed plunger (14).



2-19. ENGINE - Continued

(10) Clean and examine all components. Replace either spring if cracked, worn, or pitted. If the reason for removal was failure of the governor to control the engine, replace both springs.

(11) Inspect the spring seats for wear or corrosion. Replace as required.

(12) Place the high speed spring (13) on the plunger (14) with the loosely wound end of the spring against the shoulder of the plunger.

(13) Insert the spring and plunger assembly into the spring retainer (11).

(14) Place the adjusting pin (10) in the hole in the plunger. Thread the idle speed adjusting screw (9) into the threaded end of the plunger (14) about 1/2 in. (13 mm).

(15) Thread the locknut (8) onto the idle speed adjusting screw (9).

(16) Place the low speed spring (16) in the low speed spring cap (17) and the small end of the low speed spring seat (15) into the opposite end of the spring.

(17) Insert the low speed spring assembly into the plunger (14) and over the idle speed adjusting pin (10).

(18) Insert the spring, plunger, and retainer assembly into the opening in the governor housing and thread the retainer (11) into the housing approximately 1 in. (25 mm). Be sure the locknut (12) is installed on the retainer.

(19) Adjust the governor as detailed in ADJUSTMENT preceding.

d. Governor Weights and Bearing Repair

NOTE

Governor must be removed from engine to carry out repair of the governor weights and shaft assembly.

(1) Remove governor from engine as detailed in REMOVAL preceding.

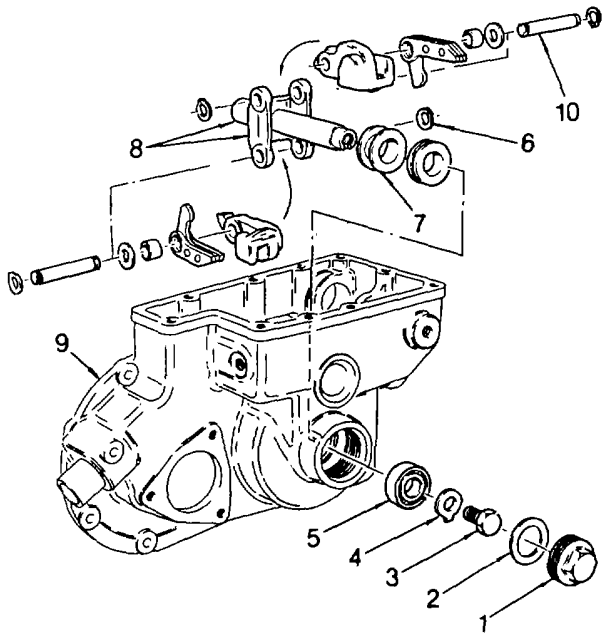
(2) Clamp the flange of the governor housing (9) in a vise equipped with soft jaws.

(3) Unscrew and remove the plug (1) and gasket (2). Discard the gasket.

(4) Bend down the tang on the lockwasher (4).

(5) While preventing the weight carrier (8) from turning, remove the bearing retaining bolt (3), flat washer, and lockwasher (4).

(6) Thread a 5/16 - 24 X 3 in. bolt into the bearing retaining bolt hole.



2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

(7) Support the governor on an arbor press with the drive shaft over a hole.

(8) Push the shaft (8) via the bolt until it is free of the bearing (5).

(9) Slide the governor riser thrust bearing (6) and riser (7) from the shaft (8).

(10) Using a suitable puller, pull bearing (5) out of the housing.

(11) Carefully maneuver the weight shaft (10) and attached weights out of the top of the housing.

(12) If replacement of individual weights is required, these can be removed via the retaining rings and shafts. However, it is not advisable to replace individual components. Replace the shaft as an assembly (P/N 5113906).

(13) Inspect all components for wear. For bearing inspection, see para. 2-7.

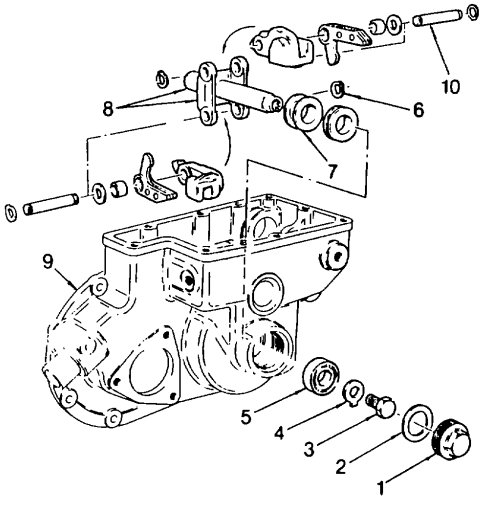
(14) Replace any components failing inspection.

(15) Lubricate each bearing with engine oil (item 17, Appendix B).

(16) Slide the governor riser (7) on the weight shaft (8) and against the fingers of the high speed weights.

(17) Place the thrust bearing (6) over the weight shaft with the bearing race having the smaller inside diameter against the riser.

(18) Insert the weight carrier and shaft assembly in the governor housing.



(19) Support the splined end of the shaft and the governor housing on an arbor press with the upper end of the shaft under the ram of the press.

(20) Place bearing (5) in the governor housing, number side up. Start it straight on the end of the shaft (8).

(21) Place a sleeve with a 1/2 in. (13 mm) inside diameter cover the inner bearing race and press the bearing into the housing and against the shoulder on the shaft.

(22) Place the lockwasher (4) on the end of shaft with the tang on the inner diameter of the washer in the notch in the end of the shaft.

(23) Place the flat washer over the shaft and thread the bolt (3) onto the shaft.

2-19. ENGINE - Continued

(24) Clamp the splined end of the shaft in the soft jaws of a vise and tighten the bearing bolt (3) to 19 it lb (26 Nm).

(25) Bend the tang of the lockwasher (4) against the head of the bolt (3).

(26) Place a new gasket (2) into the housing. Coat the threads of plug (1) with pipe sealant (item 22, Appendix B) and tighten plug to 45 ft lb (61 Nm).

(27) Rotate the governor weight assembly to check there is no bind. If it does bind, remove the housing plug and be sure the weight shaft bearing (5) is fully seated in the governor housing.

(28) Install governor on engine as detailed in INSTALLATION preceding.

e. Governor Linkage And Operating Shaft Repair

NOTE

Governor must be removed from engine to carry out repair.

(1) Remove the governor from engine as detailed in REMOVAL preceding.

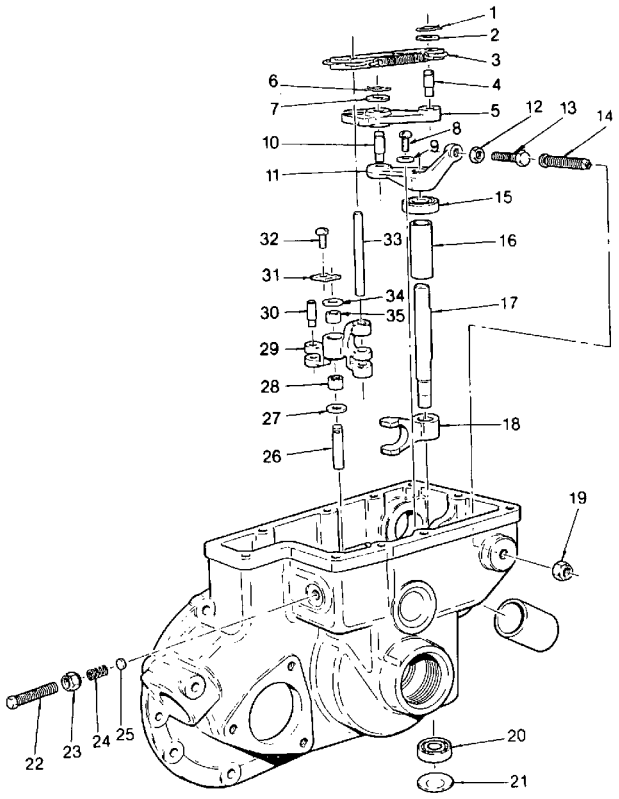
(2) Remove governor weight shaft as detailed in Governor Weights And Bearing Repair preceding.

(3) Remove the spring retainer (1) and plain washer (2) and remove the connecting link (3).

(4) Remove the spring retainer (6) and plain washers (7) and remove differential lever (5).

(5) Remove starting aid screw (14) and locknut (19).

(6) Remove the gap adjusting screw (13) and nut (12).



2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

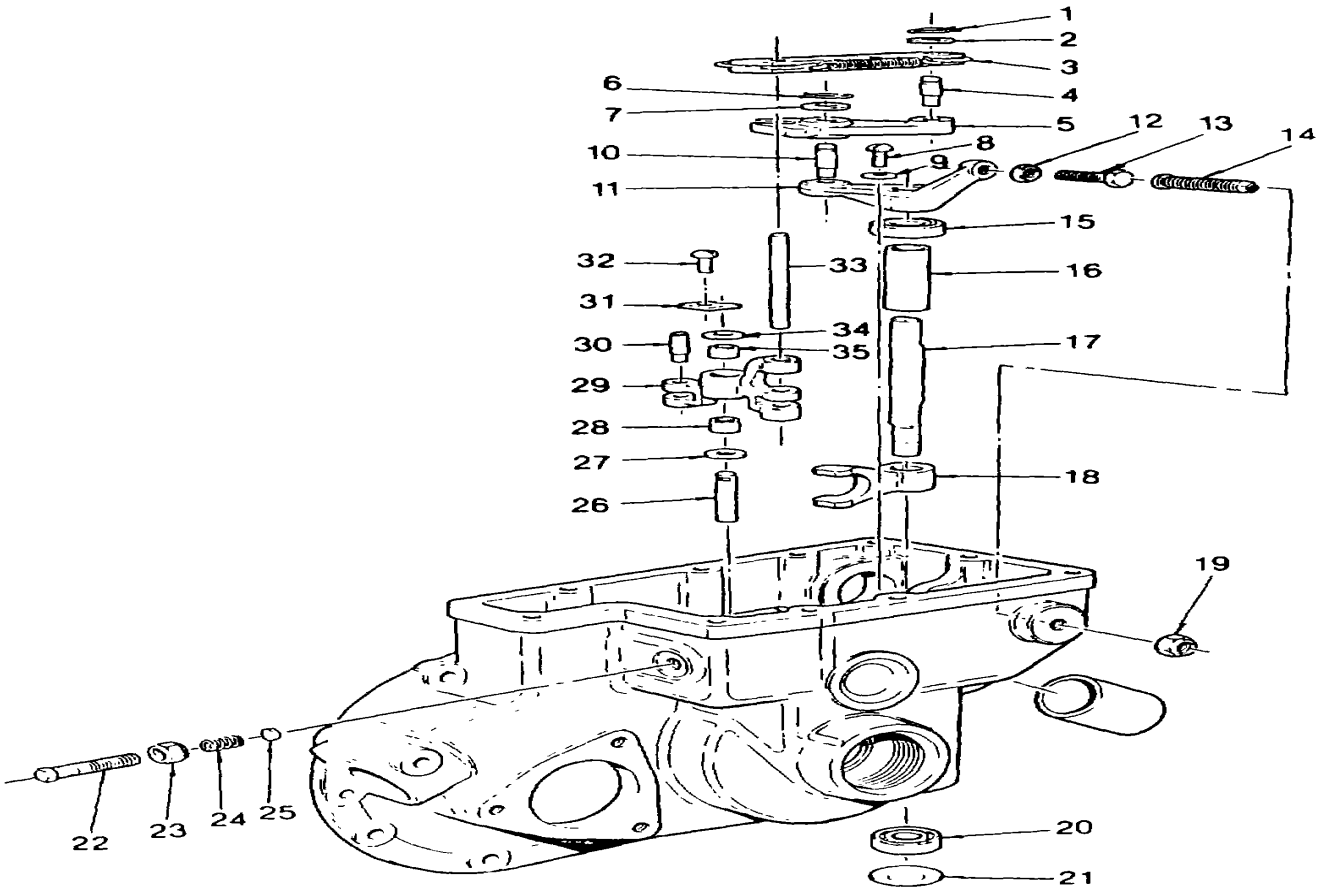
(7) Remove screw (32) and lockwasher (31) from the operating lever shaft. Lift the shaft (26) out and remove the two washers (34 and 27) on each side of lever (29).

(8) Remove the expansion plug (21) from the bottom of the housing.

(9) Remove screw (8) and lockwasher (9) that secure the upper bearing (15) in the governor housing.

(10) Support the governor housing, bottom side up, on the bed of an arbor press with the two dowel pins in the top of the housing between the two steel supports.

(11) Place a small brass rod on the end of the operating shaft (17) and press the shaft out of the bearing (20).



2-19. ENGINE - Continued

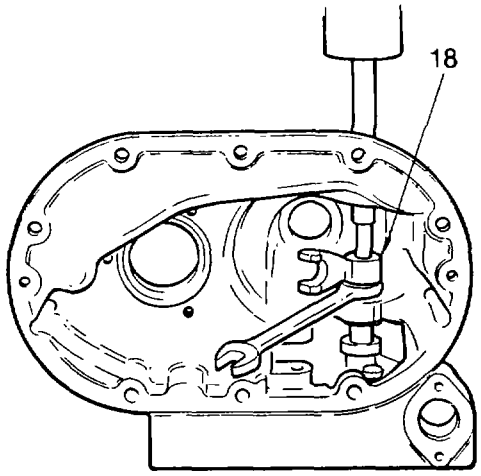
(12) With the housing still supported on the press, place a 9/16 in. wrench under the operating fork as shown.

(13) Place a brass rod on the end of the shaft and press the fork (18) off the operating shaft.

(14) Remove the shaft (17), operating lever (11) and bearing (15) as an assembly from the housing.

(15) Using a suitable puller, withdraw the lower bearing (20) from the bottom of the housing.

(16) Slide the operating shaft spacer (16) from the shaft (17).



(17) Place a short 9/16 in. inside diameter sleeve over the end of the operating shaft (17) and rest it against the inner race of the upper bearing (15).

(18) Support the operating shaft (17), lever (11), bearing (15) and sleeve on *a* large washer or plate (with a 5/8 in. hole) on the bed of an arbor press.

(19) Place a small brass rod on the end of the shaft and press the operating shaft (17) out of the lever (11) and bearing (15). Be sure the bearing inner race is resting on the sleeve or the bearing may be damaged.

(20) Inspect the control link operating lever (29) for wear or damage to the needle bearings (28 and 35). If damaged, press out using tool J8985 in an arbor press. Support the lower end of the lever on a sleeve which is the same size as the boss on the lever.

(21) Inspect all parts for excessive wear or damage. Replace components as required. For bearing inspection, see para. 2-7.

(22) Lubricate the inside diameter of the upper bearing (15) with engine oil (item 17, Appendix B).

(23) Start the bearing, number side up, on the large end of the operating shaft (17).

(24) Support the bearing and shaft on a 9/16 in. inside diameter sleeve on the bed of a press. With the inside diameter of the bearing resting on the sleeve, press the shaft into the bearing until 1/4 in. (6 mm) of the shaft protrudes through the bearing.

(25) Lubricate the inside diameter of the operating shaft lever (11) with engine oil (item 17, Appendix B). Start the lever, pivot pin (10) facing up, on the shaft (17) , the flat on shaft and lever keyed together.

(26) Continue to press lever (11) against the bearing (15) and onto shaft (17) until the shaft is flush with the top opening of the lever.

(27) Place spacer (16) over shaft (17).

2-19. ENGINE - Continued

2-19.13 Mechanical Governor - Continued

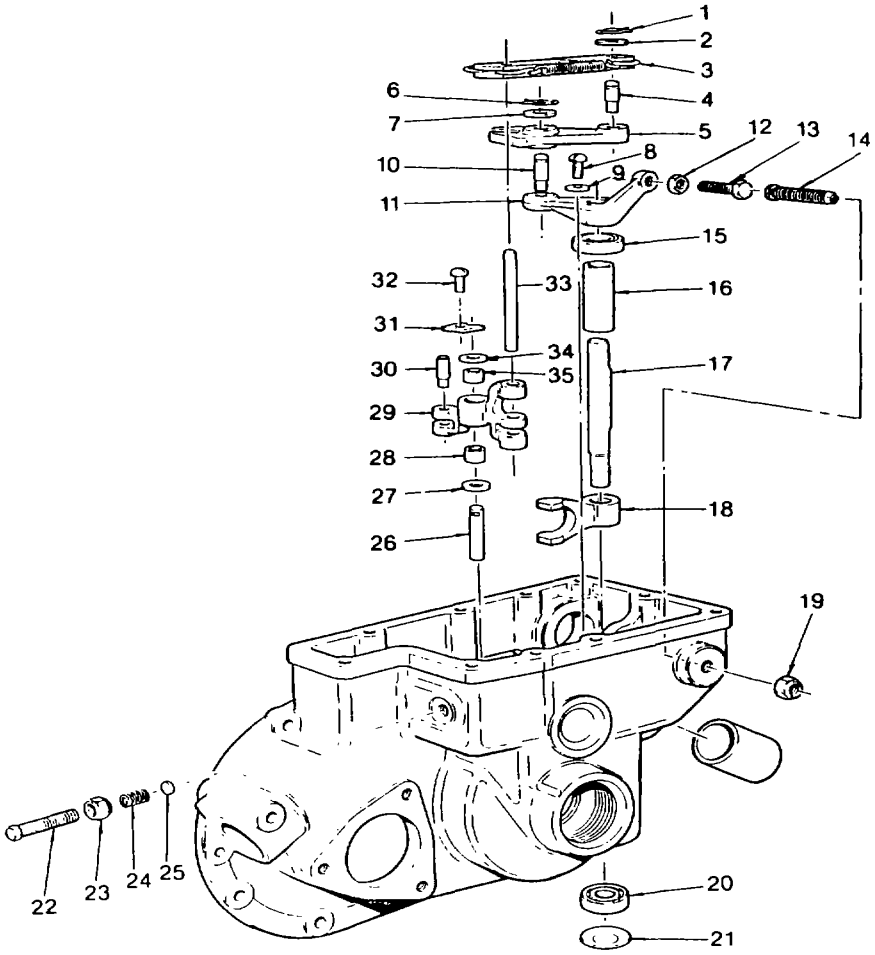
(28) Thread the gap adjusting screw (13) and locknut (12) into the lever. Thread the starting aid screw (14) and locknut (19) into the governor housing.

(29) Insert the assembly through the upper bearing bore in the governor housing, with the gap adjusting screw (13) alined with the starting aid screw (14).

(30) Lubricate the inside diameter of the governor operating shaft fork (18) with engine oil (item 17, Appendix B).

(31) Place the fork (18) over the lower end of the shaft (17) with the finished cam fingers of the fork facing the rear of the housing. Be sure the flat in the fork is keyed with the flat on the shaft.

(32) Support the governor housing on the bed of a press with the upper end of the shaft resting on a steel support.



2-262

2-19. ENGINE - Continued

(33) Place a 7/16 in. inside diameter sleeve over the end of the shaft and against the fork (18) and press the fork tight against the shaft spacer (16).

(34) Lubricate the governor operating shaft lever lower bearing (20) with engine oil (item 17, Appendix B).

(35) Start the bearing (20), number side out, in the governor housing recess and over the end of shaft (17).

(36) Using the same arrangement as in step 32 and 33, place the 7/16 in. sleeve on the inner race of bearing (20) and press the bearing onto the shaft until it seats on the shoulder in the housing

(37) Install screw (8), washer, and lockwasher (9) to secure the upper bearing (15) In the housing.

(38) Apply a thin coat of pipe sealant (item 22, Appendix B) around the edge of a new expansion plug (21). Place the plug concave side up in the housing and tap the center of the plug with a hammer to secure in place.

(39) Place the differential lever (5) over the pivot pin (10) and secure with plain washer (7) and spring retainer (6). Be sure the lever has pin (4) facing up.

(40) If removed, install new needle bearings (28 and 35) in the control link operating lever (29). Lubricate both bearings with engine oil (item 17, Appendix B). Using a press and tool J8985, press the bearing into place, number side out, until the bearing top face is flush with the boss. Repeat for the second bearing.

(41) Lubricate the bearings with grease (item 16, Appendix B) and place the operating lever (29) in position between the two bosses inside the governor housing. Insert a flat washer on each side of the lever and install the shaft (26) with the slot in the side at one end of the shaft up.

(42) Aline the slot in the operating lever shaft (26) with the lock clip screw hole in the boss next to the shaft. Install the lock clip (31), lockwasher and screw (32) and tighten securely.

(43) Place one end of the connecting link (3) over the differential lever pin (4) and secure in place with washer (2) and retainer (1).

(44) Place the other end of the connecting link (3) on top of the control link (29) and install the connecting pin (33).

(45) Install the governor weight shaft as detailed in Governor Weights and Bearing Repair preceding.

(46) Install governor on engine as detailed in INSTALLATION preceding.

2-20 REAR AXLE

2-20. REAR AXLE.

2-20.1 Power Divider (Transfer) Unit.

This task covers

a. Removal
b. Inspection
c. Installation
d. Repair

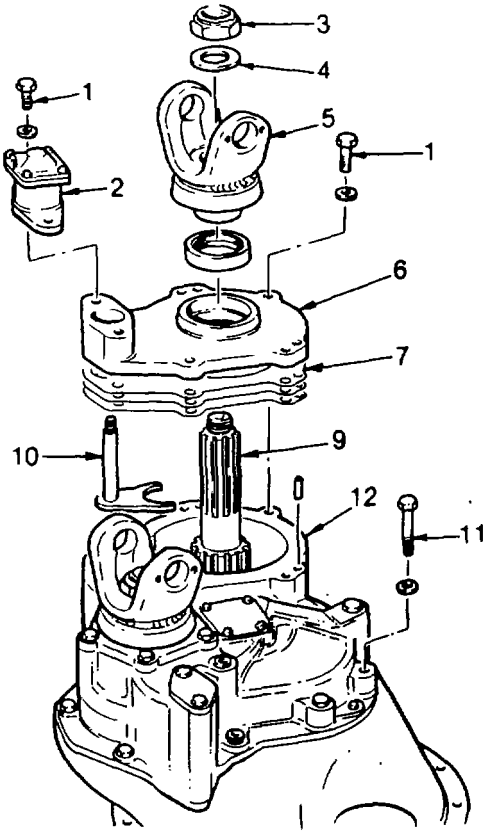
TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Engine Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Wheels Blocked
Pump and Hose Body Heat Shields Removed (see TM 5-4210-220-12)
Rear Axle Drive Lines Removed (see TM 5-4210-220-12)
Air Tanks Drained

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
28, Appendix B Silicone Sealant

NOTE
The power divider can only be replaced by replacing the individual components making up the unit. Repair of the power divider is limited to replacement of components.

To facilitate power divider replacement or major repair, the differential carrier should be removed from the axle (see para. 2-20.2 REPLACEMENT) and placed on a work bench/stand. Minor repairs such as replacement of oil seals and drive shaft yokes can be done with the power divider installed on the axle, see REPAIR.



REMOVAL

NOTE
Differential carrier removed from axle.

a. Output Shaft Removal.

(1) Mount differential carrier in a repair stand or support it on a low workbench with the power divider facing up.

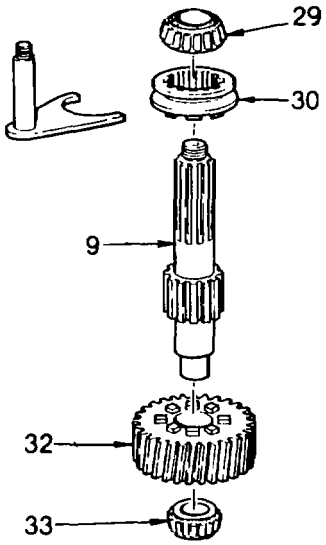
(2) Remove nut (3), washer (4), and yoke (5).

(3) If not already done, remove capscrew (1) and remove air shift unit (2), (see TM 5-4210-220-12).

(4) Lift and remove cover (6) and shims (7). If cover binds, tap cover gently with a soft mallet. Be careful not to damage mating surfaces of covers (6 and 12).

2-20. REAR AXLE - Continued

(5) Lift and remove output shaft (9) and shift fork (10) from power divider.



NOTE

Before disassembling output shaft components clean and inspect the assembled components. Unless replacement of one or more parts is required, the output shaft should be left assembled for reuse. For disassembly, refer to steps 6 and 7 following.

CAUTION

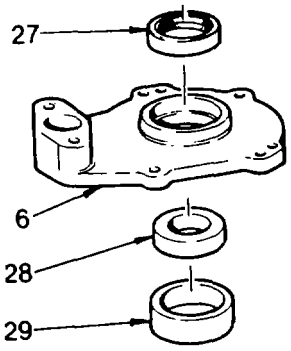
To prevent damage to clutch teeth use a suitable sleeve or collar to support gear (32) while pressing shaft (9).

(6) To replace output shaft components, remove bearing cones (29 and 33) from output shaft (9). Sliding clutch (30) will slide off shaft when cone (29) or cone (33) and gear (32) is removed. Use a split type puller to remove cone (29) from shaft. Use a press to remove cone (33) and gear (32).

NOTE

If bearing (33) has to be replaced, remove bearing cup from power divider cover, see procedure b, step 11 following.

(7) Remove oil seal (27) and discard. Retain spacer (28) and, if necessary, remove bearing cup (29) from bearing cover (6) using a press and suitable arbor.



2-20. REAR AXLE - Continued

2-20.1 Power Divider (Transfer Unit) - Continued

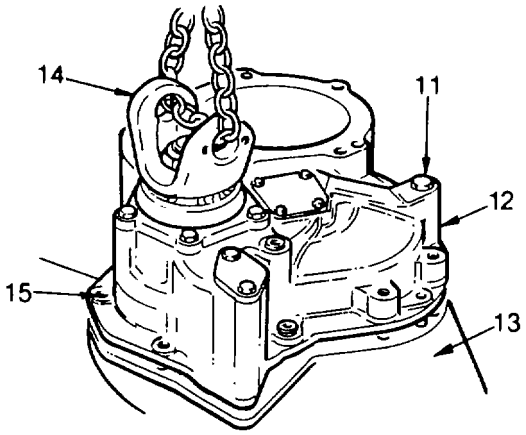
b. Power Divider Cover and Input Shaft Removal

(1) Remove nine capscrews (11) attaching power divider cover (12) to differential housing (13).

(2) Attach a suitable chain to input shaft yoke (14) and an overhead hoist.

(3) Lift power divider cover off carrier housing. If it binds, free the cover by striking it lightly using a soft mallet. Strike close to location of dowels (15).

(4) Place power divider on a workbench on suitable support. The input shaft protrudes below the lower cover flange.



NOTE

The one-piece input shaft and gear can drop out of cover (12) when yoke (18) is removed. To prevent damage, support shaft while removing yoke.

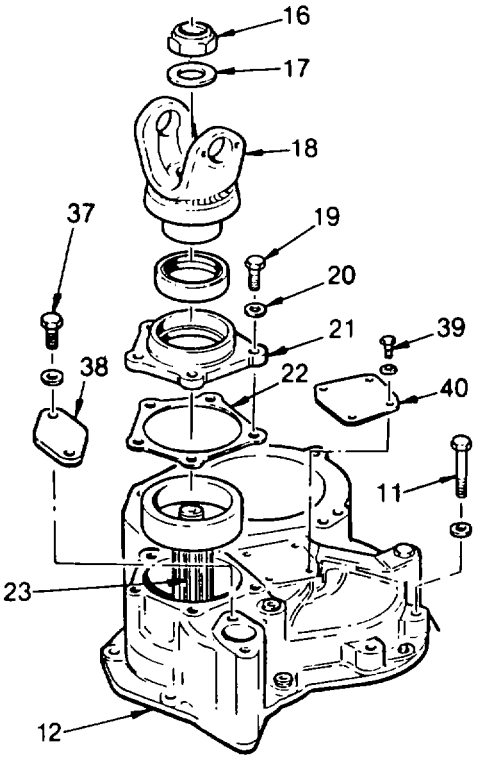
(5) Remove nut (16), washer (17), and yoke (18). Remove shaft (23) through the open bottom of cover (12).

(6) Remove capscrews (19), washers (20), bearing cap (21), and shims (22). Remove input shaft assembly (23).

(7) Remove capscrews (37 and 39) and remove covers (38 and 40).

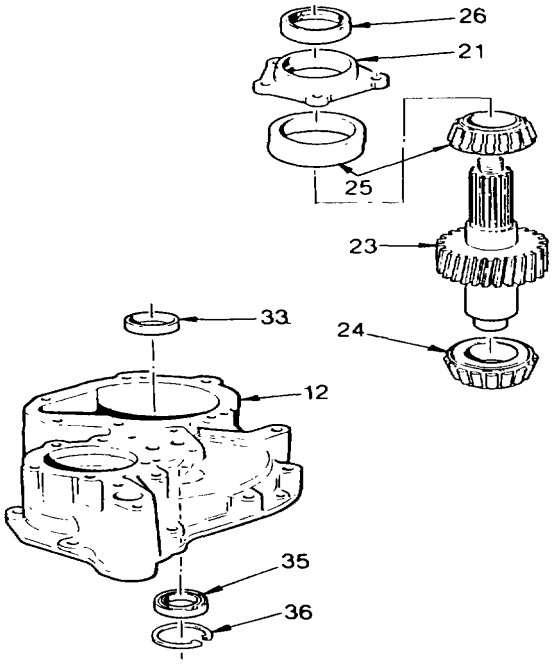
NOTE

Before disassembling bearing cones and cups from input shaft, bearing cap, and power divider cover, clean and inspect all items. Unless replacement of any bearings, shaft, or covers is required, no further disassembly should be carried out. For disassembly, refer to steps 8 thru 12 following.



2-20. REAR AXLE - Continued

(8) To replace input shaft (23) or bearings (24 and 25), remove particular bearing cone from shaft using a press and suitable arbor.
(9) If bearing (24) is replaced, remove bearing cup from differential housing using a suitable puller.
(10) If bearing (25) is replaced, remove oil seal (26) and remove bearing cone (25) from bearing cap (21) using a press and a suitable arbor.
(11) If output shaft bearing (35) is replaced,. (see procedure a. step 6 preceding), bearing cup (33) must be replaced. To do this, remove bearing cup from power divider cover (12) using a suitable puller
(12) If pinion shaft support bearing is replaced, (see 2-21.2 REPAIR), remove retaining ring (36) and bearing race (35) from power divider cover (12). Use a suitable puller to remove bearing cup.



INSPECTION

WARNING

Dry cleaning solvent P-D-680 (safety or *Stoddard's solvent* is *potentially dangerous*. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm^2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(1) Clean all power divider components with dry cleaning solvent (item 10, Appendix B). Blow components dry using compressed air.
(2) Inspect all parts for notches, visible steps or grooves created by wear. Look for pitting or cracking along gear contact lines. Scuffing, deformation, or discoloration are signs of excessive heat usually related to low lubricant levels or improper lubrication practices.
(3) Before reusing a gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment.
(4) Inspect machined surfaces of cast or malleable parts. They must be free of cracks, scoring, and wear. Look for elongation of drilled holes, wear on surfaces machined for bearing fits and nicks or burrs in mating surfaces.

2-20. REAR AXLE - Continued

2-20.1 Power Divider (Transfer Unit) - Continued

(5) Inspect fasteners for rounded heads, bends, cracks or damaged threads. The power divider cover should be examined for cracks or leaks.

(6) Inspect bearings as detailed in para. 2-7.

INSTALLATION

a. Power Divider Cover and Input Shaft Installation

(1) Check expansion plug in power divider cover to make sure it is firmly seated. If loose, strike it lightly with a hammer to seat it. If necessary, replace plug.

NOTE

Omit step 2 if pinion shaft support bearing is not replaced. Omit step 3 if output shaft bearing (35) is not replaced. Omit steps 4 thru 6 if no parts of input shaft and gear assembly are replaced.

(2) Install pinion shaft support bearing race (35) and retaining ring (36). Use a press and a suitable arbor to install race.

(3) Install bearing cup (33) in power divider cover (12) using a press. Be sure cup is fully seated against shoulder in cover.

(4) Install input shaft bearing cup (24) in differential carrier. Use a suitable arbor and hammer to seat cup.

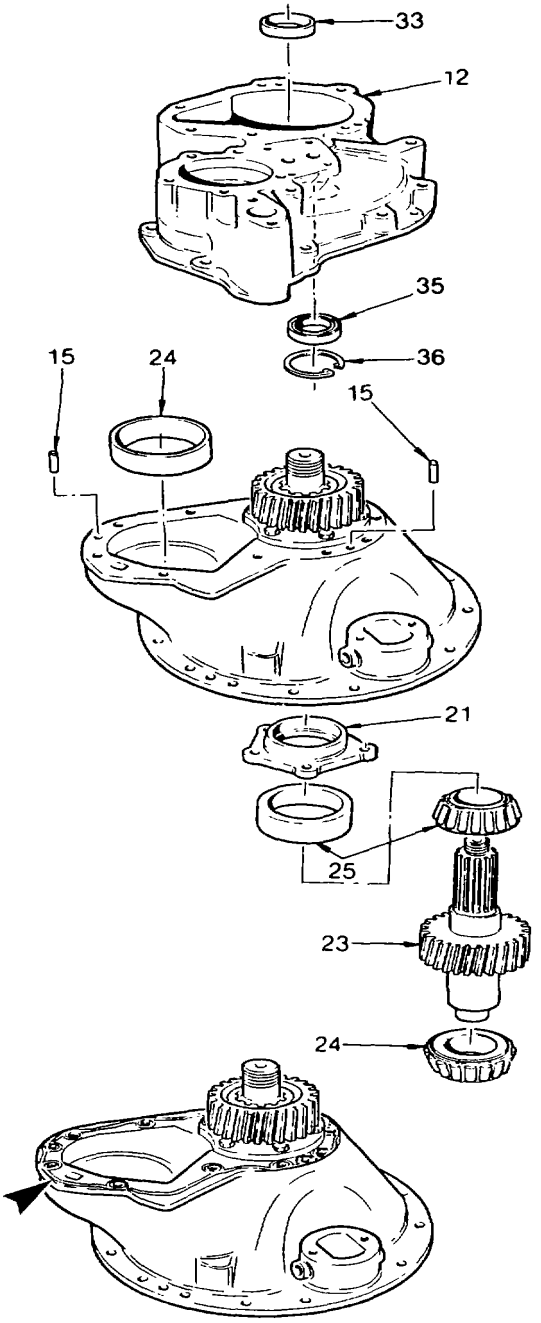
(5) If removed, replace dowel pins (15) in differential carrier.

(6) Install bearing cup (25) in bearing cap (21) using a press and suitable arbor.

(7) Using a press and a suitable arbor, press bearing cones (24 and 25) onto input shaft (23). Be careful not to press on rollers as this will damage bearings.

(8) Apply silicone sealant (item 28, Appendix B) to differential carrier flange in a 1/8 In. (3 mm) continuous bead as shown.

(9) Install input shaft (23) in differential carrier.

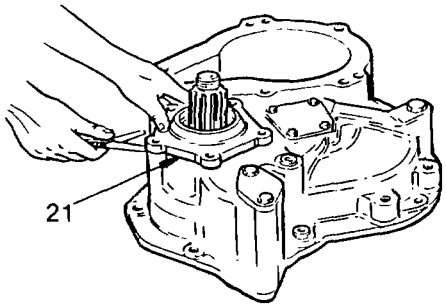


2-20. REAR AXLE - Continued

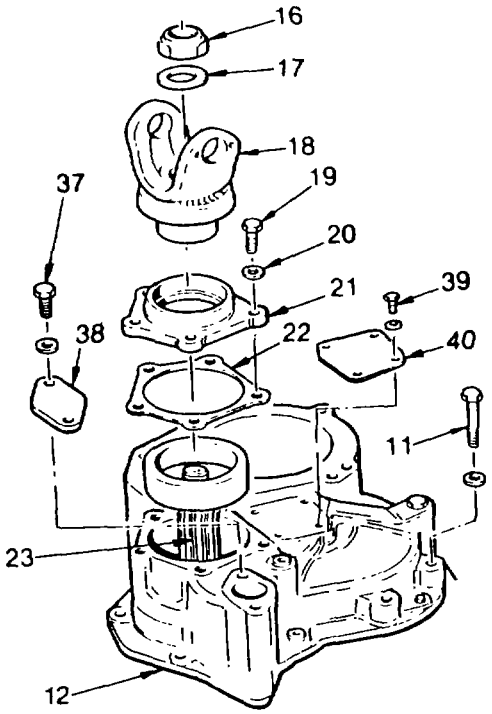
(10) Install power divider cover (12) on differential carrier. Make sure that pinion shaft support bearing slips into cup in cover (12).
(11) Fasten cover (12) to differential carrier using nine capscrews (11) and lockwashers. Tighten capscrews to 125 ft lb (170 Nm).
(12) Apply silicone sealant (item 28, Appendix B) to covers (38 and 40), and install on power divider cover (12) using capscrews (37) and (39). Tighten capscrews to 55 ft lb (75 Nm).

NOTE

To ensure proper input shaft end play, necessary shimming of cover (21) must be calculated and checked. To do this carry out steps 13 thru 19. Repeat steps as necessary.



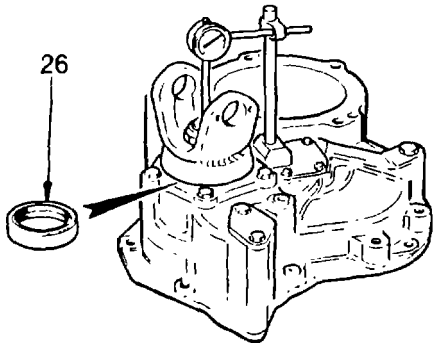
(13) Place cap (21) on power divider cover (12). Hold cap in position by hand pressure and measure clearance between cap and cover using a feeler gage as shown. The measured clearance plus 0.005 in. (0.13 mm) equals the thickness of the initial shim pack.
(14) Install cap (21) with a shim pack (22) of the calculated thickness. Fasten cap using five capscrews (19) and lockwashers. Tighten capscrews to 85 ft lb (115 Nm).
(15) Install yoke (18), washer (17), and nut (16). Tighten nut snugly. Tap lightly on the end of input shaft (23) to seat bearings.



2-20. REAR AXLE - Continued

2-20.1 Power Divider (Transfer) Unit - Continued

(16) Using a dial indicator, check input shaft end play as shown. End play should be 0.003 to 0.007 in. (0.08 to 0.18 mm) when all new parts are used; 0.013 to 0.017 in. (0.33 to 0.43 mm) when parts are reused.



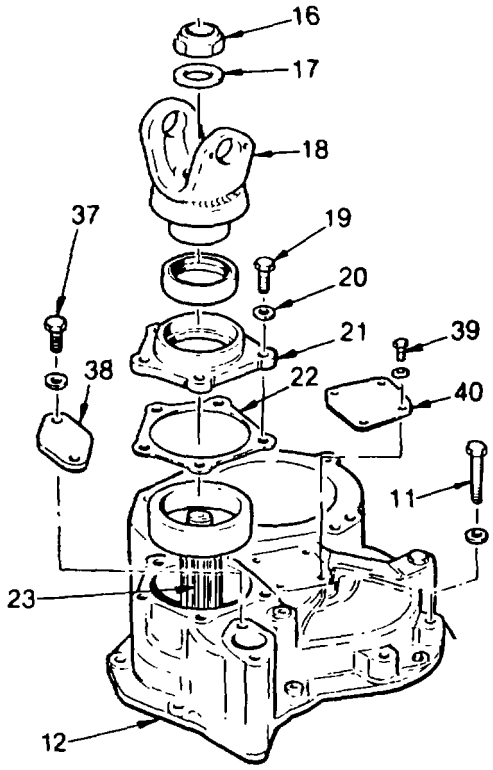
(17) Calculate the thickness of the shims to be added to or deleted from the shim pack (22).

(18) Remove yoke (18) and cap (21). Adjust shim pack as required by calculation in previous step.

(19) Reinstall cap (21) and yoke (18) as detailed in step 14 and 15 and check end play as detailed in step 16. Repeat steps until correct end play is obtained.

(20) When end play is correct, remove yoke and install oil seal (26) using a suitable arbor and a hammer. Be sure the spring side of seal faces inward.

(21) Install yoke (18), washer (17), and nut (16). Tighten nut firmly.



b. Output Shaft Installation

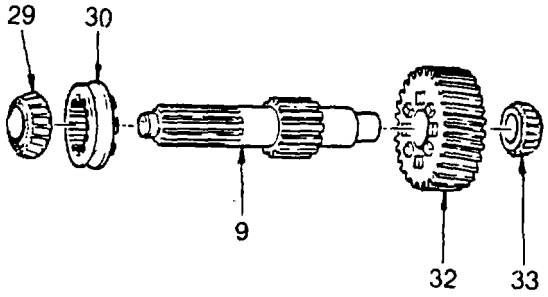
NOTE

Proceed to step 6 of installation procedure if none of the parts making up the output shaft assembly have been replaced.

(1) Mount output shaft (9) in a press with yoke splines facing down. Install gear (32) on shaft with clutch teeth facing down.

(2) Install bearing cone (33). Be sure bearing cone seats completely against shoulder on output shaft. To prevent bearing damage, use an arbor that only contacts the bearing race.

(3) Check that gear (32) can rotate freely on output shaft. Place sliding clutch (30) with clutch teeth facing gear (32) on the other end of the shaft.



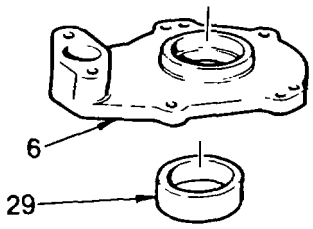
2-20. REAR AXLE - Continued

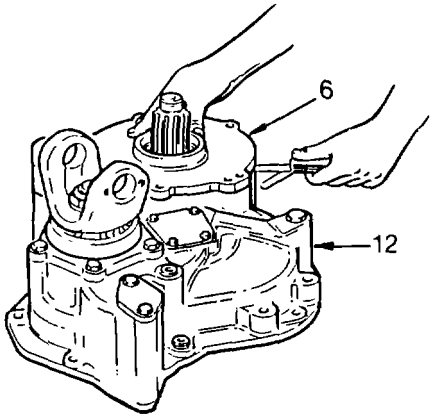
(4) Press bearing cone (29) onto shaft (9). Be sure to use an arbor which only contacts the bearing race and not the bearing rollers.

(5) Install bearing cup (29) in cover (6) using a press and suitable arbor. Be sure cup is fully seated against shoulder inside cover.

(6) Install assembled shaft (9) in power divider cover (12) but do not install shift fork.

(7) Place cover (6) in assembly position with power divider cover (12) as shown. Hold cover in position by hand and measure clearance between the covers using a feeler gage. The measured clearance plus 0.005 in. (0.13 mm) equals the thickness of the initial shim pack.





NOTE

To ensure proper output shaft end play, necessary shimming of cover (6) must be calculated and checked. To do this, carry out step 8 thru 10. Repeat these steps as necessary until correct end play is obtained.

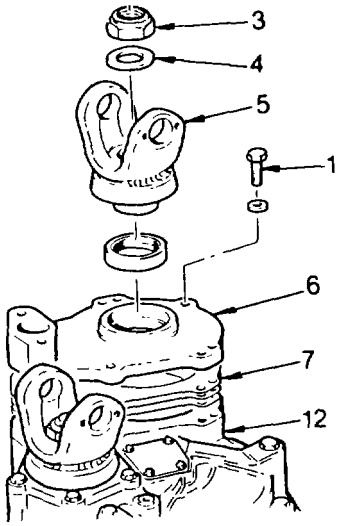
(8) Install bearing cover (6) with a shim pack of calculated thickness. Fasten cover (6) to cover (12) using four capscrews (1) and lockwashers installed around shaft (9). Tighten capscrews to 125 ft lb (170 Nm). Install yoke (5), washer (4), and nut (3). Tighten nut snugly.

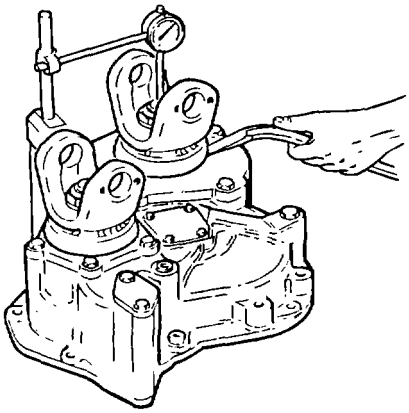
(9) Using a dial indicator, check output shaft end play as shown. End play should be in the range of 0.003 to 0.007 in. (0.08 to 0.18 mm). Calculate shim thickness to be added to or deleted from the installed shim pack (7).

(10) Remove yoke (5) and cover (6). Adjust shim pack as required by calculation in previous step. Install cover and yoke, and recheck end play.

(11) Remove yoke and cover and install shift fork 431) on sliding clutch.

(12) Install spacer (28) and oil seal (27) in cover (6). Be sure the open side of seal faces inwards. Use a suitable arbor to drive seal in place.



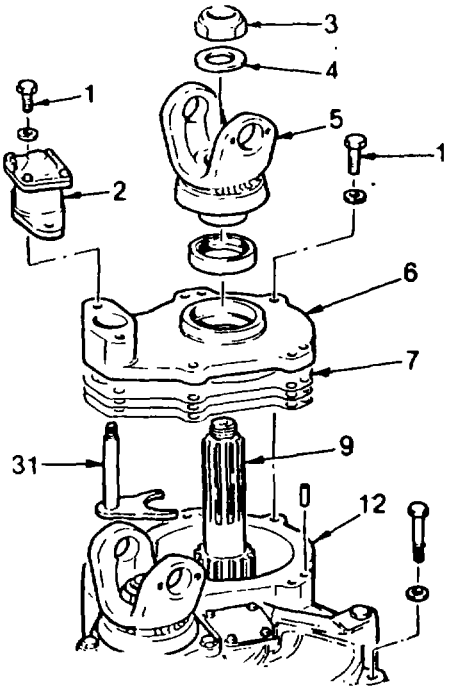


2-20. REAR AXLE - Continued

2-20.1 Power Divider (Transfer) Unit - Continued

(13) Be sure shim pack (7) is in place on cover (12). Install cover (6) over output shaft (9) and shift fork (31) being careful not to damage oil seal (27). Check that shift fork remains engaged with sliding clutch while installing the cover. Attach cover (6) to cover (12) and install yoke (5) as detailed in step 8.

(14) Install air shift unit (2) as detailed in TM'.-4210-220-12.



REPAIR

NOTE

Repair of the power divider while installed on the axle is limited to replacement of input and output shaft yoke and oil seals.

(1) Remove drive shaft from input or output shaft yoke as applicable, see TM 5-4210-220-12.

(2) Remove nut (1), washer (2), and yoke (3). Replace yoke if damaged or faulty.

(3) If oil seal (4) is leaking due to wear or damage, pry the leaking seal out of cover seat and replace it with a new one.

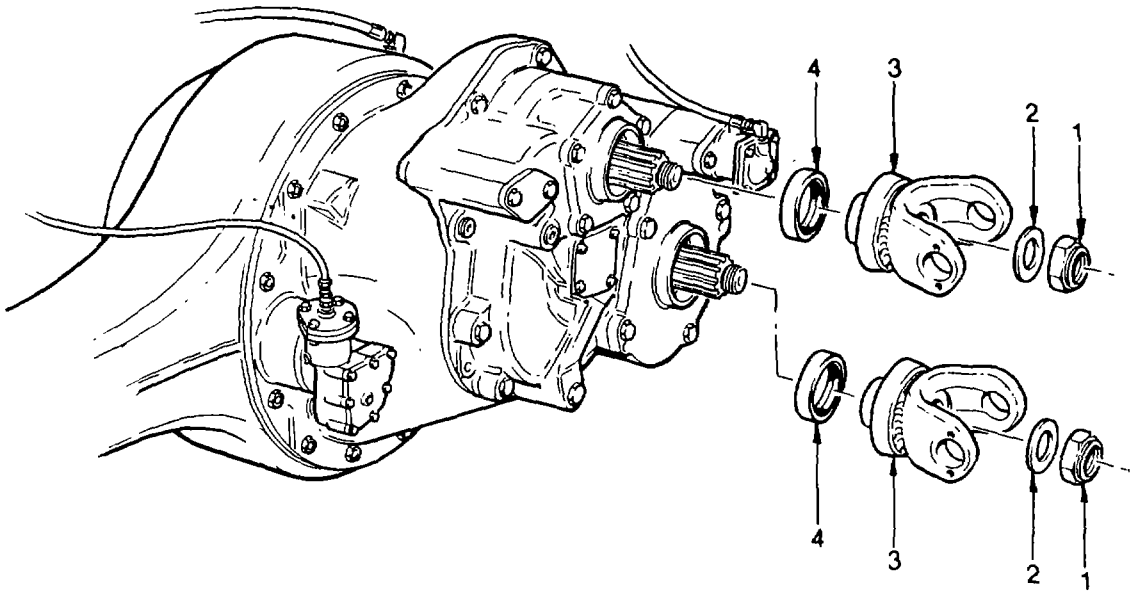
(4) Install new seal with spring side inward. Use a suitable sleeve and hammer to properly seat seal in bearing cover or cap.

(5) Install yoke (3), washer (2), and nut (1). Tighten nut to 960 ft lb (1300 Nm).

NOTE

It may be necessary to block or lower wheels to the ground to adequately torque yoke nut. (6) Install drive shaft to yoke (see TM 5-4210-220-12).

2-20. REAR AXLE - Continued



2-20. REAR AXLE - Continued

2-20.2 Differential Carrier.

This task covers

a. Removal
b. Installation
c. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Engine Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Wheels Blocked
Pump and Body Heat Shields Removed (see TM 5-4210-220-12)
Rear Axle Drive Lines Removed (see TM 5-4210-220-12)
Air Tanks Drained
Axle Drained of Oil (see LO 5-4210-220-12)

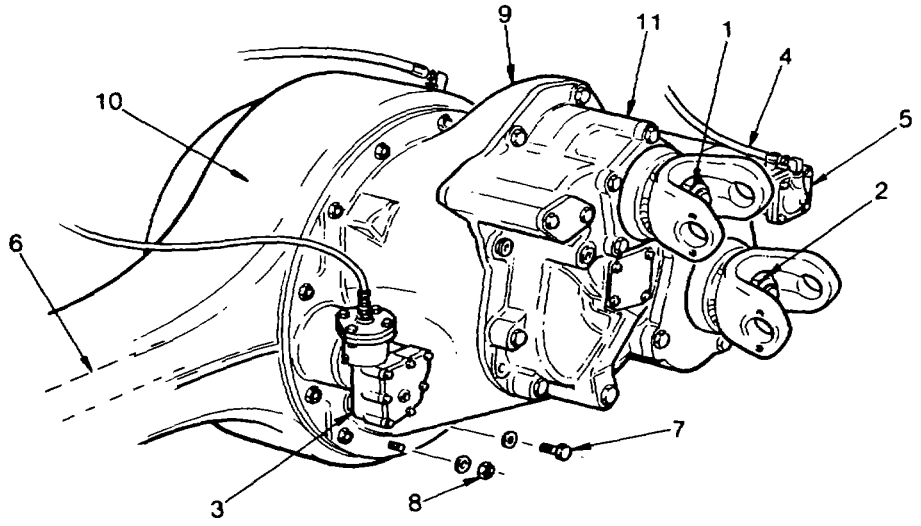
MATERIALS/PARTS
28, Appendix B Silicone Sealant

NOTE

The differential carrier can be removed and installed as a unit; however, the differential carrier can only be repaired by replacing individual components making up the unit.

NOTE

To facilitate replacement or major repair, the differential carrier should be removed from the axle and placed on a workbench stand. minor repairs such as replacement of input shaft oil seal or drive shaft yoke can be done while the carrier is installed to the axle.



2-20. REAR AXLE - Continued

REMOVAL

(1) Loosen power divider input and output yoke nuts (1 and 2) but do not remove. A force in excess of 1000 ft lb (1360 Nm) may be required to loosen nuts.

WARNING

Accidents causing serious or fatal injuries may occur unless the truck is supported on maintenance trestles. Never rely on hydraulic jacks or mechanical lifting devices for support.

(2) Lift rear end of truck and place maintenance trestles under the axle.
(3) Remove differential lock air shift unit (3) as detailed in TM 5-4210-220-12.
(4) Disconnect air line (4) and remove air shift unit (5) as detailed in TM 5-4210-220-12.
(5) Remove left and right axle shaft (6) as detailed in TM 5-4210-220-12.

WARNING

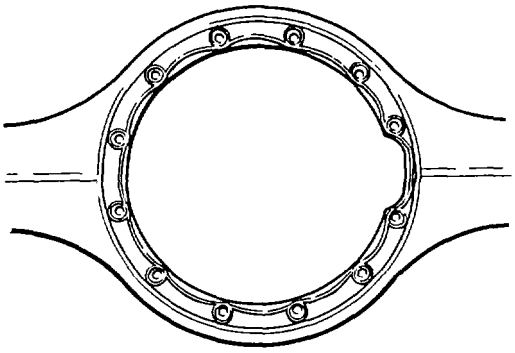
Serious injuries may be sustained unless safe work practices are maintained. Do not lie under differential carrier after attaching hardware is removed. Use a suitable jack to support and remove carrier assembly.

(6) Place a transmission jack under differential carrier and power divider and remove capscrews (7) and nuts (8).
(7) Be sure differential lock sliding clutch is engaged, then pull *differential* carrier (9) free of axle housing (10).
(8) Remove power divider (11) from differential carrier (9) as detailed in para. 2-20.1 preceding.

INSTALLATION

NOTE

Before installing differential carrier on axle housing, inspect and clean interior of axle housing.



(1) Install power divider (11) on differential carrier (9) as detailed in para. 2-20.1 preceding.
(2) Apply 1/8 in (3 mm) bead silicone sealant (item 28, Appendix B) to mounting flange of axle housing as shown.
(3) Install differential carrier (9) in axle housing (10) using lockwashers, capscrews (7), and nuts (8). Tighten capscrews to 220 ft lb (300 Nm) and nuts to 240 ft lb (325 Nm).

2-20. REAR AXLE - Continued

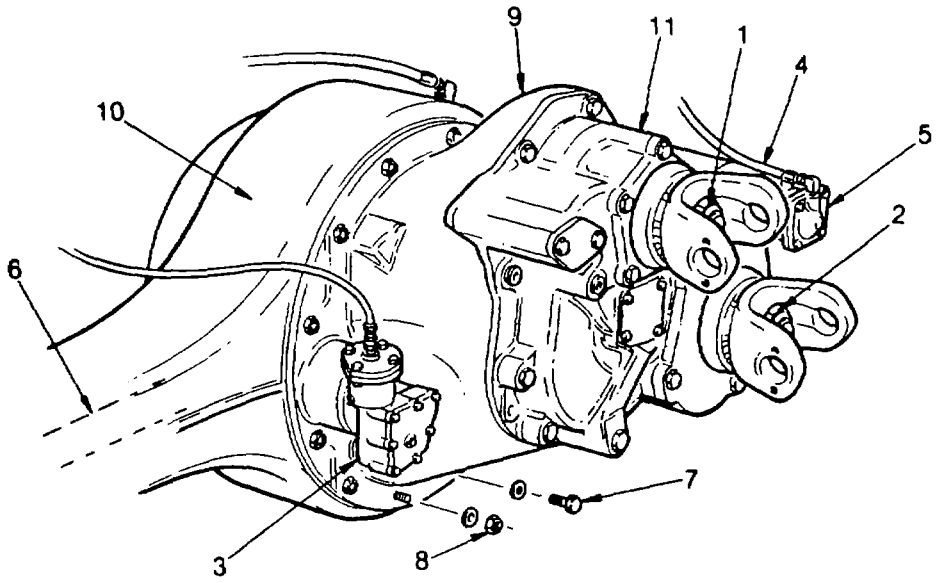
2-20.2 Differential Carrier - Continued

(4) Install left and right axle shaft assembly as detailed in TM 5-4210-220-12.
(5) Install air shift unit (5) and connect air line (4) as detailed in TM 5-4210-220-12.
(6) Install differential lock air shift unit (3) as detailed in TM 5-4210-220, 12.
(7) Remove maintenance trestles and, with truck resting on the floor, tighten power divider input and output shaft yoke nuts (1 and 2) to 960 ft lb (1300 Nm).
(8) Fill axle housing with lube oil as detailed in LO 5-4210-220-12.

REPAIR

NOTE

The repair procedures for the rear axle differential carrier are the same as for the front axle carrier as detailed in para 2-21.2. Refer to para., 2-21.2 REPAIR when repair or replacement of rear differential carrier components is required,



2-21 FRONT AXLE

2-21. FRONT AXLE.

2-21.1 Ball Socket Assembly.

This task covers

a. Removal
b. Inspection
c. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Engine Shutdown (see TM 5-4210-00-220-12)
Batteries Disconnected (see TM 5-4210-00-220-12)
Rear Wheels Blocked
Air Tanks Drained
16, Appendix B Grease
Applicable Front Wheel Removed (see TM 5-4210-00-220-12)
Axle Drained of Oil (see LO 5-4210-220-12)
Applicable Brake Assembly Removed (see TM 5-4210-00-220-12)
Applicable Wheel Hub Removed (see TM 5-4210-22Q-12)
Applicable Axle Shaft -removed (see TM 5-4210-22, 1472)
Applicable Tie Rod End Disconnected (see TM 5-4210-00-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent

NOTE

This procedure is applicable to both left and right ball socket assembly

The ball socket assembly can only be replaced by replacing the individual components making up the assembly. Removal, inspection, and installation of these components are detailed in this procedure.

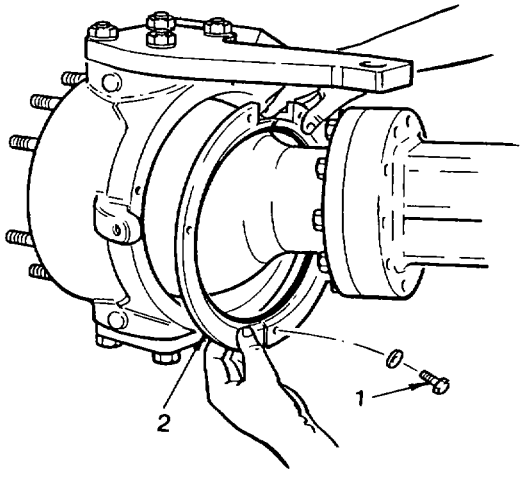
REMOVAL

NOTE

To remove left hand ball socket assembly, it is necessary to remove steering drag link from steering arm at top of left ball socket, see TM 5-4210-220-12.

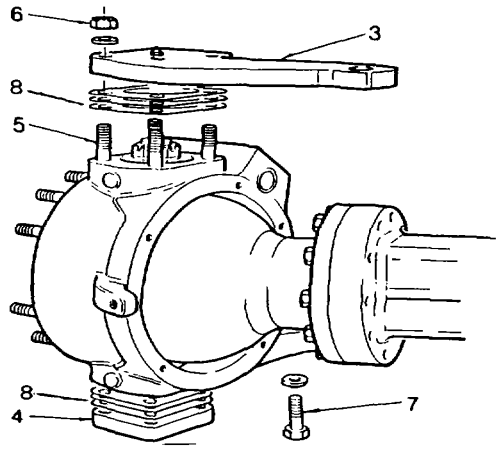
As the ball socket is disassembled, identify socket and related parts to ensure that these parts are returned to their original positions.

(1) Remove ball seal retainer capscrews (1) and lockwashers; then carefully pry retainer (2) and seal from its mounting.



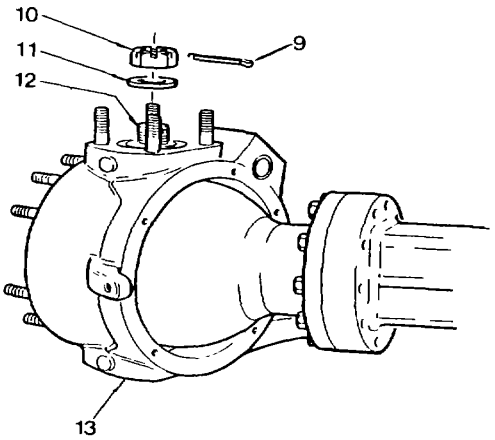
2-21. FRONT AXLE - Continued

(2) Remove kingpin cover (3 and 4). Left top cover (steering arm) is attached with split-type dowels (5), lockwashers, and nuts (6). Right top cover is attached with nuts and washers (6) only and bottom covers (4) are attached with capscrews (7) and lockwashers.



(3) Remove and identify shims (8) for installation.

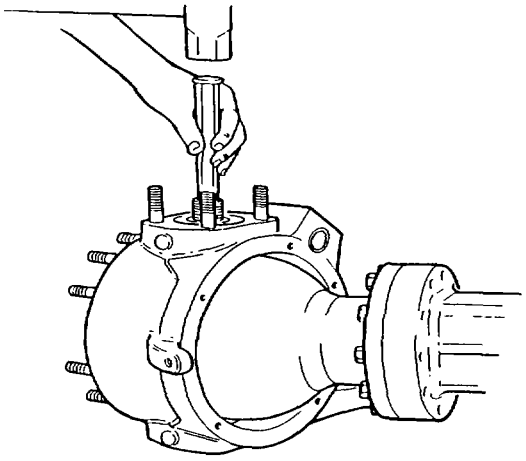
(4) Remove cotter pin (9), nut (10), and washer (11) from upper and lower kingpins (12 and 13).



(5) Using a brass drift (J36136), drive upper and lower kingpins (12 and 13) out of wheel end mounts.

(6) While keeping upper kingpin bearing cone fully seated in its cup, carefully drive the ball socket (13) down by striking it with a mallet. Stop when upper bearing cup is pushed approximately 1/8 in. (3 mm) above the bearing cover parting line.

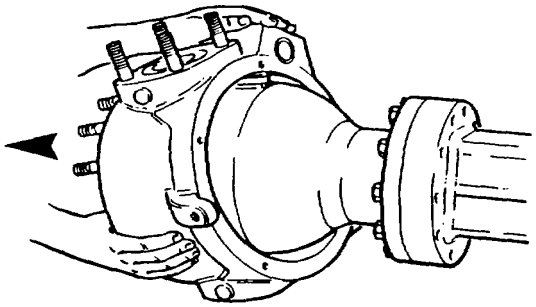
(7) Repeat step (5) for the lower kingpin bearing cup.



2-21. FRONT AXLE - Continued

2-21.1 Ball Socket Assembly - Continued

(8) Holding upper kingpin bearing up in its full mounting position in its cup, tip and remove ball socket by grasping and pulling it off axle ball as shown.

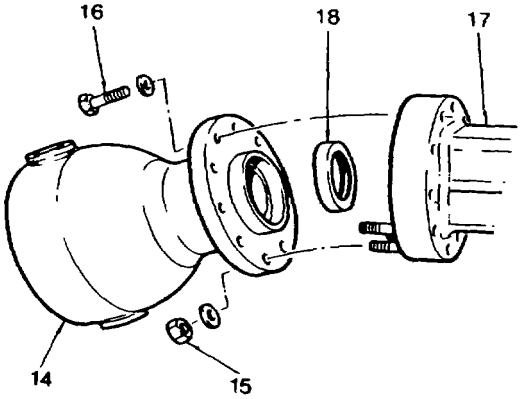


NOTE

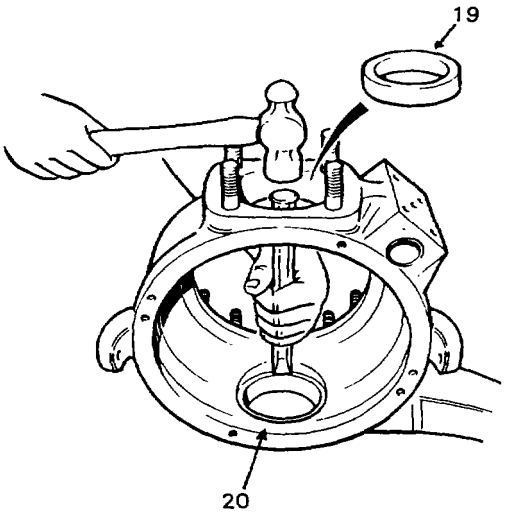
With ball socket removed, the bearing cones can be removed. The upper and lower bearings are different sizes.

(9) Remove axle ball (14) by removing nuts (15), capscrews (16), and lockwashers attaching axle ball (14) to housing (17).

(10) Remove oil seal (18) and discard.



(11) If replacement of kingpin bearings is required, (see INSPECTION following) remove bearing cups (19 and 20) using a suitable drift and hammer.



INSPECTION

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

2-21. FRONT AXLE - Continued

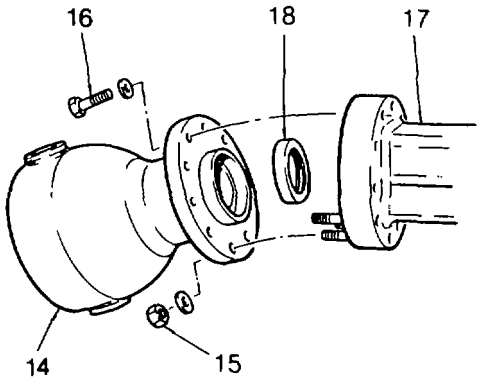
WARNING

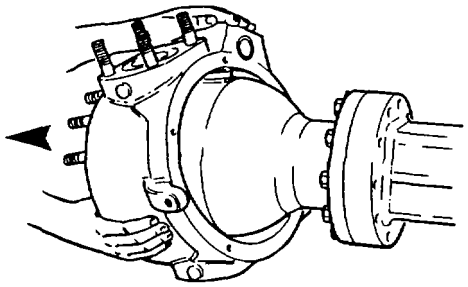
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air, always use chip guards eye protection and other personal protective equipment.

(1) Clean all components with dry cleaning solvent (item 10, Appendix B) blow dry using compressed air.
(2) Inspect ball for deep grooves or scratches. Check clearance between ball bushing and journal area (on axle shaft) that contacts bushing. If clearance exceeds 0.015 in. (0.38 mm), replace ball and bushing assembly.
(3) Inspect kingpins for wear. Replace if pins show signs of heavy or excessive wear.
(4) Inspect kingpin bearings as detailed in para. 2-7. Replace cone and cup as required.

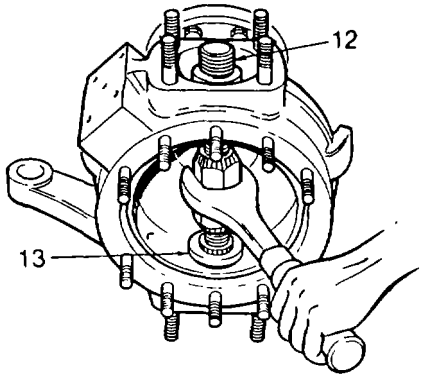
INSTALLATION

(1) Install new oil seal (18). Be sure seal is positioned so its open side faces axle housing when axle ball is installed on axle. Push seal in place using a suitable arbor.
(2) Place axle ball on axle housing studs and install nuts (15), lockwashers, and capscrews (16). Tighten nuts to 360 ft lb (490 Nm) and tighten capscrews to 220 ft lb (300 Nm).





(3) Tip ball socket and install it on axle ball as shown. Position socket on ball to maintain correct relationship between top and bottom of the ball and socket.
(4) Install kingpins (12 and 13) using spreading fixture to seat the pins as shown. Be sure fixture is tightened sufficiently to keep pins in place.



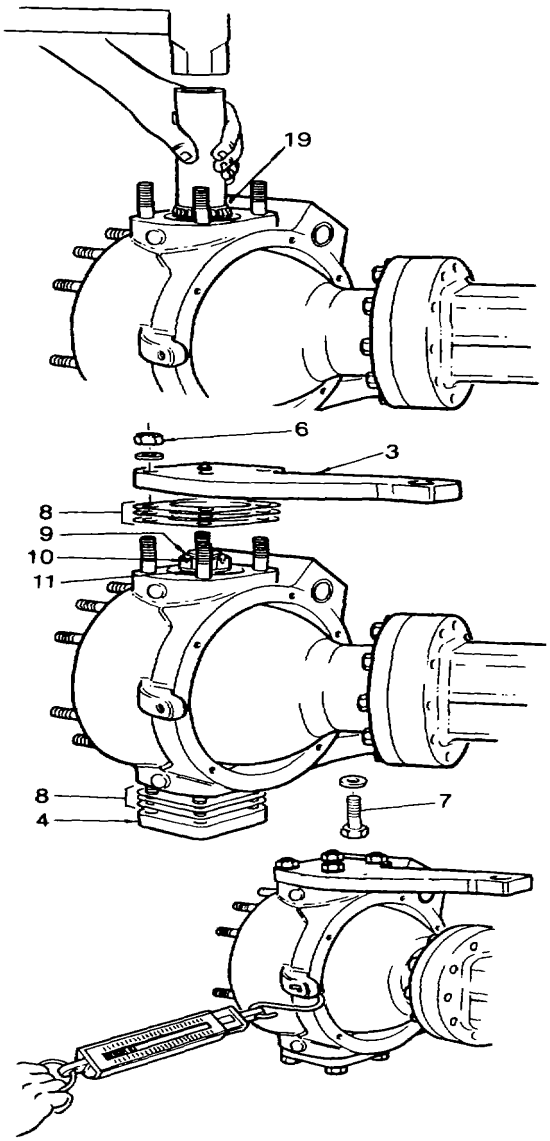
2-21. FRONT AXLE - Continued

2-21.1 Ball Socket Assembly - Continued

NOTE

Upper kingpin bearing has a smaller diameter bearing cone and a thicker wall bearing cup compared to lower kingpin bearing.

(5) Install upper and lower kingpin bearing cones (20 and 19). Be sure correct bearings are used with upper and lower pins. Drive each bearing cone in place using a suitable arbor and hammer. Be sure sleeve only contacts bearing race and not roller cage.
(6) If removed, install upper and lower bearing cups using a suitable arbor and hammer. Tap bearing cups into ball socket until flush with the kingpin cover surfaces.
(7) Install washer (11) and nut (10) on kingpins (12 and 13). Tighten nuts to 500 ft lb (680 Nm). If needed, tighten nuts further to line up holes in kingpins with slots in nuts. Install and secure cotter pins (9).



NOTE

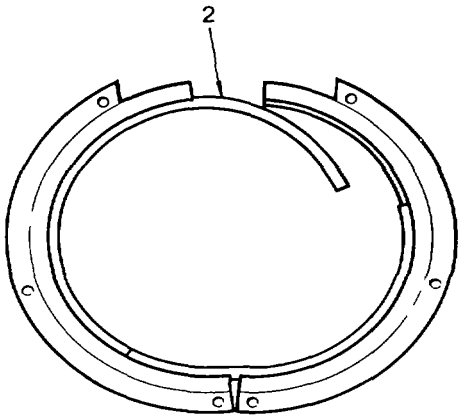
Shims 0.003, 0.005, and 0.020 in. (0.08, 0.13, and 0.51 mm) in thickness, are used between kingpin covers and ball socket. If new components are assembled, a shim pack of 0.045 in. (1.14 mm) should be used under each kingpin cover. If existing components are reassembled, use either original shim packs or new shim packs equal to the original packs in thickness.

(8) Install kingpin covers (3 and 4) together with shims packs (8). Make sure ball socket is centered on axle ball by using shim packs of same thickness. If different, exchange shims between packs until even thickness is achieved. Tighten cover nuts (6) to 360 ft lb (490 Nm) and capscrews (7) to 220 ft lb (300 Nm).
(9) Lubricate upper and lower kingpin bearings with grease (item 16, Appendix B). Lubricate until grease can be seen coming out of bearing cones.
(10) Remove kingpin spreading fixture.

2-21. FRONT AXLE - Continued

(11) Check bearing preload using a spring scale, calibrated in lbs or N (100 lb or 500 N capacity), as shown. A preload of 38 - 42 lb or 170 - 185 N should be measured after ball socket starts moving.

(12) Add or delete shims if bearing preload is different from specified range. Repeat steps 11 and 12 until correct preload is achieved.

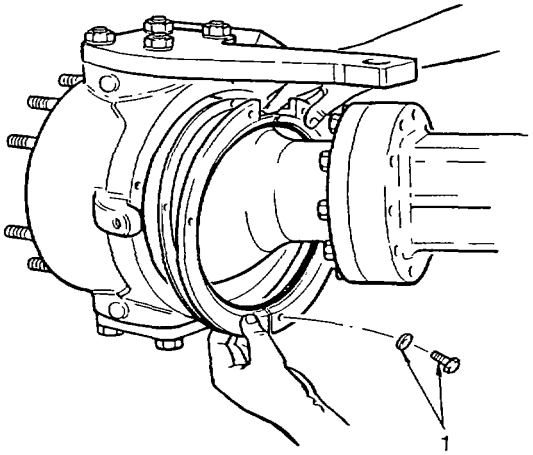


NOTE

It is recommended that at least one shim be installed in both upper and lower positions. In some instances, it might be necessary to grind or machine the ball socket cover surfaces to achieve this.

(13) With ball adjusted as required, fill the cavity between ball and socket with grease (item 16, Appendix B).

(14) Preassemble ball seals and seal retainers (2). Use a vise to hold retainer halves together in a circle while installing seals. Be sure gaps between seals and between retainers do not coincide (see illustration). Trim or cut off excess seal material at a slight angle to ensure that the seal ends join together.



(15) Install seals and retainers on ball socket as shown. Insert retainer gaskets between retainer halves. Tighten retainers to ball socket using capscrews and lockwasher(1). Tighten capscrews to 170 ft lb (230 Nm).

(16) Coat exposed area of axle ball with a thin film of grease (item 16, Appendix B). Adjust steering stops, if necessary, see TM 5-4210-520-12.

2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier.

This task covers

a. Removal
b. Installation
c. Repair
d. Adjustment

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

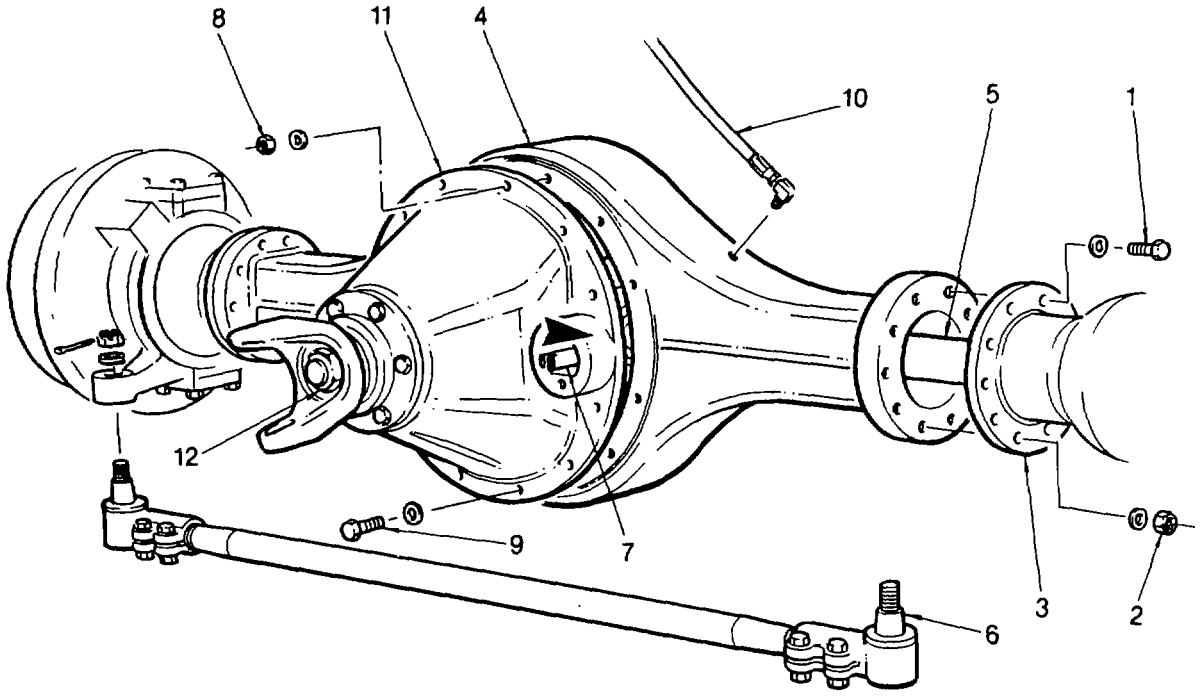
EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Engine Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Wheels Blocked
Front Heat Shield Removed (see TM 5-4210-220-12)
Front Axle Drive Line Removed (see TM 5-4210-220-12)
Air Tanks Drained
Axle Drained of Oil (see LO 5-4210-220-12)

MATERIALS/PARTS
28, Appendix B Silicone Sealant

NOTE

The differential carrier can be removed and installed as a unit; however, the differential carrier can only be repaired by replacing individual components making up the unit.

To facilitate replacement or major repair, the differential carrier should be removed from the axle and placed on a workbench/stand. Minor repairs such as replacement of input shaft oil seal or drive shaft yoke can be carried out with the carrier installed on the axle.



2-21. FRONT AXLE - Continued

REMOVAL

(1) Loosen pinion yoke nut (12), but do not remove. A force in excess of 1000 ft lb (1360 Nm) may be required to loosen nut.

WARNING

Accidents causing serious or fatal injuries may occur unless the truck is supported by maintenance trestles. Never rely on hydraulic jacks or mechanical lifting devices for support.

(2) Lift front end of truck and place maintenance trestles under both ends of axle housing. Be sure trestles are positioned under axle housing and not wheel ends.

(3) Remove differential lock air shift unit as detailed in TM 5-4210-220-12.

(4) Disconnect tie rod end (6) and steering drag link from left wheel end (see TM 5-4210-220-12).

(5) Support left-hand wheel using a wheel lift truck. Remove capscrews (1) and nuts (2) attaching wheel end (axle ball) (3) to axle housing (4). Pull wheel and wheel end away from axle housing sufficiently to disengage axle shaft (5) from differential. Remove brake air lines if necessary.

(6) Repeat step 5 for the right-hand wheel and wheel end.

(7) Push shift fork (7) to the side, away from differential, to engage sliding clutch. This clutch must be engaged in order to permit removal of carrier from housing.

WARNING

Serious injuries may be sustained unless safe work practices are maintained. Do not lie under differential carrier after attaching hardware is removed. Use a suitable jack to support and remove carrier assembly.

(8) Place a transmission jack under differential housing and remove capscrews (8), nuts (9), and vent line (10).

(9) Pull differential carrier assembly (11) free and remove from axle housing (4).

INSTALLATION

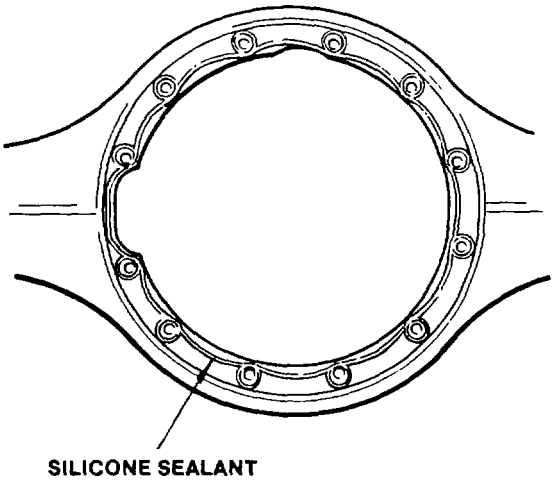
NOTE

Before installing differential carrier in axle housing, inspect and thoroughly clean interior of axle housing.

2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier - Continued

(1) Apply a 1/8 in. (3 mm) bead of silicone sealant (item 28, Appendix B) to mounting flange on axle housing as shown.



(2) Ensure shift fork (7) is to the side, away from the differential, and the sliding clutch is engaged.

(3) Install differential carrier (11) in axle housing (4) using lockwashers, nuts (9), and capscrews (8). Tighten nuts to 240 ft lb (325 Nm). Tighten capscrews to 220 ft lb (300 Nm).

(4) Push left and right wheel end assemblies (3) into axle housing (4). Turn pinion yoke, if necessary, to line up and engage axle shaft and differential side gears. Attach wheel ends to axle housing using lockwashers, nuts (2), and capscrews (1).

(5) Tighten nuts to 360 ft lb (490 Nm) and tighten capscrews to 220 ft lb (300 Nm).

(6) Install axle breather (10).

(7) Install differential lock air shift unit as detailed in TM 5-4210-220-12.

(8) Install brake air lines, if removed, between frame and wheel-end-mounted brake air chambers.

(9) Install and adjust tie rod end (6) and steering drag link on left wheel end as detailed in TM 5-4210-220-12.

(10) Remove maintenance trestles and, with truck resting on the floor, tighten pinion shaft yoke nut (12) to 960 ft lb (1300 Nm).

REPAIR

a. Differential, Differential Lock, and Ring Gear Repair

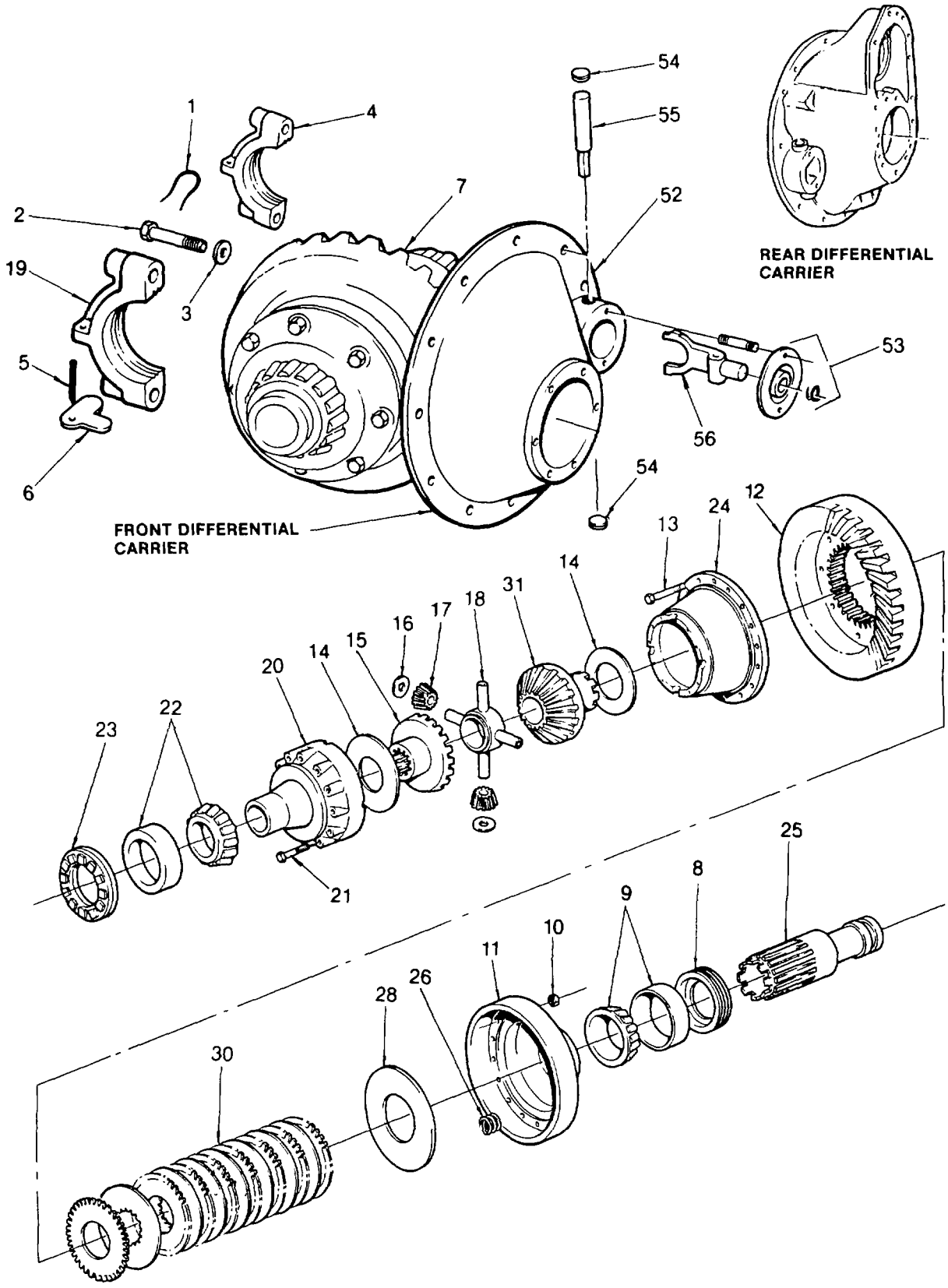
NOTE

If ring gear and pinion are considered reuseable, check tooth contact pattern and ring gear backlash before disassembling differential carrier. See ADJUSTMENT following. Best results are obtained when established wear patterns are maintained in used gearing. Before disassembling differential carrier, the effectiveness of the differential lock should be checked.

(1) Mount differential carrier assembly in a repair stand.

(2) Remove shift fork seal and spring (53). Remove expansion plugs (54) and drive out shift fork shaft (55).

2-21. FRONT AXLE - Continued



2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier - Continued

(3) Disengage shift fork (56) from sliding clutch (25) and remove sliding clutch and shift fork in this order.

(4) Punch mark both bearing caps (4 and 19) and corresponding pedestal bearing caps as reference for assembly. If ring gear and pinion are to be reused, punch mark position of bearing adjustors (8 and 23).

(5) On teeth side of ring gear, cut lock wire (1) and remove bearing capscrews (2) and lockwashers (3). Remove bearing cap (4), cotter pin (5), and lock (6). Unscrew/remove adjustor (23).

(6) Repeat procedure in step 5 for second bearing cap.

(7) Remove bearing cups (9 and 22). With a chain hoist, lift ring gear and differential assembly (7) out of carrier (52).

WARNING

Prevent personal injury when removing gear support cover (24). This cover is under spring pressure and may pop off when removing the last screw and nut.

(8) To protect ring gear against damage, place differential and ring gear assembly on a soft board. Remove two locknuts (10) and capscrews (13), 180 deg. apart.

(9) In place of capscrews (13) removed, install two 5/8 16 UNF auxiliary capscrews 1.5 in. (40 mm) longer than the capscrews removed, and secure with plain nuts. The longer capscrews are necessary to provide smooth removal of support cover when remaining capscrews (13) are removed.

(10) Remove remaining capscrews (13) and nuts (10). Alternately unscrew auxiliary capscrews and nuts to ease spring tension. Remove support cover (11).

(11) Remove springs (26), pressure plate and clutch pack (28 and 30). Keep clutch pack in original order.

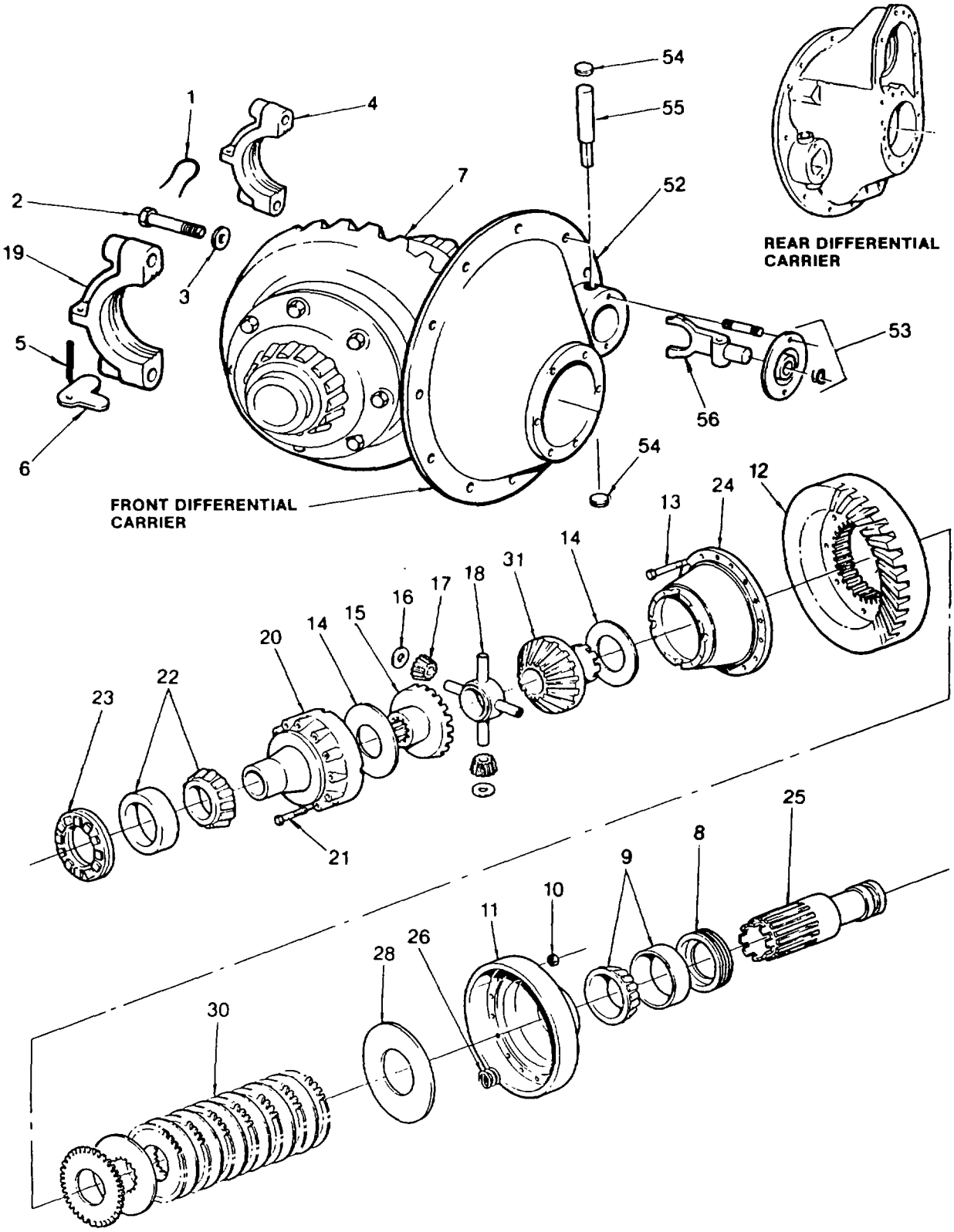
(12) Inspect clutch pack friction plates. If deeply scored, burned or excessively worn, replace the clutch pack.

