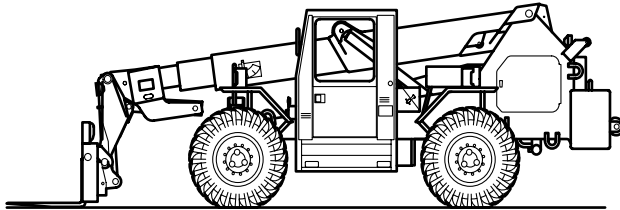


## TECHNICAL MANUAL

# DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL



## ALL TERRAIN LIFTER ARMY SYSTEM (ATLAS)

**10,000 LB CAPACITY**

**NSN 3930-01-417-2886**

Approved for public release;  
distribution is unlimited.

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**WARNING**

CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU.

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

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

- DO NOT operate personnel heater or engine of vehicle in enclosed area without adequate ventilation.
- DO NOT idle engine for long periods without ventilator blower operation. If tactical situation permits, open hatches.
- DO NOT drive any vehicle with inspection plates, cover plates, or engine compartment doors removed unless necessary for maintenance purposes.
- NEVER sleep in a vehicle when the heater is operating or the engine is idling.
- BE ALERT at all times during vehicle operation for exhaust odors and exposure symptoms. If either are present, IMMEDIATELY EVACUATE AND VENTILATE the area. Affected personnel treatment shall be: expose to fresh air; keep warm, DO NOT PERMIT PHYSICAL EXERCISE; if necessary, give artificial respiration as described in FM 4-25.11 and get medical attention.
- BE AWARE; neither the gas particulate filter unit nor field protection mask for nuclear-biological-chemical protection will protect you from carbon monoxide poisoning.

THE BEST DEFENSE AGAINST CARBON MONOXIDE POISONING IS GOOD VENTILATION.

**WARNING**

Personnel hearing can be PERMANENTLY DAMAGED if exposed to constant high noise levels of 85 dB (A) or greater. Wear approved hearing protection devices when operating or working within 61 ft (19 m) of vehicle when engine is running. Personnel exposed to high noise levels shall participate in a hearing conservation program in accordance with TB MED 501. Hearing loss occurs gradually but becomes permanent over time.

**WARNING**

Fuel is very flammable and can explode easily. To avoid serious injury or death:

- Keep fuel away from open flame or any spark (ignition source).
- Keep at least a B-C fire extinguisher within easy reach when working with fuel or on a fuel system.
- Do not work on fuel system when engine is hot; fuel can be ignited by a hot engine.
- Clean fuel tank to purge any flammable liquid or vapors before welding, grinding or using any heat producing device near the fuel tank.
- Post signs that read “NO SMOKING WITHIN 50 FEET (15 m)” when working with open fuel, fuel lines or fuel tanks.

**WARNING**

- Hydraulic oil in system can be under pressures over 3000 psi (20685 kPa) with engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in hydraulic system. With engine OFF and attachment on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.
- Boom assembly including boom extend cylinder weighs approximately 4100 lb (1859.72 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.
- BEFORE REMOVAL OF COMPLETE BOOM ASSEMBLY, REMOVE THE COUNTERWEIGHT. FAILURE TO REMOVE THE COUNTERWEIGHT WILL RESULT IN THE MACHINE BEING REAR END HEAVY AND REAR TIPPING MAY OCCUR.

**WARNING**

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

**WARNING**

- Dry cleaning solvent MIL-PRF-680 Type III is an environmentally compliant and low toxic material. However, it may be irritating to the eyes and skin. The use of protective gloves and goggles is suggested. Use in well-ventilated areas. Keep away from open flames and other sources of ignition.
- NOTE: P-D-680 Type II is no longer in use and has been replaced by MIL-PRF-680 Type III.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.
- Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.
- Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.

**WARNING**

- Always wear eye protection around refrigerant, or when servicing the air-conditioning system. Injury will result if refrigerant comes in contact with eyes.
- Exercise extreme care when handling refrigerant, direct contact between refrigerant and skin may cause frostbite.
- Never smoke in areas where refrigerant is used or stored. Injury to personnel may result.
- Ensure adequate ventilation whenever refrigerant is being discharged. Injury to personnel may result if used in a confined area.
- Personnel with a history of cardiac rhythm abnormalities should be made aware of potential aggravation as a result of exposure to refrigerant. Failure to do so may result in injury to personnel.
- Do not attempt to connect servicing equipment while engine is running. Injury to personnel or damage to equipment may result.



**DIRECT SUPPORT AND GENERAL SUPPORT  
MAINTENANCE MANUAL**

**FOR**

**ALL TERRAIN LIFTER ARMY SYSTEM (ATLAS)  
10,000 LB CAPACITY**

**(NSN 3930-01-417-2886)**

TM 10-3930-673-34, dated 4 May 1998, is changed as follows:

1. Remove old pages and insert new pages.
2. New or changed material is indicated by a vertical bar in the margin.

**Remove Pages**

*a thru c/(d blank)*

*iii thru vi*

*4-11 thru 4-20*

*5-3 and 5-4*

*6-3 and 6-4*

*7-49 thru 7-54*

*8-29 and 8-30*

*16-33 and 16-34*

*16-37 and 16-38*

*16-43 thru 16-88*

*16-99 and 16-100*

*16-107 and 16-108*

*16-111 and 16-112*

*A-1 and A-2*

*B-1 thru B-5/(B-6 blank)*

*D-3/(D-4 blank)*

*Index-1 and Index-2*

*FP-5 /FP-6 blank)*

*FP-7/(FP-8 blank)*

*Front Cover*

**Insert Pages**

*a thru c/(d blank)*

*A/B (blank)*

*iii thru vi*

*4-11 thru 4-20.1/(4-20.2 blank)*

*5-3 and 5-4*

*6-3 and 6-4*

*7-49 thru 7-53.1*

*8-29 and 8-30*

*16-33 and 16-34*

*16-37 and 16-38*

*16-43 thru 16-88*

*16-99 and 16-100*

*16-107 and 16-108*

*16-111 and 16-112*

*17-1 thru 17-12*

*A-1 and A-2*

*B-1 thru B-5/(B-6 blank)*

*D-3/(D-4 blank)*

*Index-1 and Index-2*

*FP-5 /FP-6 blank)*

*FP-7/(FP-8 blank)*

*Front Cover*


3. File this change sheet in front of the publication for reference purposes.

TM 10-3930-673-34  
C1

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER  
*General, United States Army*  
*Chief of Staff*

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## LIST OF EFFECTIVE PAGES

## NOTE

A vertical line in the outer margins of the page indicates the portion of text affected by the change.

Dates of issue for original and change pages are:

Original - 4 May 1998

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TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 74 AND TOTAL NUMBER OF CHAPTERS IS 17 CONSISTING OF THE FOLLOWING:

Page No.	Change No.	Page No.	Change No.
Cover (Back blank)	1	15-1 to 15-36	0
a	1	16-1 to 16-33	0
b	0	16-34	1
c/(d blank)	1	16-35 to 16-36	0
A/(B blank)	1	16-37 to 16-38	1
i to ii	0	16-39 to 16-42	0
iii to v	1	16-43 to 16-87	1
vi to x	0	16-88 to 16-99	0
1-1 to 1-6	0	16-100	1
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3-1 to 3-149/(3-150 blank)	0	16-107	1
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7-1 to 7-49	0	D-3/(D-4 blank)	1
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8-1 to 8-29	0	SCHMTC-1/(SCHMTC-2 blank)	0
8-30	1	Sample 2028-2	0
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9-1 to 9-41/(9-42 blank)	0	FP-1 to FP-3/(FP-4 blank)	0
10-1 to 10-17/(10-18 blank)	0	FP-5 to FP-7/(FP-8 blank)	1
11-1/(11-2 blank)	0	FP-9/(FP-10 blank)	0
12-1 to 12-16	0	Metric Conversion Chart	0
13-1 to 13-3/(13-4 blank)	0	Back Cover	0
14-1 to 14-17/(14-18 blank)	0		

\* Zero in this column indicates an original page.

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**DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL**

FOR

**ALL TERRAIN LIFTER ARMY SYSTEM (ATLAS)  
CLEAN BURN DIESEL  
10,000 LB CAPACITY  
MODEL SKYTRAK 10000M  
NSN 3930-01-417-2886**

**REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any discrepancies or know a way to improve this TM, let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications) or DA Form 2028-2 located in the back of this manual to: Commander, US Army Tank-automotive and Armaments Command, Attn: AMSTA-AC-NML, Rock Island, IL 61299-7630. A reply will be furnished to you. You can also provide DA Form 2028-2 information to TACOM via datafax or e-mail. TACOM's datafax number is: DSN 793-0726 or (309) 782-0726. E-mail address: amsta-ac-nml@ria-ehm 2.army.mil.

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## HOW TO USE THIS MANUAL

### 1. ABOUT YOUR MANUAL

Spend some time looking through this manual. You'll find that it has a new look, different than most of the TMs you've been using.

New features added to make this manual easier for you to use are:

- a. Finding Information.** These include entry features such as the thumb indexing indicators on the cover and edge of the manual. Extensive troubleshooting guides for specific systems lead directly to step-by-step directions for problem solving and maintenance tasks.
- b. Illustrations.** Many methods are used to make finding and fixing parts much easier. Locator illustrations with keyed text, exploded views, and cutaway diagrams make the information in this manual easier to understand and follow.
- c. Keying Text With Illustrations.** Instructions/text are located together with figures that illustrate the specific task you are working on. In most cases, the task steps and figures are located side by side.

This TM is organized so that information and procedures needed to perform maintenance tasks are easily located. Take a few minutes to read through this How To Use part of the manual to learn how it is put together and how to find the information you need.

### 2. BEFORE YOU START

- a.** Read and understand all warning and first aid data in the front of this manual. This data contains general shop safety practices not included in maintenance tasks.
- b.** Read Chapter 1 to learn more about the ATLAS purpose, capabilities and features.

### 3. CONTENTS OF MANUAL

- a.** This TM contains direct support and general support maintenance instructions at the intermediate level for the ATLAS. Included are principles of operation, fault isolation troubleshooting and corrective maintenance tasks as authorized by the Maintenance Allocation Chart (MAC).
- b.** This TM is made up of:
  - (1) *Chapters.* There are 17 chapters.
    - (a) Chapter 1, Introduction. This chapter contains general ATLAS information of interest to intermediate level maintenance technicians.
    - (b) Chapter 2, Maintenance Instructions. This chapter contains instructions of interest to intermediate level maintenance technicians on tools, equipment, preventive maintenance and troubleshooting.
    - (c) Chapter 3, Engine System Maintenance. This chapter contains engine maintenance divided by major systems.

## HOW TO USE THIS MANUAL (CONT)

- (d) Chapter 4, Fuel System Maintenance. This chapter contains maintenance of fuel system components.
  - (e) Chapter 5, Cooling System Maintenance. This chapter contains maintenance of cooling system components.
  - (f) Chapter 6, Electrical Systems Maintenance. This chapter contains electrical maintenance divided by major systems.
  - (g) Chapter 7, Transmission Maintenance. This chapter contains maintenance of transmission components.
  - (h) Chapter 8, Front Axle Maintenance. This chapter contains maintenance of front axle components.
  - (i) Chapter 9, Rear Axle Maintenance. This chapter contains maintenance of rear axle components.
  - (j) Chapter 10, Brake Maintenance. This chapter contains maintenance of brake components.
  - (k) Chapter 11, Wheel and Tire Maintenance. This chapter contains maintenance of wheels and tires.
  - (l) Chapter 12, Steering System Maintenance. This chapter contains maintenance of steering components.
  - (m) Chapter 13, Frame and Towing Attachment Maintenance. This chapter contains maintenance of frame and towing attachment components.
  - (n) Chapter 14, Body, Cab, and Hood Maintenance. This chapter contains maintenance of body, cab, and hood components.
  - (o) Chapter 15, Body and Chassis Accessory Items Maintenance. This chapter contains maintenance of accessory components.
  - (p) Chapter 16, Hydraulic System Maintenance. This chapter contains maintenance of hydraulic components.
  - (q) Chapter 17, Arctic Heater Kit Installation. This chapter contains step-by-step procedures for installing the arctic heater kit.
- (2) *Sections*. All chapters are further subdivided into sections. Sections allow for easier break-up of material. They are:
- (a) Chapter 1 has two sections: General Information and Equipment Description.
  - (b) Chapter 2 has three sections: Repair Parts, Special Tools, TMDE and Support Equipment; General Maintenance, and Troubleshooting.
  - (c) Chapters 3 through 16 have two sections each: Description and Data and Maintenance Procedures.
- (3) *Paragraphs*. Paragraphs make up sections. The paragraphs have the information needed to do the job properly. Each paragraph is the start of a major topic within the chapter.

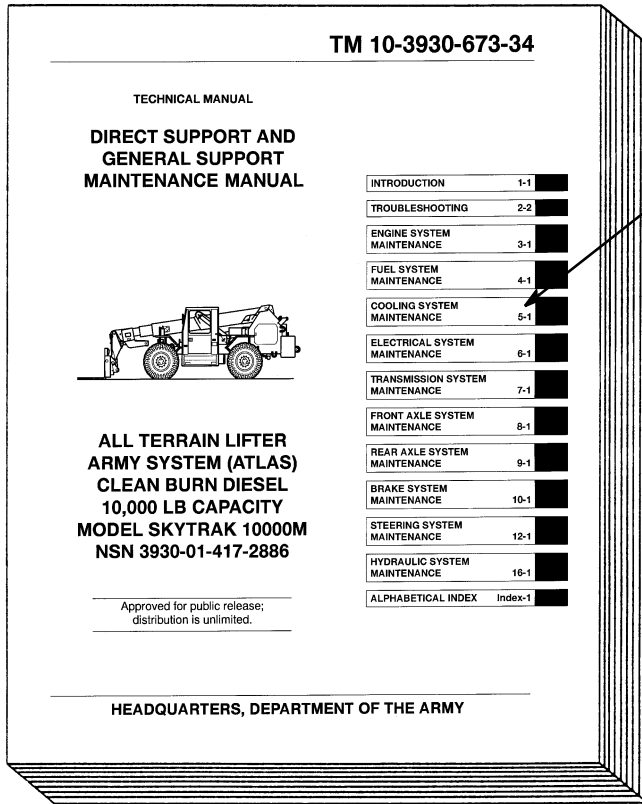
## HOW TO USE THIS MANUAL (CONT)

- (4) *Pages.* Pages are numbered consecutively within each chapter. The first part is the chapter number followed by a dash and the consecutive page number. For example, page 3 of Chapter 2 is numbered 2-3.
- (5) *Appendices.* Appendices are found in the back of the manual. They provide reference information required for maintenance.
  - (a) Appendix A, References. This appendix contains other information you may need to do your job.
  - (b) Appendix B, Expendable/Durable Supplies and Materials List. This appendix contains information on expendable/durable items you need for maintenance.
  - (c) Appendix C, Illustrated List of Manufactured Items. This appendix contains information you need to make parts that are not procured.
  - (d) Appendix D, Tool List. This appendix lists the tool kits and other tools required to perform the maintenance tasks.
- (6) *Index.* The index is located in the back of the manual. It lists topics in alphabetical order and references the paragraph numbers where information on the topic can be found.

### 4. HOW TO FIND INFORMATION QUICKLY

- a. Using the Front Cover.** The front cover of the manual has boxed titles for major topics. At the right side of each box is a blackened area. The blackened area matches black markings on the first page of that major topic in the manual. Fan the outer edge of the manual to find the topic material.
- b. Using the Table of Contents.** The table of contents lists all chapters, appendices, sections and other important information in this manual and the page number where each starts. The boxed-in items in the table of contents correspond to the items listed on the front cover.
- c. Using Chapter Indexes.** On the first page of each chapter is a numerical listing of all paragraphs in that chapter and the page number where each can be found.
- d. Using Paragraph Numbers and Titles.** Paragraph numbers include the chapter number. The paragraph number appears before the title of the paragraph title line. Paragraphs that are longer than one page will have the paragraph number and title continued at the top of each following left-hand page.

## HOW TO USE THIS MANUAL (CONT)



THIS MAJOR TOPIC STARTS ON THIS PAGE

TOOLS

EQUIPMENT CONDITION

MAJOR STEPS

WARNINGS, CAUTIONS AND NOTES

TM 10-3930-673-34

Section II. TRANSMISSION MAINTENANCE PROCEDURES

**7-3. TORQUE CONVERTER REPLACEMENT/REPAIR**

This Task Covers:

a. Removal	c. Cleaning	e. Assembly
b. Disassembly	d. Inspection	f. Installation

**INITIAL SETUP**

<p><i>Tools and Special Tools</i></p> <p>Tool Kit, General Mechanic's Automotive (Item 10, Appendix D)</p> <p>Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 5, Appendix D)</p> <p>Wrench, Torque 0 - 175 lb-ft (0 - 237 N•m) (Item 15, Appendix D)</p>	<p><i>Materials/Parts</i></p> <p>Oil, Hydraulic (Item 28, Appendix B)</p> <p>Rags, Linen-Free (Item 33, Appendix B)</p> <p>Sealing Compound (Item 36, Appendix B)</p> <p>Sealing Compound (Item 38, Appendix B)</p> <p>Lockwashers (12)</p> <p>Packing, Prefformed</p>
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*Equipment Condition:*  
Transmission output shaft removed (Para 7-6)

**a. Removal.**

- (1) Remove nut (1), washer (2), and yoke (3) from torque converter assembly (4).
- (2) Remove 12 nuts (5), starwashers (6), screws (7), and torque converter cover (8) from transmission housing (9).
- (3) Remove torque converter (4) from transmission housing (9) and place on a clean workbench with front cover facing up.

**b. Disassembly.**

- (1) Remove parts (10 through 13) from torque converter cover (8).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove snap ring (10), bearing (11), and oil seal (12) from torque converter cover (8).
- (b) Remove lubrication fitting (13) from torque converter cover (8).

MATERIALS/PARTS

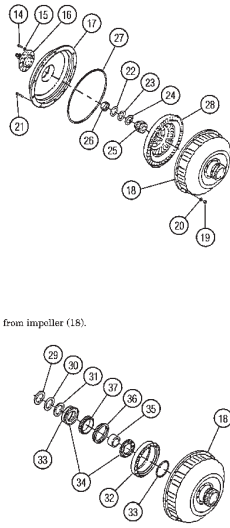
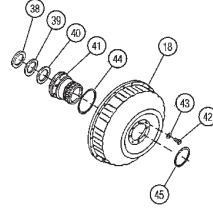
ILLUSTRATIONS

## HOW TO USE THIS MANUAL (CONT)

**CHAPTER NUMBER**

**PARAGRAPH NUMBER**

**PARAGRAPH TITLE CONTINUED**

<p>TM 10-3930-673-34</p> <p><b>7-3. TORQUE CONVERTER REPLACEMENT/REPAIR (CONT)</b></p> <p>(2) Remove parts (14 through 16), front cover (17), parts (18 through 27), and turbine (28).</p> <p>(a) Remove 12 screws (14), lockwashers (15), and converter input shaft (16) from front cover (17). Discard lockwashers.</p> <p>(b) Mark front cover (17) and impeller (18) for ease of assembly. Remove 20 nuts (19), washers (20), screws (21), and front cover from impeller.</p> <p>(c) Remove outer thrust race (22), needle thrust bearing (33), and inner thrust race (24) from turbine hub (25).</p> <p>(d) Use a suitable puller and remove bearing (26) from input shaft (16).</p> <p>(e) Remove preformed packing (27) from front cover (17). Discard preformed packing.</p> <p>(f) Remove turbine hub (25) and turbine (28) from impeller (18).</p> <p>(3) Remove parts (29, 30, and 31), stator (32), and disassemble parts (33 through 37).</p> <p>(a) Remove outer thrust washer (29), needle thrust bearing (30), inner thrust washer (31), and stator (32) from impeller (18).</p> <p><b>WARNING</b></p> <p>Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.</p> <p>(b) Remove two retaining rings (33), two clutch retainers (34), inner race (35), sprag clutch assembly (36), and outer race (37).</p> 	<p>TM 10-3930-673-34</p> <p>(4) Remove parts (38 through 40), impeller hub (41), and parts (44 and 45).</p> <p>(a) Remove outer thrust washer (38), needle thrust bearing (39), and inner thrust washer (40) from impeller hub (41).</p> <p>(b) Remove eight screws (42), washers (43), and impeller hub (41) from impeller (18).</p> <p>(c) Remove preformed packing (44) and seal ring (45). Discard preformed packing.</p> <p><b>c. Cleaning.</b> See Cleaning Instructions (Para 2-10).</p> <p><b>d. Inspection.</b> See Inspection Instructions (Para 2-11).</p> <p><b>e. Assembly.</b></p> <p><b>NOTE</b></p> <p>Wipe all sealing surfaces clean and dry. Apply a thin film of clean hydraulic oil to all seals and bearings as they are installed.</p> <p>(1) Install parts (44 and 45), impeller hub (41), and parts (38 through 40).</p> <p>(a) Install preformed packing (44) at base of impeller hub (41).</p> <p>(b) Install seal ring (45) on impeller hub (41).</p> <p>(c) Install impeller hub (41), eight screws (42), and washers (43) on impeller (18). Tighten screws to 25 lb-ft (33.9 N•m).</p> <p>(d) Install inner thrust washer (40), needle thrust bearing (39), and outer thrust washer (38) on impeller hub (41).</p> 
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**PAGE NUMBER**

### 5. HOW TO USE THE TROUBLESHOOTING CHARTS

Troubleshooting is divided into mechanical, hydraulic, and brake sections. An overall fault index is located at the beginning of the troubleshooting procedures and individual indexes are located at the beginning of each troubleshooting part. The fault index lists common problems that you may have with the ATLAS and the page number where each can be found.

Troubleshooting procedures are divided into logic tree pages and test pages. A logic tree page is always a left-hand page facing the test page on the right. The logic tree page provides the sequence of steps required to isolate a fault to a failed component. All critical information for decision making is on the left-hand page.

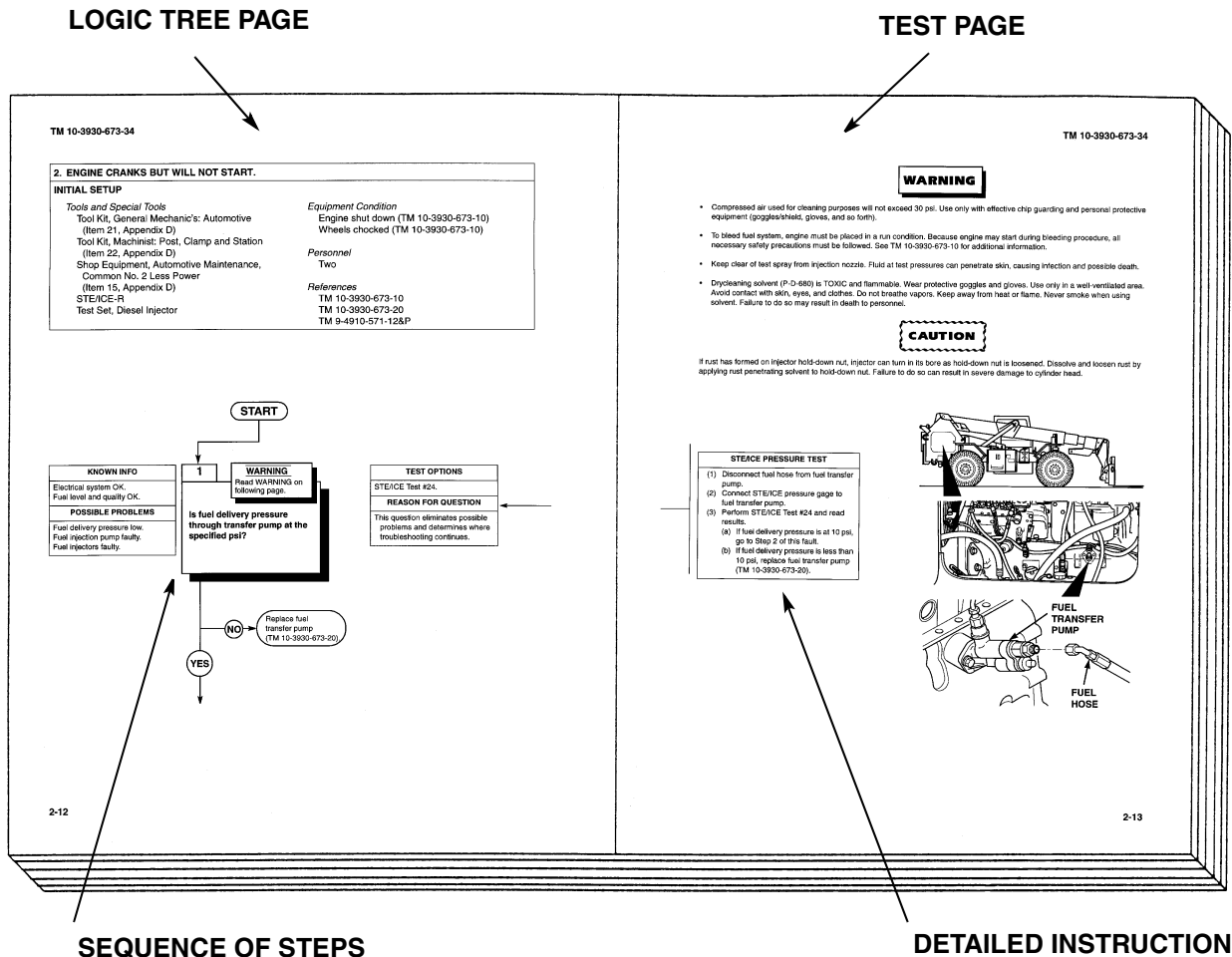
A test page is always a right-hand page facing the logic tree page on the left. The test provides detailed instructions for testing the first component listed in the POSSIBLE PROBLEMS box. This test will also provide an answer for the question in the middle column. Note the arrow connecting the test on the right-hand page to the REASON FOR QUESTION. When possible, illustrations are included to provide visual details. Warnings, cautions, and notes contain additional information for testing.

Please refer to Introduction to Logic Tree Troubleshooting (Para 2-6) for additional troubleshooting instructions.

### 6. HOW TO USE A PROCEDURE



## HOW TO USE THIS MANUAL (CONT)



Each procedure consists of two parts, an initial setup and a task section. You must familiarize yourself with the entire maintenance procedure before beginning the maintenance task.

The initial setup table contains all or some of the following headings:

- *Tools and Special Tools* - Describes tools needed to perform the procedure.
- *Test Equipment* - Describes test equipment needed to perform the procedure.
- *Equipment Condition* - Refers to other procedures that must be performed before attempting the procedure.
- *Materials/Parts* - Describes miscellaneous materials and parts needed to perform the procedure.
- *Personnel Required* - Describes quantity of personnel needed to perform the procedure.
- *References* - Lists manuals that may be needed to perform the procedures.

### 7. HOW TO FIND CRITICAL INFORMATION

## HOW TO USE THIS MANUAL (CONT)

Critical information in maintenance chapters has been highlighted for experienced technicians so that they may scan a task quickly and pick out the information needed without reading the entire task. This way, the level of detail needed by low-experienced technicians will not interfere with critical information.

Information of interest to experienced users is highlighted with bold letters. More detailed information is shown with roman letters.

# CHAPTER 1

## INTRODUCTION

Para	Contents	Page
Section I. General Information		
1-1.	Scope .....	1-1
1-2.	Maintenance Forms and Records .....	1-1
1-3.	Official Nomenclature, Names, and Designations .....	1-2
1-4.	Reporting Equipment Improvement Recommendations (EIR'S) .....	1-2
1-5.	Equipment Improvement Report and Maintenance Digest (EIR MD) .....	1-2
Section II. Equipment Description and Data		
1-6.	Location and Description of Major Components .....	1-3
1-7.	Equipment Data .....	1-5
1-8.	Safety, Care, and Handling .....	1-6

### Section I. GENERAL INFORMATION

**1-1. SCOPE**

**a. Type of Manual.** This manual contains Direct Support (DS) and General Support (GS) maintenance instructions for the ATLAS.

**b. Model Numbers and Equipment Name.** The ATLAS (All Terrain Lifter Army System) Forklift Truck Skytrak 10000M NSN 3930-01-417-2886 is equipped with a 6,000 lb and a 10,000 lb lifting tool. The vehicle is manufactured by TRAK International, Inc.

**c. Purpose of Equipment.** The ATLAS is designed for loading and unloading munitions and other palletized items from transport vehicles and containers. The ATLAS is also designed for use as a standard rough terrain forklift.

**d. Special Limitations on Equipment.** The ATLAS has no special limitations. Normal limitations such as travel speed, lift capacity, etc., are given in (Para 1-7).

**1-2. MAINTENANCE FORMS AND RECORDS**

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. OFFICIAL NOMENCLATURE, NAMES, AND DESIGNATIONS**

Refer to the nomenclature cross-reference list below. This listing gives nomenclature cross-references used in this manual. The common name is in the left column and the official name is in the right.

<u>Common Name</u>	<u>Official Nomenclature</u>
ATLAS	All Terrain Lifter Army System

### **1-4. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S)**

If your ATLAS 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: Commander, U.S. Army Tank-Automotive Command, Attn: AMSTA-TR-E/MPA, Warren, MI 48397-5000. We'll send you a reply.

### **1-5. EQUIPMENT IMPROVEMENT REPORT AND MAINTENANCE DIGEST (EIR MD)**

The quarterly Equipment Improvement Report and Maintenance Digest, TB 43-0001-39 series, contains valuable field information on the equipment covered in this manual.

The information in the TB 43-0001-39 series is compiled from some of the Equipment Improvement Recommendations that you prepared on the vehicles covered in this manual. Many of these articles result from comments, suggestions, and improvement recommendations that you submitted to the EIR program. The TB 43-0001-39 series contains information on equipment improvements, minor alterations, proposed Modification Work Orders (MWOs) warranties (if applicable), actions taken on some of your DA Forms 2028-2 (Recommended Changes to Publications), and advance information will help you in doing your job better and will help in keeping you advised of the latest changes to this manual. Also refer to DA Pam 310-1 Consolidated Index of Army Publications and Blank Forms, and Appendix A, References, of this manual.

## Section II. EQUIPMENT DESCRIPTION AND DATA

### 1-6. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS

#### a. Right Side View of the ATLAS.

**RADIATOR.** Contains coolant which provides engine cooling.

**BOOM HOIST CYLINDER.** Raises and lowers the boom.

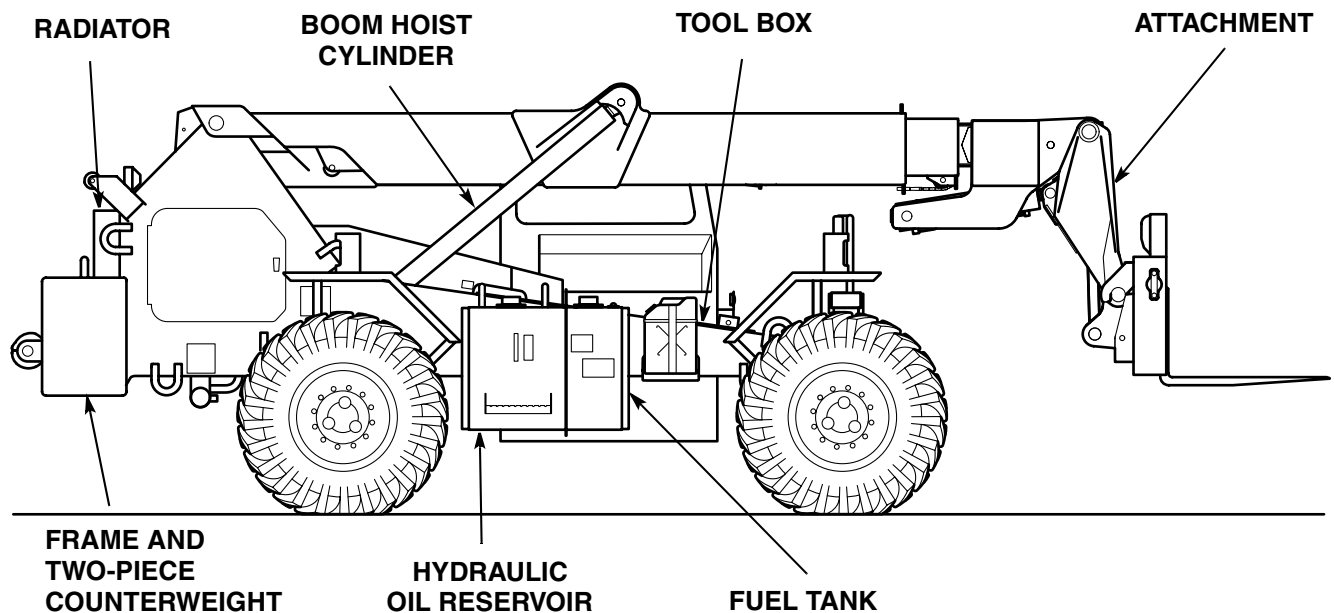
**ATTACHMENT.** The attachment is required for all forklift operations. The attachment can be raised to a nearly horizontal position, creating a low profile and extended reach configuration. This configuration is useful in loading and unloading munitions from transport vehicles and containers.

**FUEL TANK.** Contains diesel fuel or JP-8 for engine operation.

**HYDRAULIC OIL RESERVOIR.** Contains hydraulic fluid for the hydraulic system.

**FRAME AND TWO-PIECE COUNTERWEIGHT.** The frame is a heavy-duty design constructed of 1-3/16 in. thick steel plates. The frame is equipped with tie-down lugs meeting air transport specifications, tow lugs, a pintle hook, and a 5,800 lb three-piece counterweight. The counterweight is self removable so that axle loading can be adjusted to meet air transport requirements for some aircraft.

**TOOL BOX.** Storage area for tools and basic issue items.



**1-6. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS (CONT)**

**b. Left Side View of the ATLAS.**

**FORKS AND CARRIAGE.** Serves as an anchoring point of the forks. The fork carriage is also equipped with automatic fork leveling. Moving a switch will keep the forks level when raising or lowering the boom. ATLAS 6K carriage has a hinged backrest. Remove the pins to tip it to the low profile position.

**BOOM.** The telescopic, three stage boom is constructed of welded high strength steel. The boom will retract or extend the reach and height of the forks.

**BOOM ANGLE INDICATOR.** Shows the angle of the boom relative to the horizon.

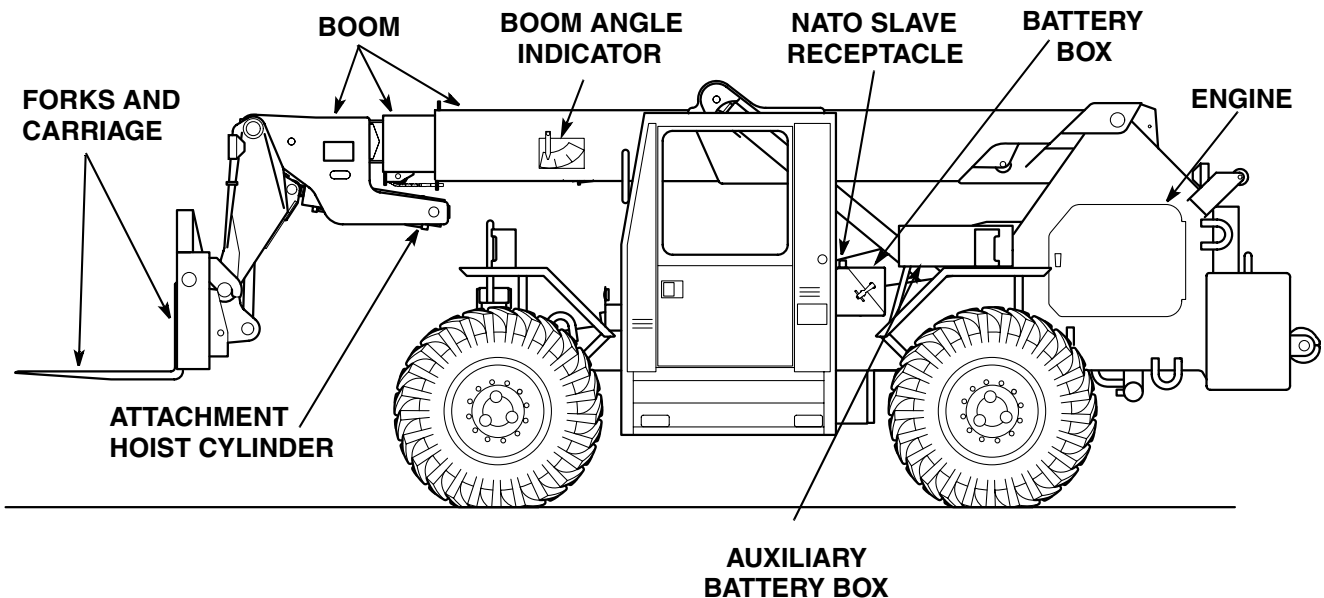
**NATO SLAVE RECEPTACLE.** Connection point for starting a disabled vehicle or for receiving starting assistance when disabled.

**BATTERY BOX.** Holds the batteries which provide current for the electric system.

**AUXILIARY BATTERY BOX.** Holds the batteries which provide auxiliary current for the arctic heater. Not present on all vehicles.

**ENGINE.** Provides the necessary power to drive the transmission. The engine also contains sending units for the Simplified Test Equipment for Internal Combustion Engines (STE/ICE) diagnostics.

**ATTACHMENT HOIST CYLINDER.** Moves the attachment forward and back.



**1-7. EQUIPMENT DATA**

*Table 1-1. Equipment Data*

*ENGINE:*

Model .....	6BT5.9-C165
Manufacturer .....	Cummins
Horsepower (2,500 RPM) .....	165 hp
Number of Cylinders .....	6
Displacement .....	359 cu. in.
Weight .....	930 lb
Maximum No Load RPM .....	2650 to 2750 RPM

*TRANSMISSION:*

Model .....	1723
Manufacturer .....	Funk
Powershift .....	3 speed forward and reverse
Speed Range	
First Gear .....	0-4 mph, level surface
Second Gear .....	0-8 mph, level surface
Third Gear .....	0-23 mph, level surface
Weight .....	846 lb

*AXLE AND BRAKES:*

Model (Front) .....	PSOC-205-HDB-331
Model (Rear) .....	PSOC-205-HDB-332
Manufacturer .....	Rockwell
Weight - Axle Assembly (Front or Rear) .....	1,650 lb

*DIMENSIONS AND WEIGHT:*

<i>Vehicle Operational Weights:</i>	
With 6K carriage .....	31,300 lb
With 10K carriage .....	32,600 lb
Roading (both carriages) .....	33,500 lb
Boom Assembly Weight .....	5,165 lb
Inner Boom Weight .....	1,280 lb
Intermediate Boom Weight .....	955 lb
Outer Boom Weight .....	1,950 lb
Boom Extend Cylinder .....	600 lb
<i>Max Length in Carry Position:</i>	
With 6K carriage .....	324.2 in.
With 10K carriage .....	356.3 in.
Roading: .....	356.3 in.
Width .....	100.2 in.
Max Height .....	107 in.
Track Width (Tread) .....	80.3 in.

**1-7. EQUIPMENT DATA (CONT)**

*Table 1-1 Equipment Data (Cont)*

*CAPACITIES:*

Fuel Tank .....	44 gal
Cooling System .....	8 gal
Hydraulic Oil Reservoir .....	56.6 gal
Hydraulic System .....	75 gal
Engine Crankcase .....	15 qt
Engine Crankcase w/filter cap .....	15.3 qt
Transmission .....	5.5 gal
Transmission w/filter cap .....	5.75 gal

*MISCELLANEOUS:*

Max lift height with 6K carriage:	
6,000 lb (max height) .....	27 ft, 11.5 in.
Max lift height with 10K carriage:	
6,000 lb (max height) .....	27 ft, 8 in.
8,000 lb .....	24 ft, 9.5 in.
10,000 lb .....	16 ft, 11 in.
Boom Lift Angle (Maximum) .....	45 degrees
Max reach from load center to front tires with 6K carriage	
(4,000 lb @ 2 ft load center) .....	24 ft, 3.5 in.
Max reach from load center to front tires with 10K carriage	
(2,000 lb @ 4 ft load center) .....	26 ft, 4 in.
Max reach below grade with 6K carriage .....	33.3 in.
Max reach below grade with 10K carriage .....	36.8 in.
Ground Clearance .....	15.2 in. min.
Curb to Curb Turning Circle (Diameter) .....	27 ft, 10 in.
Frame Oscillation .....	9 degrees to the left or right
Fording Depth (Freshwater) .....	3 ft
Travel Speed (Maximum) .....	23 mph

**1-8. SAFETY, CARE, AND HANDLING**

Correct servicing procedures must be followed to ensure the safety of technicians working on the ATLAS. Refer to the warning pages of this manual (page a) for a list of safety precautions.



## CHAPTER 2

### DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Para	Contents	Page
Section I. Repair Parts, Special Tools, TMDE, and Support Equipment		
2-1.	Common Tools and Equipment . . . . .	2-1
2-2.	Special Tools, TMDE, and Support Equipment. . . . .	2-1
2-3.	Repair Parts. . . . .	2-1
Section II. Troubleshooting		
2-4.	General . . . . .	2-2
2-5.	Troubleshooting Procedures . . . . .	2-2
2-6.	Introduction to Logic Tree Troubleshooting . . . . .	2-2
2-7.	General Troubleshooting Instructions. . . . .	2-4
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2-9.	Scope . . . . .	2-66
2-10.	Work Safety . . . . .	2-66
2-11.	General Information . . . . .	2-66
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2-16.	Painting Instructions . . . . .	2-75

#### 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.

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

For authorized special tools, TMDE, and support equipment refer to the RPSTL and maintenance allocation chart (TM 10-3930-673-20) pertaining to direct and general support maintenance for this equipment.

#### 2-3. REPAIR PARTS

Repair parts are listed and illustrated in the repair parts and special tools list (RPSTL) TM 10-3930-673-24P covering unit, direct, and general support maintenance for this equipment.

## Section II. TROUBLESHOOTING

### 2-4. GENERAL

The Troubleshooting Fault Index (Table 2-1) lists the most common failures experienced during operation of the forklift. Find the symptom that is closest to the symptom your forklift has and refer to that step for the troubleshooting procedures. This manual cannot list all malfunctions that may occur, nor can it list all tests, inspections, and corrective actions. Obvious mechanical failures and damage are not covered. If a malfunction is not listed or is not corrected by the corrective actions described, notify your supervisor. Additional troubleshooting procedures are detailed in TM 10-3930-673-20-1.

### 2-5. TROUBLESHOOTING PROCEDURES

Paragraph 2-8 details common malfunctions which may occur during the operation of the ATLAS. This section includes troubleshooting procedures for the engine, drivetrain, steering, brakes, and hydraulics. Table 2-1 lists the symptoms covered.

### 2-6. INTRODUCTION TO LOGIC TREE TROUBLESHOOTING

**a. Page Layout.** Troubleshooting procedures are divided into logic tree pages and test pages.

(1) A logic tree page is always a left-hand page, facing the test page on the right. The logic tree page provides the sequence of steps required to isolate a fault to a failed component. All critical information for decision making is on the left-hand page. Each logic tree page contains the following information:

(a) **INITIAL SETUP** – This box is located only on the first logic tree page of a fault. INITIAL SETUP lists tools, materials, references, personnel, and equipment needed to troubleshoot the fault.

(b) **KNOWN INFO** – This box is located in the top left-hand column. KNOWN INFO lists conditions and information that will eliminate specific components as the cause of the fault.

(c) **POSSIBLE PROBLEMS** – This box is located directly below KNOWN INFO. All of the system components that could cause a fault are listed in the POSSIBLE PROBLEMS box. The first component listed in the POSSIBLE PROBLEMS box is the one that will be tested at that step in the logic sequence. When one of the components is tested and found to be operational, it is entered at the bottom of the KNOWN INFO box as OK.

(d) **QUESTION** – Each question, located in the middle column, refers to the first possible problem listed in POSSIBLE PROBLEMS. If the answer to the question is YES, proceed to the next step. If the answer is NO, follow the NO arrow to obtain directions for correcting the problem. If the step contains a WARNING or CAUTION message, a small shadow box is printed above the question. Text for WARNINGS and CAUTIONS is on the following right-hand page.

(e) **TEST OPTIONS** – This box is located directly below TEST OPTIONS. It explains the purpose for the question in the middle column.

(f) **REASON FOR QUESTION** – This box is located directly below TEST OPTIONS. It explains the purpose for the question in the middle column.

(2) A test page is always a right-hand page, facing the logic tree page on the left. The test provides detailed instructions for testing the first component listed in the POSSIBLE PROBLEMS box. This test will also provide an answer for the question in the middle column. Note the arrow connecting the test on the right-hand page to the REASON FOR QUESTION. When possible, illustrations are included to provide visual details. Warnings, cautions, and notes contain additional information for testing.

***b. How to Begin Troubleshooting.***

(1) Determine the symptom or condition that indicates a problem or failure. Troubleshooting is divided into symptoms peculiar to a system or a component, for example: hydraulic system or engine. Refer to the Troubleshooting Index (Table 2-1).

(2) Go to the referenced page to begin troubleshooting. Open the manual flat so both the left-hand and right-hand pages are displayed before you. The information on both pages is important to resolve the problem or failure. However, the experienced technician can follow the left-hand page instructions and refer to the right-hand page when necessary.

(3) Follow the diagnostic procedure. Answer question No. 1 on the left-hand page and follow the YES or NO path to either the remedy or the next question. If necessary, look on the right-hand page for test instructions and illustrations.

(4) Observe warnings, cautions and notes. The formatting symbols used in this manual for warnings, cautions, and notes are as follows:

**WARNING**

This is the symbol for a warning statement. If you see the word WARNING above a question on the left-hand page, look on the right hand page for the test of the message. WARNINGS describe a situation which could cause severe injury or death to personnel.

**CAUTION**

This is the symbol for a caution statement. If you see the word CAUTION above a question on the left-hand page, look on the right-hand page for the text of the message. CAUTIONS describe a situation which could cause damage to equipment.

**NOTE**

This is the symbol for a note. Notes are located directly above the test to which they refer. Notes provide additional information for performing a test.

(5) Before taking any action to diagnose a malfunction, follow the guidelines below:

(a) Question the vehicle operator to obtain any information that might help you determine the cause of the problem.

(b) Use all your senses (especially your common sense) to observe and locate troubles.

(c) Never overlook the possibility that the problem could be of simple origin - you may be able to fix it with minor adjustments.

## 2-6. INTRODUCTION TO LOGIC TREE TROUBLESHOOTING (CONT)

(d) Isolate the system where the malfunction occurs, then locate the defective component within the system.

(e) Use the test instruments specified to help you isolate the problem.

## 2-7. GENERAL TROUBLESHOOTING INSTRUCTIONS

### NOTE

The troubleshooting makes use of the Simplified Test Equipment for Internal Combustion Engines-Reprogrammable (STE/ICE-R) and conventional methods for testing and fault isolation.

**a. Simplified Test Equipment for Internal Combustion Engines - Reprogrammable (STE/ICE-R).** STE/ICE-R tests are incorporated into the standard troubleshooting test to aid in fault isolation. The STE/ICE-R acts as a conventional digital multimeter to measure voltage, current, and resistance. It can also measure pressure, speed, compression unbalance, engine power, and some specialized battery and starter evaluations. The STE/ICE-R is powered by the forklift battery. The complete system includes a test meter (VTM), cables, transit case, and technical publications. The STE/ICE-R can make TK mode measurements while connected to the batteries. STE/ICE-R tests are referenced.

**b. General Electrical Troubleshooting Procedures.**

### WARNING

Remove rings, bracelets, wristwatches, neck chains, etc., before working on any vehicle. Jewelry can catch on equipment and cause injury, or may short across an electrical circuit and cause severe burns or electrical shock.

### CAUTION

Use proper sized test leads when checking for resistance, continuity, or voltage at connectors or damage to equipment can result.

### NOTE

- The piece of electrical test equipment used will be referred to as the “multimeter.” The multimeter's red test lead will be referred to as the “positive (+) multimeter lead.” The multimeter's black test lead will be referred to as the “negative (–) multimeter lead.”
- If your multimeter does not operate in the way described in the following steps, learn how it operates before performing troubleshooting.
- Multimeter leads must remain in contact with the circuit being tested for a minimum of three seconds to obtain a reading.

(1) Resistance and Continuity Measurements.

(a) Connect positive (+) multimeter lead to multimeter VOLT-OHM connector. Connect negative (–) multimeter lead to multimeter COM connector. When the multimeter leads are separated or are measuring a circuit with no continuity, the multimeter will indicate “OL” (Over Limit) on its display. When multimeter leads are connected together, multimeter should display “0,” indicating a continuous circuit with no (zero) resistance.

(b) Set multimeter function/range switch to the desired OHM position. If the amount of the expected resistance is not known, set the switch to the highest range, then reduce until a satisfactory reading is obtained. If only continuity is to be checked, without regard to resistance, set the multimeter function/range switch to the highest ohm range.

(c) Always turn the main power switch to the OFF position before connecting multimeter leads to a circuit unless instructed to do otherwise in the troubleshooting procedure.

(d) Connect multimeter leads to the circuit being checked. The multimeter leads must only contact the point of measurement to ensure an accurate reading.

(e) Read the resistance value displayed on the multimeter.

(f) Disconnect multimeter leads from circuit.

(g) Turn off multimeter.

(2) Voltage Measurements. The forklift is equipped with a 24-volt electrical system. Troubleshooting procedures will reference 24 vdc measurements; however, these values can vary depending on battery conditions and if the engine is running or not. If battery voltages are below 12 vdc, charge batteries.

(a) Connect positive (+) multimeter lead to multimeter VOLT-OHM connector. Connect negative (–) multimeter lead to multimeter COM connector.

(b) Set the function/range switch to the setting closest to, but not below, 24 vdc. If multimeter is equipped with a DC-AC switch, set the switch to the DC position.

(c) Always turn the main power switch to the OFF position before connecting multimeter leads to a circuit unless instructed to do otherwise in the troubleshooting procedure 15.

(d) Connect the positive (+) multimeter lead to the circuit being tested. Connect the negative (–) multimeter lead to a known good ground.

(e) Set main power switch to ON position and operate any other controls necessary to energize the circuit being tested.

(f) Read the voltage value displayed on the multimeter.

(g) Set the main power switch to the OFF position. Return other controls to their “at rest” positions.

(h) Disconnect multimeter leads from circuit.

(i) Turn off multimeter.

## 2-7. GENERAL TROUBLESHOOTING INSTRUCTIONS (CONT)

(3) General Relay Troubleshooting Procedure. The following general relay troubleshooting procedure applies to most relays that are pushed into a receptacle and do not require any attaching hardware.

(a) Pull relay out of receptacle just enough for the relay terminals to make contact with receptacle terminals. Leave about 1/4 - 3/8 in. (6.35 - 9.53 mm) space between the relay and the receptacle to insert a multimeter lead and make contact with the terminal listed in the troubleshooting test.

(b) Perform necessary test.

(4) General Wiring Harness Short Test. The following procedure applies to any wiring harness suspected of being shorted. Refer to electrical schematics during this procedure.

(a) Connect positive (+) multimeter lead to multimeter VOLT-OHM connector. Connect negative (-) multimeter lead to multimeter COM connector. When the multimeter leads are separated or are measuring a circuit with no continuity, the multimeter will indicate "OL" (Over Limit) on its display. When multimeter leads are connected together, multimeter should display "0," indicating a continuous circuit with no (zero) resistance. Wires in a harness that are not purposely joined or connected at a component should not have continuity (multimeter indicates "OL").

(b) Set multimeter function/range switch to the highest OHM range.

(c) Disconnect harness connector.

(d) Connect positive (+) multimeter lead to harness connector terminal of suspected wire.

(e) Connect negative (-) multimeter lead to each of the remaining harness connector terminals. If multimeter does not display "OL," and is displaying a resistance value of zero or higher, this indicates a continuous circuit. Refer to the electrical schematic before repairing wires or replacing wiring harness to determine that the wires making a continuous circuit are not purposely joined or are not connected intentionally at a component.

(f) Disconnect multimeter leads from connector.

(g) Turn off multimeter.

### ***c. Abbreviations and Commonly Used Terms.***

gpm = gallons per minute  
lbs-ft = foot pounds (torque)  
psi = pounds per square inch  
vdc = volts direct current

## 2-8. TROUBLESHOOTING

This paragraph covers troubleshooting. Table 2-1 lists faults for the ATLAS. Refer to schematics when performing test and corrective actions.

**Table 2-1. Troubleshooting Fault Index**

<b>Fault No.</b>	<b>Description</b>	<b>Page No.</b>
1	Engine will not crank . . . . .	2-8
2	Engine cranks but will not start . . . . .	2-12
3	Engine oil pressure below normal . . . . .	2-18
4	Engine coolant temperature above normal . . . . .	2-24
5	Low transmission oil pressure from torque converter . . . . .	2-30
6	Steering difficult, front differential binds . . . . .	2-34
7	Excessive driveline noise . . . . .	2-40
8	Premature wear/failure of front differential components . . . . .	2-46
9	Emergency steering pump runs but does not develop pressure or flow . . . . .	2-52
10	Brake accumulator does not charge, charges frequently . . . . .	2-54
11	Leaks between attachment/main control valve sections . . . . .	2-58
12	Plungers stick in attachment/main control valves . . . . .	2-60

**1. ENGINE WILL NOT CRANK.**

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Forklift Truck, 2000 lb capacity
- Lifting Chain, 2000 lb capacity
- Nylon Straps, 200 lb capacity
- Lifting Device, 200 lb capacity
- Engine Stand

*Equipment Condition*

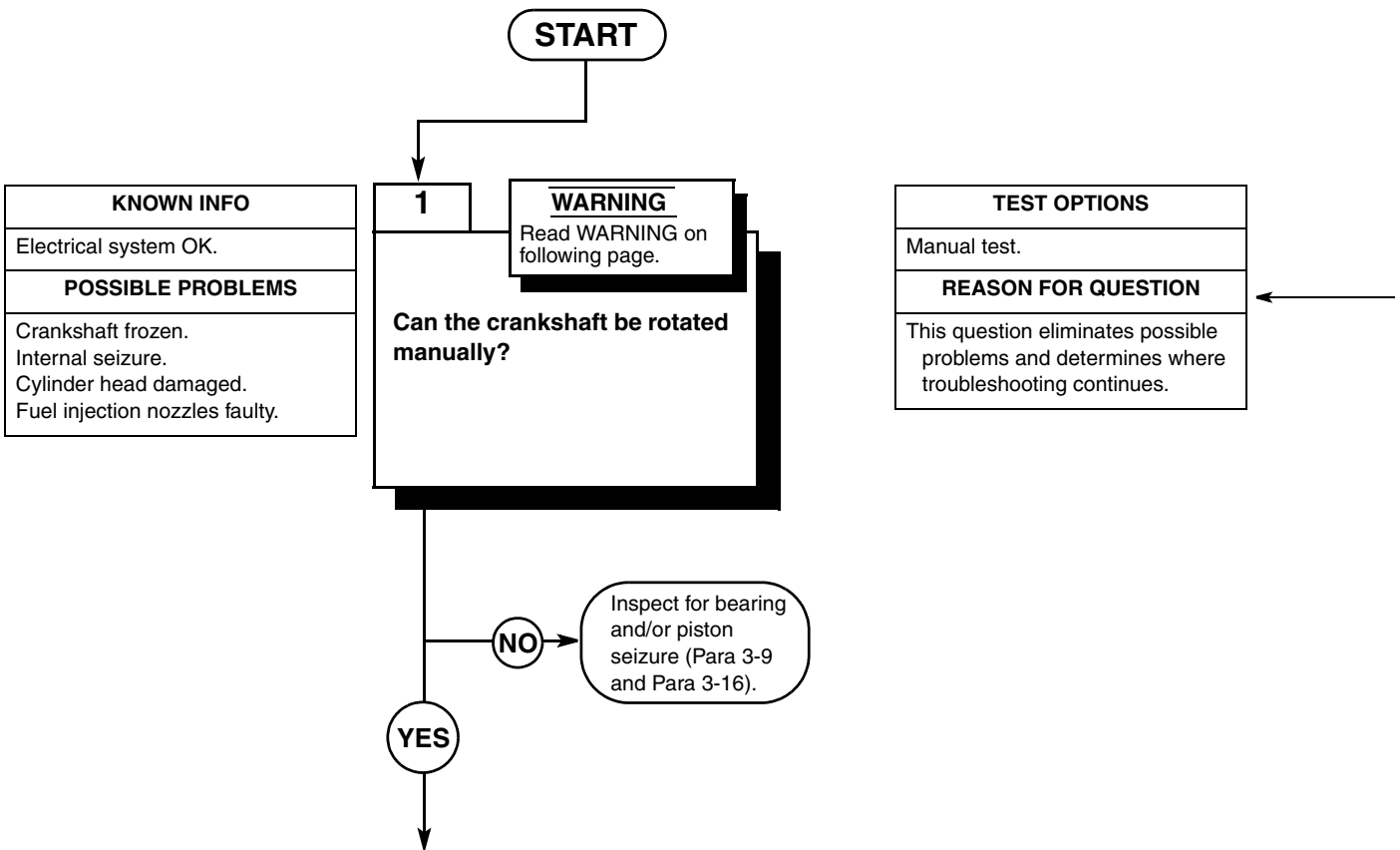
- Engine shut down (TM 10-3930-673-10)
- Wheels chocked (TM 10-3930-673-10)

*Personnel*

Two

*References*

- TM 10-3930-673-10
- TM 10-3930-673-20





**WARNING**

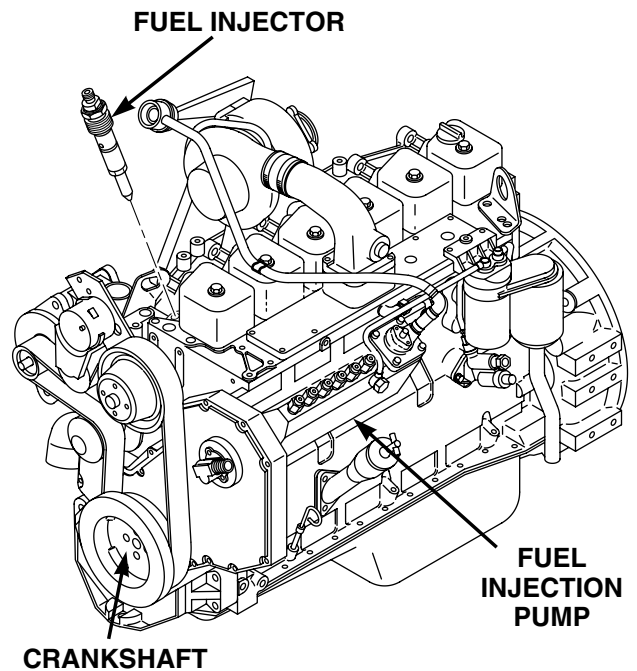
- When engine is removed, be sure engine is securely attached to engine stand. If engine falls from the stand, serious bodily injury could occur, and the block and crankshaft could be damaged.
- Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released, and could cause severe eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Keep clear of test spray from injection nozzle. Fluid at test pressures can penetrate skin, causing infection and possible death.

**CAUTION**

- If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and crankshaft.
- Be careful not to scratch or damage crankshaft when removing connecting rod caps and upper half of bearings. Any damage to the crankshaft could result in premature engine failure.

**MANUAL TEST**

- (1) Disconnect fuel supply lines from injectors and remove fuel injection nozzles (Para 4-3).
- (2) Attempt to rotate crankshaft manually (Para 3-8).
  - (a) If crankshaft can be rotated manually, go to Step 2 of this fault.
  - (b) If crankshaft cannot be rotated manually, remove engine from vehicle (Para 3-3), and inspect bearings for bearing seizure (Para 3-9) and/or pistons for piston seizure (Para 3-16). Replace components as necessary.

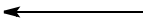
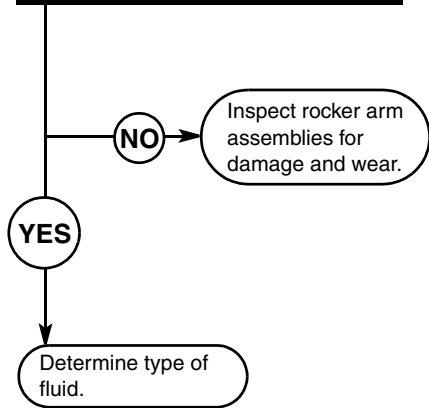


1. ENGINE WILL NOT CRANK (CONT).

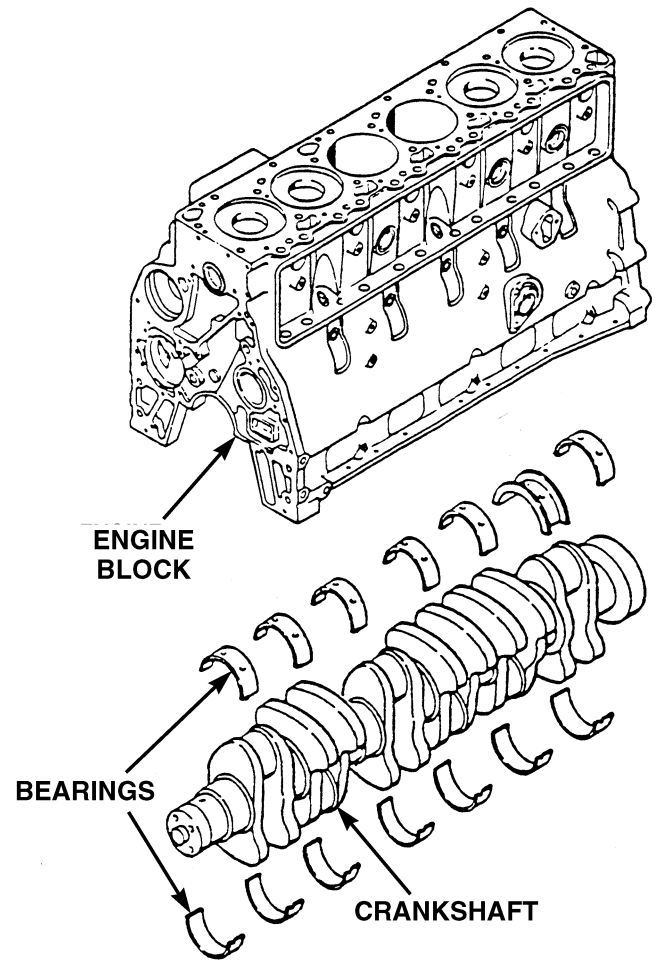
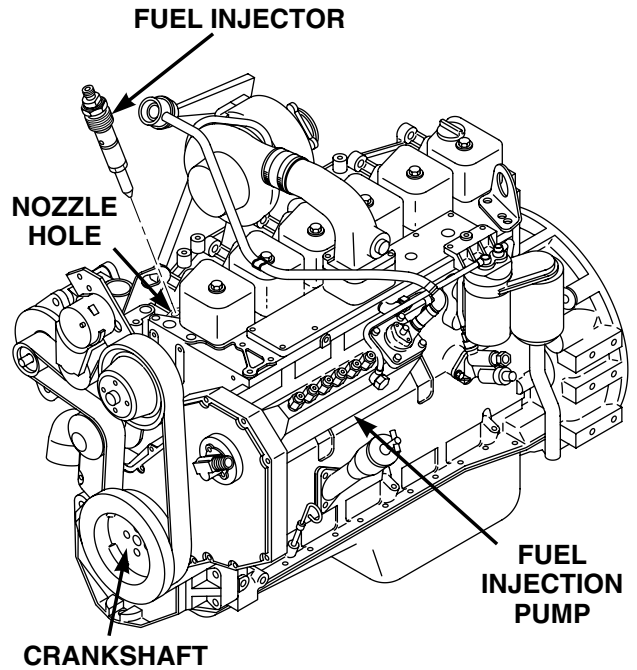
KNOWN INFO
Electrical system OK. Crankshaft can be rotated manually. Bearings and pistons OK.
POSSIBLE PROBLEMS
Cylinder head damaged. Fuel injection nozzles faulty.

<b>2</b>
<b>Is fluid discharged from injection nozzle holes when crankshaft is rotated?</b>

TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If fluid is discharged when crankshaft is rotated, engine has internal damage.



<b>VISUAL INSPECTION</b>	
(1)	Manually rotate crankshaft.
(2)	Inspect nozzle holes to see if fluid is discharged. <ul style="list-style-type: none"> <li>(a) If fluid is discharged, go to (3) below.</li> <li>(b) If fluid is not discharged, remove and inspect connecting rods (Para 3-17) and rocker arm assemblies (Para 3-18) for damage and/or wear. Replace rods and assemblies as necessary.</li> </ul>
(3)	Examine the discharged fluid to determine whether it is coolant or fuel. <ul style="list-style-type: none"> <li>(a) If fluid is coolant, replace the cylinder head assembly (Para 3-7).</li> <li>(b) If fluid is fuel, test the fuel injection nozzles and replace faulty nozzles (Para 4-3) as necessary.</li> </ul>
(4)	Install engine (Para 3-3).



**2. ENGINE CRANKS BUT WILL NOT START.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
 (Item 23, Appendix D)  
 Tool Kit, Machinist: Post, Clamp and Station  
 (Item 24, Appendix D)  
 Shop Equipment, Automotive Maintenance,  
 Common No. 2 Less Power  
 (Item 17, Appendix D)  
 STE/ICE-R  
 Test Set, Diesel Injector

*Equipment Condition*

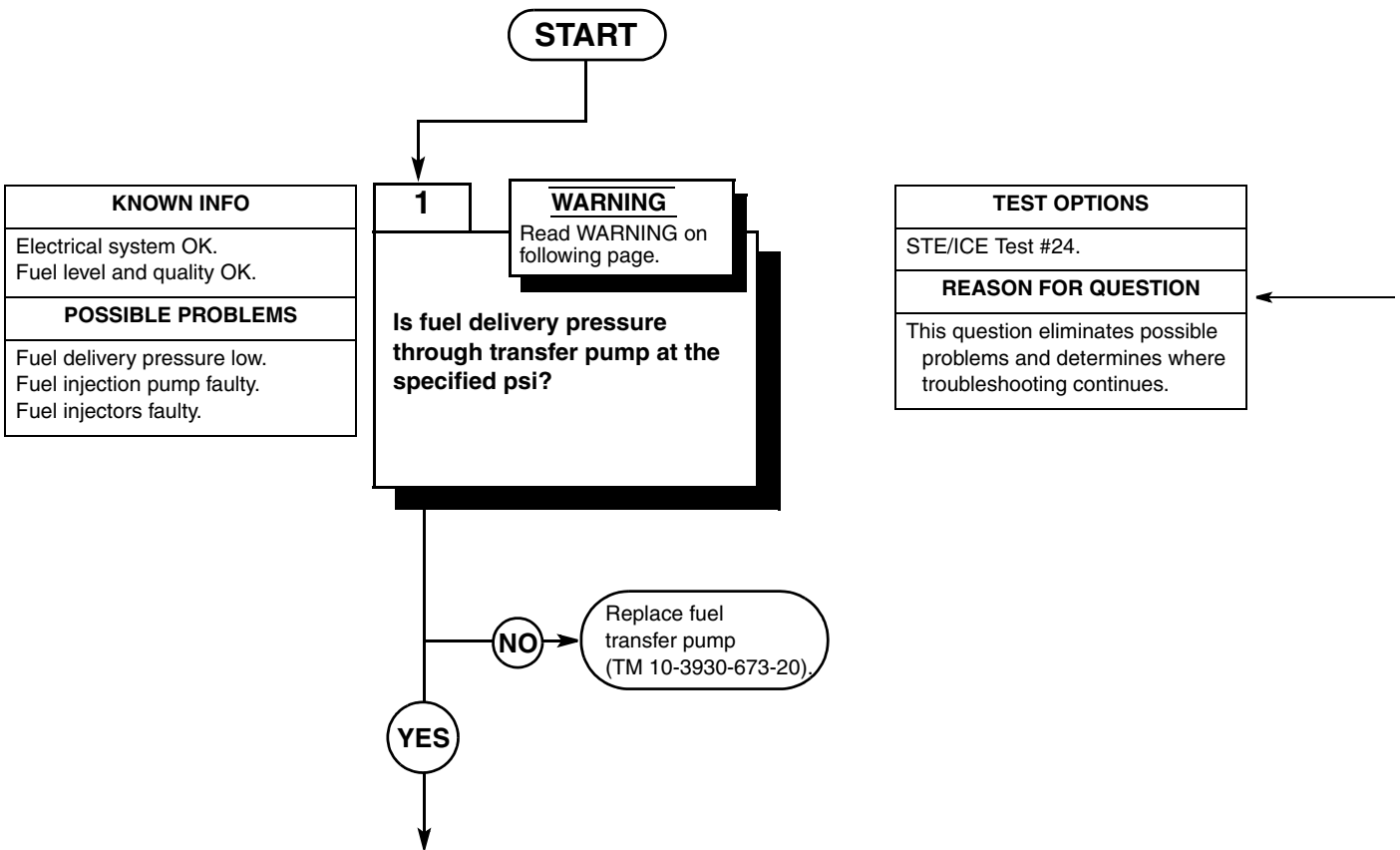
Engine shut down (TM 10-3930-673-10)  
 Wheels chocked (TM 10-3930-673-10)

*Personnel*

Two

*References*

TM 10-3930-673-10  
 TM 10-3930-673-20  
 TM 9-4910-571-12&P



**WARNING**

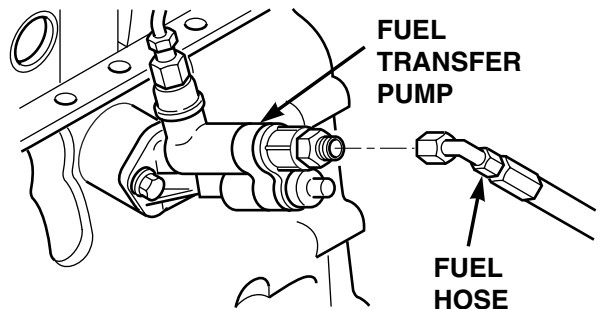
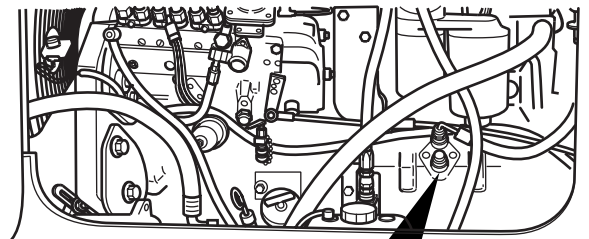
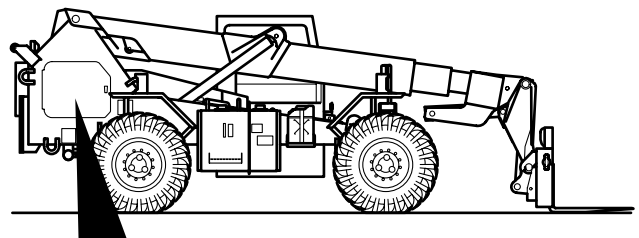
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- To bleed fuel system, engine must be placed in a run condition. Because engine may start during bleeding procedure, all necessary safety precautions must be followed. See TM 10-3930-673-10 for additional information.
- Keep clear of test spray from injection nozzle. Fluid at test pressures can penetrate skin, causing infection and possible death.
- Drycleaning solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves. Use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. Failure to do so may result in death to personnel.

**CAUTION**

If rust has formed on injector hold-down nut, injector can turn in its bore as hold-down nut is loosened. Dissolve and loosen rust by applying rust penetrating solvent to hold-down nut. Failure to do so can result in severe damage to cylinder head.

**STE/ICE PRESSURE TEST**

- (1) Disconnect fuel hose from fuel transfer pump.
- (2) Connect STE/ICE pressure gage to fuel transfer pump.
- (3) Perform STE/ICE Test #24 and read results.
  - (a) If fuel delivery pressure is at 10 psi, go to Step 2 of this fault.
  - (b) If fuel delivery pressure is less than 10 psi, replace fuel transfer pump (TM 10-3930-673-20).

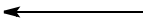
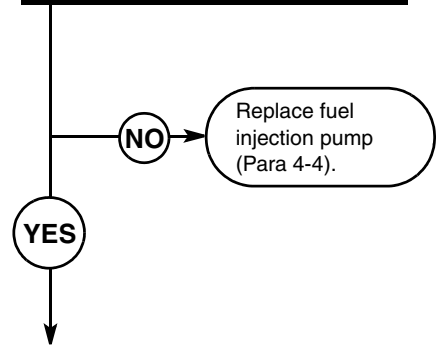


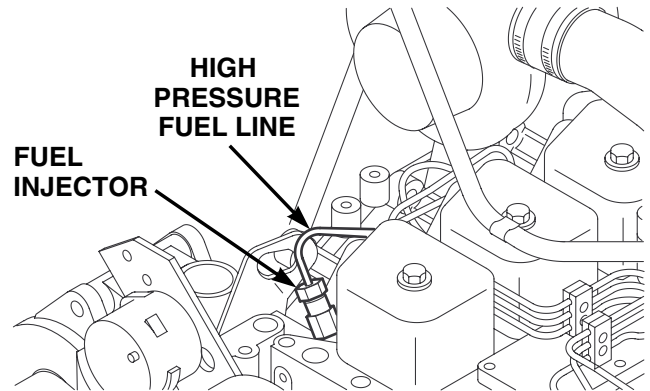
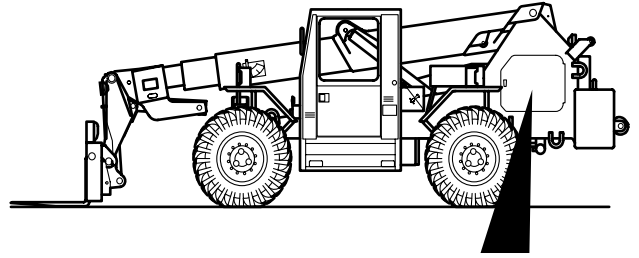
2. ENGINE CRANKS BUT WILL NOT START (CONT).

KNOWN INFO
Electrical system OK. Fuel level and quality OK. Fuel delivery pressure OK.
POSSIBLE PROBLEMS
Fuel injection pump faulty. Fuel injectors faulty.

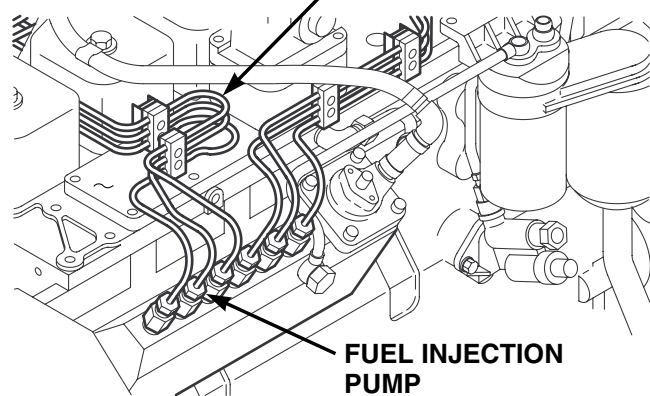
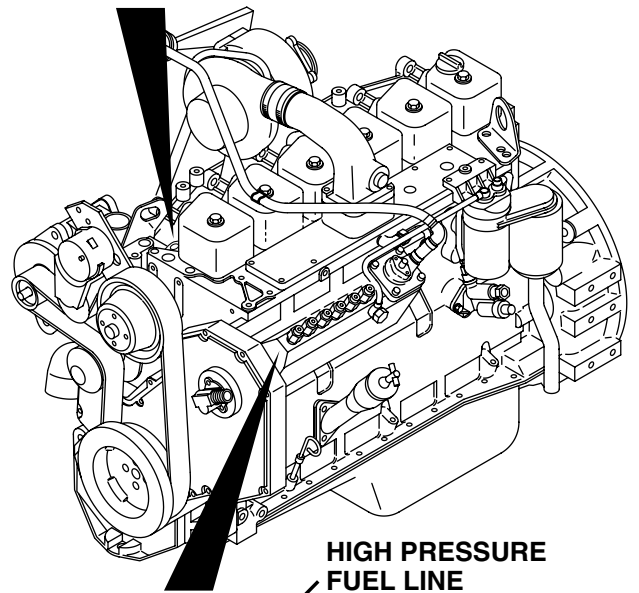
<b>2</b>
<b>Is fuel injection pump operating properly?</b>

TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If fuel injection pump is faulty engine will not receive fuel.





VISUAL INSPECTION	
(1)	Loosen the high pressure fuel line at two of the injectors.
(2)	Crank engine for approximately 30 seconds.
(3)	Observe fuel delivery at loosened connections.
(a)	If fuel flow is consistent, go to Step 3 of this fault.
(b)	If fuel flow is inconsistent, sporadic, replace fuel injection pump (Para 4-4).



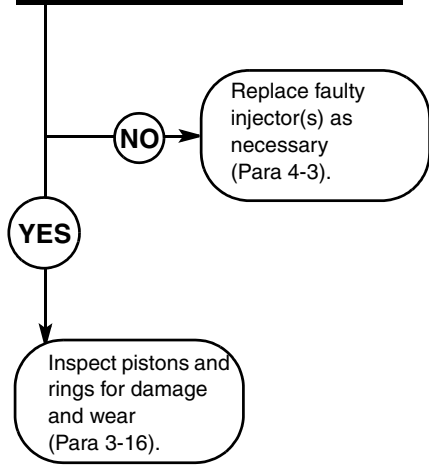
2. ENGINE CRANKS BUT WILL NOT START (CONT).

KNOWN INFO
Electrical system OK. Fuel level and quality OK. Fuel delivery pressure OK. Fuel injection pump OK.
POSSIBLE PROBLEMS
Fuel injectors faulty.

**3**

**Do fuel injectors produce well atomized spray at a pressure of 3553 ±73 psi?**

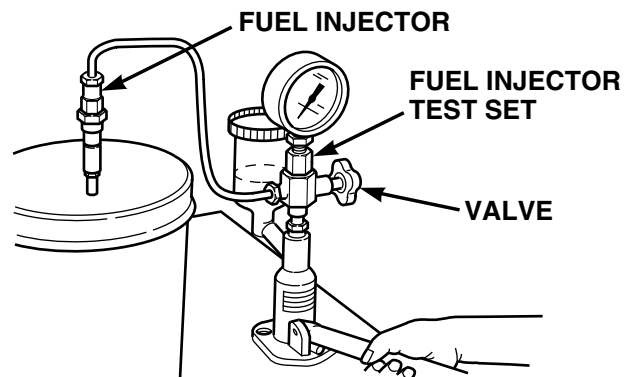
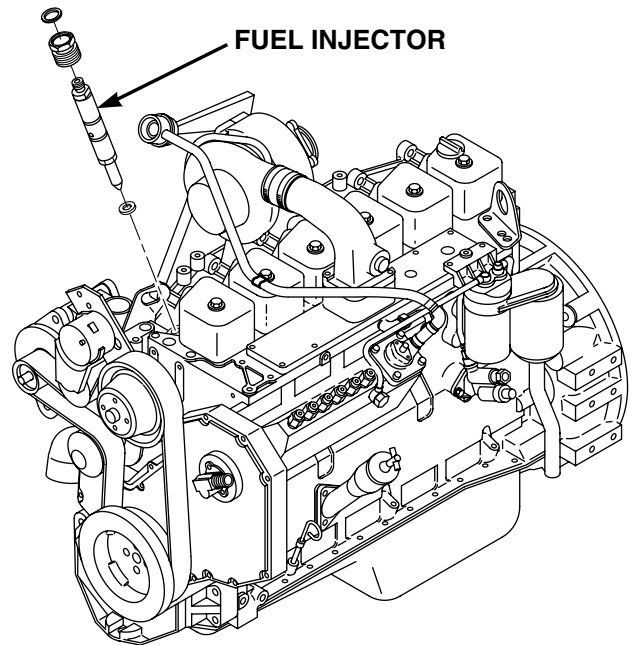
TEST OPTIONS
Injector test.
REASON FOR QUESTION
If fuel injections faulty, engine will not receive fuel.





**INJECTOR TEST**

- (1) Remove fuel injectors (Para 4-3).
- (2) Connect one injector at a time to fuel injector test set.
- (3) Perform injector test (Para 4-3).
  - (a) If well atomized spray begins at pressure of  $3553 \pm 73$  psi, inspect pistons and rings for damage and wear. Replace as necessary (Para 3-16).
  - (b) If spray does not begin at specified pressure, replace faulty injectors (Para 4-3).



**3. ENGINE OIL PRESSURE BELOW NORMAL.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
 (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance,  
 Common No. 2 Less Power  
 (Item 17, Appendix D)  
 Wrench, Torque, 0-175 lb-ft  
 Driver  
 Mallet

*Personnel*

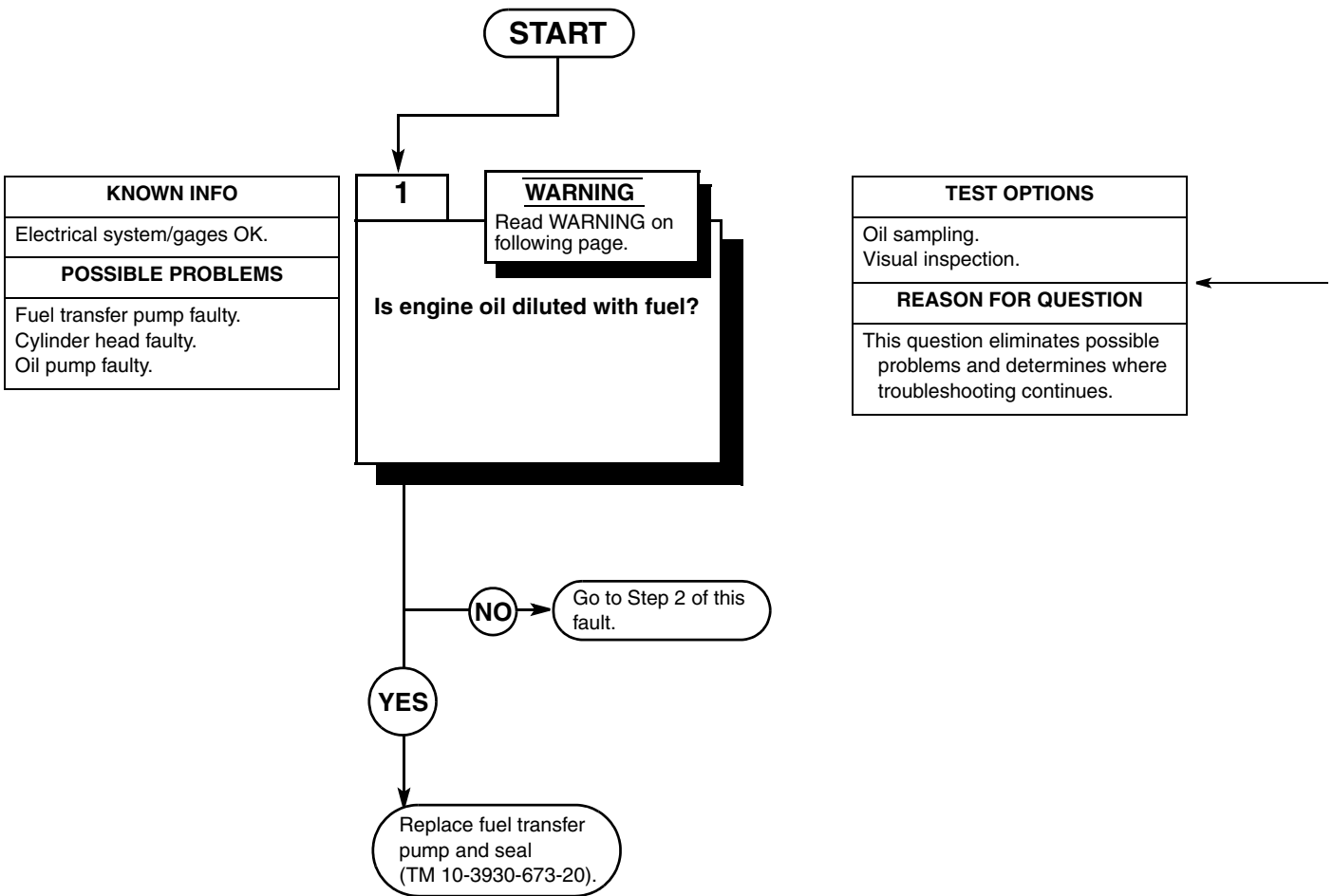
Two

*References*

TM 10-3930-673-10  
 TM 10-3930-673-20

*Equipment Condition*

Engine shut down (TM 10-3930-673-10)  
 Wheels chocked (TM 10-3930-673-10)



**WARNING**

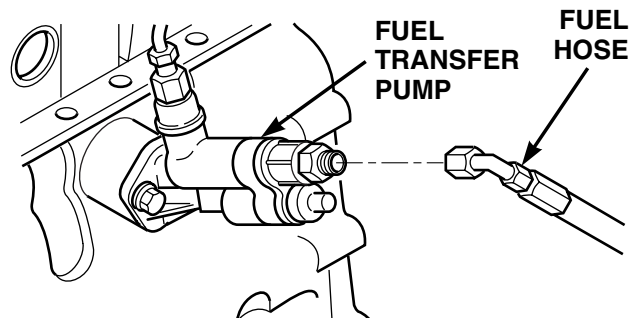
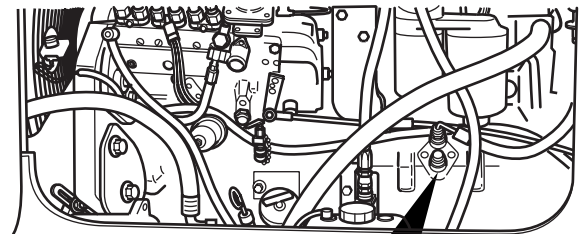
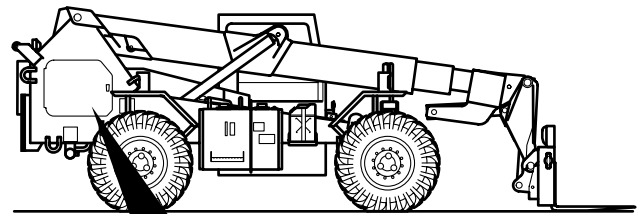
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Drycleaning solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves. Use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. Failure to do so may result in injury or death to personnel.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

When installing oil pump, be sure idler gear pin is installed in the locating bore in the cylinder block. Failure to properly locate oil pump can result in damage to oil pump and to cylinder block bore .

**OIL SAMPLING/VISUAL INSPECTION**

- (1) Draw engine oil sample from sampling valve (TM 10-3930-673-10).
- (2) Examine oil sample to determine if oil is diluted with fuel.
  - (a) If oil is diluted with fuel, remove and replace fuel transfer pump and its seal (TM 10-3930-673-20). Change oil and filter.
  - (b) If oil is not diluted with fuel, go to Step 2 of this fault.



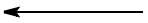
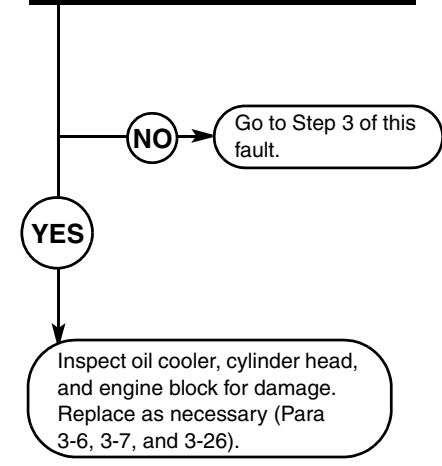
3. ENGINE OIL PRESSURE BELOW NORMAL (CONT).

<b>KNOWN INFO</b>
Electrical system/gages OK. Fuel transfer pump OK.
<b>POSSIBLE PROBLEMS</b>
Cylinder head faulty. Oil pump faulty.

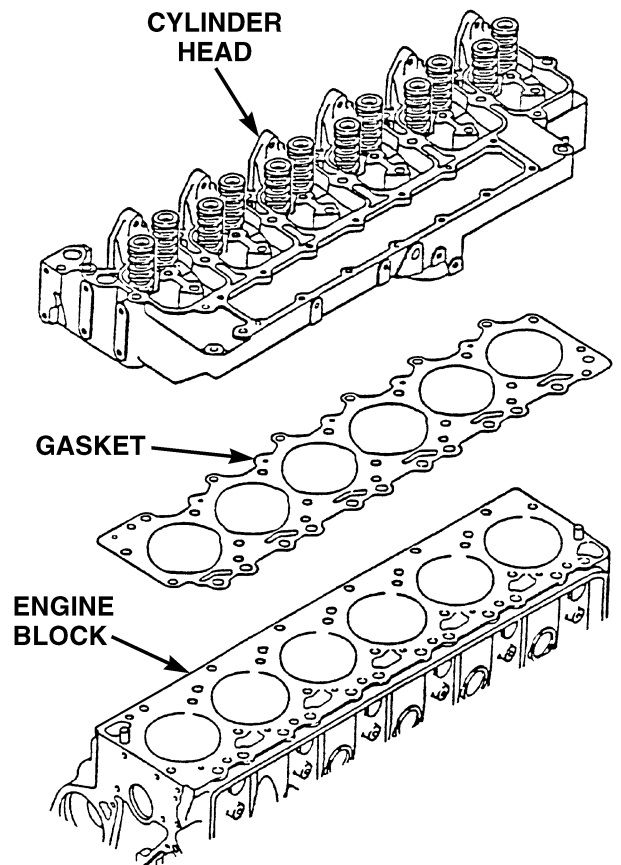
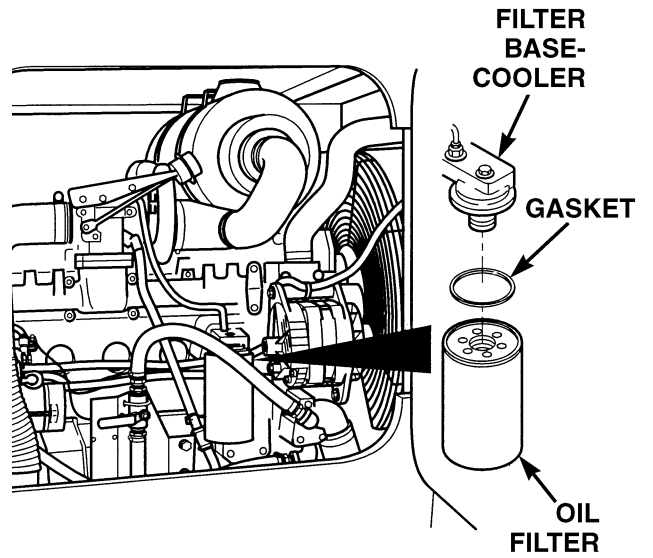
**2**

**Is engine oil diluted with coolant?**

<b>TEST OPTIONS</b>
Oil sampling. Visual inspection.
<b>REASON FOR QUESTION</b>
If engine oil is diluted, oil pressure will drop below normal.



<b>VISUAL INSPECTION</b>	
(1)	Draw engine oil sample from sampling valve (TM 10-3930-673-10).
(2)	Examine sample to determine if oil is diluted with coolant.
(a)	If oil is diluted with coolant, inspect oil cooler (Para 3-26), cylinder head and gasket (Para 3-7), and engine block (Para 3-6) for damage and leaks. Replace damaged components as necessary. Change oil and filter.
(b)	If engine oil is not diluted, go to Step 3 of this fault.



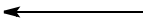
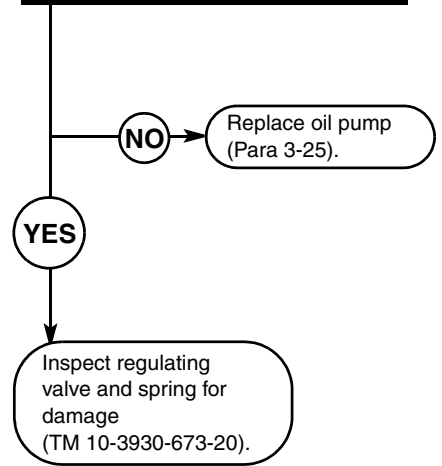
3. ENGINE OIL PRESSURE BELOW NORMAL (CONT).

<b>KNOWN INFO</b>
Electrical system/gages OK. Fuel transfer pump OK. Cylinder head OK.
<b>POSSIBLE PROBLEMS</b>
Oil pump faulty.

**3**

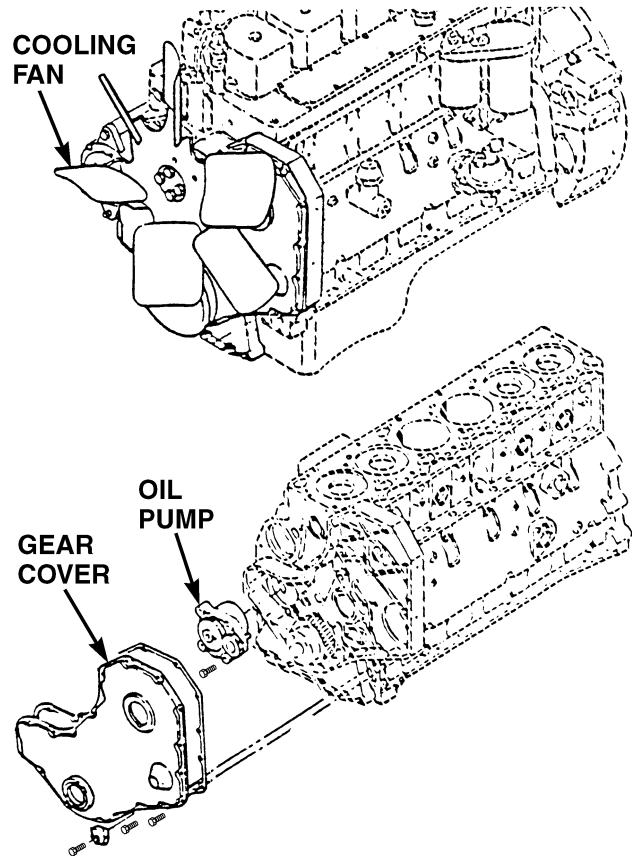
**Is engine oil pump free from signs of damage and leaks?**

<b>TEST OPTIONS</b>
Visual inspection.
<b>REASON FOR QUESTION</b>
If oil pump is faulty, oil pressure will not be maintained.



**VISUAL INSPECTION**

- (1) Remove drive belt, tachometer drive, and gear cover.
- (2) Inspect area around oil pump for leaks.
- (3) Remove oil pump and inspect it for damage.
  - (a) If oil pump is free from signs of damage and leaks, inspect regulating valve and spring for damage (Para 3-26). Replace components as necessary. Change oil and filter.
  - (b) If pump shows signs of damage and leaks, replace pump (Para 3-25).
- (4) Install gear cover, tachometer drive, and drive belt.



**4. ENGINE COOLANT TEMPERATURE ABOVE NORMAL.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Tool Kit, Machinist: Camp and Station  
(Item 24, Appendix D)

*Personnel*

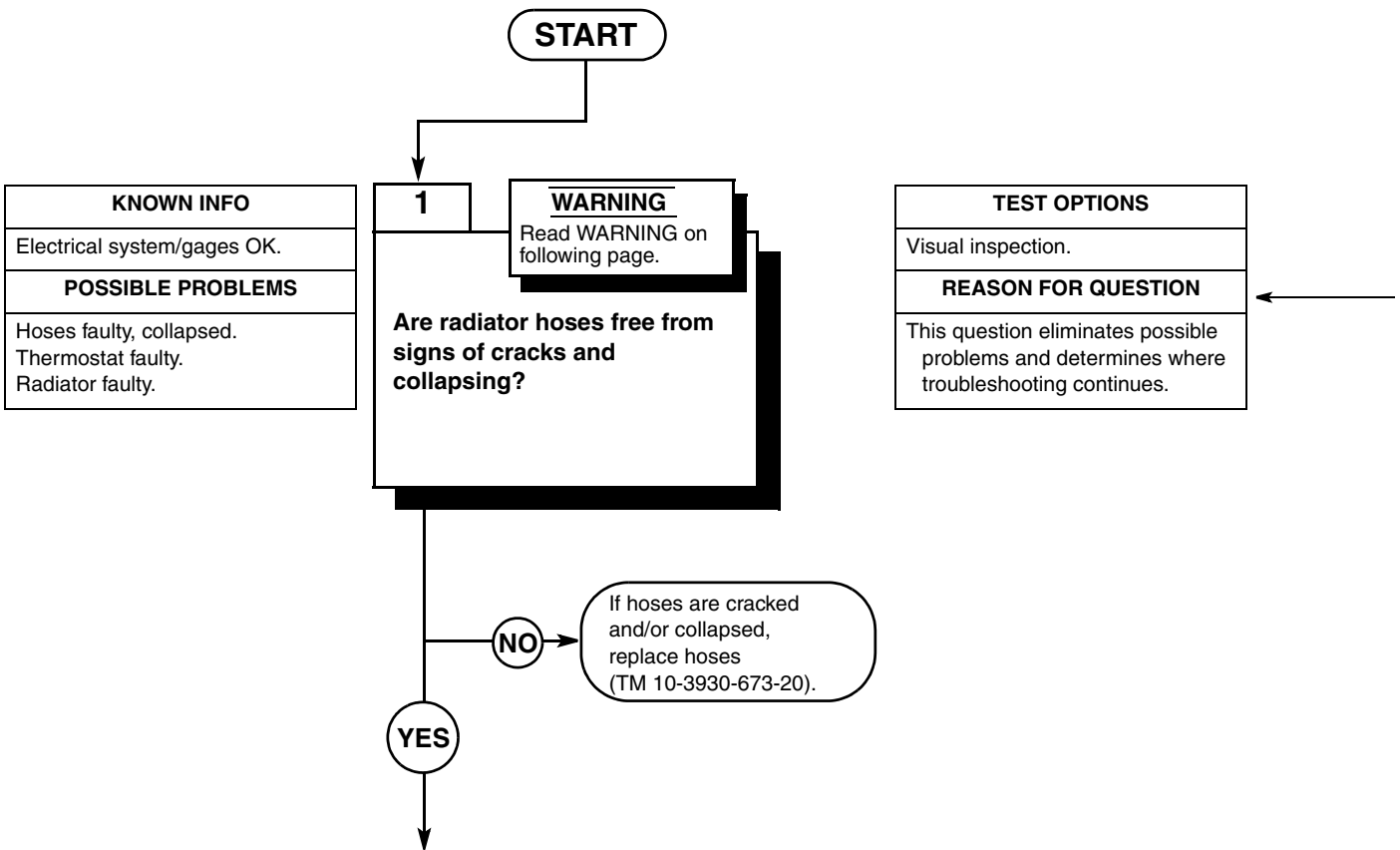
Two

*References*

TM 10-3930-673-10  
TM 10-3930-673-20

*Equipment Condition*

Engine shut down (TM 10-3930-673-10)  
Engine cooled to ambient temperature  
Wheels chocked (TM 10-3930-673-10)



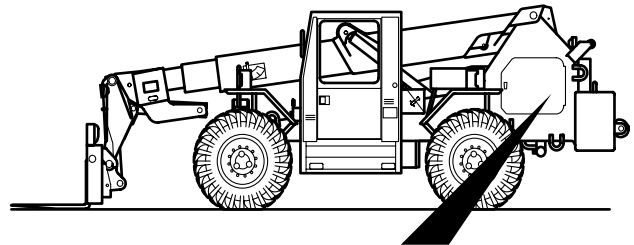


**WARNING**

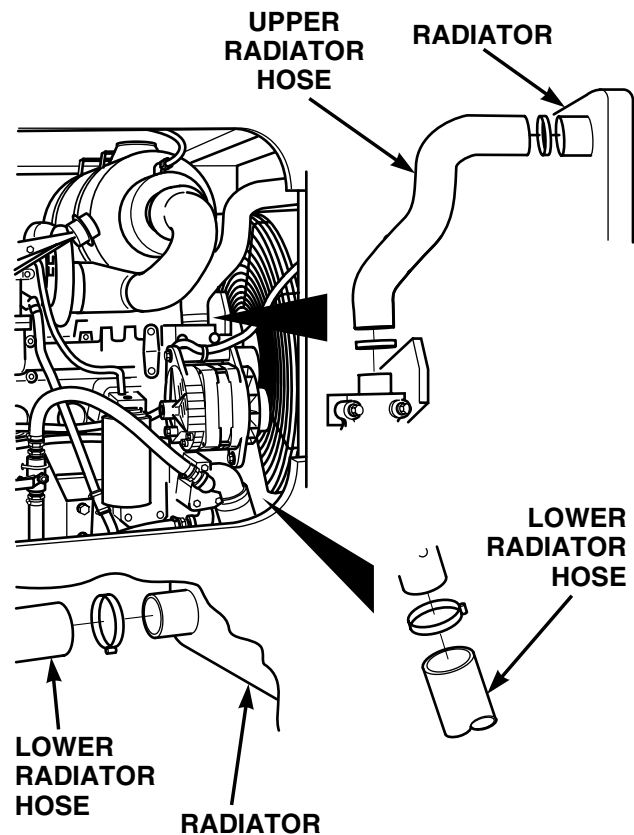
- Let engine cool before removing radiator cap from radiator. Always turn cap slowly to first stop and allow pressure to escape before removing cap completely. Removing cap while coolant is hot can result in injury to personnel.
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Drycleaning solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves. Use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent. Failure to do so may result in injury or death to personnel.

**CAUTION**

- All rubber residue must be removed from hose fittings to avoid coolant leaks.
- Do not attempt to clean radiator core fins with any sharp instrument. A sharp instrument may damage core, leading to leaks from core.



VISUAL INSPECTION
Visually inspect radiator hoses for signs of cracks and collapsing.
(a) If hoses are free from signs of cracks and collapsing, go to Step 2 of this fault.
(b) If hoses are cracked and/or collapsed, replace hoses as necessary (TM 10-3930-673-20).



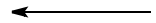
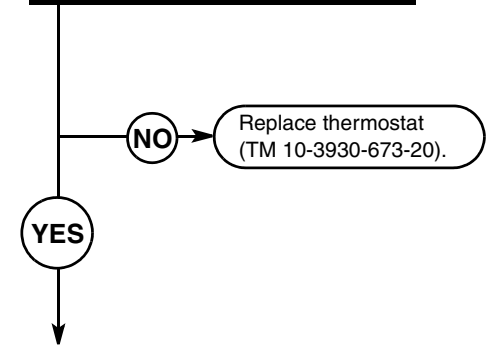
4. ENGINE COOLANT TEMPERATURE ABOVE NORMAL (CONT).

<b>KNOWN INFO</b>
Electrical system/gages OK. Radiator hoses OK.
<b>POSSIBLE PROBLEMS</b>
Thermostat faulty. Radiator faulty.

**2**

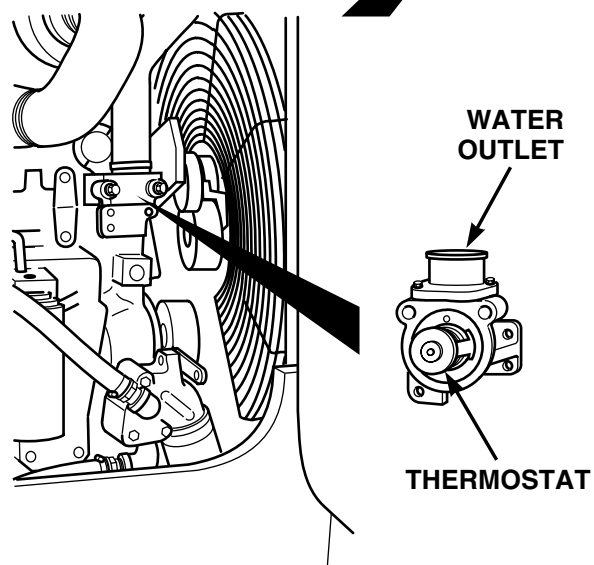
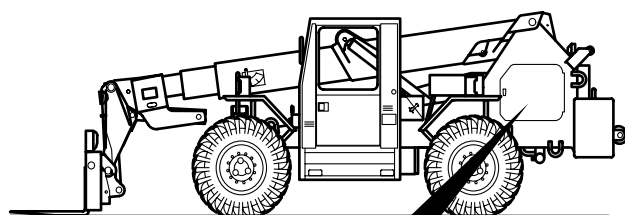
**Is thermostat functioning properly?**

<b>TEST OPTIONS</b>
Visual inspection.
<b>REASON FOR QUESTION</b>
If thermostat is faulty, engine coolant temperature will be above normal.



**VISUAL INSPECTION**

- (1) Remove thermostat from engine (TM 10-3930-673-20).
- (2) Place thermostat in hot (+190 degrees F) water to determine if it is functioning properly.
  - (a) If thermostat is functioning properly, install thermostat and go to Step 3 of this fault.
  - (b) If thermostat is not functioning properly, replace thermostat (TM 10-3930-673-20).



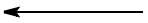
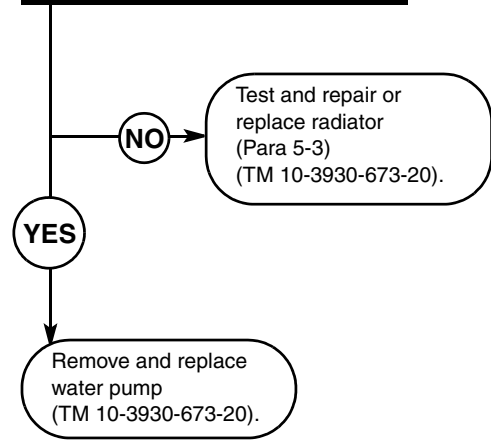
4. ENGINE COOLANT TEMPERATURE ABOVE NORMAL (CONT).

<b>KNOWN INFO</b>
Electrical system/gages OK. Radiator hoses OK. Thermostat OK.
<b>POSSIBLE PROBLEMS</b>
Radiator faulty.

**3**

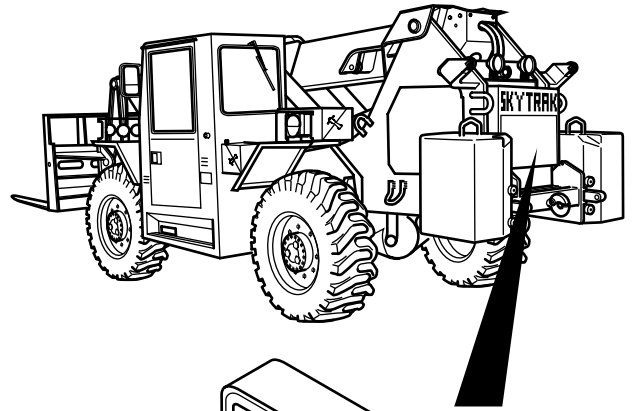
**Is radiator free from signs of damage and functioning properly?**

<b>TEST OPTIONS</b>
Visual inspection. Pressure test.
<b>REASON FOR QUESTION</b>
If radiator damaged or faulty, coolant temperature will be above normal.

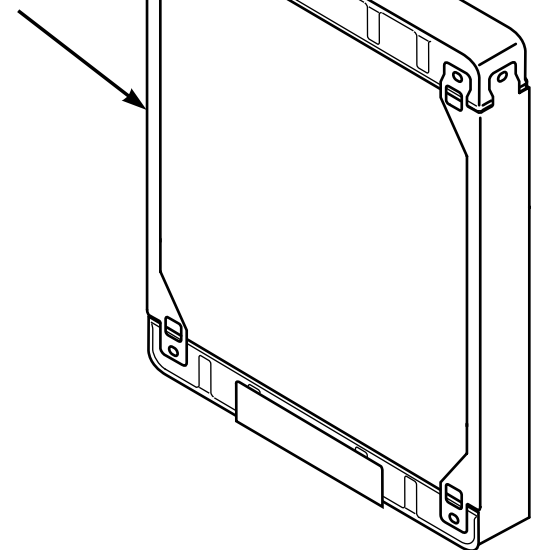


**VISUAL INSPECTION/PRESSURE TEST**

- (1) Remove radiator (TM 10-3930-673-20).
- (2) Visually inspect radiator for damage and leaks.
- (3) Pressure test radiator (TM 10-3930-673-20).
  - (a) If radiator is free from signs of damage and maintains pressure, remove and replace water pump (TM 10-3930-673-20).
  - (b) If radiator is damaged or does not maintain pressure, repair or replace radiator (Para 5-3).
- (4) Install radiator (TM 10-3930-673-20).



**RADIATOR**



**5. LOW TRANSMISSION OIL PRESSURE FROM TORQUE CONVERTER.**

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Lifting Chain, 2000 lb capacity
- Lifting Device, 2000 lb capacity
- Wrench, Torque, 0-175 lb-ft (Item 28, Appendix D)
- Bearing Puller (Item 15, Appendix D)

*Equipment Condition*

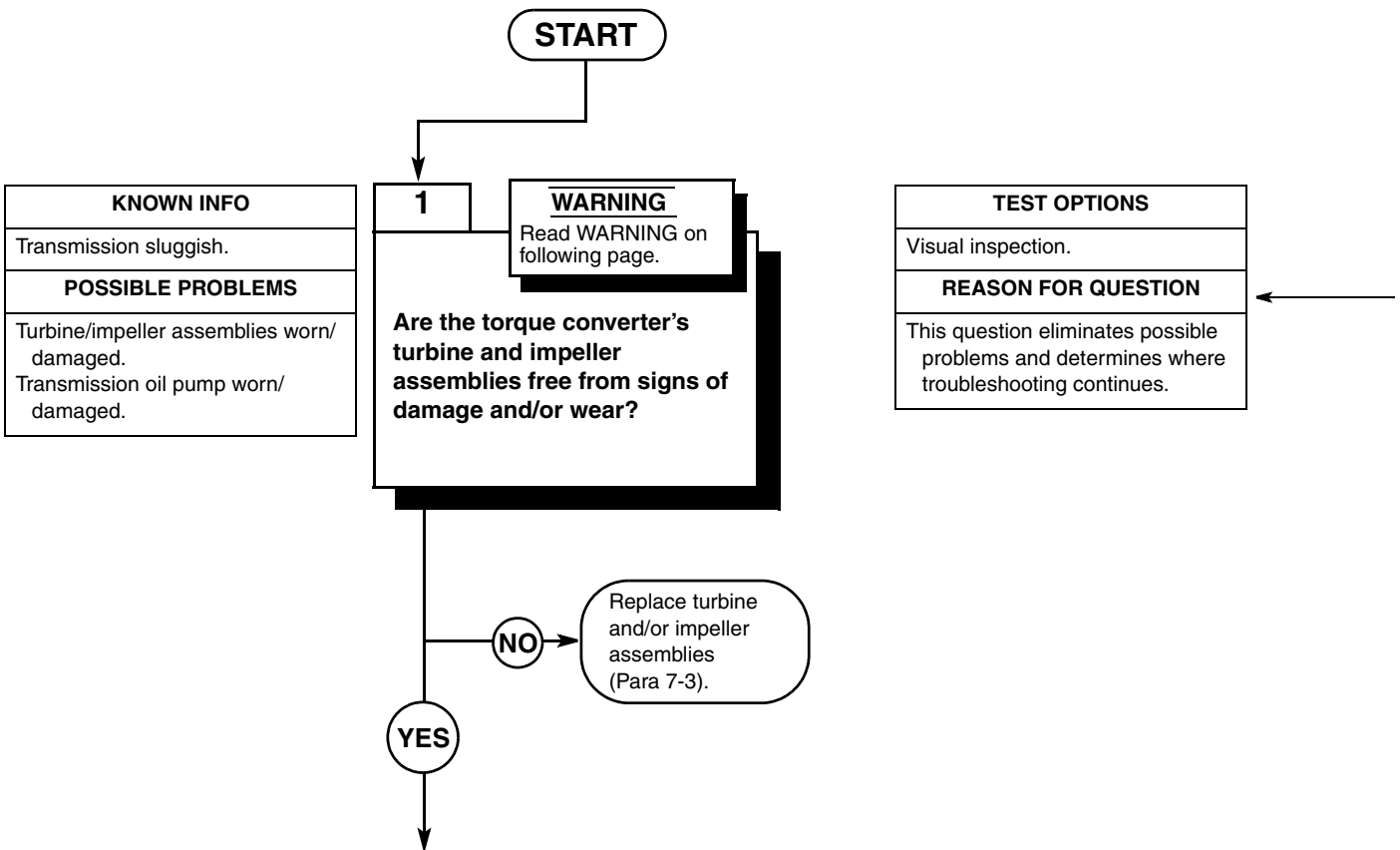
- Engine shut down (TM 10-3930-673-10)
- Wheels chocked (TM 10-3930-673-10)
- Transmission input shaft removed (Para 7-7.)

*Personnel*

Two

*References*

- TM 10-3930-673-10
- TM 10-3930-673-20

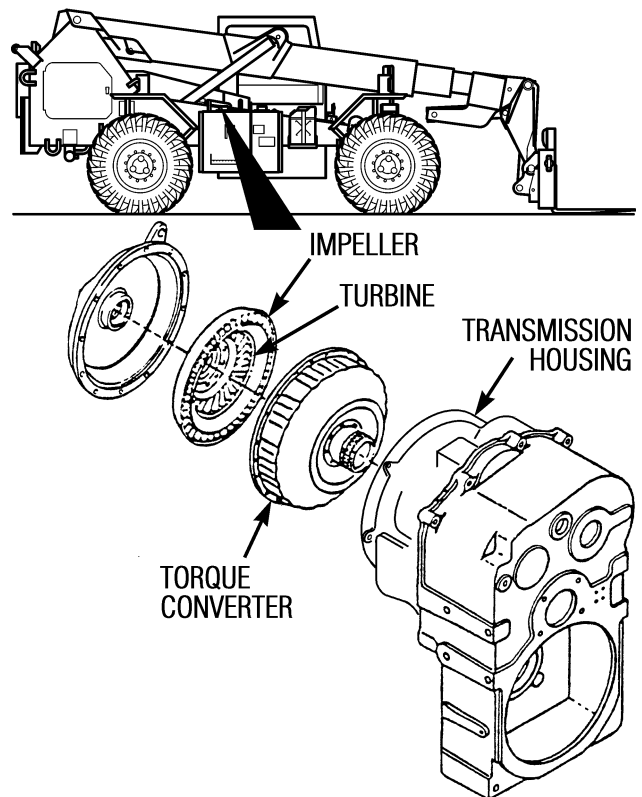


**WARNING**

- Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released, and could cause severe eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.



**VISUAL INSPECTION**

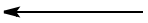
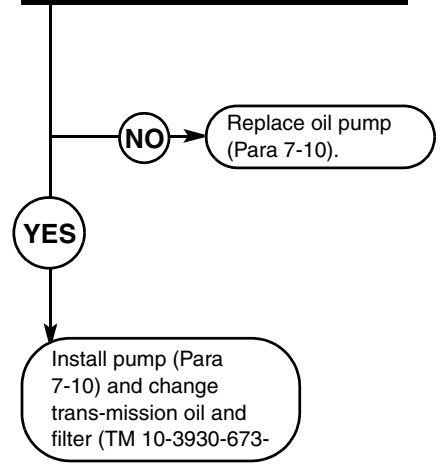
- (1) Remove torque converter from transmission housing (Para 7-3).
- (2) Disassemble torque converter.
- (3) Visually inspect the turbine and impeller assemblies for signs of damage and/or wear.
  - (a) If the assemblies are free from signs of damage and/or wear, go to Step 2 of this fault.
  - (b) If the assemblies show signs of damage and/or wear, replace the assemblies as necessary (Para 7-3).

5. LOW TRANSMISSION OIL PRESSURE FROM TORQUE CONVERTER (CONT).

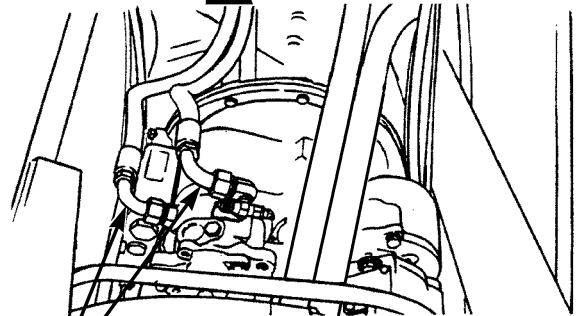
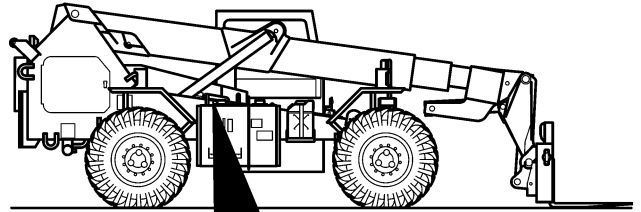
KNOWN INFO
Transmission sluggish. Turbine/impeller assemblies OK.
POSSIBLE PROBLEMS
Transmission oil pump worn/ damaged.

<b>2</b>
<p><b>Is transmission oil pump free from signs of damage and/or wear?</b></p>

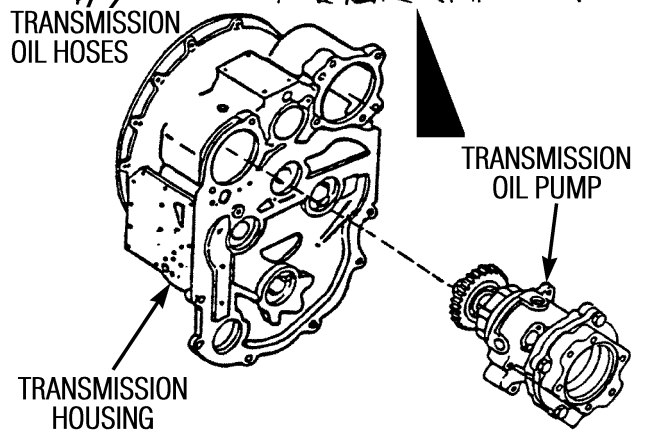
TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If oil pump is worn or damaged, oil pressure will be low.







<b>VISUAL INSPECTION</b>	
(1)	Remove transmission oil pump from transmission housing (Para 7-10).
(2)	Inspect pump for signs of damage and/or wear.
(a)	If pump is free from signs of damage and/or wear, install pump (Para 7-10).
(b)	If pump shows signs of damage and/or wear, replace pump (Para 7-10).
(3)	Assemble torque converter.
(4)	Install torque converter on transmission housing.
(5)	Change transmission oil and filter (TM 10-3939-673-20).



**6. STEERING DIFFICULT, FRONT DIFFERENTIAL BINDS.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
 (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance,  
 Common No. 2 Less Power  
 (Item 17, Appendix D)  
 Shop Equipment, Automotive Maintenance and  
 Repair; Field Maintenance, basic, Less Power  
 (Item 18, Appendix D)  
 Lifting Device, 2-ton capacity  
 Bearing Puller (Item 15, Appendix D)  
 Dial Indicator

*Tools and Special Tools (Cont)*

Drill  
 Seal Puller

*Equipment Condition*

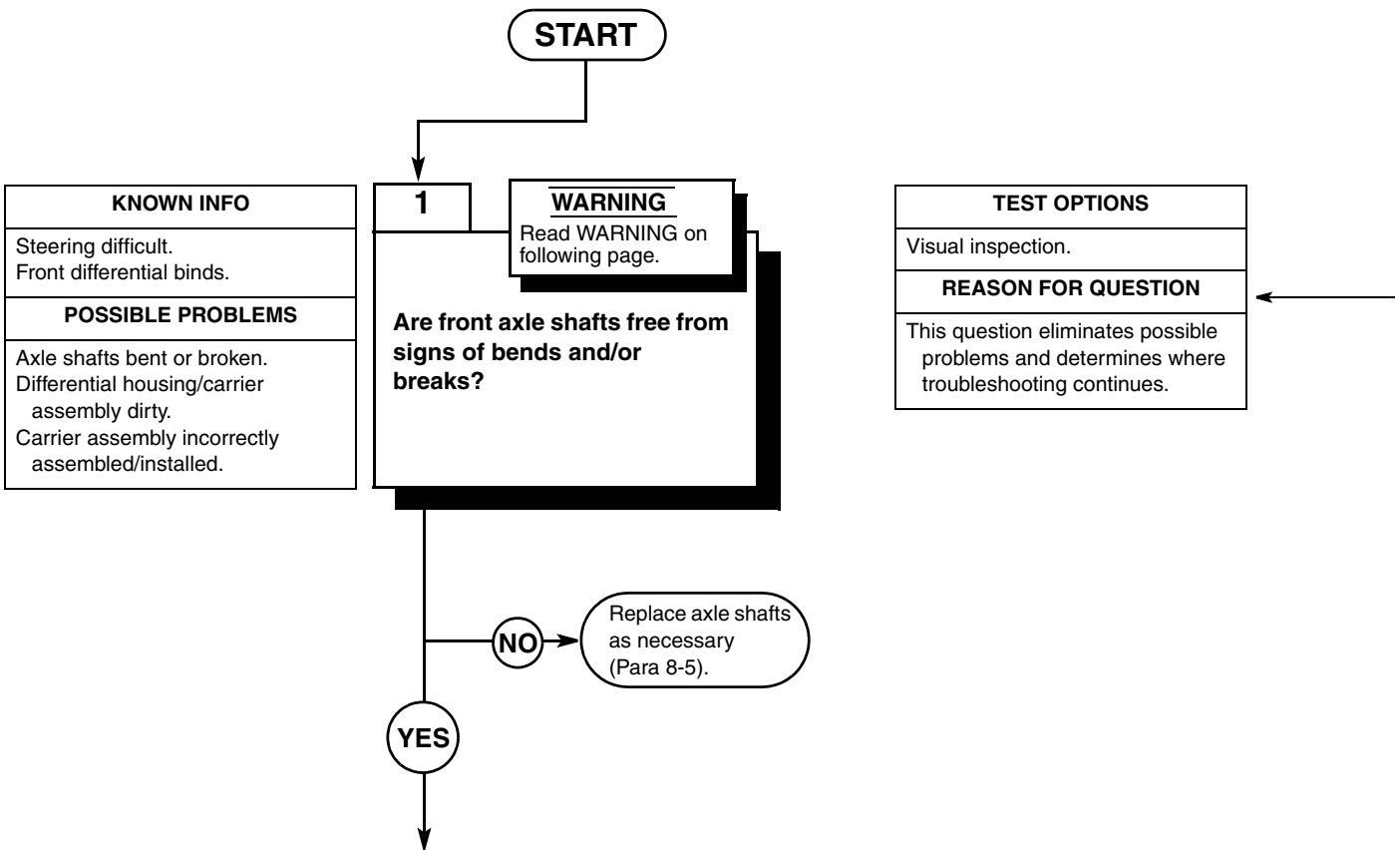
Front axle housing removed (Para 8-3)  
 Disc brake assemblies removed (Para 10-3)  
 Planetary wheel ends removed (Para 8-6)

*Personnel*

Two

*References*

TM 10-3930-673-20



**WARNING**

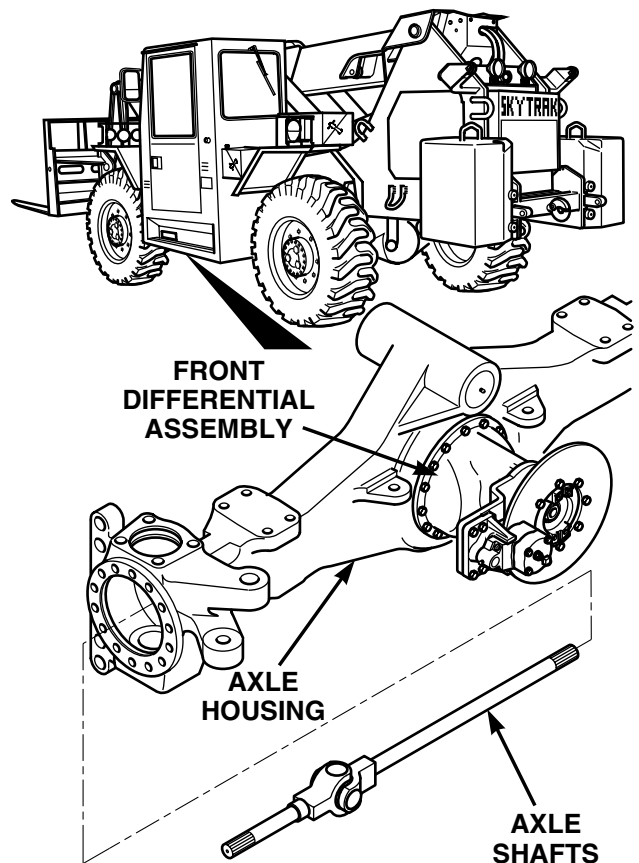
- Differential and ring gear weighs 100+ lbs. Attach suitable lifting device prior to removal to prevent possible injury to personnel.
- No-spin differential contains compression springs under pressure. Failure to use a retaining bolt or other means of restraint can cause injury to personnel when removing no-spin differential.
- Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released, and could cause severe eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

- Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.
- Ring gear must be heated before installation. Failure to heat ring gear before installation could cause damage to differential case half because of tight fit.
- Spacing between four initially installed screws must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

**VISUAL INSPECTION**

- (1) Remove axle shafts from axle housing (Para 8-5).
- (2) Visually inspect shafts for bends and breaks.
  - (a) If axle shafts are free from signs of bends and/or breaks, go to Step 2 of this fault.
  - (b) If axle shafts show bends and breaks, replace the shafts as necessary (Para 8-5).

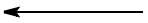
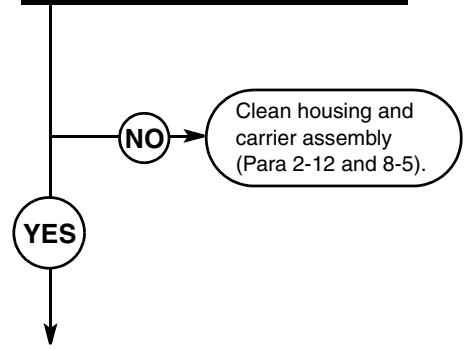


6. STEERING DIFFICULT, FRONT DIFFERENTIAL BINDS (CONT).

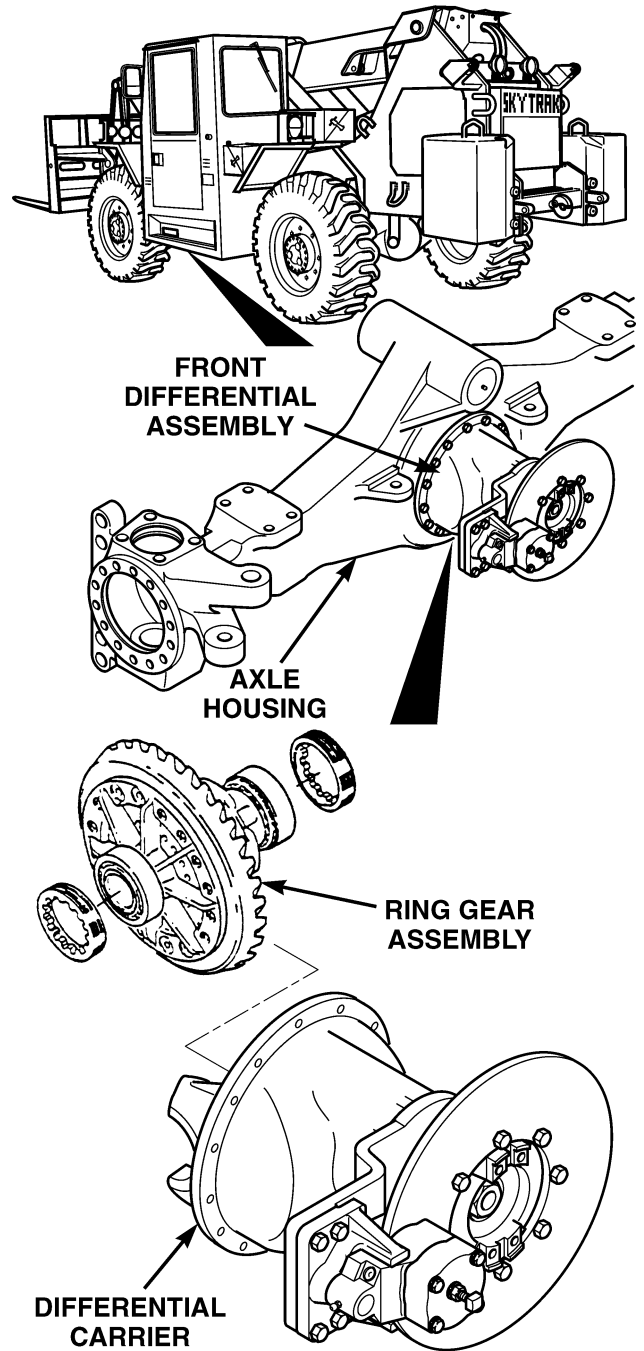
KNOWN INFO
Steering difficult. Front differential binds. Axle shafts OK.
POSSIBLE PROBLEMS
Differential housing/carrier assembly dirty. Carrier assembly incorrectly assembled/installed.

<b>2</b>
<b>Are front differential housing and carrier assembly free from dirt and debris?</b>

TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If housing and carrier assembly are dirty, differential will bind.



VISUAL INSPECTION	
(1)	Remove differential carrier assembly from differential housing (Para 8-5).
(2)	Visually inspect housing and assembly for signs of dirt and debris.
(a)	If housing and assembly are clean, go to Step 3 of this fault.
(b)	If housing and/or assembly are dirty, disassemble carrier assembly and clean both housing and assembly (Para 2-12 and 8-5).



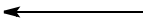
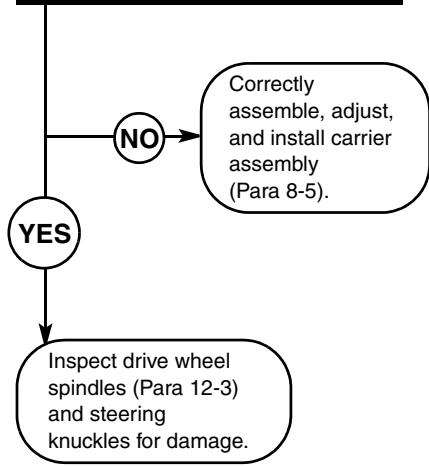
6. STEERING DIFFICULT, FRONT DIFFERENTIAL BINDS (CONT).

KNOWN INFO
Steering difficult. Front differential binds. Axle shafts OK. Differential housing/carrier assembly clean.
POSSIBLE PROBLEMS
Carrier assembly incorrectly assembled/installed.

**3**

**Is differential carrier assembly correctly assembled and properly installed?**

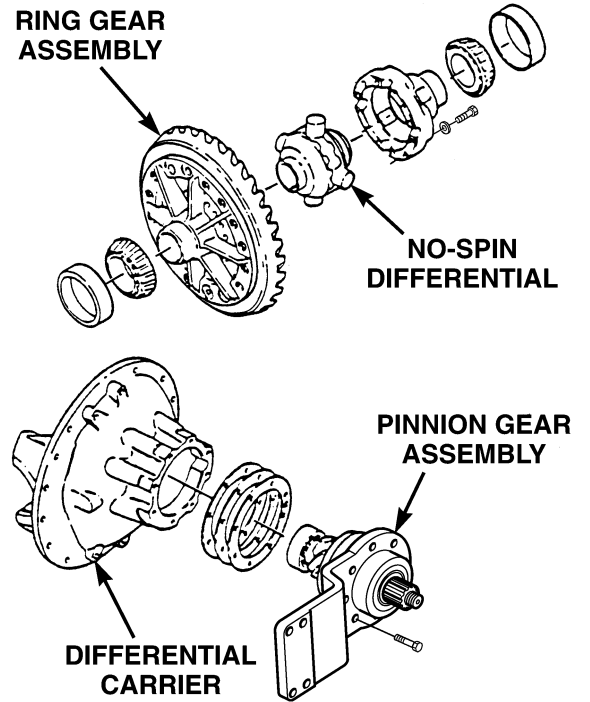
TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If carrier assembly is incorrectly assembled and/or installed, differential will bind.



**VISUAL INSPECTION**

Visually inspect differential carrier assembly for correct order of components.

- (a) If components are in correct order and assembled properly, install assembly in differential housing (Para 8-5). Then, inspect drive wheel spindles (Para 12-3) and steering knuckles for damage.
- (b) If components are not in correct order or not assembled properly, disassemble, reassemble, and adjust carrier assembly. Install assembly in differential housing (Para 8-5).



**7. EXCESSIVE DRIVELINE NOISE.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)  
 Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)  
 Dial Indicator (Item 3, Appendix D)  
 Drill  
 Lifting Device, 2,000 lb (907.18 kg) capacity (2)  
 Seal Puller

*Equipment Condition*

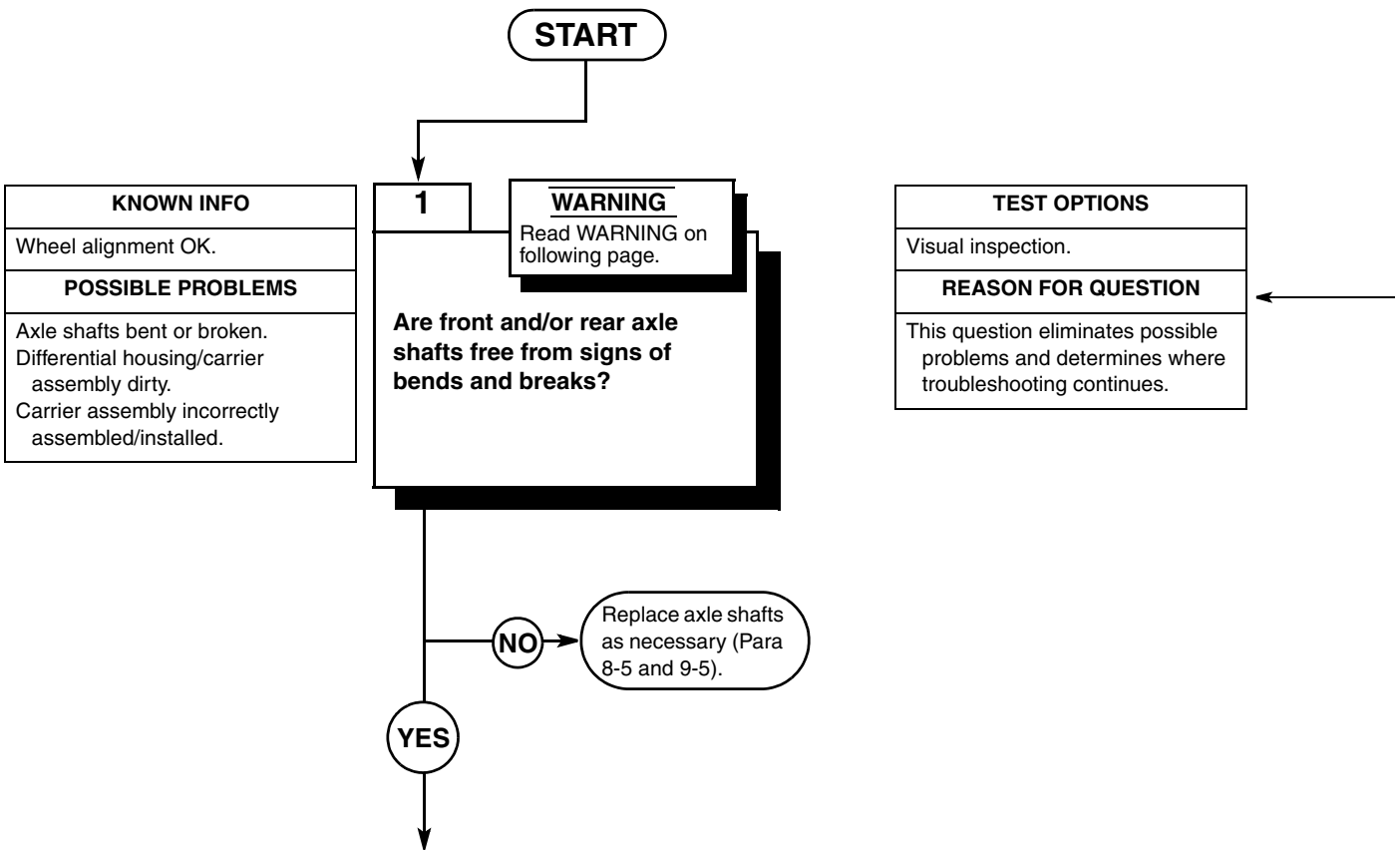
Front and/or rear axle housings removed (Para 8-3 and 9-3)  
 Disc brake assemblies removed (Para 10-3)  
 Planetary wheel ends removed (Para 8-6 and 9-6)

*Personnel Required*

Two

*References*

TM 10-3930-673-20





**WARNING**

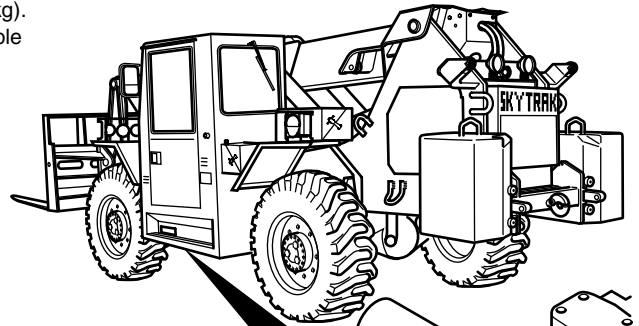
- Differential and ring gear weigh approximately 100 lbs (45.4 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.
- No-spin differential contains compression springs under pressure. Failure to use a retaining bolt or other means of restraint can cause injury to personnel when removing no-spin differential.
- Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released, and could cause severe eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

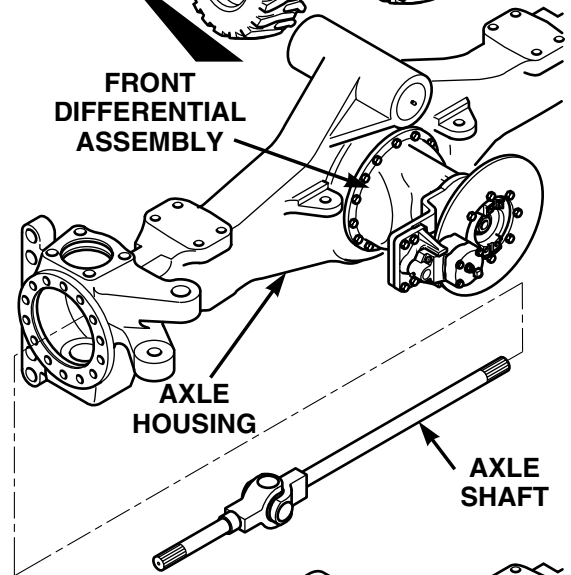
- Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.
- Ring gear must be heated before installation. Failure to heat ring gear before installation could cause damage to differential case half because of tight fit.
- Spacing between four initially installed screws must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

**VISUAL INSPECTION**

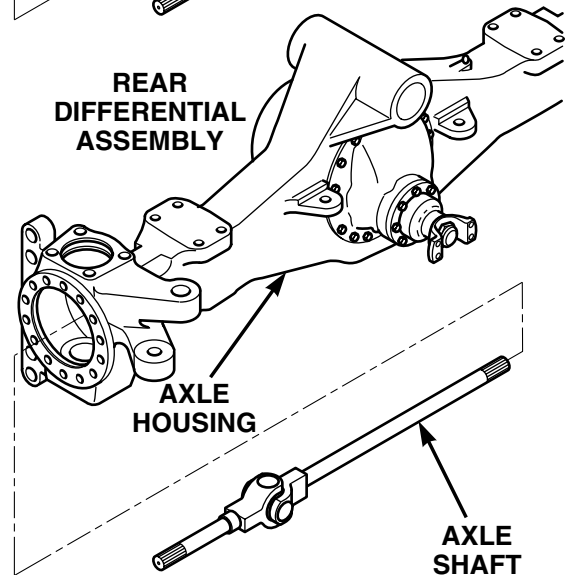
- (1) Remove front and/or rear axle shafts from axle housing (Para 8-5 and 9-5).
- (2) Visually inspect shafts for bends and breaks.
  - (a) If axle shafts are free from signs of bends and breaks, go to Step 2 of this fault.
  - (b) If axle shafts show bends and breaks, replace the shafts as necessary (Para 8-5 and 9-5).



**FRONT DIFFERENTIAL ASSEMBLY**



**REAR DIFFERENTIAL ASSEMBLY**



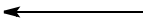
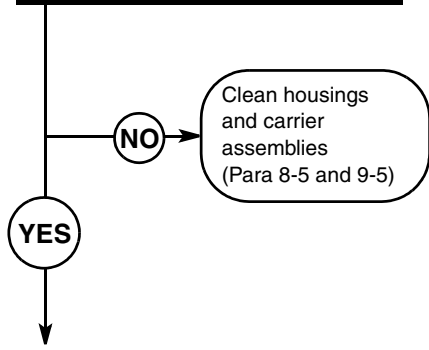
7. EXCESSIVE DRIVELINE NOISE (CONT).

KNOWN INFO
Wheel alignment OK. Axle shafts OK.
POSSIBLE PROBLEMS
Differential housing/carrier assembly dirty. Carrier assembly incorrectly assembled/installed.

2

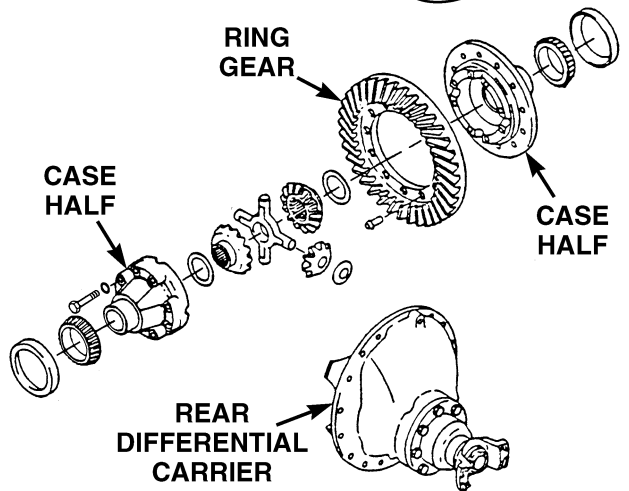
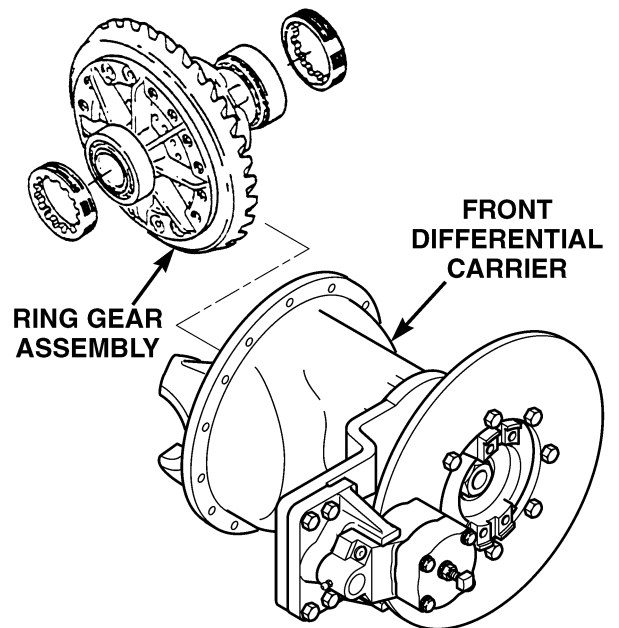
**Are front and/or rear differential housings and carrier assemblies free from dirt and debris?**

TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If housing and carrier assembly are dirty, differential will bind and produce excessive noise.



**VISUAL INSPECTION**

- (1) Remove differential carrier assemblies from differential housings (Para 8-5 and 9-5).
- (2) Visually inspect housing and assemblies for signs of dirt and debris.
  - (a) If housings and assemblies are clean, go to Step 3 of this fault.
  - (b) If housings and/or assemblies are dirty, disassemble carrier assemblies and clean both housings and assemblies (Para 8-5 and 9-5).



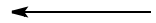
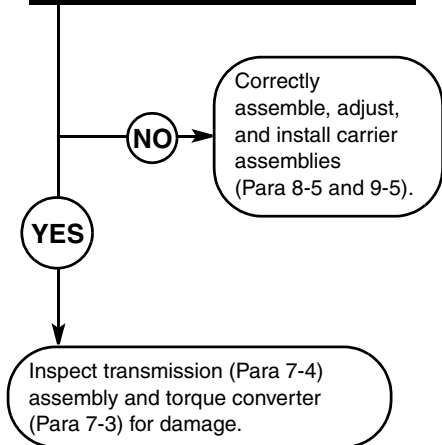
7. EXCESSIVE DRIVELINE NOISE (CONT).

KNOWN INFO
Wheel alignment OK. Axle shafts OK. Housing/carrier assemblies clean.
POSSIBLE PROBLEMS
Carrier assembly incorrectly assembled/installed.

**3**

**Are front and/or rear differential carrier assemblies correctly assembled and properly installed?**

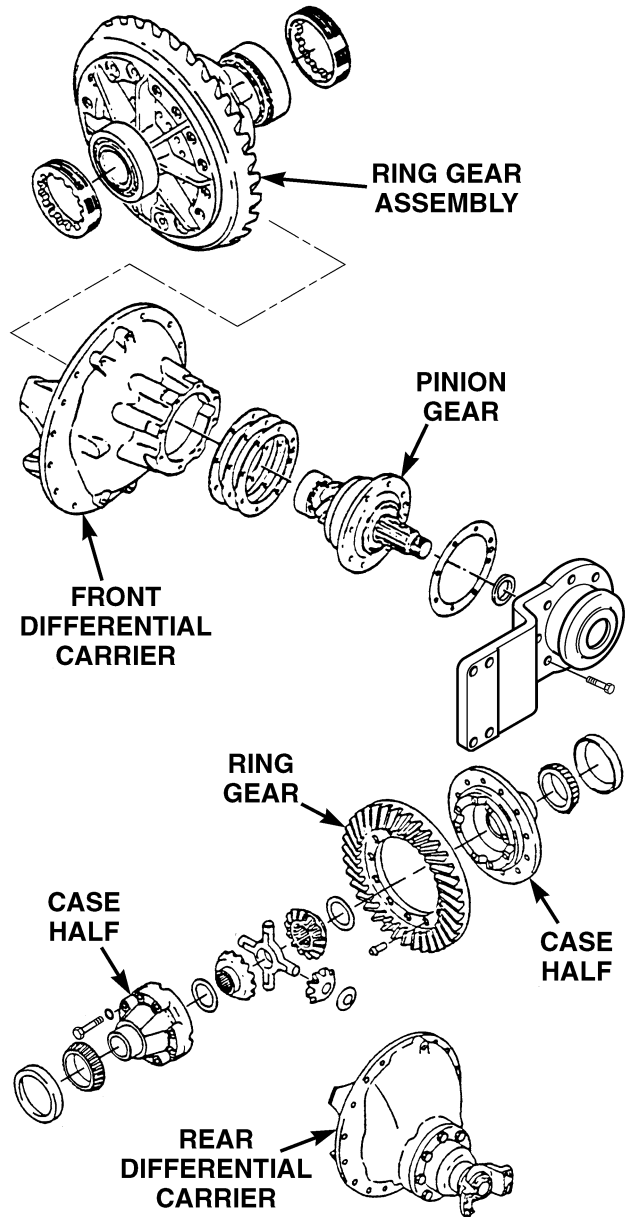
TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If carrier assemblies are incorrectly assembled and/or installed, differentials will bind and produce excessive noise.



**VISUAL INSPECTION**

Visually inspect front and/or rear differential carrier assemblies for correct order of components.

- (a) If components are in correct order and assembled properly, install assemblies in differential housings (Para 8-5 and 9-5). Then, inspect transmission assembly (Para 7-4) and torque converter (Para 7-3) for damage.
- (b) If components are not in correct order or not assembled properly, disassemble, re-assemble, and adjust carrier assemblies. Install assemblies in differential housings (Para 8-5 and 9-5).



**8. PREMATURE WEAR/FAILURE OF FRONT DIFFERENTIAL COMPONENTS.**

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Bearing Puller Kit (Item 15, Appendix D)
- Dial Indicator (Item 3, Appendix D)
- Drill
- Lifting Device, 2,000 lb (907.18 kg) capacity (2)
- Seal Puller

*Equipment Condition*

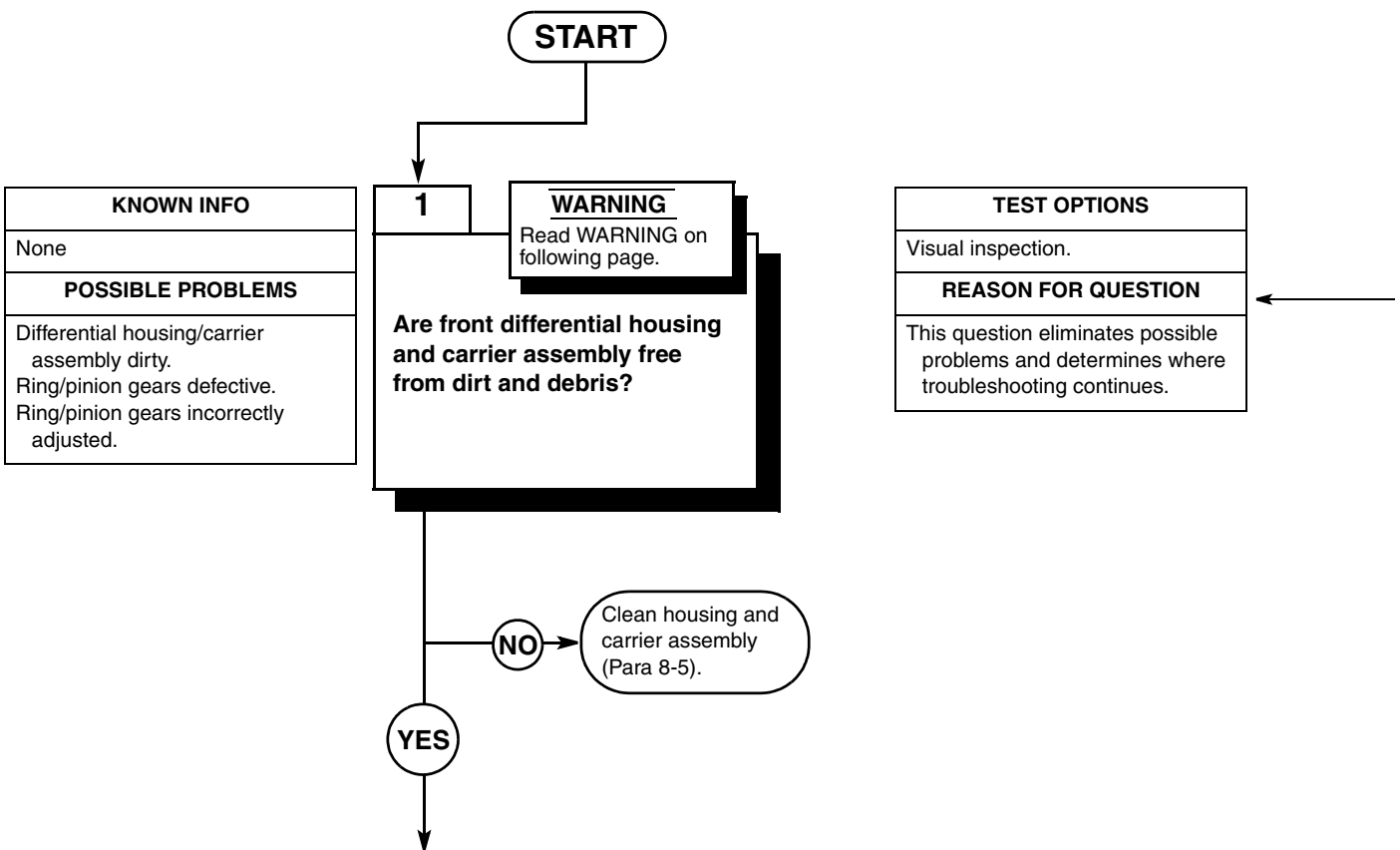
- Front axle housings removed (Para 8-3)
- Disc brake assemblies removed (Para 10-3)
- Planetary wheel ends removed (Para 8-6)

*Personnel Required*

Two

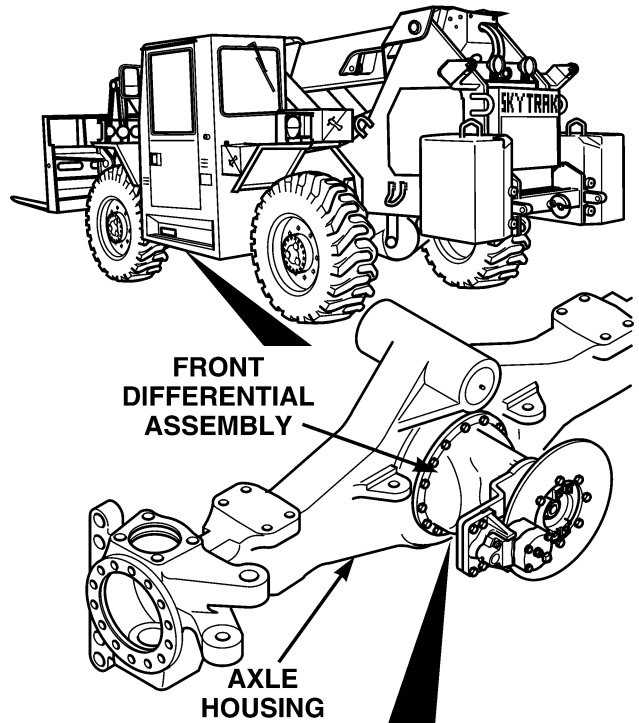
*References*

TM 10-3930-673-20



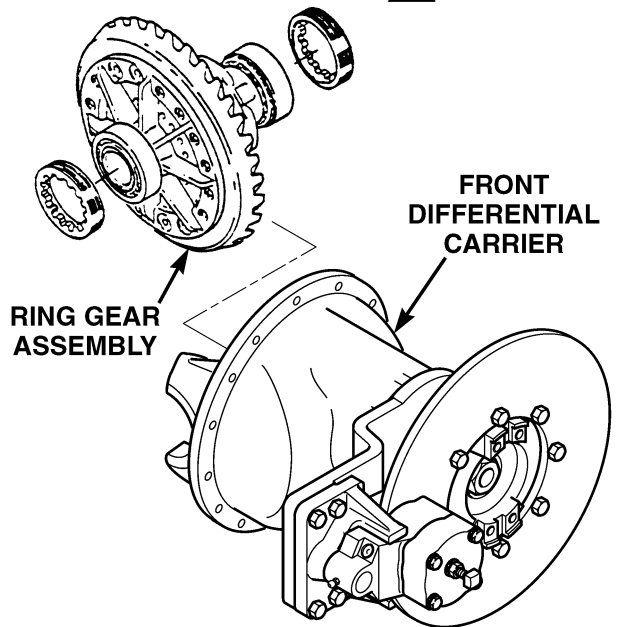
**WARNING**

- Differential and ring gear weigh 100+ lbs (45.4 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.
- No-spin differential contains compression springs under pressure. Failure to use a retaining bolt or other means of restraint can cause injury to personnel when removing no-spin differential.
- Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released, and could cause severe eye injury.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.



**CAUTION**

- Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.
- Ring gear must be heated before installation. Failure to heat ring gear before installation could cause damage to differential case half because of tight fit.
- Spacing between four initially installed screws must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.



**VISUAL INSPECTION**

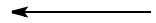
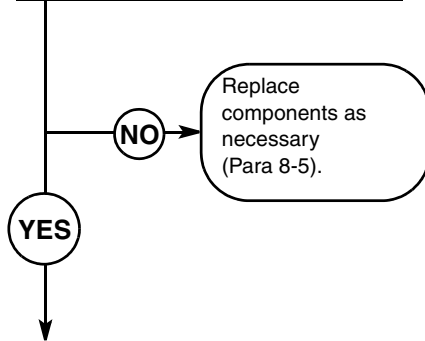
- (1) Remove differential carrier assembly from differential housing (Para 8-5).
- (2) Visually inspect housing and assembly for signs of dirt and debris.
  - (a) If housing and assembly are clean, go to Step 2 of this fault.
  - (b) If housing and/or assembly are dirty, disassemble carrier assembly and clean both housing and assembly (Para 8-5).

8. PREMATURE WEAR/FAILURE OF FRONT DIFFERENTIAL COMPONENTS (CONT).

<b>KNOWN INFO</b>
Housing/carrier assembly clean.
<b>POSSIBLE PROBLEMS</b>
Ring/pinion gears defective. Ring/pinion gears incorrectly adjusted.

<b>2</b>
<b>Are ring and pinion gears, bearings and seals free from signs of defects?</b>

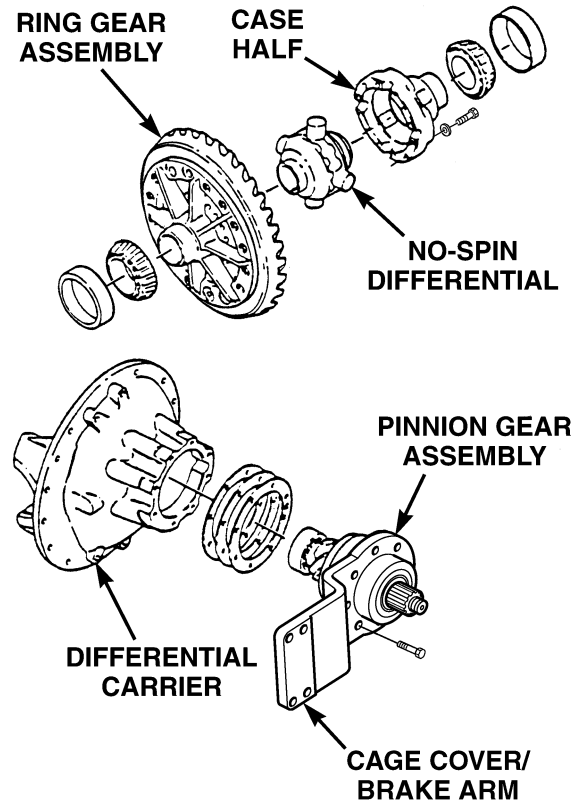
<b>TEST OPTIONS</b>
Visual inspection.
<b>REASON FOR QUESTION</b>
If ring/pinion gears are defective, premature wear/failure of components will occur.





**VISUAL INSPECTION**

- (1) Disassemble carrier assembly (Para 8-5).
- (2) Visually inspect components for defects and/or damage.
  - (a) If components are free from signs of defects go to Step 3 of this fault.
  - (b) If components show signs of defects and/or damage, replace components as necessary.

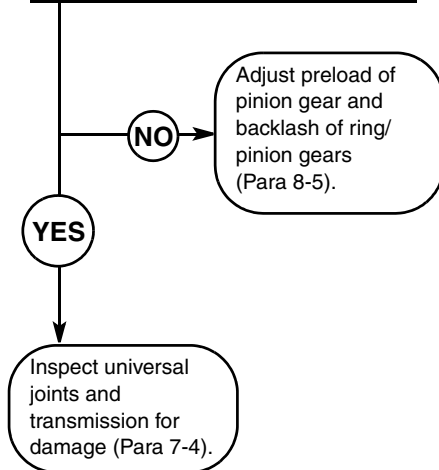


8. PREMATURE WEAR/FAILURE OF FRONT DIFFERENTIAL COMPONENTS (CONT).

KNOWN INFO
Housing/carrier assembly clean. Ring/pinion gears OK.
POSSIBLE PROBLEMS
Ring/pinion gears incorrectly adjusted.

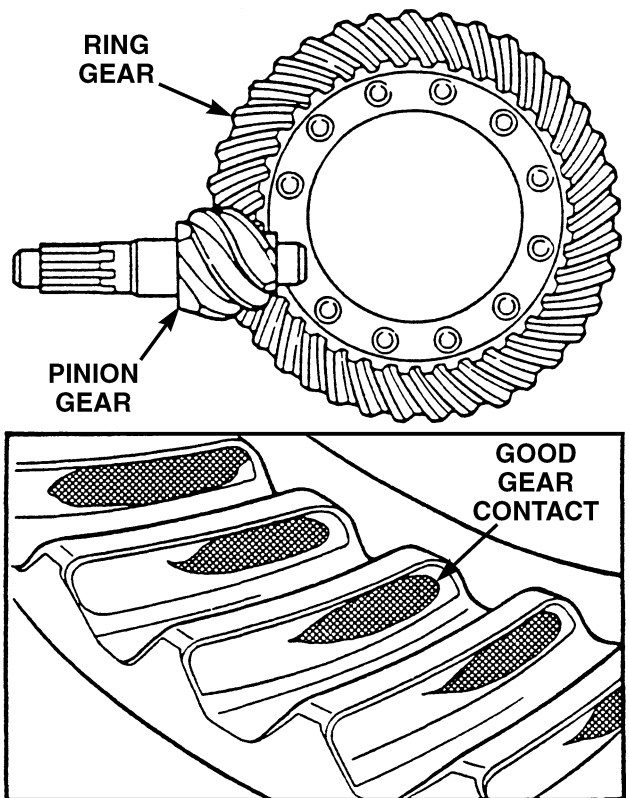
<b>3</b>
<b>Are ring and pinion gears correctly adjusted?</b>

TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If ring/pinion gears are incorrectly adjusted, premature wear/failure of components will occur.



**VISUAL INSPECTION**

- (1) Disassemble and clean ring and pinion gear assemblies (Para 8-5).
- (2) Assemble pinion gear-bearing-cage cover/brake mounting arm assembly.
- (3) Test preload of pinion gear-cage cover/brake mounting arm assembly.
  - (a) If assembly can be rotated around bearings with 4 to 6 lbs pull as measured with dial indicator, go to Step (4) below.
  - (b) If assembly cannot be rotated around bearings with 4 to 6 lbs of pull, disassemble and add or take away spacer shims to adjust preload (Para 8-5).
- (4) Assemble ring and pinion gear assemblies.
- (5) Test backlash of ring and pinion gears.
  - (a) If backlash is within 0.008 to 0.010 inch, install assemblies in housing. Inspect universal joints and transmission for damage (Para 7-4).
  - (b) If backlash is greater than 0.008 to 0.010, adjust mesh between ring and pinion gears (Para 8-5).
- (6) Install carrier assembly in housing.



**9. EMERGENCY STEERING PUMP RUNS BUT DOES NOT DEVELOP PRESSURE OR FLOW.**

**INITIAL SETUP**

*Tools and Special Tools*

Shop Equipment, Automotive Maintenance,  
Common No. 1 Less Power  
(Item 16, Appendix D)

*Personnel Required*

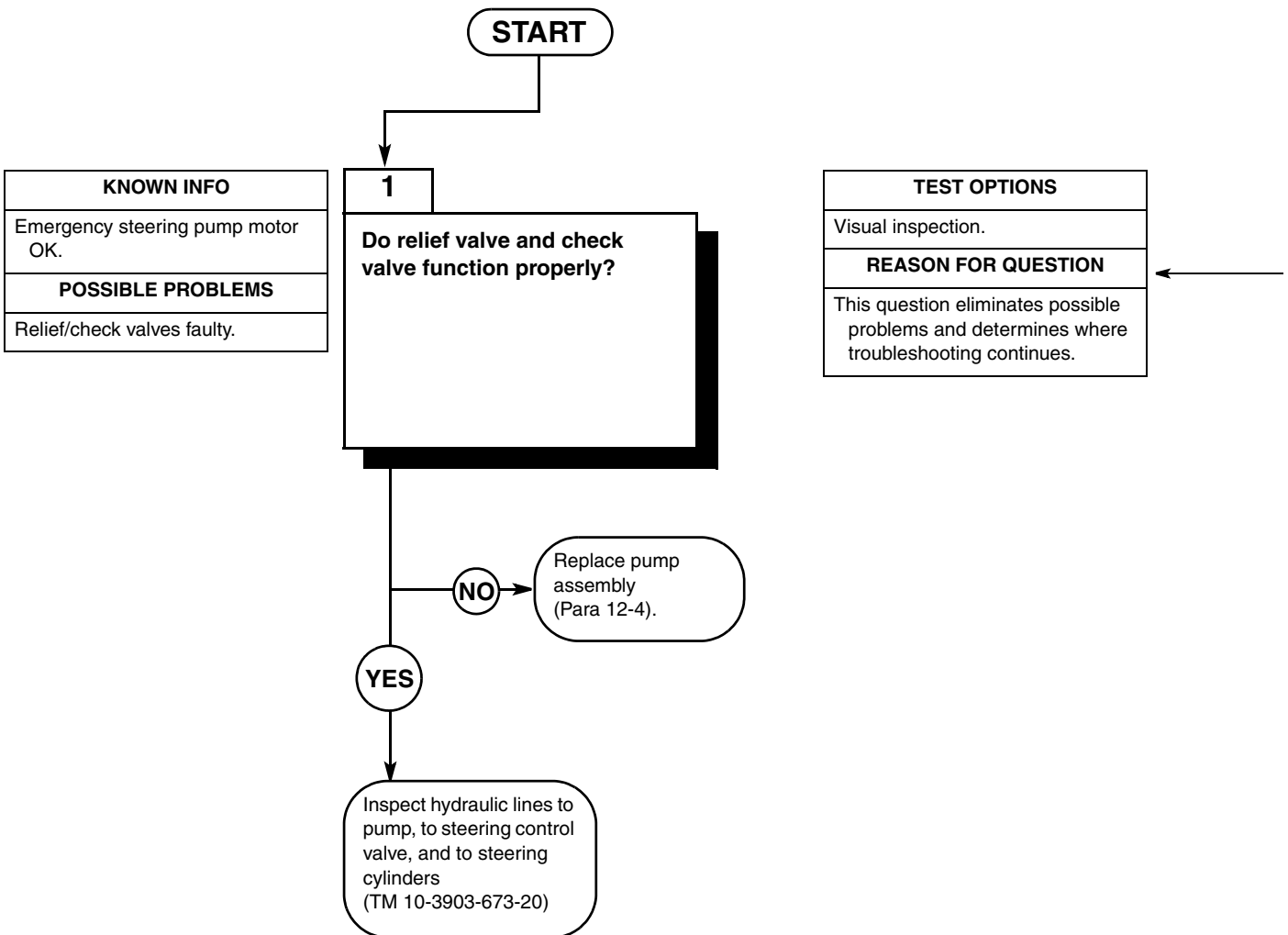
Two

*References*

TM 10-3930-673-20

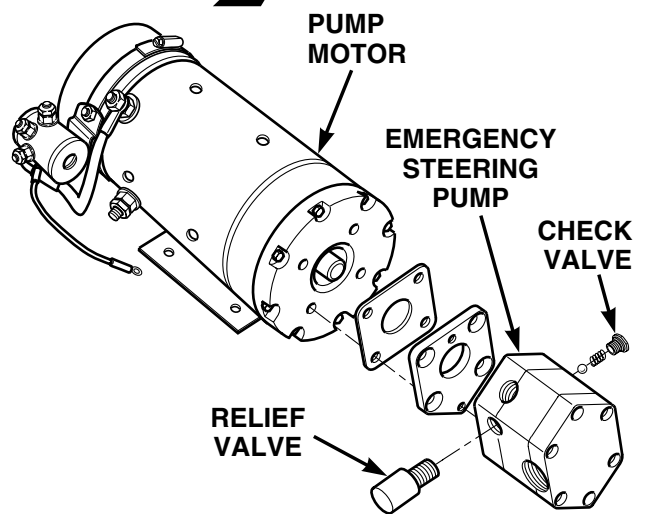
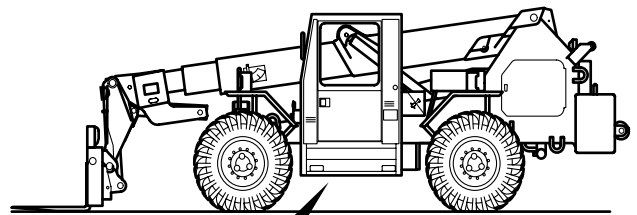
*Equipment Condition*

Emergency steering pump removed  
(TM 10-3930-673-20)



**VISUAL INSPECTION**

- (1) Remove relief valve and check valve from pump assembly (Para 12-4).
- (2) Visually inspect valves for damage and/or wear.
  - (a) If valves are free from signs of damage and/or wear, install valves in pump assembly. Then, inspect hydraulic lines leading to pump, to steering control valve, and to steering cylinders. Replace components as necessary (TM 10-3930-673-20).
  - (b) If valves show signs of damage and/or wear, replace pump assembly and valves (Para 12-4).



**10. BRAKE ACCUMULATOR DOES NOT CHARGE, CHARGES FREQUENTLY.**

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m) (Item 28, Appendix D)
- Wrench, Torque, 0 - 800 lb-ft (0 - 1085 N•m) (Item 29, Appendix D)
- Micrometer (Item 13, Appendix D)
- Pressure Gage (0-5000 lbs)

*Equipment Condition*

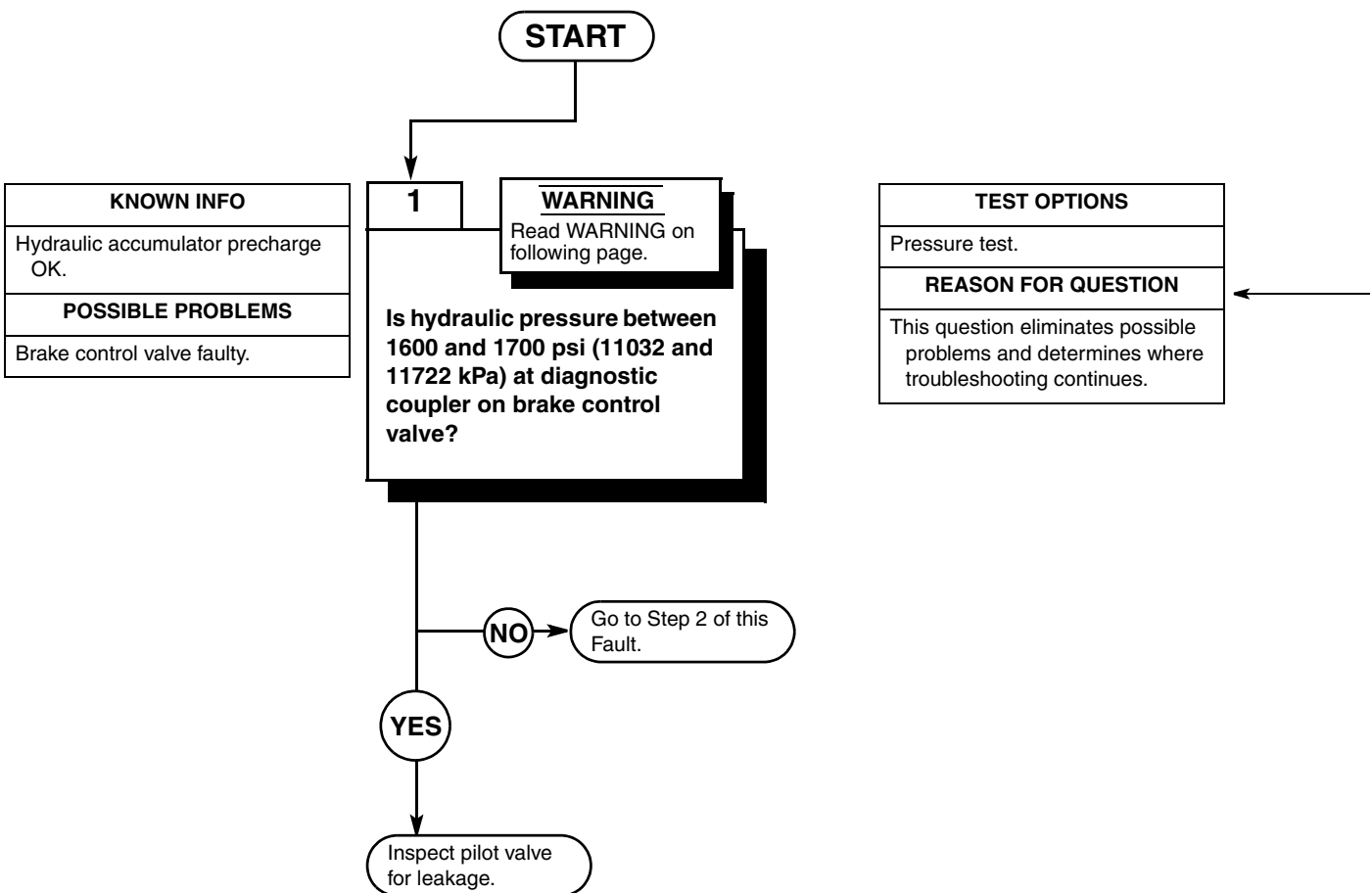
- Engine shut down (TM 10-3930-673-10)
- Wheels chocked (TM 10-3930-673-10)

*Personnel Required*

Two

*References*

TM 10-3930-673-20

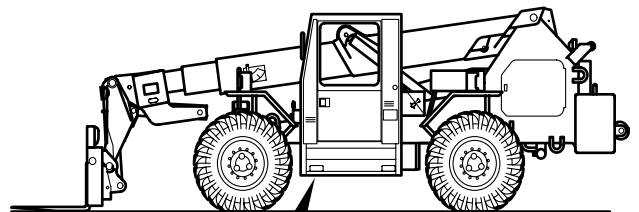


**WARNING**

- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

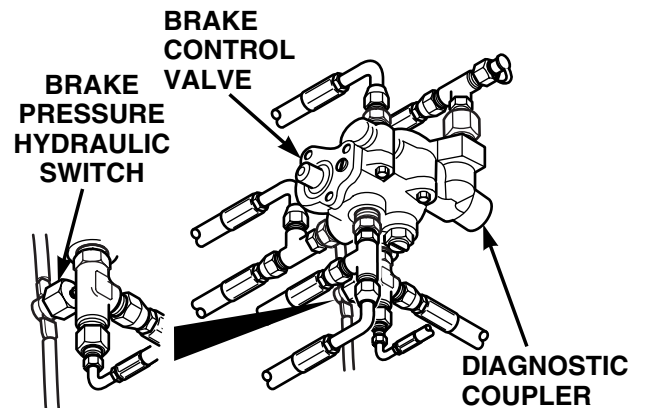
**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.



**PRESSURE TEST**

- (1) Remove cap from diagnostic coupler on brake control valve.
- (2) Perform a pressure test at the diagnostic coupler.
  - (a) If hydraulic pressure is between 1600 and 1700 psi (11032 and 11722 kPa), inspect pilot valve for signs of damage.
  - (b) If hydraulic pressure is not between 1600 and 1700 psi (11032 and 11722 kPa), go to Step 2 of this Fault.



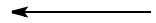
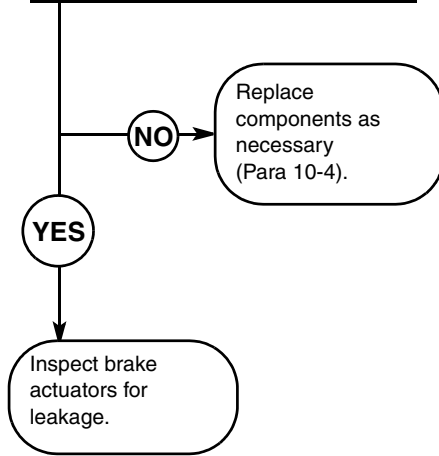
10. BRAKE ACCUMULATOR DOES NOT CHARGE, CHARGES FREQUENTLY (CONT).

KNOWN INFO
Hydraulic accumulator precharge pressure OK.
POSSIBLE PROBLEMS
Brake control valve faulty.

**2**

**Are brake control valve components free from signs of damage and/or wear?**

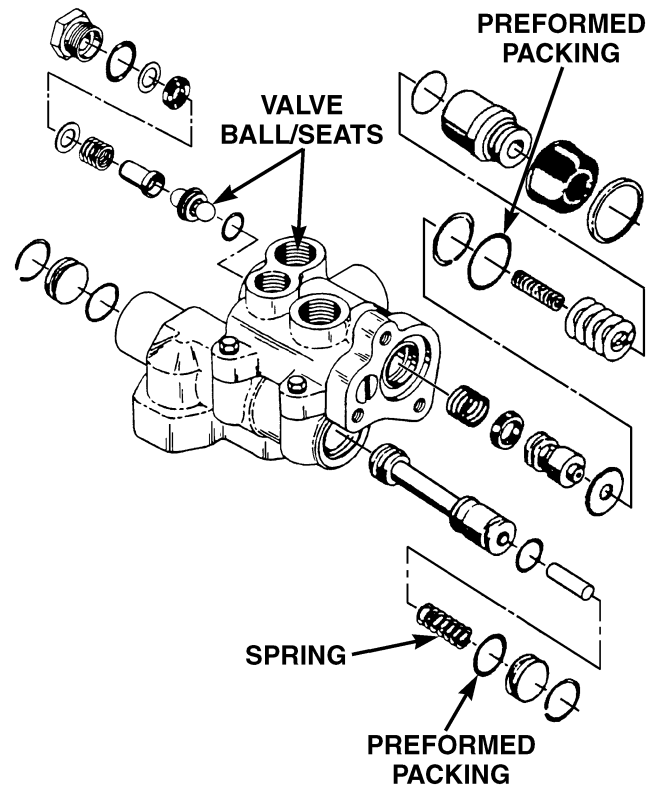
TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If brake control valve is faulty, accumulator may not charge, or will charge frequently.





**VISUAL INSPECTION**

- (1) Remove service brake control valve from vehicle (TM 10-3930-673-20).
- (2) Disassemble brake control valve (Para 10-4).
- (3) Visually inspect seals and preformed packings for leaks, springs for breaks and/or wear, the correct seating of balls in valves, and plug and locking pin for damage. Also, inspect filter for dirt and/or obstructions.
  - (a) If components are free from signs of leaks, damage and/or wear, and dirt or obstructions, reassemble brake control valve (Para 10-4) and inspect brake actuators for leakage.
  - (b) If components show signs of leaks, damage and/or wear, and dirt or obstructions, clean and/or replace components as necessary (Para 10-4).
- (4) Reassemble brake control valve (Para 10-4).
- (5) Install brake control valve on vehicle (TM 10-3930-673-20).



**11. LEAKS BETWEEN ATTACHMENT/MAIN CONTROL VALVE SECTIONS.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

*Personnel Required*

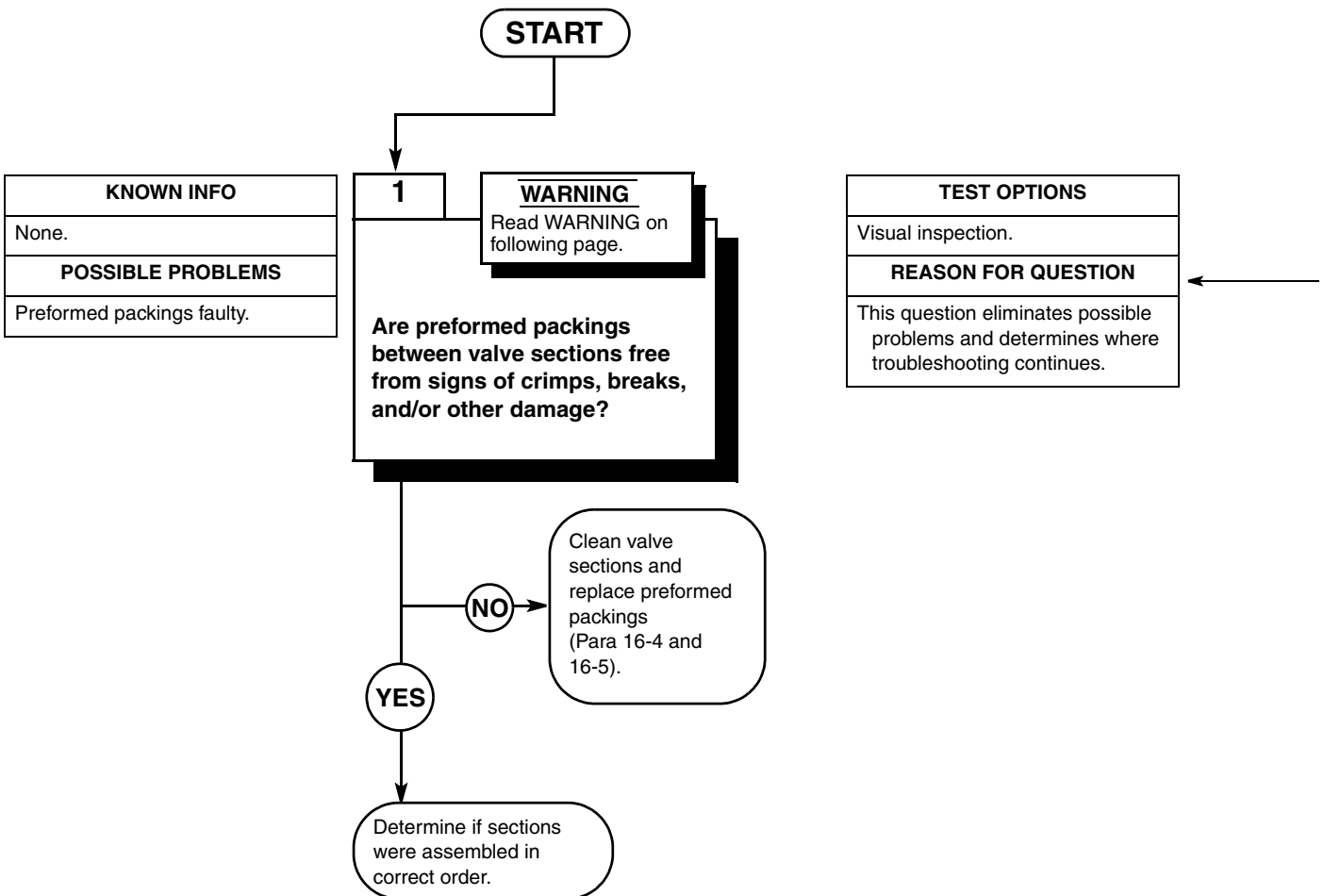
Two

*References*

TM 10-3930-673-20

*Equipment Condition*

Attachment control valve removed  
(TM 10-3930-673-20)  
Main control valve removed  
(TM 10-3930-673-20)



**WARNING**

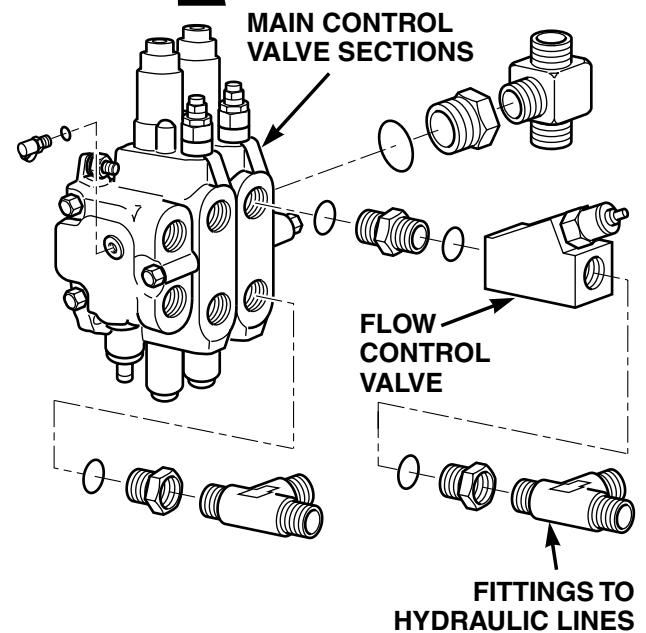
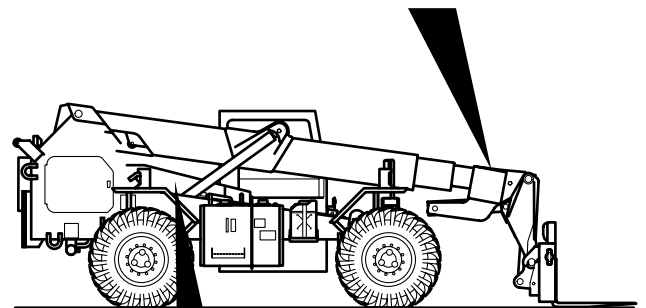
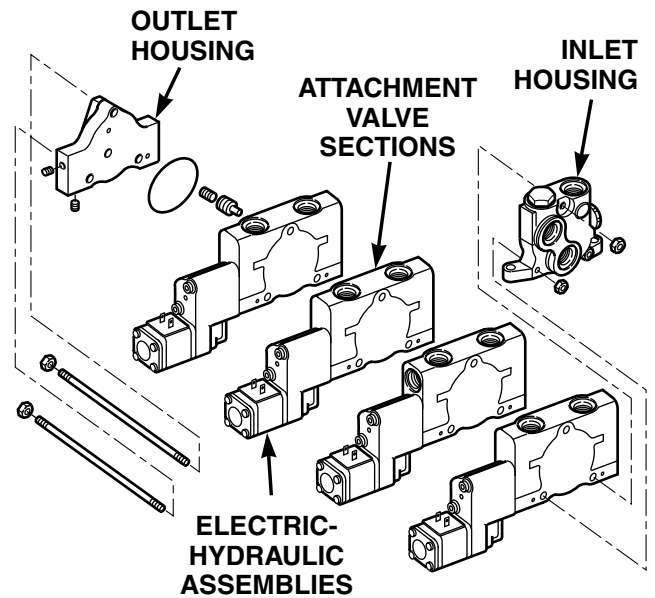
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (37.8°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

**VISUAL INSPECTION**

- (1) Separate the various sections of the attachment control valve and/or main control valve.
- (2) Visually inspect preformed packings between sections for crimps, breaks, and/or other damage.
  - (a) If preformed packings are free from signs of crimps, breaks, and/or other damage, determine if sections were assembled in correct order. Go to Step (3) below.
  - (b) If preformed packings are crimped, broken, or show signs of other damage, replace faulty packings (Para 16-4 and 16-5) and go to Step (3) below.
- (3) Assemble the various sections of the attachment control valve and/or main control valve in correct order on tie rod.
- (4) Torque tie rods as specified (Para 16-4 and 16-5).
- (5) Install attachment control valve and/or main control valve (TM 10-3930-673-20).



**12. PLUNGERS STICK IN ATTACHMENT/MAIN CONTROL VALVES.**

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

*Personnel Required*

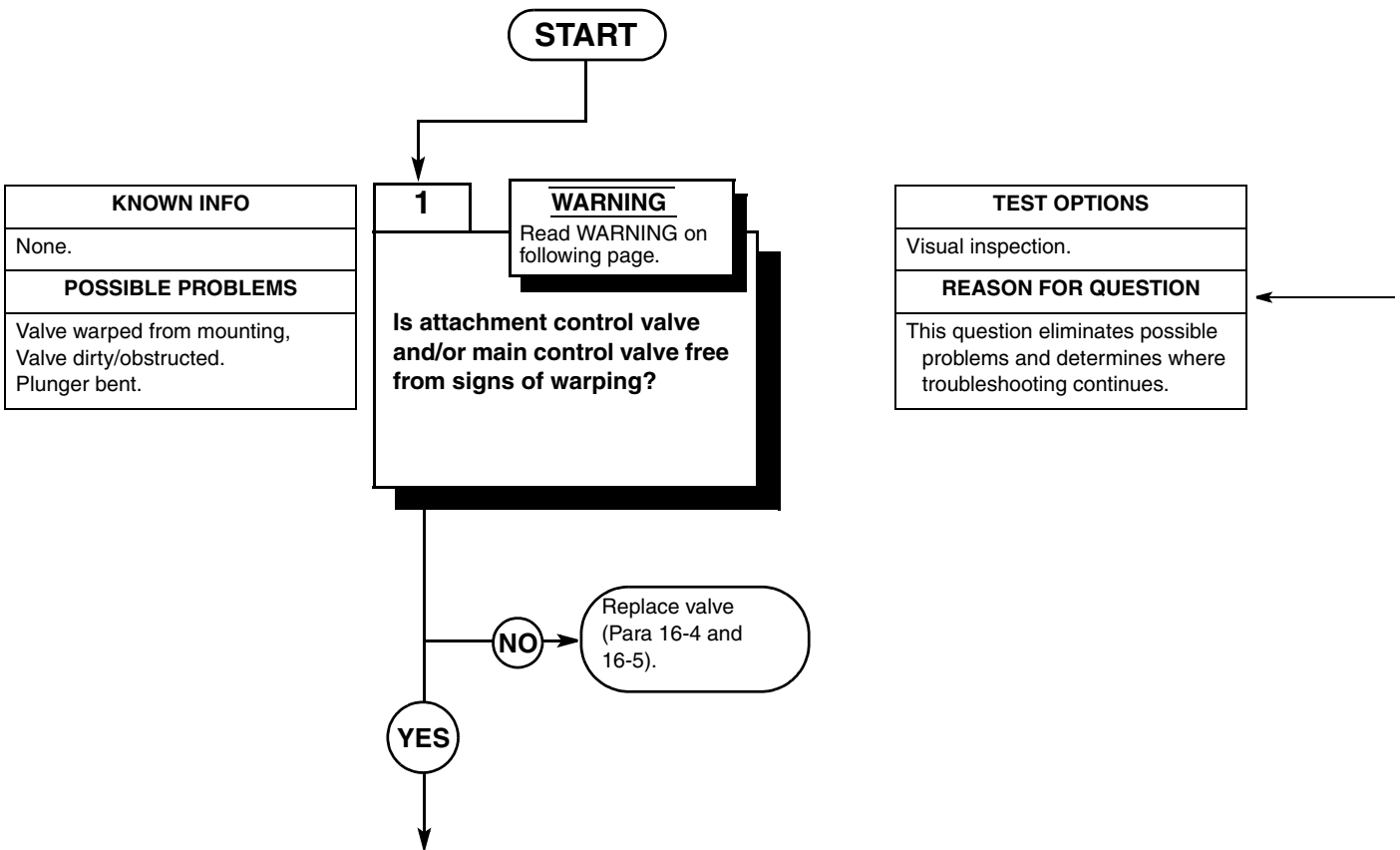
Two

*References*

TM 10-3930-673-20

*Equipment Condition*

Pressure relieved from hydraulic system  
(TM 10-3930-673-20)  
Transmission cover removed  
(TM 10-3930-673-20)



**WARNING**

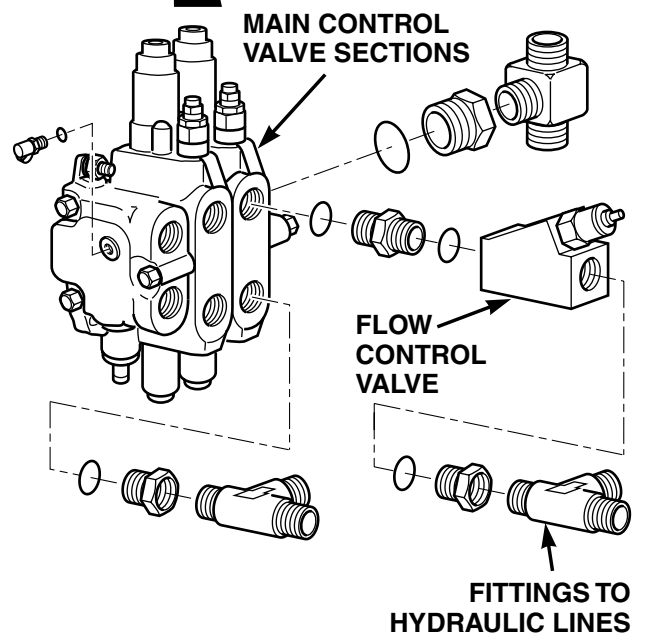
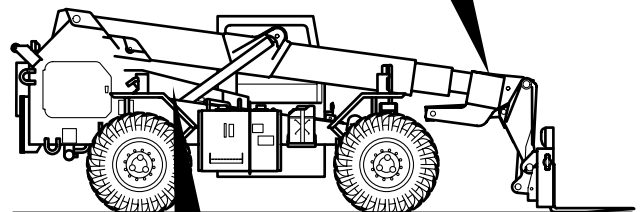
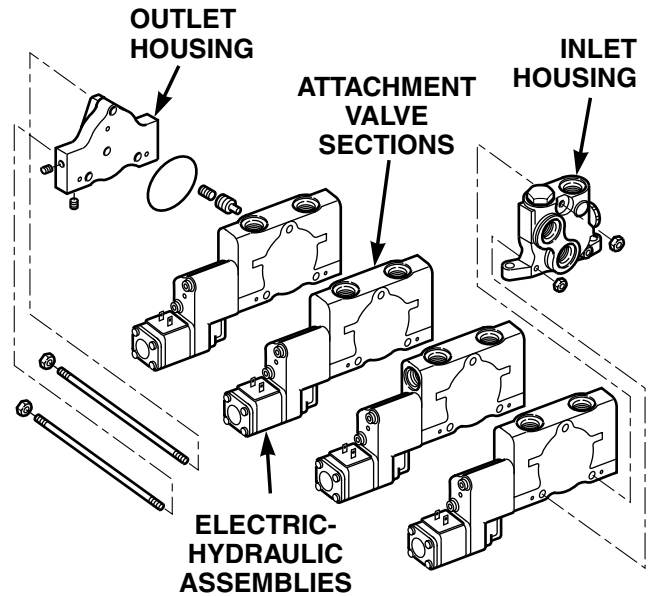
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, and so forth).
- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.

**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure

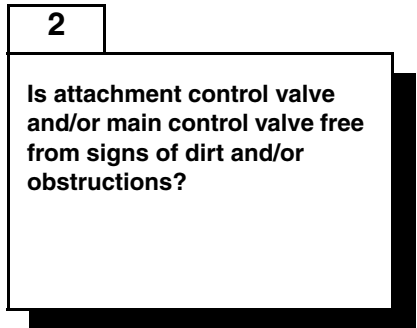
**VISUAL INSPECTION**

- (1) Visually inspect attachment control valve and/or main control valve as mounted for signs of warping.
- (2) Loosen and re-tighten mounting screws; loosen and re-torque tie rods.
  - (a) If attachment control valve and/or main control valve is free from signs of warping, go to Step 2 of this Fault.
  - (b) If valve shows signs of warping, remove valve (TM 10-3930-673-20) and repair or replace valve (Para 16-4 and 16-5).

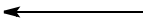
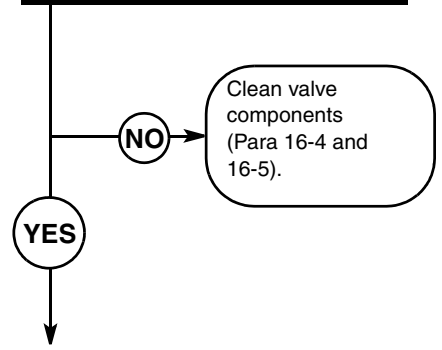


12. PLUNGERS STICK IN ATTACHMENT/MAIN CONTROL VALVES (CONT).

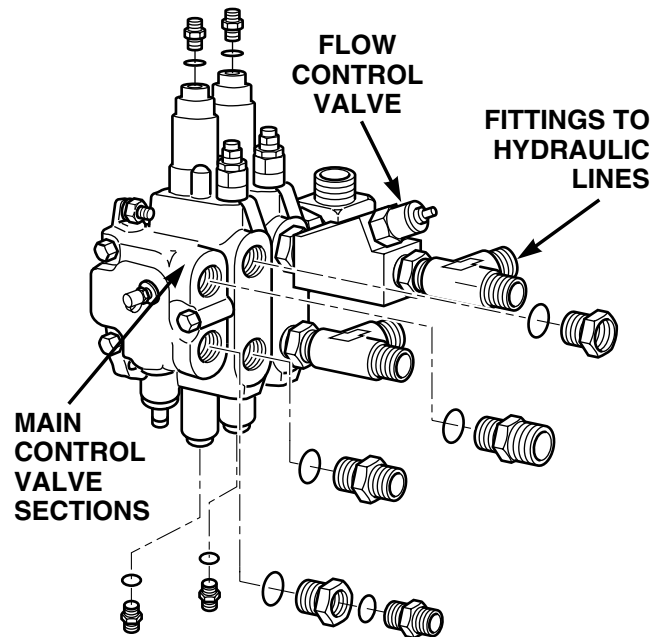
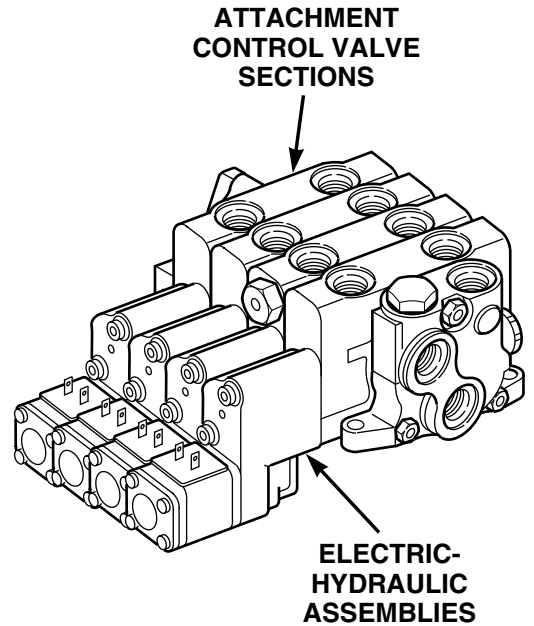
KNOWN INFO
Valve not warped.
POSSIBLE PROBLEMS
Valve dirty/obstructed. Plunger bent.



TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
If valve is dirty or obstructed, plungers will stick.



<b>VISUAL INSPECTION</b>	
(1)	Remove attachment control valve and/or main control valve (TM 10-3930-673-20).
(2)	Disassemble valve (Para 16-4 and 16-5) and visually inspect components for dirt and obstructions.
(a)	If attachment control valve and/or main control valve is free from signs of dirt and obstructions, go to Step 3 of this Fault.
(b)	If valve shows signs of dirt and obstructions, clean components (Para 16-4 and 16-5).



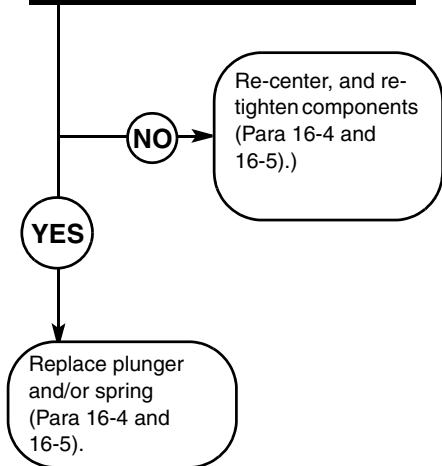
12. PLUNGERS STICK IN ATTACHMENT/MAIN CONTROL VALVES (CONT).

KNOWN INFO
Valve not warped. Valve clean/unobstructed.
POSSIBLE PROBLEMS
Plunger bent.

**3**

**Is valve plunger bent? Is return spring damaged or broken?**

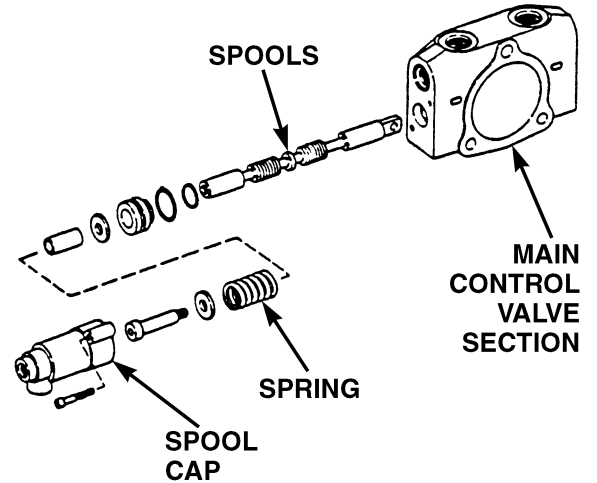
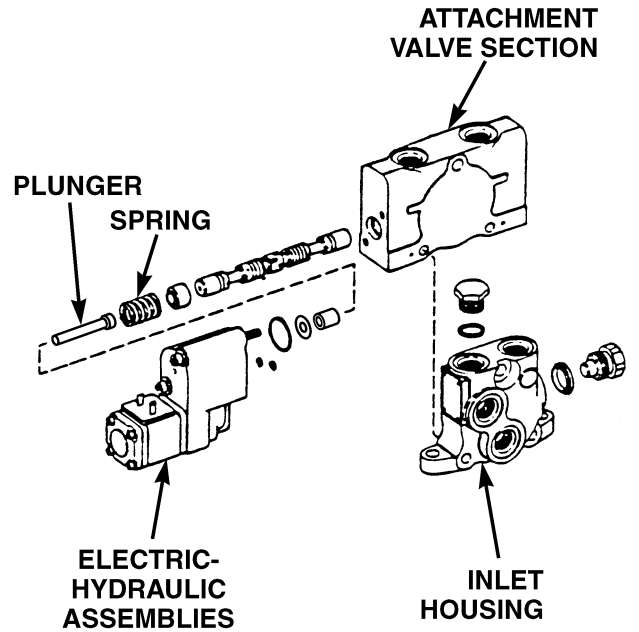
TEST OPTIONS
Visual inspection.
REASON FOR QUESTION
IF valve is dirty or obstructed, plungers will stick.





**VISUAL INSPECTION**

- (1) Visually inspect plunger and return spring of attachment control valve and/or main control valve for bends and breaks.
  - (a) If valve plunger and return spring are bent and/or broken, replace plunger and/or spring (Para 16-4 and 16-5).
  - (b) If plunger and return spring are not bent or broken, re-center and re-tighten valve components (Para 16-4 and 16-5).
- (2) Check to see that valve is correctly assembled.
- (3) Install attachment control valve and/or main control valve (TM 10-3930-673-20).



## Section III. GENERAL MAINTENANCE INSTRUCTIONS

### 2-9. SCOPE

These general maintenance instructions contain general shop practices and specific methods you must be familiar with to properly maintain the ATLAS. You should read and understand these practices and methods before starting maintenance tasks on the ATLAS.

### 2-10. WORK SAFETY

**a.** Before starting a task, think about the risks and hazards to your safety as well as others. Wear protective gear such as safety goggles or lenses, safety shoes, rubber apron, or gloves. Protect yourself against injury.

**b.** When lifting heavy parts, have someone help you. Make sure that lifting equipment is working properly, that it is suitable for the task assigned, and is secured against slipping.

**c.** Always use power tools carefully.

**d.** Disconnect negative battery terminal before performing any maintenance.

### 2-11. GENERAL INFORMATION

**a.** Before beginning a task, find out how much repair, modification, or replacement is needed to fix the equipment as described in this manual. Sometimes the reason for equipment failure can be seen right away and complete teardown is not necessary. Disassemble the equipment only as far as necessary to repair or replace damaged or broken parts.

**b.** All tags and forms attached to the equipment must be checked to learn the reason for removal from service. Check all Modification Work Orders (MWO) and Technical Bulletins (TB) for equipment changes and updates.

**c.** In some cases a part may be damaged by removal. If the part appears to be good, and other parts behind it are not defective, leave it on and continue the procedure. Here are a few simple rules:

- (1) Do not take out dowel pins or studs unless loose, bent, broken, or otherwise damaged.
- (2) Do not pull bearings or bushings unless damaged. If you must get at parts behind them, pull out bearings or bushings carefully.
- (3) Replace all gaskets, seals, and preformed packings.

### 2-12. CLEANING INSTRUCTIONS

#### **a. General.**

- (1) The cleaning instructions will be the same for the majority of parts and components that make up the ATLAS.
- (2) The importance of cleaning must be thoroughly understood by maintenance personnel. Great care and effort are required in cleaning. Dirt and foreign material are a constant threat to satisfactory maintenance. The following should apply to all cleaning, inspection, repair, and assembly operations.

- (a) Clean all parts before inspection, after repair, and before assembly.
  - (b) Hands should be kept free of any accumulation of grease, which can collect dust, dirt, or grit.
  - (c) After cleaning, all parts should be covered or wrapped to protect them from dust and dirt. Parts that are subject to rust should be lightly oiled.
- (3) Observe the following precautions during all cleaning operations:

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel. If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.
- Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.
- Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.

**b. External Engine Cleaning.**

- (1) Protect all electrical equipment that could be damaged by the steam or moisture before steam cleaning.
- (2) Cover all openings before steam cleaning.
- (3) After cleaning, dry and apply a light coat of oil to all parts subject to rust.
- (4) Blow out all tapped (threaded) holes with compressed air to remove dirt and cleaning fluids.

**c. Disassembled Parts Cleaning.**

- (1) Place all disassembled parts in wire baskets for cleaning.
- (2) Dry and cover all cleaned parts.
- (3) Place parts on or in racks and hold for inspection or repair.
- (4) All parts subject to rusting must be lightly oiled and wrapped.
- (5) Keep all related parts and components together. Do not mix parts.

## 2-12. CLEANING INSTRUCTIONS (CONT)

### *d. Castings.*

- (1) Clean inner and outer surfaces of castings and all areas subject to grease and oil with cleaning solvents. Refer to TM9-247.
- (2) Use a stiff brush to remove sludge and gum deposits.
- (3) Blow out all tapped (threaded) holes with compressed air to remove dirt and cleaning fluids.

### *e. Oil Passages.* Particular attention must be given to all oil passages in castings and machined parts. Oil passages must be clean and free of any obstructions.

- (1) Clean passages with wire probes to break up any sludge or gum deposits.
- (2) Wash passages by flushing with solvents. Refer to TM9-247.
- (3) Dry passages with compressed air.

### *f. Oil Seals, Electrical Cables, and Flexible Hoses.*

#### CAUTION

Washing oil seals, electrical cables, and flexible hoses with dry cleaning solvents or mineral spirits will cause serious damage or destroy the material.

- (1) Wash electrical cables and flexible hose with water and mild soap solution and wipe dry.
- (2) Oil seals are generally damaged during removal, so cleaning will not be necessary since new seals will be used in assembly.

### *g. Bearings.*

- (1) Bearings require special cleaning. After removing surface oil and gum deposits, place bearings in hot oil (140°F (60°C)) to loosen congealed oil and grease. Wipe bearings dry. Do not use compressed air. After cleaning, coat bearings with oil, wrap in paper, and hold for inspection.
- (2) Refer to TM9-214 for information and care of bearings.

### *h. Machine Tooled Parts.*

#### WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel. If personnel become dizzy while using cleaning solvent, immediately get

fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

- Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.
  - Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.
  - Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.
- (1) Clean machine tooled parts with dry cleaning solvent (P-D-680).
  - (2) Dry parts with compressed air.

***i. Machined Surfaces.***

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel. If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
  - Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.
  - Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.
  - Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.
- (1) Clean machined surfaces with dry cleaning solvent (P-D-680).
  - (2) Dry surfaces with compressed air.

## 2-12. CLEANING INSTRUCTIONS (CONT)

### *j. Mated Surfaces.*

#### **WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel. If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
  - Improper cleaning methods and use of unauthorized cleaning solvents may injure personnel and damage equipment. Refer to TM9-247 for correct information.
  - Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.
  - Particles blown by compressed air are hazardous. Make certain the air stream is directed away from user and other personnel in the area. To prevent injury, user must wear protective goggles or face shield when using compressed air.
- (1) Remove old gasket and/or sealing compound using wire brush and dry cleaning solvent (P-D-680).
  - (2) Lightly oil and wrap all parts subject to rust before storing.

*k. Rusted Surfaces.* Clean all rusted surfaces using wire brush and crocus cloth.

*l. Oil Bathed Internal Parts.* Wipe oil bathed internal parts clean with lint free cloth.

*m. Air Actuated Internal Parts.* Wipe air actuated internal parts clean with lint free cloth.

*n. Externally Exposed Parts.* Wash externally exposed parts with soap and water. Rinse thoroughly and air dry.

## 2-13. GENERAL DISASSEMBLY AND ASSEMBLY INSTRUCTIONS

- a.* Always put together or take apart one part at a time. Do not work on two parts at the same time. Be sure to make all adjustments. Always check your work when you are finished. Make sure everything is done.

- b.** Check the adjustments for the last time by operating the vehicle. If all adjustments are correct, the vehicle is ready to go back to work.

## 2-14. INSPECTION INSTRUCTIONS

- a. General.** All components and parts must be carefully checked to determine if they are serviceable for reuse, if they can be repaired, or if they must be scrapped.

**b. Drilled and Tapped (Threaded) Holes.**

- (1) Inspect for wear, distortion (stretching), cracks, or any other damage in or around holes.
- (2) Inspect threaded areas for wear, distortion, or evidence of cross-threading.
- (3) Mark all damaged areas for repair or replacement.

**c. Metal Lines, Flexible Lines (Hoses) and Fittings.**

- (1) Inspect lines for sharp kinks, cracks, bends, or dents.
- (2) Inspect flexible lines for fraying, evidence of leakage, or loose fittings or connectors.
- (3) Check all fittings and connectors for thread damage. Check for hex heads that are worn or rounded by poorly fitting wrenches.
- (4) Mark all damaged material for repair or replacement.

**d. Castings.**

- (1) Inspect all ferrous and nonferrous castings for cracks using a magnifying glass and strong light.
- (2) Refer to MIL-I-6866, Inspection, Liquid Penetrant Methods, and MIL-I-6868, Inspection Process, Magnetic Particles.
- (3) Particularly check areas around studs, pipe plugs, threaded inserts, and sharp corners. Replace all cracked castings.
- (4) Inspect machined surfaces for nicks, burrs, or raised metal. Mark damaged areas for repair or replacement.
- (5) Inspect all pipe plugs, pipe plug openings, screws, and screw openings for damaged or stripped threads.
- (6) Check all gasket mating surfaces, flanges on housings, and supports for warpage with a straightedge or surface plate. Inspect mating flanges for discolorations that may indicate persistent oil leakage.
- (7) Check all castings for conformance to applicable repair standards.

- e. Bearings.** Refer to TM9-214 for inspection of bearings. Check all bearings for conformance to applicable repair standards.

- f. Studs, Bolts, and Screws.** Replace if threads are damaged, bent, loose, or stretched.

## 2-14. INSPECTION INSTRUCTIONS (CONT)

### ***g. Gears.***

#### **NOTE**

When gear teeth wear limits are not established, good judgement is required to determine if gear replacement is necessary.

- (1) Inspect all gears for cracks using a magnifying glass and strong light. No cracks are permissible.
- (2) Inspect gear teeth for wear, sharp fins, burrs, and galled or pitted surfaces.
- (3) Check keyway slots for wear or damage.

### ***h. Bushings and Bushing Type Bearings***

- (1) Check all bushings and bushing type bearings for secure fit, evidence of overheating, wear, burrs, nicks, and out-of-round condition. Replace as necessary.
- (2) Check for dirt in lubrication holes or grooves. Holes and grooves must be clean and free from damage.

***i. Oil Seals.*** Oil seals are mandatory replacement items.

***j. Core Hole Expansion Plugs.*** Inspect for leakage. Replace plugs when leakage is present.

***k. Machine Tooled Parts.*** Inspect for cracks, breaks, elongated holes, wear, and chips. Replace any damaged parts.

***l. Machined Surfaces.*** Inspect for cracks, evidence of wear, galled or pitted surface, burrs, nicks, and scratches.

***m. Mated Surfaces.*** Inspect for remains of old gasket, seal, secure fit, pitting, and evidence of leakage.

***n. Rusted Surfaces.*** Inspect for pitting, holes, and severe damage.

***o. Oil Bathed Internal Parts.*** Inspect for cracks, nicks, burrs, evidence of overheating, and wear.

***p. Air Actuated Internal Parts.*** Inspect for cracks, nicks, burrs, evidence of overheating, and wear.

***q. Externally Exposed Parts.*** Inspect for breaks, cracks, rust damage, and wear.

***r. Springs.*** Inspect for broken, collapsed, and twisted coils.



## 2-15. REPAIR INSTRUCTIONS

- a. General.** Any repair procedure peculiar to a specific part or component is covered in the section or paragraph relating to that item. After repair, clean all parts thoroughly to prevent dirt, metal chips, or other foreign material from entering any working parts.

### CAUTION

Repaired items must be thoroughly cleaned to remove metal chips and abrasives to prevent them from entering working parts of the ATLAS.

**b. Castings.**

- (1) All cracked castings will be replaced.
- (2) Only minor repairs to machined surfaces, flanges, and gasket mating surfaces are permitted. Remove minor nicks, burrs, and scratches with:
  - (a) Fine mill file.

### WARNING

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
  - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- (b) Crocus cloth dipped in drycleaning solvent.
  - (c) Lapping across a surface plate.
- (3) Remachining of machined surfaces to repair damage, warpage, or uneven surfaces is not permitted. Replace castings.
  - (4) Repair damaged threaded pipe plug or screw threads with a tap. Repair oversize holes with threaded inserts.

- c. Bearings.** Refer to TM9-214 for repair of bearings.

**2-15. REPAIR INSTRUCTIONS (CONT)**

**d. Studs.** Replace all bent and stretched studs. Repair minor thread damage with a thread die. Replace studs having stripped or damaged threads as outlined below:

- (1) Remove using a stud remover. Back studs out slowly to avoid heat buildup and seizure that can cause stud to break off.

**CAUTION**

Refer to TM9-237, Welding Instructions, to avoid damage to castings if welding method is used.

- (2) If studs break off too short to use a stud remover, use a stud extractor to remove or use “welding method.”
- (3) Broken studs can be removed by welding bar stock or a nut to stud and removing with wrench.
- (4) Install replacement stud slowly to prevent heat buildup and snapping off.

**e. Gears.**

- (1) Remove gears using pullers.
- (2) Only minor repairs to gears are permitted. Remove minor nicks, burrs, or scratches on gear teeth with:
  - (a) Fine mill file.

**WARNING**

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- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

- (b) Crocus cloth dipped in drycleaning solvent.
- (3) If keyway is worn or enlarged, replace gear.

**f. Bushings and Bushing Type Bearings.** When bushings and bushing type bearings seize to a shaft and spin in the bore, the associated part must also be replaced.

***g. Oil Seals.***

- (1) Remove oil seals by pressing or prying out, being careful not to damage casting or adapter bore.
- (2) Always install new seal in bore using proper seal replacing tool.

**2-16. PAINTING INSTRUCTIONS**

Upon installation, restored parts must be painted per TB 43-0209.



## CHAPTER 3

### ENGINE SYSTEM MAINTENANCE

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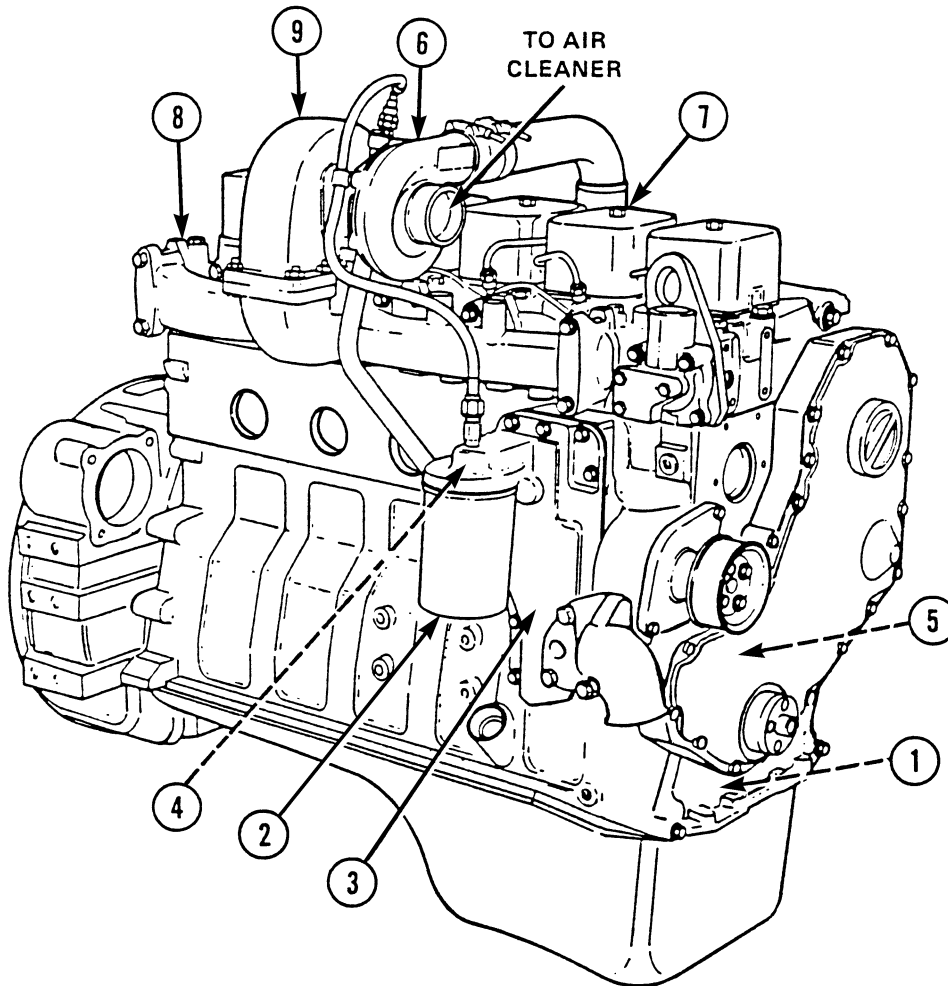
#### Section I. DESCRIPTION AND DATA

##### 3-1. GENERAL

This chapter covers maintenance procedures for the engine system components, as well as principles of operation.

### 3-2. PRINCIPLES OF OPERATION

**a. Construction.** Engine is a six cylinder, inline, four-stroke-cycle, turbocharged, fuel injected, liquid cooled diesel. A 4.02 in. bore and a 4.72 in. stroke produce a piston displacement of 359 cu. in. Engine firing order is 1, 5, 3, 6, 2, 4, and engine rotation is clockwise, as viewed from front (fan) end. Cylinder number 1 is closest to fan. Rated horsepower is 165 hp, at engine speed of 2500 rpm. Maximum rated torque is 400 ft-lb at engine speed of 1500 rpm.



**b. Fuel System.** Engine fuel system is described in Para 4-2.

**c. Cooling System.** Engine cooling system is described in Para 5-2.

**d. Lubrication System.** Engine lubricating oil is forced through various internal passages by an internally mounted, gear type pump (1). Oil is cleaned by a disposable filter cartridge (2) and is cooled by engine coolant flow through a cooler (3) mounted to the side of the engine. A pressure operated bypass valve (4) is incorporated to provide continued oil flow around filter in the event filter becomes clogged. A differential pressure of 20 psi will open filter bypass valve. A pressure regulating valve (5), located in the front of the engine, is designed to open at a pressure of 60 psi to protect pump and other system components against excessive pressures.

**e. Air Intake System.** Air intake system includes an air cleaner, turbocharger (6), intake manifold (7) and connecting piping. Purpose of air intake system is to provide a supply of clean, pressurized air for fuel combustion in the engine cylinders. Turbocharger rotation draws air through the air cleaner, where most airborne contaminants are removed, and forces this air, under pressure into the intake manifold. From the intake manifold, air is distributed to the cylinders through timing action of the intake valves.

**f. Exhaust System.** Exhaust system includes exhaust manifold (8), turbocharger turbine (9), exhaust piping, and muffler. Exhaust gases are directed against the turbine blades, causing turbine to rotate at high speed. Exhaust gases leaving turbocharger pass through the muffler, which reduces level of exhaust noises.

**Section II. ENGINE SYSTEM MAINTENANCE PROCEDURES**

**3-3. ENGINE ASSEMBLY REPLACEMENT**

This Task Covers:

- a. Removal
- b. Installation

**INITIAL SETUP**

*Tools and Special Tools*

- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Forklift Truck, 2,000 lb (907.18 kg) capacity
- Engine Stand, 2,000 lb (907.18 kg) capacity
- Lifting Chain, 2,000 lb (907.18 kg) capacity

*Test Equipment*

- STE/ICE (Item 21, Appendix D)

*Equipment Condition*

- Engine oil drained (TM 10-3930-673-20)
- Radiator removed (TM 10-3930-673-20)
- Air cleaner removed (TM 10-3930-673-20)
- Muffler removed (TM 10-3930-673-20)
- Transmission cover removed (TM 10-3930-673-20)

*Materials/Parts*

- Compound, Sealing (Item 42, Appendix B)
- Oil, Lubricating, Transmission/Hydraulic (Item 30, Appendix B)

*Materials/Parts (Cont)*

- Tags (Item 55, Appendix B)
- Tie Wraps (Item 57, Appendix B)
- Clamp
- Clamp
- Locknut
- Locknut
- Locknut
- Lockwashers (4)
- Lockwasher
- Lockwasher
- Lockwasher
- Lockwashers (2)
- Lockwasher
- Lockwasher
- Lockwasher
- Lockwashers (6)
- Lockwashers (3)
- Mount, Rubber
- Mount, Rubber
- Mount, Rubber
- Pin, Cotter

*Personnel Required*

Two

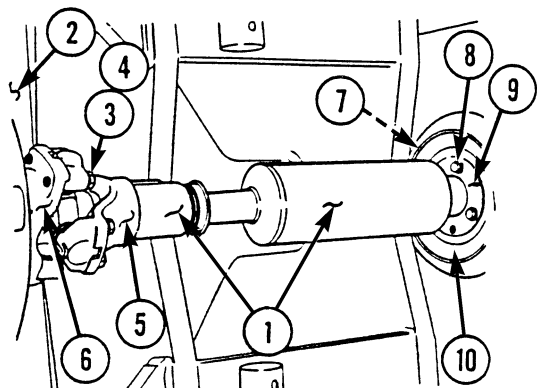
**a. Removal.**

**NOTE**

Note tie wrap locations, then remove and discard all tie wraps that secure electrical wiring, tubing, and hoses to engine.

- (1) **Remove drive shaft assembly (1) from transmission (2).**

Remove four screws (3), lockwashers (4), universal joint (5), and shaft assembly (1) from input yoke (6) and transmission (2). Discard lockwashers.





**(2) Remove drive shaft assembly (1) from engine dampener (7).**

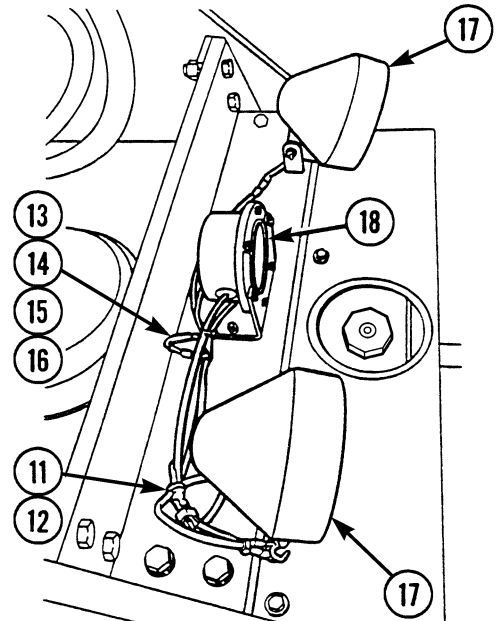
- (a) Remove three screws (8) from engine coupling (9).
- (b) Temporarily install two screws (8) removed in Step (2)(a) above in two jacking holes (10) of engine coupling (9).
- (c) Tighten two screws (8) evenly until shaft assembly (1) and engine coupling (9) separates from engine dampener (7).
- (d) Remove coupling (9) and shaft assembly (1) from vehicle as an assembly.

**NOTE**

Note routing of engine and STE/ICE wiring harnesses before removal.

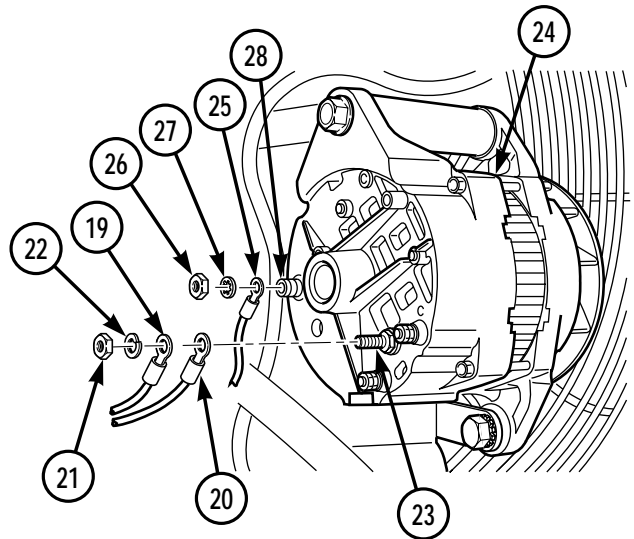
**(3) Tag, mark, and disconnect engine and STE/ICE wiring connections.**

- (a) Tag, mark, and disconnect electrical connections (11 through 16) from rear flood lights (17) and back-up alarm (18).



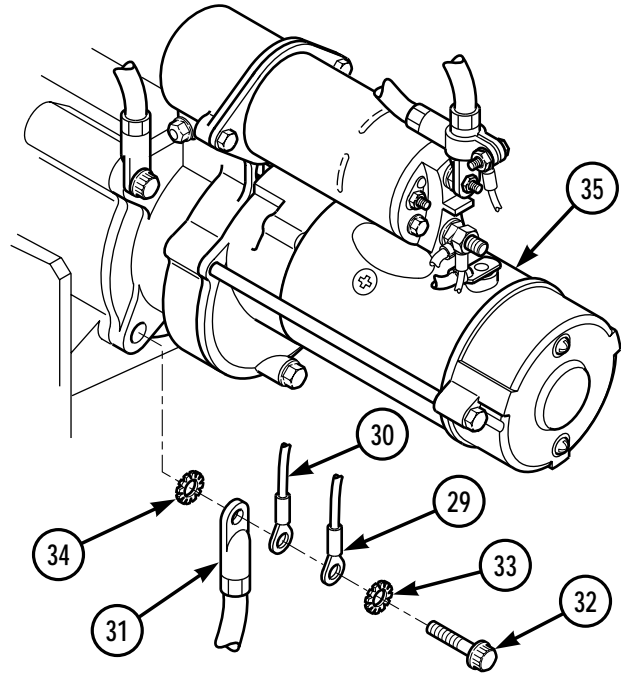
- (b) Tag and mark electrical wires no. N (19) and no. 60 (20). Remove nut (21), lockwasher (22), electrical wires no. N, and no. 60 from "BAT" terminal (23) on alternator (24). Discard lockwasher.

- (c) Tag and mark electrical wire no. P (25). Remove nut (26), lockwasher (27), and electrical wire no. P from "GRD" terminal (28) on alternator (24). Discard lockwasher.

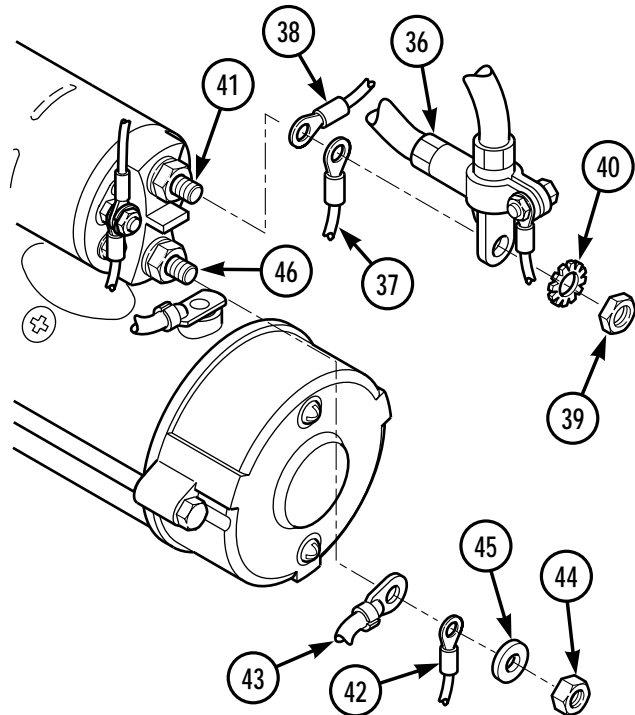


**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

- (d) Tag and mark electrical wires (29) and no. M (30) and battery ground cable (31). Remove bolt (32), starwasher (33), electrical wire, electrical wire no. M, battery ground cable (31), and starwasher (34) from starter (35).

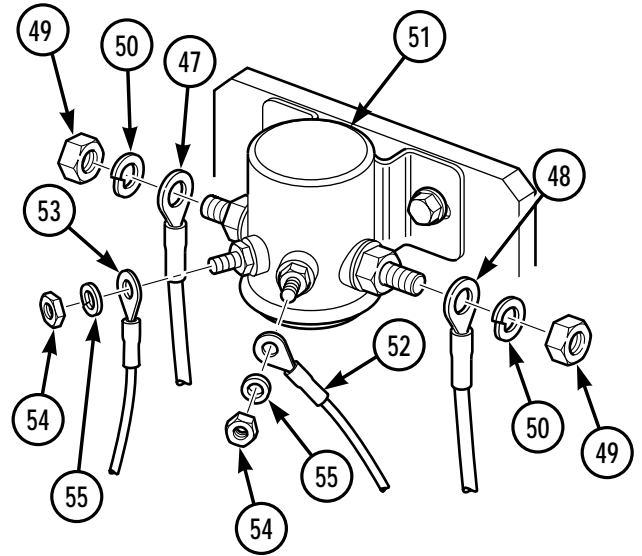


- (e) Tag and mark battery positive cable (36), electrical wire no. T (37), and connector (38). Remove nut (39), starwasher (40), battery positive cable, electrical wire no. T, and connector from starter solenoid "BAT" terminal (41).



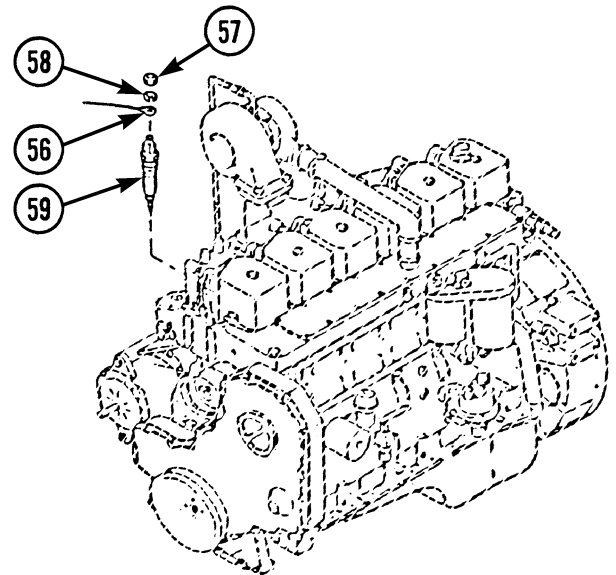
- (f) Tag and mark electrical wires no. S (42) and no. 38 (43). Remove nut (44), lockwasher (45), electrical wires no. S, and no. 38 from starter solenoid S terminal (46). Discard lockwasher.

