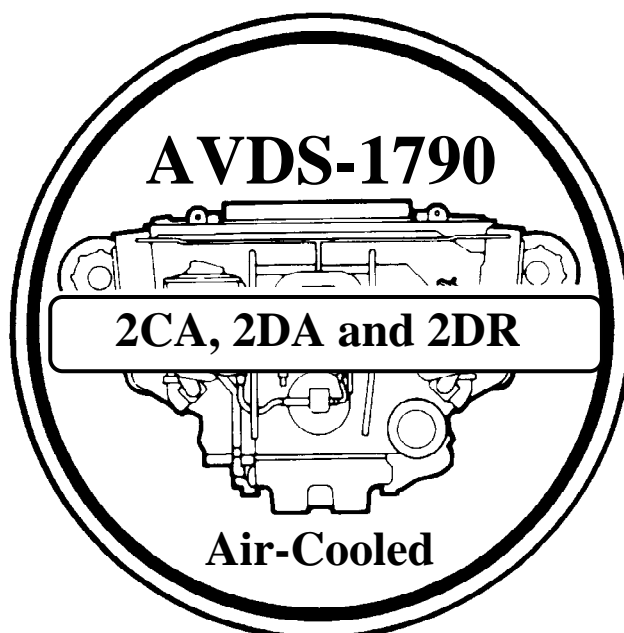


# TM 9-2815-220-24

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## TECHNICAL MANUAL

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



### 12-Cylinder Diesel Engines

Description	NSN (Engine with Container)
AVDS-1790-2CA:	2815-01-149-1313
AVDS-1790-2DA:	2815-01-166-2051
AVDS-1790-2DR:	2815-00-124-5387

**DISTRIBUTION STATEMENT A** - Approved for public release, distribution is unlimited.

**SUPERSEDURE NOTICE** - This manual supersedes TM 9-2815-220-34 dated 20 December 1975 and all changes

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**HEADQUARTERS, DEPARTMENT OF THE ARMY**  
**DECEMBER 2005**



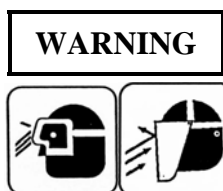
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**WARNING SUMMARY**

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This section provides a summary of all **WARNINGS** in this manual. They are repeated here in full text to let you know how important they are. Warnings in work packages are often presented in an abbreviated version; these are the unabridged versions.

Study these **WARNINGS** carefully. They can save your life and the lives of personnel working with or near you.



**Air Pressure in excess of 30 psi (207 kPa) can injure personnel.**

- **Do not direct pressurized air at yourself or others.**
- **Use goggles or face shield.**



**Carbon-Removing Compound is mildly toxic. Compound evaporates and fumes should not be inhaled. Continued contact with compound can cause skin problems**

- **Avoid inhalation of fumes. Provide adequate ventilation.**
- **Avoid contact with skin.**
- **Use goggles, rubber gloves, and rubber apron**
- **If compound is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor is preferred.**

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WARNING SUMMARY

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WARNING



**Cleaning Compound Solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.**

- **Ensure there is good airflow when using solvent and that work area is away from heat and flames.**
- **Keep fire extinguisher nearby.**
- **Do not breathe solvent fumes.**
- **Avoid skin contact: use gloves or a brush if necessary.**
- **Wash hands after using solvent.**
- **Wear eye protection: solvent could splash into eyes.**
- **If solvent gets in eyes, flush with fresh water for at least 15 minutes and get medical assistance.**

**Do not use P-D-680 solvent, dry cleaning solvent, benzene (benzol), paint thinner, gasoline, or diesel fuel oil as solvent replacements. These materials are more flammable and more toxic. They can damage materials.**



WARNING

**Do not allow upper and lower sensor probes of fuel water separator to come in contact with each other or with metal container. Do not touch probes. Failure to comply may result in electrical shock, inaccurate test results, or damage to equipment.**



WARNING

**The intake manifold heater ignition coils (1) are capable of producing extremely high voltage. The output of this ignition system is sufficient to cause a dangerous electrical shock. Never touch any uncovered or live connections.**

---

**WARNING SUMMARY**

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**WARNING****Electric Shock**

**Shock** happens when the body becomes part of an energized electrical path and energy is transferred between parts of the body, or through the body to a ground or the earth. In order for shock to occur, a potential difference or stored electrical charge must be present to cause the current to flow. Current flowing through the highly sensitive central nervous system can, under certain conditions, cause serious injury or death. Some of the conditions, which govern the severity of a shock, are mentioned below.

**Type of current**

The type of current involved, alternating current (AC) or direct current (DC) is important. Low voltage, up to 40 volts of direct current (DC) circuits do not normally present a hazard to human life. Under some circumstances, however severe burns can result. Even at low voltage, alternating current (AC) circuits can be dangerous and present a lethal threat. At commercial frequencies (50-60 cycles or hertz) and intermediate voltages (50 to 600 volts), lethal current may be conducted through the body.

**Resistance**

The resistance of the body and the degree to which the skin is insulated from the ground govern the amount of current flowing through the body. The skin offers the principle resistance which the human body presents to the flow of current. If the skin is wet or moist, the resistance is lowered and therefore the greater flow of current and the severity of shock.

**Time**

The length of time the body is in the circuit is also important, particularly with respect to the severity of burns. Burns break down the skin, thereby lowering the resistance. The more extensive the burn, the less resistance provided. Time becomes critical when current flowing through the body causes loss of muscular control, contraction of the chest (which affects breathing), and ventricular fibrillation of the heart. When the last occurs, the heart's pumping rhythm becomes irregular and it ceases to function properly.

Both the magnitude and path of the current flowing through the body are of primary importance. When the path of the current is hand-to-hand or hand-to-foot, vital organs (brain, heart, lungs, spinal cord) are affected, possibly with serious consequences.

**Emergency Measures for Shock**

Everyone engaged in any electrical or electronic work should be capable of carrying out the following measures:

- Free the person involved from the live circuit. If a person is "frozen" to a live electrical contact, shut off the current if possible. If this cannot be done, use wood boards, poles, or sticks, a belt, piece of dry rope, an article of clothing, or any non-conducting material of sufficient length to pull the body away from the contact. Act quickly, and remember to protect yourself during this operation.
- Cut off the power. Because of the dangers involved in being caught in a live circuit, know how to cut off the power anywhere in your work area, and how to summon help in case of an emergency. **Administer cardiopulmonary resuscitation.**

WARNING SUMMARY

WARNING



**Exhaust Gases Can Be Deadly** Engine exhaust systems, including diesel, emit carbon monoxide (CO), a colorless and odorless deadly gas.

CO, when breathed, deprives the body of oxygen. This gas could overcome personnel causing illness, brain damage, or death by suffocation.

<p><b>Symptoms of CO poisoning are:</b></p> <ul style="list-style-type: none"> <li>• <b>Dizziness</b></li> <li>• <b>Drowsiness</b></li> <li>• <b>Weakness</b></li> <li>• <b>Loss of muscular control</b></li> <li>• <b>Headache</b></li> <li>• <b>Nausea</b></li> <li>• <b>Reddened skin</b></li> </ul>	<p><b>If you see another person with CO poisoning symptoms:</b></p> <ul style="list-style-type: none"> <li>• <b>Remove the person from the area</b></li> <li>• <b>Do not permit physical exercise</b></li> <li>• <b>Expose the person to open air</b></li> <li>• <b>Keep the person warm</b></li> <li>• <b>Administer artificial respiration if necessary</b></li> <li>• <b>Seek medical attention immediately</b></li> </ul>
---	---

**These precautions will ensure personnel safety:**

- **Do not operate the vehicle engine in an enclosed area without adequate ventilation**
- **Be alert for exhaust odors**
- **Be alert for CO poisoning symptoms (listed above)**
- **Note: The field protection mask for NBC (nuclear, biological, chemical) protection will NOT protect you from CO poisoning**

**The best defense against carbon monoxide poisoning is adequate ventilation.**

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WARNING SUMMARY

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WARNING



**Explosion** Rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition or high pressure.

WARNING



**Fuel under Pressure** has penetrating power and can puncture the skin and cause blood poisoning leading to loss of fingers!

- Keep hands away from nozzles or fuel injection tubes during test.

WARNING



**Vaporized Diesel Fuel** can cause irritation of the upper respiratory tract and eyes, with possible euphoria, dizziness, headache, loss of coordination, ringing in the ears, convulsions, coma, and respiratory arrest.

- Do not breathe fuel diesel fuel fumes.

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WARNING SUMMARY

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WARNING



**Hanging Loads** could fall and kill you.

- Keep away from hanging loads and overhead equipment.
- Never walk under a hanging load.
- Use head protection when working around overhead equipment.

WARNING



Some wiring **Harnesses and Cables are Live (hot)**, even with MASTER BATTERY switch in the OFF position.

- Disconnect the three battery ground cable assemblies prior to disconnecting any wiring harness or cable.

WARNING



**Heavy parts** could fall and injure you. Improper lifting technique of heavy parts could result in physical injury.

- Always have help when lifting or use lifting device.



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WARNING SUMMARY

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WARNING



**Heavy Spring Tension** of valves, locks and valve covers can cause harm when released.

- Use extreme care when removing locks, retainers, springs, and valve covers.

WARNING



Extremely **High Voltage** can be produced from ignition units on this engine. The output of this ignition system is enough to cause a dangerous electrical shock!

- Never touch any uncovered or live connections!

WARNING



**Noise Hazard** Hearing can be permanently damaged if exposed to constant high noise levels of 85 decibels or greater. Hearing loss occurs gradually but becomes permanent over time.

- Use hearing protection when working in an environment where engines are running.

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WARNING SUMMARY

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WARNING



Remove All Nozzles when performing a compression check whenever possible.

Nozzle removal will prevent the possibility of the engine firing on other cylinders when the engine is cranked and will permit the engine to be cranked at the desired rpm to check compression. Unexpected starting of engine could injure personnel.

WARNING



Parts or Particles may become airborne causing eye injury.

- Use goggles when using power tools, hammers, chisels, or when removing/installing snap rings.
- Use common sense.

WARNING



Sharp Edges can cut hands.

- Use rags or brush to lubricate.
- Use gloves whenever handling sharp parts.

WARNING SUMMARY

---

WARNING



**Sharp Object** Pointed object in hand shows that a sharp object presents a danger to limbs.

WARNING



**Slick Floor** Wavy line on floor with legs out front shows that slick floor presents a danger of falling.

WARNING



**Fire Hazard** Do not smoke or allow open flames or sparks in areas where diesel fuel is used or stored. DEATH or severe injury may result if personnel fail to observe this precaution.

WARNING SUMMARY

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WARNING



**Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals. Follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment used, a suitable fire extinguisher kept nearby, and requirements of TC 9-237 strictly followed.**

WARNING



**Do not attempt to start the engine until operation of electrical fuel shutoff has been verified. Failure to comply could cause injury to personnel.**

WARNING



**Do not file, sand, or otherwise remove metal from fan blades since this will disturb the balance of the fan. An unbalanced fan could explode causing serious injury or death to personnel. Any repair of a fan blade must be done at Depot.**

WARNING SUMMARY

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WARNING



**Swinging loads** Flywheel is heavy. Be sure that lifting device is attached and do not allow flywheel to swing about uncontrolled. Failure to comply may result in personal injury.

WARNING



The pressure regulator valve access cover is spring-loaded. Exercise care when removing cover. Failure to comply may result in personnel injury from flying parts.

WARNING



Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.

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WARNING SUMMARY

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WARNING



AVDS-1790-2 series engines weigh approximately 5,000 pounds.

- Be careful not to place any part of your body underneath a lifted engine.
- Insure that the lifting device you are using is rated for at least 5,000 pounds.

WARNING



Use of incorrect sling can cause lifting point failure leading to injury or even death of personnel.

- Engine models 2CA and 2DA use sling Part Number 12257229.
- Engine model 2DR uses sling Part Number 11671664.

WARNING



Crankcase adapter is heavy. Take care when removing it so that it does not swing around and injure personnel or equipment.

---

WARNING SUMMARY

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WARNING



**Valves and locks are under heavy spring tension. Exercise extreme care when removing locks, seats, and springs. Each valve spring set consists of three separate springs. Failure to comply may result in injury.**

WARNING



**The crankshaft damper is heavy and awkward. It requires a two-man lift or a suitable lifting device. Use a 4-1/4 to 4-1/2-inch long bolt with the head cut off and tapered (item 16 WP 0177) to facilitate installation and removal.**

WARNING



**Damper/oil filter housing is heavy, use suitable lifting device. Take care that damper/oil filter housing does not swing on hoist and injure personnel.**

WARNING SUMMARY

---

WARNING



**The oil pressure regulator valve cover is spring loaded. Exercise care when removing cover.**

WARNING



**Fuel injection advance unit test stand fixture cover must be in place and secured any time the unit is being tested. Hot oil and moving parts could cause severe personal injury.**

WARNING



**Fuel injection pump advance unit will be hot following test. Operator should wear gloves when adjusting unit.**



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**LIST OF EFFECTIVE PAGES/WORK PACKAGES**

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INSERT LATEST CHANGED PAGES/WORK PACKAGES. DESTROY SUPERSEDED DATA.

**NOTE**

**A vertical line in the outer margins of the page indicates the portion of text affected by the change. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.**

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<b>Page/WP No.</b>	<b>*Change No.</b>	<b>Page/WP No.</b>	<b>*Change No.</b>	<b>Page/WP No.</b>	<b>*Change No.</b>
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i - xiii .....	0				
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\* Zero (0) in this column indicates an original page or work package.



**TECHNICAL MANUAL**  
**UNIT, DIRECT SUPPORT AND GENERAL SUPPORT**  
**MAINTENANCE MANUAL**  
**FOR**



<b>Description</b>	<b>NSN (Engine with Container)</b>
AVDS-1790-2CA:	2815-01-149-1313
AVDS-1790-2DA:	2815-01-166-2051
AVDS-1790-2DR:	2815-00-124-5387

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**SUPERSEDURE NOTICE** - This manual supersedes TM 9-2815-220-34 dated 20 December 1975 and all changes

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## HOW TO USE THIS MANUAL

---

### INTRODUCTION

This technical manual contains instructions for Organizational, Direct and General Support of the 12-cylinder, AVDS-1790 Engine, Models 2CA, 2DA and 2DR. Organizational tasks are included so that the Direct Support (DS) or General Support (GS) maintainer has no need to refer to vehicle Organizational Level Manuals to complete repairs of the engine. Included are descriptions of, and procedures for, removal of engine accessories and components, troubleshooting, disassembly, inspection (including engine repair standards) repair, reassembly, and testing of the engines. These descriptions and procedures are identical for each model except where otherwise indicated.

### WHAT'S IN THE MANUAL - FRONT TO BACK

**Summary of Warnings** lists the warnings in this manual. These warnings contain additional information about things that could hurt or kill personnel. The maintenance work package may have a shorter version of these warnings.

**How To Use This Manual** is an overview of the contents of this manual.

**Table of Contents** lists all the work packages (WPs) in this manual.

**General Information** (WP 0001) covers required maintenance forms, records, and reports; provides direction for safe handling of equipment, for storage or shipment of equipment, and for tools, equipment and repair parts; addresses equipment preservation, quality of material, and cross-references common terms to nomenclature.

**Chapter 1** contains Location and Description (WP 0002), including End Item Application, located on the last page, which lists the vehicles that use the AVDS-1790-2 series engine; Engine Specifications (WP 0003), and Theory of Operation (WP 0004).

**Chapter 2** begins with Troubleshooting Instructions and Quick Guide to Troubleshooting (WP 0005), which is followed by work packages that provide step-by-step instructions for isolating and correcting malfunctions.

**Chapter 3**, Standard Maintenance Procedures, includes Service Upon Receipt (WP 0027), Standard Maintenance Instructions (WP 0028) for cleaning, inspection, repair, and assembly guidelines; Helical-Coil Insert Replacement (WP 0029), and Threaded Insert Replacement (WP 0030).

**Chapter 4**, Service Operations includes engine Oil Replacement and Engine Preservation.

**Chapter 5**, Engine Tests and Adjustments, includes Engine Operating Parameters, Engine Run-In as well as engine tests, adjustments, and checks.

**Chapter 6** contains Organizational Maintenance procedures to remove and install accessories and exterior engine components.

**Chapter 7** is Direct Support (DS) maintenance and information on work packages.

**Chapter 8** contains General Support (GS) maintenance work packages.

## HOW TO USE THIS MANUAL

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### WHAT'S IN THE MANUAL - FRONT TO BACK (Continued)

**Chapter 9** contains Supporting Information:

**References** (WP 0172) lists forms, publications, supply catalogs, engine accessory and vehicle technical manuals and other documentation used by personnel.

**Expendable and Durable Items List** (WP 0173) lists expendable supplies and materials identified in the INITIAL SETUP section of the work package. The list is in alphabetical order.

**Torque Limit Tables** (WP 0174) includes special and standard torque limits for fasteners, studs, and pipe plugs.

**Mandatory Replacement Parts List** (WP 0175) lists mandatory replacement parts identified in the INITIAL SETUP section of the work package. The list is in part number (not alphabetical nomenclature) sequence.

**Tool Identification List** (WP 0176) lists tools and equipment identified in the INITIAL SETUP section of the work package. The list is in alphabetical order.

**Illustrated List of Manufactured Items** (WP 0177) provides directions to locally fabricate tools, fixtures, or other items needed to maintain or repair the engine.

**Disassembly/Assembly Procedure Sequence for the AVDS 1790-2 Engine** (WP 0178) lists the procedures to disassemble and then to assemble the engine. This is presented in a table which lists the work package number.

**Abbreviations and Glossary** (WP 0179) defines abbreviations and unusual terms found in the manual.

**Alphabetical Index** lists major engine and container parts repaired or replaced at the Organizational, Direct Support or General Support level. Each entry in the index includes the work package number.

**DA Form 2028** is used to report an error found in this manual.

**Metric Conversion Chart** (last page) converts U.S. measurements to metric equivalents. Measurements in the work packages are given in both U.S. and metric units.

### CONFIGURATION DIFFERENCES

Configuration differences between engine models are covered in the work packages as they occur. When the difference between models is significant there will be a separate work package for each model.

### DA FORM 2407

A DA Form 2407 will accompany any faulty engine. Before you repair a faulty engine, review the DA Form 2407 that came with it. One or more fault symptoms will be described on the form. You will use the fault symptoms and the Quick Guide to Troubleshooting (WP 0005) to determine which work package to use for a given fault.

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HOW TO USE THIS MANUAL

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**WARNINGS, CAUTIONS, AND NOTES**

Pay attention to all warnings and cautions within the work packages. Ignoring a warning could cause death or injury to personnel. Ignoring a caution could cause damage to equipment. Notes contain facts to make the maintenance easier. Warnings, cautions, and notes always appear just above the work package step to which they apply.

EXAMPLES:

**WARNINGS:** Call attention to things that could kill or injure personnel. They are preceded by the word "WARNING" in bold face type and in a box. A warning icon is often presented along with the text.



**Air Pressure in excess of 30 psi (207 kPa) can injure personnel. Do not direct pressurized air at yourself or others. Use goggles or face shield.**

Some warnings are often used in a work package. In the procedure, they may be presented in an abbreviated version.

All warnings in this manual appear in full description in the Warning Summary located just after the front cover.



**CAUTIONS:** Call attention to things or actions that could damage equipment. They are preceded by the word "Caution" in bold face type and underlined.

**CAUTION**

**Do not run engine longer than 10 minutes at 675-725 rpm without cooling fans installed. Damage to engine from overheating will occur.**

**NOTES:** Contain important facts or things to make maintenance easier. They are preceded by the word "Note" in bold face type.

**NOTE**

**Engine leak test should be done before run-in.**

HOW TO USE THIS MANUAL

HOW TO USE WORK PACKAGES

The following is an example of the "INITIAL SETUP" section in a maintenance work package. Not every work package will have all of the categories listed; only those that apply will be there.

TM 9-2520-220-24	
<b>INTAKE AND EXHAUST VALVE CLEARANCE ADJUSTMENT</b>	<b>0034 00</b>
<b>THIS WORK PACKAGE COVERS:</b>	
Before Adjustment, Adjustment, and After Adjustment	
<b>INITIAL SETUP:</b>	
<b>Tools:</b>	<b>Expendable Materials:</b>
General mechanic's tool kit (item 121, WP 0176)	Lubriplate (item 23, WP 0173)
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)	<b>Personnel Required:</b>
<b>Manufactured Items:</b>	Track Vehicle Repairer (2) 63H10
Engine (flywheel) turning tool, 2DR only (item 4, WP 0177)	<b>Equipment Conditions:</b>
<b>Mandatory Replacement Parts:</b>	Cooling fans, vane housings, and fan housing removed (WP 0054)
Gasket (2) (item 350, WP 0175)	

LEGEND

<b>TITLE:</b>	Identifies the name and number of the work package.
<b>THIS WORK PACKAGE COVERS</b>	Describes the overall actions to be performed (remove, disassemble, adjust, assemble, install, etc.).
<b>Tools:</b>	This is a list of the tools and equipment you will need. Part number and national stock number of each tool can be found in the referenced work package. Tools found in the general mechanic's tool kit are not listed separately.
<b>Expendable Materials:</b>	These supplies are needed to perform the work package.
<b>Manufactured Items:</b>	These are items that have to be manufactured or fabricated in order to do the work package. The referenced work package describes how to do this.
<b>Mandatory Replacement Parts:</b>	The parts listed are those you must replace every time the work package is performed. Use the Repair Parts and Special Tools List (RPSTL) TM 9-2815-220-24P to order the parts you need for the work package.
<b>Personnel Required:</b>	This tells you the person authorized to perform the work package.
<b>Equipment Conditions:</b>	Describes the condition the equipment must be in before you start the work package. Each condition is followed by a work package reference. Use this reference to find the work package that sets up that equipment condition.  <b>NOTE:</b> When you go to the referenced work package, you must also perform the Equipment Conditions on that referenced work package.

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**HOW TO USE THIS MANUAL**

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**HOW TO USE WORK PACKAGES (Continued)****Work Package Steps and Elements**

Read through the work package for step-by-step illustrated instructions. The numbered steps tell WHAT to do; the lettered steps tell HOW to do it. Occasionally, a numbered step will have several lettered steps. Note that the letter "1" is intentionally omitted because it looks like the number 1, which could be confusing.

If you are an experienced mechanic, you may need to read only the numbered steps. If you are a beginning mechanic, you will want to read all the steps. If you come to a step that has already been done, skip that step and go to the next step.

**Replacement Work Packages**

There are two uses for "Replacement" work packages within this manual. A Replacement work package can be performed to gain access to another part or to replace a defective component.

1. The following comments apply to a Replacement work package used to replace defective components:
  - a. Replacement components are new and usually will not be cleaned and inspected. Preservatives must be removed from long-term stored components.
  - b. Replacement components will be installed.
  - c. Defective components will be discarded or sent to a higher maintenance level. Components sent to depot maintenance must have a completed DA Form 2407.
2. Most Replacement work packages can also be used for access to another part. In this case, the original part is removed and then installed later.
  - a. Removed components will be cleaned, inspected, and reinstalled if no defects are found or repairs have been accomplished.
  - b. General cleaning, inspection, and repair will be performed according to general maintenance instructions in WP 0028. However, some general cleaning, inspection, and repairs are included in the maintenance work package where applicable.
  - c. A new component will be installed if inspection indicates a component cannot be repaired.
  - d. The item that can be removed for access or repair will not be listed under "Mandatory Replacement Parts." Also, this part will not be identified as "new" in the INSTALL section of the work package.

**Repair Work Package**

This term is used to identify a work package where defective components are disassembled, repaired, and reassembled. Most Repair work packages are performed with the component on the workbench. A few can be performed with the engine mounted on the overhaul stand. General maintenance instructions are detailed in WP 0028.

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**HOW TO USE THIS MANUAL**

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**HOW TO USE WORK PACKAGES (Continued)**

**Referring to another Work Package**

Steps within a work package may refer to another work package in this manual:

“Remove fuel injection pump assembly (WP 0115).”

In this example, only the REMOVAL part of the referenced work package is to be performed.

**Cleaning and Inspection**

General cleaning and inspection procedures for every work package are found in WP 0028, General Maintenance Instructions. Use these procedures to clean and inspect any part being removed, repaired, or installed. Special cleaning and inspection, if required, will be covered in the procedural work package.

**Check**

This term is used when an instruction step requires the use of a tool to determine a specific value. When checking the fit of a part, a range of acceptable values may be provided. The letter L or T may follow a value. L means looseness of fit, T means tightness of fit.

**Go to End of Work Package**

This term is used in a work package step that contains a conditional situation that might require performance of more steps. If no more steps are to be performed, the work package or work package element is complete, and you are directed to GO TO END OF WORK PACKAGE. Anytime you arrive at END OF WORK PACKAGE, you must return to the maintenance work package or troubleshooting work package that sent you to that work package.

**All Work Packages**

The following comments apply:

1. Items that are always consumed will be listed under Mandatory Replacement Parts or Expendable Materials in the INITIAL SETUP section of the work package and will be referred to as “new” when installed. Examples of items usually consumed are:
 

Bearings	Gaskets	Lock wire	Self-locking nuts
Filters	Hoses	O-rings	Lock washers
Preformed packings			
2. Items that are to be replaced or discarded as the result of a condition (as determined when performing steps that check and inspect) will not be listed under Mandatory Replacement Parts or Expendable Materials. They will not be referred to as “new” when installed.

**HOW TO USE THIS MANUAL**

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**HOW TO USE WORK PACKAGES (Continued)**

**All Work Packages (Continued)**

3. Use the RPSTL (TM 9-2815-220-24P) to order parts used in the work packages. The RPSTL gives the required National Stock Number (NSN), in addition to the Source, Maintenance, and Recoverability (SMR) code that indicates the manner of acquiring support items for maintenance, repair, or overhaul of end items. To use the RPSTL to identify and order a part, do the following:
  - a. In this manual, turn to the first page of the work package to be performed.
  - b. Find “Mandatory Replacement Parts” under INITIAL SETUP, and read the part(s) that are listed. If any part is listed, it will be illustrated in the work package steps and must be replaced when the work package is performed. Next, determine if any other parts are damaged and need to be replaced in the work package.
  - c. Go to the RPSTL and find the same illustrated part. That part will have an item number assigned to it. Look up the item number in the listing for that figure. Look up the SMR (source, maintenance, recoverability) code for the item that must be replaced. The SMR code specifies the level of maintenance authorized to perform repair of that item.
  - d. If the SMR code authorizes you to repair the item, look for the item NSN in the National Stock Number Cross-Reference Index. Use the item NSN to order a new replacement part.

**Remember**

Pay attention to all warnings, cautions, and notes within the work packages. Ignoring a warning could cause death or injury to personnel. Ignoring a caution could cause damage to equipment. Notes contain facts to make the maintenance easier. Both warnings and cautions always appear just above the step to which they apply.





**TM 9-2815-220-24**

**CHAPTER 1**

**INTRODUCTORY INFORMATION,  
DESCRIPTION, AND THEORY OF OPERATION**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



**SCOPE**

This technical manual contains instructions for Organizational, Direct, and General Support of the 12-cylinder AVDS-1790 engine, models 2CA, 2DA, and 2DR. Included are descriptions and procedures for removal of engine accessories and components, troubleshooting, disassembly, inspection (including engine repair standards) repair, reassembly, and testing of the engines.

Descriptions and procedures are identical for each model unless otherwise indicated.

Technical manual TM 9-2815-220-24P contains an illustrated list of all repair parts and special tools stocked for Organizational, Direct, and General Support maintenance of the engine.

Work Package 0172, References, lists current references, including supply manuals, forms, technical manuals, and other available publications applicable to the AVDS-1790-2CA, 2DA, and 2DR engines.

**MAINTENANCE FORMS, RECORDS, AND REPORTS**

The prescribed maintenance responsibilities are designated in the appropriate columns of the maintenance allocation charts located in the pertinent vehicle organizational manual.

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by (as applicable) DA PAM 738-750, Functional Users Manual for the Army Maintenance Management System (TAMMS); DA PAM 738-751, Functional Users Manual for the Army Maintenance Management Systems - Aviation (TAMMS-A); or AR 700-138, Army Logistics Readiness and Sustainability.”

**REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS**

If your diesel engine needs improvement, let us know. Send us an Equipment Improvement Recommendation (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. Tell us why a procedure is hard to perform.

Put it on an SF 368 (Product Quality Deficiency Report). Mail it to the address specified in DA PAM 738-750. A reply will be sent to you.

**CORROSION PREVENTION AND CONTROL**

Corrosion Prevention and Control (CPC) of Army materiel is a continuing concern. It is important that any corrosion problem with the engine be reported so that improvements can be made to prevent the problem in the future. While corrosion is typically associated with rusting of metals, it can also include deterioration of other materials such as rubber and plastic. Unusual cracking, softening, swelling, or breaking of these materials may be a corrosion problem. If a corrosion problem is identified, it can be reported using SF 368 (Product Quality Deficiency Report). Use of key words such as “corrosion,” “rust,” “deterioration,” or “cracking” will ensure that the information is identified as a CPC problem. SF 368 should be submitted to the address specified in DA PAM 738-750.

**DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE**

Refer to TM 750-244-6 for procedures on destruction of the AVDS-1790 engine, models -2CA, -2DA, and -2DR

Below are some general guidelines to follow in destruction of equipment to prevent enemy use. Destruction of equipment, when subject to capture or abandonment in a combat zone, will be undertaken only when such action is necessary in accordance with orders of, or policy established by, the Army commander.

In general, destruction of essential parts, followed by burning, will usually be sufficient to render equipment useless. Time is usually critical.

Materiel must be damaged so that it cannot be restored to usable condition by either repair or cannibalization. If lack of time or personnel prevents destruction of all parts, give priority to destruction of parts hardest to replace. It is important that the same parts be destroyed on all engines to prevent construction of one complete engine from several damaged ones.

The procedure outlined below requires the use of demolition materials and explosives which normally may not be authorized items of issue to the using organization. The issue of these and related materials and conditions under which destruction will be effected, are command decisions in each case, according to the tactical situation.

Varying degrees of damage to the armament and other equipment may be expected during destruction of engine as outlined below:

1. Smash all vital elements such as auxiliary power unit, switches, coupling devices, mechanical pumps and all accessible engine components. Slash electrical cables and harnesses.
2. Drain fuel oil or puncture them as near the bottom as possible.
3. For the engine, use 1-pound TNT blocks or equivalent together with the necessary detonating cord to make up the required charges. Place the required charges as follows:
  - Set the first charge on the accessory drive housing at the forward end of the engine.
  - Set the second and third charges on the engine, one on the left side and one on the right side.
  - Connect all charges for simultaneous detonation with detonating cord.
4. Provide for dual priming to minimize the possibility of a misfire. For complete details on the use of demolition materials and methods of priming and detonating demolition charges, refer to FM 5-25.
  - Training and careful planning are essential. The danger area is estimated to be 500 yards; elapsed time is approximately 10 minutes.

**PREPARATION FOR STORAGE OR SHIPMENT**

Refer to Work Package 0098, Engine and Container Replacement, for instructions on preparation for storage and shipment.

**ADMINISTRATIVE STORAGE**

See AR 750-1 for the requirements for administrative storage of Army materiel.

**NOMENCLATURE CROSS – REFERENCE LIST**

In general, nomenclature used in this manual is in accordance with the terms used for provisioning as they appear in the Repair Parts and Special Tools List (RPSTL).

A few tools, parts, and components are, however, referred to by names more common than those in the RPSTL.

**NOMENCLATURE**

Cable assembly  
Gauge rod  
Hand hammer  
Hinged handle  
Insert wrench  
Key, woodruff key, machine key  
Metal seal ring  
Retaining ring  
Safety glasses  
Safety wire  
Screw-thread inserter  
Screw-thread remover  
Shipping/storage container  
Socket head screw key  
Spring resiliency tester  
Threaded insert remover  
Transmitter  
Wire rope

**COMMON NAME**

Wiring harness or lead assembly  
Dipstick  
Plastic-faced hammer  
Breaker bar  
Drive wrench  
Key  
Shaft seal  
Snap ring  
Goggles  
Lock wire  
Drive wrench  
Removal tool  
Container  
Hex key  
Spring scale  
Removal tool  
Sending unit  
Cable

**LIST OF ABBREVIATIONS**

A list of common abbreviations including symbols and a glossary are included in Work Package 00179.

**QUALITY OF MATERIAL**

Material used for replacement, repair, or modification must meet the requirements of this manual. If quality of material requirements is not stated in this manual, the material must meet the

**SAFETY, CARE, AND HANDLING**

Read all **WARNINGS** in the front of this manual, and observe all **WARNINGS** found throughout this technical manual.

Some of the maintenance and repair procedures require the use of lubricants, solvents, and cleaning fluids that may be dangerous or harmful if safety precautions are not observed. Read manufacturer's warnings and cautions on product labels before using, and observe recommended safety precautions.

Avoid damage to engine subassemblies and parts during disassembly, cleaning, inspection, repair, and assembly procedures. Nicks, scratches, and dents caused by careless handling can cause oil leakage or improper functionality leading to premature subassembly or part failure.

Care must be used to protect the engine against contamination. This is especially true during overhaul or maintenance operations when the engine is partially disassembled. Dirt, small tools, and parts could fall into access holes and cavities. This could result in an engine failure. When an engine is not being serviced, protect it from contamination.

**CALIBRATION**

Refer to the appropriate equipment manual for your equipment for calibration information.

**COMMON TOOLS AND EQUIPMENT**

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE), CTA 60-970; or CTA 8-100, as applicable to your unit.

The general mechanic's tool kit is identified in the individual maintenance paragraphs by nomenclature, item number and work package. No tool in the kit is further identified. Other tools required for performance of tasks for the maintenance levels covered in the manual are identified in "SETUP" and are referenced to the Tool Identification List, WP 0176. "Other Tools" includes tools which are part of the shop sets authorized to section/teams; tools authorized by RPSTL and CTA 50-970; special tools and equipment, fabricated tools; and items of TMDE.

**SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT**

Work Package 0176, Tool Identification List, includes information on special tools and equipment. See TM 9-2815-220-24P for lists and illustrations of special tools needed to maintain the engine. See WP 0177 in this manual for an illustrated list of manufactured items needed to maintain the engine.

**REPAIR PARTS**

See WP 0175 in this manual for a list of mandatory replacement parts needed to maintain the engine.

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Overview, Engine Orientation, Location and Description (Major Components, Engine Major Working Parts, and Container Assembly), and End Item Application

**OVERVIEW**

The following models of the AVDS-1790 engine share many characteristics, capabilities, and features. When features are not common, they are identified throughout the manual.

The National Stock Numbers and Part Numbers are provided for the three engine models and for an engine container (this one container will accommodate any of these engine models). The National Stock Numbers and Part Numbers are provided for the three engine models with a container.

Description	NSN (Engine with Container)
AVDS-1790-2CA:	2815-01-149-1313
AVDS-1790-2DA:	2815-01-166-2051
AVDS-1790-2DR:	2815-00-124-5387

**ENGINE CHARACTERISTICS, CAPABILITIES, AND FEATURES**

- Air-cooled, V-type, diesel, fuel injected, turbosupercharged, 12-cylinder, 90-degree configuration, four cycle, engine
- Fuel injection system and a turbosupercharged air induction system provide optimum engine performance
  - Fuel injection pump delivers high pressure, metered fuel, to individual cylinders through fuel injector nozzles
  - Two turbochargers are exhaust-gas driven and increase the air flow pressure entering the air intake manifolds
- Fuel supply pump, located at the front of the engine, draws fuel through the primary and secondary fuel systems from the vehicle fuel tanks and delivers it to the injection pump
- Cylinder assemblies are individually replaceable units with overhead valves and valve rocker assemblies in the head
- Cylinders are arranged in two banks of six cylinders each
  - Each bank of cylinders has an overhead camshaft arrangement to actuate the valves of each cylinder
- Solenoid-operated 24-volt starter low-voltage sensing module prevents starter activation with improperly charged batteries

**ENGINE CHARACTERISTICS, CAPABILITIES, AND FEATURES (Continued)**

- Lubrication of engines by forced feed system consisting of four circuits
  - Scavenge, main or pressure oil, leveling, make up
  - Circuits are operated independently by one oil pump with four separate sections
- Two intake manifold heaters
  - Installed in air intake systems between intake manifold elbows and turbosuperchargers
  - Preheats air entering cylinders to facilitate cold-weather starting and cold-weather idle operation
- Crankcase vented by enclosed crankcase breather system
  - Vented through crankcase breather tube at left of turbosupercharger exhaust pipe
- Fuel filters have top-mounted bleeder valves to remove air from fuel system
  - Primary and fuel/water separator type secondary fuel filters
- Water in fuel filters is removed
  - Primary fuel filter: Water is removed by a constant bleed orifice
  - Fuel/water separator type secondary fuel filter: Water is removed by an automatic water drain

**Models    Distinguishing Features**

- |            |   |
|------------|---|
| <b>2CA</b> | <ul style="list-style-type: none"><li>• Clean Air Package</li><li>• Oil-cooled 28-volt dc, 650 ampere generator<ul style="list-style-type: none"><li>– Produces alternating current rectified within the unit to give direct current to output terminals</li></ul></li></ul>  |
| <b>2DA</b> | <ul style="list-style-type: none"><li>• Clean Air Package</li><li>• Air-cooled, 28-volt dc, 300 ampere generator<ul style="list-style-type: none"><li>– Blower motor mounted on generator draws cooling air from crew compartment through air intake tube which extends along crankcase below intake manifold on right side of engine</li><li>– Generator air exhaust tube elbow is connected to rear of engine shroud</li><li>– Outlet air is exhausted through engine rear cooling fan vane</li></ul></li></ul> |



**ENGINE CHARACTERISTICS, CAPABILITIES, AND FEATURES (Continued)****Models   Distinguishing Features (Continued)**

- 2DR**
- Air-cooled, 28-volt dc, 300 ampere generator
    - Blower motor mounted on generator draws cooling air from crew compartment through air intake tube which extends along crankcase below intake manifold on right side of engine
    - Generator air exhaust tube elbow is connected to rear of engine shroud
    - Outlet air is exhausted through engine rear cooling fan vane
  - Power Take-off (PTO) Unit
    - Mounted on damper housing
    - Solenoid-controlled throttle linkage designed to maintain a minimum engine speed for PTO unit
  - Turbosuperchargers location
    - Location is about 2.5 inches inboard, and therefore turbosuperchargers outlets are re-indexed
  - Flywheel
    - Internal ring gear for driving the transmission
    - Internal ring gear is mounted to crankshaft through an adapter
  - Transmission adapter (housing)
    - Serves as spacer for attaching transmission to engine
  - Fuel metering pump overflow fuel
    - Fuel is routed back through front engine shroud, and
    - Fuel return tube cross at rear of engine is blocked
  - Not Equipped With:
    - Clean Air Package
    - Engine installation guides or wiring harness

## ENGINE ASSEMBLY ORIENTATION

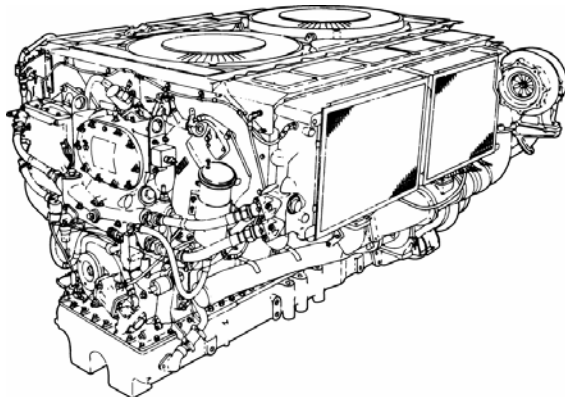
### Engine Assembly Orientation

- For illustration purposes the AVDS-1790 engine, Model 2DR, is shown below

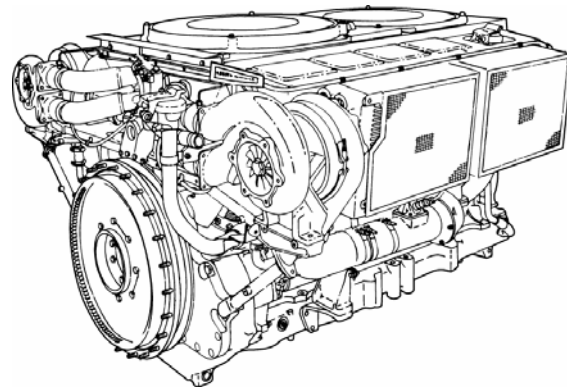
### Directional Terms

Directional terms for the AVDS-1790 engine Models 2CA, 2DA, and 2DR are referenced as follows:

- When facing the damper end (the front end) of the engine,
  - The engine left side is your left side;
  - The engine right side is your right side.



Damper (Front) Right View



Flywheel (Rear) Left View

### Numbering of Cylinders and Main Bearings

Beginning at the damper end (the front), the left bank of cylinders is numbered 1L through 6L, and the right bank of cylinders is numbered 1R through 6R.

Starting at the damper end (the front), the main bearings are numbered 1 through 7.

The cylinders, pistons, connecting rods, and connecting rod bearings are numbered with their respective cylinder number locations.

**LOCATION AND DESCRIPTION**

The Location and Description part of this work package consists of three parts:

**Location and Description - Major Components**

Location and Description of Major Components presents views of the AVDS-1790 engine, Models 2CA, 2DA, and 2DR and identifies the location of major components.

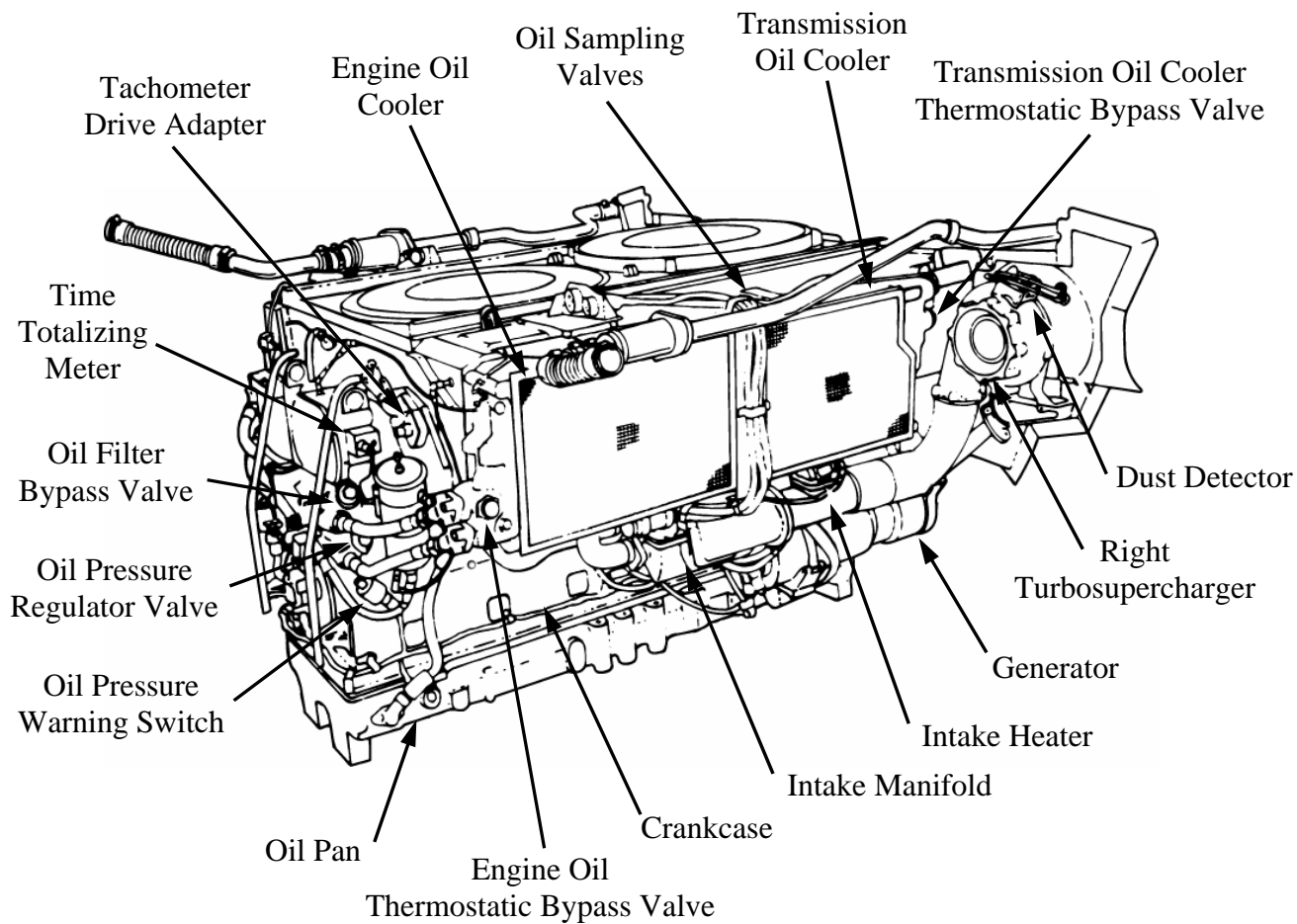
**Location and Description - Engine Major Working Parts  
(ILLUSTRATIONS on following pages)**

Location and Description of Engine Major Working Parts.

**Location and Description - Container Assembly**

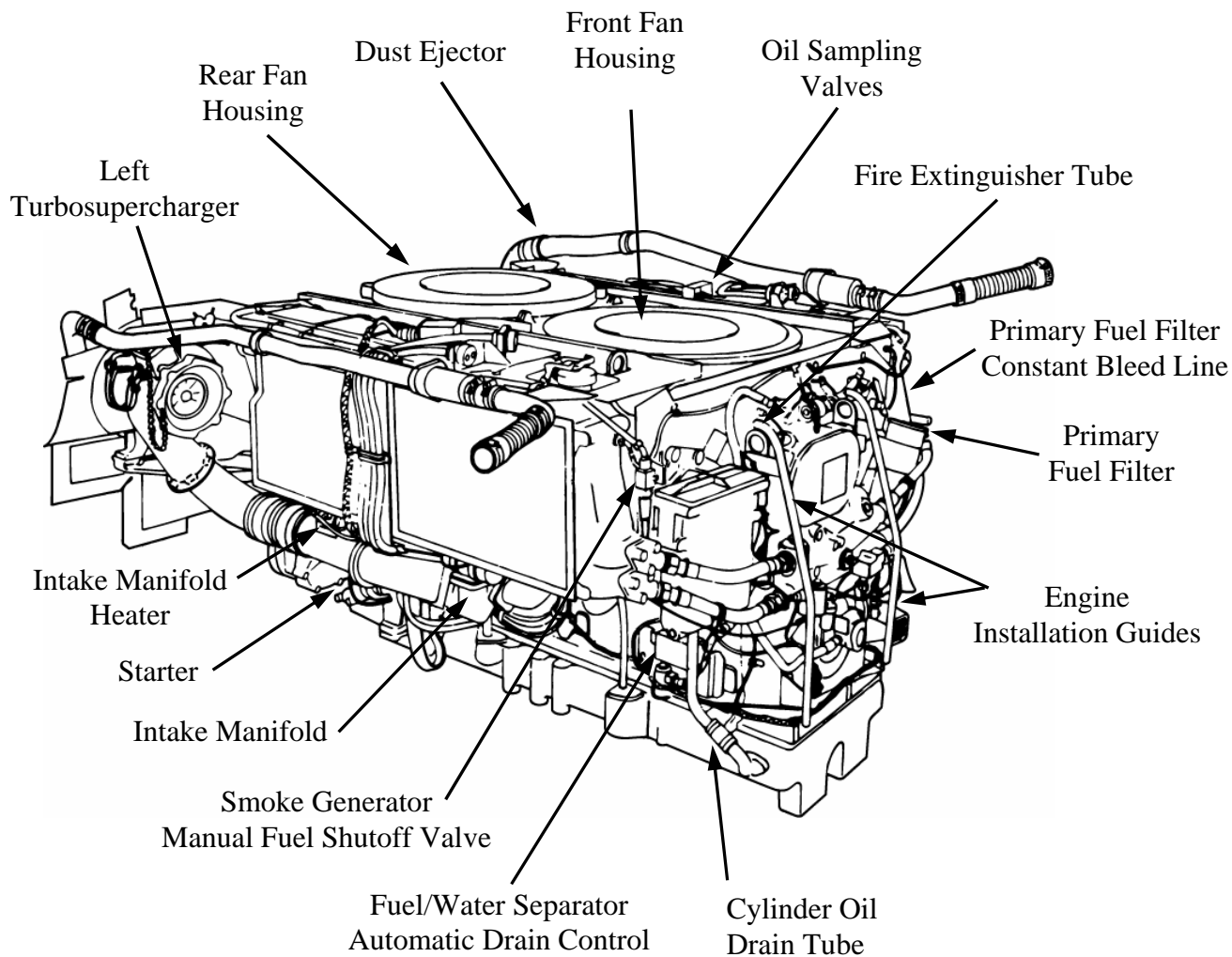
Location and Description of Container Assembly illustrates the shipping and storage container assembly and parts.

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



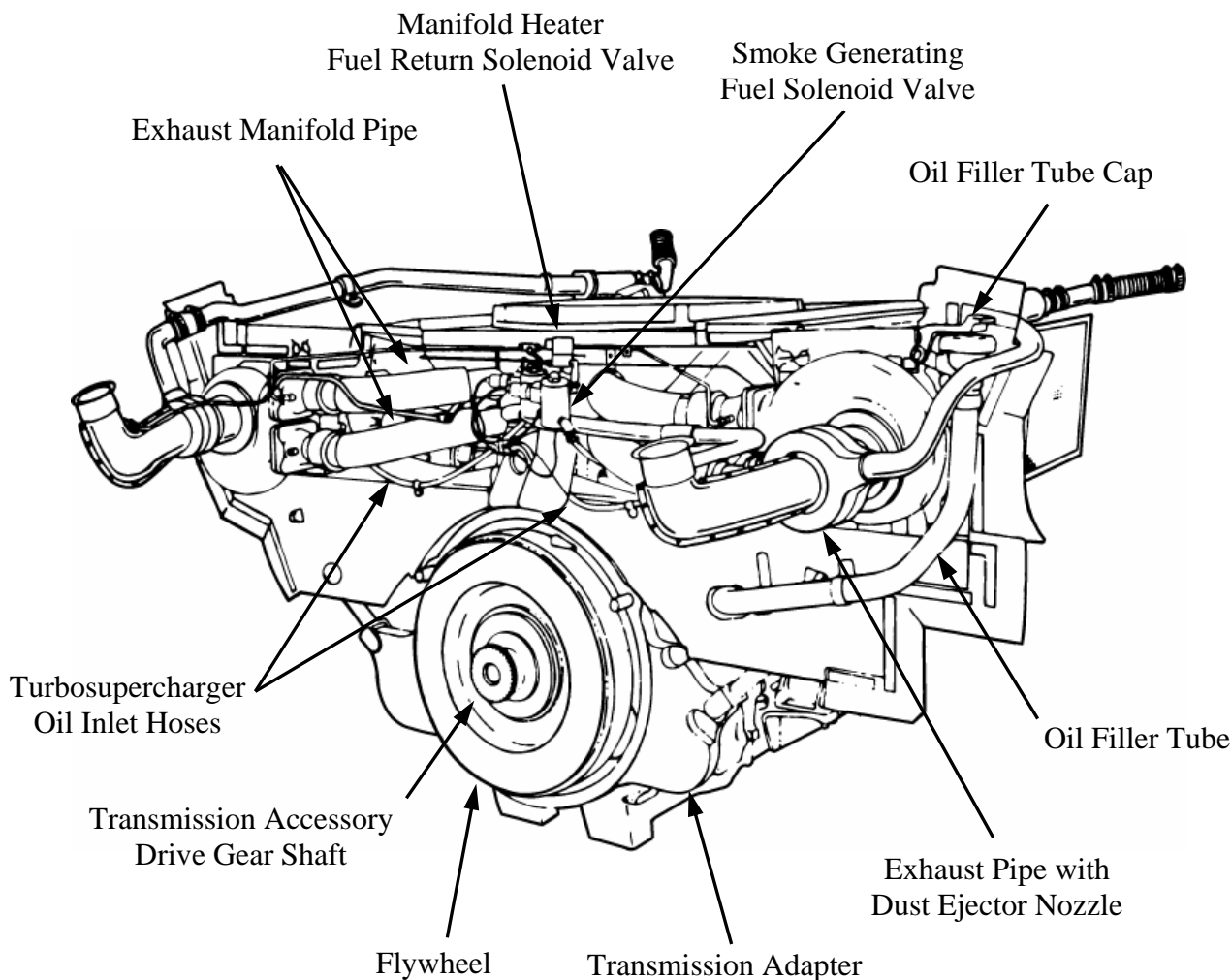
Model 2CA  
Right Front View

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



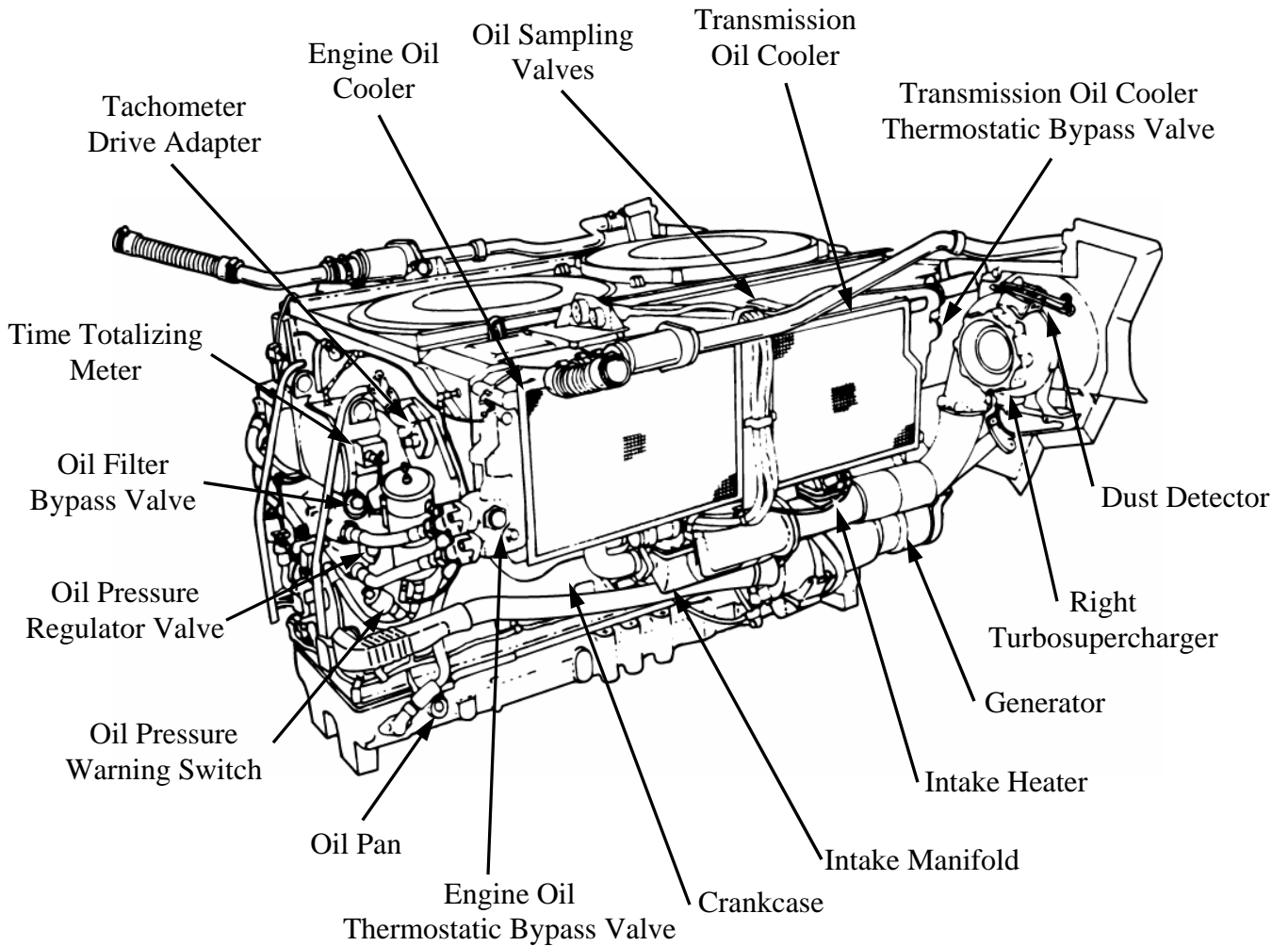
Model 2CA  
Left Front View

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



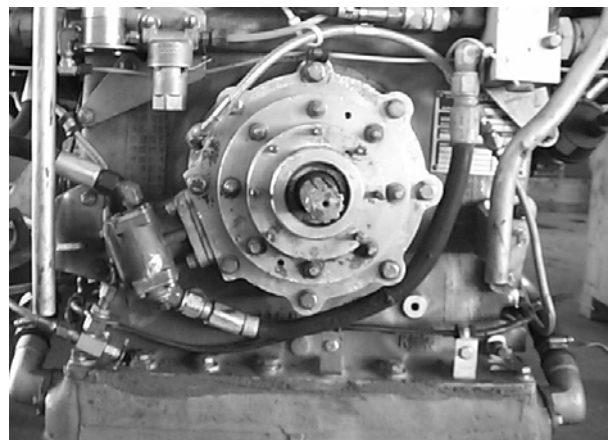
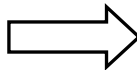
Model 2CA  
Rear View

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)

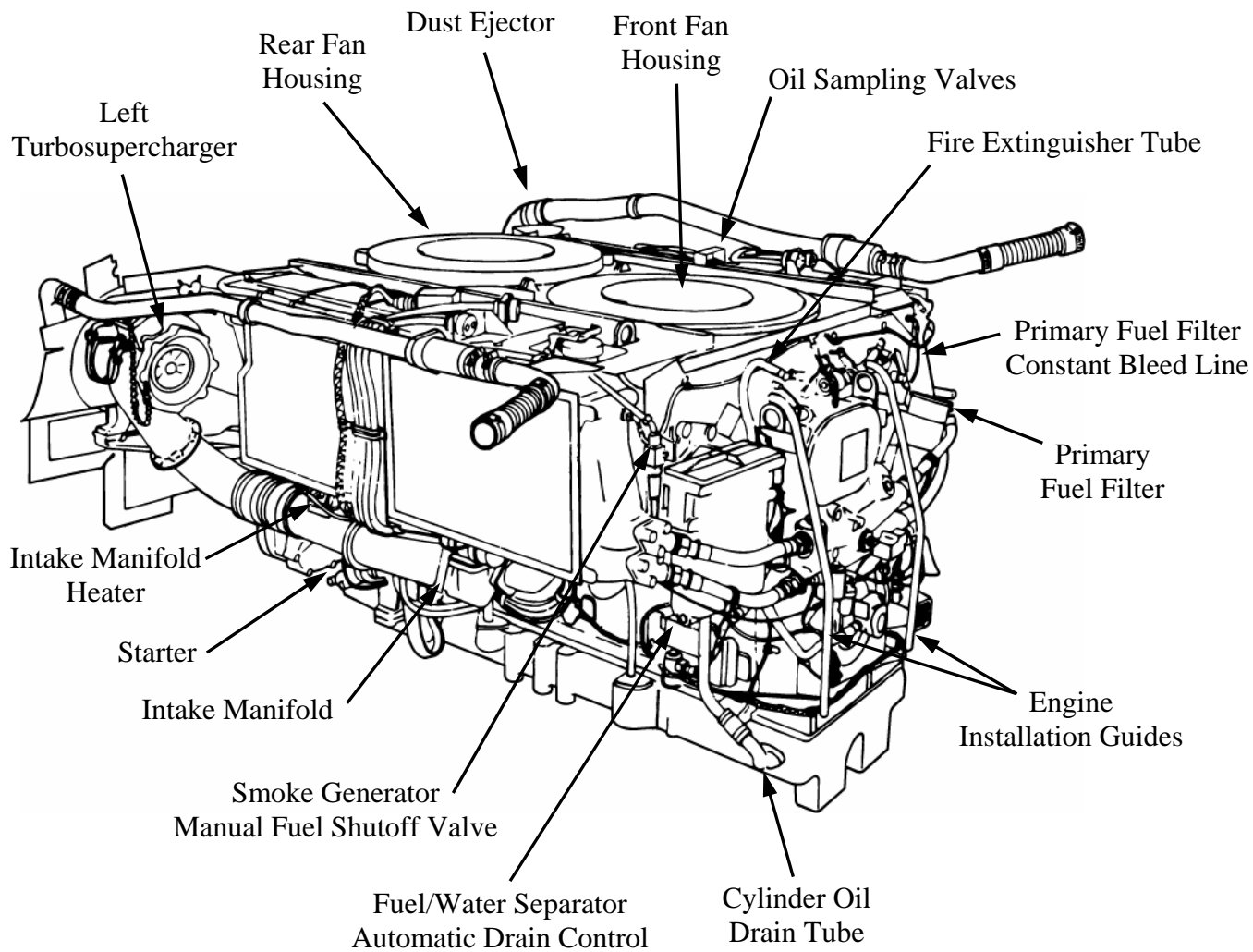


Model 2DA - Right Front View

2DA engine with  
aftermarket PTO installed  
for AVLB application



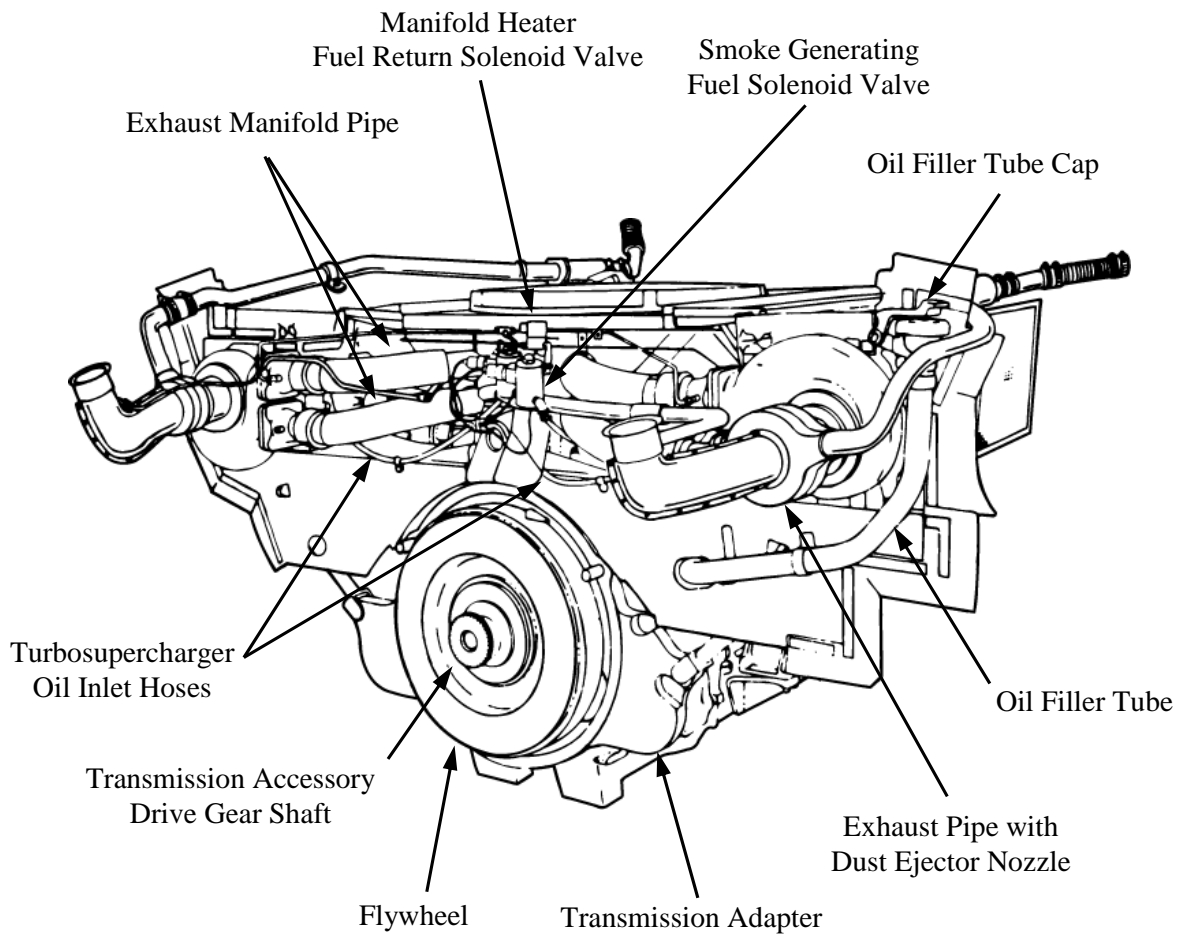
LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



Model 2DA  
Left Front View

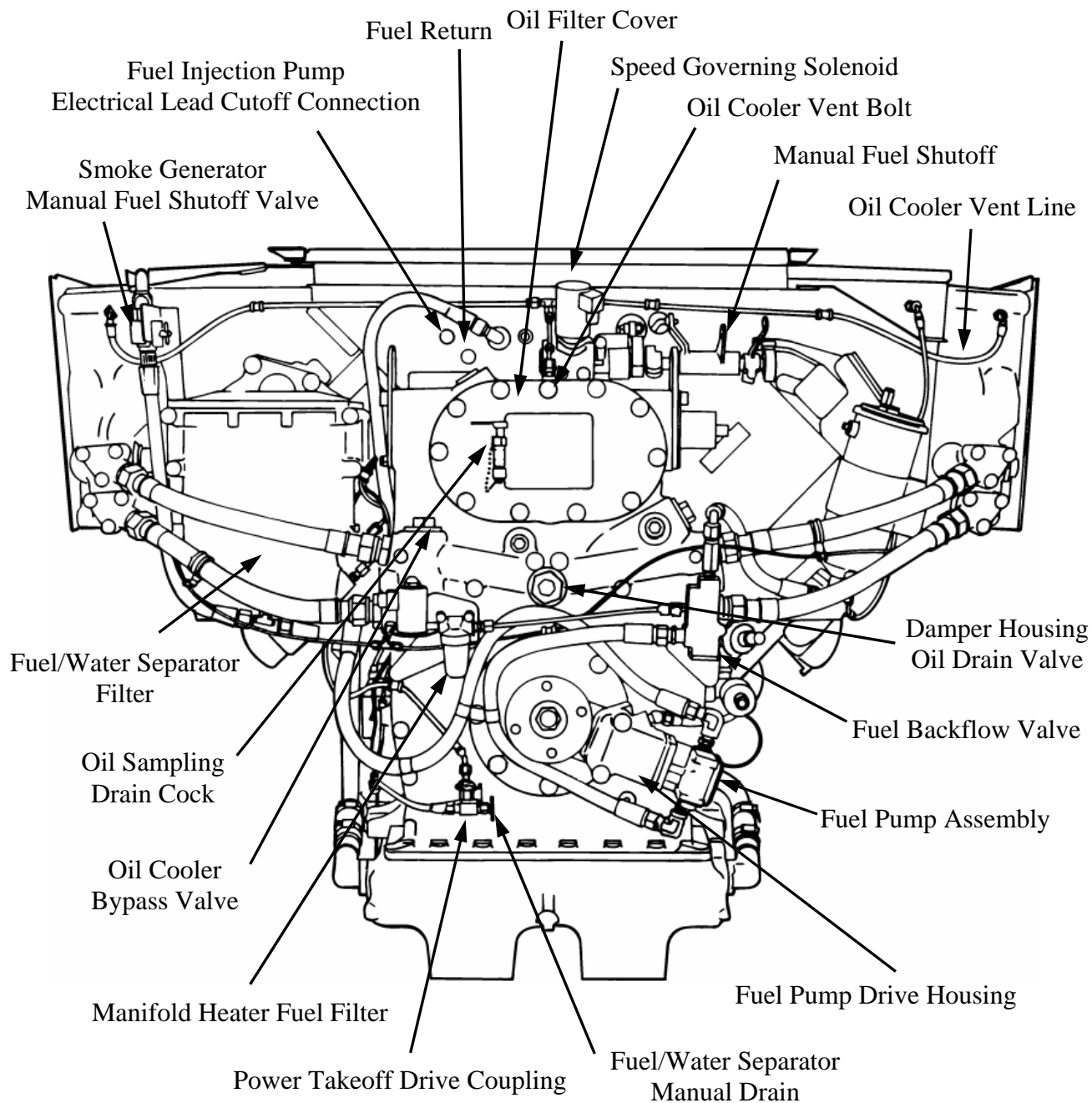


LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



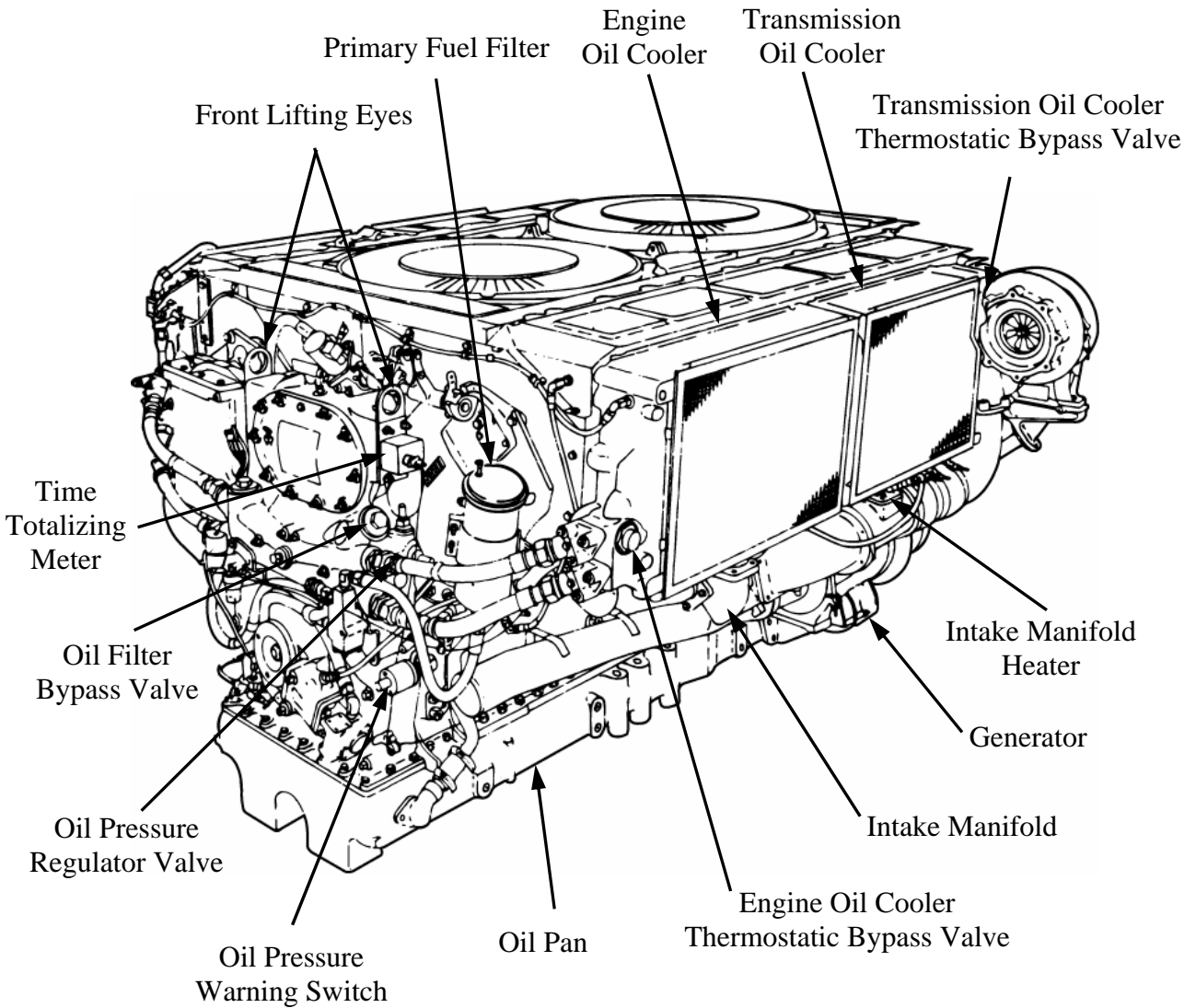
Model 2DA  
Rear View

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



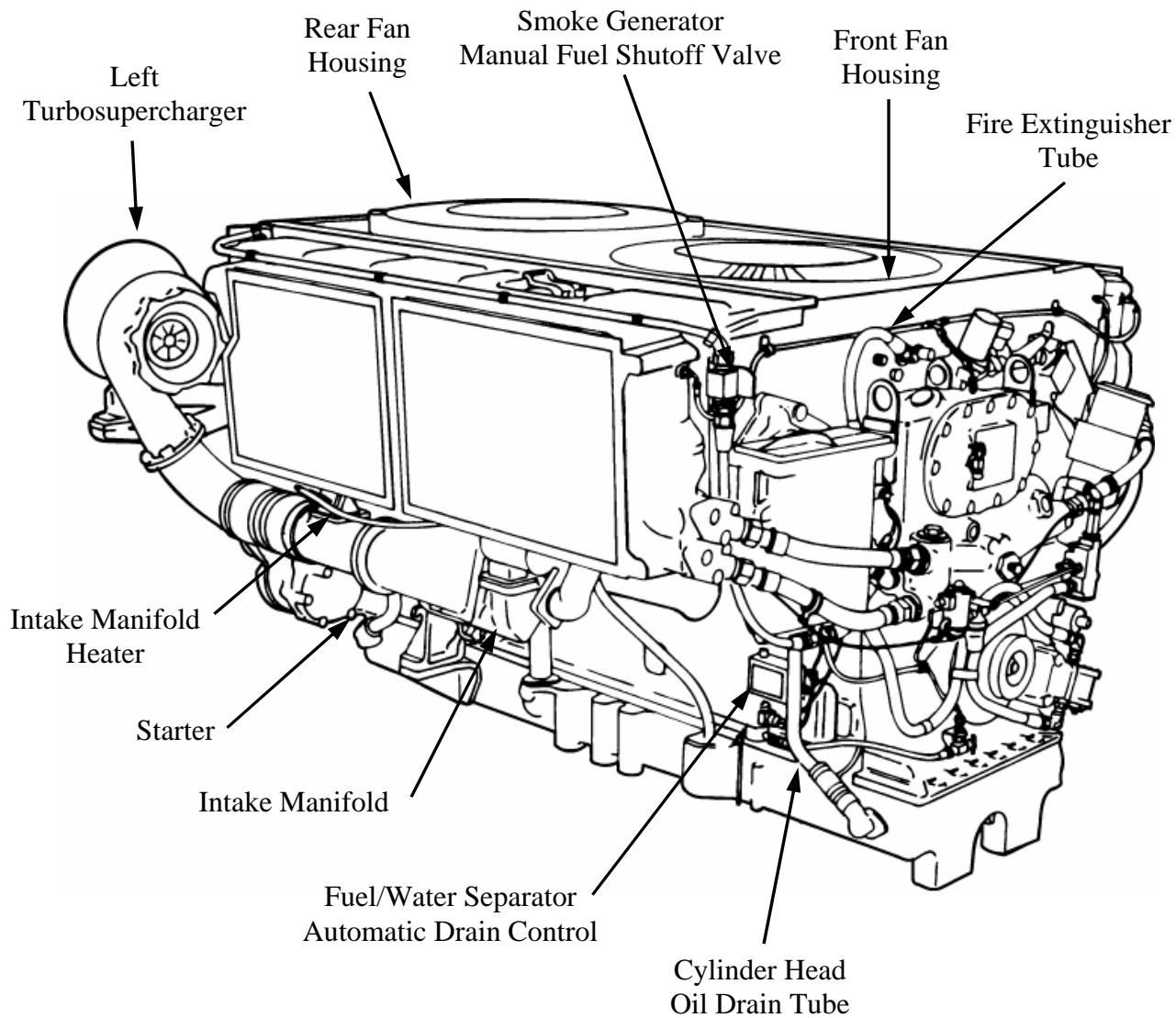
**Model 2DR  
Front View**

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)



Model 2DR  
Right Front View

LOCATION AND DESCRIPTION - MAJOR COMPONENTS (Continued)

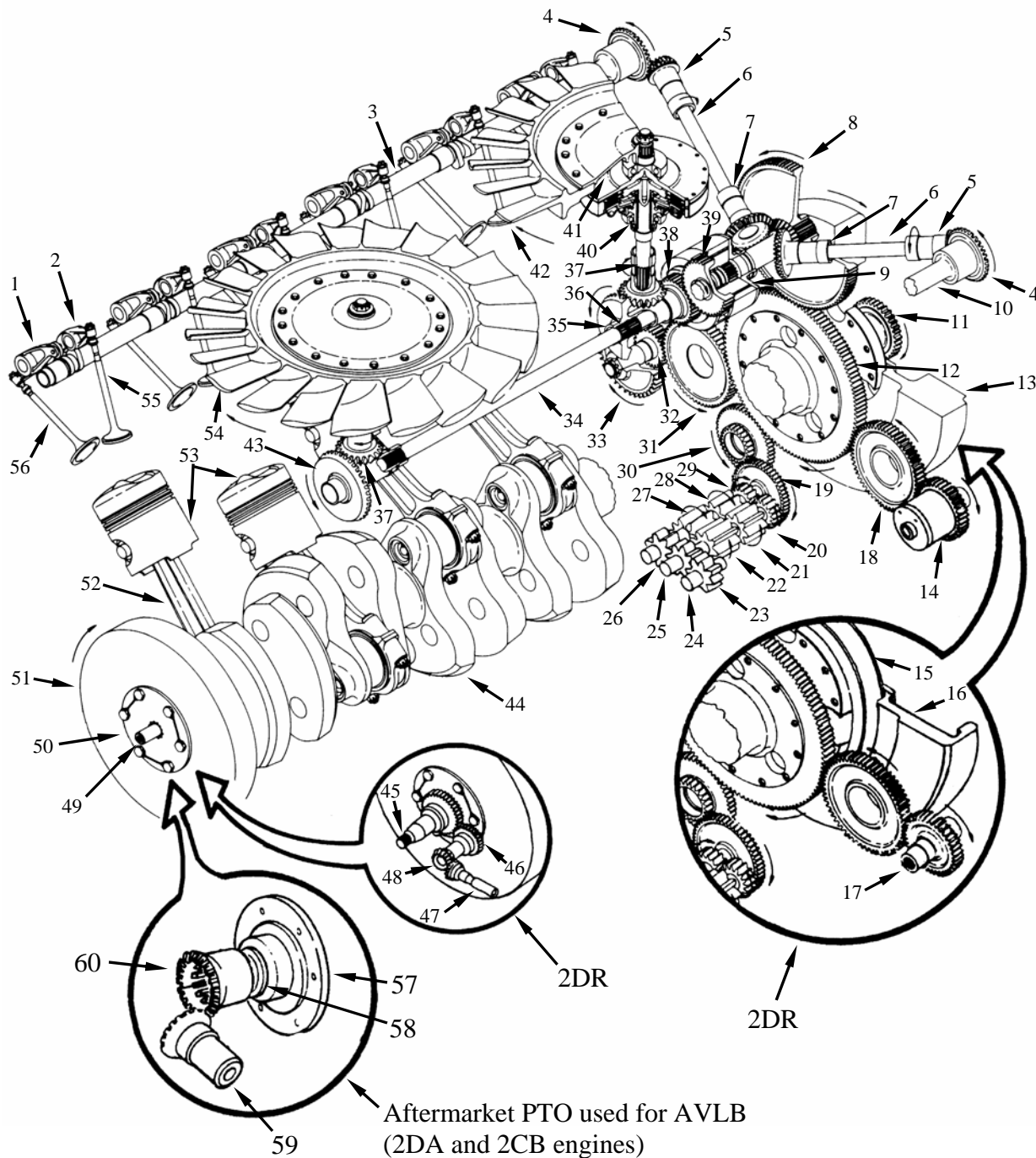


Model 2DR  
Left Front View



LOCATION AND DESCRIPTION - ENGINE MAJOR WORKING PARTS

The item called out in the illustration starts top left on the illustration and continues clockwise.



## LOCATION AND DESCRIPTION - ENGINE MAJOR WORKING PARTS (Continued)

## Legend

1	Intake valve rocker arm assembly	31	Starter idler gear
2	Exhaust valve rocker arm assembly	32	Starter-driven gear shaft
3	Left camshaft assembly	33	Starter drive gear
4	Camshaft driven gear	34	Front fan drive shaft
5	Camshaft drive gear shaft	35	Fan drive bevel gear shaft
6	Camshaft drive shaft	36	Rear fan drive shaft
7	Camshaft drive bevel gear shaft	37	Fan driven gear shaft
8	Accessory drive gear shaft assembly	38	Fuel injection pump drive gear shaft
9	Fuel injection pump advance assembly	39	Fuel injection pump driven shaft gear
10	Right camshaft assembly	40	Fan drive clutch assembly
11	Transmission accessory drive gear shaft	41	Cooling fan adapter
12	Accessory drive gear	42	Rear cooling fan assembly
13	Flywheel	43	Fan drive bevel gear shaft
14	Generator (650 ampere) drive gear shaft	44	Crankshaft assembly
15	Flywheel adapter (2DR)	45	Power takeoff gear shaft (2DR)
16	Flywheel (2DR)	46	Fuel pump drive gear (2DR)
17	Generator (300 ampere) drive gear shaft	47	Fuel pump driven gear (2DR)
18	Generator idler gear	48	Fuel pump drive idler gear (2DR)
19	Oil pump driven gear	49	Fuel supply pump drive
20	Level control oil pump driven impeller	50	Fuel supply pump drive adapter
21	Pressure oil pump driven impeller	51	Crankshaft torsional vibration damper
22	Scavenge oil pump driven impeller	52	Connecting rod assembly
23	Make up oil pump driven impeller	53	Piston
24	Make up oil pump drive shaft	54	Front cooling fan assembly
25	Oil pump driven impeller shaft	55	Exhaust valve
26	Make up oil pump drive impeller	56	Intake valve
27	Scavenge oil pump drive impeller	57	Adapter
28	Pressure oil pump impeller drive shaft	58	Shaft, shouldered
29	Level control oil pump drive impeller	59	Gear shaft
30	Oil pump drive gear	60	Gear shaft

**LOCATION AND DESCRIPTION - CONTAINER ASSEMBLY**

This engine container assembly is used for the AVDS-1790 engine, Models 2CA, 2DA, and 2DR. To remove or install an engine in the container, refer to WP 0095.

The national stock number for the engine container is: 8145-00-856-8147

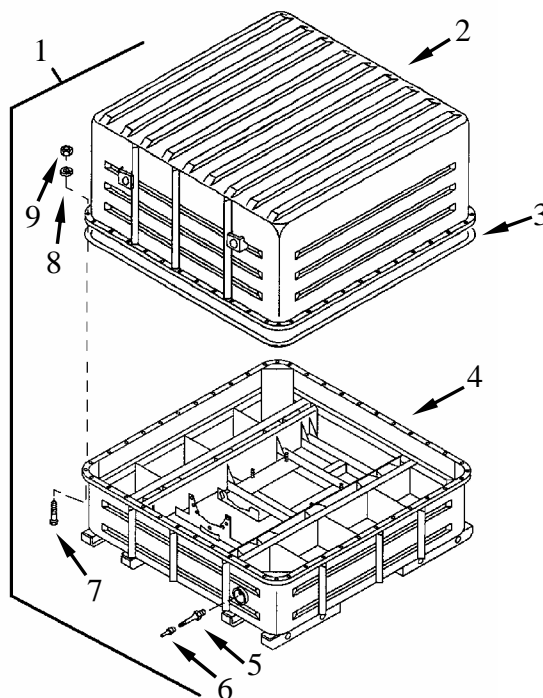
The part number for the engine container is: 10912269

**Characteristics:**

- Provides protective two-piece housing for engine.
- Provides controlled environment during shipping and storage.

**Capabilities and Features**

- Container is hermetically sealed
- Engine can be stored in container with no harmful effect from temperature.
- Container is reusable.



**Legend**

- |                             |                    |
|-----------------------------|--------------------|
| 1 Engine Container Assembly | 6 Valve core       |
| 2 Upper container           | 7 Screw (48)       |
| 3 Gasket                    | 8 Lock washer (48) |
| 4 Lower container           | 9 Nut (48)         |
| 5 Pneumatic valve           |                    |



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**EQUIPMENT DESCRIPTION AND DATA**

**0002 00**

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**END ITEM APPLICATION**

**Engines: AVDS-1790-2CA and -2DA**

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<b>Vehicle</b>	<b>TM Number</b>
Tank, Combat, Full Tracked: 105-MM Gun, M48A5	9-2350-258
Tank, Combat, Full Tracked: 105-MM Gun, M60 and M60A1	9-2350-215
Tank, Combat, Full Tracked: 105-MM Gun, M60A1 (RISE)	9-2350-257
Tank, Combat, Full Tracked: 152-MM Gun, M60A2	9-2350-232
Tank, Combat, Full Tracked: 105-MM Gun, M60A3	9-2350-253
Armored Vehicle Launched Bridge: M48A2 AVLB	5-5420-200
Armored Vehicle Launched Bridge: M60A1 AVLB	5-5420-202
Armored Vehicle Launched Bridge: M48A5 AVLB	5-5420-226
Vehicle, Combat Engineer, Full Tracked: M728	9-2350-222

**Engine: AVDS-1790-2DR**

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<b>Vehicle</b>	<b>TM Number</b>
Recovery Vehicle, Full Tracked: Medium, M88A1	9-2350-256

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Engine configuration, drive ratios and rotation (from front), settings; clearances, and shipping/storage container

**ENGINE**

Make ..... General Dynamics Land Systems  
 Type ..... Diesel, air-cooled, V-12  
 Models ..... AVDS-1790-2CA, 2DA, and 2DR

**Configuration**

Camshafts:

Number ..... 2  
 Rotation (viewed from front) ..... counterclockwise

Cooling:

Type ..... air cooled (two engine-driven fans)  
 Air Flow ..... 20,000 cfm at 2400 rpm

Crankshaft rotation (viewed from front) ..... clockwise

Cylinders:

Number ..... 12  
 Arrangement ..... 90-degree upright V  
 Numbering (from front):  
 Left side ..... 1L, 2L, 3L, 4L, 5L, 6L  
 Right side ..... 1R, 2R, 3R, 4R, 5R, 6R  
 Firing order ..... 1R, 2L, 5R, 4L, 3R, 1L, 6R, 5L, 2R, 3L, 4R, 6L  
 Bore ..... 5.750 inch

Dimensions, including shroud:

Length (to transmission adapter):  
 Models AVDS-1790-2CA and -2DA ..... 68.59 inch  
 Model AVDS-1790-2DR ..... 72.50 inch  
 Width (overall, shrouds installed):  
 Models AVDS-1790-2CA and -2DA ..... 88.74 inch  
 Model AVDS-1790-2DR ..... 70.25 inch  
 Height:  
 Model AVDS-1790-2CA and -2DA ..... 47.19 inch  
 Model AVDS-1790-2DR ..... 45.30 inch

Displacement ..... 1790 cubic inch

Drive (from crankshaft) ..... Direct

**ENGINE, Configuration (Continued)**

Fuel:

Type ..... JP-8  
 Specification ..... MIL-DTL-83133  
 Supply pressure (at injection pump inlet) ..... 55-60 psi  
 Consumption at 750 hp and 2400 rpm ..... 305 pounds per hour

Fuel System:

Induction ..... supercharged  
 Air flow (at rated power and speed) ..... 2000 cfm

Horsepower:

Gross ..... 735 to 780 brake horsepower at 2400 rpm  
 Net ..... 642 brake horsepower at 2400 rpm

Ignition ..... compression

Lubrication:

Normal oil temperature ..... 180 °F at 60 °F ambient  
 Maximum oil temperature (out of cooler) ..... 250 °F

Manifold heater (cold weather starting and idle operation in cold weather):

Type ..... flame-type spark ignition  
 Spark plug (ignition) gap ..... 0.094 to 0.114 inch  
 Pump (hand operated from driver's compartment) ..... 90 psi  
 Spray nozzle flow ..... 1.5 to 2.2 pounds per hour  
 Fuel (type) ..... same as engine fuel

Oil

Capacity (approximate):

Dry engine ..... 20.0 gallons  
 Oil and filter change ..... 17.0 gallons  
 Oil type ..... lubricating  
 Specification ..... MIL-L-45199, Grade 2 (OE30)

Oil pressure (crankcase main oil gallery):

700 rpm ..... 15 psi (SAE 30 oil at 140 to 250 °F)  
 2400 rpm ..... 40 to 70 psi (SAE 30 oil at 180 °F)

Oil Pump (high volume) output, (SAE 30 oil at 170-180 °F at 2400 rpm engine speed):

Leveling Pump (minimum flow) ..... 32 gpm  
 Pressure Pump (minimum flow) ..... 97 gpm  
 Scavenge Pump (minimum flow) ..... 121 gpm  
 Reserve Pump ((minimum flow) ..... 17 gpm

Pistons:

Stroke ..... 5.750 in.  
 Compression ratio ..... 16:1  
 Displacement ..... 149.1 cubic inches per cylinder

**ENGINE, Configuration (Continued)**

Speed:

Governed, full load .....	2400 rpm
Governed, no load.....	2260 rpm (max)
Idle .....	700 rpm
AVLB launch speed: Models 2CB and 2DA.....	1500-1800 rpm
Winching speed: Model 2DR .....	1800 ±25 rpm, no load

Torque:

Gross .....	1770 to 1842 foot pounds at 1800 rpm
Net.....	1585 foot pounds at 1800 rpm

Weight, dry (with accessories):

Models AVDS-1790-2CA and -2DA.....	4998 pounds
Model AVDS-1790-2DR .....	4925 pounds

**Drive Ratios and Rotation (From Front)**

Camshafts .....	0.500:1 counterclockwise
Cooling fans.....	2.000:1 clockwise
Generator .....	3.200:1 clockwise
Starter .....	11.846:1 clockwise
Fuel injection metering pump.....	1.000:1 clockwise

Fuel supply pump:

Models AVDS-1790-2CA and -2DA .....	1.000:1 clockwise
Model AVDS-1790-2DR.....	1.000:1 counterclockwise

Power takeoff:

Model AVDS-1790-2DR.....	1.000:1 clockwise
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Oil pump .....	1.327:1 clockwise
Tachometer drive.....	0.500:1 counterclockwise

**Settings**

Valve timing:

Intake opens .....	25 degrees BTC (before top center)
Intake closes.....	55 degrees ABC (after bottom center)
Intake remains open .....	260 degrees
Exhaust opens .....	45 degrees BBC (before bottom center)
Exhaust closes.....	20 degrees ATC (after top center)
Exhaust remains open .....	245 degrees
Setting (0.100 in. clearance) .....	intake closes 32 degrees ABC (after bottom center)

**ENGINE, Settings (Continued)**

Valves:

Lift.....	0.460 inch
Clearance (cold engine):	
Exhaust.....	0.025 inch
Intake.....	0.010 inch

Fuel injection metering pump timing:

Static setting with injection advance in fuel retarded position .....	26 degrees BTC
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**CLEARANCES**

**Turbocharger Clearances:**

1. Turbine and compressor wheel end play ..... 0.0015 – 0.0060 inch
2. Compressor wheel back clearance ..... 0.0190 – 0.0220 inch
3. Compressor wheel to cover clearance ..... 0.0140 – 0.0160 inch

**Miscellaneous Clearances:**

1. Clearance on thrust bearing No. 4 main  
    (between bearing & crankcase) ..... 0.004 – 0.008 inch
2. Side clearance limits of connecting rods on crankshaft ..... 0.009 – 0.017 inch
3. Crankshaft end-play limits ..... 0.007 – 0.015 inch
4. Flywheel run-out limits ..... 0.000 – 0.015 inch
5. Side clearance between rocker arms & rocker covers: Exhaust..... 0.006 – 0.014 inch  
    Intake..... 0.006 – 0.014 inch
6. Valve clearance (right & left side) ..... Intake set at ..... 0.010 inch  
    Exhaust set at..... 0.025 inch
7. Fan blade tip clearance in fan housing ..... 0.062 inch minimum

**SHIPPING/STORAGE CONTAINER**

Accommodated equipment identifying number .....	AVDS-1790-2 Model Number
End item identification .....	shipping and storage container, engine
Material.....	steel
Mounting surface plane .....	parallel
Overall height .....	5.145 feet nominal
Overall length .....	7.459 feet nominal
Overall width .....	7.459 feet nominal
Shape.....	rectangular
Storage/shipment condition .....	hermetically sealed
Surface treatment.....	enamel

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Engine description, general theory of operation, and theory of operation for engine systems, components, and transmitters

**ENGINE DESCRIPTION**

The AVDS-1790-2 Series engines are air-cooled, 4-cycle, 12-cylinder, fuel injected, turbosupercharged diesel engines. They are rated at 750 gross horsepower at 2400 rpm. The engines are of the 90-degree upright Vee configuration and have overhead valves with a separate overhead camshaft for each cylinder bank. Extensive use of aluminum components throughout the engine provides for a high power-to-weight ratio.

The front of the engine is the damper housing end and the rear of the engine is the flywheel end. When viewed from the front looking towards the rear, the side to the right is the right side of the engine, and the side to the left is the left side of the engine.

The air-cooled design of the AVDS-1790-2 Series engine has eliminated the maintenance burden of liquid type cooling systems. Two engine-driven fans producing airflow of approximately 20,000 cfm at 2400 engine rpm provide this air cooling.

The engine can operate while totally submerged in water with the aid of a snorkel. It can be started and operated at extreme temperatures ranging from -25 to +125 °F (-32 to +52 °C).

The compact design of the AVDS-1790 series engine includes individual and easily replaceable cylinders arranged in two banks of six each. All scheduled maintenance items are easily accessible from the top of the engine.

Electronic sensors protect the engine electrical system and internal components from damage should electrical overload or lubrication deficiencies occur. In addition to these operational safety devices, a Dust Detector/Ejector System to protect the engine is provided on Model 2CA and 2DA engines.

The Dust Detector System incorporates a sensor mounted on each turbosupercharger that monitors the induction air to detect the presence of dust. Each turbosupercharger uses a special housing that includes an orifice and a filter strip. Engine induction air from the intake manifold circulates through the filter strips. When the filter strip(s) become restricted from dust ingestion a pressure switch activates automatically, signaling the operator.

The Dust Ejector System uses engine exhaust gas velocity to produce a scavenging action through the system. Engine exhaust flowing through ejector nozzles produces a pressure differential which creates air flow for the scavenging action of the vehicle pre-cleaner. The dust-laden scavenge air flows through the ejector nozzles, mixes with the exhaust gases, and exits through the exhaust pipes. The exhaust pipe cap assemblies prevent the back-flow of exhaust gases and/or water entry during fording operations.

**ENGINE DESCRIPTION (Continued)**

The starter is protected by a Low Voltage Protective Module. Whenever battery voltage is below 12.3 volts, the module prevents the starter from activating. This prevents starter damage from low voltage and also preserves the remaining battery power for operation of the vehicle communication system in case of emergency.

The use of quick-release fuel and electrical connectors permit the engine to be performance checked in the vehicle or easily "ground-hopped" outside the vehicle.

**GENERAL THEORY****Energy:**

All engines convert chemical energy of fuel into mechanical energy (motion) which may be used in various ways including moving a vehicle or driving an electric generator.

**Combustion:**

The primary characteristic that distinguishes diesel engines from other internal combustion engines is the method of fuel ignition. In diesel engines, the fuel is injected into the combustion chamber during a time when it is charged with extremely hot compressed air. When the fuel enters the chamber, it ignites without an externally made spark. Another name for diesel engines is compression ignition engines.

**Fuel Distribution:**

Fuel injection nozzles and a fuel injection pump replace the distributor, coil, and spark plugs required by gasoline engines, because no externally made spark is required for diesel engines. The fuel injection pump pressurizes the fuel and determines when it is to be sprayed into the chamber by the injection nozzles.

**Compression:**

Since no fuel is mixed with air until after the air has been compressed, diesel engines can develop a much higher compression ratio than other engines. In the AVDS-1790-2 series engine, air is compressed to one-sixteenth of its original volume, giving a compression ratio of 16 to 1. The higher compression ratio of the diesel engine allows it to achieve greater fuel efficiency. An important feature of the higher compression is the fact it allows the engine to operate efficiently on a heavier and cheaper fuel than gasoline.

**Construction:**

Because diesel engines operate under higher pressure and temperatures, it must be constructed of stronger and heavier material than that used for gasoline engines.

**Stopping:**

Since there is no electric spark to cause ignition, there is only one practical way to shut off a diesel engine once it starts running. The way that diesel engines are normally shut off is to stop the fuel from being injected in the cylinder and thus "starve" combustion until the engine stops running. The AVDS-1790-2 Series engines are equipped with both mechanical and electrical fuel shut-off capabilities.



**GENERAL THEORY (Continued)****Basic Four-Cycle Engine Operation:**

Four-cycle (four-stroke) engines fire every other time the piston reaches Top Dead Center (TDC). This means that the crankshaft makes two revolutions and the piston makes four strokes, one stroke up, and one stroke down per revolution.

The first cycle is the intake stroke, or suction stroke. The stroke begins with the exhaust valve closed and the intake valve open. As the crankshaft rotates, it pulls the connecting rod down and piston down. A vacuum is created as the piston moves down the cylinder, and this vacuum draws a charge of fresh air into the cylinder. When the piston reaches Bottom Dead Center (BDC), the intake valve closes.

The second cycle is the compression stroke. The stroke begins as the crankshaft rotates enough to force the connecting rod and piston upward. Since the charge of air cannot escape, it is compressed until the piston reaches TDC. The temperature of the air charge is raised to 1,000 °F or more as a result of the high compression.

The third cycle is the power stroke. With the charge of air compressed and hot, fuel is sprayed into the cylinder through the fuel injection nozzle. The temperature causes the fuel and air to ignite beginning the power or working stroke. The resulting heat greatly increases the temperature, causing the gases to expand. As the gases expand, the piston is forced down. As the piston approaches BDC the fuel has completed burning and the exhaust valve opens. The gases are cooled considerably because of their expansion and release from pressure.

The fourth cycle is the exhaust stroke. When the piston starts upward, the exhaust stroke begins. With the exhaust valve open, all the burned gasses are expelled completing the four cycles and preparing the cylinder for the next cycle.

**Timing:**

For efficient operation, the timing of the valve action is engineered so that opening and closing do not exactly coincide with the piston reaching Top Dead Center (TDC) or Bottom Dead Center (BDC). The intake valves open 25 degrees before the piston reaches TDC and remains open for 260 degrees, closing at 55 degrees after the piston has passed BDC. Fuel is injected into the cylinder from 11 to 37 degrees before TDC depending on the injection advance unit, which in turn is controlled by engine speed. The exhaust valves open 45 degrees before BDC and remain open for 245 degrees, closing at 20 degrees after TDC. There are times during which both intake and exhaust valves are open (overlap).

**ENGINE SYSTEMS**

The AVDS-1790-2 series engine has been divided into six interrelated major systems.

**1. Fuel System**

The overall function of the fuel system is to deliver the proper amount of clean fuel to the cylinders at the correct time. The system must also provide a safe place to store the fuel and a safe method of transferring it from storage to the cylinder. The major components of this system include:

**ENGINE SYSTEMS (Continued)****1. Fuel System (Continued)**

- Fuel tanks, which store the fuel
- Fuel transfer pumps, which move fuel from the tanks to the fuel injection pump
- Fuel filters, which help keep the fuel clean
- Fuel injection pump, which times, meters, and pressurizes fuel delivered to the fuel nozzles
- Fuel injection nozzles, which atomizes and injects fuel into the cylinders.

**2. Induction System**

The function of the intake system is to supply the engine with the proper amount of clean air at the proper temperature for good combustion. The four components of the intake system are:

- Air cleaners - The air cleaners prevent dust and dirt from entering the combustion chamber and damaging the engine.
- Turbosuperchargers - The turbosuperchargers are driven by exhaust gases and compress more air into the cylinders than would be possible through natural aspiration. This greatly increases engine horsepower.
- Intake manifolds - The intake manifolds conduct the air to the intake valves of the engine. The intake manifolds also have heaters in them to help start the engine in cold weather.
- Intake valves - The intake valves allow entry of combustion air into the cylinders.

**3. Exhaust System**

The exhaust system performs three functions, it:

- Removes heat from the engine.
- Provides power to drive the turbosupercharger.
- Carries exhaust gases from the cylinders to the atmosphere via the exhaust valves and the exhaust manifold.

**4. Electrical System**

The electrical system provides three functions:

- Battery power to crank the engine.
- Electricity from the generator to operate the various accessories when the engine is running.
- Controls and monitors engine operation through various sensors.

**5. Cooling System**

The function of the cooling system is to carry away heat generated by engine combustion. The major components of the cooling system are:

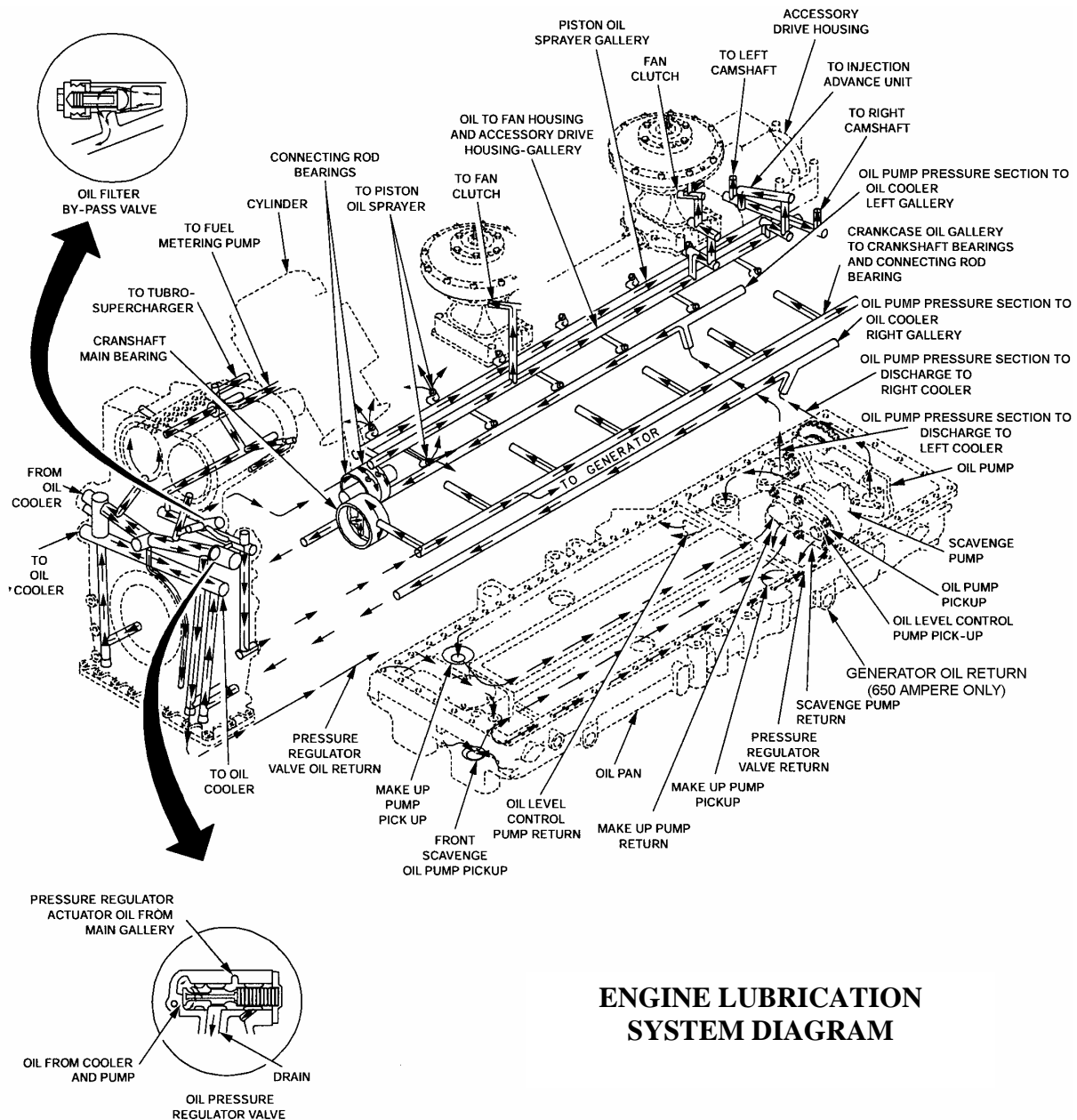
- Cooling fans.
- Oil coolers (heat exchangers).
- Cylinder cooling fins.

**ENGINE SYSTEMS (Continued)****6. Lubrication System**

The lubrication system has five functions, it:

- Reduces friction between moving parts.
- Absorbs and dissipates heat.
- Seals piston rings to cylinder walls.
- Cleans and flushes parts.
- Helps reduce operating noises of the engine.

The engine oil pump produces pressurized oil that is forced through the engine oil coolers and oil filters to the engine oil galleries, bearings, turbosuperchargers, fuel injection metering pump and to the piston oil sprayer nozzles. These sprayer nozzles are located in the crankcase below each cylinder and provide a continuous oil spray to the pistons and cylinder walls. A pressure regulator valve, located on the right side of the crankshaft damper and oil filter housing, is influenced by the pressure in the main bearing oil gallery and returns the incoming excess unfiltered oil to the oil pan. Oil level is maintained by the leveling section of the oil pump allowing operation under all conditions such as cold oil and slope operation.

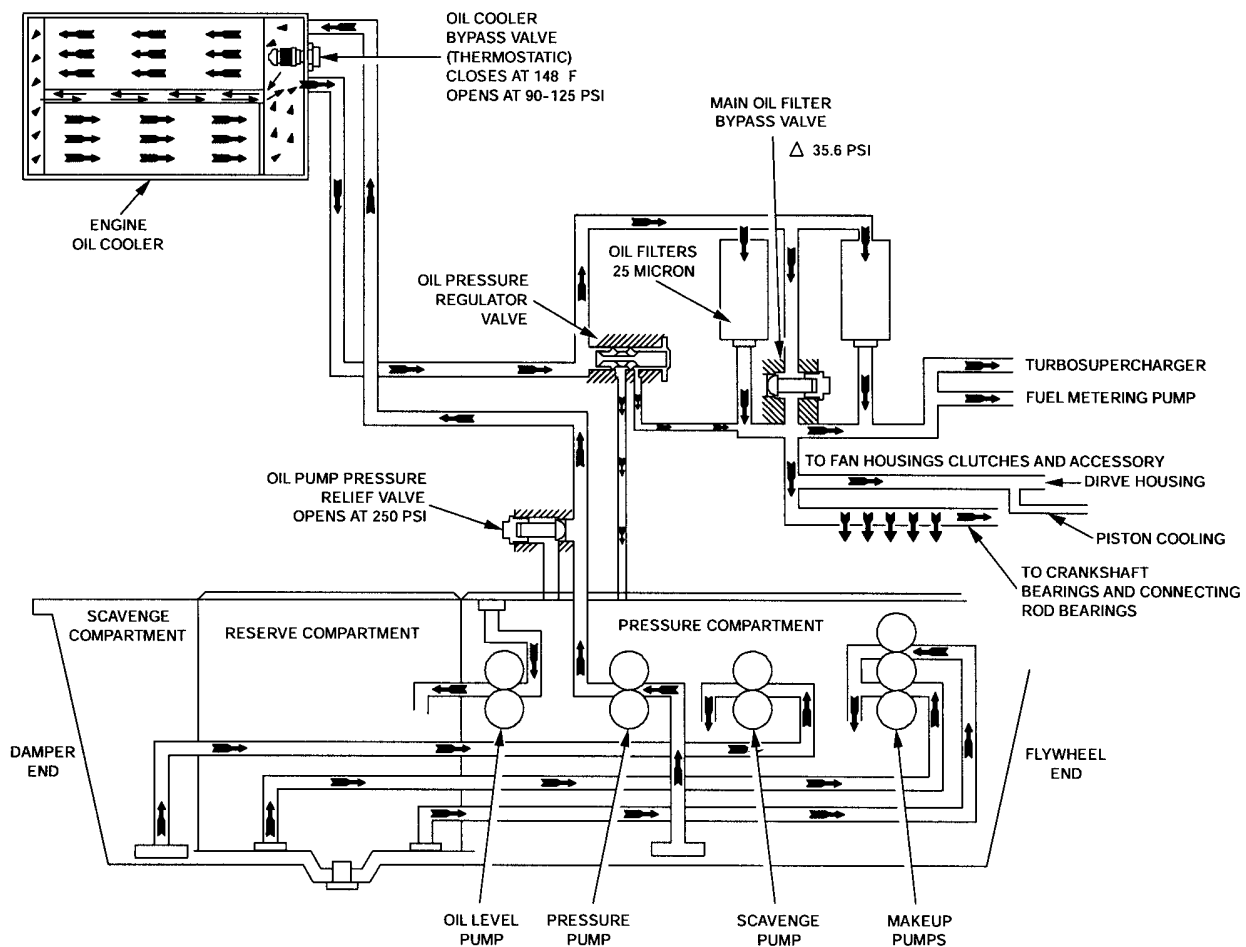


ENGINE LUBRICATION SYSTEM DIAGRAM

ENGINE SYSTEMS (Continued)

5. Lubrication System (Continued)

The following diagram illustrates engine oil flow. The oil level, pressure, scavenge, and makeup pumps are sections of the engine oil pump and are contained in a single unit.



ENGINE OIL FLOW DIAGRAM

**ENGINE SYSTEMS (Continued)****6. Mechanical System**

The mechanical system provides the entire drive train; it is the heart of the engine. Consisting of five major components, they are:

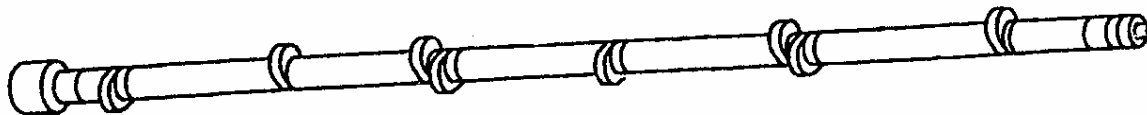
- Crankshaft assembly
- Connecting rod and piston assembly
- Cylinder and valves
- Camshafts
- Accessory drive subsystem

**ENGINE COMPONENTS**

The following engine components with a brief description of their functions are arranged in alphabetical order for ease of reference.

**Camshaft:**

The gear-driven shaft uses cam lobes (eccentrics) to operate the valves via the rocker arms. Left and right camshaft assemblies are mounted, one per engine bank, on the cylinders and operate the intake and exhaust valves. The camshafts are hollow to provide oil passages for pressure lubrication to the valve parts and to permit deflection when the cylinders fire. Tubular molded rubber hoses enclose the camshafts between cylinders.

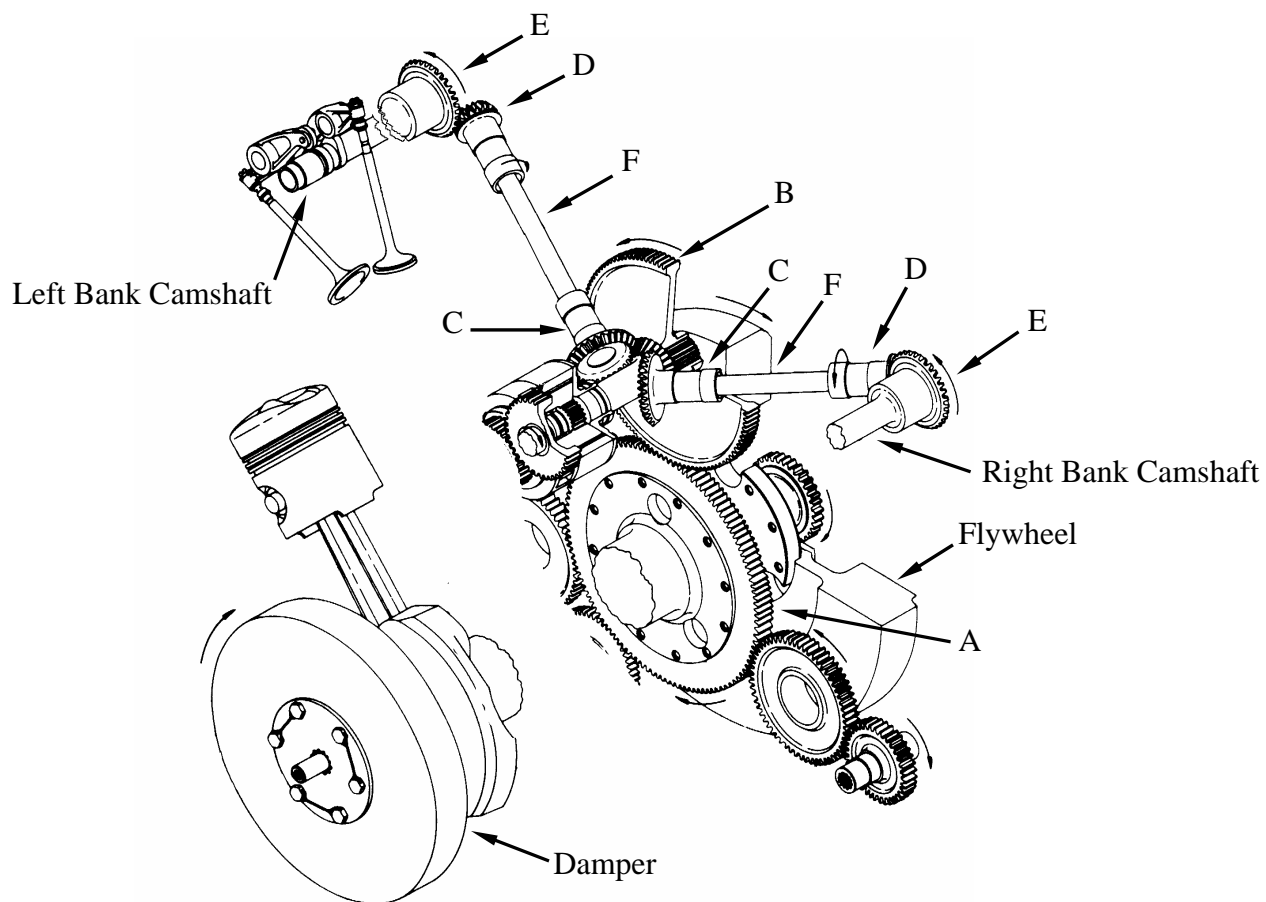


**ENGINE COMPONENTS (Continued)****Camshaft Timing Gears:**

The camshaft timing gears are a series of gears and shafts that transfer power from the crankshaft to drive the camshaft in such a way as to ensure the valves operate at the proper time.

The accessory drive gear (A) and accessory drive gear shaft assembly (B) drive both camshafts. Individual drive bevel gear shafts (C), camshaft drive gear shafts (D), and camshaft driven gear shafts (E) drive each camshaft through inclined quill-type drive shafts (F).

The quill shafts can be removed to permit separate rotation of the camshafts for engine timing. The quill shafts have different number of splines on each end that allows them to be inserted in the camshaft bevel gear shafts when camshafts are correctly positioned in relation to the crankshaft without disturbing the relationship between the camshafts and crankshaft.

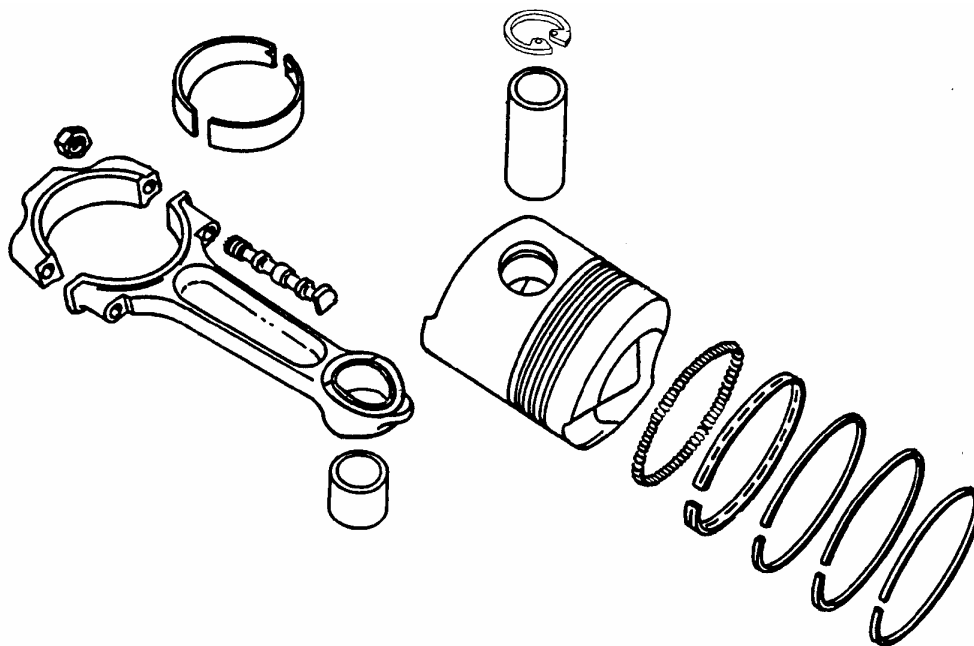


**ENGINE COMPONENTS (Continued)****Connecting Rod, Piston, and Piston Pin:**

Connecting Rod - The rod connects the piston to the crankshaft. The connecting rod is the means by which the reciprocating motion of the piston is changed to rotating motion at the crankshaft. The connecting rod assemblies are tapered, I-beam section steel forgings. A bronze-lined, steel-backed, split, bushing-type bearing is pressed into the piston pin end of the rod. Replaceable precision connecting rod bearings are steel-backed, split type, having copper-lead alloy bearing surfaces.

Piston - The piston is a cylindrical part closed at one end, connected to the crankshaft by the connecting rod and traversing a portion of the cylinder bore. The force of the expanding gases in the cylinder is exerted against the closed end of the piston, causing the connecting rod to move the crankshaft. The pistons are aluminum castings, cam-ground and tapered to provide an accurate fit in the cylinders at operating temperatures. The piston dome is machined to the shape of a conical section so that it tapers into the open-type combustion chamber. Each piston is fitted with four rings. The top ring groove is composed of a steel insert, which is an integral part of the piston. The three remaining ring grooves are machined into the aluminum piston. The upper three rings are compression rings, and the bottom ring is an oil control ring.

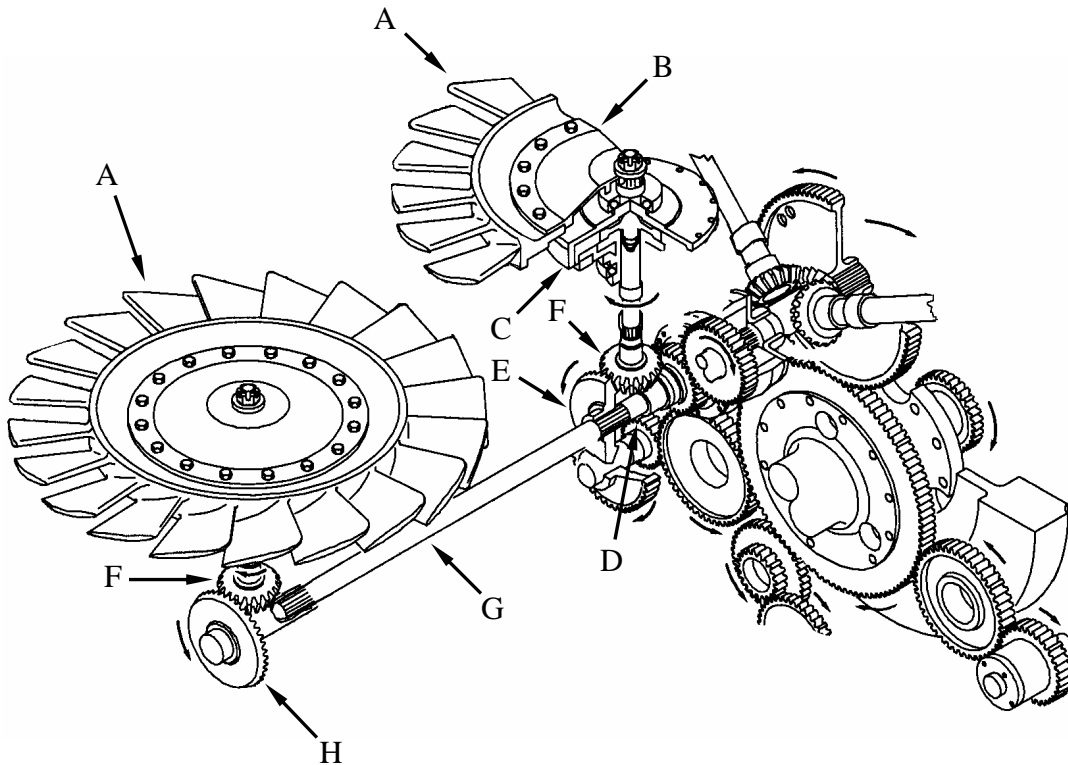
Piston Pin - The heavy walled, tubular steel piston pins are full floating in the piston and the connecting rod. Retaining rings retain the piston pin in the piston, one at each end of the piston pin.





**ENGINE COMPONENTS (Continued)****Cooling Fans and Drive:**

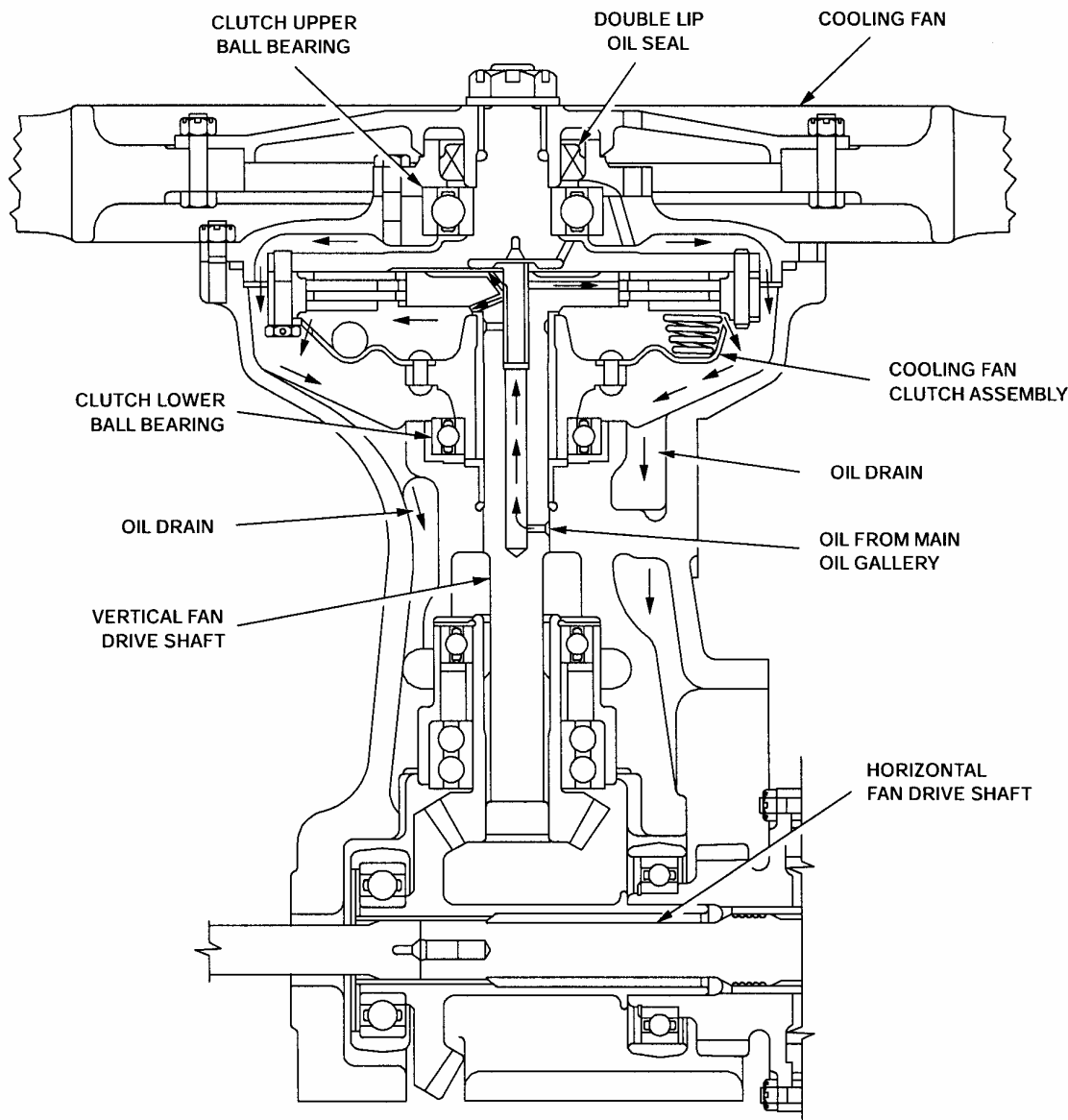
The top of the engine is shrouded to house two cooling fans which draw cool air from the underside of the engine through the cylinder fins and discharge the hot air vertically from the top shroud. The fans (A) are attached to adapters (hubs) (B) and are mounted on shafts which are driven through a fan drive clutch assembly (C). The rear fan clutch is driven by the rear fan driveshaft (D), drive bevel gear shaft (E), and driven bevel gear shaft (F). The front fan clutch is driven by the front fan driveshaft (G), drive bevel gear shaft (H), and another driven bevel gear shaft (F).



ENGINE COMPONENTS (Continued)

Cooling Fans and Drive (Continued):

The fan clutch is cooled with engine oil. The fan clutch drive and driven disks are loaded by the centrifugal action of clutch balls and springs housed in the clutch assembly. The balls and springs are in the driven member and apply upward force to the clutch disks. The clutch oil enters the fan drive vertical shaft from the fan drive housing through an annular groove in the shaft. The oil flows through a central hole in the shaft to a distributor where it is dispersed to the ball bearings and to the clutch disks. The oil moves between the clutch disks by centrifugal action and drains back through the fan drive housing into the engine oil pan.



**ENGINE COMPONENTS (Continued)****Crankcase (Cylinder Block):**

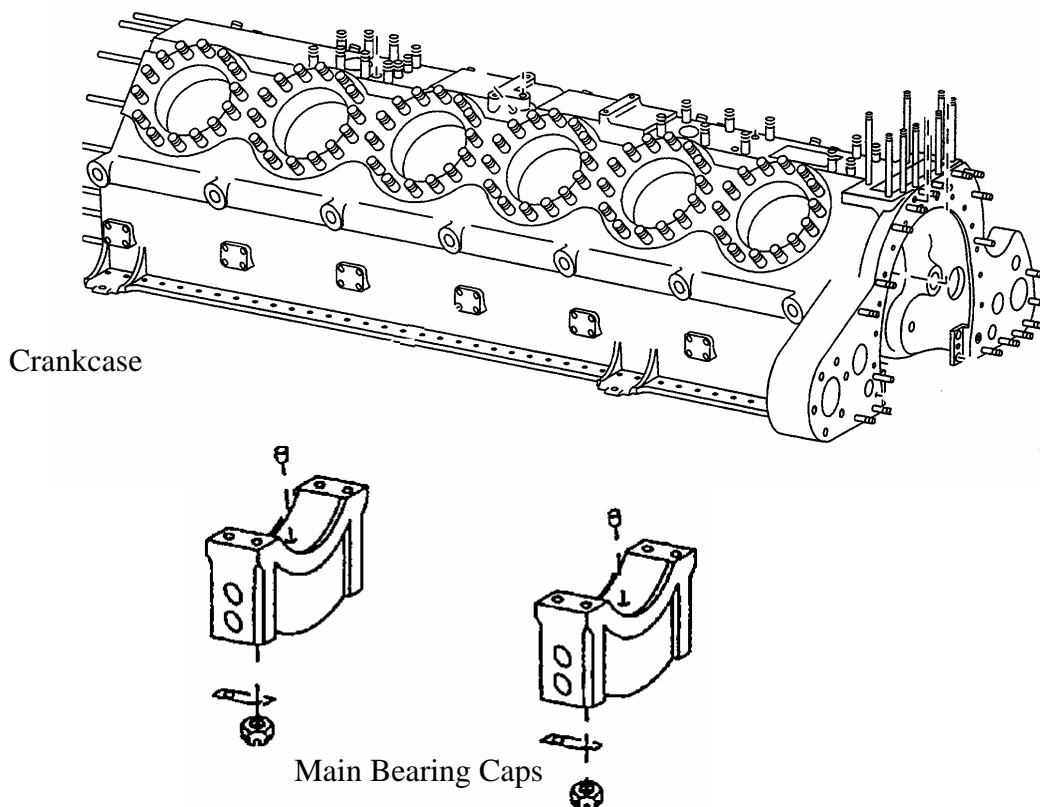
The crankcase is a solid metal (aluminum) casting that makes up the bulk of the engine. The cylinder mounting holes and various oil passages are bored in the block. It is a one-piece aluminum casting with forged aluminum main bearing caps.

Seven main bearing caps function as an integral part of the crankcase. Each cap is secured with four studs and four slotted nuts in addition to two through bolts that clamp the main bearing cap in the crankcase. With this type of crankcase and bearing cap construction, uniform load distribution in the bearing area is obtained making possible uniform distribution of combustion forces over the entire crankcase.

**IMPORTANT**

**Main bearing caps must be kept in their original location. They are numbered 1 through 7 beginning at the front (damper) end of the crankcase. The caps are secured to the crankcase before being line-bored making them an integral component of the crankcase.**

The seven replaceable main bearings are steel-backed, split type, having copper-lead alloy bearing surfaces. The center main bearing is double-flanged with bearing material to control crankshaft endplay and thrust.

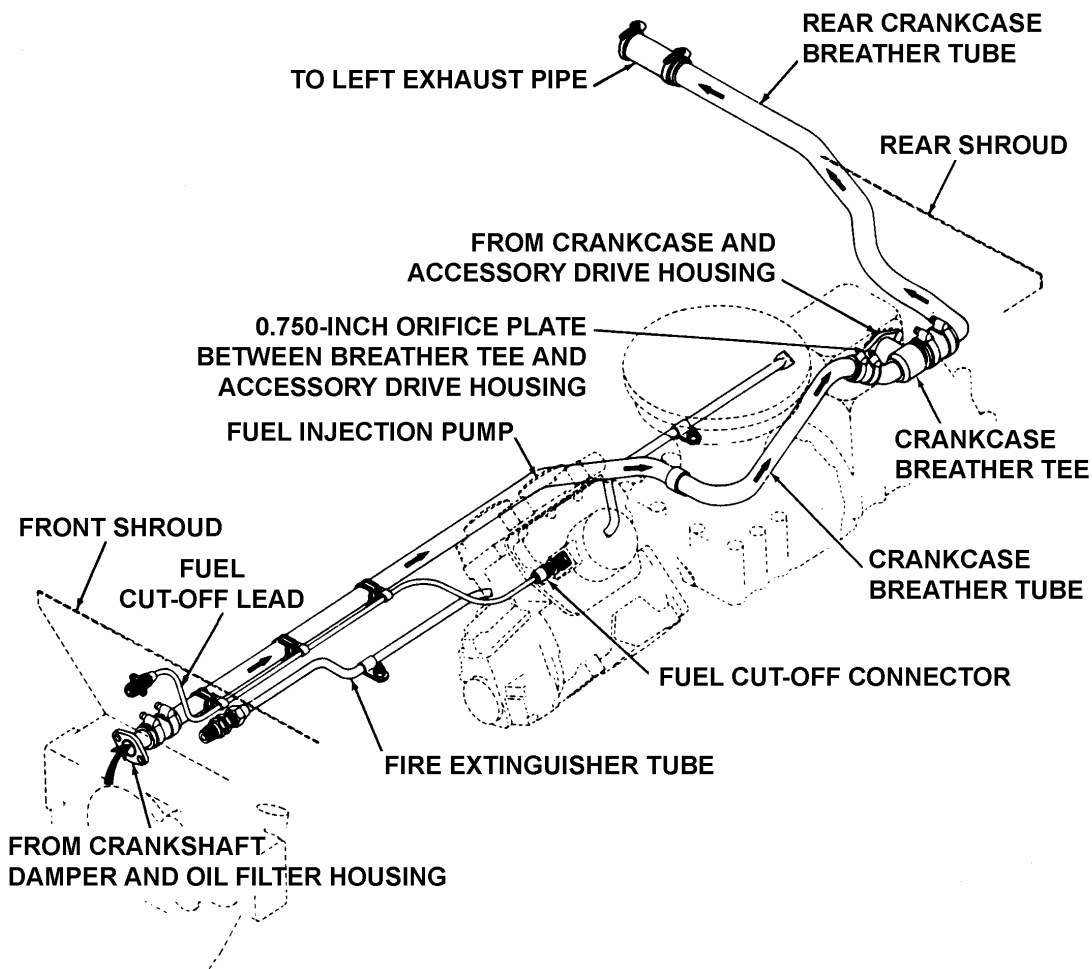


ENGINE COMPONENTS (Continued)

Crankcase Breather and Fire Extinguisher Systems:

The engine crankcase breather system is completely enclosed which allows the engine to be submerged without entrance of water and permits the crankcase to be vented. The breather system is vented through the left turbosupercharger exhaust outlet into the vehicle exhaust system.

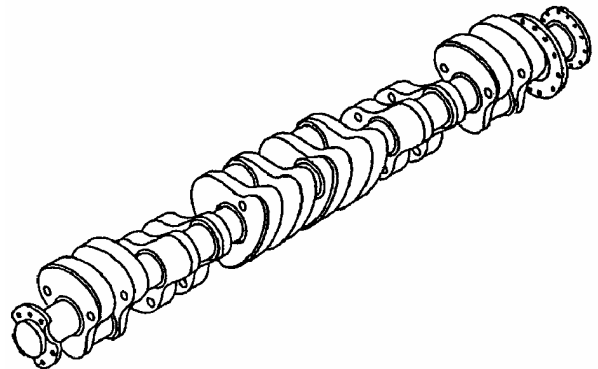
The engine fire extinguisher system is equipped with a fire extinguisher tube located in the "V." The tube has small holes drilled along the entire length to direct carbon dioxide (CO<sub>2</sub>) in predetermined directions around cylinders, the fuel injection pump, and inter-cylinder components in case of fire.



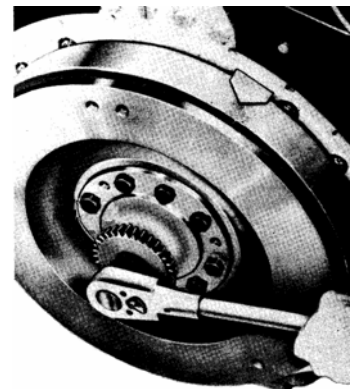
**ENGINE COMPONENTS (Continued)****Crankshaft, Flywheel, and Damper:**

The crankshaft is the main shaft of the engine which, when turned by connecting rods, changes the reciprocating motion of the pistons to rotary motion of the power train.

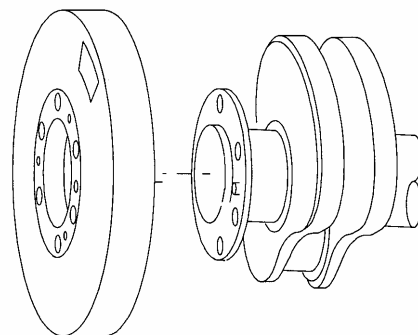
The crankshaft assembly is a nitrided steel forging with seven main bearing journals and six crankpins (connecting rod journals). Each crankpin accommodates two opposing connecting rod assemblies. Flanges are provided on the crankshaft for mounting the flywheel on the rear and a torsional vibration damper on the front end.



The flywheel is attached to one end of the crankshaft and provides inertia so the crankshaft will complete the rotation resulting from each compression-induced firing to the next. It helps smooth the operation of the engine.

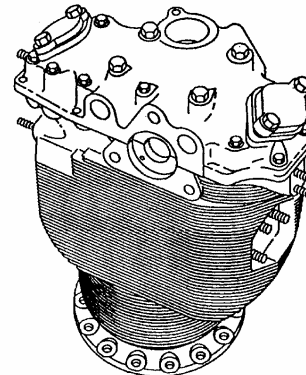


The torsional vibration damper is attached to the opposite end of the crankshaft. It is a precision viscous type and is replaceable only as an assembly. It augments the function of the flywheel.



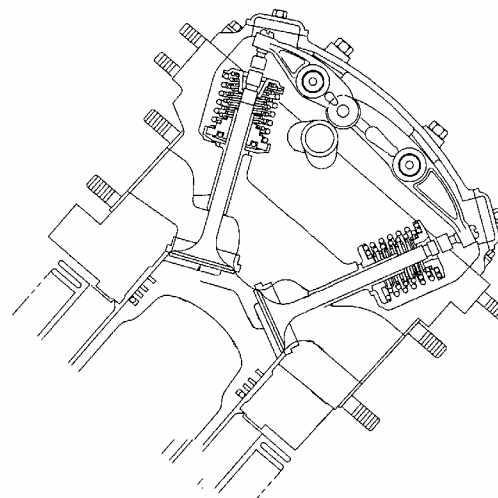
**ENGINE COMPONENTS (Continued)****Cylinder and Head Assembly:**

Each cylinder assembly is an individually replaceable unit that consists of a barrel, cooling fin muff, and a cylinder head. The cylinder barrel, dome, intake and exhaust port liners are made of steel. The aluminum cylinder head cooling fins are cast to the steel dome. The cooling fins for the barrel are machined into an aluminum muff and shrunk onto the steel barrel. After the cylinder barrel fins are machined, the head and barrel are electron-beam welded to form a single unit. Valve guides and seats are shrunk into place in the head.



The cylinder barrel is tapered at the head end to provide a straight bore under running conditions. A mounting flange is machined on the cylinder barrel near the base to provide an attachment of the cylinder to the crankcase. The cylinder assembly is secured to the crankcase with studs and nuts. An outer extension of the cylinder head provides mounting for the fuel injection nozzle and encloses a recess or rocker box, which houses the valves, valve springs, and related parts. Rocker arm assemblies are held in place by rocker shafts in the cylinder head valve rocker support cover.

The stem of the intake valve and exhaust valve for each cylinder extends into the rocker box. Three nested springs, compressed between two retainers and secured to the valve stem by two cone-shaped locks, hold each valve to its seat. Each exhaust valve has a positive valve rotator, which also serves as the lower spring retainer. Valve clearance adjusting screws with flat swivel pusher pads are mounted on one end of the valve rocker arms.

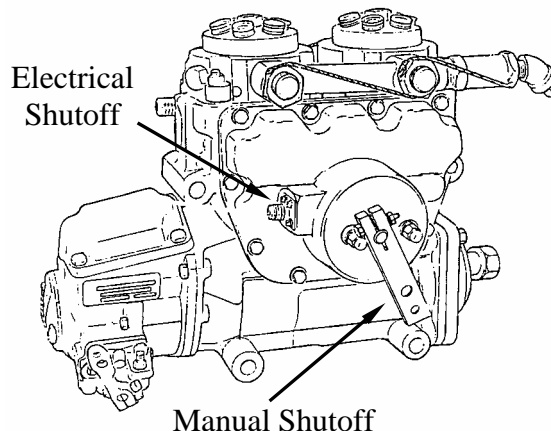


Forged steel valve rocker arms with roller cam-followers are used. The rollers are hardened and honed to provide an extremely smooth and permanent contact surface. Hollow rocker arm shafts and drilled passages in the rocker arms convey oil to all moving parts.

A camshaft bearing surface is provided in each cylinder and is split equally between the cover and the cylinder head. The camshaft bearing surface is bored with the cylinder head valve rocker support cover in place. Therefore, the covers are not interchangeable and each must remain as part of a specific cylinder assembly. Identifying numbers are used on cylinders and covers to prevent mismatching. Each cylinder has replaceable camshaft bearings at the camshaft bore. Counter bores in the rocker box and rocker support covers accommodate inter-cylinder rubber hoses and steel flanges which enclose the camshaft between the cylinders.

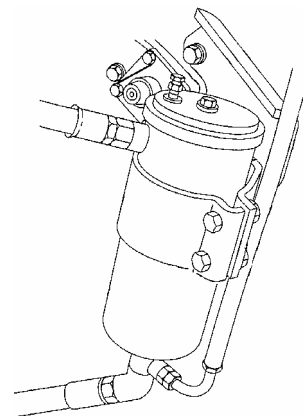
**ENGINE COMPONENTS (Continued)****Fuel Cutoff Solenoid:**

An electrically-operated fuel cutoff solenoid is contained within the fuel injection pump. The solenoid is normally open. A switch in the vehicle driver's compartment actuates the circuit to close the solenoid. Closing the solenoid shuts off fuel delivery from the fuel injection pump and stops the engine. A manually operated override shutoff is provided to permit stopping the engine in the event of an electrical failure.

**Fuel Filters:**

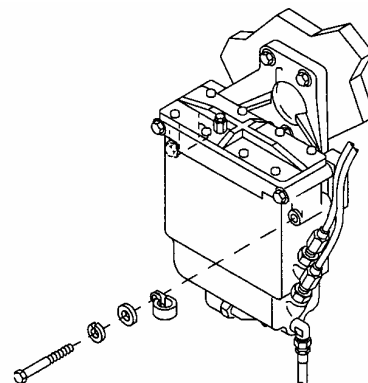
Fuel flows from the vehicle fuel tanks through the primary fuel filter, backflow valve, engine-mounted fuel supply pump, fuel/water separator filter to the fuel injection pump where it passes through a final filter built into the pump. Excess fuel provides pump cooling as it flows through the fuel injection pump hydraulic heads and is returned to the fuel tanks.

Primary Fuel Filter - The replaceable-element type primary fuel filter is mounted on the right front of the engine. It is equipped with a constant bleed orifice and drain line that removes a metered amount of fuel and returns it to the main fuel tank through the fuel injector nozzle drain lines. This continuous drain, from the bottom of the filter, removes water that has been filtered from the fuel by the primary fuel filter element.



Fuel/Water Separator Filter - a replaceable-element type filter, it is mounted on the left front of the engine. A dual-purpose filter, the fuel/water separator filter first removes emulsified water from the fuel and then removes solid particles not trapped previously by the primary fuel filter.

The fuel/water separator filter consists of two outer elements (coalescer elements for removing water) a center element, which is the final fuel filter (down to 5 microns), and a water collection chamber with two water-sensing electric probes.



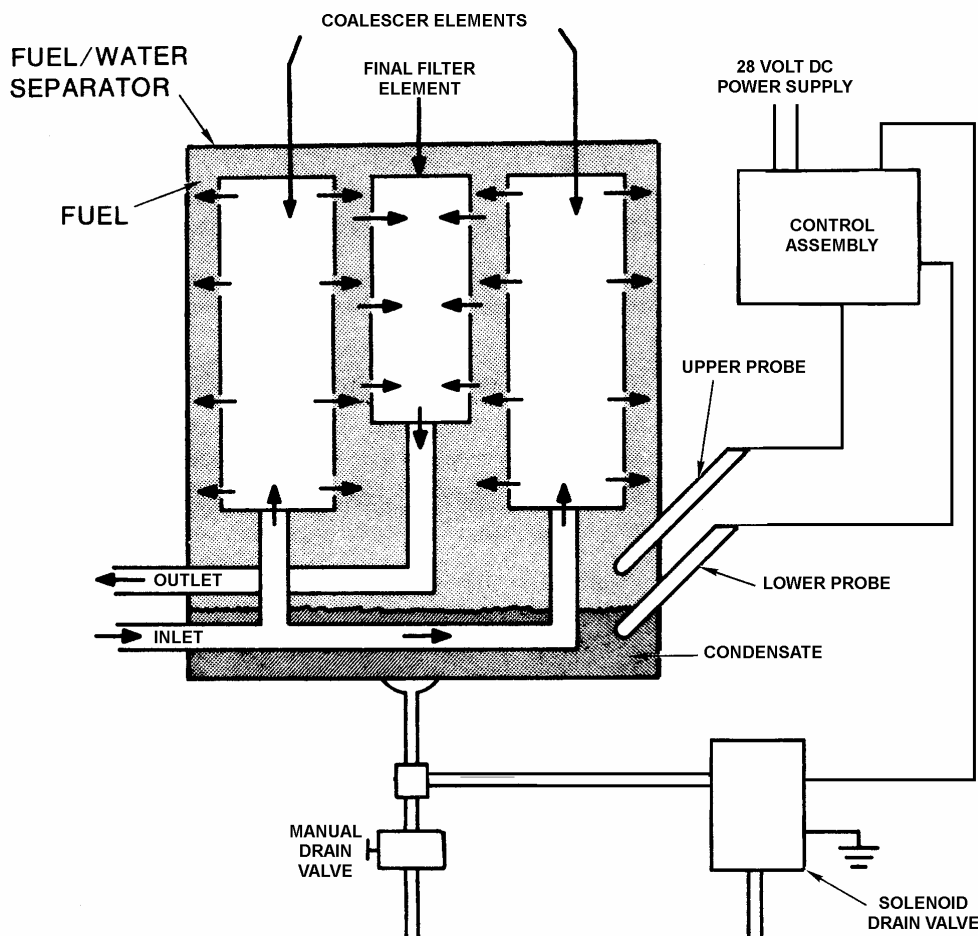
ENGINE COMPONENTS (Continued)

Fuel Filters, Fuel/Water Separator Filter (Continued):

Fuel enters both coalescer (outer) elements simultaneously from the inside and passes through the element walls to the outside. The separated fuel and water fill the collection chamber. Water, which has a higher specific gravity, sinks and collects at the bottom of the chamber. The separated fuel, floating on the water, passes through the center element (final fuel filter) from the outside inward and then out of the separator filters assembly through a hose to the fuel injection pump.

Water removed from the fuel by the separator filter is drained automatically as needed. Two water-sensing electric probes act as water-activated switches. When the collection chamber water level reaches the upper probe, an electric circuit is closed to a solenoid-operated dump valve located on the lower left side of the engine. The solenoid valve opens and water is drained via a hose from the separator filter through the valve. When the separator water level goes below the lower probe, the electric circuit to the solenoid drain valve is opened, and the valve closes.

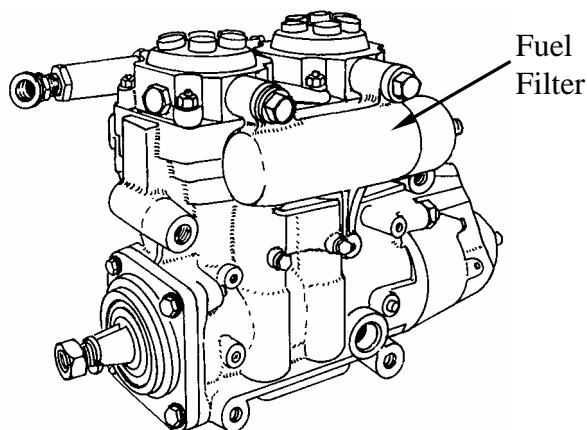
Both the primary filter and the fuel/water separator filter incorporate top-mounted bleeder valves to assist in the removal of air from the fuel system.





**ENGINE COMPONENTS****Fuel Filters (Continued):**

Fuel Injection Pump Filter - Also known as "Last Chance Filter" or "Watchdog Filter" is a ten-micron filter built onto the side of the fuel injection pump.

**Fuel Injection Pump:**

The injection pump has three main functions.

First, it must meter, or measure, the amount of fuel delivered to each injector nozzle. A small amount of fuel is needed for an idling engine, while a larger amount is needed for high engine speed.

Second, it must pressurize the fuel delivered to the injector nozzles. The pump must be capable of producing pressure higher than the nozzle opening pressure (greater than 3300 psi).

Third, it must distribute the fuel to the correct cylinder at the proper time.

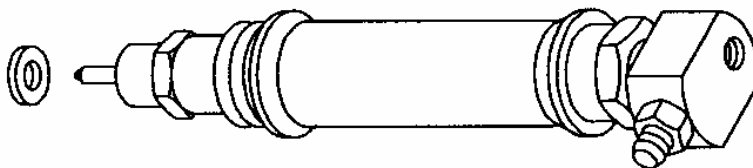
The injection pump is a single plunger, constant stroke, distributor type. Although it is called a single plunger type, the pump actually has a plunger in each of its two hydraulic distributing heads. Each head supplies fuel to one bank of six cylinders. The pump is mounted between the two cylinder banks and between the two fan towers. A shaft coupled to the accessory drive gearing drives it. A timing advance unit is built into the injection pump drive to automatically advance the injection timing at high engine speeds. The injection pump camshaft, gears, and governor are lubricated by oil supplied from the engine main lubrication system.

**Fuel Injection Nozzles and Tubes:**

The fuel injection nozzle is a device that sprays fuel as a fine mist into the cylinder at the proper time allowing efficient combustion. The injector nozzle must inject the fuel into the combustion chamber in a pattern that produces maximum power and economy.

Twelve fuel injector nozzles, one per cylinder, are used to inject fuel into the combustion chambers.

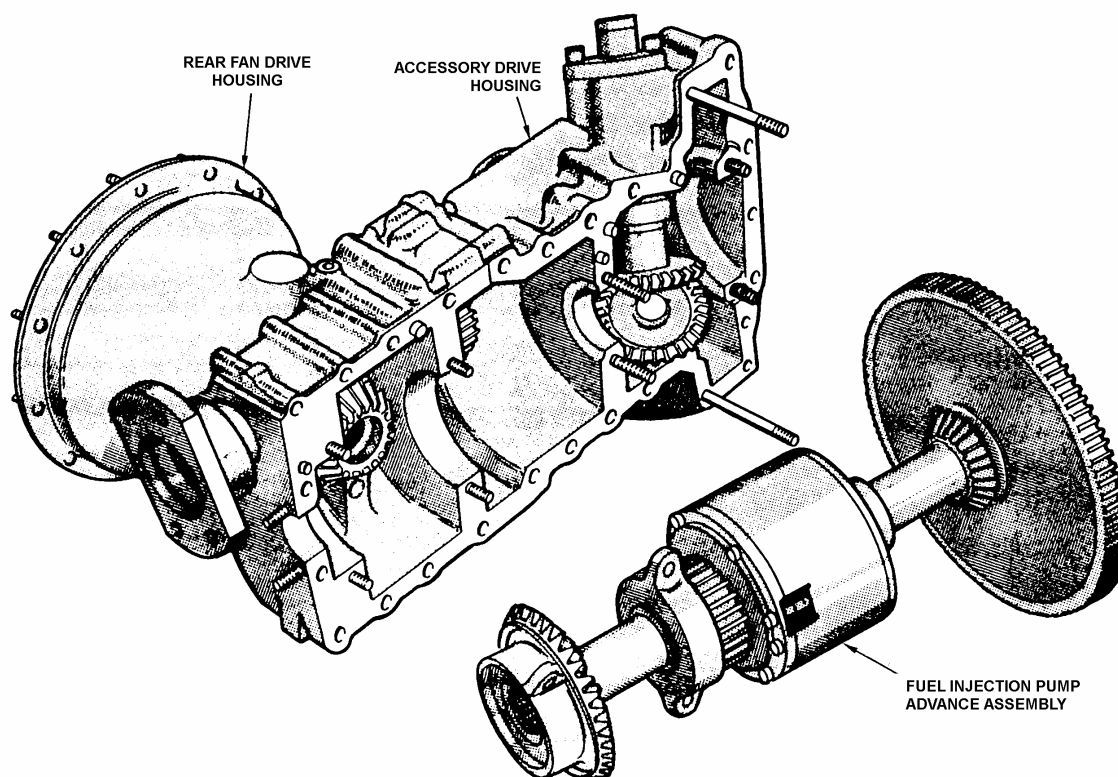
Fuel injector tubes of equal length carry the fuel from the fuel injection pump to the nozzles. Interconnecting fuel return lines provide a path for the return of excess fuel from the nozzles.



**ENGINE COMPONENTS (Continued)****Fuel Injection Pump Advance Assembly:**

The advance assembly is a device that automatically advances the time of the fuel injection to maximize power and economy. The advance unit is located within the gear train that drives the fuel injection pump and is housed in the accessory drive housing.

The advance unit is designed to gradually advance the injection timing in relation to engine speed from idle to 1,850 rpm. A maximum advance of 11 degrees is reached at this speed and remains constant to maximum engine rpm.



**ENGINE COMPONENTS (Continued)**

**Fuel Purge System:**

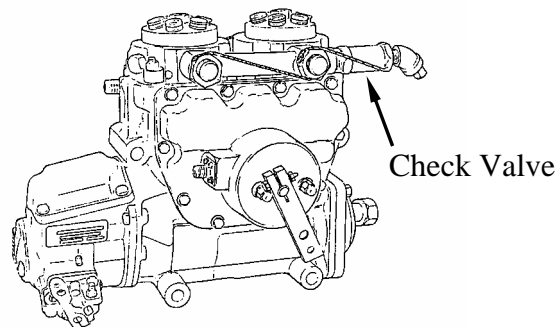
A manually operated purge pump is provided in the vehicle operator's compartment and is used to clear the engine main fuel system and flame heater system of air, and fill them with fuel. Most of the purged air is removed through bleeder valves, located in the top of the primary fuel filter and the fuel/water separator filter.

The rest of the air is forced through the main fuel tubes into the fuel return lines and then to the vehicle fuel tanks. Constant bleed orifices in the primary fuel filter and automatic water drain in the fuel/ water separator filter remove water from the system.



**Fuel Return Check Valve:**

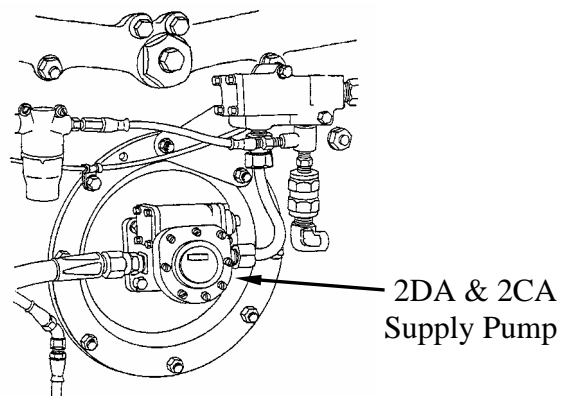
A fuel return check valve is installed between the fuel injection pump fuel return outlet and the fuel return hose assembly. The valve prevents fuel flowing back to the injection pump when the fuel supply is closed.



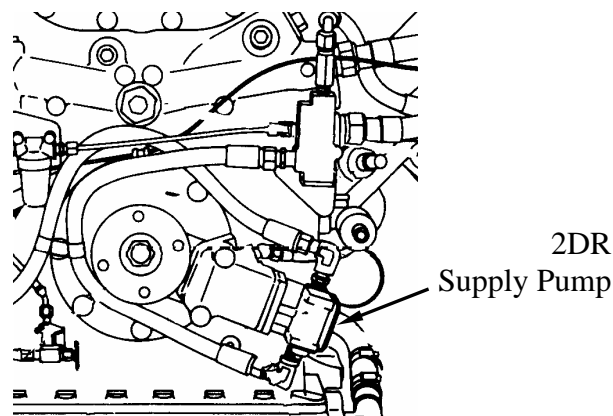
**Fuel Supply Pump:**

The engine driven fuel supply pump receives fuel after it has been routed through the backflow valve and the primary filter. It supplies the fuel injection pump with a uniform delivery pressure of 40 to 60 psi maintained by an internal relief valve.

Engine Model 2DR uses a different supply pump from that which Models 2CA and 2DA use. However, both are vane-type pumps with a built-in bypass valve that allows fuel to bypass during purging.



The fuel supply pump used on engine Model 2DR rotates in an opposite direction from the one used on Models 2CA and 2DA. Therefore, they are not interchangeable.



**ENGINE COMPONENTS (Continued)****Generator:**

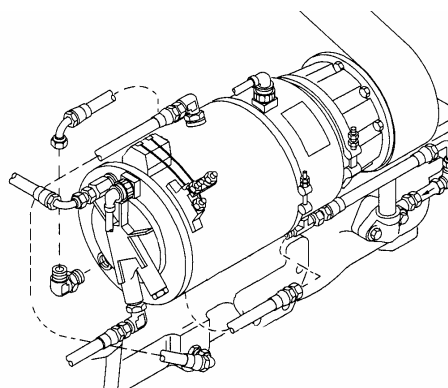
The generator changes the mechanical energy of the diesel engine into electrical energy. There are two different generators used on the AVDS-1790-2 Series engine. Both are 28-volt dc generators, one is rated at 300 amperes and the other is rated at 650 amperes.

All Model 2CA engines are equipped with the 650-ampere model.

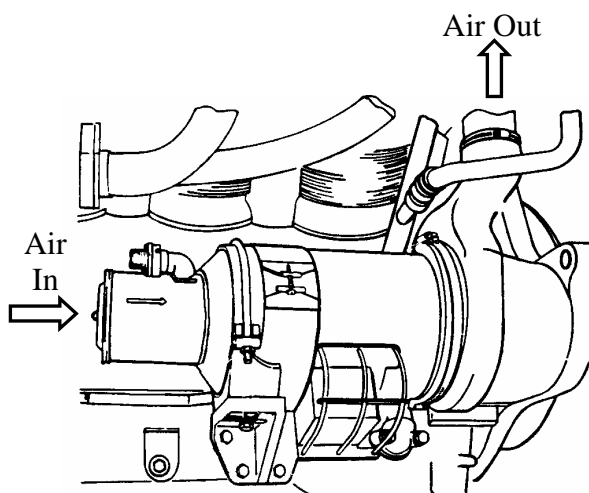
All Model 2DR engines are equipped with the 300-ampere model.

All Model 2DA engines are equipped with the 300-ampere model in their original configuration. However, some models, when used on the Armored Vehicle Launched Bridge (AVLB), have been upgraded to the 650-ampere generator.

The 650-ampere generator is an oil-cooled, brushless, direct-current type (the generator generates an alternating current which is rectified within the unit to produce a direct current). The generator uses filtered oil from the engine main gallery line for cooling. Oil circulation is provided by a pump integral within the generator and equipped with an appropriate by-pass valve to limit oil pressure and flow. The generator is completely enclosed and waterproofed and will function equally well in or out of water.



The 300-ampere generator is an air-cooled, six-pole, six-brush, direct-current type. It is equipped with radio noise suppression capacitors for protection of nearby communications equipment. A blower motor mounted on the generator draws cooling air from the crew compartment through the air intake tube. This tube extends along the crankcase below the intake manifold on the right side of the engine. The generator cooling air exhaust tube is connected to the engine cooling shroud and exits through the rear cooling fan vane. A fording valve is available to render the generator air system water tight for deep water fording. A vehicle mounted voltage regulator controls generator output.



**ENGINE COMPONENTS (Continued)****Intake Manifold Heaters:**

The intake manifold, which distributes induction air to each bank of cylinders, is equipped with an electrically-operated flame-type intake manifold heater. The heater is provided as an aid for cold weather starting and cold weather operations.

A flow diagram of the manifold air induction heater system is illustrated on the facing page.