(13) With the differential lock clutch removed, ring gear (12) can be removed. If gear binds on support cover (24), use a soft mallet to tap it free.

(14) Punch mark differential case (20) and support case (24) to enable reassembly of components in original position.

(15) Remove capscrews (21), differential case (20), thrust washer (14), and outer side gear (15).

2-21. FRONT AXLE - Continued



2-21. FRONT AXLE - Continued

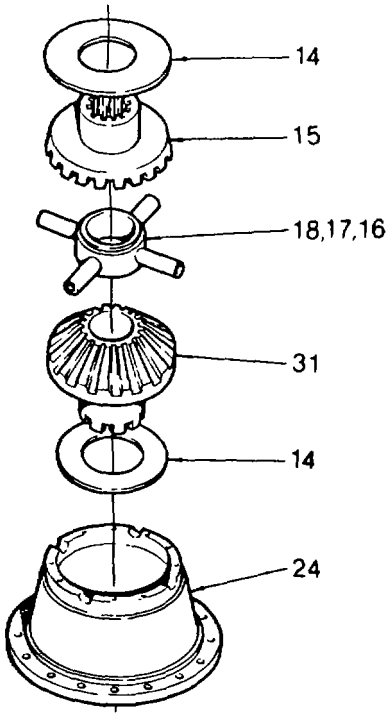
2-21.2 Differential Carrier - Continued

(16) Lift out spider (18) together with side pinions (17), and thrust washers (16). Remove inner side gear (31) and thrust washer (14).

(17) Inspect inner and outer side gears and the four side pinions. Replace all gears If excessively worn or damaged teeth, splines, or bearing surfaces are noticed on any of the gears.

(18) Discard all thrust washers, (16 and 14) and replace with new components. Inspect thrust washer bearing surfaces in differential case. Replace both halves as a matched set if any surface is excessively worn.

(19) Inspect differential bearings (9 and 22) as detailed in para. 2-7. If replacement is required, remove bearing cones from differential case (20) and support cover (11) using a suitable puller. Replace bearing cups and cones in pairs.



NOTE

Prior to reassembly or installation, make sure all components are clean and coated with a film of lubricating oil (item 17, Appendix B).

(20) If bearings are replaced, press new bearing cones (9 and 22) onto differential case (20) and support cover (11). Be sure to use arbors that contact the bearing races only. Bearings may be damaged if pressure is exerted on bearing roller cages.

(21) Install thrust washer (14), inner side gear (31), and spider (18) complete with side pinions (17) and thrust washers (16) in support case (24).

(22) Install side gear (15), remaining thrust washer (14) and differential case (20). Make sure punch marks on differential case and support case aline. Install capscrews (21) and tighten to 180 ft lb (245 Nm).

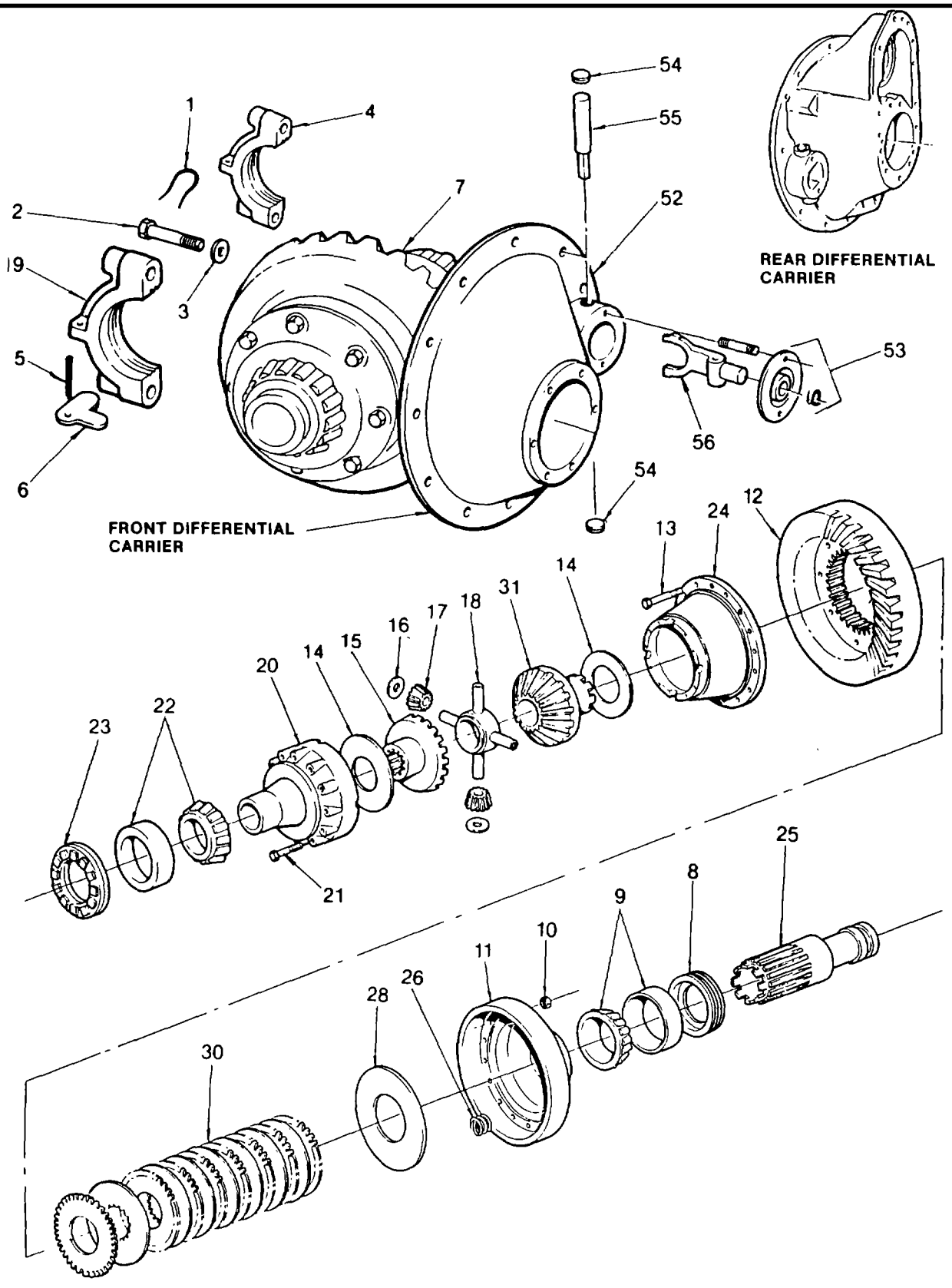
(23) Check free rotation of differential by turning side gear hub. Differential may require up to 50 ft lb (70 Nm) torque to rotate.

NOTE

Front differential ring gear is attached with eight 3/4 in. 16 capscrews and locknuts. Rear differential ring gear IS attached with sixteen 5/8 in. 18 capscrews and locknuts.

(24) Install ring gear (12) on differential support case (24) making sure bolt holes aline. A slight interference fit may be present between the parts. If required, use a brass hammer to tap ring gear in place.

2-21. FRONT AXLE - Continued



2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier - Continued

(25) Brush surface of each friction plate making up the clutch pack (30) with gear oil (item 15, Appendix B). Install clutch pack by inserting friction plates, one at a time, into bore of ring gear (12). Use sliding clutch (25) to line up teeth as each plate with internal teeth is inserted.

(26) When all clutch plates are installed, insert pressure plate (28) and check once more, using sliding clutch, that clutch plates are alined. Place clutch springs (26) on pressure plate forming the smallest possible circle.

(27) Install support case cover (11) using two 5/8 in. 18 auxiliary capscrews, 1.5 in. (40 mm) longer than the regular capscrews (13), and nuts. Install capscrews 180 deg. apart and tighten nuts alternately until cover (11) butts against ring gear (12).

(28) Install capscrews (13) and new locknuts (10). Remove auxiliary capscrews once two or three of the regular capscrews (13) are installed. Tighten locknuts (10) to specified torque.
5/8 in. **-** 18 capscrews and nuts - 130 ft lb (175 Nm)
3/4 in. - 16 capscrews and nuts - 170 ft lb (230 Nm)

CAUTION

If drive pinion has not been removed from differential carrier, check carefully that no contamination has been introduced and retained in carrier. Any foreign object can cause damage to gears or bearings.

(29) Install shift fork (56) and shaft (55) in carrier (52). Tap shaft in place using a hammer and a suitable arbor. Install expansion plugs (54).

(30) Install sliding clutch (25) in differential and, using a hoist, place differential and ring gear assembly (7) in carrier (52). Line up shift fork with sliding clutch. Be sure they engage before lowering assembly. Be careful not to damage unprotected bearing cones (9 and 22).

(31) Install bearing cups (9 and 22), bearing caps (4 and 19), and adjustors (8 and 23). Be careful not to cross bearing cap and adjustor threads.

(32) Install capscrews (2) and lockwashers (3). Tighten capscrews fingertight.

(33) Carry out adjustments of differential bearing preload, ring gear backlash, and ring gear and pinion tooth contact as detailed in ADJUSTMENT procedures a. and b. following.

(34) When adjustments are complete, tighten capscrews (2) to 400 ft lb (540 Nm).

(35) Install locks (6) and secure with cotter pins (5). Install lock wire (1) to secure capscrews (2).

b. Drive Pinion, Oil Seal, and Yoke Repair

NOTE

If replacement of front axle yoke (43) only is required, carry out steps 1 and 17. If front axle oil seal (42) only requires replacement, carry out steps 1, 4, 16, and 17. Both items can be replaced with differential installed in axle If pinion and ring gear are to be reused, record number and sizes of shims (37) removed during disassembly.

2-21. FRONT AXLE - Continued

(1) For front axle, remove nut (45), washer (44) and yoke (43) from drive pinion; for rear axle, remove helical gear (46) as detailed in REPAIR procedure c. following.

(2) Remove capscrews (40) and lockwashers (39). Remove bearing cage (38) Record number and sizes of shims (37).

(3) Support bearing cage (38), and using a press and suitable arbor, press pinion (34) out of bearing cone (41).

(4) Using a suitable tool, pry oil seal (42) free of bearing cage (38) and discard.

(5) Remove bearing cone (41) from bearing cage.

(6) Inspect bearings (33, 35, and 41) as detailed in para. 2-7. If required, replace bearing cones and cups as detailed in steps 8 thru 12 following. If bearings are reuseable, proceed to step 13.

(7) Remove and retain spacer (36).

(8) Remove bearing cone (35) and pilot bearing (33) from pinion (34) using a split-type puller.

(9) Remove bearing cups (35 and 41) from bearing cage (38) using a suitable puller.

(10) Press new bearing cups (35 and 41) in cage (38).

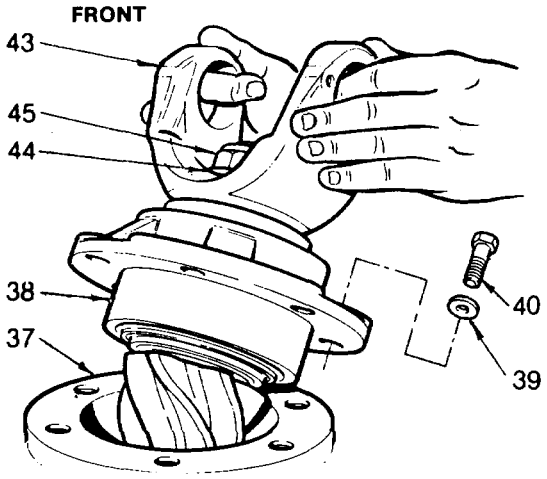
(11) Check space (S) using a feeler gage. Bearing cups must be firmly seated with a maximum clearance of 0.001 in. (0.03 mm) between seat and race.

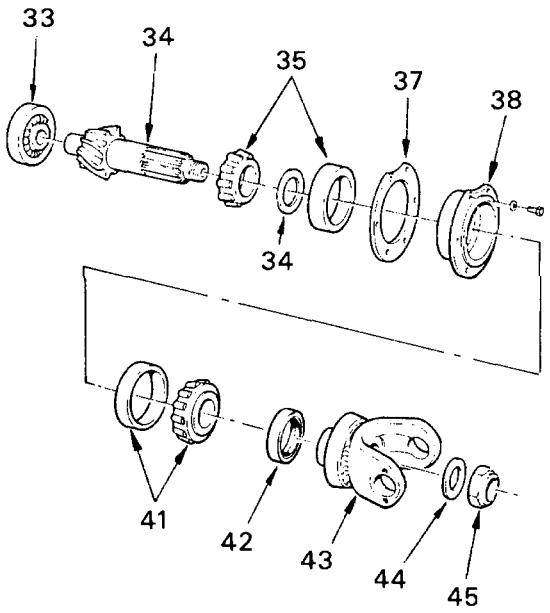
(12) Carry out preliminary pinion bearing preload adjustment as detailed in ADJUSTMENT procedure c.

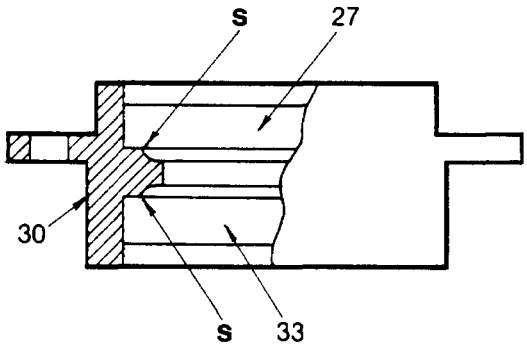
(13) Press pilot bearing (33) on pinion (34) and stake it in place.

(14) Install bearing cone (35) on pinion (34) using a press. Install spacer (28).

(15) Install bearing cage (28) on drive pinion (34).







2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier - Continued

(16) Press outer pinion bearing (41) onto pinion (34) using a suitable press.

(17) For front axle only, install oil seal (42) in bearing cage (38) using a press or a hammer and a suitable arbor. Be sure the arbor (sleeve) exerts pressure on seal flange only as shown.

(18) For front axle only, lubricate oil seal with a few drops of oil (Item 15, Appendix B) and install yoke (43), washer (44), and nut (45). Tighten nut to 700 ft lb (950 Nm) (19) Carry out final pinion bearing preload adjustment as detailed in ADJUSTMENT procedure d. following.

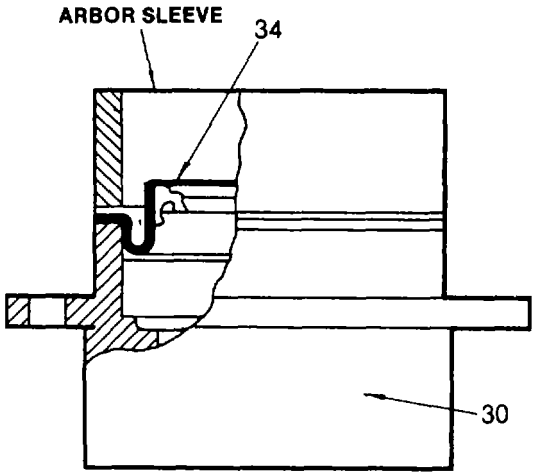
NOTE

If ring gear and pinion are to be reused, install same quantity and thickness of shims between pinion bearing cage and differential carrier as removed. When a new gear set is used, select a nominal shim pack 0.023 in. (0.58 mm) thick.

(20) Place shim pack (29) on carrier flange. On front axle differential carrier make sure lube holes in shims line up with lube holes in carrier flange.

(21) Install pinion assembly using capscrews (40) and lockwashers (39). Tighten capscrews as follows: Front differential, 125 ft lb (170 Nm) Rear differential, 175 ft lb (235 Nm) (22) For rear axle, install helical gear (46) as detailed In procedure c. following.

(23) Proceed with installation of power divider or differential carrier to axle as required, see para. 2-20.1 or para. 2-21.2.



c. Pinion Helical Gear and Support Bearing Repair

NOTE

This procedure is applicable to rear differential only. If bearing (48) is found faulty when inspected, both the cone shown as well as the outer race must be replaced, as detailed in para. 2-20.1 REMOVAL procedure a, step 12 and INSTALLATION procedure a. step 2. If power divider input or output shaft gear, see para. 2-20.1, or pinion gear (46) Is damaged, all three gears must be replaced.

(1) Inspect bearing cone (48) and gear (46) as detailed in para. 2-7. If replacement of either component is required carry out following procedures. If pinion (26) is damaged or faulty, carry out repair as detailed in REPAIR procedure b. preceding.

(2) Remove roll pin (51) and nut (49).

2-21. FRONT AXLE - Continued

NOTE

Carry out step 3 even if bearing (48) only needs replacement.

(3) Remove bearing cone (48), spacer (47), and gear (46) in one operation using a suitable puller as shown.

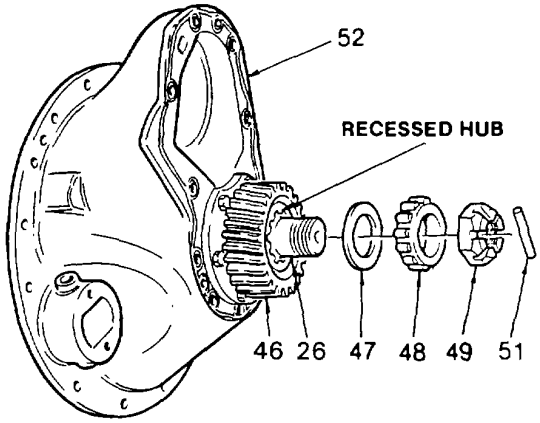
(4) Install gear (46) on pinion (26). Be sure recessed hub is facing out as shown.

(5) Install spacer (47) and bearing (48). Use a hammer and a suitable sleeve to seat bearing.

(6) Install castle nut (49) and tighten to 840 ft lb (1140 Nm). Continue to tighten nut further until a roll pin hole in pinion alines with a slot in castle nut.

(7) Install roll pin (51).

(8) Proceed with installation of power divider as detailed in para. 2-20.1.



ADJUSTMENT

NOTE

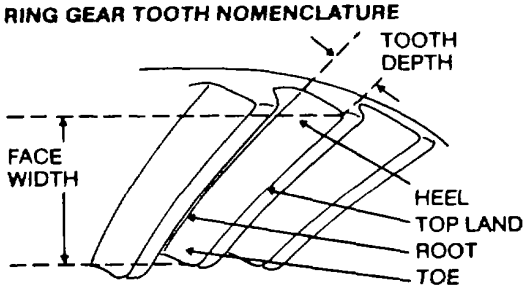
Bearing preload adjustment Is performed for both pinion and differential bearings. It maintains proper gear alinement by creating correct bearing cone and cup relationship for free rotation under load. The pinion pilot bearing does not require a preload adjustment.

Ring gear tooth contact adjustment positions ring gear and pinion for best contact under load Correct adjustment distributes torque evenly over gear teeth and helps maximize gear set life.

a. Differential Bearing Preload And Ring Gear Backlash Adjustment

(1) Loosen the bearing adjustor on the same side as, the ring gear teeth until its first thread is visible.

(2) Tighten the bearing adjustor on the backface side of the ring gear until there is no backlash. This can be tested by facing the ring gear away from the body while gently rocking the gear from side to side. There should be no free movement. Rotate the ring gear and check for any point where the gear may bind. If such a point exists, loosen and retighten the back side adjustor. Make all further adjustments from the point of tightest mesh.



2-21. FRONT AXLE - Continued
2-21.2 Differential Carrier - Continued

(3) At teeth side of ring gear, tighten adjustor until it contacts the bearing cup. Continue tightening adjustor two or three notches and this will preload bearings and provide backlash.

(4) Measure backlash with a dial indicator. Used Gear Ring Reset to backlash recorded before disassembly. New Gear Ring Backlash should be 0.006 0.016 in. (0.15 0.41 mm). If backlash is incorrect, proceed as described below to readjust.

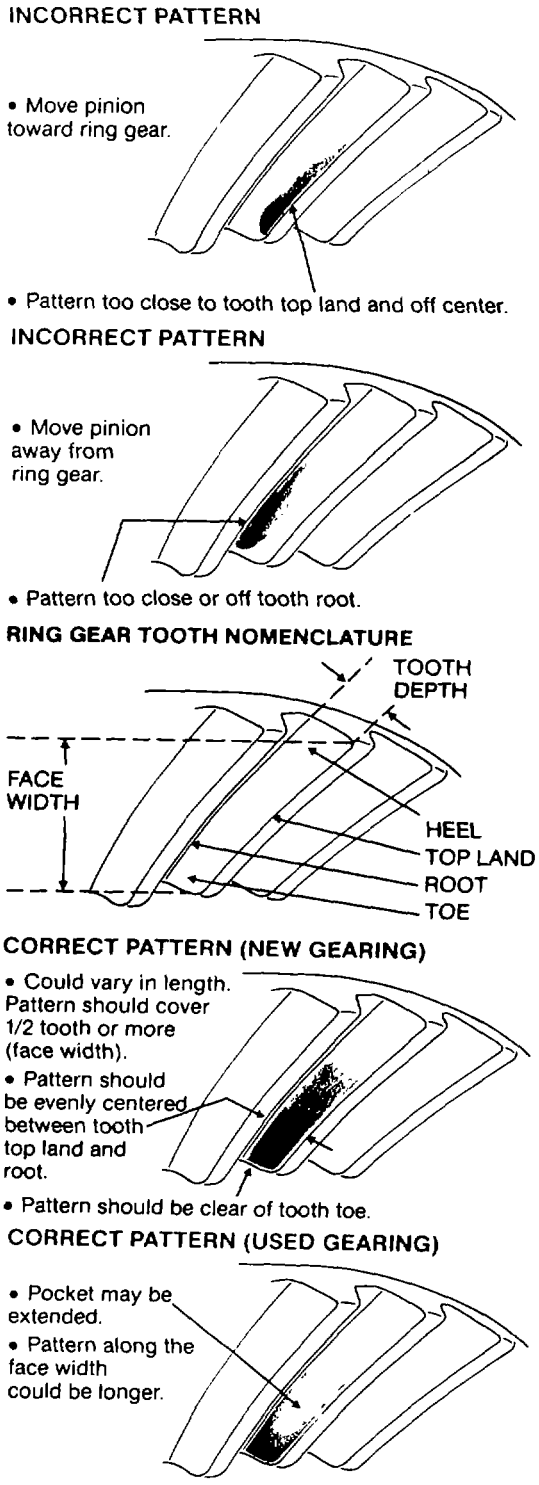
(5) To add backlash: Loosen the adjustor on the teeth side of the ring gear several notches. Loosen the opposite adjustor one notch. See illustration for definition. Return to adjustor on teeth side of the ring gear and tighten adjustor until it contacts the bearing cup. Continue tightening the same adjustor 2 or 3 notches. Recheck backlash.

(6) To remove backlash: Loosen the adjustor on the teeth side of the ring gear several notches. Tighten the opposite adjustor one notch. Return to adjustor on teeth side of ring gear and tighten adjustor until it contacts the bearing cup. Continue tightening the same adjustor 2 or 3 notches. Recheck backlash.

b. Ring Gear And Pinion Tooth Contact Adjustment

(1) Check tooth contact pattern (new gear). Paint twelve ring gear teeth with marking compound and roll the gear to obtain a contact pattern. The correct pattern is well-centered on the ring gear tooth within lengthwise contact clear of the toe. The length of the pattern in an unloaded condition is approximately one-half to two-thirds of the ring gear tooth. If adjustment Is necessary proceed to step 3.

(2) Check tooth contact pattern (used gear). Used gearing will not usually display the square, even contact pattern found in new gear sets. The gear will normally have a "pocket" at the toe-end of the gear tooth which tails into a contact line along the root of tooth. The more use a gear has had, the more the line becomes the dominant characteristic of the pattern. Adjust used gear sets to display the same contact pattern observed before disassembly. A correct pattern is clear of the toe and centers evenly along the face width between the top land and root. Otherwise, the length and shape of the pattern are highly variable and is considered acceptable as long as it does not run off the tooth at any point.



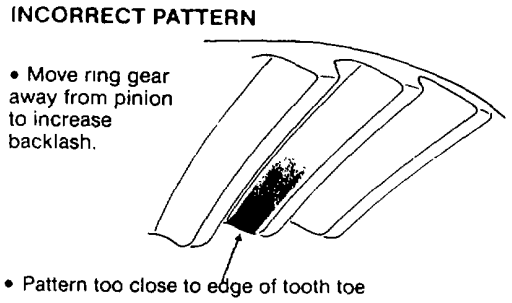
2-21. FRONT AXLE - Continued

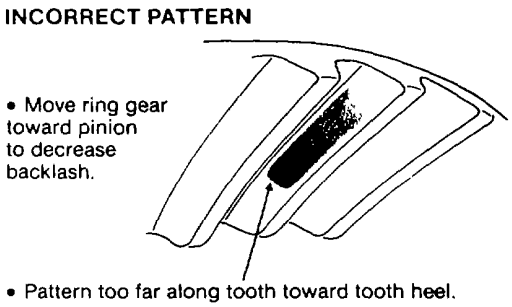
(3) If necessary, adjust the contact pattern by moving the ring gear and drive pinion. Ring gear position controls the backlash. This adjustment moves the contact pattern along the face width of the gear tooth. Pinion position is determined by the size of the pinion bearing cage shim pack. It controls contact on the tooth depth of the gear tooth. These adjustments are interrelated. As a result, they must be considered together even though the pattern is altered by two distinct operations. When making adjustments, first adjust the pinion, then the backlash. Continue this sequence until the pattern is satisfactory.

(4) If the gear pattern shows incorrect tooth depth contact, change drive pinion position by altering the shim pack. Used gears should achieve proper contact with the same shims removed from the axle during disassembly.

(5) If the pattern Is too close to the top land of the gear tooth, remove pinion shims.

(6) If the pattern is too close to the root of the gear tooth, add pinion shims.





NOTE

Check ring gear backlash after each shim change and readjust as necessary to maintain 0.006 0.016 in. (0.16 0.41 mm).

(7) If the gear pattern shows incorrect face width contact, change backlash.
(8) With the pattern concentrated at the toe (too far down the tooth), add backlash, see a. preceding.
(9) If the pattern is concentrated at the heel (to far up the tooth), remove backlash see a. preceding.

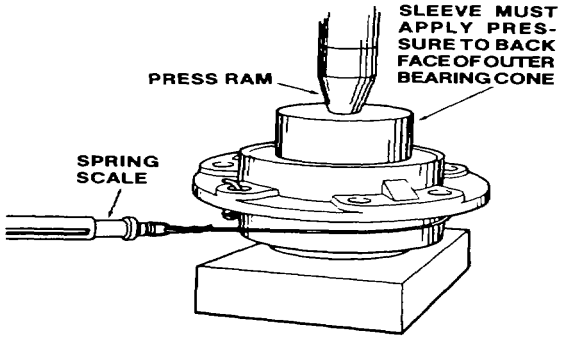
c. Pinion Bearing Preload Adjustment Preliminary

(1) Assemble pinion bearing cage, bearings and spacer (without drive pinion or oil seal). Center bearing spacer between two bearing cones.

NOTE

When new gear set or pinion bearings are used, select nominal size spacer from the specification chart below. If original parts are used, use spacer removed during disassembly.

(2) With the bearings well lubricated, place the assembly in a press. Position sleeve so that load is applied directly to the backface of the outer bearing cone.



2-21. FRONT AXLE - Continued

2-21.2 Differential Carrier - Continued

(3) Apply press load (see chart below) to the assembly and check rolling torque. Wrap soft wire around the bearing cage, attach spring scale and pull. Preload is correct when torque required to rotate the pinion bearing cage is from 10 20 in. lb (1.1 2.3 Nm). This specification is translated into spring scale readings in the chart below.

(4) If necessary, adjust pinion bearing preload by changing the pinion bearing spacer. A thicker spacer will decrease preload. A thinner spacer will increase preload.

NOTE

Once correct bearing preload has been established, note the spacer size used. Select a spacer 0.001 in. (0.03 mm) larger for use in the final pinion bearing cage assembly. The larger spacer compensates for slight "growth" in the bearings which occurs when they are pressed on the pinion shank. The trial build-up will result in proper pinion bearing preload in three of four cases. Do not assume that all assemblies will retain proper preload once bearings are pressed on pinion shank. FINAL PRELOAD TEST MUST BE MADE IN EVERY CASE.

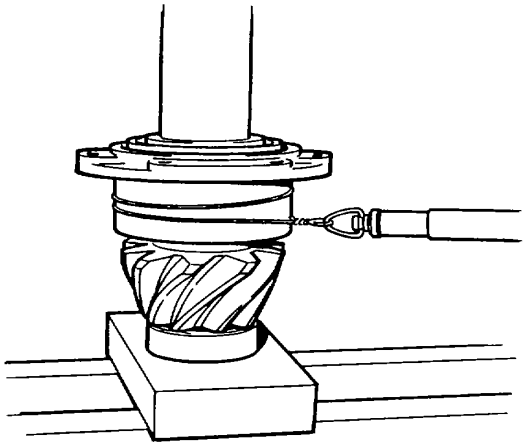
Specifications for Pinion Bearing Trial Build-up Preload Test — **Spring Scale Reading (without pinion seal)**

Nominal Bearing Spacer Thickness			**Press Loads**			
	in.	mm	Tons	Metric Tons	lbs.	kgs.
Front Axle	0.638	16.2	13.5-15.5	12.2-14.0	4-8	2-4
Rear Axle	0.496	12.6	17-19	15.4-17.2	3-7	2-3

d. Pinion Bearing Preload - Final Test And Adjustment

NOTE

Rear axle pinion is equipped with helical gear. For easier disassembly during bearing adjustment procedure, use a dummy yoke in place of helical gear.



(1) Apply clamp load to the pinion bearing cage assembly. Either install the yoke (or helical gear) and torque the pinion nut to specifications or use a press to simulate nut torque (see chart below).

Vise Method - If the yoke and nut are used, mount the assembly in a vise, clamping yoke firmly.

Press Method - If a press is used, position a sleeve or spacer so that load is applied directly to the backface of the outer bearing cone.

(2) Measure pinion bearing preload by using a spring scale to test the assembly rolling torque.
To use the spring scale, wrap soft wire around the bearing cage, attach the scale and pull. Preload is correct when torque required to rotate the pinion bearing cage is from 15 35 in. lb (1.7 4.0 Nm). This specification is translated into spring scale readings in the chart below.

2-21. FRONT AXLE - Continued

(3) If necessary, adjust pinion bearing preload. Disassemble the pinion bearing cage as detailed in REPAIR procedure b. preceding and change the pinion bearing spacer. A thicker spacer will decrease preload. A thinner spacer will increase preload.

NOTE

Use the correctly sized spacer. Do not use shim stock or grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

Specifications for Final Pinion Bearing Preload Test					**Spring Scale Reading (without pinion seal)**	
	Nut Torque		**Press Loads**			
	ft lb.	Nm	Tons	Metric Tons	lbs.	kgs.
Front Axle	700	950	15.5	14.0	6-14	3-6
Rear Axle	840	1140	19	17.2	5-12	2-5

CHAPTER 3

INTERMEDIATE GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

SECTION I. REPAIR PARTS, SPECIAL TOOLS; TMDE; AND SUPPORT EQUIPMENT

3-1. COMMON TOOLS AND EQUIPMENT.

For authorized common tools and equipment refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

Nomenclature	National/NATO Stock Number
Tool Kit, General Mechanic, Automotive	5180-00-177-7033
Tool Kit, Master Mechanic	5180-00-699-5273
Shop Equipment, Automotive Maintenance and Repair	4910-00-754-0650
Shop Equipment, General Purpose Repair	4940-287-4894
Shop Equipment, Automotive Maintenance and Repair	4910-00-754-0705

3-2. SPECIAL TOOLS, TMDE AND SUPPORT EQUIPMENT.

For special tools and support equipment for repair at the General Support level of maintenance, refer to TM 5-4210-220-34P. Individual equipment requirements are covered in the specific equipment maintenance tasks.

3-3. REPAIR PARTS.

Repair parts for this equipment are listed in TM 5-4210-220-34P, Repair Parts and Special Tools List (RPSTL), covering Direct and General Support Maintenance for this equipment.

SECTION II. GENERAL SUPPORT TROUBLESHOOTING

3-4. GENERAL.

Troubleshooting at the general support level requires you to investigate major problems with the engine and transmission prior to overhauling these components.

3-5. PROCEDURES.

Before using the troubleshooting table (see table 3-1), check your work order and talk to the other levels of maintenance which may have checked the symptoms and ruled out certain faults prior to referring the unit to General Support.

3-6. SYMPTOM INDEX.

Refer to table 3-1 TROUBLESHOOTING, under the number of the symptom in this index to determine the tests and corrective actions required.

TRANSMISSION

ENGINE

Table 3-1. GENERAL SUPPORT TROUBLESHOOTING

MALFUNCTION
TEST AND INSPECTION
CORRECTIVE ACTION

1a TRANSMISSION SHIFTS ROUGHLY

Step 1. Check control valves for sticking.

Replace or rebuild control valve assembly.

Step 2. Check modulator valve for sticking.

Repair or replace valve.

1b TRANSMISSION HAS HIGH STALL SPEED

Step 1. Check clutch pressure.

Replace or rebuild valve body assembly or replace piston seal for specific clutch.

Step 2. Check if clutch slipping.

Rebuild forward, first, fourth and low clutches.

1c TRANSMISSION HAS LOW STALL SPEED

Check torque converter.

Replace/rebuild torque converter.

1d AUTOMATIC SHIFTS OCCUR AT TOO HIGH SPEED

Step 1. Check governor valve for sticking.

Clean or replace governor valve if stuck.

Step 2. Check if shift points properly adjusted.

Adjust shift points.

Step 3. Check if shift signal valve spring adjustment is too tight.

Backoff spring adjusting ring.

Step 4. Check if control valves are sticking.

Overhaul valve body assembly.

Table 3-1 GENERAL SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION
TEST AND INSPECTION
CORRECTIVE ACTION

1e AUTOMATIC SHIFTS OCCUR AT TOO LOW SPEED

Step 1. Check governor valve for sticking.

Clean or replace valve if stuck.

Step 2. Check if shift points properly adjustment.

Adjust shift points.

Step 3. Check if shift signal valve spring adjustment is too loose.

Tighten spring adjusting ring.

Step 4. Check if modulator valve is stuck.

Clean or replace modulator valve.

Step 5. Check if governor spring is weak.

Replace governor.

1f TRANSMISSION OIL PRESSURE LOW

Step 1. Check lubrication valve spring.

Replace valve spring.

Step 2. Check valve body mounting bolts, lubrication valve seat and spring, seal ring at oil intake pipe, main pressure regulator valve spring weak, leaks in valve body, trimmer, relay valves stuck or worn oil pump.

Overhaul transmission

1g OIL LEAKING INTO CONVERTER HOUSING

Step 1. Check converter pump hub seal for wear.

Replace seal.

Step 2. Check seal area on converter pump hub for wear.

Replace pump hub.

Step 3. Check engine rear seal.

Replace seal.

Table 3-1 GENERAL SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST AND IN.SPECTION CORRECTIVE ACTION	
1h	**TRUCK OPERATES SLUGGISHLY WITH HIGH ENGINE REVS**
Step 1.	Check oil level in transmission. Add oil as required.
Step 2.	Check if one or more clutches are slipping. Overhaul transmission.
1j	**CLUTCH SLIPPAGE IN ALL GEARS.**
Step 1.	Check clutch if (main) pressure low. Refer to If preceding.
Step 2.	Check if forward clutch slipping. Rebuild forward clutch and replace piston seal rings.
Step 3.	Check if seal rings on front support hub worn or broken. Replace seal rings.
1k	**CLUTCH SLIPPAGE IN ALL FORWARD GEARS, BUT NO SLIPPAGE IN REVERSE.**
	Check if forward clutch slipping. Rebuild clutch and replace piston seal rings.
1l	**CLUTCH SLIPPAGE IN FIFTH AND REVERSE GEARS ONLY.**
	Check if fourth clutch slipping. Rebuild clutch and replace piston seal rings.
1m	**CLUTCH SLIPPAGE IN FOURTH GEAR ONLY.**
	Check if third clutch slipping. Rebuild clutch and replace piston seal rings.
1n	**CLUTCH SLIPPAGE IN THIRD GEAR ONLY.**
	Check if second clutch slipping. Rebuild clutch and replace piston seal rings.

Table 3-1 GENERAL SUPPORT TROUBLESHOOTING - Continued

MALFUNCTION TEST AND INSPECTION CORRECTIVE ACTION
1p CLUTCH SLIPPAGE IN SECOND AND REVERSE GEARS ONLY.
Check if first clutch slipping.
Rebuild clutch and replace piston seal rings.
1q CLUTCH SLIPPAGE IN FIRST GEAR ONLY.
Check if low Clutch slipping.
Rebuild clutch and replace piston seal rings.
2a ENGINE LOW OIL PRESSURE
Step 1. Check engine crankshaft bearings.
Replace bearings if worn.
Step 2. Check block and cy4vdJer head for major oil leaks.
Repair/replace components as required.
2b FUMES OR OIL SEEN AT ROAD DRAFT TUBE
Step 1. Check piston and liner of cylinder with low compression.
Replace piston, piston rings or liner.
Step 2. Check end plate.
Replace end plate gasket.
2c HIGH LUBRICATING OIL CONSUMPTION
Step 1. Check engine compression
a. Repair piston/liner and piston rings as required.
b. Check piston pin retainer for looseness.
Step 2. Check for excessive oil in the air box.
a. Replace liner seals.
b. Replace piston oil control rings.
c. Replace blower oil seals.
d. Replace turbocharger oil seals.,

SECTION III. GENERAL SUPPORT MAINTENANCE PROCEDURES

3-7 TRANSMISSION

3-7. TRANSMISSION.

This task covers Overhaul

TOOLS

Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

J8646-2	Puller Body Screw
J24171	Seal And Dust Shield Remover
J24192	Clutch Pack Clearance Gage (forward fourth)
J24193	Clutch Pack Clearance Gage (third)
J24194	Clutch Pack Clearance Gage (first, second, low)
J24195	Center Support Lifting Bracket
J24196	Main Shaft Lifting Bracket
J24197	Front Support Needle Bearing Installer
J24198	Oil Pump And Dust Shield Installer
J24200 Set	Collector Ring Installer And Staking Assembly Lifter
J24201	Sun Gear Shaft Bushing Installer
J24202-1A	Output Shaft Seal Installer
J24202-4	Driver Handle
J24204	Clutch Spring Compressor Set
J24205-A	Speedometer Driven Gear Bushing Remover And Installer Set
J24208-D	Center Support Compressor Set
J24209	Fourth Clutch Lifting Fixture
J24210	Low And First Clutch Piston Inner Seal Protector
J24216-01	Forward Clutch Piston Inner Seal Protector
J24218-2	Stator Cam Spring And Roller Retainer Ring
J24219	Lockup Valve And Main Pressure Regulator Spring Compressor
J24224	Fourth Clutch Alinement Fixture
J24310	Transmission Holding Fixture
J24315	Guide Pin Set
J24365	Flywheel Lifting Bracket
J24369	Orifice Plug Output Shaft Installer
J24453	Retaining Ring Installer
J24769	Output Shaft Bushing Installer
J25007	Torque Convertor Pump Bearing Puller Set
J26282	Shift Lever Seal Installer
J26401	Shift Lever Seal Remover
J26598-A	Converter Pump Snap Ring Remover & Installer
J26899PTO	Gear Removing Fixture Set
J26997-A	Sun Gear Bushing Swaging Tool Set
J28489	Sun Gear Bushing Reamer Set
J28525	Center Support Bushing Installer & Staking Set
J28557	Front Support Rear Bearing Remover
J28646-A	Charging Pump Bearing Installer
J28684	Governor Support Pin Installer
J29121	Stator Rivetor Set
J29198-3	Seal Ring Groove Gage
J29612	Valve Body Torque Wrench
J33079-1	Forward Clutch And Shaft
J33080	Charging Pump Driven Gear(s) Spindle
J33163	Valve Body Parts Tray Set
J34127	Selective Snap Ring Gage
J34814	PTO, Turbine Driven Backlash Gage
J25587-1	Fixture
J25587-2	Adapter - Installer Remover
J25587-3	Support Block
J25587-4	Support Block
J25587-5	Support Block
J25587-6	Spacer - Installer Remover
J25587-7	Loading Pin
J25587-9	Pin Installer
J25587-16	Pin Remover
J25587-17	Swaging Tool Holder
J25587-20	Loading Pin
J25587-21	Swaging Tool
J25587-25	Swaging Tool
J25587-29	Pin Remover
J25587-30	Pin Installer
J25587-31	Pin Installer
J25587-36	Pin Installer
J25587-47	Guide Pin
J25587-49	Guide Pin
J25587-67	Loading Pin

EQUIPMENT CONDITION

Transmission Removed From Truck (see TM 5-4210-220-12)

MATERIALS/PARTS

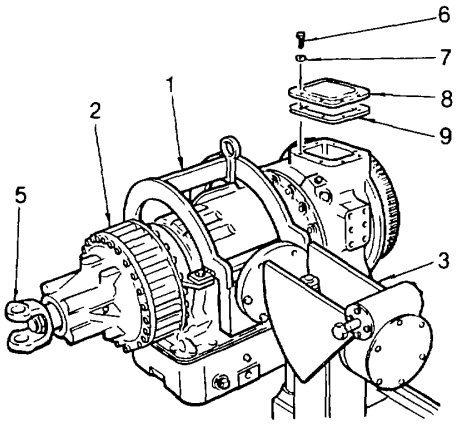
9, Appendix B Dexron II
21, Appendix B Petroleum Jelly
2310827 Basic Overhaul Kit

PERSONNEL REQUIRED - 2

3-7. TRANSMISSION - Continued

OVERHAUL

a. Mounting Transmission To Overhaul Stand.

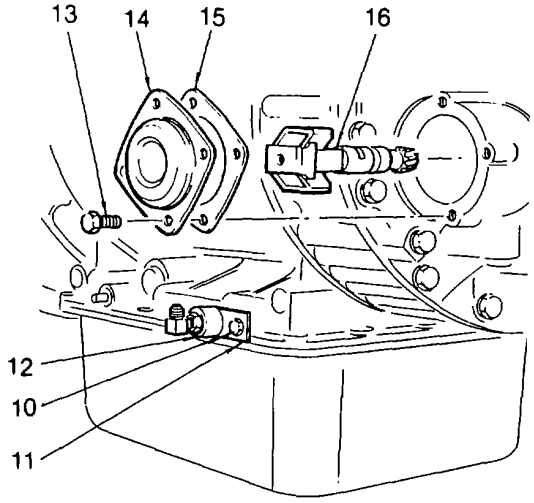


(1) Before installing the lifting bracket J24310 (1), onto the transmission (2), remove any bolts which cannot be removed due to obstruction by the bracket.

(2) With transmission securely attached to mounting bracket J24310, install transmission and bracket to overhaul stand (3).

(3) Check the number of notches that have been cut into the wrenching flats of the yoke retaining nut (4). If there are five notches, remove the nut and throw it away.

(4) If there are less than five notches, or none at all, remove all dirt and any burrs from the exposed shaft threads. Then, loosen the yoke nut until there is approximately 1/16-in. (1.6 mm) gap between the nut and yoke (5).



(5) Check the running torque while removing the nut. The nut can be reused only if it meets the following requirements: -The first time (no notches) the nut is removed the running torque must be at least 400 in. lb (45 Nm). -Each additional time (one to four notches) the nut is removed the running torque must be at least 300 in. lb (34 Nm).

(6) Each time the nut is removed, deeply scribe one of the wrenching flats. This method of marking the nut will indicate how many times the nut has been reused.

(7) Remove the output yoke (5) using a suitable puller.

(8) Remove eight bolts (6), washers (7), top cover (8) and gasket (9) from converter housing.

(9) Remove bolt (10) that retains the modulator retainer (11) and remove retainer and modulator valve (12). (10) Remove four bolts (13) that retain the governor cover (14) and gasket (15). Remove the cover and gasket. Remove the governor (16) by rotating it clockwise while removing.

b. Disassembly And Inspection Of Flywheel Assembly, Torque Converter And Lockup Clutch Assemblies

(1) Position the transmission horizontally.

3-7. TRANSMISSION - Continued

WARNING

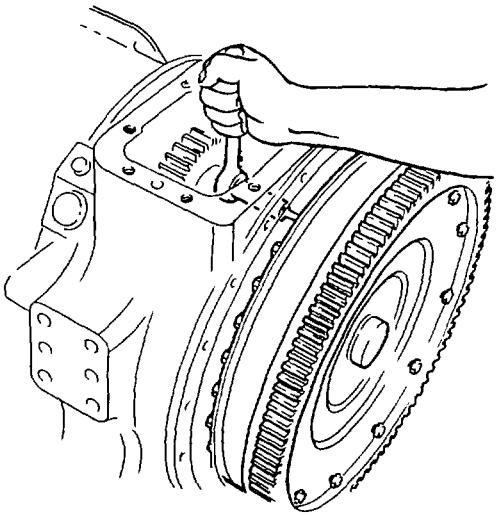
Place a suitable container beneath the flywheel to catch any oil which may drain during removal of the flywheel.

(2) Remove twenty-nine of the thirty bolts and washers that retain the flywheel on the converter pump.

(3) Install lifting tool J24365 onto the flywheel assembly.

(4) Attach a hoist to the lifting tool. Support the weight of the flywheel during removal of the remaining bolt and washer.

(5) Remove the flywheel and attached parts from the converter housing.



CAUTION

Whether the turbine is removed with the flywheel as shown, or remains on the transmission, use care to prevent it falling.

(6) Holding the stator assembly, lock the stator and the freewheel roller race together by rotating the stator in a counterclockwise direction as shown.

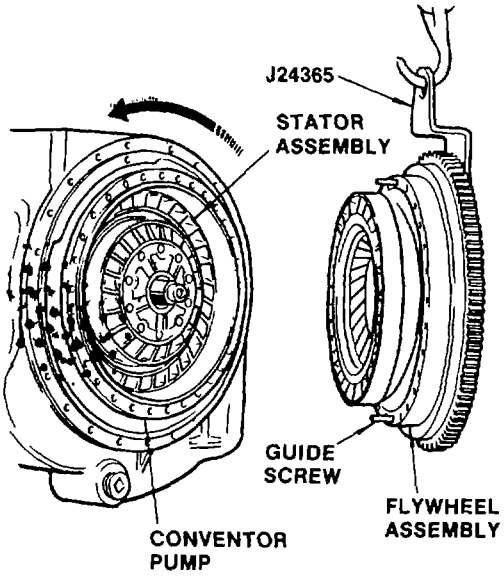
(7) Carefully lift the stator assembly from the turbine shaft.

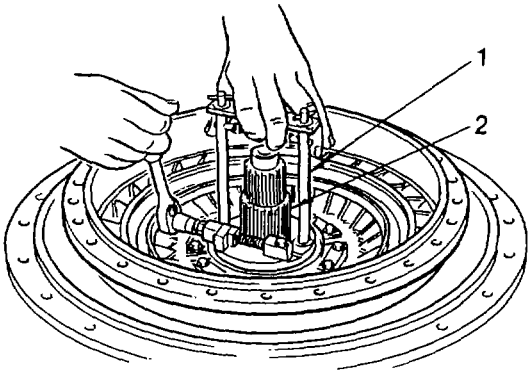
(8) Holding the safety guards of tool J26598-A (1) open, place the tool over the converter ground sleeve (2) and snap ring.

(9) Position the jaws into the snap ring gap

(10) Close the jaws by rotating the adjusting nut.

(11) Release the safety guards by rotating the tool arms. Rotate the adjusting nut to the stop nut.





3-7. TRANSMISSION - Continued

(12) Lift off snap ring and remove the splined spacer Place tool J26598-A on a bench, face down, close the jaws and remove the snap ring.

NOTE

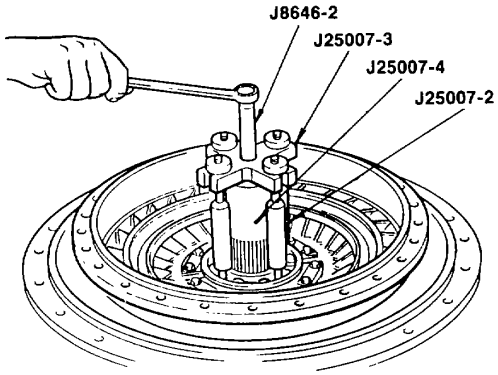
If special tool J26598-A is not available, remove the snap ring with snap ring pliers. Do not scrape the ground sleeve splines during removal.

(13) Place puller sleeve J25007-4 onto the converter ground sleeve.

(14) Insert the feet of leg and nut assemblies J25007-2, between the balls of the bearing assembly, spacing them 90 deg. apart.

(15) Rotate the legs to make the feet bear against both the inner and outer bearing race grooves.

(16) Install puller head tool J25007-3 onto the legs, tightening the nuts evenly.



(17) Install center screw J8646-2 and tighten it by hand until it is centered on sleeve J25007-4. Hold the pump assembly, and tighten the center screw until the pump assembly will lift off the ground sleeve.

(18) Position flywheel assembly, ring gear side down, on workbench.

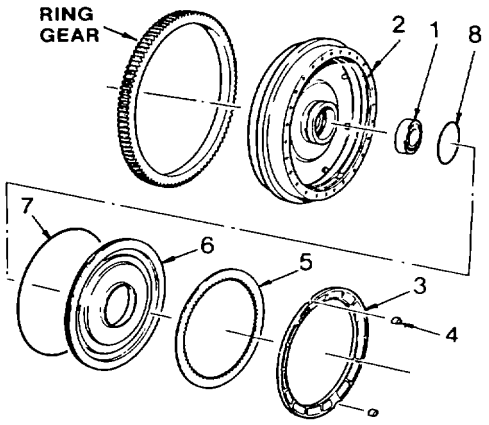
(19) Using two pry bars, cushioned to prevent scratching the parts, remove the torque converter turbine from the flywheel.

(20) Remove ball bearing (1) from the flywheel assembly (2), only if replacement Is necessary.

(21) Remove the lockup clutch backplate (3) from the flywheel (2). Remove the keys (4) from the flywheel bore.

(22) Remove the lockup clutch plate (5).

(23) Remove the lockup clutch piston (6). Remove the seal ring (7) from the piston outer groove. Remove the seal ring (8) from the inner hub of the flywheel (2).



(24) If ring gear Is worn excessively, remove from flywheel.

(25) If the seal ring surface of the flywheel bore is worn beyond 1.007 in. (25.58 mm) diameter, rework is necessary as detailed in c. following. Otherwise proceed to d. following

3-7. TRANSMISSION - Continued

c. Flywheel Seal Ring Surface Rework.

(1) Rework the bore and install a sleeve (P/N 6881519) as shown.

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(2) Cool the sleeve in dry ice for at least thirty minutes before installing. Proper alinement during installation is necessary to prevent damaging the bore and sleeve.

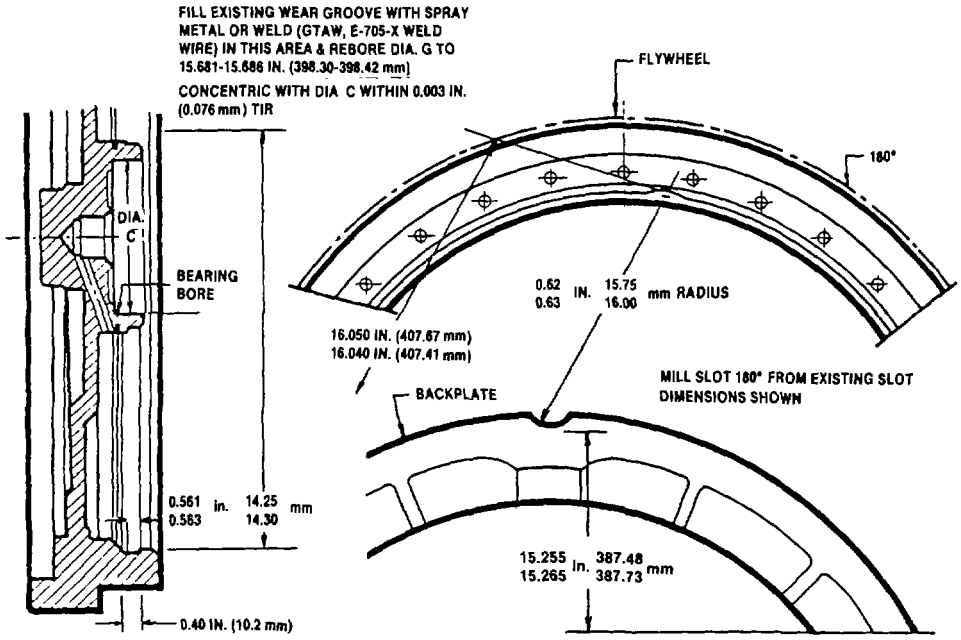
(3) Press the sleeve flush with surface X. Be sure the internal chamfer is toward the rear side of the flywheel.

NOTE

Do not attempt this rework procedure unless adequate machining capabilities are available.

(4) Maximum allowable step wear in the lockup backplate bore of the flywheel is 0.030 in. (0.76 mm).

(5) If the step wear is less than 0, 030 in. (0.76 mm), refer to the addition of second locking key machining instructions.



(6) If the step wear is greater than the maximum allowable wear, refer to welding (or spray metaling) and machining instructions.

(7) All new configuration flywheels have two locking keys.

3-7. TRANSMISSION - Continued

d. Converter Turbine Assembly Overhaul

NOTE

Do not disassemble the turbine unless the drive gear or turbine hub must be replaced. If the converter turbine is damaged, replace the assembly.

To disassemble the turbine, a hydraulic press having a minimum capacity of ten tons, and adjustable press bed with a 25 In. opening and a pressure gage to assist in determining the rivet staking loads is required. A reworked turbine assembly must be rebalanced.

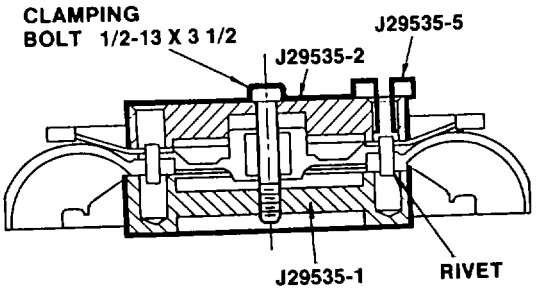
(1) Punch mark relationship of lockup clutch hub and turbine.

(2) Place base plate J29535-1 on a workbench, hole side up.

(3) Place converter turbine assembly, hub side up, on top of base plate J29535-1.

(4) Aline the sixteen rivets to the sixteen holes in the base plate.

(5) Place guide plate J29535-2, on top of converter turbine hub. Centrally locate each rivet in the guide plate holes.



(6) Install clamping bolt to retain the guide plate, converter turbine, and base plate together. Tighten the bolt to 50 ft lb (68 Nm).

(7) Place the turbine assembly and fixture in a drill press.

(8) Place drill guide J29535-5, into guide plate J29535-2. Using a 1/4 in. drill, drill approximately 3/16 in. (4.76 mm) deep.

(9) Place the drill guide in the next hole. Rotate the guide plate and drill the rivet. Continue until all the rivet heads have been removed.

CAUTION

Do not use a hammer to remove the rivets.

(10) Place the turbine and fixture in a hydraulic press. Install rivet remover tool J29535-4 into the guide plate. Press out each rivet.

(11) Remove the guide plate retaining bolt.

(12) Inspect turbine for cracks, distortion and abrasions. If deficiencies are noted, the turbine must be scrapped.

3-7. TRANSMISSION - Continued

(13) Inspect the rivet holes for burrs or swelling. Deburr as necessary.

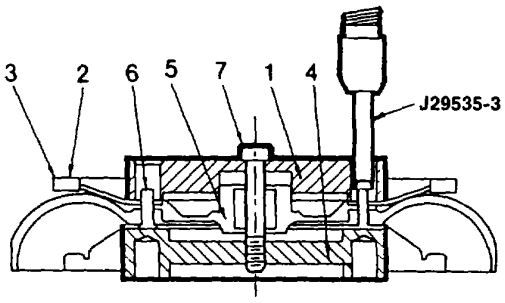
(14) Inspect lockup clutch drive gear for cracks distortion, abrasion, battered or broken teeth.

(15) Reassemble components, being sure to correctly index punch marks of the lockup drive gear, turbine, and hub. Use the new rivets to help index the components.

(16) Install sixteen new rivets (6) through the turbine (3), turbine hub (5), and lockup clutch gear (2).

(17) Assemble base plate J29535-1 (4) placing solid side of plate against the rivet heads.

(18) Place guide plate J29535-2 (1) on top of the assembled components. Centrally locate the rivets in the holes of the guide plate.



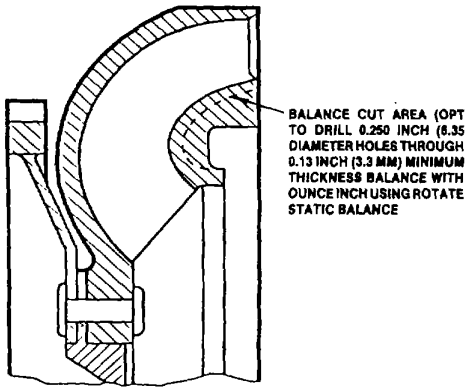
(19) Retain the turbine assembly and the two plates with bolt (7). Tighten the bolt to 50 ft lb (68 Nm).

(20) Place the turbine and fixture in hydraulic press.

(21) Insert staking tool J29535-3 into the top plate. Using an alternating pattern, swage each rivet.

(22) Remove staking tool, retaining bolt, guide, and base plate.

(23) Each reclaimed assembly must be balanced by rotating type static balance to within 1.0 ounce in. (720 Nm) by removing metal from area indicated but maintaining 0.13 in. (3.30 mm) minimum wall. It is also possible to drill 0.250 in. (6.35 mm) diameter holes for balancing.



e. Assembly Of Lockup Clutch, Flywheel And Turbine Assembly

(1) If the starter ring gear was removed, install a new gear, as follows.

(2) Install the starter ring gear after heating it uniformly to 400 deg. F (204 deg. C) maximum temperature. Be sure the chamfers of the teeth are facing to front of flywheel, engine side for proper starter pinion engagement. The ring gear must seat firmly against the shoulder on the flywheel.

(3) Place flywheel on assembly table, with the cavity side upward.

3-7. TRANSMISSION - Continued

NOTE

If bearing (1) shows signs of excessive wear or damage, it must be replaced.

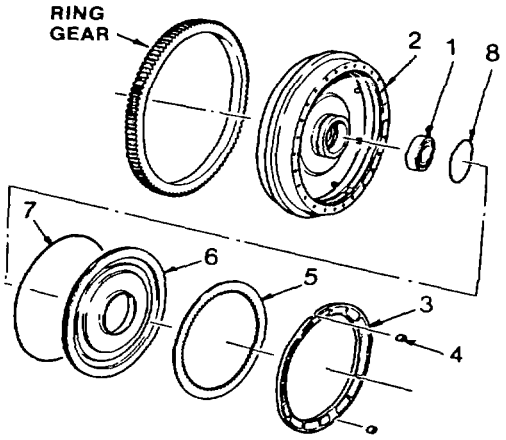
(4) Install seal ring (8) onto the flywheel hub, and seal ring (7) onto the outside diameter of lockup clutch piston (6). Lubricate both seal rings with petroleum jelly (item 21, Appendix B).

(5) Place a pencil mark on the edge of the lockup clutch piston opposite a dowel pin hole. Also place a pencil mark in the flywheel bore, opposite a dowel pin.

(6) Install the lockup clutch piston into the flywheel, alining the pencil marks, to engage the recesses in the piston with the dowel pin. Be certain the dowel pins are engaged.

(7) Install the lock keys (4) in the lock key grooves of the flywheel. Use petroleum jelly (item 21, Appendix B) to retain them.

(8) Install the lockup clutch plate (5).



(9) Install the lockup clutch backplate (3) flat side first, engaging the notches in the plate with the keys (4) in the flywheel.

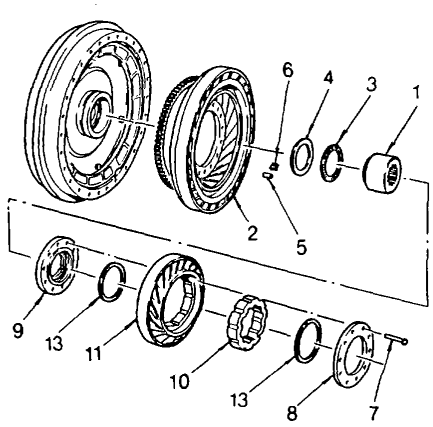
(10) Carefully center the lockup clutch plate in the flywheel. Install the torque converter turbine (9), engaging its hub splines with the internal splines of the lockup clutch plate.

(11) Flywheel, lockup clutch, and turbine are now assembled and ready for final installation.

f. Disassembly And Repair Of Torque Converter Stator Assembly

(1) Rotate stator freewheel roller race (1) in a clockwise direction to free it for removal from the stator (2).

(2) Remove race (1), thrust bearing (3), thrust bearing race (4), ten stator rollers (5), and ten freewheel roller springs (6) from stator assembly (2).



NOTE

Do not disassemble the stator assembly unless replacement of stator thrust washer (9), rivets (7), or washer (8) is necessary. If stator (11) or cam (10) is cracked or damaged, replace the complete stator assembly.

A hydraulic press having a minimum capacity of five tons, an adjustable table, and a pressure gage, to assist in determining the rivet staking load, is required to rebuild the stator assembly.

3-7. TRANSMISSION - Continued

(3) Place the stator assembly in a drill press, formed rivet side up.

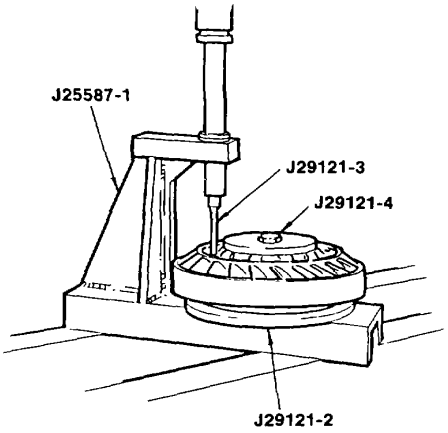
(4) Using a 3/8 in. drill, aline and drill the rivet, removing the formed head.

(5) Place base plate J29121-2, under the stator assembly. Be sure the holes in the base plate are under the rivet heads. Place top plate J29121-4 on top of the stator assembly.

(6) Install bolt to hold the two plates together. Tighten the bolt to 60 ft lb (81 Nm).

(7) Place fixture stand J25587-1 on a hydraulic press. Install rivet remover pin J29121-3 into fixture J25587-1 head. Tighten the tool retainer thumb screw.

(8) Place the stator assembly, with base and top plates, onto the fixture stands, drilled rivet side up.



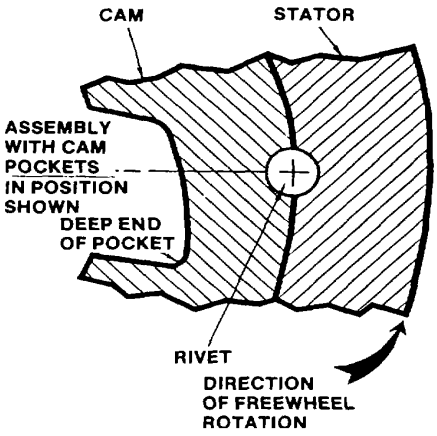
(9) Aline the rivet remover pin with the drilled rivet and press the rivet from the stator assembly. Repeat process for each rivet.

(10) Remove the retaining bolt and top plate. Separate thrust washer (9), side plate washers (8 and 12), two cam washers (13), and cam (10) from stator (11).

(11) Inspect the stator and cam for cracks, rivet holes for burrs or swelling. Deburr as required. If cam or stator is cracked or distorted, replace the stator assembly.

(12) If the cam becomes separated from the stator, install in the following manner. Place the stator on a work table so that the thick portion of the vanes is upward. Temporarily place two rivets 180 deg. apart with the headless ends up into the grooves in the stator. Using the rivets for alinement, install the cam so that the deep end of each pocket is positioned as shown. Tap the cam into place with a soft drift. Remove the two rivets.

(13) Install cam washers (13), one on each side of the stator. Install freewheel washer (8) and thrust washer (9).



(14) Aline the rivet holes and insert ten new 1/4 X 2 5/8 in. rivets into the stator assembly (11) from the side plate washer side and through the stator thrust washer.

3-7. TRANSMISSION - Continued

(15) Place the stator assembly on base plate J29121-2. Be sure the rivet heads rest on the base plate, between clearance holes. Install top plate J29121-4, and the 5/8 11 X 3 1/4 retaining bolt. Strike the top plate with a rubber mallet to seat components. Tighten retainer bolt to 60 ft lb (81 Nm).

(16) Place the stator assembly on fixture J25587-1. Install stake tool J29121-1 into the fixture head of J25587-1 and tighten the thumb screw fingertight.

(17) Apply approximately 8000 lb (3629 kg) load to swage each rivet head. Swage the second rivet 180 deg. from the first. Locate the third rivet, 90 deg. from the second, etc., until all rivets are swaged.

(18) Remove the top and bottom plate retaining bolt from stator assembly. Remove the two plates.

(19) Place stator assembly on work table, rear side upward. Install thrust bearing race into the stator.

(20) Coat the pockets of stator assembly, stator springs and rollers with petroleum jelly (item 21, Appendix B).

(21) Install stator roller holder J24218-2, into the stator against the thrust bearing race installed previously.

(22) Install ten freewheel roller springs into the stator cam pockets. The springs must be positioned as shown with the convolutes (bends) against the stator thrust washers. The ends of the spring can be up or down against the roller.

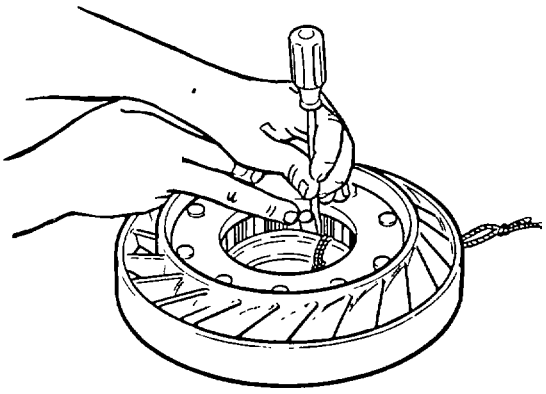
(23) Install ten freewheel rollers into small end of ca m pockets.

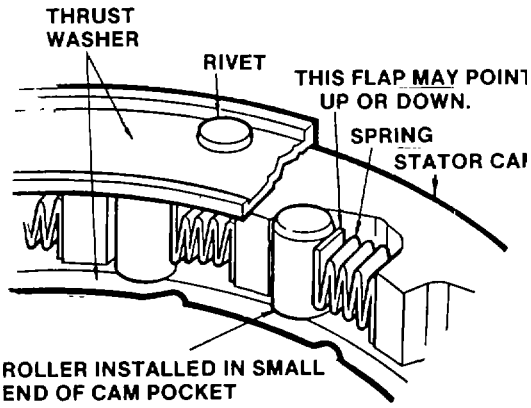
(24) Install thrust bearing onto the freewheel roller race.

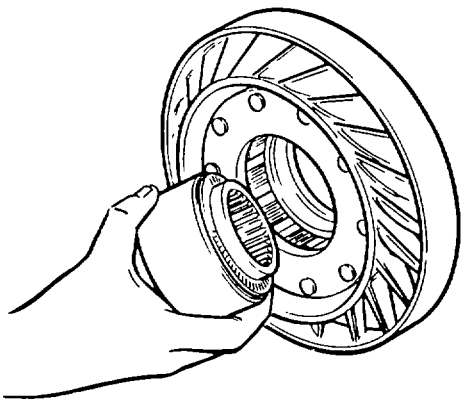
(25) Start the freewheel roller race into the stator until the thrust bearing is near the roller holder. Rotate the race clockwise to install it.

(26) Remove the roller holder by pulling on the thong attached to It. Push the roller race inward (rotating it clockwise) until the thrust bearing seats.

(27) Rotate the freewheel roller race counterclockwise to lock in place. Position the stator assembly with its roller race upward until ready for installation Cover or wrap the assembly to keep out dust and dirt.







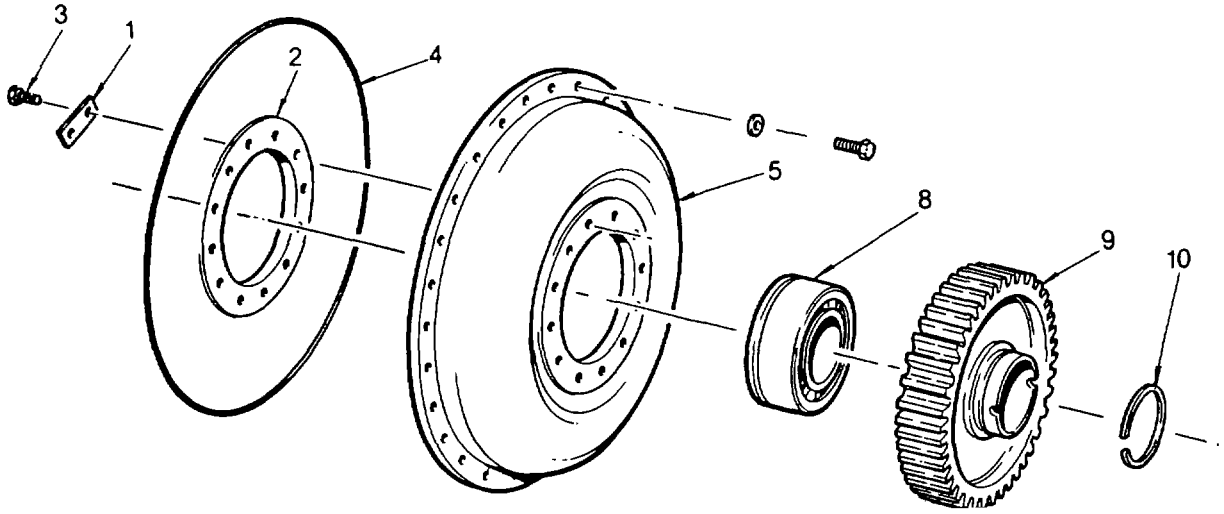
3-7. TRANSMISSION - Continued

g. Torque Converter Pump Assembly Repair

(1) Remove seal ring (4) from the front of converter pump.

(2) Flatten the corners of the lockstrips (1), and remove twelve bolts (3) from the converter pump.

(3) Remove bolts (3), lockstrips (1), retainer (2), gear hub (9) and hub seal (10).



(4) Do not remove bearing from housing unless part replacement is necessary.

(5) If bearing (8) was removed, install a new bearing grooved end last, into drive gear (9)

(6) Install drive gear (9) and bearing (8) onto converter pump (5). Retain drive gear (9) and bearing

(8) to converter pump (5) with retainer (2), twelve bolts (3) and six lockstrips (1).

(7) Tighten the bolts to 33 - 40 ft lb (45 - 54 Nm). Bend the corner of each lockstrip to retain the twelve bolts.

(8) Install seal ring onto the outside diameter of converter pump assembly.

(9) Converter pump ready for assembly to converter shaft.

h. Scavenge Oil Pump Removal, Inspection And Repair

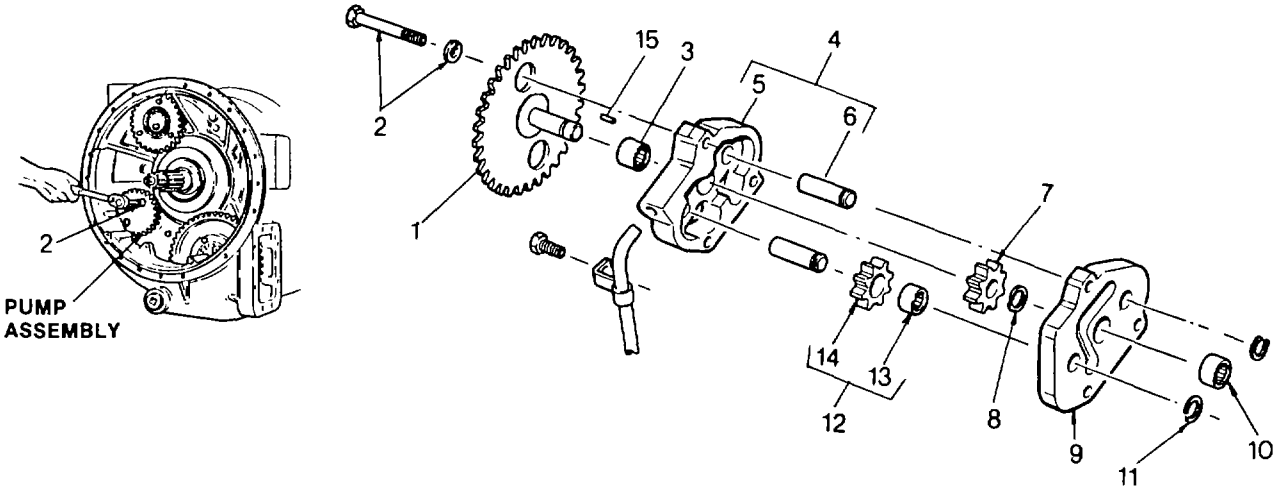
(1) Position the transmission horizontally, bottom side downward. Remove bolt from the suction tube retaining clip on the scavenge pump.

(2) Remove three bolts and lockwashers (2) that retain the scavenge pump assembly. Remove the pump assembly.

(3) Place scavenge oil pump assembly on assembly table with external drive gear (1) down and remove snap rings (11).

(4) Remove oil scavenge pump body plate (9).

3-7. TRANSMISSION - Continued



(5) Remove snap ring (8) from the shaft of drive gear (1).

(6) Remove driven gear assembly (12) from spindle (6).

(7) Remove drive gear (7) from the shaft of drive gear (1). Remove lock roller(15)from the shaft of gear (1).

(8) Remove gear (1) from pump body (4).

(9) If replacement is necessary, press needle bearing (3) out of body (5). Press needle bearing (10) out of plate (9).

(10) If replacement is necessary, press spindles (6) toward the inside of body (5).

CAUTION

Do not remove bushing (13) from gear (14) if proper machining procedure cannot be used at installation of new bushing. Replace pump as an assembly.

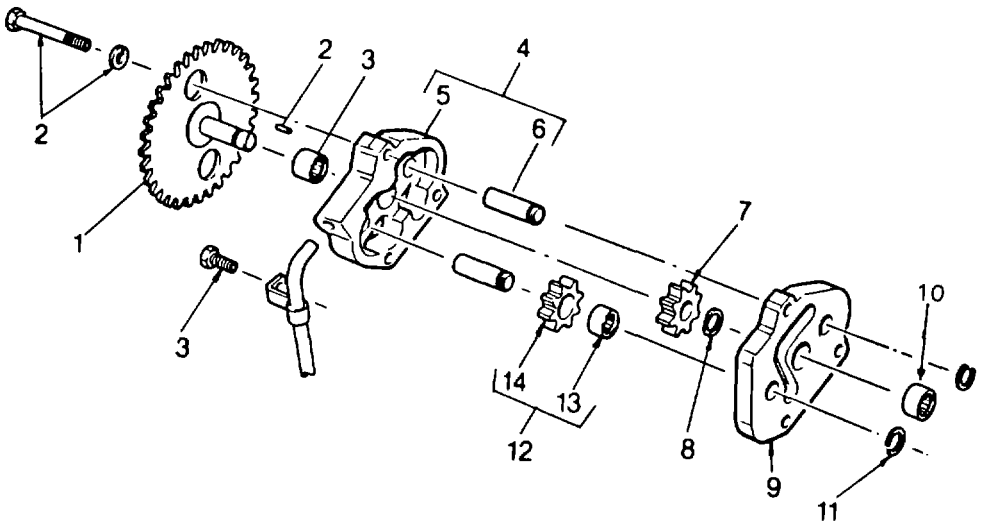
(11) Remove damaged bushing (13) from scavenge pump driven gear (14).

(12) Press a new bushing into gear (14) to 0.030 in. (076 mm) below the surface of the gear.

(13) Check the ID of the bushing for runout. Runout must not exceed 0.001 in. (0.03 mm) Surface finish of the bushing should be 30 microinch (0.762 micrometer).

(14) If spindles (6) were removed, install the spindles, plain ends first, into the inside of body (5). Press the spindles to 1.0 in. (25.4 mm) above the inside surface of the body. Install driven gear (14) onto spindle (6).

3-7. TRANSMISSION - Continued



CAUTION

Press only on numbered end of bearing when Installing needle bearings.

(1 5) If needle bearing (3) was removed, press a new bearing to 0.04 in. (1.0 mm) below the outside surface of body (5).

(16) If bearing (10) was removed, press a new bearing flush with, to 0.010 in. (0.25 mm) below the outside surface of plate (9).

(17) Install pump drive gear (1) into body (5) and install lock roller(15) into Its groove in the shaft of gear (1). Install internal drive gear (7) onto the shaft of gear (1), alining the lock roller with the groove in the gear. Secure the gear with snap ring (8).

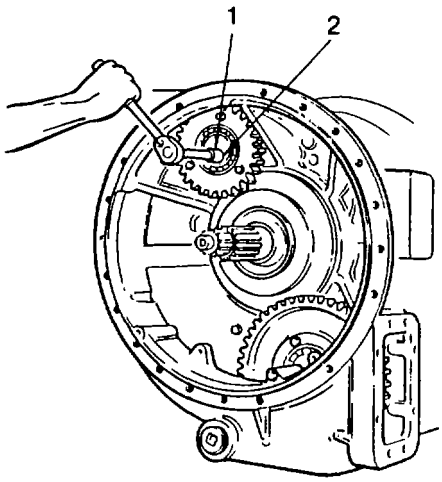
(18) Install plate (9) onto body (5). Install snap rings (11) onto spindles (6).

(19) Pump assembly is ready for installation.

j. PTO Top And Side Drive Gear Removal And Repair

(1) Remove the bolt (1) that retains the top PTO idler gear spindle (2).

(2) Use slide hammer J24171-4 (3) and adapter J24171-2 to remove the -spindle and top gear assembly (4). Press the spindle from the bearing. If the gear is damaged, replace the gear assembly.



3-7. TRANSMISSION - Continued

(3) If replacement of bearing is determined necessary remove two snap rings securing bearing with in gear assembly.

(4) Using suitable fixture to hold assembly press in new bearing. Apply retaining compound (item 23, Appendix B) onto bearing circumference. Allow parts to dry for 2 hours.

(5) Assembly is ready for installation into transmission housing.

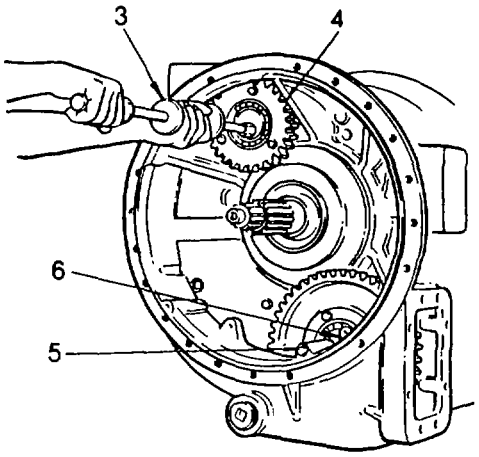
(6) Remove the 1/2 20 X 3 3/4 in. bolt, lockwasher and plain washer (5) that retains the side PTO gear spindle (6). Install a 1/2 20 X 6 in. bolt to replace the 3 3/4 in. bolt, and tighten it fingertight.

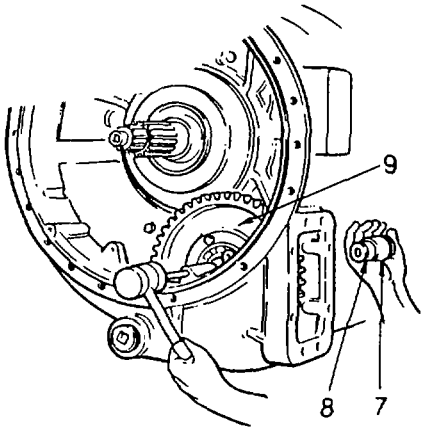
(7) Using a hammer, drive the bolt rearward while supporting the PTO gear (4). When the spindle is free of the housing, remove the bolt, spindle and PTO gear.

(8) Remove the seal ring (7) from the PTO gear spindle (8). If the gear is damaged, replace the gear assembly (9).

(9) If replacement of bearing is necessary, remove two snap rings securing bearing within gear assembly. Using suitable fixture to hold assembly, press in new bearing. Apply retaining compound (item 23, Appendix B) onto bearing circumference. Allow parts to dry for 2 hours.

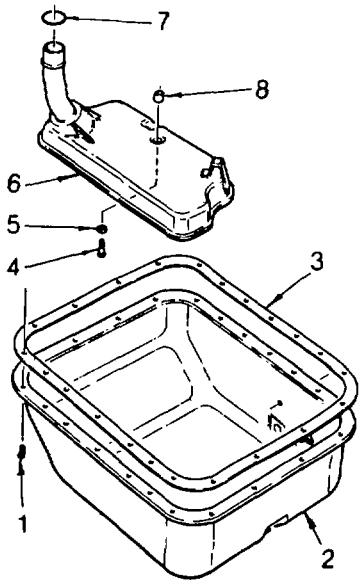
(10) Assembly is ready for installation into transmission housing.





k. Removal Of Oil Pan And Filter

(1) Position transmission vertically, converter housing upward.
(2) Remove two oil pan bolts and install two 5/16 - 18 guide bolts J3387-2.
(3) Remove the remaining twenty-one pan bolts (1). Remove the oil pan (2). Remove guide bolts, discard gasket (3).
(4) Remove oil filter retaining bolt (4) and plain washer (5).
(5) Remove oil filter (6), seal ring (7), and the retaining bolt spacer (8).



13-7. TRANSMISSION - Continued

I. Removal Of Valve Bodies

(1) Remove signal tube (1) and low signal tube (2)

(2) Remove bolts 'A' and 'B' Install two 1/4 - 20 guide bolts J24315-3 into positions 'A' and 'B'.

(3) Remove the five bolts remaining in the low trimmer valve body. Remove the low trimmer valve body (3).

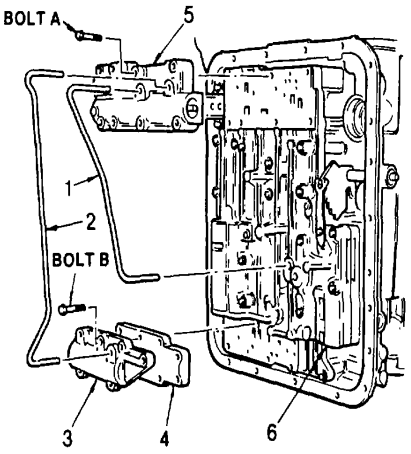
(4) Remove the one remaining bolt in the low shift valve body (4). Remove the low shift valve body.

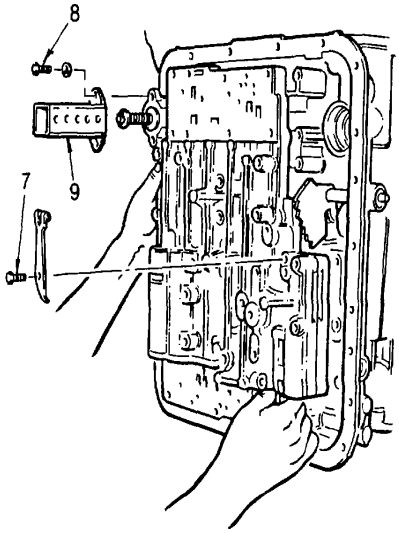
(5) Remove the seven remaining bolts that retain the lockup cutoff valve (5). Remove the lockup cutoff valve.

(6) Remove eighteen bolts from the control valve (6). Remove the selector lever detent retainer bolt (7).

(7) Remove the two bolts and washers (8) that retain the baffle (9) to the oil transfer plate.

(8) Remove the control valve body assembly, separator plate and transfer plate as a unit.



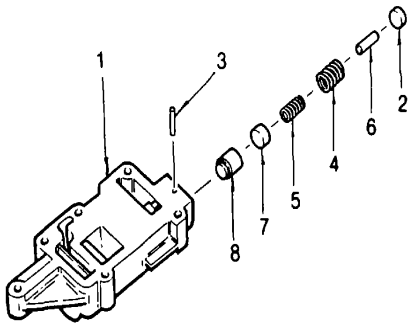


m. Low Clutch Trimmer Valve Inspection, Repair And Assembly

(1) Press inward on retainer plug (2), and remove retainer pin (3) from valve assembly (1).

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 13.8.deg. F (30 to 59 deg. C).



(2) Release pressure, and remove plug (2), spring (4 and 5), valve stop (6), plug (7) and valve (8). Inspect and clean parts with dry cleaning solvent (item 10, Appendix B) replace any damaged parts.

(3) Install low clutch trimmer valve (8), recessed end first, into valve body (1).

3-7. TRANSMISSION - Continued

NOTE

Valves, when installed dry, should move by their own weight,

(4) Install trimmer plug (7).

(5) Install springs (4 and 5), valve stop (6), and retainer plug (2).

(6) Compress springs (4 and 5) and install retainer pin (3) to secure plug (2).

n. Low Shift Valve Inspection, Repair And Assembly

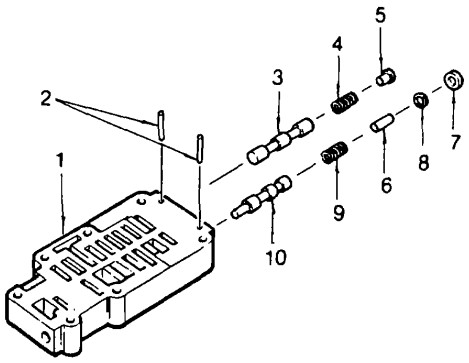
(1) Depress valve stop (5) against its spring and remove retainer pin (2).

(2) Release spring pressure and remove valve stop (5), spring (4) and relay valve (3).

NOTE

Note position of adjusting ring (7) in relation to retainer pin (2) before removal.

(3) Depress adjusting ring (7) against its spring and remove retainer pin (2).



(4) Remove adjusting ring (7), washer (8), valve stop (6), spring (9), and valve (10).

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(5) Inspect and clean parts with dry cleaning solvent (item 10, Appendix B). Replace any damaged parts.

NOTE

Valves, when installed dry, should move by their own weight.

(6) Install valve (10) into valve body (1).

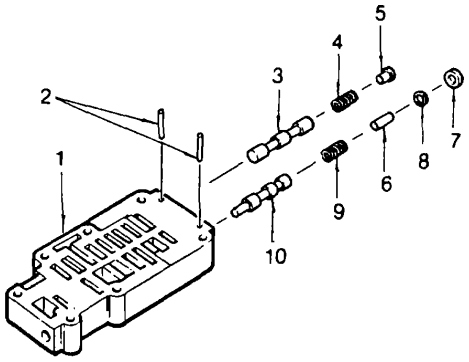
(7) Install spring (9), valve stop (6), washer (8), and adjusting ring (7). Aline the hole in valve stop (6) with the pin hole in valve body (1). Position the adjusting ring in the same position as it was before removal.