- (g) Tag and mark electrical wires no. 38 (47) and no. 39 (48). Remove two nuts (49), lockwashers (50), and electrical wires no. 38 and no. 39 from starter relay (51). Discard lockwashers.

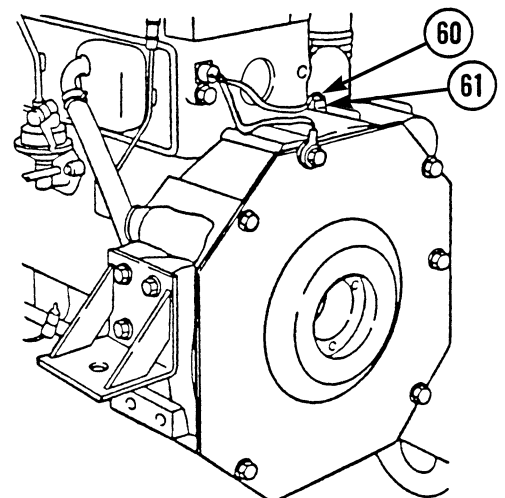


- (h) Tag and mark electrical wires no. 4A (52) and no. 492 (53). Remove nuts (54), lockwashers (55), electrical wires no. 4A and no. 492 from starter relay (51). Discard lockwashers.

- (i) Tag and mark electrical wire no. 15 (56). Remove nut (57), lockwasher (58), and electrical wire no. 15 from water temperature sender (59). Discard lockwasher.

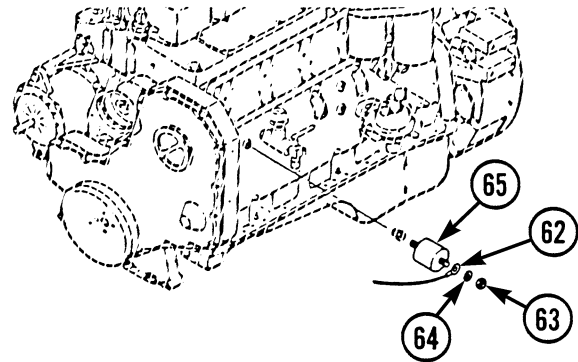


- (j) Tag, mark, and remove ether start thermostat connector (60) from engine wiring harness connector (61).

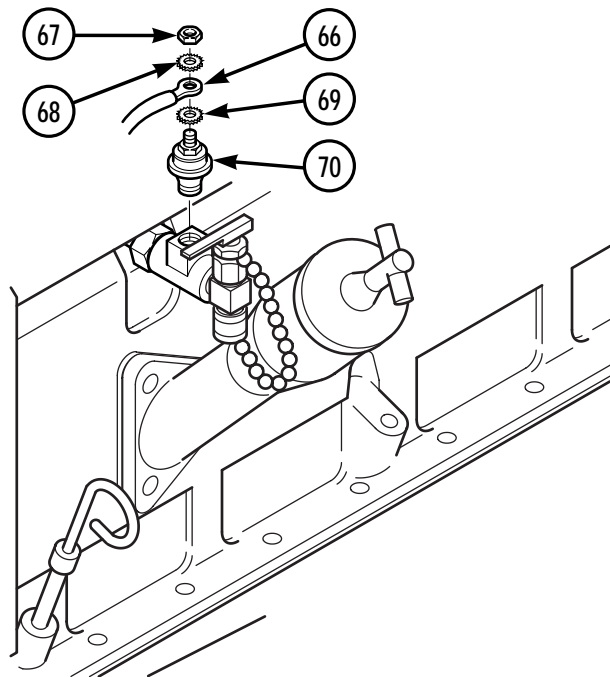


**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

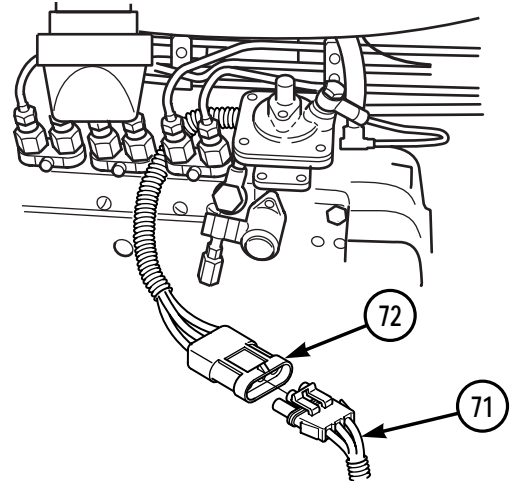
- (k) Tag and mark electrical wire no. 17 (62). Remove nut (63), lockwasher (64), and electrical wire no. 17 from oil pressure sender (65). Discard lockwasher.



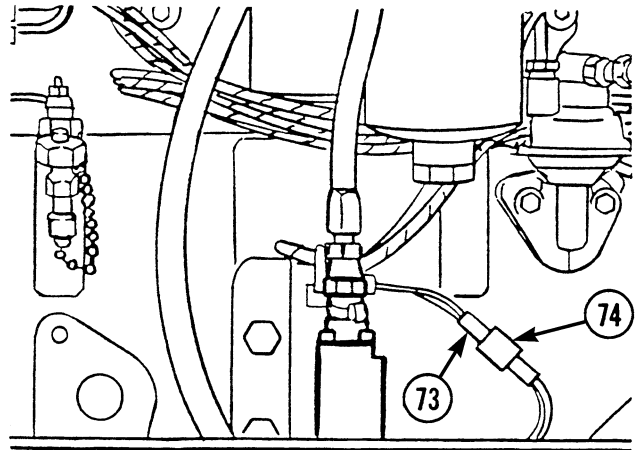
- (l) Tag and mark electrical wire no. 16 (66). Remove nut (67), starwasher (68), electrical wire no. 16, and starwasher (69) from oil pressure switch (70).



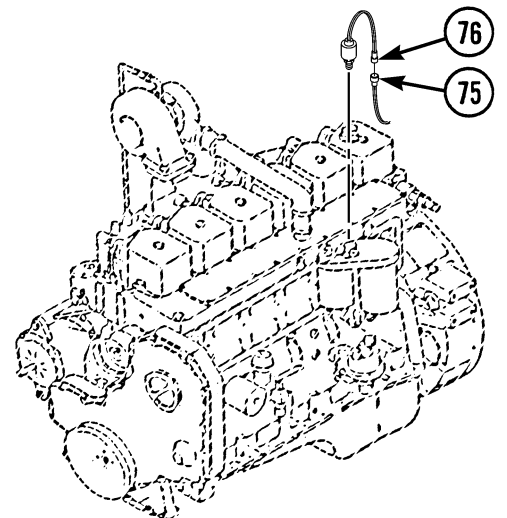
- (m) Tag, mark, and remove electrical connector (71) from fuel solenoid (72).



- (n) Tag, mark, and remove electrical connector (73) from pressure differential switch connector (74).

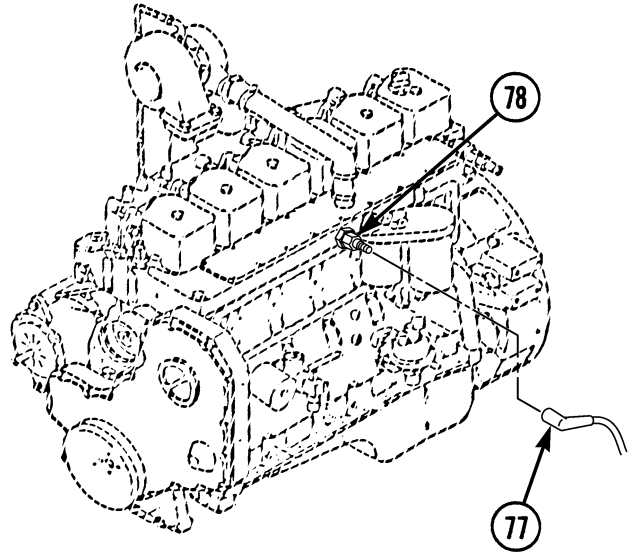


- (o) Tag, mark, and remove electrical connector (75) from pressure transducer (76).



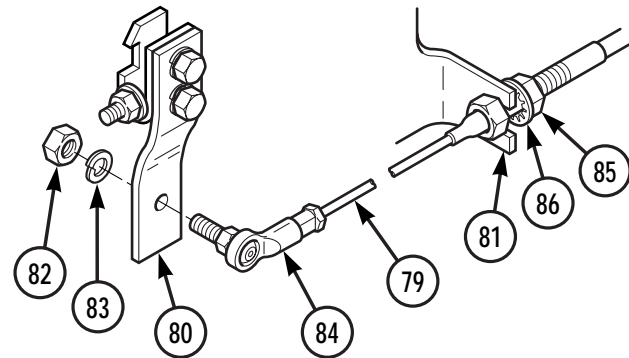
**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

- (p) Tag, mark, and remove electrical wire no. 14 (77) from water temperature switch (78).



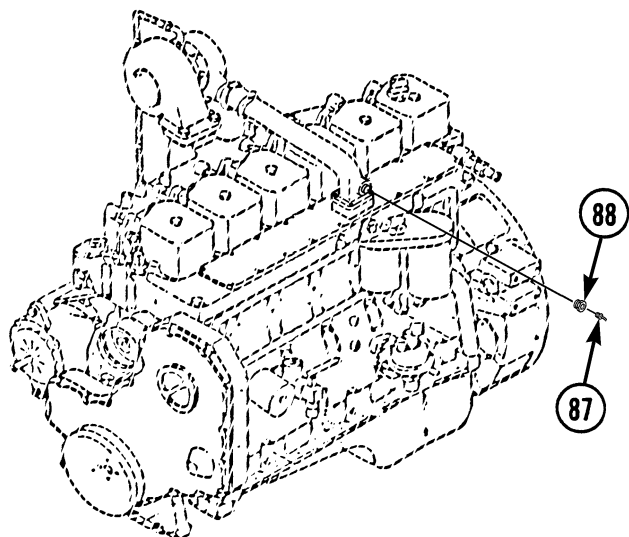
**(4) Remove throttle cable (79) from brackets (80 and 81).**

- (a) Remove nut (82), lockwasher (83), and heim joint (84) from bracket (80). Discard lockwasher.
- (b) Loosen nut (85) and starwasher (86). Remove throttle cable (79) from bracket (81).



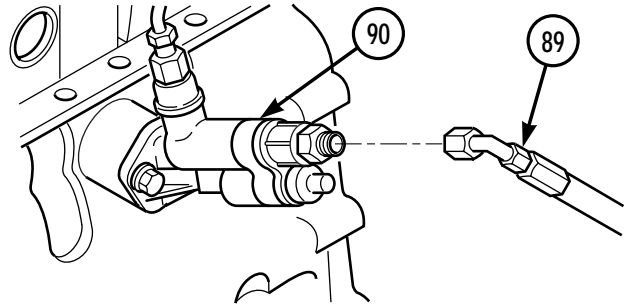
**(5) Tag, mark, and disconnect tubing and hoses.**

- (a) Tag, mark, and remove ether starting aid tubing (87) from bushing (88).

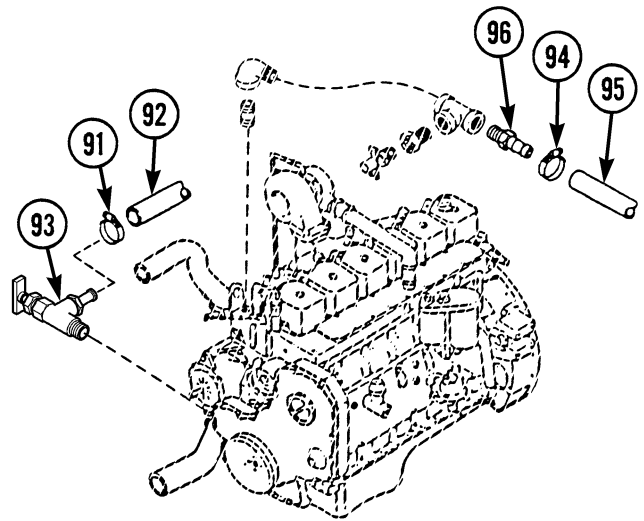


**WARNING**

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET (15 m).



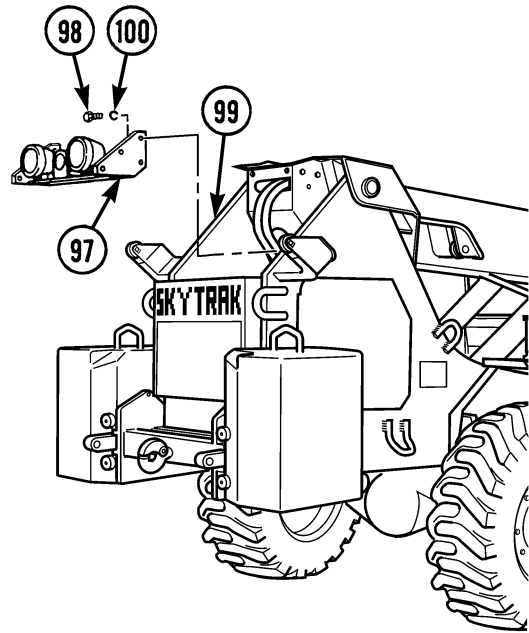
- (b) Tag, mark, and remove supply fuel hose (89) from fuel transfer pump (90).
- (c) Loosen clamp (91) and disconnect heater hose (92) from drain valve (93). Discard clamp.
- (d) Loosen clamp (94) and disconnect heater hose (95) from adapter (96). Discard clamp.



### 3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)

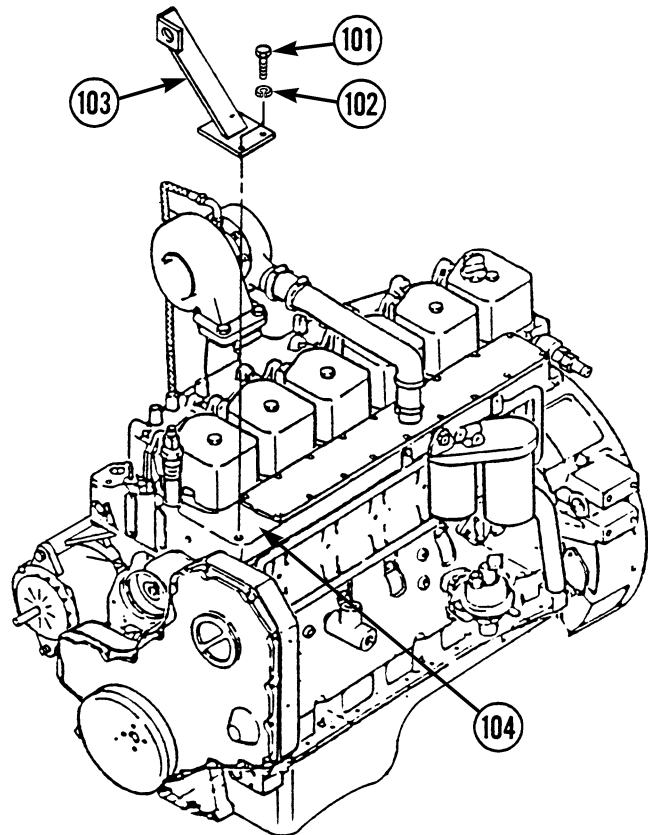
**(6) Remove crossmember (97) from frame (99).**

- (a) Attach suitable lifting device to crossmember (97).
- (b) Remove six screws (98) and lockwashers (100), and crossmember (97) from frame (99). Discard lockwashers.



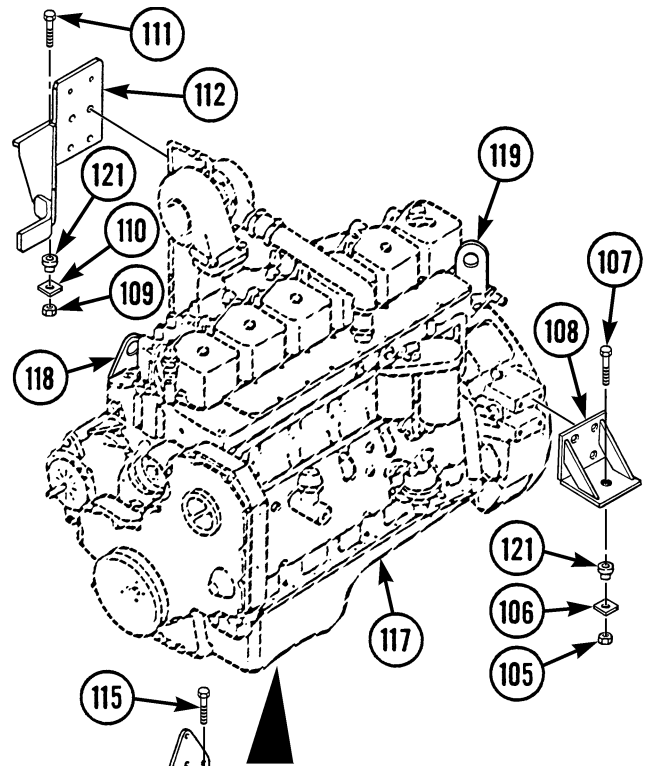
**(7) Remove engine mounting hardware parts (101 through 116).**

- (a) Remove three screws (101), lockwashers (102), and radiator support (103) from cylinder head (104). Discard lockwashers.





- (b) Remove locknut (105), rebound washer (106), and screw (107) from right front engine mount (108). Discard locknut.
- (c) Remove locknut (109), rebound washer (110), and screw (111) from left front engine mount (112). Discard locknut.
- (d) Remove locknut (113), rebound washer (114), and screw (115) from rear engine mount (116). Discard locknut.

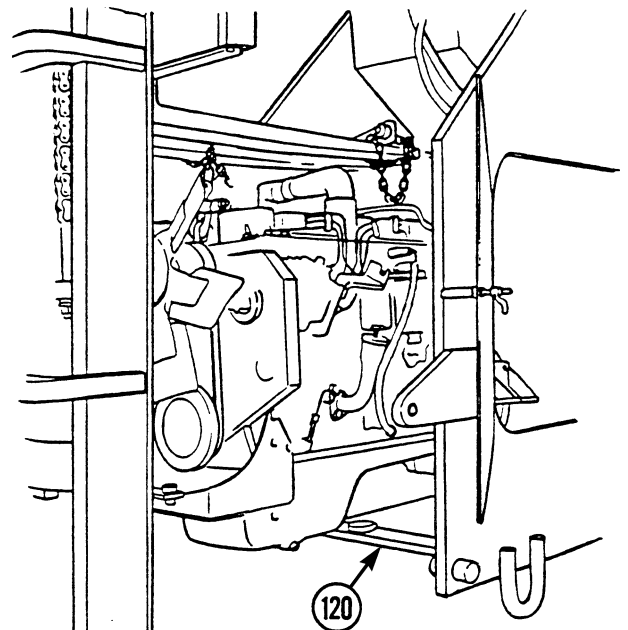
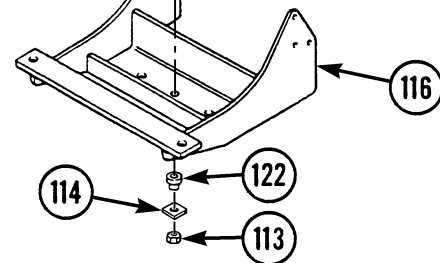


**WARNING**

Engine assembly weighs 1,075 lb (487.61 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

**(8) Remove engine (117) from vehicle.**

- (a) Attach lifting chains (2,000 lb [907.18 kg] capacity) to engine lifting brackets (118 and 119).
- (b) Use forklift truck or other suitable lifting device to remove engine. Attach lifting chains to forklift forks or other suitable lifting device.
- (c) Raise engine (117) high enough to clear rear frame support bar (120).
- (d) Slowly remove engine (117) through the back of engine compartment.
- (e) Place engine (117) in suitable engine stand.
- (f) Remove and discard two front rubber mounts (121) and rear rubber mount (122) from right and left front engine mounts (108 and 112) and rear engine mount (116).



### 3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)

#### NOTE

If new engine is to be installed, remove engine components in Step (9) below. Components removed will be installed on new engine.

#### (9) Remove engine (117) components.

- (a) Remove fan (TM 10-3930-673-20).
- (b) Remove alternator (TM 10-3930-673-20).
- (c) Remove STE/ICE fuel pressure sender and STE/ICE fuel filter differential pressure switch (TM 10-3930-673-20).
- (d) Remove starter relay (TM 10-3930-673-20).
- (e) Remove oil sampling valve and fittings (TM 10-3930-673-20).
- (f) Remove engine oil pressure and water temperature switches (TM 10-3930-673-20).
- (g) Remove engine oil pressure and water temperature senders (TM 10-3930-673-20).
- (h) Remove engine mounts (Para 3-4).
- (i) Remove flywheel housing cover (Para 3-15).
- (j) Remove coupling from flywheel (Para 3-14).
- (k) Remove ether start thermostat (TM 10-3930-673-20).

#### *b. Installation.*

#### NOTE

If new engine is to be installed, install engine components in Step (1) below

#### (1) Install components on engine (117).

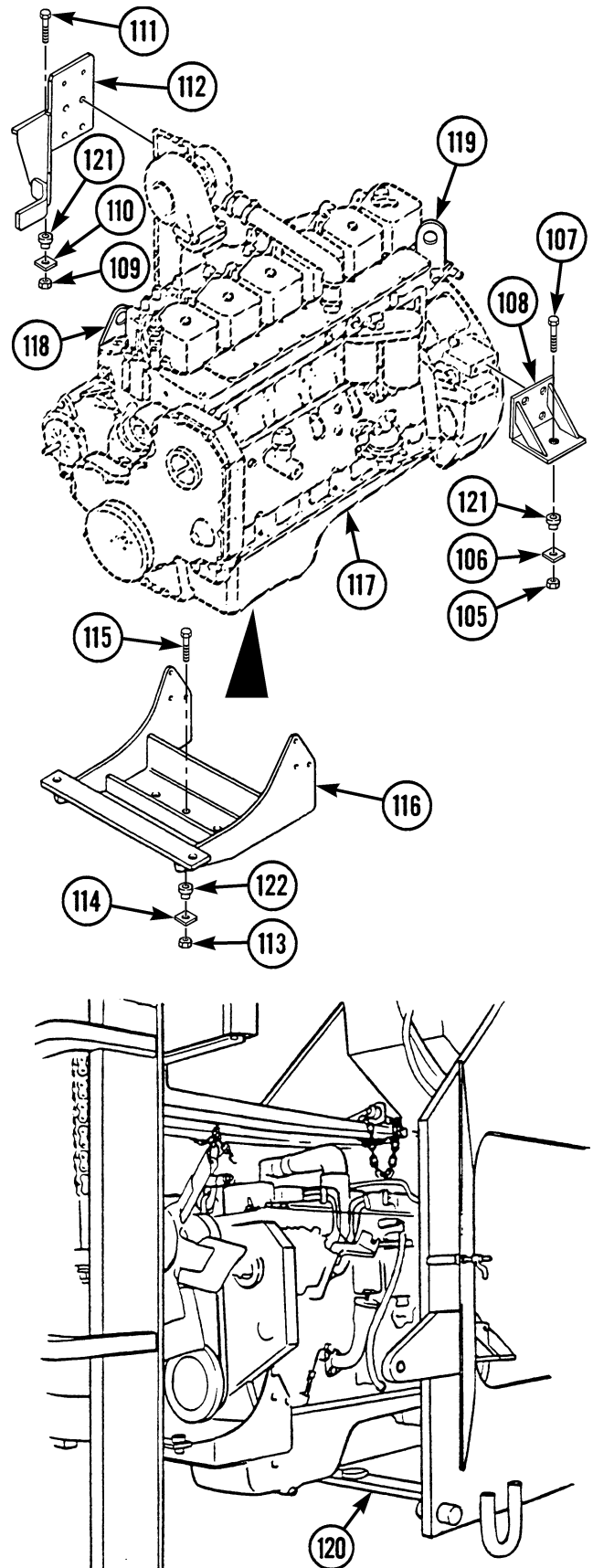
- (a) Install engine mounts (Para 3-4).
- (b) Install ether start thermostat (TM 10-3930-673-20).
- (c) Install water temperature and oil pressure senders (TM 10-3930-673-20).
- (d) Install engine oil pressure and water temperature switches (TM 10-3930-673-20).
- (e) Install oil sampling valve and fittings (TM 10-3930-673-20).
- (f) Install starter relay (TM 10-3930-673-20).
- (g) Install STE/ICE fuel pressure sender and STE/ICE fuel filter differential pressure switch (TM 10-3930-673-20).
- (h) Install alternator (TM 10-3930-673-20).
- (i) Install fan (TM 10-3930-673-20).
- (j) Install coupling to flywheel (Para 3-14).
- (k) Install flywheel housing cover (Para 3-15).

**WARNING**

Engine assembly weighs 1,075 lb (487.61 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

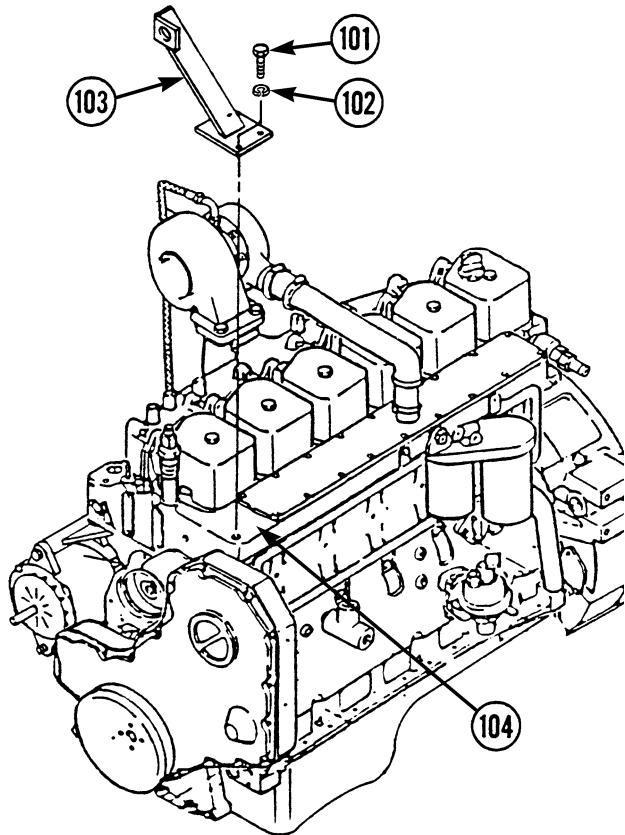
**(2) Install engine (117) in vehicle.**

- (a) Install two front rubber mounts (121) and rear rubber mount (122) on right and left front engine mounts (108 and 112) and rear engine mount (116).
- (b) Attach lifting chains to front and rear engine lifting brackets (118 and 119).
- (c) Attach lifting chains to forklift truck forks or other suitable lifting device. Slowly lift and install engine through the back of the engine compartment. Lift engine high enough to clear rear frame support bar (120).
- (d) Lower engine into position over rubber mounts and install screw (115), rebound washer (114), and locknut (113) on rear engine mount (116).
- (e) Install screw (111), rebound washer (110), and locknut (109) on left front engine mount (112).
- (f) Install screw (107), rebound washer (106), and locknut (105) on right front engine mount (108).
- (g) Remove lifting device and lifting chains from engine lifting brackets (118 and 119).
- (h) Tighten locknuts (105, 109, and 113) to 307 lb-ft (416.24 N•m).



**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

- (i) Install radiator support (103), three lockwashers (102), and screws (101) on cylinder head (104).

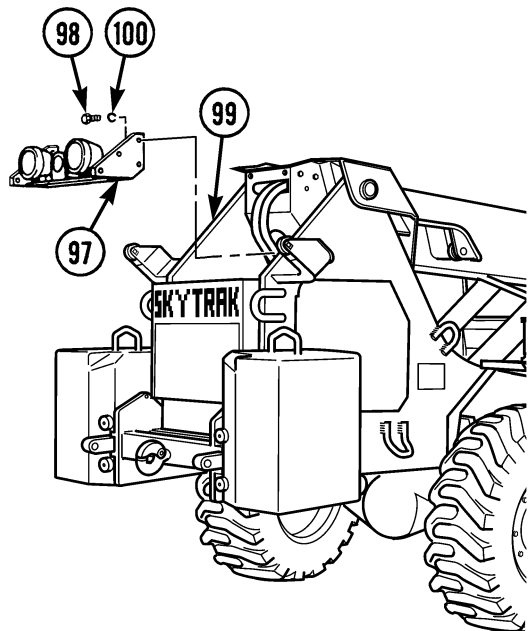


**(3) Install frame cross member (97) on frame (99).**

- (a) Using suitable lifting device hoist and sling, position frame cross member (97) on frame (99).

**WARNING**

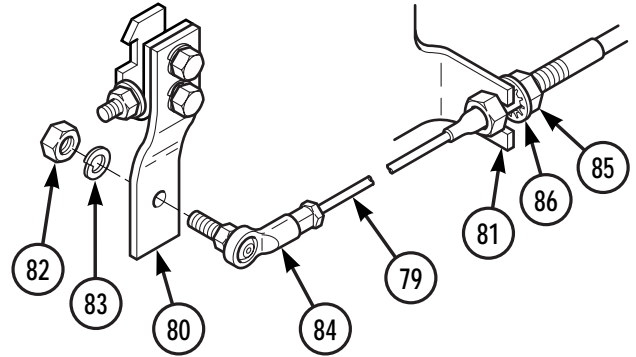
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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



- (b) Apply sealing compound to threads of six screws (98).
- (c) Install six lockwashers (100) and screws (98). Tighten screws to 210 lb-ft (284.72 N•m).

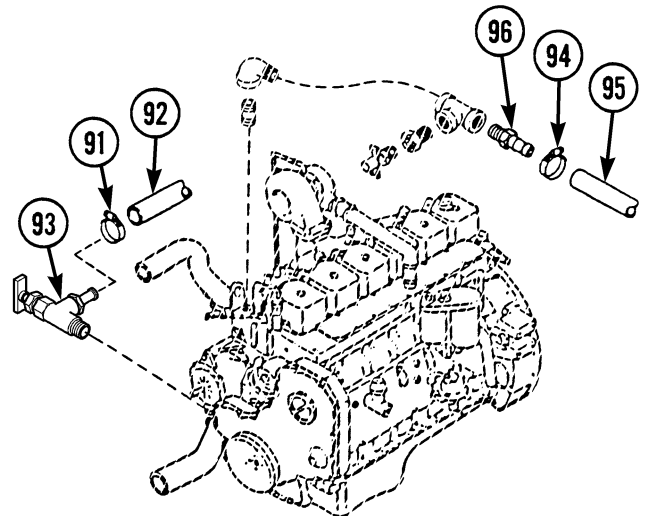
**(4) Install throttle cable (79) on brackets (80 and 81).**

- (a) Position throttle cable (79) on bracket (81) and tighten nut (85) and starwasher (86).
- (b) Install heim joint (84), lockwasher (83), and nut (82) on bracket (80).



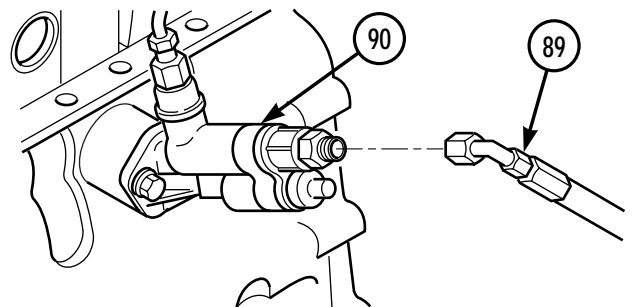
**(5) Connect hoses and tubing.**

- (a) Connect heater hose (95) on adapter (96) with clamp (94).
- (b) Connect heater hose (92) on drain valve (93) with clamp (91).



**WARNING**

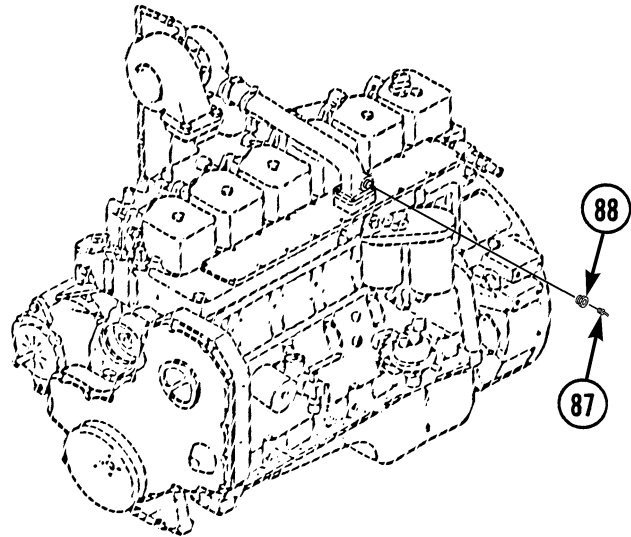
Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET (15 m).



- (c) Connect fuel supply and return hose (89) on adapter (90).

**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

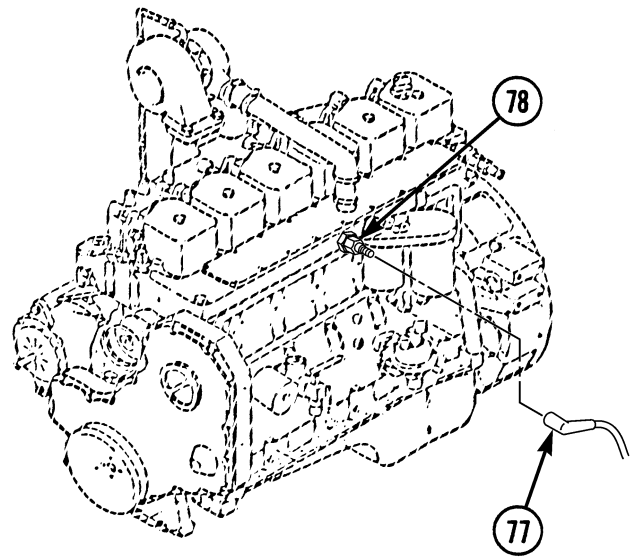
- (d) Connect ether starting aid tubes (87) bushing (88).



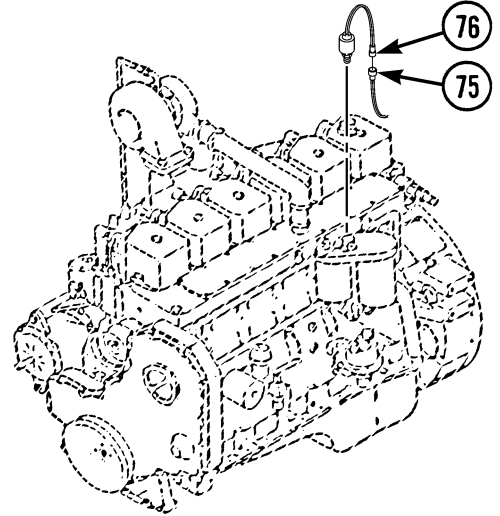
- (6) **Route engine and STE/ICE wiring harness as noted at engine removal.**

- (7) **Connect engine and STE/ICE wiring connections to electrical wires.**

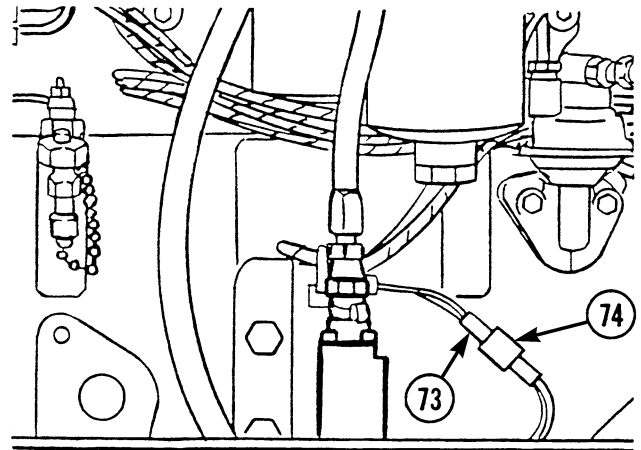
- (a) Connect electrical wire no. 14 (77) to water temperature switch (78).



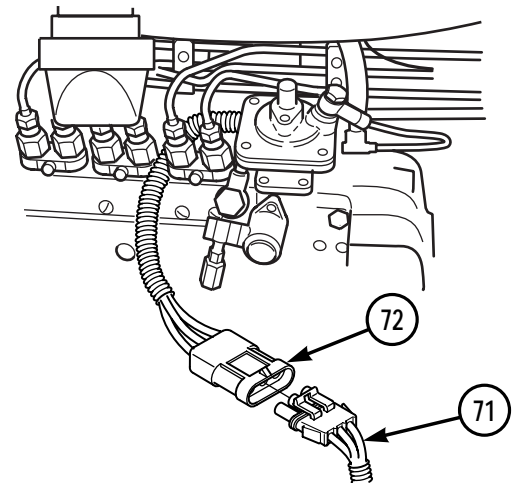
- (b) Connect pressure transducer (76) to electrical connector (75).



- (c) Connect pressure differential switch connector (74) to electrical connector (73).

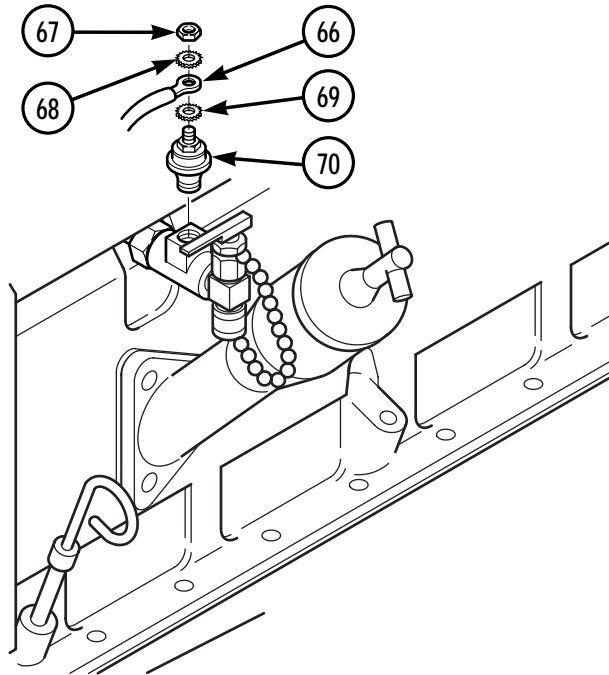


- (d) Connect electrical connector (71) to fuel solenoid (72).

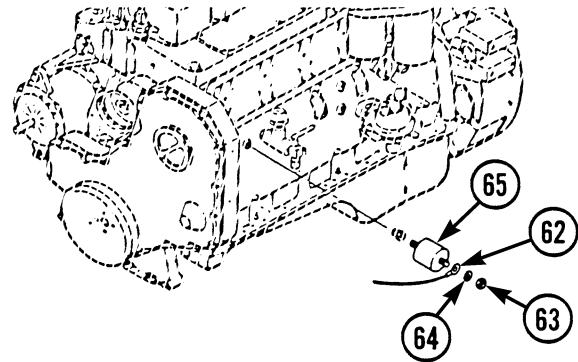


**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

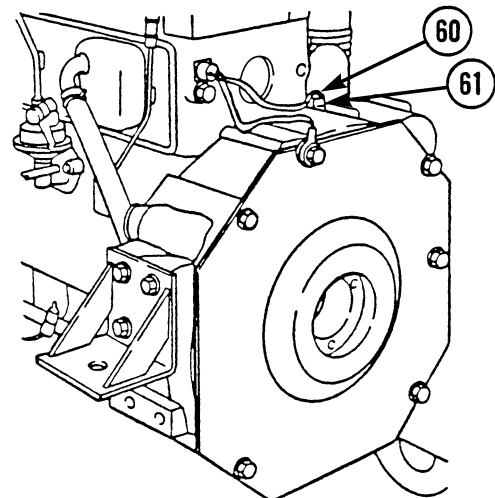
- (e) Connect electrical wire no. 16 (66) to oil pressure switch (70) and install starwasher (68) and nut (67).



- (f) Connect electrical wire no. 17 (62) to oil pressure sender (65) and install lockwasher (64) and nut (63).

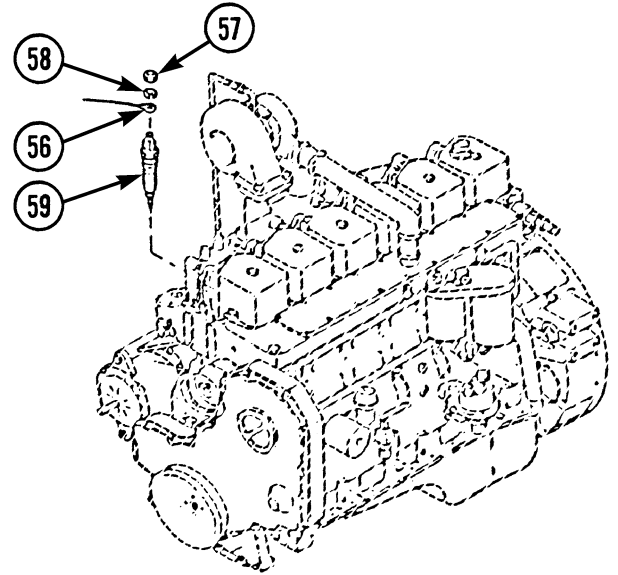


- (g) Connect ether thermostat connector (60) to engine wiring harness connector (61).

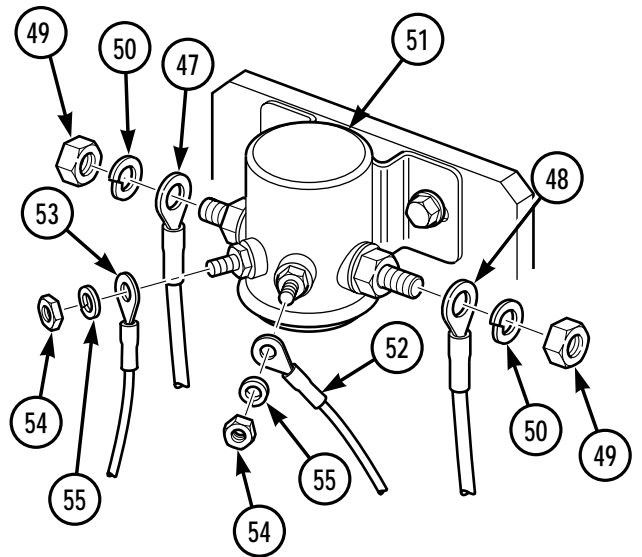




- (h) Connect electrical wire no. 15 (56) to water temperature sender (59) and install lockwasher (58) and nut (57).

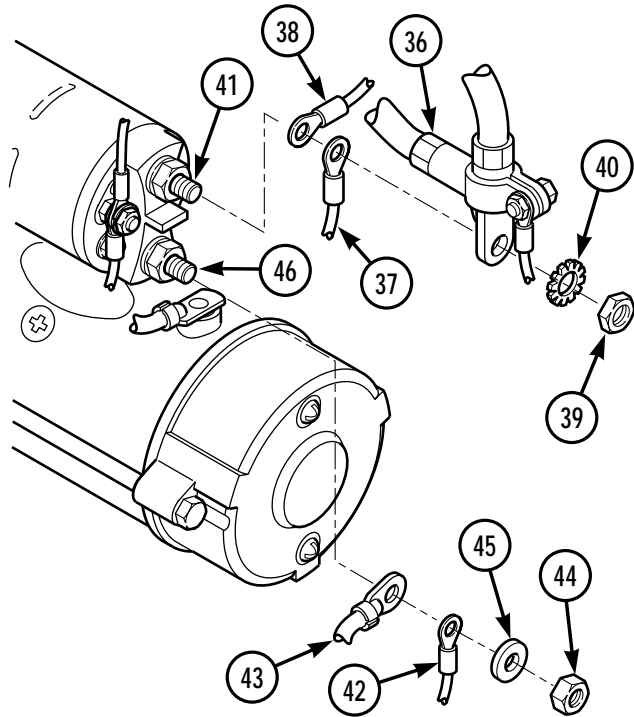


- (i) Connect electrical wire no. 492 (53), no. 4A (52), no. 39 (48), no. 38 (47), lockwashers (50 and 55), and nuts (49 and 54) to starter relay (51).

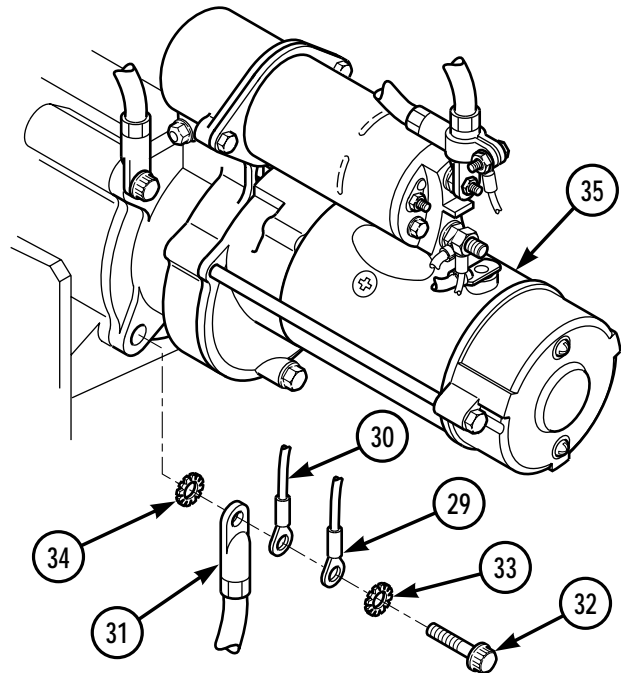


**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)**

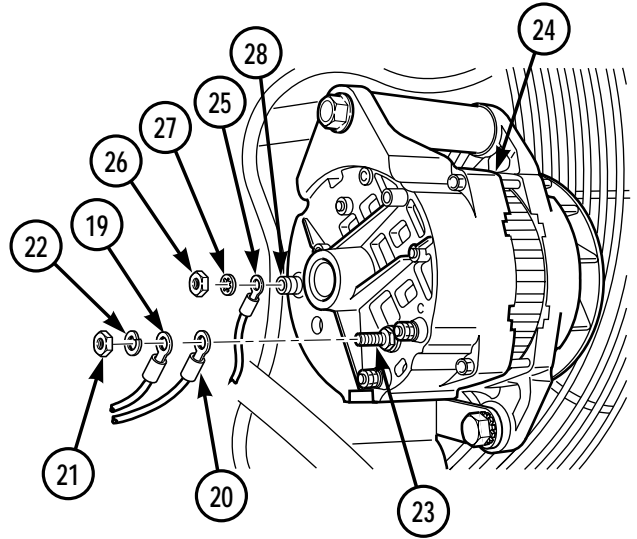
- (j) Connect electrical wires no. 38 (43), no. S (42), lockwasher (45), and nut (44) to starter solenoid "S" terminal (46).
- (k) Connect connector (38), electrical wire no. T (37), battery positive cable (36), starwasher (40), and nut (39) to starter solenoid terminal "BAT" terminal (41).



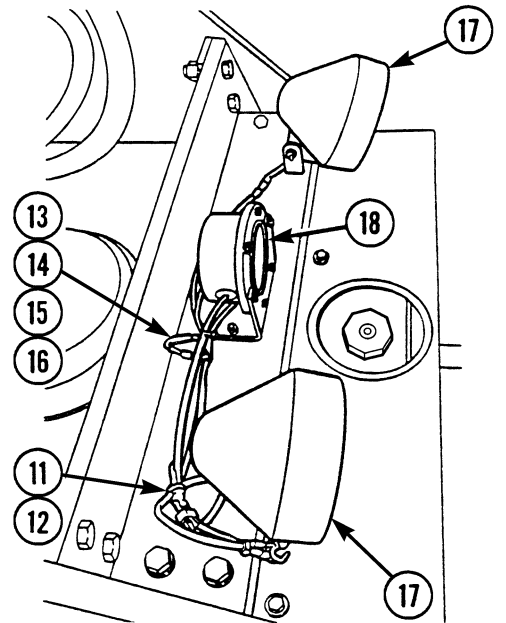
- (l) Install starwasher (34), and connect electrical wire no. M (30), electrical wire (29), battery ground cable (31), starwasher (33), and bolt (32) to starter (35).



- (m) Connect electrical wires no. 60 (20) and no. N (19) to "BAT" terminal (23) on alternator (24) and electrical wire no. P to "I" terminal of alternator (24).
- (n) Connect electrical wire no. P (25), lockwasher (27), and nut (26) to "GRD" terminal (28) on alternator (27).

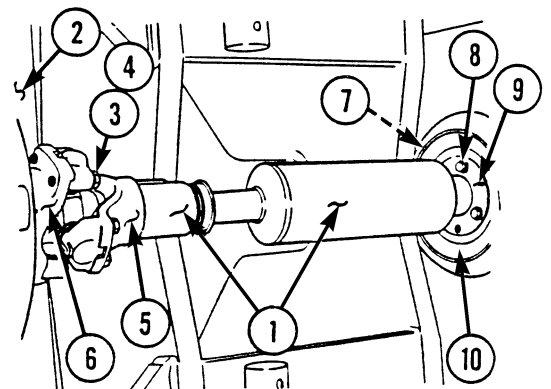


- (o) Connect electrical wires (11 through 16) to back-up alarm (18) and rear floodlights (17).



**(8) Install drive shaft assembly (1) to engine dampener (7).**

- (a) Position coupling (9) with shaft assembly (1) into engine dampener (7).



**3-3. ENGINE ASSEMBLY REPLACEMENT (CONT)****WARNING**

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

- (b) Apply sealing compound to threads of three screws (8).
  - (c) Install coupling (9) on engine with three screws (8). Tighten screws to 25 lb-ft (33.90 N•m).
- (9) Install drive assembly (1) on transmission (2).**

**WARNING**

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

- (a) Apply sealing compound to threads of four screws (3).
  - (b) Install universal joint (5) of shaft assembly (1) on input yoke (6) of transmission (2) with four lockwashers (4) and screws (3). Tighten screws to 41 lb-ft (55.59 N•m).
- (10) Tie wrap hoses and electrical wires as noted during engine removal and as necessary to prevent damage to hoses and wires.**

**NOTE**

Follow-on Maintenance:

- Install muffler (TM 10-3930-673-20).
- Service air cleaner elements (TM 10-3930-673-20).
- Install air cleaner (TM 10-3930-673-20).
- Install radiator (TM 10-3930-673-20).
- Service cooling system with coolant (TM 10-3930-673-20).
- Service engine with engine oil (TM 10-3930-673-20).
- Connect negative battery cable (TM 10-3930-673-20).
- Adjust accelerator cable (TM 10-3930-673-20).

**END OF TASK**

### 3-4. ENGINE MOUNTS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Wrench, Torque, 0 - 800 lb-ft (0 - 1085 N•m)  
(Item 29, Appendix D)  
Forklift Truck, 2,000 lb (907.18 kg) capacity  
Lifting Chains, 2,000 lb (907.18 kg) capacity (2)

##### *Materials/Parts*

Compound, Sealing (Item 42, Appendix B)  
Tags (Item 55, Appendix B)  
Lockwashers (2)  
Lockwashers (3)  
Lockwashers (4)  
Mounts, Rubber (3)  
Washers, Rebound (2)

##### *Equipment Condition*

Radiator removed (TM 10-3930-673-20)  
Muffler removed (TM 10-3930-673-20)  
Engine covers and air cleaner removed  
(TM 10-3930-673-20)

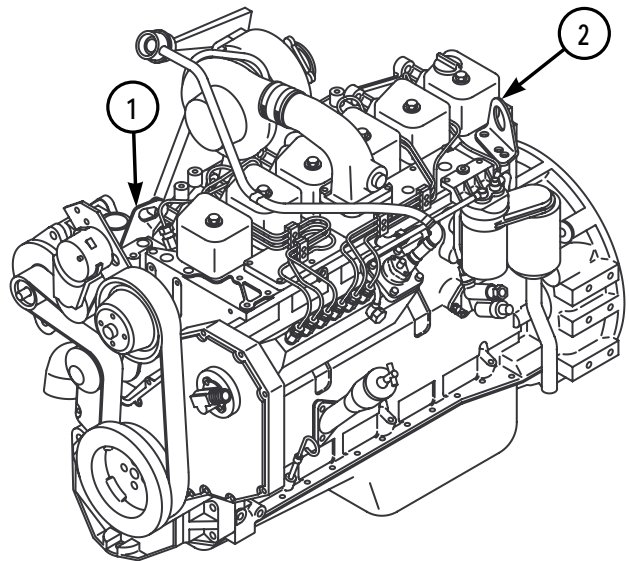
#### a. Removal.

#### **WARNING**

Engine assembly weighs 1,075 lb (487.61 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

#### **NOTE**

“Front” and “rear” engine references used in this paragraph are relative to front and rear of vehicle. Fan side of engine is designated rear of engine, and flywheel end of engine is identified as front of engine.



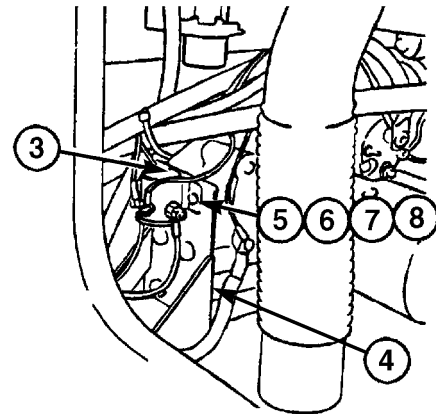
#### (1) **Support engine with lifting chains (2,000 lb [907.18 kg] capacity) and forklift truck (2,000 lb [907.18 kg] capacity).**

- (a) Attach lifting chains to engine lifting brackets (1 and 2).
- (b) Attach lifting chains (2,000 lb [907.18 kg] capacity) to forklift forks and operate forklift just enough to remove slack from lifting chains.

**3-4. ENGINE MOUNTS REPLACEMENT (CONT)**

- (2) Tag and disconnect four electrical leads from starter relay (3).
- (3) Remove starter relay (3) from engine mount (4).

Remove two nuts (5), lockwashers (6), screws (7), washers (8), and starter relay (3) from engine mount (4). Discard lockwashers.

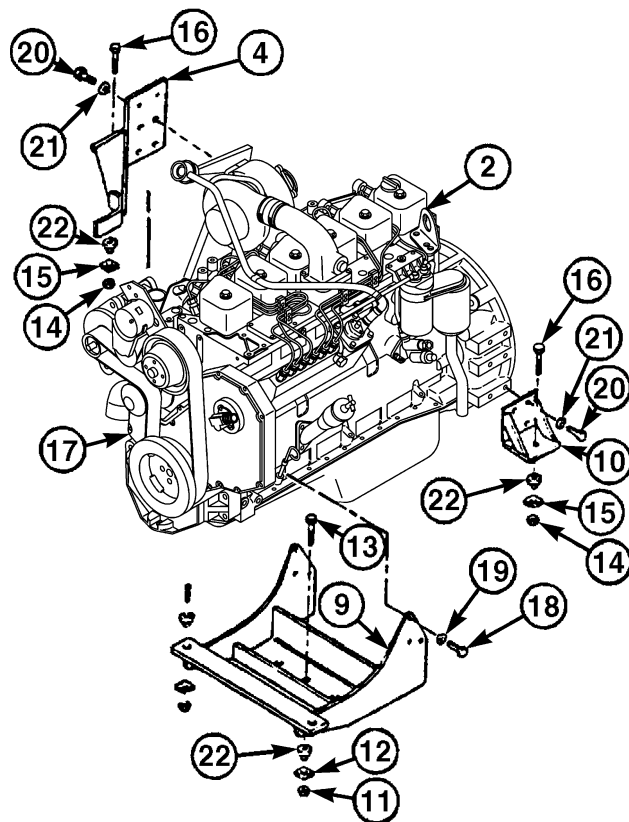


- (4) Separate engine mounts (9, 4, and 10) from vehicle frame.

- (a) Remove nut (11), washer (12), and screw (13) from rear engine mount (9). Discard washer.
- (b) Remove nut (14), washer (15), and screw (16) from front engine mounts (4 and 10). Discard washer.

- (5) Remove engine mounts (9, 4, and 10) from engine (17).

- (a) Remove three screws (18) and lockwashers (19) from each side of rear engine mount (9). Discard lockwashers.
- (b) Remove rear engine mount (9) from engine (17).
- (c) Remove four screws (20) and lockwashers (21) from left front engine mount (4) and right front engine mount (10). Discard lockwashers.
- (d) Remove engine mounts (4 and 10) from engine (17).



- (6) Remove and discard three rubber mounts (22) from vehicle frame.

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

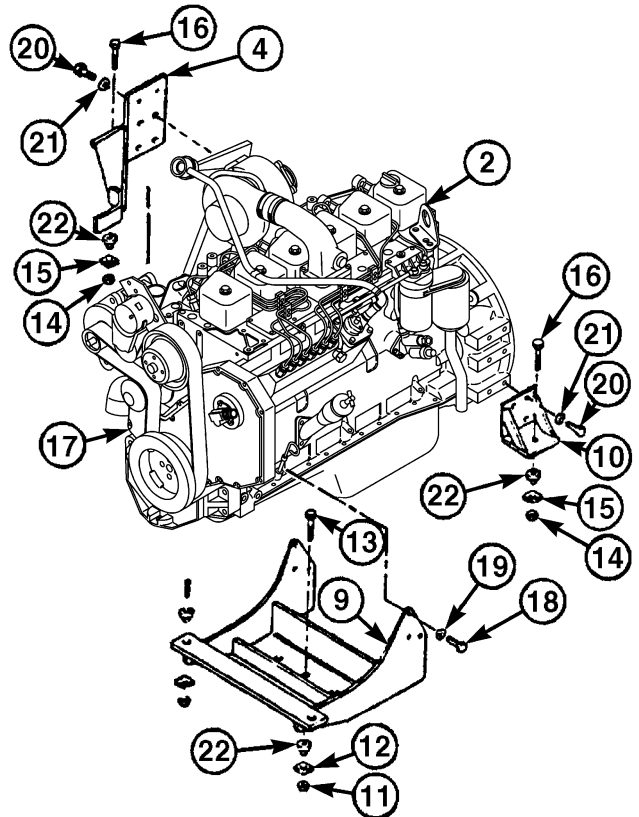
**d. Installation.**

- (1) **Install rubber mounts (22) into vehicle frame.**
- (2) **Install engine mounts (9, 4, and 10) on engine (17).**

**WARNING**

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

- (a) Apply sealing compound to threads of screws (18 and 20).
- (b) Install right front engine mount (10), lockwashers (21), and screws (20) on engine (17).
- (c) Install left front engine mount (4), lockwashers (21), and screws (20) on engine (17).
- (d) Position rear engine mount (9) on engine (17). Install six screws (18) and lockwashers (19).

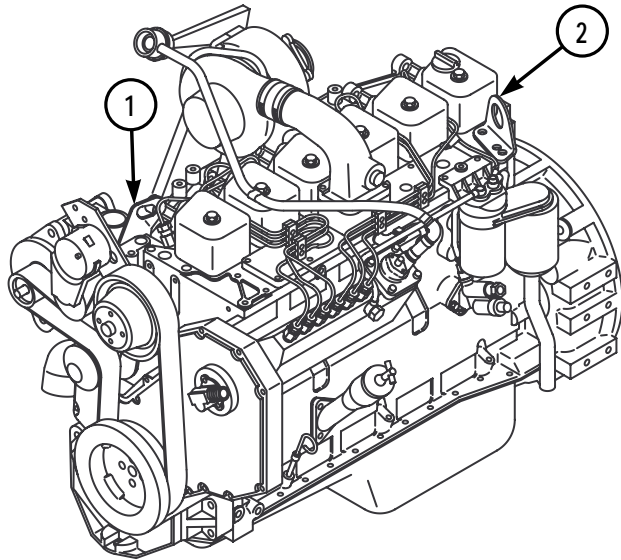
**WARNING**

Engine assembly weighs 1,075 lb (487.61 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

- (3) **Attach engine mounts (9, 4, and 10) to vehicle frame, and remove lifting chains.**
  - (a) If engine was lifted for engine mounts removal, slowly lower engine onto rubber mounts (22) and align engine mounts (9, 4, and 10) to rubber mounts.
  - (b) Install two screws (16), washers (15), and nuts (14) on engine mounts (4 and 10). Tighten nuts to 307 lb-ft (416.24 N•m).
  - (c) Install screw (13), washer (12), and nut (11) on engine mount (9). Tighten nut to 307 lb-ft (416.24 N•m).

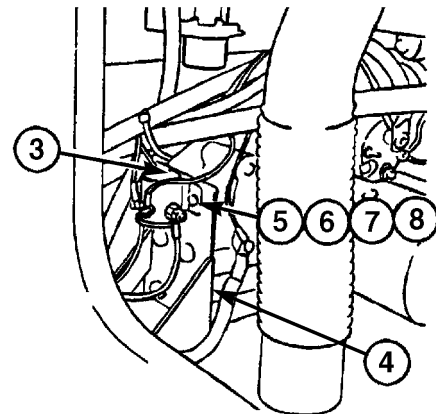
**3-4. ENGINE MOUNTS REPLACEMENT (CONT)**

- (d) Remove lifting chains from engine lifting brackets (1 and 2) and forklift truck. Back forklift truck away from vehicle.



**(4) Install starter relay (3) and connect electrical leads.**

- (a) Install starter relay onto left front engine mount (4) with two screws (7), washers (8), lockwashers (6), and nuts (5). Connect relay ground lead under lockwasher.
- (b) Connect electrical leads to starter relay (3).



**(5) If transmission input shaft was disconnected, connect shaft (TM 10-3930-673-20).**

**NOTE**

Follow-on Maintenance:

- Install muffler (TM 10-3930-673-20).
- Install radiator (TM 10-3930-673-20).
- Install engine covers (TM 10-3930-673-20).

**END OF TASK**



### 3-5. ENGINE LIFTING BRACKETS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
 (Item 23, Appendix D)  
 Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m)  
 (Item 28, Appendix D)

*Materials/Parts*

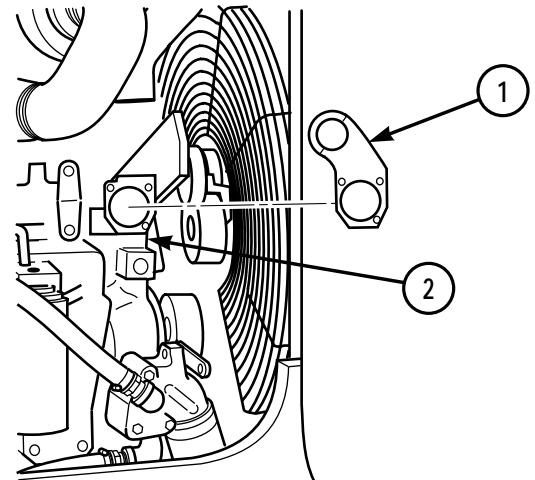
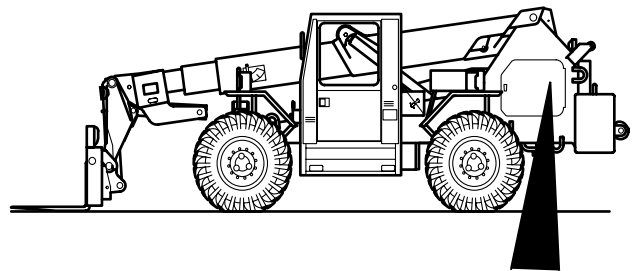
Compound, Sealing (Item 40, Appendix B)

#### NOTE

“Front” and “rear” engine references used in this paragraph are relative to the front and rear of vehicle, with engine mounted in the vehicle. Fan side of engine is at rear, and flywheel end of engine is at front.

**a. Removal.**

- (1) **Remove thermostat (TM 10-3930-673-20) and rear lifting bracket (1) from engine (2).**



**3-5. ENGINE LIFTING BRACKETS REPLACEMENT (CONT)**

- (2) **Remove engine front lifting bracket (3) from engine (2).**

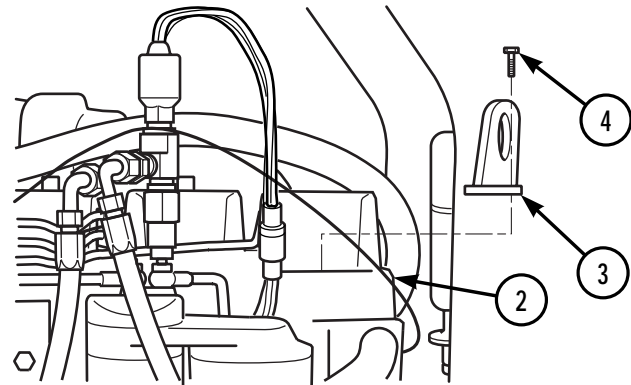
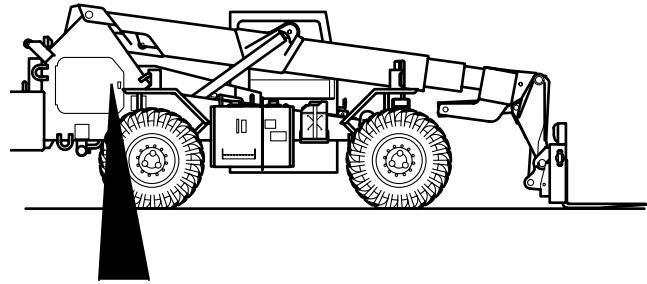
Remove two screws (4) and front lifting bracket (2).

*b. Cleaning.* See Cleaning Instructions (Para 2-12).

*c. Inspection.* See Inspection Instructions (Para 2-14).

*d. Installation.*

- (1) **Install front lifting bracket (3) on engine (2).**

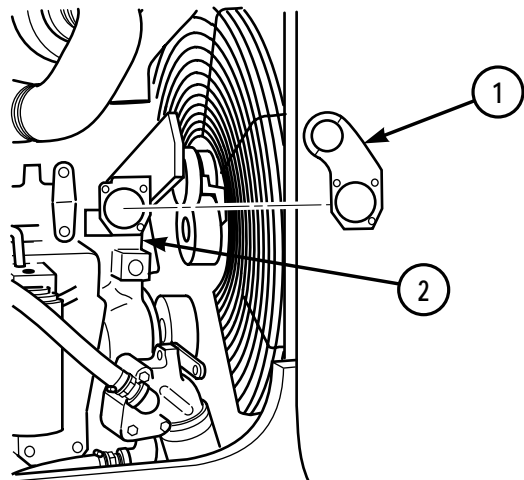


**WARNING**

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

- (a) Apply sealing compound to threads of screws (4).
- (b) Install front lifting bracket (3) on engine (2) with two screws. Tighten screws to 57 lb-ft (77.28 N•m).

- (2) **Position engine rear lifting bracket (1) on engine, and install thermostat (TM 10-3930-673-20).**



**END OF TASK**

### 3-6. CYLINDER BLOCK REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Wrench, Torque, 0 - 200 lb-in (0 - 22.60 N•m) (Item 27, Appendix D)
- Inside Micrometer (Item 12, Appendix D)

*Equipment Condition*

- Engine removed from vehicle (Para 3-3)
- Valve tappets removed (Para 3-19)
- Camshaft and timing gears removed (Para 3-20)
- Crankshaft removed (Para 3-8)
- Flywheel housing and cover removed (Para 3-15)
- Cylinder head assembly remove (Para 3-7)

*Equipment Condition (Cont)*

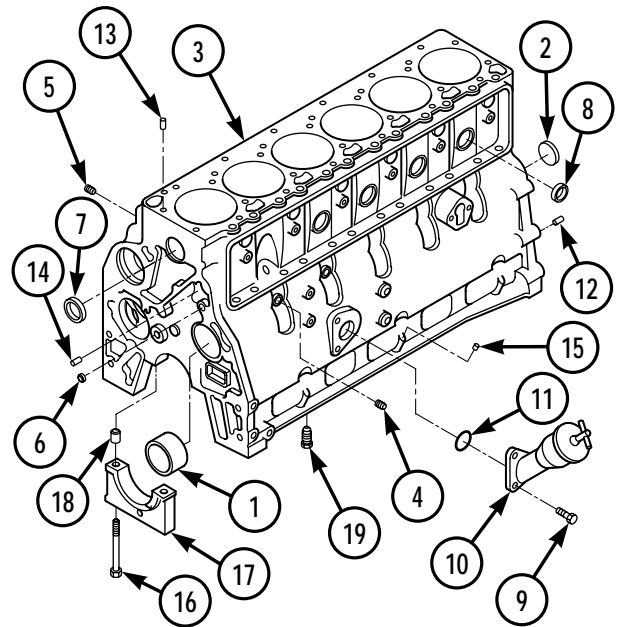
- Connecting rods and bearings removed (Para 3-17)
- Crankshaft main bearings removed (Para 3-9)
- Engine oil cooler removed (Para 3-26)

*Materials/Parts*

- Compound, Sealing (Item 43, Appendix B)
- Compound, Sealing (Item 44, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Cup Plugs (3)
- Cup Plugs (6)
- Cup Plugs (4)
- Packing, Preformed
- Wire, Soft

**a. Removal.**

- (1) **Remove camshaft bushing (1) and expansion plug (2) from cylinder block (3).**
  - (a) Remove camshaft bushing (1) from cylinder block (3) by driving bushing inward.



**3-6. CYLINDER BLOCK REPLACEMENT (CONT)****CAUTION**

When removing camshaft expansion plug in Step (b) below, use care not to damage camshaft bore with drift. A damaged camshaft bore can lead to premature camshaft wear.

- (b) Remove camshaft expansion plug (2) from cylinder block (3) by driving against inside face of plug with a hammer and a long drift.

- (2) **Remove two pipe plugs (4) and one pipe plug (5) from cylinder block (3).**

- (3) **Remove and discard three cup plugs (6) from cylinder block (3) oil passages.**

- (a) Drill hole in center of each cup plug (6) using suitably sized drill bit.

- (b) Remove and discard cup plugs (6) using a slide hammer, or other suitable tool.

- (4) **Remove and discard six cup plugs (7) and four cup plugs (8) from cylinder block (3) coolant passages.**

- (a) Tap against center of each cup plug (7 or 8) using a punch and a hammer.

- (b) Grasp cup plug (7 or 8) with a plier and remove from cylinder block (3) coolant passage bore. Discard cup plugs.

- (5) **Remove two screws (9), oil filler pipe (10), and preformed packing (11) from cylinder block (3). Discard preformed packing.**

- (6) **Remove parts (12 through 19) from cylinder block (3).**

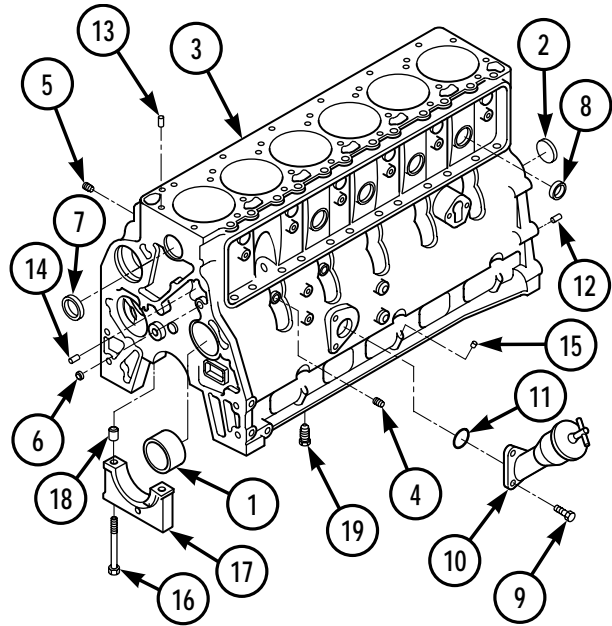
- (a) Remove two bearing sleeves (12) from cylinder block (3).

- (b) Remove two dowel pins (13) and dowel pins (14) from cylinder block (3).

- (c) Remove two expansion plugs (15) from cylinder block (3).

- (d) Remove 14 bolts (16), seven main bearing caps (17), and 14 dowel pins (18) from cylinder block (3).

- (e) Remove six piston cooling nozzles (19) from cylinder block (3).



**b. Cleaning.****CAUTION**

Do not clean cylinder block in an acid bath unless camshaft bushing has been removed. An acid bath can severely damage camshaft bushing.

- (1) **Soak cylinder block (3) in an acid bath if camshaft bushing (1) has been removed and if heavy deposits exist in coolant passages.**
- (2) **If camshaft bushing (1) has not been removed and coolant passages have heavy deposits, soak cylinder block in a solution of hot water and laundry detergent. Maintain water temperature of 190°F (88°C) and allow cylinder block to soak for a period of 30 minutes.**
- (3) **Following cleaning by either method (Step (1) or (2)), rinse thoroughly with clean, fresh water and allow surface to dry completely.**
- (4) **If a sizing hone is used to correct a minor cylinder bore taper or to remove minor grooves in cylinder walls, immediately clean bores using a strong solution of laundry detergent and hot water. Rinse thoroughly with clear water.**
- (5) **After rinsing and drying cylinder bores, wipe bores with white, lint-free cloth that is lightly oiled. If grit residue is present on cloth, clean bores again in detergent solution.**

**c. Inspection.**

- (1) **Check flatness of cylinder block (3) top surface.**
  - (a) Place a straightedge along length of cylinder block top.
  - (b) Measure gap under straightedge in area between cylinders (five measurements, total) using a feeler gauge.
  - (c) Maximum allowable variation between any two of the five measurements is 0.002 in. (0.05 mm).
- (2) **Inspect cylinder bores.**
  - (a) Visually inspect all bores for excessive glazing. Deglaze cylinder bores, as required.

**NOTE**

A properly deglazed cylinder bore surface will have a crosshatched appearance with lines at angles from 15° to 25° with respect to top of cylinder block. Included angles on crosshatch will be from 30° to 50°.

- (b) Measure diameter of each cylinder bore, from a point 1 in. (25.4 mm) below top of cylinder block to a point 5.5 in. (139.7 mm) below top of cylinder block.
- (c) Minimum allowable diameter is 4.0157 in. (102 mm).
- (d) Maximum allowable diameter is 4.0203 in. (102.12 mm).
- (e) Maximum allowable taper is 0.003 in. (0.08 mm).
- (f) Maximum allowable out-of-roundness is 0.0015 in. (0.04 mm).

**3-6. CYLINDER BLOCK REPLACEMENT (CONT)**

- (3) **Inspect piston cooling nozzles (19) for restricted oil passages or damage. Clean clogged passages using fine, soft wire. Replace nozzles if condition is in doubt.**

**d. Installation.**

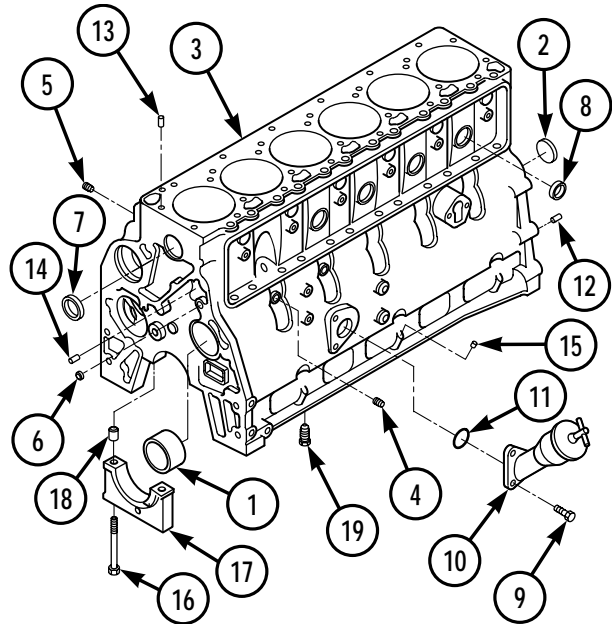
- (1) **Install parts (12 through 19) on cylinder block (3).**

**NOTE**

When installed, piston cooling nozzles must be flush with or slightly below bearing saddle surface.

- (a) Install six piston cooling nozzles (19) in cylinder block (3).
- (b) Install 14 dowel pins (18), bearing caps (17), and 14 bolts (16) on cylinder block (3).
- (c) Install two expansion plugs (15) in cylinder block (3).
- (d) Install dowel pins (14) and dowel pins (13) in cylinder block (3).
- (e) Install two bearing sleeves (12) in cylinder block (3).

- (2) **Install preformed packing (11), oil filler pipe (10), and two screws (9) on cylinder block (3).**
- (3) **Install six cup plugs (7) and four cup plugs (8) in cylinder block (3) coolant passages.**



**WARNING**

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

- (a) Apply a bead of sealing compound to entire circumference of each cup plug (7 and 8).
- (b) Install cup plugs (7 and 8) with convex side out until outer edges are flush with countersink in cylinder block (3).

**WARNING**

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

**NOTE**

When installing cup plugs, apply sealing compound.

**(4) Install three new cup plugs (6) in cylinder block (3) oil passages.**

- (a) Apply a bead of sealing compound to entire circumference of each new cup plug (6).
- (b) Using a drift and a hammer, install cup plugs (6) with convex side out and until outer edges are flush with countersink in cylinder block (3).

**(5) Install one pipe plug (5) and two pipe plugs (4) in cylinder block (3).****WARNING**

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

- (a) Apply small amount of sealing compound to threads of all three pipe plugs (5 and 4).
- (b) Install pipe plugs (4 and 5) and tighten to 120 lb-in (12.56 N•m).

**(6) Install camshaft expansion plug (2).****WARNING**

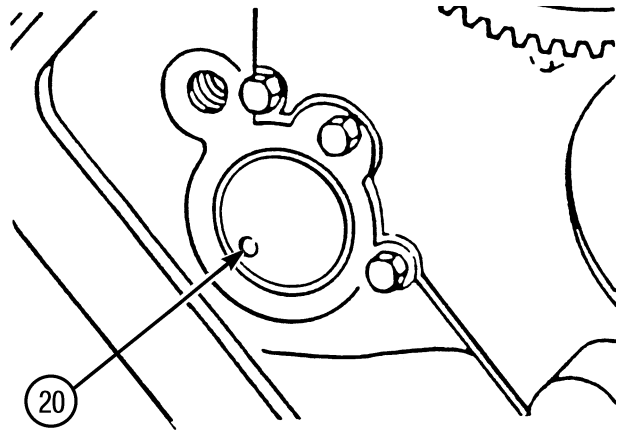
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

- (a) Apply a bead of sealing compound to entire circumference of each expansion plug (2).
- (b) Place expansion plug (2) in bore with convex side out.
- (c) Drive against convex side of expansion plug (2) using a large drift and a hammer to expand plug. Continue to drive against convex side of plug until convex side of plug is flush with face of cylinder block.

**3-6. CYLINDER BLOCK REPLACEMENT (CONT)**

**(7) Install camshaft bushing (1) in cylinder block (3).**

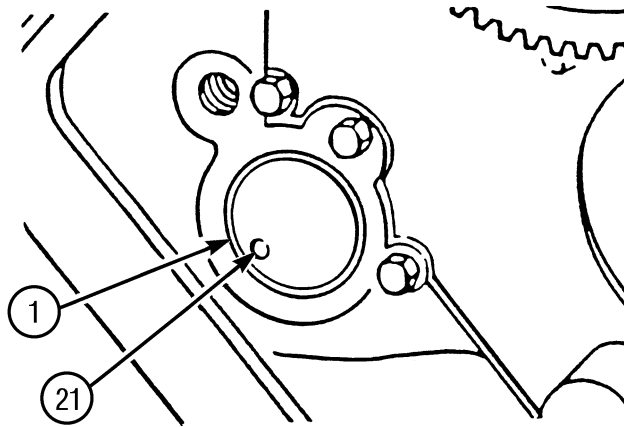
- (a) Mark location of oil hole (20) in camshaft bore using felt pen.
- (b) Place camshaft bushing (1) in its bore, taking care to align oil hole in bushing with oil hole (20) in camshaft bore.
- (c) Install camshaft bushing (1) until bushing is flush with face of cylinder block (3).



**NOTE**

The specified rod diameter represents the minimum sized oil passage required for adequate camshaft bushing lubrication. Remove and reinstall camshaft bushing if oil hole alignment is unsatisfactory.

- (d) Check oil hole alignments by inserting a 0.128 in. (3.2 mm) diameter rod into bushing oil hole (21) and insuring that rod can also enter oil hole (20) in camshaft bore.



**NOTE**

Follow-on Maintenance:

- Install engine oil cooler (Para 3-26).
- Install crankshaft main bearings (Para 3-9).
- Install connecting rods and bearings (Para 3-17).
- Install flywheel housing and cover (Para 3-15).
- Install crankshaft (Para 3-8).
- Install camshaft and timing gears (Para 3-20).
- Install valve tappets (Para 3-19).
- Install engine in vehicle (Para 3-3).

**END OF TASK**



**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | d. Inspection | g. Installation |
| b. Disassembly | e. Repair     |                 |
| c. Cleaning    | f. Assembly   |                 |

**INITIAL SETUP***Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Shop Equipment, Automotive Maintenance and  
Repair; Field Maintenance, Basic, Less Power  
(Item 18, Appendix D)  
Tool Kit, Machinists: Post, Camp and Station  
(Item 24, Appendix D)  
Lifting Chains, 200 lb (90.72 kg) capacity  
Lifting Device, 200 lb (90.72 kg) capacity  
Soft Wire Wheel  
Valve Spring Compressor  
Valve Seat Installation and Staking Tool

*Materials/Parts*

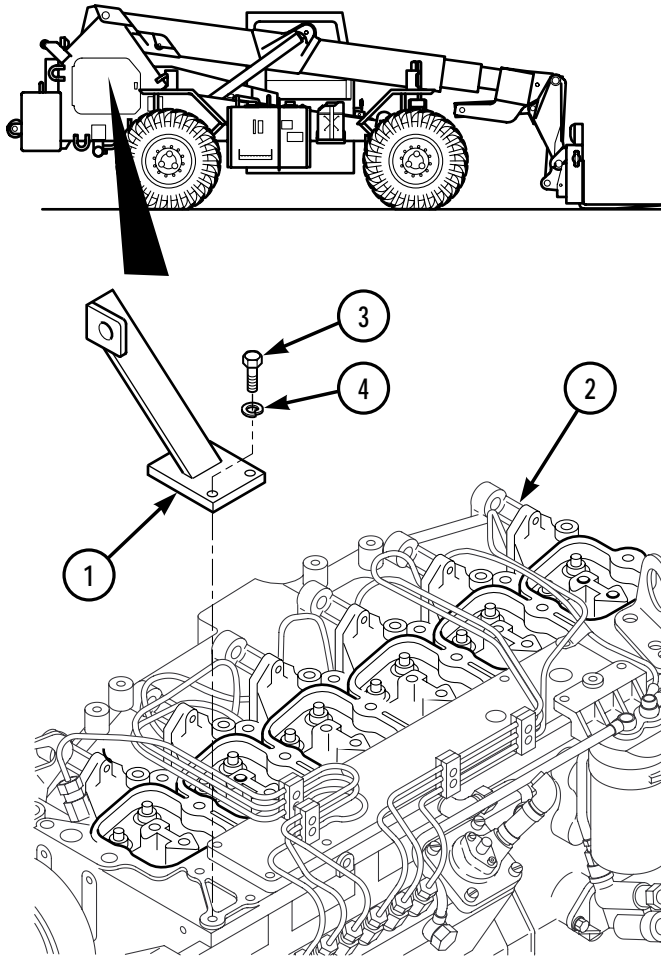
Cloth, Crocus (Item 8, Appendix B)  
Compound, Sealing (Item 40, Appendix B)  
Compound, Valve Lapping  
(Item 11, Appendix B)  
Gloves (Item 17, Appendix B)  
Oil, Fuel, Diesel (Item 24, Appendix B)  
Oil, Lubricating, Engine (Item 27, Appendix B)  
Oil, Lubricating, Gear Multipurpose  
(Item 29, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Solvent, Drycleaning (Item 52, Appendix B)  
Collets  
Gasket  
Lockwashers (3)  
Seals, Valve Stem

*Equipment Condition*

Engine oil drained (TM 10-3930-673-20)  
Radiator removed (TM 10-3930-673-20)  
Engine rocker covers removed  
(TM 10-3930-673-20)  
Heater hoses disconnected from engine  
(TM 10-3930-673-20)  
Exhaust manifold removed  
(TM 10-3930-673-20)  
Air cleaner removed (TM 10-3930-673-20)  
High pressure, supply, and drain fuel lines  
removed (TM 10-3930-673-20)  
Fuel injector nozzles removed (Para 4-3)  
Rocker arm covers removed  
(TM 10-3930-673-20)  
Rocker arm assembly removed (Para 3-18)  
Fuel filter head removed (TM 10-3930-673-20)

**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

*a. Removal.*



**(1) Remove top radiator mount (1) from cylinder head (2).**

Remove three screws (3), lockwashers (4), and top radiator mount (1) from cylinder head (2). Discard lockwashers.

- (2) Remove 14 screws (5) and six screws (6) from cylinder head (2). Work from center to ends of cylinder.
- (3) Remove cylinder head (2).

**WARNING**

The cylinder head weighs 114 lb (51.71 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

- (a) Attach lifting chains and hoist (or other suitable lifting device) to engine lifting brackets.

**CAUTION**

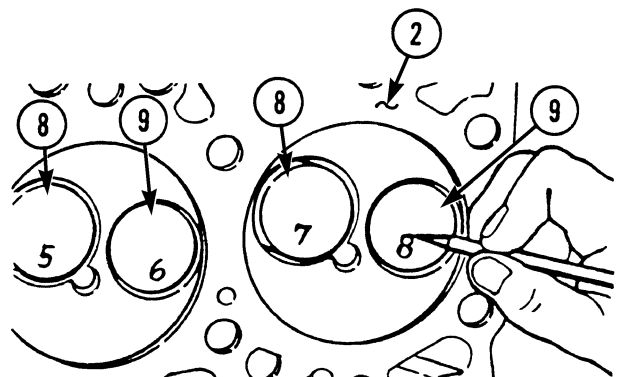
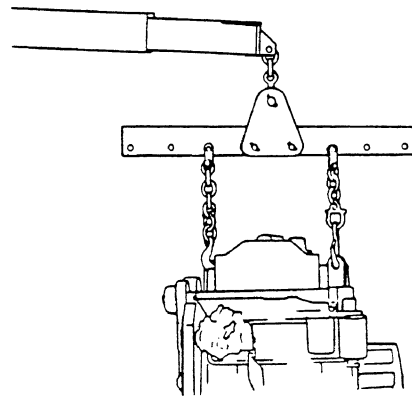
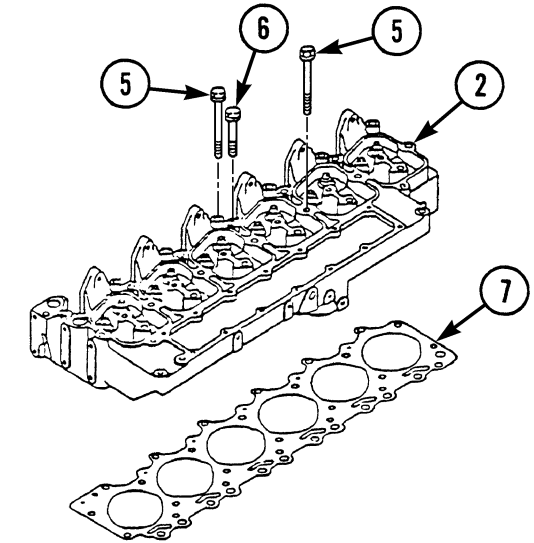
Do not lower cylinder head onto a flat surface as this could damage valves.

- (b) Slowly and carefully lift cylinder head (2) from cylinder block and place it on a suitable stand or platform that will support bottom perimeter of the cylinder head.

- (4) Remove gasket (7) from cylinder head (2). Discard gasket.

**b. Disassembly.**

- (1) Remove engine lifting brackets (Para 3-5).
- (2) Tag and mark intake and exhaust valves (8 and 9) locations in cylinder head (2).



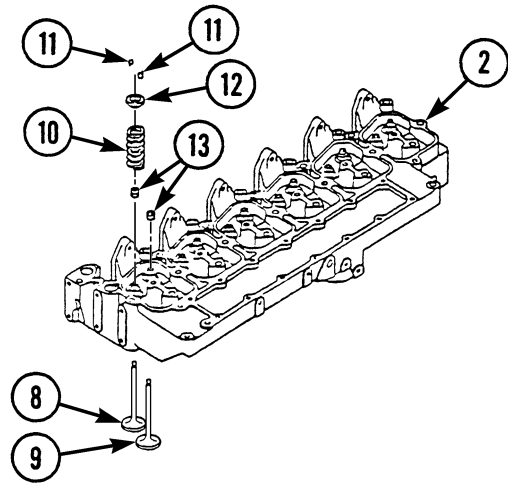
**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (3) Remove intake and exhaust valves (8 and 9) and parts (10 through 13) from cylinder head (2).

**NOTE**

All 12 valves are removed the same way.

- (a) Using valve spring compressor, compress valve spring (10).
- (b) Remove and discard collet (11).
- (c) Release spring pressure and remove spring compressor.
- (d) Remove spring retainer (12) and spring (10).
- (e) Remove intake and exhaust valves (8 and 9).
- (f) Remove and discard valve stem seals (13).



**c. Cleaning.**

**NOTE**

If cylinder head and valve components are not to be assembled right away, lightly oil and wrap the parts after inspection and before storing.

- (1) See cleaning instructions (Para 2-12).
- (2) Polish cylinder head gasket surfaces with scouring pads.
- (3) Clean carbon from intake and exhaust valves (8 and 9) and re-mark according to location in cylinder head (3).

**WARNING**

Eye shields must be worn when cleaning with a wire brush. Flying rust and metal particles may cause injury to personnel.

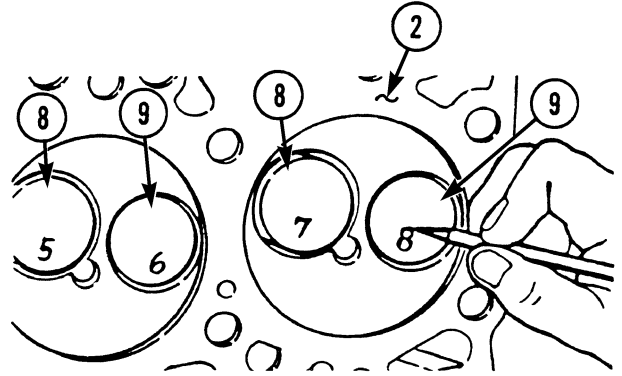
- (a) Clean intake and exhaust valve (8 and 9) heads with soft wire wheel.
- (b) Clean intake and exhaust valve (8 and 9) stems with crocus cloth.

**WARNING**

Fuel is very flammable and can explode easily. To avoid serious injury or death, keep fuel away from open fire and keep fire extinguisher within easy reach when working with fuel. Do not work on fuel system when engine is hot. Fuel can be ignited by hot engine. When working with fuel, post signs that read NO SMOKING WITHIN 50 FEET (15 m).

- (c) Wash intake and exhaust valves (8 and 9) with fuel oil and wipe dry with clean lint-free rag.

- (d) Remark intake and exhaust valves (8 and 9) according to their location in the cylinder head (2).



### WARNING

Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.

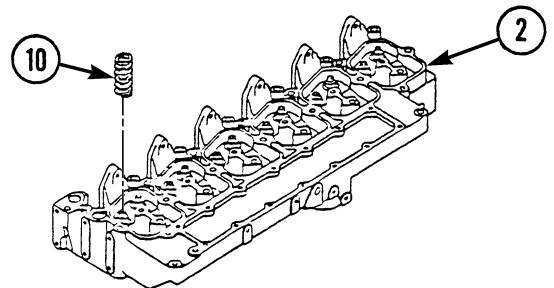
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (4) **Clean valve springs (10) with dry cleaning solvent and dry thoroughly with compressed air.**

#### *d. Inspection.*

- (1) **Inspect cylinder head (2).**

- Check for uneven surfaces and warpage of cylinder head (2).
- Place a straightedge along length of cylinder head (2) mating surface and check for distortion.

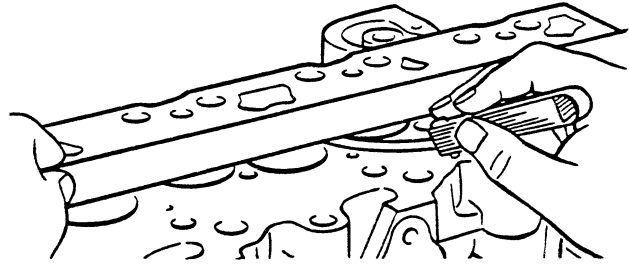


**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (c) Measure gap under straightedge in areas indicated in illustration.

**NOTE**

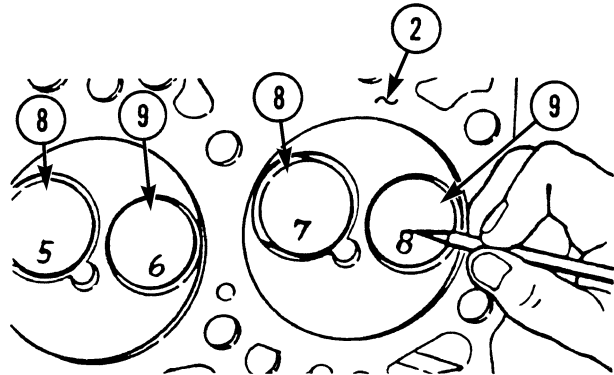
If warpage, uneven surfaces, or distortion are found, cylinder head assembly must be replaced.



Measured Area	Variation Limit
Any 2 inch dia. area	0.004 in.
Overall end-to-end	0.003 in.
Overall side-to-side	0.003 in.

- (2) **Inspect intake and exhaust valves (8 and 9). Grind all reused valves. Tag and mark new valves respective to their location in the cylinder head (3).**

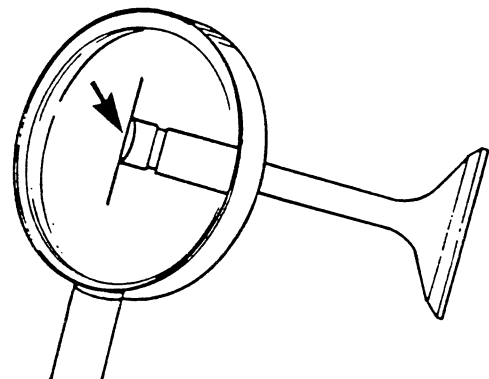
- (a) Inspect intake and exhaust valves (8 and 9) stems for scratches or scuff marks.
- (b) Inspect intake and exhaust valves (8 and 9) faces for ridges, cracks, or pitting.
- (c) Check intake and exhaust valves (8 and 9) stem tip for flatness and replace valve if necessary.



**NOTE**

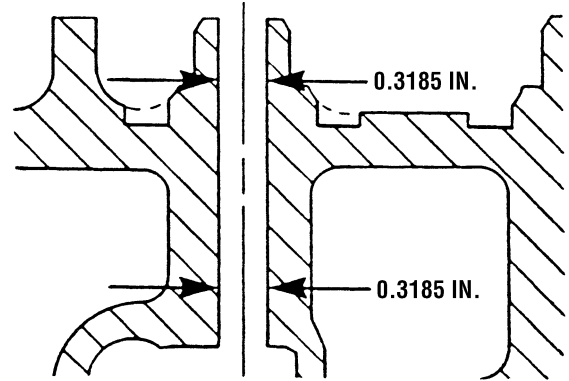
If a new valve is required, mark replacement location on valve.

- (3) **Measure valve stem diameter. Minimum allowable diameter is 0.3126 in. (7.94 mm). Tag and mark new valves respective to their location in the cylinder head (3).**



**NOTE**

Cylinder head has integral valve guides. Service valve guides can be installed to meet tolerance specifications after cylinder head is machined.



**(4) Inspect valve guide bores.**

Inspect valve guide bores for scuffing or scoring. If guide bores are scuffed or scored, service valve guides must be installed. See Step **e. Repair**.

**(5) Measure valve guide bore. Maximum allowable diameter is 0.3185 in. (8.09 mm).**

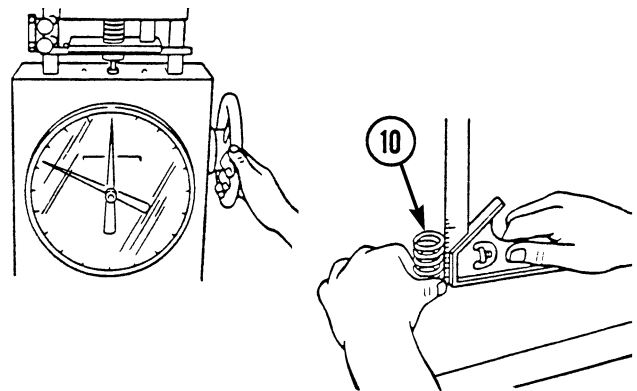
If guide bores are worn, service valve guides must be installed. See Step **e. Repair**.

**(6) Inspect valve seats.**

- (a) Inspect valve seats for scoring, scratches, or burned condition.
- (b) If a valve seat is scored, scratched, or burned it must be ground or replaced. See Step **e. Repair**.

**(7) Inspect valve springs (10).**

Visually inspect valve springs for nicks, deep scratches, rust deposits, notches at end of spring, and for wear between coils.



**(8) Using valve spring tester, check spring force.**

Description	Specification
Test force	65.0 - 72.2 lb (29.48 - 32.75 kg)
Length under test force	1.94 in. (49.28 mm)
Free length after test	2.19 in. (55.63 mm)
Spring must not be bent more than	0.039 in. (0.99 mm)

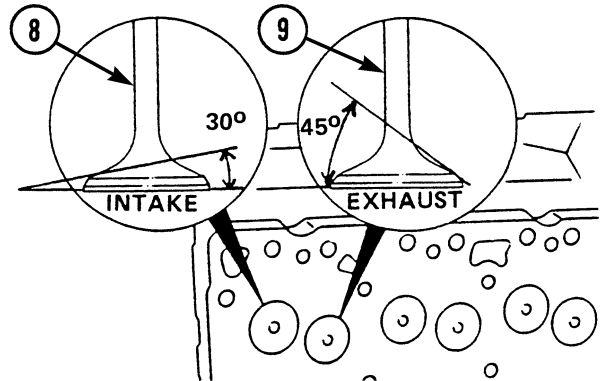
**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**e. Repair.**

**(1) Grind intake and exhaust valves (8 and 9).**

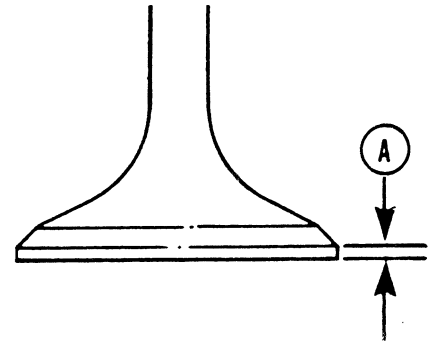
(a) Grind valves to proper face angle.

Valve Face Angle
Intake: 30°
Exhaust: 45°

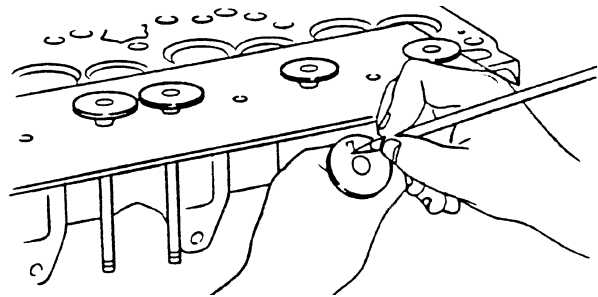


(b) Measure valve rim thickness.

Limit
Minimum (A): 0.031 in. (0.79 mm)
If rim thickness is less than 0.031 in. (0.79 mm) after grinding, replace valve.



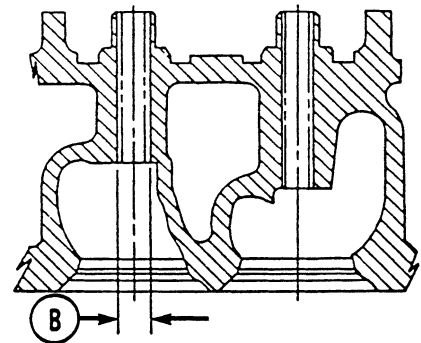
(c) Tag and mark valves again respective to their location in cylinder head.



**(2) Machine valve guide bores.**

If valve guide bores are scratched, scored, burned, or worn, the guide bores must be machined and service valve guides installed.

(a) To install service valve guides 3906206 (thin wall intake and exhaust guides), machine cylinder head parent metal valve guide bores (B) to 0.4375 - 0.4385 in. dia (11.11 - 11.14 mm).

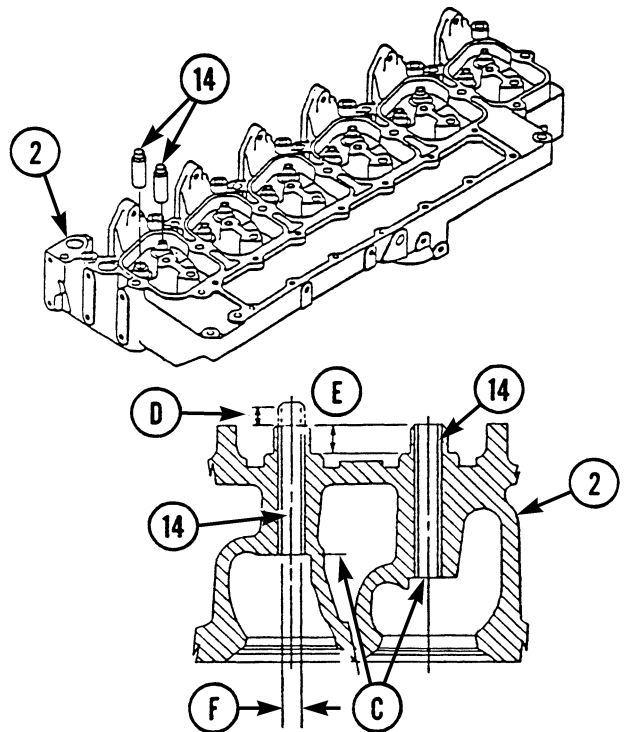




- (b) To install service valve guides 3904408 (thick wall intake) and 3904409 (thick wall exhaust), machine cylinder head parent metal valve guide bores (B) to 0.5507 - 0.5517 in. dia (13.99 - 14.01 mm).

**(3) Install service valve guides 3906206 (14).**

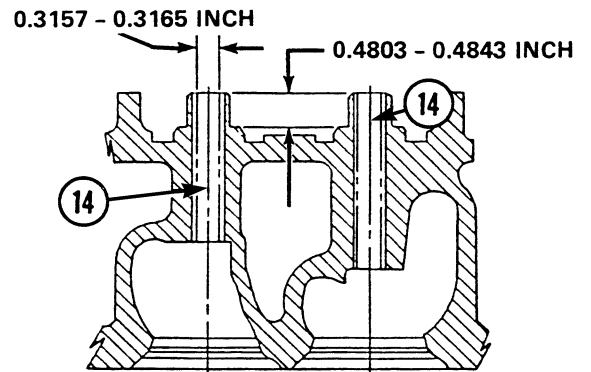
- (a) Install service valve guides 3906206 (14) by lubricating valve guides with engine lubricating oil and pressing guides in cylinder head (2) until they are flush with bottom of guide boss at C.
- (b) If necessary, trim service guides (14) so they are flush with top of guide boss at D. Note reference dimension E.
- (c) Finish ream service valve guides (14) to a diameter F of 0.3157 - 0.3165 in. (8.02 - 8.04 mm).



Reference Dimension E = 0.4429 - 0.5019 inch

**(4) Install service valve guides 3904408 and 3904409 (14).**

- (a) Install service valve guides 3904408 and 3904409 (14) by lubricating service guides with engine lubricating oil and pressing guides into cylinder head (2) until guide is 0.4803 - 0.4843 in. (12.20 - 12.30 mm) above cylinder head.
- (b) Finish ream service valve guides to a diameter of 0.3157 - 0.3158 in. (8.02 - 8.02 mm).



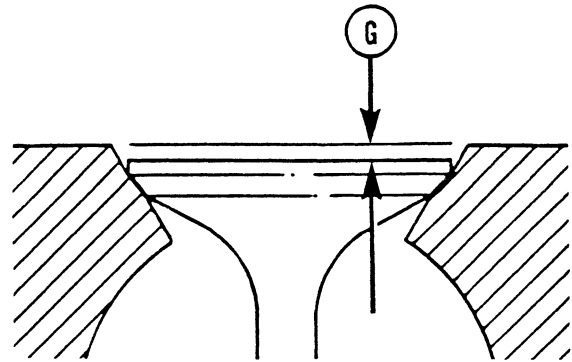
**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**NOTE**

Grind valve seats for only a few seconds to avoid making the seats too wide.

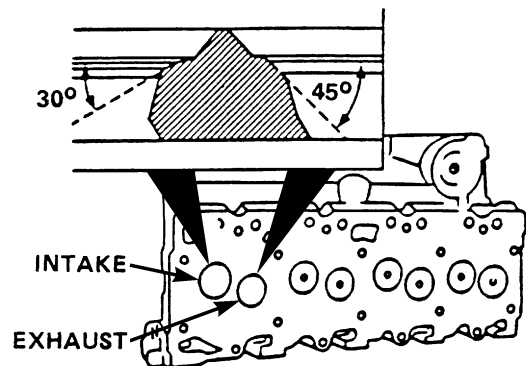
**(5) Grind integral valve seats.**

Integral (parent metal) valve seats can be ground once only. Valve seats that have been previously ground are marked with one X. If regrinding of X marked seats is necessary, service seats must be installed.



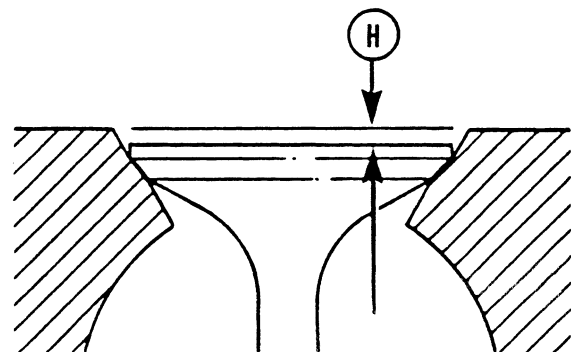
- (a) Install valves in their designated locations and measure valve depth G. Valve depth is the distance from valve face to cylinder head surface.
- (b) Record depth G for each valve.
- (c) Lightly grind valve seats to proper angle. Be careful not to remove too much material and cause excessive seat width.

Seat Angle
Intake: 30°
Exhaust: 45°

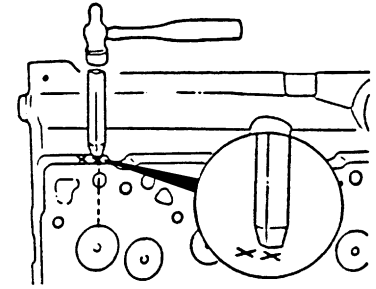


- (d) Reinstall valves in their designated bores. Measure and record depth H.
- (e) Calculate grinding depth (GD) from G and H measurements as follows:

Maximum Limit
$GD = H - G$
GD - 0.010 in. (0.25 mm)

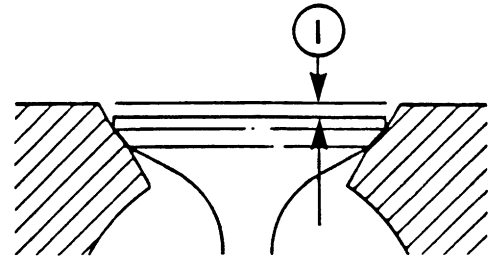


- (f) If GD is equal to or less than given tolerance, identify valve seat with an X.
- (g) If GD is greater than 0.010 in. (0.25 mm), a service valve seat must be installed.



- (h) With valves in their designated bores, measure and record depth I.

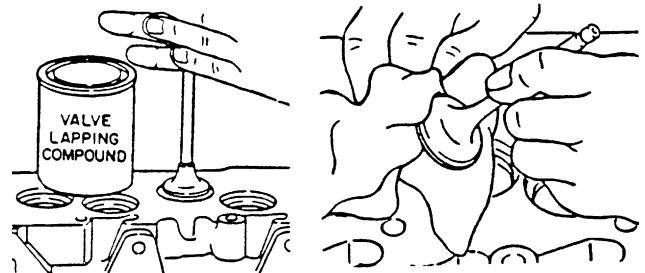
Depth Limit
I Depth: 0.039 - 0.060 in. (1 - 1.52 mm)



- (i) If depth I exceeds tolerance limits, replace the valve and check depth I again.

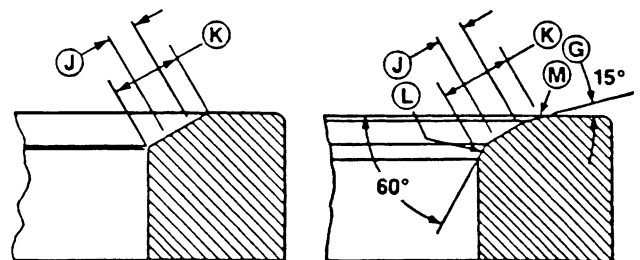
- (j) Apply a light coat of valve lapping compound to each valve and lap each valve to its companion seat.

- (k) Remove valves and clean grinding compound from valves and seats.



- (l) Measure valve seat width.

Valve Seat Width Range Limit
Point J: 0.060 in. (1.52 mm)
Point K: 0.080 in. (2.03 mm)



- (m) If valve seat is too wide after lapping, grind lower seat surface L using a 60° seat grinder, and upper seat surface M with a 15° seat grinder until seat width is centered and within specifications listed in Step (k) above.

**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**NOTE**

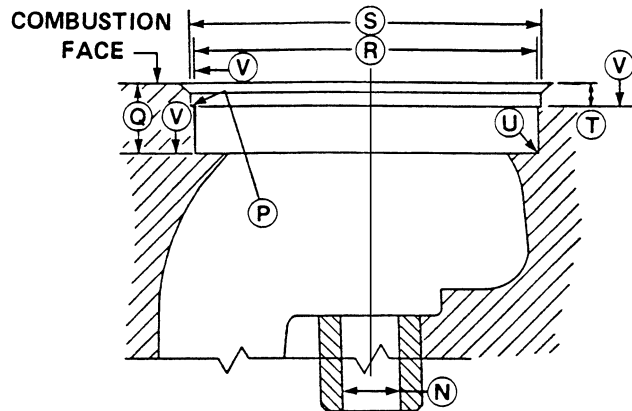
If it was necessary to install service valve guides (**Repair** Steps (3) and (4)), install service guides before installing the service seats.

- (6) **Machine parent metal intake valve combustion seat pockets and install intake face valve service seat(s).**

**NOTE**

Valve seats marked with one X at side of cylinder head have been ground once and if regrinding is necessary, a service seat must be installed.

- (a) Machine parent metal intake valve seat pocket to the dimensions shown.

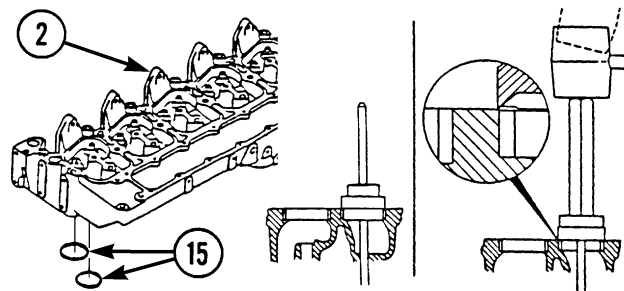


- N = 0.3157 - 0.3165 in.
- P = 0.015 in. radius max.
- Q = 0.4054 - 0.4134 in.
- R = 1.8499 - 1.8509 in. dia.
- S = 1.8848 - 1.8948 in. dia.
- T = 0.1454 - 0.1554 in.
- U = 0.0157 in. radius max.
- V = 128 microinch surface finish

**NOTE**

No. 3823031 valve seat installation staking tool is available from Cummins Engine Co., Inc. for installing and staking valve seats.

- (b) Using a driver, push service seats (15) into machined pockets.
- (c) Using a suitable staking tool, stake service seals into seal pockets.

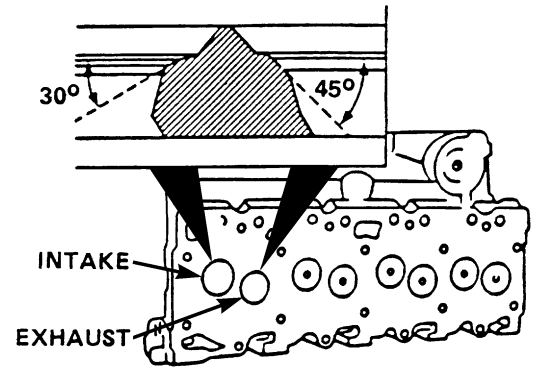


**NOTE**

Grind service seats for only a few seconds only to avoid making them too wide.

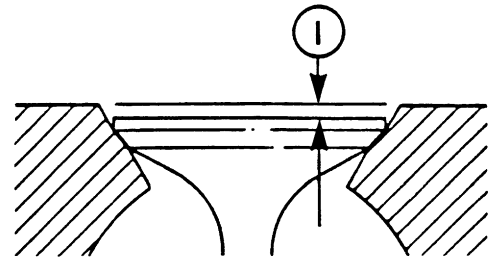
- (d) Grind service valve seats lightly to ensure proper seat angle.

Seat Angle
Intake: 30°
Exhaust: 45°



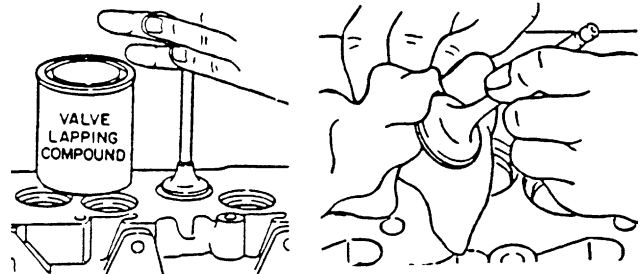
- (e) Install valves in their designated locations and measure depth I.

Limit
I Depth: 0.039 - 0.060 in. (1 - 1.52 mm)



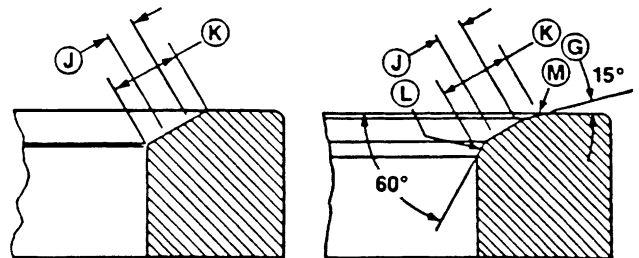
- (f) Apply a light coat of valve lapping compound to each valve and lap valve to its companion service seat.

- (g) Remove valves from cylinder head and clean grinding compound from valves and service seats.



- (h) Measure width of service seats.

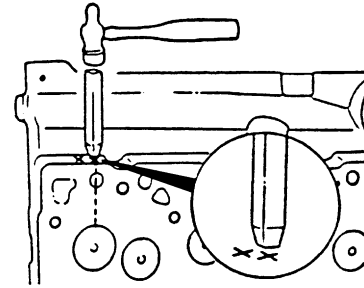
Valve Service Seat Width Range Limit
Point J: 0.060 in. (1.52 mm)
Point K: 0.080 in. (2.03 mm)



- (i) If service seat is too wide after lapping, grind lower seat surface L using a 60° seat grinder, and upper seat surface M with a 15° seat grinder until seat width is centered and within specifications listed in Step (h) above.

**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

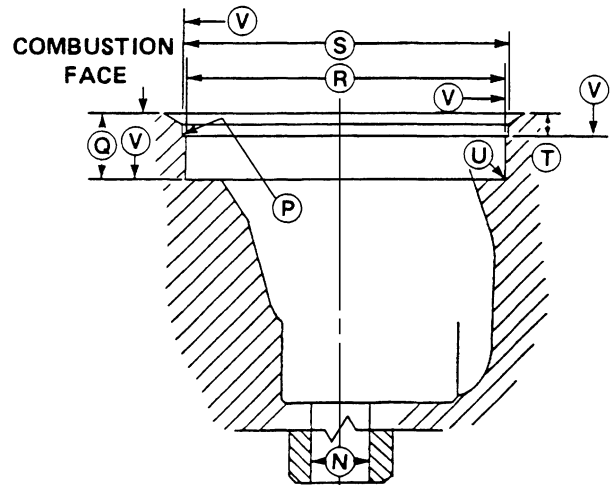
- (j) Stamp two X's on side of cylinder head in line with pocket with service seat.



**(7) Machine parent metal exhaust valve seat pockets and install exhaust.**

Valve seats marked with one X at side of cylinder head have been ground once and if regrinding is necessary, install service seat.

- (a) Machine parent metal intake valve seat pocket to dimensions shown.
- (b) Install exhaust valve service seats the same way as described for the intake service seats (see Steps (5)(b) through (6)(j) above).



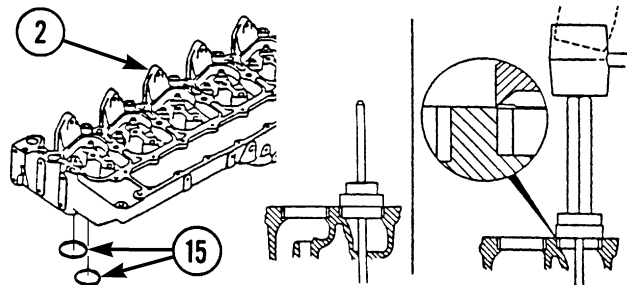
- N = 0.3157 - 0.3165 in.
- P = 0.015 in. radius max.
- Q = 0.3975 - 0.4055 in.
- R = 1.7180 - 1.7190 in. dia.
- S = 1.7489 - 1.7589 in. dia.
- T = 0.1379 - 0.1479 in.
- U = 0.0157 in. radius max.
- V = 128 microinch surface finish

**NOTE**

If it can not be accurately determined that service valve seats have been ground only once after initial installation, replace seat.

**(8) Grind valve service seat(s). Grind service seats (15) for a few seconds only to avoid making them too wide to fit in cylinder head (2).**

- (a) Valve seats marked with two X's on cylinder head have service seats installed. Service seats, like the parent metal seats, can only be ground once after initial installation.



- (b) Grind service seats the same way, and to same tolerances, as used for grinding integral seat in Step (4) above.

**f. Assembly.**

**WARNING**

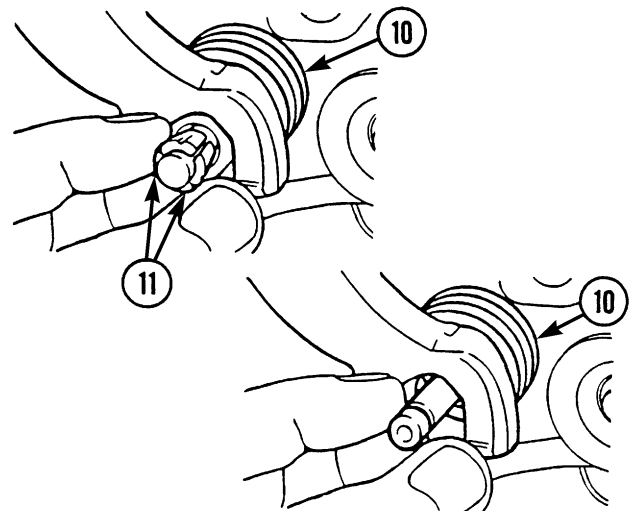
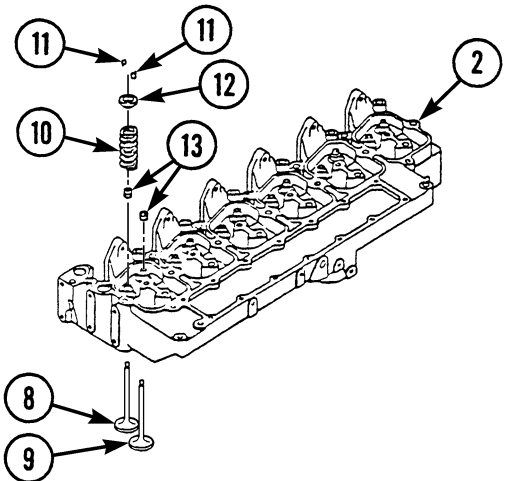
If collet is not correctly installed on valve stem, it will unseat and be thrown with force when the spring compressor is released. The thrown collet could cause serious personal injury.

**NOTE**

The intake and exhaust valve stem seals are the same.

**(1) Install intake and exhaust valves (8 and 9) and parts (10 through 13) on cylinder head (2).**

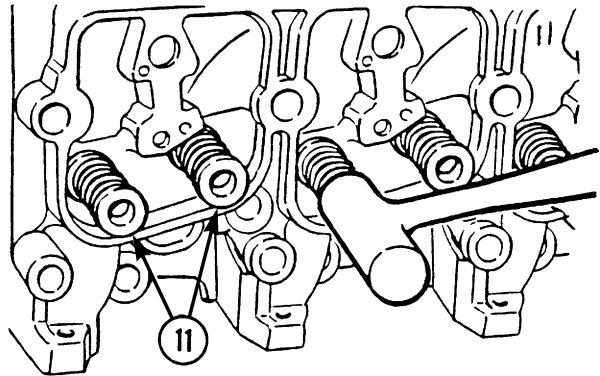
- (a) Install valve stem seals (13).
- (b) Coat valve stems with clean gear lubricating oil GO 80/90 and install intake valve (8) and exhaust valve (9) in their designated locations.
- (c) Install springs (10) and spring retainers (12) over intake and exhaust valve stems (8 and 9).
- (d) Using a valve spring compressor, compress springs (10) and install new collets (11).
- (e) Slowly release valve spring compressor and remove it from valve.



**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (f) Tap valve stems lightly to seat collets (11).
- (g) Repeat Steps (a) through (e) for remainder of valves.

**(2) Install engine lifting brackets (Para 3-5).**



**g. Installation.**

**CAUTION**

The bottom surface of cylinder head and top of cylinder block must be clean of all residue and dry. Dirty surfaces could cause leaks or incorrect seat between cylinder head and block.

**(1) Install gasket (7).**

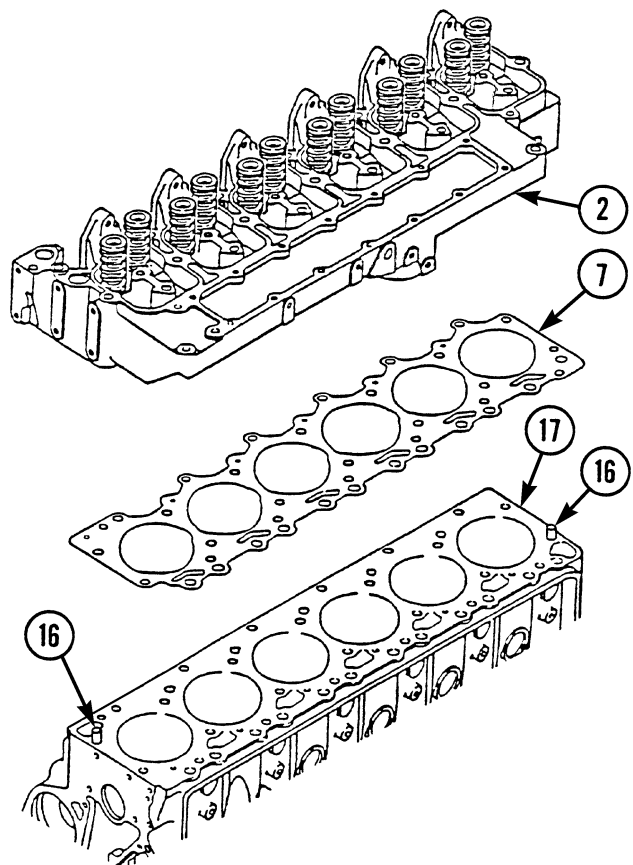
Install gasket (7) over cylinder block dowels (16). Be sure gasket is correctly aligned with holes in block.

**(2) Place cylinder head (2) on block (17).**

**WARNING**

The cylinder head weighs 114 lb (51.71 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

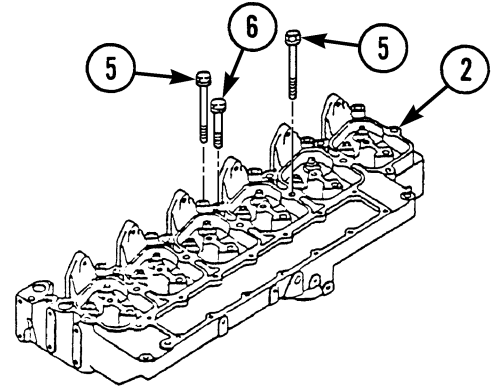
- (a) Attach lifting chains and hoist (or other suitable lifting device) to engine lifting brackets.
- (b) Carefully place cylinder head (2) over block dowels (16) and on block (17).
- (c) Remove lifting chains and hoist.



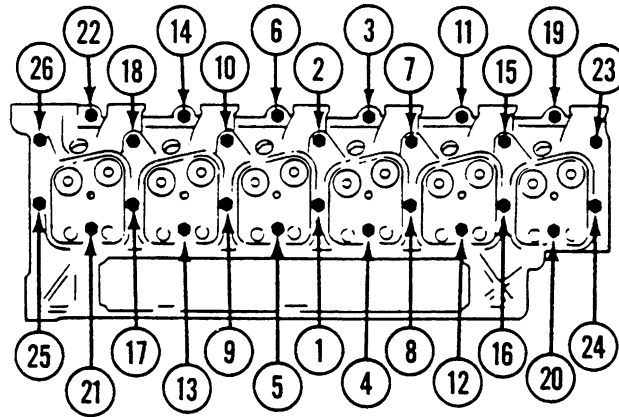


(3) **Install rocker arm assembly (Para 3-18). Do not tighten mounting screws at this time.**

(4) **Install 14 screws (5) and six screws (6) in cylinder head (2). Tighten to final torque in the sequence shown, in three steps.**



- (a) Put engine lubricating oil under the heads and on the threads of 14 screws (5) and six screws (6).
- (b) Install screws (5 and 6) in cylinder head (2) finger tight.



Step	Torque Value
1 .....	29 lb. ft.
2 .....	62 lb. ft.
3 .....	92 lb. ft.

- (c) Tighten screws (5 and 6) and rocker lever pedestal M12 screws in sequence shown to final torque value in three steps.
  - (d) Tighten rocker lever pedestal M8 screws to 18 lb-ft (24.4 N•m).
- (5) **Adjust valves (TM 10-3930-673-20).**
- (6) **Install rocker arm covers (TM 10-3930-673-20).**

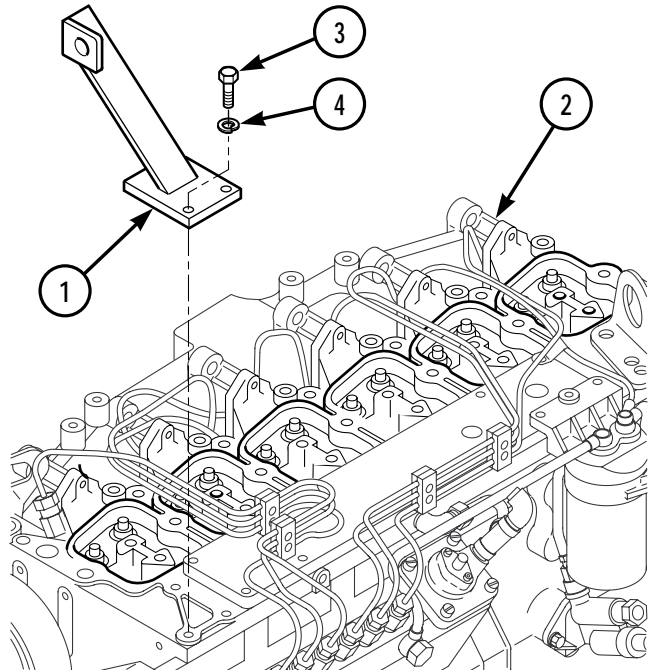
**3-7. CYLINDER HEAD ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (7) **Install top radiator mount (1) on cylinder head (2).**

**WARNING**

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

Apply sealing compound to threads of screws (3). Install top radiator mount (1), three lockwashers (2), and screws.



**NOTE**

Follow-on Maintenance:

- Connect heater hoses to engine (TM 10-3930-673-20).
- Install fuel filter (TM 10-3930-673-20).
- Install exhaust manifold (TM 10-3930-673-20).
- Install fuel injector nozzles (Para 4-3).
- Install high pressure, supply, and drain fuel lines (TM 10-3930-673-20).
- Install air cleaner (TM 10-3930-673-20).
- Install radiator (TM 10-3930-673-20).
- Install engine covers (TM 10-3930-673-20).
- Service engine with lubricating oil (TM 10-3930-673-20).

**END OF TASK**

### 3-8. CRANKSHAFT REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Nylon Straps, 200 lb (90.72 kg) capacity)
- Lifting Device, 200 lb (90.72 kg) capacity)
- Dial Indicator
- Engine Stand
- Gear Puller
- Inside Micrometer, 3 in. (76.2 mm)
- Inside Micrometer, 4 in. (101.6 mm)

##### *Materials/Parts*

- Gloves, Insulated (Item 17, Appendix B)
- Lubriplate (Item 23, Appendix B)
- Oil, Lubricating, Engine (Item 27, Appendix B)
- Plastigage (Item 32, Appendix B)
- Bearings, Connecting Rod
- Bearings, Connecting Rod
- Bearings, Main
- Bearings, Main
- Bearing, Thrust
- Gasket
- Pin, Roll
- Screws (2)
- Wear Sleeve, Front
- Wear Sleeve, Rear

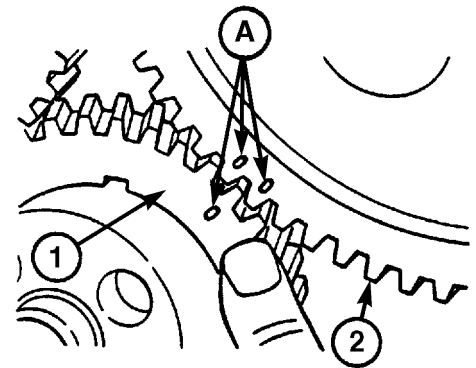
##### *Equipment Condition*

- Engine removed (Para 3-3)
- Flywheel housing and cover removed (Para 3-15)
- Front housing cover only removed (Para 3-21)
- Engine oil pan removed (Para 3-23)

#### **a. Removal.**

- (1) **Align and mark crankshaft gear (1) and camshaft gear (2).**

Turn crankshaft until timing mark (A) on crankshaft gear (1) is aligned with timing mark (A) on the camshaft gear (2).



**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

**WARNING**

Be sure engine is securely attached to engine stand. If engine falls from the stand, serious bodily injury could occur and the block and crankshaft could be damaged.

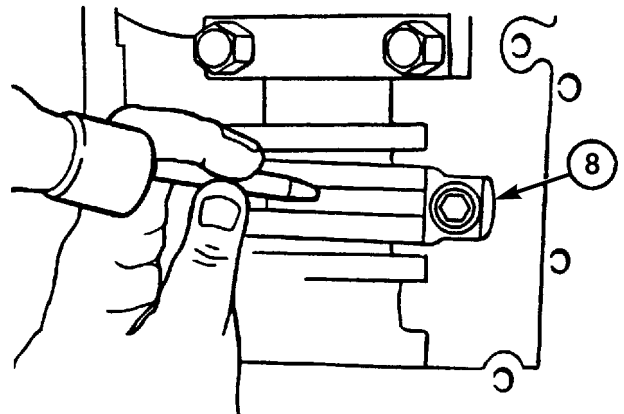
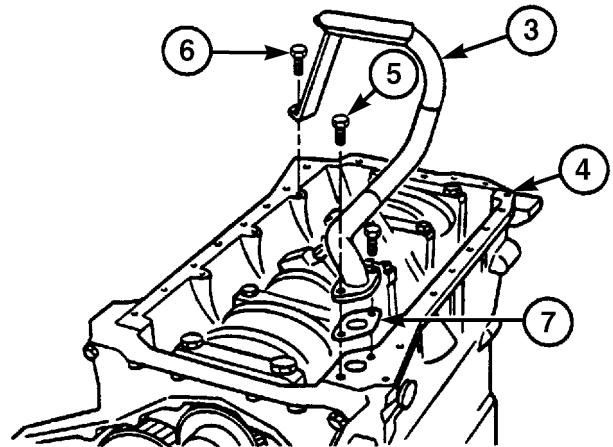
- (2) **Check that engine is securely attached to the engine stand, then turn engine stand so that crankshaft is up.**

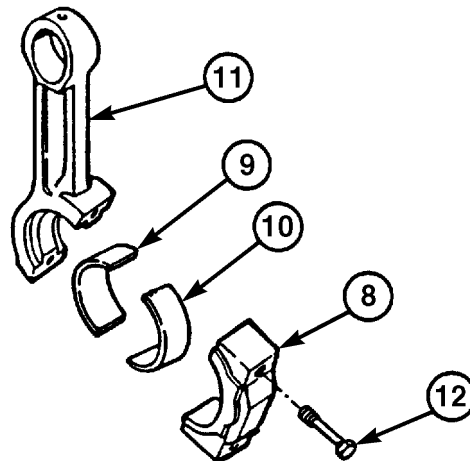
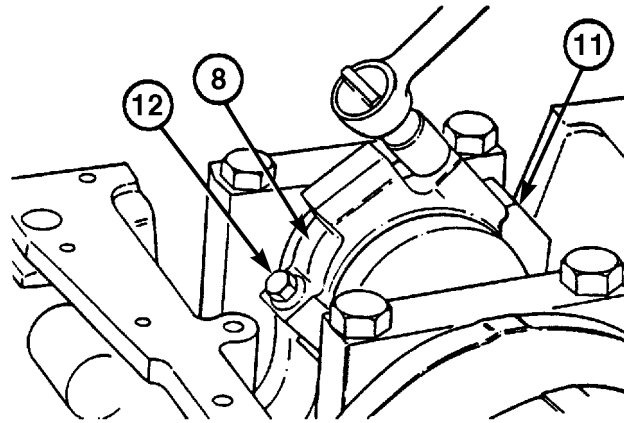
- (3) **Remove oil suction tube (3) from cylinder block (4).**

- (a) Remove two screws (5) and screw (6) from cylinder block (4).
- (b) Remove oil suction tube (3) and gasket (7) from cylinder block (4). Discard gasket.

- (4) **Remove piston connecting rod caps (8) and upper and lower bearing halves (9 and 10) from connecting rod (11).**

- (a) Turn crankshaft until two pistons are bottom center.
- (b) Mark cylinder number onto each connecting rod cap (8).





**CAUTION**

Be careful not to scratch or damage crankshaft when removing connecting rod caps and upper half of bearings. Any damage to the crankshaft could result in premature engine failure.

**NOTE**

Do not reuse connecting rod screws.

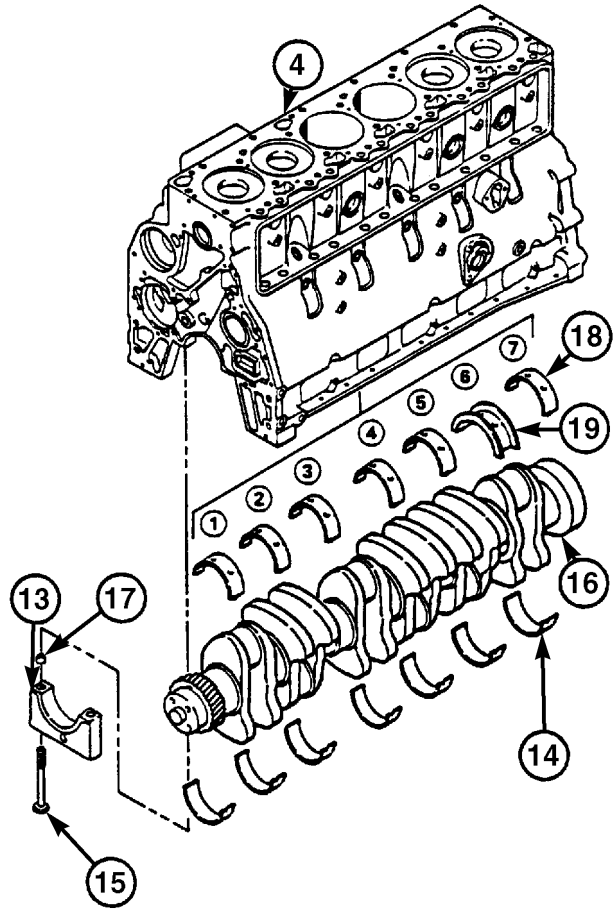
- (c) Remove two screws (12) and connecting rod caps (8) from connecting rods (11). Discard screws.
- (d) Push pistons and connecting rods (11) away from crankshaft.
- (e) Remove upper bearing half (9) from connecting rods (11) and lower bearing half (10) from connecting rod caps (8). Keep connecting rod caps and bearing halves together as a set.

**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

**NOTE**

The four-digit number stamped on the connecting rod and connecting rod cap are the same. Connecting rod and cap are machined as a set and must be kept that way.

- (5) **Repeat Steps (4)(a) through (4)(e) for remaining connecting rod caps and bearings.**
- (6) **Remove main bearing caps (13) and lower bearing halves (14).**
  - (a) Remove 14 screws (15) and seven main bearing caps (13) from crankshaft (16).
  - (b) Remove lower bearing halves (14) from bearing caps (13). Discard bearing halves.
  - (c) If damaged, remove 14 ring dowels (17) from bearing caps (13).



**CAUTION**

Use only nylon straps, or equivalent, to remove crankshaft from cylinder block. Be sure that nothing hard contacts the machined surfaces of the crankshaft. A scratched or damaged crankshaft could cause premature engine failure.

- (7) **Remove crankshaft (16) from cylinder block (4).**

**WARNING**

Crankshaft weighs 123 lb (55.79 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

- (a) Attach nylon or equivalent straps to the crankshaft (16).

**CAUTION**

Be careful not to damage or scratch the crankshaft during removal.

- (b) Attach lifting straps to a suitable hoist. Slowly and carefully lift crankshaft (16) from the cylinder block (4).
  - (c) Place crankshaft (16) in a clean, dry work area.
- (8) Remove upper bearing halves (18) and thrust bearing (19).**
- (a) Remove upper bearing halves (18) from main bearing positions (1 through 5 and 7) in cylinder block (4).
  - (b) Remove thrust bearing (19) from no. 6 main bearing location in cylinder block (4).

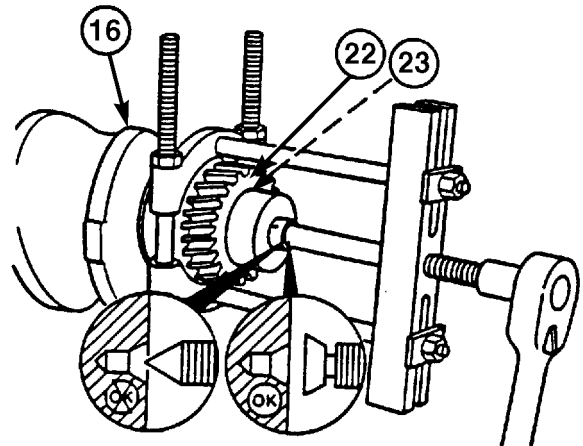
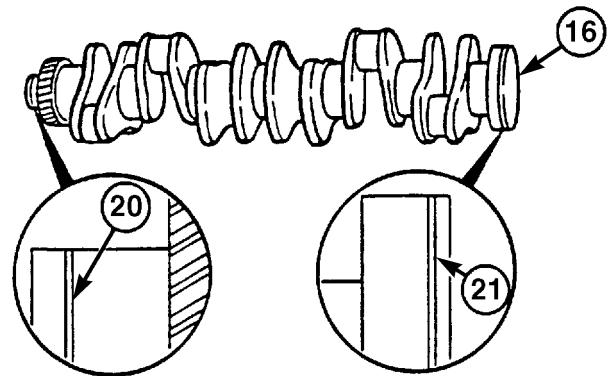
**b. Disassembly.**

- (1) Remove wear sleeves (20 and 21) if installed or necessary.**

Remove and discard front wear sleeve (20) and rear wear sleeve (21) from crankshaft (16).

- (2) Remove crankshaft gear (22).**

Use a suitable gear puller to remove crankshaft gear (22) and roll pin (23), if necessary, from crankshaft (16).



**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

*c. Cleaning.*

- (1) See cleaning instructions (Para 2-12).

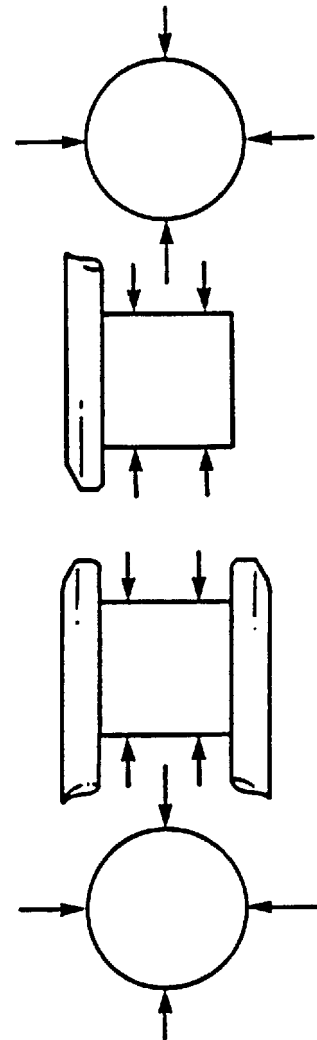
**CAUTION**

If crankshaft is not to be reinstalled within one hour after it is cleaned, apply lubricating oil on the bearing journals. Failure to comply with this recommendation will result in bearing journal corrosion.

- (2) Apply lubricating oil to all crankshaft bearing journals if crankshaft is not going to be installed within one hour after cleaning.

*d. Inspection.*

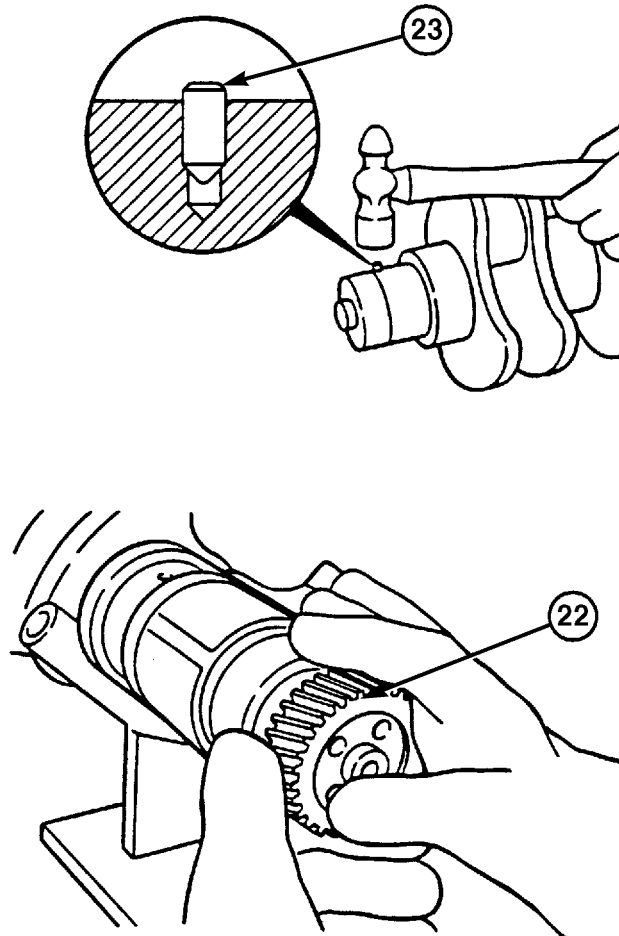
- (1) See inspection instructions (Para 2-14).
- (2) Visually inspect crankshaft
  - (a) Inspect for large, deep cracks or broken material throughout the crankshaft, especially in the fillet and journal areas.
  - (b) Inspect for a high concentration of depressions or pitting.
  - (c) Inspect for burning or scoring in the journal areas.
  - (d) If any of the conditions mentioned in Steps (a) through (c) exist, replace the crankshaft.
- (3) Measure crankshaft bearing journals.
  - (a) Measure crankshaft main bearing journals. If any main bearing journal measures less than 3.2662 in. (82.96 mm), replace the crankshaft or use oversize bearings. If any main bearing journal is out of round by more than 0.0020 in. (0.05 mm), replace crankshaft or machine crankshaft and use oversize bearings.
  - (b) Measure crankshaft connecting rod journals. If any connecting rod journal measures less than 2.7150 in. (68.96 mm), replace the crankshaft or use oversize bearing. If any connecting rod journal is out of round by more than 0.0020 in. (0.05 mm), replace crankshaft or machine crankshaft and use oversize bearings.





- (4) **Inspect main bearing bores for damage or abnormal wear (Para 3-9).**
- (5) **Measure diameter of main bearing bores (Para 3-9).**
- (6) **Inspect and measure connecting rod bearings (Para 3-17).**

**e. Assembly.**



**(1) Install roll pin (23) and crankshaft gear (22).**

- (a) If a new crankshaft is being installed, a new roll pin (21) must be installed.

**CAUTION**

Do not heat crankshaft gear longer than 45 minutes. The gear will become permanently distorted if it is heated for longer than 45 minutes.

- (b) Heat crankshaft gear (22) in an oven for 45 minutes at 250°F (121.11°C).

**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

**WARNING**

Wear gloves and proper clothing while handling hot crankshaft gear. Failure to follow this precaution could result in serious personal injury.

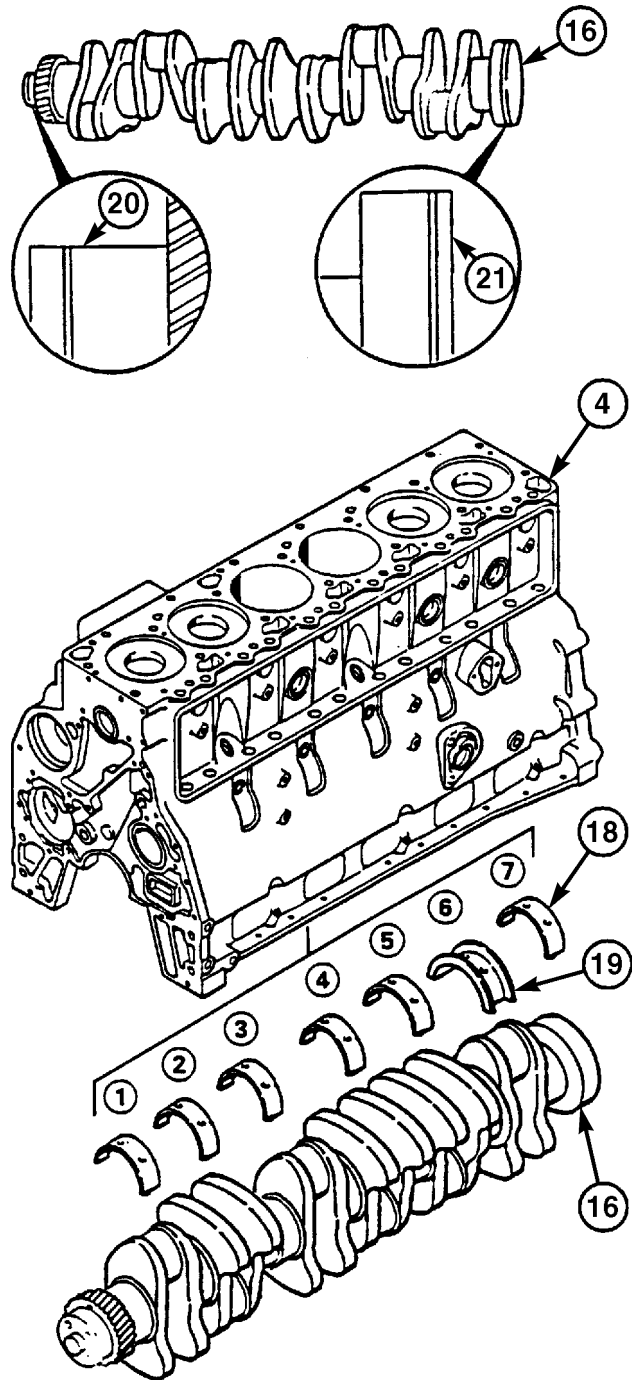
- (c) Wearing insulated gloves, install crankshaft gear (22), with timing mark facing you, onto crankshaft until it is against the crankshaft (16) shaft shoulder.

**NOTE**

Wear sleeves are used only if seal surfaces were damaged and the surface was machined to allow for sleeve installation.

**(2) Install wear sleeves (20 and 21).**

- (a) Install front wear sleeve (20) over end of crankshaft (16).
- (b) Install rear wear sleeve (21) over end of crankshaft (16).



**f. Installation.**

- (1) **Clean main bearing surfaces in cylinder block (Para 3-9).**

**NOTE**

If the crankshaft journals have been ground, appropriate oversize bearings will need to be installed.

- (2) **Check upper and lower bearing halves (14 and 18) and thrust bearing (19) clearance.**

**NOTE**

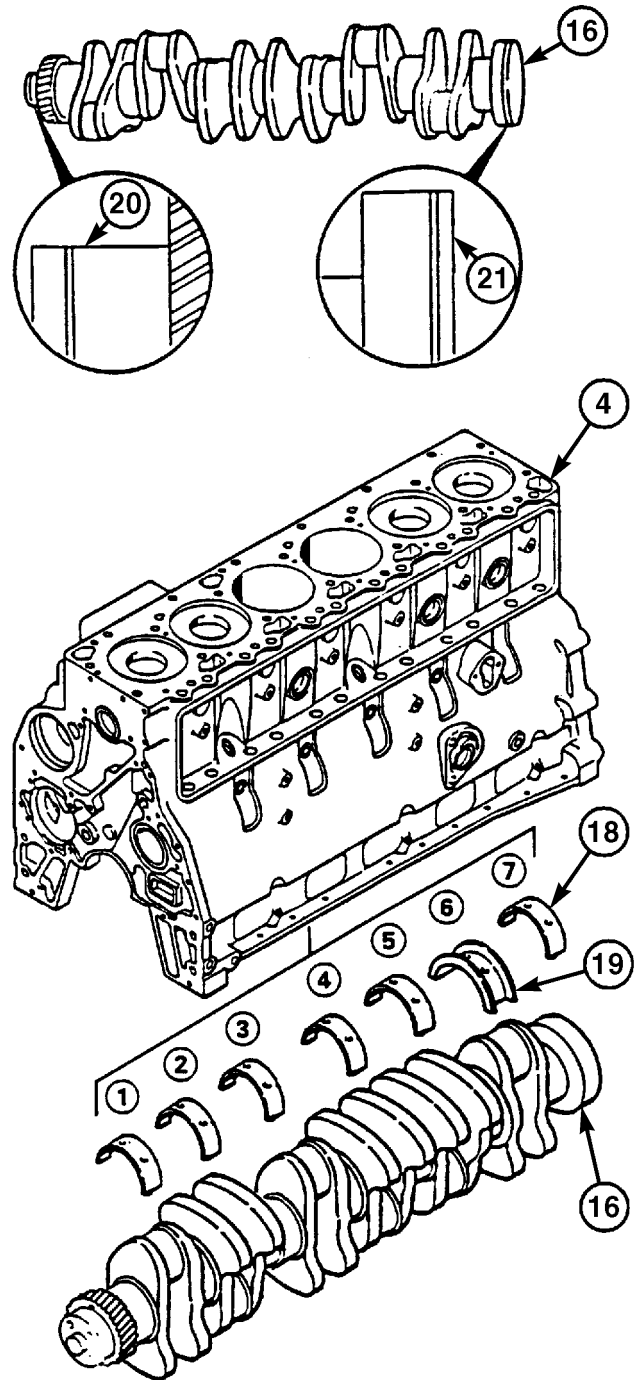
Install new main bearings dry at this time. Be sure cylinder block bearing bores, backsides of bearings, and inner surface of bearing caps are clean and dry.

- (a) Align tab of new upper bearing half (18) with groove in crankshaft bearing bore (cylinder block), and press bearing half into place. Perform this procedure for main bearing positions (1 through 5 and 7).
- (b) Install thrust bearing (19) in crankshaft bearing bore no. 6 with tab in bearing bore groove.

**CAUTION**

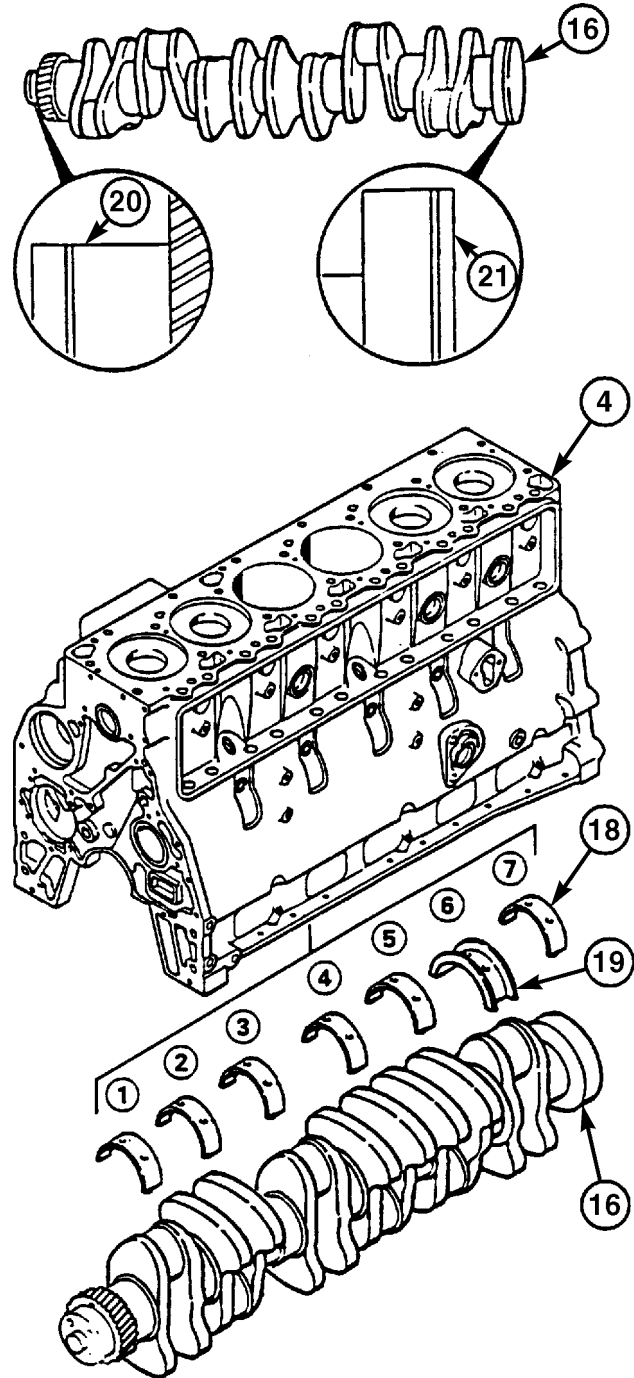
Use only nylon straps, or equivalent, to install crankshaft into cylinder block. Be sure that nothing metallic comes in contact with the machined surfaces of the crankshaft. A scratched or damaged crankshaft could cause premature engine failure.

- (c) Attach nylon or equivalent straps to the crankshaft (16).

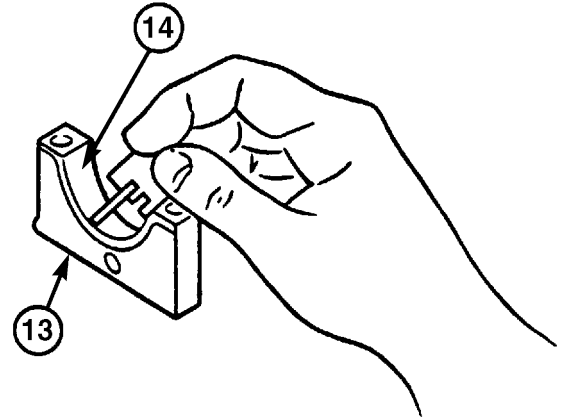


**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

- (d) Attach lifting straps to a suitable hoist. Slowly and carefully move crankshaft (16) from the engine stand to the cylinder block (4).
- (e) Slowly lower crankshaft (16) into cylinder block (4). Be careful not to scratch the crankshaft journals.
- (f) Check that the crankshaft gear-to-camshaft gear timing marks are aligned. Allow crankshaft to firmly rest against the upper main bearing halves (18).



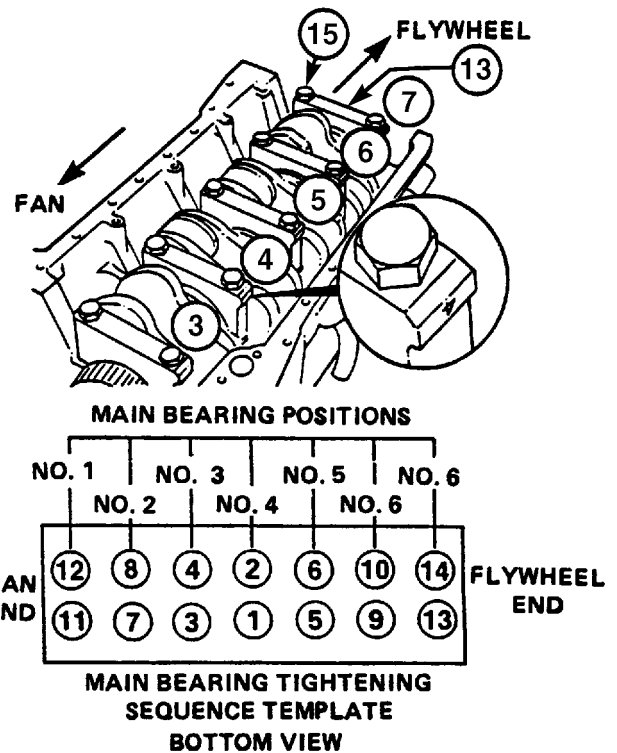
- (g) Place lower bearing halves (14) in bearing caps (13) with bearing tab in groove of cap.
- (h) Place a piece of plastigage on the surface of each lower main bearing half (14).



**NOTE**

The number on the bearing cap must correspond to the number in the cylinder block and it must be facing towards the oil cooler side of the engine.

- (i) Apply clean lubricating oil to threads of 14 screws (15), then install seven bearing caps (13) and screws on crankshaft (16). Tighten screws finger tight.
- (j) The main bearing screws (15) must be tightened evenly in a series of three steps, and in the sequence shown in this illustration. The torque values for each step are shown in this chart.



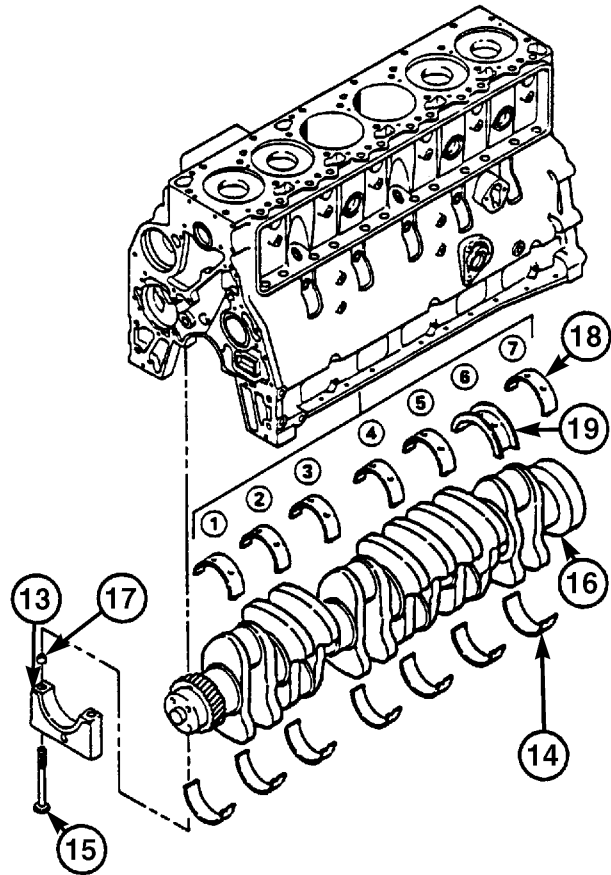
- (k) Remove all screws (15) and bearing caps (13).

**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)****NOTE**

If clearance exceeds tolerance listed below proceed to Steps (m) and (n).

If clearance does not exceed tolerance proceed to Step (3)(h).

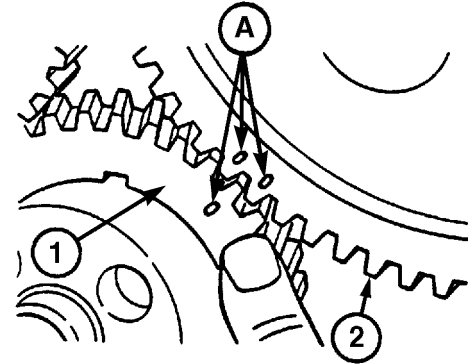
- (l) Remove and measure plastigage. Main bearing clearance must not exceed 0.00474 in. (0.120 mm). If bearing clearance exceeds clearance measurement, use appropriate oversize bearings.
  - (m) Remove lower bearing halves (14) from bearing caps (13).
  - (n) Lift crankshaft (16) from cylinder block (4) far enough to remove upper bearing halves (18) and thrust bearing (19). Be careful that connecting rods do not scratch crankshaft.
- (3) Install upper and lower bearing halves (14 and 18).**

**CAUTION**

Be sure cylinder block bearing bores, backsides of bearings, and inner surface of bearing caps are clean and dry. Oil on these areas could cause less heat transfer between the bearings and the block which, in turn, could cause overheated bearings.

- (a) If removed, install 14 ring dowels (16) in bearing caps (13).
- (b) Place lower bearing halves (14) in bearing caps (13) with tab inserted in cap groove.
- (c) At main bearing positions (1 through 5, and 7), align tab of upper bearing half (18) with groove in bearing bore (cylinder block), and press bearing half into place.
- (d) Align tab of thrust bearing (19) with groove in cylinder block at main bearing position (6) and press thrust bearing into place.

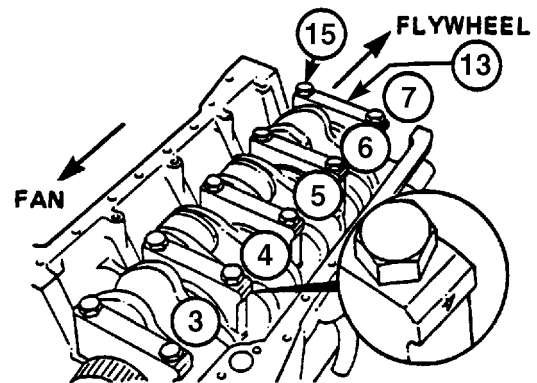
- (e) Apply Lubriplate 105 to the inside surfaces of the upper and lower bearing halves (14 and 18) and thrust bearing (19).
- (f) Slowly lower crankshaft into cylinder block. Be careful not to scratch the crankshaft journals.
- (g) Check that the crankshaft gear (1) to camshaft gear (2) timing marks are aligned at point "A", then allow crankshaft to firmly rest against the upper bearing halves (18).



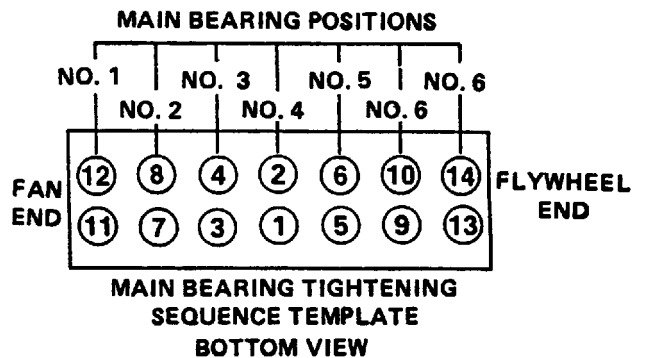
**NOTE**

The number on the bearing caps must correspond to the numbers in the cylinder block and they must be towards the oil cooler side of the engine.

- (h) Install seven bearing caps (13) and 14 screws (15). Tighten screws finger tight.
- (i) The main bearing screws (15) must be tightened evenly in a series of three steps, and in the sequence shown in this illustration. The torque value for each step is shown in this chart.



Step	Torque Value
1	44 lb-ft (59.66 N•m)
2	88 lb-ft (119.31 N•m)
3	129 lb-ft (174.90 N•m)



**(4) Check crankshaft (16) end play.**

**NOTE**

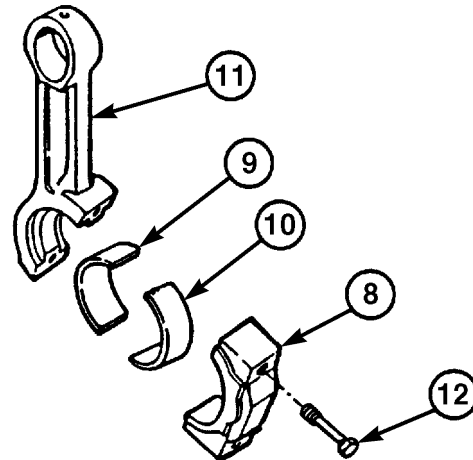
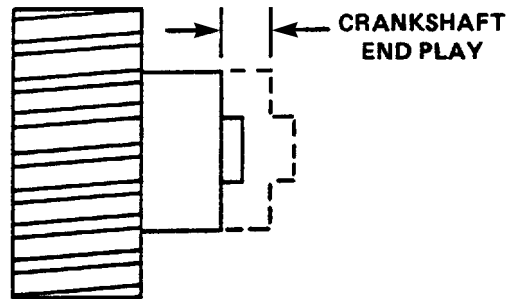
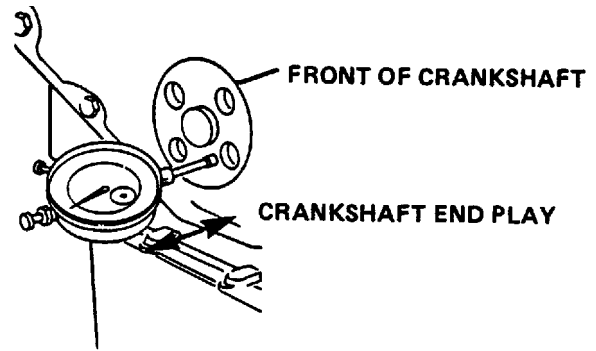
End play is controlled by the dimensions of the thrust bearing and crankshaft journal at the no. 6 main bearing position.

- (a) Measure crankshaft (16) end play using a dial indicator as shown in this illustration.
- (b) Push crankshaft (16) forward, then toward rear of engine. With a new thrust bearing, end play limits must not exceed 0.005 - 0.010 in. (0.13 - 0.25 mm).
- (c) If end play measurement is greater than 0.010 in. (0.25 mm), install a larger size thrust bearing (19).

**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

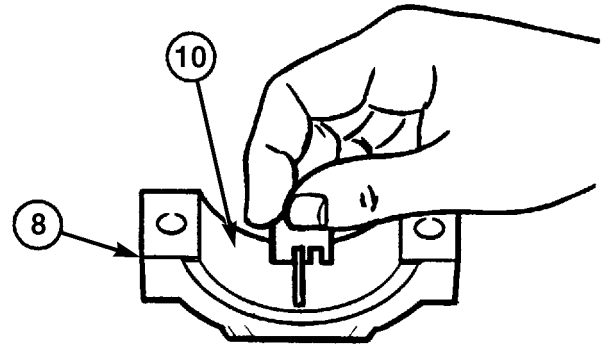
(5) **Determine connecting rod upper and lower bearings (9 and 10) clearance. Use new bearings.**

- (a) Turn crankshaft (16) until two connecting rod bearing journals are bottom center.
- (b) Be sure crankshaft journals, bearing area on connecting rods, inner surface of connecting rod caps, and connecting rod bearings are dry and clean.
- (c) Put upper bearing half (9) on connecting rod (11) and pull piston and connecting rod assembly against crankshaft journal. Bearing tabs must be in the tab grooves of the connecting rod.





- (d) Put new lower bearing half (10) in connecting rod cap (8). Bearing tabs must be in the tab grooves of the rod cap.
- (e) Put plastigage on the surface of the lower half of connecting rod bearing (11).



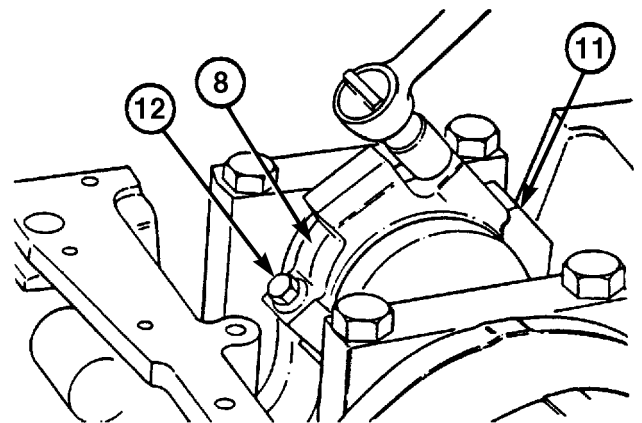
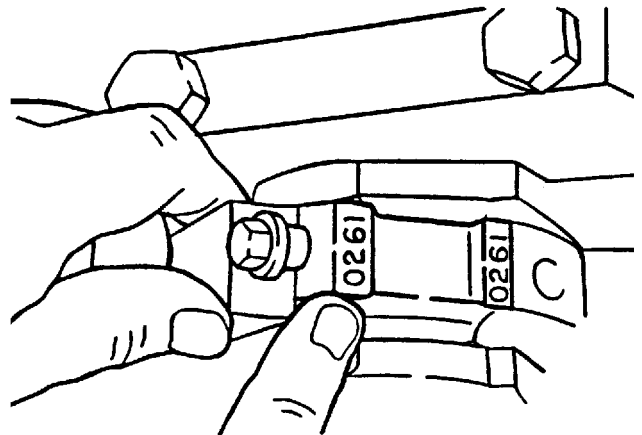
**CAUTION**

The four digit number stamped on the connecting rod and the rod cap must match and be facing the oil cooler side of the engine. Connecting rod and cap are machined as a set and must be kept that way. Failure to install matched sets could result in premature engine damage.

**NOTE**

Do not reuse connecting rod screws.

- (f) Apply lubricating oil to threads of connecting rod screws (12) then install connecting rod cap (8) and screws on connecting rod (11). Tighten screws finger tight.
- (g) The connecting rod screws (12) must be tightened evenly in a series of three steps. The torque value for each step is shown in this chart.



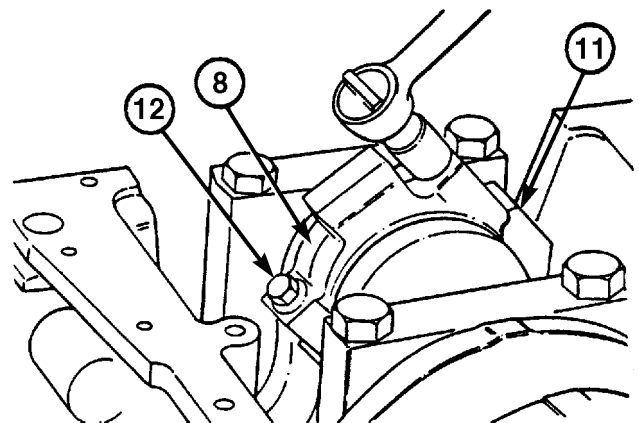
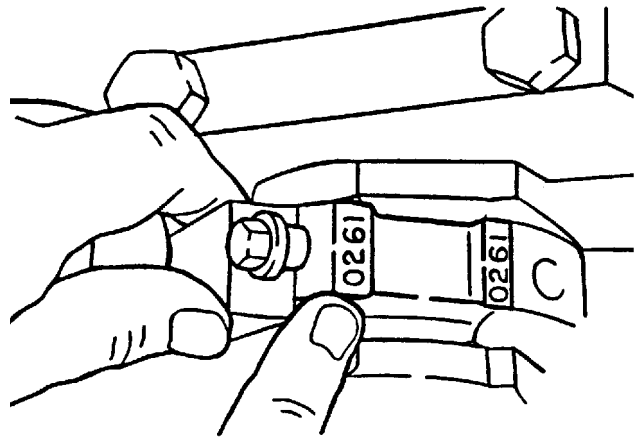
Step	Torque Value
1	26 lb-ft (35.25 N•m)
2	50 lb-ft (67.79 N•m)
3	73 lb-ft (98.97 N•m)

**3-8. CRANKSHAFT REPLACEMENT/REPAIR (CONT)**

- (h) Remove screws (12) and connecting rod caps (8).
- (i) Measure plastigage to determine what size connecting rod bearings to install.
- (j) Repeat Steps (a) through (i) for the other five connecting rods.

**(6) Install connecting rod bearings (10 and 11) and caps (7).**

- (a) Turn crankshaft (16) until two connecting rod bearing journals are bottom center.
- (b) Put upper bearing half (9) on connecting rod (11) with tab in the rod groove.
- (c) Put lower bearing half (10) in connecting rod cap (8) with tab in cap groove.
- (d) Apply Lubriplate 105 to inside surfaces of upper and lower bearing halves (9 and 10).



**CAUTION**

The four digit number stamped on the connecting rod and the rod cap must match and be facing the oil cooler side of the engine. Connecting rod and cap are machined as a set and must be kept that way. Failure to install matched sets could result in premature engine damage.

- (e) Pull piston and connecting rod assembly against crankshaft journal and install bearing cap (8) and screws (12). Tighten screws finger tight.
- (f) The connecting rod screws (12) must be tightened evenly in a series of three steps. The torque value for each step is shown in the following chart.

Step	Torque Value
1	26 lb-ft (35.25 N•m)
2	50 lb-ft (67.79 N•m)
3	73 lb-ft (98.97 N•m)

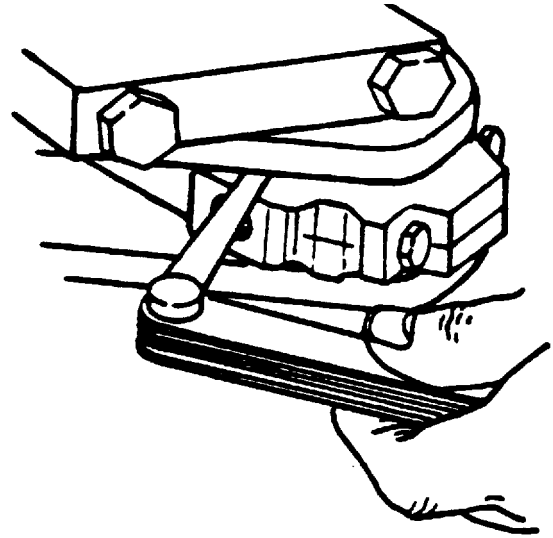
(g) Repeat Steps (a) through (f) for the other five connecting rods.

**(7) Measure connecting rod (11) side play at each connecting rod assembly.**

- (a) Measure connecting rod (11) side play.
- (b) Wear tolerance is 0.012 in. (0.30 mm) maximum.
- (c) If side play exceeds wear tolerance stated in Step (b), replace connecting rod (9) and connecting rod cap (8).

**(8) Install oil suction tube (3) and gasket (7) on cylinder block (4).**

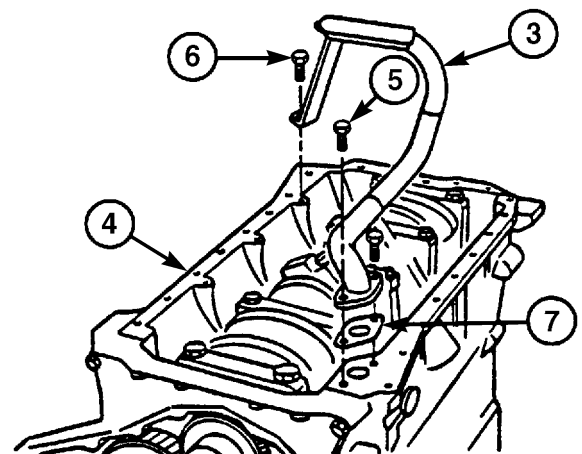
- (a) Install gasket (7) on cylinder block (4).
- (b) Position oil suction tube (3) over gasket (7) and install screws (5 and 6). Tighten screws to 18 lb-ft (24.04 N•m).



**NOTE**

Follow-on Maintenance:

- Install oil pan (Para 3-23).
- Install front housing cover (Para 3-21).
- Install flywheel housing and cover (Para 3-15).
- Install engine (Para 3-3).



**END OF TASK**

### 3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT

This Task Covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Bearing Removal/Installation Tool - Fabricated Tool (Figure C-7, Appendix C)
- Dial Indicator (Item 3, Appendix D)

*Equipment Condition*

- Vehicle parked on level ground
- Oil pan removed (Para 3-23)
- Oil pump inlet tube removed (Para 3-24)

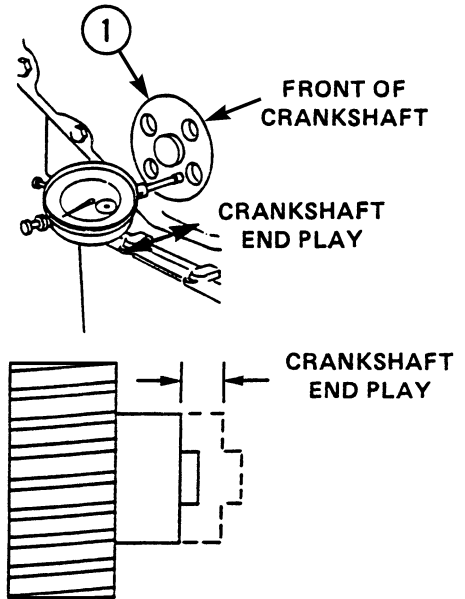
*Materials/Parts*

- Oil, Lubricating, Engine (Item 27, Appendix B)
- Plastigage (Item 32, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Solvent, Drycleaning (Item 52, Appendix B)
- Lubriplate (Item 23, Appendix B)

**a. Removal.**

**(1) Check crankshaft (1) end play.**

- (a) End play is controlled by the dimensions of the thrust bearing (2) and crankshaft (1) journal at the no. 6 main bearing position.
- (b) Measure crankshaft (1) end play using a dial indicator as shown in this illustration.
- (c) Push crankshaft (1) forward, then toward rear of engine. Record end play measurement. This data will be needed later during thrust bearing installation.



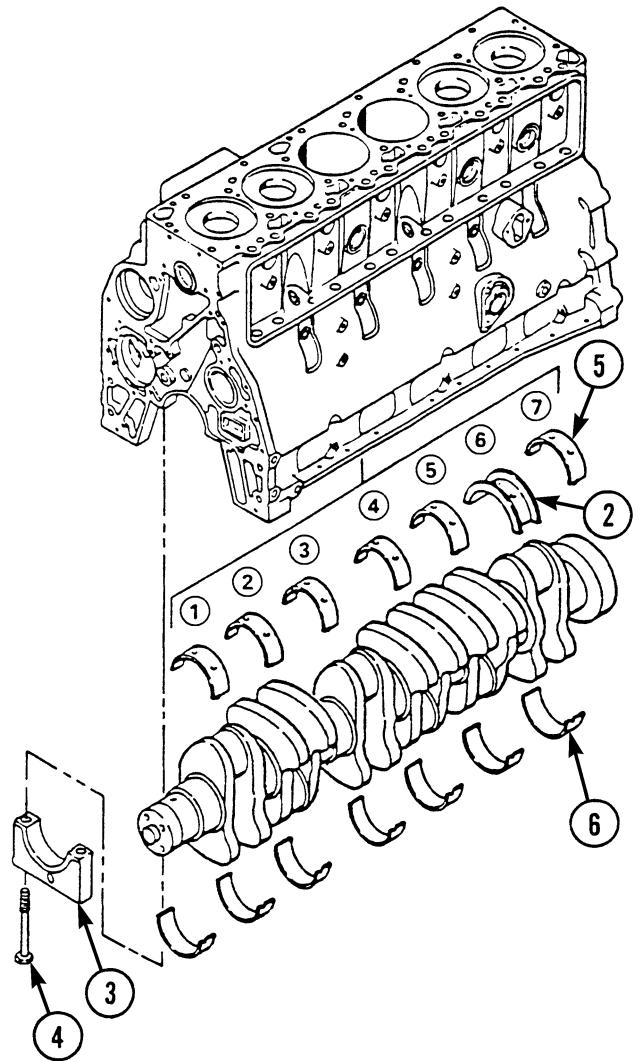
- (2) Remove main bearing halves (5 and 6) from main bearing positions (2 through 6).

### NOTE

- Remove only one bearing set at a time.
  - Bearing removal instructions for main bearing positions (1 and 7) will be covered in the **Installation** paragraph.
- (a) If main bearing position number on bearing cap (3) is missing or hard to read, etch the correct number on the bearing cap so that it is facing the oil cooler side of the engine.
- (b) Remove two screws (4) and bearing cap (3) from main bearing positions (2, 3, 4, 5, or 6) only. DO NOT remove bearing caps from main bearings (1 and 7) at this time.

### CAUTION

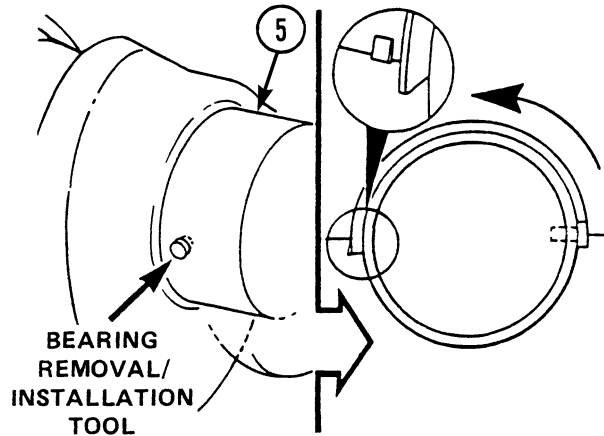
If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.



- (c) Install bearing removal/installation tool into oil hole in crankshaft journal for main bearing being removed.

**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

- (d) Slowly turn crankshaft (1) so the bearing removal/installation tool pushes against the end of the bearing opposite the tab, and upper bearing half (5) is out of the cylinder block.
- (e) Remove bearing removal/installation tool from crankshaft (1) oil hole.
- (f) Remove lower bearing half (6) from bearing cap (3). Keep main bearings and bearing caps together as a set.



**NOTE**

When bearings are reused, each bearing must be installed in its original location because the bearing surfaces have a wear pattern matched to the crankshaft journals.

- (g) Repeat Steps (a) through (f) for remaining main bearing positions (2 through 5) and thrust bearing (2) at main bearing position (6).

***b. Cleaning.***

**CAUTION**

Never use any type of rough material or tools such as sandpaper, emery or crocus cloth, files, or glassbead cleaning equipment to clean bearings.

- (1) **See cleaning instructions (Para 2-12).**
- (2) **Apply a light coat of oil over the bearings and the bearing surface in the bearing caps if the bearings are not going to be installed within one hour after cleaning.**

**c. Inspection.**

**(1) Inspect main bearing halves (5 and 6) and thrust bearing (2). Replace bearing if:**

- back of bearing shows that fretting has taken place,
- back of bearing has a mirror-like (shiny) finish,
- there are scratches in the bearing surface which do not disappear after cleaning,
- bearing surface has material damage such as cracks or flaking,
- there is a hole in the bearing surface,
- bearing shows wear on the mating face,
- bearing oil hole is distorted,
- there are hot spots in bearing surface, and/or
- bearing has damage to the tab.

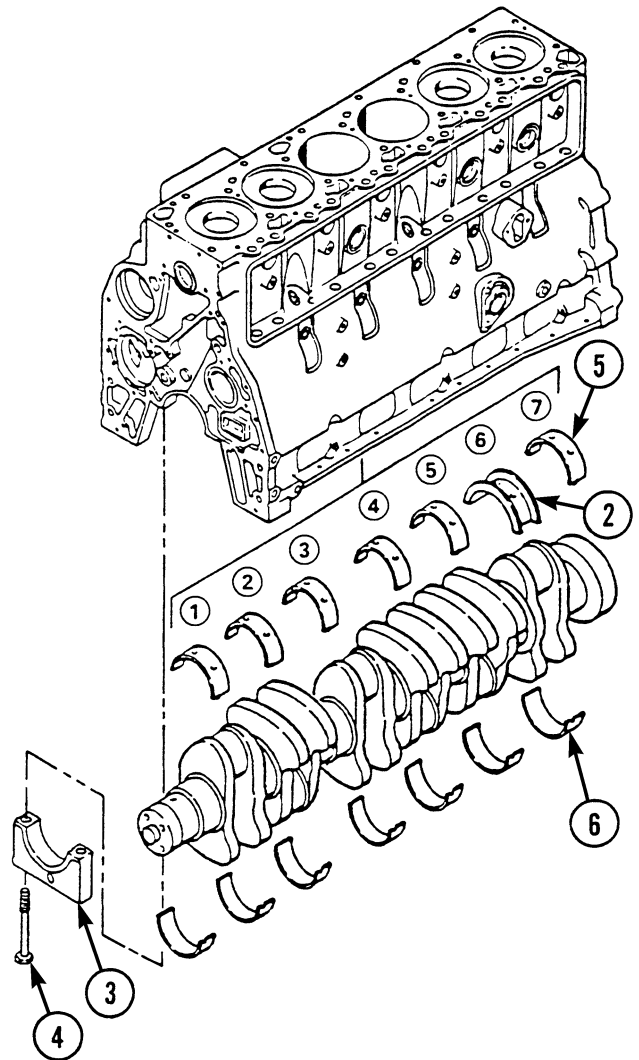
**(2) Inspect thrust bearing (2) flanges for damage. If damaged, replace thrust bearing.**

**(3) Inspect main bearing bores in the block for cracks, chips, distortion, thread damage, or other damage. Replace cylinder block if there is bearing bore damage.**

**(4) Inspect and measure crankshaft (1) main bearing journals (Para 3-8).**

**(5) Inspect main bearing caps (3) for cracks, fretted or chipped mating surfaces, distortion, or damaged ring dowels.**

- (a) Replace a damaged bearing cap (3).
- (b) Replace both bearing cap ring dowels if one or both are damaged.



**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

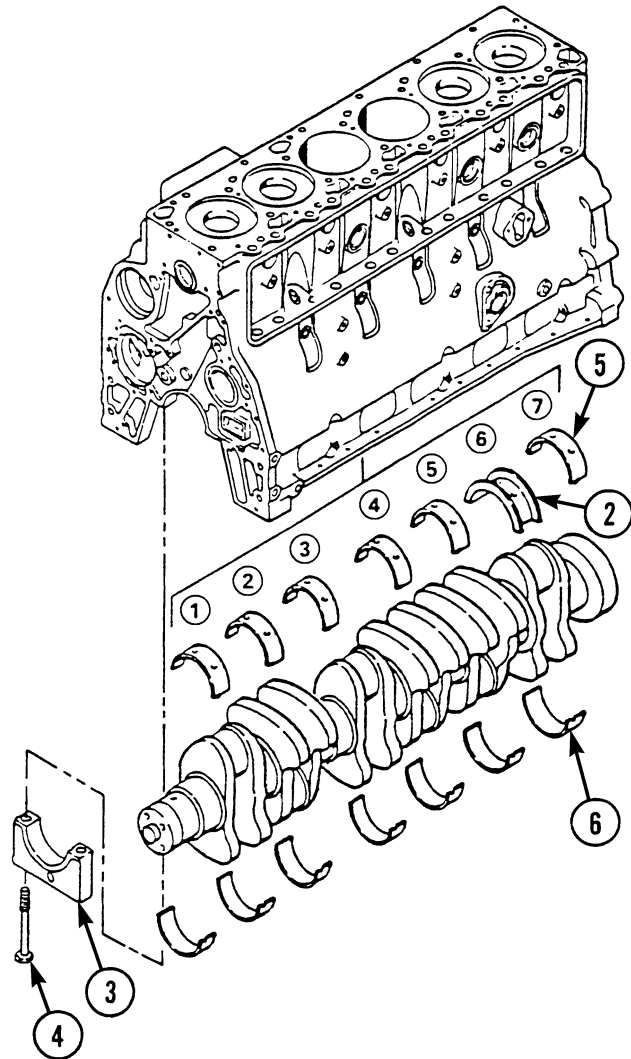
**d. Installation.**

(1) **Install main bearing halves (5 and 6) in bearing positions (2 through 6) for main bearing clearance checks.**

(a) If main bearing halves (5 and 6) are coated with oil, remove oil with a clean wiping rag.

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.



**CAUTION**

To help prevent damage to the cylinder block during main bearing bore cleaning, compressed air shall not exceed 15 psi (103.43 kPa). Use compressed air only with effective chip guarding and personal protective equipment.

(b) Clean main bearing surfaces in the cylinder block and bearing caps (3) with cleaning solvent P-D-680. Dry surfaces thoroughly with low pressure compressed air (15 psig [103.43 kPa] max).



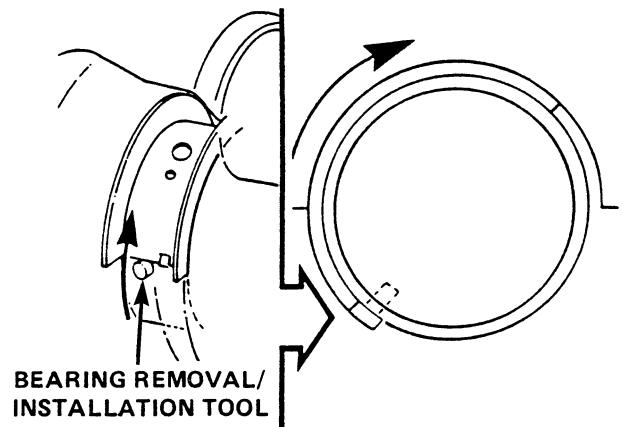
**NOTE**

Install bearing halves dry for the following clearance checks.

- (c) Refer to end play data measured earlier in **Removal**, Step (1). If crankshaft (1) end play is not within 0.005 - 0.010 in. (0.13 - 0.25 mm), install a new, appropriate oversize thrust bearing (2).
- (d) Install a dry main upper bearing half (5) over the crankshaft (1) journal such that the bearing tab will fit into the notch in cylinder block. If used main bearing half is being installed, install upper bearing half in the same position it was removed from.
- (e) Insert bearing removal/installation tool into bearing journal oil hole so that it will push against tab end of bearing.

**CAUTION**

If the crankshaft is turned in the wrong direction, the bearing tab will be pushed between the crankshaft and bearing area in the block. This could cause damage to the block and the crankshaft.

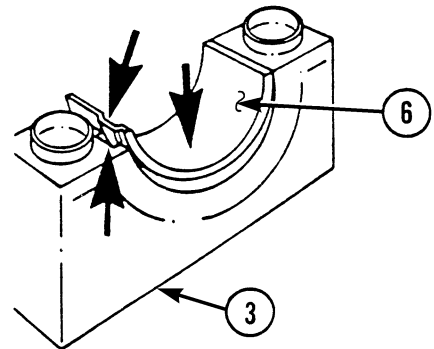


- (f) Slowly turn crankshaft (1) in the correct direction until upper bearing tab is in the cylinder block notch.
- (g) Remove bearing removal/installation tool from crankshaft oil hole.

**NOTE**

After each upper bearing half is installed, install the respective lower bearing half and bearing cap as described in the following steps.

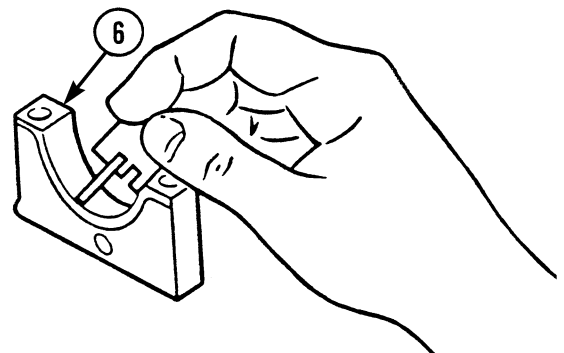
- (h) Install a dry lower main bearing half (6) in bearing cap (3). Tab on bearing must be in the notch in bearing cap. If used main bearing is being installed, install bearing in the same bearing cap it was removed from.



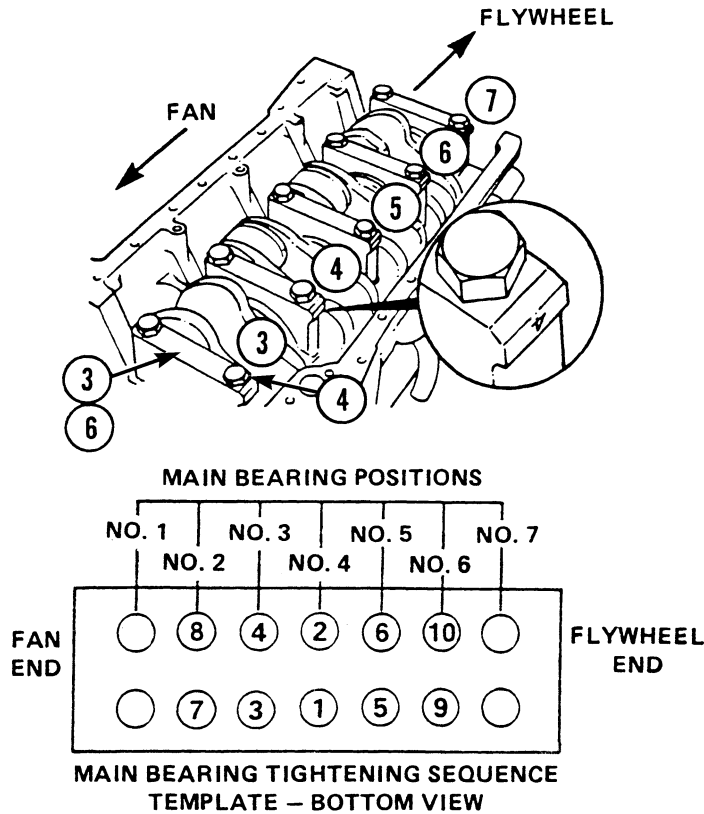
**NOTE**

Do not turn crankshaft after plastigage is in position. Plastigage will be distorted.

- (i) Place plastigage on the surface of lower bearing half (6).



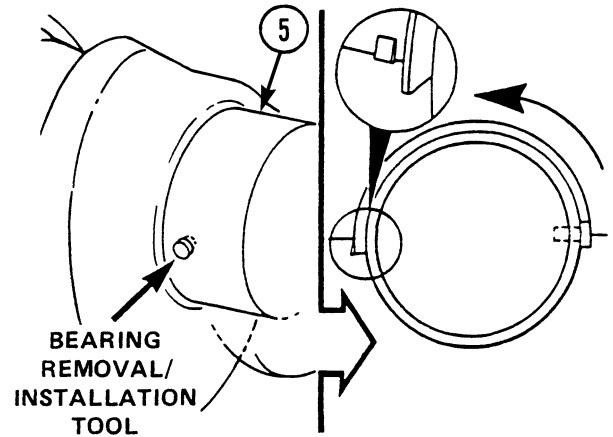
**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**



- (j) Apply a light coat of lubricating oil on threads of screws (4). Install lower bearing half (6), bearing cap (3), and two screws. The bearing cap must be installed in the same position it was removed from with number on bearing cap facing towards the oil cooler side of engine.
  - (k) After each bearing and bearing cap (3) is installed, tighten screws (4) to 37 lb-ft (50.17 N•m). Do not tighten screws to final torque value at this time.
  - (l) Repeat Steps (a) through (j) for the other main bearings (5 and 6) in positions (2 through 5) and thrust bearing (2) at position no. 6.
  - (m) Tighten screws (4) evenly, in the sequence shown, to 44 lb-ft (59.66 N•m).
  - (n) Tighten screws (4) evenly again in the sequence shown to 88 lb-ft (119.31 N•m).
  - (o) Tighten screws (4) evenly in the sequence shown to 129 lb-ft (174.90 N•m) final torque.
- (2) Check bearing clearance for main bearings at positions (2 through 6).**
- (a) Remove two screws (4) and bearing cap (3) from main bearings positions (2, 3, 4, 5, or 6). Remove one set of main bearings at a time.
  - (b) Remove and measure plastigage. Main bearing clearance must not exceed 0.00474 in. (0.12 mm). If bearing clearance exceeds the specified measurement, the appropriate oversize bearing set must be installed.

**CAUTION**

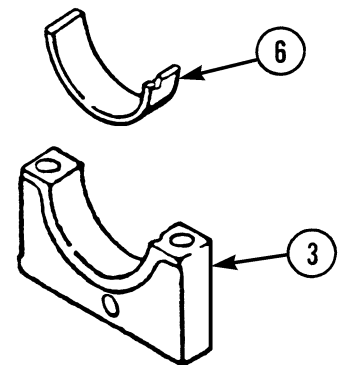
If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.



- (c) Install bearing removal/installation tool into oil hole in crankshaft (1) journal for main bearing being removed.
- (d) Slowly turn crankshaft (1) so the special pin pushes against the end of the bearing opposite the tab, and upper bearing half (5) is out of the cylinder block.
- (e) Remove bearing removal/installation tool from crankshaft (1) oil hole.
- (f) Remove lower bearing half (6) from bearing cap (3). Keep main bearings and bearing caps together as a set.

**NOTE**

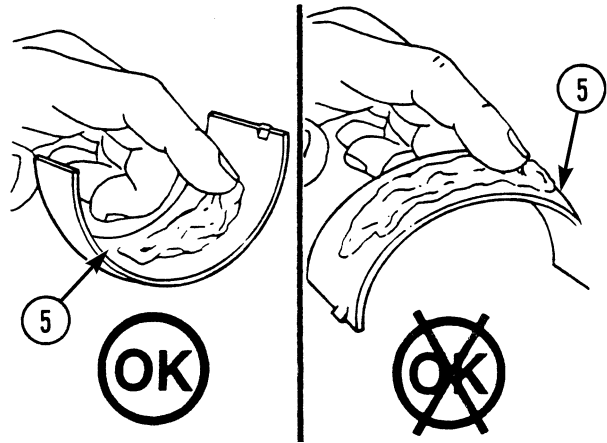
When bearings are reused, each bearing set must be installed in its original location because the bearing surfaces have worn to the crankshaft journals.



- (g) Repeat Steps (a) through (f) for remaining main bearing positions (2 through 5) and thrust bearing (2) at main bearing position 6.
- (3) Install main bearing (5 and 6) halves in positions (2 through 6).**
- (a) Be sure bearing bore surfaces in the cylinder block are clean and dry.
  - (b) Check that the backsides of main bearing halves (5 and 6) are clean and dry.
  - (c) Check that inside surfaces of bearing caps (3) are clean and dry.

**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

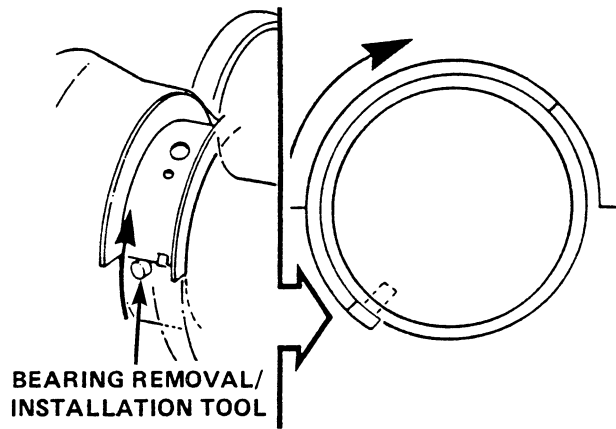
- (d) Apply Lubriplate 105 to the inside surface of upper bearing half (5). Do not lubricate the side that is against the cylinder block bearing bore.
- (e) Install one bearing set at a time. Install upper bearing half (5) over the crankshaft journal such that the bearing tab will fit into the notch in cylinder block. If used main bearing is being installed, install main bearing half in the same position it was removed from. If a new bearing is being installed, use the correct size bearing as determined in Step (2) above.
- (f) Insert bearing removal/installation tool into bearing journal oil hole so that it will push against tab end of bearing.



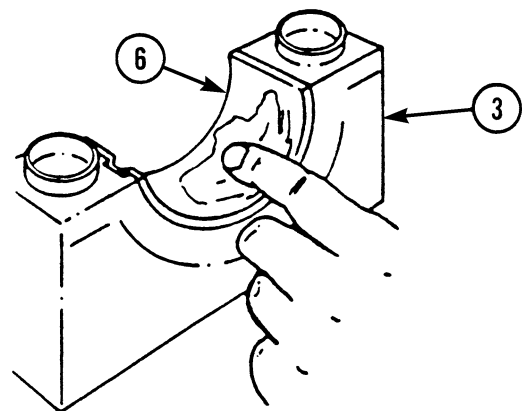
- (f) Insert bearing removal/installation tool into bearing journal oil hole so that it will push against tab end of bearing.

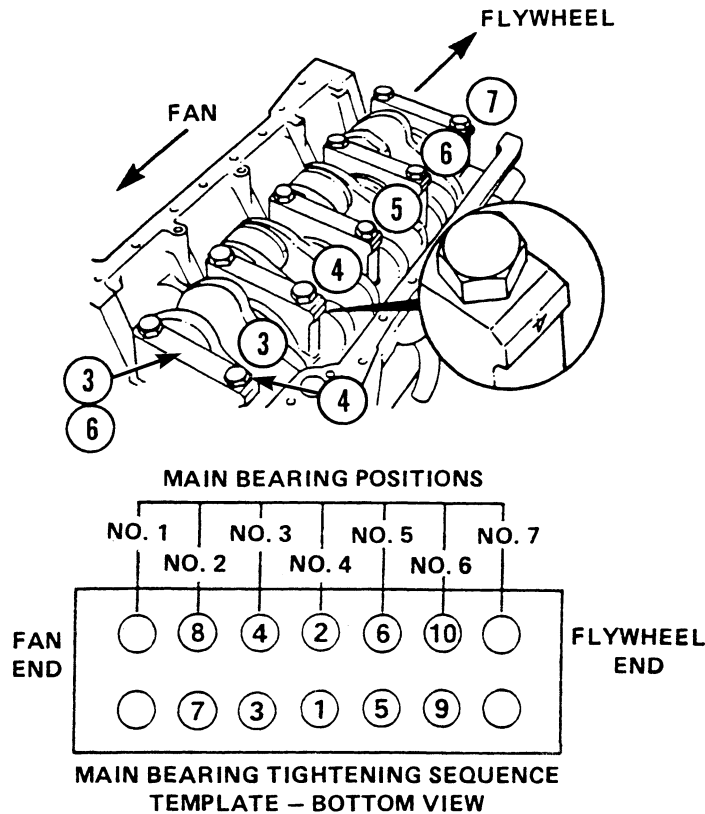
**CAUTION**

If the crankshaft is turned in the wrong direction, the bearing tab will be pushed between the crankshaft and bearing area in the block. This could cause damage to the block and the crankshaft.



- (g) Slowly turn crankshaft (1) in the correct direction until upper bearing (5) tab is in the cylinder block notch.
- (h) Remove bearing removal/installation tool from crankshaft (1) oil hole.
- (i) Place lower bearing half (6) into bearing cap (3) that it was removed from. If a new bearing is being installed, use the correct size bearing as determined in Step (2) above. Apply Lubriplate 105 to inside surface of lower bearing half.



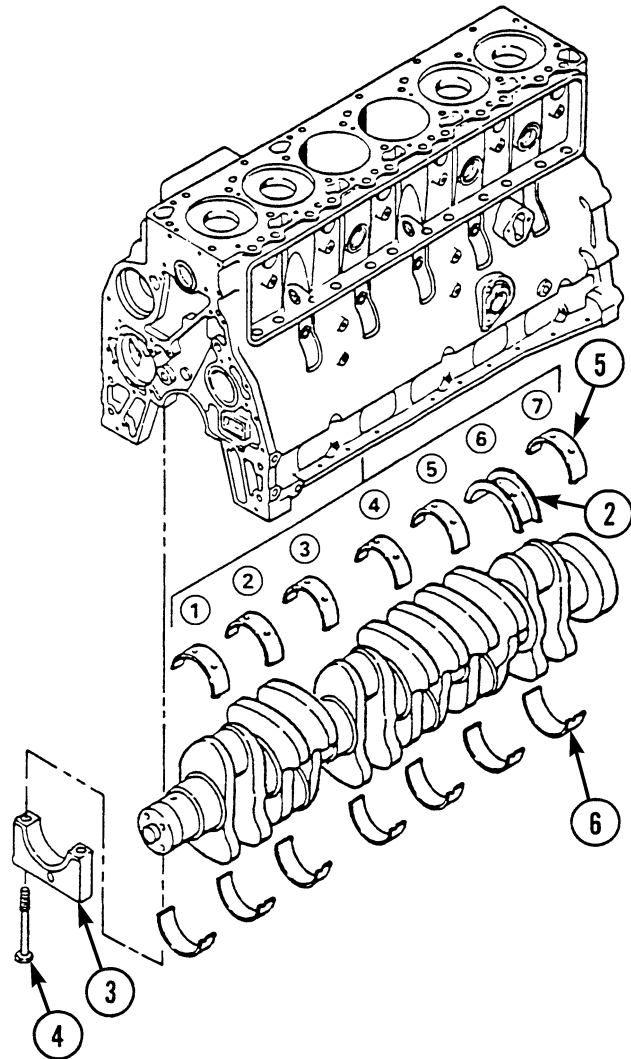


- (j) Install lower bearing half (6), bearing cap (3), and two screws (4) on bearing bore with the same number as that stamped on cap, with number facing towards the oil cooler side of engine.
- (k) After installing each bearing and bearing cap, tighten screws (4) to 37 lb-ft (50.17 N•m). Do not tighten screws to final torque value at this time.
- (l) Repeat Steps (a) through (k) for the other main bearing positions (2 through 5) and thrust bearing (2) at position no. 6.
- (m) Tighten screws (4) evenly in the sequence shown to 44 lb-ft (59.66 N•m).
- (n) Tighten screws (4) evenly again in the sequence shown to 88 lb-ft (119.31 N•m).
- (o) Tighten screws (4) evenly in the sequence shown to 129 lb-ft (174.90 N•m) final torque.

**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

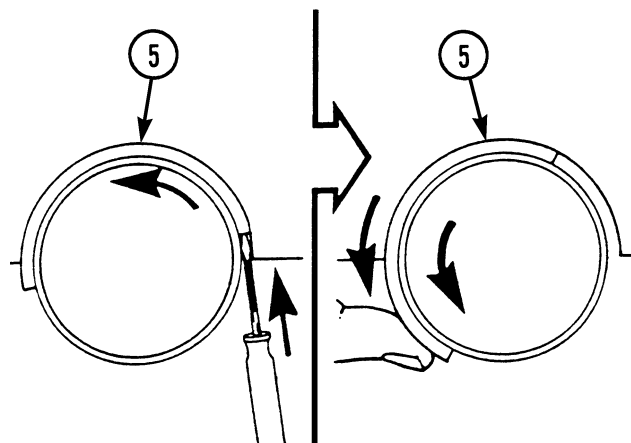
(4) **Remove main bearings halves (5 and 6) from main bearing positions (1 and 7).**

- (a) If main bearing position number on bearing cap (3) is missing or hard to read, etch the correct number on the bearing cap so that it is facing the oil cooler side of the engine.
- (b) Remove two screws (4) and bearing cap (3) from bearing position no. 1. Remove lower bearing half (6) from bearing cap.



**CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the removal of the upper bearing halves. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.



- (c) Use a flat blade screwdriver to remove upper bearing half (5) from main bearing position no. 1 because the crankshaft journal for no. 1 main bearing does not have an oil hole. Gently push end of upper bearing half (5) to loosen it from the cylinder block.

- (d) Press finger against bearing half (5) and turn crankshaft (1) to roll the bearing half from the cylinder block.

**CAUTION**

If crankshaft is turned in the wrong direction, the tab on the upper bearing half will be pushed between the crankshaft and main bearing bore in the block. This could cause damage to the block and the crankshaft.

- (e) Remove main bearing halves (5 and 6) from main bearing position no. 7, **Removal Steps (2)(b)** through (f).

**NOTE**

When bearings are reused, each bearing must be installed in its original location because the bearing surfaces have worn to the crankshaft journals.

- (5) **Clean and inspect main bearing halves (5 and 6) from no. 1 and no. 7 main bearing positions, *Cleaning Steps (1) and (2), Inspection Steps (1), (3), (4), and (5).***
- (6) **Check main bearing halves (5 and 6) bearing position no. 1 clearance.**
- (a) If main bearing halves (5 and 6) are coated with oil, remove oil with a clean wiping rag.

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

**CAUTION**

To help prevent damage to the cylinder block during main bearing bore cleaning, compressed air shall not exceed 15 psig (103.43 kPa). Use compressed air only with effective chip guarding and personal protective equipment.

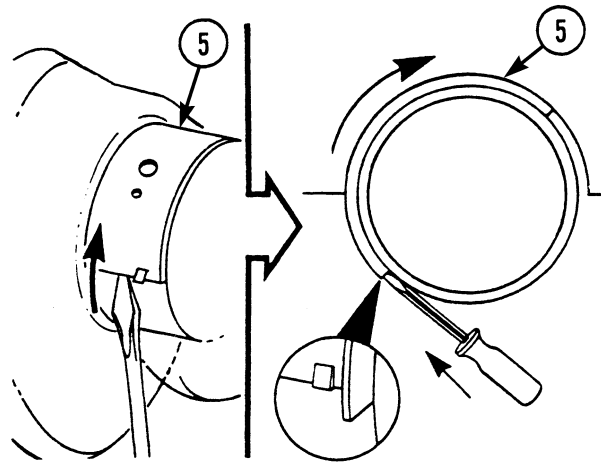
- (b) Clean main bearing halves (5 and 6) surfaces in the cylinder block and bearing caps with drycleaning solvent P-D-680. Dry surfaces thoroughly with low pressure compressed air (15 psig [103.43 kPa] max.).

**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

**NOTE**

Install bearing halves dry for the following clearance checks.

- (c) Install a dry upper bearing half (5) over the crankshaft journal for main bearing position no. 1 such that the bearing tab will fit into the notch in cylinder block. If used main bearing half is being installed, install main bearing half in the same position it was removed from.

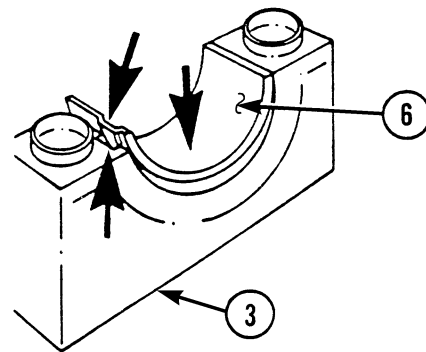


**CAUTION**

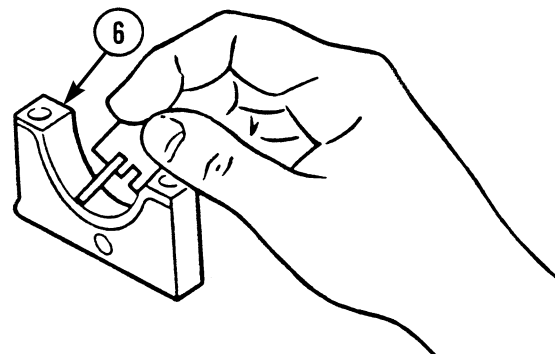
Be very careful not to scratch the crankshaft or the bearing bore during the installation of the upper bearing half. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.

- (d) Simultaneously push the upper bearing half (5), with a flat blade screwdriver, and turn the crankshaft (1) until bearing tab is in notch in cylinder block.

- (e) Install a dry lower main lower bearing half (6) in position no. 1 main bearing cap (3). Tab on bearing half must be in the notch in bearing cap. If used main bearing half is being installed, install bearing in the same bearing cap it was removed from.



- (f) Place plastigage on the surface of lower main bearing half (6).





- (g) Apply a light coat of lubricating oil on threads of two screws (4).
- (h) Install lower bearing half (6), bearing cap (3), and two screws (4) on position no. 1 bearing bore in the cylinder block.
- (i) Alternately tighten two screws (4) to final torque value in these three steps:

Step	Torque Value
1	44 lb-ft (59.66 N•m)
2	88 lb-ft (119.31 N•m)
3	129 lb-ft (174.90 N•m)

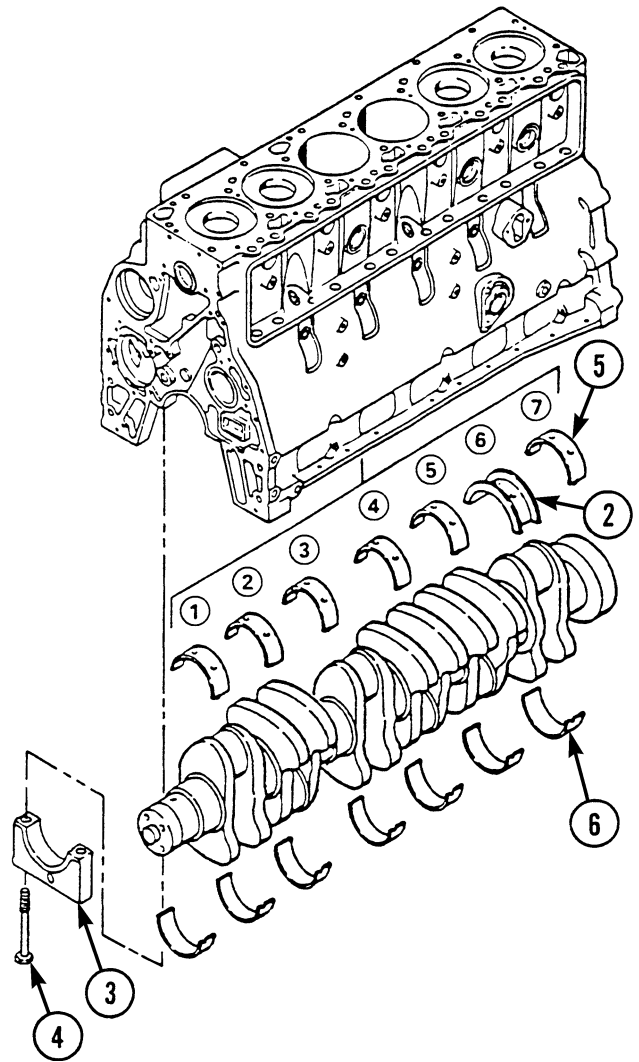
- (j) Check main bearing halves (5 and 6) position no. 1 clearance, Steps (2)(a) and (b).
- (k) Remove main bearing halves (5 and 6) position no. 1, Steps (4)(b), (c), and (d).

**(7) Check main bearing halves (5 and 6) bearing position 7 clearance.**

- (a) Install main bearing halves (5 and 6) position no. 7, Steps (1)(a) through (j).
- (b) Alternately tighten capscrews (4) to final torque value in these three steps:

Step	Torque Value
1	44 lb-ft (59.66 N•m)
2	88 lb-ft (119.31 N•m)
3	129 lb-ft (174.90 N•m)

- (c) Check bearing clearance, Steps (2)(a) through (f).



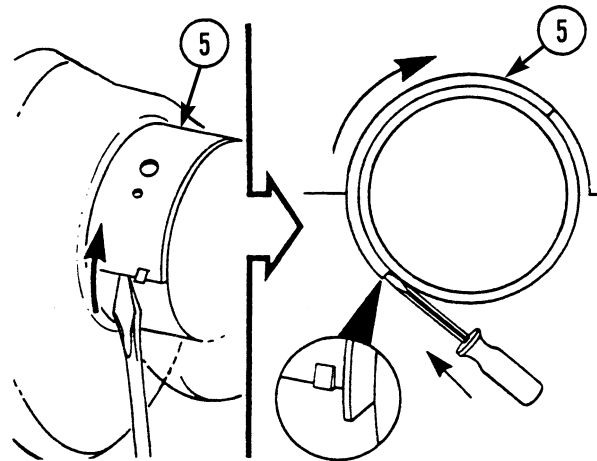
**3-9. CRANKSHAFT MAIN BEARINGS REPLACEMENT (CONT)**

**(8) Install main bearing halves (5 and 6) positions no. 1 and no. 7.**

- (a) Install main bearing halves (5 and 6) position no. 1, Steps (3)(a) through (e).

**CAUTION**

Be very careful not to scratch the crankshaft or the bearing bore during the installation of the upper bearing half. A scratched or damaged crankshaft, or bearing bore, could result in premature engine failure.



- (b) To install upper bearing half (5) position no. 1 into bearing bore, simultaneously push the upper bearing half with a flat blade screwdriver and turn the crankshaft (1) until bearing tab is in notch in cylinder block.
- (c) Continue with main bearing halves (5 and 6) position no. 1 **Installation**, Steps (3)(i), (j), and (m) through (o).

**(9) Check crankshaft (1) rotation.**

Crankshaft (1) must turn freely. If it does not turn with relative ease, check main bearing halves (5 and 6) installations and size of bearings.

**(10) Check crankshaft (1) end play (Para 3-8).**

**NOTE**

Follow-on Maintenance:

- Install oil inlet tube (Para 3-24).
- Install oil pan (Para 3-23).

**END OF TASK**



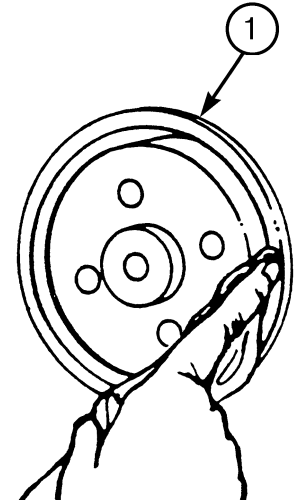
**3-10. CRANKSHAFT FRONT SEAL REPLACEMENT (CONT)**

*b. Installation.*

**CAUTION**

The seal lip and sealing surface on crankshaft must be clean to help prevent an oil leak around the seal.

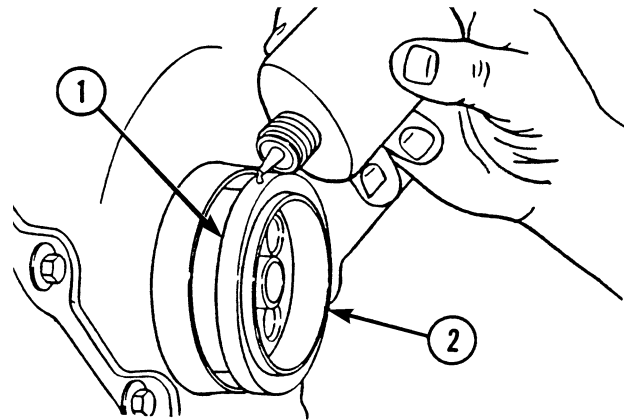
- (1) **Clean oil seal (1) lip and sealing surface on crankshaft with clean wiping rags.**



**CAUTION**

The seal and seal pilot used in Step (2) are packaged as a single item. Do not separate these two components before seal installation. Failure to use the pilot could result in a damaged seal.

- (2) **Install oil seal (1) and seal pilot (2) onto crankshaft.**



**WARNING**

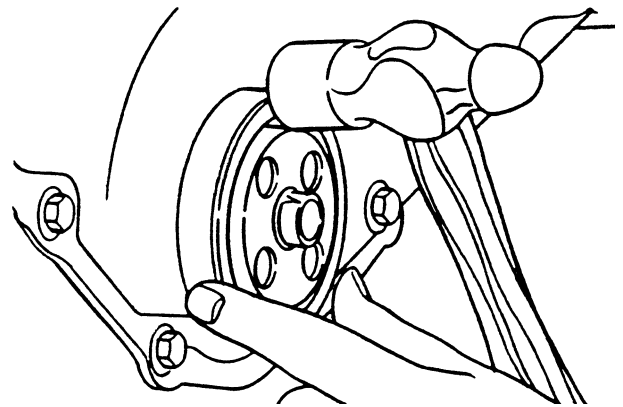
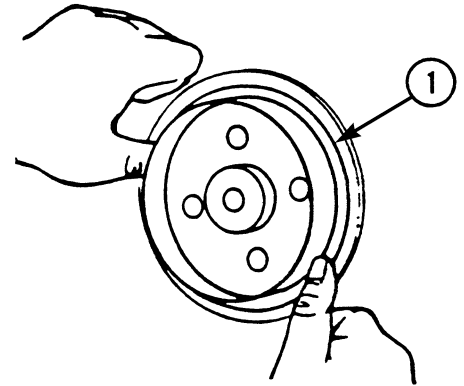
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

- (3) **Apply a bead of sealing compound around outside surface of oil seal (1).**
- (4) **Push on oil seal (1) until oil seal is inside gear cover then remove seal pilot (2).**

**CAUTION**

Drive the alignment/installation tool at the 12, 3, 6, and 9 o'clock positions only. Driving the tool at other positions could damage the seal carrier.

- (5) **Install oil seal (1) to correct depth using alignment/installation tool supplied with the oil seal.**
- (a) Position the alignment/installation tool over the crankshaft and against the seal carrier with the flange of the tool away from the seal.
  - (b) Use a hammer to tap seal into front cover until flange of tool is against front cover.

**NOTE**

Follow-on Maintenance: Install crankshaft vibration damper (Para 3-13).

**END OF TASK**

### 3-11. CRANKSHAFT REAR SEAL REPLACEMENT

This Task Covers:

- a. Removal
- b. Installation

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power (Item 19, Appendix D)
- Slide Hammer Dent Puller (Item 20, Appendix D)

*Equipment Condition*

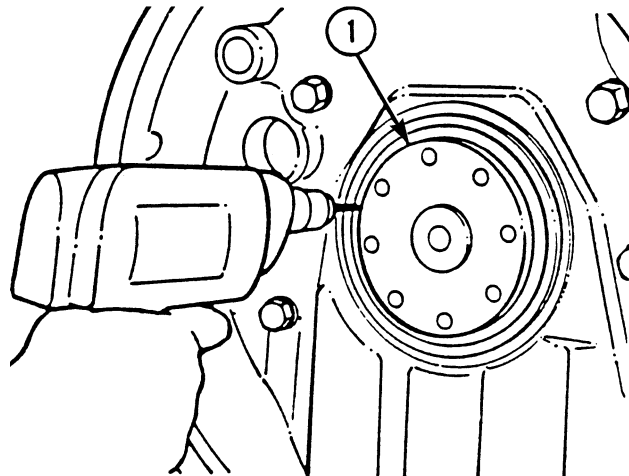
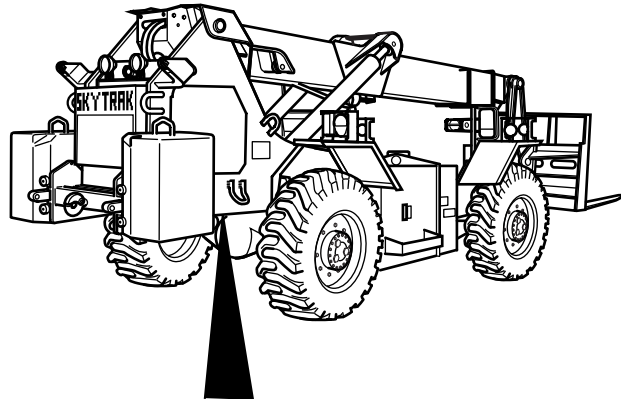
Flywheel removed (Para 3-14)

*Materials/Parts*

- Rags, Wiping (Item 35, Appendix B)
- Screw, #10 Sheet Metal
- Seal, Rear Oil

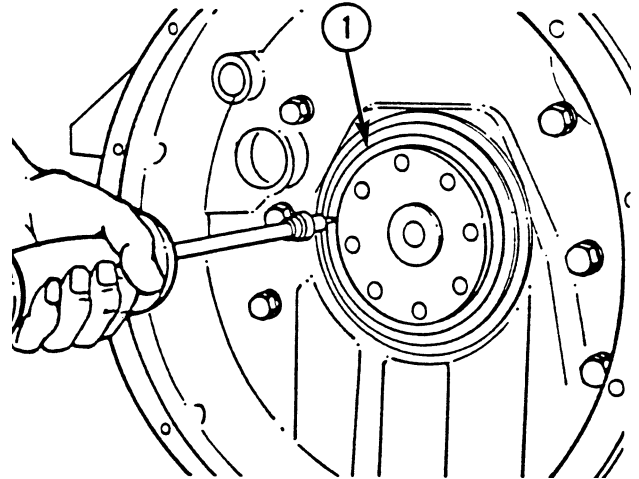
**a. Removal.**

- (1) Drill two 1/8 in. (3.175 mm) holes 180° apart in oil seal (1) carrier.



**(2) Remove rear crankshaft oil seal (1) with slide hammer dent puller.**

- (a) Insert a #10 sheet metal screw into end of slide hammer dent puller.
- (b) Alternately put slide hammer dent puller into the two 1/8 in. (3.175 mm) drilled holes and pull until oil seal (1) is removed. Discard rear oil seal.

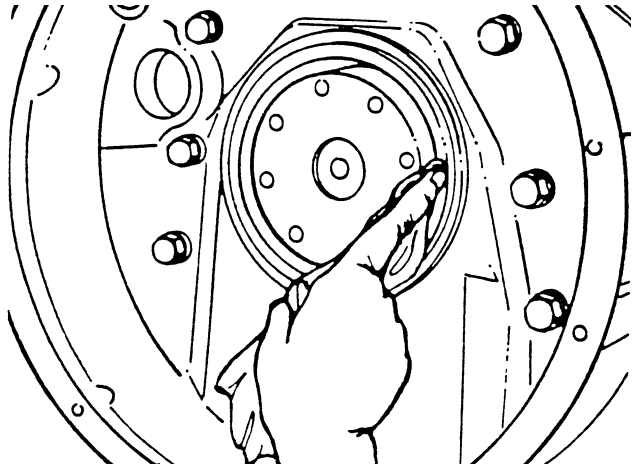


**b. Installation.**

**CAUTION**

The seal lip and sealing surface on crankshaft must be clean to help prevent an oil leak around the seal.

- (1) **Clean oil seal (1) lip and sealing surface on crankshaft with clean wiping rags.**

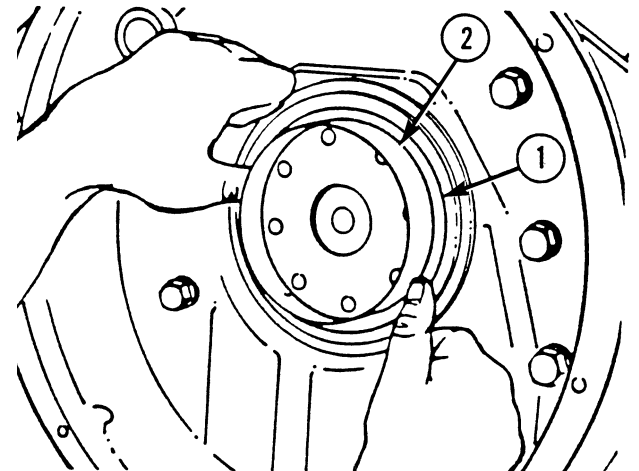


- (2) **Install seal pilot (2) supplied with seal kit onto crankshaft.**

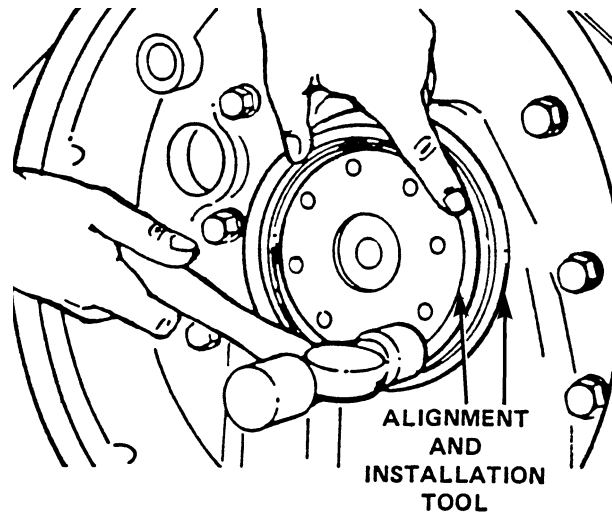
**CAUTION**

Always use the seal pilot to install rear oil seal (1). Failure to do so could result in a damaged oil seal.

- (3) **Install oil seal (1) over seal pilot (2) and onto crankshaft.**
- (4) **Remove seal pilot (2) from crankshaft.**



**3-11. CRANKSHAFT REAR SEAL REPLACEMENT (CONT)**



**CAUTION**

Tap alignment/installation tool at the 12, 3, 6, and 9 o'clock positions only. Striking the tool at other locations could damage the seal carrier.

- (5) **Use alignment/installation tool supplied with seal kit to move oil seal (1) to correct depth in the housing.**
- (a) Place alignment/installation tool supplied with rear seal kit onto crankshaft and against seal carrier with the flange of the tool away from the seal.
  - (b) Use a hammer to tap seal into seal retainer until flange of tool is against seal retainer.

**NOTE**

Follow-on Maintenance: Install flywheel (Para 3-14).