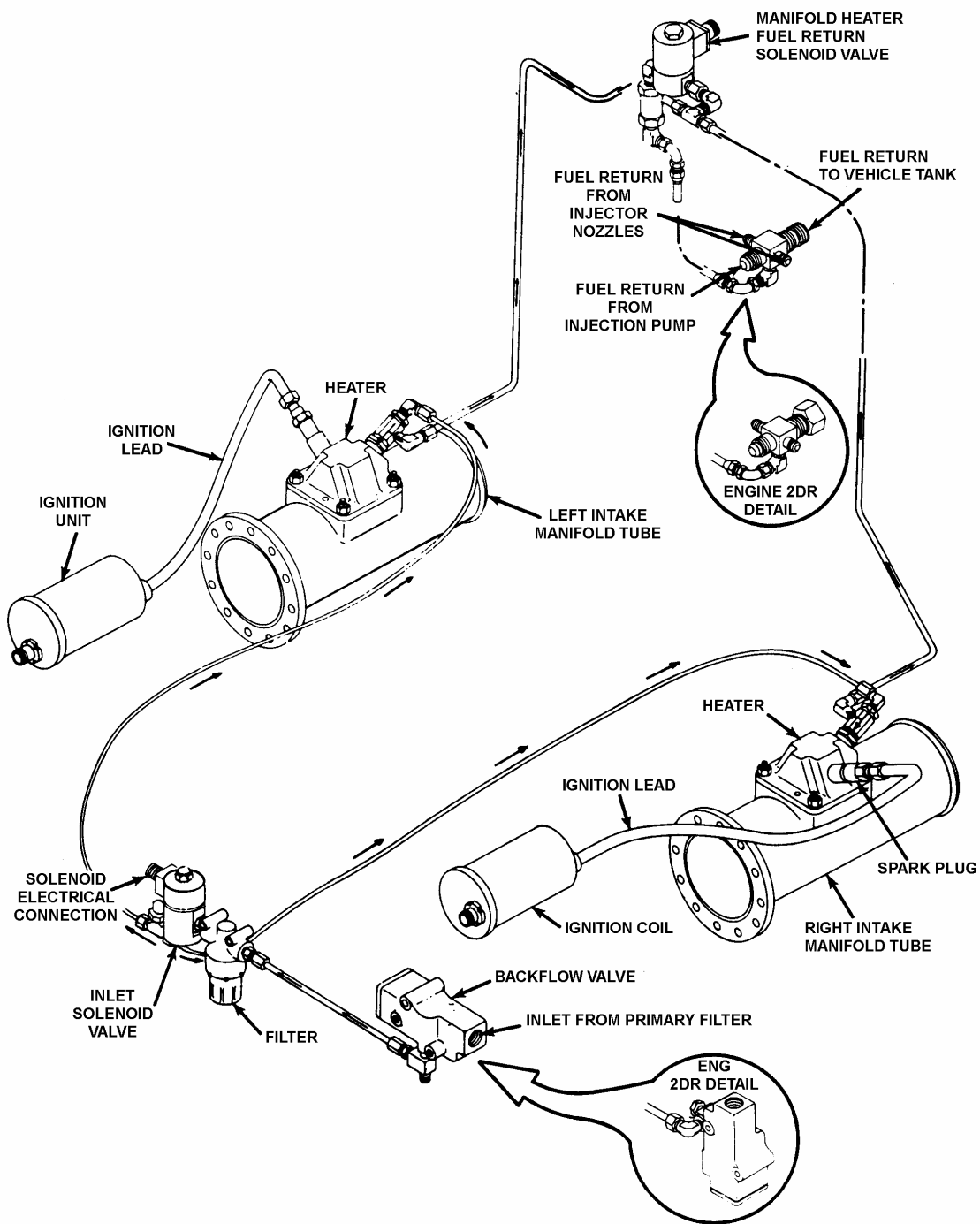
Operation of the heater switch (in the vehicle operator's compartment) energizes the manifold heater fuel solenoid valve, heater ignition unit, and spark plug for each heater simultaneously.

Fuel is hand pumped by the purge pump through the manifold heater fuel filter and fuel solenoid valve and sprayed into the intake manifold. The fuel ignited by the spark plug, burns in the intake manifold as the engine is cranking, and the flame heats the incoming air. This flame-heated air and the products of combustion are fed directly into the cylinders with little heat loss. The results are immediate engine response assuring complete combustion at low engine rpm and at no-load operating conditions with low ambient temperatures.

The manifold heater, fuel inlet solenoid valve, prevents fuel pumped by the fuel pump assembly from entering the air intake manifold heater unless the heater system is energized. A manifold heater fuel return check valve and solenoid valve are located at the rear of the engine. The solenoid valve is also energized (opened) when the ignition unit and heater spark plugs are energized permitting excess fuel to be returned to the fuel tanks. The main fuel backflow valve prevents back flow of the fuel when the purge pump in the driver's compartment is actuated.

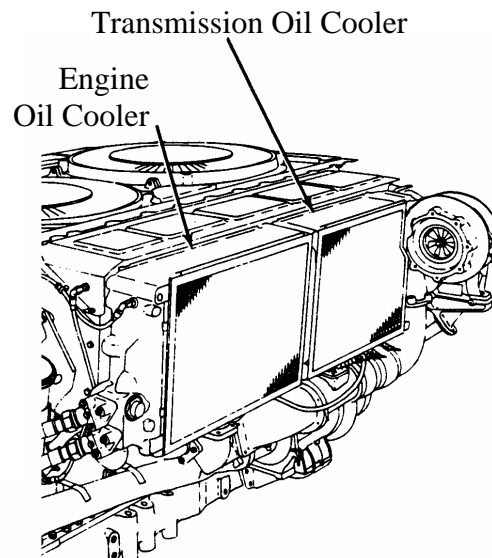
ENGINE COMPONENTS (Continued)

Intake Manifold Heater Flow Diagram



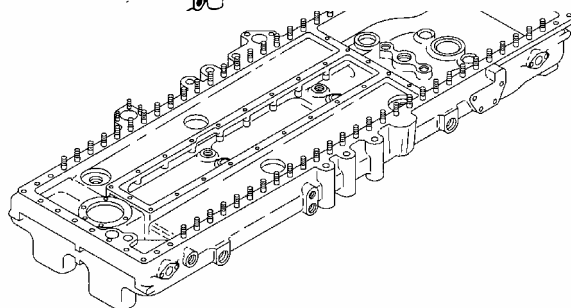
**ENGINE COMPONENTS (Continued)****Oil Coolers, Transmission and Engine:**

External oil coolers accomplish transmission and engine oil cooling. The oil coolers are located on the sides of the engine above the cylinders. Air is drawn through the oil coolers by the cooling fans. A thermostatic control valve in each oil cooler controls the temperature of the oil from the cooler by permitting cold oil to bypass the coolers. This valve also permits oil to bypass the cooler in the event that the cooler becomes clogged.

**Oil Pan:**

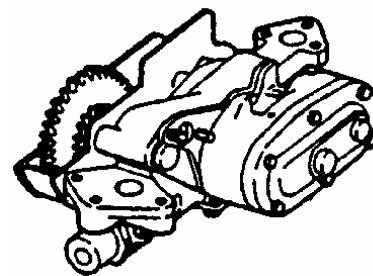
The oil pan acts as a reservoir for the oil, and is the base for the cylinder block, thereby forming a strong engine structure.

It is a one-piece aluminum alloy casting divided into an oil pump pressure compartment, an oil reserve compartment, and a sump compartment. Cored passages from each of the compartments terminate at a central outlet and permits draining. A separate passage permits draining the oil coolers and oil filter compartment directly without permitting any sludge to enter the oil pan. The oil pan is designed to maintain a constant oil level, above the oil pump pickup tube, regardless of the angle at which the engine/vehicle is operated.

**Oil Pump:**

The oil pump provides pressure to circulate oil to engine parts minimizing wear.

The oil pump consists of four sections combined in a single unit. The main section (pressure) draws oil from the oil pump pressure compartment in the oil pan. This oil pan compartment is fed by the scavenge section of the pump which picks up oil from the sump compartment at the front end of the oil pan and by oil which drains into the pressure compartment from the cover of the pressure pump compartment and the reserve compartment. The dual inlet make-up section picks up oil from opposite corners of the reserve compartment. The dual inlet feature assures that the inlet to the main section is supplied regardless of engine tilt. The leveling pump section returns any excess oil to the reserve compartment. The make-up section and the leveling pump section work together to maintain a constant level in the main pressure compartment.



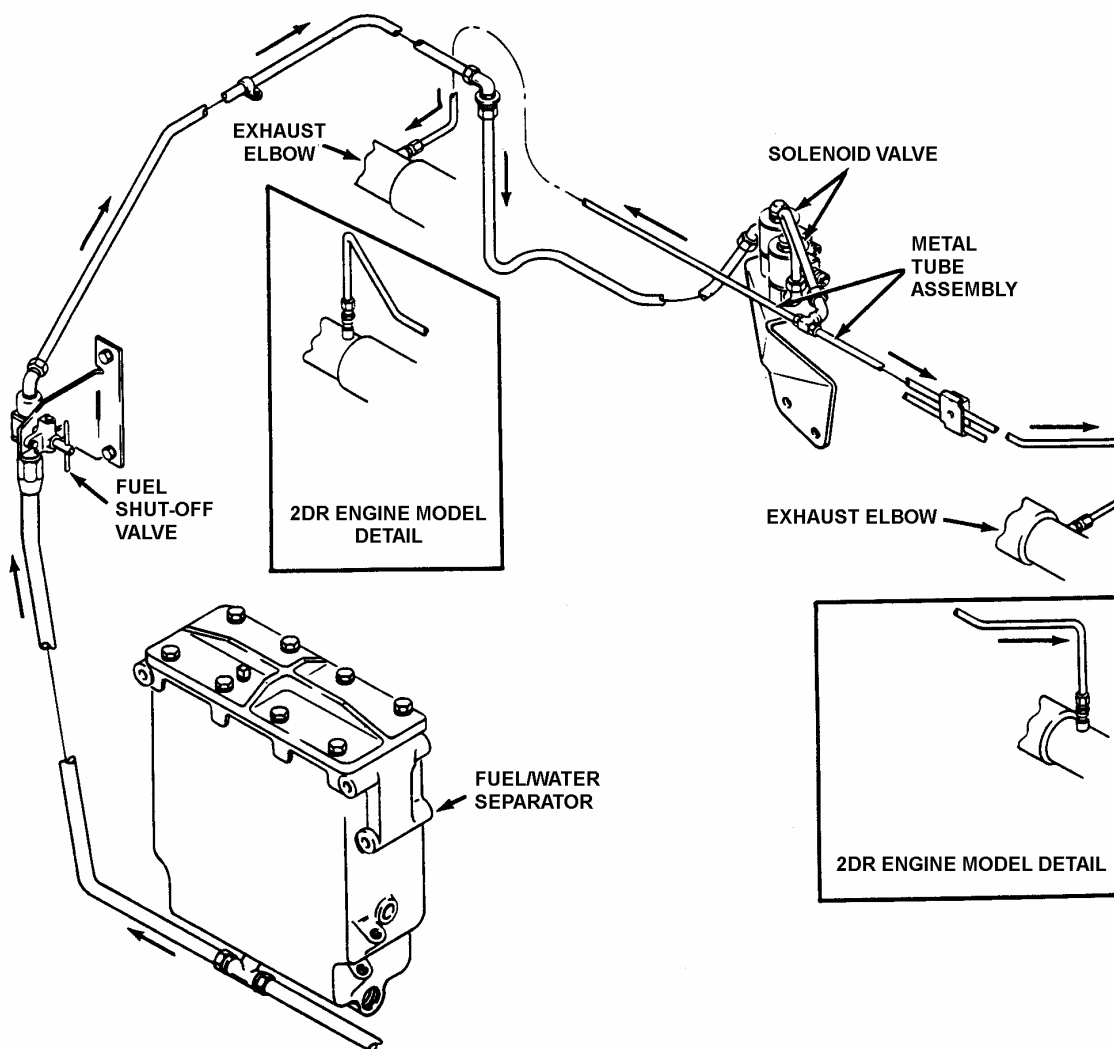
ENGINE COMPONENTS (Continued)

Smoke Generating System:

The smoke generating system uses the engine fuel pump to supply diesel fuel, from the vehicle fuel tanks, to two solenoid valves mounted at the rear of the engine. When the solenoid valves are energized (opened) they allow diesel fuel to be sprayed into the engine exhaust system. The fuel vaporizes and exits together with the engine exhaust gases. The fuel vapor cools on contact with the ambient air and condenses to form a dense homogeneous smoke screen. The electrical power to energize the solenoid valves is supplied by the vehicle air cleaner blower motor circuit on Model AVDS-1790-2CA, -2DA engines, and the warning indicator and warning horn circuit on the Model AVDS-1790-2DR engine. This prevents accidental activation of the smoke generating system when the engine is not running.

**IMPORTANT**

**When the engine is running on JP8 fuel, the fuel cutoff valve for the smoke generator system must be safety-wired in the OFF position.**



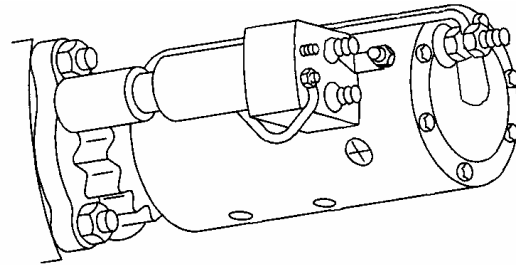


**ENGINE COMPONENTS (Continued)**

**Starter:**

The starter cranks the engine by converting electrical energy to mechanical energy.

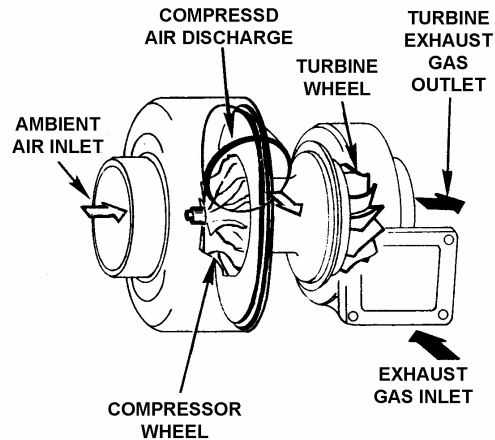
The starter is a heavy-duty, 24-volt, insulated, waterproof, fungus and corrosion resistant, solenoid-operated, enclosed shift-lever-type engine starter with 12 brush holders. The drive clutch is a heavy-duty overrunning type and the pinion clearance is adjustable.



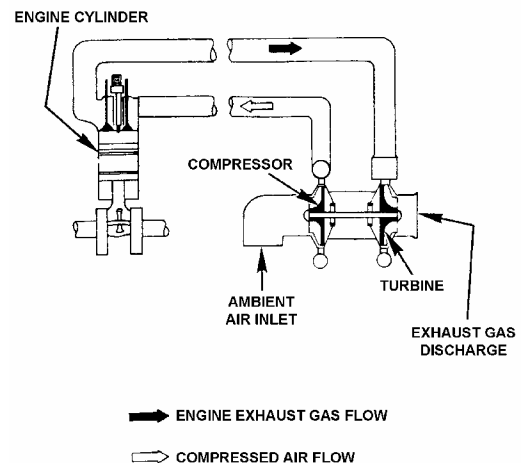
**Turbochargers:**

By compressing air to a density approximately two times atmospheric pressure, the turbocharger enables the AVDS-1790 engine to increase its power and efficiency without increasing its size or weight. The increased fuel economy also gives the vehicle a greater range.

Exhaust gases from the engine cylinder combustion chamber drive the turbine wheel that is coupled to the compressor wheel on a common shaft in the turbocharger. As the exhaust gases turn the turbine and compressor wheels, ambient air enters into the center of the compressor wheel and flows radially outward. It increases in pressure and density while it is ducted into the engine intake manifold.



Since the exhaust gases drive the turbine wheel, there is always a direct relationship between the power of the engine and the amount of air being delivered to the cylinders. The engine is supplied with all the air it needs to go faster because the increased exhaust gases drive the turbine and compressor faster. Conversely, as the engine goes slower, so does the compressor wheel.



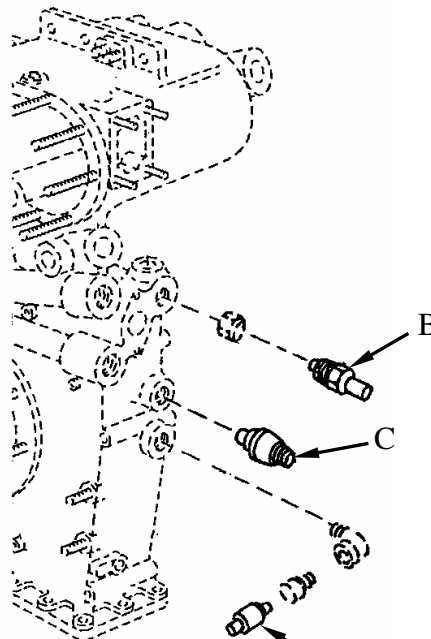
## TRANSMITTERS

**Low Oil Pressure Warning Light Switch:**

The low oil pressure warning light switch (A) is located at the lower right side of the crankshaft damper and oil filter housing. The electrical contact points in this switch close when the oil pressure in the main oil gallery is below  $11 \pm 2$  psi. Completion of the electrical circuit lights the low pressure warning lamp on the vehicle instrument panel.

**Oil Temperature Transmitter:**

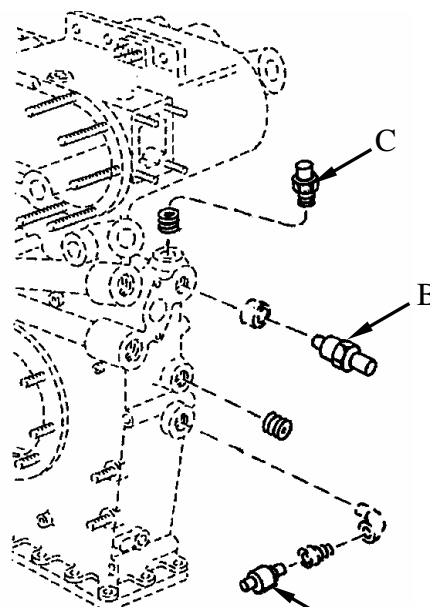
The oil temperature gauge transmitter (B) is located at the upper right side of the crankshaft damper and oil filter housing above the oil pressure regulator valve.



Engine Models 2CA &amp; 2DA A

**High Oil Temperature Warning Light Switch**

The high oil temperature warning light switch (C) is located in the oil passage above the oil pressure warning light switch in the right side of the crankshaft damper and oil filter housing. The warning light sending switch thermostatically-controlled electrical contact points close when oil temperatures in the engine main oil passage reaches  $245 \pm 5$  °F. Completion of the electrical circuit lights the oil high temperature warning lamp on the vehicle instrument panel.

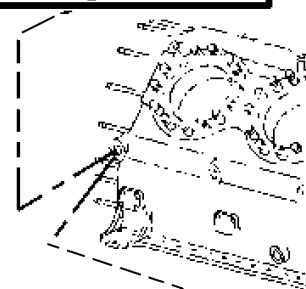
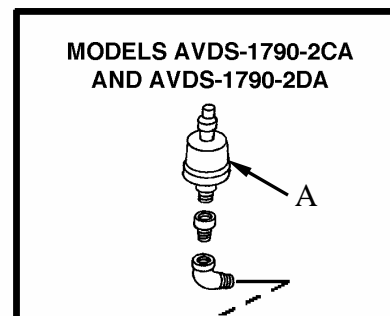


Engine Model 2DR A

TRANSMITTERS (Continued)

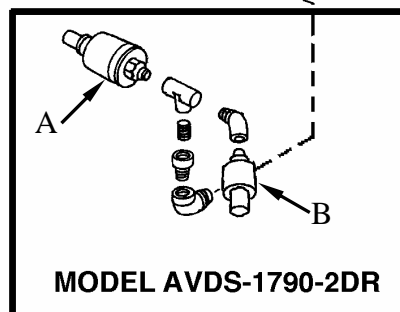
**High Oil Pressure Transmitter:**

The electrical oil pressure gauge transmitter (A) is located at the front of the crankcase in the gallery line below the number 1 right cylinder. This sealed transmitter consists of a threaded plate to which a diaphragm, a radially notched spring, and an overload guard plate are crimped. Electrical resistance in the transmitter varies directly as the oil pressure varies. The resulting variation in the current is transmitted to the electrical oil gauge on the vehicle instrument panel.



**Auxiliary Generator High Oil Pressure Sending Switch (Model 2DR only):**

The auxiliary generator high oil pressure sending switch (B) is located at the right front of the crankcase in the "T" that mounts the oil pressure gauge transmitter. This switch prevents simultaneous operation of the main engine and auxiliary generating systems.



END OF WORK PACKAGE



**TM 9-2815-220-24**

**CHAPTER 2**

**TROUBLESHOOTING PROCEDURES**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



**THIS WORK PACKAGE COVERS:**

General Instructions and Quick Guide

**GENERAL INSTRUCTIONS**

1. Troubleshooting Information for Organizational Level Maintenance can be found in the appropriate Vehicle manual in which the engine is installed.
2. Troubleshooting Information in this Manual is for use of Direct and General Support maintenance personnel only. It provides the instructions to supporting maintenance personnel for corrective action. Good Troubleshooting procedures can:
  - a. Prevent Damage. Operation of a malfunctioning or deadlined engine without a preliminary examination can cause further damage to the engine and possible injury to personnel. By careful inspection and troubleshooting, such damage and injury can be avoided or at least minimized. In addition, the cause of faulty operation can often be determined without extensive disassembly.
  - b. Initiate Precautions mandated by Inspection. The inspections are to be performed before attempting to operate the engine. Troubleshooting inspections are mainly to determine conditions and to take precautions to prevent further damage.
2. In-Vehicle Troubleshooting.
  - a. Troubleshooting performed while the engine is mounted in the vehicle is included in this troubleshooting section. The procedures for troubleshooting vehicle components and systems related to engine operation are also included.
3. Out-of-Vehicle Troubleshooting.
  - a. When the engine only is received, inspection should be performed to verify the diagnosis made while the engine was installed in the vehicle. This inspection, to uncover further defects or to determine malfunction, is important as it is the only means for determining the trouble without completely disassembling the engine.
4. Diagnostic Tests.
  - a. Diagnostic tests are included in each troubleshooting work package as needed. These tests provide analysis for the purpose of determining further corrective action required for eliminating a malfunction.

**QUICK GUIDE TO TROUBLESHOOTING**

Chapter Two's listing of work packages is an index which serves as a "Quick Guide to Troubleshooting". The index is the master reference table for locating troubleshooting information and is a cross-reference of various malfunctions, which may occur during operation or inspection, and the work packages that provide solutions. Each troubleshooting work package provides step-by-step instructions for isolating and correcting malfunctions.

1. Troubleshooting procedures to be performed while a malfunctioning engine is still mounted in the vehicle and after it has been removed are included in the index.
  
2. How to use the index:
  - a. Determine the symptom.
  - b. Locate the symptom in the Chapter Index.
  - c. Locate the troubleshooting work package for the symptom.
  - d. Turn to the work package identified in the Chapter Index.
  - e. Study the function description, pictorial view, and/or schematic located in the work package.
  - f. Perform the corrective action as required by troubleshooting procedure in the work package.
  - g. Verify that the corrective action eliminated the symptom.

**END OF WORK PACKAGE**



**ENGINE FAILS TO CRANK**

**0006 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Engine will not crank (no response when starter switch is pressed).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Master switch "OFF".	(1) Turn switch "ON."
b. Transmission shift selector not in "neutral/park" position.	(1) Place shift selector in "neutral/park" position.
c. Transmission shift linkage and "neutral/park" position out of adjustment.	(1) Adjust transmission shift linkage. Refer to pertinent vehicle technical manual. (2) Adjust "neutral/park" switch for full travel. Refer to pertinent vehicle technical manual.
d. Low voltage protection module operating and/or batteries discharged (below 12 volts).	(1) Verify all panel lights are "ON", at normal brightness. (2) Check battery indicator as follows:

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Master switch "OFF".	Indicator needle at extreme left (no voltage indicated).	Indicator satisfactory.
	Indicator needle at any position other than extreme left.	Indicator defective.
Master switch "ON".	Indicator needle moves into "yellow" area (indicating battery voltage) with panel lights on.	Indicator satisfactory.
	Indicator needle does not move from extreme left position with panel lights on.	Indicator defective.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
d. (Continued) Low voltage protection module operating and/or batteries discharged (below 12 volts).	(3) Check battery condition as follows:

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Master switch "ON".	Indicator needle in "yellow" area.	Battery charged.
	Indicator needle in left "red" area.	Batteries discharged.
	Indicator needle in "green" area.	Batteries overcharged.

**ENGINE FAILS TO CRANK**

**0006 00**

**MALFUNCTION 1: (Continued)**

Engine will not crank (no response when starter switch is pressed).

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
(Continued) Master switch "ON".	Indicator needle at extreme left position.	Batteries dead. Cables disconnected or corroded.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
d. (Continued) Low voltage protection module operating and/or batteries discharged (below 12 volts).	(4) Check for loose, broken or corroded cables and terminals. Repair or replace as needed. Refer to pertinent vehicle technical manual.	
	(5) Recharge/replace batteries or slave-start engine. If starter cranks and engine starts, go to step e.	
	(6) If starter still fails to crank, starter is faulty and must be replaced (WP 0049, Starter Motor Replacement) or engine is seized (Malfunction 2, this work package).	
e. Generator defective.	(1) Check generator as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Start and operate engine at 1000-1200 rpm.	Indicator needle in "green" area.	Generator charging normal.
	Indicator needle just entering "yellow" area.	Generator not charging properly or voltage regulator faulty.
	Indicator needle in "yellow" area	Generator charging slowly (below normal).
	Indicator needle in left side of "red" area.	Batteries discharging (possible reversed cable connection).
	Indicator needle in right side of "red" area.	Generator overcharging and voltage regulator is malfunctioning.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
f. Electrical starting circuit defective.	(1) Check circuits, switches and connectors. Refer to pertinent vehicle technical manual.	
	(2) Replace starter low voltage protective module (WP 0050, Low Voltage Starter Protection Module Replacement).	

**ENGINE FAILS TO CRANK**

**0006 00**

**MALFUNCTION 2:**

Starter engages but engine does not crank (audible solenoid action or starter gear engagement).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Starter engagement assembly damaged.		(1) Remove starter and inspect assembly. Repair or replace starter (WP 0049, Starter Motor Replacement).
b. Starter drive gear damaged.		(1) With starter removed, inspect engine starter driven gear (WP 0157, Starter Drive Mechanism Repair).
c. Starter failure.		(1) Replace starter assembly (WP 0049, Starter Motor Replacement).
d. Engine hydrostatic lock.		(1) Investigate as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
With Master switch "ON," hold fuel shut-off (engine "stop") switch in the off position.		
Press starter switch momentarily (about 3 seconds).	Audibly note normal starter engagement action.	Starter energized and engagement proper.
	Engine does not crank.	Fluid in cylinder chamber causing hydrostatic lock. Hydrostatic damage to engine may exist.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
d. (Continued) Engine hydrostatic lock.		(2) Remove shroud and access covers for access to injector nozzles (WP 0090, Engine and Transmission Oil Cooler Access Covers and Frames Replacement, and WP 0055, Top Shroud and Mounting Brackets Replacement).
		(3) Remove all fuel injector nozzles (WP 0114, Fuel Injector Nozzles and Holder Repair).
		(4) Clear intake manifolds as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Hold fuel shut-off (engine "stop") switch, and crank engine several revolutions (5-10 seconds).	If knock occurs, cease cranking.	Connecting rod or piston damage exists.
	Note fluid blown from cylinders.	Combustion chamber clear.

**ENGINE FAILS TO CRANK**

**0006 00**

**MALFUNCTION 2: (Continued)**

Starter engages but engine does not crank (audible solenoid action or starter gear engagement).

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Perform compression test to determine if hydrostatic lock has damaged engine (WP 0033, Cylinder Compression Test).	Cylinder(s) compression normal (above 330 psi and less than 70 psi differential); go to END OF WORK PACKAGE.	No hydrostatic damage.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
d. (Continued) Engine hydrostatic lock.		(5) If compression test indicates damage to engine, repair or replace as necessary.
e. Engine seized internally.		(1) Repair and replace as required.
f. Transmission "locked up".		(1) Check transmission (refer to pertinent vehicle technical manual). (2) Repair or replace transmission as necessary (refer to pertinent vehicle technical manual).

**MALFUNCTION 3:**

Starter drive spins, but engine does not crank.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Starter clutch slipping or engagement assembly damaged.	(1) Replace starter assembly (WP 0049, Starter Motor Replacement).
b. Engine starter drive gear damaged (teeth milled).	(1) Remove starter (WP 0049, Starter Motor Replacement) and inspect engine drive gear (WP 0157, Starter Drive Mechanism Repair).

**END OF WORK PACKAGE**

**ENGINE CRANKS TOO SLOW**

**0007 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Cranking speed too slow for starting: (below 90 rpm).

PROBABLE CAUSE		CORRECTIVE ACTION
a. Batteries partially discharged.		(1) Check battery condition:
PROCEDURE	OBSERVATION	ANALYSIS
<b>Indicator (Battery/Generator) Preliminary Check</b>		
Master switch "OFF".	Indicator needle at extreme left (no voltage indicated).	Indicator satisfactory.
	Indicator needle at any position other than extreme left.	Indicator defective.
Turn master switch "ON".	Indicator needle moves into "yellow" area (indicating battery voltage) with panel lights on.	Indicator satisfactory.
	Indicator needle does not move from extreme left position with panel lights on.	Indicator defective.
<b>Battery Preliminary Check</b>		
Turn master switch "ON".	Indicator needle in "yellow" area.	Battery charge satisfactory.
	Indicator needle in left "red" area.	Batteries discharged.
	Indicator needle in "green" area.	Batteries overcharged.
	Indicator needle at extreme left position.	Batteries dead or cables disconnected or corroded.
PROBABLE CAUSE		CORRECTIVE ACTION
b. Incorrect seasonal grade of oil. Applies in cold weather.		(1) Drain and refill with proper oil (refer to pertinent vehicle lubrication order).

**END OF WORK PACKAGE**



**ENGINE FAILS TO START AT NORMAL CRANKING SPEED**

**0008 00**

**THIS WORK PACKAGE COVERS:**

**TROUBLESHOOTING TABLE AND DIAGNOSTIC TESTS**

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.



**MALFUNCTION 1:**

Cylinders not firing (insufficient fuel or incomplete combustion).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
a. Out of fuel.		(1) Refuel.	
b. Air in fuel system.		(1) Bleed and purge system (WP 0020, Fuel System Abnormal Conditions).	
c. Cylinders too cold. Applies in cold weather.		(1) Operate engine intake manifold heater to assist in starting (refer to pertinent vehicle manual).	
		(2) If engine does not start, check heater operation as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>		<b>ANALYSIS</b>
<b>Heater Operational Check</b>			
Hold fuel shut-off (engine "stop") switch and crank engine.			
While cranking engine, engage manifold heater switch and hand operate purge pump.			
Place hand on intake manifold heater housing. Check both sides of engine.	Note housing temperature (warm or hot to touch).		Evidence of heat indicates heater operation is normal.
			No heat indicates heater is inoperative.
<b>Heater Voltage Checks</b>			
<b>NOTE</b>			
<b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b>			

**MALFUNCTION 1: (Continued)**

Cylinders not firing (insufficient fuel or incomplete combustion).

PROCEDURE	OBSERVATION	ANALYSIS
<p><b>(Heater Voltage Checks, Continued)</b> Check electrical circuit voltages (master switch and heater switch "ON").</p>	24 volts at heater switch, both connectors.	Proper voltage through heater switch.
	No voltage to switch.	Defective circuit.
	No voltage from switch.	Defective switch.
	24 volts at engine bulk head connector.	Proper voltage.
	No voltage to bulkhead connector.	Defective circuit between switch and connector.
	24 volts at solenoid valve(s) supply and return wire connector.	Proper voltage supply to solenoid valves.
	No voltage at solenoid valves.	Defective circuit between connector and valves.
	24 volts at ignition unit connector. No voltage at ignition unit.	Proper voltage to ignition unit. Defective circuit to ignition unit.
<p><b>Ignition Unit Operational Check</b></p> <p style="text-align: center;"><b>NOTE</b></p> <p><b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b></p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 2px; text-align: center;"><b>WARNING</b></div> <div style="text-align: center;">  <p><b>High Voltage/High Amperage (see decal on unit)</b></p> </div> </div>		
Remove high-tension wire from igniter (spark plug). Position lead wire end to ground for spark gap (1/4 inch).	Note high-tension spark (hot bluish-white) across gap (lead-to-ground).	High-tension spark indicates ignition unit operation normal.
		Improper spark or no spark indicates ignition unit or lead is defective
<p><b>Spark Plug Operational Check</b></p> <p style="text-align: center;"><b>NOTE</b></p> <p><b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b></p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 2px; text-align: center;"><b>WARNING</b></div> <div style="text-align: center;">  <p><b>High Voltage.</b></p> </div> </div>		
Remove spark plug, reconnect wire to spark plug, ground plug body to engine and press heater switch "ON".	Note high tension spark across spark plug electrodes.	High tension spark indicates spark plug firing, operation normal.
		No spark indicates the spark plug is defective.



**MALFUNCTION 1: (Continued)**

Cylinders not firing (insufficient fuel or incomplete combustion).

PROCEDURE	OBSERVATION	ANALYSIS
<p><b>Solenoid Valve(s) Operation</b></p> <p><b>NOTE</b></p> <p><b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b></p>		
<p>Press heater switch intermittently "ON" and "OFF".</p>	<p>Note audible "click" or opening and closing valve action (by touch) of both solenoid valves (fuel supply and fuel return).</p>	<p>Evidence of action indicates normal solenoid valve operation.</p>
		<p>No audible "click" or action indicates solenoid valve(s) is defective.</p>
<p><b>Fuel System Checks</b></p>		
<p>Purge Pump: Disconnect purge pump fuel hose quick disconnect coupling at engine main fuel backflow valve. Hold coupling valve open and operate purge pump.</p>	<p>Note fuel with each firm stroke of purge pump.</p>	<p>Moderate flow with each stroke indicates normal purge pump operation.</p>
		<p>If flow is not evident, purge pump is defective, or purge lines are blocked or leaking.</p>
<p>Fuel Filter: Disconnect fuel tube between fuel check valve tee and manifold heater fuel filter and operate purge pump.</p>	<p>Note fuel flow with each stroke of purge pump.</p>	<p>Moderate flow with each stroke indicates no in-line filter restriction. Filter satisfactory.</p>
		<p>No flow, or restricted flow, indicates in-line filter is plugged.</p>
<p>Solenoid Valve and Fuel Filter: Disconnect one fuel tube from engine front solenoid valve outlet tree, operate purge pump and press heater switch "ON" and "OFF".</p>	<p>With switch in "ON" position, note fuel flow from tee opening with each purge pump stroke.</p>	<p>Fuel flow indicates solenoid valve is operating properly and fuel filters are satisfactory.</p>
		<p>No fuel or restricted flow indicates manifold heater filter or felt filters in solenoid valve are restricted or clogged.</p>

**MALFUNCTION 1: (Continued)**

Cylinders not firing (insufficient fuel or incomplete combustion).

PROCEDURE	OBSERVATION	ANALYSIS
(Continued) Solenoid Valve and Fuel Filter	With switch in "OFF" position note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck open).
Fuel Nozzle Assembly: Disconnect lines and remove nozzle assembly. Reconnect lines to nozzle, (position nozzle beside housing) and operate heater system.	With switch in "ON" position, nozzle should have fine conical fuel spray pattern.	Fine fuel spray pattern indicates proper nozzle operation.
		No spray pattern, stream of fuel, dribble, or no fuel indicates defective nozzle or plugged felt port filters in nozzle assembly.
Return Fuel Solenoid Valve and Check Valve: Remove fuel return solenoid outlet tube after the check valve at rear of engine, operate purge pump and press heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from check valve opening.	Moderate flow indicates solenoid valve is operating properly and check valve is opening properly.
		No fuel or restricted flow indicates check valve stuck closed or felt filters in solenoid valve are restricted or clogged.
	With switch in "OFF" position, note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck in open position).
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
d. Low cylinder compression.		(1) Check cylinder compression (WP 0033, Cylinder Compression Test).
e. Throttle linkage disconnected.		(1) Check linkage (WP 0122, Injection Pump Throttle Linkage and Associated Parts Repair). (WP 0123 for 2DR)
f. Injection pump or drive deficiency.		(1) Check for deficiencies (WP 0020, Fuel System Abnormal Conditions, Malfunction 6).

**ENGINE FAILS TO START AT NORMAL CRANKING SPEED**

**0008 00**

**MALFUNCTION 1: (Continued)**

Cylinders not firing (insufficient fuel or incomplete combustion).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
g. Electric fuel shut-off defective.	(1) Activate electrical shut-off and listen for audible click. If click is heard, shut-off is good. If not, replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
h. Manual fuel shut-off defective.	(1) Check manual fuel shut-off (WP 0122, Injection Pump Throttle Linkage and Associated Parts Repair). (WP 0123 for 2DR)

**MALFUNCTION 2:**

Cylinders partially firing (insufficient fuel).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Air in fuel system	(1) Bleed and purge system (WP 0020, Fuel System Abnormal Conditions).
b. Water contaminated fuel.	(1) Check automatic drain system (WP 0020, Fuel System Abnormal Conditions).
c. Cylinder too cold. Applies in cold weather.	(1) Operate engine intake manifold heater to assist starting (refer to pertinent vehicle technical manual).
d. Induction air restricted or blocked.	(1) Inspect, repair and replace as required (WP 0037, Induction Leak Test).
e. Low cylinder compression.	(1) Check cylinder compression (WP 0033, Cylinder Compression Check).
f. Injection pump timing improper.	(1) Check timing (WP 0036, Injection Pump Timing).

**END OF WORK PACKAGE**



**ENGINE LOW IDLE ABNORMAL OPERATION**

**0009 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Low idle speed, below 650 rpm.

PROBABLE CAUSE		CORRECTIVE ACTION	
a. Insufficient warm-up. Applies in cold weather.		(1) Extend warm-up period. Increase warm-up speed to 1000 - 1200 rpm.	
b. Improper idle adjustment.		(1) Adjust idle speed (WP 0043, Throttle Adjustments).	
c. One bank not firing.		(1) Increase warm-up speed to 1000 - 1200 rpm. If bank still does not fire, check fuel-injection pump operation as follows:	
PROCEDURE	OBSERVATION	ANALYSIS	
Remove one engine cover on each side of engine for access to fuel injector nozzle tube fittings.			
Crank engine with fuel switch "ON" or start engine and operate at idle speed.			
Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage (one nozzle on each side of the engine).	High-pressure fuel spray pulsations at nozzle fitting.	Fuel injection pump action is normal.	
	No fuel spray pulsations noted at nozzle fitting.	Fuel injection pump deficiency. Replace fuel-injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	
<b>Bench Test</b>			
Install nozzle and holder assembly on tester.			
Perform nozzle test (WP 0098, Fuel Injector Nozzle and Holder Repair).	Spray pattern and nozzle leakage test requirements.	If spray pattern is not acceptable and leakage is noted, nozzle is defective.	

**ENGINE LOW IDLE ABNORMAL OPERATION**

**0009 00**

**MALFUNCTION 1: (Continued)**

Low idle speed, below 650 rpm.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
c. (Continued) One bank not firing.	(2) Check inlet filter (watchdog) on fuel injection pump (TM9-2910-212-34 & P).

**MALFUNCTION 2:**

Low-idle speed erratic (unsteady or surge).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Idle speed too low.	(1) Adjust idle speed (WP 0043, Throttle Adjustments).
b. Accelerator or throttle linkage loose, worn, or cross-shaft shock spring defective.	(1) Inspect linkage (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
c. One or more cylinders partially firing. (Water or air in fuel system).	(1) Refer to WP 0020, Fuel System Abnormal Conditions.
d. Injector nozzles defective.	(1) Remove and check nozzles (WP 0114, Fuel Injector Nozzle Replace/Repair).
e. Fuel-injection pump governor defective.	(1) Replace defective fuel-injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
f. Fuel injection-pump improperly timed.	(1) Check timing (WP 0036, Injection Pump Timing).

**MALFUNCTION 3:**

Misfires at idle (usually accompanied by white exhaust smoke, oily or heavy carbon deposits on exhaust grilles).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Engine operating at idle for extended period during cold weather.	(1) Increase engine idle speed to 1000 - 1200 rpm.

**END OF WORK PACKAGE**

**ENGINE HIGH IDLE (NO LOAD) ABNORMAL OPERATION**

**0010 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

High idle speed too low (below 2500 rpm).

PROBABLE CAUSE	CORRECTIVE ACTION
a. Accelerator or throttle linkage deficiency.	(1) Inspect linkage (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
b. Low fuel pressure (fuel filter restriction).	(1) Check filters (WP 0020, Fuel System Abnormal Conditions).
c. Fuel injection pump governor defective.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**MALFUNCTION 2:**

High idle speed too high: (above 2640 rpm).

PROBABLE CAUSE	CORRECTIVE ACTION
a. Cooling fan malfunction.	(1) Check fans (WP 0053, Cooling Fan Inspection). (2) Check fan clutch (WP 0129, Fan Drive Clutch Assembly and Associated Parts Replace/Repair).
b. Fuel injection pump governor defective.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**END OF WORK PACKAGE**





**ENGINE OVER SPEEDS**

**0011 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle.

**MALFUNCTION 1:**

Over speeds during vehicle operation.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Vehicle operating on steep downgrade.	(1) Apply vehicle brakes to avoid over-speed.
b. Cooling fans malfunction.	(1) Inspect cooling fans (WP 0053, Cooling Fan Inspection).
	(2) Inspect cooling fan drives (WP 0129, Fan Drive Clutch Assembly and Associated Parts Replace/Repair).
c. Governor improperly adjusted.	(1) Adjust per TM 9-2910-212-34&P or replace fuel injection pump (WP 0101, Fuel Injection Pump Assembly Replacement).

**MALFUNCTION 2:**

Engine speed excessive with accelerator pedal released.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Accelerator or throttle stuck or disconnected.	(1) Inspect throttle linkage (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
b. Fuel control stuck.	(1) Refer to WP 0020, Fuel System Abnormal Conditions.
c. Fuel injection pump governor defective.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replace/Repair).

**END OF WORK PACKAGE**



**ENGINE STOPS DURING OPERATION**

**0012 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle.

**MALFUNCTION 1:**

Engine stops gradually with loss of power and speed (with accelerator pedal depressed).

PROBABLE CAUSE	CORRECTIVE ACTION
a. Out of fuel.	(1) Refuel.
b. Fuel system deficiency.	(1) Refer to WP 0020, Fuel System Abnormal Conditions.

**MALFUNCTION 2:**

Engine stops suddenly.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Fuel system deficiency.	(1) Refer to WP 0020, Fuel System Abnormal Conditions.
b. Engine internal failure.	(1) Check for engine damage as in Malfunction 3, this work package.

**MALFUNCTION 3:**

Engine will not rotate, or rotates with binding, grinding or squealing noise.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Engine seized; failed or damaged connecting rod, bearing, piston, gears, etc.	(1) Drain oil; inspect oil and filters for metal materials.
	(2) Repair or replace engine as necessary.

**END OF WORK PACKAGE**



**ENGINE FAILS TO SHUT DOWN**

**0013 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Engine fails to stop when activating electrical fuel shut-off.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Electrical fuel shut-off malfunction.	(1) Listen for audible click while activating and de-activating electrical shut-off. If no audible sound is detected, replace fuel-injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
b. Defective fuel injection pump governor.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**MALFUNCTION 2:**

Engine fails to stop with manual fuel shut-off.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Manual fuel shut-off malfunction.	(1) Check throttle linkage (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
b. Defective fuel injection pump.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**MALFUNCTION 3:**

Engine fails to stop when vehicle fuel supply is shut off (engine continues to run for 12 to 14 seconds at idle speed after the fuel is shut off).

PROBABLE CAUSE	CORRECTIVE ACTION
a. Vehicle fuel shut-off valve malfunction.	(1) Inspect fuel shut-off valve. Replace as required. Refer to appropriate vehicle manual.

**END OF WORK PACKAGE**



**ENGINE ROUGH OPERATION**

**0014 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.


**MALFUNCTION 1:**

Engine misfires (more noticeable at idle operation).

PROBABLE CAUSE		CORRECTIVE ACTION
a. Water contaminated fuel.		(1) Check fuel for water (WP 0020, Fuel System Abnormal Conditions).
b. Engine operating at idle for extended period during cold weather.		(1) Increase engine idle speed to 1000 - 1200 rpm.
c. Fuel leak, nozzle high-pressure tube.		(1) Inspect for leak (WP 0020, Fuel System Abnormal Conditions).
d. Fuel injector nozzle defective.		(1) Refer to WP 0114, Fuel Injector Nozzle Replace/Repair.
e. No valve rocker clearance.		(1) Locate faulty cylinder as follows:
PROCEDURE	OBSERVATION	ANALYSIS
<b>Audible Check:</b>		
Open grilles, remove top deck, engine shroud, and covers for access to cylinders.		
Operate engine at idle.	Listen or use sounding rod to determine noisy cylinder.	Location of noise isolates faulty cylinder.

**MALFUNCTION 1: (Continued)**

Engine misfires (more noticeable at idle operation).

PROBABLE CAUSE		CORRECTIVE ACTION
e. (Continued) No valve rocker clearance.		(1) Locate faulty cylinder as follows:
PROCEDURE	OBSERVATION	ANALYSIS
		
<b>Fuel "Shorting" Method:</b>		
Check all cylinders, one at a time.		
Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage.	Note cylinder on which no change in engine operation occurs, knock disappears or decreases, and/or engine roughness or misfire still exists.	Indicates faulty cylinder, defective nozzle, tight rocker arm, worn valve or hydrostatically damaged connecting rod.
<b>High Pressure Fuel Check:</b>		
Remove one engine cover on each side of engine for access to fuel injector nozzle tube fittings.		
Crank engine with fuel switch "ON" or start engine and operate at idle speed.		
Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage.	High-pressure fuel spray pulsations at nozzle fitting.	Fuel injection pump action is normal.
	No fuel spray pulsations noted at nozzle fitting.	Fuel injection pump deficiency.
<b>Cylinder Compression Test Method:</b>		
Perform Cylinder Compression Test (WP 0033, Cylinder Compression Test).	Note cylinder with low pressure (below 330 psi at 140-180 cranking rpm).	Indicates faulty cylinder, damaged rings, piston, valve, connecting rod or tight rocker arm (no valve clearance).
PROBABLE CAUSE		CORRECTIVE ACTION
e. (Continued) No valve rocker clearance.		(2) Adjust valve to proper clearance (WP 0034, Intake and Exhaust Valve Clearance Adjustment).
f. Intake or exhaust valve failure (burned, worn or damaged).	(1) Locate faulty cylinder as above.	
	(2) Inspect, repair or replace valve and/or cylinder (WP 0133, Cylinder Assembly Replacement).	



**ENGINE ROUGH OPERATION**

**0014 00**

**MALFUNCTION 1: (Continued)**

Engine misfires (more noticeable at idle operation).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
g. Return fuel line disconnected or restricted.		(1) Inspect fuel line (WP 0088, Manifold Heater Assembly and Related Parts Replacement).
h. Manifold heater solenoid defective.		(1) Check solenoid operation as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Press heater switch intermittently "ON" and "OFF".	Note audible "click" or opening and closing valve action (by touch) of both solenoid valves (fuel supply and fuel return).	Evidence of action indicates normal solenoid valve operation.
		No audible "click" or action indicates solenoid valve(s) is defective.
To Check Solenoid Valve and Fuel Filter: Disconnect one fuel tube from engine front solenoid valve outlet tee, operate purge pump and press heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from tee opening with each purge pump stroke.	Fuel flow indicates solenoid valve is operating properly and fuel filters are satisfactory.
		No fuel or restricted flow indicates manifold heater filter or felt filters in solenoid valve are restricted or clogged.
	With switch in "OFF" position note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck open).
To Check Return Fuel Solenoid Valve and Check Valve: Remove fuel return solenoid outlet tube after the check valve at rear of engine, operate purge pump and press heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from check valve opening.	Moderate flow indicates solenoid valve is operating properly and check valve is opening properly.
		No fuel or restricted flow indicates check valve stuck closed or felt filters in solenoid valve are restricted or clogged.
	With switch in "OFF" position, note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck in open position).

**ENGINE ROUGH OPERATION**

**0014 00**

**MALFUNCTION 1: (Continued)**

Engine misfires (more noticeable at idle operation).

PROBABLE CAUSE	CORRECTIVE ACTION
h. (Continued) Manifold heater solenoid defective.	(2) Replace solenoid (WP 0087, Manifold Heater Fuel Filter and Solenoid Replacement).
PROBABLE CAUSE	CORRECTIVE ACTION

**MALFUNCTION 2:**

Vibration or roughness.

a. Engine misfire.	(1) Repeat all steps of Malfunction 1 of this work package.
b. Fuel injection pump defective.	(2) Refer to WP 0115, Fuel Injection Pump Assembly Replacement.

**END OF WORK PACKAGE**

**ENGINE NOISY OPERATION**

**0015 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**


Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Knock or tapping sound.

PROBABLE CAUSE		CORRECTIVE ACTION
a. Rocker arm assembly defective or out of adjustment.		(1) Locate faulty cylinder as follows:
PROCEDURE	OBSERVATION	ANALYSIS
<b>Audible Check:</b>		
Open grilles, remove top deck, engine shroud, and covers for access to cylinders (WP 0090, Oil Cooler Access Covers and Frames Replacement (Engine and Transmission)).		
Operate engine at idle.	Listen or use sounding rod to determine noisy cylinder.	Location of noise isolates faulty cylinder.
		
<b>Fuel "Shorting" Method:</b>		
Check all cylinders, one at a time.		
Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage.	Note cylinder on which no change in engine operation occurs, knock disappears or decreases, and/or engine roughness or misfire still exists.	Indicates faulty cylinder, defective nozzle, tight rocker arm, worn valve or hydrostatically damaged connecting rod.
<b>High Pressure Fuel Check:</b>		
Remove one engine cover on each side of engine for access to fuel injector nozzle tube fittings.		
Crank engine with fuel switch "ON" or start engine and operate at idle speed.		
Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage.	High-pressure fuel spray pulsations at nozzle fitting.	Fuel injection pump action is normal.
	No fuel spray pulsations noted at nozzle fitting.	Fuel injection pump deficiency.

**MALFUNCTION 1: (Continued)**

Knock or tapping sound.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. (Continued) Rocker arm assembly defective or out of adjustment.		(1) (Continued) Locate faulty cylinder as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
<b>Cylinder Compression Test Method:</b>		
Perform Cylinder Compression Test (WP 0033, Cylinder Compression Test).	Note cylinder with low pressure (below 330 psi at 140-180 cranking rpm).	Indicates faulty cylinder, damaged rings, piston, valve, connecting rod or tight rocker arm (no valve clearance).
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
b. Excessive intake or exhaust valve clearance or damage.		(1) Locate faulty cylinder as above.
		(2) Adjust valve clearance (WP 0034, Intake and Exhaust Valve Clearance Adjustment).
c. Rocker arm assembly defective.		(1) Inspect, repair, or replace valve and/or cylinder (WP 0133, Cylinder Assembly Replacement).
		(2) Replace rocker arm (WP 0104, Rocker Arm Assembly and Cover Replacement).
d. Connecting rod, piston, ring damage, or loose piston pin.		(1) Locate faulty cylinder as above.
		(2) Check for damage (WP 0143, Connecting Rod Assembly and Associated Parts Repair and WP 0142, Pistons, Rings, and Associated Parts Replace/Repair).
e. Crankshaft bearing damage.		(1) Check for damage (WP 0138, Crankshaft Main Bearing Inspection).
f. Worn or damaged gears or bearings.		(1) Check for damage (WP 0178, Disassembly/ Assembly Procedure Sequence for the AVDS 1790-2 Engine).

**ENGINE NOISY OPERATION**

**0015 00**

**MALFUNCTION 2:**

Diesel knock ("ping," usually at low-idle speed).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Manifold heater solenoid valves defective.		(1) Check solenoid operation as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Press heater switch intermittently "ON" and "OFF".	Note audible "click" or opening and closing valve action (by touch) of both solenoid valves (fuel supply and fuel return).	Evidence of action indicates normal solenoid valve operation.
		No audible "click" or action indicates solenoid valve(s) is defective.
To Check Solenoid Valve and Fuel Filter: Disconnect one fuel tube from engine front solenoid valve outlet tee, operate purge pump and press heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from tee opening with each purge pump stroke.	Fuel flow indicates solenoid valve is operating properly and fuel filters are satisfactory.
		No fuel or restricted flow indicates manifold heater filter or felt filters in solenoid valve are restricted or clogged.
	With switch in "OFF" position note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck open).
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
To Check Return Fuel Solenoid Valve and Check Valve: Remove fuel return solenoid outlet tube after the check valve at rear of engine, operate purge pump and press heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from check valve opening.	Moderate flow indicates solenoid valve is operating properly and check valve is opening properly.
		No fuel or restricted flow indicates check valve stuck closed or felt filters in solenoid valve are restricted or clogged.
	With switch in "OFF" position note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck in open position).
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. (Continued) Manifold heater solenoid valves defective.		(2) Replace solenoid valve (WP 0087, Manifold Heater Fuel Filter and Solenoid Replacement).

**ENGINE NOISY OPERATION**

**0015 00**

**MALFUNCTION 2: (Continued)**

Diesel knock ("ping," usually at low-idle speed).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
b. Return fuel line disconnected or restricted.	(1) Inspect fuel line (WP 0080, Fuel Injection Nozzle Return Hoses and Related Parts Replacement).
c. Engine fuel-injection pump.	(1) Check timing (WP 0036, Injection Pump Timing).

**MALFUNCTION 3:**

Grinding or squeaking sound.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Cooling fan interference (fan housing vane or foreign material).	(1) Inspect fan for proper clearance (WP 0053, Cooling Fan Inspection). Repair or replace damaged parts.
b. Engine accessories.	(1) Replace damaged accessory.
c. Worn or damaged gears, camshaft, rocker arm bearing or bushings.	(1) Check for damage (WP 0178, Disassembly/Assembly Procedure Sequence for the AVDS 1790-2 Engine).

**END OF WORK PACKAGE**

**ENGINE ABNORMAL EXHAUST**

**0016 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Excessive black smoke (one or both banks).

PROBABLE CAUSE		CORRECTIVE ACTION
a. Induction air inlets blocked with debris.		(1) Inspect and clean air inlet grilles and air cleaner inlets.
b. Air cleaner restriction (element dirty, wet, or blower motor inoperative).		(1) Check restriction as follows:
PROCEDURE	OBSERVATION	ANALYSIS
<b>Pre-cleaner Blower:</b>		
Start engine and operate at idle.	Note blast of air (on hand) from pre-cleaner air exhaust outlets, two on each air cleaner.	Blast of air indicates blower(s) is operating.
	No air blast.	Blower(s) is inoperative.
<b>Air Cleaners</b>		
Perform "stall" test as follows.		
Start engine and warm to normal operating temperature (140 °F).		
With vehicle brakes applied and transmission in "high range", depress accelerator pedal fully and operate engine for 20 seconds (max.); release accelerator pedal and allow engine to idle 1 minute.	Engine speed below 1800 rpm.	Engine and transmission partially warmed up (not to normal operating temperature of 140°F).

**ENGINE ABNORMAL EXHAUST**

**0016 00**

**MALFUNCTION 1: (Continued)**

Excessive black smoke (one or both banks).

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
<b>Air Cleaners</b> (Continued) Repeat the preceding step, but operate engine for 30 seconds (maximum).	Engine speed 1800-1950 rpm.	Engine power is normal.
	Engine speed below 1800 rpm.	Power is below normal.
	Engine speed above 1950 rpm.	Transmission is slipping or fuel injection pump is out of adjustment.
	Normal engine speed (1800-1950 rpm).	Air cleaner elements satisfactory.
	Speed below normal.	Proceed to next step.
Open doors, remove elements, clean element chamber and close doors. Repeat stall test.	If engine speed increases from speed obtained previously to normal speed.	The elements are dirty.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
b. (Continued) Air cleaner restriction (element dirty, wet or blower motor inoperative).		(2) Service filter (clean, dry or replace). Refer to pertinent vehicle technical manual.
c. Air cleaner hose collapsed.		(1) Inspect, repair or replace (refer to pertinent vehicle technical manual).
d. Turbocharger air inlet blocked with plastic plug, tape, rag, or other debris (usually one bank only).		(1) Inspect and clean (refer to pertinent vehicle technical manual).
e. Turbocharger compressor housing clamp.		(1) Tighten or replace clamp.
f. Turbocharger defective (sticky, worn or failed bearings, seals and damaged impeller).		(1) Remove inlet elbows (refer to pertinent vehicle technical manual) and check for bearing play or looseness, impeller damage, or excessive carbon deposits on turbine wheel. Replace defective turbocharger (WP 009, Turbocharger Assembly Replacement (2CA & 2DA) or WP 0100 for 2DR).
g. Exhaust manifold leak (loose flange, failed gasket, cracked or damaged manifold or elbow).		(1) Inspect exhaust manifold for leaks and repair as required (WP 0107, Exhaust Manifolds and Associated Parts Replacement).



**ENGINE ABNORMAL EXHAUST**

**0016 00**

**MALFUNCTION 1: (Continued)**

Excessive black smoke (one or both banks).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
h. Fuel-injection pump timing incorrect.	(1) Check timing of fuel injection pump (WP 0036, Injection Pump Timing).
i. Fuel injection pump fuel adjustment improper (over fueled).	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
j. Fuel injection pump advance unit defective.	(1) Replace advance unit (WP 0160, Fuel Injection Advance Control Repair).

**MALFUNCTION 2:**

Excessive bluish smoke during vehicle operation (one or both banks).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. High oil consumption.	(1) Refer to WP 0018, Engine Abnormal Oil Pressure.

**MALFUNCTION 3:**

White (grayish) smoke during low-idle operation (one or both banks).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Engine operating at idle for extended period during cold weather.	(1) Increase engine idle speed to 1000 - 1200 rpm.

**MALFUNCTION 4:**

Oily and/or heavy carbon deposits on vehicle rear grille.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. External oil leaks.	(1) Refer to WP 0018, Engine Abnormal Oil Pressure.
b. Excessive oil consumption.	(1) Refer to WP 0018, Engine Abnormal Oil Pressure.
c. Engine operating at idle for extended period during cold weather.	(1) Increase engine idle speed to 1000 - 1200 rpm.

**END OF WORK PACKAGE**



**COOLING SYSTEM DEFICIENCIES**

**0017 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle.

**MALFUNCTION 1:**

Engine overheating (evidenced by high oil temperature, low oil pressure, and warning lights "ON").

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Oil cooler screens and fins blocked with debris.	(1) Clean screens and oil cooler finned air passages.  <b>NOTE</b> <b>Inspect for oil leaks and avoid oil spillage.</b>
b. Restricted cooling air inlets (blocked with debris).	(1) Clean air inlets and grilles.
c. Oil level overfull.	(1) Refer to WP 0031, Engine Oil Replacement.
d. Seasonal grade of oil improper (too heavy) for ambient temperature.	(1) Check oil in engine. Drain and refill with proper grade of oil (refer to pertinent Vehicle Lubrication Order).
e. Cooling fan clutch slipping, fan drive failed, or blades eroded.	(1) Check fan rotation and clutch torque (WP 0045, Cooling Fan Clutch Slip Test). Inspect fan blades (WP 0053, Cooling Fan Inspection). Repair as required.
f. Cooling shroud, baffle, deflector or plates loose, cracked or broken.	(1) Inspect and repair as required.
g. Oil cooler thermostatic valve and/or bypass valve defective.	(1) Remove valves and replace. Go to WP 0072, Oil Cooler Replacement (Engine and Transmission).
h. Engine over-powered due to improper fuel adjustment.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**COOLING SYSTEM DEFICIENCIES**

**0017 00**

**MALFUNCTION 1: (Continued)**

Engine overheating (evidenced by high oil temperature, low oil pressure, and warning lights "ON").

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
i. Engine operation under full load for extended periods at high ambient temperatures (desert) under heavy load conditions (sand, mud, hills).	(1) Limit operation to short periods when operating under such conditions.

**END OF WORK PACKAGE**

**ENGINE ABNORMAL OIL PRESSURE**

**0018 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Low oil pressure, temperature normal.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Low oil level.	(1) Refer to WP 0031, Engine Oil Replacement.
b. Seasonal grade of oil improper (oil too light) for ambient temperature.	(1) Check oil in engine. Drain and refill with proper grade of oil (refer to pertinent lubrication order).
c. Oil diluted with fuel.	(1) Refer to Malfunction 9 in this work package.
d. Pressure sending unit or gauge defective.	(1) Check electrically (refer to pertinent vehicle technical manual).
	(2) Repair or replace as required.
e. Oil pressure regulator valve malfunction.	(1) Inspect for sticky or defective valve. Repair or replace as required (WP 0074, Damper/Oil Filter Housing Related Parts Replacement).
f. Defective oil pump or obstructed oil pickup screen.	(1) Remove oil pump and inspect pump and screen (WP 0153, Oil Pump Assembly Replacement).
g. Crankshaft bearing worn or damaged.	(1) Check for deposits in filter. If found, disassemble engine, clean and repair as required (WP 0178, Disassembly/Assembly Procedure Sequence for the AVDS 1790-2 Engine).
	(2) Check for damage (WP 0139, Crankshaft Replace/Repair).

**ENGINE ABNORMAL OIL PRESSURE**

**0018 00**

**MALFUNCTION 2:**

Low oil pressure with normal oil temperature and warning light "OFF".

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Oil pressure gauge or transmitter defective.	(1) Check electrically (refer to pertinent vehicle technical manual). Replace as required.

**MALFUNCTION 3:**

Low oil pressure with high oil temperature and warning light "ON".

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Engine overheating.	(1) Refer to WP 0017, Cooling System Deficiencies.

**MALFUNCTION 4:**

Low oil pressure with high oil temperature and warning light "OFF".

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Warning light burned out.	(1) Replace bulb (refer to pertinent vehicle technical manual).

**MALFUNCTION 5:**

High oil temperature with normal oil pressure and warning light "OFF".

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Oil temperature gauge or transmitter defective.	(1) Check electrically (refer to pertinent vehicle technical manual). Replace as required.

**MALFUNCTION 6:**

Low oil level (below "Add" mark).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Vehicle not on level ground during oil level check.	(1) Position vehicle on level ground and recheck oil level.
b. "Oil check" service neglected.	(1) Add oil to proper level.
c. Loss of oil due to oil leak.	(1) Inspect for leaks (WP 0038, Engine Leak Test). Repair as required.
d. High oil consumption.	(1) Refer to Malfunction 9 in this work package.

**ENGINE ABNORMAL OIL PRESSURE**

**0018 00**

**MALFUNCTION 7:**

High oil level (overfull).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Overfilled in error.	(1) Drain to proper level.
b. Oil diluted with fuel.	(1) Refer to Malfunction 8 in this work package.

**MALFUNCTION 8:**

Oil diluted with fuel (evidenced by rising oil level, thin oil consistency).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Engine operating at idle for extended periods during cold weather.		(1) Drain oil and refill with proper oil (refer to lubrication order). (2) Avoid operating at idle for extended periods during cold weather.
b. Fuel leakage at fuel injector nozzle body.		(1) Locate faulty nozzle as follows.
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Operate engine at idle speed.	Look for any signs of fuel leakage at nozzle.	Leakage indicates nozzle is defective.
	Note any movement (jumping) of nozzle in cylinder head (visually or by touch).	Movement indicates loose nozzle cap nut in body or collapsed nozzle holder spring. Nozzle is defective.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
b. (Continued) Fuel leakage at fuel injector nozzle body.		(2) Repair or replace nozzle assembly (WP 0114, Fuel Injector Nozzle Replace/Repair).
c. Engine fuel supply pump shaft seal leak.		(1) Repair or replace pump assembly (WP 0047, Fuel Pump Replacement (2CA & 2DA), use (WP 0048 for 2DR).
d. Fuel injection pump internal fuel leak into oil.		(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).

**MALFUNCTION 9:**

Excessive oil consumption (150:1 fuel-to-oil ratio maximum).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Loss of oil due to leaks.	(1) Inspect engine for oil leaks. Repair as required.
b. Oil level overfull.	(1) Refer to WP 0031, Engine Oil Replacement.

**ENGINE ABNORMAL OIL PRESSURE**

**0018 00**

**MALFUNCTION 9: (Continued)**

Excessive oil consumption (150:1 fuel-to-oil ratio maximum).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
c. Seasonal grade of oil improper (oil too light) for ambient temperature.	(1) Refer to pertinent vehicle lubrication order.
d. Piston rings or valve guides worn (result of dust ingestion).	(1) Inspect induction system for dust entry (air cleaner seals, hoses and clamps). Repair or replace (WP 0037, Induction Leak Test).
	(2) Verify cylinder compression (WP 0033, Cylinder Compression Check).
	(3) If compression test indicates engine damage, repair or replace cylinder (WP 0135, Cylinder Assembly Repair) and piston rings (WP 0142, Pistons, Rings, and Associated Parts Replace/Repair) as required.
e. Piston rings damaged (scuffed due to engine overheating).	(1) Refer to WP 0142, Pistons, Rings, and Associated Parts Replace/Repair.
	(2) Verify cylinder compression (WP 0033, Cylinder Compression Test).
	(3) If compression test indicates engine damage, repair or replace defective parts as required.
<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
f. Turbocharger defective (worn or damaged seals).	(1) Remove inlet and exhaust elbows, then check for evidence of oil. Replace defective turbocharger (WP 0099, Turbocharger Assembly Replacement (2CA & 2DA), use WP 0100 for 2DR).

**MALFUNCTION 10:**

Excessive crankcase blow-by (high crankcase pressure).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Rings worn or damaged. Indicated by heavy carbon deposits in breather tube at turbocharger exhaust pipe.		(1) Perform Crankcase Blow-by Test as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Open rear grille doors and remove transmission cover. Install 10-inch H <sub>2</sub> O gauge in crankcase breather system.		



**MALFUNCTION 10: (Continued)**

Excessive crankcase blow-by (high crankcase pressure).

PROCEDURE	OBSERVATION	ANALYSIS
Start engine, warm up to operating temperature, and perform "stall" test (WP 0041, Engine Stall Test). Go to WP 0016, Engine Abnormal Exhaust.	5 inch H <sub>2</sub> O (max.) pressure.	Crankcase pressure is normal.
	Above 5 inch H <sub>2</sub> O pressure.	Crankcase pressure is high, indicating excessive blow-by or restricted crankcase vent at turbocharger exhaust outlet pipe.
PROBABLE CAUSE		CORRECTIVE ACTION
a. (Continued) Rings worn or damaged.		(2) Clean engine crankcase breather tube (WP 0078, Engine Oil Hose Assemblies, Tube Assemblies and Related Parts Replacement).
		(3) Replace piston rings WP 0142, Pistons, Rings, and Associated Parts Replace/Repair.

**MALFUNCTION 11:**

Generator oil pressure abnormal (650 ampere generator).

PROBABLE CAUSE		CORRECTIVE ACTION	
a. Restricted oil lines.		(1) Inspect lines for plugging or damage (WP 0091, Generator Oil Cooling System Lines and Fittings Replacement).	
b. Generator oil pump failure.		(1) Perform Oil Pressure Test as follows:	
PROCEDURE	OBSERVATION	ANALYSIS	
Remove 1/8-inch pipe plug in center of generator end plate and install 200 psi gauge.			
Start and warm up engine at idle speed (675-725 rpm) to operating temperature (140 °F).	Oil pressure 100 ± 10 psi.	Generator oil pump operation is normal, the generator is rotating and the drive coupling is functioning.	
	Oil pressure same as normal engine gallery pressure (15-25 psi).	Generator oil pump failed, and/or generator not rotating, and/or drive coupling failed.	

**MALFUNCTION 11:**

Generator oil pressure abnormal (650 Ampere generator, PN 11655469 only).

PROBABLE CAUSE		CORRECTIVE ACTION	
b. (Continued) Generator oil pump failure.		(2) Replace generator (WP 0051, Generator Replacement (650 Ampere) (2CA).	
c. Drive clutch failure.		(1) Perform Clutch Test as follows:	
PROCEDURE	OBSERVATION	ANALYSIS	
Torque check (generator removed). Check slip torque of drive gear assembly with generator coupling tool and torque wrench (300 foot-pound capacity).	Note if there is slippage of the drive gear while increasing torque to 167 foot pounds.	If slippage occurs below 167 foot pounds, drive gear assembly is defective.	
		If no slippage occurs below 167 foot pounds, slip torque is acceptable, but gear assembly may have other damage (low torque rate). Proceed to 2 below.	
Check torque rotational deflection rate. Using tool and torque wrench as in 1 above, apply 167 foot-pound torque.	Note deflection in degrees from zero torque to 167 foot-pound torque.	If rotation is more than 8°, but less than 17°, drive gear assembly is satisfactory.	
		If rotation is greater than 17°, or less than 8°, the drive gear assembly is defective.	

**END OF WORK PACKAGE**

**ENGINE PERFORMANCE LOW**

**0019 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**CAUTION**

**If a rough, noisy, or overheated engine is associated with the reported low power, prior correction of these malfunctions often will eliminate the poor performance and, in addition, may prevent further damage to the engine.**

**When low power or poor vehicle performance is reported, an engine "stall" speed test will indicate whether the malfunction is engine or vehicle related.**

**PRELIMINARY INVESTIGATION**

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Engine rough operation.	(1) Refer to WP 0014, Engine Rough Operation.
b. Engine noisy.	(1) Refer to WP 0015, Engine Noisy Operation.
c. Engine overheating.	(1) Refer to WP 0017, Cooling System Deficiencies.

**POWER VERIFICATION: Perform engine "stall" test as follows:**

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Start engine and warm to normal operating temperature (140 °F).		
With vehicle brakes applied and transmission in "high range," depress accelerator pedal fully and operate engine for 20 seconds, release accelerator pedal and allow engine to idle 1 minute.	Engine speed below 1800 rpm.  <p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;"><b>Use a calibrated tachometer for "Stall Test".</b></p> <p style="text-align: center;"><b><u>CAUTION</u></b></p> <p style="text-align: center;"><b>Limit "Stall Test" to 30-second intervals maximum, and terminate immediately if transmission warning light activates.</b></p>	Engine and transmission partially warmed up (not to normal operating temperature of 140°F).

**POWER VERIFICATION: Perform engine "stall" test as follows: (Continued)**

PROCEDURE	OBSERVATION	ANALYSIS
Repeat the preceding step, but operate engine for 30 seconds.	Engine speed 1800-1950 rpm.	Engine power is normal.
	Engine speed below 1800 rpm.	Power is below normal.
	Engine speed above 1950 rpm.	Transmission is slipping or fuel injection pump is out of adjustment.
PROBABLE CAUSE		CORRECTIVE ACTION
a. If stall speed is normal (1800-1950 rpm), low performance is vehicle related or vehicle may be operating under severe conditions.	(1) Investigate transmission clutches, brakes, and vehicle suspension for being too tight. Repair as required (refer to pertinent vehicle technical manual).	
	(2) Check vehicle performance on hard road; and if performance is satisfactory, limit vehicle operation under severe conditions to short periods of operation. Possible engine damage may be prevented.	
b. If stall speed is above normal (more than 1950 rpm) low performance is transmission related and engine is over-powered.	(1) Investigate for transmission slippage (refer to vehicle technical manual).	
	(2) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	

**MALFUNCTION 1:**

Low stall with both banks firing and normal smoke.

PROBABLE CAUSE	CORRECTIVE ACTION
a. In-tank fuel pump inoperative.	(1) Check in-tank fuel pump operation (refer to pertinent vehicle manual). Repair as required.
b. Throttle travel limited.	(1) Inspect accelerator and throttle linkages (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
c. Water contaminated fuel or improper fuel.	(1) Check fuel system for water content (WP 0020, Fuel System Abnormal Conditions). Service as required (refer to pertinent vehicle technical manual for proper fuel specification).
d. Fuel filter restriction (dirty).	(1) Inspect fuel filters (refer to pertinent vehicle technical manual). Service filters as required.

**MALFUNCTION 1: (Continued)**

Low stall with both banks firing and normal smoke.

PROBABLE CAUSE	CORRECTIVE ACTION
e. Fuel return restriction.	(1) Inspect fuel return (WP 0020, Fuel System Abnormal Conditions). Repair as required.
f. Fuel supply leaks.	(1) Inspect for leaks and repair.
g. Governor high-idle adjustment improper.	(1) Check high-idle operation. If out of specifications, replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
h. Fuel injection pump fuel adjustment improper.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
i. Engine fuel supply pump defective.	(1) Check pump operation. (WP 0020, Fuel System Abnormal Conditions). Repair or replace as required.
j. Fuel injection pump fuel pressure regulating valve defective.	(1) Replace Fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
k. Fuel injection pump timing improper.	(1) Check timing (WP 0036, Injection Pump Timing). Retime as required.

**MALFUNCTION 2:**

Low stall speed with black exhaust smoke: (one or both banks).

PROBABLE CAUSE	CORRECTIVE ACTION	
a. Vehicle air cleaner inlets blocked with debris.	(1) Inspect and clean.	
b. Air cleaner restriction.	(1) Check air cleaner as follows:	
PROCEDURE	OBSERVATION	ANALYSIS
<b>Pre-cleaner Blower:</b>		
Start engine and operate at idle.	Note blast of air (on hand) from pre-cleaner air exhaust outlets, two on each air cleaner.	Blast of air indicates blower(s) is operating.
	No air blast.	Blower(s) is inoperative.
<b>Air Cleaners:</b>		
Perform "stall" test as outlined on page 1, this work package.  <b>CAUTION</b> <b>Do not perform under dusty conditions.</b>	Normal speed (1800-1950 rpm).	Air cleaner elements satisfactory.
	Speed below normal.	Proceed to next step.

**MALFUNCTION 2: (Continued)**

Low stall speed with black exhaust smoke: (one or both banks).

PROCEDURE	OBSERVATION	ANALYSIS
Open doors, remove elements, clean element chamber, re-install elements and close doors. Repeat stall test.	Engine speed increases from speed obtained in the previous step to normal speed	Elements are dirty (refer to pertinent vehicle manual).
	Engine speed remains the same.	Filters are not the problem; continue to next probable cause.
PROBABLE CAUSE		CORRECTIVE ACTION
c. Air cleaner hose collapsed.		(1) Inspect hose. Replace as required.
d. Turbocharger air inlet blocked.		(1) Inspect turbocharger inlet (WP 0016, Engine Abnormal Exhaust).
e. Turbocharger deficiency.		(1) Inspect turbocharger (WP 0016, Engine Abnormal Exhaust).

**MALFUNCTION 3:**

Low stall with excess bluish exhaust smoke (one or both banks).

PROBABLE CAUSE	CORRECTIVE ACTION
a. Worn or damaged rings with excessive oil consumption.	(1). Overhaul engine (WP 0178, Disassembly/ Assembly Procedure Sequence for the AVDS 1790-2 Engine).

**MALFUNCTION 4:**

Low stall with one bank not firing.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Fuel injection pump malfunction.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement)

**END OF WORK PACKAGE**

**FUEL SYSTEM ABNORMAL CONDITIONS**

**0020 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Container (minimum 2 gallon/7.5 liter capacity)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Air in system.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Occurred during fuel filter replacement, engine or power pack installation, or long period shutdown.	(1) "Purge" fuel system. Turn master and in-tank fuel pump switches to "ON". Operate in-tank fuel pump for 1 or 2 minutes. Simultaneously operate purge pump, completing 4 or 5 strokes after firm handle pressure is noted.  <p style="text-align: center;"><b><u>CAUTION</u></b></p> <p style="text-align: center;"><b>Do not depress flame heater button. Damage to engine could occur.</b></p> (2) With in-tank pumps operating, open bleeder valves (on cover of both primary and fuel/water separator filters) until all fuel (no air) is noted.
b. Return fuel restriction.	(1) Refer to Malfunction 10 in this work package.
c. Damaged fuel hoses (fuel pump to filter, or filter to fuel injection pump).	(1) Remove and install new hoses (WP 0084, Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement).

**MALFUNCTION 2:**

Water contaminated fuel.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Automatic drain system inoperative.	(1) Refer to Malfunction 12 in this work package.

**MALFUNCTION 3:**

Accelerator and throttle linkage deficiencies.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Insufficient throttle travel.	(1) Place 3/4-inch wide piece of writing paper over end of high idle adjusting screw and depress accelerator pedal fully. If control lever stop contacts adjusting screw and holds paper tightly, full throttle travel exists. Repeat this after each step in this Malfunction 3.
b. Vehicle accelerator linkage loose, worn, binding, disconnected, improperly adjusted, or pedal return spring malfunction.	(1) Inspect, repair, and adjust (refer to pertinent vehicle technical manual).
c. Engine throttle linkages loose, worn, binding, improperly adjusted or disconnected.	(1) Inspect, repair or replace as necessary (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
d. Engine throttle cross-shaft idle or full-throttle positions improperly adjusted.	(1) Adjust to proper stop clearances (WP 0043, Throttle Adjustments).
e. Engine throttle cross-shaft shock spring defective (broken spring allows free movement between tangs and lever pins).	(1) Inspect for broken spring and replace (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)
	(2) Check free movement. Replace spring if clearance is greater than 0.010 inch.
f. Improper low idle adjustment (engine cross-shaft idle screw).	(1) Adjust low idle screw to proper engine speed (675-725 rpm). Turn clockwise to increase and counter clockwise to decrease speed (WP 0040, Engine Operating Parameters).
	(2) If speed below 725 rpm cannot be obtained with adjustment above, proceed to Malfunction 6 in this work package.
g. Engine will not maintain 1800 rpm speed during winching operations (AVDS-1790-2DR only).	(1) Adjust speed control solenoid screw (WP 0040, Engine Operating Parameters), or repair throttle control solenoid assembly (WP 0122, Throttle Control and Manual Fuel Shutoff Replace/Repair). (WP 0123 for 2DR)



**FUEL SYSTEM ABNORMAL CONDITIONS**

**0020 00**

**MALFUNCTION 4:**

In-tank fuel pump deficiencies.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Electric circuit defective or electric motor failure.		(1) Check operation as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Open top grilles. Turn master switch and in-tank fuel pump switch to "ON".	Electric pump operation is audible (left and right fuel tanks).	Pump(s) is operative.
	Pump(s) operation is not audible.	Pump(s) is inoperative.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. (Continued) Electric circuit defective or electric motor failure.		(2) Check electric circuit (refer to pertinent vehicle technical manual). Repair as required. (3) Replace pump assembly (refer to pertinent vehicle technical manual).
b. Pump output insufficient (defective pump or screen clogged).		(1) Check pressure and output as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
<b>Pump Operational Check</b>		
Open top grilles. Turn master switch and in-tank fuel pump switch to "ON".	Electric pump operation is audible (left and right fuel tanks).	Pump(s) is operative.
	Pump(s) operation is not audible.	Pump(s) is inoperative.
<b>Pump Fuel Pressure Check</b>		
Install pressure test gauges: 100 psi gauge in fuel/water separator filter cover bleeder valve opening (WP 0084, Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement). 10 psi gauge in primary filter cover bleeder valve opening (WP 0086, Primary Fuel Filter Replacement).		
Turn master and in-tank fuel pump switches "ON".	Less than 5 PSI at both fuel/water separator and primary fuel filters.	In-tank pump is operative.
Operate engine at high-idle speed (2500-2640 rpm).	Zero psi at fuel/water separator filter, and zero psi at primary fuel filter.	In-tank pump(s) inoperative or fuel line restriction.
<b>Pump Output Check (Fuel Flow Capacity):</b>		
Open left grille doors. Disconnect fuel tank supply hose quick-disconnect coupling valve at engine.		
Open coupling valve (hold open) to collect fuel in suitable container (5 gallon).		
Turn master and in-tank fuel pump switches "ON".		

**MALFUNCTION 4: (Continued)**

In-tank fuel pump deficiencies.

PROCEDURE	OBSERVATION	ANALYSIS
<b>Pump Output Check (Fuel Flow Capacity): (Continued)</b>		
Time fuel flow into measured container.	3 gpm fuel flow	Pump output is satisfactory.
	Fuel flow below 3 gpm.	Pump output below normal.
PROBABLE CAUSE		CORRECTIVE ACTION
b. (Continued) Pump output insufficient (defective pump, or screen clogged).		(2) Repair or replace pump (refer to pertinent vehicle technical manual).

**MALFUNCTION 5:**

Fuel filter restriction.

PROBABLE CAUSE		CORRECTIVE ACTION
a. Primary and/or fuel/water separator filter element clogged. (Dirt, water soaked or waxed.)		(1) Check fuel pressure as follows:
PROCEDURE	OBSERVATION	ANALYSIS
Install pressure test gauges: 100 psi gauge in fuel/water separator filter cover bleeder valve opening (WP 0064, Fuel/Water Separator Automatic Drain System and Wiring Harness E2ca128-006 Replacement). 10 psi gauge in primary filter cover bleeder valve opening (WP 0086, Primary Fuel Filter Replacement).		
Turn master and in-tank fuel pump switches "ON".	Less than 5 PSI at both fuel/water separator and primary fuel filters.	In-tank pump is operative.
Operate engine at high-idle speed (2500-2640 rpm).	Zero psi at fuel/water separator filter, and zero psi at primary fuel filter.	In-tank pump(s) inoperative or fuel line restriction.
PROBABLE CAUSE		CORRECTIVE ACTION
a. (Continued) Primary and/or fuel/water separator filter element clogged (dirt, water soaked or waxed).		(2) Replace defective filter elements (WP 0085, Fuel/Water Separator Filters Repair, and WP 0086, Primary Fuel Filter Repair).

**MALFUNCTION 6:**

Fuel injection pump deficiencies.

PROBABLE CAUSE		CORRECTIVE ACTION	
a. Fuel injection pump governor low-idle speed adjustment improper.		(1) Adjust low-idle stop screw on fuel injection pump.	
		<p style="text-align: center;"><b>NOTE</b></p> <p style="text-align: center;"><b>Required only when engine speed cannot be adjusted as described in WP 0040, Engine Operating Parameters.</b></p>	
b. Fuel injection pump governor high-idle speed improper.		(2) If low idle speed cannot be obtained, replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	
		(1) Check high-idle speed as follows:	
PROCEDURE	OBSERVATION	ANALYSIS	
<b>High Idle Test</b>			
<b>NOTE</b> Use a calibrated tachometer for this test.			
Start engine and warm-up to normal operating temperature (140 °F).			
With transmission in "neutral", depress accelerator pedal fully for approximately 10 seconds.		Engine speed 2500-2640 rpm.	Speed is normal and governor no-load adjustment is proper.
		Engine speed below 2500 rpm.	Speed too low.
		Engine speed exceeds 2640 rpm.	Speed too high.
PROBABLE CAUSE	CORRECTIVE ACTION		
b. (Continued) Fuel injection pump governor high-idle speed improper.	(2) Check linkages and adjustment (WP 0043) then repeat High Idle Test (above).		
	(3) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).		
c. Fuel-metering governor mechanism binding, loose, worn or broken.	(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).		

**MALFUNCTION 6: (Continued)**

Fuel injection pump deficiencies.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
d. Fuel adjustment improper.		(1) Check engine power (WP 0044, Engine Run-In) or perform Engine Stall Test (WP 0041).	
		(2) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	
e. Electric fuel shutoff failure (electric circuit defective or solenoid failure).		(1) Check solenoid operation as follows :	
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>	
Open top grille door. With master switch "ON", intermittently operate fuel shut-off switch "ON" and "OFF" (with manual control in normal engine "ON" position).	Note audible solenoid "clicking" indicating opening and closing action.	Audible "clicking" indicates normal fuel shut-off operation.	
		No audible "clicking" indicates solenoid or circuit defective.	
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
e. (Continued) Electric fuel shutoff failure (electric circuit defective or solenoid failure).		(2) Check circuit voltage (refer to pertinent vehicle technical manual).	
		(3) Replace fuel injection pump.	
f. Manual fuel shut-off malfunction (improper control linkage adjustment or internal failure).		(1) Check manual operation as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>	
With master switch "ON", hold manual control handle in engine "OFF" position and intermittently operate electric fuel shut-off switch "ON" and "OFF".	If no audible "clicking" is noted.	Manual control is holding fuel shut-off in "OFF" position and manual operation is satisfactory.	
	If audible "clicking" is noticed.	Manual control out of adjustment, or defective.	

**MALFUNCTION 6: (Continued)**

Fuel injection pump deficiencies.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
f. (Continued) Manual fuel shut-off malfunction (improper control linkage adjustment or internal failure).		(2) Check manual control for full travel or disconnected linkage. Adjust or repair as required (WP 0040, Engine Operating Parameters).	
		(3) Remove fuel injection pump shut-off cover and inspect lever operation. If defective, replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	
g. Fuel control stuck in "No-Fuel" position (result of improper preservative oil during long-term storage).		(1) Operate engine fuel shut-off (electric and manual separately) six to eight times. This may free fuel control from stuck position. Attempt engine start.	
		(2) Check fuel-metering operation as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>		<b>ANALYSIS</b>
Install pressure test gauges: 100 psi gauge in fuel/water separator filter cover bleeder valve opening (WP 0084, Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement). 10 psi gauge in primary filter cover bleeder valve opening (WP 0086).			
Turn master and in-tank fuel pump switches "ON".	5-7 psi at fuel/water separator filter and at primary fuel filter.		In-tank pump(s) operation normal.
	Below 5 psi at fuel/water separator filter and at primary fuel filter.		Screens clogged or pump(s) defective (refer to pertinent vehicle technical manual).
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
g. (Continued) Fuel control stuck in "no-fuel" position (result of improper preservative oil during long term storage).		(3) Remove fuel shut-off cover and inspect fuel control lever (lever is stuck when in extreme right position). Refer to pertinent fuel injection pump technical manual.	
		(4) Manually move lever to the left, counter clockwise, and alternately rotate (both directions gradually) until full travel and complete freeness of lever is obtained.	
		(5) Reinstall fuel shut-off cover and check engine for normal start.	

**FUEL SYSTEM ABNORMAL CONDITIONS**

**0020 00**

**MALFUNCTION 6: (Continued)**

Fuel injection pump deficiencies.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
g. (Continued) Fuel control stuck in "no-fuel" position (result of improper preservative oil during long term storage).		(6) If engine fails to start, replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	
h. Fuel injection pump drive coupling failure (pump not rotating).		(1) Check fuel injection pump rotation as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>	
Remove top deck, engine rear cooling fan vane and rear fan.			
Crank engine.	Fuel injection pump shaft is rotating.	Drive coupling is satisfactory.	
	Fuel injection pump shaft and/or coupling do not rotate.	Fuel injection pump coupling failed or is loose on pump shaft.	
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
h. (Continued) Fuel injection pump, drive coupling failure (pump not rotating).		(2) Replace fuel injection pump drive coupling (WP 0116, Coupling, Fuel Injection Pump Replace/Repair).	
i. Fuel injection pump timing improper.		(1) Check timing (WP 0036, Injection Pump Timing).	
j. Fuel injection pump internal failure.		(1) Replace fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).	

**MALFUNCTION 7:**

Engine fuel supply pump defective.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Fuel pump failure (insufficient fuel output due to defective regulating valve, internal pump wear or shaft seal leak causing fuel leakage into engine oil).	(1) Check fuel pressure as follows:

**MALFUNCTION 7: (Continued)**

Engine fuel supply pump defective.

PROCEDURE	OBSERVATION	ANALYSIS
<b>Fuel Pressure Check</b>		
Install pressure test gauges: 100 psi gauge in fuel/water separator filter cover bleeder valve opening (WP 0084, Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement). 10 psi gauge in primary filter cover bleeder valve opening (WP 0086, Primary Fuel Filter Repair and Element Replacement).		
Turn master and in-tank fuel pump switches "ON".		
Operate engine at high-idle speed (2500-2640 rpm).	40 psi at fuel/water separator filter, and below 1 psi at primary fuel filter.	Primary filter restriction. Element dirty or clogged.
PROBABLE CAUSE		CORRECTIVE ACTION
a. (Continued) Fuel pump failure (insufficient fuel output due to defective regulating valve, internal pump wear or shaft seal leak causing fuel leakage into engine oil).	(2) Repair or replace defective fuel pump assembly (refer to pertinent fuel pump manual).	
	(3) Drain oil and replace filters in engine (WP 0031, Engine Oil Replacement, and WP 0073, Oil Filters Replacement).	


**MALFUNCTION 8:**

Fuel injector nozzle defective.

PROBABLE CAUSE		CORRECTIVE ACTION
a. Abnormal spray pattern (sticky action, stuck partially open, or orifices partially plugged).		(1) Locate faulty cylinder as follows:
PROCEDURE	OBSERVATION	ANALYSIS
<b>Nozzle Malfunction</b>		
Perform High Pressure Fuel Check on one cylinder at a time with engine idling (all engine covers removed).	Note cylinder on which no change in engine operation occurs, or if cylinder misfire still exists.	Cylinder is not firing due to defective nozzle.
Alternate check with power pack removed. Operate engine at idle speed.	Note if cylinder temperature is cold (by touch) at intake port area of cylinder head.	A cold cylinder indicates the cylinder is not firing due to defective nozzle.

**MALFUNCTION 8: (Continued)**

Fuel injector nozzle defective.

PROCEDURE	OBSERVATION	ANALYSIS
<p><b>High Pressure Fuel Check</b></p>  <p><b>Keep hands away from nozzle during test.</b></p>		
<p>Remove one engine cover on each side of engine for access to fuel injector nozzle tube fittings (WP 0072, Engine and Transmission Oil Cooler Access Covers and Frames Replacement).</p>		
<p>Crank engine with fuel switch "ON" or start engine and operate at idle speed.</p>		
<p>Loosen fuel injector tube fitting at nozzle end sufficiently to allow fuel leakage (one nozzle on each side of the engine).</p> <p><b>NOTE</b> <b>Leave fitting loosened only long enough to verify fuel is flowing.</b></p>	<p>High-pressure fuel spray pulsations at nozzle fitting.</p>	<p>Fuel injection pump action is normal.</p>
	<p>No fuel spray pulsations noted at nozzle fitting.</p>	<p>Fuel injection pump deficiency.</p> <p><b>NOTE</b> <b>Test all fuel injector nozzles for proper operation after a fuel injection pump failure.</b></p>
<p><b>Bench Test</b></p>		
<p>Install nozzle and holder assembly on tester.</p>		
<p>Perform nozzle test (WP 0098, Fuel Injector Tubes, Brackets, and Associated Parts Replacement).</p>	<p>Spray pattern and nozzle leakage test requirements.</p>	<p>If spray pattern is not acceptable or leakage is noted, nozzle is defective.</p>
<p><b>Nozzle Loose in Cylinder</b></p>		
<p>Operate engine at idle speed.</p>	<p>Note any movement (jumping) of nozzle in cylinder head (visually or by touch).</p>	<p>Movement indicates loose nozzle cap nut in body, or collapsed nozzle holder spring. Nozzle is defective.</p>
<p><b>PROBABLE CAUSE</b></p>		<p><b>CORRECTIVE ACTION</b></p>
<p>a. (Continued) Abnormal spray pattern (sticky action, stuck partially open, or orifices partially plugged).</p>	<p>(2) Repair or replace defective nozzle assembly (WP 0114, Fuel Injector Nozzle Replace/Repair).</p>	



**MALFUNCTION 8: (Continued)**

Fuel injector nozzle defective.

PROBABLE CAUSE	CORRECTIVE ACTION
b. Fuel injector nozzle valve stuck closed or orifice plugged.	(1) Bench test injector nozzle (WP 0114, Fuel Injector Nozzle Replace/Repair).
	(2) Repair or replace defective fuel injector nozzle and holder assembly (WP 0114, Fuel Injector Nozzle Replace/Repair).
	(3) If defective fuel injector nozzle is found, the fuel injection pump must be tested for damage. Replace defective fuel injection pump (WP 0115, Fuel Injection Pump Assembly Replacement).
PROBABLE CAUSE	CORRECTIVE ACTION
c. Fuel injector nozzle holder spring failed (result of improper installation of nozzle).	(1) Locate faulty nozzle (as described earlier in this work package).
	(2) Repair or replace fuel injector nozzle and holder assembly (WP 0114, Fuel Injector Nozzle Replace/Repair).
d. Fuel leakage at fuel injector nozzle body.	(1) Locate faulty fuel injector nozzle.
	(2) Repair or replace fuel injector nozzle and holder assembly (WP 0114, Fuel Injector Nozzle Replace/Repair).

**MALFUNCTION 9:**

Fuel injector tube high-pressure fuel leakage.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Fitting loose, tubing cracked or broken.	(1) Tighten fitting nut.
	(2) Inspect tubing sleeve.
	(3) Replace defective tube (WP 0113, Fuel Injection Tube Replacement).
b. Fuel injector tube clamps (loose or missing clamps allow tube vibration resulting in fuel leaks).	(1) Tighten loose clamps, replace damaged clamps and install missing clamps (WP 0113, Fuel Injection Tube Replacement).

**MALFUNCTION 10:**

Engine fuel return restriction.

PROBABLE CAUSE		CORRECTIVE ACTION
a. Engine fuel return hose quick-disconnect coupling not connected.		(1) Reconnect coupling (refer to pertinent vehicle technical manual).
b. Quick-disconnect coupling, tube or hoses defective or damaged (restricting return fuel flow).		(1) Check return fuel flow as follows:
PROCEDURE	OBSERVATION	ANALYSIS
Open rear grille doors and remove transmission cover. Disconnect tank fuel return hose quick-disconnect coupling at rear of transmission.		
Hold quick-disconnect coupling valve open to collect fuel in suitable container.		
<p><b><u>CAUTION</u></b></p> <p><b>Do not operate engine unless coupling valve is held open.</b></p>		
Start and operate engine at idle speed and collect fuel in suitable container.	Moderate fuel flow from coupling valve (about 1/2 gpm).	No restriction. Return fuel flow rate is satisfactory.
	Trickle or no flow from hose.	Fuel flow is insufficient. Pinched or kinked line or quick-disconnect coupling valve defective.
PROCEDURE	OBSERVATION	ANALYSIS
Remove coupling half from fuel tank tube and connect coupling halves on hose; operate engine.	Moderate flow.	Quick-disconnect coupling valve satisfactory.
	Trickle or no flow.	Fuel tank return tube or hose pinched or kinked, or quick-disconnect coupling defective.
PROBABLE CAUSE		CORRECTIVE ACTION
b. (Continued) Quick-disconnect coupling, tube or hoses defective or damaged (restricting return fuel flow).		(2) Replace defective coupling tube or hose.

**FUEL SYSTEM ABNORMAL CONDITIONS**

**0020 00**

**MALFUNCTION 11:**

Fuel return, check valve defective.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Check valve not seating (leaking at seat)	(1) Remove and inspect valve for proper seating (no leakage allowed).
	(2) Replace valve if leakage is detected.

**MALFUNCTION 12:**

Automatic water drain system in-operative.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. System malfunction (water not draining).	(1) Open manual drain cock and drain into suitable container. If more than one quart of water is drained, system is inoperative.
	(2) If excessive water is found in filter, replace filter elements (WP 0085, Fuel/Water Separator Filters Repair and Element Replacement).
b. Electrical wiring defect.	(1) Check voltage supply to control unit and repair or replace wiring as required, refer to pertinent vehicle technical manual.
c. Solenoid valve defective.	(1) Apply 24 volts to solenoid and check operation. If defective, replace solenoid valve (WP 0087, Manifold Heater Fuel Filter and Solenoid Replacement).
d. Control unit or sensors defective.	(1) Replace control unit and sensor assembly (WP 0084, Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement).

**END OF WORK PACKAGE**



**GENERATOR ABNORMAL OPERATION (650 AMPERE)**

**0021 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Not charging (indicator reads in "yellow" same as battery reading with engine stopped and master switch "ON").

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Battery cables or terminals loose, corroded, broken or disconnected (connector nuts not tightened).	(1) Check battery condition.
	(2) Inspect and repair cables and terminals (refer to pertinent vehicle technical manual).
b. Defective electrical circuits or voltage regulator.	(1) Check circuits and voltage regulator (refer to pertinent vehicle technical manual).
	(2) Repair and replace as necessary (refer to pertinent vehicle or generator technical manual).
c. Generator failed.	(1) Check circuits and generator (refer to pertinent vehicle or generator technical manual).
	(2) Repair and replace as necessary (refer to pertinent vehicle technical manual).
	(3) Replace generator (WP 0051, Generator Replacement - 650 Ampere).
	(4) Assure that generator oil hoses are free of obstruction.
d. Generator drive gear assembly failed.	(1) Perform Generator Drive Gear Assembly Torque Check as follows:

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Remove 1/8-inch pipe plug located in center of end plate and install 200 psi gauge.		
Start and warm up engine at idle speed (675-725 rpm) to operating temperature (140 °F).	Oil pressure 100 ± 10 psi.	Generator oil pump operation is normal, the generator is rotating and the drive coupling is functioning.

**MALFUNCTION 1: (Continued)**

Not charging (indicator reads in “yellow” same as battery reading with engine stopped and master switch “ON”).

PROCEDURE	OBSERVATION	ANALYSIS
(Continued) Start and warm up engine at idle speed (675-725 rpm) to operating temperature (140 °F).	Oil pressure same as normal engine gallery pressure (15-25 psi).	Generator oil pump failed, and/or generator not rotating, and/or drive coupling failed.
Check slip torque of drive gear assembly (WP 0039, NOTE: Generator must be removed (WP 0051).	Note if there is slippage of the drive gear while increasing torque to 167 foot pounds.	If slippage occurs below 167 foot pounds, drive gear assembly is defective.
		If no slippage occurs below 167 foot pounds, slip torque is acceptable, but gear assembly may have other damage (low torque rate). Proceed to next step.
Check torque-rotational deflection rate (WP 0039)	Note deflection in degrees from zero torque to 167 foot pounds torque.	If rotation is more than 8°, but less than 17°, drive gear assembly is satisfactory.
		If rotation is greater than 17° or less than 8°, the drive gear assembly is defective.
PROBABLE CAUSE		CORRECTIVE ACTION
d. (Continued) Failed generator drive gear assembly.		(1) Replace drive gear assembly (WP 0156, Generator Replacement - 650 Ampere).

**MALFUNCTION 2:**

Undercharging (maximum indicator reading in “yellow” during vehicle operation.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Loose, corroded or grounded battery terminals or cables.	(1) Inspect, clean, tighten, repair or replace as necessary (refer to pertinent vehicle technical manual).
b. Defective batteries.	(1) Check individual battery cells (refer to pertinent vehicle technical manual).
	(2) Replace batteries (refer to pertinent vehicle technical manual).

**GENERATOR ABNORMAL OPERATION (650 AMPERE)**

**0021 00**

**MALFUNCTION 2: (Continued)**

Undercharging (maximum indicator reading in “yellow” during vehicle operation.

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
c. Voltage regulator defective.		(1) Inspect voltage regulator and replace if necessary (refer to pertinent vehicle technical manual).
d. Generator drive gear assembly failure..		(1) Perform functionality check as follows:
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Remove 1/8-inch pipe plug located in center of end plate and install 200 psi gauge.		
Start and warm up engine at idle speed (675-725 rpm) to operating temperature (140 °F).	Oil pressure 100 ± 10 psi.	Generator oil pump operation is normal, the generator is rotating and the drive coupling is functioning.
	Oil pressure same as normal engine gallery pressure (15-25 psi).	Generator oil pump failed, and/or generator not rotating, and/or drive coupling failed. Go to next step.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
d. (Continued) Failed generator drive gear assembly.		(2) Check slip torque of drive coupling assembly (WP 0039)
		(3) If drive coupling is OK and generator failed functionality test, replace generator (WP-0051, Generator Replacement - 650 Ampere).

**MALFUNCTION 3:**

Overcharging (indicator reads right “red”).

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. Loose or corroded battery terminals, or grounded cables.		(1) Inspect, clean, tighten, or repair as necessary (refer to pertinent vehicle technical manual).
b. Defective batteries.		(1) Check individual battery cells. Replace defective batteries (refer to pertinent vehicle technical manual).
c. Voltage regulator defective.		(1) Inspect voltage regulator and replace if necessary (refer to pertinent vehicle technical manual).

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**GENERATOR ABNORMAL OPERATION (650 AMPERE)**

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**0021 00**

**MALFUNCTION 4:**

4. Discharging (indicator reads in left “red”).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Heavy load or “short” in vehicle system.	(1) Check electrical system circuits (refer to pertinent vehicle technical manual).

**MALFUNCTION 5:**

Erratic charging (indicator fluctuates).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Loose or corroded battery terminals, grounded cables, or defective battery.	(1) Inspect, clean, tighten, or repair as necessary and check batteries (refer to pertinent vehicle technical manual).

**END OF WORK PACKAGE**



**GENERATOR ABNORMAL OPERATION (300 AMPERE)**

**0022 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Not charging (indicator reads in "yellow" same as battery reading with engine stopped and master switch "ON").

<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
a. Battery cables or terminals loose, corroded, broken or disconnected (connector nuts not tightened).		(1) Check battery condition.	
		(2) Inspect and repair cables and terminals (refer to pertinent vehicle technical manual).	
b. Defective electrical circuits or voltage regulator.		(1) Check circuits and voltage regulator (refer to pertinent vehicle technical manual).	
		(2) Repair and replace as necessary (refer to pertinent vehicle or generator technical manual).	
c. Generator failed.		(1) Check circuits and generator (refer to pertinent vehicle or generator technical manual).	
		(2) Repair and replace as necessary (refer to pertinent vehicle technical manual).	
		(3) Perform Generator Electrical Failure Test as follows:	
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>	
Remove generator from engine.			
Inspect generator windings and insulation (accessible through drive end plate), and check for free rotation of drive shaft turning shaft by hand.	Damaged winding – burned insulation debris, and odor – also observe for debris in drain tubes and freeness of rotation, of generator shaft.	Debris and odor indicates generator burned out. Rotational bind indicates failure.	
		If above not evidenced, generator may have electrical failure or drive gear assembly failure.	
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>	
c. (Continued) Generator failed.		(4) Replace generator (WP 0052, Generator Replacement – 300 Ampere).	

**MALFUNCTION 2:**

Undercharging (maximum indicator reading in “yellow” during vehicle operation).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Loose, corroded or grounded battery terminals or cables.	(1) Inspect, clean, tighten, repair or replace as necessary (refer to pertinent vehicle technical manual).
b. Defective batteries.	(1) Check individual battery cells (refer to pertinent vehicle technical manual).
	(2) Replace batteries (refer to pertinent vehicle technical manual).
c. Voltage regulator defective.	(1) Inspect voltage regulator and replace if necessary (refer to pertinent vehicle technical manual).

**MALFUNCTION 3:**

Overcharging (indicator reads right “red”).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Loose or corroded battery terminals, or grounded cables.	(1) Inspect, clean, tighten, or repair as necessary (refer to pertinent vehicle technical manual).
b. Defective batteries.	(1) Check individual battery cells. Replace defective batteries (refer to pertinent vehicle technical manual).
c. Voltage regulator defective.	(1) Inspect voltage regulator and replace if necessary (refer to pertinent vehicle technical manual).

**MALFUNCTION 4:**

Discharging (indicator reads in left “red”).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Heavy load or “short” in vehicle system.	(1) Check electrical system circuits (refer to pertinent vehicle technical manual).

**MALFUNCTION**

Erratic charging (Indicator fluctuates).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Loose or corroded battery terminals, grounded cables, or defective battery.	(1) Inspect, clean, tighten, or repair as necessary and check batteries (refer to pertinent vehicle technical manual).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Manifold heater inoperative.

PROBABLE CAUSE		CORRECTIVE ACTION
a. Electrical or fuel system malfunction.		(1) Check manifold heater operation. Repair or replace defective parts as indicated by the following tests.
PROCEDURE	OBSERVATION	ANALYSIS
<b>Manifold heater Operational Check</b>		
Hold fuel shut-off (engine "STOP") switch and crank engine.		
While cranking engine, engage manifold heater switch and hand operate purge pump.		
Place hand on intake manifold heater housing. Check both sides of engine.	Note housing temperature (warm or hot to touch).	Evidence of heat indicates manifold heater operation is normal.
		No heat indicates manifold heater is inoperative. Replace manifold heater (WP 0088, Manifold Heater Assembly and Related Parts Replacement).



**MALFUNCTION 1: (Continued)**

Manifold heater inoperative.

<b>Manifold heater Voltage Checks</b>		
<b>NOTE</b>		
<b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b>		
<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Check electrical circuit voltages (master switch and manifold heater switch "ON").	24 volts at manifold heater switch, both connectors.	Proper voltage through manifold heater switch.
	No voltage to switch.	Defective circuit. See appropriate vehicle technical manual.
	No voltage from switch.	Defective switch.
	24 volts at engine bulkhead connector.	Proper voltage.
	No voltage to bulkhead connector.	Defective circuit between switch and connector. See appropriate vehicle technical manual.
	24 volts at solenoid valve(s) supply and return wire connector.	Proper voltage to solenoid valves.
	No voltage at solenoid valves.	Defective circuit between connector and valves. See appropriate vehicle technical manual.
	24 volts at ignition unit connector.	Proper voltage supply to ignition unit.
	No voltage at ignition unit.	Defective circuit to ignition unit. See appropriate vehicle technical manual.


**MALFUNCTION 1: (Continued)**

Manifold heater inoperative.

<p><b>Ignition Unit Operation</b></p> <p style="text-align: center;"><b>NOTE</b></p> <p><b>Disconnect purge pump fuel hose quick-disconnect coupling at engine before performing test.</b></p> <div style="float: right; border: 1px solid black; padding: 5px; text-align: center; width: fit-content;"> <p><b>WARNING</b></p> </div> <div style="float: right; text-align: center;">  <p><b>High Voltage!</b> (See decal on unit.) <b>Voltage High Amperage Output.</b></p> </div>		
PROCEDURE	OBSERVATION	ANALYSIS
Remove high-tension wire from igniter (spark plug). Position lead wire end to ground for spark gap (1/4 inch)	Note high-tension spark (hot bluish-white) across gap (lead-to-ground).	High-tension spark indicates ignition unit operation normal.
		Improper spark or no spark indicates ignition unit or ignition unit lead is defective. Replace unit and lead (WP 0088 Manifold Heater Assembly and Related Parts Replacement).
<p><b>Spark Plug Operation</b></p> <div style="float: right; border: 1px solid black; padding: 5px; text-align: center; width: fit-content;"> <p><b>WARNING</b></p> </div> <div style="float: right; text-align: center;">  <p><b>High Voltage!</b></p> </div>		
Remove spark plug, reconnect wire to spark plug, ground plug body to engine and press manifold heater switch "ON".	Note high-tension spark across spark plug electrodes.	High-tension spark indicates spark plug firing, operation normal.
		No spark, the spark plug is defective. Replace spark plug.
<p><b>Solenoid Valve(s) Operation</b></p>		
Press manifold heater switch intermittently "ON" and "OFF".	Note audible "click" or opening and closing valve action (by touch) of both solenoid valves (fuel supply and fuel return).	Evidence of action indicates normal solenoid valve operation.
		No audible "click" or action indicates solenoid valve(s) is defective.

**MALFUNCTION 1: (Continued)**

Manifold heater inoperative.

PROCEDURE	OBSERVATION	ANALYSIS
<p><b>Fuel System Checks</b></p> <div style="text-align: center;"> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <div style="text-align: center; margin: 10px auto;">  </div> <ul style="list-style-type: none"> <li>• <b>Keep hands away from nozzle during test.</b></li> </ul> </div>		
<p>Purge Pump: Disconnect purge pump fuel hose quick disconnect coupling at engine main fuel back flow valve. Hold coupling valve open and operate purge pump.</p>	<p>Note fuel with each firm stroke of purge pump.</p>	<p>Moderate flow with each stroke indicates normal purge pump operation.</p>
		<p>If flow is not evident, purge pump is defective, or purge lines are blocked or leaking. See appropriate vehicle technical manual.</p>
<p>Fuel Filter: Disconnect fuel tube between fuel check valve tee and manifold heater fuel filter and operate purge pump.</p>	<p>Note fuel flow with each stroke of purge pump.</p>	<p>Moderate flow with each stroke indicates no in-line filter restriction. Filter satisfactory.</p>
		<p>No flow, or restricted flow, indicates filter is plugged. See appropriate vehicle technical manual.</p>

**MALFUNCTION 1: (Continued)**

Manifold heater inoperative.

PROCEDURE	OBSERVATION	ANALYSIS
<p>Solenoid Valve and Fuel Filter: Disconnect one fuel tube from engine front solenoid valve outlet, operate purge pump and press manifold heater switch "ON" and "OFF".</p>	<p>With switch in "ON" position, note fuel flow from tee opening with each purge pump stroke.</p>	<p>Fuel flow indicates solenoid valve is operating properly and fuel filters are satisfactory.</p>
		<p>No fuel or restricted flow indicates manifold heater filter or filters in solenoid valve are restricted or clogged. See appropriate vehicle technical manual.</p>
	<p>With switch in "OFF" position note that fuel flow stops.</p>	<p>If fuel flow stops, solenoid valve is closing properly.</p>
		<p>If fuel flow continues, solenoid valve is defective (stuck open). Replace solenoid.</p>
<p>Fuel Nozzle Assembly: Disconnect lines and remove nozzle assembly. Reconnect lines to nozzle, (position nozzle beside housing) and operate manifold heater system.</p>	<p>With switch in "ON" position, nozzle should have fine conical fuel spray pattern.</p>	<p>Fine fuel spray pattern indicates proper nozzle operation.</p>
		<p>No spray pattern, stream of fuel, dribble or no fuel indicates defective nozzle or plugged port filters in nozzle assembly. See appropriate vehicle technical manual.</p>

**MALFUNCTION 1: (Continued)**

Manifold heater inoperative.

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Return Fuel Solenoid Valve and Check Valve: Remove fuel return solenoid outlet tube after the check valve at rear of engine, operate purge pump and press manifold heater switch "ON" and "OFF".	With switch in "ON" position, note fuel flow from check valve opening.	Moderate flow indicates solenoid valve is operating properly and check valve is opening properly.
		No fuel or restricted flow indicates check valve stuck closed or filters in solenoid valve are restricted or clogged. See appropriate vehicle technical manual.
	With switch in "OFF" position note that fuel flow stops.	If fuel flow stops, solenoid valve is closing properly.
		If fuel flow continues, solenoid valve is defective (stuck in open position). Replace solenoid.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
Fuel backflow valve		Perform pressure tests in work package

**END OF WORK PACKAGE**



**ENGINE TIME TOTALIZING METER OPERATION**

**0024 00**

**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Meter inoperative.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Generator inoperative.	(1) Check generator (refer to WP 0021, Generator Abnormal Operation – 650 Ampere, or WP 0022 for 300 ampere generator).
b. Wiring defective.	(1) Check circuit voltage to meter lead (refer to pertinent vehicle technical manual).
c. Totalizing meter defective.	(1) Replace totalizing meter. See appropriate depot maintenance work requirement (DMWR).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**WARNING**

**When using JP-8 fuel the smoke generator must be disabled. Smoke will not be generated when using JP-8 and excess fuel could puddle causing a potential fire hazard. See Field Service Bulletin 458 for disabling procedure.**

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:** Engine fails to produce smoke when engine is operating and smoke generating system is activated.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Fuel shut-off valve closed.	(1) Open fuel shut-off valve.
b. No generator output.	(1) Bring engine speed to 1000 rpm momentarily to insure generator output.
	(2) Troubleshoot generator malfunction (WP 0021 for 650 ampere, or WP 0022 for 300 ampere).
c. Restricted fuel tube adapters in exhaust pipes.	(1) Replace fuel tube assemblies.
d. Air cleaner blower motors not operating.	(1) Refer to pertinent vehicle technical manual.
e. Ruptured fuel hose or tube.	(1) Replace fuel hose or tube.
f. Fuel solenoid valve(s) not operating.	(1) Replace solenoid valve(s).
g. Restricted fuel hose or tube.	(1) Replace fuel hose or tube.

**MALFUNCTION 2:** Smoke produced is of poor quality.

PROBABLE CAUSE	CORRECTIVE ACTION
a. Loss of fuel from loose connection or ruptured hose or tube.	(1) Tighten connection or replace hose or tube.
b. Restricted fuel hose or tube.	(1) Replace hose or tube.
c. Restricted fuel filters.	(1) Service fuel filters.
d. Restricted fuel tube adapters in exhaust pipes.	(1) Replace fuel tube assemblies.
e. No current to solenoid valves.	(1) Repair wiring harness.
f. Solenoid valve(s) defective.	(1) Replace solenoid valve(s).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Troubleshooting Table and Diagnostic Tests

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle or ground hop.

**MALFUNCTION 1:**

Abnormal operation of dust detector system (power pack warning lamp and dust detector warning lamps ON, with pressure switch plunger(s) visible).

PROBABLE CAUSE		CORRECTIVE ACTION
a. Restricted filter strip.		(1) Service dust detector filter strip, refer to pertinent vehicle technical manual.
b. Loose or defective hose clamps on turbosupercharger air inlet hose.		(1) Repair or replace as necessary.
c. Defective or missing seals at turbosupercharger air inlet elbow or air cleaner air outlet elbow.		(1) Repair or replace as necessary.
d. Restricted orifices in turbosupercharger compressor housing and cover.		(1) Remove dust detector filter strip cover. Clean all orifices and cavities. Service filter strip.
e. Defective pressure switch.		(1) Remove pressure switch (WP 0082, Turbosupercharger Dust Detector System Replacement). Perform pressure switch operational check.
PROCEDURE	OBSERVATION	ANALYSIS
Install an adapter in the bottom (low pressure) opening in pressure switch.		
Suck on connector with the mouth.	Pressure switch plunger pops up.	Switch is operational.
	Pressure switch plunger does not pop up.	Switch needs to be replaced. Remove adapter and replace switch.
Using a voltmeter, check for continuity across the two pressure switch connector pins.	No continuity.	Switch defective. Replace pressure switch.
	There is continuity.	Switch is operational.

**MALFUNCTION 1: (Continued)**

Abnormal operation of dust detector system (power plant warning lamp and dust detector warning lamps ON, with pressure switch plunger(s) visible).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
f. Defective wiring harness.	(1) Inspect electrical leads for broken wire or damaged connectors. Check for continuity using a voltmeter. Replace defective cable assembly (WP 0067, Dust Detector Harness Replacement).
g. Air cleaner access door seals damaged or cam arm pins worn or broken.	(1) Repair or replace as necessary, refer to pertinent vehicle technical manual.
h. Leak in engine induction system (turbocharger compressor housing and engine air induction manifold).	(1) Inspect engine turbocharger and manifold system. Clean, tighten, or replace parts as necessary (WP 0037, Induction Leak Test).
i. Oil leakage from turbocharger compressor side bearing and seal.	(1) Repair turbocharger as shown in TM 9-2990-205-34&P, and TM 9-2990-206-34&P, or replace turbocharger (WP 0099 Turbocharger Assembly Replacement). (WP 0100 for 2DR)
j. Ingestion of re-circulated smoke/fuel caused by missing/broken air cleaner access door seals or components.	(1) Repair or replace as needed.
k. Ingestion of re-circulated exhaust smoke caused by missing/broken air cleaner access door seals or components.	(1) Repair or replace as needed.
L. Air cleaner filter damaged or punctured due to installation, disassembly, or foreign objects.	(1) Service air cleaner; refer to pertinent vehicle technical manual.

**CLEAN AIR SYSTEM TROUBLESHOOTING****0026 00****MALFUNCTION 2:**

Abnormal operation of dust ejector system (air cleaner requires cleaning too often).

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Restricted air cleaner (air cleaner restriction indicators have reached 30 inches H <sub>2</sub> O).	(1) Service air cleaner, refer to pertinent vehicle technical manual.
b. Leak in vehicle exhaust dust ejector system due to loose or missing clamps or damaged hoses and gaskets.	(1) Inspect, clean, tighten, and replace parts as necessary. Refer to pertinent vehicle technical manual.
c. Submergence exhaust pipe cap assembly flapper restricting scavenge tube opening due to flapper hinge pin worn or broken.	(1) Replace as necessary. Refer to pertinent vehicle technical manual.
d. Submergence exhaust pipe cap assembly flapper in restricting tube opening due to water freezing flapper in closed position.	(1) Repair or replace as necessary. Refer to pertinent vehicle technical manual.
e. Scavenge system not functioning due to punctured or damaged tubes.	(1) Repair or replace as needed.
f. Exhaust dust ejector nozzle worn or damaged due to operation, installation, or disassembly.	(1) Repair or replace as needed.

**MALFUNCTION 3:**

Low power and excessive black smoke.

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Leak in engine air induction system or defective turbosupercharger.	(1) Inspect engine air induction system and clean, tighten, or replace parts as necessary (WP 0037, Induction Leak Test).
b. Restricted air cleaner (air cleaner restriction indicators have reached 30 inches H <sub>2</sub> O).	(1) Service air cleaners, refer to pertinent vehicle technical manual.

**END OF WORK PACKAGE**





**TM 9-2815-220-24**

**CHAPTER 3**

**STANDARD MAINTENANCE PROCEDURES**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



## GENERAL

This section covers the procedures for servicing the AVDS-1790-2 series engine upon receipt.

## INITIAL PROCEDURES

### Initial Procedures

Inspect the engine for damage incurred during shipment. If the engine has been damaged, report the damage on SF Form 364, Report of Deficiency.

Check the engine against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions on DA PAM 738-750.

Check whether the engine has been modified. Reference shall be made to the authorized equipment configuration change list when applicable.

### Assembly of Equipment

The engine is shipped as an assembled unit. Assembly is not required.

### Equipment Instructions

Follow all precautions on DD Form 1397 (Processing and De-processing Record for Shipment, Storage and Issue of Vehicles and Spare Engines). One tag will be with the Records Book and one in an envelope attached to the engine.

## PREOPERATIONAL PROCEDURES

Inspect all wires, fuel lines, connectors, electrical connectors, welds, bolts and seals. Check for the following:

ENGINE OIL: Check level (refer to Work Package 0031).

## OPERATIONAL PROCEDURES

### Initial Starting and Break-in

#### NOTE

**Engine may contain preservative oil upon receipt. Preservative engine oils PE1 and PE2 are identical to engine oils OE-10 and OE-30 except that they contain a preservative additive.**

**PE1 and PE2 will be used in the same manner as the regularly used engine oils OE-10 and OE-30 until the first semiannual oil change.**

**Due to international processing, engine may be hard to start and may smoke and run rough. Let it run for 5 minutes and see if it improves. Perform troubleshooting procedures if engine fails to develop full power after 5 minutes.**

**Start and run engine until preservative oil is out of combustion chambers and engine is operating smoothly. Check for fuel and oil leaks immediately.**

### Operational Test

Test engine systems for proper operation (refer to Work Package 0044).

## EQUIPMENT FAULTS

Equipment faults disclosed during preliminary inspection and servicing or during break-in period will be corrected by the using unit or support maintenance.

Serious equipment faults that appear to involve unsatisfactory design or material will be reported on SF 368, Quality Deficiency Report (Category II), as prescribed in DA PAM 738-750.

## END OF WORK PACKAGE

**THIS WORK PACKAGE COVERS:**

General Information, Standard Maintenance Instructions (Cleaning, Inspection, Repair), and Assembly Guidelines

**GENERAL INFORMATION**

This work package contains general preparation, cleaning, inspection, repair, and fault isolation. Perform these procedures during disassembly, repair, and assembly of the engine, the container, and their parts.

The procedures for cleaning, inspection, repair and assembly of the various parts and components that make up the engine sub-assemblies will be the same for a great percentage of parts and components. To avoid repetition, these standard instructions are detailed in this work package. The tools and expendable materials needed to perform the standard instructions will be identified in the initial setup part of the procedural work package.

The "procedural" work package will reference this Standard Maintenance Instructions work package throughout the manual.

Any "nonstandard" cleaning, inspection, repair, or assembly procedure – procedures that are peculiar to a specific part or component – will be covered in the procedural work package in the section or paragraph relating to that item.

**REPAIR PARTS, SPECIAL TOOLS, AND SUPPORT EQUIPMENT**

Part or item numbers of tools, kits and inserts, in addition to working dimensions are tabulated in appropriate procedural work package.

Tables of Allowance (TA) and Tables of Organization and Equipment (TOE) authorize standard and common tools and equipment that are used on the engine and container for issue.

Refer to Work Package 0176 for lists of special tools and support equipment needed to maintain the engine and container.

Refer to Work Package 0177 for lists and illustrations of fabricated items needed to maintain the engine.

Repair parts and special tools are listed and illustrated in TM 9-2815-220-24P. This is your authority for ordering replacement parts.

**SERVICE UPON RECEIPT**

Go to Work Package 0027 for specific instructions.

**PERSONNEL SAFETY**

To ensure safety of personnel, proper care should be exercised when handling the engine and its subassemblies and parts. Many subassemblies are heavy. Assistance of another person, lifting device, or other support equipment is needed to manipulate them. Personnel should not try to handle heavy parts by hand. Ensure that all lifting devices are in good working order.

Maintenance of the engine requires removal and installation of many large retaining rings that are spring loaded. Two approved methods for handling retaining rings safely are as follows:

Safety glasses (goggles) must be worn to protect the eyes in either case.

- a. Place a wiping rag around retaining ring and hold in place with one hand. Release retaining ring with approved retaining ring pliers.
- b. Place a small hammer handle on the shaft or in the bore of the hardware you're working on. Hold hammer in place with one hand and release retaining ring using approved retaining ring pliers.

Two warnings are frequently used in this work package, cleaning compound solvent and compressed air. In the procedure, they will be presented in an abbreviated version. They are presented here in full.

**WARNING**

**Cleaning compound solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.**

**Ensure there is good airflow when using solvent, and work area is away from heat and flames.**

- **Keep fire extinguisher nearby.**
- **Do not breathe solvent fumes.**
- **Avoid skin contact. See Warning in front of Manual.**

**WARNING**

**Compressed air can injure you and others. Do not aim air at personnel. Do not use more pressure than 30 psi (207 kPa). Always wear goggles. See Warning in front of Manual.**

**EQUIPMENT**

Obtain the proper equipment before beginning disassembly. This equipment includes: a suitable lifting device (the engine and transmission together weigh approximately 10,000 pounds), an engine maintenance stand, proper hand tools and special tools, receptacles for small parts, a work table, wood blocks, oil-soluble grease, and wiping cloths.

## HANDLING TECHNIQUES

Avoid damage to engine and container parts and subassemblies during disassembly, cleaning, inspection, repair, and assembly procedures. Nicks, scratches, and dents caused by careless handling can cause oil leakage or improper functionality leading to premature engine failure.

Replace or repair all defective parts. When servicing the engine, care must be used to protect it against contamination. Dirt, small tools, and parts could fall into access holes and cavities. This could result in an engine failure. When an engine is not being serviced, protect it from contamination.

## TORQUE

When a special torque value is required it is indicated in the work package relating to the part. Work Package 0174 is a listing of special and standard torque values.

## CLEANING

Standard cleaning instructions in this work package cover:

- Bearings
- Castings, forgings, and machined surfaces
- Electrical cables and flexible hoses
- Oil passages and screens
- Oil seals and flexible hoses
- Painted parts
- Shafts and spindles
- Threaded parts and inserts

Procedures for cleaning will be the same for most engine and container parts. Standard cleaning instructions are detailed here. Special cleaning procedures are covered in the procedural work package relating to the specific part.

The importance of cleaning must be thoroughly understood by maintenance personnel. Great care and conscientious effort are required in all cleaning operations. Foreign matter such as dirt and metal chips in the engine could damage parts, cause malfunctions, and interfere with accurate measurements. A dirty procedure can result in:

- Cylinder scuffing or scratching
- High oil consumption
- Bearing destruction
- Component failures directly attributed to the entrance of dirt

Maintain rigid standards during all phases of the cleaning operation. The following general instructions apply to all cleaning operations.

**CLEANING (Continued)**

Inspect all air and fluid openings, lines, and hoses. Make sure they are capped.

**WARNING****Cleaning Compound Solvent**

1. Clean all parts before inspections, checks, after repair, and before assembly. Use cleaning solvent (item 8, WP 0173) or approved cleaner. Remove gum, varnish, and sealant compound by soaking parts in cleaning solvent and scrubbing with a soft bristle brush. Clean thoroughly to remove any dirt and residue. Dry parts with wiping rag (item 26, WP 0173).
2. Keep hands free of grease; grease collects dirt.
3. Except where specified, never use abrasives, files, scrapers, wire brushes, or sharp tools on surfaces where the finish is important to the operation or sealing of parts.
4. Apply a thin film of clean oil to parts that have been cleaned and dried to prevent rusting.
5. Never use lye or caustic solutions that will corrode or etch metal surfaces.
6. After cleaning, cover and wrap parts to protect from dirt.

**Bearings**

Bearings require special attention for cleaning and oiling.

**NOTE**

**Do not immerse sealed-type ball bearings in cleaning solvent or hot oil. Entrance of cleaning agent will destroy lubricants sealed in bearing at time of manufacture. Loss of lubricant will result in premature failure of bearing and possible damage to the engine.**

1. Remove the surface dirt, oil or grease from the bearings.

**CAUTION**

**Do not use compressed air for cleaning or drying ball or needle bearings. Damage to bearings will result from spinning of bearing by air blast.**

2. For sealed-type ball bearings, clean by wiping the exterior surfaces with a clean cloth (item 10, WP 0173) moistened in cleaning solvent (item 8, WP 0173).
3. For other bearings, place in hot oil (about 150 °F) to loosen congealed oil and grease.
4. After cleaning, wrap the bearings tightly in oiled or waxed paper until inspection and assembly.
5. Refer to TM 9-214, *Inspection, Care, and Maintenance of Antifriction Bearings*, for information on inspection, care, and maintenance of bearings.



**CLEANING (Continued)**Castings, Forgings, and Machined Surfaces**WARNING****Cleaning Compound Solvent**

1. Clean inner and outer surfaces of castings with cleaning solvent (item 8, WP 0173).
2. Dry casting with compressed air.
3. Remove sludge and gum deposits with a stiff brush.
4. After cleaning, dry casting and blow out all tapped holes with compressed air.

Electrical Cables and Flexible Hoses**CAUTION**

**Do not use dry-cleaning solvent or mineral spirits paint thinner on rubber components and flexible hoses. Prolonged contact with these cleaners cause leather, rubber, and synthetic materials to dry, rot, and lose pliability, making them unserviceable.**

Clean cables and flexible hoses with soap and water. Dry parts with wiping rags (item 26, WP 0173).

Oil Passages and Screens**CAUTION**

**Do not clean oil screens with wire probes. Damage to equipment can occur.**

**NOTE**

**Particular attention must be given to all oil passages in machined parts. All oil passages must be free of obstructions.**

1. Make sure all oil inlets, outlets, orifices, and passages are free of obstructions.
2. Clean all oil inlets, outlets, orifices, and passages with soft wire (brass or copper) probes to break up all sludge or gum deposits.

**CAUTION**

**Assure that passages are free from obstructions; remove any particles which might later become dislodged and contaminate the oil system.**

**CLEANING (Continued)**Oil Passages and Screens (Continued)**WARNING****Cleaning Compound Solvent - Compressed air**

3. Flush all passageways and screens as follows:
  - a. Flush all oil passageways and screens with cleaning solvent (item 8, WP 0173) in the opposite direction of oil flow.
  - b. Then flush with solvent in the direction of oil flow and observe uniform flow through the passageway or orifice.
  - c. If the flow is irregular or lacking, use compressed air to blow out the passageway and/orifice in the opposite direction of oil flow to remove the blockage.
  - d. Flush again with solvent in the direction of oil flow and observe uniform flow through the passageway or orifice.

Oil Seals and Flexible Hoses**CAUTION**

**Cleaning solvent causes leather, rubber, and synthetic materials to become brittle. Do not use cleaning solvent to clean seals and flexible hoses.**

1. Clean seals and flexible hoses with soap (item 37, WP 0173) and water. Dry parts with wiping rag (item 26, WP 0173).

**WARNING****Compressed Air**

2. Flush all hoses with clean engine oil (item 21, WP 0173) and blow out with compressed air.

Painted Parts

Take care when cleaning painted parts that you do not remove or otherwise damage the painted surface. Clean painted parts with a soap solution (item 37, WP 0173) and warm water. Rinse with clear water.

**CLEANING (Continued)**Shafts and Spindles**WARNING****Compressed Air**

Remove obstructions with compressed air or by probing with soft wire.

Threaded Parts and Inserts**WARNING****Compressed Air**

Blow out insert holes with compressed air.

**INSPECTION**

Standard inspection instructions in this work package cover:

- Adapters and hose-to-boss elbows
- Bearings
- Bushings and bushing-type bearings
- Castings, forgings, and machined surfaces
- Dowel pins
- Gears and shafts
- Hoses
- Inserts: helical-coil and threaded
- Oil passages
- Oil seals, preformed packings, and reusable gaskets
- Oil transfer tubes
- Painted parts
- Plugs
- Retaining rings
- Shafts and spindles
- Splined parts
- Springs
- Studs
- Thrust washers and shims

**INSPECTION (Continued)**General Inspection Information

Procedures for inspection will be the same for most engine and container parts. Standard inspection instructions are presented here. Special inspection procedures are covered in the procedural work package relating to the specific part.

The engines are precision-built and the Repair Standards tables have been fixed at close limits. The following general instructions apply to all inspection procedures.

- Care must be exercised in all phases of inspection.
- Inspect finish of all parts.
- Mark all parts that require refinishing.

Repair Standards

Repair Standards appear in the inspection part of some procedural work packages. Accompanying illustrations are used to locate points of measurement for repair limits. The standards contain maximum and minimum limits and key clearances for new or repair parts. The clearances, listed mainly for reference, will automatically be achieved if the mating parts are within the dimensional tolerances listed in the tables.

In some cases, a part that is out of dimensional tolerance may be used providing that the mating part has been carefully selected and, when mated, is within the maximum clearance specified in the "Wear Limits" column of the tables.

In order to assure maximum service and minimum replacement, values in the "Wear Limits" column indicate the point at which parts may be worn before replacement. Normally, all parts that have not worn beyond dimensions shown in the "Wear Limits" column or are not damaged from corrosion will be approved for service.

The Repair Standards table uses the following symbols:

- \* – An asterisk in the "Wear Limits" column indicates that the part must be replaced when worn beyond the limits given in the "Size and Fit of New Parts" column.
- L – An "L" following the tolerance dimensions given in the "Size and Fit of New Parts" column and the "Wear Limits" column indicates a loose fit (clearance).
- T – A "T" following the tolerance dimensions given in the "Size and Fit of New Parts" column and the "Wear Limits" column indicates a tight fit (interference).

Adapters and Hose-To-Boss Elbows

1. Inspect adapters and elbows for leakage or damaged threads.
2. Inspect adapters and elbows for damaged or extruded preformed packings caused by excessive torque when tightening adapters or elbows.
3. Inspect adapter and elbow seats for scoring, pitting, or corrosion.

**INSPECTION (Continued)****Bearings**

Check all bearings for conformance to the applicable Repair Standards.

To inspect bearings removed from hardware, refer to TM 9-214, *Inspection, Care, and Maintenance of Antifriction Bearings*.

To inspect bearings in-place, use the instructions that follow:

**Ball and Roller Bearings (Non-Separable):**

1. Remove the shaft or gear on which the bearing is mounted.

**WARNING****Cleaning Compound Solvent**

2. Clean the mounted bearing with cleaning solvent (item 8, WP 0173).
  - a. Flood the bearing with solvent (item 8, WP 0173).
  - b. Use a sash or paint brush to clean.
  - c. Do **not** use compressed air.
3. Reject the bearing for the following defects:
  - Broken, cracked or split rings
  - Dented seals or shields
  - Cracked or broken separators
  - Loose separator pins
  - Heat discoloration (brown-blue or blue-black color)
4. Rotate the free race slowly and feel for roughness.
  - a. If any defect is observed or felt, the bearing is to be removed with final inspection and disposition per TM 9-214.
5. If the bearing exhibits no defects, lubricate bearing with engine oil (item 21, WP 0173).

**INSPECTION (Continued)**Tapered Roller Bearings:

The cup and cone are separable; but the cup is press-fitted into a housing or retainer, and the cone is press-fitted on a shaft.

1. During disassembly, clean bearing components (cup and cone) in place.
2. Reject bearing cup for pitting, flaking, scoring or wear bands.
3. Reject bearing cone rollers for similar defects found on cup and other defects listed below:
  - Cracked or broken separators
  - Heat discoloration
4. If any defect is observed or felt, the bearing is to be removed from hardware with final inspection and disposition in accordance with TM 9-214.
5. If cup and cone exhibit no defects, lubricate cup and cone with engine oil (item 21, WP 0173).

Three-Piece Cylindrical Roller Bearings (Separable):

1. In cases where all three pieces of the bearing are retained on a shaft, inspect the bearing in the same manner as described for ball and roller bearings (non-separable) above.
2. If, during removal of a gear, the race, bearing, and end plate separate, inspect the bearing components in the same manner as described for tapered roller bearings (separable) above.

Bushings and Bushing-Type Bearings

1. Check all bushings and bushing-type bearings for secure fit in casting or mating part. Reject for color changes, which could indicate overheating.
2. Check for dirt in oil holes and in bushing-type bearings. Oil holes and grooves must be clean and not damaged.
3. Reject for wear, burrs, nicks, or out-of-round condition.
4. Inspect thrust faces of bushing-type bearings for wear by temporarily assembling mating parts and checking end play with a feeler gauge inserted between the thrust faces.
5. Check for conformance to applicable Repair Standards.

Castings, Forgings, and Machined Surfaces

1. Use magnetic particle inspection equipment to check ferrous (cast iron, steel, etc.) castings for cracks.
2. Inspect all nonferrous (aluminum) castings for cracks.
  - a. The preferable method is the dye penetrant method.
  - b. An alternate method is to use a magnifying glass (five power magnification minimum) (item 73, WP 0176) and a strong light to check suspected cracks.
  - c. Check particularly the areas adjacent to studs, threaded inserts, sharp corners, and fillets.

**INSPECTION (Continued)**Castings, Forgings, and Machined Surfaces (Continued)

3. Inspect machined surfaces and castings for nicks, burrs, and raised metal. Mark damaged areas for repair.
4. Using a straightedge or surface plate, check all mating flanges and mounting pads on housings and supports for bends and warpage.
5. Inspect mating flanges and mounting pads for stains, which could indicate oil leakage.
6. Inspect all plug and tapped openings for damaged or stripped threads.
7. Check all castings for conformance to applicable Repair Standards included in procedural work packages.

Dowel Pins

1. Reject dowel pins for looseness or damage. Mark for repair.

Gears and Shafts

1. Inspect all gears and shafts for cracks using a magnifying glass (five power magnification minimum) (item 73, WP 0176) and a strong light. Reject any found.
2. Inspect all gear teeth and splines for wear, sharp fins, burrs, and galled or pitted surfaces. Reject any found.
3. Inspect shaft and gear hub splines for damage, wear, and fit with splines on mating parts. Mating splines must match without binding or looseness.
4. Inspect the mating gear of any defective gear. Reject any found.
5. Check all gears and shafts for conformance to the applicable Repair Standards included in procedural work packages..

Hoses

1. Reject hoses for cuts, breaks, or abrasions in the wire-braided covering.
2. Reject hoses covered by plastic tubing for breaks.
3. Inspect hose fittings for leakage or twisting of the hoses in their assembled positions.
4. Inspect hoses connected to 45-degree or 90-degree hose-to-boss elbows for kinking caused by incorrect elbow position.

Inserts: Helical-Coil and Threaded

## Description:

- To permit higher stresses on studs and bolts that are set in aluminum castings, it is standard practice to install inserts of a stronger metal into which the studs or bolts are threaded.
- Helical-coil and screw thread inserts are designated to perform this function. The inserts are spiral steel coils having a right hand thread-shaped form on the inside and on the outside diameter of the coils. A bar or tang at the bottom end of the coil, which is engaged by an inserting tool, is used for threading the insert into the casting.
- Some inserts have a serrated tooth section at the top end of the coil to stake them in place in the castings.

**INSPECTION (Continued)**Inserts: Helical-Coil and Threaded (Continued)

1. Inspect inserts for cracks and stripped or damaged threads.
2. Check inserts for loose fit.
3. Replace all helical-coil and threaded inserts that do not fit securely in the casting or when casting threads have become galled or stripped.

Oil Passages

Inspect all oil passageways, internal jet plugs or outlet orifices for obstructions and dirt.

Oil Seals, Preformed Packings, and Re-useable Gaskets

1. Reject hook-type metallic seal rings for wear, distortion, cracks, and broken hooks. Ensure that edges of hook ring are square.
2. Reject gaskets, composition-type seals, rings, and packings for wear, brittleness, cracks, cuts, deformation, and deterioration.
3. Reject lip seals for cracks, wear, cuts, and brittleness. Reject springs and seal shells for deformation and cracks.
4. Reject feather edge of oil seals (which contain rotating part) for damage: tears, fraying, hardening, and cracking. Sealing edge must be soft and pliable.

Oil Transfer Tubes

Inspect for bent or damaged oil transfer tubes. Mark those found for replacement.

Painted Parts

The reconditioning of painted parts is a matter of good judgment. Parts that appear to be in good condition after cleaning need not be stripped and repainted in their entirety, but should be cleaned and designated for touch-up only.

1. Check parts for straightness. Mark parts that can be straightened for repair.
2. Check for broken welds, loose rivets or loose weld nuts. Mark those found for repair or replacement.
3. Check shroud seals for hardness, tears, or other damage. Mark damaged seals for replacement if the part is otherwise serviceable.

Plugs

1. Inspect plugs for leakage or damaged threads. Repair or replace as necessary.
2. Inspect plugs for damaged or extruded preformed packings caused by excessive torque when tightening plugs. Replace preformed packings.
3. Inspect plug seats for scoring, pitting, or corrosion. Repair or replace as necessary.



**INSPECTION (Continued)**Retaining Rings

Retaining rings are mandatory replacement parts.

Shafts and Spindles

Inspect shafts and spindles for excessive wear, binding, scoring, cracks, burrs, and obstructed oil passages. Repair or replace as necessary.

Splined Parts

Inspect splined parts for burrs, wear, and twisted, cracked or broken splines. Repair or replace as necessary.

Springs

1. Reject springs for wear, distortion, breaks, and discoloration (evidence of overheating).
2. Use indicator caliper to check spring length. Physical specifications are contained in the work package relating to the specific part.

Studs

Reject all studs for damaged or stripped threads, bent or loose condition, or for any signs of stretching.

Thrust Washers and Shims

Reject thrust washers and shims for wear, distortion, scores, nicks, and burrs.

**REPAIR**

Standard repair instructions in this work package cover:

- Bearings
- Bushings, liners, and bushing-type bearings
- Castings
- Dowel pins
- Gears and shafts
- Inserts
- Oil seals
- Oil transfer tubes
- Painted parts
- Preformed packings and gaskets
- Snap rings
- Splined parts
- Springs
- Studs
- Threaded parts
- Thrust washers and shims

**REPAIR (Continued)**General Repair Information

Procedures for repair will be the same for most engine and container parts. Standard repair instructions are detailed in this section. Special repair procedures are covered in the procedural work package relating to the specific part. The tools and expendable materials needed to perform standard repair instructions will be identified in the initial setup part of the procedural work package.

**CAUTION**

**After repair, clean all parts thoroughly to prevent metal chips, resulting from repair operations or abrasive used in repair operations, from entering working parts of engine.**

Bearings

See TM 9-214 (*Inspection, Care, and Maintenance of Antifriction Bearings*) for inspection and maintenance procedures for roller bearings, needle roller bearings, and ball bearings.

1. Replace all galled, pitted, or damaged bearings.
2. Replace all bearings that do not conform to tolerances specified in the appropriate Repair Standards table in the inspection section of the procedural work package.
3. Replace any bearing if defects are found.

Bushings, Liners, and Bushing-Type Bearings

When bushings, liners, and bushing-type bearings are damaged or worn beyond specified limits, generally the associated parts with which they are used must be replaced.

To remove:

1. Drill out bearing retaining pins used to secure bearings in castings or retaining cages when applicable.
2. Press out bushing or bushing-type bearing with suitable arbor press (item 8, WP 0176).

To install:

1. Align bushing, liner, or bushing-type bearing in casting or retaining cage. Press into place with an arbor press (item 8, WP 0176).
2. Select proper drill size for installation of bearing retaining pins. Drill through bearing and into casting or retaining cage to the proper depth so that the pin will be flush with the bearing surface after installation. Drive retaining pin through bearing and into casting or retaining cage. Cut off any portion of the pin that extends above bearing.
3. Ream or burnish bushing, liner, or bushing-type bearing to size specified in appropriate repair standards table in the inspection section of the procedural work package.
4. Clean repaired parts thoroughly before assembly or installation.

**REPAIR (Continued)**Castings

1. Replace all castings when cracks have penetrated high stress areas such as fillets or webbing.
2. Replace all castings that do not conform to tolerances specified in the appropriate repair standards table in the inspection section of the procedural work package.
3. Replace all castings if machined surfaces are burred or nicked to the point of impairing subsequent assembly or operation.

**WARNING****Cleaning Compound Solvent**

4. Repair minor damage to machined surfaces of castings with a fine mill file, crocus cloth (item 9, WP 0173) dipped in cleaning compound (item 8, WP 0173), or soft honing stone. Pay particular attention to gasket surfaces.
5. Replace all castings having flanges that are severely warped and cannot be repaired to provide a proper seating surface with its mating part.
6. Repair minor warpage of mounting flanges and mounting pads by working surface across a sheet of crocus cloth (item 9, WP 0173) or held tightly on a surface plate or similar flat surface. Replace bent castings, which may impair assembly or operation.

**CAUTION**

**Pipe plug threads in castings must be in good condition to prevent oil leakage.**

7. Repair damaged pipe or screw threads in tapped holes with a tap or die.

Dowel Pins

1. Remove dowel pins that are loose or damaged.
2. If original dowel pin was only slightly loose, install new pin using sealing compound.
3. In cases where the dowel pin hole is grossly out of round, drill the hole oversize, fashion a bushing, and install a new dowel pin in the bushing.

**REPAIR (Continued)**Gears and Shafts

1. Replace all cracked gears and shafts, and shafts that are bent or twisted.
2. Replace all gears and shafts that do not conform to tolerances specified in the repair standards tables in the inspection section of the procedural work package.
3. Replace all gears and shafts having worn, galled, nicked, burred, or pitted teeth and splines.
4. Remove any sharp fins and burrs from splines with crocus cloth (item 9, WP 0173) dipped in cleaning compound (item 8, WP 0173) or with a soft honing stone.
5. Replace all splined gears and shafts that are damaged to the point of impairing assembly or operation.
6. Replace all gears and shafts having splines that do not match properly with mating splines.

Inserts

For standard helical coil insert procedures see Work Package 0029.

For standard threaded insert procedures see Work Package 0030.

Oil Seals

Replace all oil seals at engine repair. During field repair, replace oil seal when thin feather edge is damaged or when seal material is hard or brittle.

1. Press damaged oil seal from casting or adapter. Be careful not to damage bore.

**WARNING****Cleaning Compound Solvent**

2. When oil seal bore in casting or adapter is burred or damaged to the point where an oil-tight seal is impossible, repair or replace casting or adapter. Remove slight nicks, burrs, and scratches with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
3. Install new oil seal in casting bore or adapter using suitable oil seal replacement tool.

Oil Transfer Tubes

1. Remove oil transfer tubes that are loose or damaged.
2. Install new oil transfer tube using sealing compound (item 31, WP 0173).

**REPAIR (Continued)**Painted Parts

The reconditioning of painted parts is a matter of good judgment. Parts that appear to be in good condition after cleaning need not be stripped and repainted in their entirety, but should be cleaned and designated for touch-up only.

- 1 Parts that are rusted or otherwise devoid of paint must be stripped to bare metal. Rubber composition shroud seals must be removed and discarded before the parts can be stripped of paint.
- 2 Retouch or repaint parts to their original color in accordance with procedures contained in TM 43-0139, *Painting Instructions for Field Use*. Install new replacement seals as necessary.

Preformed Packings, O-rings and Gaskets

When directed within a step to remove and discard preformed packings, o-rings and gaskets, replace all that are removed. Do not reuse them.

Shafts and Spindles**WARNING****Compressed Air**

Remove burrs and minor surface irregularities with a crocus cloth (item 9, WP 0173) or soft honing stone. Remove obstructions with compressed air or by probing with soft wire.

Snap Rings (Retaining Rings)

Replace defective snap rings using snap-ring pliers.

Splined Parts

1. Replace parts that are excessively worn or have twisted, cracked, or broken splines.
2. Remove burrs with a soft honing stone.

Springs

1. Discard defective springs. Length inspection data, where needed, is given in procedural work packages.

**REPAIR (Continued)**

Studs

Stud Identification: Stud Identification data appears in the procedural work package for the specific part. The data includes relevant information regarding setting heights, number required, identification and location.




1. Replace all bent or loose studs or studs showing evidence of stretching. Repair minor damage with a thread chaser or thread die and tap set (item 120, WP 0176).
2. Replace all studs having stripped or damaged threads.
  - a. Using a stud remover (item 115, WP 0176), back stud out slowly to avoid heating and possible seizure.
  - b. When studs are broken off too short to use extractor, drill stud and extract with a suitable remover such as Easy Out or similar tool from tool crib.
  - c. Short studs may also be removed by welding a piece of bar stock or a nut to stud and removing with a wrench.
3. Repair minor thread damage in tapped holes with a thread chaser or thread die and tap set (item 120, WP 0176).

**NOTE**

**When the threads on each end of a stud are of a different pitch (number of threads per inch), the coarse threaded end must enter the aluminum casting.**

**When threads are stripped or damaged or when stud is removed from an aluminum casting for loose fit, always replace stud with next larger oversize, or in cases of complete thread pullout, drill out threaded holes, tap hole for thread insert, install insert and standard stud for repair.**

Markings and color code indicates whether a stud is standard or oversize. Check marking and color and refer to the following guide to be sure replacement is the proper size. Studs available for replacement (as shown in guide) are marked on the coarse thread end of the stud.

STUD	STANDARD	0.003 OVERSIZE	0.007 OVERSIZE
COLOR CODE	NONE	RED	BLUE
MARK			

**REPAIR (Continued)****Studs (Continued)**

1. Apply a small amount of lubrication (item 16, Lubriplate) to threads before installing stud.
2. Drive stud into tapped hole slowly to prevent heating. Drive to setting height given in procedural work package.

**NOTE**

**When tapped holes in castings cannot be fitted with oversize studs, the holes in the castings can be fitted with helical-coil inserts (see Helical-Coil Inserts Replacement instructions in this work package), and studs of the original size can then be installed.**

**Threaded Parts**

1. Replace all parts that have stripped threads that cannot be repaired by chasing threads with a tap or die. Replace parts that cannot be repaired by installing insert (see helical-coil inserts or threaded inserts replacement procedures in this work package).
  - a. Chase damaged threads with tap or die (item 120, WP 0176) of correct size.

**Thrust Washers and Shims**

1. Remove minor defects with a crocus cloth (item 9, WP 0173) or soft honing stone.
2. Replace parts that are worn, scored, nicked, or deformed.

**ASSEMBLY GUIDELINES**

Extreme care must be exercised in all assembly operations to insure satisfactory engine performance. General rules for assembly are outlined below. Procedures for assembling the various components are covered in the paragraph relating to the specific component.

**PRECAUTIONARY RULES**

- Cleanliness is essential in all assembly operations. Dirt and dust, even in minute quantities, are abrasive. Parts must be cleaned as specified and kept clean.
- Wrap or cover parts and components when assembly procedures are not immediately completed.
- Coat all bearings, shafts, and all contact surfaces with lubricating oil (item 21, WP 0173) to ensure lubrication of parts during initial engine starting.
- Always use new gaskets, O-rings, and preformed packings when assembling engine.
- Use flat washers under all lock washers, nuts and bolts to protect aluminum surfaces.
- When specified, secure bolts, cap screws, and nuts with lock washers, tab washers, locking wire, or cotter pins.
- Whenever a locking method is not specified for bolts and cap screws, the mid-grip helical-coil threaded inserts into which the bolts or screws are threaded serves as the locking device.
- Tightening hardware to the specified torque is very important. For procedures and specifications, refer to Torque Limits, WP 0174.

**END OF WORK PACKAGE**





**HELICAL-COIL INSERT REPLACEMENT**

0029 00

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, and Installation

**INITIAL SETUP:****Tools:**

Extraction tool (see items 39-41 for size, WP 0176)  
 General mechanic's tool kit (item 121, WP 0176)  
 Inserter tool (see items 66-70 for size, WP 0176)

**Expendable and Durable Items::**

Lubricating oil (item 21, WP 0173)  
 Cleaning solvent (item 8, WP 0173)

**Personnel Required**

Track Vehicle Repairer (1) 63H10

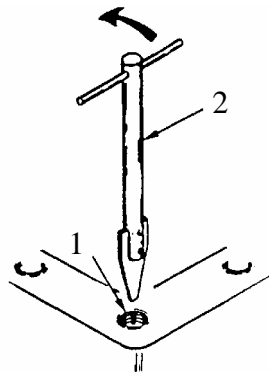
To permit higher stresses on studs and bolts that are set in aluminum castings, it is common practice to install inserts of a stronger metal into which the studs or bolts are threaded. Helical-coil and screw thread inserts are designed to perform this function. The AVDS-1790 family of engines incorporates helical-coil inserts in many locations as original equipment. If the hole that the original insert is installed in becomes oversize, a threaded insert may be used in its place to allow the original size fastener to be used.

Helical-coil inserts are spiral steel coils having a right hand thread-shaped form on the inside and on the outside diameter of the coils. A bar or tang at the bottom end of the coil, which is engaged by an inserting tool, is used for threading the insert into the casting. Some inserts have a serrated tooth section at the top end of the coil to stake them in place in the castings. Other inserts have turns at the center of the coil in the form of a hexagon. This provides a locking effect when the stud or bolt is threaded into the insert. Part or item numbers of tools, kits and inserts, in addition to working dimensions are included in appropriate procedural work packages.

**REMOVAL****CAUTION**

**Do not damage threads of tapped hole when using extraction tool.**  
**Remove inserts from end of tapped hole where the insert is closest.**  
**Threads in tapped hole can be damaged.**

1. Remove insert (1).
  - a. Place extraction tool (2) in insert (1). Tap top of extraction tool (2) lightly with hammer to "set" tool.
  - b. Maintaining a steady downward pressure, turn tool (2) counter-clockwise. Remove insert (1).



## CLEANING

**WARNING**

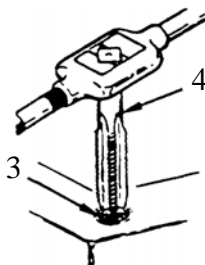
**Compressed air can injure you and others. Do not aim air at personnel. Do not use more than 30 psi. Always wear goggles.**



**Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. See Warning in front of Manual.**



1. See Work Package 0028 for Standard Cleaning Procedures.
2. Clean threads (3).
  - a. Lubricate helical-coil tap (4) with engine oil.
  - b. Using tap (4) and tap handle, slowly thread tap in and out of threads (3).
  - c. Flood insert with cleaning solvent (item 8, WP 0173), then, using compressed air, blow dirt and any loose metal chips out of threads (3).



## HELICAL-COIL INSERT REPLACEMENT

0029 00

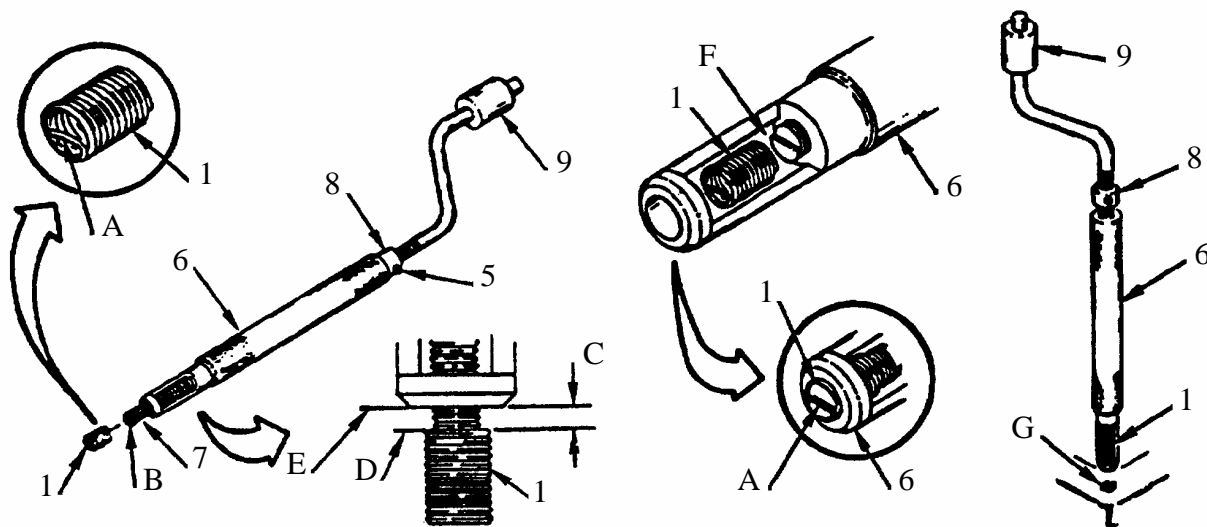
## INSTALLATION

1. Loosen setscrew (5).
2. Install new insert (1) on insertion tool (6).
  - a. Turn handle until shaft (7) extends past tip of insertion tool (6), slightly longer than length of insert (1).
  - b. Screw new insert (1) on shaft (7) until tang (A) of insert goes into shaft notch (B).
3. Set depth of insertion tool (6).
  - a. Adjust distance (C) between end (D) of insert (1) and tip (E). Turn handle until distance is equal to installation depth below surface of tapped hole. See procedural work package for proper installation depth.
  - b. Push down stop collar (8) until it contacts body of insertion tool (6).
  - c. Tighten setscrew (5).
4. Remove insert (1) from insertion tool (6).
5. Turn handle (9) until shaft (7) retracts fully into insertion tool (6).
6. Place insert (1) in opening (F) of insertion tool (6).
7. Turn handle (9) until tang (A) of insert (1) is even with tip of insertion tool (6).

**CAUTION**

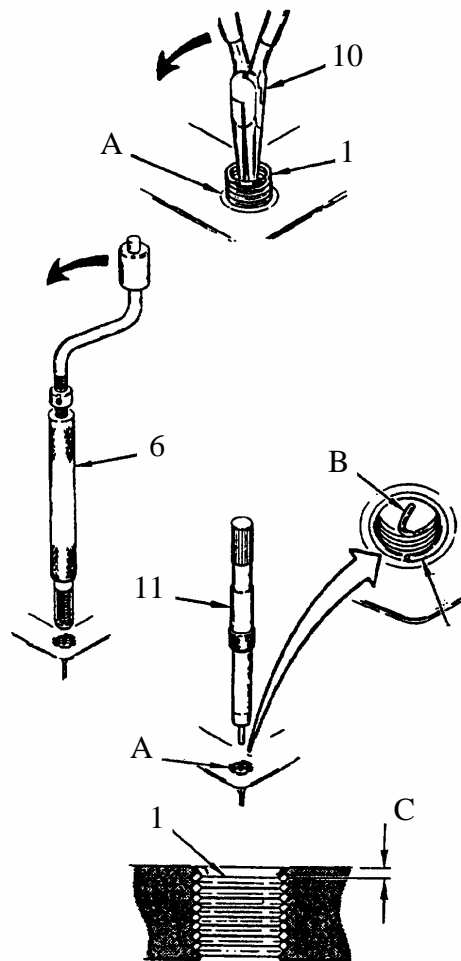
**Insertion tool must be straight and not allowed to wobble when installing insert. Equipment can be damaged. Do not force insert into tapped hole. Threads will be damaged.**

8. Install new insert (1).
  - a. Put tip of insertion tool (6) against tapped hole (G) being sure that insertion tool is straight.
  - b. Slowly turn handle (9) of insertion tool (6) to the right until stop collar (8) contacts body of insertion tool.
  - c. If insert (1) does not go into tapped hole (G) easily, go to step 9. If insert (1) does go into tapped hole (G) easily, go to step 12.
9. Remove insertion tool (6).
  - a. Turn handle (9) of insertion tool (6) counterclockwise until insertion tool can be removed.



**INSTALLATION (Continued)**

10. Remove damaged insert (1).
  - a. Using needle nose pliers (10), grasp tang of insert (1) and turn insert to the left until it can be removed from tapped hole (A).
  - b. Remove and discard damaged insert (1).
11. Return to Installation step 8.
12. Remove insertion tool (6).
  - a. Turn handle of insertion tool (6) counterclockwise until insertion tool can be removed.
13. Remove tang (B) from insert (1).
  - a. Place appropriate tool (11) in tapped hole (A) with installed insert (1).
  - b. Push down end of break-off tool (11) until tang (B) breaks off of insert (1).
  - c. If tapped hole (A) is a blind hole, remove and discard tang.
14. Inspect installed insert (1).
  - a. Check that threads of insert (1) are not twisted, cracked, or stripped.
  - b. Check that insert is just below chamfer area of hole.
  - c. If new insert (1) was damaged during installation, or installation depth is not correct, go to Removal step 1.

**END OF WORK PACKAGE**

**THREADED INSERT REPLACEMENT****0030 00****THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:****Tools:**

Compressed air  
 General mechanic's tool kit (item 121, WP 0176)  
 Electric drill, portable (item 34, WP 0176)  
 Extractor tool (item 39 or 40, depending on insert size, WP 0176)  
 Slimsert tool kit (item 122, WP 0176)  
 Thread die & tap set (item 120, WP 0176)

**Expendable and Durable Items:**

Cleaning solvent (item 8, WP 0173)  
 Goggles (item 23, WP 0173)  
 Lubricating oil (item 21, WP 0173)  
 Sealant compound (item 30, WP 0173)

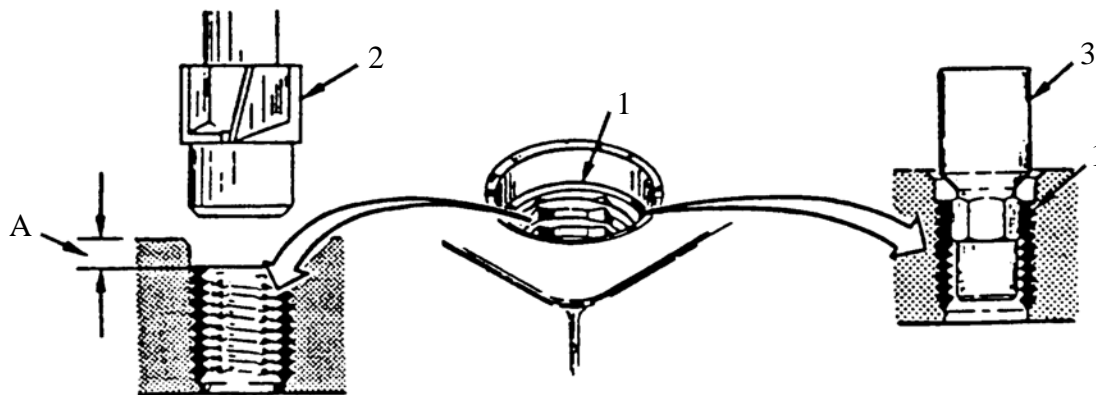
**Personnel Required:**

Track Vehicle Repairer (1) 63H10

To permit higher stresses on studs and bolts that are set in aluminum castings, it is common practice to install inserts of a stronger metal into which the studs or bolts are threaded. Helical-coil and screw thread inserts are designed to perform this function. The AVDS-1790 family of engines incorporates helical-coil inserts in many locations as original equipment. If the hole in which the original insert is installed becomes oversize, a threaded insert may be used in its place to allow the original size fastener to be used.

**REMOVAL**

1. Verify type of insert.
  - a. If insert is swage type, go to step 2.
  - b. If insert is lock-ring type, go to step 4
2. Removal of swage type insert (1).
  - a. Using portable electric drill and extractor tool (2), drill out top of insert (1) to counterbore depth (A).
3. Remove insert (1).
  - a. Insert drive wrench (3) into insert (1).
  - b. Using ratchet handle and drive wrench, unscrew insert (1).
  - c. Go to Cleaning.