(8) Press inward against adjusting ring (7) until retainer pin (2) can be installed.

3-7. TRANSMISSION - Continued

(9) Install relay valve (3), spring (4), valve stop (5).

(10) Press inward against valve stop (5), and install retainer pin (2).



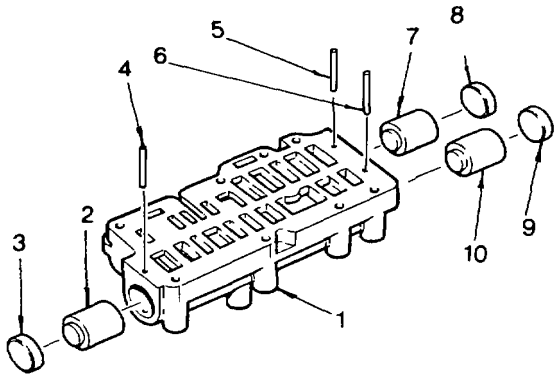
o. Lockup Cutoff Valve Inspection, Repair And Assembly

(1) Remove retainer pins (4, 5, and 6) from valve body (1).

(2) Remove valve plugs (3, 8, and 9) and valves (2, 7, and 10) from their respective bores.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).



(3) Inspect and clean parts with dry cleaning solvent (item 10, Appendix B). Replace any damaged parts.

NOTE

All valves, when dry, must move freely of their own weight in their respective bores.

Unless parts replacement is required, the lockup cutoff valves should be installed In the same location from which they were removed.

(4) Install valves (2, 7, and 10) into their respective bores in valve body (1).

(5) Install valve plugs (3, 8, and 9) into their respective bores. Retain the valves with pins (4, 5, and 6).

3-7. TRANSMISSION - Continued

p. Control Valve Body Assembly, Inspection, Repair And Assembly

CAUTION

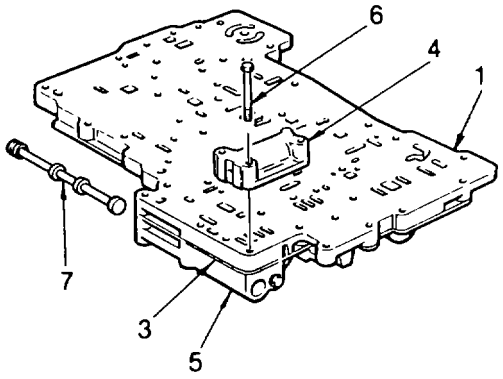
The valve body assembly contains a number of springs, some of which are *similar and can* be mistakenly Interchanged. If the springs are not reinstalled in the same locations from which removed, erratic shift patterns may occur. For these reasons, it is recommended that each spring, at removal, be tagged with its item number, and placed in valve body parts tray set J33163. This will simplify correct assembly of the valve body components.

(1) Place valve assembly on the work table, modulator valve body (4) upward.

(2) Remove manual selector valve (7).

(3) Remove three bolts (6) that retain modulator valve body (4). Remove control valve body (5) while holding oil transfer plate (1) and separator plate (3) together.

(4) Invert the oil transfer and separator plates (separator plate on top) while holding them firmly together. Place them on the work table.

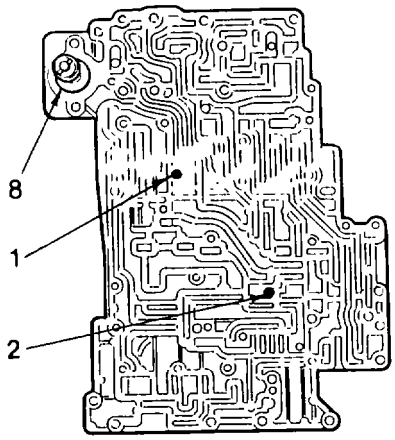


(5) Lift or slide separator plate (3) off oil transfer plate (1). Note check ball locations in the oil transfer plate. Make a sketch or *list* that will *identify* the ball sizes and locations of balls in oil transfer plate. This will assist in reassembly. Remove the balls.

(6) Check ball # 1 (1/4 in. ball) is located in the third clutch pressure line, next to the 4-5 relay valve. Its function is to restrict the feed to third clutch for clutch overlap and allow full exhaust.

(7) Check ball # 2 (1/4 in. ball) is located in the second clutch pressure line next to the 3-4 relay valve. Its function is to restrict the feed to second clutch for clutch overlap and allows full exhaust.

(8) Remove the lubrication pressure regulator valve (8) from the oil transfer plate. Depress cup washers and remove pin. Release washer and remove it. Remove spring and valve. Remove valve pin from the' oil transfer plate.

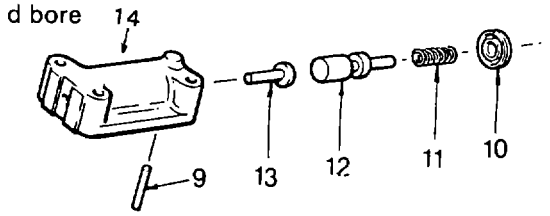


(9) Disassemble the modulator valve. Before removing pin (9) note position of adjusting ring (10). Reinstall in same position as removed. Press adjusting ring (10) inward and *remove retainer* pin (9). Release the adjusting ring and remove spring (11), modulator valve (12) and modulator actuator valve (13).

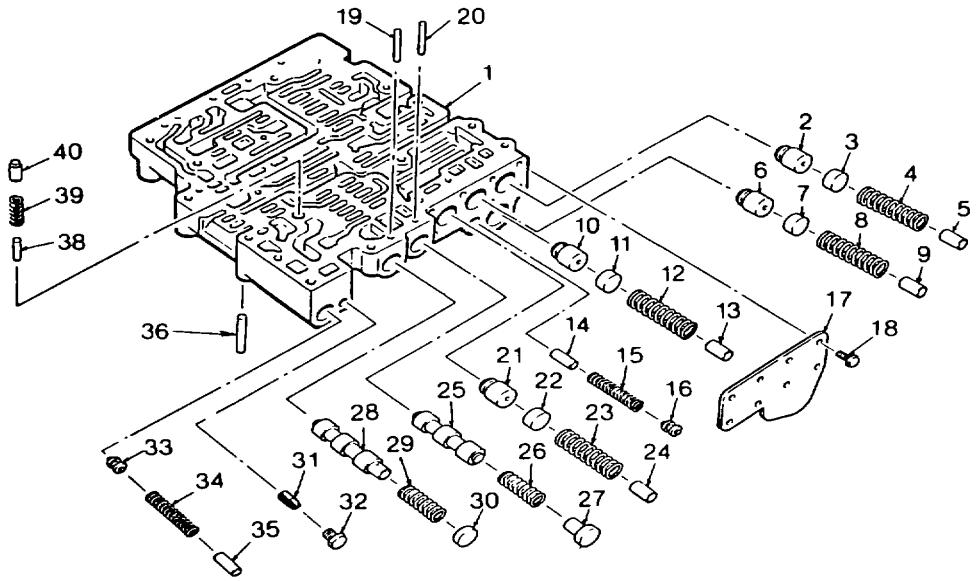
3-7. TRANSMISSION - Continued

(10) Inspect valve body (14) and valve (12) for damaged bore or scored valve surface. Replace necessary parts.

(11) Install modulator actuator valve (13), modulator valve (12), spring (11) and adjusting ring (10), into bore of valve body (14).



(12) Compress the spring, and install retainer pin (9) into valve body (14) to retain adjusting ring (10). Be sure the adjusting ring is in the same position as it was before removal.



(13) Remove priority valve (40), spring (39), and valve stop (38) from the control valve body (1).

(14) Position valve body (1), flat side upward, on the work table. Remove plug (32) and screen assembly (31).

(15) Remove eight bolts (18) while holding trimmer cover (17) against spring pressure. Relieve pressure and remove cover (17).

(16) Remove spring (4), valve stop (5), trimmer plug (3), and trimmer valve (2).

(17) Remove spring (8), stop (9) plug (7), and valve (6).

(18) Remove spring (12), stop (13), plug (11), and valve (10)

(19) Remove valve (16), spring (15), and stop (14).

(20) Remove spring (23), stop (24), plug (22), and valve (21).

3-7. TRANSMISSION - Continued

NOTE

The components in each bore are spring-loaded and must be compressed while removing the retainer pins.

(21) Remove retainer pin (20), valve stop (27), spring (26), and valve (25).

(22) Remove retainer pin (19). spring spacer (30), spring (29) and valve (28).

(23) Remove retainer pin (36), spring (34), stop (35), and valve (33).

NOTE

Before removing pins (41, 47, 63 and 67), make a note or sketch that shows the position of the adjusting rings (45, 52, 53, and 58) with respect to their retaining pins. If the value body is reassembled with the same springs, and the adjusting rings are in their original positions, the original calibration of the valve body is maintained.

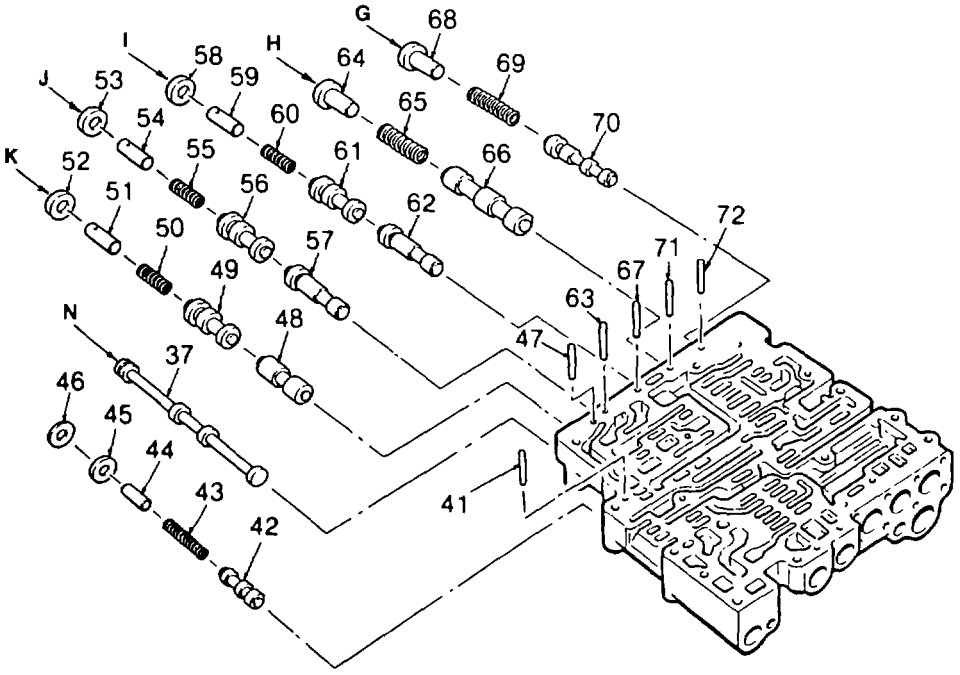
(24) Remove retainer pin (41), adjusting ring (45), spring washer (46), valve stop (44), spring (43), and valve (42).

(25) Remove retainer pin (47), adjusting ring (52), valve stop (51), spring (50), modulated valve (49), and 1-2 shift valve (48).

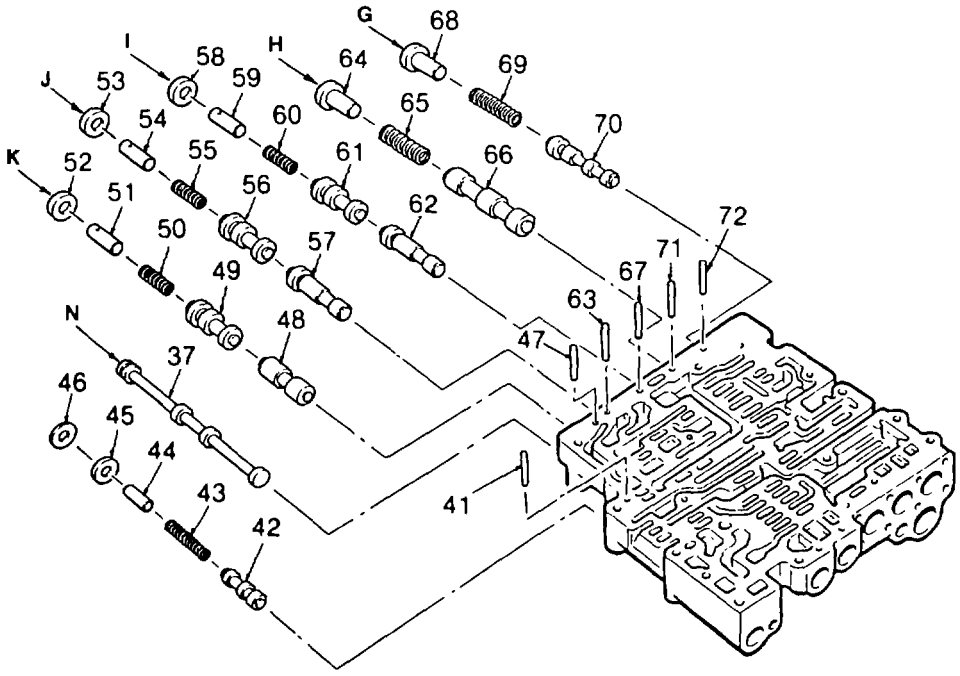
(26) Remove retainer pin (63), adjusting ring (53), spring (55), valve stop (54), and valves (56 and 57).

(27) Remove retainer pin (67), adjusting ring (58), spring (60), valve stop (59), and valves (61 and 62).

(28) Remove retainer pin (71), valve stop (64), spring (65), and valve (66).



3-7. TRANSMISSION - Continued



(29) Remove retainer pin (72), spring (69), valve stop (68), and valve (70).

(30) Inspect all valves and springs individually for scoring, breakage or tension fatigue. Inspect main valve body for scuffed bores. Replace damaged parts.

NOTE

Check the position of all components, the configuration of all valves and plugs, and the identification of all springs before installation. Place the valve body on a work table, flat side upward. Refer to spring specification charts (Appendix C). All valves, when dry, should move freely by their own weight, in their bores.

(31) Install 2-3 relay valve (28), larger diameter first, spring (29) and valve spring spacer (30) into bore. Depress spacer (30) and install retainer pin (19) into its hole in valve body (1).

(32) Install 3-4 relay valve (25), spring (26) and valve stop (27) into bore. Depress the valve stop and install retainer pin (20) into its hole in valve body (1).

(33) Install fourth clutch trimmer valve (21) (smaller end first), plug (22). spring (23), and valve stop (24) into bore of valve body (1).

(34) Install second clutch trimmer valve (10) (smaller end first), plug (11), spring (12), and valve. Stop (13) into bore of valve body (1).

(35) Install third clutch trimmer valve (2), smaller end first, plug (3), spring (4), and valve stop (5) into bore of valve body (1).

(36) Install first clutch trimmer valve (6) (smaller end first), plug (7), spring (8), and valve stop (9) into bore of valve body (1).

3-7. TRANSMISSION - Continued

(37) Install trimmer boost accumulator stop (14), spring (15) and trimmer boost accumulator valve (16) into bore of valve body (1).

(38) Place trimmer valve cover (17) onto valve body (1). Compress the springs and retain the cover with eight 1/4 - 20 X 5/8 in. bolts (18). Tighten the bolts to 8 - 12 ft lb (11 - 16 Nm).

(39) Install priority valve stop (38), spring (39) and priority valve (40) into bore of valve body (1).

(40) Install governor accumulator valve (33), spring (34), and valve stop (35) into bore of valve body (1). Aline stop (35) and valve body for correct retainer pin installation. Compress spring (34) and install retainer pin (36).

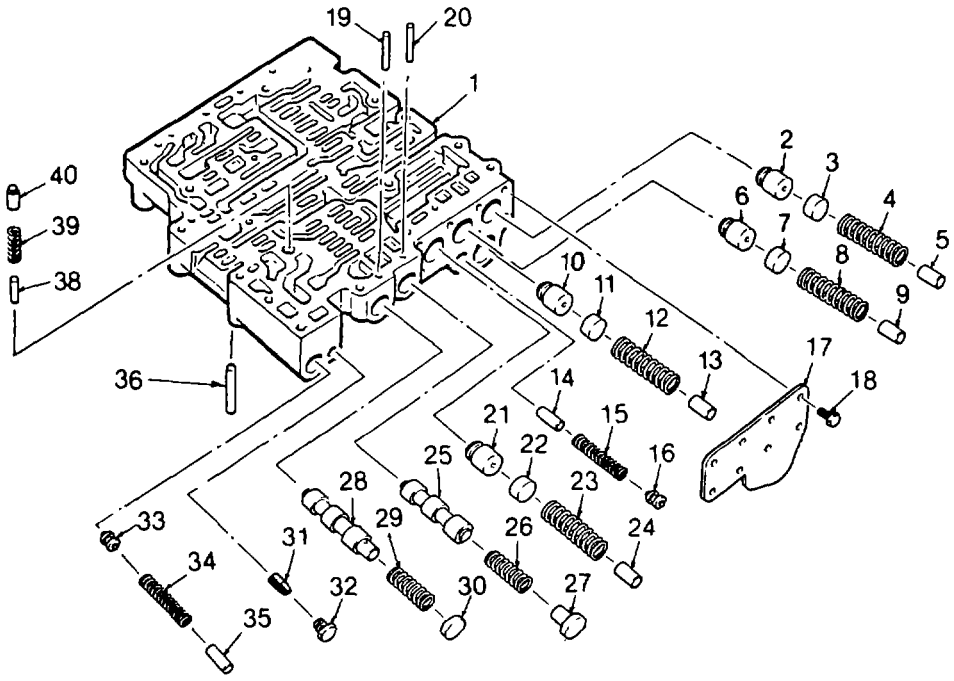
(41) Install governor screen assembly (31), open end first, into bore. Retain the screen assembly with plug (32). Tighten to 4 - 5 ft lb (5 - 7 Nm).

(42) Install hold regulator (42), spring (43), valve stop (44), washer (46) and adjusting ring (45), flat side first, into bore of valve body (1).

(43) Aline the pin hole in valve stop (44) with the pin holes in the valve body. Compress the spring, and install retainer pin (41) into the valve body to retain adjusting ring (45). Be sure the adjusting ring is in the same position as it was before removal.

(44) Install trimmer regulator valve (70), smaller diameter first, spring (69), and valve stop (68) into bore of valve body (1). Depress the valve stop and insert retainer pin (72) into its hole in the valve, body.

(45) Install 4-5 relay valve (66), spring (65), and valve stop (64) into bore of valve body. Depress the valve stop and insert retainer pin (71) into the hole at the front of the valve bore.



3-7. TRANSMISSION - Continued

(46) Install 4-5 shift valve (62), smaller end first, modulator valve (61), smaller end first, spring (60), valve stop (59) and adjusting ring (58), flat side first, into bore of valve body (1).

(47) Aline the pin hole in valve stop (60) with the pin holes in the valve body. Compress the spring, and install retainer pin (68) into the valve body to retain adjusting ring (59). Be sure the adjusting ring is In the same position as it was before removal.

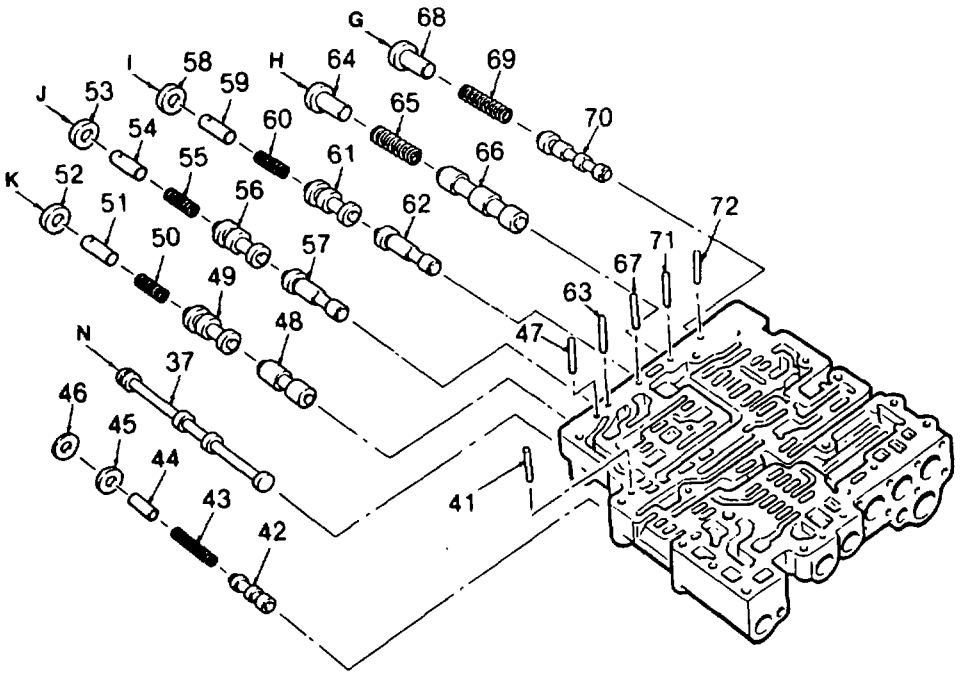
(48) Install 3-4 shift valve (57), smaller diameter first, modulator valve (56), smaller diameter first, spring (55), valve stop (54) and adjusting ring (53), flat side first, into bore of valve body (1).

(49) Aline the pin hole in valve stop (54) with the pin holes in the valve body. Compress the spring, and install retainer pin (63) into the valve body to retain adjusting ring (53). Be sure the adjusting ring is in the same position as it was before removal.

(50) Install 1-2 shift (48), 1-2 modulator valve (49), spring (50), valve stop (51), and adjusting ring (52) into bore of valve body (1).

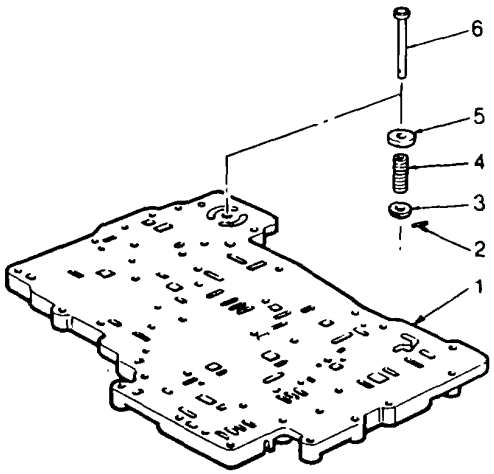
(51) Aline the pin hole in valve stop (51) with the pin holes in the valve body. Compress the spring and install retainer pin (47) into the valve body to retain adjusting ring (52). Be sure the adjusting ring is in the same position as it was before removal.

(52) Manual selector valve (37) will be installed later during assembly into bore.



3-7. TRANSMISSION - Continued

(53) Install check valve pin (6), smaller end first, through the top side of oil transfer plate (1). Install lubrication valve (5), spring (4), and cup washer (3) onto pin (6), from bottom side of plate (1). Depress cup washer (4) and install retainer pin (2).

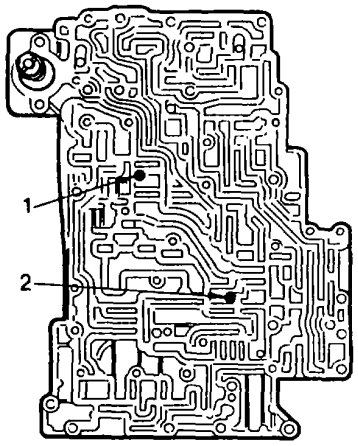


(54) Position oil transfer plate (1), channeled side upward, on the work table.

CAUTION

Failure to retain the balls with petroleum jelly (item 21, Appendix B) may result in balls being accidentally misplaced during subsequent assembly steps.

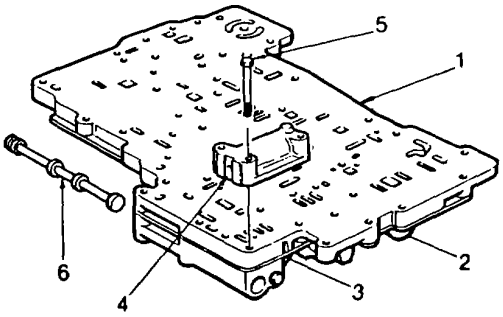
(55) Place check ball # 1 in the third clutch pressure line next to the 3-4 relay valve. Place check ball # 2 in the second clutch pressure line next to the 2-3 relay valve. Retain balls in the plate with petroleum jelly (item 21, Appendix B).



CAUTION

Do not separate the oil transfer plate and the separator plate during handling. A slight separation could dislocate the check valve balls and cause malfunction of the transmission.

(56) Place separator plate (3) onto the oil transfer plate (1) so that their bolt holes aline. Grasp the two plates together, invert them, and position them on the assembled control valve body so that priority valve (40) is compressed against spring (39) into its bore in valve body (1).



(57) Install the assembled modulator valve (4) onto the oil transfer plate as shown. Install three 1/4 20 X 2 1/2 in. bolts to retain the modulator body, oil transfer plate, separator plate, and control valve body assembly as a unit. Do not tighten the bolts at this time.

(58) Aline the bolt holes in the control valve assembly with those in the separator plate and oil transfer plate. When all bolt holes are alined, tighten the bolts 12 ft lb (16 Nm).

(59) Install manual selector valve (6) into bore of control valve body (1). Valve may be retained by tape or soft wire temporarily until the valve assembly is installed onto the transmission.

3-7. TRANSMISSION - Continued

(60) Install low shift valve, low clutch trimmer valve and lockup cutoff valve assemblies to control valve assembly with original mounting bolts. Tighten the bolts to 12 ft lb (16 Nm).

(61) Complete valve assembly is ready for final assembly.

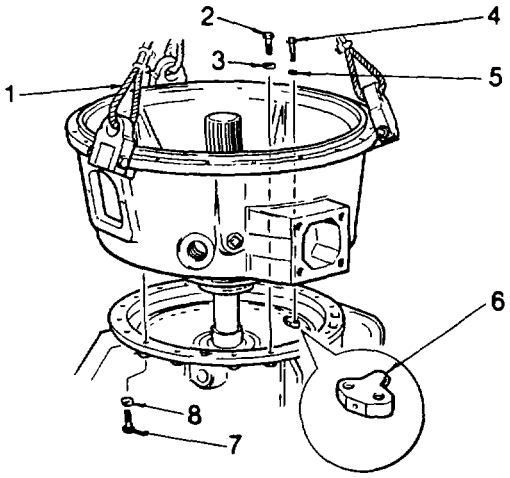
q. Converter Housing Removal, Inspection And Repair Of Charge Oil Pump.

(1) Remove the two screws (2) and washers (3) retaining the pitot tube from inside the converter housing.

(2) Remove seven bolts (4) and washers (5) from inside the converter housing.

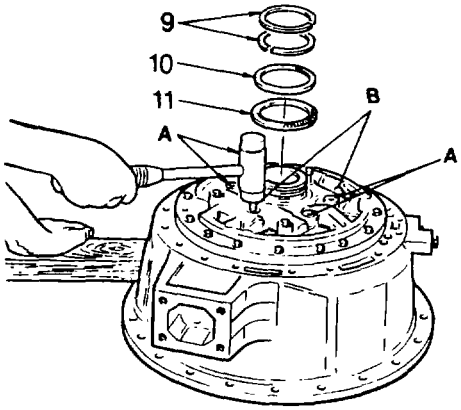
(3) Remove nine bolts (7) and lockwashers (8) retaining the converter housing to the transmission housing (two bolts removed when holding fixture was installed).

(4) Attach a three strand lifting sling (1) and remove the converter housing. Remove pitot tube (6).



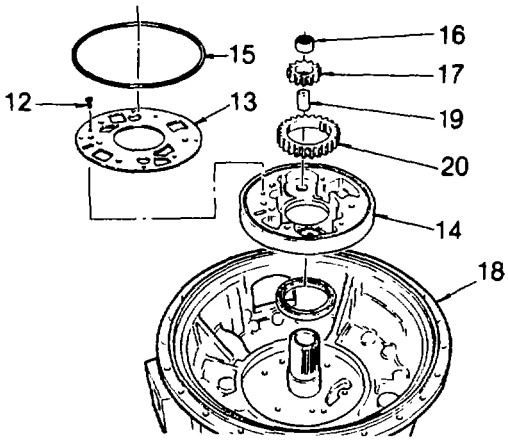
(5) Place the converter housing front downward. Remove and discard the two front support hub seal rings (9). Remove thrust bearings (2) and race (11) from the front support hub.

(6) Insert a piece of 2 X 4 wood through the converter housing access opening, about 14 in. (356 mm) into the housing. Remove four of the six bolts 'A' retaining the oil pump assembly. Loosen the remaining two bolts 'B', leaving about four turns of thread engaged.



(7) Press on the wood 2 X 4 (51 X 102 mm) and tap alternately on the two loose bolts. This will dislodge the oil pump. Remove the two remaining bolts, and allow the pump to drop onto the wood support. Remove the pump assembly. Remove the seal ring from the outer circumference of the pump.

(8) Remove the screw (12) that retains the cover (13) to the oil pump body (14). Remove the cover, seal ring (15) and the oil pump body containing the drive gear and driven gears (2 of). If any of the 3/4 in. plugs in the oil pump body are damaged, replace them with new plugs.



(9) Remove the roller bearing (16) from each driven gear (17), and the oil seal (18) from the pump assembly, if replacement is necessary.

3-7. TRANSMISSION - Continued

(10) Remove each driven gear shaft (19) (pump spindle) from the pump body, if necessary, using special tool set J33080.

(11) Place puller assembly, puller bridge J33080-20 and collet J33080-4, over shaft to be removed with the legs of the puller on the pump body.

(12) Tighten the collar locknut until collar is secured against collet and onto the shaft that is to be removed.

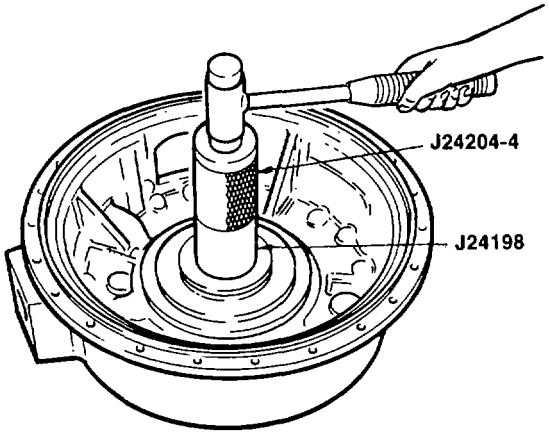
(13) Hold puller screw with wrench while tightening puller nut to remove shaft.

(14) To remove the shaft from collet, back off the collar locknut and puller nut. Position collar over retriever J33080-2 and tap top of puller screw with a hammer to remove the shaft from the collet.

(15) Install new oil seal using seal installer J24198 , and driver handle J24204-4. Coat oil seal bore in pump body with seal retainer (item 26, Appendix B). The lip of the seal must face inward (toward rear of transmission). Seal should be flush with front of the housing

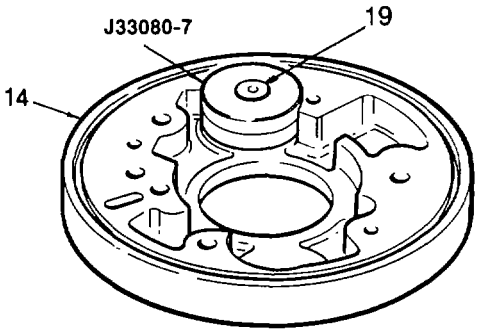
NOTE

Installer J24198 can be used with the transmission assembled except for the flywheel and torque converter.



(16) To install a new driven gear shaft (pump spindle) support the charging pump housing (14) in a press Position height gage J33080-7 over the shaft bore and place new shaft (19) into the gage so the chamfer on the shaft will engage into the housing bore.

(17) Press the shaft until flush with height gage. The installed height of the spindle after installation should be 0.926 - 0.885 in. (23.52 - 22.48 mm).



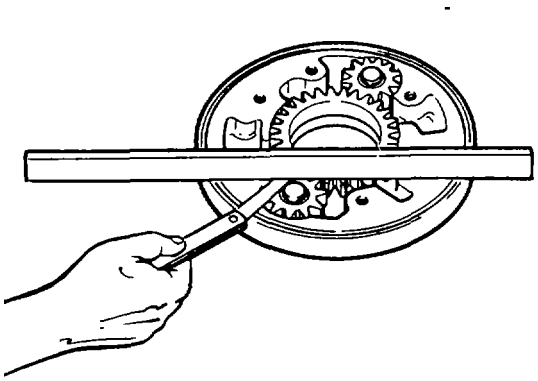
(18) If needle bearing was removed from either driven gear, install a new bearing. Place the bearing, numbered end first, onto installer tool J28646A. Attach handle J8092. Install the bearing into driven gear.

(19) Install the driven gears (17) and the drive gear

(20) into the oil pump body (14).

3-7. TRANSMISSION - Continued

(20) Place a straight edge across the surface of the pump body and gears. Insert a thickness gage between each gear and the straight edge. If any gear end clearance exceeds 0.006 in. (0.15 mm), replace the gear, or gears.



(21) Install the cover, and retain it with the 1/4 20 X 5/8 in. flat-head screw (12). Tighten screw to 11 ft lb (15 Nm).

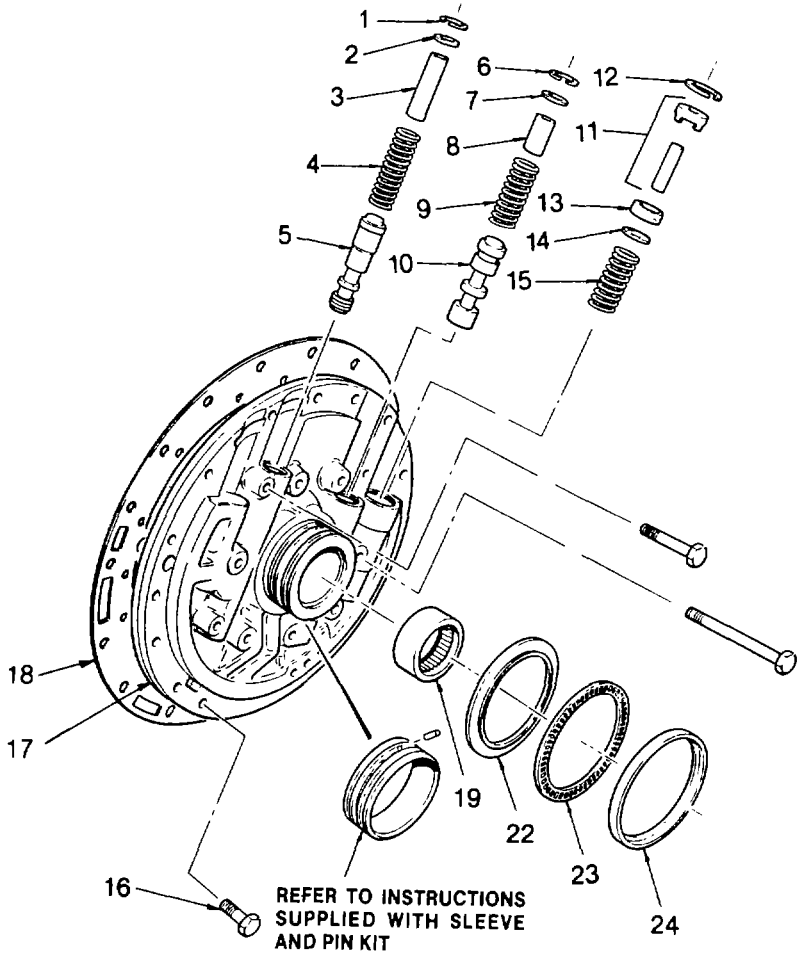
(22) Install the seal ring (15) around the cover outer circumference.

(23) Lubricate the seal ring and oil pump cavity in the housing with petroleum jelly (item 2' Appendix B).

r. Main Regulator Valve, Disassembly, Inspection And Repair

WARNING

The main pressure regulator valve spring is under approximately 85 lbs (378 N) compression.



3-7. TRANSMISSION - Continued

(1) Using spring compressor J24219, depress the main pressure regulator valve spring. Remove the snap ring (1).

NOTE

The spring compressor may be used whether the front support assembly is attached to or removed from the torque converter housing.

(2) Remove the spring compressor, and remove washer (2), valve stop (3), spring (4), and main pressure valve (5).

(3) Using the spring compressor, remove snap ring (6), washer (7), valve stop (8), spring (9), and lockup shift valve (10).

(4) The spring compressor is not required for the remaining valve components. Push inward against valve support assembly (11), and remove snap ring (12). Remove support assembly (11), seat (13) converter bypass valve (14), and spring (15).

(5) Remove the nineteen bolts (16) remaining in the front support assembly. Lift off the front support assembly (17) and gasket (18).

(6) If replacement is necessary, remove the needle bearing (19) from the bore of the support hub. Special tool J28557 may be used to remove the needle bearing.

NOTE

Do not attempt this rework procedure unless adequate machining capabilities are available.

(7) Determine the serviceability of the seal ring grooves on the front support hub. Insert, without force, gage J29198-3 into a groove on the support hub. Rotate the gage 360 deg. around the hub.

(8) If the gage does not rotate freely, the support is damaged and should be replaced or reworked.

NOTE

A damaged or worn front support hub can be salvaged with guidance from the instructions on the instruction sheet in the sleeve and pin kit. The kit contains one unfinished *front support* sleeve, one sleeve retainer pin and one machining and installation instruction sheet. Kit P/N 23011446 (21).

If there is evidence of movement or damage to the ground sleeve, replace the front support and sleeve as an assembly.

(9) If the needle bearing (19) was removed from the front support, install a new bearing. *Installer* J24197 may be used with handle J8092 for driving the bearing, or without the handle when press-installing the bearing. Drive or press on the numbered side of the bearing until installer bottoms on housing for proper bearing depth.

3-7. TRANSMISSION - Continued

(10) Inspect removed valves and springs from main regulator housing. Clean scoured valves with crocus cloth (item 7, Appendix B). Replace worn or broken springs. Inspect bore holes in housing for damage. Replace damaged component parts.

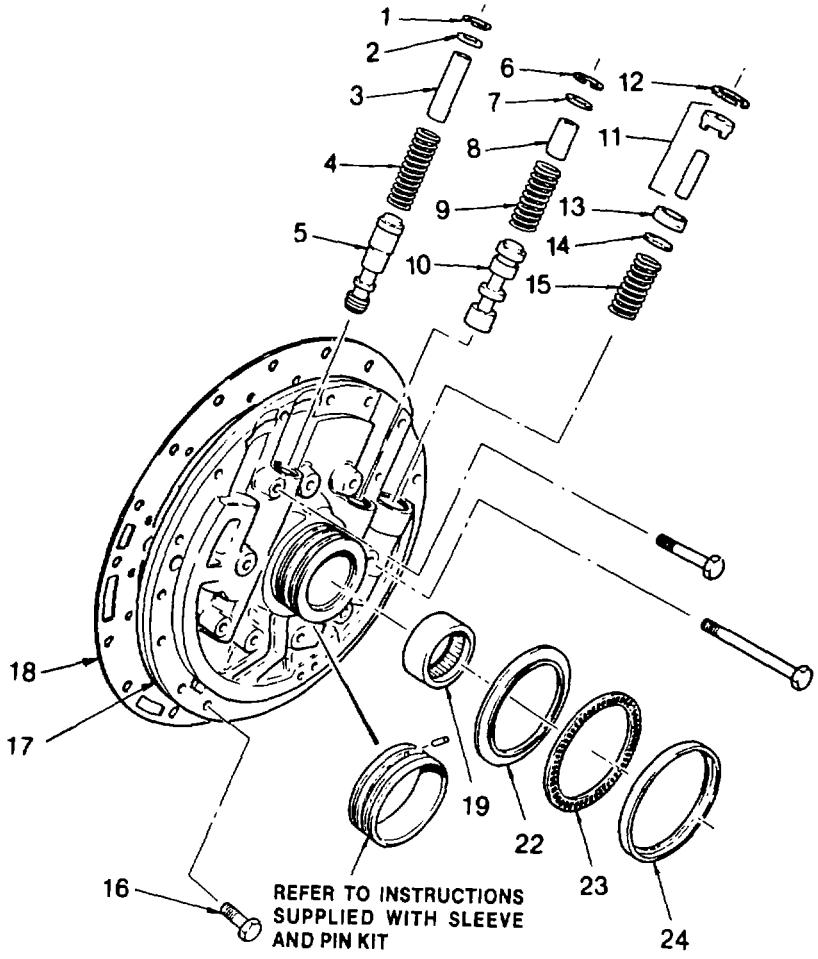
(11) Installation of main-pressure regulator and lockup shift valves is done with the aid of spring compressor J24219. The spring compressor is not required for installation of the converter regulator valve.

(12) Install main-pressure regulator valve (5), small end first, into the bore. Be sure the valve will move freely of its own weight in its bore.

(13) Install spring (4) and valve stop (3). Place washer (2) on spring (4) and compress the spring into the valve bore until the snap ring groove is clear. Install snap ring (1).

(14) Install lockup shift valve (10), small end first, into the bore. Be sure the valve will move freely of its own weight in its bore.

(15) Install spring (9) and valve stop (8). Place washer (7) on spring (9) and compress the spring into the valve bore until the snap ring groove is clear. Install snap ring (6).



3-7. TRANSMISSION - Continued

(16) Install spring (15) into the converter regulator valve bore. Install converter bypass valve (14) and valve seat (13).

(17) Install support assembly (11) and snap ring (12) into the valve bore.

(18) Place converter housing on the work table, front side downward.

(19) Place front support gasket (8) onto the converter housing. Aline holes in the gasket with those in the converter housing.

(20) Install front support assembly onto converter housing.

(21) Install all bolts (16) of proper ;ength in respective holes. Torque bolts to 40 ft lb (52 Nm).

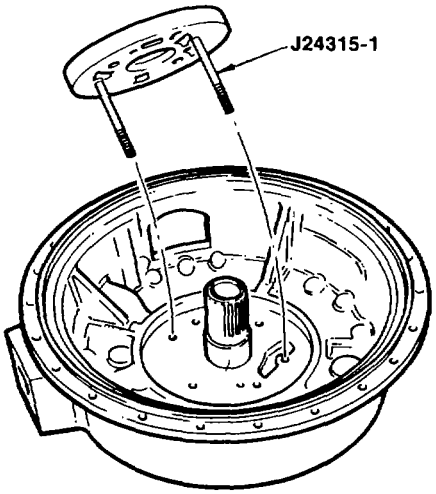
(22) Install two 3/8-16 X 6 in. guide screws J24315-1 into pump as shown.

(23) While holding oil pump in position, install six bolts. Remove guide pins last. Tighten all bolts to 43 ft lb (58 Nm).

(24) Lubricate both race and thrust bearings with petroleum jelly (item 21, Appendix B).

(25) Install bearing race (22) flat side down onto the front support hub. Install roller bearing (23) onto the race.

(26) Install both seal rings (24) on support hub.

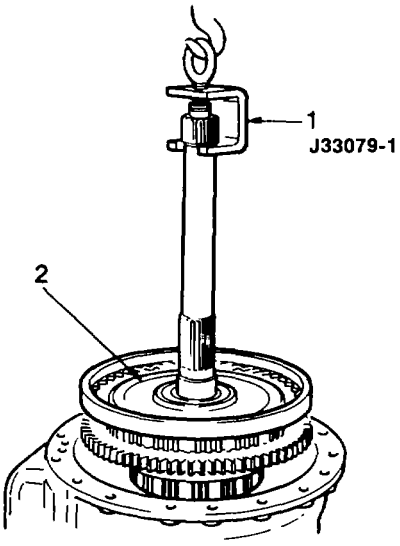


a. Removal Forward, Fourth, And Third Clutches

(1) install lifter tool J33079-1 (1) onto the forward clutch turbine shaft. Lift out the forward clutch and turbine shaft assembly (2).

CAUTION

Do not let weight rest on the governor oil collector.



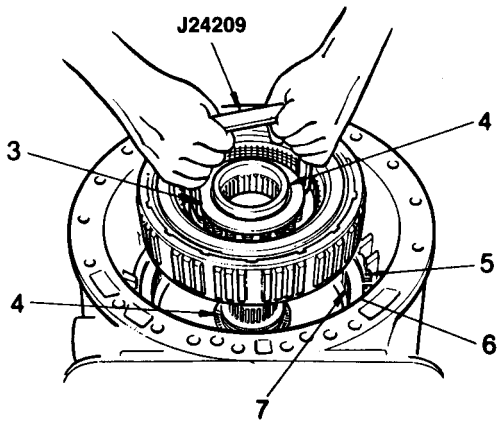
(2) During removal of the forward clutch assembly, do not lose bearing races or needle bearing, if they adhere to the forward clutch hub.

(3) Place the hooked legs of lifting tool J24209 under the edges of the fourth clutch spring retainer (3) and remove the fourth clutch.

3-7. TRANSMISSION - Continued

NOTE

Keep both front and rear bearing races (4) with the clutch assembly during rebuild.



(4) Remove the snap ring (5) that retains the third-clutch backplate (6). Remove the backplate.

(5) Remove eight third-clutch plates (7).

NOTE

Tie the third-clutch plates together, and identify the pack. Retain for inspection,

t. Forward Clutch And Turbine Shaft Overhaul

(1) Remove hook-type seal ring (1) from the front of the turbine shaft.

(2) Remove bearing race (2) from the hub of forward clutch housing assembly (4).

(3) Remove two hook-type seal rings (3) from the turbine shaft.

(4) Position forward clutch assembly on work table, turbine shaft down.

(5) Remove bearing race (6) and bearing (7) from forward clutch hub (8).

(6) Remove snap ring (9) and fourth clutch driving hub (10).

(7) Remove five each of clutch plates (11 and 12).

(8) Remove forward clutch hub (8).

(9) Remove bearing race (13) and needle bearing (14) from the inner hub of the forward clutch hub (8).

(10) Remove bearing race (15) from the inner hub of the forward clutch housing (16).

(11) Using spring compressor J24204-3, compress the spring retainer (17), and remove the snap ring (18).

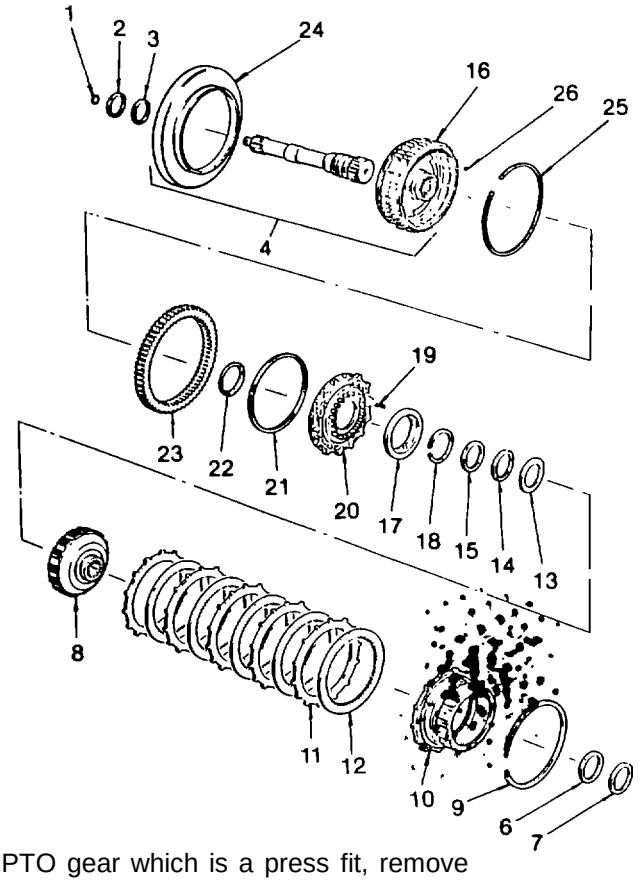
(12) Carefully remove pressure from the spring retainer and remove the spring retainer.

(13) Remove 20 piston return springs (19).

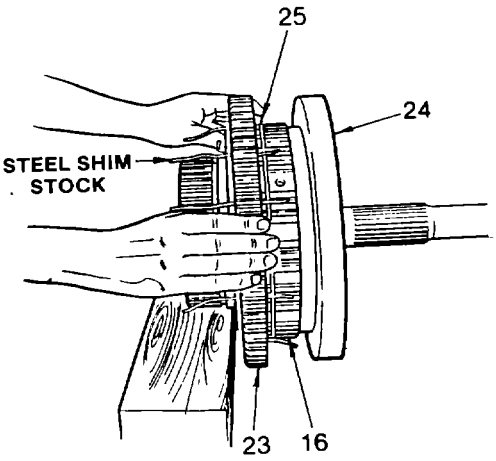
(14) Remove forward clutch piston (20) and seal rings (21 and 22).

(15) If the piston is replaced, be sure the identification letter (A, B or C) for the new piston is identical to that of the piston replaced.

(16) Do not remove the PTO gear (23) unless replacement is necessary.



(17) To remove PTO gear which is a press fit, remove oil collector ring (24) from clutch housing (16) by supporting the inner circumference of the ring and pressing the forward clutch housing and input shaft assembly free.



(18) Place PTO gear fixture J26899-2 on a press, flat side downward.

(19) Remove the PTO gear by compressing the snap ring (25) into the clutch housing and sliding the gear from the housing.

(20) To compress the snap ring, insert 10 pieces of steel shim stock (3/32 in. X 0.020 in. X 3 in.) between the snap ring and the PTO gear. To accomplish this, locate the snap ring gap, and at the cut out nearest the gap, press the snap ring into the groove in the housing. Slip a piece of shim stock between the snap ring and the inner ends of the splines of the PTO. gear. Repeat the operation at the other side of the snap ring gap. Working at each opening (missing spline) to compress the snap ring, insert the remaining pieces of shim stock at approximately 3 in. increments.

3-7. TRANSMISSION - Continued

(21) Position the clutch housing, turbine shaft downward, so the PTO gear is resting on the cylindrical fixture. Center the fixture directly under the PTO gear.

(22) Center fixture tool J26899-1 inside the forward clutch housing and apply sufficient pressure to the tool to remove the PTO gear. Remove the snap ring.

CAUTION

Pressure applied directly to the turbine shaft will cause permanent damage.

(23) Do not remove balls (26) from the forward clutch housing unless replacement is necessary.

(24) If the turbine shaft is damaged or loose or the butt-joint seal ring area of the housing requires rework, support the front of the forward clutch housing in a ten-ton press and remove the turbine shaft.

(25) It is permissible to hard chrome plate the splines of a used shaft (0.001 - 0.002 in. (0.025 - 0.051 mm) thick) to tighten loose joint on used assembly.

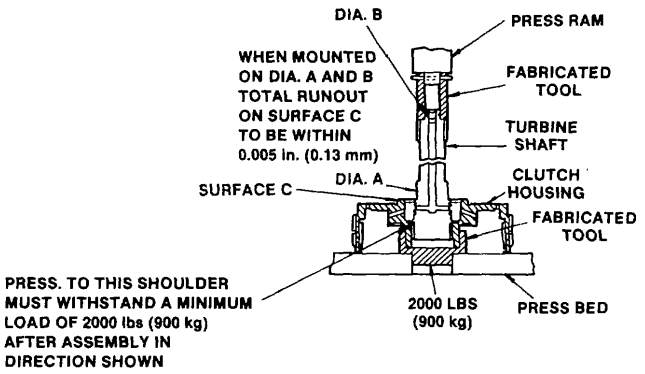
Do not attempt this rework procedure unless adequate machining capabilities are available.

(26) Acceptable wear in the rotating seal bore of the forward (or fourth) clutch housing is normal polishing of the sealing surfaces by the seals and no greater step wear than 0.0005 in. (0.0127 mm). Replace housing if worn beyond specification.

NOTE

If the forward clutch housing is replaced, selection of a proper piston (A, B or C) Is imperative before seal ring installation. If the forward clutch housing is not replaced and a new piston is required, make sure the identification letter stamped on the new piston is identical to that on the old piston.

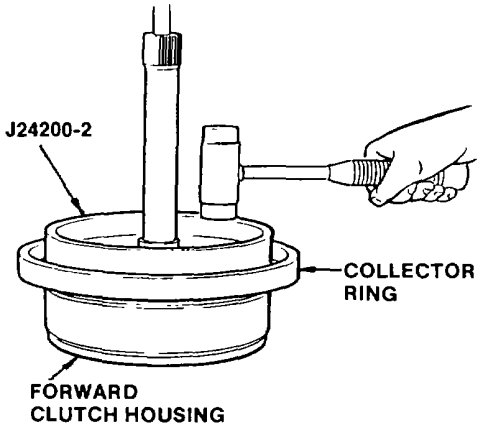
(27) Ensure that the shaft is pressed squarely into the housing assembly to locate the forward clutch housing assembly center line square and true with the center line of the ram.



3-7. TRANSMISSION - Continued

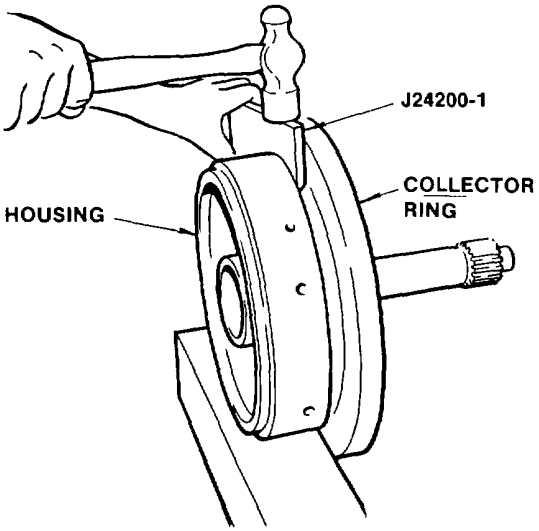
(28) Install PTO gear in oven or oil bath and heat to 350 - 375 deg. F (177 - 191 deg. C).

(29) Carefully install the PTO gear onto the forward clutch housing (chamfer end first), until the snap ring expands into the PTO gear groove. Make sure the snap ring is expanded and free in the internal groove of the gear before the gear cools. Failure to obtain this condition can result in difficulty during subsequent removal.

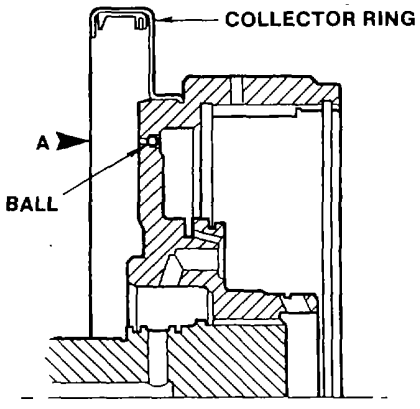


(30) Position the forward clutch housing, turbine shaft upward. Apply retaining compound (item 23, Appendix B) onto the collar of the collector ring. Install the collector ring. Use installer J24200-2 to drive the collector ring onto the clutch housing. Use light hammer blows, and work around the entire installer circumference.

(31) Using staking tool J24200-1, bend the edge of the collector ring into the groove in the clutch housing. Press to shoulder and bend metal into groove for entire circumference.



(32) Check the four steel balls (7) in the housing. Make sure they are securely staked in the housing and are free to move without restriction. Must withstand 30 lb (133.45 N) load applied in direction indicated by arrow A.



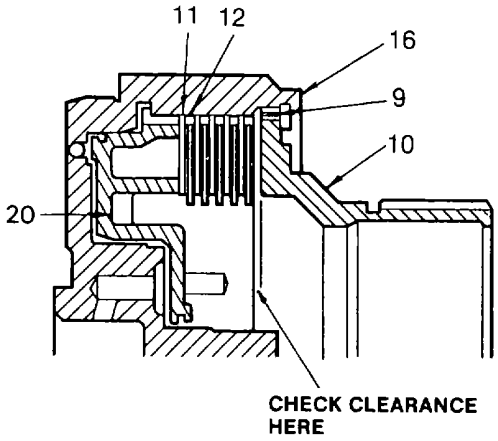
3-7. TRANSMISSION - Continued

(33) Before completing the assembly, the clutch clearance must be established. Install forward piston (20) into clutch housing (16).

(34) Beginning with an external-tanged plate, alternately install five external-tanged plates (11) and five internal-splined plates (12) into forward-clutch housing (16).

WARNING

Do not install forward-clutch hub and fourth-clutch driving hub into the fourth-clutch housing assembly. Be sure the forward-clutch hub and the fourth-clutch driving hub are Installed into the forward-clutch assembly. If these two hubs are installed into the fourth-clutch housing assembly by mistake, the transmission will operate in reverse when the driver selects any forward range.



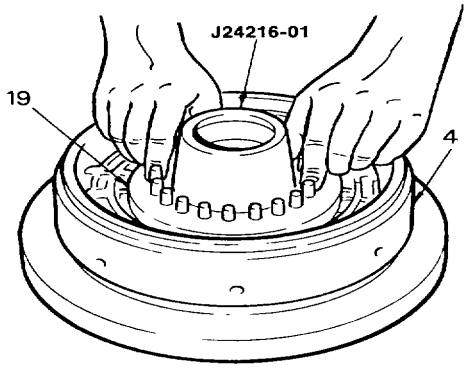
(35) Install the fourth-clutch driving hub (10) into housing (16) and retain it with snap ring (9).

(36) While holding hub (10) firmly against snap ring (9), measure the clutch clearance with gage J24192 at the location shown. When clearance are satisfactory, the thinner step of the gage
will enter between the driving hub and clutch plates; the thicker step will not. The prescribed clearance is 0.080 - 0.120 in. (2.03 - 3.05 mm).

(37) If the clutch clearance is not within the specified limits, remove snap ring (9), fourth-clutch driving hub (10) and clutch plates (11) and (12). Replace clutch plates, as required, to obtain the desired clearance. Refer to wear limits (Appendix C) to determine the plate thicknesses.

(38) When the clutch clearance is within the specified limits of 0.080 0.120 (2.03 3.05 mm), remove snap ring (9) and hub (10), clutch plates (11 and 12), and piston (20).

(39) Place piston on a work table with the return spring bosses up. Lubricate with transmission fluid (item 9, Appendix B) and install two new lip-type teflon seal rings into the inner and outer seal ring grooves in the piston.



(40) Install seal ring protector J24216-01 onto the clutch housing hub (4).

(41) Lubricate the piston seal rings with
transmission fluid (item 9, Appendix B) and centrally locate the piston (19) in the housing bore. Place the piston and piston housing under an arbor press and apply pressure evenly until the piston is properly seated.

(42) f a press is not available, seat the piston in the housing bore by tapping the piston lightly with a mallet in a continuous circular pattern until the piston is properly seated.

3-7. TRANSMISSION - Continued

(43) Install twenty piston return springs (19) onto the spring guide bosses of piston (20). Place spring retainer (17) on top of the twenty springs, recessed side (outer lip) of the retainer facing down.

(44) Compress spring retainer (17) until the snap ring groove on the clutch housing hub is exposed. Install the snap ring into the groove.

(45) Install the clutch plate pack. Beginning with an external-tanged plate, alternately install five external-tanged (11) and five internal-splined plates (12), into the forward-clutch housing (16).

(46) Lubricate with petroleum jelly (item 21, Appendix B) and install the thrust bearing race (15) onto the inner hub of forward clutch housing (16).

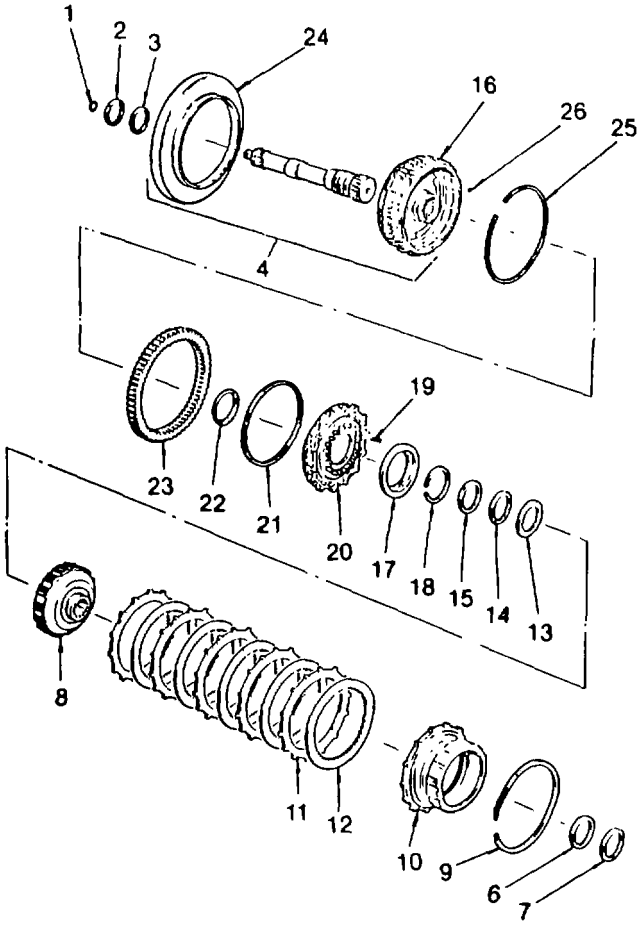
(47) Lubricate with petroleum jelly (item 21, Appendix B) and install the bearing race (13) and needle bearing (14) onto the inner hub of the forward clutch hub.

(48) Install the forward clutch hub (8), outer splines first, into the forward clutch *housing (16)*

(49) Install fourth-clutch driving hub (10) and retain it with snap ring (9).

(50) Lubricate and install two scarf cut seal rings (3). Install hook-type seal ring (1) on the front of the turbine shaft. Install thrust bearing race (2), cupped side first, onto the front of the forward clutch housing.

(51) Lubricate with petroleum jelly (item 21, Appendix B) and install bearing race (6), flat side first and needle bearing (7) onto the rear of forward clutch hub (8).



3-7. TRANSMISSION - Continued

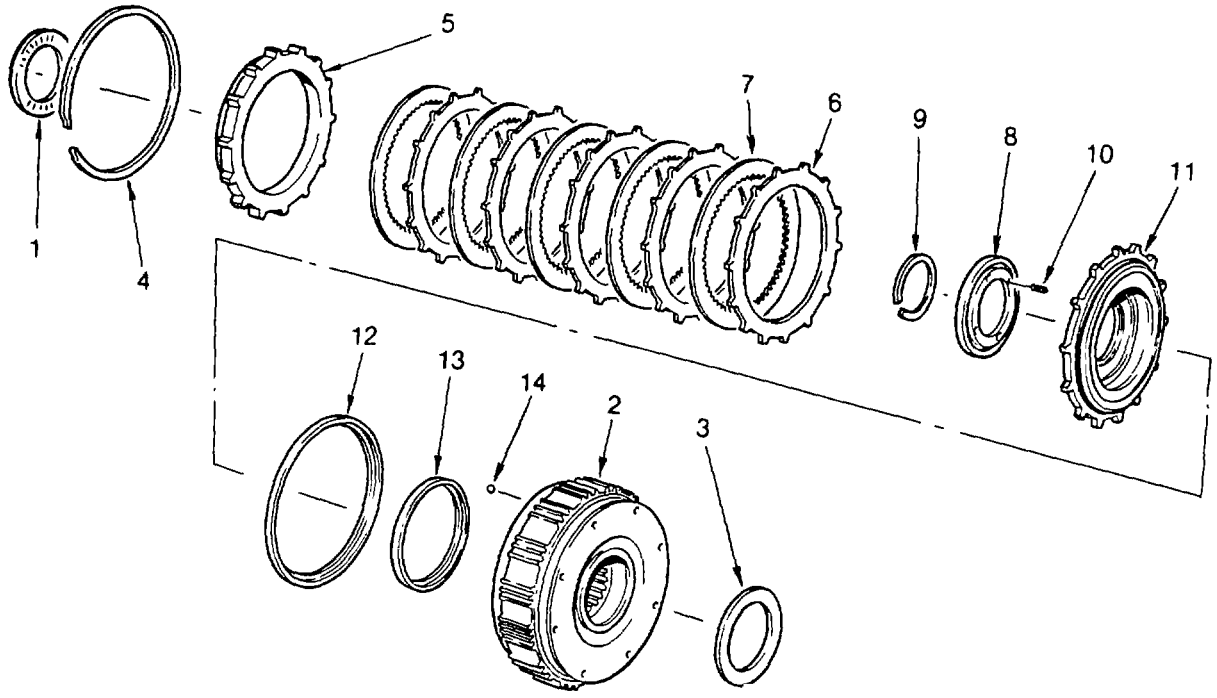
u. Fourth Clutch Overhaul

(1) Remove the the bearing race (1) from the front hub of the fourth-clutch housing (2).

(2) Remove the bearing race (3) from the rear hub of the fourth-clutch housing (2).

(3) Place the fourth-clutch assembly, snap ring up, on the work table.

(4) Remove the large snap ring (4) and the backplate (5).



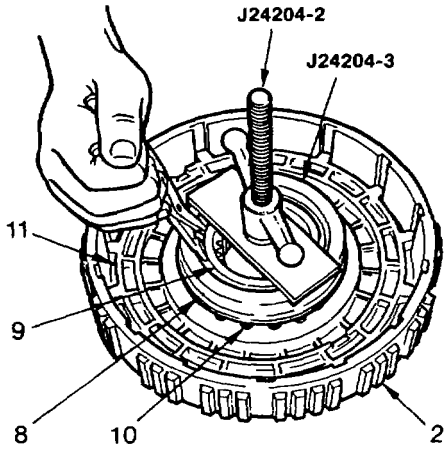
(5) Remove five external-tanged clutch plates (6) and five internal-splined clutch plates (7).

(6) Using J24204-2 and J24204-3 compress the spring retainer (8) until it is clear of the snap ring (9). Remove the snap ring.

(7) Carefully release the pressure from the spring retainer (8). Remove the retainer and twenty piston return springs (10).

(8) Remove the piston (11) from the clutch housing (2).

(9) Remove seal rings (12 and 13).



(10) Check the eight steel balls (14) in fourth-clutch housing (2). Make sure they are securely staked in the housing and are free to move without restriction.

3-7. TRANSMISSION - Continued

NOTE

If the fourth-clutch housing is replaced, selection of a proper piston is imperative before seal ring installation or clutch plate clearance check is done. If the fourth-clutch housing is not replaced and a new piston is required, make sure the identification letter (M, S, or T) stamped on the new piston is Identical to that on the old piston.

(11) Place fourth-clutch housing assembly (2) on the work table, flat (rear) side downward.

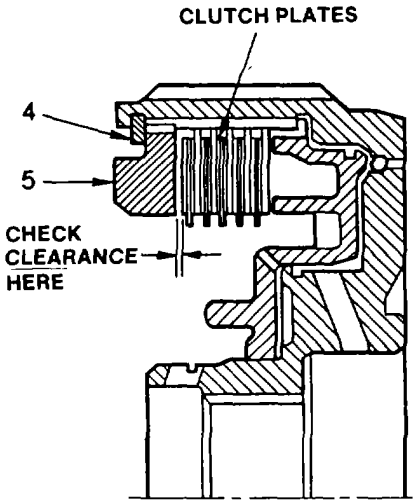
(12) Before continuing the assembly, the clutch clearance must be established.

(13) Install fourth-clutch piston (11) into the clutch housing. Do not install a seal ring into the fourth-clutch housing or on piston at this time.

(14) Beginning with an external-tanged plate, alternately install five external-tanged plates (6) and five internal-splined plates (7) into the fourth-clutch housing (2).

(15) Install the backplate (5) and snap ring (4).

(16) Hold the backplate firmly against the snap ring. Insert gage J24192 and check the clearance at the location shown. When clearance is satisfactory, the thinner step of the gage will enter between the backplate and clutch plates; the thicker step will not. The prescribed clearance is 0.080 - 0.120 in. (2.03 - 3.05 mm).

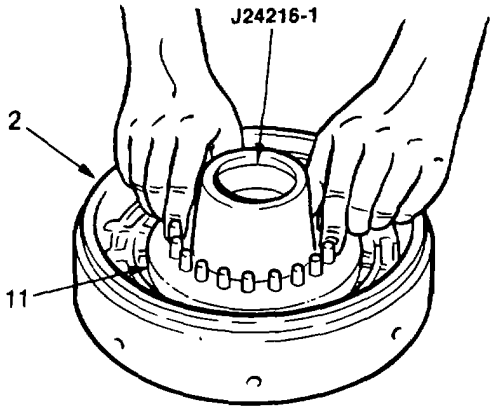


(17) Remove the snap ring, backplate, clutch plates and piston from the clutch housing. When clutch plates are properly selected for proper clearance, keep the clutch plates in a pack.

(18) Lubricate with petroleum jelly (item 21, Appendix B) and install a new teflon seal ring (13) into the clutch housing. Be sure the lip of the seal ring is facing the bottom of the piston cavity.

(19) Place fourth-clutch piston (11) on the work table, spring bosses side up. Lubricate with transmission fluid (item 9, Appendix B) and install new teflon seal ring (12), lip downward into the groove on the outside circumference of the piston. A seal ring for the inside groove in piston (11) is not required.

(20) Centrally locate the piston in the housing bore over protector J24216-1. Place the piston and housing in an arbor press and apply pressure evenly until the piston is properly seated.



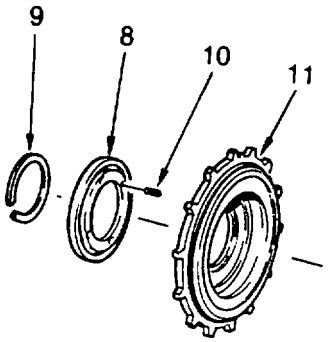
3-7. TRANSMISSION - Continued

(21) If a press is not available, the piston may be installed with a hammer. Tap the piston lightly in a continuous circular pattern until the piston is properly seated.

(22) Install 20 piston release springs (10), one each on the 20 cast bosses on the fourth-clutch piston.

(23) Install the spring retainer (8), recessed side (outer lip) down, on the twenty piston return springs (10).

(24) Compress the spring retainer, using J24204-2 and J24204-3 tools until the snap ring groove on the clutch hub is clear. Install the snap ring (9).

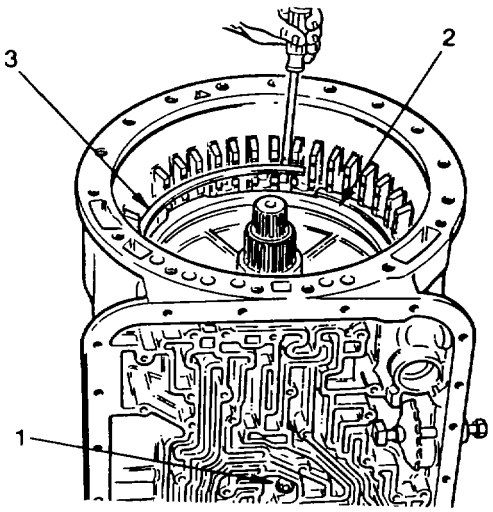


WARNING

Do not install forward-clutch hub and fourth-clutch driving hub into the fourth-clutch housing assembly. Be sure the forward-clutch hub and the fourth-clutch driving hub are installed into the forward-clutch assembly. If these two hubs are installed into the fourth-clutch housing assembly by mistake, the transmission will operate in reverse when the driver selects any forward range.

(25) Lubricate with petroleum jelly (item 21, Appendix B) and install the bearing race onto the rear hub of the fourth-clutch housing.

(26) Lubricate with petroleum jelly (item 5, Appendix B) and install the bearing race onto the front hub of the fourth-clutch housing assembly. Fourth clutch assembly is ready for final installation.



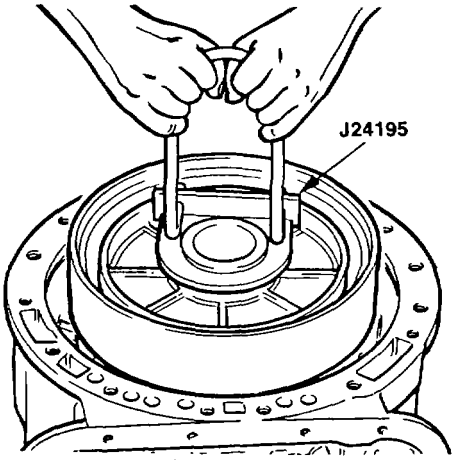
v. Removal of Center Support, Gear Unit, and Second Clutch

(1) Remove the center support anchor bolt and washer (1).

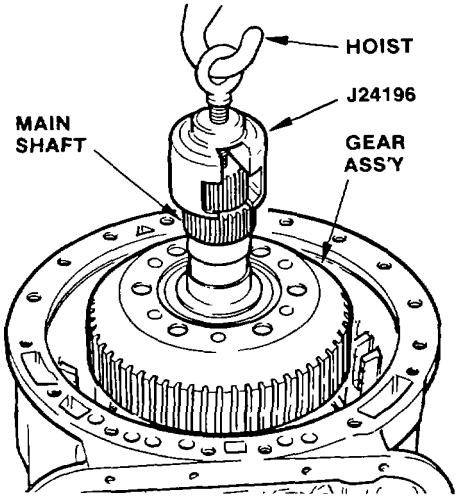
(2) Remove the snap ring (3) that retains the center support assembly (2).

3-7. TRANSMISSION-Continued

(3) Install center support lifting bracket J24195 into the recess between the seal rings on the center support hub.
(4) Lift carefully, straight upward, on the lifting bracket to remove the center support assembly. If the thrust washer adheres to the rear of the support, remove it.



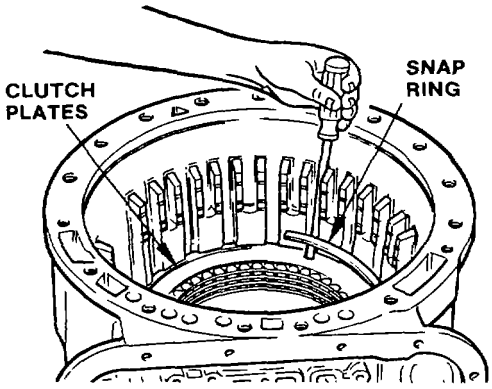
(5) Attach lifting bracket J24196 to the main shaft of the gear unit assembly.
(6) Attach a hoist to the lifting bracket eyebolt and remove the gear unit and shaft assembly from the transmission housing. If needle bearing and races adhere to gear unit inner side, remove them.



(7) Remove the snap ring that retains second-clutch plates.
(8) Remove 13 second-clutch plates, of which seven are external-tanged and six are internal-splined plates.

NOTE

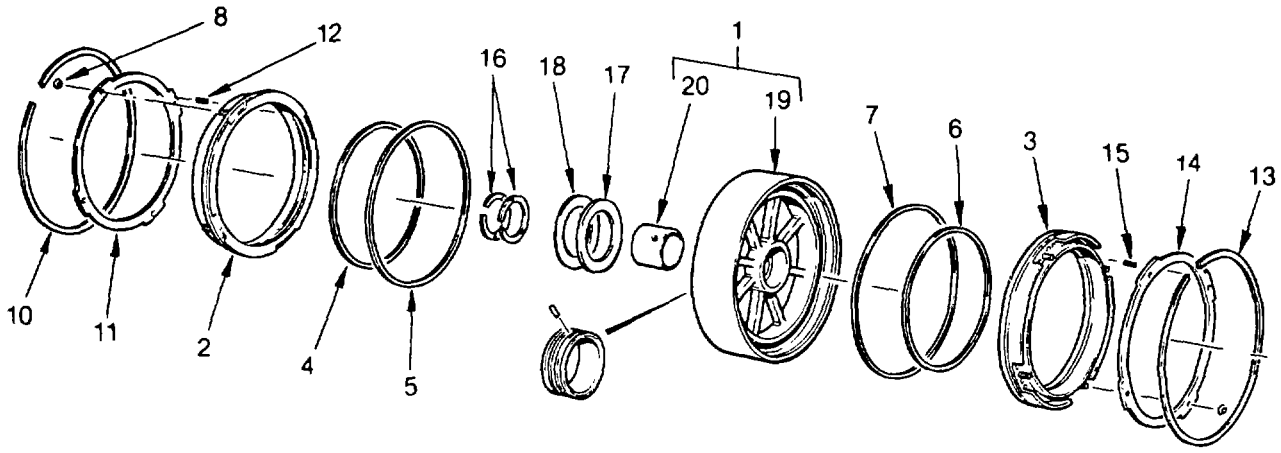
Tie the second-clutch plates together, and identify the pack. Retain for inspection.



3-7. TRANSMISSION-Continued

w. Disassembly And Repair Of Center Support Assembly And Second Clutch

(1) Place center support housing assembly (1), vertically (upright), on the work table.
(2) Remove pistons (2 and 3) with attached parts.
(3) Remove inner seal ring (4 and 6), and outer seal ring (5 and 7) from piston (2 and 3).
(4) If replacement is necessary, disassemble the two piston assemblies. Cut retainer rings (8 and 9) to prevent damaging the piston projections.
(5) Remove the retainer rings (10 and 13), retainers (11 and 14), and springs (12 and 15) from pistons (2 and 3).
(6) Remove seal rings (16) and discard. Remove thrust bearing race (17) and needle bearing (18) from the hub of center support housing (19).
(7) Determine the serviceability of the seal ring grooves on the center support hub. Insert, without force, gage J29198-3 into a groove on the support hub. Rotate the gage 360 deg. around the hub. If the gage does not rotate freely, the support is damaged and should be replaced.



NOTE

A damaged or worn center support hub can be salvaged with guidance from the instructions on the instruction sheet in the Sleeve and Pin Kit. The kit contains one unfinished center support sleeve, and one sleeve retainer pin and one machining and installation instruction sheet. Kit part number 22011446.

(8) If bushing replacement is necessary, collapse bushing (20) at its seam using a small half-round chisel. Be careful not to damage the support bore.
(9) Place center support (19) on a press, hub side up. Using bushing installer tool J28525-2 (4), install a prebored bushing (16). Be sure the oil hole in bushing (20) is in proper alinement with the oil hole in center support (19). Swage bushing using swaging tool J28525-1.

3-7. TRANSMISSION-Continued

(10) Temporarily place third clutch piston (2) in the front piston cavity of center support housing (1). Install twenty springs (12) into the pockets of the piston. Aline spring retainer (11) on the four ejector pin bosses of the piston. Compress the springs by forcing the retainer into the recess at the outer edge of the center support when the retainer rings are installed. Install a new self-locking retainer ring (8) on the ejector pins of each piston, using installer J24453 Remove the piston from the center support.

(11) Repeat above procedure to assemble second clutch piston (3) in the rear cavity of support housing. Install twenty springs (15) into pockets of the piston. Install retainer (14) and self-locking retainers (9).

(12) Lubricate with petroleum jelly (item 21, Appendix B) and install inner seal ring (4 and 6), and outer seal ring (5 and 7) onto pistons (2 and 3). The lips of all seal rings must be toward the piston cavities of the center support.

(13) Inspect the piston cavities in center support housing (1) for any obstruction or foreign material Install second clutch piston (3) into the rear of the center support. Be sure the lips of both the Inner and outer seal ring face the bottom of the piston cavity. Force piston to the bottom of cavity. This will ensure proper clutch clearance.

(14) Leave the assembled third clutch piston (2) out of the center support until final installation of the center support assembly.

(15) Lubricate needle roller bearing (18) and bearing race (17) with petroleum jelly (item 21, Appendix B). Ensure that the inner lube direction lip of the race on the hub is 0.233 in. (5.9 mm) in length. Install the race, flat side first, onto the front hub of the center support. To facilitate assembly, keep the race square with the support housing hub during installation. Forcing may damage the race. Install the needle roller bearing onto the race.

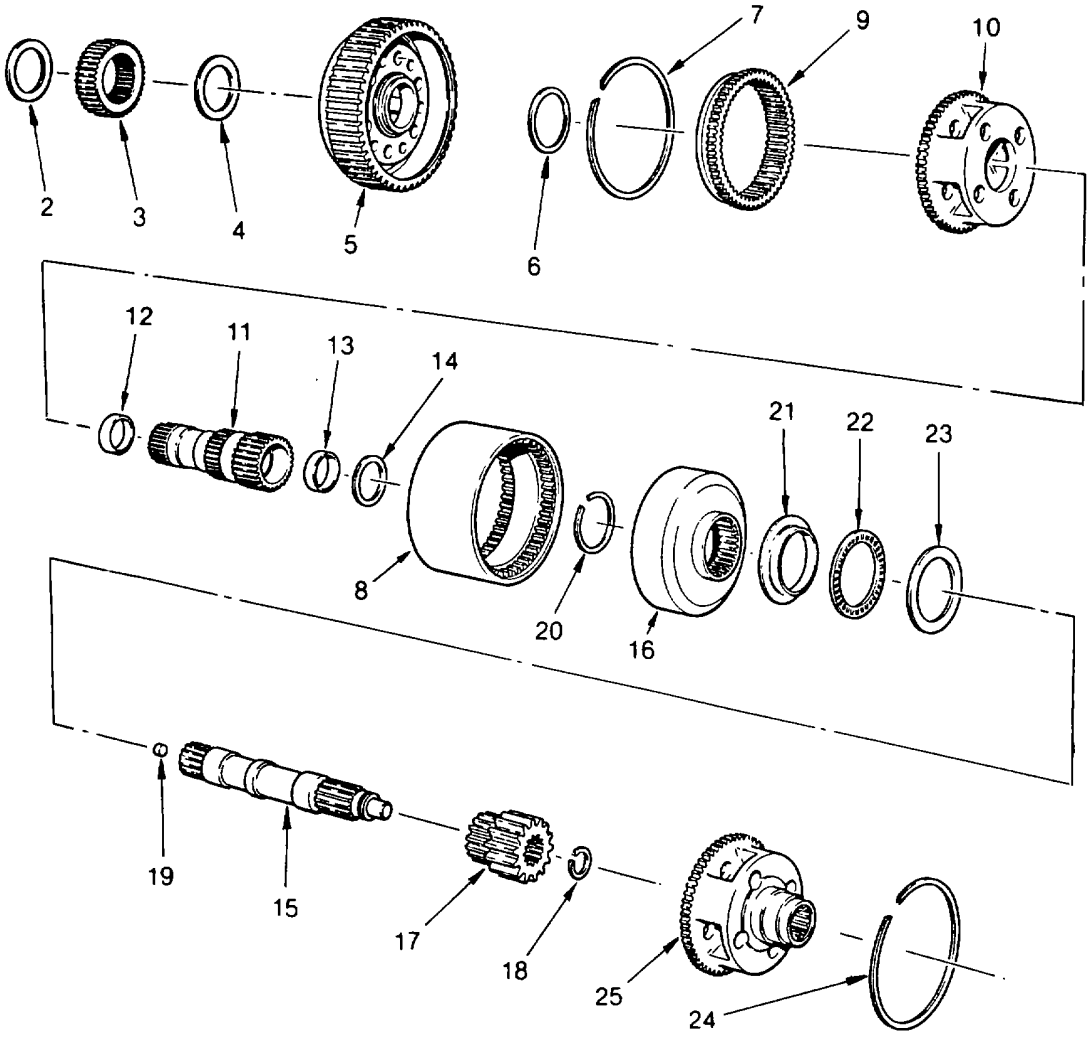
NOTE

Do not install butt-joint seal rings onto the support hub until the center support and fourth-clutch assemblies are installed into the transmission.

3-7. TRANSMISSION-Continued

x. Disassembly And Repair Of Gear Unit

(1) Place unit and main shaft assembly (1) on clean workbench area.
(2) Remove thrust washer (2) from the front of front planetary sun gear (3).
(3) Remove sun gear (3) and thrust washer (4).
(4) Remove front planetary carrier assembly (5). Set unit clear of immediate work area for further inspection and rebuild. Remove thrust washer (6).
(5) Remove snap ring (7) from the front of the planetary connecting drum (8). Remove front planetary ring gear (9). Remove center carrier assembly (10). Set unit clear of immediate work area for further Inspection and rebuild.
(6) Remove center sun gear shaft assembly (11), and thrust washer (14). If bushings, (12 and 13) in the sun gear shaft assembly are worn, remove them.



3-7. TRANSMISSION-Continued

(7) Lift main shaft assembly (15) from the gear unit. Center planetary ring gear (16), and rear planetary sun gear (17) are attached.

(8) Remove snap ring (18), and remove main shaft assembly (15) from rear planetary sun gear (17). If orifice plug (19) in shaft requires replacement, remove it.

(9) Remove snap ring (20) and separate ring gear (16) and sun gear (17).

(10) Remove thrust race (21), needle bearing (22), and thrust race (23).

(11) Remove snap ring (24). Remove rear planetary carrier assembly (25) from planetary connecting drum (8). Set unit clear of immediate work area for further inspection and rebuild.

(12) If sun gear shaft bushings were removed, install new bushings using retaining compound (item 23, Appendix B) on bushing circumference.

(13) Position bushing (12) at bore of shaft (11). Aline interlock split so that it is more than 45 deg. from the swaging hole in the shaft.

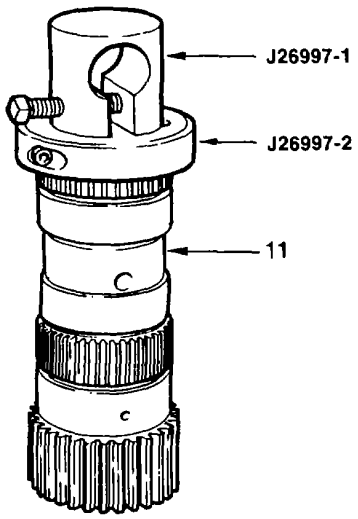
(14) Using bushing installer tool J24201 long end, press new bushing (12) to 0.360 in. (9.14 mm) below end surface into the small OD end of shaft (11).

NOTE

Use a minimum of 500 lb (2224 N) assembly force on bushing installer.

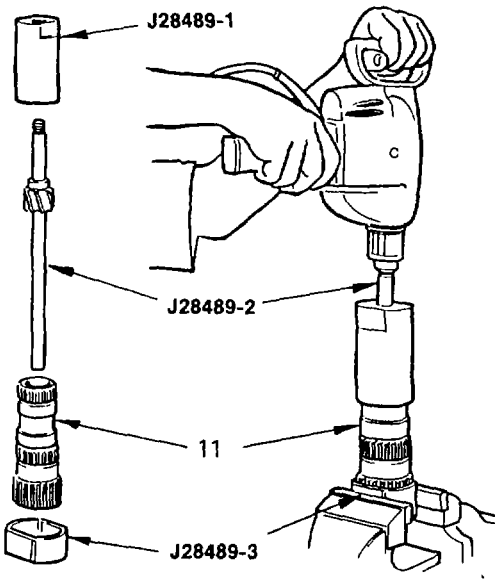
(15) Install bushing (13) in the same manner as bushing (12) except, use short end of tool J24201. Press new bushing (13) to 0.260 in. (6.60 mm) below end surface into the large OD end of shaft (11).

(16) Using swaging tool J26997-A, swage both bushings into holes in sun gear shaft.



3-7. TRANSMISSION-Continued

(17) Using tool J28489, clamp the holding fixture in a vise. Place the sun gear shaft assembly in the holding fixture, and put the reamer and pilot tool in place.

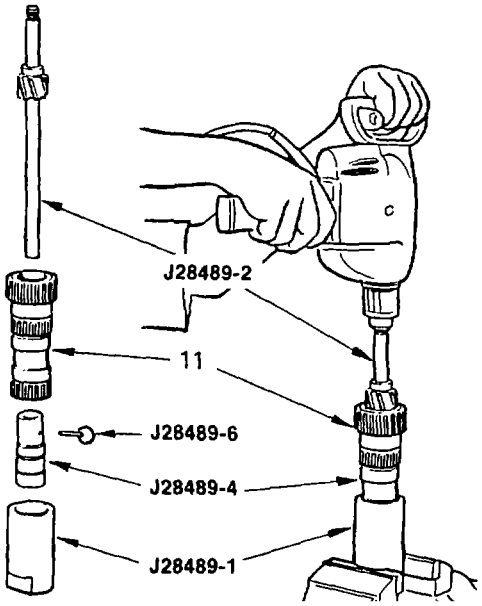


CAUTION

When machining any bushing, keep reamer at full drill speed when pulling it back through the bushing. If reamer is not rotating during retrieval, it could damage the bushing and cutting tool.

(18) Using a 1/2 in. electric drill, machine the small OD shaft bushing (approximately 75 to 150 rpm) while adding cutting lubricant (item 8, Appendix B) through the holes in the pilot tool. If a proper drill speed cannot be obtained with a standard drill, use a variable speed control to reduce its rpm.