**END OF TASK**



**3-12. AIR CONDITIONER COMPRESSOR PULLEY REPLACEMENT**

This Task Covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

**INITIAL SETUP**

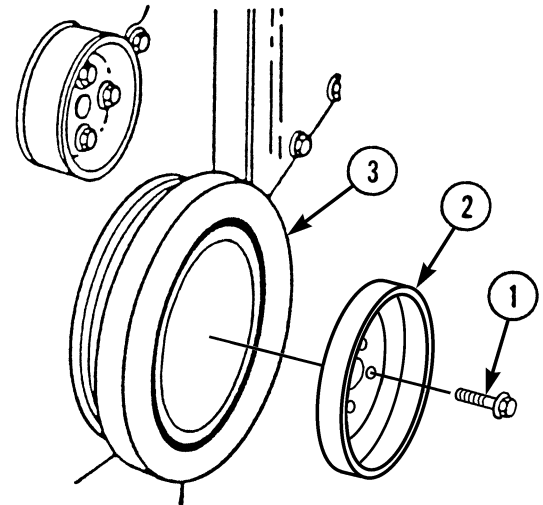
*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

*Equipment Condition*

Compressor drive belt removed  
(TM 10-3930-673-20)

- a. Removal.** Remove four screws (1) and pulley (2) from vibration damper (3).
- b. Cleaning.** See Cleaning Instructions (Para 2-12).
- c. Inspection.** See Inspection Instructions (Para 2-14).
- d. Installation.** Install pulley (2) with four screws (1) on vibration damper (3).



**NOTE**

Follow-on Maintenance: Install compressor drive belt (TM 10-3930-673-20).

**END OF TASK**

### 3-13. CRANKSHAFT VIBRATION DAMPER REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
 (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance,  
 Common No. 2 Less Power  
 (Item 17, Appendix D)

*Equipment Condition*

Radiator removed (TM 10-3930-673-34)  
 Drive belt removed (TM 10-3930-673-34)

**a. Removal. Remove vibration damper (1) from crankshaft (2) end.**

**b. Cleaning. See Cleaning Instructions (Para 2-12).**

**c. Inspection.**

- (1) Check that index lines (A) are aligned. If index lines are more than 1/16 in. (1.59 mm) apart, replace vibration damper.
- (2) Inspect rubber part (B) of damper for deterioration and missing pieces. Replace damper if deterioration and/or missing pieces are evident.
- (3) See Inspection Instructions (Para 2-14).

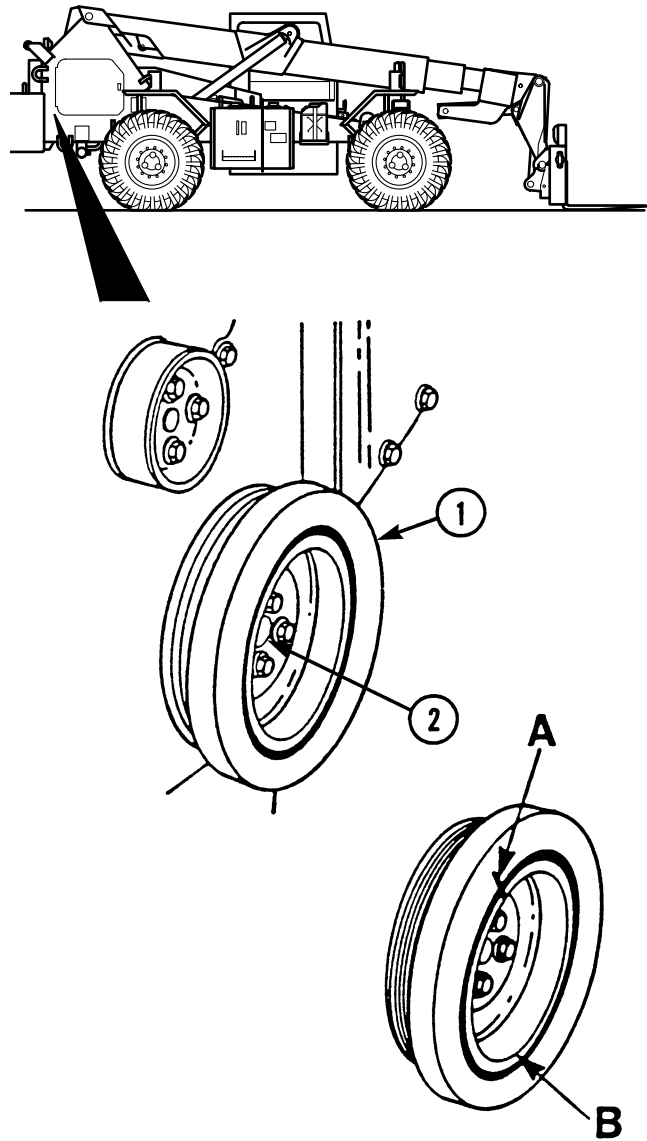
**d. Installation. Install vibration damper (1) on crankshaft (2) end.**

**NOTE**

Follow-on Maintenance:

- Install drive belt (TM 10-3930-673-20).
- Install radiator (TM 10-3930-673-20).

**END OF TASK**



### 3-14. FLYWHEEL REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

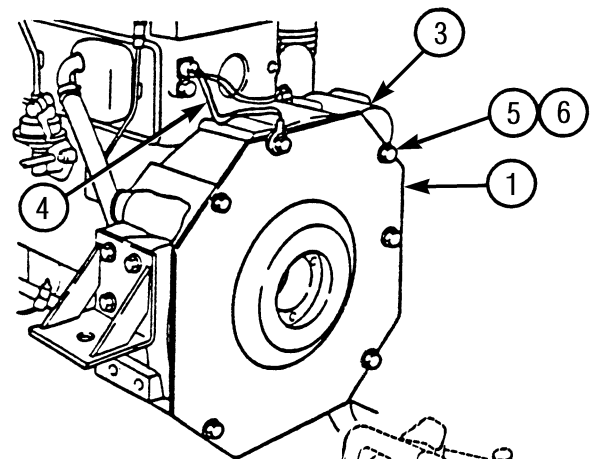
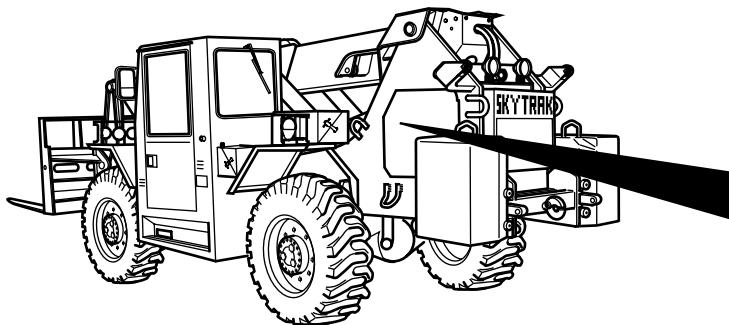
*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Engine Barring Tool (Item 7, Appendix D)
- Lifting Device, 200 lb (90.72 kg) capacity
- Engine removed (Para 3-3)
- Starting motor removed (TM 10-3930-673-34)

*Materials/Parts*

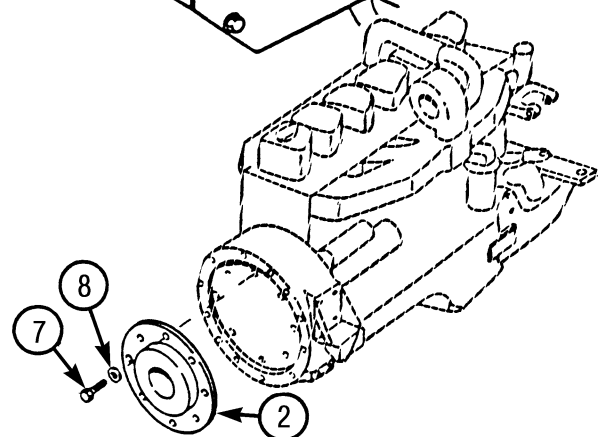
- Compound, Sealing (Item 40, Appendix B)
- Tags (Item 55, Appendix B)
- Lockwashers (6)
- Lockwashers (8)
- Screws (8)
- Washers (8)

**a. Removal.**



**(1) Remove flywheel housing cover (1) and coupling (2) from flywheel housing (3).**

- (a) Tag, mark, and disconnect wire (4). Remove six screws (5), lockwashers (6), and ground wire and flywheel housing cover (1) from flywheel housing (3). Discard lockwashers.
- (b) Remove eight screws (7), lockwashers (8), and coupling (2). Discard lockwashers.



**NOTE**

If necessary, install two screws in tapped holes of coupling to push coupling from flywheel.

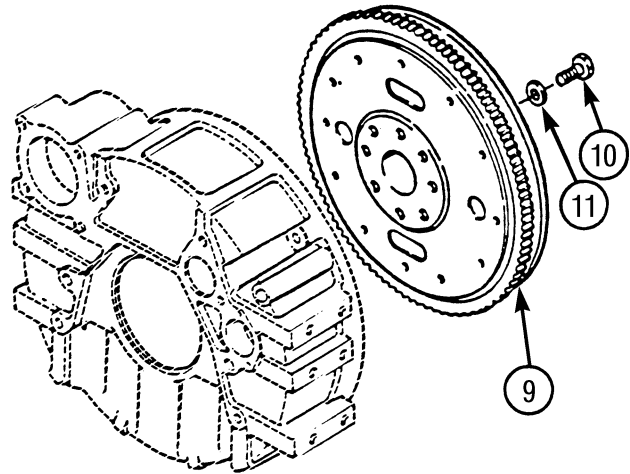
**3-14. FLYWHEEL REPLACEMENT (CONT)**

**WARNING**

Flywheel assembly weighs in excess of 125 lbs (56.75 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

**CAUTION**

Do not use timing pin to lock the engine. Using timing pin as a locking device while loosening flywheel mounting hardware could damage the pin.



**(2) Remove flywheel (9) while keeping the crankshaft from turning.**

- (a) Install two long screws in vibration damper. Use a bar between the long screws to hold crankshaft.
- (b) Attach a suitable lifting device and hoist, with a capacity of at least 200 lbs (90.72 kg), to flywheel (9).
- (c) Firmly hold barring tool to keep flywheel (9) from turning. Loosen eight screws (10).
- (d) Remove barring tool. Remove eight screws (10), washers (11), and flywheel (9). Discard screws and washers.

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**WARNING**

Flywheel assembly weighs in excess of 125 lbs (56.75 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

**CAUTION**

Do not use the timing pin to lock the engine. Use a barring tool to hold the engine crankshaft during flywheel installation. Using the timing pin as a locking device while tightening the flywheel mounting hardware could damage the pin.

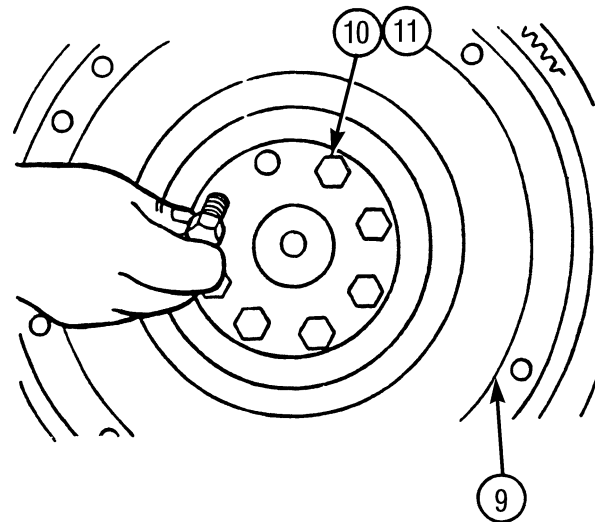
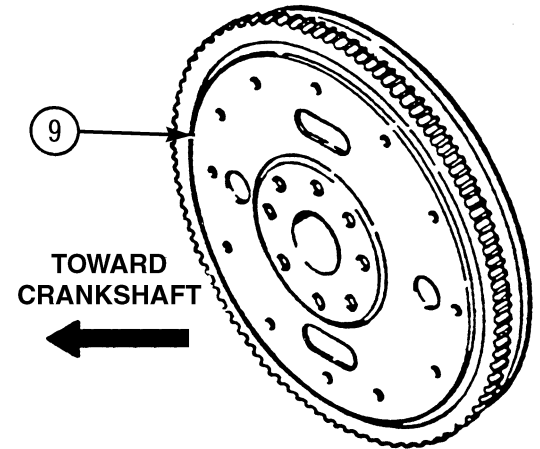
**d. Installation.**

- (1) **Install flywheel (9). Use barring tool to keep the crankshaft from turning. Use new screws (10) and washers (11).**
  - (a) Attach a suitable lifting device and hoist, with a capacity of at least 200 lbs (90.72 kg), to the flywheel.

**CAUTION**

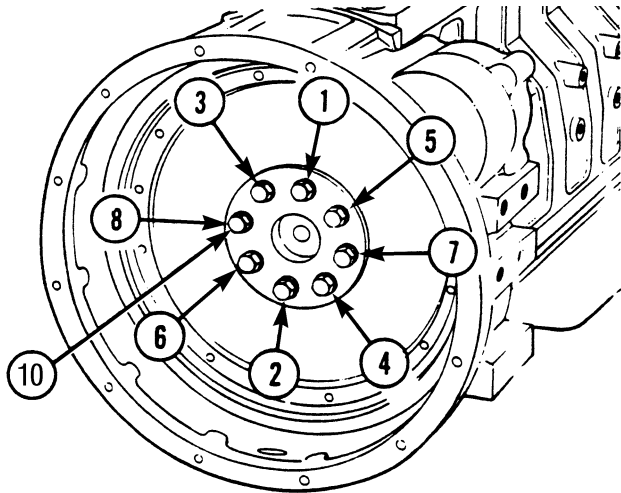
Install new screws each time flywheel is removed to help prevent possible engine failure.

- (b) Position flywheel (9) against end of crankshaft and install eight screws (10) and washers (11). Remove hoist and lifting device.
- (c) Install barring tool between long screws in vibration damper.



**3-14. FLYWHEEL REPLACEMENT (CONT)**

- (d) Firmly hold barring tool to keep flywheel from turning, and tighten screws (10), in the sequence shown, to 101 lb-ft (136.94 N•m).
- (e) Remove barring tool.

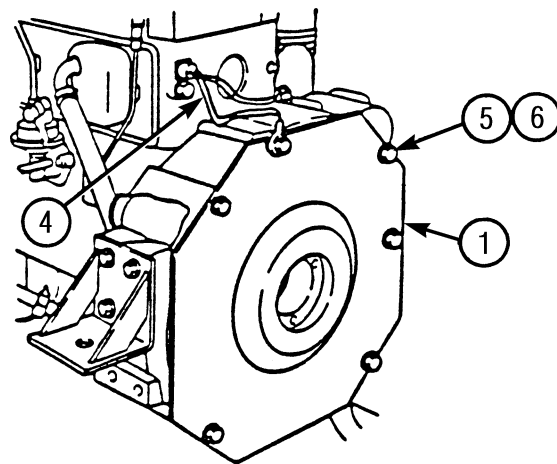
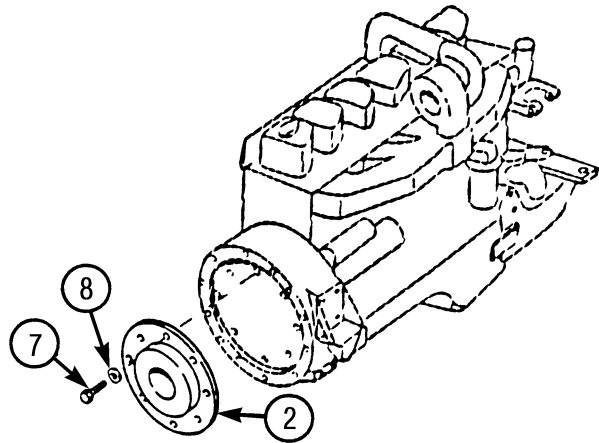


- (2) **Install flywheel housing cover (1) and coupling (2).**

**WARNING**

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

- (a) Apply sealing compound to threads of screws (7). Install coupling (2), lockwashers (8), and screws. Tighten screws to 25 lb-ft (33.90 N•m) and let set for 24 hours before operating engine.
- (b) Install flywheel housing cover (1), ether wire (4), six lockwashers (6), and screws (5).



**NOTE**

Follow-on Maintenance:

- Install starting motor (TM 10-3930-673-20).
- Install engine (Para 3-3).

**END OF TASK**

### 3-15. FLYWHEEL HOUSING AND COVER REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)  
 Lifting Device, 300 lb (136.08 kg) capacity  
 Driver Tool

*Equipment Condition*

Flywheel removed (Para 3-14)

*Materials/Parts*

Rags, Lint-free (Item 34, Appendix B)  
 Gasket  
 Packing, Preformed  
 Packing, Preformed  
 Seal, Oil

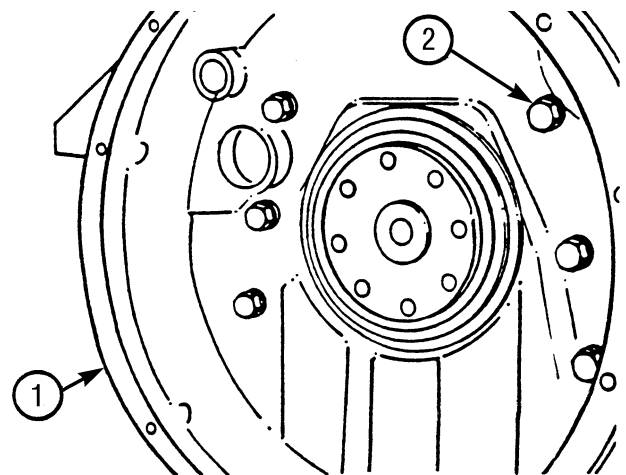
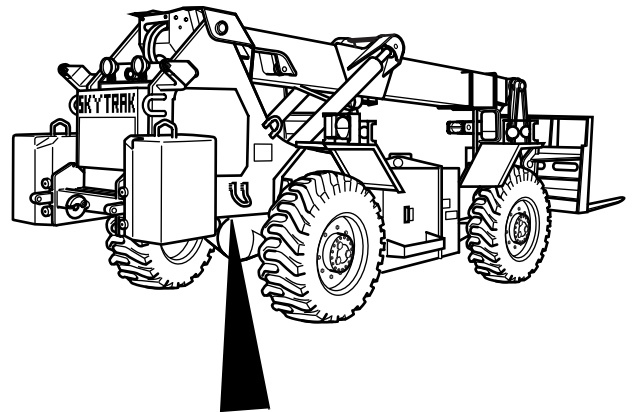
**a. Removal.**

- (1) Remove flywheel housing (1).

**WARNING**

Flywheel housing weighs approximately 75 lbs (34 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

- (a) Attach a suitable lifting device and hoist to flywheel housing (1).  
 (b) Remove eight screws (2) and lift flywheel housing (1) from engine.

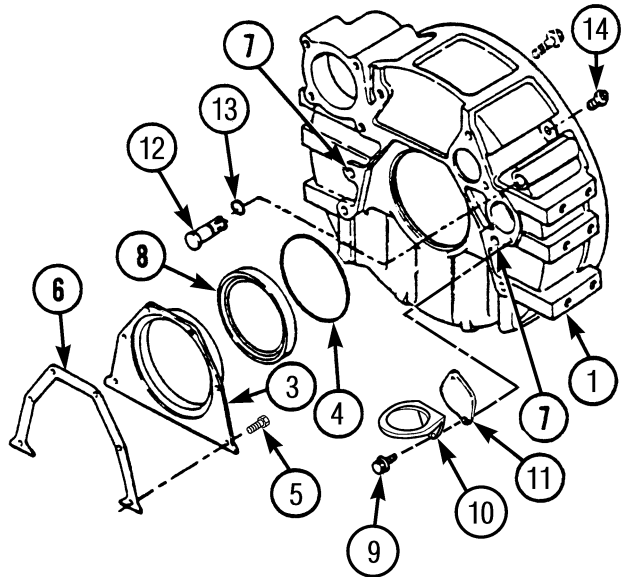


**3-15. FLYWHEEL HOUSING AND COVER REPLACEMENT/REPAIR (CONT)**

**(2) Remove rear cover (3).**

- (a) Remove preformed packing (4) from rear cover (3). Discard preformed packing.
- (b) Remove six screws (5) and rear cover (3).
- (c) Remove gasket (6) from rear cover (3).

**(3) If damaged, remove two ring dowels (7) from flywheel housing (1).**



**b. Disassembly.**

**(1) Remove and discard rear oil seal (8) from rear cover (3).**

Use a suitable driver tool to press rear oil seal (8) from rear cover (3). Discard seal.

**(2) Remove flywheel housing (2) parts (9 through 14).**

- (a) Remove two screws (9), bracket (10), and cover plate (11) from flywheel housing (1).
- (b) Remove plug (12) and preformed packing (13) from flywheel housing (1). Discard preformed packing.
- (c) Remove plug (14) from flywheel housing (1).

**c. Cleaning. See Cleaning Instructions (Para 2-12)**

**d. Inspection. See Inspection Instructions (Para 2-14).**

**e. Assembly.**

**(1) Assemble flywheel housing (2) parts (9 through 14).**

- (a) Install plug (14) in flywheel housing (1).
- (b) Install plug (12) and preformed packing (13) in flywheel housing (1).
- (c) Install cover plate (11), bracket (10), and two screws (9) on flywheel housing (1).



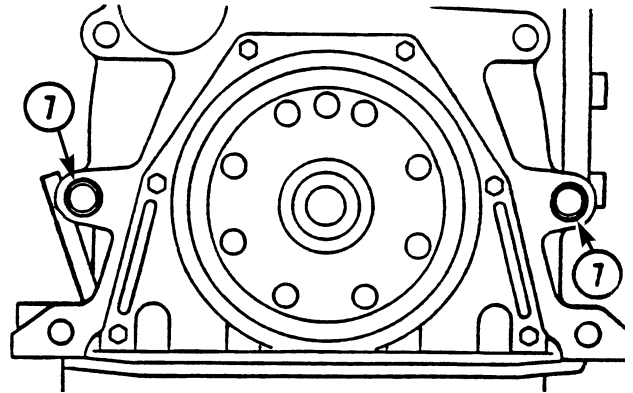
**f. Installation.**

- (1) **If removed, install two ring dowels (7) in flywheel housing (1).**

Drive two ring dowels (7) into cylinder block until they are against bottom of bore.

- (2) **Clean and dry rear crankshaft sealing surface.**

Clean and dry rear crankshaft sealing surface with clean lint-free rags.



**CAUTION**

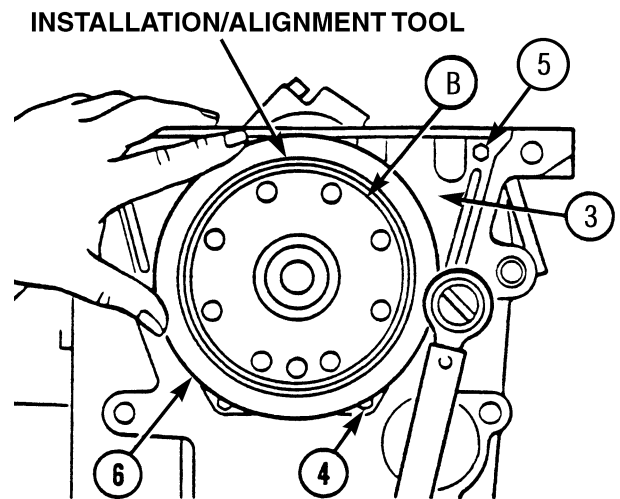
The oil seal sealing surface on the crankshaft must be clean to help prevent seal leaks.

- (3) **Install gasket (6) and rear cover (3).**

- (a) Install gasket (6) and rear cover (3) onto cylinder block.
- (b) Loosely install six screws (5).

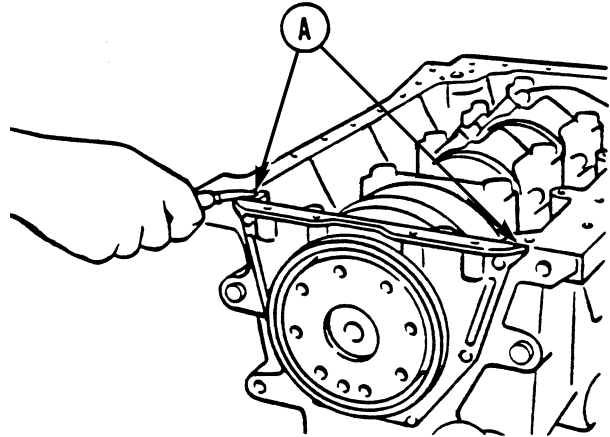
- (4) **Align rear cover (3) to crankshaft (B) using seal kit installation and alignment tool.**

- (a) Place installation and alignment tool supplied with oil seal kit over the crankshaft (B) and into the rear cover (3). This aligns the cover to the crankshaft.
- (b) Align rear cover (3) with both sides of the cylinder block oil pan rail until surfaces are flush. Tighten six screws (5) to 7 lb-ft (9.49 N•m).



**3-15. FLYWHEEL HOUSING AND COVER REPLACEMENT/REPAIR (CONT)**

- (c) Remove installation and alignment tool and trim gasket even with oil pan mounting surface at points "A".

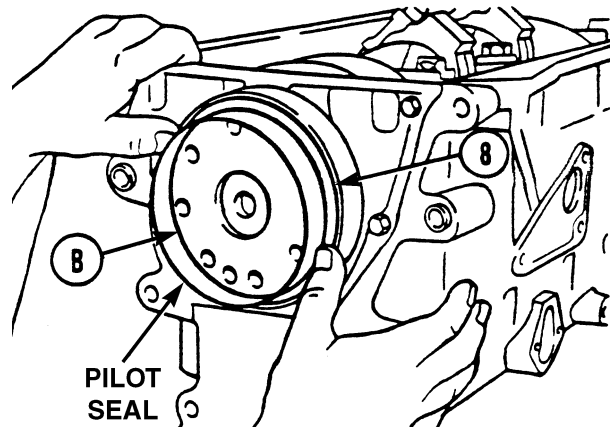


**CAUTION**

- The rear oil seal lip must be clean to help prevent seal leaks.
- Always use the seal pilot to install rear seal. Failure to do so could result in a damaged seal.

**(5) Install rear oil seal (8) using seal pilot supplied with oil seal kit.**

- (a) Wipe oil seal (8) lip clean with a clean lint-free rag. Install oil seal with seal pilot onto crankshaft (B).
- (b) Push oil seal (8) onto crank and remove seal pilot.



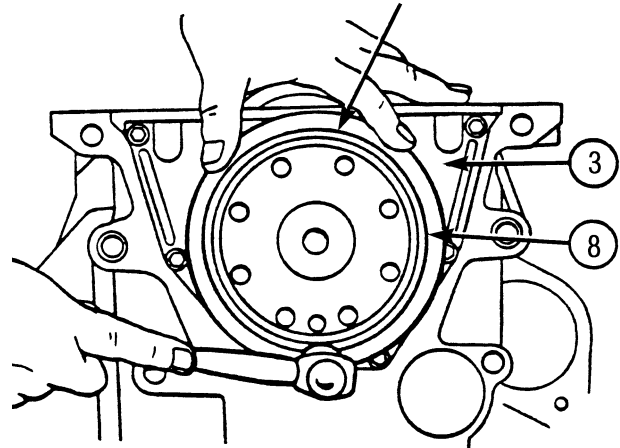
**CAUTION**

Tap alignment and installation tool at the 12, 3, 6, and 9 o'clock positions only. Striking the tool at other locations could damage the seal carrier.

**(6) Position rear oil seal (8) to correct depth in rear cover (3) with installation and alignment tool.**

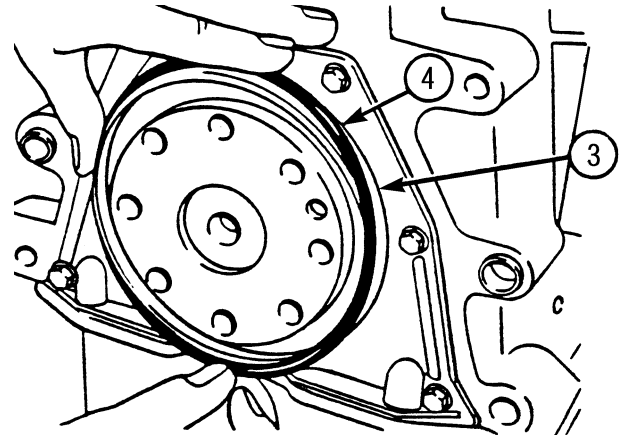
- (a) Place installation and alignment tool onto crankshaft and against oil seal (8) carrier.

**INSTALLATION/ALIGNMENT TOOL**



- (b) Tap tool with a plastic hammer at the 12, 3, 6, and 9 o'clock positions to drive new oil seal (8) evenly into position and to prevent damaging the seal carrier.
- (c) Drive oil seal (8) into rear cover (3) until installation and alignment tool stops against the cover.
- (d) Remove installation and alignment tool from crankshaft.

**(7) Install preformed packing (4) over rear cover (3).**

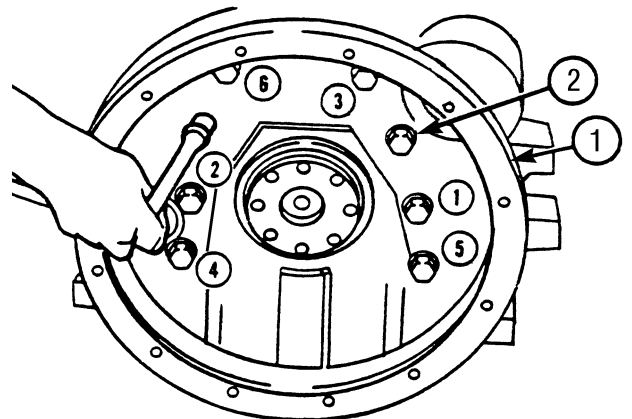


**(8) Install flywheel housing.**

**WARNING**

Flywheel housing weighs approximately 75 lbs (34 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

- (a) Attach suitable lifting device and hoist to flywheel housing (1) and lift housing into position on engine.
- (b) Install eight screws (2) in flywheel housing (1). Tighten screws to 57 lb-ft (77.28 N•m) in the sequence shown.



**NOTE**

Follow-on Maintenance: Install flywheel (Para 3-14).

**END OF TASK**

### 3-16. PISTONS, PISTON PINS, AND RINGS REPLACEMENT

This Task Covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Tool Kit, Machinists: Post, Camp and Station (Item 24, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Micrometer (Item 13, Appendix D)
- Feeler Gauge

*Equipment Condition*

Connecting rod/piston assembly removed from engine (Para 3-17).

*Materials/Parts*

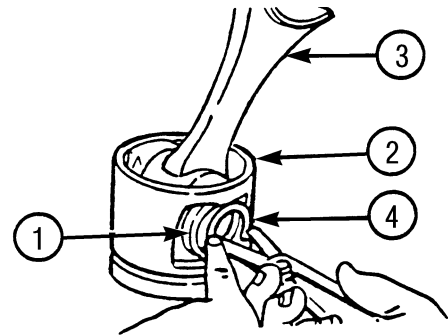
- Oil, Lubricating, Engine (Item 27, Appendix B)
- Solvent, Drycleaning, (Item 52, Appendix B)
- Ring, Piston (Set)

**a. Removal.**

**NOTE**

Pistons do not have to be heated in order to remove piston pins.

- (1) **Remove piston pin (1) from piston (2) and connecting rod (3).**

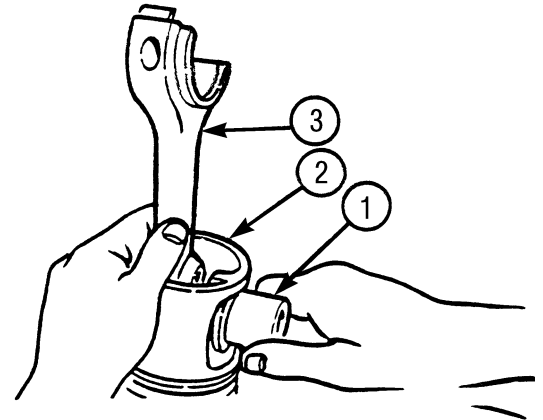


**WARNING**

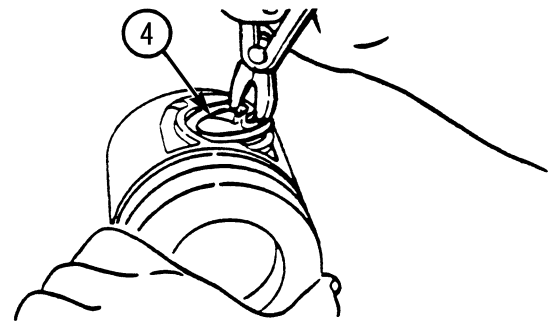
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove one retaining ring (4) from piston pin (1).

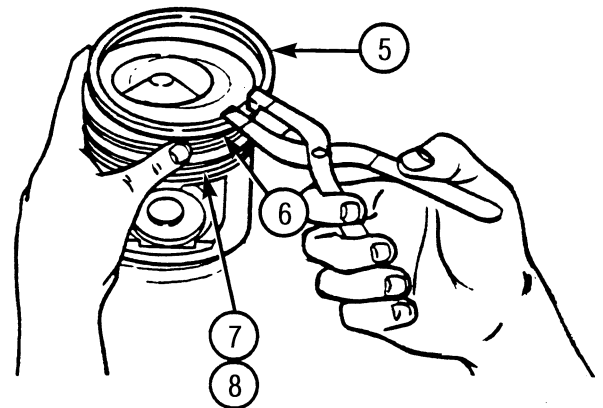
- (b) Remove piston pin (1) and connecting rod (3) from piston (2).
- (c) Separate piston (2) from connecting rod (3).



- (d) Remove second retaining ring (4).



- (2) Remove and discard piston rings (5, 6, and 7) and oil control ring expander (8) from piston (2).**



**3-16. PISTONS, PISTON PINS, AND RINGS REPLACEMENT (CONT)**

*b. Cleaning.*

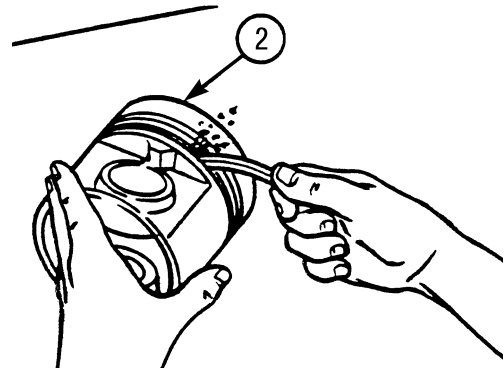
**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

**CAUTION**

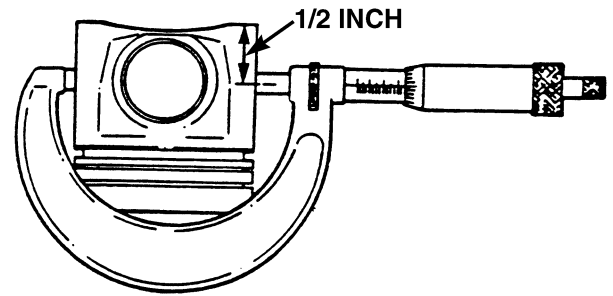
Do not use bead blast to clean pistons. Bead blasting may damage piston.

- (1) Soak pistons (2) in dry cleaning solvent P-D-680 to remove carbon deposits.
- (2) Wash pistons in a strong solution of laundry detergent and hot water, to remove carbon residue. Use a stiff bristle brush.
- (3) Clean ring grooves in piston (2) using square end of a broken piston ring. Use care to avoid scratching ring sealing surfaces in piston grooves.
- (4) Clean pistons again in solution of laundry detergent and hot water.
- (5) Rinse pistons in clean, fresh water and dry using compressed air.

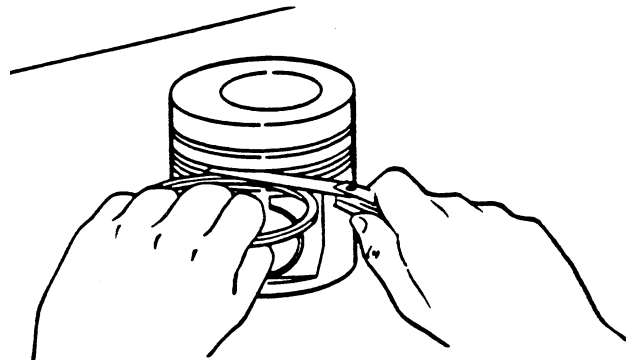


**c. Inspection.**

- (1) Visually inspect ring grooves, piston top, piston skirt, and piston pin bore for cracks or other damage and for excessive wear.
- (2) Check piston skirt diameter using an inside micrometer as shown, at a point approximately 1/2 in. (12.7 mm) above bottom edge of piston. Minimum allowable skirt diameter is 4.0088 in. (101.82 mm).

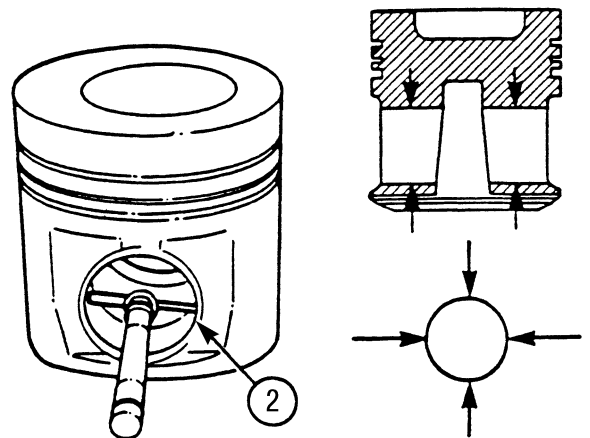


- (3) Check top piston ring for nicks, cracks or other visible defects. Ring clearance check is not required for top piston ring.
- (4) Check ring clearance in intermediate and oil control ring grooves using new rings and a feeler gauge as shown. Maximum allowable clearances for these two grooves are:

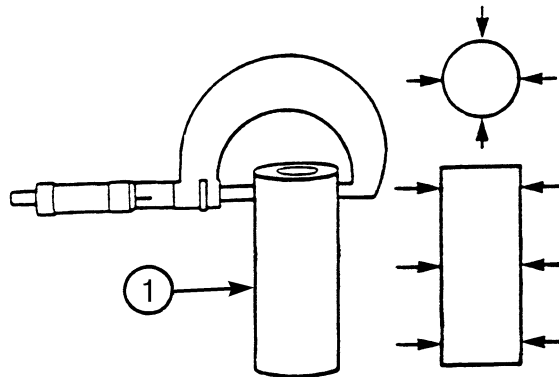


Limit	
Intermediate ring groove	0.006 in. (0.15 mm)
Oil control ring groove	0.005 in. (0.13 mm)

- (5) Check piston pin bore diameter at four points noted. Maximum allowable bore diameter is 1.5758 in. (40.03 mm).

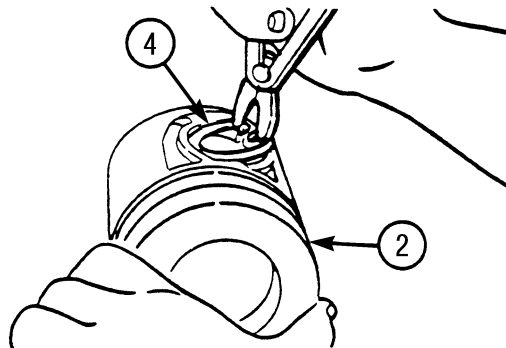


**3-16. PISTONS, PISTON PINS, AND RINGS REPLACEMENT (CONT)**



- (6) Check piston pin (1) diameter at six points as shown. Minimum allowable pin diameter is 1.5744 in. (39.99 mm).

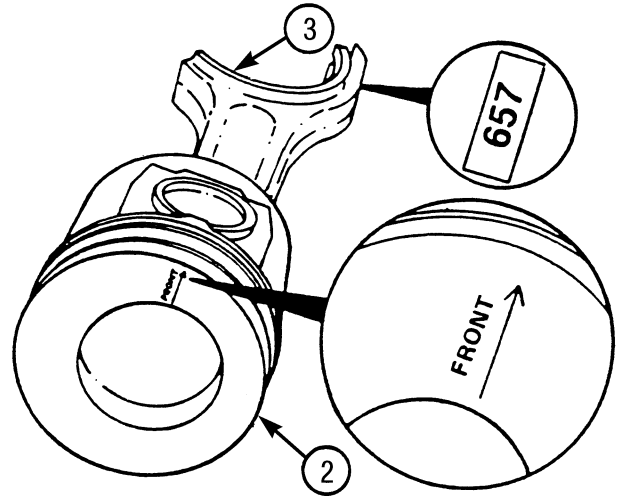
**d. Installation.**



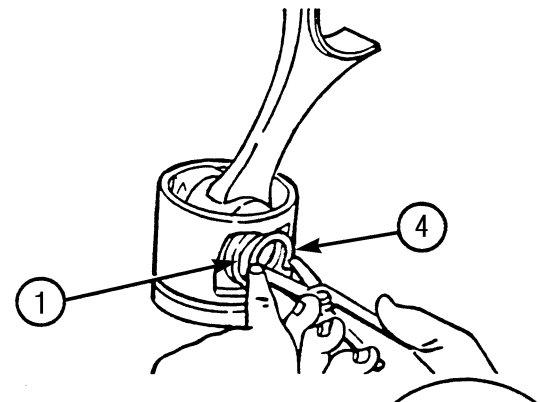
- (1) Install one retaining ring (4) into groove on side of piston (2) marked "FRONT."  
(2) Lubricate piston pin (1) and piston (2) pin bore with clean engine oil.



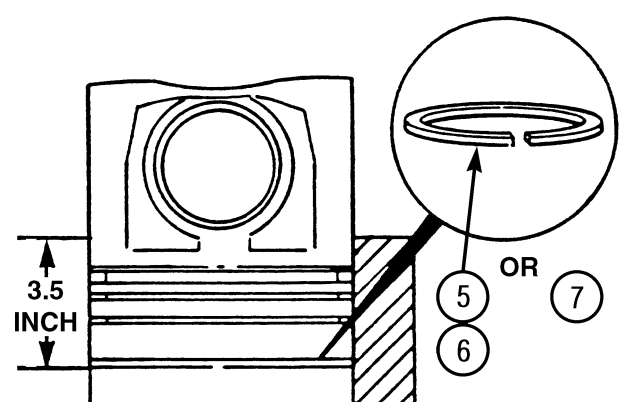
- (3) Orient word, "FRONT," on top of piston (2) and number on connecting rod (3) as shown, and then install piston pin (1).



- (4) Install second retaining ring (4).



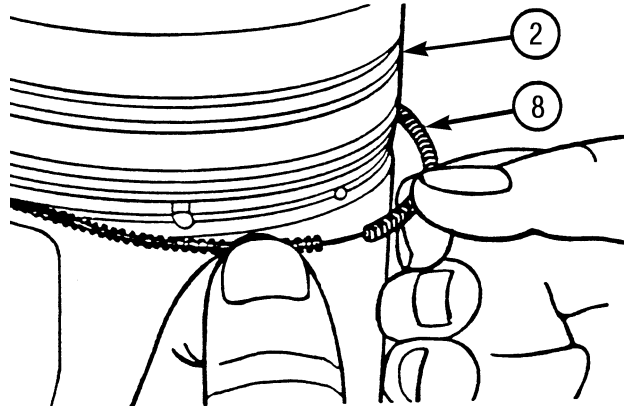
- (5) Place each piston ring (5, 6, and 7), individually, into cylinders to a depth of 3.5 in. (88.9 mm) and square ring in bore using piston as shown.



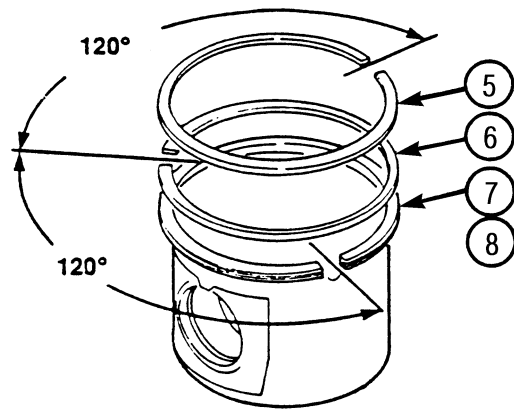
**3-16. PISTONS, PISTON PINS, AND RINGS REPLACEMENT (CONT)**

- (6) **Measure and record piston ring gaps while rings are in cylinders. Gaps should be as follows:**

Piston Ring Gaps	
Top ring gap	0.0160 - 0.0275 in. (0.41 - 0.70 mm)
Intermediate ring gap	0.0100 - 0.0215 in. (0.25 - 0.55 mm)
Oil control ring gap	0.0100 - 0.0215 in. (0.25 - 0.55 mm)



- (7) **If gaps are excessive, select next oversized ring set.**
- (8) **If gaps are too close, and new piston sleeves have been installed, bore out piston sleeves as necessary to allow gaps to open up to specifications.**
- (9) **Install oil control ring expander (8) and piston rings (5, 6, and 7) on piston (2).**



- (a) Place oil control ring expander (8) in bottom groove of piston (2).
- (b) Install oil control ring (7) over expander (8), with gap at a point 120° from gap in expander.
- (c) Install intermediate ring (6), placing its gap at a point 120° from gap in oil control ring (7).
- (d) Install top ring (5), placing its gap at a point 120° from gap in intermediate ring (6).

**NOTE**

Follow-on Maintenance: Install pistons and connecting rods (Para 3-17).

**END OF TASK**

### 3-17. CONNECTING RODS AND BEARINGS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Tool Kit, Machinists: Post, Camp and Station |  
(Item 24, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Inside/Outside Micrometer  
(Item 13, Appendix D)  
Hammer  
Ring Compressor  
Steel Number Stamps

##### *Equipment Condition*

Cylinder head removed (Para 3-7)  
Oil pan removed (Para 3-23)  
Oil pump inlet tube removed (Para 3-24)

##### *Materials/Parts*

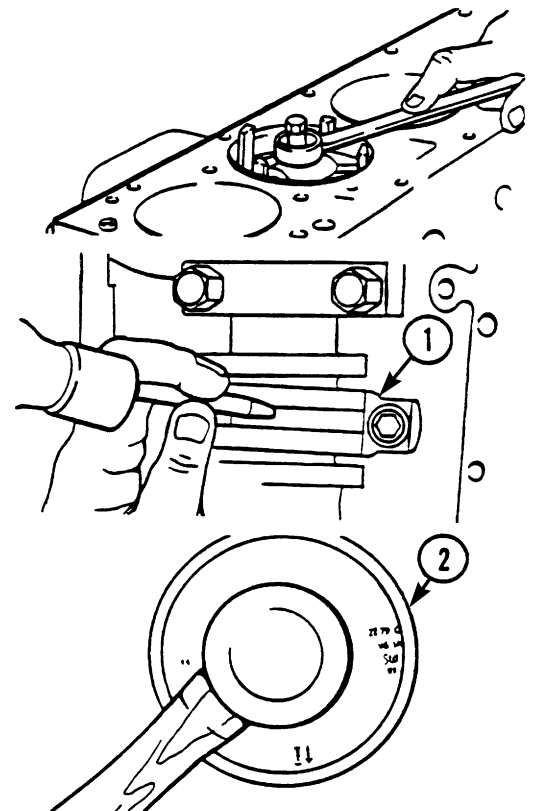
Lubriplate 105 (Item 23, Appendix B)  
Oil, Lubricating, Engine (Item 27, Appendix B)  
Rags, Wiping (Item 35, Appendix B)  
Bearing Set, Piston Rod  
Screws

#### a. Removal.

#### NOTE

Maximum allowable cylinder bore diameter is 4.0203 in. (102.12 mm). Make sure that ridge reamer does not gouge into cylinder bore or remove more metal than necessary.

- (1) **If necessary, remove ridge from top of cylinders using ridge reamer.**
- (2) **Mark each bearing cap (1) and matched piston (2) with cylinder number. Use a hammer and steel number stamps.**

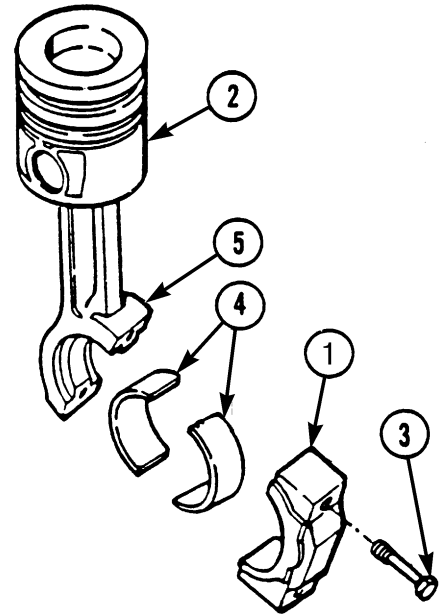


**3-17. CONNECTING RODS AND BEARINGS REPLACEMENT (CONT)**

**NOTE**

Do not use connecting rod screws.

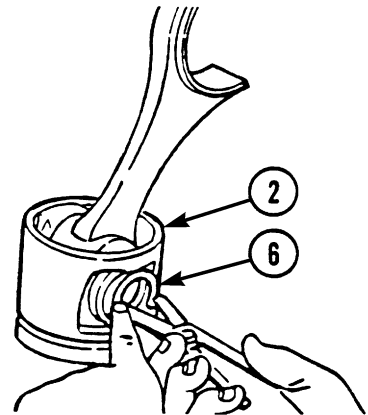
- (3) Remove screws (3), bearing cap (1), and rod bearings (4) from connecting rod (5). Discard rod bearings and screws.
- (4) Remove piston (2) and connecting rod (5) as an assembly by pushing out through top of cylinder block.
- (5) Remove connecting rod (5) from piston (2).



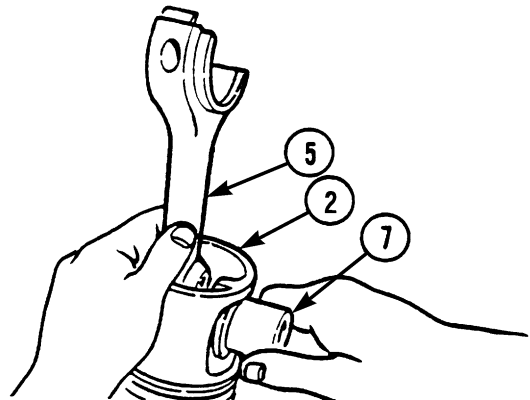
**WARNING**

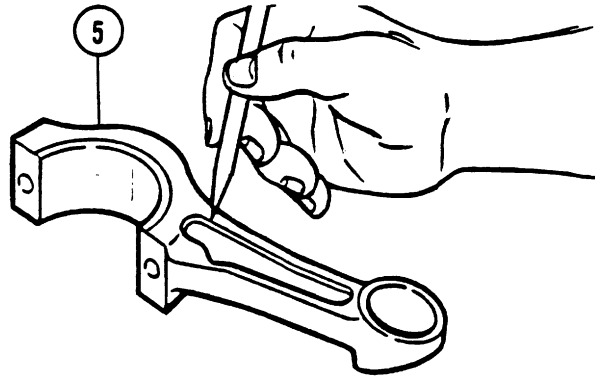
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove two retaining rings (6) from piston (2).



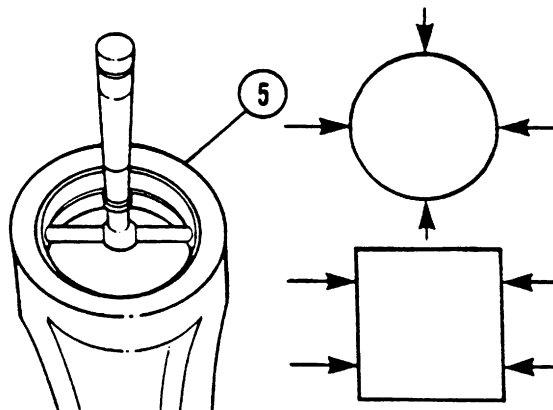
- (b) Remove piston pin (7) and separate piston (2) from connecting rod (5).



**b. Cleaning.****WARNING**

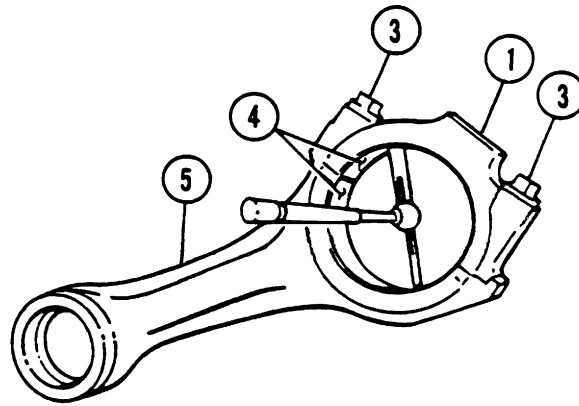
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- (1) Wash connecting rods (5) in a strong solution of laundry detergent and hot water.
- (2) Rinse connecting rods (5) in fresh, clean water and wipe dry using wiping rags.

**c. Inspection.**

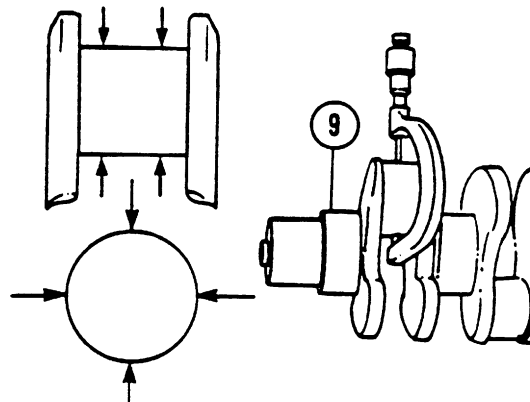
- (1) Visually inspect connecting rods (5) for damage or obvious wear.
- (2) Check I-beam section of connecting rods (5) for dents or other damage. Any damage in this area can cause stress which will lead to breakage.
- (3) Measure I.D. of piston pin bore in connecting rod (5), at four points as shown, to check for wear. Take average of all readings. Average reading must not exceed range from 1.5769 - 1.5784 in. (40.05 - 40.09 mm).

**3-17. CONNECTING RODS AND BEARINGS REPLACEMENT (CONT)**



**(4) Check rod bearing (4) clearance.**

- (a) Assemble connecting rod (5), rod bearings (4) and bearing cap (1).
- (b) Install screws (3) in bearing cap (1) and connecting rod (5). Tighten screws to 73 lb-ft (98.97 N•m).
- (c) Record smallest diameter measured at various points around bore.



**NOTE**

Maximum allowable rod bearing clearance is 0.0035 in (0.09 mm). Select required undersized bearing set to compensate for excessive rod bearing clearance.

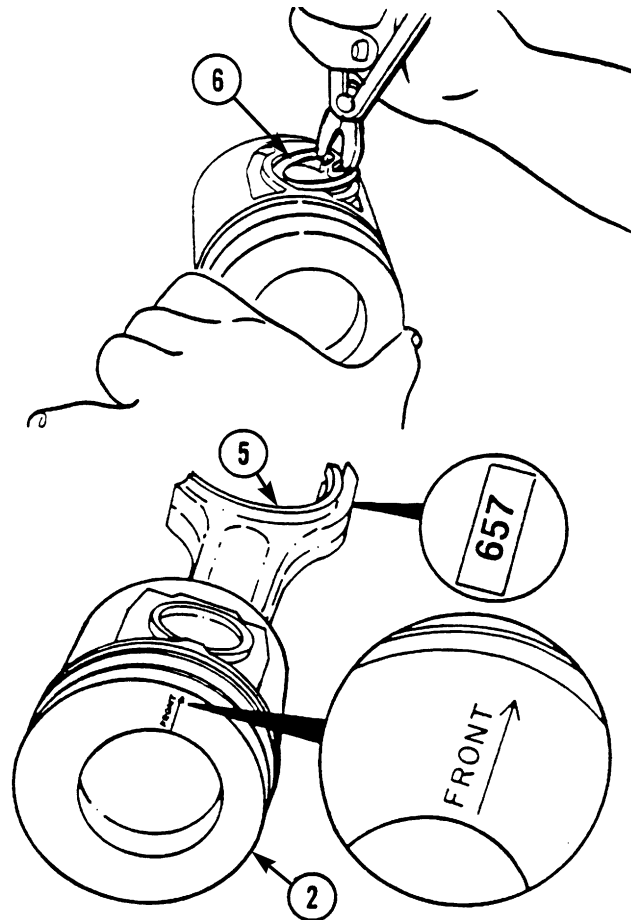
- (d) Measure and record mean diameter of rod journal on crankshaft (9). Take four readings on each journal at points noted.
- (e) Subtract rod journal mean diameter, Step (d), from smallest rod bearing diameter, Step (c), to determine rod bearing clearance.

**d. Installation.****NOTE**

If required, replace piston rings (Para 3-16), before proceeding.

**(1) Assemble connecting rod (5) to piston (2).**

- (a) Liberally apply engine oil to piston pin (7) and to piston pin bores in connecting rod (5) and in piston (2).
- (b) Install one retaining ring (6) on side of piston marked, "FRONT."
- (c) Orient piston (2) and connecting rod (5) so word, "FRONT," on top of piston and number stamped on connecting rod are positioned as shown.
- (d) Install piston pin (7) through bores in piston (2) and in connecting rod (5).
- (e) Install retaining ring (6) on piston (2).

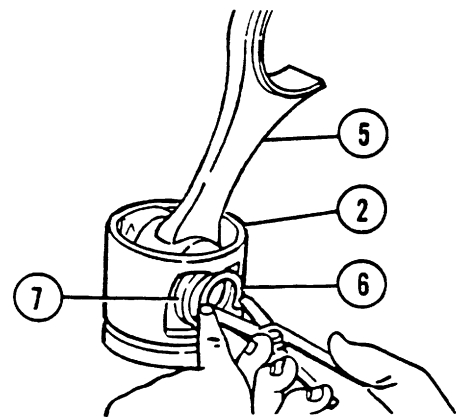
**(2) Install piston (2) and connecting rod (5) as an assembly in cylinder block.**

- (a) Apply engine oil to cylinder bores, piston rings, and piston skirts.

**CAUTION**

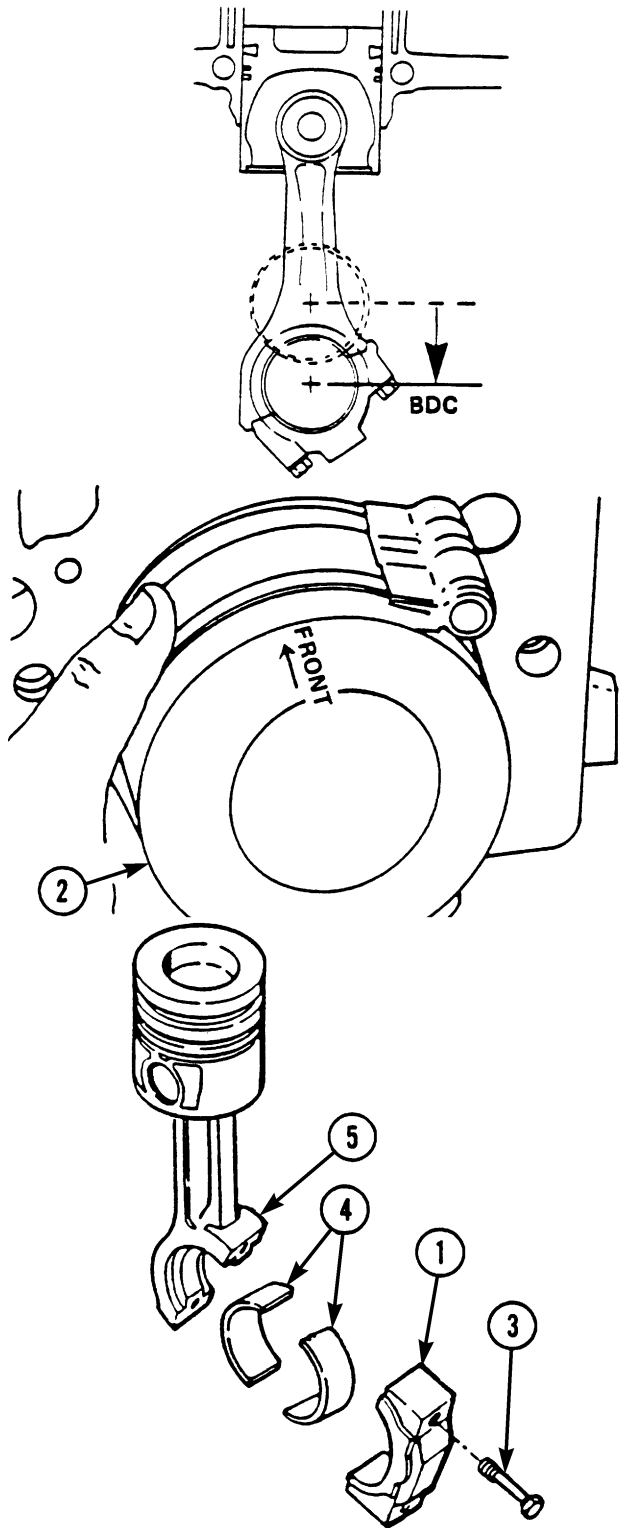
If a strap-type ring compressor is used in Step (b), take care not to hook strap on a ring gap, as doing so could cause ring to break.

- (b) Compress piston rings using a suitable ring compressor.



**3-17. CONNECTING RODS AND BEARINGS REPLACEMENT (CONT)**

- (c) Bar crankshaft (9) over so rod journal for piston (2) and connecting rod (5) assembly being installed is at bottom dead center (BDC).
- (d) Install piston (2) and connecting rod (5) assembly through top of cylinder bore, using care not to damage cylinder liner walls. Make sure that side of piston containing word, "FRONT," faces front (fan end) of engine.
- (e) Continue to push piston (2) into cylinder bore until top of piston is approximately 2 in. (50.8 mm) below top surface of cylinder block.
- (f) Repeat above procedure until all six piston (2) and connecting rod (5) assemblies are installed.
- (g) Obtain proper sized rod bearing set, according to rod bearing clearance measurement, in **Inspection** Steps (4)(d) and (4)(e).
- (h) Install rod bearings (4) in connecting rods (5) and bearing caps (1).
- (i) Apply light coat of Lubriplate 105 to rod bearing (4) bearing surfaces.
- (j) Grasp bottom of connecting rod (5) and pull downward onto crankshaft (9) rod journal.
- (k) Install bearing caps (1) with four-digit numbers stamped on bearing caps and on connecting rods (5), at parting line, towards oil cooler side of engine.
- (l) Apply engine lubricating oil to threads and under heads of screws (3). Install screws in bearing cap (1) and connecting rod (5). Tighten screws fingertight.



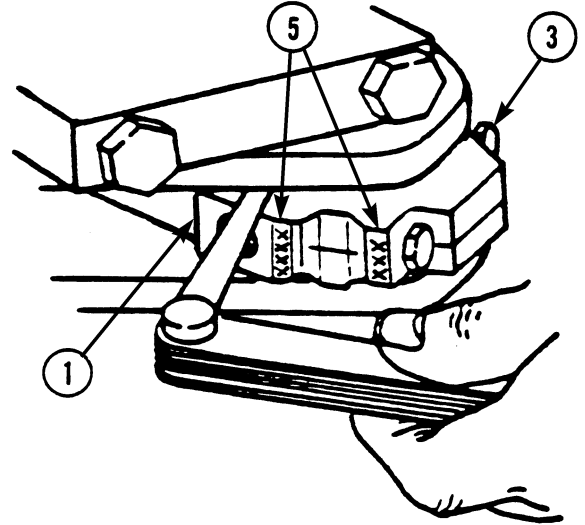


(m) Tighten screws (3) in three increments.

1 First increment - 26 lb-ft  
(35.25 N•m).

2 Second increment - 52 lb-ft  
(70.50 N•m).

3 Third increment - 73 lb-ft  
(98.97 N•m).



**(3) As bearing caps (1) are installed, manually rotate crankshaft (9) to ensure that crankshaft rotates freely. If crankshaft fails to rotate freely at some point, check for installation or incorrect size of rod bearings (4).**

**(4) Repeat Steps (2) and (3) for remaining piston (2) and connecting rod assemblies (5) are installed**

**(5) Measure connecting rod (5) side play at each connecting rod (5) assembly.**

(a) Measure connecting rod (5) side play.

(b) Wear tolerance is 0.012 in (0.30 mm).

(c) If side play exceeds wear tolerance stated in Step (b), replace connecting rod (5) and bearing cap (1).

### NOTE

Follow-on Maintenance:

- Install oil pump inlet tube (Para 3-24).
- Install oil pan (Para 3-23).
- Install cylinder head (Para 3-7).

**END OF TASK**

### 3-18. ROCKER ARM ASSEMBLY REPLACEMENT

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Tool Kit, Machinists: Post, Camp and Station (Item 24, Appendix D)
- Inside Micrometer (Item 12, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)

*Equipment Condition*

- Rocker arm covers removed (TM 10-3930-673-20)
- Negative battery cable disconnected (TM 10-3930-673-20)

*Materials/Parts*

- Oil, Lubricating, Engine (Item 27, Appendix B)
- Tags (Item 55, Appendix B)

**a. Removal.**

- (1) **Remove rocker arm assembly (1).**

**NOTE**

Tag or mark rocker arm assemblies, to include push rods, so assemblies can be installed into the same position from which they were removed.

- (a) Loosen two nuts (2).
- (b) Loosen two adjusting screws (3).
- (c) Remove screws (4 and 5), and remove rocker arm assembly (1).
- (d) Repeat Steps (a) through (c) for the other five rocker arm assemblies sets (1).

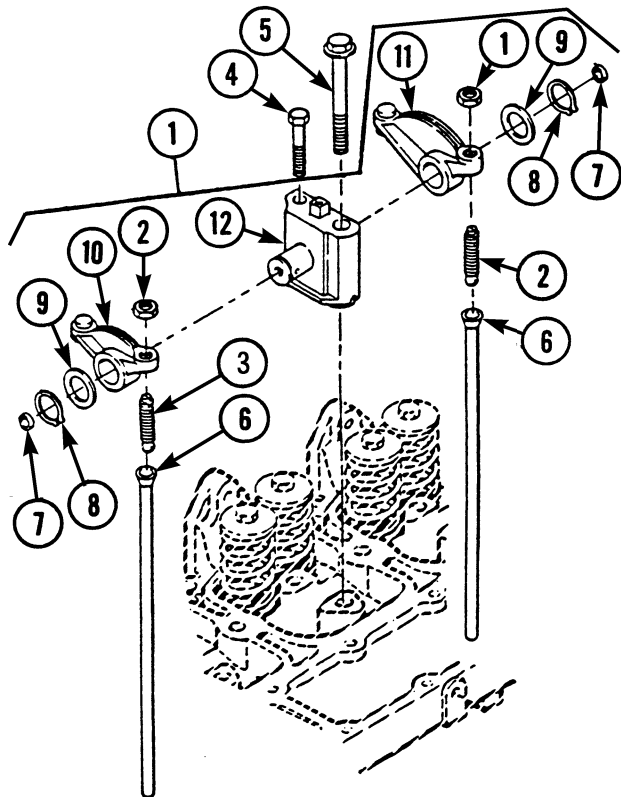
- (2) **Remove 12 push rods (6).**

**b. Disassembly.**

**NOTE**

Keep each rocker arm assembly together as a set.

- Disassemble rocker arm assembly (1).**



**NOTE**

Remove expansion plug only if necessary.

- (a) Remove two expansion plugs (7), retaining rings (8), and washers (9).

**CAUTION**

Do not remove shaft from support. The support and shaft must be replaced as an assembly.

- (b) Remove intake rocker arm (10) and exhaust rocker arm (11) from support (12).
- (c) Remove nuts (2) and adjusting screws (3) from intake rocker arm (10) and exhaust rocker arm (11).
- (d) Repeat Steps (a), (b), and (c) for other five rocker arms assemblies (1).

**c. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**d. Inspection.**

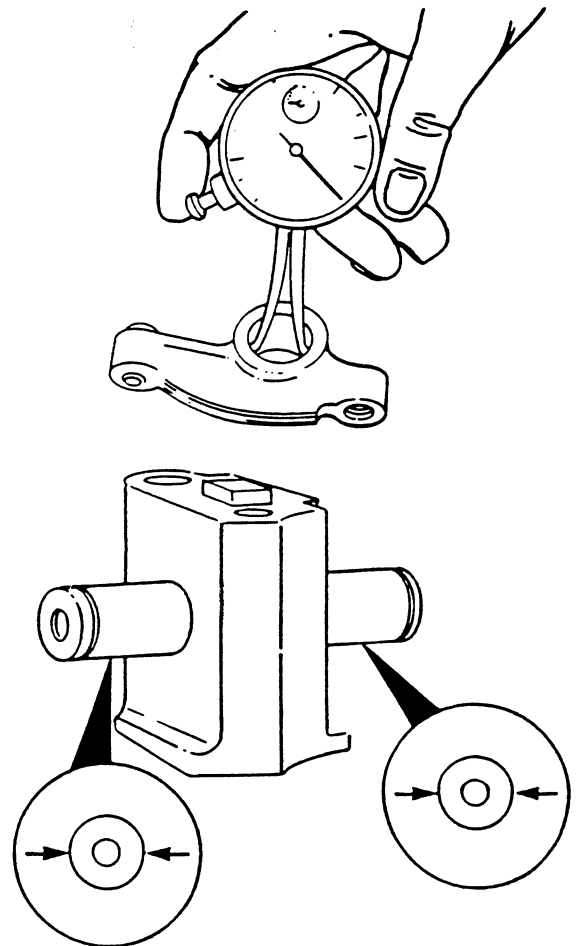
- (1) **See Inspection Instructions (Para 2-14).**

- (2) **Measure rocker arm bore.**

Maximum Allowable Diameter: 0.750 in.  
(19.05 mm).

- (3) **Measure rocker arm support shaft diameter.**

Minimum Allowable Diameter: 0.746 in.  
(18.95 mm).



**3-18. ROCKER ARM ASSEMBLY REPLACEMENT (CONT)**

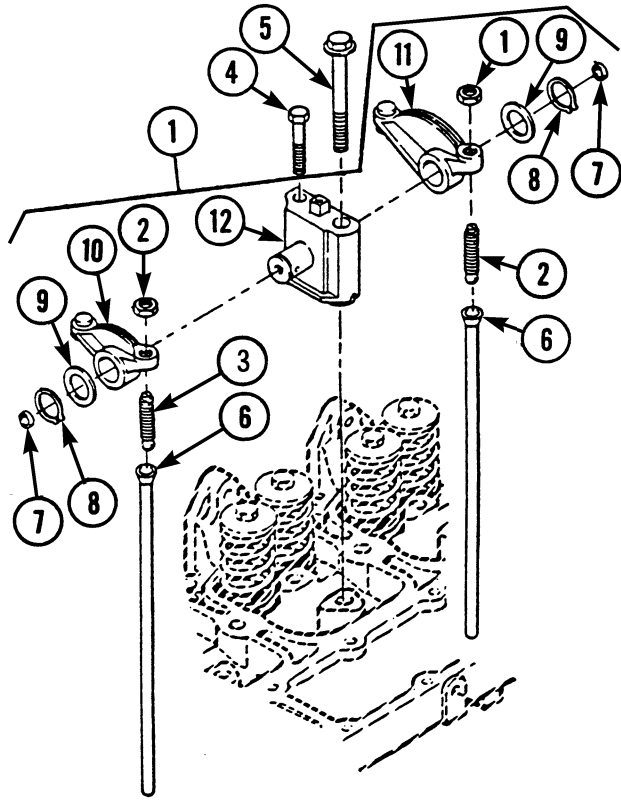
*e. Assembly.*

**NOTE**

Be sure to assemble intake rocker arm and exhaust rocker arm in the correct location.

**Assemble rocker arm assembly (1).**

- (a) Assemble adjusting screws (3) and nuts (2) to rocker levers (10 and 11).
- (b) Lubricate both ends of support (12) shaft with engine lubricating oil.
- (c) Check to make sure adjusting screws (3) are completely backed out.
- (d) Assemble intake rocker arm (10) and exhaust rocker arm (11) onto support (12) shaft.
- (e) Install two washers (9), retaining rings (8), and new expansion plugs (7) if removed.
- (f) Repeat Steps (a) through (e) for the other five rocker arm assemblies (1).



*f. Installation.*

- (1) **Install 12 push rods (6) into same position in engine as originally placed. Lubricate push rod sockets with clean engine oil.**
- (2) **Install rocker arm assembly (1) in original position. Tighten screws (5) to final torque value in three steps.**
  - (a) Position rocker arm assembly (1) on cylinder head.
  - (b) Apply clean lubricating oil to threads and under heads of screws (4 and 5).
  - (c) Install screws (4 and 5) in rocker arm assembly (1). Tighten screw (4) to 18 lb-ft (24.40 N•m). Tighten screw (5) in three steps as follows:

Step	Torque Value
1	29 lb-ft (39.32 N•m)
2	62 lb-ft (84.06 N•m)
3	92 lb-ft (124.74 N•m)

(d) Repeat Steps (a) through (c) for remaining rocker arm assemblies (1).

**NOTE**

Follow-on Maintenance:

- Adjust valves (TM 10-3930-673-20).
- Install rocker arm covers (TM 10-3930-673-20).

**END OF TASK**

### 3-19. VALVE TAPPETS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Inside/Outside Micrometers  
(Item 13, Appendix D)  
Engine Stand  
Magnet

*Equipment Condition*

Camshaft removed (Para 3-20)  
Oil pan removed (Para 3-23)

*Materials / Parts*

Lubriplate (Item 23, Appendix B)

#### NOTE

If a new camshaft is being installed, all tappets must be replaced.

**a. Removal.**

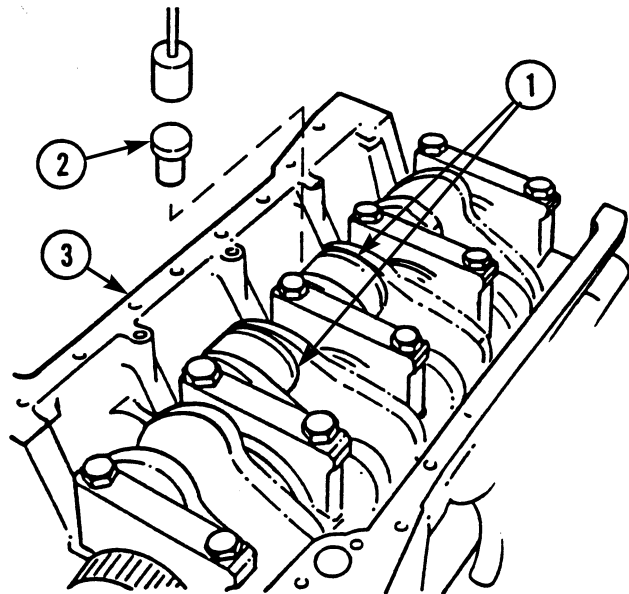
- (1) **Position engine stand so crankshaft (1) is facing up.**

**CAUTION**

Be careful not to drop the tappets into the bottom of the pistons during tappet removal as this could damage the pistons.

- (2) **Use a magnet to remove tappets (2) from cylinder block (3).**

**b. Cleaning.** See Cleaning Instructions (Para 2-12).



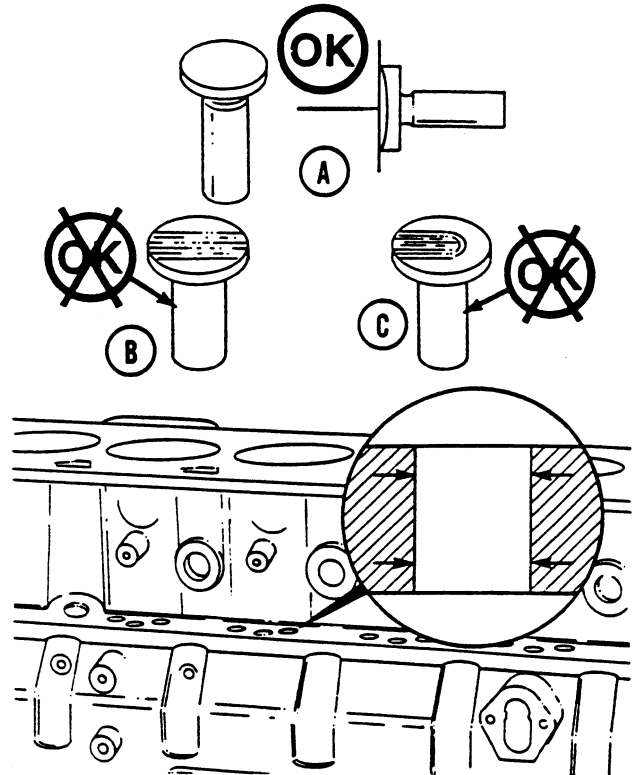
**c. Inspection.**

- (1) **See Inspection Instructions (Para 2-14).**

- (2) **Inspect tappets.**

Inspect socket, stem and face for excessive wear and other damage.

Inspection Point	Indication
A	Normal wear
B and C	Abnormal wear, do not reuse.



- (3) **Measure tappet bores. If tappet bores in cylinder block are not within specified tolerance, the engine must be rebuilt.**

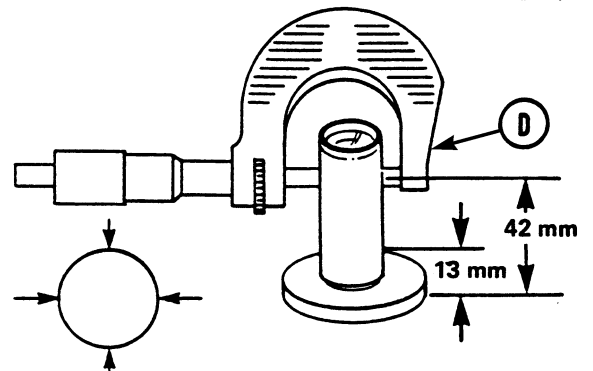
Wear Limit Tolerance
0.630 - 0.632 in. (0.85 - 0.86 mm)

- (4) **Check tappet dimensions.**

D (Minimum Diameter) = 0.627 in. (0.85 mm)
---

Check tappet diameter in four places:

Dimension
1.65 in. (42 mm) from face
0.51 in. (13 mm) from face
90° to each measurement



### 3-19. VALVE TAPPETS REPLACEMENT (CONT)

*d. Installation.*

#### NOTE

If new tappets were installed, a new camshaft must also be installed.

- (1) **Position engine stand so crankshaft (1) is facing up.**

#### CAUTION

Be careful not to drop the tappets into bottom of the pistons during tappet installation as this could damage pistons.

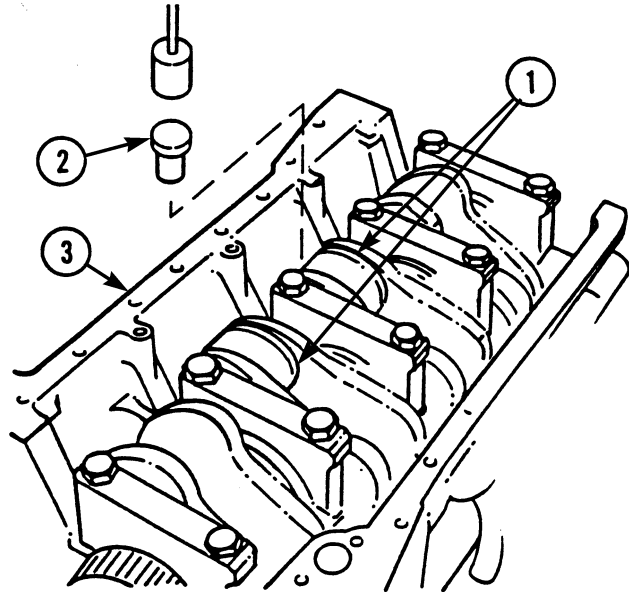
- (2) **Apply Lubriplate 105 to outside diameter of tappet (2).**
- (3) **Use a magnet to install tappets (2) into cylinder block (3).**

#### NOTE

Follow-on Maintenance:

- Install camshaft (Para 3-20).
- Install oil pan (Para 3-23).

**END OF TASK**





**3-20. CAMSHAFT, CAMSHAFT GEAR, AND CAMSHAFT BUSHING REPLACEMENT**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Dial Indicator (Item 3, Appendix D)
- Inside Micrometers (Item 12, Appendix D)
- Engine Stand
- Felt Pen
- Universal Bushing Installation Tool

*Equipment Condition*

- Fuel transfer pump removed (TM 10-3930-673-20)
- Engine removed (Para 3-3)
- Front housing cover removed (Para 3-21)
- Rocker lever arms removed (Para 3-18)

*Materials/Parts*

- Cloth, Crocus (Item 8, Appendix B)
- Gloves, Insulated (Item 17, Appendix B)
- Lubriplate (Item 23, Appendix B)

**a. Removal.**

**NOTE**

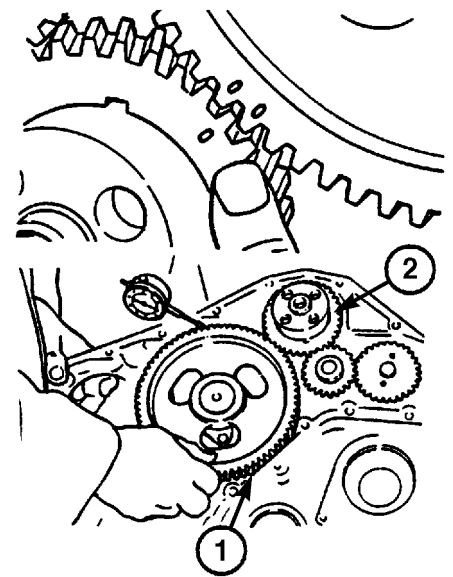
If new tappets were installed, the camshaft and camshaft bushing(s) must be replaced.

- (1) **Turn crankshaft to align timing marks on camshaft gear (1) with timing marks on crankshaft gear (2).**

**NOTE**

When measuring camshaft gear backlash, hold the camshaft gear and the crankshaft gear to avoid getting a false backlash reading.

- (a) Measure camshaft gear (2) backlash using a dial indicator as shown.
- (b) Record measured backlash for reference.



**3-20. CAMSHAFT, CAMSHAFT GEAR, AND CAMSHAFT BUSHING REPLACEMENT (CONT)**

- (c) Measure camshaft (3) endplay using a dial indicator positioned on a machined surface of the camshaft gear (1). Record indicator reading for reference.

- (2) **To prevent tappets from dropping out of the cylinder block when camshaft (3) is removed, turn engine stand so the crankshaft is facing up.**

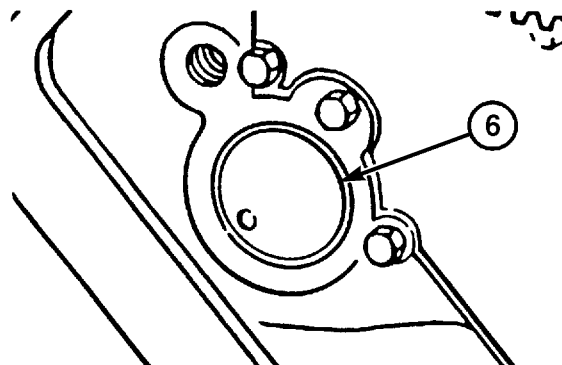
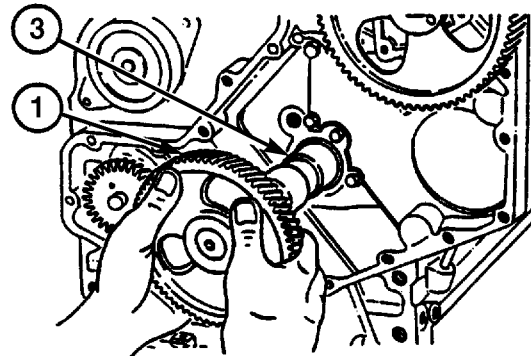
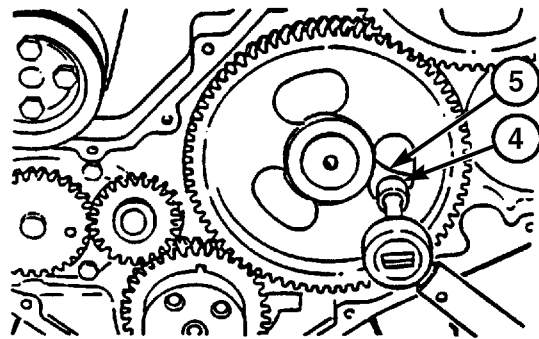
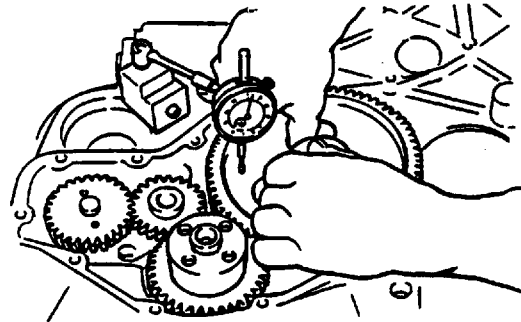
- (3) **Remove camshaft gear (1) and camshaft (3) as an assembly from cylinder block.**

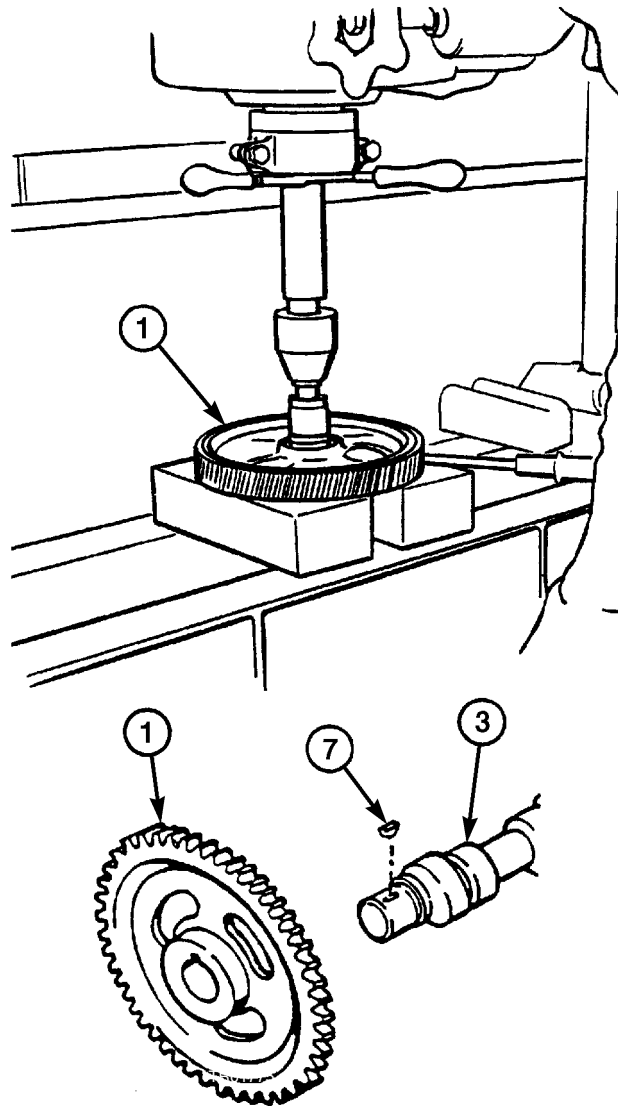
- (a) Remove two screws (4) and thrust plate (5) from cylinder block.
- (b) Slowly and carefully remove camshaft (3) and camshaft gear (1), being careful not to damage the camshaft lobes and bearing journals, and camshaft bores in the cylinder block. It may be necessary to slowly turn the camshaft, during removal, to allow lobes to clear the tappets.

**NOTE**

If a new camshaft is to be installed, or if the camshaft bushing is damaged or dimensions exceed specified tolerance (see *Inspection*), the camshaft bushing, and all service bushings that may be installed in the other cam bores, must be replaced.

- (4) **If necessary, remove camshaft bushing (6) and all cam service bushings using the universal bushing installation tool.**



**b. Disassembly.**

- (1) Use a press to remove camshaft gear (1) from camshaft (3).
- (2) Remove key (7) from camshaft (3).
- (3) Use crocus cloth to remove all burrs and smooth any rough surfaces on the camshaft (3) that could have been caused by gear removal.

**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**3-20. CAMSHAFT, CAMSHAFT GEAR, AND CAMSHAFT BUSHING REPLACEMENT (CONT)**

**d. Inspection.**

**(1) Inspect camshaft bushing and camshaft bores in cylinder block.**

- (a) Inspect camshaft bushing (6) and camshaft (3) bores for burrs, scoring, grooves, and pitting.
- (b) Measure front camshaft bushing (6) I.D. Acceptable range is 2.1295 - 2.1314 in (54.09 - 54.14 mm).

**NOTE**

If intermediate and rear camshaft bores have service bushings installed, the I.D. dimension must be within the tolerance specified above in Step (b).

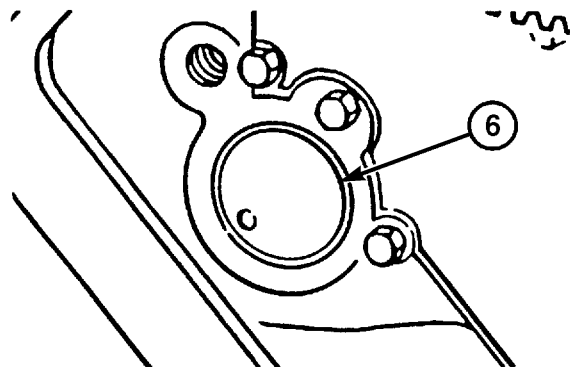
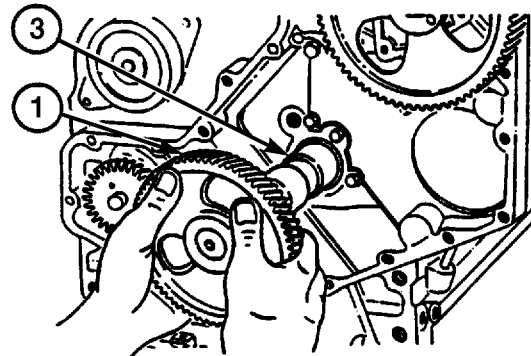
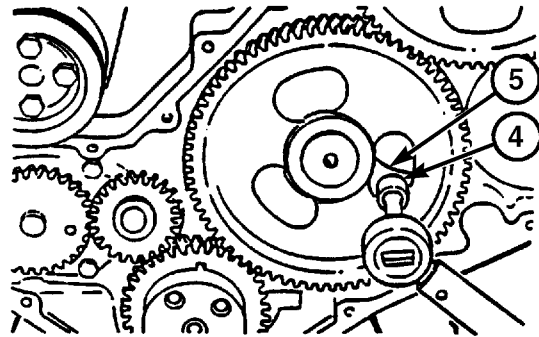
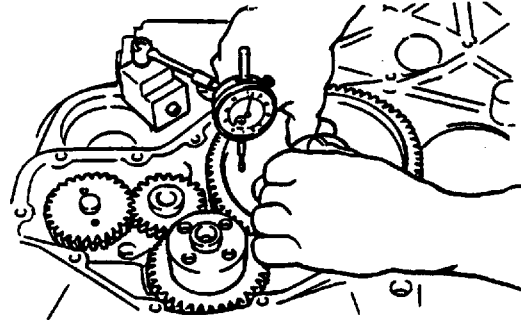
- (c) Measure intermediate and rear camshaft bores I.D. Acceptable bore I.D. range is 2.1295 - 2.1314 in. (54.09 - 54.14 mm). If bores are worn beyond this specification, the cylinder block must be machined and service bushings installed, or the cylinder block must be replaced. Refer to Depot level maintenance.

**NOTE**

If new valve tappets are being installed, the camshaft and camshaft bushing must be replaced.

**(2) Inspect camshaft (3).**

- (a) Inspect fuel lift pump lobe, valve lobes and camshaft bearing journal for cracking, pitting, or other defects.
- (b) Measure bearing journal diameter. Minimum allowable diameter is 2.1245 in. (53.962 mm).



- (c) Measure valve lobe diameters at peak of lobe. Minimum allowable intake valve lobe diameter at peak of lobe is 1.852 in. (47.04 mm). Minimum allowable exhaust valve lobe diameter at peak of lobe is 1.841 in. (46.77 mm).
- (d) Measure fuel lift lobe diameter. Minimum allowable fuel pump lobe diameter is 1.398 in. (35.5 mm).

**(3) Inspect camshaft gear (1).**

- (a) Discard camshaft gear if measured backlash (**Removal**, Step (1)(a)) is not 0.003 - 0.013 in. (0.08 - 0.33 mm).
- (b) Inspect gear teeth for damage or excessive wear.
- (c) Check for cracks at roots of gear teeth.

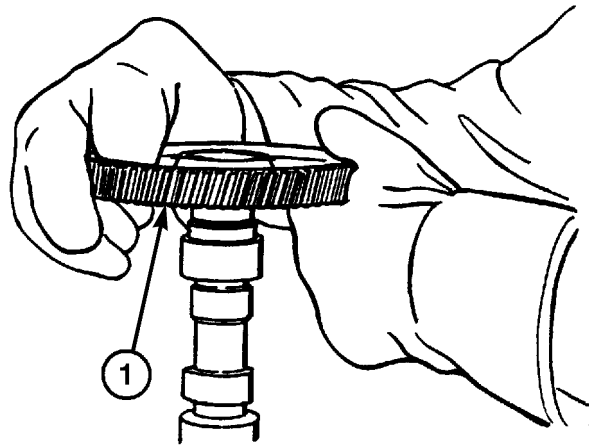
**(4) Inspect thrust plate (5).**

- (a) Examine thrust plate (5) for damage distortion or excessive wear.
- (b) Discard thrust plate (5) if measured camshaft endplay (**Removal**, Step (1)(c)) is not 0.007 - 0.011 in. (0.17- 0.29 mm). Also check for enlarged thrust plate (5) slot in camshaft if endplay is excessive.

**3-20. CAMSHAFT, CAMSHAFT GEAR, AND CAMSHAFT BUSHING REPLACEMENT (CONT)**

**e. Assembly.**

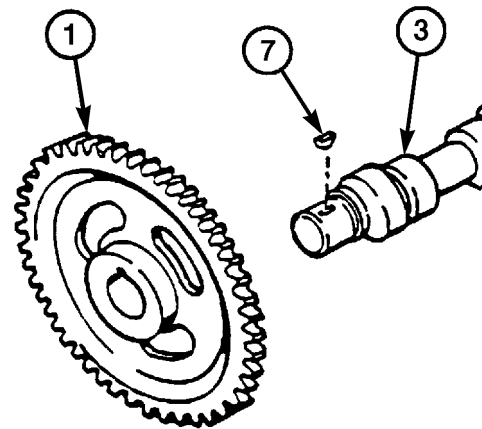
- (1) **Install key (7) in camshaft (3).**
- (2) **Install camshaft gear (1) on camshaft (3).**
  - (a) Apply Lubriplate 105 to gear mounting surface of camshaft gear (1).
  - (b) Heat camshaft gear (1) in an oven to 250°F (121.11°C) for 45 minutes.



**WARNING**

Wear gloves and proper clothing while handling hot camshaft gear. Failure to follow this precaution could result in serious personal injury.

- (c) Install camshaft gear (1) on camshaft (3) with timing marks away from camshaft and gear tight against shoulder of camshaft.

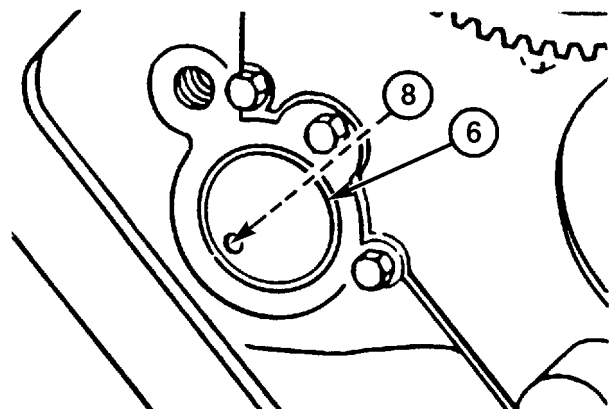


**f. Installation.**

**NOTE**

If a new camshaft is being installed, a new camshaft bushing must be installed.

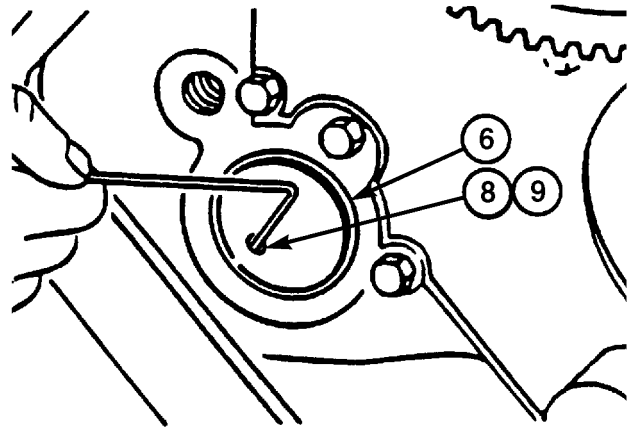
- (1) **Install camshaft bushing (6).**
  - (a) Mark location of oil hole (8) in camshaft (3) bore using felt pen.
  - (b) Place camshaft bushing (6) in its bore, taking care to align oil hole in bushing with oil hole (8) in camshaft (3) bore.
  - (c) Install camshaft bushing (6), using universal bushing installation tool, until bushing is flush with face of cylinder block.



- (d) Check oil hole alignments by inserting a 0.128 in. (3.25 mm) diameter rod into bushing oil hole (9) and insuring that rod can also enter oil hole (8) in camshaft bushing (6) if oil hole alignment is unsatisfactory.

**NOTE**

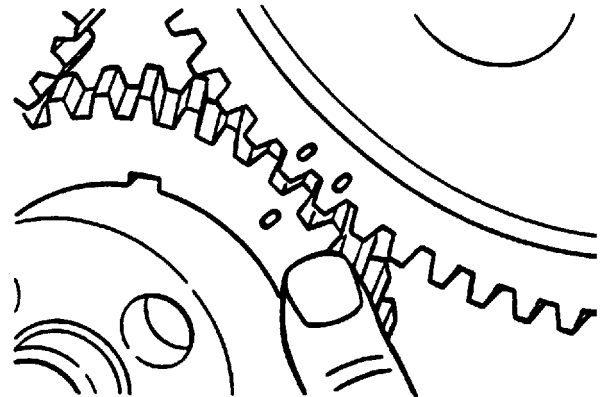
The specified rod diameter represents the minimum sized oil passage required for adequate camshaft bushing lubrication.



- (2) **Apply Lubriplate 105 to camshaft bores in cylinder block and to lobes of camshaft.**

- (3) **Install camshaft (3), camshaft gear (1), and thrust plate (5).**

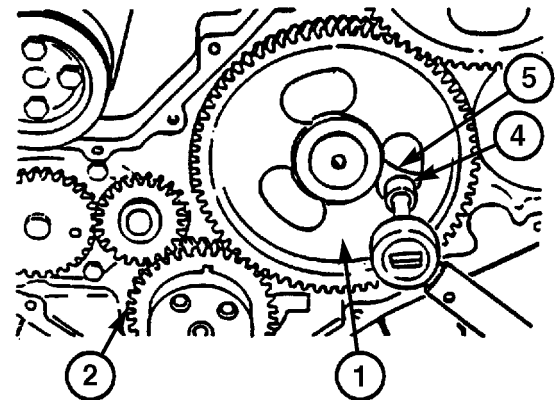
- (a) Position camshaft (3), camshaft gear (1), and thrust plate (5) in cylinder block.
- (b) Align timing marks on camshaft gear (1) with timing mark on crankshaft gear (2).
- (c) Install screws (4) in thrust plate (5). Tighten screws to 216 lb-ft (292.86 N•m).



**NOTE**

Follow-on Maintenance:

- Install rocker arm levers (Para 3-18).
- Install fuel transfer pump (TM 10-3930-673-20).
- Install front housing cover (TM 10-3930-673-20).
- Install oil pan (Para 3-23).



**END OF TASK**

### 3-21. FRONT HOUSING AND COVER REPLACEMENT

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Gasket Scraper
- Seal driver/puller

*Equipment Condition*

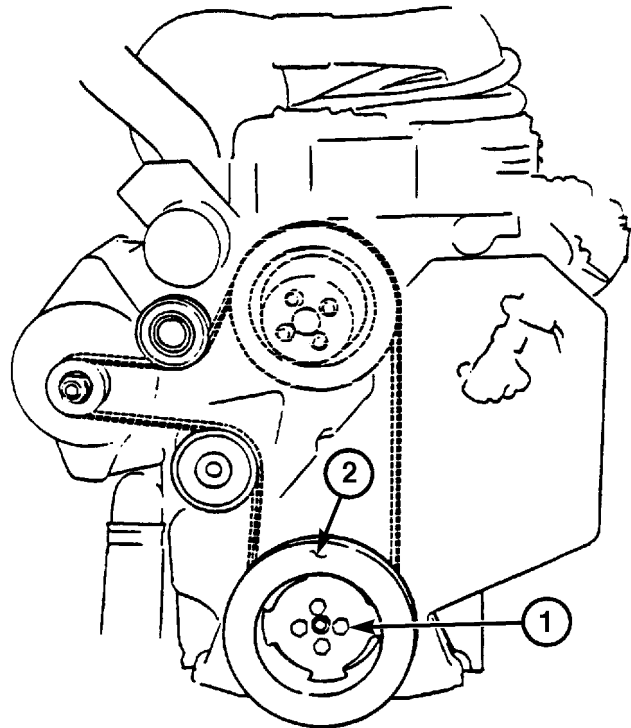
- Engine removed (Para 3-3)
- Tachometer drive removed (TM 10-3930-673-20)
- Fan and fan belt removed (TM 10-3930-673-20)

*Materials/Parts*

- Compound, Sealing (Item 43, Appendix B)
- Gasket
- Gasket
- Gasket
- Gasket
- Packing, Preformed
- Packing, Preformed
- Packing, Preformed
- Seal, Oil
- Seal, Rectangular Ring

**a. Removal.**

- (1) Remove four screws (1) and vibration damper (2).

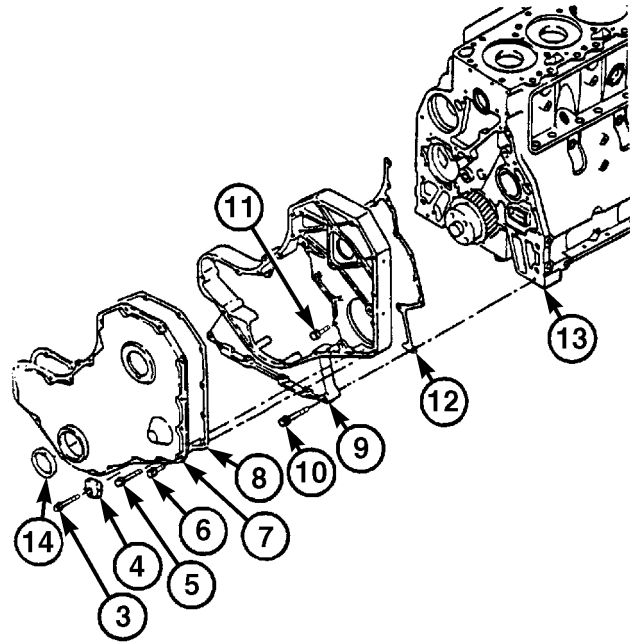




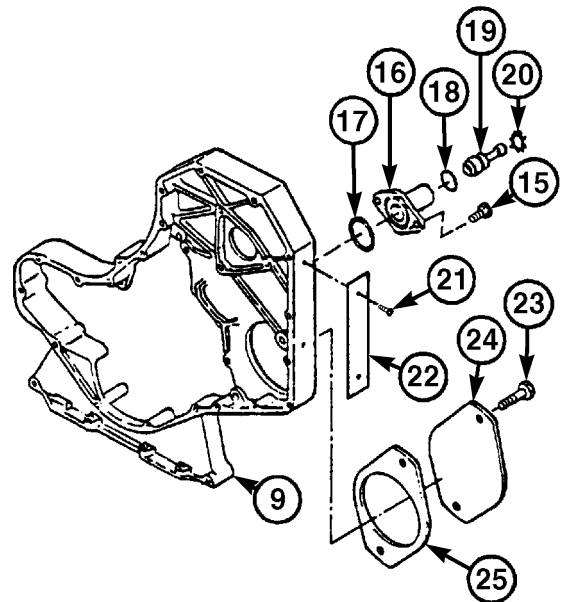
**NOTE**

Screws which retain the gear housing and cover are of three sizes. Note sizes and locations of screws during removal to ensure proper assembly.

- (2) Remove screw (3) and belt guide (4).
- (3) Remove eight screws (5) and 11 screws (6) from gear cover (7).
- (4) Remove gear cover (7) and gasket (8) from gear housing (9). Discard gasket.
- (5) Remove camshaft and timing gear (Para 3-20).
- (6) Remove fuel injection pump (Para 4-4).
- (7) Remove two screws (10) and five screws (11) from gear housing (9).
- (8) Remove gear housing (9) and gasket (12) from cylinder block (13). Discard gasket.
- (9) Use a gasket scraper to remove old gasket material from cylinder block (13) and gear housing (9).

**b. Disassembly.**

- (1) If damaged, using a suitable puller or driver remove oil seal (14) from gear cover (7).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (2) Remove two screws (15), housing (16), preformed packings (17 and 18), timing pin (19), and retaining ring (20) as an assembly from gear housing (9). Discard preformed packing (17).

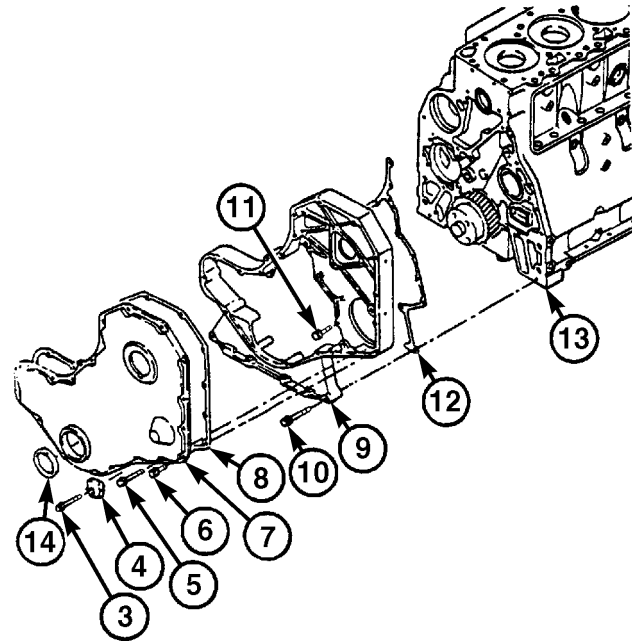
**3-21. FRONT HOUSING AND COVER REPLACEMENT (CONT)**

- (3) Remove retaining ring (20), timing pin (19), and preformed packing (18) from housing (16). Discard preformed packing.
- (4) If damaged, remove screws (21) and dataplate (22) from gear housing (9).
- (5) If damaged, remove screws (23), cover plate (24), and gasket (25) from back of gear housing (9). Discard gasket.

c. *Cleaning.* See Cleaning Instructions (Para 2-12).

d. *Inspection.* See Inspection Instructions (Para 2-14).

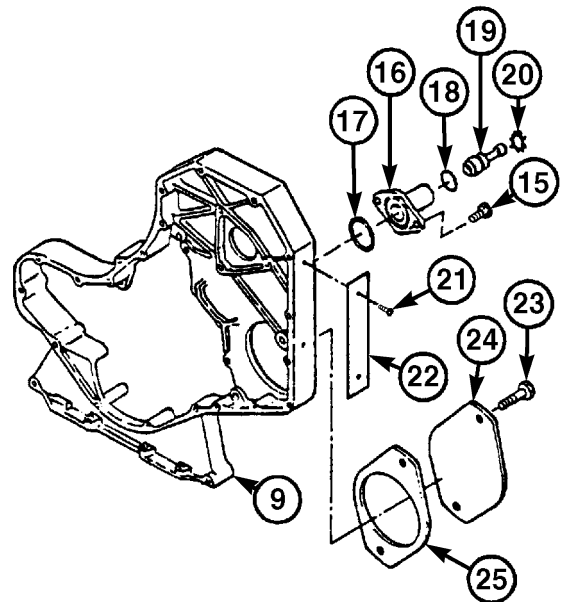
e. *Assembly.*



**CAUTION**

If a new housing is installed, the timing pin assembly must be accurately located. Failure to do so could result in improper timing adjustment.

- (1) If removed, install gasket (25), cover plate (24), and screws (23) on gear housing (9).
- (2) If removed, install dataplate (22) and screws (21) on gear housing (9).



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (3) Install preformed packing (18), timing pin (19), and retaining ring (20) into housing (16).
- (4) Install preformed packing (17) into housing (16).

**f. Installation.**

- (1) **Install gasket (12), gear housing (9), five screws (11) and two screws (10) on cylinder block (13). Tighten screws to 216 lb-in (24.40 N•m).**
- (2) **Install camshaft and timing gear (Para 3-20).**
- (3) **Install timing pin (19), retaining ring (20), housing (16), preformed packings (17 and 18), and screws (15) on gear housing (9). Tighten screws fingertight. Hold timing pin in and engage hole in camshaft gear to ensure proper alignment. Tighten screws to 48 lb-in (5.42 N•m).**
- (4) **Pull timing pin (19) out of camshaft gear.**
- (5) **Install fuel injection pump (Para 4-4).**

**CAUTION**

Lips of seal and seal surface on crankshaft should be clean and free of oil prior to installation. Failure to clean surfaces could cause oil to leak at seal.

- (6) **If removed, install oil seal (14).**

**NOTE**

Install screws in locations noted during disassembly

- (a) Install gasket (8), gear cover (7), 11 screws (6), and eight screws (5) on gear housing (9). Do not tighten screws at this time.
- (b) Install alignment/installation tool from seal kit onto crankshaft end and into seal bore in gear cover (7) with crankshaft end.
- (c) Tighten eight screws (5) and 11 screws (6) to 216 lb-in (24.40 N•m).

**WARNING**

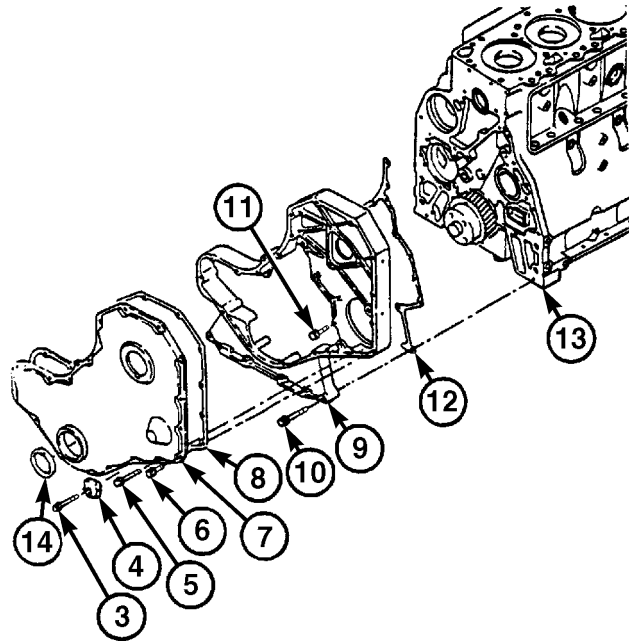
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

- (d) Apply a bead of sealing compound to outside of oil seal (14).
- (e) Press oil seal (14) and seal pilot onto crankshaft end.
- (f) Remove seal pilot from oil seal (14).
- (g) Use alignment/installation tool included in seal kit to drive oil seal (14) to correct depth in gear cover (7) bore.

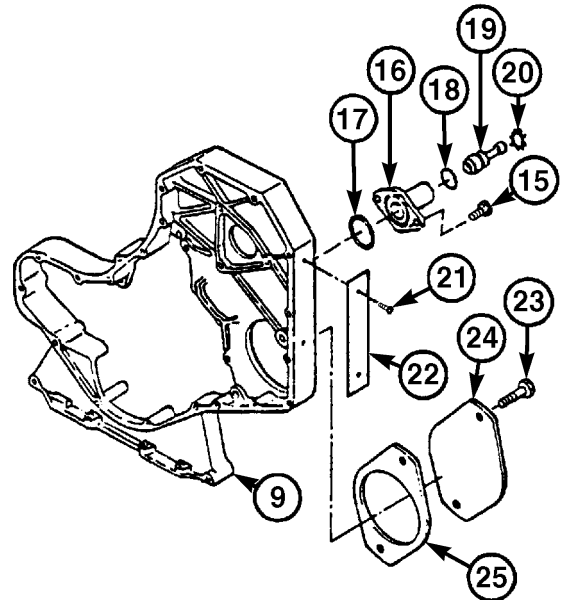
**3-21. FRONT HOUSING AND COVER REPLACEMENT (CONT)**

**(7) If oil seal (14) is to be reused:**

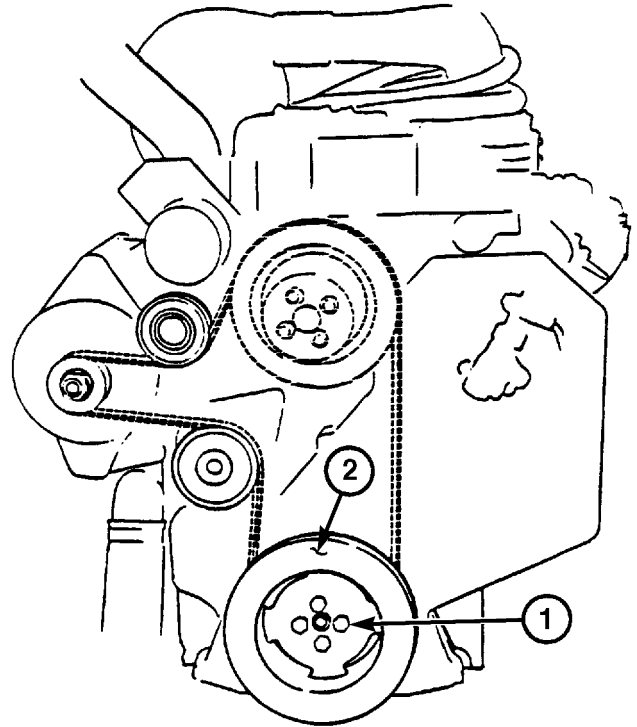
- (a) Install seal pilot from seal kit into inside diameter of oil seal (14) to protect lips of oil seal during installation.
- (b) Install gasket (8) onto gear housing (9).
- (c) Install oil seal (14) and gear cover (7) onto gear housing (9) as an assembly.
- (d) Install 11 screws (6) and eight screws (5) in gear cover (7) and gear housing (9). Tighten screws to 216 in-lb (24.40 N•m).



**(8) Install screw belt guide (4) and screw (3). Tighten screw to 216 lb-in (24.40 N•m).**



- (9) **Install vibration damper (2) and four screws (1). Tighten screws to 101 lb-ft (136.94 N•m).**



#### NOTE

Follow-on Maintenance:

- Install fan and belt (TM 10-3930-673-20).
- Install tachometer drive (TM 10-3930-673-20).
- Install engine (Para 3-3).

**END OF TASK**



**b. Installation.**

- (1) **If removed, align baffle (8) on push rod cover (3).**

**WARNING**

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

- (2) **Apply sealant to adhesive side of gasket (7). Install gasket, push rod cover (3), grommet seals (5), and screws (4) on engine block (6).**
- (3) **Install hose (2) and spring clamp (1) on push rod cover (3).**

**NOTE**

Follow-on Maintenance:

- Install fuel injection pump (Para 4-4).
- Install fuel filter assembly (TM 10-3930-673-20).

**END OF TASK**

### 3-23. OIL PAN REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair, Common No. 1 Less Power (Item 16, Appendix D)
- Wrench, Torque, 0 - 200 lb-in (0 - 22.60 N•m) (Item 27, Appendix D)

*Materials/Parts*

- Compound, Sealing (Item 18, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Container, 5 gal (18.93 l) capacity
- Gasket

*Equipment Condition*

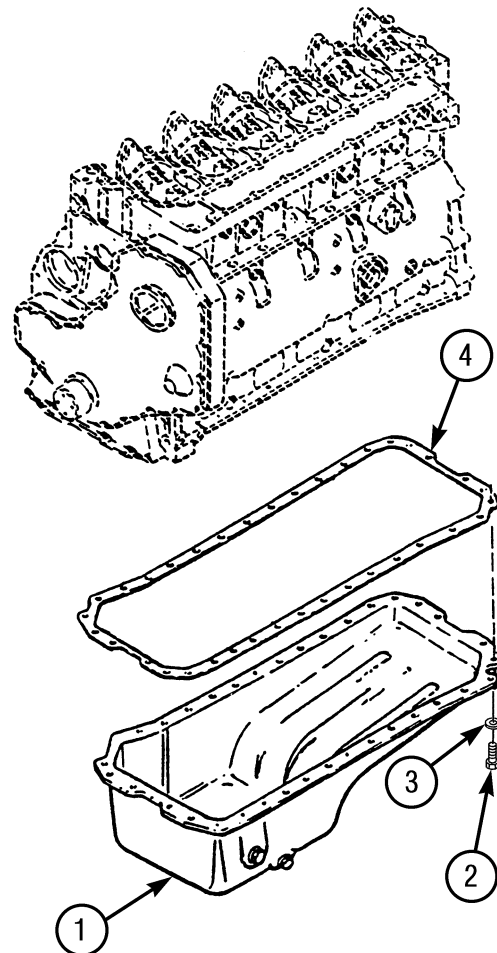
- Engine oil drained (TM 10-3930-673-20)
- Negative battery cable disconnected (TM 10-3930-673-20)

**a. Removal.**

- (1) Place a suitable container under oil pan (1).
- (2) Remove 36 screws (2) and washers (3) from oil pan (1).
- (3) Remove oil pan (1) and gasket (4). Discard gasket.

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).





**d. Installation.****WARNING**

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

- (1) **Coat both sides of gasket (4) with sealant.**

**NOTE**

Install special washers with concave side towards oil pan.

- (2) **Install gasket (4), oil pan (1), 36 washers (3), and screws (2). Tighten screws to 216 lb-in (24.40 N•m).**

**NOTE**

Follow-on Maintenance:

- Fill engine with oil (TM 10-3930-673-20).
- Connect negative battery cable (TM 10-3930-673-20).

**END OF TASK**

### 3-24. ENGINE OIL PUMP INLET TUBE REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

*Materials/Parts*

Rags, Lint-free (Item 34, Appendix B)  
Compound, Sealing (Item 18, Appendix B)  
Gasket  
Gasket  
Container, 5 gal (18.93 l) capacity

*Equipment Condition*

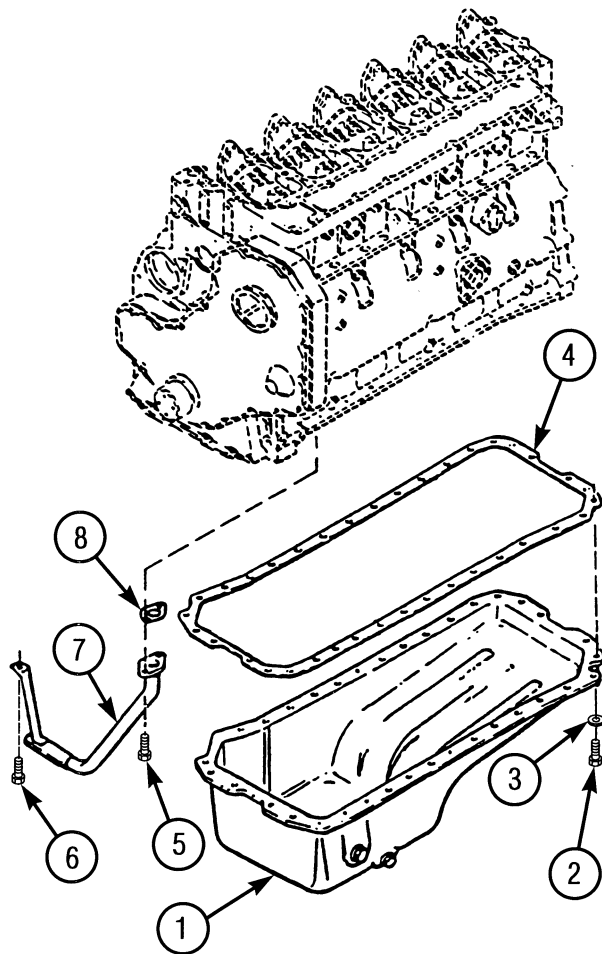
Engine oil drained (TM 10-3930-673-20)  
Negative battery cable disconnected  
(TM 10-3930-673-20)

**a. Removal.**

- (1) Place a suitable container under oil pan (1).
- (2) Remove 36 screws (2) and washers (3) from oil pan (1).
- (3) Remove oil pan (1) and gasket (4). Discard gasket.
- (4) Remove screws (5 and 6) oil pump inlet tube (7) and gasket (8).

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).



**d. Installation.**

- (1) **Install gasket (8) oil pump inlet tube (7) and screws (5 and 6). Tighten screws to 216 lb-in (24.40 N•m).**

**WARNING**

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

- (2) **Coat both sides of gasket (4) with sealant.**

**NOTE**

Install special washers with concave side towards oil pan.

- (3) **Install gasket (4), oil pan (1), 36 washers (3), and screws (2). Tighten screws to 216 lb-in (24.4 N•m).**

**NOTE**

Follow-on Maintenance:

- Fill engine with oil (TM 10-3930-673-20).
- Connect negative battery cable (TM 10-3930-673-20).

**END OF TASK**

### 3-25. ENGINE OIL PUMP REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

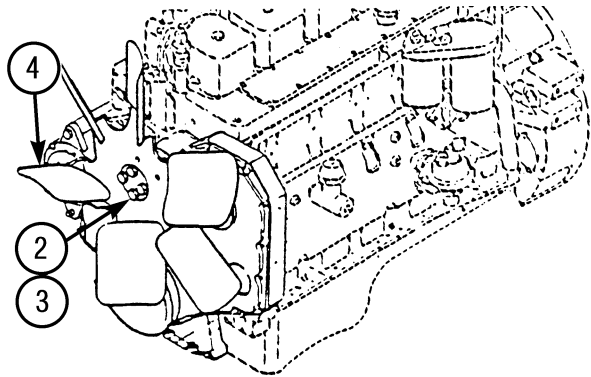
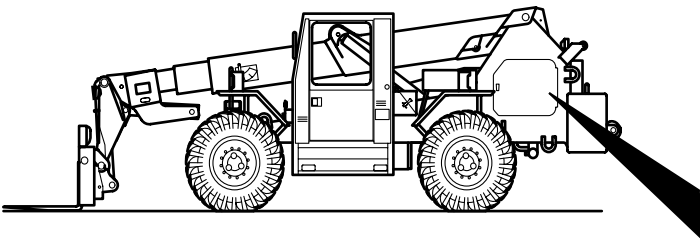
*Equipment Condition*

Engine oil drained (TM 10-3930-673-20)  
Radiator removed (TM 10-3930-673-20)

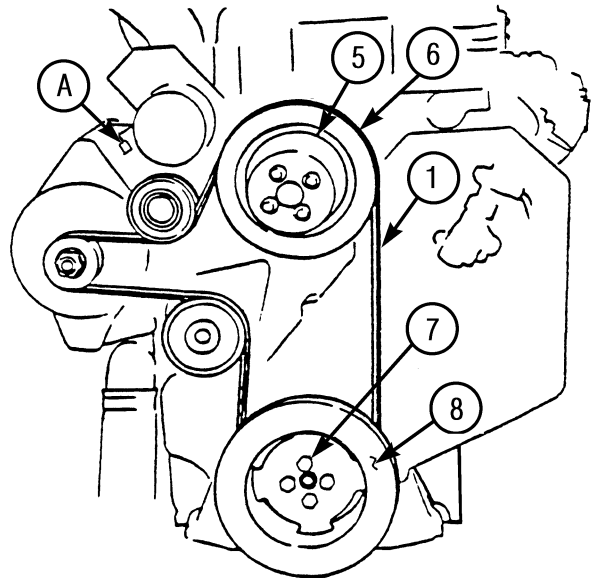
*Materials / Parts*

Oil, Lubricating, Engine (Item 27, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Gasket  
Seal Kit

**a. Removal.**



- (1) Place a 1/2 in. (12.7 mm) socket driver in hole (A) and pull up to release tension on drive belt (1).
- (2) Remove drive belt (1).
- (3) Remove four screws (2), washers (3), cooling fan (4), fan pulley (5), and spacer (6).
- (4) Remove four screws (7) and vibration damper (8).
- (5) Remove tachometer drive (TM 10-3930-673-20).

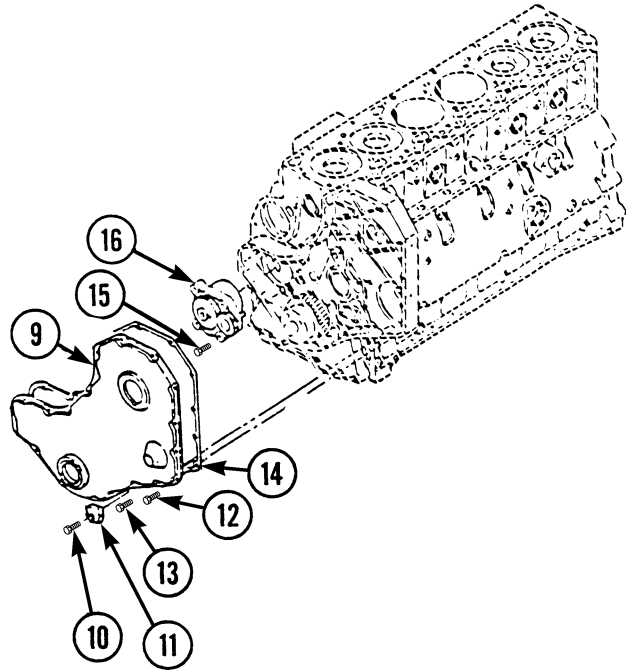


**NOTE**

Screws which retain timing gear cover are of three sizes. Note size and location of screws before removal to allow correct location at assembly.

**(6) Remove gear cover (9).**

- (a) Remove screw (10) and belt guide (11).
- (b) Remove 11 screws (12) and eight screws (13) from gear cover (9).
- (c) Remove gear cover (9) and gasket (14). Discard gasket.

**(7) Remove four screws (15) and oil pump (16).**

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Installation.**

**CAUTION**

When installing oil pump, be sure idler gear pin is installed in the locating bore in the cylinder block. Failure to properly locate oil pump can result in damage to oil pump and to cylinder block bore.

**(1) Using engine lubricating oil lubricate oil pump (16).****NOTE**

- Filling oil pump with oil prior to installation will help to prime oil pump at engine start-up.
  - Back plate on oil pump seats against bottom of cylinder block bore. When oil pump is correctly installed, flange on pump will not touch cylinder block.
- (2) Install oil pump (16) and four screws (15). Tighten screws in opposite pairs to 216 lb-in (24.40 N•m).**

**3-25. ENGINE OIL PUMP REPLACEMENT (CONT)**

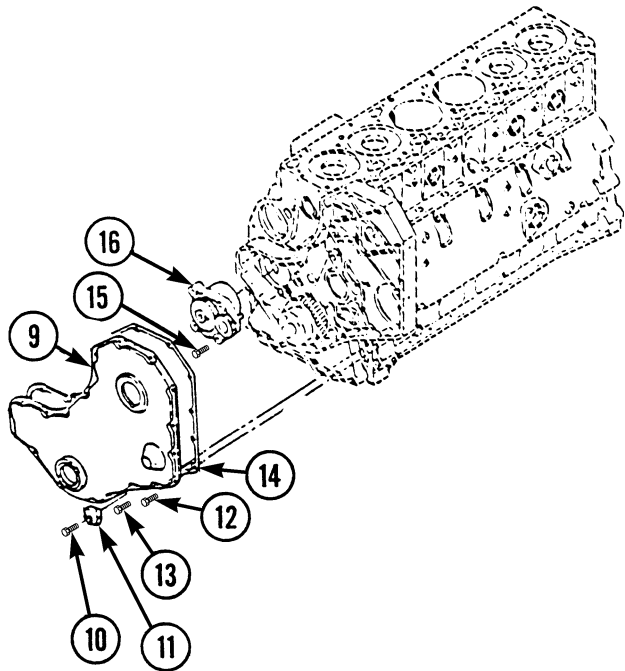
**CAUTION**

Lips of oil seal in gear cover and seal surface on crankshaft end must be clean and free of oil. Failure to properly clean sealing surfaces may cause oil to leak at oil seal.

**(3) Install gear cover (9).**

**CAUTION**

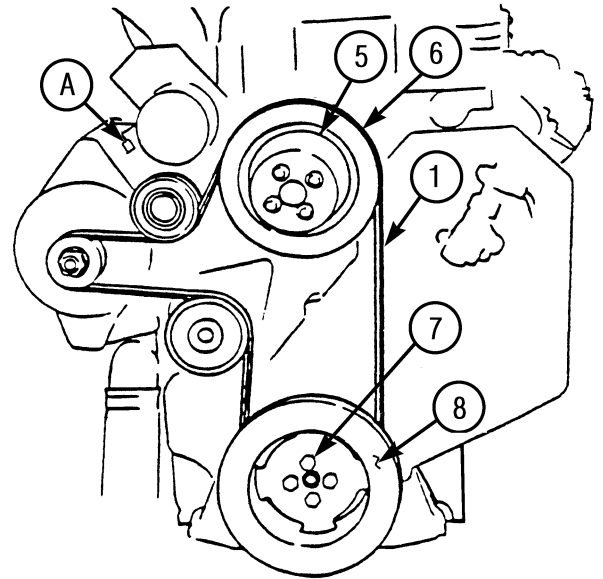
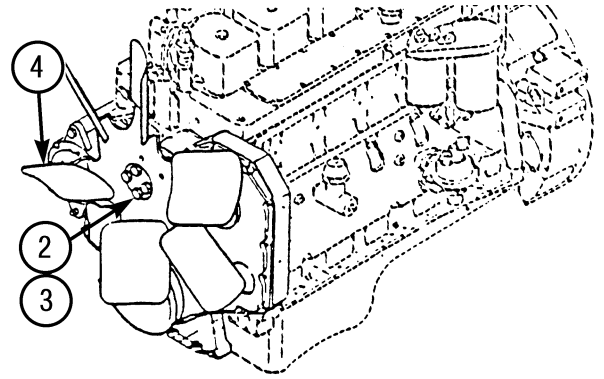
When installing gear cover be careful not to damage lips of oil seal. Failure to protect oil seal lips during installation of oil seal over crankshaft end may damage oil seal lips and cause leakage.



- (a) Install pilot tool from seal kit inside diameter of oil seal to protect oil seal lips during gear cover (9) installation.
- (b) Install gasket (14) and gear cover (9) on engine block.
- (c) Remove pilot tool from seal bore.
- (d) Install eight screws (13) and 11 screws (12) in gear cover (9).
- (e) Tighten screws hand tight.
- (f) Install belt guide (11) and screws (10). Tighten screws (10, 12, and 13) to 216 lb-in (24.40 N•m).

**(4) Install tachometer drive (TM 10-3930-673-20).**

- (5) Install vibration damper (8) and four screws (7). Tighten screws to 101 lb-ft (136.94 N•m).
- (6) Install fan pulley (5), spacer (6), cooling fan (4), four washers (3), and four screws (2).
- (7) Place a 1/2 in. (12.7 mm) socket driver in hole (A) and pull up to allow installation of drive belt (1).
- (8) Install drive belt (1).



### NOTE

Follow-on Maintenance:

- Install radiator (TM 10-3930-673-20).
- Fill engine with oil (TM 10-3930-673-20).

**END OF TASK**

### 3-26. ENGINE OIL COOLER AND FILTER BASE REPLACEMENT

This Task Covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)  
 Mallet (Item 10, Appendix D)  
 Driver

*Materials / Parts*

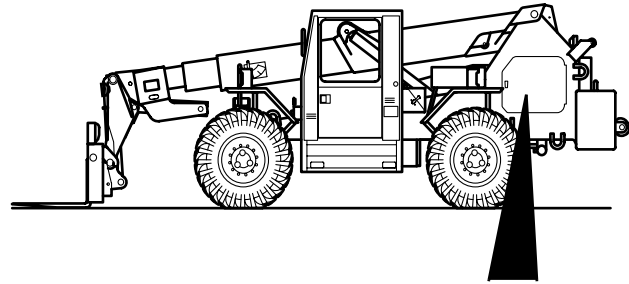
Compound, Sealing (Item 44, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)  
 Tags (Item 55, Appendix B)  
 Gasket  
 Gasket  
 Packing, Preformed

*Equipment Condition*

Engine oil filter removed (TM 10-3930-673-20)  
 Cooling system drained (TM 10-3930-673-20)

**a. Removal.**

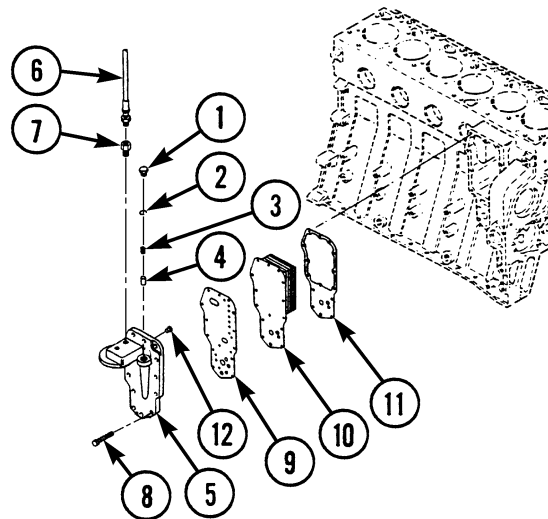
- (1) **If damaged, remove threaded plug (1), preformed packing (2), compression spring (3), and plunger (4) from filter head (5). Discard preformed packing.**



**CAUTION**

Area around turbocharger supply line should be cleaned thoroughly before removal of supply line. Failure to do so could result in contamination of turbocharger lubricant and premature turbocharger failure.

- (2) **Tag, mark, and disconnect turbocharger supply line (6) from adapter (7).**
- (3) **If damaged, remove adapter (7) from filter head (5).**
- (4) **Remove 14 screws (8) from filter head (5).**





(5) Remove filter head (5), gasket (9), cooler core (10), and gasket (11). Discard gaskets.

(6) If damaged, remove bypass valve (12) from filter head (5).

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Installation.**

(1) If removed, install bypass valve (12) in filter head (5) using a mallet and suitable driver.

(2) Install gasket (11), cooler core (10), gasket (9), filter head (5), and 14 screws (8). Tighten screws to 216 in-lb (24.40 N•m).

(3) Connect turbocharger supply line (6) to top of filter head (5).

### WARNING

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

(a) If removed, apply sealing compound to threads of adapter (7). Install adapter (7).

(b) Connect turbocharger supply line (6) to adapter (7).

(4) If removed, install plunger (4), compression spring (3), preformed packing (2), and plug (1) in filter head (5). Tighten plug to 60 lb-ft (81.35 N•m).

### NOTE

Follow-on Maintenance:

- Install oil filter (TM 10-3930-673-20).
- Fill cooling system (TM 10-3930-673-20).

**END OF TASK**



## CHAPTER 4

### FUEL SYSTEM MAINTENANCE

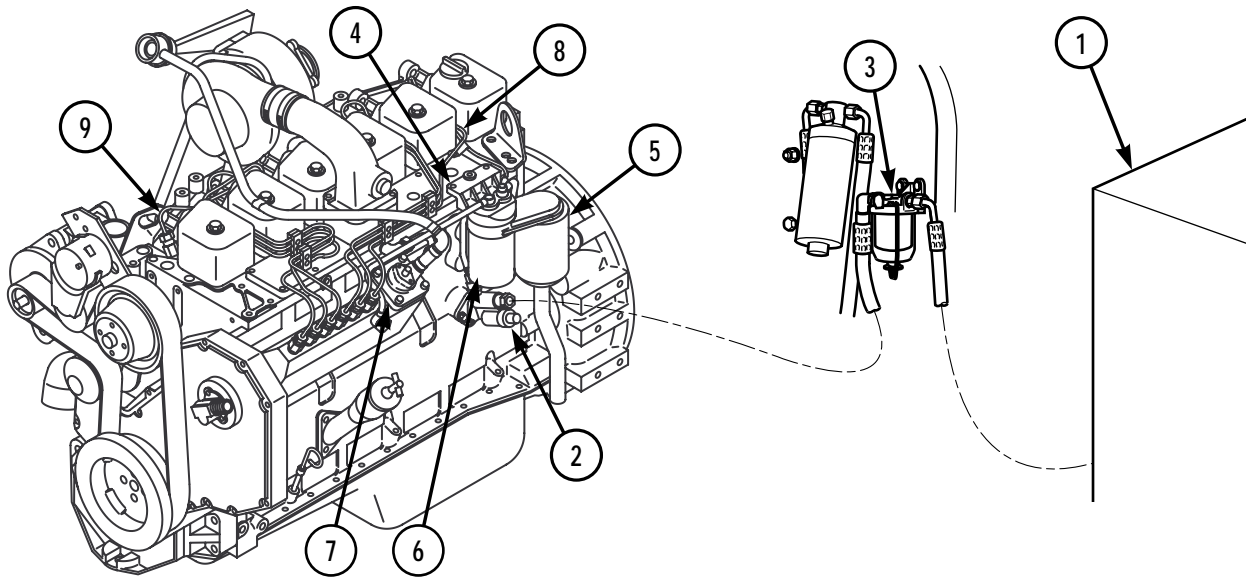
Para	Contents	Page
Section I. Description and Data		
4-1.	General .....	4-2
4-2.	Principles of Operation .....	4-2
Section II. Fuel System Maintenance Procedures		
4-3.	Fuel Injector Test/Replacement .....	4-6
4-4.	Fuel Injection Pump Replacement .....	4-11
4-5.	Fuel Shutoff Solenoid Replacement .....	4-20
4-6.	Turbocharger Assembly Repair .....	4-21
4-7.	Fuel/Hydraulic Oil Tank Replacement/Repair .....	4-33

## Section I. DESCRIPTION AND DATA

## 4-1. GENERAL

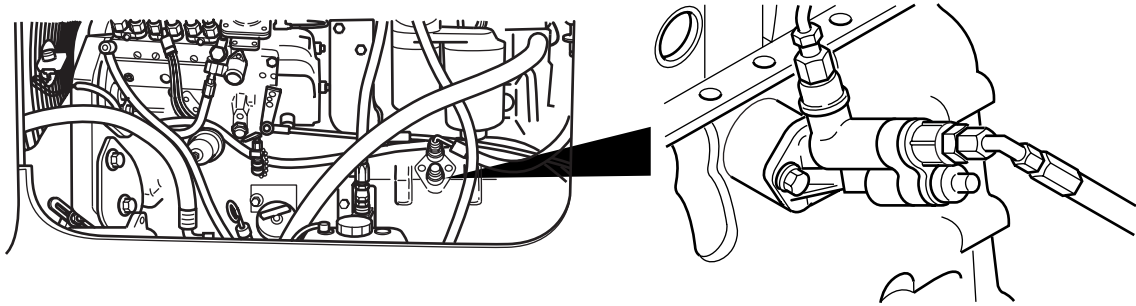
Fuel system maintenance procedures not covered in this section may be found in TM 10-3930-673-20.

## 4-2. PRINCIPLES OF OPERATION

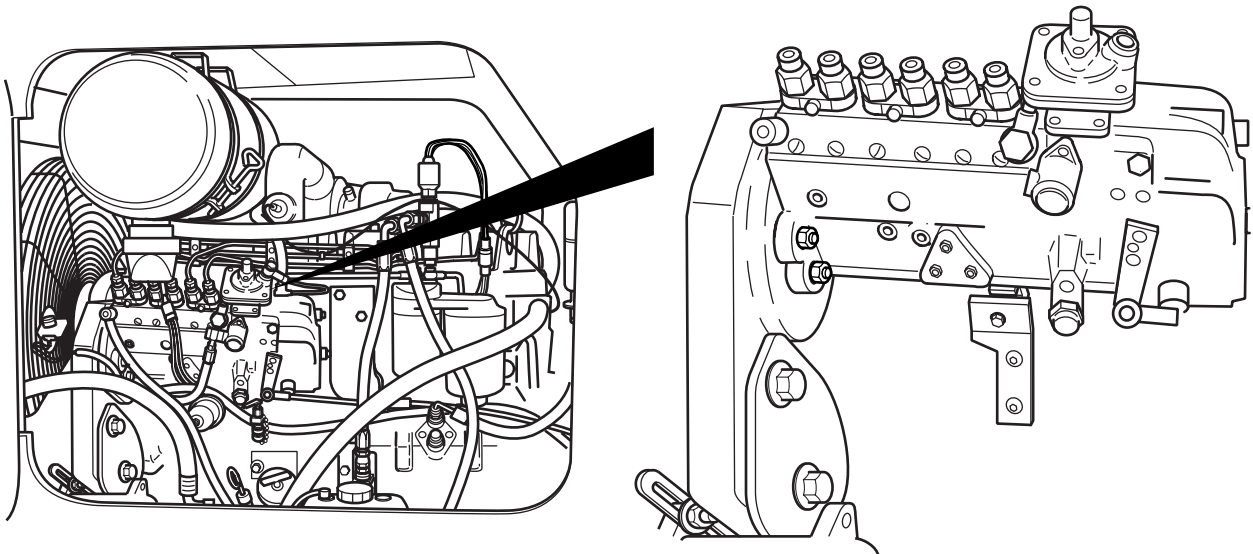


**a. Fuel Flow.** Fuel is pulled from fuel tank (1) by a cam actuated fuel transfer pump (2). The fuel is drawn through a chassis mounted combination filter/separator (3) and into the fuel transfer pump (2) which supplies low-pressure fuel (20-39 psi) to the engine mounted fuel filter head (4). The fuel is pumped through a canister-type combination filter/separator (5) and a canister-type filter (6) and into the fuel injection pump (7). The engine uses a distributor-type fuel pump supplied by Robert Bosch. The distributor pump builds the high injection pressure (3,200 psi) required for combustion, and routes the fuel through individual high-pressure fuel lines (8) to each injector (9).

When the high-pressure fuel reaches the injector, the pressure lifts a needle valve against spring tension in the injector to let the fuel enter the combustion chamber. The fuel injector has very small holes in the tip that change the flow of fuel to a very fine spray that burns easily in the cylinder. Leakage of fuel past the needle valve stem is used for lubrication of the injector. This leakage enters a fuel drain manifold. The fuel drain manifold routes controlled venting (lubrication) from the distributor injector pump and injectors back to the fuel tank.



**b. Fuel Transfer Pump.** The fuel transfer pump is mechanically driven by a lobe on the camshaft. The fuel transfer pump is located on the left side of the engine.

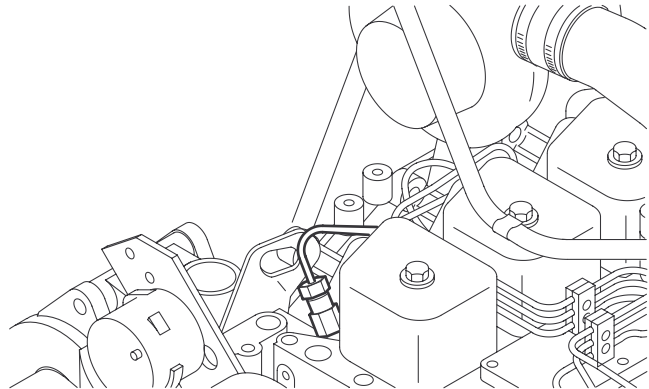


**c. Fuel Injection Pump.** The injection pump is a rotary distributor pump. The pump uses a single rotor to develop and distribute the high pressure required for injection. This pump performs the following functions:

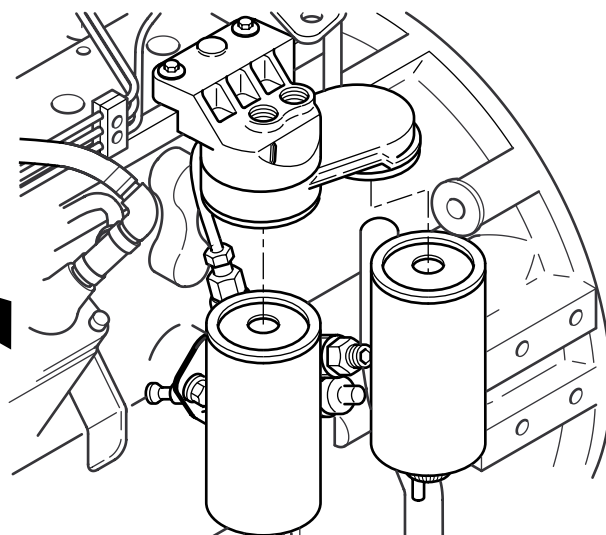
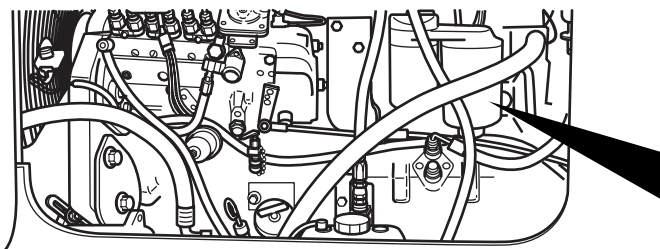
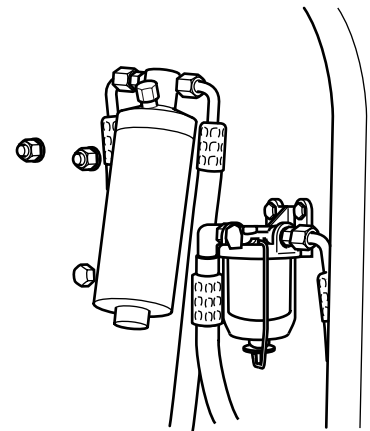
- (1) Produces high fuel pressure required for injection.
- (2) Meters exact amount of fuel for each injection cycle.
- (3) Distributes high pressure metered fuel to each cylinder at the precise time.
- (4) Changes distribution time relative to engine speed.

**4-2. PRINCIPLES OF OPERATION (CONT)**

**d. Fuel Injectors.** The fuel injectors are Robert Bosch, 17 mm closed nozzle, hole-type injectors. During the injection cycle, high pressure from the injection pump rises to operating (pop) pressure which causes the needle valve in the injector to lift. Fuel is then injected into the cylinder. A shimmed spring is used to force the needle valve closed as the injection pressure drops below the pop pressure to seal off the nozzle after injection.



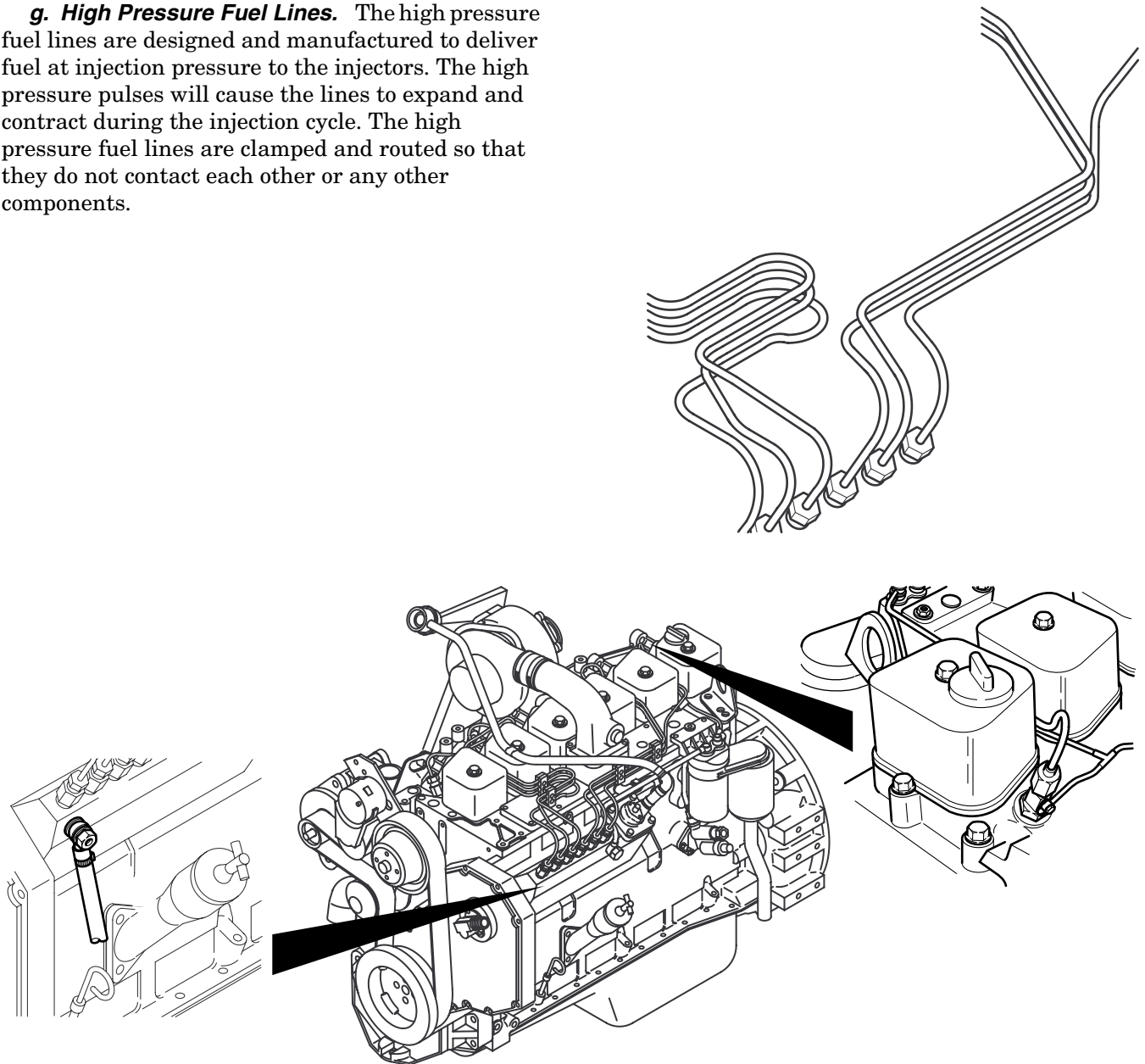
**e. Chassis Mounted Fuel-Water Separator/Filter.** Filtration and separation of water from the fuel is important for trouble free operation and long life of the fuel system. Some of the clearances between the pump parts are very close. For this reason the parts can easily be damaged by rust formation and contaminants. The chassis mounted separator/filter has two filter elements in a single glass bowl through which the fuel must flow before flowing through the outlet. Water and contaminants settle to the bottom of the sediment bowl and are removed by removing the drain plug.



**f. Engine Mounted Fuel-Water Separator Filter Unit.** The engine mounted fuel-water separator/filter unit has two replaceable elements. One element of the filter has a valve which can be opened regularly to drain the

collected water. The dual canister configuration provides additional filtering capacity. The fuel flows through the adaptor to a large combination fuel-water separator/filter and back to the fuel filter for final filtering.

**g. High Pressure Fuel Lines.** The high pressure fuel lines are designed and manufactured to deliver fuel at injection pressure to the injectors. The high pressure pulses will cause the lines to expand and contract during the injection cycle. The high pressure fuel lines are clamped and routed so that they do not contact each other or any other components.



**h. Fuel Drain Manifold.** The fuel system is designed to use fuel to cool and lubricate the injection pump and injectors. Fuel is continually vented from the injection pump and a small amount of fuel leaks by the injector needle valve stem during injection. This fuel is returned to the supply tank by the fuel drain manifold.

## Section II. FUEL SYSTEM MAINTENANCE PROCEDURES

### 4-3. FUEL INJECTOR TEST/REPLACEMENT

This Task Covers:

- |             |               |                 |
|-------------|---------------|-----------------|
| a. Removal  | c. Inspection | e. Installation |
| b. Cleaning | d. Testing    |                 |

#### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m)  
(Item 28, Appendix D)

*Test Equipment*

Test Set, Diesel Injector

*Equipment Condition*

Engine shut off and cooled  
Negative battery cable disconnected  
(TM 10-3930-673-20)

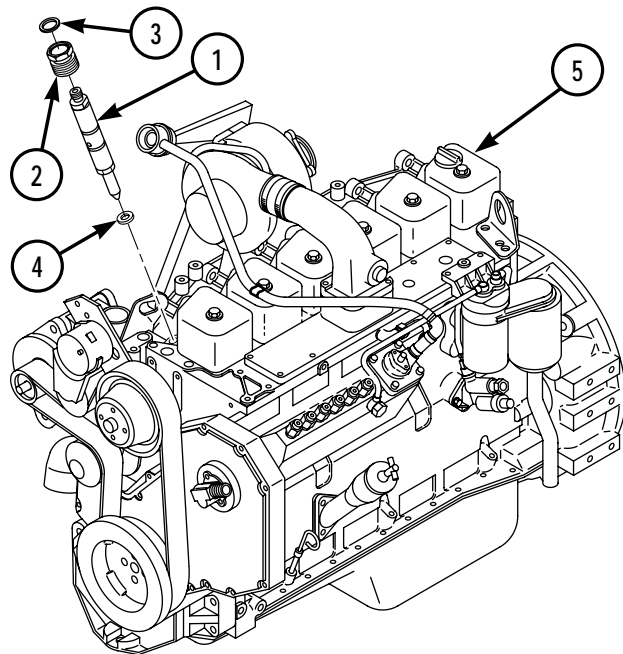
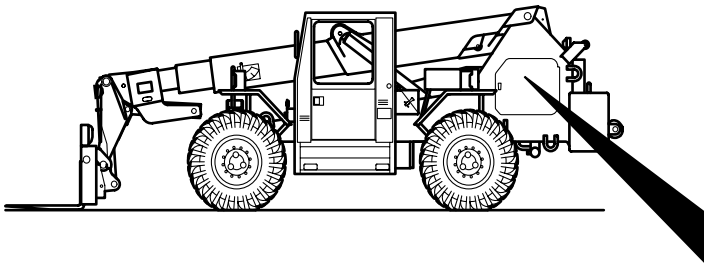
*Equipment Condition (Cont)*

Fuel lines and fuel manifold removed  
(TM 10-3930-673-20)

*Materials/Parts*

Compound, Anti-seize, MIL-T-83483  
(Item 10, Appendix B)  
Oil, Fuel, Diesel (Item 24, Appendix B)  
Solvent, Rust Penetrating  
(Item 53, Appendix B)  
Seals, Copper Injector  
Packing, Preformed

**a. Removal.**





**WARNING**

Fuel is very flammable and can explode easily. To avoid serious injury or death:

- Keep fuel away from open flame or any spark (ignition source).
  - Keep at least a B-C fire extinguisher within easy reach when working with fuel or on a fuel system.
  - Do not work on fuel system when engine is hot; fuel can be ignited by a hot engine.
  - Post signs that read “NO SMOKING WITHIN 50 FEET (15 m)” when working with open fuel, fuel lines or fuel tanks.
  - Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- (1) Clean area of cylinder head around injectors (1) with a soft brush and low pressure compressed air.**

**CAUTION**

If rust has formed on injector hold-down nut, injector can turn in its bore as hold-down nut is loosened. Dissolve and loosen rust as instructed in Step (2). Failure to follow instructions in Step (2) can result in severe damage to cylinder head.

- (2) If necessary, apply rust penetrating solvent to injector hold-down nut (2) and allow solvent to remain for a minimum of three minutes. Then tap against injector body with hammer and drift pin to loosen rust.**
- (3) Hold injector (1) with wrench while turning hold-down nut (2) out of injector bore.**
- (4) Remove injector (1), preformed packing (3), and copper injector seal (4) from engine (5). Discard preformed packing washer and copper injector seal.**

### 4-3. FUEL INJECTOR TEST/REPLACEMENT (CONT)

#### *b. Cleaning.*

- (1) See Cleaning Instructions (Para 2-12).

#### **WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (37.8°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

- (2) Rinse nozzle with drycleaning solvent (Para 2-12).

#### *c. Inspection.*

- (1) See Inspection Instructions (Para 2-14).
- (2) Inspect needle tip for roughness or erosion. Note that rough machined appearance is normal for pressure shoulder (Para 2-14).

#### *d. Testing.*

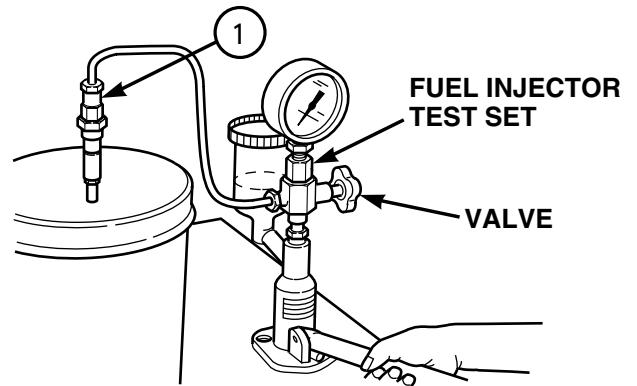
- (1) Opening pressure test.

#### **WARNING**

Fuel is very flammable and can explode easily. To avoid serious injury or death:

- Keep fuel away from open flame or any spark (ignition source).
- Keep at least a B-C fire extinguisher within easy reach when working with fuel or on a fuel system.
- Do not work on fuel system when engine is hot; fuel can be ignited by a hot engine.
- Keep clear of test spray from nozzle. Fluid at test pressures can penetrate skin, causing infection and possible death.

- (a) Connect injector (1) to fuel injector test set.
- (b) Open valve and operate pump lever at a rate of one stroke per second while observing test pressure gauge.
- (c) Spray must begin at a pressure of  $3553 \pm 73$  psi ( $24497.94 \pm 503.34$  kPa).
- (d) Check for well atomized spray pattern.



## (2) Leakage test.

- (a) Use same test setup as for opening pressure test (Step (1) above).
- (b) Open valve on test set.
- (c) Operate pump lever as necessary to hold pressure at a level about 290 psi (1999.55 kPa) below opening pressure noted in Step (1)(c) above.
- (d) No drops must fall from nozzle tip for a period of 10 seconds, while maintaining pressure specified in Step (c), above. If drops do appear within 10 seconds, replace injector.

## (3) Chatter test.

- (a) Use same test setup as for opening pressure test (Step (1) above).

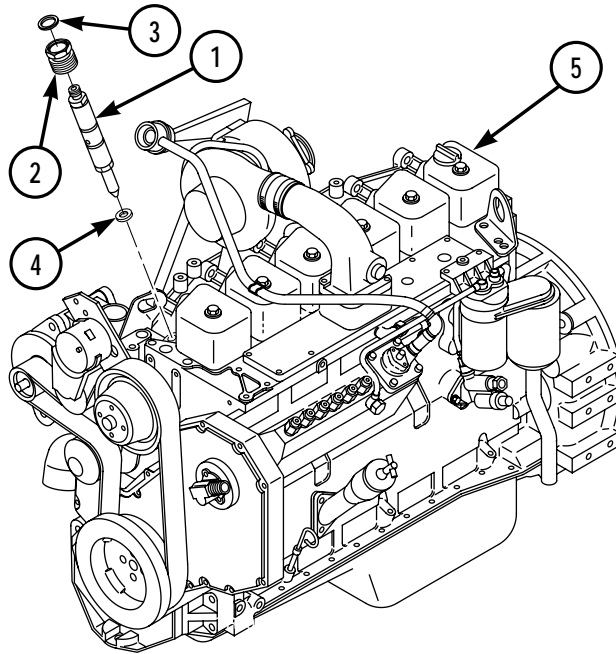
### NOTE

Do not evaluate used nozzles at lower pumping rates. A used nozzle is serviceable if it passes the leakage test, chatters audibly at higher pumping rates and uniformly atomizes fuel.

- (b) Operate pump lever at a rate that causes nozzle to chatter softly while discharging fuel in a broad and finely atomized pattern. If conditions of prior note are not met, replace nozzle.

### 4-3. FUEL INJECTOR TEST/REPLACEMENT (CONT)

*e. Installation.*



**(1) Install fuel injectors (1) in engine (4).**

- (a) Install one copper injector seal (3) on each injector (1) nozzle.
- (b) Install injector (1) using care to align button on injector nozzle holder with notch in cylinder head bore.
- (c) Install injector hold-down nut (2) on injector (1). Tighten nut to 44 lb-ft (59.66 N•m).
- (d) Install preformed packing (3) on fuel injector (1).

#### **NOTE**

Follow-on Maintenance:

- Install fuel lines and fuel manifold (TM 10-3930-673-20).
- Connect negative battery cable (TM 10-3930-673-20).
- Bleed fuel system (TM 10-3930-673-20).

**END OF TASK**

## 4-4. FUEL INJECTION PUMP REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### Tools and Special Tools

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Engine Barring Tool (Item 7, Appendix D)  
 Wrench, Torque, 0-175 lb-ft (Item 28, Appendix D)

#### Equipment Condition

Fuel shut-off solenoid disconnected (TM 10-3930-673-20)  
 Fuel drain tubes disconnected (TM 10-3930-673-20)  
 Fuel supply tubes disconnected (TM 10-3930-673-20)  
 High pressure fuel tubes disconnected (TM 10-3930-673-20)

#### Equipment Condition (Cont)

STE/ICE Pulse tachometer and drive assembly removed (TM 10-3930-673-20)  
 Accelerator cable removed (TM 10-3930-673-20)

#### Personnel Required

Two

#### Materials/Parts

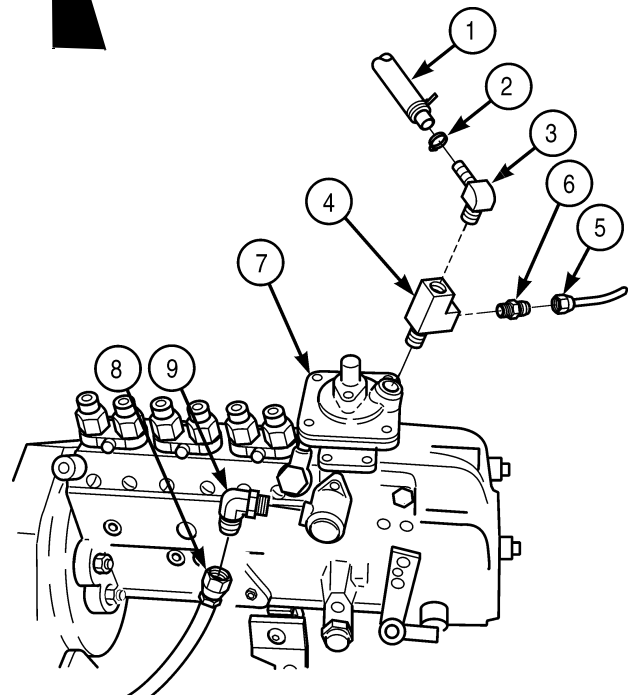
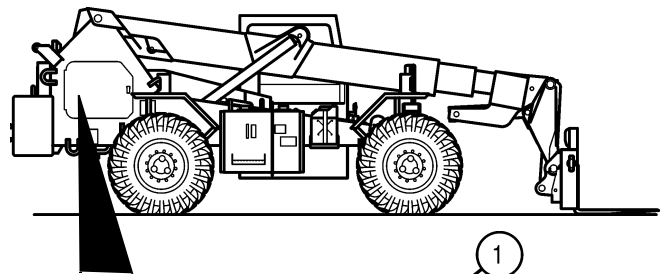
Gasket  
 Lockwasher  
 Preformed Packing  
 Seal

### a. Removal.

#### WARNING

Spilled fuel is slippery and flammable. Clean up and dispose of spilled fuel properly. Failure to follow this warning may cause injury or death.

- (1) Tag and mark hose (1). Loosen hose clamp (2) and disconnect hose from elbow (3). Remove elbow from tee (4).
- (1.1) Tag and mark hose (5). Disconnect hose from adapter (6) and remove adapter from tee (4).
- (1.2) Remove tee (4) from fuel injection pump (7).
- (1.3) Tag and mark hose (8). Disconnect hose from elbow (9) and remove elbow from fuel injection pump (7).



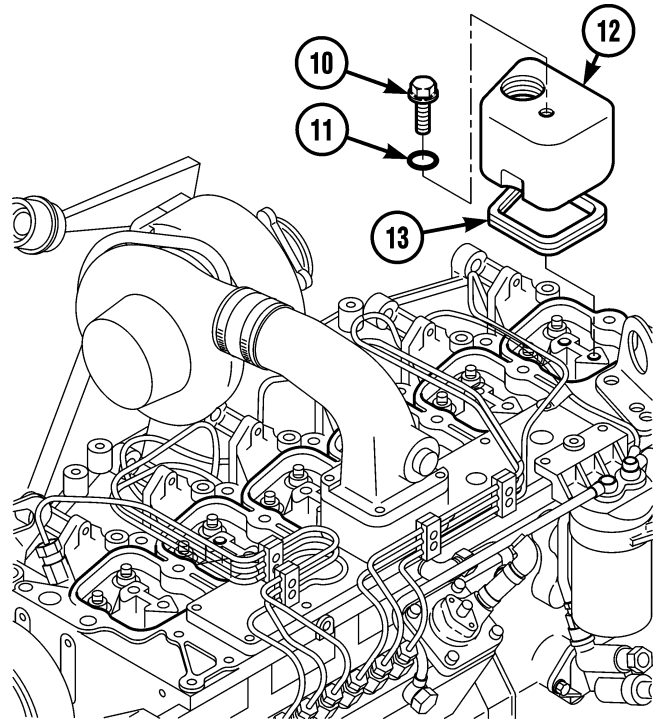
**4-4. FUEL INJECTION PUMP REPLACEMENT (CONT)**

- (2) Locate top dead center for number 1 cylinder.

**NOTE**

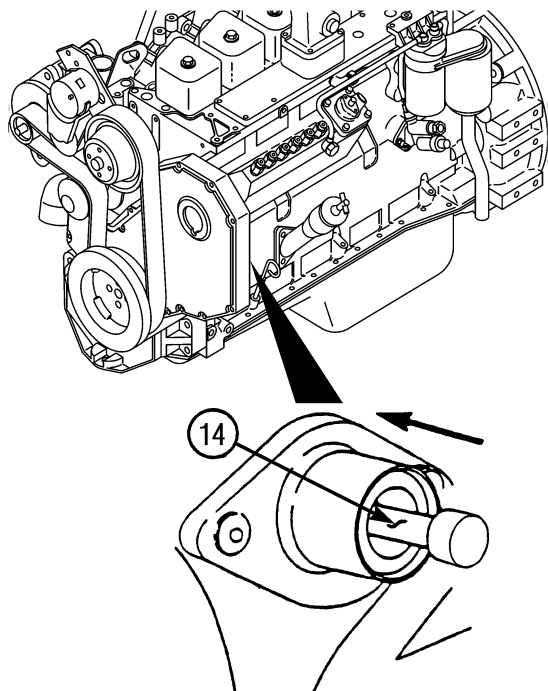
- If engine timing pin is not serviceable, TDC is achieved when exhaust valve stops moving and intake valve is beginning to open.
- Disengage timing pin immediately after locating top dead center.
- Mark flywheel housing and flywheel housing coupling for aid in installation.

- (a) Remove screw (10), preformed packing (11), number 6 cover (12) and gasket (13). Discard preformed packing and gasket.

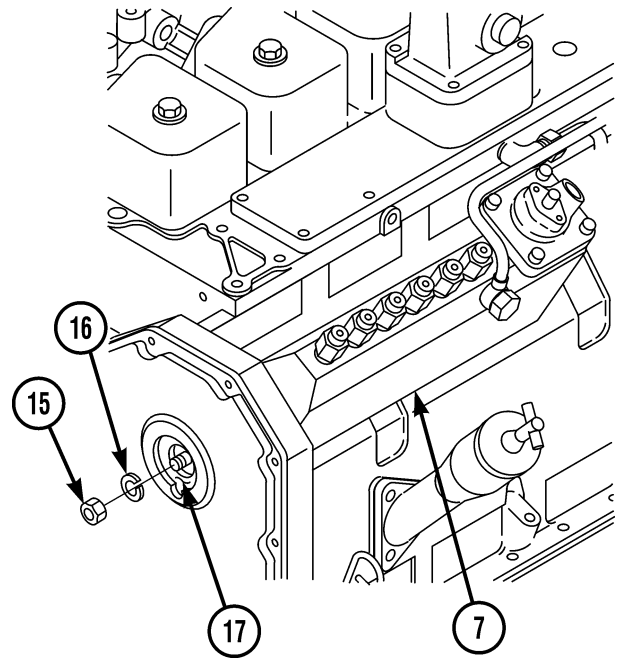


- (b) Rotate engine counterclockwise while observing position of exhaust and intake valves. When exhaust valve is closing, push engine timing pin (14) into hole in the camshaft gear.

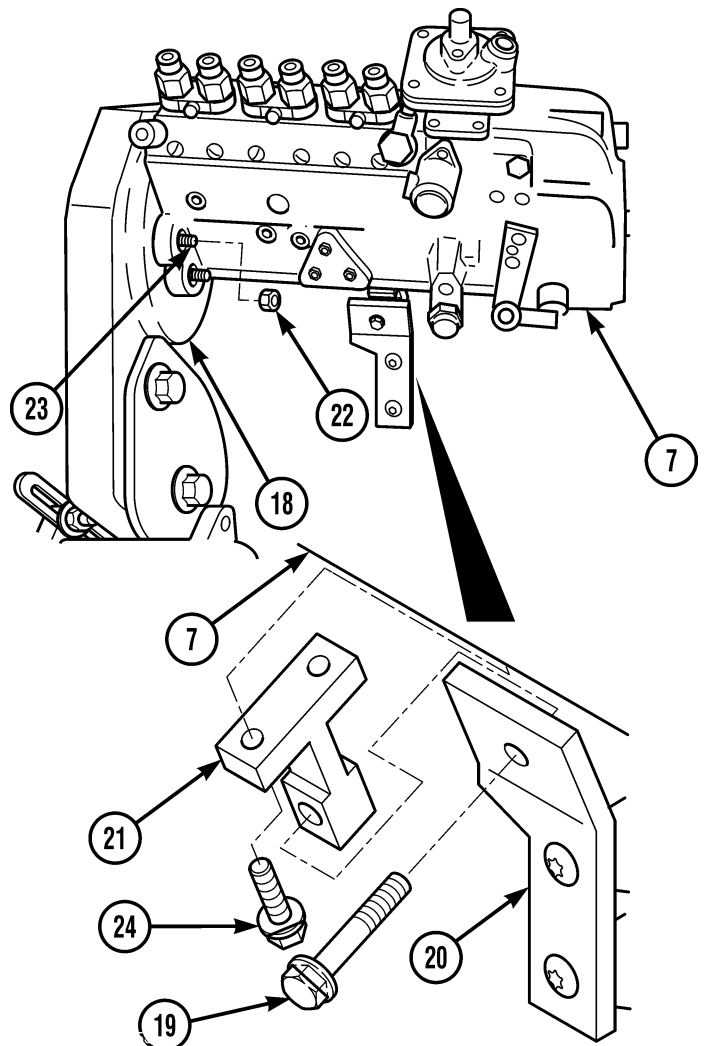
- (c) Mark flywheel housing/flywheel housing coupling for aid in installation.



- (3) Remove nut (15) and lockwasher (16) from fuel injection pump (7) shaft. Discard lockwasher.
- (4) Pull drive gear (17) loose from fuel injection pump (7) shaft.



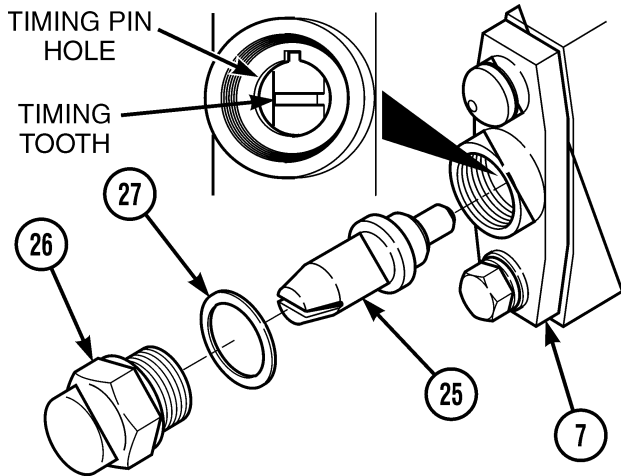
- (5) Mark fuel injection pump (7) and timing gear housing (18) for aid in installation.
- (6) Remove screw (19) from bracket (20) and mounting bracket (21).
- (7) Remove four nuts (22) and fuel injection pump (7) from timing gear housing studs (23).
- (8) Remove two screws (24) and mounting bracket (21) from fuel injection pump (7).



**4-4. FUEL INJECTION PUMP REPLACEMENT (CONT)**

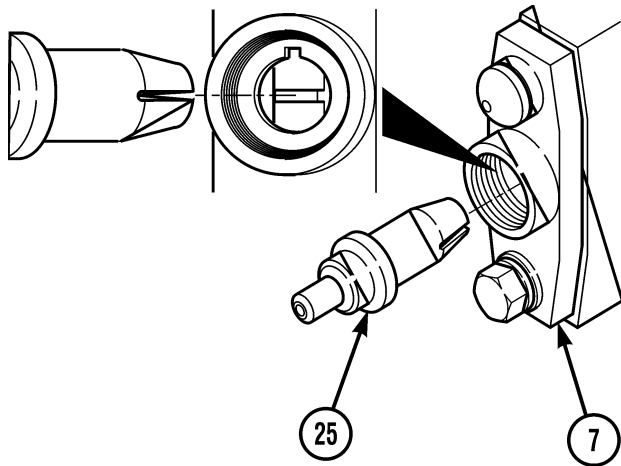
(9) Deleted.

- (a) Remove plug (26), sealing washer (27), and timing pin (25) from fuel injection pump (7). Discard sealing washer.
- (b) If timing tooth is not aligned with timing pin hole, rotate fuel injection pump (7) shaft until timing tooth aligns.



- (c) Reverse position of timing pin (25) so the slot in pin will fit over timing tooth in fuel injection pump (7).

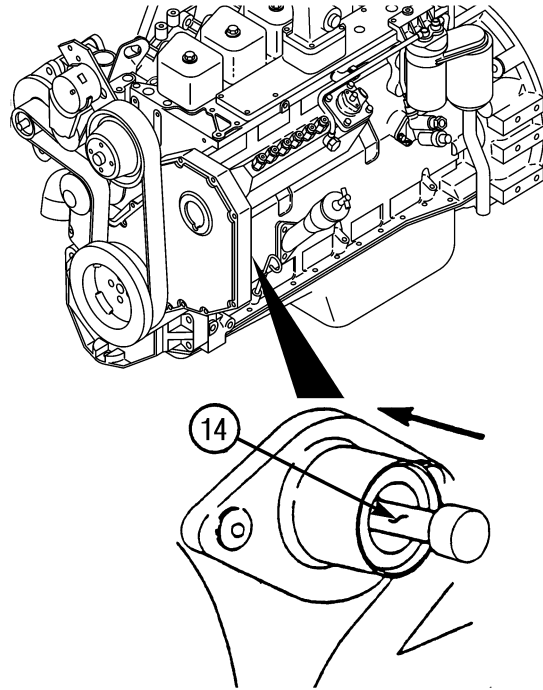
(10) Remove fuel shutoff solenoid (Para 4-5) and bracket, if equipped.



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).



**d. Installation.**

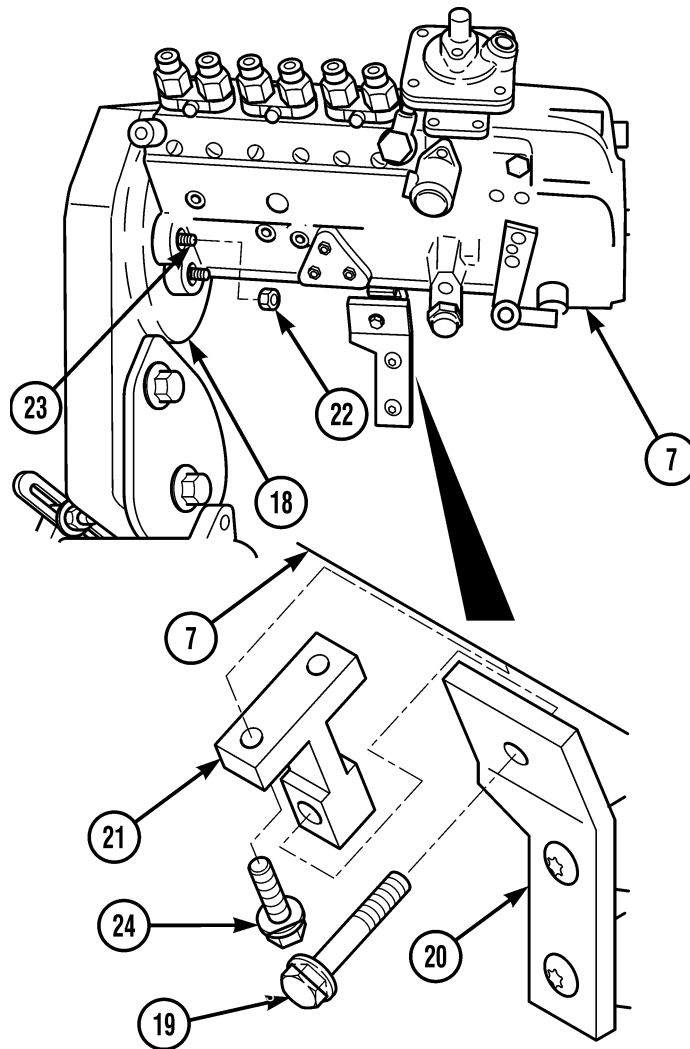
- (1) **Push in engine timing pin (14) to verify top dead center for number 1 cylinder. If necessary, rotate engine counterclockwise at universal joint of transmission input shaft while assistant pushes on engine timing pin.**

**NOTE**

Verify TDC by examining marks on flywheel housing and flywheel housing coupling. If necessary, align marks by turning engine.

- (2) **Install fuel shutoff solenoid (Para 4-5).**

**4-4. FUEL INJECTION PUMP REPLACEMENT (CONT)**

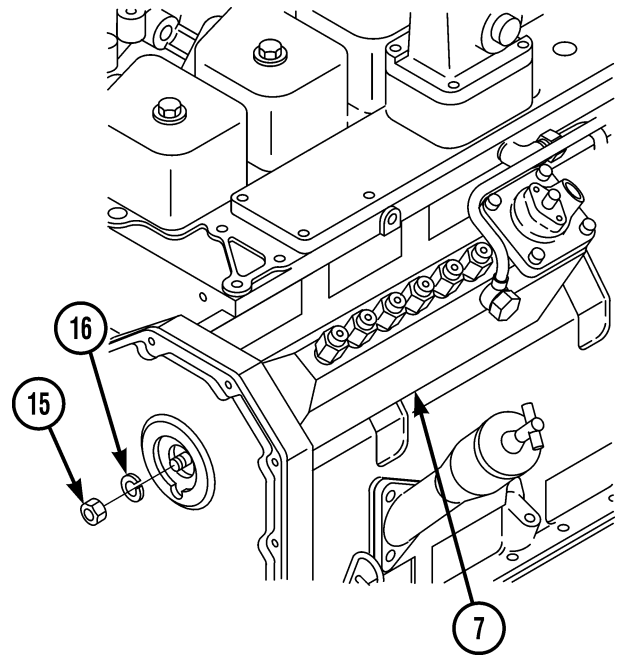


- (3) Install mounting bracket (21) and two screws (24) on fuel injection pump (7).
- (4) Install fuel injection pump (7) and four nuts (22) on timing gear housing studs (23). Tighten nuts to 32 lb-ft (43 N•m).
- (5) Install screw (19) on mounting bracket (21) and bracket (20).

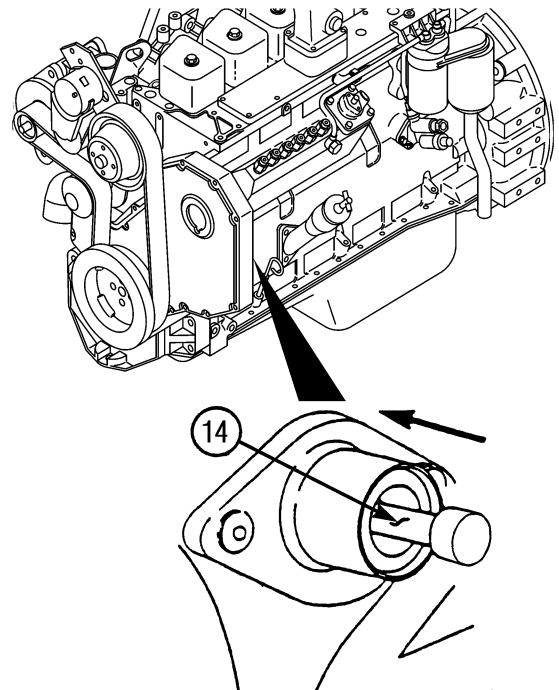
**CAUTION**

To prevent damage to timing pin, do not exceed torque value in Step (6) below.

- (6) Install new lockwasher (16) and nut (15) on fuel injection pump (7) shaft. Tighten nuts to 7 - 15 lb-ft (9.5 - 20.3 N•m).



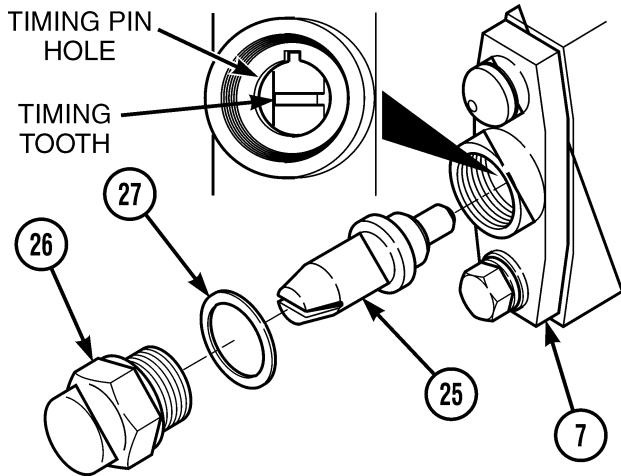
- (7) Disengage engine timing pin (14).



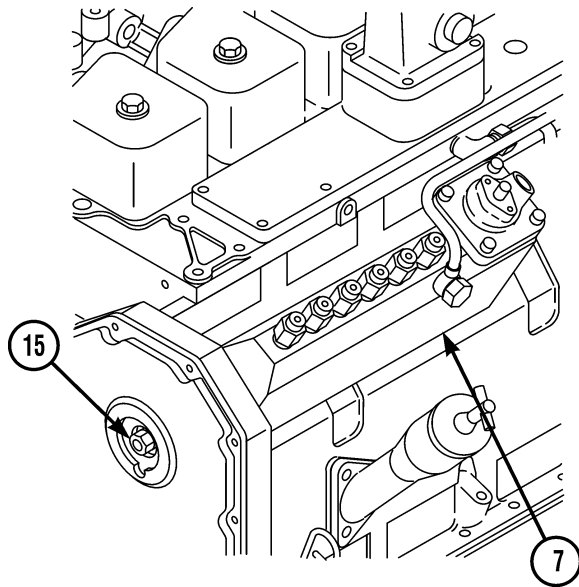
**4-4. FUEL INJECTION PUMP REPLACEMENT (CONT)**

**(8) Reposition timing pin (25) in fuel injection pump (7).**

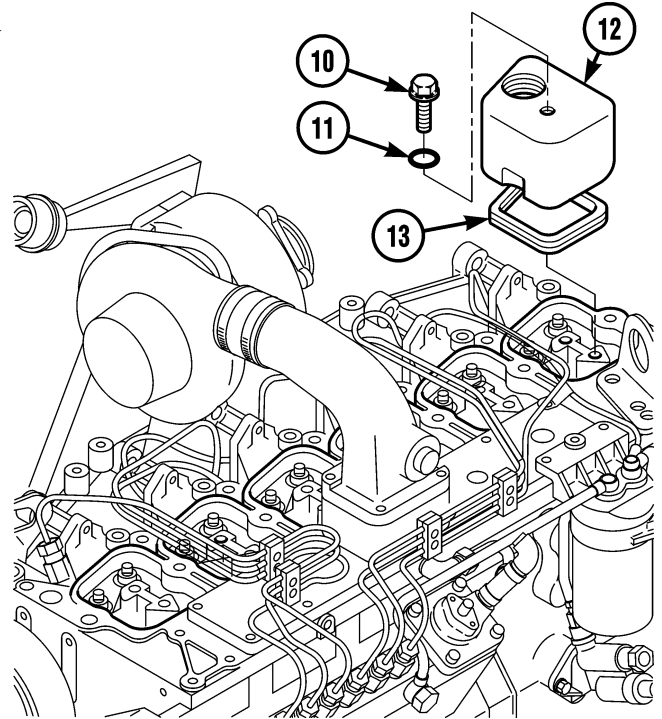
- (a) Remove plug (26), sealing washer (27), and timing pin (25) from fuel injection pump (7). Discard sealing washer.
- (b) Reverse position of timing pin (25) so the slot in pin will fit in the over timing tooth in fuel injection pump (7).
- (c) Install plug (26) and new sealing washer (27).



**(9) Tighten nut (15) to 66 lb-ft (90 N•m).**



- (10) Install new gasket (13), number 6 valve cover (12), new preformed packing (11) and screw (10). Tighten screw to 18 lb-ft (24.4 N•m).

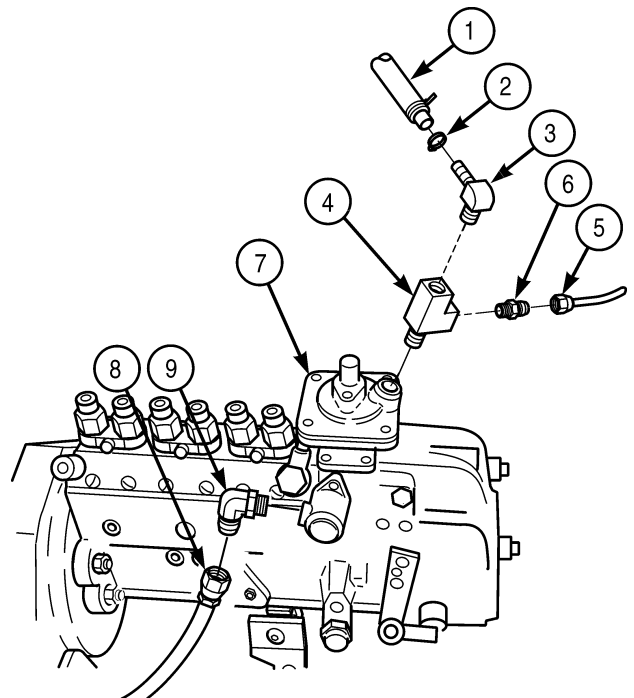


- (11) Install elbow (9) to fuel injection pump (7). Connect hose (8) to elbow.

- (12) Install tee (4) to fuel injection pump (7).

- (13) Install adapter (6) to tee (4). Connect hose (5) to adapter.

- (14) Install elbow (3) to tee (4). Connect hose (1) to elbow and tighten hose clamp (2).



**NOTE**

Follow-on Maintenance:

- Install accelerator cable (TM 10-3930-673-20).
- Install STE/ICE Pulse tachometer and drive assembly (TM 10-3930-673-20).
- Connect high pressure fuel tubes (TM 10-3930-673-20).
- Connect fuel supply tubes (TM 10-3930-673-20).
- Connect fuel drain tubes (TM 10-3930-673-20).
- Connect fuel shutoff solenoid (TM 10-3930-673-20).

**END OF TASK**



**4-5. FUEL SHUTOFF SOLENOID REPLACEMENT (CONT)**

**NOTE**

Perform step 5 if vehicle is equipped with new fuel shutoff solenoid.

- (5) Remove two screws (11) and fuel shutoff solenoid (4) from side of fuel injection pump (9) and threaded stud (8).

**b. Installation.**

**NOTE**

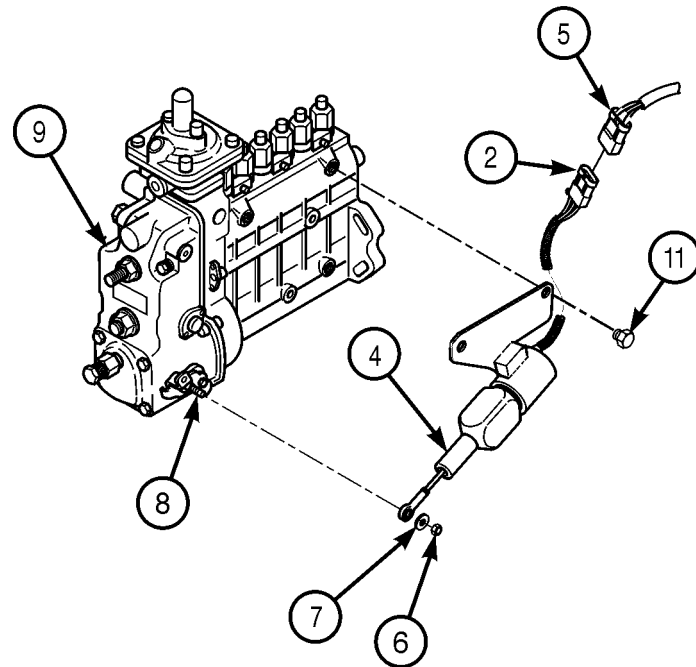
Perform steps 1, 4 and 5 to install new fuel shutoff solenoid to vehicle.

- (1) Install fuel shutoff solenoid (4) to side of fuel injection pump (9) and threaded stud (8) with two screws (11).

**NOTE**

Perform steps 2 and 3 to install original fuel shutoff solenoid which includes a separate bracket.

- (2) Install bracket (12) to side of fuel injection pump (9) with three screws (11).
- (3) Install fuel shutoff solenoid (3) to bracket (12) and threaded stud (8) with two screws (10).
- (4) Install washer (7), if equipped, and new locknut (6) to threaded stud (8).
- (5) Connect connector (1 or 2) of fuel shutoff solenoid (3 or 4) to connector (5) of engine wiring harness.



NEW SOLENOID  
(WITHOUT BRACKET)

**END OF TASK**





## 4-6. TURBOCHARGER ASSEMBLY REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Dial Indicator (Item 3, Appendix D)

#### *Equipment Condition*

Turbocharger removed (TM 10-3930-673-20)

#### *Materials/Parts*

Engine Lubricating Oil (Item 27, Appendix B)  
Locknuts (2)  
Locknut  
Retaining Ring  
Retaining Ring  
Retaining Ring  
Retaining Rings (2)  
Retaining Rings (2)  
Seal Ring  
Seal Ring

### a. Disassembly.

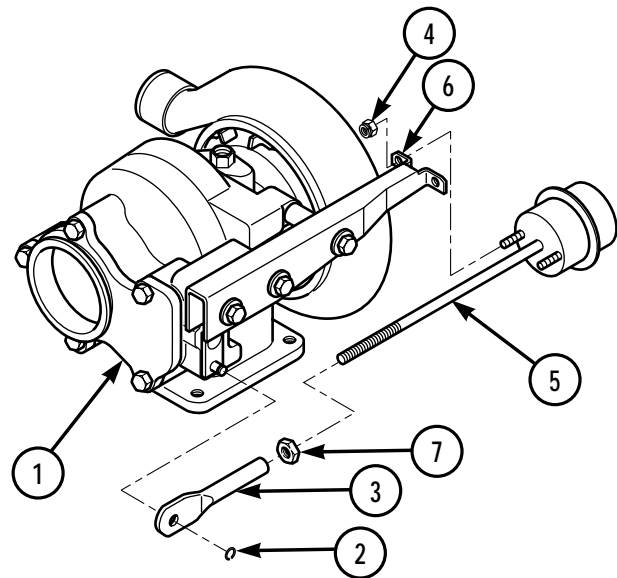
- (1) Place turbocharger in a vise with soft jaws and clamp by the turbine housing (1) inlet flange.

### NOTE

Note position and length of control rod from boost capsule actuator for aid in installation.

### WARNING

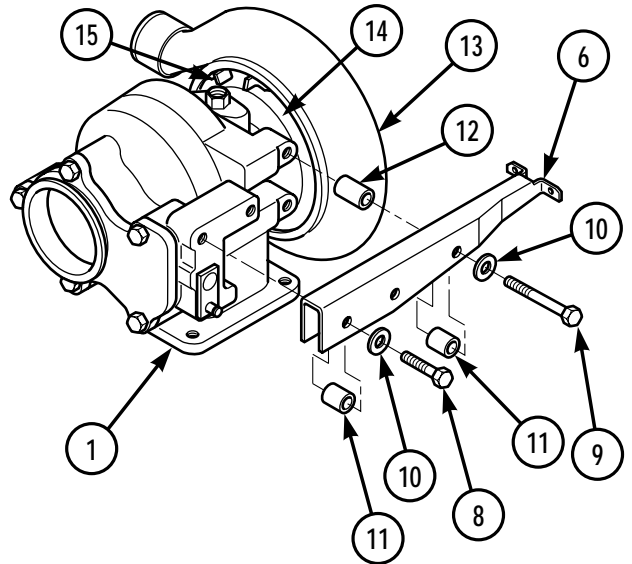
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.



- (2) Remove retaining ring (2) from turbine housing (1) control lever.
- (3) Remove adjusting link (3) from turbine housing (1) control lever.
- (4) Remove two locknuts (4), boost capsule actuator (5), and adjusting link (3) from bracket (6). Discard locknuts.
- (5) Loosen nut (7). Remove adjusting link (3) and nut from boost capsule actuator (5).

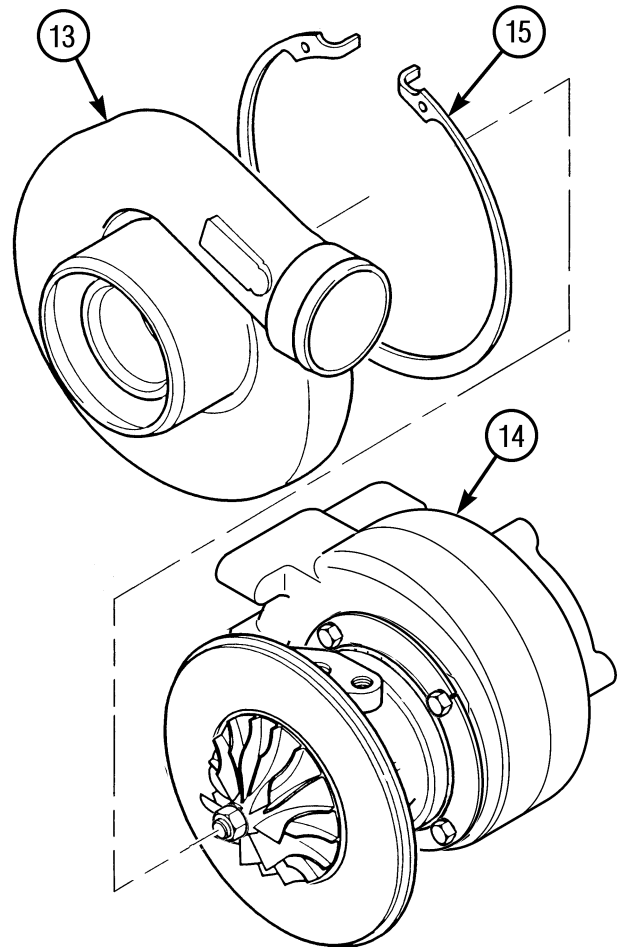
**4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)**

- (6) Remove three screws (8 and 9), washers (10), spacers (11), one spacer (12), and bracket (6) from turbine housing (1).
- (7) Mark compressor housing (13), turbine housing (1), bearing housing (14), and retaining ring (15) for aid in assembly.

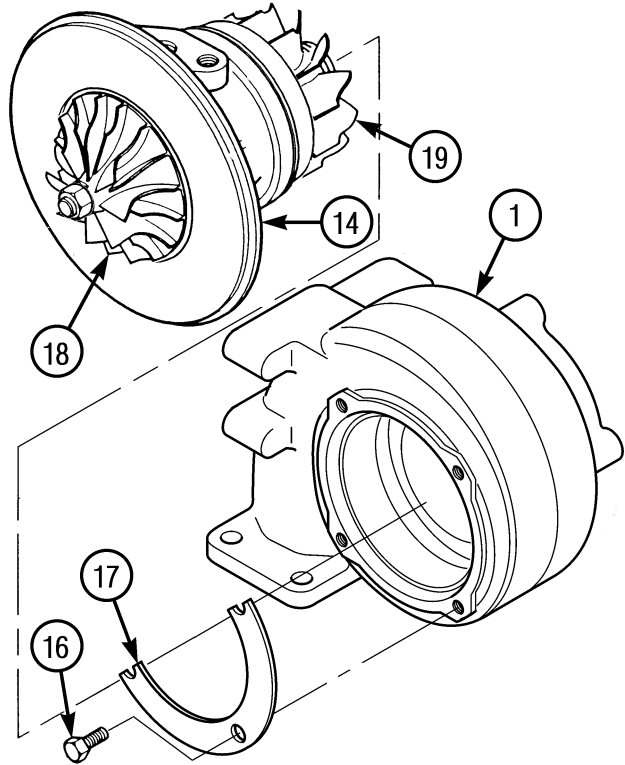
**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (8) Remove retaining ring (15) from compressor housing (13) and bearing housing (14).
- (9) Remove compressor housing (13) from bearing housing (14).



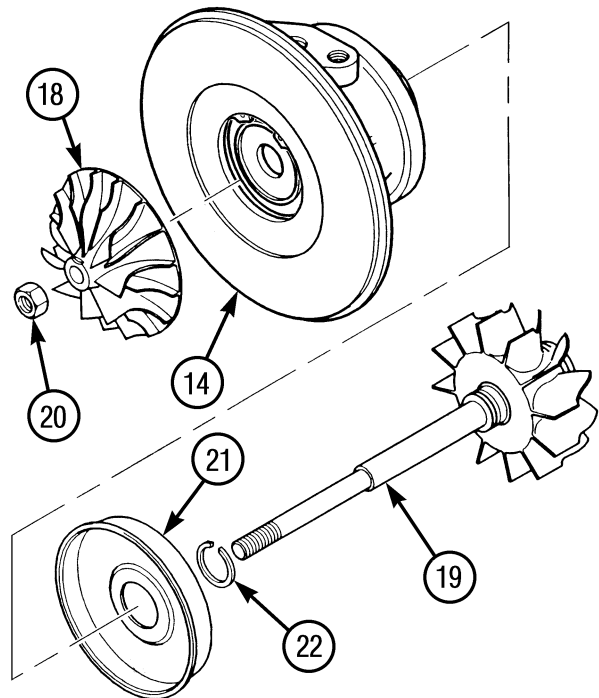
- (10) Remove four screws (16) and two clamp plates (17) from turbine housing (1).
- (11) Remove impeller (18), bearing housing (14), and shaft and wheel (19) as an assembly from turbine housing (1).
- (12) Place bearing housing (14) in a vise with soft jaws.



**NOTE**

Threads on locknut are left handed.  
Turn locknut clockwise to remove.

- (13) Remove locknut (20) and impeller (18) from shaft and wheel (19). Discard locknut.
- (14) Remove shaft and wheel (19) and heat shield (21) from heat shield (21) from bearing housing (14).
- (15) Remove seal ring (22) from shaft and wheel (19). Discard seal ring.

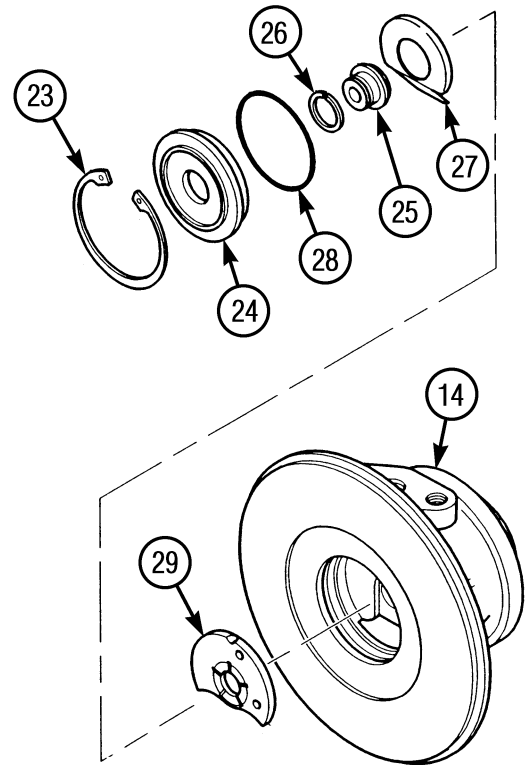


**4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

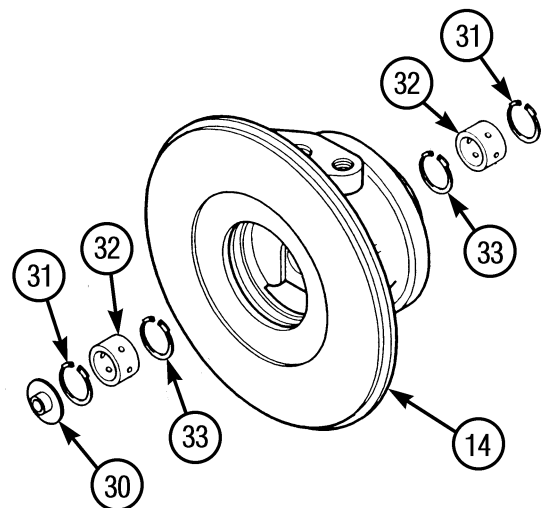
- (16) **Remove retaining ring (23) from bearing housing (14).**
- (17) **Using two flat nose pliers remove oil seal plate (24) from bearing housing (14).**
- (18) **Remove oil slinger (25) and seal ring (26) from oil seal plate (24). Discard seal ring.**
- (19) **Remove oil baffle (27) from oil seal plate (24).**
- (20) **Remove and discard preformed packing (28) from bearing housing (14).**
- (21) **Remove thrust bearing (29) from bearing housing (14).**
- (22) **Remove thrust collar (30) from bearing housing (14).**



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (23) **Remove two outer retaining rings (31) from bore of bearing housing (14). Discard retaining rings.**
- (24) **Remove two bearings (32) from bearing housing (14). Discard bearings.**



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

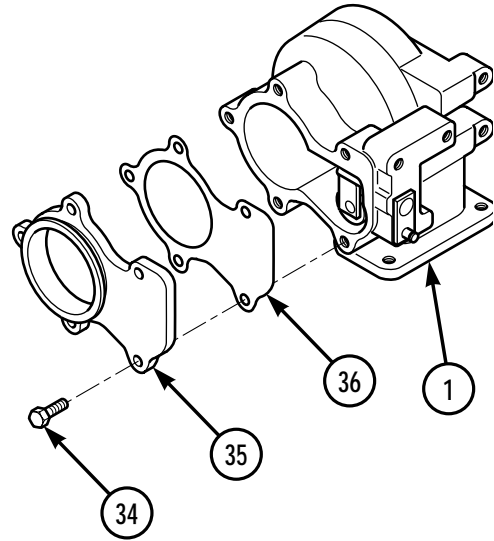
- (25) Remove two inner retaining rings (33) from bore of bearing housing (14). Discard retaining rings.
- (26) If damaged, remove five screws (34), adapter (35), and gasket (36) from turbine housing (1).

**b. Cleaning.**

**CAUTION**

Do not use a wire brush on the compressor wheel. Use of a wire brush on compressor wheel may cause premature component failure.

- (1) Use a scraper and medium grit emery cloth to remove carbon buildup from turbine housing (1).
- (2) For general cleaning instructions, see **Cleaning Instructions**, (Para 2-12).



**c. Inspection.**

- (1) Measure shaft and wheel (19) bearing diameter. Shaft bearing surface minimum diameter is 0.432 in. (10.972 mm).
- (2) Measure bearing housing (14) bore diameter. Bearing housing bore minimum diameter is 0.6254 in. (15.885 mm).
- (3) For general inspection instructions, see **Inspection Instructions**, (Para 2-14).

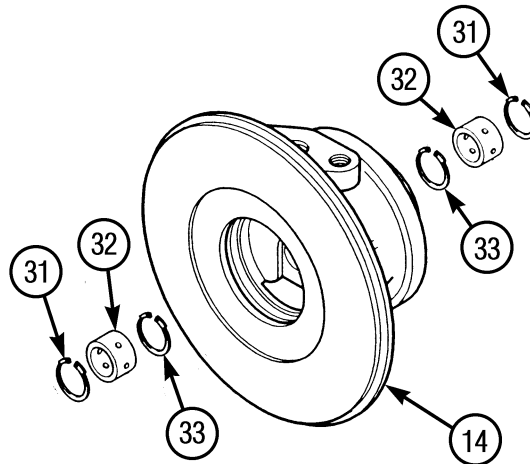
**d. Assembly.**

**NOTE**

Balance marks on shaft and wheel, impeller, thrust collar and oil slinger must be aligned to make sure rotating parts of turbocharger are properly balanced.

- (1) If removed, install gasket (36), adapter (35), and five screws (34) on turbine housing (1).

## 4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)



### WARNING

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

### NOTE

Beveled face of retaining rings must face bearings.

- (2) **Install two inner retaining rings (33) in bearing housing (14) bore.**
- (3) **Apply engine oil to two bearings (32).**
- (4) **Install new bearings (32) in bearing housing (14).**

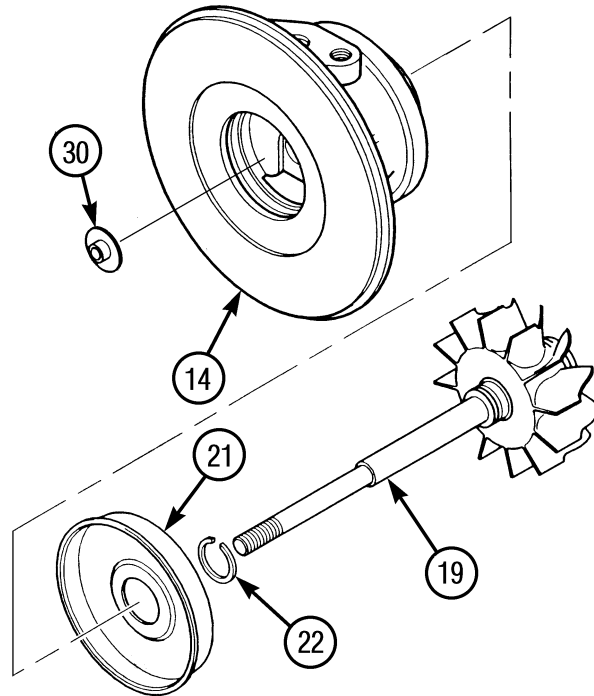
### WARNING

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

### NOTE

Beveled face of retaining rings must face bearings.

- (5) **Install two outer retaining rings (31) in bearing housing (14).**



- (6) **Position heat shield (21) on bearing housing (14).**
- (7) **Install seal ring (22) on shaft and wheel (19).**

**CAUTION**

Ensure that seal ring gap is positioned 180° from bearing housing drain hole to prevent damage to turbocharger assembly.

- (8) **Install shaft and wheel (19) and seal ring (22) as an assembly in bearing housing (14).**
- (9) **Apply engine oil on shaft and wheel (19) shaft.**
- (10) **Support shaft and wheel (19) and bearing housing (14) in a suitable fixture.**

**CAUTION**

When installing thrust collar ensure balance mark on collar is aligned with shaft and wheel shaft balance mark. Mark top surface of thrust collar so alignment can be verified after installing thrust bearing . Failure to align balance marks could cause premature component failure.

- (11) **Install thrust collar (30) on shaft and wheel (19).**

**4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)**

- (12) Apply engine oil to thrust bearing (29).
- (13) Install thrust bearing (29) in bearing housing (14).
- (14) Install seal ring (26) on oil slinger (25).
- (15) Apply engine oil to oil slinger (25).
- (16) Install oil slinger (25) in oil seal plate (24).
- (17) Install oil baffle (27) in oil seal plate (24).
- (18) Install preformed packing (28) on oil seal plate (24).

**CAUTION**

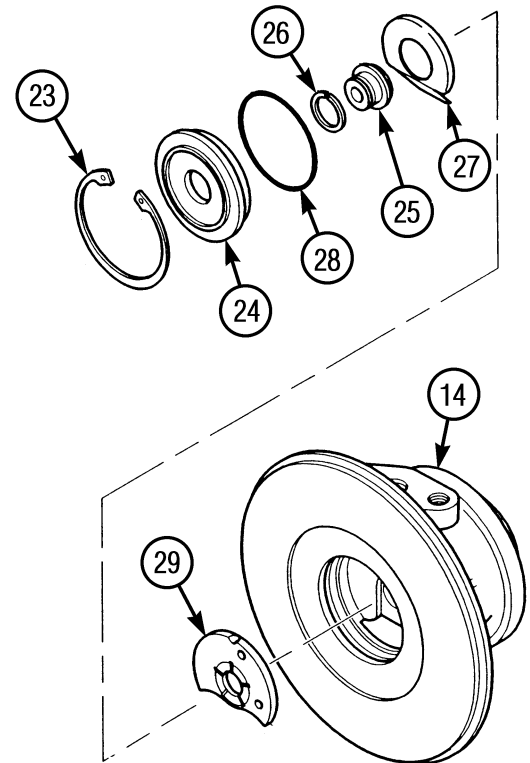
When installing oil slinger ensure balance mark on collar is aligned with shaft and wheel balance mark. Failure to align balance marks could cause premature component failure.

- (19) Install oil seal plate (24) in bearing housing (14).

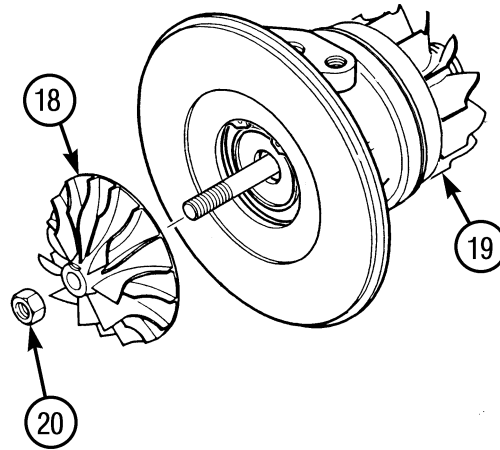
**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (20) Install retaining ring (23) in bearing housing (14).







**CAUTION**

- When installing impeller ensure balance marks on shaft and wheel and impeller. Failure to do so could cause premature component failure.
- Do not move bearing housing when installing impeller. Moving bearing housing during impeller installation will cause improper balance and premature component failure.

**(21) Install impeller (18) on shaft and wheel (19).**

**CAUTION**

Do not allow impeller to turn when installing locknut. Failure to prevent impeller from turning will result in improper balance and premature component failure.

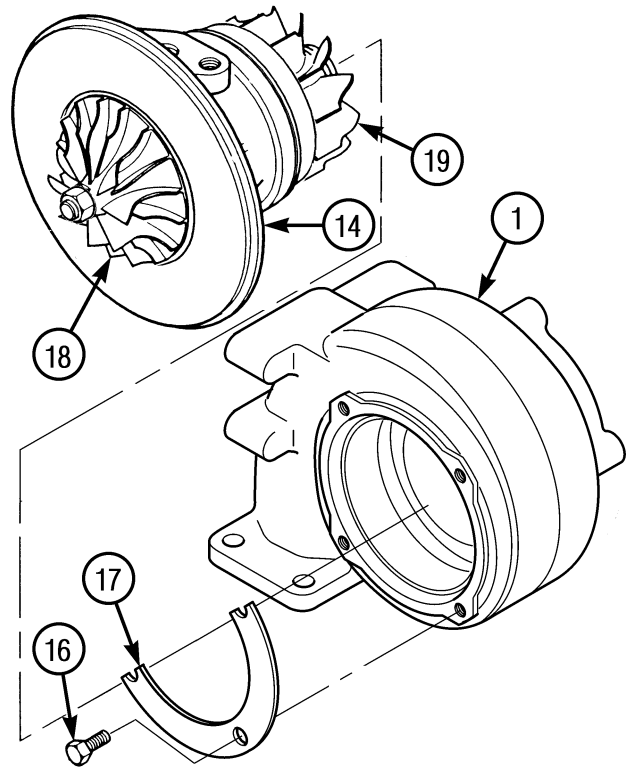
**NOTE**

Locknut has left-hand threads, be sure to turn locknut counterclockwise when installing.

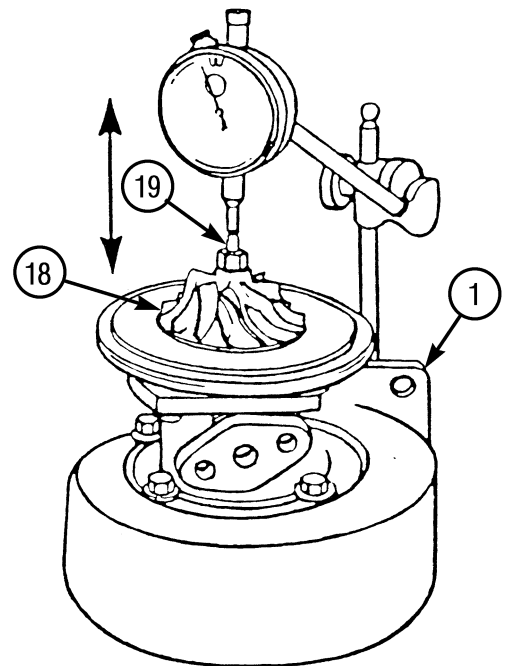
**(22) Install locknut (20) on shaft and wheel (19). Tighten locknut to 150 lb-in (17 N•m).**

#### 4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)

- (23) Install impeller (18), bearing housing (14), and shaft and wheel (19) into turbine housing (1) as an assembly.
- (24) Align match marks on bearing housing (14) and turbine housing (1) that were made at disassembly.
- (25) Install two clamp plates (17) and four screws (16) on turbine housing (1). Tighten bolts to 120 lb-in (14 N•m).

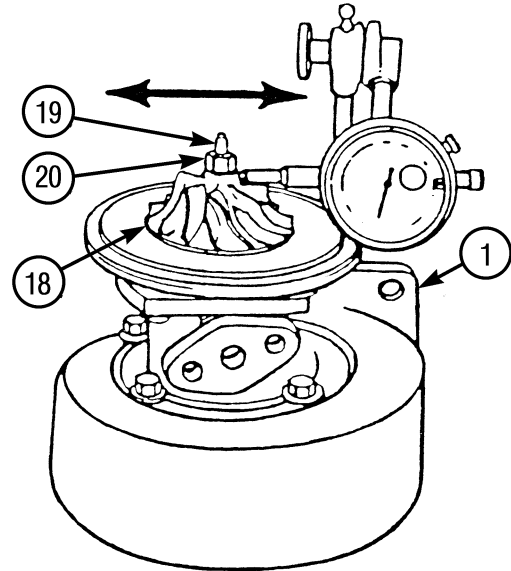


- (26) Measure shaft and wheel (19) end play.
  - (a) Attach a dial indicator to the turbine housing (1). Adjust dial indicator so that plunger is against shaft and wheel (19) end.
  - (b) Set dial indicator to zero.
  - (c) Move shaft and wheel (19) and impeller (18) assembly back and forth and read end play on dial indicator. If end play is less than 0.0015 in. (0.038 mm), or greater than 0.0037 in. (0.093 mm), disassemble turbocharger, Steps (8) through (25), and check for problem. Replace defective parts and assemble, Steps (2) through (26).



**(27) Measure radial clearance of shaft and wheel (19).**

- (a) Attach a dial indicator to turbine housing (1). Adjust dial indicator plunger so that plunger is against end of impeller (18) between fins and nut (20).
- (b) Set dial indicator to zero.
- (c) Move end of impeller (18) left and right and read radial clearance on dial indicator. If radial clearance is less than 0.0128 in. (0.326 mm) or greater than 0.018 in. (0.496 mm), disassemble turbocharger, Steps (8) through (25), and check for problem. Replace defective parts and assemble, Steps (2) through (27).

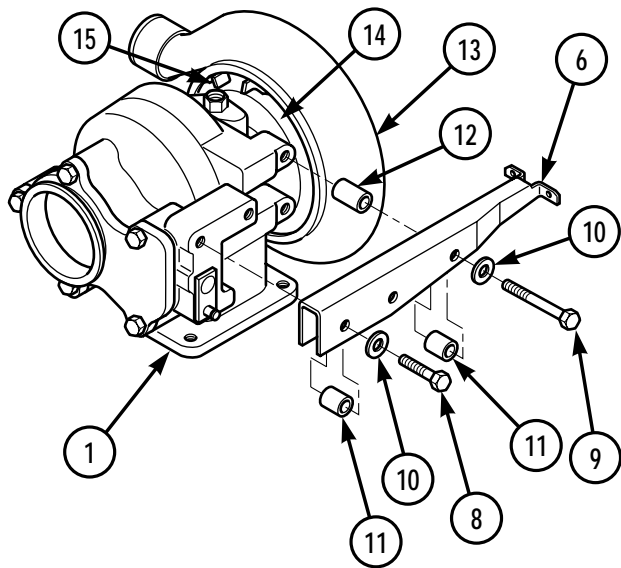


**(28) Position compressor housing (13) on bearing housing (14).**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (29) Install retaining ring (15) on compressor housing (13) and bearing housing (14).
- (30) Install bracket (6), spacer (12), three spacers (11), washers (10), and screws (8 and 9) on turbine housing (1).



#### 4-6. TURBOCHARGER ASSEMBLY REPAIR (CONT)

(31) Install nut (7) and adjusting link (3) on boost capsule actuator (5).

(32) Install boost capsule actuator (5) and two locknuts (4) on bracket (6). Tighten locknuts to 40 lb-in (4.5 N•m).

(33) Install turbocharger (TM 10-3930-673-20).

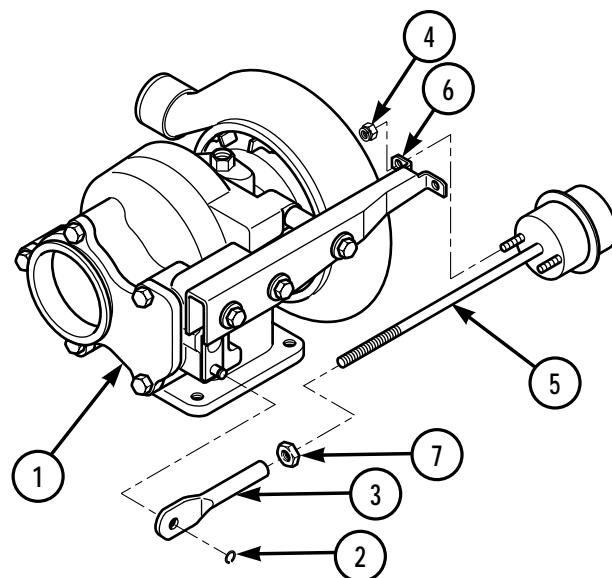
(34) Measure boost capsule actuator (5) travel. Specified travel should be 0.013 to 0.050 in. (0.33 to 1.3 mm).

(a) Attach a dial indicator to the turbine housing (1).

(b) Set dial indicator to zero.

(c) Connect 27.7 psi (191 kPa) regulated air pressure to boost capsule actuator (5).

(d) Measure boost capsule actuator (5) travel. If travel is less than 0.013 in. (0.33 mm) or greater than 0.050 in. (1.3 mm) replace boost capsule actuator.



#### CAUTION

Do not force alignment of boost capsule actuator or adjusting link may cause damage to parts.

(35) Install boost capsule actuator (5), and adjusting link (3) on turbine housing (1) control lever.

(a) Position turbine housing (1) lever towards boost capsule actuator (5).

(b) Adjust the adjusting link (3) length to where adjusting link aligns with turbine housing (1) lever.

#### WARNING

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

(c) Install adjusting link (3) and retaining ring (2) on turbine housing (1) lever.

(36) Disconnect regulated air pressure from boost capsule actuator (5).

END OF TASK

## 4-7. FUEL/HYDRAULIC OIL TANK REPLACEMENT/REPAIR

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### Tools and Special Tools

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Machine Shop: Field  
Maintenance Basic, Less Power  
(Item 19, Appendix D)  
Tool Kit, Body and Fender Repair  
(Item 22, Appendix D)  
Lifting Device, 1000 lb capacity

#### Equipment Condition

Fuel and hydraulic tanks drained  
(TM 10-3930-673-20)  
Negative battery cable removed  
(TM 10-3930-673-20)  
Fuel level sender removed (TM 10-3930-673-20)

#### Equipment Condition - Continued

Hydraulic oil sight gauge removed  
(TM 10-3930-673-20)  
Fuel supply and drain lines removed  
(TM 10-3930-673-20)  
Hydraulic hoses, lines, and fittings removed  
(TM 10-3930-673-20)  
Fuel and hydraulic strainers removed  
(TM 10-3930-673-20)

#### Materials / Parts

Compound, Sealing (Item 42, Appendix B)  
Lockwashers (2)  
Lockwashers (3)

#### References

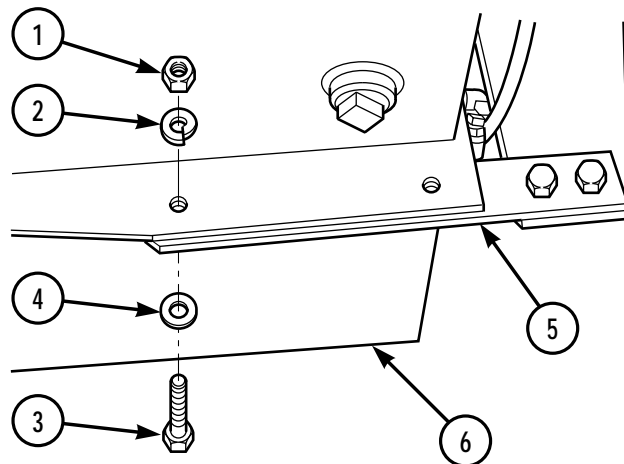
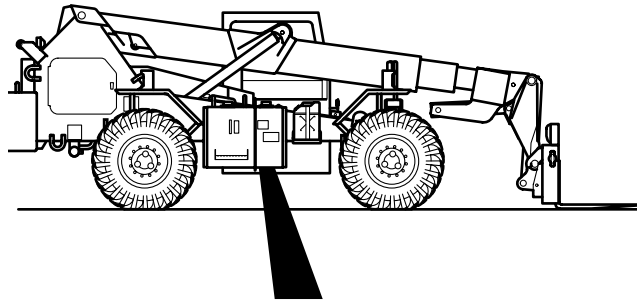
TM 9-237

### a. Removal.

#### WARNING

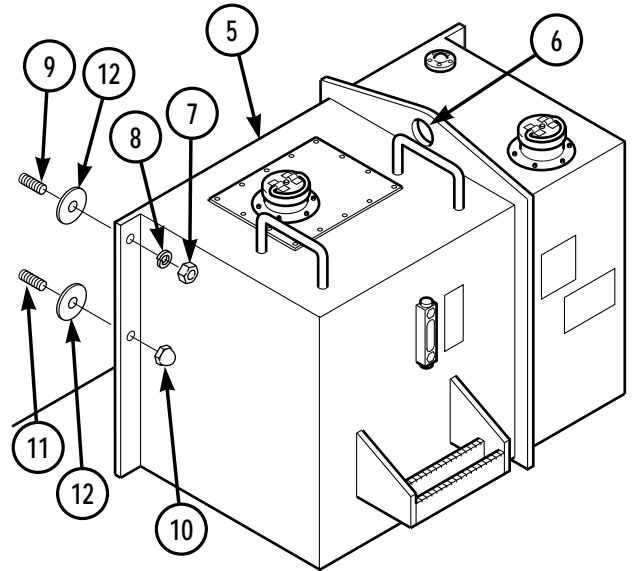
Fuel tank weighs 600 lbs (272.16 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (1) **Attach lifting device to fuel tank.**
- (2) **Remove two nuts (1), lockwashers (2), screws (3), and washers (4) from support bar (5) and fuel/hydraulic tank (6). Discard lockwashers.**



#### 4-7. FUEL/HYDRAULIC OIL TANK REPLACEMENT/REPAIR (CONT)

- (3) Take up slack in lifting device attached to lifting eye (6) and remove three nuts (7) and lockwashers (8) from mounting studs (9). Discard lockwashers.
- (4) Remove acorn nut (10) from stud (11).
- (5) Lift fuel/hydraulic tank (6) away from vehicle frame. Remove four washers (12) from mounting studs (9) and stud (11).



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.**

- (1) See Inspection Instructions (Para 2-14).
- (2) Inspect exterior surfaces, hardware, and threaded fittings for corrosion or damage (Para 2-14). Repair breaks in tank walls, if possible, by welding (see TM 9-237).

**d. Installation.**

#### WARNING

Fuel tank weighs 600 lbs (272.16 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

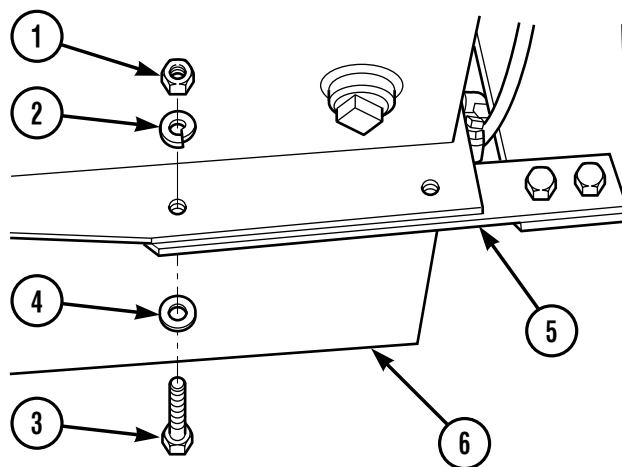
- (1) Position four washers (12) on mounting studs (9) and stud (11).
- (2) Using suitable lifting device, position fuel/hydraulic tank (6) on mounting studs (9) and stud (11).

#### WARNING

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

- (3) Apply sealing compound to threads of mounting studs (9) and stud (11).
- (4) Install three lockwashers (8) and nuts (7) on mounting studs (9).
- (5) Install acorn nut (10) on stud (11).

- (6) Install two washers (4), screws (3), lockwashers (2), and nuts (1) on fuel/hydraulic tank (6) and support bar (5).
- (7) Remove lifting device.



### NOTE

Follow-on Maintenance:

- Install hydraulic hoses, lines, and fittings (TM 10-3930-673-20).
- Install fuel supply and drain lines (TM 10-3930-673-20).
- Install hydraulic oil sight gauge (TM 10-3930-673-20).
- Install fuel and hydraulic strainers (TM 10-3930-673-20).
- Install fuel level sender (TM 10-3930-673-20).
- Install negative battery cable (TM 10-3930-673-20).

**END OF TASK**





## CHAPTER 5

### COOLING SYSTEM MAINTENANCE

<b>Para</b>	<b>Contents</b>	<b>Page</b>
	Section I. Description and Data	
5-1.	General .....	5-2
5-2.	Principles of Operation .....	5-2
	Section II. Cooling System Maintenance Procedures	
5-3.	Radiator Repair .....	5-3

## Section I. DESCRIPTION AND DATA

### 5-1. GENERAL

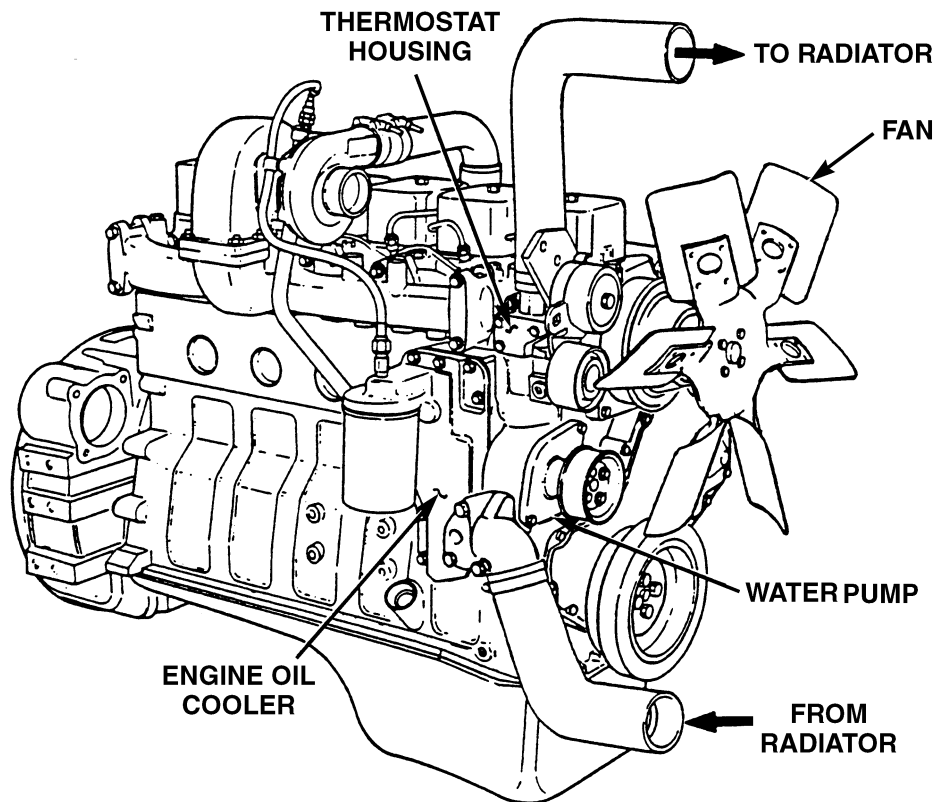
This chapter covers maintenance procedures for the engine cooling system components, as well as principles of operation.