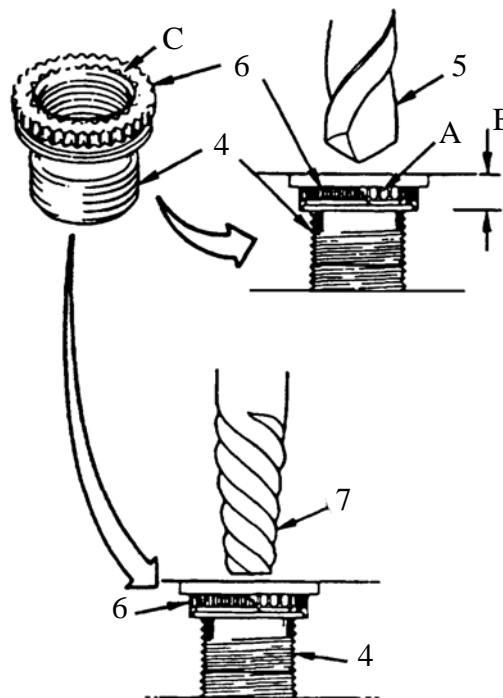


**THREADED INSERT REPLACEMENT**

0030 00

**REMOVAL (Continued)**

4. Remove lock-ring type insert (4).
  - a. Using portable electric drill and drill bit (5), drill through lock-ring (6) and neck (A) of insert (4).
  - b. Drill to existing counterbore depth (B).
  - c. Remove all serration interlocks (C) on lock-ring (6) and neck of insert (4).
  - d. Drive screw extractor (7) through lock-ring (6) into insert (4).
  - e. Using screw extractor (7), unscrew insert (4). Lock-ring (6) will be forced out with insert (4).



**CLEANING**

**WARNING**



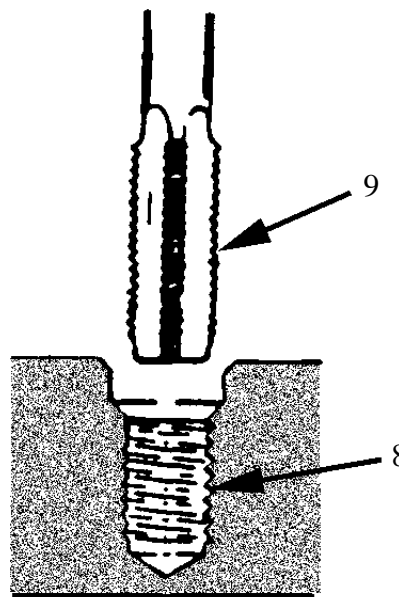
Compressed air can injure you and others. Do not aim air at personnel. Do not use more than 30 psi. Always wear goggles.



Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. See Warning in front of Manual.



1. See Work Package 0028 for Standard Cleaning Procedures.
2. Clean component (8) threads.
  - a. Lubricate thread cutting tap (9) with engine oil (item 21, WP 0173).
  - b. Using tap wrench and thread cutting tap (9) (item 120, WP 0176), clean component (8) threads by slowly turning tap in and out of component threads.



- c. Flood with cleaning solvent (item 8, WP 0173), then use compressed air to blow dirt and any loose metal chips out of component (8) threads.

**THREADED INSERT REPLACEMENT**

**0030 00**

**INSPECTION**

1. When replacing threaded inserts, inspect component threads for wear or stripping.
  - a. If component threads are damaged, and a standard insert is in use, install an oversize insert. Go to Repair.
  - b. If component threads are damaged and a lock-ring type insert is in use, component must be replaced. Go to End of Work Package.
  - c. If replacing a lock-ring type insert in an undamaged component, go to Installation, step 1.
  - d. If replacing a standard insert with a standard insert, go to Installation, step 8.

**NOTE**

**If component threads are not damaged but internal threads of insert are damaged, either type insert may be replaced.**

**REPAIR**

1. Bore out tapped hole (A) in component (8).

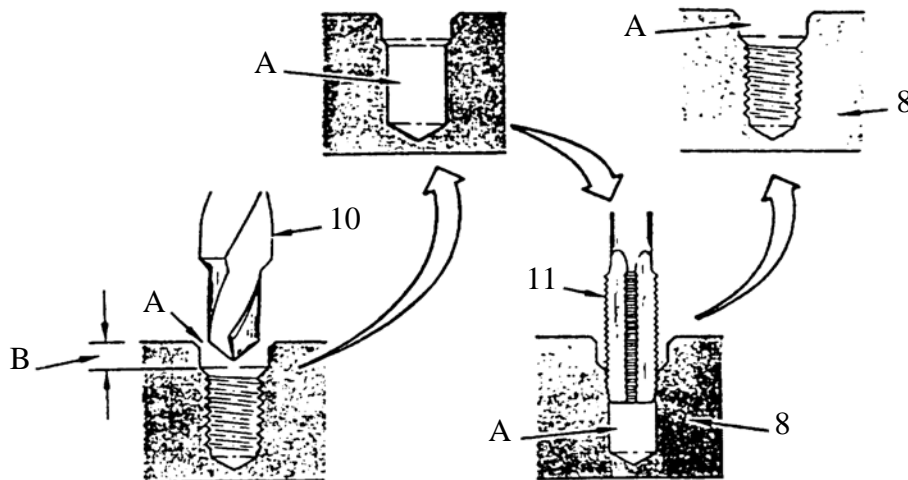
- a. Using portable electric drill and step drill (10) for oversize inserts, bore tapped hole (A) to counterbore depth (B).

**WARNING**



**Compressed air can injure you and others. Do not aim air at personnel. Do not use more than 30 psi. Always wear goggles.**

2. Clean hole (A).
  - a. Using compressed air, blow metal chips out of hole.
3. Tap hole (A).
  - a. Coat thread cutting tap (11) for oversize insert with engine oil.
  - b. Using tap wrench and tap (11) cut threads until tap bottoms.
4. Clean newly tapped hole (A).
  - a. Using compressed air, blow out metal chips.
5. Go to Installation, step 8.



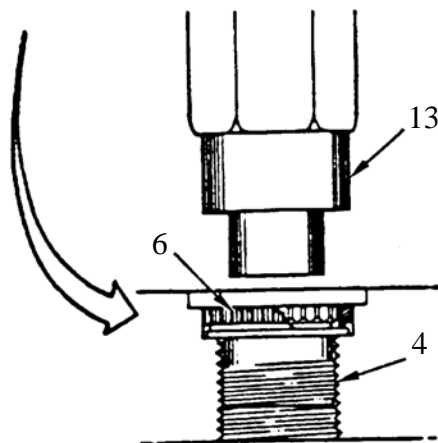
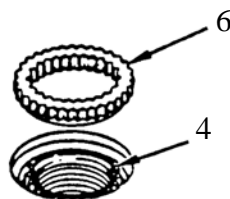
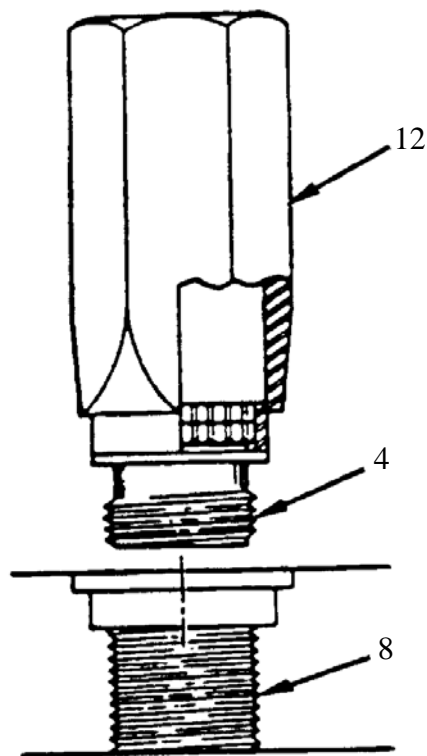
**INSTALLATION**

1. Put new lock-ring insert (4) on drive wrench (12).
2. Install lock-ring insert (4).
  - a. Coat outside threads of insert (4) with sealant compound (item 30, WP 0173).
  - b. Using drive wrench (12), screw insert (4) into component (8) threads.
3. Position new lock-ring (6) on insert (4).
  - a. Align serrations of insert (4) with serrations of lock-ring (6).

**CAUTION**

**Do not allow drive tool to contact component. Any impact of pressure on component surface may damage component threads. Damage to equipment can occur.**

4. Install new lock-ring (6).
  - a. Position drive tool (13) in lock-ring (6) on insert (4).
  - b. Using hammer, strike top of drive tool (13) until lock-ring (6) is in position.
5. Inspect new lock-ring (6) for damage.
  - a. If lock-ring (6) is not in position or is damaged, go to Removal, step 4.
6. Clean new lock-ring (6), insert (4), and related component.
7. Go to End of Work Package.



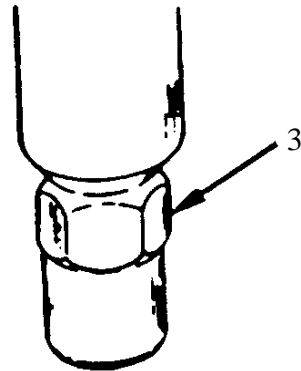


**THREADED INSERT REPLACEMENT**

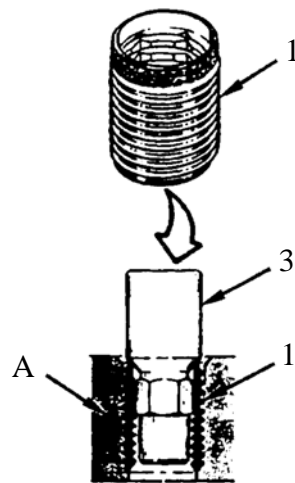
0030 00

**INSTALLATION (Continued)**

8. Put new oversize or standard insert (1) on drive wrench (3).

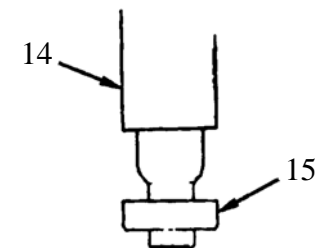


9. Install new oversize or standard insert (1).  
 a. Coat outside threads of insert (1) with sealant compound (item 30, WP 0173).  
 b. Using ratchet handle and drive wrench (3), screw insert (1) into threaded hole (A) in component (8).



10. Prepare oversize or standard insert swage tool (14) (item 122, WP 0176).

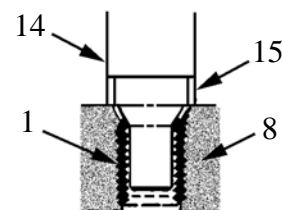
a. Determine proper insert swage tool (14) and swage tool stop (15) depth.  
 b. Install swage tool stop (15) on swage tool (14).



11. Lock insert (1) in place.  
 a. Put swage tool (14) into insert (1).  
 b. Using hammer, strike top of swage tool (14) until swage tool stop (15) bottoms on component (8). Remove tool.  
 c. Inspect new insert (1) for damage during installation. If damaged, go to Removal, step 1.

12. Clean all new inserts and related components.

a. Clean assembly and hardware (WP 0028).



**END OF WORK PACKAGE**



**TM 9-2815-220-24**

**CHAPTER 4**

**SERVICE OPERATIONS**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



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**ENGINE OIL REPLACEMENT**

**0031 00**

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**THIS WORK PACKAGE COVERS:**

Drain engine oil and Fill engine oil

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**INITIAL SETUP:**

**Tools:**

Engine-lifting sling:  
Models 2CA/2DA: item 38, WP 0176  
Model 2DR: item 37, WP 0176  
General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124,  
WP 0176)  
Torque wrench, 500-2500 inch-pounds (item 126,  
WP 0176)  
Container (approximately 25-gallon capacity)

**Expendable Materials:**

Lubricating oil, engine, 20 gallons (item 21,  
WP 0173)

**Personnel Required:**

Track Vehicle Repairer (3) 63H10

**Equipment Conditions:**

Engine out of vehicle and separated from  
transmission

**Mandatory Replacement Parts:**

Packing with retainer (item 153, WP 0175)

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**NOTE**

**The purpose of this work package is to drain the engine oil in preparation for disassembly and to fill the engine with oil after rebuild. Normal oil replenishment is covered in the appropriate manual for your vehicle.**

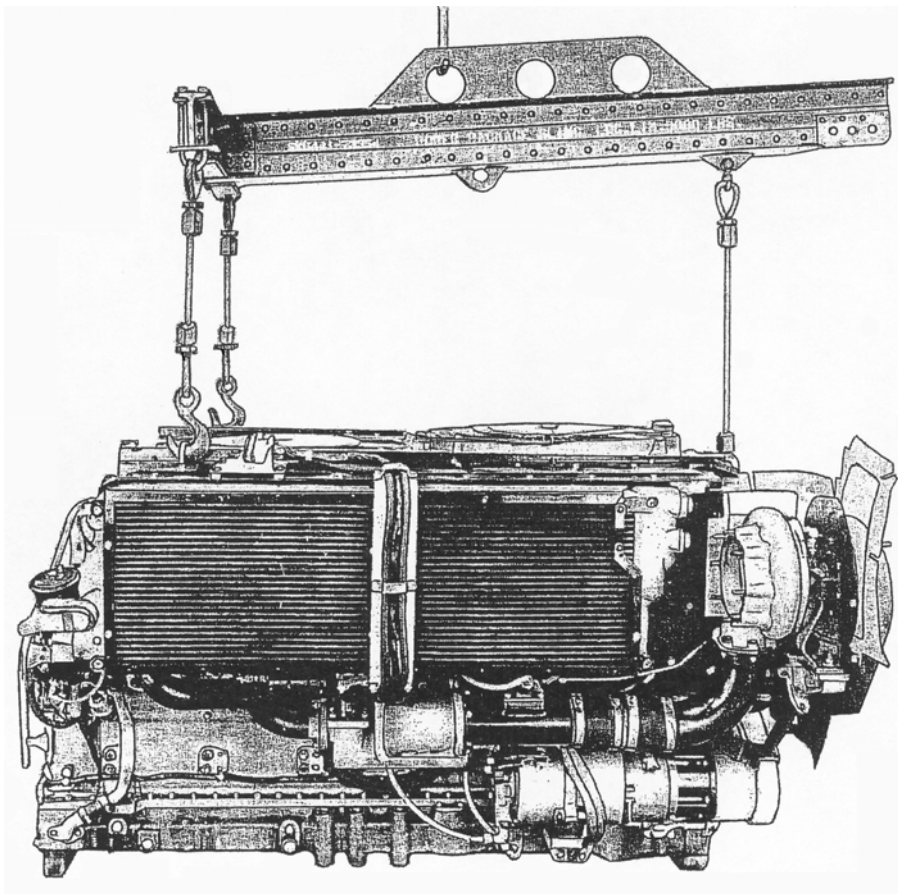
**Go to Work Package 0073, Oil Filters Replacement, for instructions on replacement of the engine oil filters.**

**DRAIN OIL**

1. Lift engine using engine-lifting sling.
  - a. For engine models 2CA and 2DA, use sling item 38, WP 0176 (illustrated).
  - b. For engine model 2DR, use sling item 37, WP 0176 (not illustrated). Engine front lifting point is lifting eyes attached to damper housing. Engine rear lifting point is as illustrated.
2. Place engine on suitable blocks.

**WARNING**

**Do not stand under or place any body parts under engine when supported by hoist, without suitable blocks. Engine is heavy and could cause serious injury or death.**



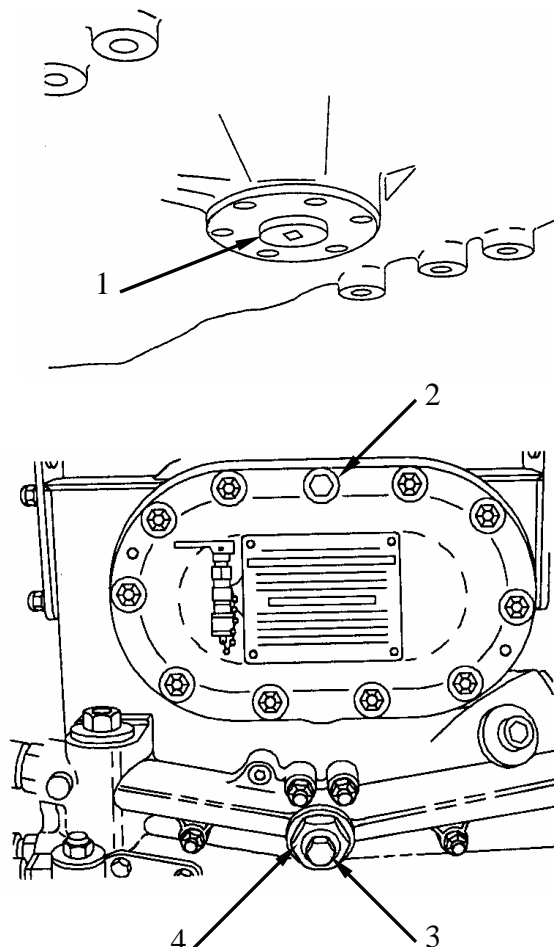
**DRAIN OIL (Continued)**

3. Remove oil pan drain plug (1).
4. Drain oil into a suitable container (approximately 25-gallon capacity).
  - a. As oil drains from drain plug opening, do step 5.

**NOTE**

**Step 5 opens an internal passage allowing oil to drain from the filter housing and oil coolers out of the oil pan drain plug opening.**

5. Drain oil filter housing and oil coolers.
  - a. Remove oil vent cap screw (2) with flat washer and seal washer (packing with retainer). Discard seal washer.
  - b. Loosen oil drain valve (3) six complete turns. Do not loosen oil drain valve adapter (4).
  - c. If replacing oil filters, go to Work Package 0073, Oil Filters Replacement.
6. After oil is drained from engine:
  - a. Reinstall oil vent cap screw (2) with flat washer and new seal washer (item 153, WP 0175).
  - b. Turn drain valve (3) counterclockwise until tight (150 inch-pounds, 17 N•m).
  - c. Reinstall oil pan drain plug (1) and tighten to 1000-1050-inch pounds (113-119 N•m) torque.
7. Using engine-lifting sling, lower engine to floor or suitable flat cart.

**FILL OIL****NOTE**

**Proper oil level is crucial to engine life. If the engine has been rebuilt and this is the initial oil fill, go to step 1 of Fill Oil. If the engine oil level is in question, go to step 1 of Oil Level Check.**

1. Initial Oil Fill.
  - a. With engine on a flat level surface, add 20 gallons lubricating engine oil (item 21, WP 0173).

## CHECK OIL LEVEL

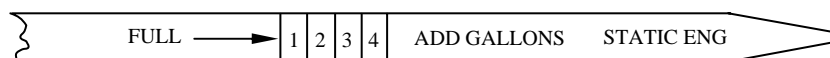
## NOTE

**There are two methods for checking engine oil level on the AVDS-1790 series engine. The first method is designated as a "Before Operations" oil check and is taken with the engine stopped. The second method is designated as a "During Operations" oil check and is taken with the engine running.**

## 1. Before Operations oil check:

It is imperative to check the oil level before operating the engine. This Before Operations check must only be performed when the engine has been shut down for a minimum of 2 hours or a faulty reading will result. There are three key requirements that must be met to assure accurate reading of the oil level gauge rod:

- a. The engine must have been shut down for a minimum of 2 hours.
- b. The engine must be flat and level.
- c. The correct side of the gauge rod must be read.

**CORRECT SIDE OF GAUGE ROD FOR BEFORE CHECK****Example**

**Read the oil gauge rod before you add any oil. Add oil based on your reading. After adding oil, do NOT check with the gauge rod using the "Before Operations" check method unless the engine has been run then shut down for a minimum of 2 hours. Instead, use the "During Operations" method to check the oil level after the engine has been run and warmed up to normal operating temperature.**

## 2. During Operations oil check:

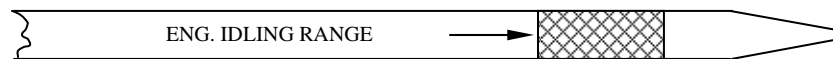
During operations it is critical to maintain proper engine oil level. There are four key requirements that must be met to assure accurate reading of the oil level gauge rod for During Operations checks.

- a. The oil temperature must be less than 140 °F (60 °C).
- b. The engine must have been idling for at least 5 minutes.
- c. The engine must be level and flat.
- d. The correct side of the gauge rod must be read.



**CHECK OIL LEVEL (Continued)****NOTE**

During extended operations, oil level should be checked at least once every 8 hours. Always verify oil level by the "Before Operations" method at the earliest opportunity.

**CORRECT SIDE OF GAUGE ROD FOR DURING CHECK****END OF WORK PACKAGE**



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**ENGINE PRESERVATION**

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0032 00

**THIS WORK PACKAGE COVERS:**Engine Preservation

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**INITIAL SETUP:****Tools:**

Fuel container (1) with fuel line  
General mechanic's tool kit (item 121, WP 0176)

**Expendable and Durable Items:**

Engine preservative oil (5 to 7 gallons) (item 22,  
WP 0173)  
Clear tubing

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine coupled to dynamometer or ground hop,  
or installed in vehicle.

---

**ENGINE PRESERVATION**

Equip an auxiliary fuel container with a fuel line and fill with a sufficient amount of preservative oil (item 22, WP 0173), conforming to Specification VV-L-800, to operate the engine as prescribed below.

1. Arrange the container to provide adequate pressure to assure proper supply of the preservative oil to the fuel system.
2. Disconnect the fuel line at the most convenient point nearest to the engine fuel pump, and connect the line from the auxiliary fuel container to the fuel-to-engine line at the point of disconnect.
3. Disconnect the engine fuel return line and connect a transparent plastic tube to the fuel return connection. Insert other end of plastic tube into a container to collect the return diesel fuel.
4. The fuel valve on the auxiliary fuel container should be turned to the ON position; the engine started and operated at 750-1000 rpm until the observed fuel return is purged of diesel fuel and the system filled with preservative oil.

Remove engine from test stand and cap or plug all openings.

**END OF WORK PACKAGE**



**TM 9-2815-220-24**

**CHAPTER 5**

**ENGINE TESTS AND ADJUSTMENTS**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



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**CYLINDER COMPRESSION TEST**

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0033 00

**THIS WORK PACKAGE COVERS:**Before Test, Test, and After Test

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**INITIAL SETUP:****Tools:**

- Cylinder compression adapter (item 1, WP 0176)
- Cylinder compression gauge (item 24, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (12) (item 272, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine at normal operating temperature with fuel supply cut off.
  - Fuel injector nozzle assemblies removed (WP 0114)
- 

**BEFORE TEST**

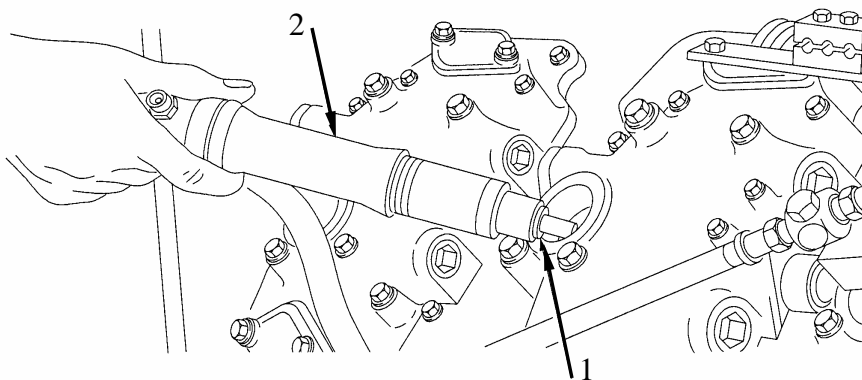
**WARNING**

**All nozzles must be removed when performing a compression check. Nozzle removal will prevent the possibility of the engine firing on other cylinders when the engine is cranked, and permits the engine to be cranked at the required rpm to check compression. Unexpected starting of the engine could injure personnel.**

**NOTE**

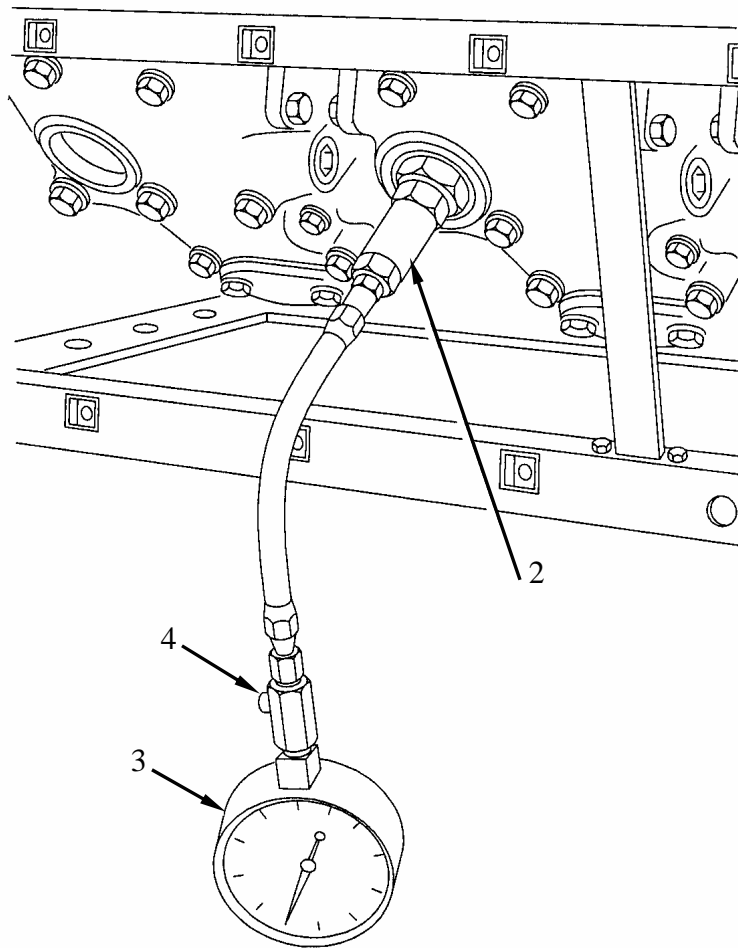
**Compression testing must be performed within 1 hour after stopping engine.**

1. With all nozzles removed from engine, crank engine for 30 seconds to clear cylinders of possible sources of ignition.
2. Position new injector nozzle gasket (flat washer) (1) (item 272, WP 0175) on end of compression adapter (2) (item 1, WP 0176). Apply a light coating of Lubriplate (item 23, WP 0173) on gasket so it adheres to adapter when installed in cylinder.



**BEFORE TEST (Continued)**

3. Install compression adapter (2) into fuel injector nozzle holder opening and tighten securely.
4. Install gauge assembly (3) (item 24, WP 0176) onto compression adapter (2) and tighten securely.

**TEST**

1. Crank engine several seconds or until compression gauge (3) reaches maximum reading.
  - a. Cylinder compression must be within 330 to 480 psi (2,275 to 3310 kPa) at engine cranking speed.
2. Depress gauge vent valve (4) to release pressure and reset gauge (3) to zero after compression reading is taken.
3. Test compression on all cylinders in the same manner.



## TEST (Continued)

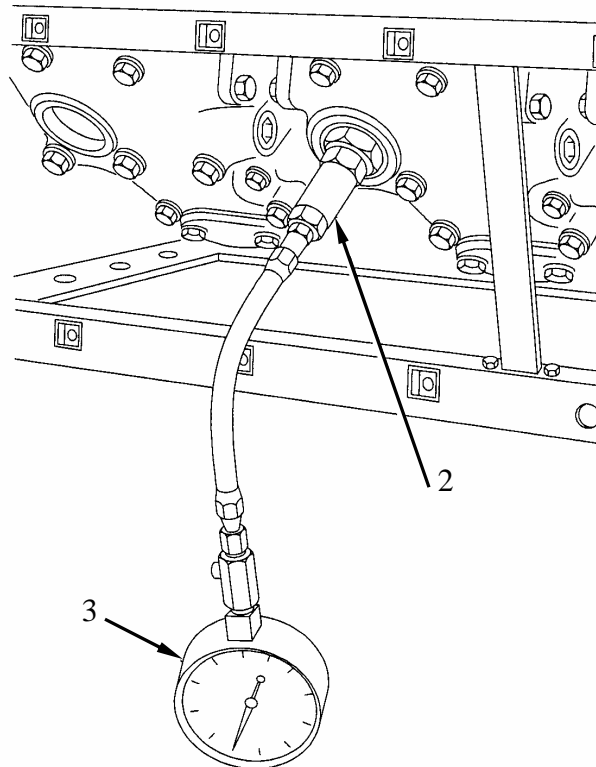
## NOTE

**High cylinder pressures can be caused by combustion of lubricating oil in the cylinder combustion chamber. If this occurs, allow combustion gases to escape prior to taking compression readings by cranking the engine with the starter for 30 seconds with the fuel supply shut off.**

4. After all 12 cylinders are checked, determine the pressure difference between high and low cylinder readings.
  - a. This variation should not exceed 70 psi. (483 kPa).
  - b. If compression readings are below the low limit of 330 psi (2,275 kPa), the engine motoring rpm should be checked to be sure that it is 140 to 180 rpm.
  - c. Compression should be checked again to confirm the previous readings before submitting an engine for overhaul.

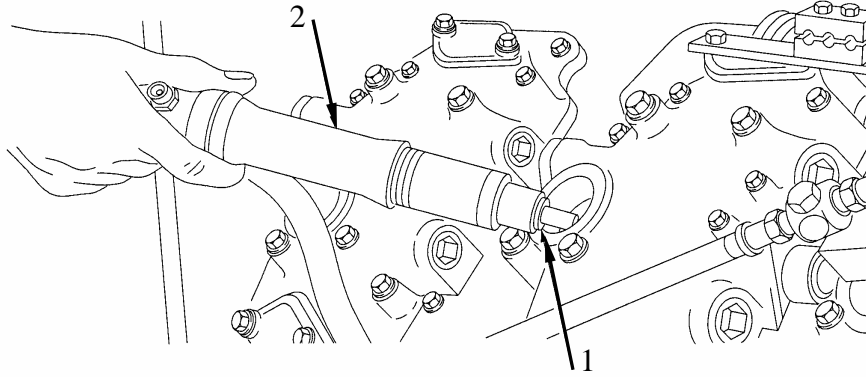
## AFTER TEST

1. Remove gauge assembly (3) from compression adapter (2).



**AFTER TEST (Continued)**

2. Remove compression adapter (2) and gasket (1). Discard gasket.

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Before Adjustment, Adjustment, and After Adjustment

**INITIAL SETUP:**

**Tools:**

- Breaker bar, 3/4-inch used with 2DR engine turning tools (tool crib)
- Engine (flywheel) turning tool, for 2CA/2DA: splined wrench (item 136, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Thickness gauge blade (0.010) (item 55, WP 0176)
- Thickness gauge blade (0.025) (item 56, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Fabricated Items:**

- Engine (flywheel) turning tool, 2DR only (item 4, WP 0177)
- Engine (front end) turning tool, 2DR only (item 3, WP 0177)

**Mandatory Replacement Parts:**

- Gasket (2) (item 350, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

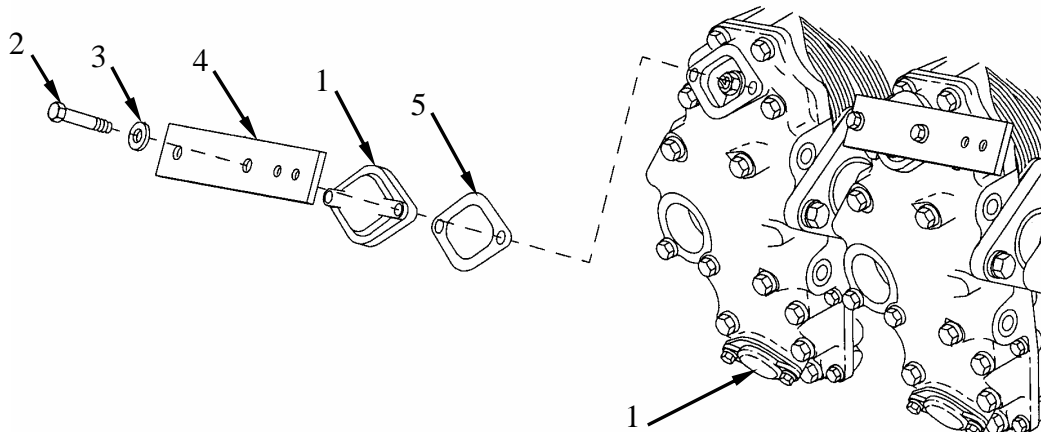
- Cooling fans, vane housings, and fan housing removed (WP 0054)
- Fuel injector tube brackets removed (WP 0079)
- Fuel return hoses removed (WP 0080)
- Fuel injection nozzles removed (WP 0114)
- Engine and transmission oil coolers removed (WP 0072)

**BEFORE ADJUSTMENT**

**NOTE**

**The engine has 12 cylinders. The following procedure applies to one or all cylinders.**

1. Remove upper and lower access covers (1).
  - a. Remove four screws (2) and four flat washers (3).
  - b. Remove spacer plate (4), two access covers (1), and two gaskets (5).
  - c. Discard gaskets (5).

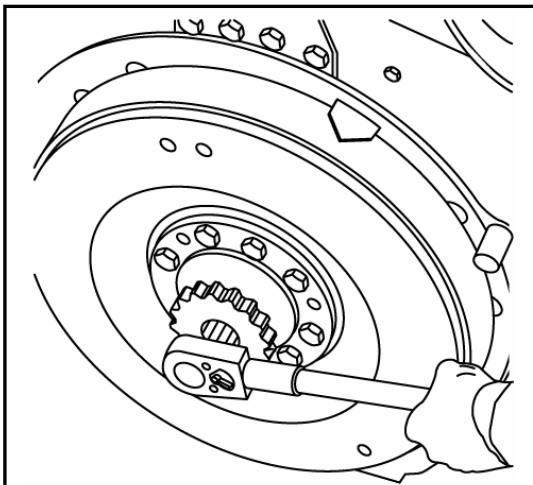


**BEFORE ADJUSTMENT (Continued)**

**NOTE**

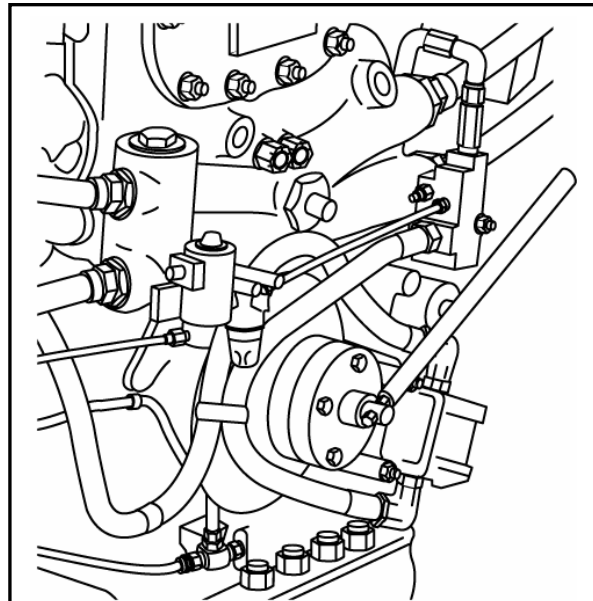
**Model 2DR crankshaft may be turned from the flywheel or from the power takeoff coupling.**

**Flywheels on models 2CA and 2DA are the same. Flywheels on 2DRs are different and require different turning tools.**



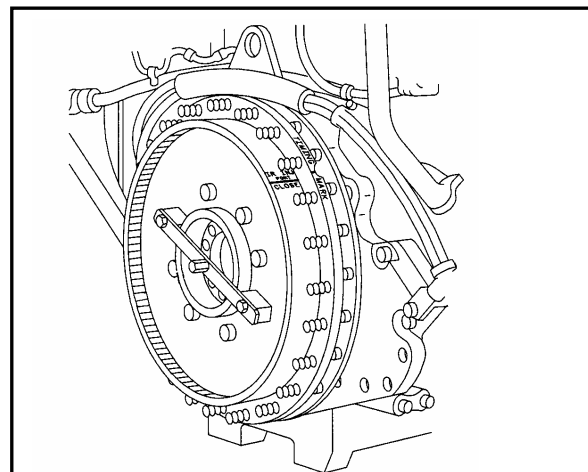
Model 2CA and 2DA  
Flywheel Turning Tool:

Transmission spur gear should already be in place on flywheel, if not place in position and secure with two bolts. Use splined turning tool splined wrench, (item 136, WP 0176)



Model 2DR Front Turning Tool:

Position improvised engine turning tool (item 3, WP 0177) on power takeoff coupling and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.

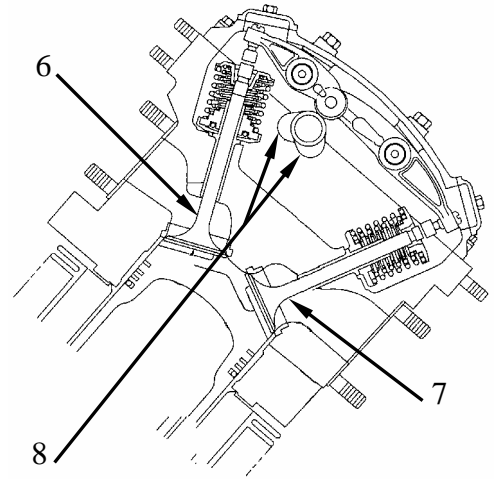


Model 2DR Flywheel Turning Tool:

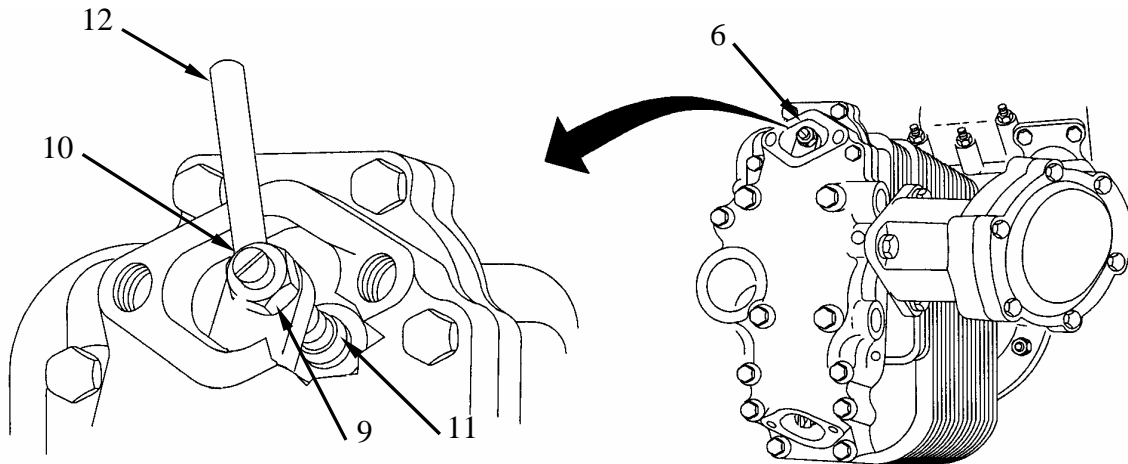
Position improvised engine turning tool (item 4, WP 0177) on flywheel, and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.

**BEFORE ADJUSTMENT (Continued)**

2. Turn crankshaft until valves (6,7) are closed and camshaft lobes (8) are pointing towards cylinder base as shown.

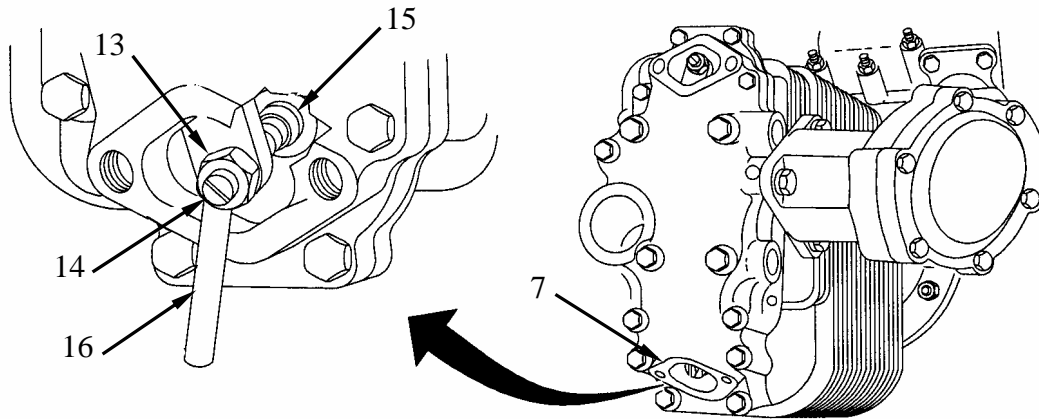
**ADJUSTMENT**

1. Adjust exhaust valve (6) clearance (0.025 inch, 0.635 mm).
  - a. Loosen exhaust valve adjusting screw lock nut (9).
  - b. Turn valve adjusting screw (10) until clearance between screw pad (11) and valve stem is 0.025 inch (0.635 mm) using thickness gauge blade (12) (item 56, WP 0176).
  - c. Torque lock nut (19) to 200-225 inch-pounds (23-25 N•m) after correct adjustment is made. Make certain setting has not changed after tightening lock nut (9).



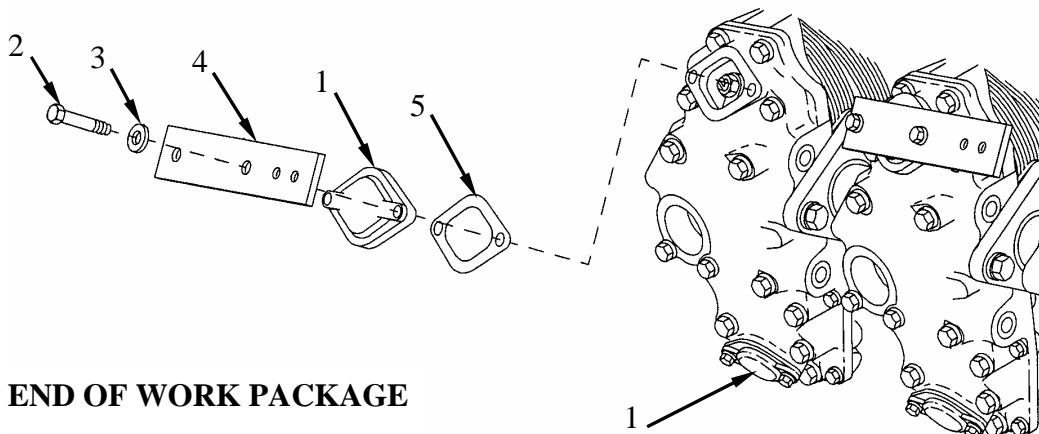
**ADJUSTMENT (Continued)**

2. Adjust intake valve (7) clearance (0.010 inch, 0.254 mm).
  - a. Loosen intake valve adjusting screw lock nut (13).
  - b. Turn valve adjusting screw (14) until clearance between valve adjusting screw pad (15) and valve stem is 0.010 inch (0.254 mm) using thickness gauge blade (16) (item 55, WP 0176).
  - c. Torque lock nut (13) to 200-225 inch-pounds (23-25 N•m) after correct adjustment is made. Make certain setting has not changed after tightening lock nut (13).



**AFTER ADJUSTMENT**

1. Install upper and lower access covers (1).
  - a. Apply Lubriplate (item 23, WP 0173) to threads of four screws (2) prior to installation.
  - b. Install access cover (1) with spacer plate (4) on exhaust side of valve cover using new gasket (5) (item 350, WP 0175), two screws (2), and two flat washers (3).
  - c. Install access cover (1) on intake side of valve cover, using new gasket (5) (item 350, WP 0175), two screws (2), and two flat washers (3).
  - d. Torque four screws (2) to 150-175 inch-pounds (17-20 N•m).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Introduction, Removal, Timing Check, Timing Adjustment, and Installation

**INITIAL SETUP:**

**Tools:**

- Breaker bar, 3/4-inch used with 2DR engine turning tools (tool crib)
- Engine (flywheel) turning tool, for 2CA/2DA: splined wrench (item 136, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Mechanical puller (item 89, WP 0176)
- Thickness gauge blade (0.010) (item 55, WP 0176)
- Thickness gauge blade (0.100) (item 57, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Fabricated Items:**

- Engine (flywheel) turning tool, 2DR only (item 4, WP 0177)

**Fabricated Items:**

- Engine (front end) turning tool, 2DR only (item 3, WP 0177)

**Mandatory Replacement Parts:**

- Gasket (item 329, WP 0175)
- Gasket (2) (item 350, WP 0175)
- Retaining ring (item 12, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

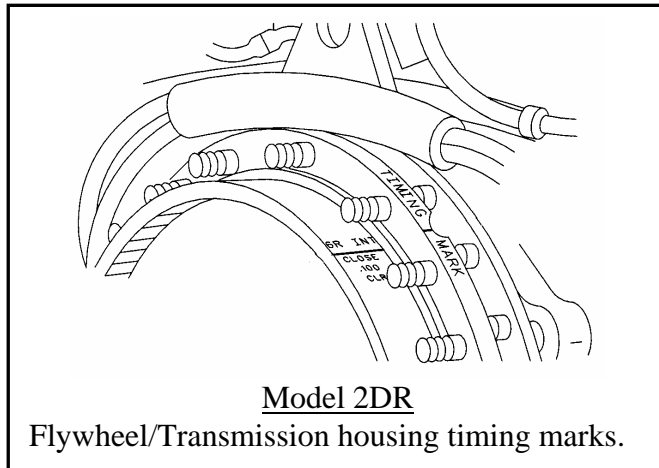
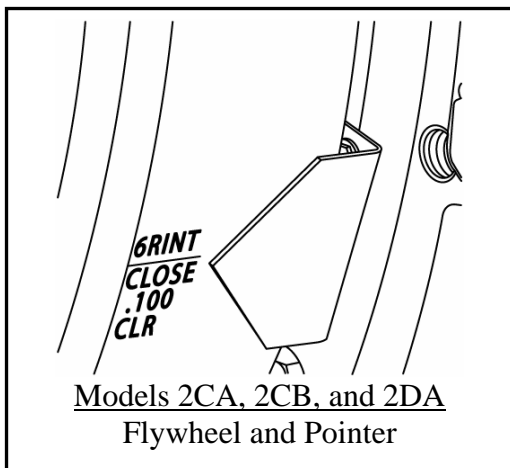
- Engine removed from vehicle and placed on a flat stationary surface

**INTRODUCTION**

Valve timing is checked with cylinder numbers 6R and 6L intake valve clearance set at 0.100-inch. The flywheel is stamped with timing marks "6R INT CLOSE 0.100 CLR" for timing the right camshaft with the crankshaft, and marked "6L INT CLOSE 0.100 CLR" for timing the left camshaft with the crankshaft.

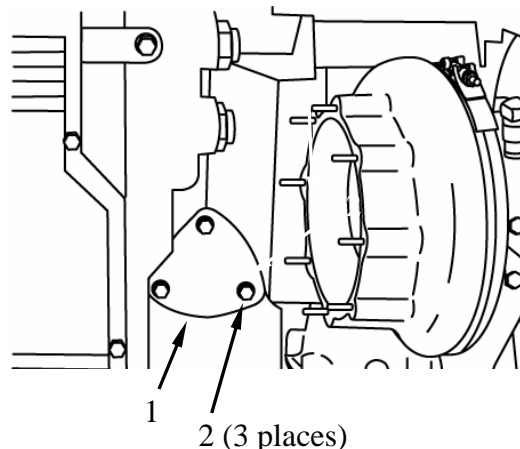
Flywheels: 2CA and 2DA are the same; however, 2DRs are different and are not interchangeable. Timing markings, described above, are identical. However, on Models 2CA and 2DA, a timing pointer is affixed to the transmission housing, while on Model 2DR there are scribed markings on the transmission housing.

For instructional purposes, the timing of the right camshaft on a 2DR Model is described and illustrated. Right and left camshaft timing is identical. Timing on all models is identical.

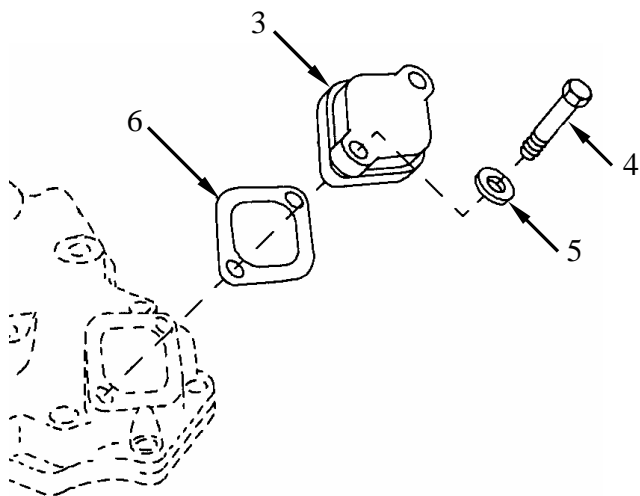


**REMOVAL**

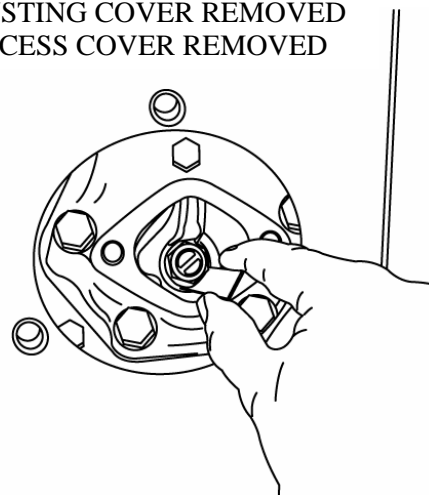
1. Remove timing access cover (1) on right side of engine.
  - a. Remove three cap screws (2), and remove timing access cover (1).



2. Remove intake valve adjustment cover (3) from 6R cylinder.
  - a. Remove two bolts (4) and flat washers (5) attaching intake valve adjusting cover. Remove cover and gasket. Discard gasket (6).



ADJUSTING COVER REMOVED  
ACCESS COVER REMOVED





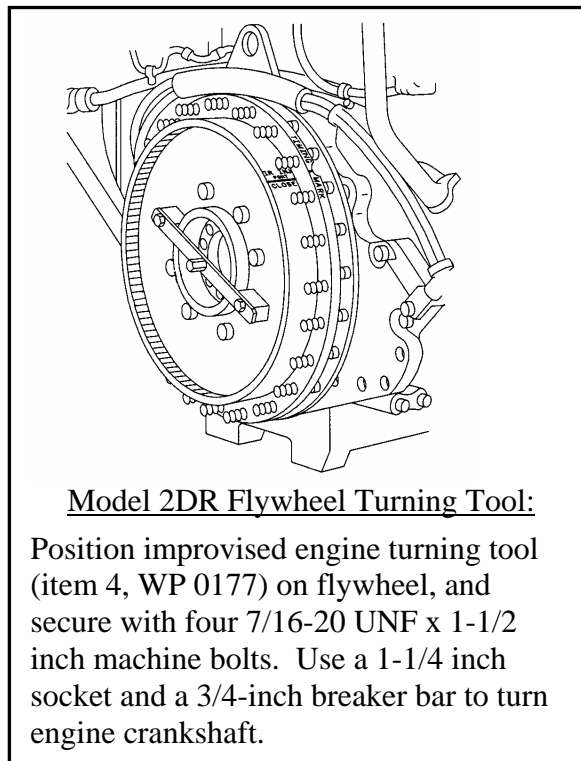
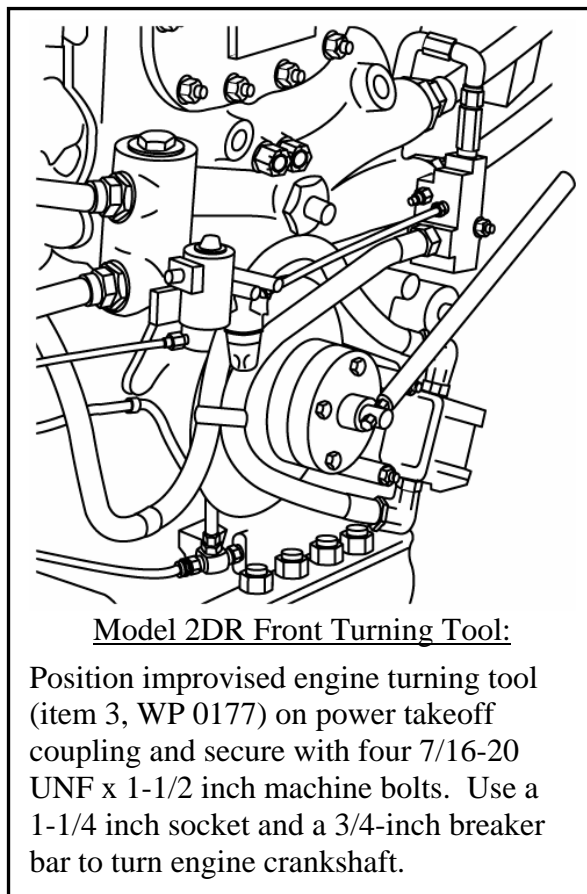
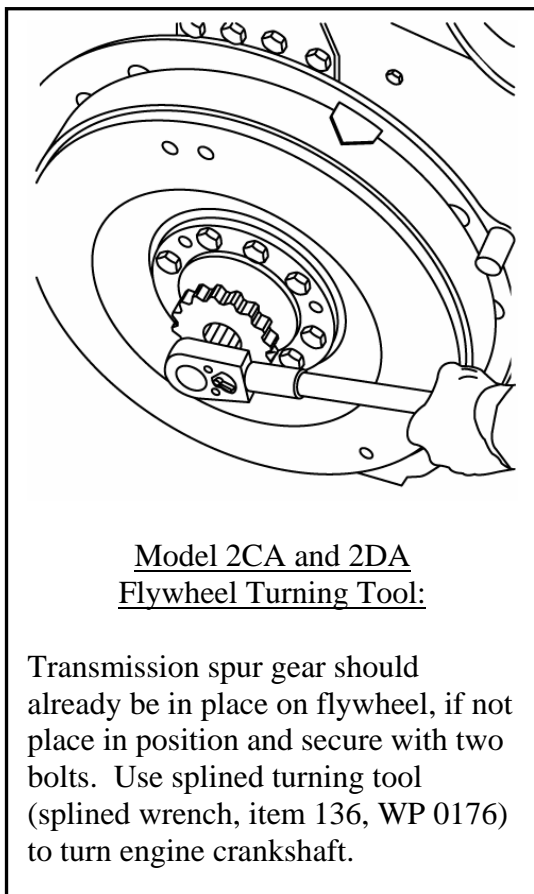
**TIMING CHECK**

**REMOVAL (Continued)**

**NOTE**

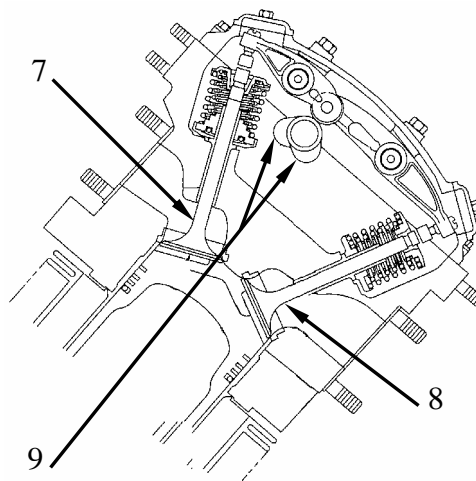
**Model 2DR crankshaft may be turned from the flywheel or from the power takeoff coupling.**

**Flywheels on models 2CA and 2DA are the same. Flywheels on 2DRs are different and require different turning tools.**



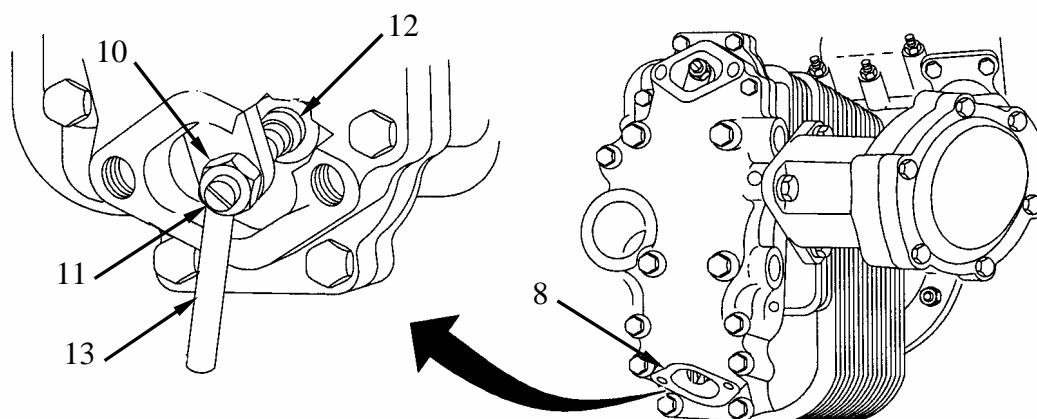
**TIMING CHECK (Continued)**

1. Turn crankshaft until valves (7,8) are closed and camshaft lobes (9) are pointing towards cylinder base as shown.

**NOTE**

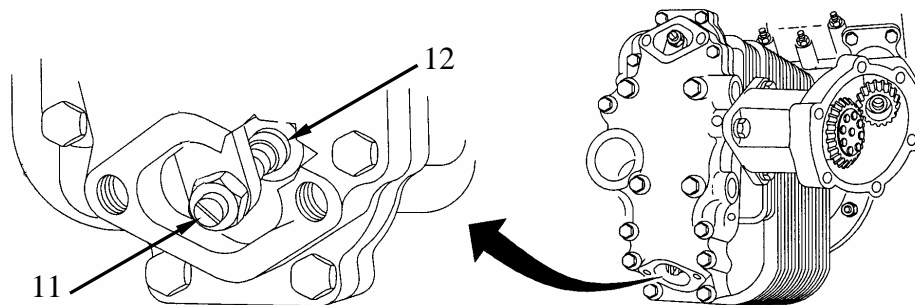
**Standard intake valve clearance is set to 0.010 inch (0.254 mm); when checking valve timing, this clearance is increased to 0.100 inch (2.54 mm).**

2. Adjust intake valve (8) clearance for timing check (0.100 inch, or (2.54 mm).
  - a. Loosen intake valve adjusting screw lock nut (10).
  - b. Turn valve adjusting screw (11) until clearance between valve adjusting screw pad (12) and valve stem is 0.100 inch using thickness gauge blade (13) (item 57, WP 0176). Gauge blade must move through clearance with a slight drag.
  - c. Check position of valve adjusting screw pad (12) to make sure seat is flat on valve stem.
  - d. Torque lock nut (10) to 200-225 inch-pounds (22.6-25.4 N•m) after correct adjustment is made. Make certain setting has not changed after tightening lock nut (10).

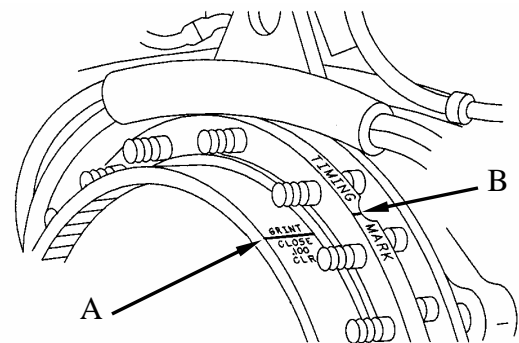


**TIMING CHECK (Continued)**

3. Checking procedure.
  - a. Check valve timing by slowly rotating flywheel counterclockwise, as viewed from flywheel end, until number 6R intake valve is just closed.
  - b. Closing point is determined by trying to rotate the valve adjusting screw pad (12) on the intake valve adjusting screw (11) while the flywheel is being rotated.
  - c. Place a finger through the adjustment opening and rest it on the pad (12) to check for the first instant of movement.
  - d. The valve is closed the instant the valve adjusting screw pad (12) is free to move.

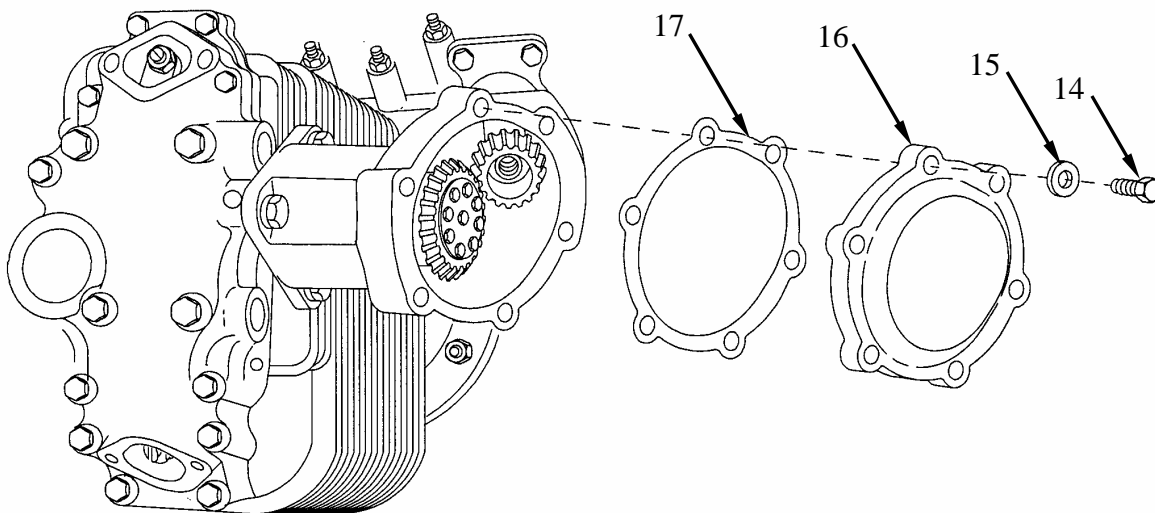


4. Check valve timing.
  - a. Observe position of flywheel timing mark "6R INT CLOSE .100 CLR" (A).
  - b. If timing mark (A) is aligned within 1/8 inch of engine timing mark (B), valve timing is correct. Go to step 4 of Installation.
  - c. If timing marks (A and B) are not aligned within 1/8 inch, the timing must be adjusted. Go to Timing Adjustment.

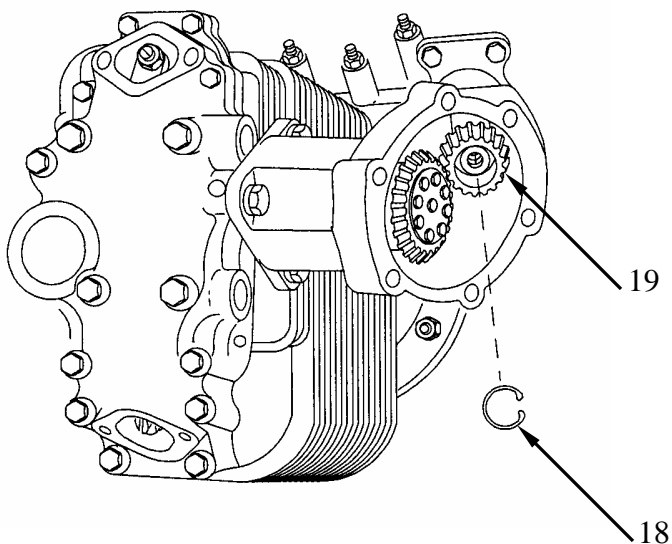


**TIMING ADJUSTMENT**

1. Remove six cap screws (14), six flat washers (15), access cover (16), and gasket (17). Discard gasket.

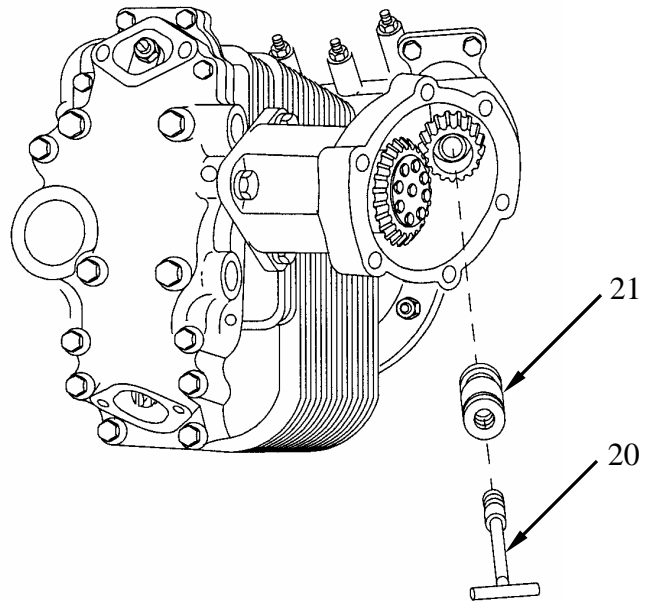


2. Remove retaining ring (18) from bevel gear shaft (19). Discard retaining ring.

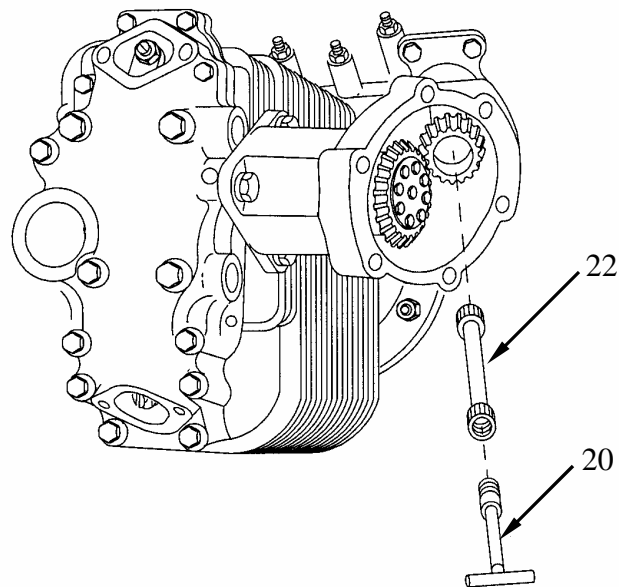


**TIMING ADJUSTMENT (Continued)**

3. Using mechanical puller (20) (item 89, WP 0176), remove lubrication fitting (21).



4. Using mechanical puller (20), remove shouldered shaft (22).



## TIMING ADJUSTMENT (Continued)

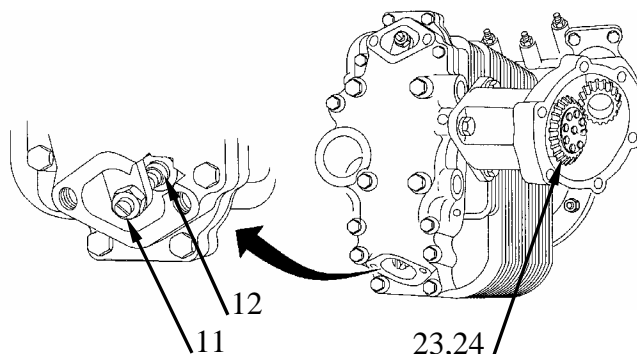
**WARNING**

**Hold wrench securely when turning camshaft as spring pressure from the valve springs can throw the wrench from your hand and cause an injury.**

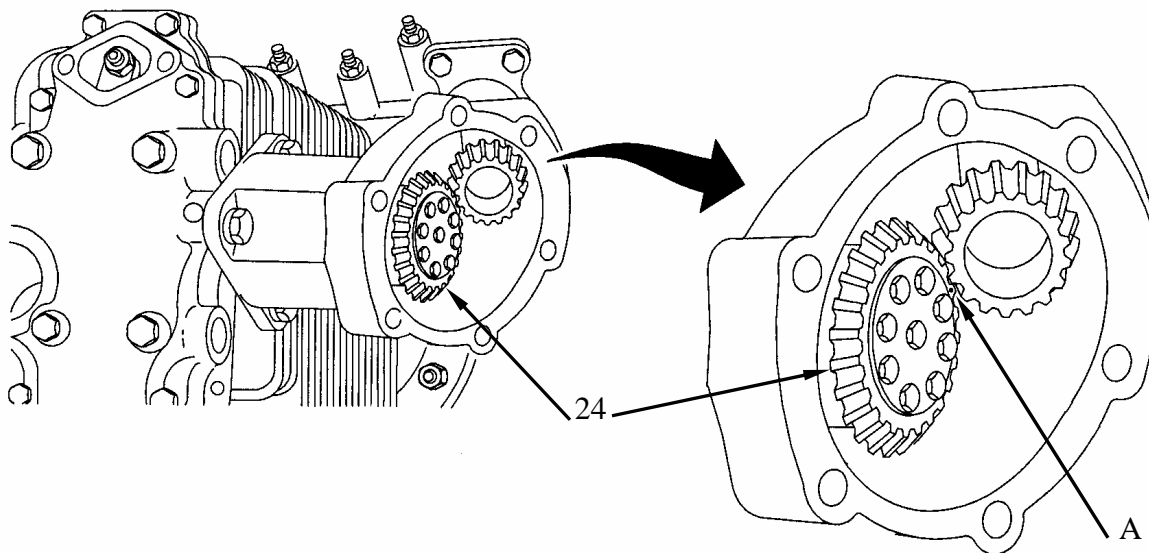
**CAUTION**

**Move the camshaft slowly and do not force the camshaft or damage to engine may occur. It may be necessary to turn camshaft counterclockwise a small amount before valve closing point can be determined by turning the camshaft clockwise.**

5. Position camshaft assembly (23).
  - a. Using 5/8-inch wrench, affixed to camshaft beveled gear (24), slowly turn camshaft assembly (23) clockwise, as viewed from flywheel end, until number 6R intake valve is just closed.
  - b. Closing point is determined by placing a finger on the valve adjusting screw pad (12) of the intake valve adjusting screw (11) and trying to rotate it while the camshaft is being rotated.
  - c. The valve is closed the instant the valve adjusting screw pad (12) is free to move.



6. As a second check, the scribed tooth (A) on camshaft beveled gear (24) should point down toward the crankshaft.



## TIMING ADJUSTMENT (Continued)

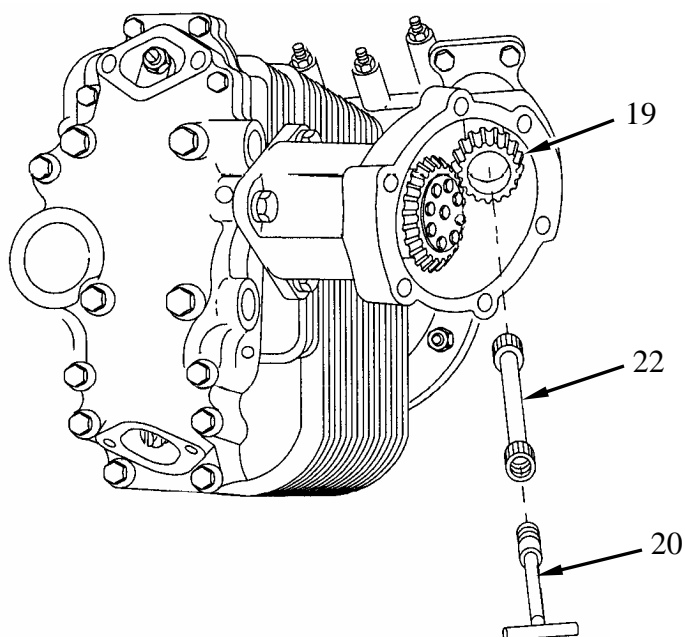
**CAUTION**

**Do not force shouldered shaft while installing. Damage to the shaft and gears may occur. The shaft is machined with a 24-tooth spline on inner end and a 28-tooth spline on outer end. The difference in the number of teeth provides a vernier effect which makes it possible to index the shouldered shaft so it will engage the splines of the inner bevel gear shaft and the outer bevel gear shaft at some point within 360 degrees. An accurate installation is then provided without changing the relationship of the camshaft and the crankshaft.**

**NOTE**

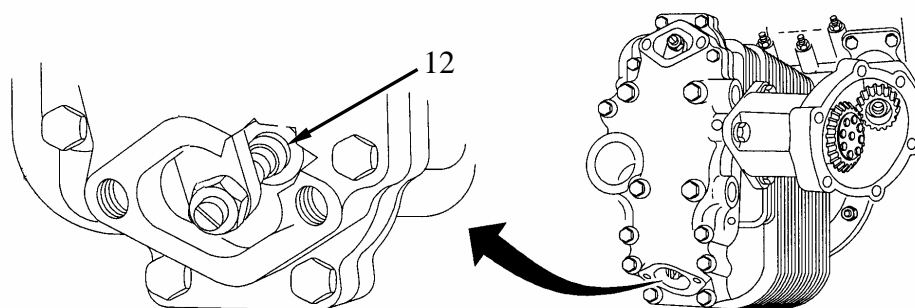
**It may be necessary to repeat the following operation a number of times before splines will mate and allow shouldered shaft to be inserted into position.**

7. Insert shouldered shaft (22).
  - a. Maintain the position of camshaft assembly (23) and insert shouldered shaft (22), using mechanical puller (20) (item 89, WP 0176).
  - b. Mate splines on lower (not illustrated) and upper (19) bevel gear-shafts.
  - c. If splines of shouldered shaft (22) do not mate with lower and upper bevel gear shafts, withdraw shouldered shaft (22) and turn slightly before again attempting insertion.

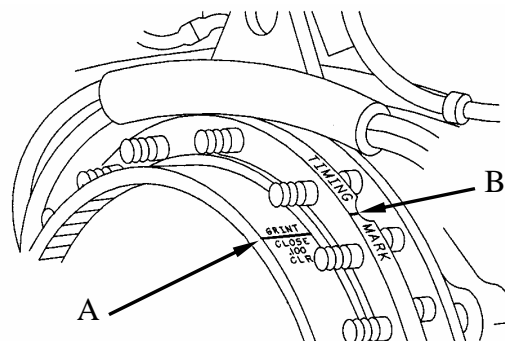


## TIMING ADJUSTMENT (Continued)

8. Verify setting.
  - a. Check valve timing by rotating flywheel clockwise, as viewed from the flywheel end, approximately 1/8 turn to remove gear backlash, then turn counterclockwise until the intake valve is just closed.
  - b. Stop rotating the flywheel the instant the valve adjusting screw pad (12) becomes free.



- c. Observe position of flywheel timing mark "6R INT CLOSE .100 CLR" (A).
- d. When timing mark (A) is aligned within 1/8 inch of engine timing mark (B), the valve timing is correct. Go to Installation.
- e. If timing mark is not aligned within 1/8 inch, withdraw shouldered shaft and repeat steps 3 through 8.



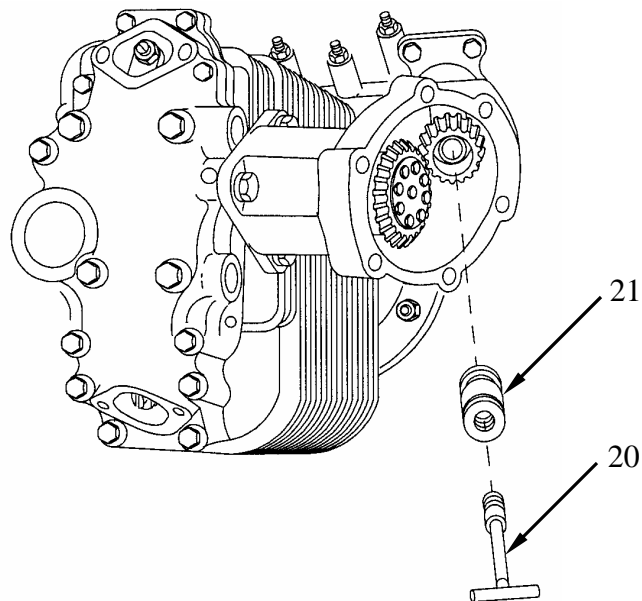
## NOTE

**When correct timing cannot be obtained as described above, it may be necessary to set timing mark (A) 1/8 to 1/4 inch out of alignment with mark (B) before installing shouldered shaft (22).**

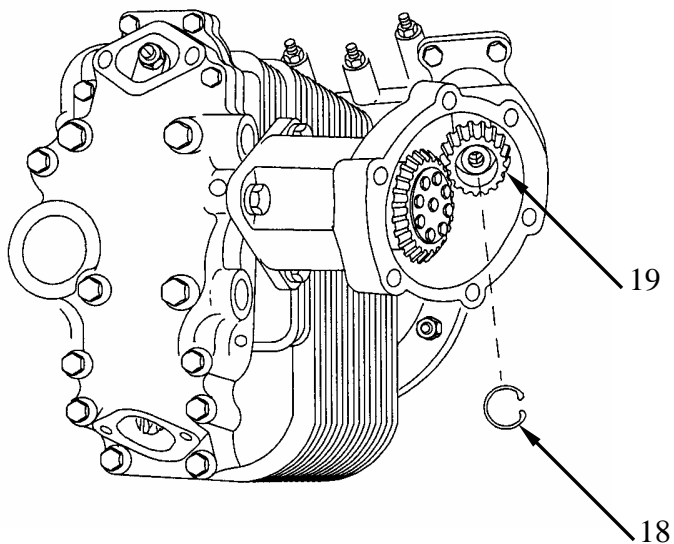


**INSTALLATION**

1. Using mechanical puller (20) (item 89, WP 0176), install lubrication fitting (21).

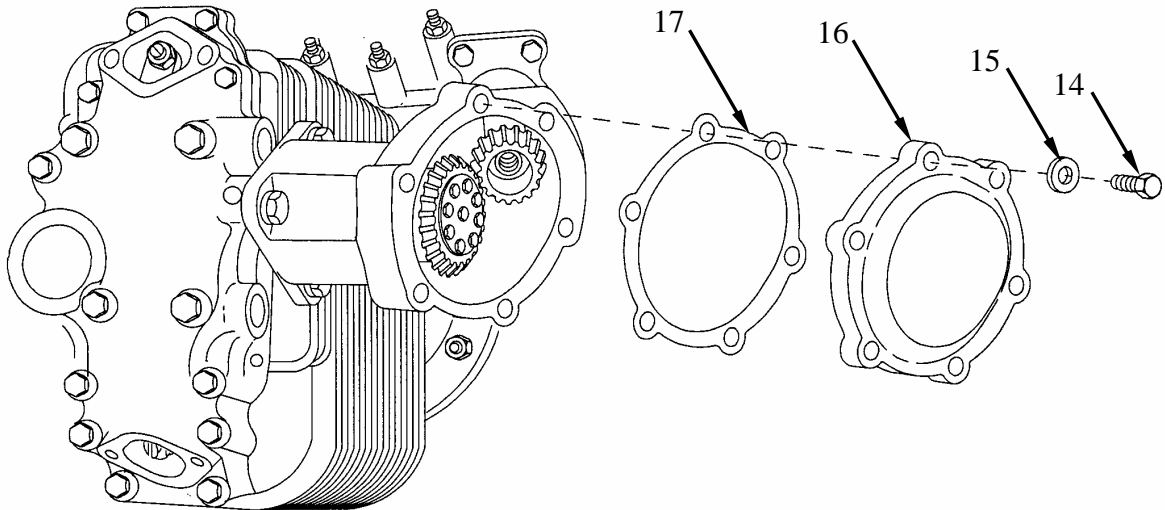


2. Install new retaining ring (18) (item 12, WP 0175) into bevel gear shaft (19).

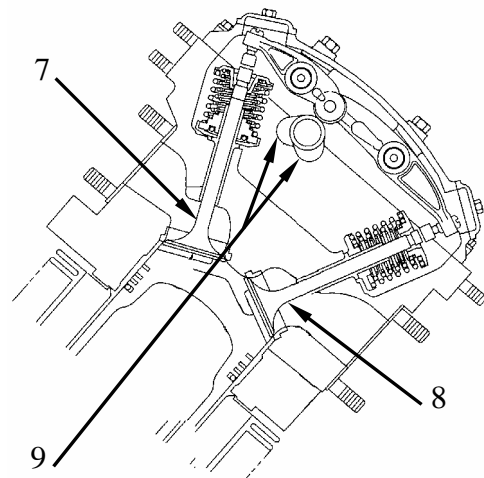


**INSTALLATION (Continued)**

3. Install access cover (16).
  - a. Using new gasket (17) (item 350, WP 0174), secure cover (16) with six cap screws (14), and six flat washers (15).

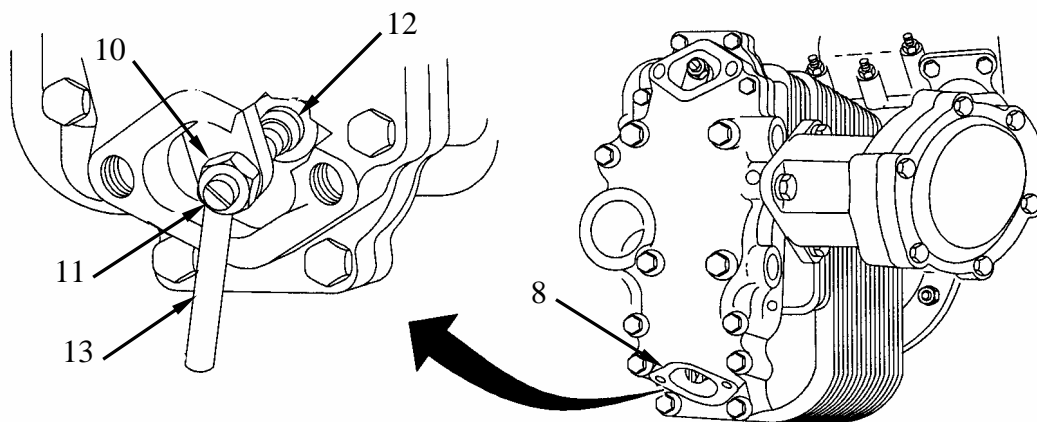


4. Set intake valve back to standard 0.010-inch (0.254-mm) clearance.
  - a. Turn crankshaft until valves (7,8) are closed and camshaft lobes (9) are pointing towards cylinder base as shown.

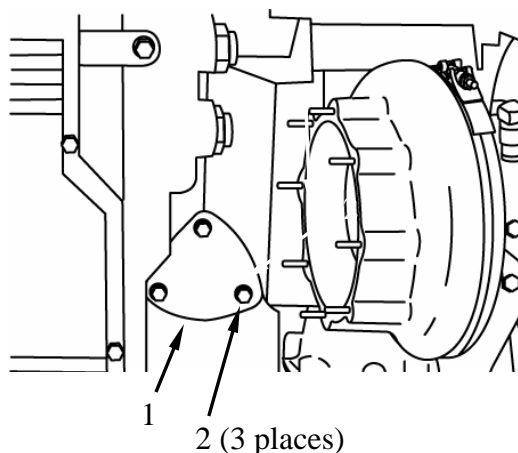


## INSTALLATION (Continued)

5. Adjust intake valve (8) clearance (0.010 inch, 0.254 mm).
  - a. Loosen intake valve adjusting screw lock nut (10).
  - b. Turn valve adjusting screw (11) until clearance between valve adjusting screw pad (12) and valve stem is 0.010 inch using thickness gauge blade (13) (item 55, WP 0176). Gauge blade must move through clearance with a slight drag.
  - c. Check position of valve adjusting screw pad (12) to make sure seat is flat on valve stem.
  - d. Torque lock nut (10) to 200-225 inch-pounds (23-25 N•m) after correct adjustment is made. Make certain setting has not changed after tightening lock nut (10).



6. Install intake valve adjustment cover (3).
  - a. Using new gasket (6) (item 350, WP 0175), install cover (3).
  - b. Secure with two bolts (4) and flat washers (5).
7. Install timing access cover (1).
  - a. Secure with three cap screws (2).



**END OF WORK PACKAGE**



**FUEL INJECTION PUMP TIMING CHECK**

0036 00

**THIS WORK PACKAGE COVERS:**

Introduction, Removal, Timing Check, Timing Adjust, and Installation

**INITIAL SETUP:****Tools:**

- Breaker bar, 3/4-inch (used with 2DR engine turning tool)
- Engine (flywheel) turning tool for 2CA/2DA: splined wrench (item 136, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)

**Fabricated Items:**

- Engine (flywheel) turning tool, 2DR only (item 4, WP 0177)

**Mandatory Replacement Parts:**

- Gasket (2) (item 329, WP 0175)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface

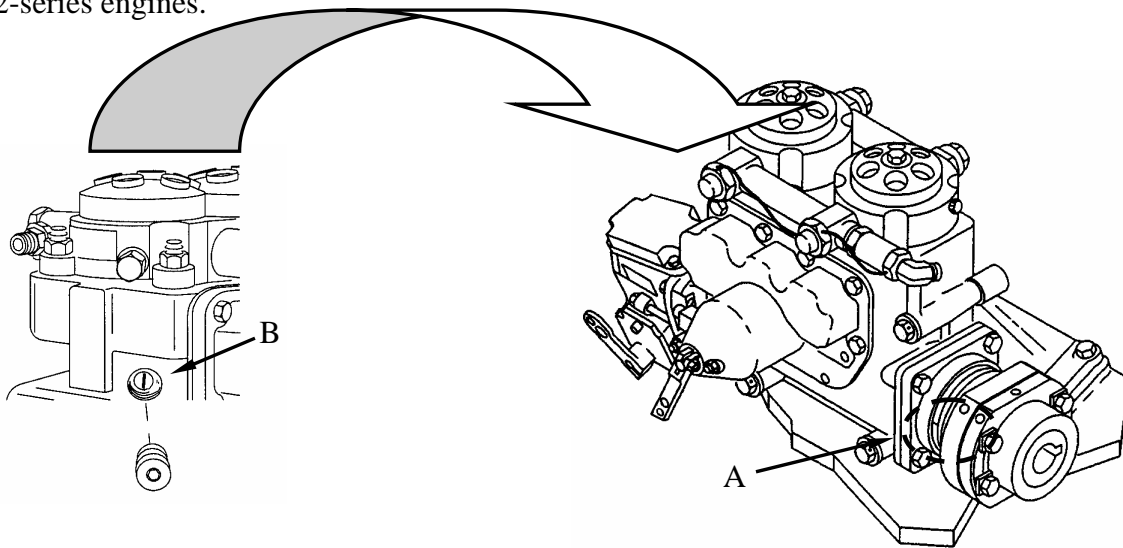
**INTRODUCTION**

The engine crankshaft and camshafts must be properly oriented before checking the fuel injection pump timing. It is possible for the external timing marks on the fuel injection pump and on the engine flywheel to align and still have the fuel injection pump be 180 degrees out of phase. The fuel injection pump has external timing marks (A) as well as an internal gear tooth marking (B). The fuel injection pump drive coupling rotates two times to each revolution of the internal gear tooth that is part of the timing process. In addition, the crankshaft rotates two times to each revolution of the camshafts. Strict attention to the procedure must be observed.

Flywheels between Models 2DA and 2DR are different and are not interchangeable. Timing markings are identical. However, on Model 2DA, a timing pointer is affixed to the transmission housing, while on Model 2DR there are scribed markings on the transmission housing.

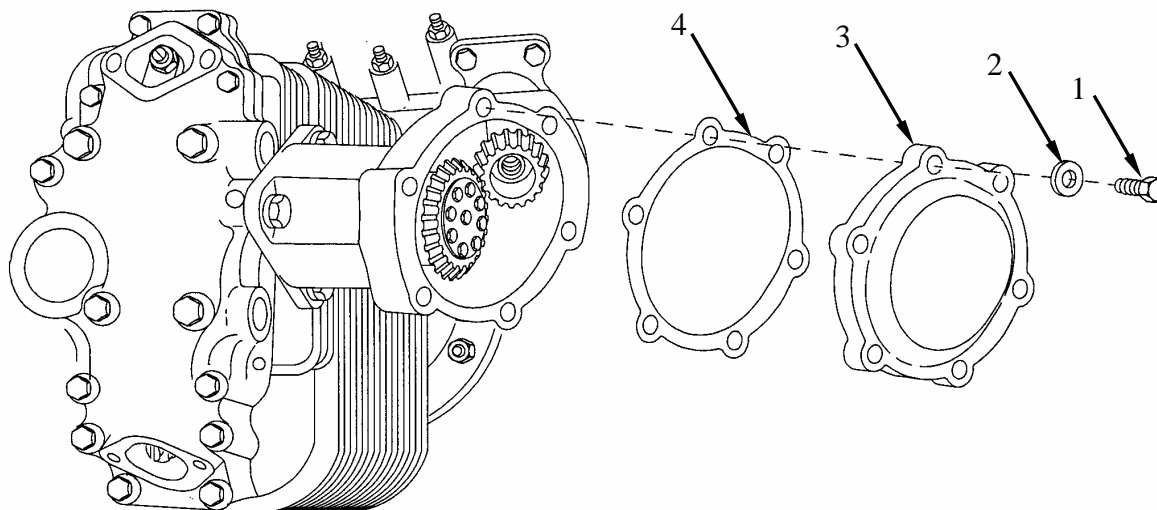
Methods for turning the crankshaft between models require different turning tools (see WP 0034, Intake and Exhaust Valve Clearance Adjustment).

For instructional purposes, a 2DR Model is described and illustrated. Timing is identical for all 2-series engines.

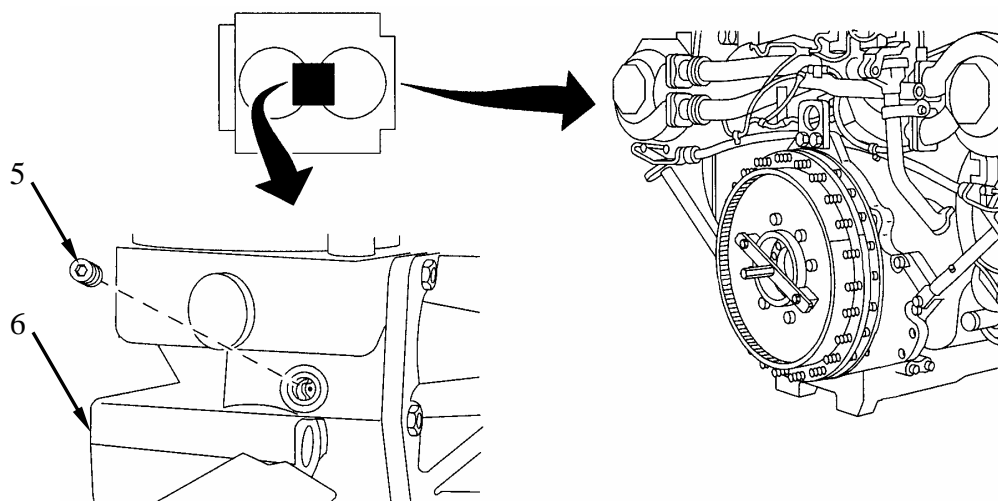


**REMOVAL**

1. Remove six cap screws (1), six flat washers (2), access cover (3), and gasket (4) from both right and left banks. Discard gaskets.



2. Remove timing plug (5) from fuel injection pump (6).

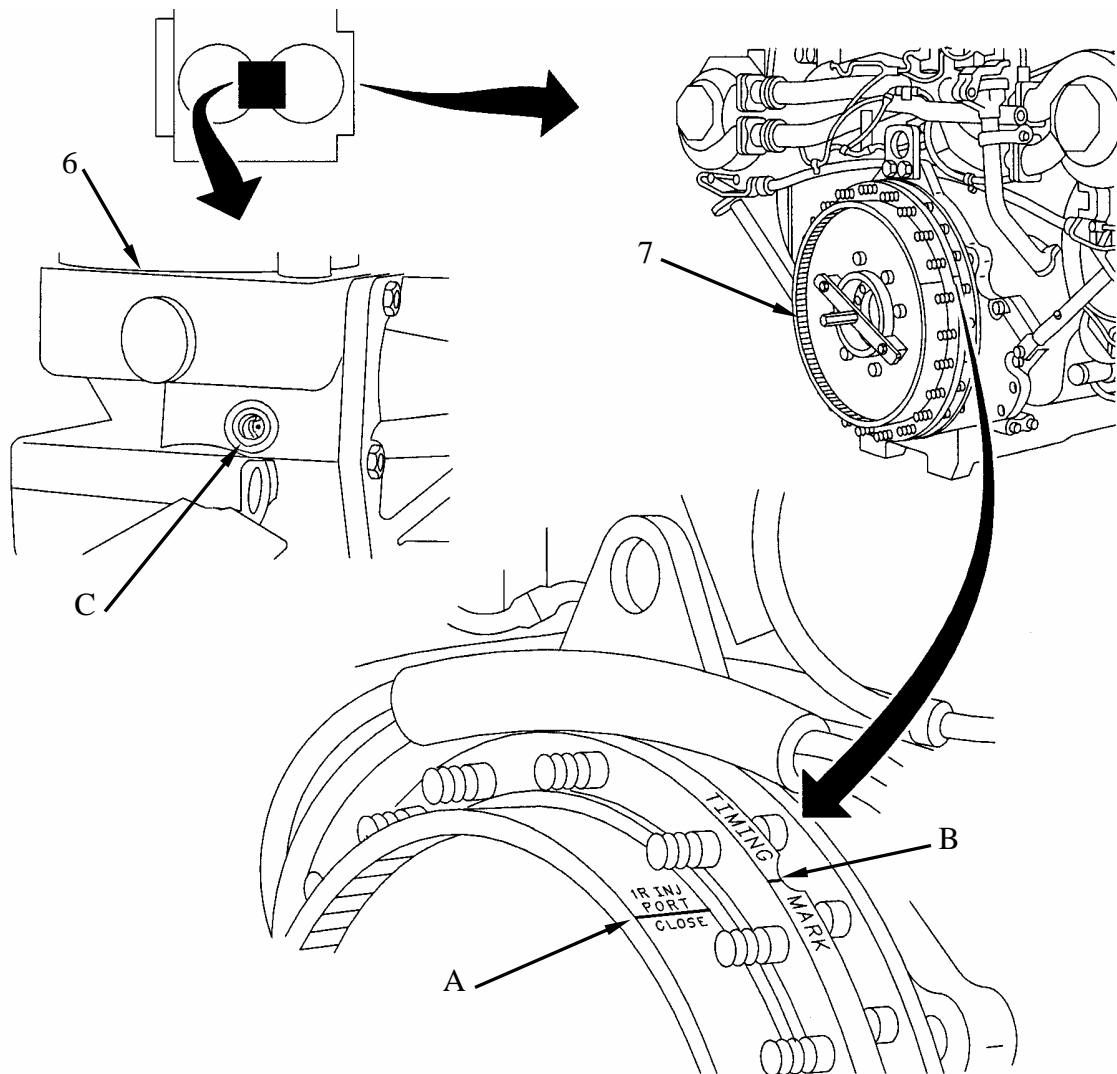


**FUEL INJECTION PUMP TIMING CHECK**

0036 00

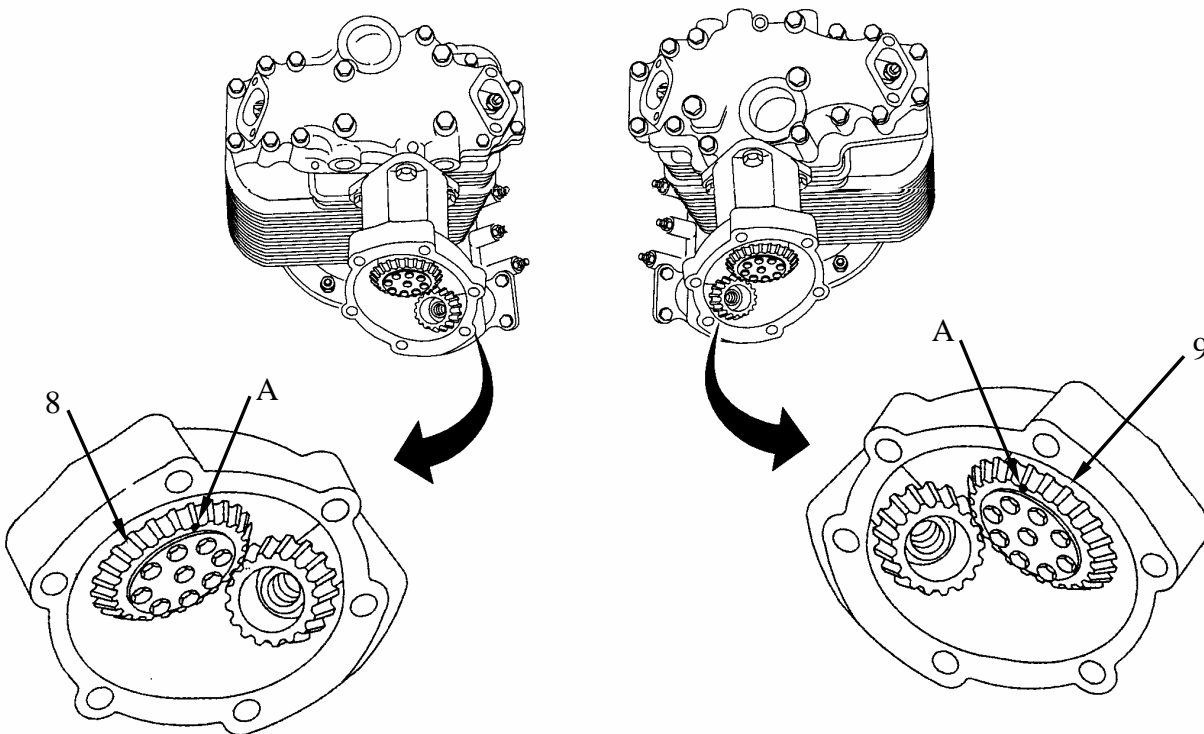
**TIMING CHECK**

1. Using engine turning tool, rotate flywheel (7) counterclockwise, as viewed from the flywheel end, until "1R INJ PORT CLOSE" timing mark (A) aligns with engine timing mark (B).
2. Check timing hole in fuel injection pump (6) making sure marked tooth (C) (wide tooth painted white) is visible.
3. If marked tooth (C) is not visible, rotate flywheel (7) counterclockwise 360 degrees, as viewed from the flywheel end, until "1R INJ PORT CLOSE" timing mark (A) aligns with engine timing mark (B) and marked tooth (C) is visible in timing hole of fuel injection pump (6).



**TIMING CHECK (Continued)**

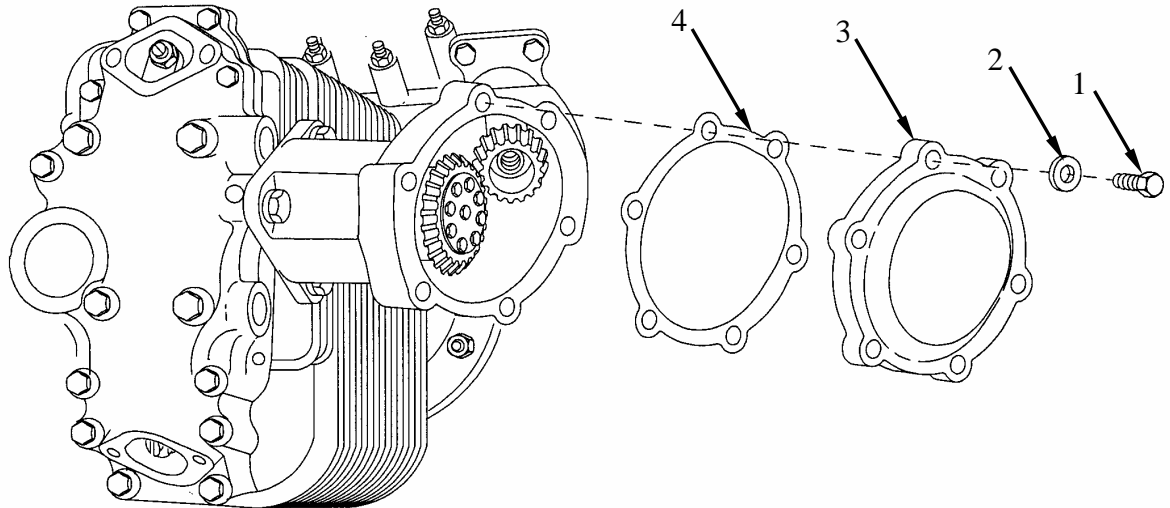
4. Check camshaft bevel gear timing marks.
  - a. With timing marks aligned and the marked tooth visible in the fuel injection pump, the scribed tooth (A) on the right and left bank cam beveled gears (8 and 9) should be approximately in the 12 o'clock position.
  - b. If the timing marks are in the 12 o'clock position, timing is good. Go to Installation.
  - c. If the timing marks are not in the 12 o'clock position, the fuel injection pump must be timed. Go to WP 0115 (Fuel Injection Pump Replacement) for timing procedure.





**FUEL INJECTION PUMP TIMING CHECK****0036 00****INSTALLATION**

1. Install access cover (3).
  - a. Using new gasket (4) (item 329, WP 0175), secure cover (3) with six cap screws (1), and six flat washers (2) to both right and left banks.

**END OF WORK PACKAGE**



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**INDUCTION LEAK TEST**

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0037 00

**THIS WORK PACKAGE COVERS:**Before Test, Test, and After Test

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Regulator assembly (item 97, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface

**Fabricated Items:**Turbosupercharger covers (2) (item 10, WP 0177)

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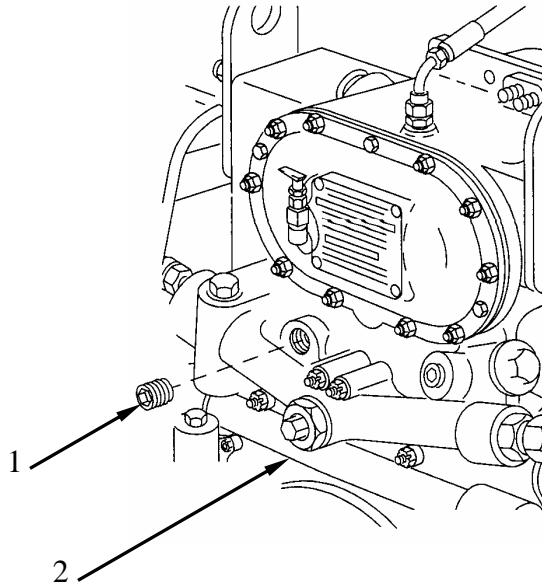
**BEFORE TEST****CAUTION**

**Left and right banks must be tested separately and engine front and rear vents must be open.**

**NOTE**

**Procedure is the same for each bank of the engine.**

1. Remove pipe plug (1) from damper housing (2) to vent the front of the engine.

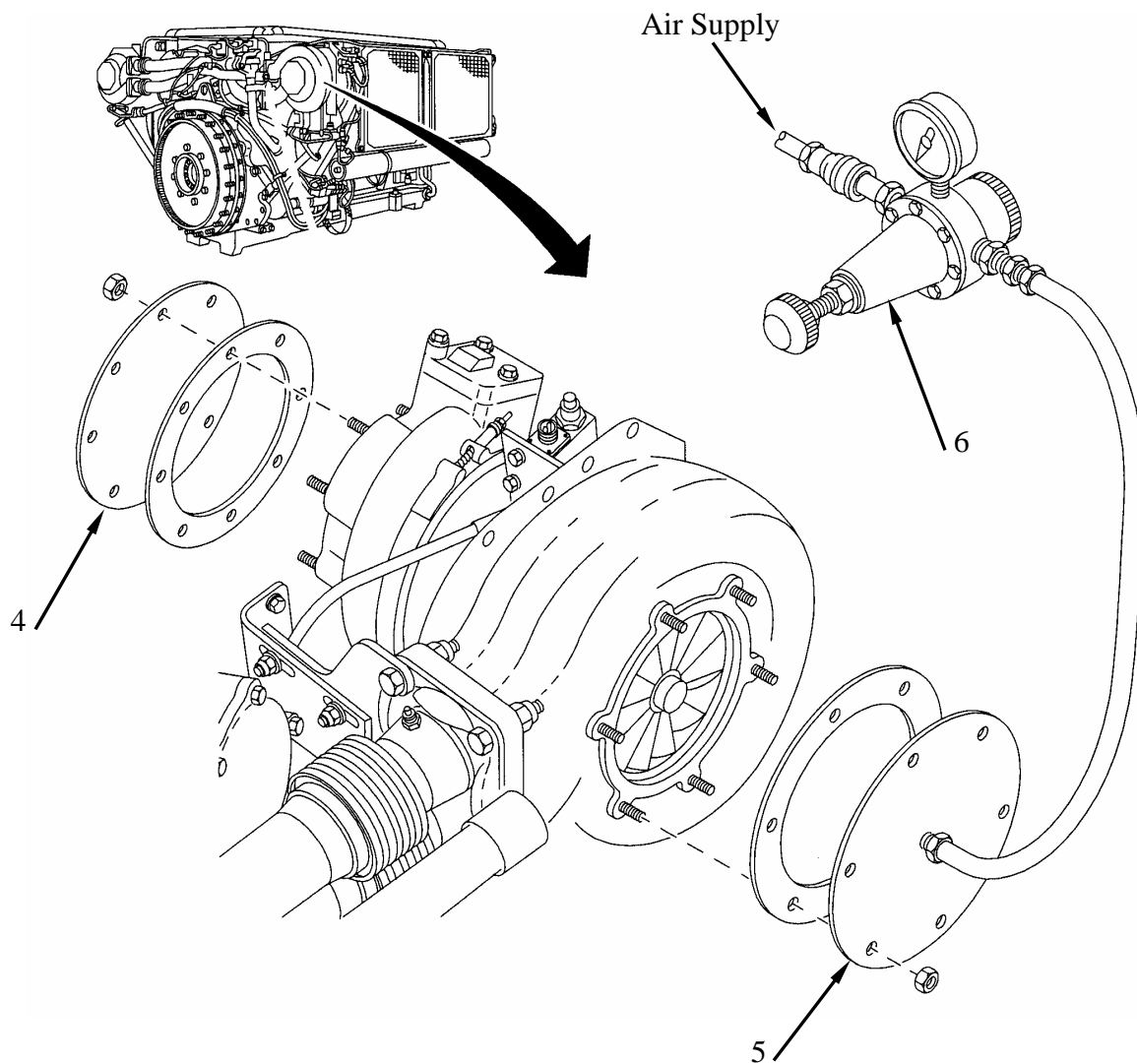


**INDUCTION LEAK TEST****0037 00****BEFORE TEST (Continued)**

2. Assure that rear vent (3) on engine is open.
3. Install turbosupercharger covers (4 and 5) (item 10, WP 0177) over openings in turbosupercharger (3). Secure with fasteners and gaskets normally used to hold vehicle parts on turbosupercharger.
4. Attach regulator assembly (6) (item 97, WP 0176) to cover (5) and to an air supply.

**TEST**

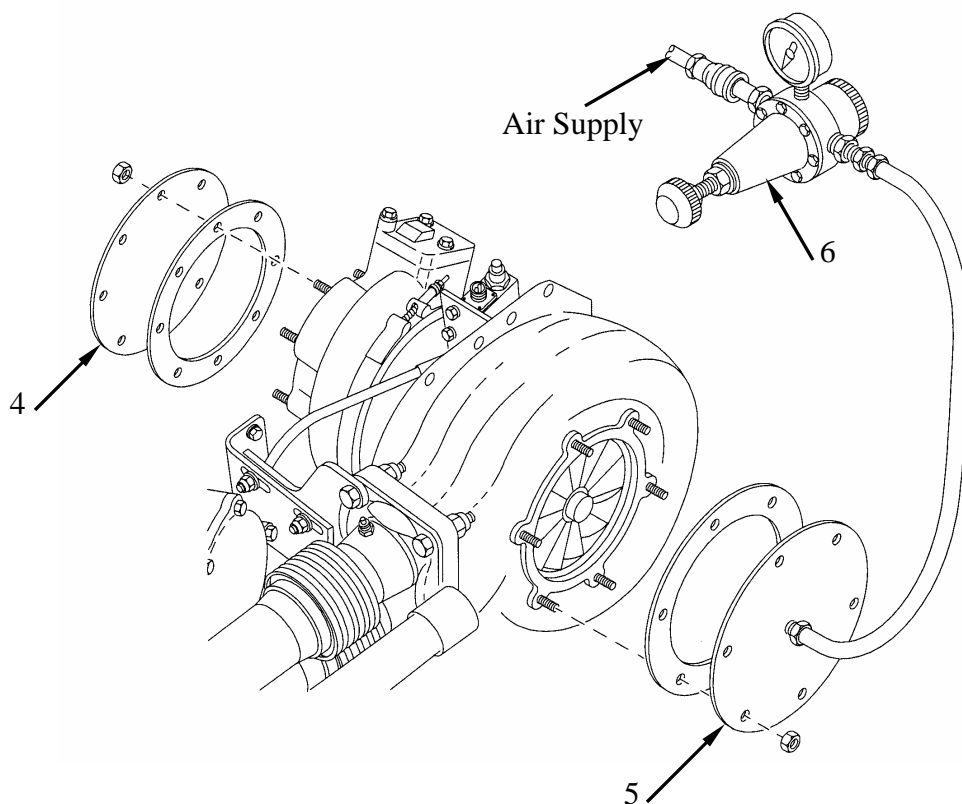
1. Adjust regulator assembly (6) to 15 psi (103.4 kPa).



**TEST (Continued)****NOTE**

**Some air escaping past the rings and from vents will be heard.**

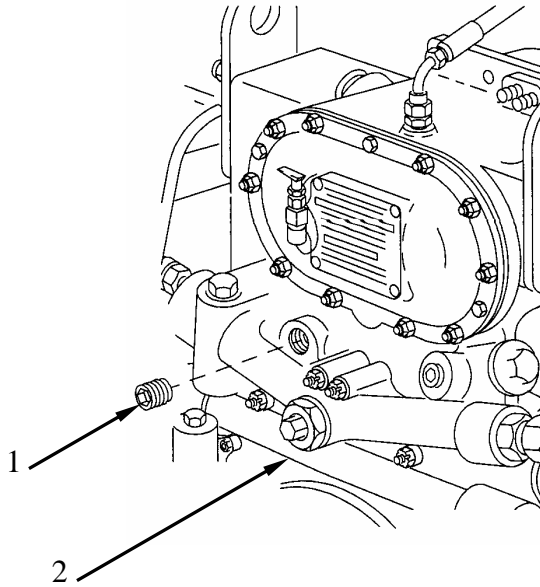
2. Leaks in the induction system may be detected by using water and soap solution at all joint areas.
3. If leaks are found, remove air supply and repair leaks. Refer to the appropriate section in this manual for repair.
4. Repeat steps 1, 2 and 3 until all leaks are repaired.

**AFTER TEST**

1. Remove air supply and regulator assembly (6).
2. Remove turbosupercharger covers (4 and 5).

**AFTER TEST (Continued)**

3. Install pipe plug (1) in damper housing (2).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Before Test, Test, and After Test

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Manometer (item 74, WP 0176)
- Regulator assembly (item 97, WP 0176)

**Fabricated Items:**

- Turbosupercharger covers (2) (item 10, WP 0177)
- Oil level gauge plug (item 11, WP 0177)

**Personnel Required:**

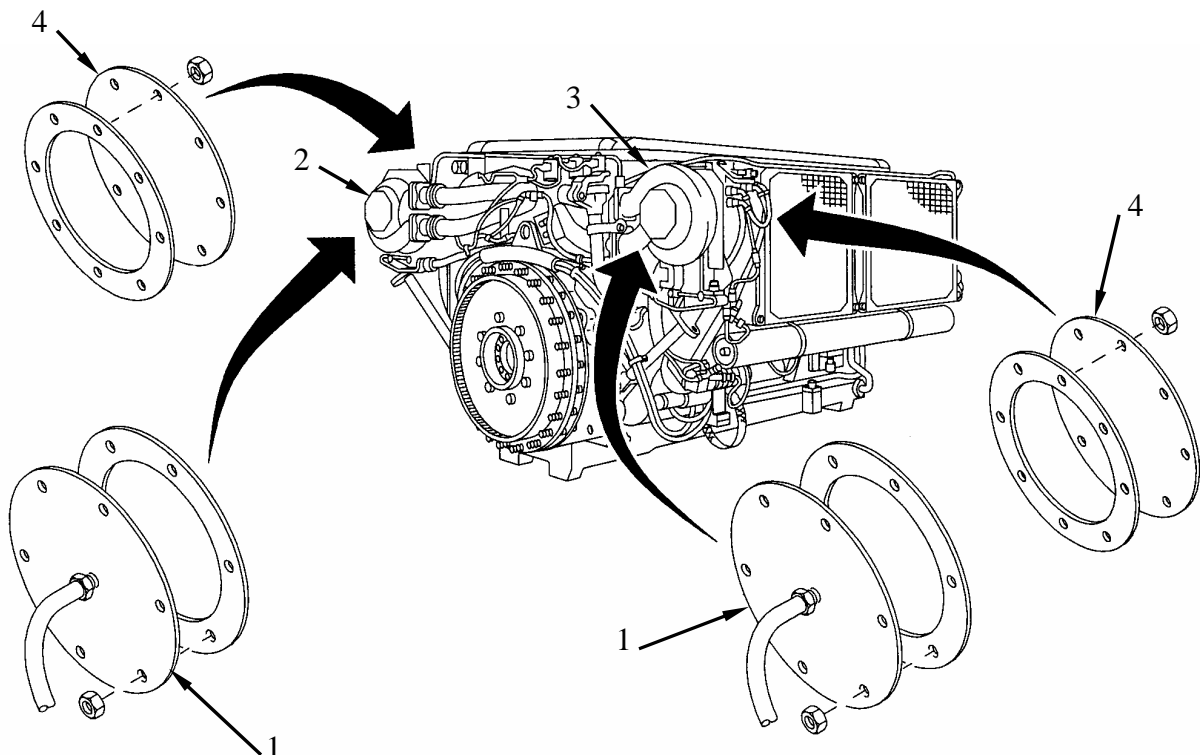
- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface.
- Oil level gauge rod cover removed (WP 0076)
- Rear vent tube removed (WP 0078)

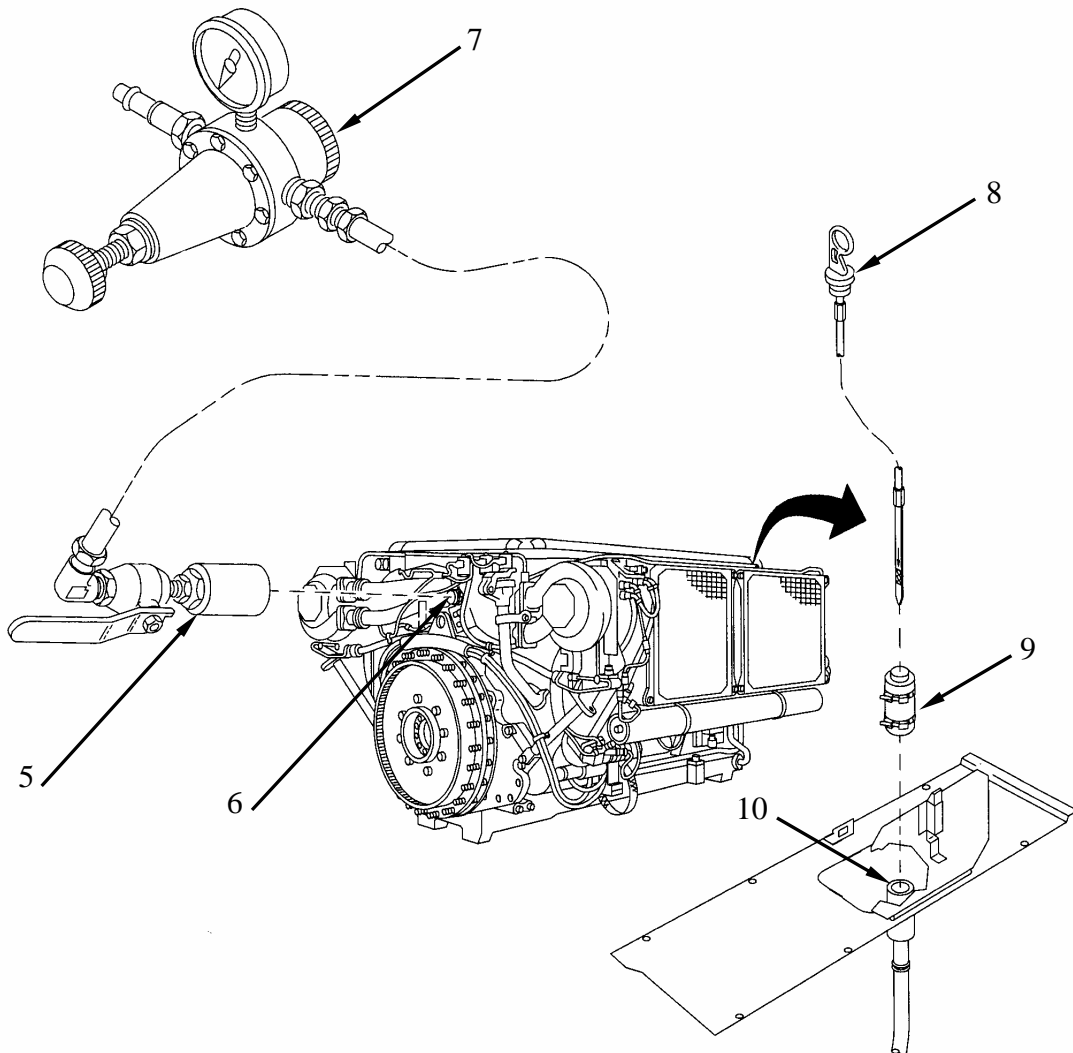
**BEFORE TEST**

1. Install covers (1) (item 10, WP 0177) with fittings over exhaust openings of turbosuperchargers (2 and 3).
  - a. Secure with fasteners and gaskets normally used to hold exhaust onto turbosupercharger.
2. Install blank covers (4) over intake openings of turbosuperchargers (2 and 3).
  - a. Secure with fasteners and gaskets normally used to hold intake on turbocharger.



**BEFORE TEST (Continued)**

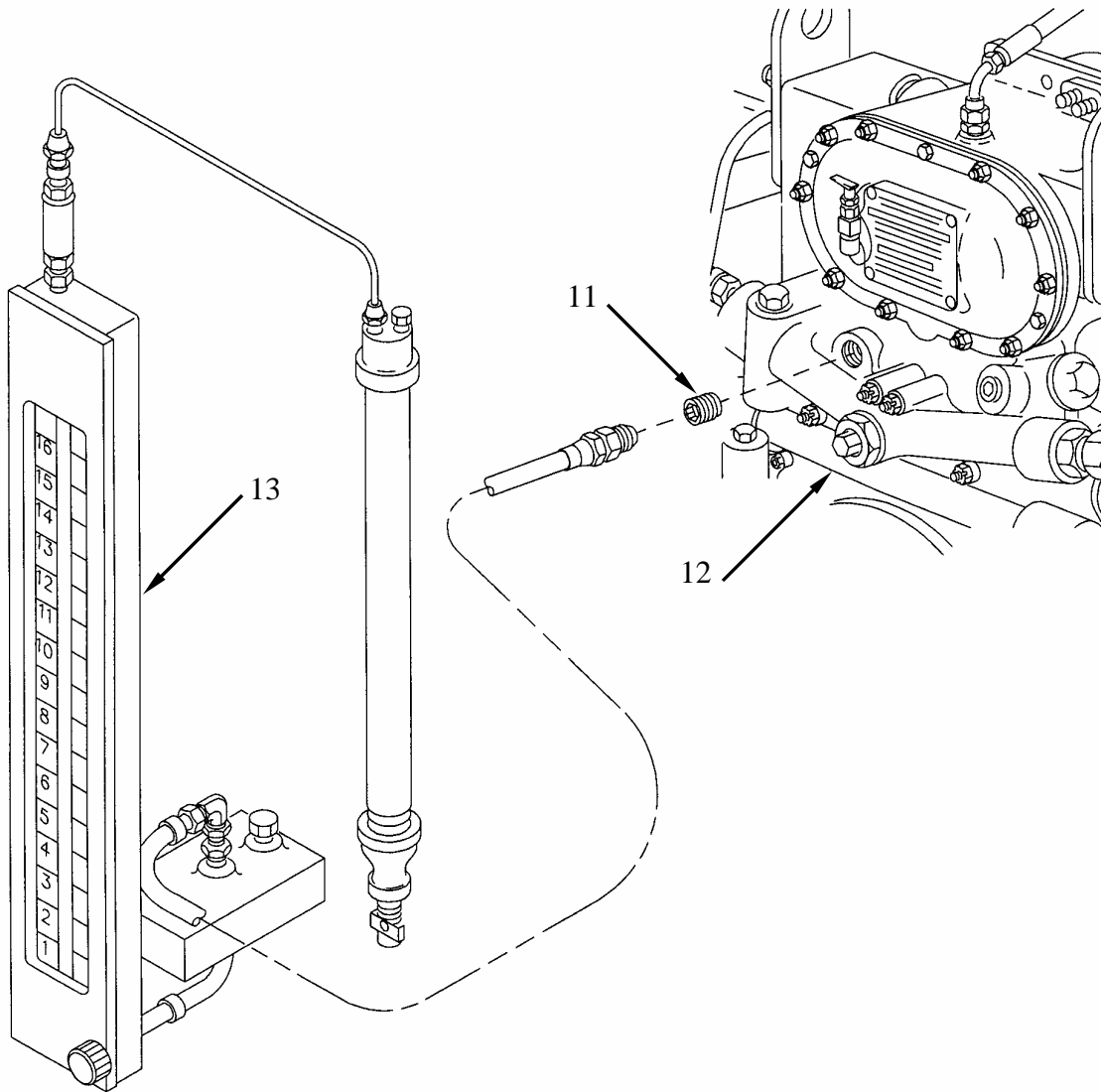
3. Install air valve adapter (5) in breather hose (6) in place of removed vent tube.
4. Attach regulator assembly (7) (item 97, WP 0176) to air valve (5).
5. Remove oil level gauge rod (8) and install plug (9) (item 11, WP 0177) in tube (10).





**BEFORE TEST (Continued)**

6. Remove pipe plug (11) from damper housing (12) and attach manometer (13) (item 74, WP 0176).

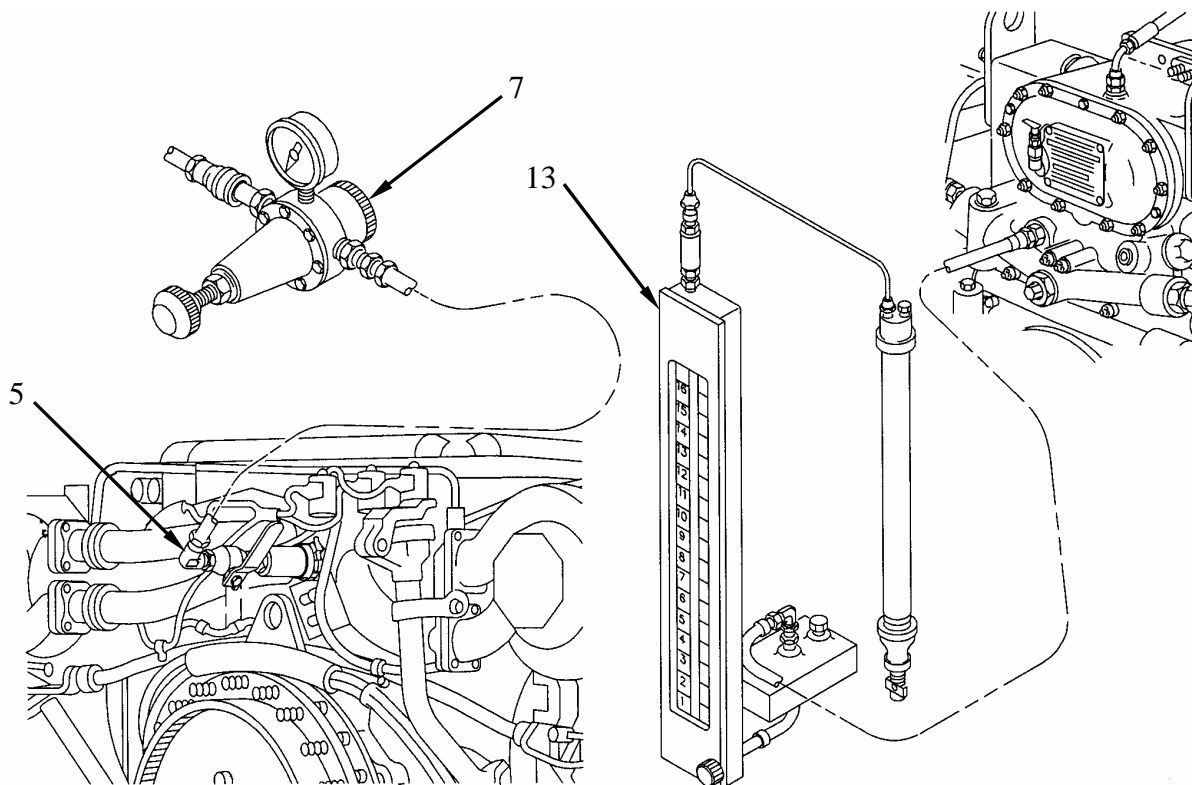


## TEST

**CAUTION**

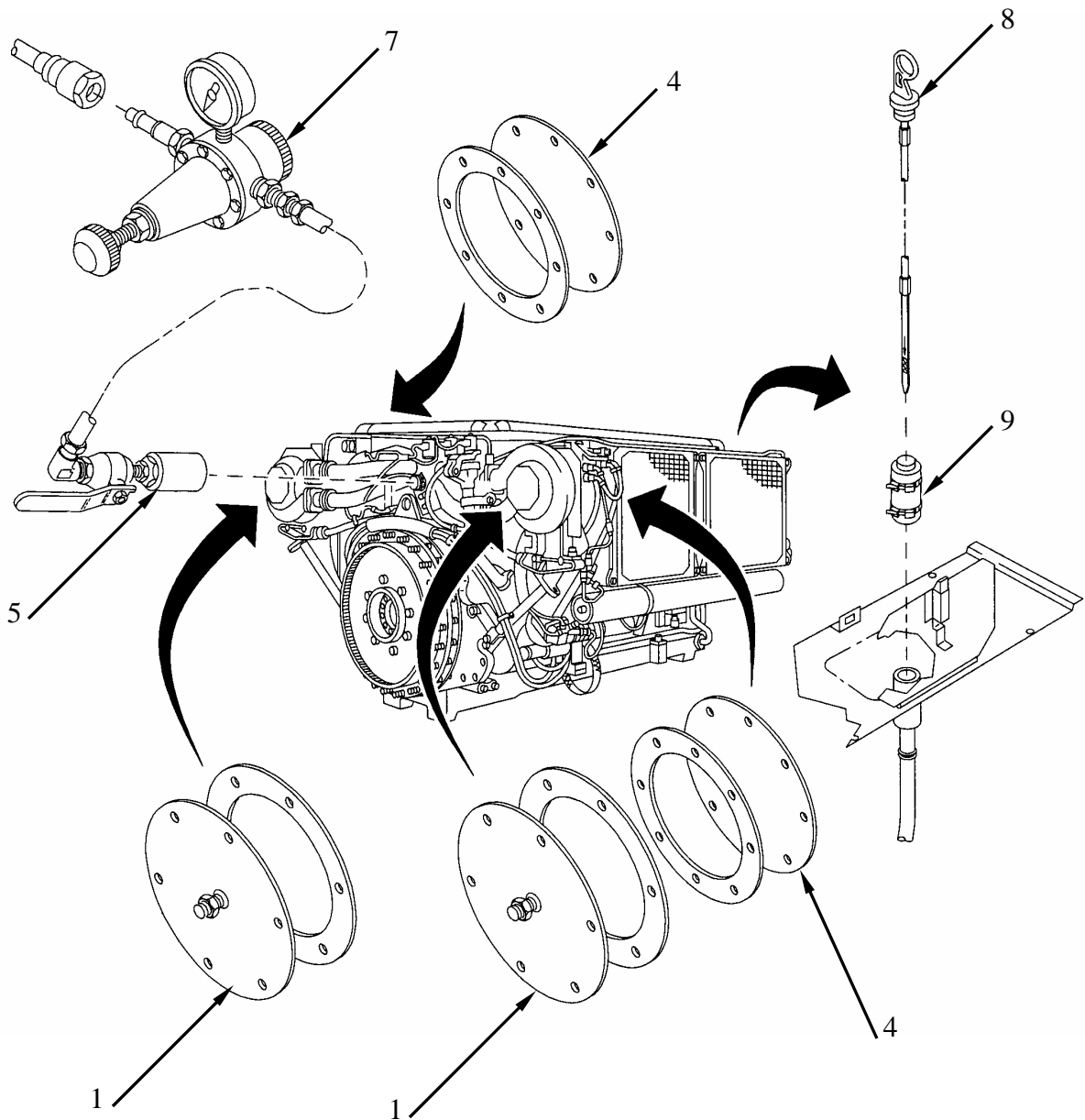
**Make sure regulator is turned all the way down (counterclockwise) before air supply is attached so that seals in the engine will not be damaged. Do not let pressure go above 6 inches mercury (Hg).**

1. Attach regulator assembly (7) to an air supply.
  - a. Slowly adjust air pressure until manometer (13) reaches and stabilizes at 6 inches Hg.
2. Close air valve adapter (5) and observe manometer (13) for 3 minutes.
  - a. If manometer loses more than 0.9 inches Hg in 3 minutes, check for leaks with water and soap solution.
  - b. When leaks are found, shut off air supply and repair leaks. Refer to the appropriate section of this manual for repair.
  - c. Repeat steps a and b until pressure loss is less than 0.9 inches Hg in a 3-minute period.



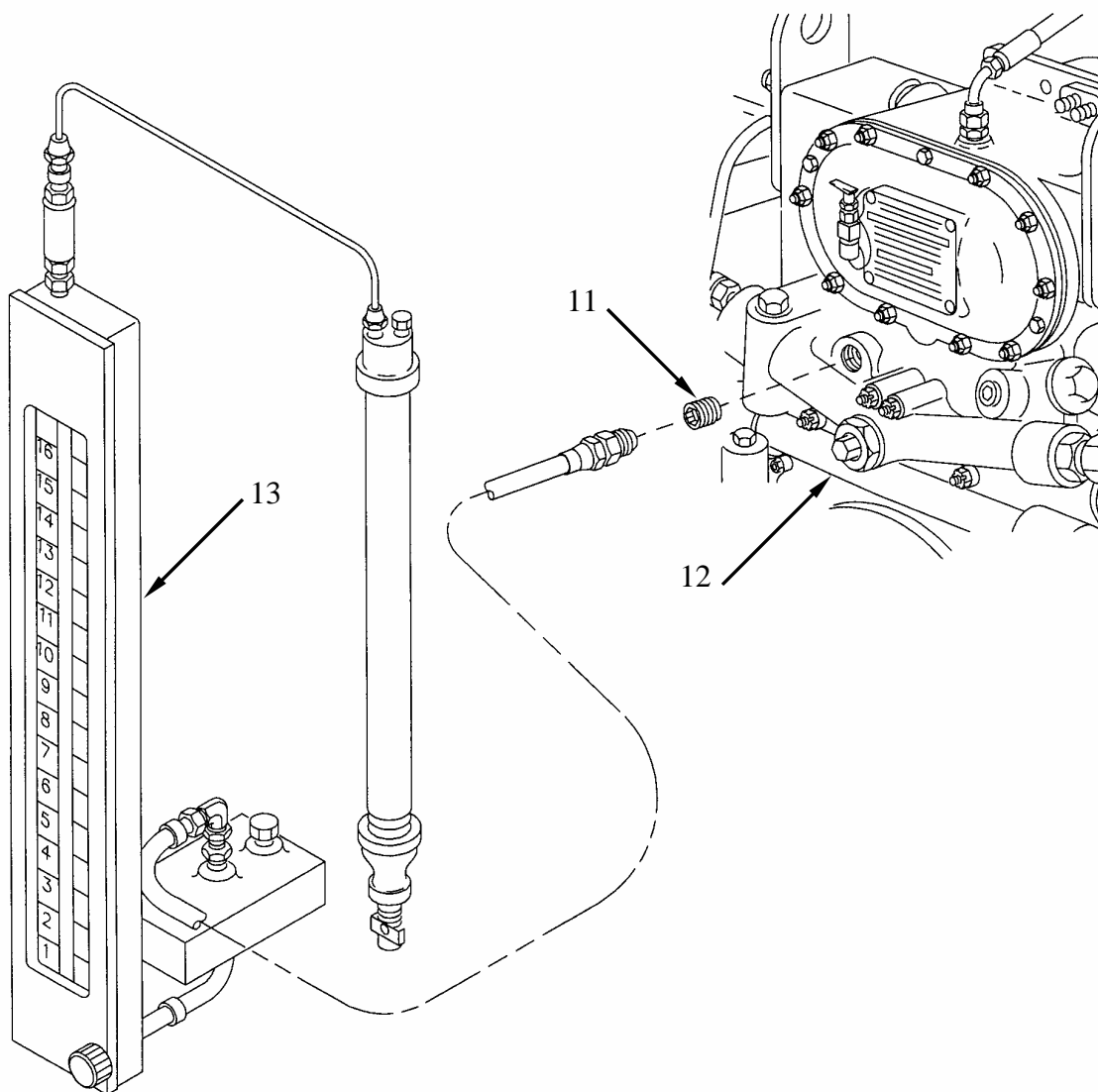
**AFTER TEST**

1. Remove air supply, regulator assembly (7), and air valve adapter (5).
2. Remove turbosupercharger covers (1 and 4).
3. Remove plug (9) and replace gauge rod (8).



**AFTER TEST (Continued)**

4. Remove manometer (13), and install pipe plug (11) in damper housing (12).

**FOLLOW-ON MAINTENANCE**

Replace rear vent tube (WP 0078).

Replace oil level gauge rod cover (WP 0076).

**END OF WORK PACKAGE**

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**GENERATOR (650 AMPERE) DRIVE GEAR TEST**

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0039 00

**THIS WORK PACKAGE COVERS:**Test

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Generator coupling tool (item 58, WP 0176)  
Generator holding fixture (item 59, WP 0176)  
Torque wrench, 0-600 foot-pounds (item 128, WP 0176)  
Engine (flywheel) turning tool (for Models 2CA and 2DA): splined wrench (item 136, WP 0176)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Mandatory Replacement Parts:**

Gasket (2) (item 353, WP 0175)  
Lock washer (5) (item 98, WP 0175)  
Self-locking nut (item 35, WP 0175)

**Personnel Requirements:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

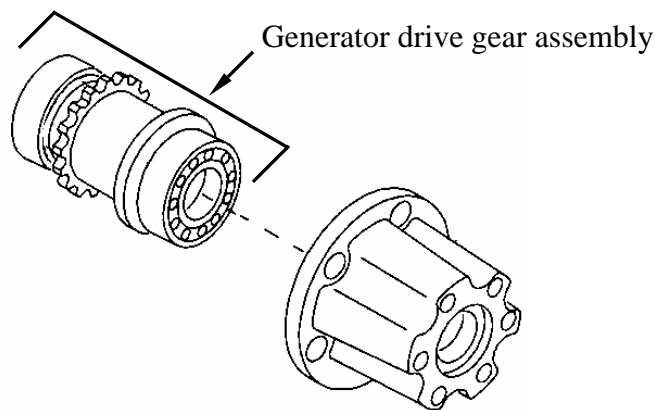
Generator removed (WP 0051)

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**GENERATOR DRIVE GEAR TEST****NOTE**

**The drive gear test is to be performed when generator output is questionable and whenever the generator is replaced (WP 0051). Refer to WP 0021 (Generator Abnormal Operation).**

**There are two methods of testing the drive gear: the first one is with the gear installed on the engine, the other is a bench test. Use the method that best suits your situation.**



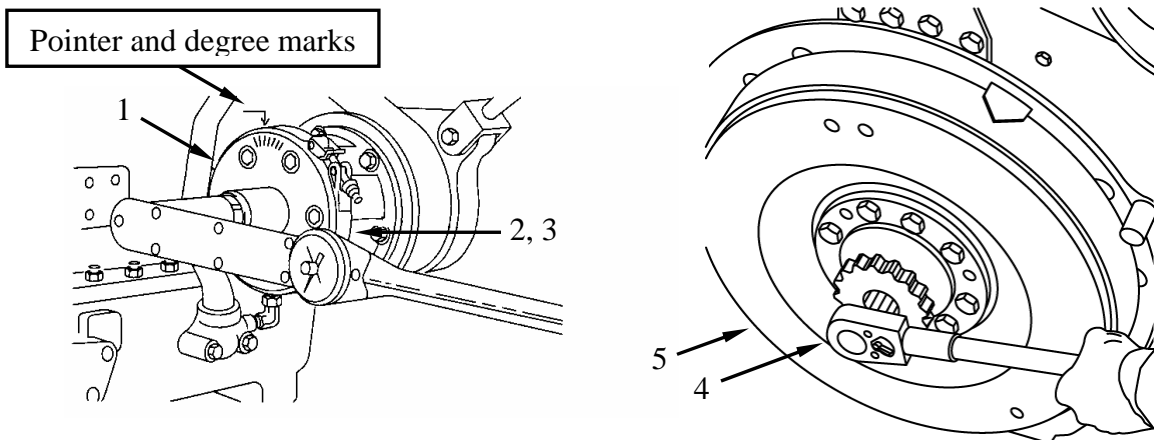
**TEST METHOD ONE: DRIVE GEAR INSTALLED ON ENGINE**

1. Position generator coupling tool (1) on generator end plate (2) and secure with coupling clamp (3) that was removed with generator.
  - a. Improvise a pointer and align it with degree markings on generator coupling tool.
2. Prevent crankshaft from rotating.
  - a. Install engine turning tool (4) (item 136, WP 0176) on flywheel (5) and block so that crankshaft cannot rotate.

**NOTE**

**A 300 foot-pound (406 N•m) capacity torque wrench is required for the test.**

3. Check drive gear deflection/slippage.
  - a. While watching indicator on the generator coupling tool (1), remove backlash, then gradually increase torque to 167 foot-pounds (227 N•m).
  - b. Check deflection by observing degrees indicated on coupling tool at 167 foot-pounds (227 N•m) torque. Reading must be between 8 and 17 degrees. If not, coupling is faulty and must be replaced.
  - c. Check slippage by removing torque and reading indicator. If indicator returns to zero, slippage has not occurred and coupling is good. If indicator does not return to zero, coupling has slipped at too low a torque value and must be replaced.

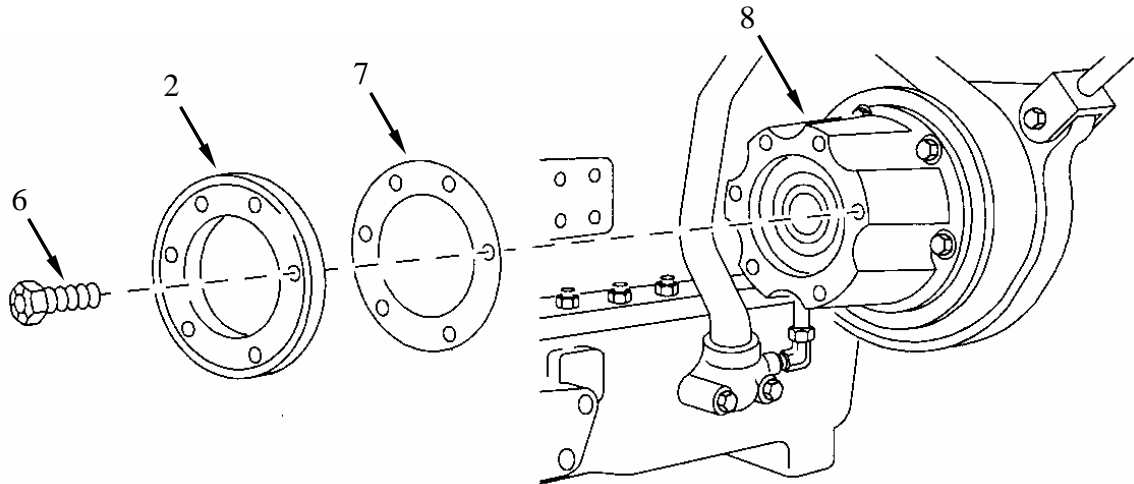


**END OF TEST METHOD ONE**

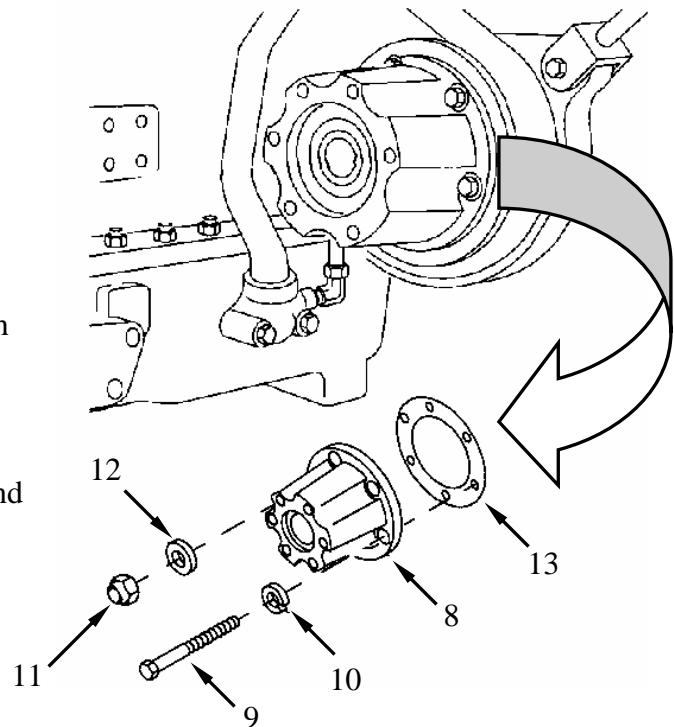
**TEST METHOD TWO: BENCH TEST**

**PREPARATION**

1. Remove generator end plate (2).
  - a. Remove six screws (6).
  - b. Remove generator end plate (2) and gasket (7) from generator drive adapter (8). Discard gasket.



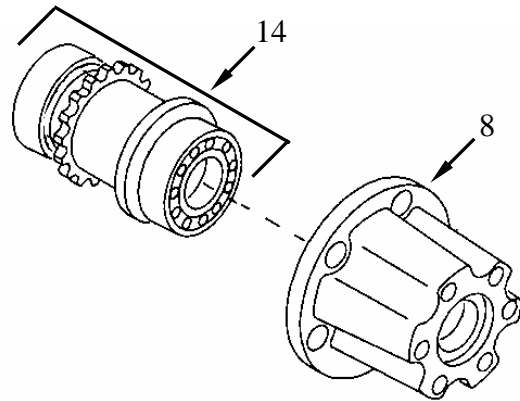
2. Remove generator drive adapter (8).
  - a. Remove five screws (9) with lock washers (10). Discard lock washers.
  - b. Remove one self-locking nut (11) with flat washer (12). Discard self-locking nut.
  - c. Remove generator drive adapter (8) and gasket (13). Discard gasket.



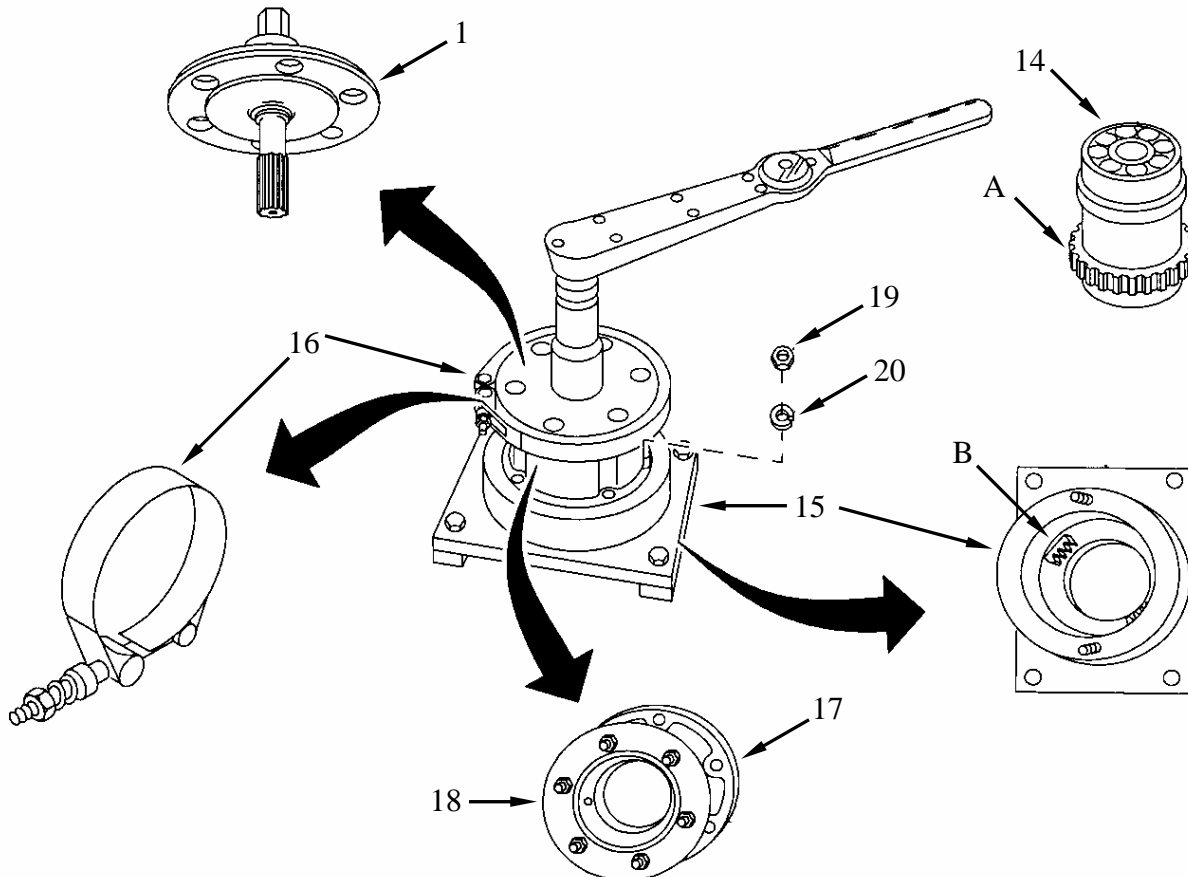
**TEST METHOD TWO: BENCH TEST (Continued)**

**PREPARATION (Continued)**

3. Remove generator drive gear assembly (14) from generator drive adapter (8).



4. Secure generator holding fixture (15) to workbench and remove coupling clamp (16).
5. Remove adapter (17) with plate (18) as an assembly from fixture (15) base by removing two plain nuts (19) with lock washers (20).
6. Place drive gear assembly (14) in fixture (15) base assuring that gear teeth (A) of coupling tool (1) (item 58, WP 0176) are meshed with teeth (B) in the base of fixture (15) (item 59, WP 0176).
7. Secure adapter (17) and attached plate (18) to fixture (15) base using two plain nuts (19) with lock washers (20).
8. Install splined end of generator coupling tool (1) into drive gear (14) and secure to fixture (15) with coupling clamp (16).

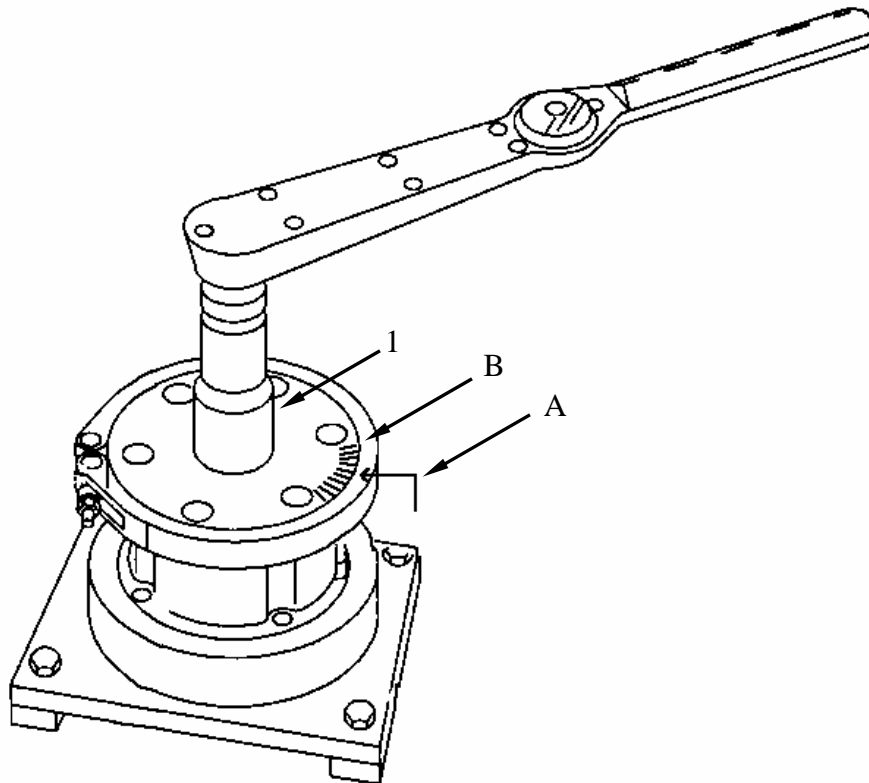




**TEST METHOD TWO: BENCH TEST (Continued)****BENCH TEST****NOTE**

**A 300 foot-pound (406 N•m) capacity torque wrench is required for the bench test.**

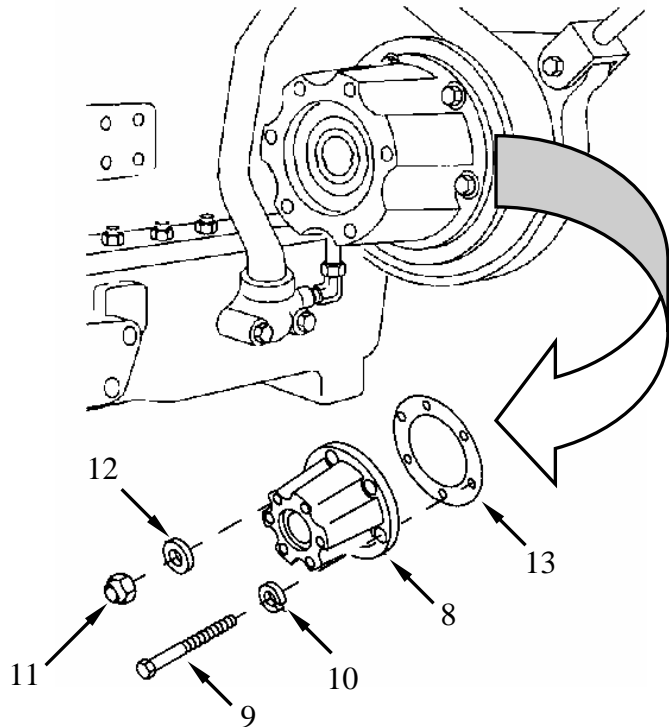
1. Align pointer (A) with degree indicator marks (B) on coupling tool (1).
2. Check drive gear deflection/slippage.
  - a. While watching indicator on the generator coupling tool (1), gradually increase torque to 167 foot-pounds (227 N•m).
  - b. Check deflection by observing degrees indicated on coupling tool at 167 foot-pounds (227 N•m) torque. Reading must be between 8 and 17 degrees. If not, coupling is faulty and must be replaced.
  - c. Check slippage by removing torque and reading indicator. If indicator returns to zero, slippage has not occurred and coupling is good. If indicator does not return to zero, coupling has slipped at too low a torque value and must be replaced.



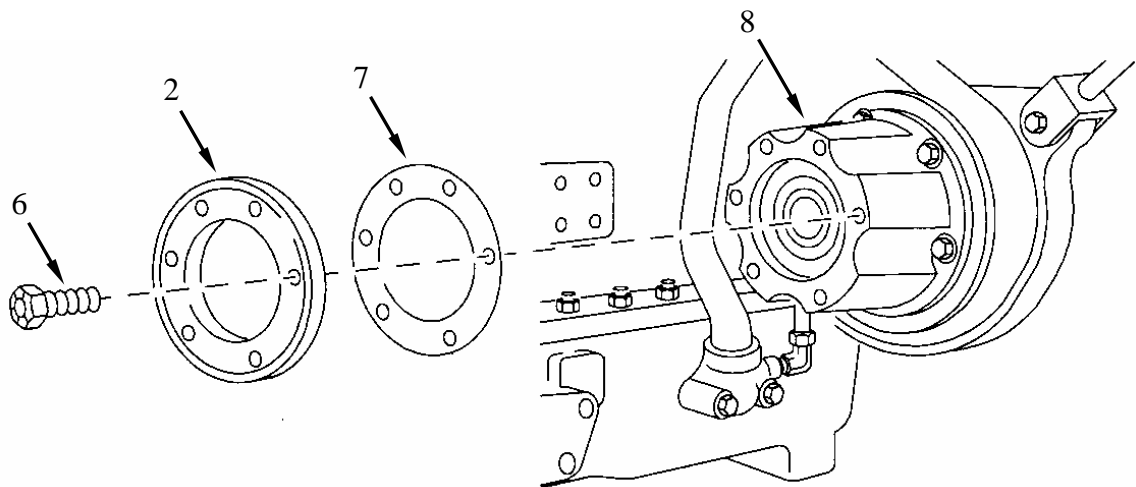
**TEST METHOD TWO: BENCH TEST (Continued)**

**AFTER BENCH TEST**

1. Install generator drive adapter (8).
  - a. Apply lubricant (item 23, WP 0173) to five screws (9).
  - b. Install generator drive adapter (8), drive gear assembly (14), and new gasket (13) (item 353, WP 0175).
  - c. Secure using five screws (9) with new lock washers (10) (item 98, WP 0175), and one new self-locking nut (11) (item 35, WP 0175), with flat washer (12).



2. Install generator end plate (2).
  - a. Apply lubricant (item 23, WP 0173) to six screws (6).
  - b. Install generator end plate (2) using new gasket (7) (item 353, WP 0175) onto generator drive adapter.
  - c. Secure with (8) with six screws (6).



**END OF WORK PACKAGE**

**ENGINE OPERATING PARAMETERS**

**0040 00**

**ENGINE OPERATING PARAMETERS**

**Blow-by Pressure.** With engine under full throttle and full load, blow-by should not exceed 18 cubic feet per minute (cfm) with new cylinders and 21 cfm with used cylinders.

**Exhaust Gas Temperature.** Exhaust gas temperatures, measured at individual cylinder ports, should not exceed 1250 °F (677 C°). Temperature variation between cylinders should not exceed 150 °F (66 C°) under full load conditions.

**Exhaust Smoke Density Test.** The maximum exhaust smoke density at full power position, with breather tube disconnected, when measured within one foot of the exhaust outlet, should not exceed the following conditions when using fuel conforming to Specification VV-F-800 (DF-2).

**NOTE**

**Meter readings have precedence over visual reading.**

<b>Engine rpm</b>	<b>No.</b>	<b>Visual</b>	<b>Robert Bosch Meter Number</b>
1800	3	Light Gray	3.5
2000	3	Light Gray	3.2
2200	2	Haze	2.6
2400	1	Clear	2.4

**Fuel Consumption (Without Accessories).** When operating at full throttle under full load on a dynamometer at a speed of 2400 rpm, engine should not consume more than 0.420 pounds per brake horsepower hour (lbs/bhp/hr) fuel conforming to Specification VV-F-800 (DF-2).

**Fuel Pressure.** Fuel pressure at the injection pump inlet should be 40-60 psi at engine speeds of 1800 to 2400 rpm.

**Gross Horsepower (Without Accessories).** Under full throttle setting, engine will develop 735 to 780 gross horsepower at 2400 rpm using fuel conforming to Specification VV-F-800 (DF-2).

**Gross Torque (Without Accessories).** Under full throttle setting, engine will develop the following gross torque using fuel conforming to Specification VV-F-800 (DF-2):

- 1609 to 1707 foot-pounds at 2400 rpm
- 1770 to 1842 foot-pounds at 1800 rpm

**Lubricating Oil Temperature.** Temperature of oil in the engine oil pan sump should not exceed 250 °F (121 C°). Temperature of oil entering the engine through the oil pump should be maintained between 140 and 250 °F (60 and 121 C°).

**ENGINE OPERATING PARAMETERS (Continued)**

**Manifold Pressure.** Intake manifold pressure rise above atmospheric after the turbosupercharger with boost to 0 inches Hg (mercury) atmospheric pressure, should not exceed 35 inches Hg; without boost, 28 to 32 inches Hg. Variation between left and right banks should not exceed 4 inches Hg.

**Oil Consumption.** Engine should not consume more than 0.0075 pounds per brake horsepower hour (lbs/bhp/hr) of lubricating oil when operating under full load and using engine oil conforming to Military Specification MIL-L-45199 Grade 2 (OE 30) (item 21, WP 0173).

**Oil Pressure.** Engine oil pressure should not be more than 70 psi or less than 40 psi when engine is operating at 2400 rpm. The engine oil pressure should not be less than 15 psi when engine is idling at 700 rpm, measured at or adjacent to the oil pressure sending unit, with oil temperature of 140 to 250 °F (60 to 121 °C), using engine oil conforming to Military Specification MIL-L-45199 Grade 2 (OE 30).

**Speed Range.** The engine must operate satisfactorily under all loads through a speed range of 1000 to 2400 rpm and must idle satisfactorily at 675 to 725 rpm.

**Temperatures.** Induction air inlet temperature should be  $85 \pm 10$  °F ( $29 \pm -5$  °C). When operating at full throttle under full load on a dynamometer at 1800 rpm, the engine should not consume more than 0.400 lbs/bhp/hr of fuel conforming to Specification VV-F-800 (DF-2).

**END OF WORK PACKAGE**

**ENGINE STALL TEST**

**0041 00**

**THIS WORK PACKAGE COVERS:**

Engine Stall Test

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine installed in vehicle

**CAUTION**

**If a rough, noisy, or overheated engine is associated with the reported low power, prior correction of these malfunctions often will eliminate the poor performance, and, in addition, may prevent further damage to the engine.**

**When low power or poor vehicle performance is reported, an engine "stall" speed test will indicate whether the malfunction is engine or vehicle related. See Work Package 0019 for engine low performance troubleshooting procedures.**

**PRELIMINARY INVESTIGATION**

<b>PROBABLE CAUSE</b>	<b>CORRECTIVE ACTION</b>
a. Engine rough operation.	(1) Refer to WP 0014 (Engine Rough Operation).
b. Engine noisy.	(1) Refer to WP 0015 (Engine Noisy Operation).
c. Engine overheating.	(1) Refer to WP 0017 (Cooling System Deficiencies).

**ENGINE STALL TEST**

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Start engine and warm to normal operating temperature (140 °F).		
With vehicle brakes applied and transmission in "high range," depress accelerator pedal fully and operate engine for 20 seconds, release accelerator pedal and allow engine to idle 1 minute.	Engine speed below 1800 rpm. <b>NOTE</b> <b>Use a calibrated tachometer for "Stall Test."</b> <b><u>CAUTION</u></b> <b>Limit "Stall Test" to 30-second intervals maximum and terminate immediately if transmission warning light activates.</b>	Engine and transmission partially warmed up.

**ENGINE STALL TEST**

**0041 00**

**ENGINE STALL TEST (Continued)**

<b>PROCEDURE</b>	<b>OBSERVATION</b>	<b>ANALYSIS</b>
Repeat the preceding step, but operate engine for 30 seconds.	Engine speed 1800-1950 rpm.	Engine power is normal.
	Engine speed below 1800 rpm.	Power is below normal.
	Engine speed above 1950 rpm.	Transmission is slipping or fuel injection pump is out of adjustment.
<b>PROBABLE CAUSE</b>		<b>CORRECTIVE ACTION</b>
a. If stall speed is normal (1800-1950 rpm), low performance is vehicle related, or vehicle may be operating under severe conditions.	(1) Investigate transmission clutches, brakes, and vehicle suspension for being too tight. Repair as required. Refer to pertinent vehicle technical manual.	
	(2) Check vehicle performance on hard road: if performance is satisfactory, limit vehicle operation under severe conditions to short periods of operation. Possible engine damage may be prevented.	
b. If stall speed is above normal (more than 1950 rpm), low performance is transmission related and engine is over-powered.	(1) Investigate for transmission slippage. Refer to vehicle technical manual.	
	(2) Replace fuel injection pump (WP 0115).	