(19) To machine the large OD shaft bushing, clamp the pilot tool in a vise. Insert the bushing pilot tool J28489-4 into the sun gear shaft (end with newly machined bushing) and fasten them together with the locking pin J28489-6. Using the same electric drill, engage the shaft of the reamer in the pilot tool, and machine the bushing. Add cutting lubricant (item 8, Appendix B) during machining operation. Refer to the preceding caution when retrieving the reamer from the bushing.



(20) Check ID 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).

(21) Thoroughly clean shaft of chips and debris.

(22) If orifice plug was removed from shaft, use installer J24369 to properly position replacement orifice plug below chamfer in shaft.

y. Planetary Carrier Assemblies Inspection And Repair

NOTE

The disassembly and assembly procedures for all planetary carrier assemblies differ only in the proper tool selection for the specific application and identifies the carrier involved (front, center, rear, low).

3-7. TRANSMISSION-Continued

(1) Visually inspect planetary carrier assembly for evidence of excessive wear, overheat indication, damaged or heavy metal contamination.

(2) Tools required for rebuild are planetary rebuilding kit J25587-01 and a ten ton hydraulic press with an adjustable bed of 25 in. minimum opening. The press must also have a pressure gage to correctly install the pinion pins.

NOTE

Do not disassemble carrier assembly unless parts replacement is necessary. Failure of one pinion requires replacement of the entire pinion gear set because they are selectively matched.

(3) Check end play of planetary carrier pinions. With washer held flat, insert feeler gage between carrier and thrust washer. End play must be within 0.008-0.031 in. (0.203-0.787 mm).

(4) If planetary carrier requires overhaul, use a drill that is slightly smaller than the pinion pin diameter, drill into the swaged ends of the pins (only one end required). Do not drill into the carrier. The rear ends of all pinion pins except those in the center carrier assembly will be drilled. Drill the front ends of the center assembly pins.

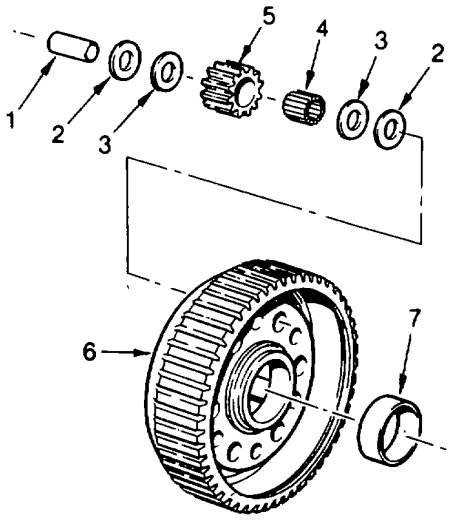
(5) Place press fixture J25587-1 in hydraulic press. Select proper adaptors to perform removal or installation operations on planetary to be overhauled.

(6) Refer to para. z. for front planetary gear overhaul; para. aa. for center planetary gear overhaul; para. ab. for rear planetary gear overhaul and para. ac. for low planetary gear overhaul.

z. Front Planetary Gear Overhaul

(1) Front planetary gear overhaul requires tools

J25587-1 Fixture
J25587-16 Pin Remover
J25587-20 (six) Loading Pin
J25587-49 (six) Guide Pin
J25587-9 Pin Installer
J25587-17 Swaging Tool Holder
J25587-25 (two) Swaging Tool
J25587-4 Support Block



(2) Drill out planetary pins from rear side of carrier. Place carrier assembly in fixture with drilled pins up, Install pin remover J25587-16 into fixture ram.

(3) Press out six pins. Remove and keep six groups separate.

(4) Inspect carrier (6) for loose or worn bushing (7). Replace housing carrier if damaged or worn excessively.

(5) Install loading pin J25587-20 in each pinion (5). Install roller bearing (4) on pin, then steel and bronze thrust washers (2 and 3) on each end. Lubricate needle bearings with transmission fluid (item 9, Appendix B) before installation of groups into carrier.

3-7. TRANSMISSION-Continued

(6) Place carrier rear side up and place all pinion groups into carrier. Install guide pins J25587-49, large diameter first, in place of loading pins.

(7) Put carrier on fixture in press. Insert pin installer J25587-9 into fixture ram.

CAUTION

Do not put pressure on the carrier. Distortion of the carrier will damage it.

NOTE

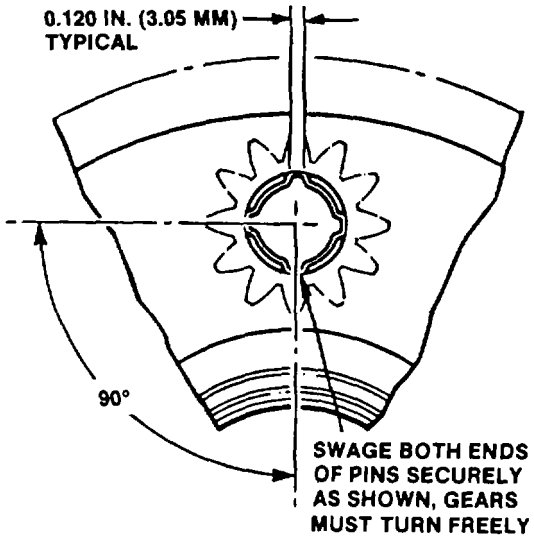
Pin installers are shaped to avoid interference with bosses on the carrier assemblies. They must be installed in the ram so that the cutaway portion of the installer will clear the bosses when the pinion pin is pressed in.

(8) Place a pinion pin (1) onto the pilot end of a pin guide in carrier. Press the pinion pin into the carrier until the installer contacts the carrier.

(9) Install the remaining pinion pins.

(10) Remove the carrier assembly from the press fixture. Install swaging tool holder J25587-17 into the opening of the press fixture bed. Install a swaging tool J25587-25 into the holder. Install another swaging tool J25587-25 into the press fixture ram, Lubricate both ends of the pinion pins with petroleum jelly (item 21, Appendix B).

(11) Position the carrier assembly, rear end upward on the press fixture. Use support block J25587-4 to level the carrier while the lower swaging tool is supporting the lower end of one pinion pin.



NOTE

Swaging pressure is approximately three tons for each pinion pin. While applying pressure, rotate pinions and feel for reduction of end play. The pinions must rotate freely and have 0.008 in. (0.20 mm) minimum end play after swaging the pins.

(12) Apply sufficient pressure to the press fixture ram to firmly swage the ends of the pinion pins against the metal of the carriers.

(13) Swage the remaining pinion pins.

3-7. TRANSMISSION-Continued

aa. Center Planetary Gear Overhaul

(1) Center planetary gear overhaul requires tools
J25587-1 Fixture
J25587-29 Pin Remover
J25587-67 (four) Loading Pin
J25587-47 (four) Guide Pin
J25587-30 Pin Installer
J25587-17 Swaging Tool Holder
J25587-21 (two) Swaging Tool
J25587-3 Support Block

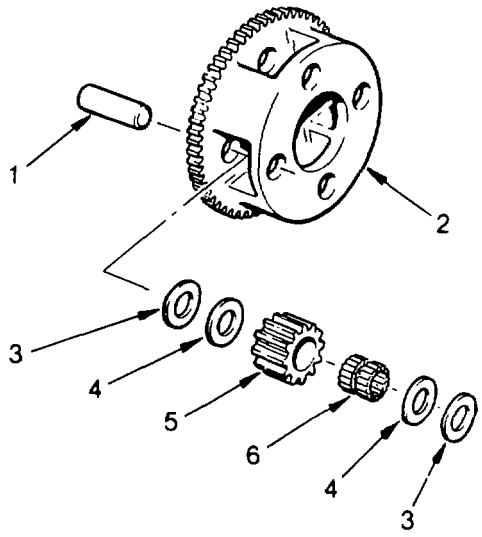
(2) Drill out planetary pins drilled from front side of carrier. Place carrier assembly in fixture with drilled pins up. Install pin remover J25587-29 into fixture ram.

(3) Press out four pins. Remove and keep four groups separate.

(4) Inspect carrier (2) for excessive wear. Replace damaged or excessively worn housings.

(5) Install loading pin J25587-67 in each pinion (5). Install roller bearing (6) on pin then steel and bronze thrust washers (3 and 4) on each end. Lubricate needle bearings with transmission fluid (item 23, Appendix B) before installation of groups into carrier.

(6) Place carrier front side up and place all pinion groups into carrier. Install guide pins J25587-47, large diameter first in place of loading pins.



(7) Put carrier on fixture in press. Insert pin installer J25587-30 into fixture ram.

CAUTION

Do not put pressure on the carrier. Distortion of the carrier will damage it.

NOTE

Pin installers are shaped to avoid interference with bosses on the carrier assemblies. They must be installed in the ram so that the cutaway portion of the installer will clear the bosses when the pinion pin is pressed in.

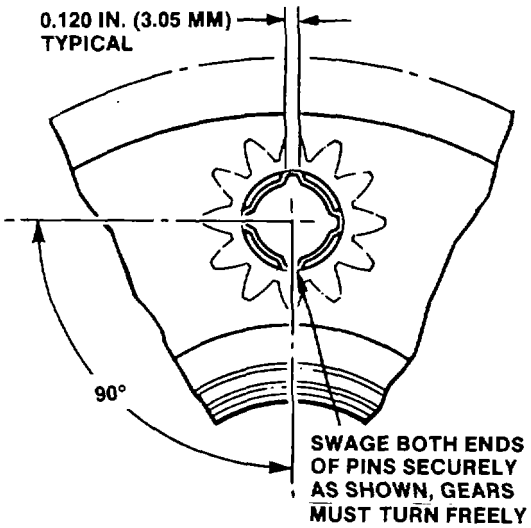
(8) Place a pinion pin (1) onto the pilot end of a pin guide in carrier. Press the pinion pin into the carrier until the installer contacts the carrier.

(9) Install the remaining pinion pins.

3-7. TRANSMISSION-Continued

(10) Remove the carrier assembly from the press fixture. Install swaging tool holder J25587-17 into the opening of the press fixture bed. Install a swaging tool J25587-21 into the holder. Install another swaging tool J25587-21 into the press fixture ram. Lubricate both ends of the pinion pins with petroleum jelly (item 21, Appendix B).

(11) Position the carrier assembly, rear end upward on the press fixture. Use support block J25587-3 to level the carrier while the lower swaging tool is supporting the lower end of one pinion pin.



NOTE

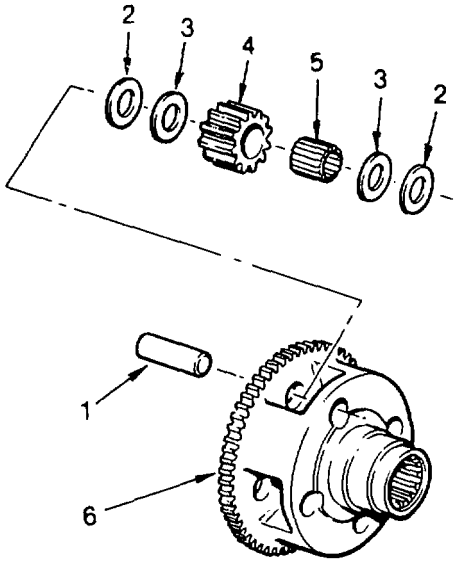
Swaging pressure is approximately three tons for each pinion pin. While applying pressure, rotate pinions and feel for reduction of end play. The pinions must rotate freely and have 0.008 in. (0.20 mm) minimum end play after swaging the pins.

(12) Apply sufficient pressure to the press fixture ram to firmly swage the ends of the pinion pins against the metal of the carrier.

(13) Swage the remaining pinion pins.

ab. Rear Planetary Gear Overhaul

(1) Rear planetary gear overhaul requires tools
- J25587-1 Fixture
- J25587-2 Pin Remover and Installer Adapter
- J25587-6 Pin Remover and Installer Spacer
- J25587-29 Pin Remover
- J25587-7 (four) Loading Pin
- J25587-47 (four) Guide Pins
- J25587-31 Pin Installer
- J25587-17 Swaging Tool Holder
- J25587-21 (two) Swaging Tool
- J25587-5 Spacer Block



(2) Drill planetary pins drilled from rear side of carrier. Place carrier assembly in fixture with drilled pins up. Install pin remover J25587-29 into fixture ram. Place J25887-2 Adapter and J25587-6 Spacer.

(3) In position press out four pins. Remove and keep four groups separate.

(4) Inspect carrier (6) for excessive wear. Replace housing if damaged or worn excessively.

(5) Install loading pin J25587-7 in each pinion (4). Install roller bearing (5) on pin then steel and bronze thrust washers (2 and 3) on each end. Lubricate needle bearings with transmission fluid (item 9, Appendix B) before installation of groups into carrier.

3-7. TRANSMISSION-Continued

(6) Place carrier, rear side up and place all pinion groups into carrier. Install guide pins J25587-47 large diameter first, in place of loading pins.

(7) Put carrier on fixture in press. Insert pin installer J25587-31 into fixture ram. Place J25587-2 Adapter and J25587-6 Spacer in position.

CAUTION

Do not put pressure on the carrier. Distortion of the carrier will damage it.

NOTE

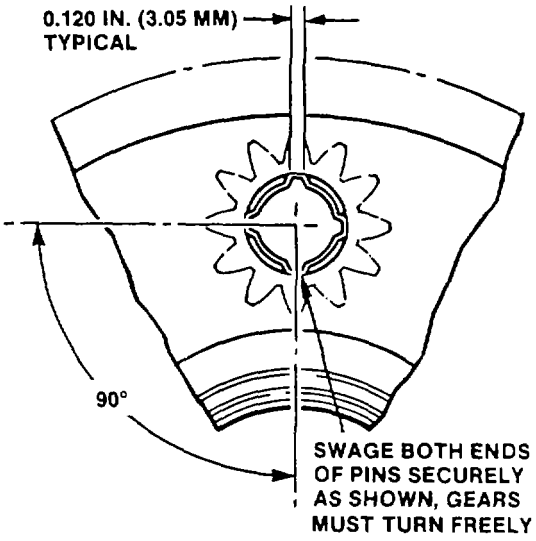
Pin installers are shaped to avoid interference with bosses on the carrier assemblies. They must be installed in the ram so that the cutaway portion of the installer will clear the bosses when the pinion pin is pressed in.

(8) Place a pinion pin (1) onto the pilot end of a pin guide in carrier. Press the pinion pin into the carrier until the installer contacts the carrier.

(9) Install the remaining pinion pins.

(10) Remove the carrier assembly from the press fixture. Install swaging tool holder J25587-17 into the opening of the press fixture bed. Install a swaging tool J25587-21 into the holder. Install another swaging tool J25587-21 into the press fixture ram. Lubricate both ends of the pinion pins with petroleum jelly (item 21, Appendix B).

(11) Position the carrier assembly, rear end upward on the press fixture. Use support block J25587-5 to level the carrier while the lower swaging tool is supporting the lower end of the one pinion pin.



NOTE

Swaging pressure is approximately three tons for each pinion pin. While applying pressure, rotate pinions and feel for reduction of end play. The pinions must rotate freely and have 0.008 in. (0.20 mm) minimum end play after swaging the pins.

(12) Apply sufficient pressure to the press fixture ram to firmly swage the ends of the pinion pins against the metal of the carrier.

(13) Swage the remaining pinion pin ends.

3-7. TRANSMISSION-Continued

ac. Low Planetary Gear Overhaul

(1) Low planetary gear overhaul requires tools
J25587-1 Fixture
J25587-29 Pin Remover
J25587-7 (four) Loading Pins
J25587-47 (four) Guide Pins
J25587-36 Pin Installer
J25587-17 Swaging Tool Holder
J25587-21 Swaging Tool
J25587-4 Support Block

(2) Drill out planetary pins drilled from rear side of carrier. Place carrier assembly in fixture with drilled pins up. Install pin remover J25587-29 into fixture ram.

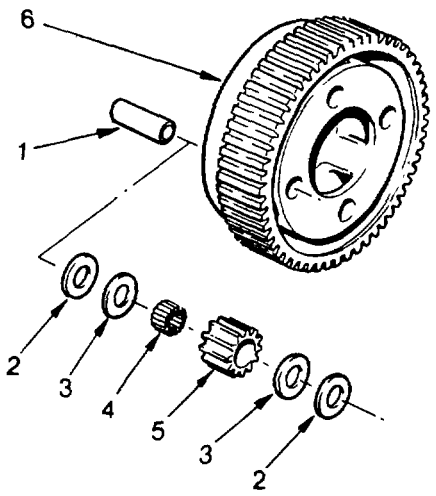
(3) Press out four pins. Remove and keep four groups separate.

(4) Inspect carrier (6) for excessive wear. Replace housing if damaged or worn excessively.

(5) Install loading pin J25587-7 in each pinion (5). Install roller bearing (4) on pin, then steel and bronze thrust washers (2 and 3) on each end. Lubricate needle bearings with transmission fluid (item 9, Appendix B) before installation of groups into carrier.

(6) Place carrier rear side up and place all pinion groups into carrier. Install guide pins J25587-47, large diameter first, in place of loading pins.

(7) Put carrier on fixture in press. Insert pin installer J25587-36 into fixture ram.



CAUTION

Do not put pressure on the carrier. Distortion of the carrier will damage it.

NOTE

Pin installers are shaped to avoid interference with bosses on the carrier assemblies. They must be installed in the ram so that the cutaway portion of the installer will clear the bosses when the pinion pin is pressed in.

(8) Place a pinion pin (1) onto the pilot end of a pin guide in carrier. Press the pinion pin into the carrier until the installer contacts the carrier.

(9) Install the remaining pinion pins.

(10) Remove the carrier assembly from the press fixture. Install swaging tool holder J25587-17 into 3-58 the opening of the press fixture bed. Install a swaging tool J25587-21 into the holder. Install another swaging tool J25587-21 into the press fixture ram. Lubricate both ends of the pinion pins with petroleum jelly (item 21, Appendix B).

3-7. TRANSMISSION-Continued

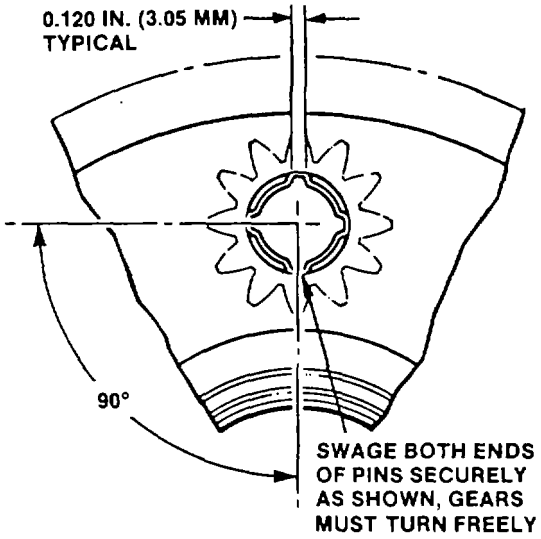
(11) Position the carrier assembly, rear end upward on the press fixture. Use support block J25587-4 to level the carrier while the lower swaging tool is supporting the lower end of one pinion pin.

NOTE

Swaging pressure is approximately three tons for each pinion pin. While applying pressure, rotate pinions and feel for reduction of end play. The pinions must rotate freely and have 0.008 in. (0.20 mm) minimum end play after swaging the pins.

(12) Apply sufficient pressure to the press fixture ram to firmly swage the ends of the pinion pins against the metal of the carrier.

(13) Swage the remaining pinion pin ends.



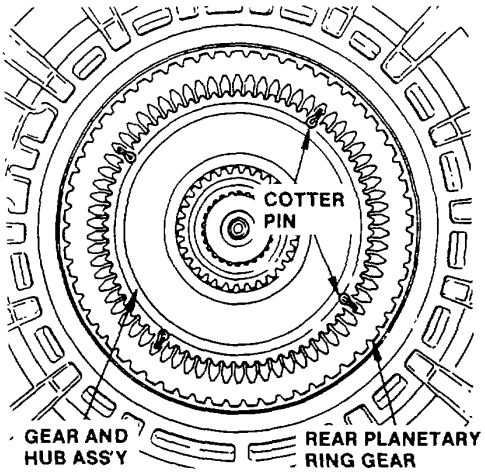
ad. Removal Of Rear Cover, Low Planetary And Clutch, First Clutch And Ring Gear

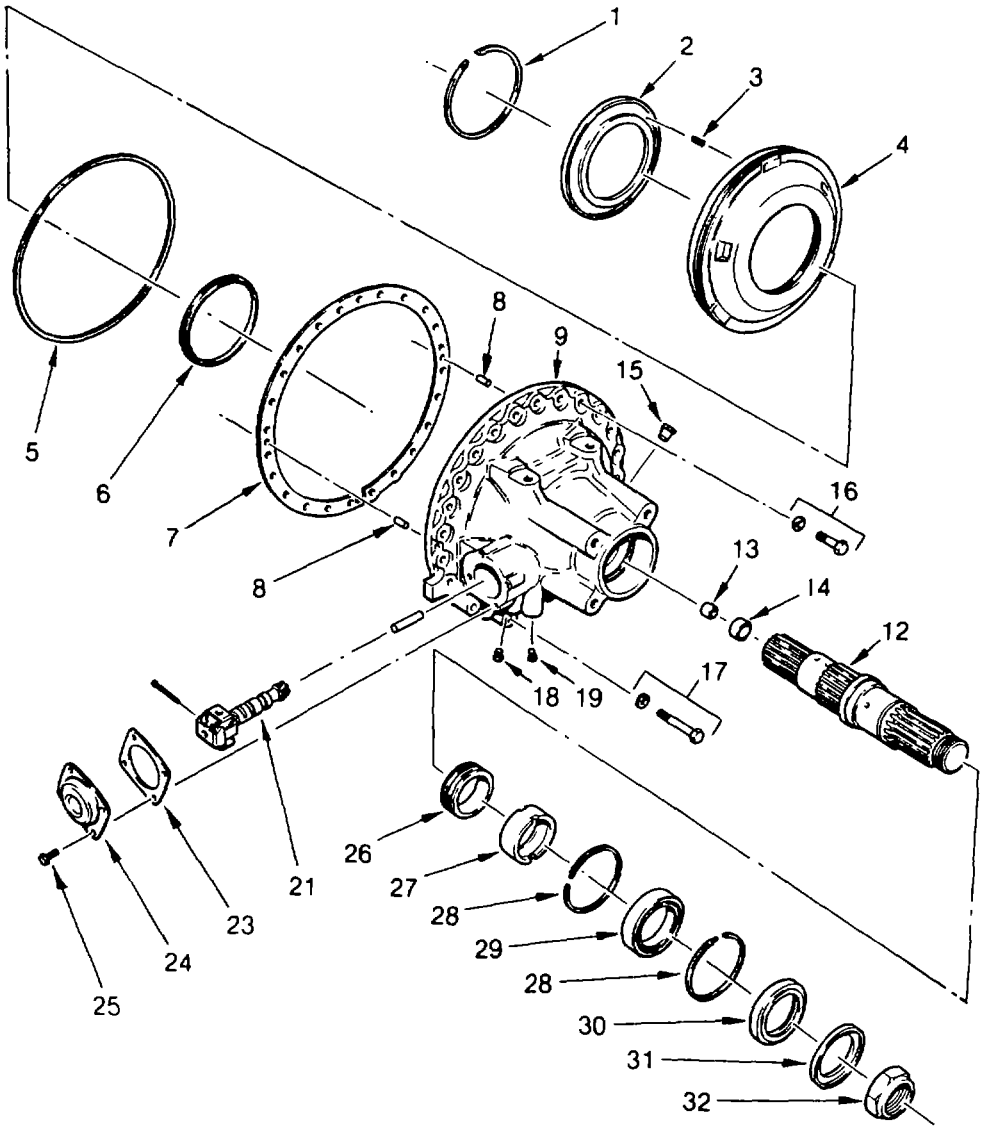
NOTE

Governor assembly already removed, see para. a.

3-7. TRANSMISSION-Continued

(1) Position transmission front end upwards.
(2) Locate the oil passage holes in the rear planetary ring gear. Insert four 1/8 in. cotter pins, ninety deg. apart, into the oil passage holes in the ring gear until they bottom. Pins should be greased to retain them in position, and should be in holes in the same plane.
(3) Carefully invert the transmission housing, rear cover upward.
(4) Remove the twenty-four bolts and lockwashers that retain the rear cover and adapter housing to the transmission housing.





3-7. TRANSMISSION-Continued

(5) Attach a hoist to the lifting bracket, fastened to output shaft. Carefully separate the rear cover from the adapter housing. Remove the rear cover gasket and discard.

(6) Properly block rear housing on clean workbench area with output end upwards.

(7) Using tools J24171-1, 2, 4, remove dust shield (31) and output shaft oil seal (30) from the rear cover output end.

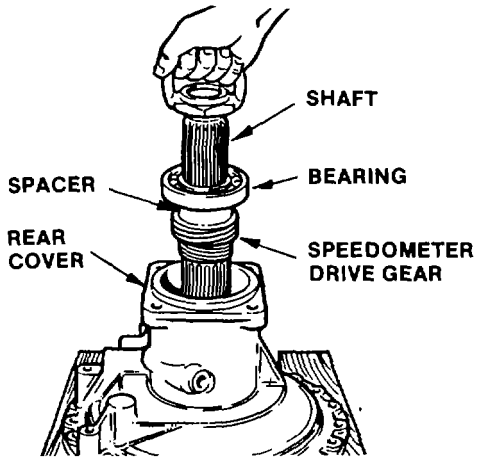
(8) Remove speedometer drive components.

(9) Remove the snap ring (28) that retains the rear output shaft bearing (29).

(10) Remove the rear output shaft (12), and its attached parts, from the rear cover.

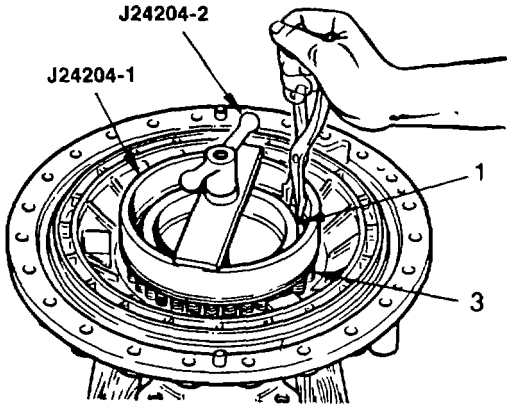
(11) Support the front of the speedometer drive gear, and press the output shaft from the gear, spacer sleeve, and bearing.

(12) If orifice plug or bushing requires replacement, remove either or both as required.



(13) Using compressor components J24202-1 and J24204-2, compress the spring retainer and springs. Remove the snap ring (1), and remove the compressor.

(14) Remove the spring retainer (2) and 30 springs (3).



(15) Remove the clutch piston (4). Remove the inner (6) and outer (5) seal rings from the piston.

(16) If the speedometer driven gear bushing (15) requires replacement, remove it. Thread remover J24205-2 into the bushing. Attach slide hammer J6125-1 to remover J24205-2 and remove the bushing.

(17) Remove any remaining parts that require replacement, from the rear cover.

3-7. TRANSMISSION-Continued

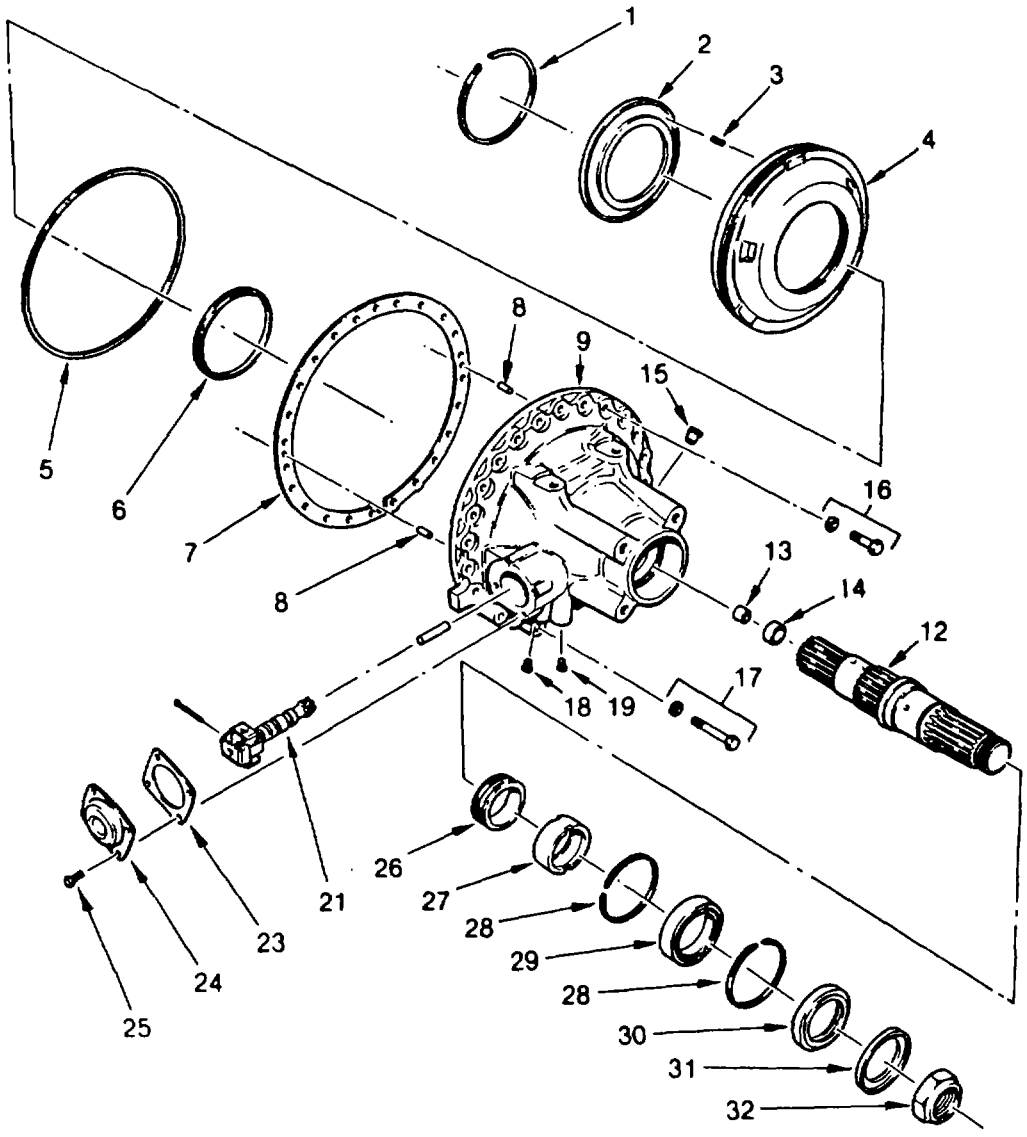
(18) If removed, replace the dowel pins (8) in the mounting face of the rear cover. The dowel pins project 0.360-0.400 in. (9.14-10.16 mm) above the face of the cover.

(19) If removed, install the governor support pin (20) using J28684. Accuracy of location and concentricity with governor bore is of the utmost importance when Installing the pin.

(20) If removed, install a new speedometer driven gear bushing (15). Use installer J24205-1 to seat the bushing in the rear cover.

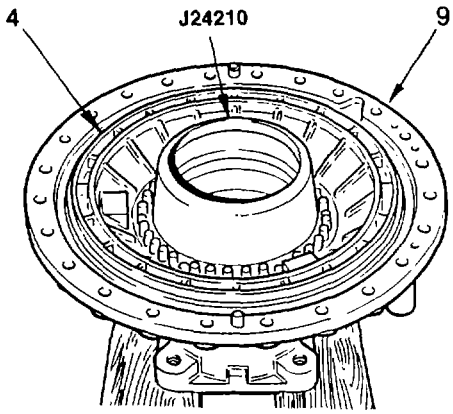
(21) Lubricate seal rings (5 and 6) with transmission fluid (item 9, Appendix B) and install them into the grooves of piston. The lip of each seal ring must face the rear of the piston (toward piston cavity in rear cover).

(22) Using inner seal protector J24210, carefully install the piston (4) into the rear cover (9). Use extreme care to prevent the lip of either seal folding back over itself. If installation is difficult, remove the piston and check the seal and cover bore before again attempting installation.



3-7. TRANSMISSION-Continued

(22) Using inner seal protector J24210, carefully install the piston (4) into the rear cover (9). Use extreme care to prevent the lip of either seal folding back over itself. If installation is difficult, remove the piston and check the seal and cover bore before again attempting installation.



(23) Remove the seal protector. Install thirty springs (3). Install the spring retainer (2), cupped side first, onto the springs.

(24) Using compressor components J24204-1 and J24204-2, compress the retainer and springs. Install snap ring (1), and remove the compressor.

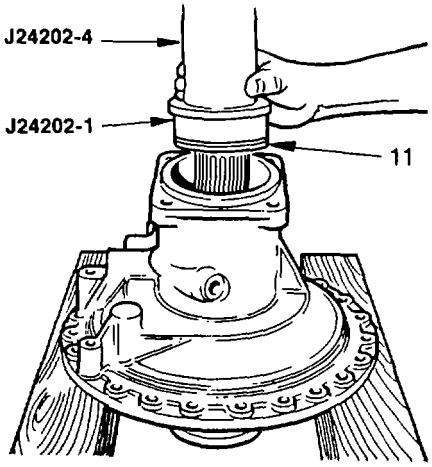
(25) If the orifice plug (13) was removed from the output shaft, install a new plug, orificed side first. Use installer J24369 to properly position the plug in the shaft. The plug must clear the chamfer at the front of the plug bore in the output shaft.

(26) If the bushing (14) was removed from the front of the output shaft, install a new bushing with installer J24769 located 0.330-0.350 in. (8.38-8.89 mm) from front of shaft.

(27) Press speedometer drive gear (26), spacer sleeve (27) and bearing (29) onto output shaft. Install assembled shaft.

(28) Install proper snap ring to match groove in the housing. Be sure snap ring is expanded fully into the groove.

(29) Install oil seal (30) , spring-loaded lip first. Use installerJ24202-1A and driver handle J24202-4 to locate the rear of the seal (30) 0.60-0.70 in. (15.2-17.8 mm) in front of the rear mounting surface.

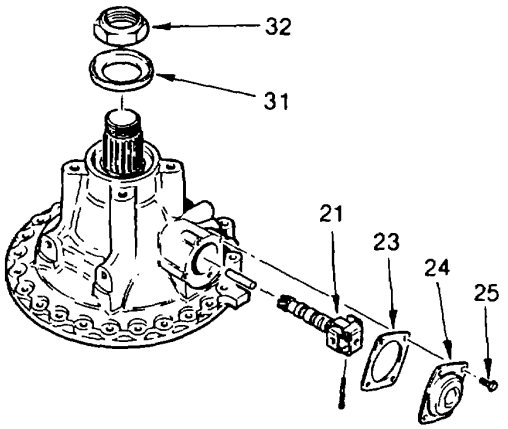


3-7. TRANSMISSION-Continued

(30) Coat the outer circumference of dust shield (31) with seal retainer (item 26, Appendix B). Install the shield, flat side first, into the rear cover using installer J24198. The rear edge of the shield must be flush with, the rear surface of the cover.

(31) Coat the thread of the retaining nut with grease (item 16, Appendix B). Retain flange (32) with holder bar. Tighten flange retaining nut to 600-800 ft lb (814-1085 Nm).

(32) Install the speedometer drive components.

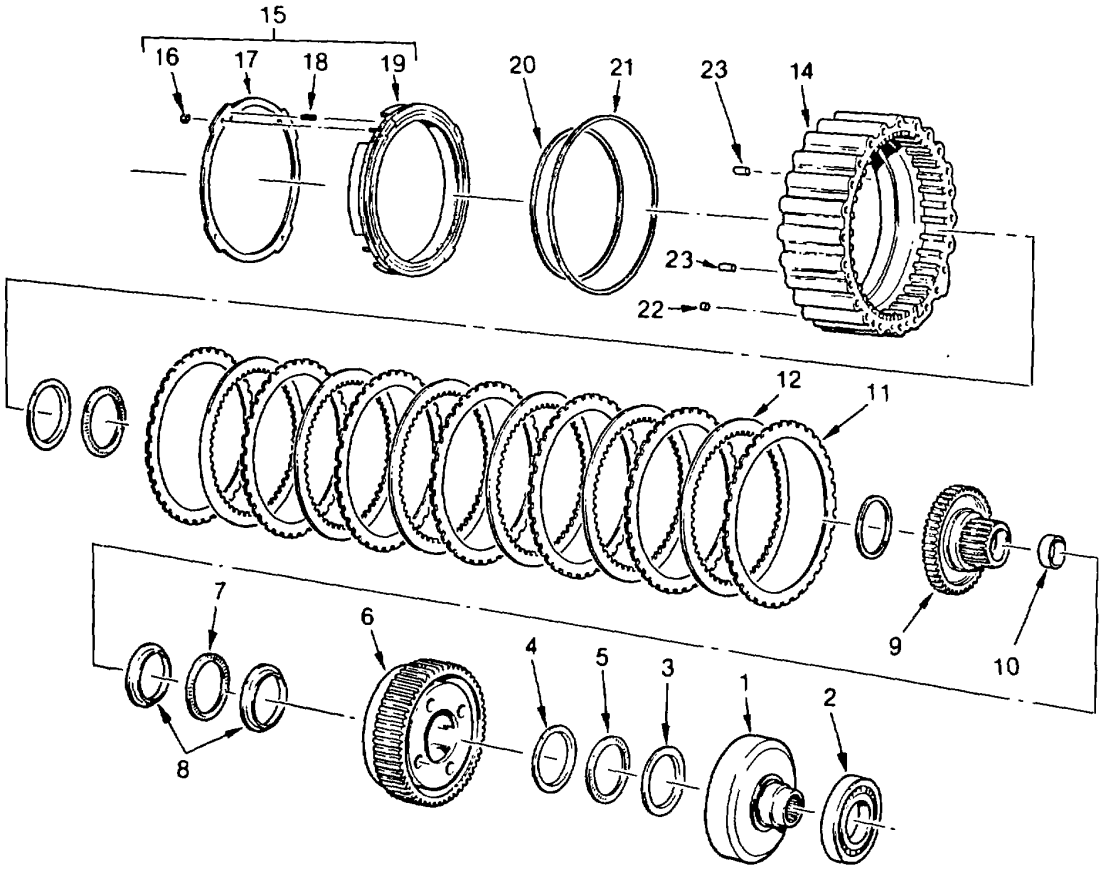


NOTE

Governor assembly may be disassembled for cleaning and inspection. Do not disassemble the governor unless overhaul kit consisting of governor weight pins and cover gasket is available.

(33) Install governor cover gasket (23). Install governor assembly (21) into the rear cover by rotating it counterclockwise Install cover (24) using four bolts (25) torqued to 13 ft lb (18 Nm). The rear cover is now ready for final installation.

(34) Install cover (24) using four bolts (25) torqued to 13 ft lb (18 Nm).



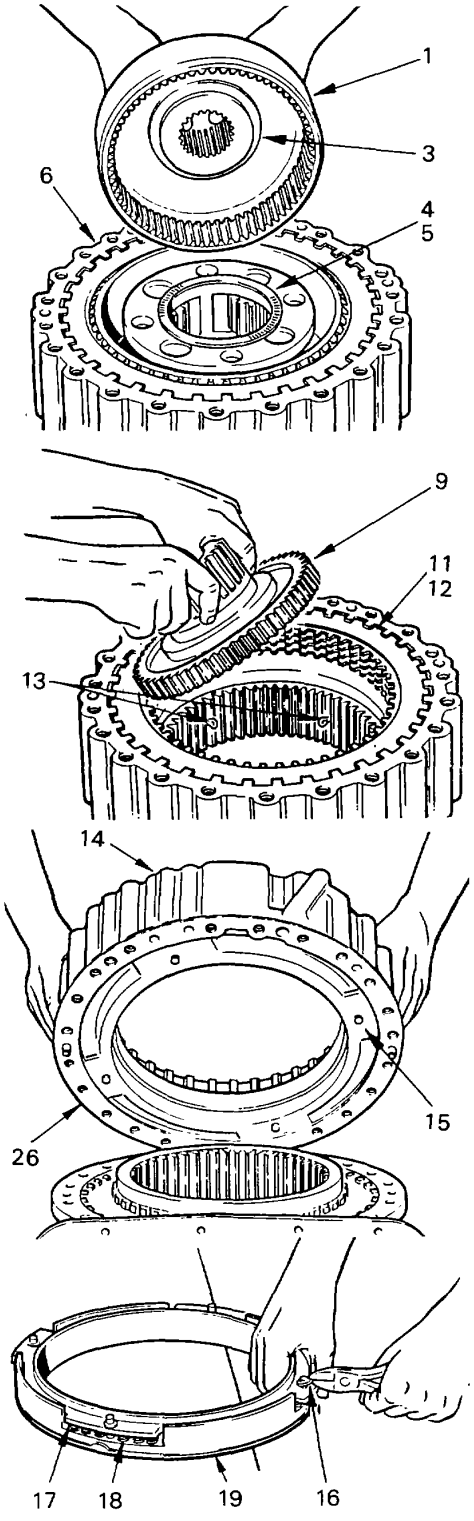
3-7. TRANSMISSION-Continued

(35) Remove the low ring gear (1) with ball bearing assembly. Remove the ball bearing assembly (2) from the ring gear if bearing replacement is necessary.
(36) Remove bearing race (3) from ring gear
(37) Remove the bearing race (4) and needle bearing (5) from the low planetary carrier (6).
(38) Remove the low planetary carrier assembly (6). Remove the bearing (7) and bearing races (8) from the low gear assembly (9).
(39) Remove the low planetary carrier (1). Replace bushing (10) if worn using Tool J24371. Refer to para. ac. for rebuild of the low planetary carrier.
(40) Remove seven external-tanged (11) and six internal-splined (12) low clutch plates from the adapter housing.
(41) Remove 1/8 in. cotter pins from the rear planetary ring gear (13).
(42) Remove adapter housing (14).
(43) Position adapter housing and piston assembly upward. Lift out the piston assembly (15).
(44) Remove the inner (20) and outer (21) seal rings from the piston.

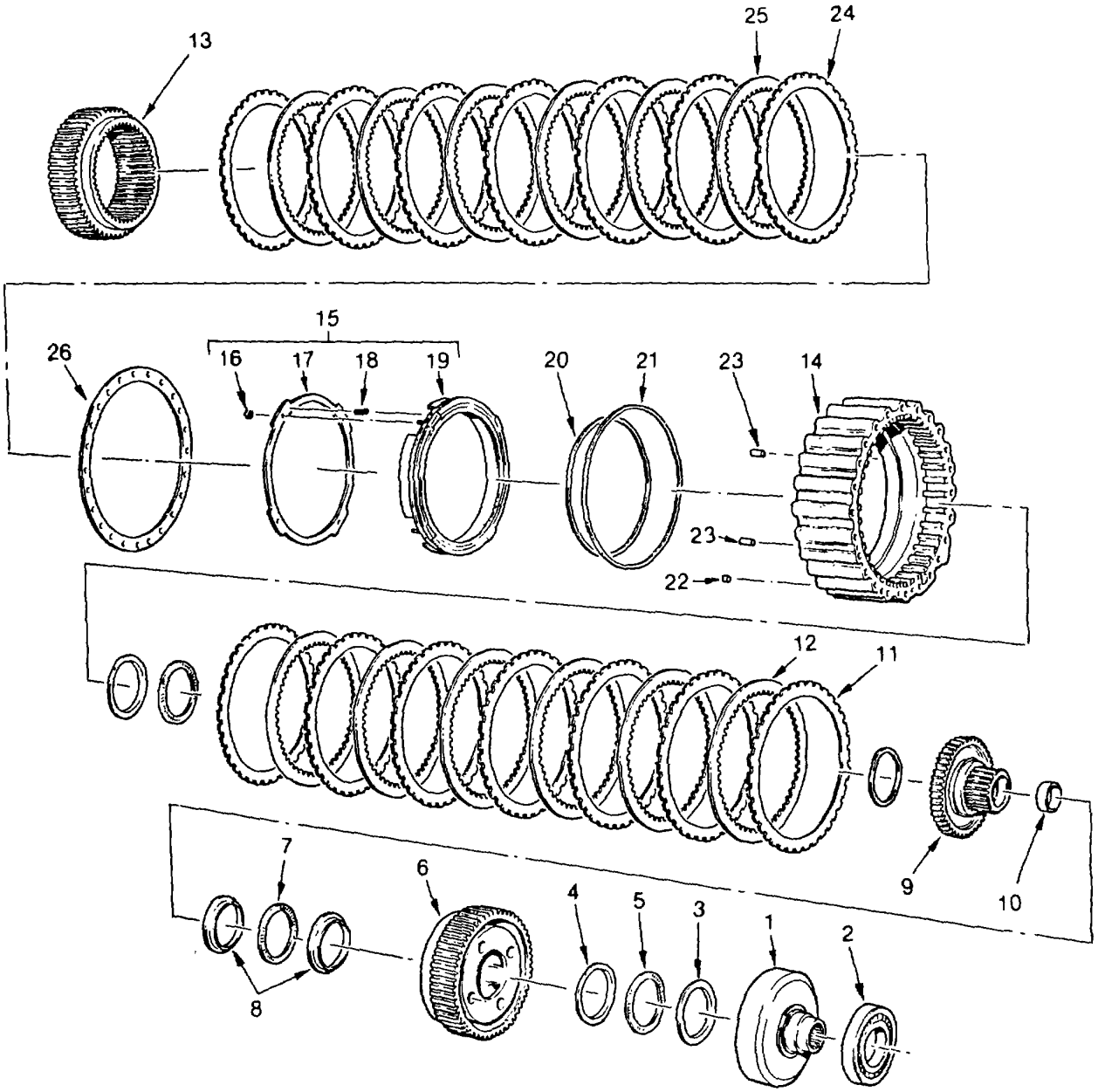
CAUTION

Any method of removal except cutting may damage the risers on the piston. Damage will lessen the holding power of retainer rings installed thereafter.

(45) Turn the piston assembly (15) over, and cut the four retainer rings (16) while depressing the retainer.
(46) Remove the spring retainer(17)and twenty-eight springs (18) from the piston (19).
(47) Install new orifice plug (22) flush with housing. Install new dowel pins (23) if removed. They must project 0.360-0.400 in. above the front face of adapter housing.



3-7. TRANSMISSION-Continued



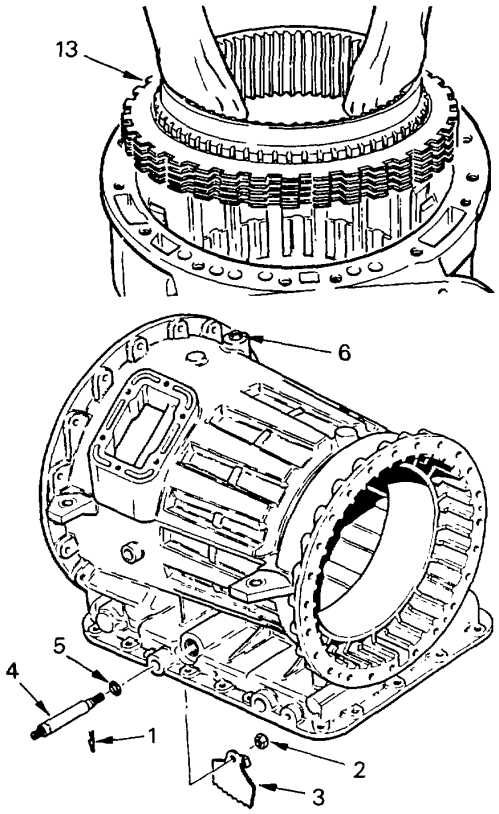
3-7. TRANSMISSION-Continued

(48) Place piston in the piston cavity of housing. Be sure it is firmly bottomed in the cavity.
(49) Install twenty-eight springs into their recesses in the piston. Install retainer, so the offset tangs are upward, onto the piston and springs. Aline the holes in the tangs with the bosses on the piston.

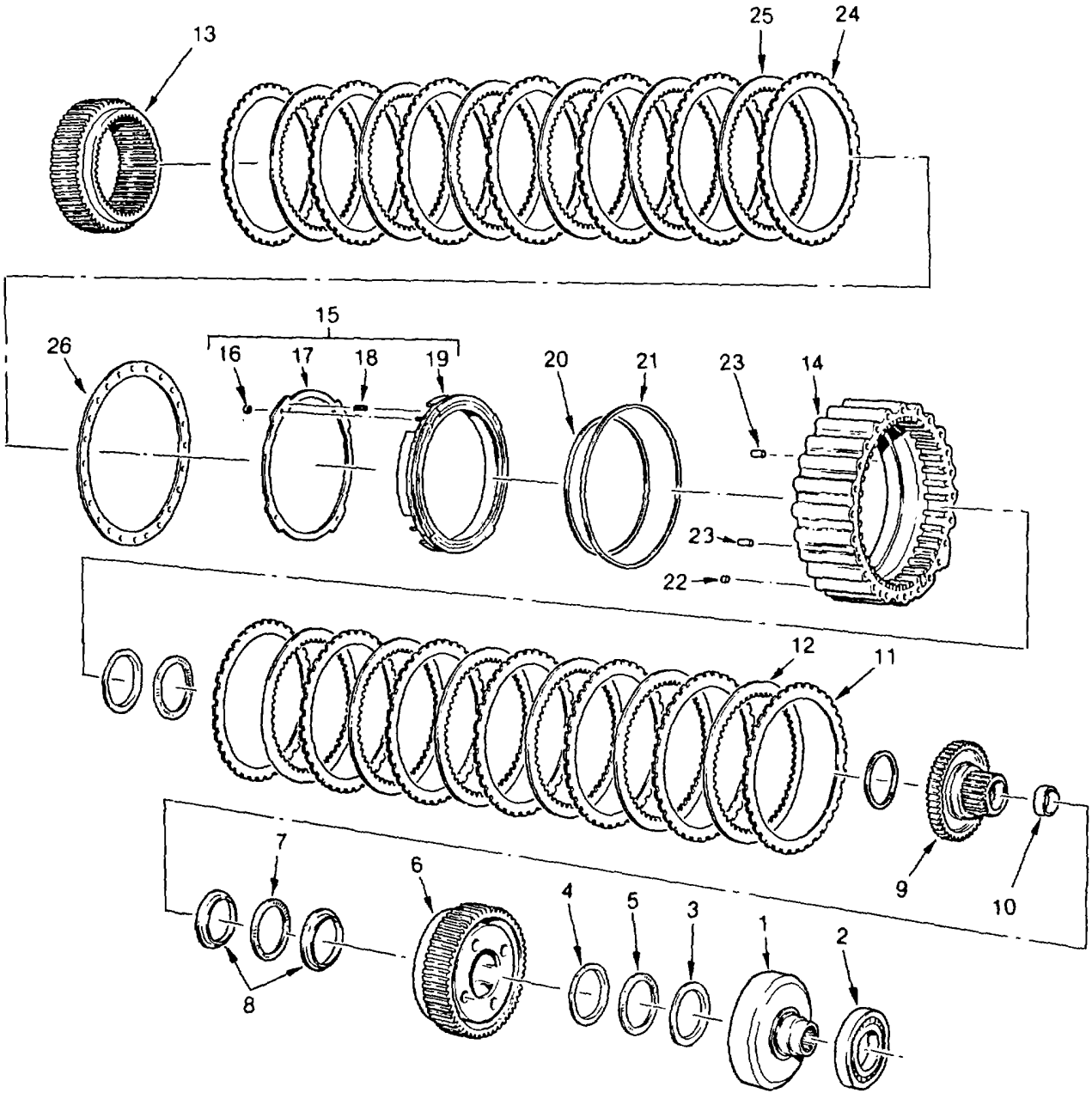
CAUTION

Failure to install the retainer rings properly can result in transmission damage or malfunction. If installed too far onto the risers, proper clutch clearance cannot be obtained. If not installed far enough, the retainers may fall off.

(50) Using installer J24453, install four retainer rings. Press each ring into place until the adjacent retainer tang bottoms in the counterbore of the adapter housing.
(51) When all four retainer rings are properly installed, remove the piston assembly from the adapter housing.
(52) Lubricate seal rings with transmission fluid (item 9, Appendix B). Install the seal rings, with the lip of each seal ring facing rearward, away from the spring side of the piston.
(53) Install the piston assembly into the adapter housing, being very careful to avoid folding the seal lips back upon themselves. If any difficulty is encountered, remove the piston, and check the seals and housing bore before again attempting installation.
(54) Grasp the ring gear (13) internally and lift upward, removing the ring gear and ten clutch plates from the transmission housing.
(55) Remove the three remaining clutch plates.
(56) Remove retaining pin (1) and locknut (2) to remove detent lever (3). Remove any burred or rough areas from shaft (4) before removal to avoid scratching the housing bore.
(57) Hold the detent lever in one hand, remove the manual shaft (4) by carefully pulling it through the oil seal (5) in the housing. Remove the detent lever.
(58) Remove manual shift shaft oil seal (5) using seal remover J26401.
(59) If replacement of breather (6) is necessary, remove it from the housing.



3-7. TRANSMISSION-Continued



3-7. TRANSMISSION-Continued

ae. Assembly of Complete Transmission After Overhaul

(1) Coat the inside diameter of detent lever oil seal with petroleum jelly (item 21, Appendix B) and the outside diameter with seal retainer sealant (item 26, Appendix B). Install the oil seal, lip first, into the transmission housing. Use installer J26282 to properly locate the seal in the housing. The seal must clear the chamfer in the housing.

(2) Hold detent lever so that the selector valve pin extends toward the side of the housing. Slide the manual shaft through the opening in the housing, oil seal, and slot in the detent lever. Install locknut and retainer pin. Tighten the locknut to 20 ft lb (27 Nm).

(3) Install new breather if removed. Torque to 16 ft lb (22 Nm).

(4) Place transmission housing in a vertical position, rear upward.

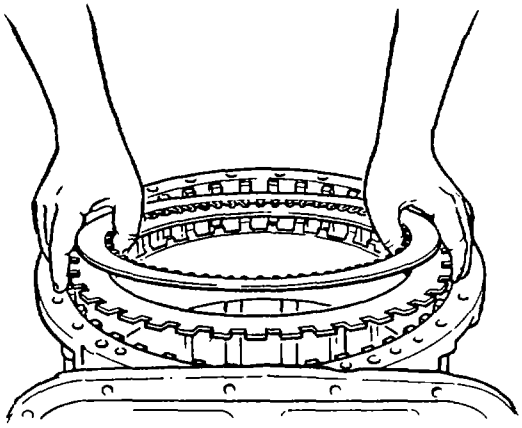
NOTE

Two methods of checking clutch plate clearance have been established. One method is by direct measurement. The alternate method is by stack dimension computation. Method one is detailed following.

af. First Clutch Installation

(1) Beginning with an external-tanged clutch plate (24), alternately install seven external-tanged, and six internal-splined (25) first clutch plates.

(2) Install two guide bolts (180 deg. apart) into the transmission housing. Aline and install the adapter housing assembly (14) and gasket (29).

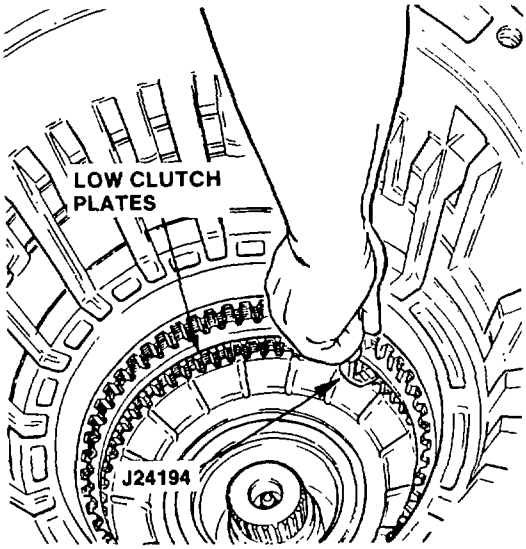


ag. Low Clutch Installation

(1) Beginning with an external-tanged clutch plate, alternately install seven external-tanged and six internal-splined low clutch plates.

(2) Install the rear cover assembly, previously overhauled ready for final assembly, and gasket onto the rear of the transmission housing and secure it with six' 1/2 - 13 bolts and lockwashers, evenly spaced. Tighten the bolts to approximately 30 ft lb (41 Nm).

(3) Invert the transmission, front upward. Using gage J24194, check the clearance between the low clutch plates. It is recommended the gage be placed between the adapter housing wall and the first steel plate. The prescribed clearance is 0.095 -0.145 in. (2.41 -3.68 mm). Any dimension within 0.095-0.145 in. (2.41-3.68 mm) is satisfactory. Replace worn clutch plates with -new plates to establish the desired clearance. Recheck the clearance.



3-7. TRANSMISSION-Continued

(4) Using gage J24194, check the clearance between the first clutch plates. It is recommended the gage be placed between the transmission housing and the first steel plate. The prescribed clearance is 0.095-0.145 in. (2.41-3.68 mm). Any dimension within 0.095-0.145 in. (2.41-3.68 mm) is satisfactory. Replace worn clutch plates with new plates to establish the desired clearance. Recheck the clearance.

ah. Selection of Proper Center Support Snap Ring

(1) Install thirteen second clutch plates, beginning with an external-tanged plate. Alternately install seven external-tanged plates and six internal-splined plates.

(2) Retain the plates with the selective snap ring. The snap ring should be color coded white, 0.155-0.157 in. (3.94-3.99 mm).

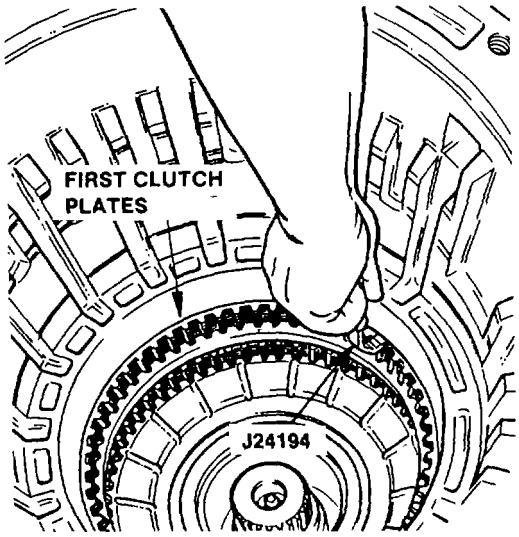
(3) The third-clutch piston was left from the center support assembly during rebuild. Install bracket J24195 into the recess between the seal ring on the center support hub.

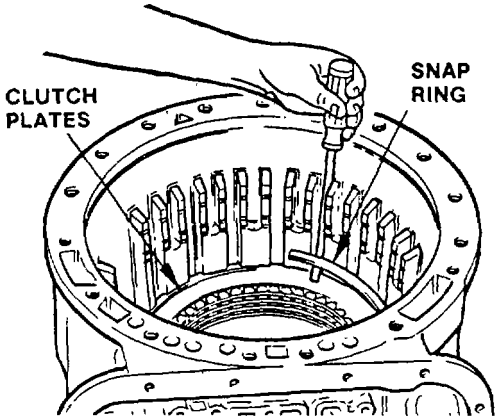
(4) Install center support into the transmission housing. Be sure the tapped hole in the support is alined with the anchor bolt hole in the bottom of the housing. Second clutch piston already Inspected repaired and installed in center support.

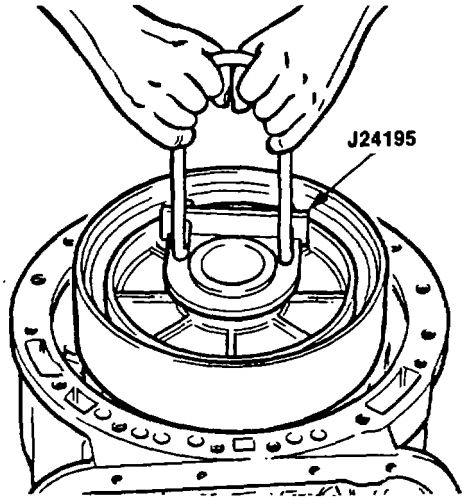
(5) Remove lifting bracket J24195 from the center support. Install a 3/8-16 x 3 in. anchor bolt into the support through the anchor bolt hole in the bottom of the housing. Tighten the bolt fingertight.

(6) Place the compressor sleeve J24208-2 on the hub of the center support. Place compressor J24208-3 across the transmission housing. Retain the compressor bar with two bolts.

(7) Compress the center support by applying a torque of 5 ft lb (6.8 Nm) to the center screw J24208-1. Determine the width of the snap ring opening, using gage J33127. Gage lug thicknesses are stamped on the tool shaft. Select one of the snap rings in the following list. Select the thickest snap ring that can be put into the groove.







3-7. TRANSMISSION-Continued

Gage Lug	Snap Ring Color Code	Snag Ring Thickness
0.149 in. (3.78 mm)	Blue	0.148-0.150 in. (3.76-3.81 mm)
0.153 in. (3.88 mm)	Yellow	0.1.52-0.154 in. (.86-3.91 mm)
0.156 in. (3.96 mm)	White	0.155-0.157 in. (3.94-3.99 mm)
0.159 in. (4.04 mm)	Red	0.158-0.160 in. (4.01-4.06 mm)

NOTE

If a red selective snap ring fits loosely, a red snap ring can be used in place of the white snap ring under the center support to retain second clutch. If the selective snap ring continues to be loose, refer to the following list for two service released snap rings of thicker dimension, to be used in the selective snap ring location.

Snap Ring P/N	Snap Ring Color Code	Snap Ring Thickness
23013848	Orange	0.162-0.164 in. (4.11-4.16 mm)
23013852	Orange/ Blue	0.165-0.167 in. (4.19-4.16 mm)

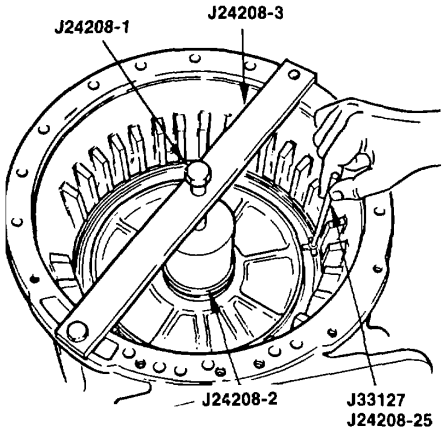
(8) Install the selected snap ring to retain the center support . Be sure the snap ring gap is at the top of the transmission housing.

(9) Remove compressor J24208-3 and sleeve J24208-2.

(10 The second clutch clearance is checked by direct measurement of clutch pack.

(11) Invert the transmission housing, rear cover upward.

(12) Remove the six bolts and washers that temporarily retained the rear cover to the transmission housing. Remove the rear cover and gasket.



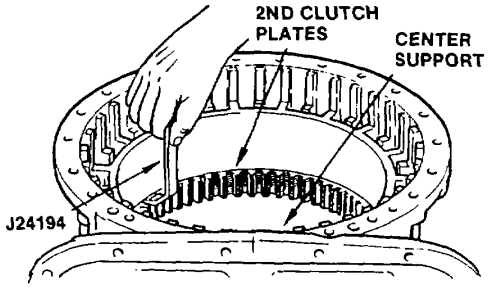
(13) Remove the thirteen low clutch plates from the adapter housing. Since these plates are preset for the low clutch clearance, they should be maintained in a package form so they cannot be intermixed with other plates.

(14) Remove the adapter housing and gasket from the transmission housing.

(15) Remove the thirteen first clutch plates from the transmission housing. These plates were preset for proper clearance and should be maintained as a package for final installation.

3-7. TRANSMISSION-Continued

(16) Using gage J24194, check the second clutch plate clearance. It is recommended the gage be placed between the transmission housing and the first steel plate. The prescribed clearance is 0.095-0.145 in. (2.41-3.68 mm). Any dimension within 0.095-0.145 in. (2.41-3.68 mm) is satisfactory. Replace worn plates with new plates to establish the desired clearance. Recheck the clearance.



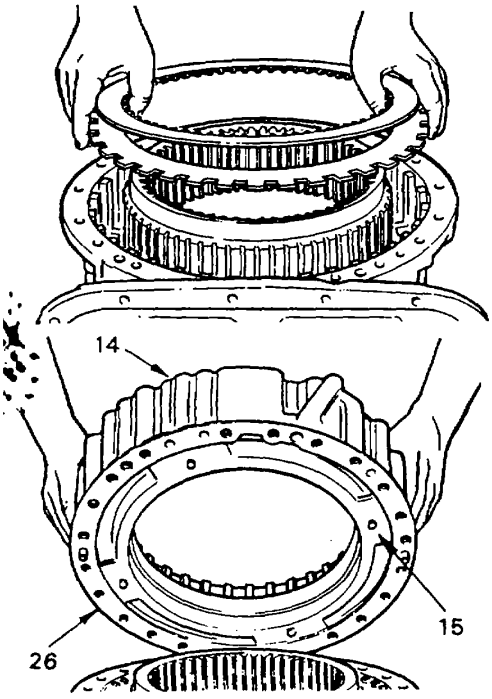
NOTE

Leave the second clutch and the center support in the transmission housing until the housing Is again positioned front end upward.

(17) Install, one external-tanged and one internal-splined plate from premeasured and properly calculated first clutch pack.

(18) Install the rear planetary ring gear, stepped diameter upward.,

(19) Install the remainder of the first clutch removed. Begin with an external-tanged plate, and alternately install six external-tanged and five internal-splined plates. The last plate must be a thick external-tanged plate.

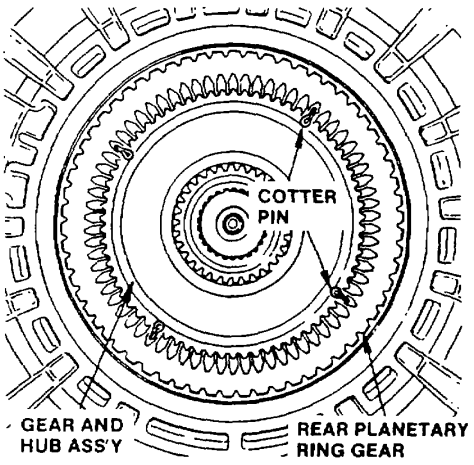


(20) Place the adapter housing gasket (26) on the adapter housing (14). Retain the gasket on the housing with petroleum jelly (item 21, Appendix B). Be sure all holes in the gasket are alined with those in the housing.

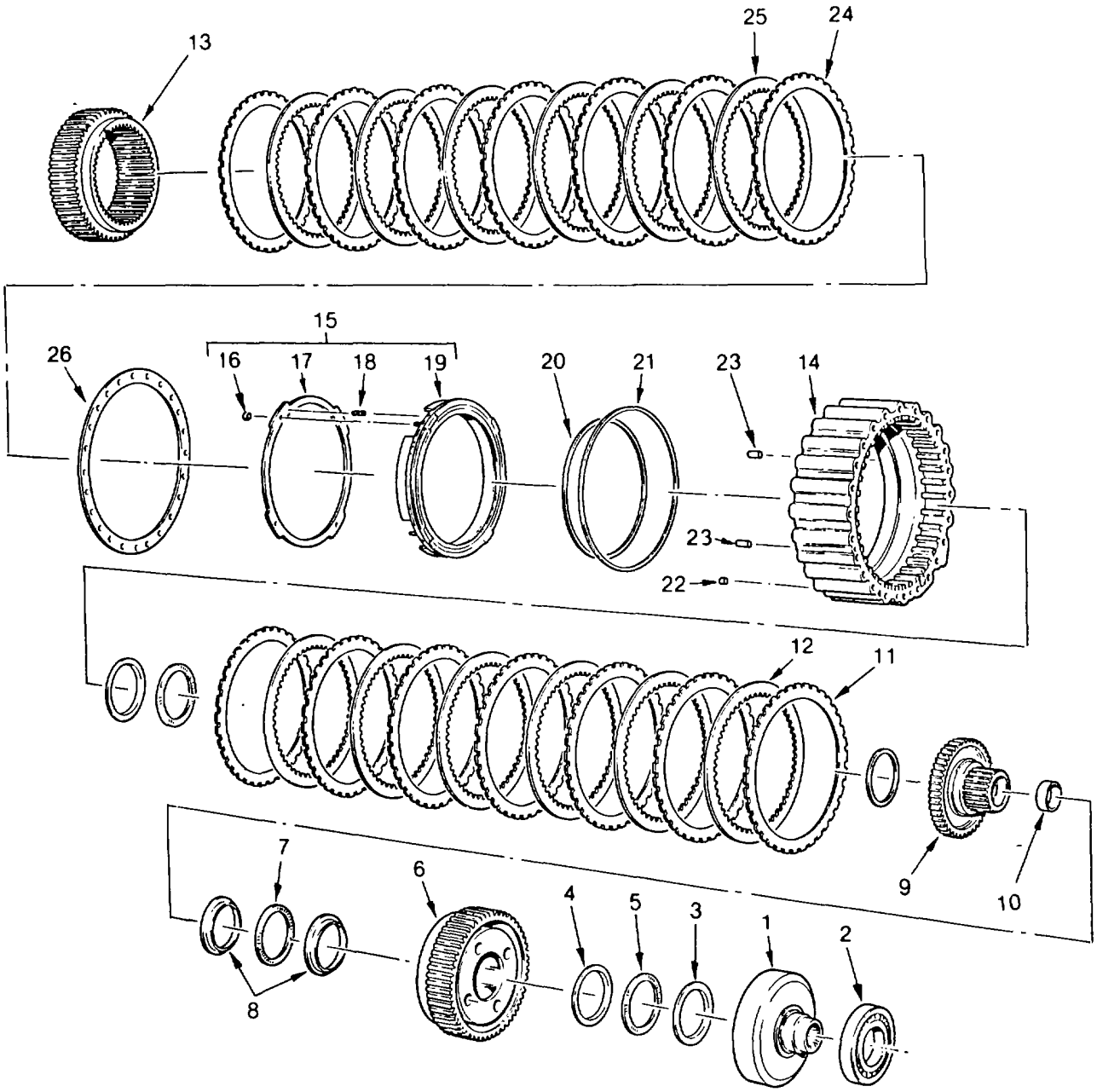
(21) Carefully place the adapter housing assembly (14), onto the transmission housing. Since the dowel pins are different in size, installation Is simplified.

(22) Install four 1/8 in. cotter pins 1½ In. maximum length, into the four oil holes nearest the rear of the rear planetary ring gear (13).

(23) Install gear an hub assembly (9) large end first into the rear planetary ring gear (13). The hub will stop when it reaches the four cotter pins.



3-7. TRANSMISSION-Continued

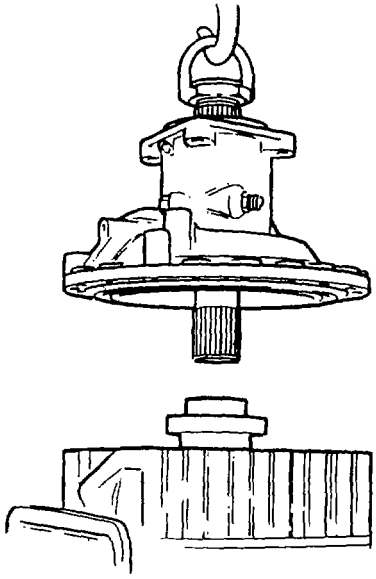


3-7. TRANSMISSION-Continued

(24) Install rear bearing race (8), flat side first, onto the rear of ring gear and hub assembly (9). Coat needle roller bearing (7) and front race, with petroleum jelly (item 21, Appendix B) and install them onto rear race (8).
(25) Install the low planetary carrier assembly (6) into the adapter housing (14).
(26) Beginning with an external-tanged plate, alternately install seven external-tanged (11) and six internal-splined (12) low clutch plates.
(27) Install ball bearing (2) onto low planetary ring gear rear hub (1).
(28) Install a bearing race (4), lip first, and a needle bearing (5) onto the rear inner diameter of the low carrier assembly (6). Install the rear race (3) on the front hub of the low ring gear (1). Retain the bearing and two races with petroleum jelly (item 21, Appendix B).
(29) Install the low ring gear by carefully engaging the teeth of the gear with those of the four planetary pinions.

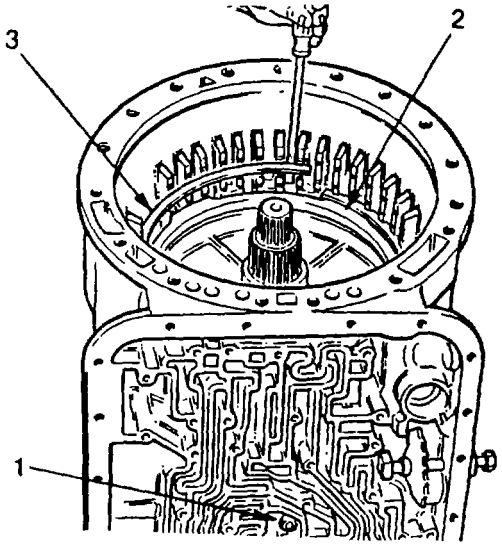
aj. Installation of Rear Cover

(1) Install a lifting sling into the lifting bracket of output shaft.
(2) Install the rear cover gasket onto the rear cover. Be sure the holes in the gasket aline with those in the adapter housing. Retain the gasket on the rear cover with petroleum jelly (item 21 Appendix B).
(3) Attach a hoist to the lifting bracket. Install the rear cover onto the adapter housing. Since the two dowel pins in the cover are of different size, installation is simplified.
(4) Install twenty-one ½ -13 X 5 ¾ in. bolts and three 1/2/13 X 7 ¼ in. bolts, and lockwashers, to retain the rear cover. Tighten the bolts to 67-80 ft lb (91-108 Nm).
(5) Invert transmission front upward.



ak. Installation Of Gear Unit, Second Clutch And Center Support

(1) Remove the selective snap ring (3) that retains the center support (2). Remove the anchor bolt (1) that retains the center support to the transmission housing.

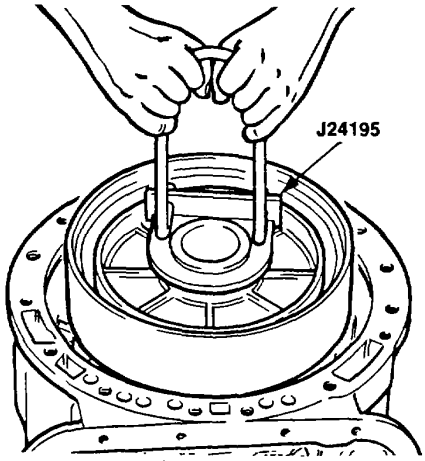


3-7. TRANSMISSION-Continued

(2) Install lifting bracket J24195 onto center support and remove the support.

(3) Remove the second-clutch snap ring. Remove the second-clutch plates. Identify the pack and keep it intact.

(4) Remove the four 1/8 in. cotter pins Installed during gear and hub assembly.



CAUTION

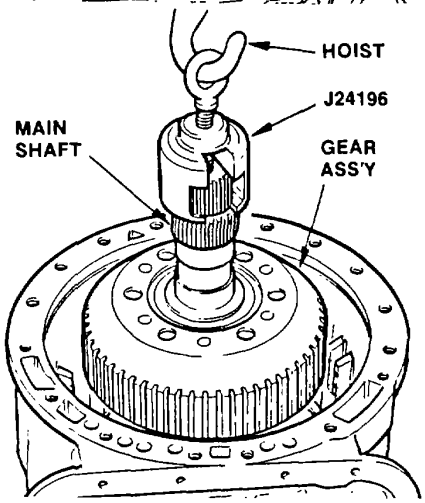
Be sure all four cotter pins have been removed from the rear planetary ring gear.

(5) Install bearing race into the recess in the front of the gear and hub assembly. Retain it with petroleum jelly (item 21, Appendix B).

(6) Install bearing race and needle bearing onto the hub of the rear carrier assembly Retain them with petroleum jelly (item 21, Appendix B).

(7) Attach lifting bracket J24196 to the main shaft of the gear unit assembly. Attach a hoist to the eyebolt on the lifting bracket.

(8) Lower the gear unit assembly engaging the teeth of the four carrier pinions and the Internal splines in the carrier hub with the internal teeth of the rear ring gear and external splines of the output shaft respectively.



(9) Install the 13 pre-selected second-clutch plates beginning with an external-tanged plate, and alternately installing seven external-tanged and six internal-splined plates.

(10) Install the white color coded snap ring or red color coded snap ring (if initial installation check called for thicker snap ring) that retains the second-clutch plates. Be sure the snap ring gap is located at the top of the transmission housing.

(11) Install the third clutch piston assembly into the center support. The lips of the seal rings must be toward the cavity in the center support.

CAUTION

Improper installation of butt-joint seal rings may cause transmission failure. If humidity is allowed to penetrate and expand the butt-joint seal ring, the seal ring can be damaged during installation. A damaged seal ring will leak oil from the clutch piston cavity and cause clutch3-75 slippage. Do not open the sealed package until you are ready to install the seal ring.

3-7. TRANSMISSION-Continued

(12) Before installing the seal ring, the end clearance must be checked to ensure that the seal ring has not been expanded.

(13) Remove the seal ring from its sealed package. Place it in its operational position Inside the bore that it will be sealing.

(14) Using a feeler gage, check the end clearance of the seal ring. The end clearance must not be less than 0.010 in. (0.25 mm).

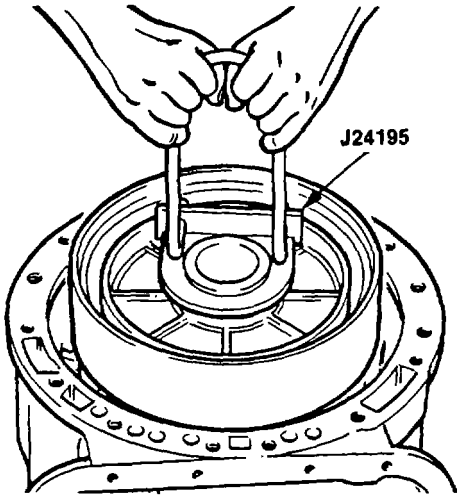
(15) If the end clearance is less than 0.10 in. (0.25 mm), bake the seal ring in an oven at 200-300 deg. F (93-149 deg. C) for 24 hours or get a new seal ring. Recheck end clearance.

(16) Pack the seal ring and its groove with a liberal amount of petroleum jelly (item 21, Appendix B).

(17) Roll up the seal ring to about half its free diameter and hold it that way for about 10 seconds. Being careful not to spread the seal ring more than necessary, slide it onto the hub. Place one end of the seal ring into the groove and gradually work the seal into the groove.

(18) Attach lifting bracket J24195 and install the center support assembly. Aline the tapped hole in the support to the hole in the transmission housing.

(19) Install the special 3/8-16 X 3 in. bolt and plain washer, fingertight. Remove the lifting bracket.



NOTE

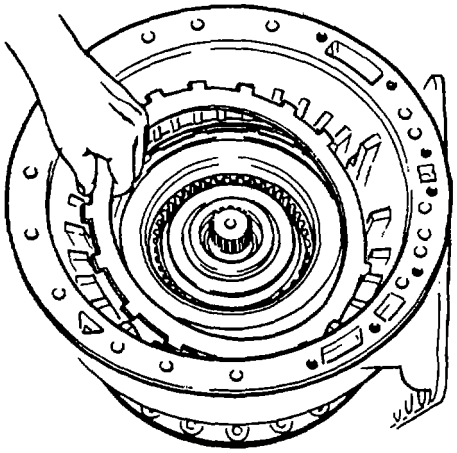
It may be necessary to compress the center support to install the selective snap ring.

(20) Install the selective snap ring that retains the center support. Be sure the gap of the snap ring is at the top of the transmission housing.

am. Installation Third And Fourth Clutch

(1) When installing the third clutch plates, the external-tanged clutch plates must have a definite tang-to-slot relation. The tangs must be installed into the shorter, narrower slots.

(2) Install ten third-clutch plates, beginning with a thick external-tanged plate and alternately installing five external-tanged plates and five internal-splined plates.



3-7. TRANSMISSION - Continued

CAUTION

Be sure the clutch plate next to the piston is a thick plate.

(3) Install backplate and white color coded snap ring. Be sure the gap of the snap ring is at the top of the transmission housing.

(4) Check the third clutch clearance by inserting gage J24193 between the snap ring and the backplate of the third clutch. The clearance should be 0.060 1.120 in. (1.52 3.05 mm). Any dimension between 0.060 0.120 in. (1.52 3.05 mm) is satisfactory. Replace worn plates with new plates to establish the desired clearance. When the assembly is satisfactory, continue assembly.

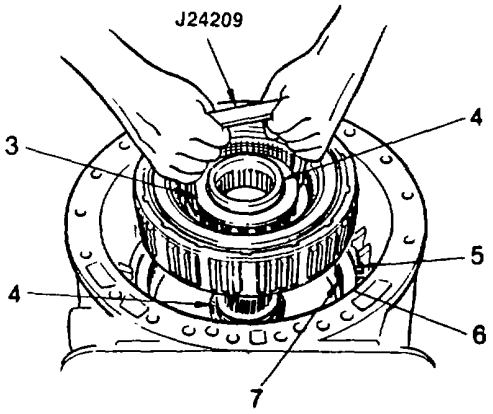
(5) Prior to the installation of the fourth-clutch assembly, be sure the bearing races at both the front and back are in place.

(6) Check the seal rings, bearing, and race are in place on the center support. Ensure the inner lube direction lip of the race on the center support is 0.233 In. (5.9 mm).

NOTE

Do not remove the support ring from the fourth-clutch housing.

(7) Place lifting bracket J24209 under the spring retainer of the fourth-clutch assembly. Aline the internal-splines of the third-clutch plates and the sun gear shaft to the fourth-clutch housing. Install the housing.

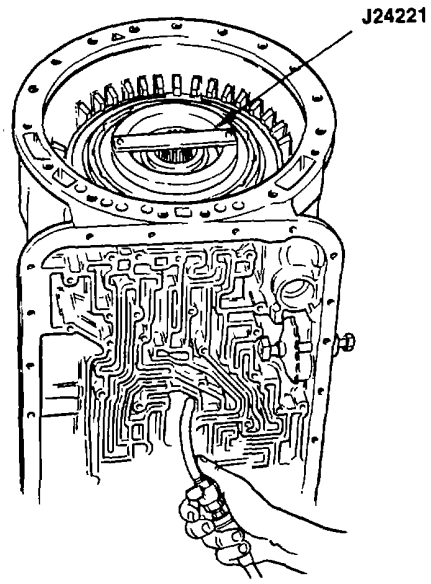


(8) Be sure the bearing race at the top (front) of the clutch is in place. If not, lubricate it with petroleum jelly (item 21, Appendix B) and install.

an. Installation Of Forward Clutch Assembly

(1) Prior to installation of the forward clutch assembly, make sure the thrust bearing race and thrust bearing have been installed at the rear of the clutch assembly. The other bearing race was previously installed in fourth clutch assembly.

(2) Install alinement fixture J24221. Engage the fourth-clutch plates by applying air pressure to the fourth-clutch piston. If all plates do not engage tool J24221, the fixture will rise slightly when air pressure is applied.

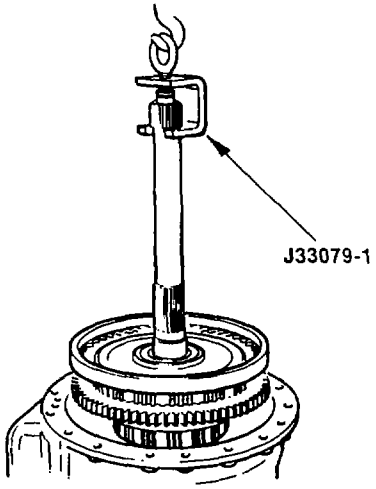


3-7. TRANSMISSION - Continued

(3) Hold air pressure in the clutch and remove the fixture. Install lifting fixture J33079-1 to the turbine shaft and lift into installation position. Continue holding air pressure, and install the forward clutch assembly.

(4) Release the air pressure when the forward clutch is fully seated (forward clutch will fall slightly when air is released if the clutch is not fully seated).

(5) Install thrust race, cup side first, onto the forward clutch hub. Install needle bearing onto the race. Retain the bearing and race with petroleum jelly (Item 21, Appendix B).



(6) Install new center support bolt. Tighten the bolt to 46 ft lb (62 Nm).

ap. Installation Torque Converter Housing

(1) Place converter housing assembly on workbench so both front and rear are accessible.

(2) Install thrust race to rear of converter housing. Retain with petroleum jelly (item 21, Appendix B). Ensure the inner lube direction lip of the race is 0.233 in. (5.9 mm). If bearing was not installed on forward clutch assembly, install it to converter housing using petroleum jelly (item 21, Appendix B).

CAUTION

Improper installation of the two butt-joint seal rings onto front support hub may cause transmission failure. If humidity is allowed to penetrate and expand the butt-joint seal ring, the seal ring can be damaged during installation. A damaged seal ring will leak oil from the clutch piston cavity and cause clutch slippage. Do not open the sealed package until you are ready to install the seal ring.

(3) Before installing the seal ring, the end clearance must be checked to ensure that the seal ring has not been expanded.

(4) Remove the seal ring from its sealed package. Place it in its operational position inside the bore that it will be sealing.

(5) Using a feeler gage, check the end clearance of the seal ring. The end clearance must not be less than 0.010 in. (0.25 mm).

(6) If the end clearance is less than 0.10 in. (0.25 mm), bake the seal ring in an oven 200 300 deg. F (93 149 deg. C) for 24 hours or get a new seal ring. Recheck end clearance.

(7) Pack the seal ring and its groove with a liberal amount of petroleum jelly (item 21, Appendix B).

3-7. TRANSMISSION - Continued

(8) Roll up the seal ring to about half its free diameter and hold it that way for about 10 seconds. Being careful not to spread the seal ring more than necessary, slide it onto the hub. Place one end of the seal ring into the groove and gradually work the seal into the groove.

(9) Install the butt-joint seal rings onto the front support hub.

(10) Attach a lifting sling to the converter housing. Raise the converter housing assembly above the transmission in the vertical position.

(11) Install two 1/2 13 X 2 3/8 in. guide screws J1126, one in the converter housing and one in the transmission housing.

(12) Install two # 10 32 X 6 in. guide screws J6889-1 into the pitot tube. Exit port of pitot tube must face toward guide bolts. Ins-all the pitot tube and guide bolts so that the guide bolts enter the screw holes in the converter housing, and entrance port of pitot tube faces outward (toward pitot collector ring).

(13) Install the converter housing onto the transmission housing, using care to avoid damage to the pitot tube and the collector ring.

(14) Install two 1/2 13 X 2 1/4 in. self-locking bolts, with flat washers, into the recessed holes in the mounting pad (at the 8 o'clock position, viewed from front of transmission. Tighten the bolts to 97 ft lb (132 Nm).

(15) Into the next bolt hole, counterclockwise, install a 1/2 13 X 2 1/2 in. bolt, with a lockwasher. Tighten the bolt to 80 ft lb (108 Nm).

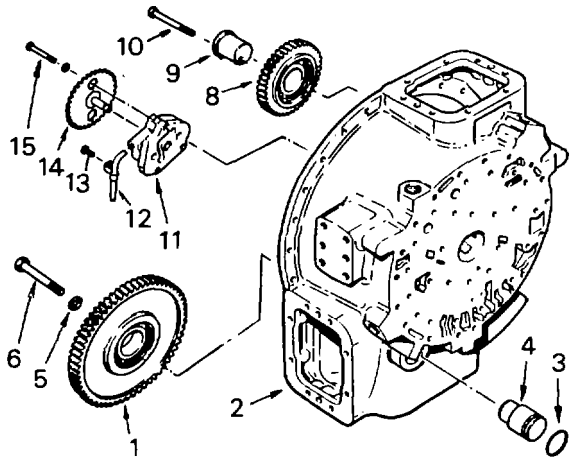
(16) Install 1/2 13 X 3 3/4 in. bolt, with lockwashers, at the 5 o'clock position. Install three 1/2 13 X 2 1/8 in. bolts, with lockwashers, into the remaining holes. Tighten the bolts to 80 ft lb (108 Nm).

(17) Install the pitot tube screws and washers as each guide bolt is removed. Tighten the screws to 48 in. lb (5 Nm).

(18) Install eleven 1/2 13 X 2 in. bolts, with lockwashers through the front flange of the transmission housing, into the rear of the converter housing. Some bolt holes may be blocked by mounting fixture. Install bolts when removed from fixture. Tighten the bolts to 80 ft lb (108 Nm).

aq. Installation PTO Drive Assemblies And Scavenge Pump

(1) Install gear assembly (1) into the converter housing (2). Install seal ring (3) onto spindle (4). Coat the spindle with petroleum jelly (item 21, Appendix B). Aline the gear with the spindle bore in the housing. Install spindle (4) by driving it forward with a soft mallet until its larger diameter seats against the inner race of the bearing in the gear. Install lockwasher (5) and the 1/2 20 X 3 3/4 in. bolt (6) to retain the spindle. Tighten the bolt to 100 ft lb (136 Nm).