### 5-2. PRINCIPLES OF OPERATION

**a. System Operation.** Coolant liquid is circulated through passages in engine cylinder block and through the engine oil cooler by an engine-driven water pump. The water pump also serves to force coolant to flow through the radiator, from top to bottom, as long as thermostat is open to allow flow to radiator. As coolant flows downward in radiator, airflow produced by the engine fan is forced through the radiator. Heat is removed from the coolant in this way.

**b. Water Pump.** The water pump is a centrifugal-type unit that is driven by belt off the crankshaft pulley.

**c. Thermostat.** The thermostat is a heat-operated valve which serves to regulate coolant temperature within a range that provides the most efficient engine operation. The thermostat is a modulating type, which begins to open at a coolant temperature of 180°F (82°C) and is fully open when coolant temperature reaches 190°F (88°C).



## Section II. COOLING SYSTEM MAINTENANCE PROCEDURES

### 5-3. RADIATOR REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Tool Kit, Machinists: Post, Camp and Station  
(Item 24, Appendix D)

##### *Equipment Condition*

Radiator removed (TM 10-3930-673-20)

##### *Materials/Parts*

Brush, Wire (Item 6, Appendix B)  
Sandpaper (Item 37, Appendix B)

- a. Disassembly.** Remove drain petcock (1) from radiator (2).
- b. Cleaning.**

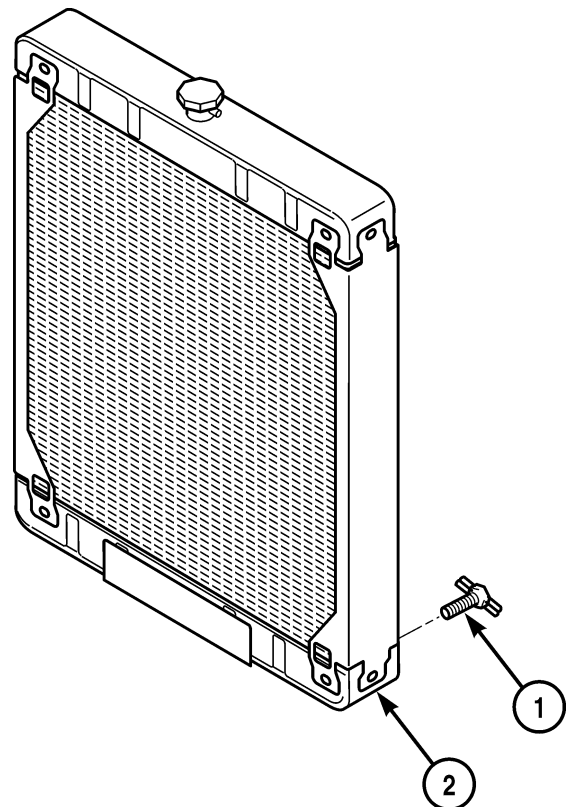
#### **WARNING**

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

#### **CAUTION**

Do not attempt to clean radiator core fins with any sharp instrument. A sharp instrument may damage core, leading to leakage from core.

- (1) Remove dirt and other debris from core fins using compressed air.
- (2) Remove any surface corrosion from upper and lower tanks using a wire brush or sandpaper.

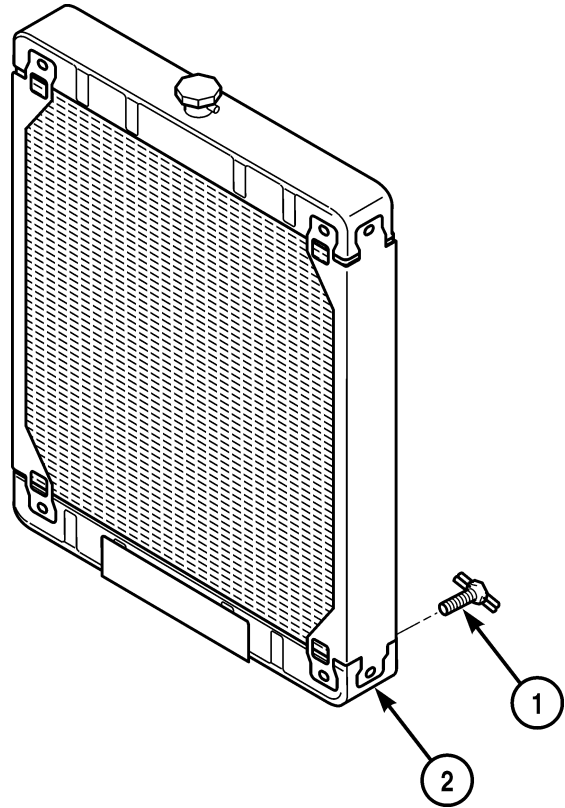


### 5-3. RADIATOR REPAIR (CONT)

*c. Inspection.*

- (1) Inspect core and upper and lower tanks for small holes, or for other evidence of minor leaks. Repair minor leaks by soldering or brazing.
- (2) Check filler cap opening pressure in a suitable testers opening pressure must be a minimum of 7 psi (48.3 kPa).
- (3) Check drain petcock (1) for damaged threads or signs of leakage.

- d. Assembly.* Install drain petcock (1) in radiator (2).



#### NOTE

Follow-on Maintenance: Install radiator (TM 10-3930-673-20).

END OF TASK

## CHAPTER 6

### ELECTRICAL SYSTEM MAINTENANCE

Para	Contents	Page
Section I. Description and Data		
6-1.	General .....	6-1
6-2.	Principles of Operation .....	6-1
Section II. Electrical System Maintenance Procedures		
6-3.	Alternator Repair/Test .....	6-3
6-4.	Starter Repair .....	6-12
6-5.	Cab Wiring Harness Replacement/Repair .....	6-19
6-6.	Main Wiring Harness Replacement .....	6-24
6-7.	Electric Joystick Assembly Repair/Test/Adjustment .....	6-28

#### Section I. DESCRIPTION AND DATA

##### 6-1. GENERAL

This chapter covers maintenance procedures for the electrical system components, as well as principles of operation.

##### 6-2. PRINCIPLES OF OPERATION

**a. Charging System.** The charging system includes the alternator, rectifier and voltage regulator. The rectifier and voltage regulator are integral with the alternator. The basic function of the charging system is to maintain the vehicle battery voltage (charge) at the specified level.

The alternator is an AC generator that is belt-driven by the engine crankshaft pulley. The AC produced in the alternator stator windings is converted to DC by action of a diode rectifier bridge. The initial output from the alternator is made possible by residual magnetism in the rotor poles. As the rotor turns, the magnetic lines of force produced by the residual magnetism cut through the stator windings and current flow is produced by the stator windings. As engine speed increases, alternator rotor speed also increases. Current flow produced by the stator increases accordingly.

A portion of the current produced in the stator windings is shunted through a diode trio to the field winding. The diode trio converts the AC output of the stator windings to DC for application to the field winding. Current flow through the field winding increases the strength of the magnetic field surrounding the rotor, and a resultant increase in stator current occurs. Current flow in the field winding circuit is controlled electronically by the regulator. The regulator, in effect, monitors battery voltage and switches on and off several times a second in normal operation to maintain the required battery voltage level.

## 6-2. PRINCIPLES OF OPERATION (CONT)

**b. Starting Motor.** The function of the starting motor is to turn the engine flywheel at a fast enough rate to initiate engine combustion.

An electric solenoid, activated by the START switch, pulls the starting motor drive pinion into engagement with the ring gear on the engine flywheel. At the same time, movement of the solenoid closes a set of switch contacts which connect the starting motor armature to the battery through a set of four carbon brushes. Current flow in the armature causes the armature to rotate. The drive pinion then rotates and turns the engine flywheel. When the engine starts, centrifugal force resulting from increased flywheel speed, moves the starting motor pinion out of engagement with the flywheel ring gear. Releasing the START switch causes the solenoid to de-energize and disconnect the battery from the starting motor.

**Section II. ELECTRICAL SYSTEM MAINTENANCE PROCEDURES**

**6-3. ALTERNATOR REPAIR/TEST**

This Task Covers:

- |                |               |             |
|----------------|---------------|-------------|
| a. Disassembly | c. Inspection | e. Assembly |
| b. Cleaning    | d. Testing    |             |

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
Multimeter, Digital (Item 14, Appendix D)

*Equipment Condition*

Alternator removed (TM 10-3930-673-20)

*Materials/Parts*

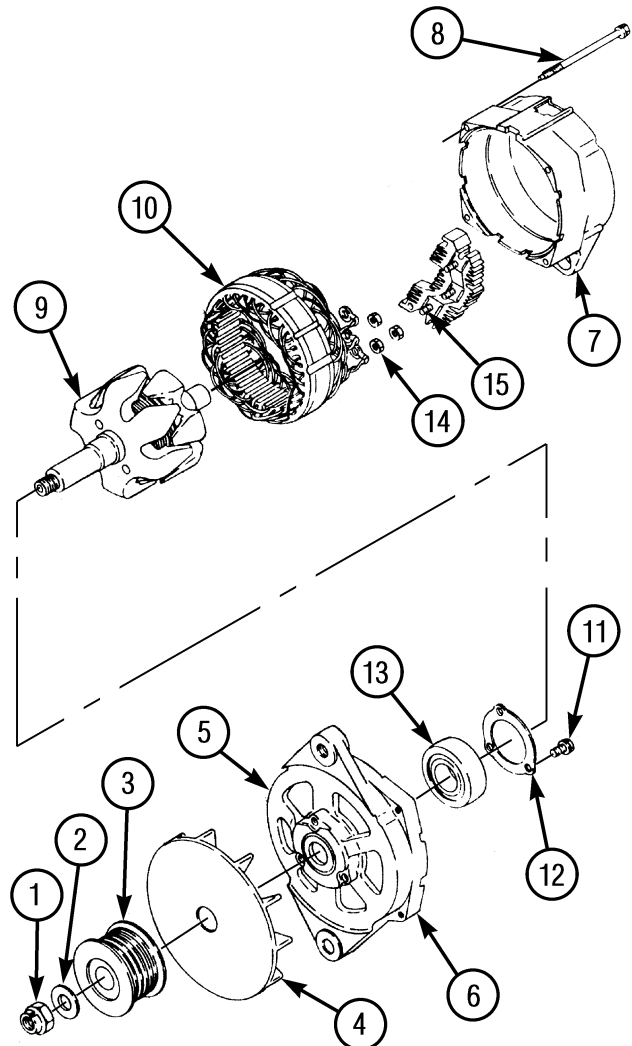
Lubricant, Delco-Remy (Item 21, Appendix B)  
Sandpaper (Item 37, Appendix B)  
Bearing Cap  
Bushings (2)  
Locknut

**NOTE**

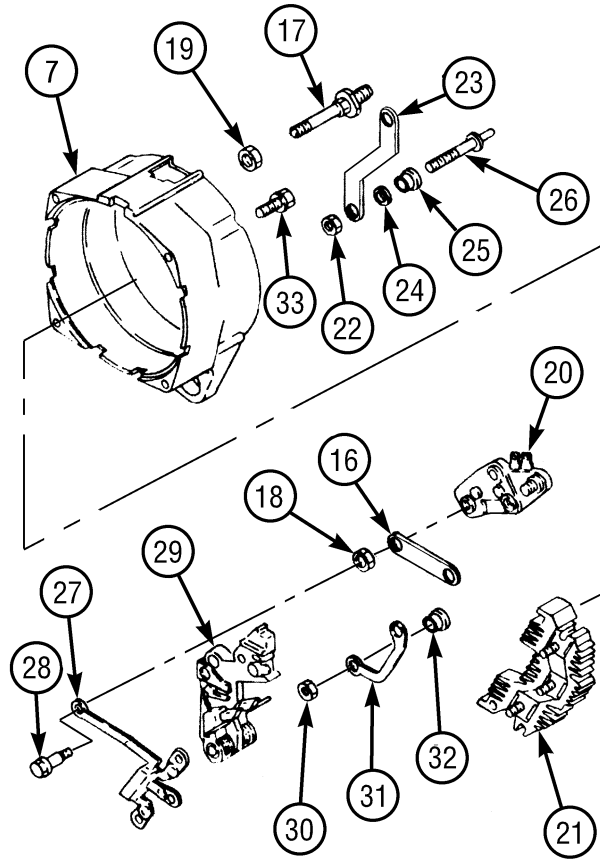
Alternator is one of two different models used on ATLAS vehicles. Although configuration of a few components between models is slightly different, many are identical. This paragraph can be used to repair/test either alternator.

**a. Disassembly.**

- (1) Remove locknut (1), washer (2), pulley (3), and fan (4) from alternator (5). Discard locknut.
- (2) Separate front frame (6) from rear frame (7).
  - (a) Remove four screws (8) from alternator (5).
  - (b) Separate front frame (6) and rotor assembly (9) from rear frame (7) and stator assembly (10).
- (3) Remove rotor assembly (9) from front frame (6).
  - (a) Use suitable press to remove bearing (13) in front frame (6) from rotor assembly (9).
  - (b) Remove three screws (11), retainer plate (12), and roller bearing (13) from front frame (6).
- (4) Remove stator assembly (10) from rear frame (7).
  - (a) Remove three nuts (14) from studs (15).
  - (b) Remove stator assembly (10) from rear frame (7).

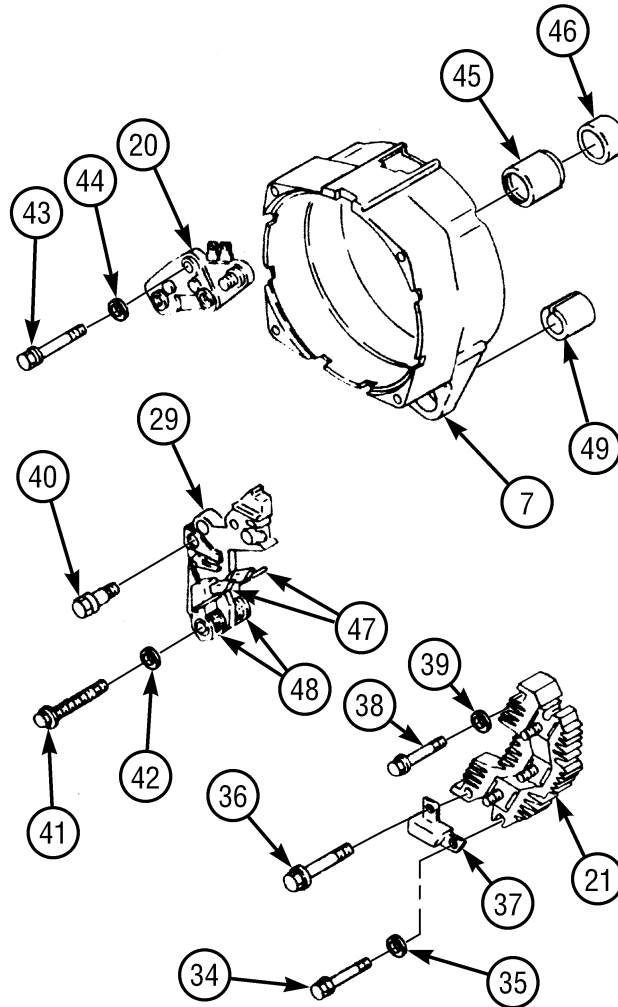


**6-3. ALTERNATOR REPAIR/TEST (CONT)**



- (5) **Remove stud connector (16) and output terminal (17) from rear frame (7).**
  - (a) Remove nut (18), nut (19), and stud connector (16) from regulator (20) and rectifier bridge assembly (21).
  - (b) Remove output terminal (17) from rear frame (7)
- (6) **Remove nut (22), stud connector (23), washer (24), insulator (25), and indicator light terminal (26) from rear frame (7).**
- (7) **Remove diode trio (27) from rectifier bridge assembly (21).**
  - (a) Remove insulated screw (28) from brush holder assembly (29).
  - (b) Remove diode trio (27) from rectifier bridge assembly (21).
- (8) **Remove nut (30), relay terminal connector (31), insulator (32), and relay terminal (33) from rear frame (7).**





- (9) Remove screw (34), washer (35), insulated screw (36), and capacitor (37) from rectifier bridge assembly (21).
- (10) Remove screw (38), washer (39), and rectifier bridge assembly (21) from rear frame (7).
- (11) Remove insulated screw (40), screw (41), washer (42), and brush holder assembly (29) from rear frame (7).
- (12) Remove screw (43), washer (44), and regulator (20) from rear frame (7).

**NOTE**

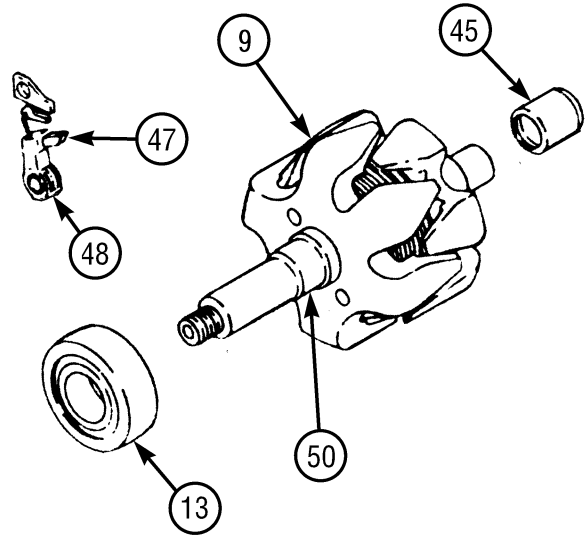
If roller bearing is not being removed, apply pressure sensitive tape over it for protection against dirt. Do not use friction tape or other tape that will leave a residue behind.

- (13) Using a suitable press, remove roller bearing (45) and cap (46) from rear frame (7).
- (14) Remove two brushes (47), and two springs (48) from brush holder assembly (29).
- (15) Using a suitable press, remove bushing (49) from rear frame (7).

**6-3. ALTERNATOR REPAIR/TEST (CONT)**

**b. Cleaning.**

- (1) Clean brushes (47) using soft, dry cloth.
- (2) Clean slip rings on rotor assembly (9).
  - (a) Place rotor assembly (9) in a lathe, with slip ring of shaft free.
  - (b) While rotor is spinning in lathe, hold No. 00 sandpaper or 400 grit silicon carbide paper against slip ring (50) surface.
  - (c) After polishing slip rings (50), clean using low pressure (15 psi maximum) compressed air.

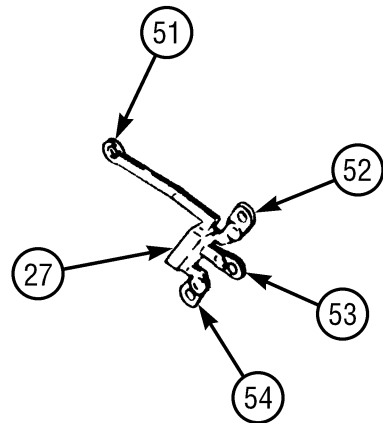


**c. Inspection.**

- (1) Inspect roller bearings (13 and 45) for rough rotation or visible damage. Replace if faulty.
- (2) Inspect brushes (47) for excessive wear. Replace as needed.
- (3) Inspect brush springs (48) for distortion or discoloration. Replace as needed.

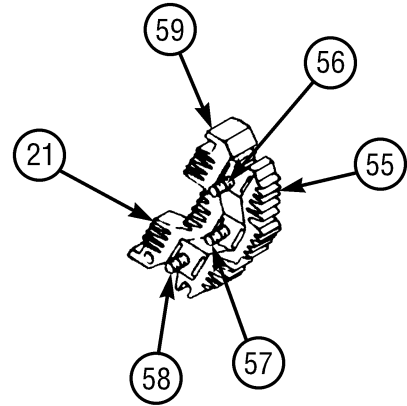
**d. Testing.**

- (1) Test diode trio (27).
  - (a) Connect multimeter between diode trio single connector (51) and each of the other connectors (52,53, and 54) in turn. Observe resistance reading.
  - (b) Reverse multimeter leads, or reverse meter polarity, and repeat STEP a, above.
  - (c) At one polarity, resistance reading should be low and at the other polarity, resistance reading should be very high, if diodes are good. If both readings on same set of connectors are either high or low, the associated diode is faulty and entire diode trio must be replaced.



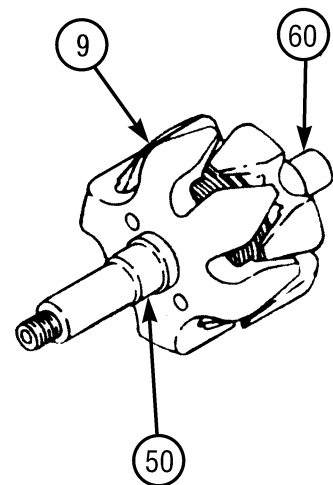
**(2) Test rectifier bridge assembly (21).**

- (a) Connect multimeter from grounded heat sink (55) to diode terminal (56) and note resistance reading.
- (b) Reverse multimeter leads or reverse meter polarity and again note resistance reading.
- (c) At one polarity, resistance reading should be low and at the other polarity, resistance reading should be very high, if diode is good. If diode is faulty, both readings will be either low or high.
- (d) Repeat above sequence between grounded heat sink (55) and diode terminals (57 and 58), and then between insulated heat sink (59) and each diode terminal (56, 57 and 58).
- (e) If any set of readings indicates a faulty diode, replace complete rectifier bridge (21).



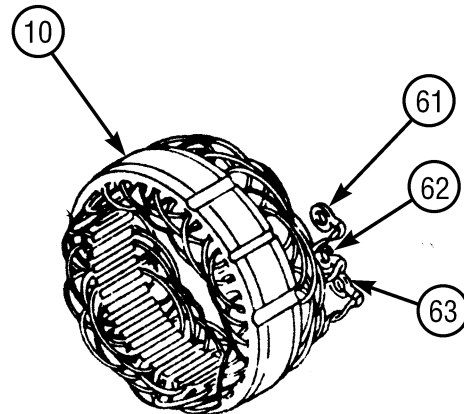
**(3) Test rotor assembly (9) for short of open circuits.**

- (a) Connect multimeter between slip rings (50), in turn, and rotor shaft (60) (connection A). Observe resistance reading on ohmmeter.
- (b) Resistance reading should be high (infinite). If not, rotor (9) is defective and must be replaced.
- (c) Connect multimeter leads across slip rings (50) (connection B). Observe resistance reading on ohmmeter. A high (infinite) resistance reading indicates an open rotor winding and rotor (9) must be replaced.



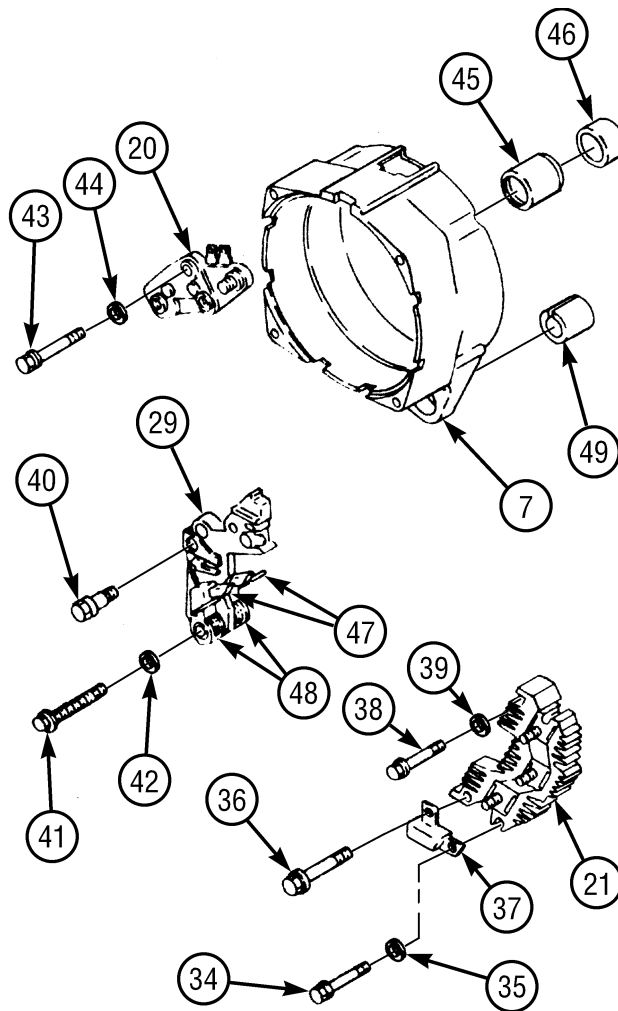
**6-3. ALTERNATOR REPAIR/TEST (CONT)**

- (4) **Test stator assembly (10) for open or grounded windings.**
- (a) Using a multimeter set to ohms, low scale, measure resistance through stator windings. Connect multimeter to terminal clips (61 through 63), from each outside clip to center clip and then between two outside clips.
  - (b) Measure resistance from each terminal clip (61 through 63) to stator frame to check for grounded windings. A low resistance reading between any terminal clip and stator frame indicates a grounded winding, and stator (10) must be replaced as a unit.



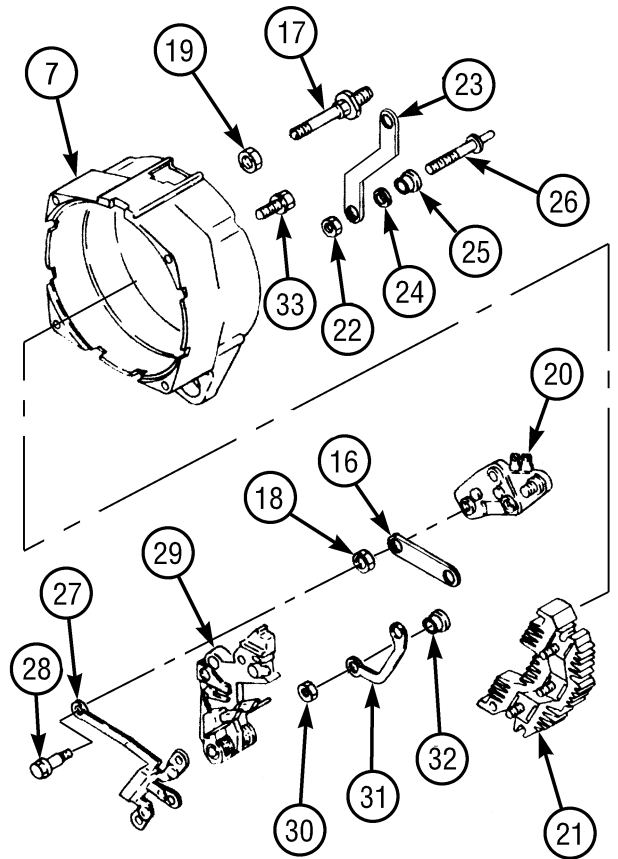
**e. Assembly.**

- (1) Using suitable press, install bushing (49) on rear frame (7).
- (2) Position two springs (48) and brushes (47) on brush holder assembly (29).
- (3) Install roller bearing (45) in rear frame (7).
  - (a) Pack roller bearing (45) with lubricant.
  - (b) Using a suitable press, install bearing (45) into rear frame (7). Bearing side should be flush with inside base of frame (7).
  - (c) Install cap (46) in rear frame (7).
- (4) Install regulator (20) on rear frame (7) with washer (44) and screw (43).
- (5) Install brush holder assembly (29) on rear frame (7) and regulator (20) with washer (42) and screw (41) and insulated screw (40).
- (6) Install rectifier bridge assembly (21) on rear frame (7) with washer (39) and screw (38).
- (7) Install capacitor (37) on bridge rectifier assembly (21) with washer (35), screw (34), and insulated screw (36).



**(8) Install relay terminal (33) and diode trio (27) on rear frame (7).**

- (a) Position relay terminal (33) in rear frame (7).
- (b) Position insulator (32) and relay terminal connector (31) on relay terminal (33).
- (c) Start nut (30) on relay terminal (33).
- (d) Position opposite side of relay terminal connector on brush holder assembly (29).
- (e) Position diode trio (27) on rectifier bridge assembly (21).
- (f) Install insulated screw (28) on brush holder assembly (29).
- (g) Tighten nut (30).



**(9) Install indicator light terminal (26) on rear frame (7).**

- (a) Position indicator light terminal (26) in rear frame (7).
- (b) Position insulator (25) on indicator light terminal (26).
- (c) Position stud connector (23) and washer (24) on rectifier bridge assembly (21) and indicator light terminal (26).
- (d) Install nut (22) on indicator light terminal (26).

**(10) Install output terminal (17) and stud connector (16) on rear frame (7).**

- (a) Position output terminal (17) in rear frame (7).
- (b) Position stud connector (16) on output terminal (17) and regulator (20).
- (c) Install nut (18) and nut (19).

**6-3. ALTERNATOR REPAIR/TEST (CONT)**

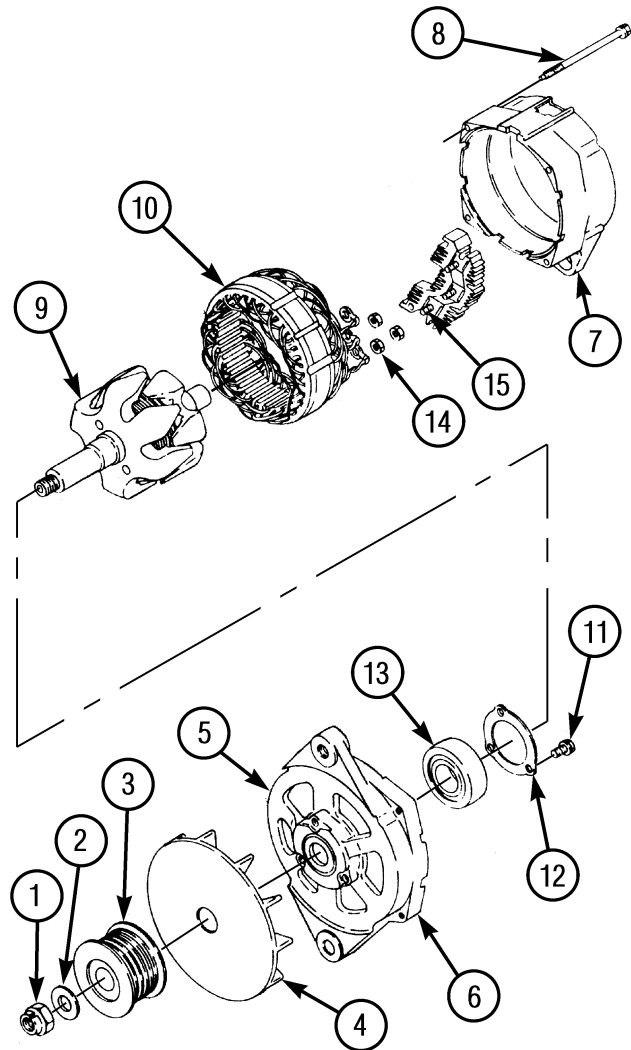
**(11) Install stator assembly (10) on rear frame (7).**

- (a) Position stator assembly (10) on rear frame (7) so that three stator terminal clips (65) are fitted on three studs (15).
- (b) Gently press stator assembly (10) into rear frame (7) so that it is properly seated.
- (c) Install three nuts (14) on protruding studs.

**(12) Install rotor assembly (9) on front frame (6).**

- (a) Pack roller bearing (13) with Delco-Remy lubricant and position bearing in front frame (6).
- (b) Install retainer plate (12) and three screws (11) in front frame (6).
- (c) Using a suitable press, install bearing (13) in front frame (6) on rotor assembly (9).

**(13) Install front frame (6) and rotor assembly (9) on rear frame (7).**



**NOTE**

Brushes must be retained before front and rear frame sections can be assembled.

- (a) Push brushes (49) into brush holder assembly (29) and insert a stiff piece of wire through hole provided in rear frame (7). Wire should then be inserted into retaining hole in brush holder assembly (29).

**NOTE**

Ensure bracket frame holes are correctly aligned when assembling frame halves. Two large bracket holes in alternator frame should be aligned.

- (b) Carefully position front frame (6) and rotor assembly (9) into rear frame (7).
- (c) Install four screws (8) into alternator (5).
- (d) Remove wire from rear frame (7).

**(14) Install fan (4) and pulley (3) with washer (2) and locknut (1). Torque locknut to 75 lb-ft (101.69 N•m).**

**NOTE**

Follow-on Maintenance: Install alternator (TM 10-3930-673-20).

**END OF TASK**

## 6-4. STARTER REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Multimeter, Digital (Item 14, Appendix D)  
Growler

#### *Equipment Condition*

Starter removed (TM 10-3930-673-20)

#### *Materials / Parts*

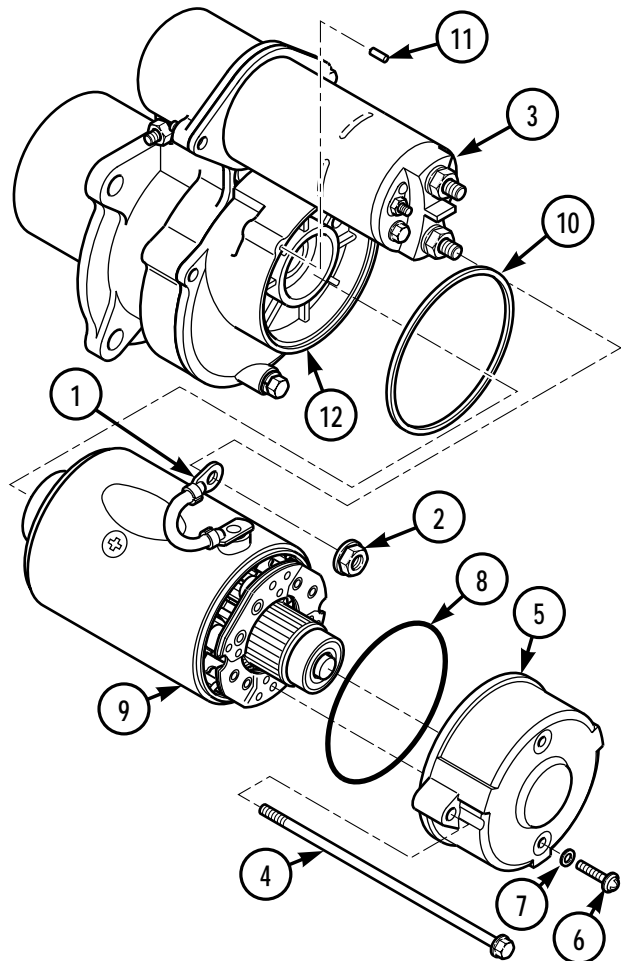
Paper, Emery #240 grit (Item 31, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Tags (Item 55, Appendix B)

#### *Materials / Parts (Cont)*

Preformed packing (2)  
Bolt w/captive lockwasher (2)  
Locknut  
Lockwasher  
Nut w/captive washer  
Packing, Preformed  
Packing, Preformed  
Ring, Retaining  
Screw w/captive lockwasher (2)  
Screw w/captive lockwasher (2)  
Screw w/captive lockwasher (2)

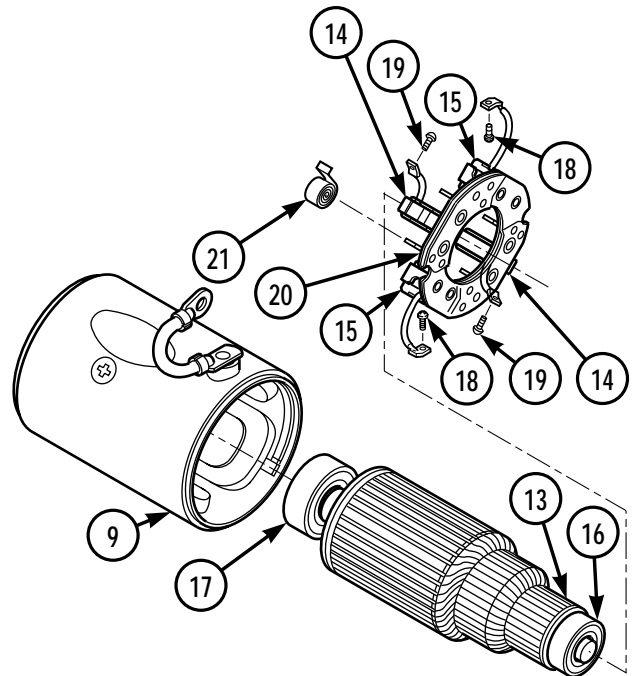
### a. Disassembly.

- (1) **Clamp starter, drive end down, in a vise with soft jaws.**
- (2) **Tag and mark wire (1). Remove nut with captive washer (2) and wire from solenoid (3). Discard nut with captive washer**
- (3) **Remove two bolts (4) from cover (5).**
- (4) **Remove two bolts (6), preformed packings (7), cover (5), and preformed packing (8) from frame and field coil assembly (9). Discard preformed packings.**
- (5) **Remove frame and field coil assembly (9), preformed packing (10), and pin (11) from bracket (12). Discard preformed packing.**

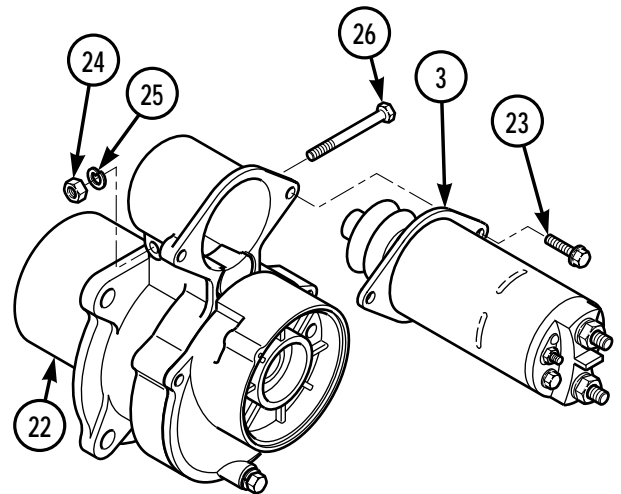




- (6) Remove armature (13) from two ground brushes (14), coil brushes (15), and frame and field coil assembly (9).
- (7) If damaged, remove bearings (16 and 17) from armature (13).
- (8) Remove two screws with captive lockwashers (18) and coil brushes (15) wire connectors from frame and field coil assembly (9). Discard screws with captive lockwashers.
- (9) Remove two screws with captive lockwashers (19) and ground brushes (14) wire connectors from brush holder (20). Discard screws with captive lockwashers.
- (10) Remove four springs (21) and two ground brushes (14) and coil brushes (15) from brush holder (20).
- (11) Remove solenoid (3) from drive housing (22).

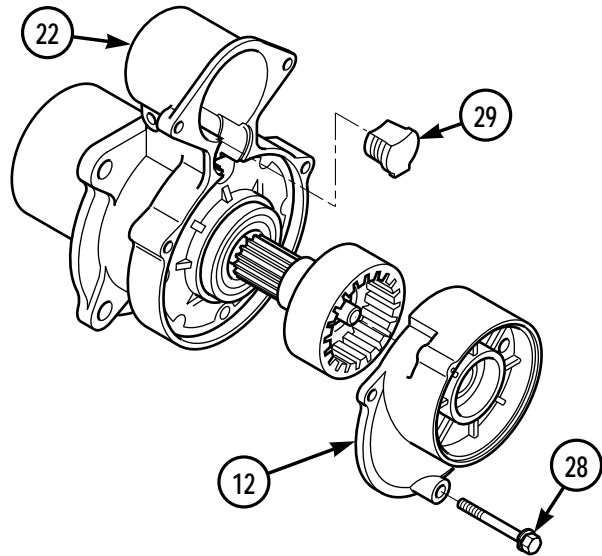


- (a) Remove two screws with captive lockwashers (23) from solenoid (3). Discard screws with captive lockwashers.
- (b) Remove locknut (24), lockwasher (25), and screw (26), from lever (27) and drive housing (22). Discard locknut and lockwasher.
- (c) Remove solenoid (3) from lever (27) and drive housing (22).

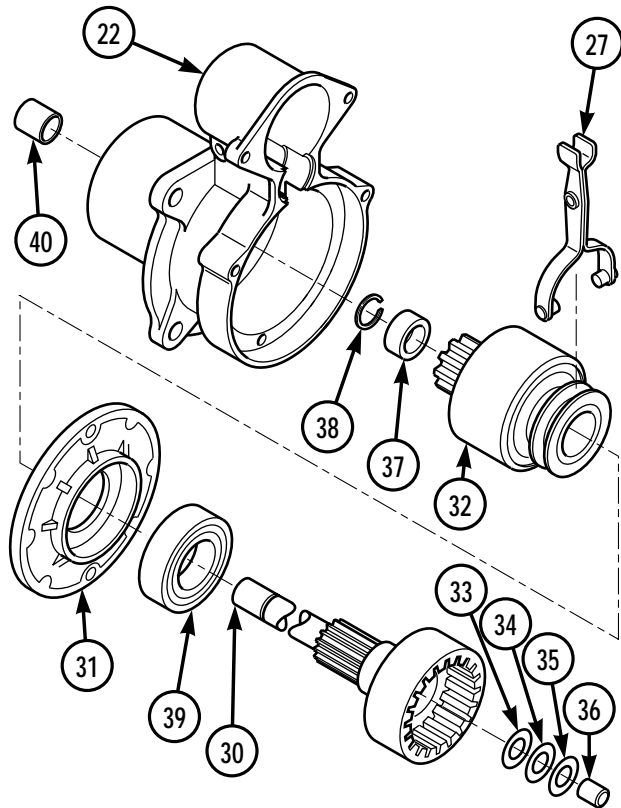


**6-4. STARTER REPAIR (CONT)**

- (12) Remove two bolts with captive lockwashers and washers (28) and bracket (12) from drive housing (22). Discard bolts with captive lockwashers.
- (13) Remove plug (29) from drive housing (22).



- (14) Remove drive shaft (30), shaft support (31), drive clutch assembly (32), and lever (27) as an assembly from drive housing (22).
- (15) Remove washers (33, 34, and 35) and plug (36) from drive shaft (30).



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (16) Drive pinion stop (37) toward drive clutch assembly (32) and remove retaining ring (38) and pinion stop from drive shaft (30). Discard retaining ring.
- (17) Remove drive clutch assembly (32) and shaft support (31) from drive shaft (30).
- (18) Remove bearing (39) from drive shaft (30).
- (19) If damaged remove bushing (40) from drive housing (22).

**b. Cleaning.**

- (1) See Cleaning Instructions (Para 2-12).

**WARNING**

- Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).
- Volatile mineral spirits burn easily and fumes can explode. Do not smoke or allow open flame nearby when using volatile mineral spirits. Failure to do so may cause serious injury or death to personnel.

**CAUTION**

Do not clean starter parts in drycleaning solvent. Drycleaning solvent may damage certain electrical parts.

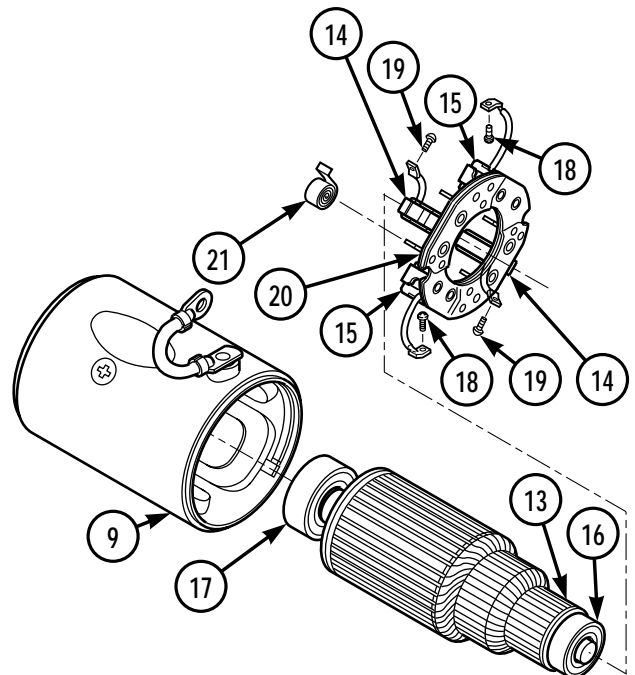
- (2) Clean starter parts in mineral spirits and dry using low pressure compressed air or clean lint-free cloth.

**c. Inspection.**

- (1) See Inspection Instructions (Para 2-14).

- (2) Inspect brush components.

- Check brushes (14 and 15) lengths against length of new brush. Brushes that are less than two-thirds the length of a new brush must be replaced.
- All oil soaked brushes must also be replaced.
- Check to ensure that brushes fit well in brush holder (20), but without binding.
- Inspect springs (21) for distortion or discoloration.



**CAUTION**

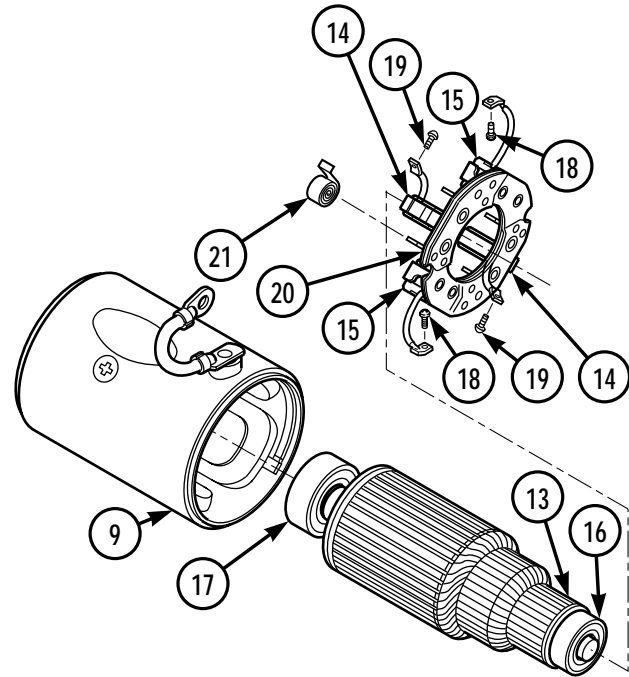
Do not turn down commutator nor undercut insulation between commutator bars. Replace armature if commutator cannot be restored satisfactorily in Step (3) below.

- (3) Check condition of commutator, and clean, if necessary, using no. 240 grit emery paper.

**6-4. STARTER REPAIR (CONT)**

**(4) Check for short circuits in armature (13) using a growler and steel strip.**

- (a) Rotate armature (13) in growler.
- (b) Hold steel strip (e.g., hacksaw blade) across armature slots as armature rotates. Steel strip will vibrate as slot between shorted bars passes under steel strip.
- (c) If short circuit is detected, check for build up of copper dust or other conductive material between commutator bars. Clean out copper dust and check again for short circuits. If commutator bars are shorted, replace armature (13).

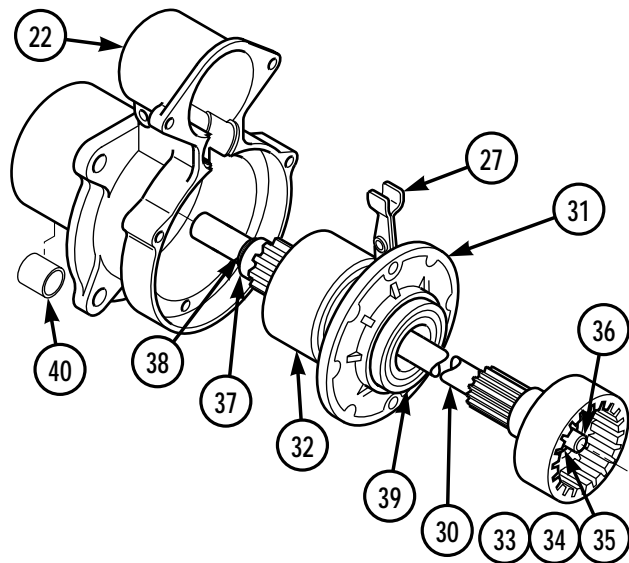


**(5) Check armature for grounds or open circuits.**

- (a) Set multimeter to ohms, on highest scale. Check for grounds by measuring resistance between commutator and one armature bar.
- (b) Switch multimeter to lowest scale.
- (c) Place multimeter leads against two adjacent commutator bars and observe multimeter. Multimeter needle should swing to zero and remain.
- (d) Repeat check for all commutator bars by moving one multimeter lead at a time. There must be continuity between each pair of bars. If there is no continuity between one or more pairs of bars, replace armature (13).

**d. Assembly.**

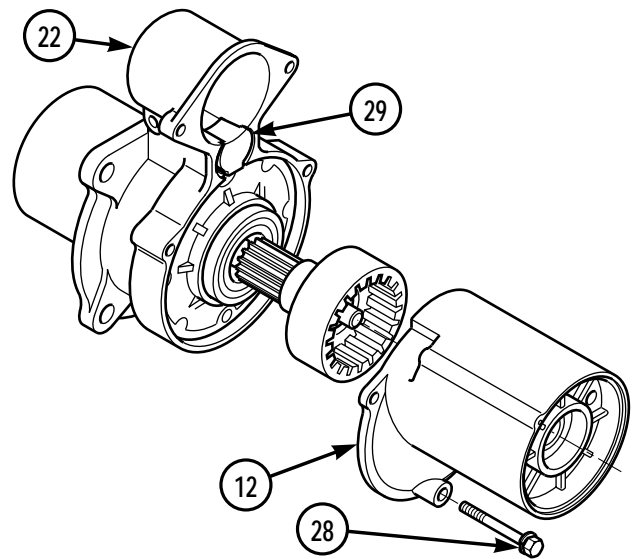
- (1) **If removed, install bushing (40) in drive housing (22).**
- (2) **Install bearing (39) on drive shaft (30).**
- (3) **Position shaft support (31) and drive clutch assembly (32) on drive shaft (30).**



**WARNING**

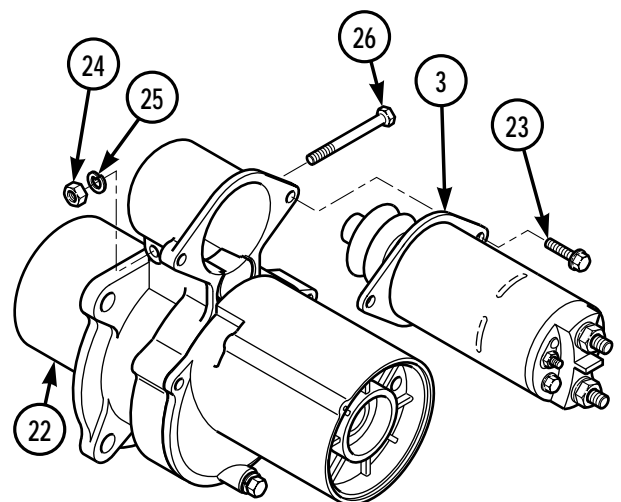
Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (4) **Install pinion stop (37) and retaining ring (38) on drive shaft (30). Retaining ring may have to be forced over drive shaft using a block of wood.**
- (5) **Install plug (36) and washers (35, 34, and 33) on drive shaft (30).**
- (6) **Install lever (27), drive clutch assembly (32), shaft support (31), and drive shaft (30) as an assembly in drive housing (22).**
- (7) **Install plug (29) in drive housing (22).**
- (8) **Install bracket (12) and two bolts with captive lockwashers and washers (28) on drive housing (22).**



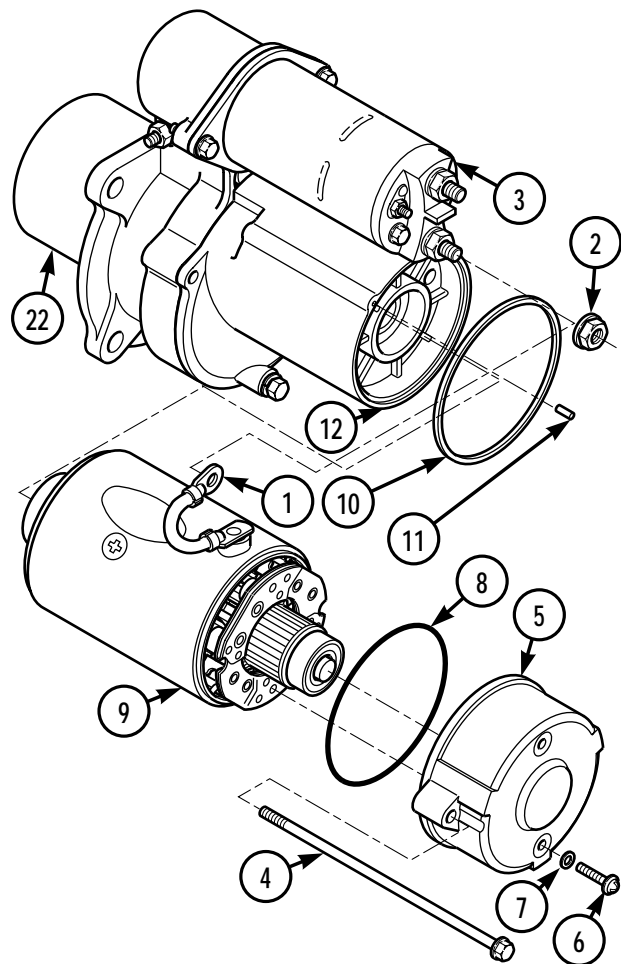
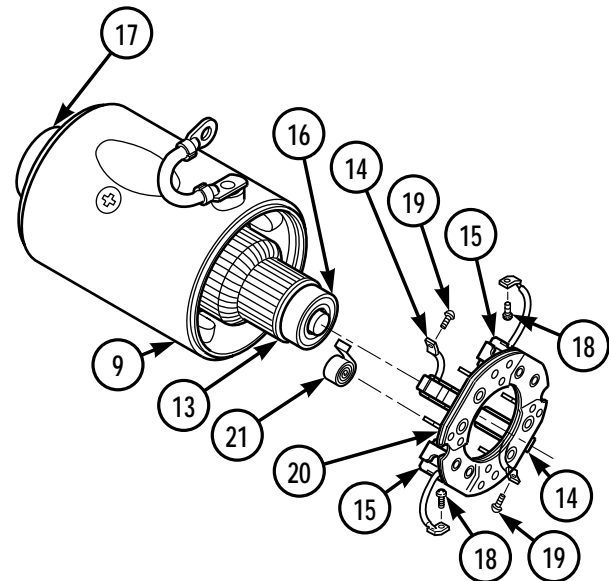
- (9) **Install solenoid (3) on drive housing (22).**

- (a) Install solenoid (3) on drive housing (22). Position solenoid so that solenoid engages lever (27).
- (b) Install screw (26), lockwasher (25), and nut (24) in drive housing (22) and lever (27).
- (c) Install two screws with captive lockwashers (23) in solenoid (3).



**6-4. STARTER REPAIR (CONT)**

- (10) Install two coil brushes (15), ground brushes (14), and four springs (21) on brush holder (20).
- (11) Install two screws with captive lockwashers (19) on ground brushes (14), wire connectors, and brush holder (20).
- (12) Install two screws with captive lockwashers (18) and coil brushers (15) wire connectors on frame and field coil assembly (9).
- (13) If removed, install bearings (16 and 17) on armature (13).
- (14) Install armature (13) in frame and field coil assembly (9). Ensure that two ground brushes (14) and coil brushes (15) clear commutator bars.
- (15) Install pin (11), preformed packing (10), frame, and field coil assembly (9) on bracket (12).
- (16) Install preformed packing (8), cover (5), two preformed packings (7), and bolts (6) on frame and field coil assembly (9).
- (17) Install two bolts (4) in cover (5).
- (18) Install wire (1) and nut with captive washer (2) on solenoid (3).



**NOTE**

Follow-on Maintenance: Install starter (TM 10-3930-673-20).

**END OF TASK**

## 6-5. CAB WIRING HARNESS REPLACEMENT/REPAIR

This Task Covers:

a. Removal

b. Inspection

c. Installation

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

#### *Materials/Parts*

Lockwashers (10)  
Lockwashers (6)  
Lockwasher  
Lockwashers (4)

#### *Equipment Condition*

Negative Battery Cable disconnected  
(TM10-3939-673-20)

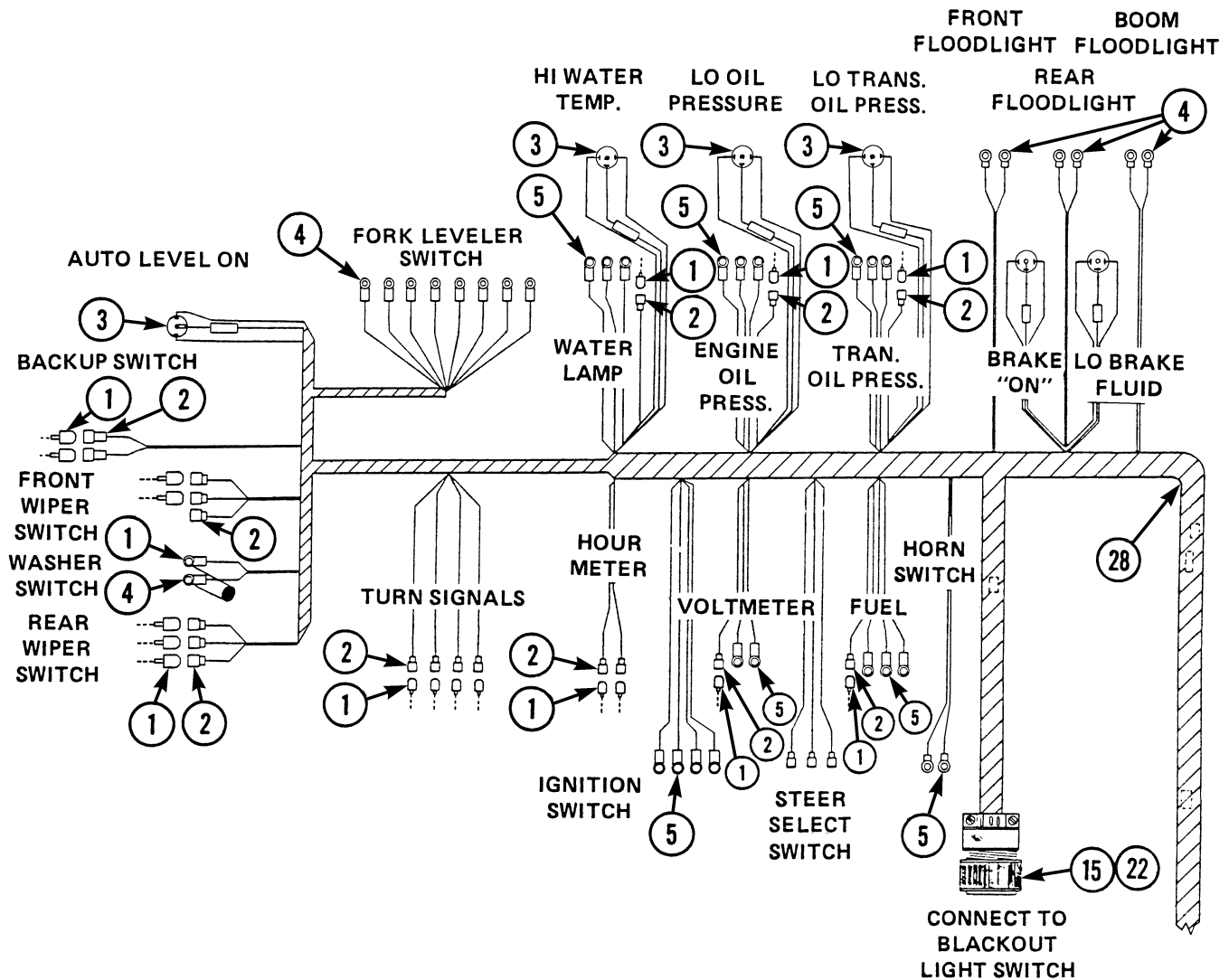
### **a. Removal.**

### NOTE

Tag all electrical leads as removed for use during installation.

- (1) **Unplug forty-four female connectors (2) from male connectors (1).**
- (2) **Disconnect wires from six lamp holders (3).**
- (3) **Disconnect eighteen connectors (4), twenty-seven connectors (5), connector (6), six connectors (7), thirty-four connectors (8), and eleven connectors (9) from devices indicated.**
- (4) **Disconnect two connectors (10) from steer select valve.**
- (5) **Remove fourteen nuts (11), ten lockwashers (12), six lockwashers (13), nut (14), lockwasher (15), five flat washers (16), twelve clamps (17), and four lockwashers (18). Discard lockwashers.**
- (6) **Remove cable clamps (19-21) and disconnect connectors (22 through 25).**
- (7) **Carefully push out two grommets (26) and grommet (27) from front harness section (28).**
- (8) **Remove front harness section (28).**
- (9) **Disconnect seven terminals (29) from devices indicated. Remove rear wire harness section (30) and grommet (27).**

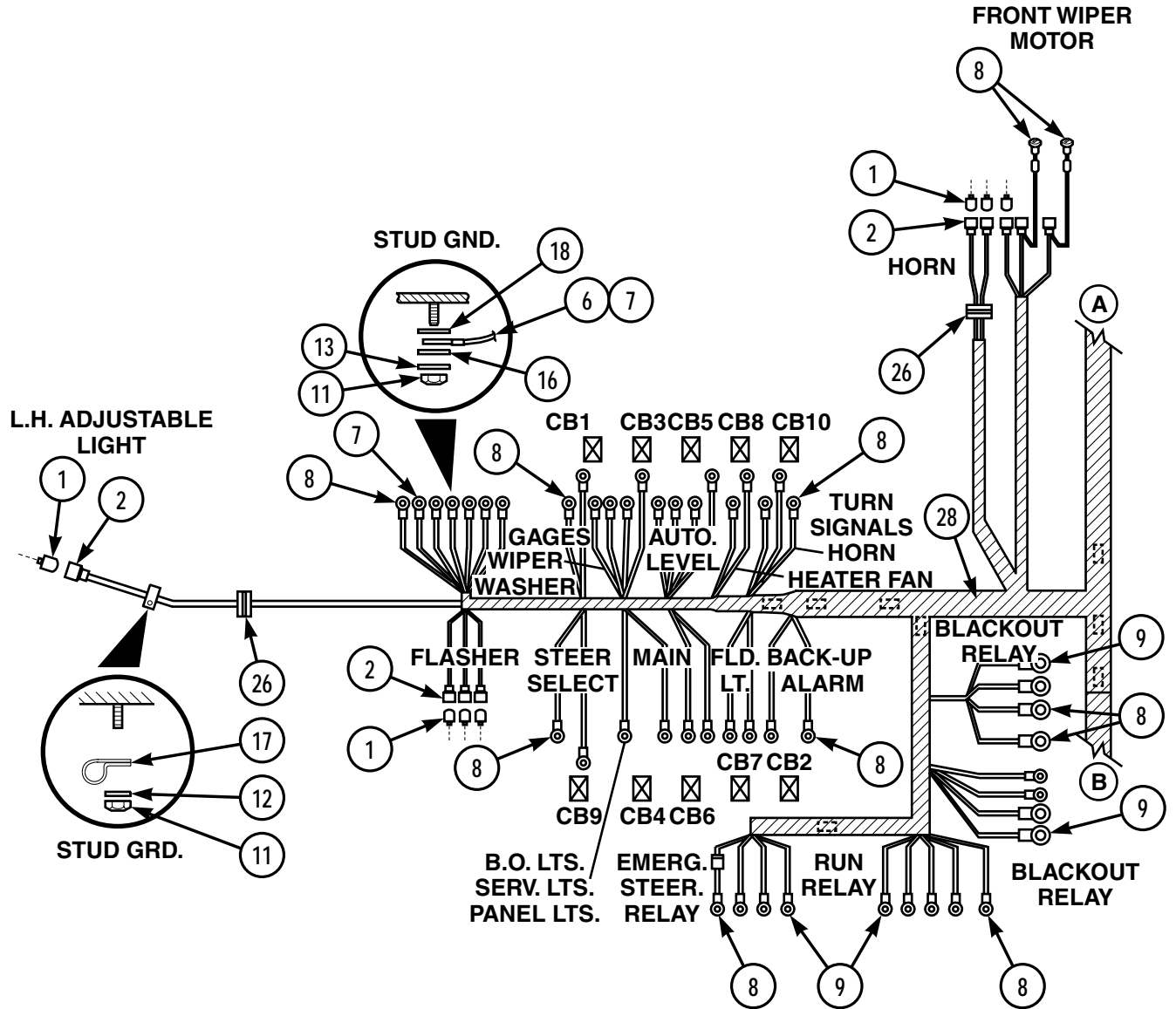
**6-5. CAB WIRING HARNESS REPLACEMENT/REPAIR (CONT)**



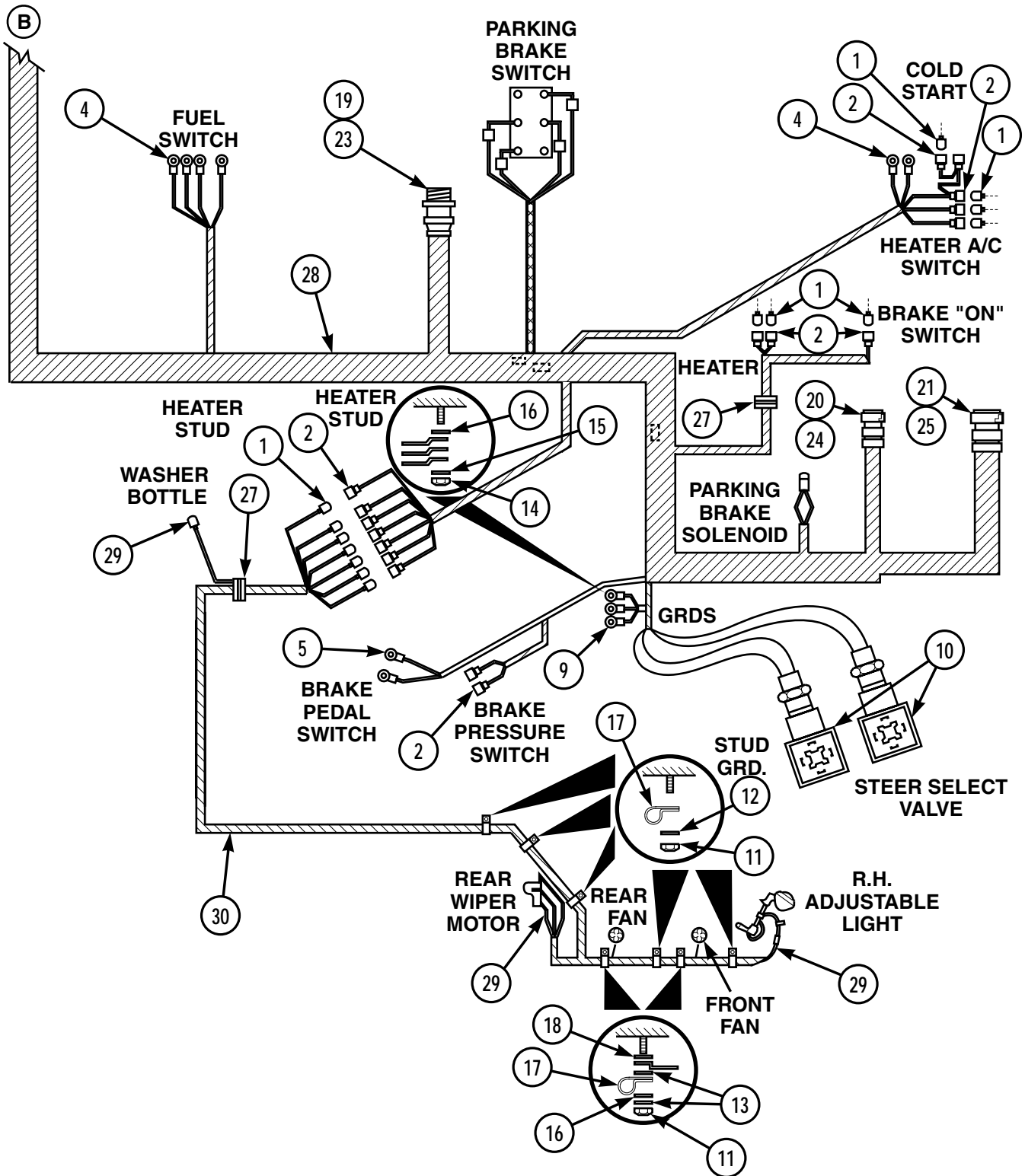
**b. Inspection.**

- (1) Check continuity of individual wires suspected of being open, using an ohmmeter. Identify wire ends by the markers.
- (2) Check connectors (22 and 23) for loose or broken pins.
- (3) Check grommets (26 and 27) for tears or deterioration.
- (4) Check terminals and single connectors for poor joints with wire, or other defects.





**6-5. CAB WIRING HARNESS REPLACEMENT/REPAIR (CONT)**



**c. Installation.****NOTE**

Connect all electrical leads as tagged during removal.

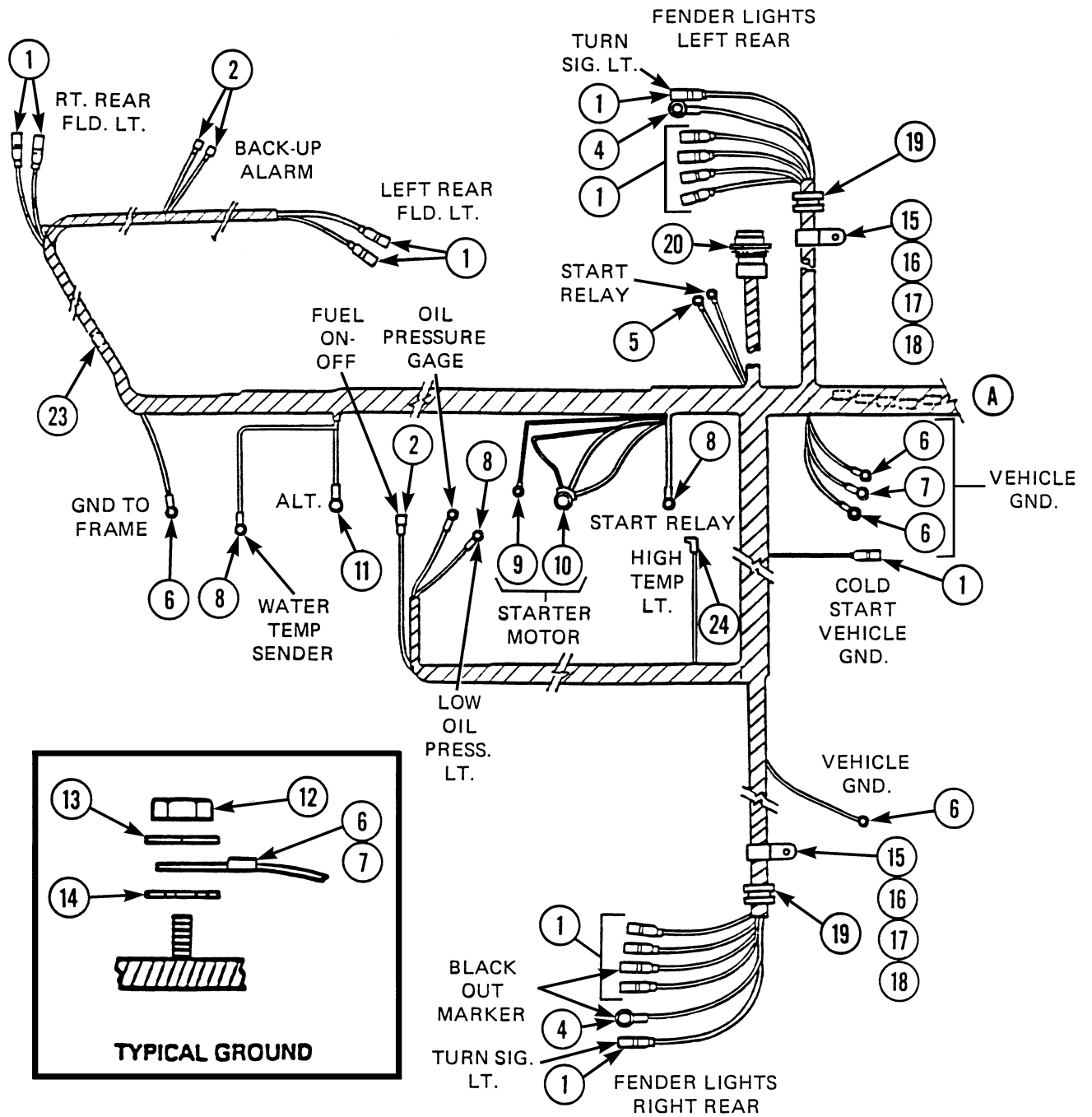
- (1) **Secure rear wire harness section (30) with eight cable clamps (17), six nuts (11), six lockwashers (12), four lockwashers (13), and two flat washers (16). Install grommet (27).**
- (2) **Insert r.h. adjustable light wire terminal (29) through cab wall. Connect terminal (29) to r.h. adjustable light.**
- (3) **Connect remaining six terminals (29) to devices indicated.**
- (4) **Connect connectors (22, 23, 24 and 25) to original locations. Install cable clamps (19, 20, and 21).**
- (5) **Install two grommets (26) and grommet (27) to front harness section (28).**
- (6) **Connect eleven connectors (9), thirty-four connectors (8), six connectors (7), connectors (6), twenty-seven connectors (5), and eighteen connectors (4) to devices indicated.**
- (7) **Secure leads to heater stud with flatwasher (16), new lockwasher (15) and nut (14).**
- (8) **Secure leads to two ground studs under instrument panel with nuts (11), lockwashers (13), flatwashers (16), and lockwashers (18).**
- (9) **Connect forty-four female connectors (2) to male connectors (1).**
- (10) **Insert l.h. adjustable light connector (2) through hole in cab wall and plug into l.h. adjustable light. Install grommet (26) and four cable clamps (17).**

**NOTE**

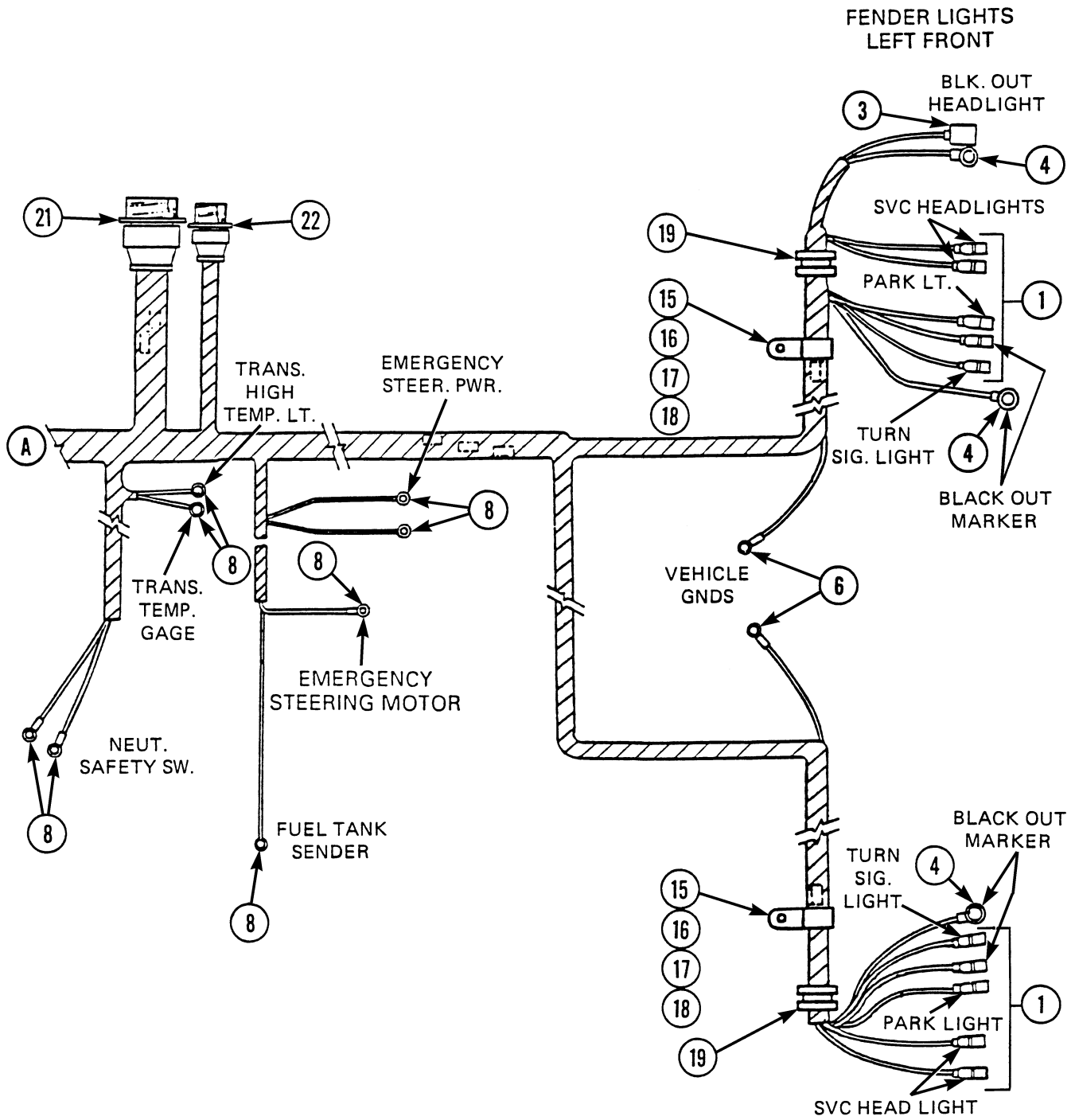
Follow-on Maintenance: Connect negative battery cable (TM10-3930-660-20).

**END OF TASK**





**6-6. MAIN WIRING HARNESS REPLACEMENT (CONT)**



**b. Installation.**

- (1) **Secure main wire harness (23) with four cable clamps (18), four lockwashers (17), four nuts (16), and four screws (15).**
- (2) **Insert wire harness branches through holes in frame and install four grommets (19).**
- (3) **Connect connectors (20, 21, and 22) to original locations.**
- (4) **Connect ground terminal rings (6 and 7), install five nuts (12) five lockwashers (13), and five flat washers (14).**
- (5) **Connect four terminal rings (4), two terminal rings (5), eight terminal rings (6), terminal ring (7), twelve terminal rings (8), terminal ring (9), terminal ring (10), terminal ring (11), and terminal ring (24) to devices indicated.**
- (6) **Plug in 25 male connectors (1), three spade terminals (2), and female receptacle (3) to devices indicated.**

**NOTE**

Follow-on Maintenance: Connect negative battery cable (TM 10-3930-660-20).

**END OF TASK**

**6-7. ELECTRIC JOYSTICK ASSEMBLY REPAIR/TEST/ADJUSTMENT**

This Task Covers:

- |                                     |   |
|-------------------------------------|---|
| a. Microswitch Removal              | d. Handle Pushbutton Switch Installation                    |
| b. Handle Pushbutton Switch Removal | e. Microswitch Installation                                 |
| c. Inspection                       | f. "Threshold" and "Max Out" Setting Testing and Adjustment |

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)

*Test Equipment*

Multimeter, Digital (Item 14, Appendix D)

*Equipment Condition*

Electric joystick removed (TM 10-3930-673-20)

*Materials/Parts*

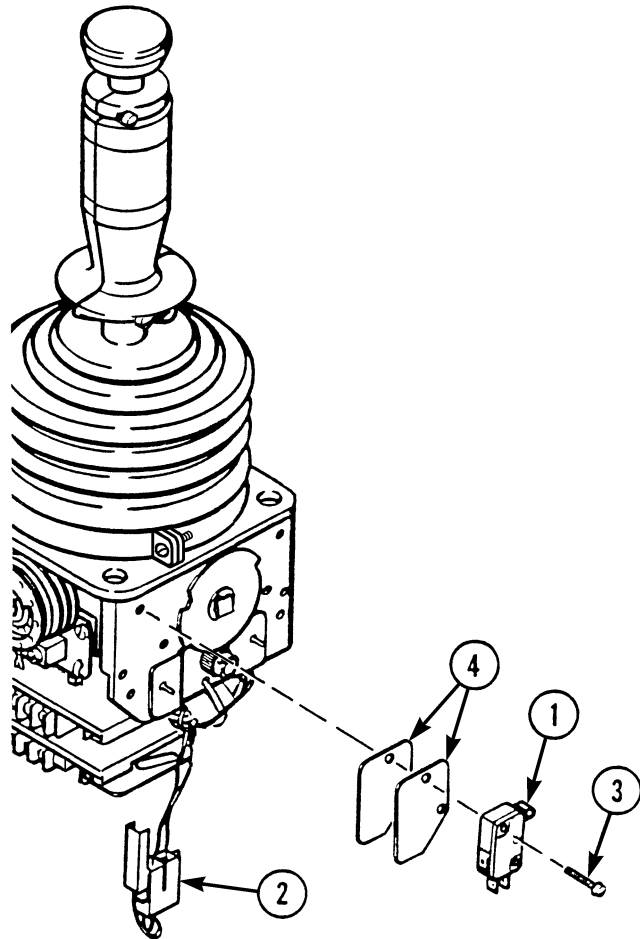
Bowed washers (2)  
 Tags (Item 55, Appendix B)  
 Solder (Item 51, Appendix B)

**NOTE**

All four microswitches are removed the same way. Only one is shown.

**a. Microswitch Removal. Remove microswitch (1).**

- (a) Tag, mark, and disconnect plug (2) from microswitch (1).
- (b) Remove two screws (3), microswitch (1), and two spacers (4).
- (c) Repeat Steps (a) and (b) for remaining microswitches.





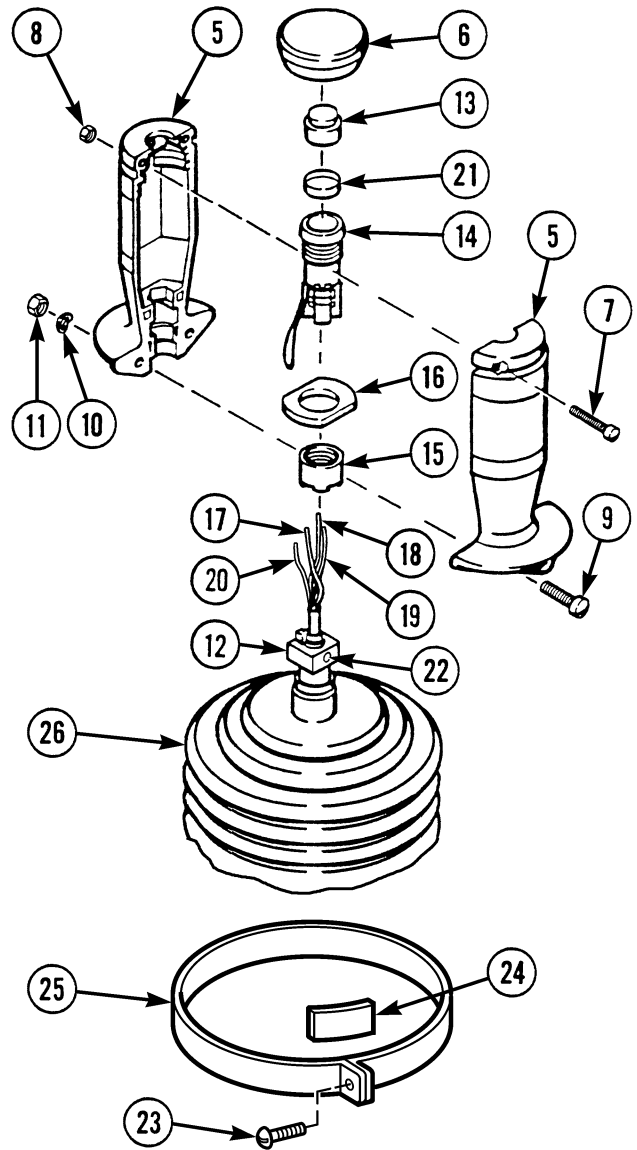
**b. Handle Pushbutton Switch Removal.**

**(1) Remove parts (6 through 11) and parts (13 through 16) from handle sections (5).**

- (a) Pull off boot (6) from handle sections (5).
- (b) Remove two screws (7) and nuts (8) from top of handle sections (5).
- (c) Remove two screws (9), bowed washers (10), and nuts (11) at bottom of handle sections (5). Discard bowed washers.
- (d) Separate handle sections (5) and remove them from shaft coupling (12).
- (e) Remove actuating button (13) from handle section (5).
- (f) Remove pushbutton switch (14), nut (15), and flange (16) as an assembly from handle sections (5).

**(2) Tag, mark, and desolder four wires (17 through 20) from pushbutton switch (14) and disassemble parts (12, 15, 16, and 21 through 26).**

- (a) Tag, mark, and desolder four wires (17 through 20) from pushbutton switch (14).
- (b) Remove nut (15) and flange (16) from pushbutton switch (14).
- (c) Remove cover (21) from pushbutton switch (14).
- (d) If damaged, loosen set screw (22) and remove shaft coupling (12) and set screw.
- (e) If damaged, remove screw (23), band (24), clamp (25), and boot (26).



**c. Inspection.**

- (1) Check for loose or disconnected plug (2) at switch (1).**
- (2) Check all switches for loose mounting hardware or visible damage.**

**6-7. ELECTRIC JOYSTICK ASSEMBLY REPAIR/TEST/ADJUSTMENT (CONT)**

**d. Handle Pushbutton Switch Installation.**

**(1) Assemble parts (12, 15, 16, and 21 through 26) and solder four wires (17 through 20) to pushbutton switch (14).**

- (a) If removed, install boot (26), clamp (25), band (24), and screw (23).
- (b) If removed, install shaft coupling (12) and set screw (22).
- (c) Install cover (21) on pushbutton switch (14).
- (d) Install flange (16) and nut (15) on pushbutton switch (14).
- (e) Solder four wires (17 through 20) to pushbutton switch (14).

**(2) Install parts (6 through 11) and parts (13 through 16) in handle sections (5).**

**NOTE**

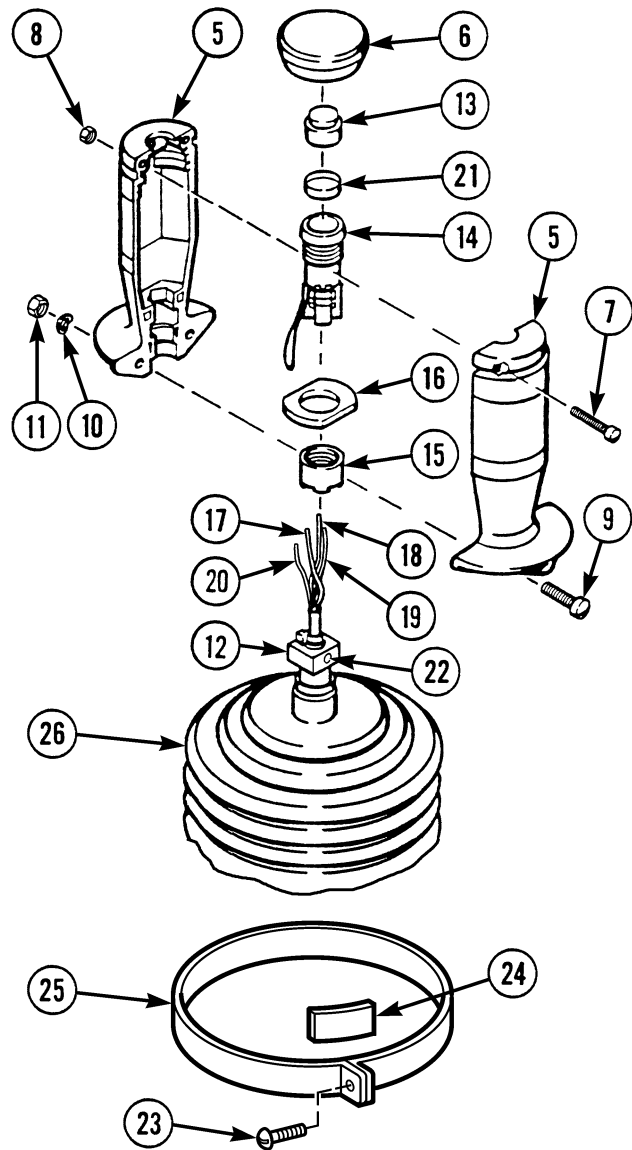
Align handle section on shaft coupling so that coupling set screw is facing center of handle section.

- (a) Place one handle section (5) on shaft coupling (12).

**NOTE**

Place switch flange in lowest slot with flat surface of flange facing center of handle section.

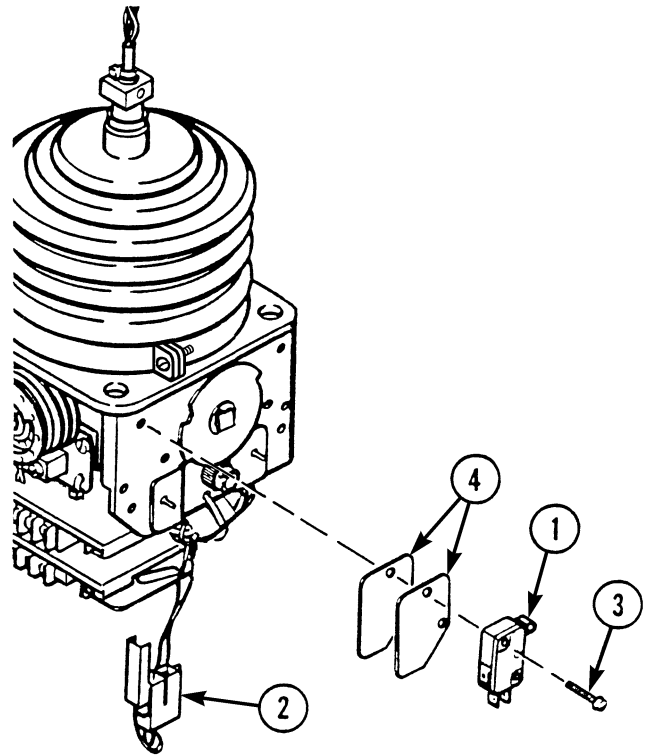
- (b) Install pushbutton switch (14), flange (16), and nut (15) as an assembly in handle section (5).
- (c) Install actuating button (13) with larger diameter of button extending through top of handle section (5).
- (d) Place other handle section (5) on shaft coupling (12).
- (e) Install two screws (9), bowed washers (10), and nuts (11) at bottom of handle sections (5).



- (f) Install two screws (7) and two nuts (8) at top of handle sections (5).
- (g) Place boot (6) on handle sections (5).

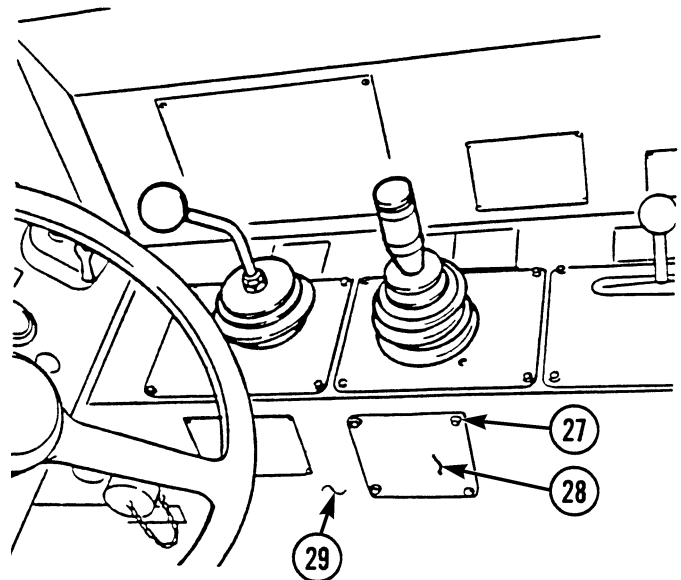
**e. Microswitch Installation. Install microswitch (1).**

- (a) Install microswitch (1), two spacers (4) and screws (3).
- (b) Connect plug (2) to microswitch (1).
- (c) Repeat Steps (a) and (b) for remaining microswitches.



**f. "Threshold" and "Max Out" Settings Testing and Adjustment.**

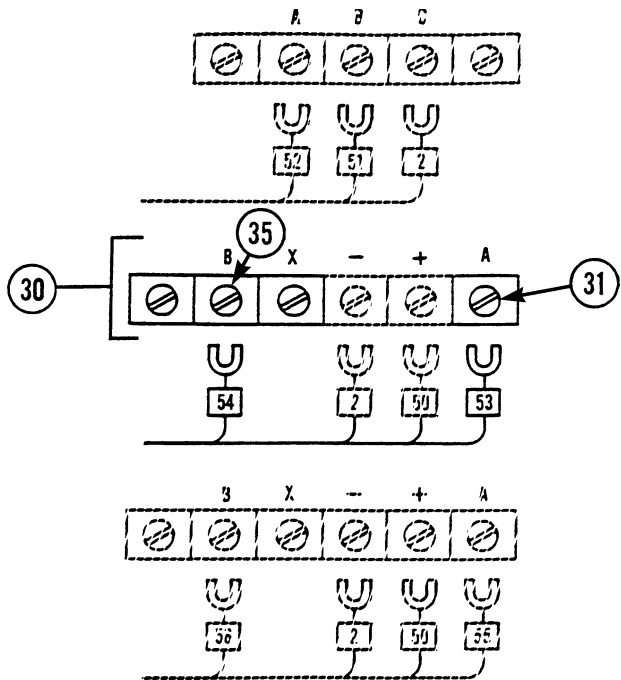
- (1) Install electric joystick (TM 10-3930-673-20).
- (2) Remove four screws (27) and cover (28) from side console (29).



**6-7. ELECTRIC JOYSTICK ASSEMBLY REPAIR/TEST/ADJUSTMENT (CONT)**

**(3) Measure current flow to upper circuit board (30). If necessary, adjust “threshold” and “max out” controls.**

- (a) Loosen screw (31) at terminal A of upper circuit board (30) and disconnect electrical lead #53.
- (b) Set multimeter to amps and connect positive (+) lead to terminal A of upper circuit board (30).
- (c) Connect negative (-) lead of multimeter to disconnected electrical lead #53.
- (d) Turn starter switch to the RUN position but do not start the engine (TM 10-3930-673-10).

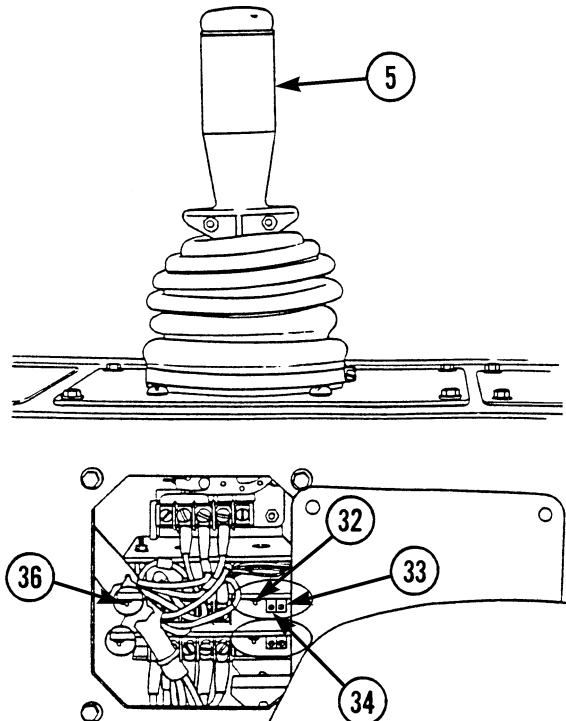


- (e) Slowly move joystick handle (5) to the left until indicator light (32) just comes on. Multimeter reading should be between 300 and 340 ma.

**NOTE**

During Step (f), turn “threshold” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

- (f) If reading in Step (e) was not within limits of 300 to 340 ma, adjust “threshold” control (33) and repeat Step (e) until multimeter reads approximately 320 ma.
- (g) Move joystick handle (5) *fully to the left* and observe multimeter reading. Reading should be between 600 and 640 ma.



**NOTE**

During Step (h), turn “max out” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

- (h) If reading in Step (g) was not within limits of 600 to 640 ma., adjust “max out” control (34) and repeat Step (g) until multimeter reads approximately 620 ma.
- (i) Turn starter switch off (TM 10-3930-673-10).
- (j) Disconnect leads of multimeter. Secure electrical lead #53 to terminal A of upper circuit board (30) with screw (31).
- (k) Loosen screw (35) at terminal B of upper circuit board (30) and disconnect electrical lead #54.
- (l) Connect positive (+) lead of multimeter to terminal B of upper circuit board (30).
- (m) Connect negative (–) lead of multimeter to disconnected electrical lead #54.
- (n) Turn starter switch to the RUN position but do not start the engine (TM 10-3930-673-10).
- (o) Slowly move joystick handle (5) to the right until indicator light (36) just comes on. Multimeter reading should be between 300 and 340 ma.

**NOTE**

During Step (p), Turn “threshold” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

- (p) If reading in Step (o) was not within limits of 300 to 340 ma, adjust “threshold” control (33) and repeat Step (o) until multimeter reads approximately 320 ma.
- (q) Move joystick handle (5) *fully to the right* and observe multimeter reading. Reading should be between 600 and 640 ma.

**NOTE**

During Step (r), turn “max out” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

- (r) If reading in Step (q) was not within limits of 600 to 640 ma., adjust “max out” control (34) and repeat Step (q) until multimeter reads approximately 620 ma.
- (s) Turn starter switch off (TM 10-3930-673-10).
- (t) Disconnect leads of multimeter. Secure electrical lead #54 to terminal B of upper circuit board (30) with screw (35).
- (u) Repeat Steps (a) through (j) and check that current headings are still within limits. Readjust “threshold” (33) and “max out” (34) controls as required.



- (h) If reading in Step (g) was not within limits of 600 to 640 ma., adjust “max out” control (41) and repeat Step (g) until multimeter reads approximately 620 ma.
- (i) Turn starter switch off (TM 10-3930-673-10).
- (j) Disconnect leads of multimeter. Secure electrical lead #55 to terminal A of lower circuit board (37) with screw (38).
- (k) Loosen screw (42) at terminal B of lower circuit board (37) and disconnect electrical lead #56.
- (l) Connect positive (+) lead of multimeter to terminal B of lower circuit board (37).
- (m) Connect negative (–) lead of multimeter to disconnected electrical lead #56.
- (n) Turn starter switch to the RUN position but do not start the engine (TM 10-3930-673-10).
- (o) Move joystick handle (5) forward until indicator light (43) just comes on. Multimeter reading should be between 300 and 340 ma.

#### NOTE

During Step (p), Turn “threshold” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

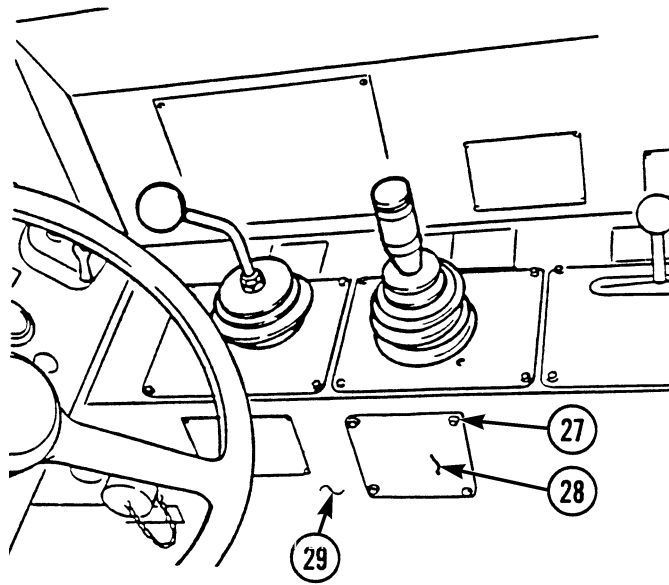
- (p) If reading in Step (o) was not within limits of 300 to 340 ma., adjust “threshold” control (40) and repeat Step (o) until multimeter reads approximately 320 ma.
- (q) Move joystick handle (5) *fully forward* and observe multimeter reading. Reading should be between 600 and 640 ma.

#### NOTE

During Step (r), turn “max out” control counterclockwise to lower multimeter reading, and clockwise to raise multimeter reading.

- (r) If reading in Step (q) was not within limits of 600 to 640 ma., adjust “max out” control (41) and repeat Step (q) until multimeter reads approximately 620 ma.
- (s) Turn starter switch off (TM 10-3930-673-10).
- (t) Disconnect leads of multimeter. Secure electrical lead #56 to terminal B of lower circuit board (37) with screw (42).
- (u) Repeat Steps (a) through (k) and check that current readings are still within limits. Readjust “threshold” (40) and “max out” (41) controls as required.

**6-7. ELECTRIC JOYSTICK ASSEMBLY REPAIR/TEST/ADJUSTMENT (CONT)**



(5) Install cover (28) and four screws (27) on console (29).

**END OF TASK**



## CHAPTER 7

### TRANSMISSION SYSTEM MAINTENANCE

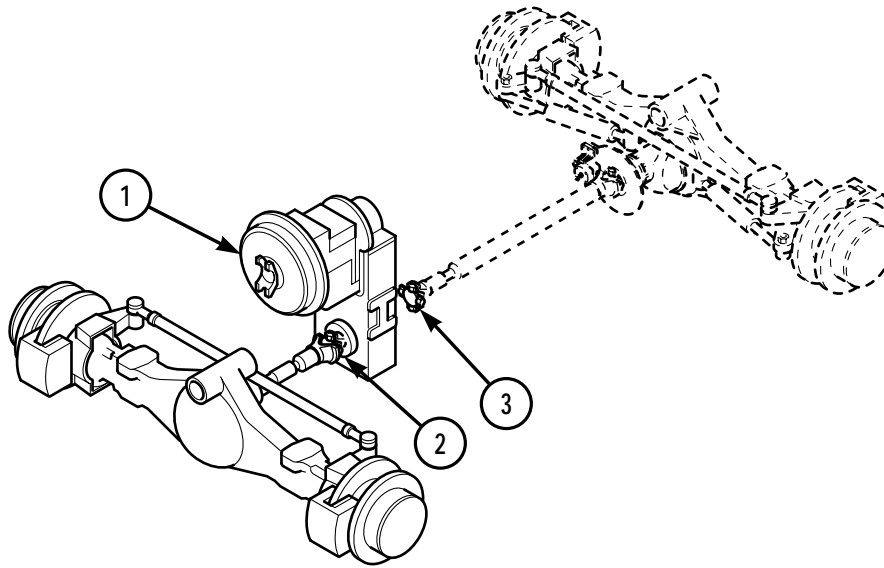
Para	Contents	Page
Section I. Description and Data		
7-1.	General .....	7-2
7-2.	Principles of Operation .....	7-2
Section II. Transmission Maintenance Procedures		
7-3.	Torque Converter Replacement/Repair .....	7-3
7-4.	Transmission Assembly Replacement/Repair .....	7-9
7-5.	Transmission Front Cover Replacement/Repair .....	7-42
7-6.	Transmission Output Shaft Replacement/Repair/Adjustment .....	7-50
7-7.	Transmission Input Shaft Replacement/Repair .....	7-54
7-9.	Transmission Control Valve Replacement/Repair .....	7-57
7-10.	Transmission Oil Pump Replacement/Repair .....	7-63

## Section I. DESCRIPTION AND DATA

### 7-1. GENERAL

This chapter covers maintenance procedures for the transmission, as well as principles of operation.

### 7-2. PRINCIPLES OF OPERATION



**a. General.** The transmission has four forward and four reverse speeds, with speed and direction controlled by hydraulic operated clutches. Engine torque is coupled to the transmission through the torque converter (1).

**b. Torque Converter.** The torque converter (1) couples engine torque to the transmission input shaft. It is basically a fluid drive, which has no mechanical connection through it. This feature not only eliminates nearly all wear, but also provides a smooth and almost shock-free drive which prevents engine stalling and lugging. Under light loads, engine speed is transmitted at almost a 1:1 ratio through the torque converter. As loads increase, however, the torque converter inherently multiplies engine torque. The need to manually shift transmission gears is therefore greatly reduced, but not totally eliminated.

**c. Clutches.** The clutches are hydraulically applied and spring released. Using hydraulic power to control clutch application permits automatic compensation for clutch wear; therefore, there is no need for clutch adjustment. Each clutch contains a number of paper graphitic friction plates and polished steel reaction plates. Clutch actuation determines speed and direction of rotation of output shafts (2 and 3), which transmit power to the respective axle differentials.

## Section II. TRANSMISSION MAINTENANCE PROCEDURES

### 7-3. TORQUE CONVERTER REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)  
 Bearing Puller (Item 15, Appendix D)

##### *Equipment Condition*

Transmission output shaft removed (Para 7-6)

##### *Materials / Parts*

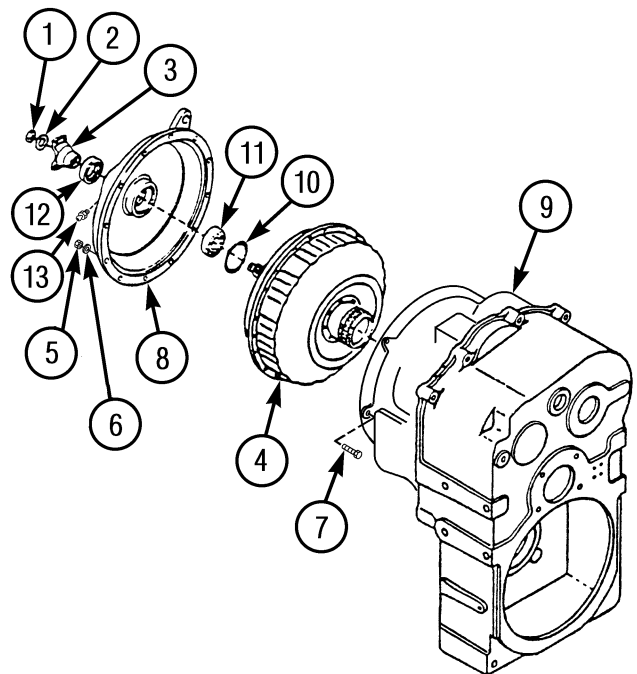
Compound, Sealing (Item 39, Appendix B)  
 Compound, Sealing (Item 41, Appendix B)  
 Oil, Hydraulic (Item 30, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)  
 Lockwashers (12)  
 Packing, Preformed  
 Packing, Preformed  
 Starwasher (12)

#### **a. Removal.**

- (1) Remove nut (1), washer (2), and yoke (3) from torque converter (4).
- (2) Remove 12 nuts (5), starwashers (6), screws (7), and torque converter cover (8) from transmission housing (9). Discard starwashers.
- (3) Remove torque converter (4) from transmission housing (9) and place on a clean workbench with front cover facing up.

#### **b. Disassembly.**

- (1) Remove parts (10 through 13) from torque converter cover (8).

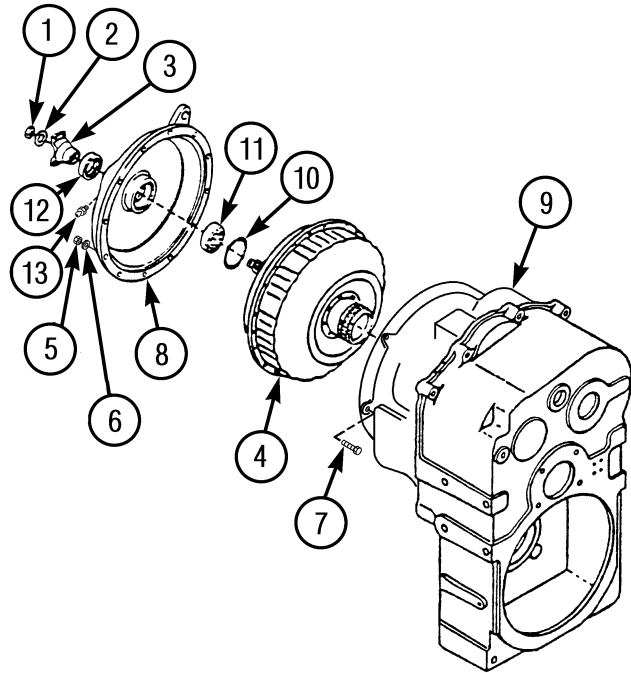


**7-3. TORQUE CONVERTER REPLACEMENT/REPAIR (CONT)**

**WARNING**

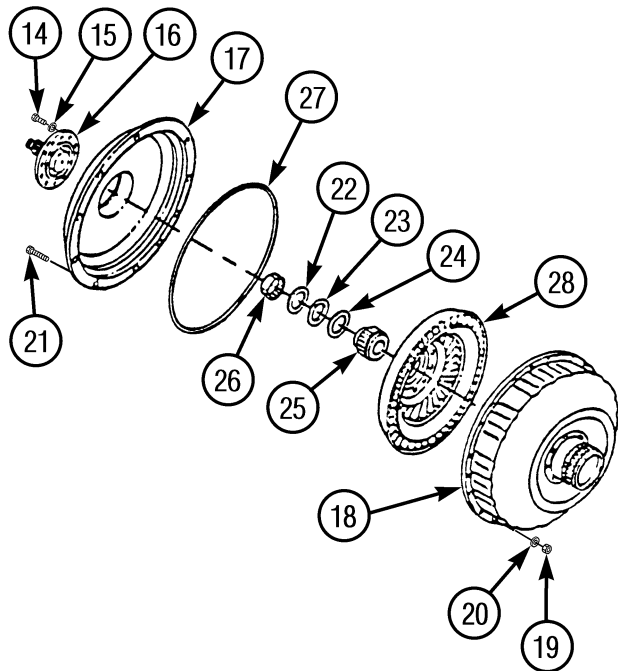
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove snap ring (10), bearing (11), and oil seal (12) from torque converter cover (8).
- (b) Remove lubrication fitting (13) from torque converter cover (8).



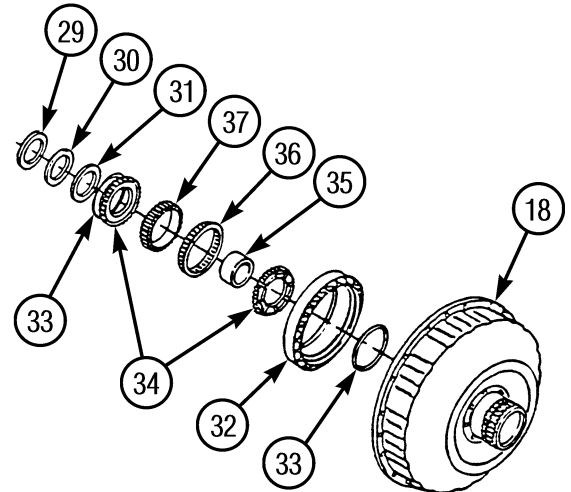
**(2) Remove parts (14 through 16), front cover (17), parts (18 through 27), and turbine (28).**

- (a) Remove 12 screws (14), lockwashers (15), and converter input shaft (16) from front cover (17). Discard lockwashers.
- (b) Mark front cover (17) and impeller (18) for ease of assembly. Remove 20 nuts (19), washers (20), screws (21), and front cover from impeller.
- (c) Remove outer thrust race (22), needle thrust bearing (23), and inner thrust race (24) from turbine hub (25).
- (d) Using suitable puller, remove bearing (26) from input shaft (16).
- (e) Remove preformed packing (27) from front cover (17). Discard preformed packing.
- (f) Remove turbine hub (25) and turbine (28) from impeller (18).



**(3) Remove parts (29, 30, and 31), stator (32), and disassemble parts (33 through 37).**

- (a) Remove outer thrust washer (29), needle thrust bearing (30), inner thrust washer (31), and stator (32) from impeller (18).



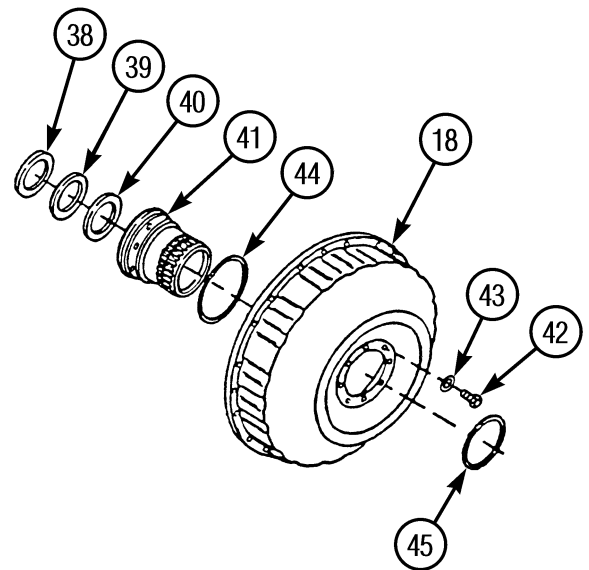
**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Remove two retaining rings (33), two clutch retainers (34), inner race (35), sprag clutch (36), and outer race (37).

**(4) Remove parts (38 through 40), impeller hub (41), and parts (44 and 45).**

- (a) Remove outer thrust washer (38), needle thrust bearing (39), and inner thrust washer (40) from impeller hub (41).
- (b) Remove eight screws (42), washers (43), and impeller hub (41) from impeller (18).
- (c) Remove preformed packing (44) and seal ring (45). Discard preformed packing.



**c. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**d. Inspection.** See **Inspection Instructions (Para 2-14).**

**e. Assembly.**

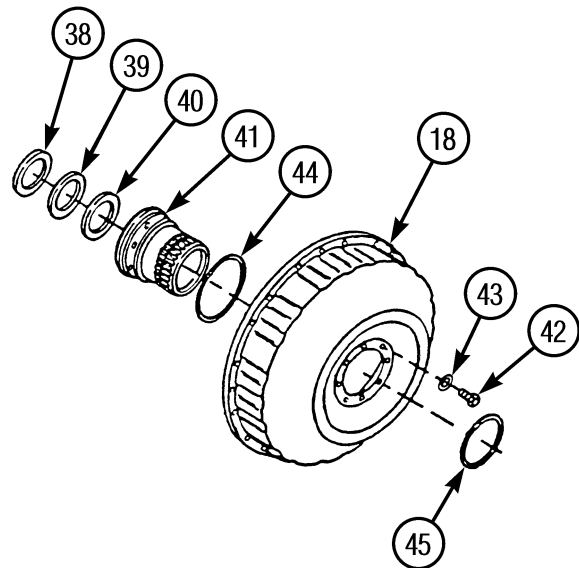
**NOTE**

Wipe all sealing surfaces clean and dry. Apply a thin film of clean hydraulic oil to all seals and bearings as they are installed.

- (1) Install parts (44 and 45), impeller hub (41), and parts (38 through 40).**

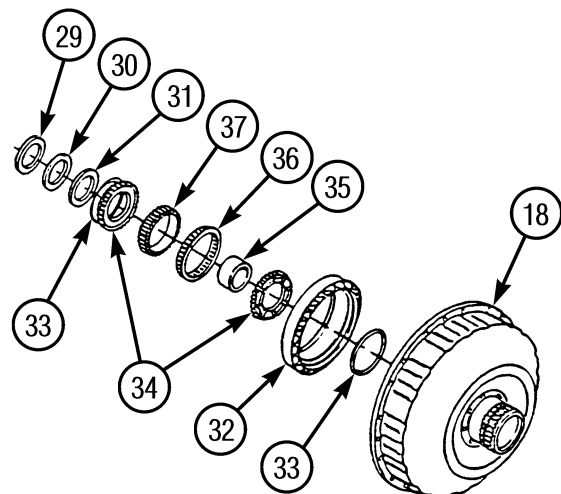
**7-3. TORQUE CONVERTER REPLACEMENT/REPAIR (CONT)**

- (a) Install preformed packing (44) at base of impeller hub (41).
- (b) Install seal ring (45) on impeller hub (41).
- (c) Install impeller hub (41), eight screws (42), and washers (43) on impeller (18). Tighten screws to 25 lb-ft (33.9 N•m).
- (d) Install inner thrust washer (40), needle thrust bearing (39), and outer thrust washer (38) on impeller hub (41).



**(2) Assemble parts (33 through 37), install stator (32), and parts (29, 30, and 31).**

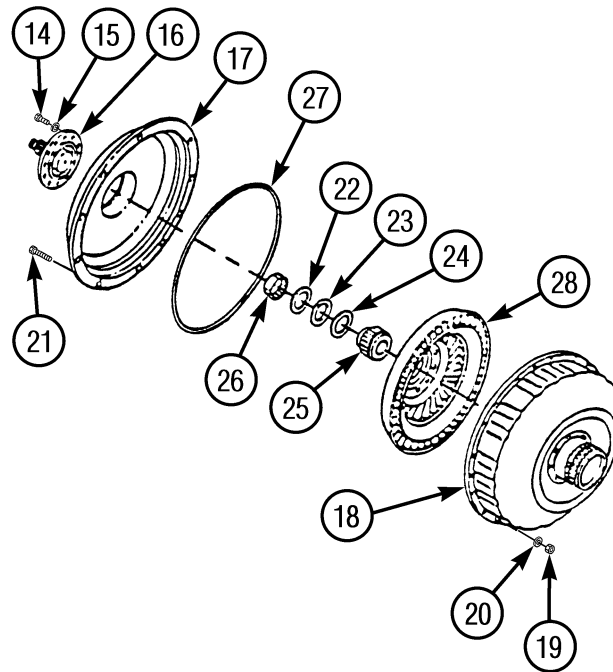
- (a) Install outer race (37), sprag clutch (36), and inner race (35). Clutch flange should be toward front of converter as shown. Stator will freewheel counterclockwise viewed from output end.
- (b) Install sprag clutch (36) with flanged edge of cage toward side of stator (32) marked "FRONT" or the letter "F." The stator will free-wheel counterclockwise when viewed from output side.



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Install two clutch retainers (34) and two retaining rings (33).
- (d) Install stator (32) in impeller (18) so that the word "FRONT" faces away from impeller.
- (e) Install inner thrust washer (31), needle thrust bearing (30), and outer thrust washer (29) on impeller (18).



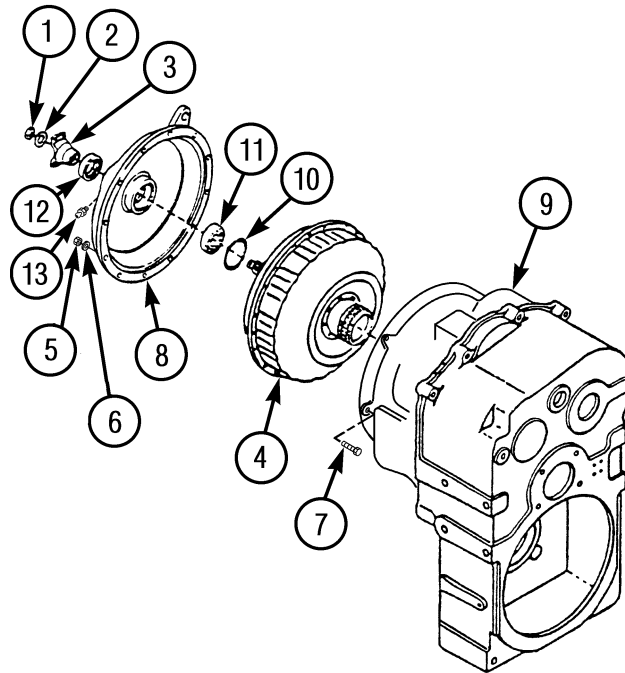
- (3) Install turbine (28), parts (24 through 27), front cover (17), and parts (14 through 18).**
- Install turbine (28) and turbine hub (25) on impeller (18).
  - Install inner thrust race (24), needle thrust bearing (23), and outer thrust race (22) on turbine hub (25).
  - Install bearing (26) 0.040 in. (1.02 mm) below thrust race (22) surface on input shaft (16).
  - Install preformed packing (27) on front cover (17).
  - Align marks made at disassembly between front cover (17) and impeller (18). Install front cover.

### WARNING

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

- Apply sealing compound to threads of screws (21). Install 20 screws (21), washers (20), and nuts (19). Tighten screws to 25 lb-ft (33.9 N•m).
- Install converter input shaft (16). Apply sealing compound to threads of screws (14). Install 12 lockwashers (15) and screws. Tighten screws to 30 lb-ft (40.7 N•m).

**7-3. TORQUE CONVERTER REPLACEMENT/REPAIR (CONT)**



**(4) Install parts (10 through 13) in front housing (8).**

- (a) Install lubrication fitting (13) on front housing (8).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Install oil seal (12), bearing (11), and snap ring (10) in front housing (8).

**f. Installation.**

- (1) Install torque converter (4) in transmission housing (9).**
- (2) Install front housing (8), twelve screws (7), starwashers (6), and nuts (5) on transmission housing (9).**
- (3) Install yoke (3), washer (2), and nut (1) on torque converter (4). Tighten nut to 300 - 350 lb-ft (406.8 - 474.5 N•m).**

**NOTE**

Follow-on Maintenance: Install transmission driveshaft shaft (Para 7-6).

**END OF TASK**



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Inspection   |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 1 Less Power (Item 16, Appendix D)
- Tool Kit (Item 25, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Wrench, Torque 0 - 175 lb-ft (0 - 237 N•m) (Item 28, Appendix D)
- Transmission alignment Bars - Fabricated Tools (Figure C-6, Appendix C)
- Lifting Device, 5 ton (4535.92 kg) capacity
- Bearing Press
- Bearing Puller
- Drift
- Gear Puller
- Pry Bars (2)
- Wedge

*Equipment Condition*

- Transmission oil drained (TM 10-3930-673-20)
- Transmission cover removed (TM 10-3930-673-20)

*Materials/Parts*

- Compound, Sealing (Item 40, Appendix B)
- Grease (Item 18, Appendix B)
- Oil, Transmission (Item 30, Appendix B)
- Tags (Item 55, Appendix B)
- Tie Wrap (Item 55, Appendix B)
- Container, 5 gal (19 l) capacity
- Gasket
- Lockwashers (4)
- Lockwashers (4)
- Lockwashers (4)
- Lockwashers (8)
- Lockwashers (2)
- Lockwashers (2)
- Packing, Preformed
- Packing, Preformed
- Packing, Preformed
- Packing, Preformed
- Packing, Preformed
- Pins, Cotter (2)
- Seal
- Seal
- Seal
- Wood Block

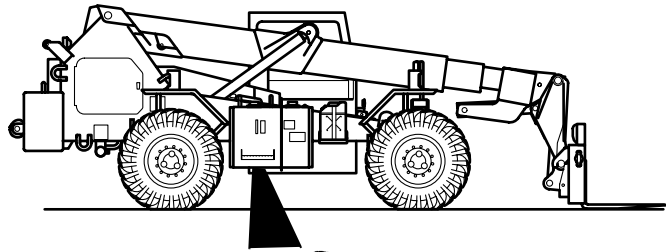
*Personnel Required*

Two

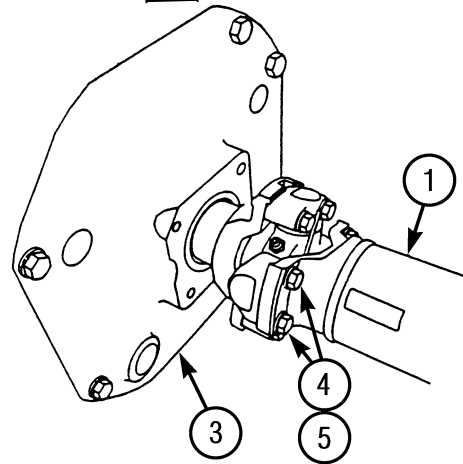
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**a. Removal.**

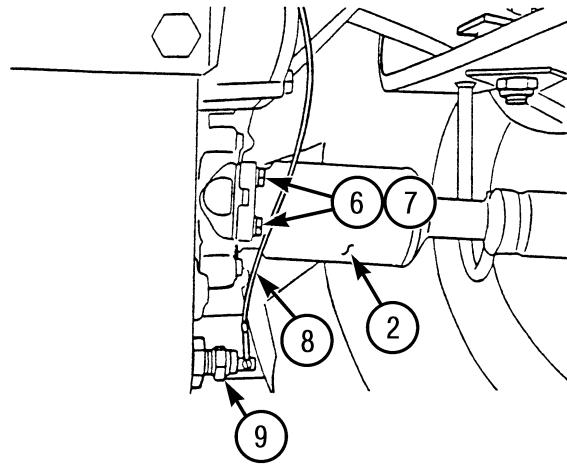
- (1) **Raise boom to maximum height. Use a hoist with sling or other suitable device to support boom.**
- (2) **Disconnect front propeller shaft (1) and rear propeller shaft (2) from transmission (3).**



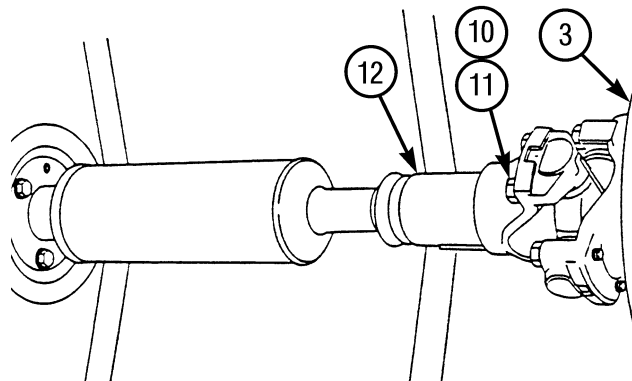
- (a) Remove four screws (4), lockwashers (5), and disconnect front propeller shaft (1) from transmission (3). Discard lockwashers. Carefully lower front propeller shaft to ground.
- (b) Remove four screws (6), lockwashers (7), and disconnect rear propeller shaft (2) from transmission (3). Discard lockwashers.

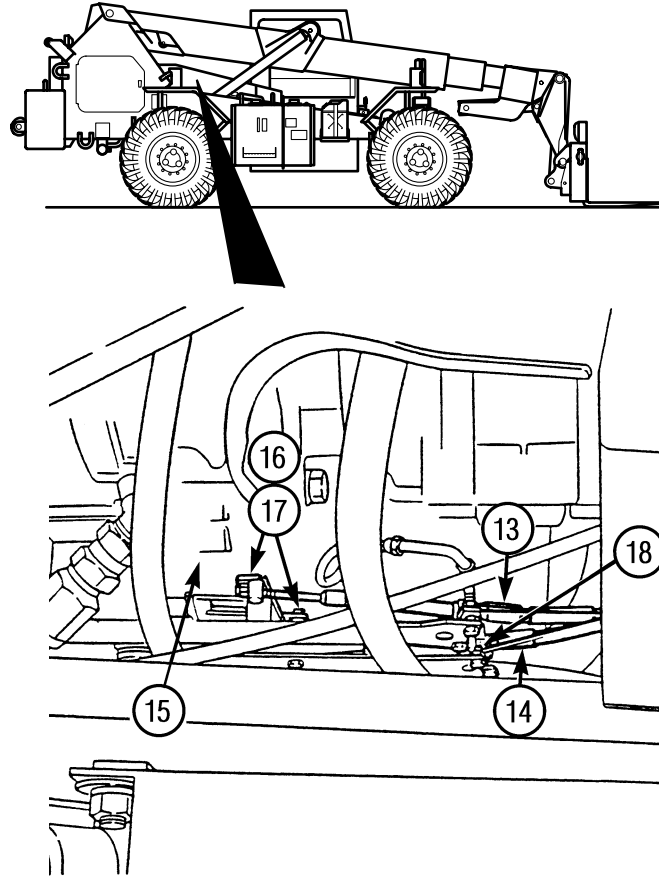


- (3) **Tag, mark, and disconnect wire (8) from transmission temperature switch (9).**



- (4) **Remove four screws (10), lockwashers (11), and disconnect transmission propeller shaft (12) from transmission (3) input yoke. Discard lockwashers. Slide yoke of shaft toward engine to provide clearance.**





**(5) Disconnect transmission cables (13 and 14) from transmission control valve (15).**

- (a) Remove cotter pin (16) and washer (17) from each transmission cable (13 and 14) at transmission control valve (15). Discard cotter pins.
- (b) Remove four nuts (18) securing clamps for transmission cables (13 and 14).
- (c) Tag, mark, and disconnect two transmission cables (13 and 14) from transmission control valve (15).

**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

**NOTE**

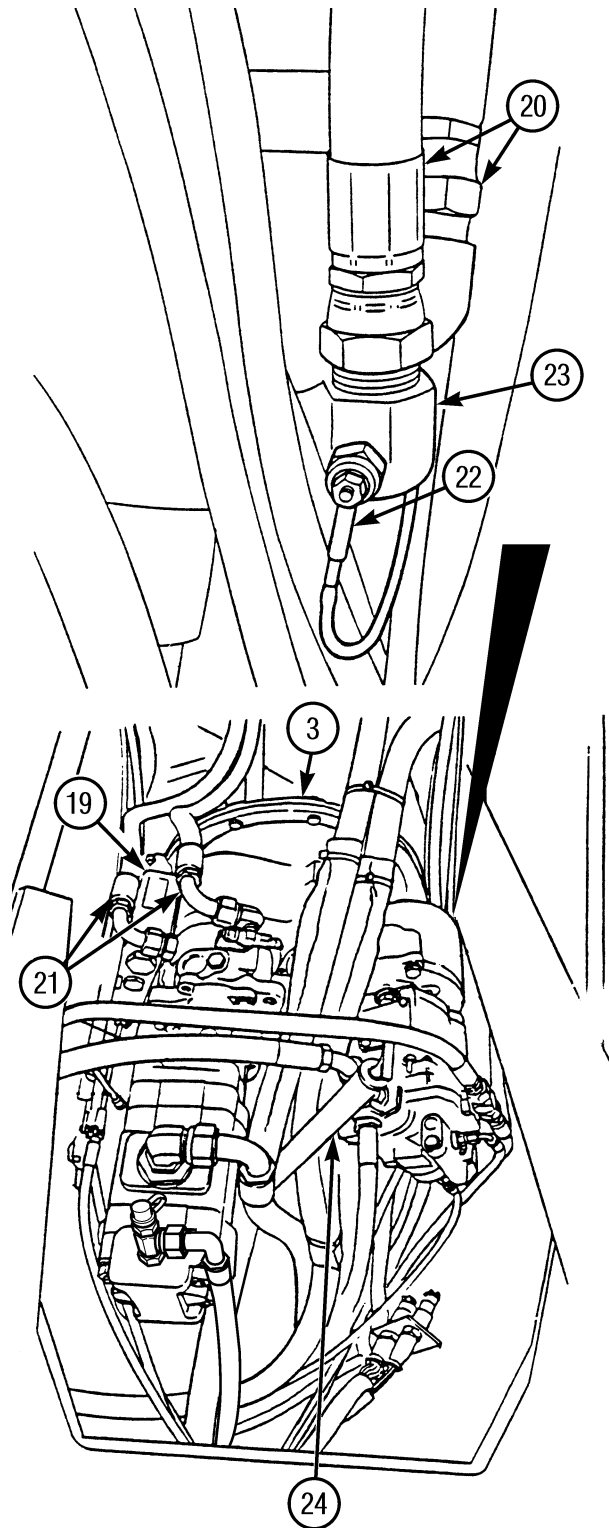
- If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.
- Remove tie wraps as necessary

**(6) Tag, mark, and disconnect hoses (19, 20, and 21).**

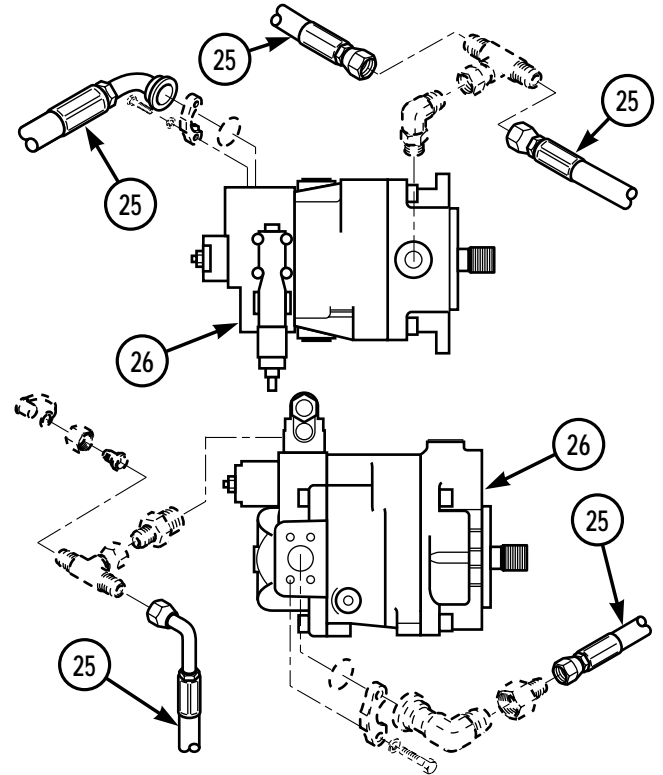
- (a) Tag, mark, and disconnect hose (19) from transmission control valve (15).
- (b) Tag, mark, and disconnect two hoses (20) from transmission (3).
- (c) Tag, mark, and disconnect two hoses (21) from transmission (3).

**(7) Tag, mark, and disconnect lead (22) from transmission temperature sender (23).**

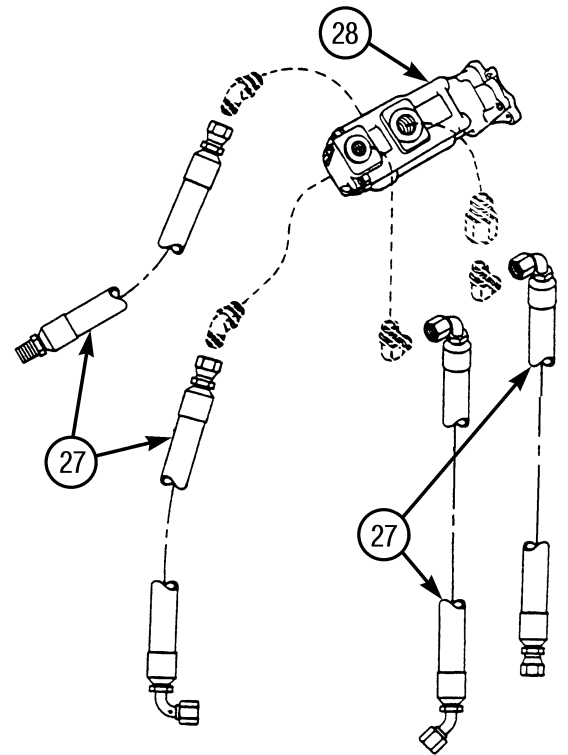
**(8) Remove transmission oil filler tube (24) from transmission (3).**



- (9) Tag, mark, and disconnect five hoses (25) from piston pump (26).

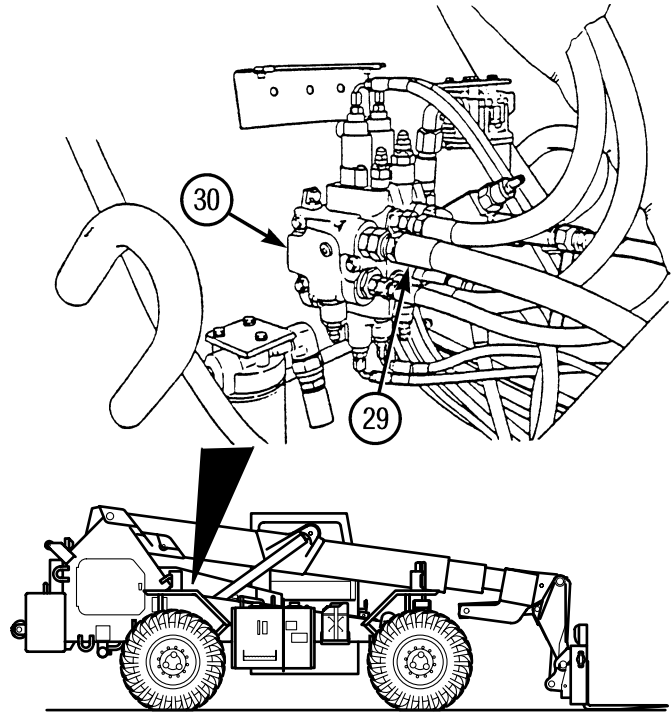


- (10) Tag, mark, and disconnect four hoses (27) from tandem gear pump (28).



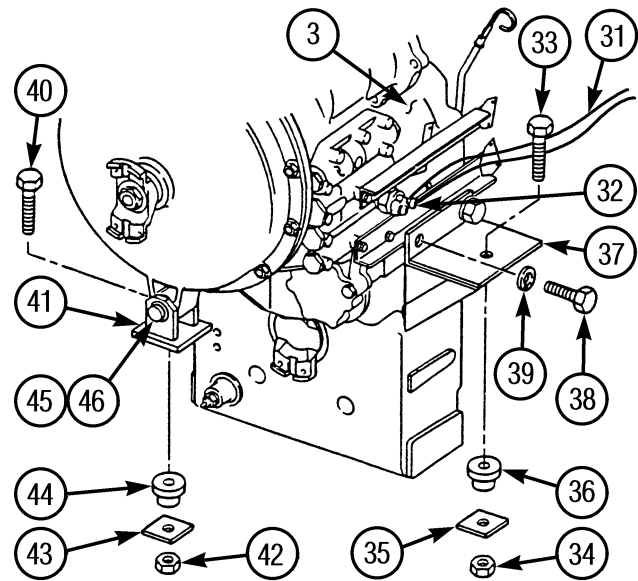
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (11) Tag, mark, and disconnect hose (29) at main control valve (30). Move all other hoses to either side of transmission to provide clearance.



- (12) Tag, mark, and disconnect two wires (31) from neutral safety switch (32).
- (13) Remove parts (33 through 38) and (40 through 43) from transmission (3).

- (a) Remove two screws (33), nuts (34), washers (35), and rubber mounts (36) from bracket (37).



**WARNING**

Transmission weighs approximately 950 lb (431 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (b) Use a hoist with slings or other suitable lifting device to support transmission (3). Place slings under input yoke and output yokes. Secure slings together.
- (c) Remove eight screws (38), lockwashers (39), and two brackets (37) from transmission (3). Discard lockwashers.

- (d) Place a drift and wedge between screw (40) and mounting bracket (41) to prevent screw from moving when removing nut (42).
- (e) Remove nut (42), washer (43), and rubber mount (44) from mounting bracket (41).

**(14) Remove transmission (3) from vehicle.**

- (a) Use hoist to slowly lift transmission (3) until it clears vehicle frame. Ensure that hoses and other obstructions are clear of transmission during removal.
- (b) Lift transmission forward and to the side so it clears boom lift cylinders.

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

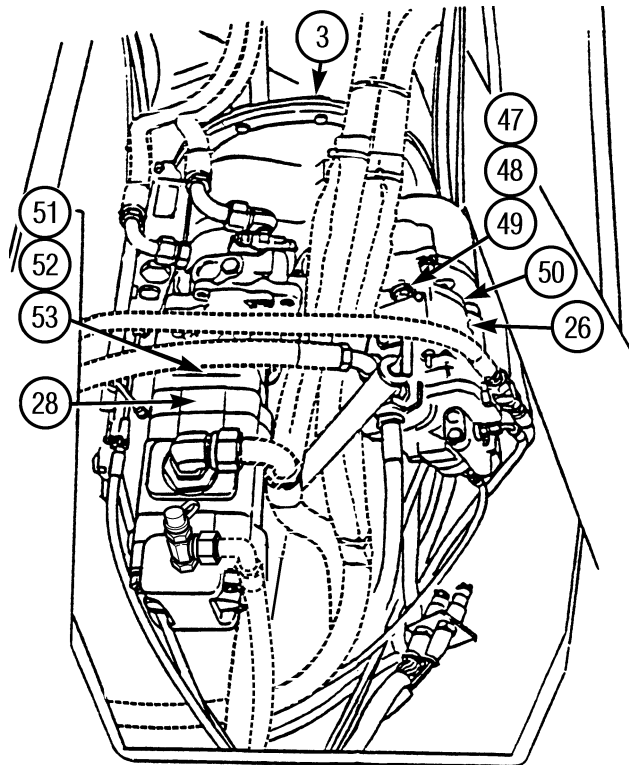
- (c) If damaged, remove retaining rings (45), shaft (46), mounting bracket (41), and screw (40) from transmission (3).

**(15) Remove piston pump (26) from transmission (3).**

- (a) Support piston pump (26) and remove two screws (47), lockwashers (48), washers (49), and piston pump. Discard lockwashers.
- (b) Remove preformed packing (50) from piston pump (26) drive adapter. Discard preformed packing.

**(16) Remove tandem gear pump (28) from transmission (3).**

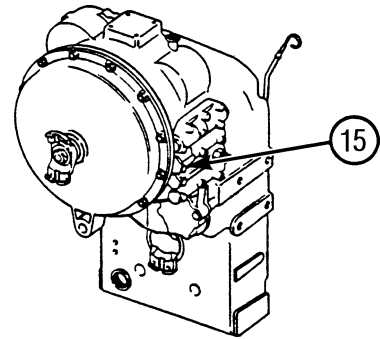
- (a) Remove two screws (51), lockwashers (52), and tandem gear pump (28) from transmission (3). Discard lockwashers.
- (b) Remove preformed packing (53) from tandem gear pump (28) drive. Discard preformed packing.



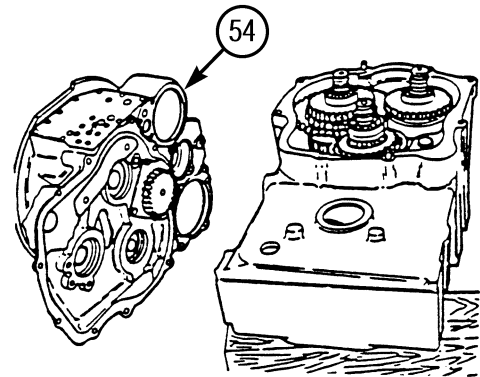
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**b. Disassembly.**

- (1) **Remove transmission control valve (15) (Para 7-9).**



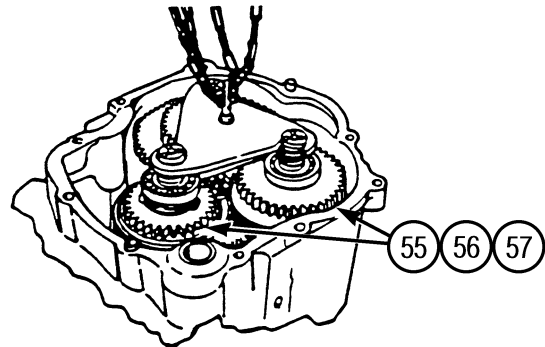
- (2) **Remove transmission front cover assembly (54) (Para 7-5).**



**NOTE**

All three clutch packs must be removed together because of gear meshing.

- (3) **Remove three clutch packs (55, 56, and 57) from transmission (3) main case.**



- (a) Install a special lifting tool in bottom groove of all three clutch packs (55, 56, and 57) shafts.
- (b) Attach a hoist with slings to special lifting tool and remove three clutch packs (55, 56, and 57).
- (c) Place clutch packs (55, 56, and 57) on a clean bench. Place a wood block under first stage clutch pack.
- (d) Remove special lifting tool from clutch packs (55, 56, and 57).

- (4) **Separate three clutch packs (55, 56, and 57).**

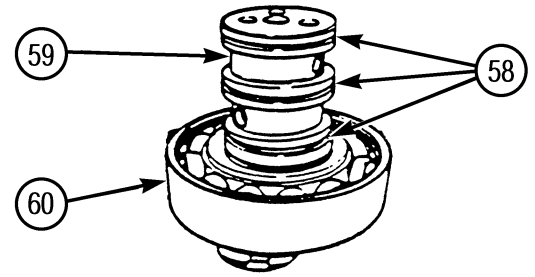


(5) **Disassemble first stage clutch pack (55) parts (58 through 75).**

**CAUTION**

Use care when removing seal rings to prevent clutch shaft damage.

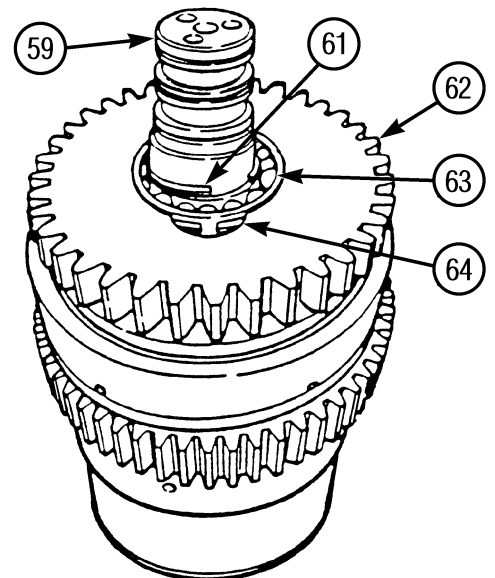
- (a) Remove three seal rings (58) from shaft assembly (59).
- (b) Use two pry bars, 180° apart, to pry bearing (60) up and remove it from shaft assembly (59).



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Remove snap ring (61) from shaft assembly (59).
- (d) Use a gear puller to remove weld gear (62) and bearing (63) as an assembly from shaft assembly (59).
- (e) Using an assistant to spread snap ring (64), use a driver to remove bearing (63) from weld gear (62).



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (f) Remove snap ring (65).
- (g) Slide retainer (66) out of shaft assembly (59).

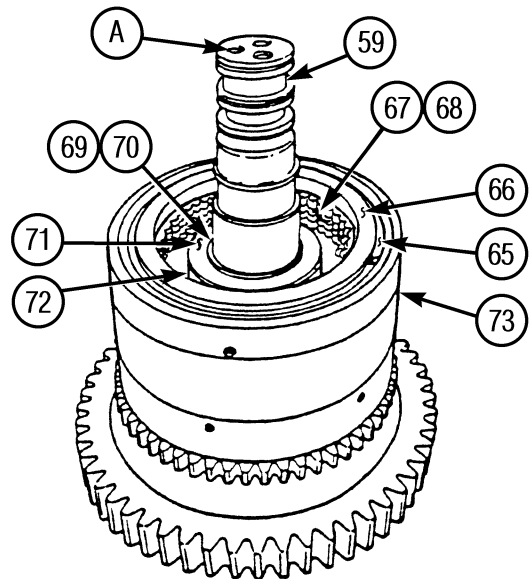
**CAUTION**

Carefully handle clutch plates so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

**NOTE**

The first stage clutch pack contains 12 clutch plates and 12 separator plates.

- (h) Remove six clutch plates (67) and six separator plates (68).



**WARNING**

Springs are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

**NOTE**

The first stage clutch pack contains 12 clutch plates and 12 separator plates.

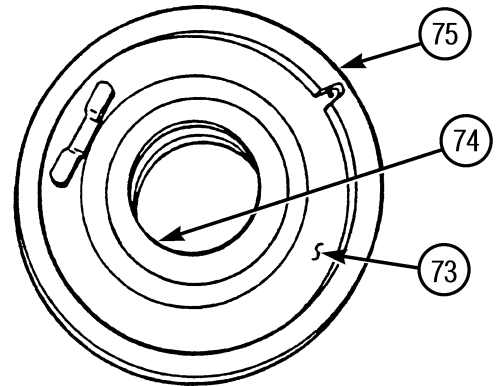
- (i) Place shaft assembly (59) in a press. Install a clutch spring compressor tool.
- (j) Press down on spring compressor tool and retainer (69) just enough to relieve pressure on retainer ring (70). Remove retainer ring. Slowly remove clutch spring compressor tool.
- (k) Remove retainer (69), four springs (71), and thrust washer (72).

**WARNING**

Do not exceed 30 psi (206.85 kPa) nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

- (l) Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (59). Use compressed air to remove piston (73).

- (m) Remove preformed packing (74) and outer piston seal (75) from piston (73). Discard preformed packing and seal.
- (n) Turn shaft assembly (59) over and repeat Steps (b) through (m).

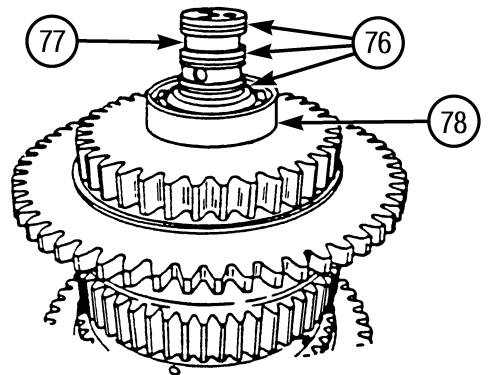


**(6) Disassemble second stage clutch pack (56) parts (76 through 97).**

**CAUTION**

Use care when removing seal rings to prevent clutch shaft damage.

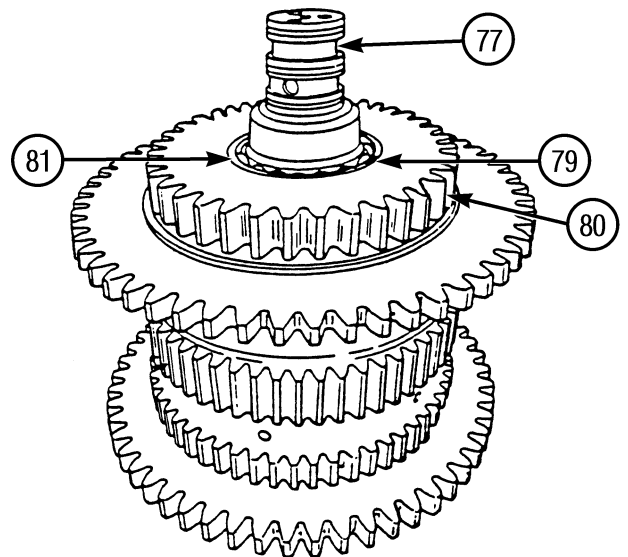
- (a) Remove three seal rings (76) from shaft assembly (77).
- (b) Use two pry bars, 180° apart, to pry bearing (78) up and remove it from shaft assembly (77).



**WARNING**

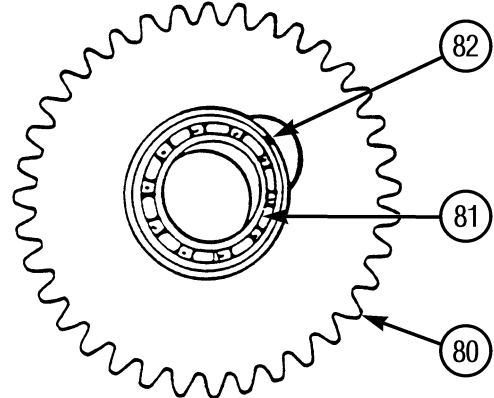
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Remove snap ring (79) from shaft assembly (77).
- (d) Use a gear puller to remove weld gear (80) and bearing (81) as an assembly from shaft assembly (77).

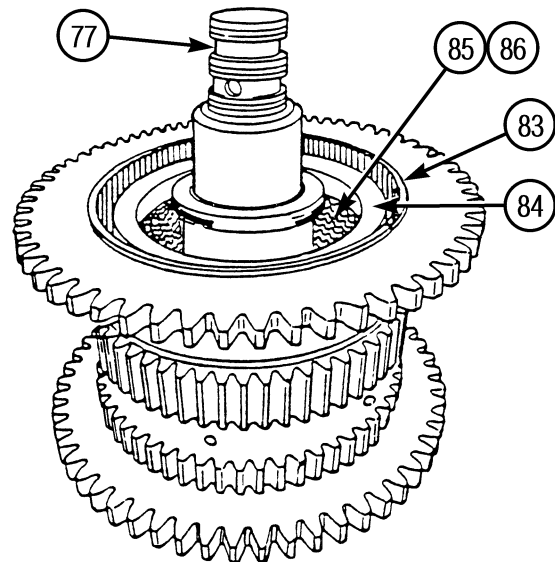


**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (e) Using an assistant to spread snap ring (82), use a driver to remove bearing (81) from weld gear (80).



- (f) Remove snap ring (83).
- (g) If necessary, remove snap ring (82) from weld gear (80).
- (h) Slide retainer (84) out of shaft assembly (77).



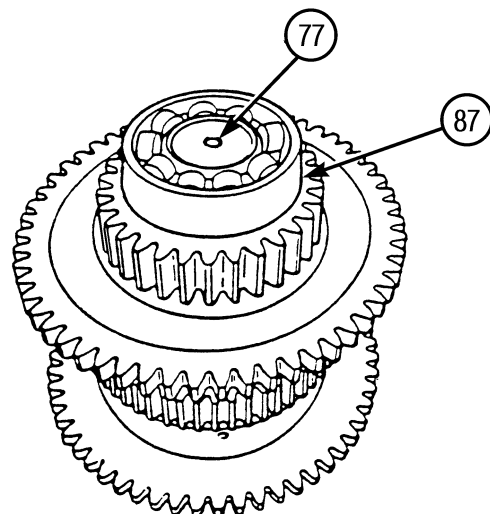
**CAUTION**

Carefully handle clutch plates so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

**NOTE**

The second stage clutch pack contains 12 clutch plates and 12 separator plates.

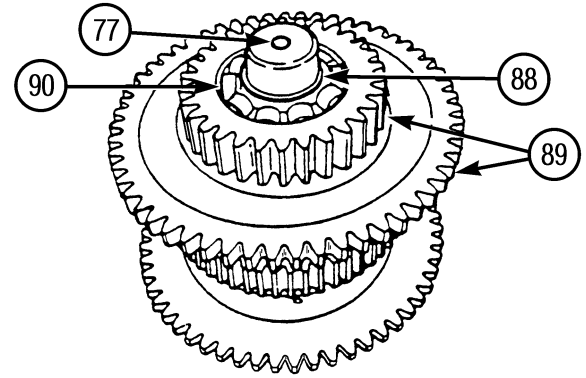
- (i) Remove six clutch plates (85) and six separator plates (86).
- (j) Turn shaft assembly (77) over.
- (k) Use two pry bars, 180° apart, to pry bearing (87) up and remove it from shaft assembly (77).



**WARNING**

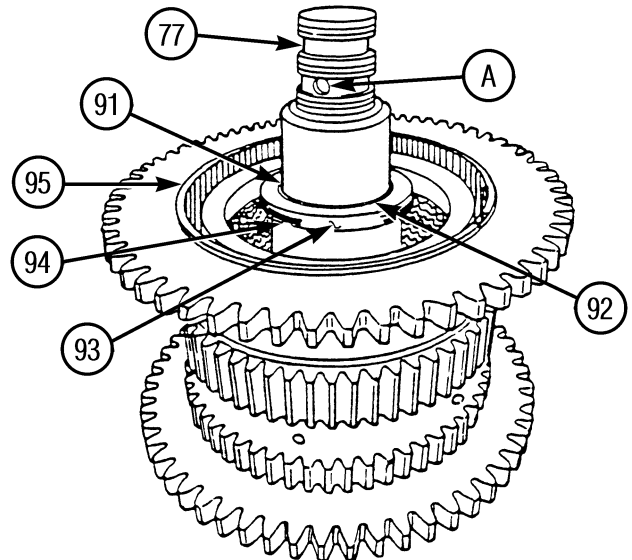
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (l) Remove snap ring (88) from shaft assembly (77).
- (m) Use a gear puller to remove weld gear (89) and two bearings (90) as an assembly from shaft assembly (77).

**WARNING**

Springs are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

- (n) Place shaft assembly (77) in a press. Install a clutch spring compressor tool.
- (o) Press down on spring compressor tool and retainer (91) just enough to relieve pressure on retainer ring (92). Remove retainer ring. Slowly remove clutch spring compressor tool.
- (p) Remove retainer (91), four springs (93), and thrust washer (94).

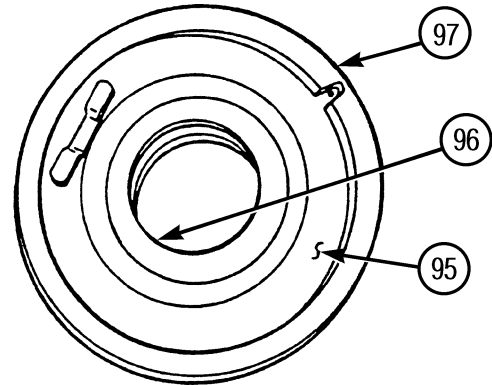
**WARNING**

Do not exceed 15 psi (103.43 kPa) nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

- (q) Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (77). Use compressed air to remove piston (95).

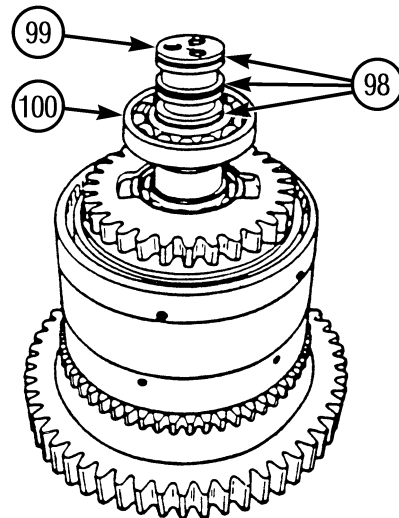
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (r) Remove preformed packing (96) and outer piston seal (97) from piston (95). Discard preformed packing and seal.
- (s) Turn shaft assembly (77) over and repeat Steps (e), (g), (h), and (m) through (q).



**(7) Disassemble third stage clutch pack (57) and parts (98 through 118).**

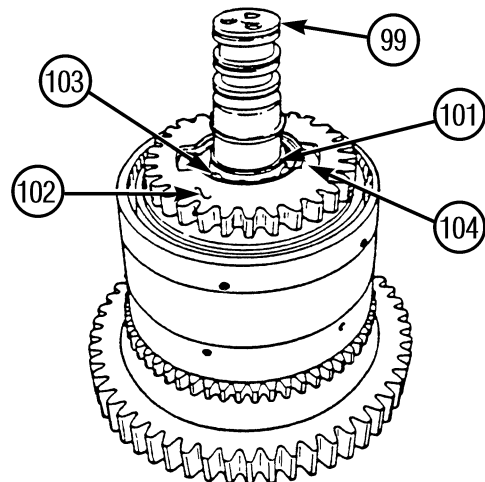
- (a) Remove three seal rings (98) from shaft assembly (99).
- (b) Use two pry bars, 180° apart, to pry bearing (100) up and remove it from shaft assembly (99).



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Remove two snap rings (101) from shaft assembly (99).
- (d) Use a gear puller to remove weld gear (102) and bearing (103) as an assembly from shaft assembly (99).
- (e) Using an assistant to spread snap ring (104), use a driver to remove bearing (103) from weld gear (102).

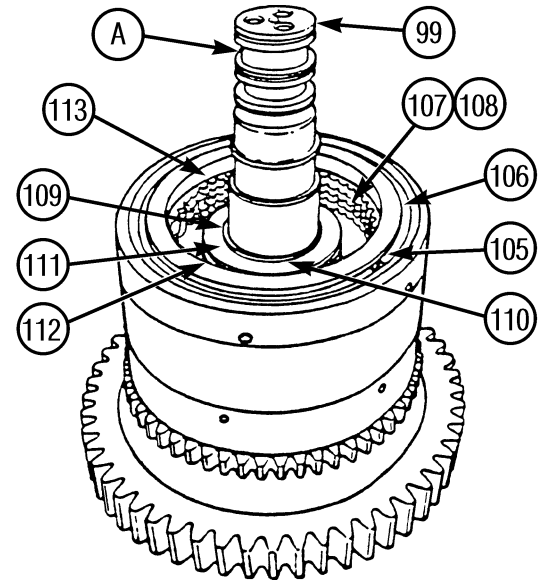


- (f) Remove snap ring (105) and clutch plate retainer (106) from shaft assembly (99).

**NOTE**

The third stage clutch pack contains four clutch plates and four separator plates.

- (g) Remove four clutch plates (107) and four separator plates (108).



**WARNING**

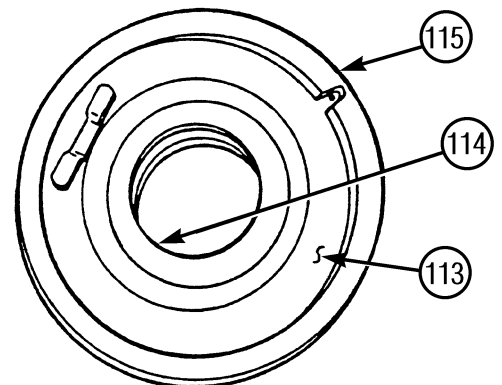
Springs are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

- (h) Place shaft assembly (99) in a press. Install a clutch spring compressor tool.
- (i) Press down on spring compressor tool and retainer (109) just enough to relieve pressure on retainer ring (110). Remove retainer ring. Slowly remove clutch spring compressor tool.
- (j) Remove retainer (109), four springs (111) and thrust washer (112).

**WARNING**

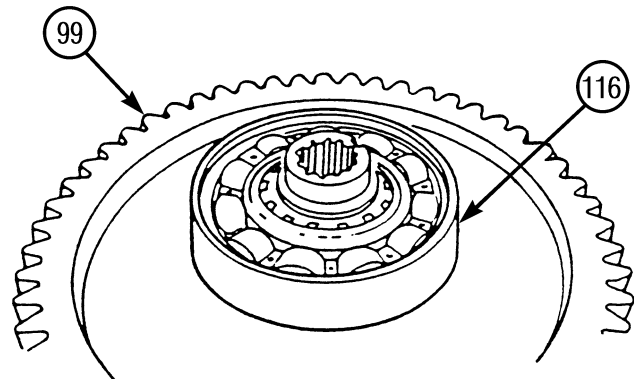
Do not exceed 15 psi (103.43 kPa) nozzle pressure when using compressed air. Do not direct compressed air against skin. Failure to follow this precaution could cause personal injury.

- (k) Insert air nozzle at pressure ports (A) located between three seal ring grooves on shaft assembly (99). Use compressed air to remove piston (113).
- (l) Remove preformed packing (114) and outer piston seal (115). Discard preformed packing and seal.



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

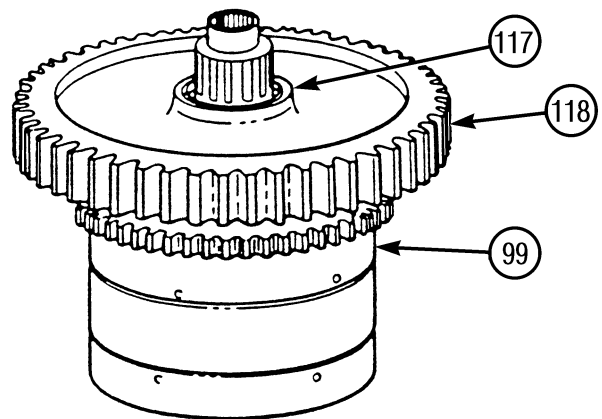
- (m) Turn shaft assembly (99) over. Use a puller to remove bearing (116) from shaft assembly (99).



**WARNING**

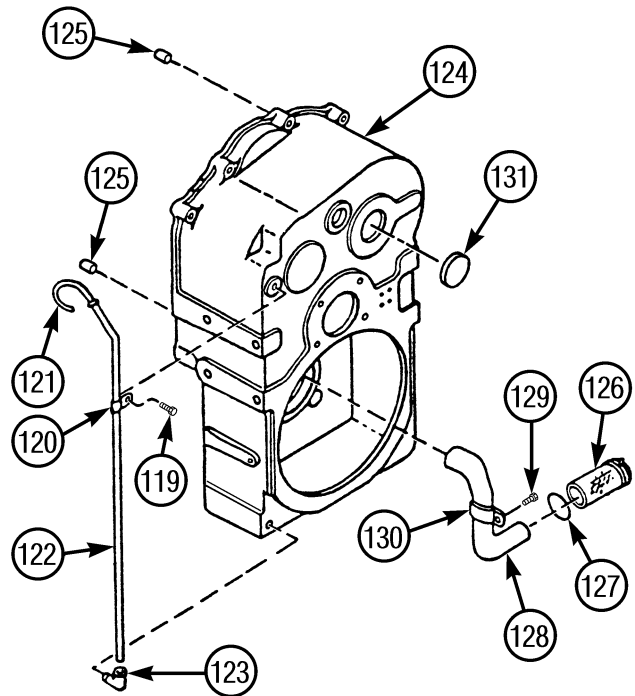
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (n) Remove snap ring (117) and gear (118) from shaft assembly (99).



**(8) If damaged, remove parts (119 through 123 and 125 through 131) from transmission case (124).**

- (a) If damaged, remove screw (119), clamp (120), dipstick (121), dipstick tube (122), and elbow (123), from transmission case (124).
- (b) If damaged, remove two locating bushings (125) from transmission case (124).
- (c) If damaged, remove suction screen (126) and gasket (127) from suction tube (128). Discard gasket.
- (d) If damaged, remove screw (129), clamp (130), and suction tube (128) from transmission case (124).
- (e) If damaged, remove expansion plug (131) from transmission case (124).





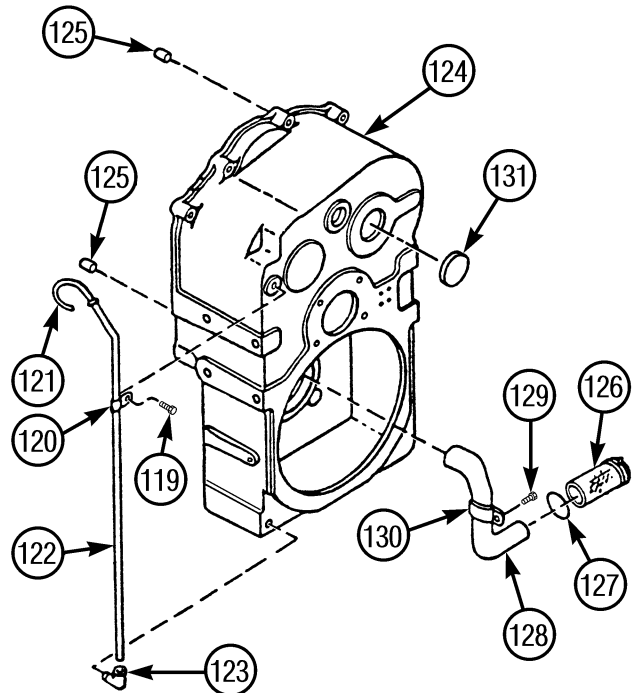
c. **Cleaning.** See **Cleaning Instructions (Para 2-12).**

d. **Inspection.** See **Inspection Instructions (Para 2-14).**

e. **Assembly.**

(1) **If removed, install parts (119 through 123 and 125 through 131) on transmission case (124).**

- (a) If removed, install expansion plug (131) in transmission case (124).
- (b) If removed, install suction tube (128), clamp (130), and screw (129) in transmission case (124).
- (c) If removed, install gasket (127) and suction screen (126) on suction tube (128).
- (d) If removed, install two locating bushings (125) in transmission case (124).
- (e) If removed, install elbow (123), dipstick tube (122), dipstick (121), clamp (120), and screw (119) on transmission case (124).

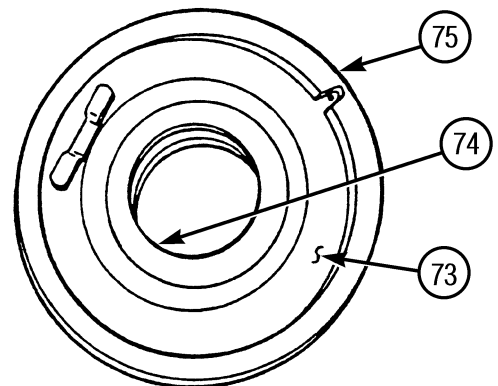


**NOTE**

Wipe all sealing surfaces clean and dry. Apply film of hydraulic oil to all parts as they are installed.

(2) **Assemble first stage clutch pack (55) parts (58 through 75).**

- (a) Install outer piston seal (75) onto piston (73).



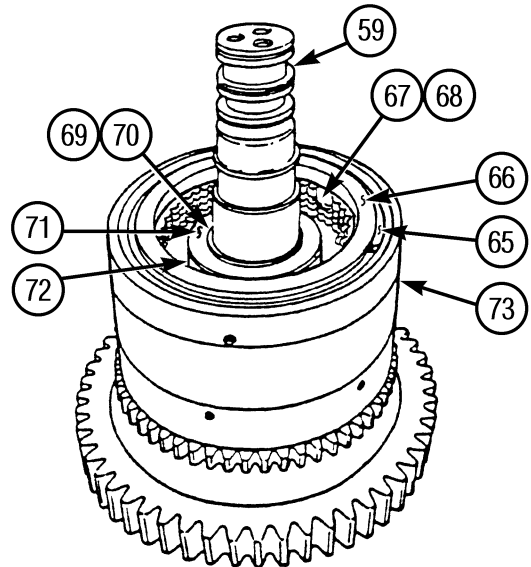
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (b) Install preformed packing (74) onto shaft assembly (59).

**CAUTION**

Use care when installing assembled piston to prevent damage to preformed packing and outer piston seal.

- (c) Install assembled piston (73) into shaft assembly (59). Ensure that piston aligns with locating pins in shaft assembly.
- (d) Install thrust washer (72), four springs (71), and retainer (69).



**WARNING**

Springs are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

- (e) Place shaft assembly (59) in a press. Install a spring compressor tool.

**WARNING**

Ensure that retainer ring is secure in groove before spring compressor tool is removed from retainer to prevent springs from flying out. Failure to follow this precaution could cause personal injury.

- (f) Press down on spring compressor tool and retainer (69) to allow installation of retainer ring (70). Slowly remove spring compressor tool.

**CAUTION**

Carefully handle clutch plates so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

**NOTE**

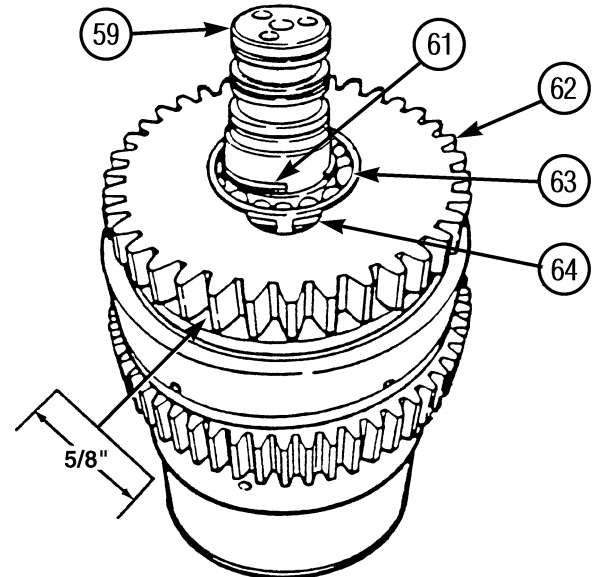
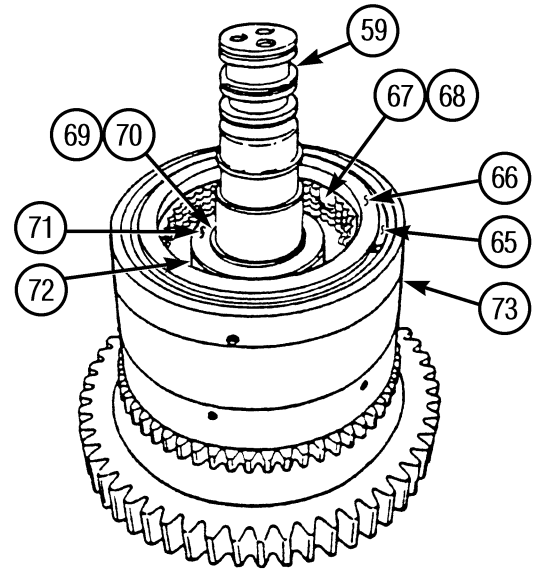
The separator plates have external teeth and clutch plates have internal teeth. The plates do not have a right or wrong side for installation.

- (g) Install six separator plates (68) and six clutch plates (67) into shaft assembly (59). Begin with a separator plate and then a clutch plate. Continue by alternating plates. The last plate must be a clutch plate.

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (h) Install retainer (66) and snap ring (65) on shaft assembly (59).
- (i) Install appropriate pair of alignment bars between weld gear (70) and piston (73), as required, to hold weld gear off piston. Use either narrow or wide side of bars to ensure that weld gear is held off piston 5/8 in. (15.9 mm) and at the same time engages all clutch plates (67).
- (j) Install weld gear (70) on shaft assembly (59). Turn weld gear so it meshes with clutch plates (67) and separator plates (68). Push weld gear until it bottoms out. Weld gear splines must be in full position with internal teeth of all clutch plates.



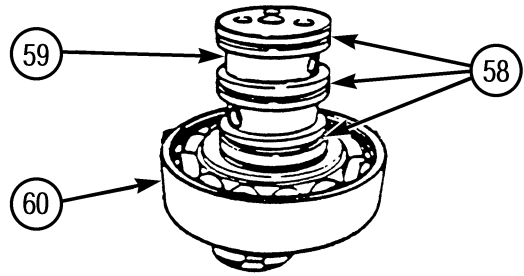
**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (k) Using an assistant to spread snap ring (64), use a bearing driver to press bearing (63) onto shaft assembly (59) and into weld gear (62). Remove alignment bars to seat bearing and weld gear as an assembly.
- (l) Install snap ring (61). Ensure that snap ring is fully in groove of shaft assembly (59).

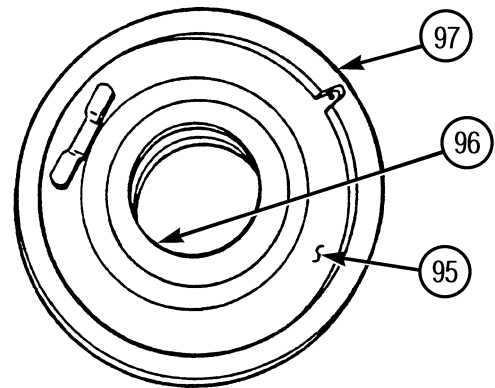
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (m) Use a bearing driver to press bearing (60) onto shaft assembly (59).
- (n) Apply grease to three seal rings (58) and install on shaft assembly (59).
- (o) Turn shaft assembly (59) over and repeat Steps (a) through (m).



**(3) Assemble second stage clutch pack (56) parts (76 through 97).**

- (a) Install new outer piston seal (97) onto piston (95).
- (b) Install preformed packing (96) onto shaft assembly (77).



**CAUTION**

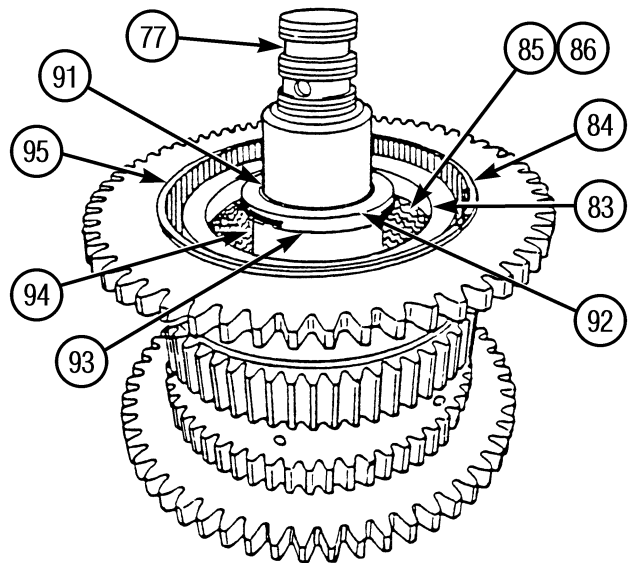
Use care when installing piston to prevent damage to preformed packing and outer piston seal.

- (c) Install assembled piston (95) onto shaft assembly (77). Ensure that piston aligns with locating pins in shaft assembly.

**WARNING**

Springs are under tension. Always wear safety glasses when working on compressed springs. Carefully handle spring in compressed form. Failure to follow this precaution could cause personal injury.

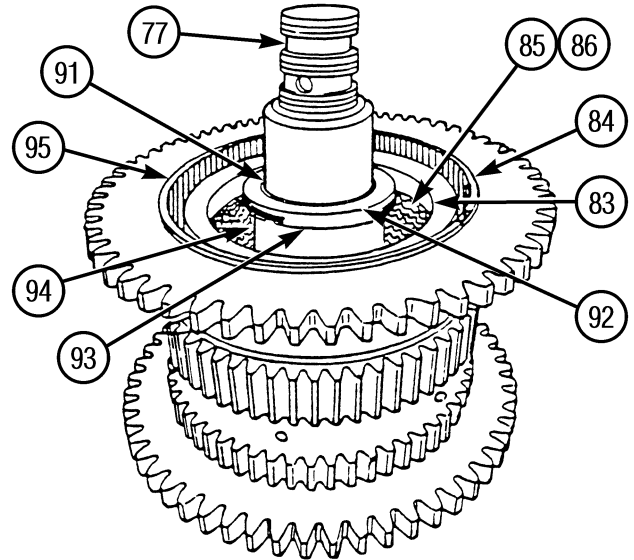
- (d) Install thrust washer (94), four springs (93), and retainer (91).
- (e) Place shaft assembly (77) in a press. Install a spring compressor tool.



**WARNING**

Ensure that retainer ring is secure in groove before spring compressor tool is removed from retainer to prevent springs from flying out. Failure to follow this precaution could cause personal injury.

- (f) Press down on spring compressor tool and retainer (91) to allow installation of retainer ring (92). Slowly remove spring compressor tool.

**CAUTION**

Carefully handle clutch plates so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.

**NOTE**

The separator plates have external teeth and clutch plates have internal teeth. The plates do not have a right or wrong side for installation.

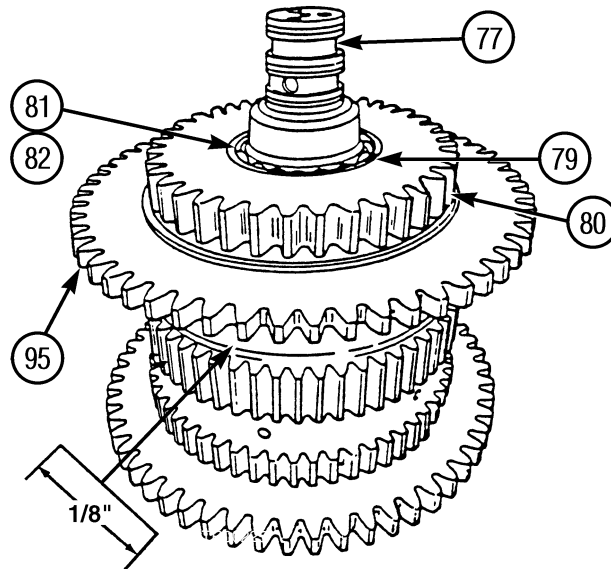
- (g) Install six clutch plates (85) and six separator plates (86) into shaft assembly (77). Begin with a separator plate and then a clutch plate. Continue by alternating plates. The last plate must be a clutch plate.
- (h) Install retainer (84) on shaft assembly (77).

**WARNING**

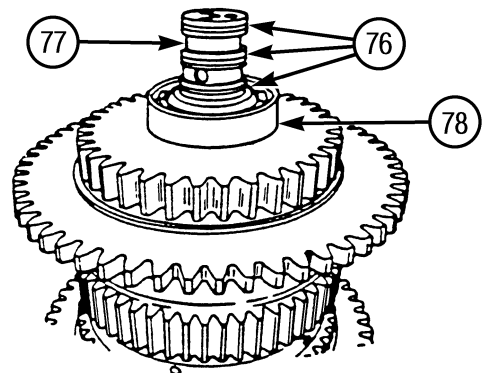
Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (i) Install snap ring (83) on shaft assembly (77).

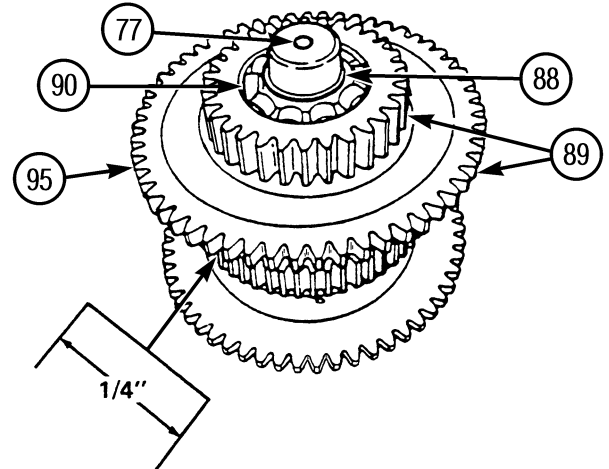
**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**



- (j) Install appropriate pair of alignment bars between weld gear (80) and piston (95) as required to hold weld gear off piston. Use either narrow or wide side of bars to ensure that weld gear is held off piston 1/8 in. (3.2 mm) and at the same time engages all clutch plates (86).
- (k) If removed, install snap ring (82) in weld gear (80).
- (l) Install weld gear (80) on shaft assembly (77).
- (m) Use a bearing driver to press bearing (81) onto shaft assembly (77) and into weld gear (80). Remove alignment bars to seat bearing and weld gear.
- (n) Install snap ring (79). Ensure that snap ring is fully in groove of shaft assembly (77).
- (o) Use a bearing driver to press bearing (78) onto shaft assembly (77).
- (p) Apply grease to three seal rings (76) and install on shaft assembly (77).
- (q) Turn shaft assembly (77) over and repeat Steps (a) through (h).



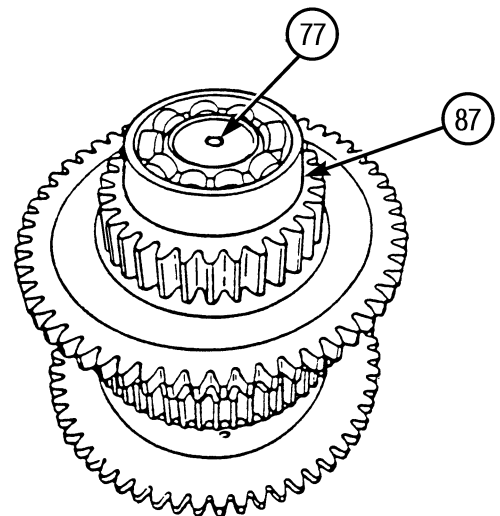
- (r) Install weld gear (89) on shaft assembly (77). Turn weld gear so it meshes with clutch plates (85) and separator plates (86). Push weld gear until it bottoms out. Weld gear splines must be in full position with internal teeth of all clutch plates.
- (s) Remove weld gear (89).



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

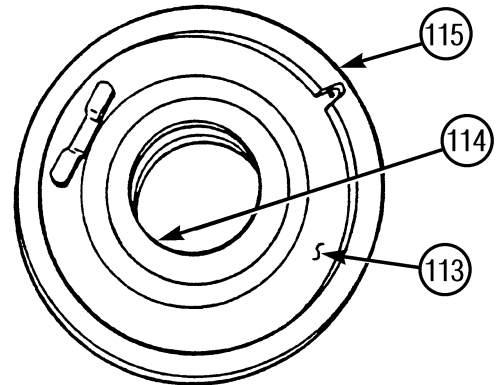
- (t) Press one bearing (90) onto shaft assembly (77) until it is tight against snap ring (79).
- (u) Install appropriate pair of alignment bars between weld gear (89) and piston (95), as required, to hold weld gear off piston. Use either narrow or wide side of bars to ensure that weld gear is held off piston 1/4 in. (6.4 mm) and at the same time engages all clutch plates.
- (v) Install weld gear (89) on shaft assembly (77).
- (w) Press one bearing (90) onto shaft assembly (77) and into weld gear (89). Remove alignment bars to seat bearing and weld gear.
- (x) Install snap ring (88) onto shaft assembly (77).
- (y) Press bearing (87) onto shaft assembly (77).



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**(4) Assemble third stage clutch pack (57) parts (98 through 118).**

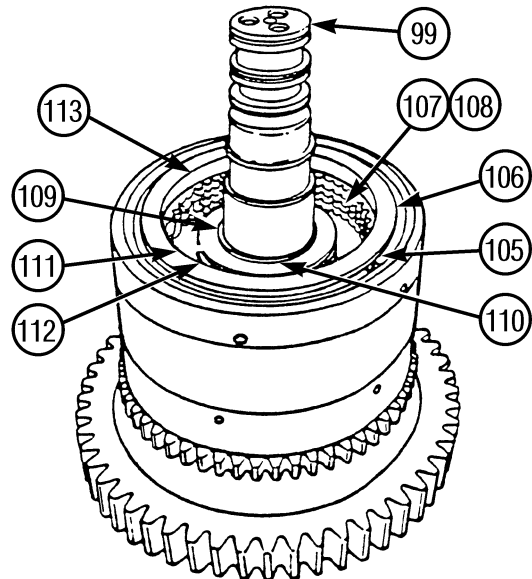
- (a) Install outer piston seal (115) onto piston (113).
- (b) Install preformed packing (114) on shaft assembly (99).



**CAUTION**

Use care when installing piston to prevent damage to preformed packing and outer piston seal.

- (c) Install assembled piston (113) into shaft assembly (99). Ensure that piston aligns with locating pins in shaft assembly.
- (d) Install thrust washer (112), four springs (111) and retainer (109).
- (e) Place shaft assembly (99) in a press. Install a spring compressor tool.



**WARNING**

Ensure that retainer ring is secure in groove before spring compressor tool is removed from retainer to prevent springs from flying out. Failure to follow this precaution could cause personal injury.

- (f) Press down on spring compressor tool and retainer (109) to allow installation of retainer ring (110). Slowly remove spring compressor tool.

**CAUTION**

Carefully handle clutch plates so graphite coating doesn't flake off. Failure to follow this precaution could cause equipment damage.



**NOTE**

The separator plates have external teeth and clutch plates have internal teeth. The plates do not have a right or wrong side for installation.

- (g) Install four clutch plates (107) and four separator plates (108) into shaft assembly (99). Begin with a separator plate and then a clutch plate. Continue by alternating plates. The last plate must be a clutch plate.

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (h) Install clutch plate retainer (106) and snap ring (105) on shaft assembly (99).

- (i) Install appropriate pair of alignment bars between weld gear (102) and piston (113), as required, to hold weld gear off piston. Use either narrow or wide side of bars to ensure that weld gear is held off piston 1/16 in. (1.6 mm) and at the same time engages all clutch plates (107).

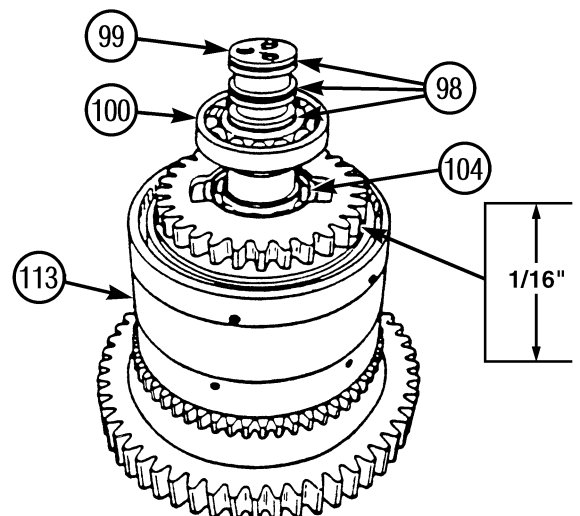
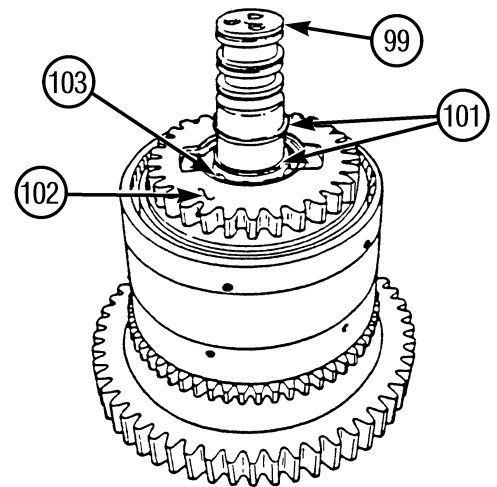
- (j) Install weld gear (102) on shaft assembly (99).

- (k) Using an assistant to spread snap ring (104) use a bearing driver to press bearing (103) onto shaft assembly (99) and into weld gear (102).

- (l) Install two snap rings (101). Ensure that snap rings are fully in grooves of shaft assembly (99).

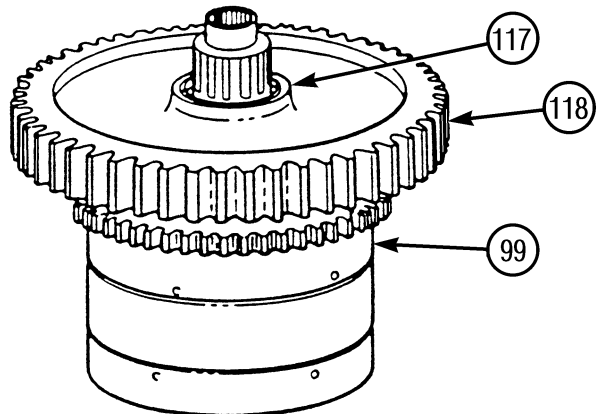
- (m) Use a bearing driver to press bearing (100) onto shaft assembly (99).

- (n) Apply grease to three seal rings (98) and install on shaft assembly (99).

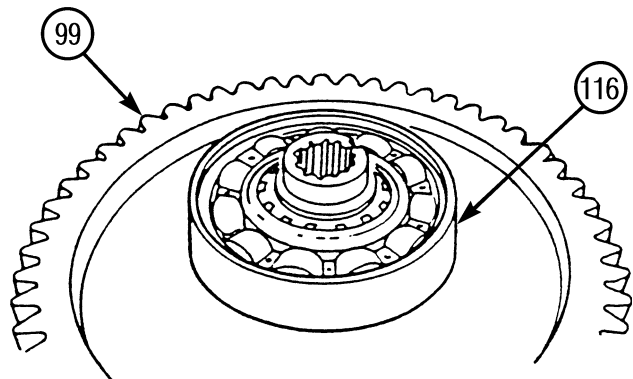


**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (o) Turn shaft assembly (99) over and press gear (118) onto shaft assembly.
- (p) Install snap ring (117) onto shaft assembly (99).

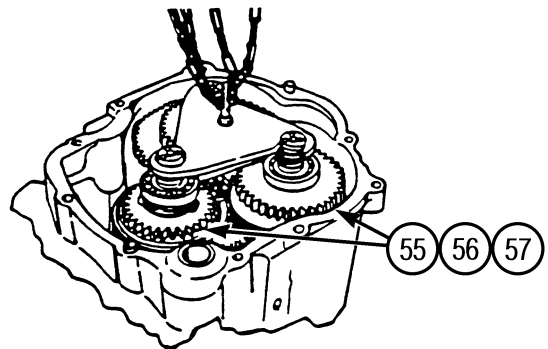


- (q) Tap or press bearing (116) onto shaft assembly (99).

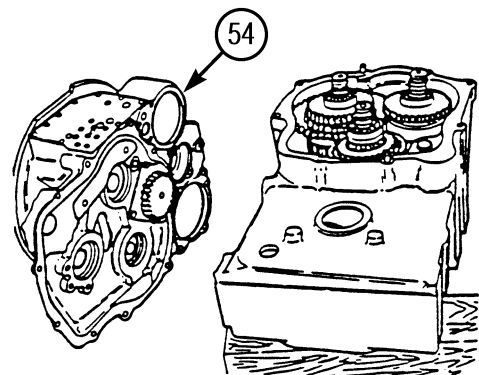


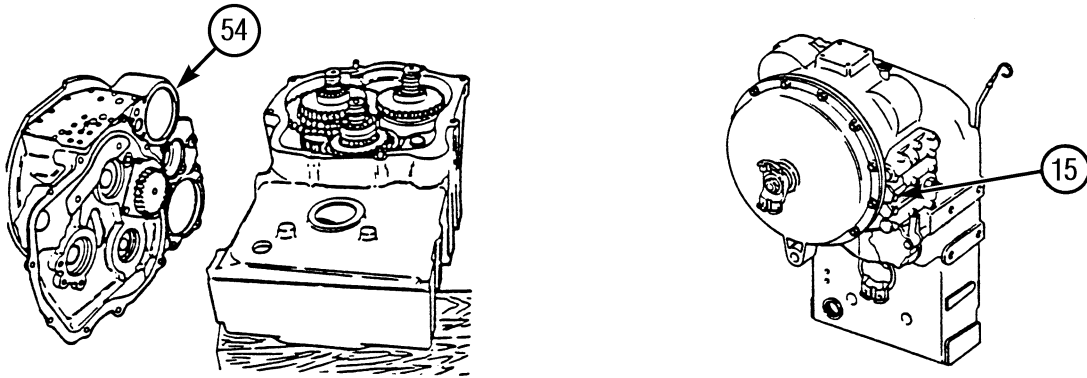
**(5) Install three clutch packs (55, 56, and 57) in transmission (3) main case.**

- (a) Place first stage clutch pack (55) on a wood block. Position remaining clutch packs (56 and 57) together.
- (b) Install a special lifting tool in bottom groove of all three clutch pack (55, 56, and 57) shafts.



- (c) Attach a hoist with slings to special lifting tool and install clutch packs (55, 56, and 57) into transmission (3) main case.
- (d) Ensure that clutch packs (55, 56, and 57) are in proper position and sequence before removing special lifting tool. Ensure that bearings engage with seats in transmission (3) main case.





- (6) Install transmission front cover assembly (54) (Para 7-5).
- (7) Install transmission control valve (15) (Para 7-9).

**f. Installation.**

**NOTE**

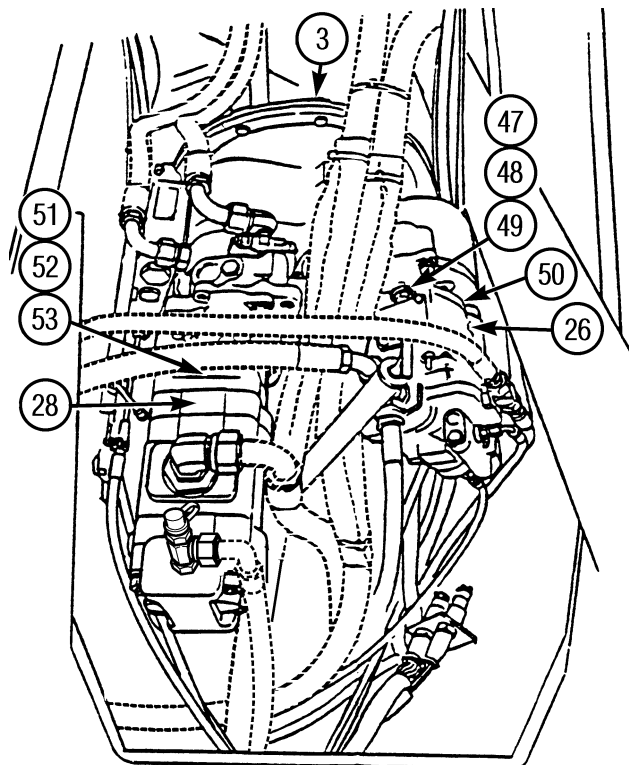
After transmission repair or replacement, ensure that parts not issued with transmission are removed and installed on new transmission.

**(1) Install tandem gear pump (28) on transmission (3).**

- (a) Install preformed packing (53) on hydraulic gear pump drive (28) drive.
- (b) Position tandem gear pump (28) on transmission (3).
- (c) Install two lockwashers (52) and two screws (51) in tandem gear pump (28) and transmission (3).

**(2) Install piston pump (26) on transmission (3).**

- (a) Install preformed packing (50) on hydraulic piston pump (26) drive adapter.
- (b) Position piston pump (26) on transmission (3).
- (c) Install two washers (49), lockwashers (48), and screws (47) in piston pump (26) and transmission (3).



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**(3) Install transmission (3) in vehicle.**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) If removed, install screw (40), mounting bracket (41), shaft (46), and retaining rings (45) on transmission (3).

**WARNING**

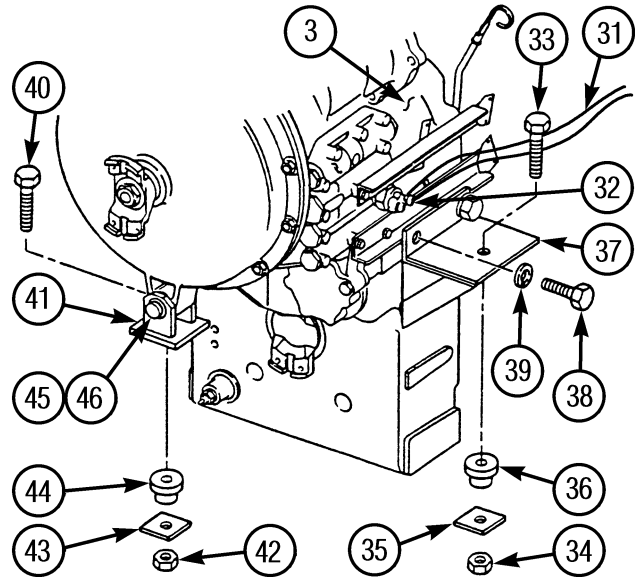
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

- (b) Apply sealing compound on threads of eight screws (38). Install two brackets (37), eight lockwashers (39), and screws. Tighten screws to 220 lb-ft (298.3 N•m).

**WARNING**

Transmission weighs approximately 950 lbs (431 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (c) Attach a hoist with slings to transmission (3). Place slings under input yoke and output yokes. Secure slings together.
- (d) Lift transmission (3) into vehicle. Ensure that hoses and other obstructions are clear of transmission during installation. Lower transmission until its mounts are resting on transmission supports.



**(4) Install parts (33 through 36 and 40 through 43) on transmission (3).**

- (a) Place a drift and wedge between capscrew (40) and mounting bracket (41) to prevent screw from moving when installing nut (42)

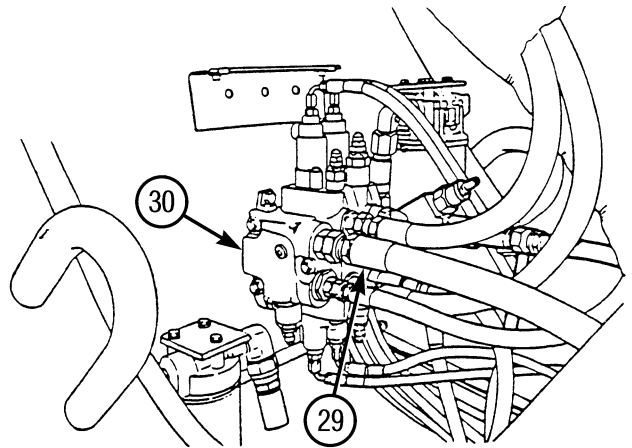
**WARNING**

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

- (b) Apply sealing compound to threads of screw (40). Install nut (42), washer (43), rubber mount (44), on screw and mounting bracket (41). Tighten nut to 307 lb-ft (416.2 N•m).
- (c) Apply sealing compound to threads of two screws (33). Install two rubber mounts (36), washers (35), nuts (34), and screws. Tighten nuts to 307 lb-ft (416.2 N•m).
- (d) Remove slings from transmission (3).

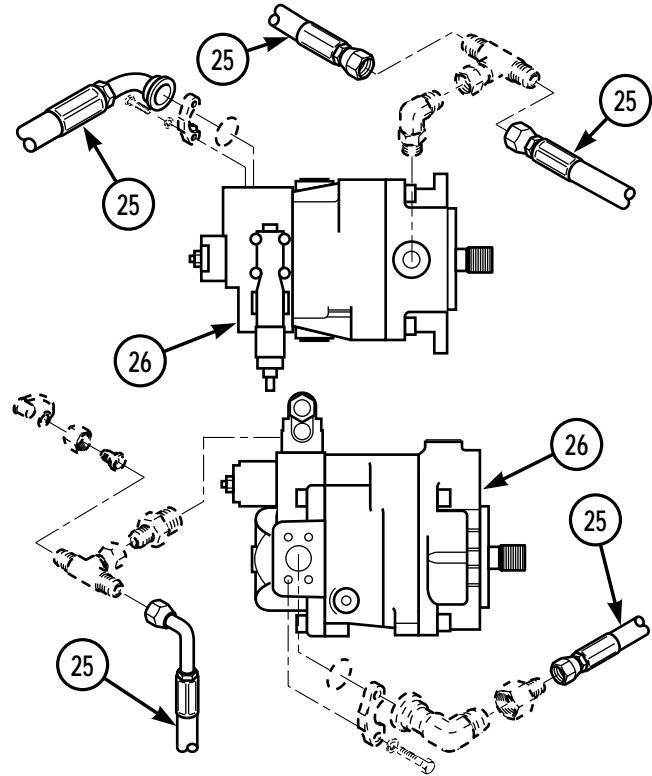
**NOTE**

Install tie wraps as required.

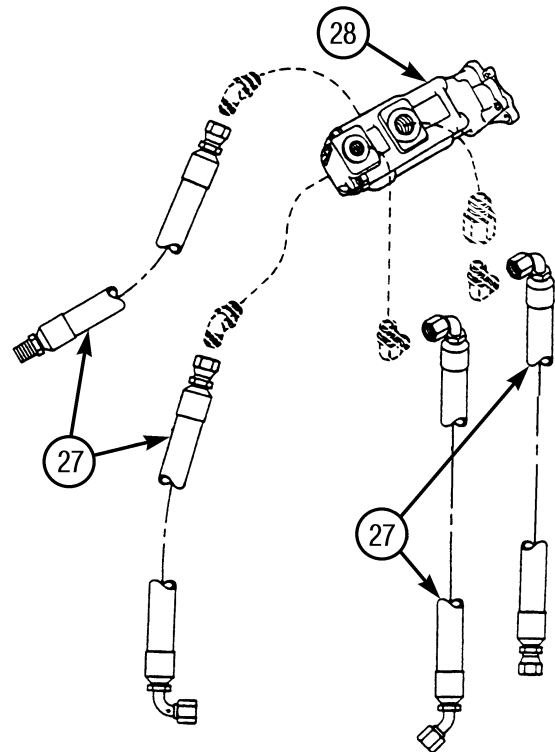
**(5) Connect two wires (31) to neutral safety switch (32).****(6) Connect hose (29) at main control valve (30) (between main control valve assembly and priority valve).**

**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

- (7) Install five hoses (25) to piston pump (26).



- (8) Install four hydraulic hoses (27) to tandem gear pump (28).

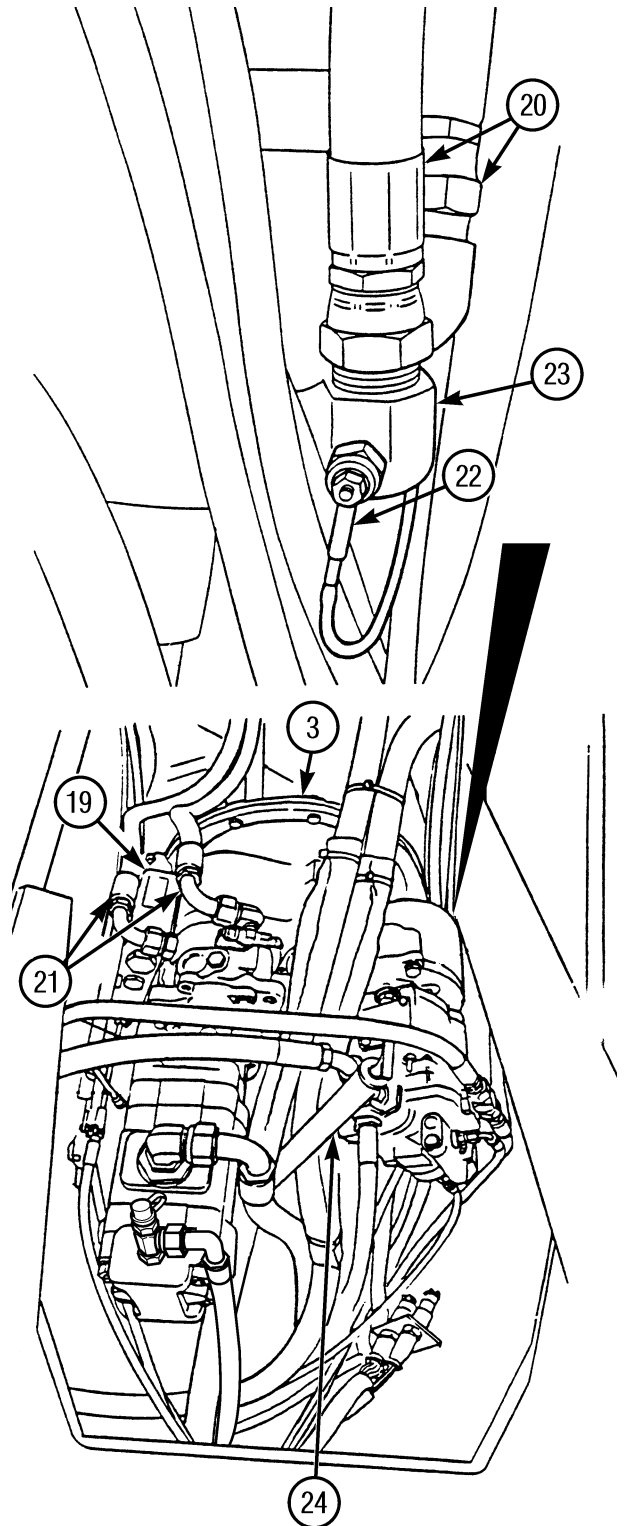


- (9) **Install transmission oil filler tube (24) on transmission (3).**
- (10) **Connect lead (22) to transmission temperature sender (23).**

**NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on transmission and hoses clean and dry. Apply film of clean transmission oil as they are installed.

- (11) **Connect hoses (19, 20, and 21).**
  - (a) Connect two hoses (21) on transmission (3).
  - (b) Connect two transmission oil hoses (20) on transmission (3).
  - (c) Connect hose (19) on transmission control valve (15).



**7-4. TRANSMISSION ASSEMBLY REPLACEMENT/REPAIR (CONT)**

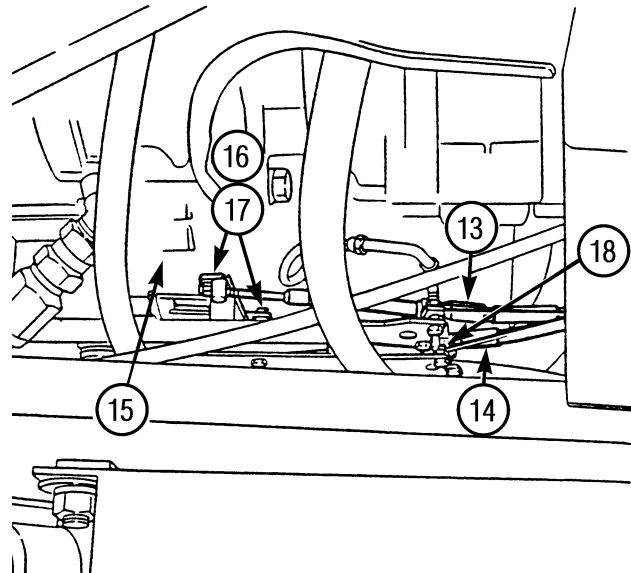
**(12) Connect transmission cables (13 and 14) to transmission control valve (15).**

- (a) Connect transmission cables (13 and 14) to transmission control valve.

**NOTE**

Ensure that cables are connected correctly for proper function.

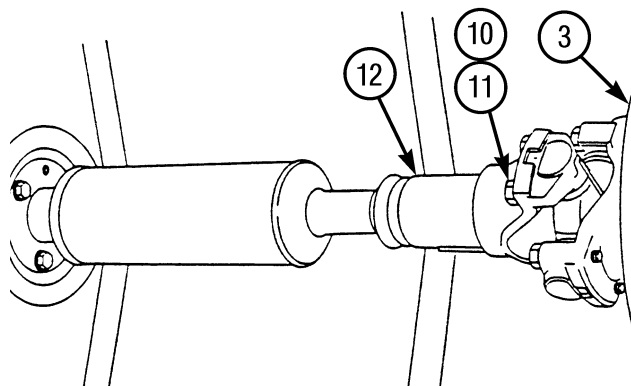
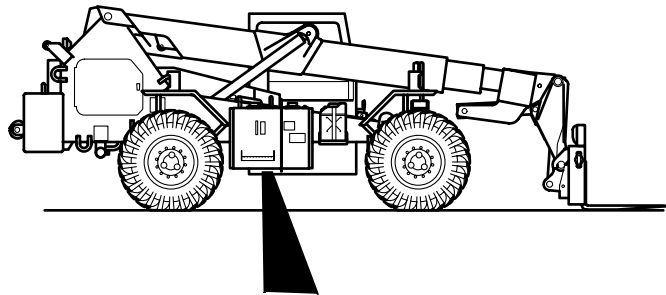
- (b) Install four nuts (18) that secure clamps for transmission cables (13 and 14).
- (c) Install washer (17) and cotter pin (16) for each transmission cable (13 and 14) at transmission control valve (15).



**WARNING**

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

**(13) Apply sealing compound on threads of four screws (10). Slide yoke of transmission propeller shaft (12) toward transmission (3) input yoke and secure with four lockwashers (11) and screws. Tighten screws to 45 lb-ft (61.0 N•m).**



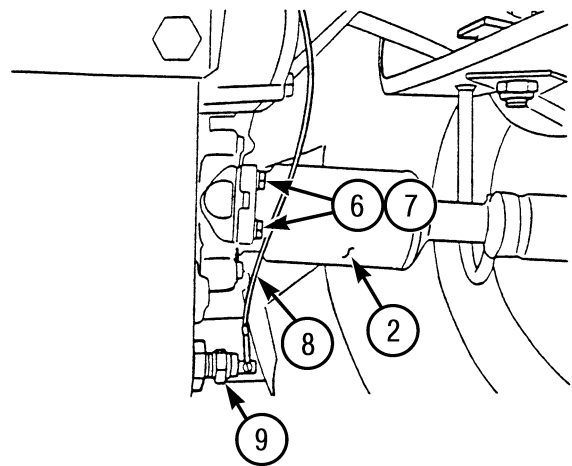
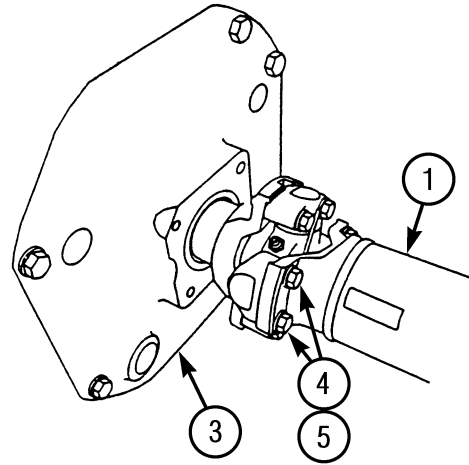


- (14) **Connect lead (8) to transmission temperature switch (9).**
- (15) **Connect front propeller shaft (1) and rear propeller shaft (2) on transmission (3).**

**WARNING**

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

- (a) Apply sealing compound on threads of capscrews (6). Install rear propeller shaft (2) four lockwashers (5), and screws (6). Tighten screws to 45 lb-ft (61.0 N•m).
- (b) Apply sealing compound on threads of capscrews (4). Install front propeller shaft (1), four lockwashers (5), and screws (4). Tighten screws to 45 lb-ft (61.0 N•m).



- (16) **Ensure that transmission drain plug is in position.**
- (17) **Service transmission (TM 10-3930-673-20).**

**CAUTION**

Do not start engine until both piston and tandem gear pumps are primed. Failure to follow this instruction may result in damage to pumps.

- (18) **Purge air (prime) from piston and tandem gear pumps (TM 10-3930-673-20).**
- (19) **Start engine and allow to run for several minutes (TM 10-3930-673-10).**
- (20) **Shut engine down, check fluid level and refill as necessary (TM 10-3930-673-10 and TM 10-3930-673-20).**

**NOTE**

Follow-on Maintenance: Install transmission cover (TM 10-3930-673-20).

**END OF TASK**

## 7-5. TRANSMISSION FRONT COVER REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance, Common  
No. 2 Less Power  
(Item 17, Appendix D)  
Lifting Device, 2,000 lb (907.18 kg) capacity  
Puller Kit (Item 15, Appendix D)

#### *Materials/Parts*

Compound, Sealing (Item 40, Appendix B)  
Compound, Sealing (Item 44, Appendix B)  
Compound, Sealing (Item 47, Appendix B)  
Grease (Item 18, Appendix B)  
Gasket  
Lockwashers (4)  
Packing, Preformed (2)

#### *Equipment Condition*

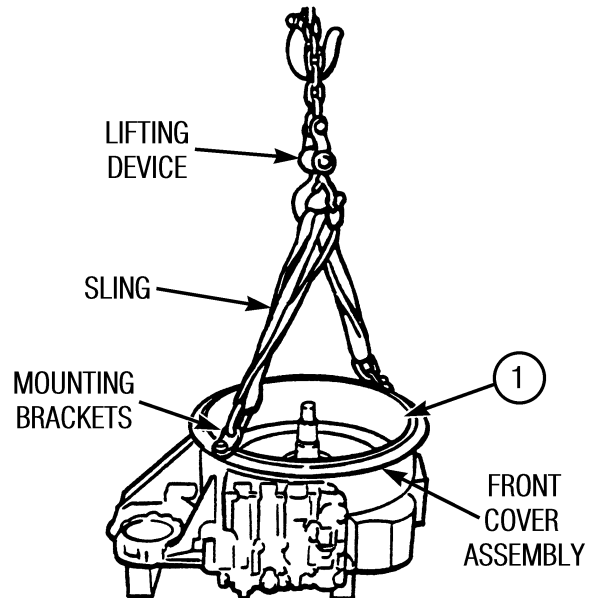
Transmission assembly removed (Para 7-4)  
Transmission control valve removed (Para 7-9)  
Torque converter removed (Para 7-3)  
Transmission oil pump removed (Para 7-10)

### a. Removal.

#### NOTE

Transmission must be lying flat for front cover removal.

- (1) **Attach hoist or other suitable lifting device to mounting brackets on front cover assembly (1).**

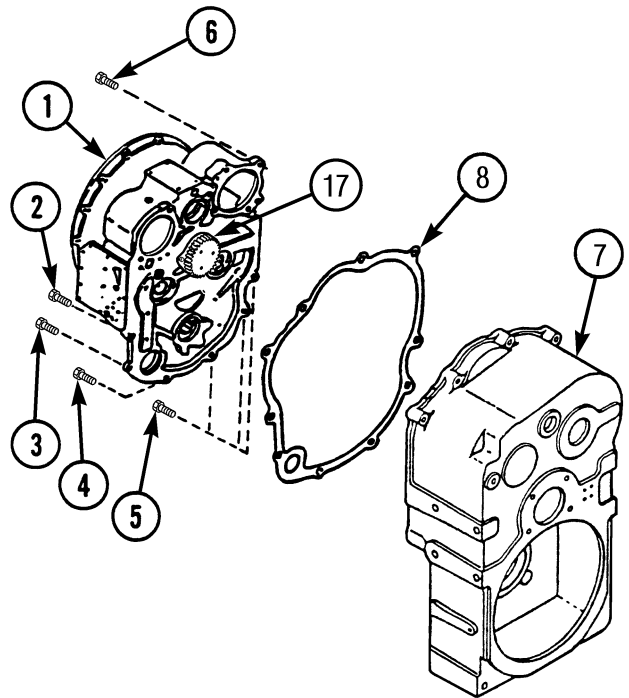


- (2) Remove screws (2, 3, and 4), three screws (5), and four screws (6) from front cover (1) and main case (7).

**CAUTION**

Use care when removing cover assembly. Clutch packs must remain in housing or clutch packs could be damaged during removal.

- (3) Using hoist or suitable lifting device lift front cover (1) off main case (7).
- (4) Place front cover assembly (1) on suitable supports.
- (5) Remove gasket (8) from main case (7). Discard gasket.



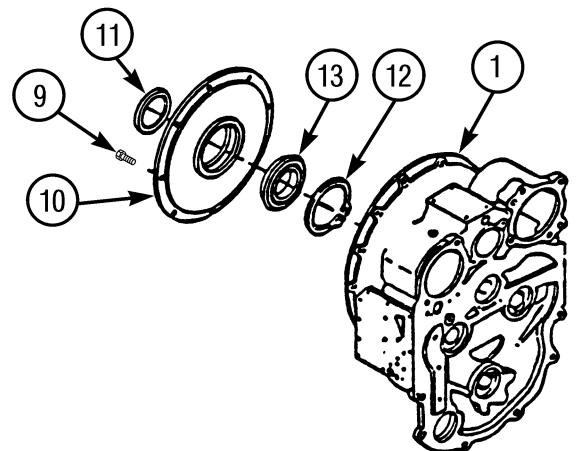
**b. Disassembly.**

- (1) Remove bearing retainer (10) and parts (9 and 11 through 13) from front cover (1).
  - (a) Remove seven screws (9) and bearing retainer (10) from front cover (1).
  - (b) Remove oil seal (11) from bearing retainer (10).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

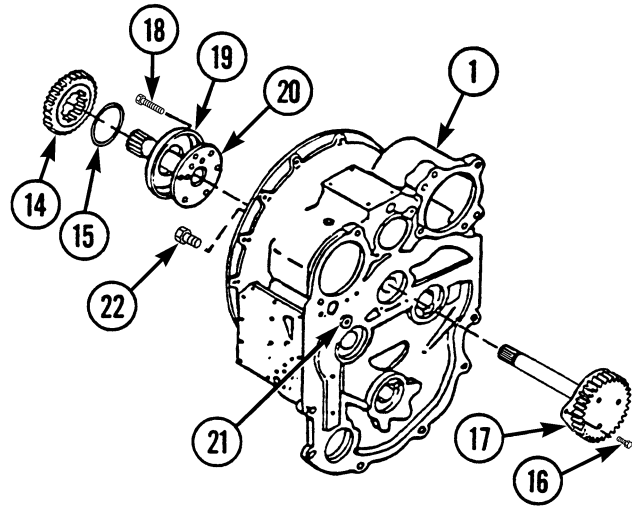
- (c) Remove retaining ring (12) and bearing (13) from bearing retainer (10).
- (d) Remove Permatex gasket material between bearing retainer (10) and front cover (1).



**7-5. TRANSMISSION FRONT COVER REPLACEMENT/REPAIR (CONT)**

**(2) Remove parts (14 through 22) from front cover (1).**

- (a) Remove hub impeller gear (14) and thrust washer (15) from front cover (1).
- (b) Remove three screws (16) and transmission input shaft (17) as an assembly from front cover (1).
- (c) Remove six screws (18), cover plate (19), and stator support tube (20) from front cover (1).



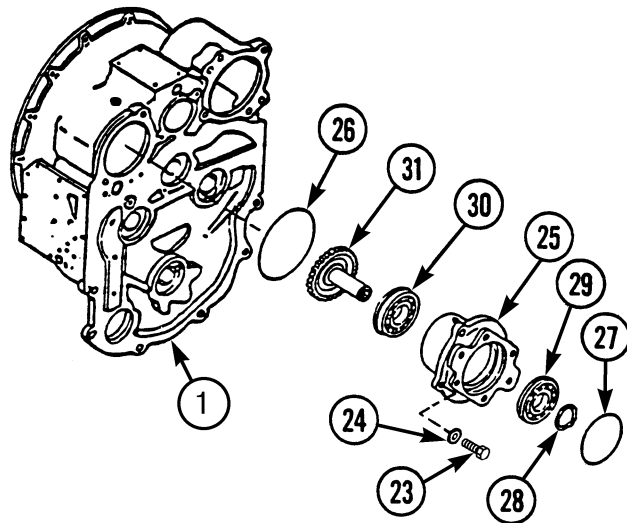
**NOTE**

Do not remove high pressure line in front cover. Entire front cover assembly must be replaced if replacement of high pressure line is necessary. High pressure line is not replaceable.

- (d) Remove plug (21) from front cover (1).
- (e) Drive out converter pressure relief valve (22) through plug (21) opening in front cover (1).

**(3) Remove hydraulic piston pump drive adapter (25) from front cover (1).**

- (a) Remove four screws (23), lockwashers (24), and hydraulic piston pump drive adapter (25) as an assembly from front cover (1). Discard lockwashers.
- (b) Remove preformed packings (26 and 27) from hydraulic piston pump drive adapter (25). Discard preformed packings.



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

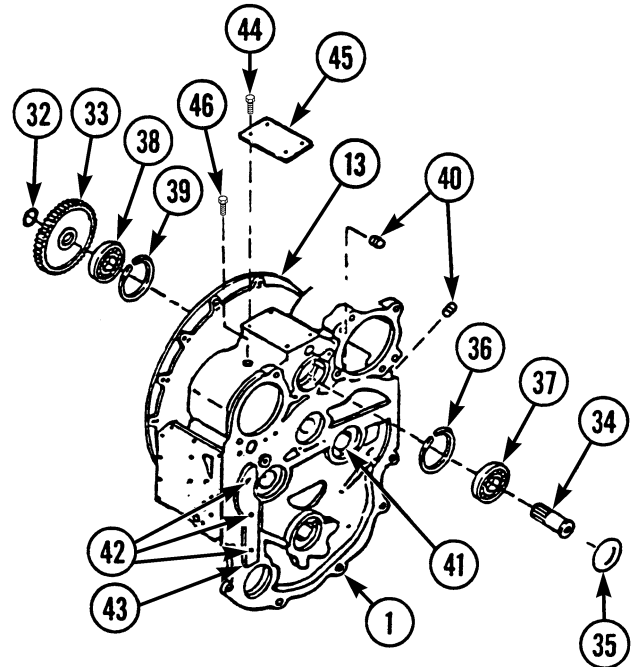
- (c) Remove snap ring (28), bearing (29), and bearing roller (30) from auxiliary pump gear (31).

**(4) Remove auxiliary pump drive assembly parts (32 through 39) from front cover (1).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove snap ring (32) and auxiliary pump gear (33) from shaft (34).
- (b) Use a punch to strike shaft (34) until cover (35) comes off and shaft can be removed from front cover (1).
- (c) Remove snap ring (36) from front cover (1).
- (d) Remove bearing (37) from shaft (34).
- (e) Remove bearing (38) and snap ring (39) from front cover (1).



**(5) If damaged, remove parts (40 through 45) from front cover (1).**

- (a) If damaged, remove two plugs (40) from front cover (1).
- (b) If damaged, remove sleeve (41) from front cover (1).
- (c) If damaged, remove three screws (42) and oil passage cover (43) from front cover (1).
- (d) If damaged, remove four screws (44) and identification plate (45) from front cover (1).
- (e) If damaged, remove breather (46) front cover (1).

**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**7-5. TRANSMISSION FRONT COVER REPLACEMENT/REPAIR (CONT)**

**e. Assembly.**

- (1) If removed, install parts (40 through 46).

**WARNING**

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

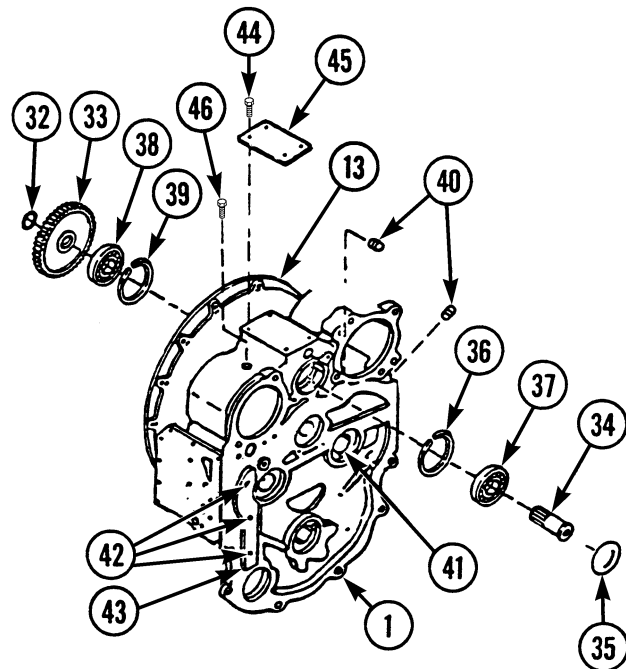
- (a) If removed, apply sealing compound to threads of breather (46) and install on front cover (1).
- (b) If removed, install identification plate (45) and four screws (44) on front cover (1).
- (c) If removed, install oil passage cover (43) and three screws (42) on front cover (1).
- (d) If removed, install sleeve (41). Align index mark on sleeve to center of locating hole in front cover (1).
- (e) If removed, apply sealing compound to threads of plugs (40) and install in front cover (1).

- (2) Install auxiliary pump drive parts (32 through 39) on front cover (1).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Install snap ring (39) and bearing (37) in front cover (1).
- (b) Install snap ring (36) inside front cover (1).
- (c) Install bearing (37) on shaft (34).
- (d) Install shaft (34) with bearing (37) in front cover (1).
- (e) Use a suitable puller to pull shaft (34) through front side of front cover (1) and through auxiliary pump gear (33) until snap ring groove is seen.
- (f) Install snap ring (32) on shaft (34).



**WARNING**

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

(g) Apply sealing compound to cover (35) and press onto front cover (1).

**(3) Install hydraulic piston pump drive adapter (25) on front cover (1).**

(a) Install bearing roller (30) and bearing (29) on shaft of auxiliary pump gear (31).

**WARNING**

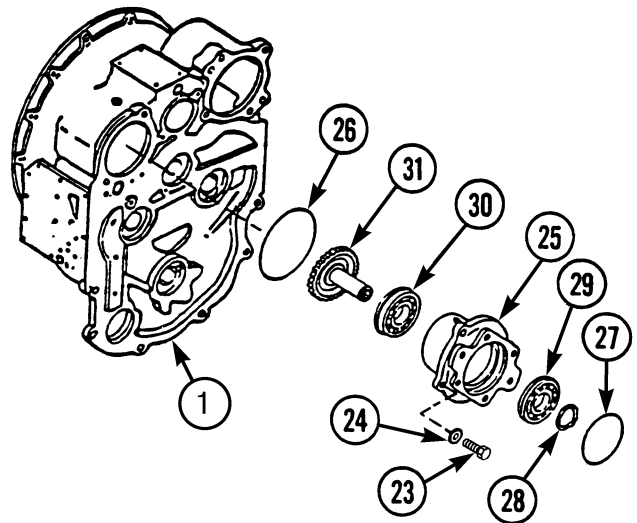
Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

(b) Install snap ring (28) on shaft of auxiliary pump gear (31).

(c) Slide parts (28 through 31) as an assembly into hydraulic piston pump drive adapter (25).

(d) Install preformed packings (26 and 27) on hydraulic piston pump drive adapter (25).

(e) Install hydraulic piston pump drive adapter (25), four lockwashers (24), and screws (23) on front cover (1).

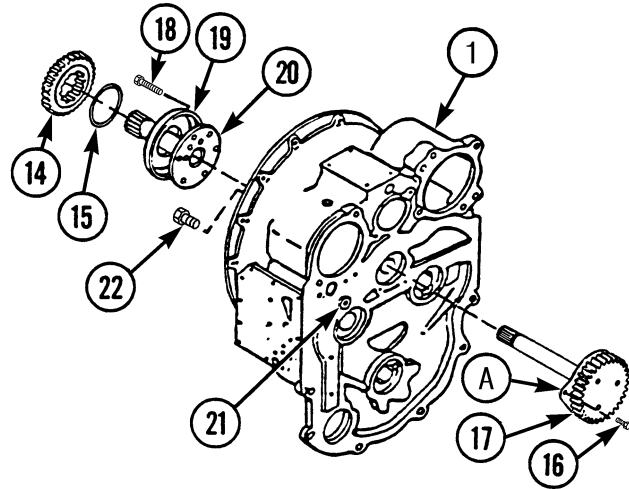


**7-5. TRANSMISSION FRONT COVER REPLACEMENT/REPAIR (CONT)**

**(4) Install parts (14 through 22).**

**WARNING**

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

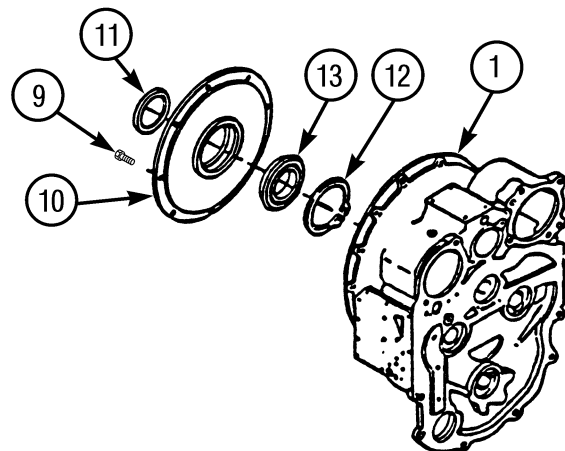


- (a) Apply sealing compound to converter pressure relief valve (22) and drive into bore until valve seat shoulders against bottom of bore.
- (b) Apply sealing compound to threads of Allen head pipe plug (21) and install Allen head pipe plug to back side of front cover (1).
- (c) Install stator support tube (20), cover plate (19), and six screws (18) on front cover (1).
- (d) Install transmission input shaft (17), as an assembly through back of front cover (1). Ensure that flat side of bearing retainer (A) is against front cover (1).
- (e) Apply sealing compound to threads of three screws (16) and install in input shaft (17) and front cover (1).
- (f) Install thrust washer (15) against cover plate (19).
- (g) Install impeller gear (14) against thrust washer (15).

**(5) Install parts (9 and 11 through 13) and bearing retainer (10) on front cover (1).**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.



- (a) Install bearing (13) with retaining ring (12) on bearing retainer (10).



- (b) Install oil seal (11) in bearing retainer (10).