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Before Tests, Tests, and After Tests

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Multimeter (item 75, WP 0176)  
 Pipe plugs, 1/8-27 (2) (item 83, WP 0176)  
 24-volt dc power source (tool crib)  
 Suitable metal containers (1.0 gal (3.8 L) minimum capacity) (2) (tool crib)

**Fabricated Items:**

Fuel/water separator jumper wire (item 9, WP 0177)  
 Fuel/water separator test harness (item 8, WP 0177)

**Expendable and Durable Items:**

Diesel fuel, as needed (item 12, WP 0173)  
 Wiping rags (item 26, WP 0173)

**Mandatory Replacement Parts:**

Filter element (1) (item 195, WP 0175)  
 Filter element (2) (item 196, WP 0175)  
 Lock washer (4) (item 93, WP 0175)  
 Lock washer (8) (item 92, WP 0175)  
 O-ring (item 197, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

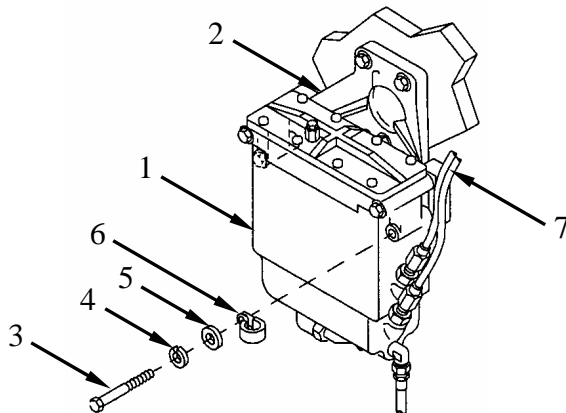
Engine removed from vehicle and placed on a flat stationary surface

**NOTE**

**To verify that the fuel/water separator is functioning properly, all tests in this work package must be performed and in the sequence listed. All tests must be performed with fuel/water separator in an upright and level position.**

**BEFORE TESTS**

1. Dismount fuel/water separator (1) from bracket (2).
  - a. Remove four screws (3), with lock washers (4) and flat washers (5) securing fuel/water separator (1) to bracket (2). Discard lock washers (4).
  - b. Remove clamp (6) from sensor probe wires (7).
  - c. Temporarily hang fuel/water separator from bracket with a bungee cord or other suitable method.



## BEFORE TESTS (Continued)

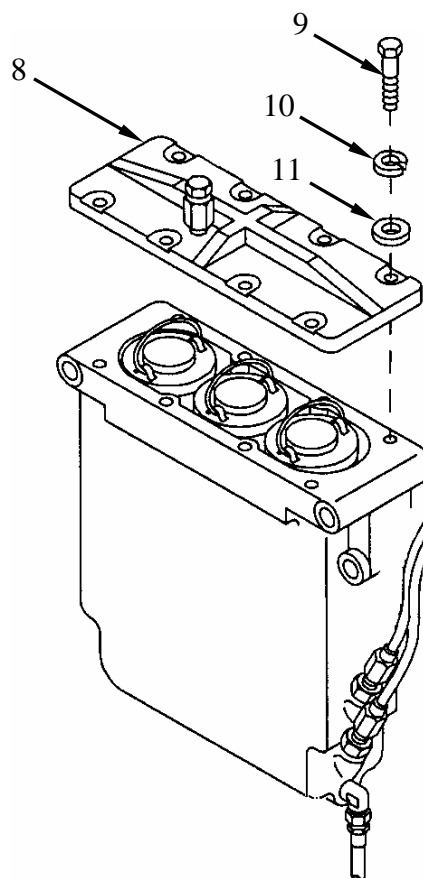


**Do not smoke or allow open flames or sparks in areas where diesel fuel is used or stored. DEATH or severe injury may result if personnel fail to observe this precaution.**

## NOTE

**Remove filters and replace at end of test according to procedures in Fuel/Water Separator Filters Repair and Element Replacement, WP 0085.**

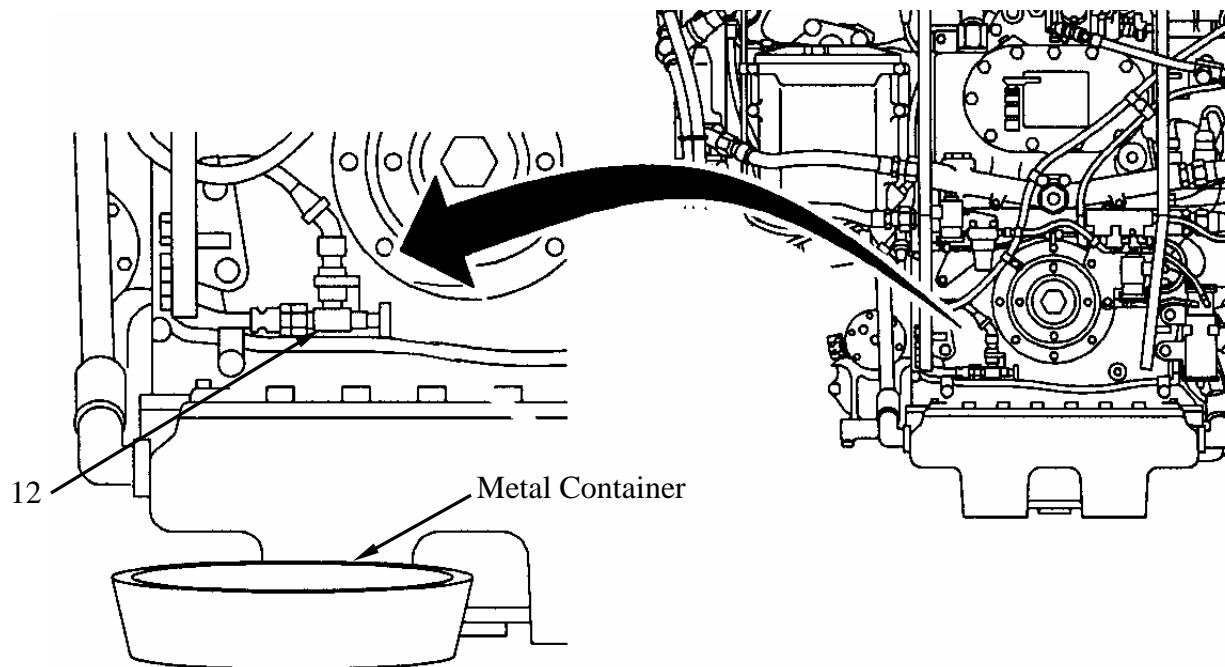
2. Remove cover (8).
  - a. Remove eight screws (9) with lock washers (10) and flat washers (11) to remove fuel/water separator cover (8). Discard lock washers (10).
3. Check fuel level in fuel/water separator (1).
  - a. Fuel should be visible with cover removed. If not, add fuel until you can visibly see it.





**TESTS**

1. Test manual drain valve (12) operation.
  - a. Place suitable metal container under manual drain valve (12) outlet, open valve and allow fuel to empty into container.
  - b. If fuel does not drain, check drain valve and lines for obstructions. Remove obstructions or repair damaged drain lines or drain valve (WP 0084). Repeat "Test Manual Drain Valve Operation" procedure.
  - c. When fuel empties, go to step 2.



TESTS (Continued)

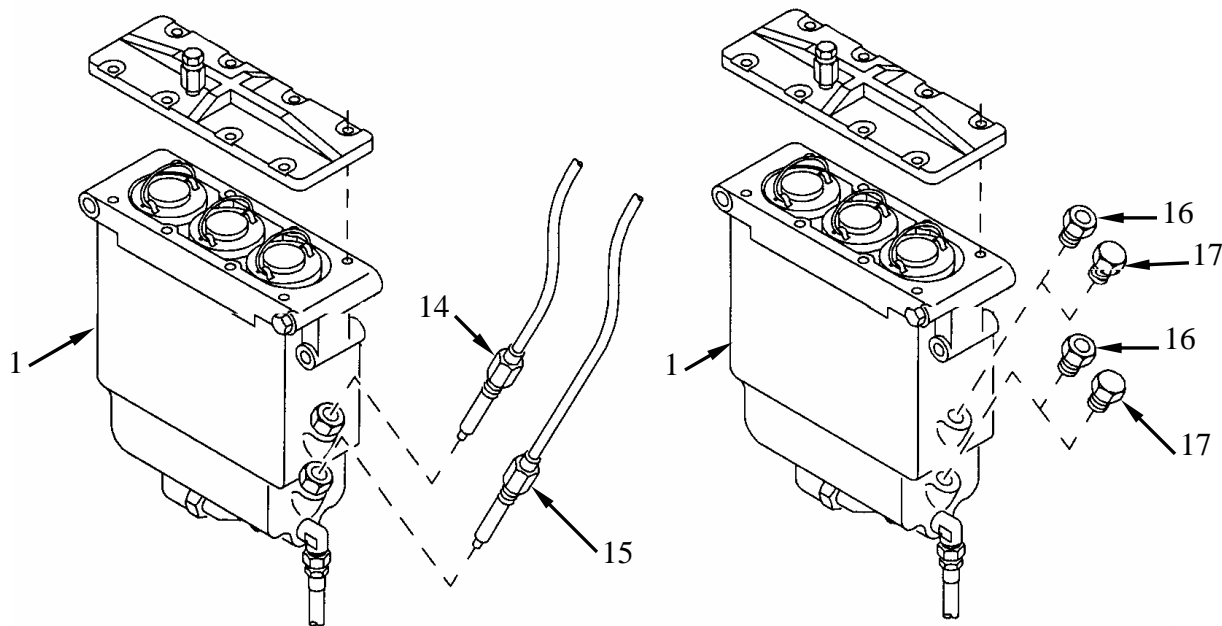
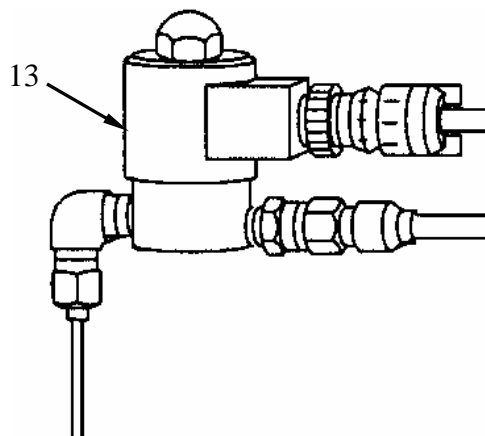
2. Test automatic drain valve (13) operation.

NOTE

It may be necessary to unseat sensor probes (14, 15) by tapping upward on edge of sensor retaining nut.

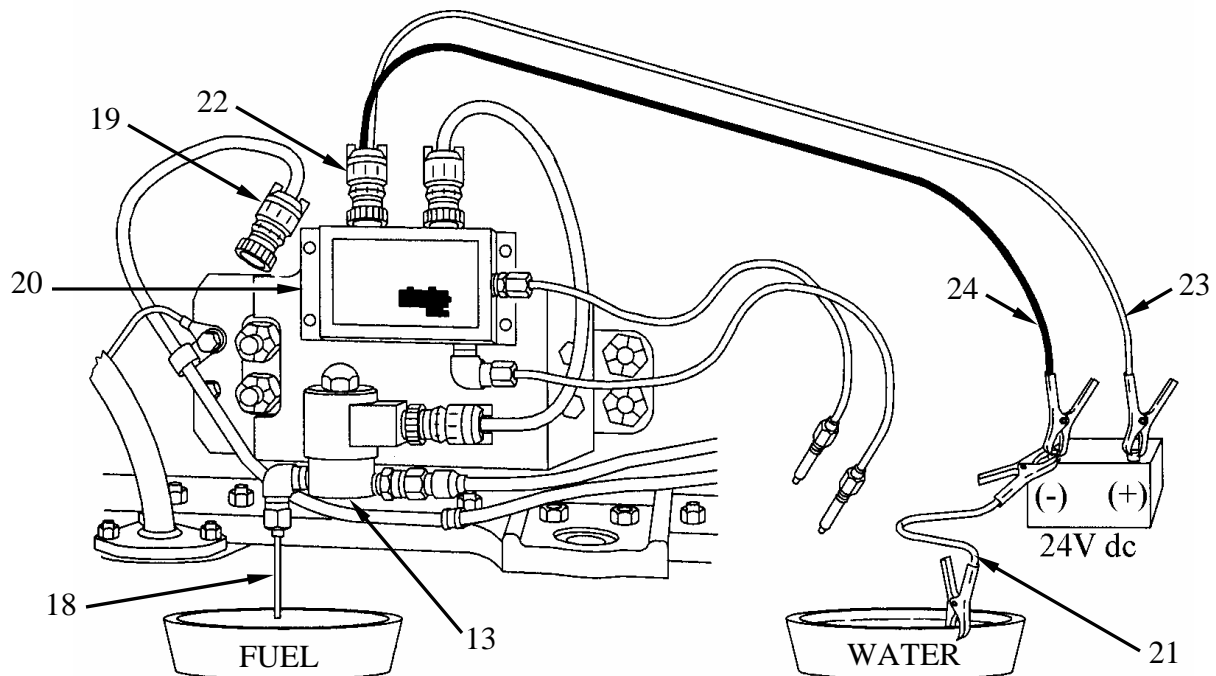
A red band identifies top sensor probe and it is also the longer of the two probes.

- a. Remove both sensor probes (14,15).
- b. Remove both sensor fittings (16).
- c. Replace sensor fittings with two 1/8-27 pipe plugs (17) (item 83, WP 0176).
- d. Refill fuel/water separator (1) with clean fuel (item 12, WP 0173) to approximately half full.



**TESTS (Continued)**

2. Test automatic drain valve (13) operation (continued):
  - e. Place metal container under drain valve tube (18).
  - f. Disconnect engine electrical harness (19) connector from control box (20).
  - g. Connect jumper wire (21) (item 9, WP 0177) from second metal container to negative (-) side of 24-volt dc power source.
  - h. Connect test harness connector (22) (item 8, WP 0177) to control box receptacle.
  - i. Connect red wire (23) to positive (+) side of 24-volt dc power source.
  - j. Connect black wire (24) to negative (-) side of 24-volt dc power source.
  - k. Fill second metal container with water.



## TESTS (Continued)

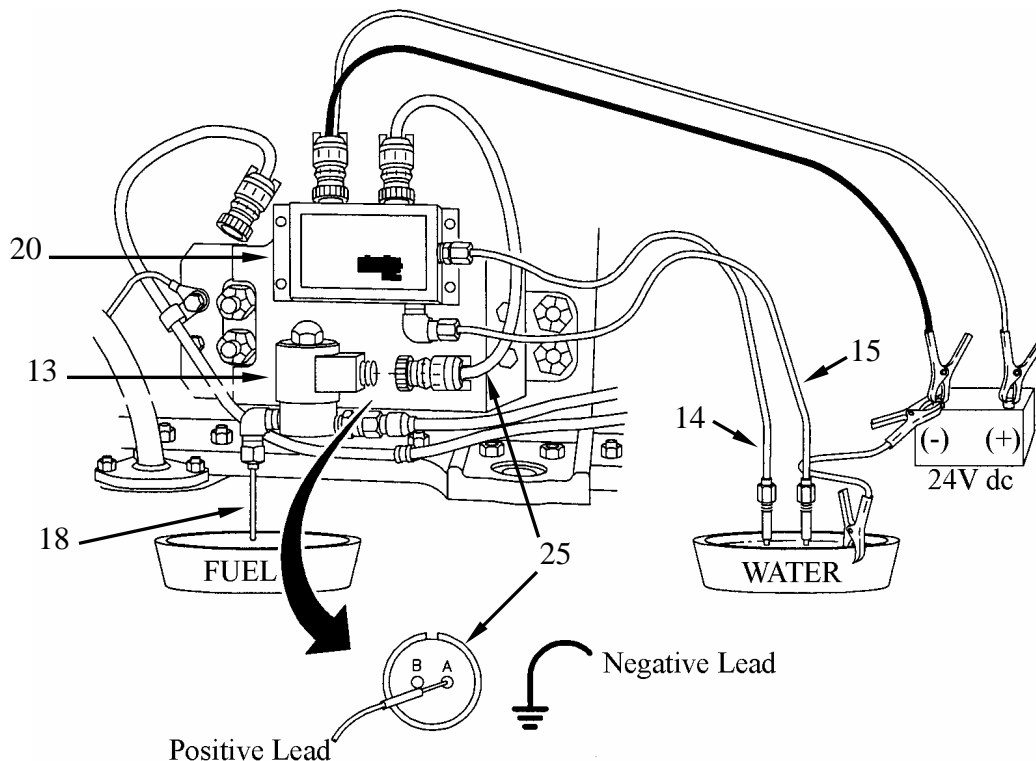
2. Test automatic drain valve (13) operation (continued):

WARNING



**Do not allow upper and lower sensor probes to come in contact with each other or with metal container. Do not touch probes. Failure to comply may result in electrical shock, inaccurate test results, or damage to equipment.**

- a. Hold tips of upper and lower sensor probes (14 and 15) in water.
- b. Listen for solenoid drain valve (13) to click and fuel to drain from tube (18).
  - (1) If click is heard and fuel drains, go to step 3.
  - (2) If fuel fails to drain and click is heard, check solenoid drain valve (13) and lines for obstructions "Fuel/Water Separator Replacement," WP 0084.
  - (3) If fuel fails to drain and click is not heard:
    - (a) Disconnect harness (25) from solenoid drain valve (13).
    - (b) Place positive lead of multimeter in socket A of harness (25) and negative lead to ground. Hold sensor probes (14 and 15) in water in suitable container. Check for voltage, and then remove sensor probes from water.
    - (c) If 24 V dc is present, replace solenoid drain valve (13) (WP 0084). If 24 V dc is not present, replace fuel/water separator control box (20) (WP 0084).



**TESTS (Continued)**

## 3. Control unit test.

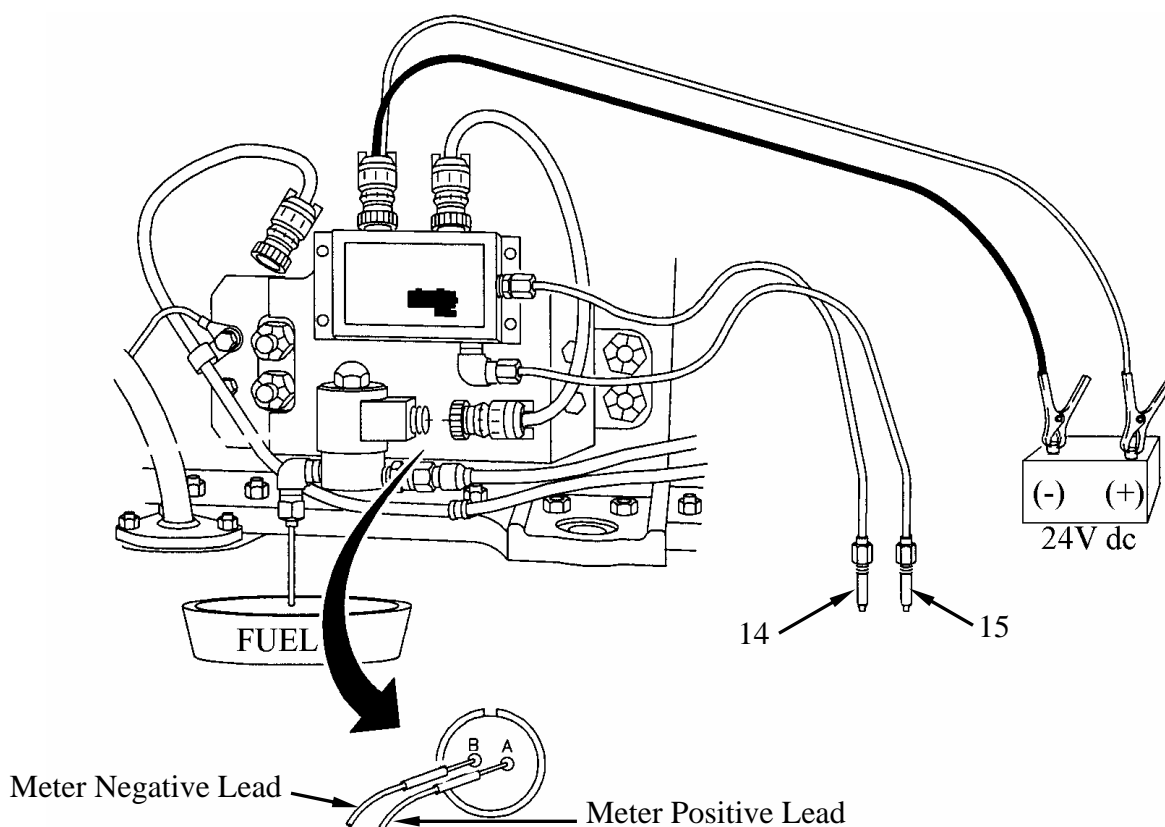
**CAUTION**

**Never touch a sensor probe to the positive terminal of the power source. Damage to equipment can occur.**

**NOTE**

**A red band identifies top sensor probe (high-level) and it is also the longer of the two probes. The lower probe is the low-level probe and is the shorter probe.**

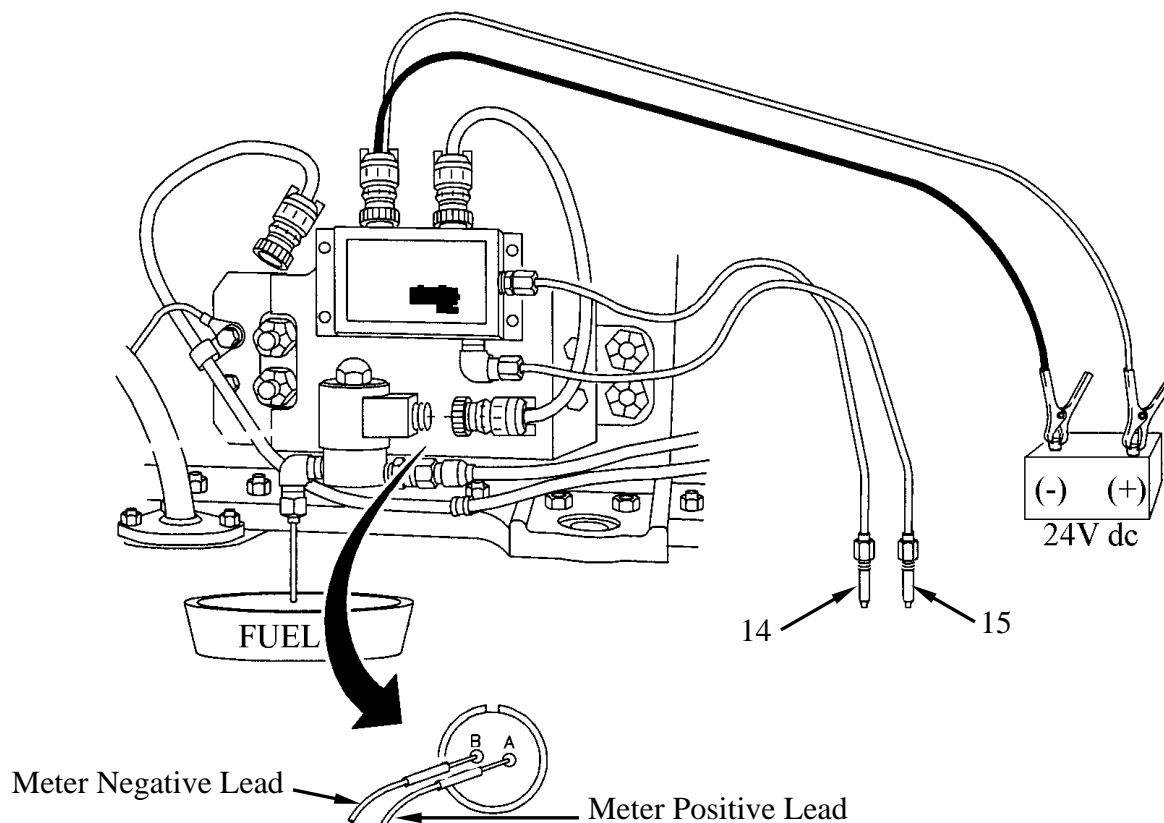
- a. With power supply connected, lightly press the tip of the low-level probe (15) to the negative (-) terminal of the 24-volt dc power supply. The voltmeter should register zero voltage.
- b. Continue holding the low level probe (15) onto the negative (-) terminal and at the same time press the tip of the high-level probe (14) onto the negative terminal. The voltmeter should now register 24 volts.
- c. Remove the high-level probe (14) only. The meter should continue to register 24 volts for 18 ( $\pm$  3) seconds and then drop to zero volts.



**TESTS (Continued)**

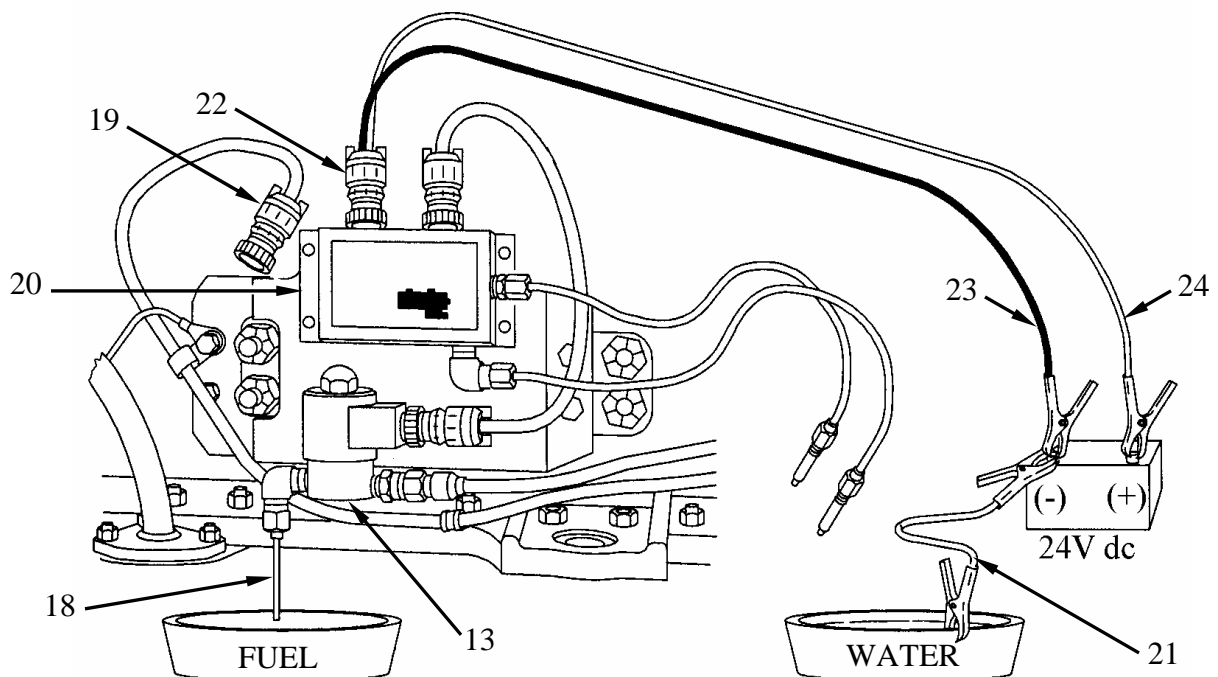
## 3. Control unit test (continued):

- d. Continue to hold the low-level probe (15) onto the negative terminal while again pressing the high-level probe (14) to the negative terminal. The voltmeter should continue to register zero volts.
- e. Turn the power supply off for 1 second or longer. Turn the power supply on and the voltmeter should again register 24 volts.
- f. Remove the high probe (14) from the negative terminal and the meter should continue to register 24 volts.
- g. Remove the low probe (15) from the negative terminal in less than 15 seconds and the meter should return to zero volts.
- h. Once again press the low probe (15) and then the high probe (14) to the negative terminal and the meter should return to 24 volts.
- i. If control unit does not respond as outlined above, it is not functioning correctly and must be replaced. Go to "Fuel/Water Separator Automatic Drain System Replacement", WP 0084.



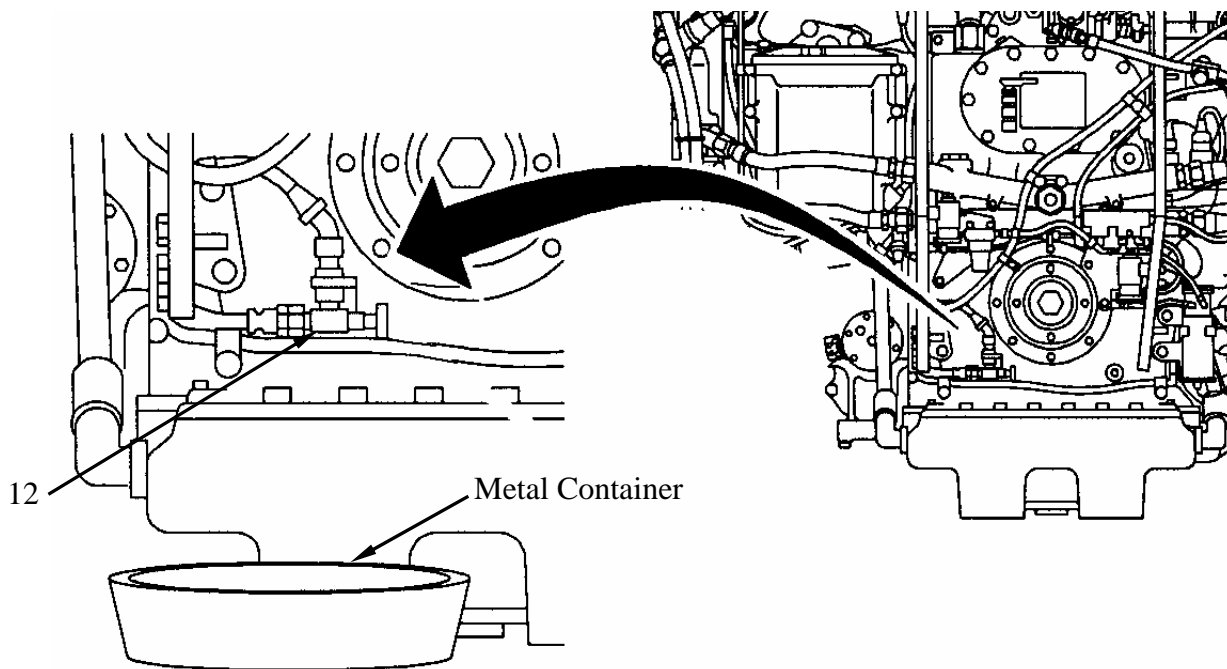
**AFTER TESTS**

1. Disconnect black wire (24) and red wire (23) from positive (+) and negative (-) terminals of 24-volt dc power source.
2. Disconnect fuel/water separator test harness connector (22) from fuel/water separator control unit (20).
3. Disconnect jumper wire (21) from negative (-) side of 24 V dc power source and from metal container.
4. Remove metal container from under automatic drain valve (13) tube (18).
5. Connect engine electrical harness (19) connector to fuel/water separator control unit (20).

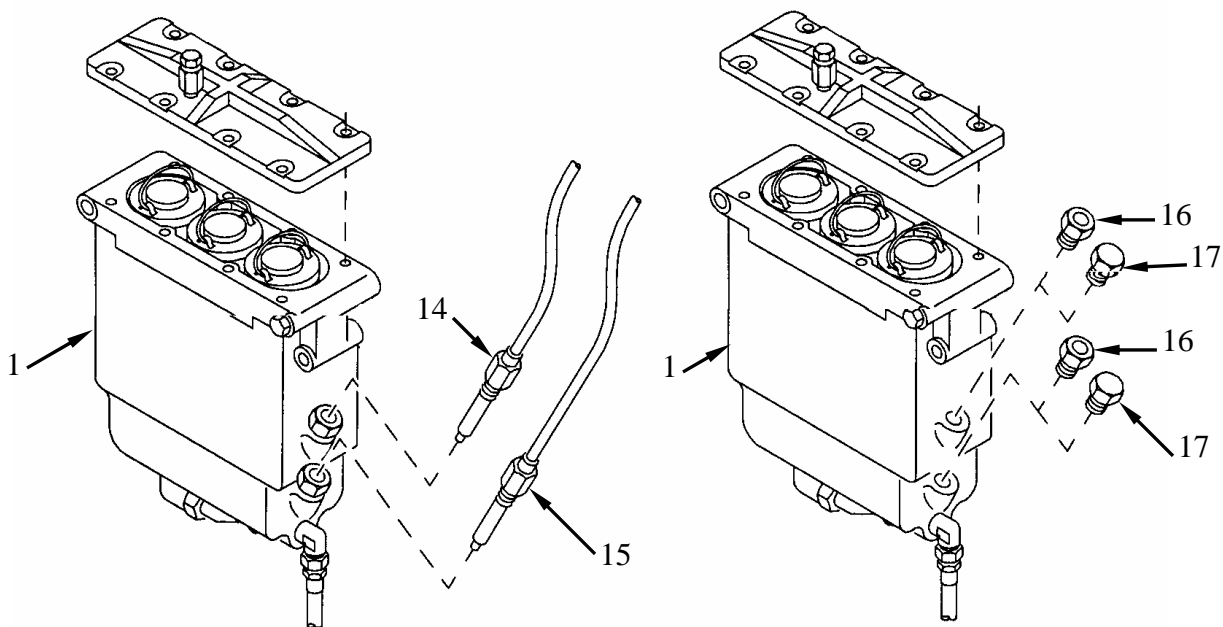


**AFTER TESTS (Continued)**

6. Install upper and lower sensor probes (14, 15).
  - a. Place metal container under manual drain valve (12) outlet, open valves and allow fuel to empty into container. When drained, close valve and remove container.



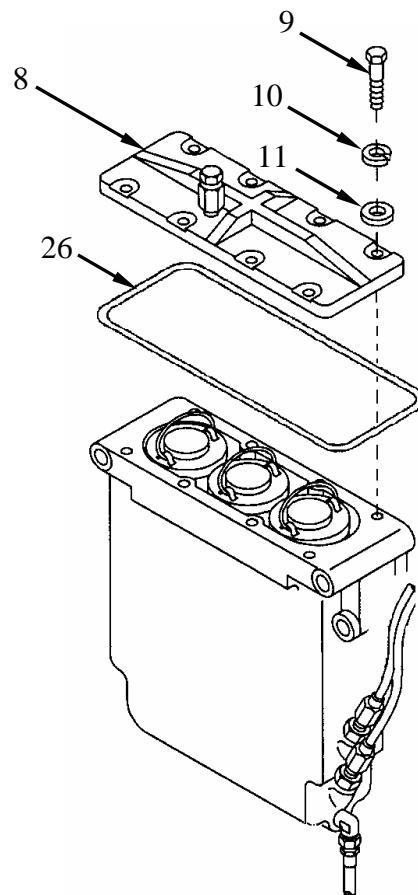
- b. Remove two pipe plugs (17) from sensor probe (14, 15) holes.
- c. Install sensor probe fittings (16).
- d. Install both probes (14, 15) in their proper locations in fuel/water separator (1).



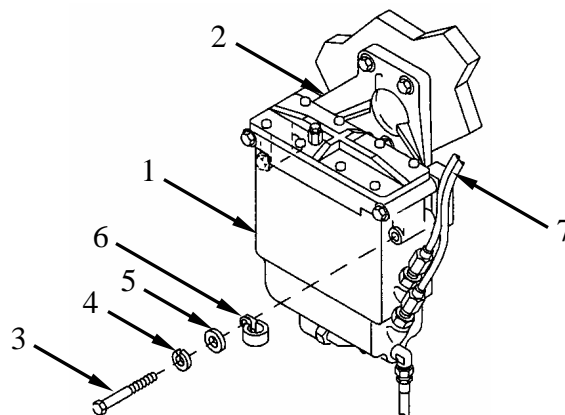


**AFTER TESTS (Continued)**

7. Replace filters (items 195 and 196, WP 0175) and bleed system according to procedures in "Fuel/Water Separator Filters Repair/Replace Elements," WP 0085.
8. Install cover (8).
  - a. Remove and discard O-ring (26).
  - b. Assure that mounting surfaces are clean and new O-ring (26) (item 197, WP 0175) is in place.
  - c. Secure cover (8) using eight screws (9) with new lock washers (10) (item 92, WP 0175) and flat washers (11).



8. Install fuel/water separator (1) to mounting bracket (2).
  - a. Place sensor wires (7) through clamp (6).
  - b. Position fuel/water separator in place against bracket (2) and move sensor wires (7) in place for mounting bolt (3).
  - c. Secure fuel/water separator (1) and sensor wires (7) using four screws (3), with new lock washers (4) (item 93, WP 0175) and flat washers (5).



**END OF WORK PACKAGE**



**THROTTLE ADJUSTMENTS**

0043 00

**THIS WORK PACKAGE COVERS:**

Before Adjustment and Adjustment

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

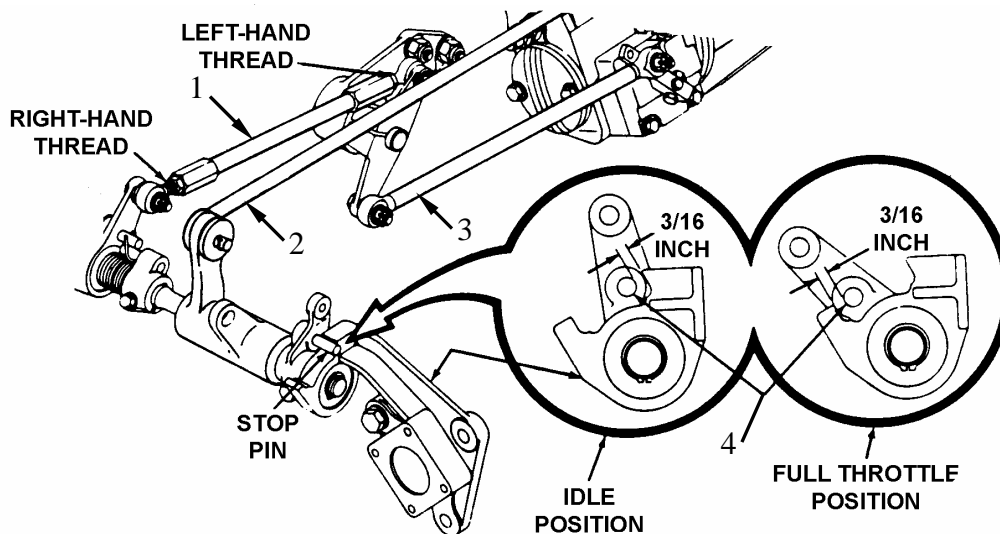
Engine removed from vehicle and placed on a flat stationary surface

**BEFORE ADJUSTMENT**

1. Check throttle control adjustable rod (1), manual fuel shutoff rod (2), and throttle operating lever rod (3) for free movement.
  - a. If linkage moves freely, proceed to Adjustment; if not, go to Throttle Control and Manual Fuel Shut-off Replace/Repair (WP 0122) for Model 2CA and 2DA engines and Throttle Control Solenoid Assembly and Associated Parts Replace/Repair (WP 0123) for 2DR engines.

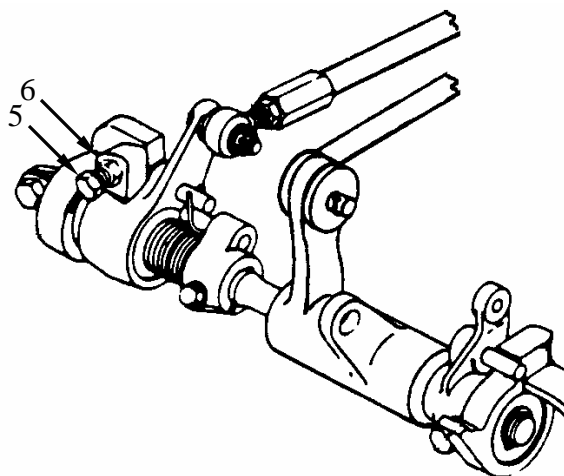
**ADJUSTMENT**

1. Stop pin (4) adjustment (all engine models).
  - a. With engine stopped, check clearance between stop pin (4) and stops at both ends of travel. Clearance must be a minimum of 3/16 inch (0.1875 mm) at each end of travel.
  - b. If clearance is not 3/16 inch (0.1875 mm) at both ends of travel, loosen lock nuts on throttle control adjustable rod (1), and adjust rod as necessary to obtain required clearance.
  - c. Tighten lock nuts after adjustment.

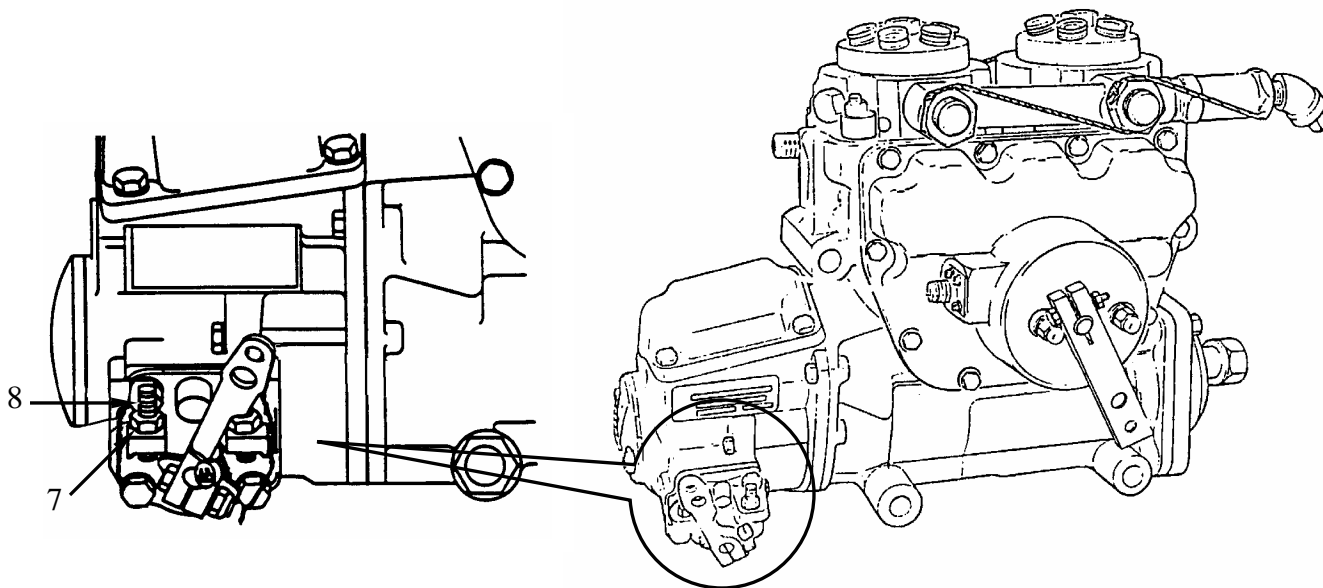


## ADJUSTMENT (Continued)

2. Engine low speed idle adjustment (made with engine running and warmed up).
  - a. Adjust engine idle to 675-725 rpm by turning idle adjusting screw (5).
  - b. Loosen lock nut (6) on idle adjusting screw (5) and turn screw clockwise to increase idle speed, and counterclockwise to decrease speed. Tighten lock nut (6).

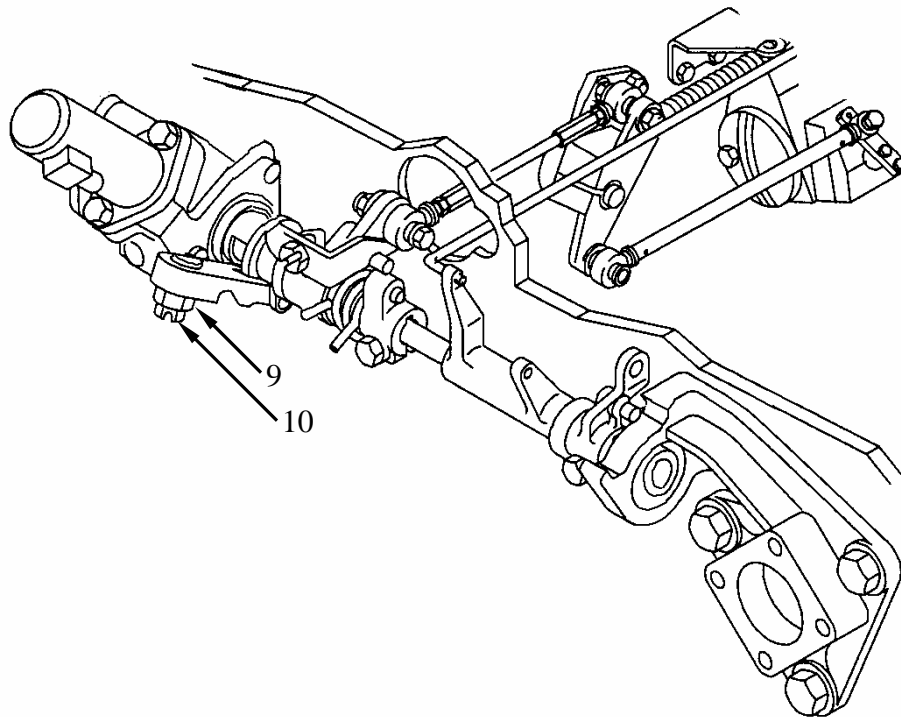


3. Engine high speed idle adjustment (2600-2660 rpm - no load, checked with engine running and warmed up, see WP 0044, Engine Run-In).
  - a. If adjustment is required, stop engine and remove front cooling fan and vane (WP 0054).
  - b. Loosen lock nut (7) on idle adjusting screw (8) and turn screw clockwise to decrease idle speed, and counterclockwise to increase speed (1/4 turn changes engine speed by approximately 25 rpm). Tighten lock nut (7).
  - c. Replace fan and vane, start engine and verify adjustment. Repeat as necessary until proper speed is attained.



**THROTTLE ADJUSTMENTS****0043 00****ADJUSTMENT (Continued)**

4. Adjust auxiliary drive speed (2DR engine only) checked with engine running, warmed up, and no load, see (WP 0044, Engine Run-In).
  - a. With engine running at high idle, activate solenoid.
  - b. Adjust engine auxiliary drive speed to 1750-1800 rpm.
    - (1) Loosen lock nut (9) on idle adjusting screw (10) and turn screw clockwise to decrease idle speed, and counterclockwise to increase speed. Tighten lock nut (9).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Before Run-in, Run-in, and After Run-in

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Spacer sleeve (2) (item 109, WP 0176)  
Torque wrench, 500-2500 inch-pounds  
(item 126, WP 0176)

**Mandatory Replacement Parts:**

Lock washers (8) (item 94, WP 0175)  
Cotter pin (2) (item 53, WP 0175)

**Expendable and Durable Items:**

Lubricating oil, engine (item 21, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine coupled to dynamometer or water brake,  
or installed in vehicle.

This work package describes run-in schedules for overhauled or rebuilt engines prior to being placed in service. Engine run-in is performed after rebuild to assist in breaking in new parts, to detect faulty assembly, to check for oil leaks, and to determine whether an engine will operate satisfactorily when installed in a vehicle.

**BEFORE RUN-IN****NOTE**

**Engine leak test should be done before run-in. Refer to WP 0038.**

1. Couple engine to suitable load.
  - a. The load may be a water brake or electric dynamometer.
2. Pre-lubricate engine by forcing engine oil under pressure into lubrication system.

**NOTE**

**Pre-lubrication will ensure adequate lubrication to engine parts until oil is circulated under pressure from engine oil pump. When pre-lubrication equipment is not available, fill crankcase with lubricating engine oil (item 21, WP 0173). Using engine starter, crank engine until pressure gauge begins to move while holding fuel shutoff in the off position.**

3. Connect external source of fuel supply to engine.
4. Connect same type air cleaners that are used with engine when installed in vehicle.

**CAUTION**

**Air intake must be located so that only cool, fresh air will be inducted into engine. A means must be provided for conducting exhaust gases and cooling air from engine to avoid re-circulation through engine cooling fans. Failure to do so may result in engine damage.**

**BEFORE RUN-IN (Continued)**

5. Provide a suitable external source of 24-volt, direct current, electrical power for starting the engine.

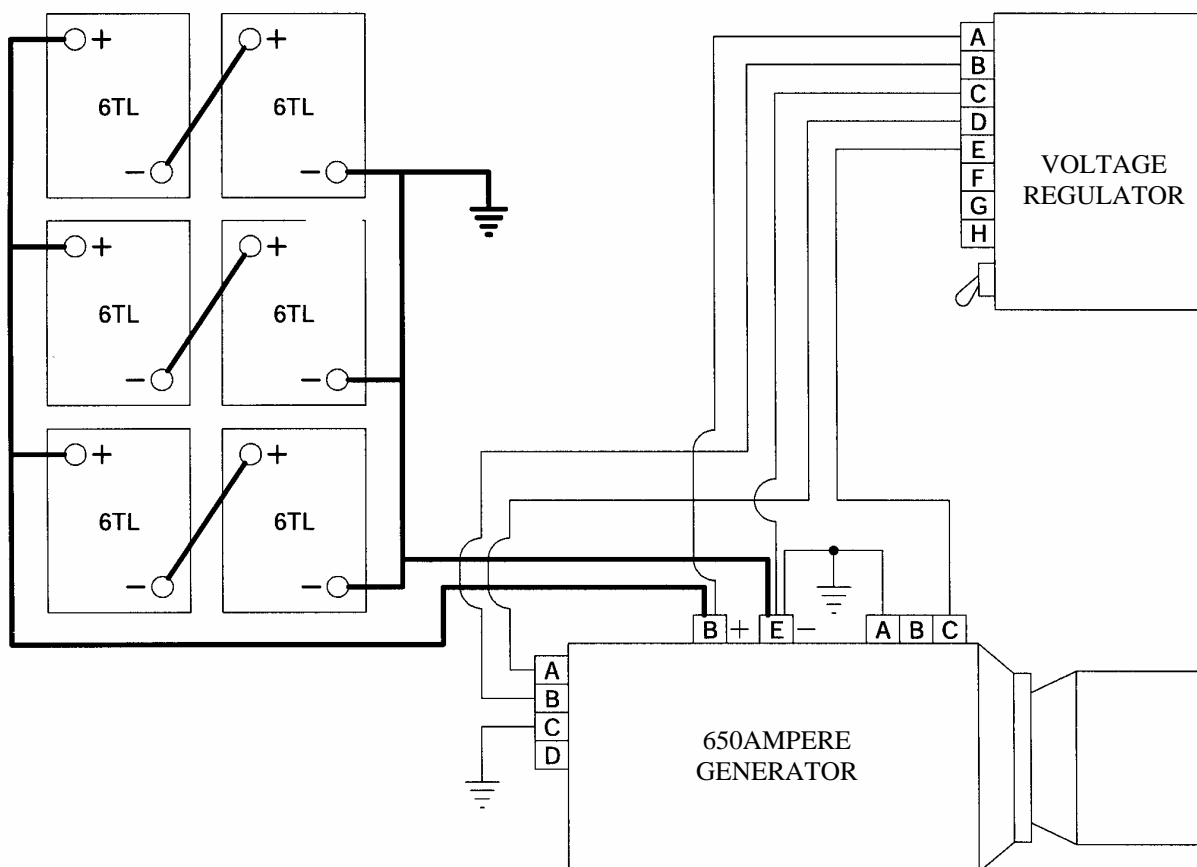
**NOTE**

The engine is equipped with a low-voltage protective module so starter will not operate below 12 volts.

**CAUTION**

On engines (all 2CAs and some 2DAs) with a 650-amp generator, it will be necessary to load the generator to 50 amperes or damage to the generators drive clutch will occur.

6. Connect generator to voltage regulator and batteries as shown.



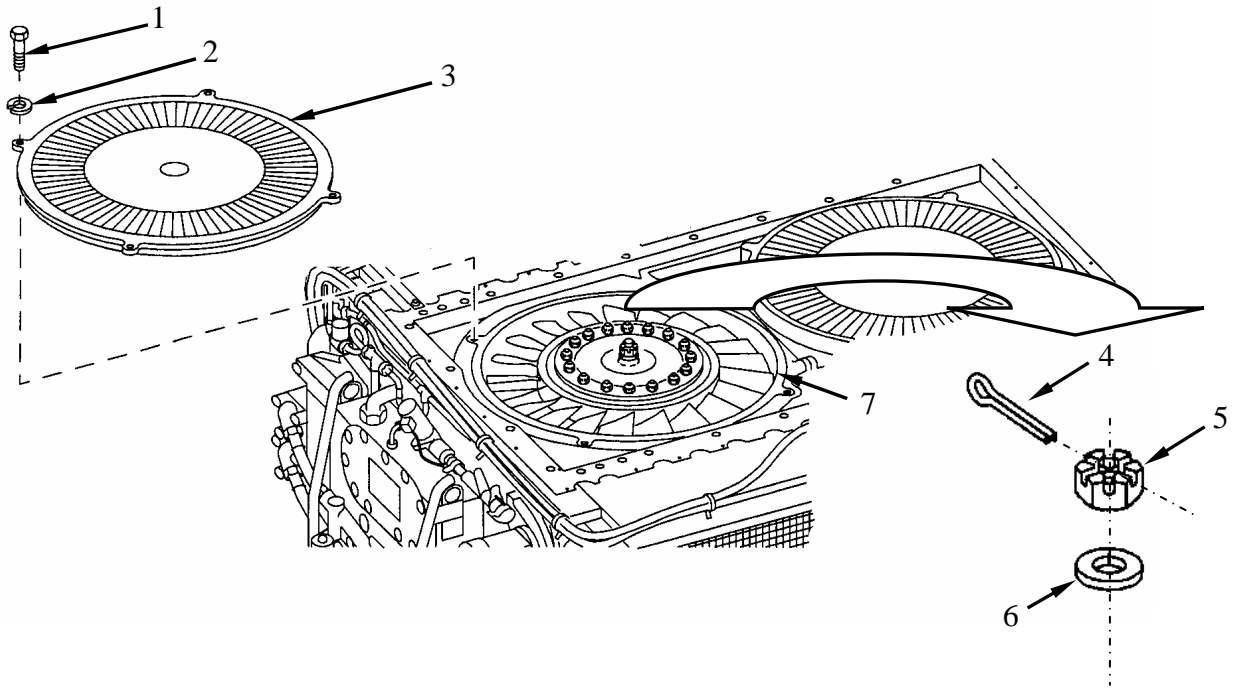


BEFORE RUN-IN (Continued)

NOTE

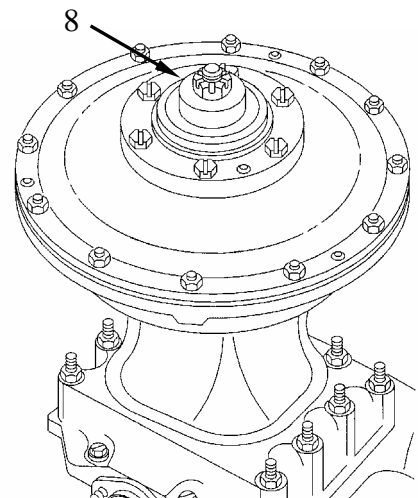
Removal of front and rear cooling fans are identical. Three different length screws secure the cooling fan vanes to the top deck. Mark each screw during removal and note the location to aid in proper placement during installation.

1. Remove eight screws (1) with lock washers (2) and two vanes (3) from engine. Discard lock washers.



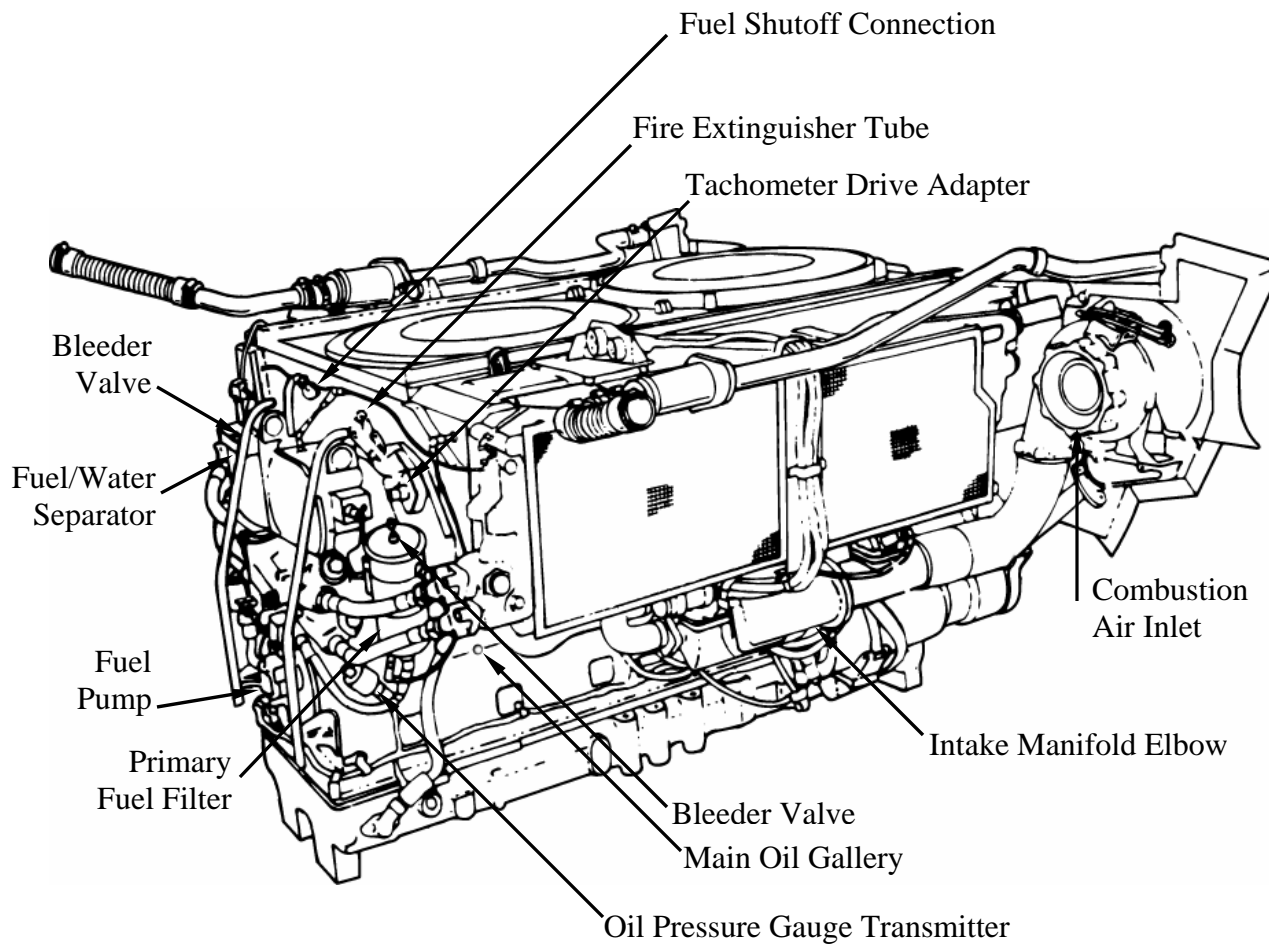
2. Remove cotter pin (4).
3. Remove slotted nut (5).
4. Remove flat washer (6).
5. Remove fan assembly (7).
6. Repeat steps 2 through 5 to remove opposite fan.

7. Install spacer sleeve (8) (item 109, WP 0176) in place of each fan.
  - a. Secure spacer sleeves with original nut (5) and cotter pin (4).



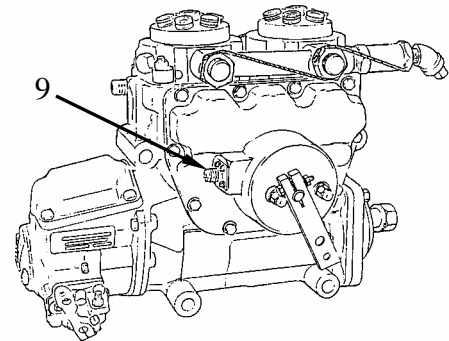
**BEFORE RUN-IN (Continued)**

Refer to the illustration below for engine connection points.



**BEFORE RUN-IN (Continued)**

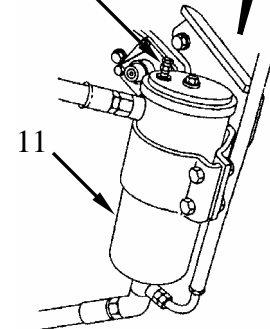
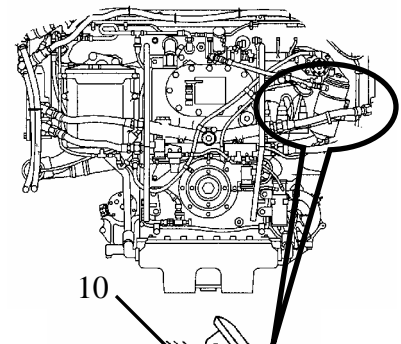
8. Check for operation of electrical fuel shutoff (9).
  - a. Listen for an audible click while activating the shutoff.



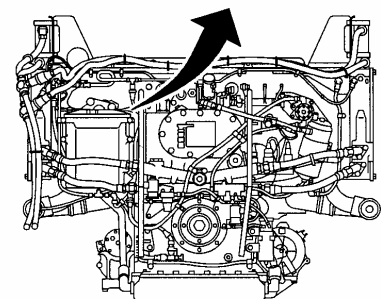
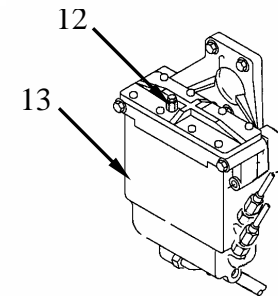
**WARNING**



9. Purge fuel filters.
  - a. Open bleeder valve (10) on primary fuel filter (11).



- b. Open bleeder valve (12) on fuel/water separator filter (13).
  - c. Turn on source supply fuel pump and bleed air from filters.
  - d. Close bleeder valves when fuel flows from both bleeder valves.



**BEFORE RUN-IN (Continued)****WARNING**

**Do not attempt to start the engine unless step number 8 has been successfully accomplished. Verify that the fuel shutoff is connected and working. Injury to personnel could occur.**

10. Crank engine several revolutions with the fuel shutoff in the OFF position to make certain the engine is not hydrostatically locked and is otherwise free from obstruction.
11. Wash all fuel and oil from the engine.

**RUN-IN****CAUTION**

**Do not operate the starter motor continuously for more than 30 seconds. Damage to starter may occur. Allow a 2-minute cool-off period between each 30-second cranking event.**

1. Crank engine with the fuel shutoff in the OFF position until oil pressure gauge moves off zero psi.
2. Allow engine to start with throttle lever in the idle position.

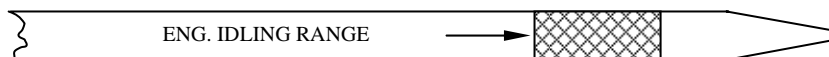
**CAUTION**

**Engine oil pressure must reach a minimum of 15 psi within 20 seconds. Damage to engine will occur. Shut engine down if pressure is not reached.**

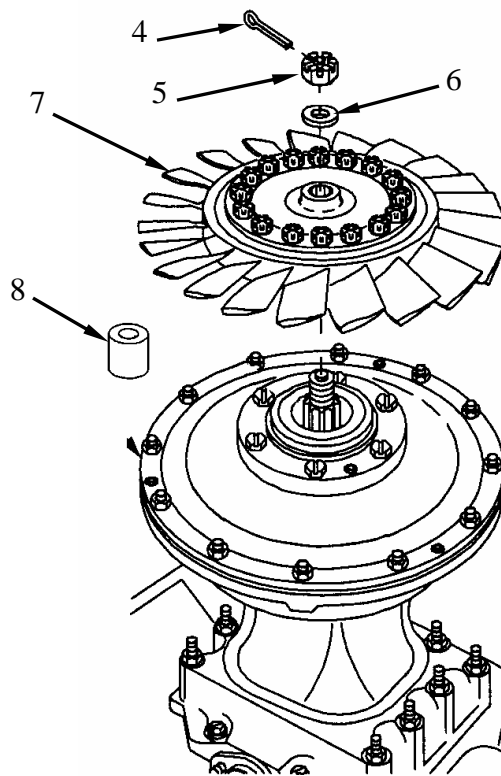
**Do not run engine longer than 10 minutes at 675-725 rpm without cooling fans installed. Damage to engine from overheating will occur.**

**RUN-IN (Continued)**

3. Run the engine at 675-725 rpm.
  - a. Check for fuel and oil leaks. Should leakage be detected, immediately shut off engine and make repair.
  - b. After 5 minutes of operation, check oil level and add sufficient amount of proper grade oil to bring oil level to FULL mark on oil level gauge rod.
- There are four key requirements that must be met to assure accurate reading of the oil level gauge rod for during operation checks.
  - \* The oil temperature must be less than 140 °F (60 °C).
  - \* The engine must have been idling for at least 5 minutes.
  - \* The engine must be level and flat.
  - \* The correct side of the gauge rod must be read.

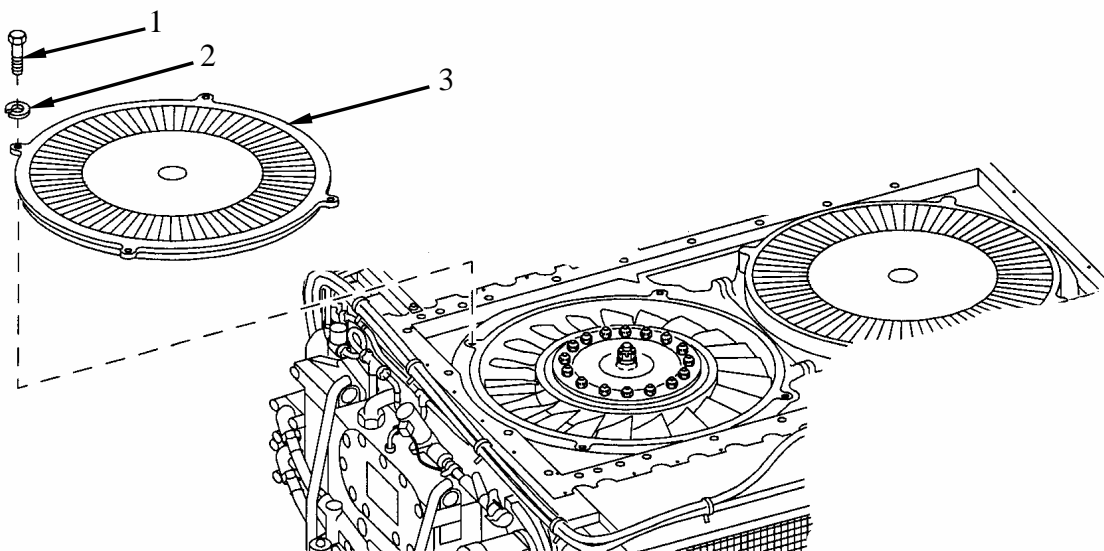
**CORRECT SIDE OF GAUGE ROD FOR DURING CHECK**

4. Stop engine.
5. Install engine cooling fans.
  - a. Remove cotter pin (4).
  - b. Remove slotted nut (5).
  - c. Remove flat washer (6).
  - d. Remove spacer sleeve (8).
  - e. Place fan (7) over shaft in place of spacer.
  - f. Secure with flat washer (6) and slotted nut (5).
  - g. Torque-tighten-nut (4) 600-625 inch-pounds (68-71 N•m).
  - h. Install new cotter pin (4) (item 53, WP 0175).

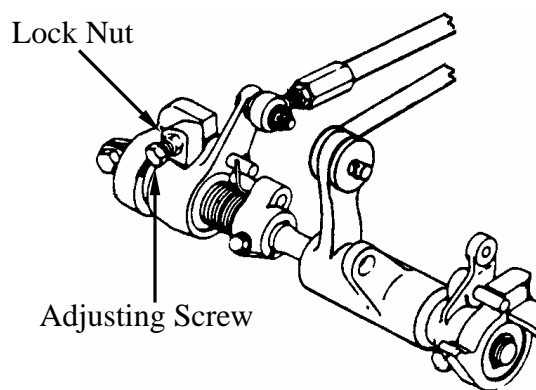


**RUN-IN (Continued)**

6. Install cooling fan vanes (3).
  - a. Place vanes (3) into position.
  - b. Secure using eight screws (1) with new lock washers (2) (item 94, WP 0175).



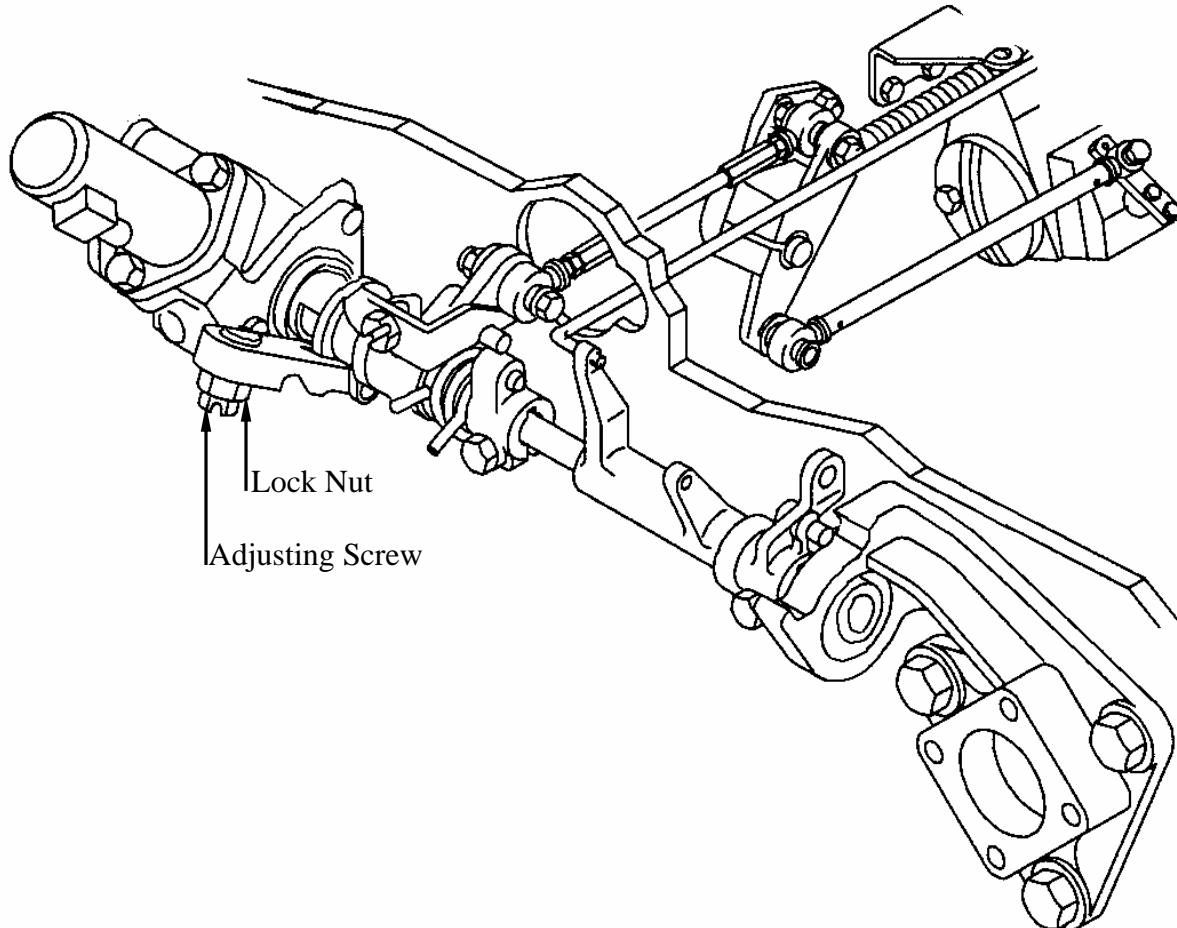
7. Start engine and check that exhaust gas temperatures are within 100 °F (38 °C) of each other.
8. Check all items vital to safe engine operation, such as fuel lines, oil lines, oil pressure, throttle control, mounting bolts, couplings, and thermocouple harness.
9. Adjust engine idle to 675-725 rpm by turning idle adjusting screw.
  - a. Loosen lock nut on idle adjusting screw and turn screw clockwise to increase idle speed, and counterclockwise to decrease speed. Tighten lock nut.



10. Allow engine to run for 15-20 minutes at 675-725 rpm.
  - a. Check for unusual noises in the engine and generator that might indicate malfunction or lack of lubrication.

**RUN-IN (Continued)**

11. On Engine Model 2DR only, check auxiliary drive governor speed.
  - a. Increase engine speed to above 2000 rpm and activate auxiliary drive speed control solenoid. The solenoid should control the engine speed to 1775-1825 rpm.
  - b. If adjustment is necessary, loosen lock nut and turn the adjustment screw clockwise to decrease speed and counterclockwise to increase speed. Tighten lock nut after adjustment is satisfactory.



**RUN-IN (Continued)**

12. Perform run-in test in accordance with the following test schedule.

- a. Set manifold pressure manometers and entrance air inclinometer to local uncorrected wet barometer reading, as applicable.
- b. Check cylinders for firing by observing exhaust gas temperature.
- c. Enter time and rpm at start of each period.
- d. Complete readings as soon as engine temperatures have stabilized.
- e. Plot oil consumption every ten minutes at 2400 rpm, full load, during run number 8.
- f. The following limits must not be exceeded:
  - Inlet air temperature of 120 °F (49 °C).
  - Exhaust gas temperature (measured at each cylinder and with turbocharger inlet air flow restriction less than 1.0 inch of mercury) of 1250 °F (677 °C).
  - Oil pressure limits. Measure during test with oil temperature of 140 to 250 °F (60 to 121 °C) at and/or adjacent to the pressure sending unit.

High oil pressure should not be more than 70 psi (482.6 kPa) nor less than 40 psi (275.8 kPa). Check high oil pressure when the engine is operating at 2400 rpm.

Low oil pressure should not be less than 15 psi (103.42 kPa). Check when engine is idling.

**TEST SCHEDULE**

Run Number	Time (Minutes)	Speed (rpm)	Net Observed Torque	
			foot-pound	N·m
1	10	700	No Load	No Load
2	15	1000	85	115
3	15	1400	440	597
4	20	1800	837	1135
5	20	2200	1024	1388
6	20	2400	1092	1481
7	30	2400	1202	1630
8	30	2400	*FR-FL	*FR-FL
9		675-725	Check low idle rpm. Adjust for smooth low idle if necessary.	
10		675-725	Inspect for oil and fuel leaks.	

\* Full Rack-Full Load



**RUN-IN (Continued)**

**TEST SCHEDULE (Continued)**

Run Number	Time (Minutes)	Speed (rpm)	Net Observed Torque	
			foot-pound	N•m
11		2600-2660	Governor high idle check at no load and dynamometer water off conditions. Adjust as necessary. If adjustment is necessary, re-check engine power (torque) as in run number 8.	
12	2DR Engine Only	1775-1825	Check and adjust as necessary auxiliary drive governor speed at no load and dynamometer water off conditions.	
13	5	2400	*FR-FL	*FR-FL
14	5	2200	*FR-FL	*FR-FL
15	5	2000	*FR-FL	*FR-FL
16	5	1800	*FR-FL	*FR-FL

\* Full Rack-Full Load

13. Acceleration check.

- a. Accelerate to full throttle, no load (2600-2660 rpm), with a moderate steady throttle movement.
- b. Return to low idle (675-725 rpm) with the same type throttle movement.

**NOTE**

**It is permissible for engine rpm to go below 675 rpm briefly at return to idle providing the governor responds and returns the engine rpm to the low idle setting.**

14. Check flame heater system for operation.

- a. Activate while idling and feel for warm intake elbow.
- b. Visually look for fuel leaks.

15. Check smoke generating system operation.

- a. Run engine at 2000 rpm.
- b. Activate smoke generating system.
- c. Verify that engine produces white smoke.

**AFTER RUN-IN**

**NOTE**

**If the engine will be used within 30 days, cap or plug all openings. If the engine will be stored longer than 30 days, preserve as directed in WP 0032.**

**If a dynamometer is not available, the engine may be installed in a vehicle and the vehicle driven at equally increasing speed increments from 0 to maximum speed in 15-minute intervals over the first 3 hours of operation. The engine may then be considered run-in.**

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Test

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)
- Spacer sleeve (item 109, WP 0176)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

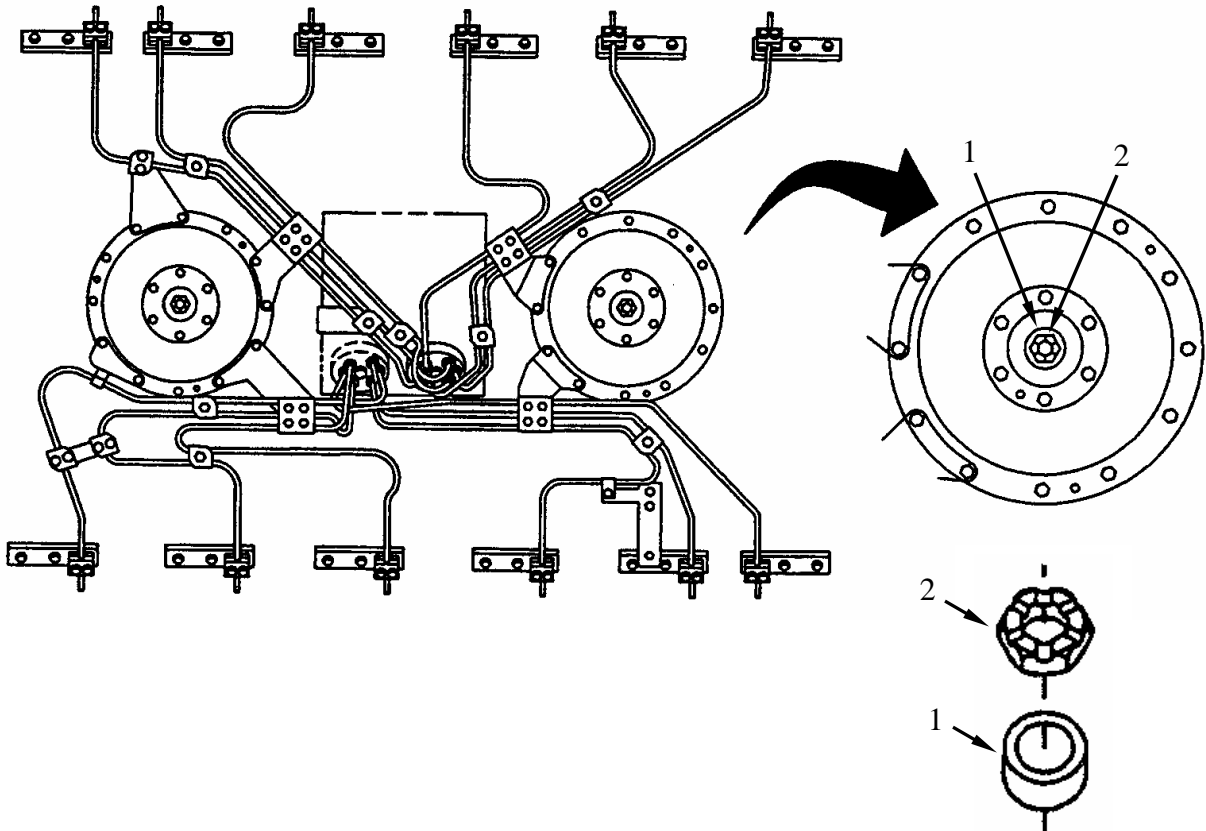
- Engine level on flat surface
- Cooling fans removed (WP 0054)

**TEST**

**NOTE**

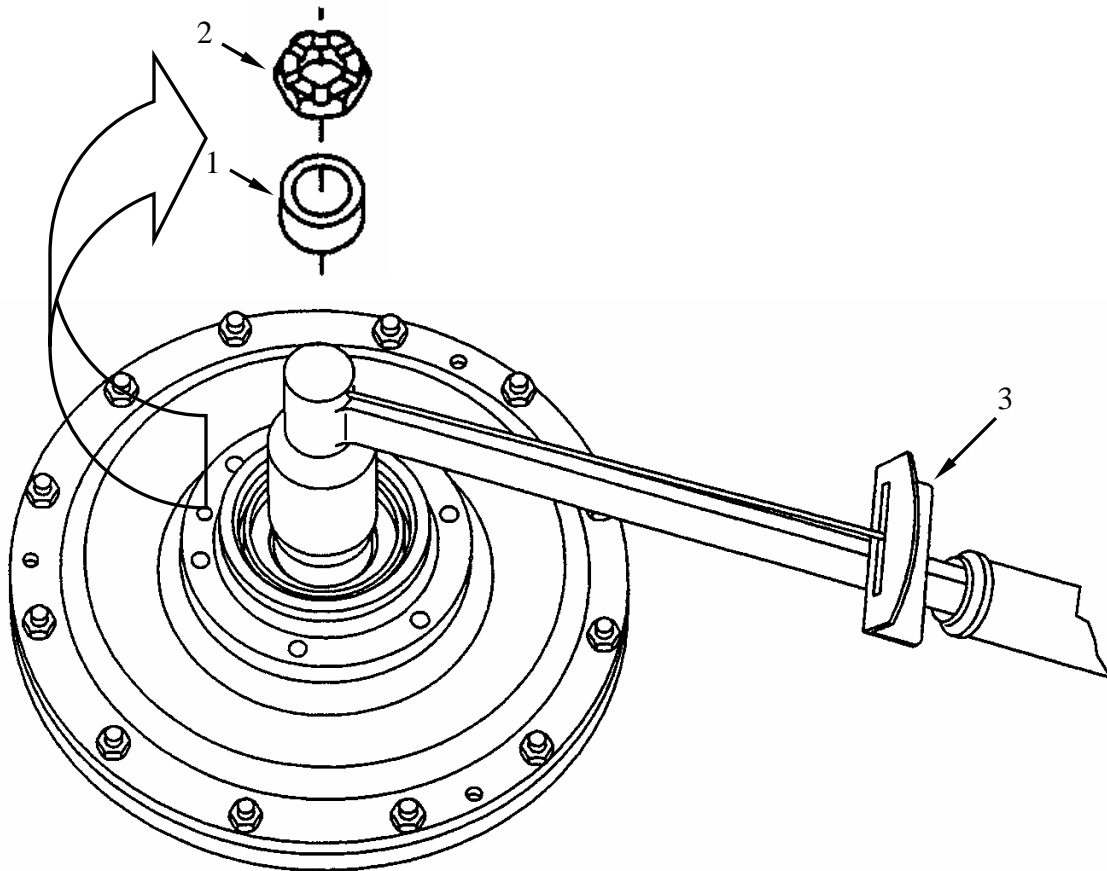
**Slip of the cooling fan clutch should be checked periodically to assure that the clutch is functioning correctly. Both fan clutches have the same slip value and are tested the same way. Only one is detailed.**

1. Install spacer sleeve (1) in place of fan and secure with fan nut (2).



**COOLING FAN CLUTCH SLIP TEST****0045 00****TEST (Continued)**

2. Check the slip-torque of fan drive friction clutch.
  - a. Rotate clutch drive by using torque wrench (3) on fan nut (2).
  - b. If slip-torque value is not between 25 and 42 foot-pounds (34-57 N•m), the fan drive friction clutch must be repaired.
  - c. Go to WP 0129 for repair of the fan clutch if test failed. If test passed, go to step 3.
3. Remove fan nut (2) and spacer sleeve (1).

**END OF WORK PACKAGE**

**FUEL BACKFLOW VALVE TEST**

0046 00

**THIS WORK PACKAGE COVERS:**

Test

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Expendable and Durable Items:**

Air supply

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

Container for fuel, minimum one gallon capacity

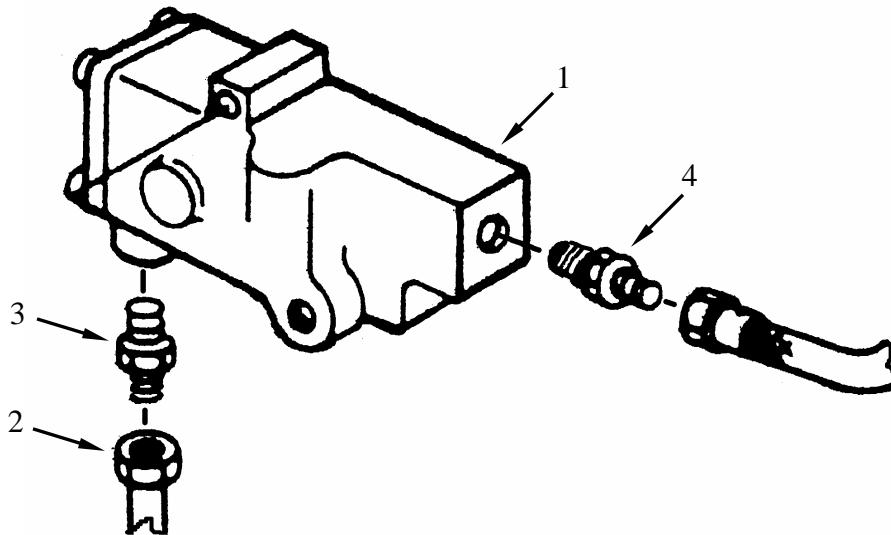
The fuel backflow valve is a dual purpose valve.

- It incorporates a check valve that prevents pressurized fuel generated by the purge pump (wobble pump) from back flowing into the primary fuel filter.
- It incorporates a by-pass valve that limits the fuel pressure to the manifold heaters.

The most notable symptom produced by a non-functioning backflow valve is a non-functioning manifold heater. To determine if your backflow valve is functioning properly, perform the following test.

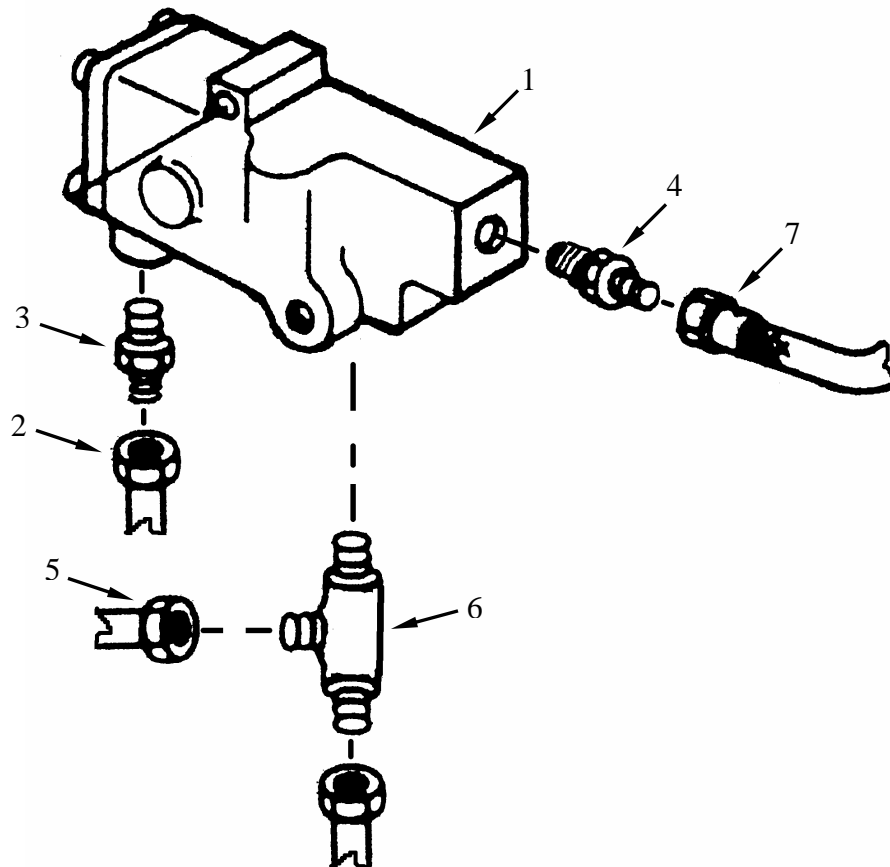
**TEST**

1. Check free flow of valve (1).
  - a. Disconnect hose (2) [fuel out of valve] from outlet fitting (3).
  - b. Provide a suitable container to catch fuel.
  - c. Provide 0.5 psi at valve inlet fitting (4).
  - d. Fuel must flow freely at 0.5 psi from outlet fitting (3).



**Test (Continued)**

2. Check by-pass function of valve (1).
  - a. Remove hose (5) and cap off side leg of tee (6).
  - b. Remove hose (7) and cap off inlet fitting (4).
  - c. Provide fuel into valve at bottom leg of tee (6) and gradually increase pressure.
    - (1) Fuel should not flow from outlet fitting (3) until pressure reaches 85-95 psi.
    - (2) Fuel should flow freely from outlet fitting (3) between 85-95 psi.
3. Check backflow function of valve (1).
  - a. Remove cap from inlet fitting (4) and install it on outlet fitting (3).
  - b. Provide fuel into valve at bottom leg of tee (6) and gradually increase pressure to 100 psi.
  - c. There should be no fuel flow out of valve at inlet fitting (4).
4. If valve fails any one of the three checks, return it to depot for repair.

**END OF WORK PACKAGE**

**TM 9-2815-220-24**

**CHAPTER 6**

**ORGANIZATIONAL MAINTENANCE**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**





**THIS WORK PACKAGE COVERS:**

Removal, Installation, and Purge

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Container to collect fuel (1.0 gal. (3.8 L) minimum capacity)

**Mandatory Replacement Parts:**

- Gasket (item 315, WP 0175)
- Lock washer (2) (item 89, WP 0175)
- Self-locking nut (4) (item 31, WP 0175)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Power pack removed from vehicle and placed on a flat stationary surface

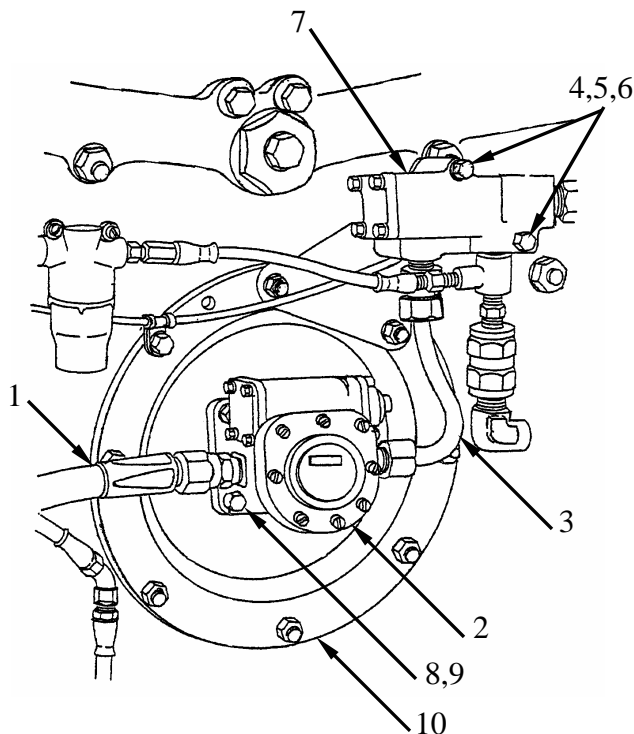
**REMOVAL**

1. Disconnect hose (1) from fuel pump (2) outlet fitting.
2. Collect fuel in a suitable container and discard.

**NOTE**

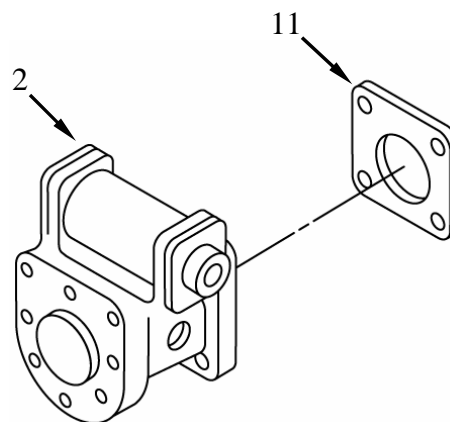
**The inlet tube is a rigid steel tube; removing it requires both ends to be free.**

3. Remove inlet tube (3).
  - a. Disconnect both ends of inlet tube (3).
  - b. Remove two machine screws (4) flat washers (5) and lock washers (6). Discard lock washers.
  - c. Displace back-flow valve (7) as necessary to remove inlet tube (3).
4. Remove fuel pump (2).
  - a. Remove four self-locking nuts (8) and flat washers (9). Discard self-locking nuts.
  - b. Remove fuel pump (2) from adapter (10).
  - c. Remove and discard mounting gasket (not illustrated).



**INSTALLATION**

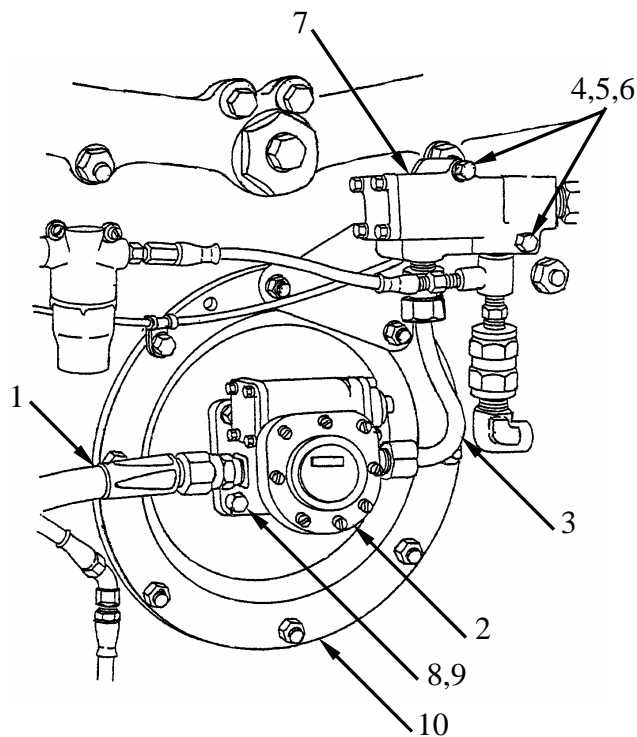
1. Install gasket (11).
  - a. Assuring that gasket surface is clean, place new gasket (11) (item 315, WP 0175) in place over mounting studs.
  
2. Position fuel pump (2) in place over mounting studs on adapter (10).
  - a. Assure that pump drive shaft splines are aligned with drive coupling.
  - b. Secure with four new self-locking nuts (8) (item 31, WP 0175) and flat washers (9).



**NOTE**

**The inlet tube is a rigid steel tube, positioning it requires both ends to be free.**

3. Install inlet tube (3).
  - a. Displace back-flow valve (7) as necessary to position inlet tube (3).
  - b. Connect both ends of inlet tube (3).
  
4. Secure back-flow valve (7).
  - a. Install two machine screws (4), flat washers (5), and two new lock washers (6) (item 2, WP 0175).
  
5. Connect hose (1) to fuel pump (2) outlet fitting.



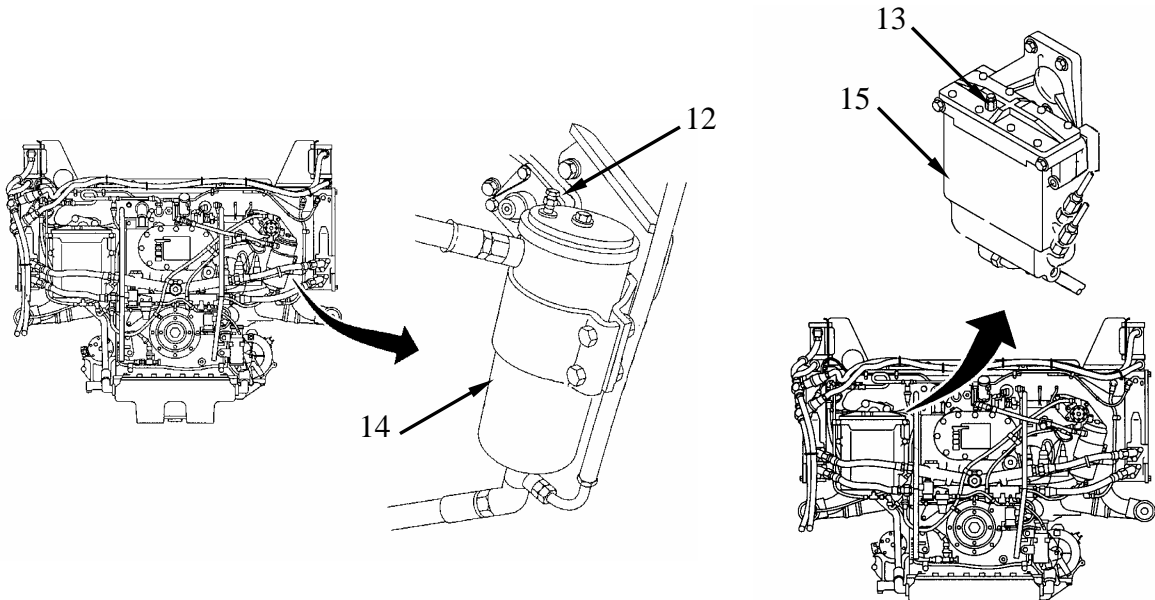
**PURGE FUEL SYSTEM****WARNING**

1. Turn master switch and in-tank fuel pump switches to "ON" position.
2. Operate in-tank fuel pump for 1 or 2 minutes. Simultaneously operate purge pump, completing 4 or 5 strokes after firm handle pressure is noted.

**CAUTION**

**Do not depress flame heater button. Damage to engine could occur.**

3. With in-tank pumps operating, open bleeder valves (12, 13) (on cover of both primary (14) and fuel/water separator (15) filters) until all fuel (no air) is noted.
4. Close bleeder valves (12, 13) when fuel flows from both.

**END OF WORK PACKAGE**



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**FUEL SUPPLY PUMP REPLACEMENT (2DR)**

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0048 00

**THIS WORK PACKAGE COVERS:**Removal, Installation, and Purge

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**INITIAL SETUP:****Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Container for fuel, minimum one gallon capacity

**Mandatory Replacement Parts:**

- Gasket (item 318, WP 0175)
- Self-locking nut (4) (item 33, WP 0175)

**Personnel Required:**

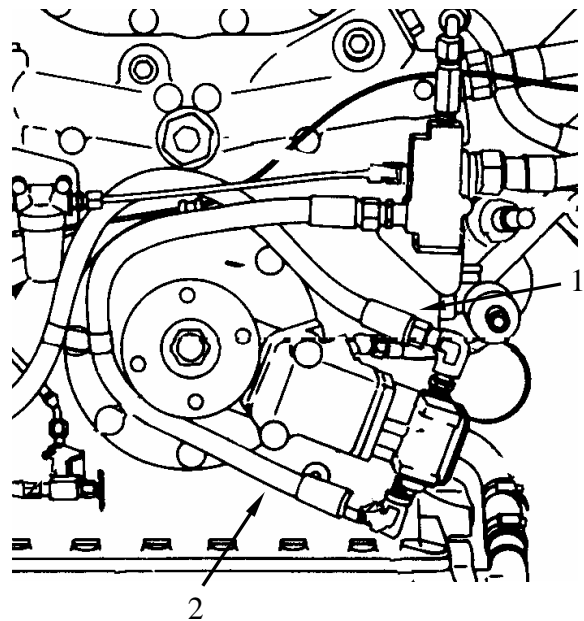
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface
- 

**REMOVAL**

1. Disconnect fuel outlet hose (1) and fuel inlet hose (2) from respective elbows.
2. Collect fuel in a suitable container and discard.



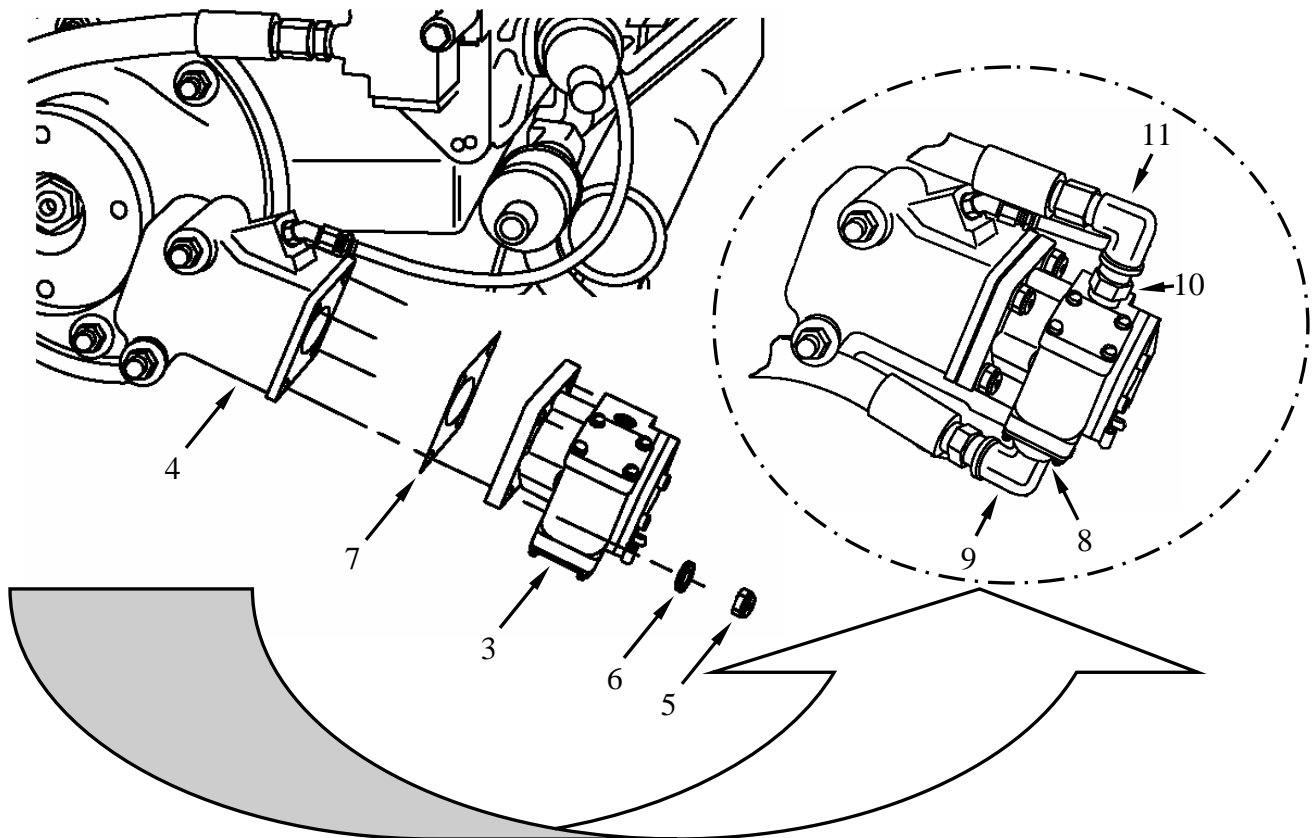
**REMOVAL (Continued)**

3. Remove fuel pump (3) from adapter (4).
  - a. Remove four self-locking nuts (5) with flat washers (6). Discard self-locking nuts.
  - b. Remove pump (3).
4. Remove and discard fuel pump mounting gasket (7).

**NOTE**

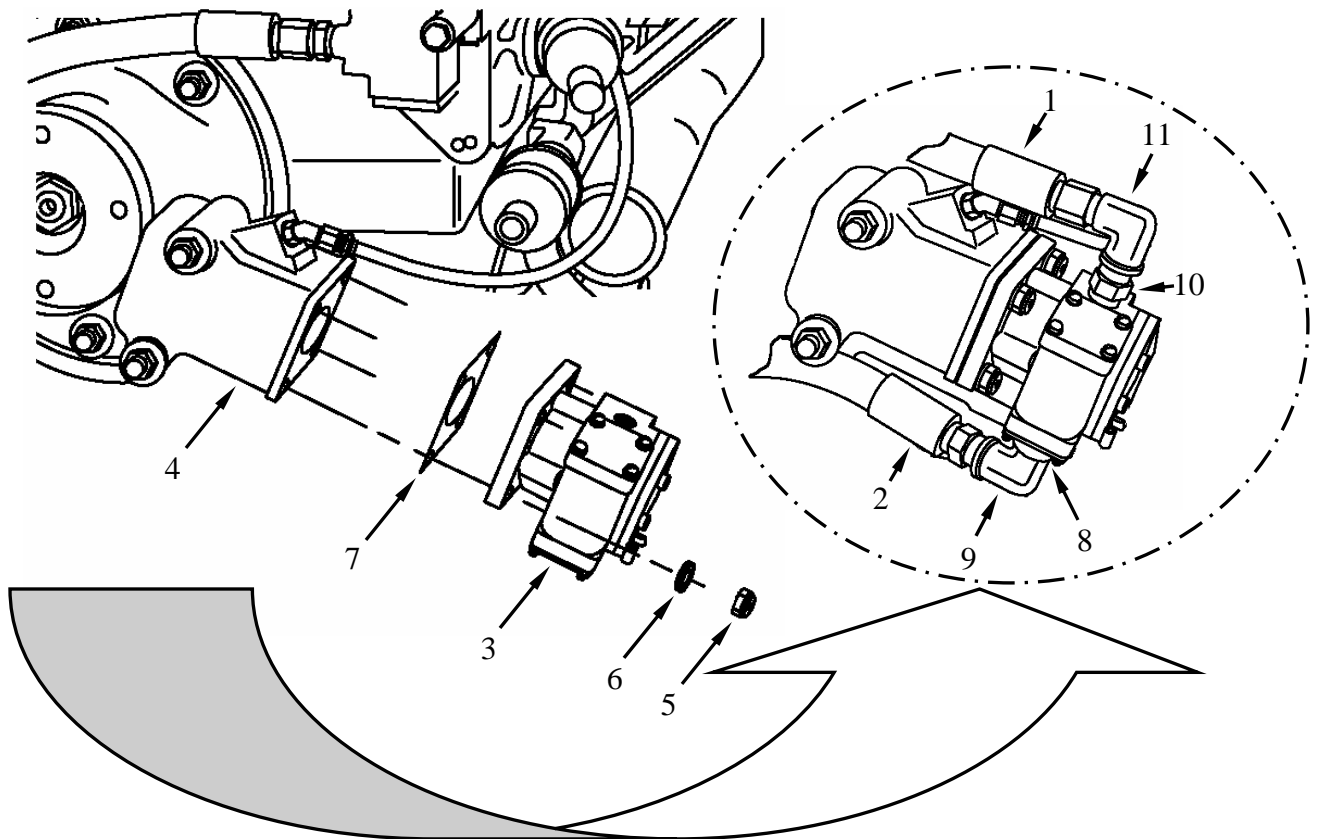
**Pay close attention to the orientation of the inlet and outlet elbows.  
The elbows will be used on the replacement pump.**

5. Remove fuel inlet connector (8) and elbow (9).
6. Remove fuel outlet connector (10) and elbow (11).



**INSTALLATION**

1. Install fuel inlet and outlet connectors (8, 10) and elbows (9, 11).
  - a. Tighten elbows (9, 11) to the same orientation as when removed from old pump.
2. Position new fuel pump mounting gasket (7) (item 318, WP 0175) on studs and install fuel pump on adapter (4).
  - a. Ensure that fuel pump shaft spline is properly aligned before securing pump to adapter.
3. Secure pump (3) to adapter (4) using four new self-locking nuts (5) (item 33, WP 0175) with flat washers (6).
4. Connect fuel inlet hose (2) to elbow (9).
5. Connect outlet hose (1) to elbow (11).



## PURGE FUEL SYSTEM

## WARNING

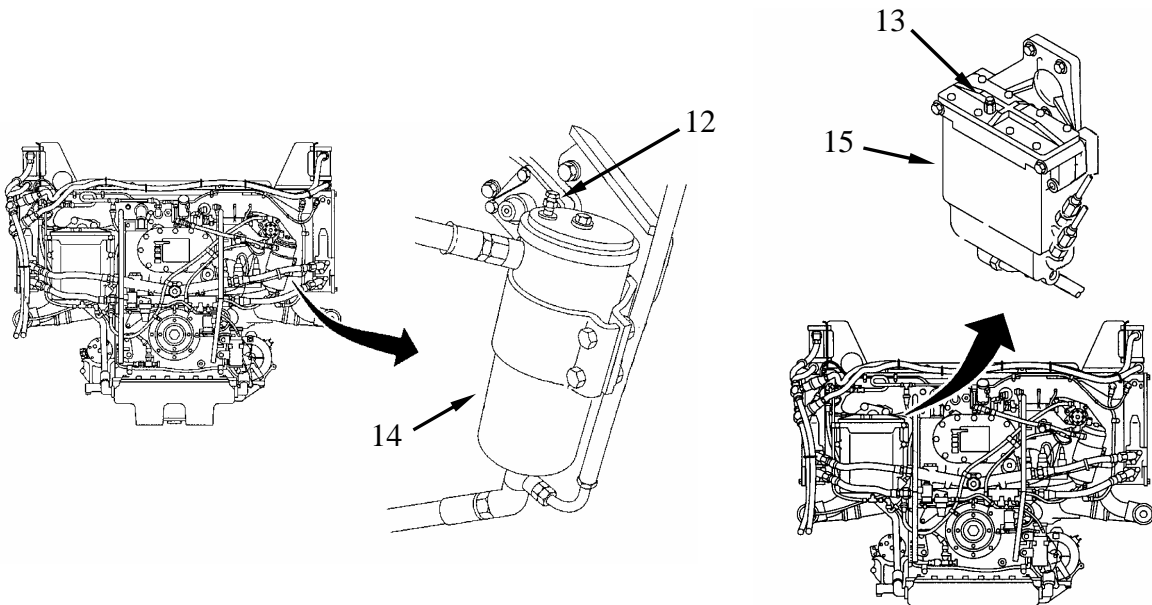


1. Turn master switch and in-tank fuel pump switches to "ON" position. (See appropriate vehicle manual).
2. Operate in-tank fuel pump for 1 or 2 minutes. Simultaneously operate purge pump, completing 4 or 5 strokes after firm handle pressure is noted.

**CAUTION**

**Do not depress flame heater button. Damage to engine could occur.**

3. With in-tank pumps operating, open bleeder valves (12, 13) (on covers of both primary (14) and fuel water separator (15) filters) until all fuel (no air) are noted.
4. Close bleeder valves (12, 13) when fuel flows from both.



**END OF WORK PACKAGE**



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**STARTER MOTOR REPLACEMENT**

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0049 00

**THIS WORK PACKAGE COVERS**Removal, Installation

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Open end wrench (item 113, WP 0176)

**Expendable and Durable Items:**

Adhesive, silicone rubber (item 3, WP 0173)  
Hardwood lumber blocks, as needed (item 20, WP 0173)  
Tags, marker (item 39, WP 0173)

**Mandatory Replacement Parts:**

Gasket (item 304, WP 0175)  
Self locking nut (2) (item 282, WP 0175)

**Mandatory Replacement Parts (Continued):**

Self locking nut (3) (item 31, WP 0175)  
Lock washer (4) (Crankcase mounted LVPM only) (item 86, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

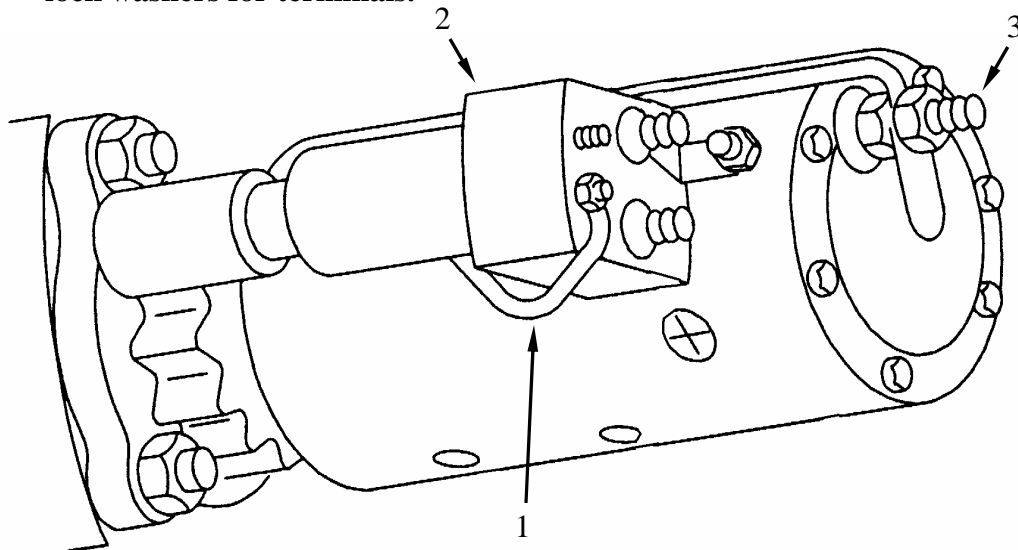
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

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**NOTE**

**Tag all electrical connections and electrical leads prior to removal to aid in installation. Large-gauge black wire (1), from starter solenoid (2) to starter motor ground terminal (3), is part of starter assembly and should not be removed (wire may not be routed exactly as illustrated). Install nuts and lock washers on starter terminals after removal of wires. New starters are supplied with new nuts and lock washers for terminals.**



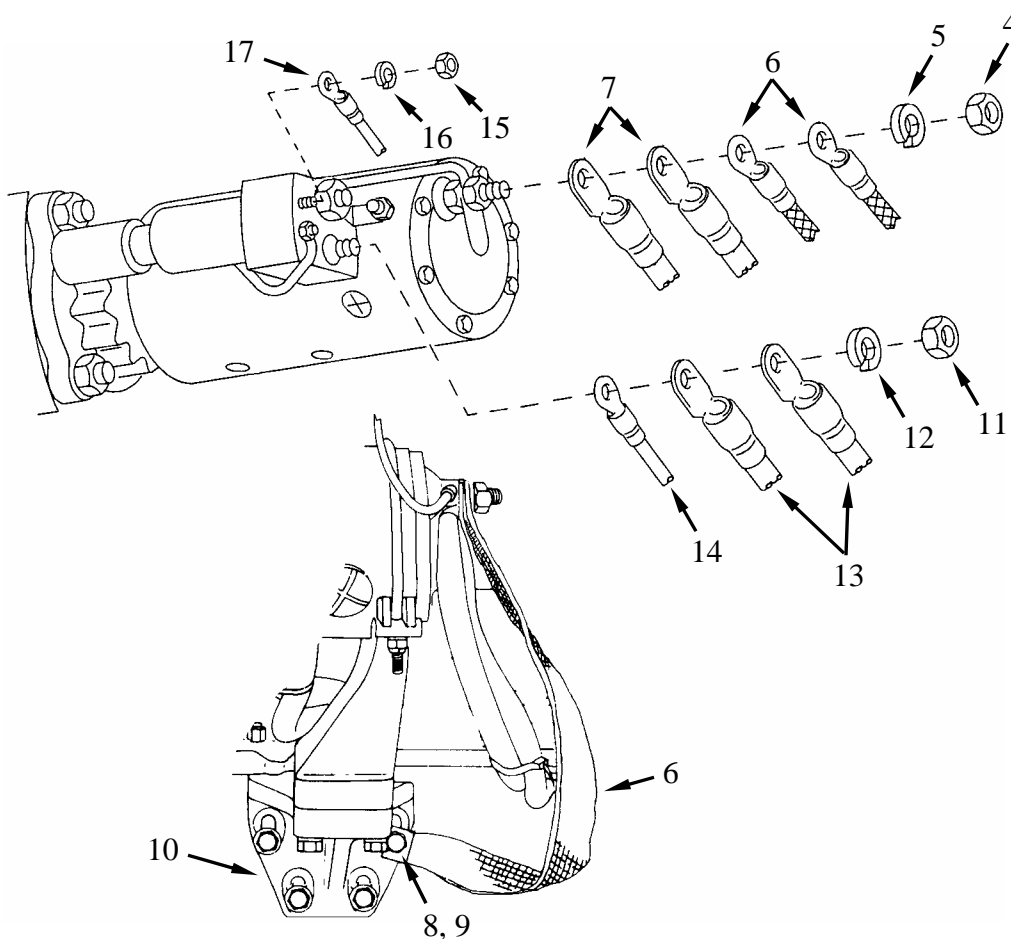
## REMOVAL

## NOTE

**Engine models with 650 ampere generators have two ground straps.**

**Engine models with 300 ampere generators have one ground strap.**

1. Disconnect starter ground wires.
  - a. Remove hexagon nut (4) and lock washer (5) to disconnect ground strap(s) (6) and two wiring harness cables (7).
  - b. Install hexagon nut (4) and lock washer (5) on starter terminal.
  - c. Remove screw (8) with flat washer (9) to remove ground strap(s) (6) from starter support bracket (10). Retain ground strap(s) for installation.
2. Disconnect starter positive cables.
  - a. Remove hexagon nut (11) and lock washer (12) to disconnect starter positive cables (13) and starter low voltage protective module electrical lead (14).
  - b. Install hexagon nut (11) and lock washer (12) on starter (battery) terminal.
  - c. Remove nut (15) with lock washer (16) from starter to disconnect low voltage protective module electrical lead (17).
  - d. Install nut (15) and lock washer (16) on starter terminal.

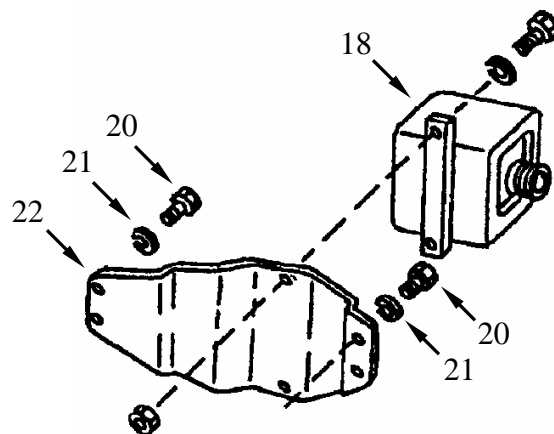
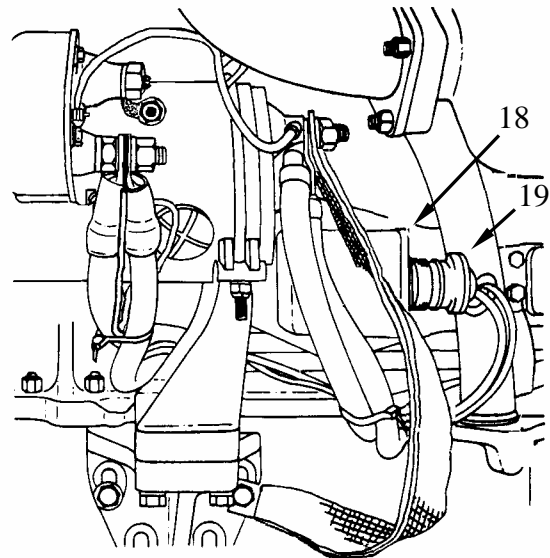


## REMOVAL (Continued)

## NOTE

**On early model engines, the low voltage protective module is mounted on the crankcase near the starter. In order to gain clearance for starter removal, the low voltage protective module must be removed prior to starter removal.**

3. (Early models only) Disconnect low voltage protective module (18).
  - a. Disconnect wiring harness electrical connector (19) from module (18).
  - b. Remove wiring clamps and/or tie wraps as necessary (not illustrated).
  - c. Remove four screws (20) with lock washers (21) to remove starter low voltage protective module (18) and bracket (22) as an assembly. Discard lock washers.



## REMOVAL (Continued)



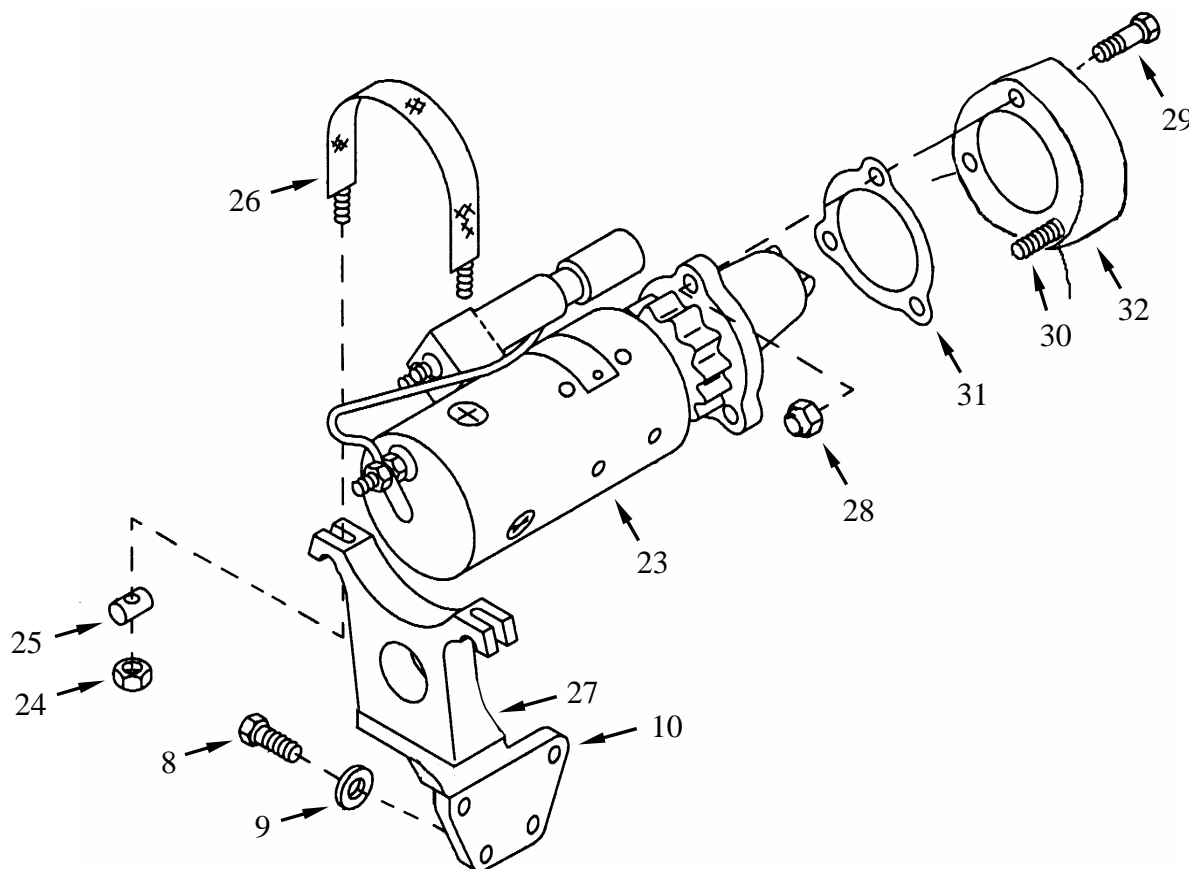
**The starter is heavy. Take care during removal or installation to prevent injury.**

4. Remove starter (23).
  - a. Remove self-locking nuts (24) and clamping bars (25) to remove U-bolt (26). Discard self-locking nuts.

**CAUTION**

**Use care in removing cradle to avoid damaging black solenoid-to-motor ground wire.**

- b. Remove remaining three screws (8) with flat washers (9) to remove starter support (10) and cradle (27) as an assembly.
- c. Position suitable wooden blocks under starter (23) for support.
- d. Remove self-locking nuts (28) from two screws (29) and one stud (30) (behind starter) using open-end wrench. Discard self-locking nuts.
- e. Remove starter (23) and mounting gasket (31) from starter adapter (32). Discard gasket.

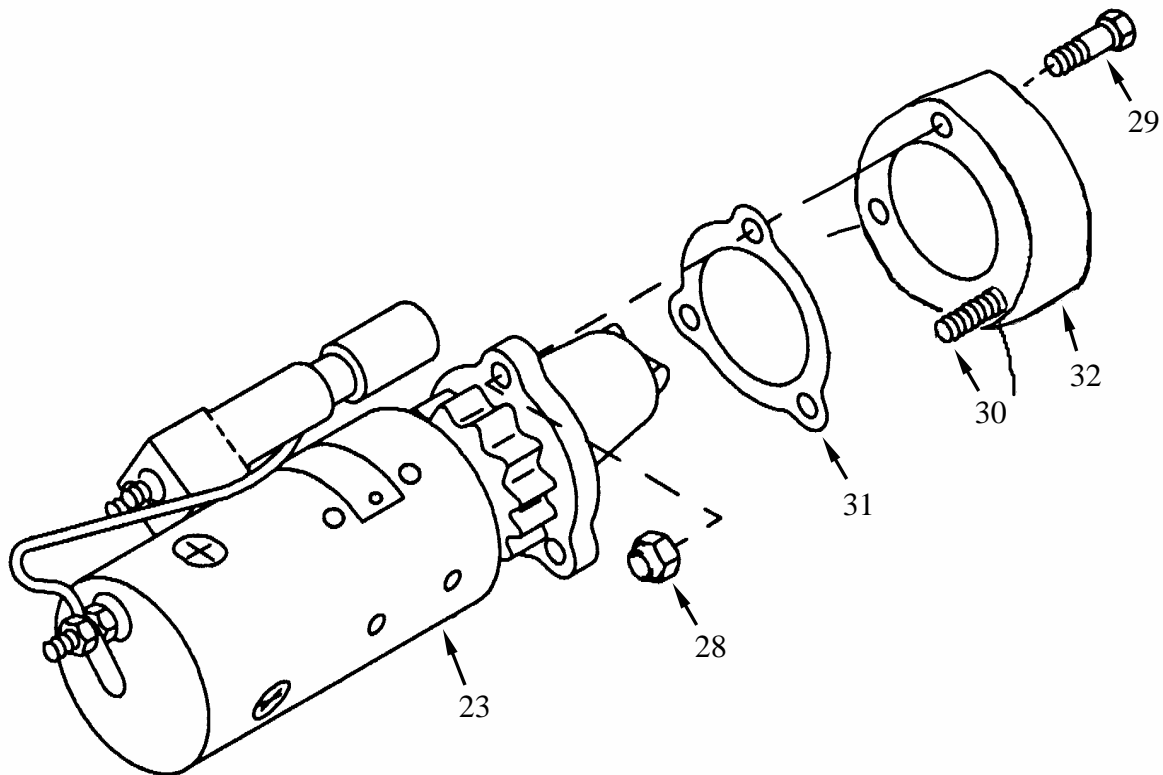


## INSTALLATION

**WARNING**

**The starter is heavy. Take care during removal or installation to prevent injury.**

1. Install starter (23).
  - a. Position two bolts (29) through adapter (32).
  - b. Position new mounting gasket (31) (item 304, WP 0175) on starter adapter (32).
  - c. Position starter (23) on starter adapter (32) and place suitable blocks under starter for support.
  - d. Secure starter using new self-locking nuts (28) (item 31, WP 0175) on two bolts (29) and one stud (30) (behind starter) using open end wrench.

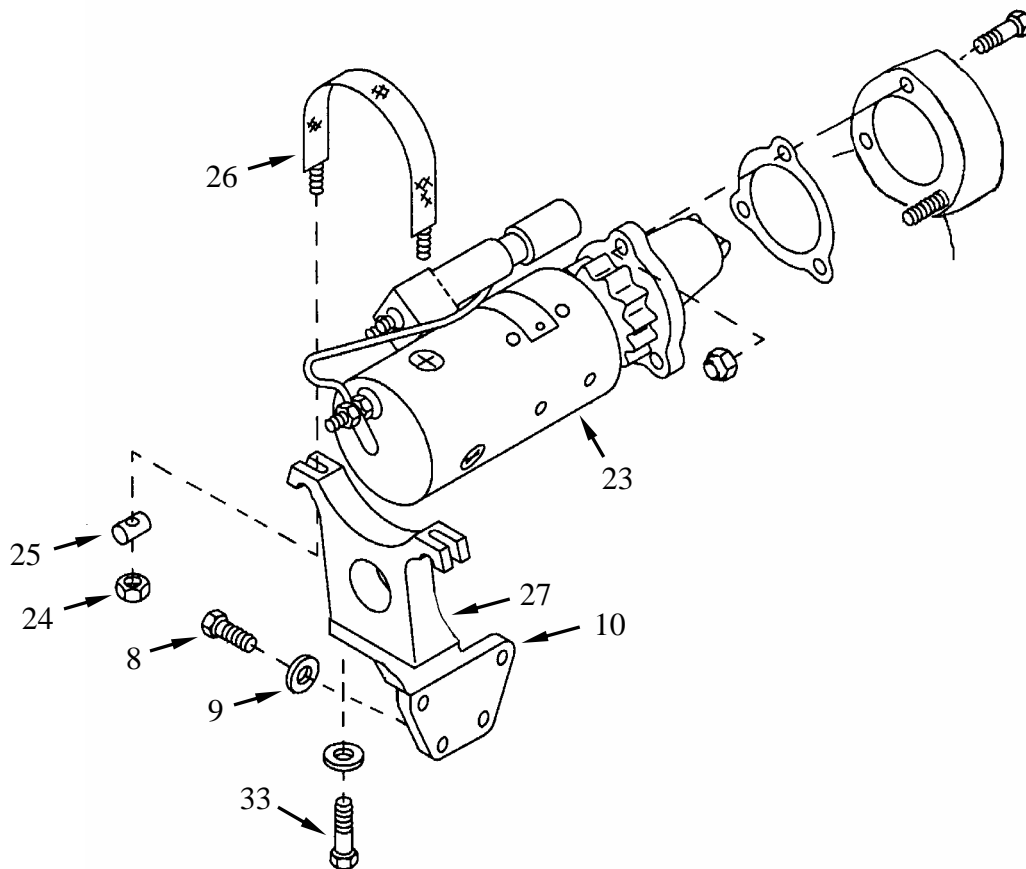


## INSTALLATION (Continued)

**CAUTION**

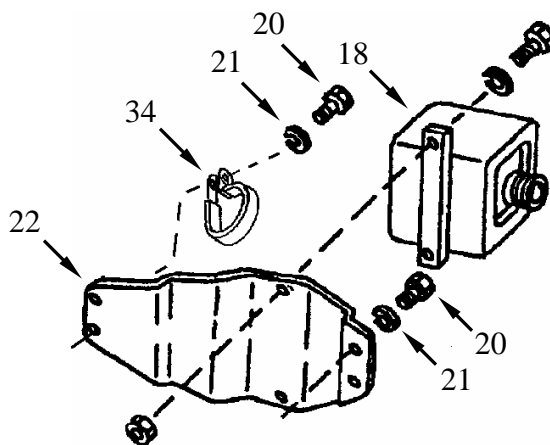
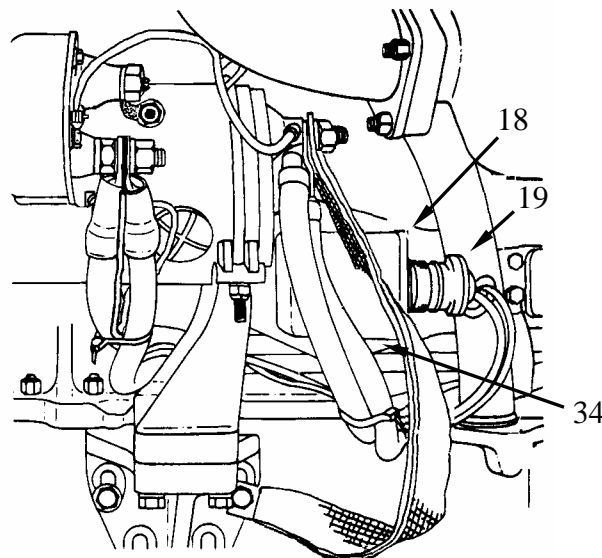
**It is of utmost importance that the starter support, cradle, and U-bolt be installed in a manner that will not disturb starter alignment and still furnish adequate support to minimize vibration. Perform step 2 in the sequence as written. Misalignment of 0.010-inch in any direction is sufficient to cause a leak (pressure loss) between the starter mounting flange and the starter housing.**

2. Install starter support bracket (10).
  - a. Position starter support bracket (10) and cradle (27) as an assembly on oil pan and secure using three screws (8) with flat washers (9).
  - b. Tighten only until screw (8) heads engage washers (9) (finger tight).
  - c. Loosen four screws (33) allowing free movement between cradle (27) and support (10).
  - d. Position U-bolt (26) over starter (23) and secure to cradle (27) with two clamping bars (25) and new self-locking nuts (24) (item 282, WP 0175) assuring that cradle (27) sits flat on support (10). Tighten nuts (24) evenly.
  - e. Tighten four screws (33) securing cradle (27) to support (10).
  - f. Tighten three screws (8) securing starter support (10) to oil pan. Fourth screw will be installed with ground straps.



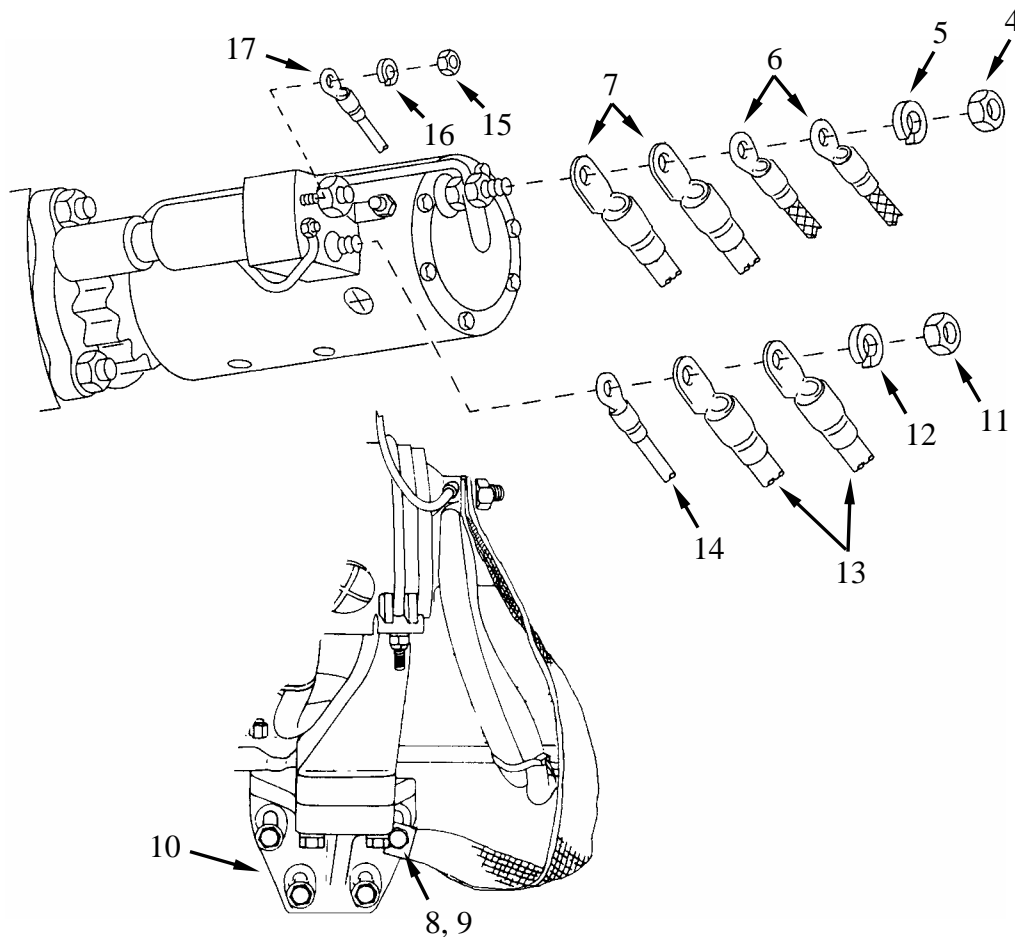
**INSTALLATION (Continued)**

3. (Early models only) Install low voltage protective module (LVPM) (18).
  - a. Position LVPM (18) and bracket (22) on crankcase and secure using three screws (20) with new lock washers (21) (item 86, WP 0175).
  - b. Install LVPM (18) electrical connector (19).
  - c. Install cable loop clamp (34) and secure to module bracket (22) using screw (20) with new lock washer (21) (item 86, WP 0175).



**STARTER MOTOR REPLACEMENT****0049 00****INSTALLATION (Continued)**

4. Install starter positive cables.
  - a. Install LVPM electrical lead (17) on starter terminal and secure using nut (15) with lock washer (16).
  - b. Install two starter cables (13) and starter low voltage protective module electrical lead (14) on starter (battery) terminal and secure using hexagon nut (11) with lock washer (12).
5. Install starter ground wires.
  - a. Install two wiring harness cables (7) and ground strap(s) (6) on starter terminal and secure with hexagon nut (4) with lock washer (5).
  - b. Install opposite end of ground strap(s) (6) to starter support (10), secure using screw (8) with flat washers (9).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Self locking nut (4) (item 37, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

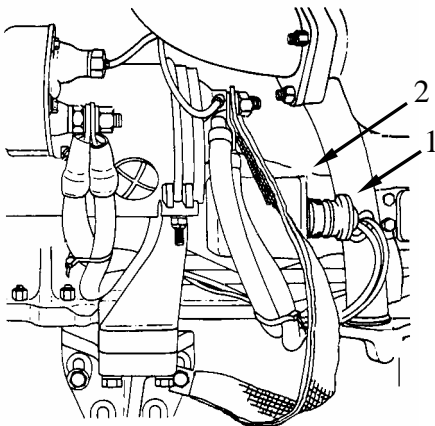
**NOTE**

**Low voltage protection modules are located differently on early model engines as opposed to later model engines. The module will either be mounted on the crankcase next to the starter (early engine models) or on the top deck, left side, front access panel (later engine models). Removal and installation procedures are identical regardless of location except for the ground lead on later engine model installations.**

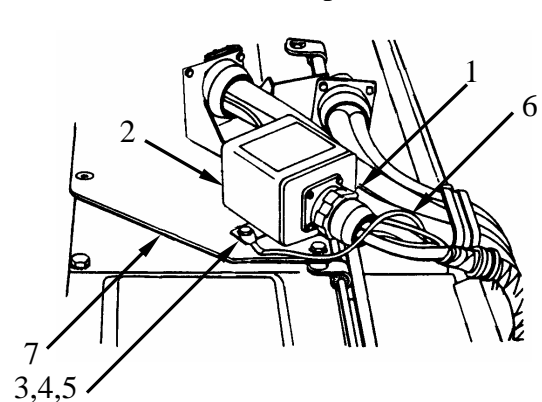
**REMOVAL**

1. Disconnect wiring harness (1) from module (2).
2. Remove two cap screws (3), washers (4) and self-locking nuts (5). Discard self locking nuts.
3. Remove module (2) (and ground lead (6) on later installations) from mounting bracket (7).

Early Installations (side of crankcase)



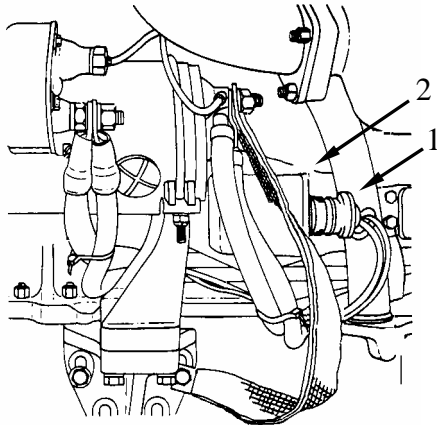
Later Installations (top mount)



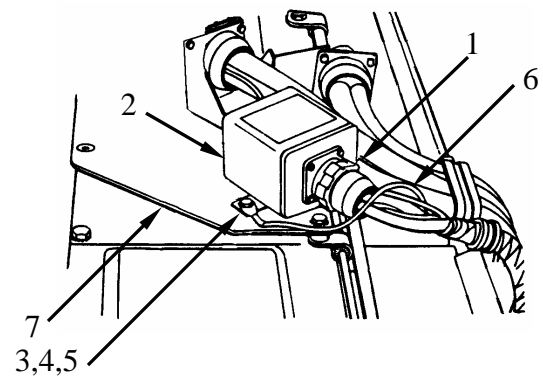
**INSTALLATION**

1. Install module (2) on mounting bracket (7).
2. Secure with two cap screws (3), washers (4), and new self-locking nuts (5) (item 37, WP 0175).
  - a. On later model installations, assure that ground lead (6) is secured with the outboard mounting screw as illustrated.
3. Connect wiring harness (1).

Early Installations (side of crankcase)



Later Installations (top mount)

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

General, Removal, Fitting Exchange, Installation and Test

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Plastic hammer (item 62, WP 0176)
- Thickness gauge, 0.002 inch (tool crib)
- Thickness gauge, 0.010 inch (item 55, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (item 324, WP 0175)
- Gasket (item 273, WP 0175)
- O-ring (item 73, WP 0175)

**Mandatory Replacement Parts (Continued)**

- O-ring (item 143, WP 0175)
- Self-locking screw (6) (item 104, WP 0175)

**Expendable and Durable Items:**

- Enamel (item 13, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface

**GENERAL**

Tag all electrical connections and electrical leads prior to removal to aid in installation. Install nuts and lock washers on generator terminals after removal of wires. New generators are supplied with nuts and lock washers.

**NOTE**

**650 ampere generators are available from two different sources; Honeywell and Ormat. Both generators carry the same NSN but have different part numbers. Check your RPSTL. Both applications are illustrated when there are noticeable differences.**

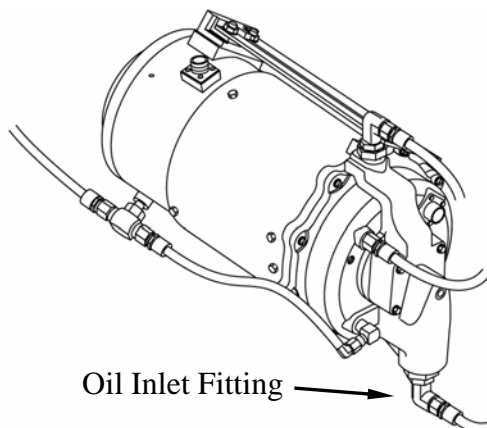
The Ormat generator is an approved second source generator for use on all AVDS-1790 Engines requiring a 650 ampere generator. Form, fit, and function are compatible with all 650 ampere Honeywell/Allied Signal (Bendix) generators.

Existing oil fittings may be re-used when exchanging generators, regardless of source.

Electrical connections are the same between Ormat and Honeywell generators.

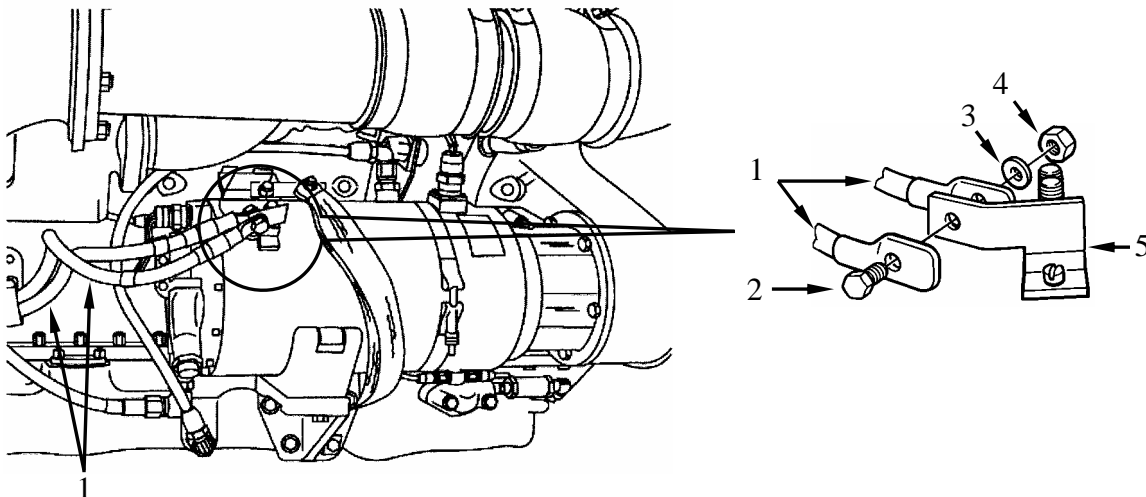
**CAUTION**

**If the generator that you are installing is an Ormat, it is imperative that you orient the oil inlet fitting at the 6 o'clock position (+/- 10°). Proper cooling depends on this orientation. Failure to comply may damage the generator.**

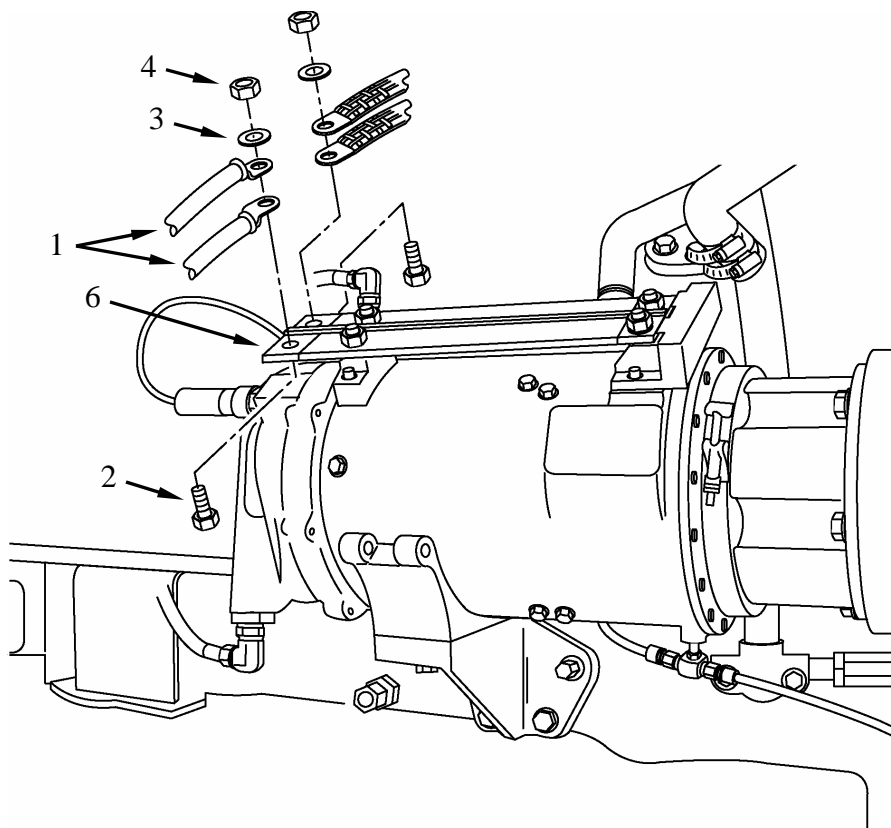


**REMOVAL**

1. Disconnect positive cables (1).
  - a. Honeywell: Remove protective coating, screw (2), flat washer (3), and nut (4) from bus bar (5) to remove cables (1).



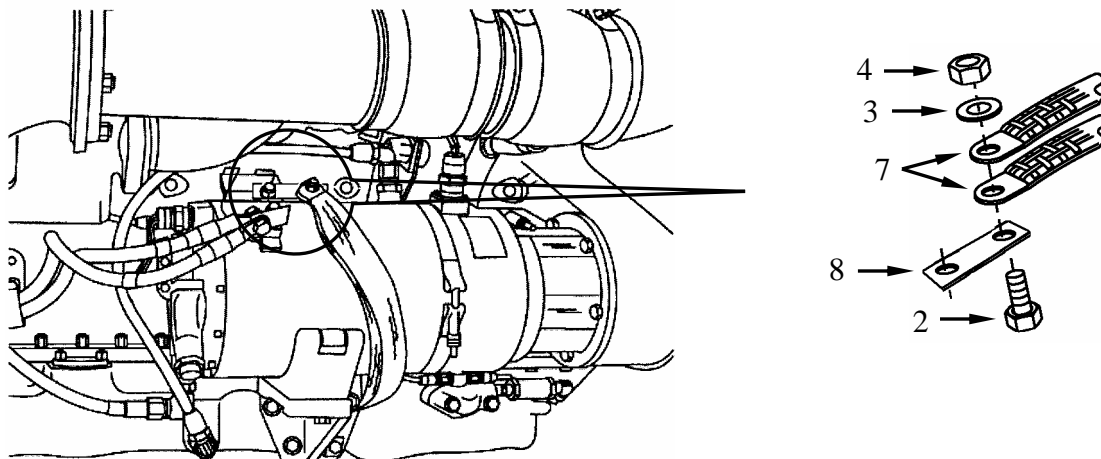
- b. Ormat: Remove protective coating, screw (2), flat washer (3), and nut (4) from bus bar (6) to remove cables (1).



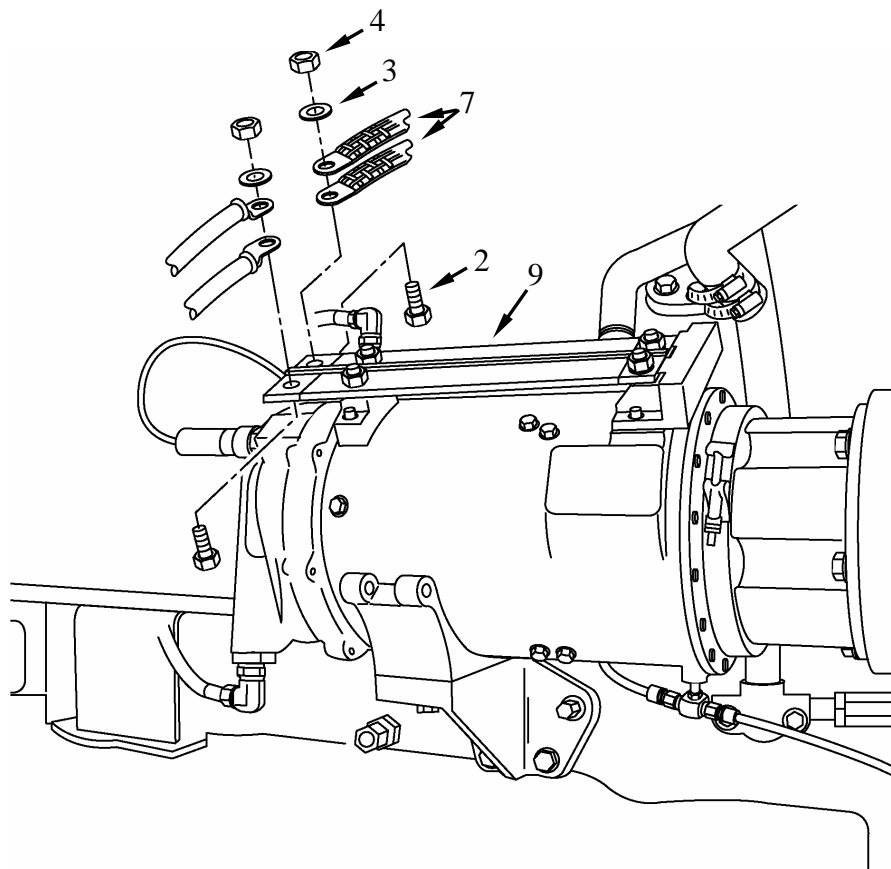
**REMOVAL (Continued)**

2. Disconnect ground straps (7).

- a. Honeywell: Remove protective coating, screw (2), flat washer (3), and nut (4) from bus bar (8) to remove ground straps (7).



- b. Ormat: Remove protective coating, screw (2), flat washer (3), and nut (4) from bus bar (9) to remove ground straps (7).



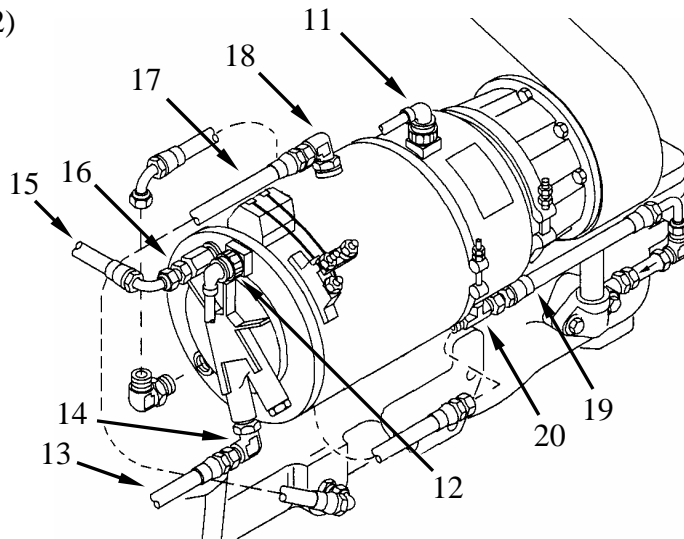
**REMOVAL (Continued)**

3. Disconnect two electrical connectors (11, 12) from generator.

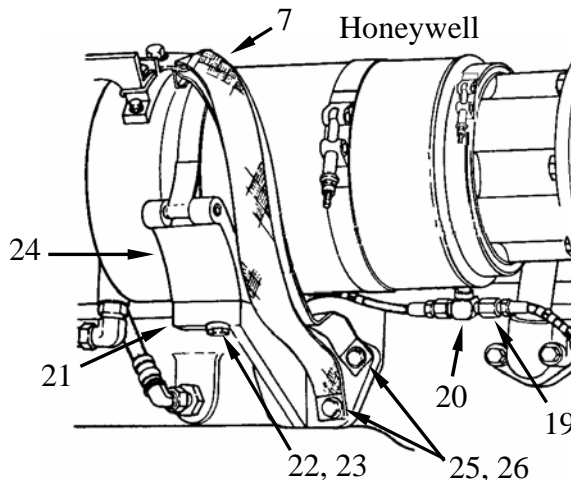
**NOTE**

**Use a suitable container to catch oil that may leak out whenever any oil line is loosened or removed. Cap all tubes, hoses, and fittings to prevent contamination.**

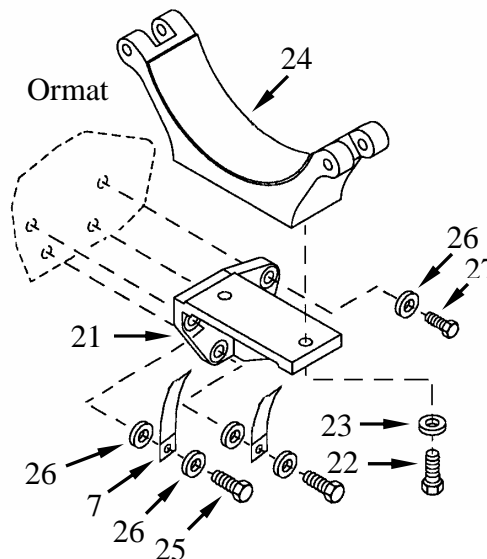
4. Disconnect oil inlet hose (13) from fitting (14).
5. Disconnect vent hose (15) from fitting (16).
6. Disconnect oil return hose (17) from fitting (18).
7. Disconnect oil drain hose (19) at rear of tee (20).



8. Remove bracket (21).
  - a. Remove two screws (22) with flat-washers (23) securing cradle (24) to bracket (21).
  - b. Remove two screws (25) with flat washers (26) securing ground straps (7) and bracket (21).



- c. Remove and retain ground straps (7).
- d. Remove remaining two screws (27) with flat washers (26) to remove bracket (21).

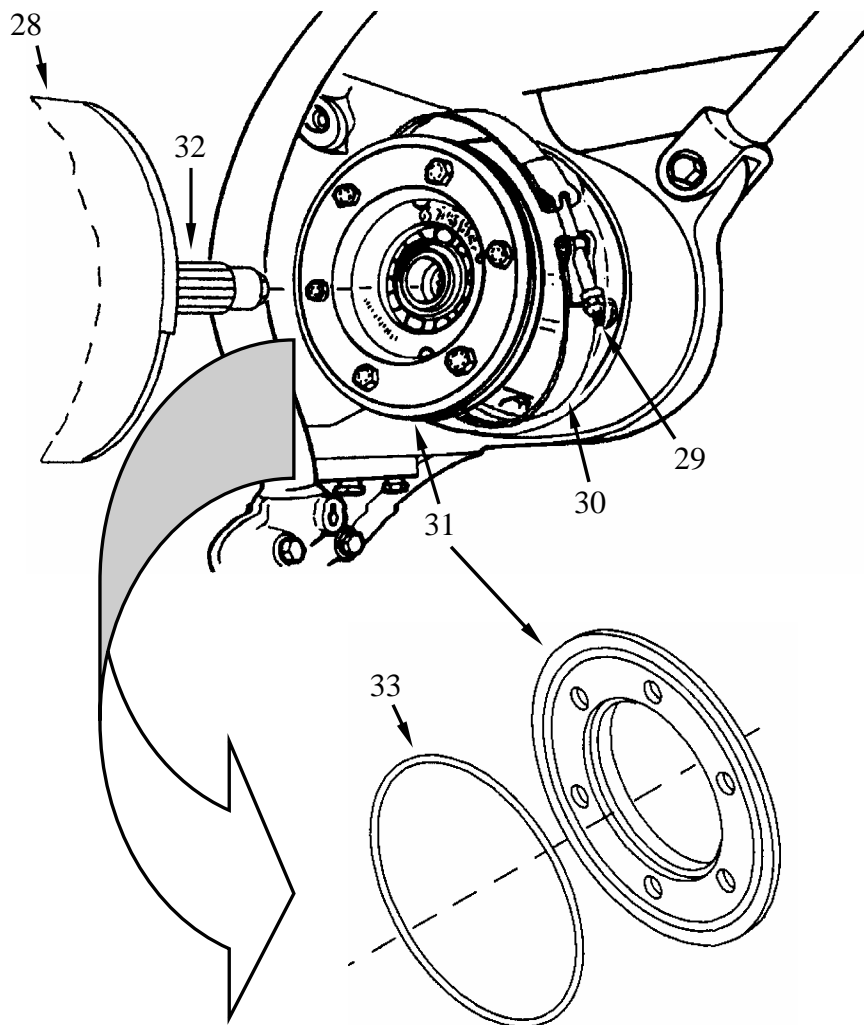


## REMOVAL (Continued)

**WARNING**

**The generator weighs between 93 and 97 pounds. Take care during removal or installation to prevent injury. Do not use bus bars as a lifting point.**

9. Position a lifting device with suitable support (not illustrated) beneath generator (28) raising just enough to support generator.
10. Loosen self-locking nut (29) on V-band clamp (30) and slide V-band clamp aside.
11. Slide generator away from adapter plate (31) until drive shaft (32) is disengaged.
12. Remove generator (28).
13. Remove and discard gasket (33).

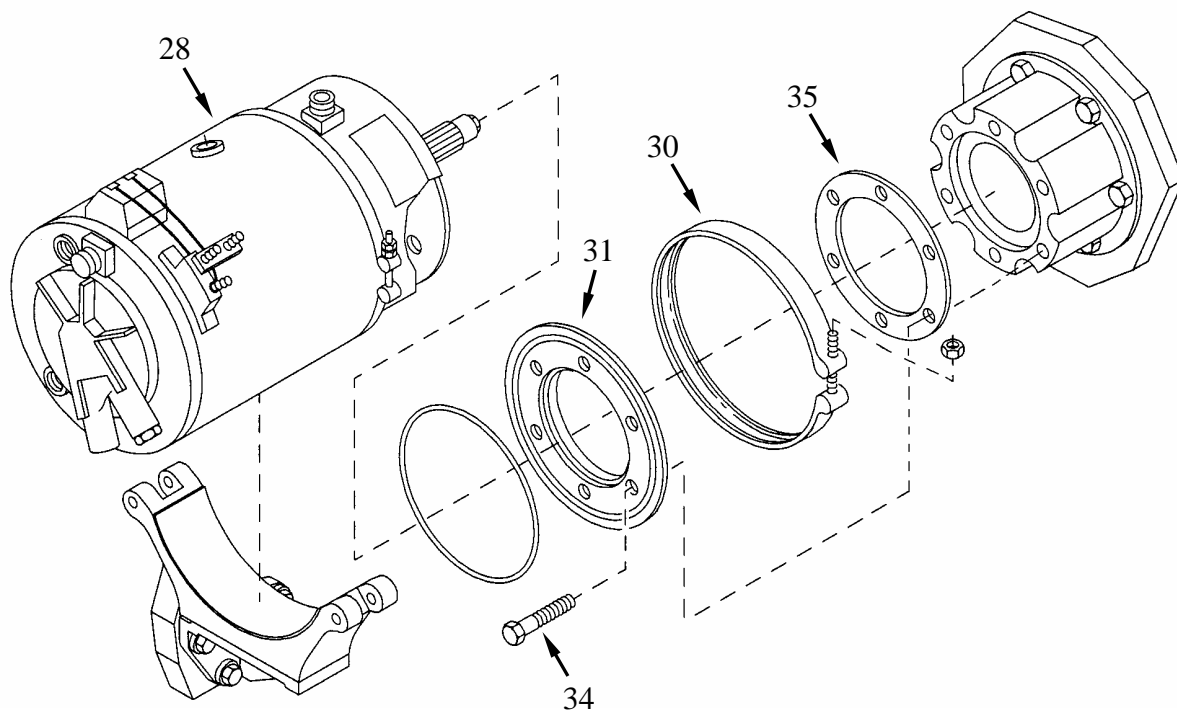


## REMOVAL (Continued)

## NOTE

**Adapter plates are identical between generator models and do not need to be removed unless damaged. Replacement generators come with new adapter plates and V-band clamps; keep a plate and clamp with each generator.**

14. Remove six self-locking screws (34) securing adapter plate (31). Discard self-locking screws.
15. Remove generator adapter plate (31), V-band clamp (30), and gasket (35). Discard gasket.
16. Place the adapter plate (31) on removed generator (28) and secure with V-band clamp (30).