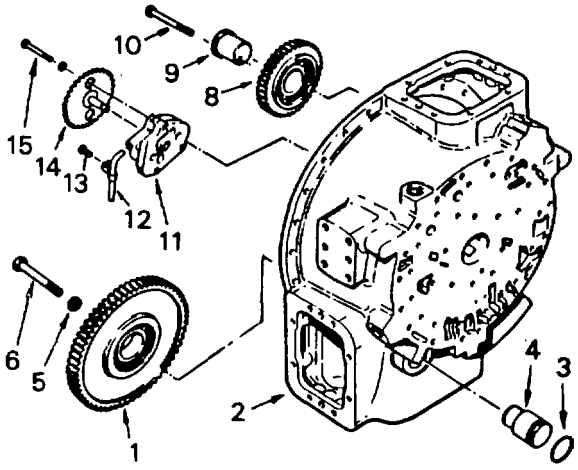


3-7. TRANSMISSION - Continued

(2) Install the PTO idler gear (8) and spindle (9). Install the gear and spindle into the bore near the top of the converter housing, alining the bolt hole in the spindle with the tapped hole in the housing.

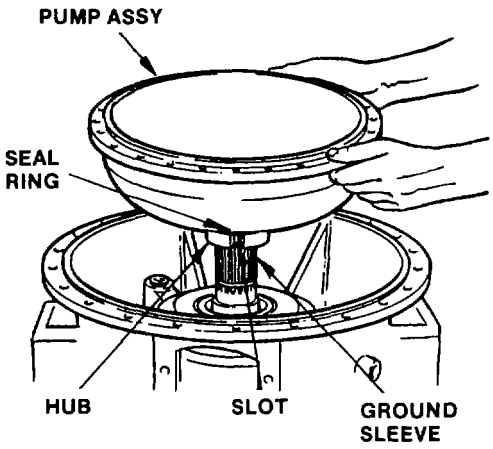
(3) Retain the gear and spindle with the 1/2-13 X 3 1/4 in. self-locking bolt (10). Tighten the bolt to 97 ft lb (132 Nm).

(4) Install three bolts (15) through holes in pump drive gear (14) retain scavenge oil pump (11). Use one bolt (13) to attach suction tube (12). Tighten mounting bolts to 32 ft lb (43 Nm), and suction mounting bolt to 43 ft lb (58 Nm).



ar. Installation Torque Converter Pump and Stator Assembly (1) Install torque converter pump assembly onto ground sleeve. Check that seal ring is on the hub.

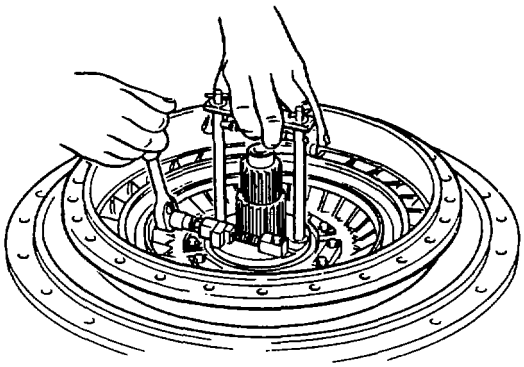
(2) Pump bearing is a press fit on the ground sleeve. It may be necessary to heat hub and bearing area of the pump assembly to 300 deg. F (149 deg. C) in oil bath before installation.



(3) Aline the slots in the pump hub with tangs in the charge oil pump drive gear as the pump is being installed.

(4) Install spacer onto the converter ground sleeve.

(5) Place snap ring into tool J26598-A as follows. Close the jaws of the tool by rotating the adjusting nut. Place the snap ring in the tool, under the safety guards. Position the jaws of the tool in the snap ring gap. Open the jaws of the tool by rotating the adjusting nut to the stop nut.



(6) Place the fixture, with snap ring over the ground sleeve. Open the safety guards to position the snap ring.

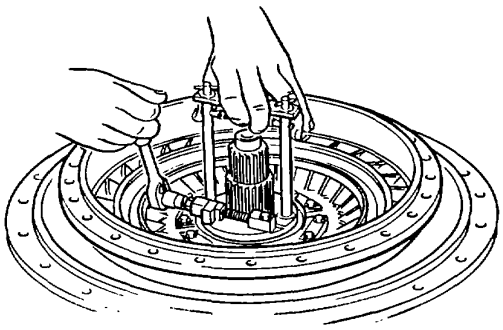
(7) Close the jaws and set the snap ring in its bore in the ground sleeve. Remove the tool.

3-7. TRANSMISSION - Continued

NOTE

If special tool J26598-A is not available, install the snap ring with snap ring pliers. Do not scrape the ground sleeve splines during installation.

(8) Install rebuilt stator assembly by rotating clockwise. The stator should lock if counterclockwise rotation is attempted.



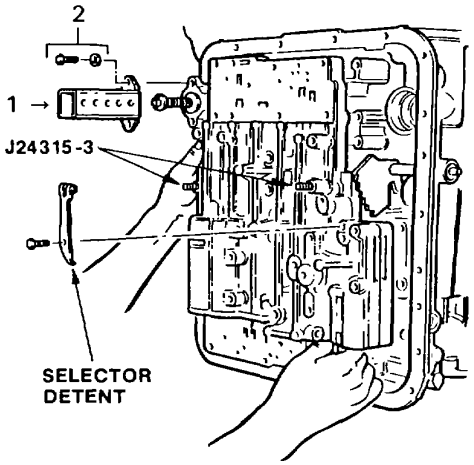
as. Installation Valve Bodies

NOTE

Pre-set to 10 ft lb (13 Nm), the valve body torque wrench, J29612, can be utilized to tighten all valve body bolts.

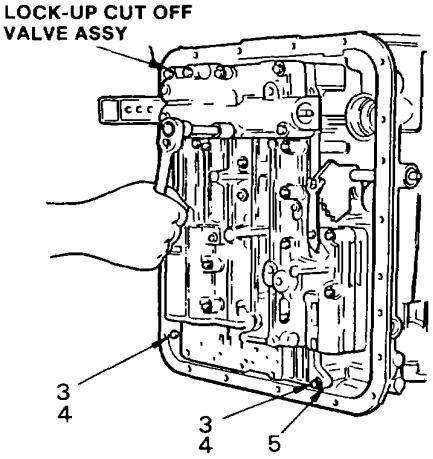
(1) Install two guide screws J24315-3 into opposite holes in the transmission housing.

(2) Install the control valve assembly using the guide screws as support, onto the transmission. The groove in the selector valve must engage the pin on the detent lever.



(3) Install the lubrication check valve baffle (1) and retain it with two 1/4 20 1 1/2 in. bolts (2).

(4) Install two 1/4 20 X 1 1/2 in. bolts (3) and two 1/4 in. washers (4) through the oil transfer plate (5) and into the transmission housing. Bolts retain the oil transfer plate, separator plate and control valve assembly to the transmission housing. Tighten the bolts to 12 ft lb (16 Nm).



(5) Install thirteen 1/4 20 X 3 in. bolts through the valve body assembly and into the housing. Remove two guide screws J24315 and install two remaining 1/4 20 X 3 in. bolts. Install the selector detent and retain it with a 1/4 20 X 2 1/2 in. bolt. Tighten the bolts to 10 ft lb (13 Nm).

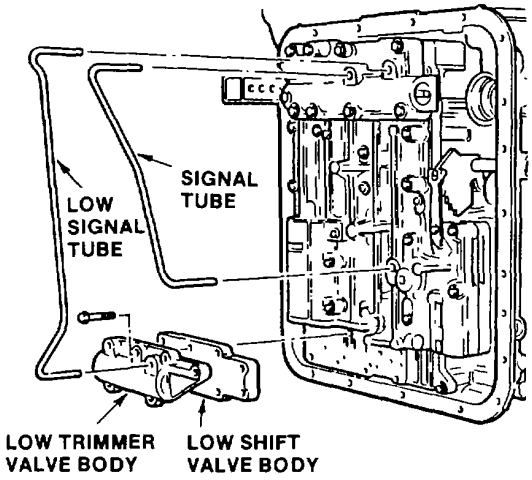
(6) Install the lockup cutoff valve body assembly. Retain it with eight 1/4 20 X 3 in. bolts. Tighten the bolts to 10 ft (13 Nm).

(7) Install the low shift valve body onto the lower guide screw. Retain the body with one 1/4 20 X 2 3/4 in. bolt. Tighten the bolt to 10 ft lb (13 Nm).

(8) Install the low trimmer valve. Install six 1/4 20 X 4 in. bolts to retain the trimmer valve. Tighten the bolts to 10 ft lb (13 Nm).

(9) Install the signal tube. The signal tube must be installed into lockup cutoff valve into the hole near the center of the valve body. The hole near the end of the valve body must remain open.

(10) Install low signal tube from low trimmer valve to lockup cutoff valve.

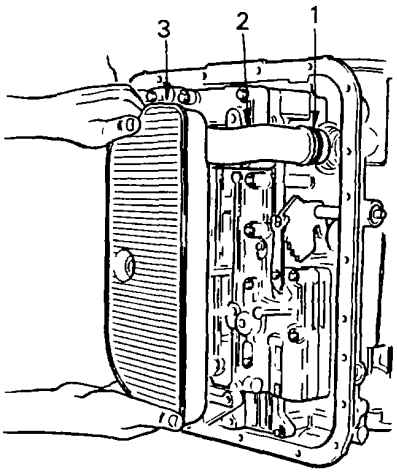


at. Installation Oil Filter And Oil Pan

(1) Lubricate and install seal ring (1) onto the neck of the intake tube (2) on the oil filter (3).

(2) Install the oil filter (3) so the intake tube and seal ring fit squarely and snugly into the transmission housing. Do not twist the oil filter during installation, push straight inward. Retain oil filter with one 5/16 18 X 2 3/4 in. bolt, 5/16 plain washer and spacer. Tighten bolt to 20 ft lb (27 Nm).

(3) Install two 5/16 18 X 3 in. guide screws J3387-2 into the transmission housing.

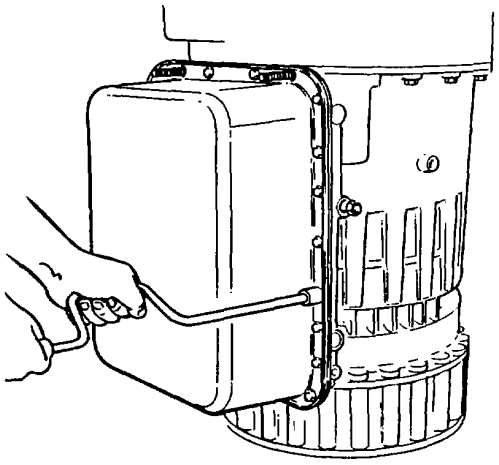


CAUTION

If adhesives or sealers are required to retain the oil pan gasket, they may be applied onto the pan mounting flange, but only in the area outside the flange bed.

(4) Install a new oil pan gasket over the guide screws. Aline all holes in the gasket with those in the housing.

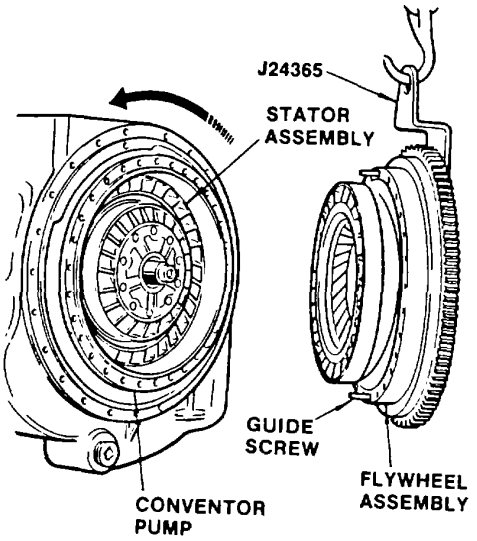
(5) To install the oil pan, use twenty-three 5/16 18 X 5/8 in. bolts. Alternately tighten each bolt, 180 deg. apart, to approximately half the specified torque. Final torquing should be 20 ft lb (27 Nm). Pan bolts must retain a minimum of 5 ft lb (7 Nm) after gasket set to prevent leakage.

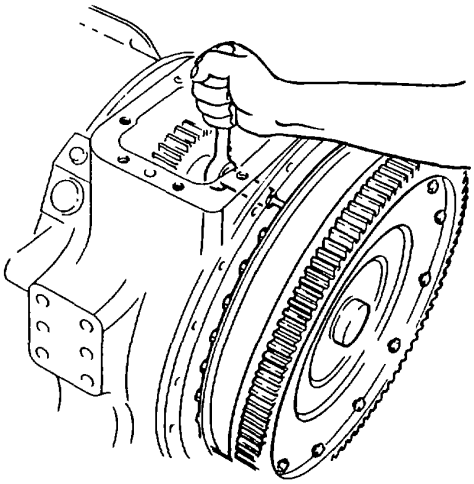


3-7. TRANSMISSION - Continued

au. Installation Flywheel, Lockup Clutch And Torque Converter Turbine

(1) Position transmission horizontally.
(2) Place the flywheel assembly on a work table, ring gear side down. Install two 3/8 24 x 2 in. guide screws J24315-2 into the flywheel mounting holes. Be sure the seal ring on the end of the input shaft is in place.
(3) Carefully lift the flywheel to a vertical position and attach lifting bracket J24366 opposite one guide screw. Retain the bracket with 1/2 20 bolts.
(4) Attach a hoist to the lifting bracket. Aline the flywheel assembly with the transmission.
(5) Push flywheel assembly straight onto the transmission, alining guide screws J24315-2 with one bolt hole in the converter pump. Engage turbine splines with the forward clutch shaft splines.
(6) Using the access hole at the top of the converter housing install one 3/8 24 X 1 1/4 in. bolt and one 3/8 flat washer through the converter housing into the flywheel assembly.
(7) Release the hoist and remove the lifting bracket.
(8) Install the remaining 29 bolts and flat washers. Prior to installing the last two bolts and washers, remove guide screws J24315-2.
(9) Tighten the bolts to 49 ft lb (66 Nm).





av. Installation Of External Components To Transmission Prior To Installation Into Unit

(1) Install the modulator valve retainer and secure it with one 5/16 18 X 3/4 in. bolt. Do not tighten the bolt at this time. Modulator actuator will be installed when the transmission goes into the vehicle.
(2) Attach hoist to the holding fixture that is secured to the transmission. Remove all fasteners that retain the holding fixture and the transmission to the overhaul stand. Remove transmission and fixture from the overhaul stand.
(3) Place transmission on transmission jack.
(4) Remove four bolts and units that retain the holding fixture to transmission Remove fixture and install any remaining bolts on transmission.

3-8. ENGINE.

3-8.1 Engine.

This task covers

a. Removal
b. Installation

TOOLS (see TM 5-4210-220-12)
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
10, Appendix D Engine Brackets
Exhaust System Removed (see TM 5-4210-220-12)

EQUIPMENT CONDITION
Water Tank Drained (see TM 5-4210-220-12)
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Auxiliary Firefighting Equipment Removed
All Air Tanks Drained
Wheels Blocked
Jump Seats Removed (see TM 5-4210-220-12)
Pump Body Panel Door Removed (see TM 5-4210-220-12)
Heat Shields Removed (see TM 5-4210-220-12)
Drive Shafts Removed (see TM 5-4210-220-12)
Engine Air Cleaner Removed (see TM 5-4210-220-12)
Engine Coolant Drained (see TM 5-4210-220-12)
Engine Canopy Removed (see TM 5-4210-220-12)
Transmission Cooling and Filter Hoses Removed
Transmission Filter Removed (see TM 5-4210-220-12)
PTO Drive Shaft and PTO Gearbox Removed (see TM 5-4210-220-12)
Air Compressor Removed
Starter Removed (see TM 5-4210-220-12)
Transmission Removed (see TM 5-4210-220-12)
Engine Crankcase Drained (see TM 5-4210-220-12)
Fan Assembly Removed (see TM 5-4210-220-12)
Radiator Removed (see TM 5-4210-220-12)
Engine Electrical Wiring Harness Disconnected (see TM 5-4210-220-12)
Alternator Removed (see TM 5-4210-220-12)
Power Steering Hoses Removed (see TM 5-4210-220-12)
Power Steering Pump Removed (see TM 5-4210-220-12)
Power Steering Filter/Res Removed (see TM 5-4210-220-12)
Fuel Lines to Engine Removed (see TM 5-4210-220-12)
Water/Fuel Separator Removed (see TM 5-4210-220-12)
Fuel Filter Removed (see TM 5-4210-220-12)
Turbocharger Removed (see para. 3-8.2)

MATERIALS/PARTS
2, Appendix B Antifreeze
9, Appendix B Dexron
14, Appendix B Gasket Eliminator
16, Appendix B Grease
17, Appendix E, Engine Oil
20, Appendix B Penetrating Oil
22, Appendix B Pipe Sealant
29, Appendix B Threadlock Liquid
WCM-1 Engine
310591 Locknut

PERSONNEL REQUIRED - 3

WARNING

Injury to personnel or damage to equipment could occur from improper hoisting. Hoist the load slowly to avoid tearing out lifting eye assemblies, slipping slings or load shift. Do not jerk the load or swing It from side-to-side when hoisting. This places additional stress on hoisting components which can cause failure and loss of load. Be sure hoisting equipment is on solid footing and is suitable for the size of the load. Watch boom angle and overhead clearance when hoisting.

3-8. ENGINE - Continued

NOTE

To remove and install the truck engine, the workshop must be equipped with an overhead hoist or crane. The hoist or crane should have a lifting capacity of at least 4000 lb (1814 kg) to a height of at least 16 ft (4.9 m) from floor to level.

REMOVAL

(1) Tag and disconnect wiring to electrical sender units in left and right-hand thermostat housings.

(2) Remove engine vent hose from left side rocker cover.

(3) Tag and disconnect all remaining coolant hoses connected to engine.

(4) Remove temperature probe, left-hand thermostat housing.

(5) Remove exhaust manifolds from heads and exhaust pipes from turbocharger assembly as detailed in para. 2-,19.1.

(6) Tag and disconnect wiring to shunt attached to rear of left-hand lifting bracket.

(7) Tag and disconnect wiring to governor control.

(8) Tag and disconnect air hose and water hose attached to fire pump governor.

(9) Tag and disconnect air hose attached to foot throttle air chamber.

(10) Remove rpm sensor from engine bell housing.

(11) Remove engine fuel shutdown, throttle cylinder and pump governor assemblies as detailed in para. 2-19.12.

(12) Remove coolant valves or fittings that may interfere in engine removal.

(13) Remove section of roof turret water pipe running under engine and frame.

(14) Remove engine oil filter as detailed in TM 5-4210-220-12.

(15) Remove mounting bolts from front engine mounting brackets.

(16) Install suitable sling (eg. J36130-806) to the three engine lift brackets, rated at 4000 lbs. Attach hoist to sling. Lift engine up. Remove front mount brackets from engine.

(17) Remove engine from engine compartment and install onto overhaul stand.

3-8. ENGINE - Continued

3-8.1 Engine - Continued

INSTALLATION

NOTE

If engine is being replaced, remove exhaust manifolds, turbocharger, starter motor, air compressor and alternator from new engine prior to installation.

(1) If engine being installed into truck is a new replacement engine transfer all senders, sensors and coolant taps and fittings from original block to replacement block. Clean all threads and coat with pipe sealant (item 22, Appendix B) prior to installation. If original engine, replace any electrical senders removed during overhaul. Install coolant valves and fittings coating with pipe sealant (item 22, Appendix B) prior to installation.

(2) Install auxiliary mounting brackets to rear engine pad mount areas (10, Appendix D) Tighten six mounting bolts to 90 ft lb (122 Nm). Install front engine mount brackets. Tighten to 90 ft lb (122 Nm).

(3) Inspect vibration isolator on front engine mount. Replace as required.

(4) Install lifting sling to the three engine lift brackets. Attach suitable hoist to sling. Remove engine from overhaul stand.

(5) Raise engine high enough to clear cab, center with cab opening and lower engine into engine compartment.

(6) Position engine in engine compartment in line with front engine cross member. Place heavy washer on top of isolators. Lower engine close to isolators. Aline and install two mounting bolts.

(7) Continue to lower engine until auxiliary rear mount brackets are resting on main frame side members and front mount brackets are resting on front engine cross member. Install snubbing washers and new 5/8 locknuts to front mount bolts. Do not tighten to full torque at this time.

(8) Remove hoist and sling from engine lift brackets.

(9) Attach transmission to engine and frame as detailed in TM 5-4210-220-12.

(10) Tighten front engine mount locknuts to 180 ft lb (245 Nm).

(11) Install radiator as detailed in TM 5-4210-220-12.

(12) Install fan assembly as detailed in TM 5-4210-220-12.

(13) Install throttle, fuel shutdown and fire pump governor as detailed in para. 2-20.12.

(14) Install starter motor as detailed in TM 5-4210-220-12.

(15) Install air compressor and air lines as detailed in TM 5-4210-220-12.

(16) Install turbocharger as detailed in para. 3-8.2.

3-8. ENGINE - Continued

(17) Install exhaust manifolds as detailed in para. 2-19.1.

(18) Install alternator as detailed in TM 5-4210-220-12.

(19) Install transmission filter as detailed in TM 5-4210-220-12.

(20) Install transmission cooling and filter hoses as detailed in TM 5-4210-220-12.

(21) Install power steering reservoir/filter as detailed in TM 5-4210-220-12.

(22) Install power steering pump as detailed in TM 5-4210-220-12.

(23) Install power steering lines as detailed in TM 5-4210-220-12.

(24) Install water/fuel separator as detailed In TM 5-4210-220-12.

(25) Install fuel filter and fuel lines as detailed in TM 5-4210-220-12.

(26) Install engine air cleaner as detailed in TM 5-4210-220-12.

(27) Install main drive shafts as detailed in TM 5-4210-220-12.

(28) Install PTO gearbox and drive shaft as detailed in TM 5-4210-220-12.

(29) Install exhaust system as detailed in TM 5-4210-220-12.

(30) Install engine wiring harness as detailed in TM 5-4210-220-12.

(31) Install engine oil filter as detailed in TM 5-4210-220-12.

(32) Install loose labeled air lines not yet connected to components.

(33) Install coolant fittings and valves previously removed and labeled. Use pipe sealant (item 22, Appendix B) on all threads.

(34) Install labeled coolant hoses not yet connected. Properly secure hoses making sure all connections are tight.

(35) Install engine coolant as detailed in LO 5-4210-220-12.

(36) Install transmission fluid as detailed in LO 5-4210-220-12.

(37) Install power steering fluid as detailed in LO 5-4210-220-12.

(38) Ensure engine lubrication oil filter is properly tightened.

CAUTION

The lubricating oil film on the rotating parts and bearings of a new or overhauled engine, or one which has been in storage, may be insufficient for proper lubrication when the engine is started for the first time. Insufficient lubrication at start up can cause serious damage to the engine components. To ensure an immediate flow of oil to all bearing surfaces at initial engine start up, the engine lubrication system must be charged with a pressure pre-lubricator as detailed following.

3-8. ENGINE - Continued

3-8.1 Engine - Continued

(39) Remove the pipe plug from the engine main oil gallery and attach the pre-lubricator hose.

(40) Remove the valve rocker covers and, using a positive displacement pump set at 25 35 psi (172 241 kPa), pump in the recommended grade of engine lubricating oil until it is observed flowing from the rocker arms.

(41) Disconnect the oil supply line at the turbocharger bearing center housing and fill the bearing housing cavities with approximately one pint of the recommended grade of clean engine oil. Turn the rotating assemblies by hand to coat all internal surfaces with oil.

(42) Reinstall the turbocharger oil supply line.

(43) Disconnect the pre-lubricator hose, plug the main oil gallery hole and replace all components previously removed.

(44) Check crankcase oil level. Add oil until level is at the "full" mark on dipstick. Do not overfill.

(45) Reconnect batteries as detailed in TM 5-4210-220-12.

(46) Turn battery switch to BOTH.

(47) Purge fuel system, by pressing PRIME switch in cab.

(48) Remove inlet fuel line to mechanical gear fuel pump on top front right side of engine. Leave line open till fuel supply is continuous with no air bubbles. Tighten fuel line.

(49) Release PRIME pushbutton in cab.

(50) Open all valves in engine compartment. Check cab heater is set to HOT.

(51) Start APU as detailed in TM 5-4210-220-12 to circulate water in winterization system. Check all hoses, valves, and heaters for leaks.

(52) Loosen clamp on top circulation hose of pump body heater. While hose is loose on heater, purge air from system. Run APU for several minutes.

(53) Shutdown APU as detailed in TM 5-4210-220-12. Check coolant level in main engine radiator. Refill with coolant as required and secure the cap.

(54) Tighten/remake any connections as required.

(55) Repeat purge cycle again using the APU steps 51 thru 53.

(56) Final engine pre-start check list.
- (a) Transmission fluid level
- (b) Power steering fluid level
- (c) Fuel system purged to mechanical fuel pump
- (d) Engine oil level
- (e) Coolant fluid level
- (f) Air intake properly clamped
- (g) Electrical system completely connected
- (h) Governor controls connected and adjusted

3-8. ENGINE - Continued

(57) Before performing start up, fill all air reservoirs with shop air. Connect shop air to the connection on the right hand side of the pump body. Charge all tanks to 100 psi. Remove ground wire from fuel shutoff solenoid. This ensures positive fuel shutoff. Crank engine several times till engine oil pressure Is registered on instrument panel gage.

(58) Reconnect ground wire to shutoff solenoid.

(59) Recheck coolant level in radiator. Add coolant (item 2, Appendix B) as required.

(60) Start engine. Run for 5 minutes at idle. Observe and listen to engine running. Record areas for further inspection and repair.

(61) Conduct a recheck of all systems. Add fluids as required (Refer to step 56). Correct and repair problems recorded during initial run period.

(62) Start engine and run for 30 minutes at 1500 rpm. The engine should be observed at all times so that any malfunction which develops will be detected.

(63) Shutdown engine, repair any components and refit all other equipment to truck.

3-8. ENGINE - Continued

3-8.2 Turbocharger.

This task covers
a. Removal
b. Installation
c. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J8001-3 Dial Indicator
J7872-2 Magnetic Base
J7872-3 Swivel Adapter
J7872-1 Extension Rod

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Compartment Covers Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
20, Appendix B Penetrating Oil
8927026 Turbocharger
5104978 Seal Ring
8923492 Gasket
5130488 Stud
9411981 Nut

WARNING

Exhaust parts can be hot enough to cause severe burns if touched. Allow exhaust system to cool before servicing.

NOTE

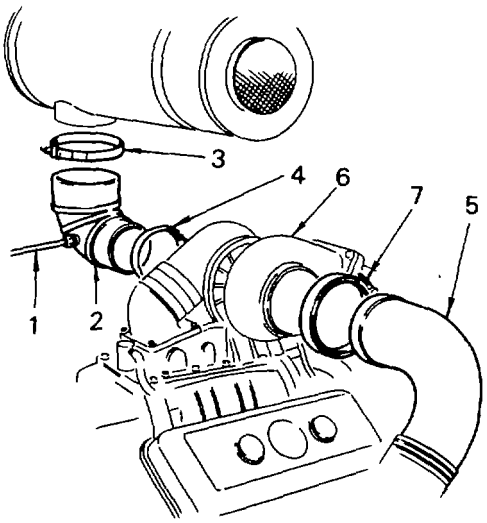
If components are excessively corroded, apply penetrating oil (item 20, Appendix B) to ease disassembly.

REMOVAL

(1) Disconnect the air filter restriction gage air line (1) from the reducing elbow (2).

(2) Remove the reducing elbow (2) by loosening and removing clamps (3 and 4).

(3) Separate the exhaust outlet elbow (5) from the turbocharger (6) by loosening and removing seal clamp (7).

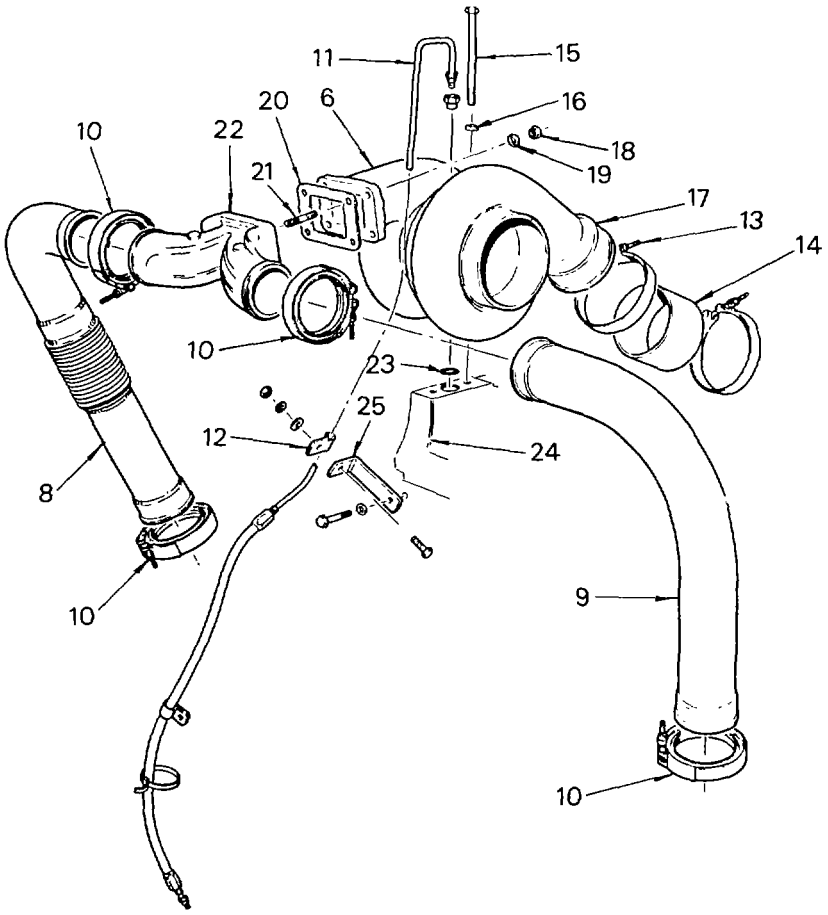


NOTE

The solid left bank tube (9) is almost symmetrical. To make assembly procedure easier, mark one end before removal.

(4) Remove both exhaust manifold to turbocharger pipes (8 and 9) by loosening and removing clamps (10). Examine flanges for cracks or corrosion.

3-8. ENGINE - Continued



(5) Remove and plug the lubrication feed line (11) from the top of the turbocharger. Remove the fasteners retaining the support clamp (12). Position the lubrication line so that it does not interfere with turbocharger removal.

(6) Loosen and remove clamp (13). Slide clamp down on connector hose (14).

(7) Remove the two capscrews (15) and lockwashers (16) that retain the turbocharger to the air inlet housing (24).

(8) Carefully lift the turbocharger assembly from engine compartment. Plug air inlet hose (14).

(9) Remove and discard the seal ring (23). Plug lubrication port in housing (24).

(10) Remove locknuts (18) and washers (19), and separate the turbocharger turbine housing (6) from the exhaust inlet adapter tee (22).

(11) Remove and discard gasket (20).

(12) Examine studs (21) for corrosion or stripped threads. Replace studs as necessary. Clean all gasket material from turbocharger turbine housing (6) and adapter (22) mating surfaces. Carefully check exhaust inlet adapter tee for cracks or any other damage that may cause an 3-93 exhaust leak. Replace inlet adapter tee as necessary.

3-8. ENGINE - Continued

3-8.2 Turbocharger - Continued

INSTALLATION

(1) Install four studs (21) into exhaust inlet adapter tee (22) and torque to 28 ft lb (38 Nm).

(2) Position gasket (20) over four studs (21).

(3) Attach exhaust inlet adapter tee (22) and turbocharger turbine housing (6) together using lockwashers (19) and locknuts (18). Torque locknuts to 28 ft lb (38 Nm).

(4) Remove plug and install a new seal ring (23) into the seal ring groove on the air inlet housing (24).

(5) Carefully lift the turbocharger assembly into engine compartment. Remove plug from air inlet hose (14). Position the turbocharger assembly over the housing (24). Attach inlet hose (14) and aline mounting holes. Make sure seal (23) is still in position.

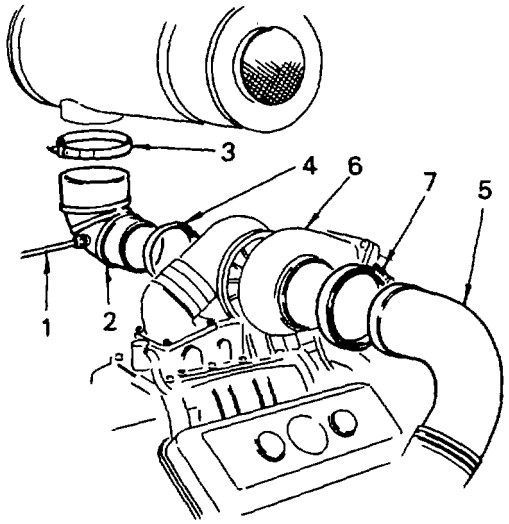
(6) Secure the turbocharger assembly to housing (24) using two lockwashers (16) and capscrews (15). Tighten the capscrews to 44 ft lb (60 Nm).

(7) Secure the air inlet hose (14) to the turbocharger compressor housing (17) using clamp (13). Tighten clamp firmly.

(8) Attach the lubrication line (11) to the turbocharger and tighten firmly.

(9) Attach the lubrication line (11) to the bracket (25) using support clamp (12).

(10) Install both exhaust manifold to turbocharger pipes (8 and 9) into proper position and secure using seal clamps (10). Do not allow exhaust piping to impose excessive loads on turbocharger. Tighten seal clamps firmly.



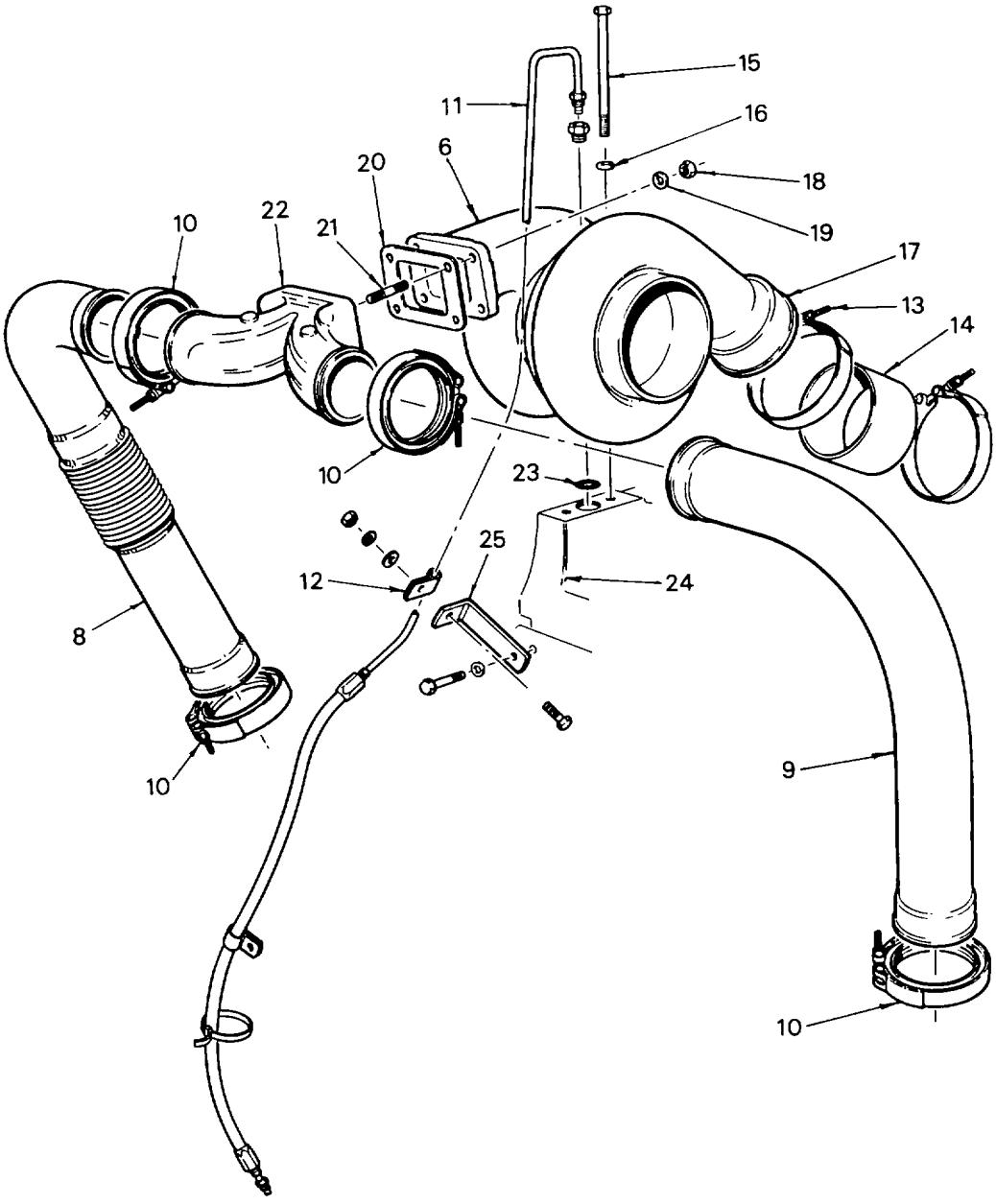
(11) Attach exhaust outlet elbow (5) to turbocharger turbine housing (6) using seal clamp (7). Tighten clamp firmly.

(12) Attach reducing elbow (2) to turbocharger air compressor housing and air cleaner using clamps (3 and 4). Tighten clamps firmly.

(13) Attach the air filter restriction gage air line (1) to the reducing elbow (2).

(14) Start engine and check for air or oil leaks. Tighten or remake connections as necessary.

3-8. ENGINE - Continued



3-8. ENGINE - Continued

3-8.2 Turbocharger - Continued

REPAIR

(1) Remove Turbocharger from engine and clean.

(2) Mark related positions of the compressor housing (2), center housing (3), and turbine housing (6) with a punch prior to disassembly to assure reassembly in the same relative positions.

(3) Remove 'V' band couplings (1 and 4) securing the compressor housing (2) to backplate assembly (14) and securing the turbine housing (6) to the center housing (3).

(4) Remove compressor housing (2) and turbine housing (6) from center housing (3).

(5) Position center housing (3) in holding fixture or suitable socket clamped in a vise. Place the turbine wheel shoulder hub in socket with the center housing upright. Remove wheel nut (7) securing compressor wheel (8) to turbine shaft assembly (9).

(6) Lift or press the compressor wheel (8) from turbine shaft assembly (9).

(7) Remove turbine shaft assembly (9) from center housing (3). The wheel shroud (10) will fall free when the turbine shaft assembly is removed.

(8) Remove and discard the turbine piston rings (11) from shaft assembly.

(9) Remove four bolts (12) attaching the backplate assembly to the center housing. Retain locking tabs (13).

(10) Remove and discard the seal ring (15) from groove in the center housing.

(11) Remove the thrust spacer (16) from backplate (14). Discard piston rings (17) from spacer.

(12) Remove thrust collar (18) thrust bearing (19), bearing (20), washer (21), and snap ring (22) from center housing.

(13) Remove snap ring (23), bearing (24), washer (25), and snap ring (26) from opposite end of center housing.

(14) Inspect all parts for signs of burning, rubbing or other damage.

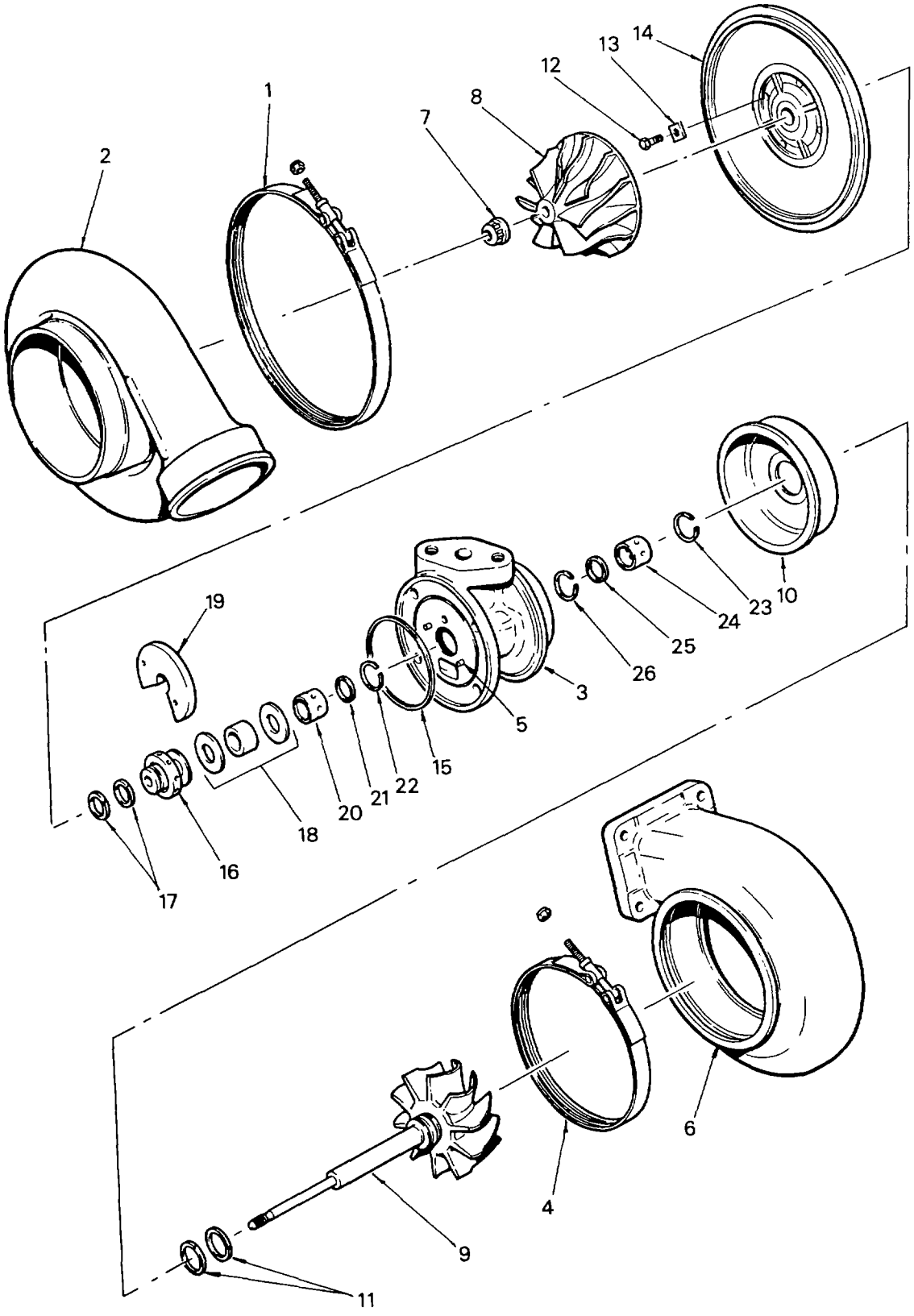
CAUTION

Never use a caustic cleaning solution for cleaning as this will damage certain parts. Use the cleaning solution in an open or well ventilated area. Avoid breathing the fumes to avoid the possible toxic effect of the cleaning solvent. Keep away from open flames to avoid the possibility of a fire. Do not use a wire brush or a steel blade scraper to clean the parts.

(15) Soak all parts in a non-caustic cleaning solvent (item 10, Appendix B). Use a stiff bristle brush to remove all dirt and carbon deposits. Dry all the parts thoroughly.

(16) Make sure that both wheels are thoroughly clean. Deposits left on the wheels will affect the balance of the rotating assembly.

3-8. ENGINE - Continued



3-8. ENGINE - Continued

3-8.2 Turbocharger - Continued

CAUTION

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(17) Clean all the Internal cavities and oil passages in center housing thoroughly with compressed air.

(18) Clean the oil passage in the backplate assembly and thrust collar with compressed air.

(19) Remove oil inlet line from engine and thoroughly clean. Replace line if dented or crimped restricting oil flow.

(20) Inspect all parts for signs of damage, corrosion, or deterioration. Check for nicked, crossed, or stripped threads.

(21) Check the turbine wheel shroud and turbine wheel assembly for signs of rubbing. Inspect shaft to bearing area contact for excessive wear, discoloration, scoring, burnt carbon deposits, bearing seizure, or aluminum transfer deposits from bearing to shaft.

(22) Check compressor wheel for signs of rubbing or damaged fins. Wheel must be free of foreign material.

(23) Inspect seal ring surfaces of center housing and backplate assembly. If signs of scoring or excessive wear are detected, replace worn part(s). During inspection of rotating group, if it is determined that numerous individual parts are required to repair turbocharger, it is advisable to repair turbocharger by replacing center housing assembly. Center housing assembly consists of housing, center bearings, thrust collar, seal rings, turbine wheel assembly, compressor wheel, and locknut.

(24) It is recommended that the seal ring, piston rings, thrust bearings, bearing washers, snap rings, lock plates, and bolts be replaced whenever the turbine is repaired. The backplate must be replaced if the thrust bearing is excessively worn.

(25) Check each part prior to installation to ensure cleanliness.

(26) Install snap ring (26), washer (25), bearing (24), and snap ring (23) in turbine end of center housing.

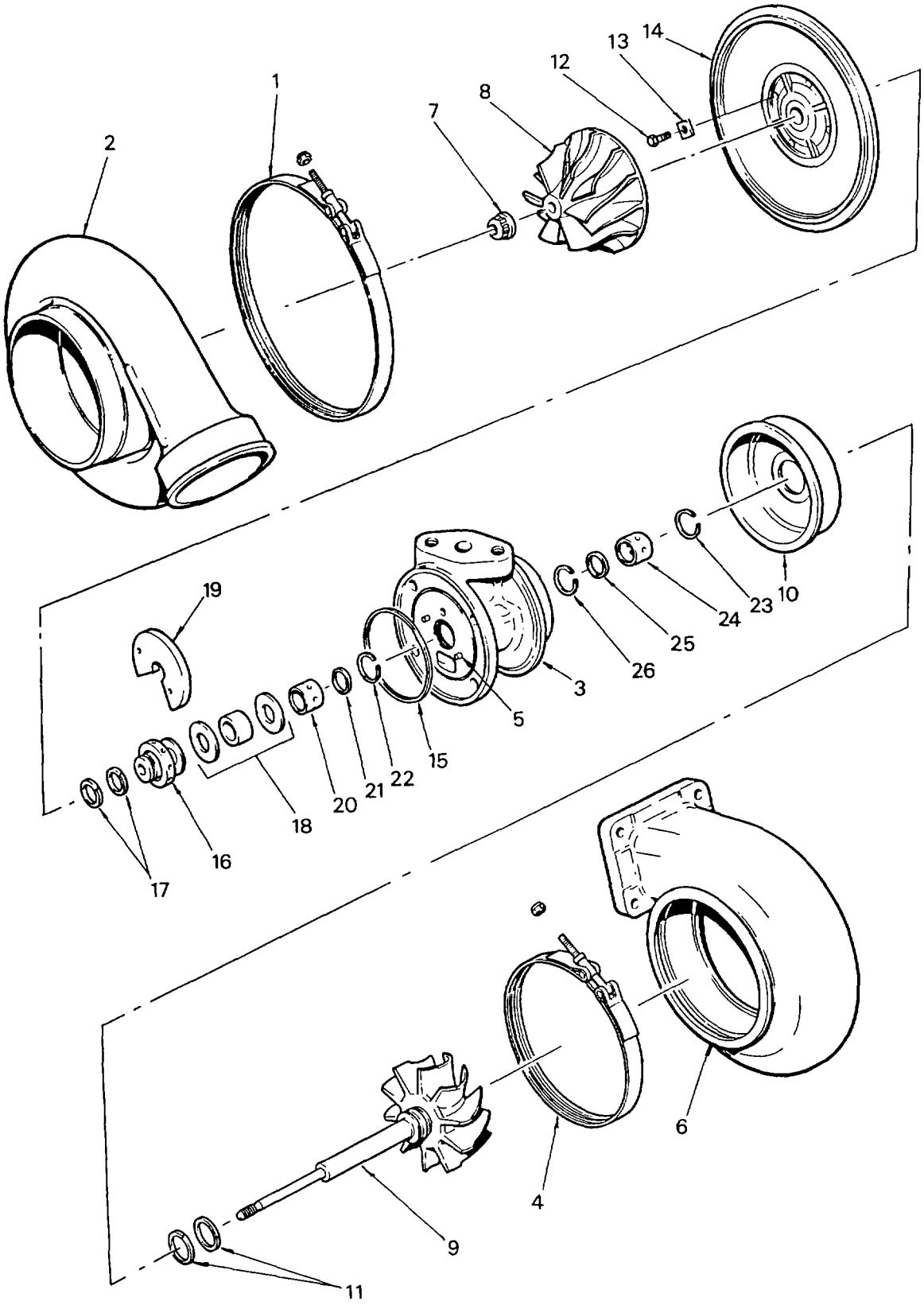
(27) Install snap ring (22), bearing washer (21), and bearing (20) in the compressor end of center housing.

NOTE

Before installing the piston rings, fill the grooves with silicone grease (item 27, Appendix B).

(28) Lubricate new bearings with clean engine oil (item 17, Appendix B).

3-8. ENGINE - Continued



3-8. ENGINE - Continued

3-8.2 Turbocharger - Continued

(29) Install piston rings (17) on thrust spacer (16). Gently Insert spacer into backplate assembly. Do not force piston rings into place .

(30) Fasten thrust washer (19) flat against center housing with the hole and cutout in thrust washer In alinement with pins (5) in center housing.

(31) Install thrust collar (18) against thrust washer. Lubricate with clean engine oil (item 17, Appendix B).

(32) Install new seal ring (15) in groove at compressor end of the center housing.

(33) Aline oil feed hole in center housing and backplate assembly. Attach bsckplate to center housing with four locking tabs (13) and bolts (12). Tighten to 8 ft lb (11 Nm). Bend up corners of locking tabs to secure bolt heads.

(34) Install new turbine piston rings (11) on wheel shaft assembly. Lubricate seal ring with clean engine oil (item 17, Appendix B).

(35) Position wheel shroud (10) against center housing (3) Insert wheel shaft assembly through wheel shroud and into center housing. Be careful not to scuff or scratch bearings when installing shaft assembly.

(36) Place turbine wheel shaft assembly, shroud, center housing, and backplate as assembled upright in holding fixture or suitable socket clamped in vise. Place the extended hub of shaft into socket.

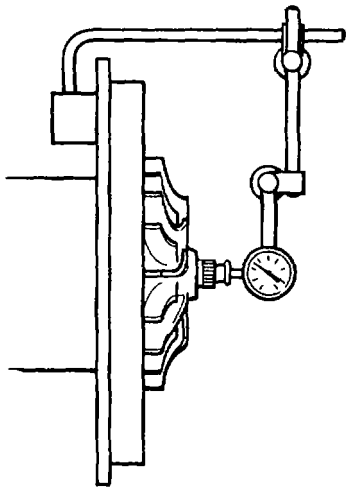
(37) Position compressor wheel over shaft.

(38) Lightly lubricate shaft threads and mounting area of wheel with clean engine oil (item 17, Appendix B). Install compressor wheel and retaining nut. Tighten to 145 in. lb (16 Nm).

(39) Loosen nut and inspect nut face and front face of compressor wheel. Be sure they are clean and smooth.

(40) Retighten nut to 50 in. lb (5 Nm). Continue to tighten nut for an additional 1/4 turn.

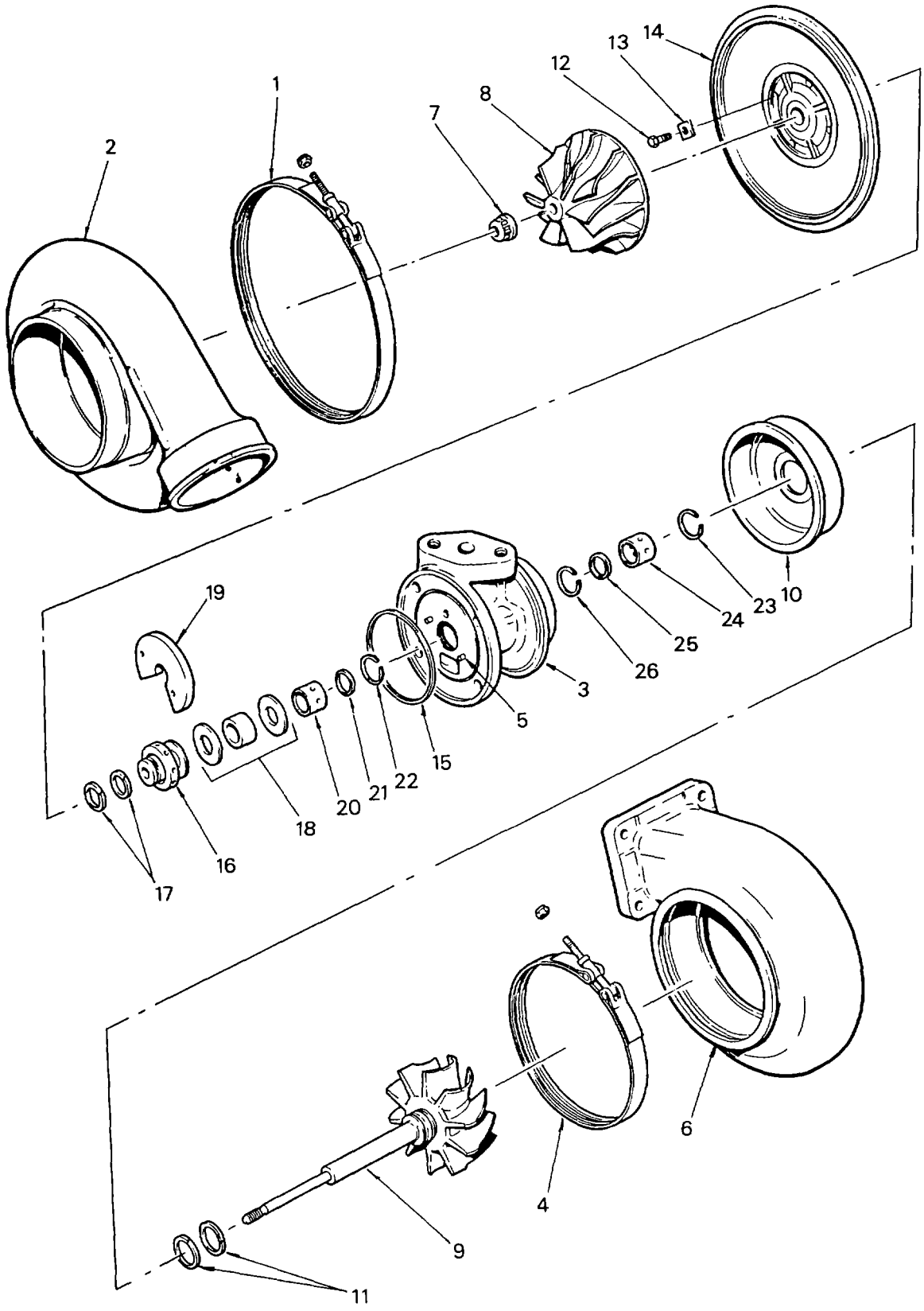
(41) Clamp center housing assembly in vise with soft jaws. Fasten dial indicator J8001-3 and base J7872-2 to center housing. Position so indicator tip rests on end of rotating shaft on compressor side. Move shaft axially back and forth by hand. Total thrust float should be 0.003 0.010 in. (0.08 0.25 mm). If dial indicator reading is not within specification, replace center housing as an assembly or replace parts to correct problem.



CAUTION

To prevent damage to turbine components do not pull misalined turbine housing into alinement with the 'V' band coupling.

3-8. ENGINE - Continued



3-8. ENGINE - Continued

3-8.2 Turbocharger - Continued

(42) Aline turbine housing and center housing marks and bring the two housings together. Secure in place with 'V' band coupling. Lubricate bolt threads with antiseize compound (item 3, Appendix B). Tighten to 160 In. lb (18 Nm).

(43) Loosen coupling band nut, and retighten again to 160 in. lb (18 Nm).

(44) Aline compressor housing and backplate marks and bring the two housings together. Secure in position with 'V' band coupling. Lubricate threads with engine oil (item 17, Appendix B).

Tighten nut to 120 in. lb (18 Nm).

(45) Position dial indicator J8001-3, swivel adapter J7872-3, extension rod J7872-1, and base J7872-2 on turbine housing base.

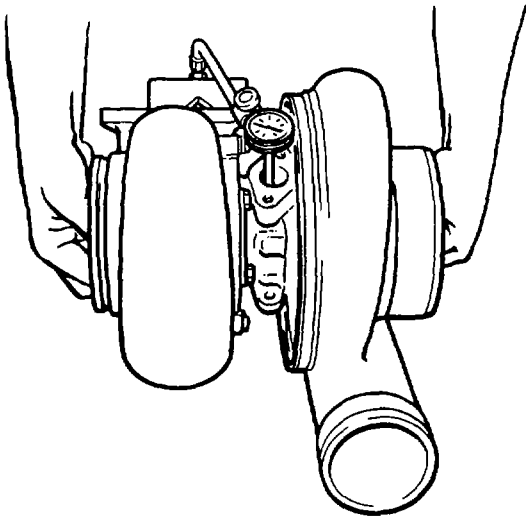
(46) Insert extension rod into oil drain hole against wheel shaft. Position so rod is perpendicular to shaft.

(47) Grasp each end of rotating assembly. Applying equal pressure at each end, move the rotating shaft toward and then away from dial indicator, creating a transverse movement in shaft.

Radial movement should 0.003 0.007 in. (0.08 0.18 mm). Replace necessary parts or complete center section if tolerances cannot be obtained.

(48) Lubricate the unit internally with clean engine oil (item 17, Appendix B) and install protective covers on all openings until final installation is performed.

(49) Stamp the letter 'R' in the lower left-hand corner of name plate to indicate that turbocharger has been reworked.



3-8. ENGINE - Continued

3-8.3 Blower

This task covers
a. Removal
b. Installation
c Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J33001 Alinement Tool
J6270-F Blower Service Tool Set
J1698-02 Feeler Gage Set

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Compartment Covers Removed (see TM 5-4210-220-12)
Air Cleaner Removed (see TM 5-4210-220-12)
Engine Canopy Removed (see TM 5-4210-220-12)
Turbocharger Removed (see TM 5-4210-220-12)
Engine Coolant Drained (see LO 5-4210-220-12)
Wheels Blocked
Air Tanks Drained
Alternator Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
21, Appendix B Petroleum Jelly
5149641 Installation Kit
5149510 Rocker Cover Gasket
5104507 Alternator Drive Gasket

WARNING

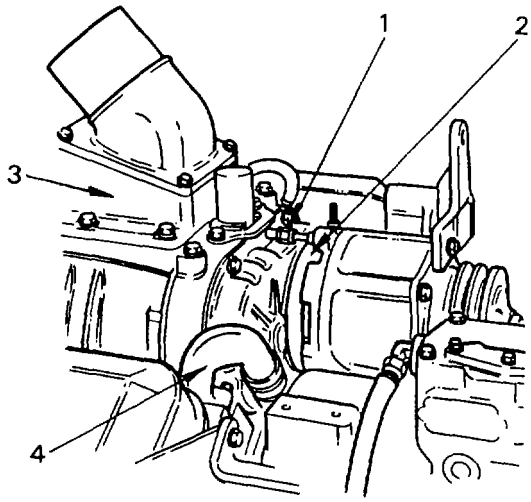
JP-4 is a highly volatile fuel. Extraordinary care must be taken when servicing components that use this fuel. The truck shall be grounded to an approved grounding point if it contains JP-4.

REMOVAL

NOTE

This task can be completed with the engine mounted in the truck or with the engine removed.

The engine governor components are assembled in a combination governor housing and blower front end. cover. The fuel pump is also attached to the front end of the blower. Therefore, when removing the blower assembly from the engine, the governor and fuel pump will also be removed at the same time.



(1) Loosen the oil pressure line fitting (1) from the rear of the blower to the blower drive support and slide the fitting back on the tube.

(2) Loosen the hose clamp (2) securing the blower drive support-to-blower seal.

(3) Remove the air inlet housing (3) from the top of the blower. Remove and discard gasket.

(4) Remove the bolts and lockwashers and carefully withdraw the alternator pulley assembly and drive coupling as detailed in para. 2-19.2. Remove and discard the gasket.

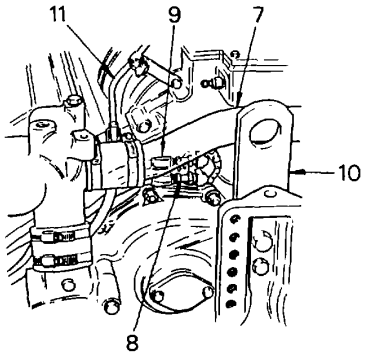
(5) Thread blower drive alinement tool J33001 into end of blower drive shaft. Slide the retaining ring up over the tool and withdraw the blower drive shaft from the blower.

(6) Loosen clamp and disconnect the breather pipe (4) at the top of the cylinder block. Discard gasket.

(7) Loosen the hose clamps and slide the hoses back on the bypass tube (7) between the thermostat housings. Remove the bypass tube.

(8) Tag and remove the fuel inlet (8) and outlet (9) lines to the fuel pump. Remove the fuel return crossover hose (11) between the cylinder heads.

(9) Remove the front engine lifter bracket (10) to obtain more working space, if necessary. Prior to removal of bracket, fan and fan clutch have to be removed as detailed in TM 5-4210-220-12.

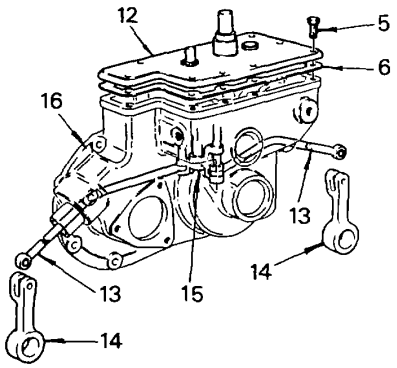


(10) Remove the throttle and fuel shutdown plate and the fire pump governor as detailed in para. 2-19.12.

(11) Clean and remove the rocker cover from each cylinder head, see para. 2-19.3.

(12) Remove the governor cover screws (15) and remove the governor cover (1 2). Discard gasket (6).

(13) Disconnect the fuel rods (13) from both injector control tube levers (14) and the governor lever (15), then remove the fuel rods.

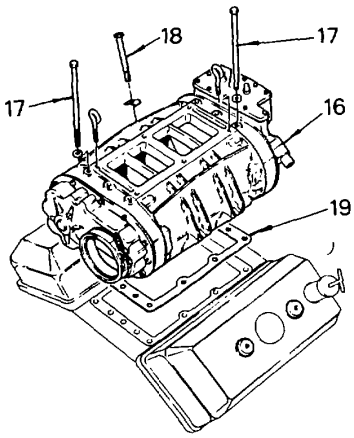


(14) Loosen the hose clamps on the fuel rod cover tube hoses next to each cylinder head and slide each hose and clamp up on tube on the governor housing (16).

(15) Remove the two capscrews (17) and-washers from the top of each blower end plate.

(16) Remove the blower-to-cylinder block capscrews (18) and retaining washers on each side of the blower.

(17) Tag, disconnect, and remove any tubing or accessories that may interfere with blower removal.



3-8. ENGINE - Continued

3-8.3 Blower - Continued

(18) Thread eye bolts in diagonally opposite tapped holes in the top of the blower housing.

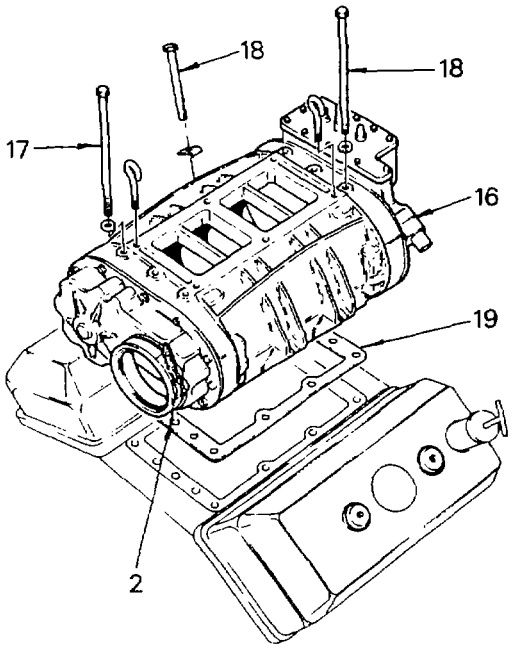
WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves, and other suitable protective clothing.

(19) Attach a chain hoist to the eye bolts. Lift the blower up slightly and move it forward to detach the blower from the seal at the drive end. Then, lift the blower up and away from the engine.

(20) Remove and discard the blower gasket (19).

(21) With the blower, fuel pump and governor assembly removed the engine, cover the air inlet and outlet openings of the blower housing and install the governor cover.



WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(22) Wash the exterior of the blower and governor assembly using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur If compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2} or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(23) Dry the exterior of the blower and governor using compressed air.

(24) If blower is to be replaced, remove end plate cover, governor, and fuel pump as detailed in REPAIR following.

3-8. ENGINE - Continued

INSTALLATION

NOTE

If a new blower assembly is being installed, assemble the end plate cover (see REPAIR following), governor, see para. 2-19.13 and fuel pump (TM 5-4210-220-12) prior to installation.

(1) Remove all covers installed to prevent contamination from entering the cylinder block. Affix a new blower housing gasket (19) to the cylinder block with petroleum jelly (item 21, Appendix B) to prevent the gasket from shifting when the blower is lowered into position.

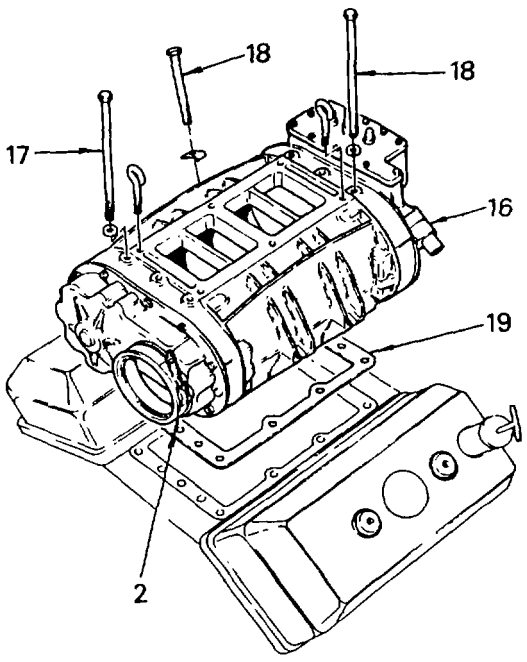
(2) Install and clamp fuel rod cover tube hoses loosely to each side of the governor housing (16).

(3) Install the cover seal ring and clamp (2) to the end of the blower drive support on the engine.

(4) Thread eye bolts in diagonally opposite tapped holes in the top of the blower housing.

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job . Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves, and other suitable protective clothing.



(5) Attach a chain hoist to the eye bolts. Lift the blower assembly at a slight angle, and lower it into position on top of the cylinder block. Make sure the flange of the rear end plate cover mates with the seal ring. Completely lower the blower assembly onto the cylinder block.

(6) Install the 7/16 in. 14 x 8-1/4 in. blower end plate capscrews (17) and special washers. Install the 3/8 in. 16 x 5-1/2 in. capscrews (18) and retaining washers on each side of the blower housing. Do not tighten.

NOTE

The lip on the bevelled end of the retaining washer goes in the small recess in the blower housing just above the bolt slot.

(7) Slip the snap ring over the notched end of the alinement tool J33001 and thread the blower drive shaft onto the end of the tool. Install the shaft into the rear of blower and position the blower so that the shaft can be removed and reinstalled without drag.

3-8. ENGINE - Continued

3-8.3 Blower - Continued

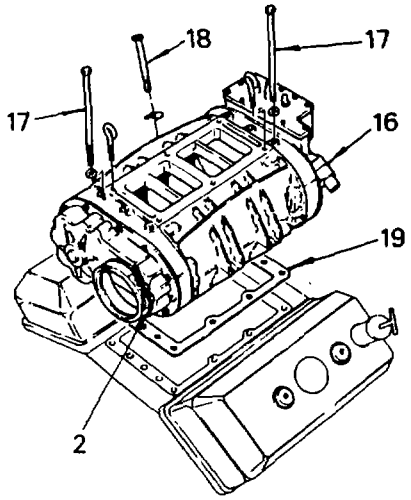
NOTE

If the blower drive shaft spring has been removed in error, compress the spring and force it into the drilled hole opposite the tachometer drive square hole. This operation must be done on a press. To check for proper assembly, hold the spring and shaft assembly vertically by the spring. Weight of the shaft cannot allow the spring to come out of the drilled hole. A simple installation tool can be made from a 0.500 in. (12.7 mm) diameter piece of steel stock.

(8) Remove the shaft with the tool and rotate the lobes of the blower in 90 deg. increments, reinserting the alinement tool and repositioning the blower, as necessary. Check the alinement at 90 deg. increments through the full 360 deg. of blower rotation.

(9) If it is not possible to position the blower so that the tool can be removed and reinstalled without drag in all positions, repeat step 8. However, this time try to achieve a condition in which the shaft can be removed with minimum drag in the two worst positions.

(10) With the shaft in place and the blower properly alined, tighten the blower-to-block end plate capscrews (17) to 45 ft lb (61 Nm). Tighten the blower housing-to-block side angle capscrews (18) uniformly to 35 ft lb (47 Nm) in 5 ft lb (7 Nm) increments.



(11) Recheck the torque of the blower-to-block end plate capscrews (17) and tighten as necessary.

(12) Install the blower driveshaft snap ring. The notch in the tool provides sufficient clearance for the installation of the snap ring with needle-nose pliers. Installing the snap ring with the alinement tool in place will prevent it from being inadvertently dropped into the engine gear train.

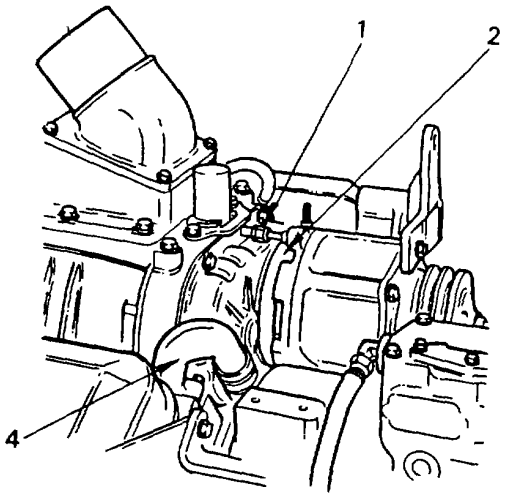
(13) Remove the alinement tool from the blower drive shaft.

(14) Place the blower rear end plate cover clamp (2) and seal ring in position. Tighten the clamp nut on the bolt until the spring in the clamp is completely compressed.

(15) Connect breather pipe (4) to cylinder block.

(16) Connect the lubricating oil tube to the fitting in the blower drive support. Tighten lubrication fitting (1) firmly.

(17) Install the alternator drive assembly as detailed in para. 2-19.2.

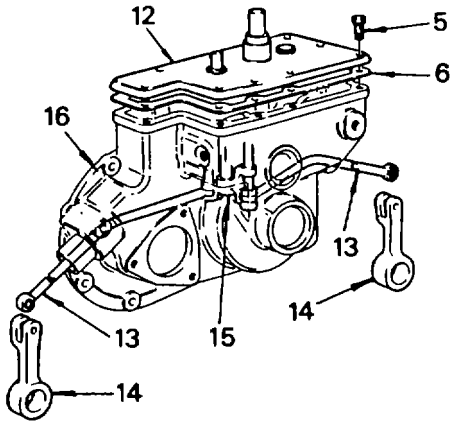


(18) Slide each fuel rod cover tube hose down on the cover tubes attached to the cylinder heads and tighten the hose clamps.

(19) Insert the end of the left-bank fuel rod (13) through the hole in the cylinder head and up through the fuel rod cover tube to the control link operating lever (15).

(20) Raise the connecting pin up in the connecting link lever (15). Insert the end of the fuel rod (13) between the two bosses on the lever and insert the connecting pin through the fuel rod and into the lower boss.

(21) Connect the opposite end of the fuel rod to the injector control tube lever (14) with a clevis pin and cotter pin.



(22) Insert the end of the right-bank fuel rod (13) through the hole in the cylinder head and up through the fuel rod cover tube to the control link operating lever (15).

(23) Remove the short screw pin from the control link operating lever (15). Insert the end of the fuel rod between the two bosses on the lever and install the screw pin. Tighten the pin securely.

(24) Connect the opposite end of the fuel rod to the injector control tube lever (14) with a clevis pin and cotter pin.

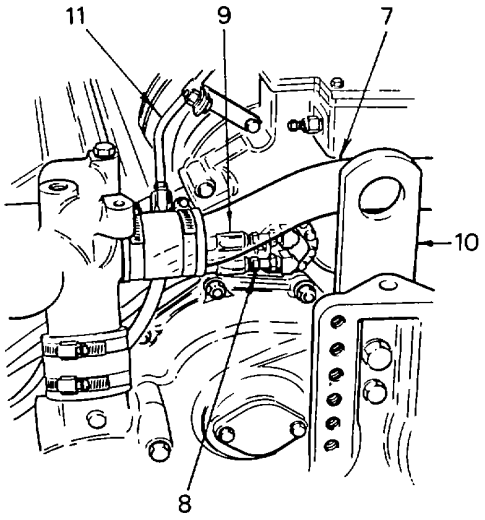
(25) Affix a new gasket (6) to the top of the governor housing (16). Place the governor cover (12) on the governor housing with the pin in the speed control shaft assembly in the slot in the differential lever and the dowel pins in the housing in the dowel pin holes in the cover. Install the eight cover attaching screws (5). Tighten the screws securely.

(26) Install and connect the crossover fuel line (11) to each cylinder head and connect the fuel lines (8 and 9) to the fuel pump.

(27) If removed, install the front engine lifter bracket (10). Replace fan and fan clutch as detailed in TM 5-4210-220-12.

(28) Place the water bypass tube (7) between the two thermostat housings and slide the hose on the thermostat housings. Position the bypass tube so it clears the governor, fuel pump, and fuel lines. Then tighten the hose clamps.

(29) Install the turbocharger and attaching parts as detailed in para. 3-8.2.



3-8. ENGINE Continued

3-8.3 Blower Continued

(30) Install the stop throttle, fuel shutdown and fire pump governor as detailed in para. 2-19.12.

(31) Attach any other accessories to the engine that were removed.

(32) Close the drains and fill the radiator with antifreeze solution as detailed in LO 5-4210-220-12.

(33) Perform the governor and injector rack control adjustments as detailed in para. 2-19.6 and para. 2-19.13.

(34) Run engine and check for coolant or oil leaks. Repair or tighten connections as necessary.

REPAIR

NOTE

Blower removed from engine (see REMOVAL preceding). If the blower is to be disassembled it is recommended to replace all seals and bearings. Blower repair kit, (5108123) contains all the necessary parts.

To remove the blower rear end plate cover, and the governor and fuel pump assembly, carrying out steps 1 thru 8.

(1) Remove the capscrews (4), lockwashers (5), and special washers (6) securing the rear end plate cover (1) to the blower end plate (3).

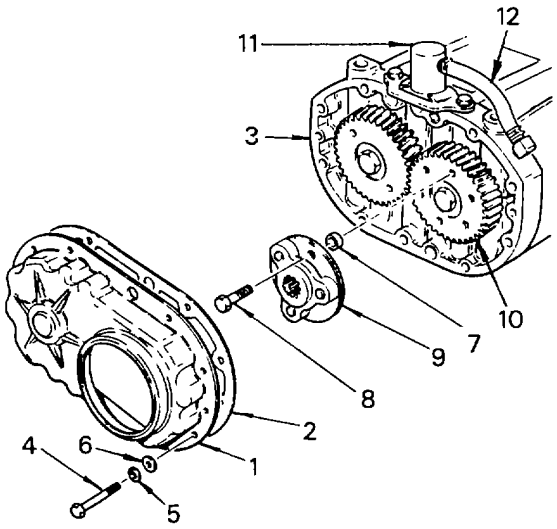
(2) Remove the cover (1) and gasket (2) from the blower end plate (3). Discard gasket (2).

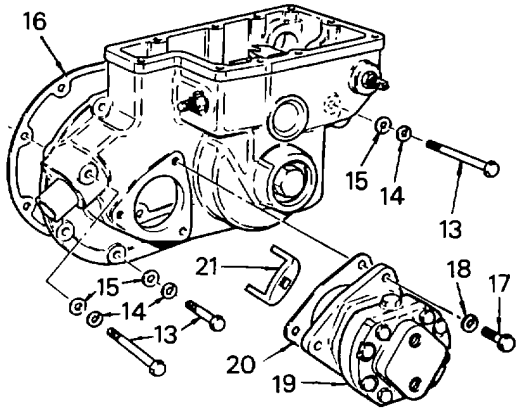
(3) Remove the three locking bolts (8) and washers securing the drive assembly (9) to the right-hand blower rotor gear (10). Remove the drive assembly (9) from the gear, being careful not to drop the thin hub spacers (7).

(4) Remove the mini-bypass blower (11) and hose (12) from the blower end plate (3).

(5) Note the location of the two copper washers, one plain washer and eight lockwashers on the governor to blower capscrews before removing them. Remove the ten capscrews (13) and washers (14 and 15) (two inside and eight outside the governor housing) securing the governor and fuel pump assembly to the blower end plate.

(6) Tap the sides of the governor and fuel pump housing lightly with a soft faced hammer to loosen it from the blower end plate. Remove and discard gasket (16).





3-8. ENGINE - Continued

(7) Pull the governor and fuel pump assembly from the dowels in the blower end plate.

(8) Remove capscrews (17) and washers (18), then remove the fuel pump (19), drive coupling fork (21), and the fuel pump gasket (20). Discard gasket.

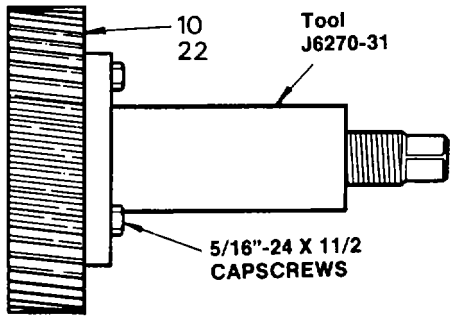
NOTE

To disassemble the blower carry out steps 9 thru 18.

Any component is given the same item number on all illustrations following for this procedure including the exploded view.

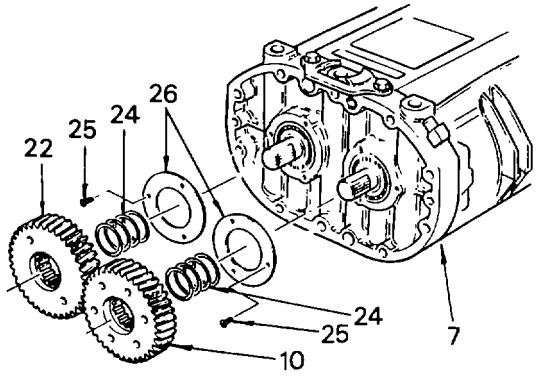
(9) Place a clean folded cloth between the rotors and remove the locking bolts (20) and thick washers (21) that secure the timing gears (10 and 22) to the blower rotor shafts.

(10) Remove the timing gears with puller tool J6270-31. Both gears must be pulled at the same time. Back out the center screws of both pullers and place the flanges against the gear faces, alining the flange holes with the tapped holes in the gears. Secure the pullers to the gears with 5/16 in. 24 x 1 -1 /2 in. capscrews (two capscrews on the left helix gear (22) and three capscrews on the right helix gear (10)).



(11) Turn the two puller screws uniformly clockwise and withdraw the gears (10 and 22) from the rotor shafts.

(12) Remove the shims (24) from the rotor shafts, after the gears (10 and 22) have been removed. Note the number and thickness of shims on each rotor shaft to ensure identical replacement when reassembling the blower.



(13) Remove the self locking screws (25) securing the rotor shaft bearing retainers (26) to the rear end plate (7). Remove the retainers. Repeat this procedure for the retainers on the front end plate.

(14) To ease assembly procedures, locate the cast triangle on the blower housing and identify the adjacent end plate similarly. Make sure the identification mark does not mark any sealing surface.

NOTE

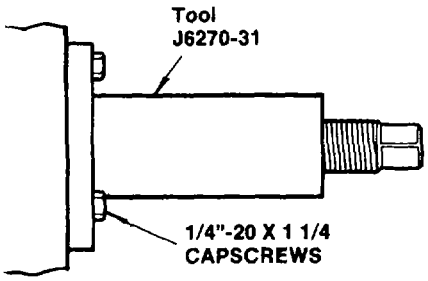
To remove the blower rear end plate and ball bearing assembly from the blower housing and rotors, carry out steps 15 thru 18.

3-8. ENGINE Continued

3-8.3 Blower Continued

(15) Remove the two fillister head screws (27) securing the rear end plate (7) to the blower housing (28) and loosen the two fillister head screws securing the front end plate to the blower housing approximately three turns.

(16) Back out the center screws of pullers J6270-31 far enough to permit the flange of each puller to lay flat on the face of the end plate.



CAUTION

To avoid damaging the blower end plate, be sure that the puller retaining capscrews are threaded all the way into the tapped holes in the end plate to provide maximum anchorage for the pullers.

(17) Align the holes in each puller with the tapped holes in the end plate and secure the pullers to the end plate with six 1/4 in. 20 x 1-1/4 in. capscrews.

(18) Turn the two puller screws uniformly clockwise and withdraw the end plate and bearings from the blower housing and rotors.

NOTE

To remove the blower front end plate and roller bearing assembly from the blower housing and rotors, carry out steps 19 thru 21.

(19) Remove the fuel pump drive bolt (29), washer (30), drive plate (32) and spacer (31).

(20) Remove the two fillister head screws (27), securing the front end plate (3) to the blower housing (28).

(21) Pull the front end plate and roller bearings from the housing and rotors. The roller bearing inner races will remain on the shaft of the rotor and the oil seals could be damaged.

(22) Withdraw the blower rotors from the housing.

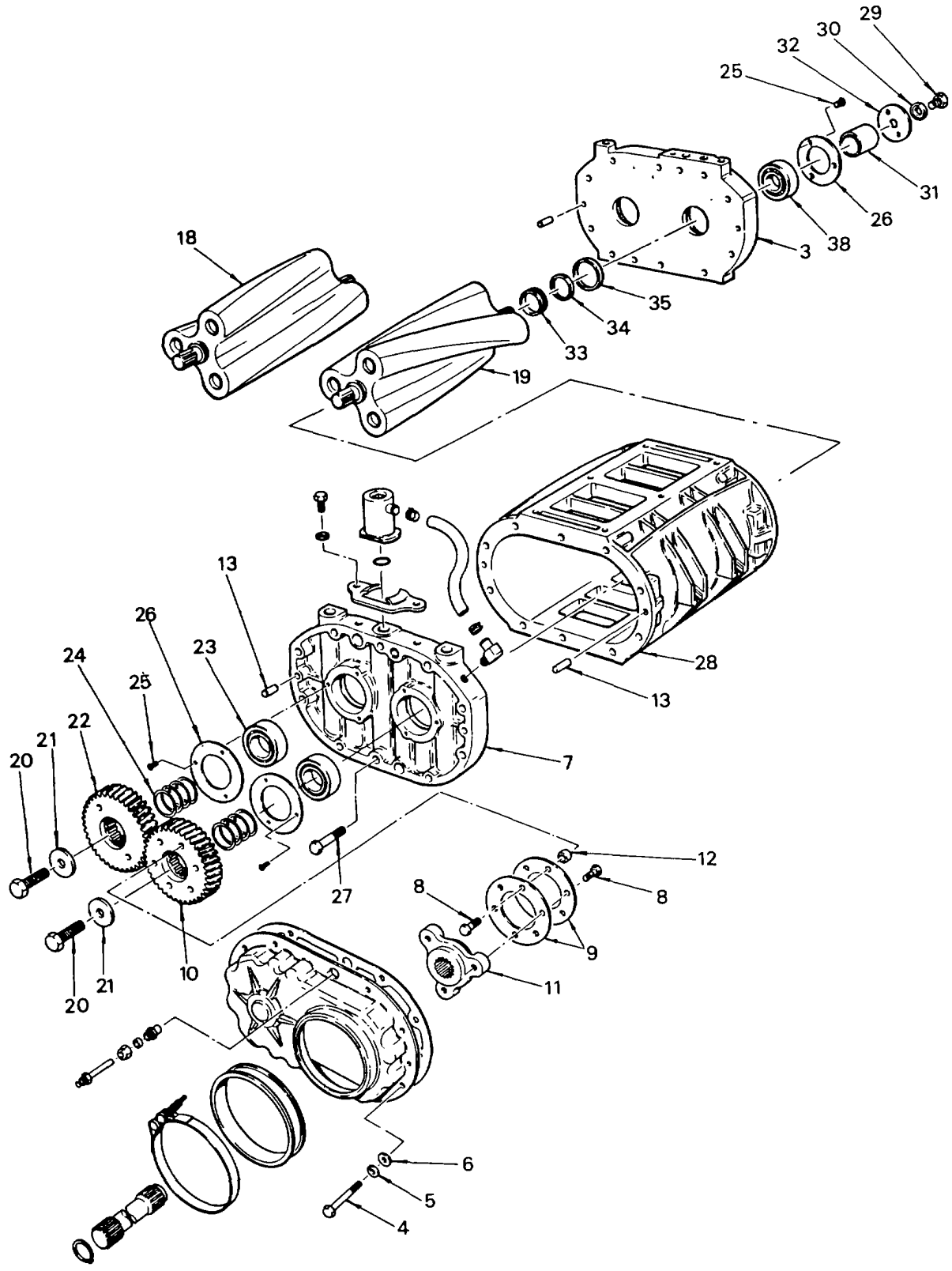
NOTE

To remove the bearings, oil seals, carriers, roller bearing inner races, and collars from the blower rotor shafts, carry out steps 23 thru 32.

(23) Clamp one lobe of rotor (19) in a bench vise equipped with soft jaws. Tighten the vise just enough to hold the rotor stationary.

(24) Remove the oil seal ring (34) from the seal ring carrier (33) on each end of the blower rotor shaft with a pair of snap ring pliers.

3-8. ENGINE Continued



3-8. ENGINE Continued

3-8.3 Blower Continued

NOTE

To avoid breakage or distortion, do not spread or twist the ring anymore than necessary to remove it.

(25) Place the seal ring carrier remover adapter J6270-2 over the carrier (33). Make sure the adapter is seated in the groove of the carrier.

(26) Back out the center screw of puller J6270-31 far enough to permit the puller flange to lay flat against the adapter J6270-2.

(27) Place the puller over the end of the rotor shaft and against the adapter on the oil seal ring carrier. Aline the holes in the puller flange with the tapped holes in the adapter, then secure the puller to the adapter with two bolts.

(28) Turn the puller screw clockwise and pull the oil seal ring carrier and roller bearing inner race (front end of blower rotors only) from the rotor shaft.

(29) Remove the remaining oil seal ring carriers (33) from all remaining rotor shafts as detailed in steps 23 thru 29 preceding.

NOTE

To remove the oil seals and bearings from the end plates, carry out steps 30 thru 32. If the bearing is good, only the oil seal has to be removed; carry out steps 33 thru 36.

(30) Support the outer face of the blower end plate on wood blocks on the bed of an arbor press.

(31) Place the long end of the oil seal remover and installer J6270-3 down through the oil seal ring collar and into the bearing, with the opposite end of the remover under the ram of the press. Then, press the bearing and oil seal ring collar out of the end plate.

(32) Remove the remaining bearings and oil seal ring collars from the end plates in the same manner.

(33) Insert the two-piece collar remover with the O-ring J6270-15, in the collar with the lip of the remover on the inside edge of the collar.

(34) Support the inner face of the blower end plate on wood blocks.