### WARNING

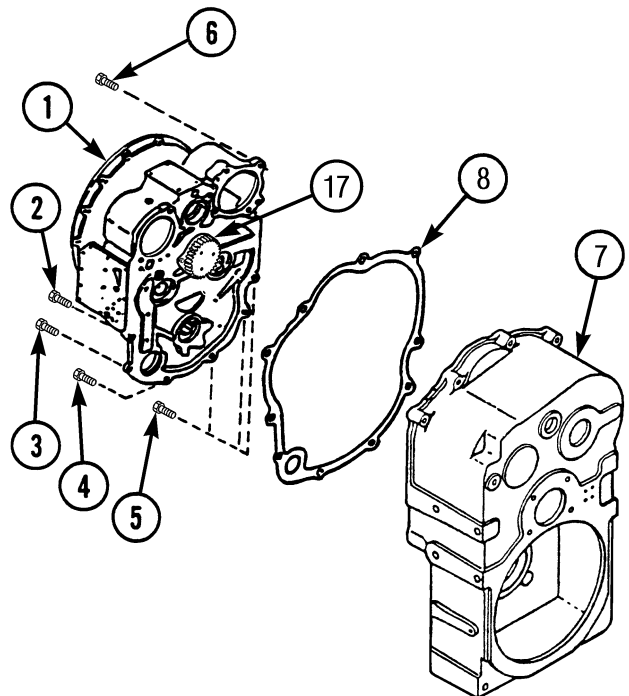
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

- (c) Apply Permatex gasket material to bearing retainer (10). Ensure that oil seal (11) is on the outside before installing bearing retainer. Install bearing retainer and seven screws (9) on front cover (1).

#### **f. Installation.**

- (1) **Install front cover assembly (1) on main case (7).**

- (a) Ensure that two locator bushings are in position on main case (7). The locator bushings align front cover assembly (1) with main case.
- (b) Place gasket (8) on main case (7).
- (c) Using suitable lifting device, lift front cover assembly (1) and place it on main case (7).
- (d) It may be necessary to rotate input shaft (17) slightly to line up gear teeth in front cover clutch packs.



- (2) **Install four screws (6), three screws (5), and screws (2, 3, and 4). Tighten screws to 50 lb-ft (67.8 N•m).**

### **NOTE**

Follow-on Maintenance:

- Install transmission oil pump (Para 7-10).
- Install torque converter (Para 7-3).
- Install transmission control valve (Para 7-9).
- Install transmission assembly (Para 7-4).

**END OF TASK**

## 7-6. TRANSMISSION OUTPUT SHAFT REPLACEMENT/REPAIR/ADJUSTMENT

This Task Covers:

- |             |                 |               |
|-------------|-----------------|---------------|
| a. Removal  | c. Inspection   | e. Adjustment |
| b. Cleaning | d. Installation |               |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)  
 Dial Indicator (Item 3, Appendix D)  
 Gear Puller (Item 15, Appendix D)

*Equipment Condition*

Front and rear propeller shafts removed (TM 10-3930-673-20)

*Equipment Condition (Cont)*

Transmission oil drained (TM 10-3930-673-20)  
 Transmission removed (Para 7-4)

*Materials/Parts*

Oil, Hydraulic (Item 30, Appendix B)  
 Packing, Preformed  
 Packing, Preformed  
 Ring, Retaining  
 Seal  
 Seal  
 Wood Blocks

#### a. Removal.

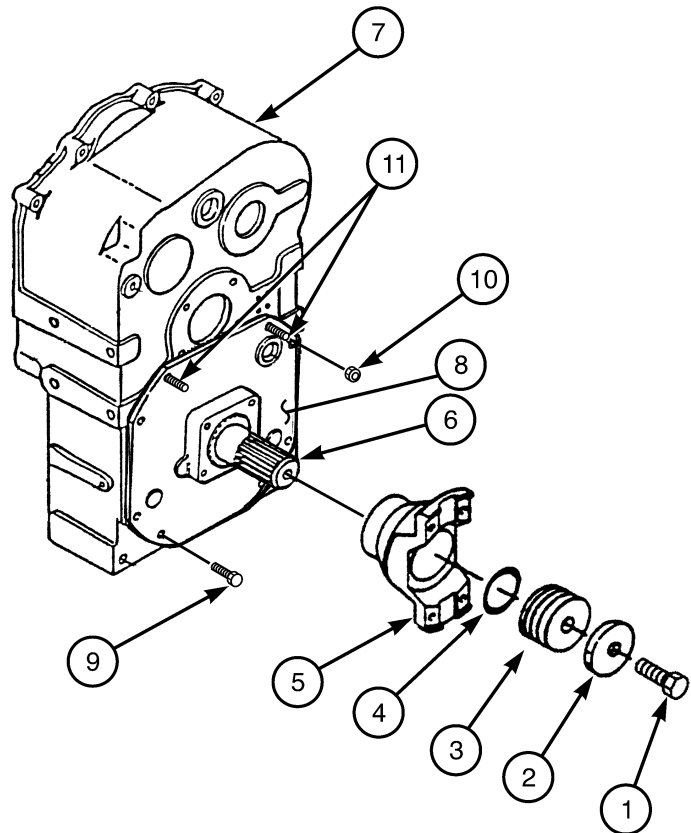
- (1) Remove screw (1), washer (2), shims (3), preformed packing (4), and yoke (5) from output shaft (6). Discard preformed packing.
- (2) Place transmission (7) horizontally on wood blocks with splines of output shaft (6) facing upward.
- (3) Mark position of output cap (8) on transmission (7) for ease in installation.
- (4) Remove two screws (9) from output cap (8).
- (5) Remove two nuts (10) from two studs (11) of transmission (7).

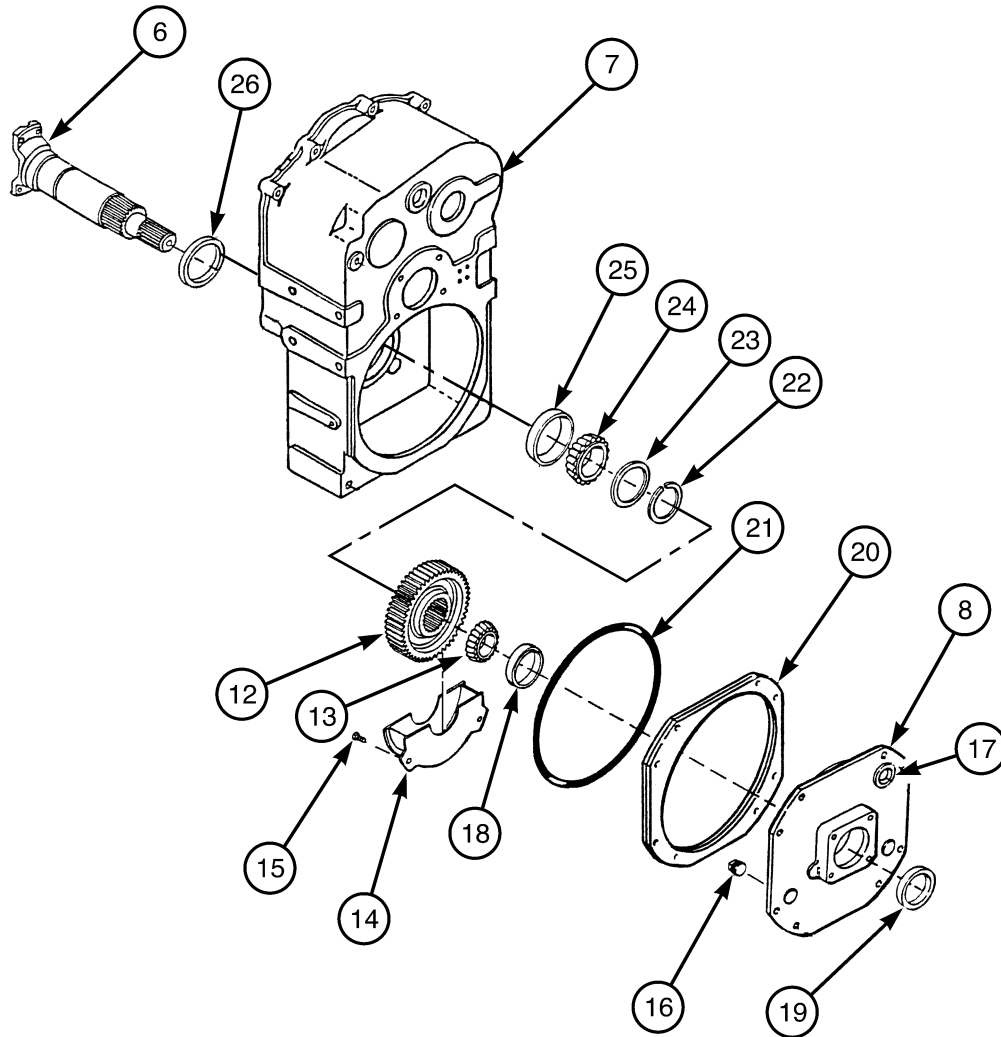
**CAUTION**

Use care when removing output cap. Failure to follow this precaution will damage oil baffle pan inside transmission.

**NOTE**

Spur gear and bearing cone will slide free of output shaft and will be removed as output cap is removed.



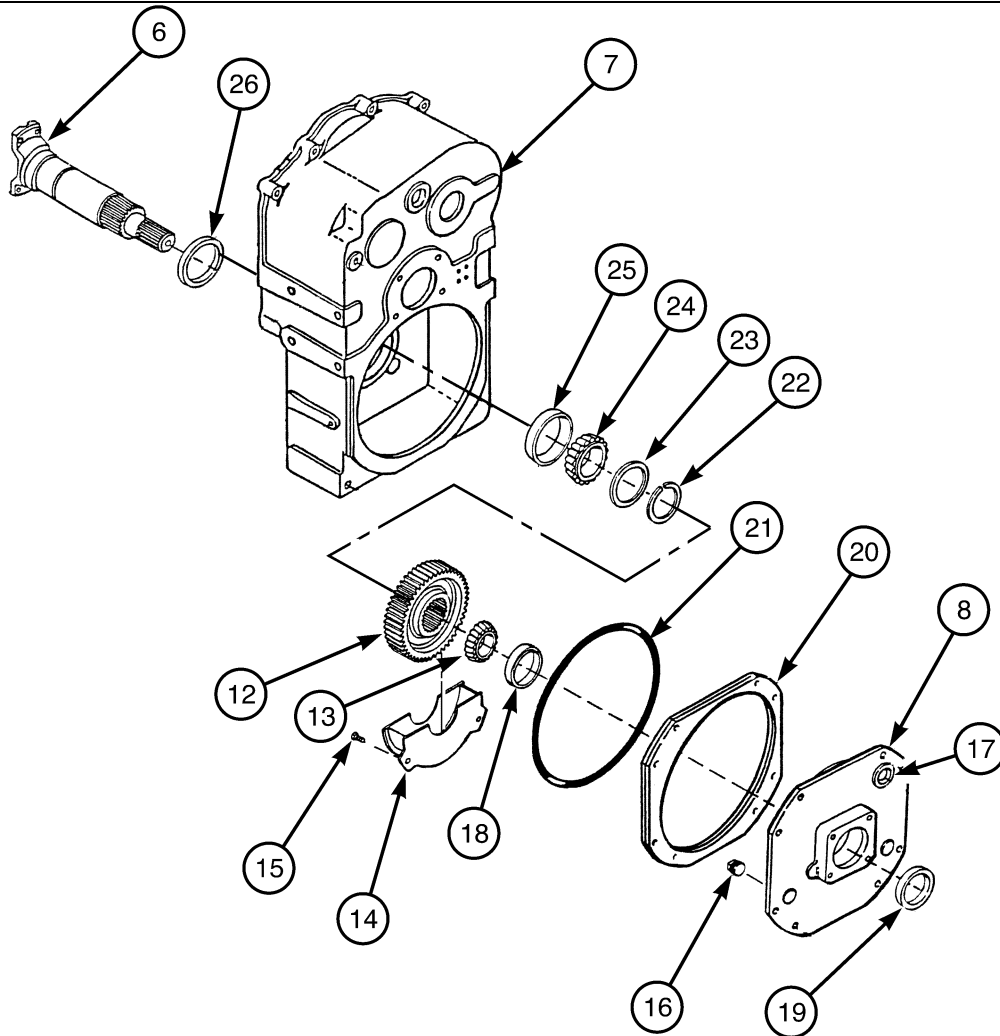


- (6) Remove output cap (8) from transmission (7) and remove spur gear (12) and bearing cone (13) from oil baffle pan (14).
- (7) Remove two screws (15) and oil baffle pan (14) from output cap (8).
- (8) Remove plug (16) and plug (17) from output cap (8).
- (9) Using puller, remove bearing cup (18) and seal (19) from output cap (8). Discard seal.
- (10) Remove shims (20) and large preformed packing (21) from top surface of transmission (7).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

**7-6. TRANSMISSION OUTPUT SHAFT REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**



- (11) At inside of transmission (7), remove retaining ring (22), thrust washer (23), and bearing cone (24) from output shaft (6). Discard retaining ring.
- (12) Raise transmission (7) to vertical position and remove output shaft (6).
- (13) Using puller, remove bearing cup (25) and seal (26) from transmission (7). Discard seal.
- (14) Remove two studs (11) from transmission (7), if necessary.

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Installation.**

- (1) Install two studs (11) to transmission (7) if removed.
- (2) With transmission (7) in vertical position, press bearing cup (25) and new seal (26) into transmission.

- (3) Position output shaft (6) into transmission (7) and hold yoke end of output shaft in place using spacer screws.
- (4) Install bearing cone (24), thrust washer (23) and retaining ring (22) over splined end of output shaft (6) and seat bearing cone into bearing cup (18).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released causing severe eye injury.

- (5) Install new retaining ring (22) to output shaft (6).
- (6) Lower transmission (7) to horizontal position with splines of output shaft (6) facing upward.
- (7) Position new large preformed packing (21) and shims (20) to top surface of transmission (7).
- (8) Press bearing cup (18) and new seal (19) into output cap (8).
- (9) Install plug (17) and plug (16) into output cap (8).
- (10) Install oil baffle pan (14) to output cap (8) with two screws (15).

**NOTE**

Position bearing cone on top surface of spur gear as spur gear is placed horizontally into oil baffle pan.

- (11) Position output cap (8) over transmission (7) and position spur gear (12) and bearing cone (13) over splines of output shaft (6).
- (12) Install output cap (8) to transmission (7).
- (13) Loosely install two nuts (10) to two studs (11) and loosely install two screws (9). Tighten nuts and screws alternately and evenly until fully tightened.
- (14) Remove spacer screws from yoke of output shaft (6).
- (15) Raise transmission (7) to vertical position and ensure that output shaft (6) rotates freely.
- (16) Install yoke (5), new preformed packing (4), shims (3), washer (2), and screw (1) to output shaft (6).

**7-6. TRANSMISSION OUTPUT SHAFT REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

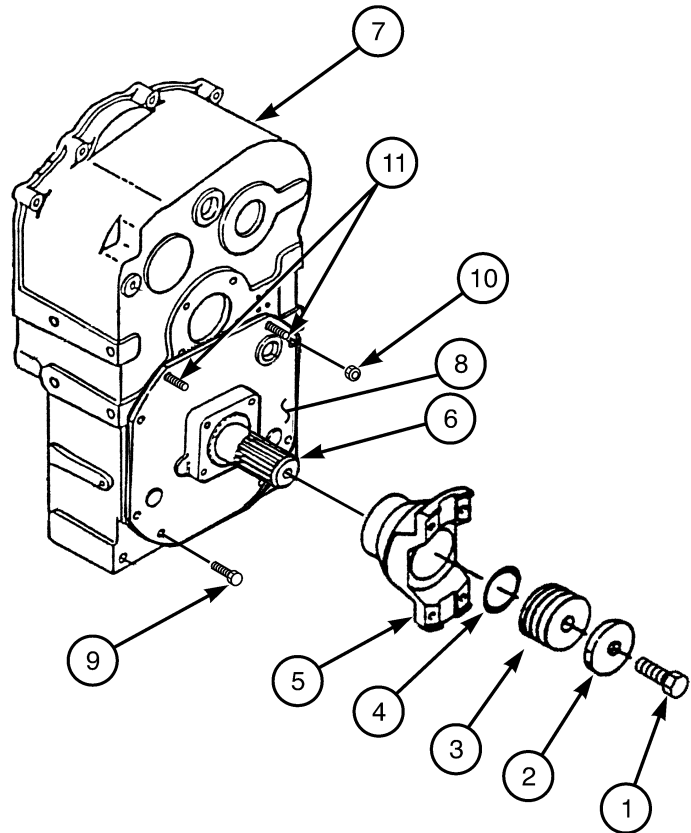
**e. Adjustment.**

**NOTE**

If a new yoke was installed, adjust shims (3) to obtain 0.005 in. (0.127 mm) gap between yoke (5) face and washer (2).

**Check and adjust output shaft (6) end play.**

- (a) Install a dial indicator to read shaft end play.
- (b) Pull up on output shaft (6) and read end play on dial indicator.
- (c) If end play is not within 0.000 - 0.004 in. (0.000 - 0.1016 mm), adjust shims (3) as necessary to bring end play within specifications.
- (d) Remove indicator and base.



**NOTE**

Follow-on Maintenance:

- Install front and rear propeller shafts (TM 10-3930-673-20).
- Fill transmission with oil (TM 10-3930-673-20).

**END OF TASK**

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## 7-7. TRANSMISSION INPUT SHAFT REPLACEMENT/REPAIR

This Task Covers:

- |                |             |                 |
|----------------|-------------|-----------------|
| a. Removal     | c. Cleaning | e. Installation |
| b. Disassembly | d. Assembly |                 |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Lifting Device, 2,000 lb (907.18 kg) capacity

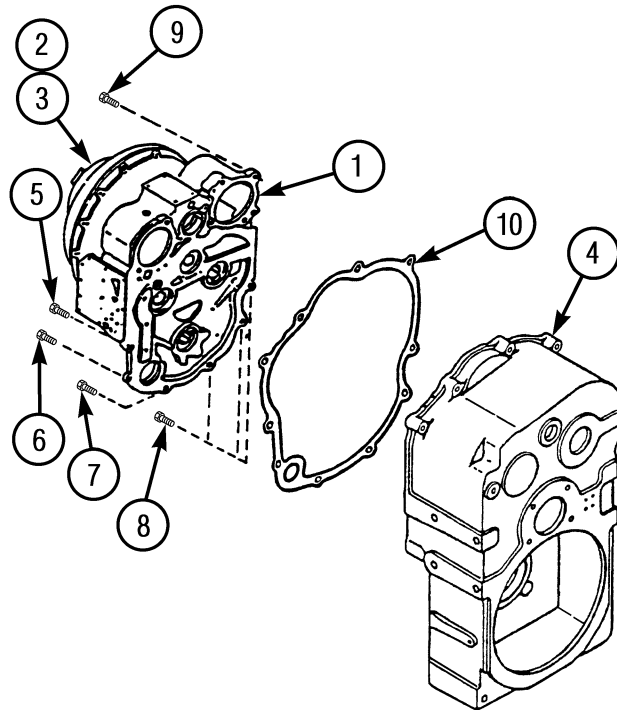
*Equipment Condition*

Transmission assembly removed (Para 7-4)

*Materials/Parts*

Compound, Sealing (Item 40, Appendix B)  
Grease (Item 18, Appendix B)  
Gasket

**a. Removal.**



**(1) Remove front cover (1), torque converter (2), and front housing (3) as a unit from main case (4).**

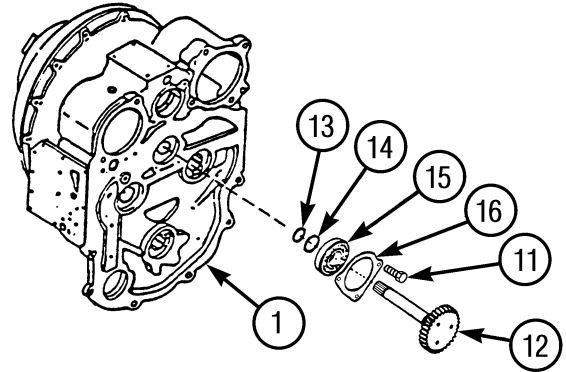
- (a) Attach suitable lifting device to front cover assembly (1), torque converter (2), and front housing (3) as a unit.
- (b) Remove screws (5, 6, and 7), three screws (8) and four screws (9) from front cover (1) and main case (4).
- (c) Using suitable lifting device, lift unit off main case (4).
- (d) Remove gasket (10) from main case (4). Discard gasket.



- (2) Remove three screws (11) and transmission shaft (12) as an assembly from front cover (1).

**b. Disassembly.**

- (a) Remove seal ring (13) from input shaft (12).



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Remove snap ring (14) and ball bearing (15) from input shaft (12).  
 (c) Remove bearing retainer (16) from input shaft (12).

**c. Cleaning.** See **Cleaning Instructions (Para 2-12)**.

**d. Assembly.**

- (1) Install bearing retainer (16) on input shaft (12). Ensure that flat side of bearing retainer faces away from input shaft gear.

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (2) Install ball bearing (15) and snap ring (14) on input shaft (12).  
 (3) Install seal ring (13) on input shaft (12).

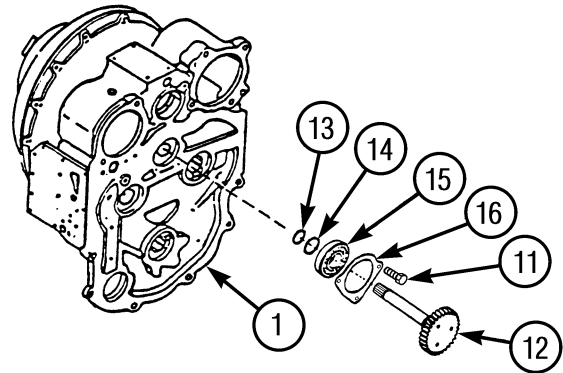
**e. Installation.**

- (1) Install input shaft (12) as an assembly in front cover (1).  
 (a) Apply grease to seal ring (13) to center it on input shaft (12).  
 (b) Install input shaft (12) as an assembly through bore in back of front cover (1). Ensure that bearing retainer (16) is placed with flat side against front cover.

**7-7.TRANSMISSION INPUT SHAFT REPLACEMENT/REPAIR (CONT)**

**WARNING**

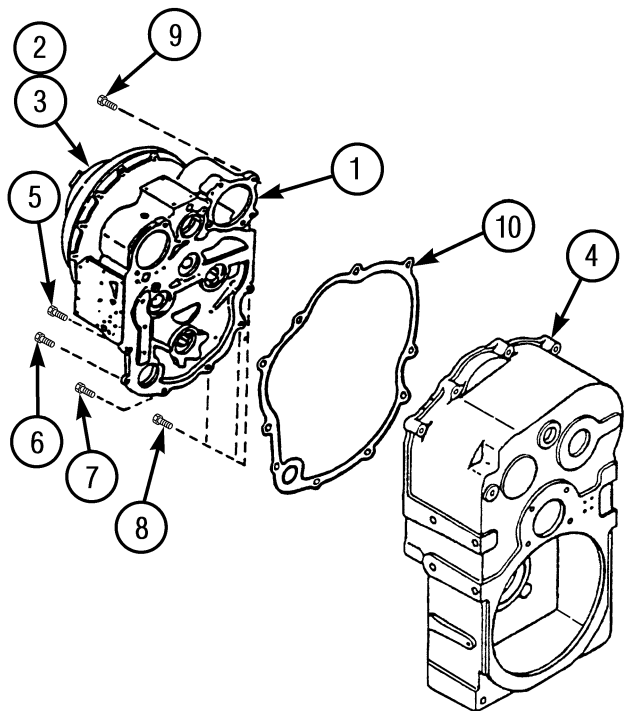
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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



- (c) Apply sealing compound, to threads of three screws (11) and install screws in input shaft (12) and front cover (1).

**(2) Install front cover (1), torque converter (2), and front housing (3) as a unit to main case (4).**

- (a) Position gasket (10) on main case (4).
- (b) Attach suitable lifting device to front cover assembly (1), torque converter (2), and front housing (3) as a unit. Lift unit into position on main case (4).
- (c) Install four screws (9), three screws (8) and screws (5, 6 and 7) on front cover (1) and main case (4).



**NOTE**

Follow-on Maintenance: Install transmission assembly (Para 7-4).

**END OF TASK**

**7-9. TRANSMISSION CONTROL VALVE REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Tool Kit, Machinists: Post, Camp and Station (Item 24, Appendix D)

*Equipment Condition*

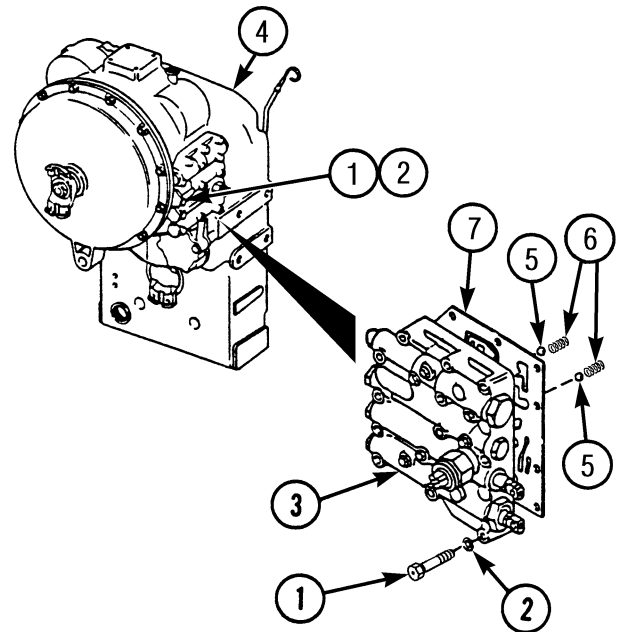
Transmission assembly removed (Para 7-4)

*Materials/Parts*

- Compound, Sealing (Item 44, Appendix B)
- Oil, Hydraulic (Item 30, Appendix B)
- Gasket
- Packing, Preformed
- Packing, Preformed (2)
- Packing, Preformed
- Packing, Preformed (2)
- Packing, Preformed
- Packing, Preformed
- Packing, Preformed
- Seal, Oil

**a. Removal.**

- (1) **Remove 13 screws (1) and washers (2) from transmission control valve (3).**
- (2) **Remove transmission control valve (3) from front cover (4).**
  - (a) Pull transmission control valve (3) straight out. Detent balls (5) are spring loaded and may fall out. Note position of balls and springs (6).
  - (b) Remove gasket (7) from transmission control valve (3). Discard gasket.
  - (c) Remove two detent balls (5) and springs (6) from back of transmission control valve (3).



**7-9. TRANSMISSION CONTROL VALVE REPLACEMENT/REPAIR (CONT)**

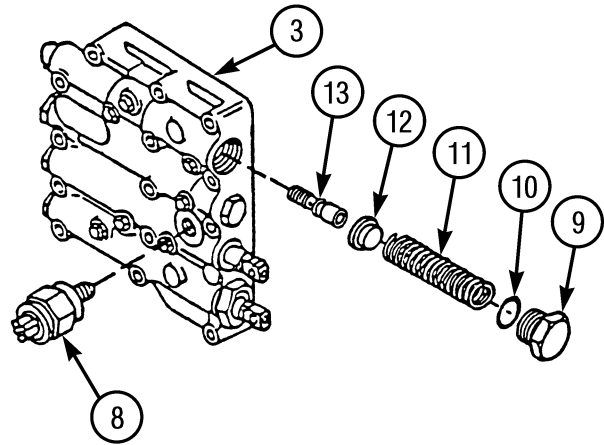
**b. Disassembly.**

- (1) Remove neutral safety switch (8) from transmission control valve (3).

**CAUTION**

Do not overtighten vise jaws. Failure to follow this precaution will cause damage to parts.

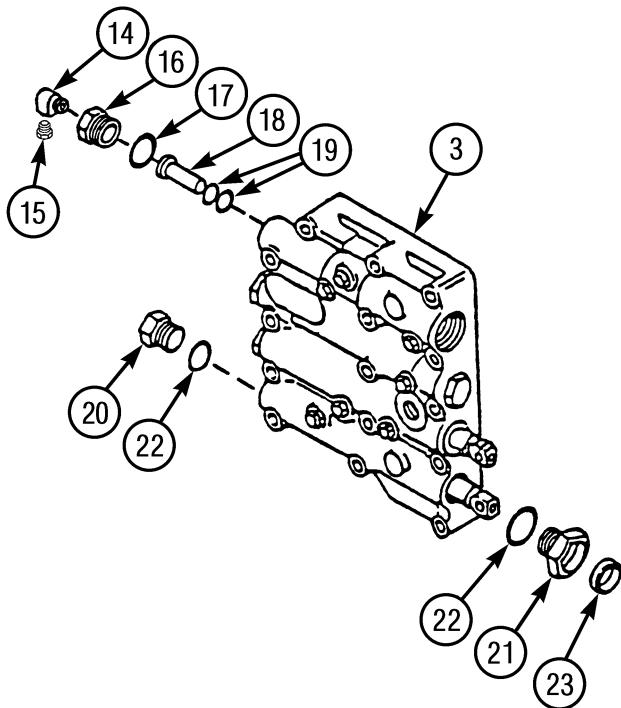
- (2) Position transmission control valve (3) in a vise with soft jaws.
- (3) Disassemble transmission control valve (3) parts (9 through 46).



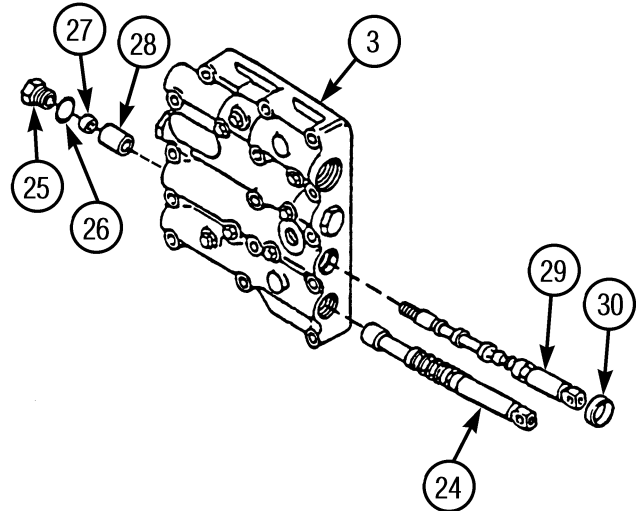
**WARNING**

Spring is under compression. Use care when removing plug.

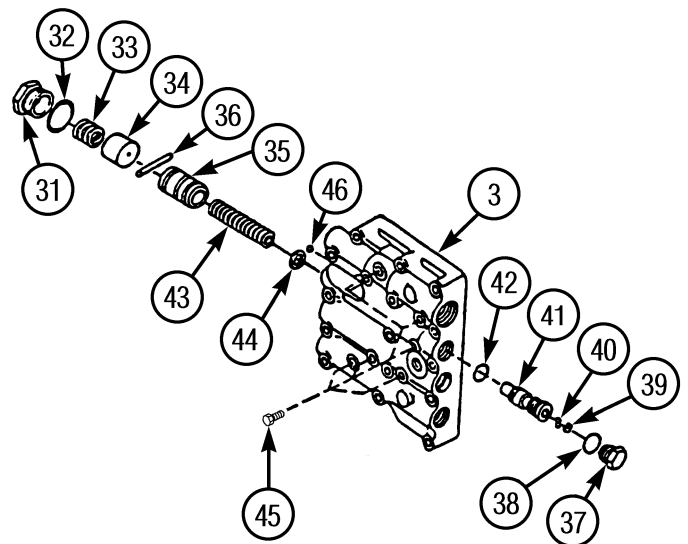
- (a) Remove plug (9), preformed packing (10), spring (11), spring guide (12), and pressure valve assembly (13) from transmission control valve (3). Discard preformed packing.
- (b) Remove elbow (14) and plug (15) from brake line plug (16).
- (c) Remove brake line plug (16) and preformed packing (17) from transmission control valve (3). Discard preformed packing.
- (d) Remove brake cutoff piston (18) from transmission control valve (3).
- (e) Remove two preformed packings (19) from transmission control valve (3). Discard preformed packings.
- (f) Remove plugs (20 and 21) and two preformed packings (22) from transmission control valve (3). Discard preformed packings.
- (g) Remove oil seal (23) from plug (21). Discard oil seal.



- (h) Remove stem assembly (24) (range selector spool) from transmission control valve (3).
- (i) Remove cap (25) and preformed packing (26) from transmission control valve (3). Discard preformed packing.
- (j) Remove nut (27) and spacer (28) from stem (29).
- (k) Remove stem (29) (directional spool) and oil seal (30) from transmission control valve (3).



- (l) Remove plug (31) and preformed packing (32) from transmission control valve (3). Discard preformed packing.
- (m) Remove dump valve spring (33) and dump valve (34) from transmission control valve (3).
- (n) Depress accumulator piston (35) and remove roller (36).
- (o) Remove plug (37) and preformed packing (38) from transmission control valve (3). Discard preformed packing.



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (p) Remove snap ring (39), orifice plate (40), spool (41), and shims (42) from transmission control valve (3).
- (q) Remove accumulator piston (35), accumulator spring (43), and washer (44) from other end transmission control valve (3).
- (r) If damaged, remove eight plugs (45) and one ball (46) from transmission control valve (3).

**c. Cleaning. See Cleaning Instructions (Para 2-12).**

**7-9. TRANSMISSION CONTROL VALVE REPLACEMENT/REPAIR (CONT)**

*d. Inspection.* See Inspection Instructions (Para 2-14).

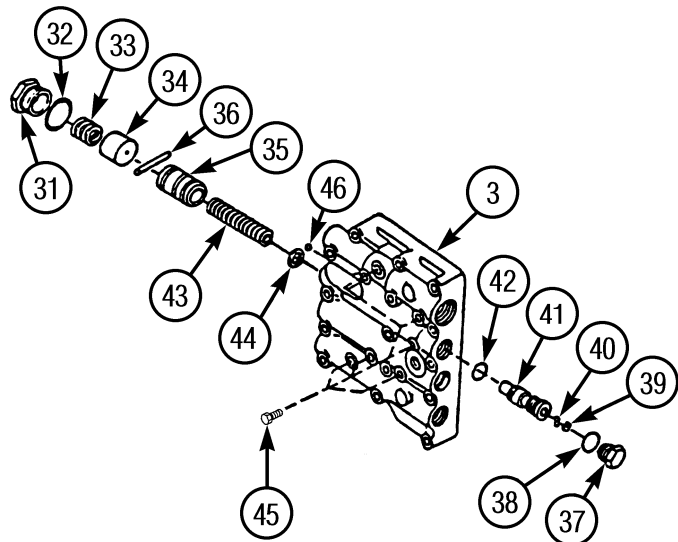
*e. Assembly.*

**NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all parts, except neutral start switch, as they are installed.

**(1) Assemble transmission control valve (3) parts (9 through 46).**

- (a) If removed, install one ball (46) and eight plugs (45) in transmission control valve (3). Ball should be 0.03 in. (0.76 mm) below surface.
- (b) Install washer (44), accumulator spring (43), and accumulator piston (35) in one end of transmission control valve (3). Depress accumulator piston to compress spring and install roller (36) in hole toward back of transmission control valve.
- (c) Install dump valve (34) and dump valve spring (33) in transmission control valve (3).
- (d) Install plug (31) and preformed packing (32) on transmission control valve (3).

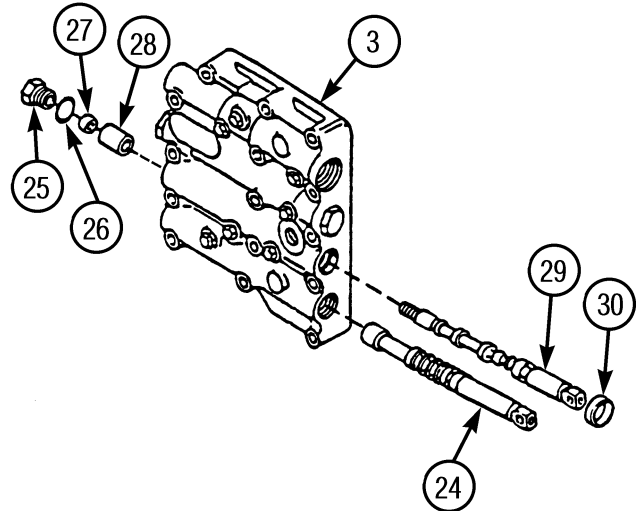


**WARNING**

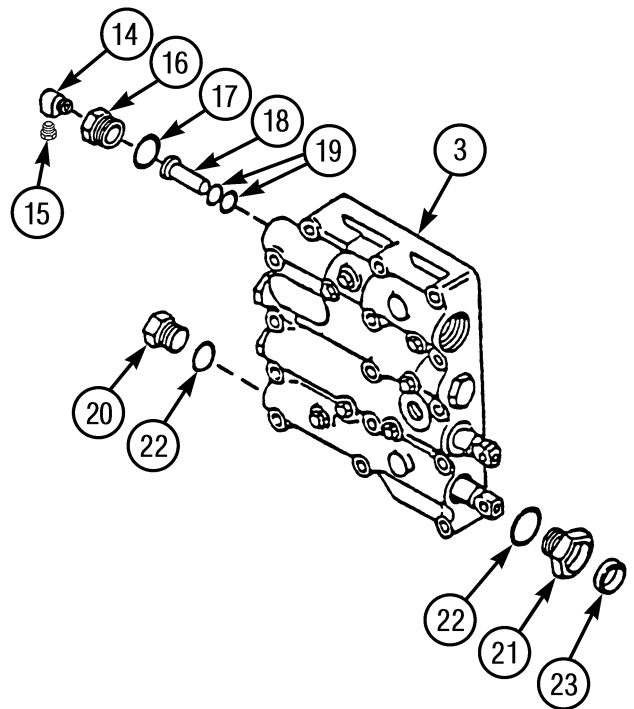
Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (e) Install shims (42), spool (41), orifice plate (40), and snap ring (39) on other side of transmission control valve (3).
- (f) Install plug (37) and preformed packing (38) on transmission control valve (3).

- (g) Install oil seal (30) into transmission control valve (3) body bore.
- (h) Install stem (29) (directional spool). Use care to prevent damage to oil seal (30) in transmission control valve (3).
- (i) Install spacer (28) and nut (27) on stem (29) (directional spool).
- (j) Install preformed packing (26) and cap (25).

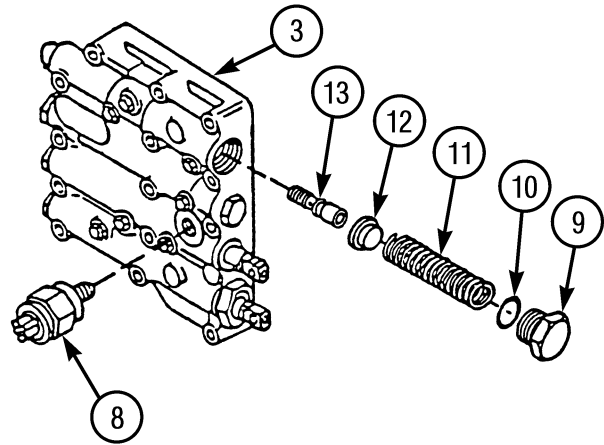


- (k) Install preformed packings (22) on plugs (20 and 21). Install plug (20) on transmission control valve (3).
- (l) Install stem assembly (24) (range selector spool) in transmission control valve (3).
- (m) Install plug (21) in transmission control valve (3).
- (n) Install oil seal (23) in plug (21).
- (o) Install two preformed packings (14) into top bore grooves of transmission control valve (3).
- (p) Install brake cutoff piston (19) in transmission control valve (3).
- (q) Install preformed packing (18) on brake line plug (17) and install plug and preformed packing in transmission control valve (3).
- (r) Install plug (16) in elbow (15).
- (s) Install elbow (15) in transmission control valve (3).



**7-9. TRANSMISSION CONTROL VALVE REPLACEMENT/REPAIR (CONT)**

- (t) Install pressure valve assembly (13), spring guide (12), and return spring (11) in transmission control valve (3).
- (u) Install preformed packing (10) on plug (9) and install plug in transmission control valve (3).



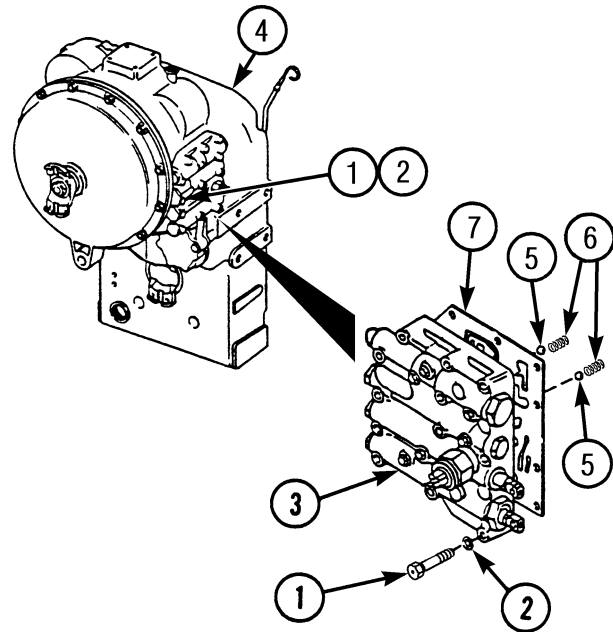
**WARNING**

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

- (2) **Apply sealing compound to threads of neutral safety switch (8) and install in transmission control valve (3).**

**f. Installation.**

- (1) **Install transmission valve (3) in front cover (4).**
  - (a) Install two springs (6) and detent balls (5) in back of transmission control valve (3).
  - (b) Install gasket (7) on front cover (4).



**CAUTION**

Use care when installing transmission control valve so as to not lose detent balls and spring.

- (c) Install transmission control valve (3) over gasket (7).
- (2) **Install 13 washers (2) and screws (1) on transmission control valve (3) and front cover (4).**

**NOTE**

Follow-on Maintenance: Install transmission assembly (Para 7-4).

**END OF TASK**



## 7-10. TRANSMISSION OIL PUMP REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance, Common  
No. 2 Less Power  
(Item 17, Appendix D)  
Cap and Plug Set (Item 1, Appendix D)  
Gear Puller (Item 15, Appendix D)  
Scribe

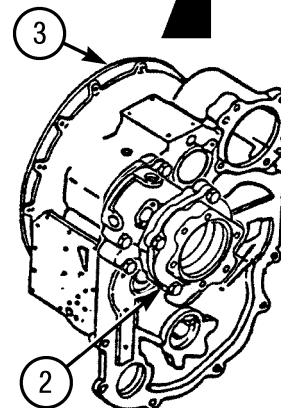
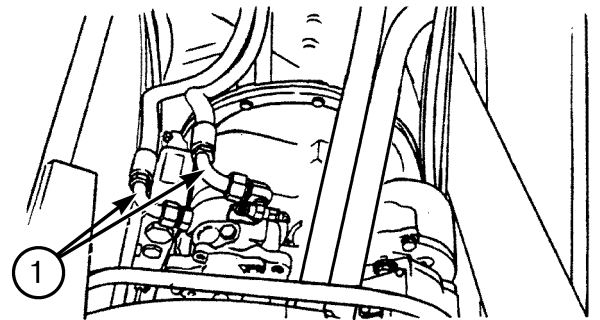
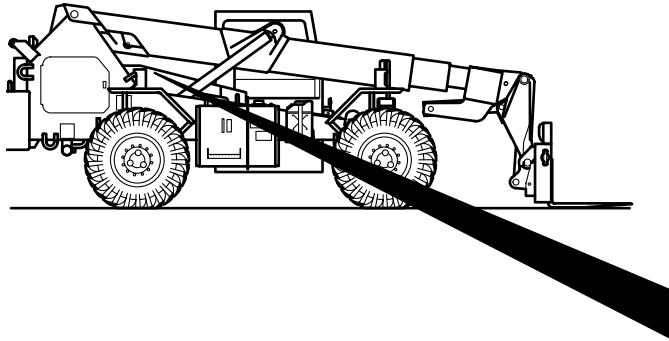
#### *Equipment Condition*

Tandem gear pump removed  
(TM 10-3930-673-20)

#### *Materials/Parts*

Alumilastic (Item 2, Appendix B)  
Rags (Item 35, Appendix B)  
Tags (Item 55, Appendix B)  
Gasket  
Lockwashers (4)  
Lockwashers (4)  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed

### a. Removal.



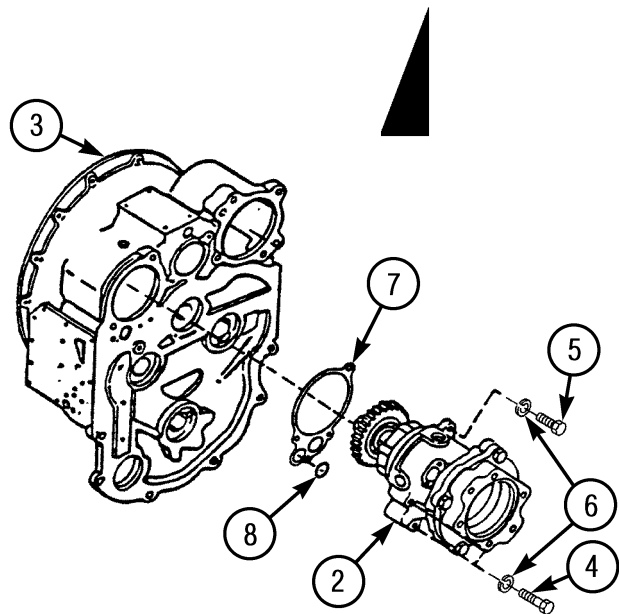
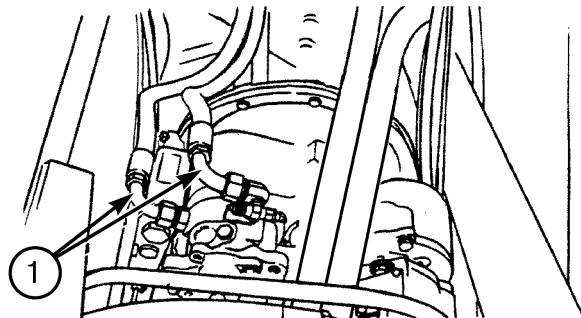
### CAUTION

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

- (1) Tag, mark, and disconnect two oil hoses (1) from transmission oil pump (2). Cap or plug all openings.
- (2) Scribe transmission oil pump (2) and front cover (3) for ease of assembly.

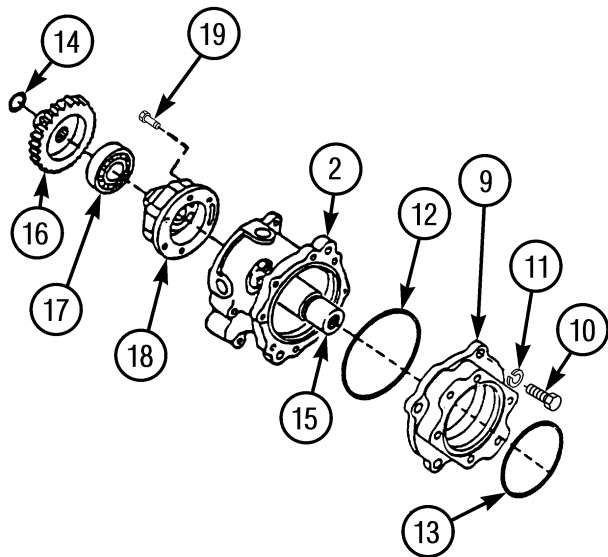
**7-10. TRANSMISSION OIL PUMP REPLACEMENT/REPAIR  
(CONT)**

- (3) Remove three screws (4), screw (5), four lockwashers (6), and transmission oil pump (2) from front cover (3). Discard lockwashers.
- (4) Remove and discard gasket (7) and preformed packing (8).



**b. Disassembly.**

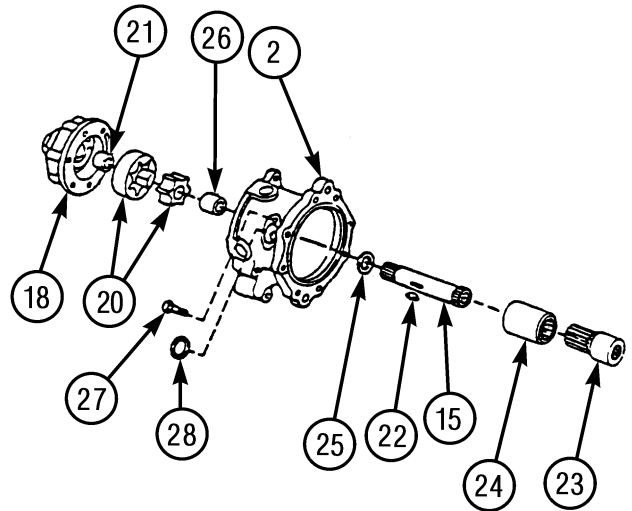
- (1) Disassemble hydraulic gear pump drive parts (9 through 13).
  - (a) Scribe adapter (9) and transmission oil pump (2) for ease of assembly.
  - (b) Remove four screws (10), lockwashers (11), and adapter (9) from transmission oil pump (2). Discard lockwashers.
  - (c) Remove preformed packings (12 and 13) from adapter (9). Discard preformed packings.



**(2) Disassemble transmission oil pump (2) parts (14 through 28).****WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove snap ring (14) from end of shaft (15).
- (b) Use a gear puller to pull gear (16) with bearing (17) from end of shaft (15).
- (c) Scribe retainer (18) and transmission oil pump (2). These marks will be used during assembly.
- (d) Remove screws (19) and retainer (18) from transmission oil pump (2).
- (e) Remove two piece geroter (20).
- (f) Remove bearing (21) from retainer (18).
- (g) Remove woodruff key (22) from keyway in shaft (15).
- (h) Remove sleeve adapter (23) and sleeve spacer (24).
- (i) Remove shaft (15) and thrust race (25).
- (j) Remove bearing (26) from transmission oil pump (2) housing.
- (k) Remove screw (27) and expansion plug (28) from transmission oil pump (2).



**c. Cleaning.** See Cleaning Instructions (Para 2-12).

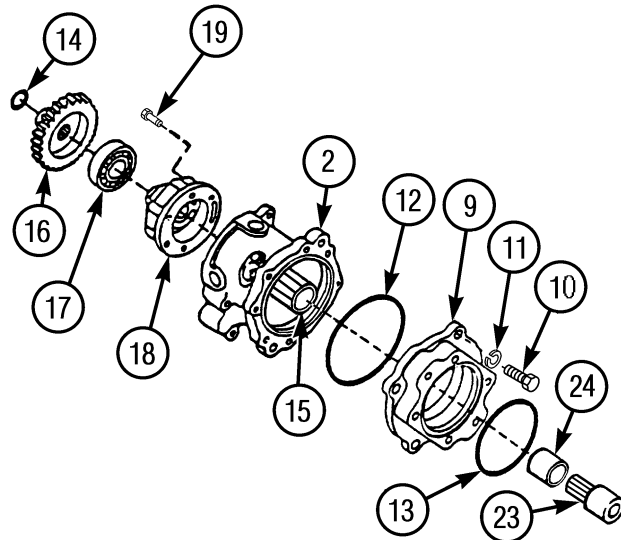
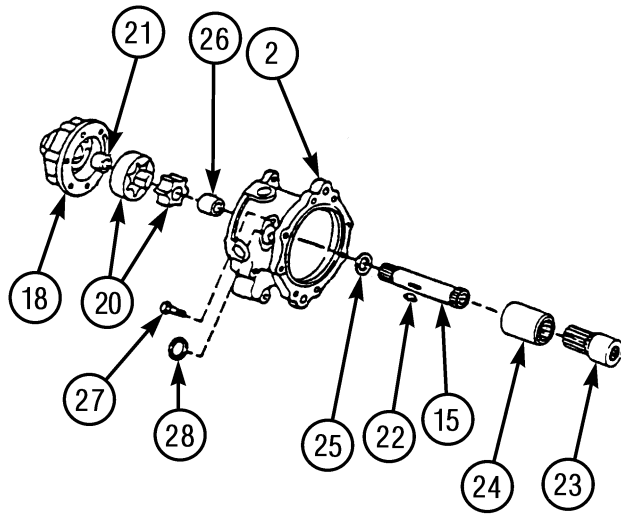
**d. Inspection.** See Inspection Instructions (Para 2-14).

**7-10. TRANSMISSION OIL PUMP REPLACEMENT/REPAIR  
(CONT)**

**e. Assembly.**

**(1) Assemble transmission oil pump (2) parts (14 through 28).**

- (a) Install expansion plug (28) and screw (27) on transmission oil pump (2).
- (b) Install bearing (26) 0.015 in. (0.38 mm) below surface in transmission oil pump (2) housing.
- (c) Install thrust race (25) and woodruff key (22) on shaft (15). Insert shaft in transmission oil pump (2) housing.
- (d) Install bearing (21) in retainer (18).
- (e) Install two piece geroter (20) on shaft (15). The geroter must assemble freely over woodruff key (22) in shaft.
- (f) Install retainer (18) on transmission oil pump (2) housing. Ensure that scribe marks align.
- (g) Apply lute or alumilastic to threads of screws (19). Install six screws. Tighten screws to 17 lb-ft. (23.05 N•m).
- (h) Install sleeve spacer (24) and sleeve adapter (23) on shaft (15).
- (i) Install bearing (17) and gear (16) on end of shaft (15).



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (j) Install snap ring (14) on end of shaft (15).

**(2) Assemble hydraulic gear pump drive parts (9 through 13).**

- (a) Install preformed packings (12 and 13) on adapter (9).

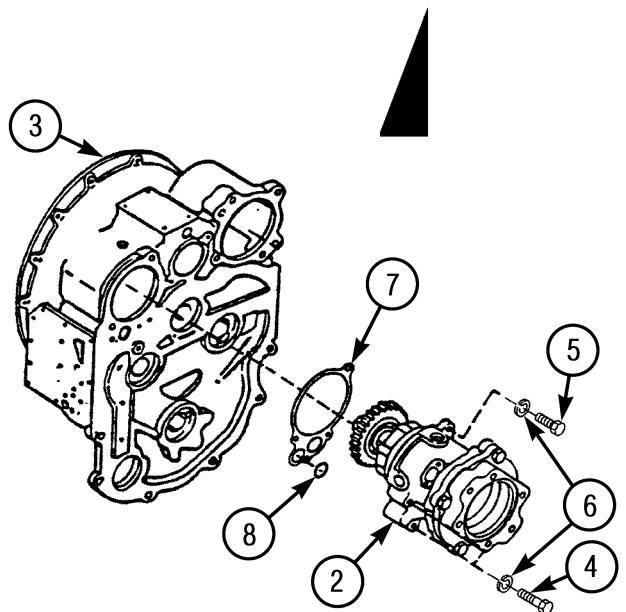
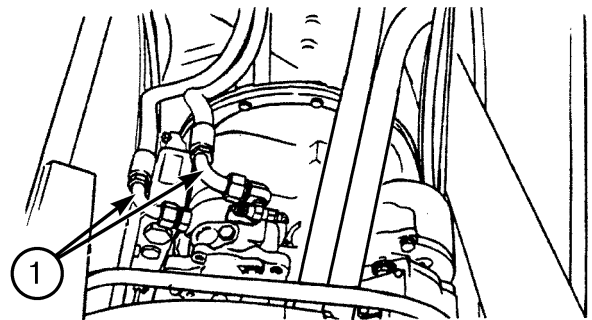
- (b) Install adapter (9) on transmission oil pump (2). Ensure that scribe marks align.
- (c) Install four lockwashers (11) and screws (10) on adapter (9) and transmission oil pump (2).

**f. Installation.**

**NOTE**

Remove caps and plugs from openings during installation. Wipe all sealing surfaces clean and dry.

- (1) Install preformed packing (8) and gasket (7).
- (2) Install transmission oil pump (2) on front cover (3). Ensure that scribe marks align.
- (3) Install lockwasher (6), one screw (5), and three screws (4) on transmission oil pump (2) and front cover (3).
- (4) Connect two oil hoses (1) to transmission oil pump (2).



**NOTE**

Follow-on Maintenance: Install tandem gear pump (TM 10-3930-673-20).

**END OF TASK**



## CHAPTER 8

### FRONT AXLE SYSTEM MAINTENANCE

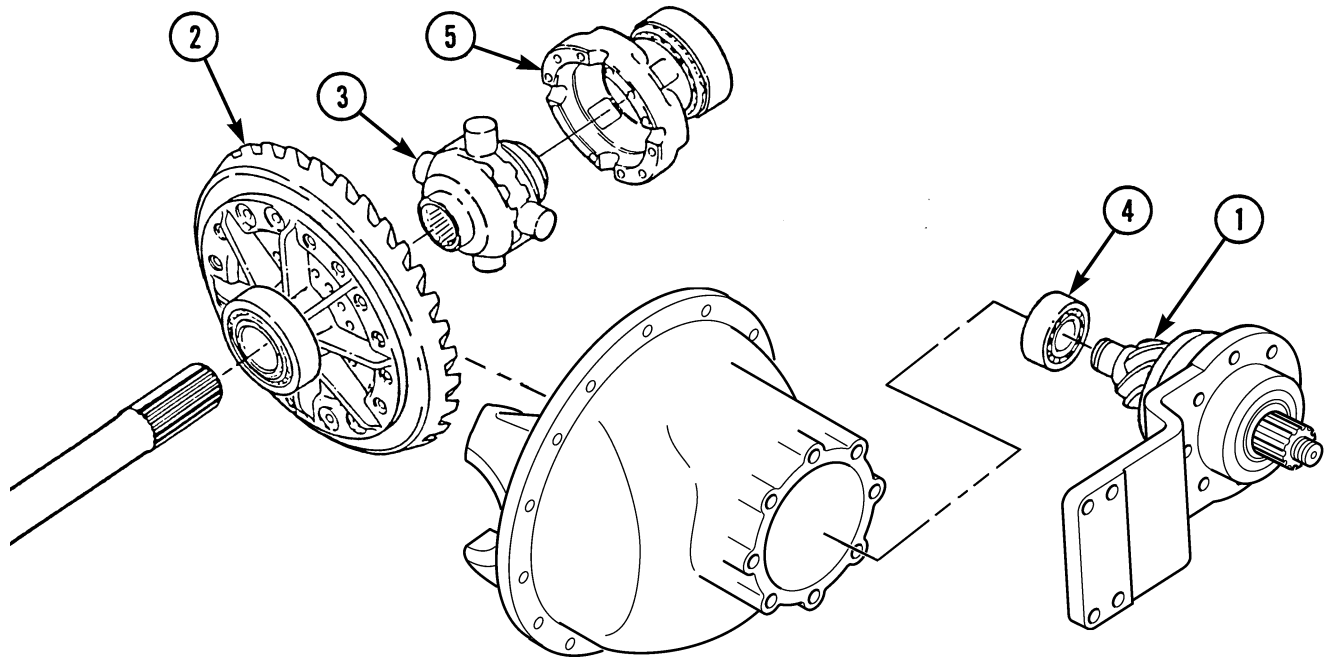
Para	Contents	Page
Section I. Description and Data		
8-1.	General .....	8-1
8-2.	Principles of Operation .....	8-2
Section II. Front Axle Maintenance Procedures		
8-3.	Front Axle Assembly Replacement/Repair .....	8-4
8-4.	Front Axle Pivot Pin Replacement .....	8-10
8-5.	Front Differential Carrier Assembly Replacement/Repair/Adjustment .....	8-11
8-6.	Front Planetary Wheel Ends Replacement .....	8-32

#### Section I. DESCRIPTION AND DATA

**8-1. GENERAL**

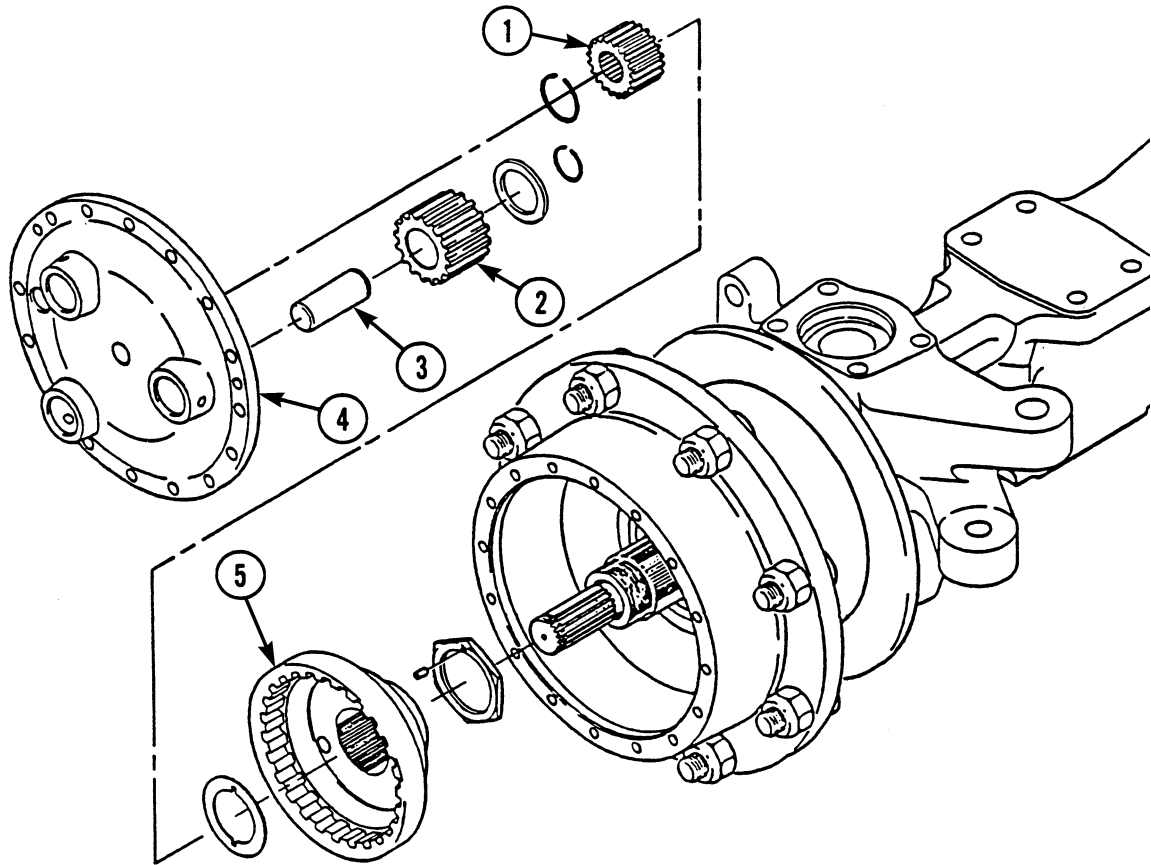
Front axle maintenance procedures not covered in this section may be found in TM 10-3930-673-20.

## 8-2. PRINCIPLES OF OPERATION



**a. Differential.** The front differential provides the primary drive gear reduction. It is a single reduction carrier and is manufactured by Rockwell. This carrier has a hypoid drive pinion (1) and ring gear (2) set and a no-spin unit (3) in the differential assembly. A straight roller (spigot) bearing (4) is mounted on the head of the drive pinion (1). All other bearings in the carrier are tapered roller bearings. The no-spin differential unit (3) is contained in the differential case (5). When the carrier operates, the no-spin unit delivers one hundred percent of the available power to both drive wheels, yet automatically allows normal differential action when required.





**b. Planetary Wheel Ends.** The planetary wheel ends provide the second gear reduction at the wheel hub. Planetary axles permit the bevel gearing of the carrier, and the axle shafts to carry nominal torsional load while providing the highest practical numerical gear reduction at the wheels.

The spur teeth of the planetary sun gear (1) mesh with teeth of the planetary gears (2). The planetary gears rotate on planetary pinion shafts (3) which are mounted on the planetary cover (4). The planetary gear (2) teeth, in turn, mesh with the teeth of the planetary ring gear (5).

Power is transmitted through the axle shafts to the sun gear, through the revolving planetary gears (1 and 2) and into the planetary cover (4) which drives the wheel hub.

## Section II. FRONT AXLE MAINTENANCE PROCEDURES

### 8-3. FRONT AXLE ASSEMBLY REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Floor Jack, 10 ton (9071.84 kg) capacity
- Jackstands (2) 40 in. (101.6 cm) height, 3-1/2 ton (3175.14 kg) capacity

##### *Equipment Condition*

- Vehicle parked on level surface.
- Parking brake set.
- Rear wheels chocked.

##### *Materials/Parts*

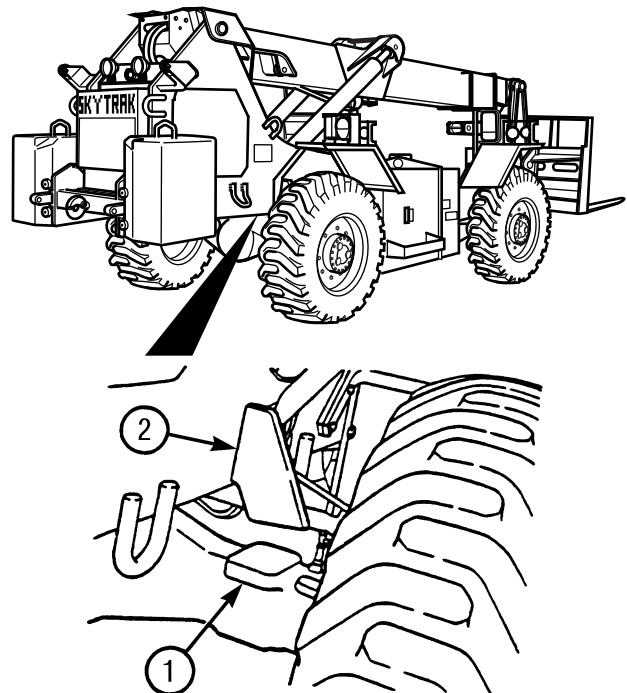
- Compound, Sealing (Item 14, Appendix B)
- Oil, Lubricating, Gear (Item 29, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Tags (Item 55, Appendix B)
- Locknut
- Lockwasher
- Wood Blocks, 3 in. (76.2 mm)
- Container, 5 gal (18.93 l) capacity
- Steel Bar (minimum 1 in. [25.4 mm] diameter and 6 ft [1.83 m] long)

##### *Personnel Required*

Two

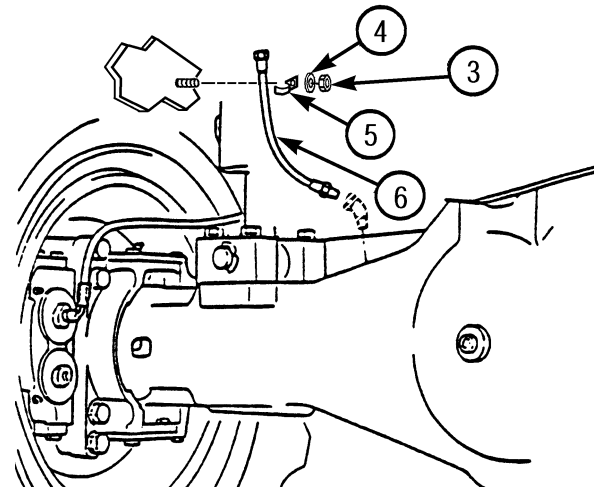
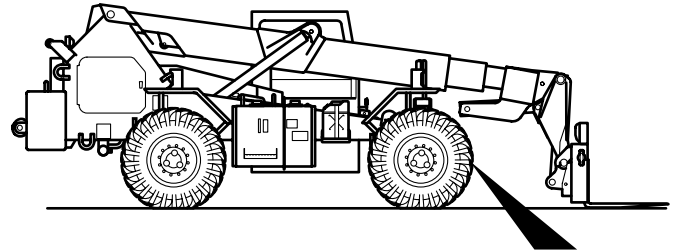
#### **a. Removal.**

- (1) Place wood blocks (3 in. [76.2 mm] thick) between frame pads (1) on rear axle and frame tilt stop pads (2). This will prevent frame from tilting when removing front tilt cylinders.
- (2) Start engine and raise boom for sufficient work clearance (TM 10-3930-673-10).
- (3) Disconnect parking brake cable (TM 10-3930-673-20).
- (4) Remove front propeller shaft (TM 10-3930-673-20).
- (5) Raise front of vehicle 8 in. (203.2 mm) off ground and support under frame (TM 10-3930-673-20).
- (6) Remove frame tilt cylinder (TM 10-3930-673-20).



(7) Remove front disk brake assemblies (Para 10-3).

(8) Remove nut (3), lockwasher (4), clamp (5), and axle breather hose (6) from frame. Discard lockwasher.



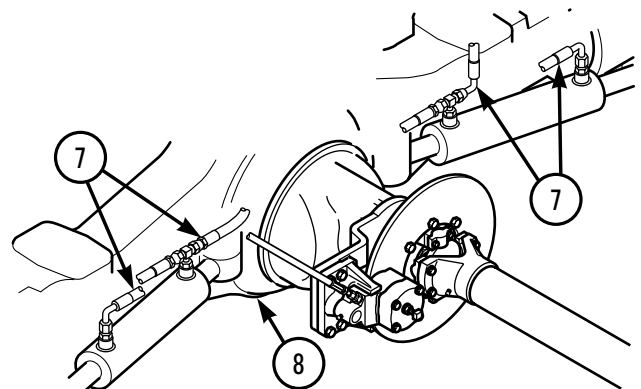
**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

**NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.

(9) Tag, mark, and disconnect front steering cylinder hoses (7) from front axle assembly (8).

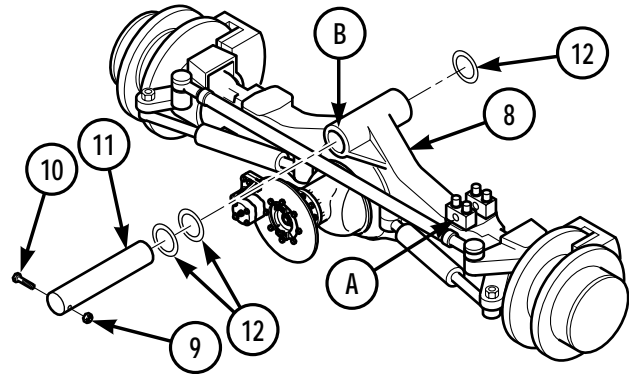


**8-3. FRONT AXLE ASSEMBLY REPLACEMENT/REPAIR (CONT)****WARNING**

Axle assembly weighs 1,650 lb (748 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (10) **Use a floor jack to support weight of front axle assembly (8).**
- (11) **Remove axle pivot pin (11) from front axle assembly (8).**

- (a) Remove locknut (9) and screw (10) from axle pivot pin (11). Discard locknut.

**NOTE**

Note the location and quantity of washer spacers during disassembly. Keep washer spacers together as a set. Do not mix washer spacer sets.

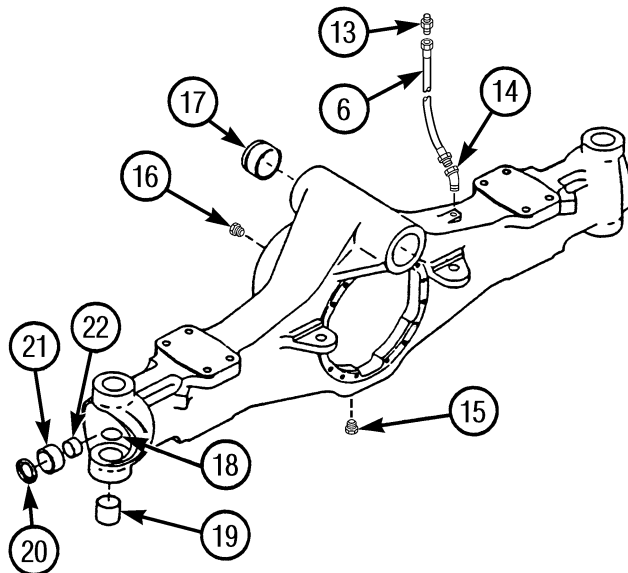
- (b) Remove axle pivot pin (11) and washer spacers (12) from front axle assembly (8).
- (12) **Remove front axle assembly (8) from vehicle frame.**
- (a) Place a steel bar (minimum 1 in. [25.4 mm] diameter and 6 ft [1.83 m] long) in the tilt cylinder rod pivot pin mounting hole (A). The bar will prevent the front axle assembly (8) from rotating when the axle is removed.
- (b) Lower floor jack and roll front axle assembly (8) to the front from under vehicle, using floor jack and 6 ft (1.83 m) bar, to prevent axle assembly from rotating.
- (c) Raise axle assembly using floor jack. Support axle assembly (8) and wheels using suitable stands.

**b. Disassembly.**

- (1) **Remove steering cylinders (TM 10-3930-673-20).**
- (2) **Remove tie rods (Para 12-6).**
- (3) **Remove parking brake assembly (TM 10-3930-673-20).**
- (4) **Remove front planetary wheel ends (Para 8-6).**
- (5) **Remove front differential carrier assembly and front universal (cardan) steering joints (Para 8-5).**
- (6) **Remove front drive wheel spindle (Para 12-3).**

**(7) If necessary, remove parts (13 through 22) from front axle assembly (8).**

- (a) Remove breather (13), hose (6), and elbow (14) from front axle assembly (8).
- (b) Remove drain plug (15) from front axle assembly (8).
- (c) Remove oil filler plug (16) from front axle assembly (8).
- (d) Remove two bushings (17) from front axle assembly (8).
- (e) Remove four plugs (18) from front axle assembly (8).
- (f) Remove four bushings (19) from front axle assembly (8).
- (g) Remove two oil seals (20) from front axle assembly (8).
- (h) Remove two sleeve assemblies (21) from front axle assembly (8).
- (i) Remove two bushings (22) from front axle assembly (8).



**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**e. Assembly.**

**(1) If removed, install parts (13 through 22) on front axle assembly (8).**

- (a) Install two bushings (22) on front axle assembly (8).
- (b) Install two sleeve assemblies (21) on front axle assembly (8).
- (c) Install two oil seals (20) on front axle assembly (8).

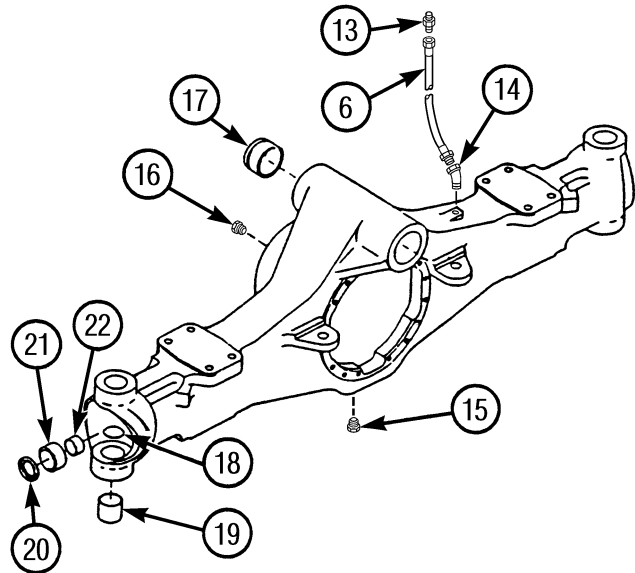
**WARNING**

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

- (d) Apply sealing compound on outside diameter of four bushings (19).
- (e) Install four bushings (19) on front axle assembly (8).
- (f) Install four plugs (18) on front axle assembly (8).
- (g) Install two bushings (17) on front axle assembly (8).

**8-3. FRONT AXLE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

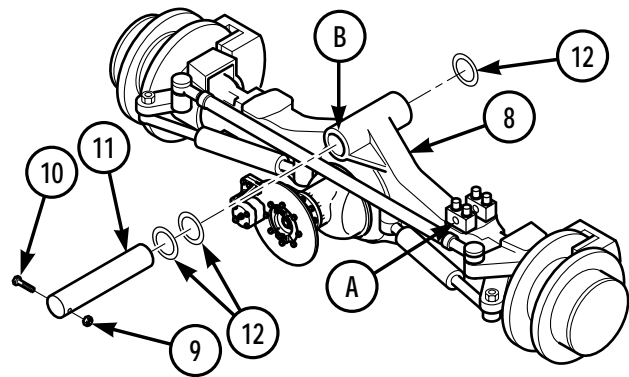
- (h) Install oil filler plug (16) on front axle assembly (8).
- (i) Install oil drain plug (15) on front axle assembly (8).
- (j) Install elbow (14), hose (6), and breather (13) on front axle assembly (8).



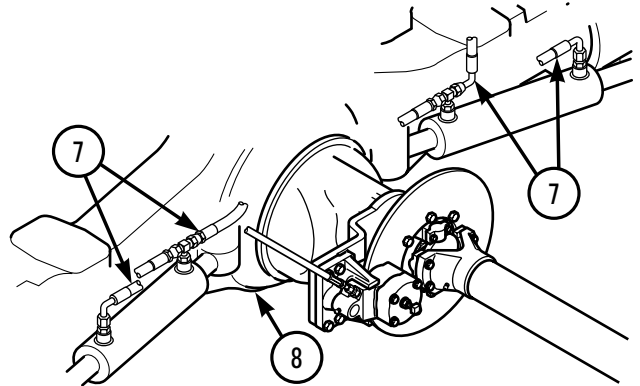
- (2) **Install front drive wheel spindle (Para 12-3).**
- (3) **Install front differential carrier assembly and front universal (cardan) steering joints (Para 8-5).**
- (4) **Install front planetary wheel ends (Para 8-6).**
- (5) **Install parking brake assembly (TM 10-3930-673-20).**
- (6) **Install tie rods (Para 12-6).**
- (7) **Install steering cylinders (TM 10-3930-673-20).**

**f. Installation.**

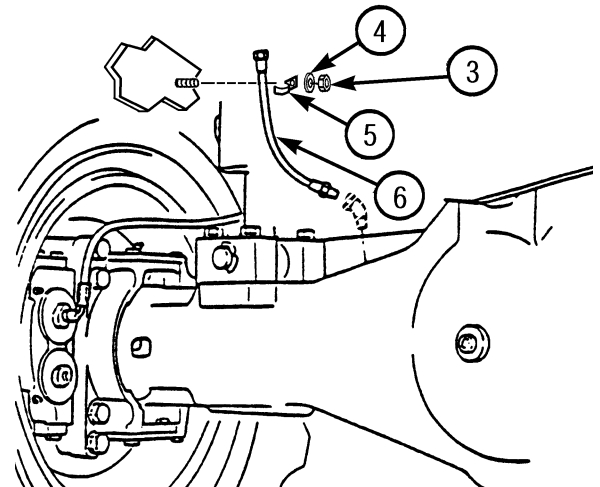
- (1) **Place a steel bar (1 in. [25.4 mm] minimum diameter and 6 ft [1.83 m] long) in the tilt cylinder rod pivot pin mounting hole (A). The bar will prevent front axle assembly (8) from rotating when installed.**
- (2) **Use a floor jack to raise front axle assembly (8).**
- (3) **Remove stands.**
- (4) **Lower front axle assembly (8) until it is supported by tires.**
- (5) **Roll front axle assembly (8) under vehicle, using 6 ft (1.83 m) bar and floor jack to prevent the axle assembly from rotating.**
- (6) **Align axle pivot pin hole (B) with frame pivot pin holes.**
- (7) **Ensure washer spacers (12) are in place on frame pivot pin hole; use floor jack to carefully raise axle assembly while assistant holds assembly steady using 6 ft [1.83 m] bar in axle tilt cylinder mounting hole (A).**



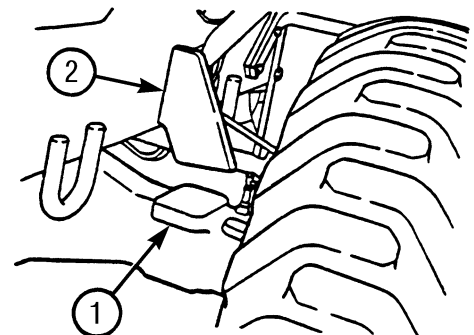
- (8) Raise floor jack until axle pivot pin hole (B) is aligned with frame pivot pin holes.
- (9) Secure front axle assembly (8) to frame with axle pivot pin (11) and washer spacers (12). At least one washer spacer on each side of axle pivot pin hole is required.
- (10) Install screw (10) and locknut (9) on axle pivot pin (11). Tighten screw to 100 lb-ft (135.58 N•m).
- (11) Use a floor jack to raise front of vehicle until vehicle frame clears jackstands; remove jackstands and carefully lower vehicle.
- (12) Connect front steering cylinder hoses (7) to front axle assembly (8).



- (13) Install axle breather hose (6), clamp (5), lockwasher (4), and nut (3) on frame.
- (14) Install front disk brake assemblies (Para 10-3).
- (15) Install frame tilt cylinder (TM 10-3930-673-20).
- (16) Install front propeller shaft (TM 10-3930-673-20).
- (17) Install parking brake cable (TM 10-3930-673-20).



- (18) Remove wood blocks from between frame pads (1) on rear axle and frame tilt stop pads (2).
- (19) Bleed hydraulic steering cylinders, by rotating steering wheel five times.



END OF TASK





## 8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ ADJUSTMENT

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | d. Inspection | g. Installation |
| b. Disassembly | e. Assembly   |                 |
| c. Cleaning    | f. Adjustment |                 |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Shop Equipment, Automotive Maintenance and  
Repair; Field Maintenance, Basic, Less Power  
(Item 18, Appendix D)  
Differential Resistance Tool - Fabricated Tool  
(Figure C-3, Appendix C)  
Yoke Nut Tool - Fabricated Tool  
(Figure C-5, Appendix C)  
Lifting Device, 2 ton (1814.37 kg) capacity  
Bearing Puller (Item 15, Appendix D)  
Dial Indicator (Item 3, Appendix D)  
Drill (Item 4, Appendix D)  
Drill Bits (Item 5, Appendix D)  
Expanding Snap Ring Pliers  
Feeler Gage (Item 8, Appendix D)  
Hammer  
Mallet, Leather or Rubber  
(Item 10, Appendix D)  
Micrometer (Item 13, Appendix D)  
Seal Puller (Item 15, Appendix D)  
Sleeve and Driver

#### *Equipment Condition*

Front axle assembly removed (Para 8-3)  
Wheel assemblies removed  
(TM 10-3930-673-20)  
Axle housing lubricant drained  
(TM 10-3930-673-20)  
Disc brake assemblies (both) removed  
(Para 10-3)  
Front planetary wheel ends removed (Para 8-6)

#### *Materials / Parts*

Compound, Marking, Prussian Blue  
(Item 12, Appendix B)  
Compound, Sealing (Item 13, Appendix B)  
Compound, Sealing (Item 43, Appendix B)  
Gloves, Insulated (Item 17, Appendix B)  
Oil, Lubricating, Gear (Item 29, Appendix B)  
Tags (Item 55, Appendix B)  
Gasket  
Pins, Cotter (2)  
Retaining Hardware – No-spin Differential  
Bolt, 1/4-20 x 7 in.  
Washers, 1-34 O.D. (2)  
Wing Nut, 1/4-20  
Rivets  
Container, 5 gal (19 l) capacity  
Wood Blocks

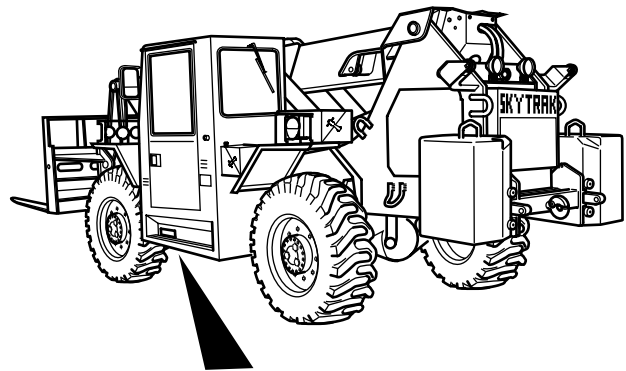
#### *Personnel Required*

Two

**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**a. Removal.**

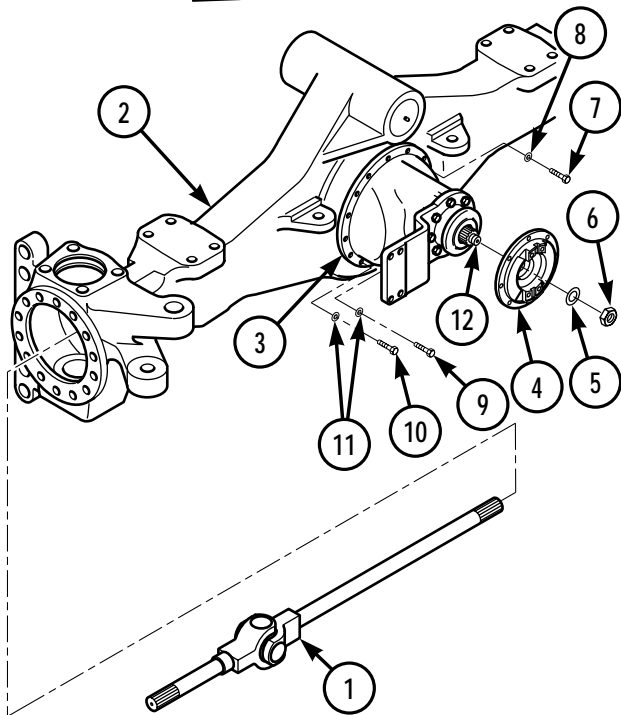
- (1) Remove axle shafts (1) from axle housing (2).
- (2) Remove differential carrier (3) from axle housing (2).
  - (a) Tip axle assembly so that front differential carrier (3) faces up.
  - (b) Reinstall companion flange (4), washer (5), and nut (6) removed with park brake assembly. Drive yoke will provide a lifting point for differential carrier (3) during removal.

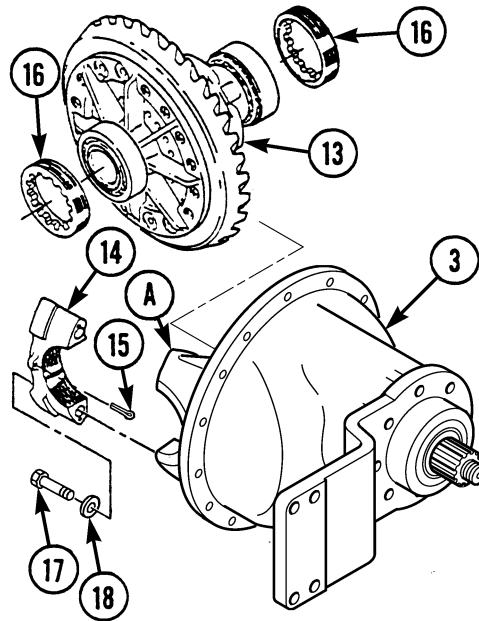


**NOTE**

Screws from differential carrier to axle housing are of three different sizes. Note size, location and quantity of screws when removing for ease of assembly.

- (c) Remove 12 screws (7), washers (8), two screws (9), screws (10), and four washers (11) from differential carrier (3).
- (d) Use leather or rubber mallet to loosen differential carrier (3) in axle housing.
- (e) Use suitable sling placed around bevel pinion (12), behind companion flange (4), to lift and support differential carrier (3) during removal.
- (f) Remove differential carrier (3) from axle housing (2).
- (g) Place differential carrier (3) on stand or bench, ring gear up, and clamp securely.
- (h) Remove companion flange (4), nut (6), and washer (5) from bevel pinion (12).



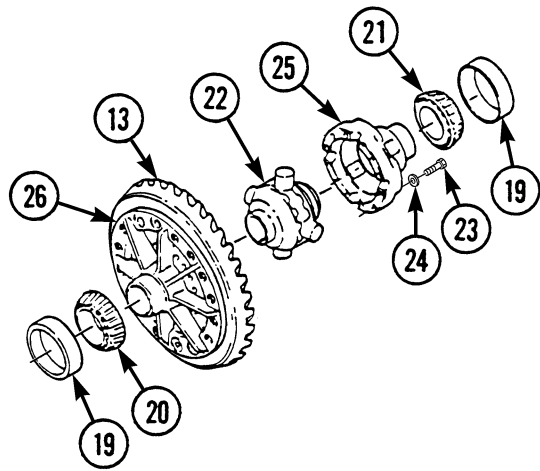
**b. Disassembly.****WARNING**

Differential and ring gear weighs approximately 100 lb (45.4 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

- (1) **Remove differential and ring gear assembly (13) from differential carrier (3).**
  - (a) Mark one carrier leg (A) and bearing cap (14) to aid in assembly.
  - (b) Remove two cotter pins (15) from bearing adjusting rings (16). Discard cotter pins.
  - (c) Remove two screws (17) and washers (18) from bearing caps (14).
  - (d) Remove two bearing caps (14) and bearing adjusting rings (16) from differential carrier (3).
  - (e) Use suitable sling to lift the main differential and ring gear (13) from carrier (3). Place assembly on bench.

**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (f) Remove two bearing cups (19) from flange case half bearing cone (20) and plain case half bearing cone (21).
- (g) Using suitable puller, remove flange case half bearing cone (20) and plain case half bearing cone (21).



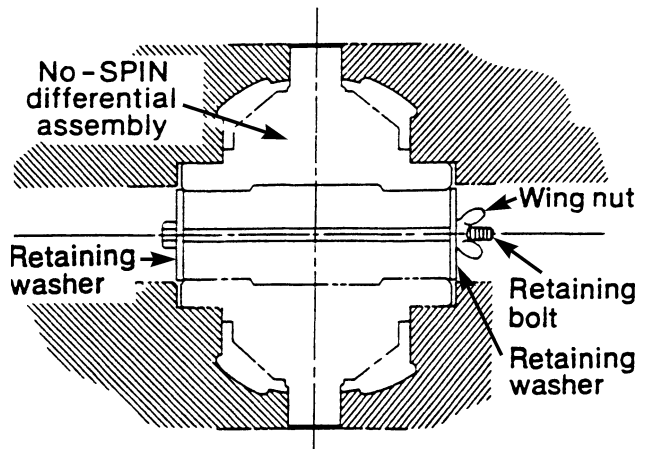
**(2) Disassemble no-spin differential (22) and ring gear (13) assembly.**

- (a) Mark each case half to aid in assembly.

**WARNING**

No-spin differential contains compression springs under pressure. Failure to use a retaining bolt or other means of restraint can cause personnel injury when removing no-spin differential.

- (b) Secure the no-spin differential (22) with a bolt, a wing nut, and two washers as shown.
- (c) Remove eight screws (23) and washers (24) from plain case half (25).
- (d) Separate case halves (25 and 26) and remove no-spin differential (22).



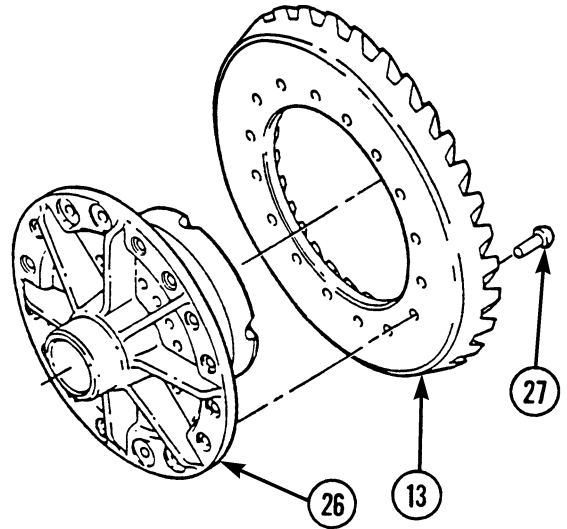
**NOTE**

No-spin differential is not serviceable and must not be disassembled. Do not remove retaining bolt for inspection.

- (e) Inspect no-spin differential (22) for damage. Replace if damaged.

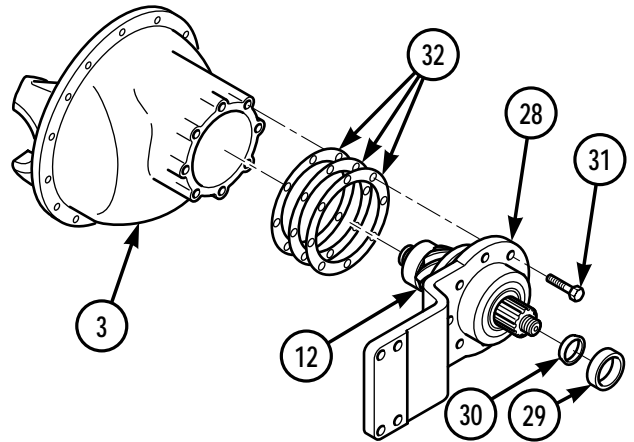
**(3) Remove ring gear (13).**

- (a) Inspect ring gear (13) for wear or damage. If ring gear needs replacement, center punch 12 rivets (27) on side of ring gear.
- (b) Drill 12 rivets (27) on side of ring gear (13) to a depth equal to thickness of one rivet head. Use a drill bit 1/32 in. (0.031 mm) smaller than body diameter of rivet.
- (c) Press or drive 12 rivets (27) from drilled side through holes in ring gear (13) and flange case half (26). Discard rivets.
- (d) Support assembly under ring gear (13) with metal or wood blocks and use suitable press to remove case half (26) through gear. Separate case half and ring gear.



**(4) Remove bevel pinion (12) and bearing cage assembly (28) from differential carrier (3).**

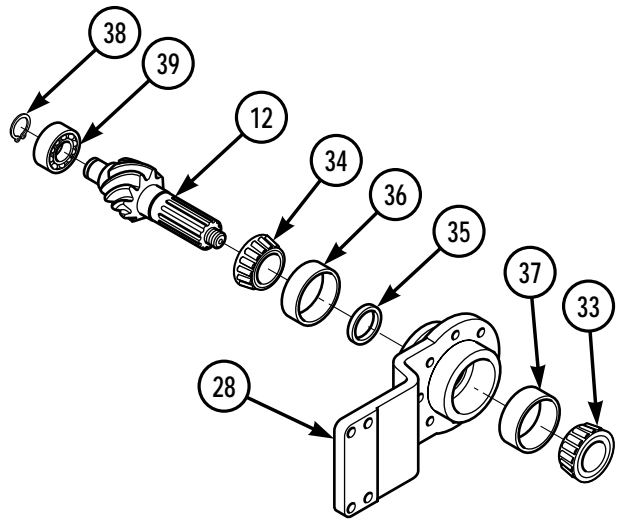
- (a) Place differential carrier (3) on bench with bevel pinion (12) facing up and clamp securely.
- (b) Use suitable puller to remove bevel pinion bearing oil seal (29) from bearing cage assembly (28).
- (c) Remove pinion bearing cage thrust washer (30).
- (d) Remove eight screws (31), bevel pinion (12) with bearing cage assembly (28) and shims (32) from differential carrier (3). Keep shims together for use during assembly. If shims are damaged, measure total thickness of shim pack and note dimension; discard shims. Shim thickness dimension will be needed to calculate depth of bevel pinion in differential carrier when gear set is installed.



**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**(5) Disassemble bevel pinion (12) and bearing cage (28).**

- (a) Place bevel pinion (12) and bearing cage (28) in suitable press with splined end at top of assembly.
- (b) Support bearing cage (28) under flange area with metal or wood blocks.
- (c) Use suitable press or leather mallet and driver to remove bevel pinion (12) from bearing cage (28).
- (d) Remove outer bearing (33) from bearing cage (28).
- (e) Use suitable puller to remove inner bearing cone (34) and bearing spacer (35) from bevel pinion (12).
- (f) Use suitable puller to remove inner bearing cup (36) and outer bearing cup (37) from bearing cage (28).
- (g) Place bevel pinion (12) in vise with soft jaws.



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (h) Use expanding snap ring pliers to remove snap ring (38) from end of bevel pinion (12).
- (i) Use a suitable puller to remove bearing (39) from spigot end of bevel pinion (12).

**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**e. Assembly.**

**NOTE**

Pinion and ring gears are a matched set. If replacement of ring gear or pinion gear is necessary, replace both gears as a set.

- (1) Assemble bevel pinion (12), bearings (33, 34, 36, and 37), and bearing cage (28).**

- (a) Use a press or suitable sleeve and driver to install inner bearing cup (36) and outer bearing cup (37) into bearing cage (28). Be sure bearing cups are flat against bottom of cage bore.
- (b) Use a press or suitable sleeve and driver to install inner bearing cone (34) on bevel pinion (12).
- (c) Use a press or suitable sleeve and driver to install bearing (39) onto spigot end of bevel pinion (12).

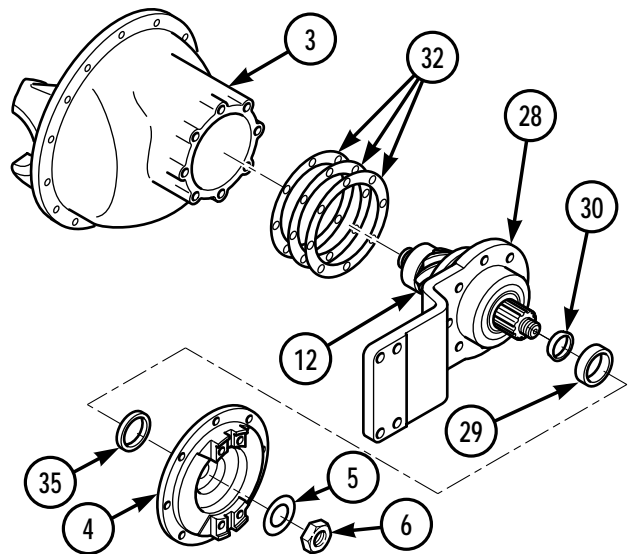
**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (d) Use an expanding snap ring pliers to install snap ring (38) into groove in end of bevel pinion (12).
- (e) Apply a thin film of gear lubricant to inner and outer bearing cups (36 and 37) and bearing cones (34 and 33).
- (f) Install bevel pinion (12) into bearing cage assembly (28).
- (g) Install bearing spacer (35) on bevel pinion (12) against inner bearing cone (34).
- (h) Use a press or suitable sleeve and driver to install outer bearing cone (33) on bevel pinion against bearing spacer (35).

**(2) Install bevel pinion bearing oil seal (29).**

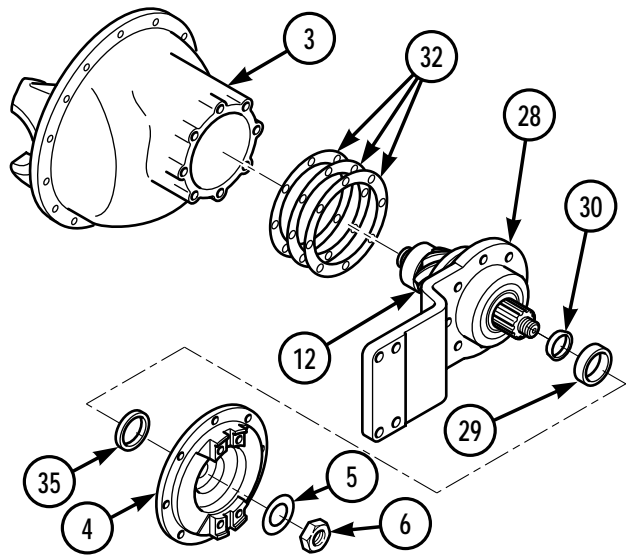
- (a) Apply a thin film of gear lubricant to inner surface of bevel pinion bearing oil seal (29).
- (b) Apply a thin film of gear lubricant to seal bore in pinion bearing cage assembly (28).
- (c) Use a press or suitable sleeve and mallet to install bevel pinion bearing oil seal (29) into pinion bearing cage assembly (28).
- (d) Use a feeler gauge to check gap between pinion bearing oil seal (29) flange and pinion bearing cage assembly (28) at several points around the pinion bearing oil seal. Gap must be within 0.015 - 0.030 in. (0.381 - 0.762 mm). The difference between the largest and smallest gap measurements must not exceed 0.010 in. (0.254 mm).



## 8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)

### (3) Adjust preload of bearings (33, 34, 36, and 37) on bevel pinion (12).

- (a) Temporarily install bevel pinion (12) and bearing cage (28) assembly in differential carrier (3). Do not install shims (32) under bearing cage (28).
- (b) Install bearing cage thrust washer (30), bearing cage assembly (28), and eight screws (31). Hand tighten screws.
- (c) Install flange (4), nut (6), and washer (5) on bevel pinion (12). Flange must be against outer bearing.
- (d) Fasten fabricated yoke nut tool to companion flange (4). Use fabricated yoke nut tool to hold bevel pinion (12) in position when nut (6) is tightened.
- (e) Tighten nut (6) on bevel pinion (12) to 300 - 400 lb-ft (406.74 - 542.33 N•m).
- (f) Remove fabricated yoke nut tool from companion flange (4).
- (g) Attach a torque wrench on bevel pinion nut (6). Rotate bevel pinion (12) and read value indicated on torque wrench. New pinion bearings should be preloaded between 5 - 45 lb-in. (0.56 - 5.08 N•m) of torque. Reused pinion bearings should be preloaded between 10 - 30 lb-in. (1.13 - 3.39 N•m).



### NOTE

Do not read starting torque. Read only torque value after bevel pinion starts to rotate. Starting torque will give a false reading.

- (h) Increase bearing preload by removing bevel pinion (12) and bearing cage (28) assembly from differential carrier (3) and installing a thinner bearing spacer (35). Repeat Steps (a) through (g).
- (i) Decrease bearing preload by removing bevel pinion (12) and bearing cage (28) assembly from differential carrier (3) and installing a thicker bearing spacer (35). Repeat Steps (a) through (g).
- (j) Remove nut (6), washer (5), and companion flange (4) from bevel pinion (12).
- (k) Remove eight screws (31) and bearing cage assembly (28).
- (l) Remove bevel pinion (12) and bearing cage assembly (28), as an assembly, from differential carrier (3).



- (4) **If replacement of bevel pinion (12) and ring gear (13) set is necessary, adjust thickness of shim pack for new bevel pinion and ring gear set.**

**NOTE**

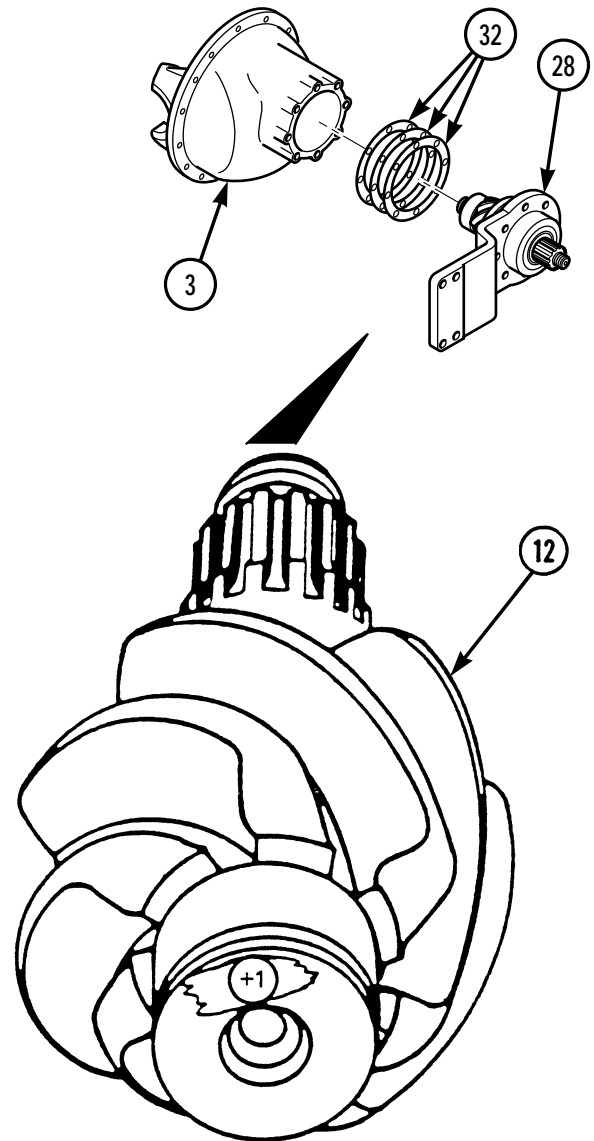
If a new bevel pinion and ring gear set is installed, or if the depth of the bevel pinion has to be adjusted, calculate the needed thickness of the shim pack using the following procedure:

- (a) Use a micrometer to measure thickness of old shim pack (32) removed from under bearing cage (28). Record measurement.
- (b) Read variation number on spigot end of old bevel pinion (12). Record number.

**NOTE**

Bevel pinion spigot end number can be in 1,000ths of an inch or 100ths of a millimeter. Example: +3 = 0.003 in., +0.03 = 0.03 mm. Be sure to convert millimeters to inches by multiplying by 0.039 before performing the following calculations:

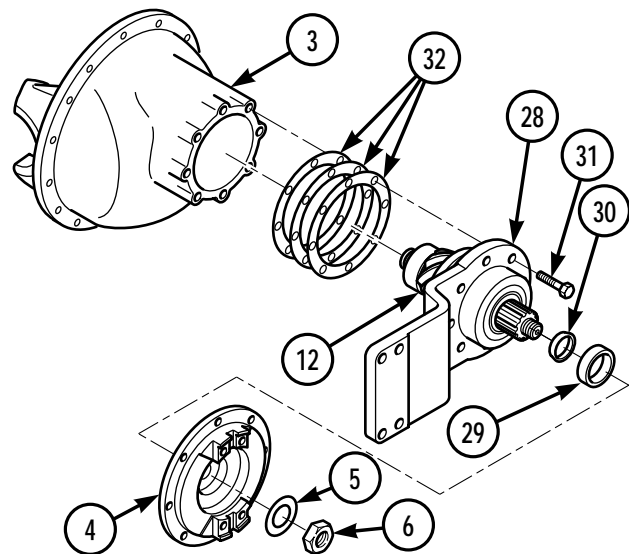
- (c) Subtract number from spigot bearing end of old bevel pinion (12) from shim pack (32) thickness measured in Step (a) if old number is a plus (+) value. If old bevel pinion spigot number is a minus (-) value, add number from spigot end of old bevel pinion to shim pack thickness. This is the thickness of the standard shim pack, without a variation.
- (d) Read number on spigot end of new bevel pinion (12). Record number
- (e) Add number from spigot end of new bevel pinion (12) to standard shim pack (32) thickness calculated in Step (c), if number on spigot end of new bevel pinion is a plus (+). If new pinion cone number is a minus (-), subtract new pinion cone number from standard shim pack thickness calculated in Step (c). This is the thickness of the new shim pack.



**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

EXAMPLES		
1.	Old Shim Pack Thickness	0.030
	Old Bevel Pinon Spigot End Number, PC + 2	-0.002
	Standard Shim Pack Thickness	0.028
	New Bevel Pinon Spigot End Number, PC + 5	+0.005
	New Shim Pack Thickness	0.033
2.	Old Shim Pack Thickness	0.030
	Old Bevel Pinon Spigot End Number, PC - 2	+0.002
	Standard Shim Pack Thickness	0.032
	New Bevel Pinon Spigot End Number, PC + 5	+0.005
	New Shim Pack Thickness	0.037
3.	Old Shim Pack Thickness	0.030
	Old Bevel Pinion Spigot End Number, PC + 2	-0.002
	Standard Shim Pack Thickness	0.028
	New Bevel Pinion Spigot End Number, PC - 5	-0.005
	New Shim Pack Thickness	0.023
4.	Old Shim Pack Thickness	0.030
	Old Bevel Pinion Spigot End Number, PC - 2	+0.002
	Standard Shim Pack Thickness	0.032
	New Pinion Cone Number, PC - 5	-0.005
	New Shim Pack Thickness	0.027

- (5) **Install bevel pinion (12) and bearing cage assembly (28) as an assembly, and shim pack (32) on differential carrier (3).**
- (6) **Install eight screws (31) and tighten screws to between 50 - 75 lb-ft (67.79 - 101.69 N•m).**
- (7) **Install bearing cage thrust washer (30) on bevel pinion (12).**
- (8) **Install flange (4), nut (6), and washer (5) on bevel pinion (12).**
- (9) **Tighten nut (6) on bevel pinion (12) to 300 - 400 lb-ft (406.75 - 542.33 N•m).**

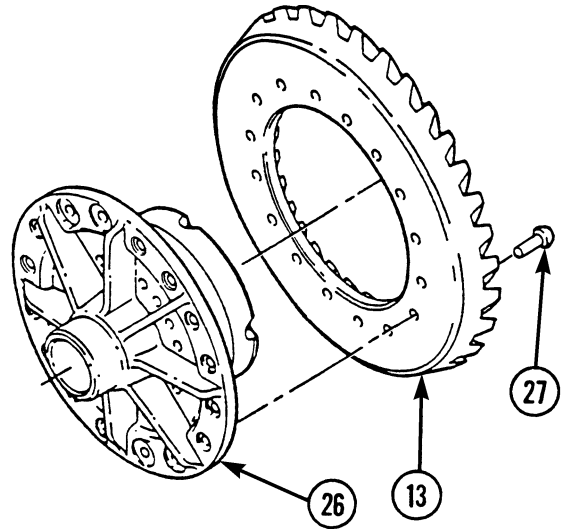


**CAUTION**

Ring gear must be heated before installation. Failure to heat ring gear before installation could cause damage to differential case half because of tight fit.

**(10) If removed, install ring gear (13).**

- (a) Expand ring gear (13) by heating in a tank of water to a temperature of 160°F - 180°F (71°C - 82°C) for 10 to 15 minutes.



**WARNING**

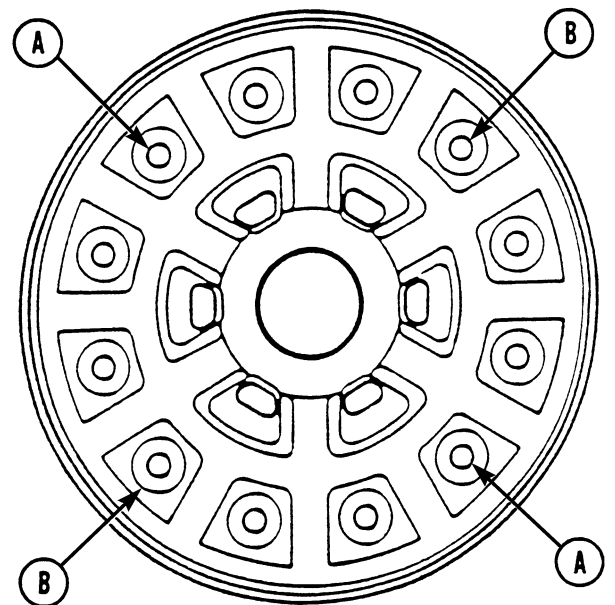
Wear gloves and proper clothing while handling hot ring gear. Failure to follow this precaution could result in serious personal injury.

- (b) Use a sling and hoist to lift the ring gear (13) from tank of water.
- (c) Install ring gear (13) on flange case half (26) immediately after heating. If ring gear does not fit easily on flange case half, repeat Step (a).
- (d) Align fastener holes of ring gear (13) and flange case half (26) by rotating ring gear as needed.

**CAUTION**

Do not heat rivets before installation. Hot rivets could damage ring gear and flange case half.

- (e) Properly install 12 rivets (27) in pairs opposite each other (A and B) from the flange case half (26) side of the assembly (side opposite gear teeth).
- (f) Use a riveting machine to press rivets (27) into place from ring gear (13) side of the assembly. Press rivets in pairs opposite each other. Apply 60,000 lb of pressure.

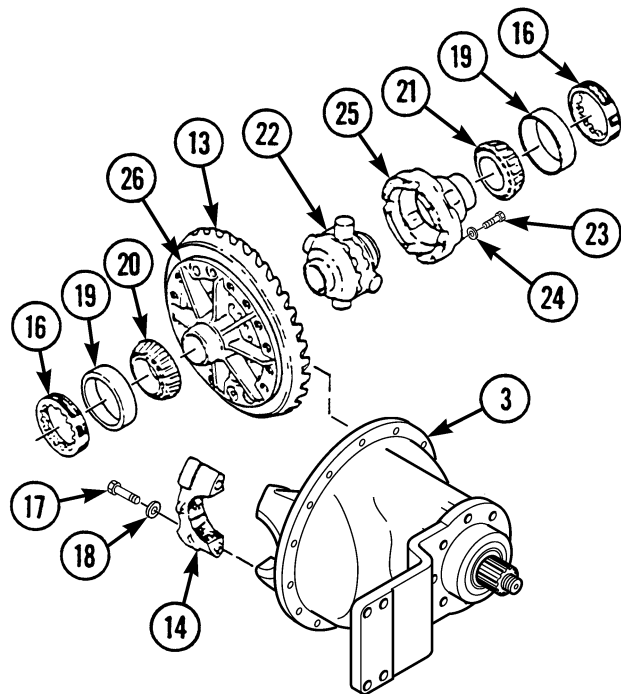


**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**CAUTION**

Pressure on rivets must be held for approximately one minute so that rivet body will completely fill hole. Failure to do so could cause rivet failure.

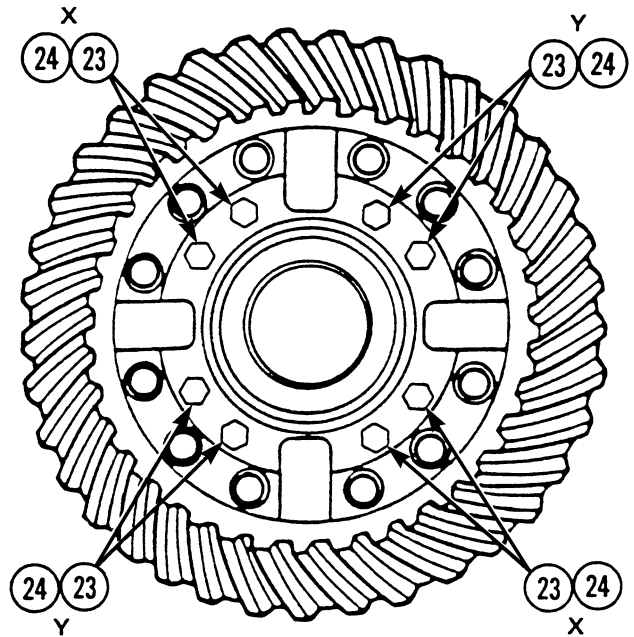
- (g) Use a 0.003 in. (0.0762 mm) feeler gauge to check for gaps between back surface of ring gear (22) and flange case half (26). If gauge fits more than half way to rivets, remove ring gear; see **Disassembly** Step (3), (a) through (d) and repeat **Assembly** Step (10), (a) through (f). If gap persists, inspect flange case half and ring gear for problem, replace defective parts.
- (h) Use a press and suitable sleeve to install bearing cone (20) on flange case half (26).
- (i) Use a press and suitable sleeve to install bearing cone (21) on plain case half (25).
- (j) Apply gear lubricant to inside surfaces of both case halves (25 and 26) and no-spin differential (22).
- (k) Place flange case half (26) on bench, ring gear (13) teeth up.
- (l) Install no-spin differential (22) into flange case half (26).
- (m) Place plain case half (25) over flange case half (26) and no-spin differential (22). Rotate plain case half as needed to align match marks.



**WARNING**

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

- (n) Apply sealing compound to threads of screws (23). Install four of the eight screws and four washers (24) as opposing pairs (X and Y) into case halves (25 and 26).



**CAUTION**

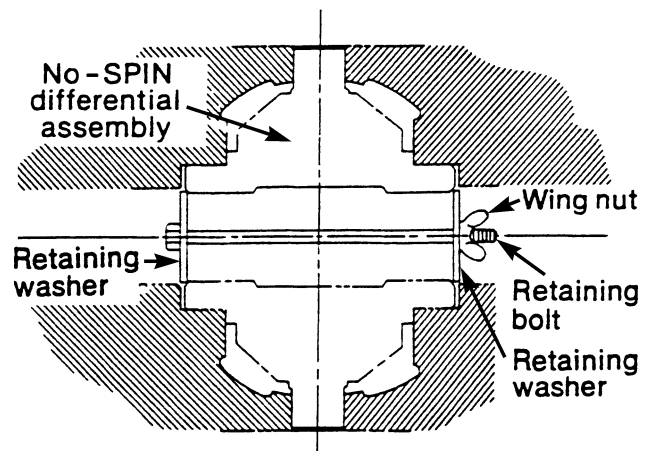
Spacing between four initially installed screws must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

- (o) Torque four screws (23) to between 60 - 75 lb-ft (81.35 - 101.69 N•m).

**NOTE**

Tighten screws in pairs on opposing sides of ring gear.

- (p) Install remaining four screws (23) and four washers (24). Tighten screws to between 60 - 75 lb-ft (81.35 - 101.69 N•m).
- (q) Remove no-spin retaining bolt, washers, and wing nut.



**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**WARNING**

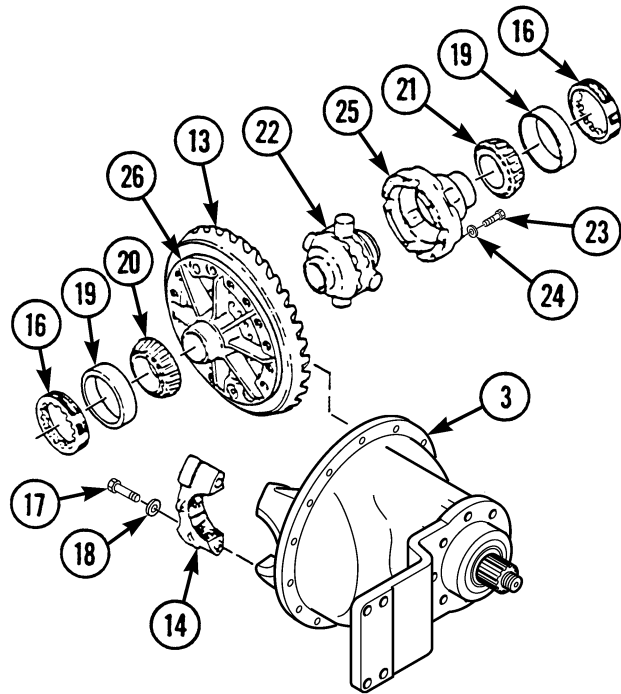
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

**NOTE**

When installing bearing cups, apply sealing compound to bearing bores of differential carrier legs and bearing caps. Do not apply sealing compound to adjusting ring threads.

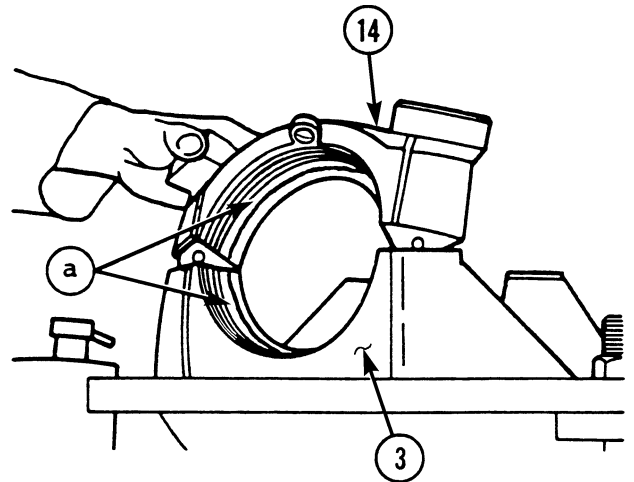
**(11) Install differential and ring gear assembly.**

- (a) Clean and dry bearing cups (19), bores of differential carrier (3) legs, and bearing caps (14).
- (b) Apply thin film of gear oil to inner diameter of the bearing cups (19) and on both bearing cones (20 and 21).

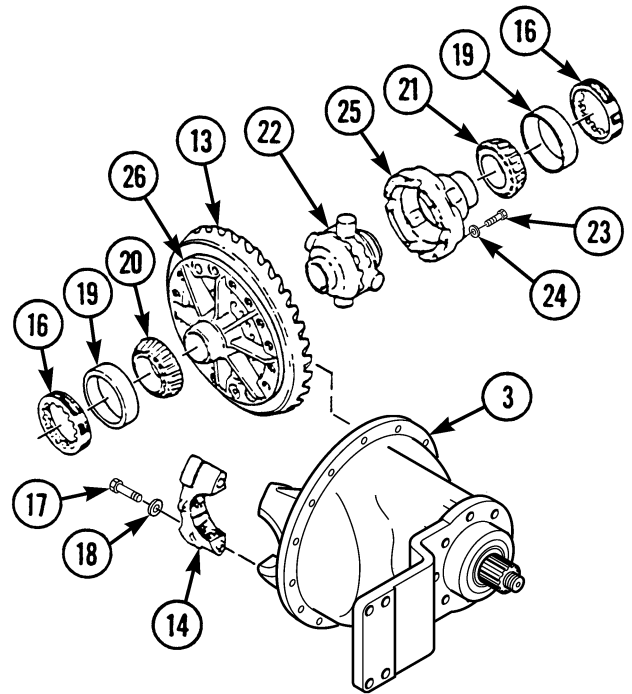


**WARNING**

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



- (c) Apply thin bead of sealing compound to bearing bores (a) of differential carrier (3) legs and bearing caps (14). Do not apply sealing compound to adjusting ring (16) threads.
- (d) Install two bearing cups (19) over bearing cones (20 and 21) on case halves (25 and 26).
- (e) Use a sling and hoist to lift differential and ring gear parts (19 through 26) as an assembly and install into differential carrier (3). Bearing cups must be flat against bores between differential carrier legs.
- (f) Install both bearing adjusting rings (16) into position between differential carrier (3) legs. Turn each adjusting ring hand tight against bearing cup (19).
- (g) Install bearing caps (14) over the assembled bearing cups (19) and bearing cones (20 and 21) and adjusting rings (16). Use match marks made during disassembly to match original location of bearing caps.
- (h) Use a plastic or leather mallet to fit each bearing cap (14) tightly against the bearing cups (19), adjusting rings (16), and differential carrier (3) legs. If bearing caps do not fit correctly, check alignment of match marks between bearing caps and differential carrier leg. If necessary, repeat Steps (f) and (g).
- (i) Install two screws (17) and washers (18) that hold bearing caps (14) to differential carrier (3) legs. Tighten screws by hand four to six turns, then tighten 110 - 145 lb-ft (149.14 - 196.59 N•m).

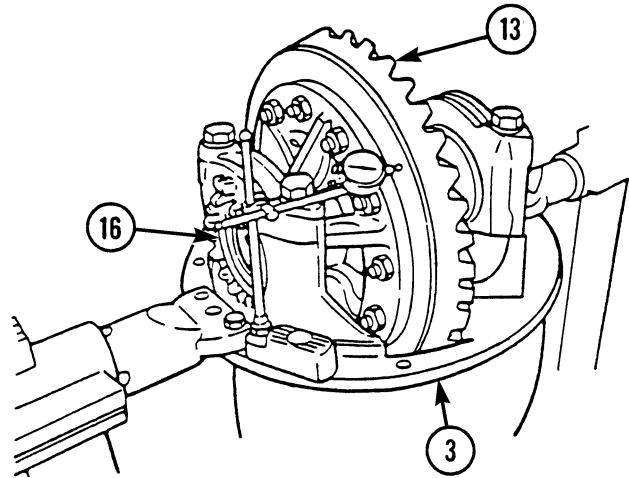


**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**f. Adjustment.**

**(1) Adjust preload of differential bearings (19, 20, and 21).**

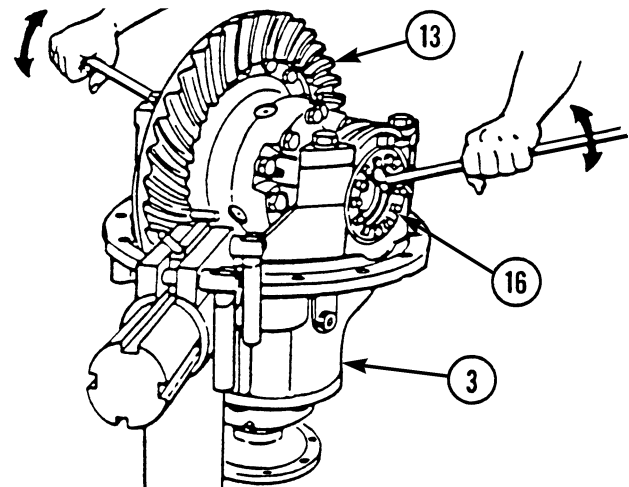
- (a) Attach a dial indicator on the mounting flange of the differential carrier (3).
- (b) Adjust the dial indicator so that the plunger is against the back surface of the ring gear (13).



**CAUTION**

When turning bearing adjusting rings, always use a tool that engages two or more opposite notches in the ring. A large screwdriver can be used for this purpose. Failure to do so could cause damage to adjusting ring lugs.

- (c) Loosen bearing adjusting ring (16) opposite ring gear (13) so that a small amount of end play shows on dial indicator. Move differential assembly and ring gear left and right with suitable pry bars while reading dial indicator. Do not allow pry bars to touch bearings (19, 20, and 21).

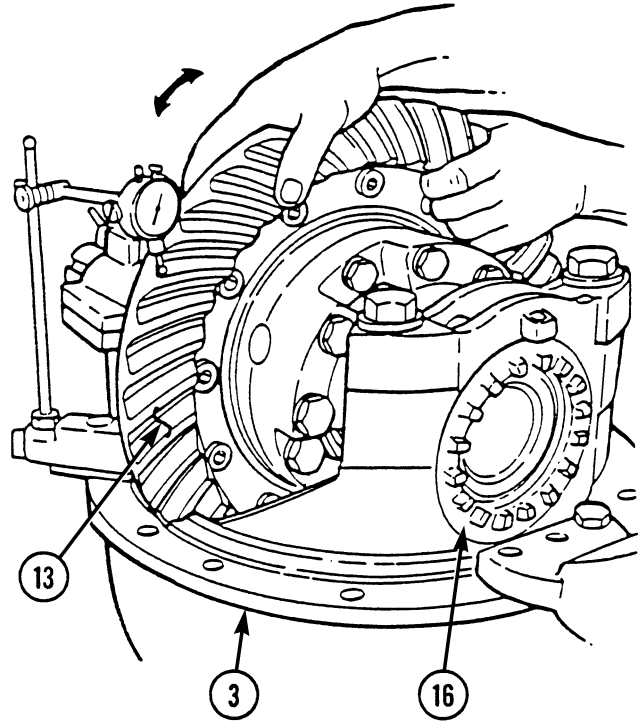


- (d) Tighten bearing adjusting ring (16) opposite ring gear (13) so that no end play shows on dial indicator. Move the differential assembly and ring gear left and right as needed.
- (e) Tighten each bearing adjusting ring (16) one notch from zero end play measured in Step (d).



**(2) Check runout of ring gear (13).**

- (a) Attach dial indicator on mounting flange of differential carrier (3). Adjust dial indicator so that plunger is against back surface of ring gear.
- (b) Adjust dial of indicator to zero.
- (c) Rotate differential assembly (3) and ring gear (13) and read dial indicator. If runout of ring gear exceeds 0.008 in. (0.2032 mm), remove differential assembly and ring gear, **Disassembly** Step (1), and inspect differential assembly for problem. Replace defective parts and reinstall differential assembly and ring gear into differential carrier, **Assembly** Step (11). Repeat preload adjustment of differential bearings, **Adjustment** Step (1).

**(3) Adjust backlash of ring gear (13).**

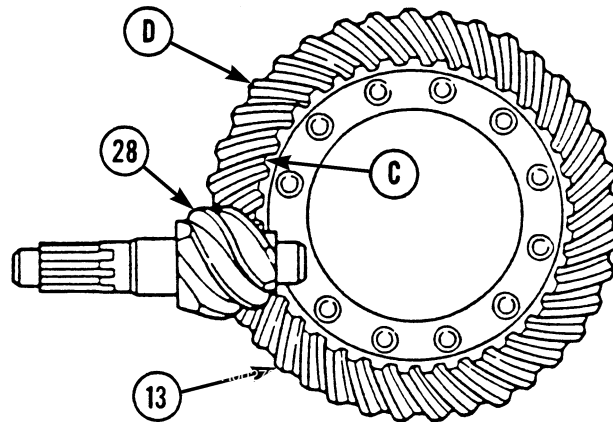
- (a) Attach a dial indicator to the mounting flange on differential carrier (3)
- (b) Adjust dial indicator so that plunger is against the tooth surface on ring gear (13).
- (c) Adjust dial of indicator to zero.
- (d) Hold bevel pinion in position.
- (e) Read dial indicator while rotating ring gear (13) a small amount in both directions.
- (f) Adjust backlash of old gear set to setting measured before carrier was disassembled (0.008 - 0.018 in. [0.203 - 0.457 mm]).
- (g) If new gear set is installed, adjust backlash to 0.012 in. (0.305 mm).

**NOTE**

When adjusting backlash, adjust only the ring gear; do not adjust the bevel pinion.

- (h) Increase backlash by loosening bearing adjusting ring (16) opposite teeth of ring gear (13), and tightening bearing adjusting ring on ring gear side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.
- (i) Decrease backlash by tightening bearing adjusting ring (16) opposite teeth of ring gear (13), and loosening bearing adjusting ring on ring gear side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.

**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**



- (4) **Check tooth contact patterns of the gear set.**

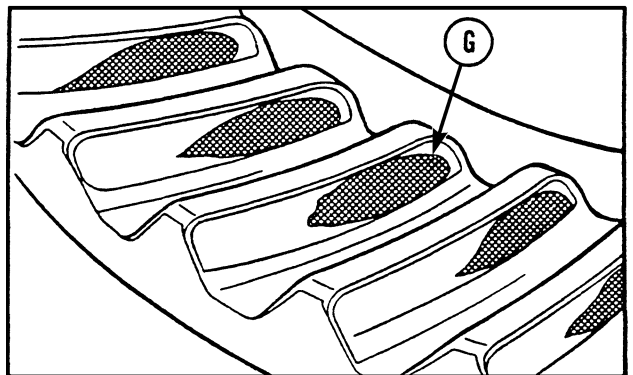
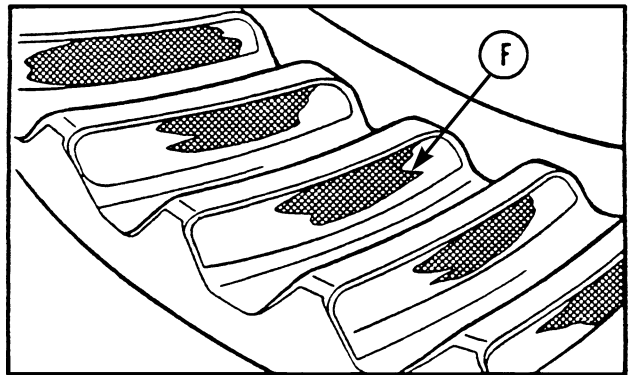
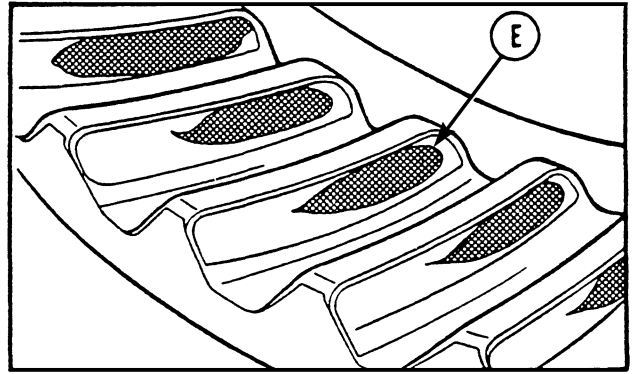
**WARNING**

Prussian Blue Dye is poisonous and can burn skin on contact. Over exposure to dye can cause heart and skin problems, dizziness, and unconsciousness.

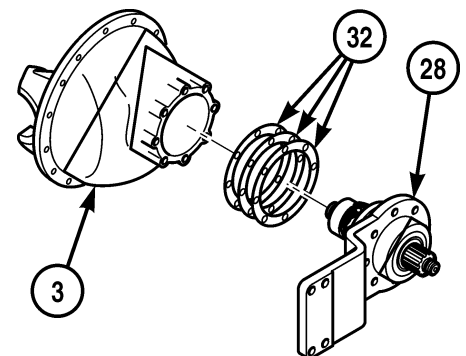
**NOTE**

- In the following steps, movement of contact pattern in length of tooth is indicated as toward “toe” (C) or “heel” (D) of ring gear.
  - Always check tooth contact patterns on drive side of gear teeth.
- (a) Apply marking compound to 12 gear teeth of ring gear (13). Rotate ring gear so that 12 gear teeth are next to bevel pinion (28).
- (b) Rotate ring gear (13) forward and backward so that 12 marked teeth go past bevel pinion six times to get contact patterns. Repeat, if necessary, to get a more clear pattern.

- (c) Inspect contact patterns on ring gear (22). Good hand rolled pattern (E) will show contact toward toe of gear tooth and in the center between top and bottom of tooth. A high pattern (F) will show contact closer to top of gear tooth. A low pattern (G) will show contact toward bottom of gear tooth. When in operation, pattern will extend to approximately full length of gear tooth.

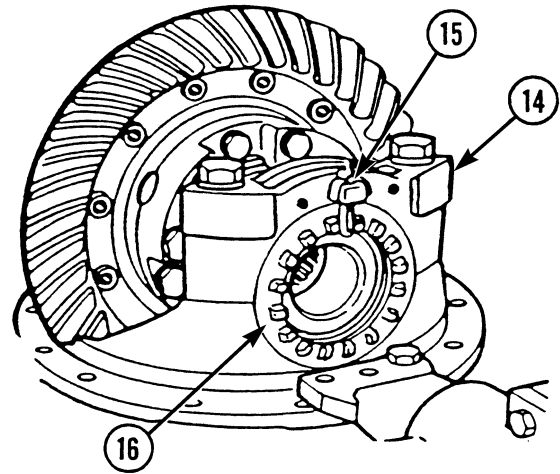


- (d) If necessary, install thinner shim pack (32) under pinion bearing cage (28) to correct high contact pattern.
- (e) If necessary, install thicker shim pack (32) under pinion bearing cage (28) to correct low contact pattern.
- (f) If necessary, decrease backlash, Step (3), (i), to move contact patterns toward toe of ring gear teeth.
- (g) If necessary, increase backlash, Step (3), (h), to move contact patterns toward heel of ring gear teeth.



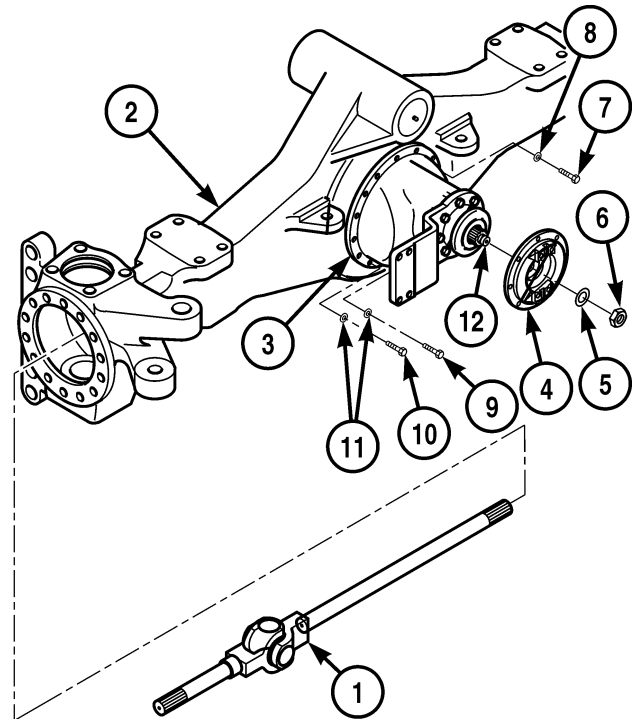
**8-5. FRONT DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (h) Install two cotter pins (15) that hold two bearing adjusting rings (16) in position. Install cotter pins through boss of bearing cap (14) and between lugs of adjusting ring.



**g. Installation.**

deleted



- (1) Install differential carrier (3) into axle housing (2).

**NOTE**

Inside of axle housing and mounting flange where carrier fastens should be clean and dry before installing carrier.

- (a) Install companion flange (4), washer (5), and nut (6) onto bevel pin (12).

**WARNING**

Minor concentrations of acetic acid may be produced during application of silicone RTV-732 clear sealing compound. Adequate ventilation should be provided when silicone RTV is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

- (b) Apply a 1/8 in. (3.175 mm) bead of silicone RTV-732 clear sealing compound to mounting surface of axle housing (2) that differential carrier (3) fastens.
- (c) Install differential carrier (3) into axle housing (2).

**CAUTION**

Four initially installed screws must be evenly spaced to prevent uneven pressure on differential carrier when torquing. Failure to do so could cause component failure.

- (d) Install four screws (7) and washers (8) into corner locations around differential carrier (3) and axle housing (2). Hand tighten.
- (e) Carefully push differential carrier (3) into position. Tighten four screws (7) two or three turns each in a pattern opposite each other.

**NOTE**

Torque screws in pairs on opposing sides of differential carrier.

- (f) Tighten screws (7) 50 - 75 lb-ft (67.79 - 101.69 N•m). Tighten in pairs across from each other.
- (g) Install remaining eight screws (7), two screws (9), two screws (10), four washers (11) and eight washers (8). Be sure fasteners are in correct location as noted during disassembly.
- (h) Install axle shafts (1) into axle housing (2).
- (i) Carefully tip axle housing (2) upright.

**NOTE**

Follow-on Maintenance:

- Install front planetary wheel ends (Para 8-6).
- Fill axle housing with lubricant (TM 10-3930-673-20).
- Install wheel assemblies (TM 10-3930-673-20).
- Install disc brake assemblies (Para 10-3).
- Install front axle assembly (Para 8-3).

**END OF TASK**

## 8-6. FRONT PLANETARY WHEEL ENDS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)  
 Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)  
 Hub Drag Tool - Fabricated Tool (Figure C-4, Appendix C)  
 Lifting Device, 2,000 lb (907.18 kg) capacity  
 Puller Kit (Item 15, Appendix D)

#### *Equipment Condition*

Front of vehicle raised 8 in. (203.2 mm) and supported under front axle (TM 10-3930-673-20)

#### *Equipment Condition (Cont)*

Planetary wheel ends drained (TM 10-3920-673-20)  
 Wheel assemblies removed (TM 10-3920-673-20)  
 Front disc brake assemblies removed (Para 10-3)

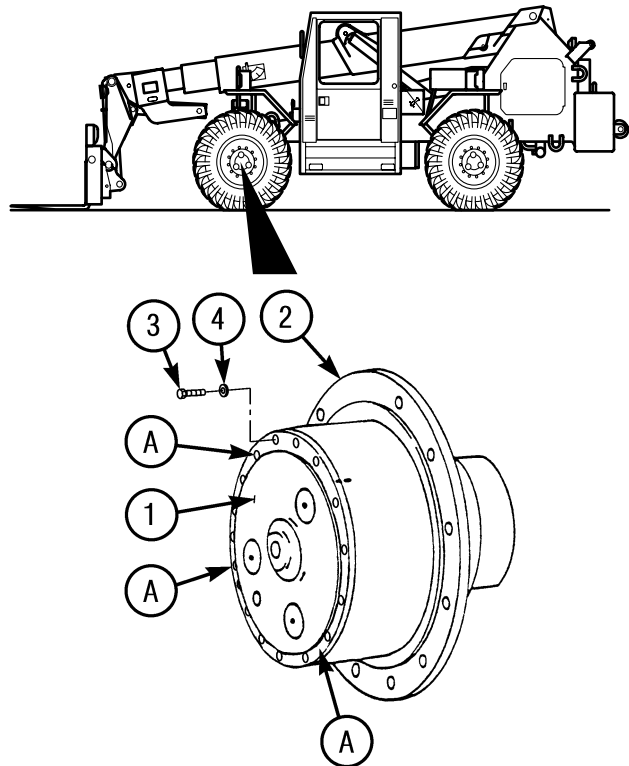
#### *Materials / Parts*

Compound, Sealing (Item 13, Appendix B)  
 Oil, Lubricating, Gear (Item 29, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)  
 Ring, Snap (3)  
 Ring, Snap  
 Container, 1 gal (3.79 l) capacity

### a. Removal.

#### (1) Remove planetary gear assembly.

- (a) Mark planetary spider (1) and wheel hub (2) for correct alignment during installation.
- (b) Place a suitable container under planetary wheel end assembly.
- (c) Remove 16 screws (3) and washers (4) from planetary spider (1) and wheel hub (2).
- (d) Use three screws (3) in jack screw holes (A) and tighten to remove planetary spider (1) from wheel hub (2).

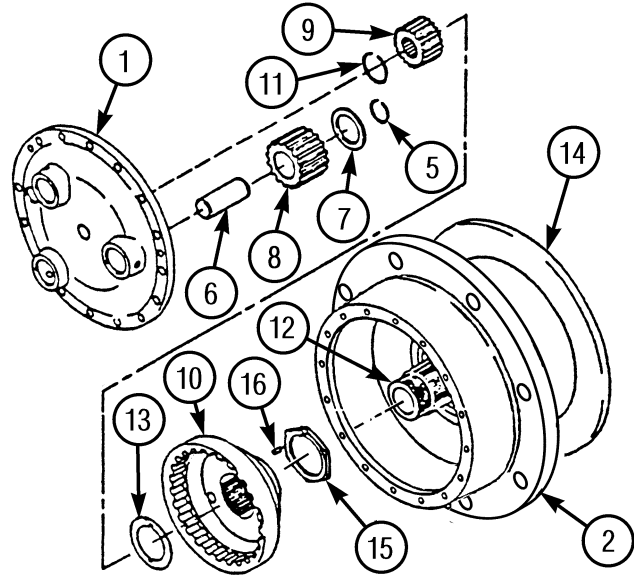


**(2) Disassemble planetary spider (1) parts (5 through 8).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove three snap rings (5) from planetary pinion shafts (6). Discard snap rings.
- (b) Remove three washers (7) and planetary gears (8) from planetary pinion shafts (6)



**(3) Remove planetary sun gear (9) and ring gear (10) from wheel hub (2).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

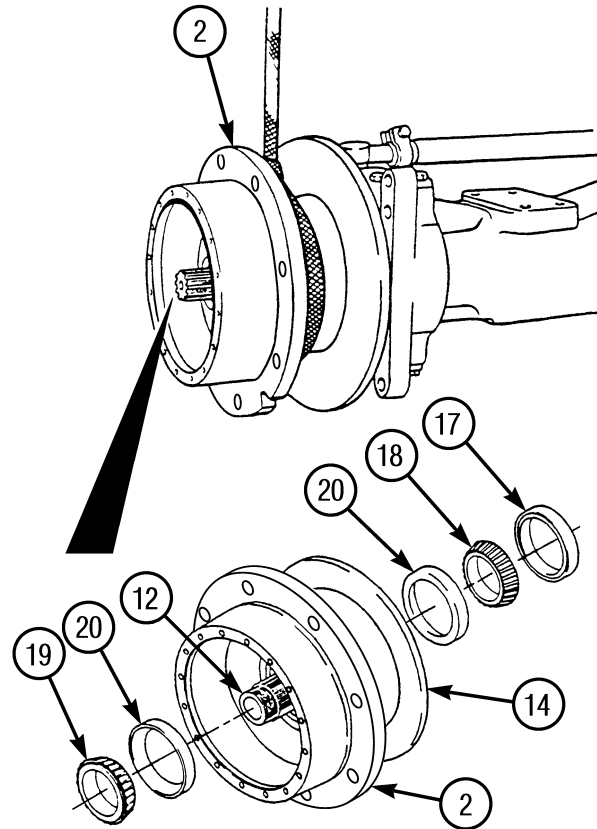
- (a) Remove snap ring (11) from end of wheel bearing spindle (12). Discard snap ring.
- (b) Remove planetary sun gear (9) from wheel bearing spindle (12).
- (c) Remove washer (13) from wheel bearing spindle (12).
- (d) Remove planetary ring gear (10) from wheel bearing spindle (12).

**(4) Remove wheel hub and disc assembly (14) and parts (15 through 20).**

- (a) Use a sling and hoist or other suitable lifting device to support wheel hub (2) weight during removal.
- (b) Remove nut (15) and dowel pin (16) from wheel bearing spindle (12).

**8-6. FRONT PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

- (c) Wobble wheel hub and disc assembly (14) to unseat oil seal (17), inner bearing cone (18), and outer bearing cone (19).
- (d) Remove outer bearing cone (19) from wheel bearing spindle (12).
- (e) Remove wheel hub and disc assembly (14).
- (f) Remove inner oil seal (17) from wheel bearing spindle (12).
- (g) Remove inner bearing cone (18) from wheel bearing spindle (12).
- (h) Using a suitable puller, remove two bearing cups (20) from wheel bearing spindle (12).



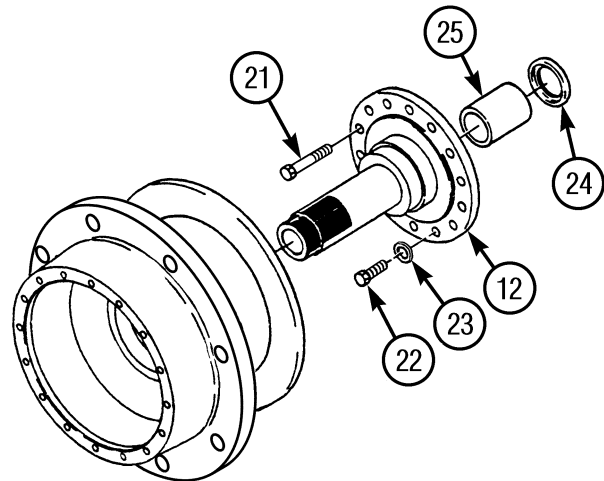
**(5) Remove wheel bearing spindle (12) parts (21 through 25).**

- (a) Remove 10 screws (21), four screws (22), and 14 washers (23) from wheel bearing spindle (12).

**CAUTION**

Inner oil seal and bushing in bore of spindle can be damaged when sliding spindle past axle splines. Remove spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure.

- (b) Remove wheel bearing spindle (12).
- (c) Remove oil seal (24) from wheel bearing spindle (12).
- (d) If damaged, remove bushing (25) from wheel bearing spindle (12).





**b. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**c. Inspection.** See **Inspection Instructions (Para 2-14).**

**d. Installation.**

**(1) Assemble wheel bearing spindle (12) parts (24 and 25).**

- (a) If removed, install bushing (24) into wheel bearing spindle (12) until top of bushing is flush or just below bottom of bore for oil seal (25).
- (b) Install oil seal (25) to bottom of wheel bearing spindle (12) bore.

**(2) Install wheel bearing spindle (12) parts (21 through 25).**

- (a) Apply a thin film of gear lubricating oil to lips of oil seal (25) and bore of bushing (24) in wheel bearing spindle (12) bore, and oil seal journal on axle shaft short end.

**CAUTION**

Inner oil seal and bushing in bore of spindle could be damaged when sliding spindle past axle splines. Install spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure.

- (b) Install wheel bearing spindle (12).

**NOTE**

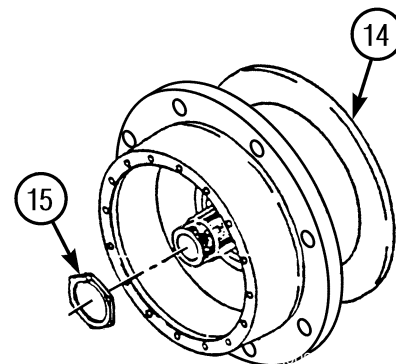
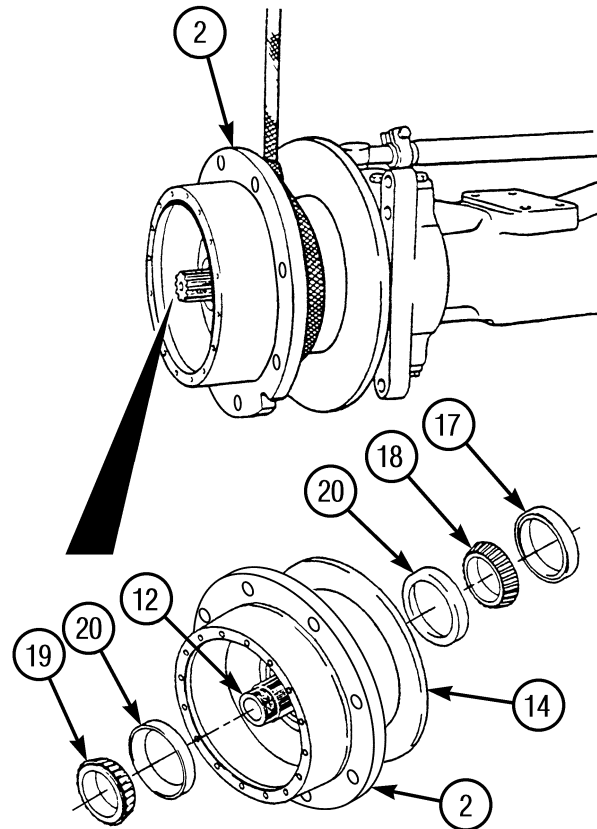
Install two shorter screws at two top holes and two screws at bottom two holes on wheel bearing spindle flange.

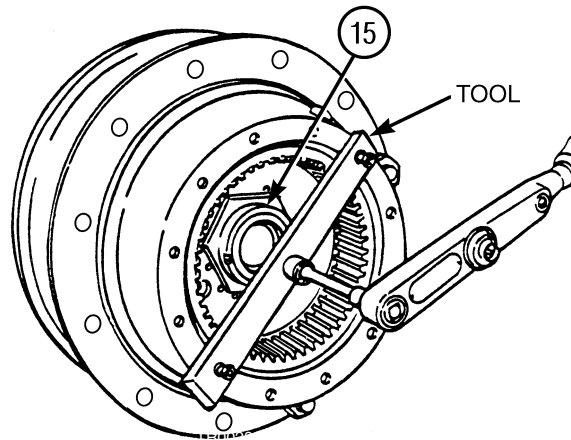
- (c) Install 10 screws (21), four screws (22), and 14 washers (23) on wheel bearing spindle (12). Tighten screws to 150 lb-ft (203.37 N•m).

**8-6. FRONT PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

**(3) Install wheel hub and disc assembly (14) parts (15 through 20).**

- (a) Using a suitable driving sleeve, install two bearing cups (20) into wheel hub (2).
- (b) Place wheel hub and disc assembly (14) on floor or bench with the brake disc up.
- (c) Apply a thin film of gear lubricating oil to inner bearing (18) and install in inner bearing cup (20).
- (d) Install oil seal (17) with a suitable driver on wheel bearing spindle (12).
- (e) Use a sling and hoist or other suitable lifting device to support weight of wheel hub and disc assembly (14).
- (f) Apply a thin film of gear lubricating oil to inside diameter of oil seal (17) and to oil seal journal surface of wheel bearing spindle (12).
- (g) Align wheel hub and disc assembly (14) with wheel bearing spindle (12) and push wheel hub and disk assembly onto spindle.
- (h) Install outer bearing cone (19) in outer bearing cup (20).
- (i) Install nut (15) and draw wheel hub and disc assembly (14) into position while rotating wheel hub.





**(4) Preload wheel bearings.**

- (a) Seat bearings and related components by tightening the hub (15) to 100 lb-ft (135.58 N•m) while hub is rotated in both directions.
- (b) Back off nut (15) to relieve preload on bearings. Torque on nut should be 0 lb-ft (0 N•m).
- (c) Use fabricated hub drag tool and a torque wrench to check rolling torque while hub is rotating at a steady rate (not starting torque). Record torque.
- (d) Tighten hub (15) and check hub rolling torque again. *Increase* in rolling torque from zero preload, should be 3 - 5 lb-ft (4.07 - 6.78 N•m) for new bearings.

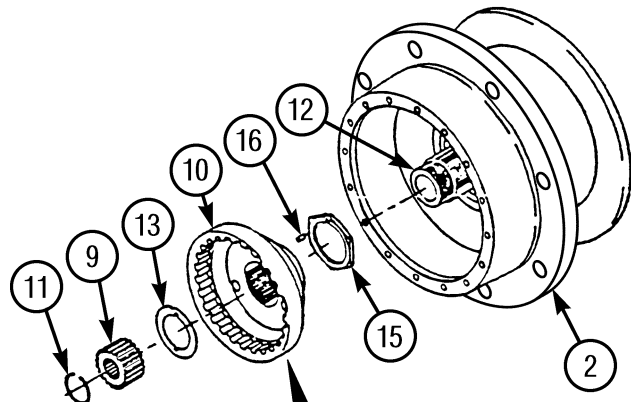
**8-6. FRONT PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

**NOTE**

If bearings are to be reused, the increase in rolling torque should be 1.5 - 2.5 lb-ft (2.03 - 3.39 N•m).

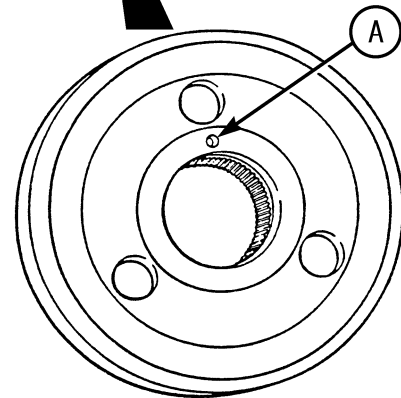
**(5) Install planetary ring gear (10) and sun gear (9) on wheel hub (2).**

- (a) Install dowel pin (16) in nut (15).
- (b) Locate hole (A) on back of planetary ring gear (10). Orient ring gear with respect to dowel pin (16) on nut (15).



**NOTE**

- If dowel pin is not aligned with hole (A) of ring gear, spider assembly will not fit tight to wheel hub.
- It may be necessary to turn nut (15) to match hole (A) on back of planetary ring gear. Hub bearing nut may be tightened to match dowel pin (16) with planetary ring gear, but torque on hub bearing nut should not exceed 150 lb-ft (203.37 N•m).

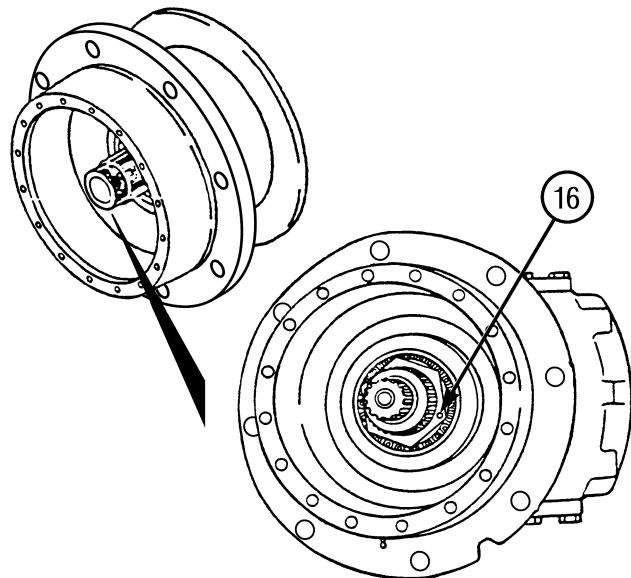


- (c) Install planetary ring gear (10).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (d) Install washer (13), sun gear (9), and snap ring (11). Tangs on washer must engage slots in ring gear (10).



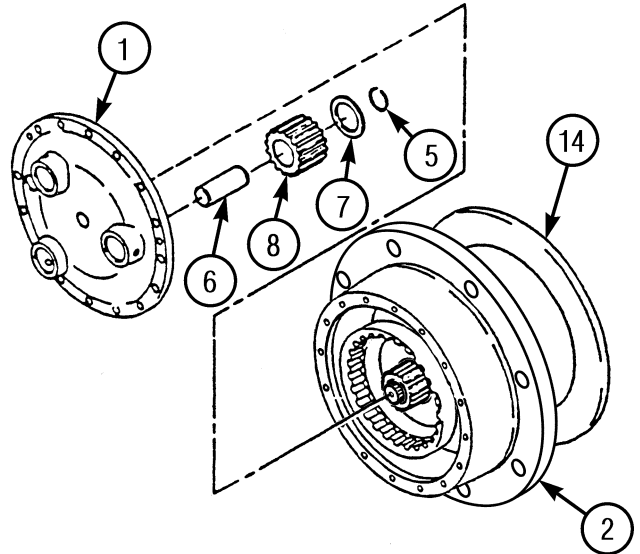
**(6) Assemble planetary spider (1) parts (5 through 8).**

- (a) Apply a thin film of gear lubricating oil to bore of planetary gear (8). Slide planetary gear and washer (7) onto planetary pinion shaft (6).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Install snap ring (5) onto planetary pinion shaft (6).
- (c) Repeat Steps (a) and (b) for second and third sets of planetary gears (8), washers (7), and snap rings (5).



**(7) Install planetary gear assembly.**

- (a) Remove dirt, grease, or moisture from the mating surfaces of the planetary spider (1) flange and wheel hub (2) mounting face.
- (b) Dry both surfaces.

**WARNING**

Adequate ventilation must be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

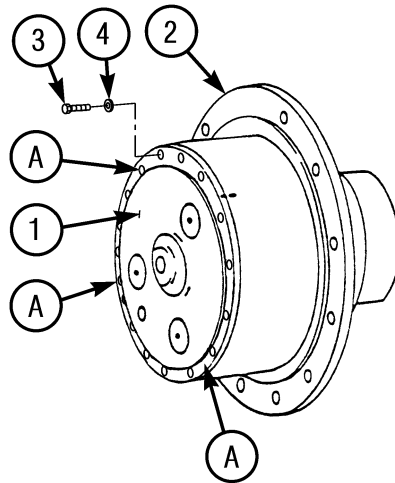
- (c) Apply a continuous bead of silicone RTV-732 clear sealing compound approximately 1/8 in. (3.175 mm) in diameter completely around the hub mounting face and around the inner edge of all fastener holes to assure complete sealing and prevent leakage.

**NOTE**

Assemble components immediately to permit silicone RTV-732 clear sealing compound to spread evenly. Failure to do so could cause axle to leak.

- (d) Start planetary spider (1) onto wheel hub (2), aligning teeth of planetary gears (8) with sun gear (9) and ring gear (10) teeth.

**8-6. FRONT PLANETARY WHEEL ENDS REPLACEMENT (CONT)**



- (e) Align the match marks on the spider flange and wheel hub as previously marked during removal.
- (f) Align holes on wheel hub (2) with holes on planetary spider (1) flange and push spider assembly against wheel hub.
- (g) Install 16 screws (3) and washers (4) on planetary spider (1) and wheel hub (2). Tighten screws 60 - 75 lb-ft (81.35 - 101.69 N•m).

**NOTE**

Follow-on Maintenance:

- Fill planetary wheel ends with lubricant (TM 10-3930-673-20).
- Install front disc brake assembly (Para 10-3).
- Install wheel assembly (TM 10-3930-673-20).

**END OF TASK**

# CHAPTER 9

## REAR AXLE SYSTEM MAINTENANCE

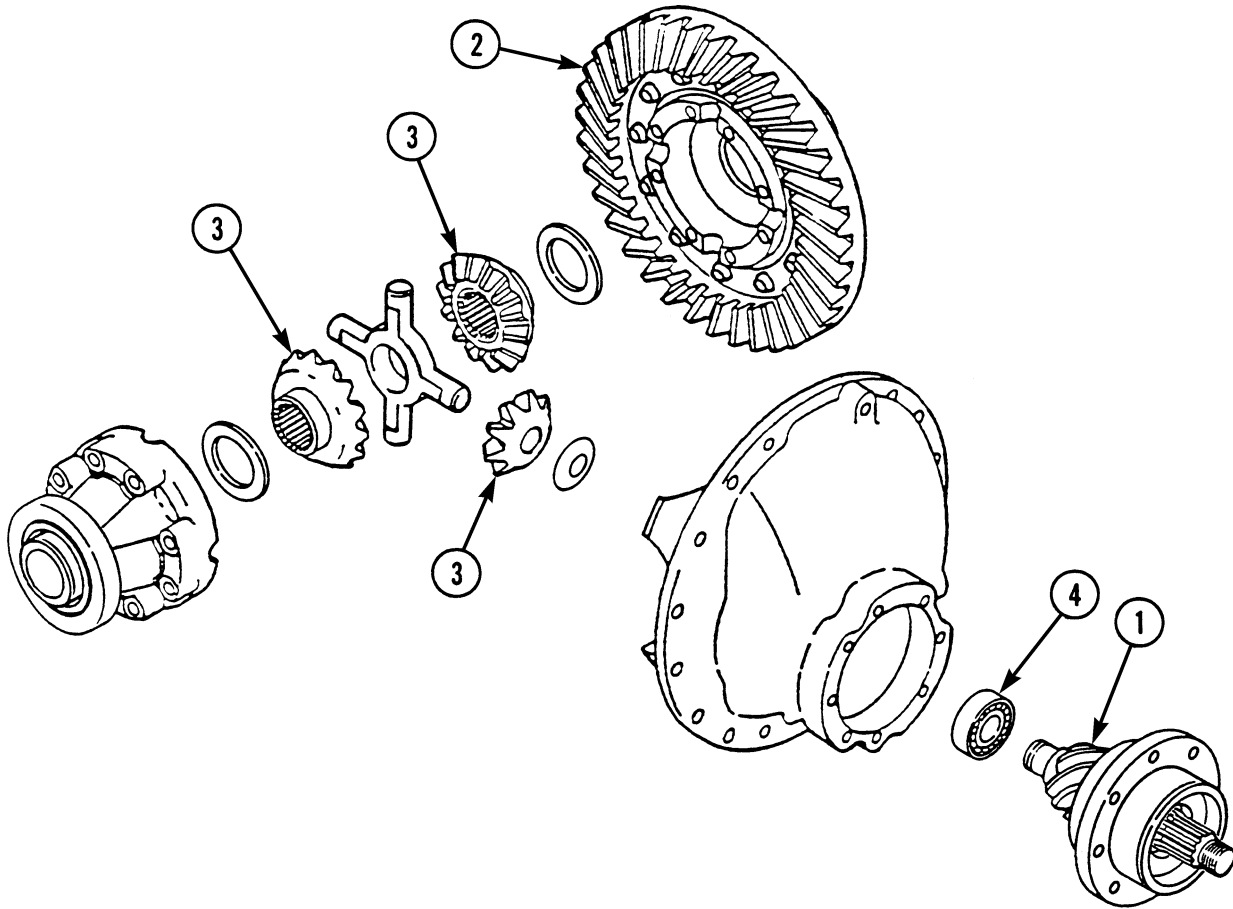
<b>Para</b>	<b>Contents</b>	<b>Page</b>
Section I. Description and Data		
9-1.	General .....	9-1
9-2.	Principles of Operation .....	9-2
Section II. Rear Axle Maintenance Procedures		
9-3.	Rear Axle Assembly Replacement/Repair .....	9-4
9-4.	Rear Axle Pivot Pin Replacement .....	9-10
9-5.	Rear Differential Carrier Assembly Replacement/Repair/Adjustment .....	9-11
9-6.	Rear Planetary Wheel Ends Replacement .....	9-33

### Section I. DESCRIPTION AND DATA

**9-1. GENERAL**

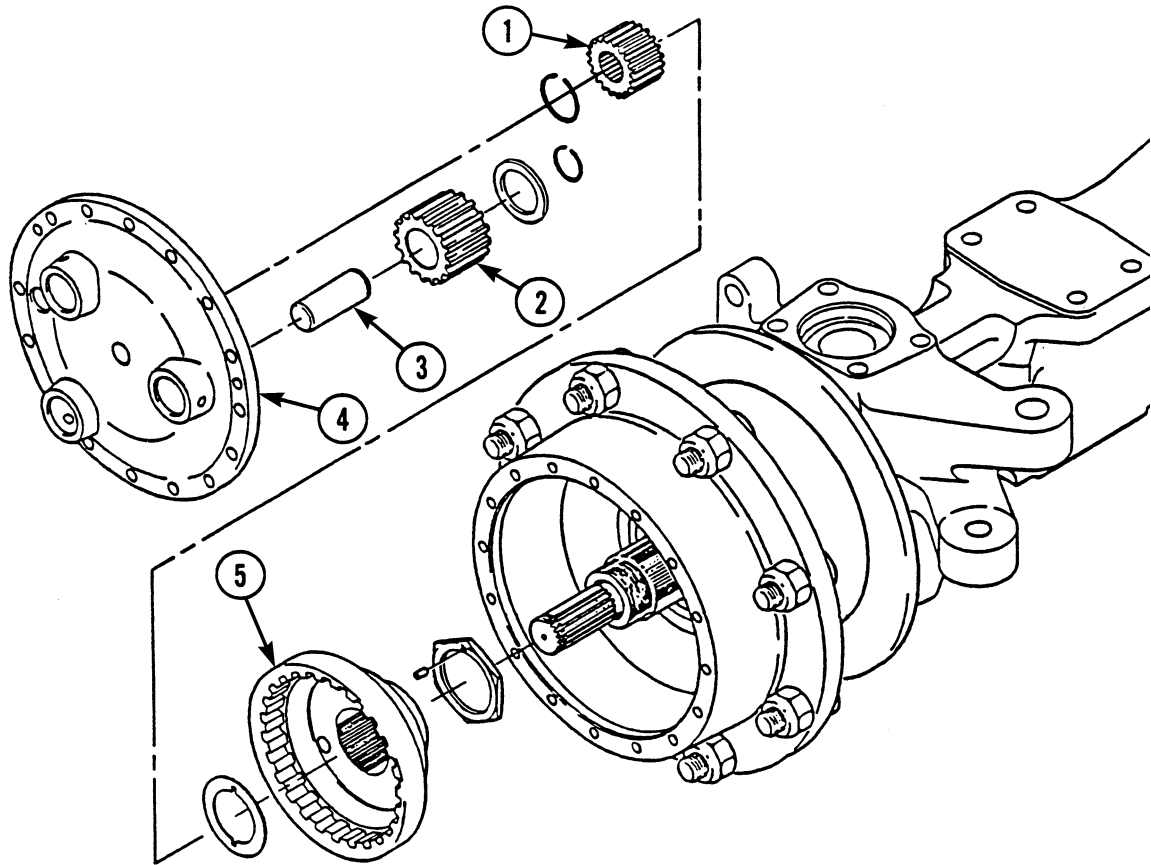
Rear axle maintenance procedures not covered in this section may be found in TM 10-3930-673-20.

**9-2. PRINCIPLES OF OPERATION**



**a. Differential.** The rear differential provides the primary drive gear reduction. It is a single reduction carrier and is manufactured by Rockwell. This carrier has a bevel drive pinion (1) and ring gear (2) set and bevel gears (3) in the differential assembly. A straight roller (spigot) bearing (4) is mounted on the head of the drive pinion (1). All other bearings in the carrier are tapered roller bearings. When the carrier operates- there is normal differential action between the wheels all the time.





**b. Planetary Wheel Ends.** The planetary wheel ends provide the second gear reduction at the wheel hub. Planetary axles permit the bevel gearing of the carrier, and the axle shafts to carry nominal torsional load while providing the highest practical numerical gear reduction at the wheels.

The spur teeth of the planetary sun gear (1) mesh with teeth of the planetary gears (2). The planetary gears rotate on planetary pinion shafts (3) which are mounted on the planetary cover (4). The planetary gear (2) teeth, in turn, mesh with the teeth of the planetary ring gear (5).

Power is transmitted through the axle shafts to the sun gear, through the revolving planetary gears (1 and 2) and into the planetary cover (4) which drives the wheel hub.

**Section II. REAR AXLE MAINTENANCE PROCEDURES**

**9-3. REAR AXLE ASSEMBLY REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Floor Jack, 10 ton (9071.84 kg) capacity
- Jackstands (2) 40 in. (101.6 cm) height, 3-1/2 ton (3175.14 kg) capacity

*Materials/Parts*

- Compound, Sealing (Item 14, Appendix B)
- Oil, Lubricating, Gear (Item 29, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Tags (Item 55, Appendix B)
- Locknut
- Lockwasher
- Container, 5 gal (18.93 l) capacity
- Wood Blocks

*Personnel Required*

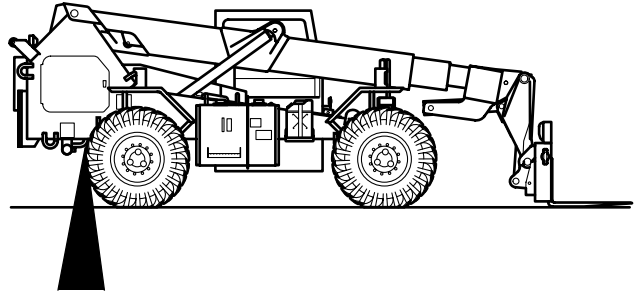
Two

*Equipment Condition*

- Rear propeller shaft removed (TM 10-3930-673-20)
- Rear wheel assemblies removed (TM 10-3930-673-20)
- Rear disc brake assemblies removed (Para 10-3)
- Counterweight removed (TM 10-3930-673-20)

**a. Removal.**

- (1) **Remove nut (1), lockwasher (2), clamp (3), and axle breather hose (4) from frame. Discard lockwasher.**

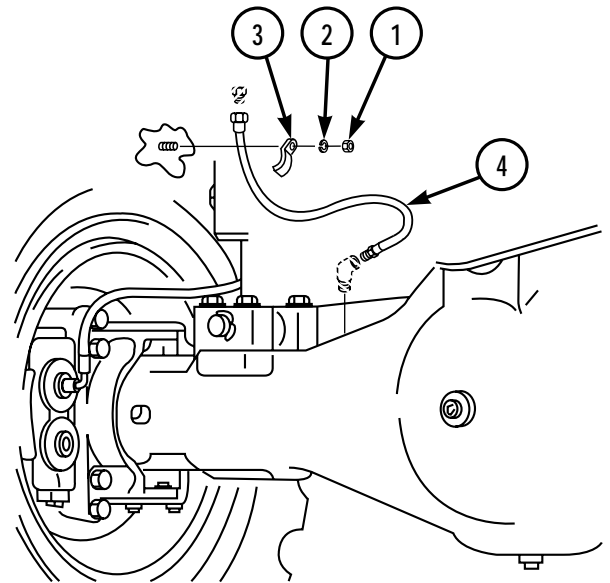


**CAUTION**

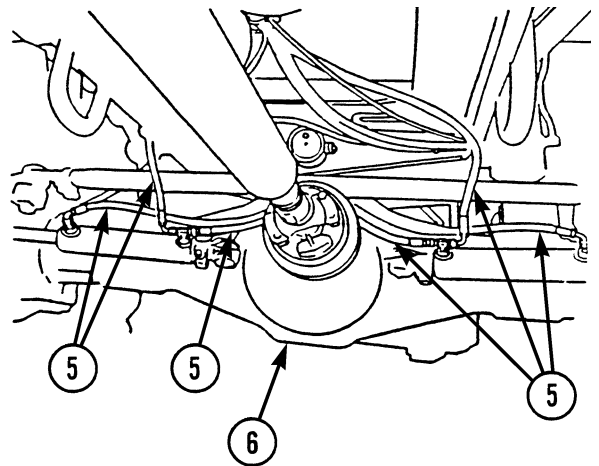
Wipe area clean around all hydraulic connections to be opened during removal. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

**NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from the system.



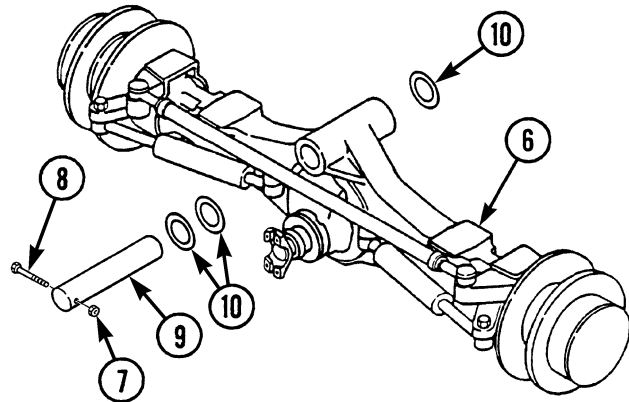
- (2) **Tag, mark, and disconnect steering cylinder hoses (5) from rear axle assembly (6).**



**9-3. REAR AXLE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**WARNING**

- Axle assembly weighs 1,550 lb (703.07 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.
- Do not raise frame off jackstands or injury to personnel may result.



**(3) Use a floor jack to support weight of rear axle assembly (6).**

**(4) Remove axle pivot pin (9) from rear axle assembly (6).**

(a) Remove locknut (7) and screw (8) from axle pivot pin (9). Discard locknut.

**NOTE**

Note the location and quantity of washer spacers during disassembly. Keep washer spacers together as a set. Do not mix washer spacer sets.

(b) Remove axle pivot pin (9) and washer spacers (10) from rear axle assembly (6).

**(5) Remove rear axle assembly (6) from vehicle frame.**

(a) Lower floor jack until top of axle housing is clear of frame and exhaust pipe. Carefully pull jack supporting axle assembly from under vehicle while assistant holds axle assembly steady.

(b) Support axle assembly using suitable stands or blocks.

**NOTE**

Repair of axle assembly at Direct Support is limited to replacement of axle seals, steering knuckle bushings, and pivot bushings.

**b. Disassembly.**

**(1) Remove tie rod (Para 12-6).**

**(2) Remove steering cylinders (TM 10-3930-673-20).**

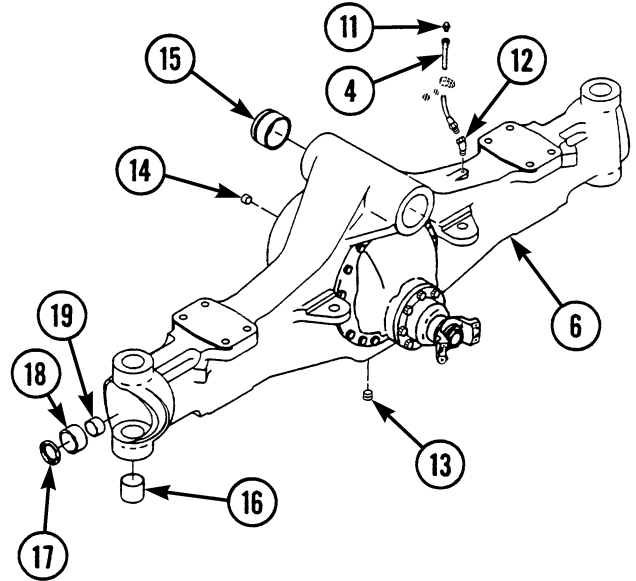
**(3) Remove rear planetary wheel ends (Para 9-6).**

**(4) Remove rear differential carrier assembly and rear universal (cardan) steering joints (Para 9-5).**

**(5) Remove drive wheel spindles (Para 12-3).**

**(6) If necessary, remove parts (11 through 19) from rear axle assembly (6).**

- (a) Remove breather (11), hose (4), and elbow (12) from rear axle assembly (6).
- (b) Remove drain plug (13) from rear axle assembly (6).
- (c) Remove oil filler plug (14) from rear axle assembly (6).
- (d) Remove two bearings (15) from rear axle assembly (6).
- (e) Remove four bushings (16) from rear axle assembly (6).
- (f) Remove two oil seals (17) from rear axle assembly (6).
- (g) Remove two sleeves (18) and bushings (19) from rear axle assembly (6).



**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**e. Assembly.**

**(1) If removed, install parts (11 through 19) on rear axle assembly (6).**

- (a) Install two bushings (19) and sleeves (18) on rear axle assembly (6).
- (b) Install two oil seals (17) on rear axle assembly (6).

**WARNING**

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

- (c) Apply sealing compound on outside diameter of four bushings (16).
- (d) Install four bushings (16) on rear axle assembly (6).
- (e) Install two bearings (15) on rear axle assembly (6).
- (f) Install oil filler plug (14) on rear axle assembly (6).
- (g) Install drain plug (13) on rear axle assembly (6).
- (h) Install elbow (12), hose (4), and breather (11) on rear axle assembly (6).

**9-3. REAR AXLE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

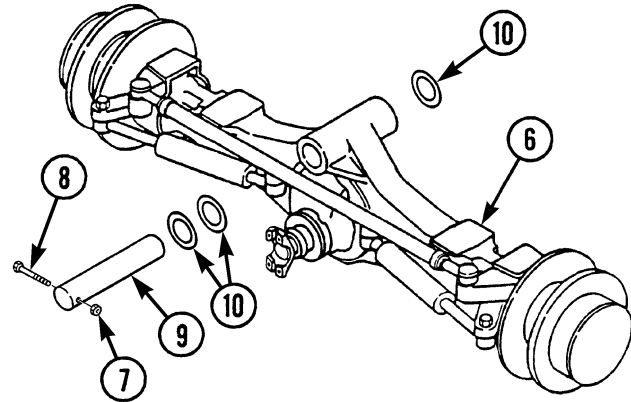
- (2) Install rear drive wheel spindle (Para 12-3).
- (3) Install rear differential carrier assembly and rear universal (cardan) steering joints (Para 9-5).
- (4) Install rear planetary wheel ends (Para 9-6).
- (5) Install steering cylinders (TM 10-3930-673-20).
- (6) Install tie rods (Para 12-6).

**f. Installation.**

**NOTE**

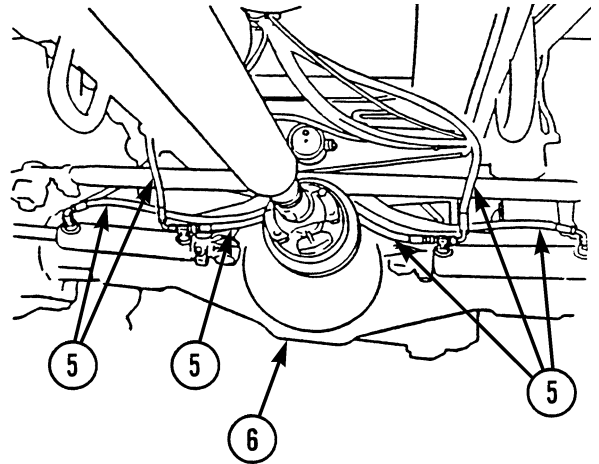
At least one washer spacer must be installed on each side of axle pivot hole.

- (1) Place washer spacers (10) on frame pivot pin holes; use thin film of grease to retain washer spacers (10).
- (2) Install rear axle assembly (6) and align with frame pivot pin holes.

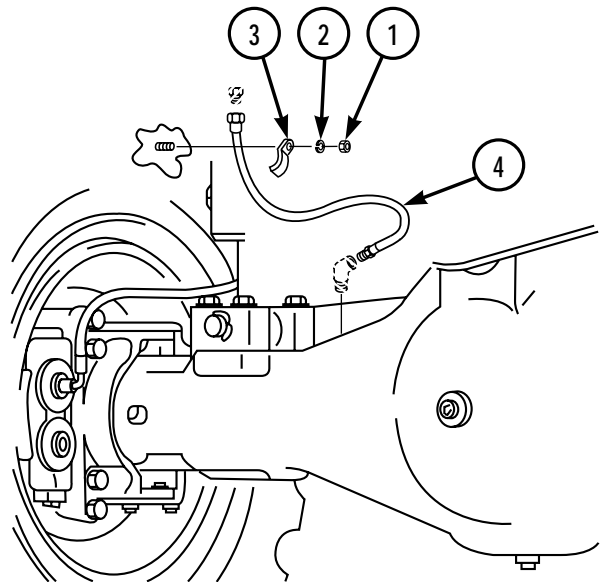


- (a) Place floor jack under center of rear axle assembly (6). Use floor jack to raise axle assembly. Have assistant hold axle assembly steady.
  - (b) Remove stands or blocks.
  - (c) Lower floor jack to allow rear axle assembly (6) to clear frame.
  - (d) Carefully move rear axle assembly (6) under vehicle with jack and position rear axle assembly pivot hole in line with frame pivot holes.
  - (e) Use floor jack to carefully raise rear axle assembly (6) while assistant holds assembly steady. Keep washer spacers (10) in position.
  - (f) Raise floor jack until rear axle assembly (6) pivot pin hole is aligned with frame pivot pin holes.
- (3) **Install pivot pin (9) in rear axle assembly (6).**
    - (a) Position rear axle assembly (6). Install axle pivot pin (9) in rear axle assembly and frame pivot pin holes.
    - (b) Install retaining bolt (8) and locknut (7) in axle pivot pin (9). Tighten bolt to 100 lb-ft (135.58 N•m)

- (4) Use a floor jack to raise rear of vehicle until vehicle frame clears jackstands. Remove jackstands and carefully lower vehicle.
- (5) Connect rear steering cylinder hydraulic supply hoses (5) to rear axle assembly (6).



- (6) Install axle breather hose (4), clamp (3), lockwasher (2), and nut (1) to frame.



### NOTE

Follow-on Maintenance:

- Install rear propeller shaft (TM 10-3930-673-20).
- Install rear disc brake assemblies (Para 10-3).
- Install rear wheel assemblies (TM 10-3930-673-20).
- Install counterweight (TM 10-3930-673-20).

**END OF TASK**





**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | d. Inspection | g. Installation |
| b. Disassembly | e. Assembly   |                 |
| c. Cleaning    | f. Adjustment |                 |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 1 Less Power (Item 16, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m) (Item 28, Appendix D)
- Wrench, Torque, 0 - 800 lb-ft (0 - 1085 N•m) (Item 29, Appendix D)
- Lifting Device, 2 ton (1814.37 kg) capacity
- Differential Resistance Tool - Fabricated Tool (Figure C-3, Appendix C)
- Yoke Nut Tool - Fabricated Tool (Figure C-5, Appendix C)
- Dial Indicator (Item 3, Appendix D)
- Micrometer (Item 13, Appendix D)
- Puller Kit (Item 15, Appendix D)

*Equipment Condition*

- Rear axle assembly removed (Para 9-3)
- Axle housing lubricant drained (TM-10-3930-673-20)
- Rear planetary wheel ends removed (Para 9-6)

*Materials / Parts*

- Compound, Marking Prussian Blue (Item 12, Appendix B)
- Compound, Sealing (Item 13, Appendix B)
- Compound, Sealing (Item 43, Appendix B)
- Gloves, Insulated (Item 17, Appendix B)
- Oil, Lubricating, Gear (Item 29, Appendix B)
- Pins, Cotter
- Rivets
- Container, 1 gal (3.79 l) capacity
- Wood Blocks

*Personnel Required*

- Two

**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

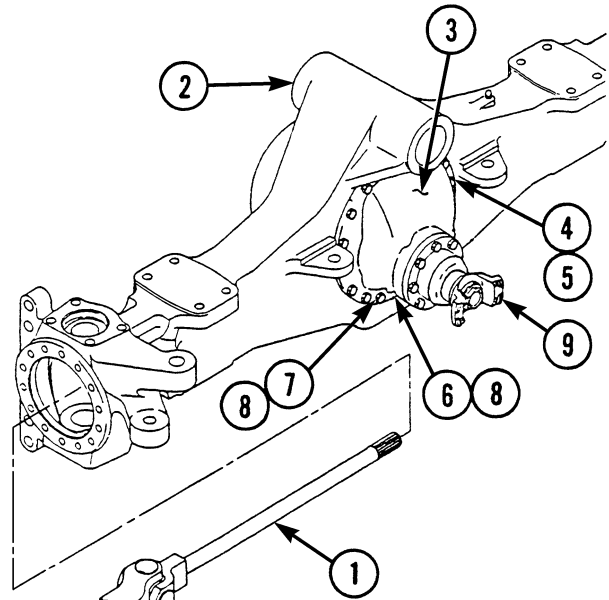
**a. Removal.**

- (1) Remove two axle shafts (1) from axle housing (2).
- (2) Remove differential carrier (3) from axle housing (2).
  - (a) Carefully tip axle assembly so that rear differential carrier (2) faces up.

**NOTE**

Screws from differential carrier to axle housing are of three different sizes. Note size, location and quantity of screws when removing for correct location during replacement.

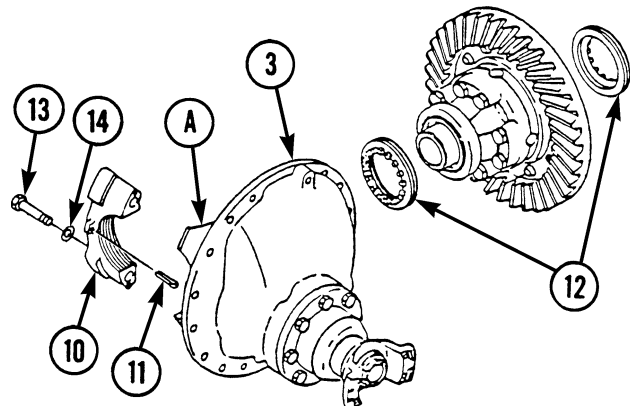
- (b) Remove 12 screws (4), washers (5), two screws (6), two screws (7), and four washers (8) from differential carrier (3).
- (c) Use sling placed around bevel pinion behind companion yoke (9) to lift and support differential carrier (3) during removal.
- (d) Use a leather or rubber mallet to loosen differential carrier (3) in axle housing (2).
- (e) Carefully remove differential carrier (3) from axle housing (2).
- (f) Place differential carrier (3) on suitable stand or bench with ring gear up and clamp securely.



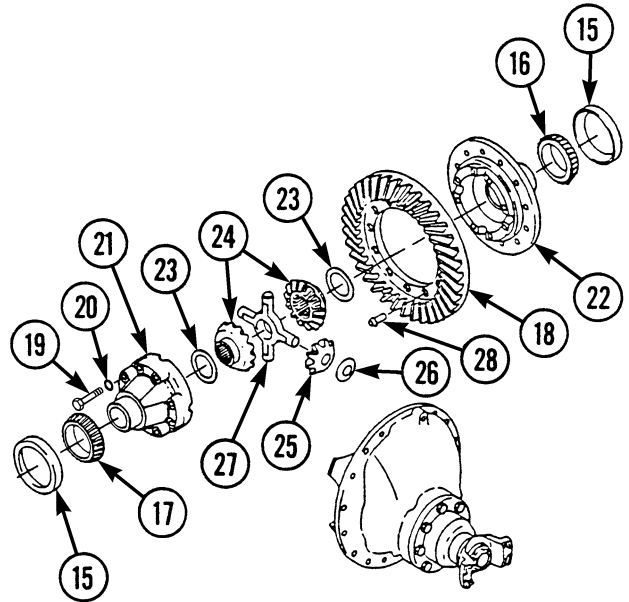
**b. Disassembly.**

- (1) Remove differential and ring gear assembly from differential carrier (3).

- (a) Mark one carrier leg (A) and bearing cap (10) for ease of assembly.
- (b) Remove two cotter pins (11) holding bearing adjusting rings (12) in position. Discard cotter pins.
- (c) Remove two screws (13) and washers (14) from each of two bearing caps (10).
- (d) Remove two bearing caps (10) and bearing adjusting rings (12) from differential carrier (3).



- (e) Use sling to lift differential and ring gear assembly from the carrier. Place assembly on a work bench.
- (f) Remove two bearing cups (15) from flange case half bearing cone (16) and plain case half bearing cone (17).
- (g) Using suitable puller, remove flange case half bearing cone (16) and plain case half bearing cone (17).



**(2) Disassemble differential and ring gear (18).**

- (a) Mark each case half for ease of assembly.
- (b) Remove eight screws (19) and washers (20) from plain case half (21).
- (c) Separate case halves (21 and 22).
- (d) Remove two side gear thrust washers (23), two side gears (24), four pinion gears (25), pinion gear thrust washers (26), and differential spider (27).

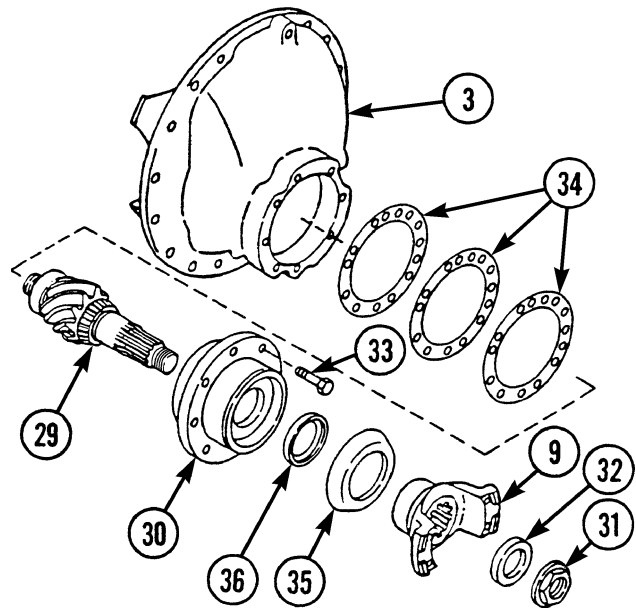
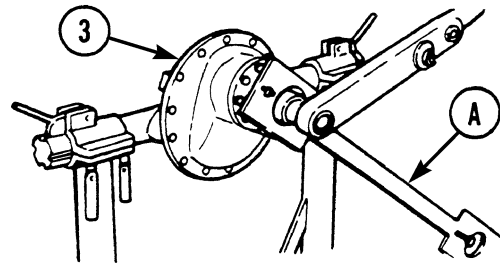
**(3) Remove ring gear (18).**

- (a) Inspect ring gear (18) for wear or damage. If ring gear needs replacement, center punch 12 rivets (28) on side of ring gear.
- (b) Drill 12 rivets (28) on ring gear (18) to a depth equal to thickness of one rivet head. Use a drill bit 1/32 in. (0.031 mm) smaller than rivet body diameter.
- (c) Press or drive 12 rivets (28) from drilled side through holes in ring gear (18) and flange case half (22). Discard rivets.
- (d) Support assembly under ring gear (18) with blocks and use suitable press to remove case half (22) through ring gear.

**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

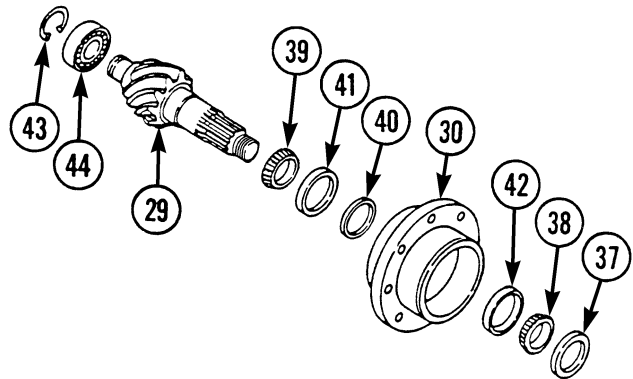
**(4) Remove bevel pinion (29) and bearing cage (30) from differential carrier (3).**

- (a) Place differential carrier (3) on bench and clamp carrier securely.
- (b) Fasten fabricated yoke nut tool to companion yoke. Hold fabricated yoke nut tool (A) to remove bevel pinion nut (31) and washer (32).
- (c) Remove companion yoke (9) with deflector (35). Use a puller if necessary.
- (d) Remove eight screws (33) from bearing cage (30).
- (e) Remove bevel pinion (29), bearing cage (30), and shims (34), as an assembly, from the differential carrier (3). Keep shims together for ease of assembly. If shims are damaged, measure total thickness of shim pack and record dimension; discard shims. Shim thickness dimension will be needed to calculate depth of bevel pinion in differential carrier when gear set is installed.



**(5) Disassemble bevel pinion (29) and bearing cage (30).**

- (a) Use suitable puller to remove pinion oil seal (36) from bearing cage (30).
- (b) Remove pinion bearing cage thrust washer (37).
- (c) Place bevel pinion (29) and bearing cage (30) in a press with splined end of pinion at the top of assembly.
- (d) Support bearing cage (30) under flange area with blocks.
- (e) Use a press to remove bevel pinion (29) from bearing cage (30)



- (f) Remove outer bearing cone (38) from bearing cage (30).
- (g) Use suitable puller to remove inner bearing cone (39) and bearing spacer (40) from bevel pinion (29).
- (h) Use suitable puller to remove inner bearing cup (41) and outer bearing cup (42) from bearing cage (30).
- (i) Install a soft metal cover over vise jaws to protect bevel pinion (29). Place bevel pinion (29) in vise.

### WARNING

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (j) Remove snap ring (43) from end of bevel pinion (29).
- (k) Use suitable puller to remove bearing (44) from spigot end of bevel pinion (29).

**c. Cleaning.** See **Cleaning Instructions (Para 2-12)**.

**d. Inspection.** See **Inspection Instructions (Para 2-14)**.

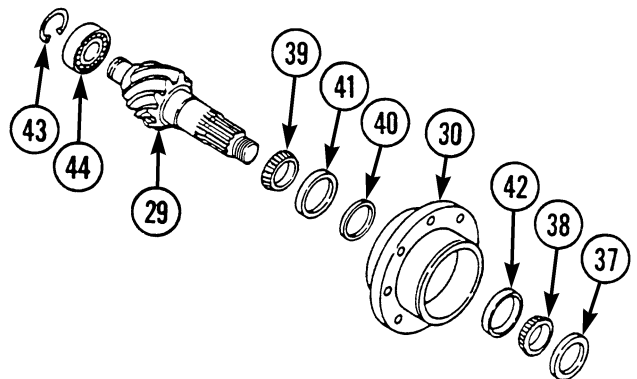
**e. Assembly.**

### NOTE

Pinion and ring gears are a matched set. If replacement of ring gear or pinion gear is necessary, replace both gears as a set.

**(1) Assemble bevel pinion (29), bearings (38, 39, 41, and 42), and bearing cage (30).**

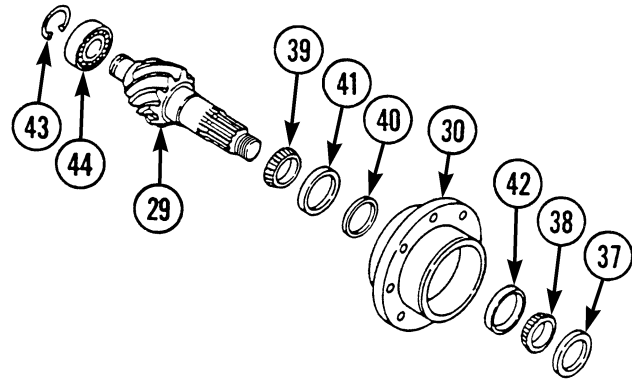
- (a) Use press and suitable driver to install inner bearing cup (41) and outer bearing cup (42) into bearing cage (30). Be sure bearing cups are tight against bottom of cage bore.
- (b) Use press and suitable sleeve driver to install inner bearing cone (41) on bevel pinion (29).
- (c) If necessary, use a press and suitable sleeve driver to install spigot bearing (44) onto spigot end of bevel pinion (29).



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.



- (d) Install snap ring (43) into groove on end of bevel pinion (29).
- (e) Apply thin film of gear lubricant to inner and outer bearing cups (41 and 42) and bearing cones (38 and 39).
- (f) Install bearing spacer (40) on bevel pinion against inner bearing cone (39).
- (g) Install bevel pinion (29) and bearing assembly into bearing cage (30).
- (h) Use press and suitable sleeve driver to install outer bearing cone (38) on bevel pinion tight against bearing spacer (40).
- (i) Install pinion bearing cage thrust washer (37).

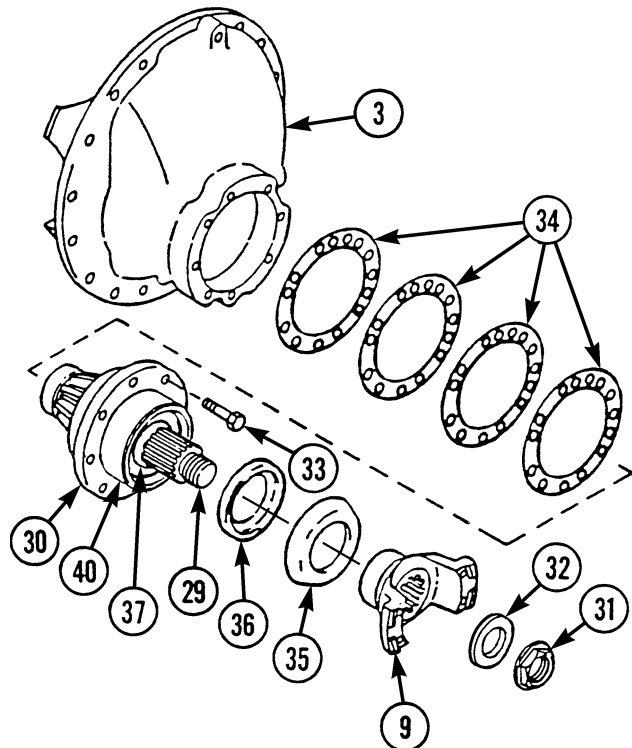
**(2) Adjust preload of bearings (38, 39, 41, and 42) on bevel pinion (29).**

- (a) Install companion yoke (9), washer (32), and nut (31) on bevel pinion (29). If necessary, use a press to push yoke on pinion. Companion yoke must be against thrust washer (37).

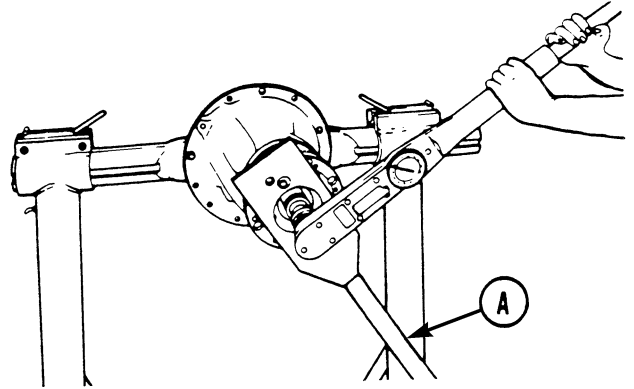
**NOTE**

Shims are not installed at this time.

- (b) Temporarily install bevel pinion (29) and bearing cage (30) assembly in differential carrier (2). *Do not install shims (34) under bearing cage.*
- (c) Install eight screws (33) in bearing cage (30) finger tight.



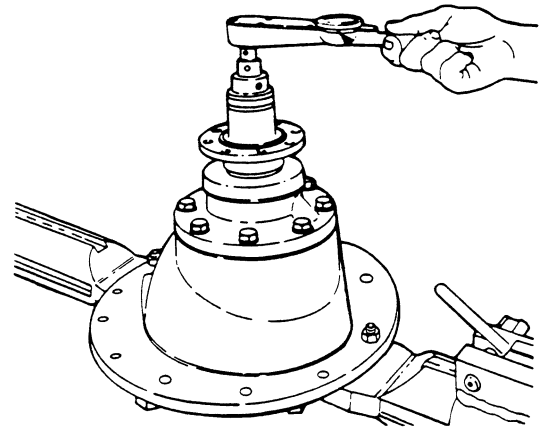
- (d) Fasten fabricated yoke nut tool to companion yoke (9). Use fabricated yoke nut tool (A) to hold bevel pinion (29) in position when nut (31) is tightened.
- (e) Tighten nut (31) on bevel pinion (29) to 300 - 400 lb-ft (406.75 - 542.33 N•m).
- (f) Remove bar from companion yoke (9).



### NOTE

Do not read starting torque. Read only torque value after bevel pinion starts to rotate. Starting torque will give a false reading.

- (g) Attach torque wrench on bevel pinion nut (31). Rotate bevel pinion (29) and read value indicated on torque wrench. New pinion bearings should be preloaded between 5 - 45 lb-in. (0.56 - 5.08 N•m) of torque. Reused pinion bearings should be preloaded between 10 - 30 lb-in. (1.13 - 3.39 N•m).



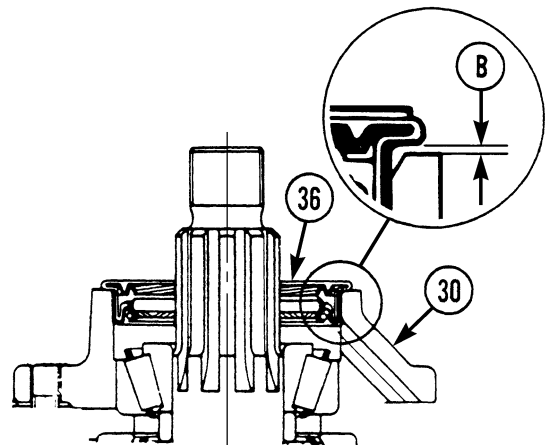
- 1 Increase bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thinner bearing spacer (40). Repeat Steps (a) through (g).
  - 2 Decrease bearing preload by removing bevel pinion (29) from bearing cage (30) and installing a thicker bearing spacer (40). Repeat Steps (a) through (g).
  - 3 Remove nut (31), washer (32), and companion yoke (9) from bevel pinion (29).
- (h) Remove eight screws (33) from bearing cage (30).
  - (i) Remove bevel pinion (29) and bearing cage (30), as an assembly, from differential carrier (3).

### (3) Install pinion oil seal (36).

- (a) Apply thin film of gear lubricant to inner surface of bevel pinion oil seal (36).
- (b) Apply thin film of gear lubricant to seal bore in bearing cage (30).
- (c) Use a press or mallet and suitable sleeve to install bevel pinion bearing oil seal (36) in bearing cage (30) until flange of seal is against bearing cage.

**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (d) Gap (B) of 0.015 - 0.030 in. (0.38 - 0.76 mm) is normal between bevel pinion bearing seal (36) and bearing cage (30). Check gap at several points. Difference between the largest and smallest gap measurement must not exceed 0.010 in. (0.25 mm).



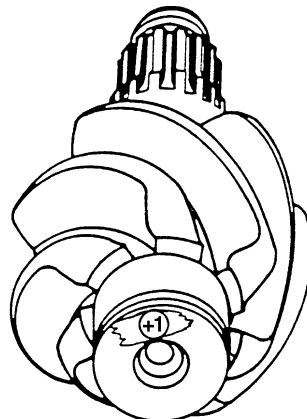
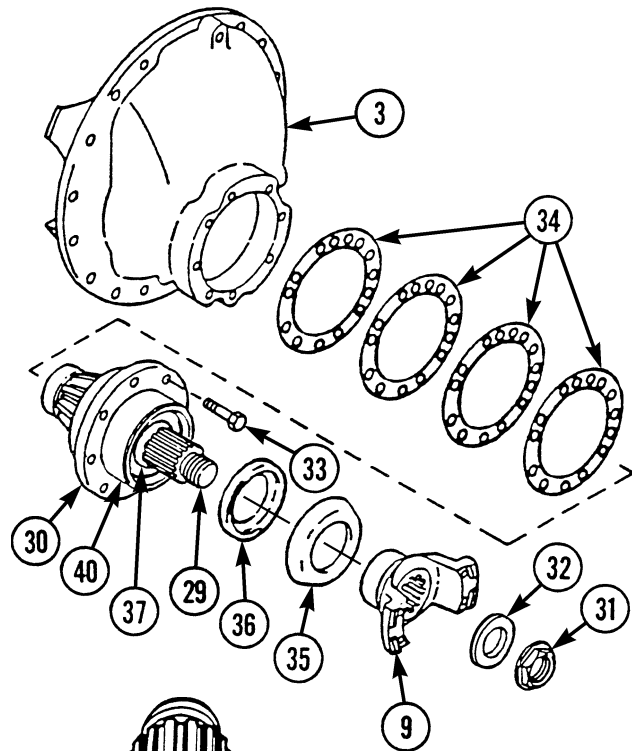
- (e) Install companion yoke (9) with deflector (35), washer (32), and nut (31).

**(4) Adjust thickness of shim pack for new bevel pinion (29) and ring gear (18) set.**

**NOTE**

If a new bevel pinion and ring gear set is installed, or if the depth of bevel pinion has to be adjusted, calculate the needed thickness of the shim pack using following procedure:

- (a) Use a micrometer to measure thickness of old shim pack (34) removed from under bearing cage (30). Record measurement.
- (b) Read cone variation number on spigot end of old bevel pinion (29). Record number.





**NOTE**

Bevel pinion spigot end number can be in 1,000ths of an inch or 100ths of a millimeter. Millimeters will be indicated with a decimal point. Example: +3 = 0.003 in., +0.03 = 0.03 mm. Be sure to convert millimeters to inches by multiplying by 0.039 before performing the following calculations:

- (c) If old bevel pinion cone number is a plus (+) value, subtract number from shim pack (34) thickness measured in Step (a). If old bevel pinion cone number is a minus (-) value, add number from spigot end of old bevel pinion (29) to shim pack thickness. This is the thickness of standard shim pack, without a cone variation.
- (d) Read number on spigot end of new bevel pinion (29). Record number.
- (e) If number on spigot end of new bevel pinion is a plus (+), add number to standard shim pack (34) thickness calculated in Step (c). If new pinion cone number is a minus (-), subtract new pinion cone number from standard shim pack thickness calculated in Step (c). This is the thickness of new shim pack with cone variation.

<b>EXAMPLES</b>		
1.	Old Shim Pack Thickness	0.030
	Old Bevel Pinon Spigot End Number, PC + 2	<u>-0.002</u>
	Standard Shim Pack Thickness	0.028
	New Bevel Pinon Spigot End Number, PC + 5	<u>+0.005</u>
	New Shim Pack Thickness	0.033
2.	Old Shim Pack Thickness	0.030
	Old Bevel Pinon Spigot End Number, PC - 2	<u>+0.002</u>
	Standard Shim Pack Thickness	0.032
	New Bevel Pinon Spigot End Number, PC + 5	<u>+0.005</u>
	New Shim Pack Thickness	0.037
3.	Old Shim Pack Thickness	0.030
	Old Bevel Pinion Spigot End Number, PC + 2	<u>-0.002</u>
	Standard Shim Pack Thickness	0.028
	New Bevel Pinion Spigot End Number, PC - 5	<u>-0.005</u>
	New Shim Pack Thickness	0.023
4.	Old Shim Pack Thickness	0.030
	Old Bevel Pinion Spigot End Number, PC - 2	<u>+0.002</u>
	Standard Shim Pack Thickness	0.032
	New Pinion Cone Number, PC - 5	<u>-0.005</u>
	New Shim Pack Thickness	0.027

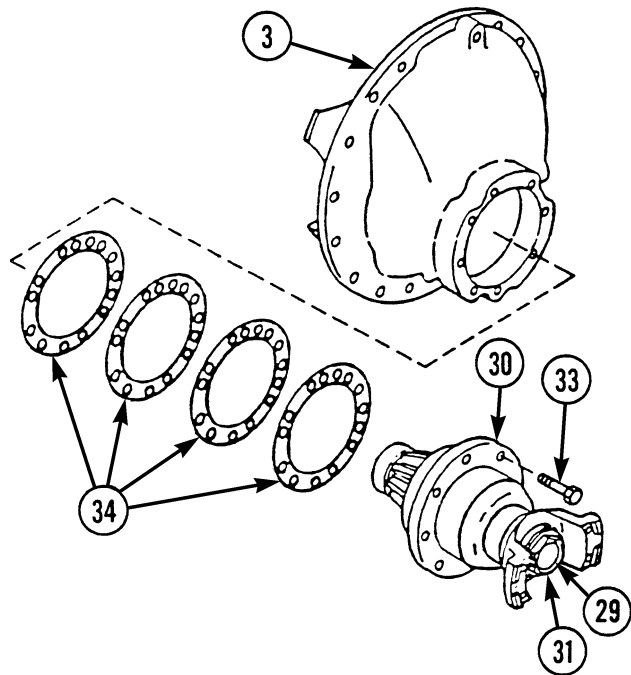
**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (5) **Install bevel pinion (29) and bearing cage (30) as an assembly, and shim pack (34) on differential carrier (3).**

**NOTE**

Use a minimum of three shims in a shim pack. Install thinnest shims on both sides of shim pack for maximum sealing.

- (a) Install bevel pinion (29), shim pack (34), bearing cage (30), and screws (33) on differential carrier (3). Tighten screws 50 - 75 lb-ft (67.79 - 101.69 N•m).
- (b) Tighten nut (31) to 300 - 400 lb-ft (406.75 - 542.33 N•m).

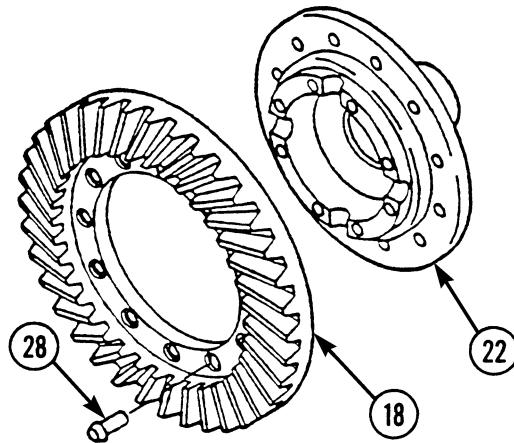


- (6) **Install ring gear (18).**

**CAUTION**

Ring gear must be heated before installation. Failure to heat ring gear before installation could cause damage to differential case half because of a tight fit.

- (a) Expand ring gear (18) by heating in a tank of water to a temperature of 160°F - 180°F (71°C - 82°C) for 10 to 15 minutes.

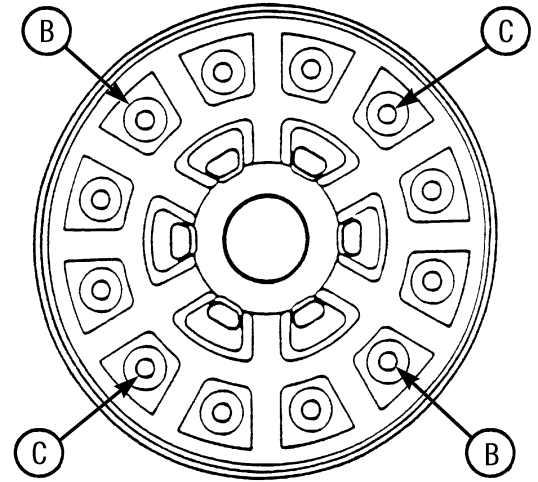


**WARNING**

Wear gloves and proper clothing while handling hot ring gear. Failure to follow this precaution could result in serious personal injury.

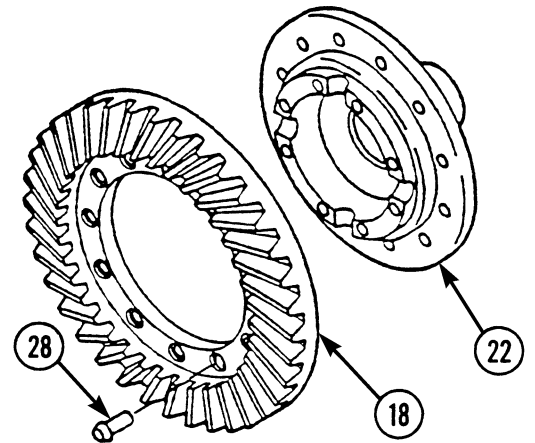
- (b) Use sling and hoist to lift the ring gear (18) from tank of water.
- (c) Install ring gear (18) on flange case half (22) immediately after heating. If ring gear does not fit easily on flange case half, repeat Step (a).

- (d) Align fastener holes of ring gear (18) and flange case half (22) by rotating ring gear as needed.
- (e) Install 12 rivets (28) in pairs opposite each other (B and C) from flange case half (22) side of assembly (side opposite gear teeth) as shown. Rivet head must be against flange case half.

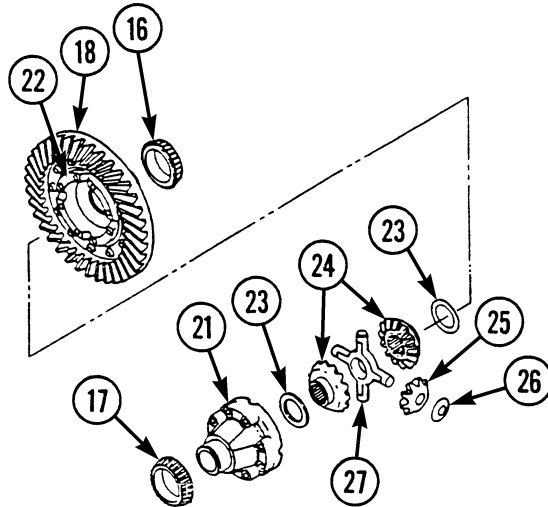


**CAUTION**

- Do not heat rivets before installation. Use only cold rivets for proper fastening.
  - Pressure on rivets must be held for approximately one minute so that rivet body will completely fill hole. Failure to do so could cause rivet failure.
- (f) Use riveting machine to press rivets (28) into place from ring gear (18) side of the assembly. Press rivets in pairs opposite each other. Apply 60,000 lb of pressure.
  - (g) Use a 0.003 in. (0.08 mm) feeler gauge to check for gaps between back surface of ring gear (18) and flange case half (22). If gauge fits more than half way to rivets, remove ring gear; see **Disassembly** Step (3), (a) through (d) and repeat **Assembly** Step (6), (a) through (f). If gap persists, inspect flange case half and ring gear for problem, replace defective parts.



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/  
ADJUSTMENT (CONT)**



- (h) Use press and suitable sleeve driver to install bearing cone (16) on flange case half (22).
- (i) Use press and suitable sleeve to install bearing cone (17) on plain case half (21).
- (j) Apply gear lubricant to inside surfaces of both case halves (21 and 22), two thrust washers (23), two side gears (24), and four pinion gears (25).
- (k) Place flange case half (22) on bench, ring gear (18) teeth up.
- (l) Install one thrust washer (23) and side gear (24) into the flange case half (22).
- (m) Install four pinion gears (25) and four pinion gear thrust washers (26) on differential spider (27). Install differential spider assembly into flange case half (22).
- (n) Install second side gear (24) and thrust washer (23) over spider (27) and differential pinion gears (25).
- (o) Place plain case half (21) over flange case half (22) and gears (24 and 25). Rotate plain case half as needed to align match marks.

**WARNING**

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

**CAUTION**

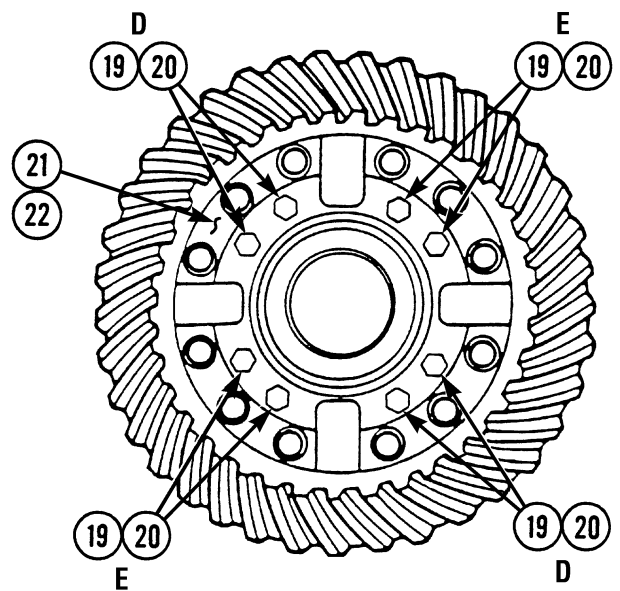
Spacing between first four installed screws must be even to prevent uneven pressure on case halves when torquing. Failure to do so could cause component failure.

- (p) Apply sealing compound to eight screws (19). Install four of the eight screws and four washers (20), as opposing pairs (D and E), into case halves (21 and 22). Tighten screws to 60 - 75 lb-ft (81.35 - 101.69 N•m).

**NOTE**

Tighten screws in pairs opposite each other.

- (q) Install remaining four screws (19) and four washers (20). Tighten screws to 60 - 75 lb-ft (81.35 - 101.69 N•m).

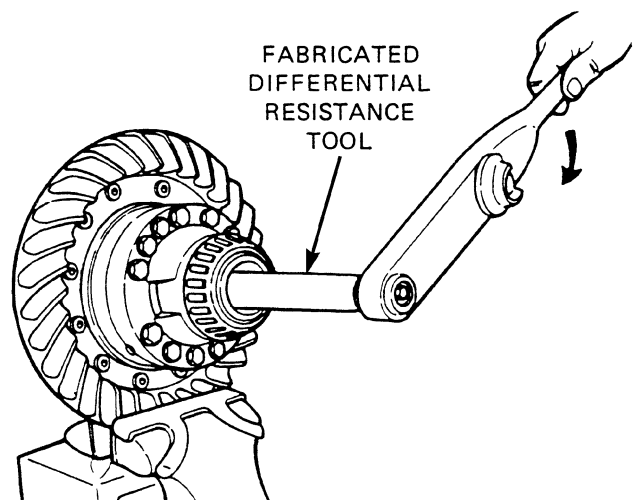


**(7) Check rotating resistance of differential gears.**

**NOTE**

Fabricate a tool from an axle's shaft that matches the spline of differential side gear (24).

- (a) Place differential in a soft-jaw vise in the normal operating position.
- (b) Install fabricated differential resistance tool in spline of one side gear.
- (c) Put torque wrench on end of differential resistance tool. Read value of torque wrench as differential gears are rotated.



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (d) If torque value exceeds 50 lb-ft (67.79 N•m), disassemble differential. Inspect case halves (21 and 22) spider (27), gears (24 and 25), and thrust washers (23 and 26) for cause of high torque reading. Replace parts as necessary.

**(8) Install differential and ring gear assembly.**

- (a) Clean and dry bearing cups (15), bores of differential carrier (3) legs and bearing caps (10).
- (b) Apply thin film of gear oil to inner diameter of bearing cups (15) and on both bearing cones (16 and 17).

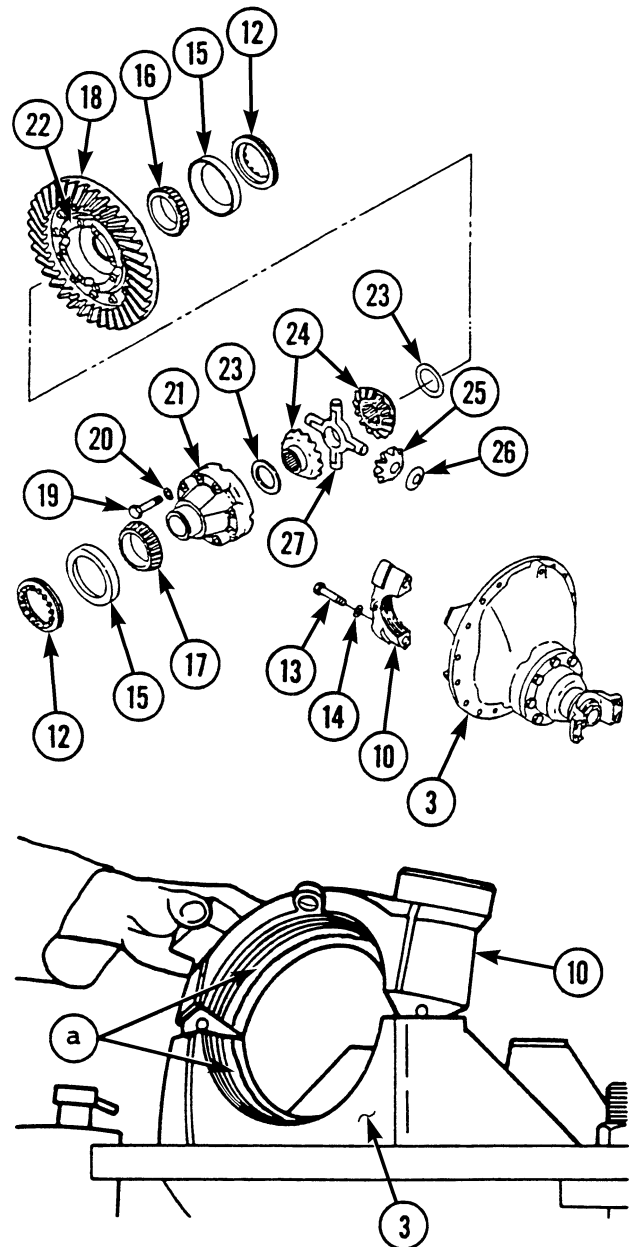
**WARNING**

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

**NOTE**

When installing bearing cups in bearing bores of differential carrier apply sealing compound to bearing bores (a) of differential carrier and bearing caps. Do not allow sealing compound to get into adjusting ring threads.

- (c) Apply thin bead of sealing compound to bearing bores (a) of differential carrier (3) legs and bearing caps (10). Do not apply sealing compound to adjusting ring (12) threads.
- (d) Install two bearing cups (15) over bearing cones (16 and 17) on case halves (21 and 22).
- (e) Use a sling and hoist to carefully lift differential and ring gear parts (15 through 27) as an assembly and install into differential carrier (3). Bearing cups (15) must be flat against bores between differential carrier legs.



**CAUTION**

Install bearing caps in correct location to avoid thread damage by cross-threading adjusting rings, when installed, or mismatching bearing caps.

- (f) Install bearing caps (10) over assembled bearing cups and bearing cones (16 and 17). Use match marks made during disassembly to match original location of bearing caps.
- (g) Install screws (13) and washers (14) and tighten hand tight in bearing caps (10).

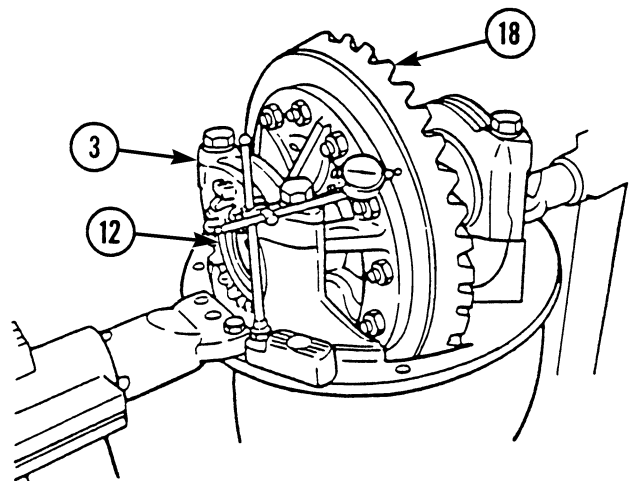
**CAUTION**

Install adjusting rings, using care not to cross-thread the rings or the caps. A plastic or leather mallet can be used to align the rings and caps during installation. DO NOT force adjusting rings; damage to threads may result.

- (h) Install adjusting rings (12) and tighten hand tight against each bearing cup (15).
- (i) Tighten screws (13) to 110 - 145 lb-ft (149.14 - 196.59 N•m).

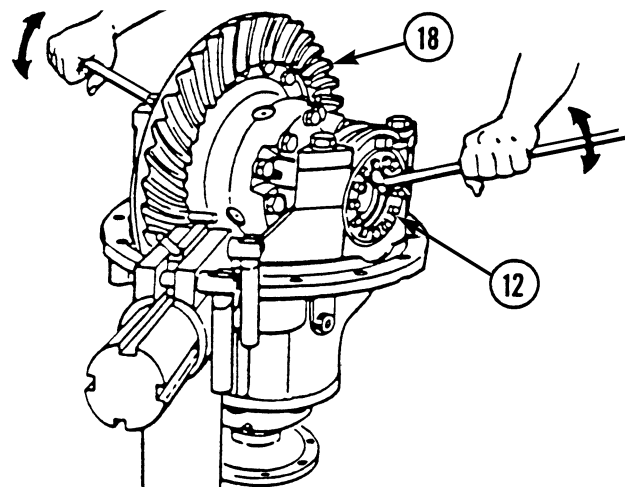
**f. Adjustment.****(1) Adjust preload of differential bearings (15, 16, and 17).**

- (a) Attach a dial indicator on mounting flange of differential carrier (3).
- (b) Adjust dial indicator so that plunger is against back surface of ring gear (18). Adjust dial indicator to zero.

**CAUTION**

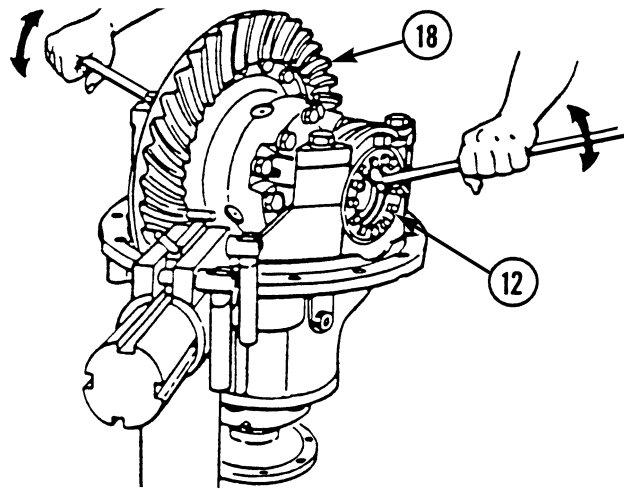
When turning bearing adjusting rings, always use a tool that engages two or more opposite notches in the ring. A large screwdriver can be used for this purpose. Failure to engage at least two notches could cause damage to adjusting ring lugs.

- (c) Loosen bearing adjusting ring (12) opposite ring gear (18) so that a small amount of end play shows on dial indicator. Move differential assembly with ring gear left and right with suitable pry bars while reading dial indicator. DO NOT allow pry bars to touch bearings (15, 16, and 17).



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (d) Tighten bearing adjusting ring (12) opposite ring gear (18) so that no end play shows on dial indicator. Move differential assembly and ring gear left and right as needed to be sure no end play is present.
- (e) Tighten each bearing adjusting ring (12) one notch from zero end play measured in Step (d) above.

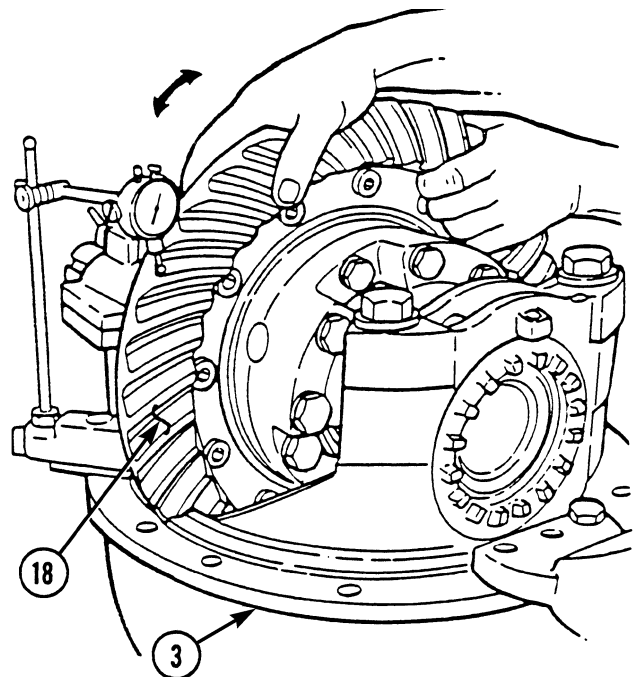


**(2) Check runout of ring gear (18).**

- (a) Attach dial indicator on mounting flange of differential carrier (3). Adjust dial indicator so that plunger is against back surface of ring gear (18).
- (b) Adjust dial of indicator to zero.
- (c) Rotate differential assembly and ring gear (18) and read dial indicator. If runout of ring gear (18) exceeds 0.008 in. (0.20 mm), remove differential assembly and ring gear, **Disassembly** Step (1), and inspect differential assembly for problem. Replace defective parts and install differential assembly and ring gear (18) in differential carrier (3), **Assembly** Step (7). Repeat preload adjustment of differential bearings, **Adjustment** Step (1).

**(3) Adjust backlash of ring gear (18).**

- (a) Attach a dial indicator to mounting flange on differential carrier (3).
- (b) Adjust dial indicator so that plunger is against the tooth surface on ring gear (18).
- (c) Adjust dial of indicator to zero.





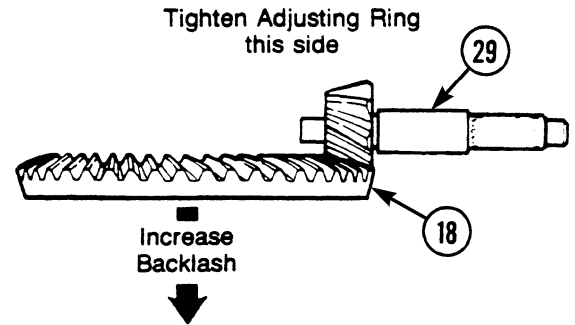
(d) Hold bevel pinion (29) in position so it does not move.

(e) Read dial indicator while rotating ring gear (18) in both directions against teeth of bevel pinion (29).

1 If old gear set is installed, backlash must be 0.008 - 0.018 in. (0.20 - 0.46 mm) or setting before carrier was disassembled.

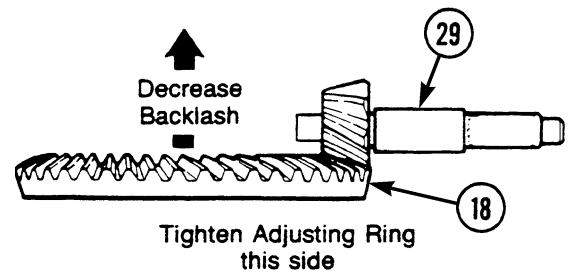
2 If new gear set is installed, backlash must be 0.012 in. (0.30 mm).

3 Adjust backlash as necessary by following Steps (f) and (g) below.



Loosen Adjusting Ring this side

Loosen Adjusting Ring this side

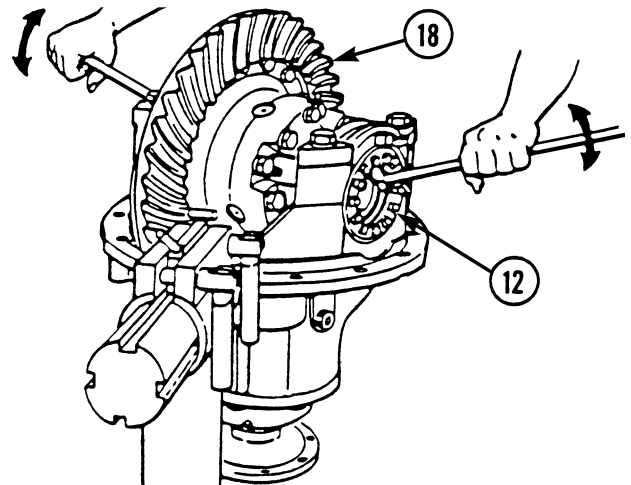


**NOTE**

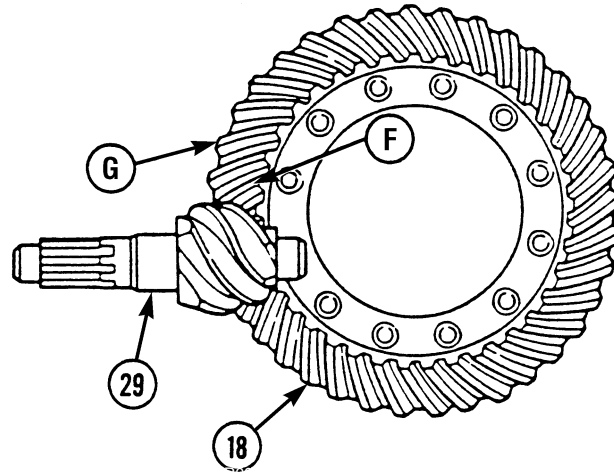
When adjusting backlash, only ring gear and differential are adjusted; do not adjust bevel pinion.