## REMOVAL (Continued)

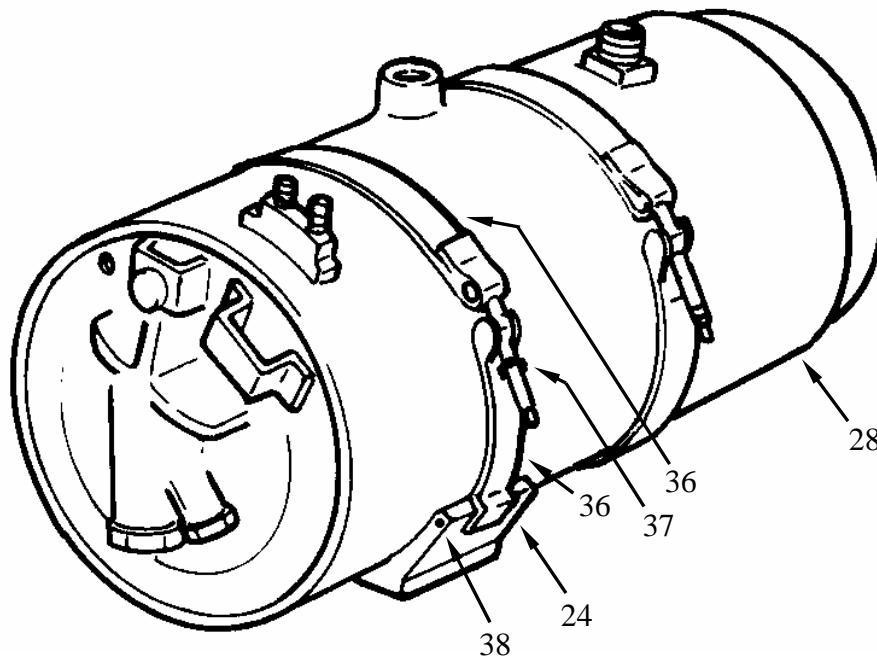
## NOTE

Early model Honeywell generators were installed with a retaining strap to hold the generator in the cradle. It has been determined that the strap is not required. If the cradle that you removed has the retaining strap, remove and discard it.

If your generator does not have a retaining strap, skip to "Exchange Parts."

17. Remove retaining strap (36).

- a. Loosen T-bolt (37) and remove cradle (24) from generator (28). Using drive punch, drive roll pins (38) attaching strap (36) ends to cradle (24) and discard strap and roll pins.



## EXCHANGE PARTS

(Ormat Illustrated - Honeywell Similar)

## NOTE

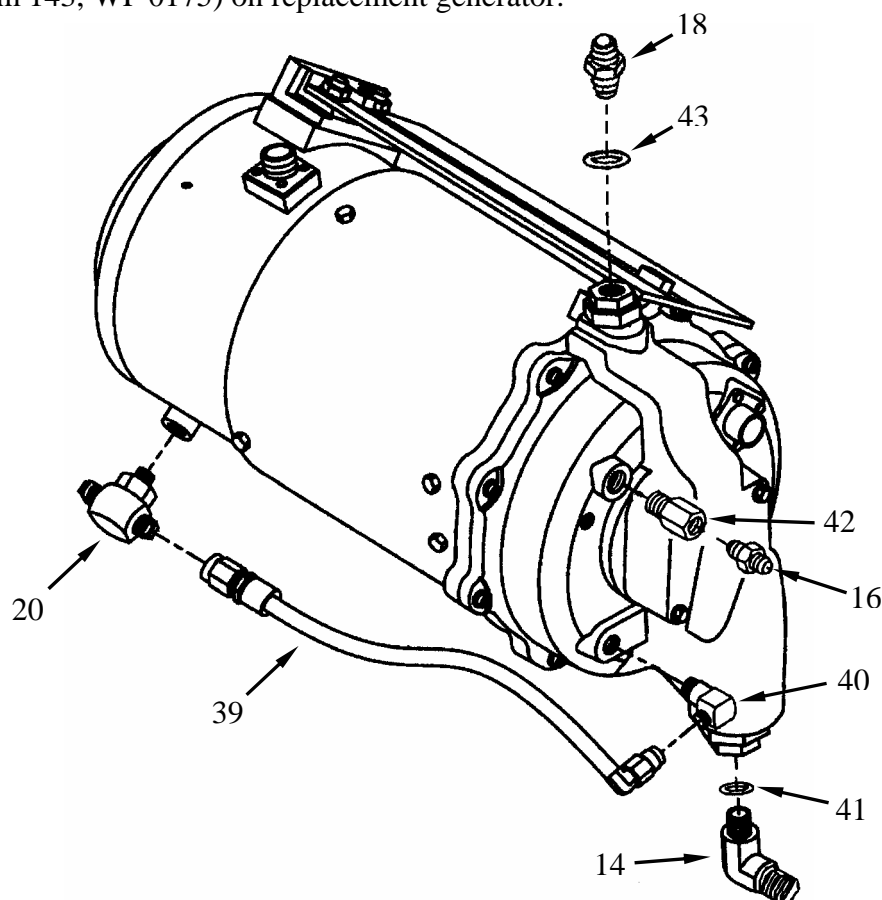
**It will help when exchanging fittings to have both generators side by side to orient the fittings the same in the replacement generator.**

1. Disconnect drain hose (39) from front of tee (20) and from drain elbow (40).
2. Remove tee (20) and drain elbow (40) and install in replacement generator. Orient both fittings the same as they were initially.
3. Connect drain hose (39) to front of tee (20) and to drain elbow (40) in replacement generator.
4. Remove oil inlet elbow (14) with O-ring (41). Discard O-ring. Install inlet elbow (14) with new O-ring (14) (item 73, WP 0175) on replacement generator orienting the elbow the same as it was.

CAUTION

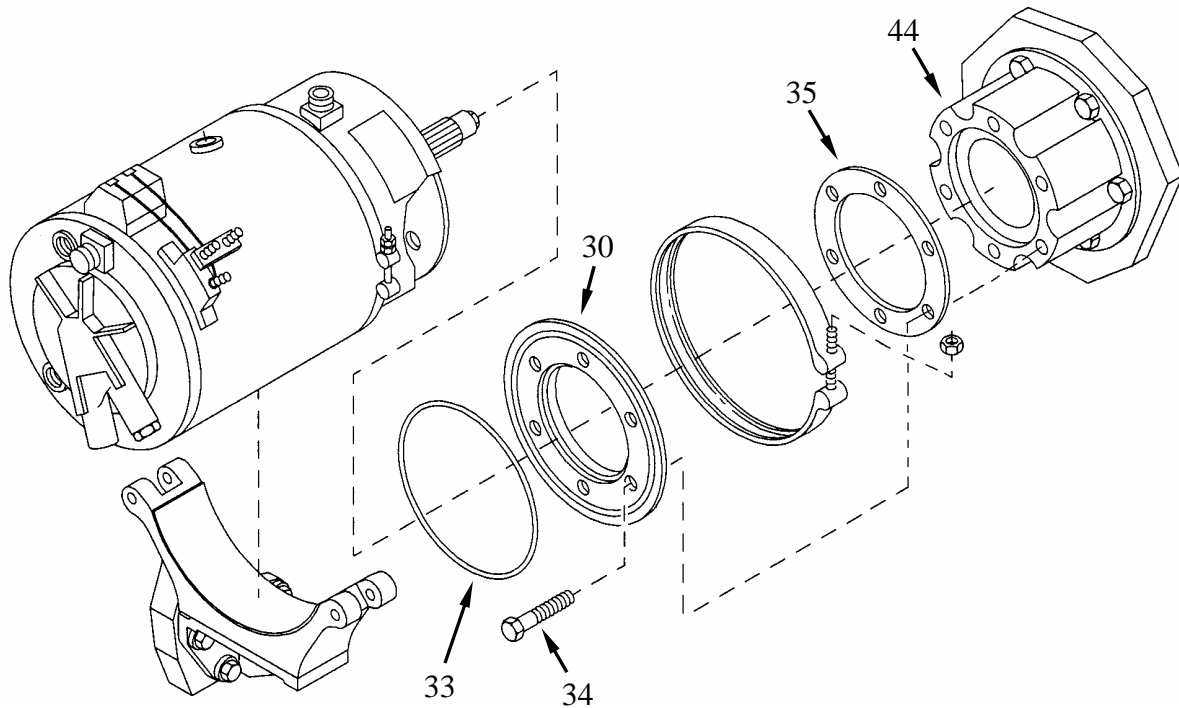
**Orifice fitting (42) must be in place. Damage to engine may occur if orifice fitting is not in place.**

5. Remove vent fitting (16) and orifice fitting (42) and install in replacement generator.
6. Remove oil return fitting (18) with O-ring (43). Discard O-ring. Install fitting (18) with new O-ring (43) (item 143, WP 0175) on replacement generator.



**INSTALLATION**

1. Ensure that mounting surface of housing (44) is clean and not damaged.
2. Position new gasket (35) (item 324, WP 0175) on housing (44) and install adapter plate (30).
3. Secure with six new self-locking screws (34) (item 104, WP 0175) and torque to 33-38 foot-pounds (45-51 N•m).
4. Install new gasket (33) (item 273, WP 0175) in groove located on front side of adapter plate (30).

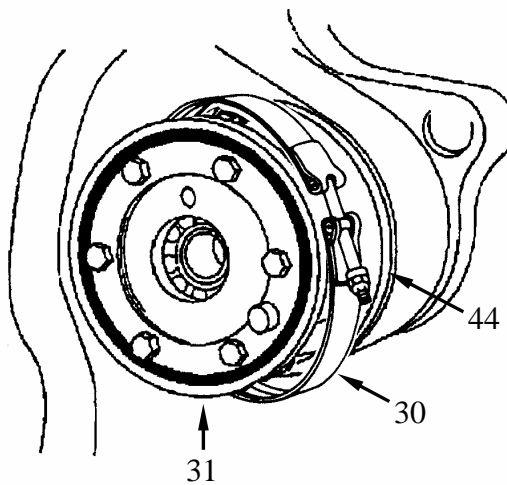


**INSTALLATION (Continued)**

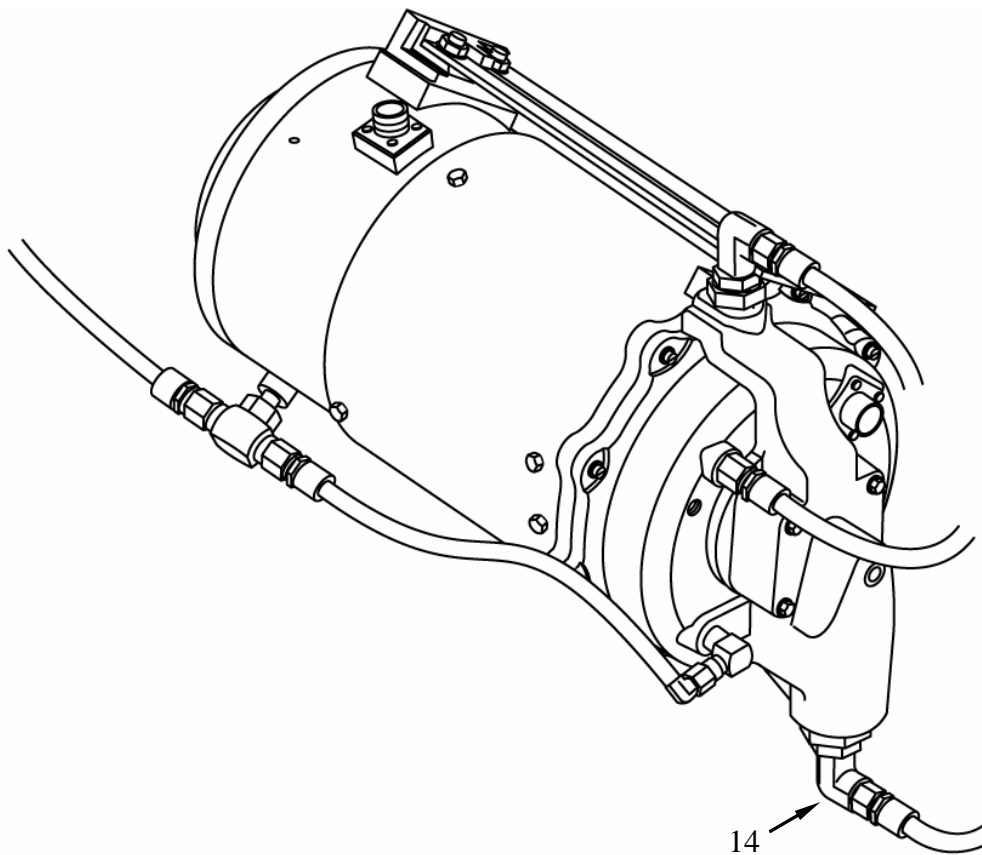
5. Loosely place V-band clamp (30) all the way over adapter plate (31) and onto housing (44) so that it is out of the way, but available for assembly.

**CAUTION**

**The Ormat generator must be oriented with the oil inlet fitting (14) at the 6 o'clock position ( $\pm 10^\circ$ ) in order to cool properly. Failure to comply may result in premature failure of the generator.**

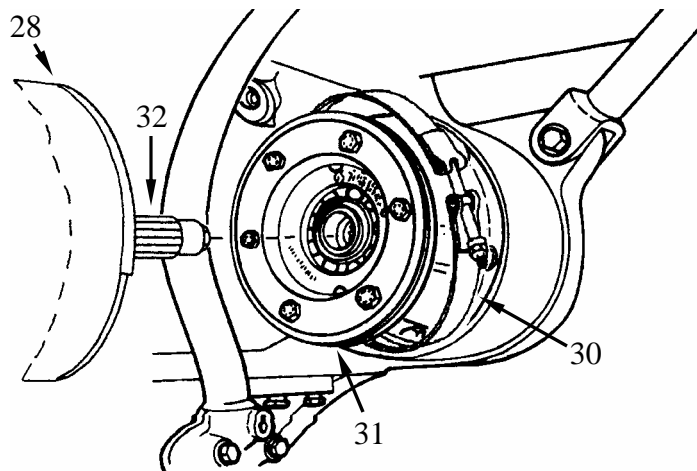


6. Position generator on lifting device, suitably supported, with oil inlet fitting (14) at approximately the 6 o'clock position.

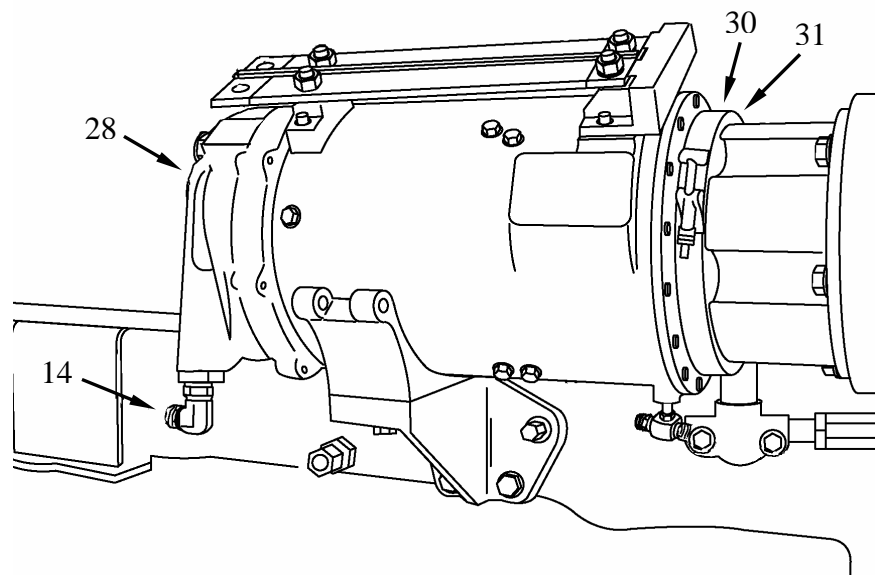


**INSTALLATION (Continued)**

7. Engage generator (28) drive shaft (32).
  - a. Slide generator (28) slowly towards adapter plate (31) until drive shaft (32) engages.
  - b. It may be necessary to turn drive shaft for proper engagement. A long screwdriver may be used for this purpose.



8. Secure generator (28) to adapter plate (31).
  - a. Be sure generator (28) is tight against adapter plate (31). Assure that inlet fitting (14) is at the 6 o'clock position (+/- 6°) for the Ormat generator. This fitting is the same for the Honeywell, but it is not critical that it be at the 6 o'clock position.
  - b. Position V-band clamp (30) over mating flanges of generator (28) and adapter plate (31).
  - c. Tighten V-band clamp (30) to 60-65 inch-pounds (7 N•m). Tap clamp lightly with plastic hammer as it is being tightened.

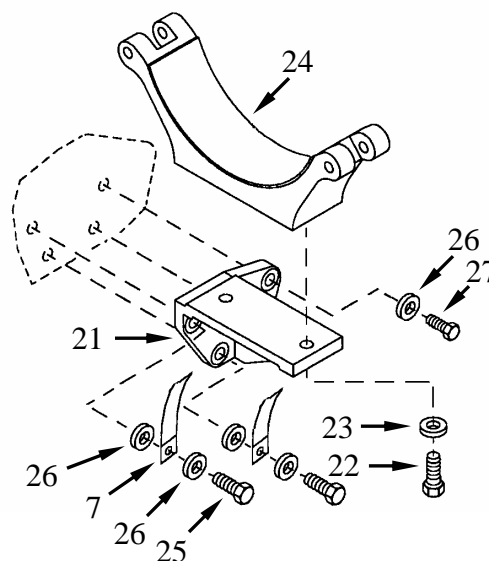


INSTALLATION (Continued)

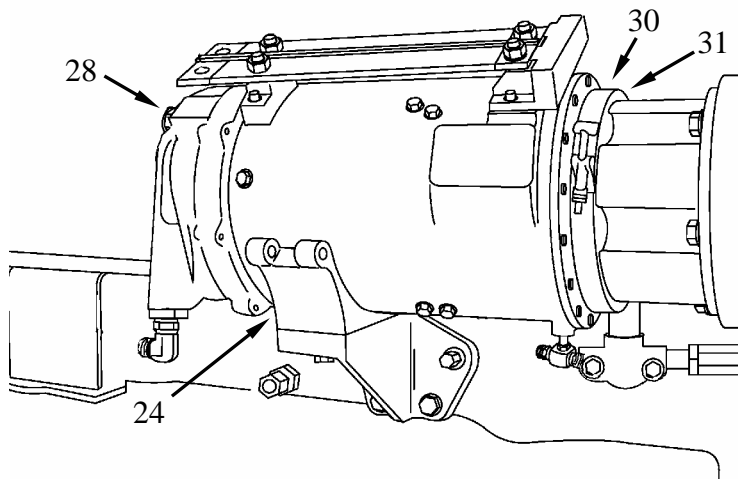
**CAUTION**

**The cradle and bracket must serve two purposes; they must support the generator and align the drive spline. Perform the following procedure carefully to assure compliance. Failure to comply may lead to oil leaks at the adapter plate and damage to generator drive.**

9. Attach cradle (24) to bracket (21) using two screws (22) with flat washers (23). Snug tighten just enough so that both pieces can be adjusted during installation.
10. Position bracket (21), ground straps (7) and cradle (24) against oil pan and secure using four screws (25, 27) with flat washers (26) as illustrated. Tap cradle and bracket upwards and inwards lightly with a plastic hammer to assure seating against the generator and oil pan while alternately tightening two cradle screws (22) and four bracket screws (25, 27).



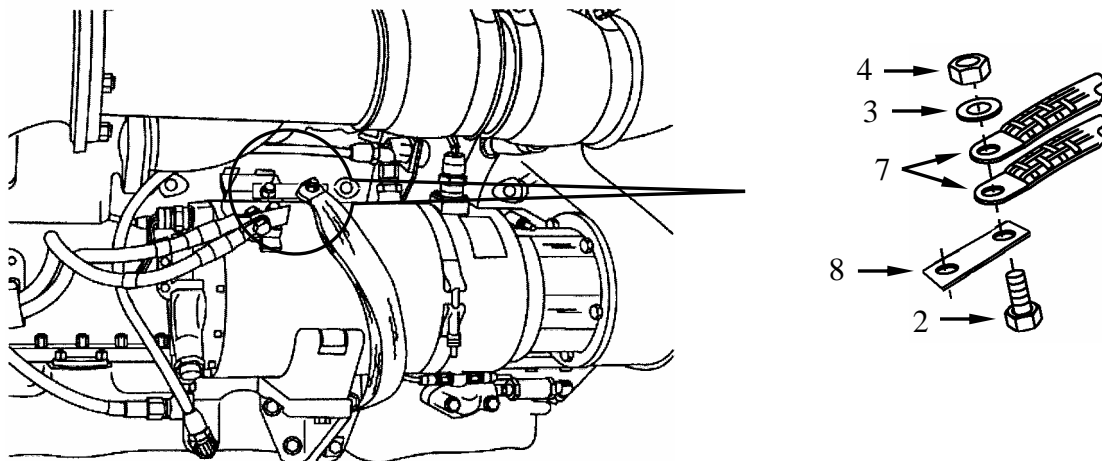
11. Check seating of generator (28) to cradle (24) and alignment of generator (28) to mounting plate (31).
  - a. Check seating of generator to cradle with a 0.002 feeler gauge. If gauge can be inserted at any point between cradle and generator; reseating is required.
  - b. Loosen V-band clamp (30) and move aside.
  - c. Using feeler gauge, check gap between generator (28) and drive adapter plate (31). More than 0.010-inch gap at any point requires realignment.
  - d. Install V-band clamp (30) and tighten to 50 inch-pounds (6 N•m) torque.



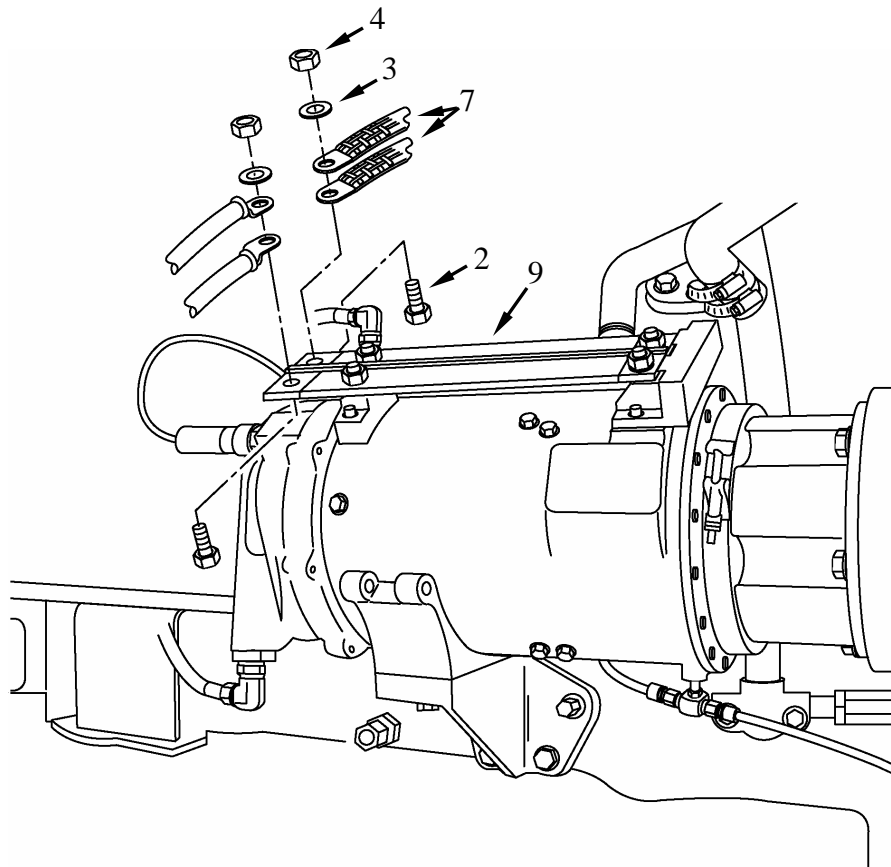
**INSTALLATION (Continued)**

12. Connect ground straps (7).

- a. Honeywell: Connect ground straps (7) to bus bar (8) using screw (2), flat washer (3), and nut (4).



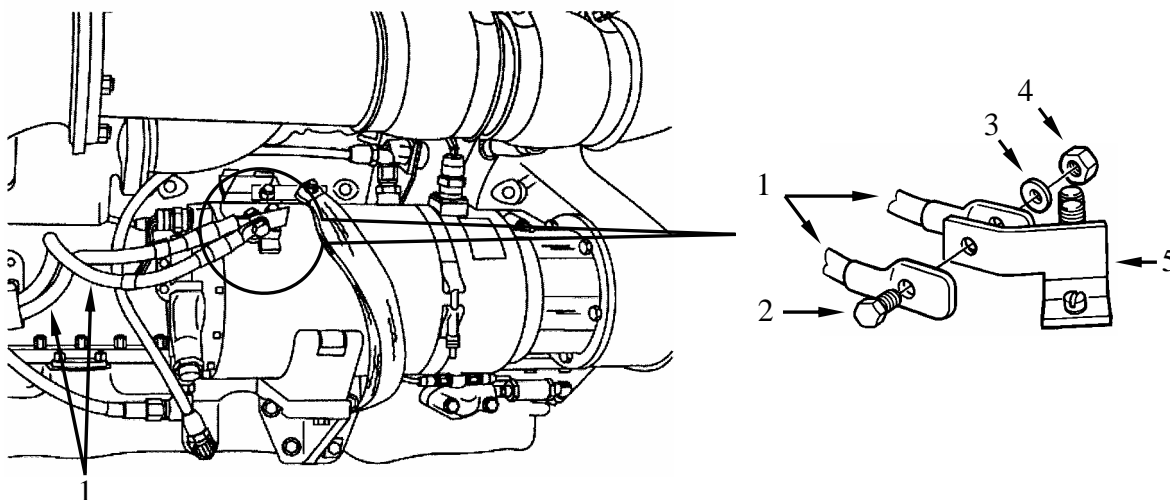
- b. Ormat: Connect ground straps (7) to bus bar (9) using screw (2), flat washer (3), and nut (4).



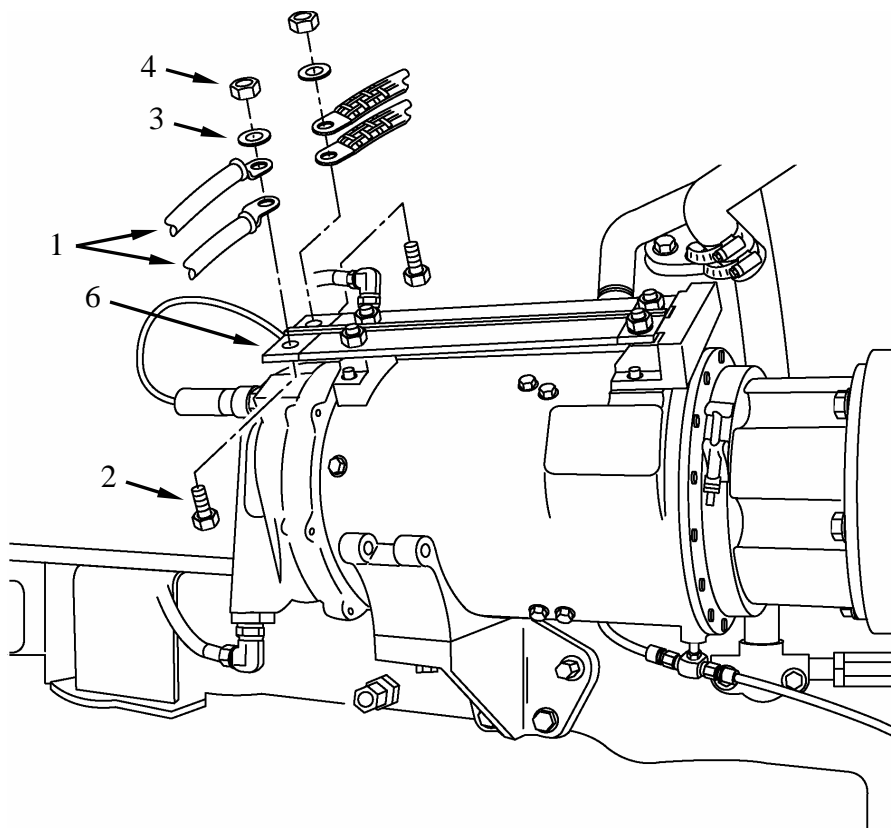
**INSTALLATION (Continued)**

13. Connect positive cables (1).

- a. Honeywell: Connect positive cables (1) to bus bar (5) using screw (2), flat washer (3), and nut (4).



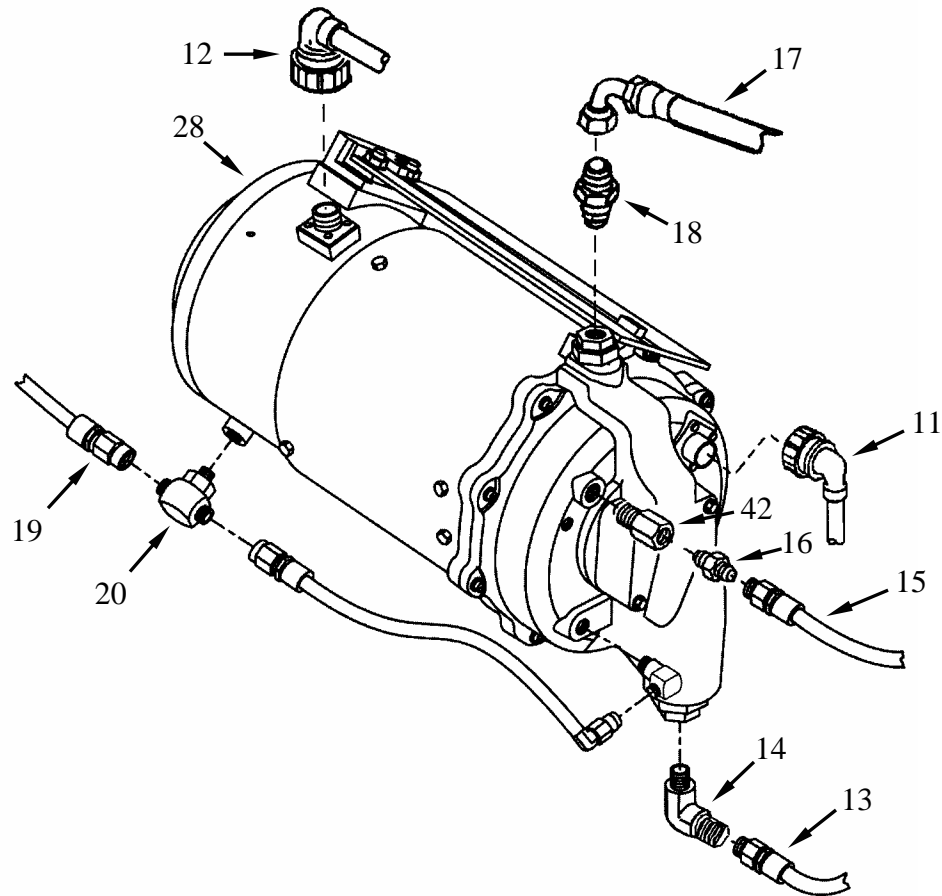
- b. Ormat: Connect positive cables (1) to bus bar (6) using screw (2), flat washer (3), and nut (4).





**INSTALLATION (Continued)**

14. Install rear oil drain hose (19) to tee (20).
15. Install oil inlet hose (13) to inlet elbow (14) on generator (28).
16. Install oil outlet hose (17) to oil outlet fitting (18) on generator (28).
17. Install vent hose (15) to fitting (16) assuring that orifice fitting (42) is in place.
18. Install J1 and J2 electrical connectors (11, 12) to generator (28).

**TEST**

1. Setup for ground hop according to the appropriate manual for your application.
2. Start engine and check generator for proper operation. Check that the Battery-Generator indicator needle is in green zone.
3. Check generator oil lines, fittings, and drive adapter for oil leaks. Correct leaks as required.
4. Disconnect from ground hop.
5. Coat all exposed generator terminals with Glyptal (MIL-E-22118) (item 13, WP 0173).

**END OF WORK PACKAGE**



**GENERATOR REPLACEMENT (300 AMPHERE)****0052 00****THIS WORK PACKAGE COVERS:**

Removal, Installation

**INITIAL SETUP:****Tools:**

Box wrench (item 135, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)

**Expendable and Durable Items:**

Silicon compound (item 34, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

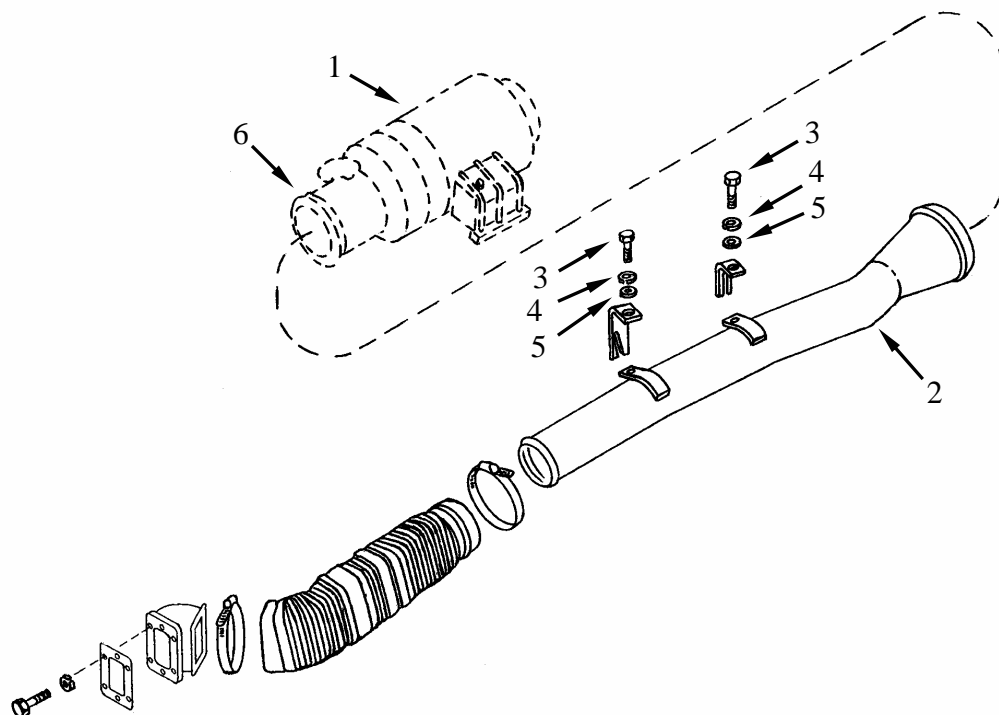
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

Tag all electrical connections and electrical leads prior to removal to aid in installation. Install nuts and lock washers on generator terminals after removal of wires. New generators are supplied with nuts and lock washers.

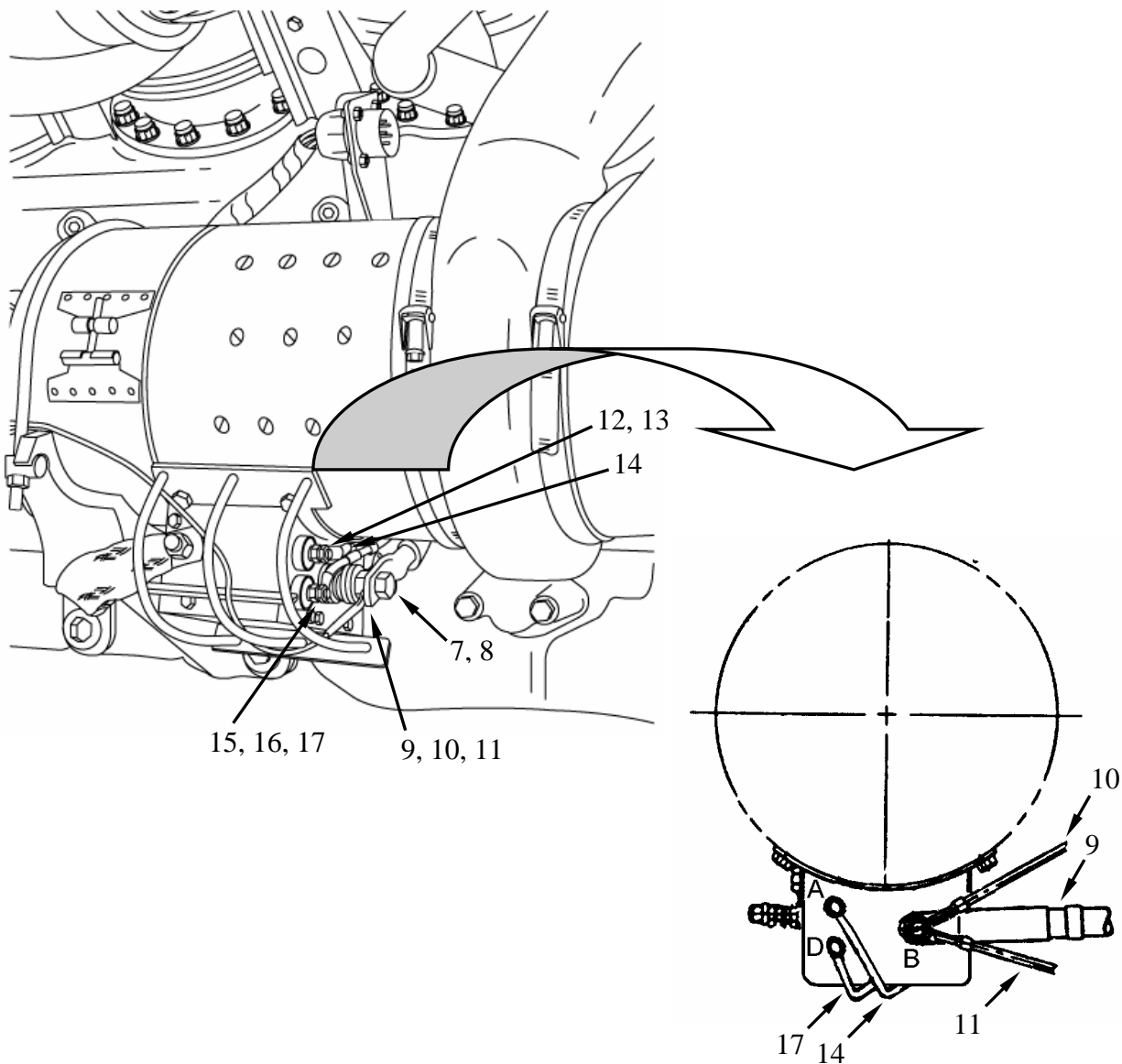
**REMOVAL**

1. Remove generator (1) air intake tube (2).
  - a. Remove two screws (3) with lock washers (4) and flat washers (5).
  - b. Slide generator air intake tube (2) away from generator (1) blower motor (6) housing to remove.



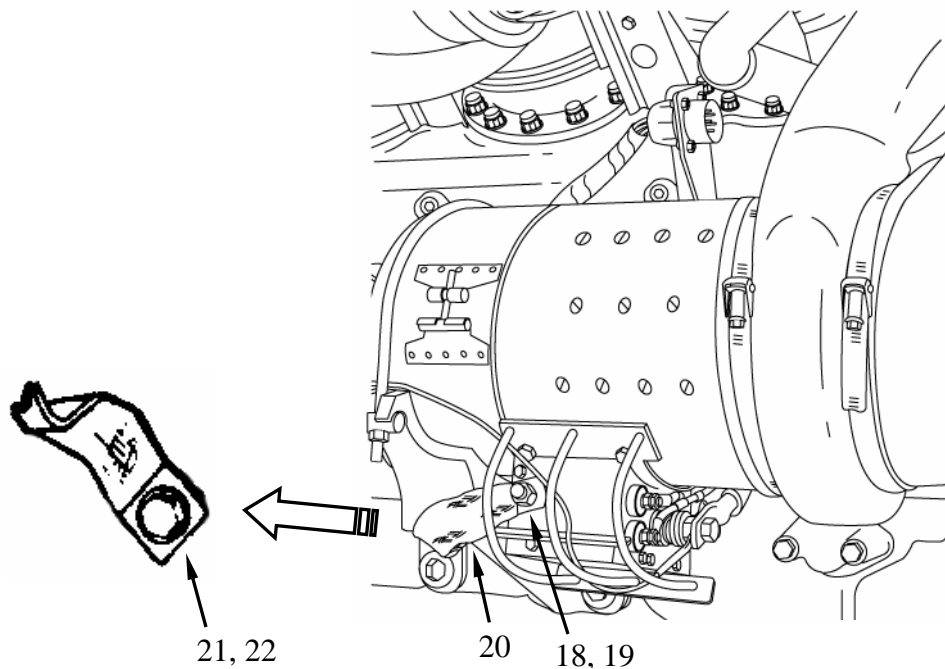
**REMOVAL (Continued)**

2. Disconnect positive polarity wiring.
  - a. Remove self-locking nut (7) with flat washer (8) to disconnect electrical cable (9) and electrical leads (10) and (11). Reinstall self-locking nut and flat washer.
  - b. Remove self-locking nut (12) with flat washer (13) to disconnect electrical lead (14). Reinstall self-locking nut and flat washer.
  - c. Remove self-locking nut (15) with flat washer (16) to disconnect electrical lead (17). Reinstall self-locking nut and flat washer.

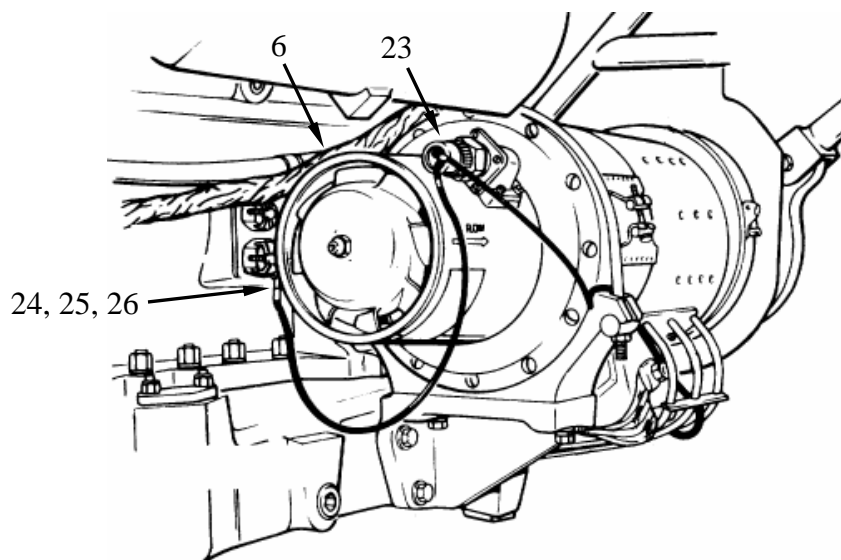


**REMOVAL (Continued)**

3. Disconnect negative polarity wiring.
  - a. Remove self-locking nut (18) with flat washer (19) to disconnect ground strap (20). Reinstall self-locking nut and flat washer.
  - b. Remove screw (21) with flat washer (22), to remove ground strap (20). Retain ground strap for reinstallation.

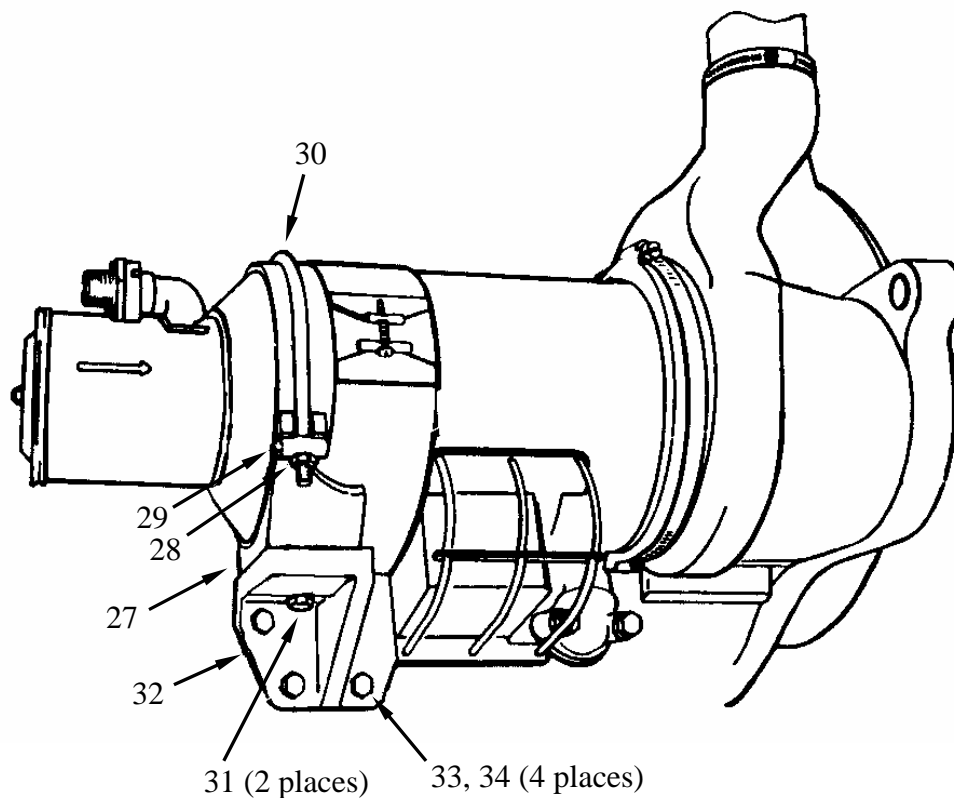


4. Disconnect generator blower (6) electrical connector (23).
  - a. Remove cap screw (24) with lock washer (25) to disconnect ground lead (26).
  - b. Disconnect and remove blower (6) electrical connector (23).



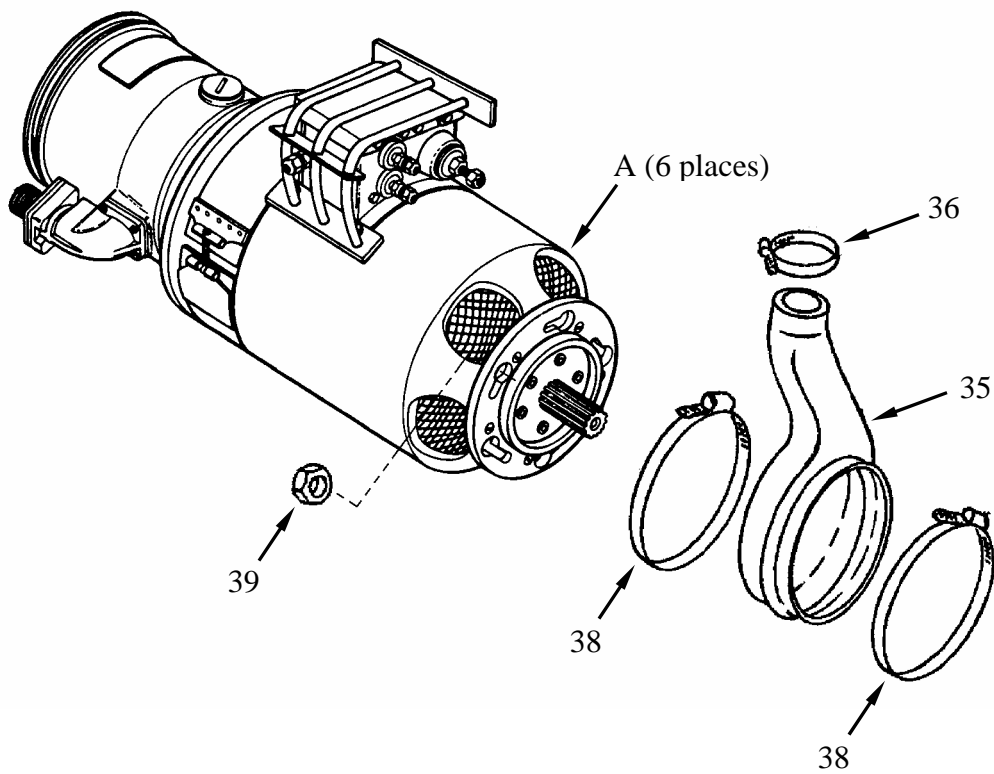
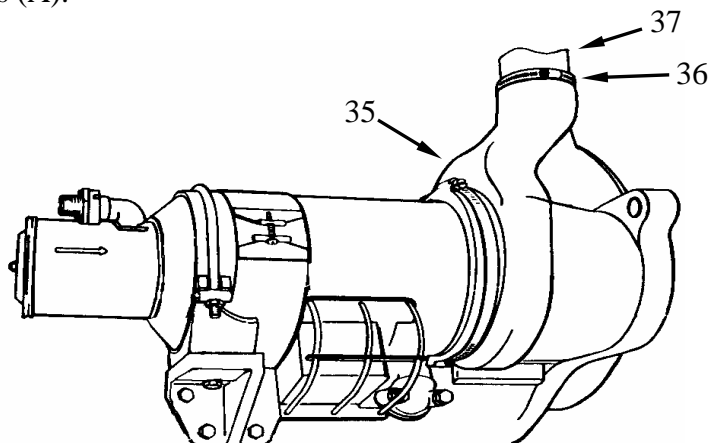
**REMOVAL (Continued)**

5. Remove cradle (27).
  - a. Remove self-locking nut (28) and clamping bar (29) from U-bolt (30).
  - b. Loosen two screws (31) securing cradle (27) to support (32).
  - c. Remove four screws (33) with flat washers (34) to remove generator support (32), cradle (27), and U-bolt (30) as an assembly.
  - d. Separate support (32), cradle (27), and U-bolt (30).



**REMOVAL (Continued)**

6. Reposition boot (35).
  - a. Loosen clamp (36) on generator cooling air exhaust tube (37).
  - b. Remove two clamps (38) securing boot (35) to generator.
  - c. Slide boot (35) back on generator far enough to expose mounting nut (39) access openings (A).

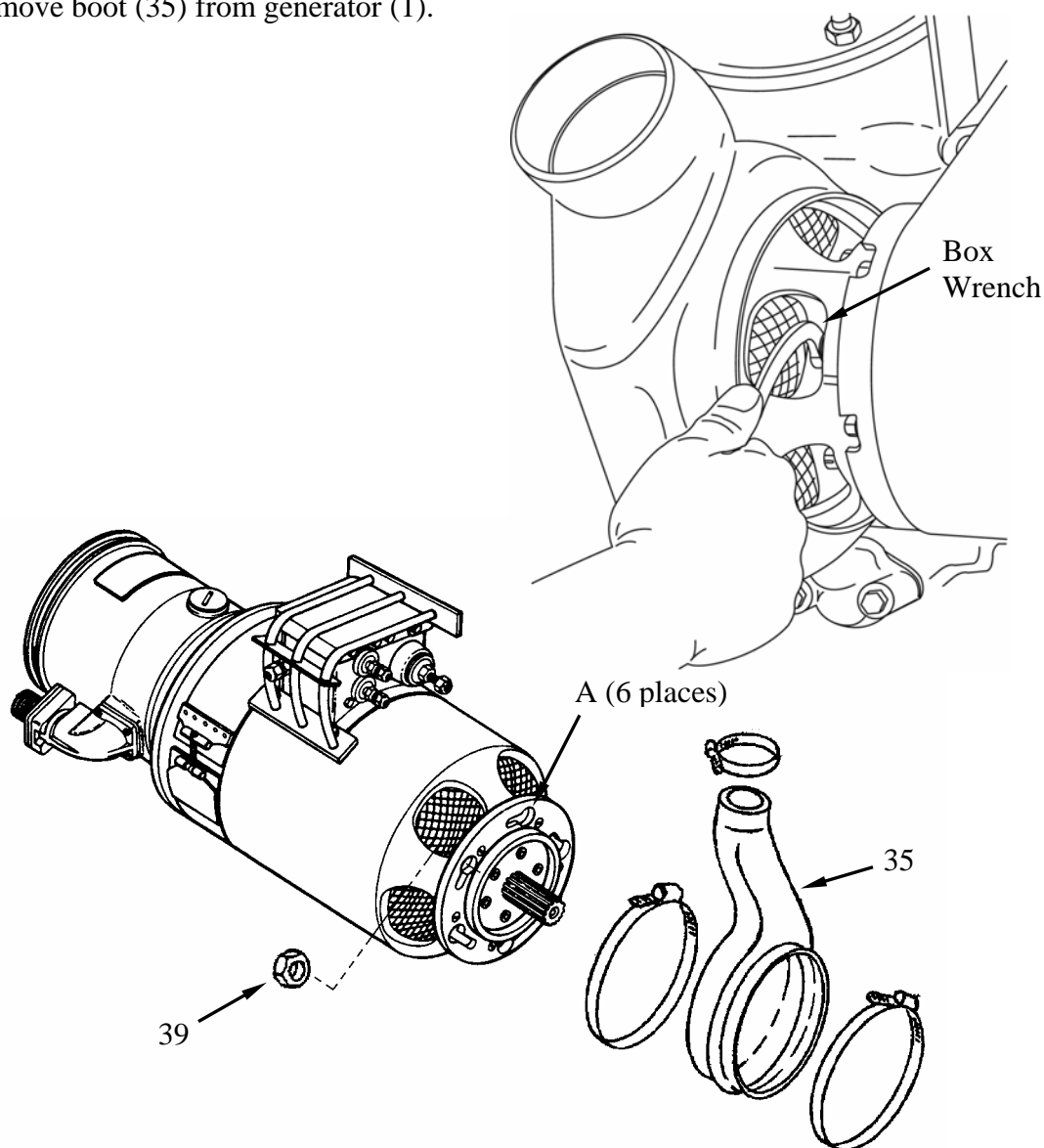


## REMOVAL (Continued)

**WARNING**

**The generator is heavy. Take care during removal or installation to prevent injury.**

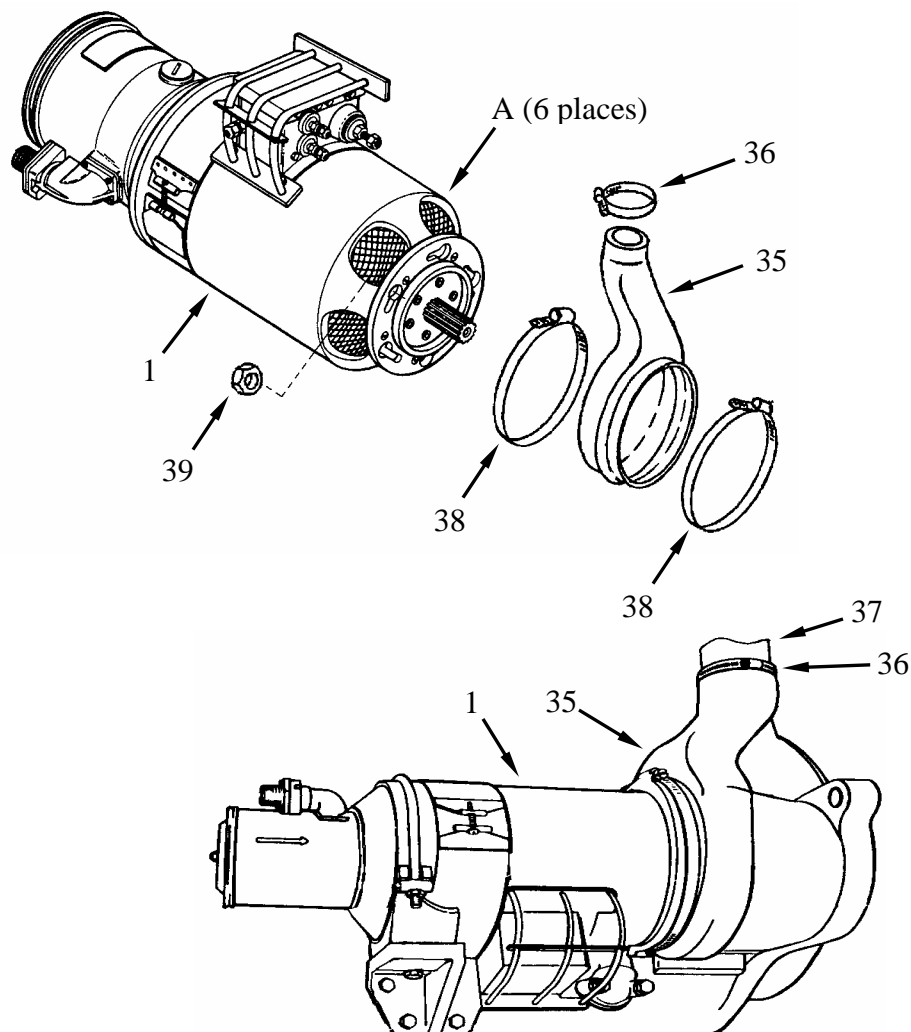
7. Remove generator (1).
  - a. Using box wrench (item 135, WP 0176), loosen but do not remove, six self-locking mounting nuts (39) to permit rotation of generator to align the large openings (A) in the elongated mounting slots.
  - b. Rotate generator counterclockwise until large openings (A) in flange are aligned with mounting nuts (39) to remove generator (1) and boot (35).
  - c. Remove boot (35) from generator (1).





**INSTALLATION**

1. Apply silicone compound (item 34, WP 0173) to the inside of the generator boot (35) sealing surface before installation.
2. Assure that six self-locking nuts (39) are started on generator mounting studs with clearance allowed for generator (1) flange.
3. Loosely install generator boot (35) on generator (1) so that mounting access openings (A) are exposed.
4. Position generator (1) so that large elongated openings in flange are aligned with mounting nuts (39), then install generator.
  - a. Rotate generator (1) counterclockwise to end of travel and tighten six self-locking nuts (39) using box wrench (item 137, WP 0176).
5. Loosely affix clamps (38), then position generator boot (35) so that outlet end aligns with exhaust tube (37) and mounting access openings (A) are not exposed.
  - a. Secure generator boot with one hose clamp (36) at exhaust tube and two clamps (38) on large diameter.

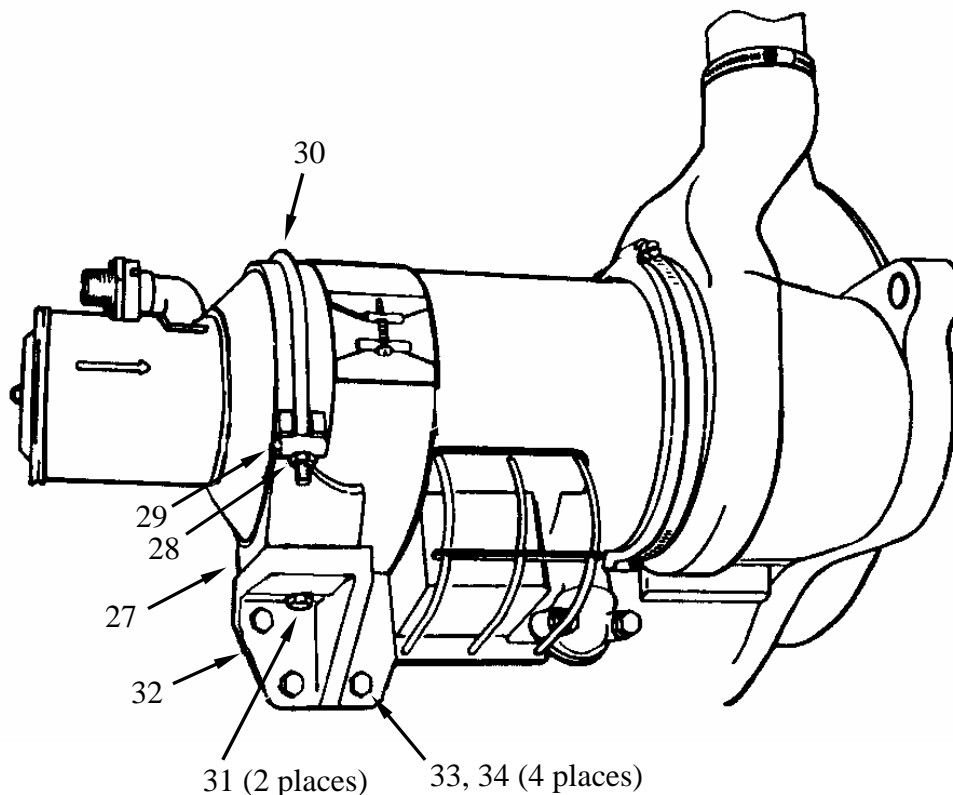


## INSTALLATION (Continued)

**CAUTION**

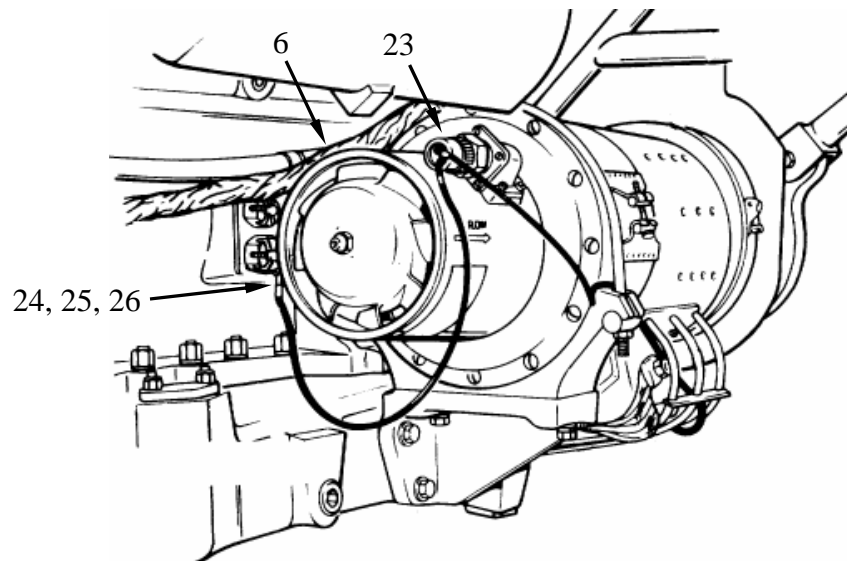
**It is of utmost importance that the generator support, cradle, and U-bolt be installed in a manner that will not disturb generator mounting alignment and still furnish adequate support to minimize vibration. Misalignment of 0.010 inch in any direction is sufficient to cause a leak (pressure loss) between the generator mounting flange and the generator mounting adapter. Follow the procedure to assure alignment and proper support.**

6. Loosely assemble cradle (27) to bracket (32) allowing cradle to move freely in elongated holes.
7. Position the assembled generator cradle (27) and bracket (32) on the oil pan.
  - a. Secure using four bolts (33) with flat washers (34). Tighten bolts only until heads engage washers (finger tight).
  - b. Install U-bolt (30) over generator and secure using self-locking nut (28) and clamping bar (29).
  - c. Tighten two screws (31) securing cradle (27) to support (32).
  - d. Tighten four screws (33) securing support.

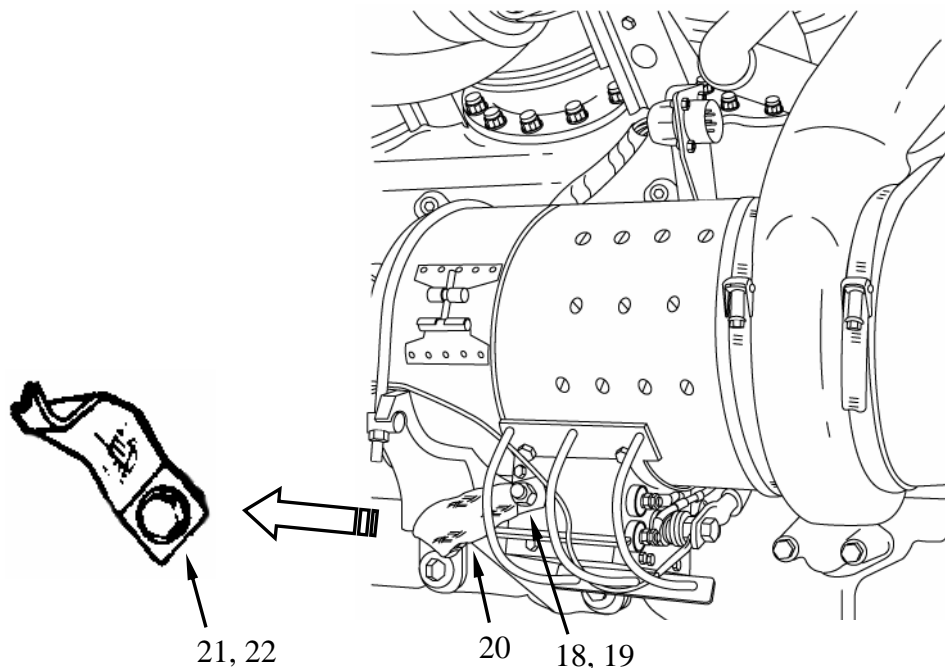


**INSTALLATION (Continued)**

8. Install generator blower (6) electrical connector (23).
  - a. Connect blower (6) electrical connector (23).
  - b. Install ground lead (26) to crankcase and secure using screw (24) with lock washer (25).

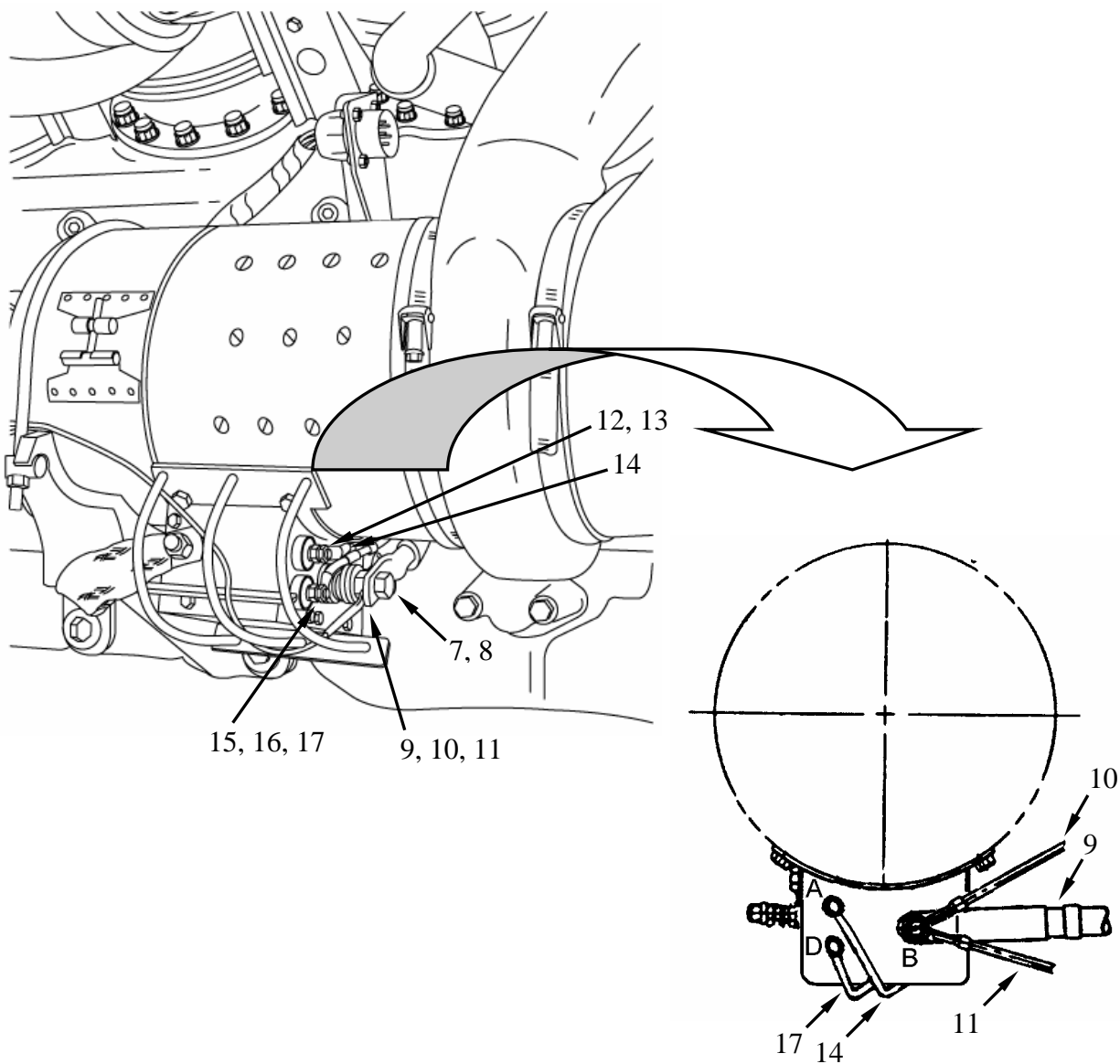


9. Connect negative polarity wiring.
  - a. Connect one end of ground strap (20) to crankcase using screw (21) with flat washer (22).
  - b. Connect opposite end of ground strap (20) to generator using self-locking nut (18) with flat washer (19).



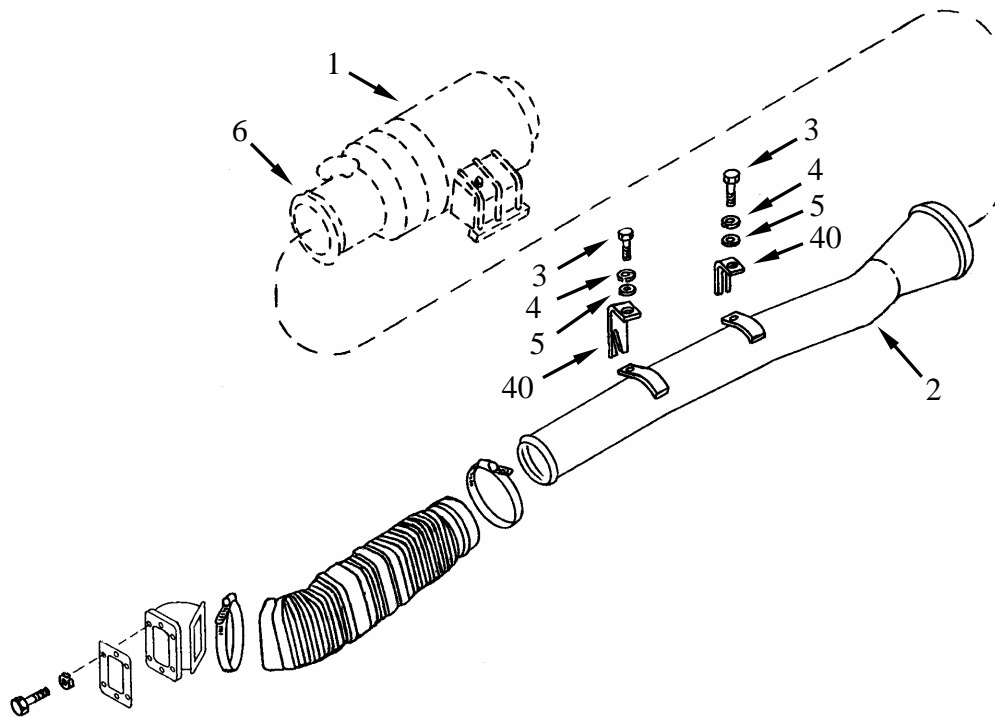
**INSTALLATION (Continued)**

10. Install electrical lead from blower motor harness (11) circuit number 530 (10) and electrical cable (9) on generator terminal "B".
  - a. Secure using self-locking nut (7) with flat washer (8).
11. Install electrical lead 478 (17) on generator terminal "D".
  - a. Secure using self-locking nut (15) with flat washer (16).
12. Install electrical lead 1 (14) on generator terminal "A".
  - a. Secure using self-locking nut (12) with flat washer (13).



INSTALLATION (Continued)

13. Install generator air intake tube (2) on generator blower motor (6) housing.
  - a. Secure to front and rear support brackets (40) using two cap screws (3), with lock washers (4), and flat washers (5).



END OF WORK PACKAGE



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**COOLING FAN INSPECTION**

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0053 00

**THIS WORK PACKAGE COVERS:**Inspection and Repair

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**INITIAL SETUP:****Tools:**

Fan rotor gauge (item 43, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Magnifier (item 73, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a  
flat stationary surface  
Fan vanes removed (WP 0054)

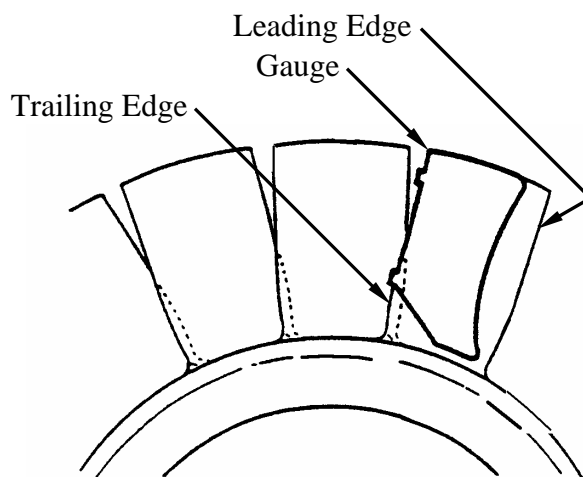
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**INSPECTION**

<b>WARNING</b>
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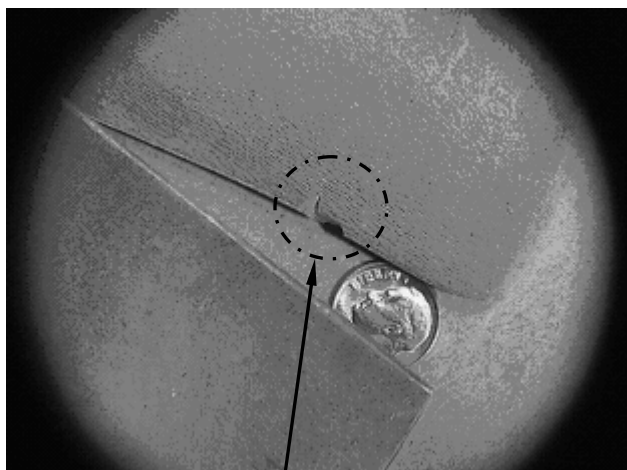
**Do not file, sand, or otherwise remove metal from fan blades since this will disturb the balance of the fan. An unbalanced fan could explode causing serious injury or death to personnel. Any repair of a fan blade must be done at Depot.**

1. Inspect fan blades for erosion.
  - a. Place fan rotor gauge (item 43, WP 0176) on the top surface of any suspect blade, with the tabs in contact with the trailing edge.
  - b. If the blade is eroded to the extent that the gauge hides any part of the leading edge of the blade, the fan must be replaced.

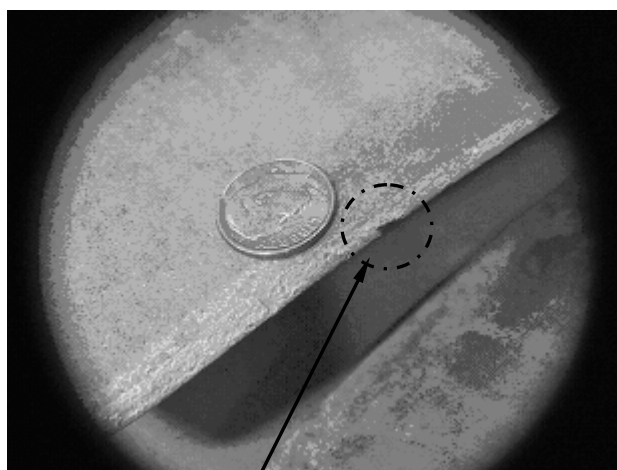


**INSPECTION (Continued)**

2. Visually inspect cooling fans. Use a magnifying glass (item 73, WP 0176) and a strong light.
  - a. Look for cracks, nicks, and scratches.
    - (1) Any crack (especially in the area of a bolt hole) is sufficient cause for replacement of a fan.
    - (2) Nicks and scratches require a judgement call: small scratches (1/32-inch deep by 1/16-inch long) and nicks (1/32-inch deep by 1/4-inch long) are acceptable while large ones are not. The following pictures are examples of acceptable and unacceptable nicks. The dimes in the pictures are for size referencing. If in doubt replace the fan.



Unacceptable Nick



Acceptable Nick

- b. Replace a cooling fan that has bent, broken or warped blades.
    - c. Replace a fan if bolt holes are elongated or show evidence of wear.

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Installation

**INITIAL SETUP:**

**Tools:**

- Fan rotor gauge (item 43, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Puller, Mechanical (2) (item 90, WP 0176)
- Torque wrench, 0-600 foot-pounds (item 128, WP 0176)

**Mandatory Replacement Parts:**

- Cotter pin (2) (item 53, WP 0175)
- Gasket (2) (item 257, WP 0175)

**Mandatory Replacement Parts (Continued):**

- Lock washer (12) (item 94, WP 0175)
- Seal (2) (item 191, WP 0175)
- Self-locking nut (2) (item 113, WP 0175)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

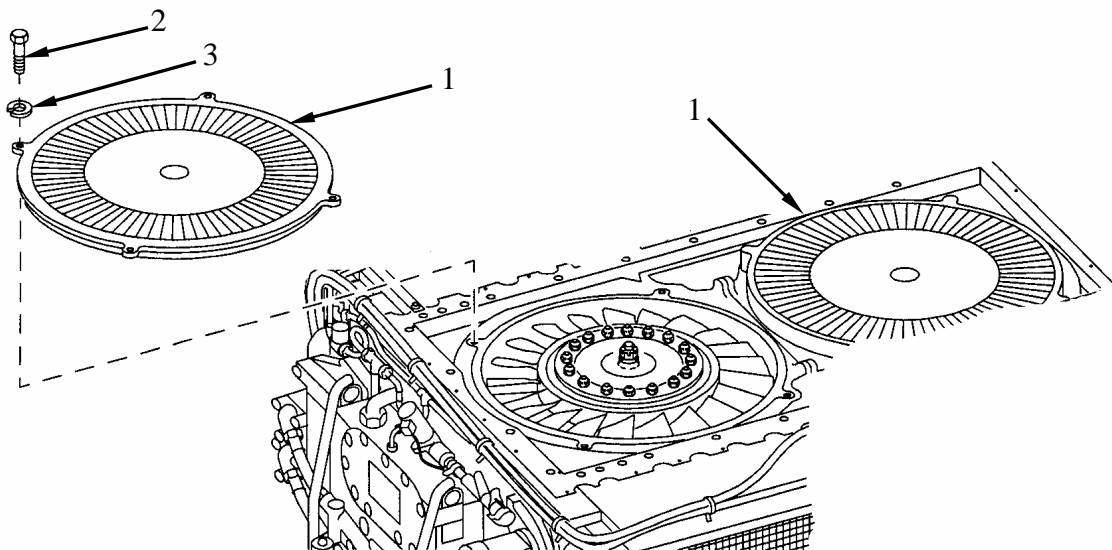
- Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

**NOTE**

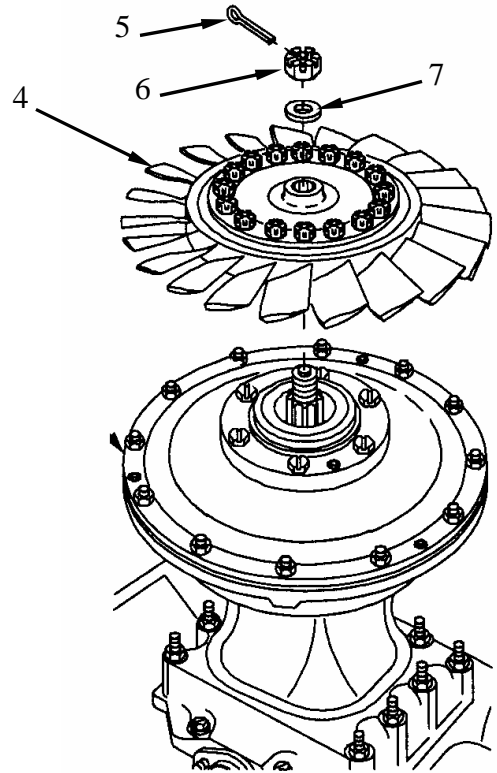
**Removal of front and rear cooling fans and vanes are identical. Three different length screws secure the cooling fan vane housings to the cooling fan housings. Mark each screw during removal and note the location to aid in proper placement during installation.**

1. Remove front and rear vane housings (1).
  - a. Remove eight screws (2) with lock washers (3). Discard lock washers.
  - b. Remove two vanes housings (1) from engine.



**REMOVAL (Continued)**

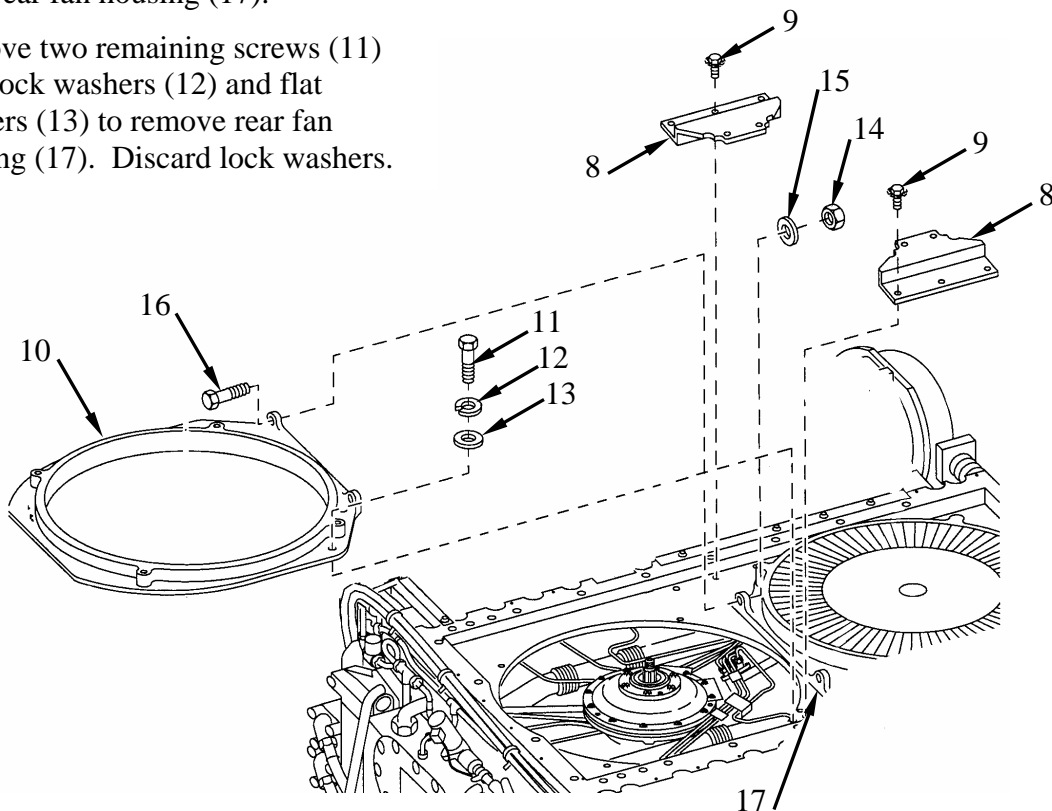
2. Remove cooling fan assemblies (4).
  - a. Remove and discard cotter pin (5).
  - b. Remove slotted nut (6).
  - c. Remove flat washer (7).
  - d. Remove fan assembly (4)
  - e. Repeat step to remove opposite fan.



3. Remove two cover plates (8).
  - a. Remove ten assembled washer screws (9) to remove cover plates (8).

4. Remove front fan housing (10).
  - a. Remove two screws (11) with lock washers (12) and flat washers (13) securing fan housing to top deck. Discard lock washers.
  - b. Remove two self-locking nuts (14), with flat washers (15) from two screws (16) to separate front fan housing (10) from rear fan housing (17). Discard nuts.

5. Remove rear fan housing (17).
  - a. Remove two remaining screws (11) with lock washers (12) and flat washers (13) to remove rear fan housing (17). Discard lock washers.



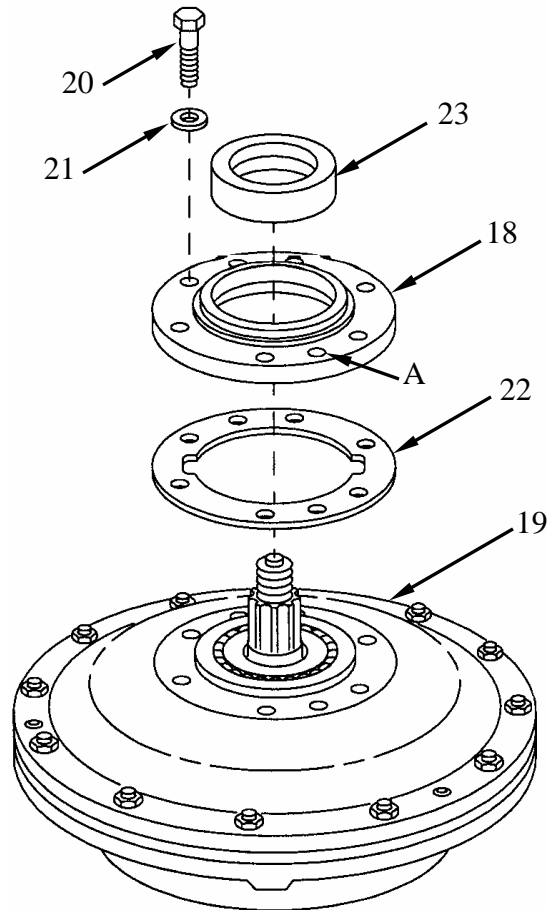
**REMOVAL (Continued)****NOTE**

**Front and rear fan tower seal replacement procedures are identical.**

**CAUTION**

**Do not attempt to pry seal housing from fan tower: both the seal housing and fan tower are made of aluminum and are easily damaged.**

6. Remove seal housing (18) from fan tower (19).
  - a. Remove six screws (20) with flat washers (21) securing seal housing (18).
  - b. Install two mechanical pullers (item 77) in threaded holes (A) of seal housing. Alternately tighten pullers to remove seal housing.
  - c. Remove and discard gasket (22).
  - d. Remove seal (23) from oil seal housing (18). Discard seal.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See WP 0028 for Standard Inspection Procedures.

**INSTALLATION**

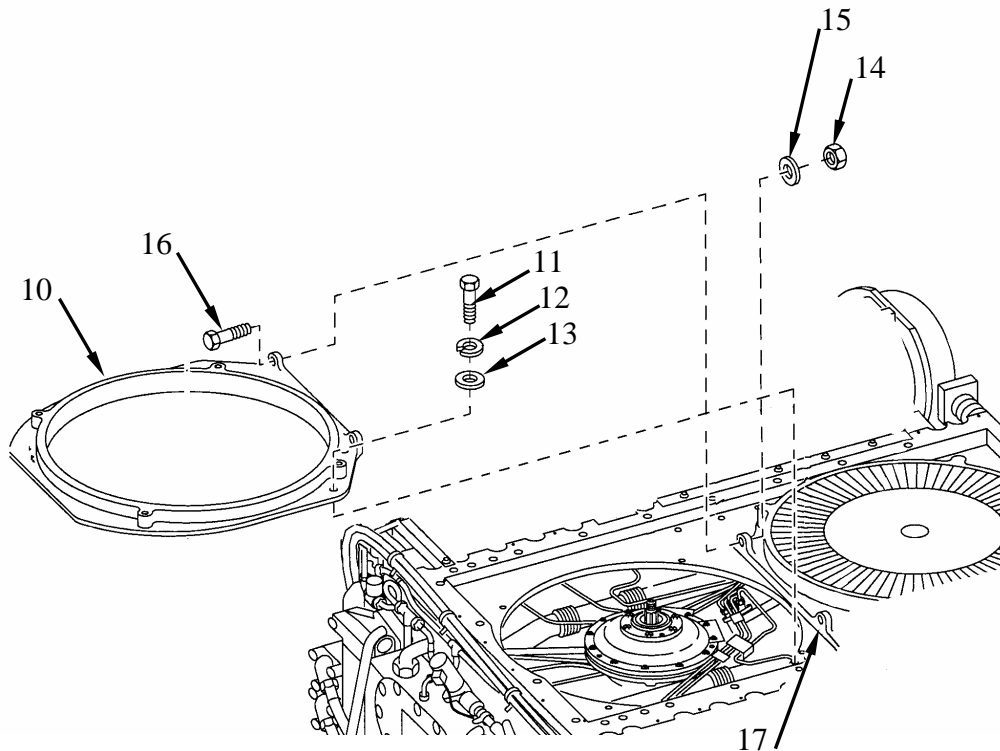
1. Install new seal (23) in seal housing (18).
  - a. Install seal (23) (item 191, WP 0175) in housing (18) with lip of seal towards bottom of housing and felt towards top.
2. Install seal housing (18) on fan tower (19).
  - a. Assuring that mating surfaces are clean, place new gasket (22) (item 257, WP 0175) on fan tower.
  - b. Install oil seal housing (18).
  - c. Secure with six screws (20) and flat washers (21).

## INSTALLATION (Continued)

## NOTE

**Front and rear fan housings must be aligned for clearance with tips of fan blades. Install all fasteners and snug tighten only until clearance is obtained.**

3. Install rear fan housing (17).
  - a. Place rear fan housing (17) into position and secure using two screws (11) with two new lock washers (12) (item 94, WP 0175) and two flat washers (13). Do not tighten screws (11) at this time.
4. Install front fan housing (10).
  - a. Place front fan housing (10) into position and secure using two screws (11) with two new lock washers (12) (item 94, WP 0175) and two flat washers (13). Do not tighten screws (11) at this time.
  - b. Install two screws (16) to fasten front fan housing (10) to rear fan housing (17). Secure with two new self-locking nuts (14) (item 113, WP 0175) using flat washers (15). Hand tighten only at this time.



**INSTALLATION (Continued)**

5. Place fan (4) over shaft (24) rotating slightly (if necessary) to align with spline.

a. Secure with flat washer (7) and slotted nut (6).

b. Using torque wrench, torque nut (6) 600-625 inch-pounds (68-71 N•m) and install new cotter pin (5) (item 53, WP 0175).

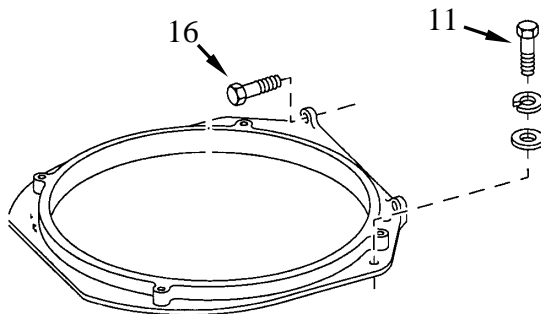
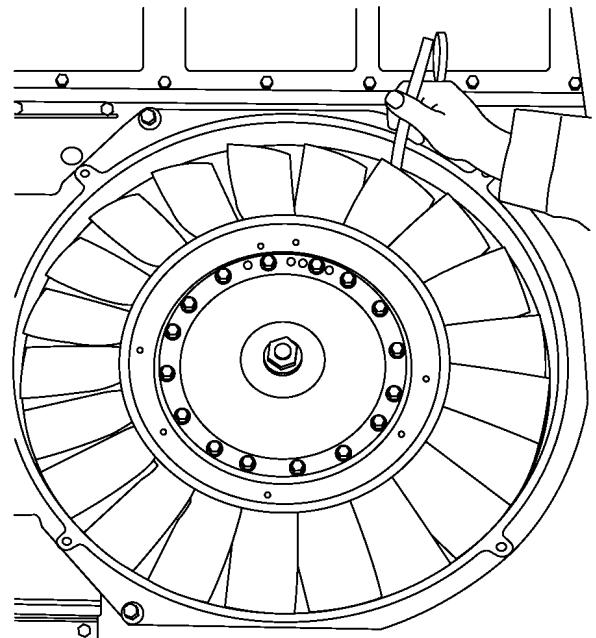
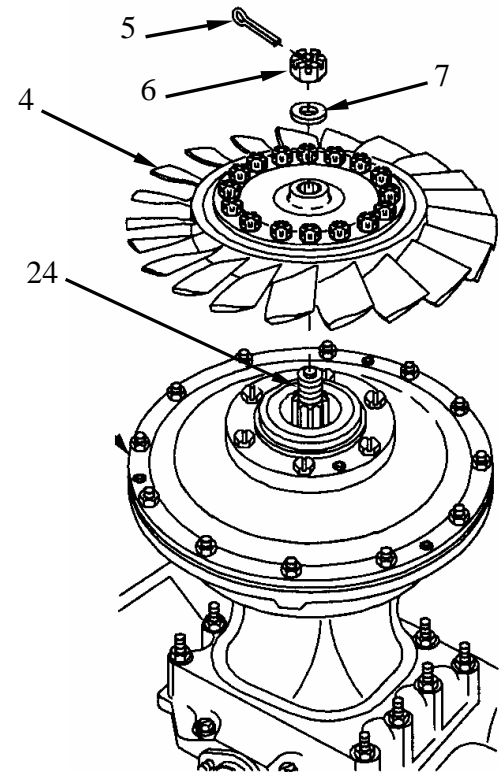
c. Repeat for opposite fan.

6. Check fan (4) clearance.

a. Using fan rotor gauge or 0.062-inch feeler stock, check clearance between tips of front and rear fan blades and inside diameter of fan housings.

b. Check clearance in four opposing positions (front, back, left, and right) for each fan. Clearance must be 0.062 inch (1.5748 mm) minimum.

c. Shift fan housings until clearance is obtained. Tighten fasteners (11 and 16), then recheck clearance. Repeat as necessary until clearance is obtained and fasteners are tight.



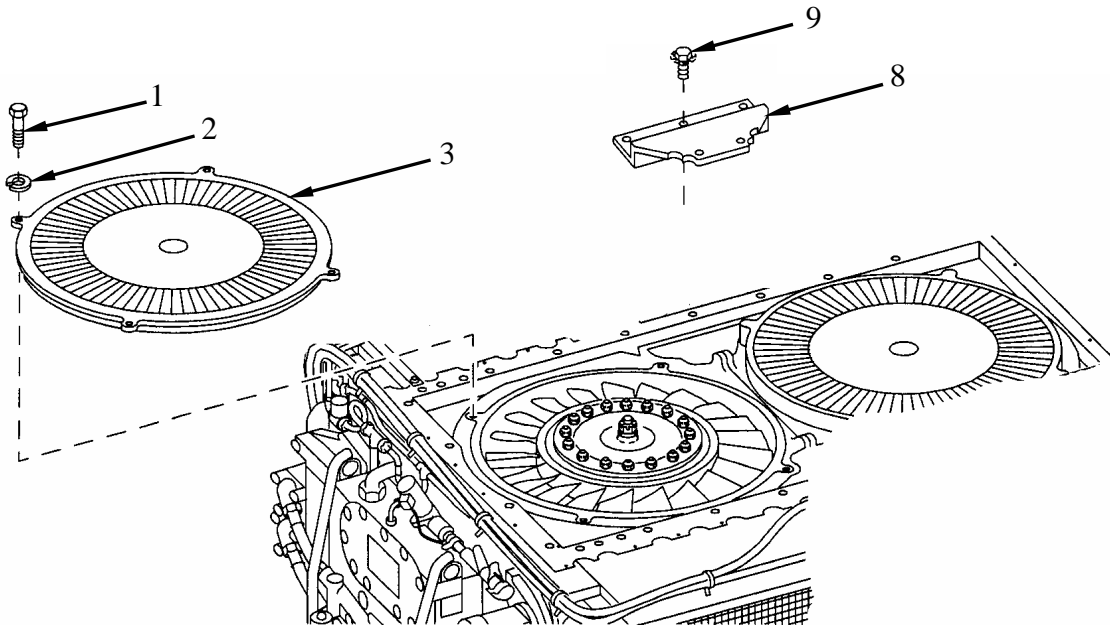
**INSTALLATION (Continued)**

7. Install two cover plates (8).
  - a. Place cover plates (8) in position and secure with ten assembled washer screws (9).

**NOTE**

**Some of the cap screws fastening vane housings also fasten fan housings. The two longest screws are used at the flywheel end and secure both vane housing and rear fan housing. The four shortest screws are used in the center and secure only the vane housings. The medium length screws are used at the damper end and secure both vane housing and front fan housing. Be sure to put the correct fastener in the correct location.**

8. Install vane housings (3).
  - a. Position two vanes housings (1) in place over fans.
  - b. Secure with eight screws (2) using new lock washers (3) (item 94, WP 0175).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Washer-bolt (10) (item 317, WP 0174)

**Mandatory Replacement Parts:**

Lock washer (8) (item 94, WP 0175)

Self-locking nut (12) (item 364, WP 0175)

**Personnel Required:**

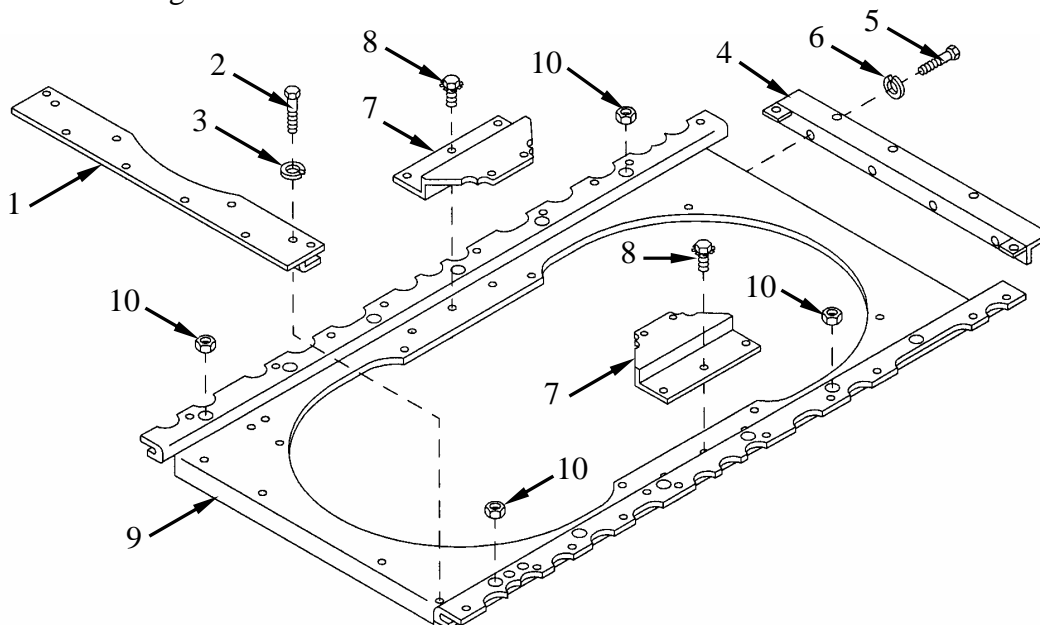
Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Cooling fans and housings removed (WP 0054)

**REMOVAL**

1. Remove front mounting bracket (1).
  - a. Remove four screws (2) with lock washers (3) to remove bracket assembly (1) from engine. Discard lock washers.
2. Remove rear mounting bracket (4).
  - a. Remove four screws (5) with lock washers (6) to remove rear mounting bracket (4) from engine. Discard lock washers.
3. Remove access covers (7).
  - a. Remove ten assembled washer-bolts (8) to remove two access covers (7) from top shroud (9). Discard assembled washer-bolts.
4. Remove top shroud (9).
  - a. Remove 12 self-locking nuts (10) to remove housing assembly (9) from engine. Discard self-locking nuts.



**CLEANING**

See Work Package 0028 for Standard Cleaning Procedures.

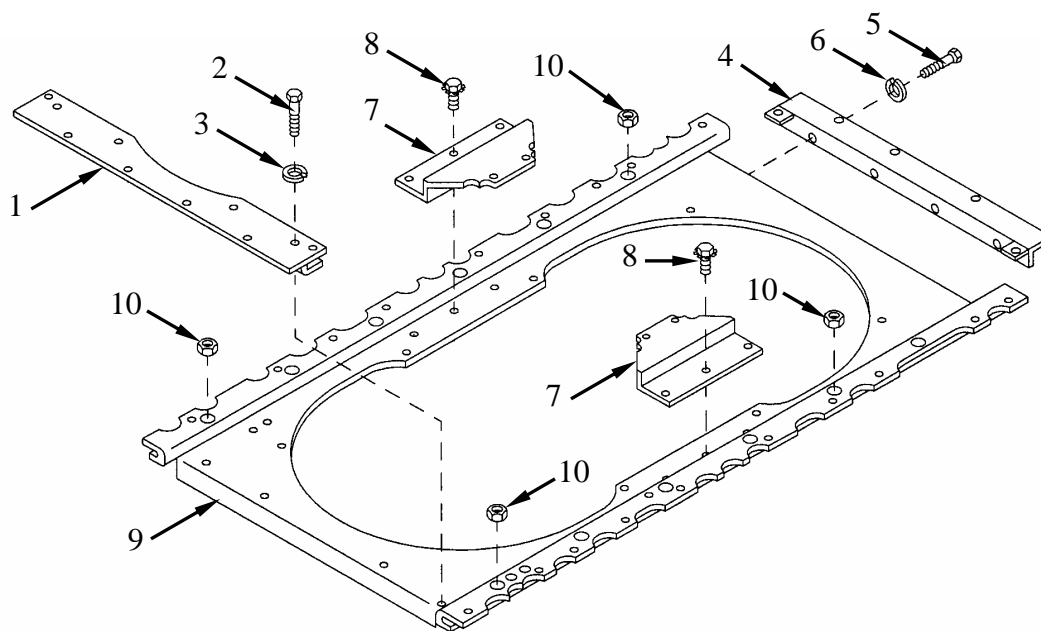
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install top shroud (9).
  - a. Secure top shroud (9) with 12 new self-locking nuts (10) (item 364, WP 0175).
2. Install access covers (7).
  - a. Secure two access covers (7) with ten new assembled washer-bolts (8) (item 317, WP 0175).
3. Install rear mounting bracket (4).
  - a. Secure rear mounting bracket (4) using four screws (5) with new lock washers (6) (item 94, WP 0175).
4. Install front mounting bracket (1).
  - a. Secure front mounting bracket (1) using four screws (2) with new lock washers (3) (item 94, WP 0175).



**END OF WORK PACKAGE**



**WIRING HARNESS AND CABLE REPAIR****0056 00****THIS WORK PACKAGE COVERS:**

General, Circuit Designations, Wiring Diagrams, Standard Repair Procedures for Wiring Harnesses and Cables, Replacement of Connectors

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

General mechanic's tool kit (item 121, WP 0176)  
 Electrical maintenance kit (item 36, WP 0176)  
 Electrical heat gun (item 63, WP 0176)  
 Soldering gun (item 108, WP 0176)

**Expendable Materials:**

Adhesive (item 1, WP 0173)  
 Heat shrink insulation tubing (item 35, 36, WP 0173)

**Expendable Materials (Continued):**

Insulation tape (item 40, WP 0173)  
 Sealing compound (item 30, 31, 32, WP 0173)  
 Sealing compound, silicone sealant (item 33, WP 0173)  
 Silicone compound (item 34, WP 0173)  
 Solder (item 38, WP 0173)  
 Soldering flux (item 14, WP 0173)  
 Varnish (item 42, WP 0167)

**GENERAL**

Repair of harnesses and power pack wiring is limited to replacement of faulty connectors and receptacles and to the substitution of a jumper wire for a defective harness wire. When repair is necessary, free the lead, harness or cable only insofar as necessary to effect the repair. This consists of disconnecting the connectors or receptacles at each end, and loosening or removing cable clamps or removing tie wraps as required. Removal of the complete harness, especially in case of the longer and more complex harnesses, should be avoided.

The electrical system wiring harness assembly for engine Models 2CA and 2DA is made up of two major circuits, the engine circuit and transmission circuit. The engine circuit includes leads for the starter, starter low voltage protection module, generator, generator blower motor (Model 2DA only), manifold heater system, engine oil pressure and oil temperature transmitters, fuel solenoids, fuel/water separator automatic drain module, and hour meter. The transmission circuit includes leads for the neutral safety switch, oil pressure and oil temperature transmitters, and manifold heater solenoid.

The electrical system wiring harness assembly for engine Model 2DR is made up of one major circuit. The engine circuit includes leads for starter solenoid wiring harness, generator, generator blower motor, manifold heater system, oil pressure and oil temperature transmitters, fuel solenoids, fuel shutoff, governor solenoid, auxiliary generator oil pressure switch, fuel/water separator automatic drain module, hour meter, and transmission oil pressure and temperature transmitters.

**DISCONNECT POINTS**

Wiring harnesses, cables and leads that terminate at removable plug-in connectors and receptacles, interconnects the various electrical components. The cables, leads and harnesses are fastened to the engine and/or transmission by means of tie wraps and loop clamps which are secured to tapped pads and brackets.

The wiring harness to vehicle interface connector mounting brackets (on Models 2CA and 2DA) are located at the top of engine. The wiring harness to vehicle interface connector mounting bracket (on Model 2DR) is located on the left side of the transmission. The interface location provides a means of quickly disconnecting the electrical circuit from the vehicle.

**CIRCUIT DESIGNATIONS**

The circuit numbers assigned to the electrical circuits are listed in the following table. Each harness, cable and electrical lead has a numbered band to identify the circuit. The band number is shown at the termination of each circuit on the wiring diagrams following the table.

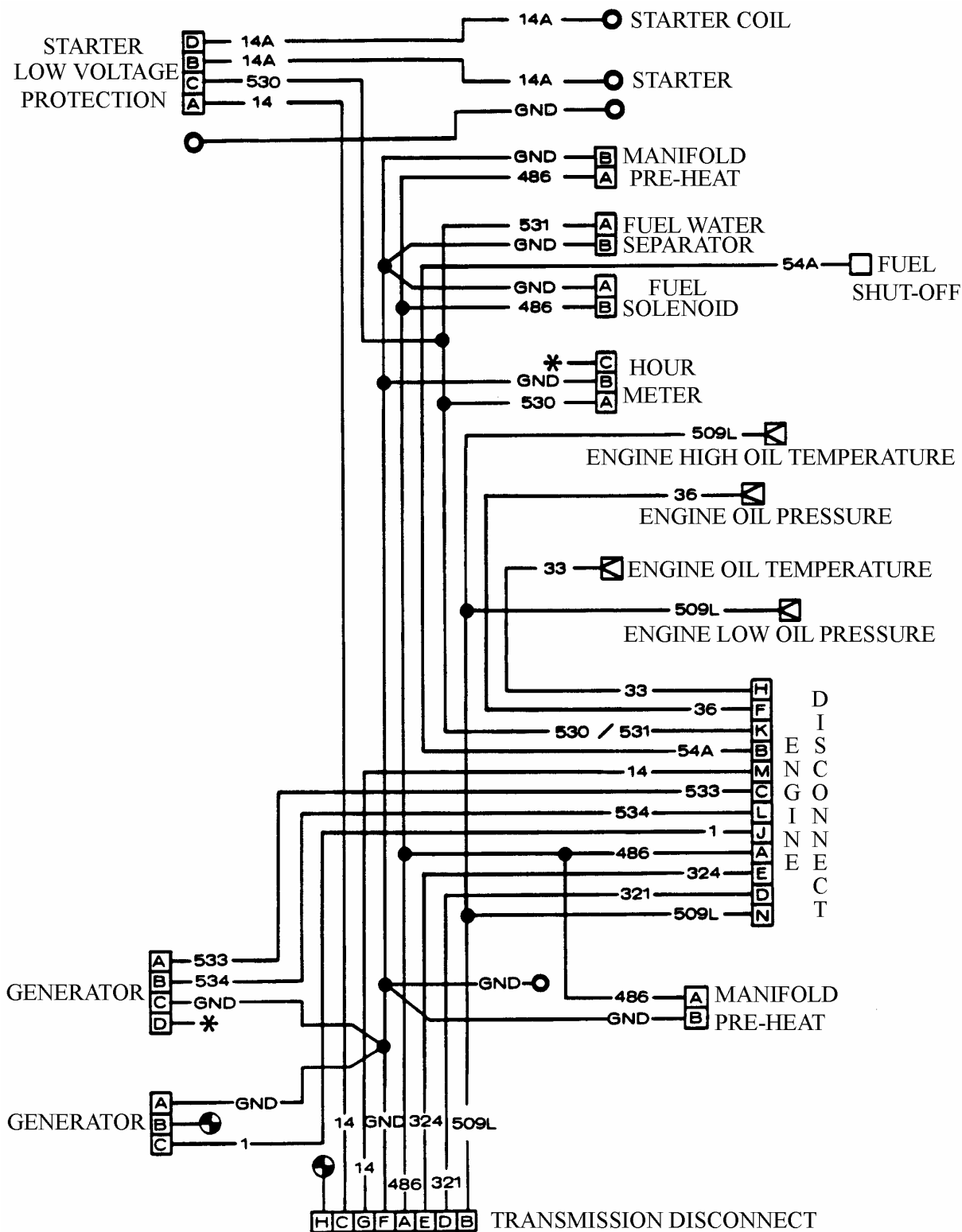
CIRCUIT DESIGNATION TABLE		
BAND	MODEL	DESIGNATION
1	---	Generator-to-engine disconnect.
2	---	Generator-to-engine disconnect.
14	2CA, 2DA	Starter low voltage protection module-to-transmission disconnect. Transmission neutral shift switch to transmission disconnect, and transmission disconnect to engine disconnect.
14	2DR	Starter low voltage protection module-to-engine disconnect.
14A	2CA, 2DA	Starter low voltage protection module to starter.
26	2DR	Generator-to-engine disconnect.
33	---	Engine oil temperature transmitter to engine disconnect.
36	---	Engine oil pressure transmitter to engine disconnect.
54	2DR	Fuel shutoff to engine disconnect.
54A	2CA, 2DA	Fuel shutoff to engine disconnect.
74	2DR	Starter solenoid to starter low voltage protection module.
81	2CA, 2DA	Starter-to-engine disconnect.
82	2DR	Starter solenoid to engine disconnect.
321	2CA, 2DA	Transmission oil pressure transmitter to transmission disconnect, and transmission disconnect to engine disconnect.
321	2DR	Transmission oil pressure transmitter to engine disconnect.

**CIRCUIT DESIGNATIONS (Continued)**

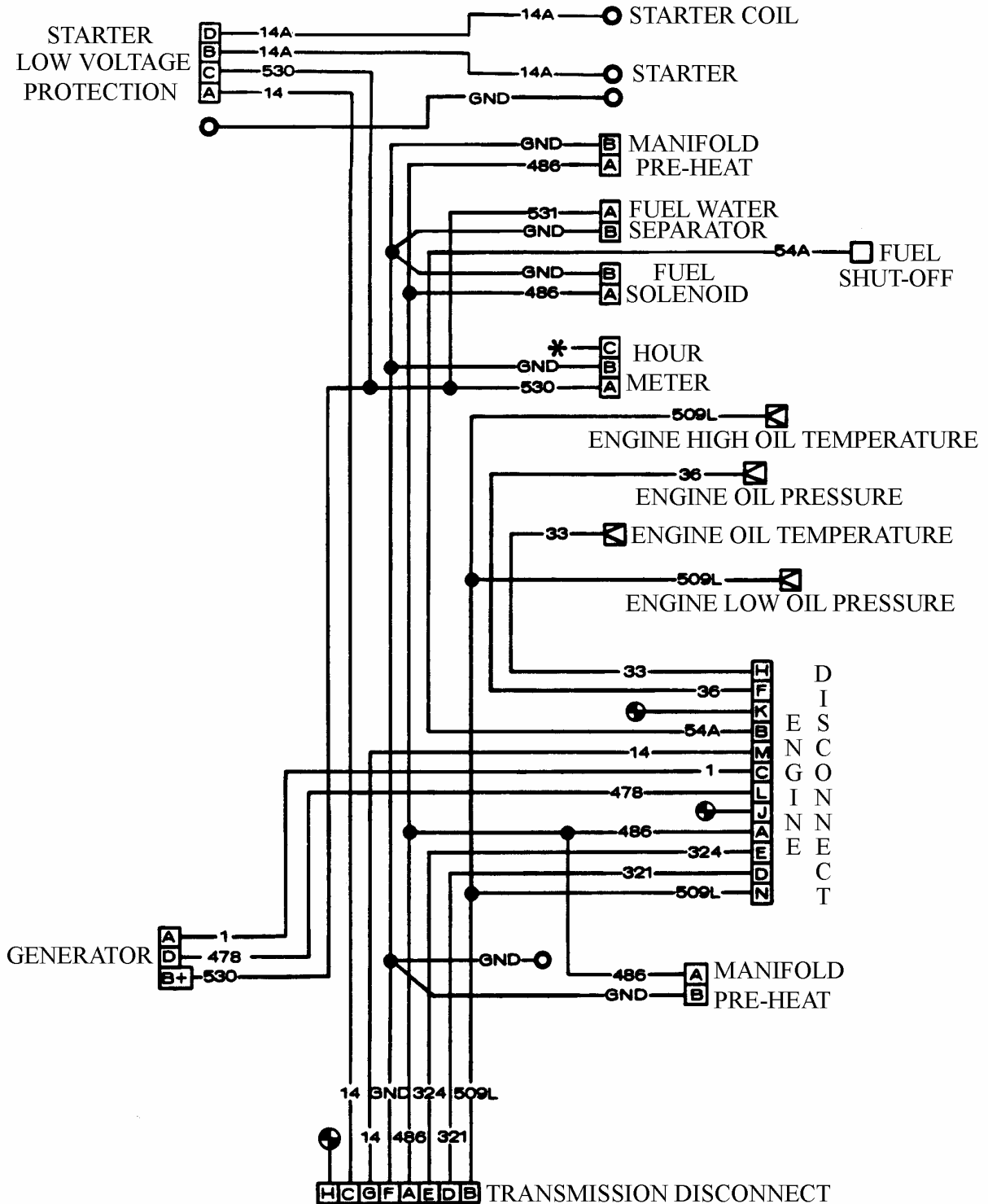
<b>CIRCUIT DESIGNATION TABLE (Continued)</b>		
<b>BAND</b>	<b>MODEL</b>	<b>DESIGNATION</b>
324	2CA, 2DA	Transmission oil temperature transmitter to transmission disconnect, and transmission disconnect to engine disconnect.
324	2DR	Transmission oil temperature transmitter to engine disconnect.
415	2DA	Generator to generator blower motor .
415	2DR	Generator blower motor to splice circuit No. 26.
478	2CA, 2DA	Generator-to-engine disconnect.
486	2CA, 2DA	Manifold pre-heaters (2) and fuel solenoid to transmission disconnect and engine disconnect. Rear fuel solenoid to transmission disconnect.
486	2DR	Manifold pre-heaters (2) and fuel solenoids (2) to engine disconnect.
509	2DR	Engine high oil temperature transmitter, engine low oil pressure transmitter, and transmission high oil temperature transmitter to engine disconnect.
509L	2CA, 2DA	Engine high oil temperature transmitter and engine low oil pressure transmitter to engine disconnect. Transmission high oil temperature transmitter to transmission disconnect. Transmission disconnect to engine disconnect.
510	2DR	Dust detector pressure switches (2) to starter ground harness.
530	2CA	Hour meter and fuel/water separator drain module to engine disconnect.
531	2DA	Hour meter and fuel/water separator to starter low voltage protection module and generator.
533	2CA	Generator-to-engine disconnect.
534	2CA	Generator-to-engine disconnect.
627	2DR	Governor solenoid to engine disconnect.
920A	2CA, 2DA	Smoke generating system fuel solenoid valves to engine disconnect.
C	2DR	Auxiliary generator oil pressure switch to starter solenoid harness.
D	2DR	Auxiliary generator oil pressure switch to engine disconnect.
K	2DR	Auxiliary generator oil pressure switch to starter ground harness.
L	2DR	Hour meter to generator.
M	2DR	Engine main harness to starter solenoid harness.
N	2DR	Fuel/water separator drain module to splice circuit No. K.
T	2DR	Smoke generating solenoid valves (2) to starter ground harness.

**END OF TABLE**

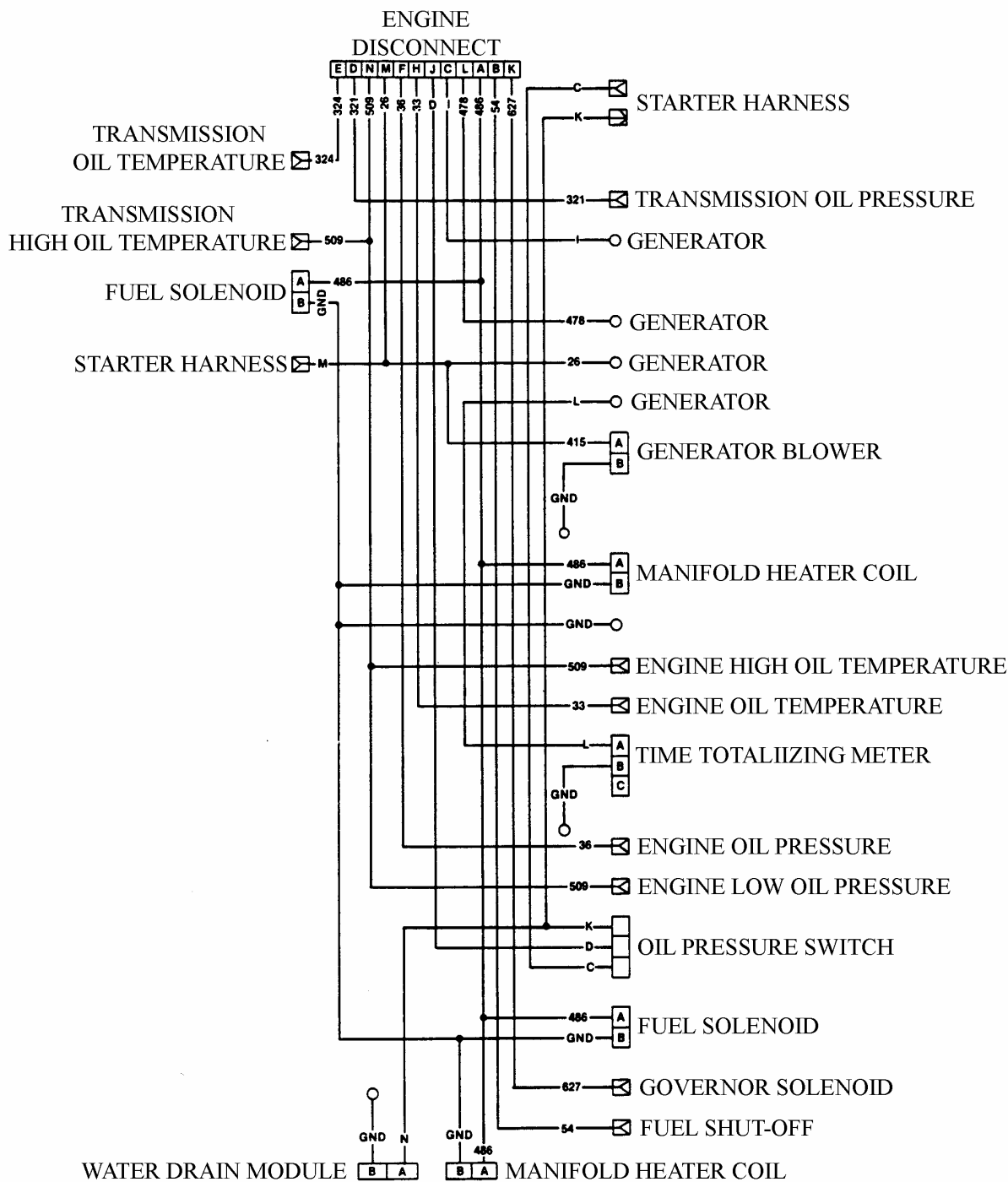
MODEL 2CA MAIN ENGINE WIRING HARNESS DIAGRAM



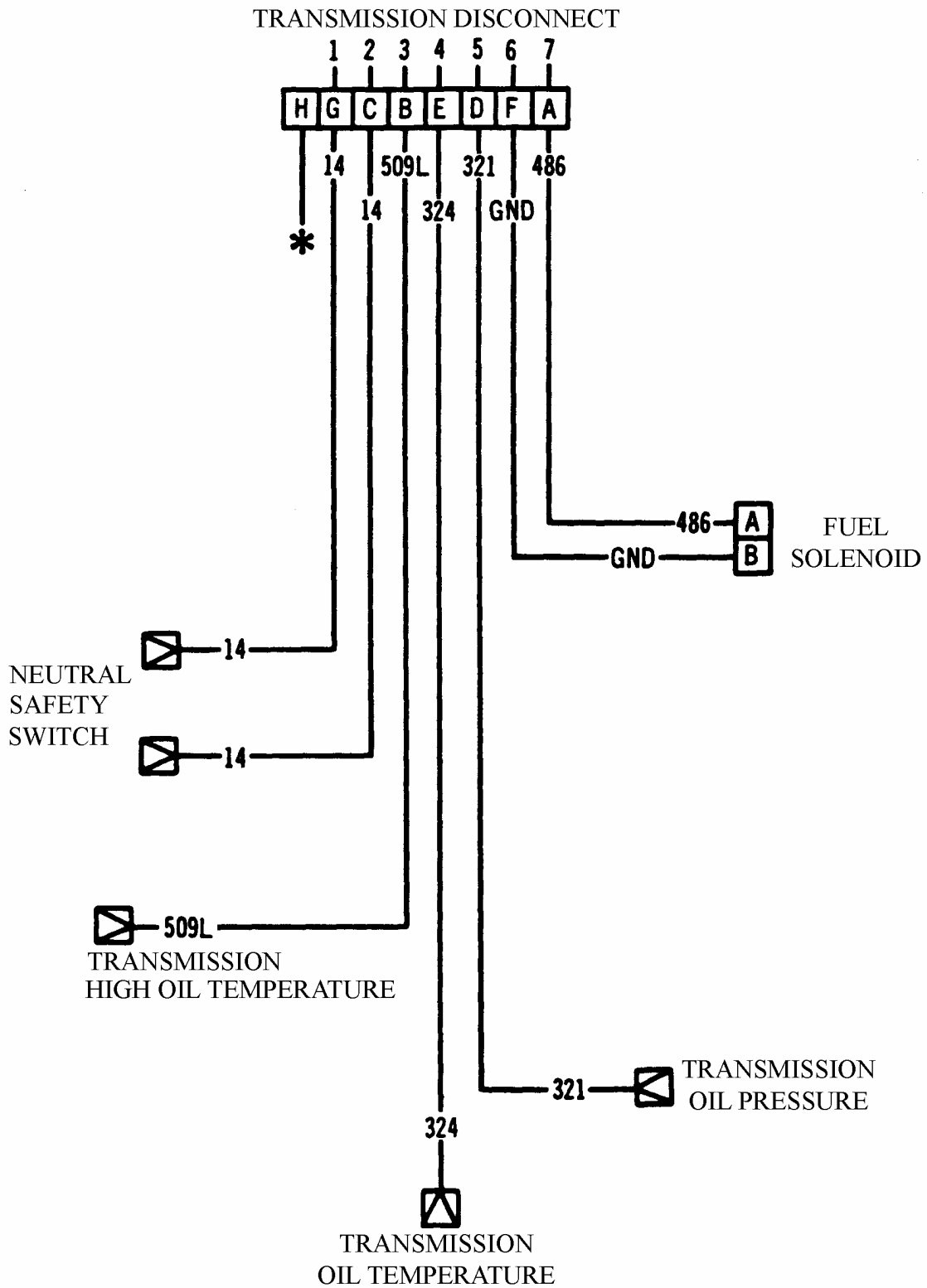
MODEL 2DA MAIN ENGINE WIRING HARNESS DIAGRAM



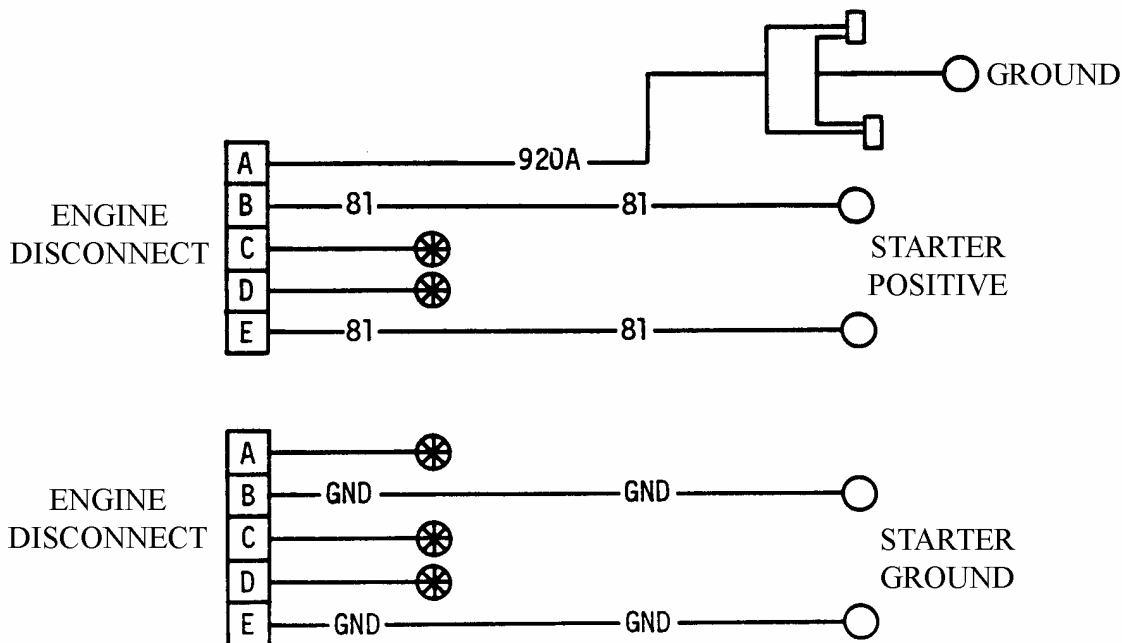
MODEL 2DR MAIN ENGINE WIRING HARNESS DIAGRAM



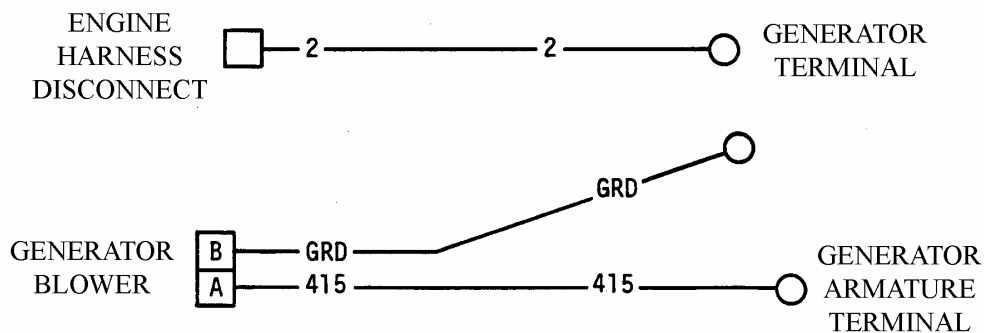
TRANSMISSION WIRING HARNESS DIAGRAM



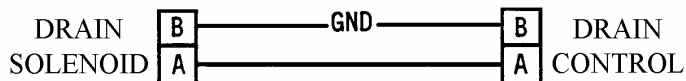
MODEL 2CA AND 2DA STARTER WIRING DIAGRAM



300 AMPERE GENERATOR WIRING DIAGRAM

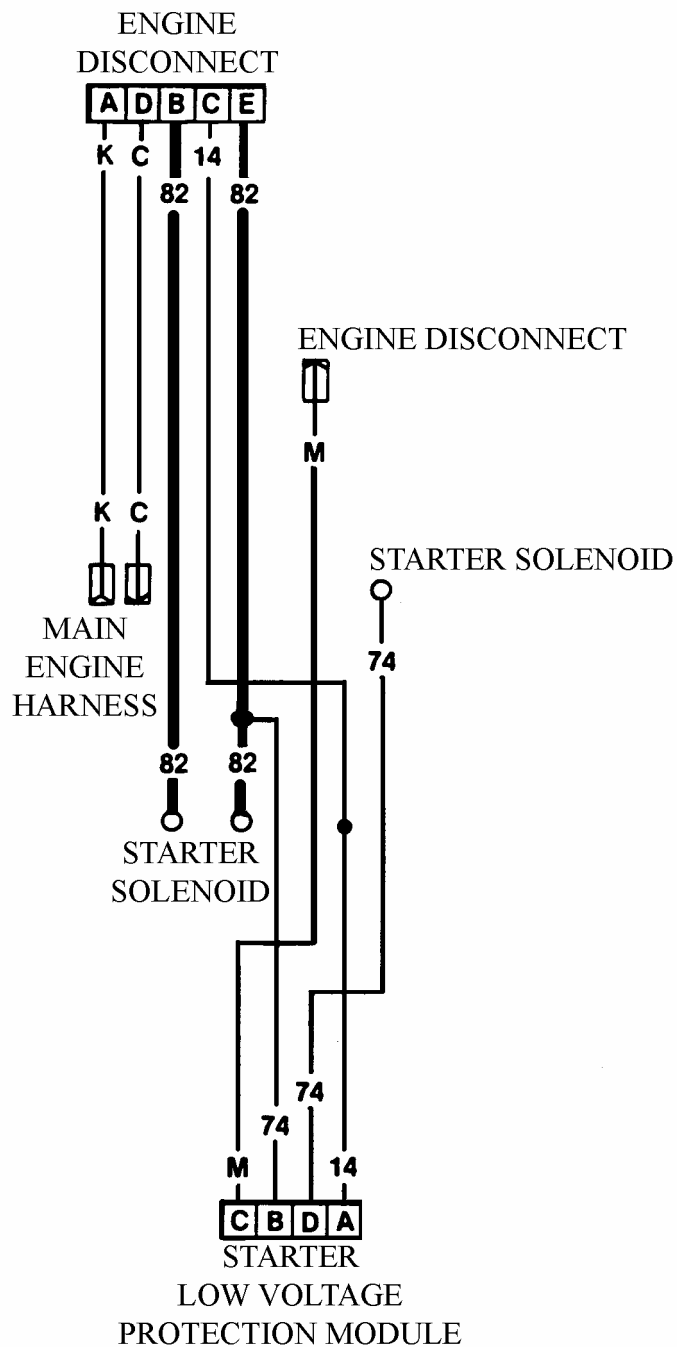


FUEL/WATER SEPARATOR WIRING DIAGRAM

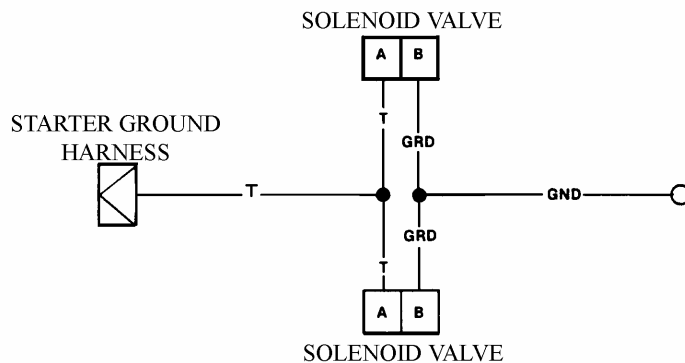




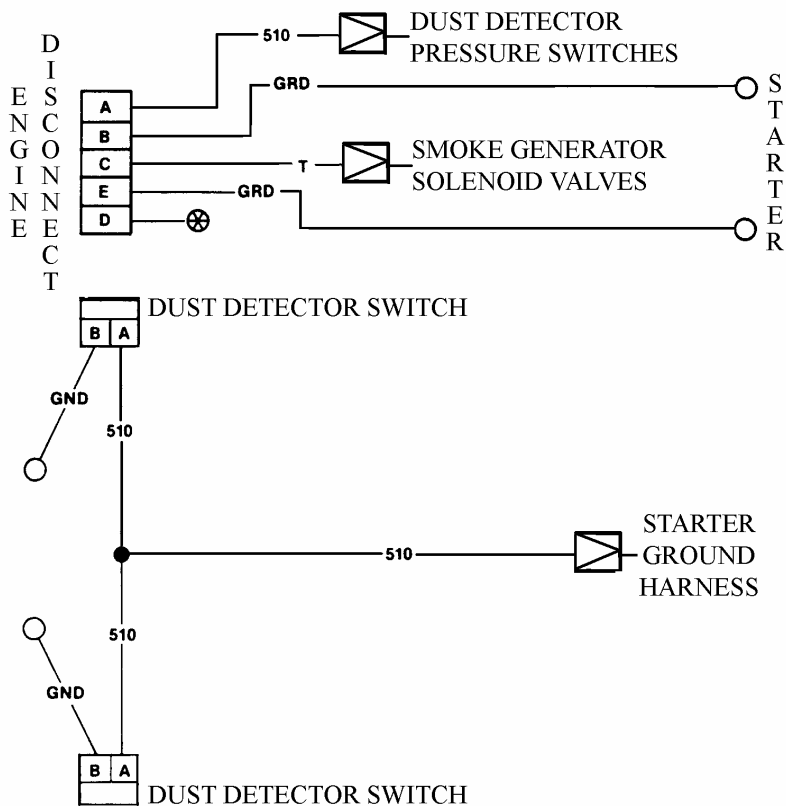
MODEL 2DR STARTER WIRING DIAGRAM



MODEL 2DR SMOKE GENERATOR WIRING DIAGRAM



MODEL 2DR DUST DETECTOR WIRING DIAGRAM



## STANDARD REPAIR PROCEDURES FOR WIRING HARNESSES AND CABLES

### CLEANING

#### CAUTION

**Do not allow dry-cleaning solvent, mineral spirits, or paint thinner to be in prolonged contact with rubber components. These cleaners cause leather, rubber, and synthetic materials to dry, rot, and lose pliability making them unserviceable.**

1. See Work Package 0028 for Standard Cleaning Procedures.
  - a. Clean cables and flexible hoses with soap and water.

### INSPECTION

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
  - a. Inspect all wiring harness assemblies and cables for broken leads, frayed insulation and deterioration. Inspect connectors, receptacles, clips, clamps and brackets for damage. Check individual circuits for continuity.

### Installation of Jumper Wire

#### **WARNING**



**Some wiring harnesses and cables are live (hot), even with MASTER BATTERY switch in the OFF position. Disconnect the three battery ground cable assemblies prior to disconnecting any wiring harness or cable.**

To substitute a jumper wire for a defective harness wire, tape jumper wire (using insulation tape, item 40, WP 0173) to the exterior of the harness; do not disassemble the harness. Disassemble the connectors as shown in the illustration (on the following pages of this work package) that most closely matches your application and unsolder connectors (or cut off crimped connectors) of the defective wire. Strip the insulation from end of the jumper wire to the depth of solder well on contact insert, or approximately 1/8 inch when used with a terminal assembly. Pass the jumper wire through the grommet-retaining nut and grommet, and solder to the insert. On crimp-type connectors, pass the jumper wire through the connector body and insulator or shell, and crimp to the terminal assembly. Reassemble the connector.

A cable that has been repaired by installing a jumper wire should be brushed or sprayed with clear electrical ignition waterproofing varnish MIL-V-13811 (item 42, WP 0173). Allow varnish to dry for approximately 24 hours before handling. The varnish is not a conductor of electricity, so care must be taken to avoid over spraying the varnish on contact surfaces of wire terminals, connector contacts, or similar parts where it will prevent the flow of electricity.

**REPLACEMENT OF CONNECTORS**

The remainder of this work package contains procedures for replacement of cable connectors, male and female plugs and receptacles. Disassemble/assemble the connectors as shown in the illustration that most closely matches your application.

**NOTE**

**Before proceeding, see detailed instructions on soldering and solder (TB SIG 222).**

**When removing more than one wire from a multiple wire receptacle, record which wire was removed from which pinhole.**

**Cable identifiers are attached to cables. These tags are embossed with the cable identification number. Cable identifier numbers are shown on the systems wiring diagram.**

**Wire identifiers are embossed with the individual wire number. Wire identifier numbers are also shown on systems wiring diagram.**

**If cable or wires are replaced, remove tags from old wire and place them on new wire.**

**All pins (male connectors) and sockets (female connectors) are alphabetically coded. Coded identification starts at connector key or groove.**

**Pin (male connector) identifying letters run clockwise. Socket (female connector) identifying letters run counterclockwise.**

**Do continuity checks upon completion of cable or harness repair.**

**Rubber-to-rubber contacts of bell-type connectors may be lubricated lightly with silicone compound MIL-S-8660 (item 34, WP 0173) to assist assembly.**

**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Heat Shrink Insulation Tubing**

1. Cut, remove, and discard old insulation tubing.

**Assembly of Heat Shrink Insulation Tubing****NOTE**

**Insulation tubing should be twice the diameter of the part over which it will be shrunk.**

1. Slide heat shrink insulating tubing (item 35, 36, WP 0173) over wire and terminal.

**NOTE**

**Remove thermal heat gun from tube as soon as tube forms to shape of wire and terminal.**

2. Hold electric heat gun (item 63, WP 0176) 4 or 5 inches (101.6 - 127.0 mm) away from tubing and apply heat for about 30 seconds.
3. Let tube cool 30 seconds before handling.

**Disassembly of Wire Contacts**

1. Cut and discard contacts.
2. Strip about 1/2 inch (12.7 mm) of insulation from end of the wire.

**Assembly of Wire Contacts****NOTE**

**Color bands on contacts indicate wire size. For example, contacts with green color bands are for 22-gauge to 26-gauge wire. Contacts with red color bands are for 20-gauge to 24-gauge wire.**

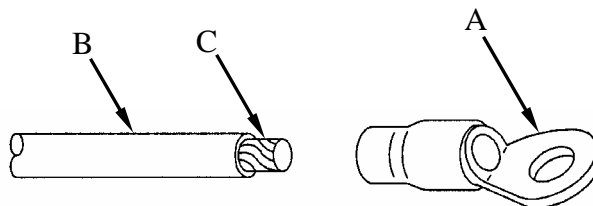
1. Place contacts in the crimping tool with the color band toward the rear.
2. Place bare wire in the contact and squeeze the crimping tool.
3. Remove crimped contact out of the tool and check the crimp by looking in the inspection hole. Verify that the end of the bare wire is visible.

**Disassembly of Crimped Terminal**

1. Cut and discard terminal (A).

**Assembly of Crimped Terminal**

1. Strip cable electrical insulation sleeving equal to depth of terminal (A) well.
2. Push cable (B) against end of terminal (A) well and crimp.
3. Apply a dab of silicone sealant (item 33, WP 0173) to exposed end of wire (C).



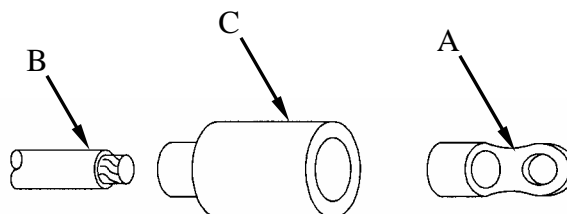
**REPLACEMENT OF CONNECTORS (Continued)**

**Disassembly of Terminal Type Cable Connectors**

1. Cut and discard terminal (A).

**Assembly of Terminal Type Cable Connectors**

1. Strip cable (B) insulation equal to depth of terminal well.
2. Slide insulator (C) over cable (B).
3. Insert cable (C) into terminal (A) well and crimp.
4. Slide insulator (C) over crimped end of terminal (A).

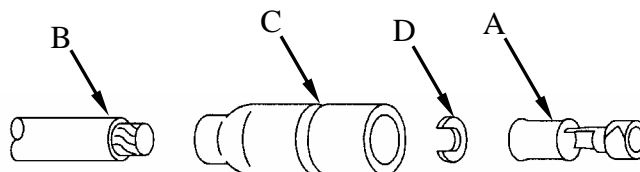


**Disassembly of Female Cable Connector with Washer**

1. Cut and discard terminal (A).

**Assembly of Female Cable Connector with Washer**

1. Strip cable (B) insulation approximately 1/8 inch (3.2 mm).
2. Slide shell (C) and washer (D) over cable (B).
3. Place cable (B) in cylinder end of terminal (A).
4. Slide shell (C) and washer (D) over terminal (A).

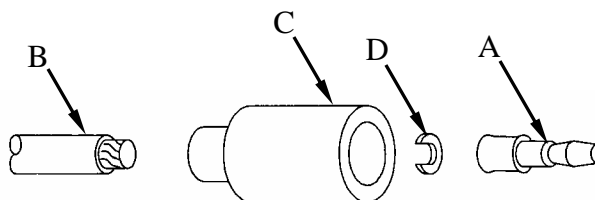


**Disassembly of Male Cable Connector with Washer**

1. Cut and discard terminal (A).

**Assembly of Male Cable Connector with Washer**

1. Strip cable (B) insulation equal to depth of terminal (A) well.
2. Slide shell (C) over cable (B).
3. Insert cable (B) into terminal (A) well and crimp.
4. Place C-washer (D) over cable (B) at crimped junction and slide shell (C) over C-washer (D) and terminal (A).



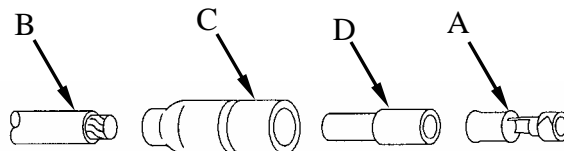
**REPLACEMENT OF CONNECTORS (Continued)**

**Disassembly of Female Cable Connector with Sleeve**

1. Cut and discard terminal (A).

**Assembly of Female Cable Connector with Sleeve**

1. Strip cable (B) insulation approximately 1/8 inch (3.2 mm).
2. Slide shell (C) and sleeve (D) over cable (B).
3. Place cable (B) in cylinder end of terminal (A) and crimp.
5. Slide shell (C) and sleeve (D) over terminal (A).

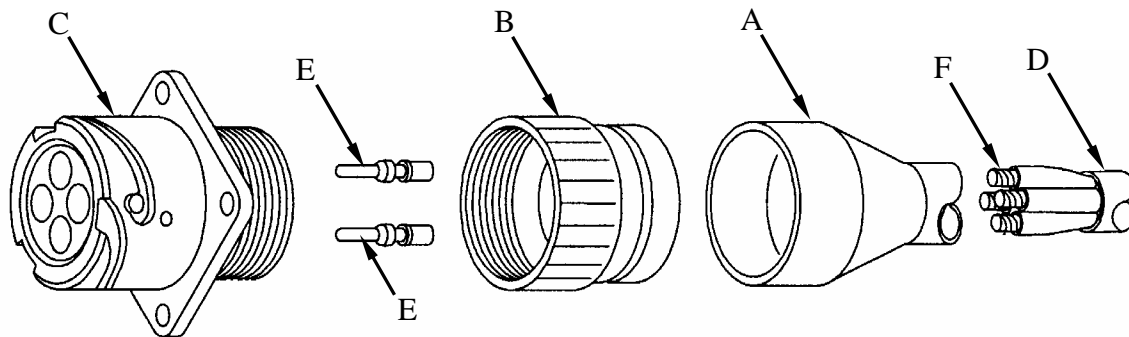


**Disassembly of Typical Male-Type Panel Mounting Receptacle**

1. Using electric heat gun (item 63, WP 0176), heat and remove boot (A) from rear of nut (B).
2. Remove nut (B) from shell (C) and slide nut (B) over cable (D).
3. Drive pin contacts (E) out through rear of shell (C) with pin extractors.
4. Unsolder or cut pin contacts (E) from cable leads (F).

**Assembly of Typical Male-Type Panel Mounting Receptacle**

1. Strip leads (F) insulation equal to depth of wells in pin contacts (E).
2. Insert leads (F) into wells in pin contacts (E) and solder or crimp leads (F) to pin contacts (E).
3. Push pin contacts (E) into shell (C) from rear until seated.
4. Install nut (B) on shell (C).
5. Apply a thin coat of adhesive (item 1, WP 0173) to boot (A).
6. Install boot (A) on nut (B).

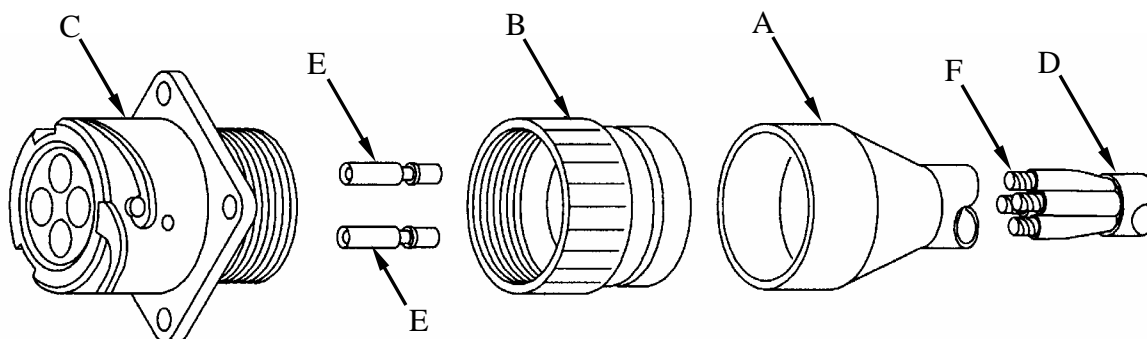


**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Typical Female-Type Panel Mounting Receptacle**

1. Using electric heat gun (item 63, WP 0176), heat and remove boot (A) from rear of nut (B).
2. Remove nut (B) from shell (C) and slide nut (B) over cable (D).
3. Drive socket contacts (E) out through rear of shell (C) with socket extractors.
4. Unsolder or cut socket contacts (E) from cable leads (F).

**Assembly of Typical Female-Type Panel Mounting Receptacle**

1. Strip the insulation of leads (F) equal to depth of wells in socket contacts (E).
2. Insert leads (F) into wells in socket contacts (E) and or crimp leads (F) to contacts (E).
3. Push socket contacts (E) into shell (C) from rear until seated.
4. Install nut (B) on shell (C).
5. Apply a thin coat of adhesive (item 1, WP 0173) to boot (A).
6. Install boot (A) on nut (B).



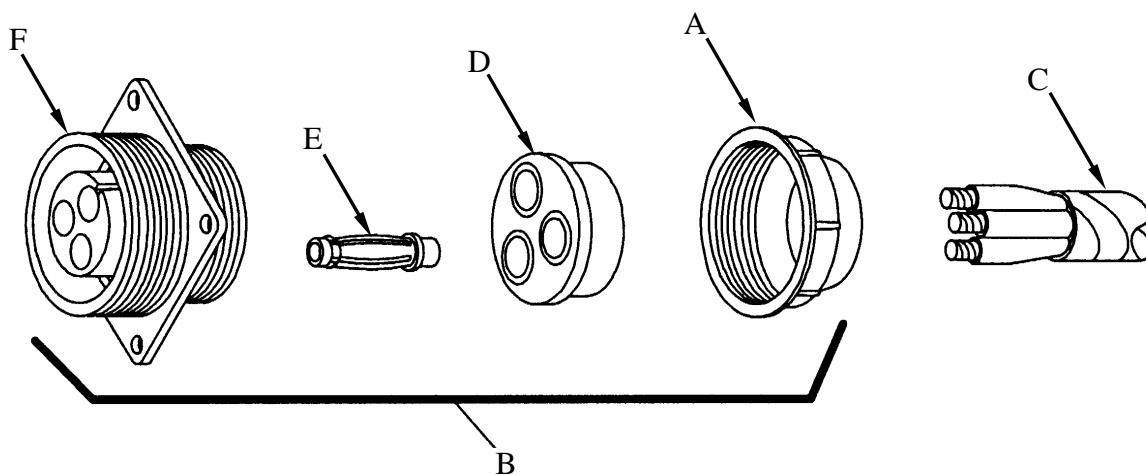


**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Typical Female-Type Panel Mounting Receptacle with Ridged Locking Nut**

1. Unscrew nut (A) from shell assembly (B) and slide back on cable (C).
2. Slide grommet (D) back on cable (C) leads.
3. Drive socket contacts (E) out through rear of shell (F) with socket extractors.
4. Using soldering gun (item 108, WP 0176), unsolder leads from socket contacts (5).

**Assembly of Typical Female-Type Panel Mounting Receptacle with Ridged Locking Nut**

1. Strip cable (C) insulation equal to depth of wells in socket contacts (E).
2. Slide nut (A) onto cable (C).
3. Slide grommet (D) over cable (C) leads.
4. Insert cable (C) leads into wells of socket contacts (E) and solder (using item 38, WP 0173).
5. Push socket contacts (E) into shell (F) from rear until seated.
6. Push grommet (D) down cable (C) leads and over wells of socket contacts (E).
7. Screw nut (A) onto shell assembly (B).

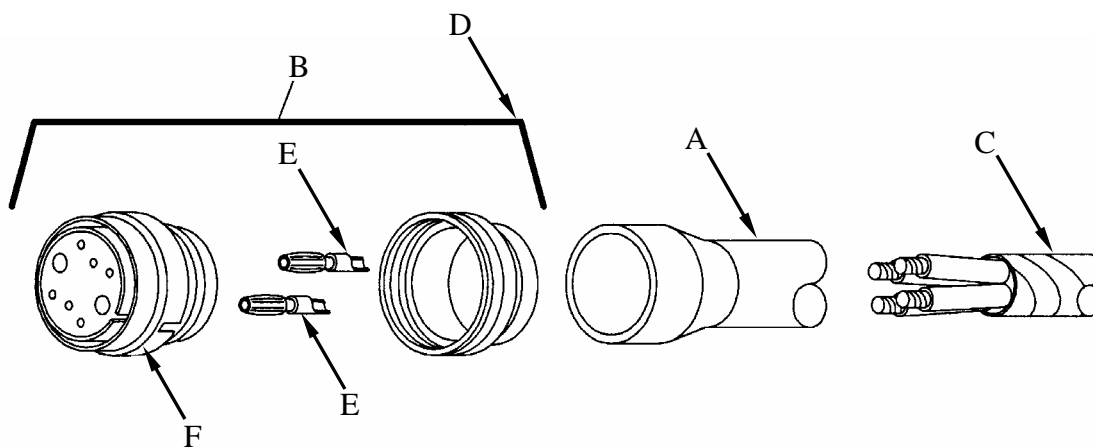


**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Typical Female-Type Plug with Ridged Locking Nut**

1. Heat boot (A) on shell assembly (B) and roll back on cable (C).
2. Unscrew nut (D) from shell assembly (B) and slide back on cable (C).
3. Drive socket contacts (E) out through rear of shell (F) with socket extractors.
4. Using soldering gun (item 108, WP 0176), unsolder or cut leads from socket contacts (E).

**Assembly of Typical Female-Type Plug with Ridged Locking Nut**

1. Strip cable (C) insulation equal to depth of wells in socket contacts (E).
2. Slide nut (D) onto cable (C).
3. Insert cable (C) leads into wells of socket contacts (E) and solder (using item 38, WP 0173) or crimp.
4. Push socket contacts (E) into shell (F) from rear until seated.
5. Screw nut (D) onto shell assembly (B).
6. Apply a thin even layer of adhesive (item 1, WP 0173) to shell assembly (B) and roll boot (A) onto shell assembly (B).

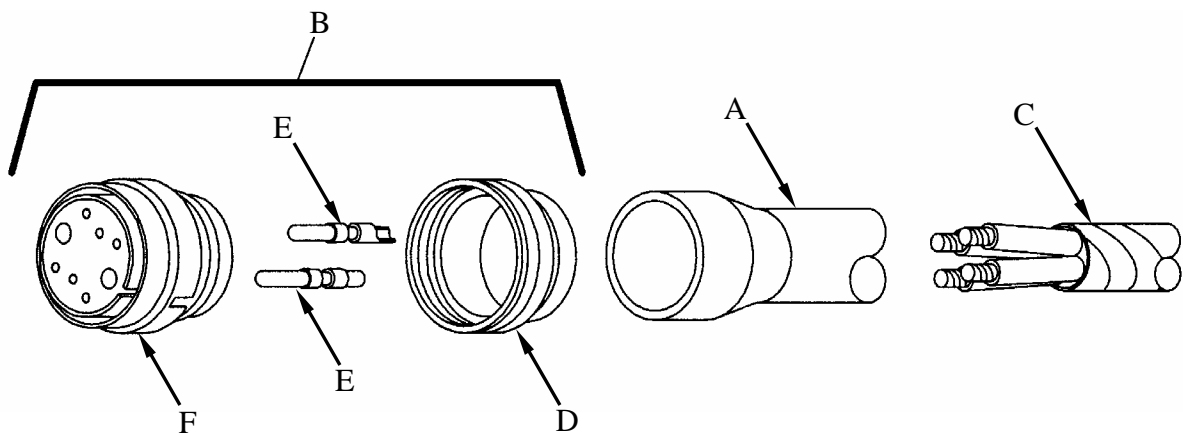


**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Typical Male-Type Plug with Ridged Locking Nut**

1. Heat boot (A) on shell assembly (B) and roll back on cable (C).
2. Unscrew nut (D) from shell assembly (B) and slide back on cable (C).
3. Drive pin contacts (E) out through rear of shell (F) with pin extractors.
4. Using soldering gun (item 108, WP 0176), unsolder or cut cable (C) leads from pin contacts (E).

**Assembly of Typical Male-Type Plug with Ridged Locking Nut**

1. Strip cable (C) insulation equal to depth of wells in pin contacts (E).
2. Insert cable (C) leads into wells of pin contacts (E) and solder (using item 38, WP 0173) or crimp.
3. Push pin contacts (E) into shell (F) from rear until seated.
4. Screw nut (D) onto shell assembly (B).
5. Apply a thin even layer of adhesive (item 1, WP 0173) to shell assembly (B) and roll boot (A) onto shell assembly (B).

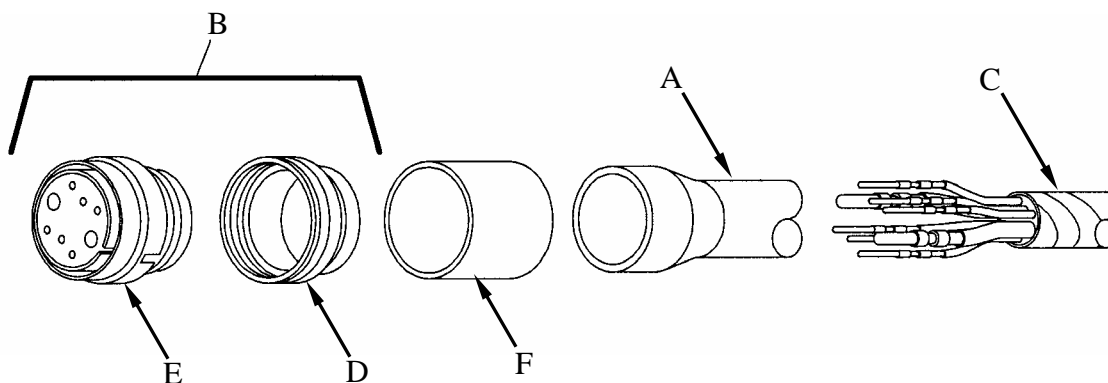


**REPLACEMENT OF CONNECTORS (Continued)****Disassembly of Waterproofing Connectors**

1. Using electrical heat gun (item 63, WP 0176), heat boot (A) on shell assembly (B) and roll back on cable (C).
2. Unscrew nut (D) from connector (E) and slide back on cable (C).

**Assembly of Waterproofing Connectors**

1. Apply sealing compound (item 33, WP 0173) on threads of shell assembly (B).
2. Screw nut (D) onto connector (E).
3. Apply an even layer of adhesive (item 1, WP 0173) on the shell assembly (B) and roll boot (A) onto the shell assembly (B). Ensure the cavity between shell assembly (B) and boot (A) is filled with adhesive.
4. Place 3-inch piece of heat-shrink insulating tubing (item 35, 36, WP 0173) (F) over at least a quarter of nut (D) to half way down the boot assembly (A).
5. Using electrical heat gun (item 63, WP 0176), heat tubing (F) until a water-tight fit is achieved. Shim tubing as needed to attain a water-tight fit.

**END OF WORK PACKAGE**

**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

- Lock washer (4) (item 82, WP 0175)
- Lock washer (8) (item 86, WP 0175)
- Lock washer (4,) (item 90, WP 0175)
- Lock washer (4) (item 91, WP 0175)
- Lock washers (as needed) (item 92, WP 0175)
- Lock washers (as needed) (item 93, WP 0175)

**Mandatory Replacement Parts (Continued)**

- Lock washer (1) (item 94, WP 0175)
- Self-locking nut (3) (item 33, WP 0175)
- Self-locking nut (2) (item 37, WP 0175)
- Tie wrap (as needed) (item 80, WP 0175)

**Personnel Required:**

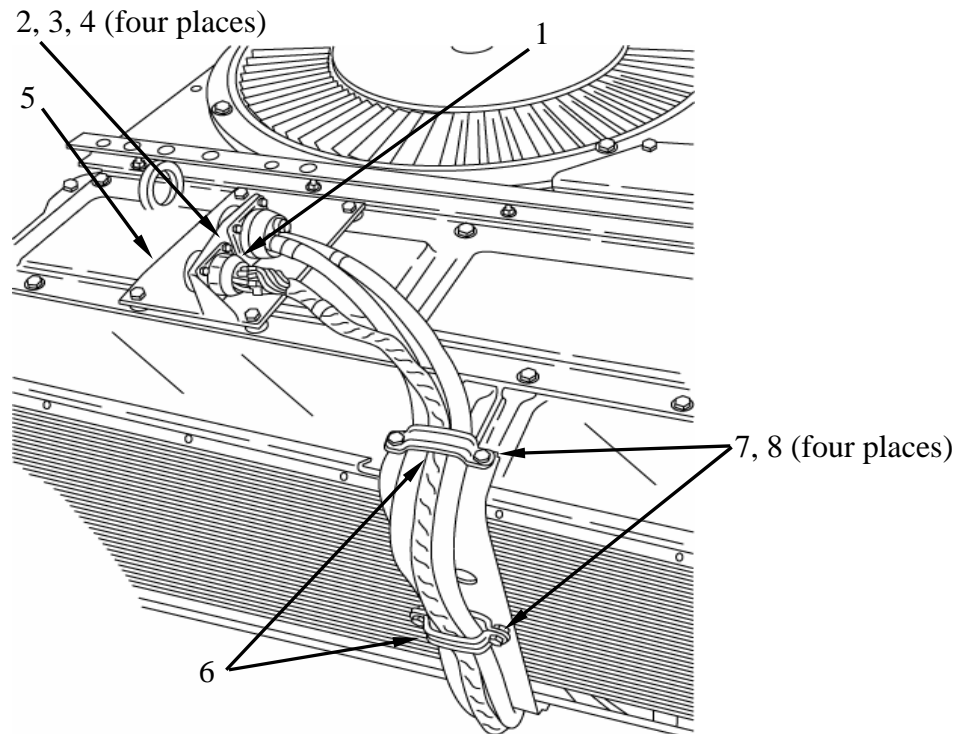
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

**REMOVAL**

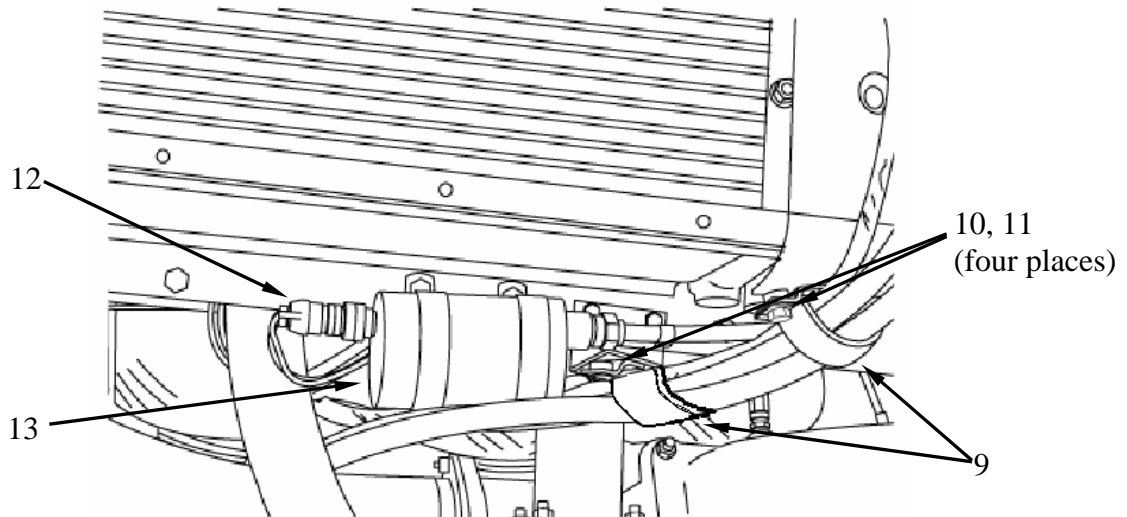
1. Disconnect harness end connector (1).
  - a. Remove four machine screws (2) with lock washers (3) and nuts (4) from wiring harness upper bracket (5). Discard lock washers.
2. Remove retaining straps (6).
  - a. Remove four screws (7) with lock washers (8) and retaining straps (6). Discard lock washers.