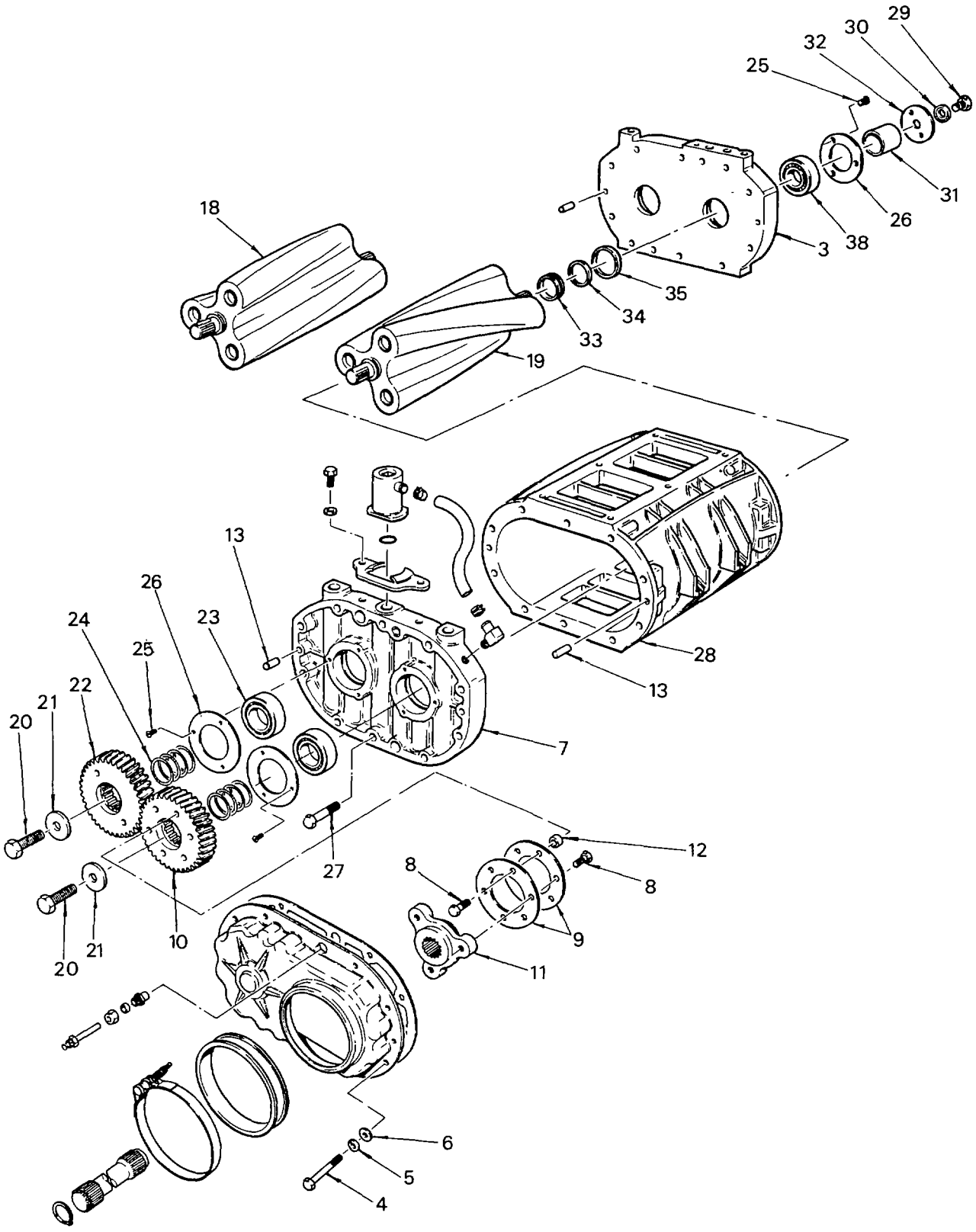
(35) Insert the small end of the driver handle J6270-17 through the bearing and into the collar remover, spreading it tight in the collar.

(36) Press or tap on the driver handle to remove the collar.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

3-8. ENGINE Continued



3-8. ENGINE Continued

3-8.3 Blower Continued

(37) Wash all of the blower parts In dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2 11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(38) Dry all of the blower parts using compressed air.

(39) Examine the bearings for any indications of corrosion or pitting. Lubricate each ball bearing with light engine oil (Item 17, Appendix B). Then, while holding the bearing inner race from turning, revolve the outer race slowly by hand and check for rough spots. The double-row ball bearings are pre-loaded and have no end play. A new bearing will seem to have considerable resistance to motion when revolved by hand.

(40) Check the oil seal rings, carriers, and collars for wear or scoring. If worn excessively, they must be replaced. The current oil seal rings are chrome flashed and the carriers are liquid nitrided. When replacement of an oil seal ring or carrier is necessary, both parts must be replaced together.

(41) Inspect the blower rotor lobes, especially the sealing ribs, for burrs or scoring. Rotors must be smooth for satisfactory operation of the blower. If the rotors are slightly scored or burred, they may be cleaned up with emery cloth (item 13, Appendix B).

(42) Examine the rotor shaft serrations for wear, burrs, or peening. Also inspect the bearing and oil seal contact surfaces of the shafts for wear or scoring.

(43) Inspect the inside surface of the blower housing for burrs or scoring. The inside surface must be smooth for efficient operation of the blower. If the inside surface of the housing is slightly scored or burred, it may be cleaned up with emery cloth (item 13, Appendix B).

(44) Check the finished ends of the blower housing for flatness or burrs. The end plates must set flat against the blower housing.

(45) The finished inside face of each end plate must be smooth and flat. If the finished face is slightly scored or burred, it may be cleaned up with emery cloth (item 13, Appendix B).

NOTE

Be careful not to remove metal at the joint face between the end plates and the housing. Air or oil leaks could develop after assembly.

(46) Examine the serrations in the blower timing gears for wear or peening. Also, check the gear teeth for wear, chipping, or other damage. If the gears are worn to the point where the backlash between the gears exceeds Q.004 in. (0.102 mm) or damaged sufficiently to require replacement, both gears must be replaced as a set.

(47) Check the blower drive shaft serrations for wear or peening. Replace the shaft if it is bent, cracked, or has excessive spline wear.

3-8. ENGINE Continued

(48) Replace all worn or excessively damaged blower parts.

WARNING

Death or serious injury could occur If compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(49) Clean the oil strainer in the vertical oil passage at the bottom side of each blower end plate and blow out all oil passages with compressed air.

NOTE

To install the ring-type oil seal carriers, collars, seal rings, and roller bearings on the rotor shafts and in the end plates carry out steps 50 thru 58 following.

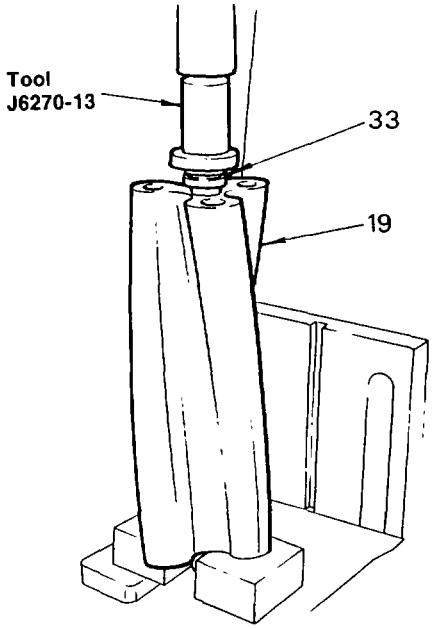
(50) Support one of the rotor assemblies (19) on wood blocks on the bed of an arbor press.

(51) Lubricate the Inside diameter of the oil seal ring carrier (33) with engine oil (item 17, Appendix B). Then start the carrier straight over the end of the rotor shaft with the chamfered inside diameter end facing the rotor.

(52) Place the oil seal ring carrier installer J6270-13 over the end of the rotor shaft and against the carrier (33) with the end of the installer under the ram of the press Then press the carrier down tight against the rotor.

(53) Install the remaining oil seal ring carriers on both rotor shafts in the same manner.

(54) Install an oil seal ring (34) in the ring groove of each carrier (33) with a pair of snap ring pliers.



NOTE

To avoid breaking the oil seal rings, do not spread them anymore than necessary to place them over the end of the carrier. Do not twist the rings or possible distortion may result in loss of side contact area.

(55) Support the blower end plate (3), inner face up, on wood blocks on the bed of an arbor press.

(56) Lubricate the outside diameter of a seal ring collar (35) with engine oil (item 17, Appendix B). Then start the chamfered outside diameter end of the collar straight into the bore in the end plate (3).

3-8. ENGINE Continued

3-8.3 Blower Continued

(57) Place the oil seal ring collar installer J6270-3 on top of the seal ring collar (35) and under the ram of the press. Then, press the collar into the end plate (3) until the shoulder on the installer contacts the end plate.

NOTE

A step under the shoulder of the installer will position the collar approximately 0.005 in. (0.127 mm) below the finished face of the end plate. This is within the 0.002 to 0.008 in. (0.051 to 0.203 mm) specified.

(58) Install the remaining oil seal ring collars (35) in both front and rear end plates in the same manner.

CAUTION

The lobes on the driving blower rotor and the teeth on its gear form a right-hand helix while the lobes and teeth of the driven rotor and gear form a left-hand helix. Hence, a rotor with right-hand helix lobes must be used with a gear having right-hand helix teeth and vica versa.

NOTE

To install the blower rotors into the blower front end plate, carry out steps 59 thru 66 following.

(59) Check the dowel pins (13) project 0.320 in. (8.13 mm) from the flat inner face of the front end plate to ensure proper alinement of the end plate with the housing.

(60) If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to 0.005 in. (0.13 mm) below the surface of the end plate.

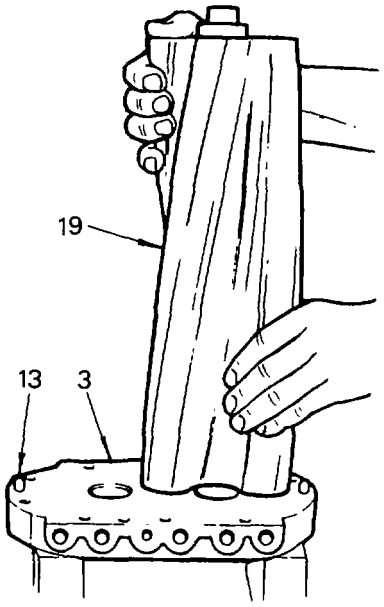
NOTE

When installed, the inside flats of the sleeve will be parallel to the center line of the housing.

(61) Support the front end plate (3) on two wood blocks approximately 4 in. (100 mm) high, with the inner face of the end plate (3) facing up and the TOP side of the plate facing to the right.

(62) Lubricate the oil seal ring in the carrier on the front end of the right-hand helix rotor shaft with engine oil (item 17, Appendix B).

(63) Hold the right-hand helix rotor (19) in a vertical position (gear end up) and position the seal ring in the carrier so the ring protrudes from its groove the same amount on each side and the gap is facing away.



3-8. ENGINE Continued

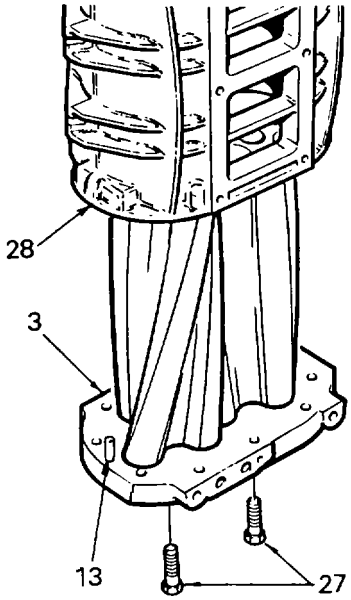
(64) With the omitted serration in the splines of the shaft facing toward the top side of the end plate, start the end of the rotor shaft into the right-hand shaft opening in the end plate so that the gap portion of the seal ring is started into the ring collar. Continue to lower the rotor and very carefully apply pressure to the seal ring approximately 180 deg. from the gap while gently working the seal ring into the collar until the rotor contacts the end plate.

(65) Repeat steps 62 and 63 preceding to prepare the left-hand helix rotor (18).

(66) Position the rotors so the lobes are in mesh and the omitted serrations in the splines of both rotor shafts are facing toward the top side of the end plate. Then install the left-hand helix rotor as detailed in step 64 preceding.

NOTE

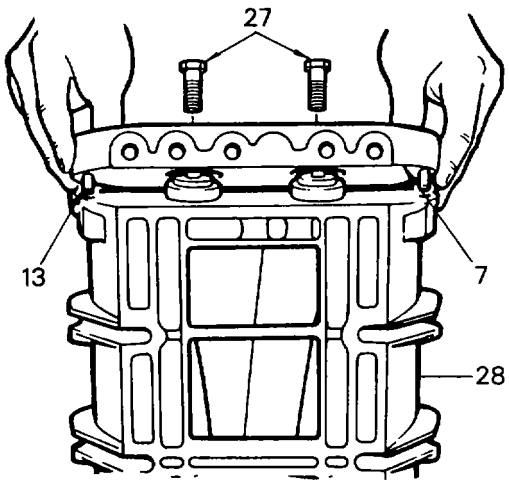
To install the blower housing (28) over the rotors (18 and 19) and attach to the front end plate, carry out steps 67 thru 69 following. Make sure to aline the cast triangle on the blower housing with the same end plate as marked during disassembly.



(67) Position the blower housing (28) over the top of the rotors so the bottom face of the housing faces the bottom side of the front end plate (3). Then lower the housing over the rotors until it contacts the dowel pins in the end plate (3).

(68) Aline the dowel pin holes in the housing with the dowel pins (13) in the end plate (3). Then push the housing (28) tight against the end plate. If necessary, tap the housing lightly with a plastic hammer.

(69) Insert the two fillister head screws (27) through the front end plate (3) and thread them into the housing (28). Tighten the screw to 10 ft lb (14 Nm). Do not use lockwashers on these screws.



NOTE

To install the blower rear end plate on the rotor shafts and housing, carry out steps 70 thru 76 following.

(70) Check the dowel pins (13) project 0.320 in. (8.13 mm) from the flat inner face of the rear end plate (7) to assure proper alinement of the end plate with the housing (28).

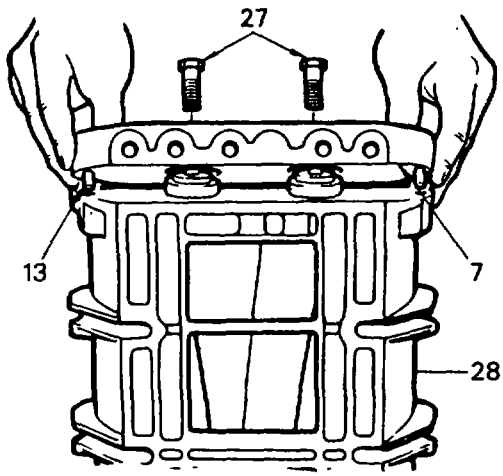
(71) If removed, press a new bolt guide sleeve (bushing) into one bolt hole in the bottom side of the end plate. Install the sleeve, with the three notches on the sleeve to the bottom side of the end plate and the center notch to the outside of the end plate, flush to 0.005 in. (0.13 mm) below the surface of the end plate.

3-8. ENGINE Continued

3-8.3 Blower Continued

NOTE

When installed, the inside flats of the sleeve will be parallel to the center line of the housing.



(72) Lubricate the oil seal rings in the carriers on the rotor shaft with engine oil (Item 17, Appendix B).

(73) Position each oil seal rings in Its carrier so the ring protrudes from its groove the same amount on each side.

(74) Position the rear end plate (7) over the top of the rotor shafts with the inner face of the end plate facing the rotors and the TOP side of the end plate facing the top side of the blower housing.

(75) Lower the end plate (7) straight over the rotor shafts until the dowel pins (13) in the end plate contact the blower housing (28). Then, carefully work the dowel pins into the dowel pin holes in the housing and the oil seal rings into the collars. Push the end plate tight against the housing (28). If necessary, tap the end plate lightly with a plastic hammer.

(76) Insert the two fillister head screws (27) through the rear end plate (7) and thread them into the housing (28). Tighten the screws to 10 ft lb (14 Nm). Do not use lockwashers on these screws.

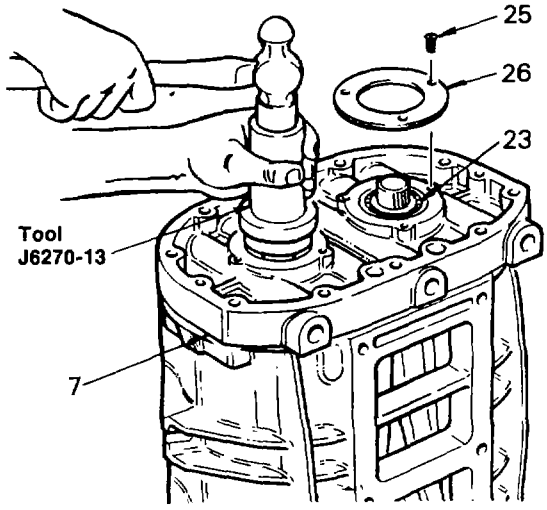
(77) Check the relationship of the blower end plates to the housing at the cylinder block side of the blower assembly. The protrusion of the housing with respect to the end plates should not be more than 0.0005 in. (.013 mm) above to 0.0065 in. (0.165 mm) below the end plate. Excessive protrusion could distort the housing when the end plate to cylinder block bolts are tightened and cause rotor to housing interference.

NOTE

To install the ball bearings on the rotor shafts and in the end plate, carry out steps 78 thru 81 following.

(78) With the blower still supported in a vertical position on the two wood blocks, lubricate one of the ball bearings (23) with engine oil (item 17, Appendix B). Start the bearing, numbered end up, straight on one of the rotor shafts.

(79) Place installer J6270-13 on top of the bearing and tap the bearing straight on the shaft and into the rear end plate (7).



3-8. ENGINE Continued

(80) Install the second ball bearing on the remaining rotor shaft in the same manner.

(81) Place the bearing retainers (26) on top of the bearings (23) and the end plate (7). Then install the self-locking screws (25). Tighten the screws to 9 ft lb (12 Nm).

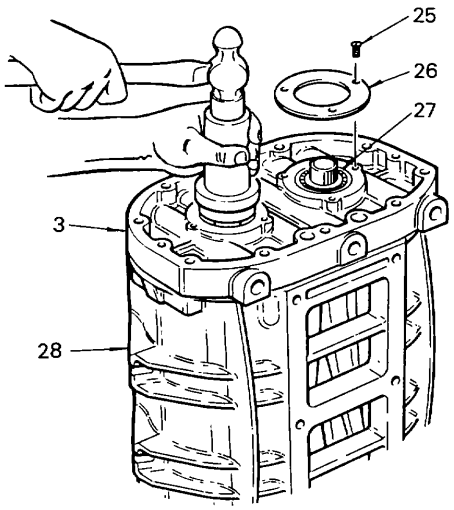
NOTE

To install the roller bearing inner races on the rotor shafts at the front end plate, carry out steps 82 thru 84 following.

(82) Reverse the position of the blower housing on the two wood blocks.

(83) Position the roller bearing inner race over the front end of the rotor shaft and press the race on the shaft with tool J6270-13 until the bearing contacts the shoulder on the shaft. Similar to steps 79 and 80 preceding.

(84) Install the bearing inner race on the front end of the other rotor in the same manner.



NOTE

To install the roller bearing outer race assemblies in the front end plate (3), carry out steps 85 thru 88 following.

(85) Lubricate one of the roller bearings (38) with engine oil (item 17, Appendix B). Start the bearing (shoulder side up) over the rotor shaft and bearing inner race and into the end plate (3).

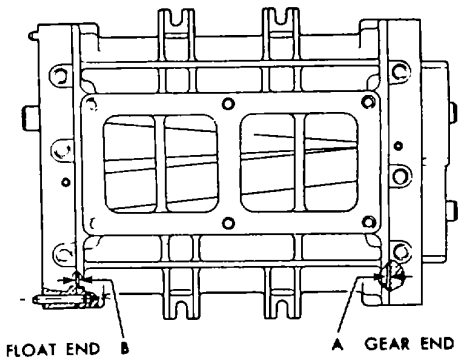
(86) Place installer J6270-13 on top of the bearing and tap the bearing straight on the inner race and into the front end plate (3). Similar to steps 79 and 80 preceding.

(87) Install the second roller bearing on the remaining rotor shaft in the same manner.

(88) Place the bearing retainers (26) on top of the bearings and the end plate (3). Then install three self-locking retainer screws (25) in each retainer. Tighten the screws to 9 ft lb (12 Nm).

(89) Make a preliminary check of the rotor-to-end plate and rotor-to-housing clearances with a feeler gage. Blower clearances are listed below:

(A) Rotor to End Plate Clearance Gear End minimal 0.007 in. (0.178 mm)
(B) Rotor to End Plate Clearance Float End minimum 0.012 in. (0.305 mm)

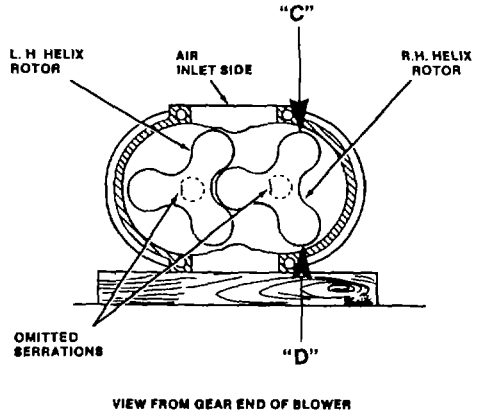


3-8. ENGINE Continued

3-8.3 Blower Continued

(C) Rotor to Housing Clearance Air Inlet Side minimum 0.015 in. (0.381 mm)

(D) Rotor to Housing Clearance Air Outlet Side minimum 0.004 in. (0.102 mm)



VIEW FROM GEAR END OF BLOWER

NOTE

One serration is omitted on the drive end of each blower rotor shaft and a corresponding serration is omitted in each gear. Assemble the gears on the rotor shafts with the serrations in alinement. The center punch mark in the end of each rotor shaft at the omitted serration will assist in alining the gears on the shafts. If shims were removed from the back side of the gears (between the inner race of the bearing and the gear), they should be replaced in their original positions before installing the gears on their respective shafts.

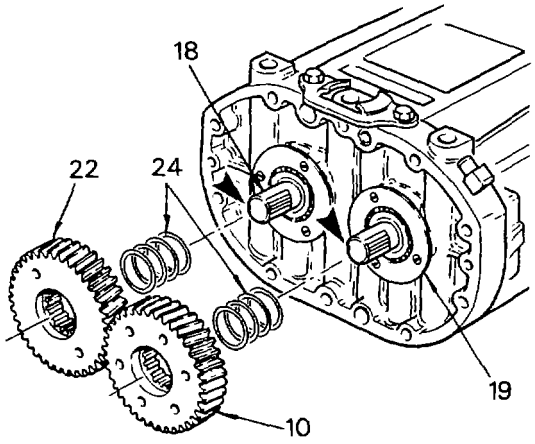
(90) Place the blower assembly on the bench, with the top of the housing up and the rear end (serrated end of rotor shafts) of the blower facing the outside of the bench.

(91) Rotate the rotors to bring the omitted serrations on the shafts in alinement and facing to the left as shown.

(92) Install a 0.140 in. (3.56 mm) thick gear spacer and the same number and thickness of shims (24) on each rotor shaft that were removed at the time of disassembly.

(93) Lubricate the serrations of the rotor shafts with engine oil (item 17, Appendix B).

(94) Place the teeth of the rotor gears in mesh so that the omitted serrations inside the gears are in alinement and facing the same direction as the serrations on the shafts.



(95) Start both rotor gears straight on the rotor shafts with the right-hand helix gear (10) on the right-hand helix rotor (19) and the left-hand helix gear (22) on the left-hand helix rotor (18), with the omitted serrations in the gears in line with the omitted serrations on the rotor shafts.

(96) Thread a 1/2 in. 20 x 1-1/4 in. bolt with a thick washer into the end of each rotor shaft. Place a clean folded cloth between the lobes of the rotors (18 and 19) to prevent the gears from turning. Draw the gears into

3-8. ENGINE Continued

(97) Remove the two bolts and washers that were used to draw the gears into position on the rotor shafts.

(98) Lubricate the threads of the 1/2 in. 20 x 1-1/2 in. gear retaining capscrews (20) with engine oil (item 17, Appendix B). Place a spacer (21) on each of the capscrews and thread them Into the rotor shafts. Tighten the bolts to 110 ft lb (150 Nm). Remove the cloth from the blower rotors.

NOTE

After the blower rotors and timing gears are installed, the blower rotors must be timed. Carry out steps 99 thru 107 to time the blower rotors.

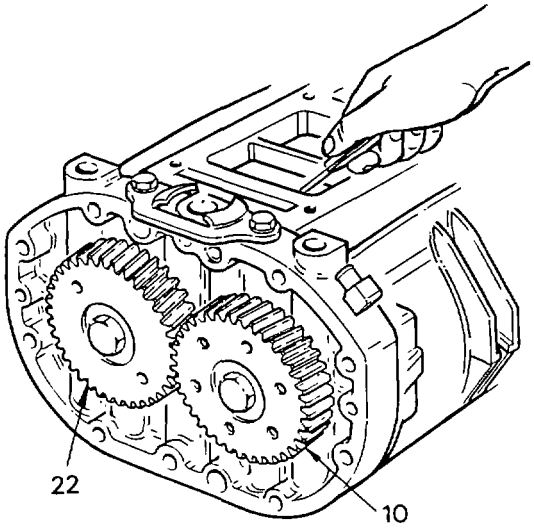
Before timing the blower, install four 5/16 in. 18 x 1-7/8 in. bolts with flatwashers through four bolt holes in each end plate (top and bottom) and thread them into the blower housing. Tighten the bolts to 17 ft lb (23 Nm). This will hold the end plates against the blower housing so the proper clearance between the rotors and the end plate can be obtained.

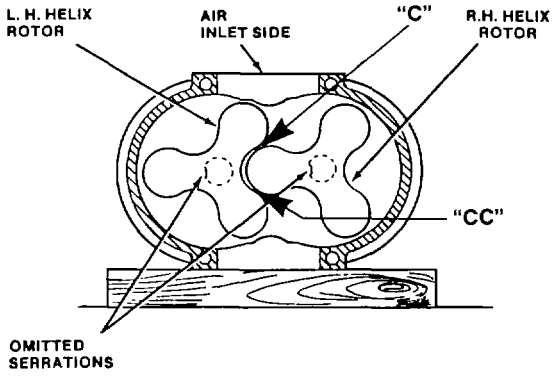
(99) The blower rotors, when properly positioned in the housing, run with a slight clearance between the lobes. This clearance may be varied by moving one of the helical gears in or out on the shaft relative to the other gear.

(100) If the right-hand helix gear (10 is moved out, the right-hand helix rotor will turn counterclockwise when viewed from the gear end. If the left-hand helix gear (22) is moved out, the left-hand helix rotor will turn clockwise when viewed from the gear end. This positioning of the gears, to obtain the proper clearance between the rotor lobes, is known as blower timing.

(101) Moving the gears OUT or IN on the rotor shafts is accomplished by adding or removing shims (24) between the gears and the bearings.

(102) The clearance between the rotor lobes may be checked with 1/2 in. (12.7 mm) wide feeler gages as shown. A specially designed feeler gage set J1698-02 for the blower clearance operation is available. Clearances should be measured from both the inlet and outlet sides of the blower.





VIEW FROM GEAR END OF BLOWER

3-8. ENGINE Continued

3-8.3 Blower Continued

(103) Time the rotors to the specified clearance between the trailing edge of the right-hand helix rotor and the leading edge of the left-hand helix rotor ('C' clearance) measured from both the inlet and outlet sides. Then, check the clearance between the leading edge of the right-hand helix rotor and the trailing edge of the left-hand rotor ('C' clearance) for the minimum clearance. Rotor-to-rotor measurements should be taken 1 in. (25 mm) from each end and at the center of the blower. Clearance between rotors: CC Minimum clearance 0.004 -.008 in. (0.10 0.20 mm) C Minimum clearance 0.010 in. (0.25 mm)

(104) After determining the amount one rotor must be revolved to obtain the proper clearance, add shims to the back of the proper gear to produce the desired result. When more or less shims are required, both gears must be removed from the rotors. Placing a 0.003 in. (0.08 mm) shim in back of a rotor gear will revolve the rotor 0.001 in. (0.03 mm).

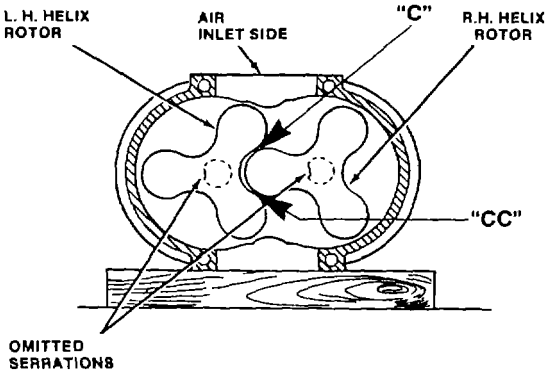
(105) Install the required thickness of shims to the back of the proper gear and next to the 0.140 in. (3.56 mm) thick gear spacer which is against the bearing inner race and reinstall both gears. Recheck the clearances between the rotor lobes.

(106) Determine the minimum rotor to end plate clearances at points (A and B). Insert the feeler gages between the end plates and the ends of the rotors. This operation must be performed at the ends of each lobe, making 12 measurements in all.

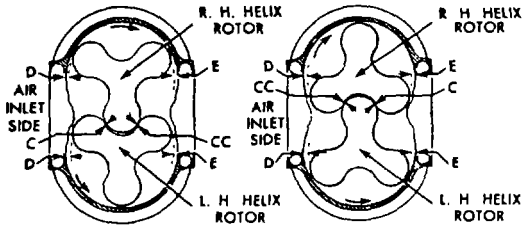
(107) Check the clearance between each rotor lobe and the blower housing at both the inlet and outlet side, 12 measurements in all. The minimum clearances are as shown in center figure.

NOTE

After the blower rotors are timed, complete assembly of the blower by carrying out steps 108 thru 111.



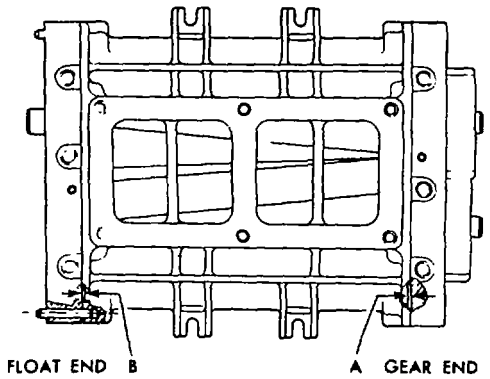
VIEW FROM GEAR END OF BLOWER



VIEWS FROM GEAR END OF BLOWER

ENGINE	BLOWER	IDENT.	A	B	C	CC	D	E
6 CYL.	TURBO	T	.867"	.912"	.916"	.004 TO .008"	.915"	.004"

NOTE: Time rotors to dimensions on chart for clearance between trailing side of R H. Helix Rotor and leading side of L.H Helix Rotor (cc) from both inlet and outlet side of blower



3-8. ENGINE Continued

(108) Place the fuel pump drive disc spacer (31) over the forward end of the right hand helix rotor shaft. Then place the special lockwasher (30) and the drive disc (32) on the retaining bolt (29) and thread the bolt into the rotor shaft against the spacer. Tighten the bolt to 65 ft lb (88 Nm). Bend one tang of the lockwasher over into the slot in the drive disc and two tangs over against the flat sides of the bolt head.

(109) If disassembled attach the two flex plates (9) to the drive hub (11) with three new type (B) hex lock bolts (8). DO NOT ATTEMPT TO REUSE PATCH BOLTS. Tighten the bolts to 30 ft lb (41 Nm).

(110) Attach the drive assembly (9) to the right-hand helix blower rotor timing gear with three spacers (12) and three type (B) hex lockbolts (8). Tighten the bolts to 30 ft lb (41 Nm).

NOTE

When replacement of a blower drive assembly is necessary, the new drive hub plus the new blower drive shaft flex plates, type (B) hex lockbolts and hub spacers must be used.

(111) Affix a new gasket to the blower rear end plate cover. Place the cover over the gears and against the end plate (7), with the opening in the cover over the blower drive hub attached to the right-hand helix gear. Install the rear cover using ten capscrews (4), special washers (5), and lockwashers (6). Tighten the capscrews to 17 ft lb (23 Nm).

NOTE

The tab on the gasket is to assure the gasket is in place.

(112) Install the mechanical governor as detailed in para. 2-19.13.

(113) Install the fuel pump as detailed in TM 5-4210-220-12.

(114) Attach the mini bypass blower and hose to the blower end plate (7).

(115) Install blower onto engine as described in INSTALLATION preceding.

NOTE

If blower is to be stored, block off inlet and outlet passages using masking tape (item 18, Appendix B) to prevent entry of contamination.

3-8. ENGINE Continued

3-8.4 Aftercooler.

This task covers
a. Removal
b. Installation
c. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705

EQUIPMENT CONDITION
Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Compartment Covers Removed (see TM 5-4210-220-12)
Air Cleaner Removed (see TM 5-4210-220-12)
Engine Canopy Removed (see TM 5-4210-220-12)
Turbocharger Removed (see para. 3-8.2)
Engine Coolant Drained (see LO 5-4210-220-12)
Wheels Blocked
Air Tanks Drained
Alternator Removed (see TM 5-4210-220-12)
Blower Removed (see para. 3-8.3) Main Engine

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil
5101196 Locking Bolt
5101138 Sealing Rings
5145581 Gasket

REMOVAL

NOTE

This task can be completed with the engine mounted in the truck or with the engine removed.

(1) Drain the coolant from the cylinder block, as some coolant may remain in the cooler if only the radiator is drained.

(2) Loosen the hose clamps (7), and slide the hose (8) toward the connector (3) on the left bank thermostat housing.

(3) Remove the capscrews (6) that secure the water outlet tube (5) to the cylinder block. Remove and discard gasket (4).

NOTE

Do not remove the four bolts in the top face of the aftercooler, as they are part of the aftercooler and need not be removed for any reason.

(4) Remove and discard the locking bolts that secure the aftercooler (1) to the cylinder block.

(5) Carefully maneuver the aftercooler (1) from the cylinder block, making sure not to damage the cooler fins.

(6) Remove and discard the seal rings (2) from the grooves in the water inlet and outlet tube ends of the aftercooler (1).

3-8. ENGINE Continued

INSTALLATION

(1) Install new seal rings (2) in the grooves on the water inlet and outlet tubes of the aftercooler Coat the seal rings lightly with engine oil (item 17, Appendix B). Do not scratch or nick the sealing edge of the seal rings.

(2) Carefully maneuver the aftercooler (1), water outlet end first, into the cylinder block opening. Carefully lower the aftercooler water inlet end into the water inlet adapter plug.

(3) Aline the aftercooler (1) to the cylinder block using new locking bolts. Do not tighten.

(4) Attach the water outlet tube (5) to the cylinder block using a new gasket (4) and capscrews (6). Do not tighten capscrews.

(5) Align the water outlet tube with the connector (3) on the thermostat housing. Slide the hose (8) equally over the tube (5) and connector (3). Install hose clamps (7) and tighten firmly.

(6) Tighten the water outlet capscrews (6) to 15 ft lb (22 Nm).

(7) Tighten the aftercooler locking bolts to 15 ft lb (22 Nm).

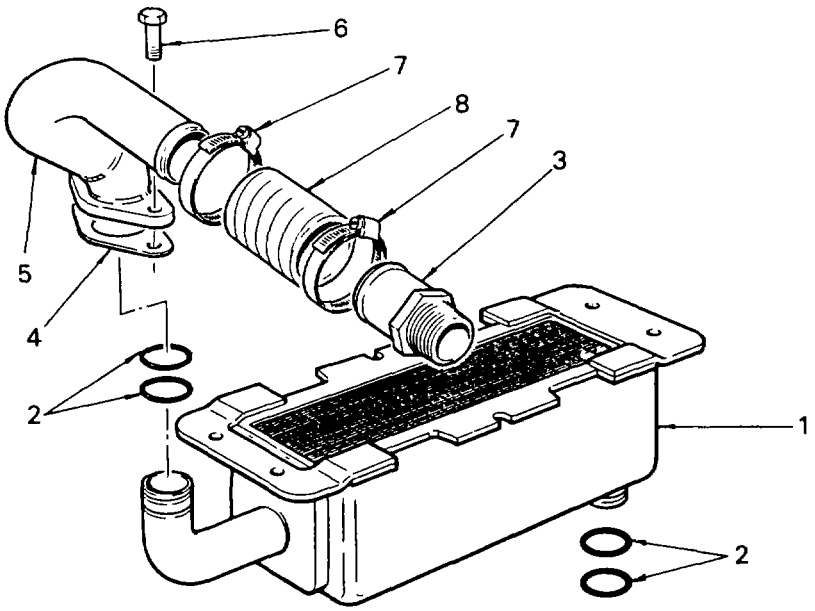
(8) Install blower, see para. 3-8.3.

(9) Install turbocharger, see para. 3-8.2.

(10) Fill radiator with antifreeze solution (see LO 5-4210-220-12).

(11) Install alternator (see TM 5-4210-220-12).

(12) Start engine and check for coolant leaks, and correct as necessary.



3-8. ENGINE Continued

3-8.4 Aftercooler - Continued

REPAIR

NOTE

Aftercooler must be removed from truck; see REMOVAL preceding.

A trace or crystal deposit left by evaporated coolant often indicates a potential leak or weak spot. If any trace of coolant or deposits are noticed, carry out step 11 following, prior to aftercooler cleaning.

Aftercooler repair is limited to the replacement of seal rings in the grooves of the water inlet and water outlet tube ends. The only other repair is cleaning of the aftercooler which is governed largely by the kind of coolant and coolant additive used in the engine cooling system.

(1) Check all of the cooler fins and air and water passages for plugging. Clean all obstructions from the fins using a small soft bristle brush.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(2) Blow all excess dirt from aftercooler fins using compressed air.

(3) Steam clean the outside of the core to remove any loose deposits.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

(4) Use dry cleaning solvent (item 10, Appendix B), clean oil and dirt from the aftercooler. If core has an excessive build up of dirt or carbon, allow aftercooler to soak in metal cleaner for about 12 hours. Leave the water connections open so that the cleaning solution can penetrate both the coolant and air sides of the aftercooler.

(5) Remove the core from the cleaning solution and rinse It thoroughly with a steam cleaner or high pressure hot water.

(6) Blow out the air and water sides of the core using compressed air. To ensure that loose debris is not forced further into the fins, direct the stream of air opposite to the direction of normal coolant and air flow.

(7) Rinse the core with clean dry cleaning solvent (item 10, Appendix B) to remove any residual oil or grease.

(8) Rinse the solvent from the core using a steam cleaner or high pressure hot water rinse.

3-8. ENGINE Continued

(9) Using compressed air, blow dry the air and water sides of the core.

(10) Visually inspect the cooler core tubes and fins to ensure that the cleaning process has completely removed all contamination. Repeat the cleaning procedure and reinspect as necessary.

(11) Test the aftercooler for leaks. Plug one core opening and attach a compressed air source to the other opening. Submerge the aftercooler in clean water and apply 30 psi (207 kPa) air pressure. Replace aftercooler if any leaks are found in the core element.

(12) Install the aftercooler as detailed in INSTALLATION preceding.

3-8. ENGINE Continued

3-8.5 Balance Weight Cover.

This task covers a. Removal
b. Installation

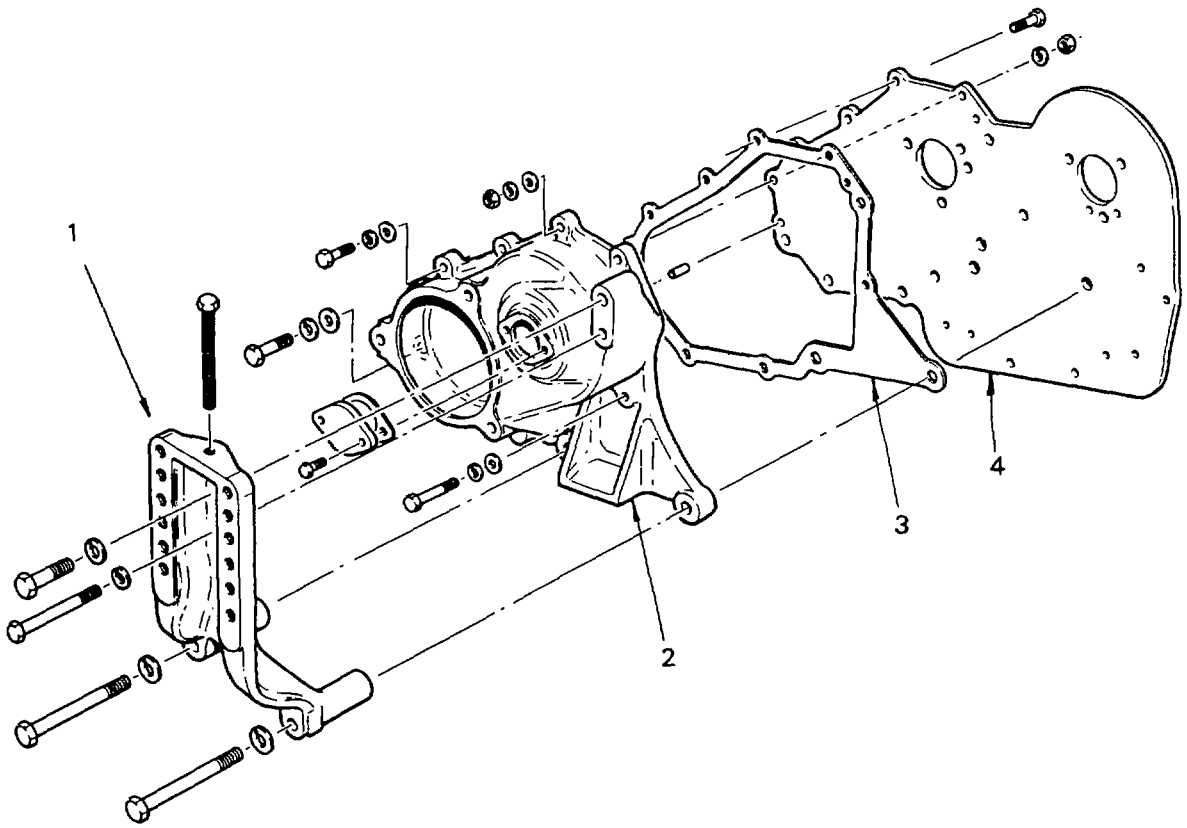
TOOLS
Shop Equipment, Automotive
Maintenance and Repair,
NSN 4910-00-754-0705
J24420-A Puller
J7932 Adapter

EQUIPMENT CONDITION
Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Both Engine Compartment Covers Removed
see TM 5-4210-220-12)
Fan Assembly Removed (see TM 5-4210-220-12)
Engine Coolant Drained
(including the cylinder block).
Wheels Blocked
Air Tanks Drained

MATERIALS/PARTS
17, Appendix B Engine Oil
5103544 Water Pump Seal
5106223 Oil Seal
5117243 Bearing Gasket
5123123 Gasket
5123638 Balance Weight Cover Gasket

REMOVAL

NOTE
This task can be completed with the engine mounted in the truck or with the engine removed. If camshaft-to-bearing clearance is excessive replace camshaft and/or bearings as detailed In para. 3-8.8.



3-8. ENGINE Continued

a. Balance Weight Cover Removal

(1) Remove water pump as detailed In para. 2-19.9.

(2) Remove the fan clutch support (1) by removing the four mounting capscrews and lockwashers. These capscrews are two different sizes and lengths. Note location to ensure proper assembly.

(3) Remove the capscrews, washers, and lockwashers, that secure the balance weight cover (2) to the front end plate (4) and the cylinder block. To make assembly easier, make a sketch of the balance weight cover and the position of each different size capscrew.

(4) Tap the ends of the cover with a soft-faced hammer to loosen it and remove cover (2) from the end plate (4).

(5) Remove all traces of gasket (3) from the balance cover (2) and end plate (4).

b. Water Pump Drive Gear Removal (1) Remove balance weight cover as detailed in a. preceding.

(2) Drain oil from engine crankcase into a suitable container.

(3) Remove the oil pan as detailed in para. 2-19.11.

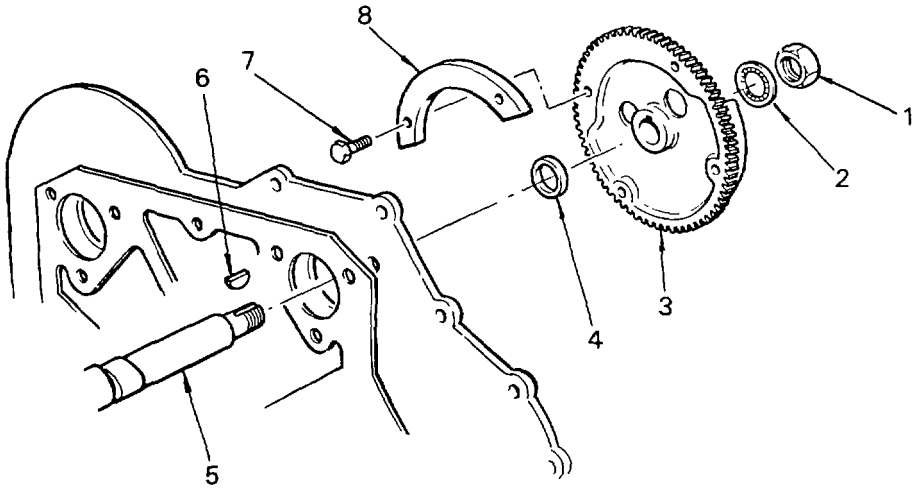
(4) Block the crankshaft between the crankshaft throw and the cylinder block to *prevent rotation* of the engine, and loosen the retaining nut (1) at front end of the camshaft.

(5) Remove the nut (1) and the internal tooth lockwasher (2) from the front end of the camshaft (5).

(6) Attach puller J24420-A to the water pump drive gear (3). Use adapter J7932 between the end of the camshaft (5) and the puller screw to protect the end of the camshaft. Tighten the puller screw and remove the water pump drive gear.

(7) Remove the woodruff key (6) and the spacer (4) from the end of the camshaft (5).

(8) Separate the counterweight (8) from the water pump drive gear (3) by removing the capscrews (7).



3-131

3-8. ENGINE Continued

3-8.5 Balance Weight Cover - Continued

c. Camshaft Pulley Removal

(1) Remove the fan clutch support by removing the four mounting capscrews and lockwashers. These capscrews are two different sizes and lengths. Note location to ensure proper assembly.

(2) Drain oil from engine crankcase into a suitable container.

(3) Remove the oil pan as detailed in para. 2-19.11.

(4) Block the crankshaft between the crankshaft throw and the cylinder block to prevent rotation of the engine and then loosen the retaining nut (1) at the front end of the camshaft (6).

(5) Remove nut (1) and internal tooth lockwasher (2) from the front end of the camshaft (6).

(6) Attach puller J24420-A to the camshaft pulley. Use adapter J7932 between the end of the camshaft and the puller screw to protect the end of the camshaft (6). Tighten the puller screw and remove the camshaft pulley (3).

(7) Remove the woodruff key (7) and the spacer (4) from the end of the camshaft (6).

d. Camshaft Pulley Bearing and Seal Removal

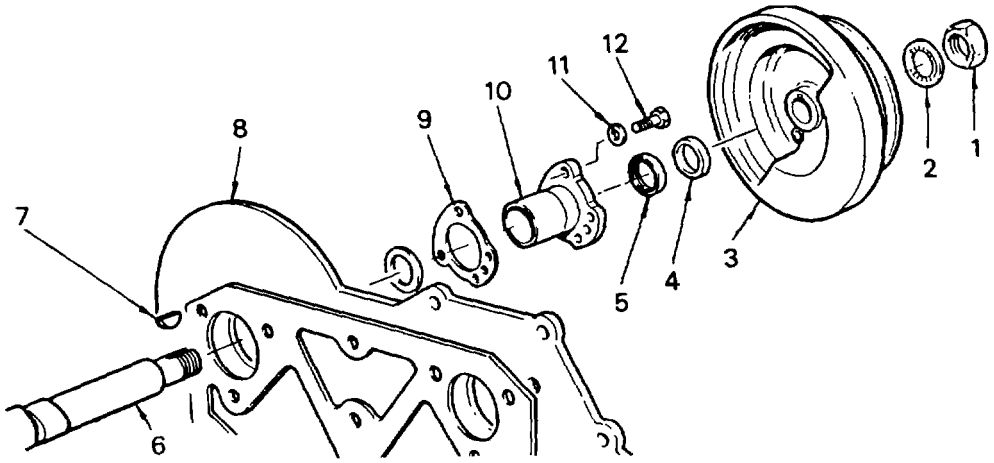
(1) Remove camshaft pulley as detailed in c. preceding.

(2) Remove the camshaft front end bearing retaining capscrews (12) and lockwasher (11). Then, withdraw the bearing (10) from the cylinder block. If necessary, use a small pry bar under the bearing flange.

(3) Remove gasket (9) from front end plate (8) and bearing flange (10).

(4) While supporting the bearing (10) on two blocks of wood, drive seal (5) from bearing using a hammer and a punch.

(5) Examine the spacer (4) used on the front end of the camshaft. The outside diameter must have a smooth sealing service. Replace as necessary.



3-8. ENGINE Continued

INSTALLATION

a. Camshaft Pulley Seal and Bearing Installation

(1) Position bearing (10) on bed of an arbor press, with the flange towards the top.

(2) Place seal (5) in the bearing (10) bore with the seal lip facing down. Carefully press the seal into the bearing bore ensuring it is installed square, and until the seal casing is flush with the bearing flange.

(3) Attach a new gasket (9) to the bearing (10). Lubricate the bearing journal with engine oil (item 17, Appendix B) and slide the bearing on the left bank camshaft.

(4) Secure the bearing (10) to the cylinder block with capscrews (12), and lockwasher (11) and tighten to 40 ft lb (54 Nm).

(5) Install pulley as detailed in b. following.

b. Camshaft Pulley Installation

(1) Lubricate the spacer (4) with the polished outside diameter using engine oil (item 17, *Appendix* B) and slide it into position on the left bank camshaft (6).

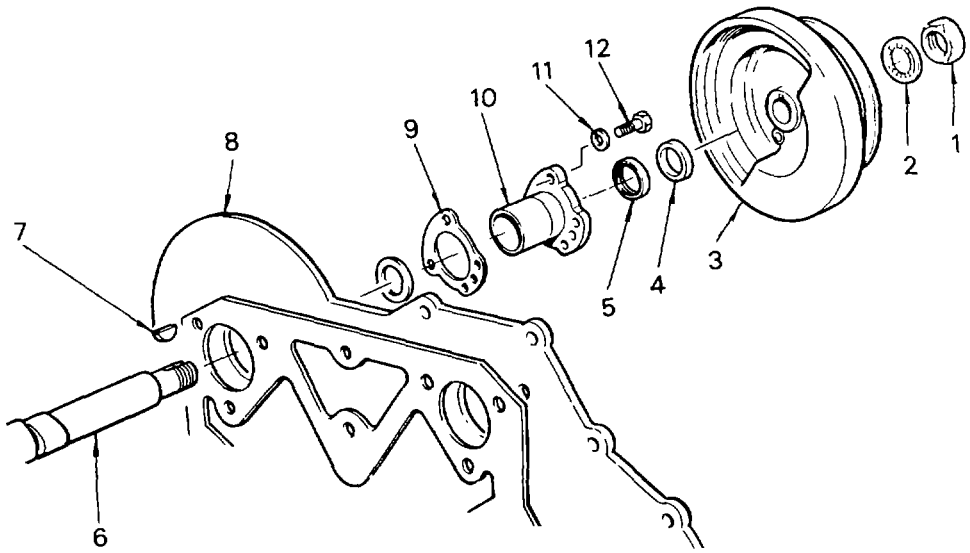
(2) Install a woodruff key (7) in camshaft (6).

(3) Install the camshaft pulley (3) on the left bank camshaft (6).

(4) Slip an internal tooth lockwasher (2) over the end of the camshaft (6), then start the retaining nut (1) on the camshaft.

(5) Block the crankshaft between the crankshaft throw and the cylinder block to prevent rotation of the engine. Then tighten the nut (1) on the end of camshaft to 325 ft lb (441 Nm).

(6) Replace other components as detailed in steps 3 thru 8 in d. following.



3-8. ENGINE Continued

3-8.5 Balance Weight Cover - Continued

c. Water Pump Drive Gear Installation

(1) Attach the counterweight (8) to the water pump drive gear (3) using capscrews (7). Tighten capscrews to 32 ft lb (43 Nm).

(2) Lubricate the spacer (4) with engine oil (item 17, Appendix B) and slide it into position on the right bank camshaft (5).

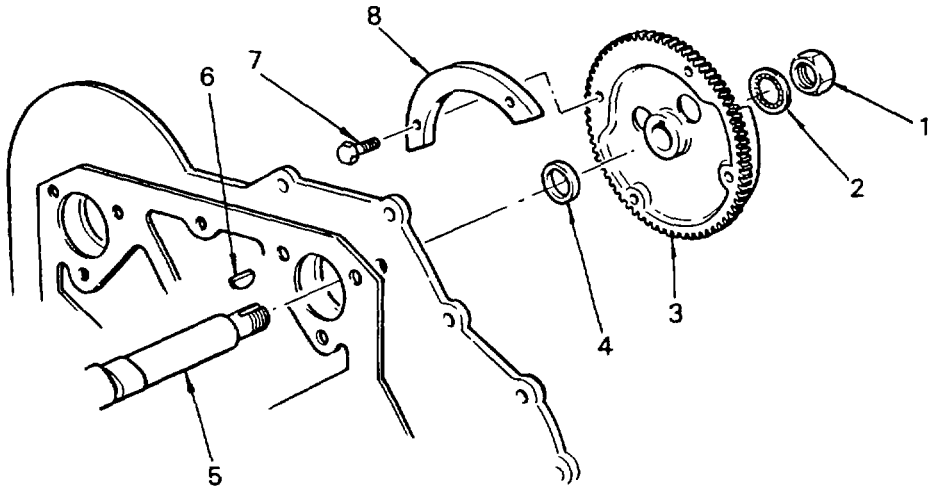
(3) Install a woodruff key (6) in camshaft (5).

(4) Install the water pump drive gear (3) on the right bank camshaft (5).

(5) Slip an internal tooth lockwasher (2) over the end of the camshaft (5), then start the retaining nut (1) on the camshaft.

(6) Block the crankshaft between the crankshaft throw and the cylinder block to prevent rotation of the engine. Then tighten the nut (1) on the end of the camshaft to 325 ft lb (441 Nm).

(7) Install balance weight cover as detailed in d. following.



3-8. ENGINE Continued

d. Balance Weight Cover Installation

(1) Affix a new gasket (3) to the balance weight cover (2).

(2) Install the balance weight cover (2) on the front end plate (4) and cylinder block. Secure with the capscrews, nuts, lockwashers and washers. Using the sketch made during removal, ensure all fasteners are In the correct location. Tighten 3/8 in.-16 fasteners to 35 ft lb (47 Nm); tighten 3/8 in. -24 fasteners to 39 ft lb (53 Nm); tighten 1/2 in. -13 fasteners to 75 ft lb (102 Nm); tighten 5/8 in. -11 fasteners to 147 ft lb (200 Nm).

(3) Attach fan support (1) to the balance weight cover (2) using the proper fasteners in the correct location. Refer to step 2 preceding for torque values.

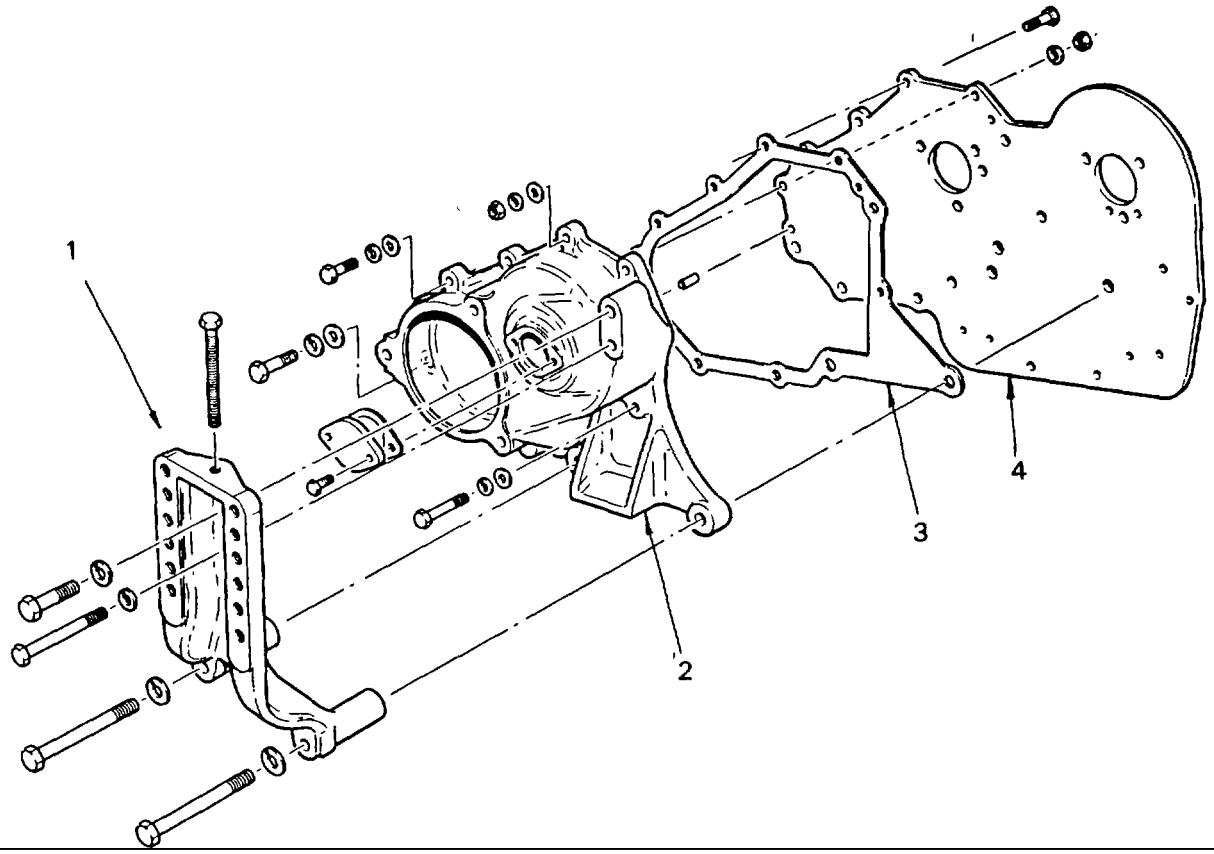
(4) Install water pump, see para. 2-19.9 if removed.

(5) Install fan and fan clutch, see TM 5-4210-220-12.

(6) Install oil pan as detailed in para. 2-19.11 and fill engine with oil as detailed in LO 5-4210-220-12.

(7) Fill engine cooling system with antifreeze solution, see LO 5-4210-220-12 if required.

(8) Start engine and run until it reaches operating temperature. Check for coolant or oil leaks. Repair or tighten connections as necessary.



3-8. ENGINE Continued

3-8.6 Flywheel Housing.

This task covers a. Removal
b. Installation
c. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J1927-01 Housing Alinement Studs
J4239 Rear Oil Seal Expander
J8092 Handle
J25002 Guide Studs
J21112-B Rear Oil Seal Installer
J3154-1 Handle
J8682 Rear Oil Seal Expander (Oversize Seal)

EQUIPMENT CONDITION
Engine Removed (see para. 3-8.1)
Flex Plate Removed (see TM 5-4210-220-12)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil
8922443 Small Cover Gasket
5104506 Large Cover Gasket
5144875 Flywheel Housing Gasket
5148499 Locking Bolts
5106321 Rear Seal

REMOVAL

NOTE

To make assembly easier, make a sketch of the flywheel housing and the size and location of all the fasteners removed.

(1) Remove the flywheel housing support brackets attached to the housing and the cylinder heads.

(2) Remove the accessories attached to the flywheel housing. (Air compressor removed during engine removal from truck.)

(a) Remove the alternator mounting brackets, see TM 5-4210-220-12.

(b) Remove the alternator pulley drive, see para. 2-19.2.

(c) Remove the power steering pump pulley drive, see para. 2-19.2.

(d) Remove the flywheel housing hole covers and discard gaskets.

(3) Remove the oil pan, see para. 2-19.11.

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the vehicle and hoisting equipment. All instructions for the hoisting operations must come from one authorized person

3-8. ENGINE Continued

(4) Support the weight of the flywheel housing using a suitable sling. Lifting eyes can be attached to flywheel housing on mounting pads.

(5) Remove the twelve attaching bolts located in the flywheel housing. Remove one bolt located behind the small hole cover on the right hand side of the flywheel housing. Then remove the remaining bolts around the upper portion of the housing, and the two bolts which go through the rear end plate from the front and thread into the flywheel housing. Install alining studs J1927-01 to guide the housing until it clears the crankshaft during removal.

(6) Using a soft-faced hammer, strike the front face of the flywheel housing alternately *on each* side of the engine to work it off the dowels and away from the cylinder block rear end plate. Take care not to force blower drive support away from blower drive flange, or to bend cylinder block end plate.

(7) Remove all traces of the old gasket from the cylinder block rear end plate and the flywheel housing.

(8) Support the outer face of the flywheel housing on wood blocks.

(9) Using a hammer and a punch, drive the oil seal out of the housing.

(10) Using a clean cloth, wipe the clean seal bore in the flywheel housing.

INSPECTION

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 Is 100 to 138 deg. F (30 to 59 deg. C).

(1) Wash the flywheel housing using dry cleaning solvent (item 10, Appendix B).

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(2) Dry the flywheel housing using compressed air.

(3) Inspect the flywheel housing for cracks, stripped threads or other damage. Replace flywheel housing as necessary.

(4) Inspect the rear end of the crankshaft for wear due to the rubbing action of the oil seal, dirt build up, or fretting caused by the action of the flywheel. The crankshaft must be clean and smooth, otherwise the oil seal lip will be damaged when the flywheel housing is reinstalled. If the seal area is grooved, refer to para. 3-8.10 to replace or to install a sleeve over the crankshaft rear boss.

3-8. ENGINE Continued

3-8.6 Flywheel Housing.

INSTALLATION

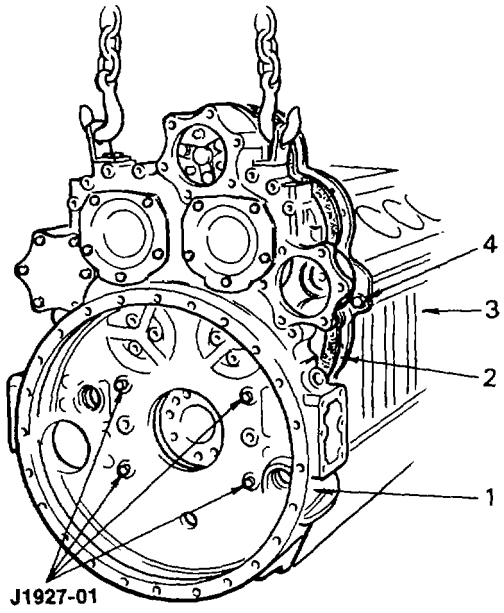
(1) Lubricate the gear train teeth with engine oil (item 17, Appendix B).

(2) Affix a new gasket (2) to the flywheel housing (1). Hold in place with petroleum jelly (item 21, Appendix B).

(3) Thread alining studs J1927-01 into the cylinder block (3) to guide the flywheel housing (1) in place.

(4) Before installing the flywheel housing, be sure the 5/8 in. -1 1 x 1 in. rear end plate-to-cylinder block bolt (4) is installed. Tighten the bolt to 110 ft lb (149 Nm).

(5) Attach lifting eyes to the mounting pads.



WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

Death or serious injury could occur if unauthorized or unnecessary personnel are in the hoisting area. Permit only personnel actually engaged in the hoisting operation to be near the vehicle and hoisting equipment. All instructions for the hoisting operations must come from one authorized person.

(6) Using a suitable lifting sling and an overhead crane, position the flywheel housing (1) over the alining studs and crankshaft. Push the housing up against the cylinder block end plate and gasket (2).

(7) Install three new flywheel housing nylon patch bolts at the right camshaft gear area, position 13, 14 and 15 as shown.

(8) Draw the flywheel housing towards the end plate by gradually tightening the bolts (with washers and lockwashers) in the following sequence; 12, 10, 11, 1, 2, 5, 6, 3, 4, 13, 23, 14, 15, 16, 17, 18, 19, 20, 21, 22, 30, 33, 27, 26, 25, 24, 32, 31, 29, 28, 9, 7, 8.

3-8. ENGINE - Continued

(9) Tighten capscrews progressively in steps to the final torque and sequence as shown in the sequence shown on the illustration.

(10) Check whether the crankshaft is fitted with a sleeve.

(11) If no sleeve is installed, place oil seal expander J4239 against the end of the crankshaft using handle J8092 and guide studs J25002.

(12) If a sleeve is installed, place oil seal expander J8682 against the end of the crankshaft. An oversize oil seal must be used.

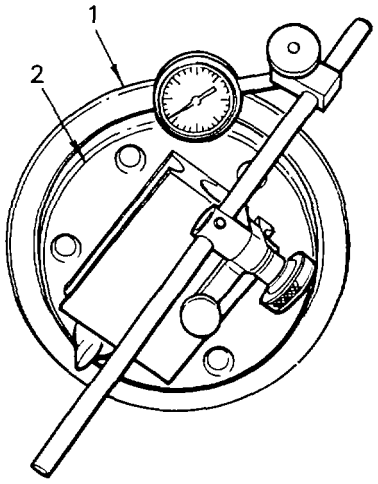
(13) Liberally lubricate the seal (standard or oversize), the crankshaft and the crankshaft oil seal expander with engine oil. (item 17, Appendix B). Failure to adequately lubricate these areas during seal installation can result In seal lip damage at engine start-up.

NOTE

Keep the sealing lip clean and free from scratches. In addition, a plastic coating which acts as a sealant is applied to the outer surface of the seal case. Do not remove this coating.

(14) With the lip of the seal pointed toward the engine, slide the seal over the expander and onto the crankshaft. Remove the seal expander and guide studs, as required.

(15) Install crankshaft rear oil seal installer J21112-2 and guide studs J9727-5. Using handle J3154-1, drive the seal in place until the installer seats squarely on the butt of the crankshaft. Remove the seal installer and guide studs.



(16) Check the squareness of the seal (1) in relation to the face of the crankshaft butt (2) by attaching a magnetic base dial indicator to the rear butt of the crankshaft as shown.

(17) Pry the crankshaft to the rear end of the block and position the point of the dial indicator on the seal face. Rotate the crankshaft and note the seal face readings at the 12, 9, 6, and 3 o'clock positions. The total run-out at each position should not exceed 0.015 in. (0.381 mm).

CAUTION

The hex head of the front crankshaft bolt may be used to turn the crankshaft. However the barring operation should ALWAYS be performed in a clockwise direction. It is very important to ensure the bolt is not loosened. Serious engine damage may result if the pulley is not securely fastened to the crankshaft.

(18) If any reading is over 0.015 in. (0.381 mm) place the seal installer J21112-2 over the seal and lightly tap with a soft-faced hammer at the high points This will ensure that the tool is squarely seated on the butt of the crankshaft.

3-8. ENGINE - Continued

3-8.6 Flywheel Housing - Continued

(19) Remove any excess sealant from the flywheel housing and the seal.

(20) Install the oil pan, see para. 2-19.11.

(21) Install the flywheel housing hole covers using new gaskets. Tighten capscrews to 35 ft lb (47 Nm).

(22) Install the power steering pump pulley drive, see para. 2-19.2.

(23) Install the alternator pulley drive, see para. 2-19.2.

(24) Install the alternator mounting brackets, see TM 5-4210-220-12.

25) Secure the flywheel housing support brackets to the cylinder heads and the flywheel housing.

(26) Install engine as detailed in para. 3-8.1.

(27) Start and run engine and check for oil, coolant or air leaks. Tighten or remake connections as necessary.

3-8. ENGINE.

3-8.7 Gear Train.

This task covers
a. Removal
b. Inspection
c. Installation
d. Repair

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
11, Appendix D Bearing Test Fixture Plates
J21983 Seal Sleeve Installer
J8092 Handle
J25002 Guide Studs
J8129 Spring Scale (Part of J5438-01)

EQUIPMENT CONDITION
Engine Removed (see para. 3-8.1)
Flex Plate Removed (see TM 5-4210-220-12)
Flywheel Housing Removed (see para. 3-8.6)

MATERIALS/PARTS
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil
5148810 Blower Drive Support Gasket
5198158 Crankshaft Oil Seal Sleeve
5103534 Idler Bearing Retainer Capscrews
8923571 Blower Flex Plate Capscrews
8920764 Flex Plates

NOTE

Gear train noise is usually an indication of excessive gear backlash, chipped, pitted or burred gear teeth, or excessive bearing wear. If a gear train noise develops, all the gears and bearings should be Inspected.

Prior to gear removal, it is advisable to line up and make a sketch indicating the position of the timing marks before removing or replacing any of the gears in the gear train. Whenever the sealant patch bolts are removed, they should be replaced with new sealant patch bolts.

REMOVAL

a. Blower Drive Gear Removal

NOTE

This task can be done with the engine mounted in the truck.

(1) Remove the blower, see para. 3-8.3.

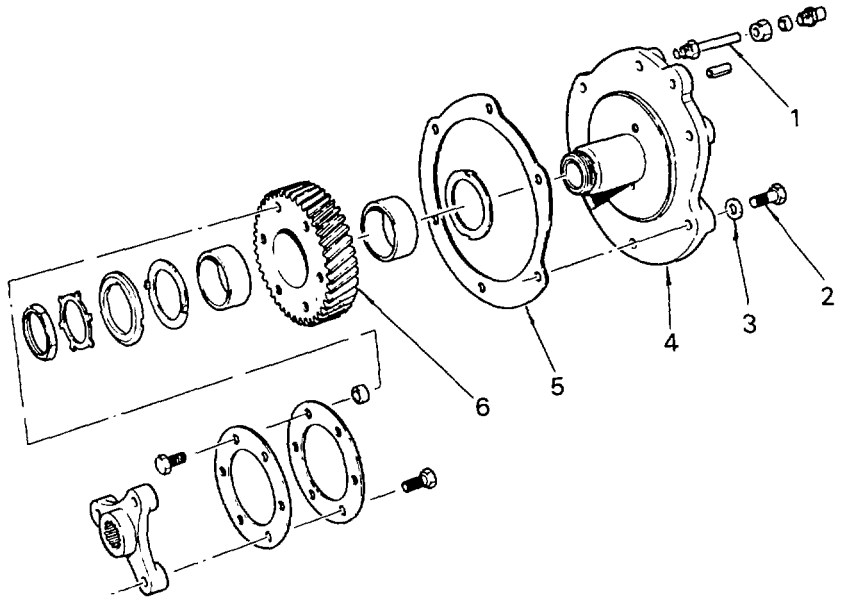
(2) Remove the lubrication tube (1) from the blower drive support (4).

(3) Note the location and remove the blower drive support-to-cylinder block rear end plate attaching capscrews (2), and copper washers (3).

(4) Tap the blower drive support (4) with a soft faced hammer to loosen it, then carefully withdraw the support from the cylinder block rear end plate so the blower drive gear teeth will not be damaged.

(5) Discard the gasket (5).

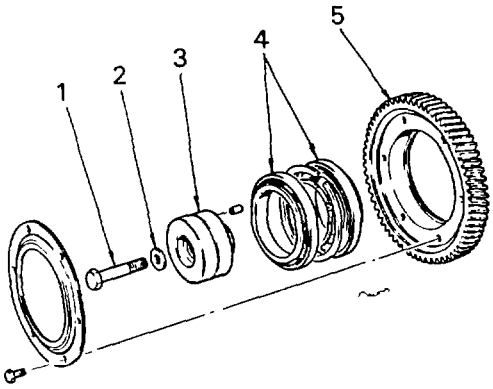
3-8. ENGINE - Continued



(6) While holding the support (4), rotate the gear (6) by hand If gear does not rotate freely or there is excessive bushing-to-support clearance repair the blower drive gear as detailed in the REPAIR section following

b. Idler Gear Removal

(1) Before removing the idler gear assembly, check the Idler gear, hub, and bearing assembly for any noticeable wobble or shake. Apply pressure by firmly grasping the rim of the gear with both hands, then rock the gear in relation to the bearing. The bearings must be replaced if the gear wobbles or shakes. If the gear assembly has no noticeable play It is only necessary to check the pre-load before reinstallation.



(2) Remove the bolt (1) and special washer (2) that secure the idler gear hub (3) to the cylinder block.

(3) Carefully remove the idler gear assembly from the cylinder block end plate.

(4) While supporting the hub (3), rotate the gear (5) by hand. If the gear does not rotate freely, or there is damage as detailed In step 1 preceding, replace the bearings (4) as detailed in REPAIR section following.

3-8. ENGINE - Continued

3-8.7 Gear Train - Continued

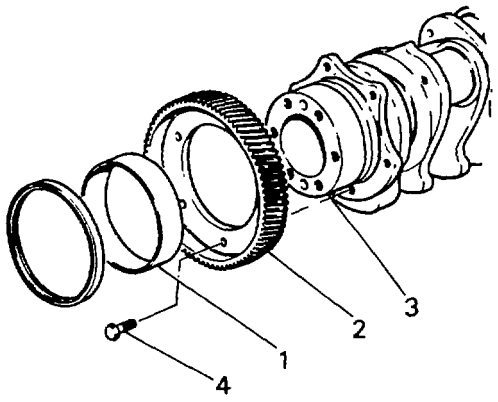
c. Crankshaft Gear Removal

(1) Remove the crankshaft rear oil sleeve (1), if used. To remove the sleeve, peen the outside diameter of the sleeve until It stretches sufficiently so it can be slipped off the crankshaft (3).

(2) Remove the bolts (4) which secure the gear (2) to the crankshaft (3)

(3) Provide a base for the gear puller by placing a steel plate across the cavity in the end of the crankshaft (3).

(4) Remove the crankshaft gear (2) using a gear puller. Follow tool manufacturers safety rules when pullers are used.



(5) Examine the gear teeth for scoring, pitting or wear. If severely damaged or worn, install a new gear. Make sure to carefully examine the other gears in the gear train.

d. Camshaft Gear Removal

(1) For camshaft gear removal, see para. 3-8.8 Camshafts.

INSPECTION

NOTE

This procedure may be used for any gear in the engine gear train.

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection, and other personal protective equipment.

(1) Clean all of the parts with dry cleaning solvent (item 10, Appendix 8) and dry them with compressed air.

(2) Examine the gears for chipped, pitted, burred or worn gear teeth. Replace gears as necessary.

(3) Examine bearings by holding the inner race stationary, and slowly spinning the outer race by hand If the bearing is worn or does not roll freely, replace the bearing.

(4) If gear assembly is damaged, refer to REPAIR section following for detailed repair procedures.

INSTALLATION

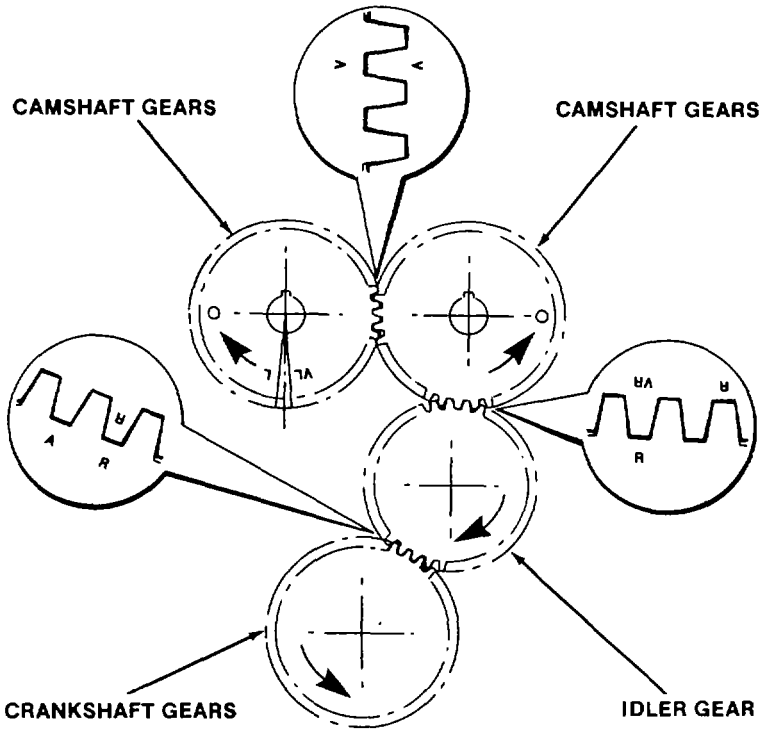
NOTE

The two camshaft gears mesh with each other and run at the same speed as the crankshaft gear. Since the camshaft gears must be in time with each other, and the two as a unit in time with the crankshaft gear, timing marks have been stamped on the face of the gears to facilitate correct gear train timing. The symbol system of marking the gears makes gear train timing a comparatively easy operation.

Using the following illustration, line up the appropriate symbols on the gears as each gear assembly is installed on the engine. There is not advance timing (A) on the V-92 engine group. After installation, check the backlash between the various mating gears.

New Gear Backlash 0.002 - 0.008 in. (0.051 - 0.203 mm)
Worn Gear Backlash 0.010 In. Maximum (0.254 mm maximum).

If the engine was completely disassembled, it is easier to install the crankshaft gear first. Then working from the crankshaft gear to the idler gear and to the camshaft gears, line up the appropriate symbols to time the gear train.



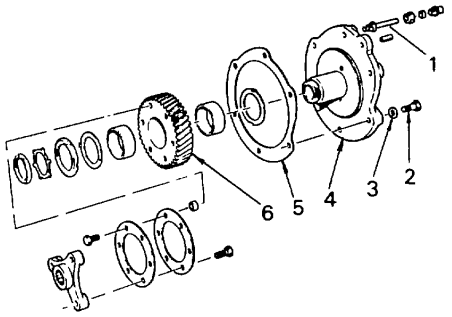
3-8. ENGINE - Continued

3-8.7 Gear Train - Continued

a. Blower Drive Gear Installation

NOTE

There are no timing marks on the blower drive gear. Therefore it is not necessary to aline this gear in any particular position during the installation procedure.



(1) Affix a new gasket (5) to the blower drive gear support (4) and attach the gear and support assembly to the cylinder block rear end plate with capscrews (2) and copper washers (3). Tighten the capscrews to 30 ft lb (41 Nm).

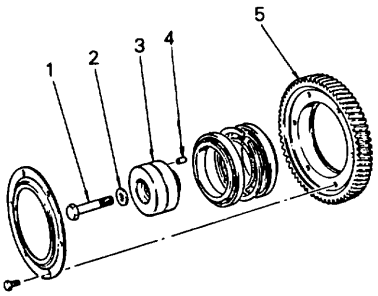
(2) ttach the lubrication line (1) to the blower drive support (4).

(3) Check the gear backlash between the blower drive gear (6) and the camshaft gear. To accurately check the backlash, all of the flywheel housing attaching capscrews must be tightened to their proper torque, see para. 3-8.6. Backlash should be 0.002 0.008 in. (0.051 0.203 mm), and should not exceed 0.010 in. (0.254 mm).

(4) Install the blower, see para. 3-8.3.

b. Idler Gear Installation

(1) Position the crankshaft gear and the camshaft gear so the timing marks will aline with those on the idler gear.



(2) With these marks aligned, start the idler gear (5) into mesh with the crankshaft gear and camshaft gear, and simultaneously rotate the gear hub (3) so the dowel (4) in the hub mates with the hole in the end plate. Then, using a soft faced hammer, gently tap the hub until it seats against the end plate.

(3) Secure the idler gear assembly to the cylinder block using the special washers (2) and bolt (1). Tighten the bolt to 90 ft lb (122 Nm).

(4) Lubricate the idler gear bearing and gear teeth with engine oil (item 17, Appendix B).

(5) After installation is complete, check the backlash between the mating gears. Allowable backlash for new gears is 0.002 0.008 in. (0.051 0.0203 mm). Backlash must not exceed 0.010 in. (0.254 mm) for worn gears.

3-8. ENGINE - Continued

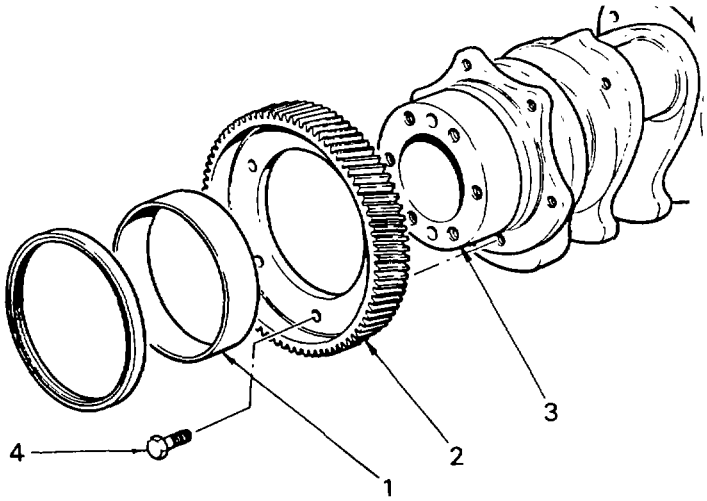
c. Crankshaft Gear Installation

(1) To make crankshaft gear timing and installation easier, remove the idler gear assembly as detailed in REMOVAL section.

(2) Position the gear (2) on the rear end of the crankshaft (3) with the bolt holes in the gear aligned with the tapped holes in the crankshaft. One bolt hole is off set so the gear can be attached in only one position.

(3) Start the bolts (4) through the gear (2) and into the crankshaft (3). Then draw the gear tight against the shoulder of the crankshaft. Tighten the bolts to 39 ft lb (53 Nm).

(4) Install the idler gear assembly as detailed in b. Idler Gear Installation preceding.



NOTE

On 6V-92 engines an oil seal sleeve may be pressed on the rear end of the crankshaft to provide a replaceable wear surface for the rear oil seal contact area.

(5) Install the oil seal sleeve (1) as detailed in following text if necessary.

(a) Stone the high spots from the oil seal contact surface of the crankshaft (3) and wipe clean.

(b) Coat the area of the crankshaft where the sleeve will be positioned with shellac or equivalent sealant.

(c) Press the sleeve on the shaft using oil seal sleeve installer J21983, handle J8092 and guide studs J25002.

(d) Wipe off any excess sealer.

(6) Make sure to install the proper oversize seal into the flywheel housing see para. 3-8.6

d. Camshaft Gear Installation

(1) For camshaft gear installation, see para. 3-8.8. Camshaft.

3-8. ENGINE - Continued

3-8.7 Gear Train - Continued

REPAIR

a. Blower Drive Gear Repair

(1) Secure the blower drive gear and support in a soft jaw vise.

(2) Remove the three capscrews (3) securing the drive gear hub (2) and flex plates (4) to the blower drive gear (11). Then remove the flex plates and blower drive gear hub as an assembly. Make sure to avoid dropping the spacers (6) during disassembly.

(3) Straighten the tabs on the lockwasher (8) and remove the blower drive gear support nut (7).

(4) Withdraw the lockwasher (8), thrust washer (9), thrust bearings (10 and 12) and gear (11) from the support (1).

WARNING

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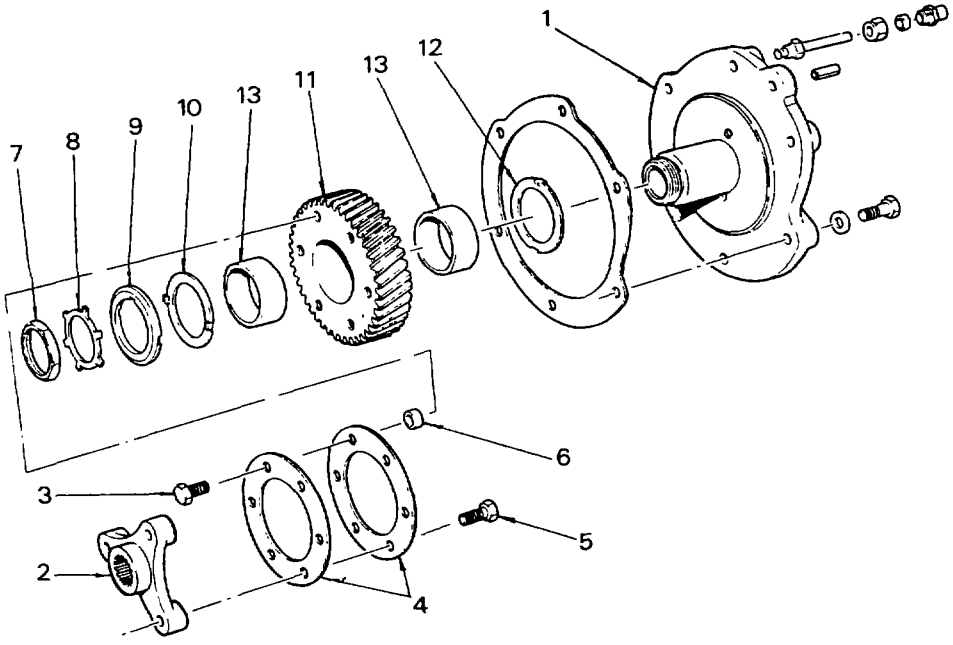
Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.



3-8. ENGINE - Continued

(5) Clean all parts with dry cleaning solvent (item 10, Appendix B) and dry them with compressed air.

(6) Using compressed air, blow the oil passage in the blower drive support to make sure It is clean

(7) Check the inside diameter of the blower drive gear bushings for wear or overheating. Support bushing (I.D.) inner diameter should be 1 6260 to 1.6265 In (41.3004 to 41 3131 mm)

(8) Check the blower drive support hub diameter for wear or overheating. Hub diameter (at bearing) should be 1.624 to 1.6250 in. (41.2496 to 41.2750 mm)

(9) Using the measurements from steps 7 and 8 preceding, determine the clearance between the blower drive gear bushings and the hub support. Hub-to-support bushing clearance should be 0.0010 to 0.0025 in. (0.0254 to 00635 mm)

(10) Examine thrust washer and thrust bearings for scoring or wear. Thrust washer thickness should be 0.2350 to 0.2450 in. (5.969 to 6.223 mm). Thrust bearing thickness should be 0.0590 to 0.0610 in. (1.4986 to 1.5494 mm)

(11) Inspect the gear teeth for scoring, pitting, burning, or wear.

(12) Inspect the flex plates for crack or wear.

(13) Examine the serrations in the blower drive hub for wear or cracks.

(14) Replace worn or damaged parts as necessary.

(15) If new bearings (13) are installed, the outer end of each bearing must be pressed in flush to 0.010 in. (0.254 mm) below the face of the gear. The bearings must be reamed to the dimensions listed in step 7 preceding and have a 20 microinch finish after installation. The bearing bores must be square with the machined faces of the bolt bosses on the gear within 0.003 in. (0.0762 mm) total indicator reading and concentric with the pitch diameter of the gear teeth.

NOTE

To assemble the blower drive gear assembly carry out steps 16 thru 25.

(16) Support the blower drive support (1) in the soft jaws of a vise.

(17) Position thrust bearing (12) on the support (1) so that the tangs on the thrust bearing aline with the holes in the support.

(18) Lubricate the hub of the support (1), the bushings in the gear (11), both thrust bearings (10 and 12) and the blower drive gear support thrust washer (9) with engine oil (item 17, Appendix B).

(19) Slide the gear (11) on the blower drive support hub (1) with the flat side of the gear down.

(20) Install the second thrust bearing (10) so that the tangs are facing up.

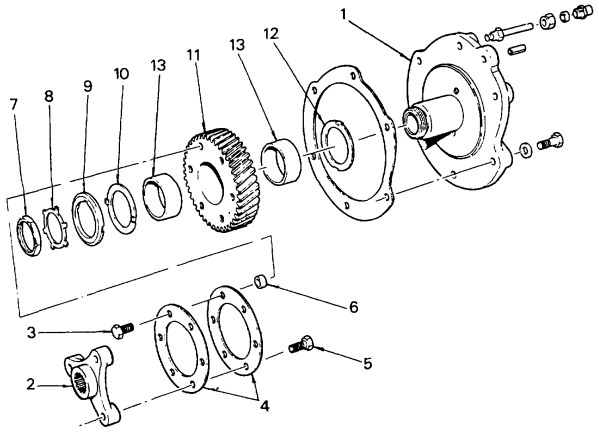
3-8. ENGINE - Continued

3-8.7 Gear Train - Continued

(21) Position the blower drive support thrust washer (9) so that the slots in the thrust washer register with the tangs on the thrust bearing (10).