(f) Increase backlash by loosening bearing adjusting ring (12) on ring gear (18) side, and tightening bearing adjusting ring (12) away from ring gear side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.

(g) Decrease backlash by tightening bearing adjusting ring (12) on ring gear (18) side, and loosening bearing adjusting ring (12) away from ring gear side of differential assembly. Make adjustments one notch at a time until backlash is within specifications.



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/  
ADJUSTMENT (CONT)**



**(4) Check tooth contact patterns of gear set.**

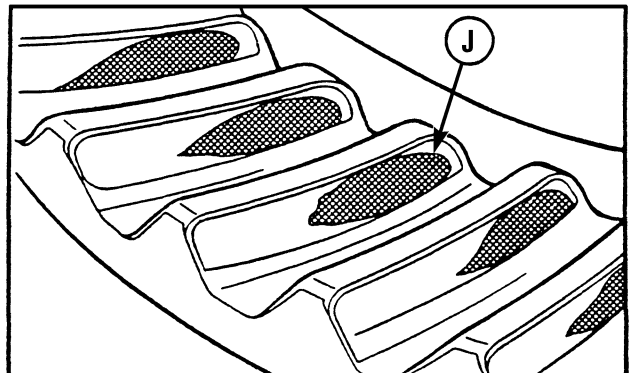
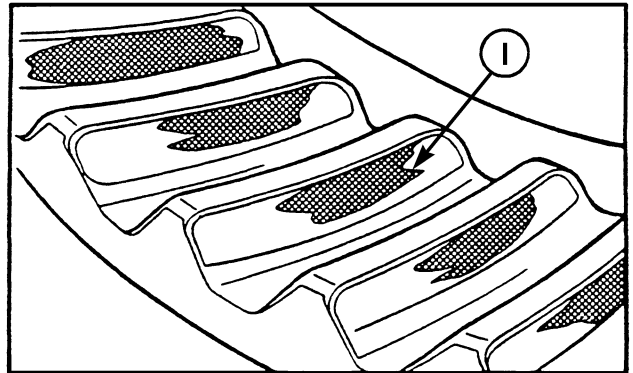
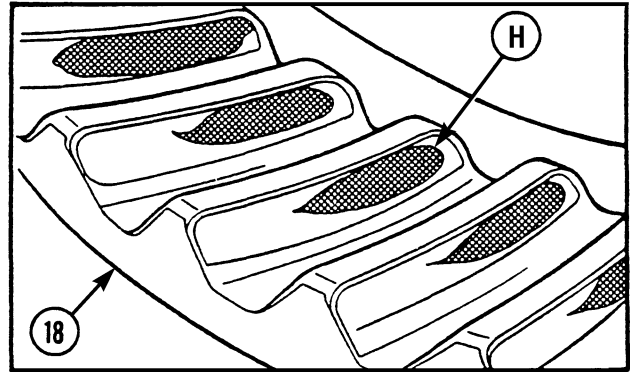
**WARNING**

Prussian Blue Dye is poisonous and can burn skin on contact. Over exposure to dye can cause heart and skin problems, dizziness, and unconsciousness.

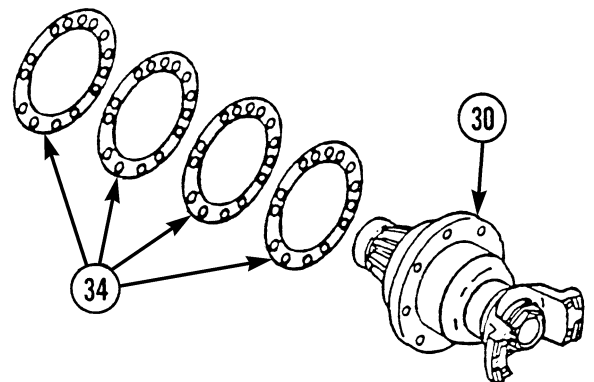
**NOTE**

- In the following steps, movement of contact pattern in length of tooth is indicated as toward “toe” (F) or “heel” (G) of ring gear.
  - Always check tooth contact patterns on drive side of gear teeth.
- (a) Apply marking compound to 12 gear teeth of ring gear. Rotate ring gear so that 12 gear teeth are next to bevel pinion (29).
  - (b) Rotate ring gear (18) forward and backward so that 12 marked teeth go past bevel pinion six times to get contact patterns. Repeat, if necessary, to get a clearer pattern.

- (c) Inspect contact patterns on ring gear (18). Good hand rolled pattern (H) will show contact toward toe of gear tooth and in the center between top and bottom of tooth. A high pattern (I) will show contact closer to top of gear tooth. A low pattern (J) will show contact toward bottom of gear tooth. When in operation, pattern will extend to approximately full length of gear tooth.

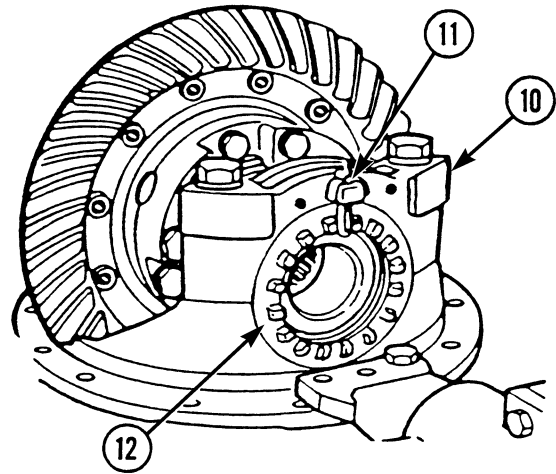


- (d) If necessary, install thinner shim pack (34) under bearing cage (30) to correct high contact pattern.
- (e) If necessary, install thicker shim pack (34) under bearing cage (30) to correct low contact pattern.



**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/ADJUSTMENT (CONT)**

- (f) If necessary, decrease backlash, Step (3), (g) to move contact patterns toward toe of ring gear teeth.
- (g) If necessary, increase backlash, Step (3), (f) to move contact patterns toward heel of ring gear teeth.
- (h) Install two cotter pins (11) that hold two bearing adjusting rings (12) in position. Install cotter pins (11) through boss of bearing cap (10) and between lugs of adjusting ring.



**g. Installation.**

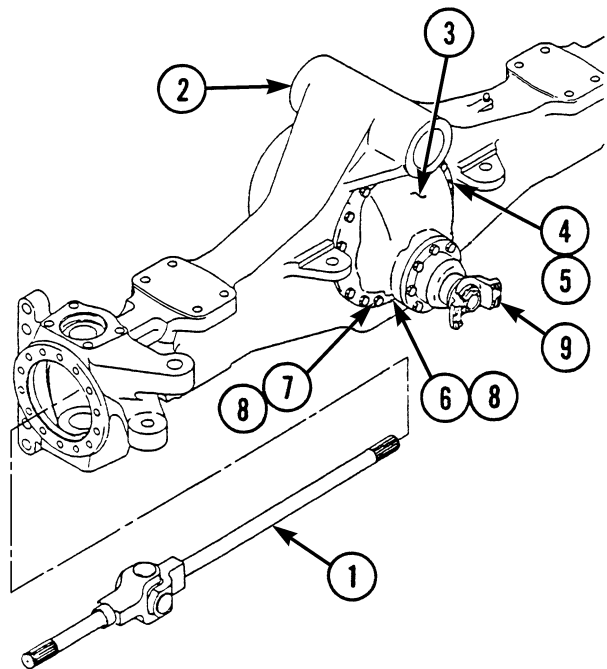
**WARNING**

Minor concentrations of acetic acid may be produced during application of silicone RTV-732 sealing compound. Adequate ventilation should be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

**NOTE**

When installing differential carrier, apply silicone RTV sealant to bunting surface of the axle housing.

- (1) **Install differential carrier (3) in axle housing (2).**



**NOTE**

Inside of axle housing and mounting flange where carrier fastens should be clean and dry before installing carrier.

**WARNING**

Minor concentrations of acetic acid may be produced during application of silicone RTV-732 sealing compound. Adequate ventilation should be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

- (a) Apply a 1/8 in. (3.18 mm) bead of silicone RTV-732 clear sealing compound to differential mounting surface of axle housing (3). Be sure to apply sealing compound around each tapped hole of mounting surface.

**CAUTION**

Be sure bearing caps of differential fit inside lugs inside of axle housing. Do not force differential into housing or damage will occur to housing and differential.

- (b) Install differential carrier (3) in axle housing (2).

**CAUTION**

First four installed screws must be evenly spaced to prevent uneven pressure on differential carrier when torquing. Failure to do so could cause component damage.

- (c) Install four screws (4) and washers (5) into corner locations around differential carrier (3) and axle housing (2). Hand tighten.
- (d) Carefully push differential carrier (3) into position. Tighten four screws (4) two or three turns each in a pattern opposite each other.

**NOTE**

Tighten screws in pairs on opposing sides of differential carrier.

- (e) Tighten screws (4) to 50 - 75 lb-ft (67.79 - 101.69 N•m) Tighten in pairs across from each other.
- (f) Install remaining eight screws (4), two screws (6), two screws (7), four washers (8) and eight washers (5). Be sure fasteners are in correct location as noted during disassembly.
- (g) Carefully install axle shafts (1) in axle housing (2) so not to damage bushings or seals in axle housing.
- (h) Carefully move axle housing (2) to upright position.

**9-5. REAR DIFFERENTIAL CARRIER ASSEMBLY REPLACEMENT/REPAIR/  
ADJUSTMENT (CONT)**

**NOTE**

Follow-on Maintenance:

- Install rear planetary wheel ends (Para 9-6).
- Fill axle housing with lubricant (TM-10-3930-673-20).
- Install rear axle assembly (Para 9-3).

**END OF TASK**

**9-6. REAR PLANETARY WHEEL ENDS REPLACEMENT**

This Task Covers:

- a. Removal
- b. Cleaning
- c. Inspection
- d. Installation

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Hub Drag Tool - Fabricated Tool (Figure C-4, Appendix C)
- Lifting Device, 2,000 lb (907.18 kg) capacity
- Puller Kit (Item 15, Appendix D)

*Equipment Condition*

- Rear of vehicle raised eight in. (203.2 mm) and supported under rear axle.
- Planetary wheel end drained (TM 10-3930-673-20).
- Wheel assembly removed (TM 10-3930-673-20).
- Rear disc brake assembly removed (Para 10-3).

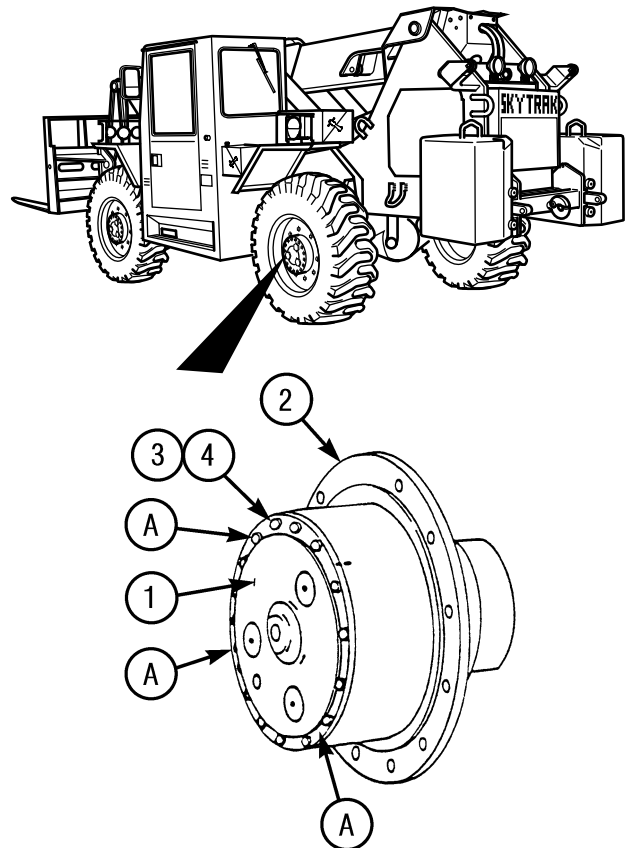
*Materials / Parts*

- Compound, Sealing (Item 13, Appendix B)
- Oil, Lubricating Gear (Item 29, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Ring, Snap (3)
- Ring, Snap
- Container, 1 gal (3.79 l) capacity

**a. Removal.**

**(1) Remove planetary gear assembly.**

- (a) Mark planetary spider (1) and wheel hub (2) for correct alignment during installation.
- (b) Place a suitable container under planetary wheel end assembly
- (c) Remove 16 screws (3) and washers (4) from planetary spider (1).
- (d) Install three screws (3) in jack screw holes (A) and tighten to remove planetary spider (1).



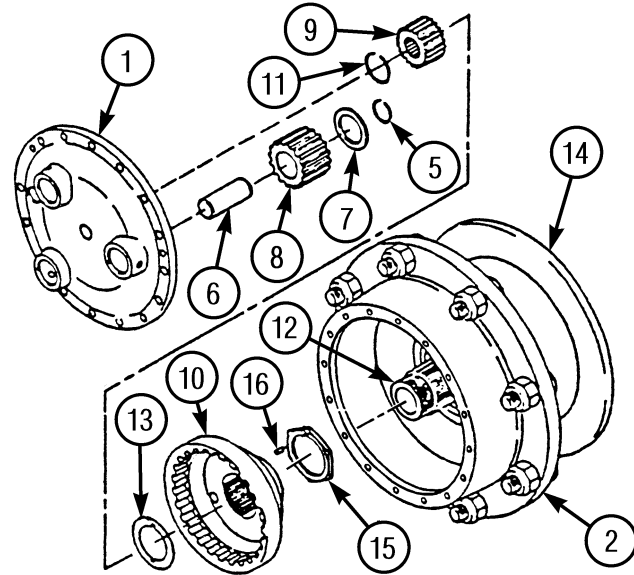
**9-6. REAR PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

**(2) Disassemble planetary spider assembly parts (5 through 8).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove three snap rings (5) from planetary pinion shafts (6). Discard snap rings.
- (b) Remove three washers (7) and planetary gears (8) from planetary pinion shafts (6).



**(3) Remove planetary sun gear (9) and ring gear (10) from wheel hub (2).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

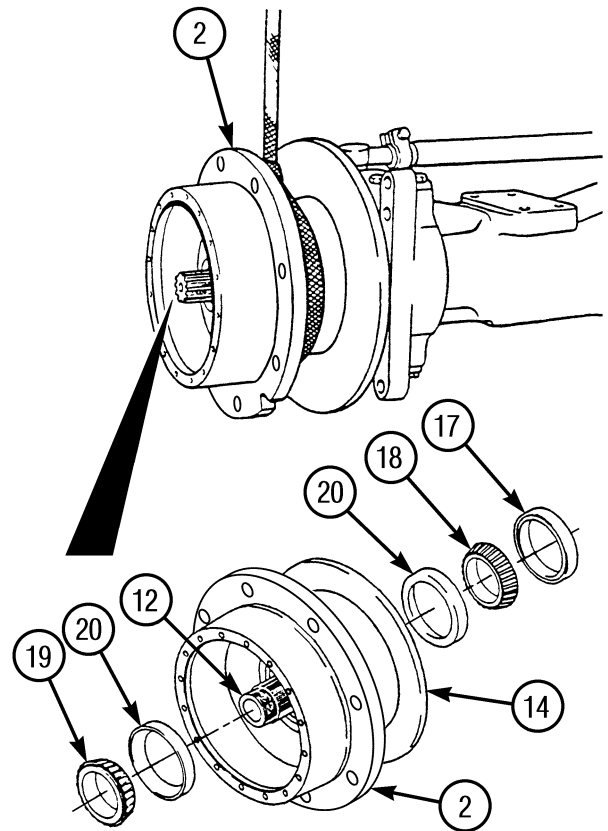
- (a) Remove snap ring (11) from end of wheel bearing spindle (12).
- (b) Remove planetary sun gear (9) from wheel bearing spindle (12).
- (c) Remove washer (13) from wheel bearing spindle (12).
- (d) Remove planetary ring gear (10).

**(4) Remove wheel hub and disc assembly (14) and parts (15 through 20).**

- (a) Use a sling and hoist or other suitable lifting device to support hub weight during removal.
- (b) Remove hub bearing nut (15) and dowel pin (16) from wheel bearing spindle (12).



- (c) Wobble wheel hub and disc assembly (14) to unseat oil seal (17), inner bearing cone (18), and outer bearing cone (19).
- (d) Remove outer bearing cone (19) from wheel bearing spindle (12).
- (e) Remove wheel hub and disc assembly (14).
- (f) Remove inner oil seal (17) from wheel bearing spindle (12).
- (g) Remove inner bearing cone (18) from wheel bearing spindle (12).
- (h) Remove two bearing cups (20) using a suitable puller from wheel bearing spindle (12).



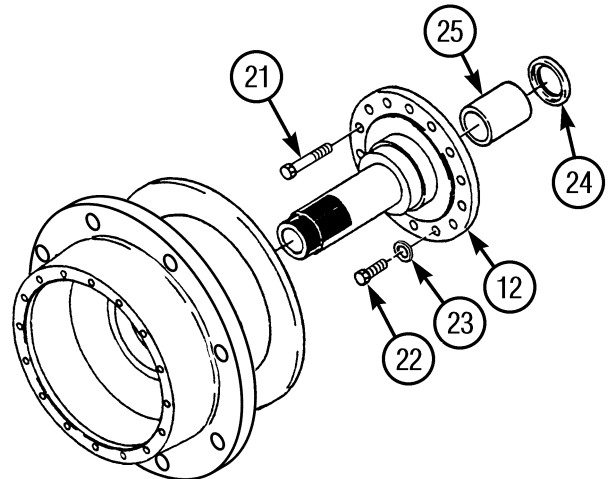
**(5) Remove wheel bearing spindle (12) parts (21 through 25).**

- (a) Remove 10 screws (21), four screws (22), and 14 washers (23) from wheel bearing spindle (12).

**CAUTION**

Inner oil seal and bushing in bore of spindle can be damaged when sliding spindle past axle splines. Remove spindle carefully to avoid damaging bushing and inner oil seal. Failure to do so could cause premature component failure.

- (b) Remove wheel bearing spindle (12).
- (c) Remove oil seal (24) from wheel bearing spindle (12).
- (d) If damaged, remove bushing (25) from wheel bearing spindle (12).



**b. Cleaning. See Cleaning Instructions (Para 2-12).**

**9-6. REAR PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

*c. Inspection.* See Inspection Instructions (Para 2-14).

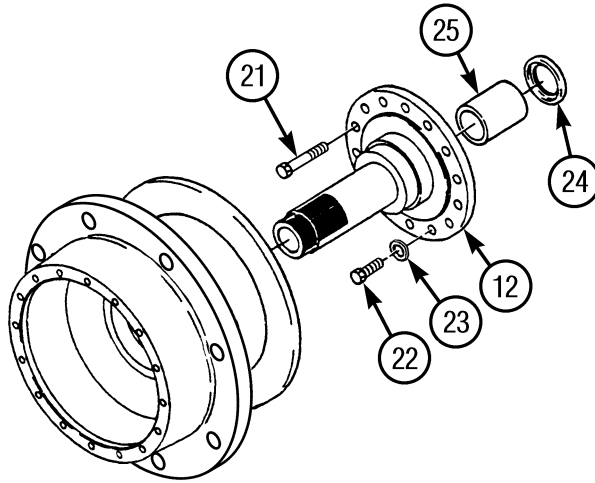
*d. Installation.*

**(1) Assemble spindle (12) parts (21 through 25).**

- (a) If removed, install bushing (24) into wheel bearing spindle (12) until top of bushing is flush or just below bottom of bore for seal (25).
- (b) Install oil seal (25) to bottom of spindle bearing spindle (12) bore.

**(2) Install wheel bearing spindle (12) parts (21 through 25).**

- (a) Apply a thin film of gear lubricating oil to lips of oil seal (25) and bore of bushing (24) in wheel bearing spindle (12) bore, and oil seal journal on axle shaft short end.



**CAUTION**

Inner oil seal and bushing in bore of spindle could be damaged when sliding spindle past axle splines. Install spindle carefully to avoid damaging bushing inner oil seal. Failure to do so could cause premature component failure.

- (b) Install wheel bearing spindle (12).

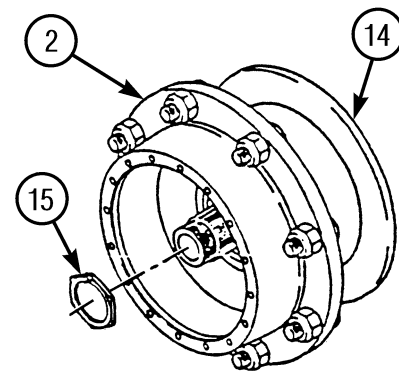
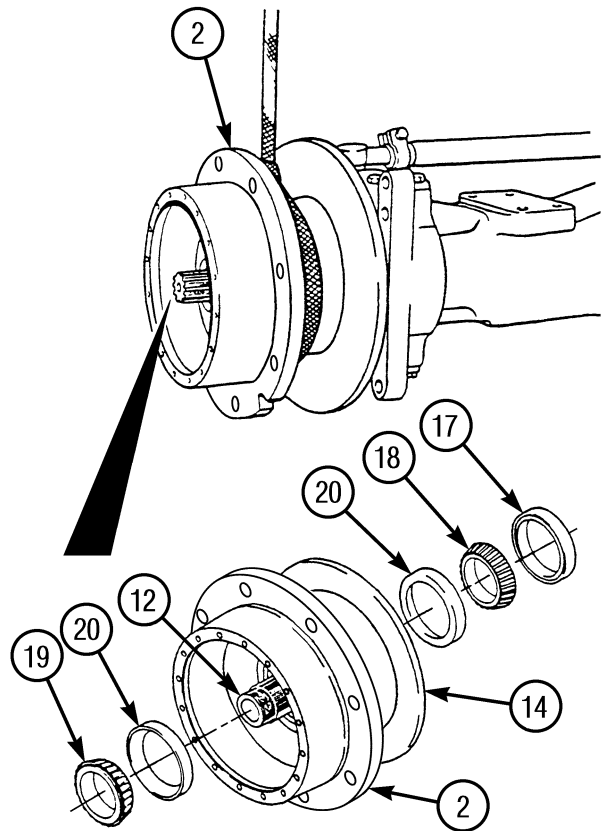
**NOTE**

Install two shorter screws at two top holes and two screws at bottom two holes on wheel bearing spindle flange.

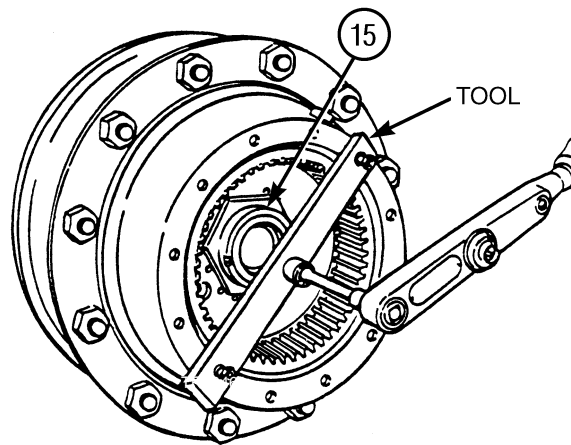
- (c) Install 10 screws (21), four screws (22), and 14 washers (23) on wheel bearing spindle (12). Tighten screws (21 and 22) to 150 lb-ft (203.37 N•m).

**(3) Install wheel hub and disc assembly (14) parts (15 through 20).**

- (a) Install two bearing cups (20) with a suitable driving sleeve into wheel hub (2).
- (b) Place wheel hub and disc assembly (14) on floor or bench with the brake disc up.
- (c) Apply a thin film of gear lubricating oil to inner bearing (18) and install in inner bearing cup (20).
- (d) Install oil seal (17) using a suitable driver on wheel bearing spindle (12).
- (e) Use a sling and hoist or other suitable lifting device to support weight of wheel hub and disc assembly (14).
- (f) Apply a thin film of gear lubricating oil to inside diameter of oil seal (17) and to oil seal journal surface of wheel bearing spindle (12).
- (g) Align wheel hub and disc assembly (14) with wheel bearing spindle (12) and push wheel hub and disc assembly onto spindle.
- (h) Install outer bearing cone (19) in outer bearing cup (20).
- (i) Install nut (15) and draw wheel hub and disc assembly (14) into position while rotating wheel hub (2).



**9-6. REAR PLANETARY WHEEL ENDS REPLACEMENT (CONT)**



**(4) Preload wheel bearings.**

- (a) Seat bearings and related components by tightening the nut (15) to 100 lb-ft (135.58 N•m) while wheel hub (2) is rotated in both directions.
- (b) Back off nut (15) to relieve preload on bearings. Torque on nut should be 0 lb-ft (0 N•m).
- (c) Use fabricated hub drag tool and a torque wrench to check rolling torque while hub is rotating at a steady rate (not starting torque). Record torque.
- (d) Tighten nut (15) and check hub rolling torque again. The increase in rolling torque from zero preload should be 3 - 5 lb-ft (4.07 - 6.78 N•m) for new bearings.

**NOTE**

If bearings are to be reused, the increase in rolling torque should be 1.5 - 2.5 lb-ft (2.03 - 3.39 N•m).

**(5) Install planetary ring gear (10) and sun gear (9) on wheel hub (2).**

- (a) Install dowel pin (16) in nut (15).
- (b) Locate hole (A) on back of planetary ring gear (10). Orient ring gear with respect to dowel pin (16) on nut (15).

**NOTE**

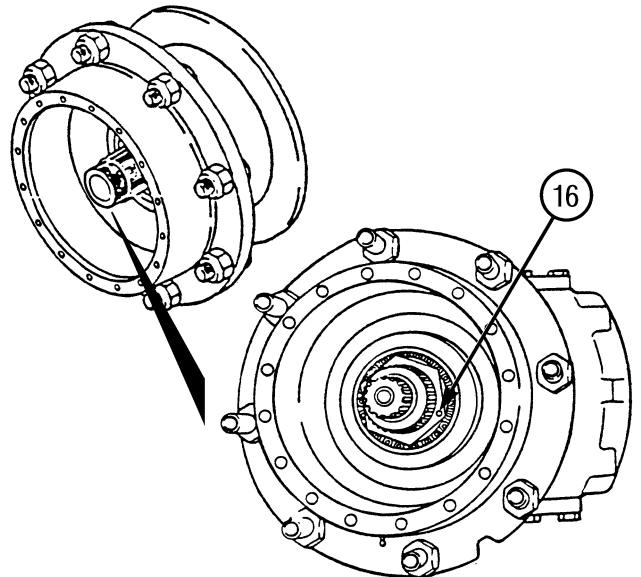
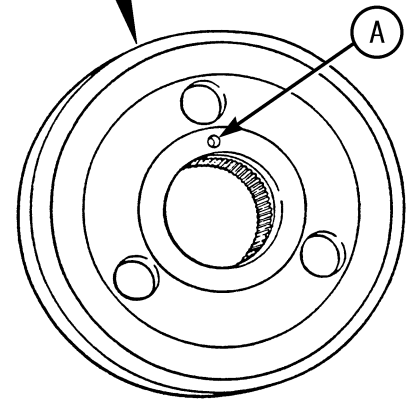
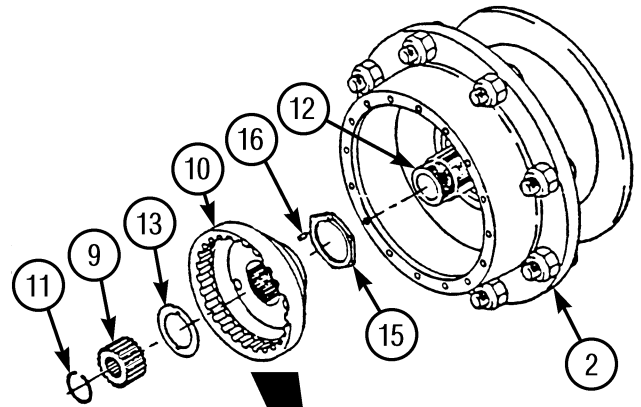
- If pin is not aligned with hole (A) of ring gear, spider assembly will not fit tight to wheel hub.
- It may be necessary to turn nut (15) to match hole (A) on back of planetary ring gear. Hub bearing nut may be tightened to match dowel pin (16) with planetary ring gear, but torque on hub bearing nut should not exceed 150 lb-ft (203.37 N•m).

- (c) Install planetary ring gear (10).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

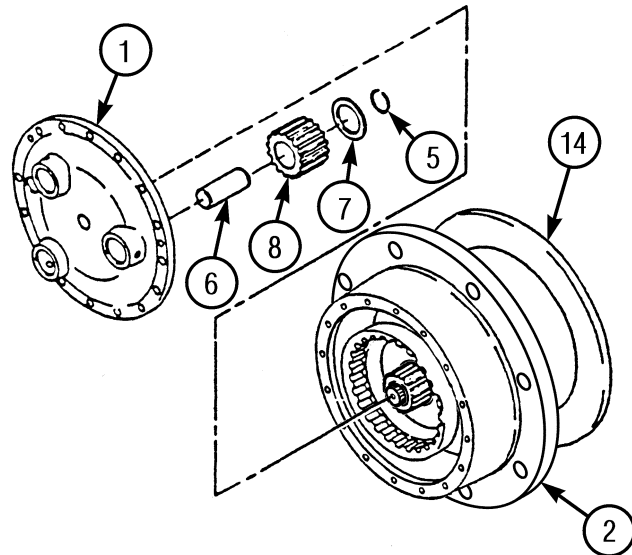
- (d) Install washer (13), sun gear (9), and snap ring (11). Tangs on washer must engage slots in ring gear (10).



**9-6. REAR PLANETARY WHEEL ENDS REPLACEMENT (CONT)**

**(6) Assemble planetary spider (1) parts (5 through 8).**

- (a) Apply a thin film of gear lubricating oil to bore of planetary gear (8). Slide planetary gear and washer (7) onto planetary pinion shaft (6).



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Install snap ring (5) onto planetary pinion shaft (6).
- (c) Repeat Steps (a) and (b) for second and third sets of planetary gears (8), washers (7), and snap rings (5).

**(7) Install planetary gear assemblies.**

- (a) Remove dirt, grease, or moisture from the mating surfaces of planetary spider (1) flange and wheel hub (2) mounting face.
- (b) Dry both surfaces.

**WARNING**

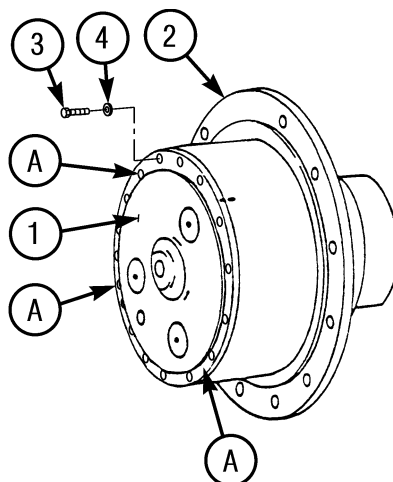
Adequate ventilation should be provided when silicone RTV-732 clear sealing compound is applied in confined areas. Failure to do so could cause respiratory irritation, headaches and nausea. Eye contact with silicone RTV-732 clear sealing compound may cause irritation; if eye contact takes place, flush eyes with water for 15 minutes and have eyes examined by a doctor.

- (c) Apply a continuous bead of silicone RTV-732 clear sealing compound approximately 1/8 in. (3.175 mm) in diameter completely around the hub mounting face and around the inner edge of all fastener holes to assure complete sealing and prevent leakage.

**NOTE**

Assemble components immediately to permit silicone RTV-732 clear sealing compound to spread evenly. Failure to do so could cause axle to leak.

- (d) Start planetary spider (1) onto wheel hub (2), aligning teeth of planetary gears (8) with sun gear (9) and ring gear (10) teeth.



- (e) Align the match marks on the planetary spider flange and wheel hub as previously marked during removal.
- (f) Align holes on wheel hub (2) with holes on planetary spider (1) flange and push spider assembly against wheel hub.
- (g) Install 16 screws (3) and washers (4) on planetary spider (1) and wheel hub (2). Tighten screws to 60 - 75 lb-ft (81.35 - 101.69 N•m).

#### NOTE

Follow-on Maintenance:

- Fill planetary wheel ends with lubricant (TM 10-3930-673-20).
- Install rear disc brake assembly (Para 10-3).
- Install wheel assembly (TM 10-3930-673-20).

**END OF TASK**





## CHAPTER 10

### BRAKE SYSTEM MAINTENANCE

Para	Contents	Page
Section I. Description and Data		
10-1.	General .....	10-1
10-2.	Principles of Operation.....	10-1
Section II. Brake System Maintenance Procedures		
10-3.	Disc Brake Assembly Replacement/Repair .....	10-3
10-4.	Brake Control Valve Repair .....	10-9
10-5.	Parking Brake Seals Replacement.....	10-16

#### Section I. DESCRIPTION AND DATA

#### 10-1. GENERAL

This chapter covers maintenance procedures for the service brake system components, as well as principles of operation.

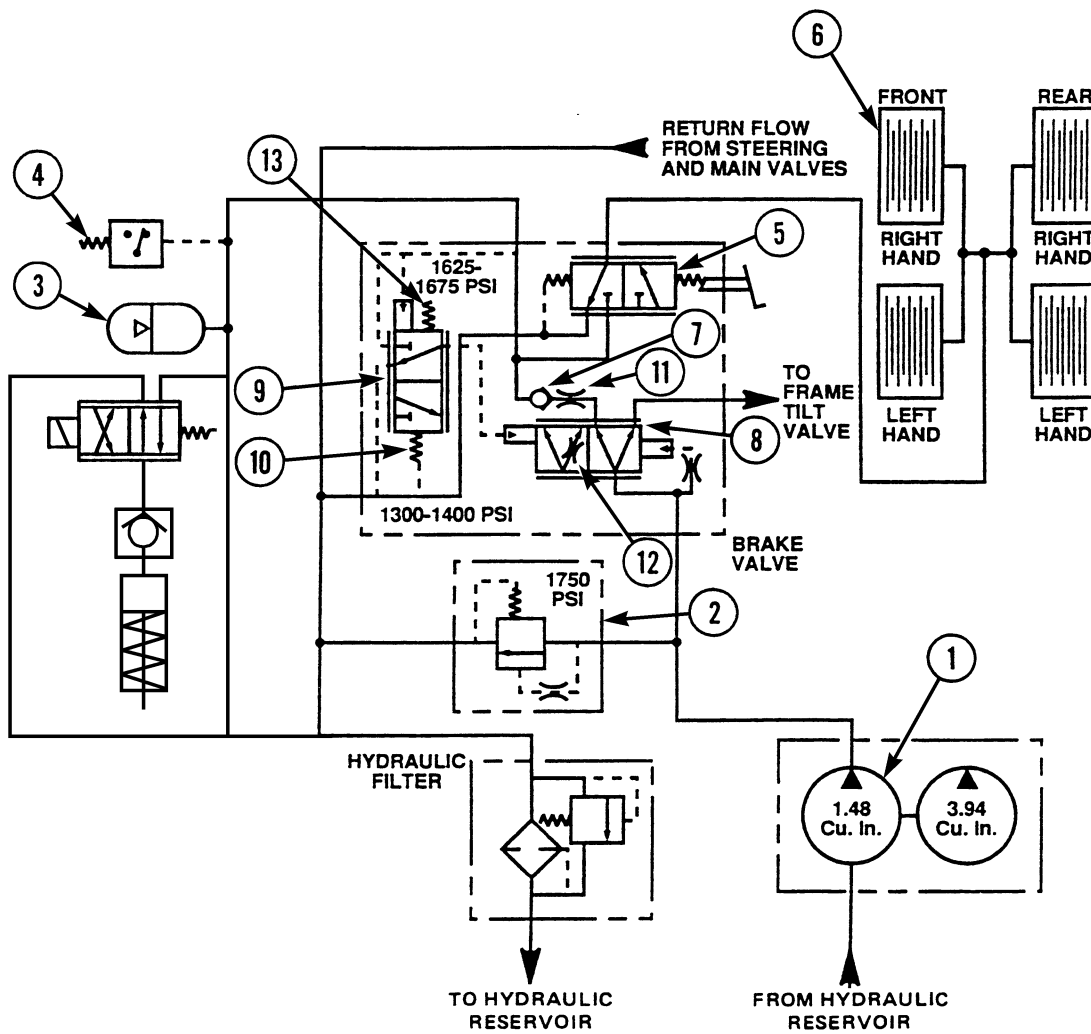
#### 10-2. PRINCIPLES OF OPERATION

**a. General.** Hydraulic fluid to operate the service brakes is drawn from the main hydraulic reservoir by the small (1.48 cu. in. [0.024 lt]) section (1) of the dual gear pump. The frame tilt circuit is supplied by the same pump section. Protection for the circuit is provided by relief valve (2), which is designed to bypass when circuit pressure reaches 1750 psi (12066.25 kPa).

Pressure to operate the brakes is supplied by accumulator (3). Pump (1) flow is used in the brake circuit solely to maintain the accumulator charge. Pressure switch (4) is used to monitor brake circuit operating pressure and turns on the LOW BRAKE PRESSURE warning light in the cab if pressure drops to below approximately 650 psi (4481.75 kPa).

**b. Accumulator Charging Cycle.** Force to operate the service brakes is produced by the precharge pressure in the accumulator (3). When the brake foot pedal is depressed, a path is completed from accumulator (3) through ball valve (5) to wheel brakes (6). Pressure exerted by the accumulator is applied equally to the cylinders of all four wheel brakes (6). The path between accumulator (5) and pump (1) is blocked at this time by check valve (7), which is seated by accumulator pressure. Check valve (7) will remain seated as long as accumulator pressure is higher than pump pressure. Charging valve (8) will then be in the position shown, and all flow from pump (1) will pass through charging valve (8) and the frame tilt valve (not shown) back to the reservoir. When, during brake operation, accumulator pressure drops below a preset pressure established by design of pilot valve (9), charging valve (8) must be shifted to permit recharging of the accumulator. When accumulator pressure reaches its lower limit, pilot spring (10) will force the spool in pilot valve (9) upward (as shown). Accumulator pressure is then applied through ports in pilot valve (9) to the left end of the spool in charging valve (8), shifting the spool to the right (as shown). Since pump pressure is higher than accumulator pressure at this time, check valve (7) will be unseated and pump flow is permitted through the charging valve ports and check valve (7) to the bottom of accumulator (3). Orifice (11) in the check valve seat restricts the rate of flow to accumulator (3). Orifice (12) in charging valve (8) limits flow to frame tilt circuit while charging valve (8) is shifted to allow accumulator recharging.

10-2. PRINCIPLES OF OPERATION (CONT)



When accumulator pressure again reaches its upper limit, accumulator pressure combined with force of spring (13) will overcome the force of spring (10) and shift pilot valve (9) spool downward (as shown). This will remove accumulator pressure from the left end of charging valve (8) spool and permit pump pressure to again shift charging valve spool to the left (as shown). Check valve (7) will again be seated by higher accumulator pressure and block the path between pump (1) and accumulator (3).

## Section II. BRAKE SYSTEM MAINTENANCE PROCEDURES

### 10-3. DISC BRAKE ASSEMBLY REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Shop Equipment, Automotive Maintenance and  
Repair; Field Maintenance, Basic, Less Power  
(Item 18, Appendix D)  
Cap and Plug Set (Item 1, Appendix D)  
Micrometer (Item 13, Appendix D)

##### *Equipment Condition*

Service brake shoes removed  
(TM 10-3930-673-20)

##### *Materials/Parts*

Cloth, Emery (Item 9, Appendix B)  
Compound, Sealing (Item 43, Appendix B)  
Compound, Sealing (Item 44, Appendix B)  
Oil, Lubricating, Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Tags (Item 55, Appendix B)  
Packings, Preformed (2)  
Packings, Preformed (4)  
Ring, Back-Up (4)  
Wood Block

**10-3. DISC BRAKE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

*a. Removal.*

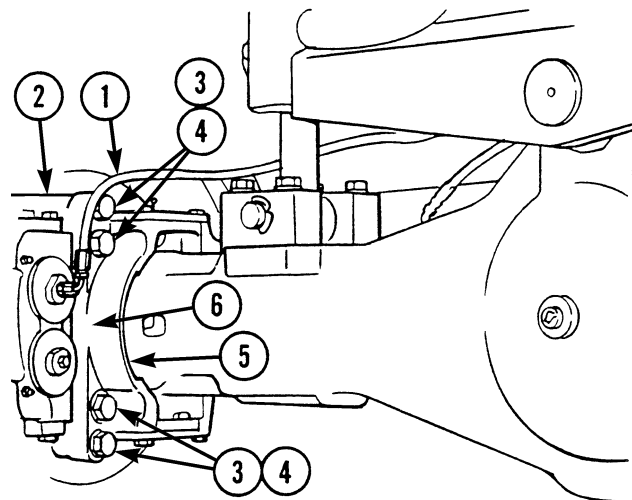
**WARNING**

Always use blocks, jackstands, or other rigid, stable supports when working beneath raised equipment. Ensure that hoists or jacks are in good condition. Never use frayed, twisted, or pinched cables. Never use bent or distorted hooks. Failure to follow this precaution could result in severe personal injury or machine damage.

**CAUTION**

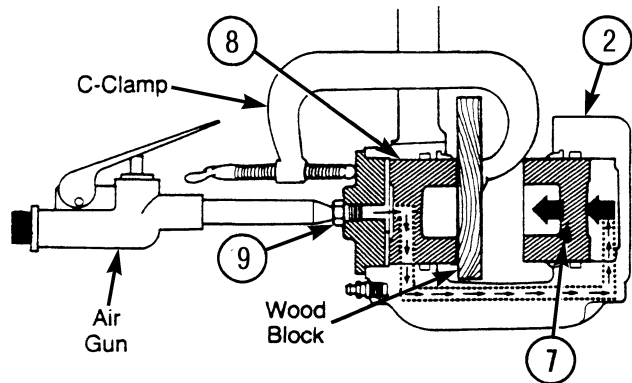
Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

- (1) **Tag, mark, and disconnect brake (1) from brake housing (2).**
- (2) **Remove four screws (3) and washers (4) from brake housing (2) and drive wheel spindle (5).**
- (3) **Remove disc brake caliper (6) from drive wheel spindle (5).**
- (4) **Repeat Steps (1) through (3) for other disc brakes calipers.**



*b. Disassembly.*

- (1) **Remove two pistons (7) from brake housing (2) side opposite the mounting plate.**
  - (a) Use C-clamp to hold a 1/2 in. (12.7 mm) wood block against two pistons (8) on mounting side of brake housing (2).

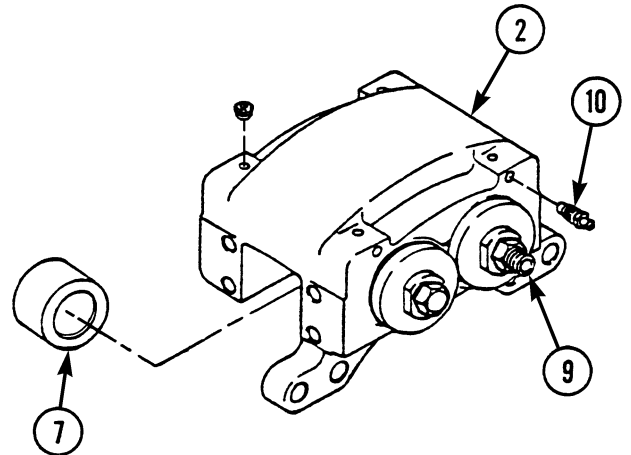


## WARNING

- Do not put hands in front of the pistons when forcing out the pistons. Failure to follow this precaution could result in severe personal injury.
- DO NOT exceed 30 psi (206.85 kPa) nozzle pressure when drying parts with compressed air. Always wear safety glasses. Do not direct compressed air against human skin. Failure to follow these instructions may result in **SERIOUS INJURY** or **DEATH**.

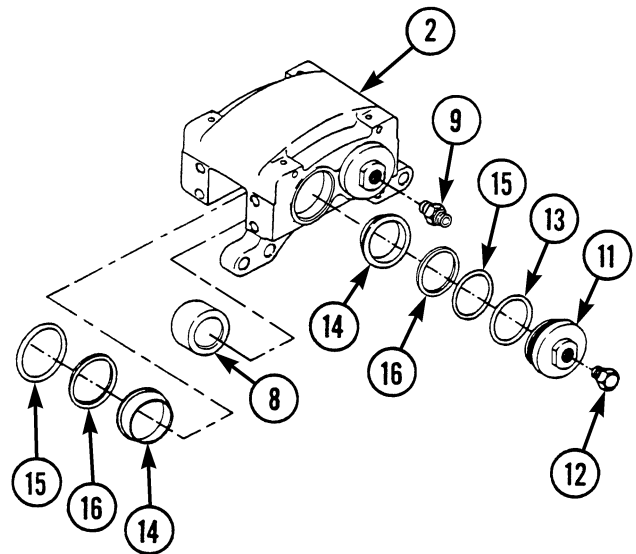
- (b) Use compressed air at inlet fitting (9) to force pistons (7) out of brake housing (2). Place a piece of wood in front of the piston that comes out first so other piston will be forced out.
- (c) Remove two pistons (7) from brake housing (2) piston bores opposite from mounting plate.

- (2) **Remove two bleeder screws (10) from brake housing (2).**



- (3) **Remove two cylinder heads (11) from brake housing (2).**

- (a) Remove plug (12) and fitting (9) from two cylinder heads (11).
- (b) Use an open-end wrench on the two flat areas on top of cylinder head (11). Remove two cylinder heads from brake housing (2).
- (c) Remove preformed packings (13) from each cylinder head (11). Discard preformed packings.



- (4) **Use wood block or dowel and push on two pistons (8) to force pistons out from mounting side of brake housing (2) towards disc side.**

- (5) **Remove four dust seals (14) from brake housing (2).**

- (6) **Remove and discard four preformed packings (15) and back-up rings (16).**

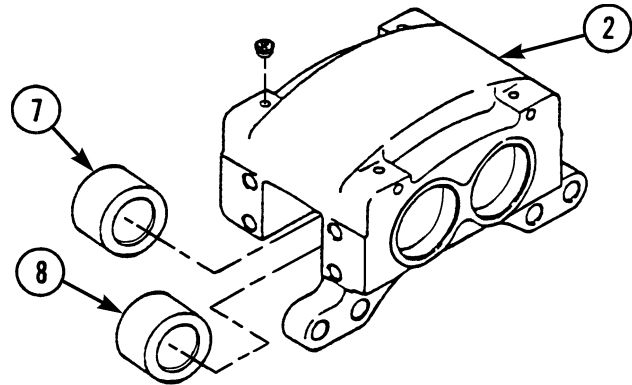
**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**10-3. DISC BRAKE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

**d. Inspection.**

**(1) Inspect pistons (7 and 8).**

- (a) Inspect pistons (7 and 8) for scratches and rust. Use emery cloth to remove small scratches and rust. Discard parts if there are large scratches or amounts of rust.
- (b) Measure outer diameter of pistons (7 and 8). Discard pistons if the outer diameter is less than 2.995 in. (76.07 mm).



**(2) Inspect brake housing (2).**

- (a) Inspect piston bores and ring grooves in brake housing (2) for scratches and rust. Use emery cloth to remove small scratches and rust. Discard brake housing if there are large scratches or amounts of rust.
- (b) Measure inner diameter of piston bores in brake housing (2). Discard brake housing if inner diameter of bore is more than 3.003 in. (76.28 mm).

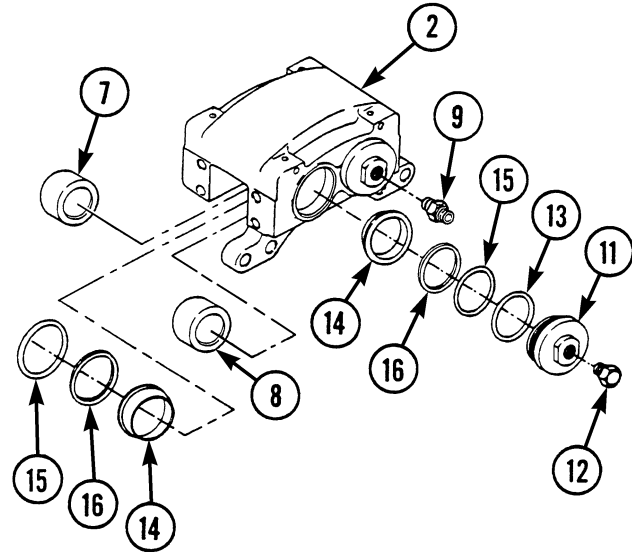
**e. Assembly.**

**WARNING**

Use only specified parts when assembling the disc brake caliper. Do not mix parts from other disc brakes calipers. If installing the wrong parts, the disc brake will not operate correctly and could result in severe personal injury and equipment damage.

**NOTE**

Wipe all sealing surfaces on disc brake caliper clean and dry. Apply film of clean hydraulic oil to all seals, pistons, and bores as parts are installed.



**(1) Install four back-up rings (16), preformed packings (15), and dust seals (14) in brake housing (2).**

- (a) Install four back-up rings (16) and preformed packings (15) in middle groove of each bore. Back-up rings are installed toward lining side of brake housing (2). Preformed packings are installed towards outside of brake housing.
- (b) Install four dust seals (14) in inner groove of brake housing (2) bore.

**(2) Install pistons (7 and 8) in brake housing (2).**

- (a) Install pistons (7 and 8) in from lining side of brake housing (2).
- (b) Ensure that pistons (7 and 8) are straight in brake housing (2) bores. Push each piston into housing bore until top of piston is even with top of dust seal (13).

**(3) Install two cylinder heads (11) in brake housing (2).**

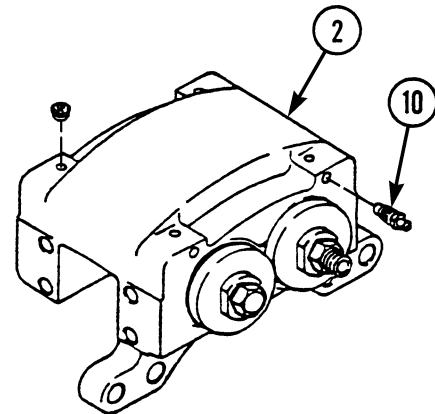
- (a) Install preformed packings (13) on two cylinder heads (11). Ensure that preformed packings are not cut by threads on cylinder head.
- (b) Install two cylinder heads (11) in brake housing (2). Tighten cylinder heads to 75 lb-ft (101.69 N•m).

**WARNING**

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

- (c) Apply sealing compound to threads of plug (12) and fitting (9) and install plug and fitting in two cylinder heads (11).

**(4) Install two bleeder screws (10) in brake housing (2).**



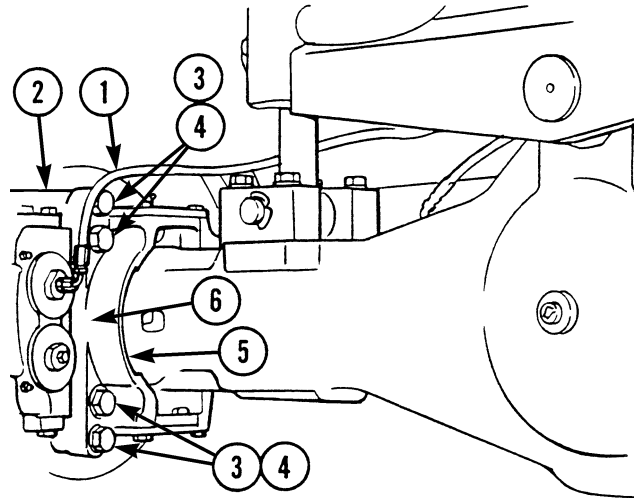
**10-3. DISC BRAKE ASSEMBLY REPLACEMENT/REPAIR (CONT)**

*f. Installation.*

**NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on disc brake clean and dry.

- (1) Position disc brake caliper (6) on drive wheel spindle (5) and disc.**
  - (a) Check proper location of disc brake caliper (6) in relation with disc.
  - (b) Verify that disc is centered between disc brake housing (2).



**WARNING**

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

- (2) Apply sealing compound on threads of four screws (3). Install four washers (4) and screws (3) on brake housing (2) and drive wheel spindle (5). Tighten screws to 280 lb-ft (379.63 N•m).**
- (3) Connect brake (1) to brake housing (2).**

**NOTE**

Follow-on Maintenance:

- Install service brake shoes (TM 10-3930-673-20).
- Check to see that linings are free to move.
- Bleed air from brakes (TM 10-3930-673-20).

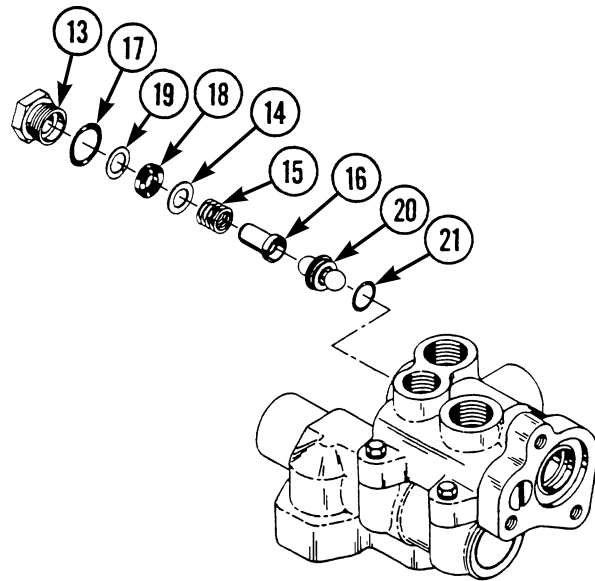
**END OF TASK**



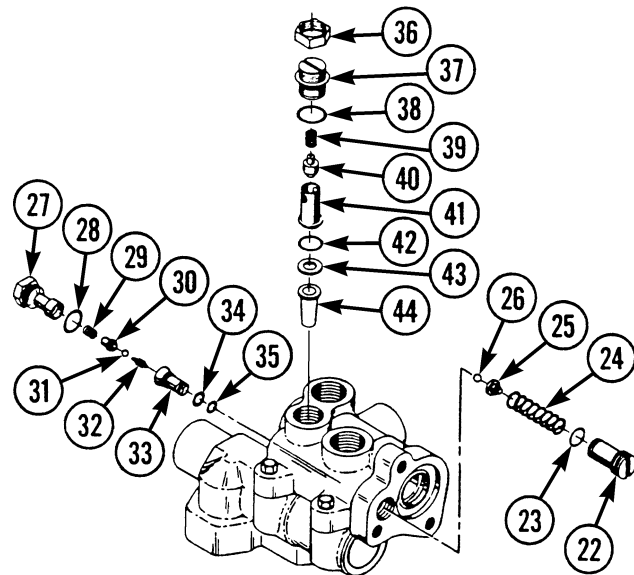


**10-4. BRAKE CONTROL VALVE REPAIR (CONT)**

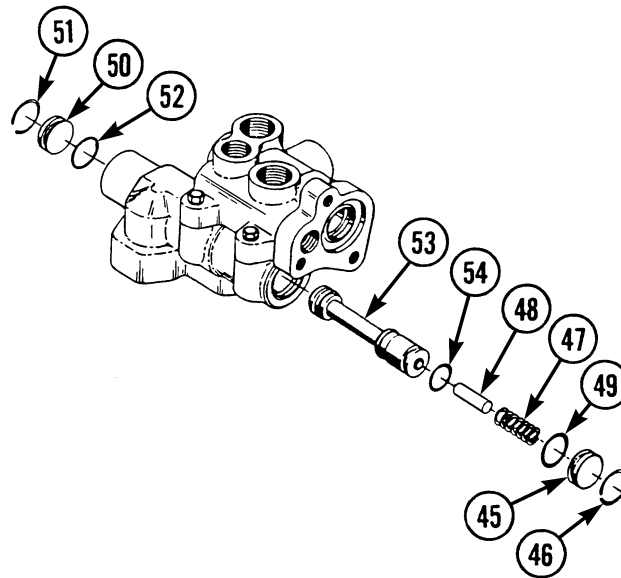
- (h) Remove plug (13).
- (i) Remove washer (14), spring (15), and guide (16).
- (j) Remove and discard preformed packing (17), cup (18), and back-up ring (19).
- (k) Remove valve and ball assembly (20).
- (l) Remove preformed packing (21) from valve and ball assembly (20). Discard preformed packing.



- (m) Count and record number of turns required to remove plug and locking pin assembly (22) and preformed packing (23) during removal. Discard preformed packing.
- (n) Remove spring (24), seat (25), and ball (26).
- (o) Remove plug (27) and preformed packing (28). Discard preformed packing.
- (p) Remove spring (29), stop (30), ball (31), spool (32), and insert (33).
- (q) Remove preformed packings (34 and 35) from insert (33). Discard preformed packings.



- (r) Remove nut (36) and adjusting screw (37).
- (s) Remove preformed packing (38) from adjusting screw (37). Discard preformed packing.
- (t) Remove spring (39), poppet (40), seat (41), preformed packing (42), washer (43), and filter (44). Discard poppet, preformed packing, and filter.



**WARNING**

Plug is under tension of spring. Use care when removing retaining ring to prevent personal injury.

- (u) Depress plug (45) and remove retaining ring (46).
- (v) Remove plug (45), spring (47), and stop (48).
- (w) Remove preformed packing (49) from plug (45). Discard preformed packing.
- (x) Depress plug (50) and remove retaining ring (51).
- (y) Remove plug (50) and preformed packing (52). Discard preformed packing.

**CAUTION**

Use extreme care when removing spool. Do not force spool at any time during removal. Failure to follow this precaution will result in part damage.

**NOTE**

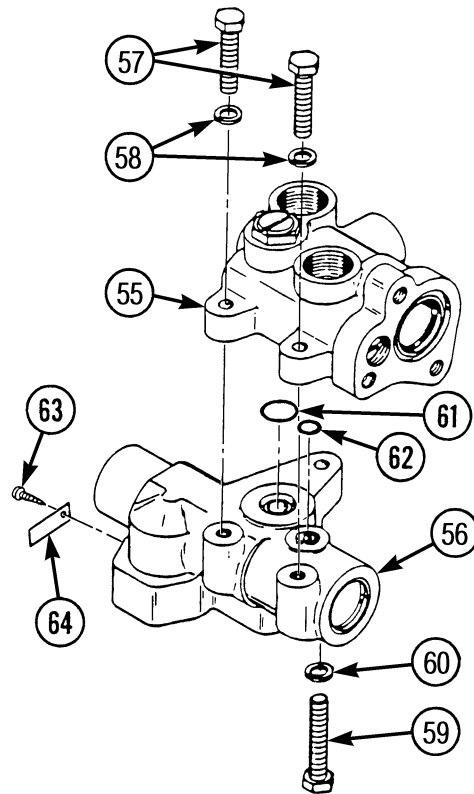
The spool can be guided out of valve by reaching into either large port on bottom.

- (z) Remove spool (53) and preformed packing (54). Discard preformed packing.

**10-4. BRAKE CONTROL VALVE REPAIR (CONT)**

**(2) Separate and disassemble control housing (55) from charging section (56).**

- (a) Remove two screws (57) and lockwashers (58). Discard lockwashers.
- (b) Remove screw (59) and lockwasher (60). Discard lockwasher.
- (c) Separate control housing (55) from charging section (56).
- (d) Remove preformed packings (61 and 62) from charging section (56). Discard preformed packings.
- (e) If damaged, remove two screws (63) and label (64) from charger section (56).

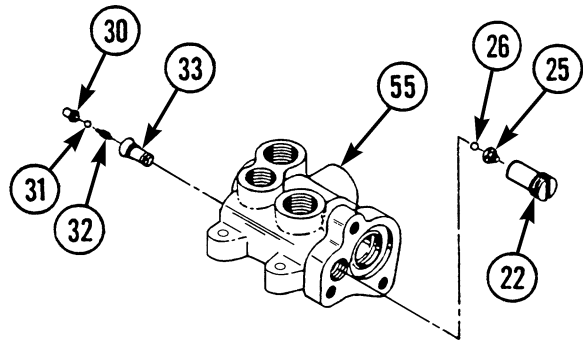


**b. Cleaning. See Cleaning Instructions (Para 2-12).**

**c. Inspection.**

**(1) Measure spool (32) and balls (26 and 31).**

- (a) Assemble spool (32) inside insert (33). Place balls (26 and 31) in respective seats. Measure across balls (26 and 31) with a micrometer. Record measurement.
- (b) Remove spool (32) and place balls (26 and 31) on their respective seats (25 and 30). Measure with a micrometer.
- (c) Subtract smaller dimension from larger dimension. If difference is less than 0.004 in. (0.10 mm), replace spool (32).



**(2) Inspect plug and locking pin assembly (22).**

- (a) The plug (22) has a nylon pin through threaded end so that plug will hold adjustment to which it is set. Screw plug into control housing (55).
- (b) Check to see if nylon pin has sufficient friction with threads to keep plug (22) from vibrating loose.
- (c) If there is no increase in torque required to turn plug (22) when pin engages threads, replace pin.

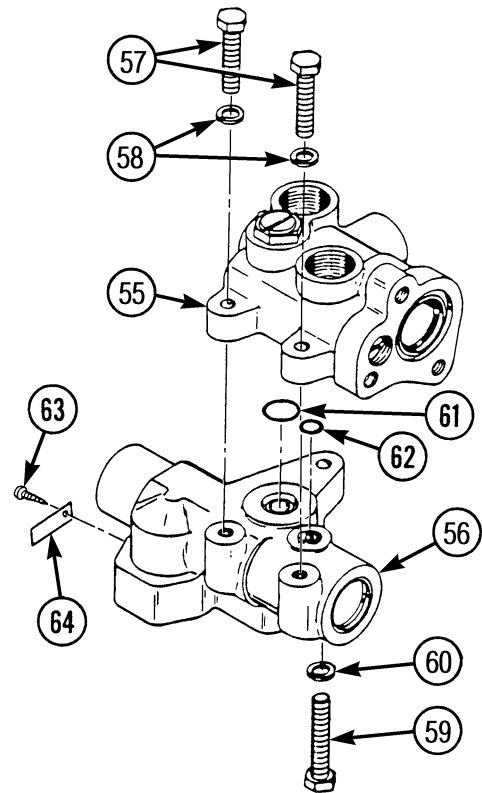
**d. Assembly.**

**NOTE**

Wipe all sealing surfaces on pump clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**(1) Assemble control housing (55) to charging section (56).**

- (a) If removed, install label (64) and two screws (63) on charging section (56).
- (b) Install preformed packings (61 and 62) in charging section (56).
- (c) Assemble control housing (55) to charging section (56).
- (d) Install lockwasher (60) and screw (59) in control housing (55) and charging section (56). Tighten screw to 22 - 27 lb-ft (29.83 - 36.61 N•m).
- (e) Install two lockwashers (58) and screws (57) in control housing (55) and charging section (56). Tighten screws to 22 - 27 lb-ft (29.83 - 36.61 N•m).



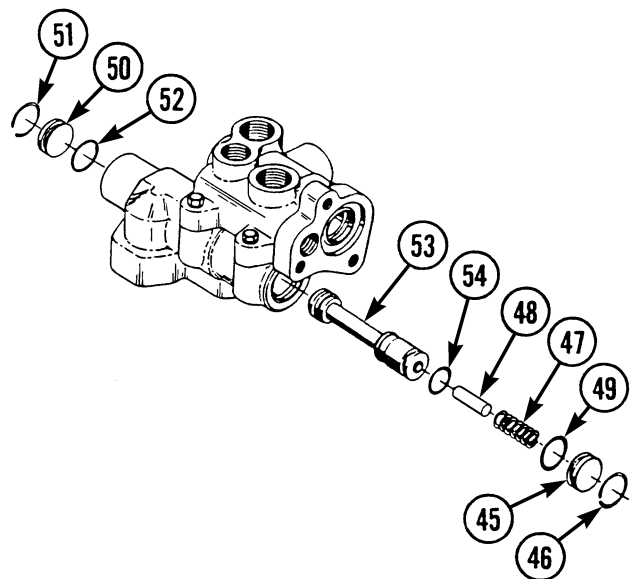
**(2) Assemble internal parts (1 through 54) of brake control valve.**

- (a) Install preformed packing (52) on plug (50) and install plug with retaining ring (51).

**CAUTION**

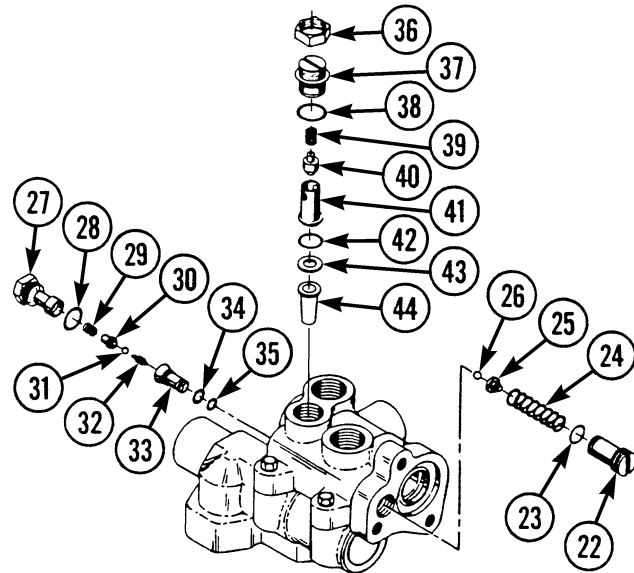
Use care to prevent damage to lands on spool and inside bore. Do not force spool into valve. Failure to follow this precaution will cause part damage.

- (b) Install preformed packing (54) on spool (53). Insert spool into valve bore. Ensure that spool is oriented correctly. Ensure that spool makes contact with plug (50) on opposite side of brake control valve.
- (c) Install stop (48) and spring (47).
- (d) Install preformed packing (49), plug (45), and retaining ring (46).



**10-4. BRAKE CONTROL VALVE REPAIR (CONT)**

- (e) Install filter (44), washer (43), preformed packing (42), seat (41), poppet (40), and spring (39).
- (f) Install preformed packing (38), and adjusting screw (37). Tighten screw to 15 - 20 lb-in. (1.69 - 2.26 N•m).
- (g) Install nut (36) and tighten to 15 - 20 lb-ft (20.34 - 27.12 N•m).
- (h) Install preformed packings (34 and 35) on insert (33). Use a wooden dowel to push insert into brake control valve.
- (i) Install spool (32) into insert (33). Insert the short end of spool first.
- (j) Install ball (31). Ensure that ball rests on insert (33).



- (k) Apply grease on end of spring (29) to hold stop (30) in place. Install stop and spring.
- (l) Install preformed packing (28) and plug (27). Tighten plug to 40 - 50 lb-ft (54.23 - 67.79 N•m).

**CAUTION**

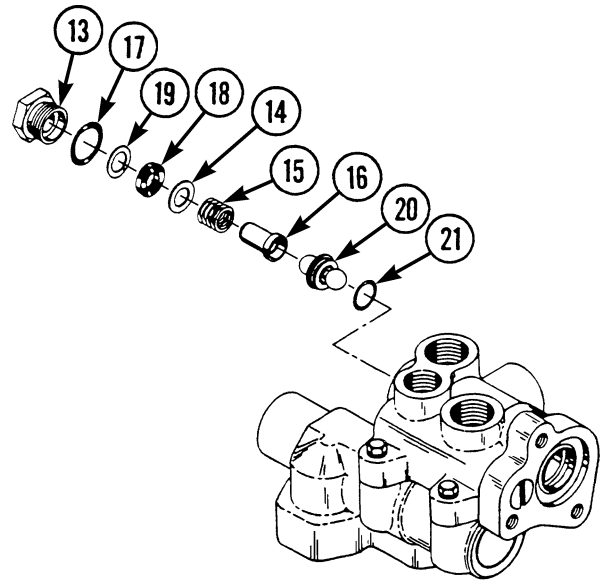
Ensure that ball is on seat before proceeding. Failure to do so could cause part damage.

- (m) Apply grease to hold ball (26) and seat (25) to spring (24). Install ball, seat, and spring.

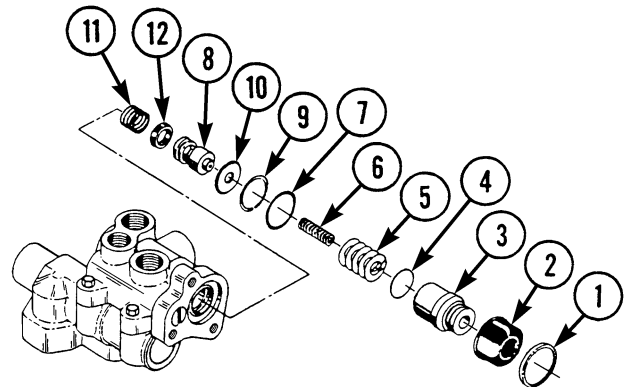
**NOTE**

- The maximum accumulator pressure is adjusted by turning plug. The high pressure limit is increased by turning plug into valve. The low pressure limit is decreased by turning plug out from valve.
  - Ensure that plug is installed by turning plug same number of times as recorded during disassembly.
- (n) Install preformed packing (23) and plug (22).

- (o) Install preformed packing (21) and valve and ball assembly (20).
- (p) Install cup (18) and back-up ring (19) in plug (13).
- (q) Install preformed packing (17) on plug (13).
- (r) Install guide (16), spring (15), and washer (14) in plug (13).
- (s) Install plug assembly (13) and tighten to 40 - 50 lb-ft (54.23 - 67.79 N•m).



- (t) Install cup (12), spring (11), and piston (8).
- (u) Install washer (10).
- (v) Install retaining ring (9).
- (w) Install preformed packing (7), springs (5 and 6), shim or shims (4), and piston (3).
- (x) Install boot (2) and retaining ring (1).



**NOTE**

Follow-on Maintenance: Install brake control valve (TM 10-3930-673-20).

**END OF TASK**

## 10-5. PARKING BRAKE SEALS REPLACEMENT

This Task Covers:

- |             |                |
|-------------|----------------|
| a. Removal  | c. Inspection  |
| b. Cleaning | d. Replacement |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

*Equipment Condition*

Parking brake removed from vehicle  
(TM 10-3930-673-20-2, Para 12-2)

*Materials/Parts*

Repair/Seal Kit  
Oil, Lubricating, Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)

**a. Removal.**

**(1) Remove brake cover (3).**

- (a) Place brake in soft jawed vise with cover in vertical position.
- (b) Loosen four capscrews (1) evenly and in order (A, B, C, D).
- (c) Remove capscrews (1), lockwashers (2), and cover (3).
- (d) Remove seal (4) from cover (3).

**(2) Remove Belleville springs (5).**

Note stacking sequence of springs.

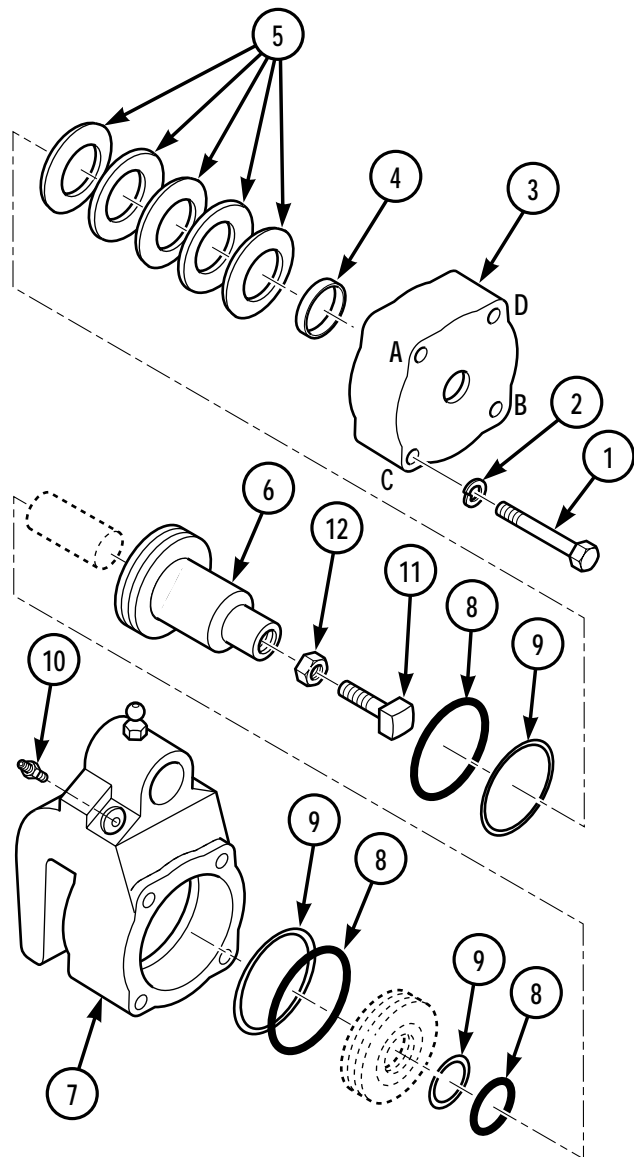
**(3) Remove adjusting screw (11) and locknut (12) from piston (6).**

**(4) Remove piston (6) from brake housing bore (7).**

- (a) Remove piston (6) from housing bore (7).
- (b) Remove preformed packings (8).
- (c) Remove backup rings (9).

**(5) Remove bleeder screw (10).**

**(6) Clean all parts and housing thoroughly and keep free of contaminants.**





**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Replacement.**

- (1) Lubricate all rubber components from seal or repair kit with clean fluid used in system.
- (2) Install new bleeder screw (10) and torque to approximately 10 lb-ft (13.6 N•m).
- (3) Install piston (6) in brake housing bore (7).
  - (a) Install new backup rings (9).
  - (b) Install new preformed packings (8).
  - (c) Install piston (6) in housing bore (7).
- (4) Fully lubricate threads of adjusting screw (11) and locknut (12) and install into piston (6).
- (5) Install Belleville springs (5).
- (6) Install brake cover (3), lockwashers (2), and four capscrews (1) in order (D, C, B, A).

#### **NOTE**

Follow-on Maintenance: Install parking brake (TM 10-3930-673-20-2, Para 12-2).



# CHAPTER 11

## WHEEL AND TIRE SYSTEM MAINTENANCE

Para	Contents	Page
Section I. Description and Data		
11-1.	General .....	11-1
11-2.	Description and Data .....	11-1
Section II. Wheel and Tire Maintenance Procedures		
11-3.	Tire Repair .....	11-1

### Section I. DESCRIPTION AND DATA

**11-1. GENERAL**

This chapter covers maintenance procedures for the wheels and tires, and provides general description and design data.

**11-2. DESCRIPTION AND DATA**

**a. Tires.** All four tires are identical in size and type (17.50-25 x 12 ply L-2). Recommended inflation pressure for the front and rear tires is 65 psi (448.18 kPa).

**b. Wheels.** The wheels are of four-piece construction, each consisting of a wheel (rim), a flange, a locking ring, and a preformed packing. The preformed packing provides a seal against air leakage. The flange, locking ring, and preformed packing are placed to the inside when wheel is mounted.

### Section II. WHEEL AND TIRE MAINTENANCE PROCEDURES

**11-3. TIRE REPAIR**

For tire repair refer to TM 9-2610-200-14.



## CHAPTER 12

### STEERING SYSTEM MAINTENANCE

Para	Contents	Page
Section III. Description and Data		
12-1.	General . . . . .	12-1
12-2.	Principles of Operation . . . . .	12-1
Section IV. Steering System Maintenance Procedures		
12-3.	Drive Wheel Spindle Replacement/Adjustment . . . . .	12-3
12-4.	Emergency Steering Pump Repair . . . . .	12-9
12-5.	Steering Control Valve Repair . . . . .	12-10
12-6.	Tie Rod Replacement . . . . .	12-15

### Section III. DESCRIPTION AND DATA

**12-1. GENERAL**

This chapter covers maintenance procedures for the steering system components, as well as principles of operation.

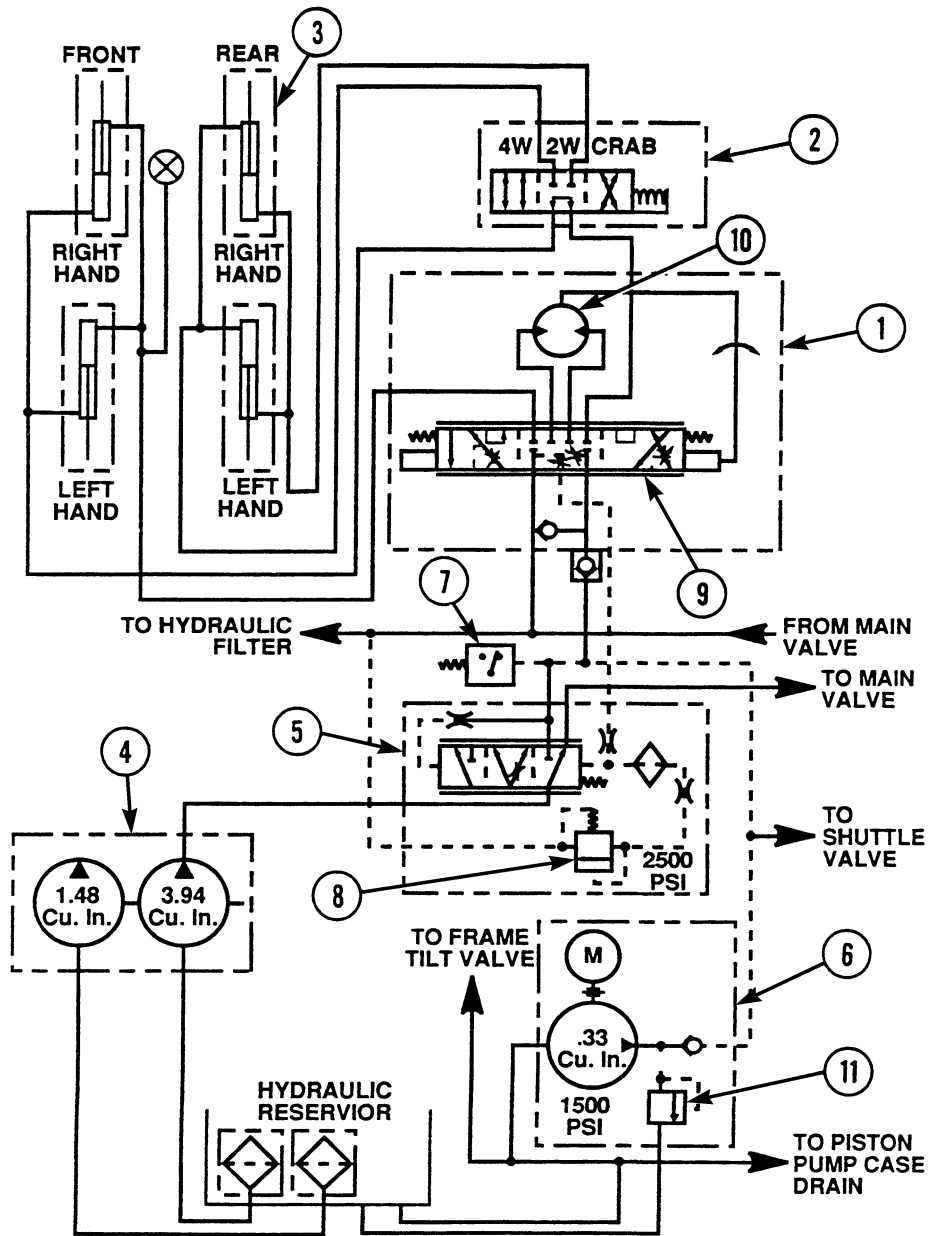
**12-2. PRINCIPLES OF OPERATION**

**a. System Components.** The steering system components include steering valve (1), steer select valve (2), and four steering hydraulic cylinders (3). Additional, related components include the large (3.94 cu. in.) section of dual gear pump (4) and priority valve (5). Making up the emergency steering system are an electric motor driven pump (6) and pressure switch (7). Pressure switch (7) senses hydraulic pressure in the main steering circuit and closes to turn on the emergency steering pump motor and a warning light in the cab when main system pressure drops to below approximately 75 psi (517.13 kPa).

**b. Normal System Operation.** Hydraulic flow from the large section of dual gear pump (4) is directed to the inlet port of priority valve (5). The function of priority valve (5) is to ensure that sufficient oil flow goes to steering valve (1) to permit normal steering in the event that any attachment functions are being operated at the same time that steering is occurring. The priority valve (5) will deprive the attachment functions of oil flow in order to maintain adequate flow for steering. Component overpressure protection is provided by relief valve (8) which is built into priority valve (5).

As long as the steering wheel is not being turned, sleeve and spool assembly (9) remains centered and gerotor (10) remains stationary. Priority valve (5) will then direct pump flow to the main control valve. The pressure resulting from the blocking condition of the centered steering valve sleeve and spool assembly (9) keeps priority valve (5) shifted to the right (as shown) to permit flow to the main valve. The steering cylinders (3) are held stationary by trapped oil in the lines.

Turning the steering wheel in either direction will cause the spool in sleeve and spool assembly (9) to rotate with respect to the sleeve. As this happens, oil is allowed to flow through passages in sleeve and spool assembly (9) to gerotor (10). This oil flow causes the gear in gerotor (10) to rotate, directing flow back to sleeve and spool assembly (9). The redirected flow now exits sleeve and spool assembly (9) via the proper work port



and goes to steer select valve (2). Steer select valve (2) ports oil flow to steering cylinders (3) according to the selected steering condition (two-wheel, four-wheel, or crab). If two-wheel steering has been selected, only the two front steering cylinders (3) are supplied. If four-wheel steering or crab steering has been selected, all four steering cylinders are supplied.

**c. Emergency Steering Function.** Emergency steering pump (6) is powered by an electric motor and can supply a flow of oil to the steering system independently of the main hydraulic system. If main steering hydraulic pressure is lost or drops below a level of 75 psi (517.13 kPa), pressure switch (7) will close and complete a circuit to energize the emergency steering pump motor. Emergency steering pump flow bypasses priority valve (8) and goes directly to the inlet port of steering valve (1). A 1500 psi (10343 kPa) relief valve (11) is used to protect the emergency steering pump (6) and other circuit components against overpressure.

## Section IV. STEERING SYSTEM MAINTENANCE PROCEDURES

### 12-3. DRIVE WHEEL SPINDLE REPLACEMENT/ADJUSTMENT

This Task Covers:

- |             |                 |               |
|-------------|-----------------|---------------|
| a. Removal  | c. Inspection   | e. Adjustment |
| b. Cleaning | d. Installation |               |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Dial Indicator (Item 3, Appendix D)  
Feeler Gauge (Item 8, Appendix D)

##### *Equipment Condition*

Planetary wheel ends removed  
(Para 8-6 or Para 9-6)  
Tie rod removed (Para 12-6).

##### *Materials/Parts*

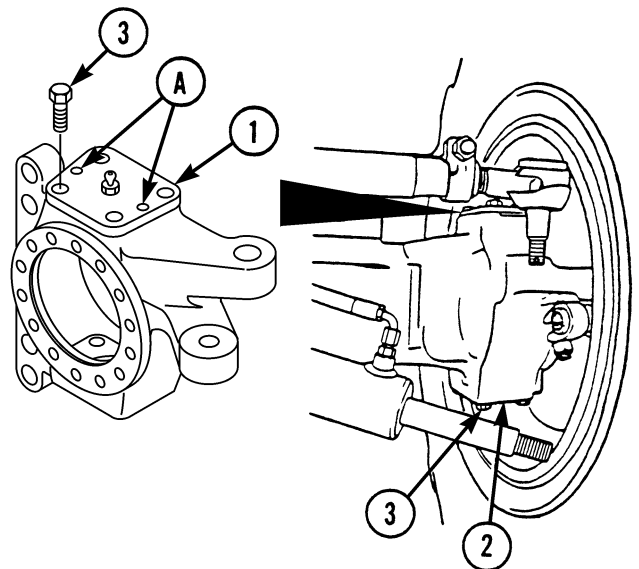
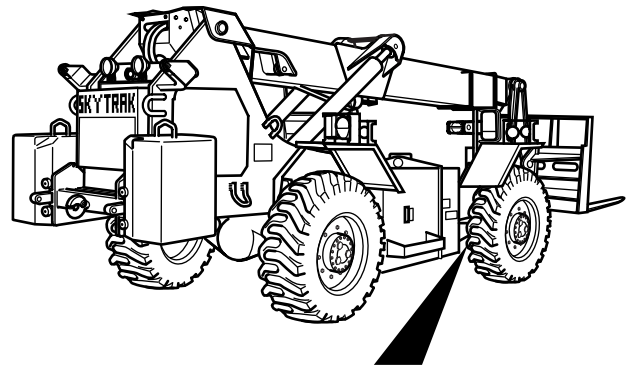
Compound, Sealing (Item 42, Appendix B)  
Grease (Item 18, Appendix B)

#### a. Removal.

#### NOTE

- Right and left side drive wheel spindles are removed the same way. Right side is shown.
- Upper and lower drive wheel spindle caps are not interchangeable.

- (1) **Mark upper and lower drive wheel spindle caps (1 and 2).**
- (2) **Remove four screws each (3) from upper and lower drive wheel spindle caps (1 and 2).**
- (3) **Install jacking screws in holes (A). Tighten jacking screws to loosen upper and lower drive wheel spindle caps (1 and 2).**

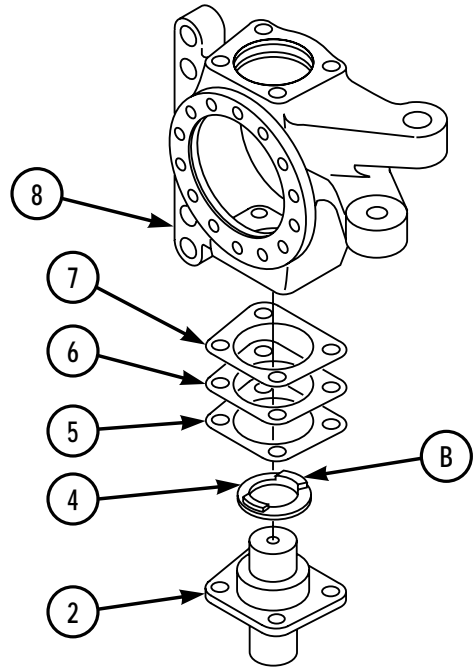


**12-3. DRIVE WHEEL SPINDLE REPLACEMENT/ADJUSTMENT (CONT)**

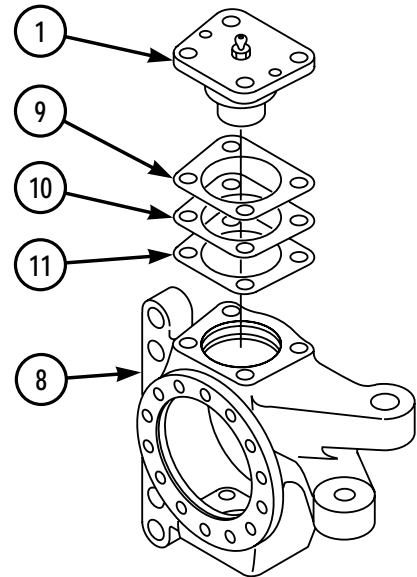
**NOTE**

Do not mix upper and lower shims.  
Keep shims together as a set for  
ease in assembly.

- (4) **Remove lower drive wheel spindle cap (2), thrust washer (4), and shims (5, 6, and 7) from drive wheel spindle (8).**

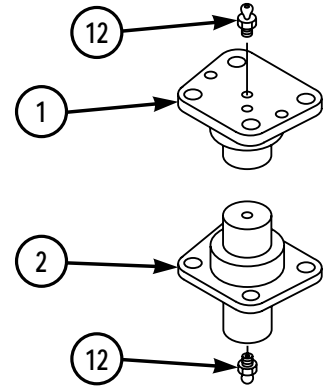


- (5) **Remove upper drive wheel spindle cap (1) and shims (9, 10, and 11) from drive wheel spindle (8).**





- (6) Remove lubrication fittings (12) from upper and lower drive wheel spindle caps (1 and 2).



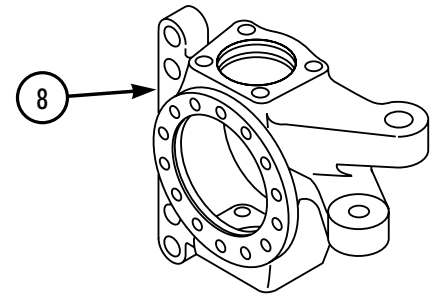
- (7) Remove drive wheel spindle (8) from axle housing end.

*b. Cleaning.* See Cleaning Instructions (Para 2-12).

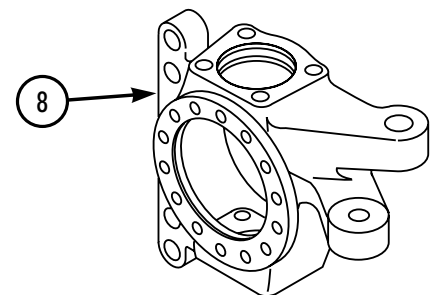
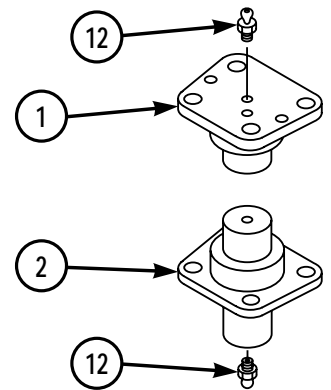
*c. Inspection.* See Inspection Instructions (Para 2-14).

*d. Installation.*

- (1) Install lubrication fittings (12) on upper and lower drive wheel spindle caps (1 and 2).



- (2) Apply thick coating of grease in bores of drive wheel spindle (8).
- (3) Install drive wheel spindle (8) on end of axle.



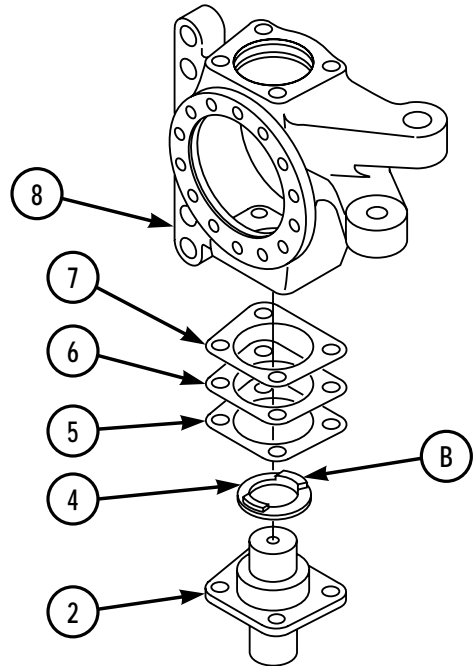
**12-3. DRIVE WHEEL SPINDLE REPLACEMENT/ADJUSTMENT (CONT)**

**(4) Install lower drive wheel spindle cap (2) on drive wheel spindle (8).**

- (a) Apply grease to groove face of thrust washer (4).

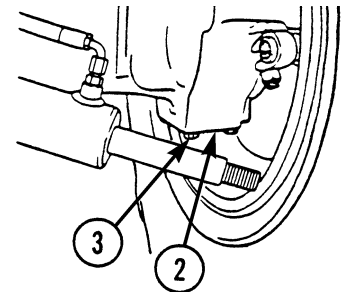
**NOTE**

- Tabs on thrust washer must be up.
  - Ensure that tabs on thrust washer engage slots in axle housing ends.
- (b) Install shim (5, 6, and 7) and thrust washer (4) on lower drive wheel spindle cap (2).
- (c) Install lower drive wheel spindle cap (2), thrust washer (4), and shims (5, 6, and 7) as an assembly on drive wheel spindle (8) and axle housing end. Ensure tabs (B) on thrust washer are facing up.



**WARNING**

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



- (d) Apply sealing compound to threads of four screws (3). Install screws in lower drive wheel spindle cap (2). Tighten screws to 85 - 115 lb-ft (115.24 - 155.92 N•m).

- (5) **Install upper drive wheel spindle cap (1) on drive wheel spindle (8).**
- (a) Install shims (9, 10, and 11) on upper drive wheel spindle cap (1).
  - (b) Install upper drive wheel spindle cap (1) and shims (9, 10, and 11) as an assembly on drive spindle (8).

**WARNING**

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

- (c) Apply sealing compound to threads of four screws (3). Install screws in upper drive wheel spindle cap (1). Tighten screws to 85 - 115 lb-ft (115.24 - 155.92 N•m).

- (6) **Install tie rod (Para 12-6).**
- (7) **Adjust tie rod (TM 10-3930-673-20).**

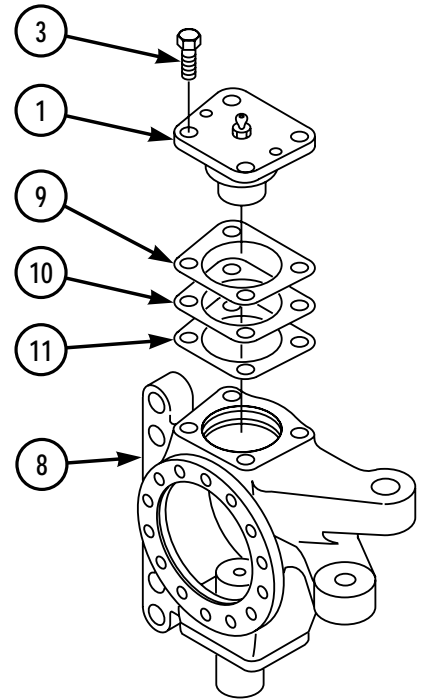
**e. Adjustment.**

(1) **Measure vertical end play.**

- (a) If wheels are on ground: Use a feeler gauge to measure gap between upper drive wheel spindle cap shoulder and top machined surface of end of the axle housing.
- (b) If wheels are removed (axle supported by blocks): Use a hydraulic jack or pry bar to push drive wheel spindle up until bottom of drive wheel spindle is tight against bottom of axle. Measure gap as in Step (a).
- (c) Vertical end play may also be measured by checking maximum vertical movement of knuckle with a dial indicator.
- (d) Record measurement.

(2) **Vertical end play limits:**

- (a) If end play is 0.013 in. (0.33 mm) or less, no adjustment is necessary.
- (b) If vertical end play exceeds 0.013 in. (0.33 mm), go to Step (3).



**12-3. DRIVE WHEEL SPINDLE REPLACEMENT/ADJUSTMENT (CONT)**

**(3) Adjust vertical end play.**

- (a) Remove upper and lower drive wheel spindle caps. Measure total current shim pack thickness (upper and lower shim packs combined).
- (b) Subtract actual end play (value obtained in Step (1)) from total shim pack thickness obtained in Step (2)(a). Divide this result by two.
- (c) Make new lower shim thickness the same value as calculated in Step (2)(b). If this thickness cannot be met exactly, choose nearest thicker shim pack.
- (d) Make new upper shim thickness the same as value obtained in Step (2)(b), plus 0.005 in. (0.13 mm). If this result cannot be met exactly, choose nearest thicker shim pack.

**NOTE**

Follow-on Maintenance: Install planetary wheel ends (Para 8-6 or Para 9-6).

**END OF TASK**



## 12-5. STEERING CONTROL VALVE REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

*Tools and Special Tools*

Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

*Equipment Condition*

Emergency steering control valve removed  
(TM 10-3930-673-20)

*Materials/Parts*

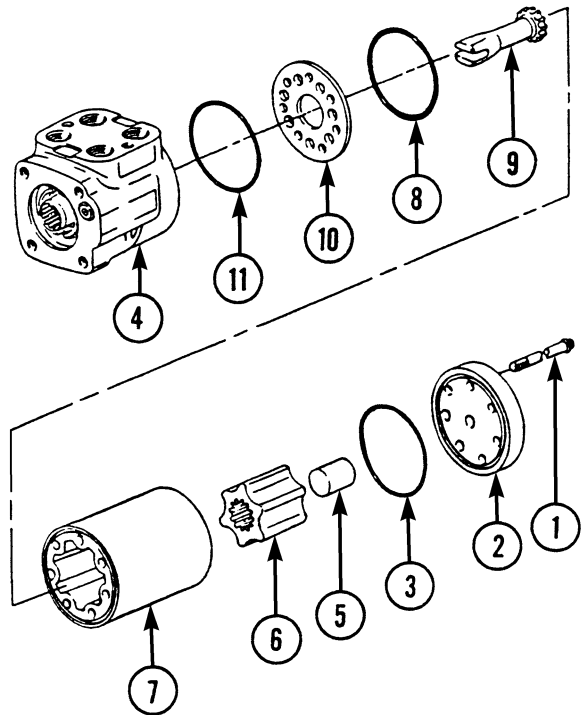
Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Seal  
Seal  
Seal  
Seal  
Seal  
Seal  
Seal

**a. Disassembly.**

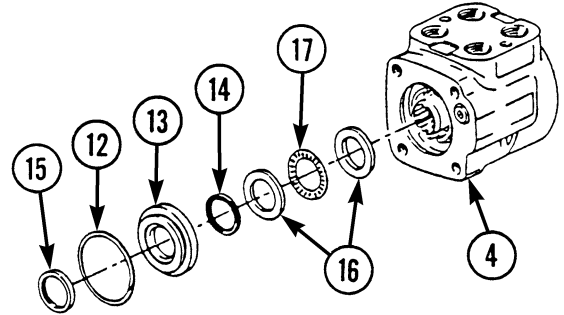
**CAUTION**

Take care not to contaminate emergency steering pump during disassembly. Dirt and other foreign substances should be removed from surrounding area and pump before disassembling. Failure to follow this precaution may cause damage to equipment.

- (1) **Place steering control valve in a vise with soft jaws, meter end up. Do not overtighten vise.**
- (2) **Disassemble steering control valve parts (1 through 28).**
  - (a) Remove seven screws (1), retaining plate (2), and seal (3) from valve housing (4). Discard seal.
  - (b) Remove spacer (5), star (6), geroter housing (7), and seal (8) from valve housing (4). Discard seal.
  - (c) Remove gear shaft (9) from valve housing (4).
  - (d) Remove retaining plate (10) and seal (11) from valve housing (4). Discard seal.



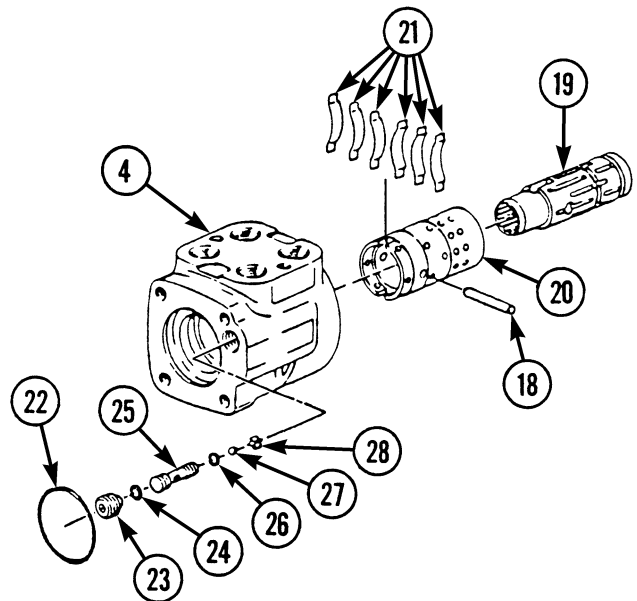
- (e) Reverse valve housing (4) in vise.
- (f) Remove retaining ring (12) from valve housing (4).
- (g) Remove seal gland bushing (13) from valve housing (4).
- (h) Remove quad ring seal (14) and seal (15) from valve housing (4). Discard seal.
- (i) Remove two bearing races (16) and thrust bearing (17) from valve housing (4).



**CAUTION**

Do not bind spool and sleeve in valve housing. Failure to follow this precaution may cause damage to equipment.

- (j) Remove centering pin (18), spool (19), and sleeve (20) as an assembly from valve housing (4).
- (k) Remove centering pin (18) from spool (19) and sleeve (20).
- (l) Push spool (19) out of sleeve (20). Rotate spool slowly to remove it from sleeve.
- (m) Remove centering springs (21) from sleeve (20).
- (n) Remove seal (22) from valve housing (4). Discard seal.
- (o) Remove set screw (23), seal (24), seat (25), seal (26), check ball (27), and retainer (28). Discard seals.



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**12-5. STEERING CONTROL VALVE REPAIR (CONT)**

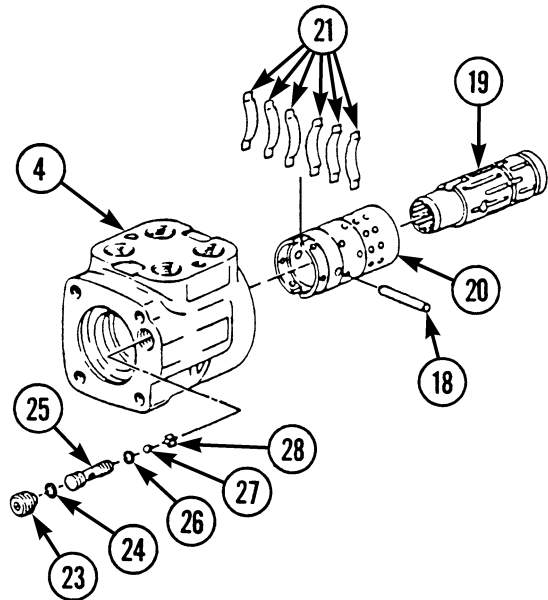
*d. Assembly.*

**NOTE**

Wipe all sealing surfaces on pump clean and dry. Apply film of clean hydraulic oil to all seals, except quad ring seal as installed.

**(1) Assemble steering control valve parts (1 through 28).**

- (a) Install retainer (28), check ball (27), seal (26), seat (25), seal (24), and setscrew (23) in valve housing (4).
- (b) Install centering springs (21) in sleeve (20).
- (c) Assemble spool (19) and sleeve (20) so that spring slots line up at same end. Rotate spool when sliding parts together. Spool should rotate smoothly in sleeve with fingertip force applied at spline end.
- (d) Install centering pin (18) through spool (19) and sleeve (20) assembly until it is flush at both sides of sleeve (20).

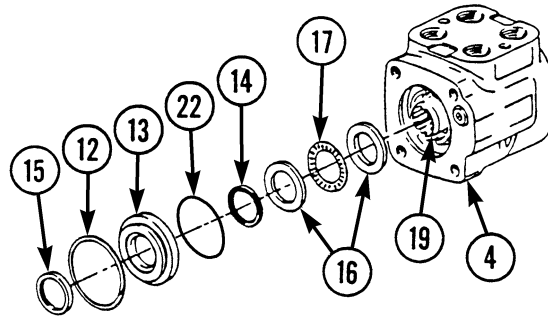


**CAUTION**

Use care when installing centering pin, spool, and sleeve to prevent shifting of parts. Failure to follow this precaution may cause damage to equipment.

- (e) Position centering pin (18), spool (19), and sleeve (20) as an assembly so that spline end of spool enters valve housing (4) end opposite steering column side. Push centering pin, spool, and sleeve assembly into valve housing until flush at gerotor housing end. Do not pull assembly beyond this point to prevent centering pin from dropping into discharge groove of valve housing.
- (f) Check for free rotation of centering pin (18), spool (19), and sleeve (20) by turning with light fingertip force at spline end.





- (g) Install two bearing races (16) and thrust bearing (17) over spool (19).
- (h) Install seal (22) in valve housing (4).

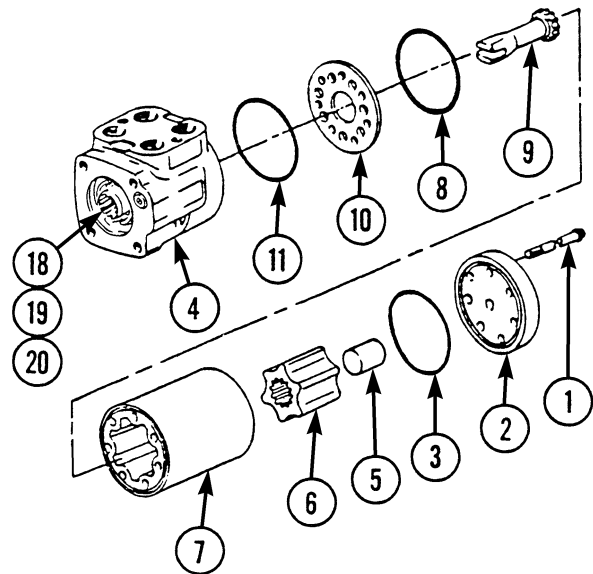
**NOTE**

Do not lubricate quad ring seal.

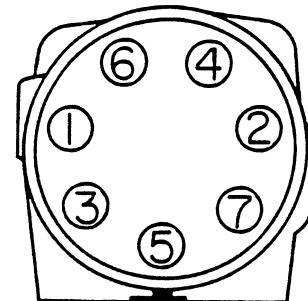
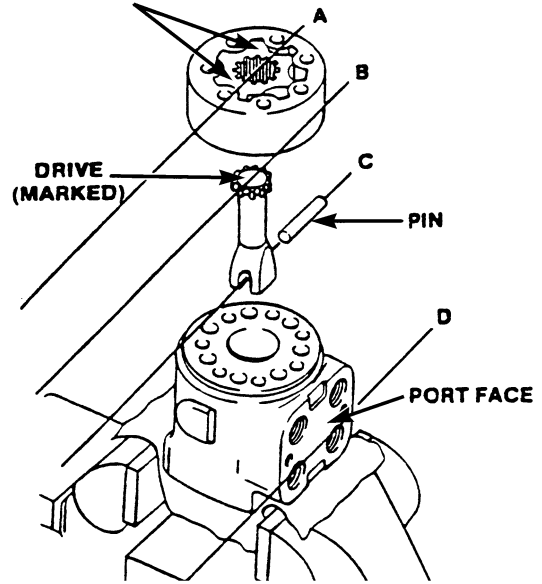
- (i) Install quad ring seal (14) and seal (15) in seal gland bushing (13).
- (j) Install seal gland bushing (13) over spool (19) in valve housing (4).
- (k) Install retaining ring (12) in valve housing (4).
- (l) Reverse valve housing (4) in vise.

**12-5. STEERING CONTROL VALVE REPAIR (CONT)**

- (m) Install seal (11) in valve housing (4).
- (n) Install retaining plate (10). Align screw holes between retaining plate and tapped holes in valve housing (4).
- (o) Rotate spool (19) and sleeve (20) assembly until pin (18) is parallel with port face.
- (p) Install gear shaft (9). Ensure that gear shaft engages centering pin (18).
- (q) Install seal (8) in gerotor housing (7).
- (r) Install gerotor housing (7). Place gerotor housing with seal (8) mating to retaining plate (10). Align valleys between gear shaft (9) and gerotor housing. Note parallel relationship between lines A, B, C, and D.
- (s) Install star (6). Engage star and gear shaft (9) without disturbing relationship of components.
- (t) Install spacer (5) in star (6).
- (u) Install seal (3) in retaining plate (2).
- (v) Install retaining plate (2) on gerotor housing (7) and align holes.
- (w) Install seven screws (1) in retaining plate (2). Pretighten screws to 150 lb-in. (16.95 N•m), then tighten to 275 lb-in. (31.07 N•m) in sequence shown.



**METER (GEROTOR) STAR VALLEY**



**NOTE**

Follow-on Maintenance: Install steering control valve (TM 10-3930-673-20).

**END OF TASK**



**12-6. TIE ROD REPLACEMENT (CONT)**

- (e) Repeat Steps (a through d) for other end of tie rod (7).
- (f) Remove tie rod (7) from vehicle.

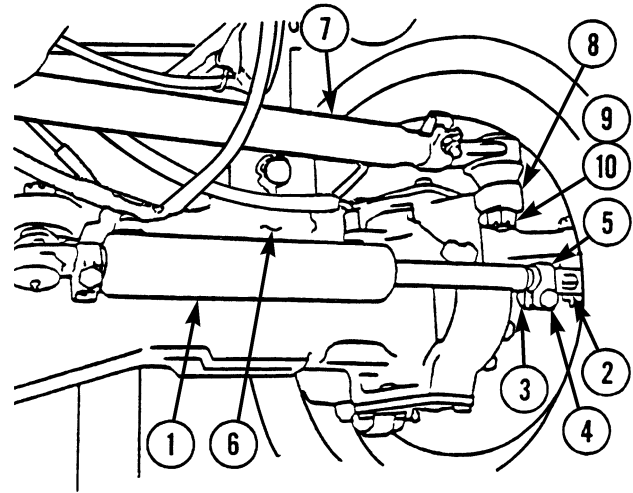
**b. Installation.**

- (1) Connect tie rod (7) to spindle knuckle (8).**

**NOTE**

It may be necessary to turn the wheels slightly when installing tie rod ends.

- (a) Position tie rod (7) ends into holes of steering spindle knuckles (8).
- (b) Install castle nuts (10) on each tie rod (7) end. Tighten castle nuts to 200 - 250 lb-ft (271.16 - 338.96 N•m).
- (c) Further tighten castle nuts (10) as necessary until notches on each nut align with cotter pin hole on each tie rod (7) end.
- (d) Install cotter pins (9) through notches on castle nuts (10) and through holes on tie rod (7) ends.



- (2) Connect rod ends of steering cylinders (1) to ball joints (2).**

- (a) Swing steering cylinder (1) toward axle (6) until steering cylinder rod end is aligned with socket of ball joint (2).
- (b) Screw steering cylinder (1) rod end into socket of ball joint (2) until number of threads visible is the same as noted in **Removal** Step (1)(a).
- (c) Tighten nut (3) and screw (4) of clamp (5) to 50 - 65 lb-ft (67.79 - 88.13 N•m).

- (3) Remove blocking material from wheels of vehicle.**

**NOTE**

Follow-on Maintenance:

- Adjust tie rod (TM 10-3930-673-20).
- Install front or rear axle (Para 8-3 or Para 9-3)
- Install wheels (TM 10-3930-673-20).

**END OF TASK**

# CHAPTER 13

## FRAME AND TOWING ATTACHMENT MAINTENANCE

Para	Contents	Page
	Section I. Description and Data	
13-1.	General .....	13-1
13-2.	Description and Data .....	13-1
	Section II. Frame and Towing Attachment Maintenance Procedures	
13-3.	Frame Assembly Repair .....	13-2

### Section I. DESCRIPTION AND DATA

**13-1. GENERAL**

This chapter covers maintenance procedures for the frame and towing attachment components, as well as descriptive information.

**13-2. DESCRIPTION AND DATA**

The frame is constructed of heavy gauge plate steel. All joints are welded. The boom, counterweight and both axles are pinned to the frame. The cab and body components are secured to the frame using a variety of screws, nuts, and washers.

Openings in the frame provide access to the transmission and engine. Sheet metal covers are attached to the frame over these access openings. The fuel/hydraulic tank, cab, and radiator guard are also attached to the frame.

## Section II. FRAME AND TOWING ATTACHMENT MAINTENANCE PROCEDURES

### 13-3. FRAME ASSEMBLY REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

#### INITIAL SETUP

##### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power (Item 19, Appendix D)  
 Tool Kit, Body and Fender Repair (Item 22, Appendix D)

##### *Equipment Condition*

Engine door panels removed (TM 10-3930-673-20)  
 Engine removed (Para 3-3)  
 Transmission removed (Para 7-4)  
 Cab assembly with ROPS/FOPS removed (Para 14-3)

##### *Equipment Condition (Cont)*

Boom assembly removed (Para 16-11)  
 Front axle removed (Para 8-3)  
 Rear axle removed (Para 9-3)

##### *Materials / Parts*

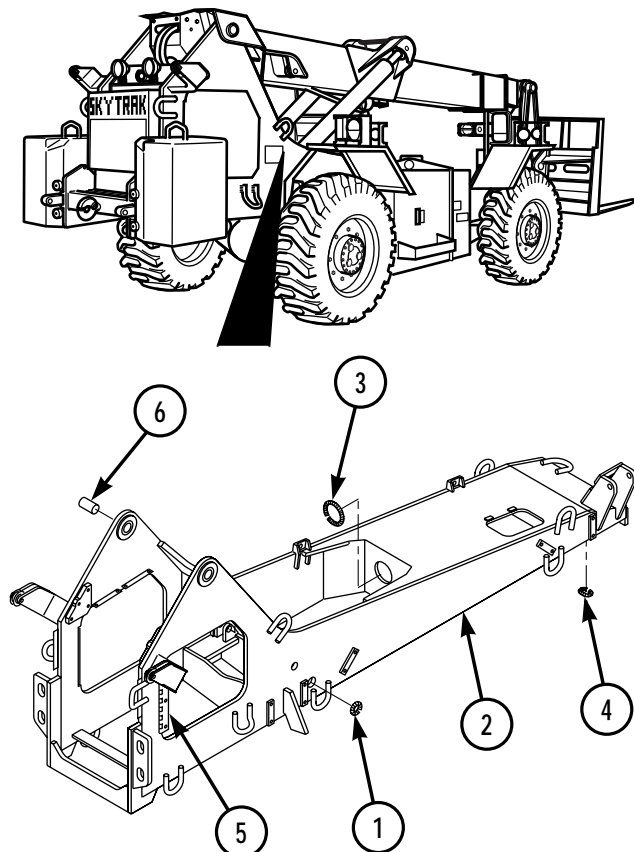
Bushing  
 Conduit (2)  
 Conduit  
 Conduit  
 Hinge

##### *References*

TM 9-237

#### **a. Disassembly.**

- (1) Remove two conduits (1) from frame (2). Discard conduit.
- (2) Remove conduit (3) from frame (2). Discard conduit.
- (3) Remove conduit (4) from frame (2). Discard conduit.
- (4) Remove two hinges (5) from frame (4).
  - (a) Measure location of hinge (5) in frame cutout for door. Record location.
  - (b) Break welds attaching hinge (5) to frame (2).
  - (c) Remove hinge (5) from frame (2). Discard hinge.
  - (d) Use a grinder or file to remove old weld material from frame (2).
- (5) Remove bushing (6) from frame (2).



**b. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**c. Inspection.** See **Inspection Instructions (Para 2-14).**

**d. Assembly.**

**(1) Install bushing (6) in frame (2).**

**(2) Install two hinges (5) on frame (2).**

(a) Position new hinge (5) on frame, using measurements taken at disassembly.

(b) Hold hinge (5) in position, using a suitable clamp.

**CAUTION**

Do not weld door side of hinge to frame. Welding incorrect half of hinge to frame will result in damage to frame and hinge.

(c) Weld hinge (5) to frame (2) at several points along pin side (refer to TM 9-237).

**(3) Install conduit (4) in frame (2).**

**(4) Install conduit (3) in frame (2).**

**(5) Install two conduits (1) in frame (2).**

**NOTE**

Follow-on Maintenance:

- Install rear axle (Para 9-3).
- Install front axle (Para 8-3).
- Install boom assembly (Para 16-11).
- Install cab assembly with ROPS/FOPS (Para 14-3).
- Install transmission (Para 7-4).
- Install engine (Para 3-3).
- Install engine door panels (TM 10-3930-673-20).

**END OF TASK**





## CHAPTER 14

### BODY, CAB AND HOOD MAINTENANCE

Para	Contents	Page
Section I. Description and Data		
14-1.	General .....	14-1
14-2.	Description and Data .....	14-1
Section II. Body, Cab and Hood Maintenance Procedures		
14-3.	Cab Assembly with ROPS/FOPS Replacement/Repair.....	14-2
14-4.	Sound Suppression Panels Replacement.....	14-15

#### Section I. DESCRIPTION AND DATA

**14-1. GENERAL**

This chapter covers maintenance procedures for the body, cab and hood components, as well as component descriptions and data.

**14-2. DESCRIPTION AND DATA**

**a. Cab.** The cab is attached to the left side of the frame. It is fully enclosed, heated and air conditioned. Sound suppression panels are installed for the purpose of reducing outside noises. The cab door is split horizontally, allowing the upper portion to be propped open for cab ventilation. Additional ventilation is provided by a skylight and the rear window, both of which can be propped open. The cab design incorporates both rollover protection (ROPS) and fall over protection (FOPS).

**b. Seat.** The operator's seat is a multiple position seat, with a suspension frame and separate cushions for seat and back. Seat belt is anchored to the seat frame.

**c. Fenders.** Fenders are provided for all four wheels. The frame mounting brackets are attached to the vehicle frame. Light brackets are attached to the tops of the fenders.

## Section II. BODY, CAB AND HOOD MAINTENANCE PROCEDURES

### 14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

#### INITIAL SETUP

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)
- Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power (Item 19, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Tool Kit, Body and Fender Repair (Item 22, Appendix D)
- Lifting Device, 1 ton (907.18 kg) capacity Cab Stands

*Equipment Condition*

- Cooling system drained (TM 10-3930-673-20)
- Hydraulic system drained (TM 10-3930-673-20)
- Batteries removed (TM 10-3930-673-20)

*Equipment Condition (Cont)*

- Hydraulic Joystick removed (TM 10-3930-673-20)
- Transmission cover removed (TM 10-3930-673-20)

*Materials/Parts*

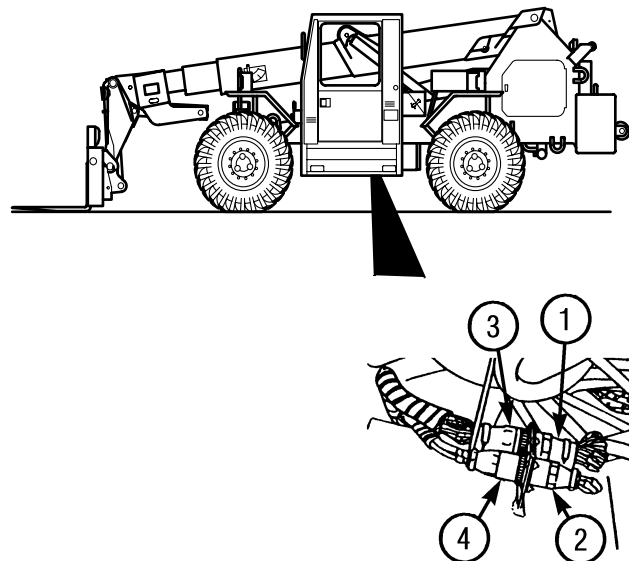
- Compound, Sealing (Item 40, Appendix B)
- Tags (Item 55, Appendix B)
- Starwashers (2)
- Starwashers (2)
- Lockwashers (4)
- Lockwashers (4)
- Washers, Rubber (4)
- Container, 1 gal (3.79 l) capacity

*Personnel Required*

Two

**a. Removal.**

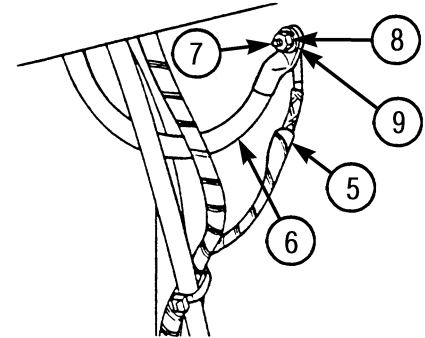
- (1) **Tag, mark, and disconnect cab wiring harness connectors (1 and 2) from cab wiring harness connectors (3 and 4).**



- (2) **Tag, mark, and disconnect STE/ICE shunt (TM 10-3930-673-20).**

- (3) **Tag, mark, and disconnect wiring connector (5) and ground cable (6) from vehicle frame (7) stud.**

Tag, mark, and disconnect wiring connector (5) and ground cable (6). Remove nut (8), washer (9), wiring connector, and ground wire from vehicle frame (7) stud.



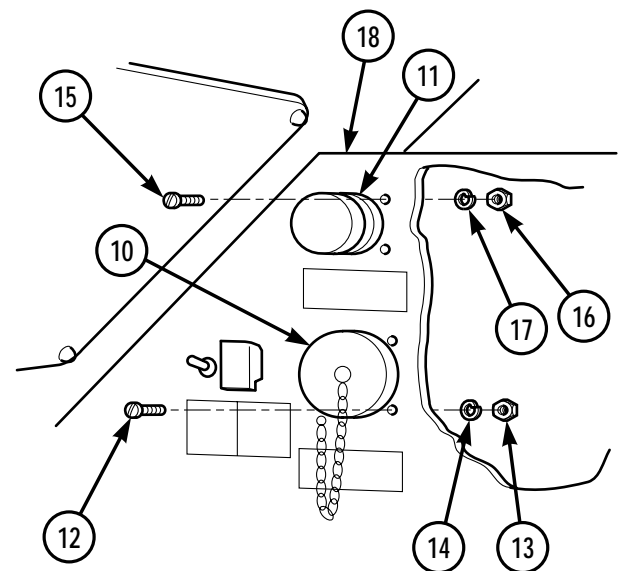
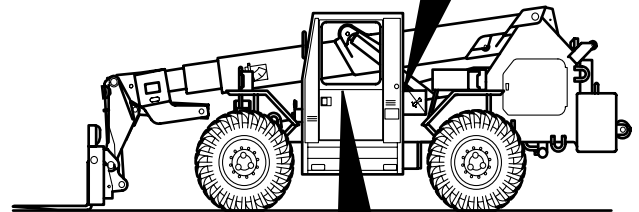
- (4) **Remove STE/ICE diagnostic receptacle (10) and resistor module (11) from cab.**

- (a) Remove four screws (12), nuts (13), and lockwashers (14) from STE/ICE diagnostic receptacle (10). Discard lockwashers.

- (b) Remove four screws (15), nuts (16), and lockwashers (17) from resistor module (11). Discard lockwashers.

- (c) Reach inside cab console (18) and position STE/ICE diagnostic receptacle (10) and resistor module (11) so they can be pulled from bottom of cab.

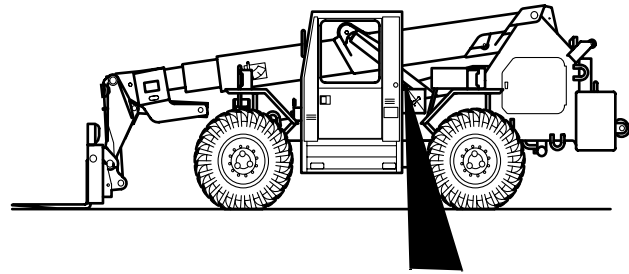
- (d) Remove STE/ICE diagnostic receptacle (10) and resistor module (11) from bottom of cab.



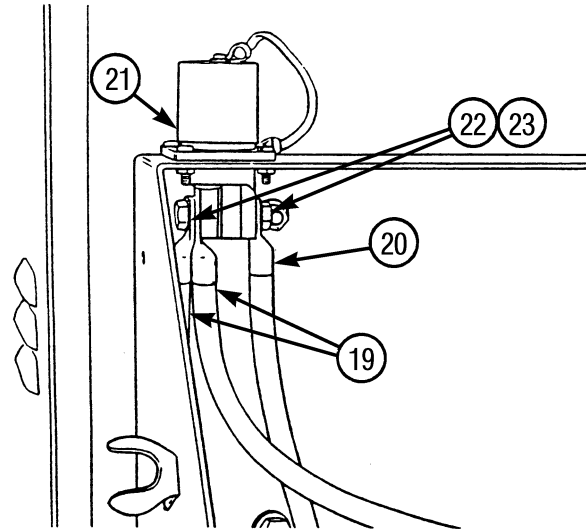
**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**

- (5) **Disconnect two cables (19) and cable (20) from NATO slave receptacle (21).**

Remove two nuts (22), starwashers (23), two cables (19), and cable (20) from NATO slave receptacle (21). Discard starwashers.



- (6) **Disconnect accelerator cable at engine (TM 10-3930-673-20).**
- (7) **Disconnect transmission cables at transmission (TM 10-3930-673-20).**
- (8) **Disconnect parking brake cable at parking brake lever in cab (TM 10-3930-673-20).**
- (9) **Disconnect heater hoses at temperature control valve and heater (TM 10-3930-673-20).**
- (10) **Disconnect A/C hoses at coil (TM 10-3930-673-20).**



**WARNING**

Hydraulic oil in system can be under pressure over 1,500 psi (10342.5 kPa) with engine and pump OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in hydraulic system. With engine OFF and hydraulic attachments on ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

**CAUTION**

Wipe area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of hydraulic system could result in premature failure.

**NOTE**

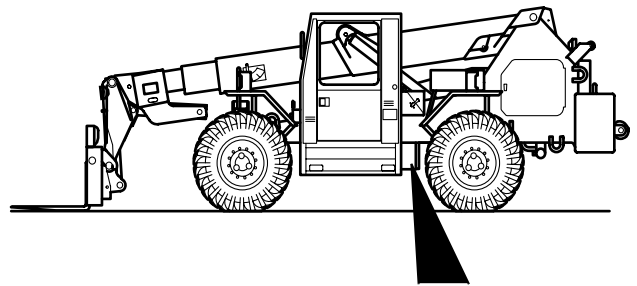
If more than one hydraulic line is removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

- (11) **Disconnect hydraulic lines.**

- (a) Disconnect two hydraulic steering control lines at priority valve (TM 10-3930-673-20).
- (b) Disconnect four hydraulic lines at boom control valve and one at shuttle valve (TM 10-3930-673-20).
- (c) Disconnect one hydraulic line from transmission disconnect master cylinder at transmission control valve (TM 10-3930-673-20).
- (d) Disconnect four hydraulic brake lines; one at each brake tee and two at frame tilt/brake relief valve (TM 10-3930-673-20).
- (e) Disconnect hydraulic line at tee of all four steering cylinders (TM 10-3930-673-20).
- (f) Disconnect hydraulic lines at frame tilt cylinder port (TM 10-3930-673-20).
- (g) Disconnect hydraulic line at hydraulic piston pump (TM 10-3930-673-20).

**(12) Remove grounding strap (24) from cab.**

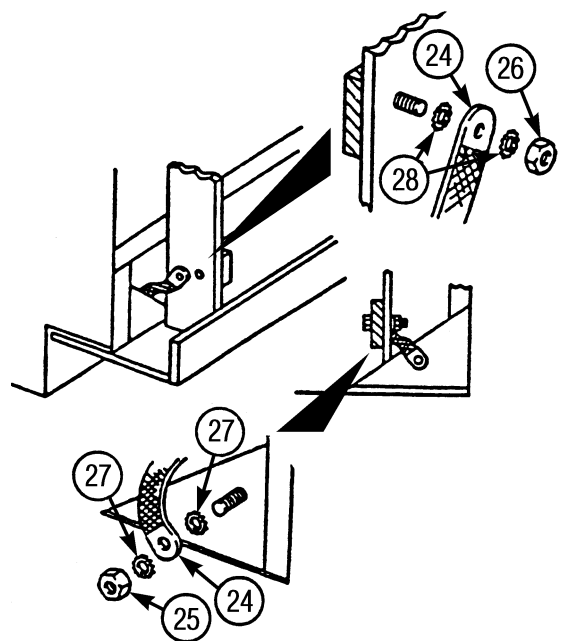
- (a) Remove nuts (25 and 26), two starwashers (27 and 28), and grounding strap (24) from cab. Discard starwashers.



**WARNING**

Cab weighs in excess of 800 lb (363.2 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

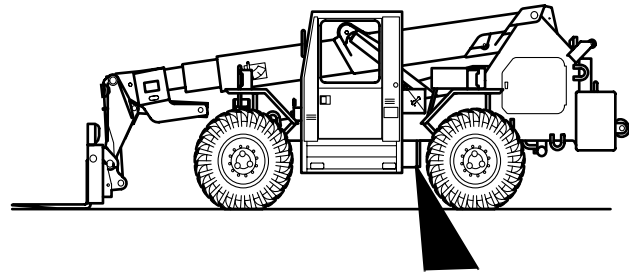
**(13) Secure cab using a suitable hoist or sling.**



**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**

- (14) Remove four nuts (29), eight washers (30), three washers (31), four rubber washers (32), two screws (33), and two screws (34) from cab and vehicle frame (7). Discard rubber washers.

- (15) Remove cab assembly. Have assistant check for any electrical or hydraulic connections which might have been missed and need to be disconnected.



**CAUTION**

When placing cab on stands, be sure no hoses or wires are between cab and stands. Failure to follow this procedure may result in damage to hoses or wiring.

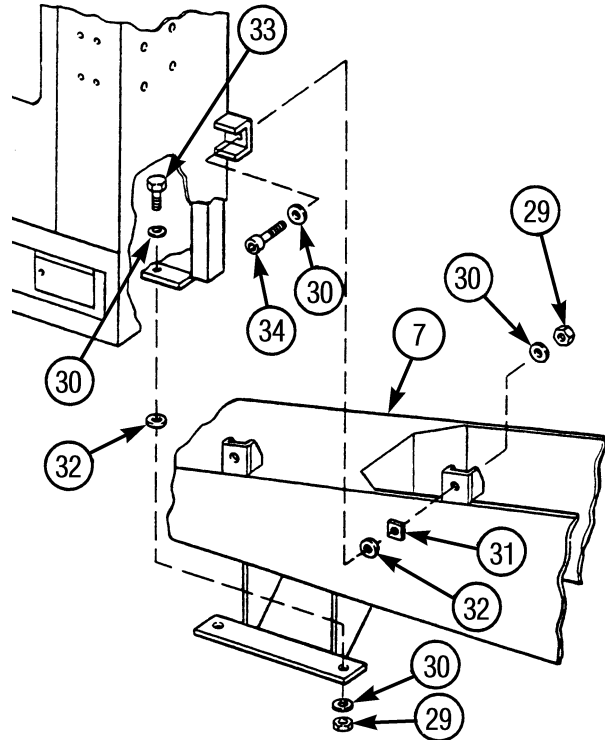
- (16) Place cab on suitable stands.

*b. Disassembly.*

**NOTE**

If necessary, components may be removed from old cab and installed on new cab assembly.

- (1) Remove turn signal switch (TM 10-3930-673-20).
- (2) Remove steering wheel and column (TM 10-3930-673-20).
- (3) Remove steering control valve (TM 10-3930-673-20).
- (4) Remove transmission shifter and cables (TM 10-3930-673-20).
- (5) Remove back-up alarm switch (TM 10-3930-673-20).
- (6) Remove gauges and meters (TM 10-3930-673-20).
- (7) Remove blackout/service light switch (TM 10-3930-673-20).
- (8) Remove start/run control (TM 10-3930-673-20).
- (9) Remove horn button (TM 10-3930-673-20).



- (10) Remove fork autoleveler switch (TM 10-3930-673-20).
- (11) Remove spotlights (TM 10-3930-673-20).
- (12) Remove warning lights (TM 10-3930-673-20).
- (13) Remove spotlight switches (TM 10-3930-673-20).
- (14) Remove circuit breakers (TM 10-3930-673-20).
- (15) Remove underdash relays (TM 10-3930-673-20).
- (16) Remove steering select valve (TM 10-3930-673-20).
- (17) Remove transmission and brake disconnect pedals (TM 10-3930-673-20).
- (18) Remove transmission disconnect master cylinder (TM 10-3930-673-20).
- (19) Remove service brake control valve (TM 10-3930-673-20).
- (20) Remove service brake hydraulic accumulator (TM 10-3930-673-20).
- (21) Remove accelerator pedal and cable (TM 10-3930-673-20).
- (22) Remove parking brake lever and cable (TM 10-3930-673-20).
- (23) Remove hydraulic joystick controller (TM 10-3930-673-20).
- (24) Remove frame tilt valve (TM 10-3930-673-20).
- (25) Remove heater temperature control cable (TM 10-3930-673-20).
- (26) Remove engine primer button (TM 10-3930-673-20).
- (27) Remove heater fan switch (TM 10-3930-673-20).
- (28) Remove seat and seat belt (TM 10-3930-673-20).
- (29) Remove cab heater, hoses, lines, and fittings (TM 10-3930-673-20).
- (30) Remove fire extinguisher and bracket (TM 10-3930-673-20).
- (31) Remove manual holder (TM 10-3930-673-20).
- (32) Remove windshield washer assembly (TM 10-3930-673-20).
- (33) Remove data plates (TM 10-3930-673-20).
- (34) Remove electric joystick controller (TM 10-3930-673-20).
- (35) Remove cab lights (TM 10-3930-673-20).
- (36) Remove front and rear windshield wiper assemblies (TM 10-3930-673-20).

**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**

- (37) Remove wire harness (TM 10-3930-673-20).
- (38) Remove neutral safety switch (TM 10-3930-673-20).
- (39) Remove battery box (TM 10-3930-673-20).
- (40) Remove windshield and windows (TM 10-3930-673-20).
- (41) Remove cab door (TM 10-3930-673-20).
- (42) Remove sound suppression panels (Para 14-4).
- (43) Remove cab level gauge (TM 10-3930-673-20).
- (44) Remove heater control valve (TM 10-3930-673-20).

*c. Cleaning.* See Cleaning Instructions (Para 2-12).

*d. Inspection.* See Inspection Instructions (Para 2-14).

*e. Assembly.*

- (1) Install heater control valve (TM 10-3930-673-20).
- (2) Install cab level gauge (TM 10-3930-673-20).
- (3) Install new sound suppression panels into new cab (Para 14-4).
- (4) Install cab door (TM 10-3930-673-20).
- (5) Install windshield and windows (TM 10-3930-673-20).
- (6) Install battery box (TM 10-3930-673-20).
- (7) Install neutral safety switch (TM 10-3930-673-20).
- (8) Install wire harness (TM 10-3930-673-20).
- (9) Install front and rear windshield wiper assemblies (TM 10-3930-673-20).
- (10) Install cab lights (TM 10-3930-673-20).
- (11) Install electric joystick controller (TM 10-3930-673-20).
- (12) Install data plates (TM 10-3930-673-20).
- (13) Install windshield washer assembly (TM 10-3930-673-20).
- (14) Install manual holder (TM 10-3930-673-20).
- (15) Install fire extinguisher and bracket (TM 10-3930-673-20).



- (16) **Install cab heater, hoses, lines, and fittings (TM 10-3930-673-20).**
- (17) **Install seat and seat belt (TM 10-3930-673-20).**
- (18) **Install heater fan switch (TM 10-3930-673-20).**
- (19) **Install engine primer button (TM 10-3930-673-20).**
- (20) **Install heater temperature control cable (TM 10-3930-673-20).**
- (21) **Install frame tilt valve (TM 10-3930-673-20).**
- (22) **Install hydraulic joystick controller (TM 10-3930-673-20).**
- (23) **Install parking brake lever and cable (TM 10-3930-673-20).**
- (24) **Install accelerator pedal and cable (TM 10-3930-673-20).**
- (25) **Install service brake hydraulic accumulator (TM 10-3930-673-20).**
- (26) **Install service brake control valve (TM 10-3930-673-20).**
- (27) **Install transmission disconnect master cylinder (TM 10-3930-673-20).**
- (28) **Install transmission and brake disconnect pedals (TM 10-3930-673-20).**
- (29) **Install steering select valve (TM 10-3930-673-20).**
- (30) **Install underdash relays (TM 10-3930-673-20).**
- (31) **Install circuit breakers (TM 10-3930-673-20).**
- (32) **Install spotlight switches (TM 10-3930-673-20).**
- (33) **Install warning lights (TM 10-3930-673-20).**
- (34) **Install spotlights (TM 10-3930-673-20).**
- (35) **Install fork autoleveler switch (TM 10-3930-673-20).**
- (36) **Install horn button (TM 10-3930-673-20).**
- (37) **Install start/run control (TM 10-3930-673-20).**
- (38) **Install blackout/service light switch (TM 10-3930-673-20).**
- (39) **Install gauges and meters (TM 10-3930-673-20).**
- (40) **Install back-up alarm switch (TM 10-3930-673-20).**
- (41) **Install transmission shifter and cables (TM 10-3930-673-20).**
- (42) **Install steering control valve (TM 10-3930-673-20).**

**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**

(43) Install steering wheel and column (TM 10-3930-673-20).

(44) Install turn signal switch (TM 10-3930-673-20).

**f. Installation.**

**WARNING**

Cab weighs in excess of 800 lb (363.2 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

(1) Use a hoist and sling to position cab on vehicle.

**WARNING**

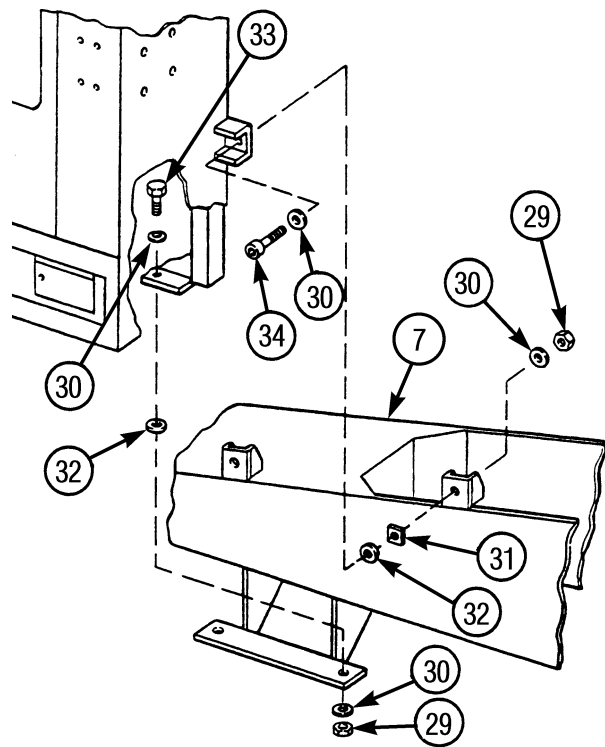
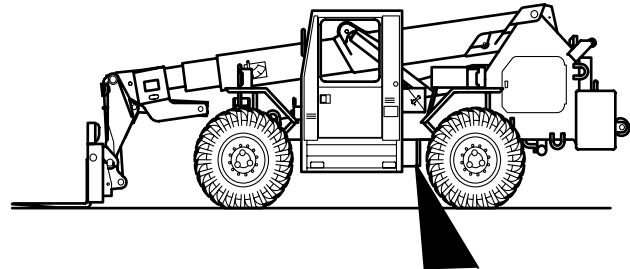
Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with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

**NOTE**

Use washers to shim cab so cab side plate to boom hoist cylinder anchor clearance with vehicle level and boom centered, is 2.75 in. (69.85 mm) minimum. Shim both upper cab mounts equally. Use as few washers as possible. Do not overshim.

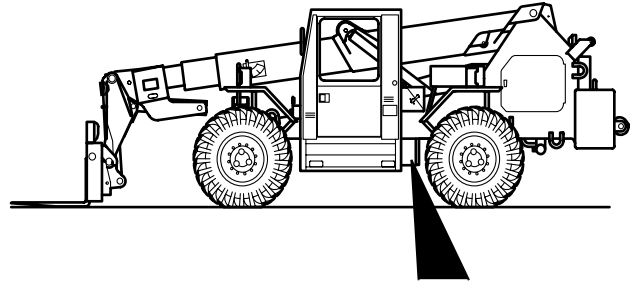
(2) Align cab and frame mounting holes. Apply sealing compound to threads of two screws (33 and 34). Install two screws (33), two screws (34), eight washers (30), three washers (31), four rubber washers (32), and four nuts (29) in cab and vehicle frame (7). Tighten nuts to 640 lb-ft (867.72 N•m).

(3) Remove hoist and sling from cab.



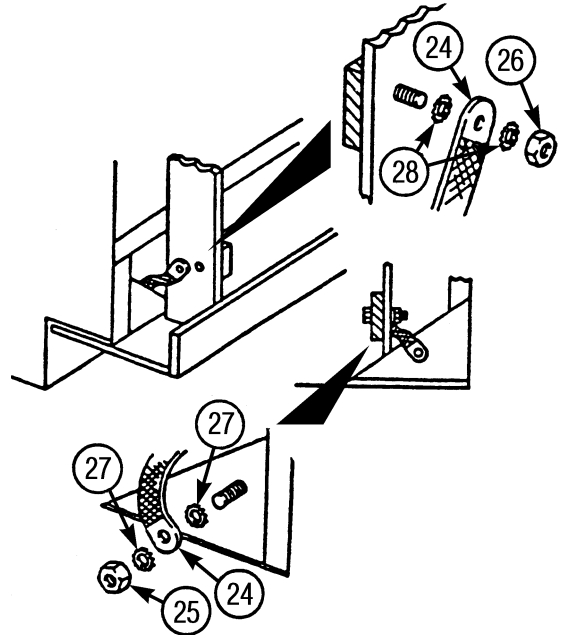
**(4) Install grounding strap (24) on cab.**

Install grounding strap (24), starwashers (27 and 28), and nuts (25 and 26) on cab.



**(5) Connect hydraulic lines. Use tags placed on lines at disassembly to ensure correct connection.**

- (a) Connect hydraulic line at hydraulic piston pump (TM 10-3930-673-20).
- (b) Connect hydraulic lines at frame tilt cylinder port (TM 10-3930-673-20).
- (c) Connect hydraulic line at tee of all four steering cylinders (TM 10-3930-673-20).
- (d) Connect four hydraulic brake lines; one at each brake tee and two at frame tilt/brake relief valve (TM 10-3930-673-20).
- (e) Connect one hydraulic line from transmission disconnect master cylinder at transmission control valve (TM 10-3930-673-20).
- (f) Connect four hydraulic lines boom control valve and one at shuttle valve (TM 10-3930-673-20).
- (g) Connect two hydraulic steering control lines at priority valve (TM 10-3930-673-20).



**(6) Connect A/C hoses at coil (TM 10-3930-673-20).**

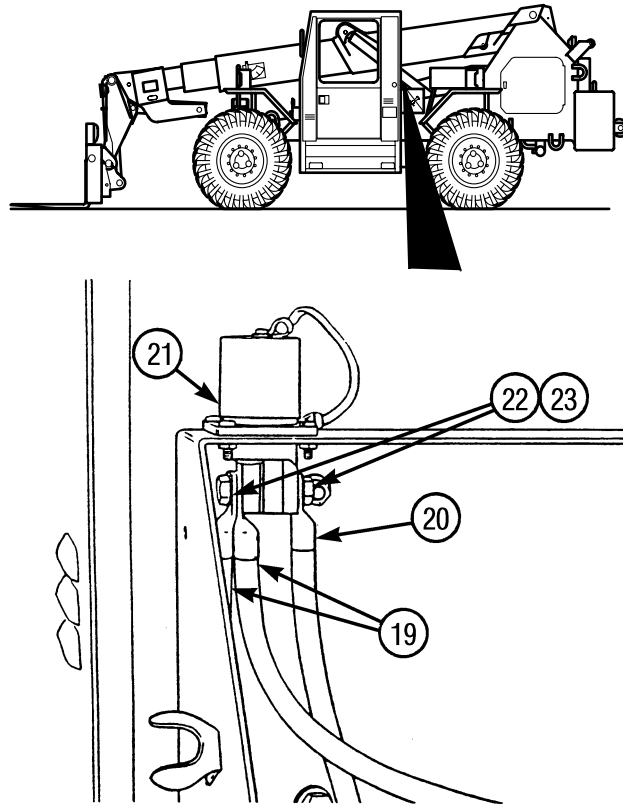
**(7) Connect heater hoses at temperature control valve and heater (TM 10-3930-673-20).**

**(8) Connect parking brake cable (TM 10-3930-673-20).**

**(9) Connect transmission cable at transmission (TM 10-3930-673-20).**

**(10) Connect accelerator cable at engine (TM 10-3930-673-20).**

**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**

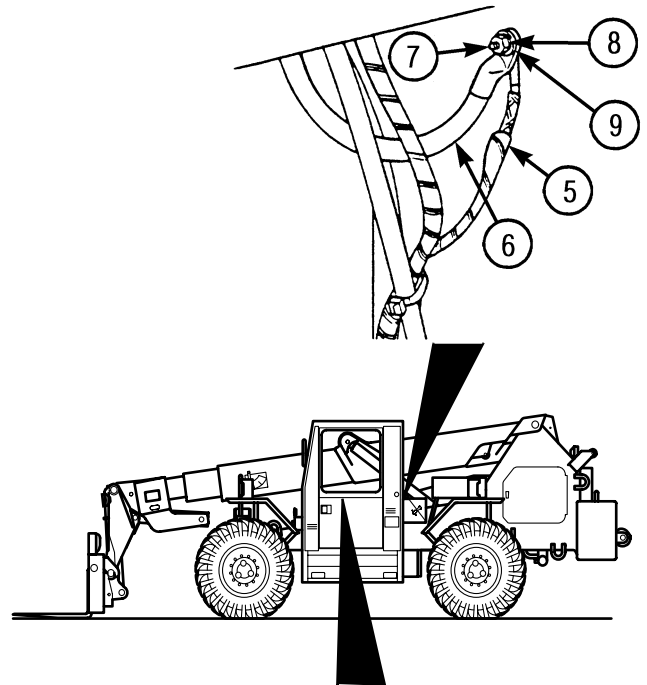


**(11) Connect cable (20) and two cables (19) to NATO slave receptacle (21).**

Connect cable (20), two cables (19), starwashers (23), and nuts (22) on NATO slave receptacle (21).

**(12) Install STE/ICE diagnostic receptacle (10) and resistor module (11) in cab.**

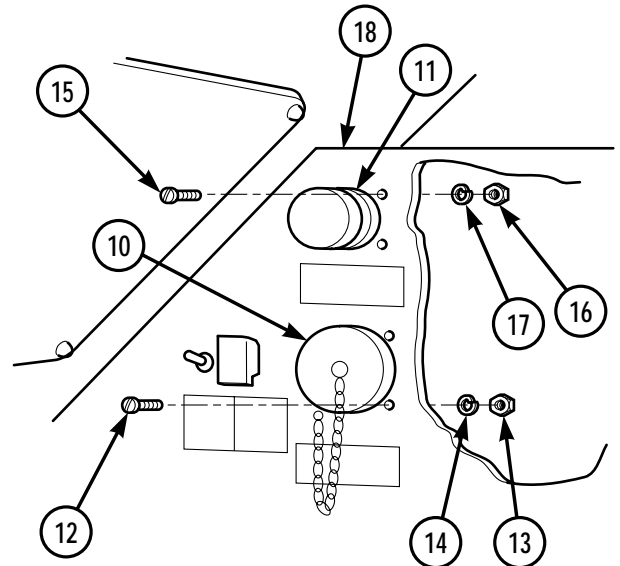
- (a) Position STE/ICE diagnostic receptacle (10) and resistor module (11) in cab console (18).
- (b) Install resistor module (11), screws (15), lockwashers (17), and nuts (16) in cab console (18).
- (c) Install STE/ICE diagnostic receptacle (10), screws (12), lockwashers (14), and nuts (13) in cab.



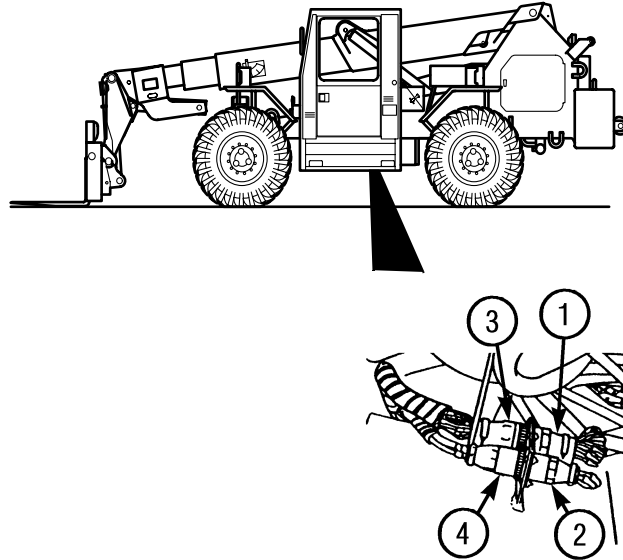
**(13) Connect ground cable (6) and wiring connector (5) to vehicle (7) stud.**

Install wiring connector (5), ground cable (6), washer (9), and nut (8) to vehicle (7) stud.

**(14) Connect STE/ICE shunt (TM 10-3930-673-20).**



**14-3. CAB ASSEMBLY WITH ROPS/FOPS REPLACEMENT/REPAIR (CONT)**



- (15) **Connect cab wiring harness connectors (3 and 4) to cab wiring harness connectors (1 and 2).**

**NOTE**

Follow-on Maintenance:

- Cooling system filled (TM 10-3930-673-20).
- Hydraulic system filled (TM 10-3930-673-20).
- Batteries installed (TM 10-3930-660-20).
- Hydraulic joystick installed (TM 10-3930-660-20).
- Transmission cover installed (TM 10-3930-660-20).

**END OF TASK**

## 14-4. SOUND SUPPRESSION PANELS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Single-edge Razor

#### *Materials/Parts*

Adhesive 3-M No. 80 (Item 1, Appendix B)  
Solvent, Drycleaning P-D-680  
(Item 52, Appendix B)

#### *Equipment Condition*

Seat removed (TM 10-3930-673-20)  
Windshield washer reservoir removed  
(TM 10-3930-673-20)  
Fire extinguisher bracket removed  
(TM 10-3930-673-20)

### a. Removal.

### WARNING

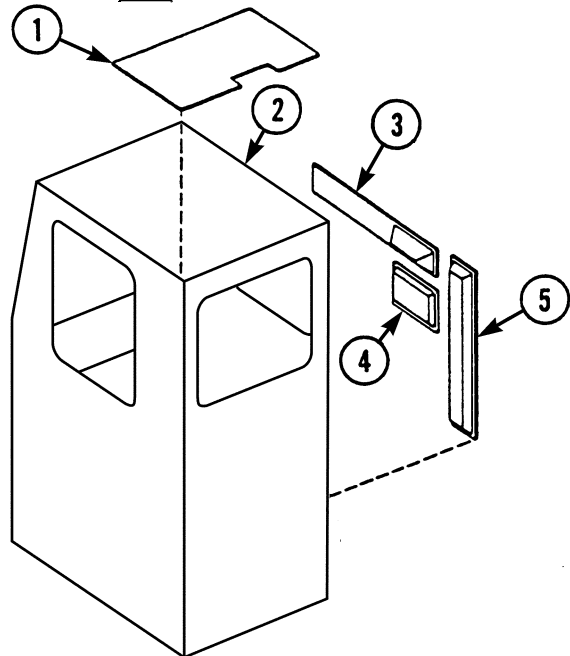
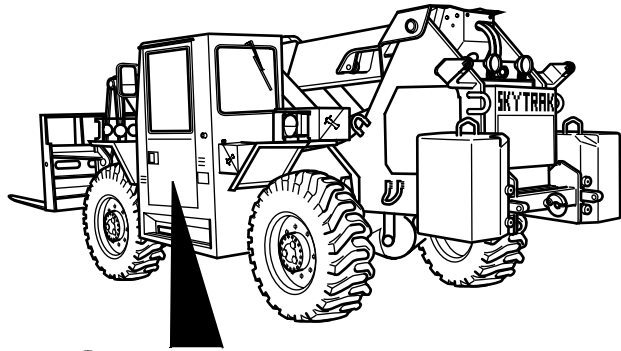
- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.

### NOTE

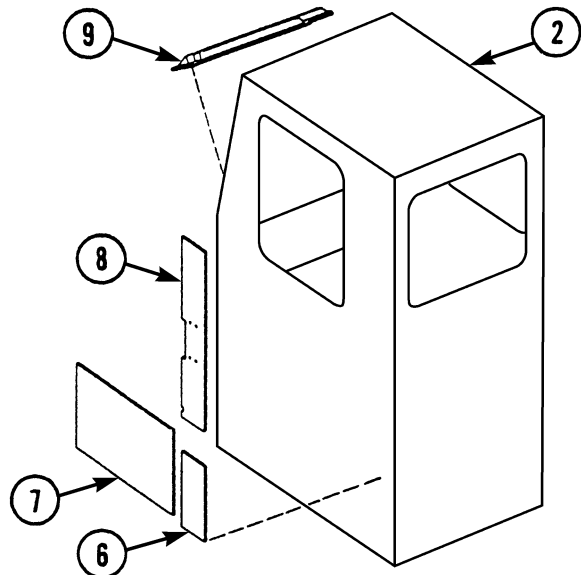
Sound suppression panels are glued to vehicle. Use a single edged razor blade to cut panels from vehicle. After removing panel, scrape away as much of old adhesive and panel material as possible. Remove remainder of old adhesive with cleaning solvent (refer to cleaning instructions [Para 2-12]).

**14-4. SOUND SUPPRESSION PANELS REPLACEMENT (CONT)**

- (1) Remove headliner panel (1) from cab (2). Discard panel (1).
- (2) Remove right sidewall upper panel (3) from cab (2). Discard panel (3).
- (3) Remove right sidewall lower panel (4) from cab (2). Discard panel (4).
- (4) Remove right sidewall rear panel (5) from cab (2). Discard panel (5).



- (5) Remove left rear sidewall lower panel (6) from cab (2). Discard panel (6).
- (6) Remove lower door panel (7) from cab (2). Discard panel (7).
- (7) Remove left rear sidewall upper panel (8) from cab (2). Discard panel (8).
- (8) Remove upper dash panel (9) from cab (2). Discard panel (9).



**b. Cleaning.** See Cleaning Instructions (Para 2-12).



**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Installation.**

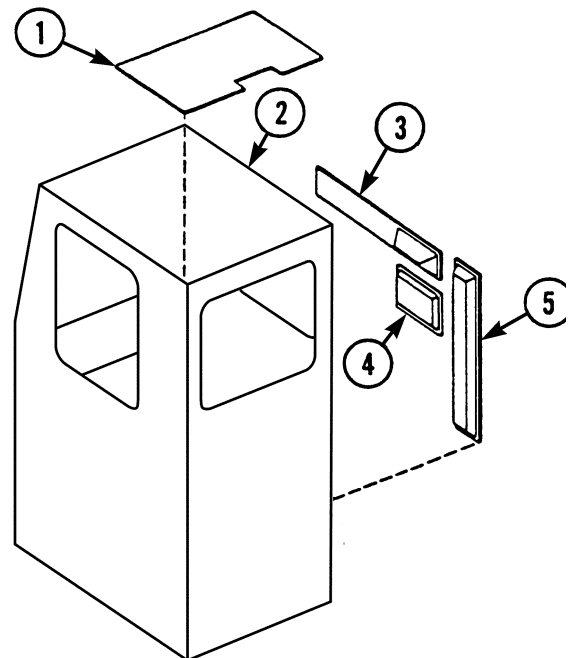
### WARNING

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

### NOTE

When installing sound suppression panels, apply adhesive to both vehicle sheet metal and back of sound suppression panel to be installed; position panel on vehicle and press into place.

- (1) **Install upper dash panel (9) in cab (2).**
- (2) **Install left rear sidewall upper panel (8) in cab (2).**
- (3) **Install lower door panel (7) in cab (2).**
- (4) **Install left rear sidewall lower panel (6) in cab (2).**
- (5) **Install right sidewall rear panel (5) in cab (2).**
- (6) **Install right sidewall lower panel (4) in cab (2).**
- (7) **Install right sidewall upper panel (3) in cab (2).**
- (8) **Install headliner panel (1) in cab (2).**



### NOTE

Follow-on Maintenance:

- Install seat (TM 10-3930-673-20).
- Install windshield washer reservoir (TM 10-3930-673-20).
- Install fire extinguisher bracket (TM 10-3930-673-20).

**END OF TASK**



# CHAPTER 15

## BODY AND CHASSIS ACCESSORY ITEMS MAINTENANCE

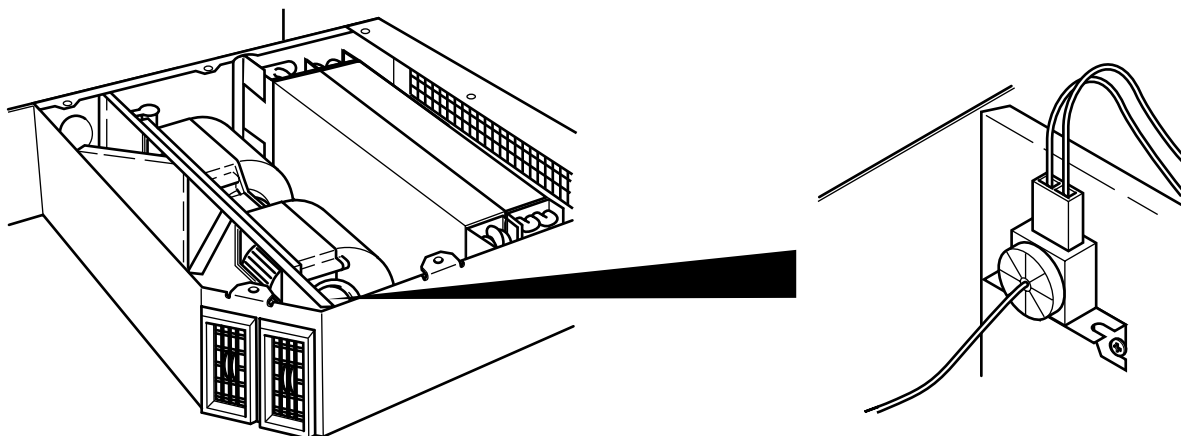
Para	Contents	Page
Section I. Description and Data		
15-1.	General .....	15-1
15-2.	Principles of Operation .....	15-1
Section II. Body and Chassis Accessory Items Maintenance Procedures		
15-3.	Air Conditioning System Servicing .....	15-5
15-4.	Air Conditioner High Pressure and Low Pressure Switch Replacement .....	15-13
15-5.	Expansion Valve Replacement .....	15-16
15-6.	Air Conditioner Evaporator Coil Replacement .....	15-18
15-7.	Receiver Drier Replacement .....	15-19
15-8.	Air Conditioner Condenser Coil Replacement .....	15-21
15-9.	Air Conditioner Hoses Replacement .....	15-24
15-10.	Air Conditioner Compressor Clutch Replacement/Repair .....	15-31

### Section I. DESCRIPTION AND DATA

#### 15-1. GENERAL

This chapter covers maintenance procedures for the cab air conditioning system, as well as a functional description of the air conditioning components.

#### 15-2. PRINCIPLES OF OPERATION



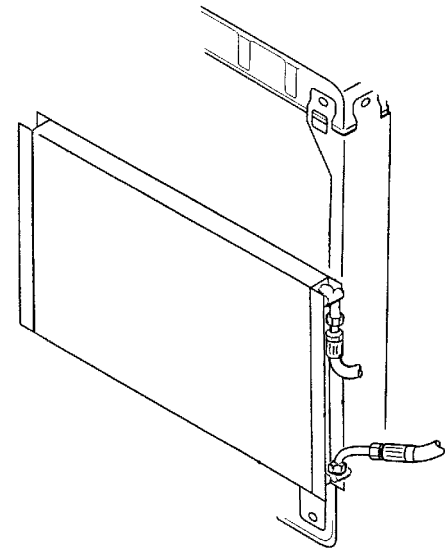
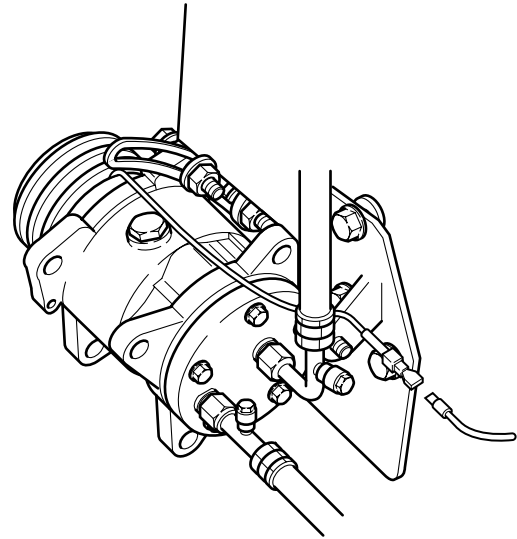
**a. Thermostat.** The thermostat senses the temperature of the evaporator coil and engages or disengages the compressor clutch as needed.

**15-2. PRINCIPLES OF OPERATION (CONT)**

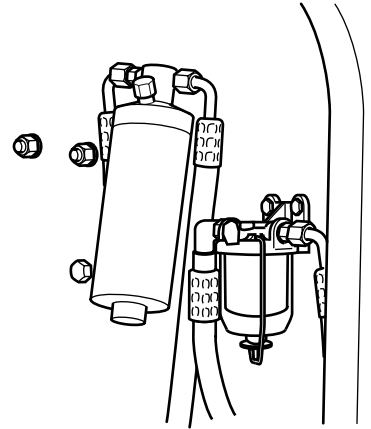
**b. Compressor.** The compressor draws vaporized refrigerant from the evaporator coil and compresses the vapor to a high pressure, that is necessary for condensation. The high pressure vapor then moves into the condenser coil where heat can be radiated to change the refrigerant back to liquid. The compressor is equipped with an electrically actuated clutch to engage or disengage drive to the compressor.

The compressor V-belt pulley is mounted on a bearing and is free to rotate without turning the compressor crankshaft anytime electrical power is disconnected. The field coil on the compressor is energized by electrical current from either the thermostat, high pressure switch, or low pressure switch. Energizing the field coil creates a magnetic force that locks the driven disk to the pulley and drives the compressor.

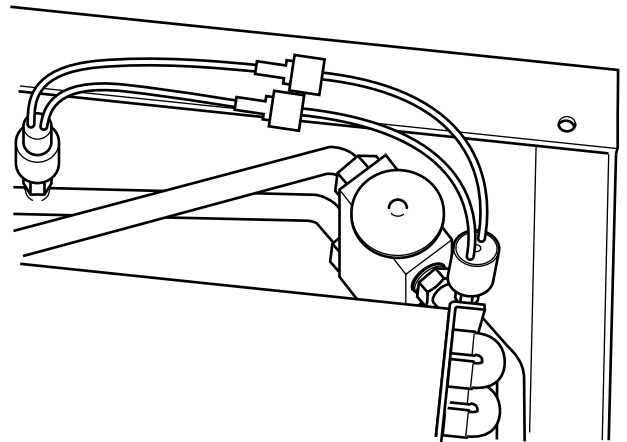
**c. Condenser Coil.** The purpose of the condenser coil is to radiate enough heat energy from the compressed high pressure vaporized refrigerant so that the refrigerant changes from a vapor to a liquid. This is done with cooling fins on the condenser coil and the engine cooling fan.



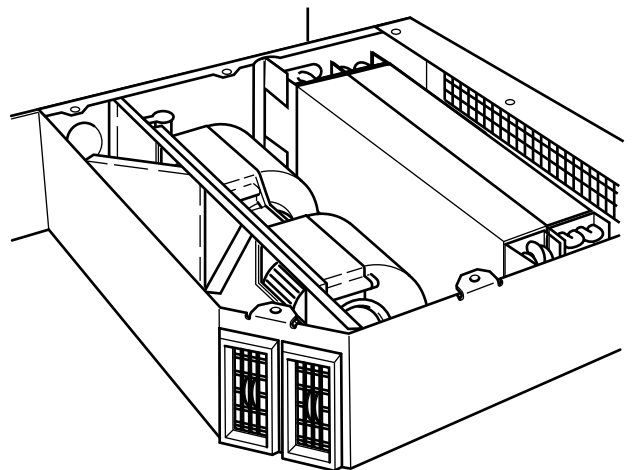
**d. Receiver Drier.** The high pressure liquid refrigerant moves from the condenser coil to the receiver drier, where the refrigerant is stored and filtered. Moisture is the major enemy of the air conditioning system, and desiccant inside the receiver drier will absorb only a small amount. The container of desiccant inside the receiver drier may break open and contaminate the system if any attempt is made to dry the desiccant, or if more moisture is inside the system than the desiccant can absorb. Every effort should be made to remove all moisture from the system and install a new receiver drier if its condition is questionable. Installation of a new receiver drier is recommended if necessary each time any part of the refrigeration system is open to the atmosphere.



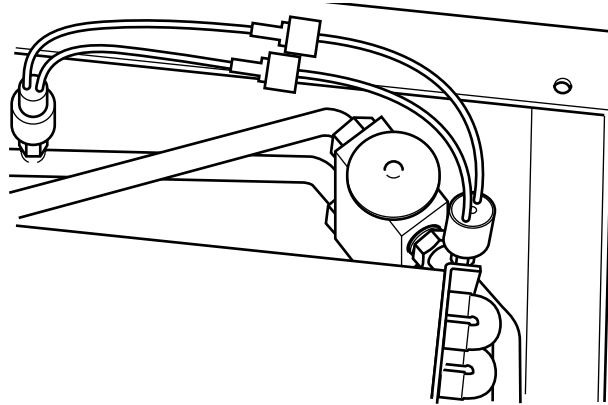
**e. Expansion Valve.** The expansion valve is installed in the air conditioning system to lower pressure before the refrigerant enters the evaporator coil. This reduction in pressure is done by passing the refrigerant through a small orifice.



**f. Evaporator Coil.** The evaporator coil is the low pressure component where liquid refrigerant absorbs heat from surrounding air. The expansion valve bleeds high pressure refrigerant into the low pressure evaporator coil. The refrigerant expands rapidly in the evaporator coil and its temperature is quickly reduced. The refrigerant absorbs heat from the air when the blower fan circulates air over the evaporator coil fins. The exchange of heat from the air to the refrigerant depends upon the difference in temperature. During high heat load, such as usually encountered when the system is first turned on, the temperature difference is great and the refrigerant will absorb heat quickly. The fan blower can be set at its highest setting to circulate large quantities of warm air around the evaporator coil. After the cab has been cooled, the fan speed should be reduced so that already cool air will have longer time to yield to the refrigerant as it passes the evaporator coil.



15-2. PRINCIPLES OF OPERATION (CONT)



**g. High Pressure and Low Pressure Switches.** The high pressure switch (located on the input line to the evaporator) and the low pressure switch (located on the expansion valve) monitor air conditioner operation. The high pressure and low pressure switches are activated at preset pressures and engage and disengage the compressor clutch.

## Section II. BODY AND CHASSIS ACCESSORY ITEMS MAINTENANCE PROCEDURES

<b>15-3. AIR CONDITIONING SYSTEM SERVICING</b>		
This Task Covers:		
a. Manifold Gage Set Installation	c. Discharging System	e. Charging System
b. Manifold Gage Set Removal	d. Evacuating System	f. Checking/Adding Refrigerant Oil
<b>INITIAL SETUP</b>		
<p><i>Tools and Special Tools</i></p> <p>Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)</p> <p>Vacuum Pump</p> <p>Compressor Tool Kit (Item 2, Appendix D)</p> <p><i>Test Equipment</i></p> <p>Manifold Gage Set (Item 11, Appendix D)</p>	<p><i>Equipment Condition</i></p> <p>Engine shut down and cooled (TM 10-3930-673-10)</p> <p>Wheels chocked</p> <p><i>Materials/Parts</i></p> <p>Lubricating Oil (Item 27, Appendix B)</p> <p>Refrigerant R-134a (Item 36, Appendix B)</p> <p>Nitrogen</p>	

### WARNING

- Always wear eye protection around refrigerant, or when servicing the air-conditioning system. Injury will result if refrigerant comes in contact with eyes.
- Exercise extreme care when handling refrigerant, direct contact between refrigerant and skin may cause frostbite.
- Never smoke in areas where refrigerant is used or stored. Injury to personnel may result.
- Ensure adequate ventilation whenever refrigerant is being discharged. Injury to personnel may result if used in a confined area.
- Personnel with a history of cardiac rhythm abnormalities should be made aware of potential aggravation as a result of exposure to refrigerant. Failure to do so may result in injury to personnel.
- Do not attempt to connect servicing equipment while engine is running. Injury to personnel or damage to equipment may result.

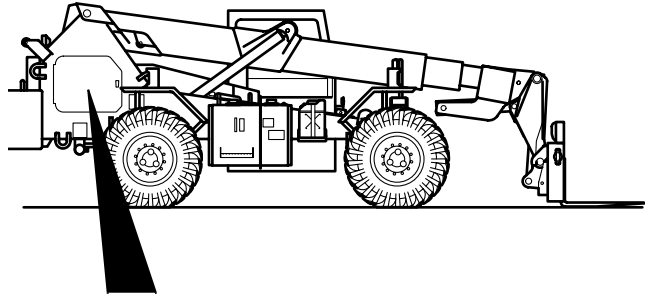
### NOTE

Whenever any air conditioning vapor system component needs replacement, the system must be discharged, flushed, and a new dryer bottle installed.

**15-3. AIR CONDITIONING SYSTEM SERVICING (CONT)**

*a. Manifold Gage Set Installation.*

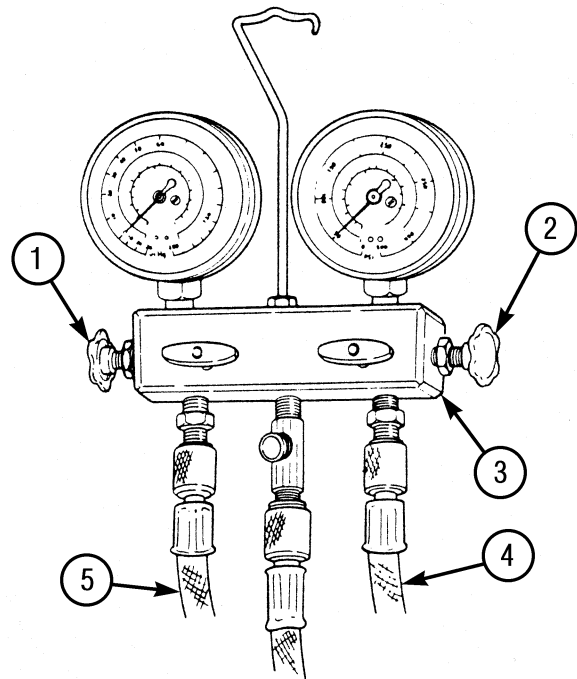
- (1) Turn high pressure gage valve (2) and low pressure gage valve (1) on gage set (3) clockwise to their front seated (closed) positions.
- (2) Remove two dust caps (8) from service valve ports (6) and (7).



**WARNING**

Make sure hand valves on manifold gage set are in closed position during connection, and hoses are clear of any moving parts in engine compartment. Injury to personnel or damage to equipment may result.

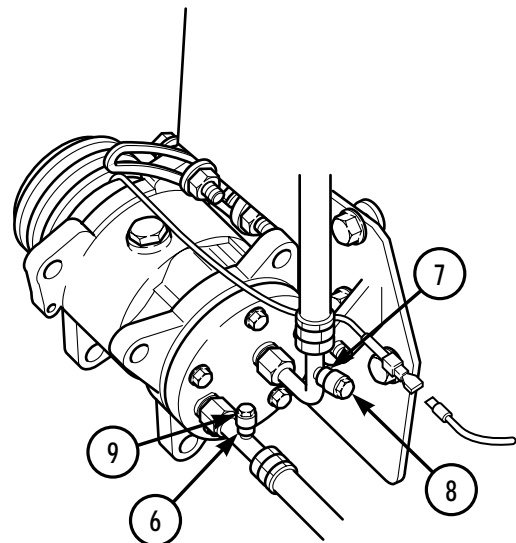
- (3) Connect low pressure gage hose (5) on manifold gage set (3) to suction (low side) service valve port (6).
- (4) Connect high pressure gage hose (4) on manifold gage set (3) to discharge (high side) service valve (7).
- (5) Hang manifold gage set (3) so that hoses (5) and (4) are well away from moving engine parts.



**NOTE**

Do not perform step (6) if system is already evacuated. High and low pressure hoses must be purged with refrigerant for charging purposes (refer to task e.).

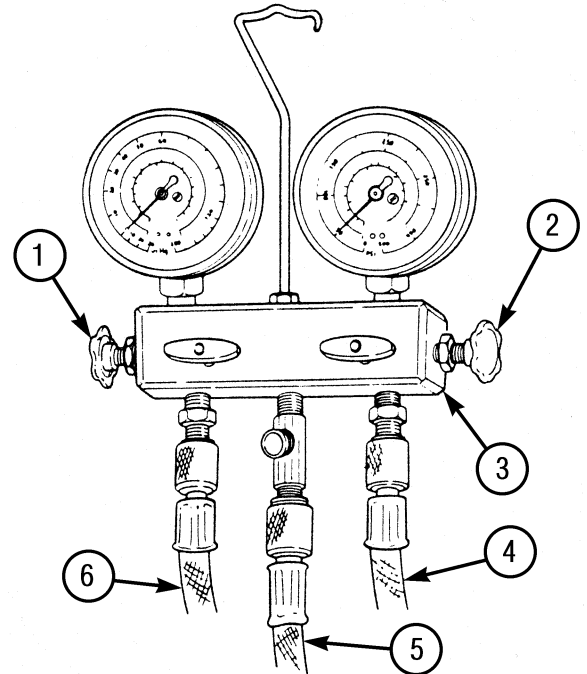
- (6) Loosen low pressure gage hose (5) and high pressure gage hose (4) at manifold gage set slightly for a second to purge air from hoses, and then tighten.





**b. Manifold Gage Set Removal.**

- (1) Loosen low pressure gage valve (1) and high pressure gage valve (2) slowly, allowing refrigerant to escape from hoses (4) and (6) through hose (5).
- (2) Disconnect low pressure gage hose (5) and high pressure gage hose (4) from service valve ports (7) and (8).
- (3) Install two dust caps (9) on service valve ports (7) and (8).



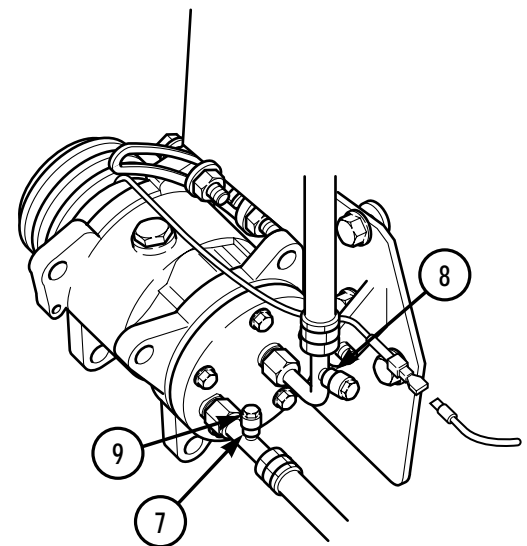
**c. Discharging System.**

- (1) Disconnect negative battery cable (TM 10-3930-673-20).
- (2) Install manifold gage set (refer to task a.).
- (3) Insert center hose (5) of manifold gage set (3) in a catch bottle or can.

**NOTE**

- Do not allow refrigerant R-134 to escape too quickly. Refrigerant oil will escape.
- When high pressure gage and low pressure gage read “zero”, the discharging procedure is complete.

- (4) Turn low pressure gage valve (1) and high pressure gage valve (2) counterclockwise slightly to permit refrigerant to slowly escape through center hose (5) until gages read “zero”.
- (5) Measure any significant accumulation of oil in discharge bottle and record for oil charging purposes.
- (6) Disconnect manifold gage set (refer to task b.).



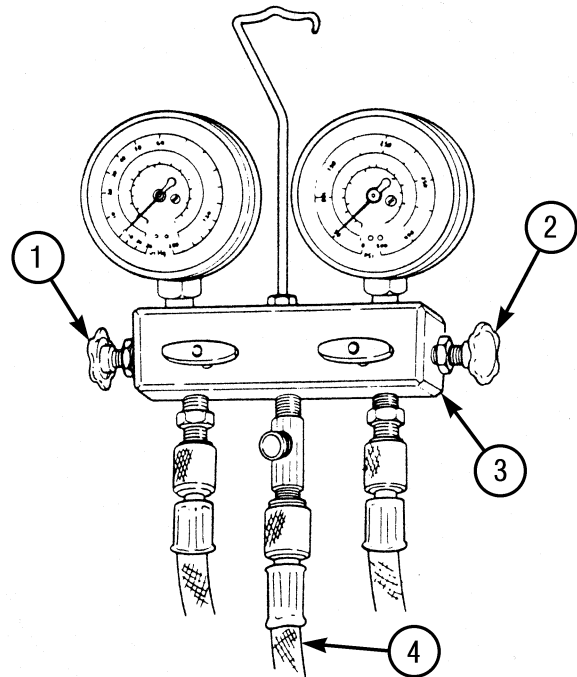
**15-3. AIR CONDITIONING SYSTEM SERVICING (CONT)**

*d. Evacuating System.*

**CAUTION**

Never attempt to evacuate A/C system if system has not been completely discharged.

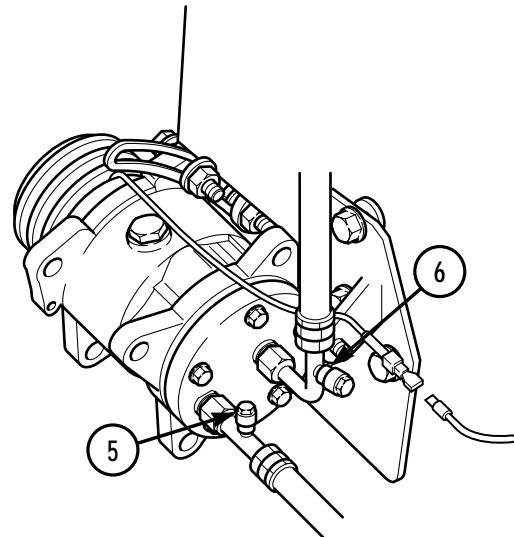
- (1) **Discharge A/C system (refer to task c.).**
- (2) **Connect manifold gage set (refer to task a.) to service valve ports (5) and (6).**
- (3) **Connect vacuum pump to center hose (4) on manifold gage set (3).**
- (4) **Turn vacuum pump on and open low pressure gage valve (1) and high pressure gage valve (2) on manifold gage set (3).**



**NOTE**

- High side gage should drop to “zero” or below. If not, a blockage in A/C system is indicated.
- 29-30 pounds of vacuum should be sustained on low pressure gage for at least ten minutes. If not, a leak in A/C system is indicated. Identify source of leak and repair as necessary.

- (5) **Evacuate unit until low pressure gage reads 29-30 pounds vacuum.**
- (6) **Continue evacuation for forty-five minutes after correct gage reading of 29-30 pounds vacuum has been achieved.**
- (7) **Turn low pressure gage valve (1) and high pressure gage valve (2) on manifold gage set (3) to closed position after evacuation is complete.**
- (8) **Turn off vacuum pump and disconnect center hose (4) from vacuum pump.**



**NOTE**

Manifold gage set can remain connected if charging A/C system will follow immediately.

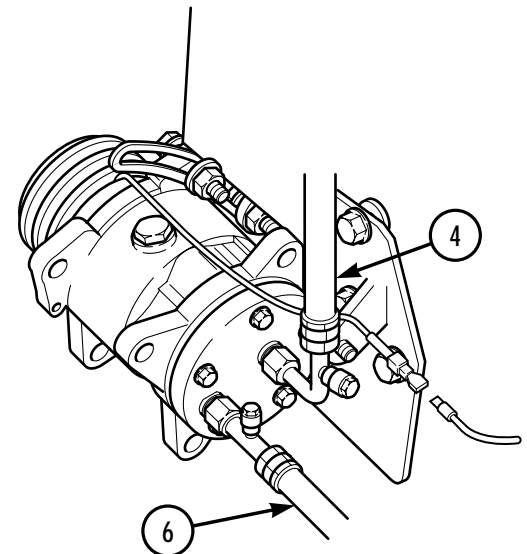
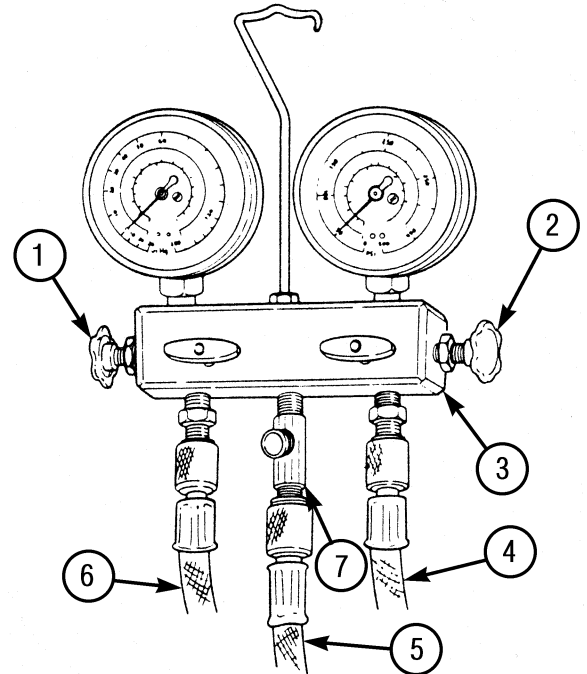
- (9) **Disconnect manifold gage set (refer to task b.) from service valve ports (5) and (6).**

**e. Charging System.**

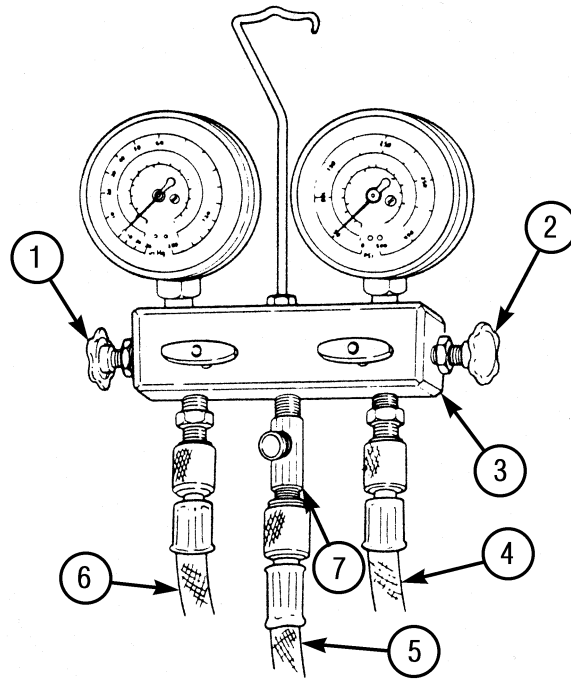
**NOTE**

If A/C system requires replacement of a major component, refrigerant oil must be added to system to compensate loss (refer to task f.).

- (1) **Evacuate A/C system (refer to task d.).**
- (2) **Connect refrigerant R-134 source to center hose (5) of manifold gage set (3).**
- (3) **Open refrigerant R-134 source to allow refrigerant to flow into center hose (5).**
- (4) **Purge center hose (5), low pressure hose (6), and high pressure hose (4) as follows:**
  - (a) Loosen center hose (5) at manifold gage set center port (7) slightly until refrigerant escapes, then tighten hose (5).
  - (b) Open high pressure gage valve (2) and low pressure gage valve (1) to allow refrigerant to flow into high pressure hose (4) and low pressure hose (6).
  - (c) Purge high pressure hose (4) and low pressure hose (6) at service valve ports at compressor.
  - (d) Turn high pressure gage valve (2) and low pressure gage valve (1) clockwise to off position.
- (5) **Connect STE/ICE (TM 9-2320-280-20) to obtain engine RPM reading.**



**15-3. AIR CONDITIONING SYSTEM SERVICING (CONT)**



**WARNING**

Make sure high pressure gage valve is in closed position on manifold gage set during charging. Failure to do so will cause compressor to build pressure in refrigerant container, causing injury to personnel or damage to equipment.

- (6) Start engine and set engine speed to 1500 rpm with hand throttle (TM 10-3930-673-10).
- (7) Turn on A/C system (TM 10-3930-673-10) and blower fans on high speed.

**NOTE**

Keep refrigerant container upright at all times so refrigerant enters system as a gas.

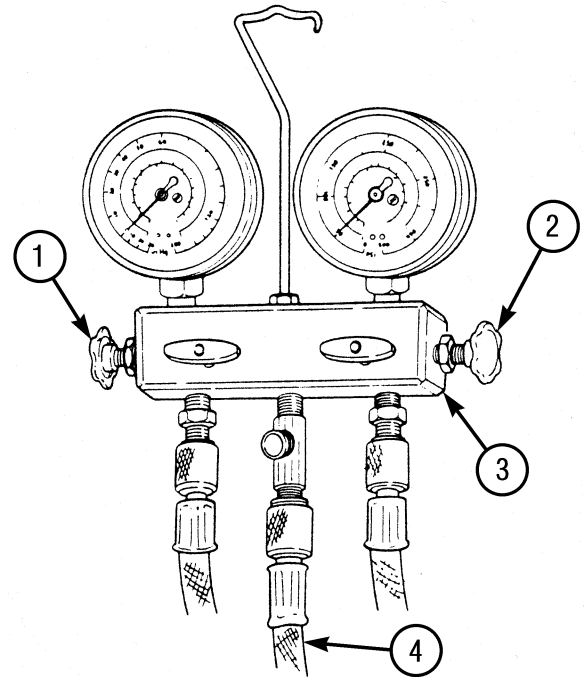
- (8) Open low pressure gage valve (1) on manifold gage set (3) until system is fully charged.
- (9) Close low pressure gage valve (1) on manifold gage set (3).
- (10) Return hand throttle to normal idle (TM 10-3930-673-10).
- (11) Stop engine (TM 10-3930-673-10).
- (12) Remove refrigerant R-134 source from center hose (5) of manifold gage set (3).

(13) Perform task f.).

**f. Checking/Adding Refrigerant Oil.**

**NOTE**

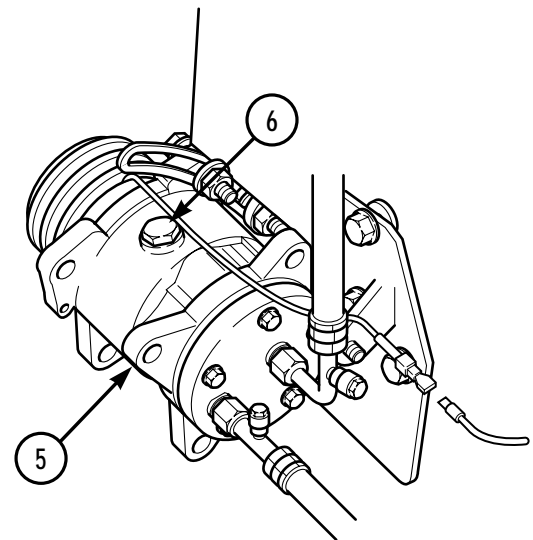
- It is not necessary to check or add oil as routine maintenance. It is necessary to check oil when the evaporator, condenser, compressor, or receiver/dryer has been replaced, or there was an obvious oil leak. When a system is discharged, it is also necessary to replace any oil carried out with the refrigerant.
- Vehicle must be on level ground.



- (1) Charge A/C system (refer to task e.).
- (2) Make sure low pressure gage valve (1) and high pressure gage valve (2) on manifold gage set (3) are turned clockwise to off position.
- (3) Start engine and turn on A/C system (refer to TM 10-3930-673-10). Allow engine to idle for approximately 10 to 15 minutes. Stop engine.

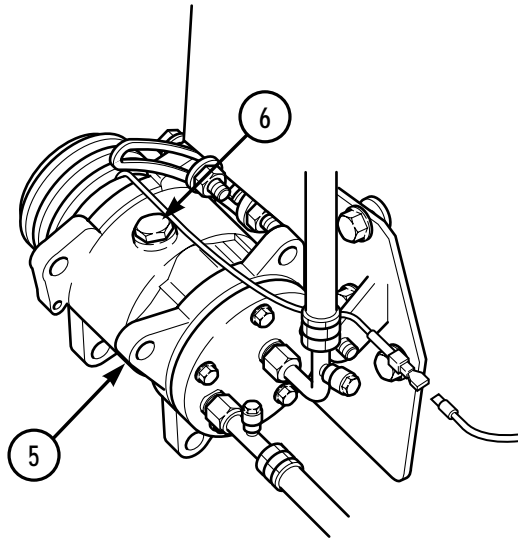
**NOTE**

- Do not allow refrigerant R-134 to escape too quickly. Refrigerant oil will escape.
- When high pressure gage and low pressure gage read “zero”, the compressor is discharged.



- (4) Turn low pressure gage valve (1) and high pressure gage valve (2) counterclockwise slightly to permit refrigerant in the compressor (5) to slowly escape through center hose (4) until gages read “zero”.
- (5) Close low pressure gage valve (1) and high pressure gage valve (2).
- (6) Remove fill plug dipstick (6) from compressor (5) and wipe clean.
- (7) Insert the dipstick to its stop position.
- (8) Remove dipstick from compressor (5) and count number of increments oil level is up to on dipstick.

**15-3. AIR CONDITIONING SYSTEM SERVICING (CONT)**

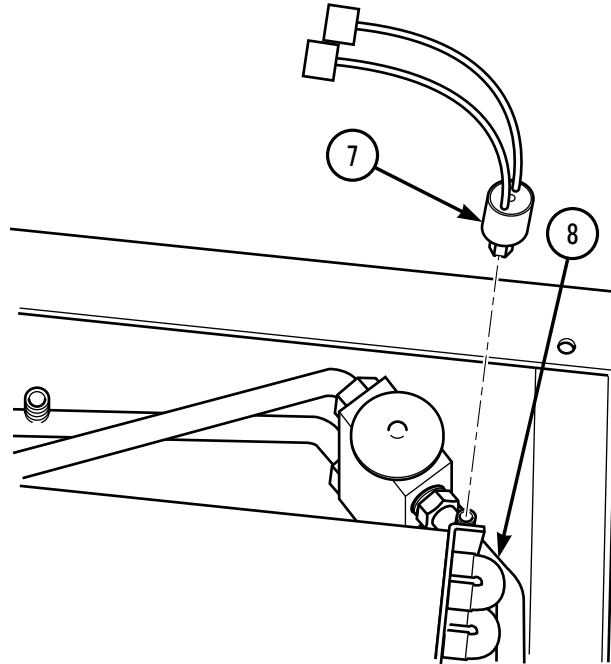


- (9) Oil level should be between six and eight increments on dipstick. Add or subtract oil as necessary to attain proper level.
- (10) Install fill plug dipstick (6) on compressor (5). Tighten fill plug dipstick (6) to 6-9 lb-ft (8-12 N•m).
- (11) Remove manifold gage set (refer to task b.).

**END OF TASK**



**15-4. AIR CONDITIONER HIGH PRESSURE AND LOW PRESSURE SWITCH REPLACEMENT (CONT)**

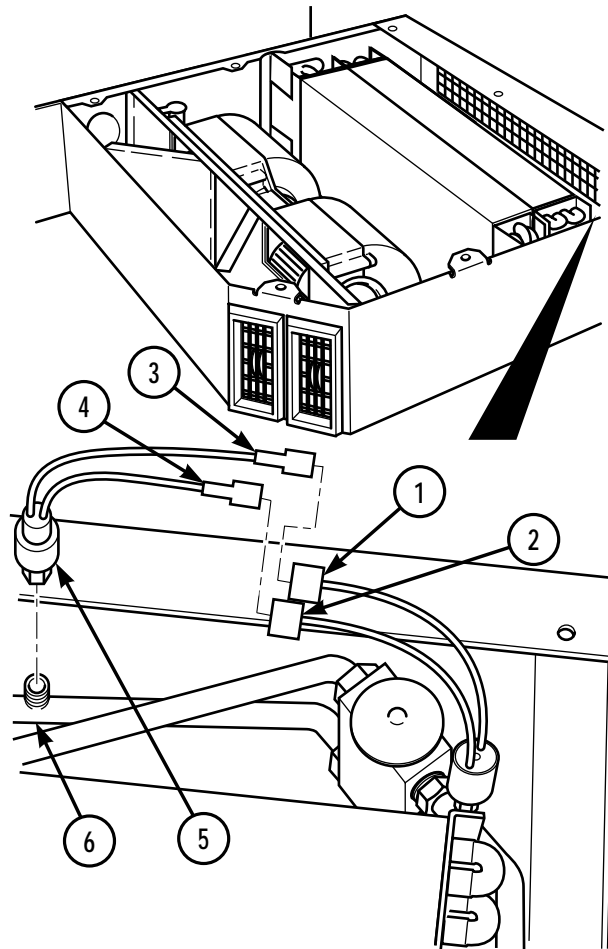


**(3) Remove low pressure switch (7) from air conditioner tube at expansion valve (8).**

***b. Installation.***

**(1) Install low pressure switch (7) on air conditioner tube at expansion valve (8).**





- (2) **Install high pressure switch (5) on air conditioner input tube (6).**
- (3) **Connect two wire connectors (3 and 4) to wire connectors (1 and 2).**

#### **NOTE**

Follow-on Maintenance:

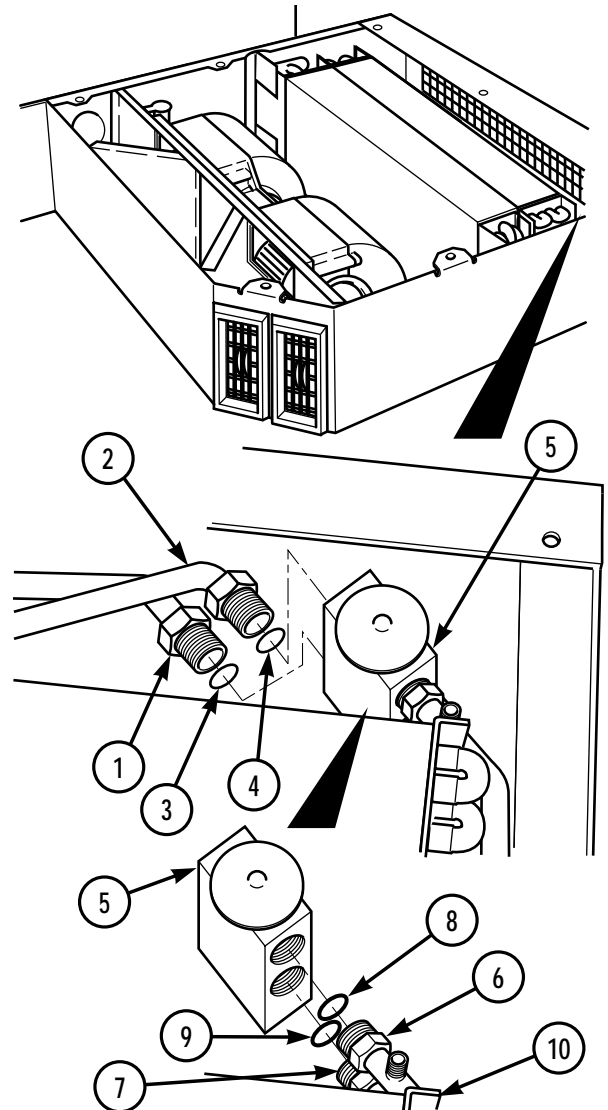
- Charge air conditioner system (Para 15-3).
- Install seat assembly (TM 10-3930-673-20).

**END OF TASK**



**b. Installation.**

- (1) Install two preformed packings (8 and 9) and expansion valve (5) on evaporator coil (10). Tighten two fittings (6 and 7).
- (2) Install two tubes (1 and 2) and preformed packings (3 and 4) on expansion valve (5).

**NOTE**

Follow-on Maintenance:

- Charge air conditioning system (Para 15-3).
- Replace receiver drier (Para 15-7).
- Install seat assembly (TM 10-3930-673-20).

**END OF TASK**

## 15-6. AIR CONDITIONER EVAPORATOR COIL REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

*Equipment Condition*

Expansion valve removed (Para 15-5)

*Materials / Parts*

Safety Glasses

- a. Removal. Remove evaporator coil (1) from heater coil (2) and base (3).**

**WARNING**

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

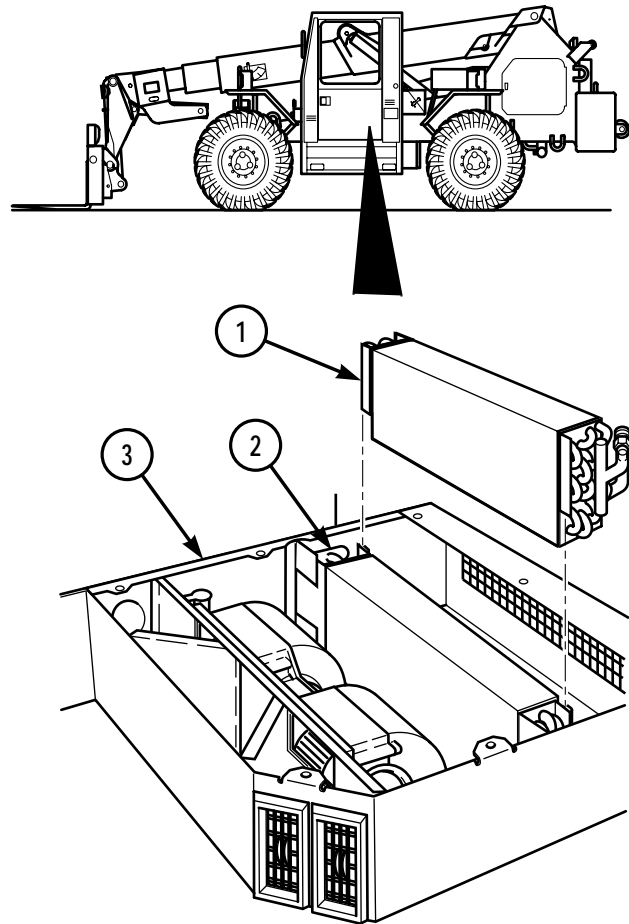
- b. Cleaning. Clean evaporator coil (1) with low pressure compressed air.**
- c. Inspection. Check evaporator coil (1) for cracks, breaks, bent fins, or other obvious signs of leakage. Replace leaking or damaged condenser coil.**
- d. Installation. Install evaporator coil (1) on base (3) and heater coil (2).**

**NOTE**

Follow-on Maintenance:

- Install expansion valve (Para 15-5).
- Replace receiver drier (Para 15-7).

**END OF TASK**

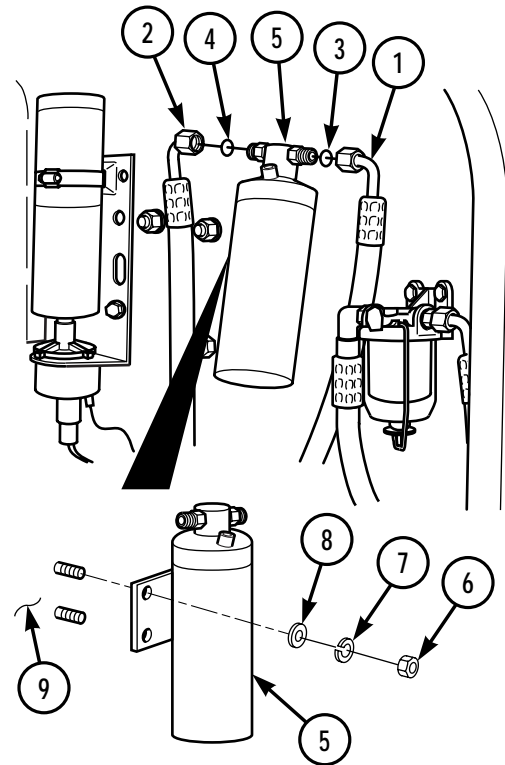




**15-7. RECEIVER DRIER REPLACEMENT (CONT)**

**b. Installation.**

- (1) Install receiver drier (5), two washers (8), lockwashers (7), and nuts (6) on frame (9) studs.
- (2) Install two hoses (1 and 2) and preformed packings (3 and 4) on receiver drier (5).



**NOTE**

Follow-on Maintenance: Charge air conditioner system (Para 15-3).

**END OF TASK**

## 15-8. AIR CONDITIONER CONDENSER COIL REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Cap and Plug Set (Item 1, Appendix D)

*Equipment Condition*

Radiator cover removed (TM 10-3930-673-20)  
Refrigerant recovered (Para 15-3)

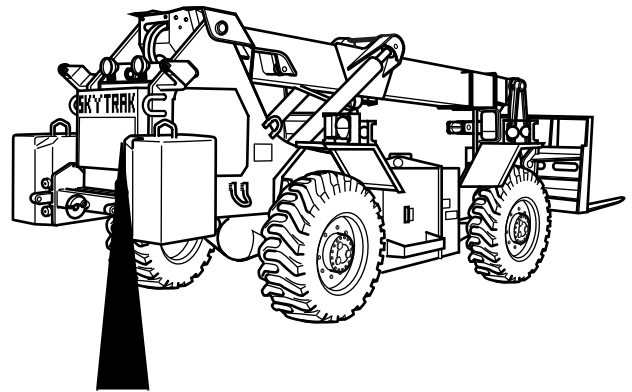
*Materials/Parts*

Rags (Item 35, Appendix B)  
Tags (Item 55, Appendix B)  
Lockwashers (8)  
Packings, Preformed (2)

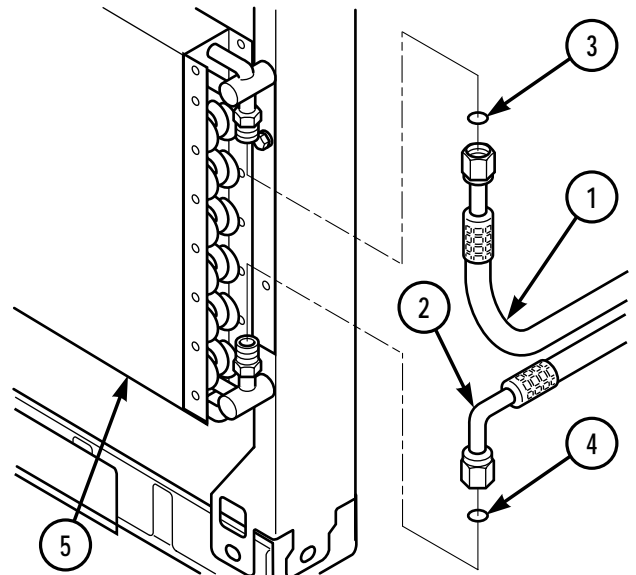
**a. Removal.**

**CAUTION**

Wipe the area clean around all A/C connections to be opened during removal and disassembly. Cap air conditioner hoses after removing hoses. Contamination of air conditioning system could result in premature failure.

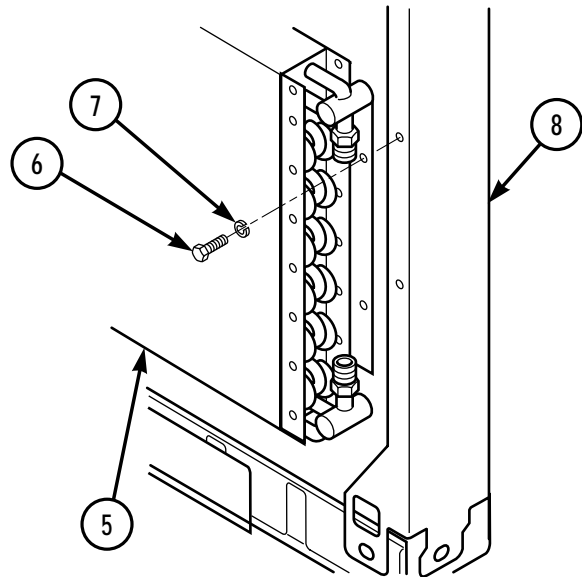


- (1) **Tag, mark, and remove two hoses (1 and 2) and preformed packings (3 and 4) from condenser coil (5). Discard preformed packing.**

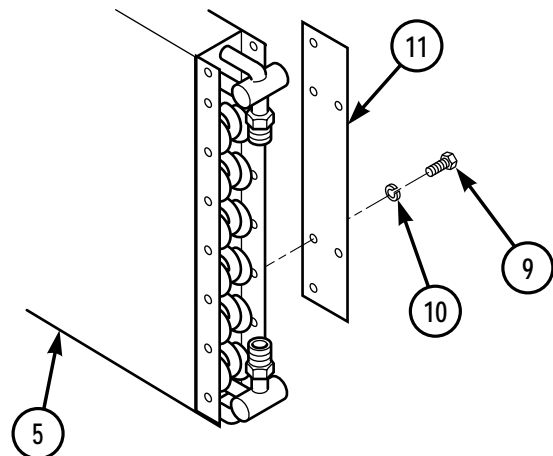


**15-8. AIR CONDITIONER CONDENSER COIL REPLACEMENT (CONT)**

- (2) Remove four screws (6), lockwashers (7), and condenser coil (5) from radiator (8). Discard lockwashers.



- (3) Remove four screws (9), lockwashers (10), and bracket (11) from condenser coil (5). Discard lockwashers.



**WARNING**

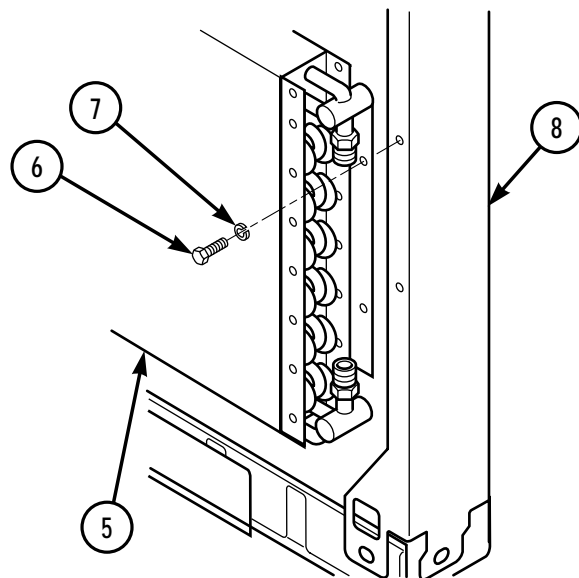
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

- b. Cleaning.* Clean condenser coil (5) with low pressure compressed air.
- c. Inspection.* Check condenser coil (5) for cracks, breaks, bent fins, or other obvious signs of leakage. Replace leaking or damaged condenser coil.
- d. Installation.*

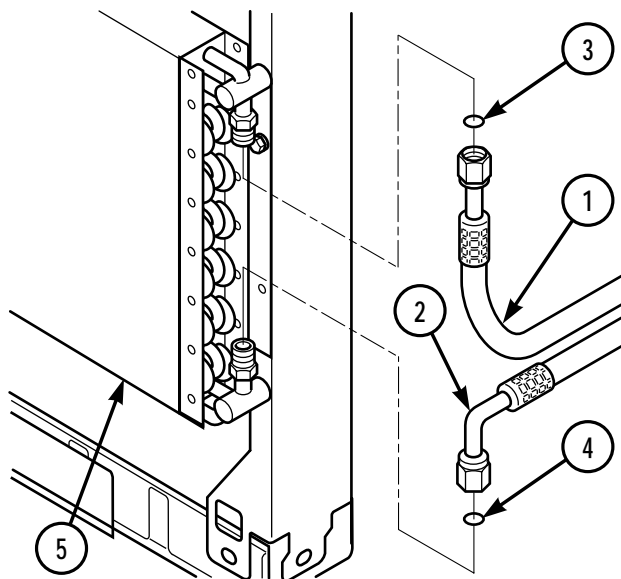
- (1) Install bracket (11), two lockwashers (10), and screws (9) on condenser coil (5).



- (2) Install condenser coil (5), lockwashers (7), and screws (6) on radiator (8).



- (3) Install preformed packings (3 and 4) and hoses (1 and 2) on condenser coil (5).



### NOTE

Follow-on Maintenance:

- Replace receiver drier (Para 15-7).
- Install radiator cover (TM 10-3930-673-20).
- Charge air conditioner system (Para 15-3).

**END OF TASK**

## 15-9. AIR CONDITIONER HOSES REPLACEMENT

This Task Covers:

- a. Removal
- b. Installation

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

*Materials/Parts*

Tags (Item 55, Appendix B)  
Packing, Preformed (10)

*Equipment Condition*

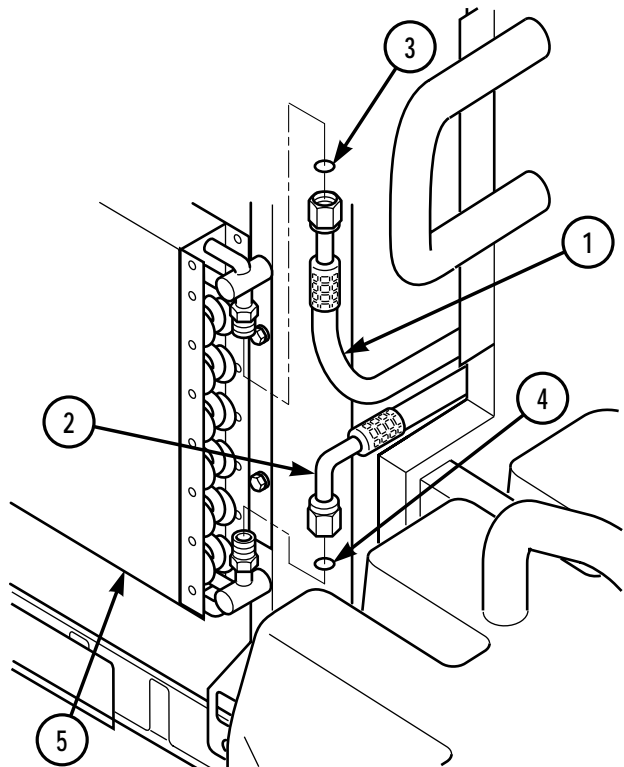
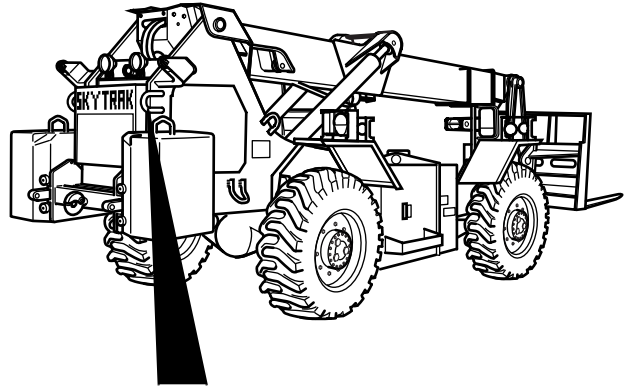
Seat assembly removed (TM 10-3930-673-20)  
Radiator cover removed (TM 10-3930-673-20)  
Refrigerant recovered (Para 15-3)

**a. Removal.**

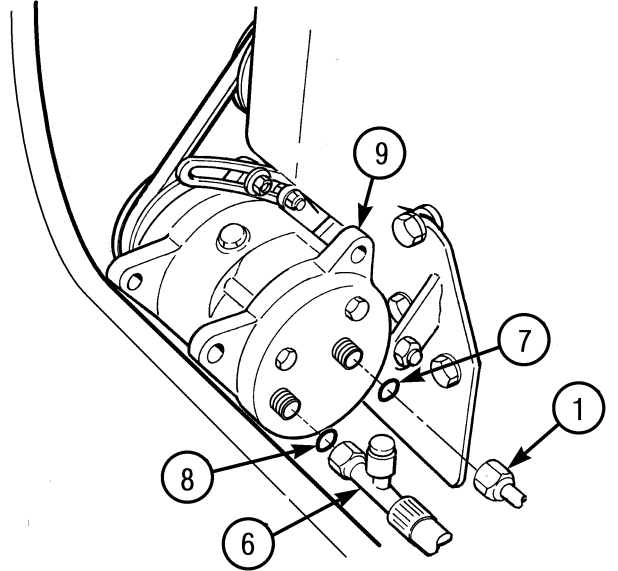
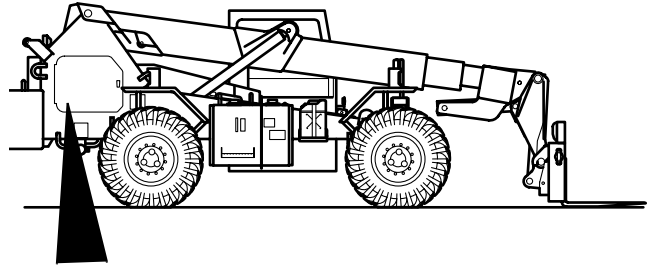
**CAUTION**

Wipe the area clean around all A/C connections to be opened during removal and disassembly. Cap air conditioner hoses after removing hoses. Contamination of air conditioning system could result in premature failure.

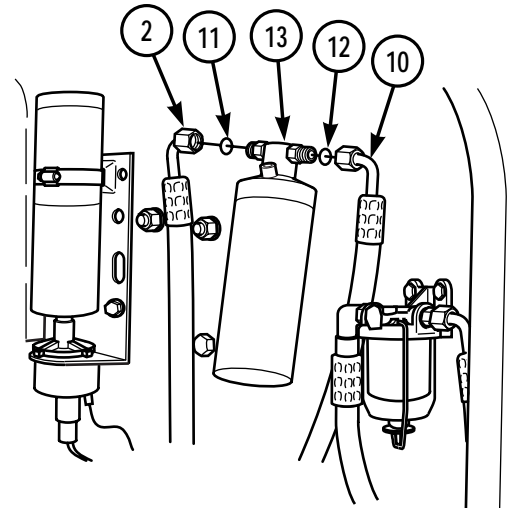
- (1) **Tag, mark, and remove two hoses (1 and 2) and preformed packings (3 and 4) from condenser coil (5). Discard preformed packing.**



- (2) Tag, mark, and remove two hoses (1 and 6) and preformed packings (7 and 8) from compressor (9). Discard preformed packings.

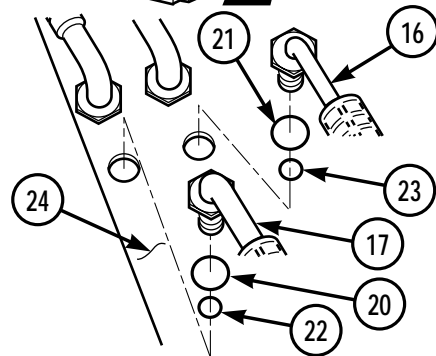
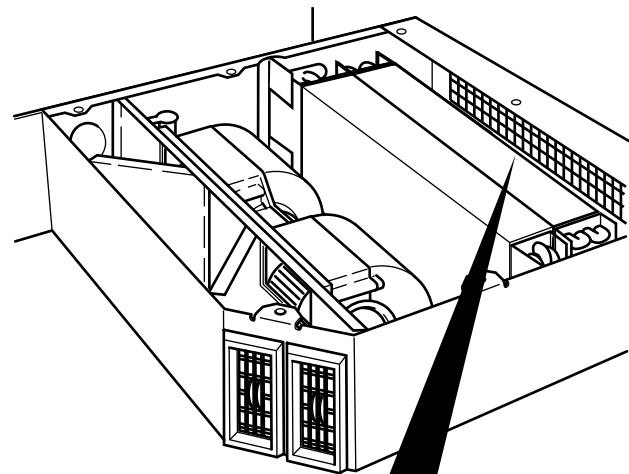
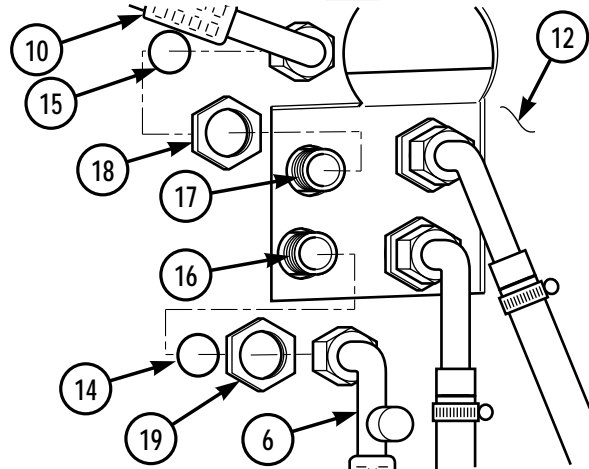
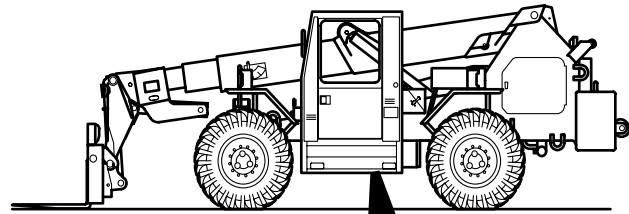


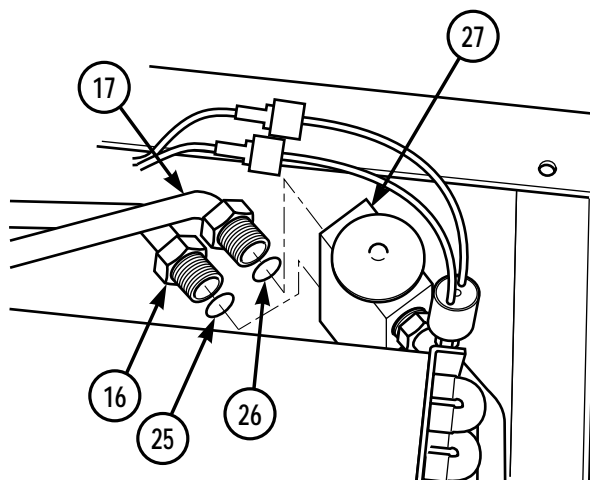
- (3) Tag, mark, and remove two hoses (2 and 10) and preformed packings (11 and 12) from receiver drier (13). Discard preformed packings.



**15-9. AIR CONDITIONER HOSES REPLACEMENT (CONT)**

- (4) Tag, mark, and remove two hoses (6 and 10) and preformed packings (14 and 15) from hoses (16 and 17). Discard preformed packings.
- (5) Tag and mark, two hoses (16 and 17). Remove two nuts (18 and 19), hoses, and four preformed packings (20 through 23) from cab (24). Discard preformed packings.





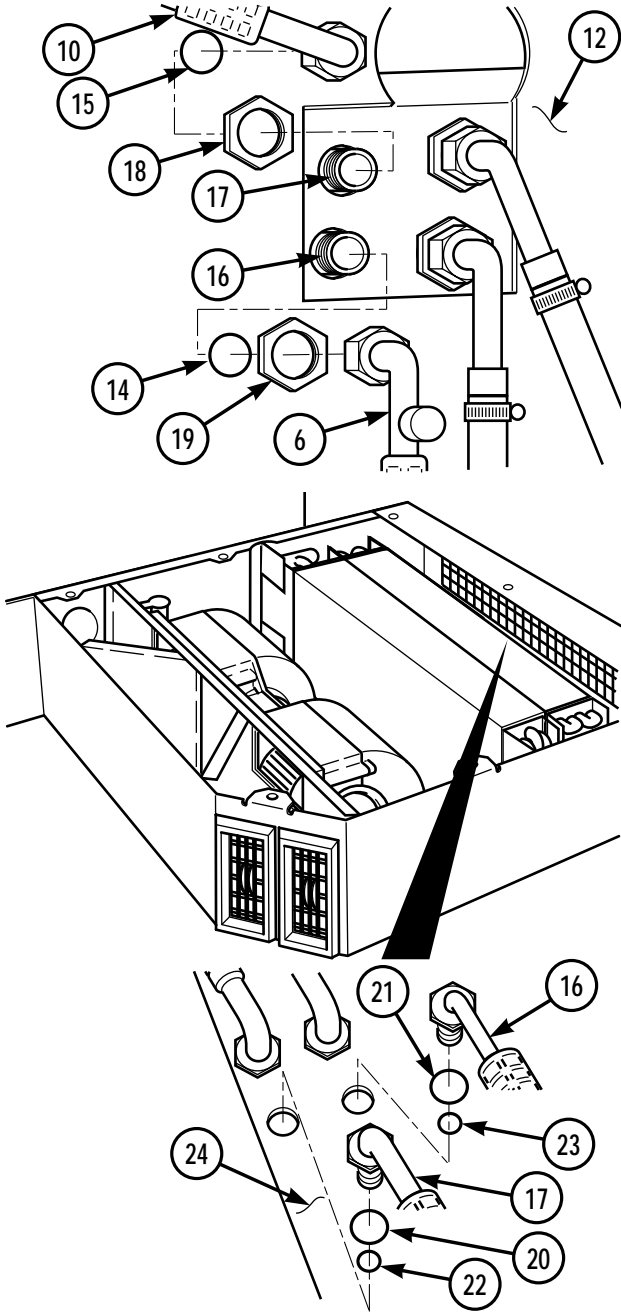
- (6) Tag, mark, and remove two hoses (16 and 17) and preformed packings (25 and 26) from expansion valve (27). Discard preformed packings.

***b. Installation.***

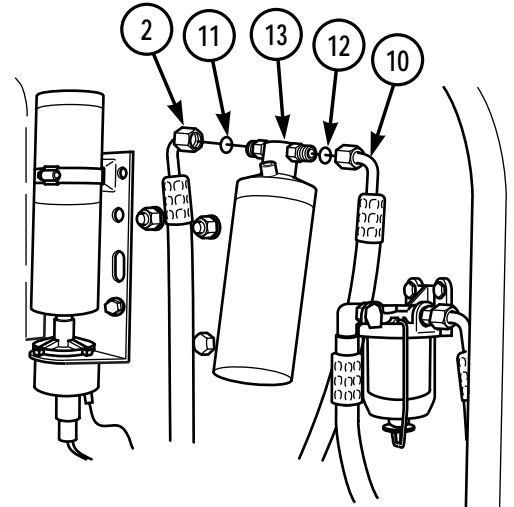
- (1) Install two preformed packings (25 and 26) and hoses (16 and 17) on expansion valve (27).

**15-9. AIR CONDITIONER HOSES REPLACEMENT (CONT)**

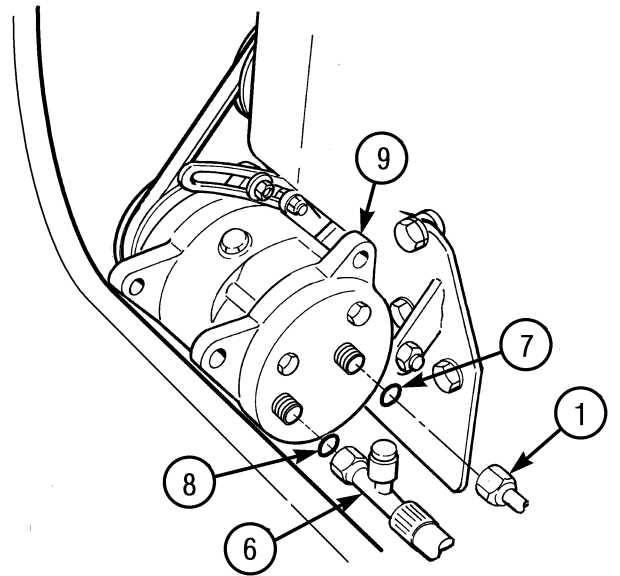
- (2) Install preformed packings (20 through 23), two hoses (16 and 17), and nuts (18 and 19) on cab (24).
- (3) Install two preformed packings (14 and 15) and hoses (6 and 10) on hoses (16 and 17).



- (4) Install two preformed packings (11 and 12) and hoses (2 and 10) on receiver drier (13).

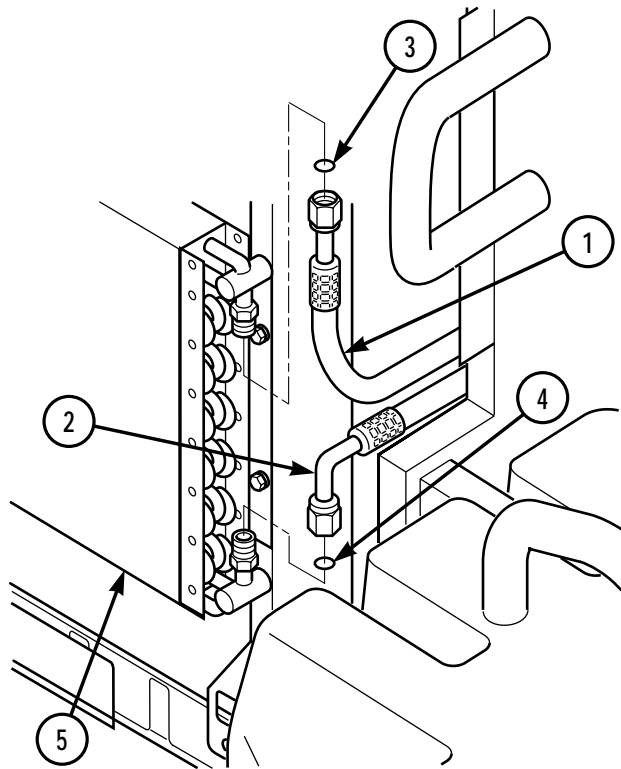


- (5) Install two preformed packings (7 and 8) and hoses (1 and 6) on compressor (9).



**15-9. AIR CONDITIONER HOSES REPLACEMENT (CONT)**

- (6) Install two preformed packings (3 and 4) and hoses (1 and 2) on condenser coil (5).



**NOTE**

Follow-on Maintenance:

- Replace receiver drier (Para 15-7).
- Charge air conditioner system (Para 15-3).
- Install seat assembly (TM 10-3930-673-20).

**END OF TASK**



**15-10. AIR CONDITIONER COMPRESSOR CLUTCH REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Puller Kit (Item 15, Appendix D)

*Equipment Condition*

Air conditioner compressor belt removed  
(TM 10-3930-673-20)  
Refrigerant recovered (Para 15-3)

*Materials/Parts*

Refrigerant Oil  
Container, 5 gal (19 l) capacity  
Key  
Locknut  
Locknut  
Locknut  
Preformed Packing  
Preformed Packing  
Retaining Ring  
Retaining Ring  
Retaining Ring

**a. Removal.**

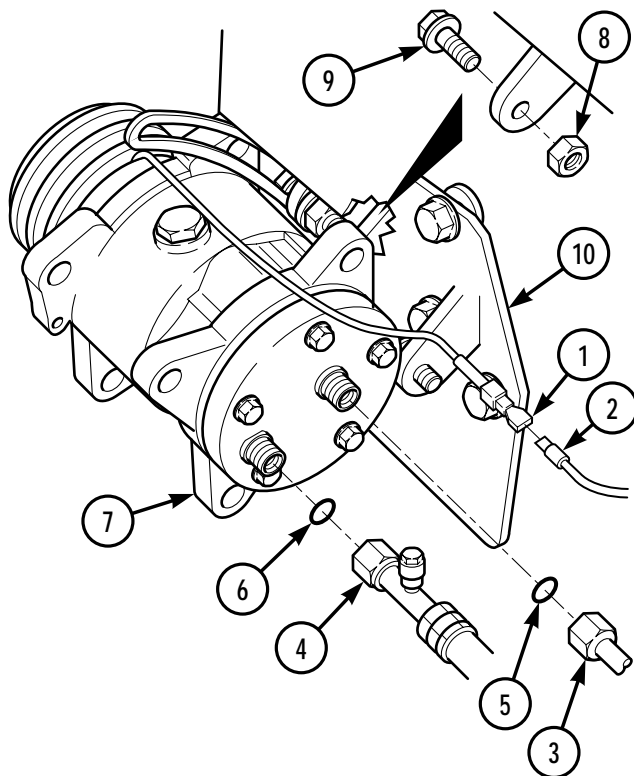
**WARNING**

Air conditioner compressors are shipped with a charge of inert gas to inhibit internal corrosion. Remove caps with great care to prevent personal injury.

**CAUTION**

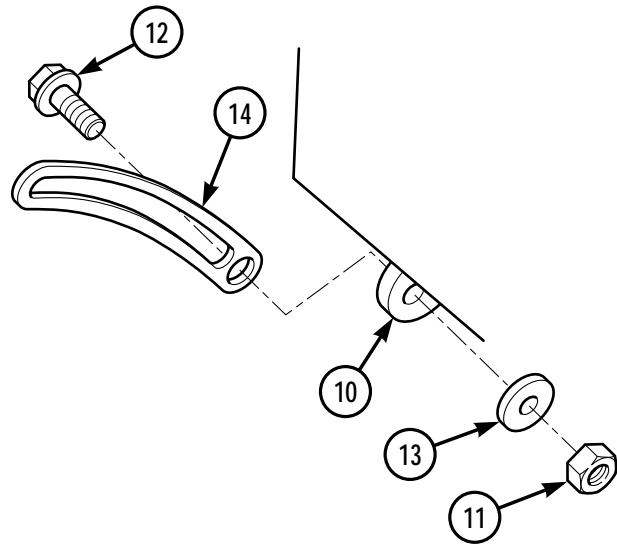
Wipe the area clean around all A/C connections to be opened during removal and disassembly. Cap air conditioner hoses after removing hoses. Contamination of air conditioning system could result in premature failure.

- (1) **Tag, mark, and disconnect wire connectors (1) from wire connector (2).**
- (2) **Tag, mark, and remove two hoses (3 and 4) and preformed packings (5 and 6) from compressor (7). Discard preformed packings.**
- (3) **Remove locknut (8), screw (9), and compressor (7) from mounting bracket (10). Discard locknut.**



**15-10. AIR CONDITIONER COMPRESSOR CLUTCH REPLACEMENT/REPAIR (CONT)**

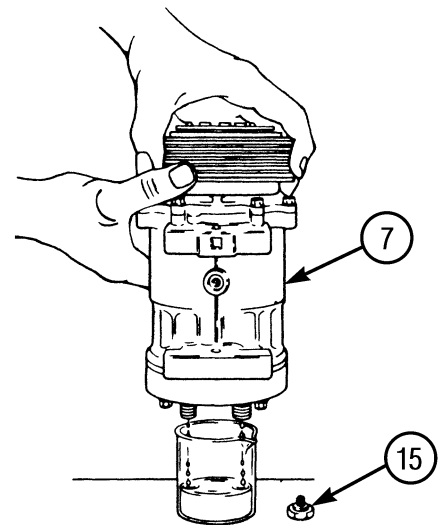
- (4) Remove locknut (11), screw (12), washer (13), and adjusting arm (14) from mounting bracket (10). Discard locknut.