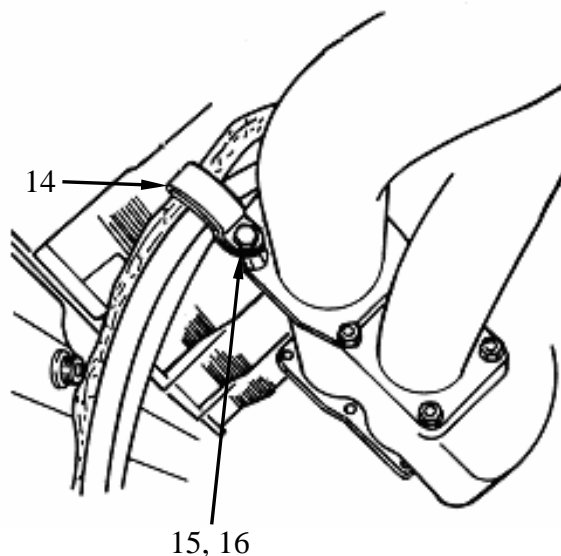
**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**REMOVAL (Continued)**

3. Remove lower retaining straps (9).
  - a. Remove four screws (10) with lock washers (11) and remove two retaining straps (9). Discard lock washers.
4. Remove electrical connector (12) at right manifold heater exciter (13).



5. Remove loop clamp (14).
  - a. Remove screw (15) with lock washer (16). Discard lock washer.
  - b. Remove loop clamp (14).



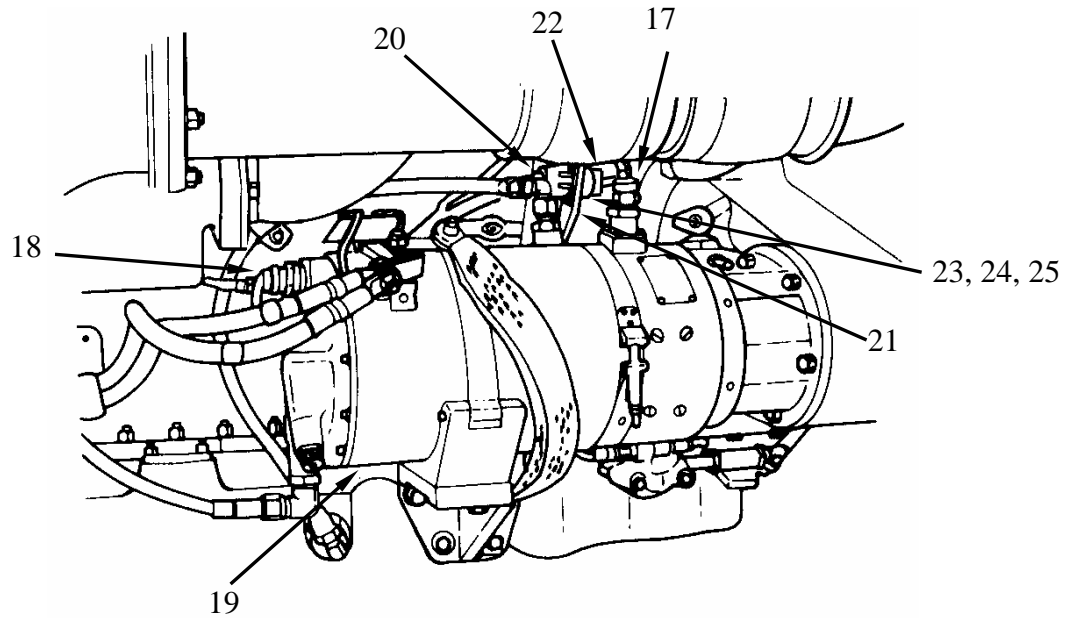
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**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

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**REMOVAL (Continued)**

6. Disconnect electrical connections (17, 18) at generator (19).
7. Remove transmission harness connector (20) from harness bracket (21).
  - a. Disconnect electrical connection (22) at transmission harness connector (20).
  - b. Remove four machine screws (23) with lock washers (24) and nuts (25) to remove transmission harness disconnect cable connector (20). Discard lock washers.



**REMOVAL (Continued)**

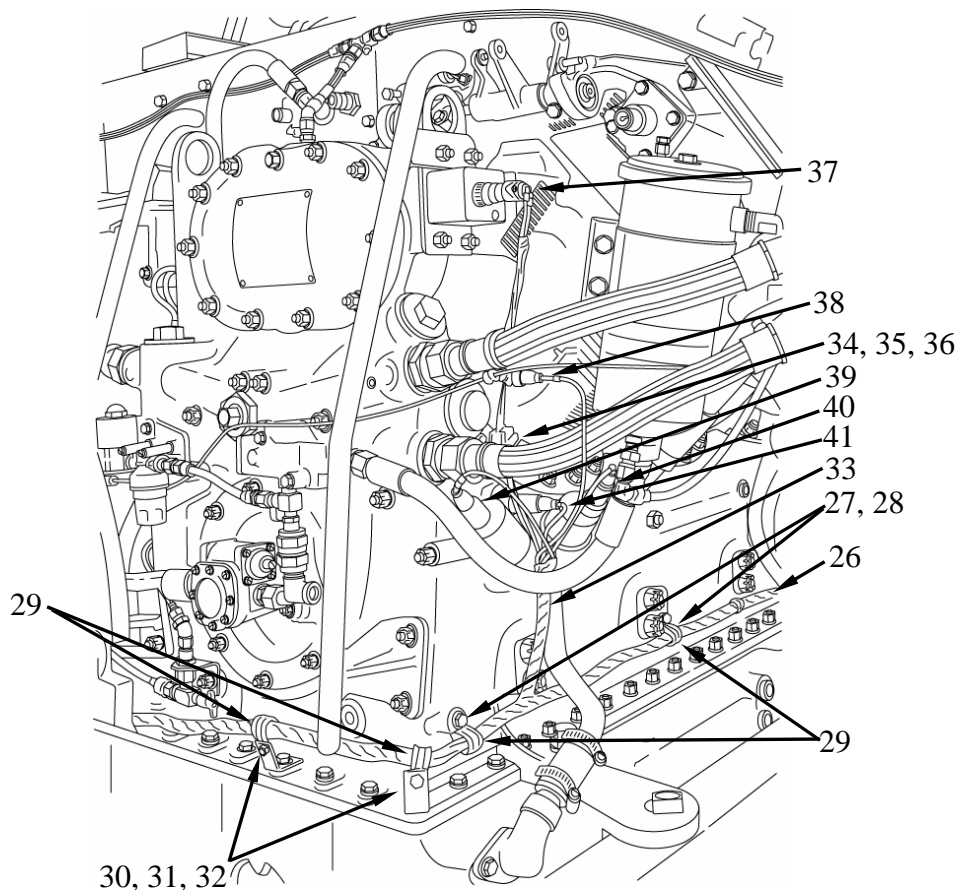
8. Remove harness (26) at front of engine.
  - a. Remove screws (27) with lock washers (28) and loop clamps (29). Discard lock washers.
  - b. Remove screws (30) with nut (31), and lock washers (32). Remove loop clamps (29). Discard lock washers.

**NOTE**

**Damper housing mounted hour meter harness removal instructions are covered in step 9.**

**Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). See step 11 for top-mounted harness removal instructions.**

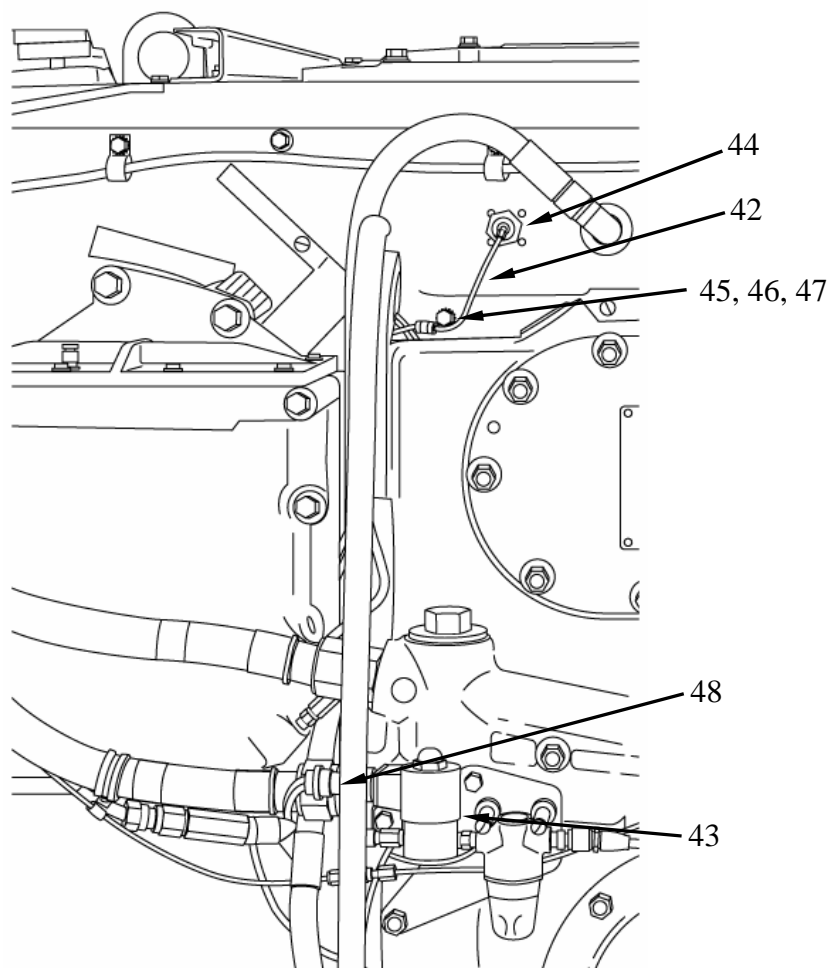
9. Remove transmitter and sensor wiring (33) (harness 12254376).
  - a. Remove self-locking nut (34) with flat washer (35). Discard locking nut. Remove loop clamp (36).
  - b. Disconnect hour meter (37), engine oil temperature transmitter (38) engine oil pressure transmitter (39), low engine oil pressure switch (40), and high oil temperature switch (41) electrical connectors.





**REMOVAL (Continued)**

10. Remove fuel cut-off wiring (42) and manifold heater solenoid (43) wiring.
  - a. Disconnect electrical connector at fuel shutoff lead connection (44).
  - b. Remove screw (45), with lock washer (46). Discard lock washer. Remove loop clamp (47).
  - c. Disconnect electrical connector (48) at manifold heater solenoid (43).



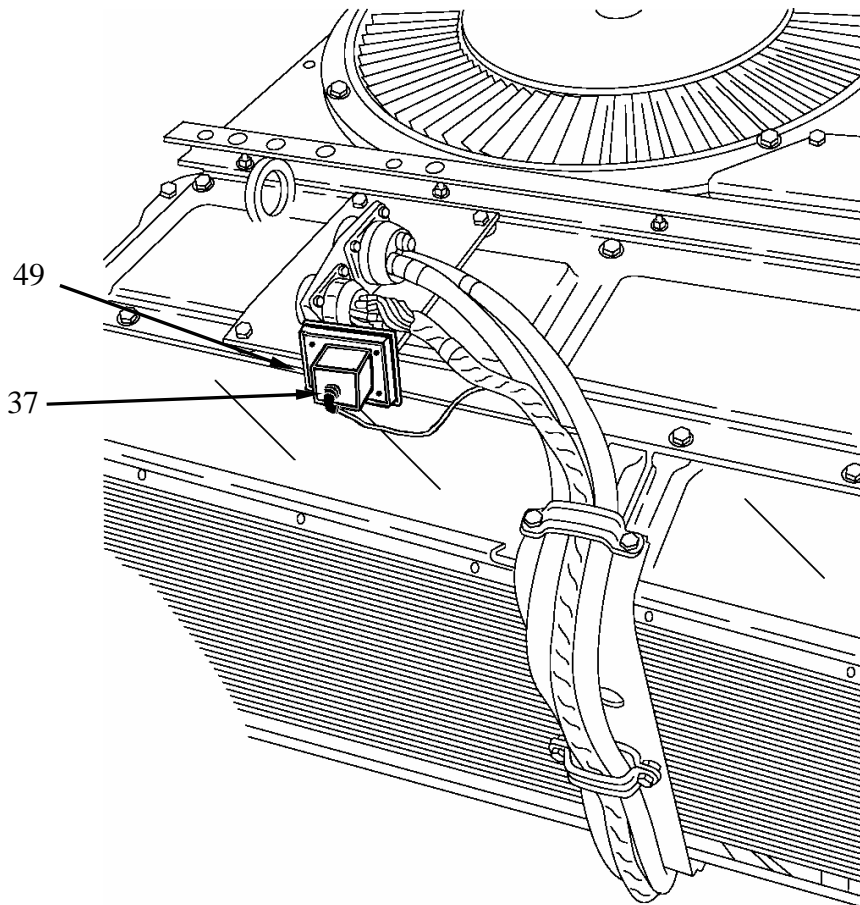
**REMOVAL (Continued)**

**NOTE**

**Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). Harness removal instructions are covered in step 11.**

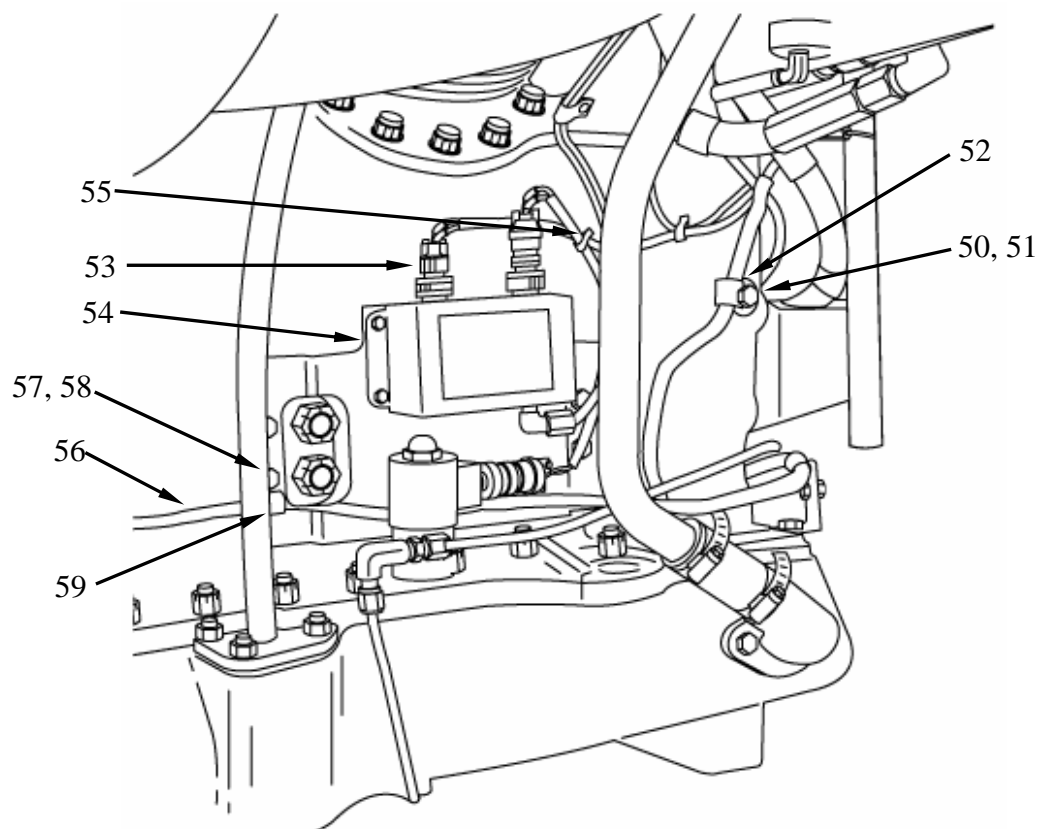
**For engines with damper housing mounted hour meter, harness removal instructions are covered in step 9.**

11. Remove harness to hour meter mounted on top of engine (harness 12354385).
  - a. Disconnect electrical connector (37) from hour meter (49).



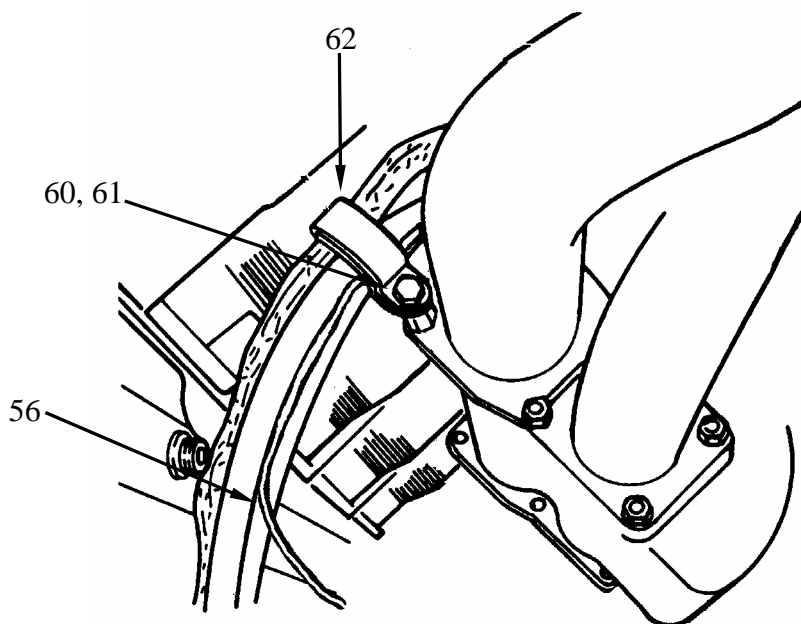
**REMOVAL (Continued)**

12. Disconnect automatic water separator harness.
  - a. Remove screw (50) with lock washer (51). Discard lock washer.
  - b. Remove loop clamp (52).
  - c. Disconnect electrical connector (53) at fuel water separator control unit (54).  
Cut tie wraps (55) as needed.
13. Remove wiring (56) to left manifold heater exciter.
  - a. Remove screw (57) with lock washer (58). Discard lock washer.
  - b. Remove loop clamp (59).

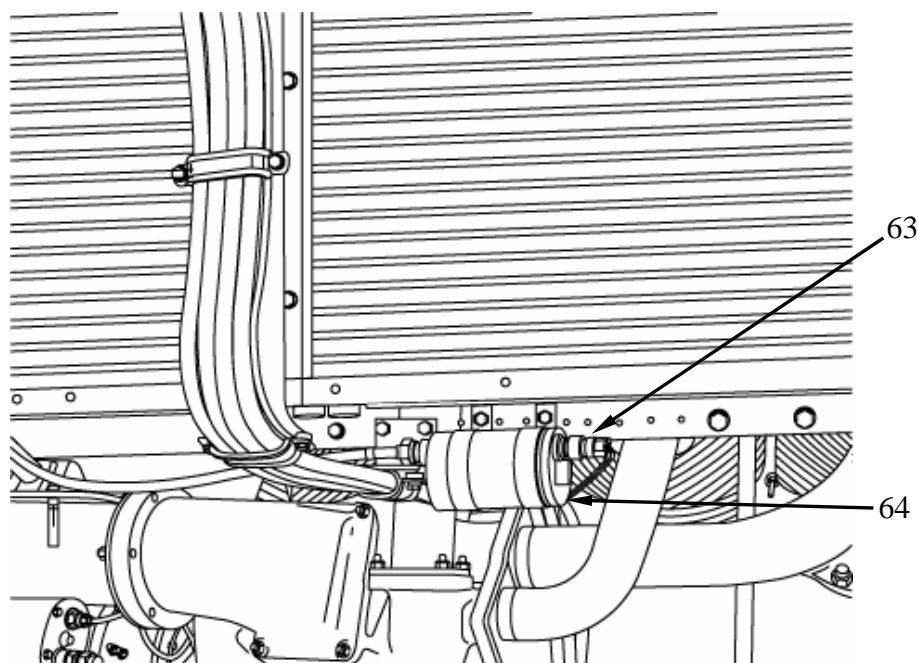


**REMOVAL (Continued)**

13. Remove wiring (56) to left manifold heater exciter (continued).
  - c. Remove screw (60), with lock washer (61) and remove wiring (56) to left manifold heater from loop clamp (62). Discard lock washer.



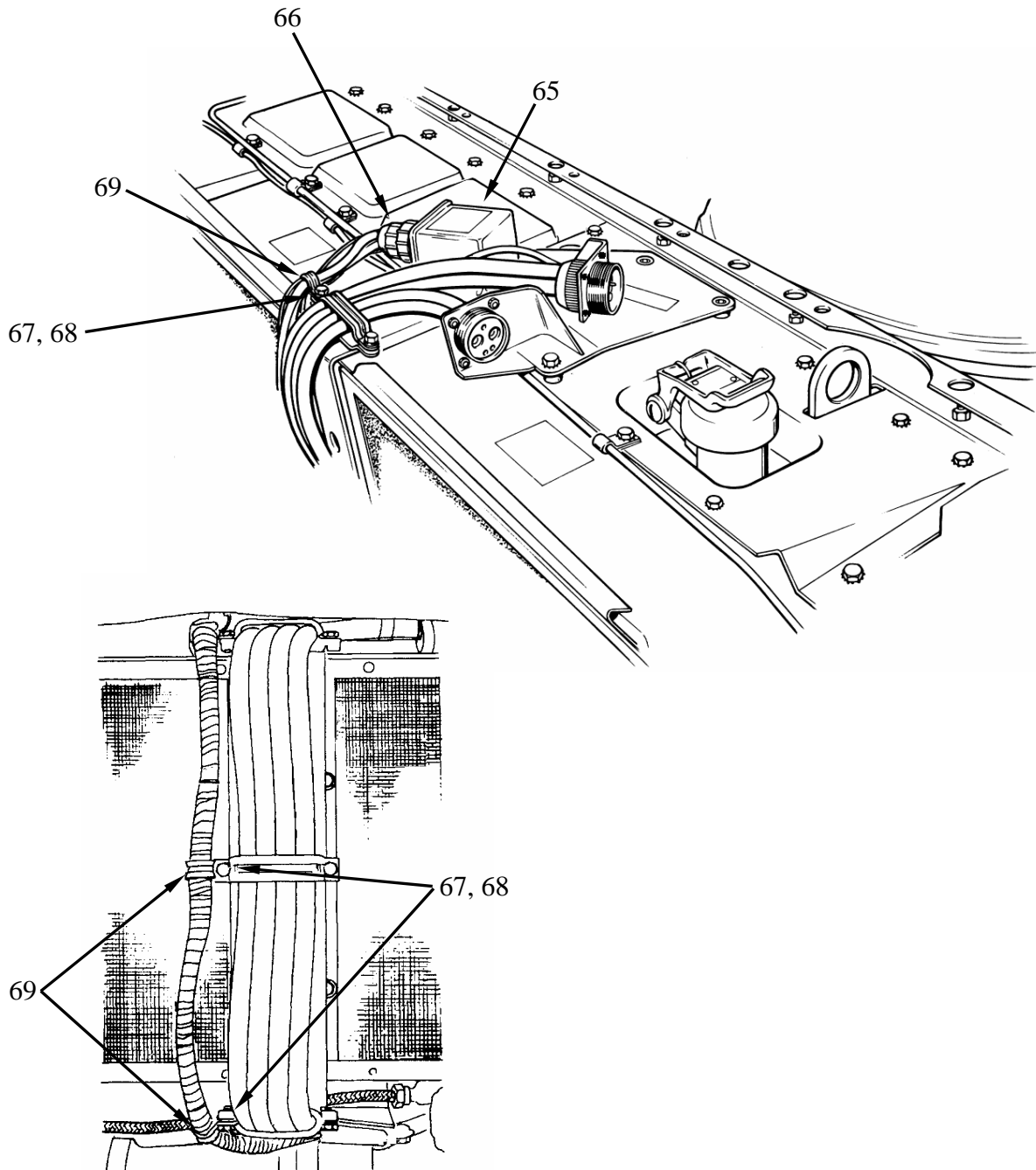
- d. Remove connection (63) at left manifold heater exciter (64).



**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

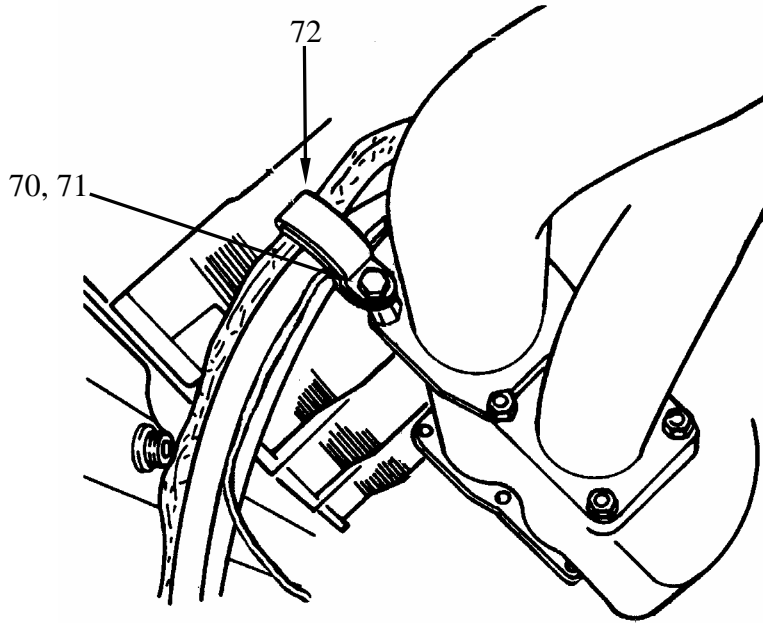
**REMOVAL (Continued)**

14. Remove harness to top-mounted low voltage protection module (LVPM) (65).
  - a. Disconnect electrical connector (66) from LVPM (65).
  - b. Remove screws (67) with lock washers (68), and remove loop clamps (69).



**REMOVAL (Continued)**

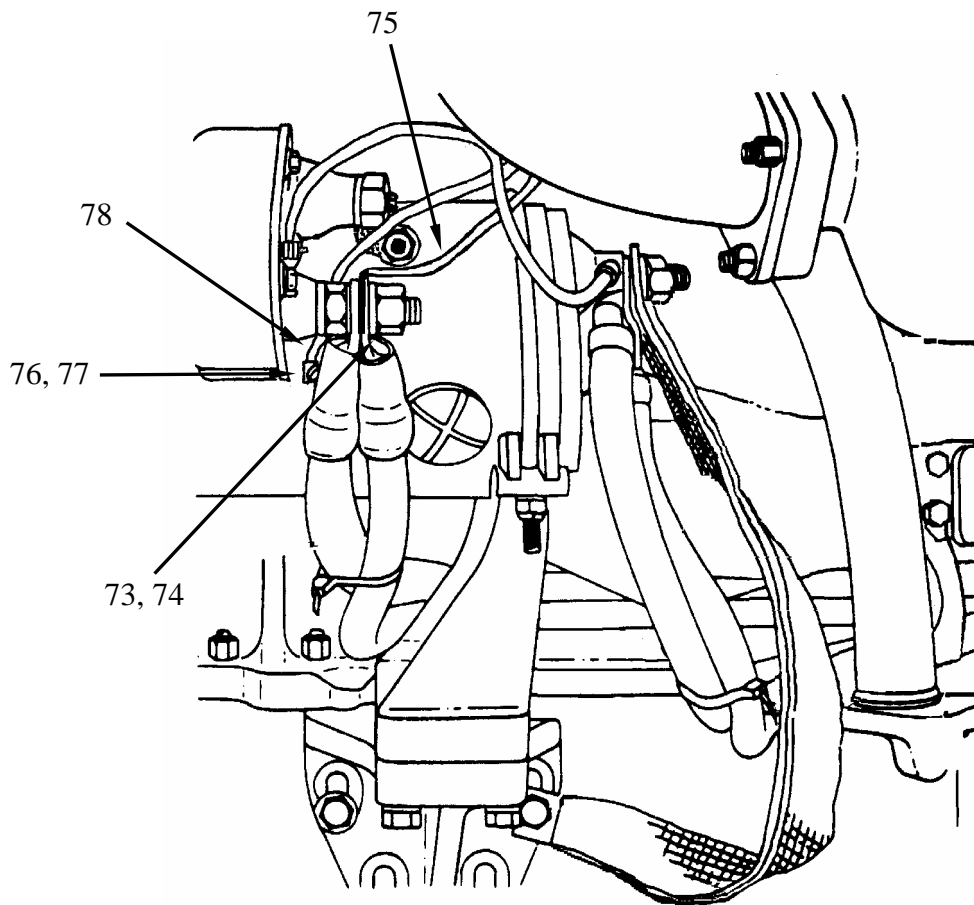
14. Remove harness to top-mounted low voltage protection module (LVPM) (65) (continued).
  - c. Remove screw (70) with lock washer (71). Discard lock washer.
  - d. Remove loop clamp (72).



**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**REMOVAL (Continued)**

14. Remove harness to top-mounted low voltage protection module (LVPM) (continued).
  - e. Remove nut (73) with lock washer (74) from starter positive lug. Remove LVPM module wire (75), re-install nut and lock washer.
  - f. Remove machine screw (76) with lock washer (77). Remove LVPM lead (78). Reinstall screw and lock washer for safe keeping.



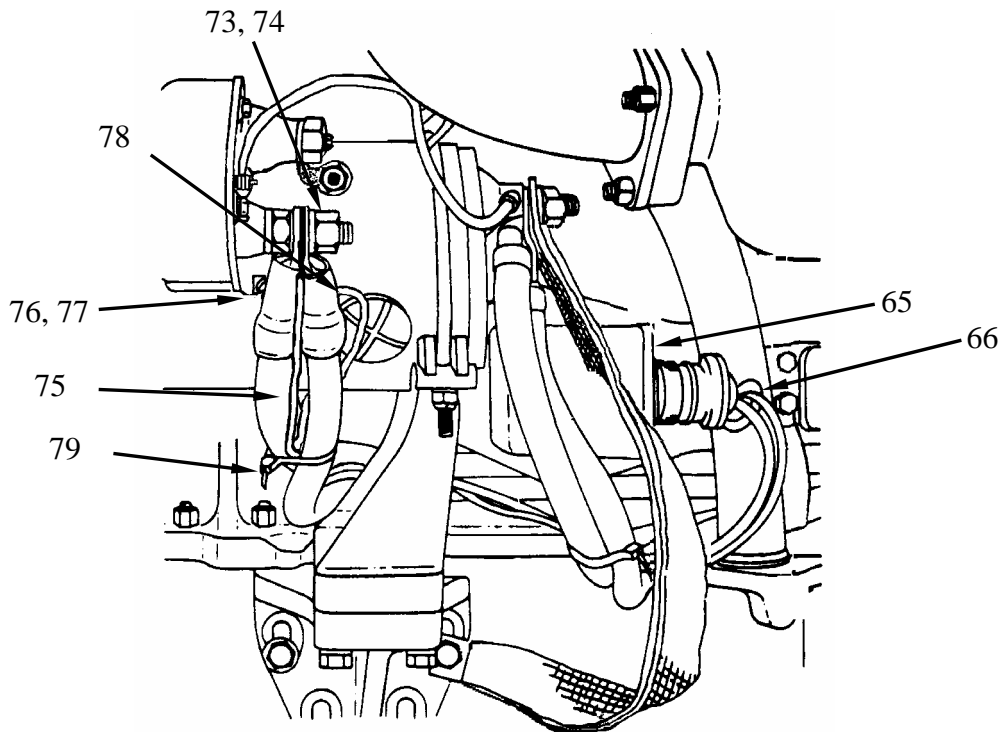
**REMOVAL (Continued)**

15. Remove harness to crankcase-mounted (near starter) low voltage protection module (LVPM).

**NOTE**

**The low voltage protection module mounted near the starter is not the current configuration of the 2CA engine, and is not supported by the repair parts manual. If your engine has the low voltage protection module mounted near the starter, low voltage protection module kit, 12254381, should be installed to reposition the module to the top of the engine.**

- a. Disconnect wiring connector (66) at low voltage protection module (65).
- b. Remove nut (73), and lock washer (74), cut tie wraps (79) as necessary, and remove LVPM lead (75). Reinstall nut (73) and lock washer (74) for later use.
- c. Remove machine screw (76) with lock washer (77). Remove LVPM lead (78). Reinstall screw and lock washer for safe keeping.

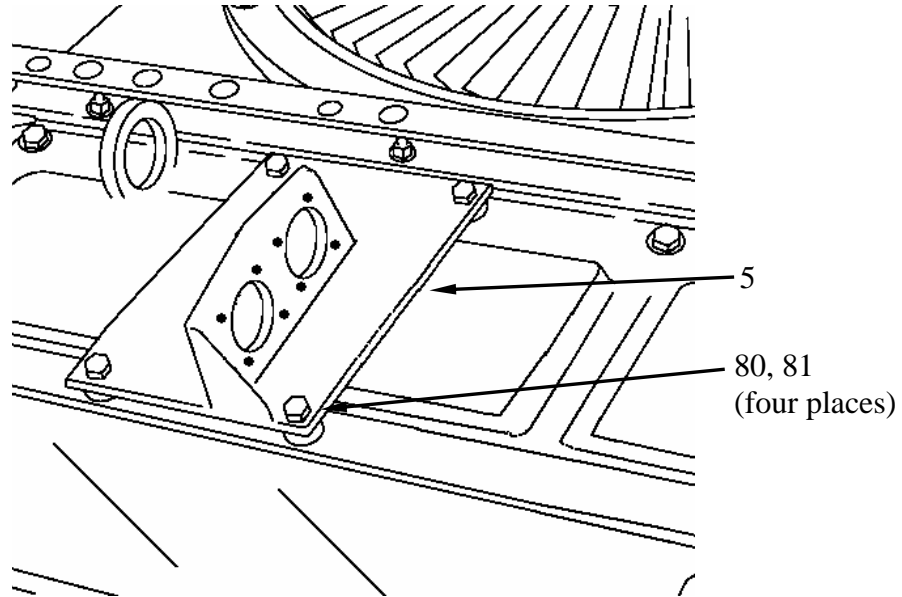




**REMOVAL (Continued)**

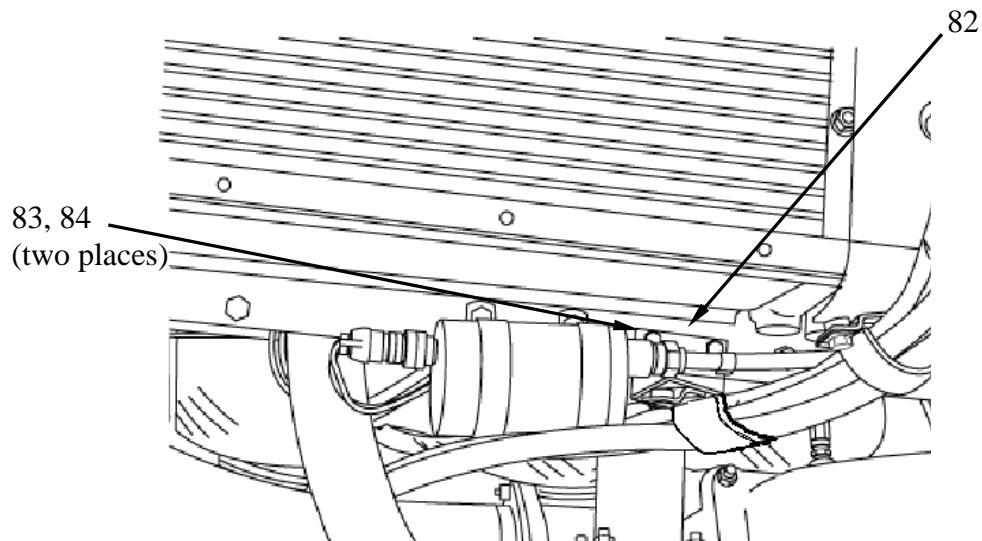
16. Remove wiring harness upper bracket.

- a. With generator harness removed from bracket, remove four screws (80) with lock washers (81), and remove bracket (5). Discard lock washers.



17. Remove starter lower cable bracket (82).

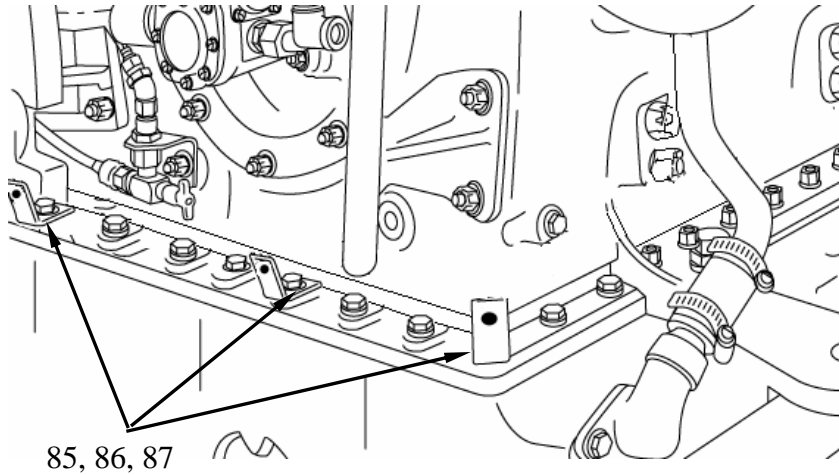
- a. Remove two screws (83) with self-locking nuts (84) and remove starter lower cable bracket assembly (82). Discard self-locking nuts.



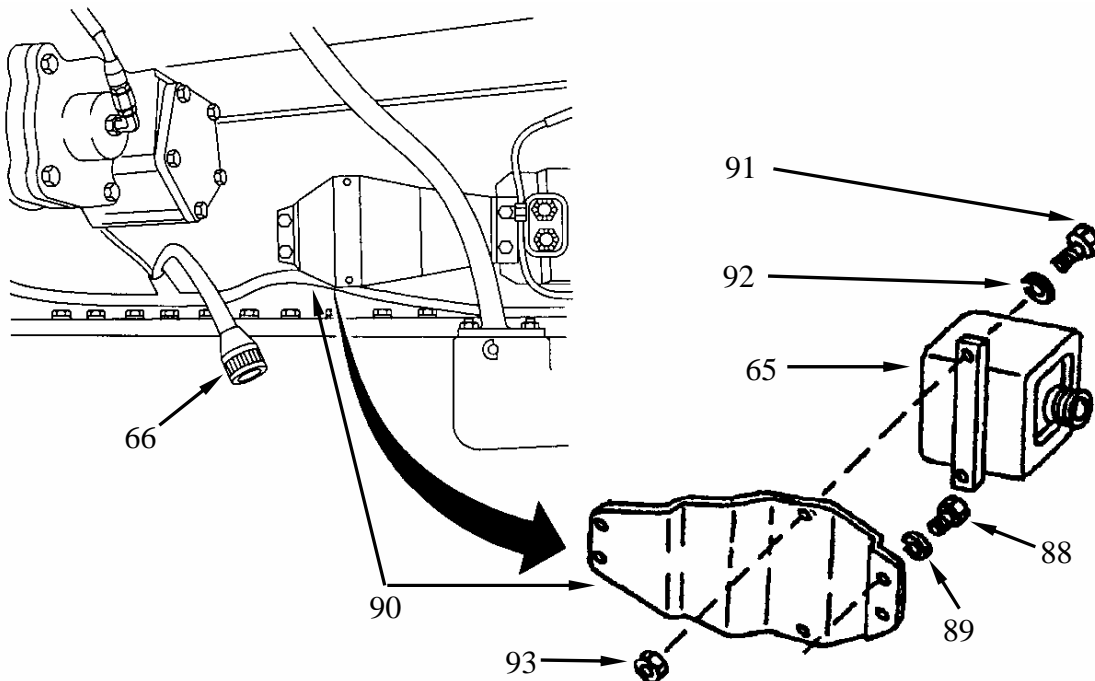
**REMOVAL (Continued)**

18. Remove harness angle brackets (85) at front of engine.

- a. Remove screws (86) with flat washers (87). Remove angle brackets (85).



- b. Disconnect electrical connector (66) at LVPM (65).
- c. Remove four screws (88) with lock washers (89) securing low voltage protection module bracket (90) to engine block. Discard lock washers.
- d. Remove two screws (91) with four lock washers (92) and two self-locking nuts (93) securing low voltage protection module (65) to mounting bracket (90). Discard lock washers and self-locking nuts.



## CLEANING

1. See Work Package 0028 for Standard Cleaning Procedures.

## INSPECTION

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

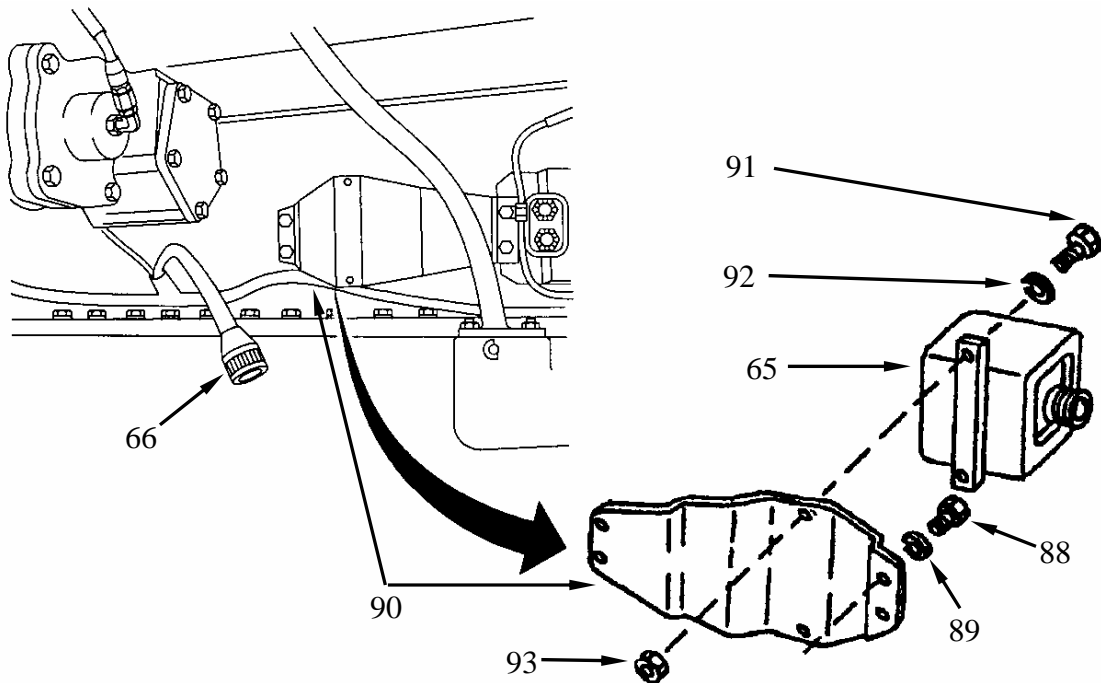
1. See Work Package 0028 for Standard Inspection Procedures.

## REPAIR

1. See Work Package 0056 for Wiring Harness Cable Repair.

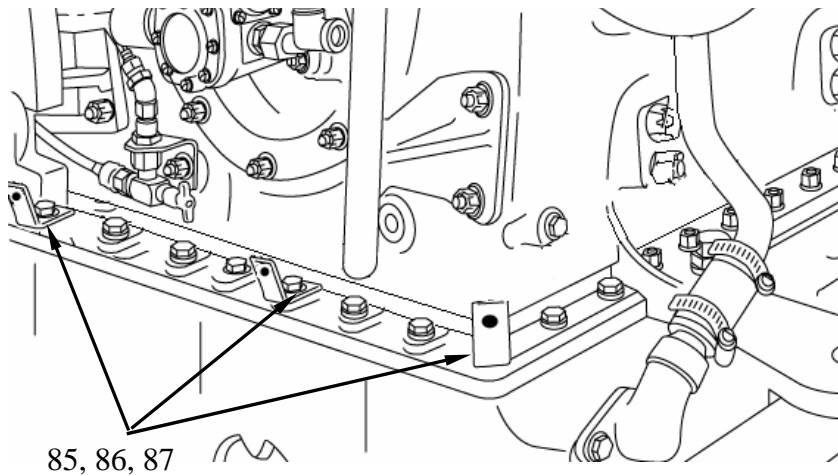
## INSTALLATION

1. Install LVPM bracket.
  - a. Install two screws (91) with four new lock washers (92) (item 82, WP 0175) and two new self-locking nuts (93) (item 37, WP 0175) securing low voltage protection module (65) to mounting bracket (90).
  - b. Install four screws (88) with new lock washers (89) (item 86, WP 0175) securing low voltage protection module bracket (90) to engine block.
  - c. Connect electrical connector (66) at LVPM (65).

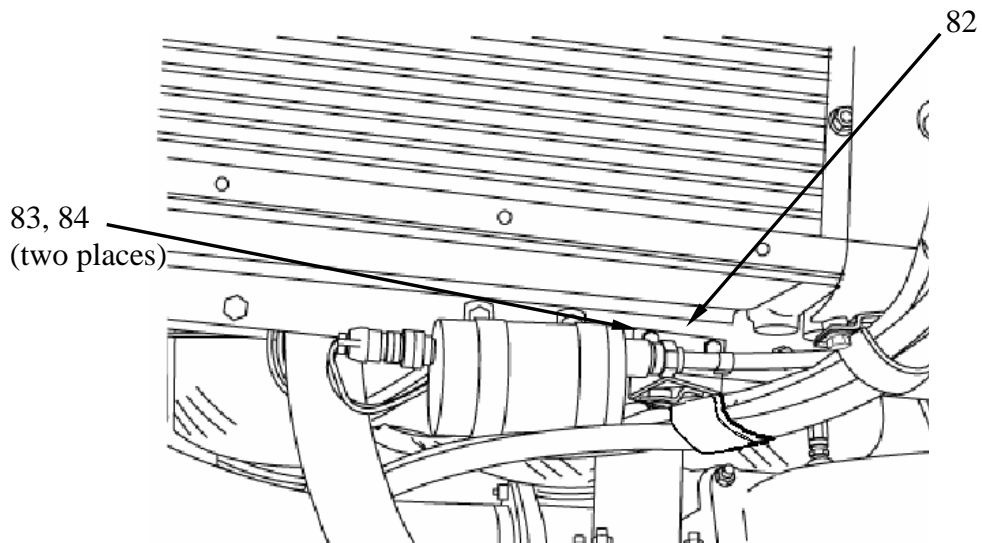


**INSTALLATION (Continued)**

2. Install harness angle brackets (85) at front of engine.
  - a. Install angle brackets (85) with screws (86), and flat washers (87).



3. Install starter lower cable bracket (82).
  - a. Install two screws (83) with new self-locking nuts (84) (item 33, WP 0175) and install starter lower cable bracket assembly (82).



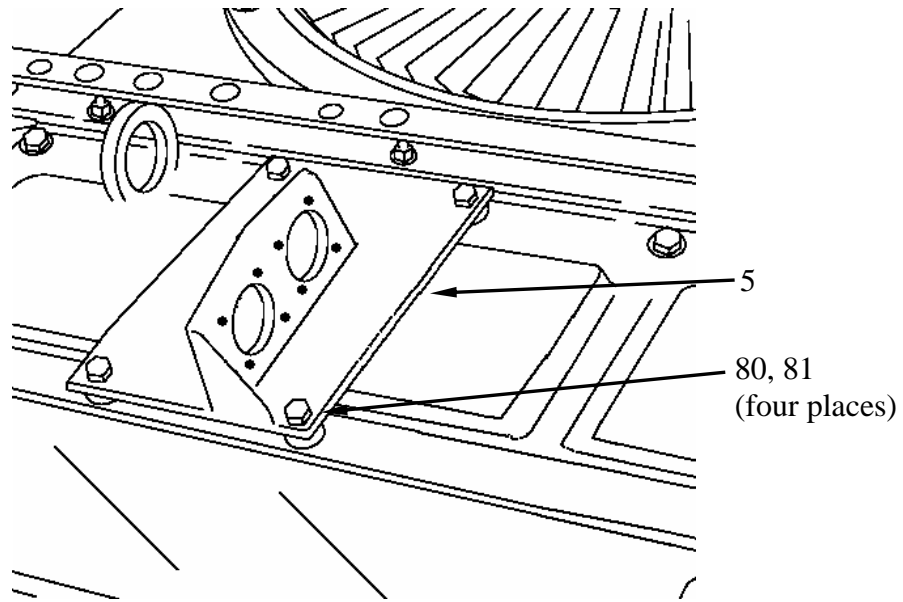
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**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

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**INSTALLATION (Continued)**

4. Install wiring harness upper bracket (5).
  - a. Install four screws (80) with new lock washers (81) (item 86, WP 0175) into bracket (5).



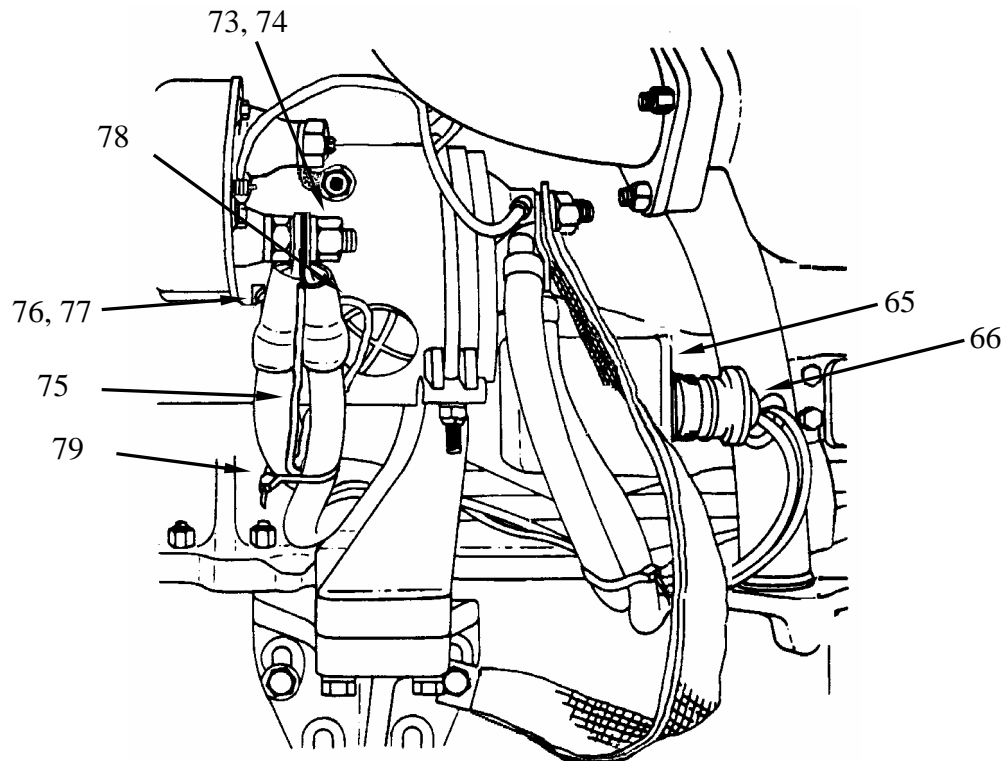
**INSTALLATION (Continued)**

5. Install harness to crankcase-mounted (near starter) low voltage protection module (LVPM).

**NOTE**

**The low voltage protection module mounted near the starter is not the current configuration of the 2CA engine, and is not supported by the repair parts manual. Low voltage protection module kit, 12254381, should be installed to reposition the module to the top of the engine.**

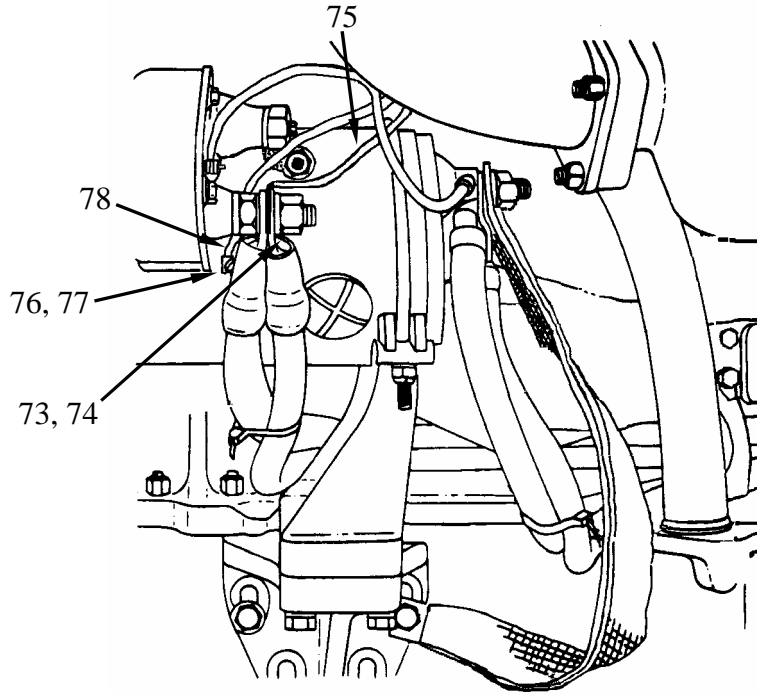
- a. Install wiring connector (66) at low voltage protection module (67).
- b. Remove nut (73), and lock washer (74), and install LVPM lead (75).
- c. Install nut (73) and lock washer (74).
- d. Install tie wraps (79) (item 80, WP 0175) as necessary.
- e. Install machine screw (76) and lock washer (77) to install LVPM lead (78).



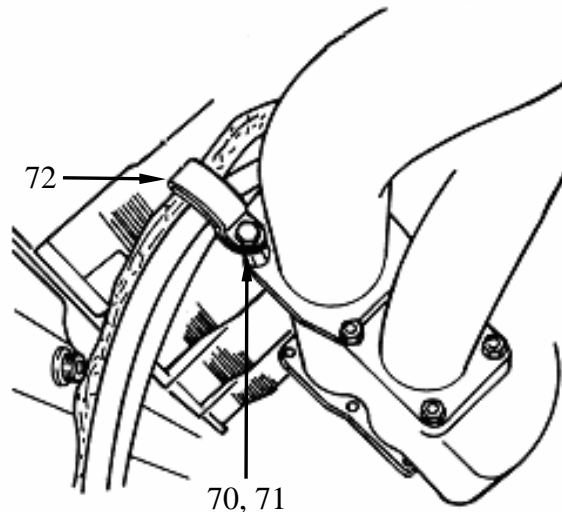
**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**INSTALLATION (Continued)**

6. Install harness to top-mounted low voltage protection module (LVPM).
  - a. Remove nut (73) and lock washer (74) from starter positive lug.
  - b. Install LVPM module wire (75) to starter positive lug with existing nut (73) and lock washer (74).
  - c. Install LVPM lead (78) with machine screw (76) and lock washer (77).



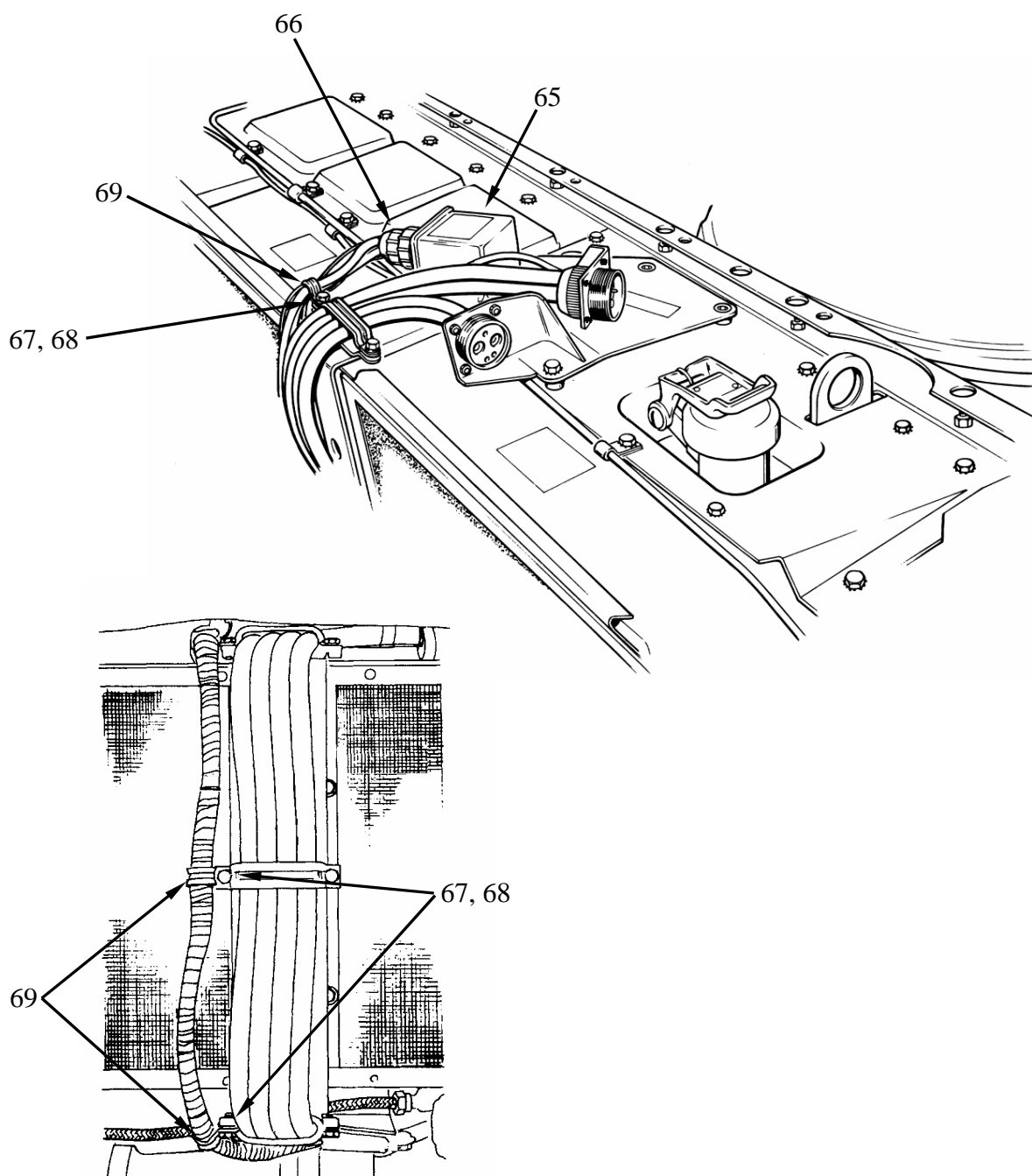
- d. Install loop clamp (72) onto cable.
- e. Install screw (70) with new lock washer (71) (item 93, WP 0175).



**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**INSTALLATION (Continued)**

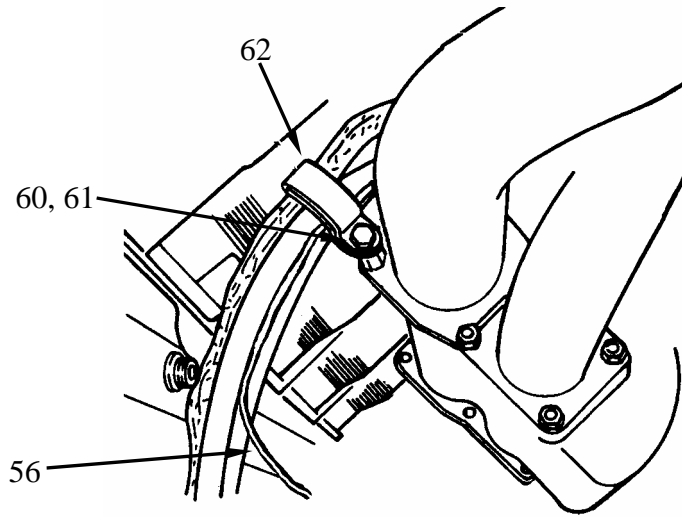
6. Install harness to top-mounted low voltage protection module (LVPM) (continued).
  - f. Install electrical connector (66) to LVPM (65).
  - g. Install loop clamps (69) with screws (67) and new lock washers (68) (item 92, WP 0175).



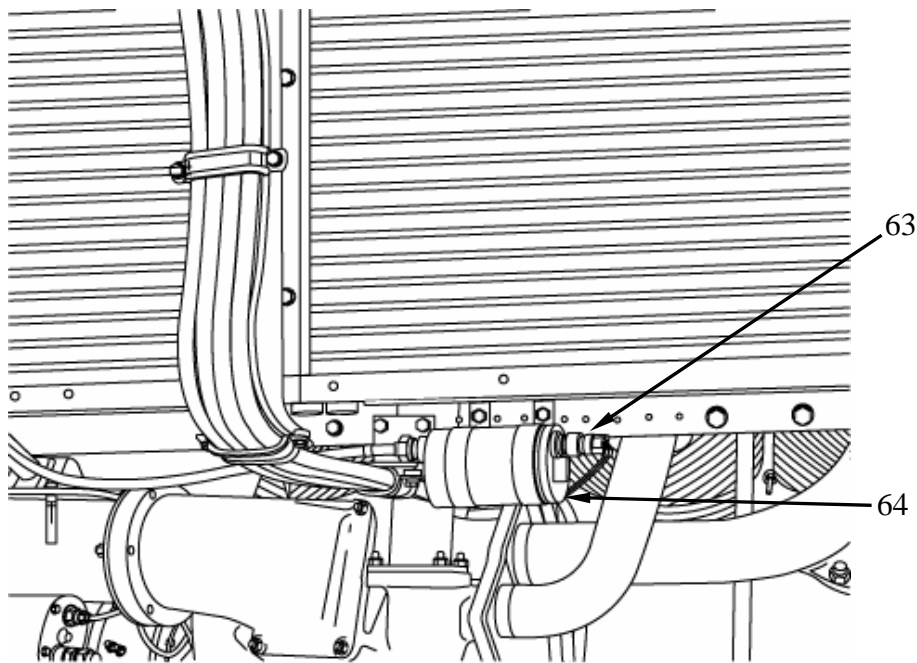


**INSTALLATION (Continued)**

6. Install harness to top-mounted low voltage protection module (LVPM) (continued).
  - h. Install screw (60), with new lock washer (61) (item 93, WP 0175) to secure wiring (56) for left manifold heater into loop clamp (62).

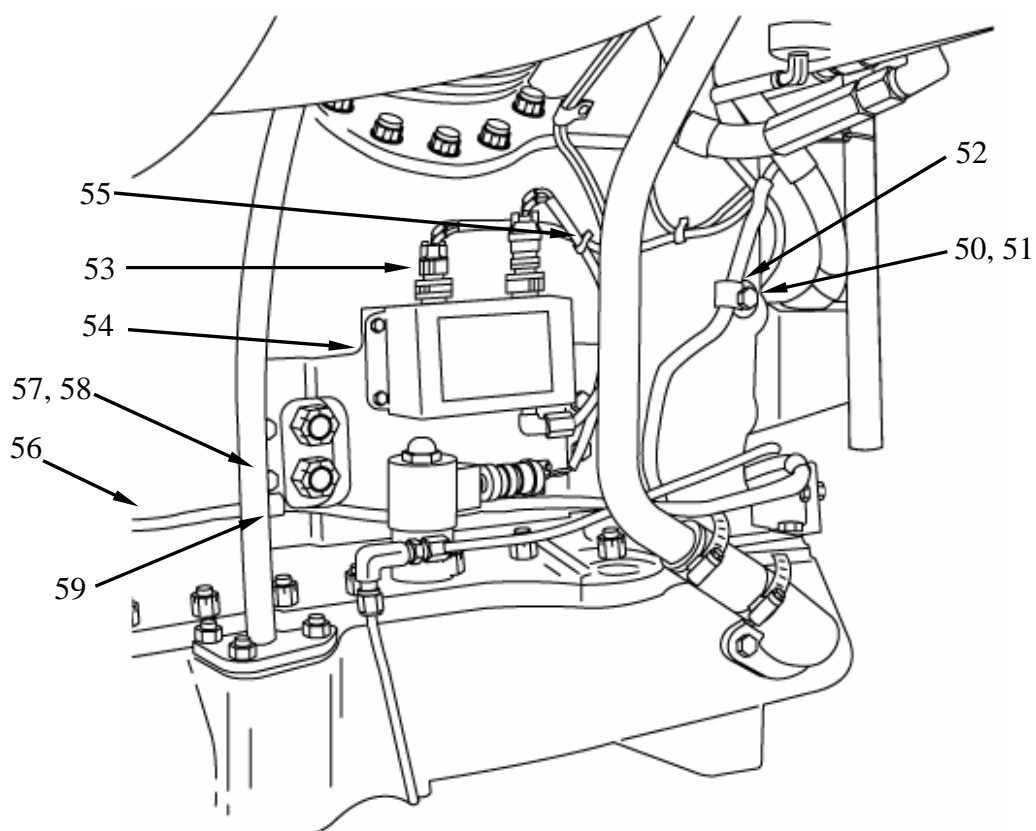


- i. Connect connection (63) at left manifold heater exciter (64).



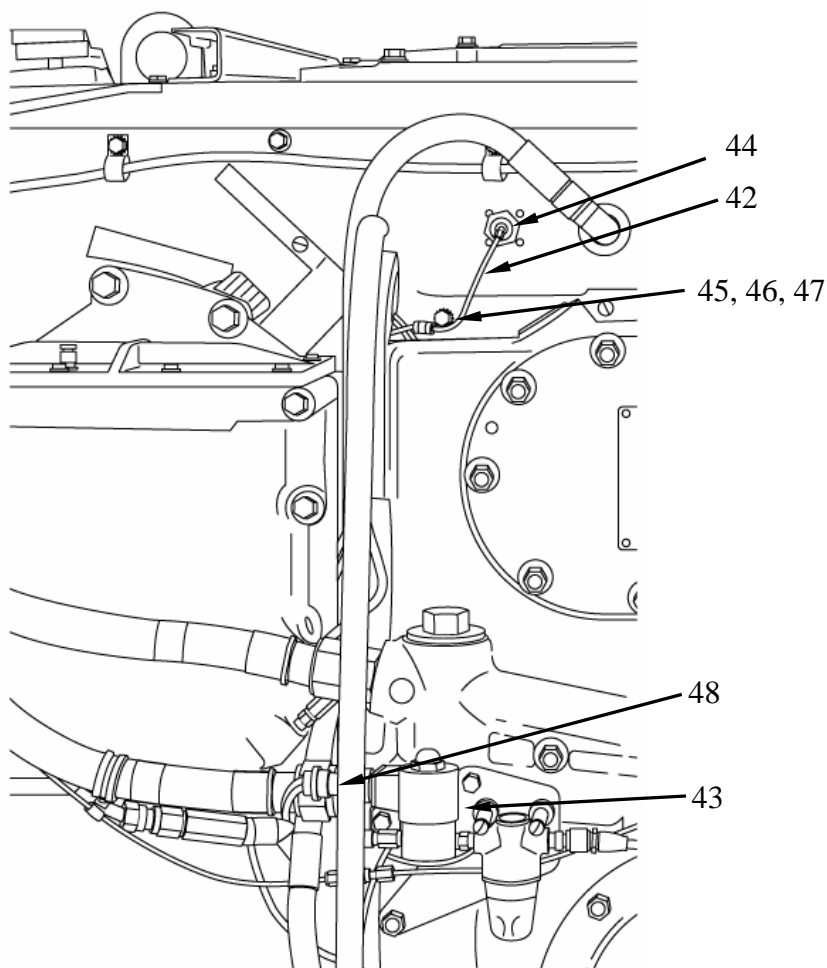
**INSTALLATION (Continued)**

7. Install harness (56) leading away from left manifold heater.
  - a. Install harness into loop clamp (59).
  - b. Install screw (57) with new lock washer (58) (item 93, WP 0175) to retain loop clamp (59).
8. Install harness on starter side of engine.
  - a. Install harness into loop clamp (52).
  - b. Install screw (50) with new lock washer (51) (item 93, WP 0175) to retain loop clamp (52).
  - c. Connect electrical connector (53) at fuel water separator control unit (54).
  - d. Install tie wraps (55) (item 80, WP 0175) as needed.



**INSTALLATION (Continued)**

8. Install harness at front of engine (continued).
  - e. Connect electrical connector (44) for fuel shutoff solenoid.
  - f. Install loop clamp (47) onto wire (42).
  - g. Install screw (45) with new lock washer (46) (item 94, WP 0175).
  - h. Connect electrical connector (48) at flame start solenoid (43).



**INSTALLATION (Continued)**

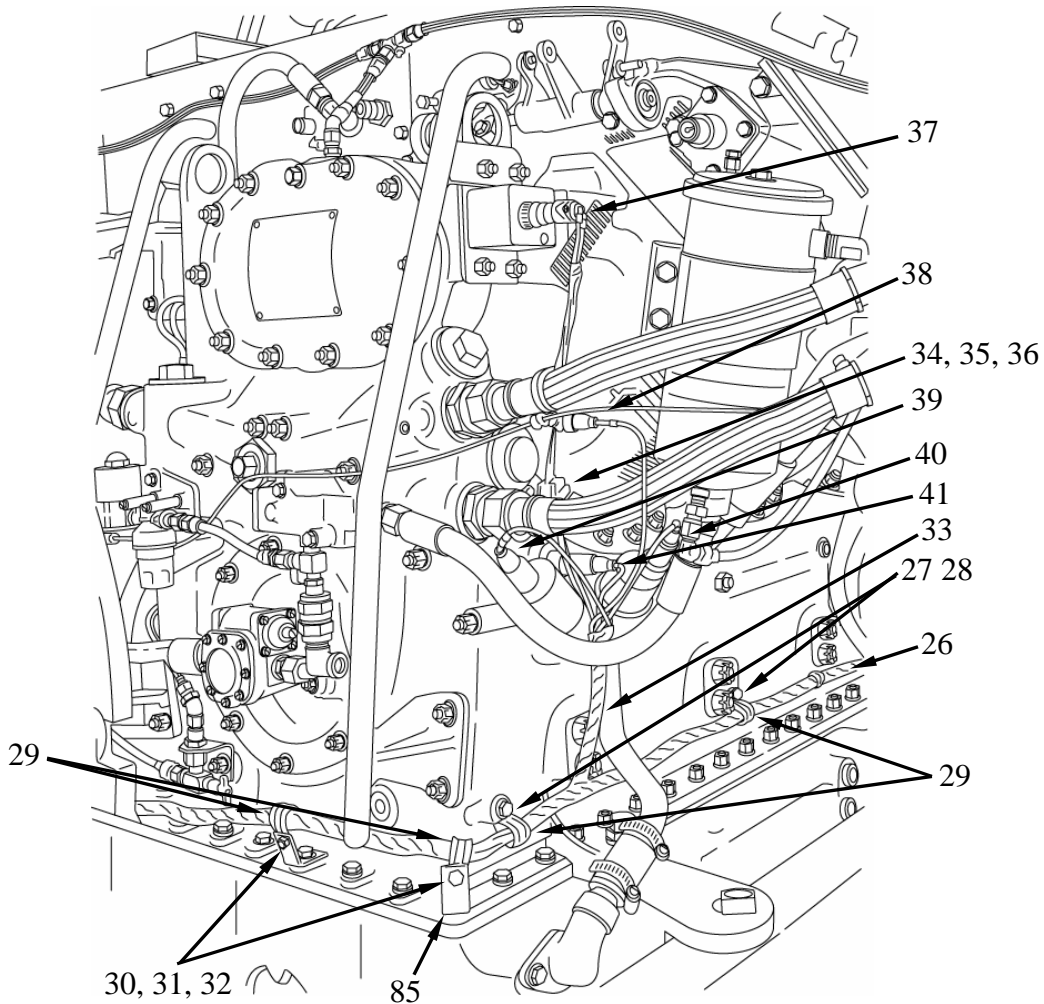
8. Install harness (26) at front of engine (continued).

**NOTE**

**Damper housing mounted hour meter harness installation instructions are covered in step 8, i.**

**Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). See step 9 for top-mounted harness installation instructions.**

- i. Install loop clamps (29) onto harness angle brackets (85) using screws (30) with nut (31), and new lock washers (32) (item 92, WP 0175).
- j. Connect electrical connectors at hour meter (37), engine oil temperature transmitter (38) engine oil pressure transmitter (39), low engine oil pressure switch (40), and high oil temperature switch (41).
- k. Install new self-locking nut (34) (item 33, WP 0175) with flat washer (35) to retain loop clamp (36).
- m. Install loop clamps (29) onto harness. Install screws (27) with new lock washers (28) (item 92, WP 0175).



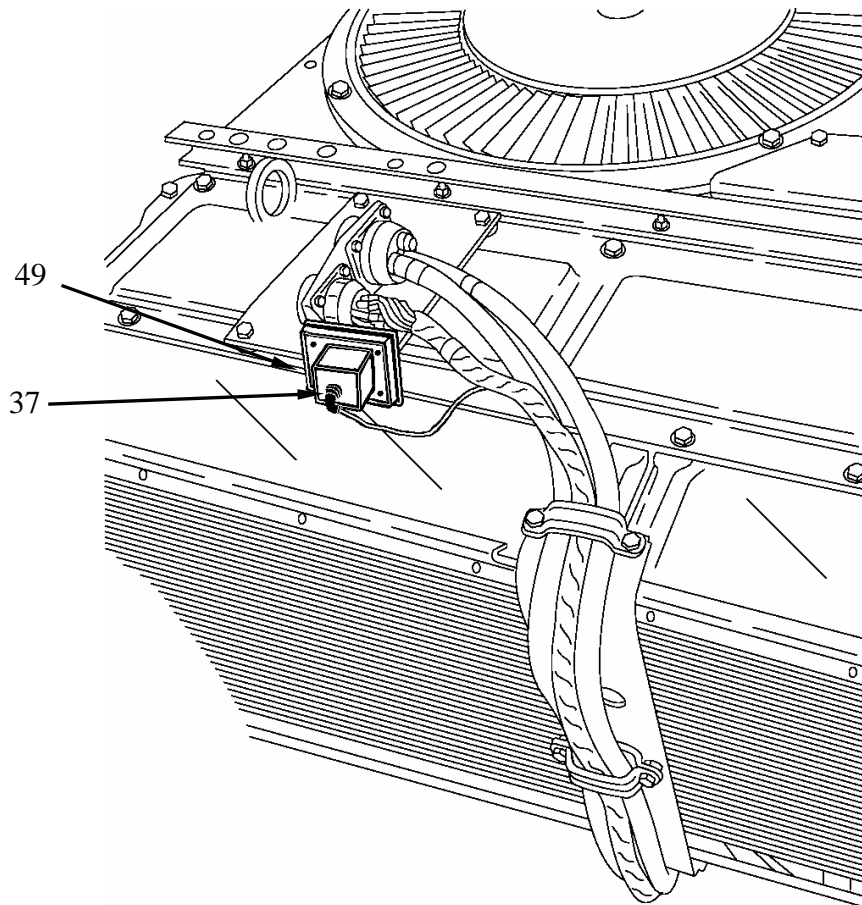
INSTALLATION (Continued)

NOTE

Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). Harness installation instructions are covered in step 9.

For engines with damper housing mounted hour meter, harness installation instructions are covered in step 8, i.

9. Install harness to hour meter on top of engine.
  - a. Install electrical connector (37) onto hour meter (49).

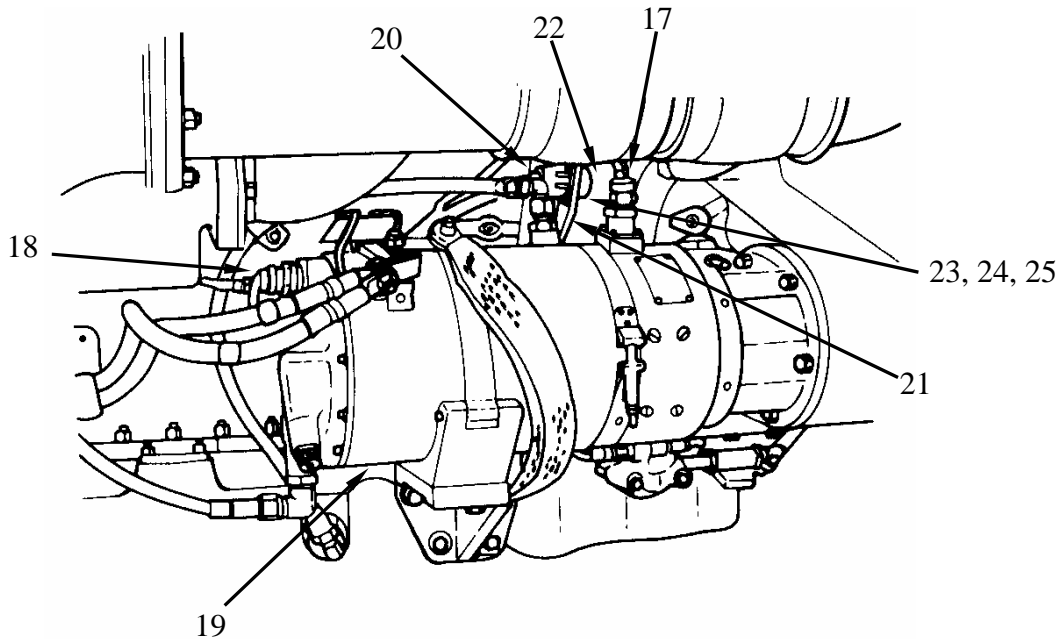


**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**INSTALLATION (Continued)**

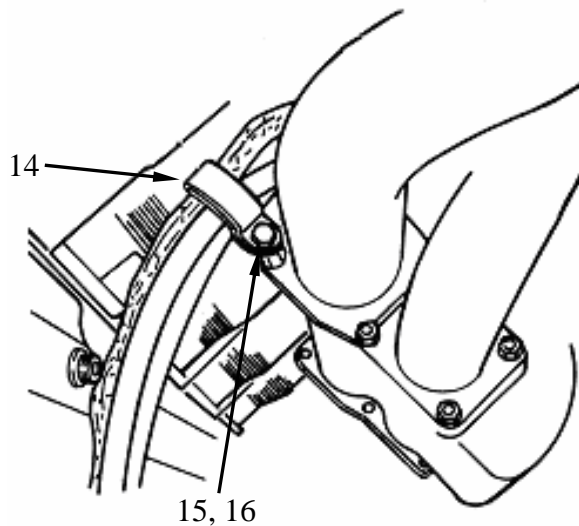
10. Install connections at generator.

- a. Connect electrical connectors (17, 18) at generator (19).
- b. Install transmission harness connector (20) into transmission harness bracket (21) using four machine screws (22) with new lock washers (24) (item 90, WP 0175) and nuts (25).



11. Install harness into loop clamp (14).

- a. Install screw (15) with new lock washer (16) (item 93, WP 0175) to retain loop clamp (14).

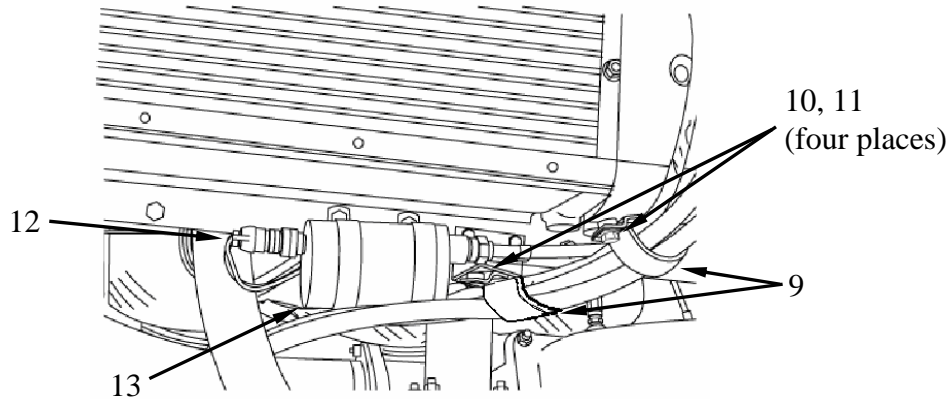


**SIGNAL WIRING HARNESS REPLACEMENT (2CA) (PN 12254376, 12354385) 0057 00**

**INSTALLATION (Continued)**

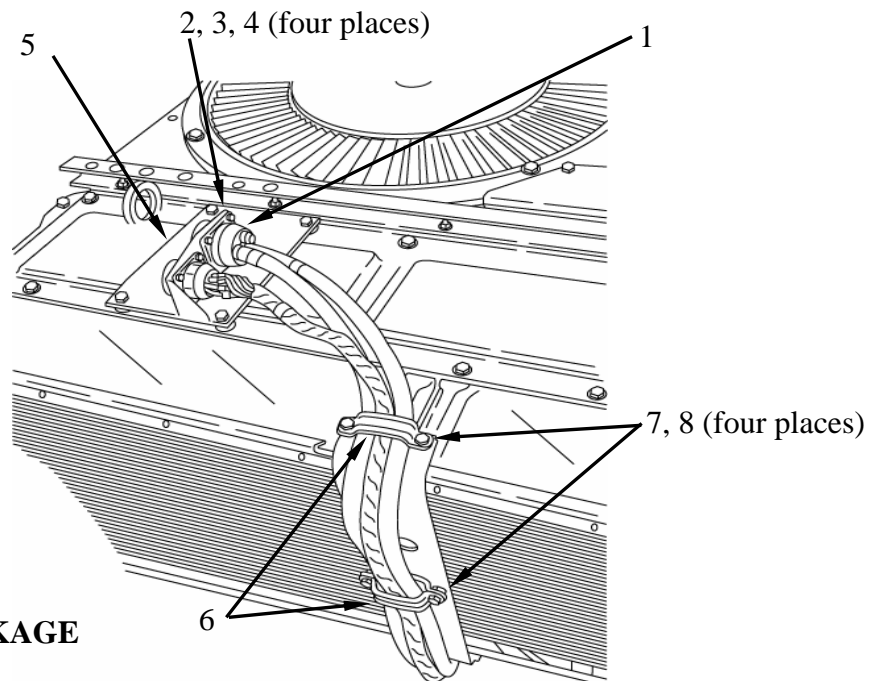
12. Install harness into retaining straps.

- a. Install harness into retaining straps (9) using four screws (10) with new lock washers (11) (item 92, WP 0175).
- b. Connect electrical connector (12) at flame start exciter (13).



- c. Install harness into retaining straps (6).
- d. Install retaining straps (6) with four screws (7) using new lock washers (8) (item 93, WP 0175).

13. Install harness end connector (1) into wiring harness upper bracket (5) using four machine screws (2) with new lock washers (3) (item 91, WP 0175) and nuts (4).



**END OF WORK PACKAGE**





**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254378, 12354384) 0058 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (1) (item 83, WP 0175)

Lock washer (4) (item 82, WP 0175)

Lock washer (8) (item 86, WP 0175)

Lock washer (4) (item 90, WP 0175)

Lock washer (4) (item 91, WP 0175)

Lock washer (as needed) (item 92, WP 0175)

Lock washer (as needed) (item 93, WP 0175)

**Mandatory Replacement Parts (Continued)**

Lock washer (1) (item 94, WP 0175)

Self-locking nut (3) (item 33, WP 0175)

Self-locking nut (2) (item 37, WP 0175)

Tie wrap (as needed) (item 80, WP 0175)

**Personnel Required:**

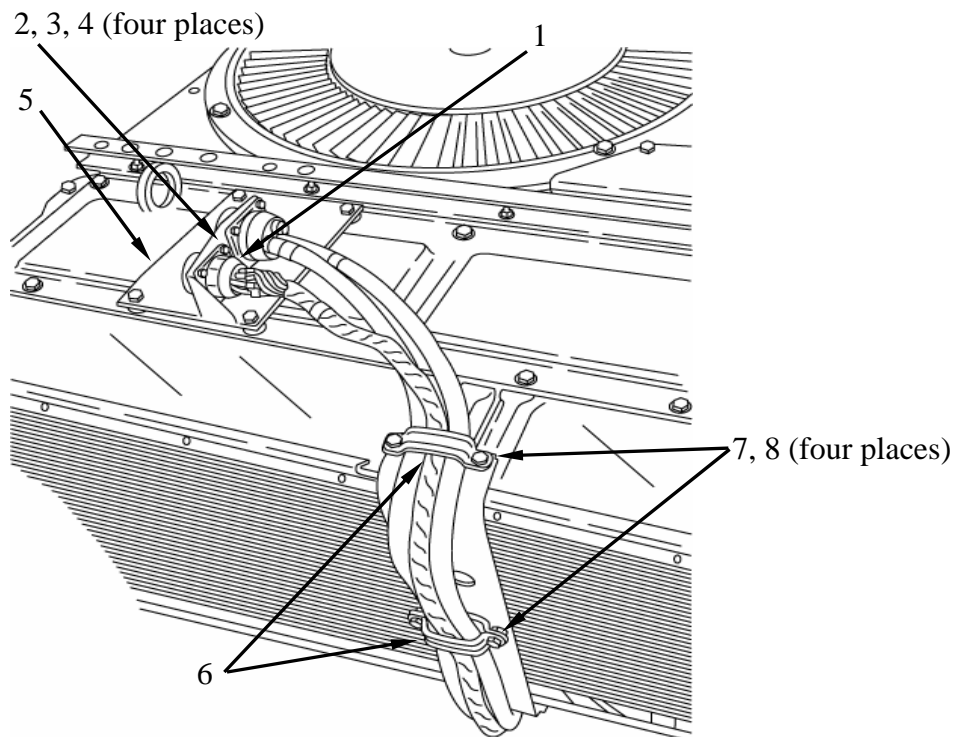
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

**REMOVAL**

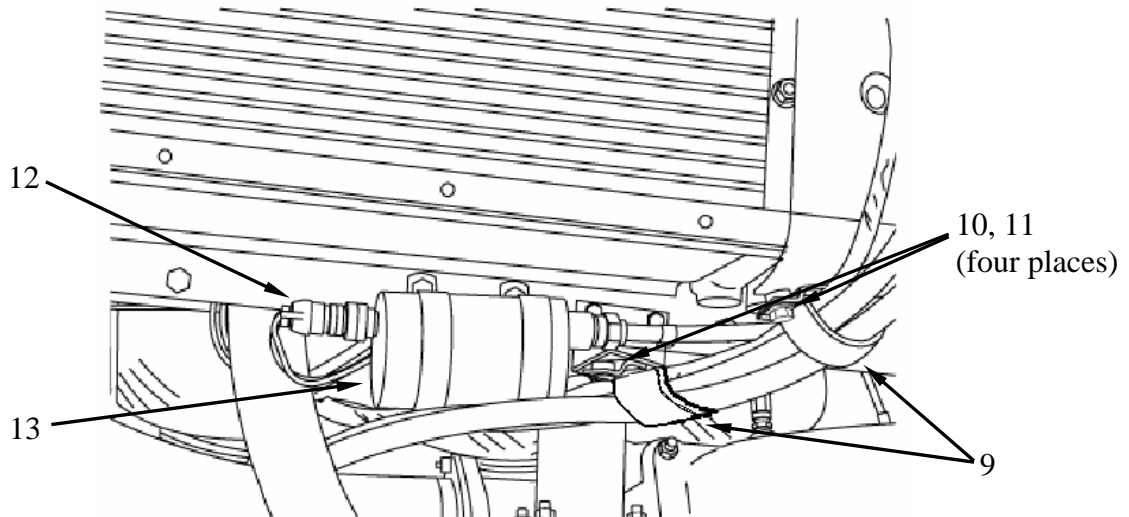
1. Disconnect harness end connector (1).
  - a. Remove four machine screws (2) with lock washers (3) and nuts (4) from wiring harness upper bracket (5). Discard lock washers.
2. Remove retaining straps (6).
  - a. Remove four screws (7) with lock washers (8) and retaining straps (6). Discard lock washers.



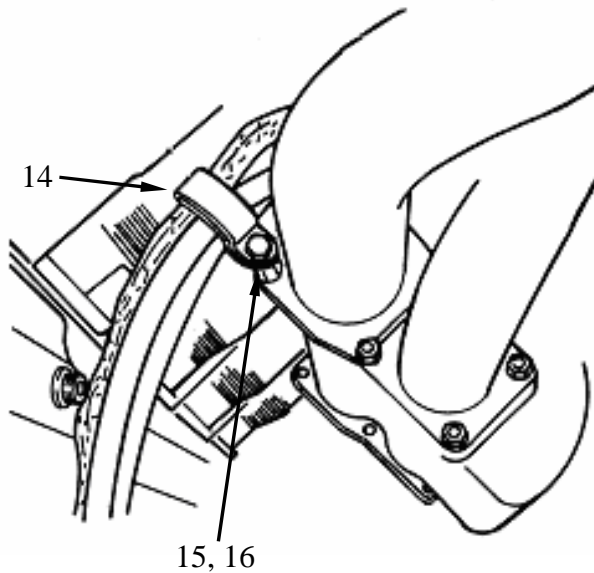
**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

**REMOVAL (Continued)**

3. Remove lower retaining straps (9).
  - a. Remove four screws (10) with lock washers (11) and remove two retaining straps (9). Discard lock washers.
4. Remove electrical connector (12) at right manifold heater exciter (13).



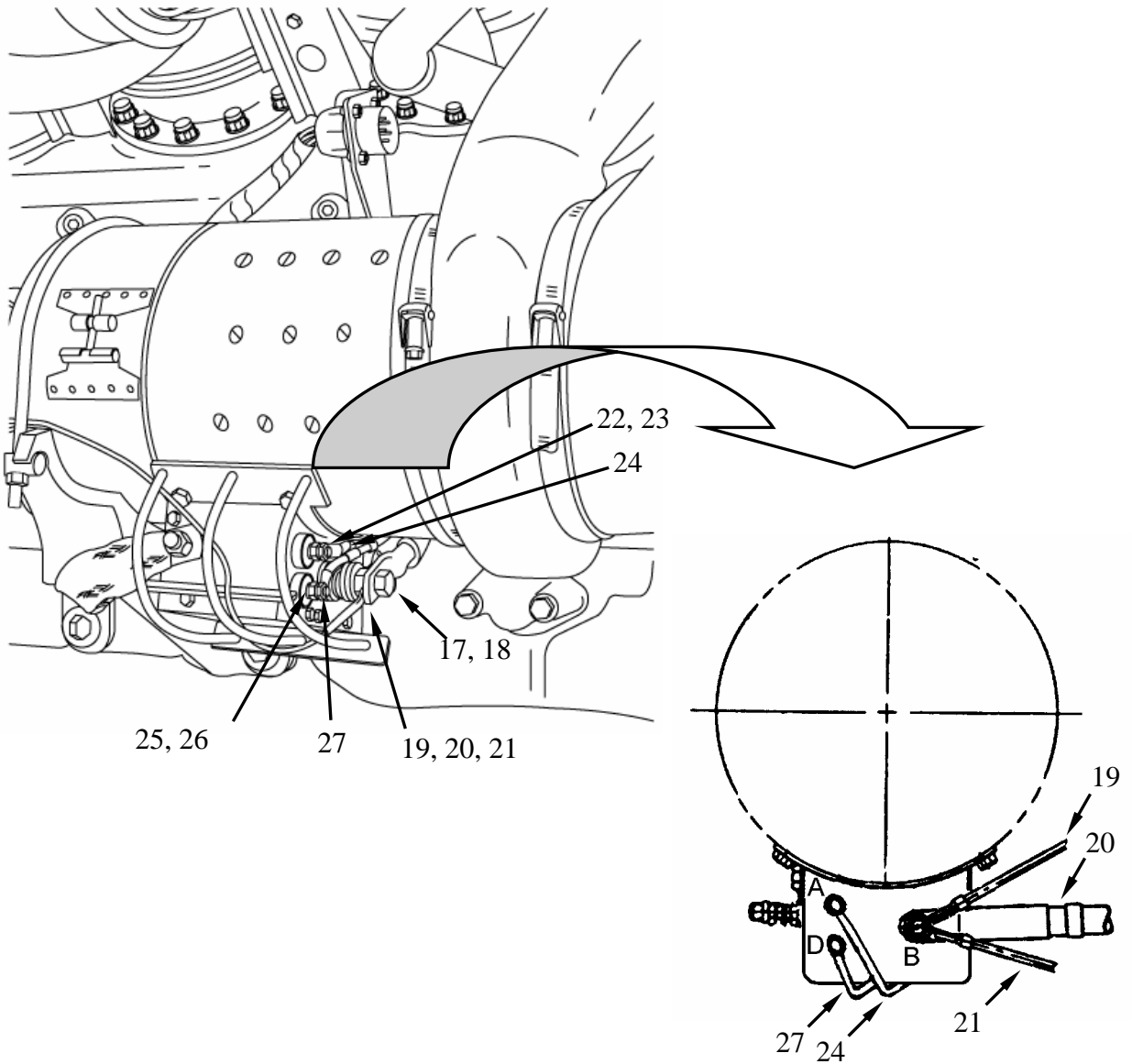
5. Remove harness from loop clamp (14).
  - a. Remove screw (15) with lock washer (16). Discard lock washer.
  - b. Remove loop clamp (14).



**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

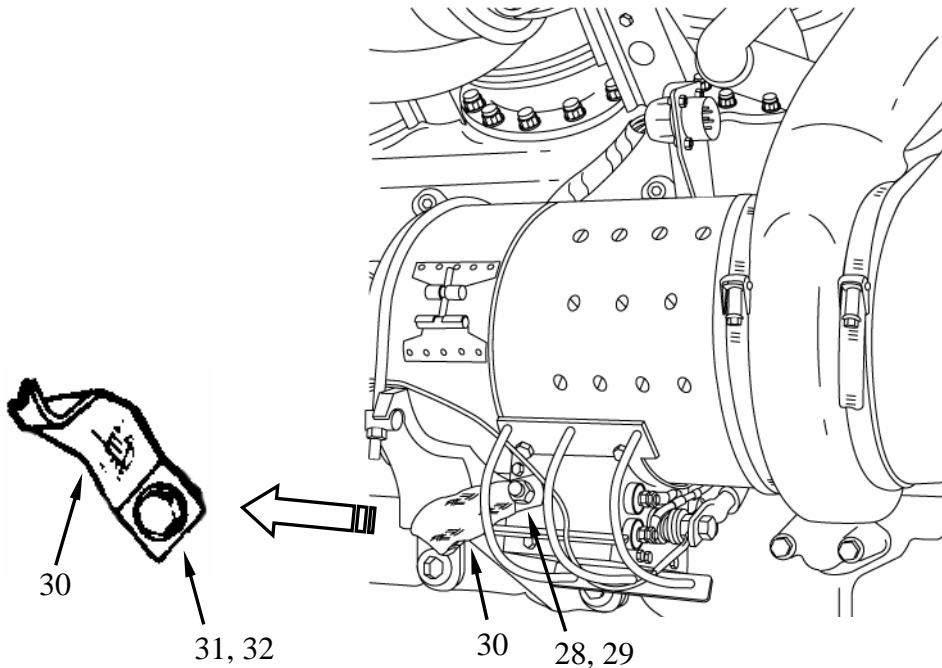
**REMOVAL (Continued)**

6. Remove harness positive connections at generator.
  - a. Remove self-locking nut (17) with flat washer (18), and remove electrical leads (19, 20, 21). Reinstall nut (17) and flat washer (18) for safe keeping.
  - b. Remove self-locking nut (22) with flat washer (23), and remove electrical lead (24). Reinstall nut (22) and flat washer (23) for safe keeping.
  - c. Remove self-locking nut (25) with flat washer (26), and remove electrical lead (27). Reinstall nut (25) and flat washer (26) for safe keeping.

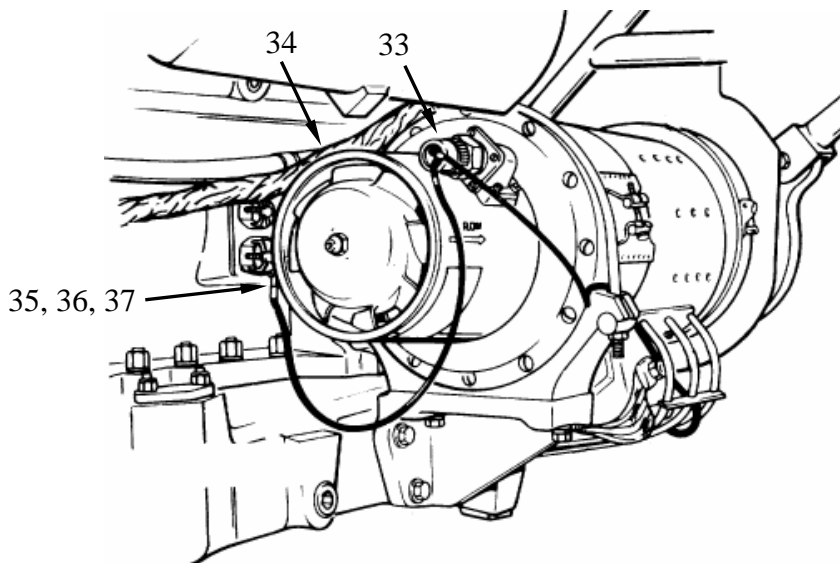


**REMOVAL (Continued)**

7. Remove harness ground connections at generator.
  - a. Remove self-locking nut (28) with flat washer (29), securing upper end of ground lead (30). Reinstall nut and flat washer for safe keeping.
  - b. Remove screw (31) with flat washer (32) and finish removing ground lead (30).

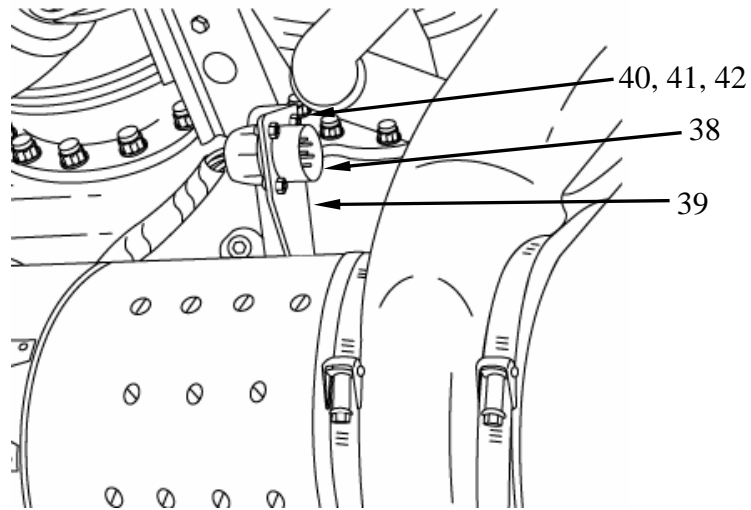


8. Disconnect electrical connector (33) to generator blower (34).
9. Remove screw (35) with lock washer (36) to remove generator blower ground lead (37). Discard lock washer.



**REMOVAL (Continued)**

10. Remove transmission harness connector (38) from harness bracket (39).
  - a. Disconnect electrical connection (shown removed) at transmission harness connector (38).
  - b. Remove four machine screws (40) with lock washers (41) and nuts (42) to remove transmission harness disconnect cable connector (38) from bracket (39).  
Discard lock washers.



**REMOVAL (Continued)**

11. Remove harness (43) at front of engine.

- a. Remove screws (44) with lock washers (45) and loop clamps (46). Discard lock washers.
- b. Remove screws (47) with nut (48), and lock washers (49). Remove loop clamps (46). Discard lock washers.

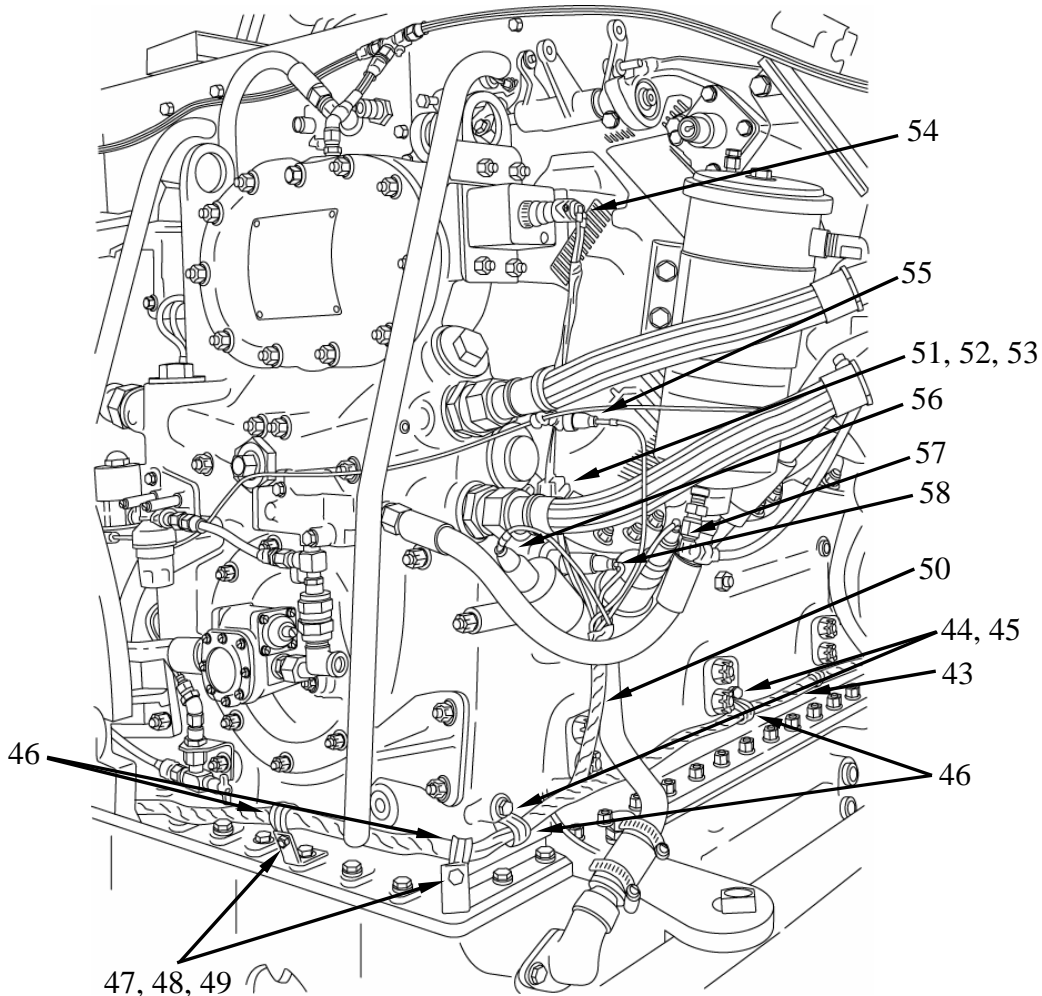
**NOTE**

**Damper housing mounted hour meter harness removal instructions are covered in step 12.**

**Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354384). See step 14 for top-mounted harness removal instructions.**

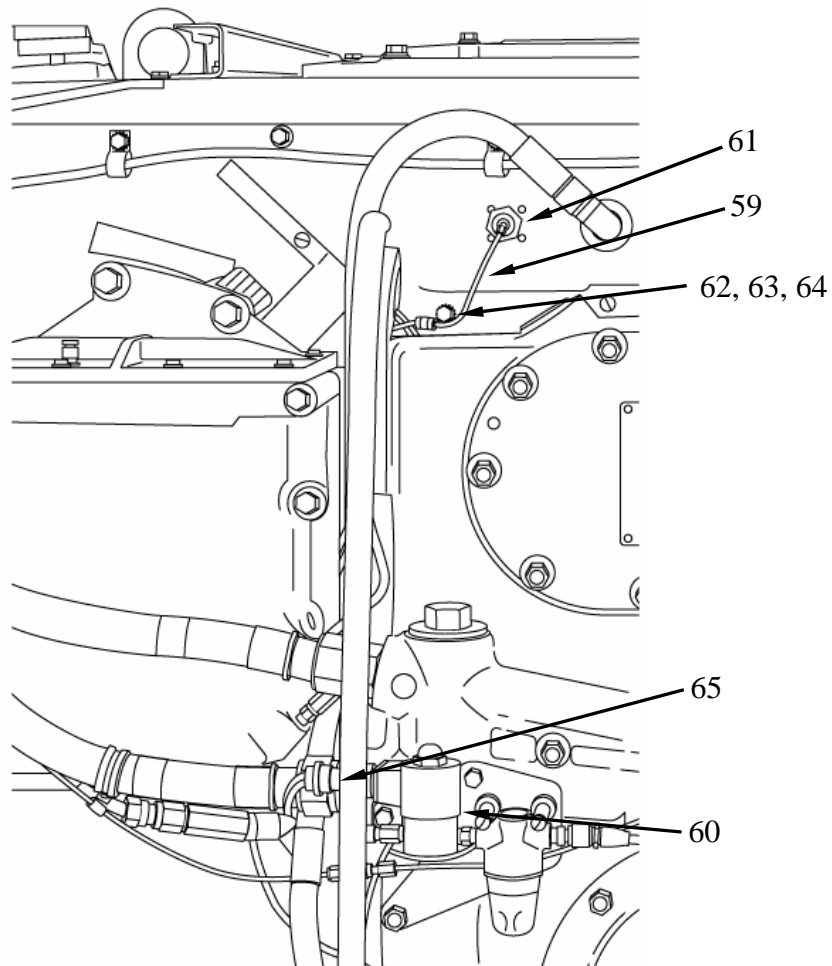
12. Remove transmitter, and sensor wiring (50).

- a. Remove self-locking nut (51) with flat washer (52). Discard locking nut. Remove loop clamp (53).
- b. Disconnect hour meter (54), engine oil temperature transmitter (55), engine oil pressure transmitter (56), low engine oil pressure switch (57), and high oil temperature switch (58) electrical connectors.



**REMOVAL (Continued)**

13. Remove fuel cut-off wiring (59) and manifold heater solenoid (60) wiring.
  - a. Disconnect electrical connector at fuel shutoff lead connection (61).
  - b. Remove screw (62), with lock washer (63). Discard lock washer. Remove loop clamp (64).
  - c. Disconnect electrical connector (65) at manifold heater solenoid (60).



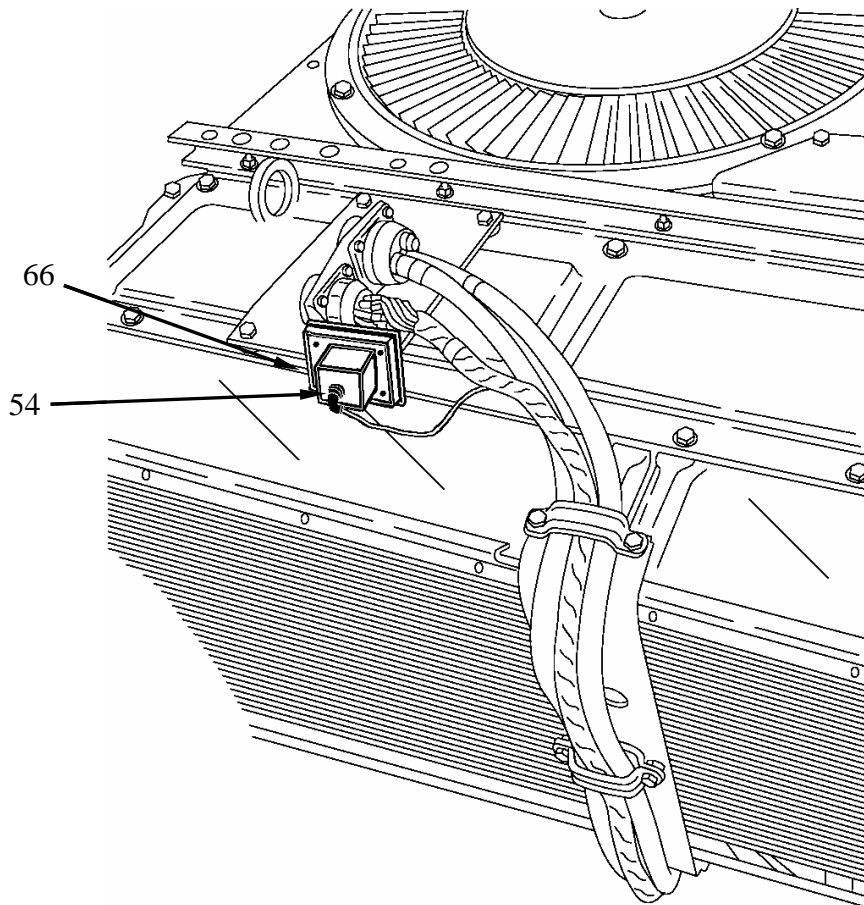
REMOVAL (Continued)

NOTE

Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). Harness removal instructions are covered in step 14.

For engines with damper housing mounted hour meter, harness removal instructions are covered in step 12.

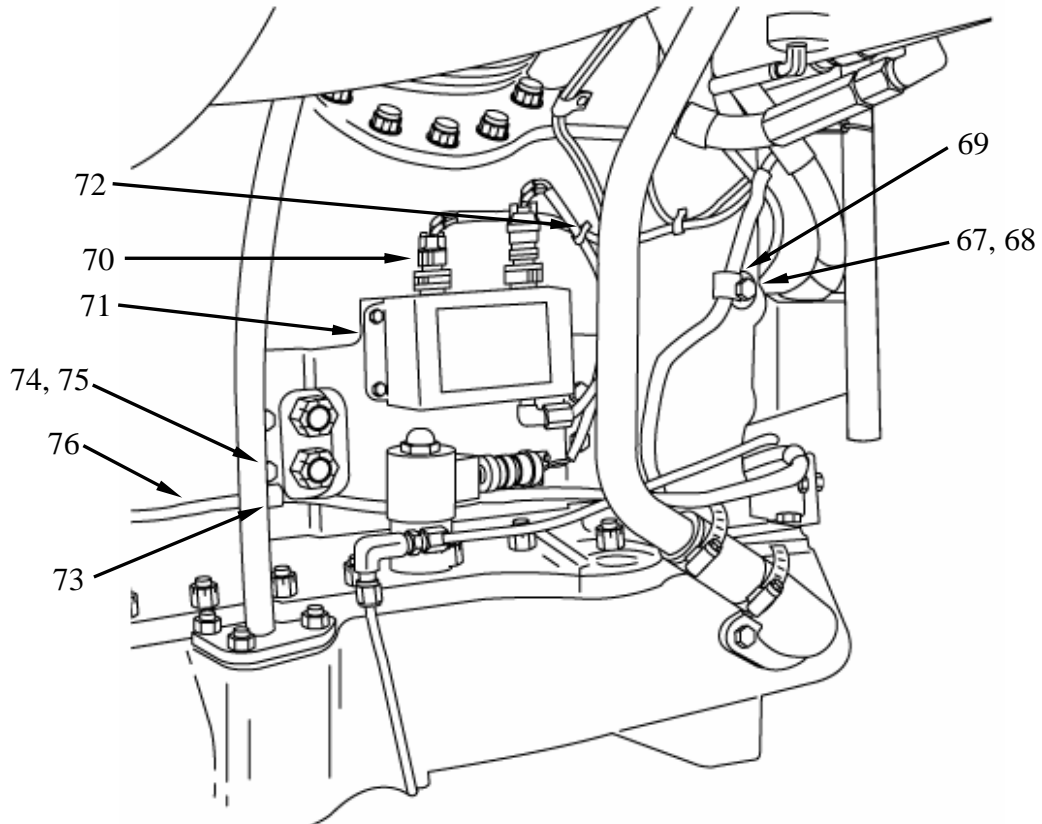
14. Remove harness to top-mounted hour meter.
  - a. Disconnect electrical connector (54) from hour meter (66).





**REMOVAL (Continued)**

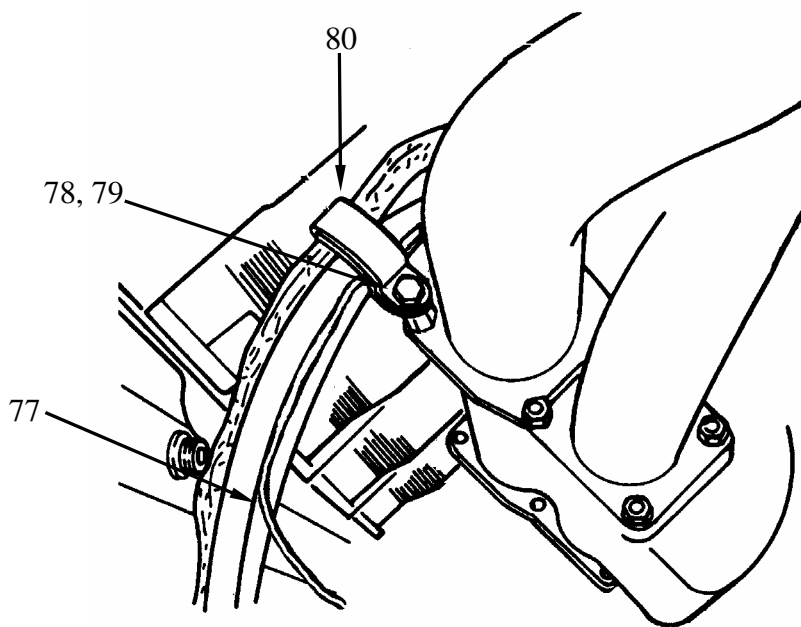
15. Disconnect automatic water separator harness.
  - a. Remove screw (67) with lock washer (68). Discard lock washer.
  - b. Remove loop clamp (69).
  - c. Disconnect electrical connector (70) at fuel water separator control unit (71).  
Cut tie wraps (72) as needed.
16. Remove wiring (73) to left manifold heater exciter.
  - a. Remove screw (74) with lock washer (75). Discard lock washer.
  - b. Remove loop clamp (76).



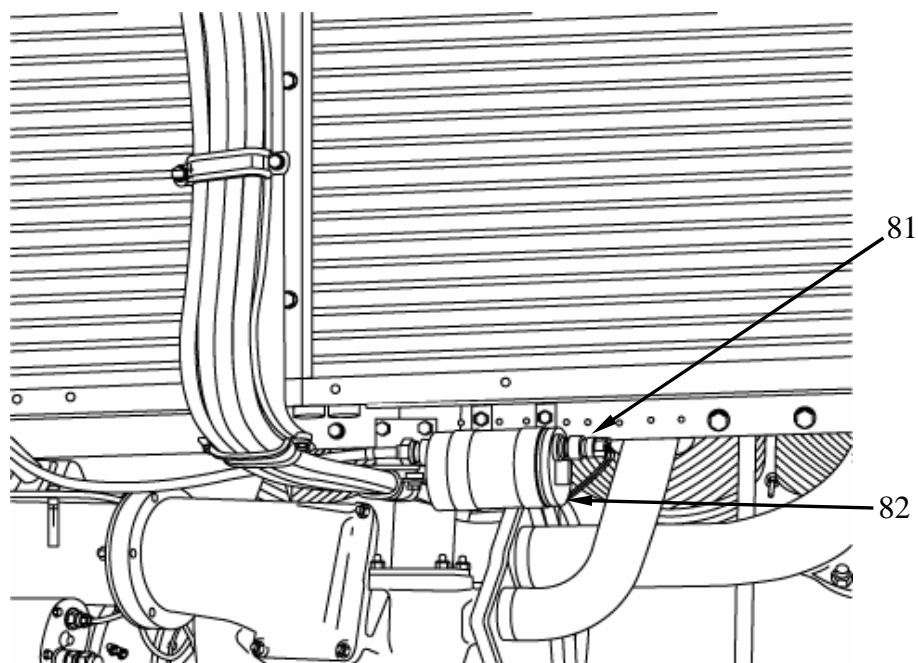
**REMOVAL (Continued)**

17. Remove wiring (77) to left manifold heater exciter (continued).

- c. Remove screw (78), with lock washer (79) and remove wiring (77) from loop clamp (80). Discard lock washer.



- d. Remove connection (81) at left manifold heater exciter (82).



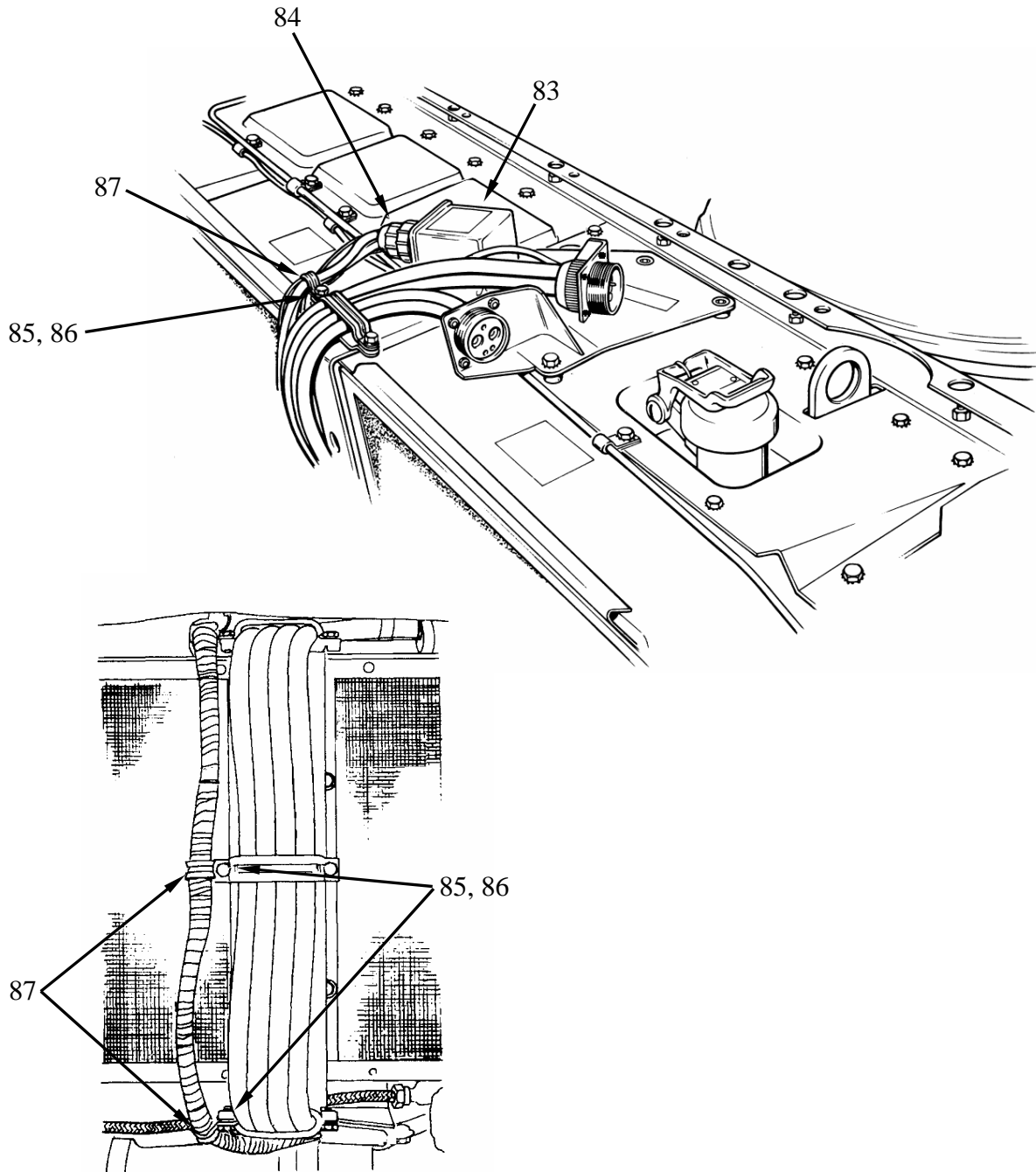
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**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

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**REMOVAL (Continued)**

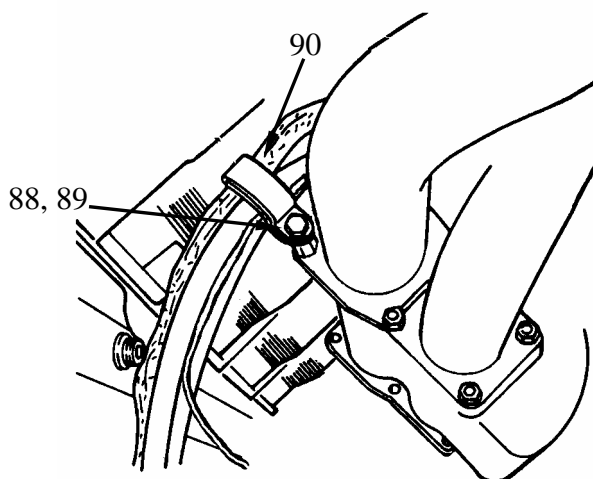
18. Remove harness to top-mounted low voltage protection module (LVPM) (83).
  - a. Disconnect electrical connector (84) from LVPM (83).
  - b. Remove screws (85) with lock washers (86), and remove loop clamps (87). Discard lock washers.



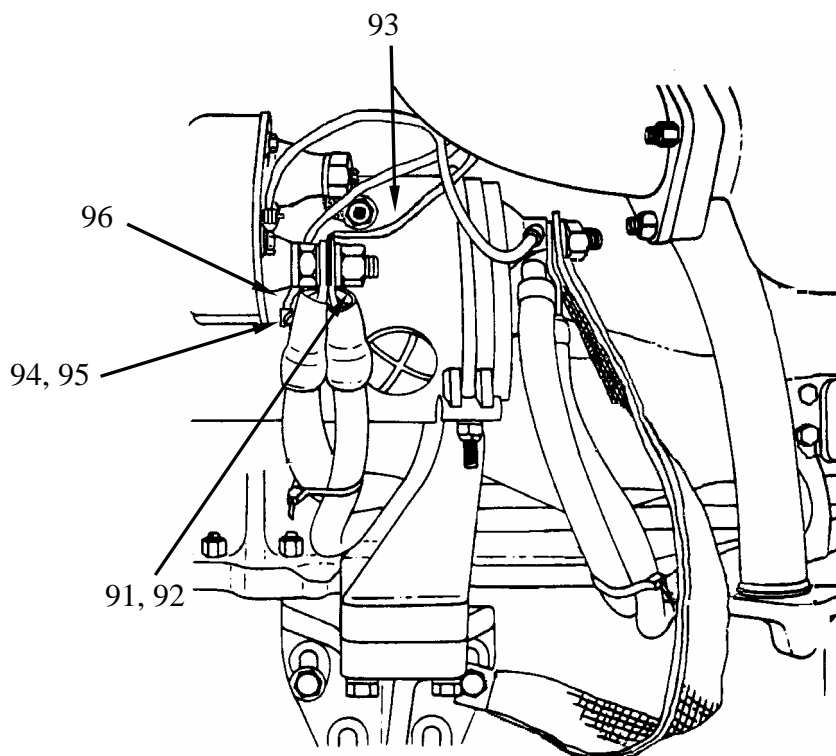
**REMOVAL (Continued)**

18. Remove harness to top-mounted low voltage protection module (LVPM) (83) (continued).

- c. Remove screw (88) with lock washer (89). Discard lock washer.
- d. Remove loop clamp (90).



- e. Remove nut (91) with lock washer (92) from starter positive lug. Remove LVPM module wire (93), reinstall nut and lock washer.
- f. Remove machine screw (94) with lock washer (95). Remove LVPM lead (96). Reinstall screw and lock washer for safe keeping.



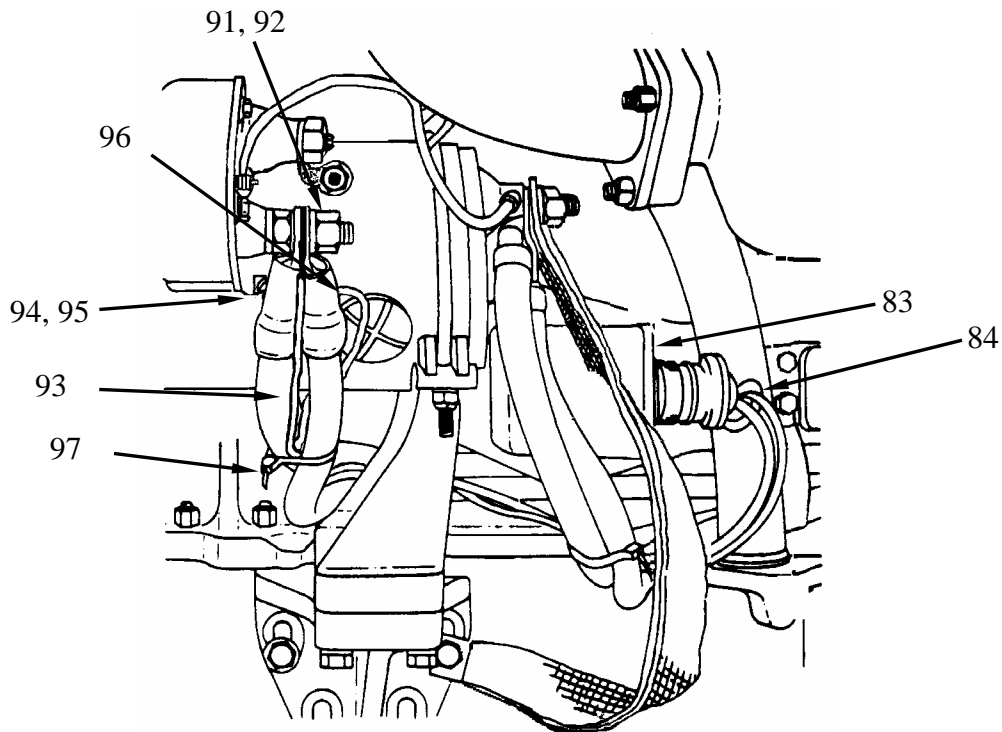
**REMOVAL (Continued)**

19. Remove harness to crankcase-mounted (near starter) low voltage protection module (LVPM).

**NOTE**

**The low voltage protection module mounted near the starter is not the current configuration of the 2CA engine, and is not supported by the repair parts manual. If your engine has the low voltage protection module mounted near the starter, low voltage protection module kit, 12254381, should be installed to reposition the module to the top of the engine.**

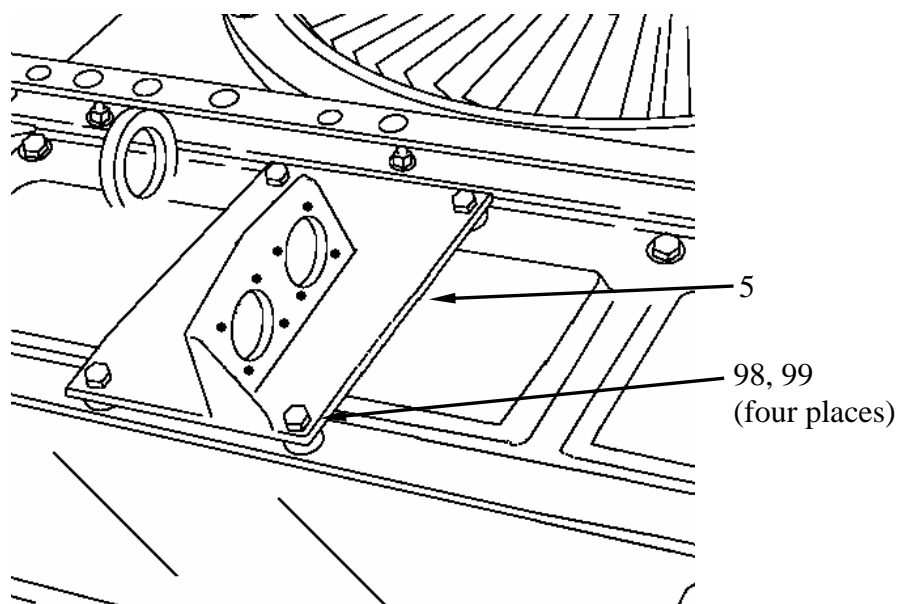
- a. Disconnect wiring connector (84) at low voltage protection module (83).
- b. Remove nut (91), and lock washer (92), cut tie wraps (97) as necessary, and remove LVPM lead (93). Reinstall nut (90) and lock washer (92) for later use.
- c. Remove machine screw (94) with lock washer (95). Remove LVPM lead (96). Reinstall screw and lock washer for safe keeping.



**REMOVAL (Continued)**

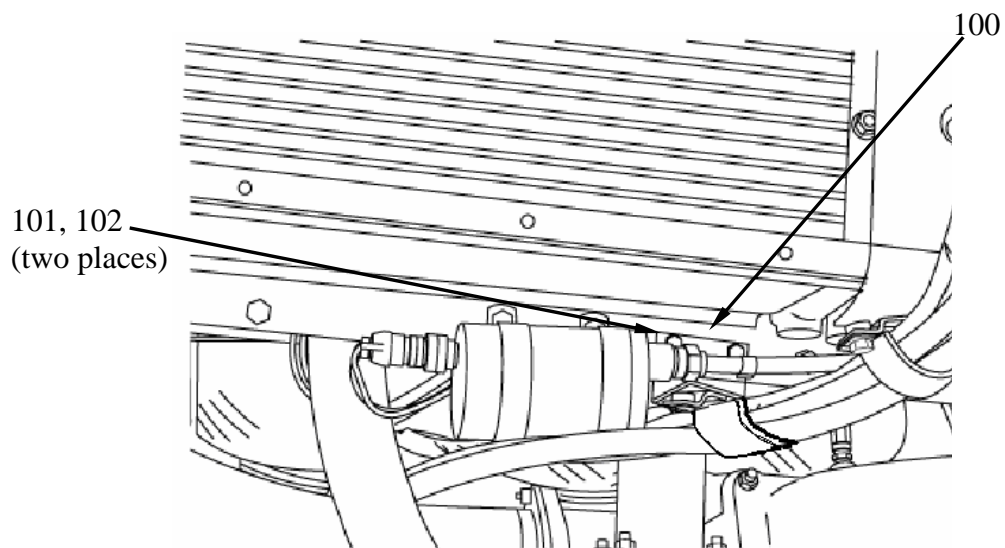
20. Remove wiring harness upper bracket (5).

- a. With generator harness removed from bracket (5), remove four screws (98) with lock washers (99), and remove bracket (5). Discard lock washers.



21. Remove starter lower cable bracket (100).

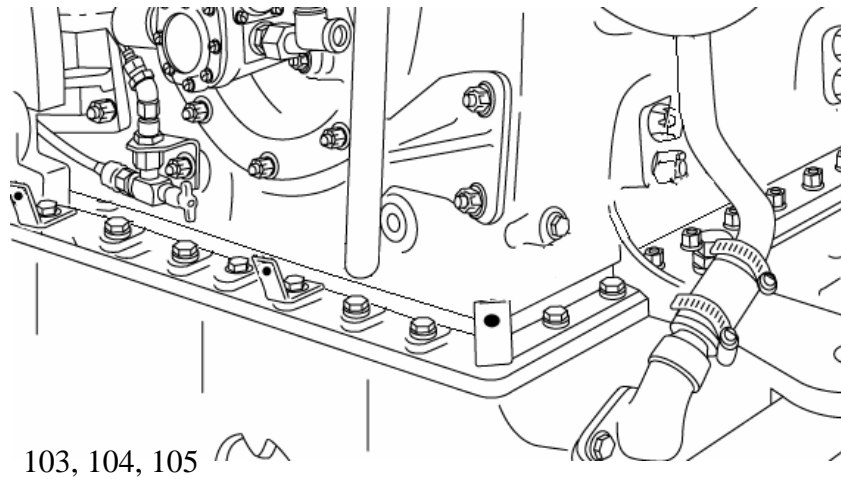
- a. Remove two screws (101) with self-locking nuts (102) and remove starter lower cable bracket assembly (100). Discard self-locking nuts.



**REMOVAL (Continued)**

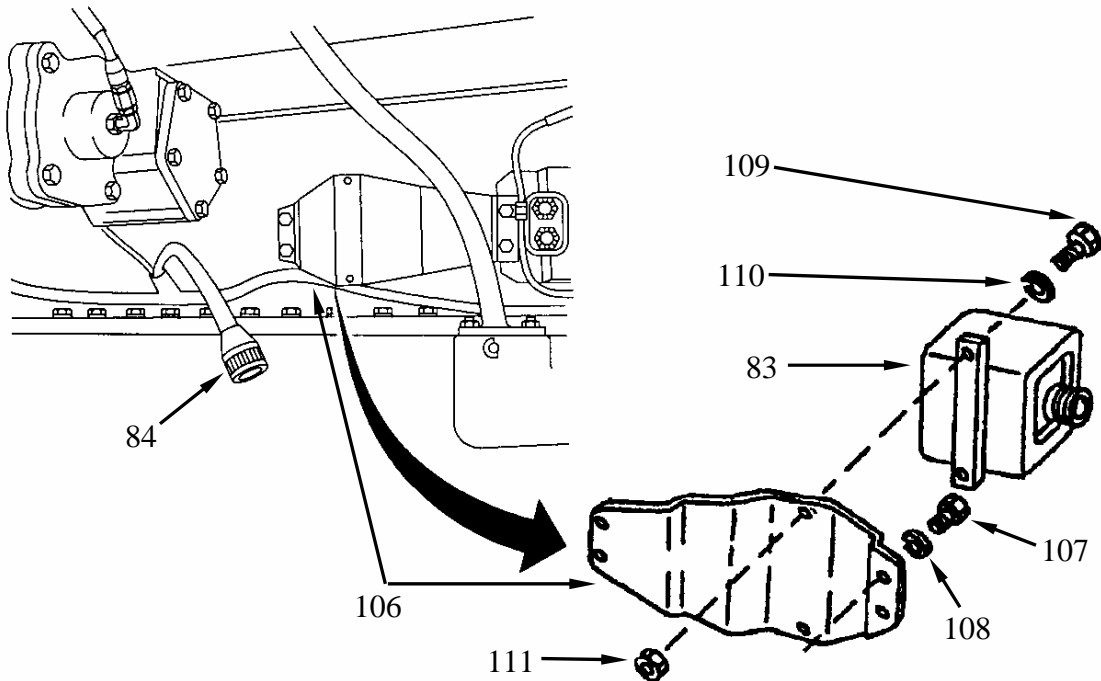
22. Remove harness angle brackets (103) at front of engine.

- a. Remove screws (104) flat washers (105). Remove angle brackets (103).



23. Remove LVPM bracket (106).

- a. Disconnect electrical connector (84) at LVPM (83).
- b. Remove four screws (107) with lock washers (108) securing LVPM bracket (106) to engine block. Discard lock washers.
- c. Remove two screws (109) with four lock washers (110) and self-locking nuts (111) securing LVPM (83) to mounting bracket (106). Discard lock washers and self-locking nuts.



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**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

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**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

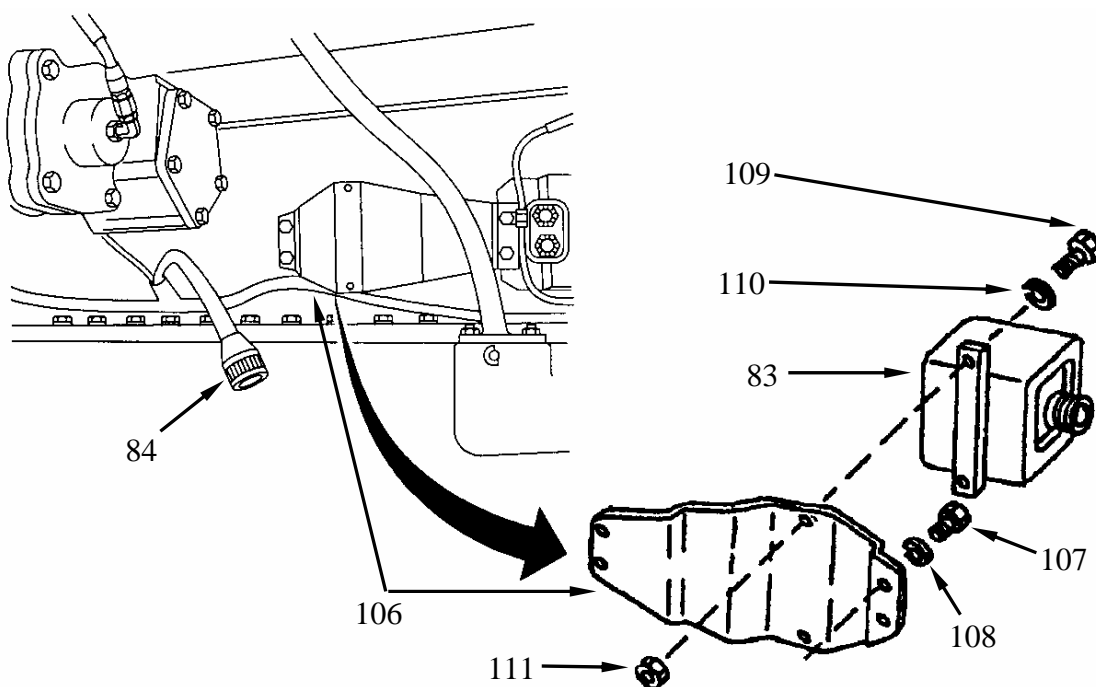
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable Repair.

**INSTALLATION**

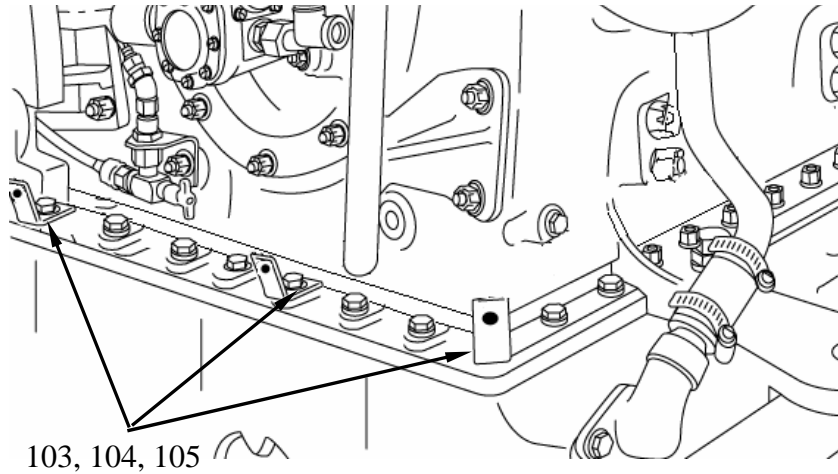
1. Install low voltage protection module (LVPM) bracket (106).
  - a. Install two screws (109) with four new lock washers (110) (item 82, WP 0175) and two new self-locking nuts (111) (item 37, WP 0175) securing LVPM (83) to mounting bracket (106).
  - b. Install four screws (107) with new lock washers (108) (item 86, WP 0175) securing LVPM bracket (106) to engine block.
  - c. Connect electrical connector (84) at LVPM (83).



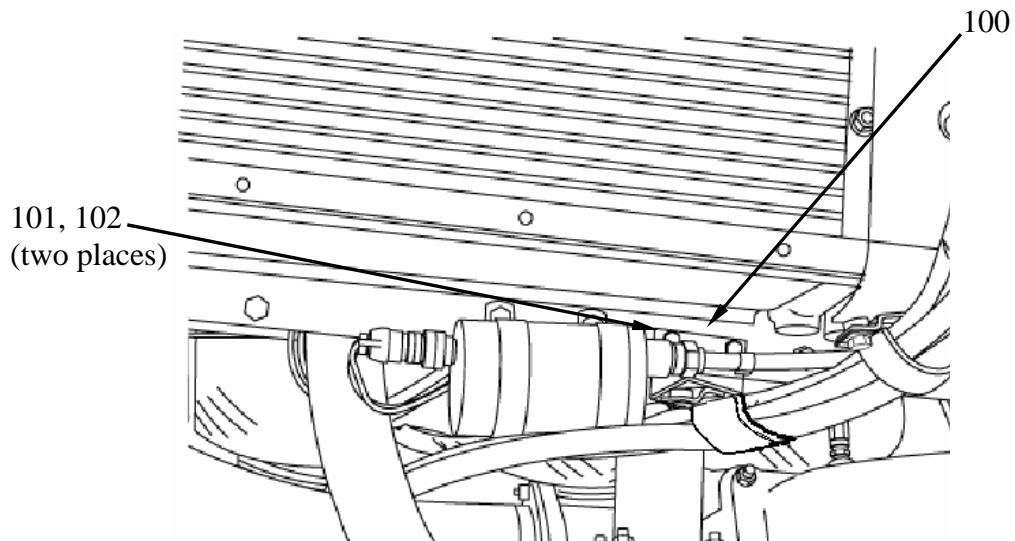


**INSTALLATION (CONTINUED)**

2. Install harness angle brackets (103) at front of engine.
  - a. Install angle brackets (103) with screws (104) and flat washers (105).



3. Install starter lower cable bracket (100).
  - a. Install two screws (101) with new self-locking nuts (102) (item 33, WP 0175) and install starter lower cable bracket assembly (100).



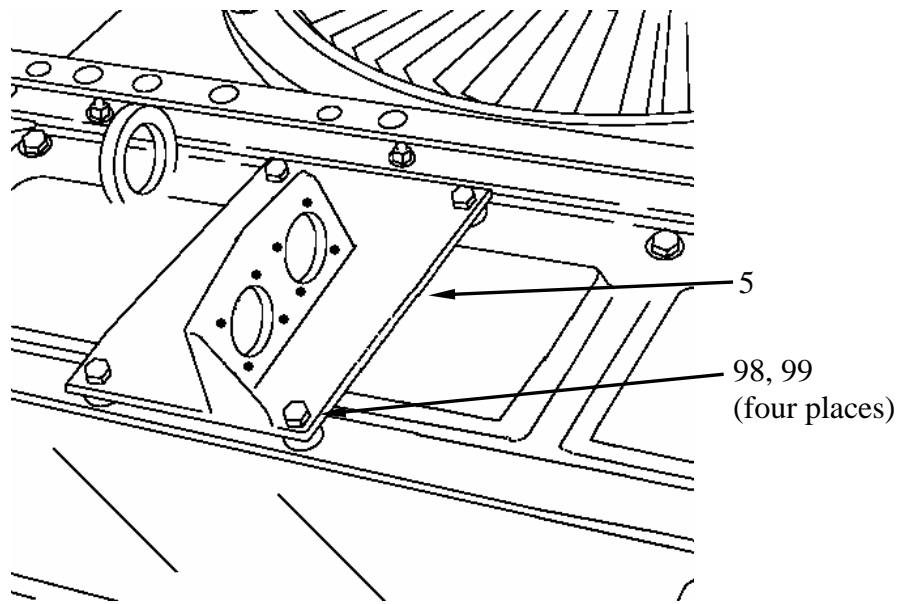
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**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

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**INSTALLATION (Continued).**

4. Install wiring harness upper bracket (5).
  - a. Install four screws (98) with new lock washers (99) (item 86, WP 0175) into bracket (5).



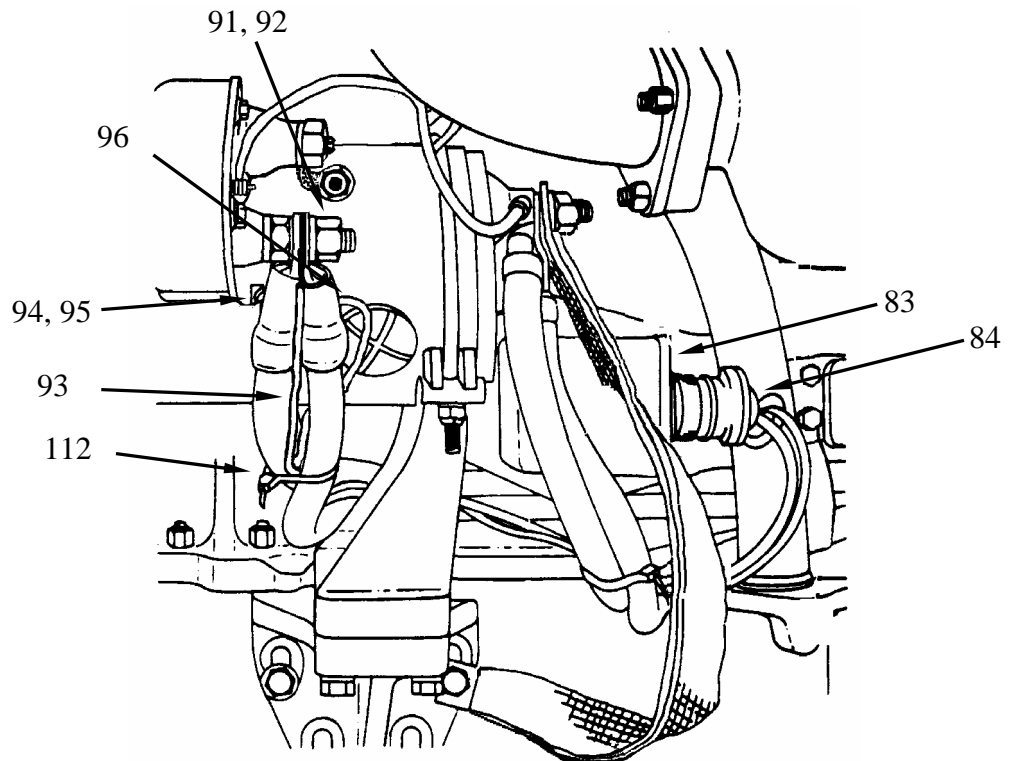
**INSTALLATION (Continued).**

5. Install harness to crankcase-mounted (near starter) low voltage protection module (LVPM).

**NOTE**

**The low voltage protection module mounted near the starter is not the current configuration of the 2DA engine, and is not supported by the repair parts manual. Low voltage protection module kit, 12254381, should be installed to reposition the module to the top of the engine.**

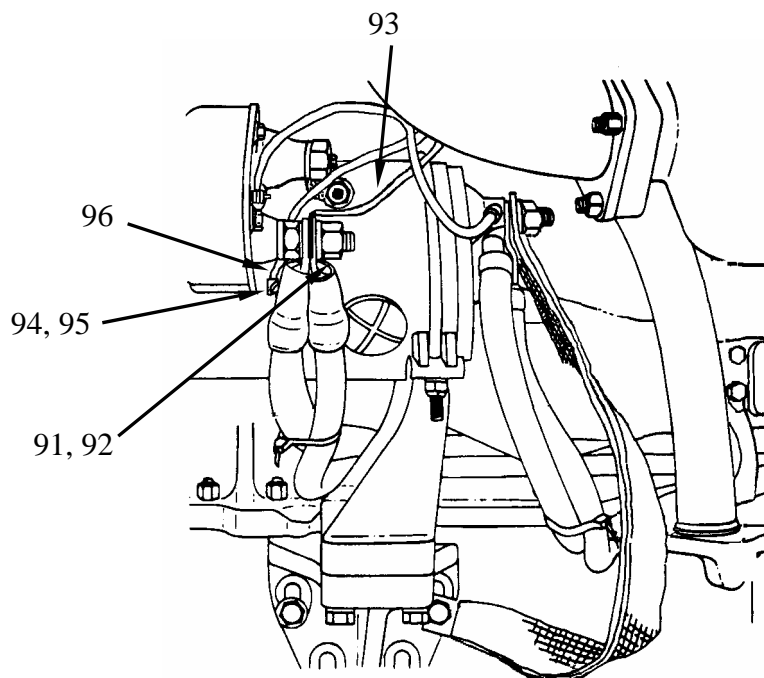
- a. Install wiring connector (84) at low voltage protection module (83).
- b. Remove nut (90) and lock washer (91), install LVPM lead (93).
- c. Install nut (90) and lock washer (91).
- d. Install tie wraps (112) (item 80, WP 0175) as necessary.
- e. Install machine screw (94) and lock washer (95) to install LVPM lead (96).



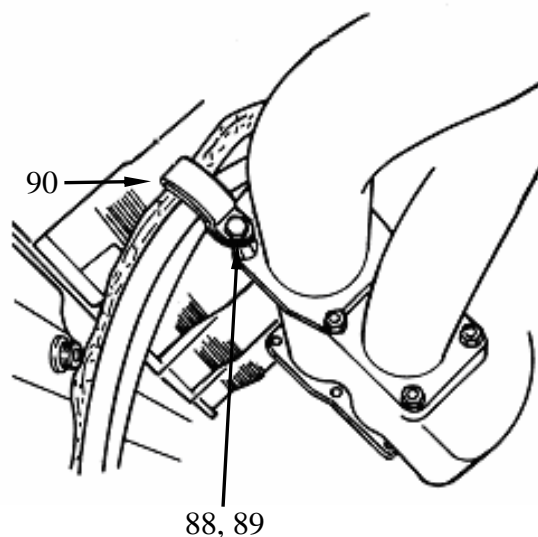
**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

**INSTALLATION (Continued).**

6. Install harness to low voltage protection module (LVPM) mounted on top of engine.
  - a. Remove nut (91) and lock washer (92) from starter positive lug.
  - b. Install LVPM module wire (93) to starter positive lug with existing nut (90) and lock washer (92).
  - c. Install LVPM lead (96) with machine screw (94) and lock washer (95).



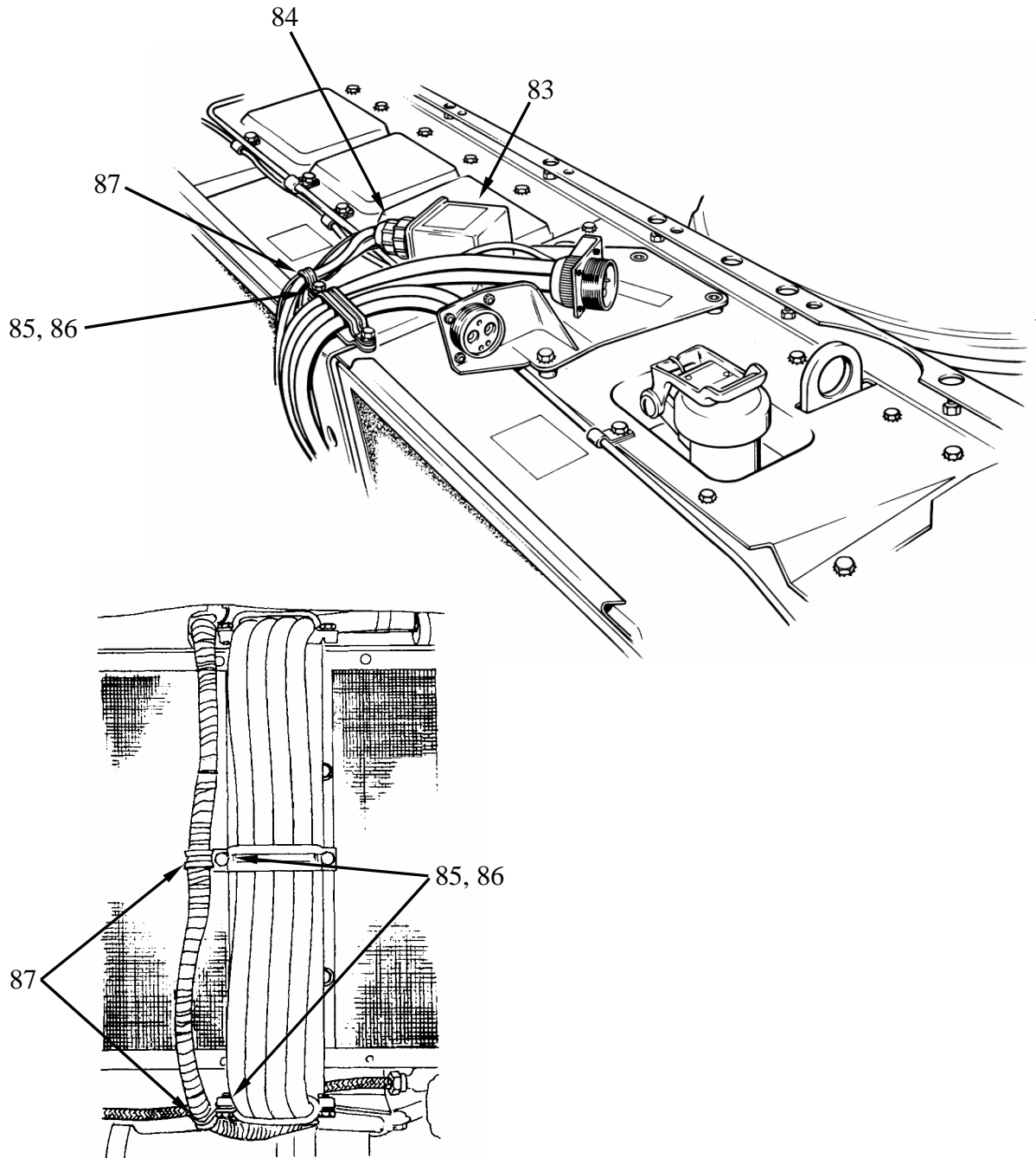
- d. Install loop clamp (90) onto cable (s).
- e. Install screw (88) with new lock washer (89) (item 93, WP 0175).



**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

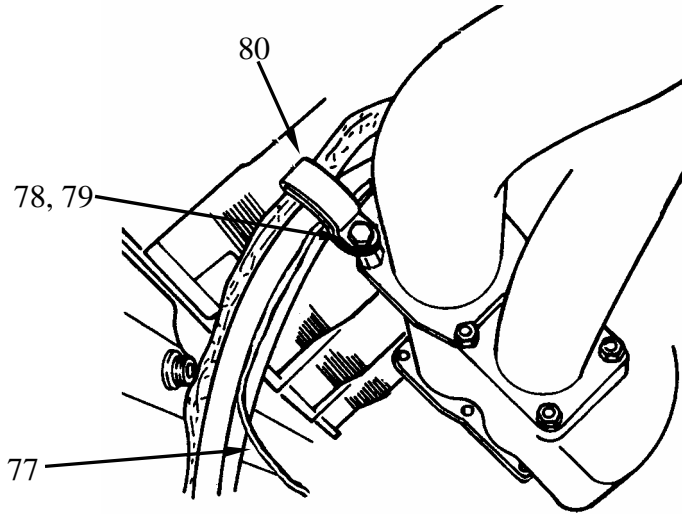
**INSTALLATION (Continued).**

6. Install harness to low voltage protection module (LVPM) (83) mounted on top of engine (continued).
  - f. Install electrical connector (84) to LVPM (83).
  - g. Install loop clamps (87) with screws (85) and new lock washers (86) (item 92, WP 0175).

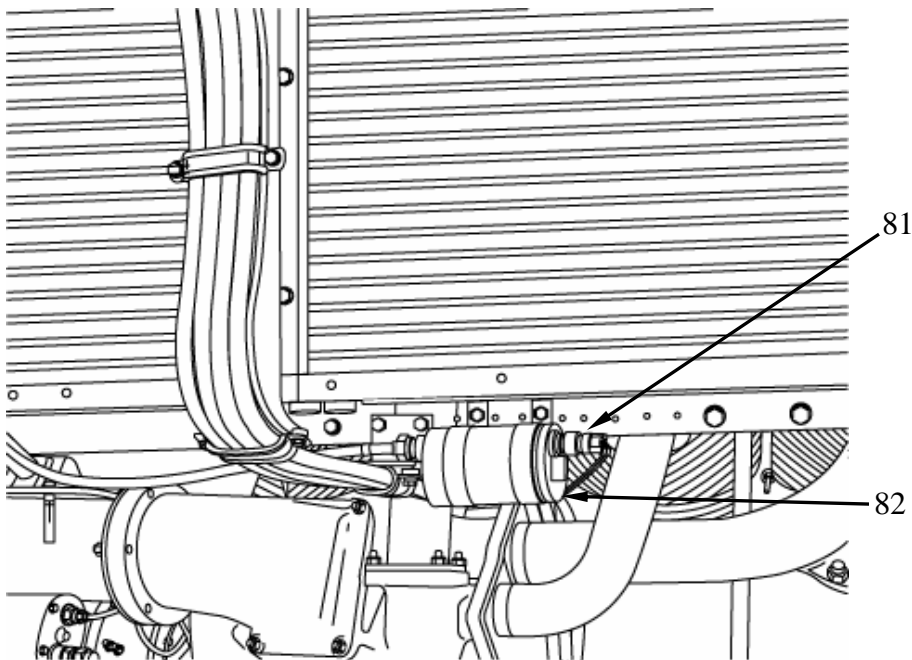


**INSTALLATION (Continued).**

7. Install left manifold heater lead (77).
  - a. Install screw (78) with new lock washer (79) (item 93, WP 0175) to secure wiring (77) for left manifold heater into loop clamp (80).



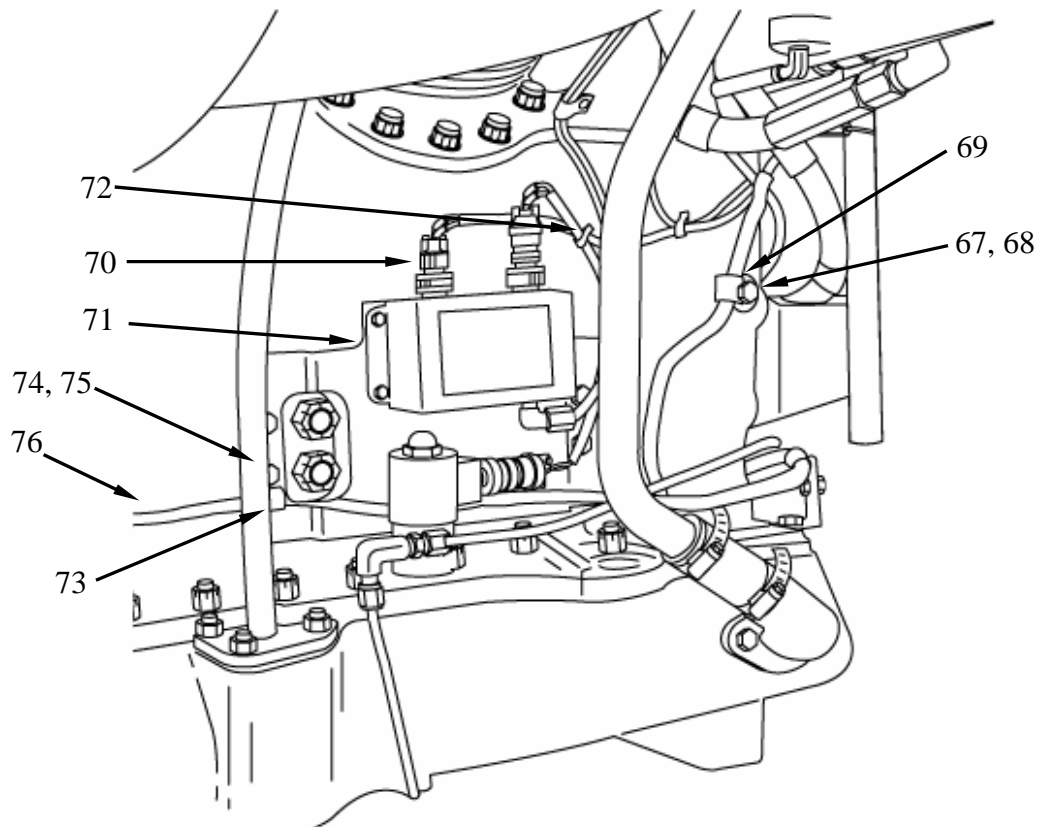
- b. Install connector (81) at left manifold heater exciter (82).