(22) Secure the gear on the support with the lockwasher (8) and nut (7). Tighten the nut to 60 ft lb (81 Nm) and bend the tabs on the lockwasher against the flats on the nut.

(23) Using feeler gages, measure the clearance between the blower drive gear support thrust washer (9) and the blower drive gear thrust bearing (10). The clearance should be 0.005 to 0.010 in. (0.127 to 0.254 mm) with new parts and should not exceed 0.012 in. (0.0305 mm) for used parts.



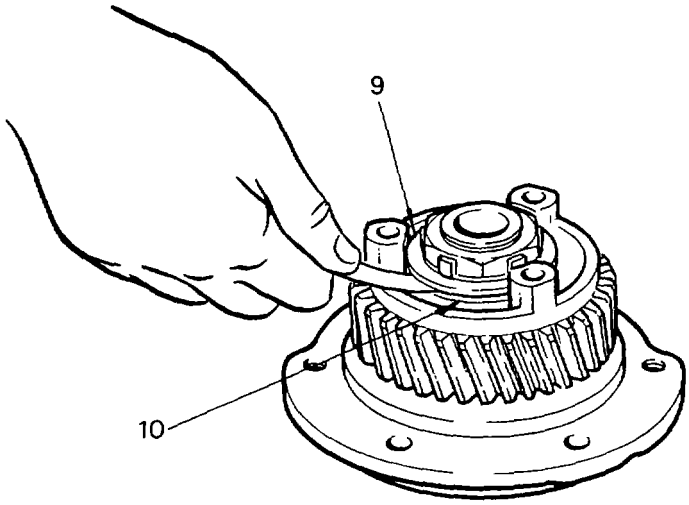
NOTE

Do not install lockwashers against the flex plates.

(24) If the flex plates (4) were removed for the blower drive gear hub (2), then secure them to the gear hub using three special 3/8 in. 24 X 0.925 in. locking bolts (5). Tighten the bolts to 39 ft lb (53 Nm).

(25) To assemble the blower drive gear hub assembly to the gear (11), install the special 3/8 in. 24 X 0.925 in. locking bolts through the flex plates and position the spacers (6) on the bolts. Thread the bolts into the gear and tighten to 39 ft lb (53 Nm).

(26) Install blower drive gear support as detailed in the INSTALLATION section preceding.



3-8. ENGINE - Continued

b. Idler Gear Repair

NOTE

While removing or installing an idler gear bearing, the bearing must be rotated to avoid the possibility of damaging the bearing.

(1) Remove the capscrews (1) that secure the bearing retainer (2) to the idler gear (3) and remove the bearing retainer. Discard the capscrews, and replace with new ones.

(2) Place the idler gear assembly in an arbor press, with the inner bearing cone supported on steel blocks. While rotating the idler gear assembly, press the hub (4) out of the bearing.

NOTE

Idler gear bearings are matched sets; match-mark the bearings to ensure proper assembly.

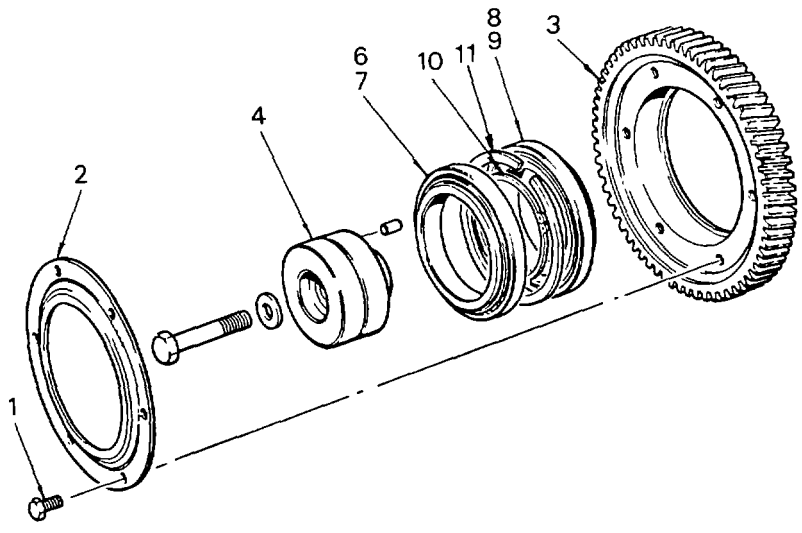
(3) Remove the gear assembly from the arbor press and remove the bearing cones (6 and 8) and spacer rings (10 and 11).

(4) Use the four notches provided around the shoulder of the gear (3) to access the bearing cups (7 and 9). Using a brass drift and a hammer alternately tap the cups from the idler gear.

(5) Carefully examine the bearings for wear, pitting, scoring or flat spots on the rollers or cones.

(6) Check the idler gear hub to ensure that no chips or foreign material is deposited In the holes so as to cause interference with the flywheel housing attaching bolts.

(7) Examine the gear teeth for scoring, pitting or wear. If gear is damaged or worn, make sure the other gears in the gear train are examined.



3-8. ENGINE - Continued

3-8.7 Gear Train - Continued

(8) Support the idler gear (3), shoulder down on an arbor press bed. Start one of the bearing cups (9), numbered side up, squarely into the bore of the idler gear. Then seat the cup against the shoulder of the gear using a bearing test fixture plate (11, Appendix D) between the ram of the press and the bearing cup.

(9) Lay the outer spacer ring (11) on the face of the bearing cup (9).

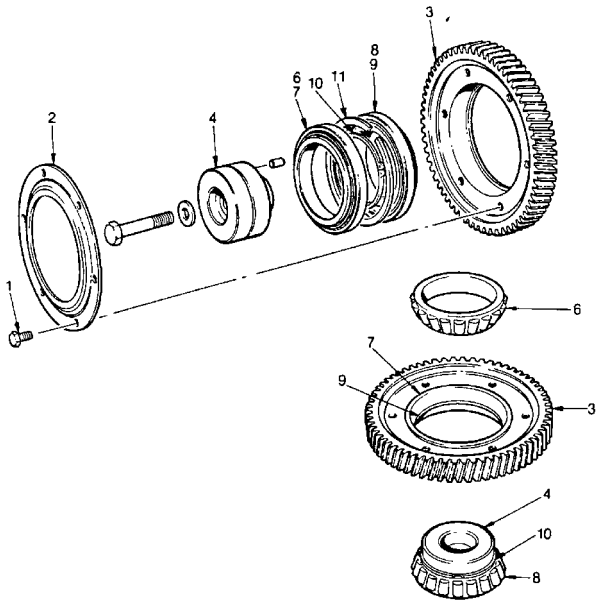
(10) Start the other bearing cup (7), numbered side down, squarely into the bore of the gear. Then press the cup tight against the spacer ring (11). Using a bearing test fixture plate (11, Appendix D) between the ram of the press and the bearing cup.

(11) Press the inner bearing cone (8), numbered side up, on the idler gear hub (4) until flush with the inner hub mounting face. Use the bearing test fixture plate (11, Appendix D) with the large center hole) between the ram of the press and the bearing.

(12) Install the inner spacer ring (10) on the idler gear hub (4) so that the oil hole in the hub is 180 deg. from the gap in the inner spacer ring.

(13) Position the gear (3) with both cups (7 and 9) installed over the hub (4) and inner bearing cone (8).

(14) Press the outer idler gear bearing cone (6) over the hub (4) while rotating the gear (3) to seat the rollers properly between the cones. The bearing cones must be supported so as not to lead the bearing rollers during this operation.



3-8. ENGINE - Continued

NOTE

Prior to the installation of the idler gear assembly, bearing pre-load must be checked. Carry out steps 15 thru 26 to check idler gear bearing pre-load.

(15) Lubricate the idler gear bearings using engine oil (item 17, Appendix B) prior to pre-load testing.

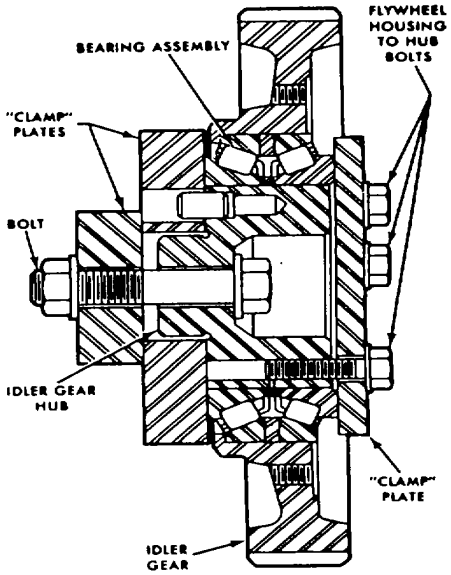
(16) Attach the two 3/4 in. bearing test fixture plates (11, Appendix D) to the Idler gear hub using a 1/2 in - 13 bolt, washers and nut. Tighten the nut to 90 ft lb (122 Nm).

(17) Attach the 3/8 in. bearing test fixture plate (11, Appendix D) to idler gear hub using 3/8 in. - 16 capscrews. Tighten the capscrews to 40 ft lb (54 Nm).

(18) Clamp the idler gear assembly and fixture in a vise.

(19) Tie one end of a piece of lintless 1/8 in. cord around a 1/8 in. round piece of wood. Place the wood between two of the gear teeth and rap the cord around the periphery of the gear several times. Attach the other end of the cord to a spring scale J8129.

(20) Maintain a straight steady pull on the cord and scale, 90 deg. to the axis of the hub, and note the pull, in pounds and ounces, required to start the gear rotating, Make several checks to obtain an average reading.



(21) If the pull is within 1/2 lb minimum to 4 lbs maximum, and does not fluctuate more than 2 lb 11 oz., the idler gear and bearing assembly is satisfactory for use. If the scale reading is within the 1/2 to 4 lb specified, but fluctuates more than 2 lb 11 ounces, the idler gear and bearing assembly must NOT be installed on the engine.

(22) Fluctuations in scale reading may be caused by the cones not being concentric to each other, damaged cones or rollers, or dirt or foreign material within the bearings. In these cases, the bearing should be inspected for the cause of fluctuation in the scale readings and corrected or a new bearing installed.

(23) A scale reading which exceeds the specified maximum indicates binding of the bearing rollers, or rollers improperly installed.

(24) When the scale reading is less than the specified minimum, the bearing is more likely worn and the bearing should be replaced.

(25) After the pre-load check is completed, remove the bearing test fixture plates (11, Appendix D) from the idler gear assembly.

(26) Attach the bearing retainer (2) to the Idler gear (3) using new capscrews (1). Tighten the capscrews to 29 ft lb (39 Nm).

(27) Attach the idler gear assembly as detailed in the INSTALLATION section preceding.

3-8. ENGINE.

3-8.8 Camshafts.

This task covers
a. Removal
b. Disassembly
c. Inspection
d. Assembly
e. Installation

TOOLS

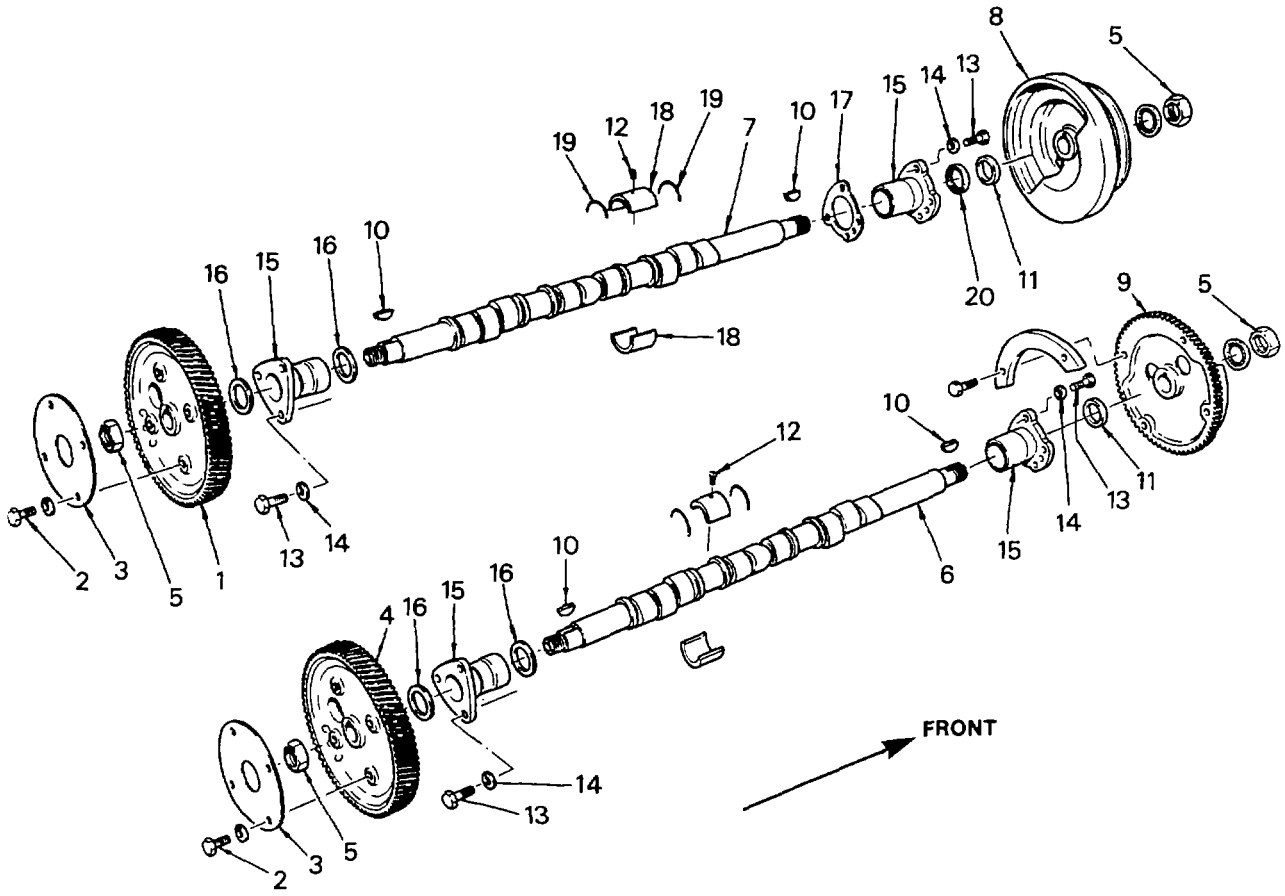
Shop Equipment, Automotive Maintenance and Repair, FSN 4940-287-4894
J24420-A Puller
J7932 Adapter
J1903 Camshaft Gear Replacer
J1902-01 Camshaft Gear Puller
J6471-02 Slide Hammer Set
J8601-01 Adapter
J29109 Engine Stand

EQUIPMENT CONDITION

Engine Removed (see para. 3-8.1)
Flex Plates Removed (see TM 5-4210-220-12)
Blower Removed (see para. 3-8.3)
Cylinder Heads Removed (see para. 2-19.8)
Flywheel Housing Removed (see para. 3-8.6)
Blower Drive Support Removed (see para. 3-8.7)
Water Pump Removed (see para. 2-19.9)
Balance Weight Cover Removed (see para. 3-8.5)

MATERIALS/PARTS

7, Appendix B Crocus Cloth
10, Appendix B Dry Cleaning Solvent
16, Appendix B Grease
17, Appendix B Engine Oil
5117243 Bearing Gasket
5106223 Seal



3-8. ENGINE - Continued

REMOVAL

(1) Remove the capscrews (2) that secure the nut retaining plates (3) to the camshaft gears (1 and 4), then remove the retaining plates.

(2) Wedge a clean rag between the lower face of the camshaft gears (1 and 4) and remove the gear retaining nuts (5) from both ends of each camshaft. On the front camshaft gears, remove the internal tooth lockwashers after removing the retaining nuts (5).

(3) Attach puller J24420-A to the camshaft pulley (8) and position adapter J7932 between the end of the camshaft (7) and the puller screw. Tighten the puller pressure screw and remove the pulley. Remove puller.

(4) Attach puller J24420-A to the water pump drive gear (9) and position adapter J7932 between the end of the camshaft (6) and the puller screw. Tighten the puller pressure and remove the water pump driver gear. Remove the puller.

(5) Remove the woodruff key (10) and spacer (11) from the front end of each camshaft (6 and 7).

(6) Remove all of the camshaft intermediate bearing lockscrews (1 2) from the top of the cylinder block.

(7) Rotate the camshaft gears (1 and 4) as necessary to reveal the camshaft rear end bearing retaining bolts (13). Remove all the retaining bolts (13) and lockwashers (14).

(8) Withdraw camshaft (6), bearing (15), thrust washers (16), and gear (4) from the cylinder block.

(9) Withdraw camshaft (7), bearing (15), thrust washers (16) and gear (1) from the cylinder block.

(10) Remove the camshaft front end bearing retaining bolts (13) and washers (14). Then withdraw the bearings (15) from the cylinder block. If necessary, use a small pry bar under the bearing flange. Remove all traces of gasket (17) from the bearing or front end plate.

DISASSEMBLY

NOTE

Prior to dismantling any components, visually examine the camshaft to determine whether or not camshaft is serviceable. Refer to INSPECTION following for measurement tolerances.

(1) Using puller J1902-01 remove the gear (1) from the camshaft (7).

(2) Remove the woodruff key (10).

(3) Slide the camshaft rear end bearing (15) and thrust washers (16) off the camshaft (7)

(4) Remove the lock rings (19) from the camshaft intermediate bearings (18), thus releasing the two bearing halves from the camshaft.

3-8. ENGINE - Continued

3-8.8 Camshafts - Continued

(5) Remove the end plugs from each end of the camshaft as detailed in the following text.

(a) Clamp the camshaft (7) in a vise equipped with soft jaws, being careful not to damage the cam lobes or machined surfaces of the shaft.

(b) Make an indentation in the center of the camshaft end plug with a 31/64 in. drill.

(c) Punch a hole as deeply as possible with a center punch, to aid in breaking through the hardened surface of the plug.

(d) Then drill a hole straight through the center of the plug with a 1.4 in. drill.

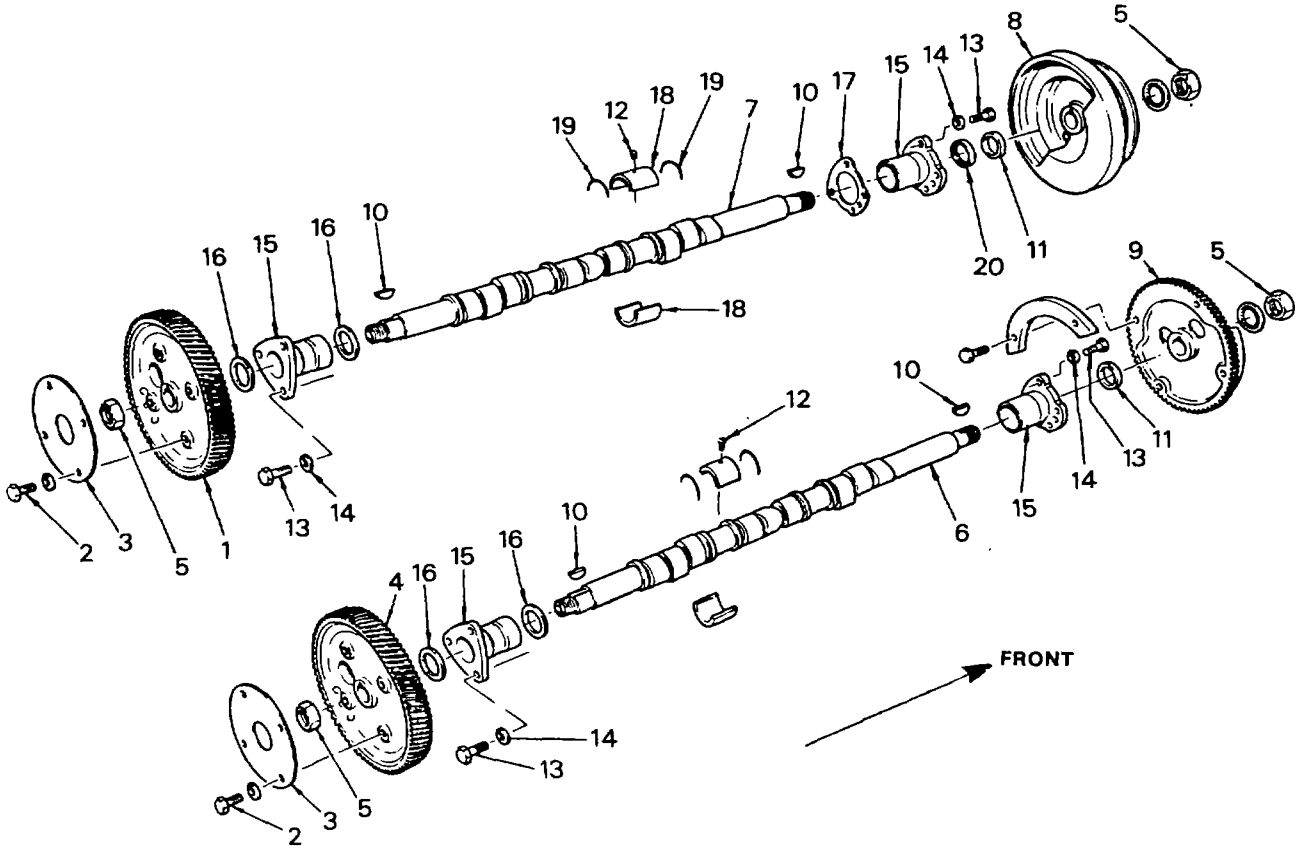
(e) Use 1/4 in. drilled hole as a guide and re-drill the plug with a 5/16 in. drill.

(f) Tap the drilled hole with a 3/8 in. 16 tap.

(g) Thread a 3/8 in. - 16 adapter J6471-2 into the plug. Then, attach slide hammer J2619-5 to the adapter and remove the plug by striking the weight against the handle.

(h) Insert a length of 3/8 in, steel rod in the camshaft oil gallery and drive the remaining plug out. If a steel rod is not available, remove the remaining plug as outlined in steps a, thru g. preceding.

(6) Disassemble the right-hand camshaft assembly (6) similarly to steps 1 thru 5 preceding.



3-8. ENGINE - Continued

INSPECTION

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2 11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

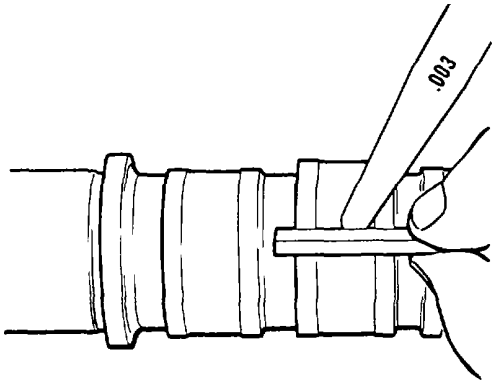
(1) Soak the camshafts in dry cleaning solvent (item 10, Appendix B).

(2) Remove sludge or foreign material from camshaft oil gallery using a small wire brush.

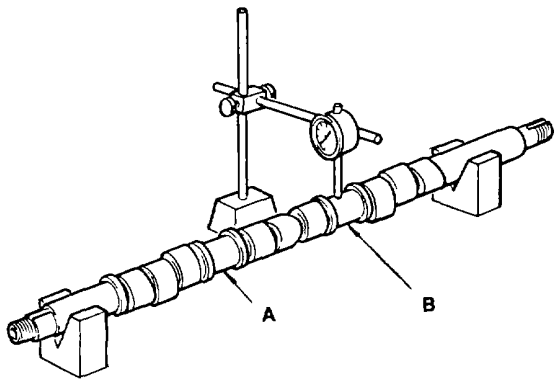
(3) Clean the camshaft exterior using dry cleaning solvent (Item 10, Appendix B) and dry using compressed air. Blow oil gallery and oil holes using compressed air.

(4) Inspect the cam lobes and journals for wear or scoring. If the cam lobes are scored, inspect the cam followers as detailed in para. 2-19.4. Front and rear journal diameters should be 1.4970 to 1.4975 in. (38.024 to 30.037 mm). Intermediate journal diameters should be 1.4980 to 1.4985 in. (38.049 - 38.062 mm).

(5) Using a tapered leaf set of feeler gages and a piece of square hard material, measure the flat on the injector rise side of the cam lobes. If the flats measure less than 0.003 in. (0.008 mm) and there are no other defects, the camshaft is satisfactory for service. A slightly worn cam lobe, still within acceptable limits, may be stoned and smoothed over using fine crocus cloth (item 7, Appendix B).



(6) Check the camshaft runout at the intermediate bearing surfaces (A and B) with the camshaft mounted on V-blocks as shown. Runout should not exceed 0.002 in. (0.05 mm).



3-8. ENGINE - Continued

3-8.8 Camshafts - Continued

(7) Examine both faces of each camshaft end bearing and thrust washer. Also, check the thrust surface of the camshaft gear for scoring or wearing. Thrust surfaces that are not damaged too severely can be smoothed down with an oil stone. Thrust washer thickness should be 0.119 to 0.122 in. (3.02 to 3.10 mm).

(8) Irspect the intermediate bearings, and the bushings in the front and rear camshaft end bearings. Replace the bearings or bushings if they are worn excessively, or if the bushings In the end bearings have turned. Bearing to shaft clearance, front and rear, should be 0.0025 to 0.0040 in. (0.064 to 0.102 mm). The absolute limit is 0.0060 in. (0.152 mm). The intermediate bearing to shaft clearance should be 0.0025 to 0.0050 in. (0.064 to 0.127 mm), with a limit at (0.0090 in. (O 229 mm).

NOTE

Rear camshaft and bearings are available in 0.010 in. (0.254 mm) or 0.020 in. (0.51 mm) undersize for use with worn shafts which exceed the specified clearance limits. New bushings must be finish bored to a 20 rms finish after installation and checked for the proper press fit, which is Indicated if the bushings will not move when a 2000 lb (910 kg) end load is applied. Also, the inside diameter of the bushings must be square with the rear face of the bearing within 0.0015 in. (0.038 mm) total indicator reading, and concentric with the outside diameter of the bearing housing within 0.002 in. (0.05 mm) total indicator reading. The bushings must project 0.045 In. 0.055 in. (1.14 to 1.40 mm) from each end of the rear camshaft end bearings. The bushings in the front camshaft end bearings must be flush with the ends of the bushing bore.

(9) Examine the intermediate bearing lock screws and the cylinder block tapped holes for damaged or stripped threads.

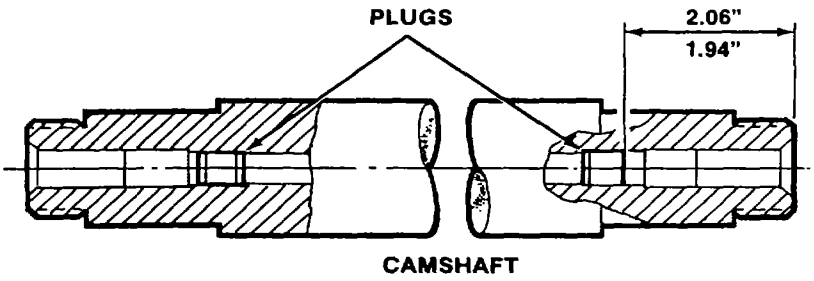
(10) Replace the seal In the left bank camshaft front end bearing. Also, examine the spacer used at the front end of each camshaft. The outside diameter of the spacer used in the left bank front end bearing must provide a smooth oil seal contact surface. The outside diameter Is not ground and polished on the original spacer used on the right bank camshaft. Only the polished spacer is available for service and may be used in either position.

(11) Examine the teeth on the water pump drive gear and the camshaft gears for wear, pitting or scoring. Also check the key ways, and all the threaded holes in the gears and camshaft pulley for stripped or damaged threads.

(12) Repair all parts showing signs of damage, and replace parts that can not be repaired

ASSEMBLY

(1) Press new plugs into each end of each camshaft as shown.



3-8. ENGINE - Continued

(2) Apply grease (item 16, Appendix B) to the steel face of each thrust washer (16) and then place one thrust washer against each end of the two camshaft rear end bearings (15). Make sure the steel face of each thrust washer faces the bearing.

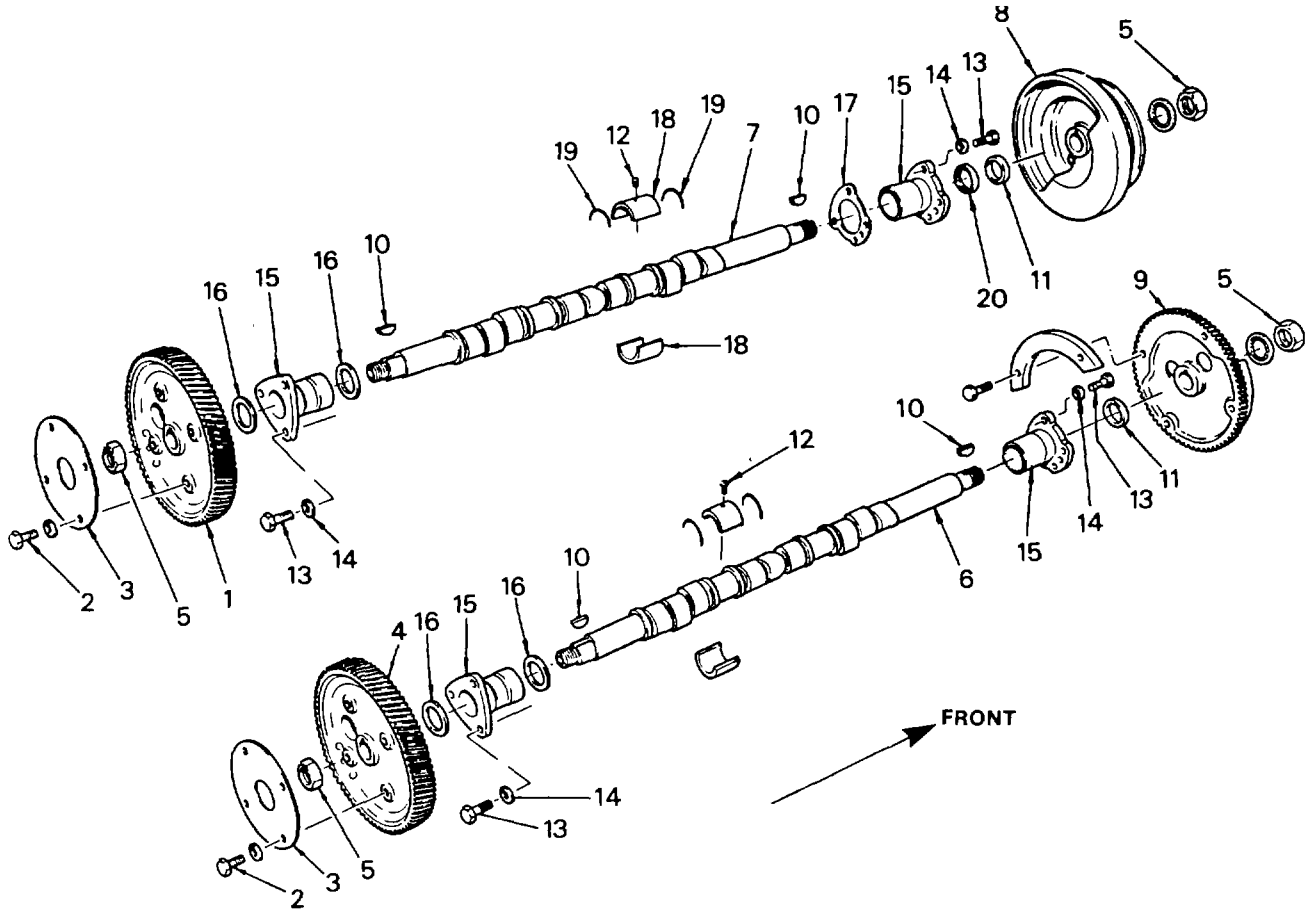
(3) Lubricate the rear camshaft bearing journal with engine oil (item 17, Appendix B) and slide a rear end bearing on each camshaft. Make sure the bolting flange of the bearing is positioned toward the outer end of the shaft.

(4) Install the woodruff key (10) in the camshaft (7)

(5) Start the gear (1) over the end of camshaft (7), with the key (10) in the shaft alined with the key way in the gear. Using tool J1903 install the gear onto the camshaft. Install gear (4) onto shaft (6) in a similar manner.

(6) Thread the camshaft gear retaining nuts (5) onto the end of the camshafts (6 and 7). Tighten the nuts after the camshafts are installed in the engine block.

(7) Lubricate the camshaft intermediate bearing journals with engine oil (item 17, Appendix B). Install the two halves of each intermediate bearing (18) on a camshaft journal and lock the halves together with the two lock rings (19). Make sure each lock ring is installed so that the gap is positioned over the upper bearing and that the ends are an equal distance above the split line of the bearings.



3-8. ENGINE - Continued

3-8.8 Camshafts - Continued

INSTALLATION

(1) Insert the front end of camshaft (6) with the right-hand helix gear (4) through the opening on the right bank side in the rear end plate until the first intermediate bearing enters the bore. Continue to maneuver the camshaft and bearings into the engine block until the camshaft gear teeth are about to engage with the mating gear Use extreme care not to damage the cam lobes during camshaft installation.

(2) Aline the timing marks of the gear train as detailed in para. 3-8.7 preceding.

(3) Secure the camshaft rear end bearing (15) to the engine block using three bolts (13) and lockwashers (14). Rotate the camshaft gear (4) as required to install the bolts through the hole in the web of the gear. Evenly tighten the bolts to 40 ft lb (54 Nm).

(4) Turn the camshaft intermediate bearings until the holes in the bearings are alined with the tapped holes in the top of the cylinder block Install the lockscrews (12) and tighten them to 20 ft lb (27 Nm).

(5) Install the camshaft (7) with the left-hand helix gear (1) through the opening on the left bank side in the rear end plate similarly to steps 1 thru 4 preceding.

(6) Attach a new gasket (17) to the camshaft front end bearing (15) that houses oil seal (20). Lubricate the bearing journal with engine oil (item 17, Appendix B) and slide the bearing on the left bank camshaft with the bolting flange of the bearing toward the outer end of the shaft. Secure the bearing (15) to the engine block using three bolts (13) and lockwashers (14). Tighten the bolts to 40 ft lb (54 Nm).

(7) Lubricate the right bank front end bearing (15) (the bearing without the seal) using engine oil (item 17, Appendix B). Slide the bearing on the right bank camshaft and secure it to the engine block using three bolts (13) and lockwashers (14). Tighten the bolts to 40 ft lb (54 Nm).

(8) Select the spacer (11) with the polished outside diameter. Lubricate the spacer with engine oil (item 17, Appendix B) and slide it in place on the left bank camshaft (7).

(9) Install the other spacer (1 1) on the right bank camshaft (6). Only the polished spacer is available for service and may be used in either position.

(10) Install a woodruff key (10) in each camshaft (6 and 7).

(11) Install the pulley (8) on the front end of the left bank camshaft (7), and install the water pump drive gear (9) (with external weight securely attached) to the right bank camshaft (6).

(12) Install an internal tooth lockwasher on the front end of each camshaft (6 and 7) and thread retaining nuts (5) on the camshafts.

(13) Wedge a clean rag between the camshaft gears (1 and 4) to prevent their turning. Tighten the retaining nuts (5) on each end of both camshafts to 325 ft lb (441 Nm).

(14) Install the camshaft gear nut retainers (3) using bolts (2) and lockwashers. Tighten the bolts to 39 ft lb (53 Nm).

3-8. ENGINE - Continued

(15) Check the end thrust between the thrust washer and the thrust shoulder of each camshaft (6 and 7). End thrust for new parts should be 0.004 to 0.012 in. (0.10 to 0.30 mm). End thrust for used parts should be 0.018 in. (0.46 mm).

(16) Check the backlash between all mating gears. Backlash for new parts should be 0.002 to 0-008 In (0.05 to 0.20 mm). Backlash for used parts should be 0.010 in. (0.25 mm) maximum.

(17) Install the front balance weight cover, see para. 3-8.5.

(18) Install the water pump, see para. 2-19.9

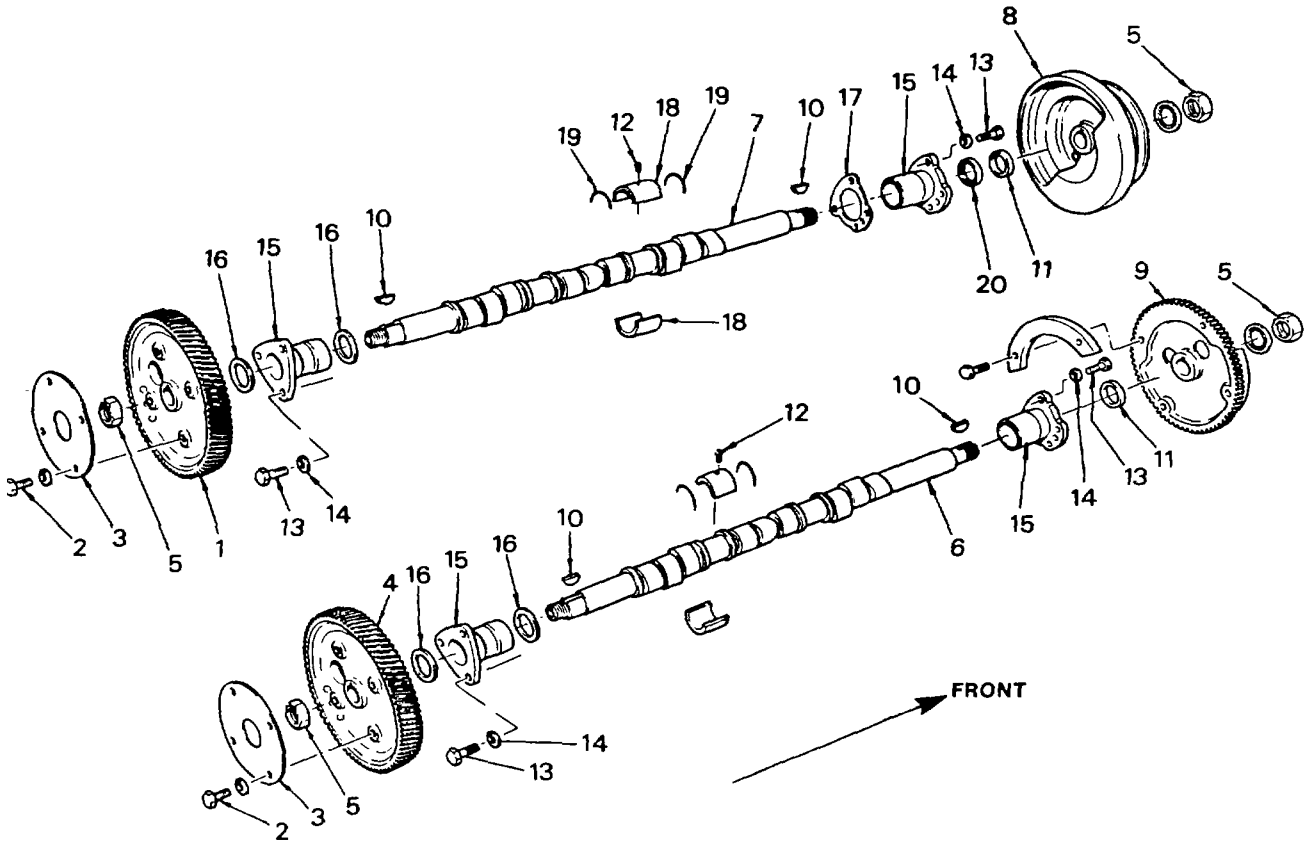
(19) Install the flywheel housing, see para. 3-8.6.

(20) Install both cylinder heads, see para. 2-19.8

(21) Install the blower drive support, see para. 3-8.7.

(22) Install the blower, see para. 3-8.3.

(23) Remove the engine block from the engine stand and adapter and install in truck as detailed in para. 3-8.1.



3-8. ENGINE.

3-8.9 Piston, Liner, Rings, Rod and Rod Bearings.

This task covers
a. Removal
b. Inspection
c. Installation

TOOLS

Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J8128 Ring Expander
J33048 Piston Disassembly Tool
J24599 Piston Ring Gage
J28460 Reamer
J24563-A Sleeve Puller Set
J23059-01 Master Setting Gage
J5902-01 Cylinder Hone Set
J5347-B Cylinder Bore Gage
J24564 Master Ring Gage
J24565-02 Hold Down Clamp Set
J24898 Cylinder Liner Depth Gage
J24226 Piston Seal Ring
J24285 Piston Pin Alignment Tool
J23762 Piston Pin Retainer Installer
J23987-01 Leak Detector
J5438-01 Feeler Gage Set
J24227 Ring Compressor

EQUIPMENT CONDITION

Main Engine Shutdown (see TM 5-4210-220-12)
APU Shutdown (see TM 5-4210-220-12)
Batteries Disconnected (see TM 5-4210-220-12)
Cab and Pump Body Head Shields Removed (see TM 5-4210-220-12)
Cooling System Drained (see LO 5-4210-220-12)
Engine Oil Drained (see LO 5-4210-220-12)
Cylinder Head Removed (see para. 2-19.8)

MATERIALS/PARTS

2, Appendix B Antifreeze
4, Appendix B Antiseize Compound
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil

PERSONNEL REQUIRED - 2

NOTE

Piston and piston liners may be removed with engine in truck. The following instructions are written assuming engine is in truck. REMOVAL

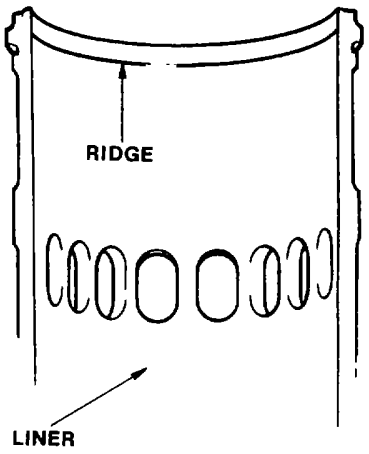
CAUTION

During disassembly of engine, tag and label all parts so related mating parts are identified for inspection and rebuild procedure.

a. Piston and Rod Removal

(1) Remove oil pan as detailed in para. 2-19.11.

(2) Inspect bore of liner before removing piston/rod assembly for wear ridge formed at top of liner by the piston ring travel. Ridge must be removed with cylinder ridge reamer (e.g., Snap-On WR-25) to avoid ring breakage and piston damage during removal of piston/rod assembly.



(3) Remove rod cap retaining nuts (12), bearing cap (10), and lower rod bearing (11).

3-8. ENGINE - Continued

(4) Push rod/piston assembly out through the top of cylinder block.

NOTE

Piston cannot be removed from the bottom of block. Piston/rod assembly component parts should be marked during disassembly to ensure that mating parts are reassembled together.

(5) Secure rod/piston assembly in soft jawed vise with piston skirt (8) resting on jaws of vise. Using tool J8128, remove all piston rings and discard.

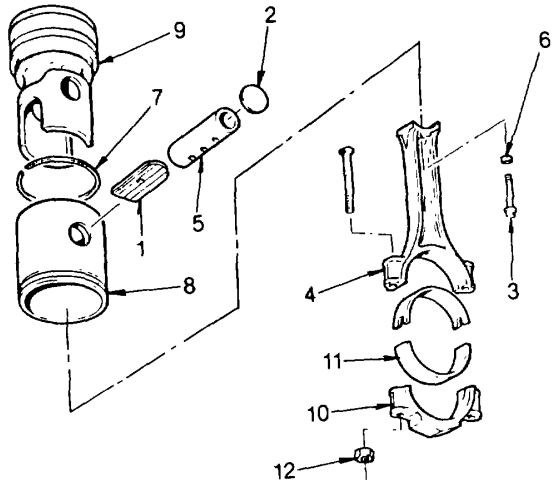
(6) Punch a hole through the center of one of the piston pin retainers (2). Pry retainer from piston. Be careful not to damage piston or bushing. Remove other retainer.

(7) Loosen the two bolts (3) which secure connecting rod (4) to piston pin (5). Remove assembly from vise. Place on bench and remove bolts (3) and spacers (6) and remove connecting rod (4).

(8) Tape together and tag upper and lower bearing shells for inspection later and for proper sizing during installation. Always replace bearing shells during assembly.

(9) Install cap on connecting rod. Snug retaining nuts to connecting rod bolts. **Piston, Liner, Rings, Rod and Rod Bearings.**Tag rod assembly for inspection.

(10) Remove piston pin (5) from piston assembly.



CAUTION

Avoid personal injury when disassembling piston. Keep fingers out of piston pin hole area. Wear safety shoes.

(11) Grasp piston assembly by skirt area, bring piston assembly down on tool J33048 in the pin area of piston with sufficient force to separate the crown (9) from the skirt (8)

(12) Remove seal ring (7) from piston crown. 3-163

(13) Remove piston pin bushing (1).

3-8. ENGINE.

3-8.9 Piston, Liner, Rings, Rod and Rod Bearings.

b. Liner Removal

(1) Inspect cylinder liner in block. If any signs of wear are present, remove liner for further inspection and repair.

NOTE

It is very important to follow proper method when removing cylinder liner. Do not attempt to push liner out by inserting a bar in the liner ports and rotating crankshaft. Piston liner damage will result.

(2) Use tool set J24563-A to pull liners. Ease the lower shoe and bolt assembly into liner. Place shoe on bottom edge of liner parallel with bore. Hold shoe assembly in upward pulling position.

(3) Place upper shoe with flat over threaded end of bolt. Tighten nut on bolt making sure both top and bottom plates are square and in position on liner.

(4) Place bridge assembly over the bolt and upper shoe.

(5) Position thrust bearing and bolt through bridge assembly.

(6) Turn bolt clockwise and withdraw liner from block. Remove tool set from liner.

(7) Remove and tag liner insert from counter-bore of block. This will save time during installation.

(8) If original sleeve is to be reused, remove and discard both liner seal rings from grooves in block bore.

(9) Repeat procedure to remove remaining liners.

INSPECTION

a. Piston, Rod and Bearing Inspection

WARNING

Dry cleaning solvent P-D-680 (safety or Stoddard's solvent) is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact with the liquid. Do not use near open flame, arcing equipment or other ignition sources. Always wear eye protection and protective clothing. The flash point of P-D-680 is 100 to 138 deg. F (30 to 59 deg. C).

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure Is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(1) Clean all parts with dry cleaning solvent (item 10, Appendix B). Blow dry with compressed air.

3-8. ENGINE - Continued

(2) Clean ring grooves with suitable carbon removal tool. Piston skirt is tin plated and must not be wire brushed to remove hard carbon deposits. Piston crown is not tin plated and may be wire, brushed to remove hard carbon deposits.

(3) Clean inside of crown area, and oil drain holes in ring groove area of skirt Do not enlarge drain holes during cleaning procedures.

(4) Inspect tin plating of skirt for scoring, abnormal wear symptoms, cracked or damaged ring groove lands. Replace if severely scored, damaged, or overheated.

(15) Inspect crown for scoring or cracked or damaged ring groove lands. Replace if severely scored or damaged.

(6) Check tapered fire ring groove in crown with tool J24599. Place wire of 0.106 in. (2.692 mm) diameter In ring groove. Slide wire completely around groove. If the wire is below flush, at any point, piston crown must be replaced. The 0.100 in. (2.54 mm) diameter wire should be flush or protrude slightly from fire ring groove of piston.

NOTE

Components of piston assemblies can in certain instances be reused. Undamaged piston pins, crowns, and bushings that meet dimensional limits for used parts can be reused if installed within the same piston assembly from which they were removed. The crown, pin and bushing of a cross head piston assembly should be considered as a matched set. If a crown is replaced, piston pin and bushing must also be replaced. Similarly, if a bushing needs replacement, a new pin must also be used.

(7) Check for bent connecting rod, bearing failure causing damage to rod or rod cap, and/or discoloration or blueing of parts. Replace rod if any of above are found.

(8) Check for cracks in rods as detailed in para. 2-7.

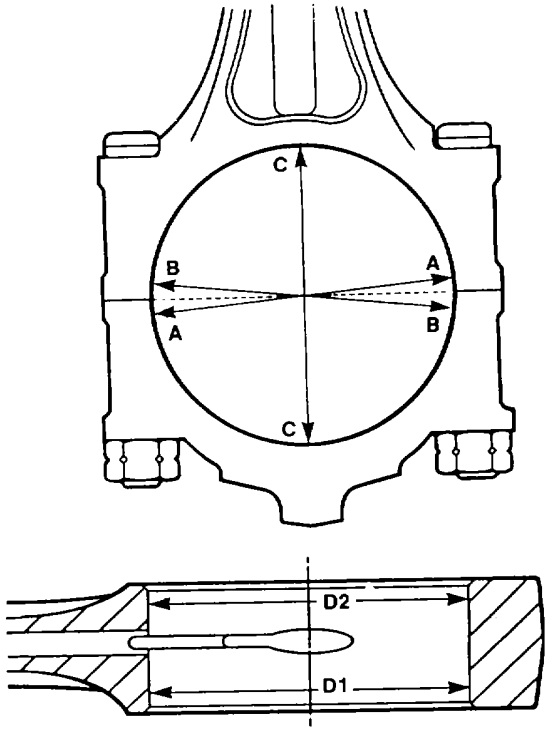
(9) Tighten retaining nuts on connecting rod to 70 ft lb (95 Nm).

(10) Measure diameter (A and B). The average measurement of (A and B) is the size at the split line (X) . X = (A + B)/2.

(11) Measure diameter (C). The difference in measurements (X and C) gives the bore out-of-round measurement; maximum of 0.005 in. (0.127 mm) is allowable. Replace rod if not within specification.

(12) Obtain average bore diameter (Y). Y = (C + X)/2. Average bore diameter must be within 3.2495 3.2515 in. (82.537 82.588 mm). Replace rod if not within specification.

(13) Measure the dimensions (D1 and D2). The difference between D1 and D2 (taper) should be 0.0005 in. (0.0127 mm) maximum. Replace rod if not within specification.



3-8. ENGINE.

3-8.9 Piston, Liner, Rings, Rod and Rod Bearings.

(14) Ream bolt holes in rods with J28460 reamer if nicks or burrs are present.

(15) Check piston pin bushing for scoring or overheating. Replace bushing if scored or if worn less then 0.086 in. (2.184 mm) thick.

(16) Inspect piston pin for signs of fretting or scouring. Measure pin diameter. Replace pin if worn to less than 1.4980 in. (38.049 mm).

(17) Inspect rod bearings for excessive and unusual wear. Inspect crankshaft for scoring, see para. 3-8 10.

(18) Install new rod bearings each time rod assembly is removed. Bearings are available as standard and 0.002, 0.010, 0.020 or 0.030 in. undersize. Refer to para. 3-8.10 for crankshaft and bearing sizing.

b. Liner Inspection

(1) Thoroughly clean liner inner bore and outer circumference. Use wire brush on outer circumference, if necessary, to clean scale build-up on water cooled portion of liner.

(2) Inspect liner for:
- Cavitation or erosion above air ports. If present replace liner.
- Cracks. If present, replace liner
- Scoring. If excessive, replace liner. If slightly scored, liners may be cleaned, honed and reused.
- Flange Irregularities. Flange must be flat and smooth on both top and bottom surfaces. Replace liner if surfaces are uneven.
- Liner insert. Must be flat and smooth on both top and bottom surfaces. Replace if evidence of brinelling is present.
- Liner contact area to block; examine the outside diameter of liner for fretting below the ports. Material transfer from block to liner may be removed from surface of liner and reused if all other specifications are met.

(3) A used liner must always be honed if reused in engine. The honing process breaks the glaze and removes ridge formed during engine operation. The glaze must be removed to properly seat new piston rings.

NOTE

Do not hone the surface finish of a new service liner as it has been properly finished at the factory.

(4) Place liner in holding fixture. Secure to hold liner but do not distort conformity of liner.

NOTE

Do not use original engine block to hold liners unless engine is dismantled and thoroughly cleaned afterward to ensure that all abrasive materials is removed. A scrap engine block makes an excellent holding fixture to hold liners during honing procedure.

(5) Use hone J5902-1 equipped with 120 grit stones. Spin hone at 300 - 400 rpm working the full length of liner a few times to produce a criss-cross pattern having marks on a 45 deg axis.

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(6) After honing the liner remove it from the holding fixture and clean it thoroughly with dry cleaning solvent (item 10, Appendix B). Blow dry with compressed air

NOTE

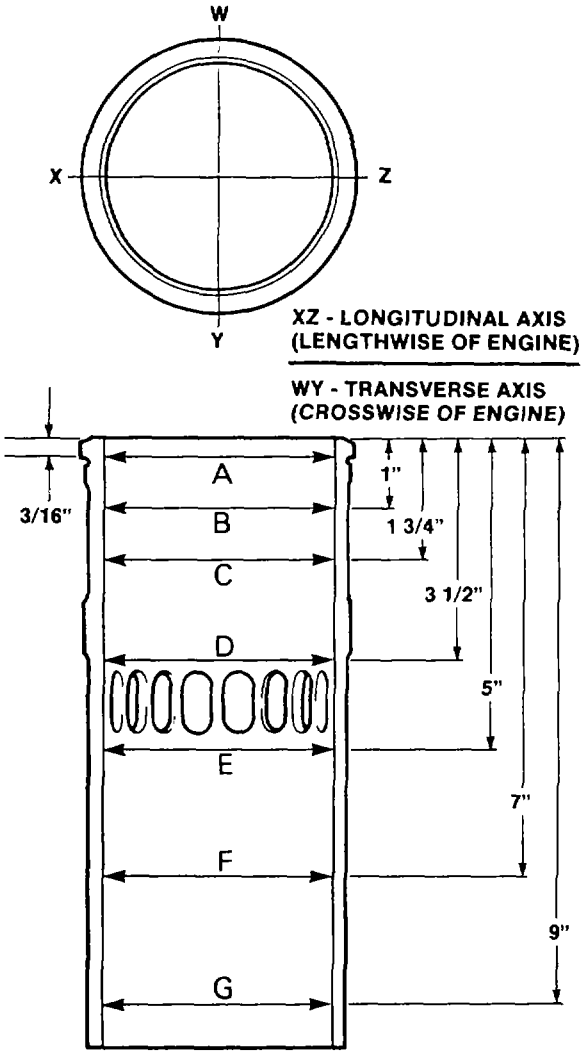
A reused liner must conform to the same limits on taper and out-of-round as a new liner.

(7) With liner secured in holding fixture measure the inside diameter at various points using cylinder bore gage J5347-B and master ring gage J24564.

(8) Measure inside diameter of liner at points A, B, C, D, E, F, and G on axis XZ and WY.

(9) The taper and out-of-round of a used liner must not exceed 0.0025 in. (0.0635 mm). Taper on a new liner must not exceed 0.0015 in. (0.0381 mm). Out-of-round on a new liner must not exceed 0.002 in. (0.0508 mm).

(10) Replace liners that do not meet required specifications.



INSTALLATION

a. Liner Installation

(1) Be sure inside and outside of liner are clean. Make sure block bore and counterbore are clean.

(2) Clean seal ring grooves in block.

3-8. ENGINE.

3-8.9 Piston, Liner, Rings, Rod and Rod Bearings.

(3) Block counterbore depth must range from either 0.4755 0.4770 in. (12.077 12 116 mm) or 0.4905 0 4950 in. (12.459 12.497 mm) and must not vary more than 0.0015 in. (0.0381 mm) in depth around the circumference.

(4) No two adjacent block counterbores may range in depth more than 0,001 in. (0.25 mm) when gaged along the longitudinal cylinder block center line.

(5) A replacement cylinder liner Is classified according to the flange thickness to control the distance from the top of the liner to the top of the cylinder block. A cylinder liner with a flange thickness of 0.3100 0.3109 in. (7.874 7.897 mm) (C1) has the part number etched on the lower portion of the bottom half of the liner. A liner with a flange thickness of 0.3110 0.3120 in. (7.899 7.925 mm) (C2) has the part number etched on upper portion of the bottom half of liner. Both liners have the same part number.

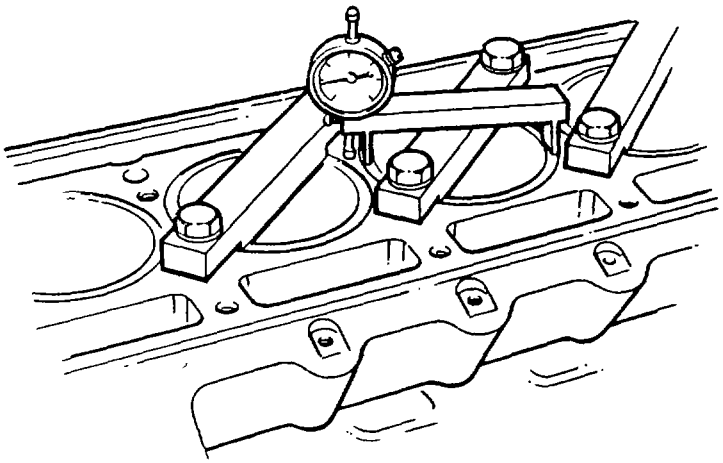
(6) Do not install cylinder seals in engine block at this time.

(7) The original liners must be installed into original hole location in block if liners are reused. Similarly original inserts or replacement ones of same thickness should be installed into each corresponding counter-bore and related liner.

(8) Install insert and cylinder liner into each cylinder bore of block. Do not use excessive force to install liner. Hand push liner into cylinder block until liner rests on insert.

(9) Clamp each liner in place with hold down clamp J24565-02. Tighten bolts to 50 ft lb (68 Nm).

(10) Measure distance from the top of the liner to the top of the block with dial indicator J24898. The liner must be 0.0418 0.0482 in. (1.062 1.224 mm) below the top of the block and the difference in depth between any two adjacent liners when measured along the cylinder longitudinal centerline must not exceed 0.0015 in. (0.038 mm). If the above limits are not met, install a different thickness insert or install liner in another cylinder bore and recheck height, or install new replacement cylinder liner and recheck height.



3-8. ENGINE - Continued

NOTE

Four inserts are available to adjust liner height during installation.

Size	Thickness	Identification (New Inserts)
std.	.1188 - .1193 in.	Black oxide or 2 purple stripes
std.	.1200 - .1205 in	No Color
std.	.1212 - .1217 in.	Copper or 2 orange stripes
+.015in.	.1362 - .1367 in.	White and orange stripe

(11) Mark liner and block with felt pen so liner may be reinstalled in same position in the same block bore.

(12) Remove cylinder liner hold down clamps.

b. Piston Installation

(1) Install bearing bushing (1) into the piston crown. It should slide in without force. It must be installed before assembling piston skirt (8) to crown (9).

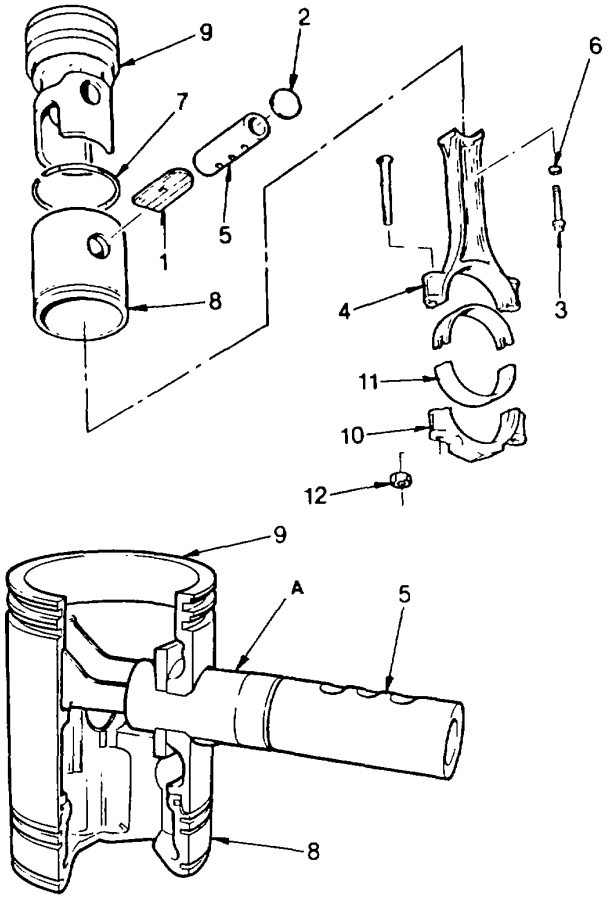
(2) Lubricate the metal seal ring (7) with engine oil (Item 17, Appendix B) and install into ring groove of crown with the chamfer toward the bottom of piston.

(3) Compress seal ring (7) with ring compressor J24226.

(4) Push skirt (8) into position on the piston crown (9)

(5) Place piston assembly resting crown down on bench. Rotate skirt full 360 deg. on crown. Seal ring must not bind or have any tight spots. If seal ring sticks, remove tight spots with flat file. Replace piston crown if binding cannot be relieved.

(6) Lubricate piston pin (5) with engine oil (item 17, Appendix B). Line up the piston pin opening in the piston skirt (8) with the bearing opening in piston crown (9) with alinement tool J24285 (A) to prevent damage to pin (5) or bearing (1). Then install piston pin.



3-8. ENGINE - Continued

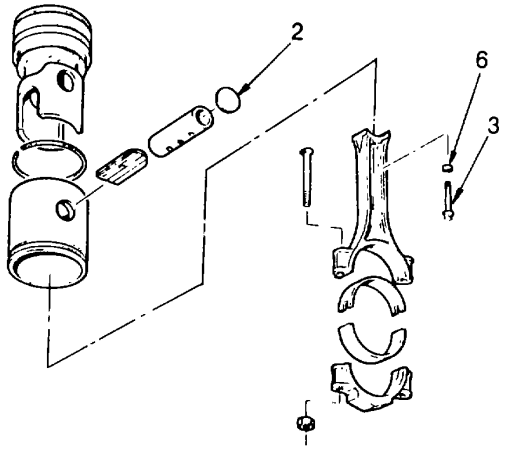
3-8.9 Piston, Liner, Rings, Rod and Rod Bearings - Continued

(7) Install spacers (6) on the two connecting rod-to-piston pin attaching bolts (3).

(8) Apply small amount of antiseize compound (item 4, Appendix B) to bolt threads and bolt head contact surfaces.

(9) Aline connecting rod with piston pin and install bolts (3) fingertight. Clamp rod in vise and tighten bolts to 60 ft lb (81 Nm). Do not over torque.

(10) Place piston pin retainer (2) in position. Place crowned end of installer J23762 against retainer, strike tool hard enough to deflect retainer and seat it evenly in piston. Install second retainer.



(11) Inspect the width of the land is even around the retainer.

(12) Place suction cup of detector J23987-01 over retainer and operate the lever to pull vacuum of 10 in. on the gage. A drop in gage reading indicates leakage at the retainer.

(13) Replace/reseat piston pin retainer if there is any leakage.

(14) With the liner installed in the block, and the block and piston at room temperature, use feeler gage J5438-01 to measure skirt to liner clearance, hold piston upside-down in liner and check clearance in four places 90 deg. apart.

(15) Select a feeler gage with a thickness that will require a pull of six lbs to remove. The clearance will be 0.001 in. (0.03 mm) greater than the thickness of the feeler gage. The clearance must be less than 0.012 in. (0.31 mm).

(16) If any binding occurs between piston and liner, examine piston and liner for burrs. Remove burrs with fine hone and recheck clearance.

(17) Pistons are fitted with three compression rings and two oil control ring assemblies.

(18) Insert one compression ring at a time into the cylinder liner in the ring travel area. Liner can be in block or reconditioned on bench. Use a piston skirt to push ring parallel with top of liner' and measure ring gap with feeler gage. The end gap should be 0.025 - 0.045 in. (0.64 - 1.14 mm).

(19) If the gap on compression ring is insufficient it may be increased by filing the ends of the ring. File so the cutting action is from the outer surface to the inner surface to prevent chipping or peeling of chrome plate on ring.

(20) Check ring side clearance on piston in each compression groove. The top fire ring clearance, measured with the keystone fire ring flush with the outside diameter of the piston crown should be 0.0010 - 0.0050 in. (0.025 - 0.127 mm).

3-8. ENGINE - Continued

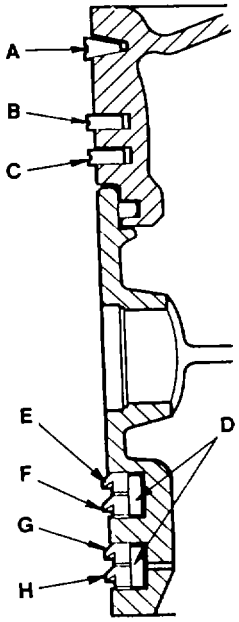
(21) The clearance on rectangular compression ring # 2 should be 0.0100 - 0.013 in. (0.254 - 0.330 mm).

(22) Clearance on rectangular compression ring # 3 should be 0.0040 - 0.0070 in. (0 102 - *0.178* mm).

(23) Repeat procedure for oil control rings. The gap for the rings in the lower groove must be 0.0100 - 0.0250 in. (0.254 - 0.635 mm) and 0.0070 - 0.0170 in. (0.178 - 0.432 mm) in upper groove. The clearance for both rings installed in each groove must be 0.0015 - 0.0055 in. (0.038 - 0.140 mm).

NOTE

New piston rings must be installed whenever a piston is removed. The top fire ring (A) and the second groove ring (B) are pre-stressed. Both are identified by an indentation mark on the top side. The fire ring is chrome plated on the lower side.



(24) Starting with bottom ring (C), install compression rings with expander J8128. Do not spread them any more than necessary to slip them over the piston. Stagger ring gap 180 deg. from each other.

(25) Place piston on bench, inverted.

(26) Install the ring expanders (D) in the oil control ring grooves in the piston skirt. Install with free ends pointing towards piston crown. Use care not to overlap ends of expanders which would result in oil ring breakage.

NOTE

The scraper edges of all oil control rings must face downward toward bottom of piston for proper oil control.

(27) Install oil control rings by hand. Start with the upper half (E) of the top oil ring, locate gap 180 deg. from expander gap (D). Ring has chrome outside diameter and is color coded with orange stripe.

(28) Install lower half (F) of the top oil ring. Locate gap 90 deg. from upper half. Ring is not chromed and is color coded with orange stripe.

(29) Install the upper half (G) of the bottom oil ring. Locate gap 180 deg. from expander gap.

(30) Install the lower half (H) of the bottom oil ring. Locate gap 90 deg. from upper half both rings slotted on bottom side and are plain black.

(31) Lubricate piston grooves and rings with engine oil. (item 17, Appendix B).

3-8. ENGINE - Continued

3-8.9 Piston, Liner, Rings, Rod and Rod Bearings - Continued

c. Piston/Sleeve Installation

CAUTION

Inspect the ring compressor for nicks or burrs at the non-tapered inside diameter end. Nicks or burrs on the inside diameter of the compressor will result in damage to the piston rings.

(1) Place ring compressor J24227 on a wooden block with the tapered end of compressor facing up.

(2) Start top of piston straight into the ring compressor. Push piston down until it contacts wooden block.

(3) Place liner of matching set with flange end down on wooden block.

(4) Place ring compressor, piston and rod assembly on liner.

(5) Push piston and connecting rod assembly down into liner until the piston is free of the ring compressor.

NOTE

Do not force piston into the liner. Care must be taken during loading operation to prevent ring breakage.

(6) Remove ring compressor and connecting rod cap, then push piston down until the compression rings pass the cylinder liner air ports. Be sure the cap bolts remain in the rod.

(7) If a new connecting rod is installed, stamp same identification number on replacement rod that was on original.

(8) Be sure the seal ring grooves in cylinder block bore are clean. Install new seal ring in each groove.

(9) Apply vegetable shortening oil (item 32, Appendix B) or antifreeze (item 2, Appendix B) to the inner surface of each seal ring (black rings only).

(10) Apply engine oil (item 17, Appendix B) to teflon coated seals (yellow-gold or green color) as a lubricant when installing cylinder liners.

(11) Rotate crankshaft until connecting rod journal of the cylinder being worked on is at the bottom of its travel. Wipe journal clean and lubricate with engine oil (item 17, Appendix B).

(12) Install upper bearing shell into connecting rod.

NOTE

Upper bearing shell is one without continuous oil groove.

3-8. ENGINE - Continued

(13) Lubricate bearing shell with engine oil (Item 17, Appendix B).

(14) Install rod and liner assembly in block bore so that the identification number and letter on the connecting rod face the outer edge of the cylinder block and the match marks on the liner and the block are in alinement.

(15) Guide the end of the connecting rod through the block bore carefully to avoid damaging or dislodging the bearing shell.

(16) Slide the piston, rod and liner assembly straight into the block bore until liner flange rests against insert in the counterbore in block.

(17) Pull piston and connecting rod into the liner until upper bearing shell is firmly seated on crankshaft journal.

(18) Be sure the marks on the end of connecting rod cap bolts are parallel with each other to indicate proper alinement of bolts in connecting rod.

NOTE

The distance from the vertical center line of the connecting rod bolts to the edges of the rod are not equal. When installing the piston and connecting rod assembly be sure that the narrow side of the two connecting rods on the crankshaft journal are together to avoid cocking of the rod.

(19) Place lower bearing shell in connecting rod cap

NOTE

Lower bearing shell is one with continuous oil groove from one parting line to the other.

(20) Lubricate bearing shell with engine oil (item 17, Appendix B).

(21) Install bearing cap and bearing shell on connecting rod with the identification numbers on the cap and the rod adjacent to each other. Tighten nuts to 70 ft lb (95 Nm).

(22) Use hold down clamps J24565-02 to retain liners in place when the crankshaft Is rotated.

(23) Check connecting rod side clearance between each pair of connecting rods Clearance of new parts should be from 0.008 - 0.016 in. (0.20 - 0.41 mm).

(24) Install remaining liner, piston and rod assemblies.

(25) After all liners are installed remove hold down clamps.

(26) Refer to para. 2-19.8 for INSTALLATION of cylinder head.

3-8. ENGINE - Continued

3-8.10 Crankshaft.

This task covers:

a. Removal
b. Inspection
c. Installation
f. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0650
J21983 Sleeve Installer
J8092 Driver Handle
J25002 Guide Studs

EQUIPMENT CONDITION
Engine Removed from Truck (see para. 3-8.1)
Oil Pan Removed (see para. 2-19.11)
51996616 Gasket Kit
Flywheel Housing Removed (see para. 3-8.6)
Oil Pump Removed (see para. 2-19.10)
Rocker Covers Removed (see para. 2-19.3)
Exhaust Manifolds Removed (see para. 2-19.1)
Cylinder Heads Removed (see para. 2-19.8)
Pistons and Liners Removed (see para. 3-8.9)

MATERIALS/PARTS
4, Appendix B Antiseize Compound
10, Appendix B Dry Cleaning Solvent
17, Appendix B Engine Oil

PERSONNEL REQUIRED - 2

WARNING

Serious injury could occur if heavy equipment is moved/lifted without sufficient personnel to do the job. Use proper physical lifting procedures or use a suitable lifting device or dolly. Wear safety shoes, gloves and other suitable protective clothing.

NOTE

The equipment conditions above are the minimum required to remove the crankshaft in order to replace bearings or the crankshaft itself. In general, if bearings or crankshaft require replacement, the engine should be stripped to check the cause of bearing failure and to ensure no other components are subject to failure.

REMOVAL

(1) Remove the crankshaft stabilizer bolts (1) and washers (2) that retain the stabilizers (3) to the cylinder block (17).

(2) Starting on the outermost bearing caps and working alternately front and back, loosen main bearing cap bolts (6).

(3) Lift off each bearing cap (18) and be sure they are marked with same number that is inscribed on the block adjacent to that cap position.

(4) Remove the thrust washers (4) from each side of the rear main bearing cap.

(5) Attach a suitable sling to the crankshaft (10) and lift from block (17).

(6) If not removed, pull off oil pump drive gear (8) and key (9) from crankshaft (10). The rear oil seal (14) was removed with the flywheel housing The gear (8) and oil seal (7) were removed with the oil pump.

3-8. ENGINE - Continued

INSPECTION

WARNING

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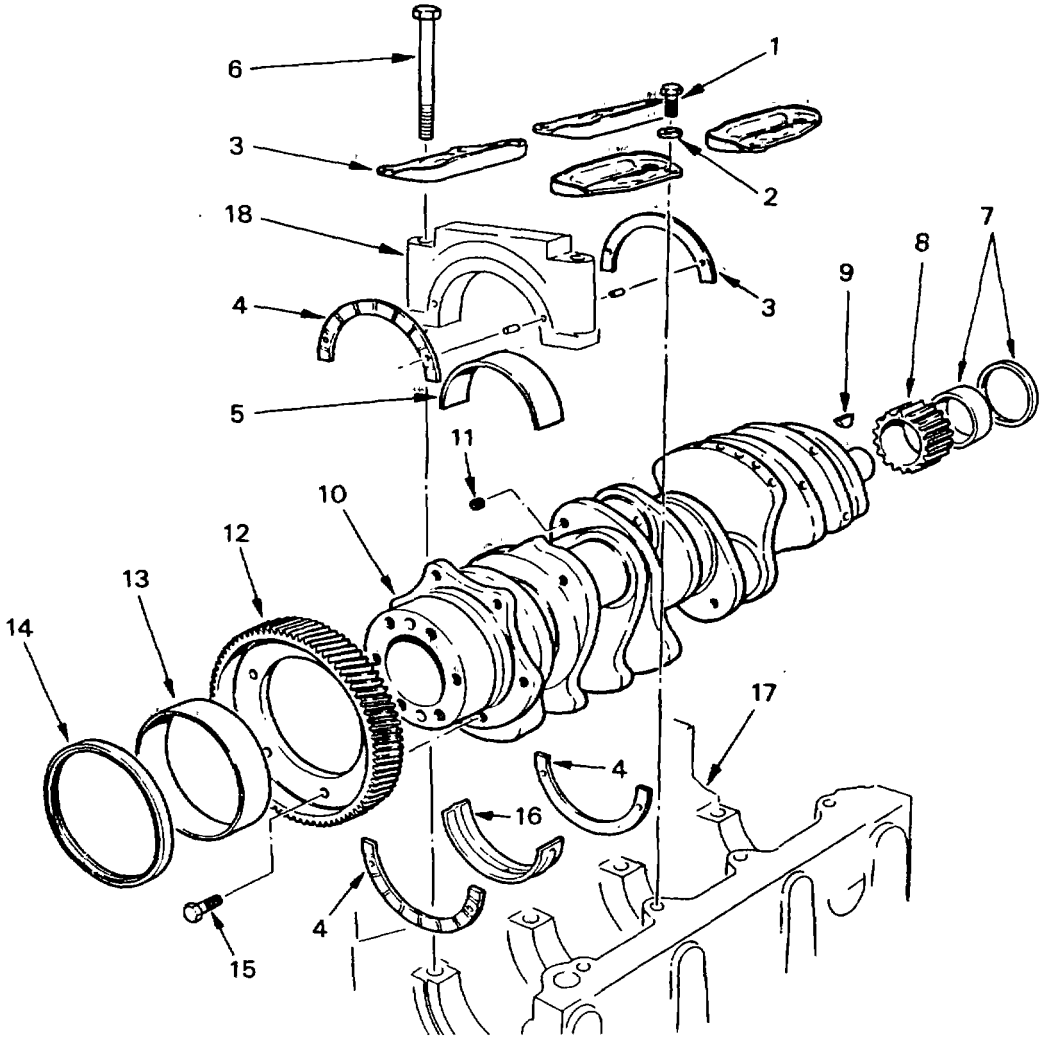
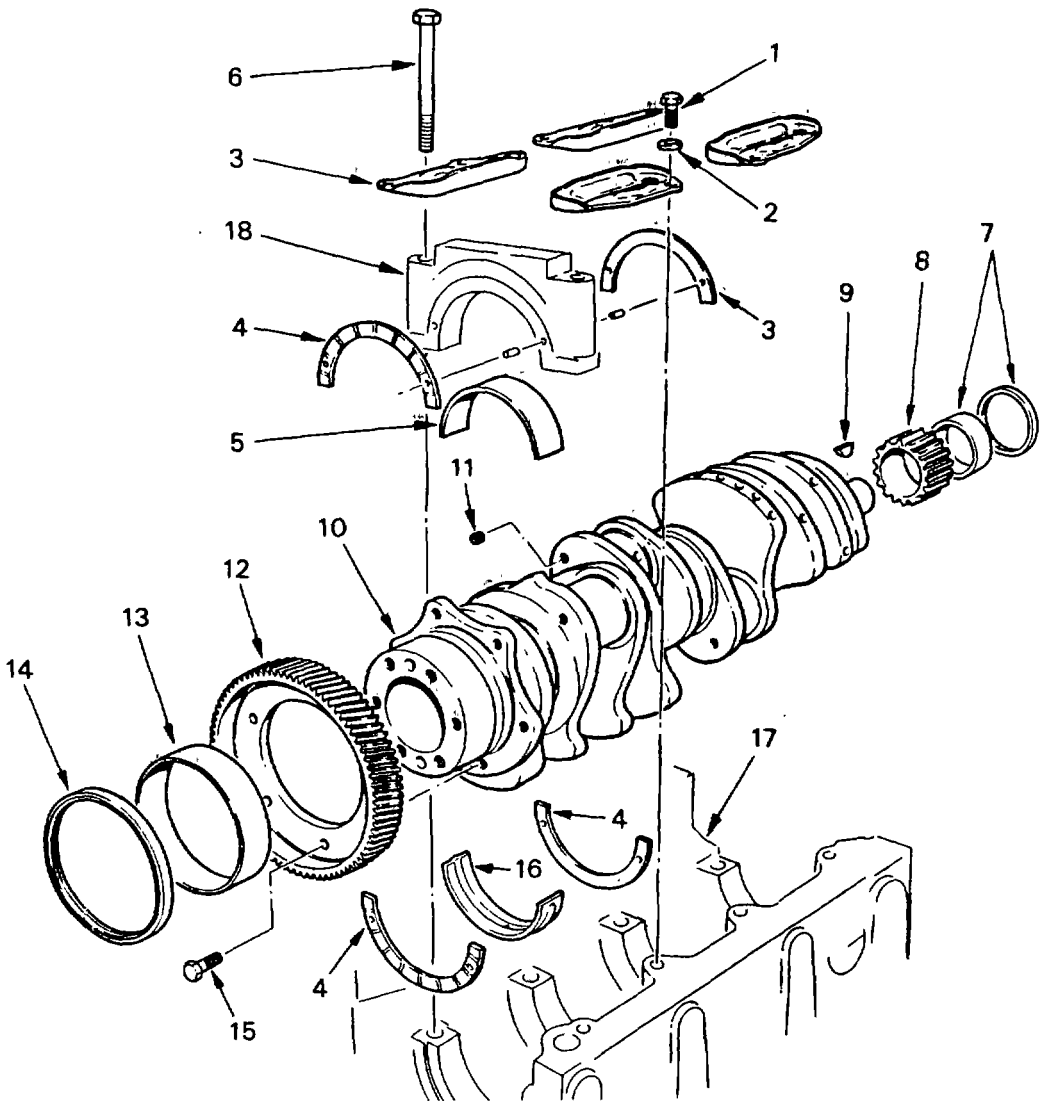


(1) Thoroughly clean the crankshaft with dry cleaning solvent (item 10, Appendix B). Remove plugs (11) and clean out the oil passages with a stiff wire brush. When *clean,* dry the crankshaft with compressed air, and replace the plugs.

3-8. ENGINE - Continued

3-8.10 Crankshaft - Continued



(2) Inspect the keyways for evidence of cracks or wear. Replace the crankshaft if any significant damage is present.

(3) If the crankshaft shows any signs of overheating, blueing or oil carbonization on the journal surfaces especially, replace the crankshaft.

(4) Inspect the rear oil seal contact surface. The crankshaft may be fitted with an oil seal sleeve (13). If the oil seal contact surface is excessively grooved or worn, replace the sleeve or install a sleeve.

3-8. ENGINE - Continued

(5) To remove the sleeve, peen the outside diameter until the sleeve stretches sufficiently so it can be slipped off the end of the crankshaft.

(6) To install a sleeve, stone the high spots from the contact surface. Coat the shaft with shellac or an equivalent sealant and press the sleeve on the shaft using installer J21983 with guide studs J25002 and driver handle J8092 as required. Then wipe off any excess sealant. An oversize seal must be used with a sleeve.

(7) Check the oil pump drive gear (8) and the crankshaft timing gear (12) for worn or chipped teeth. Replace as required. For oil pump, see para. 2-19.10. For timing gear, see para. 3-8.7.

(8) Check the crankshaft thrust surface for excessive wear or grooving. If excessively worn, the crankshaft must be replaced. Oversize thrust washers are available in sizes 0.005 in. (0.13 mm) and 0.010 in. (0.25 mm).

(9) If there is any sign of wear on the crankshaft, the crankshaft must be measured against specification. A worn crankshaft must be replaced.

(10) Support the crankshaft on No. 1 and No. 4 main journals in V-blocks. Measure the total runout on journals No. 2 and No. 3, the runout on each journal must be less than 0.002 in. (0.05 mm).

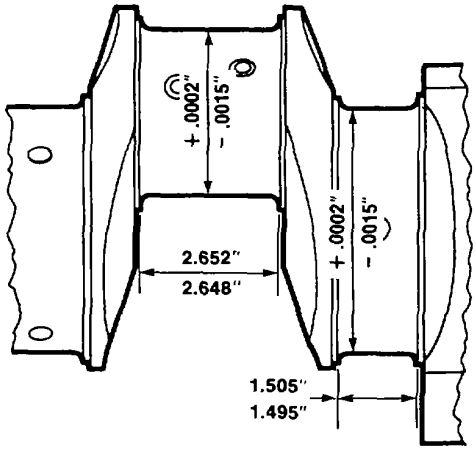
(11) If the high spots of runout on adjacent journals Is in the same or opposite directions, total runout must not exceed 0.003 in. (0.08 mm). If the total runout on adjacent bearings is at right angles to each other, total runout must not exceed 0.004 in. (0.10 mm).

(12) If runout specifications are exceeded, the crankshaft must be replaced.

(13) Measure the main and connecting rod journals In several places on the circumference so that taper, out-of-round, and bearing clearances can be determined.

(14) The crankshaft must be replaced if:

- Any main bearing taper exceeds 0.0004 in. (0.010 mm).
- Any main bearing out-of-round exceeds 0.0005 in. (0.013 mm).
- Any connecting rod bearing taper exceeds 0.0004 in. (0.010 mm).
- Any connecting rod bearing out-of-round exceeds 0.0005 in. (0.013mm).Main journal-to-bearing clearance exceeds 0.0055 in. (0.013 mm).
- Connecting rod journal-to-bearing clearance exceeds 0.0045 in. mm).



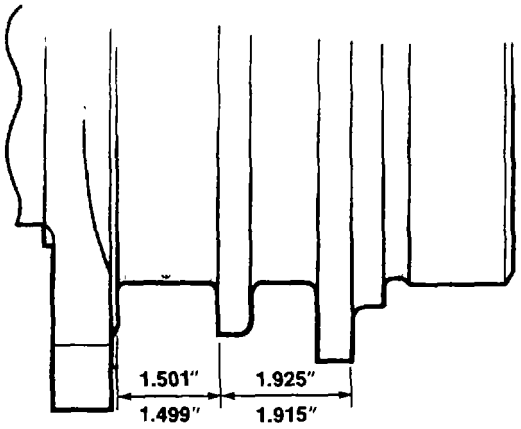
BEARING SIZE	CONN. ROD JOURNAL DIA.	MAIN BEARING JOURNAL DIA.
Standard	2.9985"/3.0002"	4.4985"/4.5002"
0020"	2.9965"/2.9982"	4.4965"/4.4982"
.0100"	2.9885"/2.9902"	4.4885"/4.4902"
.0200"	2.9785"/2.9802"	4.4785"/4.4802"
.0300"	2.9685"/2.9702"	4.4685"/4.4702"

3-8. ENGINE - Continued

3-8.10 Crankshaft - Continued

NOTE

To determine journal-to-bearing clearance, use the lowest dimensional figure obtained from the journal measurements and compare it with the highest figure in the bearing table. All measurements must be accurate to nearest 0.0002 in. (.005 mm). The bearing clearances can also be measured using crushable plastic strip, Use the 0.002 0.006 in. size to determine the clearance. Always use new bearing shells and tighten the bearing caps (main journal to 260 ft lb (350 Nm), connecting rod journal to 70 ft lb (95 Nm).



(15) Measure the crankshaft thrust washers surfaces as shown.

(16) If any dimensions are outside the tolerances, the crankshaft must be replaced.

(17) Inspect the crankshaft for cracks using any of the techniques detailed in para. 2-7. The two types of indications to look for are circumferential fillet cracks in the critical areas shown or 45 deg. with the axis cracks starting from either the critical fillet locations or the connecting rod journal holes.

(18) Replace the crankshaft if cracks of any nature are found.

INSTALLATION

(1) If a new crankshaft is to be installed, steam clean it with all oil plugs removed, to remove the rust preventative.

WARNING

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(2) Blow out all oil passages with compressed air and install the plugs.

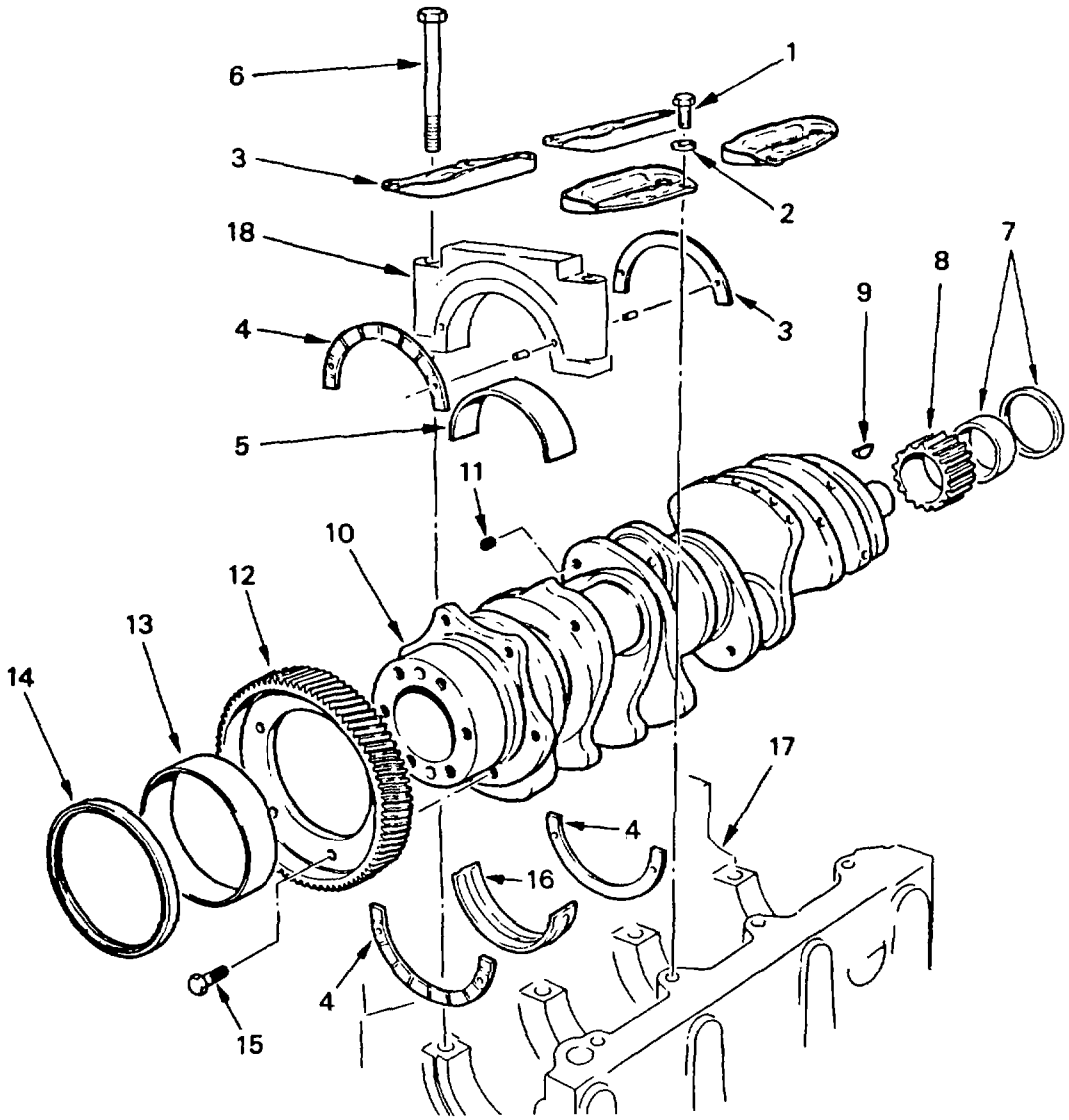
(3) Install the crankshaft timing gear (12) on the crankshaft (10) as detailed in para. 3-8.7.