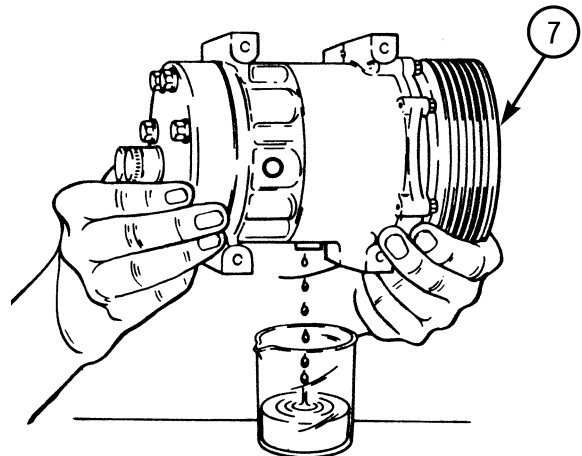
**b. Disassembly.**

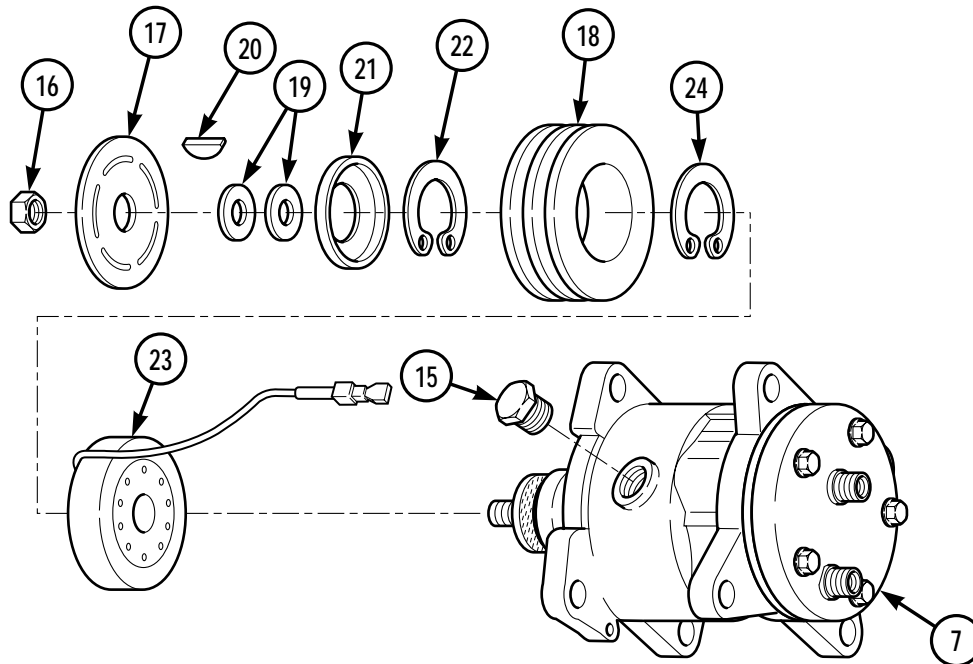
- (1) **Drain refrigerant oil from compressor (7).**

- (a) Remove plug (15) from compressor (7).  
 (b) Drain oil into a suitable container.



- (c) Remove caps (if present) and drain oil from compressor (7) suction and discharge ports into a suitable container.  
 (d) Measure and record amount of compressor oil drained from compressor (7).





- (2) Remove locknut (16) from compressor (7) shaft using spanner wrench to hold armature plate (17). Discard locknut.
- (3) Remove armature plate (17) using a suitable puller from rotor (18).

#### NOTE

Number of shims may vary.

- (4) Remove shims (19), key (20), and cover (21) from rotor (18). Discard key.

#### WARNING

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (5) Remove retaining ring (22) from rotor (18). Discard retaining ring.
- (6) Remove rotor (18) using a suitable puller from field coil assembly (23).

#### WARNING

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (7) Remove retaining ring (24) from field coil assembly (23). Discard retaining ring.
- (8) Loosen wire hold down screw and remove field coil assembly (23) from compressor (7).

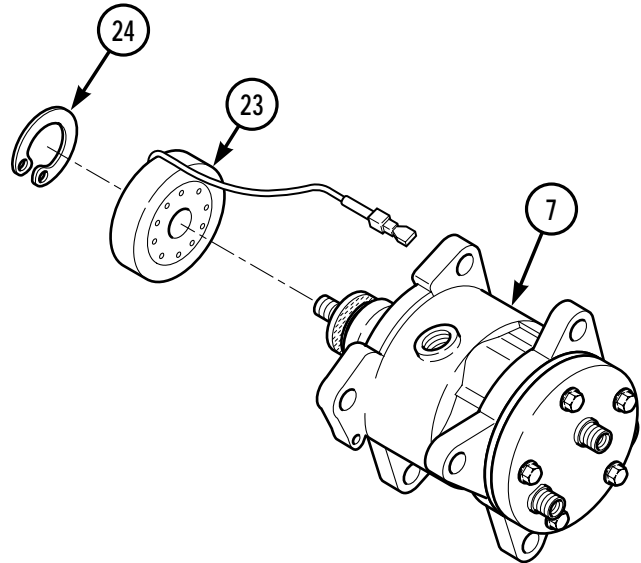
**15-10. AIR CONDITIONER COMPRESSOR CLUTCH REPLACEMENT/REPAIR (CONT)**

*c. Cleaning.* See Cleaning Instructions (Para 2-12).

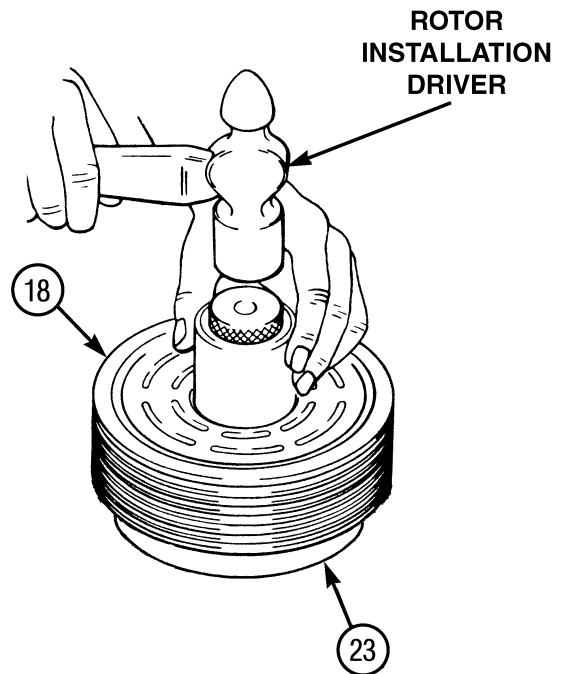
*d. Inspection.* See Inspection Instructions (Para 2-14).

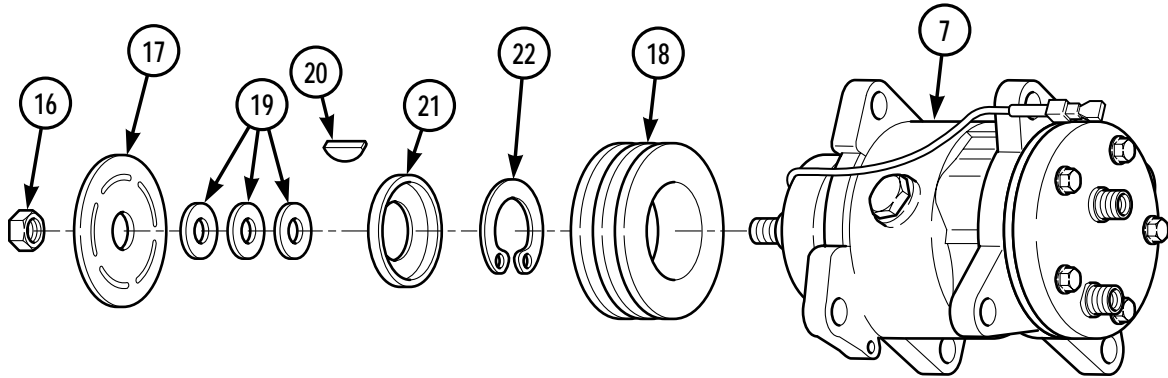
*e. Assembly.*

- (1) Install field coil assembly (23) on compressor (7) and tighten wire hold down screw.
- (2) Install retaining ring (24) in field coil assembly (23).



- (3) Install rotor (18) using rotor installation driver on field coil assembly (23).



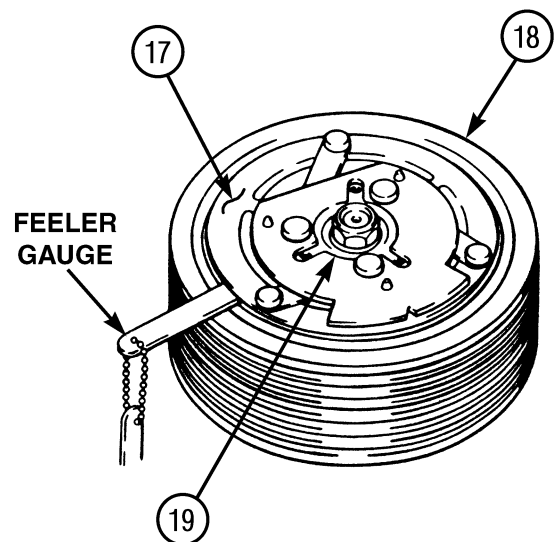


- (4) **Install retaining ring (22) on rotor (18).**
- (5) **Install cover (21), shims (19), and key (20) on rotor (18).**
- (6) **Install armature plate (17) on rotor (18).**
- (7) **Install locknut (16) on compressor (7) shaft. Tighten locknut to 20-25 lb-ft (27-34 N•m).**

- (8) **Measure armature plate (17) to rotor assembly (18) gap.**

Using a feeler gauge measure gap around armature plate (17) and rotor assembly (18). If gap is less than 0.016 in. (0.4 mm) or greater than 0.031 in. (0.8 mm) gently pry up on armature plate or tap down on armature plate. If gap is still not within specification remove armature plate and replace shims (19).

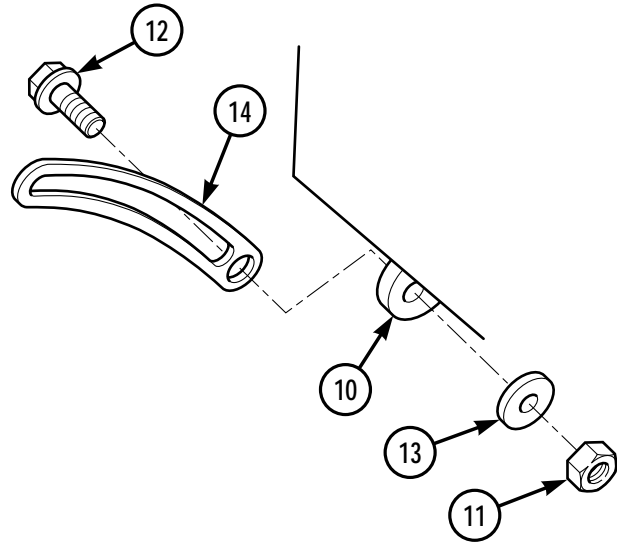
- (9) **Add same amount of refrigerant oil as was removed in disassembly Step (1).**
- (10) **Install plug (15) in compressor (7).**



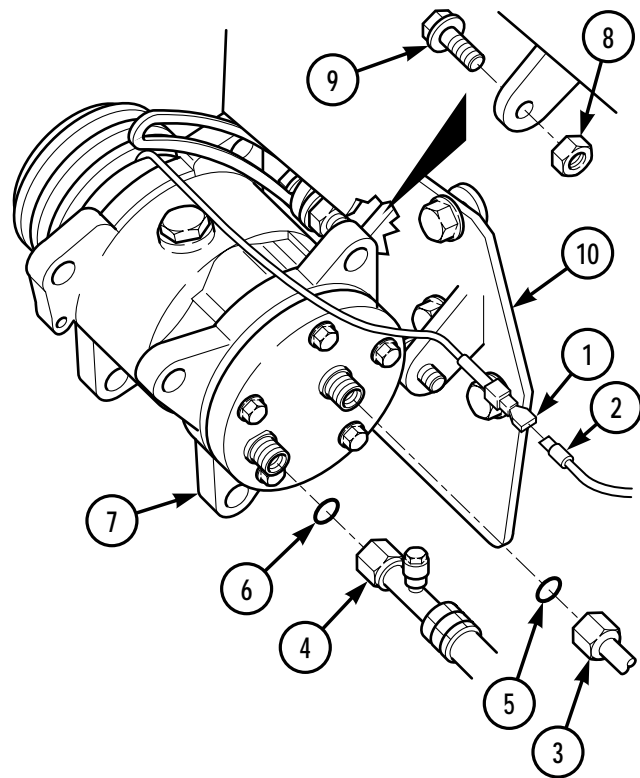
**15-10. AIR CONDITIONER COMPRESSOR CLUTCH REPLACEMENT/REPAIR (CONT)**

**f. Installation.**

- (1) **Install adjusting arm (14), washer (13), screw (12), and locknut (11) on mounting bracket (10).**



- (2) **Install compressor (7), screw (8), and locknut (8) on mounting bracket (10).**
- (3) **Install two preformed packings (5 and 6) and hoses (3 and 4) on compressor (7).**
- (4) **Connect wire (2) to wire (1).**



**NOTE**

Follow-on Maintenance:

- Replace receiver drier (Para 15-7).
- Charge air conditioner system (Para 15-3).

**END OF TASK**

## CHAPTER 16

### HYDRAULIC SYSTEM MAINTENANCE

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#### Section I. DESCRIPTION AND DATA

**16-1. GENERAL**

Hydraulic system maintenance procedures not covered in this chapter can be found in TM 10-3930-673-20.

**16-2. PRINCIPLES OF OPERATION**

**a. System Description.** The hydraulic system of the forklift supplies a controlled flow of filtered hydraulic oil for operation of the boom, carriage, forks, and frame tilt functions. Directions used in the system descriptions are as the reader is sitting in the operator's seat.

Principle components of the hydraulic system are detailed on pages 16-2 through 16-6. See the hydraulic schematics at the end of this manual for the connections among the components.

## 16-2. PRINCIPLES OF OPERATION (CONT)

A two section gear pump draws hydraulic oil from the hydraulic reservoir through the suction strainers whenever the engine is operating. The small section (1.48 cu. in.) of the gear pump supplies oil for the brake system, frame tilt function, and charge pressure oil for the axial-piston pump.

From the small section of the gear pump, oil flows past the relief valve. If system pressure exceeds 1750 psi (12066 kPa), oil pressure unseats the relief valve and allows excess oil to flow through the hydraulic filter back to the reservoir.

Past the relief valve, oil flows through the brake valve, through the frame tilt valve and finally to the axial-piston pump inlet port where the oil is used as charge pressure oil. The remaining oil flows back to the reservoir.

The large section (3.94 cu. in.) of the gear pump supplies oil to the priority valve for the steering system and to the main valve for boom hoist and extend functions. From the main valve, oil flows back through the hydraulic filter and is returned to the reservoir.

Oil flows from the large section of the gear pump to the priority valve. The steering system is first priority, receiving a portion of the total oil flow first. When the steering system is satisfied, oil pressure increases and moves the spool to return the total oil flow to the main valve. A load sensing line from the steering valve to the spring end of the priority spool monitors the pressure in the steering valve, to insure proper oil flow and pressure is provided to the steering valve. When the steering cylinder bottoms, pressure in the steering valve increases. The pilot pressure is relieved through the 2500 psi (17236 kPa) relief valve in the priority valve and all the remaining pump flow is directed to the main valve.

The variable displacement, axial-piston pump supplies oil flow for attachment control valve which controls fork, carriage, and attachment functions. The piston pump also supplies oil flow to the hydraulic joystick through the shuttle valve. The shuttle valve closes the port from the emergency steer pump during normal piston pump operation.

The piston pump utilizes specifically designed control valves which is the "brain" of the piston pump and its related hydraulic functions. The valves control delivery of oil flow and pressure in amounts only as required by the function that is operated. Both flow and pressure are tailored to the specific load. All adjustments by the control valves occur in fractions of a second.

When functions of the attachment control valve are idle, the pump is in "stand-by" mode. The load sensing line from the attachment control valve senses no load (zero pressure). Therefore, pump output pressure is controlled only by spring force of the compensator (low pressure) spool spring. The pump will continue its low output until the spring force of the compensator is overcome by the load sensing pressure. Oil from the compensator spool holds the swash plate to near vertical position. The pump is allowed to supply only enough oil flow to meet normal attachment control valve leakage and output pressure is maintained at approximately 400 psi (2758 kPa).

When one or more of the attachment control valves are actuated, the pump goes into "pumping" mode. The load sensing line from the attachment control valve is pressurized by the function experiencing the highest pressure. This pressure is fed back to the compensator spool. The pump continues its output until the load sensing pressure overcomes the compensator spool spring force. Oil from the compensator spool moves the swash plate to an angle that will provide the pump with an output equal to the load sense pressure plus approximately 400 psi (2758 kPa). Therefore the pump will supply only enough flow and pressure to perform the function(s).



The pump is in "maximum high pressure" mode when load sensing line pressure reaches approximately 3625 psi (24994.4 kPa). The high pressure spool compresses the spring and allows oil to move the swash plate to near vertical position. Oil flow from the compensator spool is stopped and now the pump will supply oil flow to meet circuit leakage and output pressure is maintained at approximately 3625 psi (24994.4 kPa).

The piston pump is connected to the reservoir so any additional oil required is readily available. Any by-pass oil in the pump can be returned to the reservoir through the drain line.

Return oil from the main valve, steering valve, relief valve of the priority valve, brake valve, and relief valve passes through the hydraulic filter before entering the reservoir. The filter is equipped with a bypass which has a visual indicator showing when bypass is occurring.

**b. Frame Tilt System.** The frame tilt valve has three operating positions, tilt right, tilt left, and hold. The center position is the hold position.

With the frame tilt valve lever in the hold (center) position, the hydraulic oil is trapped in the cylinder and lines. The cylinder cannot move. Oil flow from the brake valve, which originates from the small section of the gear pump, continues to the piston pump inlet port and returns to the reservoir through the frame tilt valve.

By moving the frame tilt valve lever forward, the cylinder is extended and tilts the machine to the left. Oil flows to the counterbalance valve for the head end of the cylinder, unseats the ball check, and enters the cylinder. Pressure in the head end begins to increase because oil in the rod end of the cylinder is trapped; the rod end counterbalance valve is closed and ball is seated. The pressure in the head end pilots open the counterbalance valve for the rod end. Oil can now flow from the rod end of the cylinder, allowing the cylinder to extend. Oil from the rod end of the cylinder continues on to the piston pump inlet port and returns to the reservoir.

Moving the frame tilt valve rearward, the cylinder is retracted and tilts the machine to the right. Oil flows to the rod end of the cylinder and pilots open the head end counterbalance valve. Oil flows through the tilt cylinder in the opposite direction of the tilt left function. Oil from the head end is routed to the piston pump inlet port and the reservoir.

All counterbalance valves in hydraulic cylinders also serve as a safety device in case of hose burst or power loss. The counterbalance valves require pressure to pilot them open which will then allow oil to flow. If pressure is removed the counterbalance valve closes and stops the oil from flowing; the cylinder is "locked up".

**c. Boom Hoist System.** The boom hoist function is controlled by the hydraulic joystick and the main valve. Pilot oil for the hydraulic joystick is routed through the shuttle valve from the piston pump. The pilot return oil is routed to the hydraulic reservoir.

As the hydraulic joystick is moved towards the rear, pilot pressure oil is allowed to flow into the left bottom pilot port of the main valve. The pilot pressure oil pushes the left (boom) spool up, allowing oil to flow through the main valve to the lower work port for the hoist cylinders. Oil flows to the counterbalance valve in the cylinders, unseats the ball check, and enters the head end of the cylinders. The oil pressure pushes the pistons up extending the cylinders, thereby raising the boom. Oil in the rod end of the cylinders is routed through ball check of the flow control, the main valve and to the reservoir through the hydraulic filter.

With the hydraulic joystick in the center position, the pilot oil flow is blocked and each valve in the joystick is connected to the return line to the hydraulic reservoir. The spools of the main control valve are kept in the center position by springs which provides passage for the oil through the valve and back to the reservoir through the hydraulic filter.

## 16-2. PRINCIPLES OF OPERATION (CONT)

As the hydraulic joystick is moved forward, pilot pressure oil is allowed to flow into the left top pilot port of the main valve. The pilot pressure oil pushes the left (boom) spool down, allowing oil to flow through the main valve and orifice of the flow control valve to the rod end of the hoist cylinders. Oil pressure pilots open the counterbalance valve to allow oil in the head end of the hoist cylinders to flow through the main valve and to the reservoir through the hydraulic filter. The orifice controls the rate at which the cylinders are retracted. Boom is lowered at the same rate whether the forks are carrying a load or not.

If working pressure in the boom lift circuit exceeds 3050 psi (21029.75 kPa), the relief valve in the main valve opens allowing overflow to the return circuit until the pressure decreases below the relief setting. The boom lower circuit relief functions the same way but the port relief valve is set at 950 psi (6206 kPa).

A port relief in the main valve protects the boom hoist circuit from hydraulic shocks or spikes when the counterbalance relief setting is exceeded and main valve spools are closed. When a spike is sensed at the port relief valve, the relief valve is piloted open and allows the excess pressure to be relieved to the return line. As soon as the pressure drops below the port relief valve setting, the valve will close. The port relief valve is set at 3250 psi (22408.75 kPa).

**d. Boom Extend System.** The boom extend function is controlled by the hydraulic joystick and the main valve. Pilot oil for the hydraulic joystick is routed through the shuttle valve from the piston pump. The pilot return oil is routed to the hydraulic reservoir.

As the hydraulic joystick is moved to the right, pilot pressure oil is allowed to flow into the bottom center pilot port of the main valve. The pilot pressure oil pushes the center section (extend) spool up, allowing oil to flow through the main valve, out the work port and to the right (head end) port of the boom extend cylinder.

Oil flows to the counterbalance valves of the extend cylinder similar to the frame tilt cylinder and retracts the cylinder. From the head end of the cylinder, oil is routed back to the main valve work port and to the reservoir through the hydraulic filter.

With the hydraulic joystick in the center position, the pilot oil flow is blocked, as in the boom hoist system. Centering springs keep the extend spool of the main control valve in the center position.

As the hydraulic joystick is moved to the left, pilot pressure oil is allowed to flow into the top center pilot port of the main valve. The pilot oil pressure pushes the center section (extend) spool down, allowing oil to flow through the main valve, out the work port and to the left (rod end) port of the boom extend cylinder.

Oil flows to the counterbalance valves of the extend cylinder similar to the frame tilt cylinder and retracts the cylinder. From the head end of the cylinder, oil is routed back to the main valve work port and to the reservoir through the hydraulic filter.

If working pressure in the boom extend circuit exceeds 3050 psi (21029.75 kPa), the relief valve in the main valve opens allowing overflow to the return circuit until the pressure decreases below the relief setting.

A port relief set at 3250 psi (22408.75 kPa) protects the boom extend function from hydraulic shocks or spikes, similar to the boom hoist function.

**e. Attachment System.** The attachment function is controlled by the electric joystick and the attachment control valve. Hydraulic oil flow from the axial piston pump supplies oil pressure and flow for attachment control valve pilot and function operations. A load sensing line from the attachment control valve to the piston pump adjusts the pump output. Pilot shuttles in each valve section, allow the pressure of the function

with the greatest load to be sensed by the pump. As the load of the attachment control valve changes, the position of the swash plate angle changes in the piston pump.

When the electric joystick is in the center position, all solenoids of the attachment control valve are de-energized and centering springs keep the control valve spools in the center (hold) position.

By moving the electric joystick forward, the top left solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the top section towards the right of the machine. The main flow of hydraulic oil goes through the top section, pilots open a load check poppet and allows oil to flow from the work port to the attachment cylinder. Oil enters the left (rod end) port of the cylinder. The oil pilots open the counterbalance valve on the head end of the cylinder, allowing oil to flow from the head end of the cylinder. The cylinder retracts, lowering the attachment. Oil from the cylinder enters the work port of the top section of attachment control valve and is directed to the return circuit where it is sent to the hydraulic reservoir through the hydraulic filter.

The load compensating check valve moves up and down as the load and pump pressure change. If the load increases, the pressure in the work port increases and pushes on the spring side of the load compensating check valve to block oil passage to the work port. At this short instance, the load compensating check valve is operating as a load hold check valve. Increased work port pressure is also sent to the piston pump through the sensing line. The pump output pressure increases sufficiently to maintain the 400 psi (2758 kPa) pressure differential. The increase in pump pressure is now sensed at the smaller end of the load compensating check valve and the valve moves up allowing oil flow to the work port again.

If the electric joystick is moved rearward, the top right solenoid is energized. The oil flow through top section of the attachment control valve is similar to the retract function but the oil flow to the cylinder is reversed. Oil pressure unseats the ball check in the counterbalance valve on the head end and forces the rod out of the cylinder. The cylinder extends and raises the attachment.

The maximum pressure in all the circuits of the attachment control valve is controlled by the maximum discharge of the pump which is 3300 psi (22753.5 kPa).

**f. Carriage Tilt System.** The carriage tilt function is also controlled by the electric joystick and the attachment control valve. Hydraulic oil from the piston pump flows through the control valve the same as for the above attachment system.

Move the electric joystick to the left and the second from the top right solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the second section towards the left of the machine. Oil flows through the second section, pilots open a load compensating check valve and flows from the work port to the rod end ports of both carriage tilt cylinders. The load compensating check valve operation is the same as described in the attachment system. Oil pressure unseats the ball check in the counterbalance valve on the rod end and pushes the cylinder piston in each cylinder. Oil in the head end of the cylinder flows from the head end port and back to the attachment control valve. The cylinder retracts which raises the fork tips. Oil from the tilt cylinders is directed to the attachment control valve return circuit and back to the hydraulic reservoir through the hydraulic filter.

If the electric joystick is moved to the right, the second from the top left solenoid is energized. The oil flow through the second section is similar to the fork tips raise function but the oil flow to the tilt cylinders is reversed. Oil flows to the head end of the tilt cylinders and pilots open the counterbalance on the rod end of the cylinders. Oil is allowed to flow from the rod end and back to the return circuit of the attachment control valve. The cylinders extend and lower the fork tips.

A port relief valve set at 4000 psi (27580 kPa) is connected to the rod end of the tilt cylinders. The relief valve protects the hydraulic lines from bursting when shocks or spikes are encountered on the rod side of the cylinder.

**16-2. PRINCIPLES OF OPERATION (CONT)**

The fork tips lower port relief valve is connected to the head end of the cylinders. The relief valve is set at 725 psi (5064 kPa) to limit any external upward force on the forks.

**g. Fork Sideshift System.** The fork sideshift function, as with the previous two functions, is controlled by the electric joystick and the attachment control valve. Hydraulic oil from the piston pump flows through the control valve as in the other two systems. The third section of the attachment valve controls the left fork (right cylinder) and the bottom (fourth) section controls the right fork (left cylinder).

Push the button on top of the electric joystick and move the joystick to the left and the third from the top right solenoid is energized. The solenoid allows pilot oil to flow through the solenoid and push the spool in the third section towards the left of the machine. System oil flows through the third section, pilots open a load compensating check valve and allows oil to flow from the work port to the head end port of right cylinder which moves the left fork to the left. Oil in the rod end of the cylinder flows back to the return circuit of the attachment control valve.

If the button is held and the electric joystick is moved to the right, the third from the top left solenoid is energized. The oil flow through the third section of the attachment control valve is similar to the above left fork motion but the flow to the cylinder is reversed. Oil pressure is sent to the rod end port of the right cylinder which retracts the cylinder and moves the left fork to the right.

The above description of hydraulic function for the left fork can also be applied to the right fork. The button is held down while the electric joystick is moved front to rear to control the right fork position.

While holding button down on top of the electric joystick and moving the joystick diagonally from center will energize two solenoids at the same time. These four diagonal positions can move the forks apart, together, both right, or both left depending on which combination of solenoids is used.

## Section II. HYDRAULIC SYSTEM MAINTENANCE PROCEDURES

### 16-3. TANDEM GEAR PUMP REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

#### INITIAL SETUP

*Tools and Special Tools*

- Took Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)
- Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m)  
(Item 28, Appendix D)
- Seal Removal Tool - Fabricated Tool  
(Figure C-1, Appendix C)

*Equipment Condition*

- Tandem gear pump removed  
(TM 10-3930-673-20)

*Materials/Parts*

- Compound, Sealing (Item 40, Appendix B)
- Compound, Sealing (Item 47, Appendix B)
- Grease (Item 18, Appendix B)
- Oil, Lubricating Hydraulic  
(Item 30, Appendix B)
- Rags, Lint-free (Item 34, Appendix B)
- Seal
- Seal
- Seal
- Seal
- Seal (2)
- Seal
- Seal (2)
- Seal
- Seal

**a. Disassembly.**



Prying notches are provided between the pump sections. If prying off sections becomes necessary, take extreme care not to mar or damage machined surfaces. Excessive force while prying can result in misalignment and damaged parts.

- (1) **Place pump in a vise with soft jaws and drive shaft pointing down. Mark all sections to be used for alignment at assembly.**

**16-3. TANDEM GEAR PUMP REPAIR (CONT)**

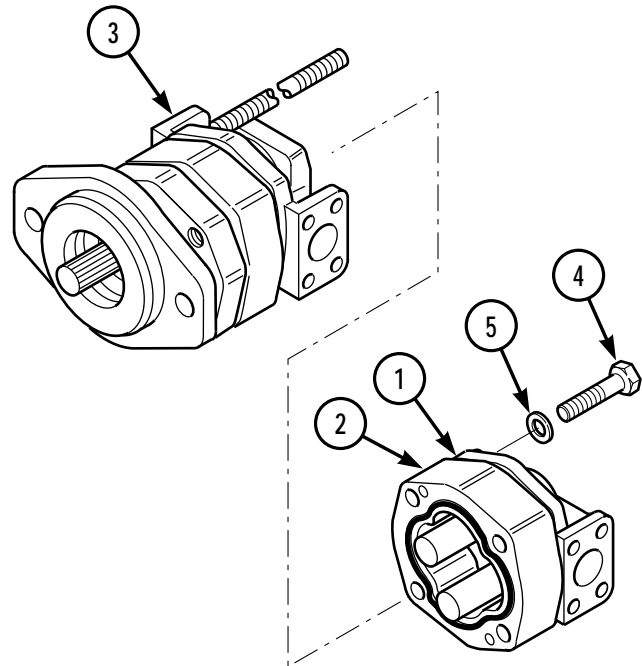
(2) **Remove cover (1) and gear housing (2) from bearing carrier (3).**

(a) Remove four screws (4) and washers (5) from cover (1).

**NOTE**

Dowel pins will stay in gear housing or bearing carrier.

(b) Remove cover (1) and gear housing (2) from bearing carrier (3).



**NOTE**

Note orientation of thrust plates for aid in installation.

(c) Remove thrust plate (6) and seals (7 and 8) from gear housing (2). Discard seals.

**CAUTION**

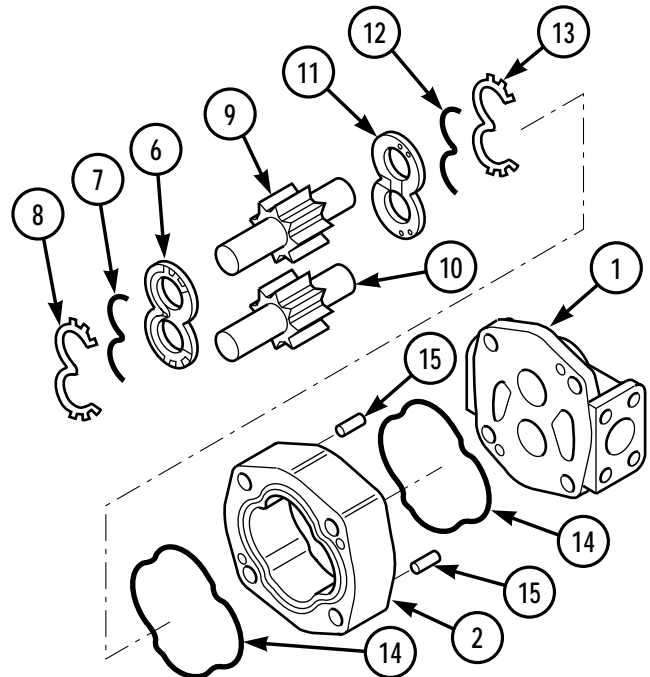
Gears are closely machined, and must be kept together as sets when removed from gear housing. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals.

(d) Remove drive gear (9) and driven gear (10) from gear housing (2). Keep drive gear and driven gear together as a matched set.

(e) Remove thrust plate (11) and seals (12 and 13) from gear housing (2). Discard seals.

**NOTE**

Dowel pins will stay in cover or gear housing.



- (f) Remove cover (1) from gear housing (2).
- (g) Remove two seals (14) from gear housing (2). Discard seals.
- (h) If damaged, remove dowel pins (15) from cover (1) and gear housing (2).

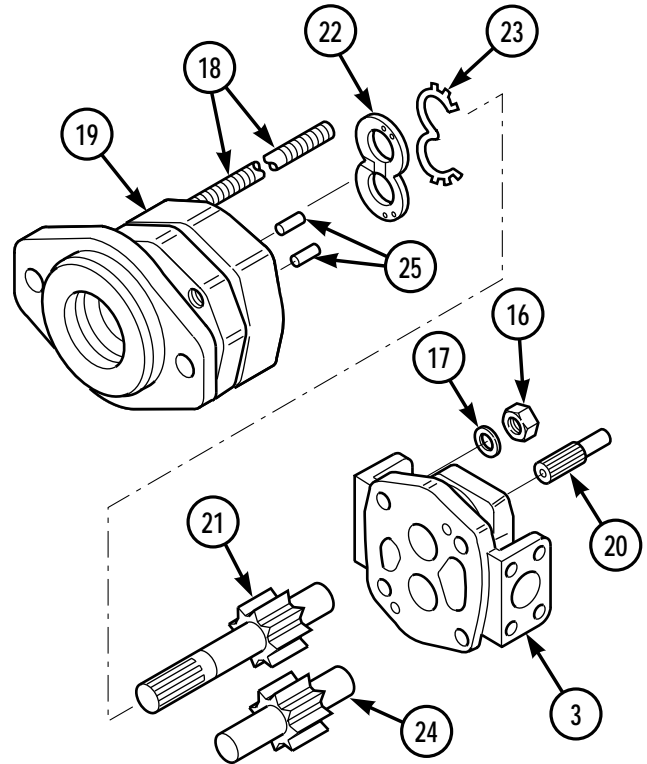
**(3) Remove bearing carrier (3) and parts (16, 17, and 20 through 25) from gear housing (19).**

- (a) Remove four nuts (16) and washers (17) from studs (18).

**NOTE**

Dowel pins will stay in gear housing or bearing housing.

- (b) Remove bearing carrier (3) from gear housing (19).
- (c) Remove connecting shaft (20) from drive gear (21).
- (d) Remove thrust plate (22) and seal (23) from gear housing (19). Discard seal.



**CAUTION**

Gears are closely machined, and must be kept together as sets when removed from gear housing. Handle with care to avoid damage to the journals or teeth. Avoid touching gear journals.

- (e) Remove drive gear (21) and driven gear (24) from gear housing (19).
- (f) If damaged, remove dowel pins (25) from gear housing (19) and bearing carrier (3).

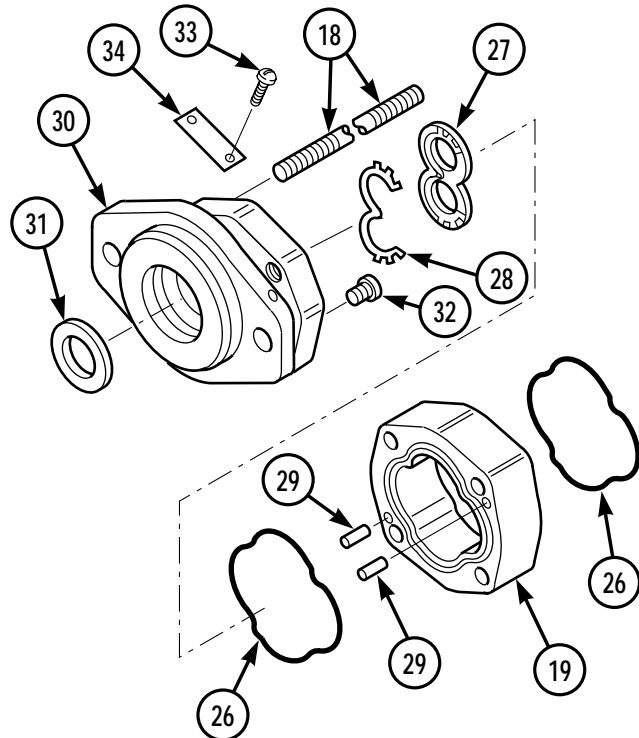
**16-3. TANDEM GEAR PUMP REPAIR (CONT)**

- (4) **Remove gear housing (19) and parts (26 through 29) from end cover (30).**

**NOTE**

Dowel pins will remain in gear housing or end cover.

- (a) Remove gear housing (19) from end cover (30).
- (b) Remove two seals (26) from gear housing (19). Discard seals.
- (c) Remove thrust plate (27) and seal (28) from gear housing (19). Discard seal.
- (d) If damaged, remove dowel pins (29) from gear housing (19) or end cover (30).



- (5) **Remove parts (18, and 31 through 34) from end cover (30).**

**CAUTION**

Do not grip on or near any machined surfaces during disassembly or assembly. Failure to follow this precaution will cause part damage.

- (a) Place end cover (30) in a vise with mounting side face down.
- (b) Insert fabricated seal removal tool into notch between seal (31) and end cover (30). Tap seal out to remove from end cover. Discard seal.
- (c) If damaged, remove plug (32) from end cover (30).
- (d) If damaged, remove two screws (33) and plate (34) from end cover (30).
- (e) Remove four studs (18) from end cover (30).

**b. Cleaning. See Cleaning Instructions (Para 2-12).**



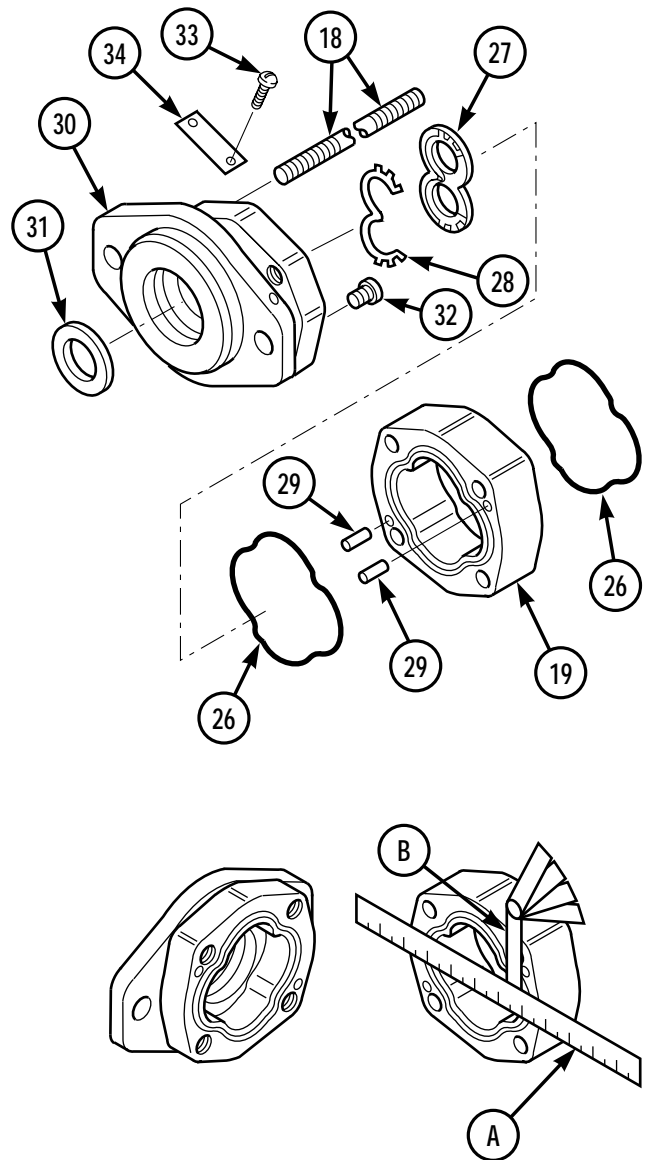
**c. Inspection.**

**(1) Inspect gear housings (19 and 30). Replace gear housings if wear exceeds 0.007 in. (0.18 mm) cutout.**

- (a) Place a straightedge (A) across the bore. If a 0.007 in. (0.18 mm) feeler gauge (B) can be slipped under the straightedge in cutout area, replace gear housing.
- (b) If cutouts are 0.007 in. (0.18 mm) or less, gear housing is in good condition and may be used.

**(2) Inspect thrust plates (6, 11, 22 and 27) for wear, scoring, pitting, or eroding.**

- (a) Erosion indicates oil contamination. Pitted thrust plates indicate cavitation or oil aeration. Discolored thrust plates indicate overheating, probably insufficient oil.
- (b) Replace thrust plates if wear exceeds 0.002 in. (0.05 mm)
- (c) See Inspection Instructions (Para 2-14).



**16-3. TANDEM GEAR PUMP REPAIR (CONT)**

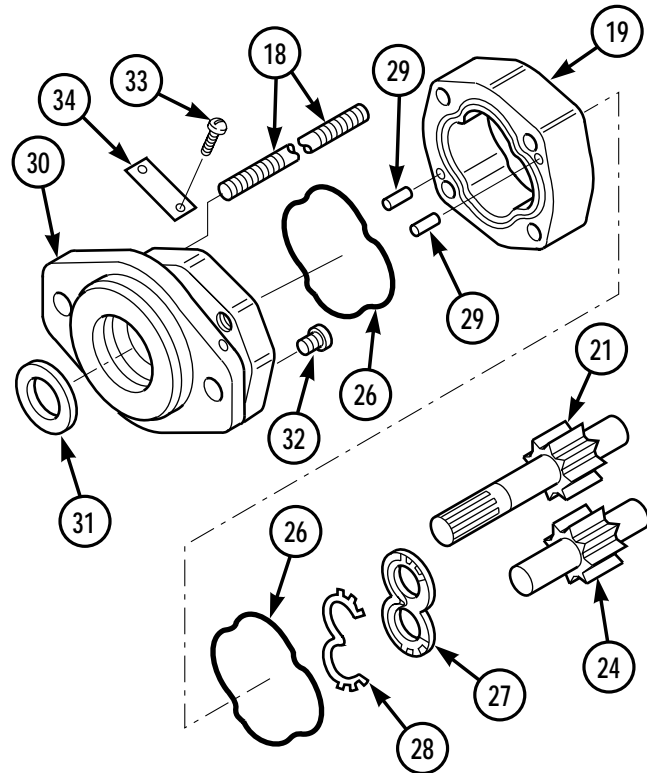
*d. Assembly.*

**CAUTION**

Do not grip on or near any machined surfaces during disassembly or assembly. Failure to follow this precaution will cause part damage.

**NOTE**

Wipe all sealing surfaces clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.



**(1) Install parts (18 and 31 through 34) in end cover (30).**

- (a) Install four studs (18) in end cover (30).
- (b) If removed, install plate (34) and two screws (33) on end cover (30).
- (c) Place end cover (30) in a vise with mounting face down.
- (d) If removed, install plug (32) in end cover (30). Stake each plug with a punch at both ends of screwdriver slot and around edges. Peen edge of hole 1/32 to 1/16 inch with a 1-1/2 inch steel diameter ball.
- (e) Apply sealant on lip of seal (31). With metal side of seal up, use an arbor press and a bar (1-3/4 in. [44.5 mm] diameter by 2 in. [50.8 mm] long bar), press seal into end cover (30). Press seal flush with recess. Wipe off excess sealant.

**(2) Install gear housing (19) and parts (21, 23, and 25 through 28) on end cover (30).**

- (a) If removed, install dowel pins (29) in gear housing (19) or end cover (20).
- (b) Apply grease on two seals (26). Install seals into grooves on gear housing (19).

**CAUTION**

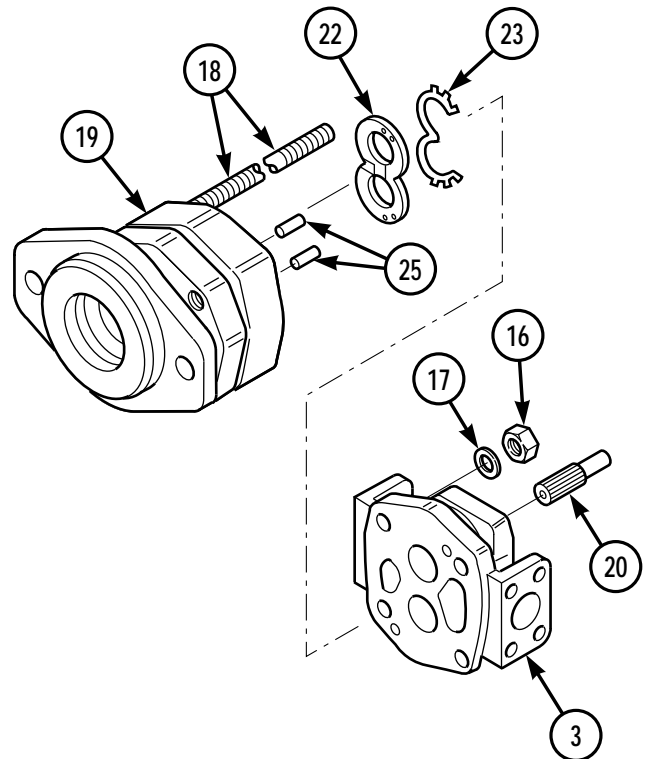
If parts are difficult to fit during assembly, tap gently with a soft hammer. Use care to prevent part damage.

- (c) Ensure that dowel pins (29) are in place. Install gear housing (19) on end cover (30). Gently tap gear housing tight against end cover use care to prevent damage to seals (26).

- (d) Install seal (28) in thrust plate (27) with flat side of seal facing away from thrust plate.
- (e) Install thrust plate (27) through gear housing (19) into end cover (30). Seal (28) should face away from end cover (30). The relief groove in thrust plate should face pump outlet side.
- (f) Install driven gear (24) through gear housing (19) into end cover (30).
- (g) Apply grease on fabricated drive gear installation tool. Place shaft of greased drive gear (21) inside tool. Slide both through end cover (30) with a twisting motion. The integral gears should rest against thrust plate (27). Remove drive gear installation tool. Apply oil on drive gear and driven gear (24).

**(3) Install bearing carrier (3) and parts (16, 17 and 20 through 23) on gear housing (19).**

- (a) If removed, install dowel pins (25) in bearing carrier (3) and gear housing (19).
- (b) Install seal (23) in thrust plate (22) with flat side of seal facing away from thrust plate.
- (c) Install thrust plate (22) over gears (21 and 24) and into gear housing (19) bore.



**CAUTION**

If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- (d) Ensure that dowel pins (25) are in place. Install bearing carrier (3) onto gear housing (19). Align dowel holes over dowel pins. Use a soft hammer to tap bearing carrier and gear housing together.
- (e) Install four washers (17) and nuts (16) on studs (18).
- (f) Install connecting shaft (20) in spline of drive gear (21).

**16-3. TANDEM GEAR PUMP REPAIR (CONT)**

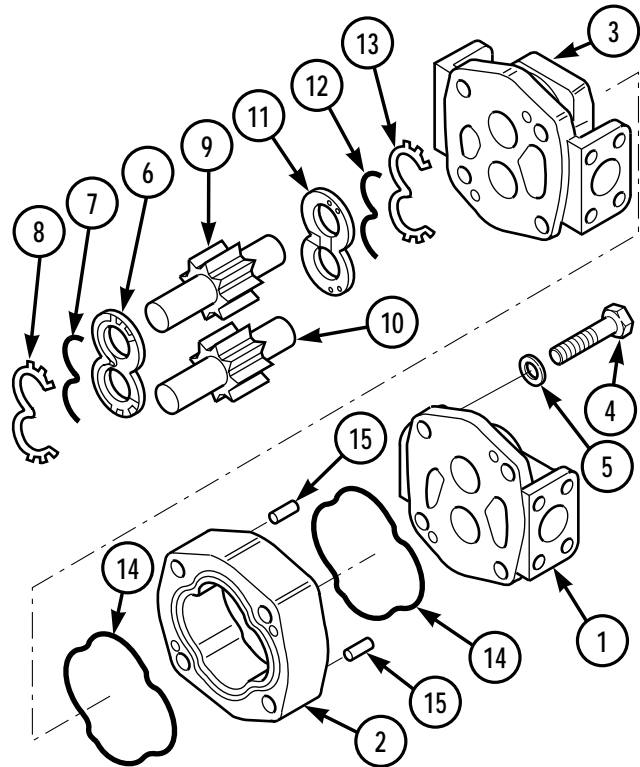
**(4) Install gear housing (2) on bearing carrier (3), gears (9 and 10), and thrust plate (6).**

- (a) If removed, install dowel pins (15) in cover (1) and housing (2).
- (b) Apply grease on two seals (14). Install seals into grooves on gear housing (2).

**CAUTION**

If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- (c) Ensure that dowel pins (15) are in place. Install gear housing (2) onto bearing carrier (3). Align dowel holes over dowel pins. Use a soft hammer to tap parts together. Use care to prevent damage to seals (14).



- (d) Install seals (12 and 13) in thrust plate (11) with flat side of seal facing away from thrust plate.
- (e) Install drive gear (9) and driven gear (10) into bearing carrier (3). Ensure that gears are in contact with thrust plate (11) face.
- (f) Install seals (7) and (8) into grooves in thrust plate (6) with flat side of seal facing away from thrust plate.
- (g) Install thrust plate (6) over gears (9 and 10). The flat side of seal (8) should be facing up with relief groove facing outlet side.

**(5) Install cover (1) on gear housing (2).**

**CAUTION**

If parts are difficult to fit during assembly, tap with a soft hammer. Use care to prevent part damage.

- (a) Ensure that dowel pins (15) are in place. Install cover (1) onto gear housing (2). Align dowel holes over dowel pins. Use a soft hammer to tap parts together. Use care to prevent damage to seals (14).

- (b) Install four washers (5) and screws (4) in cover (1).
- (c) Rotate pump shaft to ensure there is no binding.

**NOTE**

Follow-on Maintenance: Install tandem pump gear (TM 10-3930-673-20).

**END OF TASK**

## 16-4. MAIN CONTROL VALVE ASSEMBLY REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

#### *Equipment Condition*

Boom cylinder flow control valve removed  
(TM 10-3930-673-20)  
Main control valve assembly removed  
(TM 10-3930-673-20)

#### *Materials/Parts*

Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
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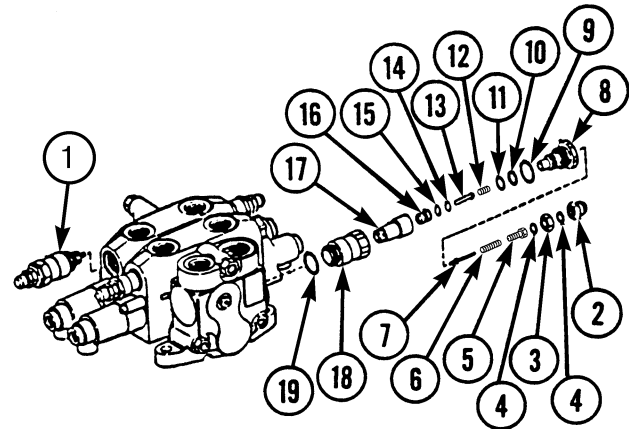
### a. Disassembly.

#### NOTE

- Do not remove main relief valves unless they are being replaced.
- Top and bottom main relief valves are removed and disassembled the same way bottom main relief valve is shown.

- (1) **Remove two main relief valves (1) and disassemble parts (2 through 19) from main control valve.**

- (a) Remove nuts (2 and 3) and preformed packings (4) from adjusting screw (5). Discard preformed packings.



#### NOTE

Count and record number of turns required to remove adjusting screw to aid in assembly.

- (b) Remove adjusting screw (5), spring (6), and poppet (7) from plug (8).

- (c) Remove plug (8), preformed packing (9), back-up ring (10), and preformed packing (11). Discard preformed packings.
- (d) Remove spring (12), piston (13), preformed packing (14), back-up ring (15), and poppets (16 and 17). Discard preformed packing.
- (e) Remove body (18) and preformed packing (19). Discard preformed packing.

**NOTE**

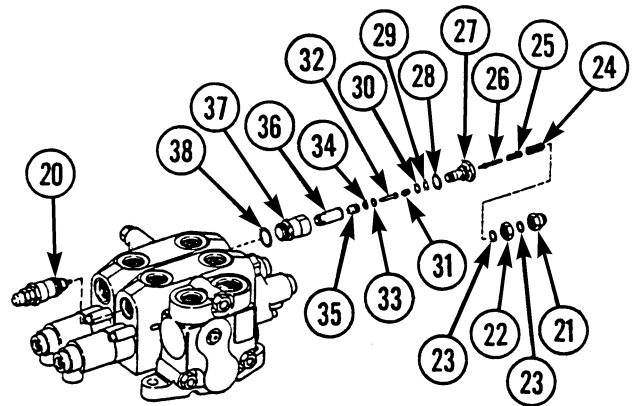
Do not remove relief valves unless they are being replaced.

**(2) Remove two relief valves (20) and disassemble parts (21 through 38) from main control valve.**

- (a) Remove nuts (21 and 22) and preformed packings (23) from adjusting screw (24).

**NOTE**

Count and record number of turns required to remove adjusting screw to aid in assembly.



- (b) Remove adjusting screw (24), spring (25), and poppet (26) from plug (27).
- (c) Remove plug (27), preformed packing (28), back-up ring (29), and preformed packing (30). Discard preformed packings.
- (d) Remove spring (31), piston (32), preformed packing (33), back-up ring (34) and poppets (35 and 36). Discard preformed packing.
- (e) Remove body (37) and preformed packing (38). Discard preformed packing.

**16-4. MAIN CONTROL VALVE ASSEMBLY REPAIR (CONT)**

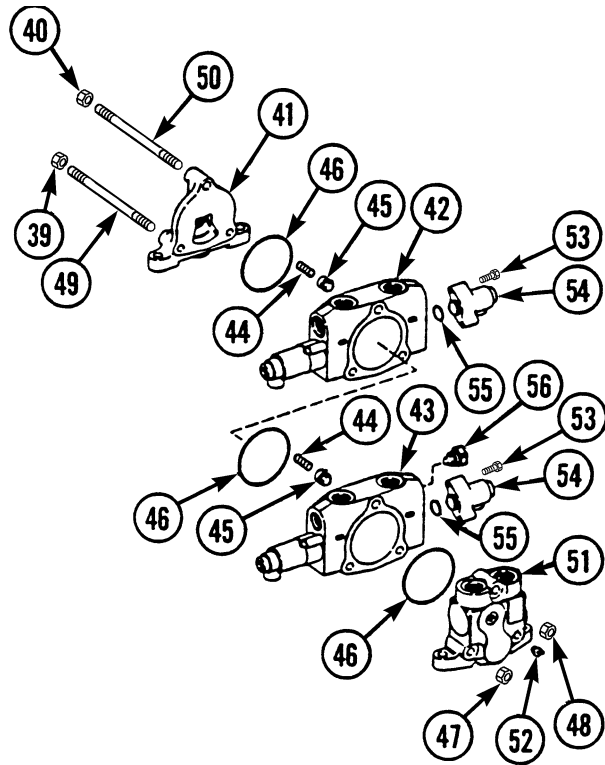
**(3) Disassemble main control valve parts (39 through 68).**

- (a) Mark housing sections of valve. These marks will be used for assembly.

**NOTE**

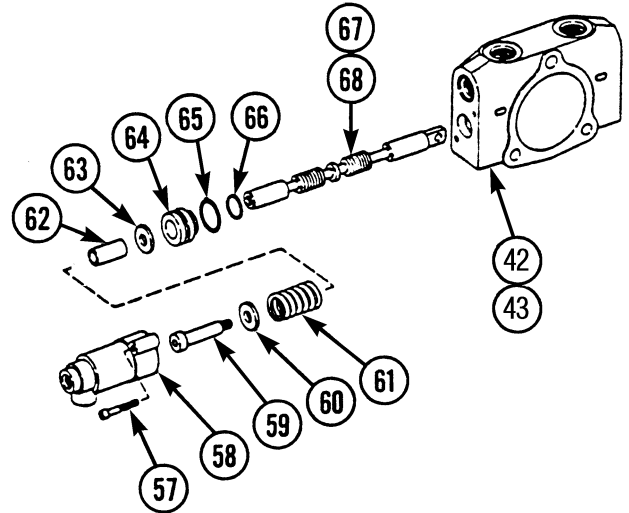
Use care when removing outlet housing and housing sections. Be careful not to lose springs and poppets when removing housing sections.

- (b) Remove two nuts (39), one nut (40), and outlet housing (41).
- (c) Remove housing sections (42 and 43).
- (d) Remove two springs (44) and two poppets (45) from each face of housing sections (42 and 43).
- (e) Remove three preformed packings (46) from housing sections (42 and 43).
- (f) Remove two nuts (47), one nut (48), two studs (49), stud (50), and inlet housing (51).
- (g) If damaged, remove plug (52) from inlet housing (51).
- (h) Remove two screws (53), two spool caps (54), and two preformed packings (55) from housing sections (42 and 43). Discard preformed packings.
- (i) If damaged, remove plug (56) from housing section (43).





- (j) Remove two screws (57) and spool caps (58) from housing section (42 and 43).
- (k) Remove two screws (59), washers (60), springs (61), spacers (62), and washers (63) from housing sections (42 and 43).
- (l) Remove two retainers (64) and preformed packings (65 and 66) from housing sections (42 and 43). Discard preformed packings.
- (m) Remove two spools (67 and 68) from housing sections (42 and 43).



**b. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**c. Inspection.** See **Inspection Instructions (Para 2-14).**

**d. Assembly.**

#### NOTE

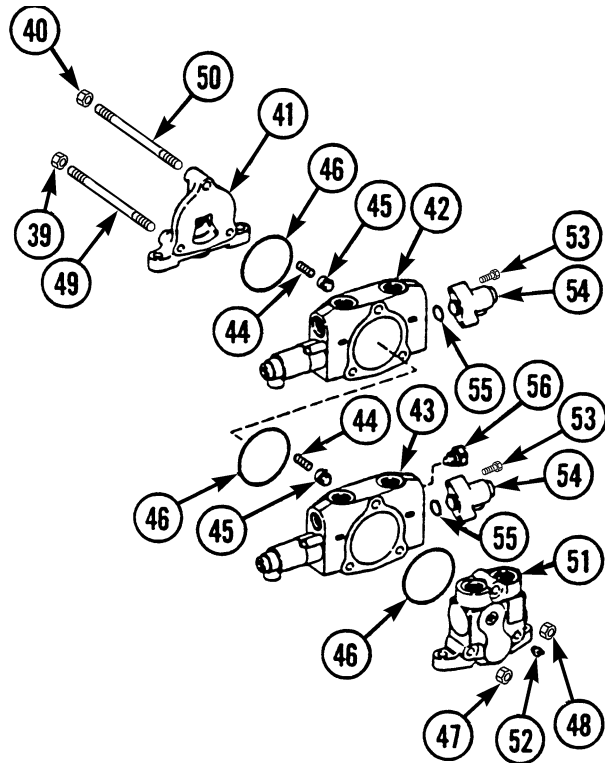
Wipe all sealing surfaces on valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**(1) Assemble main control valve parts (39 through 68).**

- (a) Install two spools (67 and 68) in housing sections (42 and 43).
- (b) Install preformed packings (65 and 66) on two retainers (64).
- (c) Install two retainers (64), washers (63), spacers (62), springs (61), washers (60), and screws (59) in housing sections (42 and 43).
- (d) Install two spool caps (58) and screws (57) on housing sections (42 and 43).

**16-4. MAIN CONTROL VALVE ASSEMBLY REPAIR (CONT)**

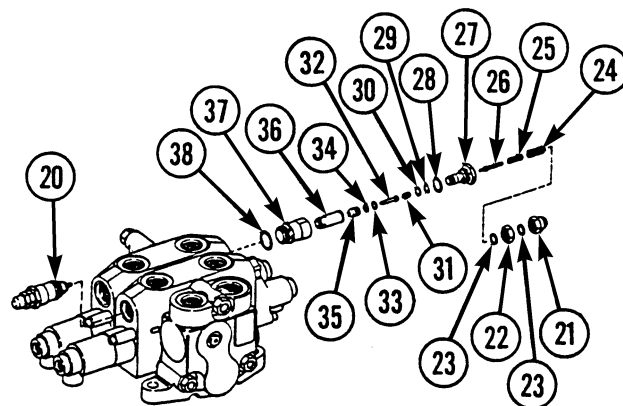
- (e) If removed, install plug (56) in housing section (43).
- (f) Install preformed packings (55) on spool caps (54).
- (g) Install two spool caps (54) and screws (53) on housing sections (42 and 43).
- (h) If removed, install plug (52) in inlet housing (51).
- (i) Install three preformed packings (46) in housing sections (42 and 43) and inlet housing (51).
- (j) Install two poppets (45) and springs (44) in each face of housing sections (42 and 43).
- (k) Use match marks on outlet housing (41), housing sections (42 and 43), and inlet housing (51) and install them in proper order on studs (49 and 50).



- (l) Install two nuts (47), one nut (48), two nuts (39), and one nut (40) on studs (49 and 50). Tighten nuts (40 and 48) to 74 lb-ft (100.33 N•m) and nuts (39 and 47) to 48 lb-ft (65.08 N•m).

**(2) Assemble parts (21 through 38) and install two relief valves (20) in main control valve.**

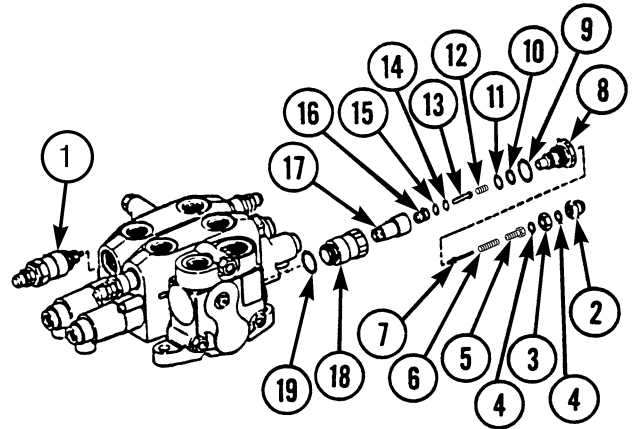
- (a) Install preformed packing (38) on body (37).
- (b) Install preformed packing (33) on poppet (35). Install back-up ring (34).
- (c) Install poppet (36), poppet (35), piston (32), and spring (31) into body (37).
- (d) Install preformed packings (28 and 30) onto plug (27).
- (e) Install back-up ring (29) and plug (27) in body (37).



- (f) Install poppet (26), spring (25), and adjusting screw (24) in plug (27).
- (g) Install one preformed packing (23) in each nut (21 and 22).
- (h) Install nuts (21 and 22) on adjusting screw (24).
- (i) Install two relief valve (20) in main control valve.

**(3) Assemble parts (2 through 19) and install two relief valves (1) in main control valve.**

- (a) Install preformed packing (19) on body (18).
- (b) Install preformed packing (14) on poppet (13). Install back-up ring (15).
- (c) Install poppet (17), poppet (16), piston (13), and spring (12) into body (18).
- (d) Install preformed packings (9 and 11) onto plug (8).
- (e) Install back-up ring (10) and plug (8) in body (18).
- (f) Install poppet (7), spring (6), and adjusting screw (5) in plug (8).
- (g) Install preformed packing (4) in each nut (2 and 3).
- (h) Install nuts (2 and 3) on adjusting screw (5).
- (i) Install two relief valves (1) in main control valve.



**NOTE**

Follow-on Maintenance:

- Install main control valve assembly (TM 10-3930-673-20).
- Install boom cylinder flow control valve (TM 10-3930-673-20).

**END OF TASK**

**16-5. ATTACHMENT CONTROL VALVE REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Wrench, Torque, 0 - 175 lb-ft (0 - 237 N•m) (Item 28, Appendix D)

*Equipment Condition*

Attachment control valve removed (TM 10-3930-660-20)

*Materials / Parts*

Oil, Lubricating, Transmission/Hydraulic (Item 30, Appendix B)

*Materials / Parts (Cont)*

Rags, Lint-free (Item 34, Appendix B)  
 Lockwashers (16)  
 Packing, Preformed  
 Packing, Preformed  
 Packing, Preformed (2)  
 Packing, Preformed  
 Packing, Preformed (2)  
 Packing, Preformed  
 Packing, Preformed (2)  
 Packing, Preformed (2)  
 Packing, Preformed

**a. Disassembly.**

**(1) Disassemble attachment control valve parts (1 through 34).**

- (a) Mark housing sections (1 through 4) of valve assembly. These marks will be used for ease of assembly.
- (b) Position attachment control valve so it is resting on inlet housing (5).

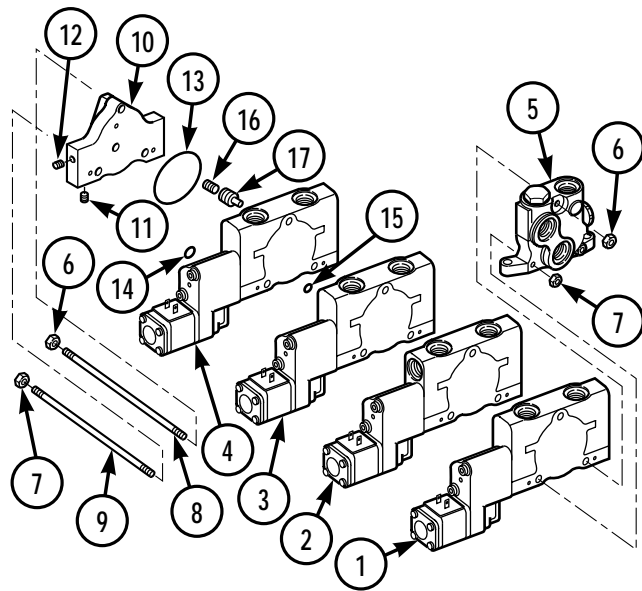
**NOTE**

Use care when removing outlet housing and housing sections. Be careful not to lose shuttle plates, springs, and pistons that may eject from inlet housing and housing sections.

- (c) Remove two nuts (6), four nuts (7), stud (8), two studs (9), and outlet housing (10).
- (d) If damaged, remove plugs (11 and 12) from outlet housing (10).
- (e) Separate housings (1 through 4) and inlet housing (5).
- (f) Remove one preformed packing (13) and two preformed packings (14) from each face of housings (1 through 4). Discard preformed packings.

**NOTE**

Housing section closest to outlet housing has no shuttle plate.



(g) Remove three shuttle plates (15), four springs (16) and four pistons (17) from each face of housings (1 through 4).

(h) Remove 16 screws (18), lockwashers (19), and eight electric hydraulic proportioning (EHP) assemblies (20) from housings (1 through 4). Discard lockwashers.

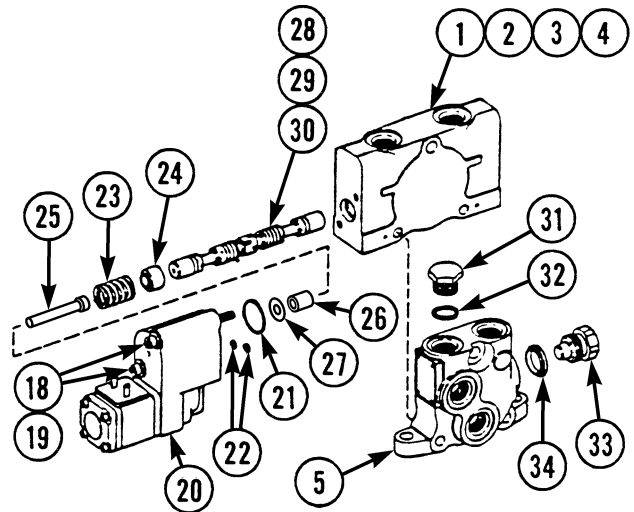
(i) Remove one preformed packing (21) and two preformed packings (22) from each EHP assembly (20). Discard preformed packings.

(j) Remove spring (23), spring seat (24), plunger (25), spacer (26), and disk (27) from each EHP assembly (20).

(k) Remove spools (28 and 29) and two spools (30) from housing sections (1 through 4).

(l) Remove two plugs (31) and preformed packings (32) from inlet housing (5). Discard preformed packings.

(m) Remove plug (33) and preformed packing (34) from inlet housing (5). Discard preformed packing.



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Assembly.**

### NOTE

Wipe all sealing surfaces on valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**(1) Assemble attachment control valve parts (1 through 34).**

(a) Install preformed packing (34) and plug (33) in inlet housing (5).

(b) Install two preformed packings (32) and plugs (31) in inlet housing (5).

(c) Install spools (28 and 29) and two spools (30) in housing sections (1 through 4).

(d) Install disk (27), spacer (26), plunger (25), spring seat (24), and spring (23) in each EHP assembly (20).

(e) Install two preformed packings (22) and preformed packing (21) on each EHP assembly (20).

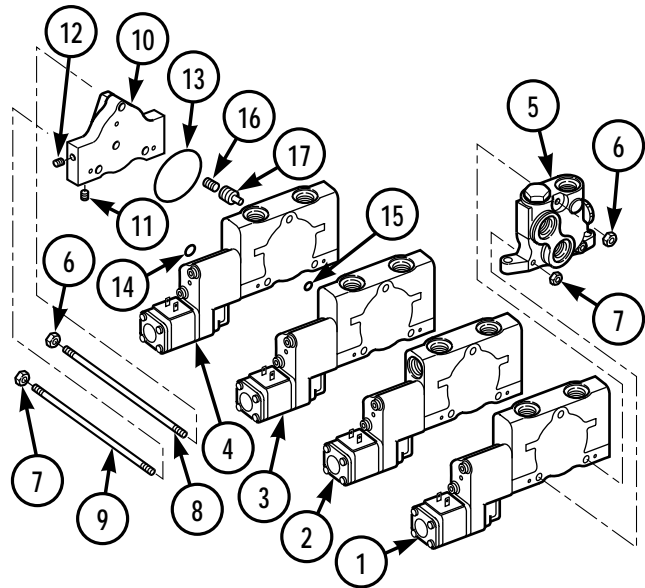
(f) Install eight EHP assemblies (20), 16 lockwashers (19), and screws (18) on housings (1 through 4).

**16-5. ATTACHMENT CONTROL VALVE REPAIR (CONT)**

**NOTE**

Valve section closest to outlet housing has no shuttle plate.

- (g) Install four pistons (17), springs (16), and three shuttle plates (15) in each face of housings (1 through 4).
- (h) Install one preformed packing (13) and two preformed packings (14) in each face of housings (1 through 4).
- (i) If removed, install plugs (11 and 12) in outlet housing (10).
- (j) Match marks on housing sections (1 through 4), inlet housing (5), and outlet housing (10) and assemble them in proper order on stud (8) and two studs (9). Install nuts (6 and 7).
- (k) Install two nuts (6) and four nuts (7) on stud (8) and two studs (9). Tighten nuts (6) to 33 lb-ft (44.74 N•m) and nuts (7) to 14 lb-ft (18.98 N•m).



**(2) Assemble relief valves (1 and 2) with parts (2 through 14).**

**NOTE**

Follow-on Maintenance: Install attachment control valve (TM 10-3930-673-20).

**END OF TASK**

## 16-6. PRIORITY VALVE REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

#### *Equipment Condition*

Priority valve removed (TM 10-3930-673-20)

#### *Materials/Parts*

Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)

Rags, Lint-free (Item 34, Appendix B)

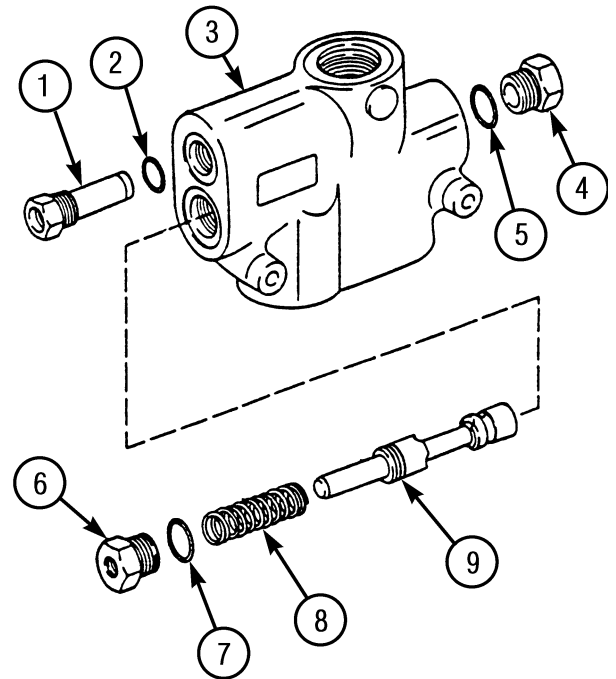
Packings, Preformed

Packings, Preformed

Packings, Preformed

#### **a. Disassembly.**

- (1) Remove relief valve cartridge (1) and preformed packing (2) from housing (3). Discard preformed packing.
- (2) Remove plug (4) and preformed packing (5) from housing (3). Discard preformed packing.
- (3) Remove plug (6) and preformed packing (7) from housing (3). Discard preformed packing.
- (4) Remove spring (8) and spool (9) from housing (3).

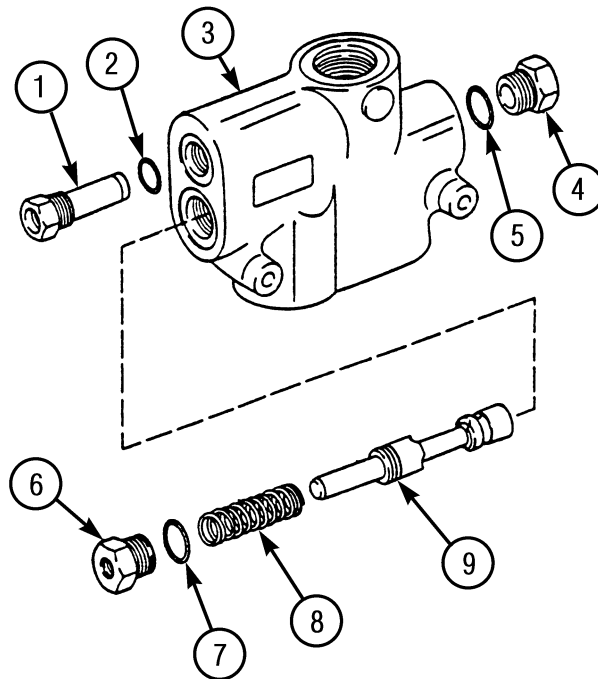


**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**16-6. PRIORITY VALVE REPAIR (CONT)**

*d. Assembly.*



**NOTE**

Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- (1) **Install preformed packing (5) and plug (4) in housing (3). Tighten plug finger tight.**
- (2) **Install spool (9) and spring (8) in housing (3).**
- (3) **Install preformed packing (7) and plug (6) in housing (3). Tighten plug finger tight.**
- (4) **Install preformed packing (2) and relief valve cartridge (1) in housing (3).**

**NOTE**

Follow-on Maintenance: Install priority valve (TM 10-3930-673-20).

**END OF TASK**



**16-7. FRAME TILT/BRAKES RELIEF VALVE REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)

*Equipment Condition*

Frame tilt/brakes relief valve removed (TM 10-3930-673-20)

*Materials/Parts*

Oil, Lubricating, Transmission/Hydraulic (Item 30, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)  
 Packings, Preformed (2)  
 Packings, Preformed  
 Packings, Preformed (2)  
 Packings, Preformed

**a. Disassembly.**

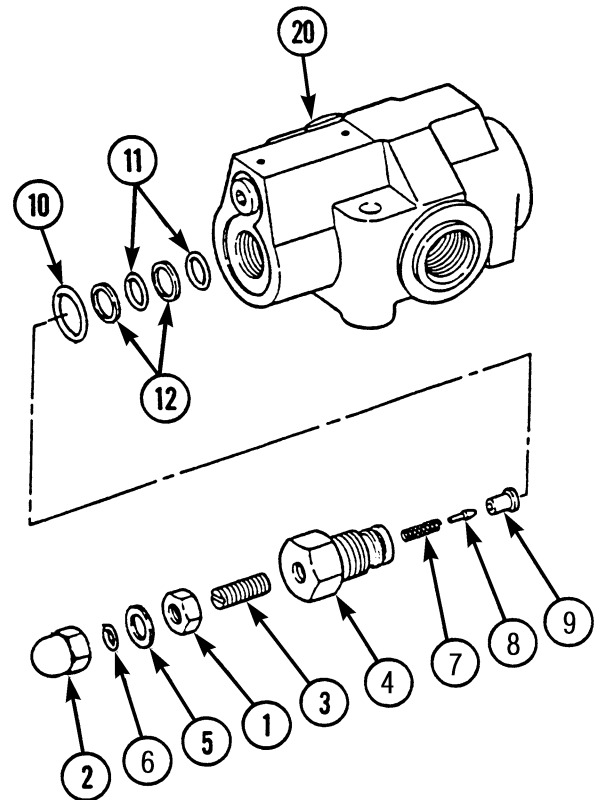
**(1) Remove and disassemble relief valve parts (1 through 19) from body (20).**

- (a) Hold jam nut (1) in place and remove acorn nut (2) from screw (3).
- (b) Hold screw (3) in place and loosen jam nut (1).

**NOTE**

Count and record number of turns required to remove screw to aid in assembly.

- (c) Remove screw (3) from cap (4).
- (d) Remove two sealing washers (5) and preformed packings (6). Discard preformed packings.
- (e) Remove spring (7), plunger (8), and seat (9) from cap (4).
- (f) Remove preformed packing (10) and two preformed packings (11). Back-up rings (12) are not removed. Discard preformed packings.



**16-7. FRAME TILT/BRAKES RELIEF VALVE REPAIR (CONT)**

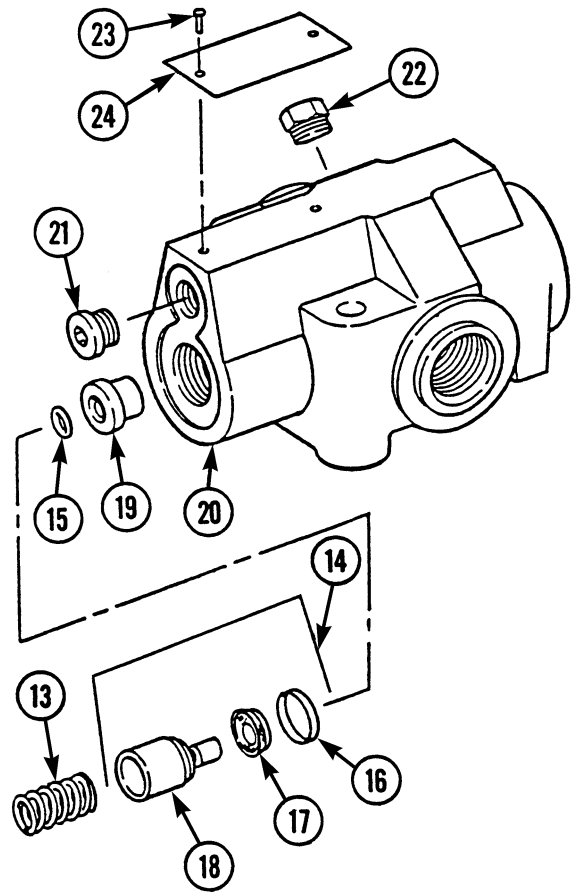
- (g) Remove spring (13), poppet assembly (14), and preformed packing (15). Discard preformed packing.
- (h) If damaged, remove retainer (16), screw (17), and poppet (18).
- (i) Do not remove seat (19) from body (20).

- (2) If damaged, remove plugs (21 and 22) from body (20).**
- (3) If damaged, remove two screws (23) and nameplate (24) from body (20).**

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

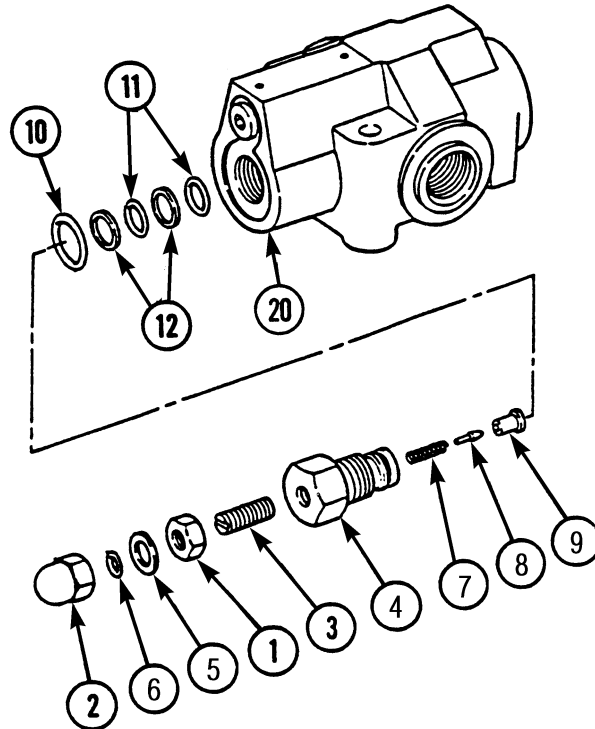
**d. Assembly.**



**NOTE**

Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are install

- (1) If removed, install nameplate (24) and two screws (23) on body (20).**
- (2) If removed, install plugs (21 and 22) in body (20).**
- (3) Assemble and install relief valve parts (1 through 19) into body (20).**
  - (a) Install preformed packing (15) in seat (19).
  - (b) If removed, install screw (17) and retainer (16) on poppet (18).
  - (c) Install poppet assembly (14) and spring (13) into body (20).



- (d) Install two preformed packings (11) and preformed packings (10) on cap (9). Ensure that back-up rings (12) are correctly positioned.
- (e) Install spring (7), plunger (8), and seat (9) in cap (4).
- (f) Install cap (9) in body (20). Ensure that spring (13) is positioned over seat (8).
- (g) Install screw (3) using the same number of turns as was noted during removal.
- (h) Install jam nut (1) and tighten to hold setting.
- (i) Install two preformed packings (6) with sealing washers (5).
- (j) Hold jam nut (1) in position and install acorn nut (2) on screw (3).

### NOTE

Follow-on Maintenance: Install frame tilt/brakes relief valve (TM 10-3930-673-20).

**END OF TASK**

## 16-8. FRAME TILT VALVE REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)

#### *Equipment Condition*

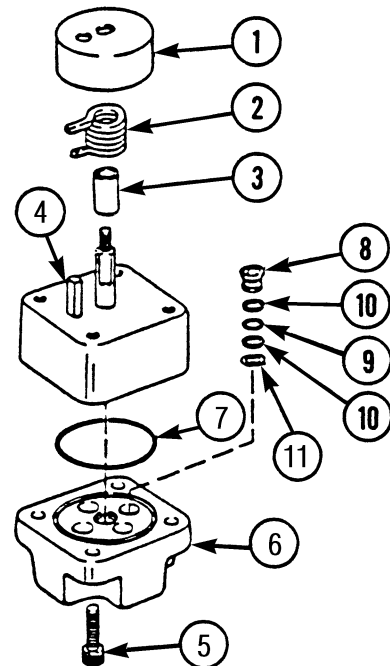
Frame tilt valve removed (TM 10-3930-673-20)

#### *Materials/Parts*

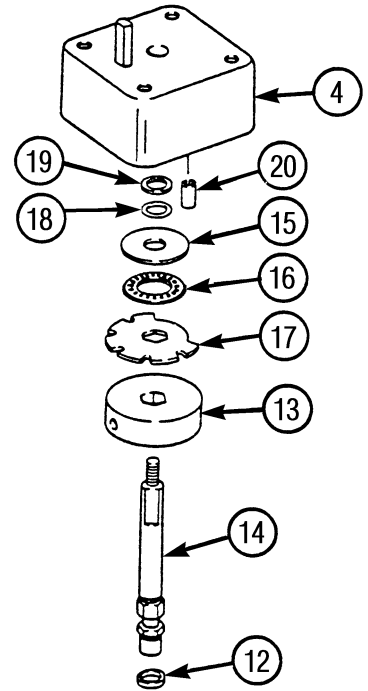
Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)  
Packing, Preformed  
Packing, Preformed (4)  
Packing, Preformed

### a. Disassembly.

- (1) **Remove hub (1), spring (2), and bushing (3) from cap (4).**
- (2) **Disassemble frame tilt valve parts (5 through 20).**
  - (a) Remove four screws (5), body (6), and preformed packing (7) from cap (4). Discard preformed packing.
  - (b) Remove four seals (8), preformed packings (9), eight back-up rings (10), and four seal springs (11) from body (6). Discard preformed packings.



- (c) Remove washer (12) and disk assembly (13) from shaft (14).
- (d) Remove shaft (14) from cap (4).
- (e) Remove bearing race (15), bearing (16), and stop plate (17) from cap (4).
- (f) Remove preformed packing (18) and back-up ring (19) from cap (4). Discard preformed packing.
- (g) If damaged, remove stop pin (20) from cap (4).



**b. Cleaning.** See **Cleaning Instructions** (Para 2-12).

**c. Inspection.** See **Inspection Instructions** (Para 2-14).

**d. Assembly.**

**NOTE**

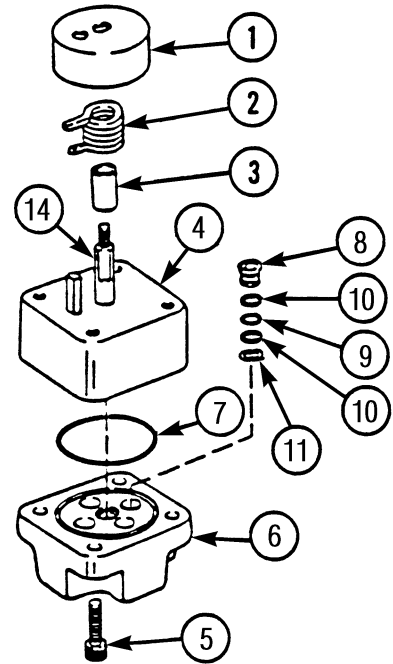
Wipe all sealing surfaces of valve clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**(1) Install shaft (14) in cap (4) with parts (1, 2, 3, and 20).**

- (a) If removed, install stop pin (20) in cap (4).
- (b) Install back-up ring (19) and preformed packing (18) in bore of cap (4).
- (c) Slide shaft (14) through hole in cap (4).

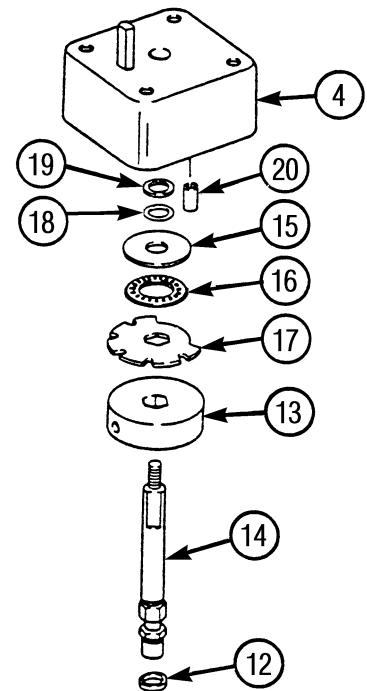
**16-8. FRAME TILT VALVE REPAIR (CONT)**

- (d) Install bushing (3) on shaft (14).
- (e) Use pliers to install spring (2) on shaft (14).
- (f) Install hub (1) on cap (4).



**(2) Assemble frame tilt valve parts (4 through 17).**

- (a) Install bearing race (15) and bearing (16) on cap (4).
- (b) Install stop plate (17) on cap (4). Ensure that stop pin (20) is centered in wide gap of stop plate.
- (c) Install disk assembly (13) on shaft (14). The side of disk assembly with holes drilled through it must face away from cap (4). Ensure that one of two holes drilled on outer surface of disk assembly align with stop pin (20).
- (d) Install washer (12) on shaft (14).



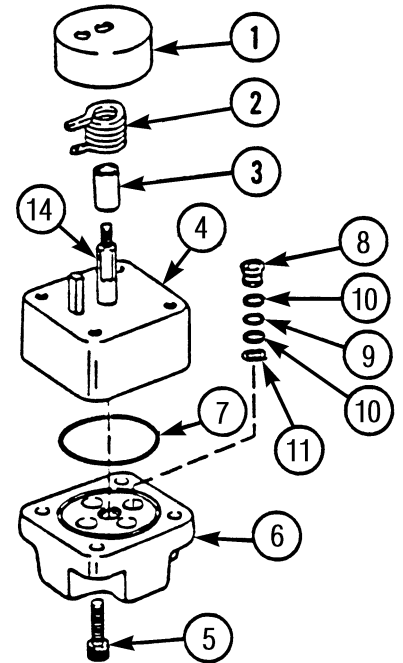
- (e) Install four seal springs (11), eight back-up rings (10), four preformed packings (9), and four seals (8) in body (6).
- (f) Install preformed packing (7) in groove on body (6).
- (g) Install four screws (5) in body (6) and cap (4).

**NOTE**

Follow-on Maintenance:

- Install frame tilt valve (TM 10-3930-673-20).

**END OF TASK**



## 16-9. FRAME TILT CYLINDER REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Wrench Set, Spanner (Item 26, Appendix D)

*Equipment Condition*

Frame tilt cylinder removed (TM 10-3930-673-20)

*Materials/Parts*

Compound, Sealing (Item 42, Appendix B)  
Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)  
Rags, Lint-free (Item 34, Appendix B)

*Materials/Parts (Cont)*

Solvent, Dry Cleaning P-D-680  
(Item 52, Appendix B)  
Container, 5 gal (19 l) capacity  
Nut  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Packing, Preformed  
Seal

*Personnel Required*

Two

### a. Disassembly.

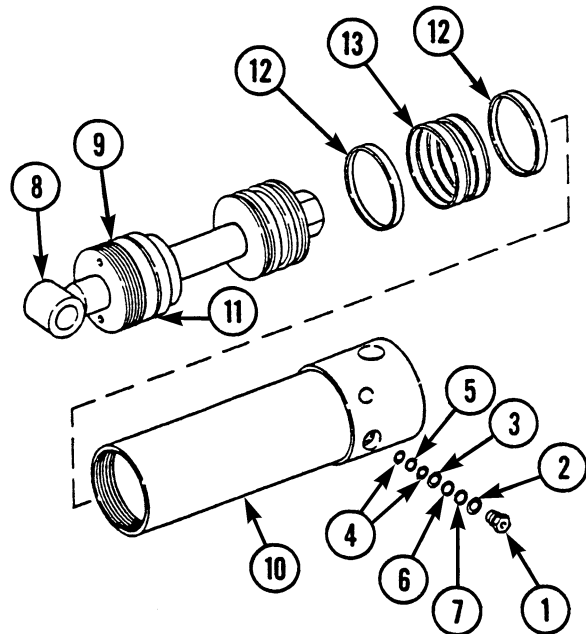
- (1) Use a vise with soft jaws to secure frame tilt cylinder in a horizontal position for disassembly.

**WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve and allow pressure to escape before removing valve entirely.

**NOTE**

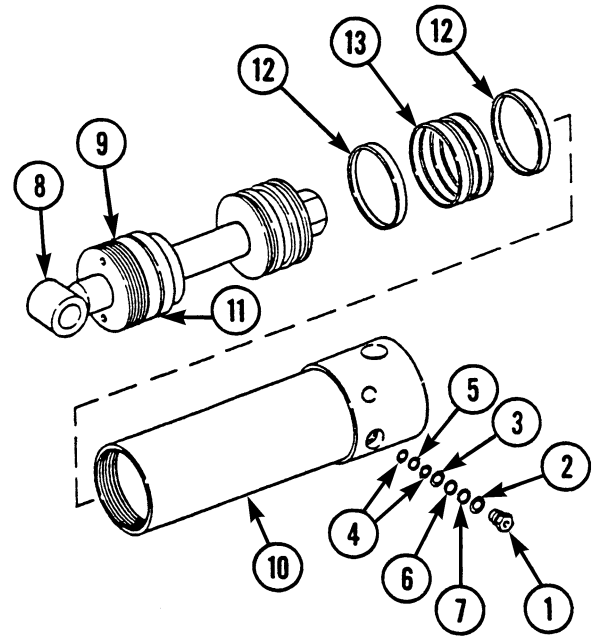
Note and mark location of counterbalance valves for use during assembly. Counterbalance valves are not interchangeable.



- (2) Relieve pressure in frame tilt cylinder by slowly removing two counterbalance valves (1). Drain residual oil through valve holes into a suitable container.



- (3) Remove back-up rings (2 and 3), two back-up rings (4), and preformed packings (5, 6, and 7) from each counterbalance valve (1). Discard preformed packings.
- (4) Disassemble frame tilt cylinder parts (8 through 19).



**CAUTION**

Do not scratch or damage the wear surface of rod, piston, or gland. Follow this precaution to prevent failure of the frame tilt cylinder.

- (a) Use a suitable tool to pull rod (8) out approximately 5 in. (127 mm) for removal of gland (9).
- (b) Place a container under gland (9) to catch oil contained in the frame tilt cylinder.
- (c) Use a spanner wrench to remove gland (9) from cylinder tube (10). Pull gland out of cylinder far enough to unseat preformed packing (11). Allow oil to drain into container.

**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (d) Remove rod (8) and piston assembly from cylinder tube (10).
- (e) Place rod (8) and piston assembly on suitable supports to prevent damage.
- (f) Remove two wear rings (12).

**CAUTION**

Do not nick or scratch seal groove during removal of seal. Failure to follow this precaution will cause part damage.

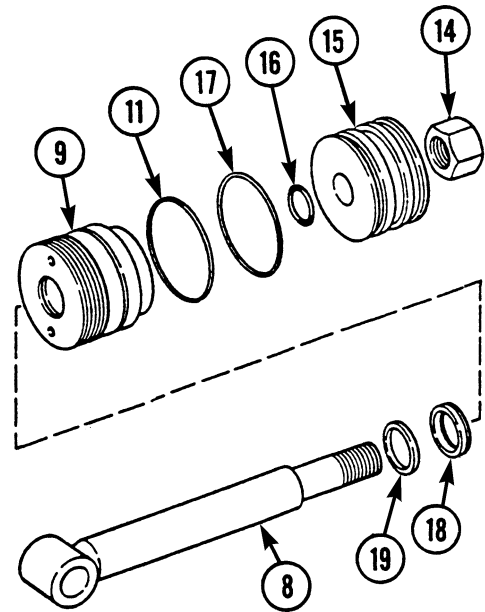
- (g) Cut and remove seal (13). Discard seal.

**16-9. FRAME TILT CYLINDER REPAIR (CONT)**

**NOTE**

The nut may need to be heated with a torch for removal.

- (h) Remove nut (14) and piston (15) from rod (8). Discard nut.
- (i) Remove preformed packing (16) from piston (15) bore. Discard preformed packing.
- (j) Remove gland (9) off rod (8).
- (k) Remove preformed packing (11) and back-up ring (17) from gland (9). Discard preformed packing.



**CAUTION**

Do not nick or scratch seal groove during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

Note direction that lip of seal is facing before removal to aid in assembly.

- (l) Remove seal (18) and rod wiper (19) from inside gland (9).

**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Assembly.**

**NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

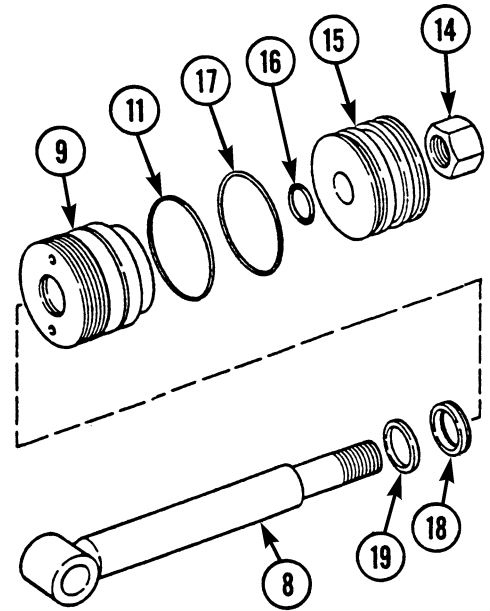
**(1) Assemble frame tilt cylinder parts (1 through 19).**

- (a) Install seal (18) and rod wiper (19) inside gland (9). Ensure that seal lip is positioned the same way as it was before disassembly.
- (b) Install back-up ring (17) and preformed packing (11) on outside diameter of gland (9).

- (c) Slide gland (9) onto rod (8).
- (d) Lubricate piston (15) inner diameter with clean hydraulic oil. Install new preformed packing (16) inside bore of piston.

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
  - If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- (e) Use drycleaning solvent and lint-free rag to clean threads on rod (8) and new nut (14).
  - (f) Slide piston (15) onto rod (8).



**WARNING**

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

- (g) Apply sealing compound on threads of rod (8) and nut (14). Install nut on rod.
- (h) Place rod (8) and piston assembly on suitable supports to prevent damage during assembly.

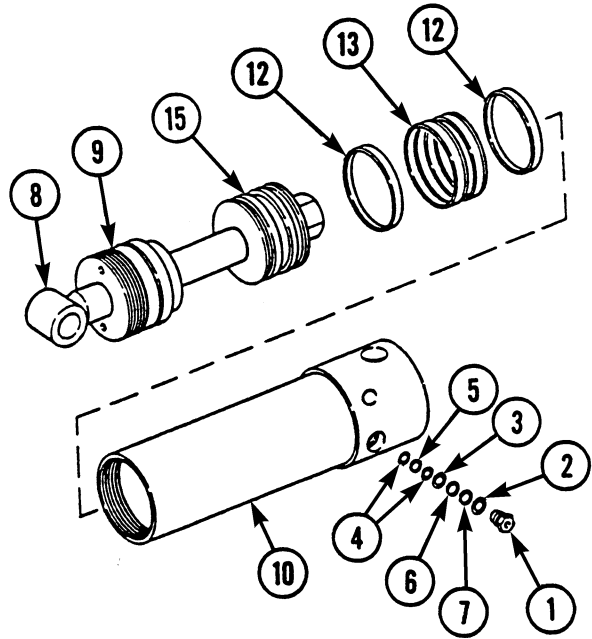
**16-9. FRAME TILT CYLINDER REPAIR (CONT)**

- (i) Install two wear rings (12) and seal (13). Position wear rings so that gaps are 180° apart.

**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with cylinder tube to prevent binding. Failure to follow this precaution will cause part damage.

- (j) Lubricate cylinder tube (10) inner diameter, piston (15) outside diameter, and gland (9) outside diameter with clean hydraulic oil.
- (k) Position rod (8) and piston assembly in cylinder tube (10).



**NOTE**

Tighten gland so that it is flush with end of cylinder tube. Do not overtighten gland.

- (l) Tighten gland (9) onto cylinder tube (10).
- (m) Install back-up rings (2 and 3), back-up rings (4), and preformed packings (5, 6, and 7) on each counterbalance valve (1).
- (n) Install two counterbalance valves (1) in cylinder tube (10) as noted in disassembly.

**NOTE**

Follow-on Maintenance: Install frame tilt cylinder (TM 10-3930-673-20).

**END OF TASK**

**16-10. CARRIAGE TILT CYLINDER REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Wrench Set, Spanner (Item 26, Appendix D)

*Equipment Condition*

Carriage tilt cylinder removed (TM 10-3939-673-20)

*Materials/Parts*

Compound, Sealing (Item 13, Appendix B)  
 Hydraulic Oil (Item 30, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)

*Materials/Parts (Cont)*

Solvent, Drycleaning P-D-680 (Item 52, Appendix B)  
 Container, 5 gal (19 l) capacity  
 Nut  
 Packing, Preformed  
 Packing, Preformed  
 Packing, Preformed  
 Seal  
 Seal

*Personnel Required*

Two

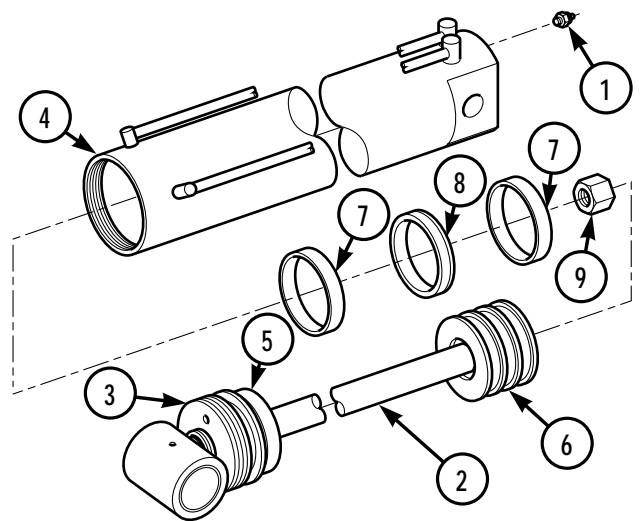
**a. Disassembly.**

- (1) Use a vise with soft jaws to secure cylinder in a horizontal position for disassembly.

**WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve and allow pressure to escape before removing valve entirely.

- (2) Relieve pressure in cylinder by slowly removing counterbalance valve (1). Drain residual oil through valve hole into a suitable container.
- (3) Disassemble cylinder parts (2 through 16).



**CAUTION**

Do not scratch or damage the wear surface of rod, piston, and gland. Follow this precaution to prevent failure of the cylinder.

- (a) Use a suitable tool to pull rod (2) out approximately 5 inches for removal of gland (3).

**16-10. CARRIAGE TILT CYLINDER REPAIR (CONT)**

- (b) Place a container under gland (3) to catch oil contained in cylinder.
- (c) Remove gland (3) from cylinder tube (4). Pull gland out of cylinder far enough to unseat preformed packing (5). Allow oil to drain into container.

**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (d) Remove rod (2) and piston (6) as an assembly from cylinder tube (4).
- (e) Place rod (2) and piston (6) as an assembly on suitable supports to prevent damage.
- (f) Remove two wear rings (7) from piston (6).

**CAUTION**

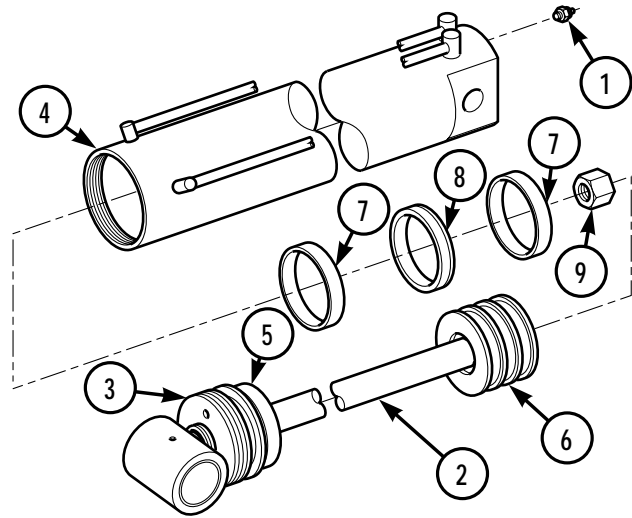
Do not nick or scratch seal groove during removal of seal. Failure to follow this precaution will cause part damage.

- (g) Remove seal (8) from piston (6). Discard seal.

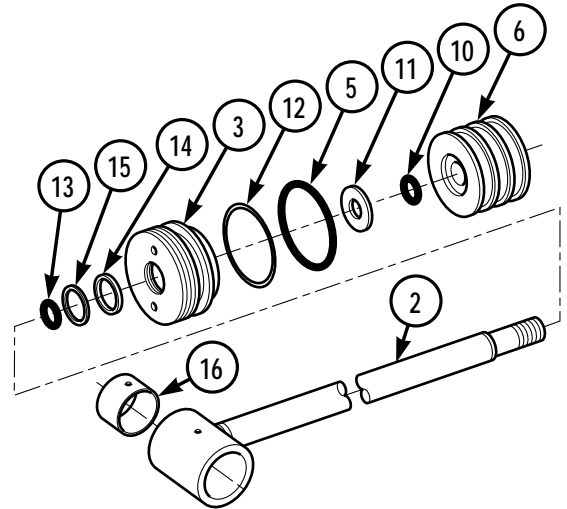
**NOTE**

Nut may need to be heated with a torch for removal.

- (h) Remove nut (9) and piston (6) from rod (2). Discard nut.



- (i) Remove preformed packing (10) from piston (6) bore. Discard preformed packing.
- (j) Remove washer (11) and gland (3) from rod (2).
- (k) Remove preformed packing (5) and backup ring (12) from gland (3). Discard preformed packing.



**CAUTION**

Do not nick or scratch seal groove of gland during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

Note direction that lip of seal is facing to aid in installation.

- (l) Remove preformed packing (13), seal (14) and rod wiper (15) from inside of gland (3).
- (m) Remove two bushings (16) from rod (2).

**b. Cleaning.** See **Cleaning Instructions (Para 2-12)**.

**c. Inspection.** See **Inspection Instructions (Para 2-14)**.

**d. Assembly.**

**NOTE**

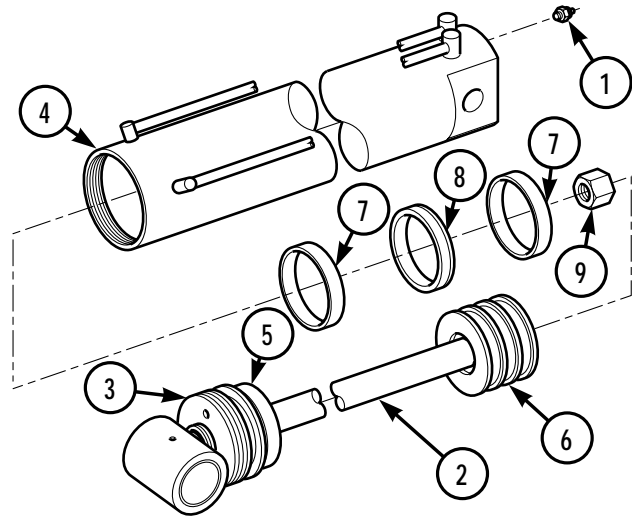
Wipe all sealing surface on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**Assemble cylinder parts (1 through 16).**

- (a) Install two bushings (16) in rod (2).
- (b) Install seal (14), rod wiper (15), and preformed packing (13) inside gland (3). Ensure that seal (14) lip is positioned the same way as it was before disassembly.
- (c) Install backup ring (12) and preformed packing (5) on outside diameter of gland (3).
- (d) Install gland (3) and washer (11) on rod (2).
- (e) Lubricate piston (6) inside diameter with clean hydraulic oil. Install preformed packing (10) inside bore of piston.

**16-10. CARRIAGE TILT CYLINDER REPAIR (CONT)**

- (f) Use cleaning solvent and lint free rag to clean threads on rod (2) and nut (9).
- (g) Install piston (6) on rod (2).
- (h) Apply sealing compound on threads of rod (2) and nut (9). Install nut on rod.
- (i) Place rod (2) and piston (6) as an assembly on suitable supports to prevent damage during assembly.
- (j) Install two wear rings (7) and one seal (8) on piston (6). Position wear rings so that gaps are 180 degrees apart.



**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with cylinder tube to prevent binding. Failure to follow this precaution will cause part damage.

- (k) Lubricate cylinder tube (4) inner diameter, piston (6) outside diameter and gland (3) outside diameter with clean hydraulic oil.
- (l) Position rod (2) and piston (6) as an assembly in cylinder tube (4).

**NOTE**

Tighten gland so that it is flush with end of cylinder tube . Do not over tighten gland.

- (m) Tighten gland (3) onto cylinder tube (4).
- (n) Install counterbalance valve (1) in cylinder tube (4).

**NOTE**

Follow-on Maintenance: Install carriage tilt cylinder (TM 10-3930-673-20).

**END OF TASK**





**16-11. BOOM ASSEMBLY REPLACEMENT (CONT)**

**CAUTION**

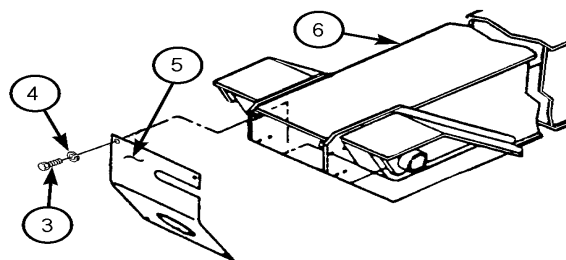
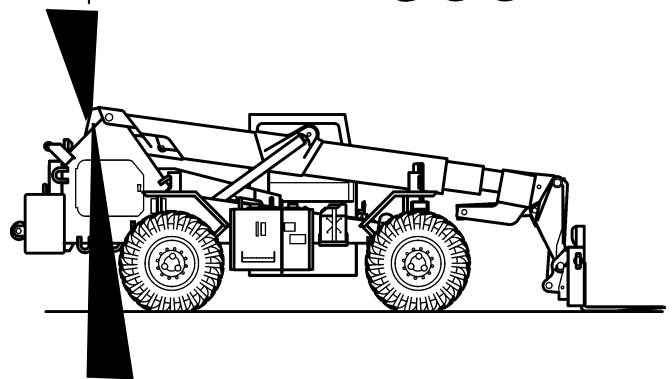
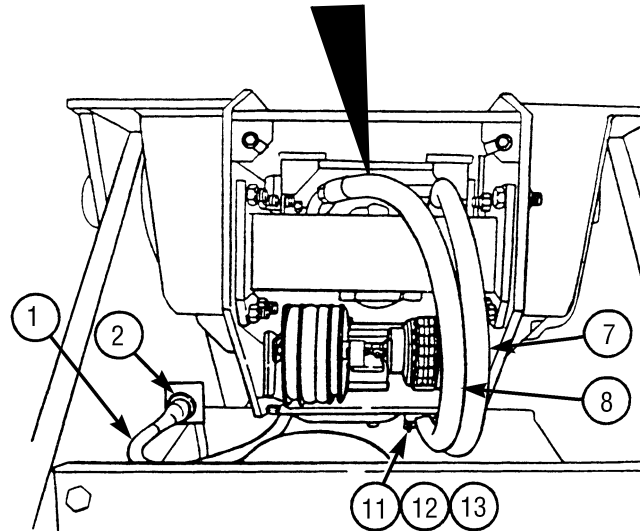
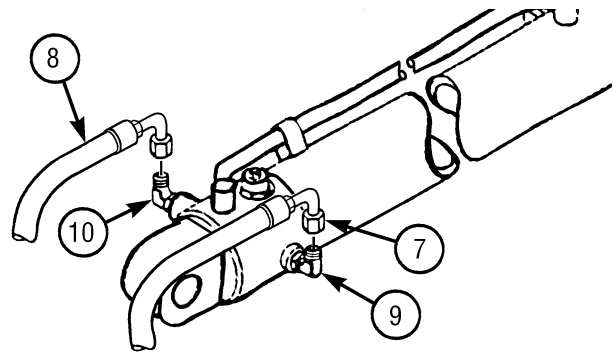
Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap hydraulic oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.

**NOTE**

If more than one hydraulic line is to be removed, identify lines to assure proper installation. Use container to catch any hydraulic oil that may drain from system.

**a. Removal.**

- (1) Disconnect boom electrical cable (1) from socket (2) on vehicle frame.
- (2) Remove four bolts (3), lockwashers (4), and cover (5) from rear of boom assembly (6). Discard lockwashers.
- (3) Tag, mark, and disconnect two hoses (7 and 8) from elbows (9 and 10). Close hoses securely with metal caps.
- (4) Remove locknut (11), screw (12), and four clamp halves (13) securing hydraulic hoses (7 and 8) to bottom of boom assembly (6). Discard locknut.

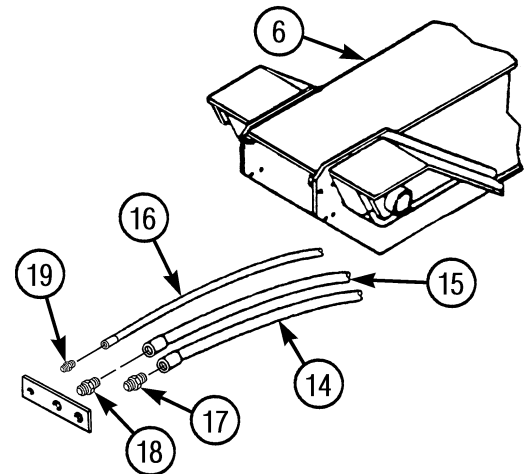


X-TR01365

- (5) Start engine (TM 10-3930-673-10) and raise boom assembly (6) as necessary to access hoses (14 through 16). Stop engine.

**WARNING**

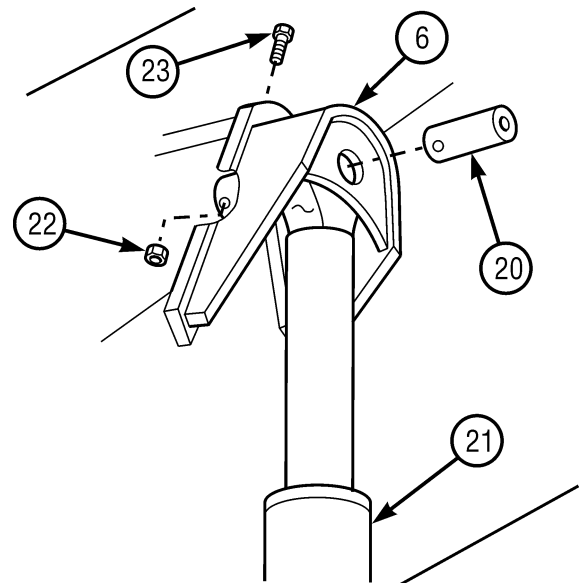
Ensure that hoses disconnected at front of boom assembly during removal of attachment and attachment cylinder are closed securely using metal plugs. Hydraulic oil under pressure can spray from hoses causing bodily injury if hoses are not closed securely.



- (6) Tag, mark, disconnect hoses (14 through 16) from fittings (17 through 19) at underside of boom assembly (6). Plug three hoses with metal caps.
- (7) Start engine (TM 10-3930-673-10). Lower boom assembly (6) until pivot pins (20) are just above cab. Stop engine.

**WARNING**

Boom assembly weighs 4100 lbs (1860 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.



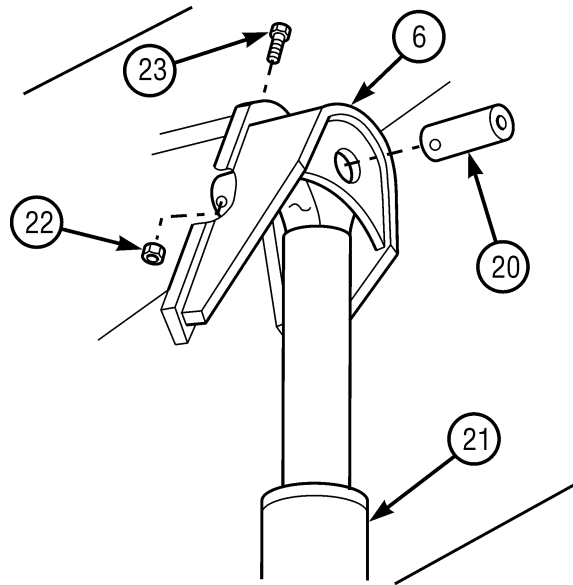
- (8) Support boom assembly (6) with hoist and slings or other suitable lifting device positioned at front of boom assembly.
- (9) Place wood block across vehicle deck behind cab to support boom hoist cylinders (21) when cylinders are lowered.
- (10) Remove locknut (22) and screw (23) from pivot pin (20). discard locknut
- (11) Support boom hoist cylinder (21). Remove pivot pin (20) from boom assembly (6) and boom hoist cylinder (21).

**16-11. BOOM ASSEMBLY REPLACEMENT (CONT)**

**CAUTION**

Release hydraulic joystick immediately after boom hoist cylinder to be removed has fully retracted. If joystick is allowed to remain open, the other cylinder will start to retract, putting extreme stress on lifting equipment and boom assembly.

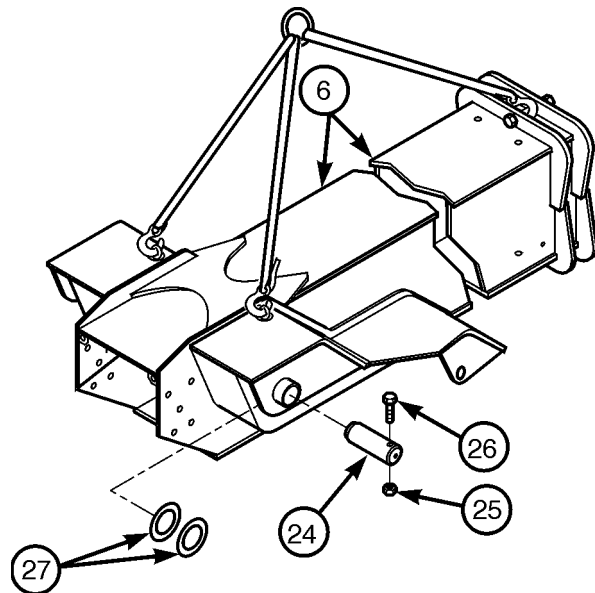
- (12) Start engine and run at idle. Fully retract boom hoist cylinder to be removed (20) using joystick. Boom hoist cylinder will retract very slowly. Stop engine.
- (13) Carefully lower boom hoist cylinder (21) onto board placed across vehicle deck so hydraulic line on cylinder is not damaged.
- (14) Repeat Steps (10) through (13) for other boom hoist cylinder (21).
- (15) Place jackstand or support on front of vehicle deck. Adjust support so that boom assembly (6) will be level when lowered.
- (16) Carefully lower boom assembly (6) with hoist and sling until front of outer boom section is on jackstand or other suitable support.



**NOTE**

- Center of gravity for boom assembly is approximately 9 ft from rear end of boom assembly.
- Install a bolt and nut to top-front of outer boom. Install one hook to bolt and other two hooks to top-rear of outer boom.

- (17) Position hoist and slings to boom assembly (6). Carefully raise boom assembly until weight of boom is removed from boom pivot pins (24).
- (18) Remove locknut (25) and screw (26) from boom pivot pin (24). Discard locknut.



**WARNING**

- Before removal of complete boom assembly, remove the countweight. Failure to remove the counterweight will result in the machine being rear end heavy and rear tipping may occur.
- Hydraulic oil in the system can be under pressures over 3000 psi (20685 kPa) with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.
- Boom assembly including boom extend cylinder weighs approximately 4100 lb (1859.72 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

**NOTE**

- Shims may fall out as pivot pins are removed.
  - Note quantity and position of shims for use during installation.
- (19) **Remove boom pivot pin (24) from boom assembly (6) and vehicle frame.**
  - (20) **Remove shims (27) from between boom assembly (6) and vehicle frame.**
  - (21) **Repeat Steps (18) through (20) for remaining boom pivot pin.**

**CAUTION**

Ensure that lines and electrical cable on underside of outer boom section are not damaged when boom assembly is lowered onto supports.

- (22) **Carefully remove boom assembly (6) from vehicle frame and lower boom assembly onto supports. Remove hoist, slings, nut and bolt from boom assembly.**

## 16-11. BOOM ASSEMBLY REPLACEMENT (CONT)

### b. Installation

#### NOTE

- Center of gravity for boom assembly is approximately 9 ft from rear end of boom assembly.
- Install a bolt and nut to top-front of outer boom. Install one hook to bolt and other two hooks to top-rear of outer boom.

#### WARNING

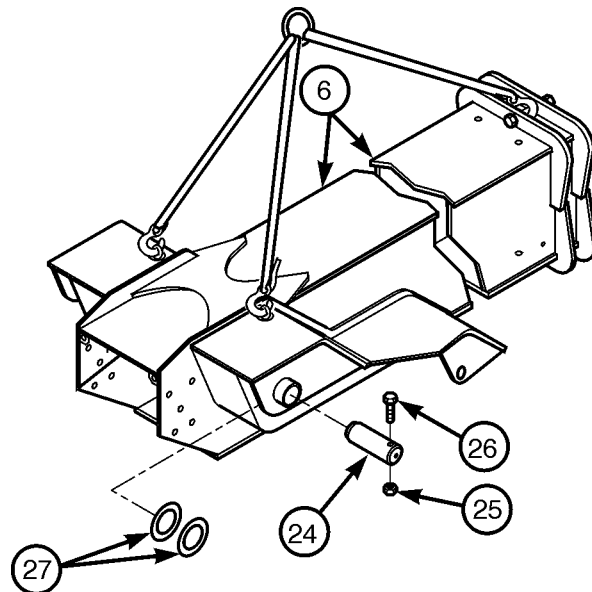
- Before installation of complete boom assembly, remove the countweight. Failure to install the counterweight will result in the machine being rear end heavy and rear tipping may occur.
- Hydraulic oil in the system can be under pressures over 3000 psi (20685 kPa) with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.
- Boom assembly including boom extend cylinder weighs approximately 4100 lb (1859.72 kg). Attach suitable lifting device prior to installation to prevent possible injury to personnel.

- (1) Carefully lift boom assembly (6) into position over vehicle with hoist and sling or other suitable lifting device. Lower boom assembly as required to align boom pivot pin holes.

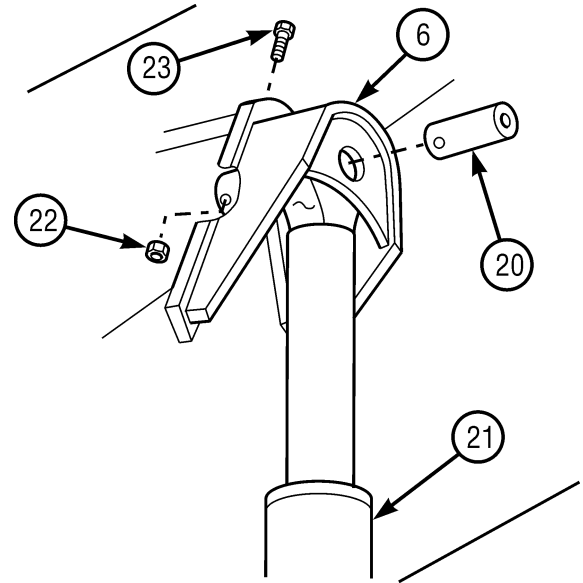
#### WARNING

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

- (2) Position shims (27) between outer boom section and inside surface of vehicle frame. Apply anti-seize compound on boom pivot pin (24) and install pivot pin in boom assembly (6) and vehicle frame.



- (3) Install screw (26) and locknut (25) in boom pivot pin (24). Repeat Steps (2) and (3) for remaining pivot pin (24).
- (4) Place jackstand or support on front of vehicle deck. Adjust support so boom assembly (6) is level when lowered.
- (5) Carefully lower boom assembly (6) with hoist and sling until front of outer boom section is on jackstand or support.
- (6) Reposition slings to front of outer boom section.
- (7) Lift boom assembly (6) until cylinder pivot pin holes of boom assembly are just above cab.
- (8) Lift hoist cylinders (21) into position and support boom hoist cylinders with boom assembly (6).



**CAUTION**

Use hoist and sling to make final alignment with cylinder rod eye and pivot pin hole. Do not use the joystick to make final alignment; damage to rod eye bushing could result.

**NOTE**

One boom hoist cylinder will begin to extend before the other. Install this cylinder first. Second cylinder will begin to extend after first cylinder is connected.

- (9) Start engine. Use joystick to extend boom hoist cylinder (21) until cylinder rod eye is aligned with pivot pin hole of boom assembly (6). Stop engine.

**WARNING**

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

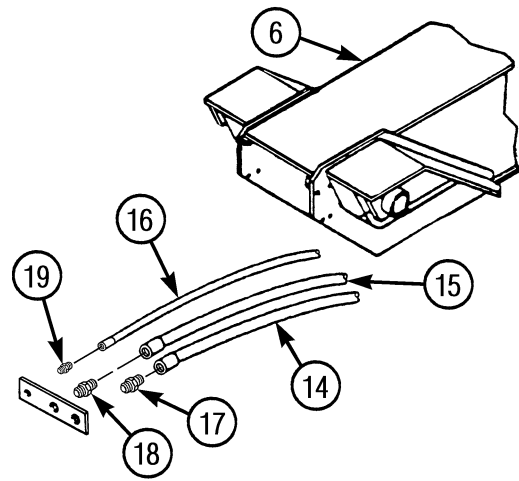
- (10) Apply anti-seize compound to pivot pin (20). Install pivot pin in boom hoist cylinder (21) and boom assembly (6).
- (11) Install screw (23) and new locknut (22) in pivot pin (20).
- (12) Repeat Steps (9) through (11) for other boom hoist cylinder (21). Remove hoist, slings, nut and bolt from boom assembly (6).

**16-11. BOOM ASSEMBLY REPLACEMENT (CONT)**

- (13) Start engine and raise boom assembly (6) as required to access hoses (14 through 16). Stop engine.

**WARNING**

Remove hose caps carefully prior to connecting hoses. Hydraulic oil may be under pressure and can spray from hoses causing bodily injury.



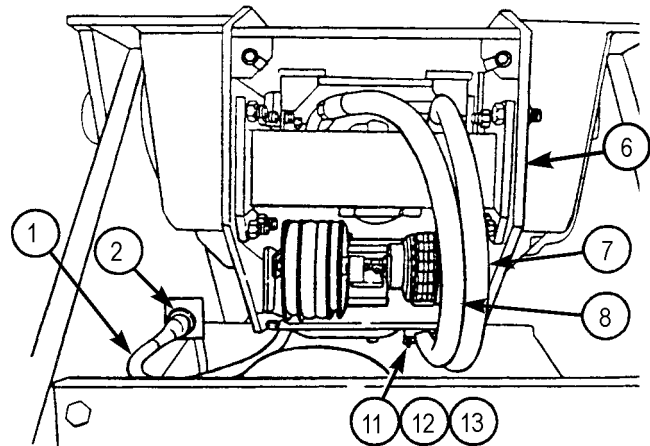
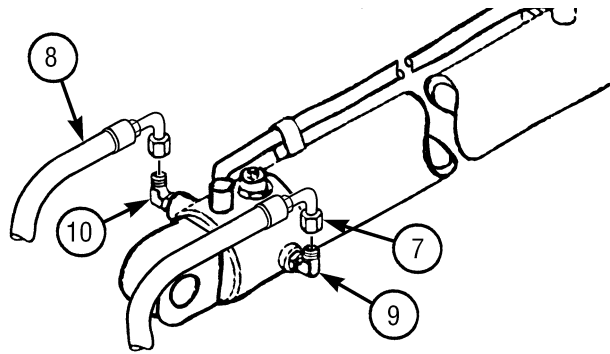
- (14) Connect hoses (14 through 16) to fittings (17 through 19) at underside of boom assembly (6).

- (15) Start engine and lower boom assembly (6) until horizontal. Stop engine.

- (16) Connect two hoses (7 and 8) to elbows (9 and 10).

- (17) Connect boom electrical cable (1) to socket (2) on vehicle frame.

- (18) Position two hoses (7 and 8) under boom assembly (6). Install four clamp halves (13), screw (12) and new locknut (11).





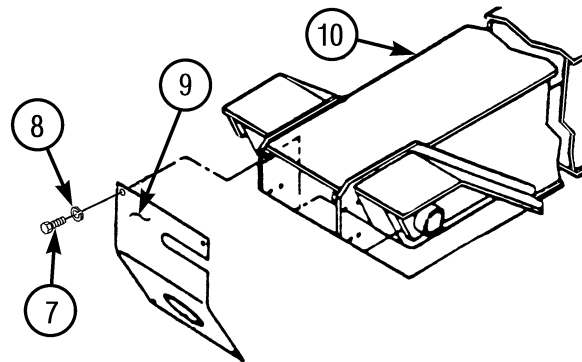
- (19) Install cover (5) to rear of boom assembly (6) with four new lockwashers (4) and bolts (3).

### NOTE

Follow-on Maintenance:

- Install counterweight (TM 10-3930-673-20).
- Install attachment cylinder (TM 10-3930-673-20).
- Install transmission cover (TM 10-3930-673-20).
- Lubricate boom pivot pins and boom hoist cylinder upper pivot pins (TM 10-3930-673-20).

**END OF TASK**



**16-12. INNER BOOM REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Lifting Device, 2 ton (1814.37 kg) capacity

*Equipment Condition*

- Transmission cover removed (TM 10-3930-673-20)
- Carriage removed (TM 10-3930-673-10)
- Boom level and retracted (TM 10-3930-673-10)
- Counterweight removed (TM 10-3930-673-10)

*Materials/Parts*

- Compound, Anti-seize (Item 10, Appendix B)
- Compound, Sealing (Item 40, Appendix B)

*Materials/Parts - Continued*

- Rags, Lint-free (Item 34, Appendix B)
- Tags (Item 55, Appendix B)
- Tape, Electrical (Item 56, Appendix B)
- Locknut
- Locknut
- Locknut (4)
- Lockwasher (4)
- Lockwasher (8)
- Pin, Cotter
- Ring, Retaining
- Ring, Retaining (2)
- Ring, Retaining (2)
- Ring, Retaining (2)
- Container, 5 gal (19 l) capacity
- Rope, 25 ft (7.6 m) (2)
- Rope, 30 ft (9.14 m)
- Wood Blocks

*Personnel Required*

Three

**WARNING**

- Hydraulic oil in the system can be under pressures over 3000 psi (20685 kPa) with the engine OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With engine OFF and boom fully lowered, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.
- At operating temperatures, hydraulic oil is hot and under pressure. Hot oil can cause injuries. Allow hydraulic oil to cool before disconnecting any hydraulic lines.
- Inner boom weldment and boom extend cylinder weighs approximately 1500 lbs (680.39 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

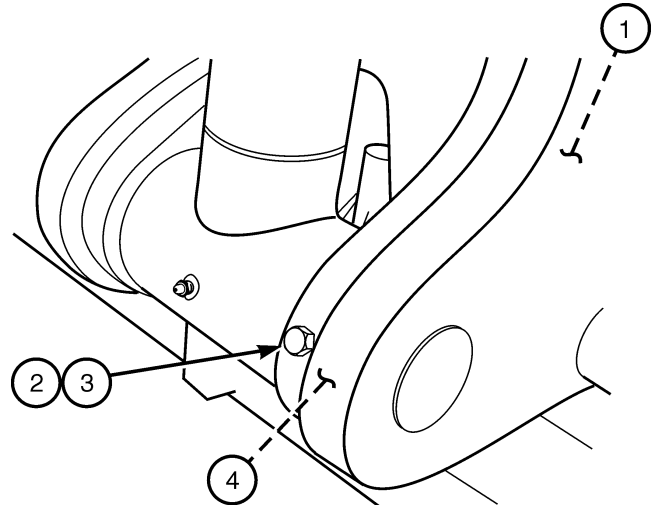
**CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap hydraulic oil lines and plug holes in fittings and quick-disconnects after removing lines. Contamination of the hydraulic system could result in premature failure.

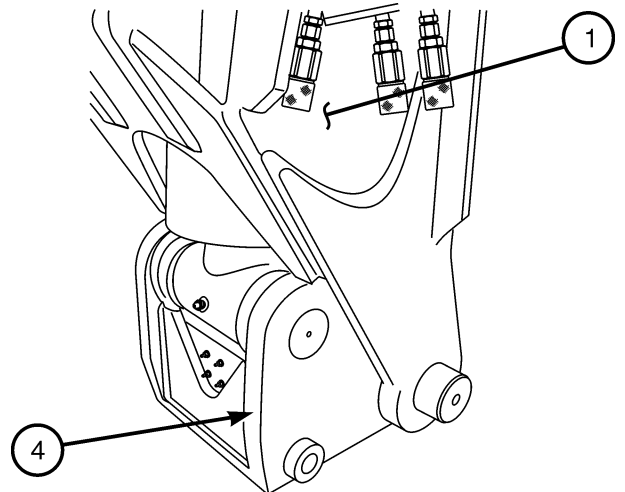
a. *Removal.***NOTE**

Counterweight can be used as a work platform at rear of vehicle.

- (1) **Start engine (TM 10-3930-673-10) and extend inner boom approximately 15 ft (4.6 m).**
- (2) **Extend carriage tilt cylinder approximately half-way (TM 10-3930-673-10).**
- (3) **At lower end of attachment (1), remove locknut (2) and screw (3) from quick-attach (4). Discard locknut.**



- (4) **Fully retract attachment cylinder (TM 10-3930-673-10).**
- (5) **Retract carriage tilt cylinder (TM 10-3930-673-10) so that flat surface of quick-attach (4) at lower end of attachment (1) is parallel to ground. Lower boom until weight of boom and attachment is supported by quick-attach.**
- (6) **Stop engine (TM 10-3930-673-10).**



**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

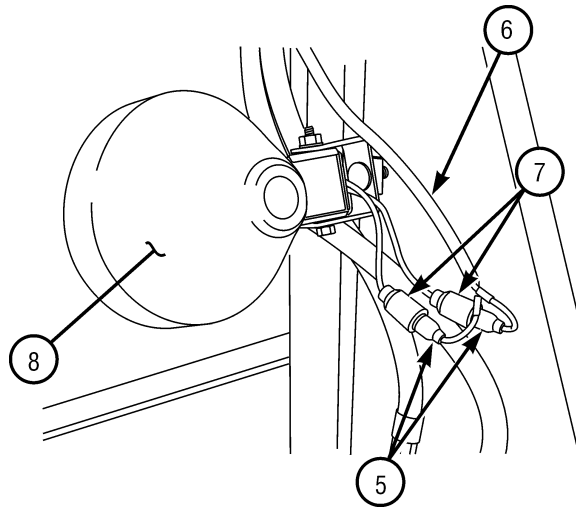
**NOTE**

Remove tie wraps as necessary.

- (7) Disconnect two connectors (5) of boom wiring harness (6) from connectors (7) of boom floodlight (8).

- (8) Pull boom wiring harness (6) through loop at top of attachment (1).

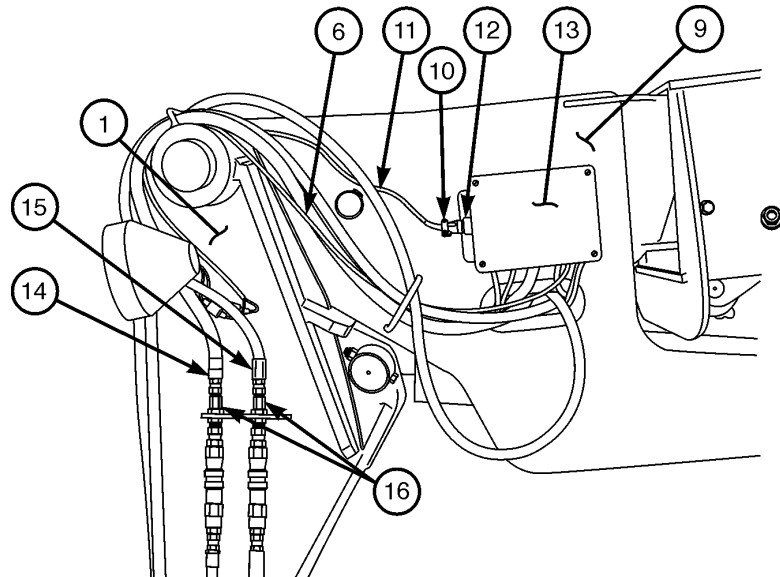
- (9) At left-front of inner boom (9), disconnect connector (10) of autoleveler cable (11) from connector (12) of boom electrical box (13).



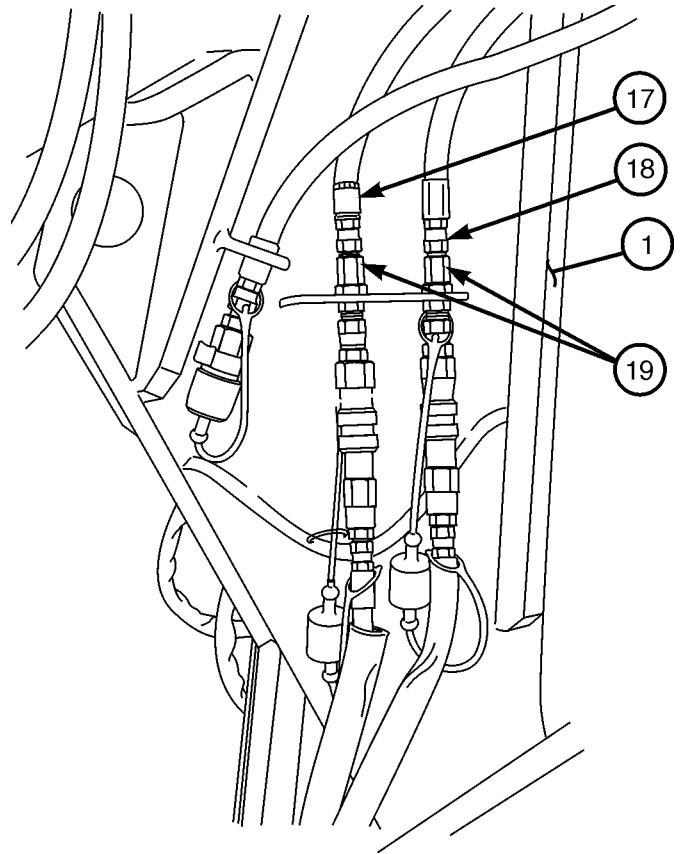
- (10) Tag or mark two hydraulic hoses (14 and 15) on left side of attachment (1). Disconnect two hydraulic hoses from two adapters (16). Plug hoses and cap adapters.

- (11) Pull two hydraulic hoses (14 and 15) through loop at top of attachment (1).

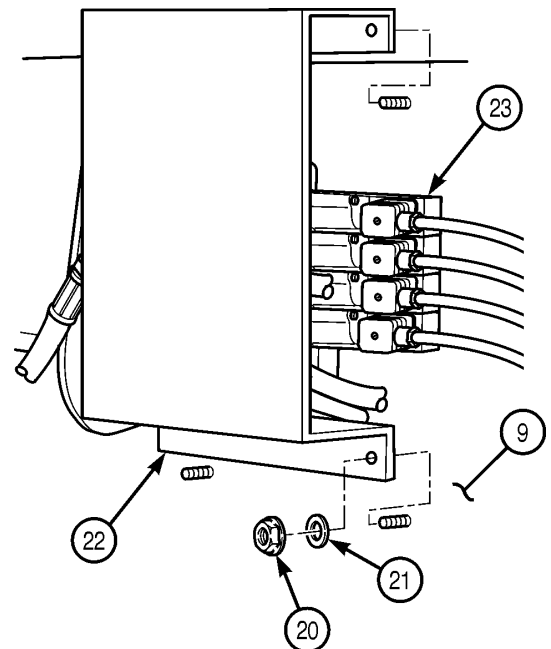
- (12) Tag or mark two hydraulic hoses (17 and 18) on right side of attachment (1). Disconnect two hydraulic hoses from two adapters (19). Plug hoses and cap adapters.



- (13) Pull two hydraulic hoses (17 and 18) through loop at top of attachment (1).

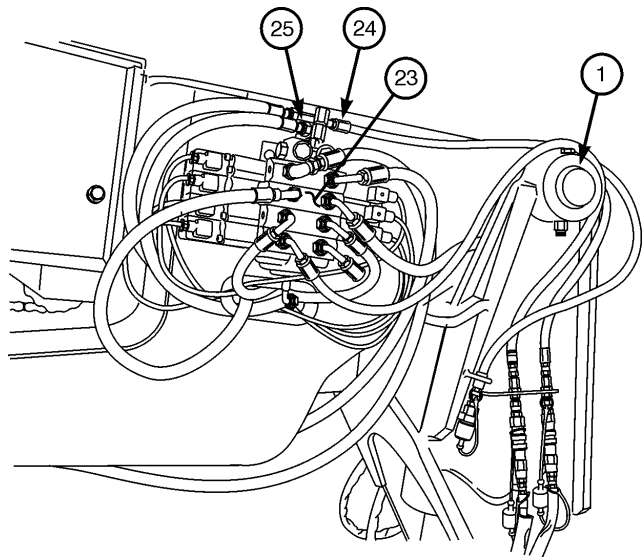


- (14) At right-front of inner boom (9), remove four locknuts (20), washers (21), and cover (22) of attachment control valve (23). Discard locknuts.



**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (15) Disconnect hydraulic return hose (24) from tee (25) at top of attachment control valve (23). Plug hose and install cap to adapter.
- (16) Pull hydraulic return hose (24) through loop at top of attachment (1).

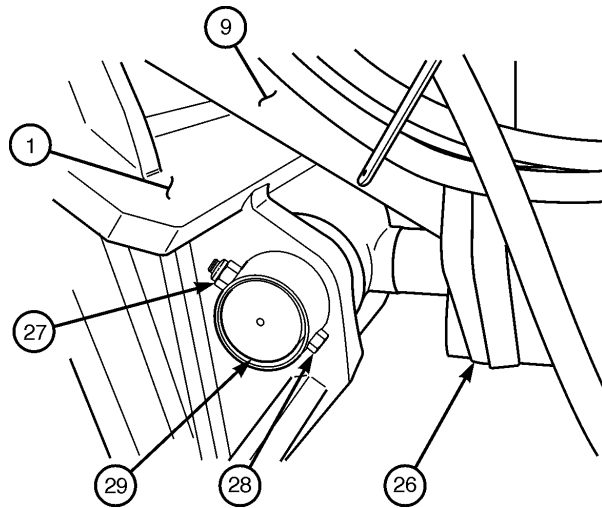


- (17) Using lifting strap, secure attachment cylinder (26) to inner boom (9) to prevent attachment cylinder from swinging downward when pin is removed.

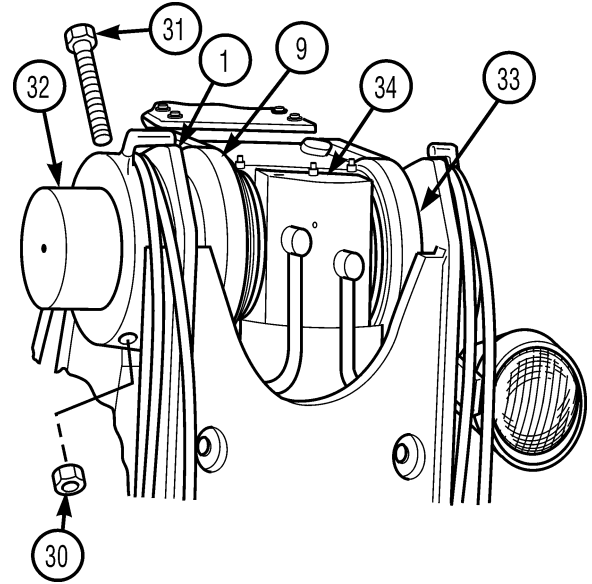
- (18) Remove locknut (27) and screw (28) from pin (29) securing attachment cylinder (26) to attachment (1). Discard locknut.

- (19) Using brass drift pin, remove pin (29).

- (20) Start engine (TM 10-3930-673-10) and retract rod end of attachment cylinder (26) from attachment (1).



- (21) Stop engine (TM 10-3930-673-10).
- (22) At top of attachment (1), remove locknut (30) and screw (31) from pin. Discard locknut.
- (23) Using 1 1/2 in. diameter brass drift pin, remove pin (32) and one or more shim washers (33) to separate attachment (1) and carriage tilt cylinder (34) from inner boom (9).



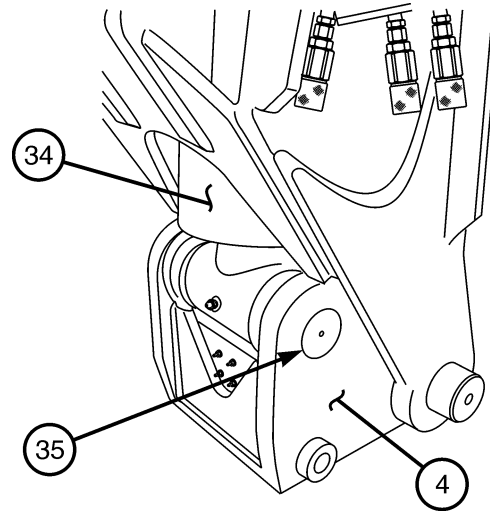
#### NOTE

Ensure that attachment and carriage tilt cylinder will remain in a vertical position.

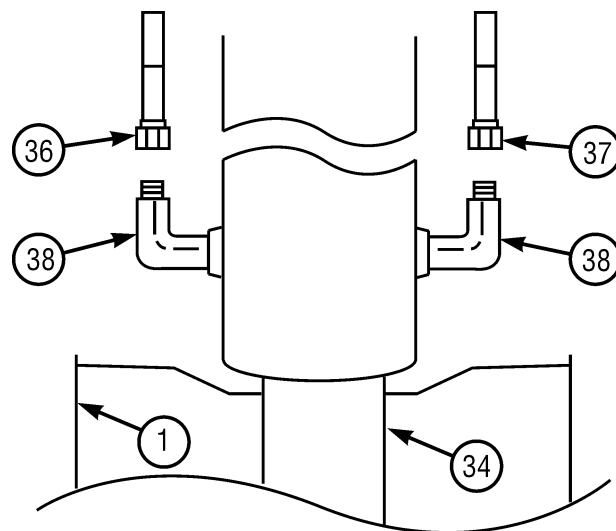
- (24) Start engine (TM 10-3930-673-10) and carefully retract inner boom (9) from attachment (1) and carriage tilt cylinder (34).
- (25) Stop engine (TM 10-3930-673-10).
- (26) Attach lifting strap through upper end of carriage tilt cylinder (34). Attach lifting strap to overhead lifting device. Take up just enough slack to support carriage tilt cylinder in a vertical position.

**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (27) Using brass drift pin, remove pin (35) to separate lower end of carriage tilt cylinder (34) from quick-attach (4).
- (28) Using attached overhead lifting device, carefully raise carriage tilt cylinder (34) just far enough to access hydraulic fittings of cylinder.



- (29) Tag or mark two hydraulic hoses (36 and 37). Disconnect two hydraulic hoses from two elbows (38) of carriage tilt cylinder (34). Plug hoses and cap elbows.
- (30) Pull two hydraulic hoses (36 and 37) out from attachment (1).
- (31) Raise carriage tilt cylinder (34) to clear top of attachment (1). Move cylinder clear of work area and place on wood blocks.



- (32) Attach lifting strap through upper end of attachment. Attach lifting strap to overhead lifting device. Move attachment clear of work area and place on wood blocks.
- (33) Start engine (TM 10-3930-673-10) and retract inner boom to within 10 ft (3 m) of fully retracted position.
- (34) Raise outer boom to horizontal position (zero degrees).
- (35) Stop engine (TM 10-3930-673-10).



**NOTE**

Keep wear pads and shims together in sets. Mark wear pads with their location on either intermediate or outer boom.

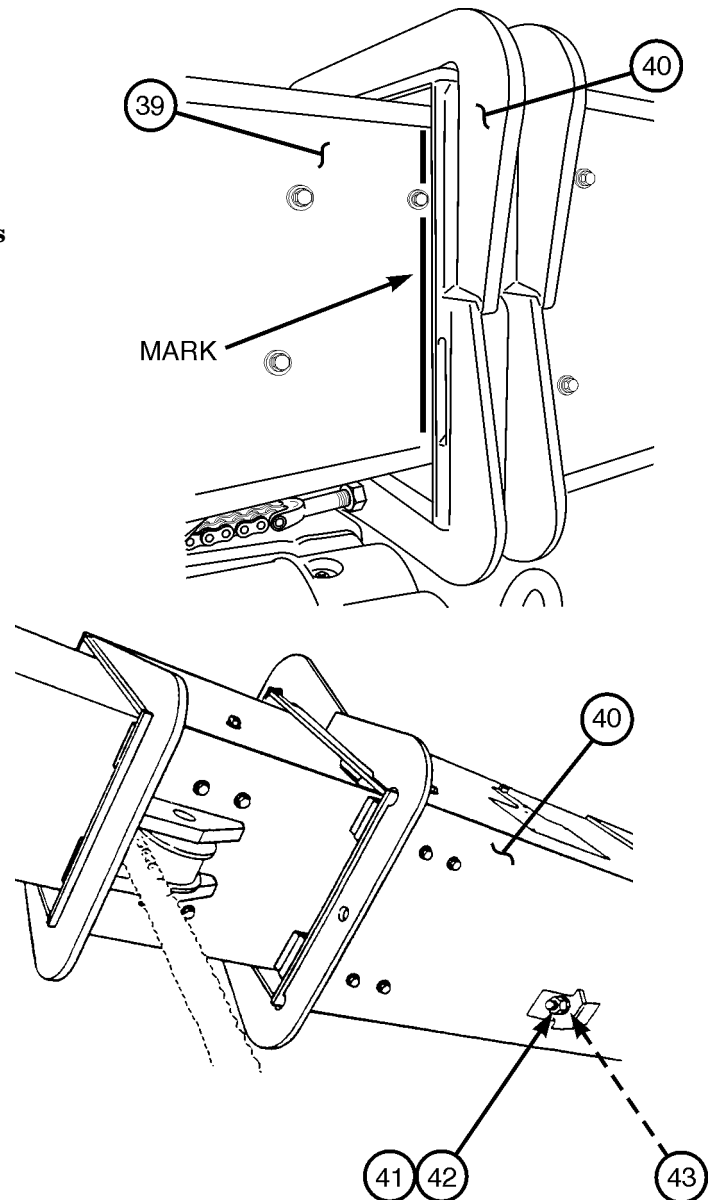
**(36) Remove top and side wear pads of intermediate and outer boom (Para 16-16).**

**(37) Start engine (TM 10-3930-673-10) and fully retract boom.**

**(38) Stop engine (TM 10-3930-673-10).**

**(39) Using chalk or suitable marker, mark location of intermediate boom (39) as to its position with outer boom (40) for ease in installation.**

**(40) At underside of outer boom (40) remove adjusting locknut (41) and washer (42) from extend chain clevis (43).**



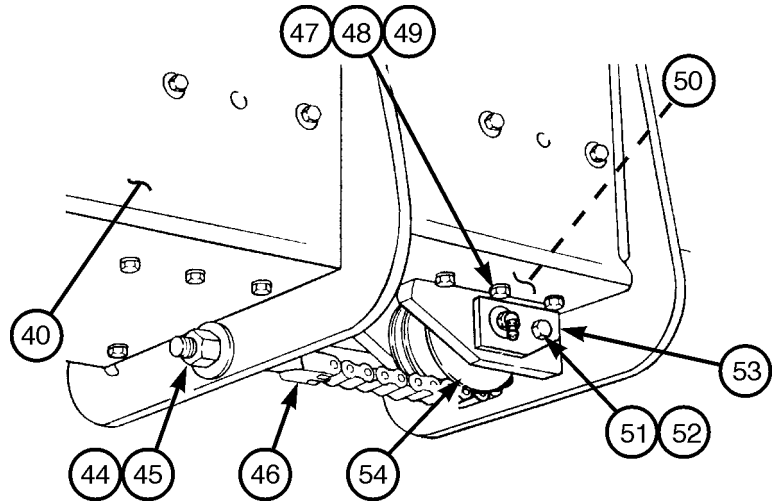
**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

(41) At front/underside of outer boom (40), remove adjusting nut (44) and washer (45) from retract chain clevis (46).

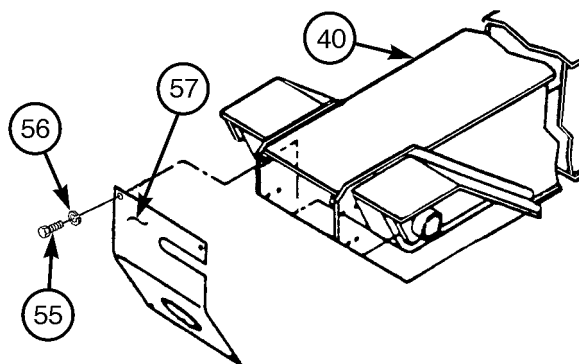
(42) Remove center bolt (47), lockwasher (48) and washer (49) from bottom-right wear pad (50). Discard lockwasher.

(43) Remove bolt (51) and lockwasher (52) from chain sheave pin (53). Discard lockwasher.

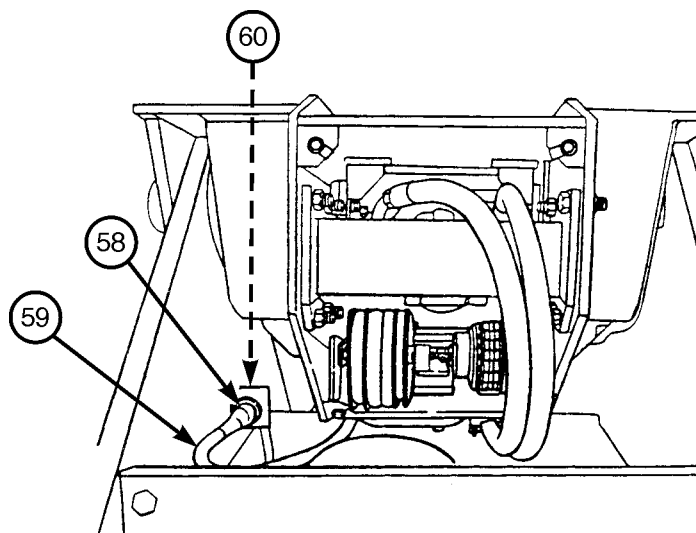
(44) Using brass drift, remove chain sheave pin (53) and sheave (54). Loosely reinstall washer (49), lockwasher (48), and center bolt (47).



- (45) At rear of outer boom (40), remove four screws (55), lockwashers (56) and cover (57). Discard lockwashers.



- (46) Disconnect connector (58) of boom electrical cable (59) from connector (60) of vehicle frame.



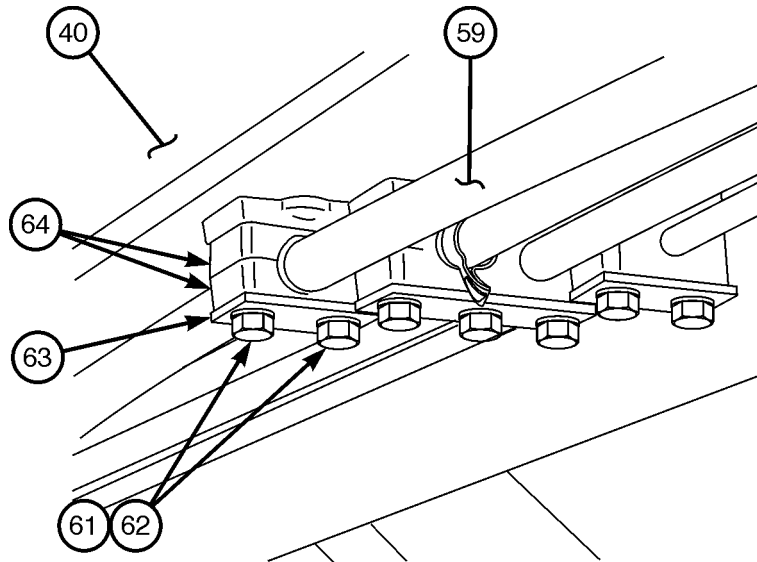
**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

**NOTE**

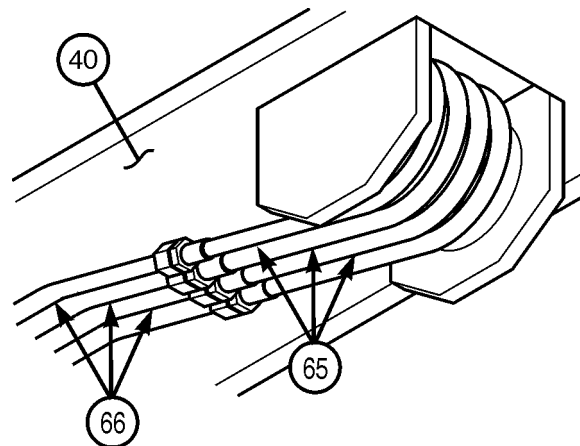
Perform following step at four places along underside of outer boom to remove boom electrical cable and hydraulic hoses.

**(47) Remove two screws (61), lockwashers (62), cable guide bracket (63) and clamp halves (64) from boom electrical cable (59) and outer boom (40). Discard lockwashers.**

**(48) Pull boom electrical cable (59) toward front of outer boom (40).**



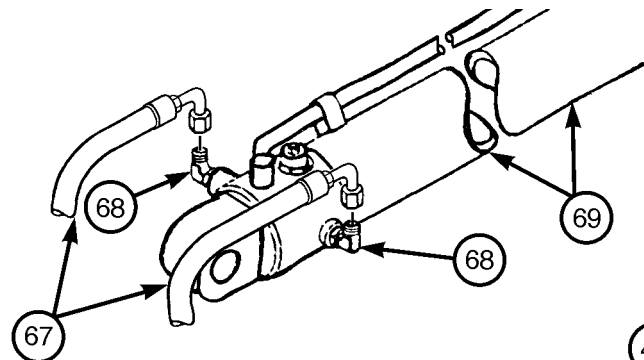
**(49) At front of outer boom (40), tag or mark three hydraulic hoses (65). Disconnect three hydraulic hoses from three metal tubes (66) underneath outer boom. Cap hoses and plug metal tubes.**



**NOTE**

Note position of hydraulic hoses for installation.

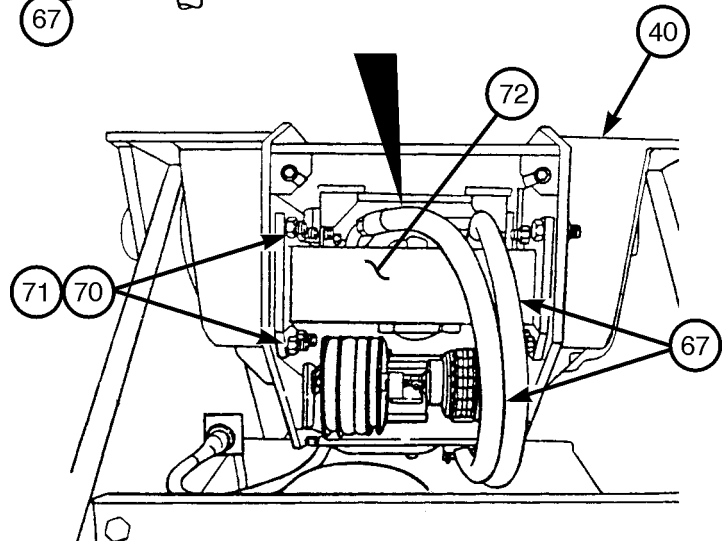
- (50) At rear of outer boom (40), tag or mark two hydraulic hoses (67). Disconnect two hydraulic hoses from two elbows (68) of boom extend cylinder (68). Plug hoses and cap elbows of cylinder.



**NOTE**

Wood block will support rear of boom extend cylinder when anchor is removed.

- (51) Underneath rear of boom extend cylinder (69), position block of wood 2 in. (51 mm) thick and 6 in. (152 mm) long.
- (52) Remove eight locknuts (70), bolts (71) and anchor (72) from sides of outer boom (40).

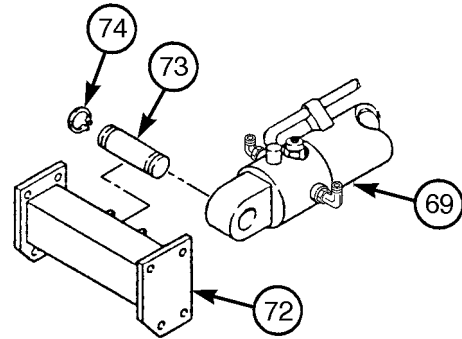


**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (53) Tilt anchor (72) slightly up and forward to gain access to pin (73) and retaining rings (74) that secure boom extend cylinder (69) to anchor.

**WARNING**

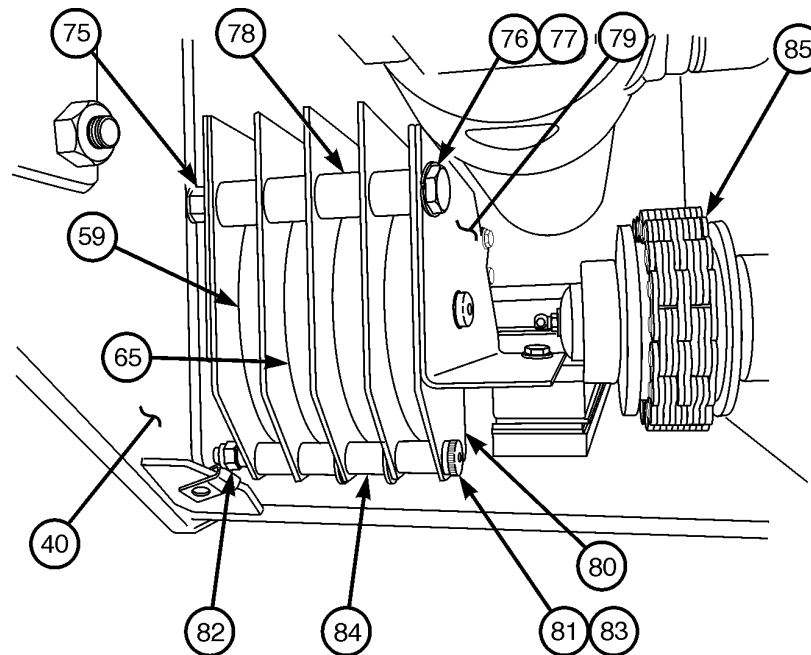
Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.



- (54) Remove retaining ring (74) at left side of pin (73) and remove pin and anchor (72) from boom extend cylinder (69). Discard retaining ring.

**NOTE**

- Partial disassembly of hose pulley assembly is necessary for ease in hose removal.
  - Note quantity and position of washers and spacers for installation.
- (55) At boom hose pulley assembly, remove locknut (75), upper screw (76), washers (77), and spacers (78) from pulley bracket (79) assembly. Discard locknut.



- (56) Pull bottom of divider (80) assembly to the rear to expose lower screw (81) and locknut (82).**

#### NOTE

Note quantity and position of washers and spacers for installation.

- (57) Remove locknut (82), lower screw (81), washers (83), and spacers (84) from divider (80) assembly. Discard locknut.**
- (58) Mark position of three hydraulic hoses (65) and electrical cable (59) and pull hoses and electrical cable out from rear of outer boom (40).**
- (59) Install upper screw (76) and locknut (75) back into pulley bracket (79) assembly.**

#### NOTE

A clean container may be used to receive extend chain.

- (60) Pull extend chain (85) out from rear of outer boom (40).**
- (61) Position another forklift vehicle in front of and facing vehicle.**
- (62) Using lifting straps or chains, secure front of inner boom to carriage of other forklift vehicle.**

#### NOTE

Chains or straps are used to prevent intermediate boom from being pulled out when inner boom is removed.

- (63) Using lifting straps or chains, secure intermediate boom to outer boom.**

**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

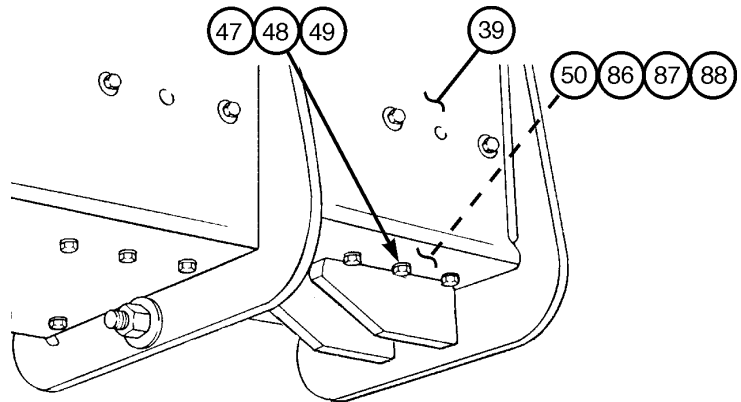
**NOTE**

Pulling inner boom outward will give access to wear pads on bottom of intermediate boom.

- (64) Using other forklift, take up slack in lifting straps or chains, lift inner boom slightly and pull inner boom outward approximately 2 ft (610 mm).**

**NOTE**

- Keep wear pads and shims together in sets.
- Mark wear pads with their location on intermediate boom.
- Perform steps 65 and 66 for each of two wear pads.

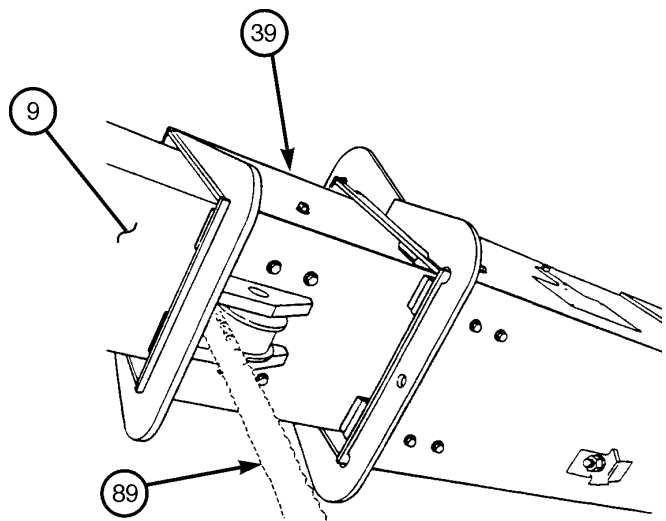


- (65) Remove three screws (47), lockwashers (48), and washers (49) from underneath intermediate boom (39). Discard lockwashers.**

- (66) From inside intermediate boom (39), remove wear pad (50), three inserts (86), spacer (87), and shims (88).**

- (67) Forward of front of intermediate boom (39), loosely attach lifting strap or chain around inner boom (9). Attach lifting strap or chain to overhead lifting device or overhead crane.**

- (68) At front of intermediate boom (39), pull on retract chain (89) and place chain so that gravity will keep tension on chain and permit smooth removal as inner boom (9) is removed.**





**WARNING**

Inner boom weldment and boom extend cylinder weighs approximately 1500 lbs (680.39 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

**NOTE**

As inner boom is removed, personnel at rear of outer boom will feed hydraulic hoses, extend chain and electrical cable through intermediate boom.

- (69) **Using forklift attached to front of intermediate boom, carefully pull inner boom out from intermediate boom until approximately 1 ft (305 mm) remains inside.**
- (70) **Using overhead crane, take up slack in lifting strap or chain to fully support rear of inner boom.**
- (71) **Remove inner boom from intermediate boom just far enough to pull hydraulic hoses, electrical cable and extend chain out from intermediate boom.**
- (72) **Using overhead crane and other forklift at the same time, evenly lower inner boom and temporarily place on jackstands or suitable supports.**
- (73) **Remove other forklift, overhead crane and lifting straps or chains from inner boom. Lifting straps or chains securing intermediate boom to outer boom may also be removed.**
- (74) **Using other forklift, lift and move inner boom clear of work area and again place on jackstands or suitable supports.**

**b. Disassembly.**

- (1) **Remove attachment cylinder from front of inner boom (TM 10-3930-673-20).**

**NOTE**

Keep wear pads and shims together in sets. Mark wear pads with their location on inner boom.

- (2) **Remove remaining wear pads and mounting hardware from inner boom (Para 16-16).**
- (3) **Remove boom extend cylinder from inner boom (TM 10-3930-673-20).**
- (4) **Remove boom hydraulic hoses from inner boom (TM 10-3930-673-20).**
- (5) **Remove attachment control valve from inner boom (TM 10-3930-673-20).**
- (6) **Remove boom electrical cable from inner boom (TM 10-3930-673-20).**
- (7) **Remove boom electrical junction box assembly from inner boom (TM 10-3930-673-20).**

**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (8) Remove cotter pin (90), pin (91), and clevis (92) and retract chain (89) from bottom-rear of inner boom (91). Discard cotter pin.

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (9) Remove two retaining rings (93), pin (94), and clevis (92) from end of retract chain (89). Discard retaining rings.
- (10) Remove two nuts (95), washer (96), clevis (97) and extend chain (85) from rear of inner boom (9).

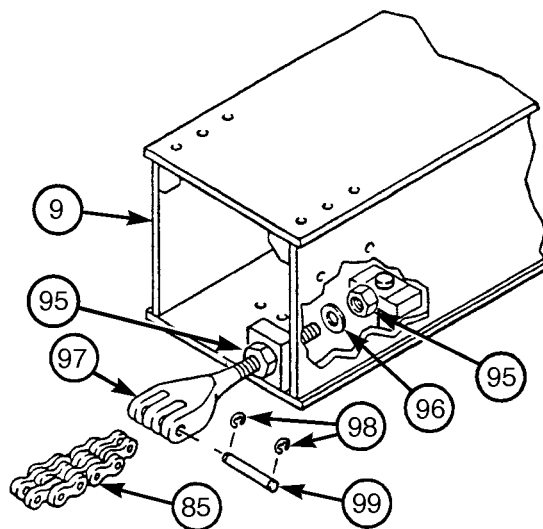
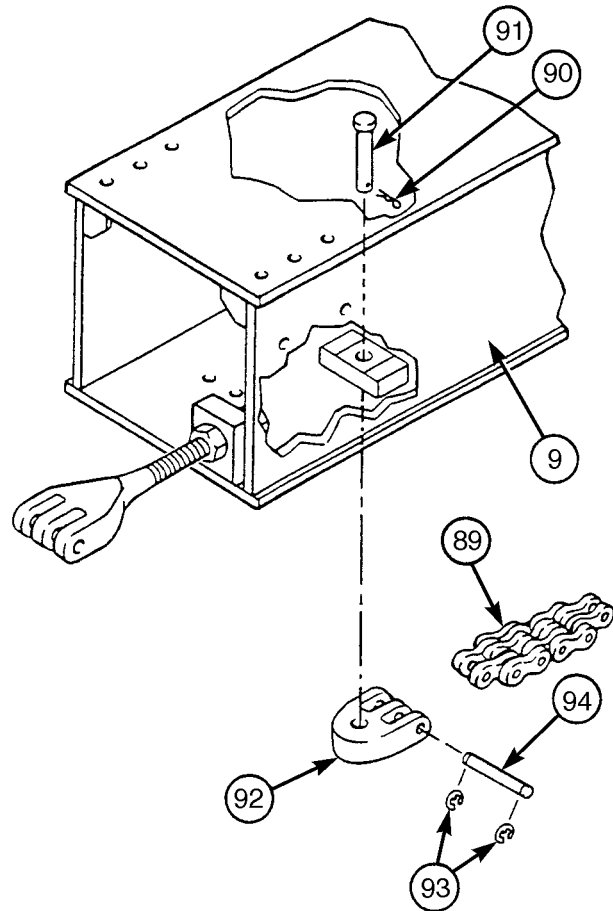
**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (11) Remove two retaining rings (98), pin (99) and clevis (97) from end of extend chain (85). Discard retaining rings.

*c. Cleaning.* See Cleaning Instructions (Para 2-12).

*d. Inspection.* See Inspection Instructions (Para 2-14).



**e. Assembly.****WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (1) **Install clevis (97) to extend chain (85) with pin (99) and two new retaining rings (98).**
- (2) **Install clevis (97) and extend chain (85) to rear of inner boom (9) with washer (96) and two nuts (95).**

**NOTE**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (3) **Install clevis (92) to end of retract chain (89) with pin (94) and two new retaining rings (93).**
- (4) **Install retract chain (89) and clevis (92) to bottom-rear of inner boom (9) with pin (91) and new cotter pin (90).**
- (5) **Install boom electrical junction box assembly to inner boom (TM 10-39030-673-20).**
- (6) **Install boom electrical cable to inner boom (TM 10-39030-673-20).**
- (7) **Install attachment control valve to inner boom (TM 10-3930-673-20).**
- (8) **Install boom hydraulic hoses to inner boom (TM 10-3930-673-20).**
- (9) **Install boom extend cylinder to inner boom (TM 10-3930-673-20).**
- (10) **Install wear pads and mounting hardware to inner boom as marked (para 16-16).**
- (11) **Install attachment cylinder to front of inner boom (TM 10-3930-673-20).**

## 16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)

### NOTE

Ropes will be used to pull extend chain, electrical cable, and three hydraulic hoses through boom when inner boom is installed.

- (1) **Place two ropes inside length of intermediate boom.**
- (2) **At front of intermediate boom, attach one rope to extend chain and other rope to electrical cable and three hydraulic hoses.**
- (3) **Using another forklift, move inner boom to position in front of and in alignment with intermediate boom of vehicle. Place on jackstands or suitable supports.**

#### *f. Installation.*

### NOTE

Ropes will be used to pull extend chain, electrical cable, and three hydraulic hoses through boom when inner boom is installed.

- (1) **Place two ropes inside length of intermediate boom.**
- (2) **At front of intermediate boom, attach one rope to extend chain and other rope to electrical cable and three hydraulic hoses.**
- (3) **Using another forklift, move inner boom to position in front of and in alignment with intermediate boom of vehicle. Place on jackstands or suitable supports.**
- (4) **Using overhead lifting device, other forklift and lifting straps or chains, carefully raise inner boom and push inner boom inside intermediate boom approximately 2 ft (610 mm).**

### NOTE

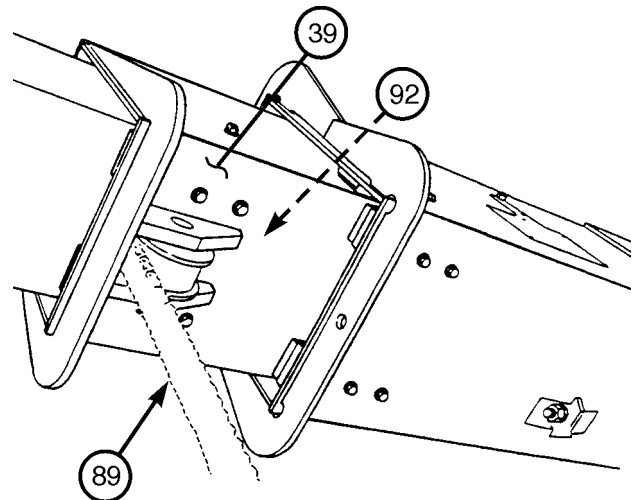
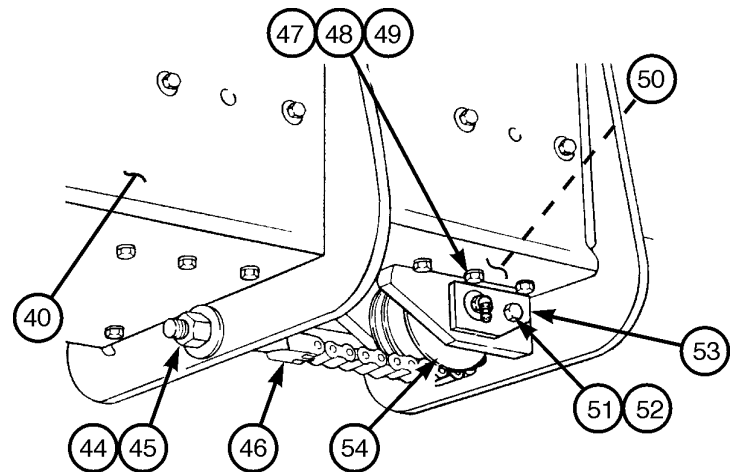
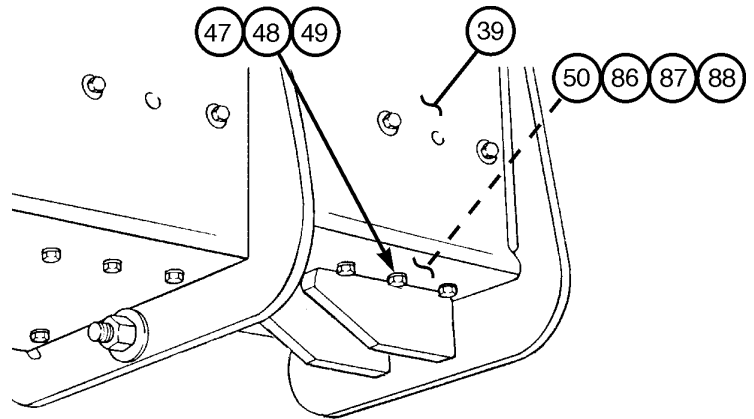
Overhead crane can remain in position for safety.

- (5) Lower overhead crane slightly to put slack in lifting straps or chains. Keep straps or chains in position around inner boom.

**NOTE**

Perform steps 6 and 7 for each of two wear pads.

- (6) At inside of intermediate boom (39) position three shims (88), spacer (87), three inserts (86), and wear pad (50).
- (7) Apply sealing compound to threads of two bolts (47) and secure wear pad (50) to inner boom (9) with two washers (49), new lockwashers (48), and bolts (47). Tighten bolts to 30 lb-ft (40.67 Nm).
- (8) Install sheave (54) to intermediate boom (39) with chain sheave pin (53). Install new lockwasher (52) and bolt (51).
- (9) Apply sealing compound to threads of remaining bolt (47) and install washer (49) new lockwashers (48) and bolt (). tighten bolt to 30 lb-ft (40.67 Nm).
- (10) Install top and side wear pads of intermediate and outer boom (Para 16-16).
- (11) Position clevis (92) and retract chain (89) into hole underneath intermediate boom (39).



**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

**NOTE**

Pull ropes to install extend chain, electrical cable, and three hydraulic hoses as inner boom is pushed inward.

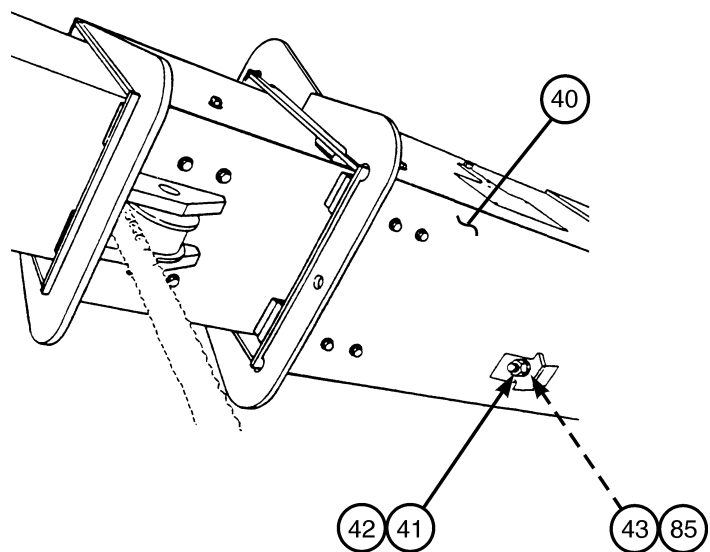
(12) Push inner boom further into intermediate boom to previously made alignment mark.

(13) Remove ropes attached to extend chain (85), electrical cable, and hydraulic hoses.

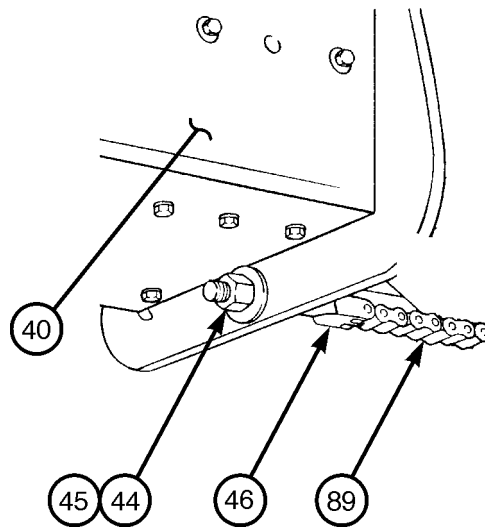
(14) Remove lifting straps or chains supporting inner boom and move other forklift and overhead crane away from work area.

(15) Using ropes previously placed between outer and intermediate boom sections, pull extend chain (85) back down and between outer boom and intermediate boom.

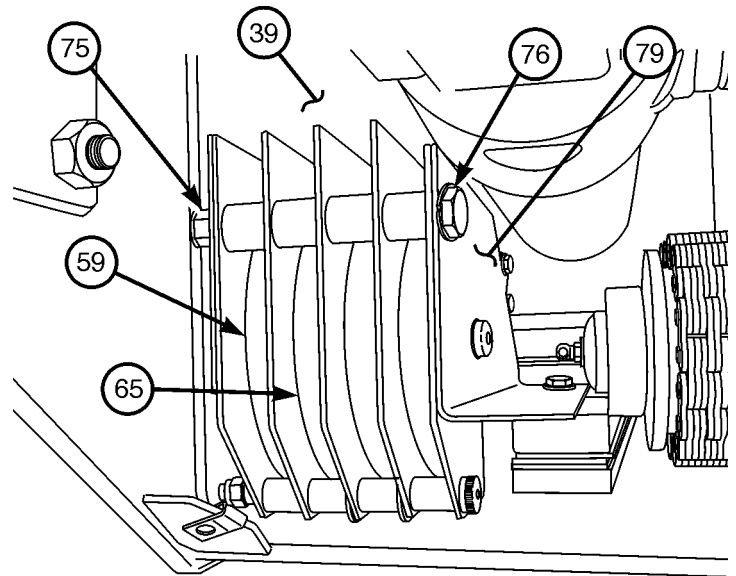
(16) Install clevis (43) of extend chain (85) to outer boom (40) with washer (42) and new locknut (41).



(17) Install clevis (46) of retract chain (89) underneath front of outer boom (40) with washer (45) and new locknut (44).



- (18) At rear of intermediate boom (39), remove locknut (75) and upper screw (76) from pulley bracket assembly (79). Discard locknut.

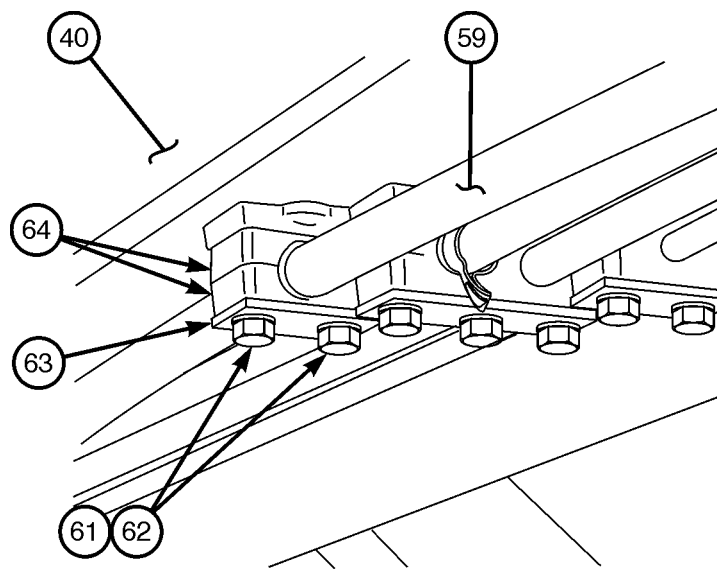


- (19) Pull boom electrical cable (59) and three hydraulic hoses (65) between boom sections.

**NOTE**

Perform following step at four places along underside of outer boom to install boom electrical cable and hydraulic hoses.

- (20) Install boom electrical cable (59) to outer boom (40) with two clamp halves (64), cable guide bracket (63), two new lockwashers (62) and two screws (61)

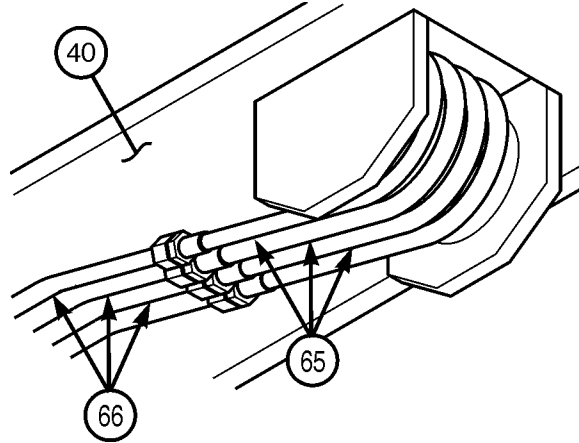


**NOTE**

Start hydraulic hose on left side of vehicle.

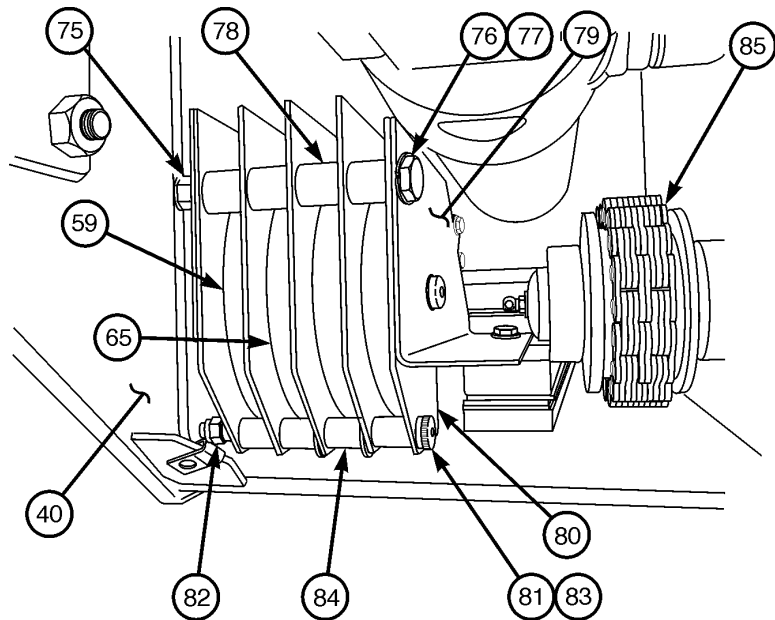
**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (21) Underneath outer boom (40), connect three hydraulic hoses (65) to metal tubes (66).



- (22) At rear of intermediate boom, install lower screw (81), washers (83), spacers (82), and new locknut (82) to divider (80) assembly.

- (23) Install upper screw (76), washers (77), spacers (78), and new locknut (75) to pulley bracket (79) assembly.

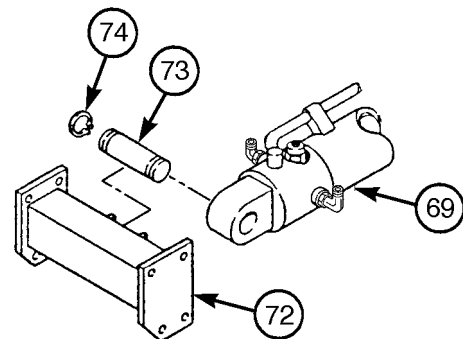


**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

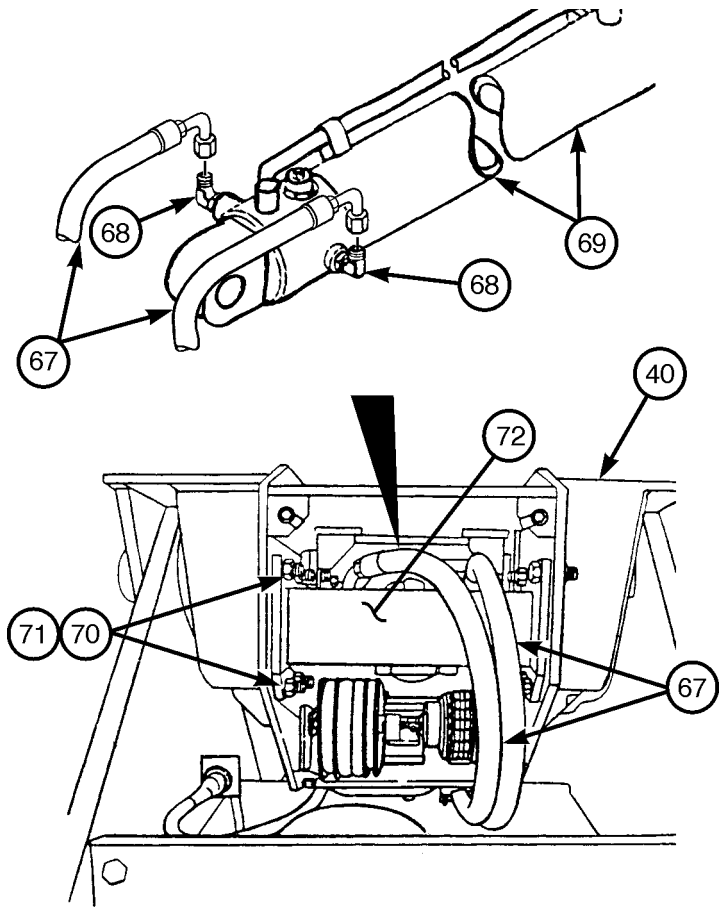
- (24) Install anchor (72) to rear of boom extend cylinder (69) with pin (73) and two new retaining rings (74).

- (25) Install anchor (72) to outer boom (40) with eight bolts (71) and new locknuts (70).



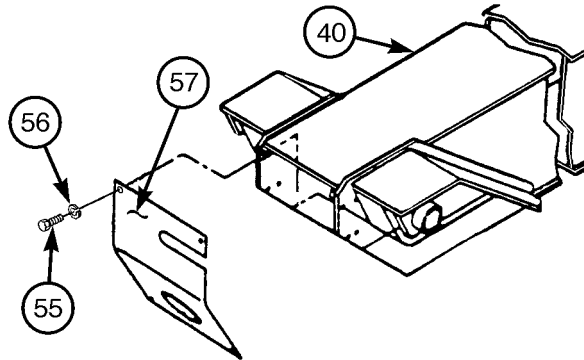


- (26) Remove wood block from under boom extend cylinder (69).
- (27) Connect two hydraulic hoses (67) to two elbows (68) of boom extend cylinder (69).
- (28) Connect connector (58) of boom electrical cable (59) to connector (60) of vehicle frame.



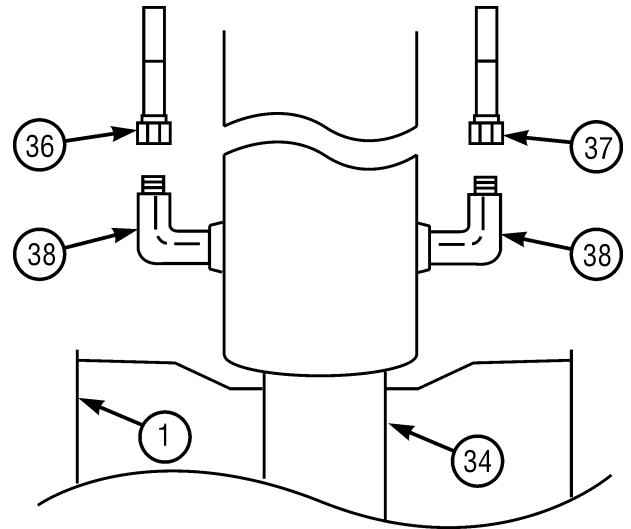
**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (29) Install cover (57) to rear of outer boom (40) with four new lockwashers (56) and screws (55).

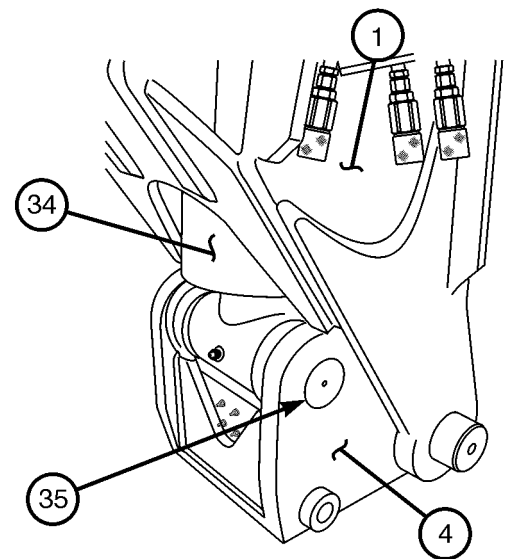


- (30) Adjust extend chain and retract chain (TM 10-3930-673-20).
- (31) Place attachment vertically approximately 15 ft (5 m) in front of vehicle in line with boom.
- (32) Start engine (TM 10-3930-673-10) and carefully extend boom so that bore in inner boom is aligned with, but still 3 ft (1 m) away from, attachment (1).
- (33) Stop engine (TM 10-3930-673-10).
- (34) Attach lifting straps through upper end of carriage tilt cylinder (34) and attach lifting strap to overhead lifting device.
- (35) Move carriage tilt cylinder (34) to attachment (1) and partially lower cylinder into attachment.

- (36) Connect two hydraulic hoses (36 and 37) to two elbows (38) of carriage tilt cylinder (34).

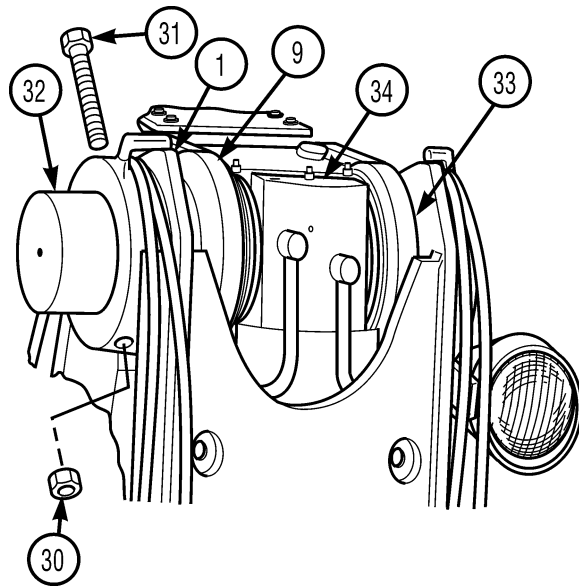


- (37) Lower carriage tilt cylinder (34) to align bore of cylinder with bore of lower end of attachment (1).
- (38) Apply thin coat of anti-seize compound to pin (35) and connect rod end of carriage tilt cylinder (34) quick-attach (4) with pin (35).

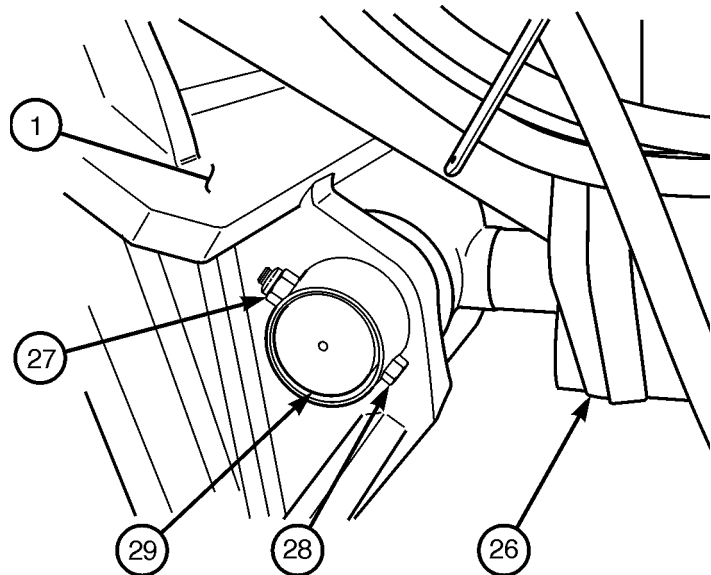


**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

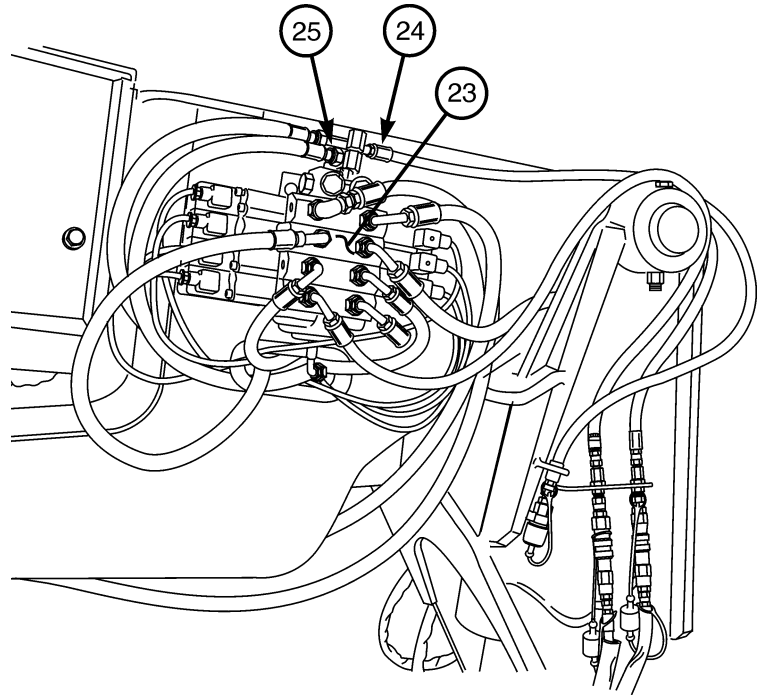
- (39) With carriage tilt cylinder (34) held in a vertical position, remove overhead lifting device and lifting strap.
- (40) Start engine (TM 10-3930-673-10) and extend boom so that bore in inner boom (9) is aligned with bore at top of attachment (1).
- (41) Apply thin coat of anti-seize compound to pin (32) and install two shim washers (33), attachment (1) and carriage tilt cylinder (34) to inner boom (9) with pin.
- (42) At top of attachment (1), install screw (31) and new locknut (30).



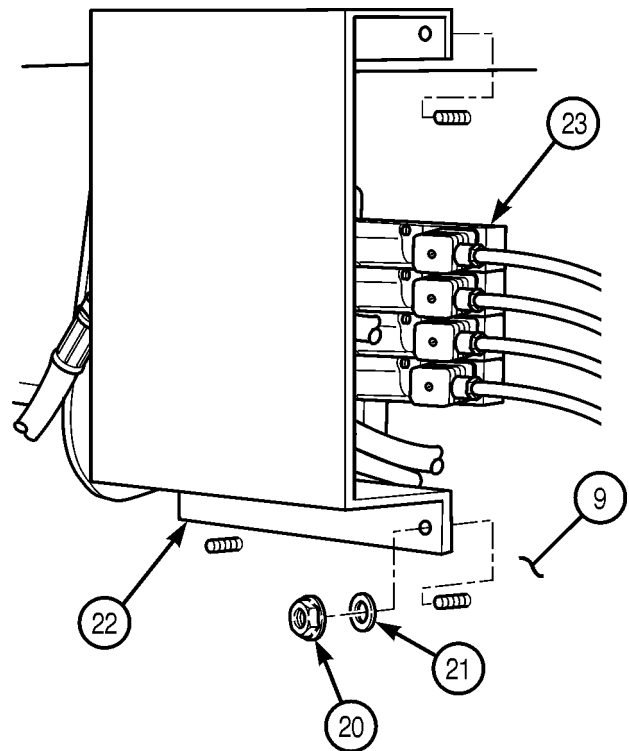
- (43) While supporting attachment cylinder (26), extend rod end of cylinder so that bore in cylinder is aligned with bore of attachment (1).
- (44) Apply thin coat of anti-seize compound to pin (29) and connect rod end of attachment cylinder (26) to attachment (1) with pin (29).
- (45) Install screw (28) and new locknut (27).



- (46) Connect hydraulic return hose (24) on tee (25) at top of attachment control valve (23).

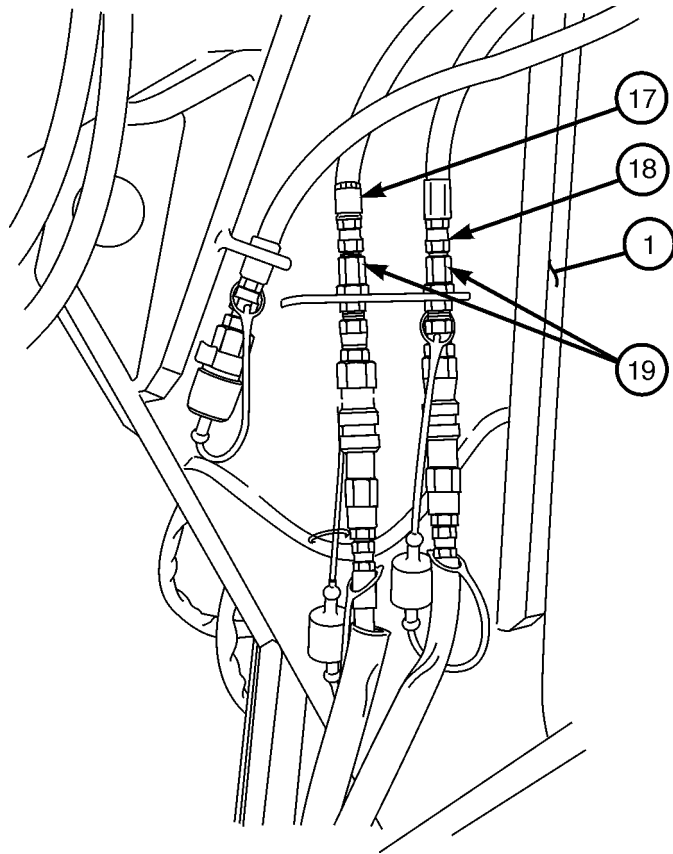


- (47) Install cover (22) of attachment control valve (23) with four washers (21) and new locknuts (20).

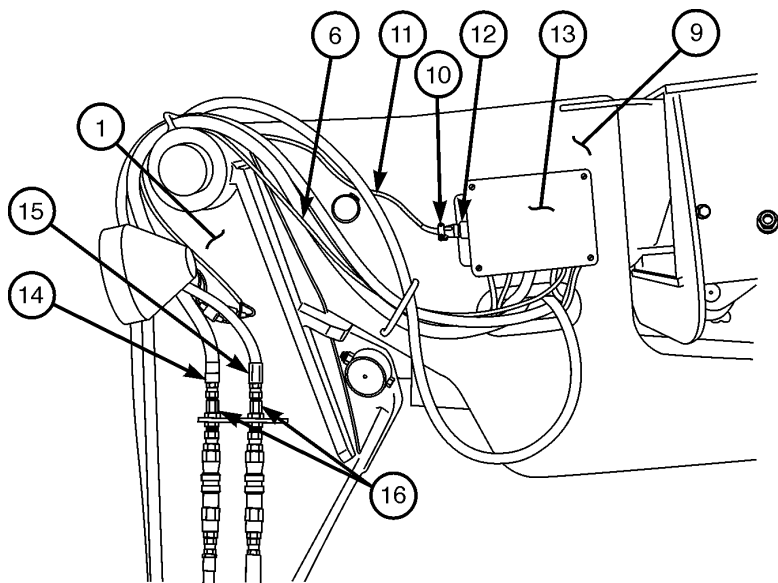


**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

**(48) Connect two hydraulic hoses (17 and 18) on two adapters (19) at right side of attachment (1).**



**(49) Connect two hydraulic hoses (15 and 14) on two adapters (16) at left side of attachment (1).**

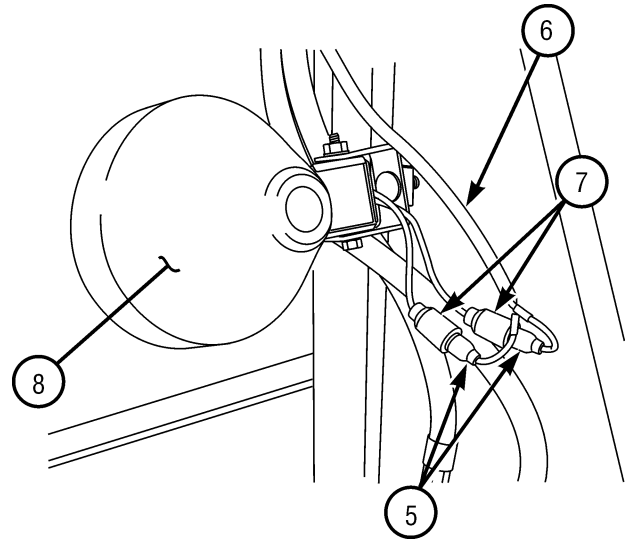


- (50) At left-front of inner boom (9), connect connector (10) of autoleveler cable (11) on connector (12) of boom electrical box (13).

### NOTE

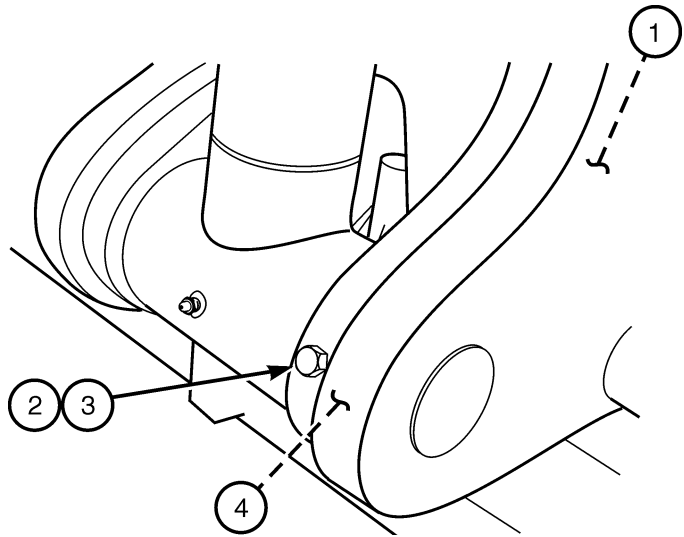
Install tie wraps as necessary.

- (51) Connect two connectors (5) of boom wiring harness (6) on two connectors (7) of boom floodlight (8).
- (52) Start engine (TM 10-3930-673-10). Raise boom to horizontal and extend carriage tilt cylinder.
- (53) Partially extend attachment cylinder. Stop engine (TM 10-3930-673-10).



**16-12. INNER BOOM REPLACEMENT/REPAIR (CONT)**

- (54) At quick-attach (4) at lower end of attachment (1), install screw (3) and new locknut (2).



**NOTE**

Follow-on Maintenance:

- Fill hydraulic tank (TM 10-3930-673-20).
- Install counterweight (TM 10-3930-673-10).
- Install carriage (TM 10-3930-673-10).
- Install transmission cover (TM 10-3930-673-20).

**END OF TASK**



**16-13. INTERMEDIATE BOOM REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair, Field Maintenance Basic, Less Power (Item 18, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Lifting Device, 1 ton (907.18 kg) capacity

*Materials/Parts*

- Compound, Sealing (Item 40, Appendix B)
- Tags (Item 55, Appendix B)
- Lockwasher (4)
- Lockwasher (4)
- Lockwasher (6)
- Container, 5 gal (19 l) capacity
- Wood Blocks

*Equipment Condition*

- Boom level (TM 10-3930-673-10)
- Inner boom removed (Para 16-12)

*Personnel Required*

Two

**a. Removal.**

**WARNING**

Intermediate boom weighs 955 lbs (433.18 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

**NOTE**

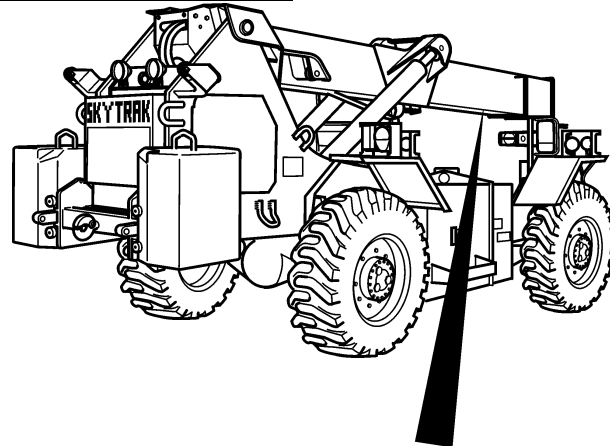
Ensure that rope used during inner boom removal (Para 16-12) is placed in intermediate boom and fastened at each end.

- (1) **Position another forklift vehicle in front of and facing vehicle.**
- (2) **Using lifting straps, secure front of intermediate boom to carriage of other forklift vehicle.**
- (3) **Using other forklift, slightly raise intermediate boom to gain access to bottom wear pads on inside of outer boom.**

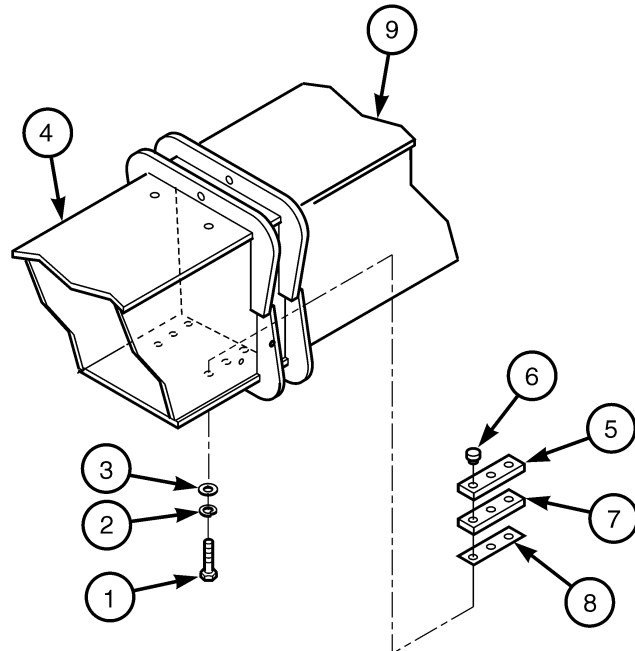
**16-13. INTERMEDIATE BOOM REPLACEMENT/REPAIR (CONT)**

**NOTE**

- Keep wear pads and shims together in sets.
- Mark wear pads with their location on outer boom.
- Perform steps 4 and 5 for each of two wear pads.



- (4) Remove three screws (1), lockwashers (2), and washers (3) from underneath outer boom(4). Discard lockwashers.
- (5) From inside outer boom (4), remove wear pad (5), three inserts (6), spacer (7), and shims (8).
- (6) Just forward of front of outer boom, loosely attach lifting strap around intermediate boom. Attach lifting strap to overhead lifting device or overhead crane.
- (7) Using forklift attached to front of intermediate boom (9), carefully pull intermediate boom from outer boom until approximately 1 ft (305mm) remains inside.
- (8) Using overhead lifting device, take up slack in lifting strap to fully support rear of intermediate boom (9).
- (9) Remove intermediate boom (9) from outer boom (4).



- (10) Using overhead lifting device and other forklift at the same time, evenly lower intermediate boom and temporarily place on jackstands or suitable supports.
- (11) Remove other forklift, overhead lifting device and lifting straps from intermediate boom.
- (12) Using other forklift, lift and move intermediate boom clear of work area and again place on jackstands or suitable supports.

**b. Disassembly.**

- (1) Remove boom extend chain sheave (TM 10-3930-673-20).
- (2) Remove boom hose pulley (TM 10-3930-673-20).
- (3) Remove wear pads (Para 16-16).

**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**e. Assembly.**

- (1) Install wear pads (Para 16-16).
- (2) Install boom hose pulley (TM 10-3930-673-20).
- (3) Install boom extend chain sheave (TM 10-3930-673-20).

**f. Installation.**

#### **NOTE**

Rope will be used to pull extend chain between outer boom and intermediate boom when inner boom is installed.

- (1) **Place small diameter, but strong rope from rear of outer boom and comes out the extend chain hole, at underside of outer boom.**

#### **NOTE**

Rope will be used to pull electrical cable and hydraulic hoses from rear of boom back through and between outer boom and intermediate boom when inner boom is installed. Rope should be twice the length of boom.

- (2) **Place another rope from rear of outer boom and comes out of the hydraulic hose hole, at underside of outer boom.**
- (3) **Using other forklift, move intermediate boom to position in front of and in alignment with, outer boom of vehicle. Place on jackstands or suitable supports.**
- (4) **Using overhead lifting device, other forklift and lifting straps, carefully raise intermediate boom and push intermediate boom inside outer boom approximately 2 ft. (610 mm).**

#### **NOTE**

Overhead crane can remain in position for safety.

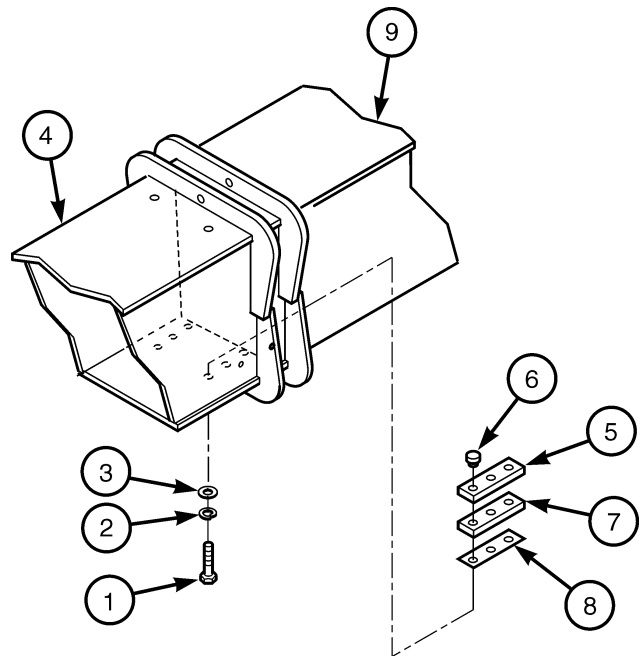
- (5) **Lower overhead lifting device slightly to put slack in lifting straps. Keep straps in position around intermediate boom.**
- (6) **Push intermediate boom into outer boom until intermediate boom extends approximately 4 ft. (1.2 m) out from front of outer boom.**

**16-13. INTERMEDIATE BOOM REPLACEMENT/REPAIR (CONT)**

**NOTE**

Perform steps 7 and 8 for each of two wear pads.

- (7) At inside of outer boom (4), position three shims (8), spacer (7), three inserts (6), and wear pad (5).
- (8) Apply sealing compound to threads of three screws (1).
- (9) Secure wear pad (5) to outer boom (4) with three washers (3), new lockwashers (2), and screws (1). Tighten screws to 30 lb-ft (40.67 Nm).
- (10) Push intermediate boom (9) into outer boom (4).
- (11) Remove lifting straps supporting intermediate boom and move other forklift and overhead lifting device away from work area.
- (12) Position ropes at rear of boom down through intermediate boom.



**NOTE**

Follow-on Maintenance: Install inner boom (Para 16-12).

**END OF TASK**



**16-14. OUTER BOOM REPLACEMENT/REPAIR**

This Task Covers:

- |                |               |                 |
|----------------|---------------|-----------------|
| a. Removal     | c. Cleaning   | e. Assembly     |
| b. Disassembly | d. Inspection | f. Installation |

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power (Item 18, Appendix D)
- Cap and Plug Set (Item 1, Appendix D)
- Lifting Device, 1 ton (907.18 kg) capacity

*Equipment Condition*

- Intermediate boom removed (Para 16-13)
- Transmission cover removed (TM 10-3930-673-20)

*Materials/Parts*

- Compound, Anti-seize (Item 10, Appendix B)
- Compound, Sealing (Item 40, Appendix B)

*Materials/Parts - Continued*

- Rags, Lint-free (Item 34, Appendix B)
- Tags (Item 55, Appendix B)
- Tape, Electrical (Item 56, Appendix B)
- Locknut
- Lockwasher (4)
- Lockwasher (6)
- Container, 5 gal (19 l) capacity
- Wood Blocks

*Personnel Required*

Two

**WARNING**

- Ensure hoses and tubes under boom are closed securely using metal plugs. Hydraulic oil under pressure can spray from hoses and tubes causing bodily injury if tubes and hoses are not closed securely.
- Outer boom weighs 1952 lbs (885.41 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

**CAUTION**

Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap hydraulic oil lines and plug holes in fittings and quick-disconnects after removing lines. Contamination of the hydraulic system could result in premature failure.

**NOTE**

If more than one hydraulic hose is to be removed, identify hoses to assure proper installation. Use container to catch any hydraulic oil that may drain from system.

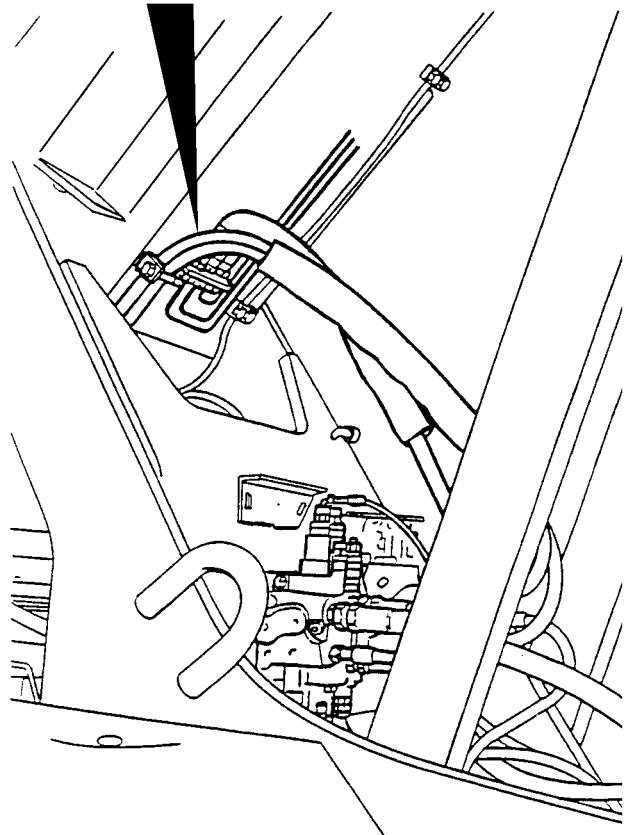
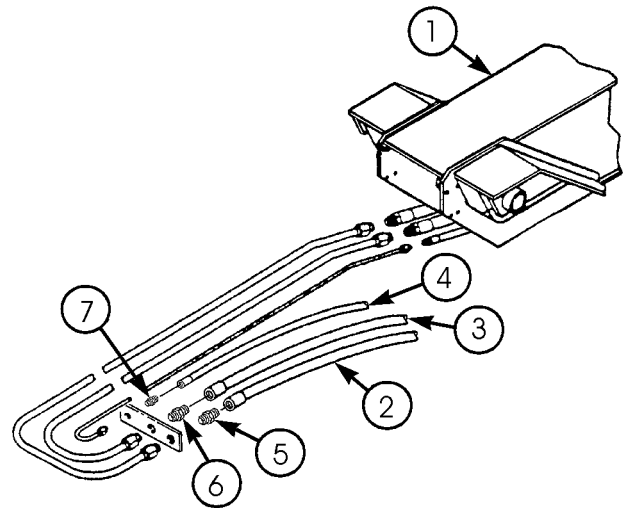
**a. Removal.**

- (1) Start engine and raise outer boom (1) as necessary to access hoses (2, 3, and 4). Stop engine.

**WARNING**

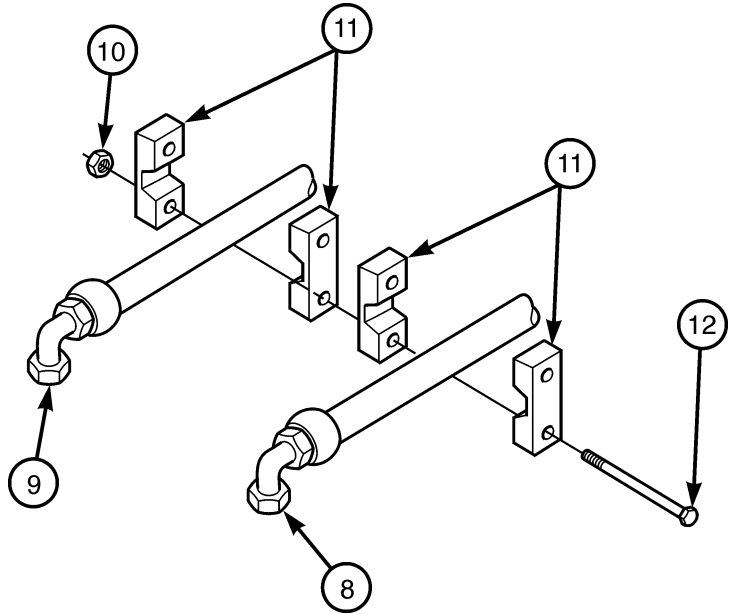
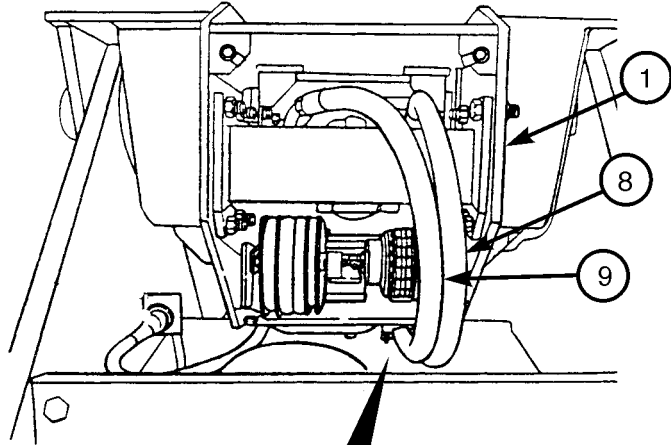
Disconnect hoses carefully. Hydraulic oil may be under pressure. Failure to follow this precaution will cause personal injury.

- (2) Tag, mark, and disconnect three hoses, (2, 3 and 4) from fittings (5, 6 and 7) at bulkhead. Plug three hoses with metal caps.



**16-14. OUTER BOOM REPLACEMENT/REPAIR (CONT)**

- (3) Tag and mark two hoses (8 and 9).  
Remove locknut (10), four clamp  
halves (11), screw (12) and two hoses  
from bottom-rear of outer boom (1).



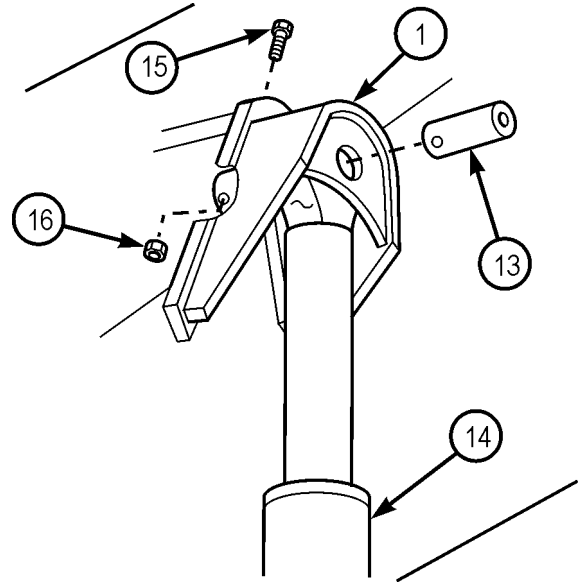


- (4) Start engine (TM 10-3930-673-10). Lower outer boom (1) until pivot pins (13) are just above cab. Stop engine.

**WARNING**

Outer boom weighs 1952 lbs (885.41 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (5) Support outer boom (1) with hoist and slings or other suitable lifting device positioned at front of boom.
- (6) Place wood block across vehicle deck behind cab to support boom hoist cylinders (14) when cylinders are lowered.
- (7) Remove screw (15) and locknut (16) from pivot pin (13). Discard locknut.
- (8) Support boom hoist cylinder (14). Remove pivot pin (13) from outer boom (1) and boom hoist cylinder.



**CAUTION**

Release hydraulic joystick immediately after boom hoist cylinder to be removed has fully retracted. If joystick is allowed to remain open, the other cylinder will start to retract, putting extreme stress on lifting equipment and boom assembly.

- (9) Start engine (TM 10-3930-673-10) and run at idle. Fully retract boom hoist cylinder (14) using joystick. Boom hoist cylinder will retract very slowly. Stop engine.
- (10) Carefully lower boom hoist cylinder (14) onto board placed across vehicle deck so hydraulic line on cylinder is not damaged.
- (11) Repeat Steps (7) through (10) for other boom hoist cylinder (14).

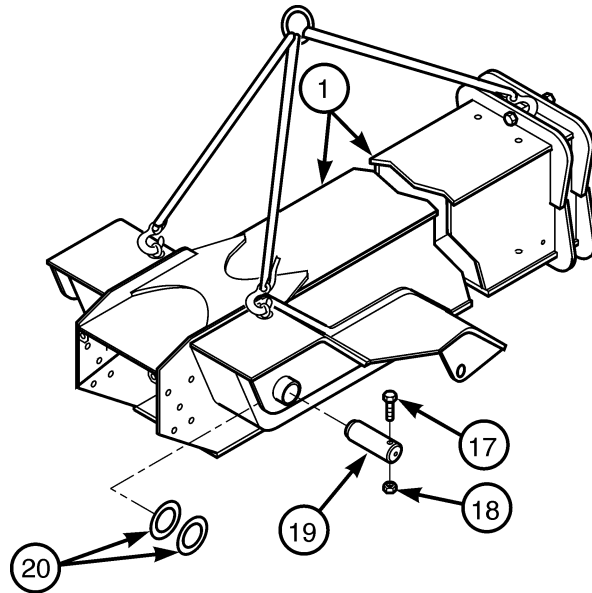
**16-14. OUTER BOOM REPLACEMENT/REPAIR (CONT)**

- (12) Place jackstand or support on front of vehicle deck. Adjust support so that outer boom (1) will be level when lowered.
- (13) Carefully lower outer boom (1) with hoist and sling until front of boom is on jackstand or support.

**NOTE**

Install a bolt and nut to top-front of outer boom. Install one hook to bolt and other two hooks to top-rear of outer boom.

- (14) Position hoist and slings to outer boom (1) at three places. Carefully raise outer boom until weight of boom is removed from boom pivot pins (19).
- (15) Remove screw (17) and locknut (18) from boom pivot pin (19). Discard lockout.



**NOTE**

- Shims, if equipped, may fall out as pivot pins are removed.
- Note quantity and position of shims for use during installation

- (16) Remove boom pivot pin (19) from outer boom (1) and vehicle frame.
- (17) Remove shims (20) from between outer boom (1) and vehicle frame.
- (18) Repeat Steps (15) through (17) for remaining boom pivot pin (19).

**CAUTION**

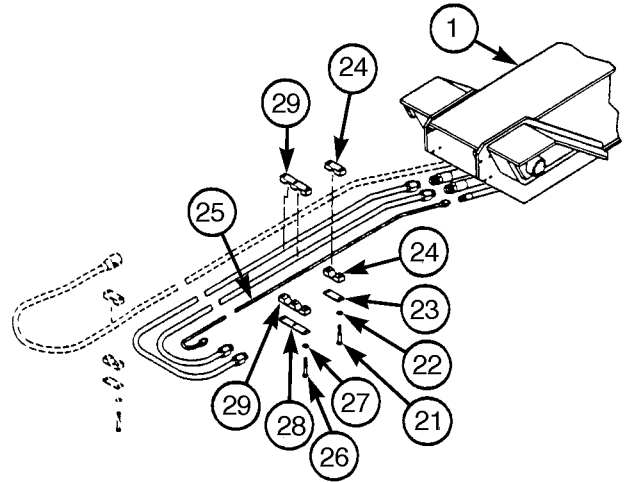
Ensure that hydraulic tubes on underside of outer boom section are not damaged when boom assembly is lowered onto supports.

- (19) Carefully remove outer boom (1) from vehicle frame and lower boom assembly onto supports.
- (20) Remove nut and bolt from top-front of outer boom (1).

**b. Disassembly.**

**NOTE**

- Tubes are not interchangeable. Note location of each tube for use during installation.
- Note location and orientation of clamp halves for use during installation.



- (1) Remove four screws (21), lockwashers (22), two clamp covers (23), four clamp halves (24), and one tube (25) from outer boom (1). Discard lockwashers.
- (2) Remove six screws (26), lockwashers (27), two clamp covers (28), four clamp halves (29), and two tubes (25) from outer boom (1). Discard lockwashers.

**c. Cleaning. See Cleaning Instructions (Para 2-12).**

**d. Inspection. See Inspection Instructions (Para 2-14).**

**e. Assembly.**

**NOTE**

Lines are not interchangeable. Install lines in locations noted during removal.

- (1) Position three tubes (25) on underside of outer boom (1).

**WARNING**

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

- (2) Apply sealing compound to threads of six screws (26).
- (3) Position one line (25). Install four clamp halves (23), two clamp covers (28), six lockwashers (27), and screws (26) on outer boom (1).
- (4) Apply sealing compound to threads of four screws (21).
- (5) Position two lines (25). Install four clamps halves (24), two clamp covers (23), four lockwashers (22), and screws (21) on outer boom (1).

**16-14. OUTER BOOM REPLACEMENT/REPAIR (CONT)**

**f. Installation.**

**NOTE**

- Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on hydraulic components and hoses clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.
- Center of gravity for boom assembly is approximately 8.5 ft (2.59 m) from rear end of boom assembly.
- Install a bolt and nut to top-front of outer boom. Install one hook to bolt and other two hooks to top-rear of outer boom.