**SIGNAL WIRING HARNESS REPLACEMENT (2DA) (PN 12254376, 12354385) 0058 00**

**INSTALLATION (Continued).**

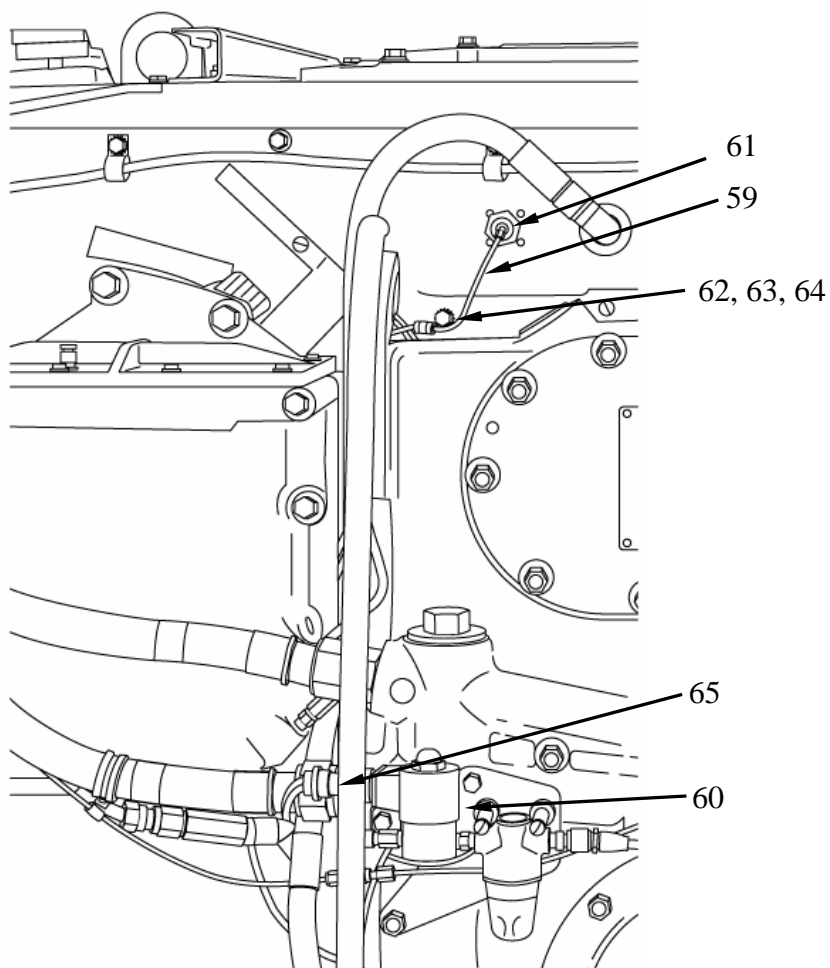
8. Install harness (76) leading away from left manifold heater.
  - a. Install harness into loop clamp (73).
  - b. Install screw (74) with new lock washer (75) (item 93, WP 0175) to retain loop clamp (73).
9. Install harness at water separator control unit (71).
  - a. Install harness into loop clamp (69).
  - b. Install screw (68) with new lock washer (67) (item 93, WP 0175) to retain loop clamp (69).
  - c. Install electrical connector (70) at fuel water separator control unit (71).
  - d. Install tie wraps (72) (item 80, WP 0175) as needed.



**INSTALLATION (Continued).**

10. Install harness at front of engine.

- a. Install electrical connector (61) for fuel shutoff solenoid.
- b. Install loop clamp (64) onto wire (59) and secure using screw (62) with new lock washer (63) (item 94, WP 0175).
- c. Connect electrical connector (65) at flame start solenoid (60).





**INSTALLATION (Continued).**

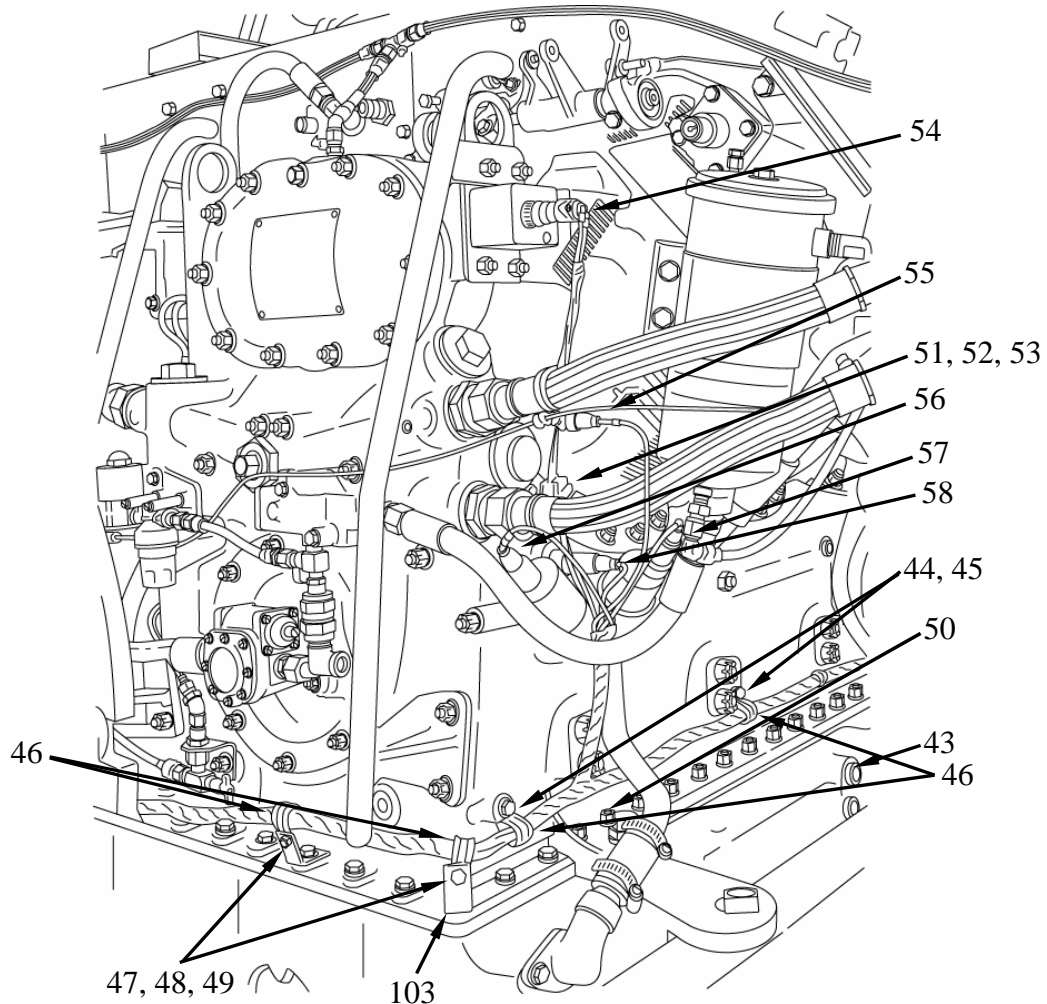
10. Install harness (43) at front of engine (continued).

**NOTE**

**Damper housing mounted hour meter harness installation instructions are covered in step 10,d.**

**Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). See step 11 for top-mounted harness installation instructions.**

- d. Install loop clamps (46) onto harness angle brackets (103) using screws (47) with nut (48), and new lock washers (49) (item 92, WP 0175).
- e. Install electrical connectors at hour meter (54), engine oil temperature transmitter (55) engine oil pressure transmitter (56), low engine oil pressure switch (57), and high oil temperature switch (58).
- f. Install new self-locking nut (51) (item 33, WP 0175) with flat washer (52) to retain loop clamp (53).
- g. Install loop clamps (46) onto harness and secure using screws (44) with new lock washers (45) (item 92, WP 0175).



INSTALLATION (Continued).

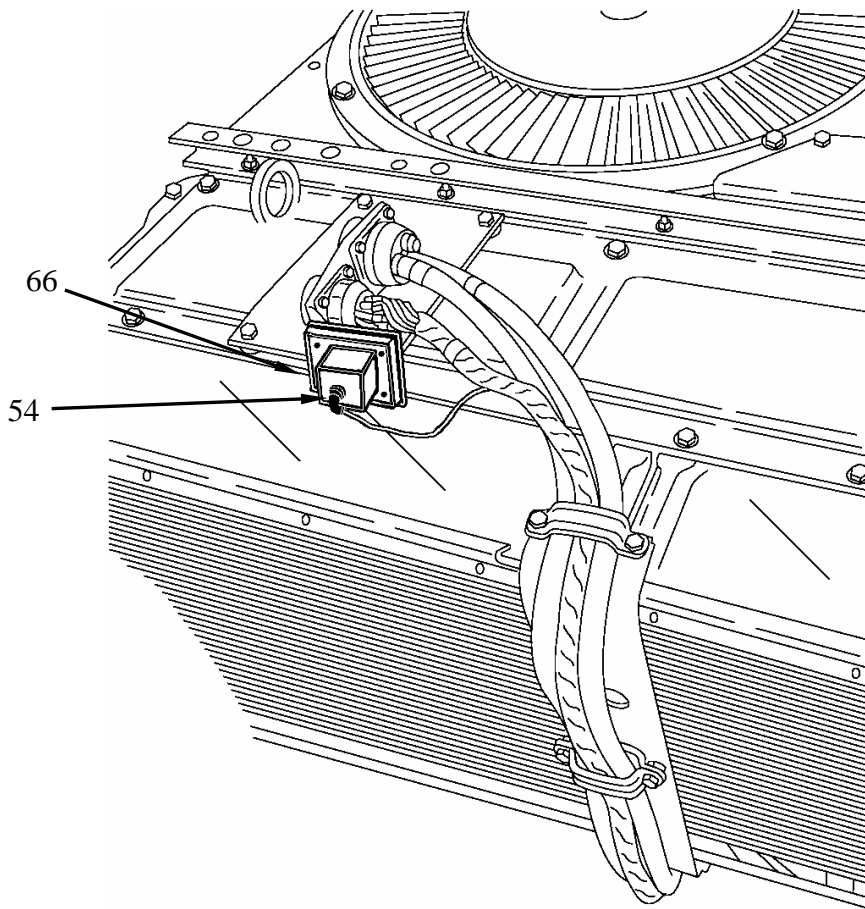
NOTE

Later engines have top-mounted hour meters positioned next to the generator and signal harness main connector (harness 12354385). Harness installation instructions are covered in step 11.

For engines with damper housing mounted hour meter, harness installation instructions are covered in step 10, d.

11. Install harness to hour meter on top of engine.

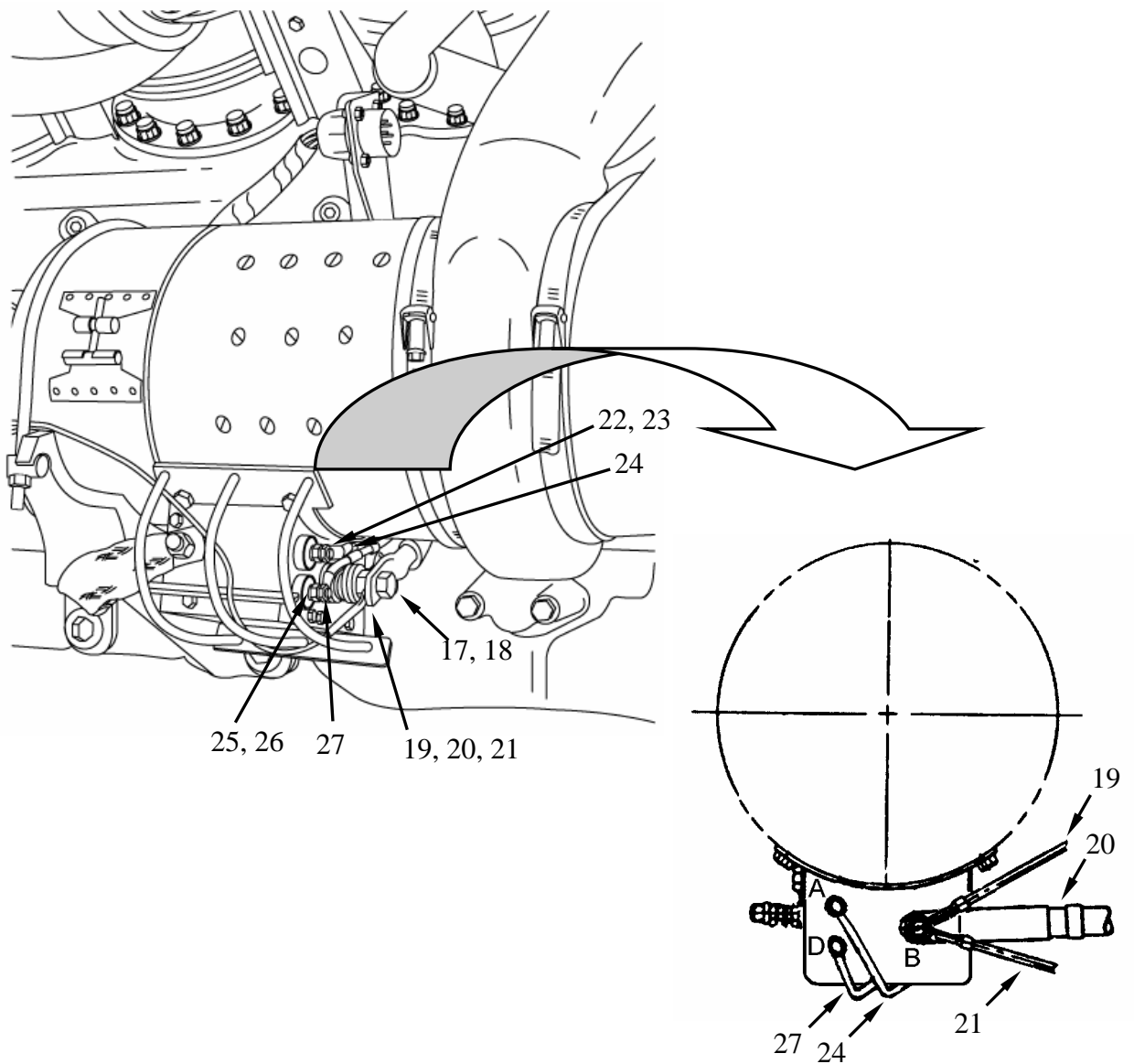
- a. Install electrical connector (54) onto hour meter (66).



**INSTALLATION (Continued).**

12. Install connectors at generator.

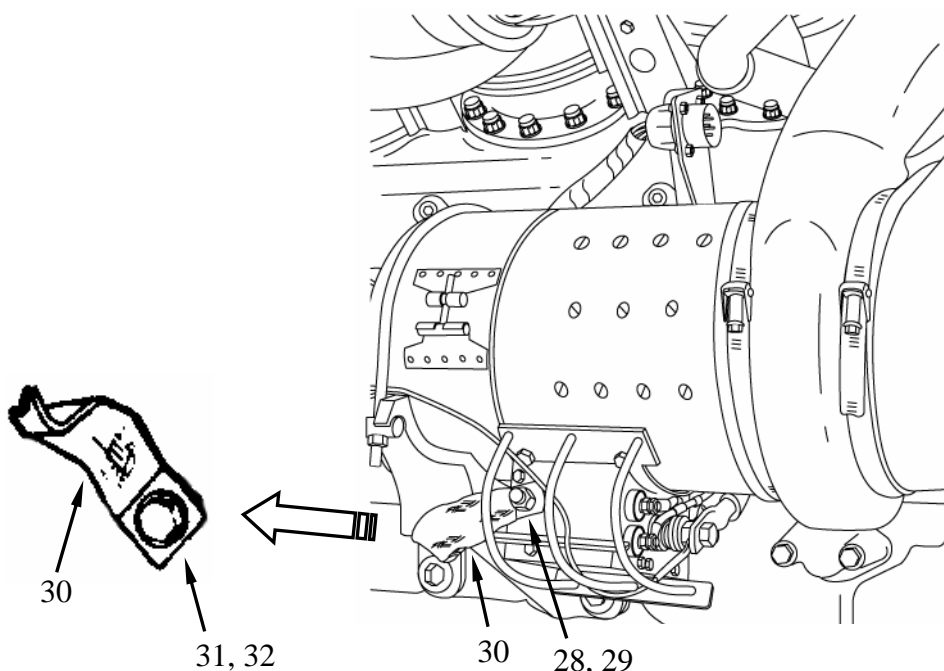
- a. Remove self-locking nut (17) with flat washer (18).
- b. Install electrical leads (19, 20, 21), nut (17) and flat washer (18).
- c. Install electric lead (24). Install nut (22) and flat washer (23).
- d. Install electric lead (27). Install self-locking nut (25) with flat washer (26).



**INSTALLATION (Continued)**

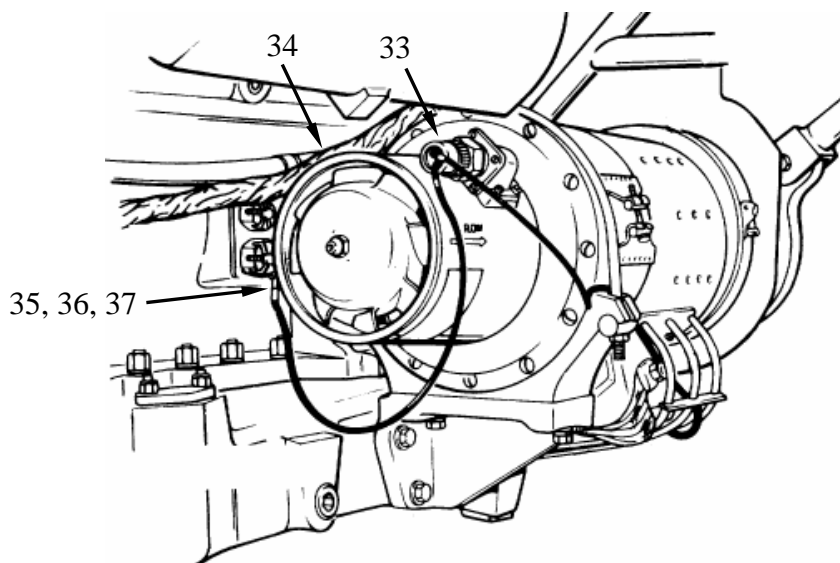
13. Install connections at generator (continued).

- a. Install self-locking nut (28) with flat washer (29) securing upper end of ground lead (30).
- b. Install screw (31) with flat washer (32) to complete installation of ground lead (30).



14. Install electrical connector (33) to generator blower (34).

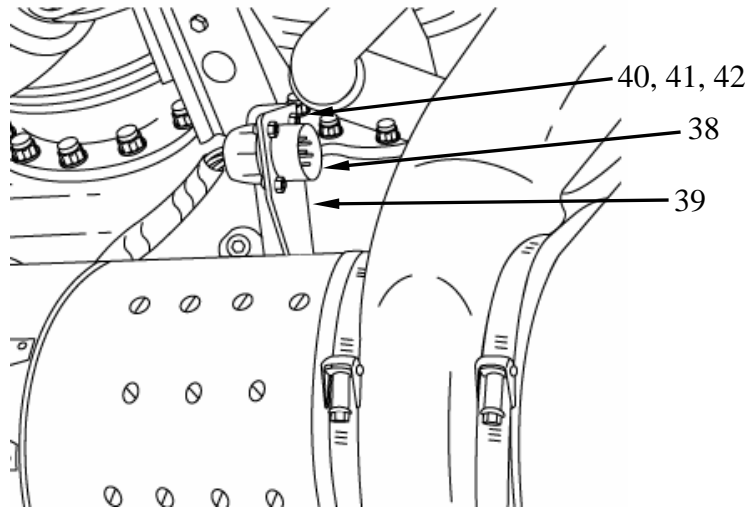
15. Install screw (35) with new lock washer (36) (item 83, WP 0175) to install generator blower ground lead (37).



**INSTALLATION (Continued).**

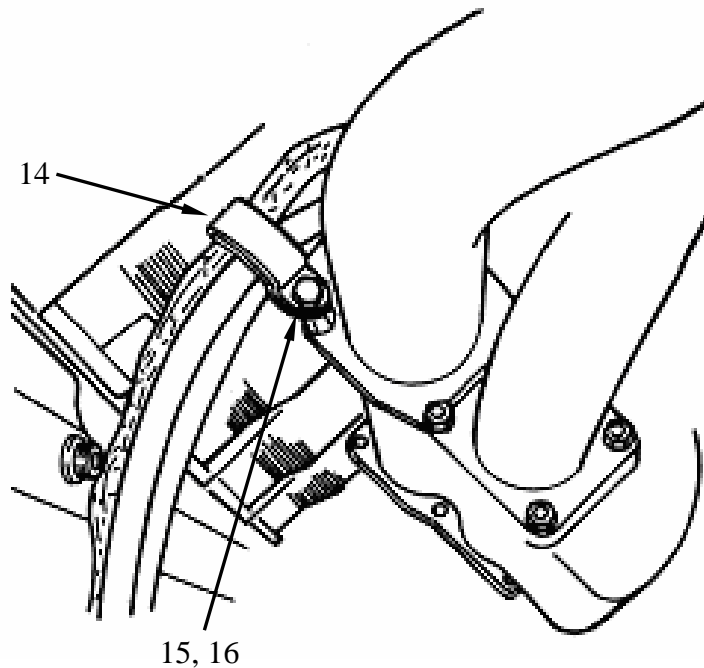
16. Install transmission harness connector (38).

- a. Position transmission harness connector (38) into harness bracket (39).
- b. Secure using four machine screws (40) with nuts (42) and new lock washers (41) (item 90, WP 0175).



17. Install harness into loop clamp (14).

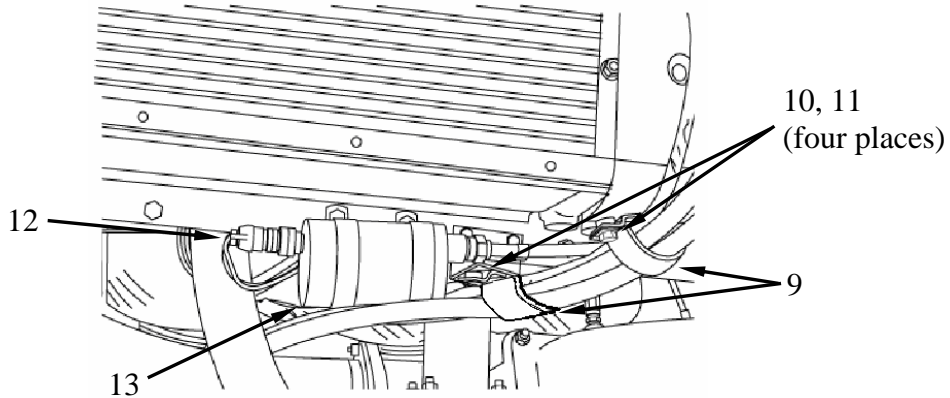
- a. Install screw (15) with new lock washer (16) (item 93, WP 0175) to retain loop clamp (14).



**INSTALLATION (Continued).**

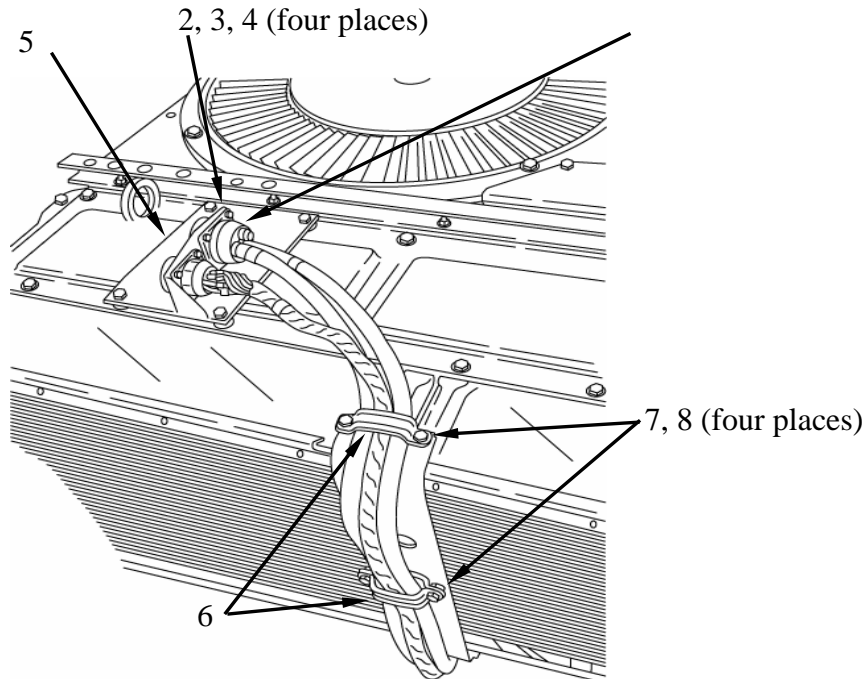
18. Install harness into retaining straps.

- a. Install four screws (10) with new lock washers (11) (item 92, WP 0175) into retaining straps (9).
- b. Connect electrical connector (12) at flame start exciter (13).



- c. Install harness into retaining straps (6).
- d. Install retaining straps (6) with four screws (7) using new lock washers (8) (item 92, WP 0175).

19. Install harness end connector (1) into wiring harness upper bracket (5) using four machine screws (2) with new lock washers (3) (item 91, WP 0175) and nuts (4).



**END OF WORK PACKAGE**

**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

---

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (4) (item 90, WP 0175)

Lock washer (1) (item 83, WP 0175)

Lock washer (as needed) (item 93, WP 0175)

Lock washer (1) (item 94, WP 0175)

Self-locking nut (1) (item 43, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

---

**NOTE**

**The Low Voltage Protection Module (LVPM) harness (12314745) is separate from the signal harness on the 2DR engine. The LVPM is mounted on top of the engine in this configuration. Connections to the LVPM and starter solenoid are the same as the 2CA engine (WP 0057).**

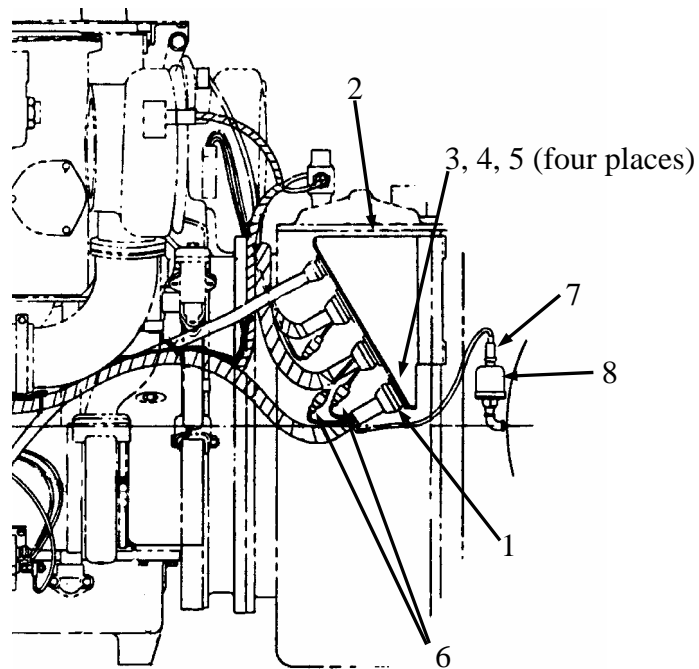
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**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

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**REMOVAL**

1. Disconnect end connector (1) at engine disconnect bracket (2).
  - a. Remove four machine screws (3) with lock washers (4) and nuts (5).  
Discard lock washers.
2. Disconnect two cannon plug connectors (6).
3. Disconnect connector (7) at transmission oil pressure switch (8).

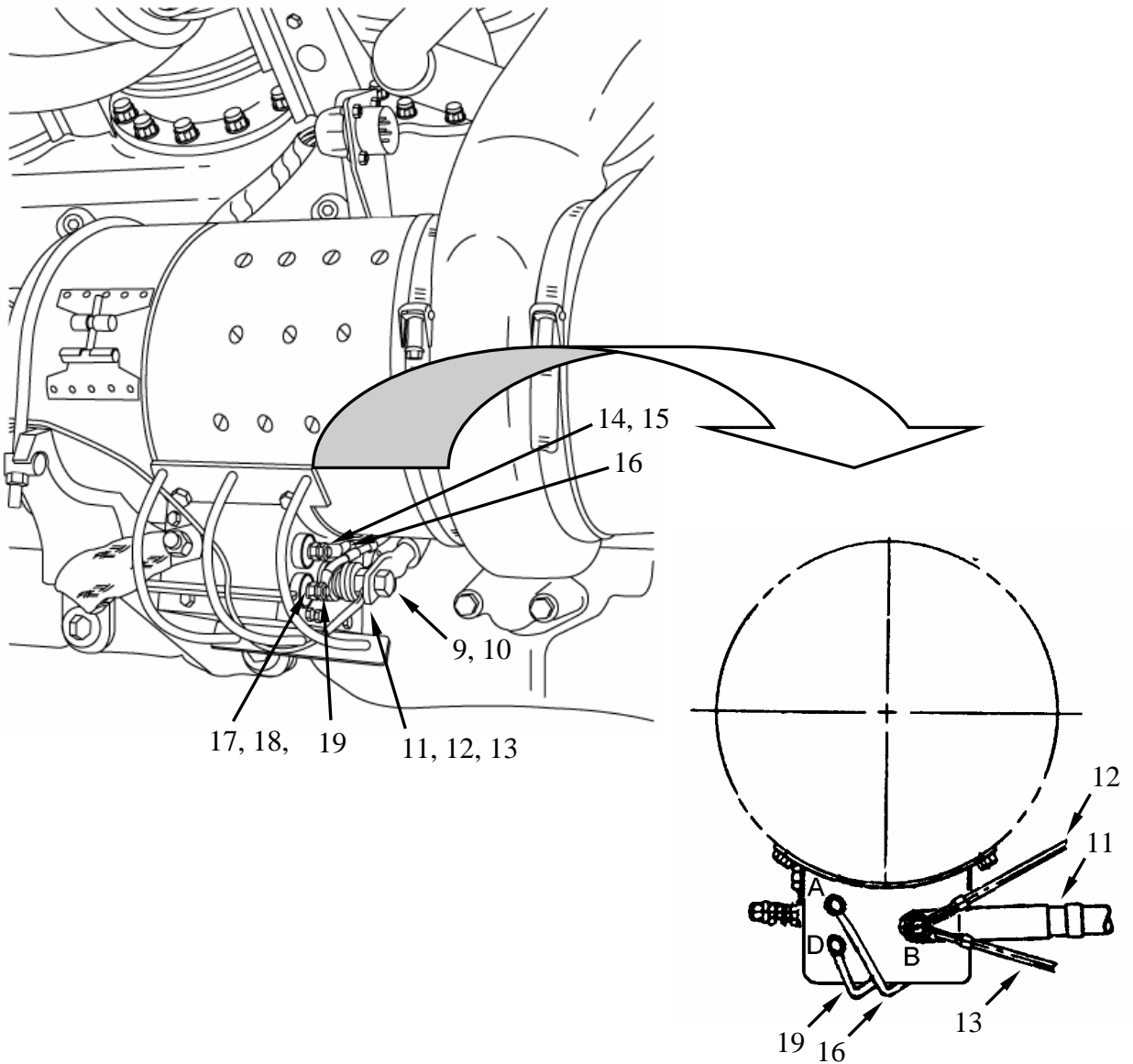




**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

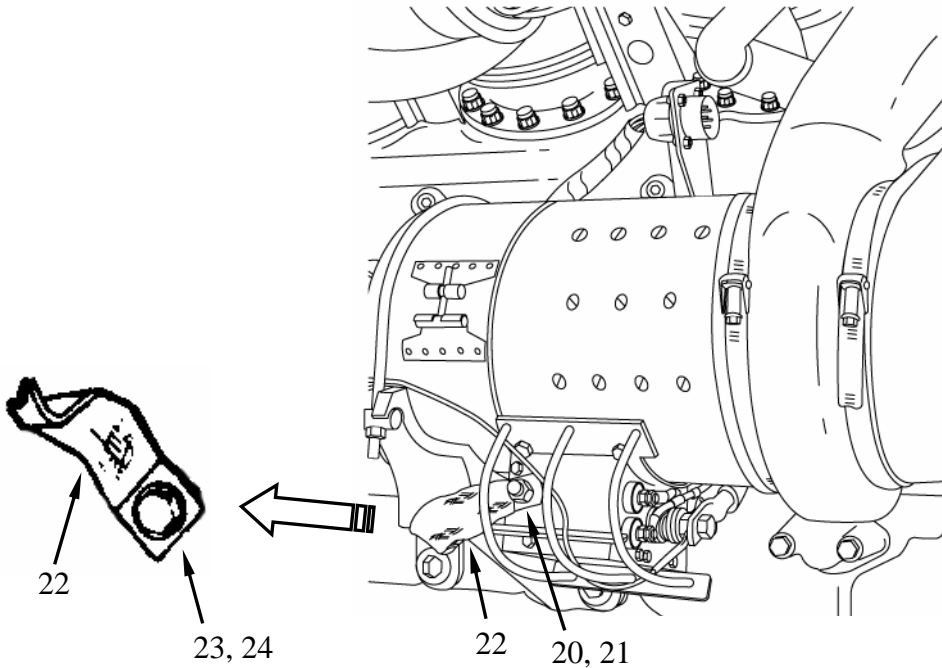
**REMOVAL (Continued)**

4. Remove harness positive connections at generator.
  - a. Remove self-locking nut (9) with flat washer (10) and remove electrical leads (11, 12, 13). Reinstall nut (9) and flat washer (10) for safe keeping.
  - b. Remove self-locking nut (14) with flat washer (15) and remove electrical lead (16). Reinstall nut (14) and flat washer (15) for safe keeping.
  - c. Remove self-locking nut (17) with flat washer (18) and remove electrical lead (19). Reinstall nut (17) and flat washer (18) for safe keeping.



**REMOVAL (Continued)**

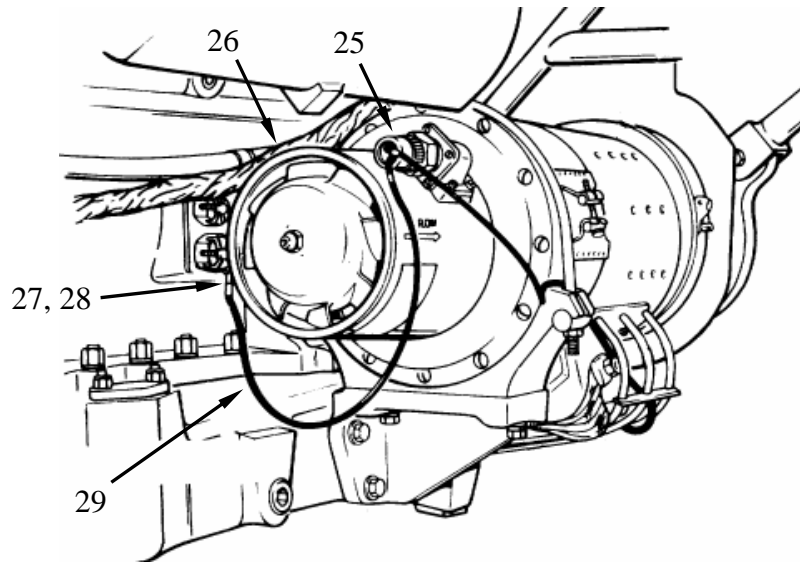
5. Remove harness ground connections at generator.
  - a. Remove self-locking nut (20) with flat washer (21) securing upper end of ground lead (22). Reinstall nut and flat washer for safe keeping.
  - b. Remove screw (23) with flat washer (24) and finish removing ground lead (22).



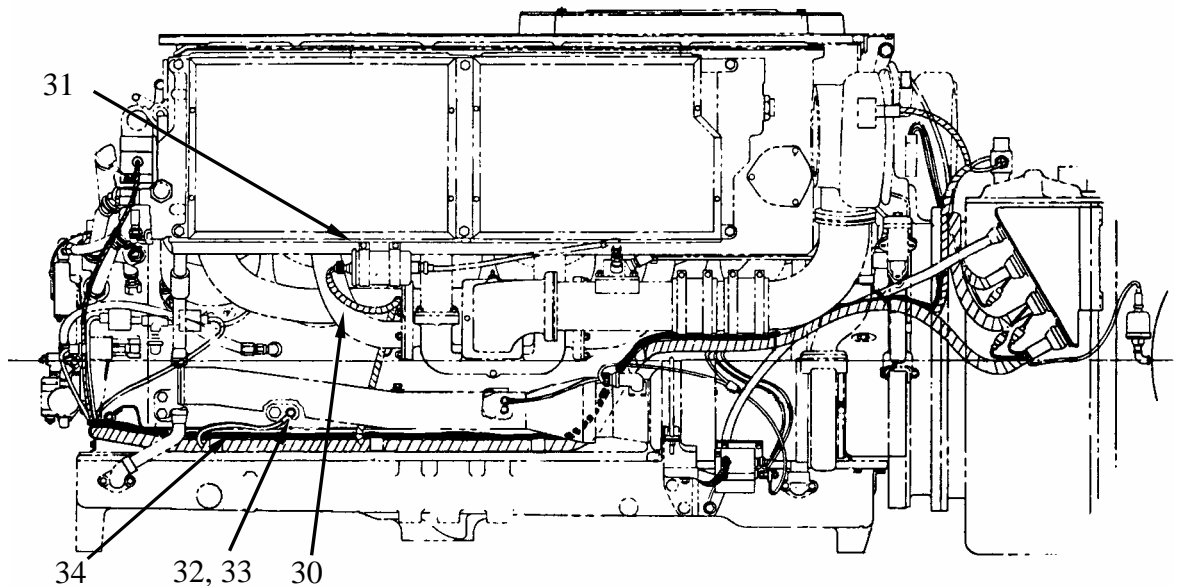
**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

**REMOVAL (Continued)**

6. Disconnect electrical connector (25) to generator blower (26).
7. Remove cap screw (27) with lock washer (28) and remove generator blower ground lead (29). Discard lock washer.



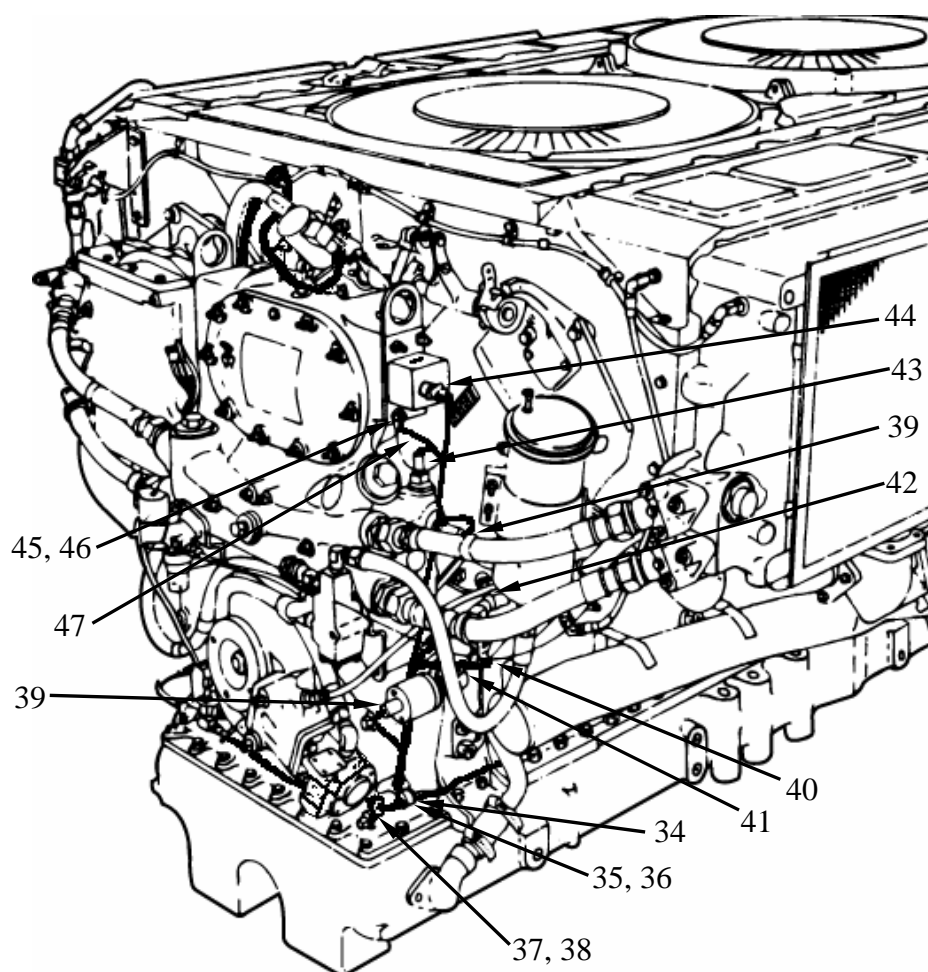
8. Disconnect electrical lead (30) at manifold heater (31).
9. Remove screw (32) with lock washer (33) to release ground lead (34). Discard lock washer.



**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

**REMOVAL (Continued)**

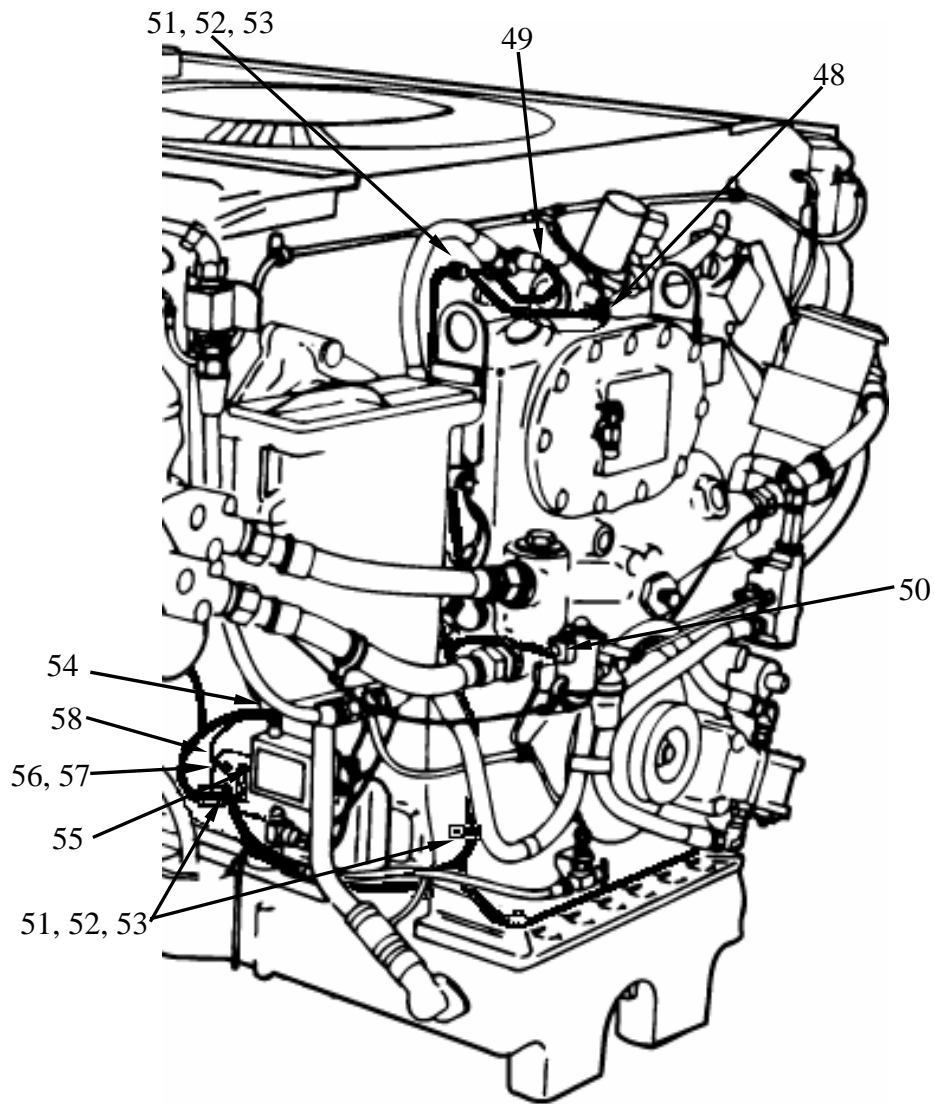
10. Remove loop clamp (34) with screw (35) and lock washer (36). Discard lock washer.
11. Remove loop clamp (37) with self-locking nut (38).
12. Disconnect wiring harness at engine oil pressure transmitter (39), low engine oil pressure switch (40), and engine oil pressure switch (41).
13. Disconnect wiring harness at engine oil high temperature switch (42), engine oil temperature switch (43), and hour meter (44).
14. Remove screw (45) with lock washer (46) and remove hour meter (44) ground lead (47).



**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

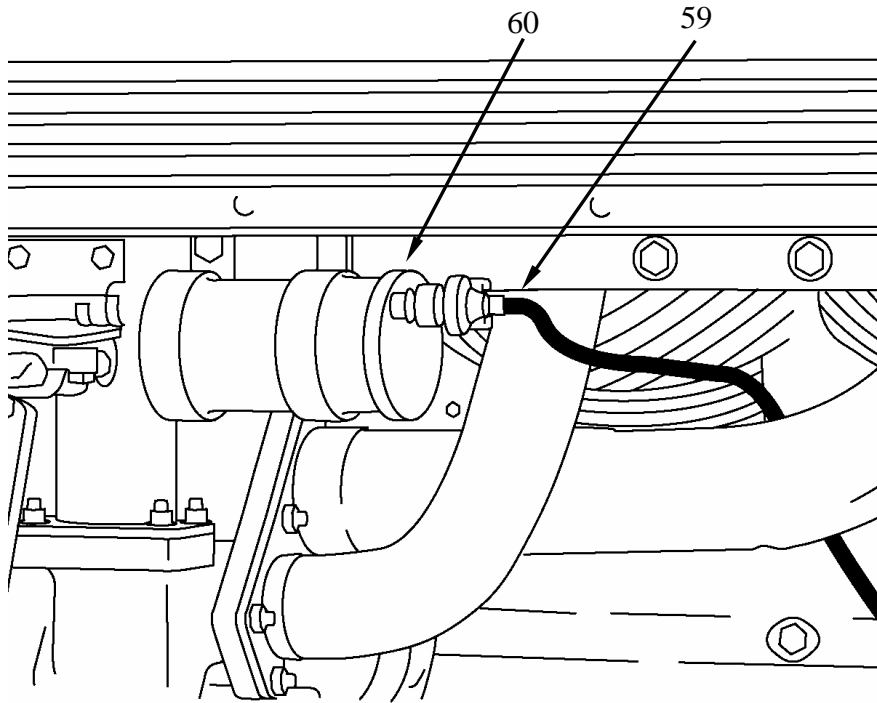
**REMOVAL (Continued)**

15. Disconnect lead at governor solenoid (48), fuel shutoff connection (49), and flame heater solenoid (50).
16. Remove loop clamps (51) with screws (52) and lock washers (53). Discard lock washers.
17. Disconnect lead (54) at automatic water drain control module (55).
18. Remove screw (56) and lock washer (57) to release ground lead (58) for automatic water drain control module (55). Discard lock washer.



**REMOVAL (Continued)**

19. Disconnect electrical lead (59) at left flame heater exciter (60).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

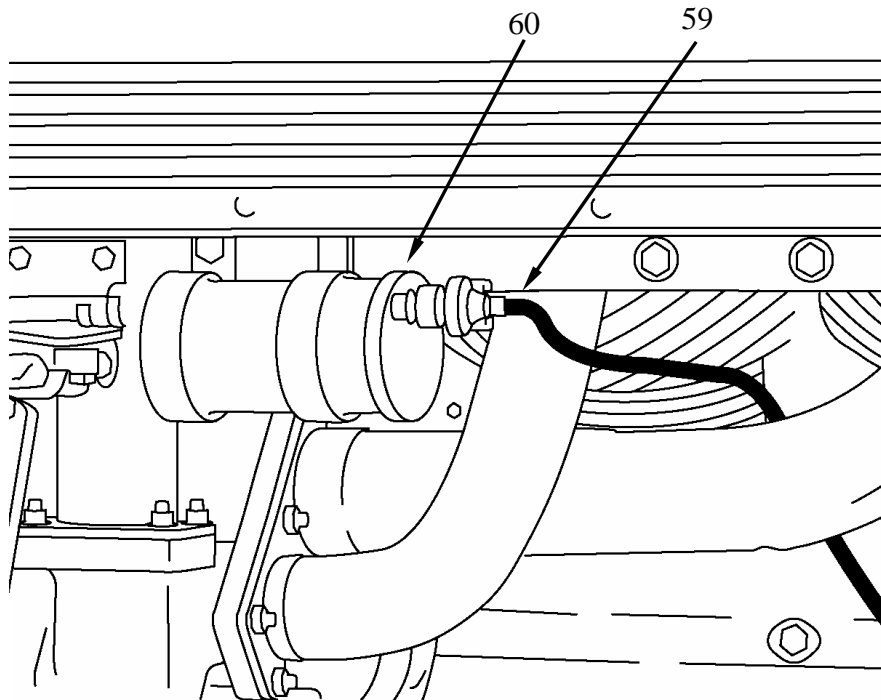
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable Repair.

**INSTALLATION**

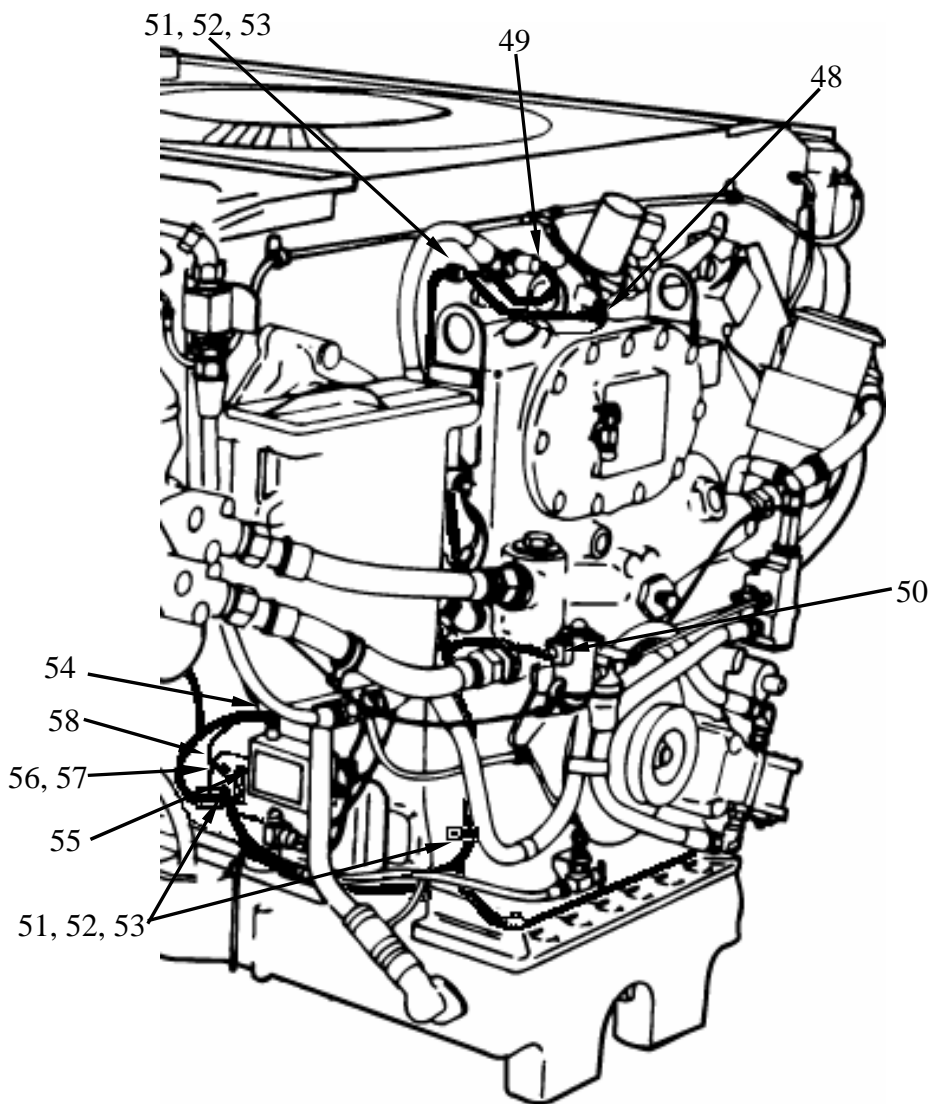
1. Install electrical lead (59) at left flame heater exciter (60).



**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

**INSTALLATION (Continued)**

2. Install screw (56) and new lock washer (57) (item 93, WP 0175) to secure ground lead (58) for automatic water drain control module (55).
3. Connect lead (54) at automatic water drain control module (55).
4. Install loop clamps (51) with screws (52) and new lock washers (53) (item 93, WP 0175).
5. Connect lead at governor solenoid (48), fuel shutoff connection (49), and flame heater solenoid (50).

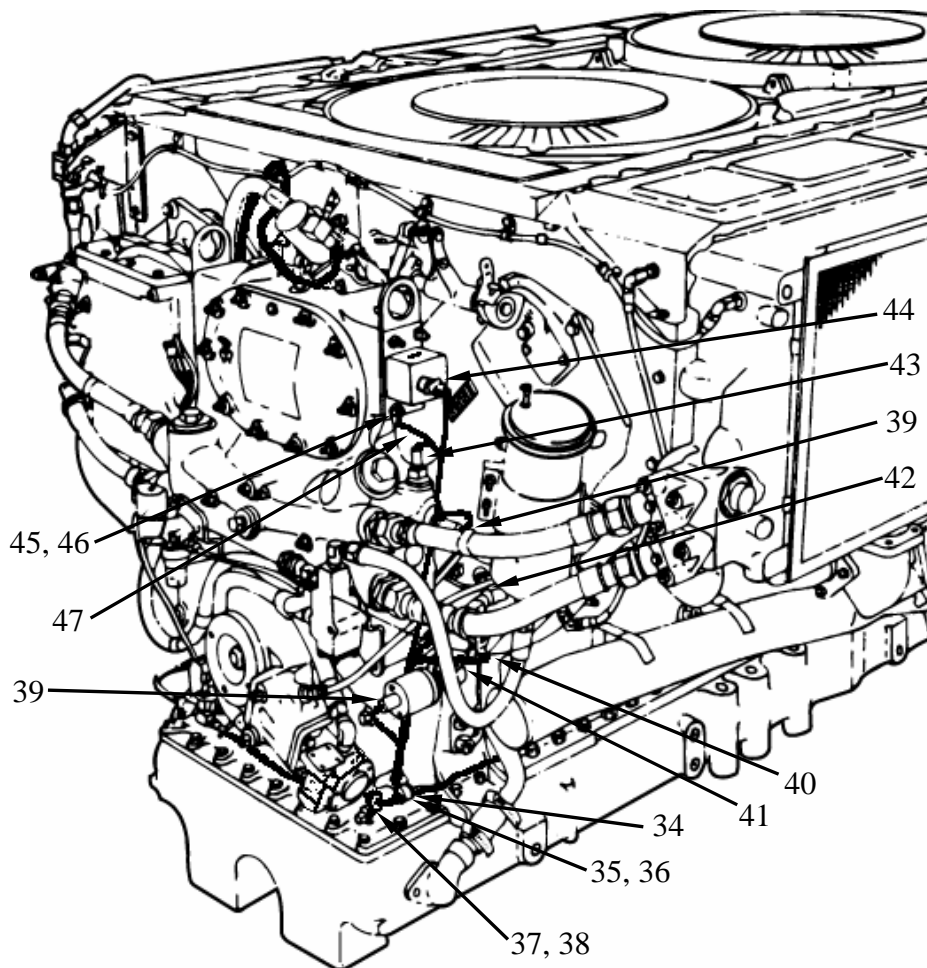




**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

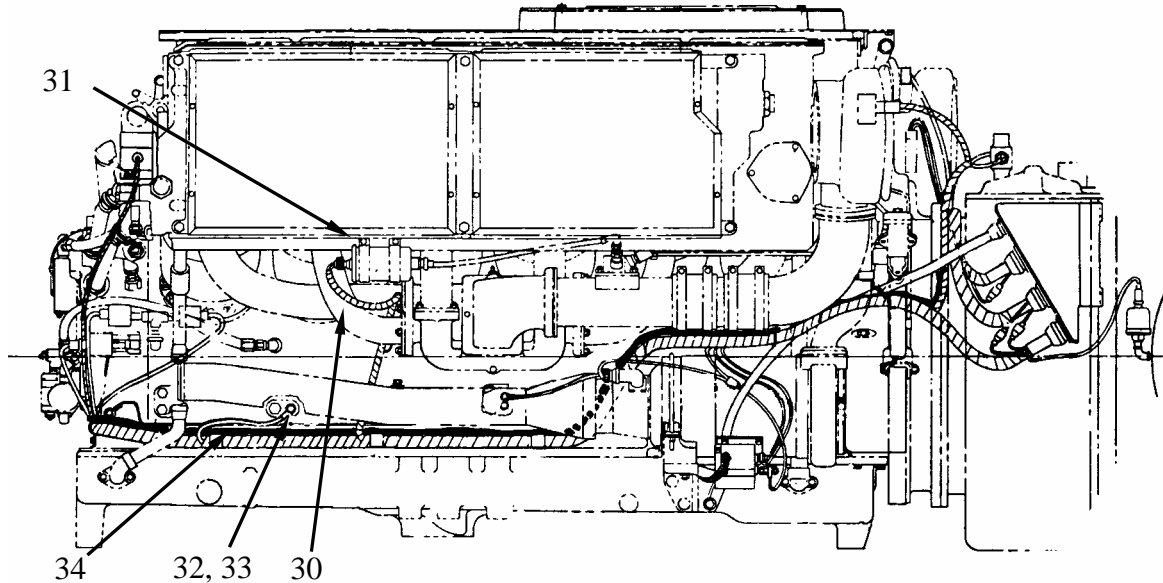
**INSTALLATION (Continued)**

6. Install harness into loop clamp (34) with screw (35) and new lock washer (36) (item 93, WP 0175).
7. Install harness into loop clamp (37) with new self-locking nut (38) (item 43, WP 0175).
8. Connect wiring harness at engine oil pressure transmitter (39), low engine oil pressure switch (40), and engine oil pressure switch (41).
9. Connect wiring harness at engine oil high temperature switch (42), engine oil temperature switch (43), and hour meter (44).
10. Install screw (45) with new lock washer (46) (item 94, WP 0175) and attach hour meter (44) ground lead (47).

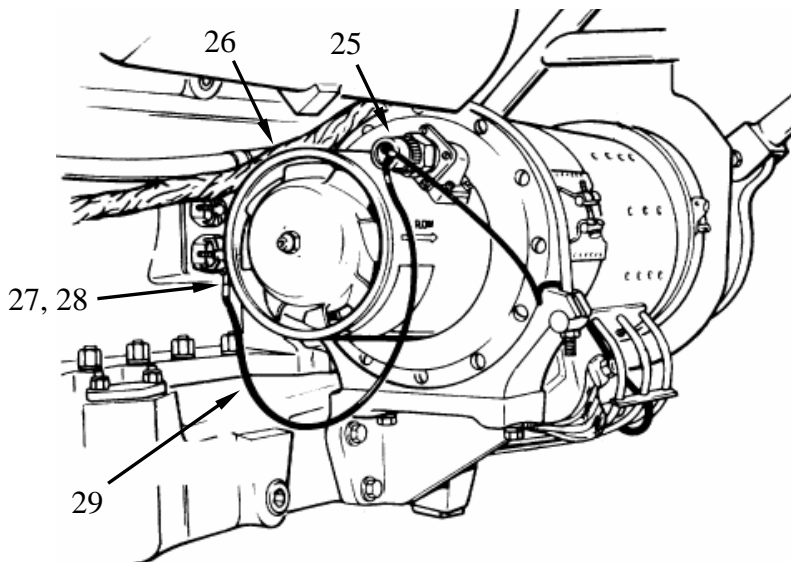


**INSTALLATION (Continued)**

11. Connect electrical lead (30) at manifold heater (31).
12. Using screw (32) with new lock washer (33) (item 93, WP 0175), secure ground lead (34).



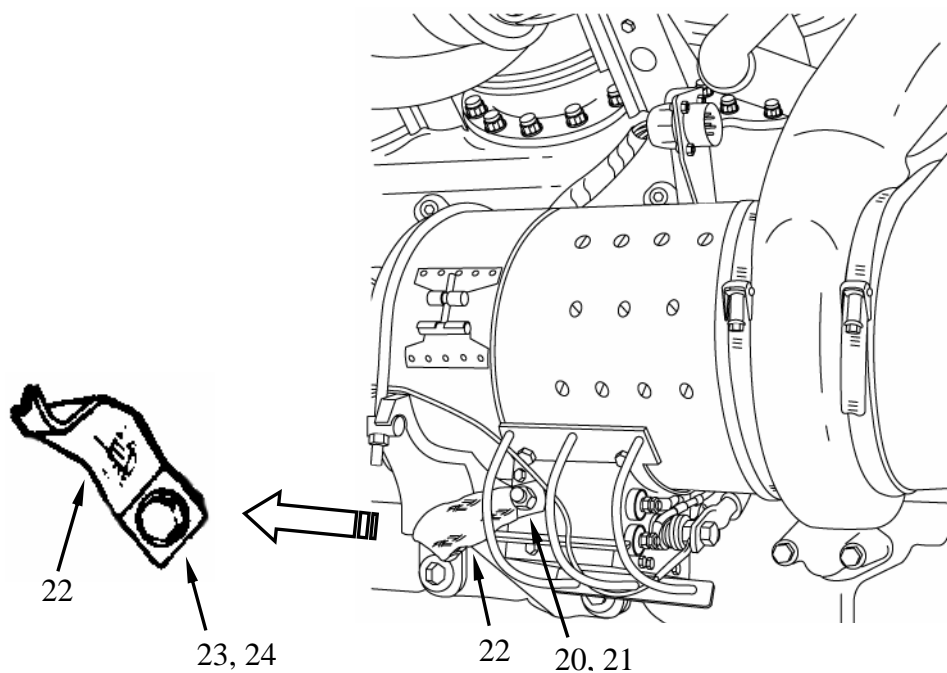
13. Connect electrical connector (25) for generator blower (26).
14. Using cap screw (27) with new lock washer (28) (item 83, WP 0175), secure generator blower ground lead (29).



**INSTALLATION (Continued)**

15. Install harness ground connections at generator.

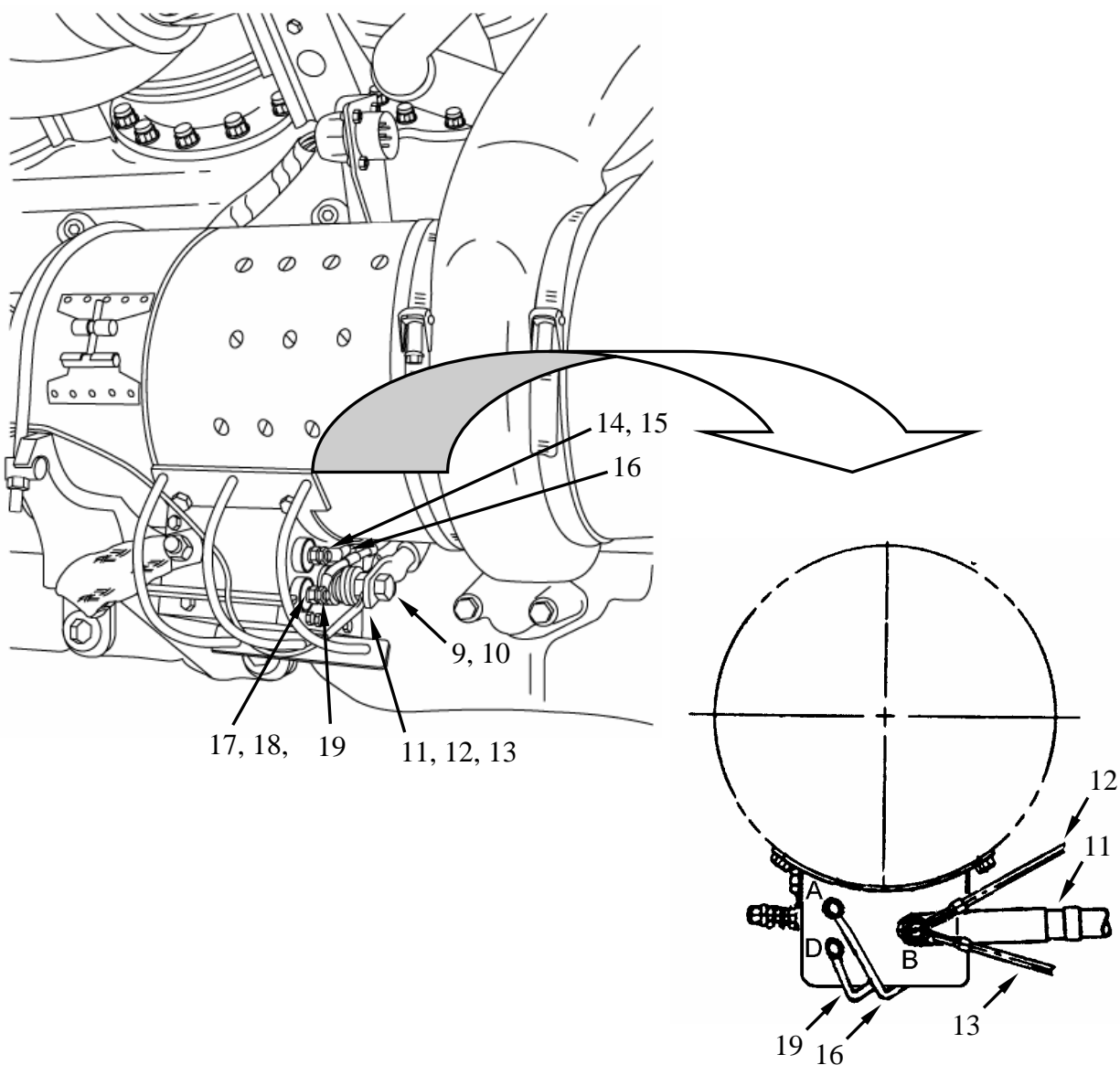
- a. Install self-locking nut (20) with flat washer (21), securing upper end of ground lead (22).
- b. Install screw (23) with flat washer (24) to finish installation of ground lead (22).



**INSTALLATION (Continued)**

16. Install harness positive connections at generator.

- a. Remove self-locking nut (9) with flat washer (10), and install electrical leads (11, 12, 13). Install nut (9) and flat washer (10).
- b. Remove self-locking nut (14) with flat washer (15), and install electrical lead (16). Install nut (14) and flat washer (15).
- c. Remove self-locking nut (17) with flat washer (18), and install electrical lead (19). Install nut (17) and flat washer (18).



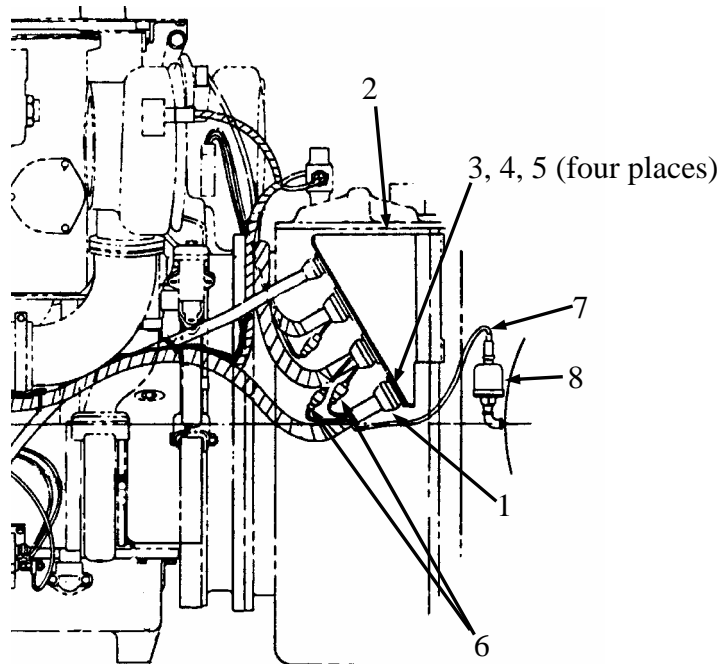
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**SIGNAL WIRING HARNESS REPLACEMENT (2DR) (PN 11671816, 10887570) 0059 00**

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**INSTALLATION (Continued)**

17. Connect end connector (1) at engine disconnect bracket (2).
  - a. Install four machine screws (3) with new lock washers (4) (item 90, WP 0175) and nuts (5).
18. Connect two cannon plug connectors (6).
19. Connect connector (7) at transmission oil pressure switch (8).



**END OF WORK PACKAGE**



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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**THIS WORK PACKAGE COVERS**

Removal, Cleaning, Inspection, Repair, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (as needed) (item 93, WP 0175)

Lock washer (8) (item 92, WP 0175)

Lock washer (4) (item 91, WP 0175)

Lock washer (2) (item 82, WP 0175)

Lock washer (3) (item 86, WP 0175)

**Mandatory Replacement Parts (Continued)**

Self-locking nut (3) (item 33, WP 0175)

Tie wrap (as needed) (item 80, WP 0175)

Tie wrap (as needed) (item 81, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

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**CAUTION**

**There are two configurations of the smoke generating system. Early systems use a dual solenoid configuration. It was found that fuel, trapped between the two solenoids and heated by the close proximity of the exhaust, expanded and caused internal seals of the solenoids to fail resulting in un-commanded smoke generation and higher fuel consumption.**

**If you have a dual fuel solenoid configuration requiring repair, it is recommended that you reference Engineering Release Record (ERR) CO-M6185 and convert your smoke generation system to the single solenoid configuration. ERR CO-M6185 authorizes the change.**

**Newer, improved systems use a single solenoid system. The newer system removes the two flywheel-end mounted solenoids and incorporates a single solenoid at the damper end of the engine where it is cooler.**

**NOTE**

**This work package includes maintenance of the smoke generation wiring harness for the 2CA and 2DA models with single or dual fuel solenoid configuration.**

**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

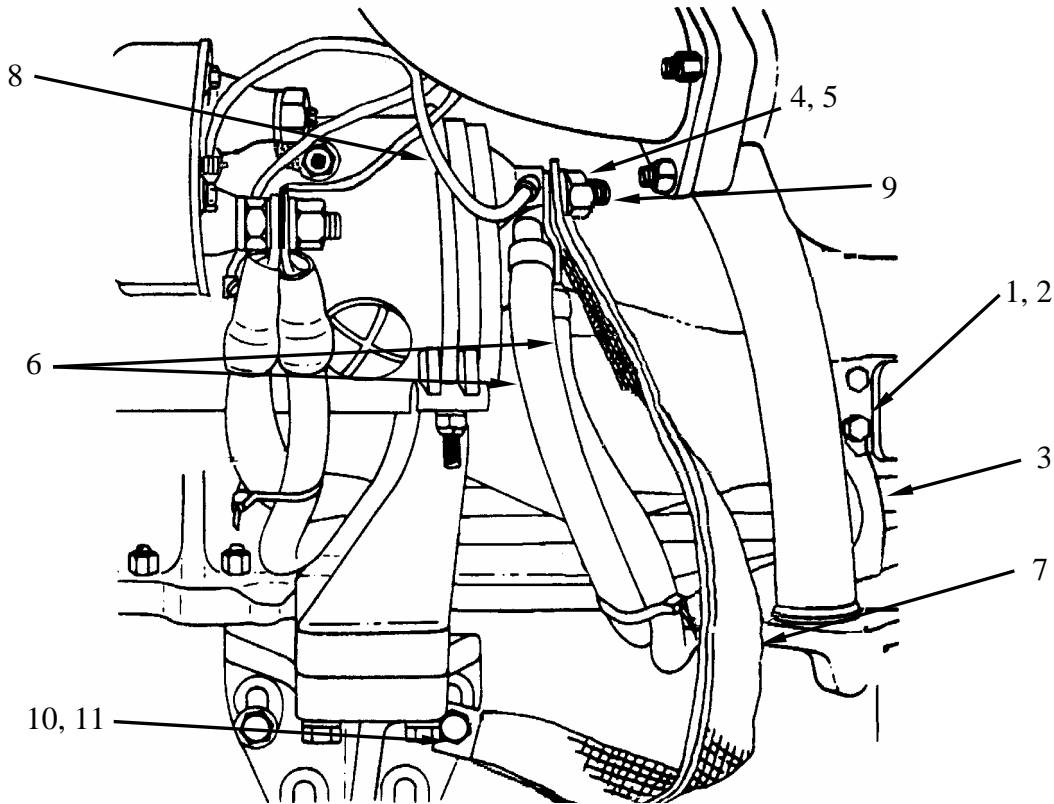
**REMOVAL**

1. Remove starter wiring harness.
  - a. Remove screw (1) with lock washer (2) and remove starter cable loop clamp (3). Discard lock washer.

**NOTE**

**Engine models with 300 ampere electrical systems have only one starter electrical ground strap (7).**

- b. Remove nut (4) with lock washer (5) and disconnect two starter ground cables (6), ground straps (7), and low voltage protection module lead (8).
- c. Reinstall nut (4) and lock washer (5) onto starter ground post (9) for safe keeping.
- d. Remove screw (10) with two flat washers (11) and remove ground straps (7).

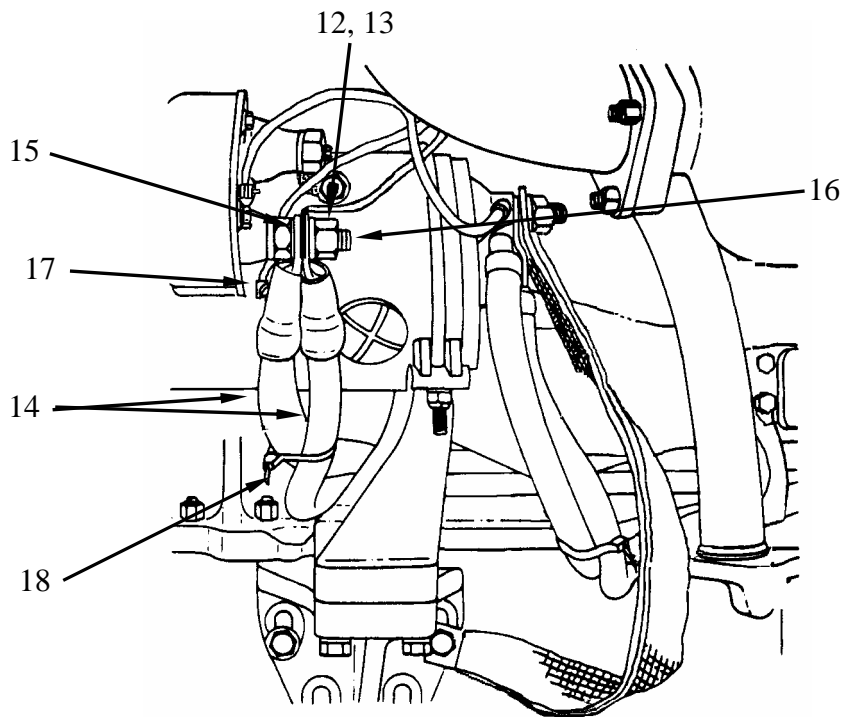




**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**REMOVAL (Continued)**

1. Remove starter wiring harness (continued).
  - e. Remove nut (12) with lock washer (13) and disconnect two starter harnesses (14) and starter low voltage protection module terminal lead (15).
  - f. Reinstall nut (12) and lock washer (13) onto starter battery post (16) for safe keeping.
  - g. Remove machine screw (17) and disconnect starter low voltage protection module cable lead.
  - h. Cut and remove tie wrap (18) on starter harnesses.



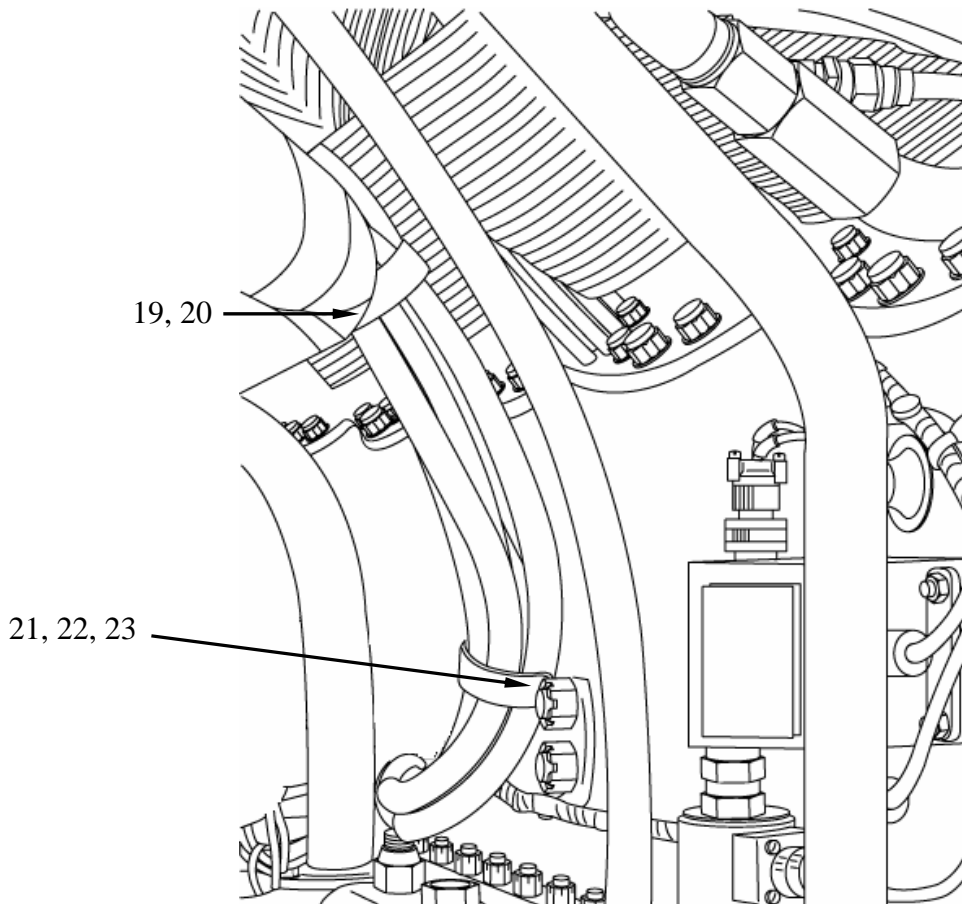
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

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**REMOVAL (Continued)**

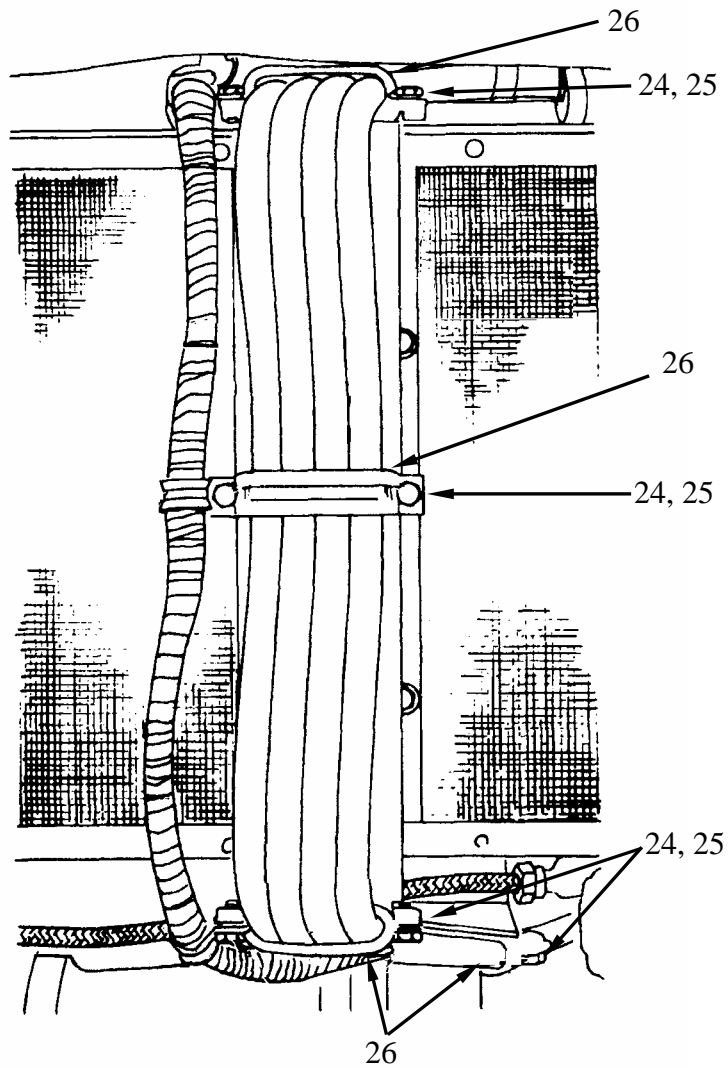
1. Remove starter wiring harness (continued).
  - i. Remove screw with lock washer (19) and remove starter cable loop clamp (20). Discard lock washer.
  - j. Remove screw (21) with lock washer (22) and remove starter cable loop clamp (23). Discard lock washer.



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**REMOVAL (Continued)**

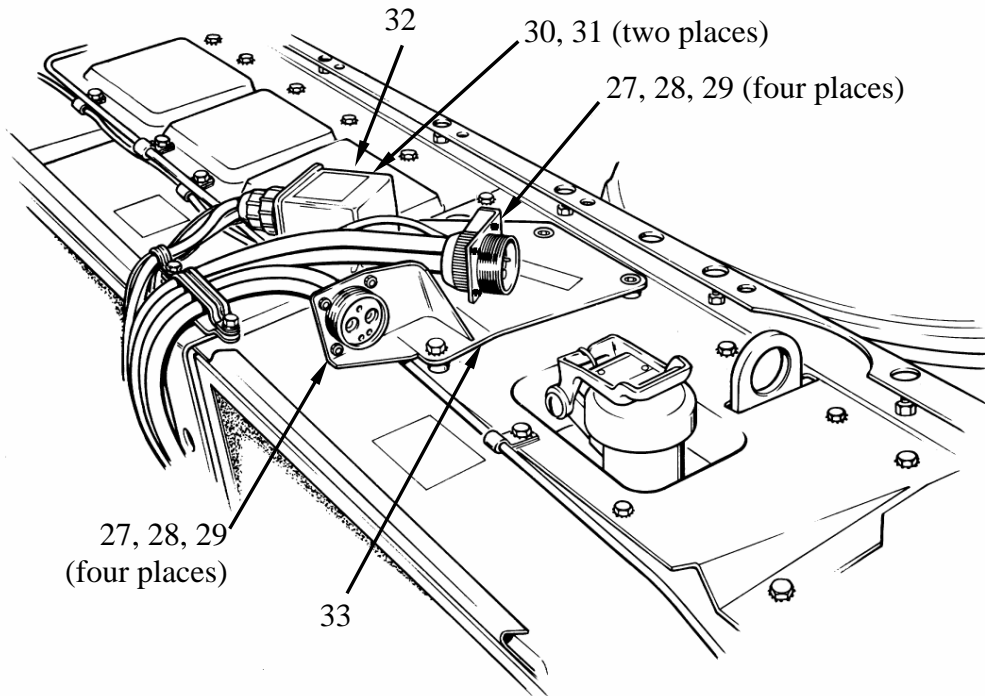
1. Remove starter wiring harness (continued).
  - k. Remove eight screws (24) with lock washers (25) and remove four retaining straps (26). Discard lock washers.



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**REMOVAL (Continued)**

1. Remove starter wiring harness (continued).
  - m. Remove four machine screws (27) lock washers (28) and nuts (29) from each connector. Discard lock washers.
  - n. Remove two screws (30), and lock washers (31) securing low voltage protection module (32) to bracket (33). Discard lock washers.



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

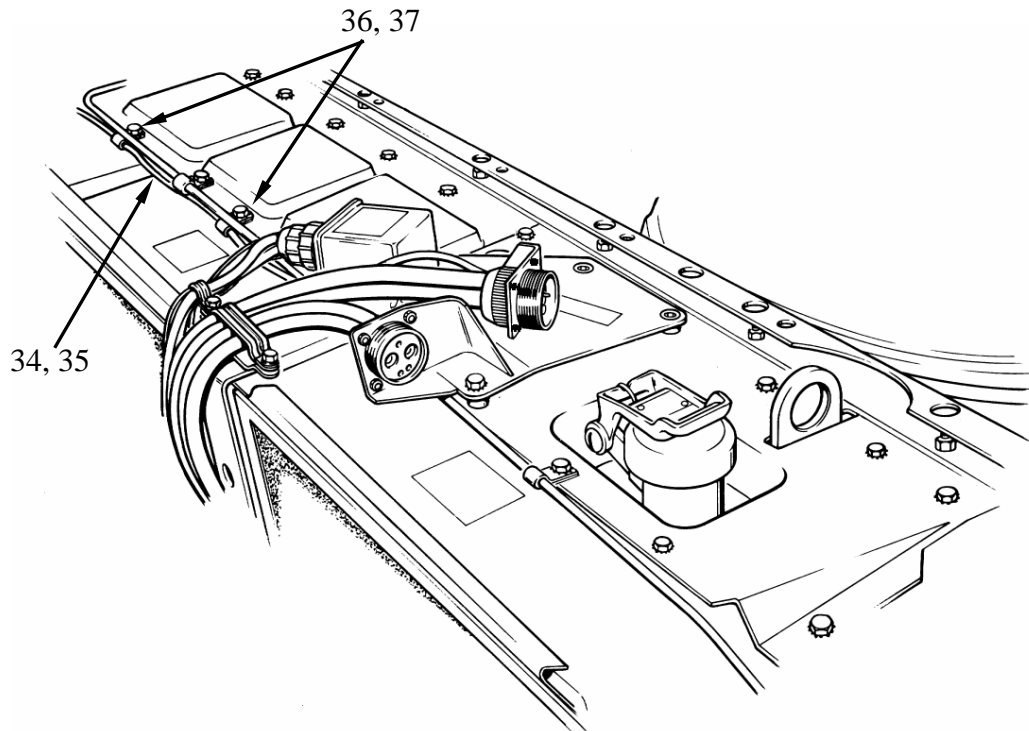
**REMOVAL (Continued)**

**NOTE**

**For smoke generation systems with dual-solenoid configuration, harness removal instructions are covered in step 2.**

**For smoke generation systems with single-solenoid configuration, harness removal instructions are covered in step 3.**

2. Harness removal with dual solenoid smoke generator harness.
  - a. Release smoke generator and dust detector leads (34, 35) by removing two assembled washer bolts (36) and loop clamps (37).



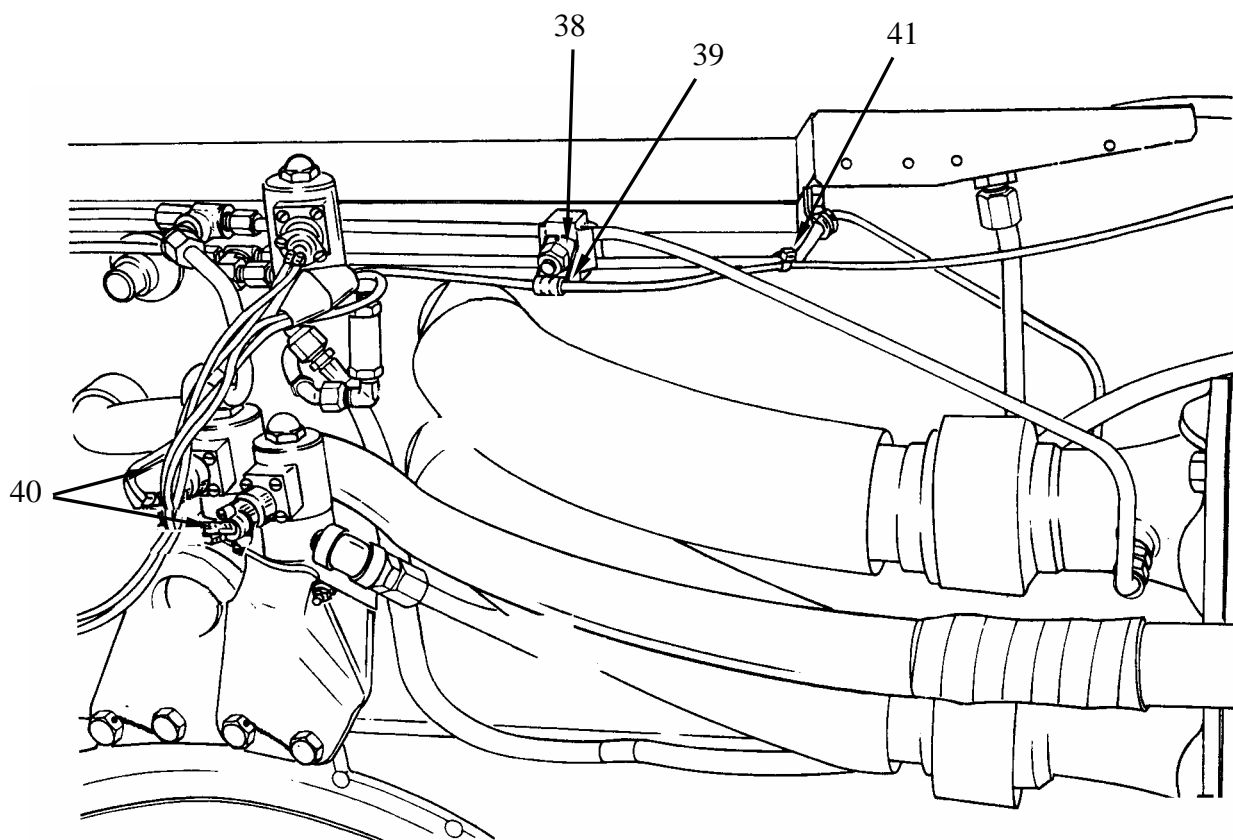
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468)**

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**0060 00****REMOVAL (Continued)**

2. Harness removal with dual solenoid smoke generator harness (continued).
  - b. Remove self-locking nut (38) and loop clamp (39) for dust detector and smoke generator leads. Discard self-locking nut.
  - c. Remove connectors at smoke generator solenoids (40).
  - d. Cut and remove tie wraps (41) as needed.



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

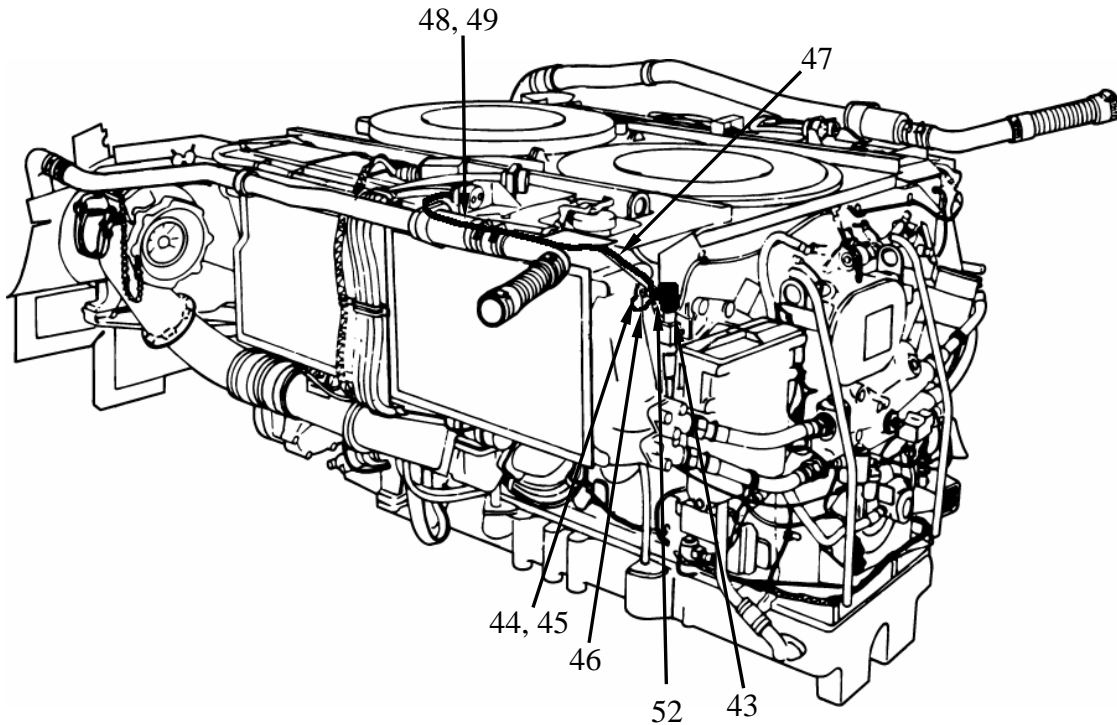
**REMOVAL (Continued)**

**NOTE**

**For smoke generation systems with single-solenoid configuration, harness removal instructions are covered in step 3.**

**For smoke generation systems with dual-solenoid configuration, harness removal instructions are covered in step 2.**

3. Harness removal with single solenoid smoke generator harness.
  - a. Remove connector (42) at smoke generator solenoid (43).
  - b. Remove screw (44) with lock washer (45) securing ground lead (46). Discard lock washer.
  - c. Clip and remove tie wraps (47).
  - d. Remove assembled washer screws (48) and loop clamps (49).



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

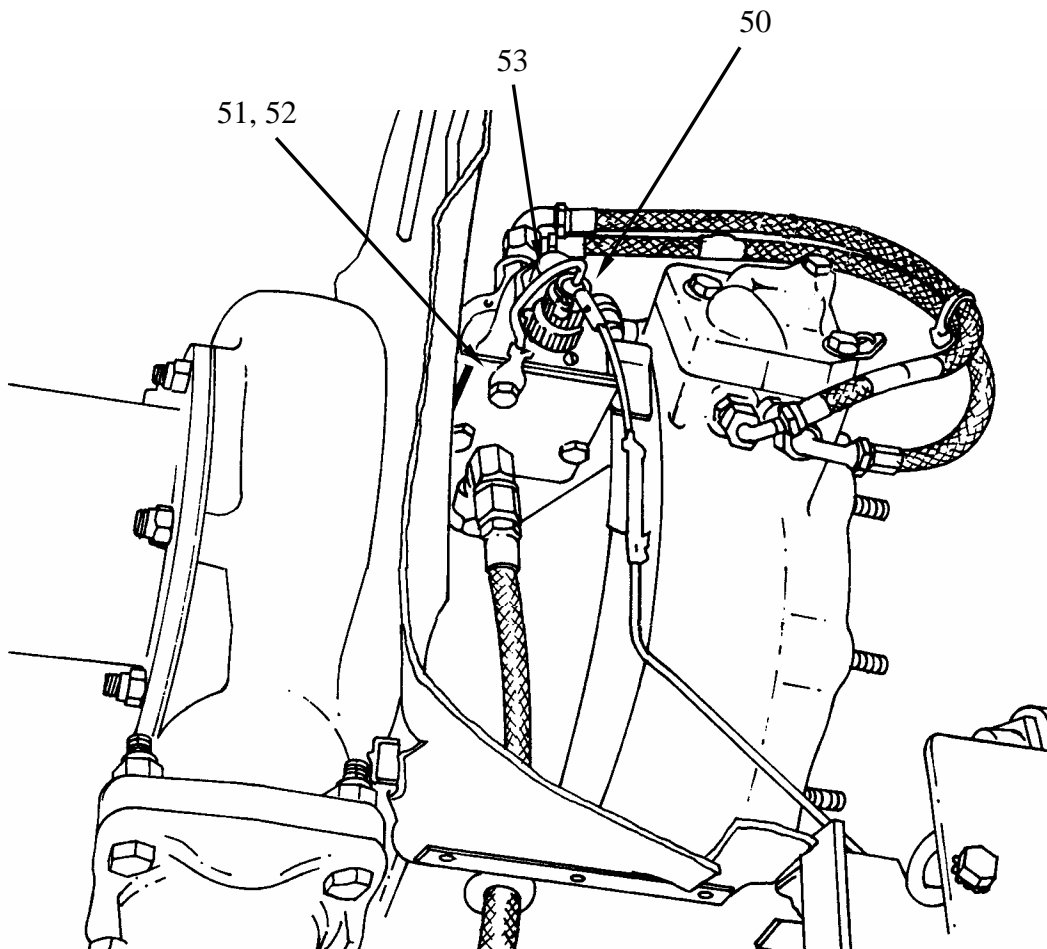
**REMOVAL (Continued)**

4. Remove dust detector harness.

**NOTE**

**Dust detector harnesses disconnect in the same fashion between left and right bank. Only the right bank is illustrated.**

- a. Disconnect electrical connectors (50).
- b. Remove screws (51), and lock washers (52) securing dust detector ground lead (53). Discard lock washers.





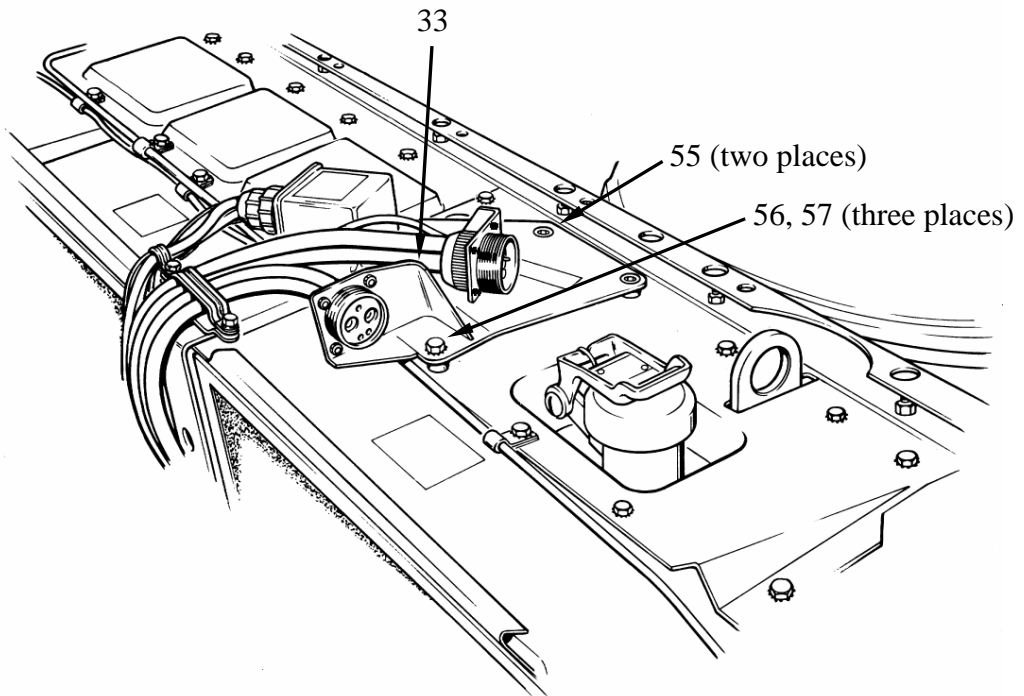
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED  
(2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

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**REMOVAL (Continued)**

5. Remove starter harness brackets.
  - a. Remove two socket head flat head screws (54).
  - b. Remove three screws (55) with lock washers (56). Discard lock washers.
  - c. Remove starter upper wiring harness bracket (33).



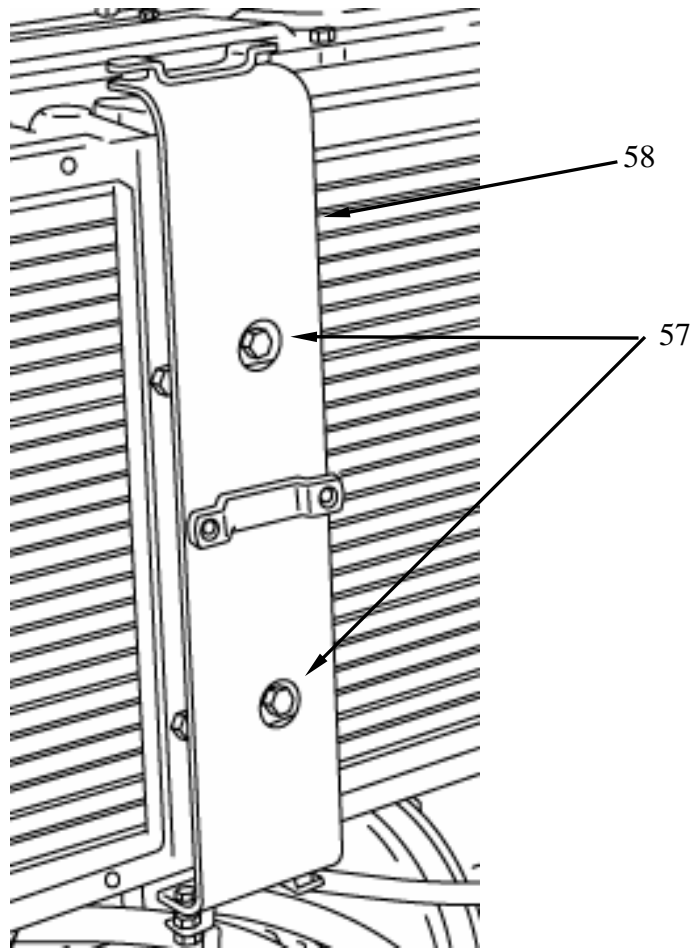
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

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**REMOVAL (Continued)**

5. Remove starter harness brackets (continued).
  - d. Remove two assembled washer bolts (57) from starter cable bracket (58) and remove bracket.



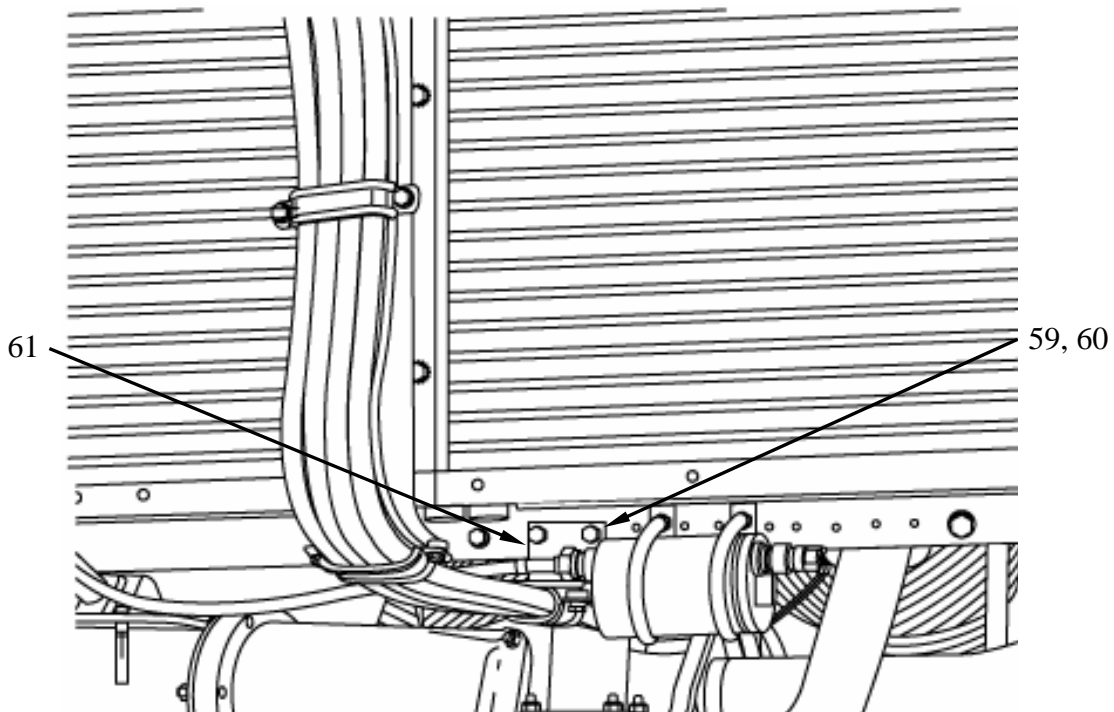
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**REMOVAL (Continued)**

5. Remove starter harness brackets (continued).
  - e. Remove two screws (59) with self-locking nuts (60) and remove starter lower harness bracket assembly (61). Discard self-locking nuts.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness and Cable Repair.

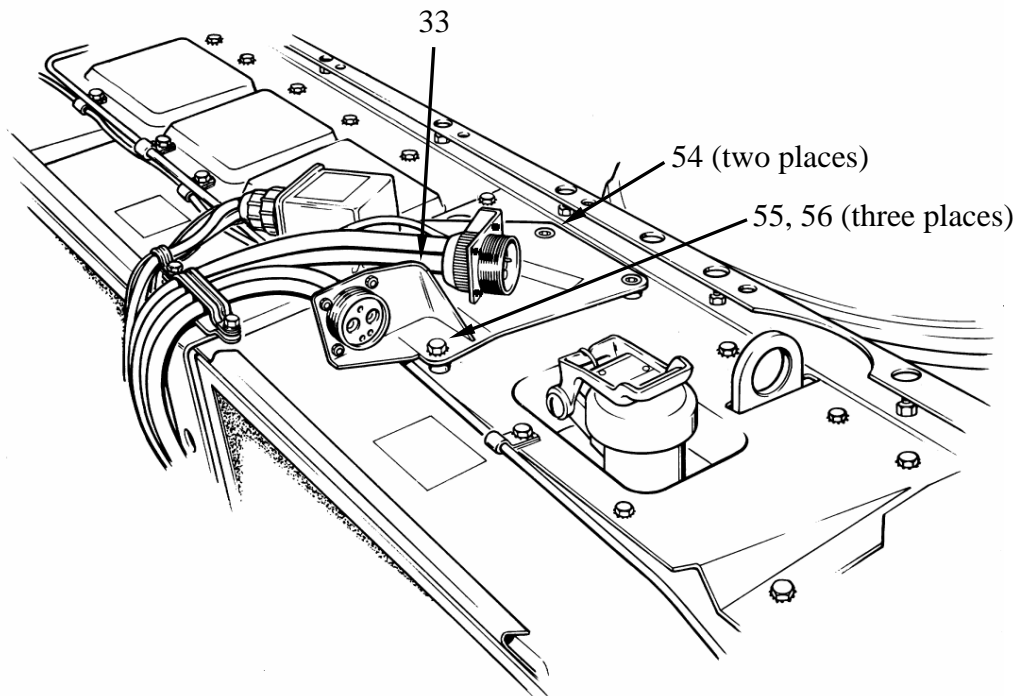
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**INSTALLATION**

1. Install starter harness brackets.
  - a. Position starter upper wiring harness bracket (33).
  - b. Install three screws (55) and new lock washers (56) (item 86, WP 0175).
  - c. Install two socket head flat head screws (54).



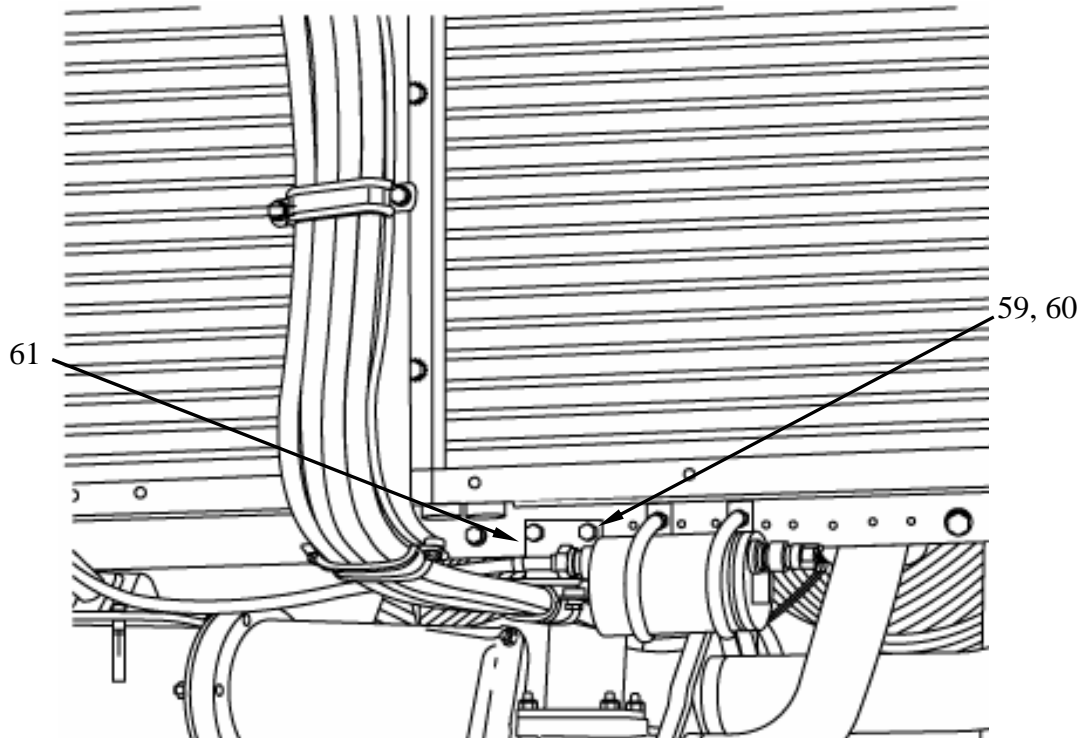
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**INSTALLATION (Continued)**

1. Install starter harness brackets (continued).
  - d. Install starter lower harness bracket assembly (61) using two screws (59) and two new self-locking nuts (60) (item 33, WP 0175).



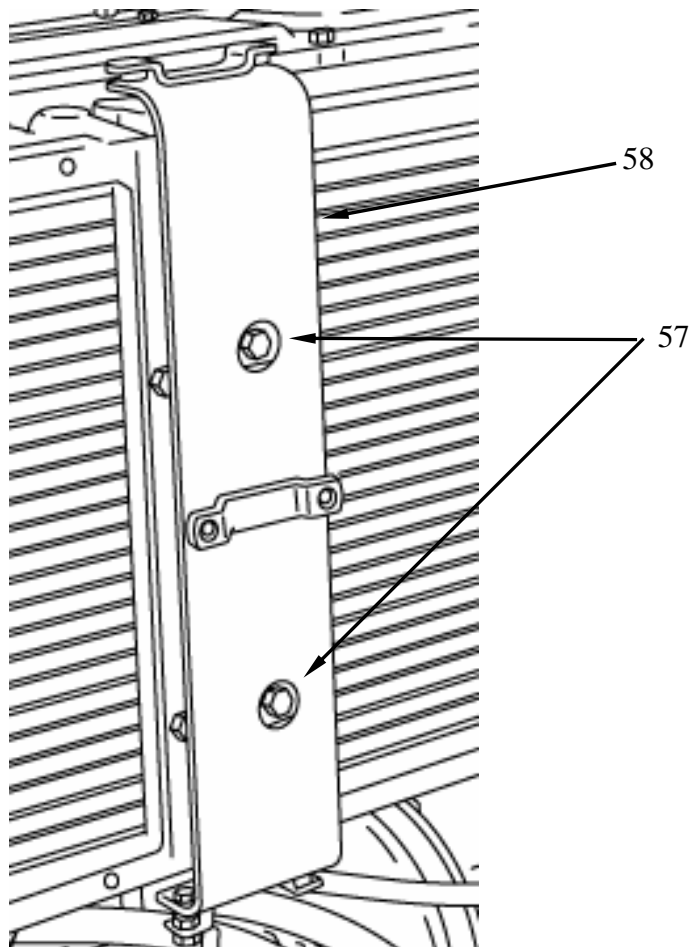
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**INSTALLATION (Continued)**

1. Install starter harness brackets (continued).
  - e. Position starter harness bracket (58) onto cooler. Install two assembled washer bolts (57) securing starter harness bracket (58) to cooler frame.



---

**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

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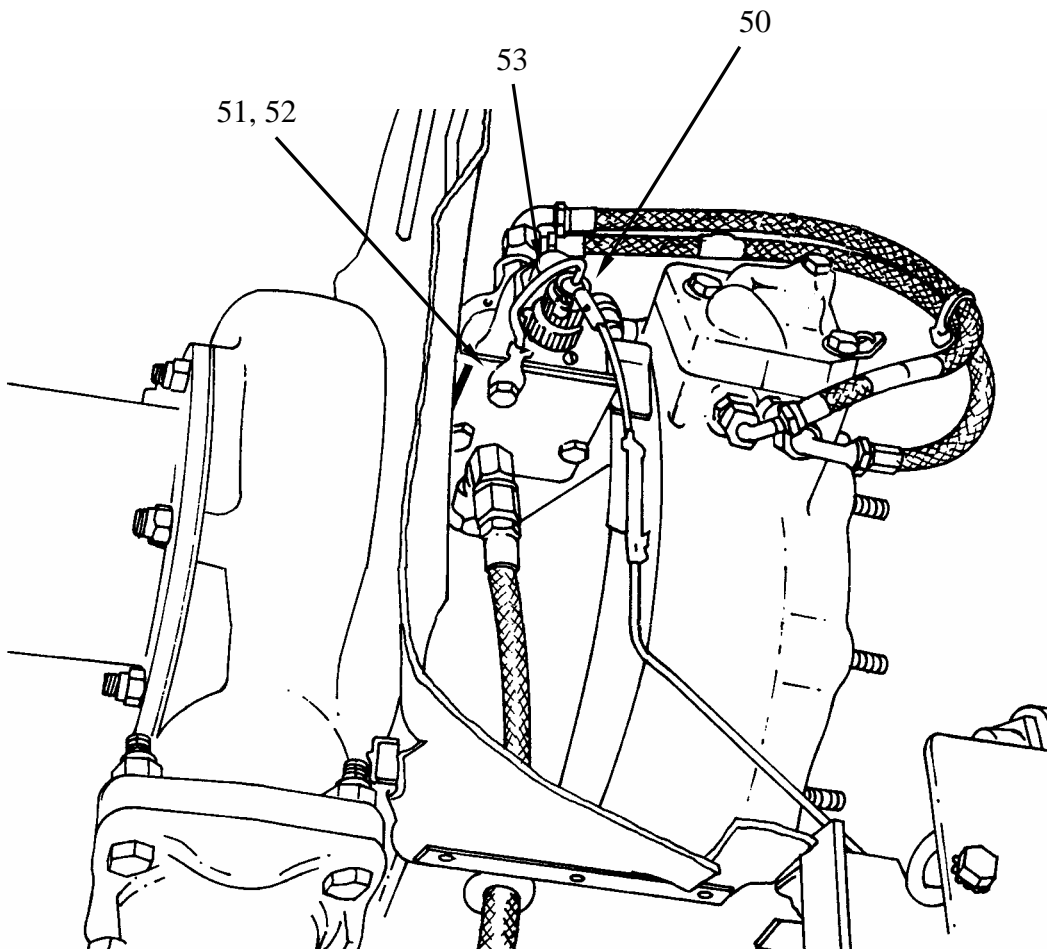
**INSTALLATION (Continued)**

2. Install dust detector harness.

**NOTE**

**Dust detector harnesses connect in the same fashion between left and right bank. Only the right bank is illustrated.**

- a. Install dust detector electrical connectors (50).
- b. Install ground leads (53) using screws (51) and new lock washers (52) (item 93, WP 0175).



---

**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468)**

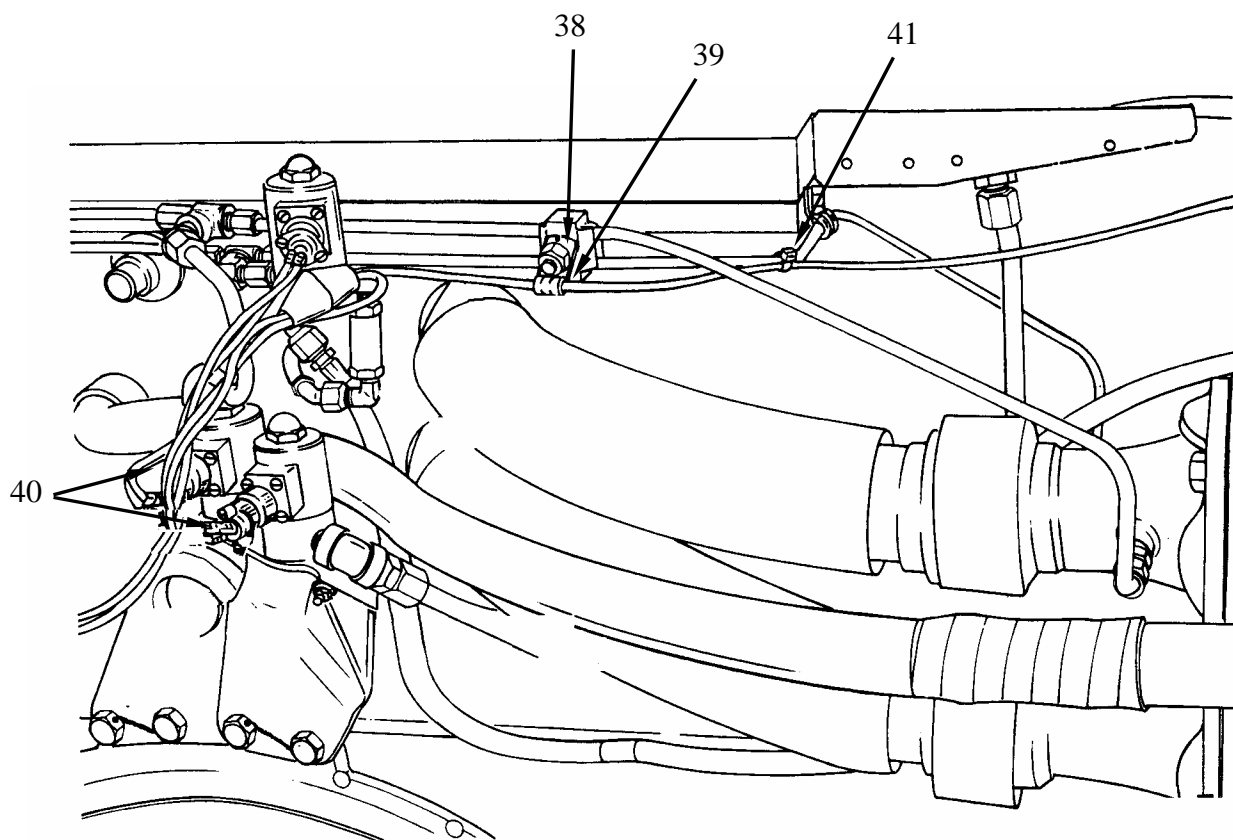
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**0060 00****INSTALLATION (Continued)****NOTE**

**For smoke generation systems with dual-solenoid configuration, harness installation instructions are covered in step 3.**

**For smoke generation systems with single-solenoid configuration, harness installation instructions are covered in step 4.**

3. Harness installation with dual solenoid smoke generator harness.
  - a. Install smoke generator solenoid connectors (40).
  - b. Install dust detector and smoke generator leads into loop clamp (39) and secure with new self-locking nut (38) (item 33, WP 0175).
  - c. Install tie wraps (41) (item 80, WP 0175) as necessary.





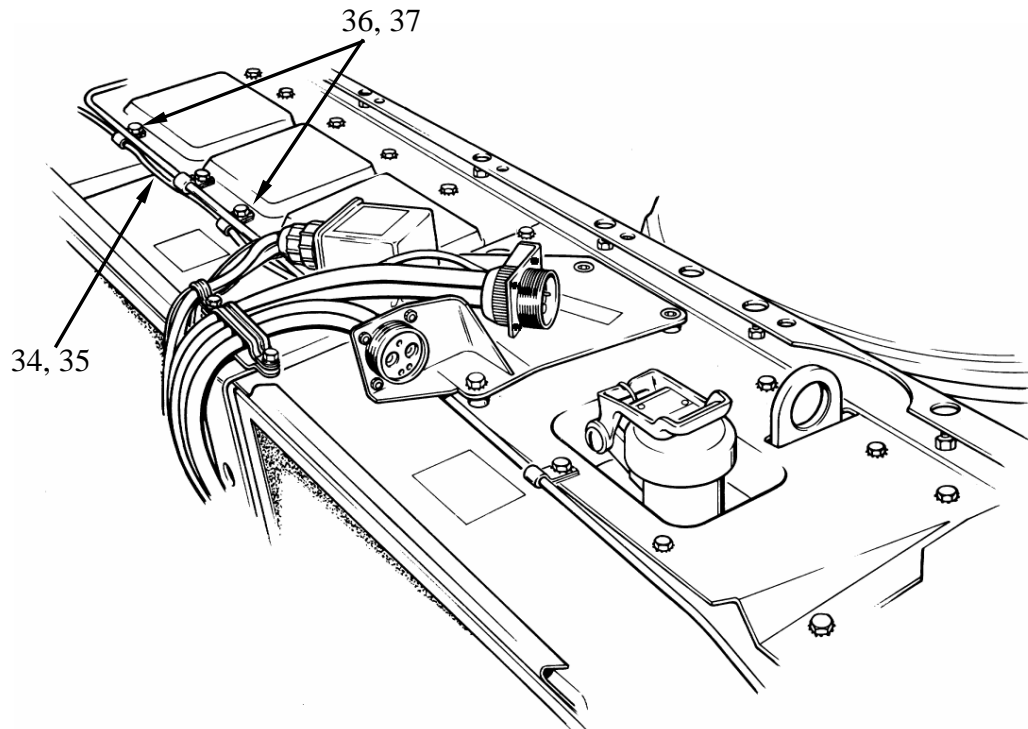
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST  
DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED  
(2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

---

**INSTALLATION (Continued)**

3. Harness installation with dual solenoid smoke generator harness (continued).
  - d. Install dust detector and smoke generator leads (34, 35) into loop clamps (36).
  - e. Install loop clamps (36) with assembled washer bolts (37).



---

**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

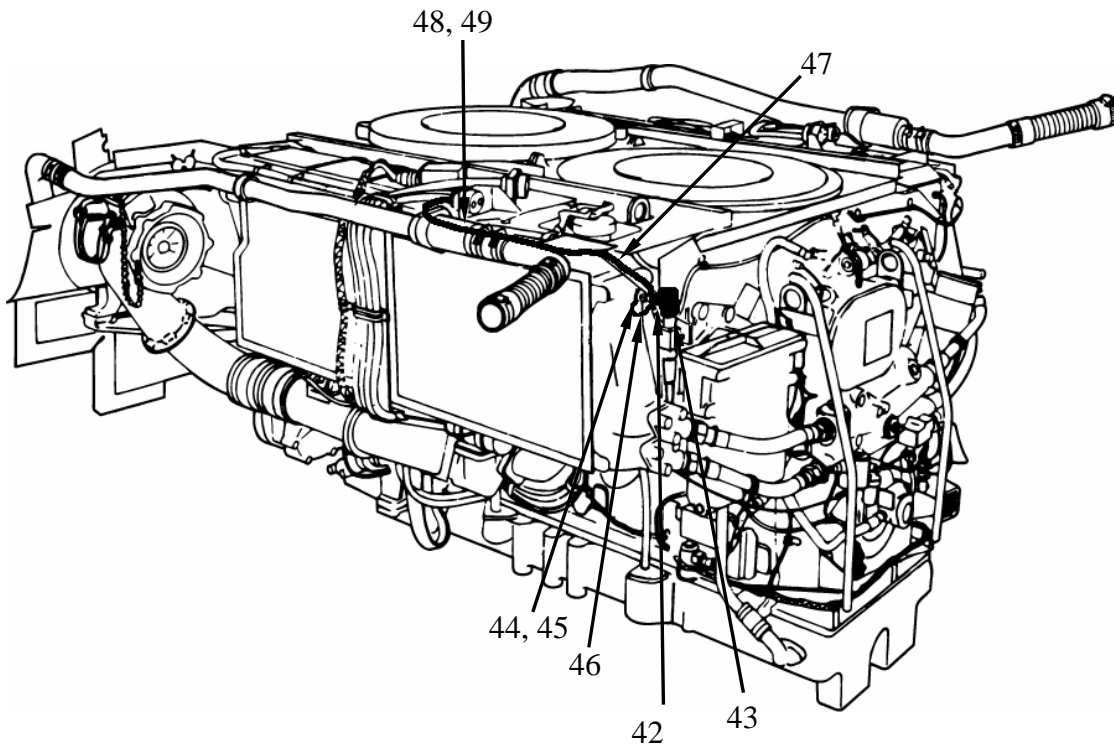
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**INSTALLATION (Continued)****NOTE**

**For smoke generation systems with single-solenoid configuration, harness installation instructions are covered in step 4.**

**For smoke generation systems with dual-solenoid configuration, harness installation instructions are covered in step 3.**

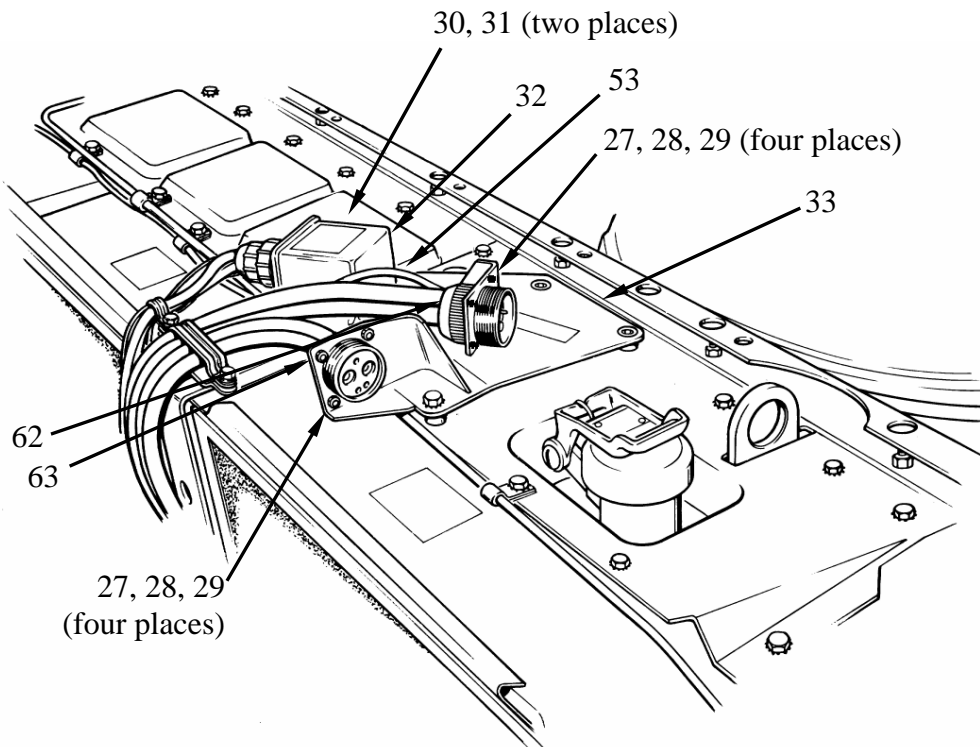
4. Harness installation with single solenoid smoke generator harness.
  - a. Install connector (42) at smoke generator solenoid (43).
  - b. Install ground lead (46) with screw (44) and new lock washer (45) (item 93, WP 0175).
  - c. Install loop clamps (49) with assembled washer screws (48).
  - d. Install tie wraps (47) (item 81, WP 0175) as needed.



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**INSTALLATION (Continued)**

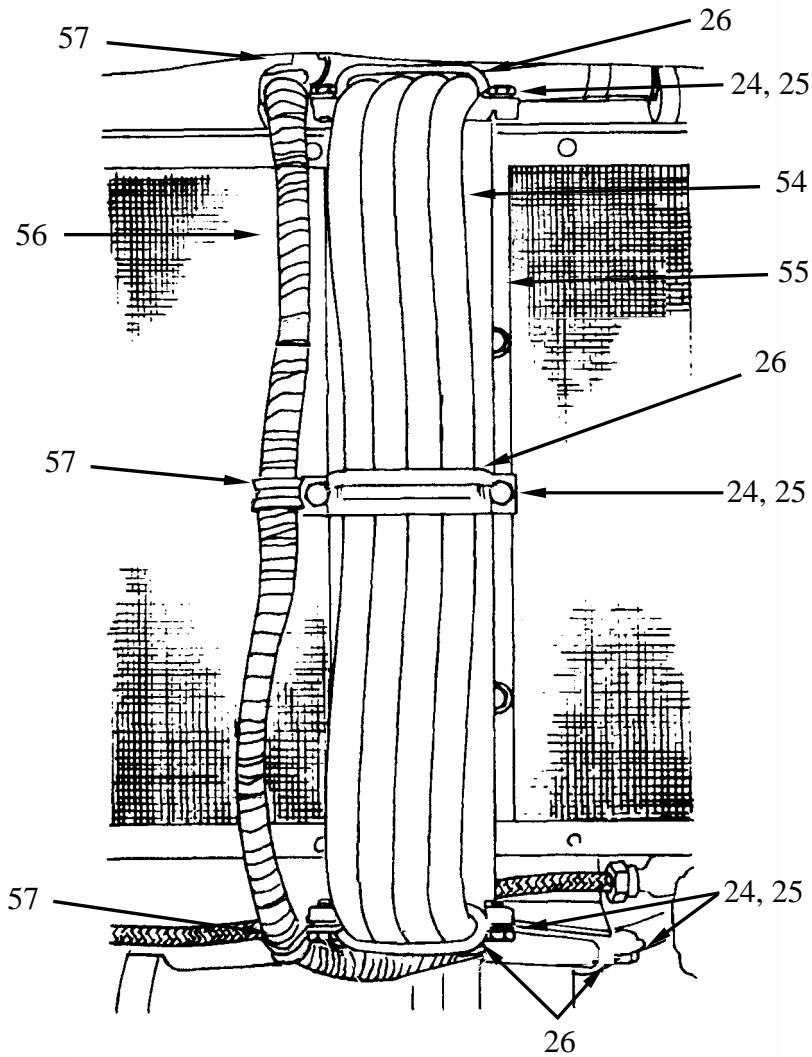
5. Install starter wiring harnesses.
  - a. Install starter main power cable end connectors (62, 63) into mounting bracket (33). Secure with four machine screws (27), new lock washers (28) (item 91, WP 0175), and nuts (29).
  - b. Install low voltage protection module (32) onto mounting bracket (33) with two screws (30) and new lock washers (31) (item 82, WP 0175). Make sure to secure ground wire (53) with one module securing screw (30).



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**INSTALLATION (Continued)**

5. Install starter wiring harnesses (continued).
  - c. Secure starter harnesses (54) in cable mounting bracket (55) with retaining straps (26) using eight screws (24) and new lock washers (25) (item 92, WP 0175). Ensure low voltage protection module harness (56) and loop clamps (57) are installed with mounting screws (24).



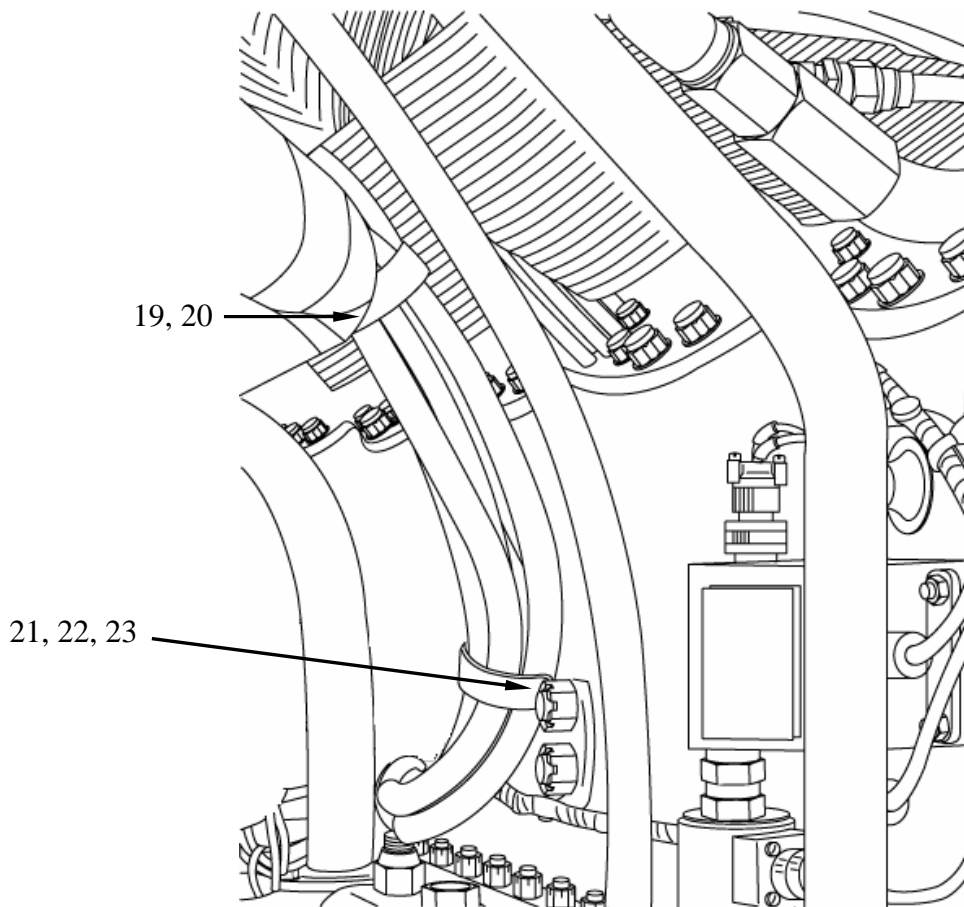
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**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

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**INSTALLATION (Continued)**

5. Install starter wiring harnesses (continued).
  - d. Install starter cables retaining loop clamp (20) using screw with new lock washer (19) (item 93, WP 0175).
  - e. Install starter harness retaining loop clamp (23) using screw (21) and new lock washer (22) (item 93, WP 0175).



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

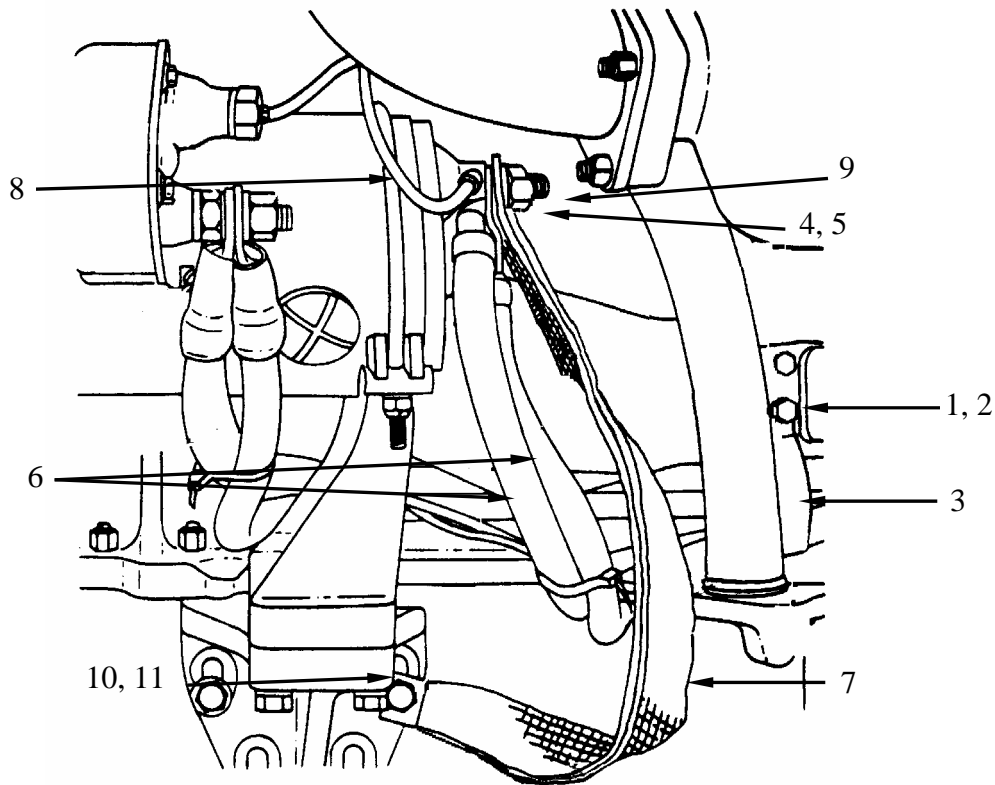
**INSTALLATION (Continued)**

5. Install starter wiring harnesses (continued).

**NOTE**

**Engine models with 300 ampere electrical systems have only one starter electrical ground strap (7).**

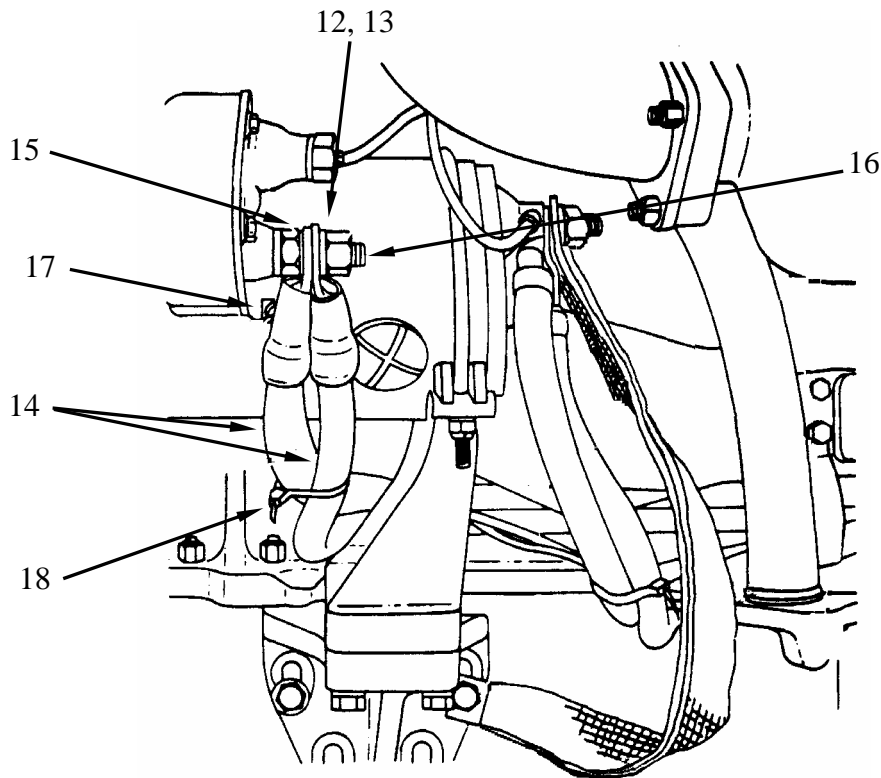
- f. Install low voltage protection module lead (8), starter ground cables (6), and ground straps (7) onto starter ground post (9) using original nut (4) and lock washer (5).
- g. Install ground strap (7) onto starter mounting bracket using screw (10) and two flat washers (11).
- h. Install starter cable loop clamp (3) with screw (1) with new lock washer (2) (item 93, WP 0175).



**WIRING HARNESS REPLACEMENT, STARTER, SMOKE GENERATOR, AND DUST DETECTOR WITH LOW VOLTAGE PROTECTION MODULE TOP MOUNTED (2CA, 2DA) (PART NUMBERS 11655454, 12314619, AND 12354468) 0060 00**

**INSTALLATION (Continued)**

5. Install starter wiring harnesses (continued).
  - i. Install machine screw (17) securing low voltage protection module lead.
  - j. Install two starter harnesses (14), low voltage protection terminal lead (15) to starter positive post (16) using existing nut (12) and lock washer (13).
  - k. Install tie wrap (18) (item 81, WP 0175) on starter harnesses.



**END OF WORK PACKAGE**





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STARTER/ SMOKE GENERATOR/ DUST DETECTOR WIRING HARNESS REPLACEMENT,  
LVPM CRANKCASE MOUNTED (2CA, 2DA) (PN 11655456, 11682726) 0061 00

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**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (as needed) (item 93, WP 0175)

Lock washer (8) (item 92, WP 0175)

Lock washer (4) (item 91, WP 0175)

Lock washer (3) (item 86, WP 0175)

Self-locking nut (3) (item 33, WP 0175)

**Mandatory Replacement Parts: Continued**

Tie wrap (as needed) (item 80, WP 0175)

Tie wrap (as needed) (item 81, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

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**CAUTION**

**There are two configurations of the smoke generating system. Early systems use a dual solenoid configuration. It was found that fuel, trapped between the two solenoids and heated by the close proximity of the exhaust, expanded and caused internal seals of the solenoids to fail resulting in un-commanded smoke generation and higher fuel consumption.**

**If you have a dual fuel solenoid configuration requiring repair, it is recommended that you reference Engineering Release Record (EER) CO-M6185 and convert your smoke generation system to the single solenoid configuration. EER CO-M6185 authorizes the change.**

**Newer, improved systems use a single solenoid system. The newer system removes the two flywheel-end mounted solenoids and incorporates a single solenoid at the damper end of the engine where it is cooler.**

**NOTE**

**This work package includes maintenance of the smoke generation wiring harness for the 2CA and 2DA models with single or dual fuel solenoid configuration.**

**The wiring harness for crankcase mounted LVPM is no longer supported by the parts manual.**

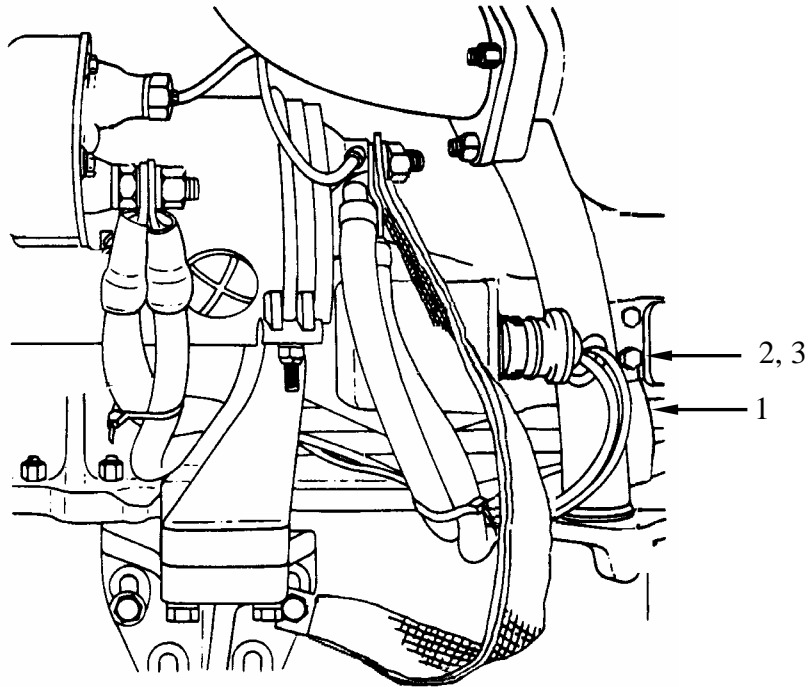
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**STARTER/ SMOKE GENERATOR/ DUST DETECTOR WIRING HARNESS REPLACEMENT,  
LVPM CRANKCASE MOUNTED (2CA, 2DA) (PN 11655456, 11682726) 0061 00**

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**REMOVAL**

1. Remove loop clamp (1).
  - a. Remove screw (2) with lock washer (3) and remove starter harness loop clamp (1). Discard lock washer.

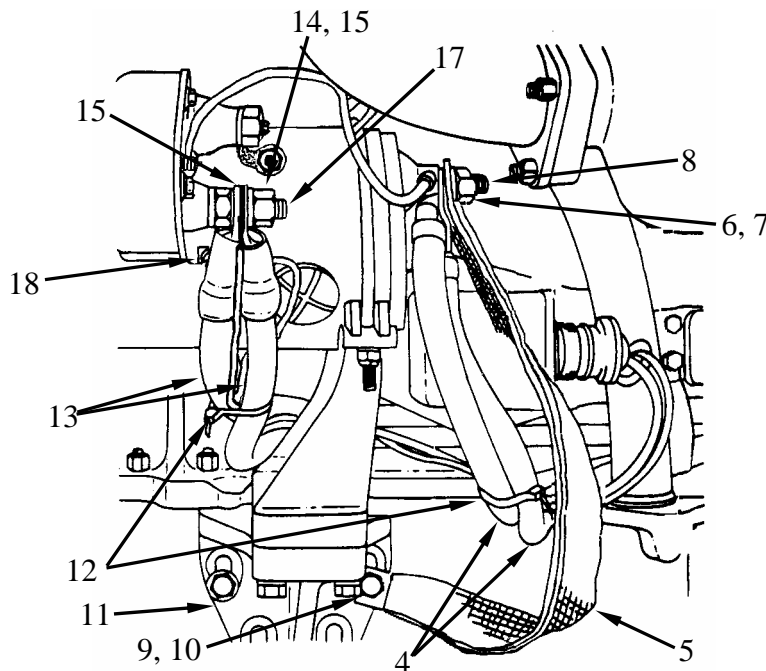


REMOVAL (Continued)

NOTE

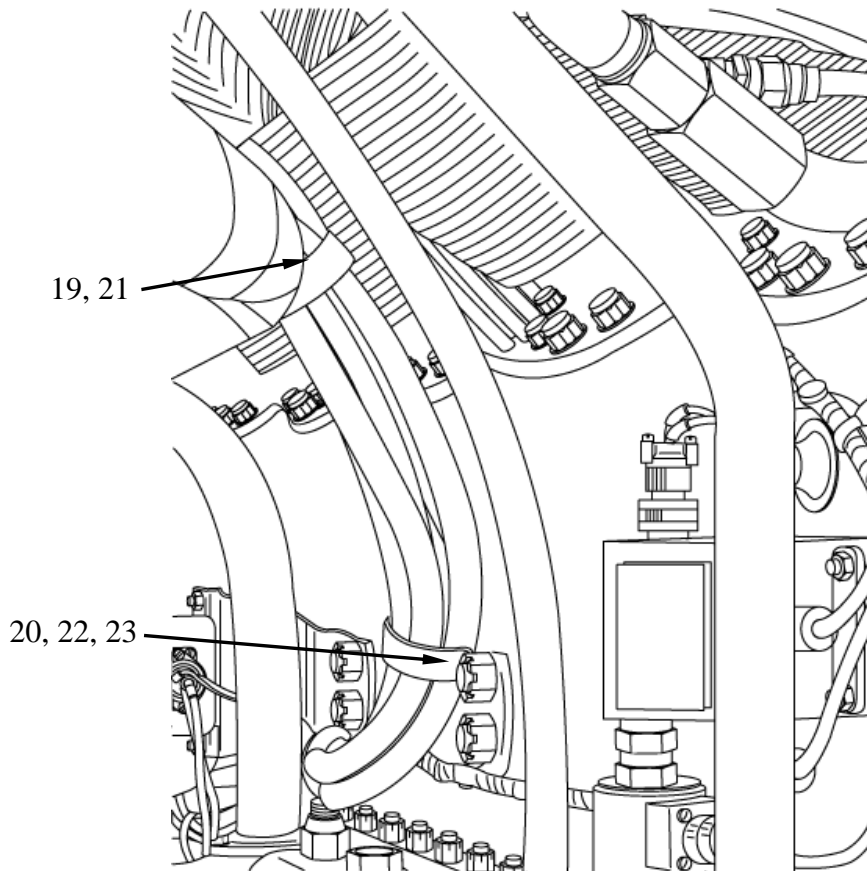
**Engine models with 300 ampere electrical systems have only one starter electrical ground strap (5).**

2. Remove starter ground harness (4) and straps (5).
  - a. Remove nut (6) with lock washer (7).
  - b. Remove two starter ground harness (4) and two ground straps (5).
  - c. Reinstall nut (6) and lock washer (7) onto starter ground terminal post (8) for safe keeping.
  - d. Remove screw (9) with two flat washers (10) from starter mounting bracket (11) and remove ground straps (5).
  - e. Cut and remove tie wraps (12) as necessary.
3. Remove starter positive harness (13).
  - a. Remove nut (14) with lock washer (15).
  - b. Remove two starter harness (13), and starter low voltage protection module harness terminal (16).
  - c. Reinstall nut (14) and lock washer (15) onto battery terminal post (17) for safe keeping.
  - d. Remove machine screw (18) and disconnect starter low voltage protection module at harness terminal.
  - e. Cut and remove tie wraps (12) as necessary.



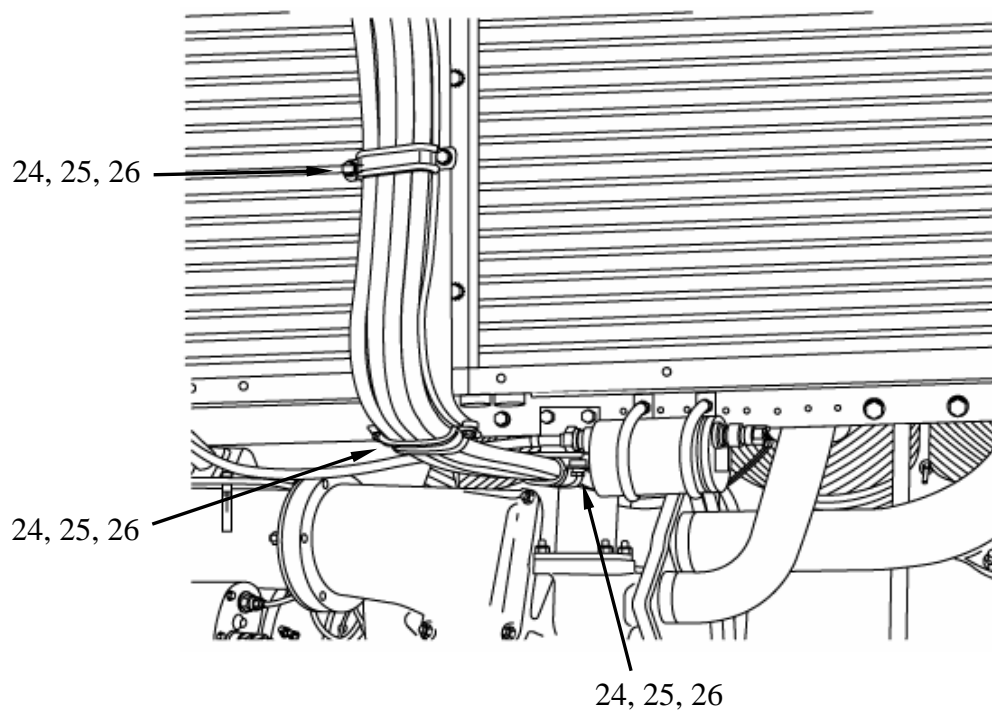
**REMOVAL (Continued)**

4. Remove intermediate loop clamps (19, 20).
  - a. Remove screw with lock washer (21) and remove starter harness loop clamp (19). Discard lock washer.
  - b. Remove screw (22) with lock washer (23) and remove starter harness loop clamp (20). Discard lock washer.



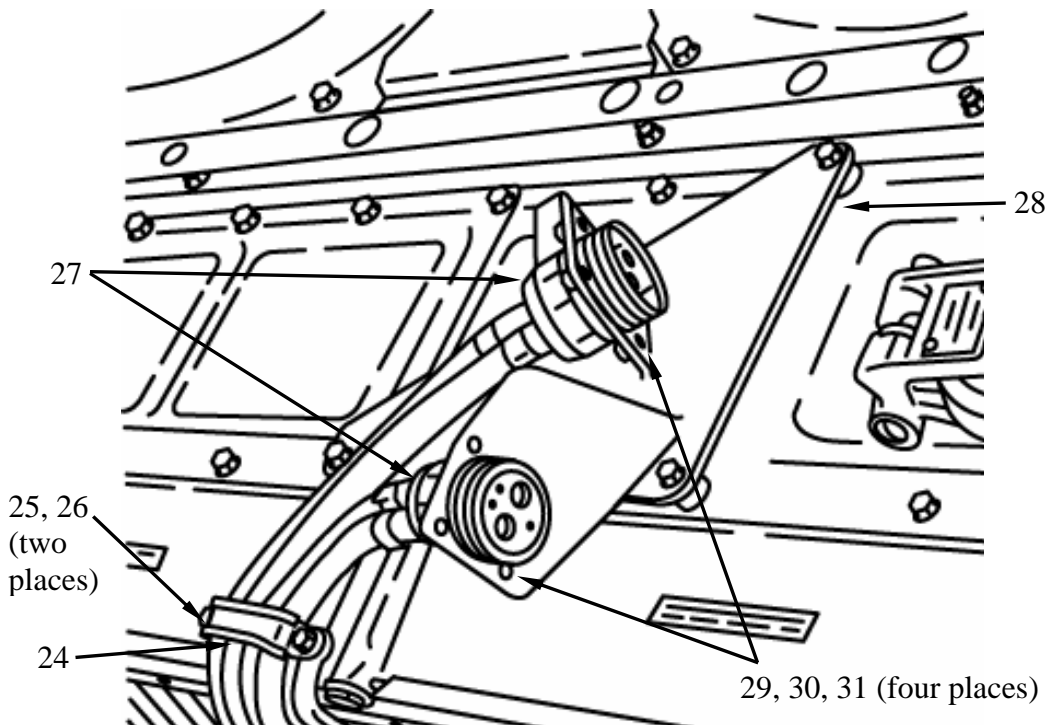
**REMOVAL (Continued)**

5. Remove starter wiring harness retaining straps (24) along cooler frame.
  - a. Remove six screws (25) with lock washers (26) and three retaining straps (24). Discard lock washers.



**REMOVAL (Continued)**

6. Remove starter wiring harness connectors (27) from upper bracket (28).
  - a. Remove screws (25) with lock washers (26) and remove remaining retaining strap (24). Discard lock washers.
  - b. Remove four slotted head machine screws (29) with lock washers (30), and nuts (31) to remove connectors (27) from starter upper wiring mounting bracket (28). Discard lock washers.

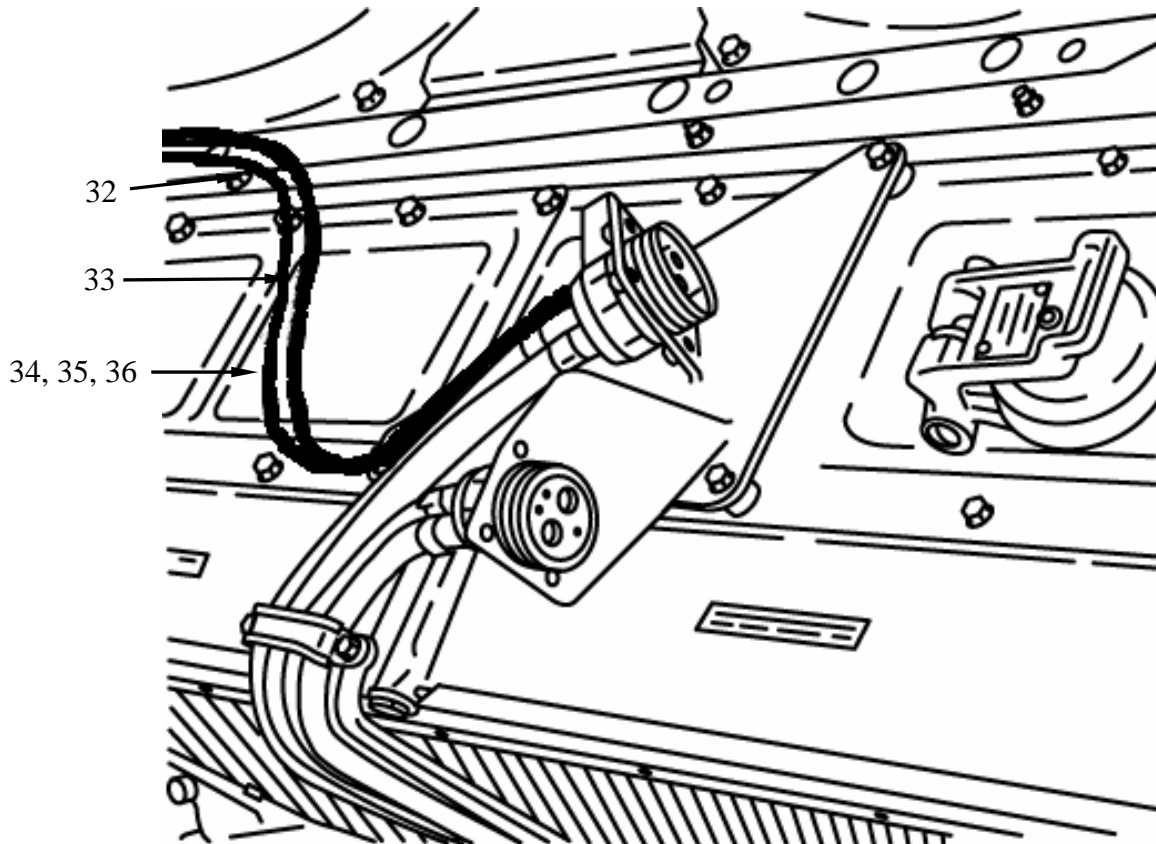


**REMOVAL (Continued)****NOTE**

**For smoke generation systems with dual-solenoid configuration,  
harness removal instructions are covered in steps 7 and 8.**

**For smoke generation systems with single-solenoid configuration,  
harness removal instructions are covered in steps 9 and 10.**

7. Remove dust detector (32) and smoke generator leads (33) on models with dual-solenoid smoke generation systems.
  - a. Remove assembled washer screws (34), loop clamps (35) and tie wraps (36) securing dust detector (32) and smoke generator (33) leads.

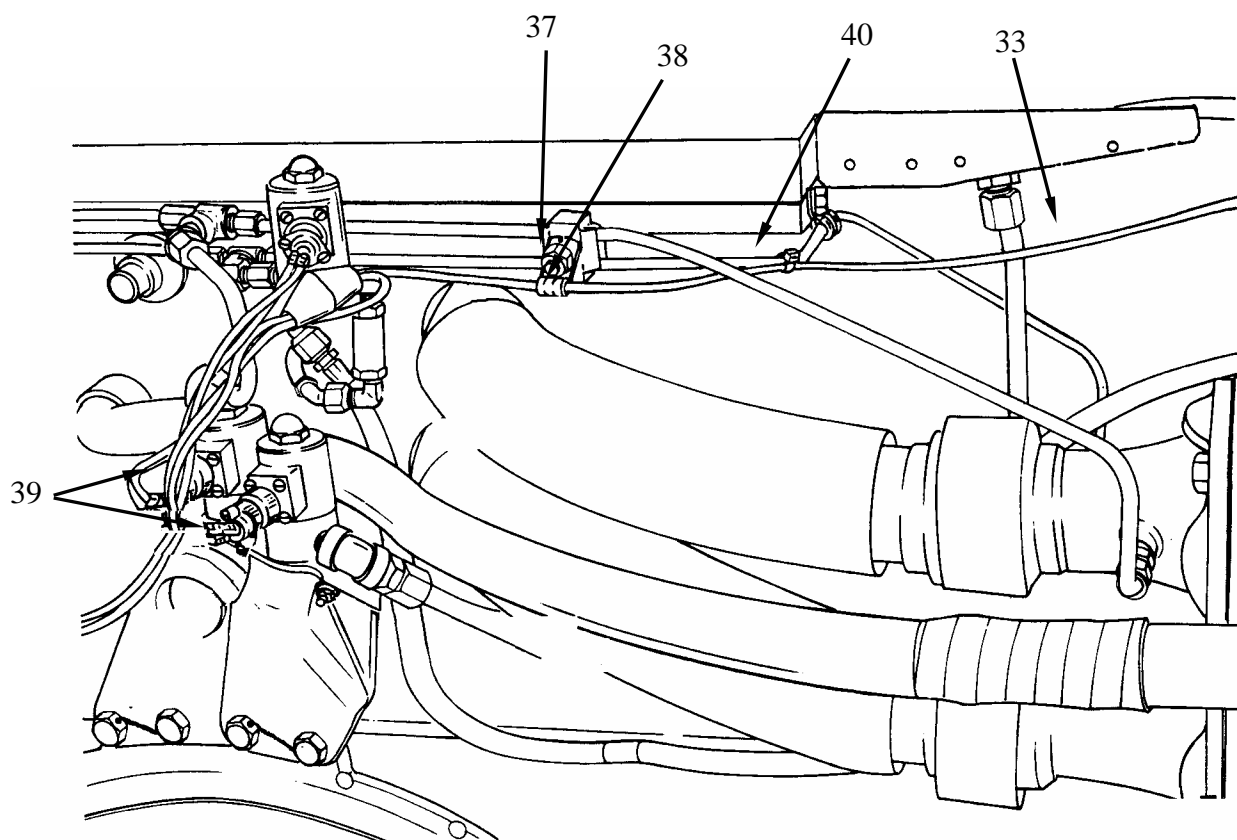


**REMOVAL (Continued)****NOTE**

**For smoke generation systems with dual-solenoid configuration,  
harness removal instructions are covered in steps 7 and 8.**

**For smoke generation systems with single-solenoid configuration,  
harness removal instructions are covered in steps 9 and 10.**

8. Remove smoke generator lead (33) on models with dual-solenoid smoke generation systems.
  - a. Remove self-locking nut (37) and loop clamp (38) for dust detector and smoke generator leads. Discard self-locking nut.
  - b. Remove connectors at smoke generator solenoids (39).
  - c. Cut and remove tie wraps (40) as needed.