(4) Install the oil pump drive gear as detailed in para. 2-19.10.

(5) Install new slotted main bearing shells (16) in the block.

(6) Install new plain bearing shells (5) in the main bearing caps (18). Be sure the tang on the bearing fits into the groove in the bearing cap.

3-8. ENGINE - Continued



(7) Liberally coat all main journals on the crankshaft with engine oil (item 17, Appendix B)

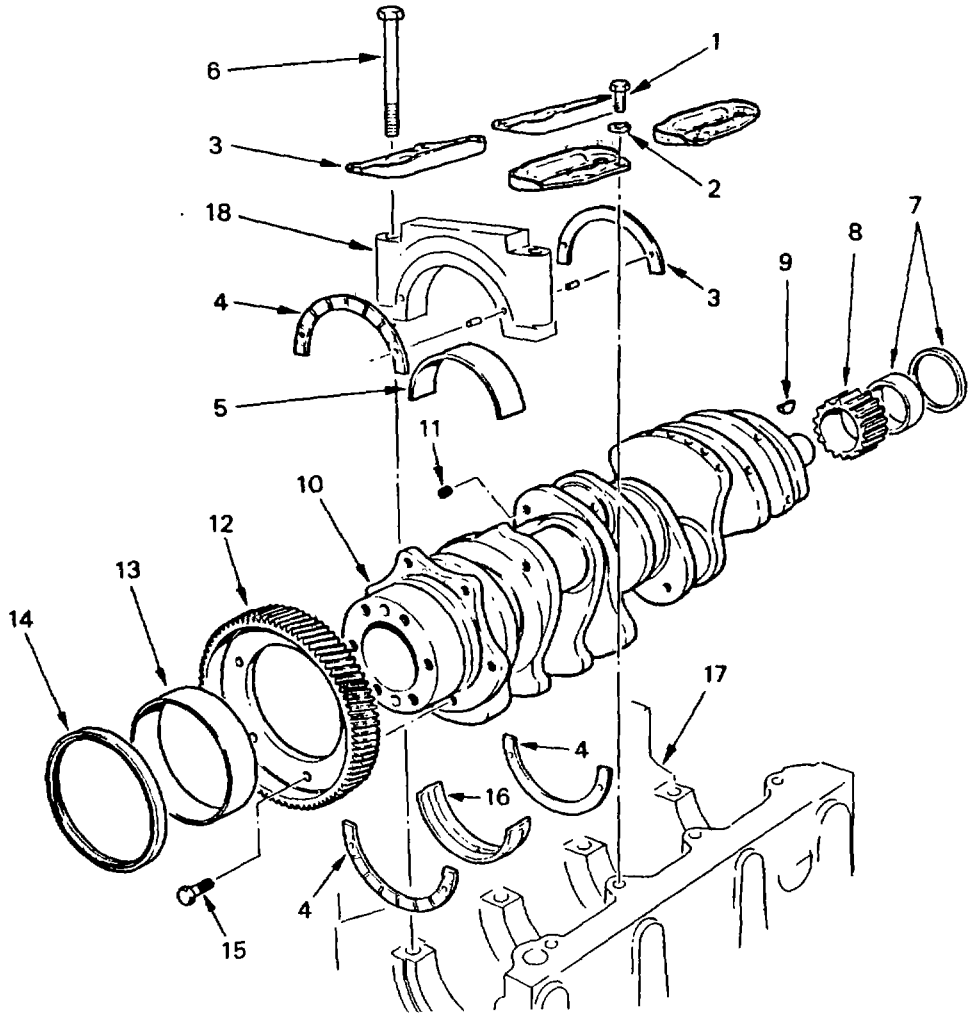
(8) Using a suitable sling, lower the crankshaft onto the block. If the idler gear is installed, be sure the timing marks (R) are alined on the crankshaft timing gear and the Idler gear.

(9) Install the upper halves of new thrust washers (4) on each side of the rear main bearing support Be sure the grooved side of the washers face toward the crankshaft thrust surfaces.

(10) Install the lower halves of new thrust washers (4) on each side of the rear bearing cap (18). Be sure the thrust washers mate with the dowels and the grooved side faces outwards.

3-8. ENGINE - Continued

3-8.10 Crankshaft - Continued



(11) It may be necessary to install oversize thrust washers. These are available as either 0.005 or 0.010 in. (0.13 or 0.25 mm) oversize.

(12) Apply a small quantity of antiseize compound (item 4, Appendix B) to the threads and heads of the cap retaining bolts (6).

(13) Install the bolts through the stabilizers into the caps (18) and install them in the block. Be sure the correct cap is installed in the correct position in the block and is oriented correctly. If the numbers on the caps and on the block are alined and the same, the cap is correctly positioned.

3-8. ENGINE - Continued

(14) Snug up all bolts. Rap the caps sharply with a soft hammer to seat them correctly and torque all bolts, except rear cap, to 260 ft lb (350 Nm). Be sure to start tightening in the sequence No. 2, No. 3, No. 1.

(15) Tighten rear cap bolts to 50 ft lb (68 Nm) and then strike both ends of crankshaft two or three times with a soft hammer to ensure correct seating of the rear cap in the block saddle.

(16) Retorque all bearing cap bolts to 260 ft lb (350 Nm) working in sequence No. 3, No. 2, No. 4, No. 1.

(17) Install stabilizers bolts (1) and washers (2) and tighten to 75 ft lb (100 Nm).

(18) Check the crankshaft rotates freely. If not, remove and reinstall the crankshaft.

(19) Attach a dial indicator to the block so the plunger rests on the rear crankshaft flange. Using a 12 in. (30 mm) pry bar, wedge the crankshaft toward and away from the dial indicator. Total end play should be between 0.004 - 0.011 in. (0.010 - 0.28 *mm).*

(20) Excess end play indicates wrong thrust washers installed, insufficient end play indicates a misalined rear bearing or dirt or burr on the washer (4).

(21) Install the cylinder liner, piston and connecting rod as detailed in para. 3-8.9.

(22) Install the cylinder heads as detailed in para. 2-19.8.

(23) Install the flywheel housing (and gear train as required) as detailed in para. 3-8.6.

(24) Install the oil pump as detailed in para. 2-19.10.

(25) Install the oil pan as detailed in para. 2-19.11.

(26) Install other equipment removed as required and install engine in truck.

3-8. ENGINE - Continued

3-8.11 Cylinder Block.

This task covers:

a. Removal
b. Inspection
c. Installation
f. Installation

TOOLS
Shop Equipment, Automotive Maintenance and Repair, NSN 4910-00-754-0705
J29109 Overhaul Stand
J8601-01 Adapter Plate
J29592 Adapter Pressure Test
J5347-01 Cylinder Bore Gage
J29005 Cylinder Block Line Boring Kit
J23019 Plug Installer
J28711 Driver After cooler Adapter
J7079-02 Driver
J8092 Driver
J24597 Adapter
J25384 11/16 - 11 Bottom Tap
J23059 Master Setting Gage

EQUIPMENT CONDITION
Engine Removed From Truck (see para. 3-8.1
Exhaust Manifolds Removed (see para. 2-19.1)
Throttle and Pump Governor Removed (see para. 2-19.12)
Accessory Drive Removed (see para. 2-19.2)
Water Pump Removed (see para. 2-19.9)
Rocker Covers Removed (see para. 2-19.3)
Rocker Arms/Cam Followers And Push Rods Removed (see para. 2-19.4)
Injector Controls Removed (see para. 2-19.6)
Fuel Injectors Removed (see para. 2-19.5)
Cylinder Heads Removed (see para. 2-19.8)
Gear Cover and Balance Weight Removed (see para. 3-8.5)
Mechanical Governor and Fuel Pump Removed (see para. 2-19.13)
Oil Pan Removed (see para. 2-19.11)
Engine Oil Cooler Removed (see TM 5-4210-220-12)
Engine Oil Pump Removed (see para. 2-19.10)
Engine Oil Filter and Base Removed (see TM 5-4210-220-12)
Blower Removed (see para. 3-8.3)
After cooler Removed (see para.3-8.4)
Flywheel Housing Removed (see para. 3-8.6)
Idler Gears Removed (see para. 3-8.7)
Camshafts Removed (see para. 3-8.8)
Pistons, Liners and Connecting Rods Removed (see para. 3-8.9)
Crankshaft Removed (see para. 3-8.10)

MATERIALS/PARTS
2, Appendix B Antifreeze
4, Appendix B Antiseize Compound
16, Appendix B Grease
17, Appendix B, Lubricating Oil
22, Appendix B Pipe Sealant
23 Appendix B Retaining Compound
29, Appendix B Threadlock Liquid
8923315 Block Assembly
5199616 Gasket Kit (Engine Overhaul)

PERSONNEL REQUIRED - 2

CAUTION

Check mounting bolts carefully to be sure engine Is securely mounted to overhaul stand before removing the lifting sling. Severe injury to personnel and destruction of engine parts will result if engine breaks away from overhaul stand.

NOTE

This instruction is written assuming engine is removed from truck and is stripped of all equipment. INSPECTION, para a., details the procedure to carry out a pressure test of the block with the engine in the truck. This procedure should be used as a quick test to determine if the block heads are cracked. Para. e details a more thorough test.

3-8. ENGINE - Continued

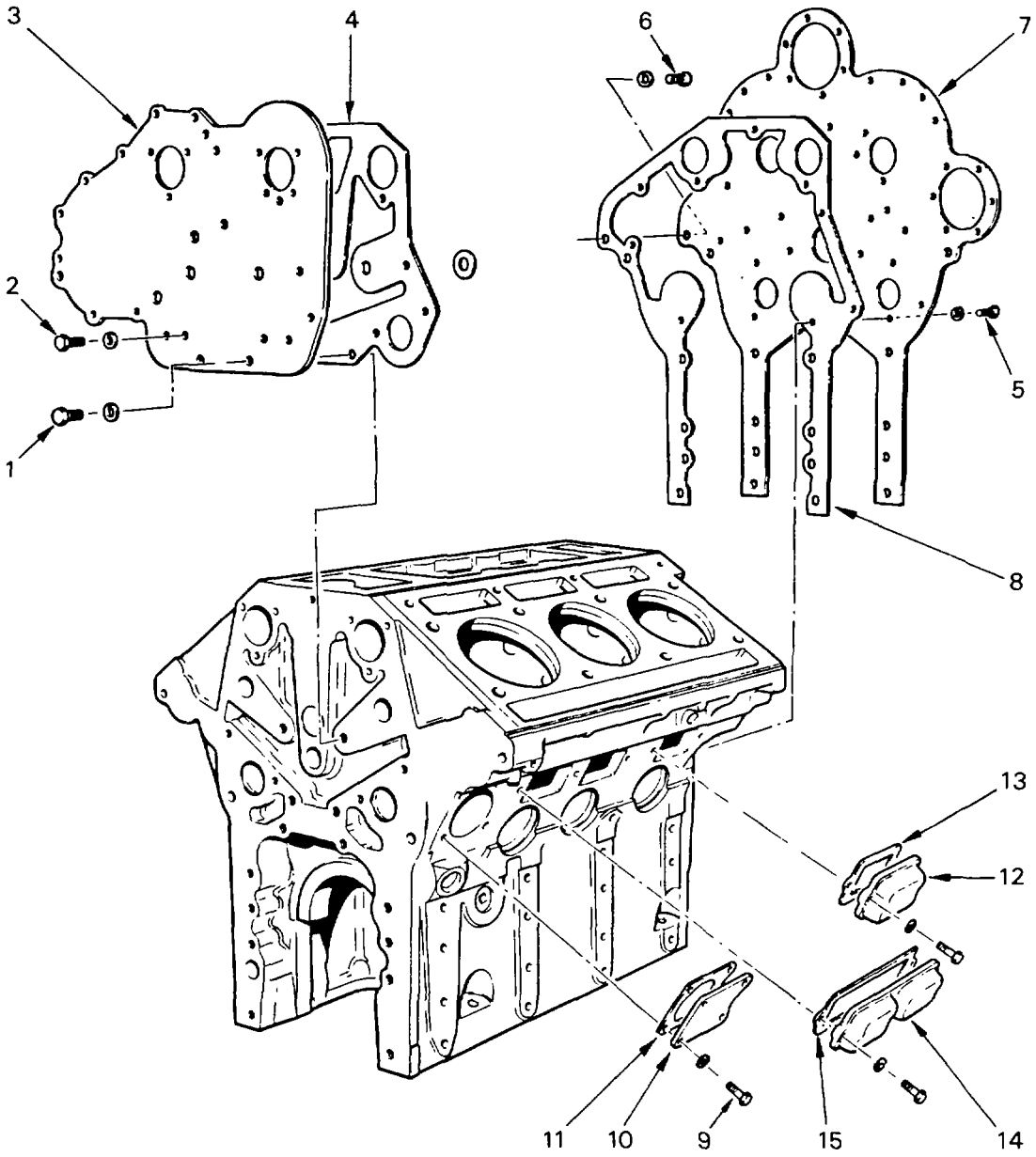
REMOVAL

(1) Remove five 3/8 - 16 X 1 bolts (1) and two 1/2 - 13 X 1 bolts (2). Remove front plate (3) and discard gasket (4).

(2) Remove one 5/8 - 11 X 1 bolt (5) and four 3/8 - 16 X 1 bolts (6). Remove rear plate (7) and discard gasket (8).

(3) Remove four 3/8 - 16 X .88 bolts (9). Remove water hole cover (10) and discard gasket (11).

(4) Remove bolts securing two small hole covers (12). Discard gaskets (13). Remove bolts securing two large hole covers (14) and discard gasket (15).



3-8. ENGINE - Continued

3-8.11 Cylinder Block - Continued

INSPECTION

a. Cylinder Block Pressure Test In Truck

NOTE

This procedure is to be used as a quick test to determine if the cylinder heads or cylinder block has been damaged.

(1) Remove rocker covers, para. 2-19.3, and oil pan, para. 2-19.11.

(2) Check/fill water jacket with mixture of water and antifreeze, (item 2, Appendix B), containing at least one gallon of antifreeze. The antifreeze will penetrate small cracks and its color can be used in detecting leak location.

(3) Apply 14 psi (100 kPa) via radiator fill neck. Maintain pressure for two hours if required, to allow mixture time to work it's way through any cracks that may be present.

(4) Examine exterior of block, interior cylinder bores, air box, oil passages and crankcase area for presence of coolant mixture and repair/replace components as required.

b. Block End Plates Inspection

(1) Remove gaskets from both front and rear end plates.

(2) Inspect front and rear end plates for nicks or scratches. Check plates for warpage. Replace plates if warped or scored too deep to seal with new gasket.

(3) Inspect plug nuts for cracks or damaged threads. Replace plug nuts, or end plate as required.

(4) When installing new plug nuts, support end plate on a solid flat surface to avoid destroying the plate. Press nut in end plate until head on the nut seats on end plate.

(5) Thoroughly clean gasket material from block ends.

c. Main Bearing Journal Bore Inspection

(1) Check the bore diameters original position. No. 1 or front main bearing cap is also stamped on the face of the pan mounting flange of the cylinder block.

(2) Lubricate main bearing bolt threads and bolt head contact areas with a small quantity of anitseize compound (item 4, Appendix B). Tighten to 240 ft lb (325 Nm) when making this check, do not install main bearing stabilizers.

(3) Specified bore diameter is 4.813 - 4.812 in. (122.22 - 122.25 mm). If all four bores do not fall within these limits, the cylinder block must be repaired or replaced. For repair, refer to REPAIR following.

3-8. ENGINE - Continued

d. Cylinder Block Cleaning and Inspection

(1) Remove all gasket material from cylinder block.

(2) Remove all oil gallery and core hole plugs, except cup plugs, to allow cleaning solution to contact the inside of the oil and water passages.

(3) If core hole plugs are difficult to remove, hold a 3/4 in. drift against the plug and give it a few sharp blows with a hammer. Using 1/2 in. flex handle placed into countersunk hole of plug, turn plug slightly in tightening direction. Turn handle and plug in opposite direction to remove plugs.

WARNING

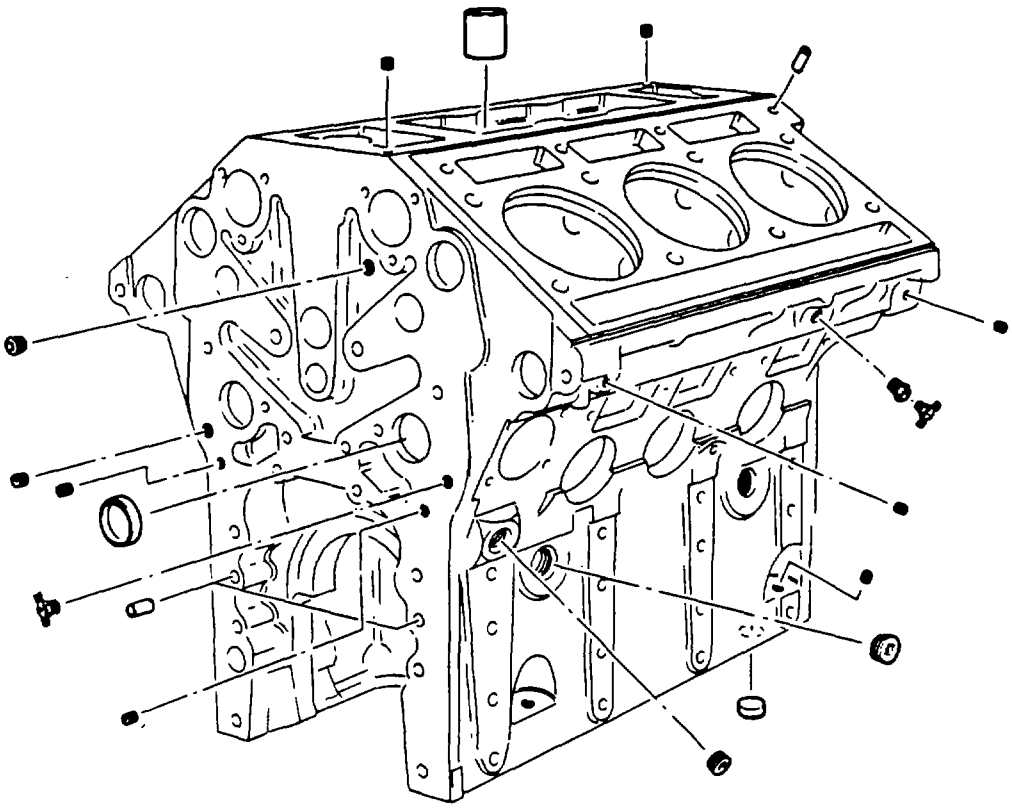
Alkaline solution is toxic to skin, eyes, and respiratory tract. Skin and eye protection required. Avoid repeated or prolonged contact. Good general ventilation normally adequate.

(4) Submerge block in tank, with agitating tray, of hot alkaline solution to remove grease

WARNING

Steam or vapor pressure cleaning creates hazardous noise levels and severe burn potentials. Eye, skin, and ear protection are required.

(5) Steam clean block after hot bath to remove the alkaline solution and any remaining sludge in block.



WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(6) Be sure all water passages, oil galleries and air box drain openings have been thoroughly cleaned.

NOTE

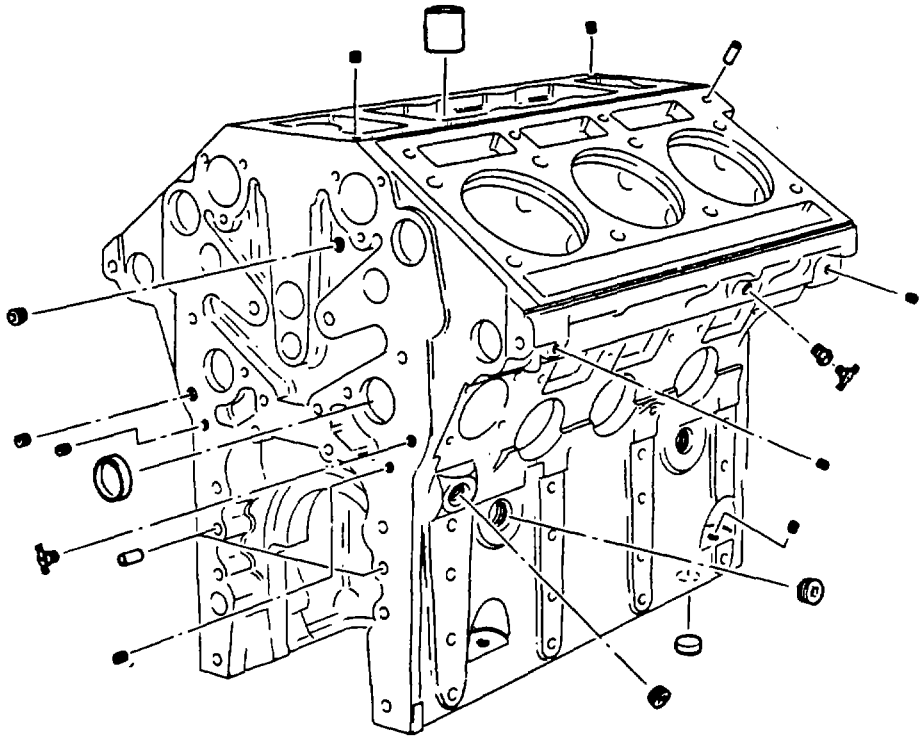
The cylinder head bolt hole plugs are designed to seal the head bolt holes from the water jacket in block assembly.

(7) After block has been cleaned, remove all ten hole plugs. Plugs have a 1/4 in. square recessed socket. Buff plugs clean, and clean threaded bores with bottom tap J25384.

(8) Apply threadlock liquid (item 29, Appendix B) to the threads in the block at plug installation level and to the plug threads screw plug in until the top of the plug is 1.980 2.070 in. (50.29 -52.58 mm) below the block surface for bolt clearance.

(9) Remove excess threadlock liquid from hole with bottom tap.

(10) Allow sealant to set for twelve hours.



3-8. ENGINE - Continued

e. Cylinder Block Pressure Test Inspection

(1) Clean seal ring grooves thoroughly. Install new seal rings in grooves. Apply light coating of antifreeze (item 2, Appendix B) to seal rings.

(2) Place liner inserts in cylinder counterbores. Slide cylinder liners into block. Be careful not to roll or damage seal rings.

(3) Install new compression gaskets and water hole seals in counterbores in the block.

(4) Make steel plates of 1/2 in. thick stock to cover each cylinder bank on block.

(5) Secure plates to block using 11/'16 in. - 11 bolts and flat washers. Tighten to 250 ft lb (339 Nm).

(6) Seal off water inlet and outlet holes using rubber gaskets and steel plates bolted in place. Drill and tap one cover plate for air inlet connection.

(7) Install adapter J29592 to seal the aftercooler water inlet adapter plug in air box floor.

(8) Immerse block for twenty minutes in a heated tank of water at 180 - 200 deg. F (82 - 93 deg. C).

(9) Apply 40 psi (276 kPa) air pressure to water jacket.

(10) Observe the water in tank for bubbles which, if present, indicates the presence of a leak or crack in block. A cracked block must be replaced.

(11) Remove block from tank. Remove plates, gaskets, liners and inserts.

WARNING

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(12) Blow out all passages in block and dry liners and inserts using compressed air.

(13) Coat all components with engine oil (item 17, Appendix B) to prevent rusting before final assembly.

f. Cylinder Block Bore Inspection

(1) Clean seal ring grooves. If grooves are eroded, or pitted, block must be replaced.

(2) Measure bore of each cylinder with bore gage J5347-01. Use master setting tool J23059-01 to set up bore gage.

3-8. ENGINE - Continued

3-8.11 Cylinder Block - Continued

(3) Measure each cylinder bore at four locations as indicated by letters A, B, C, and D. Take two readings at each location, 90 deg. to other as indicated by letters XZ and WY.

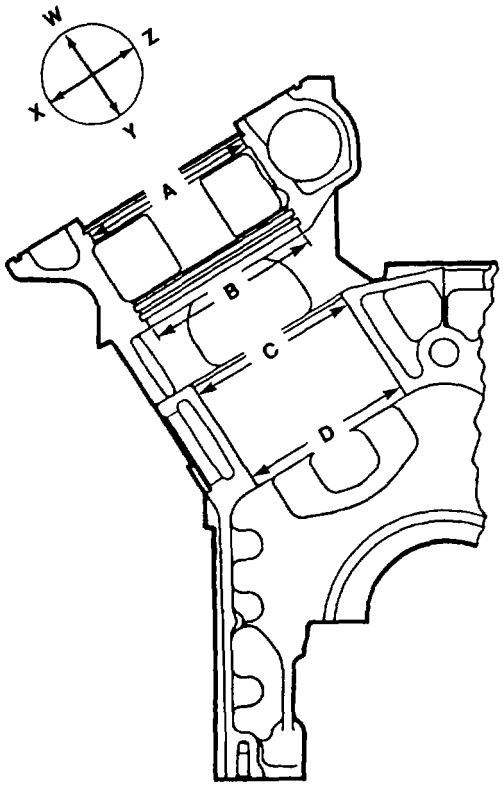
(4) The difference between the two readings at each level (out-of-round) must not exceed 0.0010 in. (0.030 mm).

NOTE

When measuring cylinder block bore, block should be flat on floor, main bearing caps installed and tightened to a torque of 240 ft lb (325 Nm).

(5) Record the average of both readings taken at each level. These measurements must not exceed those shown below. Taper between levels C and D must not exceed 0.0010 in. (0.030 in.)

Block	Maximum Allowable Average Measurement at Location			
	A	B	C	D
New	5.3620 in. 136.195 mm	5.3385 in. 135.598 mm	5.2175 in. 132.525 mm	5.2180 in. 132.537 mm
Used	5.3635 in. 136.233 mm	5.3395 in. 135.623 mm	5.2185 in. 132.550 mm	5.2185 in. 132.550 mm



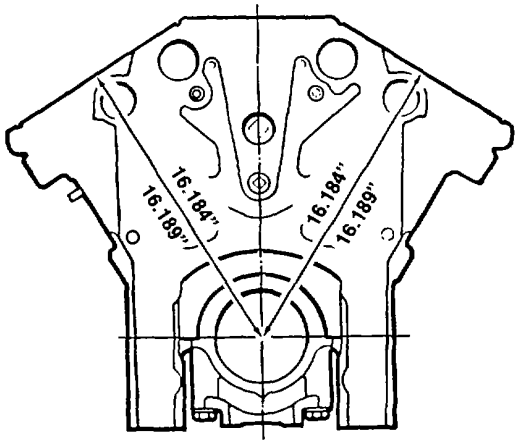
3-8. ENGINE - Continued

g. Cylinder Block Deck Surface Inspection

(1) Check head contact area of block for flatness with block straight edge and feeler gage.

(2) Block should not vary more than 0.003 in. (0.008 mm) transversely or 0.006 in. (0.15 mm) longitudinally.

(3) Distance from centerline of crankshaft to top of block/head surface must be between 16.184 in. and 16.189 in. (411.07 - 411.20 mm). If block is not within specification, it must be replaced.



h. Cylinder Counterbore Inspection

WARNING

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(1) Thoroughly clean cylinder liner counterbores. Blow area clean with compressed air.

(2) Measure counterbore depth. Counterbore depth must be 0.4755 0.4770 in. (12.078 12.116 mm) or 0.4905 0.4920 in. (12.459 12.497 mm) and must not vary more than 0.0015 in. (0.038 mm) throughout the entire circumference. There must not be over 0.0015 In. (0.038 mm) difference between any two adjacent cylinder counterbores when measured along the cylinder longitudinal center line of the cylinder block.

j. Block Bolt Hole Threads Inspection

(1) Inspect cylinder head and main bearing cap bolt holes. If threads are damaged, use a tap to clean up the threads or Install a helicoil thread insert.

(2) An insert thread repair kit, J29513, is available for installing an 11/16 in. - 11 helicoil thread insert in the cylinder head and main bearing cap retaining bolt holes of the cylinder block.

INSTALLATION

(1) Install all oil gallery and core hole plugs removed for cleaning procedure. Use pipe sealant (item 22, Appendix B) on all threads.

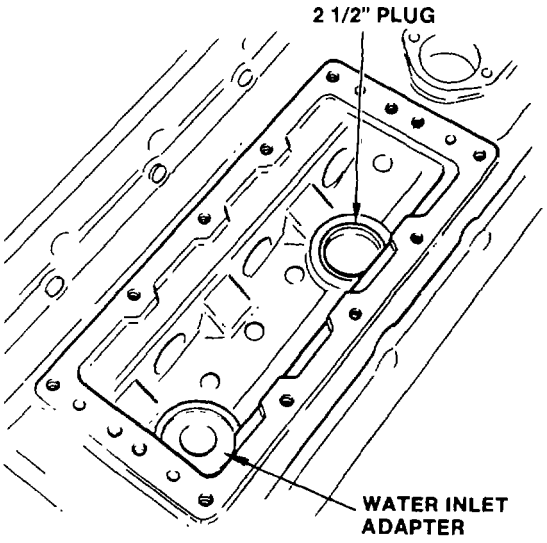
(2) Use pipe sealant (item 22, Appendix B) on outer diameter of any *cup* plugs being installed. Always use proper sized driver and pilot to fit cup plug. 2 1/2 in. plugs use driver J8092 and adapter J24597; 1 5/8 in. plugs use driver J7079-02 and adapter J21850.

(3) Coat airbox bore plugs (2 1/2 - 16) with engine oil (item 17, Appendix B). Tighten to 270 ft lb (336 Nm) using plug installer J23019.

3-8. ENGINE - Continued

3-8.11 Cylinder Block - Continued

(4) On a new service block, remove the 2 1/2 in. plug in the rear core hole in the bottom of the air box and the 2 1/4 In. plug in the top deck of the block in front of the blower mounting pad.



(5) Install the water outlet elbow and gasket in the opening In the top deck of the block.

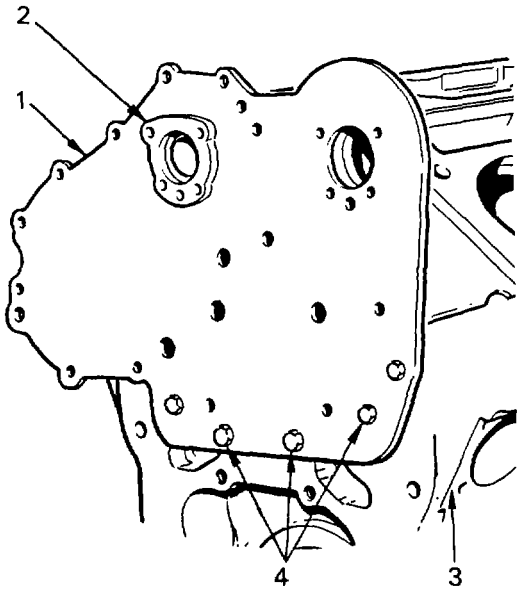
(6) Drive aftercooler water inlet adapter in place using tool J28711.

(7) Using grease (item 16, Appendix B) to hold gasket in place, install new front plate gasket in position on block.

NOTE

Be sure to install the small round gasket in the corner at front end of cylinder block.

(8) Attach front end plate (2) to cylinder block (3) with mounting bolts (4). Leave fingertight.



(9) Install right bank camshaft front bearing (1) through the small bearing bore in the end plate (2) and into the bore of block to accurately aline the end plate with cylinder block.

NOTE

The camshaft bearing mount holes in end plates are not all the same size. The smaller hole is accurately machined in both end plates for alinement purposes and is always located on the right side of the engine (as viewed from rear).

(10) With bearing in place, tighten 1/2 in. bolts to 75 ft lb (102 Nm) and 3/8 in. bolts to 35 ft lb (47 Nm).

(11) Remove camshaft bearing (1).

(12) Using grease (item 16, Appendix B) to hold rear plate gasket in place. Use a retaining compound (item 23, Appendix B) at the upper right rear of the block face and corresponding area of rear end plate. Position rear plate in place and install mounting bolts fingertight.

(13) Install right bank camshaft rear bearing through the small bearing bore in the end plate and into the bore of block to accurately aline the end plate with the cylinder block.

3-8. ENGINE - Continued

(14) With bearing in place, tighten rear end plate 5/8 in. bolts to 110 ft lb (149 Nm) *and* 3/8 in. bolts to 35 ft lb (47 Nm).

(15) Remove camshaft bearing.

(16) Trim off any excess gasket material in oil pan gasket mounting area.

(17) If required, rebuild engine.

REPAIR

a. Cylinder Block Rebore

NOTE

Use J29005 shop line boring tool, or for machine shop rebore, refer to b. following.

Block removed from truck and stripped as detailed in REMOVAL preceding.

(1) In order to rework cylinder block with damaged saddles caused by a spun main bearing using line borer J29005, t here must be two undamaged main bearings saddles, one of which must be the rear main saddle.

(2) If rear main saddle is damaged, block must be machine shop line bored; see b. following.

(3) Remove all main bearing caps. Clean rework area.

(4) The two undamaged saddles act as an alinement saddle for centering rings of line borer J29005.

(5) In a block that has front and rear saddles that can be used as the alinement saddles, boring tool will only have to be installed and set once to enable repair work to be done to either number 2, 3, or both main bearing saddles.

(6) Where the two alinement saddles are next to each other, the closest to the rear saddle is repaired first.

(7) Set centering rings into the alinement saddles. Install main bearing caps and capscrews, but do not tighten. Lubricate centering ring holes with oil (item 17, Appendix B). Slide boring bar through centering rings. Bar must rotate freely.

(8) Tighten main bearing capscrews to 230 ft lb (312 Nm). Centering rings should be held stationary and bar free to rotate.

(9) Install main bearing capscrews fingertight into all remaining saddles to prevent chips from entering bolt holes.

(10) Fasten torsion bar and hydraulic feed unit on either end of cylinder block. Index the flat on the feed rod into boring bar. Snug set screw.

(11) Zero the micrometer with the test block. Micrometer is 0.005 in. (0.13 mm) per revolution.

3-8. ENGINE - Continued

3-8.11 Cylinder Block - Continued

(12) Remove the test block and install the cutting tool holder on the micrometer test fixture. Use alien wrench to set cutting tool (4) for first cut of 0.040 in. (0.016 mm). The point of the cutting tool should be in the center of micrometer barrel.

(13) Install cutting tool on the boring bar. Do not overtighten alien screws. The tool feeds away from the operator and rotates clockwise as viewed by the operator.

(14) When installing the cutter, be use the sharp portion of the bit is in the cutting position. Lubricate bar with engine oil (item 17, Appendix B).

(15) Using 1/2 in. drill with operating speed of 300 400 rpm, attached to universal adapter, move hydraulic feed unit lever to the closed position.

(16) Line bore the damaged saddle in three steps.

Standard block saddle bore	4.812 in. (122.22 mm)
Set Tool For First Cut	+0.040 in. (1.02 mm) 4.852 in. (123.24 mm)
Set Tool For Second Cut	+0.040 in. (1.02 mm) 4.892 in. (124.26 mm)
Set Tool For Third Cut Final Dimension	+0.020 in. (0.51 mm) 4.912.4.913 (124.76/124.79 mm)

(17) Remove boring bar and clean reworked saddle.

(18) Install and aline the insert with the hold down bolts and plates. Use plate with step on the side of the Insert opposite the tang. Tighten hold down bolts to 20 ft lb (27 Nm). Check insert for alinement.

(19) Drill four 1/8 in. holes in saddle, 1/4 in. deep, using the predrilled holes in insert as a guide.

WARNING

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(20) Use compressed air to clean drilled holes.

(21) Install rivets. Be careful not to strike insert. Rivets are used only for locating insert; the bearing cap holds insert In place. File off any excess rivet material.

(22) Remove hold down bolts and retaining plates. File any excess material from insert to make flush with the saddle cap.

3-8. ENGINE - Continued

(23) Install unfinished new undersize service cap on replaced saddle. Tighten to 240 ft lb (325 Nm).

(24) Line bore the unfinished cap and insert to standard bore using similar three step procedure as used to bore saddle.

Service Cap	4.712 in. (119.68 mm)
Set Tool First Cut	+0.040 in. (1.02 mm) 4.752 in. (1.02 mm)
Set Tool Second Cut	+0.040 in. (1.02 mm) 4.792 in. (121.72 mm)
Set Tool Third Cut Final Dimension	+0.020 in. (0.51 mm) 4.812 in./4.813 in. (122.22/122.25 mm)

(25) Check finished bore with 'NO/GO' test ring. The ring should pass through the reworked saddle and cap with a slight drag.

(26) If cylinder block is line bored properly, there will be no more than 0.001 in. (0.003 mm) overhaul misalinement from one end of block to other, or 0.0005 in. (0.013 mm) between adjacent bores.

(27) Thoroughly clean block.

b. Cylinder Block Rebore

NOTE

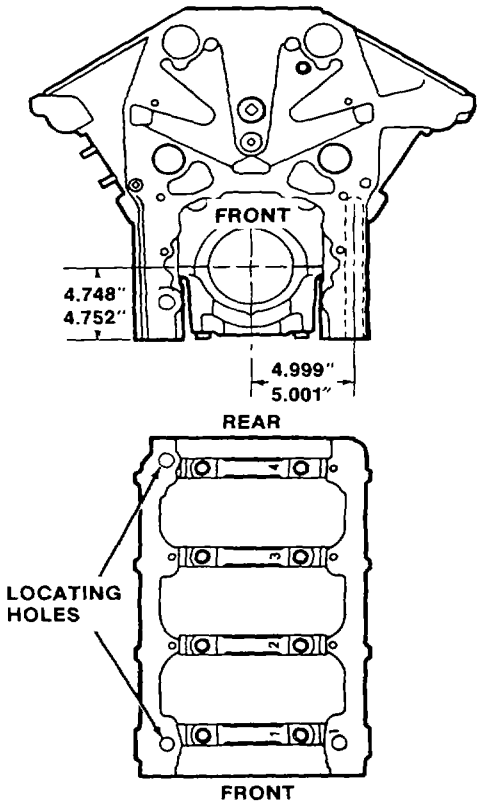
Using machine shop technique. Machine shop repair is essential when rear main saddle is damaged and cannot be used to center boring tool J29005.

(1) All critical dimensions are measured from the reamed locating holes. These are 0.937 0.938 in. (23.80 23.83 mm) in diameter and are located at each end of the left bank pan rail looking from rear of block.

(2) Center line of the crankshaft is 4.999 5.001 in. (126.97 127.03 mm) in from center line of reamed locating holes and 4.748 4.752 in. (120.60 - 120.70 mm) up from pan rail surface.

(3) Machine the main bearing saddle bore to 4.912 - 4.913 in. (124.76 - 124.79 mm).

(4) Install and aline the insert with the hold down bolts and plates. Use plate with step on the side of the insert opposite the tang. Tighten hold down bolts to 20 ft lb (27 Nm). Check insert for alinement.



3-8. ENGINE - Continued

3-8.11 Cylinder Block - Continued

(5) Drill four 1/8 in. holes in saddle 1/4 in. deep using predrilled holes in insert as a guide.

WARNING

Death or serious injury could occur if compressed air is directed against the skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi (2.11 kg/cm2) or less. When working with compressed air always use chip guards, eye protection and other personal protective equipment.

(6) Use compressed air to clean drilled holes.

(7) Install rivets, being careful not to strike insert. Rivets are used only for locating insert; the bearing cap holds insert in place. File of any excess rivet material.

(8) Remove hold down bolts and retaining plates. File any excess material from insert to make flush with the saddle cap.

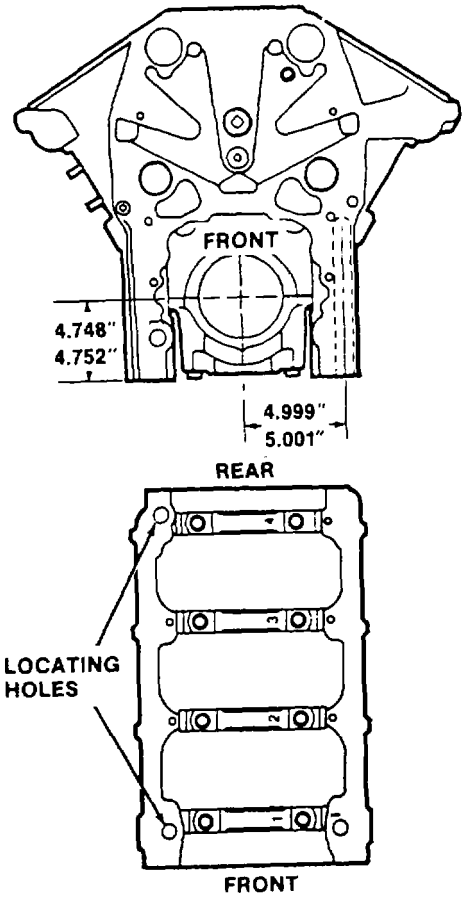
(9) Install unfinished new undersize service cap on repaired saddle. Tighten to 240 ft lb (325 Nm).

(10) Line bore the unfinished cap and insert to standard bore dimensions of 4.812 4.813 in. (122.22 - 122.25 mm).

(11) Check finished bore with 'NO/GO' test ring. The ring should pass through the reworked saddle and cap with a slight drag.

(12) If cylinder block line is properly bored, there will be no more than 0.001 in. (0.03 mm) overall misalinement from one end of block to other, or 0.0005 in. (0.013 mm) between adjacent bores.

(13) Thoroughly clean block.



APPENDIX A

REFERENCES

A-1. SCOPE.

This appendix lists all forms, field manuals, technical manuals and miscellaneous publications referenced in this manual.

A-2. FORMS.

Equipment Inspection And Maintenance Worksheet	DA Form 2404
Discrepancy In Shipment Report	SF361
Report Of Discrepancy	SF364
Quality Deficiency Report	SF368
Recommended Changes To DA Publications	DA Form 2028-2

A-3. TECHNICAL MANUALS.

Operator's And Unit Maintenance Manual	TM 5-4210-220-12
Maintenance Repair Parts And Special Tools List	TM 5-4210-220-20P
Intermediate Direct Support And General Support Maintenance Repair Parts And Special Tools List	TM 5-4210-220-34P
Lubrication Order	LO 5-4210-220-12
The Army Maintenance Management System	DA PAM 738-750
Painting Instructions For Field Use	TM 43-0139
Administrative Storage Of Equipment	TM 740-90-1
Destruction Of Army Materiel To Prevent Enemy Use	TM 750-244-3
Welding Instructions	TM 9-237

A-4. MISCELLANEOUS PUBLICATIONS.

Fuels, Lubricants, Oil And Waxes	C910011
Consolidated Index Of Army Publications And Blank Forms	DA PAM 310-1

APPENDIX B

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST
SECTION I. INTRODUCTION

B-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the Model 2500L Firefighting Truck. This listing is for information purposes only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-970, 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 material (e.g., Use cleaning compound (item 5, Appendix B)).

b. Column(2) Level. This column identifies the lowest level of maintenance that requires the listed item.

C Operator/Crew
0 Unit Maintenance
F Intermediate Direct Support Maintenance
H Intermediate General Support Maintenance

c. Column(3) National Stock Number. This is the National stock number *assigned* to the item; use it to request or requisition the item.

d. Column(4) Description. Indicates the Federal item name and, if required, a *description* to identify *the* item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) in parentheses followed by the part number.

e. Column(5) Unit of Measure (U/M).Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

ITEM NO.	LEVEL	NATIONAL STOCK NUMBER	DESCRIPTION	U/M
1	0	8950-01-079-3978	Acetic Acid (Vinegar)	Ea
2	0	6850-00-664-1403	Antifreeze	GL
3	o	8030-00-243-3285	Antiseize Compound	TU
4	0	8030-00-251-3980	Antiseize Compound	LB
5	0	8950-00-292-9611	Baking Soda	LB
6	0	8030-00-018-9532	Contact Adhesive	Ea
7	0	5350-00-221-0872	Crocus Cloth	PG
8	0		Cutting Oil	QT
9	0	9150-00-005-4859	Dexron II	QT
10	0	6850-00-281-1985	Dry Cleaning Solvent	GL
11	0	5970-00-543-1154	Electrical Tape	RO
12	0	5350-00-187-6284	Emery Cloth (80-100 Grit)	FT
13	0	5350-00-260-0750	Emery Cloth (400 Grit)	FT
14	0	8030-00-247-2525	Gasket Eliminator	TU
15	0		Gear Oil	Ea
16	0	9150-00-190-0905	Grease	Ea
17	0	9150-00-402-2372	Lubricating Oil (or engine oil)	QT
18	0	7510-00-266-5016	Masking Tape	RO
19	F	6810-00-281-2785	Methyl Ethyl Ketone	GL
20	0	6850-00-508-0076	Penetrating Oil	CN
21	0		Petroleum Jelly	Ea
22	0	8030-00-058-5398	Pipe Sealant	Ea
23	0		Retaining Compound	Ea
24	0	5350-00-264-3485	Sandpaper (00 Grit)	PG
25	0		Sealant	Ea
26	0		Seal Retainer (International Compound #2)	Ea
27	0	6850-00-664-4959	Silicone Grease	GL
28	0	8040-00-701-9546	Silicone Sealant	TU
29	0	8030-00-950-1905	Threadlock Liquid	TU
30	0		Tire Bead Lubricant	Ea
31	0	5350-00-193-7227	Valve Grinding Compound 120 Grit	LB
32	0	8945-01-066-8210	Vegetable Shortening	GL
33	0	8040-00-543-2858	Vulcanizer	PT
34	0		White Grease	Ea

APPENDIX C

TORQUE VALUES AND WEAR LIMITS

This appendix lists the torque valves used in tightening major components.

It also lists the wear limits - ie. the dimension of a particular item which, if exceeded, requires that item to be replaced.

T O R Q U E

SIZE		SAE GRADE WET		NO. 5 DRY		SAE GRADE WET		NO. 8 DRY	
DIA INCHES	THREADS PER INCH	FOOT POUNDS	NEWTON METERS	FOOT POUNDS	NEWTON METERS	FOOT POUNDS	NEWTON METERS	FOOT POUNDS	NEWTON METERS
1/4	20	7	10	8	11	11	15	12	16
1/4	28	9	12	10	14	13	17	**14**	19
5/16	18	15	22	17	23	22	29	24	33
5/16	24	17	23	19	26	24	33	27	37
3/8	16	28	38	31	42	40	54	44	60
3/8	24	32	43	35	47	44	60	49	66
7/16	14	44	60	49	66	63	85	70	95
7/16	20	50	67	55	75	70	95	78	105
1/2	13	68	92	75	100	95	130	105	140
1/2	20	77	105	85	115	110	150	120	160
9/16	12	99	135	110	150	140	190	155	210
9/16	18	110	150	120	165	150	205	170	230
5/8	11	135	180	150	205	190	260	210	285
5/8	18	150	205	170	230	220	300	240	325
3/4	10	245	330	270	365	340	450	375	510
3/4	16	265	360	295	400	380	540	420	600
7/8	9	356	480	395	535	540	740	605	820
7/8	14	390	530	435	590	610	820	675	910
1	8	530	720	590	800	820	1100	910	1200
1	14	600	800	660	900	890	1200	990	1300
1 1/8		750	1000	840	1100	1200	1600	1350	1800
1	1/4					1700	2300	1900	2600
1	3/8	1400	1900	1600	2200	2300	3100	2600	3500
1	1/2	1900	2600	2100	2800	3000	4100	3300	4500

C-2. EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS.

APPLICATION	THREAD SIZE	TORQUE (ft-lb)	TORQUE (Nm)
NOTE			
This table lists bolt and nut torque specifications exceptions according to thread size.			
Cam follower guide bolt	1/4-20	12-15	16-20
Injector control shaft bracket bolt	1/4-20	10-12	14-16
<<V<< band coupling locknut (compressor)	1/4-28	9.2-10.8	12-15
<<V<< band coupling locknut (turbine)	1/4-28	12.7-14.0	17-19
Air box cover bolt	5/16-18	8-12	11-16
Blower drive gear support to thrust collar bolt	5/16-18	16-21	22-28
Backplate to center housing bolts	5/16-18	7.5-9.2	10-12
Exhaust valve bridge adjusting screw locknut	5/16-24	20-25	27-34
Idler gear bearing retainer bolts	5/16-24	24-29	33-39
Governor weight shaft bearing retaining bolt	5/16-24	15-19	20-16
Camshaft end bearing bolts	3/8-16	35-40	47-54
Engine front cover bolts	3/8-16	25-30	34-41
Flywheel housing bolts	3/8-16	25-30	34-41
Injector clamp bolts	3/8-16	20-25	27-34
Oil pan bolts	3/8-16	15-20	20-27
Blower side angle bolt	3/8-16	30-35	41-47
Water outlet cover plate bolt	3/8-16	20-25	27-34
Air inlet housing adaptor-to-blower housing bolt	3/8-16	16-20	22-27
Air inlet housing-to-adaptor bolts	3/8-16	16-20	22-27
Accessory drive disc to camshaft gear bolt	3/8-24	45-50	61-68
Balance weight-to-camshaft gear bolt	3/8-24	15-18	20-24
Blower drive gear hub to spring plate bolt	3/8-24	40-45	54-61
Blower drive support bolts and nuts (T engines)	3/8-24	25-30	34-41
Camshaft intermediate bearing lock screw	3/8-24	15-20	20-27
Exhaust manifold outlet flange nuts (brass)	3/8-24	20-25	27-34
Flywheel housing bolts (threaded into plug nuts)	3/8-24	25-30	34-41
Flywheel housing cover (small cover) stud nut	3/8-24	20-25	27-34
Flywheel housing cover (small hole) bolt	3/8-24	30-35	41-47
Fuel Pipe Nuts	3/8-24	12-15	16-20
Left bank accessory drive support bolts and nuts	3/8-24	25-30	34-41
Compressor wheel locknut	3/8-24	15-18	14-17
Flywheel housing cover (large hole) bolt	7/16-14	30-35	41-47
Generator drive bearing retaining bolt	7/16-14	30-35	41-47
Rear accessory drive pulley bolt	7/16-14	35	47
Blower end plate-to-cylinder block bolts	7/16-14	40-45	54-61

APPLICATION	THREAD SIZE	TORQUE (ft-lb)	TORQUE (Nm)
Connecting rod nut	7/16-20	60-70	81-95
Cross-head piston pin to conn. rod bolt	7/16-20	55-60	75-81
Exhaust manifold nuts	7/16-20	30-35	41-47
Fuel manifold connector nuts	7/16-20	30-35	41-47
Fuel manifold connectors (steel washer)	7/16-20	40-45	41-47
Water pump impeller retaining nut	7/16-20	35-40	47-54
Crankshaft front cover bolts	1/2-13	80-90	108-122
Flywheel housing bolts	1/2-13	90-100	122-136
Flywheel housing cover (large hole) bolt	1/2-13	30-35	41-47
Idler gear hub and dummy hub bolt	1/2-13	80-90	108-122
Rocker shaft bolts	1/2-13	90-100	122-136
Engine drive shaft flexible coupling bolt	1/2-20	96-115	130-156
Blower rotor gear retainer bolt (large bearing blower	1/2-20	100-110	136-150
Fuel pump drive disc bolt	1/2-20	55-65	75-88
Injector filter caps	5/8-24	65-75	88-102
Cylinder head bolts	11/16-11	230-240	312-325
Main bearing bolts (assembly)	11/16-11	250-260	339-352
Main bearing bolts (former)	11/16-11	250-260	339-352
Main bearing bolts (current)	11/16-11	230-240	313-325
Accessory drive pulley nut	3/4-16	120-140	163-190
Injector nut	15/16-24	75-85	102-115
Crankshaft end bolt	1 1/4	290-310	393-421
Camshaft nut	1 1/8-18	300-325	407-441

C-3. STANDARD PIPE PLUG TORQUE SPECIFICATIONS.

- Use sealing compound (22, Appendix B) on plugs without gaskets or teflon.

NPTF SIZE THREAD	TORQUE (ft lb)	TORQUE (Nm)
1/8	10-12	14-16
1/4	14-16	19-22
3/8	18-22	24-30
1/2	23-27	31-37
3/4	33-37	45-50
1	75-85	102-115
1-1/4	95-105	129-143
1-1/2	110-130	150-177

C-4. SPECIAL PLUG TORQUE SPECIFICATION.

- Use sealing compound (22, Appendix B) on plugs without gaskets or teflon.

APPLICATION	PLUG	ASSEMBLY
Oil gallery plug	3/8 in. Dryseal PTF thread	Assemble with max. 0.0625 in. (1.588 mm) protrusion from surface
Cylinder head (side)	3/8-16 in.	Assemble flush to 0.0625 in. (1.588 mm) protrusion from surface
Cylinder head (end)	3/4 in. Dryseal PTF-SAE short	Flush to 0.1250 in. (3.175 mm) recessed
Core hole plug (air box floor)	2 1/2 in. - 16	230-270 ft lb (312-366 Nm)

C-5. STUD TORQUE SPECIFICATIONS.

APPLICATION	(ft lb)	(Nm)
Exhaust manifold stud	25-40	34-54

WEAR LIMITS

a. Engine Parts (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
(1) Cylinder Block			
Block bore:			
Diameter (upper pilot)-(A)	5.3595"	5.3620"	5.3635"
Diameter (lower two seal ring lands)-(B)	5.3365"	5.3385"	5.3395"
Diameter (water jacket)-(C)	5.2160"	5.2175"	5.2185"
Diameter (water jacket)-(D)	5.2160"	5.2180"	5.2185"
Out-of-round		0.0010"	
Taper (Lower bore)		0.0010"	
Cylinder liner counterbore:			
Diameter	5.5550"	5.5600"	
Depth (standard)	0.4755"	0.4770"	
Depth (.015" deeper)	0.4905"	0.4920"	
Main bearing bore:			
Inside diameter (vertical axis)	4.8120"	4.8130"	
Main bearing saddle to main bearing cap			0.0020"
Top surface of block:			
Centerline of main bearing bore to top of block	16.1840"	16.1890"	
Flatness-transverse (all)			0.0030"
Flatness-longitudinal			0.0060"
Depth of counterbores (top surface):			
Cylinder head seal strip groove	0.0970"	0.1070"	
Combination water and oil holes	0.0840"	0.0890"	

a. Engine Parts (Standard Size, New) - Continued	MINIMUM	MAXIMUM	LIMITS
(2) Cylinder Liner			
Outside diameter (upper surface)	5.3577"	5.3595"	
Outside diameter (seal ring surface)	5.3347"	5.3365"	
Outside diameter (lower surface)	5.2142"	5.2160"	
Inside diameter	4.8390"	4.8415"	
Out-of-round-inside diameter		0.0020"	0.0025"
Taper-inside diameter	0.0015"	0.0025"	
Depth of flange BELOW block	0.0418"	0.0482"	
Variation in depth between adjacent liners		0.0015"	
(3) Cross-Head Pistons and Rings			
Piston crown:			
Saddle-to-crown distance	2.7025"	2.7095"	
Diameter:			
At top	4.8104"	4.8134"	
Below both compression rings	4.8273"	4.8303"	
Above and below seal ring groove	4.4650"	4.4750"	
Above and below bearing saddle	3.2360"	3.2370"	
Compression rings:			
Gap (top-fire ring)	0.0250"	0.0450"	0.0600"
Gap (No. 2 and 3)	0.0250"	0.0450"	0.0600"
Clearance-ring-to-groove:			
Top (Keystone fire ring)	0.0010"	0.0050"	0.0070"
No. 2 (rectangular section)	0.0100"	0.0130"	0.0220"
No. 3 (rectangular section)	0.0040"	0.0070"	0.0130"
Measured with Keystone fire ring flush with outside diameter of piston crown.			
Seal ring:			
Gap (in skirt counterbore)	0.0020"	0.0170"	
Clearance	0.0005"	0.0030"	0.0040"
Piston skirt:			
Diameter (includes tin)	4.8318"	4.8340"	
Clearance-skirt-to-liner	0.0051"	0.0097"	0.0120"
Seal ring bore	4.5000"	4.5030"	
Piston pin bore	1.5025"	1.5035"	1.5040"
Diameter above and below the piston pin may be 4.8280"			
Oil control rings:			
Gap (two rings in upper groove-turbo)	0.0100"	0.0250"	0.0430"
Gap (two rings in upper groove-turbo)	0.0070"	0.0170"	0.0350"
Clearance	0.0015"	0.0055"	0.0080"
(4) Piston Pins (Cross-Head Piston)			
Diameter	1.4996"	1.5000"	1.4980"
Slipper bearing (bushing):			
Thickness at center	0.0870"	0.0880"	0.0860"
Clearance (edge of bushing to groove in piston)	0.0005"	0.0105"	0.0120"
(5) Crankshaft			
Journal diameter-main bearing	4.4985"	4.5002"	
Journal diameter-conn. rod bearing	2.9985"	3.0002"	

a. Engine Parts (Standard Size, New) - Continued	MINIMUM	MAXIMUM	LIMITS
Journal out-of-round	0.0005"	0.0005"	
Journal taper			
Main Bearing	0.0004"	0.0004"	
Connecting rod (full length)		0.0008"	
Connecting rod (half length)		0.0004"	
Runout on journals-total indicator reading:			
(mounted on No. 1 and No. 4 journals):			
At No. 2 and No. 3 journals		0.0020"	
Thrust washer thickness	0.1190"	0.1220"	
End play (end thrust clearance)	0.0040"	0.0110"	0.0180"
(6) Connecting Rod Bearing			
Inside diameter (vertical axis)	3.0005"	3.0035"	
Bearing-to-journal clearance	0.0008"	0.0045"	0.0045"
Bearing thickness 90 deg. from parting line	0.1240"	0.1245"	
(7) Main Bearings			
Inside diameter (vertical axis)	4.5016"	4.5040"	
Bearing-to-journal clearance	0.0014"	0.0055"	0.0055"
Bearing thickness 90 deg. from parting line	0.1545"	0.1552"	
(8) Camshaft			
Diameter (at bearing journals):			
Front and rear	1.4970"	1.4975"	
Center and intermediate	1.4980"	1.4985"	
Runout at center bearing (when mounted on end bearings)		0.0020"	
End thrust	0.0030"	0.0150"	0.0180"
Thrust washer thickness	0.1190"	0.1220"	
Camshaft Bearings			
Inside diameter:			
Front and rear	1.5000"	1.5010"	
Center and intermediate	1.5010"	1.5030"	
Clearance-bearing-to-shaft:			
Front and Rear	0.0025"	0.0040"	0.0060"
Center and, intermediate	.0.0025"	0.0050"	0.0090"
Outside diameter:			
Front and rear	2.1875"	2.1880"	
Center and intermediate	2.1840"	2.1860"	
Diameter of cylinder block bore	2.1875"	2.1889"	
Clearance-bearings-to-block:			
Front and rear	0.0005"press	0.0014" loose	
Intermediate	0.0015"	0.0045"	
(9) Camshaft Gears			
Inside diameter	1.1865"	1.1875"	
Clearance-gear-to-shaft	0.0015"press	0.0000"	
Backlash	0.0020"	0.0080"	0.0100"

a. Engine Parts (Standard Size, New) - Continued	MINIMUM	MAXIMUM	LIMITS
(10) Idler Gear			
Backlash	0.0020"	0.0080"	0.0100"
Pre-load-Variation on pull 2 lbs. 11 oz	1/2 lb	4 lb	
(11) Crankshaft Timing Gear			
Inside diameter	5.2490"	5.2510"	
Clearance-gear-to-shaft	0.001" press	0.001" loose	
Backlash	0.0020"	0.0080"	0.0100"
(12) Blower Drive Gear - 2.1:1 ratio			
Backlash	0.0020"	0.0080"	0.0100"
Inside diameter (support bushing)		1.6260"	1.6265"
Hub diameter (at bearing)		1.6240"	1.6250"
Hub-to-support bushing clearance	0.0010"	0.0025"	0.0050"
Thrust washer thickness	0.2350"	0.2450"	
Thrust bearing thickness	0.0590"	0.0610"	
End thrust	0.0050"	0.0100"	0.0120"
(13) Cylinder Head			
Flatness-transverse			0.0040"
Flatness-longitudinal			0.0055"
Distance between top deck and fire deck	3.5560"	3.5680"	3.5360"
Water nozzles (former)	0.0040"rec	Flush	
Water nozzles (current)	0.0150"rec	Flush	
Cam follower bores	1.0620"	1.0630"	1.0650"
Exhaust Valve Insert Counterbore:			
Diameter		1.4400"	1.4410"
Depth		0.3395"	0.3505"
(14) Exhaust Valve Seat Inserts			
Outside diameter	1.4415"	1.4425"	
Seat width	0.0470"		0.0770"
Valve seat runout	0.0020"	0.0020"	
(15) Exhaust Valves			
Stem diameter	0.3100"	0.3108"	0.3090"
Valve head-to-cylinder head 30 deg	0.023" recess	0.006" protr	0.038"
(16) Valve Guides			
Height above cylinder head	0.6700"	0.7100"	
Diameter-inside	0.3125"	0.3135"	0.3140"
Clearance-valve-to-guide	0.0017"	0.0035"	0.0050"
(17) Valve Bridge Guides			
Height above cylinder head	2.0400"	2.0400"	

a. Engine Parts (Standard Size, New) - Continued	MINIMUM	MAXIMUM	LIMITS
(18) Rocker Arms and Shafts			
Diameter-rocker shaft	0.8735"	0.8740"	
Diameter-inside (rocker arm bushing)	0.8750"	0.8760"	
Clearance-shaft-to-bushing	0.0010"	0.0025	"0.0040"
(19) Cam Followers			
Diameter	1.0600"	1.0610"	
Clearance-follower-to-head	.0.0010"	0.0030"	0.0060"
Rollers and pins:			
Clearance-pin-to-bushing	0.0013"	0.0021"	0.010" Horiz.
Side clearance-roller to follower	0.0110"	0.0230"	0.0230"
(20) Blower			
Backlash (timing gears)	0.0005"	0.0025"	0.0040"
Oil seal (below end plate surface)	0.0020"	0.0080"	
Oil strainer (below end plate surface)	0.0000"	0.0150"	
Dowel pin (projection beyond inside face of front end plate)	0.3200"		
Dowel pin (projection beyond inside face of rear end plate)	0.3200"		
Clearances:			
Rotor to end plate (gear end)	0.0070"		
Rotor to end plate (front end)	0.0120"		
Rotor to housing (inlet side)	0.0150"		
Rotor to housing (outlet side)	0.0040"		
Trailing edge of RH helix rotor to leading edge of LH helix rotor	0.0040"	0.0080"	0.0080"
Leading edge of RH helix rotor to trailing edge of LH helix rotor .0.0100"			
(21) Turbocharger (Airesearch)			
End play - rotating shaft	0.0030	0.0100"	
Radial movement - rotating shaft	0.0030"	0.0070"	
Turbine wheel shaft journal bearing:			
Inside diameter	0.6268"	0.6272"	
Outside diameter	0.9782"	0.9787"	
Journal diameter - turbine wheel shaft	0.6250"	0.6254"	
Bearing bore (center housing) inside diameter	0.9827"	0.9832"	0.9842"
Back plate seal bore inside diameter	0.6875"	0.6885"	0.6895"
Thrust collar:			
Thickness	0.2990"	0.3000"	0.2970"
Bore - inside diameter	0.3754"	0.3758"	0.3778"
Thrust spacer:			
Outside diameter	0.6715"	0.6725"	0.6705"
Ring groove width	0.0685"	0.0695"	0.0715"
Thrust washer, inboard thickness	0.0900"	0.0920"	
Compressor wheel bore inside diameter	0.3736"	0.3739"	0.3749"

b. Transmission Parts (Standard Size, New)	IN.
(1) Flywheel Assembly	
Max step wear, lockup backplate bore of flywheel	0.030
(2) Torque Converter and Lockup Clutch	
Piston - max face wear (plate contact area)	0.010
Plate - min thickness	0.190
Min depth of oil grooves	0.008
Backplate - max face wear (plate contact area)	0.010
Stator assembly (TC 495):	
roller thrust washer - min thickness	0.022
front thrust washer - max inside diameter	4.016
front thrust washer - min thickness	0.460
rear thrust washer - max inside diameter	4.018
Thrust bearing race - min thickness	0.029
Roller race - min outside diameter	3.998
(3) Oil Pump Assembly	
Body, gear, and cover:	
Gear max end clearance between body and cover	0.006
(4) Scavenge Oil Pump	
Body, gear, and plate	
Gear max end clearance between body and plate	0.007
(5) Forward Clutch	
External-tanged clutch plate:	
Min thickness	0.0993
Max cone	0.010
Internal-splined clutch plate - min thickness	0.090
Min depth of oil grooves	0.008
Fourth-clutch driving hub:	
Min thickness, plate contact area	0.390
(6) Fourth-Clutch Assembly	
Clutch backplate - min thickness	0.390
Internal-splined clutch plate - min thickness	0.090
Min depth of oil grooves	0.008
External-tanged clutch plate:	
Min thickness	0.0993
Max cone	0.010
(7) Third Clutch, Center Support, Second Clutch	
Third-clutch backplate - min thickness	0.490
Internal-splined clutch plate - min thickness	0.1347

b. Transmission Parts (Standard Size, New)	IN.
External-tanged clutch plate (color code, red):	
Min thickness	0.0993
Max cone	0.013
External-tanged clutch plate (color code, green):	
Min thickness	0.1161
Max cone	0.013
Center support bushing - max clearance on sun gear shaft	0.0065

(8) Gear Unit and Main Shaft Assembly

Thrust washer - min thickness	0.091
Thrust washer - min thickness	0.091
Front carrier bushing - max clearance on sun gear shaft	0.0072
Thrust washer - min thickness	0.091
Sun gear shaft bushing - max clearance on main shaft	0.0064
Sun gear shaft - max clearance in support bushing	0.0065
Sun gear shaft - max clearance in carrier bushing	0.0072
Thrust washer - min thickness	0.091
Thrust washer - min thickness	0.091
Thrust washer - min thickness	0.091
Front carrier bushing - max clearance on sun gear shaft	0.0072
Thrust washer - min thickness	0.091
Sun gear shaft bushing - max clearance on main shaft	0.0064
Sun gear shaft - max clearance in support bushing	0.0065
Sun gear shaft - max clearance in carrier bushing	0.0072
Thrust washer - min thickness	0.091

(9) Transmission Main Housing

Main housing - reaction clutch plate tang groove, max depth	0.090

(10) First Clutch

External-tanged clutch plate (color code, red):	
Min thickness	0.0993
Max cone	0.013
External-tanged clutch plate (color code, green):	
Min thickness	0.1161
Max cone	0.013
Internal-splined clutch plate - min thickness	0.1347
Min depth of oil grooves	0.008

Adapter Housing, Low Clutch Plates

Adapter housing - reaction clutch plate tang groove, max depth	0.090
Internal-splined clutch plate - min thickness	0.1347
Min depth of oil grooves	0.008
External-tanged clutch plate (color code, red):	
Min thickness	0.0993
Max cone	0.013
External-tanged clutch plate (color code, green):	
Min thickness	0.1161
Max cone	0.013
Adapter housing, reaction clutch p!ate tang groove, max depth	0.090

b. Transmission Parts (Standard Size, New)	**IN.**
Internal-splined clutch plate - min thickness	0.1347
External-tanged clutch (color code, red):	
Min thickness	0.993
Max cone	0.013
External-tanged clutch (color code, green):	
Min thickness	0.1161
Max cone	0.013
Low sun gear and hub bushing - max clearance on output shaft	0.0068

(11) Adapter Housing, Low Clutch Plates

Adapter housing - reaction clutch plate tang groove, max depth	0.090

(12) Rear Cover, Output Shaft and Governor

Rear cover - max clearance of governor bore to governor	0.004
Output shaft bushing - max clearance on main shaft	0.004

C-7. TRANSMISSION SPRING DATA.

Spring	Part No.	Color Code	Coil No.	Wire dia in. (mm)	Spring OD in. (mm)	Free Length in. (mm)	Length in. (mm)	Under Load lb. (N)
Stator freewheel	23018535	No Color Code				0.38 (20.6)	0.38 (9.7)	0.36 to 0.66 (1.6 to 2.9)
Main regulator valve	6839209	No Color Code	19	0.1285 (3.26)	0.830 (21.1)	3.94 (1001)	2.64 (67.1)	82.4 to 86.6 (366.5 to 385.2)
Lockup shift valve	6839268	Blue stripe	16	0.081 (2.04)	0.720 (18.3)	3.33 (84.6)	1 80 (45.7)	23.80 to 25.40 (105.9 to 113.0)
Converter bypass valve	6769252	Solid green	14	0.081 (2.04)	0.690 (17.5)	2.65 (67.3)	1.62 (41.2)	21.1 to 23.3 (93.9 to 103.6)
Forward clutch piston release	6836138	Solid orange	102	0.062 (1 57)	0.439 (11.2)	1 25 (31.8)	0.88 (22.4)	17.9 to 18.9 (79.6 to 84 1)
Fourth clutch piston release	6836138	Solid orange	10.2	0.062 (1.57)	0.439 (11.2)	1.25 (31.8)	0.88 (22.4)	17.9 to 18.9 (79.6 to 84.1)
Third clutch piston release	6831656	Solid green	11.5	0.041 (1.04)	0 385 (9.8)	1.29 (32.8)	0.82 (20.8)	4.30 to 5.70 (19.1 to 25.4)
Second clutch piston release	6831656	Solid green	11.5	0.041 (1.04)	0.385 (9.8)	1.29 (32.8)	0.82 (20.8)	4.30 to 5.70 (19.1 to 25.4)
First clutch piston release	6831656	Solid green	11.5	0.041 (1.04)	0.385 (9.8)	1.29 (32.8)	0.82 (20.8)	4.30 to 5.70 (19.1 to 25.4)
Low clutch piston release	6880418	Solid blue	9.5	0.073 (1.85)	0.500 (12.7)	1.31 (33.3)	0.90 (22.9)	26.05 to 27.85 (115.9 to 123.9)
Lubrication check valve	23018455	Solid yellow, black stripe	19	0.090 (2.29)	0 532 (13.5)	2.56 (65.0)	1.97 (50.0)	35.72 to 39.48 (158.9 to 175.6)
Modulator valve red stripe	6880980	Solid blue,	10	0 054 (1.37)	0.490 (12.5)	1.36 (34.5)	0.80 (20.3)	9.88 to 10.92 (44.0 to 48.6)
Third clutch trimmer valve	6839271	Solid white, yellow stripe	10	0.103 (2.61)	0.940 (23.9)	2.56 (65.0)	1.94 (49.3)	20 to 22 (89.0 to 97.9)
First clutch trimmer valve	23013754	Solid red	8.5	0 113 (2.87)	0.940 (23.9)	2.16 (54.9)	1.94 (49.3)	12.2 to 14 8 (16.5 to 20.1)
Second clutch trimmer valve	6839271	Solid white, yellow stripe	10	0.103 (2.61)	0 940 (23.9)	2.56 (65.0)	1.94 (49.3)	20 to 22 (89.0 to 97.9)
Trim boost accumulator	6838989	Solid blue, orange stripe	20	0.062 (1 57)	0.564 (14.3)	2.77 (70.4)	1.49 (37.9)	11.6 to 12.8 (51.6 to 56.9)
Fourth clutch trimmer valve	6833940	Solid orange yellow stripe	8 7	0.121 (3.07)	0.950 (24.1)	2.38 (60.5)	1.94 (49.3)	29.0 to 35.0 (129.0 to 155.7)
2-3 relay valve	6832462	Solid red	11	0.073 (1.85)	0.690 (17 5)	2.18 (55.4)	1.20 (30.5)	16.2 to 19.8 (72.1 to 88.1)
1-2 relay valve yellow stripe	6834528	Solid blue,	11	0.073 (1.85)	0.680 (17.3)	1.52 (38.6)	1.10 (28.0)	7.2 to 8.8 (32.0 to 39.1)
Governor accumulator valve	6838988	Solid orange, blue stripe	10	0.051 (1.30)	0.564 (14.3)	1.84 (46.7)	0.70 (17.8)	9.6 to 10.6 (42.7 to 47.2)

C-7. TRANSMISSION SPRING DATA - Continued

Spring	Part No.	Color Code	Coil No.	Wire dia in. (mm)	Spring OD in. (mm)	Free Length in. (mm)	Length in. (mm)	Under Load lb. (N)
Priority valve yellow stripe	6835729	Solid white,	11	0.054 (1.37)	0 384 (9.8)	1.17 (29.7)	0.94 (23 9)	8.15 to 9.25 (36.3 to 41.2)
Hold regulator valve	6836784	Solid yellow	13	0 041 (1.04)	0.400 (10.2)	1.90 (48.3)	1.15 (29.2)	5.93 to 6.17 (26.4 to 27.5)
1-2 shift	23017049	Solid light green, purple stripe	14	0.062 (1.57)	0.640 (16.3)	2.37 (60.2)	1.15 (29 2)	11.00 to 11.50 (48 9 to 51.2)
2-3 shift valve	23012954	Solid yellow, green stripe	13	0.059 (1.50)	0.640 (16.3)	2.51 (63.8)	1.15 (29.2)	10.75 to 11.25 (14.6 to 15.3)
3-4 shift valve	23013269	Solid orange	12	0.054 (1.37)	0.640 (16 3)	2.69 (68.3)	1.15 (29 2)	8.9 to 9.6 (12 1 to 13 0)
Trimmer regulator valve	6880246 (23017751)	Solid blue	13	0.041 (1.04)	0.464 (11.8)	1.81 (46.0)	0.89 (22.6)	4.25 to 4.75 (18.9 to 21.1)
Low shift relay valve	6768544	Solid yellow, orange stripe	14.0	0.054 (1.37)	0.560 (14.2)	1.99 (50.6)	0.84 (21.3)	8.10 to 9 90 (36.0 to 44.0)
Low shift signal valve	6838285	Solid yellow, orange stripe	8.0	0.041 (1.04)	0.501 (12.7)	1.10 (27.9)	0.69 (17.5)	2.57 to 3.13 (11 4 to 13.9)
Low shift trimmer valve (primary)	23012937	Solid white	9	0.099 (2.51)	0.949 (24.1)	2.27 (57.7)	1.10 (27.9)	34 8 to 38.8 (154.8 to 172.6)
Low shift trimmer valve (secondary)	6839102	Solid white8.5	0.091	0.720 (2.31)	1 68 (18.3)	1.10 (42.7)	21.60 to 39.80 (27.9)	(145 0 to 177.0)

APPENDIX D

ILLUSTRATED LIST OF MANUFACTURED ITEMS

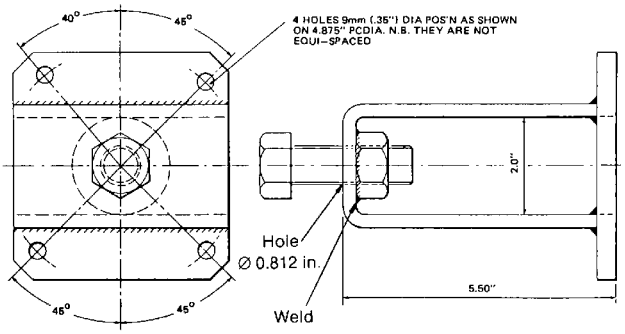
This appendix includes instructions for making items authorized to be manufactured or fabricated at direct and general support level.

All parts and bulk materials needed for manufacture on the items are listed by part number or specification number in a tabular list on the illustration.

Tool 1 Pump Puller

Material

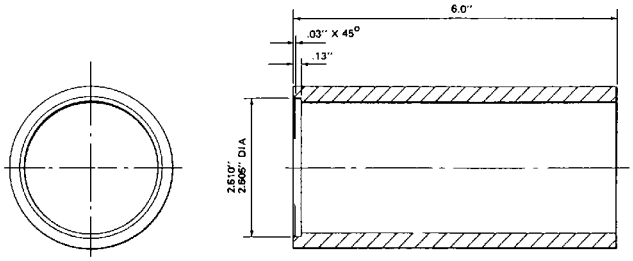
1. Mild Steel Plate 1/4 in. (ASTM A36)
2. Bolt, MS90725-187
3. Nut, MS51967-23



Tool 2, Pump Sleeve

Material

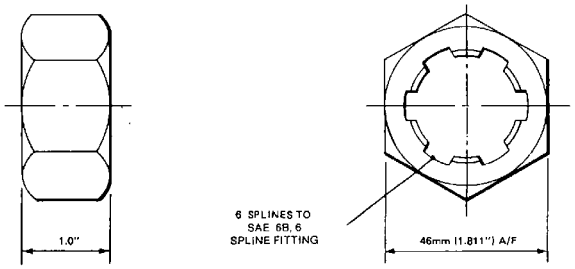
Mild Steel Tube 3 in. O.D., 2.5 in. I.D.
ASTM 120 or AS3



Tool 3 Pump Impeller Tool

Material

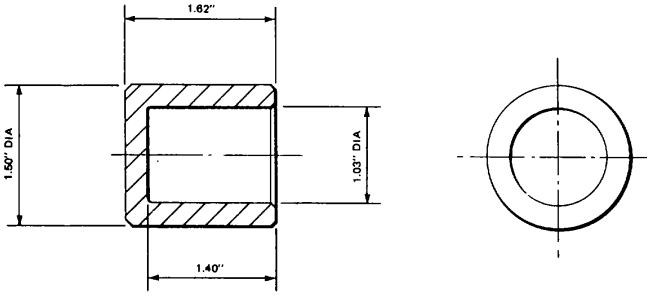
Nut 46 mm A/C, Grade 5



Tool 4 Pump Bearing Installer

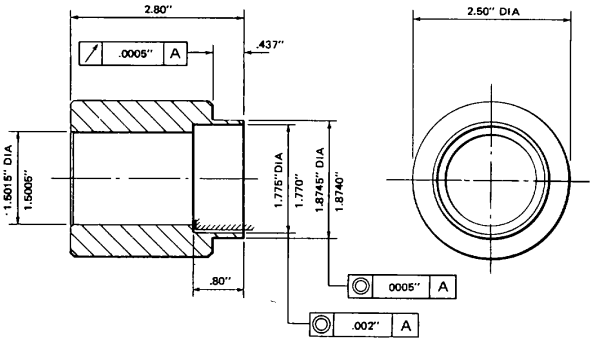
Material

Mild Steel Bar Stock (2 in)in
ASTM A36 Hot Rolled



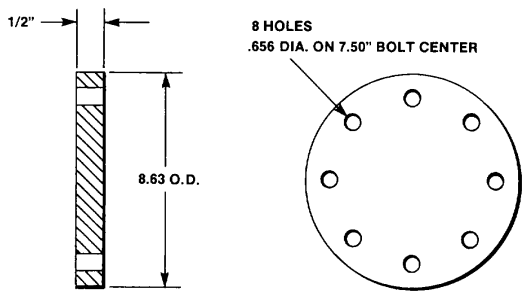
Tool 5 Pump Bearing Installer

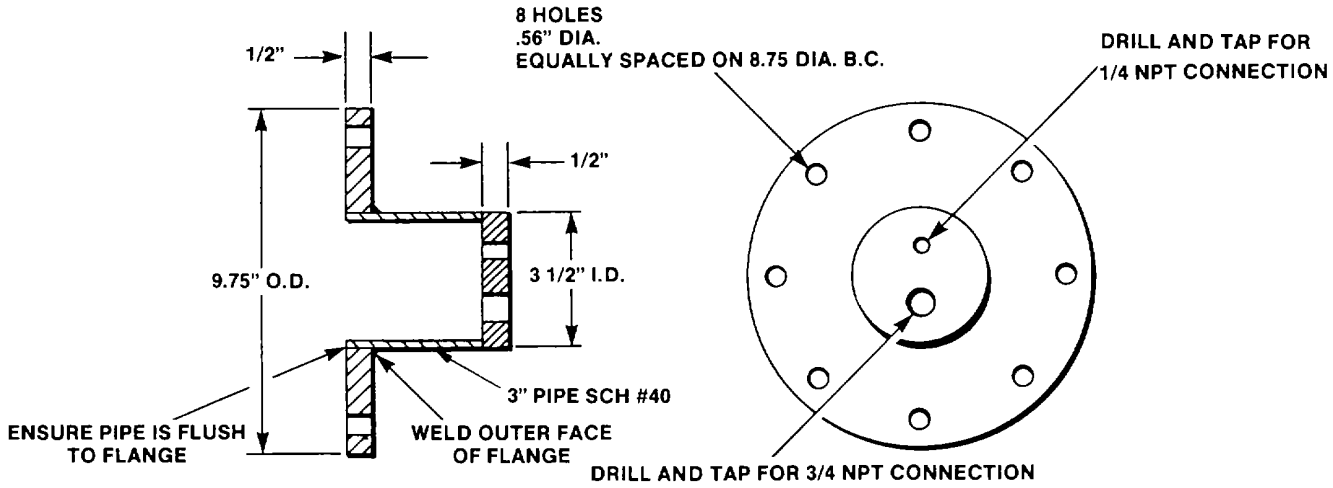
Material
Mild Steel Bar Stock (2 in. Dia.)
ASTM A36 Hot Rolled



Tool 6 Pump Discharge Plate

Material
Mild Steel Plate (1/2 in.)
ASTM A36





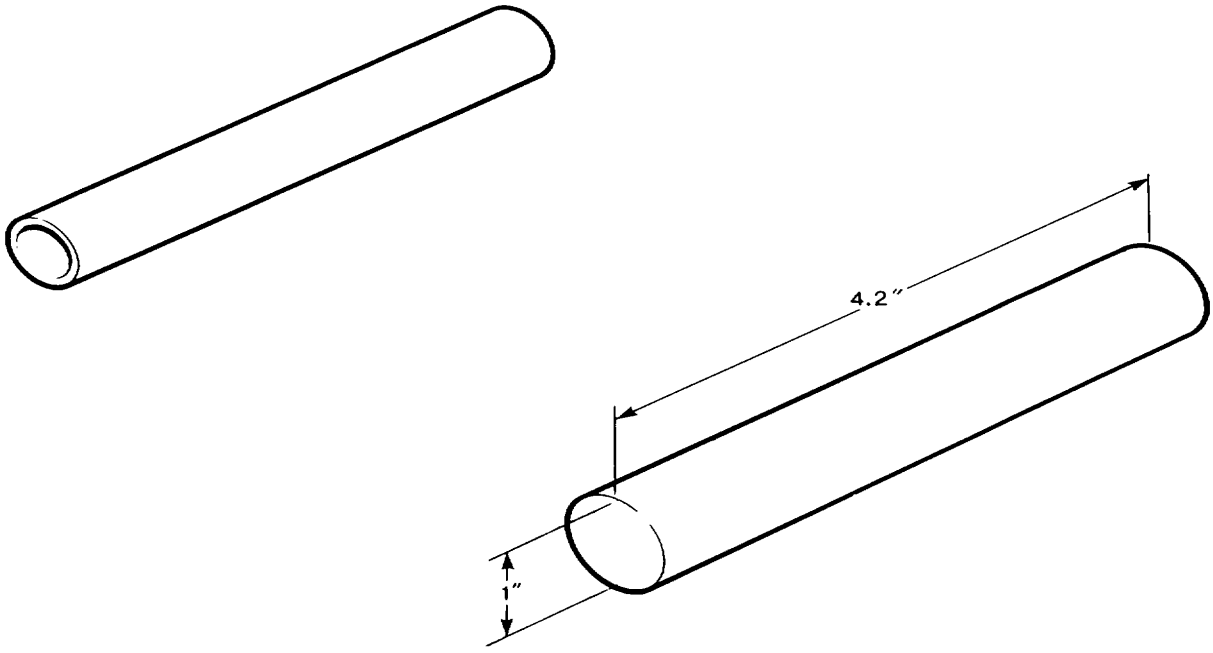
Tool 7 Pump Suction Plate

Material

1. Mild Steel Plate 1/2 in. ASTM A36
2. Pipe, Schedule 40, 3 in. ASTM 120 or A53

Tool 8 Bearing Installation Tool

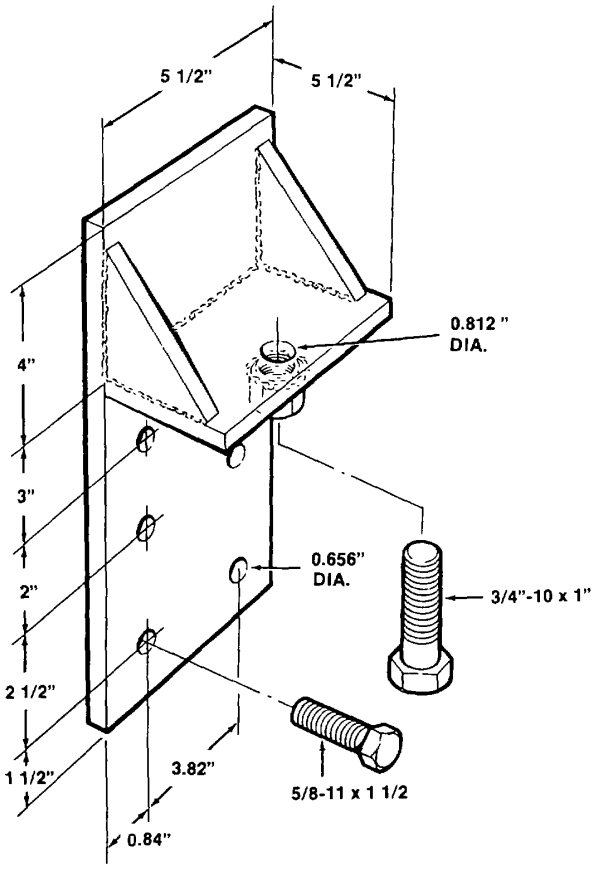
Pipe, Schedule 40, 2 in. ASTM 120 or A53



Tool 9 Dummy Shaft

Material

Mild Steel Bolt Stock (1 in. Dia.)
ASTM A36 Cold Rolled



Tool 10 Engine Support Bracket

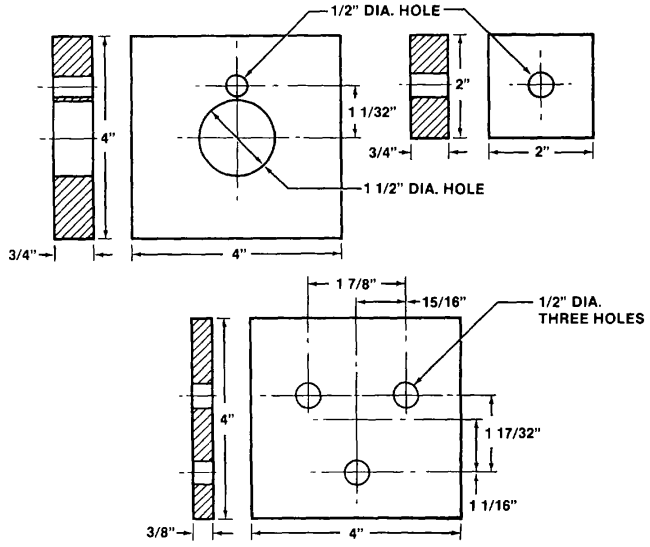
Material

1. Mild Steel Plate, ½ in., ASTM A36
2. Bolt MS90725-201 (threaded up to head)
3. Bolt MS90725-162
4. Nut MS51967-23

Tool 11 Bearing Test Fixture Plates

Material

3/4 and 3/8 in. Steel Plate, ASTM A36



ALPHABETICAL INDEX

ALPHABETICAL INDEX - Continued

ALPHABETICAL INDEX - Continued

Subject, Para.

R (Continued

S

T

V

W

By Order of the Secretary of the Army:

CARL E. VUONO
General, United Stares Army
Chief of Staff

Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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TEAR ALONG PERFORATED LINE

THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter 10 Millimeters 0 01 Meters 0 3937 Inches
1 Meter 100 Centimeters 1000 Millimeters 39 37 Inches
1 Kilometer 1000 Meters 0 621 Miles

WEIGHTS

1 Gram 0 001 Kilograms 1000 Milligrams 0 035 Ounces
1 Kilogram 1000 Grams 2 2 Lb
1 Metric Ton 1000 Kilograms 1 Megagram 1 1 Short Tons

LIQUID MEASURE

1 Milliliter 0 001 Liters 0 0338 Fluid Ounces
1 Liter 1000 Milliliters 33 82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter 100 Sq Millimeters 0 155 Sq Inches
1 Sq Meter 10,000 Sq Centimeters 10 76 Sq Feet
1 Sq Kilometer 1,000,000 Sq Meters 0 0386 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 (F 32) C
212 Fahrenheit is equivalent to 100 Celsius
90 Fahrenheit is equivalent to 32 2 Celsius
32 Fahrenheit is equivalent to 0 Celsius
9/5 C + 32 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
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0 907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubit 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