**WARNING**

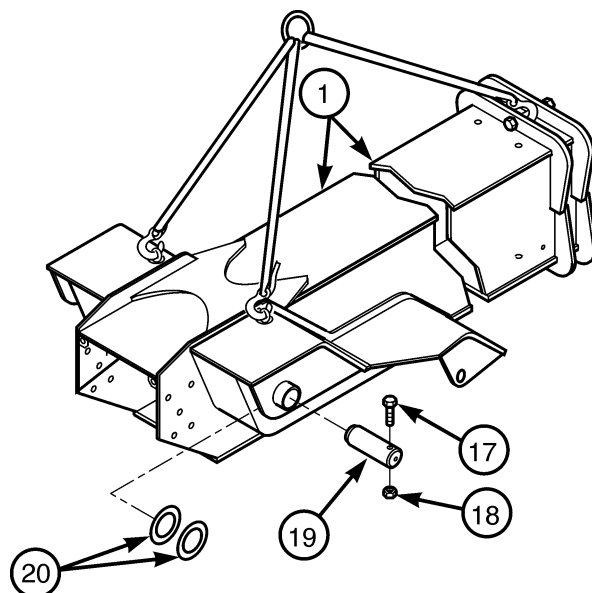
Outer boom weighs 1952 lbs (885.41 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

- (1) **Carefully lift outer boom (1) into position over vehicle with hoist and sling or other suitable lifting device. Lower outer boom as required to align boom pivot pin holes.**

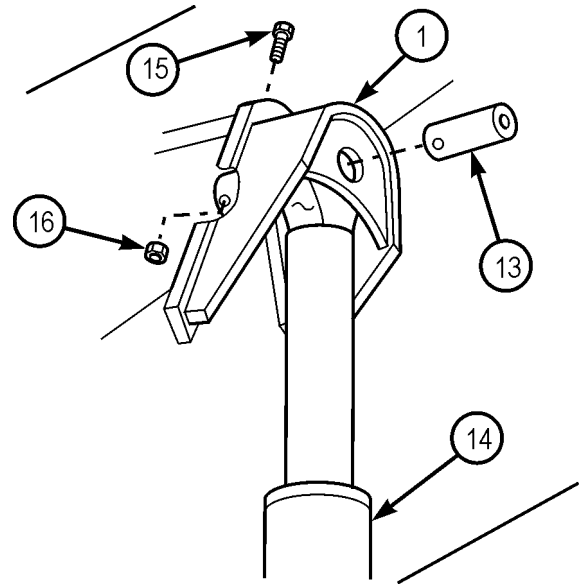
**WARNING**

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

- (2) **Position shims (20) between outer boom (1) section and inside surface of vehicle frame. Apply anti-seize compound on boom pivot pin (19) and install pivot pin in outer boom and vehicle frame.**
- (3) **Install screw (17) and locknut (18) in boom pivot pin (19).**
- (4) **Repeat Steps (2) and (3) for remaining pivot pin (19).**



- (5) Place jacksand or support on front of vehicle deck. Adjust support so outer boom (1) is level when lowered.
- (6) Carefully lower outer boom (1) with hoist and sling until front of boom is resting on support.
- (7) Reposition slings to front of outer boom (1).
- (8) Lift outer boom (1) until cylinder pivot pin holes of boom are just above cab.
- (9) Lift boom hoist cylinders (14) into position and support boom hoist cylinders with outer boom (1).



### NOTE

One boom hoist cylinder will begin to extend before the other. Install this cylinder first. Second cylinder will begin to extend after first cylinder is connected.

- (10) Start engine. Use joystick to extend boom hoist cylinder (14) until cylinder rod eye is aligned with pivot pin hole of boom. Stop engine.

### WARNING

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

- (11) Apply anti-seize compound to pivot pin (13). Install pivot pin in boom hoist cylinder (14) and outer boom (1).
- (12) Install screw (15) and locknut (16) in pivot pin (13).
- (13) Repeat Steps (10) through (12) for other boom hoist cylinder (14). Remove hoist, slings, nut and bolt from outer boom (1).

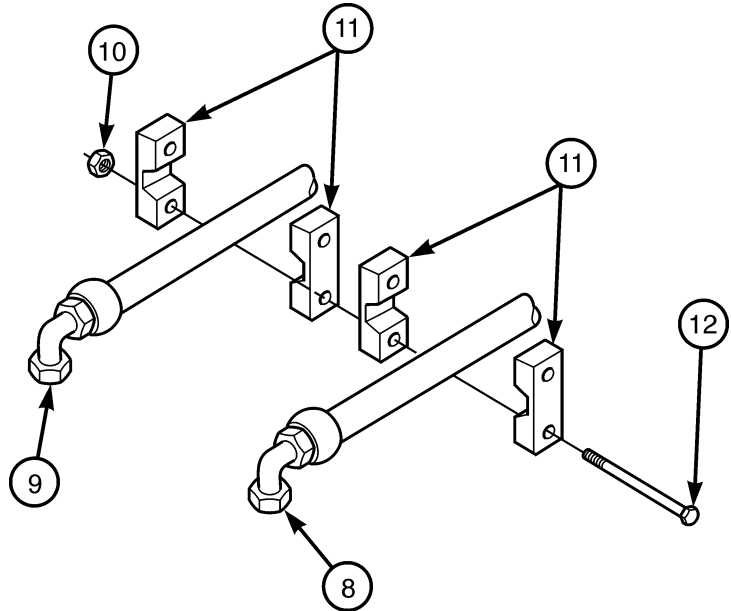
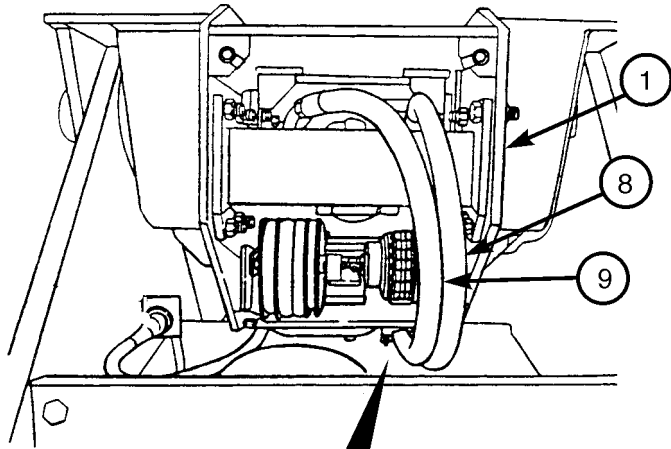
**16-14. OUTER BOOM REPLACEMENT/REPAIR (CONT)**

- (14) Start engine and raise outer boom (1) as required for access to hoses (8 and 9). Stop engine.

**WARNING**

Remove hose caps carefully prior to connecting hoses. Hydraulic oil may be under pressure. Failure to follow this precaution will cause personal injury.

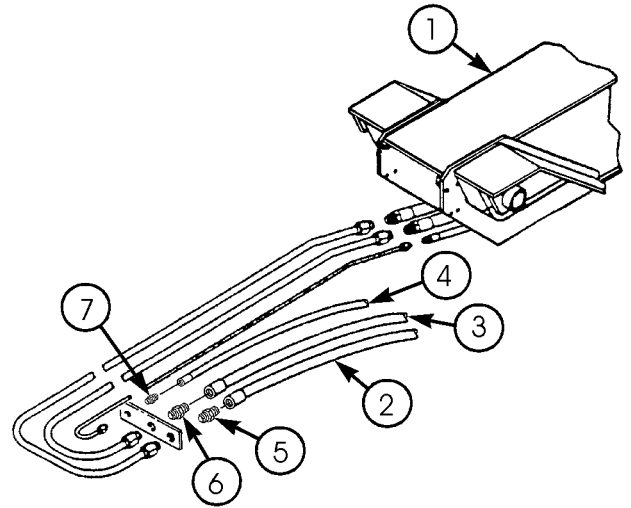
- (15) Position two hoses (8 and 9) under outer boom (1) end. Install four clamp halves (11), screw (12) and new locknut (10) on outer boom (1).



**WARNING**

Remove hose caps carefully prior to connecting hoses. Hydraulic oil may be under pressure. Failure to follow this precaution will cause personal injury.

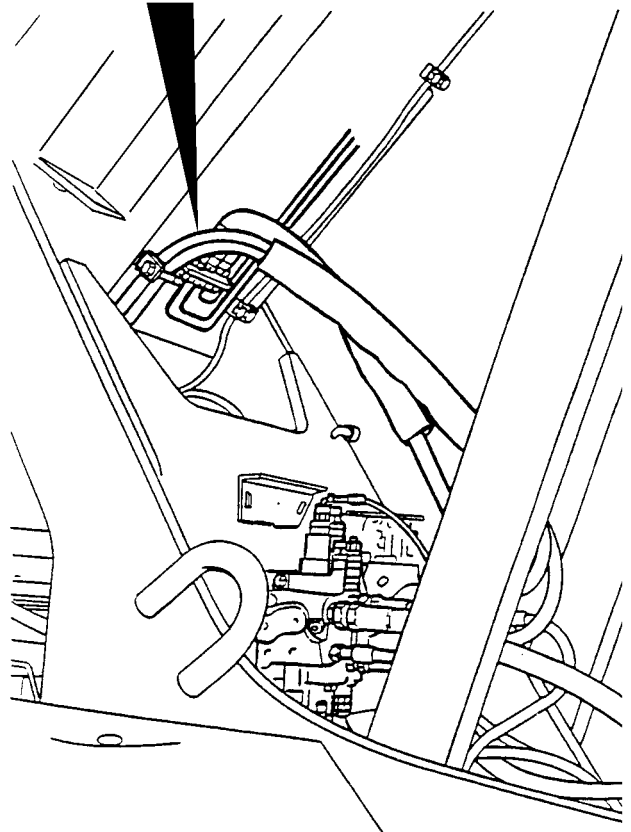
- (16) Connect three hoses (2, 3, and 4) from fittings (5, 6 and 7) at bulkhead).
- (17) Start engine and lower outer boom (1) until horizontal. Stop engine.

**NOTE**

Follow-on Maintenance:

- Install counterweight (TM 10-3930-673-10).
- Install carriage (TM 10-3930-673-10).
- Install transmission cover (TM 10-3930-673-20).

**END OF TASK**



## 16-15. BOOM PIVOT PIN REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### Tools and Special Tools

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Lifting Device, 5 ton (4535.92 kg) capacity  
Slide hammer or Puller (Item 20, Appendix D)

#### Equipment Condition

Vehicle parked on level ground  
Boom retracted and level  
Forks leveled and resting on ground

#### Materials/Parts

Compound, Anti-seize (Item 10, Appendix B)  
Grease, Automotive and Artillery  
(Item 18, Appendix B)  
Locknut

### a. Removal.

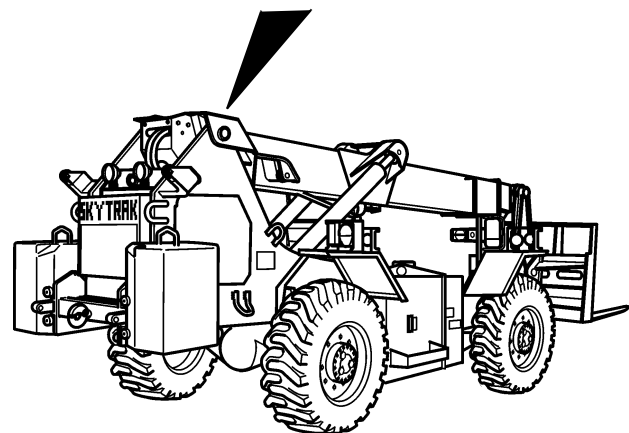
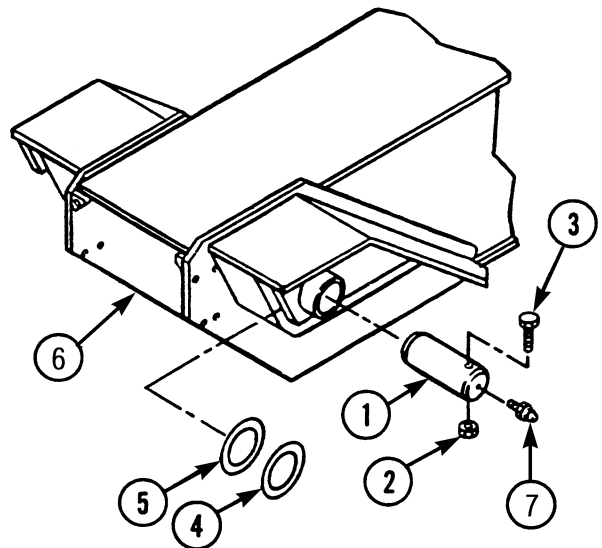
#### WARNING

Boom assembly including boom extend cylinder weighs approximately 4100 lb (1859.72 kg). Attach suitable lifting device prior to removal to prevent possible injury to personnel.

#### NOTE

The procedures to remove left and right boom pivot pins are the same, right side is shown.

- (1) Use a hoist or other suitable lifting device to support back of boom and take weight of boom off pivot pins (1).
- (2) Remove locknut (2) and screw (3) from pivot pin (1). Discard locknut.





**NOTE**

The boom has washer spacers between boom and frame. Note position and quantity of washer spacers for assembly.

- (3) **Use a slide hammer or puller to remove pivot pin (1) and any washer spacers (4 or 5) from boom (6).**
- (4) **If damaged, remove grease fitting (7) from pivot pin (1).**

***b. Cleaning.*** See **Cleaning Instructions (Para 2-12).**

***c. Inspection.*** See **Inspection Instructions (Para 2-14).**

***d. Installation.***

**NOTE**

The procedures to install left and right boom pivots are the same, right side is shown.

- (1) **If removed, install grease fitting (7) in pivot pin (1).**
- (2) **Apply anti-seize compound to pivot as it is being installed. Install washer spacers (4 or 5) as necessary, and pivot pin (1) in boom (6).**
- (3) **Install screw (3) and locknut (2) in pivot pin (1).**
- (4) **Apply grease to fitting (7).**

**END OF TASK**

## 16-16. WEAR PADS REPLACEMENT

This Task Covers:

- |             |                 |
|-------------|-----------------|
| a. Removal  | c. Inspection   |
| b. Cleaning | d. Installation |

### INITIAL SETUP

#### *Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)  
Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Tool Kit, Body and Fender Repair  
(Item 22, Appendix D)

#### *Equipment Condition*

Vehicle parked on level ground  
Boom retracted

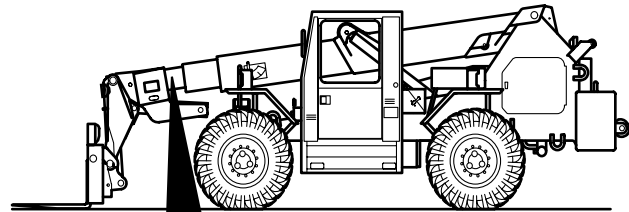
#### *Materials / Parts*

Compound, Sealing (Item 42, Appendix B)  
Inserts  
Lockwashers

### a. Removal.

#### NOTE

The amount of boom disassembly will depend upon location of wear pads being replaced.

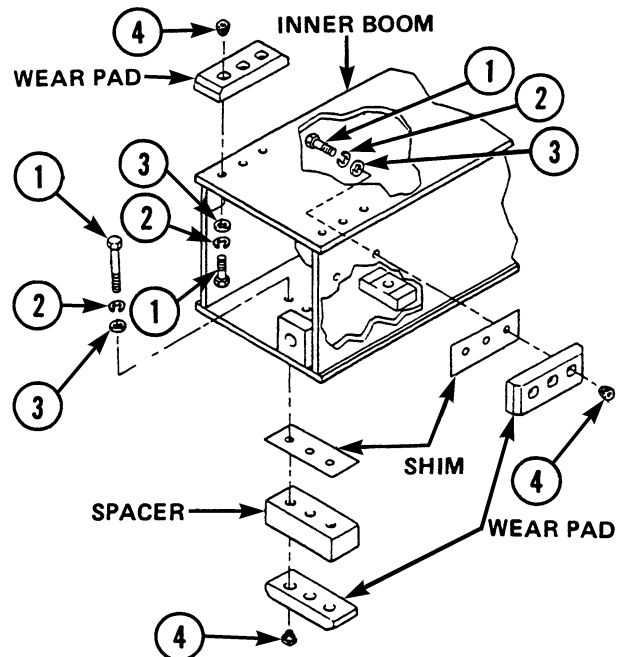


#### (1) Disassemble inner and intermediate booms as necessary for wear pad replacement (Para 16-12) and (Para 16-13).

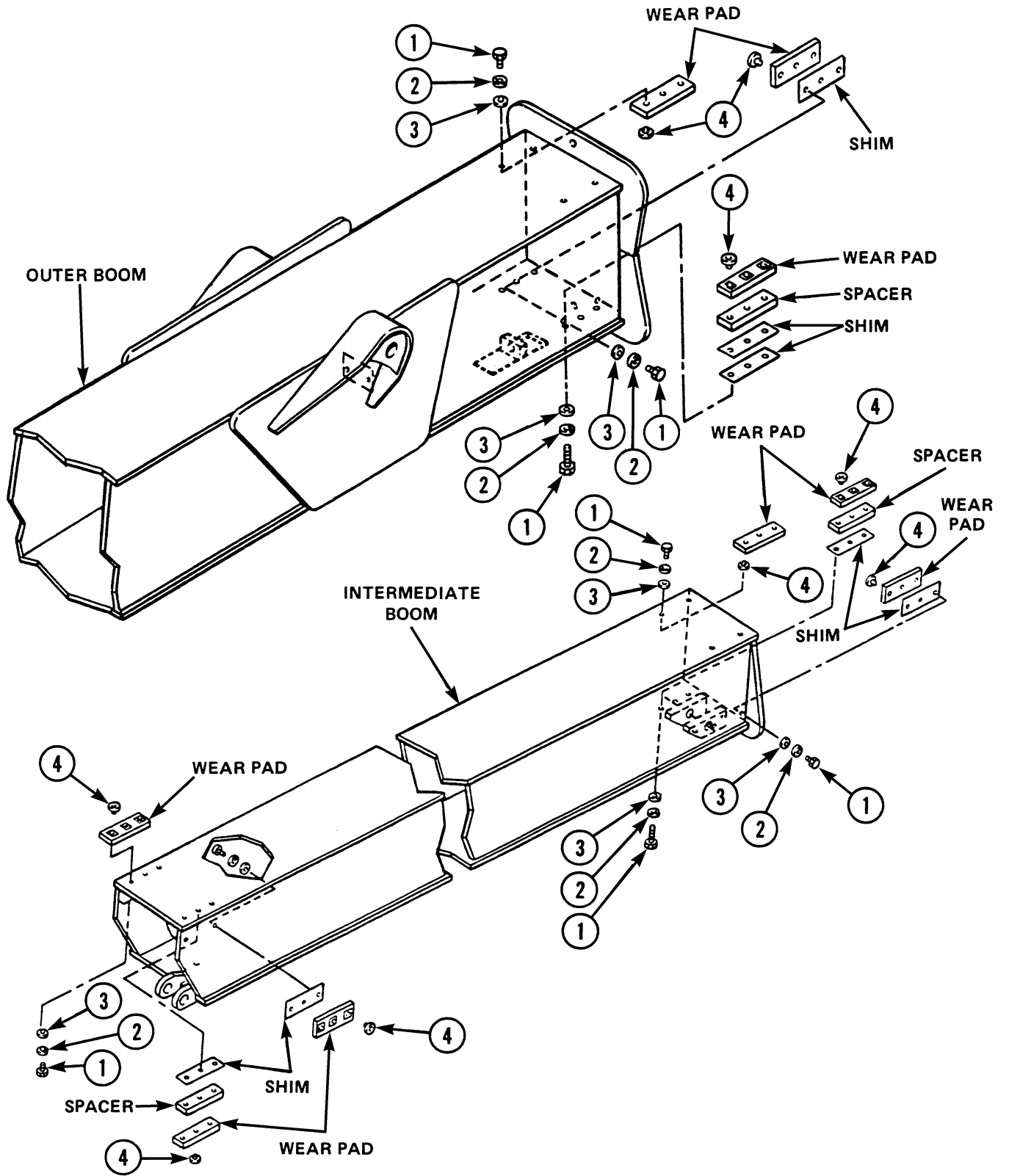
- Most wear pads have off-center mounting holes. Note orientation of wear pads prior to removal.
- Some pads have spacers and shims. Note quantity and locations of these items before removal.

#### (2) Remove wear pad which needs replacement.

- Remove screws (1), lockwashers (2), washers (3), and wear pads. Discard lockwashers
- Remove and discard inserts (4) with worn wear pad(s).



### b. Cleaning. See Cleaning Instructions (Para 2-12).



**16-16. WEAR PADS REPLACEMENT (CONT)**

*c. Inspection.* See Inspection Instructions (Para 2-14).

*d. Installation.*

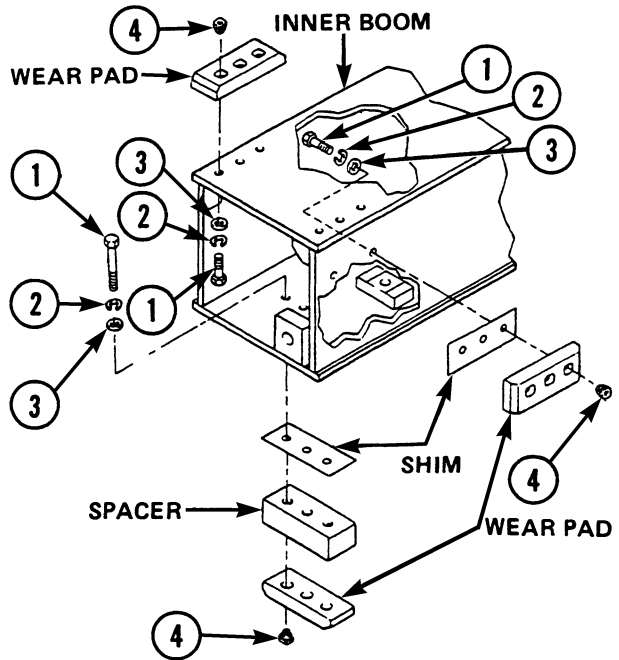
**(1) Install wear pad(s).**

(a) Install inserts (4) in wear pads.

**WARNING**

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

(b) Apply sealing compound on threads of screws (1). Install shims, spacers, wear pads, washers (3), lockwashers (2), and screws (1). Tighten screws to 30 lb-ft (40.67 N•m).



**NOTE**

Check for proper clearances between wear pads and boom sections during assembly. A total gap of 0.01 - 0.13 in. (0.25 - 3.30 mm) is allowed in both vertical and horizontal directions.

**(2) Assemble inner and intermediate booms as necessary (Para 16-12) and (Para 16-13).**

**END OF TASK**

## 16-17. EXTEND AND RETRACT CHAINS REPLACEMENT

This Task Covers:

- a. Extend chain removal
- b. Retract chain removal
- c. Extend chain installation
- d. Retract chain installation

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive  
(Item 23, Appendix D)

*Equipment Condition*

Vehicle parked on level ground  
Boom retracted  
Inner boom removed for retract chain removal  
only (Para 16-12)

*Materials/Parts*

Compound, Sealing (Item 40, Appendix B)  
Lockwashers (4)  
Pin, Cotter  
Rope

#### a. Extend Chain Removal.

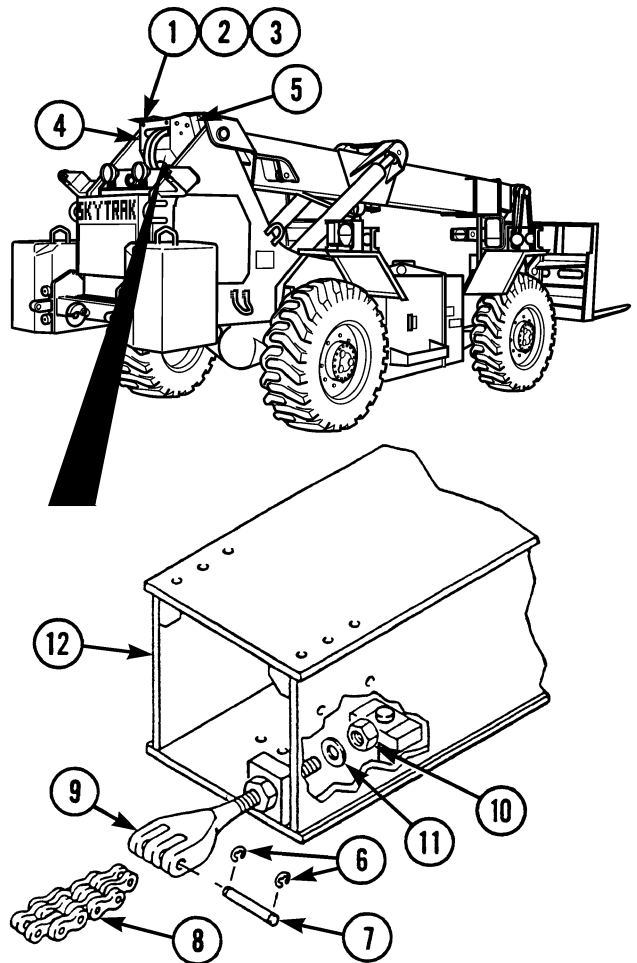
**(1) Remove parts (1 through 15).**

- (a) Remove four screws (1), lockwashers (2), washers (3), and cover (4) from boom (5). Discard lockwashers.

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (b) Remove two retaining rings (6) and one pin (7) and disconnect extend chain (8) from clevis (9).
- (c) If damaged, remove nut (10), washer (11), and clevis (9) from inner boom (12).

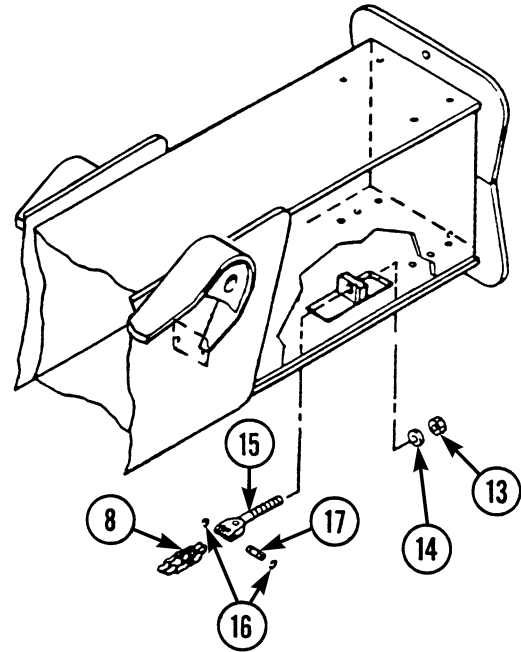


**16-17. EXTEND AND RETRACT CHAINS REPLACEMENT (CONT)**

- (d) Remove nut (13) and washer (14) from clevis (15). Remove clevis from its mounting hole near hose tensioner.

**(2) Remove extend chain (8).**

- (a) Tie a rope of suitable length to end of extend chain (8) just behind clevis (15).
- (b) Tie other end of rope to clevis (15) mounting hole.



**NOTE**

Leave rope inside boom after removing extend chain. The rope will be used to pull new extend chain through boom assembly.

- (c) Pull extend chain (8) out from back of boom. Remove rope from extend chain.

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

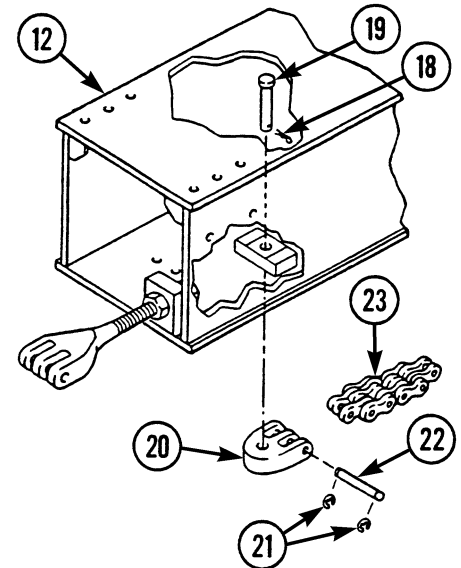
- (d) Remove two retaining rings (16), pin (17), and clevis (15). Separate extend chain (8) from clevis.

**b. Retract Chain Removal.**

**NOTE**

One end of retract chain is disconnected when inner boom is removed.

- (a) Remove inner boom (12) (Para 16-12).
- (b) Remove cotter pin (18) and clevis (19) from clevis (20). Discard cotter pin.



**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Remove retaining rings (21), pin (22), and clevis (20). Separate retract chain (23) from clevis.

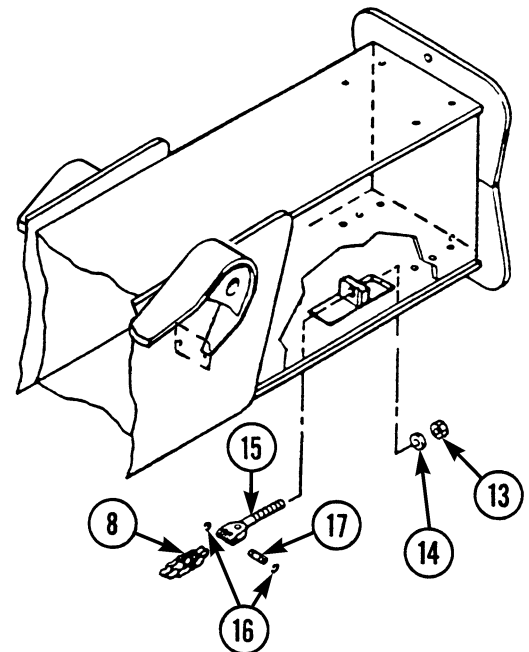
**c. Extend Chain Installation.**

- (1) **Install extend chain (8).**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Position one end of extend chain (8) to clevis (15). Install pin (17) and two retaining rings (16).
- (b) Tie rope (that was used during removal and found inside boom) to end of extend chain (8) just behind clevis (15).
- (c) Pull rope with extend chain (8) through boom. Pull rope through opening in boom near clevis (15) mounting hole. Remove rope from clevis mounting hole and end of extend chain.
- (d) Position clevis (15) with extend chain (8) into mounting hole. Install washer (14) and nut (13) on clevis.



**16-17. EXTEND AND RETRACT CHAINS REPLACEMENT (CONT)**

- (e) If removed, install clevis (9), washer (11), and nut (10) in inner boom (12).

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (f) Position extend chain (8) end to clevis (9). Install pin (7) and two retaining rings (6).
- (g) Install cover (4), four washers (3), lockwashers (2), and screws (1) on boom (5).

- (2) **Adjust extend chain (6)**  
(TM 10-3930-673-20).

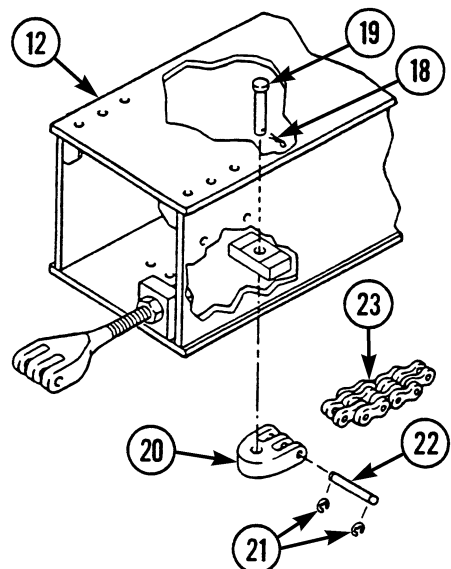
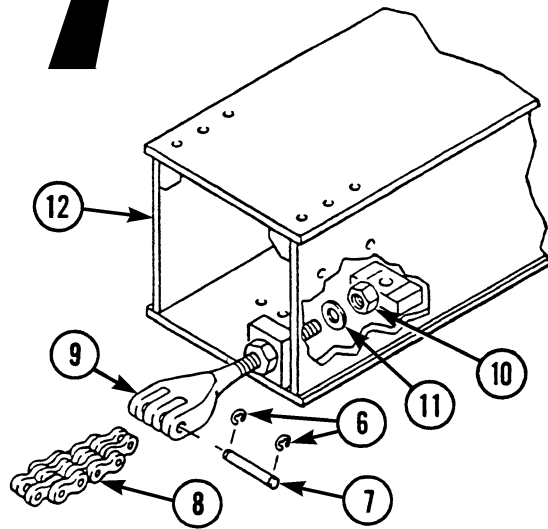
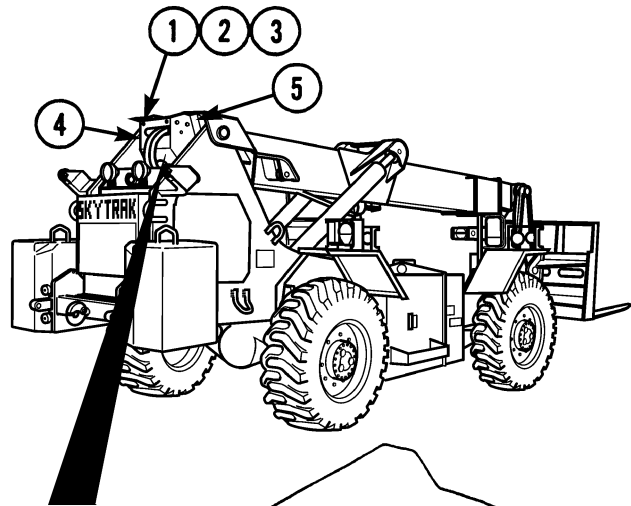
- (3) **Adjust hose and cable tension**  
(TM 10-3930-673-20).

**d. Retract Chain Installation.**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (1) **Position clevis (20) on end of retract chain (23). Install pin (22) and retaining rings (21).**
- (2) **Install clevis pin (19) through clevis (20) and secure with cotter pin (18).**
- (3) **Install inner boom (12) (Para 16-12).**
- (4) **Adjust retract chain**  
(TM 10-3930-673-20).



END OF TASK





**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

*a. Removal.*

**WARNING**

Hydraulic oil in the system can be under pressure over 5,000 psi (34475 kPa) with the engine and pump OFF. ALWAYS relieve pressure in hydraulic lines before attempting to remove any component in the hydraulic system. With the engine OFF and hydraulic attachments on the ground, move control levers through all operating positions several times to relieve line pressure. Relieve pressure in hydraulic oil tank by loosening filler cap very slowly. Failure to follow these precautions could result in serious personal injury.

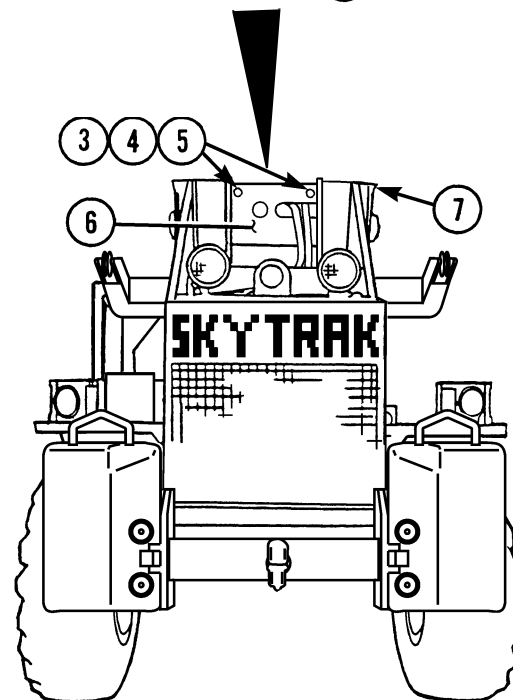
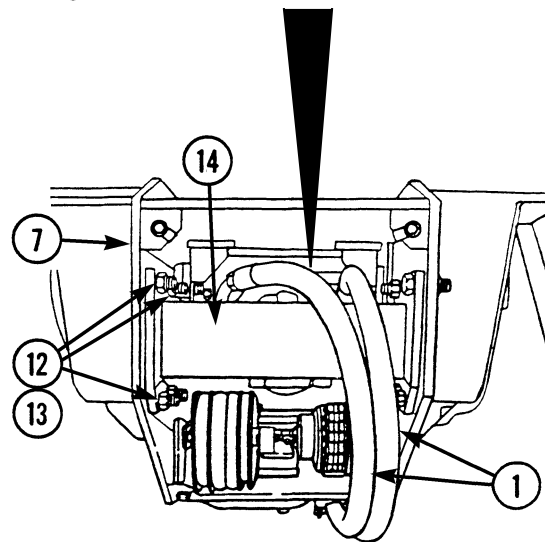
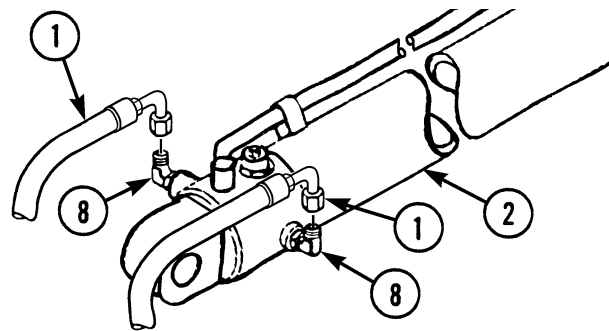
**CAUTION**

- Wipe the area clean around all hydraulic connections to be opened during removal and disassembly. Cap oil lines and plug holes after removing lines. Contamination of the hydraulic system could result in premature failure.
- Retract cylinder before removal. Failure to follow this precaution will cause part damage.

**NOTE**

If more than one hydraulic line is removed, identify lines to assure proper installation. Use suitable container to catch any hydraulic oil that may drain from system.

- (1) Tag, mark, and disconnect two hoses (1) from boom extend cylinder (2).



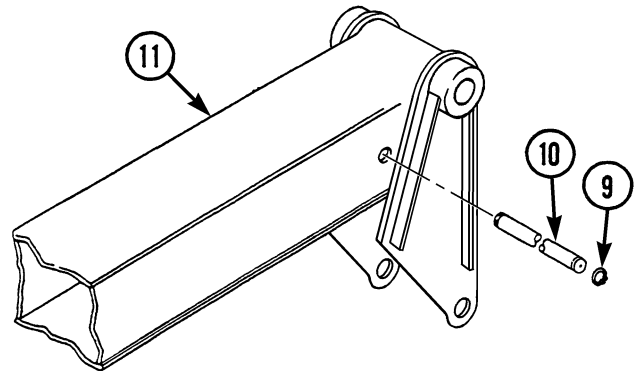
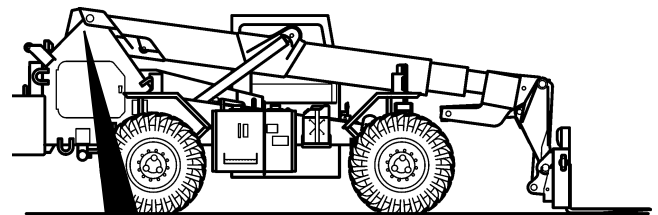
- (a) Remove four screws (3), lockwashers (4), washers (5), and cover (6) from boom (7). Discard lockwashers.
- (b) Tag and mark two hoses (1). Remove two hoses from two elbows (8).

**(2) Remove boom extend cylinder (2) and parts (9 through 22).**

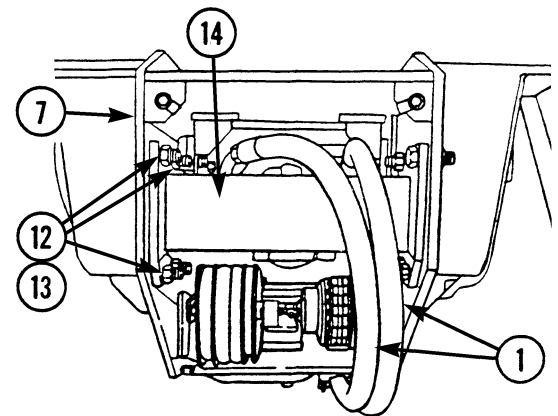
**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Remove snap ring (9) and shaft (10) from inner boom (11). Discard snap ring.
- (b) Place wood blocks underneath boom extend cylinder and inner boom.



- (c) Remove eight screws (12) and locknuts (13) from extend cylinder anchor (14). Discard locknuts.



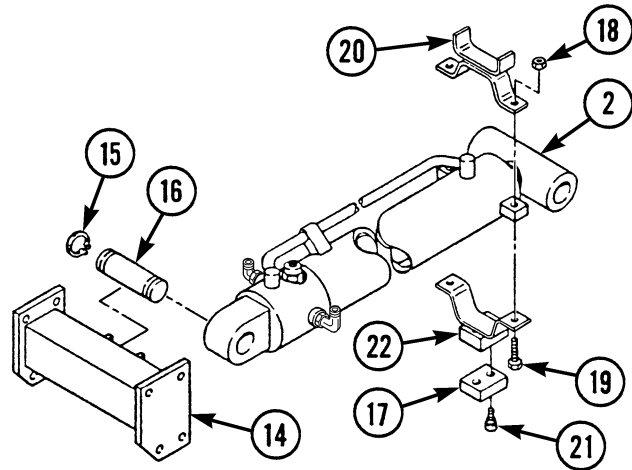
**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

**WARNING**

Boom extend cylinder weighs 600 lbs (272.4 kg). Attach suitable lifting device prior to removal or installation to prevent possible injury to personnel.

**NOTE**

Raise boom extend cylinder as needed with hoist and sling during removal to provide clearance over obstructions at rear of boom.



- (d) Use a hoist and sling to pull boom extend cylinder (2) out, with extend cylinder anchor (14).
- (e) Reposition hoist and sling as needed during removal of boom extend cylinder.
- (f) Remove boom extend cylinder (2) with extend cylinder anchor (14) as an assembly from boom (7).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

**CAUTION**

Remove cylinder from sling with care to prevent part damage.

- (g) Remove two snap rings (15) and shaft (16). Remove extend cylinder anchor (14) from boom extend cylinder (2).
- (h) Remove two screws (19), nuts (18), and buckling braces (20 and 22) from boom extend cylinder (2).
- (i) Remove two screws (21) and wear pad (17) from buckling brace (20).

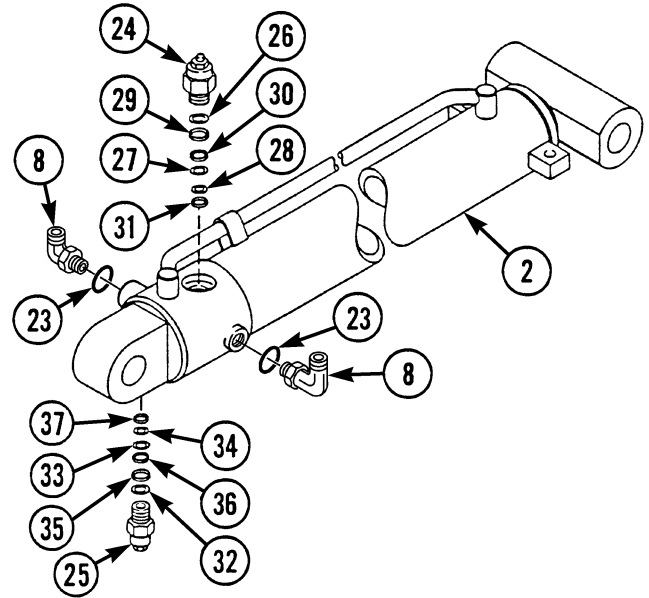
**b. Disassembly.**

- (1) Use a vise with soft jaws to secure cylinder in a horizontal position for disassembly.

**WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve, and allow pressure to escape before removing valve entirely.

- (2) Remove two elbows (8) and preformed packings (23) from boom extend cylinder (2). Discard preformed packings.



**NOTE**

Note and mark location of counterbalance valves for use during assembly. Counterbalance valves are not interchangeable.

- (3) **If damaged, remove two counterbalance valves (24 and 25) from boom extend cylinder (2).**
  - (a) Remove back-up rings (26 and 27), two back-up rings (28), and preformed packings (29, 30, and 31) from counterbalance valve (24). Discard preformed packings.
  - (b) Remove back-up rings (32, 33, and 34) and preformed packings (35, 36, and 37) from counterbalance valve (25). Discard preformed packings.

**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

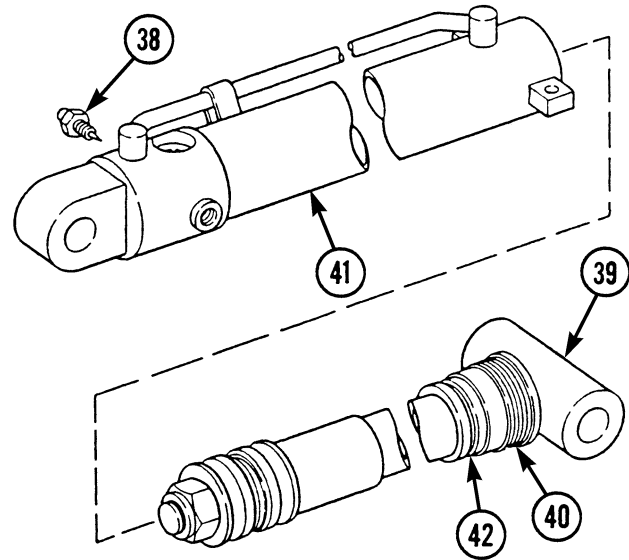
**(4) Disassemble boom extend cylinder (2) parts (38 through 52).**

- (a) Remove needle valve (38) from boom extend cylinder (2).

**CAUTION**

Do not scratch or damage the wear surface of rod, piston, or gland.

- (b) Pull rod (39) out approximately 5 in. (127 mm) for removal of gland (40).
- (c) Place a container under gland (40) to catch oil contained in cylinder.
- (d) Use a spanner wrench to remove gland (40) from barrel (41). Pull gland out of cylinder far enough to unseat preformed packing (42). Allow oil to drain into container. Discard preformed packing.



**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (e) Remove rod (39) and piston assembly from barrel (41).
- (f) Place rod (39) and piston assembly on suitable supports to prevent damage.

- (g) Remove two wear rings (43) from piston (44).

**CAUTION**

Do not nick or scratch seal groove on piston during removal of seal. Failure to follow this precaution will cause part damage.

- (h) Remove seal (45) from piston (44). Discard seal.

**NOTE**

Nut may need to be heated with a torch for removal.

- (i) Remove nut (46) and piston (44) from rod (39). Discard nut.
- (j) Remove preformed packing (47) from piston (44) bore. Discard preformed packing.
- (k) Remove tube (48) and gland (40) from rod (39).
- (l) Remove preformed packings (42 and 49) and back-up ring (50) from gland (40). Discard preformed packings.

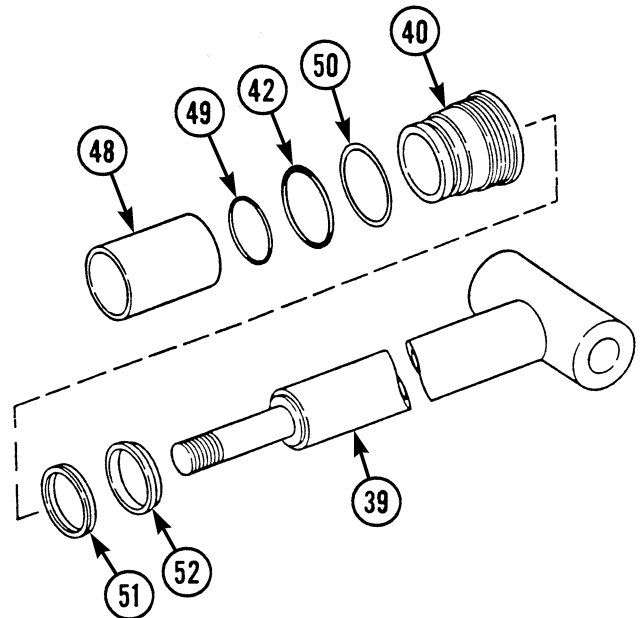
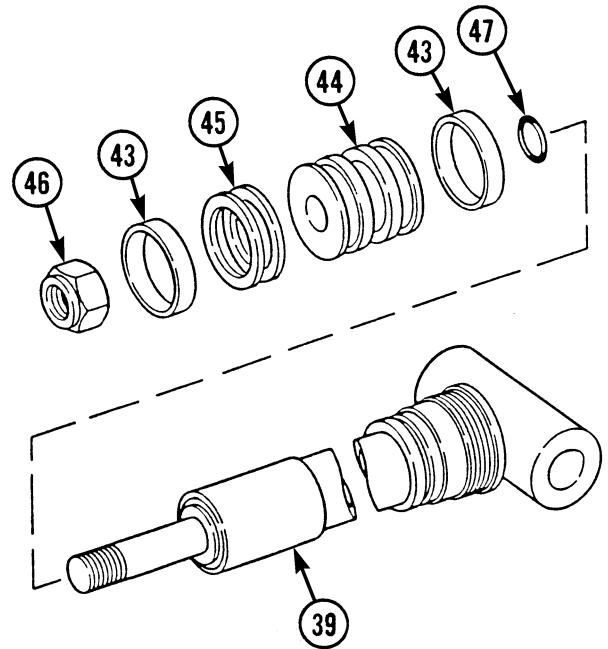
**CAUTION**

Do not nick or scratch seal groove inside gland during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

Note direction that lip of seal is facing to aid in installation.

- (m) Remove seal (51) and rod wiper (52) from inside of gland (40).



**c. Cleaning.** See Cleaning Instructions (Para 2-12).

**d. Inspection.** See Inspection Instructions (Para 2-14).

**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

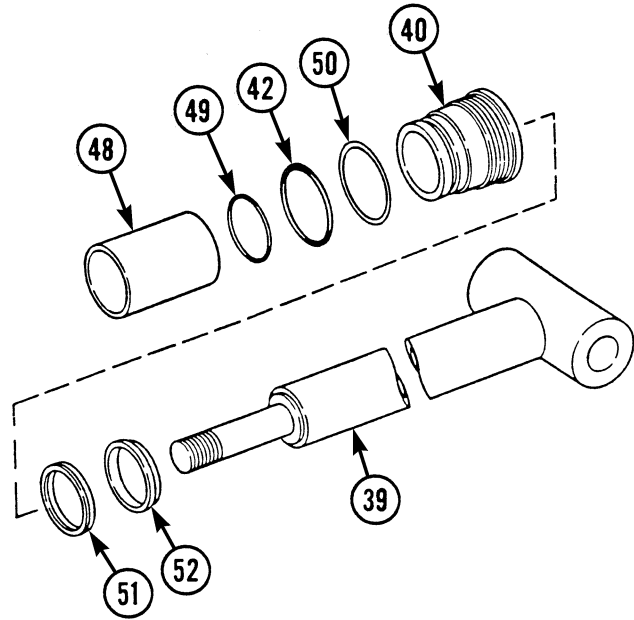
*e. Assembly.*

**WARNING**

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

**NOTE**

- Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.
- Apply sealing compound to threads of rod and nut.



**(1) Assemble boom extend cylinder (2) parts (38 through 52).**

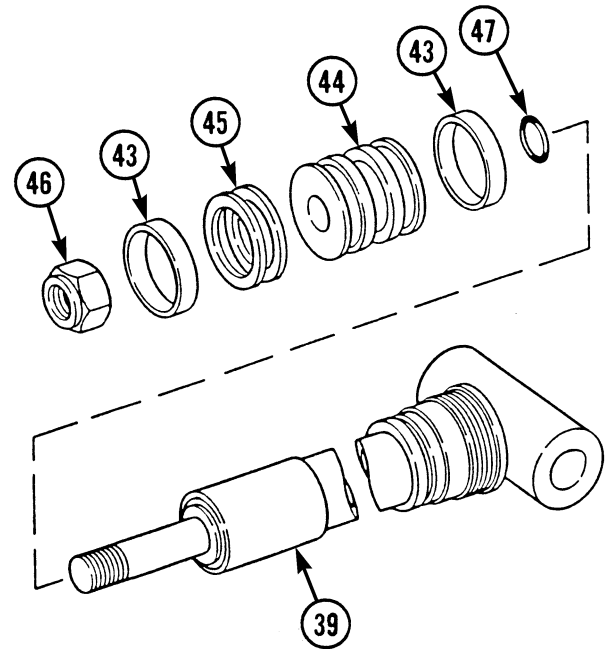
- (a) Install seal (51) and rod wiper (52) inside of gland (39).
- (b) Install back-up ring (50) and preformed packings (42 and 49) on outside diameter of gland (40).
- (c) Install gland (40) and tube (48) on rod (39).



- (d) Lubricate piston (44) inner diameter with clean hydraulic oil. Install preformed packing (47) inside bore of piston.

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.



- (e) Use drycleaning solvent and lint-free rag to clean threads on rod (39) and nut (46).

**WARNING**

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

- (f) Apply sealing compound on threads of rod (39) and nut (46). Install nut on rod.
- (g) Place rod (39) and piston (44) as an assembly on suitable supports to prevent damage during assembly.
- (h) Install two wear rings (43) and one seal (45) on piston (44). Position wear rings so that gaps are 180° apart.

**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

**CAUTION**

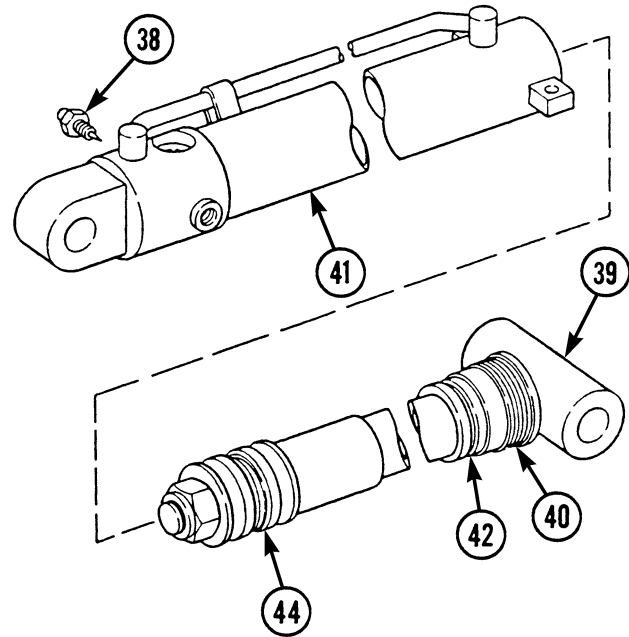
Use care when installing rod and piston assembly. Keep rod in line with barrel to prevent binding. Failure to follow this precaution will cause part damage.

- (i) Lubricate barrel (41) inner diameter, piston (44) outside diameter, and gland (40) outside diameter with clean hydraulic oil.
- (j) Position rod (39) and piston (44) as an assembly in barrel (41).

**NOTE**

Tighten gland so that it is flush with end of barrel. Do not over tighten gland.

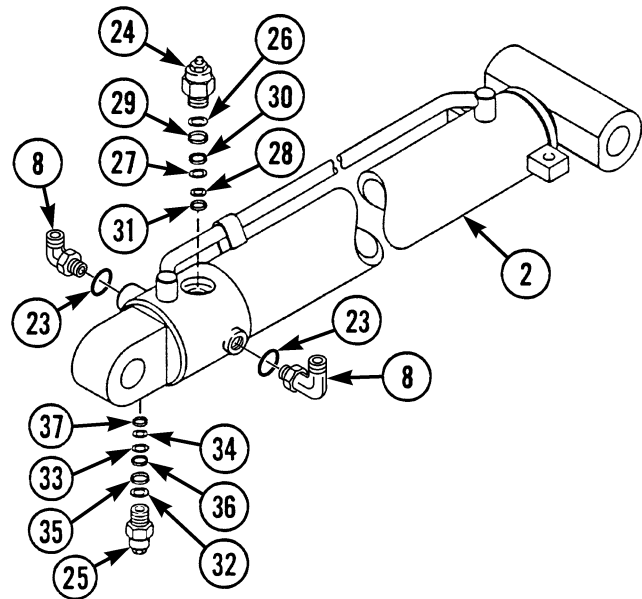
- (k) Tighten gland (40) on barrel (41).
- (l) Install needle valve (38) on barrel (41).



**(2) Install counterbalance valves (24 and 25) on boom extend cylinder (2).**

- (a) Install preformed packings (35, 36, and 37) and back-up rings (32, 33, and 34) on counterbalance valve (25).
- (b) Install back-up rings (26 and 27), two back-up rings (28) and preformed packings (29, 30, and 31) on counterbalance valve (26).
- (c) Install two assembled counterbalance valves (24 and 25) in boom extend cylinder (2) as noted during disassembly.

**(3) Install two preformed packings (23) and elbows (8) on boom extend cylinder (2).**

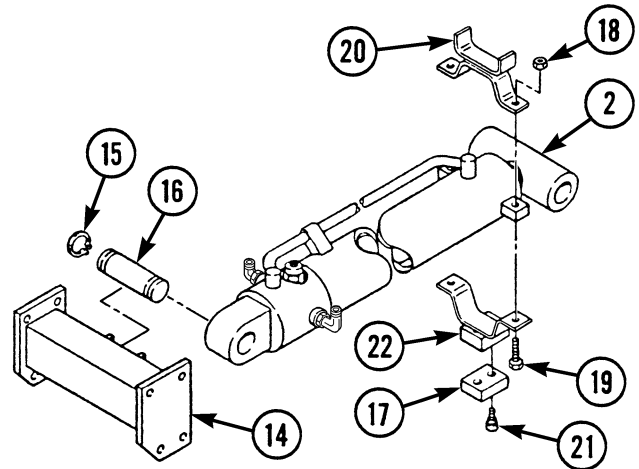


**f. Installation.**

**NOTE**

Remove caps and plugs as hoses are installed. Wipe all sealing surfaces on valve and hoses clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

- (1) **Install boom extend cylinder (2) parts (9 through 22).**



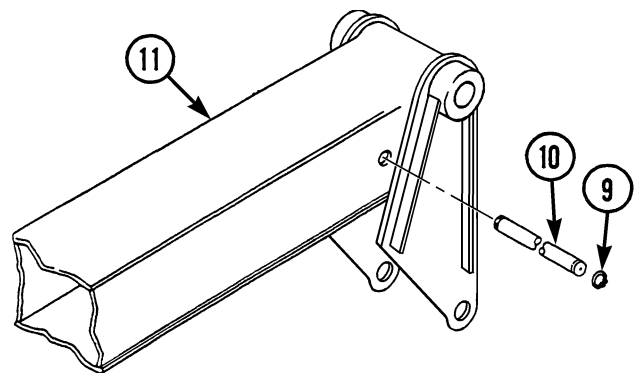
**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Apply anti-seize compound to shaft (16). Install shaft, two snap rings (15), and extend cylinder anchor (14) on boom extend cylinder (2).
- (a.1) Install sealing compound on threads of two screws (21).
- (b) Install wear pad (17) and two screws (21) on buckling brace (22). Tighten screws to 10 lb-ft (14 Nm).
- (c) Install buckling braces (20 and 22), two screws (19), and two nuts (18) on boom extend cylinder (2).
- (d) Use a sling and hoist to install boom extend cylinder (2) at back of boom.
- (e) Have an assistant guide boom extend cylinder (2) and slide it into boom.

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.



- (f) Apply anti-seize compound to shaft (10). Install shaft and snap ring (9) in inner boom (11).
- (g) Place wood blocks underneath boom extend cylinder (2) and inner boom (11).
- (h) Remove hoist and sling from back of boom extend cylinder (2).

**16-18. BOOM EXTEND CYLINDER REPLACEMENT/REPAIR (CONT)**

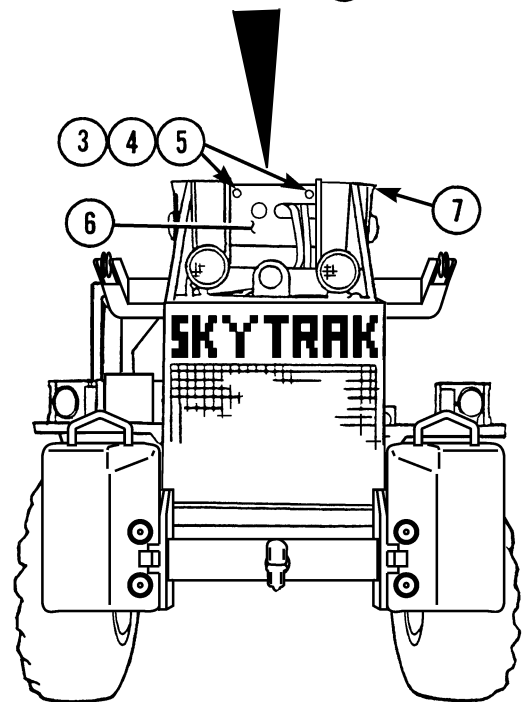
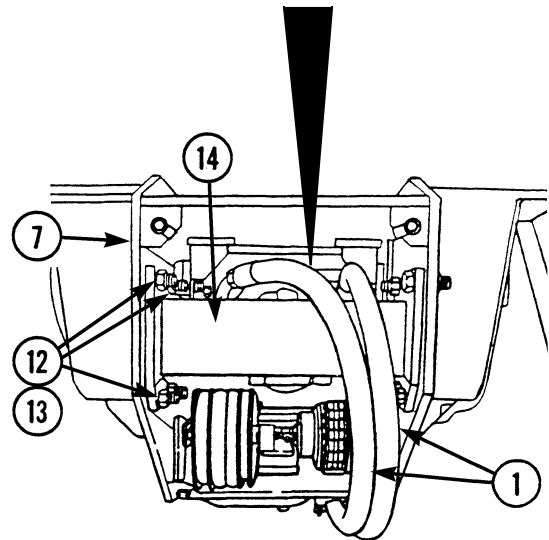
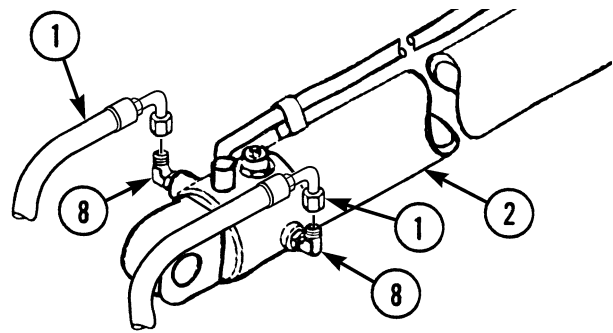
**NOTE**

Attach a hoist with sling at front of inner boom if mounting holes between outer boom and extend cylinder anchor do not align. Move inner boom as needed to align mounting holes.

- (i) Install eight screws (12) and locknuts (13) to secure extend cylinder anchor (14).
- (j) Remove wood blocks underneath boom extend cylinder and inner boom.

**(2) Connect hoses (1) to boom extend cylinder (2).**

- (a) Connect two hoses (1) to two elbows (8).
- (b) Install cover (6), four washers (5), lockwashers (4), and screws (3) on boom (7).



**END OF TASK**

**16-19. 6K FORK SIDESHIFT CYLINDERS REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Wrench Set, Spanner (Item 26, Appendix D)

*Equipment Condition*

Fork sideshift cylinder removed (TM 10-3930-673-20)

*Materials/Parts*

Oil, Lubricating Hydraulic (Item 30, Appendix B)

*Materials/Parts (Cont)*

Rags, Lint-free (Item 34, Appendix B)  
 Sealing Compound (Item 41, Appendix B)  
 Solvent, Drycleaning (Item 52, Appendix B)  
 Container, 5 gal (19 l) capacity  
 Packing, Preformed  
 Packing, Preformed  
 Seal

*Personnel Required*

Two

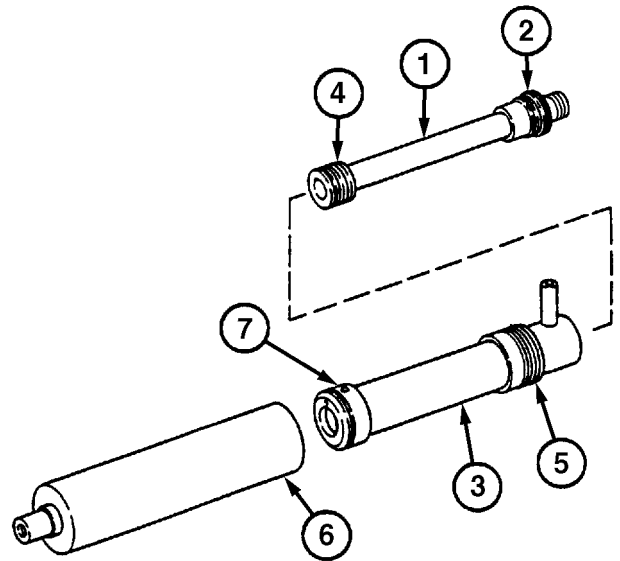
**a. Disassembly.**

- (1) Use a vise with soft jaws to secure cylinder in a horizontal position for disassembly.
- (2) Disassemble fork sideshift cylinder parts (1 through 19).

**CAUTION**

Do not scratch or damage the wear surface of rod, piston or inner gland. Follow this precaution to prevent failure of the cylinder.

- (a) Pull rod (1) out approximately 5 in. (127 mm) for removal of inner gland (2).
- (b) Place a container under inner gland (2) to catch oil contained in cylinder.



**CAUTION**

Use care when removing rod and piston assembly to prevent seal damage. Keep rod in line with barrel to prevent binding.

- (c) Using spanner wrench remove inner gland (2) from cylinder tube (3). Remove rod (1), inner gland and inner piston (4) as an assembly from cylinder tube.
- (d) Using spanner wrench remove outer gland (5) from barrel (6). Remove outer gland, cylinder tube (3) and outer piston (7) as an assembly from barrel.

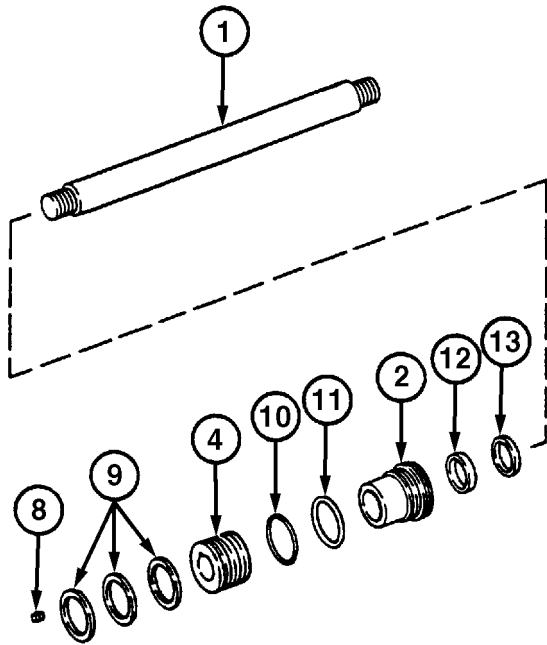
**16-19. 6K FORK SIDESHIFT CYLINDERS REPAIR (CONT)**

- (e) Remove setscrew (8) from inner piston (4) face.
- (f) Remove three piston rings (9) from inner piston (4).

**WARNING**

Unsafe torching practices can cause serious injury from fire, explosions, or harmful agents. Protective clothing and goggles must be worn; adequate protective equipment used and a suitable fire extinguisher kept nearby.

- (g) Heat inner piston (4) with acetylene torch to approximately 300 - 400°F (148 - 204°C). Use a strap wrench to remove inner piston from rod (1).
- (h) Remove inner gland (2) rod (1).



**CAUTION**

Do not nick or scratch seal groove of gland during removal of backup ring. Failure to follow this precaution will cause part damage.

- (i) Remove preformed packing (10) and backup ring (11) from outer diameter of inner gland (2). Discard preformed packing.

**NOTE**

Note direction that lip of seal is facing before removal to aid in installation.

- (j) Remove seal (12) and rod wiper (13) from inner diameter of inner gland (2).

- (k) Remove setscrew (14) from outer piston (7).
- (l) Remove seal (15) from outer piston (7).

**WARNING**

Unsafe torching practices can cause serious injury from fire, explosions, or harmful agents. Protective clothing and goggles must be worn; adequate protective equipment used and a suitable fire extinguisher kept nearby.

- (m) Heat outer piston (7) with acetylene torch to approximately 300 - 400°F (148 - 204°C). Use a spanner wrench to remove outer piston from cylinder tube (3).

- (n) Remove outer gland (5) from cylinder tube (3).

- (o) Remove preformed packing (16) and backup ring (17) from outer gland (5). Discard preformed packing.

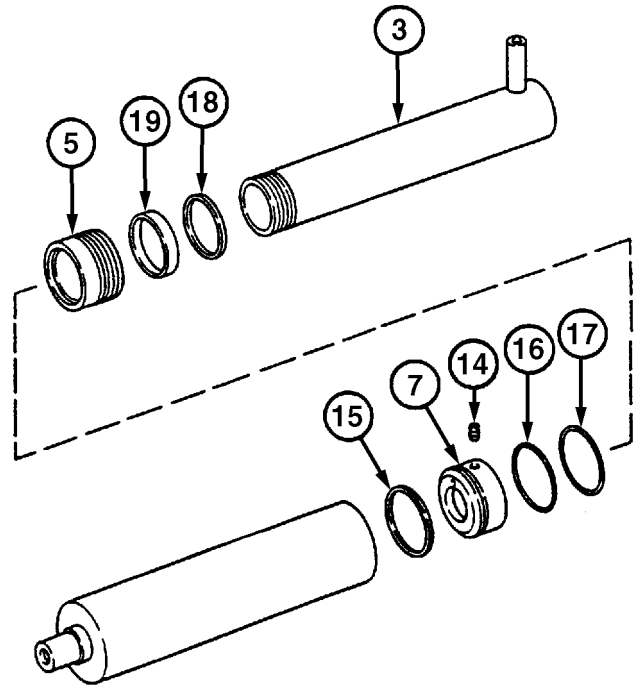
**NOTE**

Note direction that seal is facing before removal.

- (p) Remove wear ring (18) and seal (19) from inner diameter of outer gland (5).

**b. Cleaning.** See **Cleaning Instructions (Para 2-12).**

**c. Inspection.** See **Inspection Instructions (Para 2-14).**



**16-19. 6K FORK SIDESHIFT CYLINDERS REPAIR (CONT)**

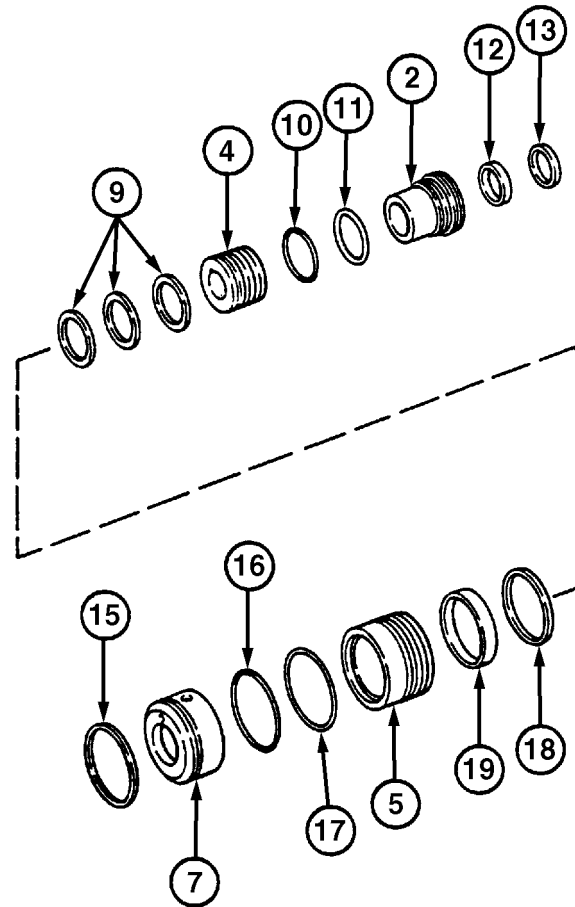
*d. Assembly.*

**NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**(1) Assemble cylinder parts (1 through 19).**

- (a) Install seal (12) and rod wiper (13) in inner diameter of inner gland (2). Ensure that seal is positioned in same direction as was noted before removal.
- (b) Install backup ring (11) and preformed packing (10) on outer diameter of inner gland (2).
- (c) Install seal (19) and wear ring (18) in inner diameter of outer gland (5). Ensure that seal is positioned in same direction as noted before removal.
- (d) Install backup ring (17) and preformed packing (16) on outer diameter of outer gland (5).



**NOTE**

Excessive piston ring bypass may occur if gaps are aligned.

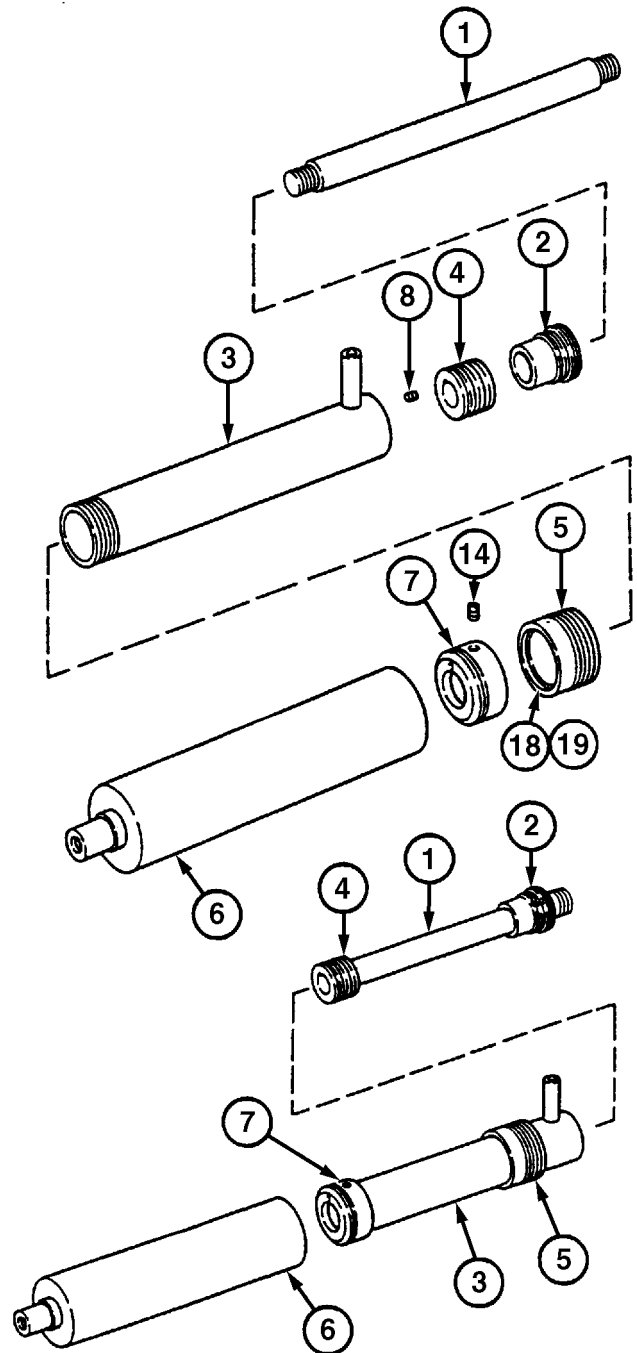
- (e) Install three piston rings (9) on inner piston (4). Stagger piston gaps to provide 90 degree relationship between all gaps.
- (f) Install seal (15) on outer piston (7).



- (g) Lubricate inner diameter of inner gland (2), seal (12) and rod wiper (13) with clean hydraulic oil. Slide inner gland (2) onto rod (1).

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.
- Adhesives, solvents, and sealing compounds can burn easily, can give off harmful vapors, and are harmful to skin and clothing. To avoid injury or death, keep away from open fire and use in a well-ventilated area. If adhesive, solvent, or sealing compound gets on skin or clothing, wash immediately with soap and water.



- (h) Use solvent to clean threads of rod (1) and apply sealing compound. Install inner piston (4) and setscrew (8) on rod. Tighten setscrew and stake.

- (i) Lubricate inner diameter of outer gland (5) and wear ring (18) and seal (19) with clean hydraulic oil. Slide outer gland onto cylinder tube (3).

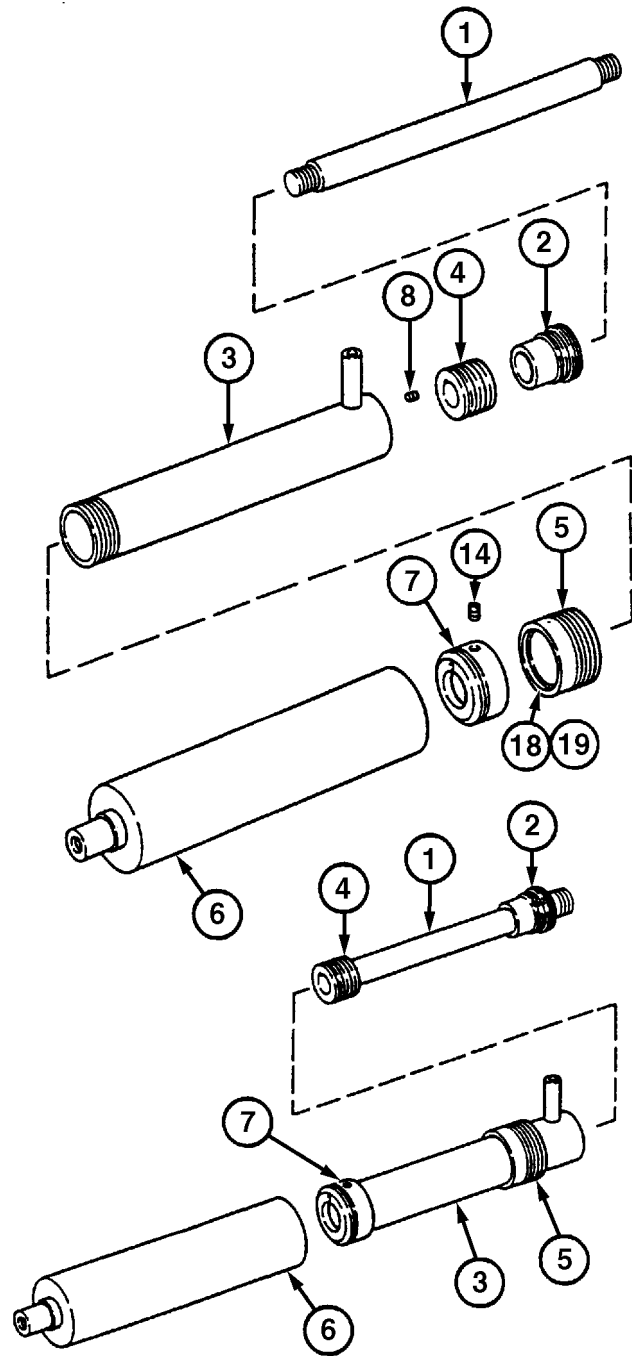
**16-19. 6K FORK SIDESHIFT CYLINDERS REPAIR (CONT)**

- (j) Use solvent to clean threads of cylinder tube (3) and apply sealing compound. Install outer piston (7) onto cylinder tube (3). Install setscrew (14) in piston. Stake setscrew.
- (k) Use solvent to clean threads of inner gland (2) and outer gland (5). Apply sealing compound to threads of inner gland.
- (l) Clean threads inside barrel (6). Slide outer piston (7) with cylinder tube (3) as an assembly, into barrel.
- (m) Install outer gland (5) into barrel (6). Tighten outer gland until it is flush with end of barrel. Do not over tighten outer gland.

**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with barrel to prevent binding.

- (n) Slide inner piston (4), inner gland (2), and rod (1) as an assembly in barrel (6). Use a spanner wrench to tighten inner gland until it is flush with end of barrel.



**NOTE**

Follow-on Maintenance: Install fork sideshift cylinder (TM 10-3930-673-20).

**END OF TASK**

**16-20. 10K FORK SIDESHIFT CYLINDERS REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

- Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)
- Torque Wrench, 0-600 lb-ft (1085 N•m) (Item 29, Appendix D)
- Wrench Set, Spanner (Item 26, Appendix D)

*Equipment Condition*

- Fork sideshift cylinder removed (TM 10-3930-673-20)

*Materials/Parts*

- Hydraulic Oil (Item 30, Appendix B)
- Compound, Sealing (Item 41, Appendix B)
- Rags, (Item 34, Appendix B)
- Solvent, Cleaning (Item 52, Appendix B)
- Packing, Preformed
- Packing, Preformed (2)
- Seal
- Container, 5 gal (19 l) capacity

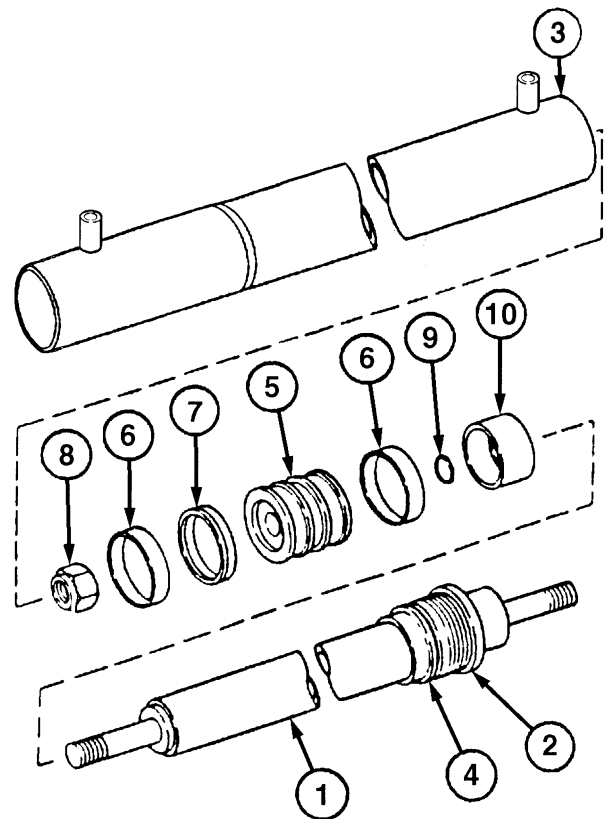
**a. Disassembly.**

- (1) Use a vise with soft jaws to secure cylinder in a horizontal position for disassembly.
- (2) Disassemble fork sideshift cylinder parts (1 through 14).

**CAUTION**

Do not scratch or damage the wear surface of rod, piston or inner gland. Follow this precaution to prevent failure of the cylinder.

- (a) Pull rod (1) out approximately 5 in. for removal of inner gland (2).
- (b) Place a container under inner gland (2) to catch oil contained in cylinder.

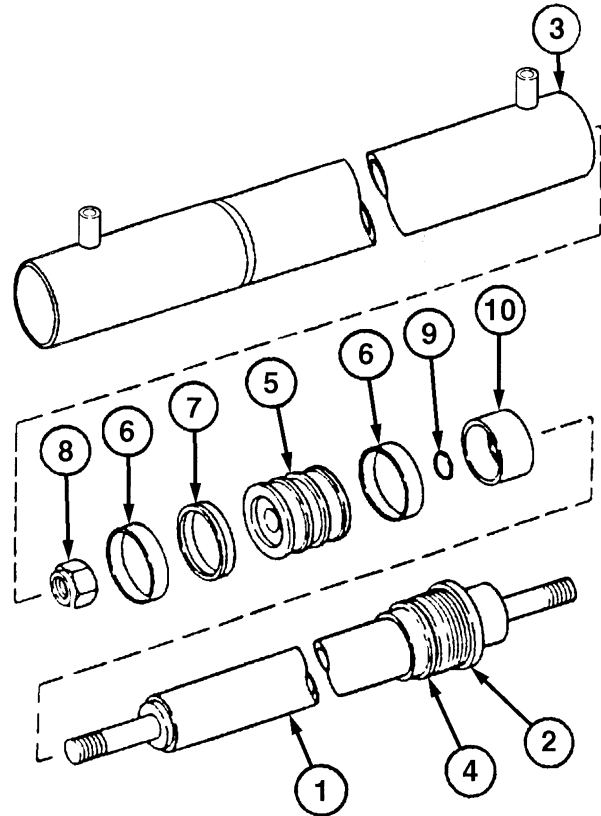


**16-20. 10K FORK SIDESHIFT CYLINDERS REPAIR (CONT)**

**CAUTION**

Use care when removing rod and piston assembly to prevent seal damage. Keep rod in line with barrel to prevent binding.

- (c) Using a spanner wrench to unscrew gland (2) from cylinder tube (3). Pull gland out of cylinder tube far enough to unseat preformed packing (4). Allow oil to drain into container.



**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (d) Remove rod (1) and piston (5) as an assembly from cylinder tube (3).
- (e) Place rod (1) and piston (5) as an assembly on suitable supports to prevent damage.
- (f) Remove two wear rings (6) from piston (5).

**CAUTION**

Do not nick or scratch seal groove of piston during removal of seal. Failure to follow this precaution will cause part damage.

- (g) Remove seal (7) from piston (5).

**NOTE**

Nut may need to be heated with acetylene torch for removal.

- (h) Remove nut (8) and piston (5) from rod (1).
- (i) Remove preformed packing (9) from piston (5) bore. Discard preformed packing.
- (j) Remove stop tube (10) from rod (1).

- (k) Remove gland (2) from rod (1).
- (l) Remove two preformed packings (4 and 11) and one backup ring (12) from gland (2). Discard preformed packing.

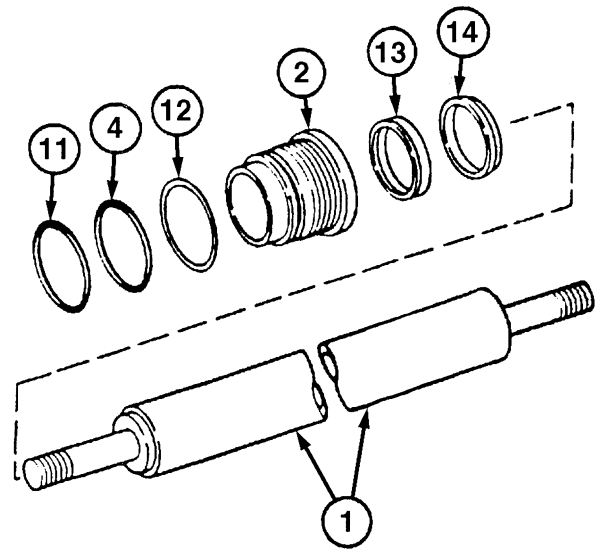
**CAUTION**

Do not nick or scratch seal groove of gland during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

Note direction of lip of seal is facing to aid in installation.

- (m) Remove seal (13) and rod wiper (14) from inside of gland (2).



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Assembly.**

**NOTE**

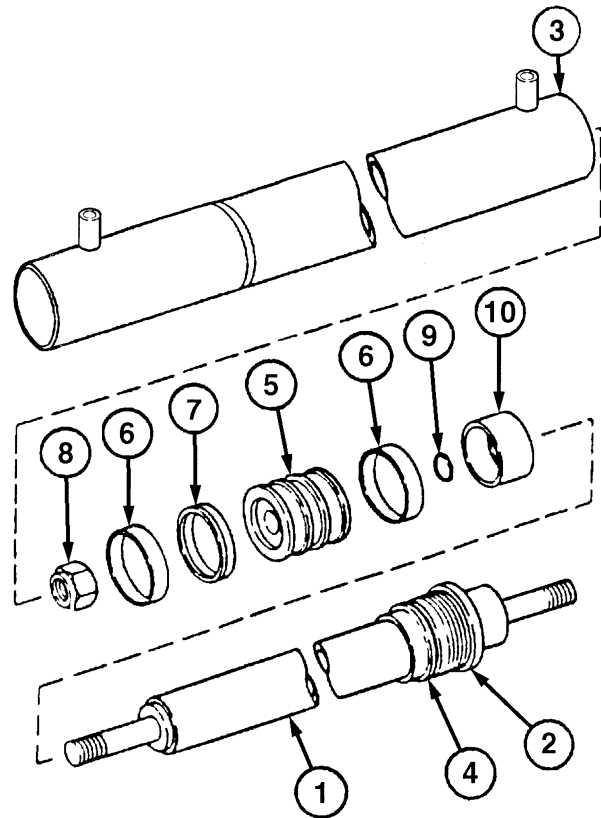
Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

**Assemble cylinder parts (1 through 14).**

- (a) Install seal (13) and rod wiper (14) in inner diameter of gland (2). Ensure that seal is positioned in same direction as was noted before removal.
- (b) Install backup ring (12) and two preformed packings (4 and 11) on outer diameter of gland (2).

**16-20. 10K FORK SIDESHIFT CYLINDERS REPAIR (CONT)**

- (c) Install stop tube (10) in rod (1).
- (d) Install gland on rod (1).
- (e) Lubricate piston (5) bore with hydraulic oil. Install preformed packing (9) in piston bore.
- (f) Use a cleaning solvent and lint free rag to clean threads on rod (1) and nut (8).
- (g) Install piston (5) on rod (1).



**WARNING**

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

- (h) Apply sealing compound on threads of rod (1) and nut (8). Install nut on rod. Tighten nut to 250 lb-ft (339 N•m).
- (i) Place rod (1) and piston (5) as an assembly on suitable supports to prevent damage during assembly.
- (j) Install two wear rings (6) and one seal (7) on piston (5). Position wear rings so that gaps are 180 degrees apart.

**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with cylinder tube to prevent binding. Failure to follow this precaution will cause part damage.

- (k) Lubricate cylinder tube (3) inner diameter, piston (5) and outside diameter with clean hydraulic oil.
- (l) Apply sealing compound to threads of gland (2).
- (m) Position rod (1) and piston (5) as an assembly in cylinder tube (3).

**NOTE**

Tighten gland so that it is flush with end of cylinder tube . Do not overtighten gland.

- (n) Tighten gland (2) onto cylinder tube (3).

**NOTE**

Follow-on Maintenance: Install fork sideshift cylinder (TM 10-3930-673-20).

**END OF TASK**

## 16-21. BOOM HOIST CYLINDER REPAIR

This Task Covers:

- |                |               |
|----------------|---------------|
| a. Disassembly | c. Inspection |
| b. Cleaning    | d. Assembly   |

### INITIAL SETUP

#### Tools and Special Tools

Shop Equipment, Automotive Maintenance,  
Common No. 2 Less Power  
(Item 17, Appendix D)  
Wrench Set, Spanner (Item 26, Appendix D)  
Spanner Wrench

#### Equipment Condition

Boom hoist cylinder removed  
(TM 10-3930-673-20)

#### Materials/Parts

Compound, Sealing (Item 42, Appendix B)  
Oil, Lubricating, Transmission/Hydraulic  
(Item 30, Appendix B)  
Solvent, Drycleaning P-D-680  
(Item 52, Appendix B)  
Nut  
Packing, Preformed (7)  
Seal  
Container, 5 gal (19 l) capacity

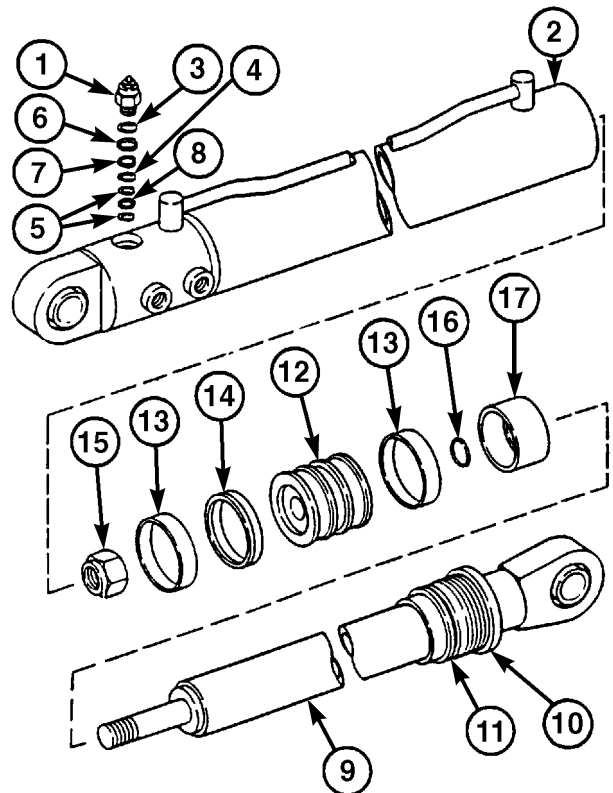
### a. Disassembly.

- (1) Use a vise with soft jaws to secure boom hoist cylinder in a horizontal position for disassembly.

#### WARNING

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve and allow pressure to escape before removing valve entirely.

- (2) Relieve pressure in cylinder by slowly removing counterbalance valve (1) from cylinder tube (2). Drain residual oil through valve holes into a suitable container.
- (3) Remove back-up rings (3 and 4), two back-up rings (5), and three preformed packings (6, 7, and 8) from each counterbalance valve (1). Discard preformed packings.
- (4) Disassemble boom hoist cylinder parts (9 through 24).





**CAUTION**

Do not scratch or damage the wear surface of rod, piston, or gland. Follow this precaution to prevent failure of the cylinder.

- (a) Use a suitable tool to pull rod (9) out approximately 5 in. (127 mm) for removal of gland (10).
- (b) Place a container under gland (10) to catch oil contained in cylinder.
- (c) Use a spanner wrench to remove gland (10) from cylinder tube (2). Pull gland out of cylinder far enough to unseat preformed packing (11). Allow oil to drain into container. Discard preformed packing.

**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (d) Remove rod (9) and piston (12) as an assembly from cylinder tube (2).
- (e) Place rod (9) and piston (12) assembly on suitable supports to prevent damage.
- (f) Remove two wear rings (13) from piston (12).

**CAUTION**

Do not nick or scratch seal groove during removal of seal. Failure to follow this precaution will cause part damage.

- (g) Remove seal (14) from piston (12).

**NOTE**

The nut may need to be heated with a torch for removal.

- (h) Remove nut (15) and piston (12) from rod (9). Discard nut.
- (i) Remove preformed packing (16) from piston (12) bore. Discard preformed packing.
- (j) Remove tube (17) from rod (9).
- (k) Remove gland (10) from rod (9).

**16-21. BOOM HOIST CYLINDER REPAIR (CONT)**

- (l) Remove preformed packings (11 and 18) and back-up ring (19) from gland (10). Discard preformed packings.

**CAUTION**

Do not nick or scratch seal groove during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

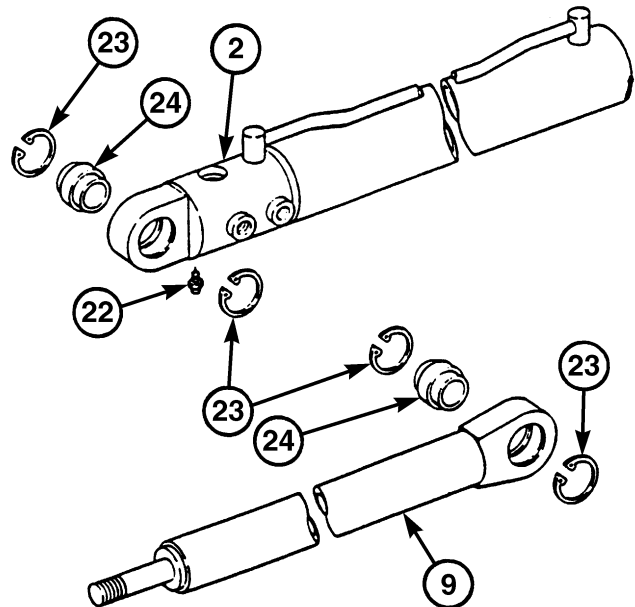
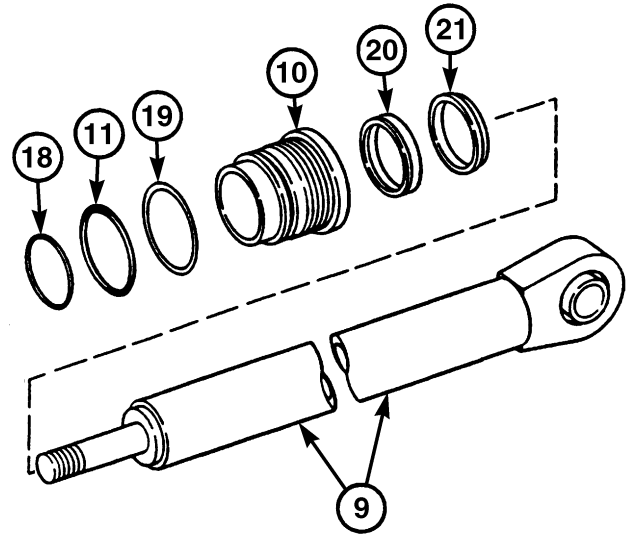
Note direction that lip of seal is facing to aid in installation.

- (m) Remove seal (20) and rod wiper (21) from inside of gland (10).
- (n) Remove needle valve (22) from cylinder tube (2).

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (o) Remove one snap ring (23) from cylinder tube (2) and rod (9).
- (p) Press out one bushing (24) from cylinder tube (2) and rod (9).
- (q) Remove one snap ring (23) from each bushing (24).



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

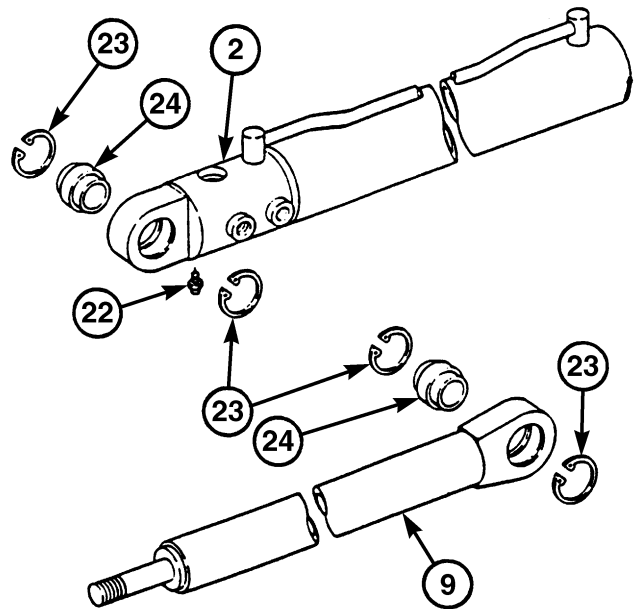
**c. Inspection.** See Inspection Instructions (Para 2-14).

**d. Assembly.**

**NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

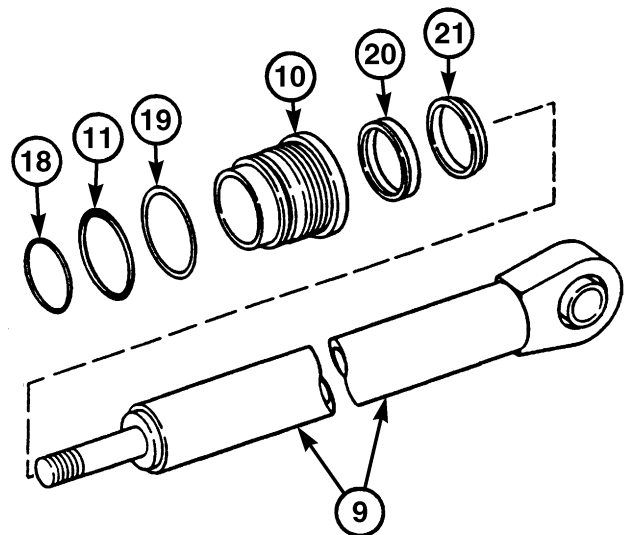
- (1) **Assemble cylinder parts (1 through 24).**
- (a) Install needle valve (22) in cylinder tube (2).
  - (b) Press one bushing (24) in cylinder tube (2) and rod (9).



**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (c) Install two snap rings (23) on each bushing (24).
- (d) Install seal (20) and rod wiper (21) inside gland (10). Ensure that seal lip is positioned the same way as it was before disassembly.
- (e) Install back-up ring (19) and preformed packings (11 and 18) on outside diameter of gland (10).
- (f) Slide gland (10) onto rod (9).

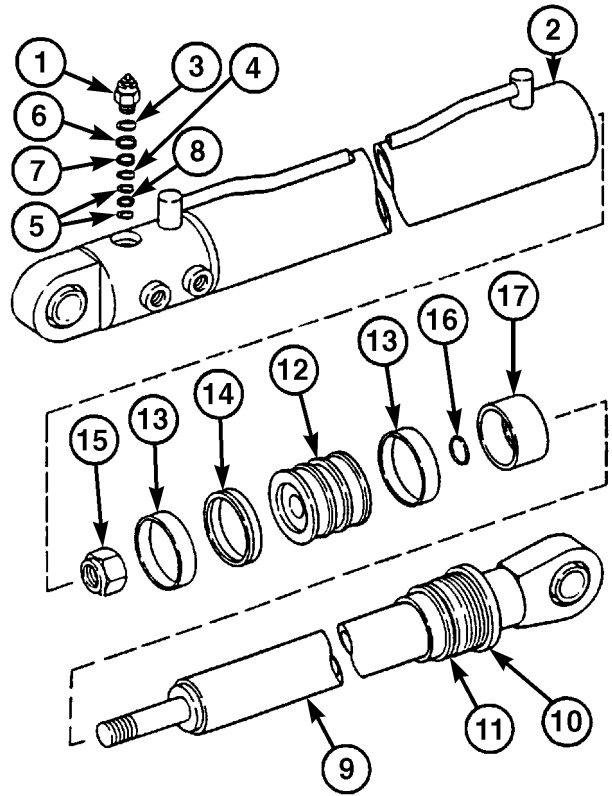


**16-21. BOOM HOIST CYLINDER REPAIR (CONT)**

- (g) Lubricate piston (12) inner diameter with clean hydraulic oil. Install preformed packing (16) inside bore of piston.
- (h) Install tube (17) on rod (9).

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.



- (i) Use drycleaning solvent and lint-free rag to clean threads on rod (9) and nut (15).
- (j) Install piston (12) onto rod (9).

**WARNING**

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

- (k) Apply sealing compound on threads of rod (9) and nut (15). Install nut on rod.
- (l) Place rod (9) and piston (12) as an assembly on suitable supports to prevent damage during assembly.

- (m) Install two wear rings (13) and one seal (14) on piston (12). Position wear rings so that gaps are 180° apart.

**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with cylinder tube to prevent binding. Failure to follow this precaution will cause part damage.

- (n) Lubricate cylinder tube (2) inner diameter, piston (12) outside diameter, and gland (10) outside diameter with clean hydraulic oil.
- (o) Position rod (9) and piston (12) as an assembly in cylinder tube (2).

**NOTE**

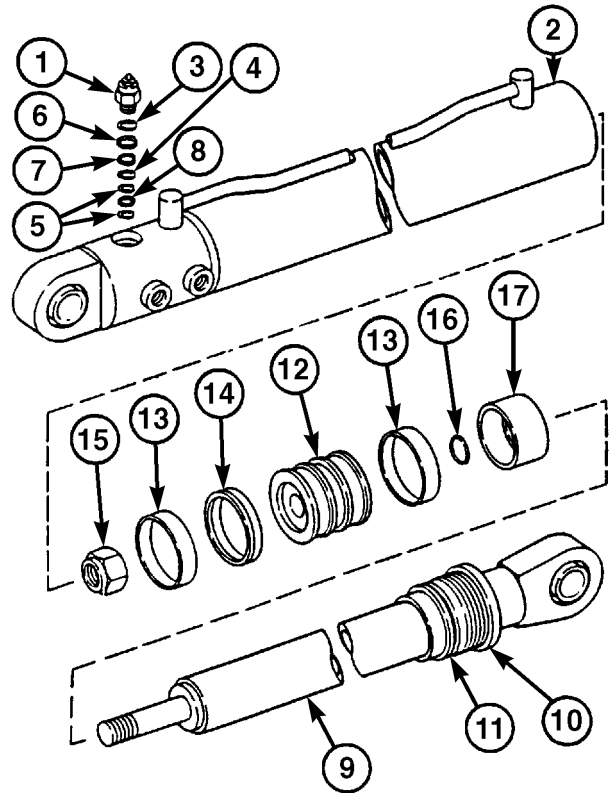
Tighten gland so that it is flush with end of cylinder tube. Do not overtighten gland.

- (p) Tighten gland (10) onto cylinder tube (2).
- (q) Install back-up rings (3 and 4), two back-up rings (5), and three preformed packings (6, 7, and 8) on counterbalance valve (1).
- (r) Install counterbalance valve (1) in cylinder tube (2).

**NOTE**

Follow-on Maintenance: Install boom hoist cylinder (TM 10-3930-673-20).

**END OF TASK**



**16-22. HYDRAULIC JOYSTICK CONTROL VALVE REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance, Common No. 2 Less Power (Item 17, Appendix D)

*Equipment Condition*

Hydraulic joystick control valve removed (TM 10-3930-673-20)

*Materials/Parts*

Compound, Sealing (Item 42, Appendix B)  
 Grease, Automotive and Artillery (Item 18, Appendix B)  
 Oil, Lubricating, Transmission/Hydraulic (Item 30, Appendix B)  
 Packing, Preformed  
 Packing, Preformed  
 Packing, Preformed  
 Ring, Back-up  
 Seal

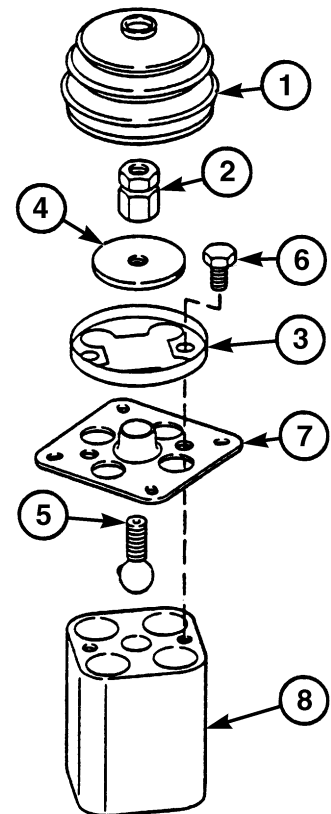
**a. Disassembly.**

- (1) **Remove boot (1) by carefully prying it from groove in nut (2) and out from under clamp (3).**
- (2) **Remove nut (2) and plate (4) from ball joint (5).**

**NOTE**

Plunger capsules are under spring compression. Hold plate down and remove screws in even increments.

- (3) **Remove two screws (6), clamp (3), plate (7), and ball joint (5) from housing (8).**
- (4) **Remove ball joint (5) from plate (7).**



**NOTE**

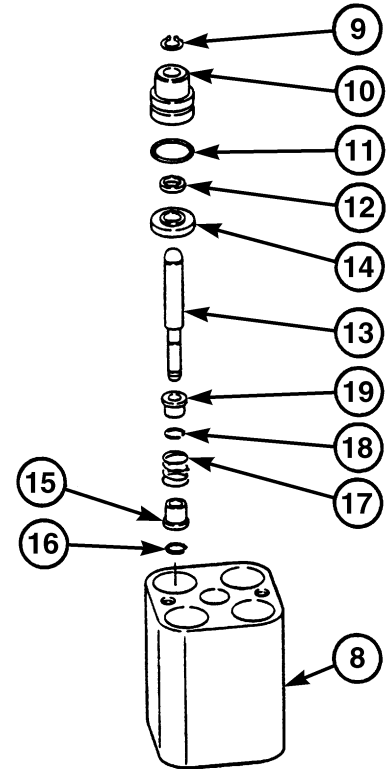
Hydraulic joystick control valve contains four plunger capsule assemblies and four metering capsule assemblies. All four plunger capsule assemblies and metering capsule assemblies are removed the same way.

- (5) **Remove plunger capsule parts (9 through 19) from housing (8).**

**WARNING**

Use care when removing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

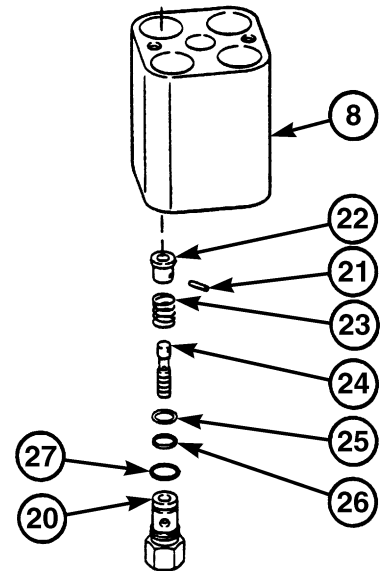
- (a) Remove retaining ring (9), cap (10), preformed packing (11), and seal (12) from plunger (13) and housing (8). Discard preformed packing and seal.
- (b) Remove retainer (14) from plunger (13) and housing (8).
- (c) Push up on spring seat (15) and remove retaining ring (16) and spring seat from plunger (13) housing (8).
- (d) Remove spring (17), retaining ring (18), and spring seat (19) from plunger (13) and housing (8).



**16-22. HYDRAULIC JOYSTICK CONTROL VALVE REPAIR (CONT)**

**(6) Remove metering capsule parts (20 through 27).**

- (a) Remove plug (20) and parts (21 through 27) as an assembly from housing (8).
- (b) Remove pin (21), spring seat (22), and spring (23) from spool (24).
- (c) Remove back-up ring (25) and preformed packings (26 and 27) from plug (20). Discard back-up ring and preformed packings.



**b. Cleaning.** See Cleaning Instructions (Para 2-12).

**c. Inspection.**

- (1) **Inspect boot (1) for tears, stretching, or signs of deterioration.**
- (2) **Inspect springs (17 and 23) for signs of stretching or distortion.**
- (3) **Inspect plungers (13) and spools (24) for burrs, nicks, or score marks.**
- (4) **Inspect bores in caps (10) and plugs (20) for burrs, nicks, or score marks.**
- (5) **Inspect nut (2), plate (4), and ball joint (5) threads for damage.**

**d. Assembly.**

- (1) **Apply a coat of lubricating oil to all internal sliding surfaces.**

**NOTE**

Hydraulic joystick control valve contains four plunger capsule assemblies and four metering capsule assemblies all four plunger capsule assemblies and metering capsule assemblies are installed the same way.

**(2) Install metering capsule parts (20 through 27) in housing (8).**

- (a) Assemble spool (24) to spring seat (22) using pin (21).
- (b) Install preformed packings (26 and 27) and back-up ring (25) on plug (20).
- (c) Place spring (23) on spool (24) and insert spool (24) in top of plug (20).
- (d) Install plug (20) and parts (21 through 27) as an assembly in housing (8). Tighten plug to 29 - 41 lb-ft (39.32 - 55.59 N•m).

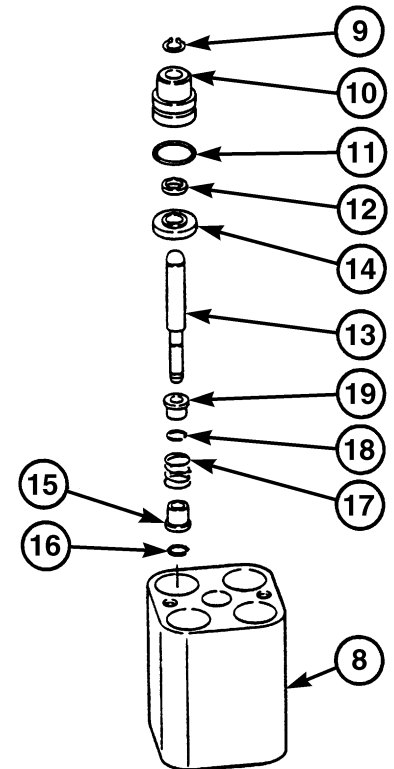


(3) **Install plunger capsule parts (9 through 19) in housing (8).**

**WARNING**

Use care when installing snap and retaining rings. Snap and retaining rings are under spring tension and can act as projectiles when released and could cause severe eye injury.

- (a) Install spring seat (19) and retaining ring (18) on plunger (13).
- (b) Install spring (17), spring seat (15), and retaining ring (16) on plunger (13).
- (c) Install retainer (14) and seal (12) on plunger (13).
- (d) Install preformed packing (11) on cap (10) and install cap on plunger (13). Secure with retaining ring (9).
- (e) Install parts (9 through 19) as an assembly in housing (8).



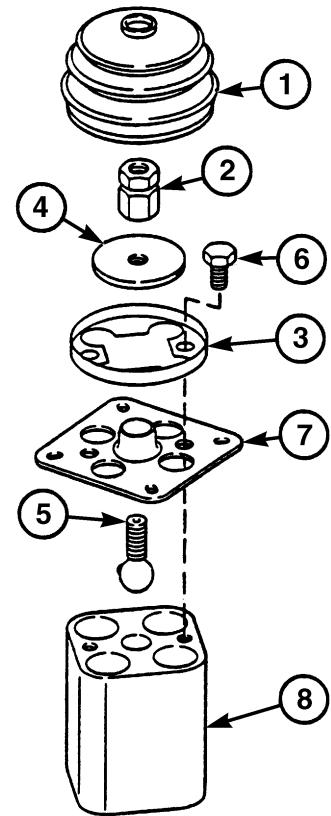
**16-22. HYDRAULIC JOYSTICK CONTROL VALVE REPAIR (CONT)**

- (4) Apply grease to contact surfaces of ball joint (5) and plate (7).
- (5) Install ball joint (5) in plate (7) from bottom side. Use care not to dislodge ball joint.
- (6) Install clamp (3) on plate (7).

**WARNING**

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

- (7) Apply sealing compound on threads of screws (6). Install screws in housing (8). Tighten screws to 15 lb-ft (20.34 N•m).
- (8) Install plate (4) onto ball joint (5) until bottom of pivot plate just contacts tops of plungers (13). Lock plate in position with nut (2). Tighten nut to 29 - 41 lb-ft (39.32 - 55.59 N•m).
- (9) Install boot (1) on clamp (3).



**NOTE**

Follow-on Maintenance: Install hydraulic joystick control valve (TM 10-3930-673-20).

**END OF TASK**

**16-23. ATTACHMENT CYLINDER REPAIR**

This Task Covers:

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

**INITIAL SETUP**

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Wrench Set, Spanner, (Item 26, Appendix D)

*Equipment Condition*

Attachment cylinder removed (TM 10-3930-673-20)

*Materials/Parts*

Hydraulic Oil (Item 30, Appendix B)  
 Rags, Lint-free (Item 34, Appendix B)  
 Loctite #271 (Item 42, Appendix B)

*Materials/Parts (Cont)*

Solvent, Drycleaning P-D-680 (Item 52, Appendix B)  
 Container, 5 gal (19 l) capacity  
 Nut  
 Packing, Preformed  
 Packing, Preformed  
 Packing, Preformed  
 Seal  
 Seal

*Personnel Required*

Two

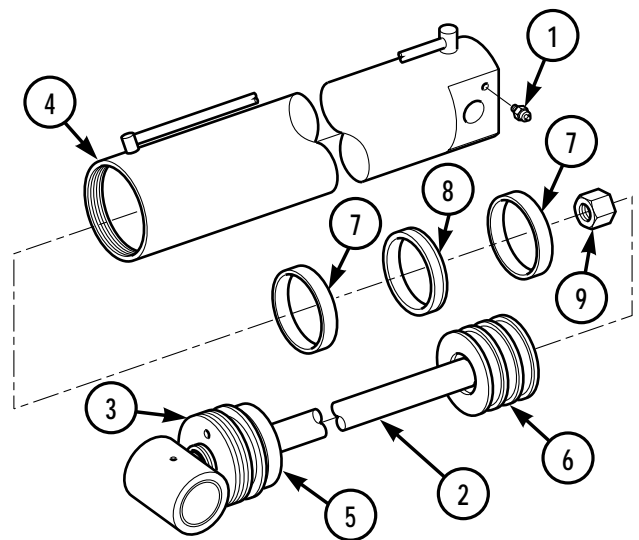
**a. Disassembly.**

- (1) Use a vise with soft jaws to secure cylinder in a horizontal position for disassembly.

**WARNING**

Hydraulic oil, under pressure, can remain within cylinder after disconnecting hydraulic hoses. To avoid severe personal injury, slowly loosen counterbalance valve and allow pressure to escape before removing valve entirely.

- (2) Relieve pressure in cylinder by slowly removing counterbalance valve (1). Drain residual oil through valve holes into a suitable container.
- (3) Disassemble cylinder parts (2 through 16).



**CAUTION**

Do not scratch or damage the wear surface of rod, piston or gland. Follow this precaution to prevent failure of the cylinder.

- (a) Pull rod (2) out approximately 5 in. (12.7 cm) for removal of gland (3).

**16-23. ATTACHMENT CYLINDER REPAIR (CONT)**

- (b) Place a container under gland (3) to catch oil contained in cylinder.
- (c) Remove gland (3) from cylinder tube (4). Pull gland out of cylinder far enough to unseat preformed packing (5). Allow oil to drain into container.

**CAUTION**

Use care when removing rod and piston assembly to prevent wear ring damage. Keep rod in line with cylinder tube to prevent binding.

- (d) Remove rod (2) and piston (6) as an assembly from cylinder tube (4).
- (e) Place rod (2) and piston (6) as an assembly on supports to prevent damage.
- (f) Remove two wear rings (7) from piston (6).

**CAUTION**

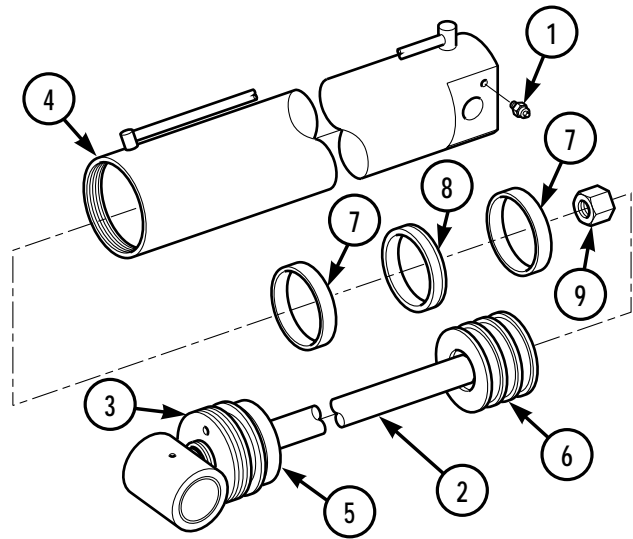
Do not nick or scratch seal groove of piston during removal of seal. Failure to follow this precaution will cause part damage.

- (g) Remove seal (8) from piston (6). Discard seal.

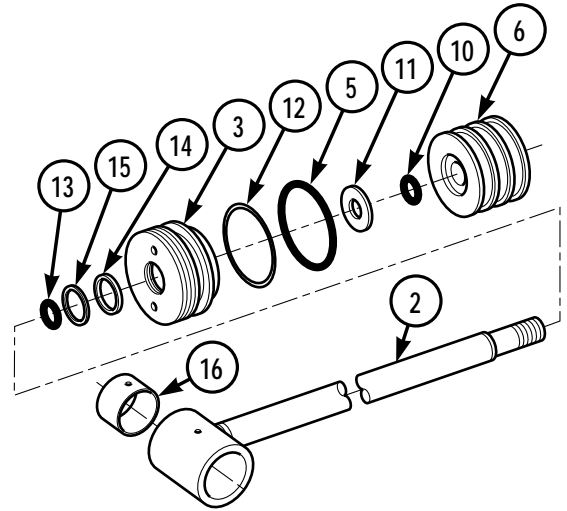
**NOTE**

The nut may need to be heated with a torch for removal.

- (h) Remove nut (9) and piston (6) from rod (2). Discard nut.



- (i) Remove preformed packing (10) from piston (6) bore. Discard preformed packing.
- (j) Remove washer (11) and gland (3) from rod (2).
- (k) Remove preformed packing (5) and backup ring (12) from gland (3). Discard preformed packing.



**CAUTION**

Do not nick or scratch seal groove of gland during removal of seal and rod wiper. Failure to follow this precaution will cause part damage.

**NOTE**

Note direction that lip of seal is facing before removal.

- (l) Remove preformed packing (13), seal (14), and rod wiper (15) from inside of gland (3).
- (m) Remove two bushings (16) from rod (2).

**b. Cleaning.** See **Cleaning Instructions (Para 2-12)**.

**c. Inspection.** See **Inspection Instructions (Para 2-14)**.

**d. Assembly.**

**NOTE**

Wipe all sealing surfaces on cylinder clean and dry. Apply film of clean hydraulic oil to all seals as they are installed.

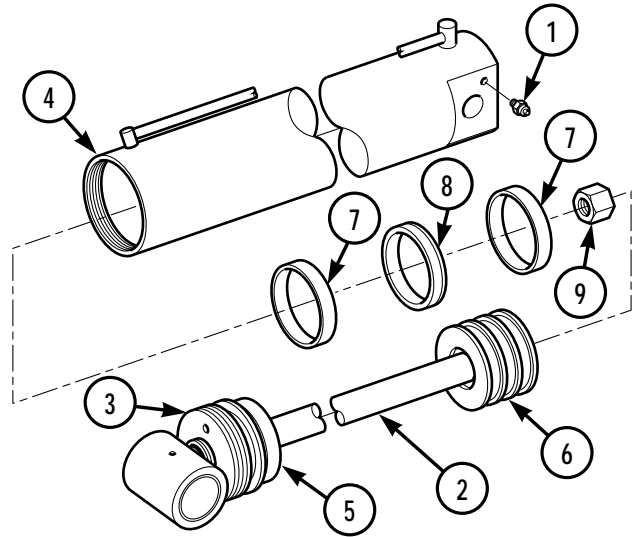
**Assemble cylinder parts (2 through 16).**

- (a) Install two bushings (16) in rod (2).
- (b) Install seal (14), rod wiper (15) and preformed packing (13) inside gland (3).
- (c) Install backup ring (12) and preformed packing (5) on outside diameter of gland (3).
- (d) Install gland (3) and washer (11) on rod (2).
- (e) Lubricate piston (6) inner diameter with clean hydraulic oil. Install preformed packing (10) inside bore of piston.

**16-23. ATTACHMENT CYLINDER REPAIR (CONT)**

**WARNING**

- Drycleaning Solvent (P-D-680) is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using solvent; the flashpoint for type I drycleaning solvent is 100°F (38°C), type II is 138°F (59°C), and type III is 200°F (93.3°C). Failure to do so may result in injury or death to personnel.
- If personnel become dizzy while using cleaning solvent, immediately get fresh air and medical help. If solvent contacts skin or clothes, flush with cold water. If solvent contacts eyes, immediately flush eyes with water and get immediate medical attention.



- (f) Use a cleaning solvent and lint-free rag to clean threads on rod (2) and nut (9).
- (g) Install piston (6) on rod (2).
- (h) Apply sealing compound on threads of rod (2) and nut (9). Install nut on rod.
- (i) Place rod (2) and piston (6) as an assembly on supports to prevent damage during assembly.
- (j) Install two wear rings (7) and one seal (8) on piston (6). Position wear rings so that gaps are 180 degrees apart.

**CAUTION**

Use care when installing rod and piston assembly. Keep rod in line with cylinder tube to prevent binding.

- (k) Lubricate cylinder tube (4) inside diameter, piston (6) outside diameter and gland (3) outside diameter with clean hydraulic oil.
- (l) Position rod (2) and piston (6) as an assembly in cylinder tube (4).

**NOTE**

Tighten gland so that it is flush with end of cylinder tube. Do not overtighten gland.

- (m) Tighten gland (3) onto cylinder tube (4).
- (n) Install counterbalance valve (1).

**NOTE**

Follow-on Maintenance: Install attachment cylinder (TM 10-3930-673-20).

**END OF TASK**

**16-24. HYDRAULIC HOSES REPAIR**

For hydraulic hose repair/manufacture, refer to TM 9-4940-46B-14.

**NOTE**

Use the Flats From Finger Tight (FFFT) method to tighten most hydraulic fittings during maintenance or repair.

The method includes these steps:

- Make sure threads and sealing surfaces are clean and free from signs of damage.
- Align tube or hose to mating fitting.
- Finger tighten nut snugly against fitting.
- Mark one of the flats of the nut and the adjoining hex of the fitting with a permanent ink marker.
- Tighten nut with a wrench by the number of flats specified in Table 1.

*Table 1*

<b>SAE SIZE</b>	<b>TUBE CONN. (F.F.F.T.)</b>	<b>SWIVEL NUT/HOSE CONN. (F.F.F.T.)</b>
2	-	-
3	-	-
4	2	2
5	2	2
6	1.5	1.25
8	1.5	1
10	1.25	1
12	1.25	1
14	1	1
16	1	1
20	1	1
24	1	1
32	1	1



## CHAPTER 17

### ARCTIC HEATER KIT INSTALLATION

<b>Para</b>	<b>Contents</b>	<b>Page</b>
17-1.	General . . . . .	17-1
17-2.	Description and Data . . . . .	17-1
17-3.	Arctic Heater Kit Installation. . . . .	17-2

**17-1. GENERAL**

This chapter covers installation procedures for the arctic heater.

**17-2. DESCRIPTION AND DATA**

**a.** During periods of low outside temperature (0°F [-18°C] and lower), the arctic heater can be utilized to warm the engine cooling system. This enables the engine fuel, lubricating oil, and internal engine components to be sufficiently warmed to permit the engine start motor to more easily crank the engine for rapid starting.

**b.** The arctic heater burns fuel from the vehicle fuel tank and is supplied by a remote fuel pump. The fuel is ignited in the heater from the vehicle electrical system and temperature is controlled by an internal thermostat. Exhaust gasses are carried off through an exhaust tube.

**c.** Coolant is circulated through the heater by an electric pump, routed through the engine and returns to the heater.

**d.** The arctic heater is actuated by a switch on the heater itself. A built-in timer limits the duration of the heating cycle.

## 17-3. ARCTIC HEATER KIT INSTALLATION

This Task Covers:

- a. Installation

### INITIAL SETUP

*Tools and Special Tools*

Tool Kit, General Mechanic's: Automotive (Item 23, Appendix D)  
 Shop Equipment, Automotive Maintenance and Repair, Common No. 1 Less Power (Item 16, Appendix D)

*Materials/Parts*

Arctic heater kit, part no. 8277171  
 Container, 1 gal. (3.8 l) capacity (2)

*Personnel Required*

Two

*Equipment Condition*

Auxiliary battery box, auxiliary batteries and cables installed (TM 10-3930-673-20-2)  
 Engine cooling system drained (TM 10-3930-673-20-2)  
 Fuel tank drained (TM 10-3930-673-20-2)

*References*

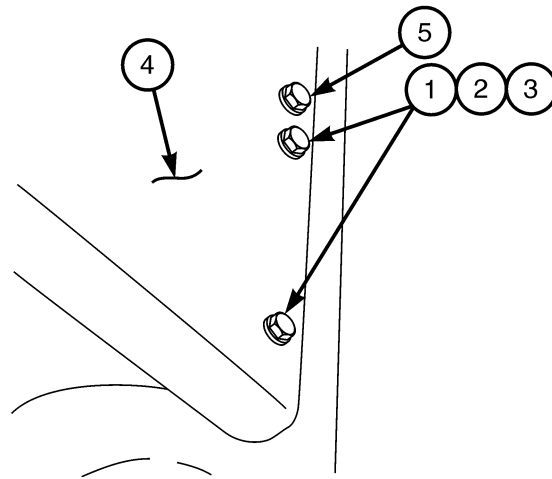
TM 10-3930-673-10  
 TM 10-3930-673-20-2

**a. Installation.**

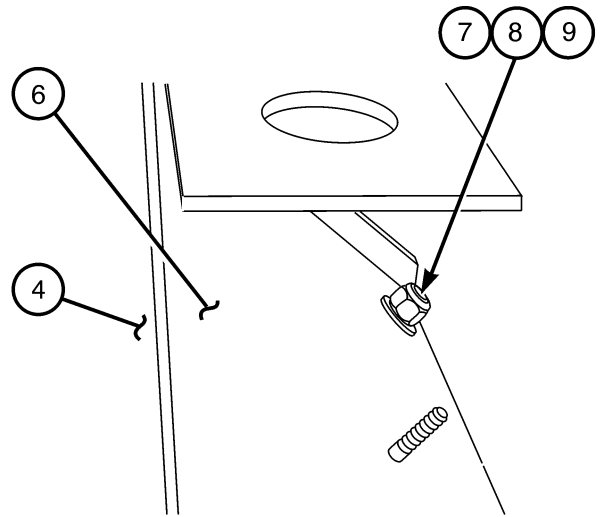
- (1) Remove two nuts (1), lockwashers (2), and carriage bolt (3) securing front of right-rear fender (4) on forward fender bracket (5). Discard lockwashers and carriage bolts.

**NOTE**

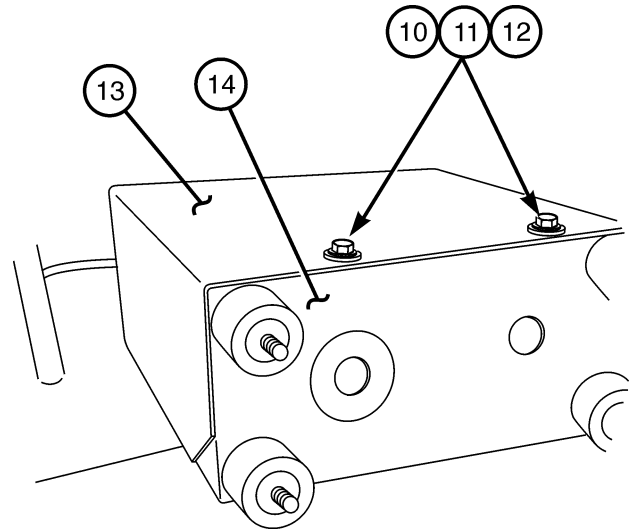
- Screw at right side of fender is installed downward thru fender. Screw at left side of fender is installed upward thru fender.
- Loosen two other carriage bolts securing fender, if necessary, for ease in aligning mounting holes.



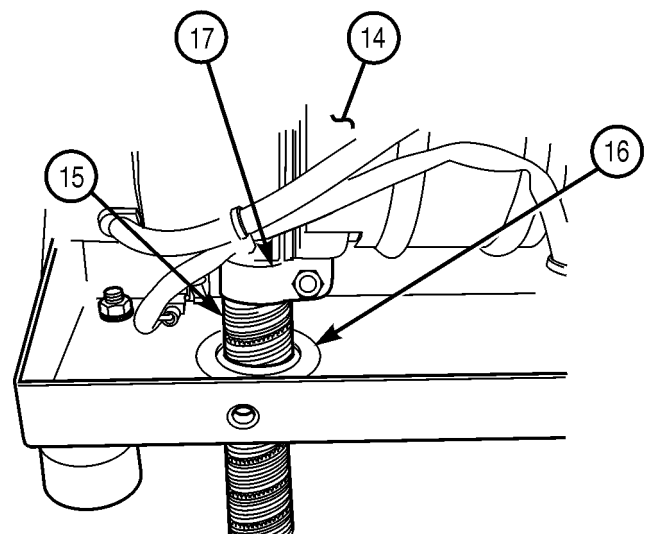
- (2) Install heater mounting bracket (6) on fender (4) and fender bracket (5) with two new screws (7), washers (8), and locknuts (9). Tighten locknuts.



- (3) Remove two screws (10), small washers (11), large washers (12), and cover (13) from heater assembly (14).



- (4) Push end of exhaust tube (15) thru grommet (16). Position clamp (17) over end of exhaust tube and push exhaust tube on exhaust port of heater assembly (14). Tighten clamp.



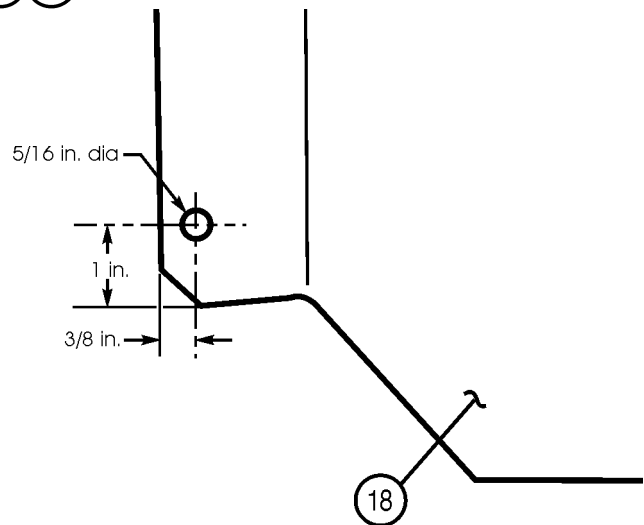
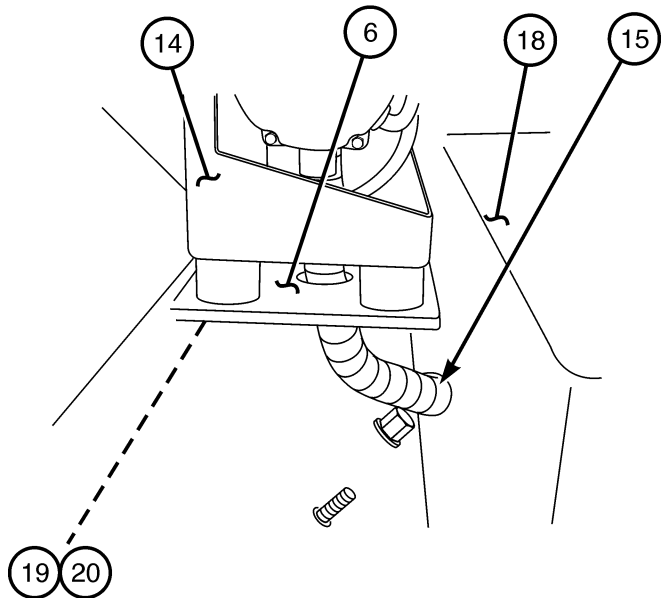
**17-3. ARCTIC HEATER KIT INSTALLATION (CONT)**

- (5) Position exhaust tube (15) of heater assembly (14) down thru hole in heater mounting bracket (6) and down thru area between heater mounting bracket and fuel/hydraulic tank (18). Direct end of exhaust tube toward lower end of flange of fuel/hydraulic tank.

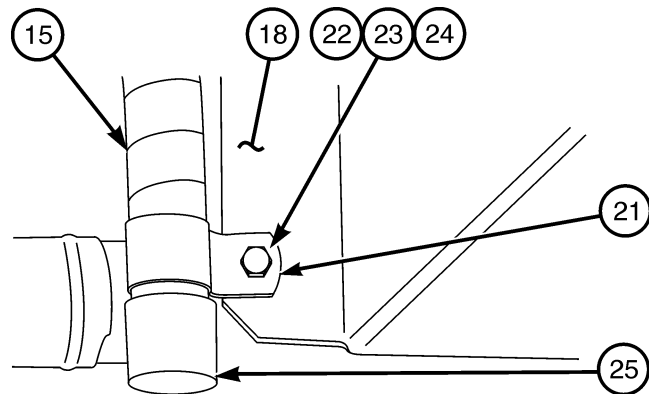
**NOTE**

Heater is to be installed with hose connection ports facing inboard on the vehicle.

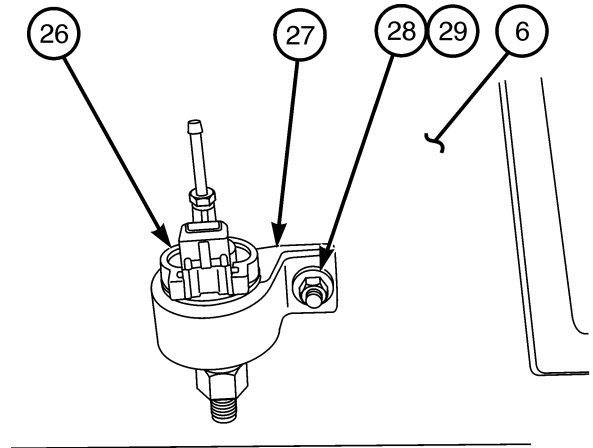
- (6) Install heater assembly (14) to heater mounting bracket (6) with four washers (19) and nuts (20) provided with heater.
- (7) If necessary, drill one 5/16 in. hole thru lower-rear FLANGE of fuel/hydraulic tank (18). See drilling diagram.



- (8) Install exhaust tube (15) on flange of fuel/hydraulic tank (18) with clamp (21), screw (22), washer (23), and locknut (24).
- (9) Screw end cap (25) on end of exhaust tube (15).



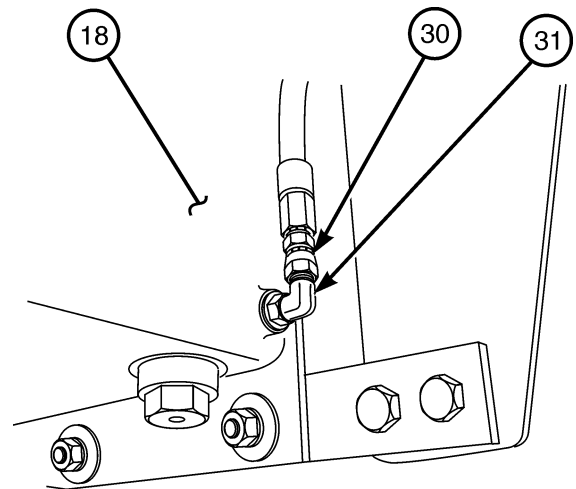
- (10) Position fuel pump (26) into holder (27) with wire connector of fuel pump facing upward.
- (11) Install holder (27) with fuel pump (26) on stud of heater mounting bracket (6) with washer (28) and locknut (29).



**WARNING**

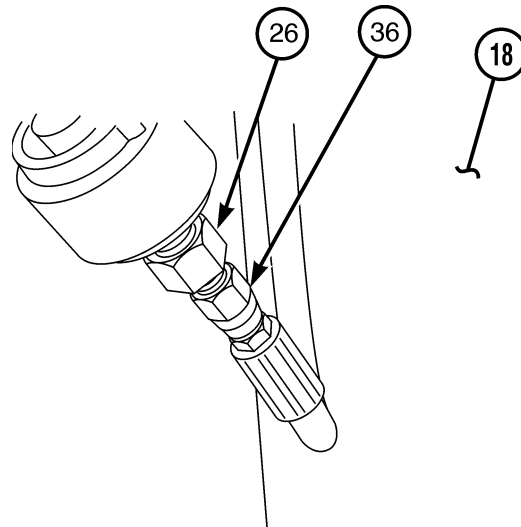
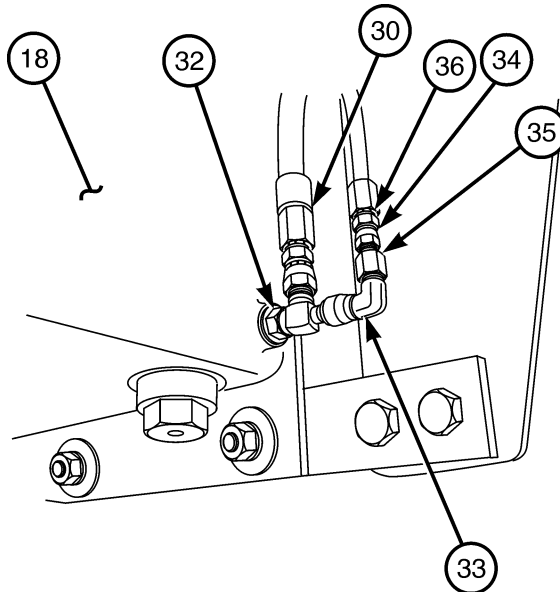
Do not smoke or allow open flame or sparks in the vicinity while working on any part of fuel system. Diesel fuel is highly flammable and can cause injury or death to personnel if accidentally ignited.

- (12) Disconnect fuel hose (30) from elbow (31) at side of fuel/hydraulic tank (18).
- (13) Remove elbow (31) from fuel/hydraulic tank (18). Discard elbow.



**17-3. ARCTIC HEATER KIT INSTALLATION (CONT)**

- (14) Install tee (32) to fuel/hydraulic tank (18) with branch of tee facing upward.
- (15) Connect vehicle fuel hose (30) to upper branch of tee (32).
- (16) Install elbow (33), reducer (34), and reducer nut (35) on tee (32) with elbow facing upward.
- (17) Connect arctic kit fuel suction hose (36) on reducer (34).
- (18) Route fuel suction hose (36) along side of fuel/hydraulic tank (18) and up to heater assembly (10).
- (19) Connect, but do not tighten, other end of fuel suction hose (36) to bottom of fuel pump (26).

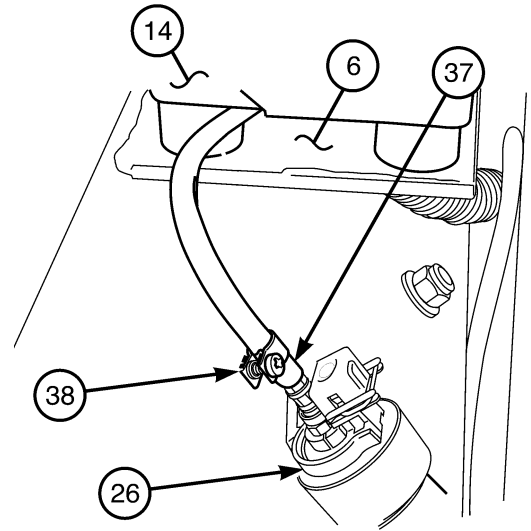


**WARNING**

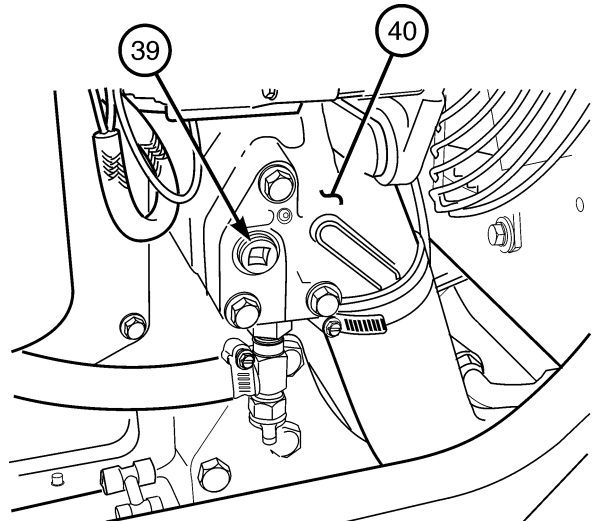
Spilled fuel is slippery and flammable. Clean up and properly dispose of spilled fuel. Failure to follow this warning may cause injury or death.

- (20) Fill vehicle fuel tank (18) with fuel (TM 10-3930-673-20-2) and allow some leakage of fuel at bottom of fuel pump (26) to purge fuel pump and bleed air from fuel suction hose (36). Tighten fuel suction hose.

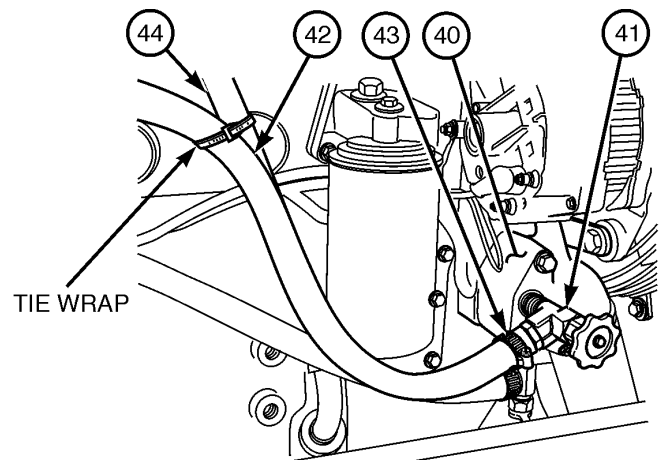
- (21) Secure fuel suction hose to bend of forward fender bracket with one large tie wrap.
- (22) Secure fuel suction hose to vehicle fuel hose and vehicle hydraulic hoses with small tie wraps.
- (23) Route fuel pressure hose (37) attached to heater assembly (14) down under heater and across top of heater mounting bracket (6) to fuel pump (26).
- (24) Connect fuel pressure hose (37) to top of fuel pump (26) with clamp (38).



- (25) At left-rear of engine, remove 1/2 in. pipe plug (39) from side of water inlet (40). Discard pipe plug.



- (26) Apply sealing compound to threads of shut-off valve (41) and install valve on water inlet (40) in position shown. Leave valve in OPEN position.
- (27) Connect heater inlet hose (42) on shut-off valve (41) and install hose clamp (43). Secure hose to turbocharger oil tube (44) with large tie wrap.

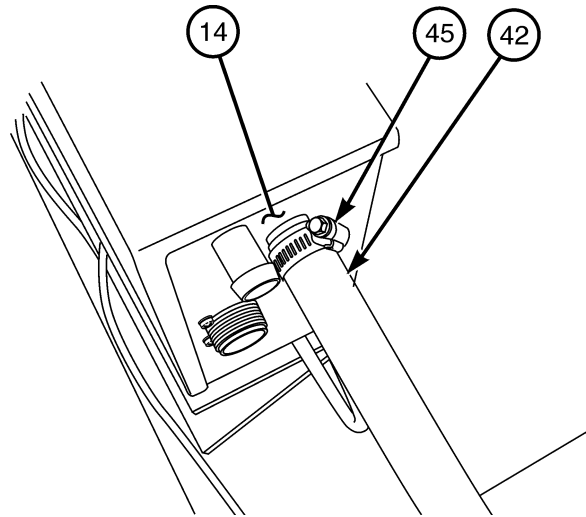


**17-3. ARCTIC HEATER KIT INSTALLATION (CONT)**

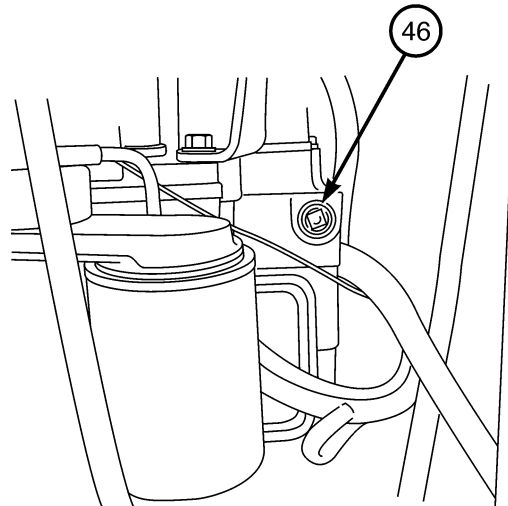
**CAUTION**

Ensure that heater inlet hose will not contact engine exhaust manifold or other hot components.

- (28) Route heater inlet hose (42) along left-side of engine, across flywheel housing and under boom hoist cylinder, along transmission oil cooler lines, to “COOLANT IN” port of heater assembly (14).
- (29) Connect heater inlet hose (42) to heater inlet port with hose clamp (45).

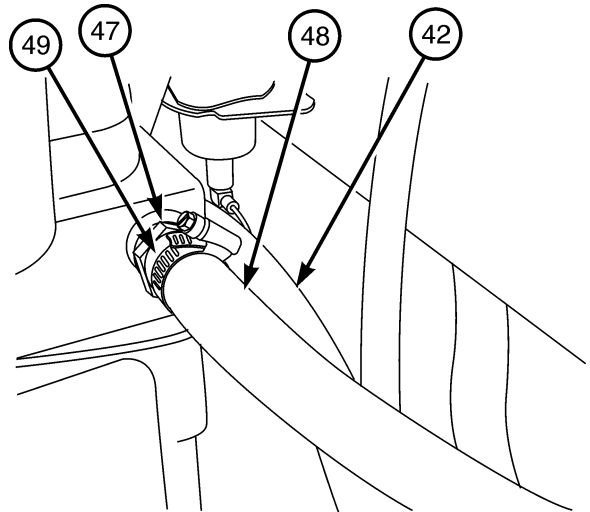


- (30) Remove 3/4 in. pipe plug (46) at flywheel end of engine near fuel filter. Discard pipe plug.

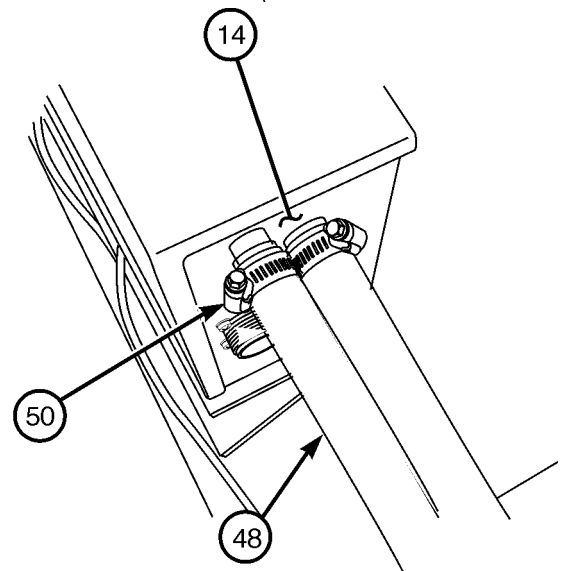




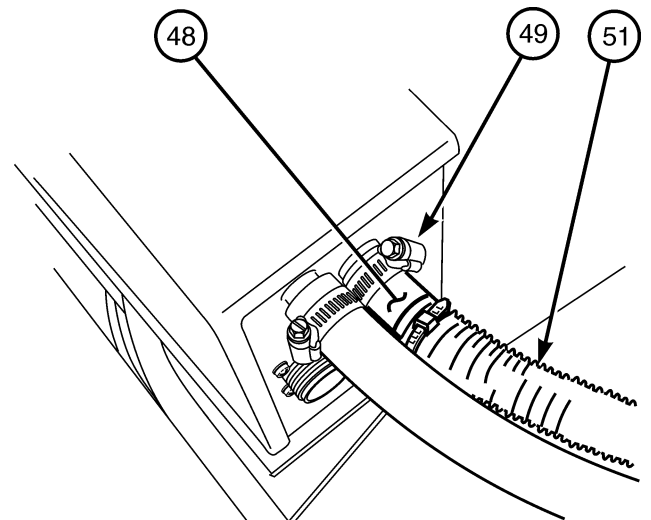
- (31) Apply sealing compound to thread of pipe coupling (47) and install pipe coupling on engine.
- (32) Connect heater outlet hose (48) on pipe coupling (47) with hose clamp (49).
- (33) Route heater outlet hose (48) next to heater inlet hose (42) to heater assembly.



- (34) Connect heater outlet hose (48) on “COOLANT OUT” port of heater assembly (19) with hose clamp (50).



- (35) Install conduit (51) over heater outlet hose (48) starting next to hose clamp (49) and install large tie wrap at each end.



**17-3. ARCTIC HEATER KIT INSTALLATION (CONT)**

- (36) Secure heater outlet hose and heater inlet hose together and to transmission oil cooler hoses at three places with large tie wraps.
- (37) Fill vehicle cooling system with coolant (TM 10-3930-673-20-2).

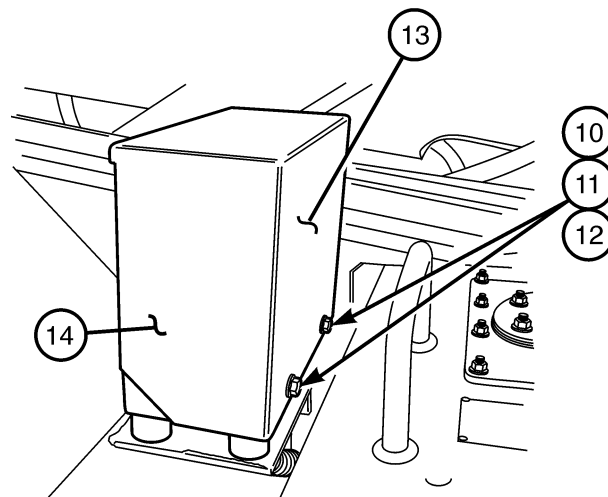
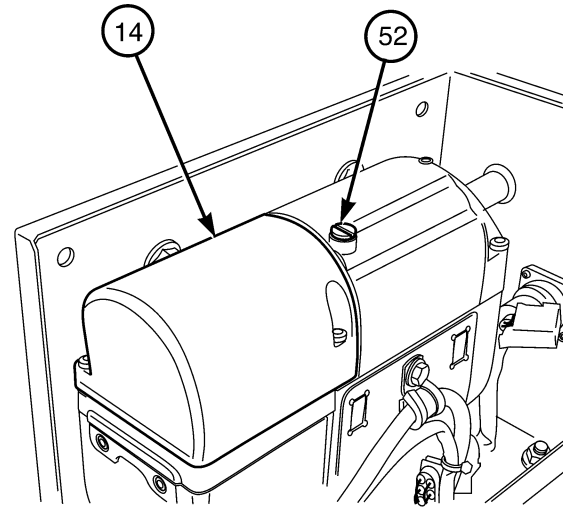
**NOTE**

Catch coolant in container and dispose of coolant properly.

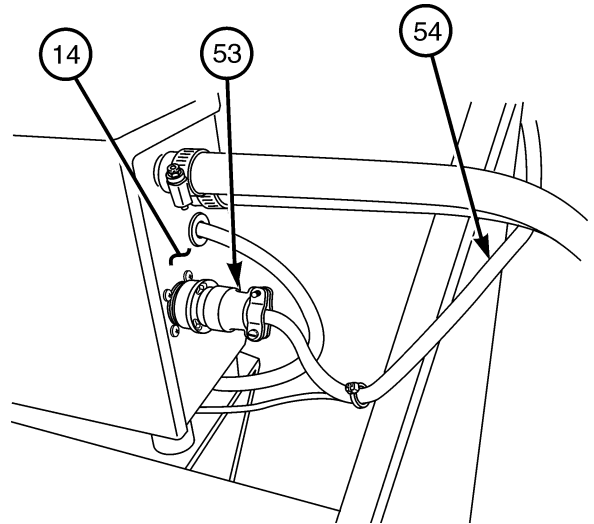
- (38) Loosen bleed screw (52) at top of heater (14) until a steady stream of coolant flows out. Tighten bleed screw. Add fresh coolant to overflow tank to replace coolant lost thru bleed screw. Bleed coolant at top of engine. Refer to radiator service (TM 10-3930-673-20-2).
- (39) Install cover (13) on heater (14) with two large washers (12), two small washers (11) and screws (10).

**WARNING**

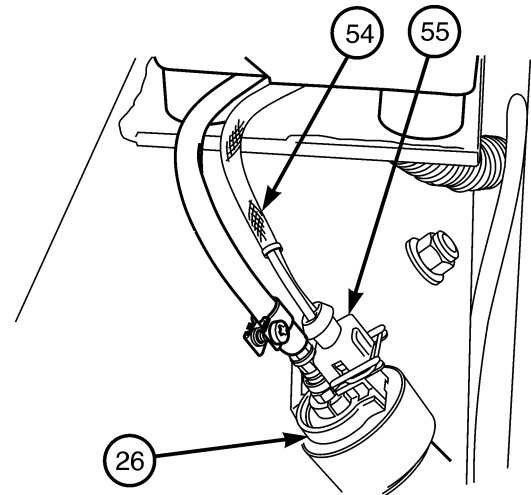
Spilled coolant is slippery. Clean up and dispose of spilled coolant properly. Failure to follow this warning may cause injury.



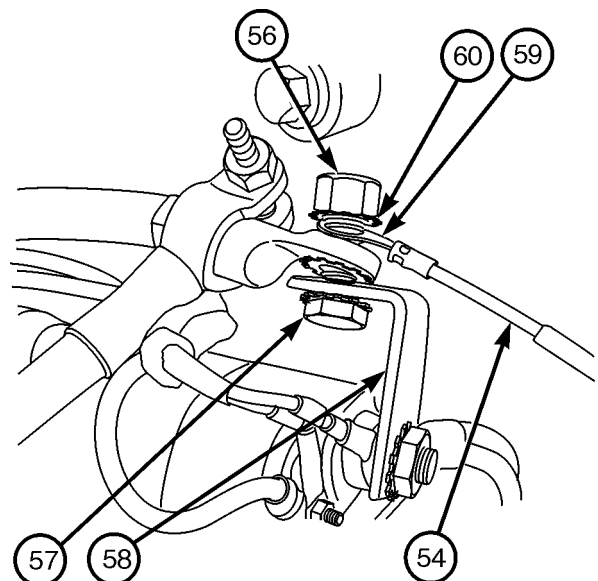
- (40) Start engine (TM 10-3930-673-10) and check for coolant leaks. Tighten connections as necessary. Stop engine.
- (41) Disconnect negative battery cable (TM 10-3930-673-20-2).
- (42) Connect large circular connector (53) of heater wiring harness (54) to heater assembly (14).



- (43) Route heater wiring harness (54) as shown and connect rectangular connector (55) of heater wiring harness (54) to fuel pump (26).

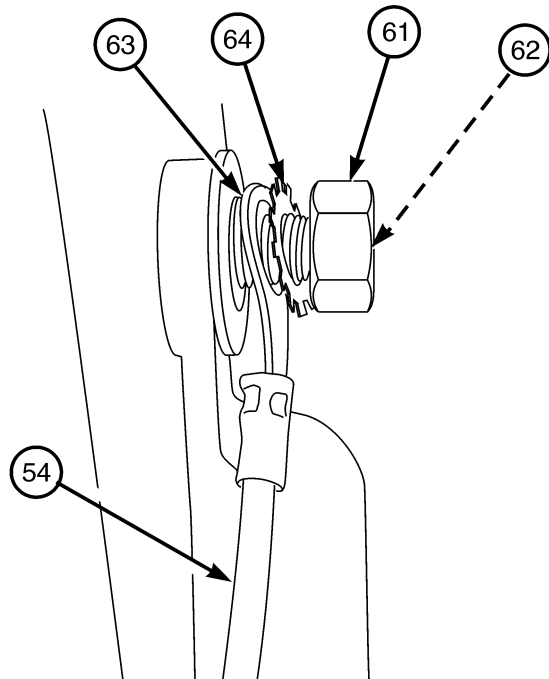


- (44) Route heater wiring harness (54) inside vehicle frame and across flywheel housing of engine.
- (45) Remove nut (56) from screw (57) of “L” shaped copper terminal (58) of starter. Place ring terminal of wire no. 9 (59) of heater wiring harness (54) and new external tooth lockwasher (60) over screw. Install nut.



**17-3. ARCTIC HEATER KIT INSTALLATION (CONT)**

- (46) At left-side of vehicle frame near starter, remove nut (61) from ground stud (62). Leave existing cable or wires in place.
- (47) Connect ring terminal of wire no. 2 (63) of heater wiring harness (54) to ground stud (62) and install new external tooth lockwasher (64) over ground stud. Install nut (61).
- (48) Secure heater wiring harness to transmission cooler hoses, existing vehicle wiring harness, and fender support bracket with small tie wraps.

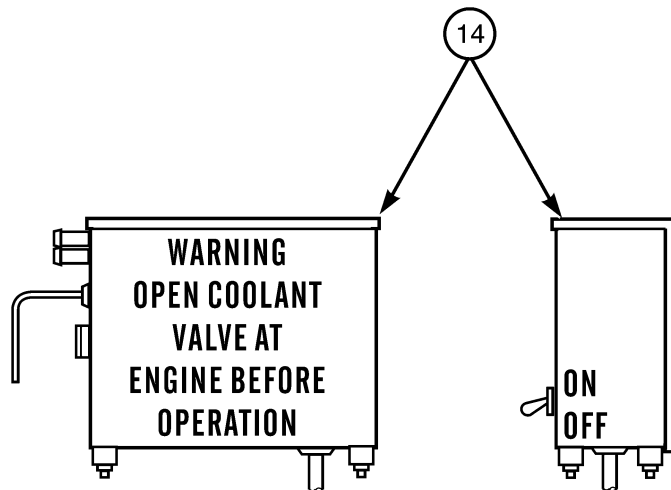


- (49) Connect negative battery cable (TM 10-3930-673-20-2).
- (50) Remove existing fan drive belt (TM 10-3930-673-20-2) and install new arctic (extended temperature) fan drive belt.

**NOTE**

Stencils are not supplied with arctic heater kit.

- (51) At rear of heater assembly, apply stencil in 1 in. high black letters “WARNING OPEN COOLANT VALVE AT ENGINE BEFORE OPERATION”.
- (52) At side of heater assembly, apply stencil in 1 in. high black letters the word “ON” above the word “OFF”.



**END OF TASK**

## APPENDIX A REFERENCES

### A-1. SCOPE

This appendix lists forms, field manuals, technical manuals, and other publications referenced in this manual and which apply to intermediate Direct Support and General Support maintenance of the ATLAS, Clean Burn Diesel Model Skytrak 10000M.

### A-2. DEPARTMENT OF THE ARMY PAMPHLETS

Consolidated Index of Army Publications and Blank Forms . . . . . DA Pam 25-30  
 The Army Maintenance Management System (TAMMS) . . . . . DA Pam 738-750

### A-3. FORMS

Recommended Changes to Equipment Technical Publications . . . . . DA Form 2028-2  
 Organizational Control Record for Equipment . . . . . DA Form 2401  
 Equipment Inspection and Maintenance Worksheet . . . . . DA Form 2404  
 Maintenance Request . . . . . DA Form 2407

Processing and Deprocessing Record for Shipment, Storage, and  
 Issue of Vehicles and Spare Engines . . . . . DD Form 1397  
 Product Quality Deficiency Report . . . . . SF 368

### A-4. FIELD MANUALS

Camouflage, Concealment, and Decoys . . . . . FM 20-3  
 First Aid . . . . . FM 4-25.11  
 Basic Cold Weather Manual . . . . . FM 31-70  
 Northern Operations . . . . . FM 31-71  
 Mountain Operations (How To Fight) . . . . . FM 3-97.6  
 Desert Operations . . . . . FM 90-3  
 Metal Body Repair and Related Operations . . . . . TC 9-510  
 Transportation Reference Data . . . . . FM 55-15

### A-5. TECHNICAL BULLETINS

Hearing Conservation Program . . . . . DA Pam 40-501  
 Equipment Improvement Report and Maintenance Digest  
 (US Army Tank-Automotive Command) Tank-Automotive Equipment . . . . . TB 430001-39 series

**A-5. TECHNICAL BULLETINS (CONT)**

- Non aeronautical Equipment Army Oil Analysis Program (AOAP) . . . . .TB 43-0210
- Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling System . . . . .TB 750-651

**A-6. TECHNICAL MANUALS**

- Operator's Manual for All Terrain Lifter Army System (ATLAS) Clean Burn Diesel  
10,000 lb Capacity Model Skytrak 10000M . . . . . TM 10-3930-673-10
- Unit Maintenance Manual for All Terrain Lifter Army System (ATLAS) Clean Burn Diesel  
10,000 lb Capacity Model Skytrak 10000M. . . . . TM 10-3930-673-20
- Unit Maintenance, Intermediate Direct Support, and Intermediate  
General Support Maintenance Repair Parts and Special Tools List  
(Including Depot Maintenance Repair Parts and Special Tools List) for All  
Terrain Lifter Army System (ATLAS) Clean Burn Diesel 10,000 lb Capacity  
Model Skytrak 10000M . . . . . TM 10-3930-673-24P
- Inspection, Care, and Maintenance of Antifriction Bearings . . . . . TM 9-214
- Operator's Circular Welding Theory and Application. . . . .TC 9-237
- Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance  
Materiel and Related Materiels Including Chemicals . . . . . TM 9-247
- Operator and Organizational Maintenance Manual Including Repair  
Parts and Special Tools List Simplified Test Equipment for Internal  
Combustion Engines (STE-ICE) (4910-00-124-2554) . . . . . TM 9-4910-571-12&P
- Operator's, Organizational, Direct Support, and General Support  
Maintenance Manual for Lead-Acid Storage Batteries; 4HN, 24V,  
(NSN 6140-00-069-3528) MS75047-1; 2HN, 12 V (6140-00-057-2553)  
MS 35000-1; 6TN, 12V (6140-00-057-2554) MS35000-3. . . . . TM 9-6140-200-14
- Painting Instructions for Field Use . . . . . TM 43-0139
- Procedures for Destruction of Equipment to Prevent Enemy Use  
(Mobility Equipment Command) . . . . . TM 750-244-3
- Tool Outfit, Hydraulic Systems Test and Repair (HSTRU) (4940-01-036-5784) . . . . . TM 9-4940-468-13

**A-7. SPECIFICATIONS AND STANDARDS**

- Dry Cleaning Solvent . . . . . Fed Spec P-D-680
- Methyl Ethyl Ketone, Technical. . . . . TT-M-261
- Human Engineering Design Criteria for Military Systems, Equipment, and Facilities. . . . . MIL-STD-1472

**A-8. OTHER PUBLICATIONS**

- Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items) . . . . . CTA-50-970
- Army Medical Department Expendable/Durable Items . . . . . CTA 8-100

## APPENDIX B

### EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

#### Section I. INTRODUCTION

##### **B-1. SCOPE**

This appendix lists expendable/durable supplies and materials you will need to operate and maintain the ATLAS. This listing is for informational purposes only and is not authority to requisition the listed items. These items are authorized to you by 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 C").

**b. Column (2) -- Level.** This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew

O - Organizational Maintenance

F - Direct Support Maintenance

H - 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 part number followed by Commercial And Government Entity (CAGE) Code in parentheses.

**e. Column (5) - Unit of Measure (U/M).** Indicates the measure used in performing the actual maintenance function. This measure is expressed by two-character alphabetical abbreviations (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

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	F	8040-01-202-1138	Adhesive, P12 (08125)	oz
2			Alumilastic CART-C	
3	F	6810-00-527-2476	Ammonia	qt
4	F	6850-01-441-3248	Anti-freeze, Permanent, Type: Arctic Grade (58536) A-A-52624 55 Gallon Drum	gal
5	F	6850-00-464-9137 6850-01-464-9152	Anti-freeze, Permanent, Ethylene Glycol, Inhibited MIL-A- 46153 (81349) 5 Gallon Can 55 Gallon Drum	gal gal
6	F	7920-00-062-5468	Brush, Bristle (72387) 2-305SBN	
7	F	8040-00-938-1535	Caulk, Silicone, Clear	tu
8	F	5350-00-221-0872	Cloth, Crocus (81348) P-C-458	sh
9	F	5350-00-584-4654	Cloth, Medium Grit, Emery	ea
10	F	8030-00-087-8630	Compound, Anti-seize, MIL-T-83483 (81349) 1 Can	lb
11	F	5350-01-010-7007	Compound, Valve Lapping 34B (77247)	
12	F	8010-00-652-3626	Compound, Prussian Blue Marking	oz
13	F	8040-00-851-0211	Compound, Sealing RTV-732 Black (71794) 1 Tube	tu
14	F	8030-01-429-8188	Compound, Sealing 680 (05972)	ea
15	F	6810-00-543-7415	Denatured Alcohol	qt
16	F	6850-00-926-2276	Fluid, Windshield Washer	qt
16.1	F	9130-01-031-5816	Fuel, Turbine, Aviation (81349) MILT83133 GR JP8	gal
17	F	8415-00-268-7859	Gloves, Heavy Duty	pr
18	F	9150-01-197-7688 9150-01-197-7693 9150-01-197-7690 9150-01-197-7692	Grease, Automotive and Artillery, GAA, MIL-G-10924 (81349) 2-1/4 Ounce Tube 14 oz Cartridge 6 Pound Can 35 Pound Can	oz oz lb lb
19	F	9150-00-735-1800	Grease, Graphite	tu
20	F	9150-00-250-0933	Jelly, Petroleum	lb



(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
21	F		Lubricant, Delco-Remy, 1948791, AMOCO 1272	oz
22	F	2640-00-256-5526	Lubricant, Ru-Glide Rubber	lb
23	F	7050-00-961-7663	Lubriplate No. 105 ST40334 (90536)	
24	F	9140-00-286-5295 9140-00-286-5296 9140-00-286-5294	Oil, Fuel, Diesel, DF-2 Regular VVF800 (81349) 5 Gallon Can 55 Gallon Drum Bulk	gal gal gal
25	F	9140-00-286-5287 9140-00-286-5288 9140-00-286-5286	Oil, Fuel, Diesel, DF-1 Winter VVF800 (81349) 5 Gallon Can 55 Gallon Drum Bulk	gal gal gal
26	F	9140-00-286-5282 9140-00-286-5284 9140-00-286-5283	Oil, Fuel, Diesel, DF-A Arctic WF800 (81349) 5 Gallon Can 55 Gallon Drum Bulk	gal gal gal
27	F	9150-01-152-4117 9150-01-152-4118 9150-01-152-4119	Oil, Lubricating, Engine OE/HDO-15/40, MIL-L-2104 (81349) 1 Quart Can 5 Gallon Can 55 Gallon Drum	qt gal gal
28	F	9150-00-402-2372	Oil, Lubricating, Engine Arctic OEA, MIL-L-46167 (81349) 1 Quart Can	qt
29	F	9150-01-035-5392 9150-01-035-5393 9150-01-035-5394	Oil, Lubricating, Gear Multipurpose GO 80/90 MIL-L-2105 (81349) 1 Quart Can 5 Gallon Can 55 Gallon Drum	qt gal gal
30	F	9150-00-189-6727 9150-00-191-2772	Oil, Lubricating, Transmission/Hydraulic OE/HDO-10 MIL-L-2140 (81349) 1 Quart Can 55 Gallon Drum	qt gal
31	F	5350-00-619-9167	Paper, Emery, Grit #80 Grit #240	pcs
32	F	5210-00-640-6178	Plastigage (77220) PR-1	
33	F	8010-00-159-4518	Primer, Metal (83421)	qt

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
34	F	7920-00-205-3570	Rags, Lint-free A-A-531 (58536)	be
35	F	7920-00-205-1711	Rags, Wiping (64067)	lb
36	F	6830-01-439-0614	Refrigerant R-134a (4V886)	
37	F	5350-00-619-9166	Sandpaper, No. 100	
38	F		Sealant, K&W Copper Coat 1504	
39	F		Sealant, Loctite 609 MIL-R-46082BB Type I (05962)	oz
40	F	8030-01-014-5869	Sealant, Loctite 242 MIL-S-46163 Type II Grade N (80244)	oz
41	F		Sealant, Loctite 262, High-Strength	oz
42	F	8030-01-158-6070	Sealant, Loctite 271 MIL-S-46163 Type I Grade L (80244)	oz
43	F	8030-01-063-7510	Sealant, Loctite 277 MIL-S-46163 Type I Grade L (80244)	oz
44	F	8030-00-204-9149	Sealant, Loctite 59241 (#227)	oz
45	F	8030-00-180-6150	Sealant, Loctite 609 MIL-R-46082B Type I (05962)	oz
46	F	9030-00-251-3980	Sealant, Anti-seize Compound 767-64	oz
47	F	8030-00-656-1426	Sealant, Permatex, Aviation Form A Gasket No. 3 MIL-S-45180C (77247) 1 Tube	tu
47.1	F	3930-01-504-6344	Sealant, Urethane (1YHH8) 8035523	oz
48	F		Sealer, Ribbon, Black 3M	ft
49	F	6810-00-252-1345	Soap, Solution (81349) MIL-W-15000 Class C	bt
50	F	6810-00-264-6618	Soda, Baking	oz
51	F		Solder	
52	F	6850-00-337-1808 6850-00-337-3349 6850-00-331-3350	Solvent, Drycleaning P-D-680 Type III (81348) 1 Quart Container 1 Gallon Container 1 Drum	qt gal dr
53	F		Solvent, Rust Penetrating	
54	F		Stone, India	
55	F	9905-00-537-8957	Tags, Identification (81349) MIL-T-12755 White	ea

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
56	F	5970-00-547-0966	Tape, Electrical (19207) BISEALTYPE3	ea
57	F	5975-00-984-6582	Tie Wraps 1 Carton	hd
58	F	8010-00-180-6343	Varnish, Anti-fungus	qt
59	F	6810-00-356-4936	Water, Distilled	gal



## APPENDIX C

### ILLUSTRATED LIST OF MANUFACTURED ITEMS

#### Section I. INTRODUCTION

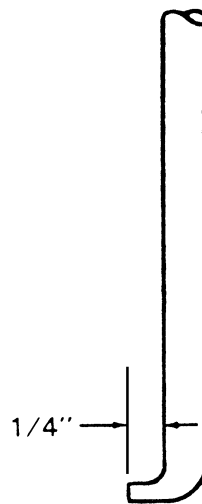
##### C-1. GENERAL

This appendix includes complete instructions for making items authorized to be manufactured or fabricated at the Direct Support and General Support maintenance levels.

#### Section II. MANUFACTURED ITEMS ILLUSTRATIONS

##### C-2. MANUFACTURED ITEMS

All bulk materials needed for manufacture of an item are shown on the illustration.

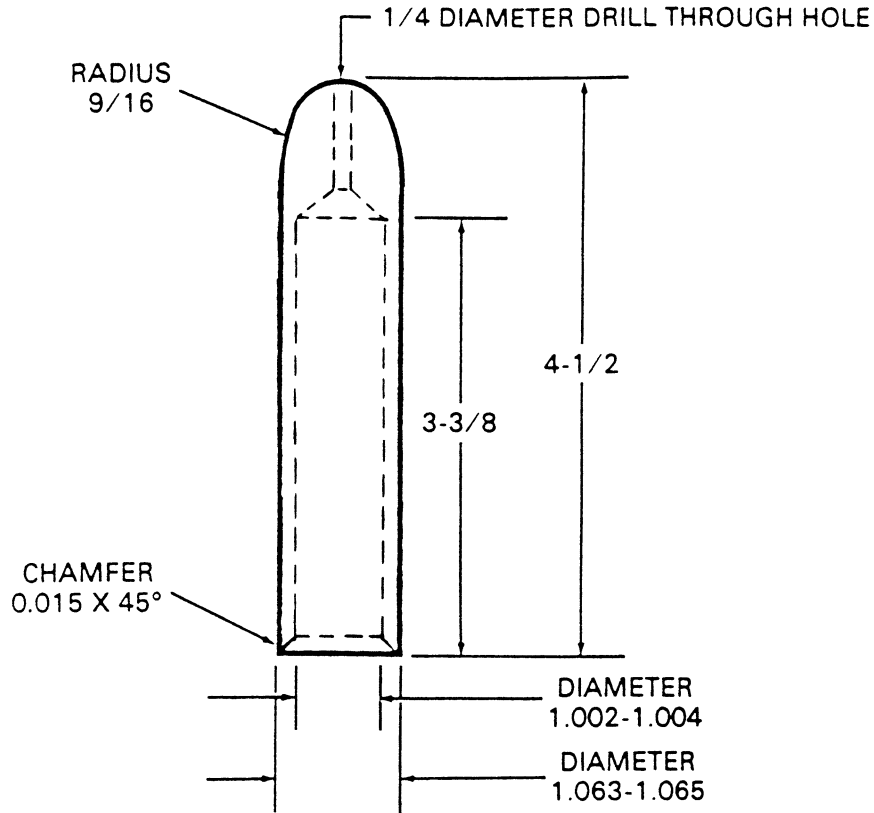


##### **WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Fabricate from a screwdriver.
2. Heat screwdriver tip and bend as shown.
3. Grind tip to fit notch behind shaft seal.

*Figure C-1. Tandem Gear Pump Seal Removal Tool*

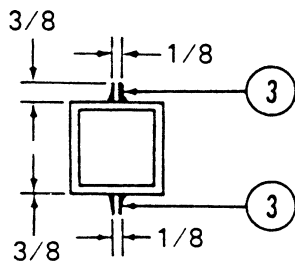
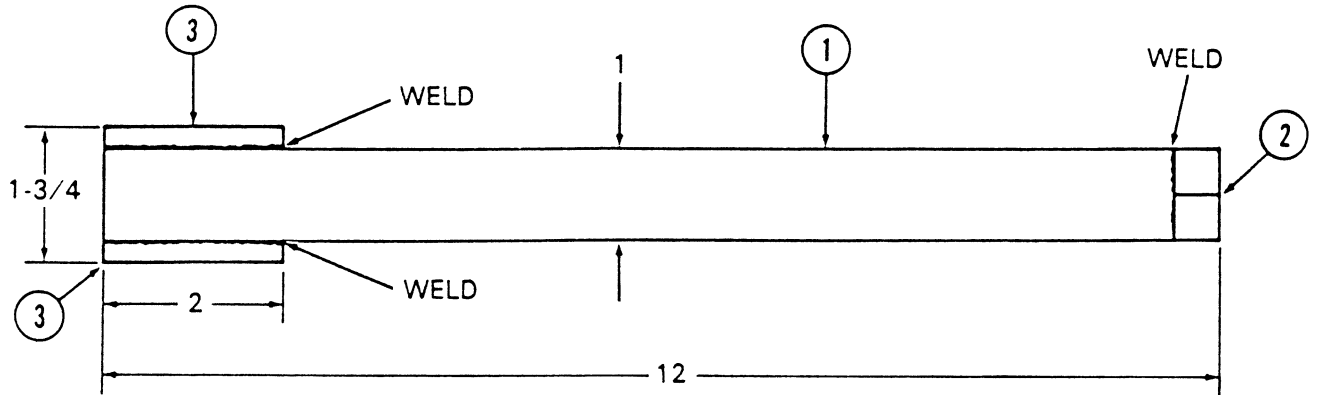


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Fabricate from steel bar stock, 1-1/8 or 1-1/4 in. diameter × 4-5/8 in. long (2.86 or 3.18 cm diameter × 11.75 cm).
2. All dimensions shown are in inches.
3. All external surfaces must be free of scratches and burrs.

**Figure C-2. Tandem Gear Pump Drive Gear Installation Tool**



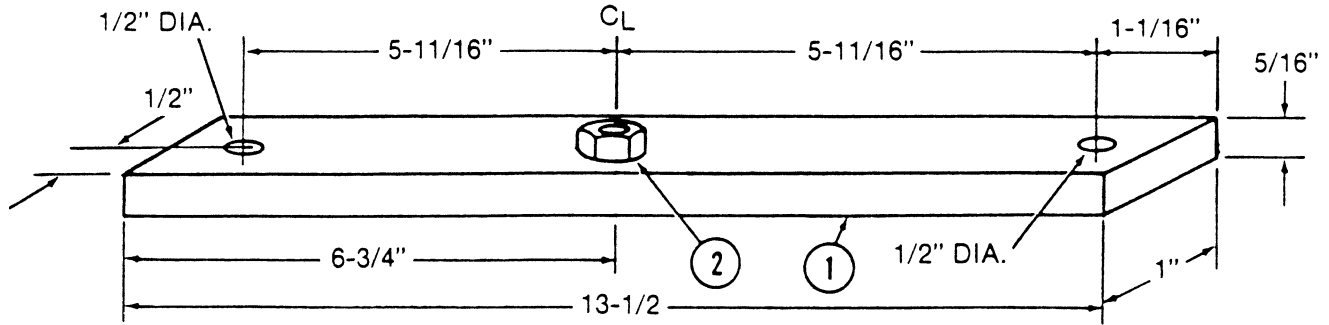
Item	Description
1	Round Steel Stock, NSN 9510-00-199-1084
2	Hexagon Nut, NSN 5310-00-763-8920
3	Flat Bar Stock, NSN 9515-00-204-3972 (2)

**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Fabricate as shown in the above illustration.
2. All dimensions are in inches.

**Figure C-3. Differential Resistance Tool**



Item	Description
1	Steel Bar Stock, 5/16 in. × 1 in. × 13-1/2 in. (0.79 cm × 2.54 cm × 34.29 cm)
2	Hexagon Nut, 1/2-16, NSN 5310-01-270-173

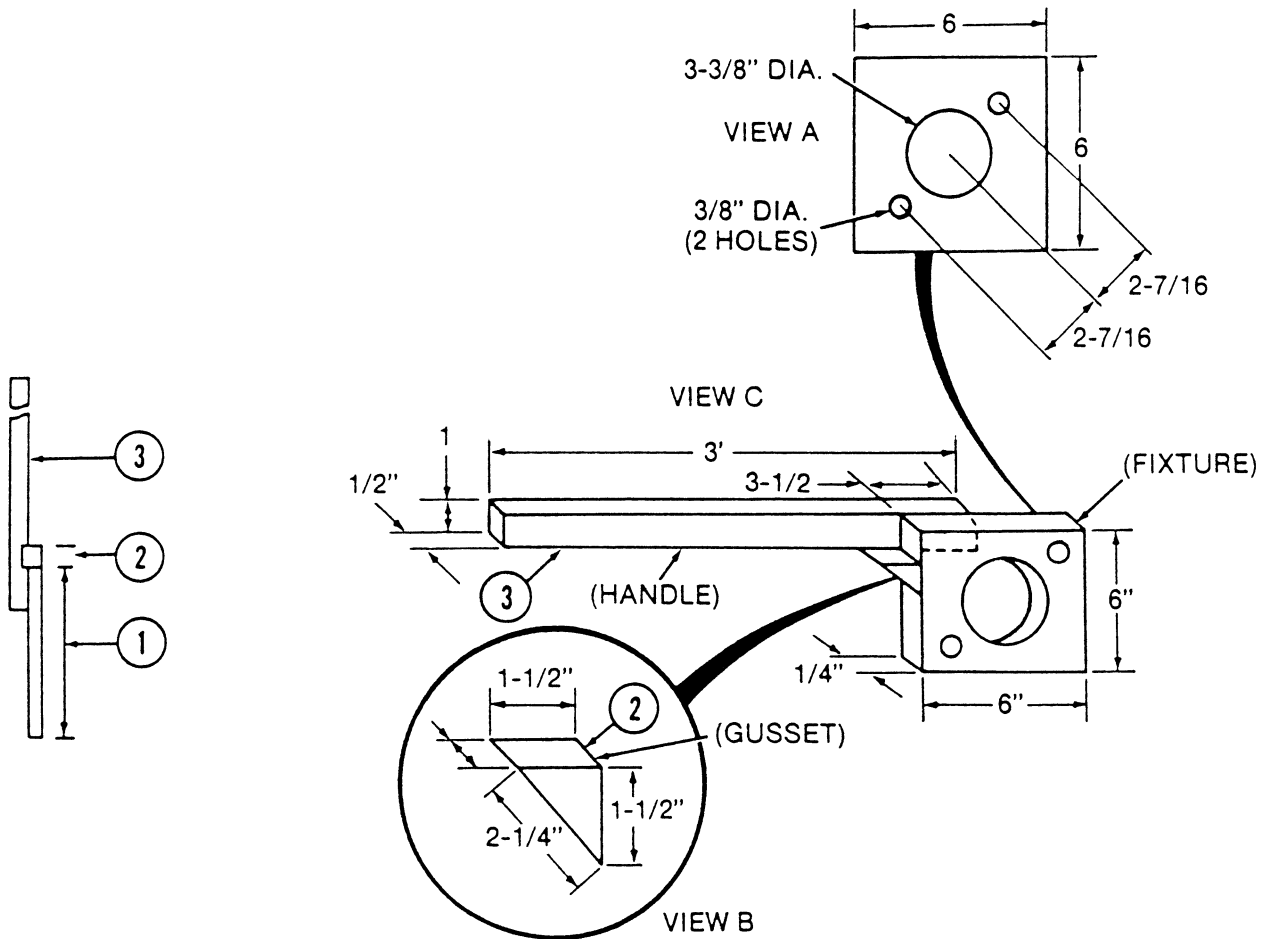
**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Drill two 1/2 in. (1.27 cm) diameter holes in the bar stock at the locations shown in the above illustration.
2. Remove burrs with a hand file.
3. Center hexagon nut (2) on bar stock (1) at location shown in above illustration.
4. Hold nut in place with a C-clamp, and weld a single layer bead around the circumference of the nut.

**Figure C-4. Planetary Hub Drag Tool**





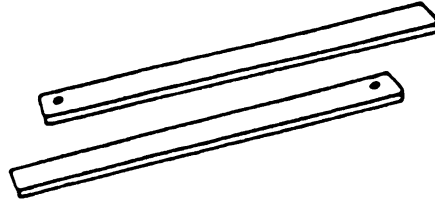
Item	Description
1	Steel Plate, 1/4 in. × 6 in. × 6 in. (0.64 cm × 15.24 cm × 15.24 cm)
2	Steel Bar Stock, 1-1/2 × 1-1/2 in. × 3/8 in. (3.81 cm × 3.81 cm × 0.95 cm)
3	Steel Bar Stock, 1/2 in. × 1 in. × 3 ft (1.27 cm × 2.54 cm × 0.91 m)

**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Cut steel plate (1) to size 6 in. × 6 in. (15.24 cm × 15.24 cm) square as shown in View A. Remove all burrs and sharp edges with a hand file.
2. Drill two 3/8 in. (0.95 cm) holes in plate as shown in View A.
3. Cut out a 3-3/8 in. (8.57 cm) diameter hole in plate as shown in View A.
4. Build a gusset, as shown in View B, from steel bar stock (2).
5. Hold bar stock (2) to steel plate (1), as shown in View C, with a C-clamp, and spot weld the two parts together.
6. Place gusset (View B) in the area shown in View C.
7. Weld a single bead over all adjoining metal.

Figure C-5. Yoke Nut Tool



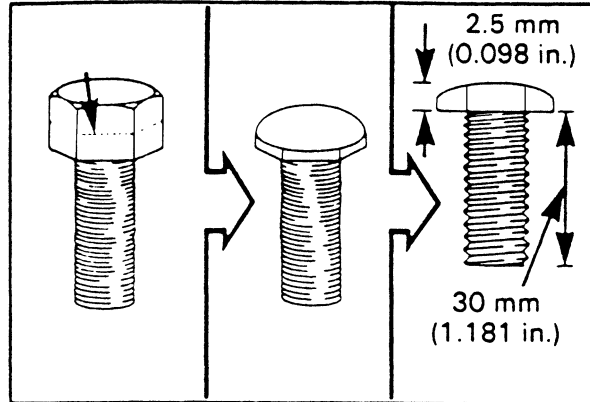
**Alignment Bars Dimension Data**

Bars Used At*	Bar Size			Number of Bars Required
	Width in. (cm)	Length in. (cm)	Height in. (cm)	
First Stage Clutch Pack, Engine Side	2 (5.08)	12 (30.48)	5/8 (1.59)	2
First Stage Clutch Pack, Non-Engine Side	2 (5.08)	12 (30.48)	1/8 (0.32)	2
Second Stage Clutch Pack, Engine Side	2 (5.08)	12 (30.48)	1/8 (0.32)	2
Second Stage Clutch Pack, Non-Engine Side	2 (5.08)	12 (30.48)	1/4 (0.64)	2
Third Stage Clutch Pack, Engine Side Only	2 (5.08)	12 (30.48)	1/16 (0.159)	2

\* Engine and non-engine side designations refer to clutch pack orientation when transmission is installed in vehicle.

1. Fabricate bars from steel bar stock to the dimensions shown the above table.

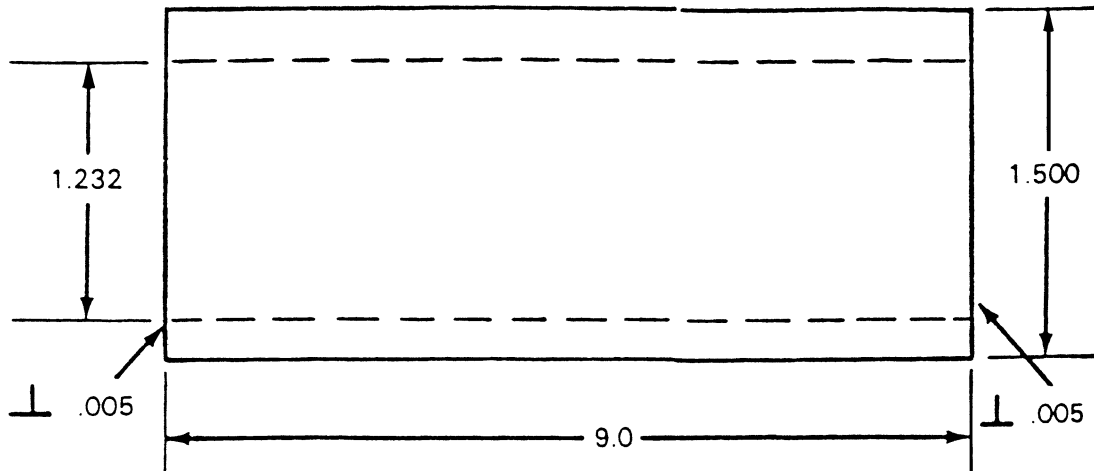
**Figure C-6. Transmission Alignment Bars**

**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Fabricate from 6 mm screw.
2. All external surfaces must be free of scratches and burrs.

**Figure C-7. Bearing Removal/Installation Tool**

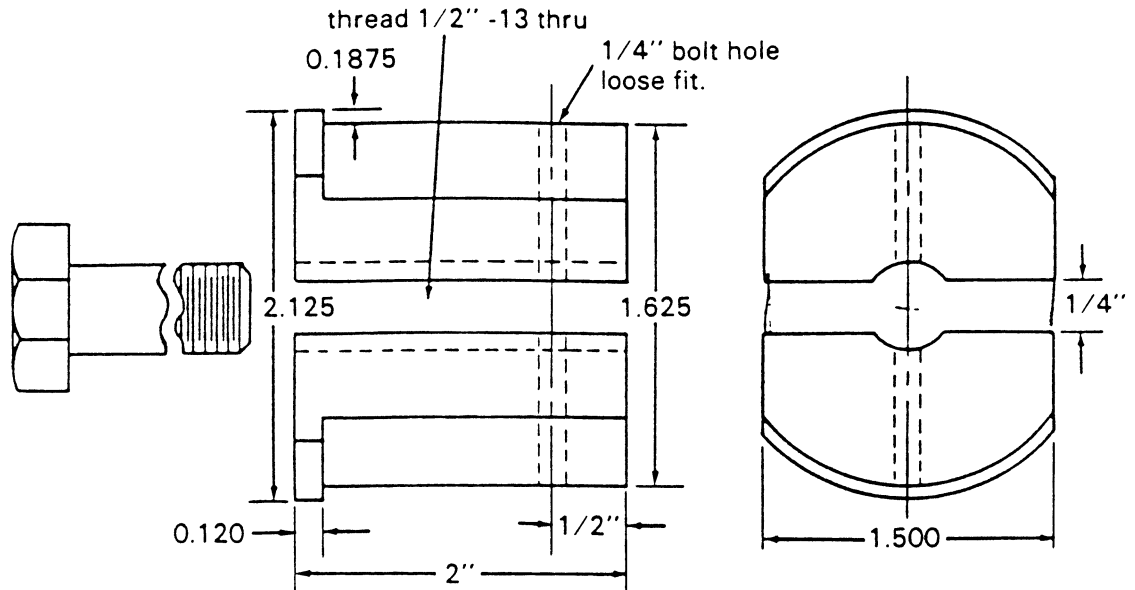


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine removal tool from 1-1/2 in. (3.81 cm) steel pipe to the dimension shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.

**Figure C-8. Hydraulic Piston Pump – Driveshaft/Pump Housing Bearing Removal Tool**

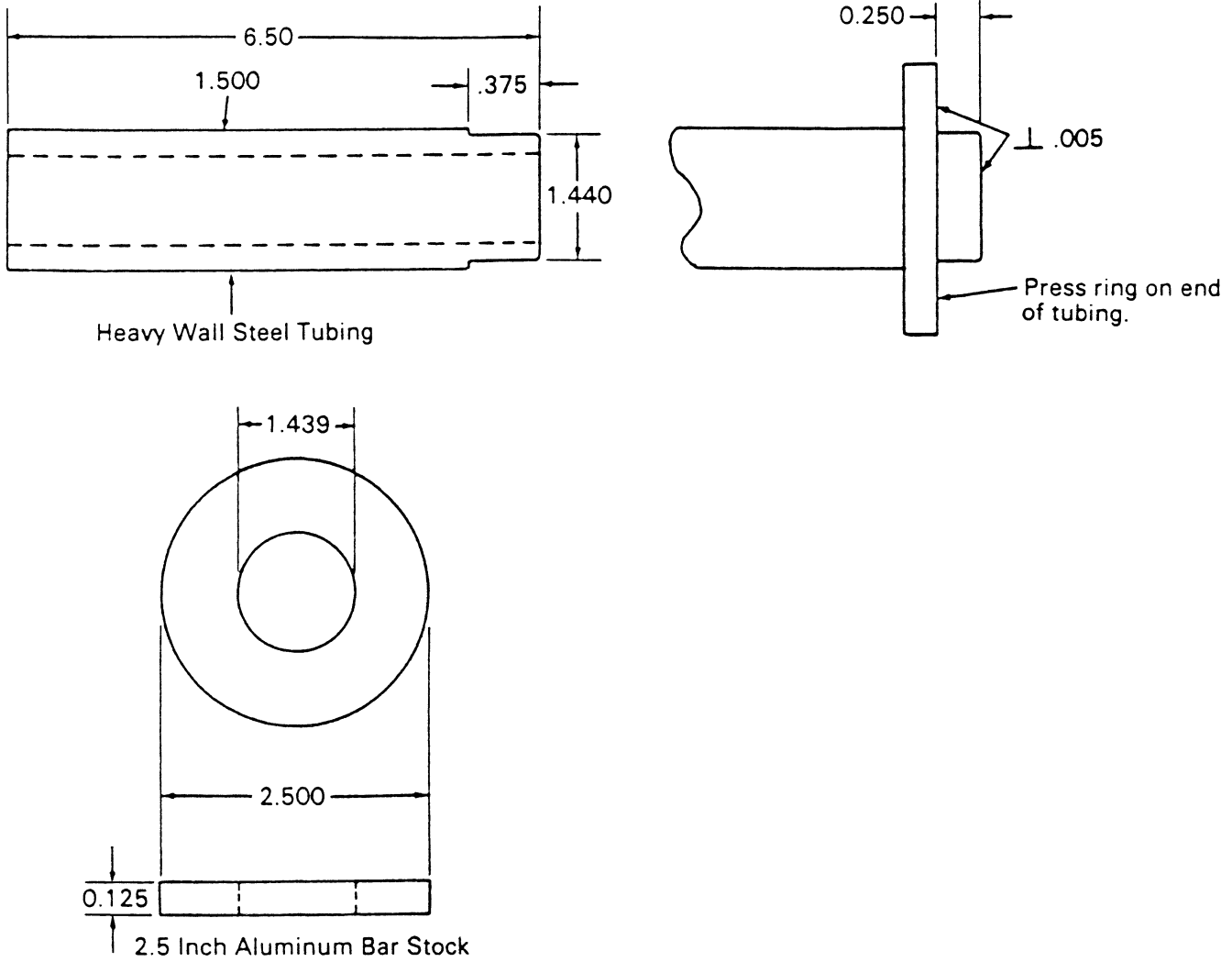


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine removal tool from 2 in. (5.08 cm) long steel bar stock to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.
4. Use a 5 in. (12.7 cm) long 1/2-13 hex head screw with this tool.

**Figure C-9. Hydraulic Piston Pump – Housing Bearing Race Removal Tool**

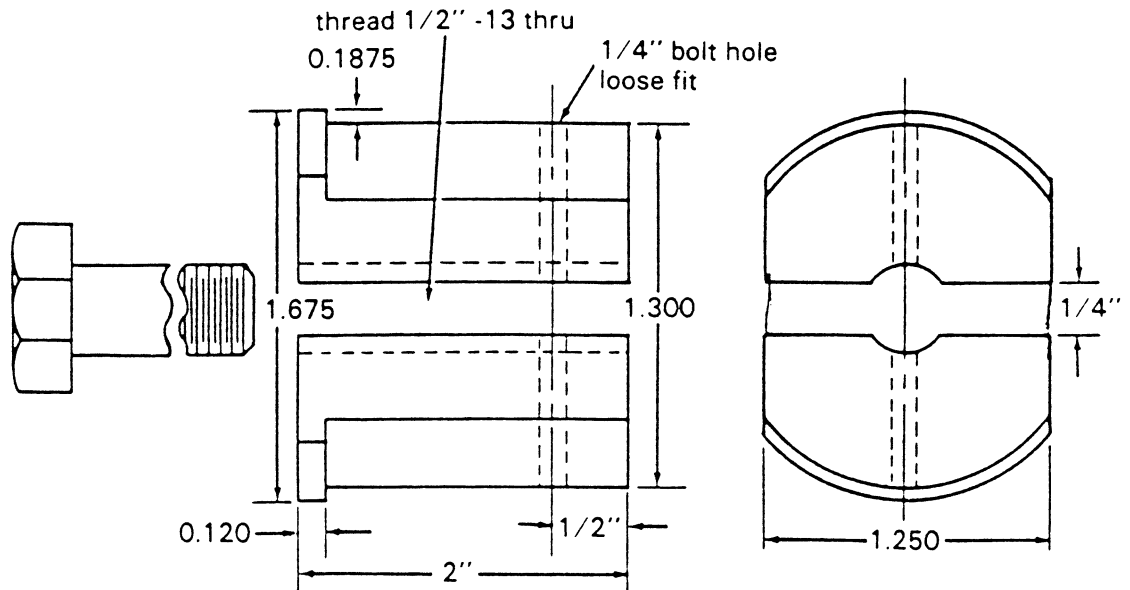


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine installation tool from heavy wall steel tubing and aluminum bar stock to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.

**Figure C-10. Hydraulic Piston Pump – Shaft Seal Driver**

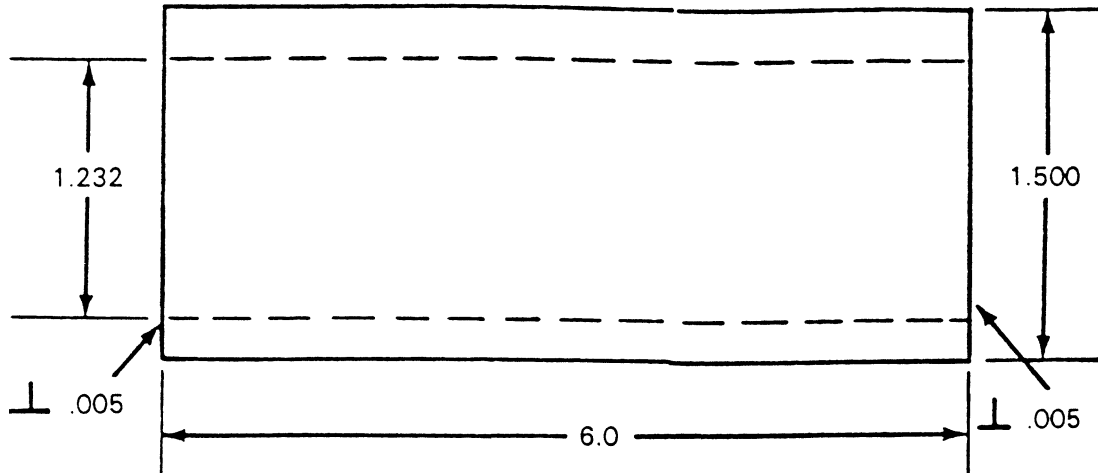


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine removal tool from 2 in. (5.08 cm) long steel bar stock to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.
4. Use a 5 in. (12.7 cm) long 1/2-13 hex head screw with this tool.

**Figure C-11. Hydraulic Piston Pump – Valve Block Bearing Race Removal Tool**



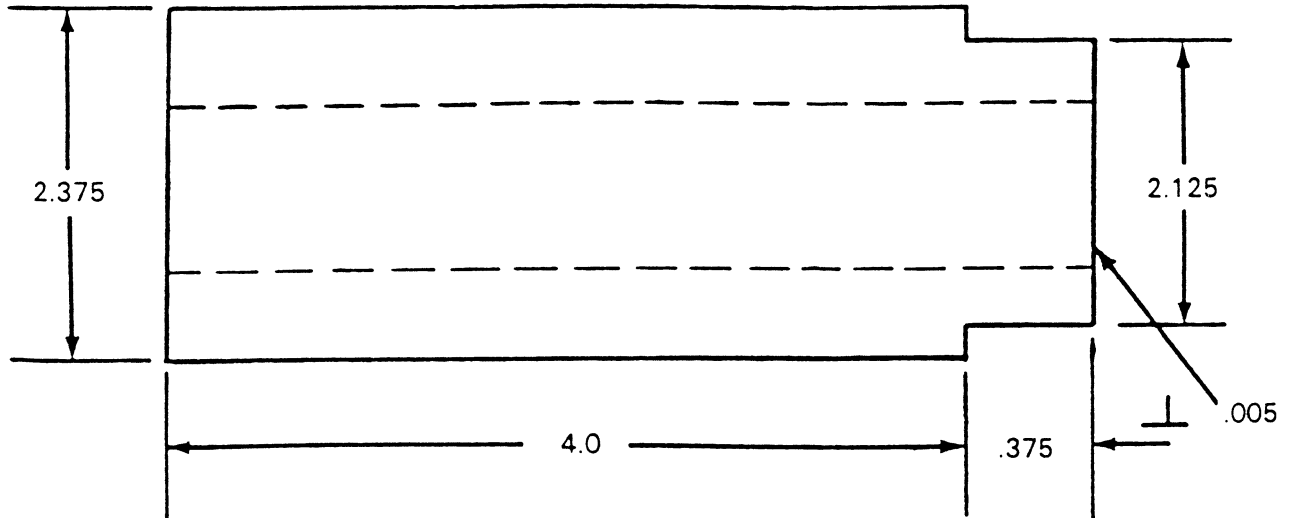
**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine installation tool from 1-1/2 in. (3.81 cm) steel pipe to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.

**Figure C-12. Hydraulic Piston Pump – Driveshaft/Pump Housing Bearing Installation Tool**



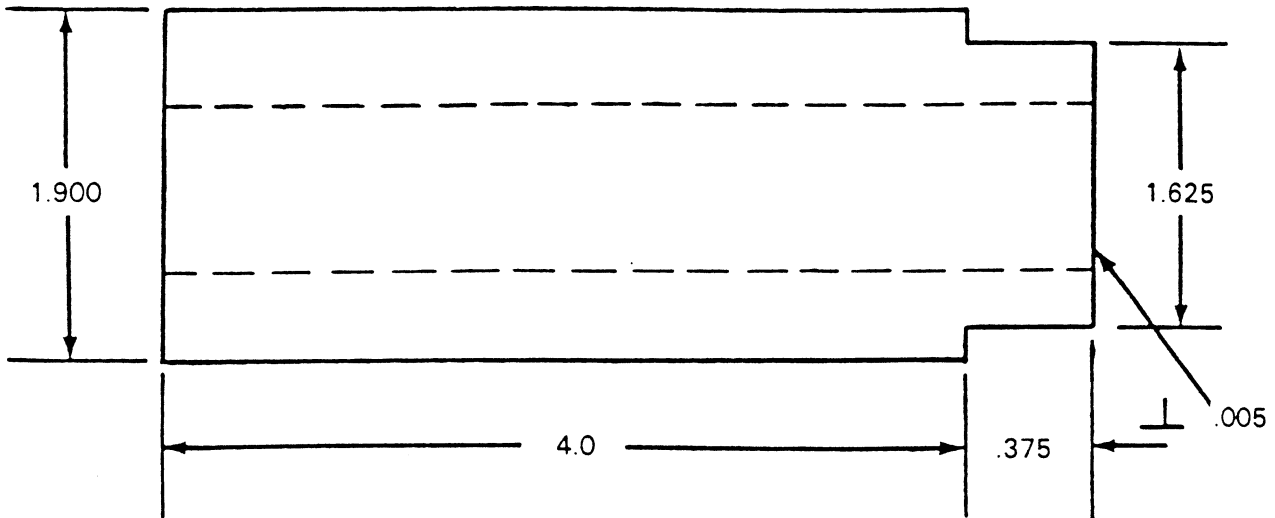


**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine installation tool from schedule 80 steel pipe to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.

**Figure C-13. Hydraulic Piston Pump – Housing Bearing Race Installation Tool**



**WARNING**

Wear eye shields and protective gloves when fabricating this tool. Flying metal particles and heated metal may cause serious personal injury.

1. Machine installation tool from schedule 80 steel pipe to the dimensions shown in the above illustration.
2. All surfaces are to be smooth and flat.
3. Radius or chamfer all sharp edges.

**Figure C-14. Hydraulic Piston Pump – Valve Block Bearing Race Installation Tool**

## APPENDIX D

### TOOL IDENTIFICATION LIST

#### Section I. INTRODUCTION

##### D-1. SCOPE

This appendix lists the tools you will need to operate and maintain the ATLAS.

##### D-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 task box to identify the tool (e.g., “Tool Kit, General Mechanic’s: Automotive (Item 23, Appendix D)”).
- b. Column (2) -- Item Name.** This column identifies the tool.
- 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) - Part Number.** This is the manufacturer’s part number assigned to the item.
- e. Column (5) - Reference.** This column references the Supply Catalog Number and tools which are part of/components of shop set authorized to section/teams; tools authorized by RPSTL and CTA 50-970; special and fabricated tools; and items of TMDE.

## Section II. TOOL IDENTIFICATION LIST

(1) Item Number	(2) Item Name	(3) National Stock Number	(4) Part Number	(5) Reference
1	Cap and Plug Set	5340-00-450-5718	109354-05	
2	Compressor Tool Kit		J529642-B	
3	Dial Indicator	5210-00-277-8840	196A	TM 9-2350-292-24P
4	Drill, Electric, Portable	5130-00-889-8993	1070	SC 4910-95-A31
5	Drill Set, Twist	5133-00-449-6775		SC 3470-95-CL-A02
6	Engine Barring Gear	5120-01-285-5193	3824591	
7	Engine Barring Tool		3377371	
8	Feeler Gage Set	5210-01-119-7601	FB310B	
9	Jackstands, 10-ton capacity	4910-01-265-0401	93525	SC 4910-95-A31
10	Mallet, Soft			
11	Manifold Gage Set	4130-01-032-2912		
12	Micrometer, Inside Caliper	5210-00-221-1921		SC 4910-95-A31
13	Micrometer, Outside Caliper	5210-00-554-7134		SC 3470-95-CL-A02
14	Multimeter, Digital	6625-01-139-2512	T00377	SC 4910-95-A72
15	Puller Kit, Universal	5180-00-423-1596	1677	SC 4910-95-A31
16	Shop Equipment, Automotive Maintenance and Repair, Common No. 1 Less Power	4910-00-754-0654	W32593	SC 4910-95-CL-A74
17	Shop Equipment, Automotive Maintenance, Common No. 2 Less Power	4910-00-754-0650	W32730	SC 4910-95-CL-A72
18	Shop Equipment, Automotive Maintenance and Repair; Field Maintenance, Basic, Less Power	4910-00-754-0705		SC 4910-95-A31
19	Shop Equipment, Machine Shop: Field Maintenance Basic, Less Power	3470-00-754-0708		SC 3470-95-CL-A02
20	Slide Hammer/Dent Puller	5120-00-557-3615	5573615	SC 4910-95-A74
21	STE/ICE-R	4910-00-124-2554	12258760	TM 9-4910-571-12&P

(1) Item Number	(2) Item Name	(3) National Stock Number	(4) Part Number	(5) Reference
22	Tool Kit, Body and Fender Repair	5180-00-754-0643		SC 5180-90-CL-N34
23	Tool Kit, General Mechanic's: Automotive	5180-00-177-7033	W33004	SC 5180-90-N26
24	Tool Kit, Machinists: Post, Camp and Station	5280-00-511-1950	W44512	SC 5280-95-CL-A02
25	Tool Kit, Transmission Consisting of the following Clutch Pack Lift Bearing Driver Bearing Driver Spring Compressor Tool	5180-01-307-9395 5120-01-311-9161 5120-01-311-7242 5120-01-311-7243 5120-01-311-7244	DR04-708-1 DR04-708-2 DR04-708-3 DR04-708-5	8801801
26	Wrench Set, Spanner, Consisting of the following:  Spanner Wrench, Boom Lift Cylinder and Boom Extend Cylinder  Spanner Wrench, Adjustable	5120-01-454-1235  5120-01-510-2556  5120-01-510-2561	6621222  8801816  6623737	
27	Wrench, Torque, 3/8 inch drive, 0 - 200 lb-in (0 - 22.60 N•m)	5120-00-853-4538	F200-1	SC 4910-95-A72
28	Wrench, Torque, 1/2 inch drive, 0 - 175 lb-ft (0 - 237 N•m)	5100-00-640-6364	A-A-2411	SC 4910-95-A72
29	Wrench, Torque, 3/4 inch drive, 0 - 600 lb-ft (0 - 1085 N•m)	5120-00-221-7983		SC 4910-95-A72



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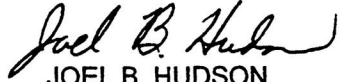
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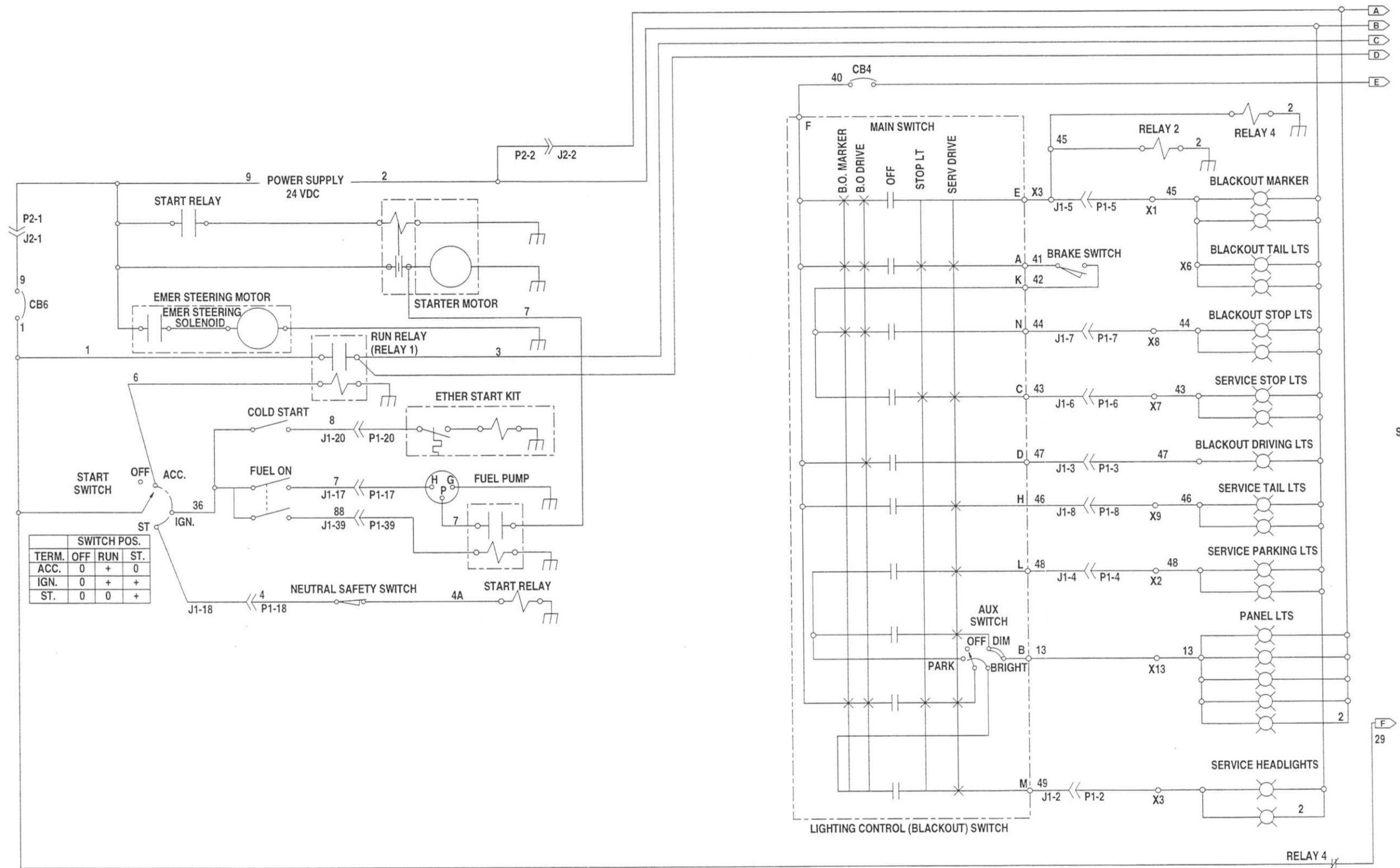
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## **SCHEMATIC SECTION**

THE FOLLOWING SCHEMATICS ARE THE SAME IN ALL VOLUMES OF  
TM 10-3930-673-20 AND TM 10-3930-673-34





	SWITCH POS.		
TERM.	OFF	RUN	ST.
ACC.	0	+	0
IGN.	0	+	+
ST.	0	0	+

TO SHEET 2

Figure FO-1. Electrical System (Sheet 1 of 3)

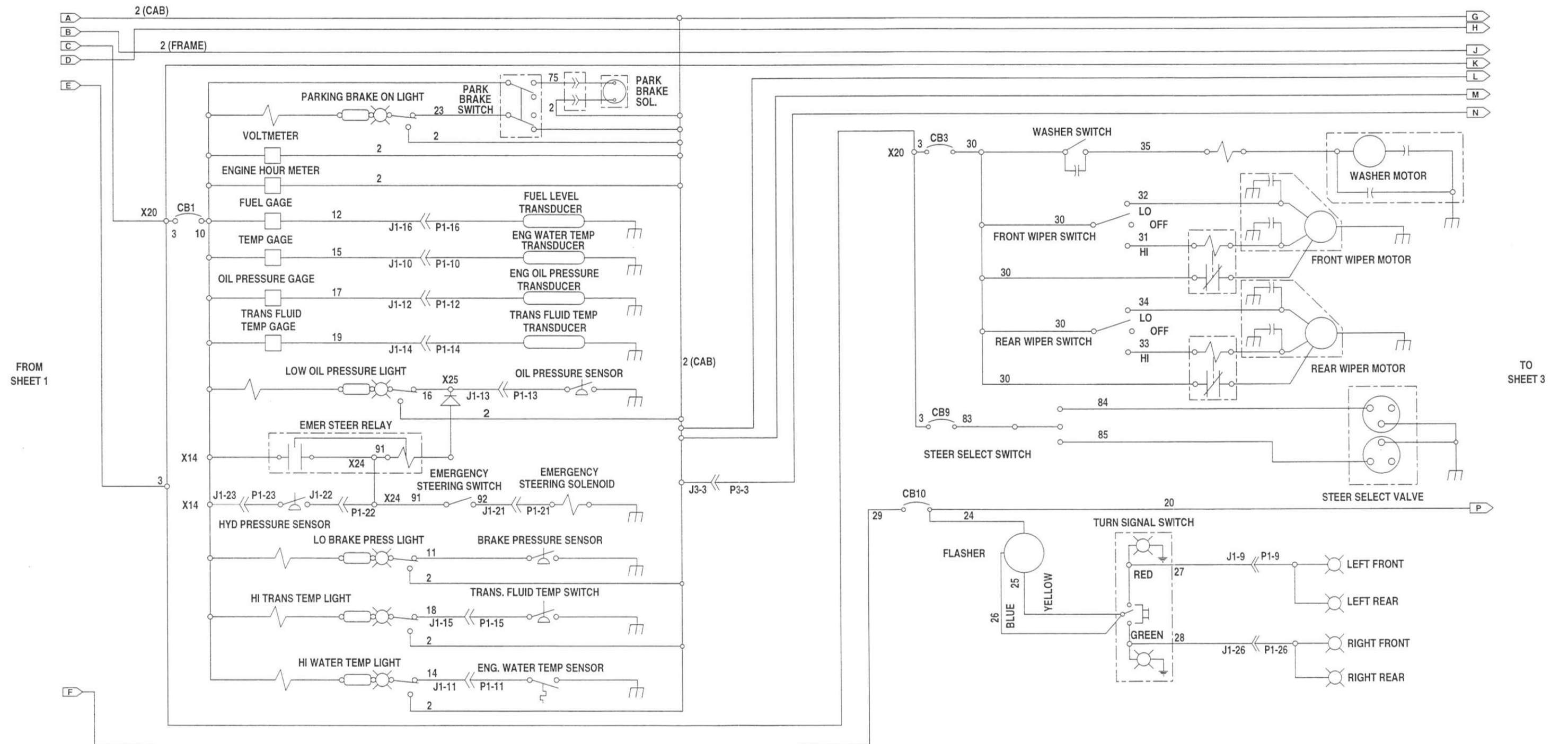


Figure FO-1. Electrical System (Sheet 2 of 3)

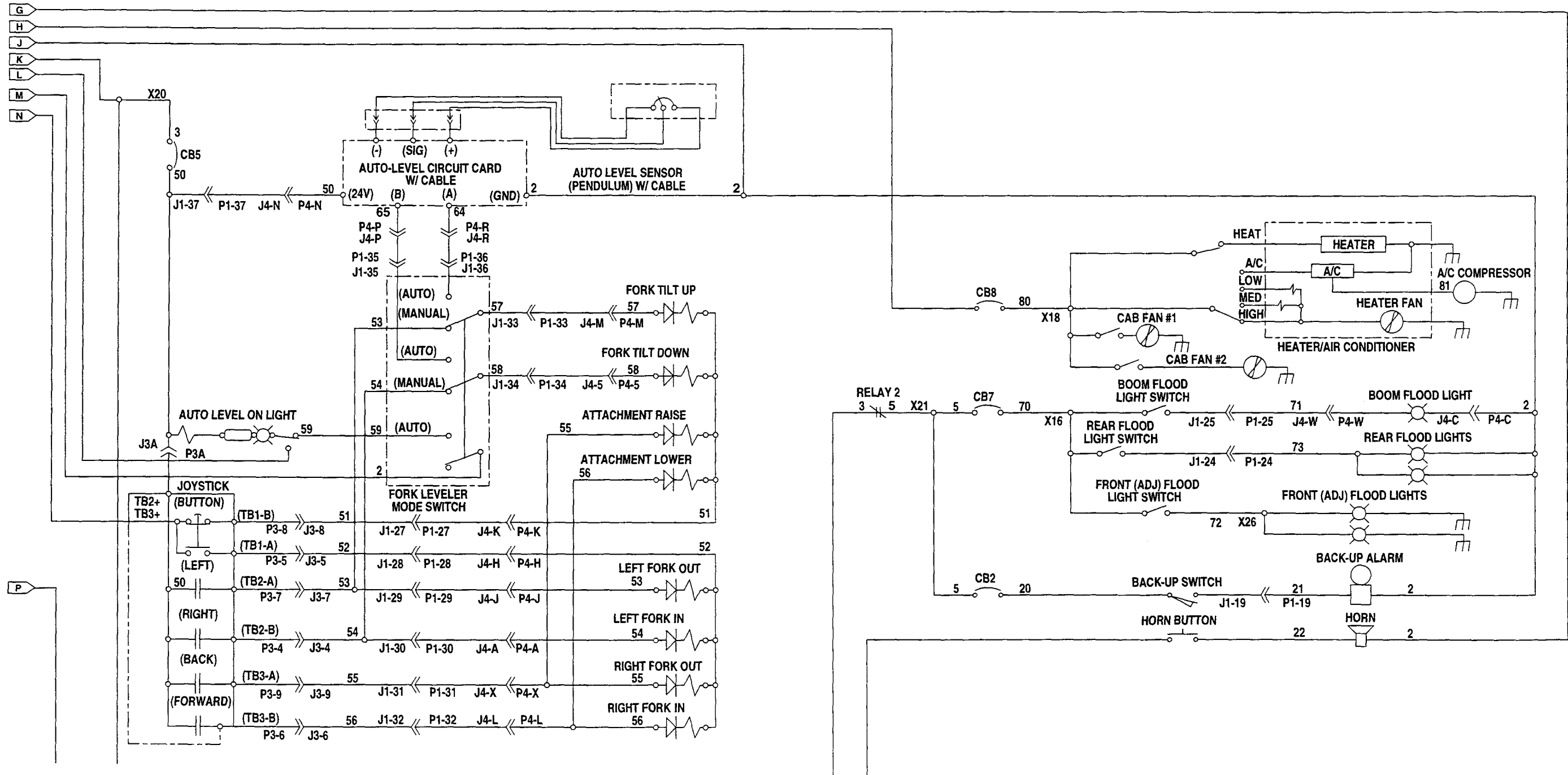


Figure FO-1. Electrical System (Sheet 3 of 3)  
Change 1 FP-5/(FP-6 blank)

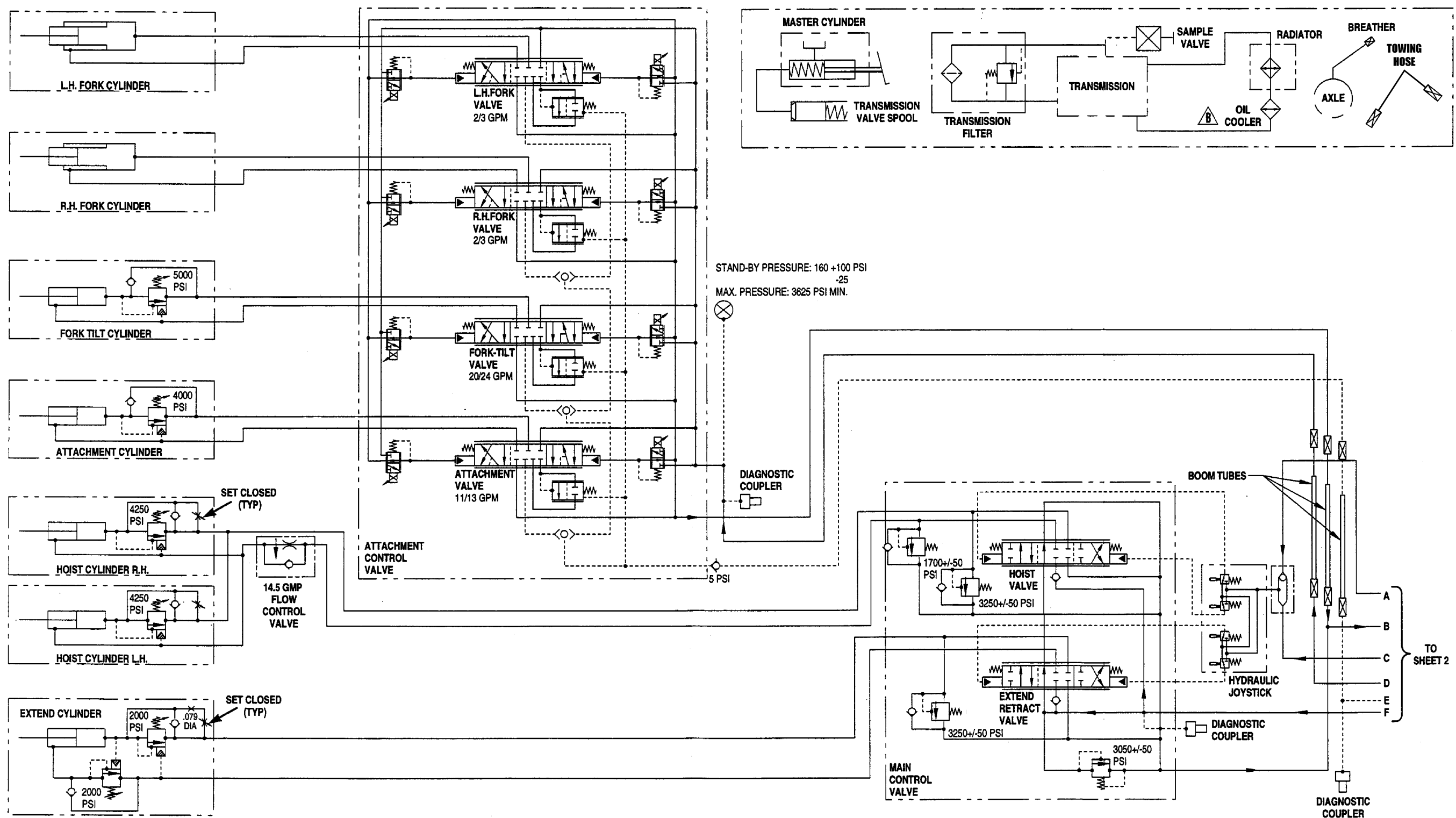


Figure FO-2. Hydraulic System (Sheet 1 of 2)

Change 1 FP-7/(FP-8 blank)



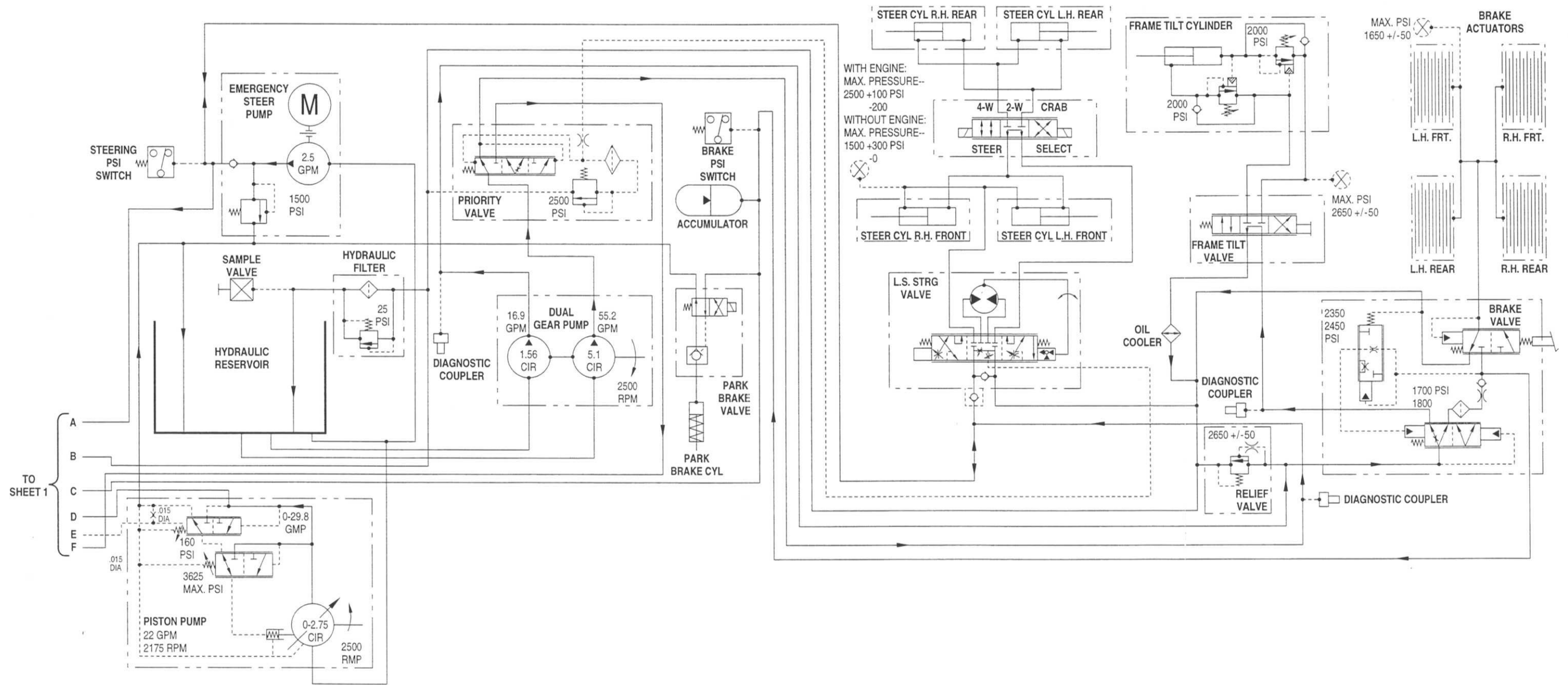


Figure FO-2. Hydraulic System (Sheet 2 of 2)



## THE METRIC SYSTEM AND EQUIVALENTS

### LINEAR MEASURE

1 Centimeter=10 Millimeters=0.01 Meters=0.3937 Inches  
 1 Meter=100 Centimeters=1000 Millimeters=39.37 Inches  
 1 Kilometer=1000 Meters=0.621 Miles

### WEIGHTS

1 Gram=0.001 Kilograms=1000 Milligrams=0.035 Ounces  
 1 Kilogram=1000 Grams=2.2 Lb  
 1 Metric Ton=1000 Kilograms=1 Megagram=1.1 Short Tons

### LIQUID MEASURE

1 Milliliter=0.001 Liters=0.0338 Fluid Ounces  
 1 Liter=1000 Milliliters=33.82 Fluid Ounces

### SQUARE MEASURE

1 Sq Centimeter=100 Sq Millimeters=0.155 Sq Inches  
 1 Sq Meter=10,000 Sq Centimeters=10.76 Sq Feet  
 1 Sq Kilometer=1,000,000 Sq Meters=0.386 Sq Miles

### CUBIC MEASURE

1 Cu Centimeter=1000 Cu Millimeters=0.06 Cu Inches  
 1 Cu Meter=1,000,000 Cu Centimeters=35.31 Cu Feet

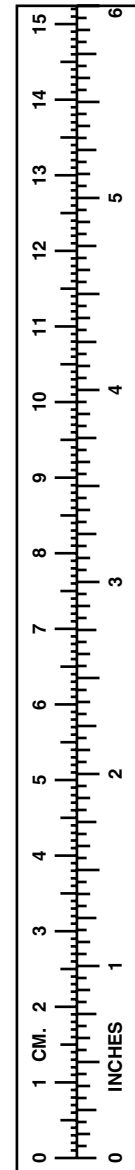
### TEMPERATURE

$5/9 (^{\circ}\text{F} - 32) = ^{\circ}\text{C}$   
 122° Fahrenheit is equivalent to 50° Celsius  
 90° Fahrenheit is equivalent to 32.2° Celsius  
 32° Fahrenheit is equivalent to 0° Celsius  
 $9/5 (\text{C}^{\circ} + 32) = \text{F}^{\circ}$

### APPROXIMATE CONVERSION FACTORS

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Inches . . . . .	Centimeters . . . . .	2.540
Feet . . . . .	Meters . . . . .	0.305
Yards . . . . .	Meters . . . . .	0.914
Miles . . . . .	Kilometers . . . . .	1.609
Squares 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/Sq Inch . . . . .	Kilopascals . . . . .	6.895
Miles per Gallon . . . . .	Kilometers per Liter . . . . .	0.425
Miles per Hour . . . . .	Kilometers per Hour . . . . .	1.609

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Centimeters . . . . .	Inches . . . . .	0.394
Meters . . . . .	Feet . . . . .	3.280
Meters . . . . .	Yards . . . . .	1.094
Kilometers . . . . .	Miles . . . . .	0.621
Sq Centimeters . . . . .	Square Inches . . . . .	0.155
Square Meters . . . . .	Square Feet . . . . .	10.764
Square Meters . . . . .	Square Yards . . . . .	1.196
Square Kilometers . . . . .	Square Miles . . . . .	0.386
Sq Hectometers . . . . .	Acres . . . . .	2.471
Cubic Meters . . . . .	Cubic Feet . . . . .	35.315
Cubic Meters . . . . .	Cubic Yards . . . . .	1.308
Milliliters . . . . .	Fluid Ounces . . . . .	0.034
Liters . . . . .	Pints . . . . .	2.113
Liters . . . . .	Quarts . . . . .	1.057
Liters . . . . .	Gallons . . . . .	0.264
Grams . . . . .	Ounces . . . . .	0.035
Kilograms . . . . .	Pounds . . . . .	2.205
Metric Tons . . . . .	Short Tons . . . . .	1.102
Newton-Meters . . . . .	Pound-Feet . . . . .	0.738
Kilopascals . . . . .	Pounds per Sq Inch . . . . .	0.145
Km per Liter . . . . .	Miles per Gallon . . . . .	2.354
Km per Hour . . . . .	Miles per Hour . . . . .	0.621



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