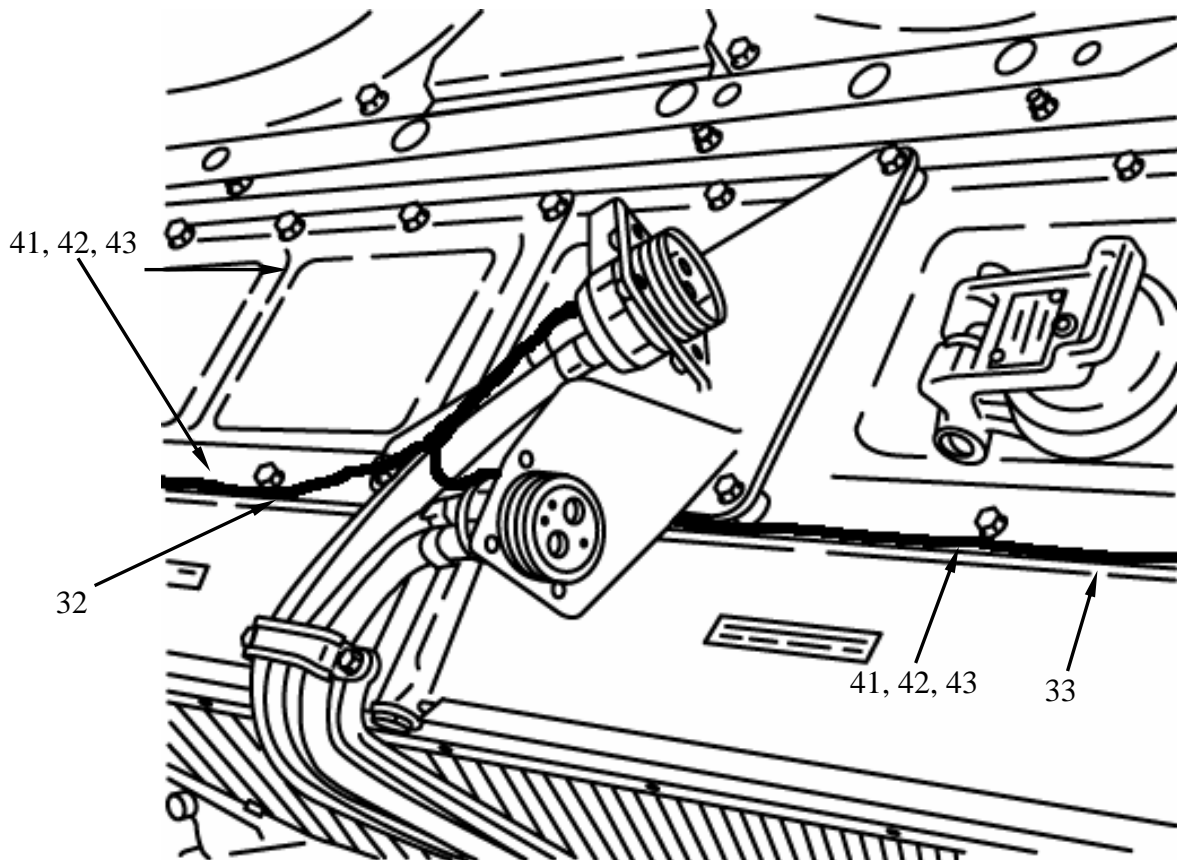


**REMOVAL (Continued)****NOTE**

**For smoke generation systems with single-solenoid configuration,  
harness removal instructions are covered in steps 9 and 10.**

**For smoke generation systems with dual-solenoid configuration,  
harness removal instructions are covered in steps 7 and 8.**

9. Remove dust detector (32) and smoke generator leads (33) on models with single-solenoid smoke generation systems.
  - a. Remove assembled washer screws (41), loop clamps (42) and tie wraps (43) securing dust detector (32) and smoke generator (33) leads.



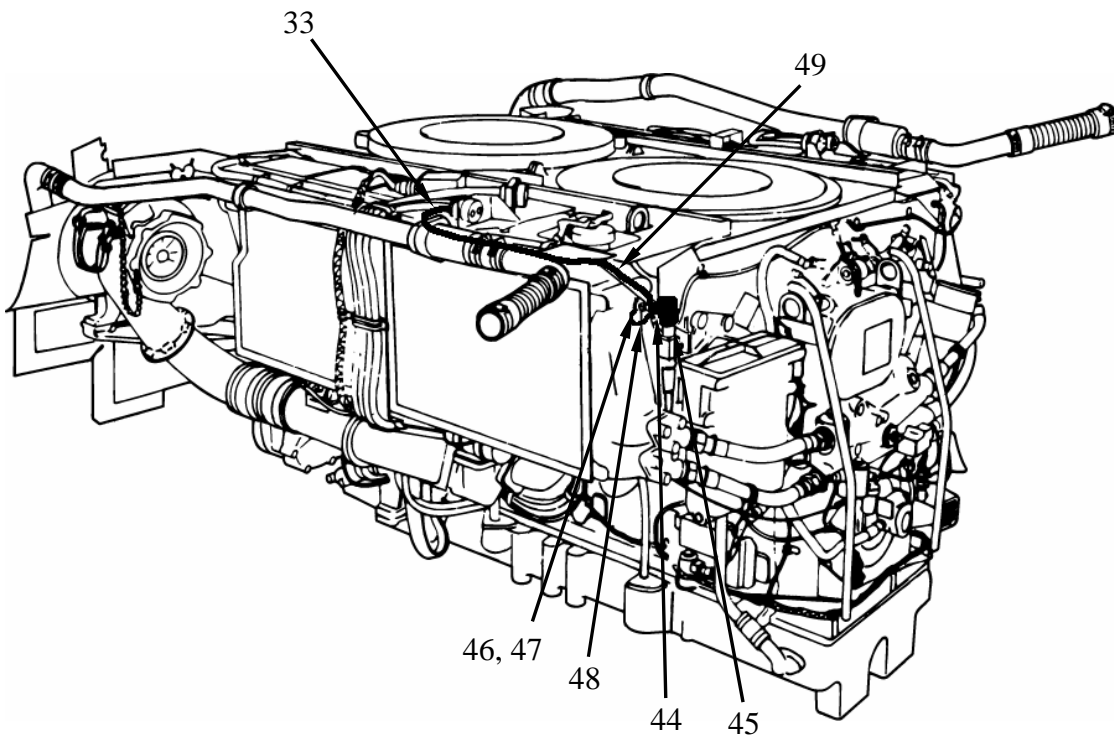
REMOVAL (Continued)

NOTE

For smoke generation systems with single-solenoid configuration, harness removal instructions are covered in steps 9 and 10.

For smoke generation systems with dual-solenoid configuration, harness removal instructions are covered in steps 7 and 8.

10. Remove single-solenoid smoke generator harness lead (33).
  - a. Remove connector (44) at smoke generator solenoid (45).
  - b. Remove screw (46) with lock washer (47) securing ground lead (48). Discard lock washer.
  - c. Clip and remove tie wraps (49) as needed.



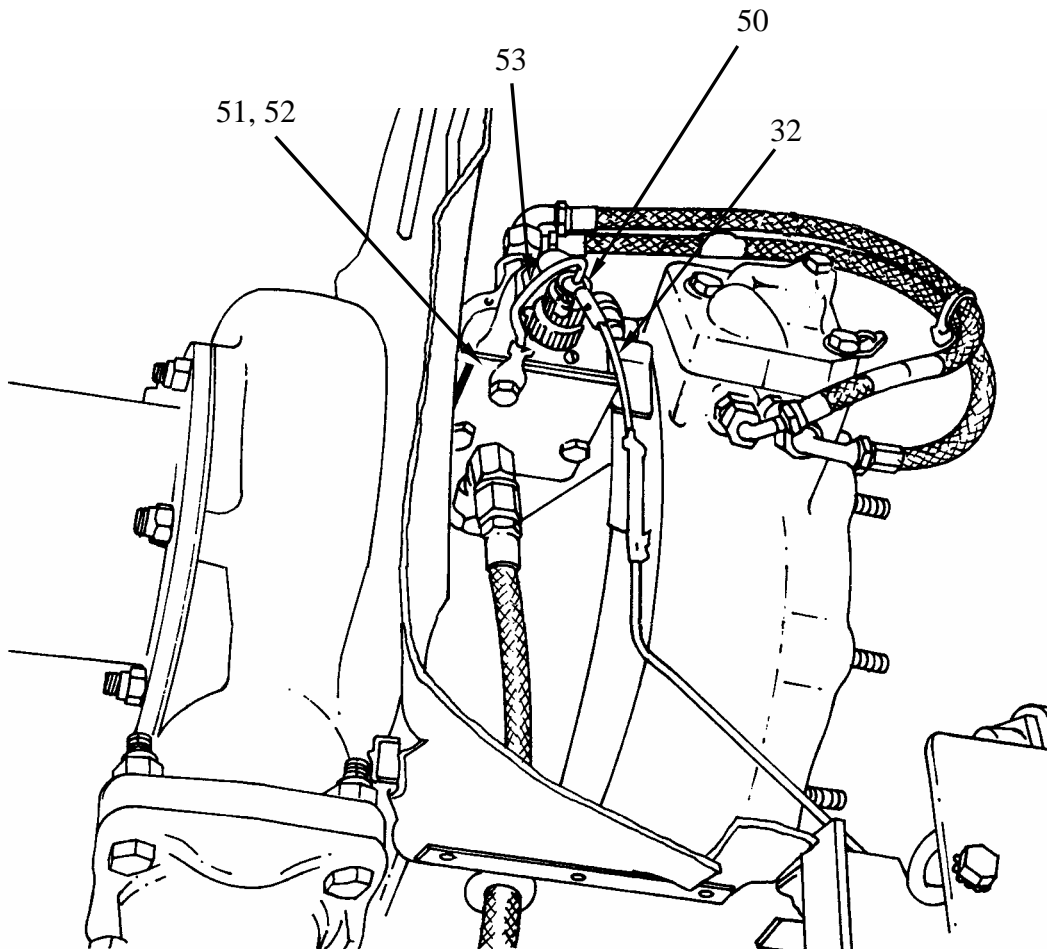
**REMOVAL (Continued)**

11. Remove dust detector lead (32) for both dual and single solenoid smoke generator applications.

**NOTE**

**Dust detector harnesses disconnect in the same fashion between left and right bank. Only the right bank is illustrated.**

- a. Disconnect electrical connectors (50).
- b. Remove screws (51) and lock washers (52) securing dust detector ground lead (53). Discard lock washers.



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**STARTER/ SMOKE GENERATOR/ DUST DETECTOR WIRING HARNESS REPLACEMENT,  
LVPM CRANKCASE MOUNTED (2CA, 2DA) (PN 11655456, 11682726) 0061 00**

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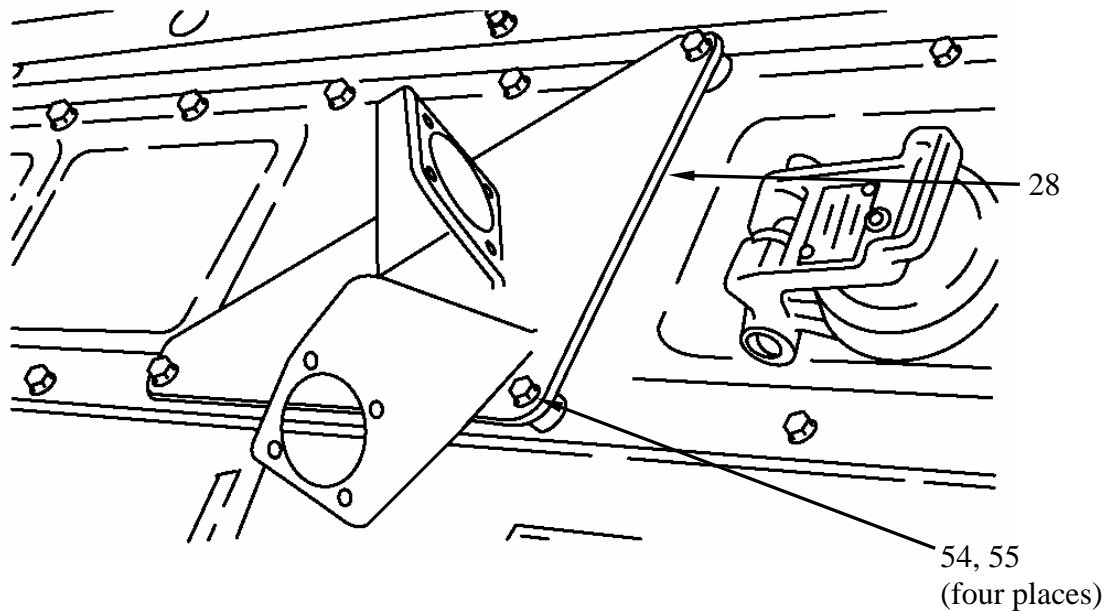
**REMOVAL (Continued)**

12. Remove starter harness upper bracket (28).
  - a. Remove four screws (54) with lock washers (55) and disconnect starter upper wiring mounting bracket (28). Discard lock washers.

**NOTE**

**If the starter upper wiring bracket (28) is unserviceable, low voltage protection module kit, 12254381, should be installed.**

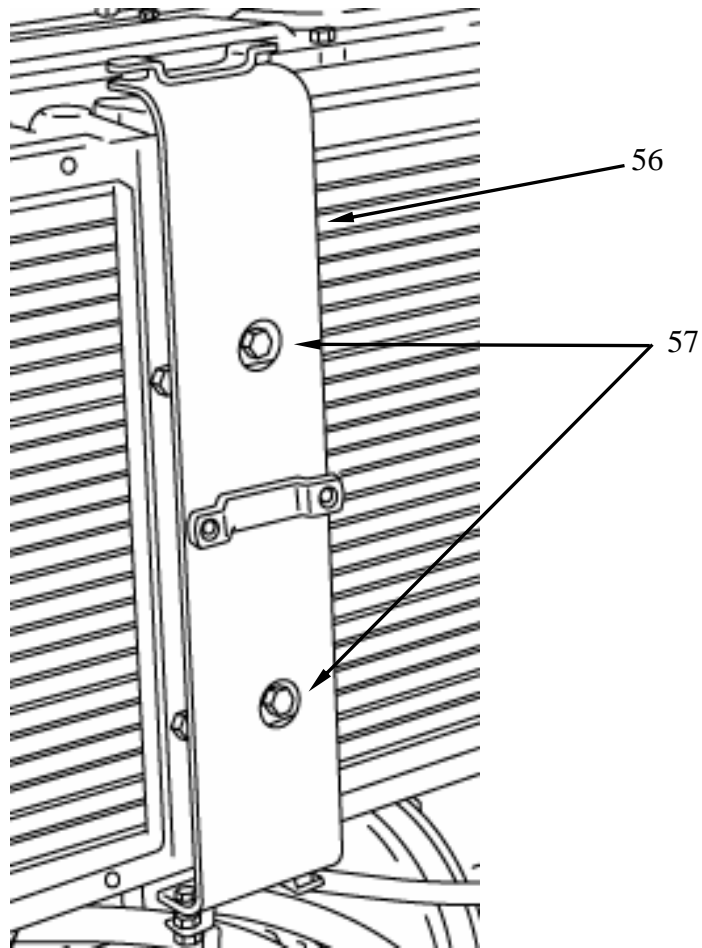
**Engineering Release Record (EER) CO-G6682 authorizes this modification kit to provide a replacement starter upper wiring bracket and to relocate the low voltage protection module to the starter upper wiring bracket (28).**



**REMOVAL (Continued)**

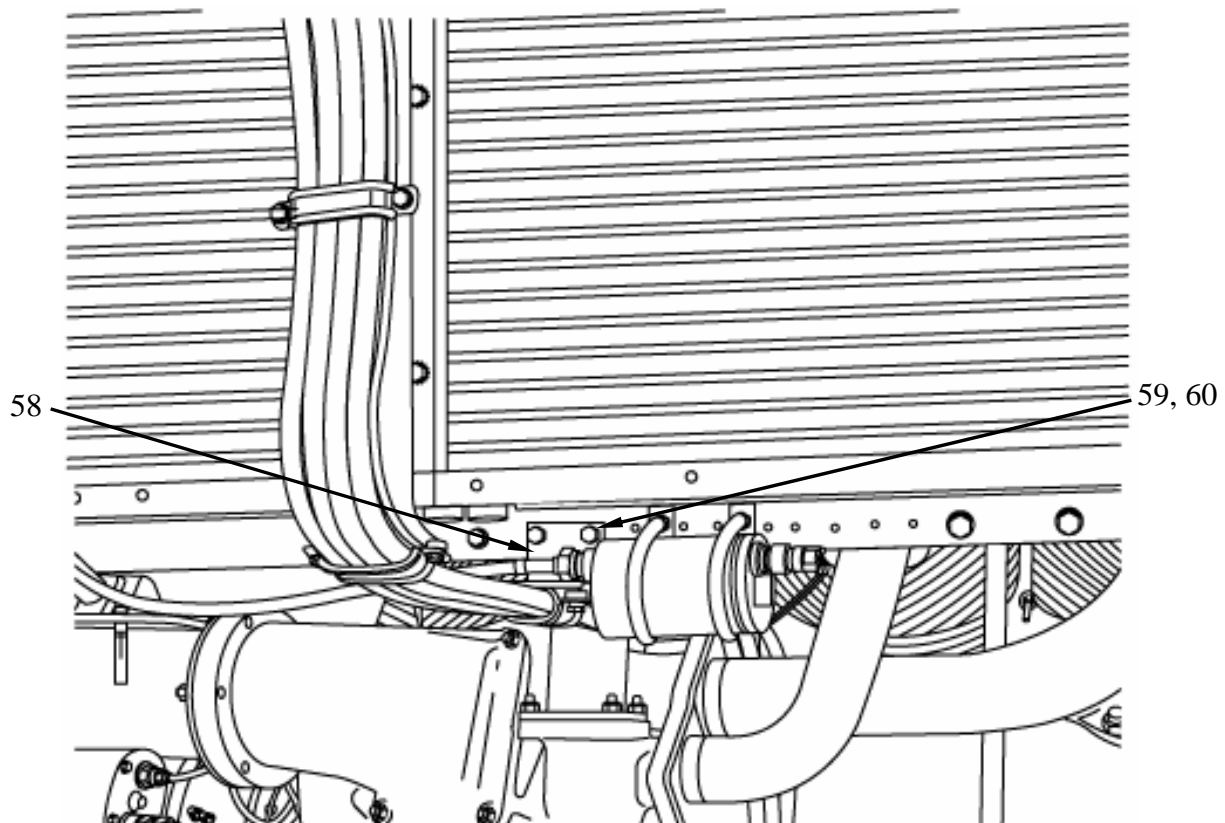
13. Remove starter harness bracket at oil cooler (56).

- a. Remove two assembled washer bolts (57) and remove starter harness bracket (56).



**REMOVAL (Continued)**

14. Remove starter harness lower bracket (58).
  - a. Remove two screws (59) with self-locking nuts (60) and remove starter harness bracket assembly (58).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

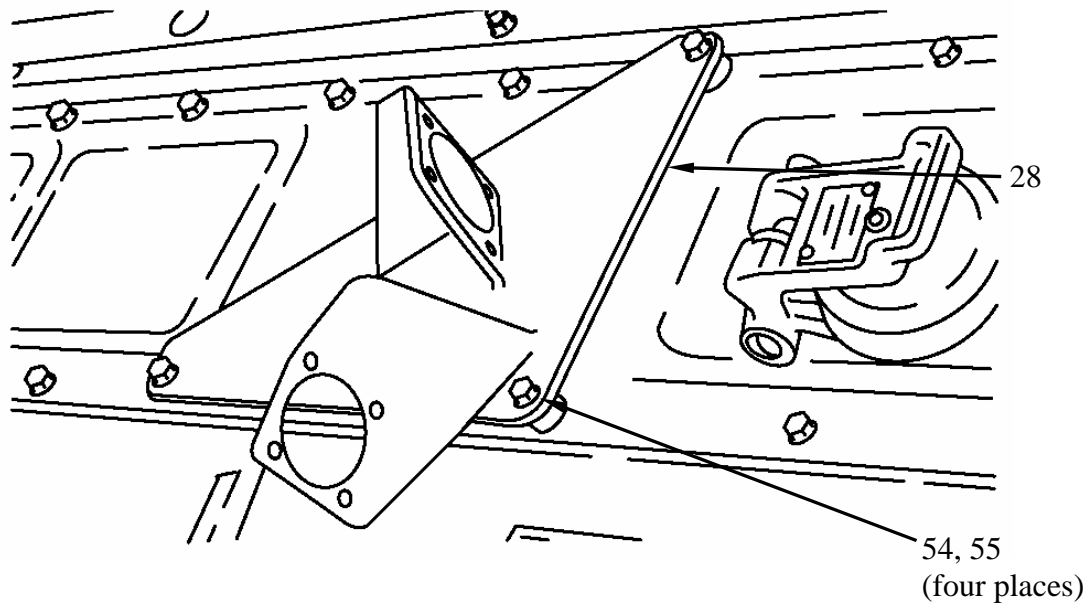
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness and Harness and Repair.

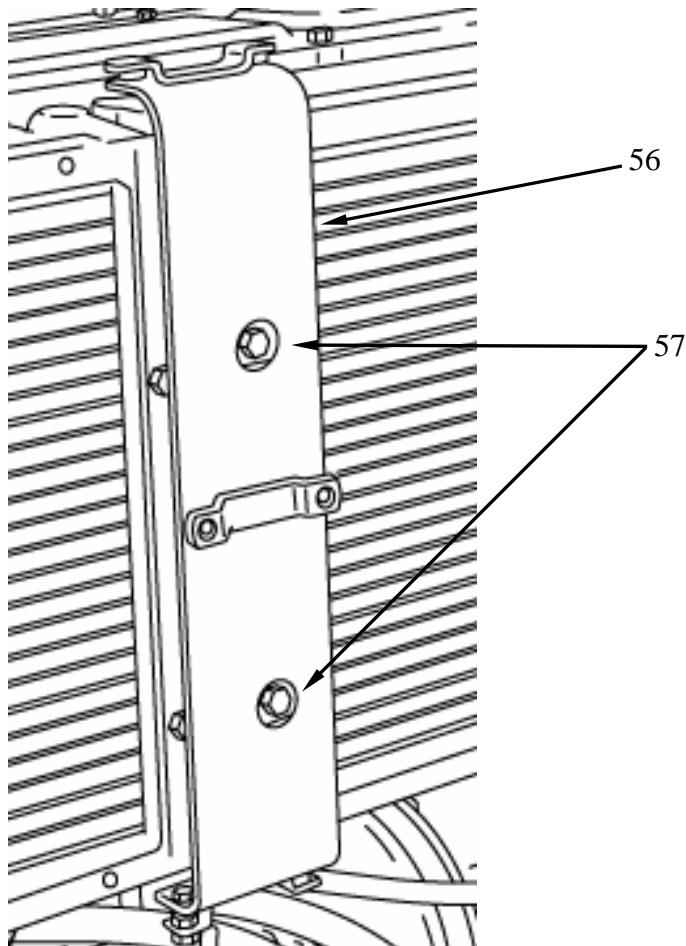
**INSTALLATION**

1. Install starter upper wiring harness bracket (28).
  - a. Install four screws (54) and new lock washers (55) (item 86, WP 0175).



**INSTALLATION (Continued)**

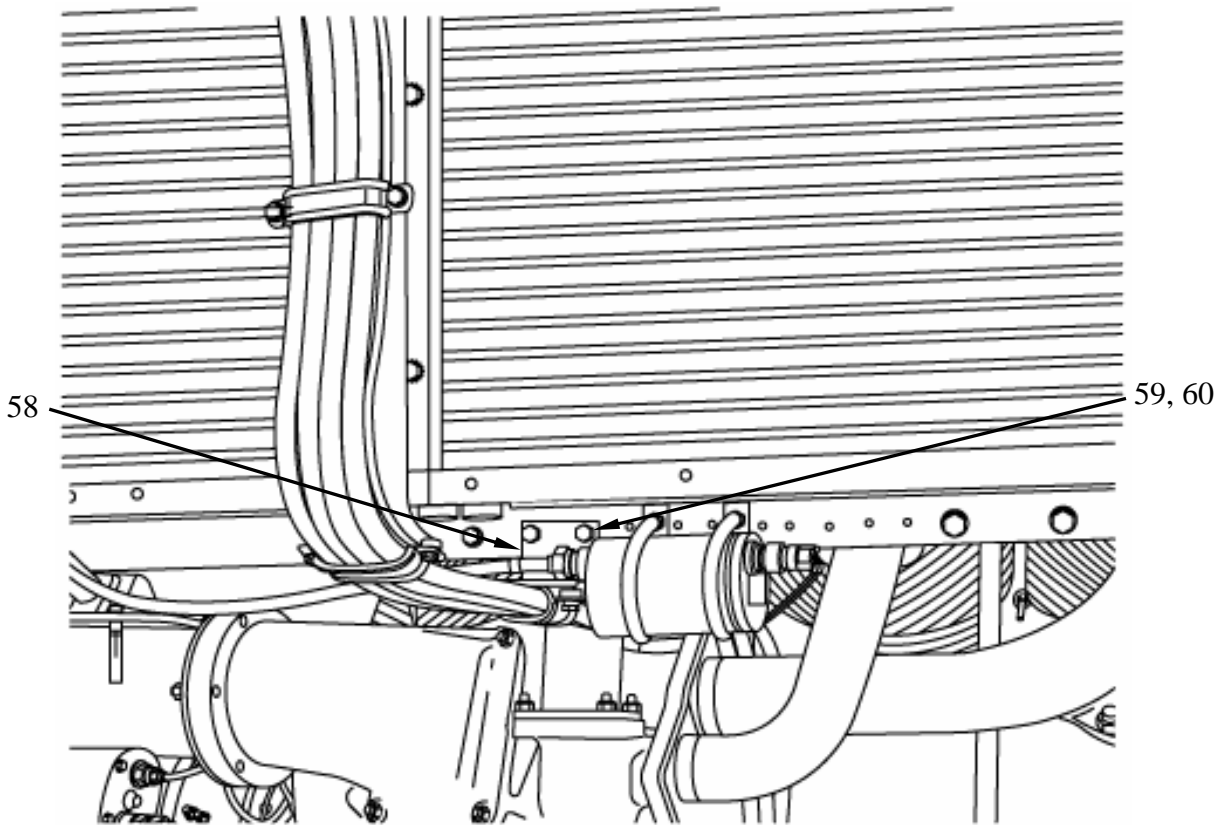
2. Install starter wiring harness bracket (56) at oil cooler.
  - a. Position starter harness bracket (56) in position.
  - b. Install two assembled washer bolts (57).





**INSTALLATION (Continued)**

3. Install starter harness lower bracket (58).
  - a. Install starter harness bracket assembly (58) using two screws (59) with new self-locking nuts (60) (item 33, WP 0175).



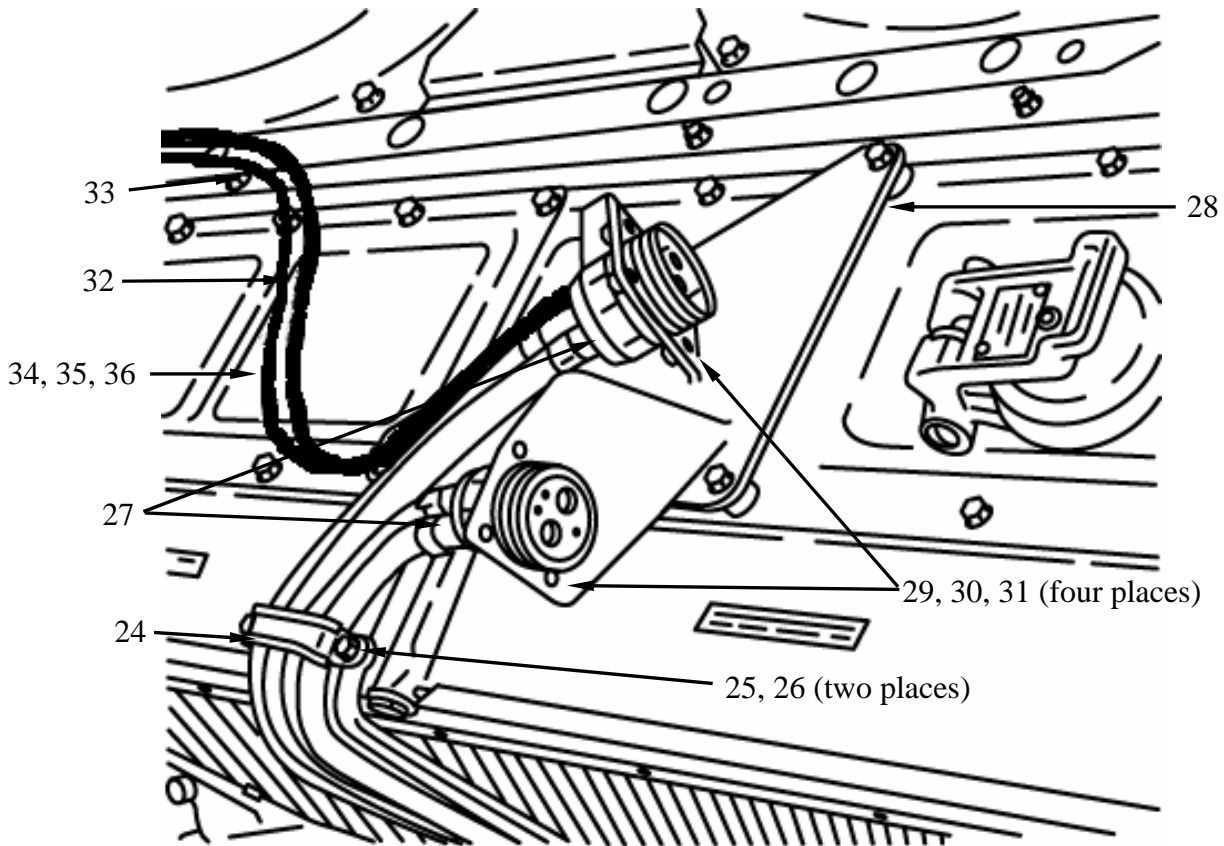
INSTALLATION (Continued)

NOTE

**For smoke generation systems with dual-solenoid configuration, harness installation instructions are covered in steps 4 and 5.**

**For smoke generation systems with single-solenoid configuration, harness installation instructions are covered in steps 6 and 7.**

4. Install smoke generator/dust detector leads (32, 33) and starter harnesses (27) on models with dual-solenoid smoke generation system.
  - a. Install wiring harness connectors (27) into bracket (28) using four slotted head machine screws (29), new lock washers (30) (item 91, WP 0175), and nuts (31).
  - b. Install retaining strap (24) on starter harnesses and secure bracket assembly using two screws (25) with new lock washers (26) (item 92, WP 0175).
  - c. Install assembled washer screws (34), loop clamps (35) and tie wraps (36) (item 80, WP 0175) as necessary securing dust detector (32) and smoke generation harness (33).

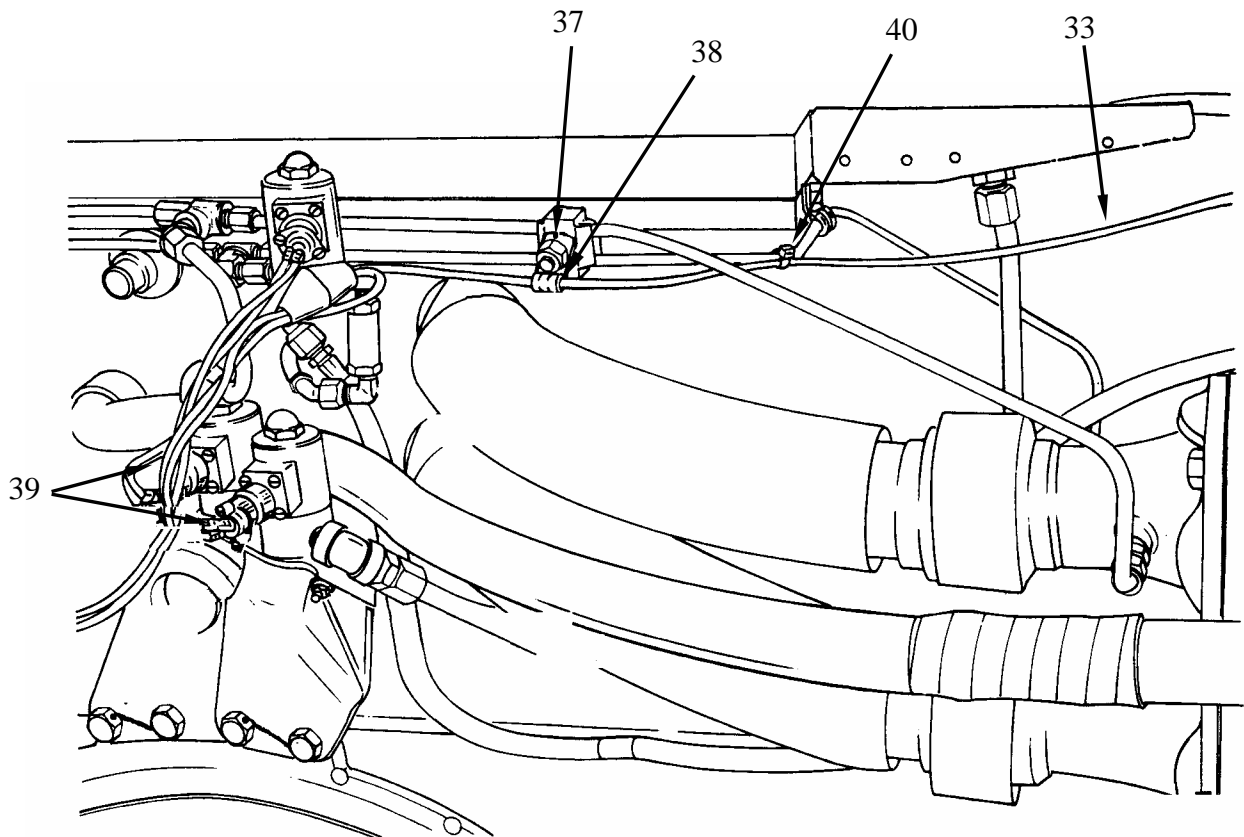


**INSTALLATION (Continued)****NOTE**

**For smoke generation systems with dual-solenoid configuration,  
harness installation instructions are covered in steps 4 and 5.**

**For smoke generation systems with single-solenoid configuration,  
harness installation instructions are covered in steps 6 and 7.**

5. Install smoke generator harness (33) on models with dual-solenoid smoke generation system.
  - a. Install connectors at smoke generator solenoids (39).
  - b. Install harness (33) into loop clamp (38) securing with new self-locking nut (37) (item 33, WP 0175).
  - c. Install tie wraps (40) (item 80, WP 0175) as needed.



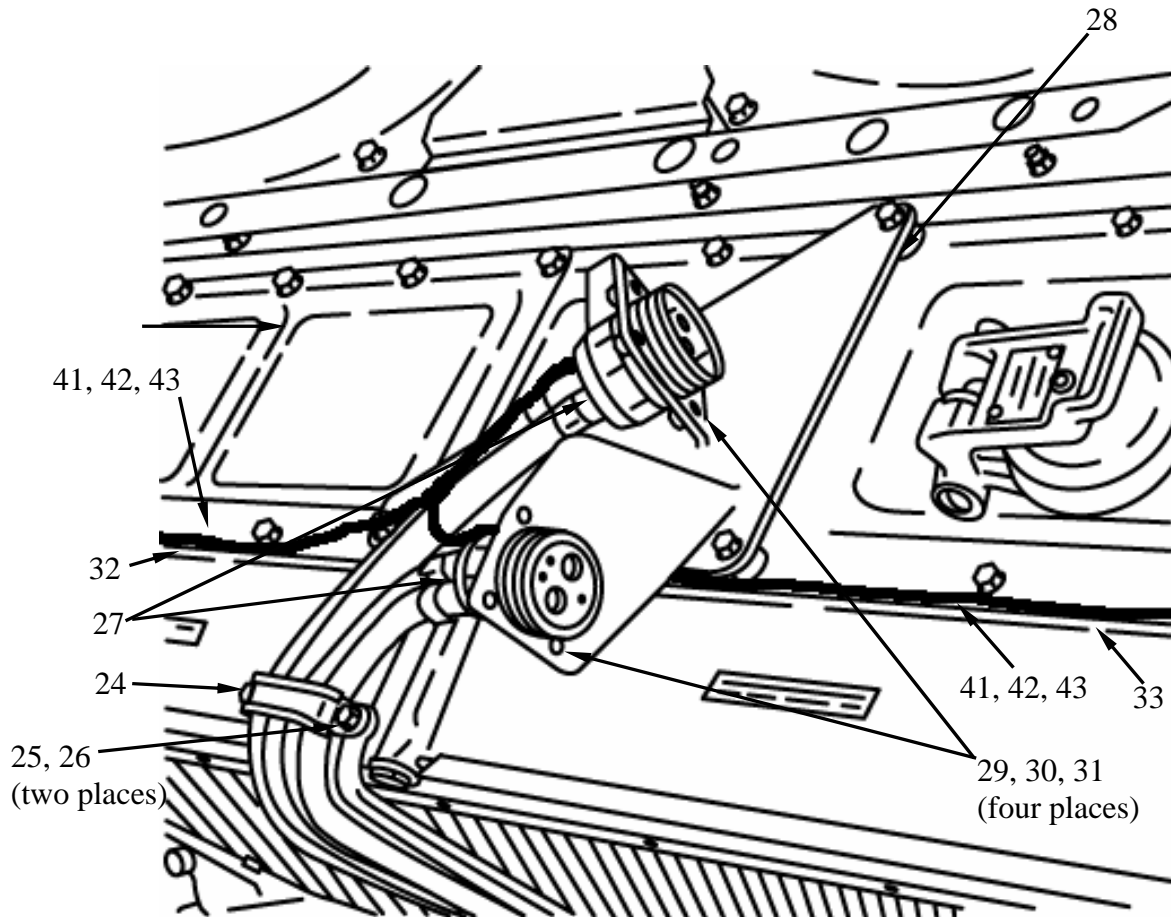
INSTALLATION (Continued)

NOTE

**For smoke generation systems with single-solenoid configuration, harness installation instructions are covered in steps 6 and 7.**

**For smoke generation systems with dual-solenoid configuration, harness installation instructions are covered in steps 4 and 5.**

6. Install smoke generator/dust detector leads (33, 34) and starter harnesses (27) on models with single-solenoid smoke generation system.
  - a. Install wiring harness connectors (27) into bracket (28) using four slotted head machine screws (29), new lock washers (30) (item 91, WP 0175), and nuts (31).
  - b. Install retaining strap (24) on starter harnesses and secure bracket assembly using two screws (25) with new lock washers (26) (item 92, WP 0175).
  - c. Install loop clamps (42), using assembled washer screws (41) as necessary to secure smoke generator harness (33) and dust detector harness (32).
  - d. Install tie wraps (43) (item 81, WP 0175) as necessary.

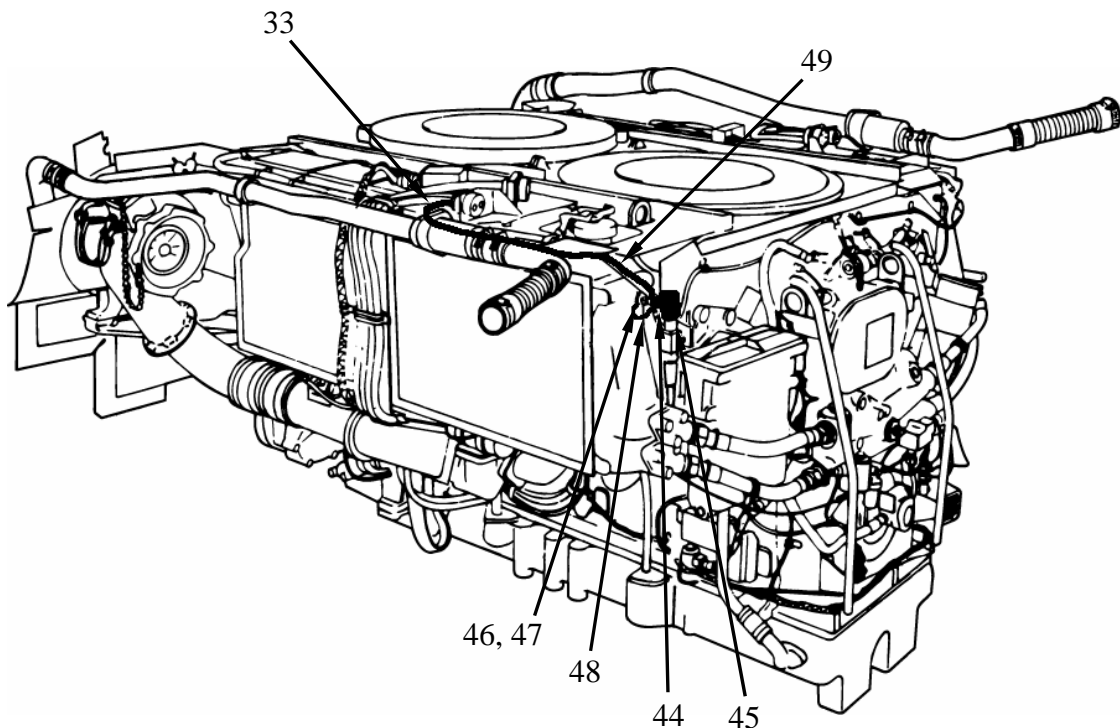


**INSTALLATION (Continued)****NOTE**

**For smoke generation systems with single-solenoid configuration,  
harness installation instructions are covered in steps 6 and 7.**

**For smoke generation systems with dual-solenoid configuration,  
harness installation instructions are covered in steps 4 and 5.**

7. Install single-solenoid smoke generator harness lead (33).
  - a. Install connector (44) at smoke generator solenoid (45).
  - b. Install screw (46) with new lock washer (47) (item 93, WP 0175) securing ground lead (48).
  - c. Install loop clamps (54) with assembled washer screws (53).
  - d. Install tie wraps (49) (item 81, WP 0175) as necessary.



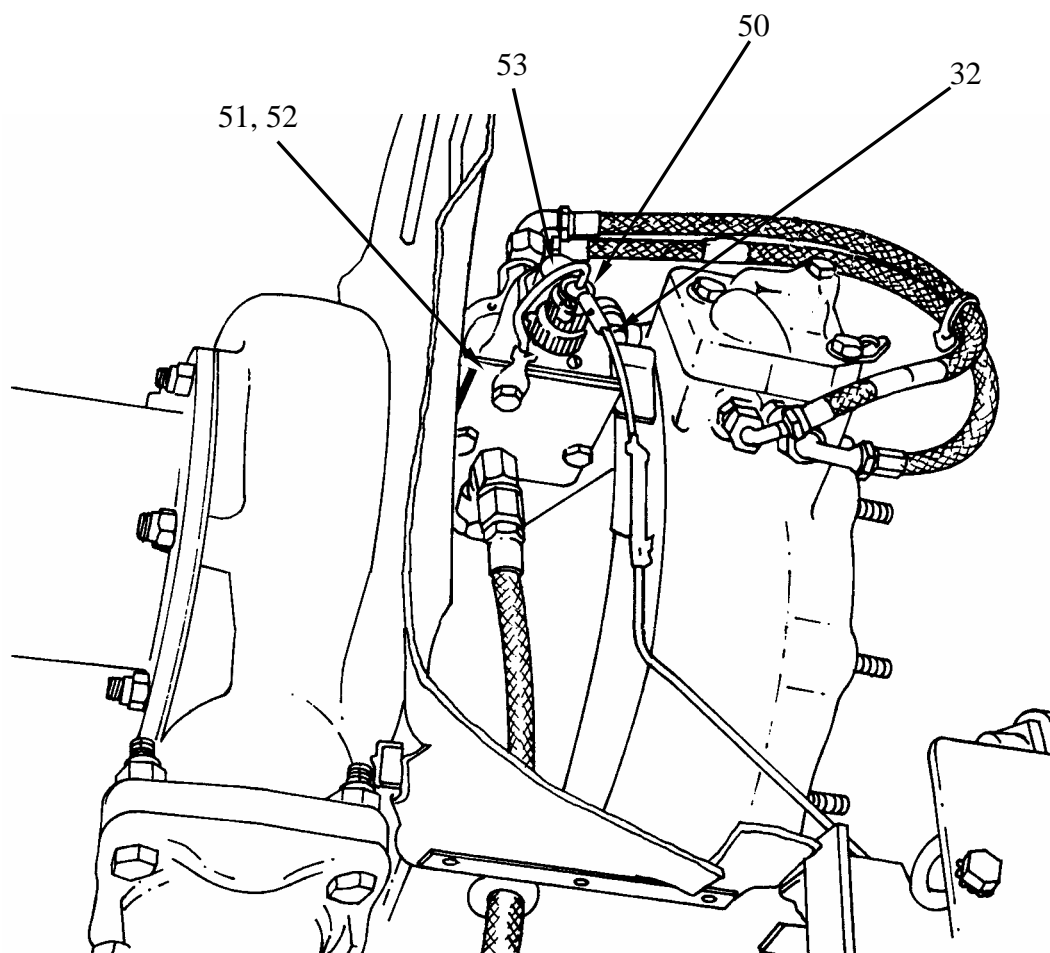
**INSTALLATION (Continued)**

8. Install dust detector lead (32) for both dual and single solenoid smoke generator applications.

**NOTE**

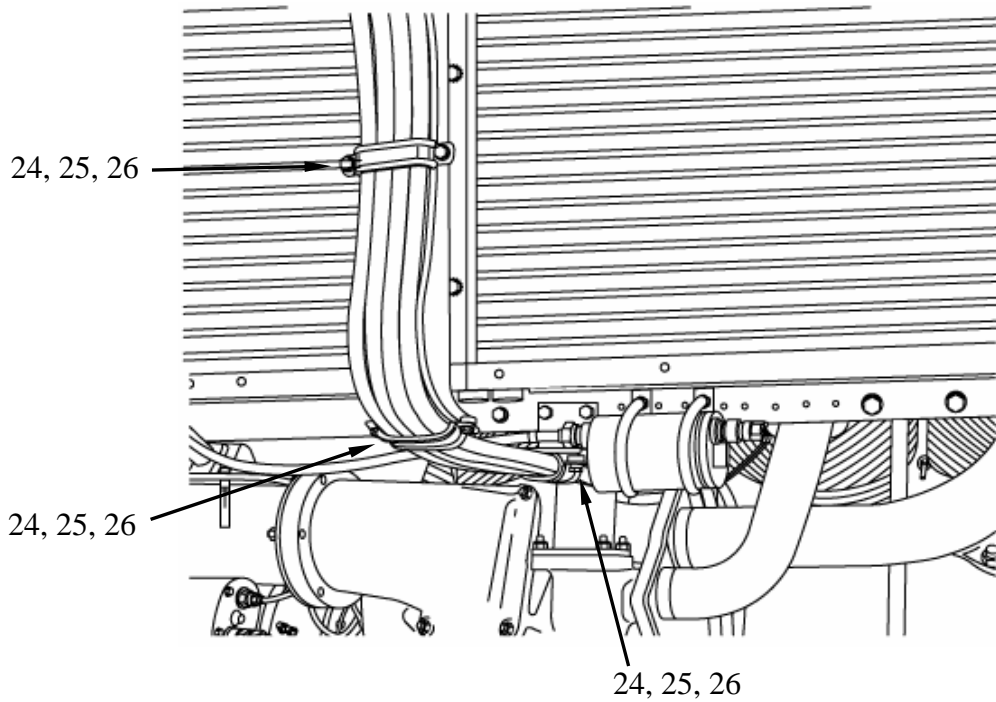
**Dust detector harnesses connect in the same fashion between left and right bank. Only the right bank is illustrated.**

- a. Install connectors (50) at left and right dust detectors.
- b. Install ground lead (53) using screws (51) with new lock washers (52) (item 93, WP 0175).



**INSTALLATION (Continued)**

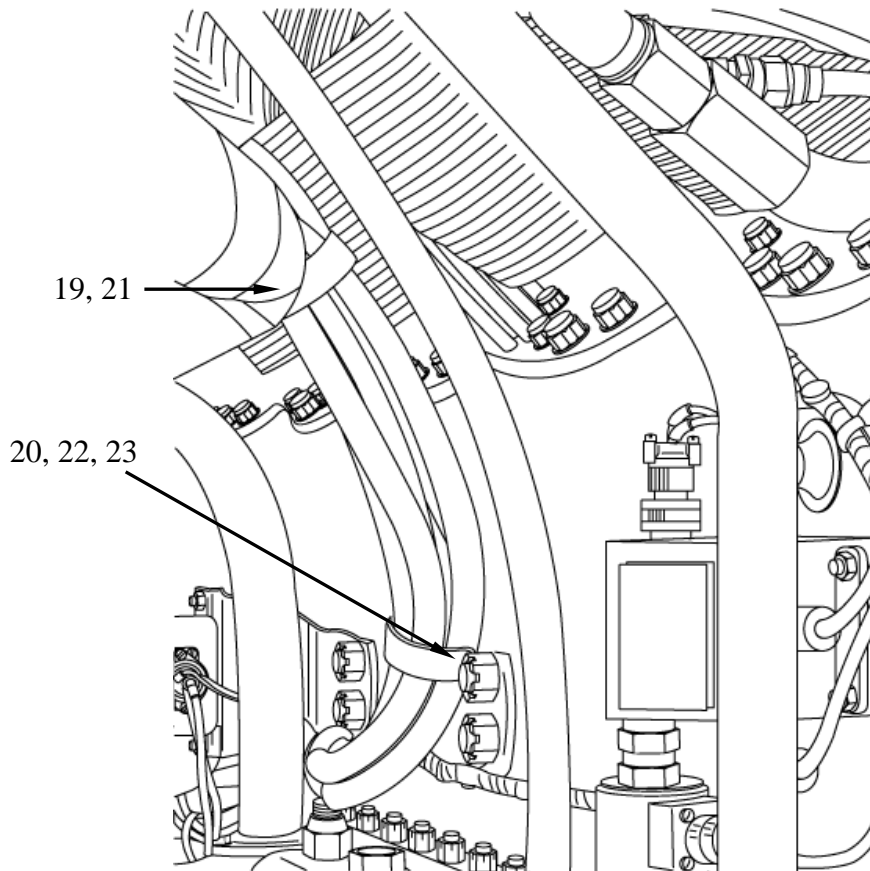
9. Install starter wiring harness retaining straps (24).
  - a. Secure wiring harnesses with three retaining straps (24) using six screws (25) and new lock washers (26) (item 92, WP 0175).



**INSTALLATION (Continued)**

10. Install intermediate loop clamps (19, 20).

- a. Install loop clamp (19) on starter harness and secure to intake manifold with screw and new lock washer (21) (item 89, WP 0175).
- b. Install loop clamp (20) on starter harness. Secure to crankcase using screw (22) with new lock washer (23) (item 93, WP 0175).



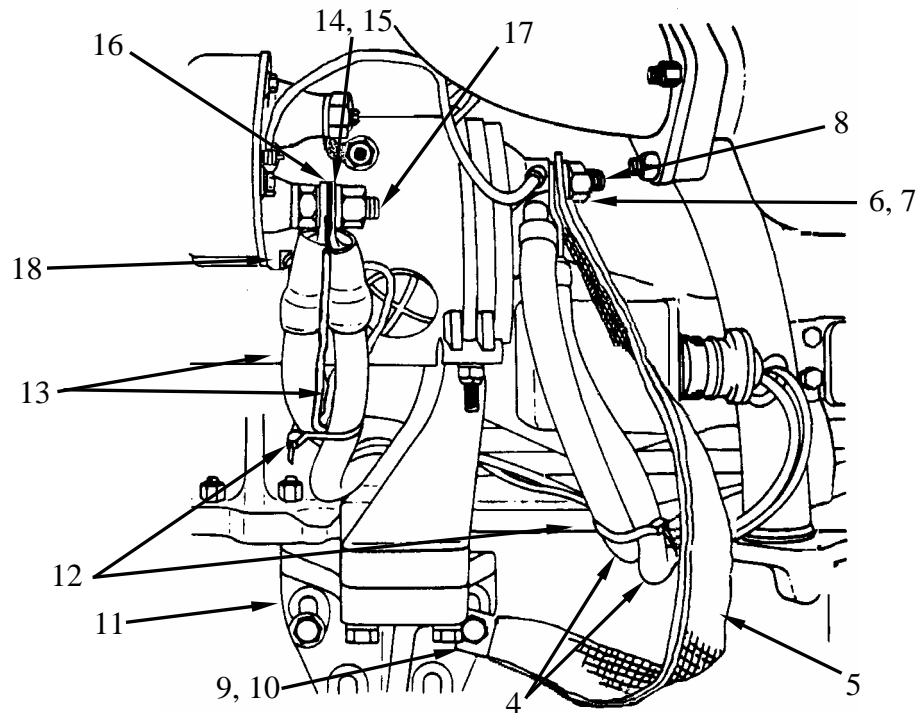


INSTALLATION (Continued)

NOTE

**Engine models with 300 ampere electrical systems have only one starter electrical ground lead (5).**

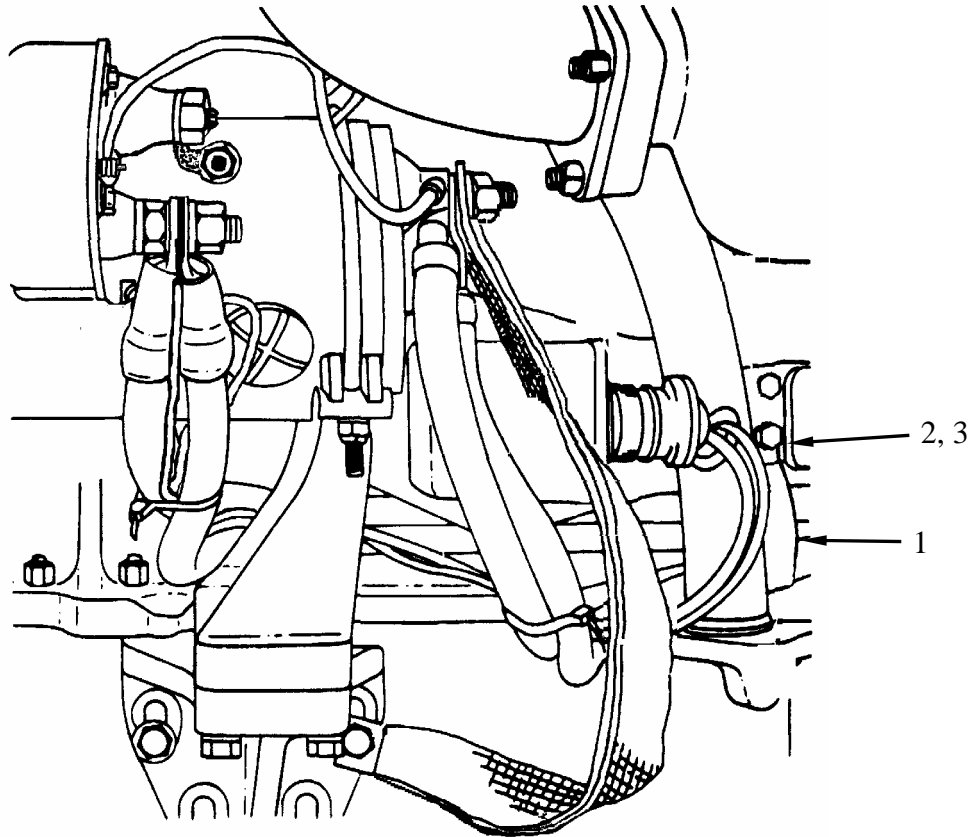
11. Install starter ground harnesses (4) and straps (5).
  - a. Remove nut (6) from starter ground terminal post (8).
  - b. Install two starter ground harness (4) and two ground straps (5).
  - c. Reinstall nut (6) and lock washer (7).
  - d. Install ground straps (5) at starter mounting base (11) using screw (9) with two flat washers (10).
  - e. Install tie wraps (12) (item 81, WP 0175) as necessary.
12. Install starter positive harness (13).
  - a. Remove nut (14) from starter positive post (17).
  - b. Install two starter harness (13), and starter low voltage protection module harness terminal (16).
  - c. Reinstall nut (14) and lock washer (15) onto starter positive post (17).
  - d. Install starter low voltage protection module harness using machine screw (18).
  - e. Install tie wraps (12) (item 81, WP 0175) as necessary.



**INSTALLATION (Continued)**

13. Install loop clamp (1).

- h. Install loop clamp (1) on starter harness and wiring harness and secure to crankcase with screw (2) and new lock washer (3) (item 89, WP 0175).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (6) (item 90, WP 0175)

Lock washer (6) (item 91, WP 0175)

Lock washer (1) (item 108, WP 0175)

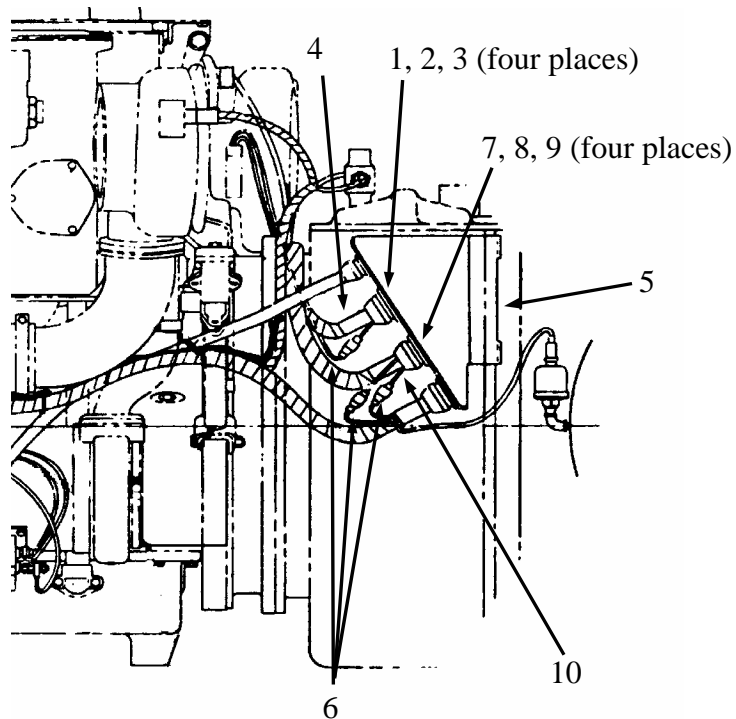
Tie wrap (as needed) (item 81, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

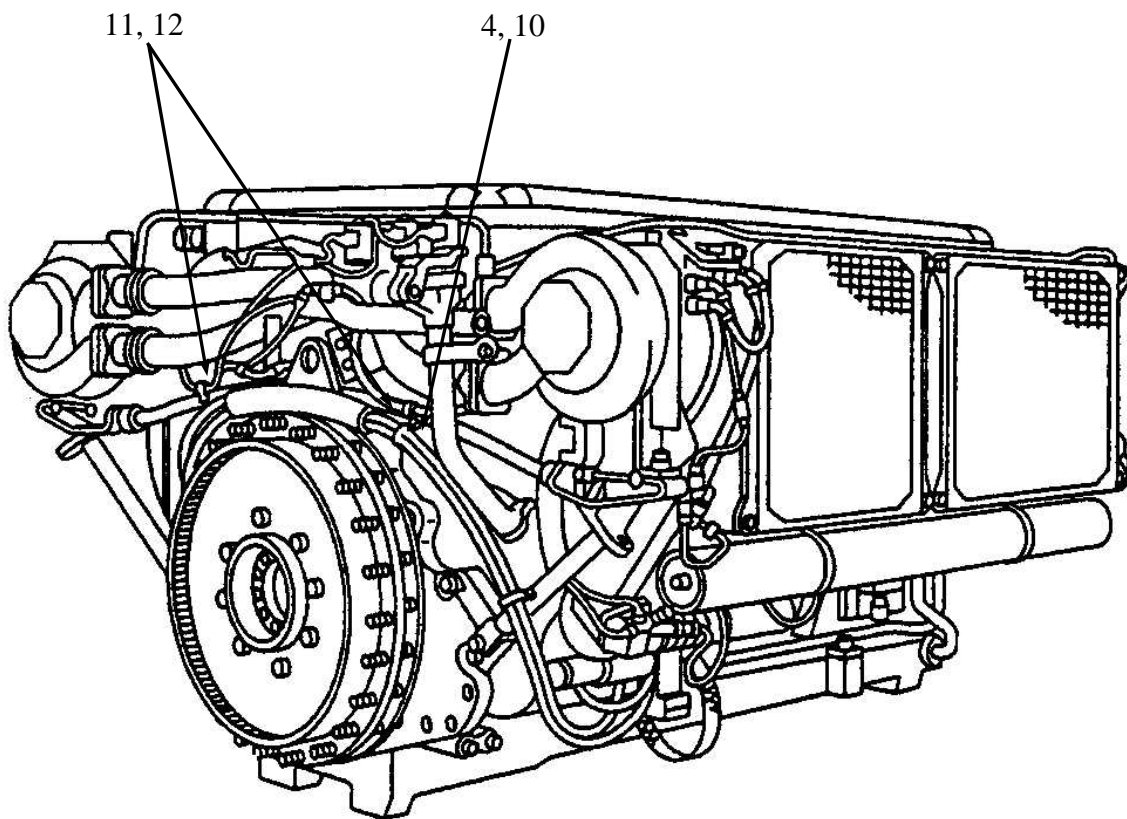
**REMOVAL**

1. Remove starter wiring harness.
  - a. Remove four machine screws (1) with nuts (2) and lock washers (3) securing starter ground cables (4) to engine disconnect bracket (5). Discard lock washers.
  - b. Disconnect plug-in harness connections (6).
  - c. Remove four machine screws (7) with nuts (8) and lock washers (9) securing starter positive cables (10) to the engine disconnect bracket (5). Discard lock washers.



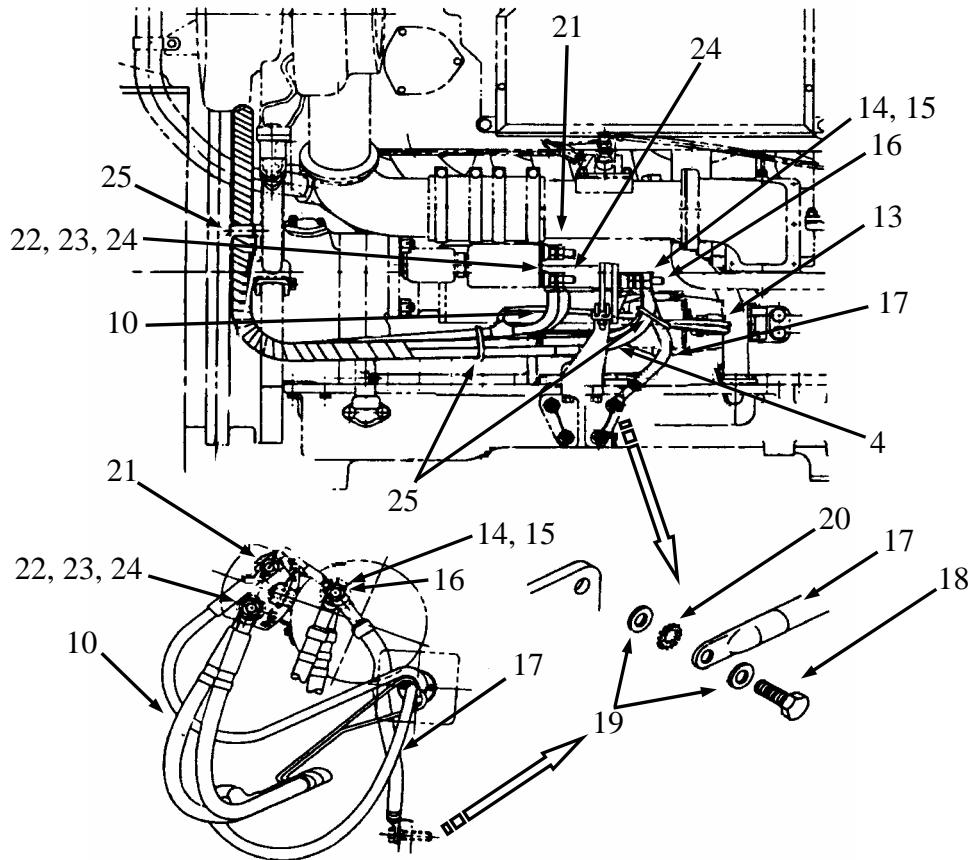
**REMOVAL (Continued)**

1. Remove starter wiring harness (continued).
  - d. Remove tie wraps (11) and loop clamps (12) as necessary to free cable assemblies (4, 10) along rear of engine.



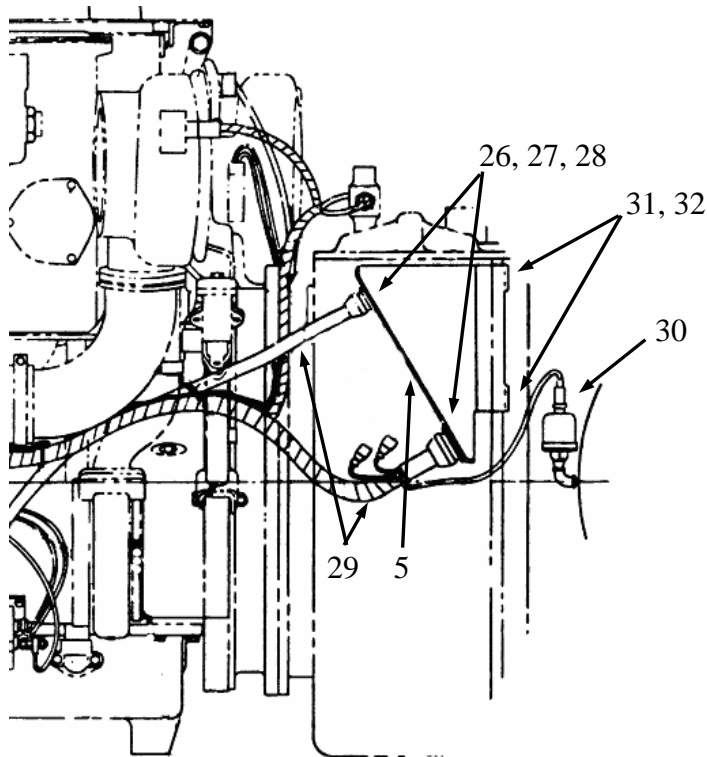
**REMOVAL (Continued)**

1. Remove starter wiring harness (continued).
  - e. Disconnect starter low voltage protection module cable connector (13).
  - f. Remove nut (14) with lock washer (15) from starter ground terminal post (16). Remove ground cables (4). Reinstall nut (14) and lock washer (15) for safe keeping.
  - g. Remove screw (18), two flat washers (19) and lock washer (20) securing ground cable (17). Discard star washer.
  - h. Remove low voltage protection module connection at starter solenoid (21).
  - i. Remove nut (22) with lock washer (23) from starter positive terminal post (24). Remove positive cables (10). Reinstall nut (22) and lock washer (23) for safe keeping.
  - j. Cut and remove tie wraps (25) on starter cables as required.



**REMOVAL (Continued)**

2. Remove engine disconnect bracket.
  - a. Remove four machine screws (26), with nuts (27) and lock washers (28) each from the two remaining electrical connectors (29) on the engine disconnect bracket (5). Discard lock washers.
  - b. Disconnect wire to transmission sending unit (30).
  - c. Remove two screws (31) with lock washers (32) retaining the engine disconnect bracket (5) to the transmission. Discard lock washers.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

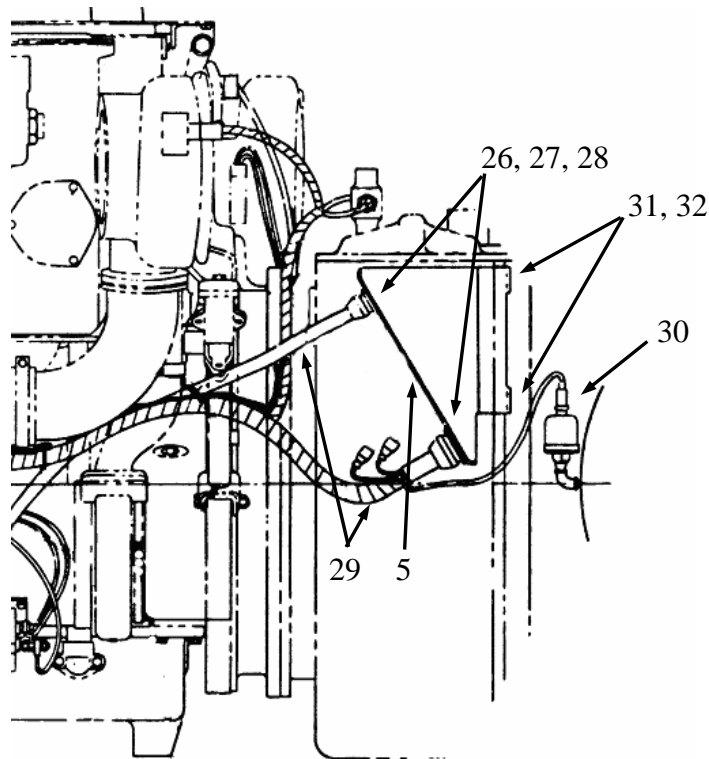
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0054 for Wiring Harness and Cable and Repair.

**INSTALLATION**

1. Install engine disconnect bracket.
  - a. Install engine disconnect bracket (5) to transmission using two screws (31) with new lock washers (32) (item 91, WP 0175).
  - b. Install two wiring harness connectors (29) onto engine disconnect bracket (5) using four machine screws (26) with nuts (27) and new lock washers (28) (item 90, WP 0175).
  - c. Install wire to transmission sending unit (30).

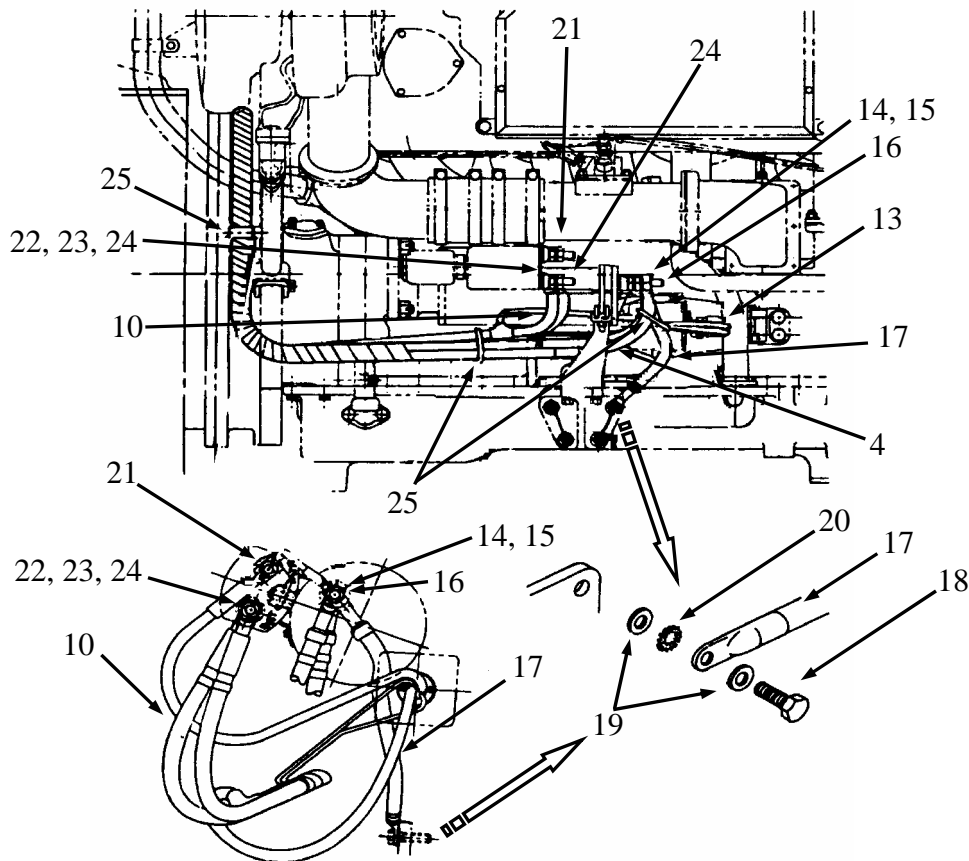




**INSTALLATION (Continued)**

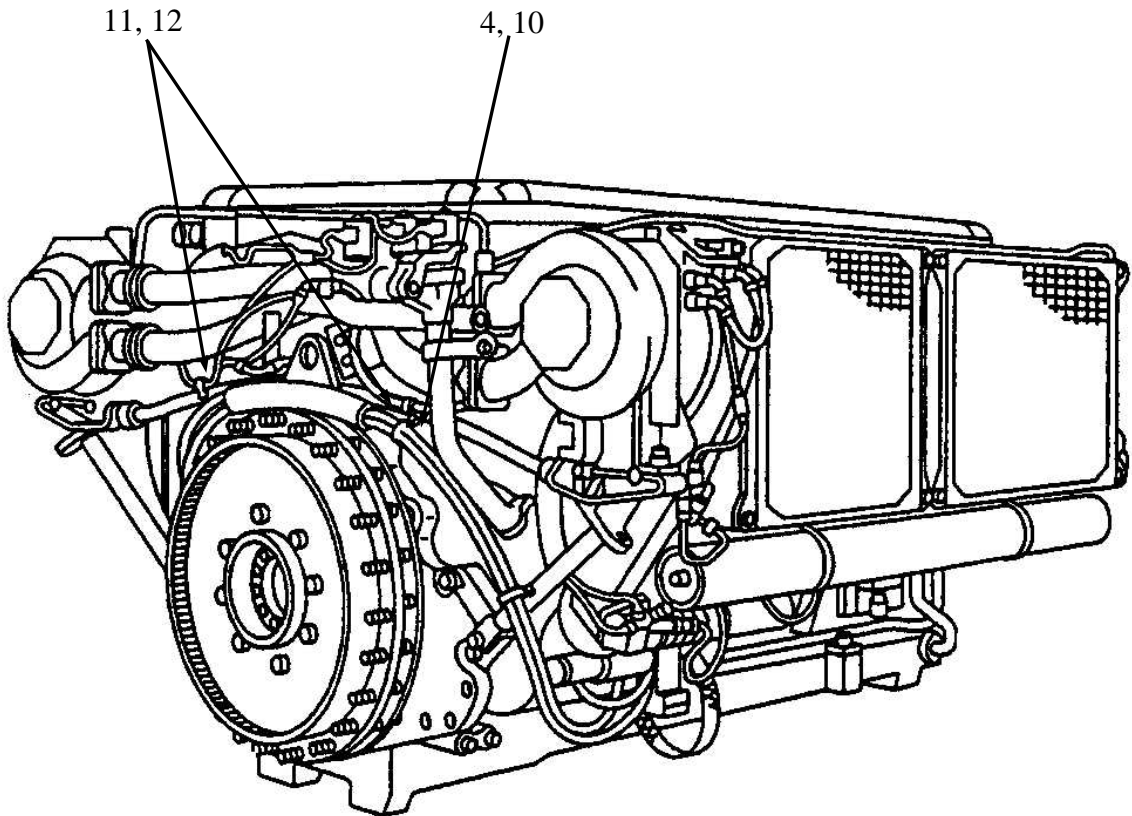
2. Install starter wiring harness.

- a. Remove nut (14) from starter ground terminal post (16).
- b. Install starter ground cables (4) onto starter ground terminal post (16) reinstalling nut (14) and lock washer (15).
- c. Remove nut (22) from starter positive terminal post (24).
- d. Install starter positive cables (10) onto starter positive terminal post (24) reinstalling nut (22) and lock washer (23).
- e. Install low voltage protection module lead (21) at starter solenoid.
- f. Install low voltage protection module connector (13).
- g. Install ground lead (17) to oil pan using screw (18), two flat washers (19) and new lock washer (20) (item 108, WP 0175).
- h. Install new tie wraps (25) (item 81, WP 0175) as necessary.



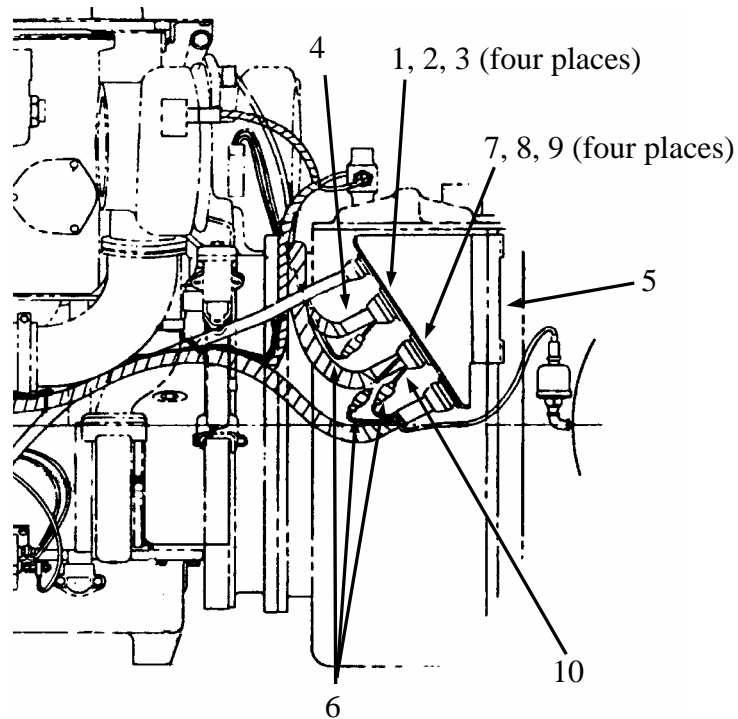
**INSTALLATION (Continued)**

2. Install starter wiring harness (continued)
  - i. Position starter cables (4, 10) across back of engine.
  - j. Install tie wraps (11) (item 81, WP 0175) and loop clamps (12) as necessary to secure starter cables (4, 10).



**INSTALLATION (Continued)**

2. Install starter wiring harness (continued).
  - k. Install ground cable (4) into engine disconnect bracket (5) using four machine screws (1), nuts (2), and new lock washers (3) (item 90, WP 0175).
  - m. Install positive cable (10) into engine disconnect bracket (5) using four machine screws (7), nuts (8), and new lock washers (9) (item 91, WP 0175).
  - n. Install plug-in harness connections (6).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (4) (item 90, WP 0175)

Lock washer (4) (item 86, WP 0175)

Lock washer (8) (item 92, WP 0175)

Lock washer (3) (item 93, WP 0175)

Self-locking nut (2) (item 33, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

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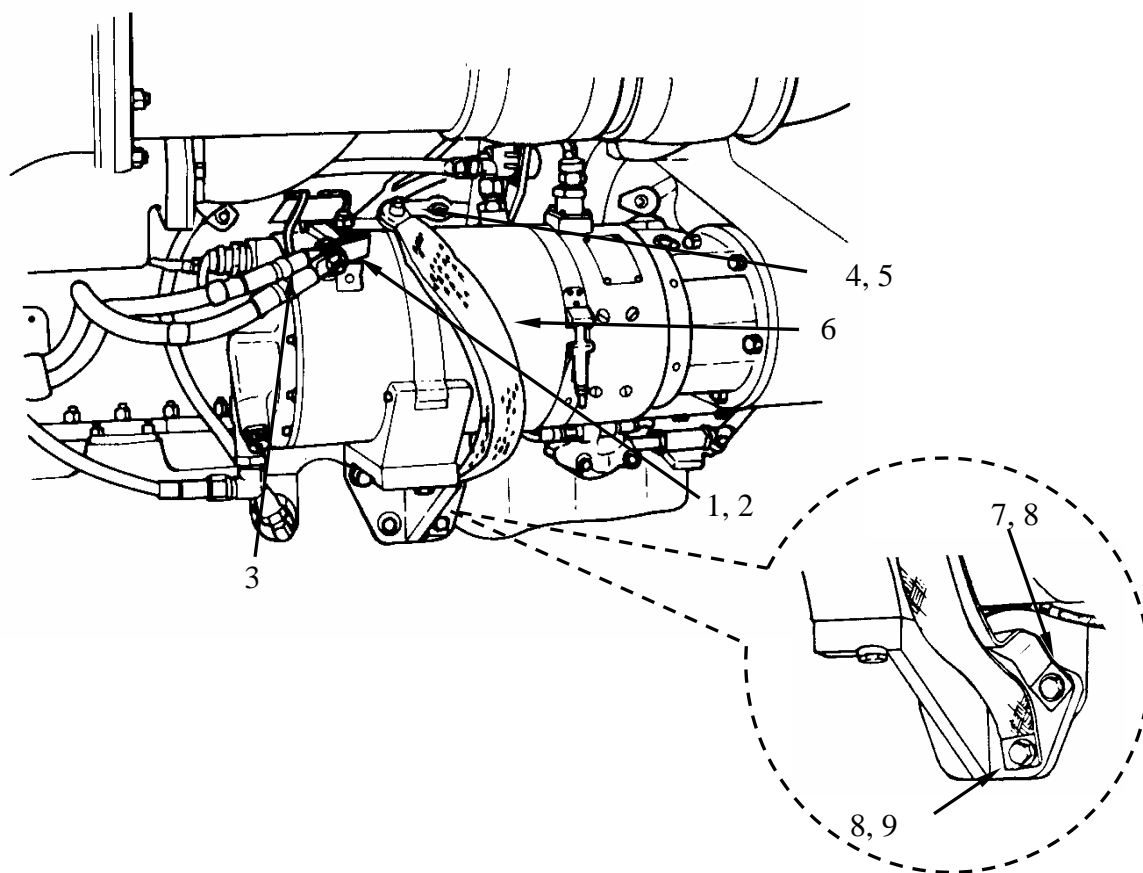
**REMOVAL**

**NOTE**

**This work package contains instructions for the removal or installation of the engine generator electrical wiring harness and associated brackets and clamps.**

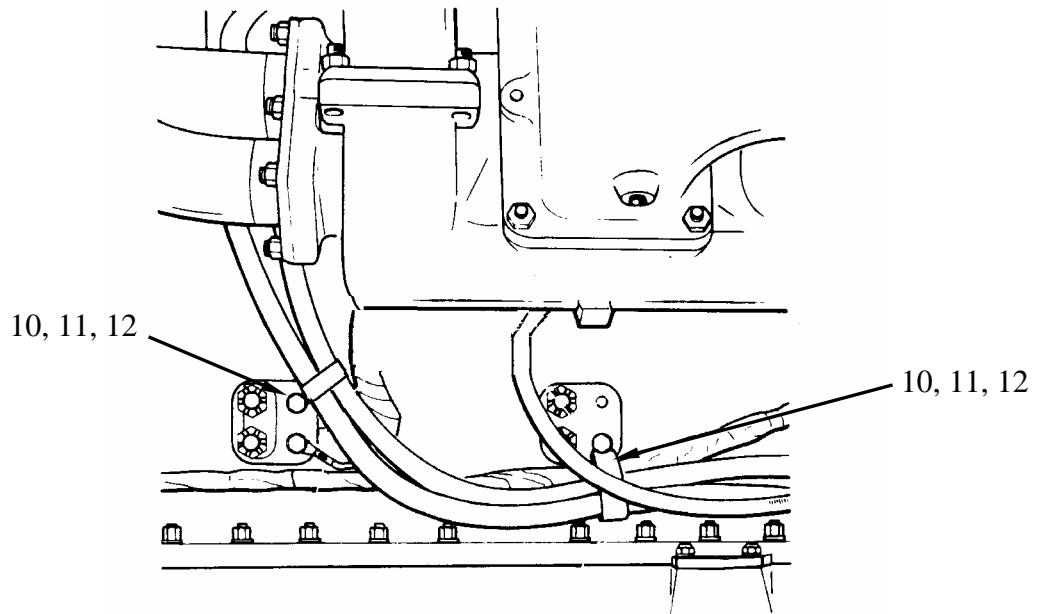
**REMOVAL (Continued)**

1. Remove generator wiring harness.
  - a. Remove self-locking nut (1) with flat washer (2), remove assembled bus bar and generator cable (3). Reinstall flat washer with self-locking nut for safe keeping.
  - b. Remove self-locking nut (4) with flat washer (5) and disconnect assembled bus bar and ground strap (6). Reinstall self-locking nut with flat washer for safe keeping.
  - c. Remove screw (7) with two flat washers (8), and remove upper ground strap.
  - d. Remove lower right generator mounting base screw (9) with two flat washers (8) and remove remaining ground strap connection (6).
  - e. Reinstall lower right generator mounting base screw (9) and two flat washers (8).

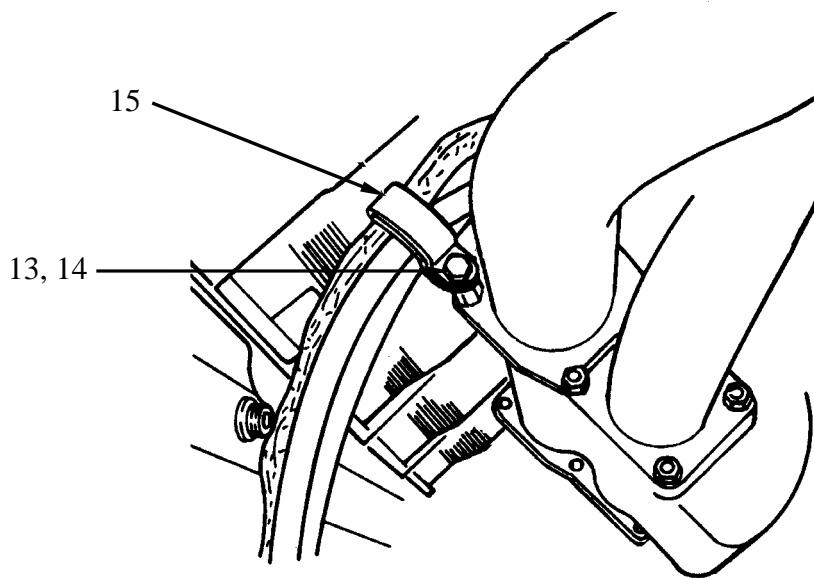


**REMOVAL (Continued)**

1. Remove generator wiring harness (continued).
  - f. Remove two screws (10) with lock washers (11) and remove two loop clamps (12). Discard lock washers.

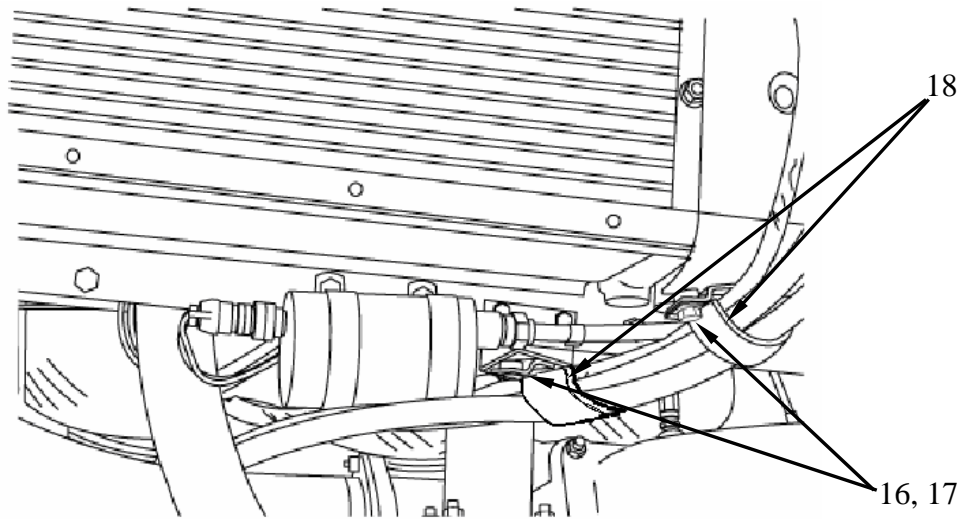


- g. Remove screw (13) with lock washer (14). Discard lock washer.
  - h. Remove loop clamp (15).



**REMOVAL (Continued)**

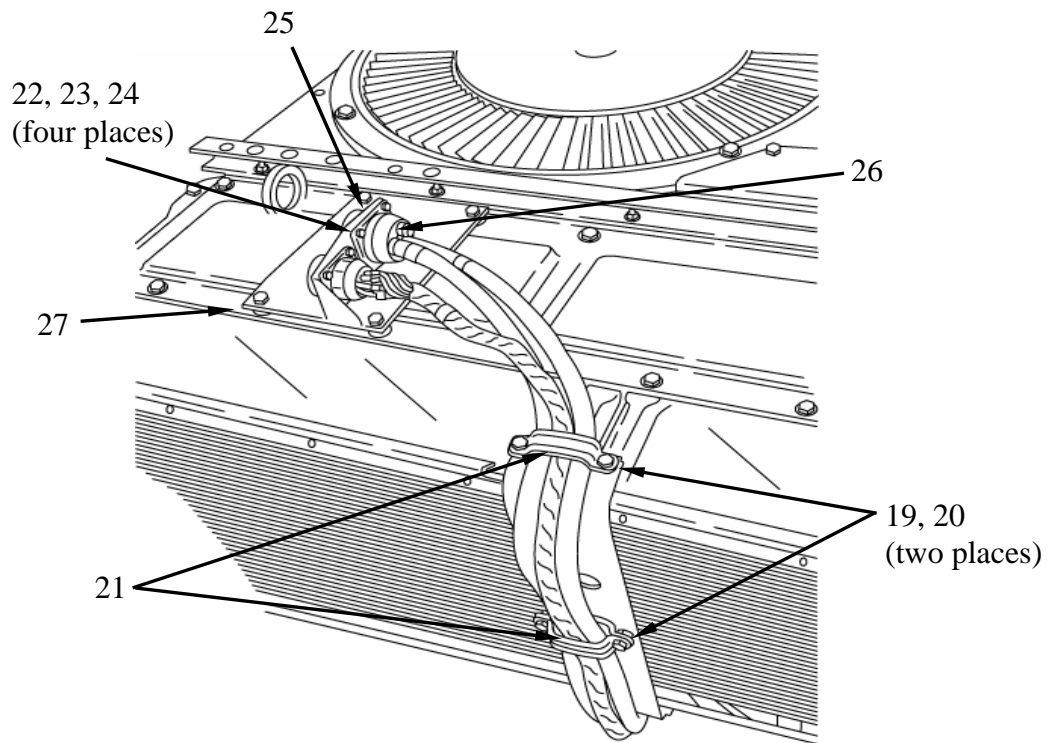
1. Remove generator wiring harness (continued).
  - i. Remove four screws (16) with lock washers (17) and remove retaining straps (18). Discard lock washers.





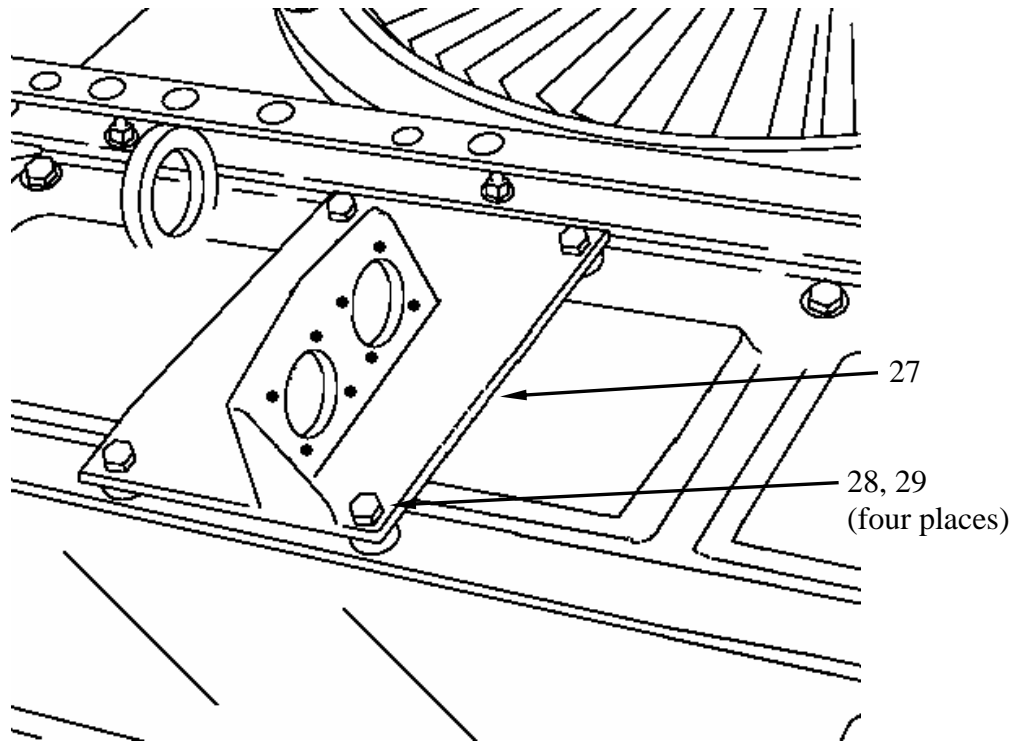
**REMOVAL (Continued)**

1. Remove generator wiring harness (continued).
  - j. Remove four screws (19) with lock washers (20) and remove two retaining straps (21). Discard lock washers.
  - k. Remove four machine screws (22) with lock washers (23) and nuts (24) from connector (25). Discard lock washers.
  - m. Remove cable (26) from bracket (27).



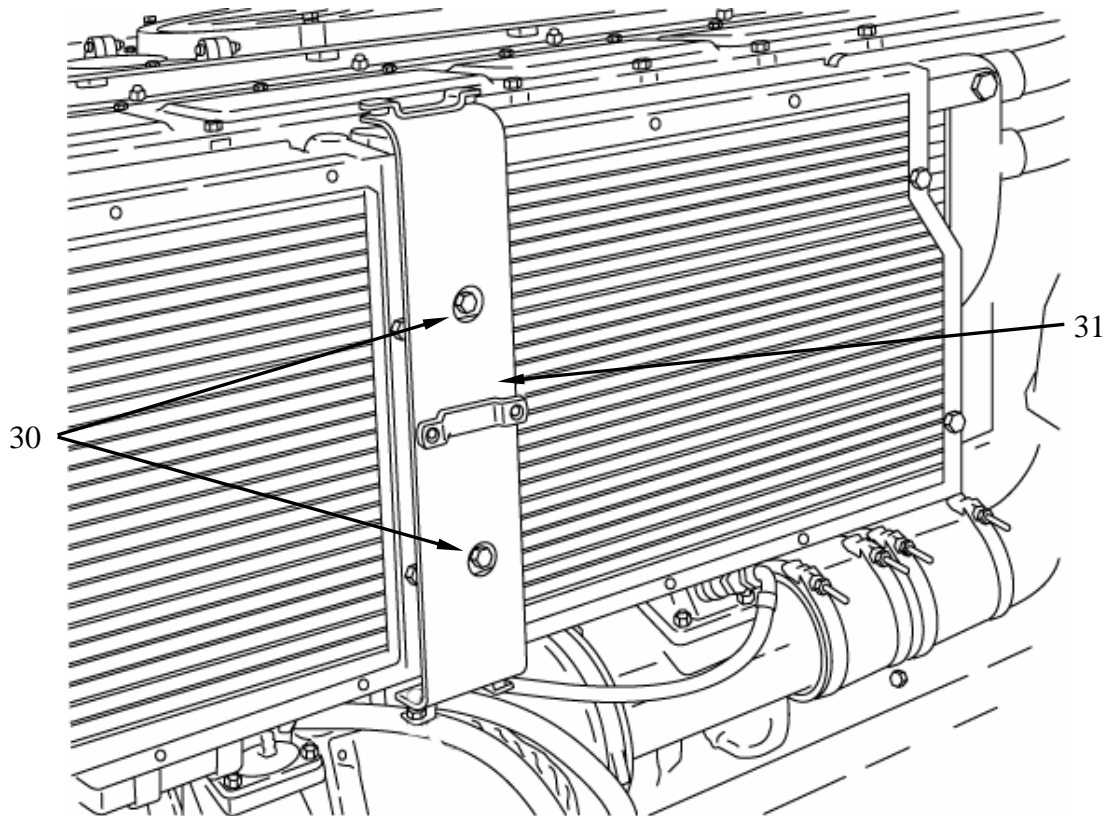
**REMOVAL (Continued)**

2. Remove generator wiring harness brackets.
  - a. With signal wiring harness removed, remove four screws (28) with lock washers (29) and remove bracket assembly (27). Discard lock washers.



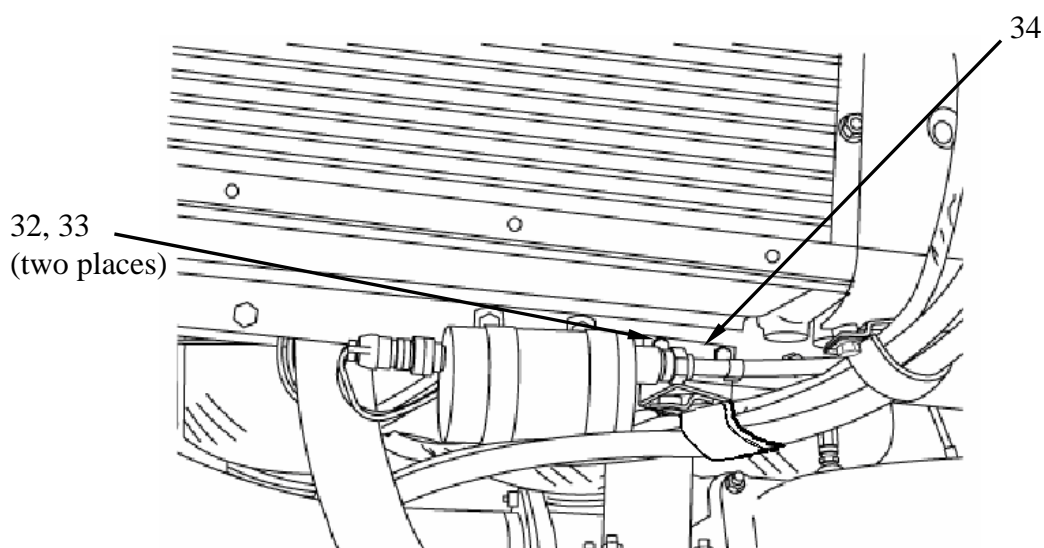
**REMOVAL (Continued)**

2. Remove generator wiring harness brackets (continued).
  - b. Remove two assembled washer bolts (30), wiring harness, and generator cable bracket assembly (31).



**REMOVAL (Continued)**

2. Remove generator wiring harness brackets (continued).
  - c. Remove two screws (32) with self-locking nuts (33) and remove starter lower cable bracket assembly (34). Discard self-locking nuts.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

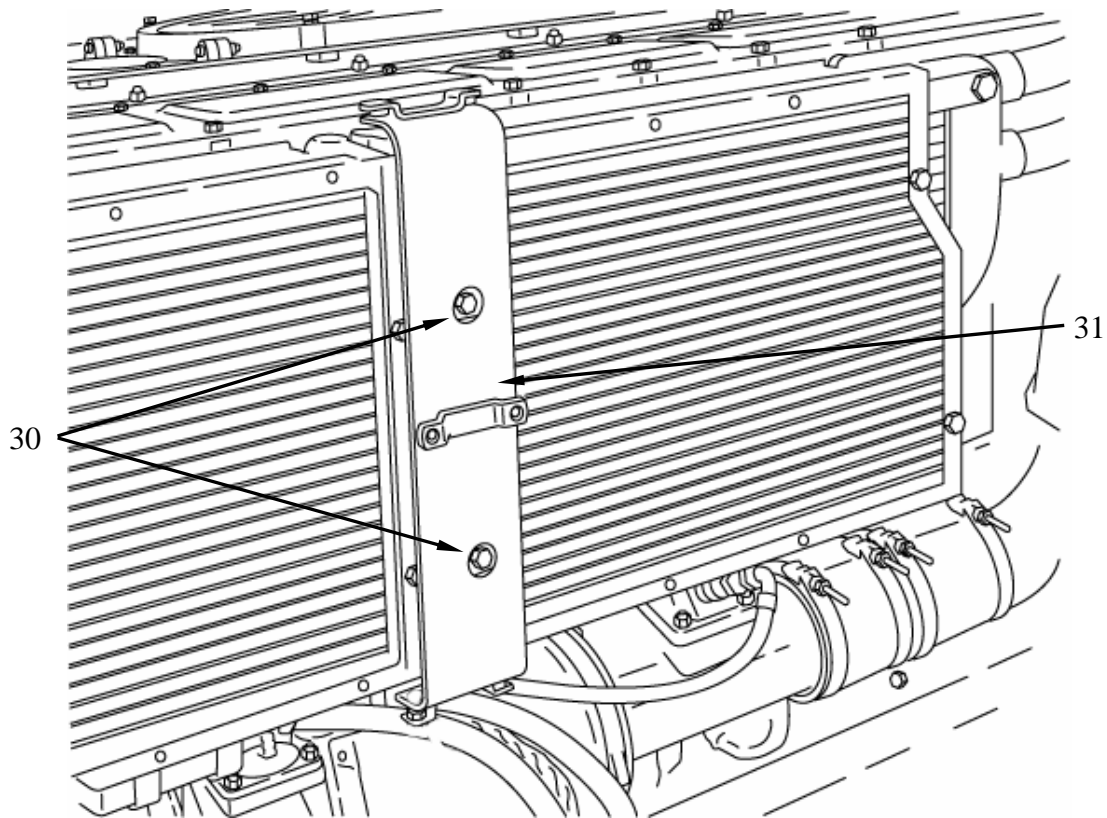
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0054 for Wiring Harness and Cable and Repair.

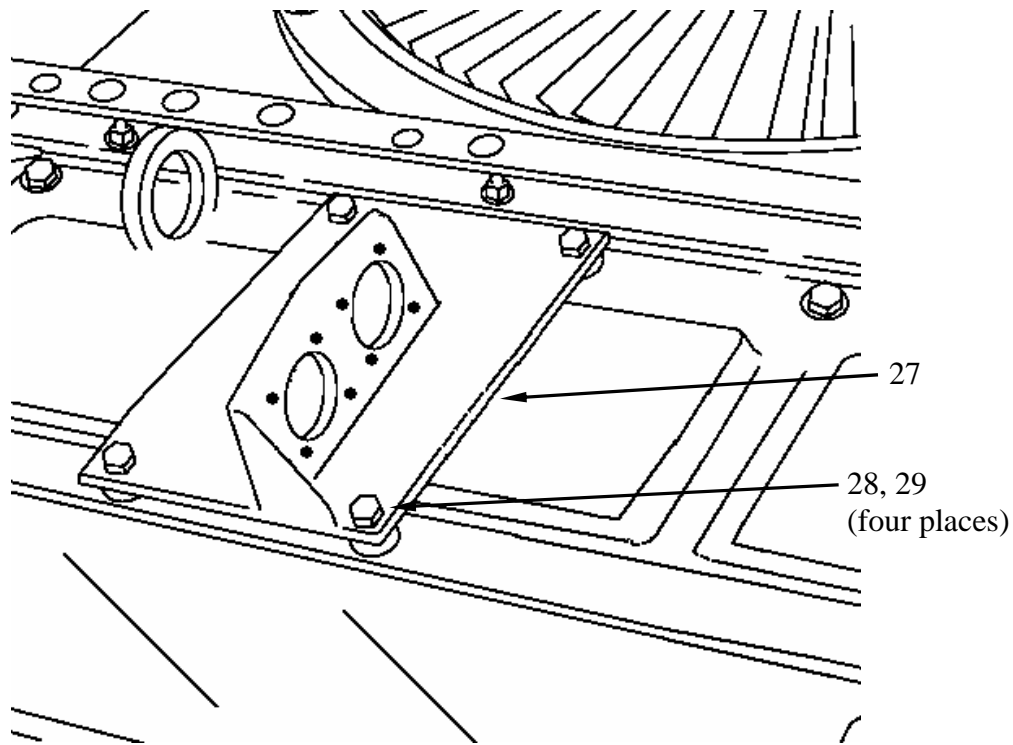
**INSTALLATION**

1. Install generator wiring harness brackets.
  - a. Install generator cable and wiring harness bracket assembly (31) and secure to center oil cooler mounting bracket with two assembled washer bolts (30).



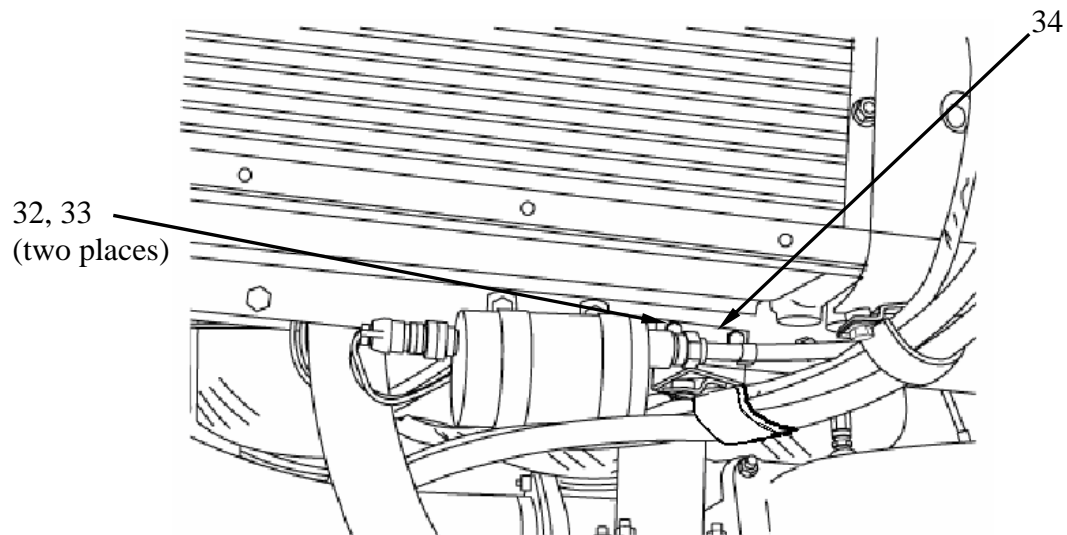
**INSTALLATION (Continued)**

1. Install generator wiring harnesses brackets (continued).
  - b. Position mounting bracket (27) over the first four mounting holes immediately to the rear of the lifting eye which extends through the right front upper cover.
  - c. Secure the bracket to the cover using four screws (28) with new lock washers (29) (item 86, WP 0175).



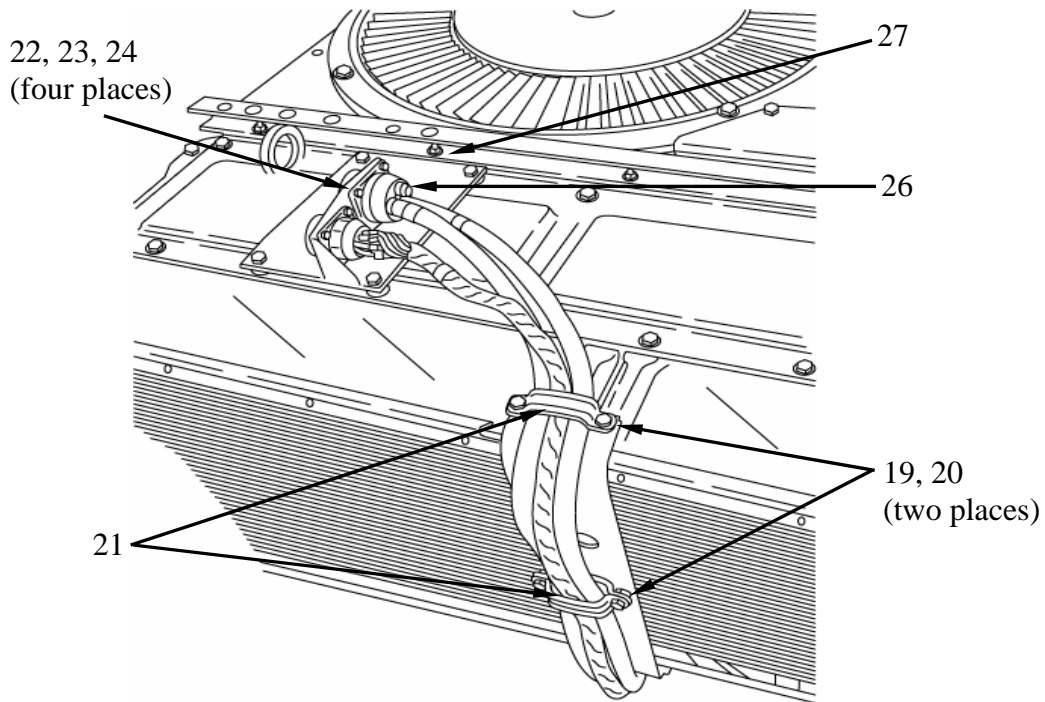
**INSTALLATION (Continued)**

1. Install generator wiring harnesses brackets (continued).
  - d. Install bracket assembly (34) and secure to oil cooler frame using two screws (32) with new self-locking nuts (33) (item 33, WP 0175).



**INSTALLATION (Continued)**

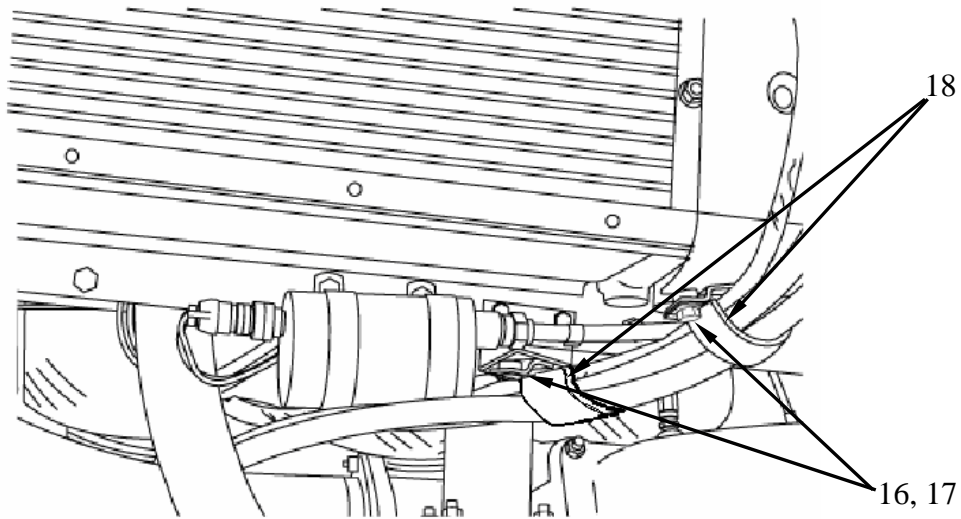
2. Install generator wiring harness.
  - a. Position harness onto engine.
  - b. Install wiring harness connector (26) into mounting bracket (27) using four screws (22), nuts (24), and new lock washers (23) (item 90, WP 0175).
  - c. Install two retaining straps (21) over harnesses using four screws (19) with new lock washers (20) (item 92, WP 0175).





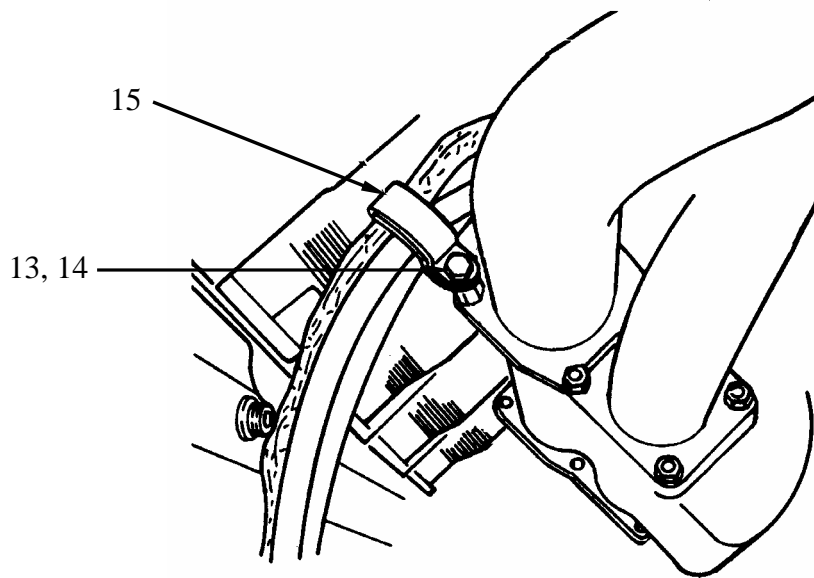
**INSTALLATION (Continued)**

2. Install generator wiring harness (continued).
  - d. Install two retaining straps (18) and secure one to each bracket assembly using four screws (16) with new lock washers (17) (item 92, WP 0175).



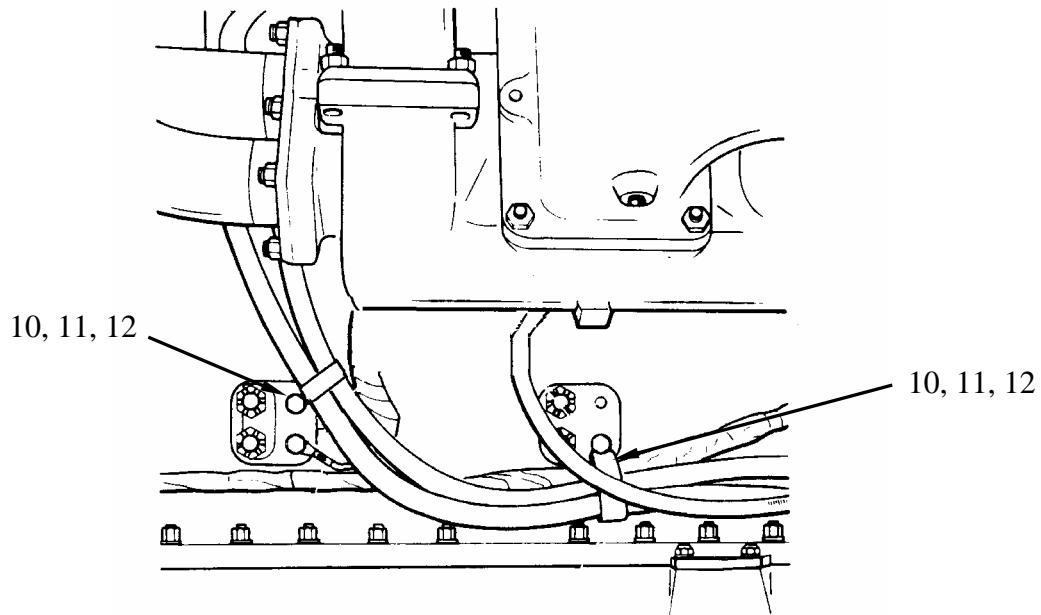
**INSTALLATION (Continued)**

2. Install generator wiring harness (continued).
  - f. Position loop clamp (15) on spacer and secure using screw (13) with new lock washer (14) (item 93, WP 0175).



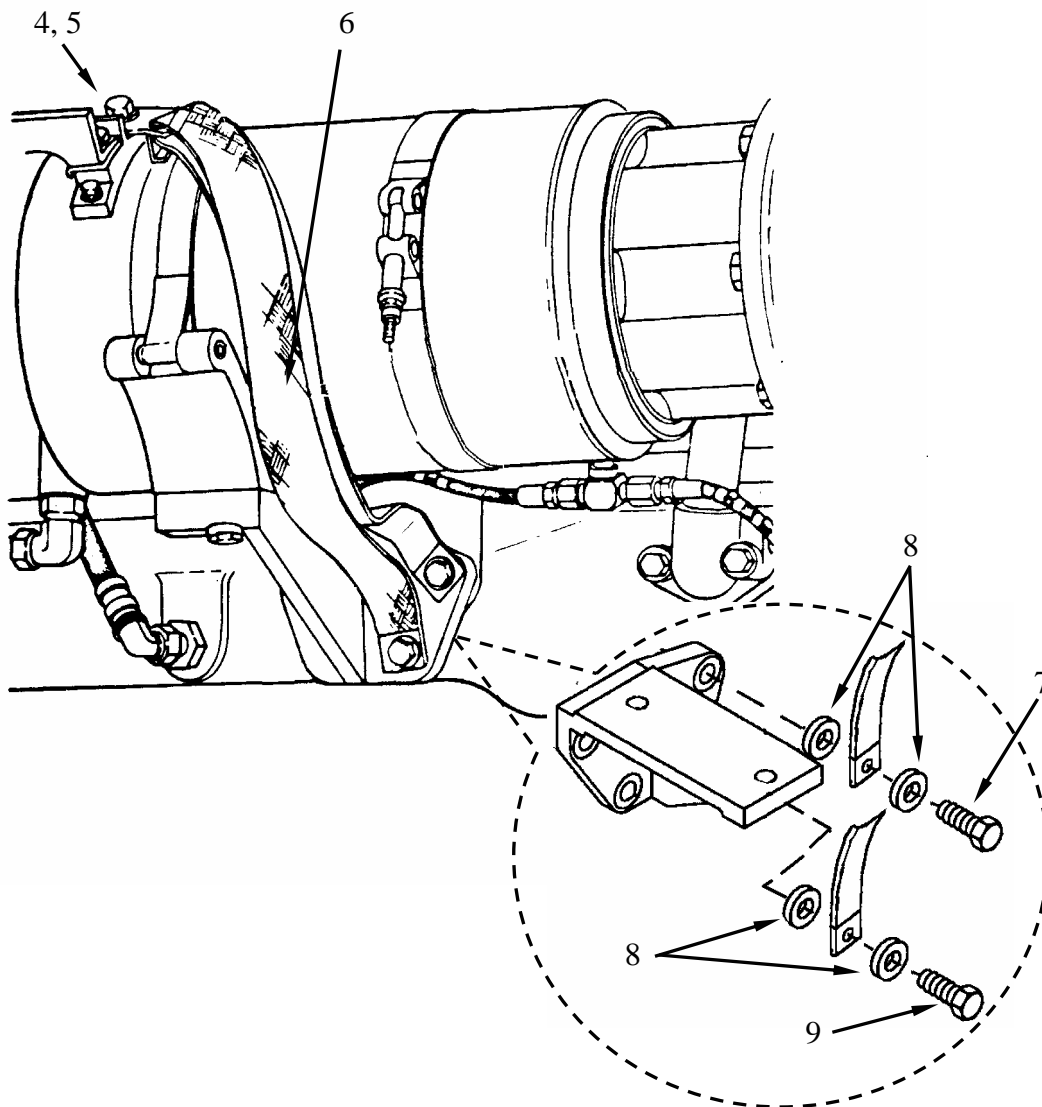
**INSTALLATION (Continued)**

2. Install generator wiring harness (continued).
  - g. Install loop clamps (12) on generator cable and secure to crankcase using two screws (10) with new lock washers (11) (item 93, WP 0175).



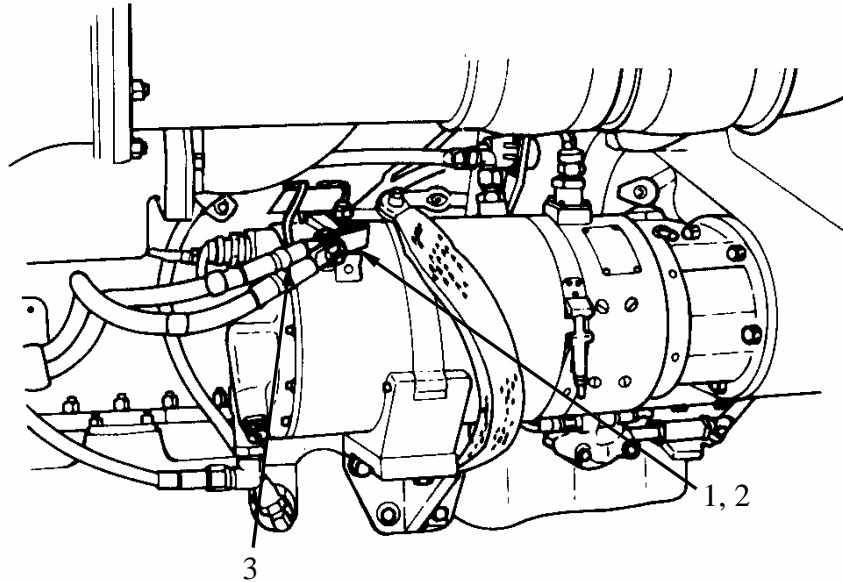
**INSTALLATION (Continued)**

2. Install generator wiring harness (continued).
  - h. Ensure that electrical lead (ground) terminals (6) are clean.
  - i. Secure the right lower ground lead with a flat washer (8) on each side of the lead using support mounting screw (9).
  - j. Remove lower right generator support screw (9) and flat washers (8). Discard screw.
  - k. Secure right upper lead with a flat washer (8) on each side of the lead using a new support mounting screw (3/8-24 x 1-3/4 long) (7).
  - m. Install assembled ground strap (s) and bus bar on generator terminal and secure using original self-locking nut (4) with flat washer (5).



**INSTALLATION (Continued)**

2. Install generator wiring harness (continued).
  - n. Install assembled generator cable (3) on generator terminal and secure using original self-locking nut (1) with flat washer (2).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (4) (item 91, WP 0175)

Lock washer (8) (item 92, WP 0175)

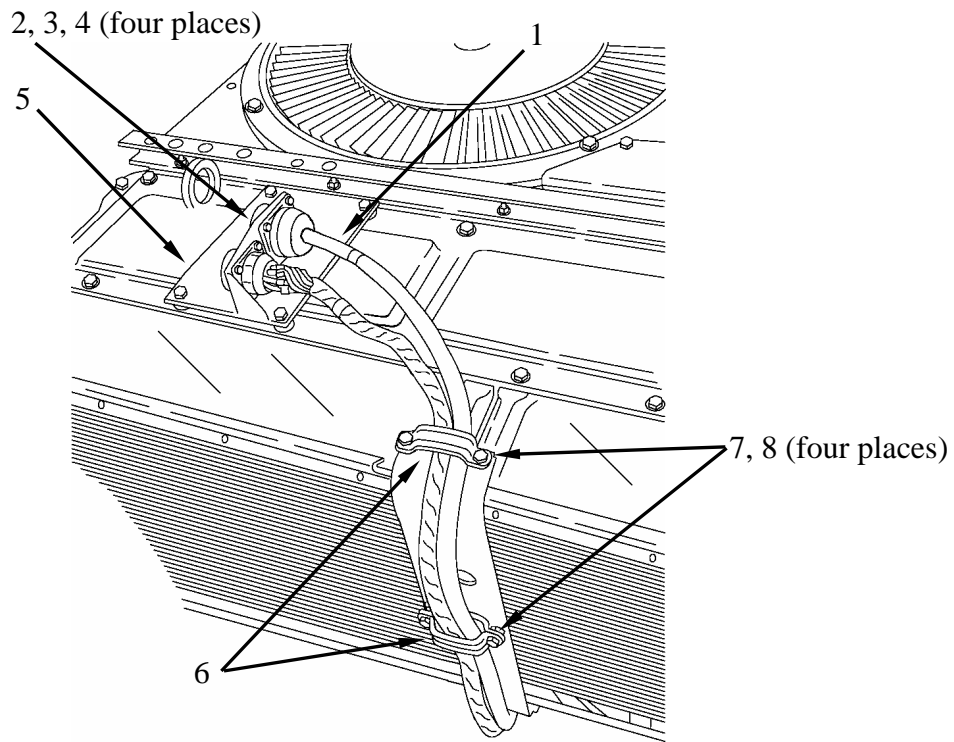
Lock washer (1) (item 93, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

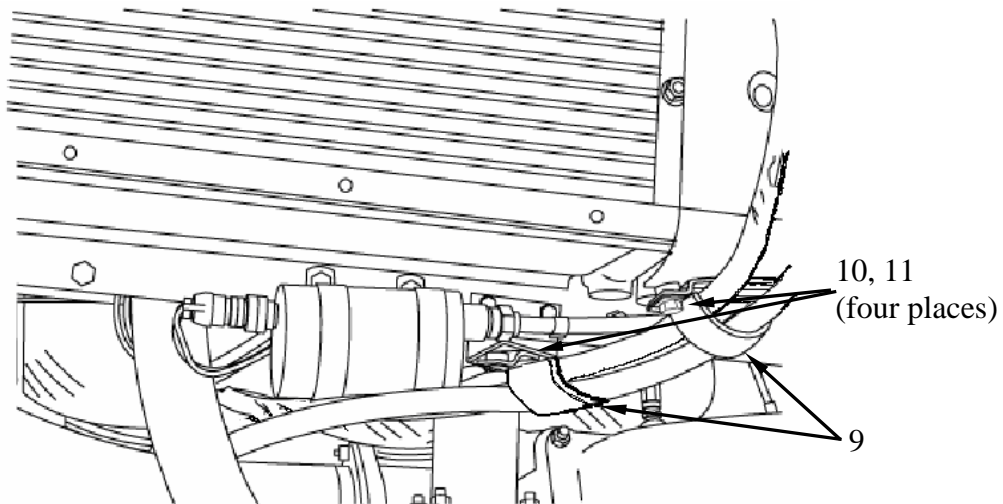
**REMOVAL**

1. Disconnect generator harness (1) at engine upper bracket (2).
  - a. Remove four machine screws (3) with lock washers (4) and nuts (5) from wiring harness upper bracket (2). Discard lock washers.
2. Remove retaining straps (6).
  - a. Remove four screws (7) with lock washers (8) and retaining straps (6). Discard lock washers.

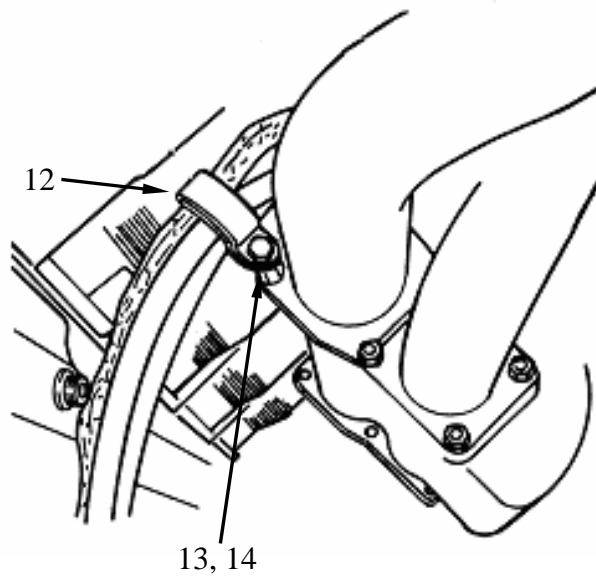


**REMOVAL (Continued)**

3. Remove lower retaining straps (9).
  - a. Remove four screws (10) with lock washers (11) to remove two retaining straps (9). Discard lock washers.



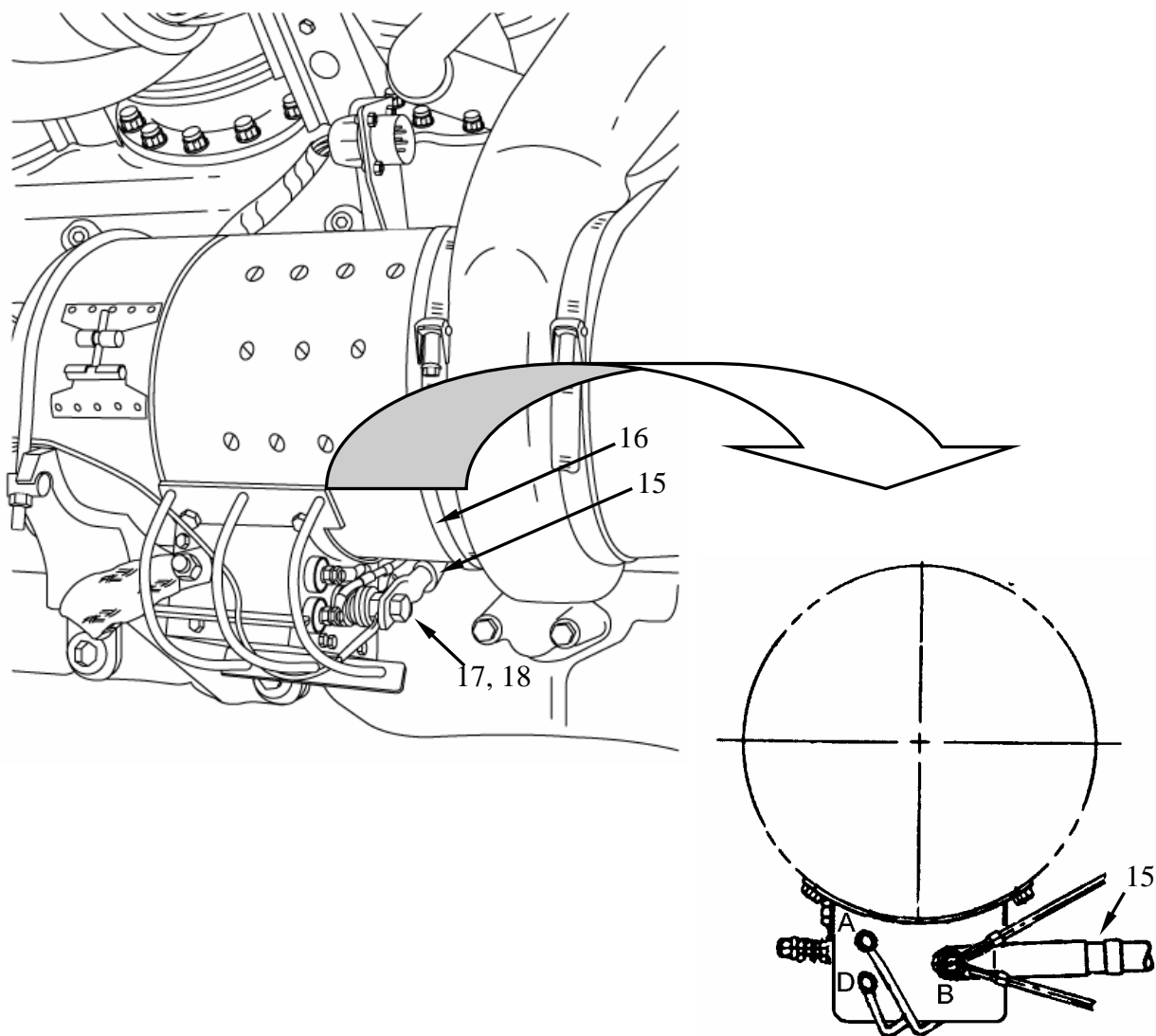
4. Remove harness from loop clamp (12).
  - a. Remove screw (13) with lock washer (14). Discard lock washer.
  - b. Remove loop clamp (12).





**REMOVAL (Continued)**

5. Remove harness positive lead (15) at generator (16).
  - a. Remove self-locking nut (17) with flat washer (18), and remove electrical lead (15).
  - b. Reinstall nut (17) and flat washer (18) for safe keeping.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

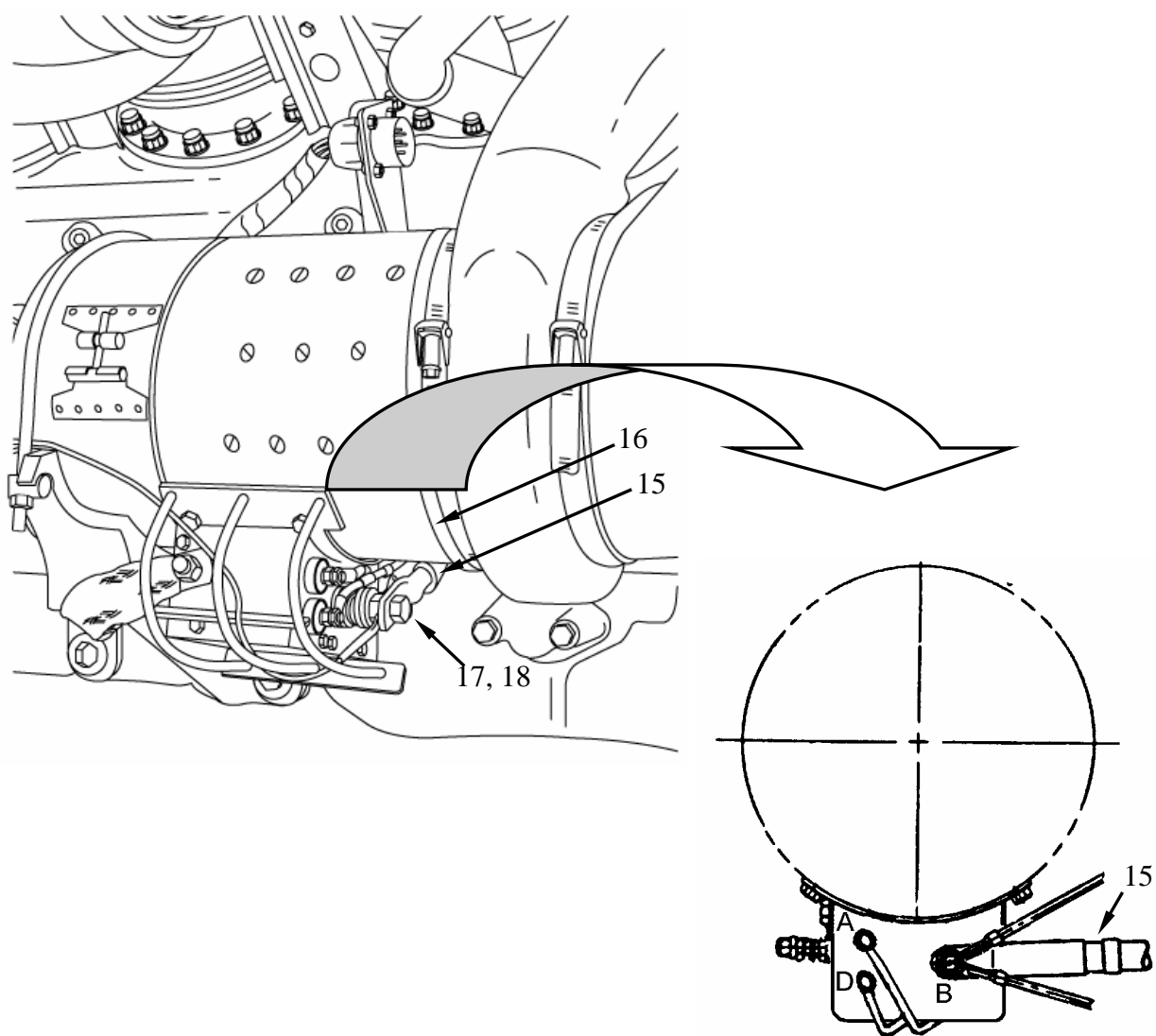
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0054 for Wiring Harness and Cable Repair.

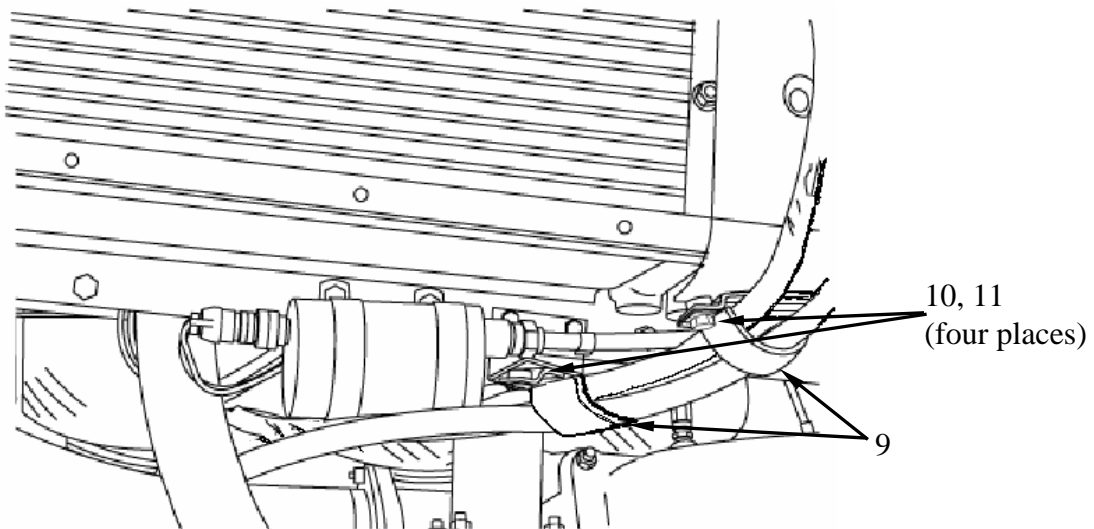
**INSTALLATION**

1. Install harness positive lead (15) at generator (16).
  - a. Remove self-locking nut (17) with flat washer (18).
  - b. Install electric lead (15).
  - c. Install nut (17) and flat washer (18).

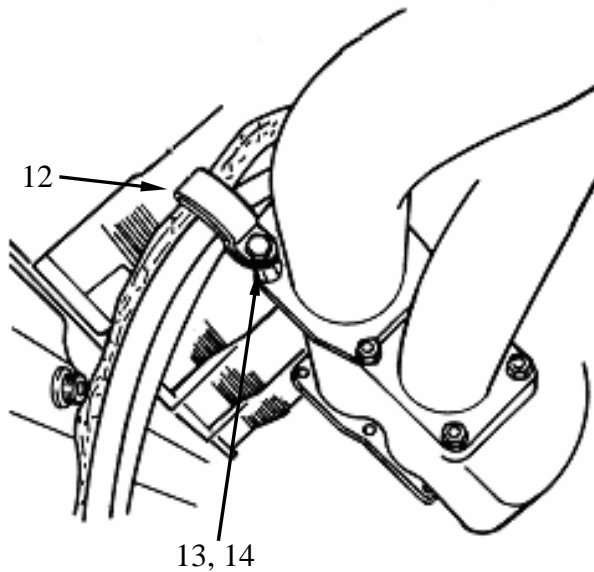


**INSTALLATION (Continued).**

2. Install lower retaining straps (9).
  - a. Position harness into retaining straps (9).
  - b. Install four screws (10) with new lock washers (11) (item 92, WP 0175).

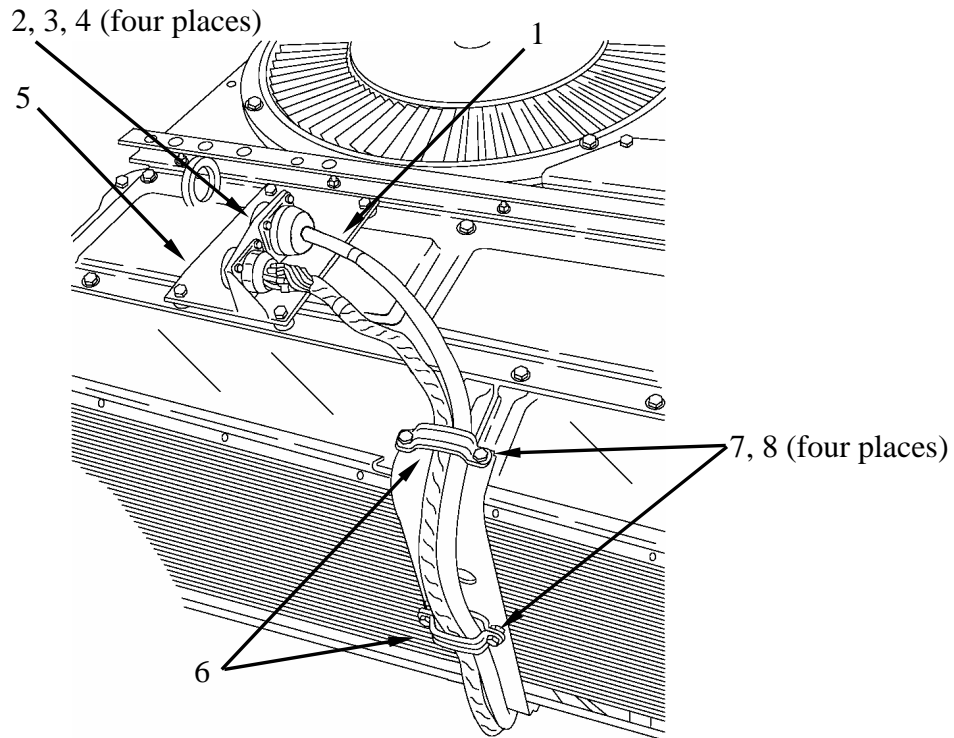


3. Position harness into loop clamp (12).
  - a. Install loop clamp (12) using screw (13) with new lock washer (14) (item 93, WP 0175).



**INSTALLATION (Continued).**

4. Install retaining straps (6).
  - a. Secure using four screws (7) with new lock washers (8) (item 92, WP 0175).
5. Connect generator harness (1) to engine upper bracket (2).
  - a. Install four machine screws (3) with new lock washers (4) (item 91, WP 0175) and nuts (5) to secure wiring harness (1) to the harness upper bracket (2).



**END OF WORK PACKAGE**



**GENERATOR HARNESS POSITIVE LEAD REPLACEMENT  
(2DR) (PN 11671357)**

0065 00

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (4) (item 90, WP 0175)

Tie wrap (as needed) (item 80, WP 0175)

**Expendable and Durable Items:**

Lubricant (item 23, WP 0173)

**Personnel Required:**

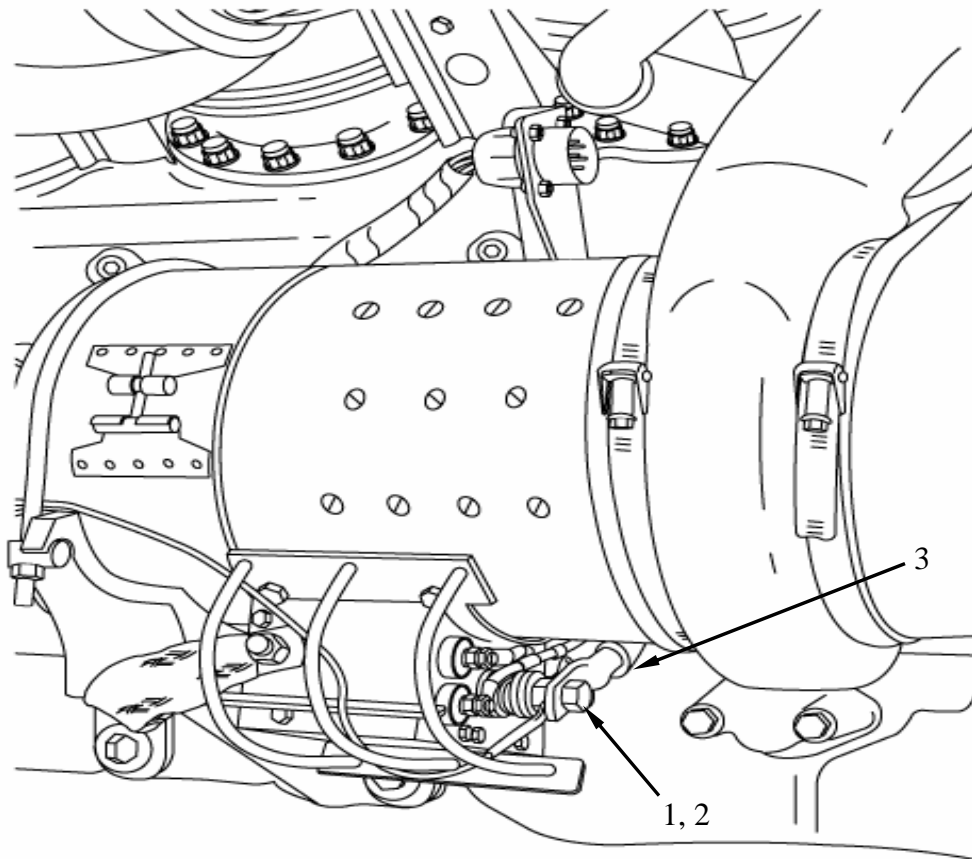
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

1. Remove self-locking nut (1) with flat washer (2), and remove electrical lead (3). Reinstall self-locking nut (1) and flat washer (2) for safe keeping.



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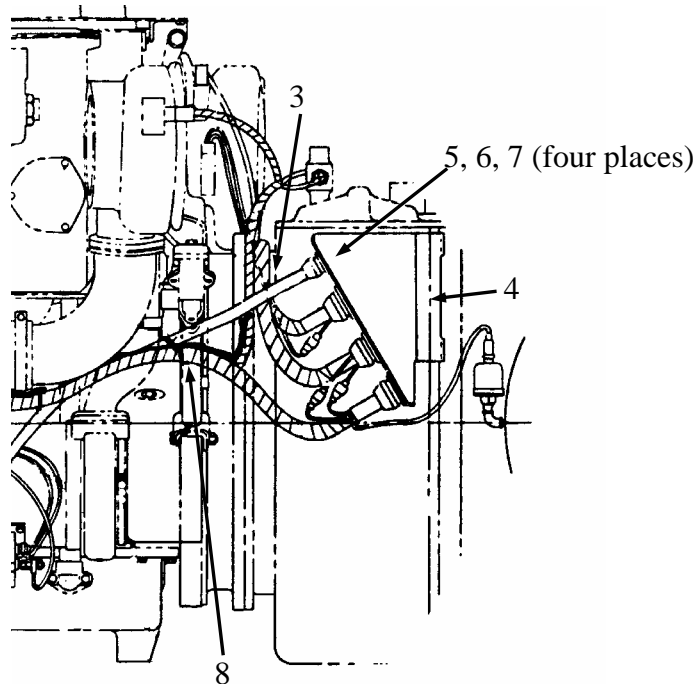
**GENERATOR HARNESS POSITIVE LEAD REPLACEMENT  
(2DR) (PN 11671357)**

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0065 00

**REMOVAL (Continued)**

2. Remove lead (3) from engine disconnect bracket (4).
  - a. Remove four machine screws (5) with lock washers (6) and nuts (7). Discard lock washers.
  - b. Clip and remove tie wraps (8) as necessary.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0054 for Wiring Harness and Cable Repair.

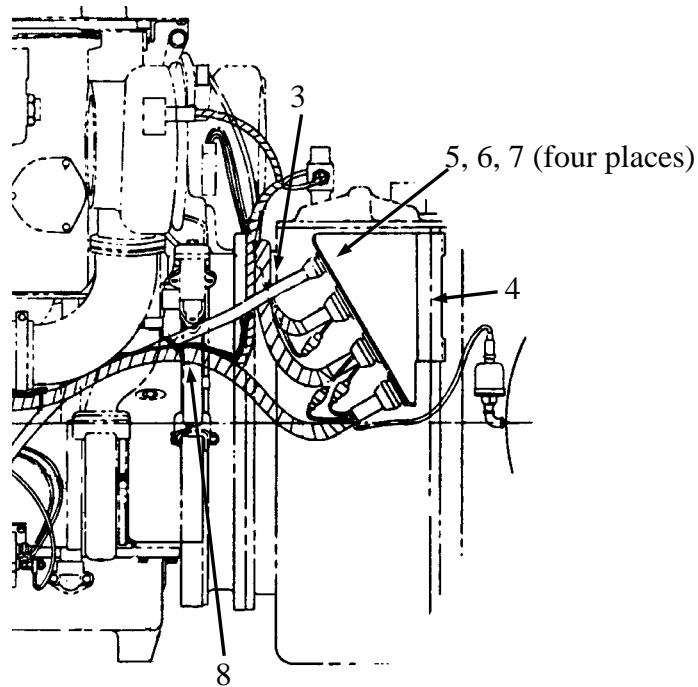


**GENERATOR HARNESS POSITIVE LEAD REPLACEMENT  
(2DR) (PN 11671357)**

**0065 00**

**INSTALLATION (Continued)**

1. Install generator to engine disconnect positive lead.
  - a. Position lead (3) onto engine and engine disconnect bracket (4).
  - b. Install four machine screws (5) with new lock washers (6) (item 90, WP 0175) and nuts (7).
  - c. Install tie wraps (8) (item 80, WP 0175) as necessary.



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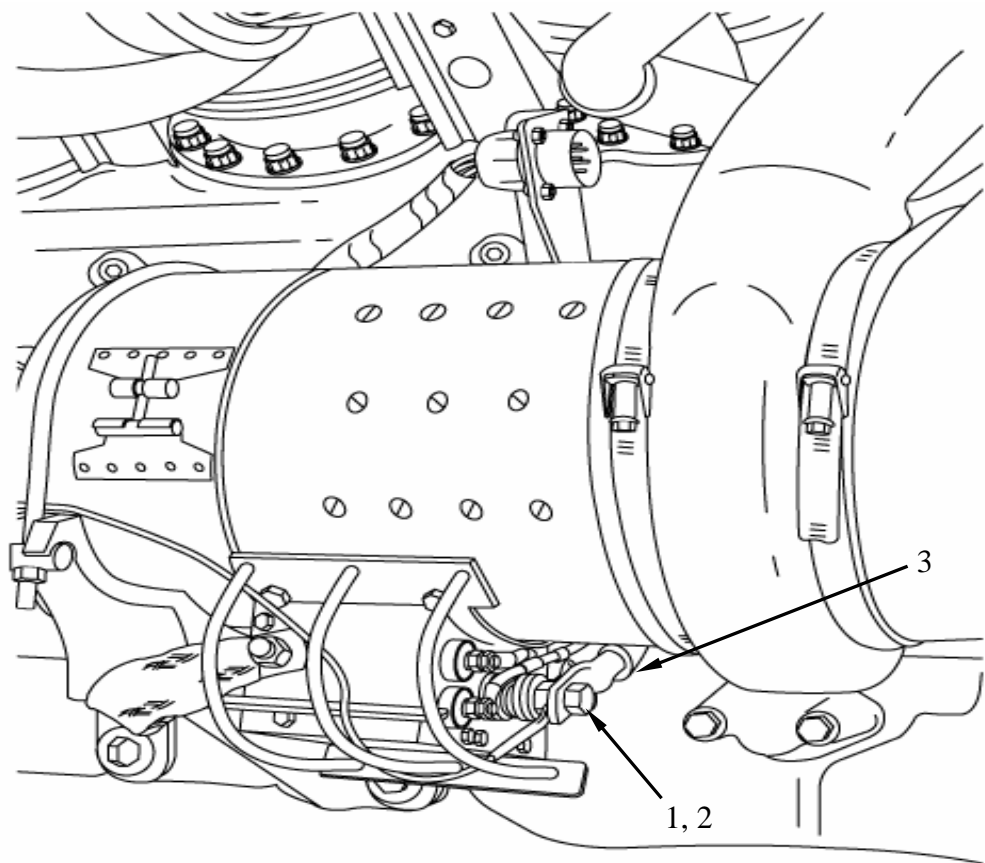
**GENERATOR HARNESS POSITIVE LEAD REPLACEMENT  
(2DR) (PN 11671357)**

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**0065 00**

**INSTALLATION (Continued)**

2. Remove self-locking nut (1) with flat washer (2).
3. Install electrical lead (3).
4. Install self-locking nut (1) with flat washer (2).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Grommet (1) (item 99, WP 0175)

Lock washer (1) (item 92, WP 0175)

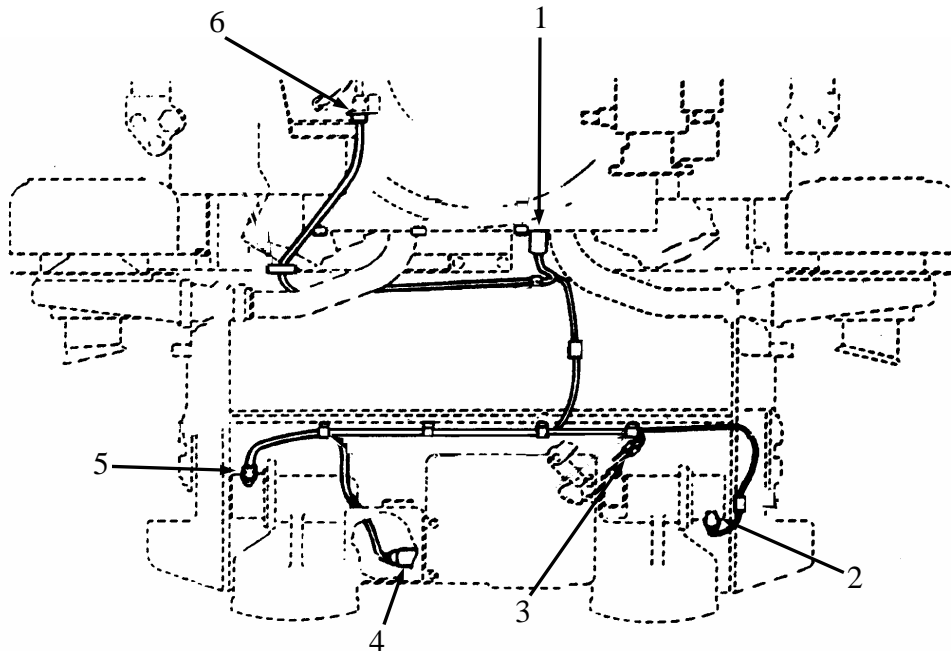
Stamped nut (as needed) (item 55, WP 0175)

**Equipment Conditions:**

Powerpack removed from vehicle and placed on a flat stationary surface.

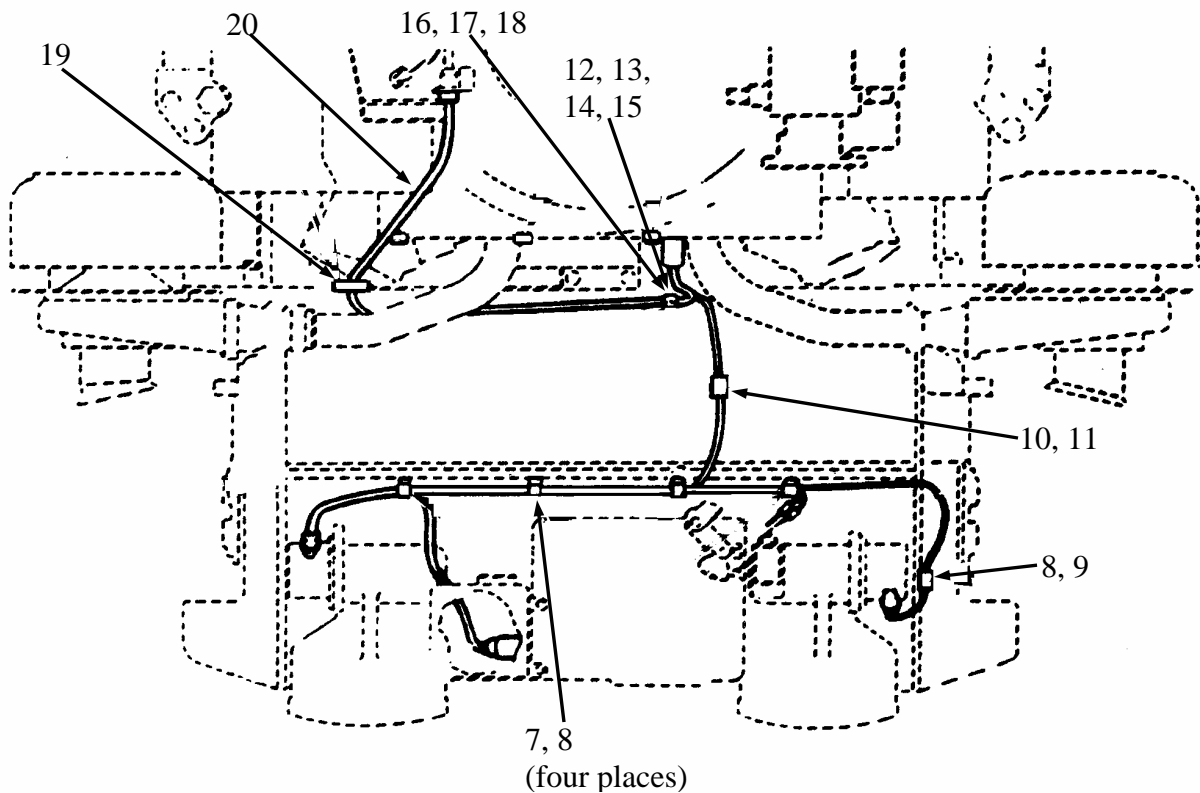
**REMOVAL**

1. Disconnect lead at fuel solenoid (1) for flame heater.
2. Disconnect lead at transmission high temperature sensor (2).
3. Disconnect leads at transmission neutral switch (3).
4. Disconnect lead at transmission oil pressure sensor (4).
5. Disconnect lead at transmission oil temperature sensor (5).
6. Disconnect lead at transmission harness disconnect (near generator) (6).



**REMOVAL (Continued)**

7. Remove loop clamps (7) and stamped nuts (8). Discard stamped nuts.
8. Remove loop clamp (9) and stamped nut (8). Discard stamped nut.
9. Remove loop clamp (10) and retaining nut (11).
10. Remove loop clamp (12) with screw (13) nut (14) and lock washer (15). Discard lock washer.
11. Remove angle bracket (16) secured with nut (17) and lock washer (18). Set aside lock washer for safe keeping.
12. Remove grommet (19) and feed harness (20) through opening. Discard grommet.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

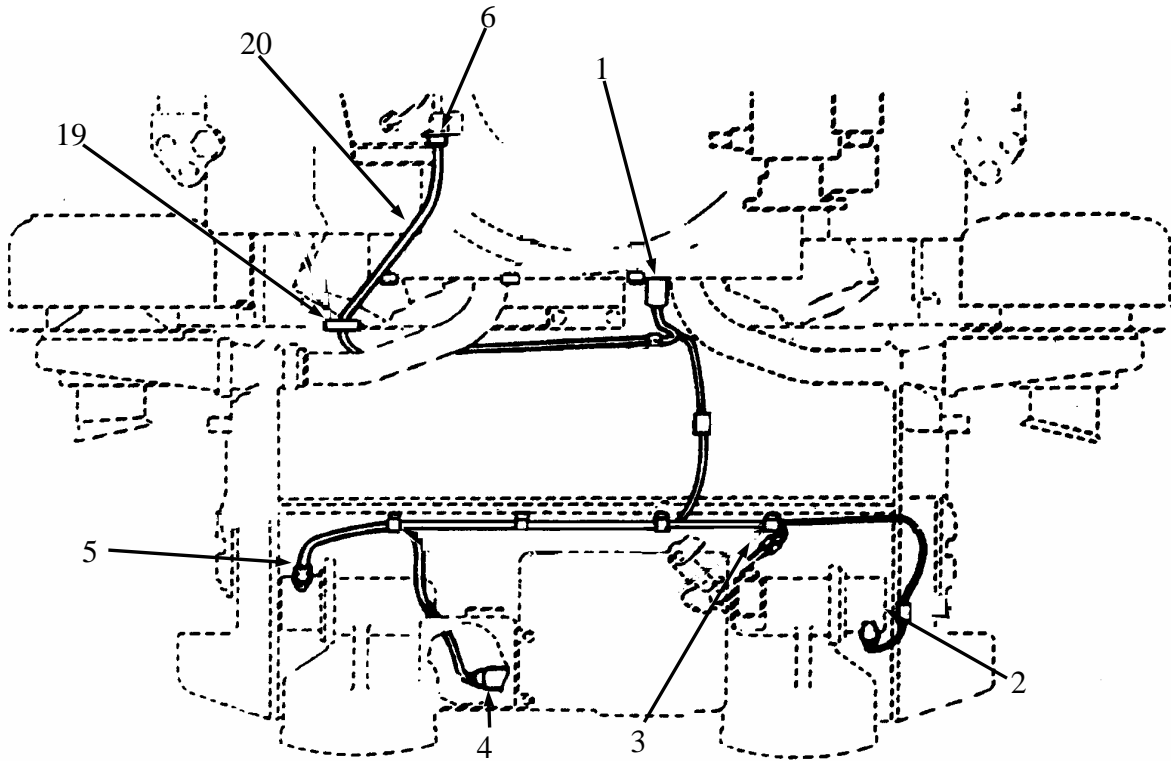
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable Repair.

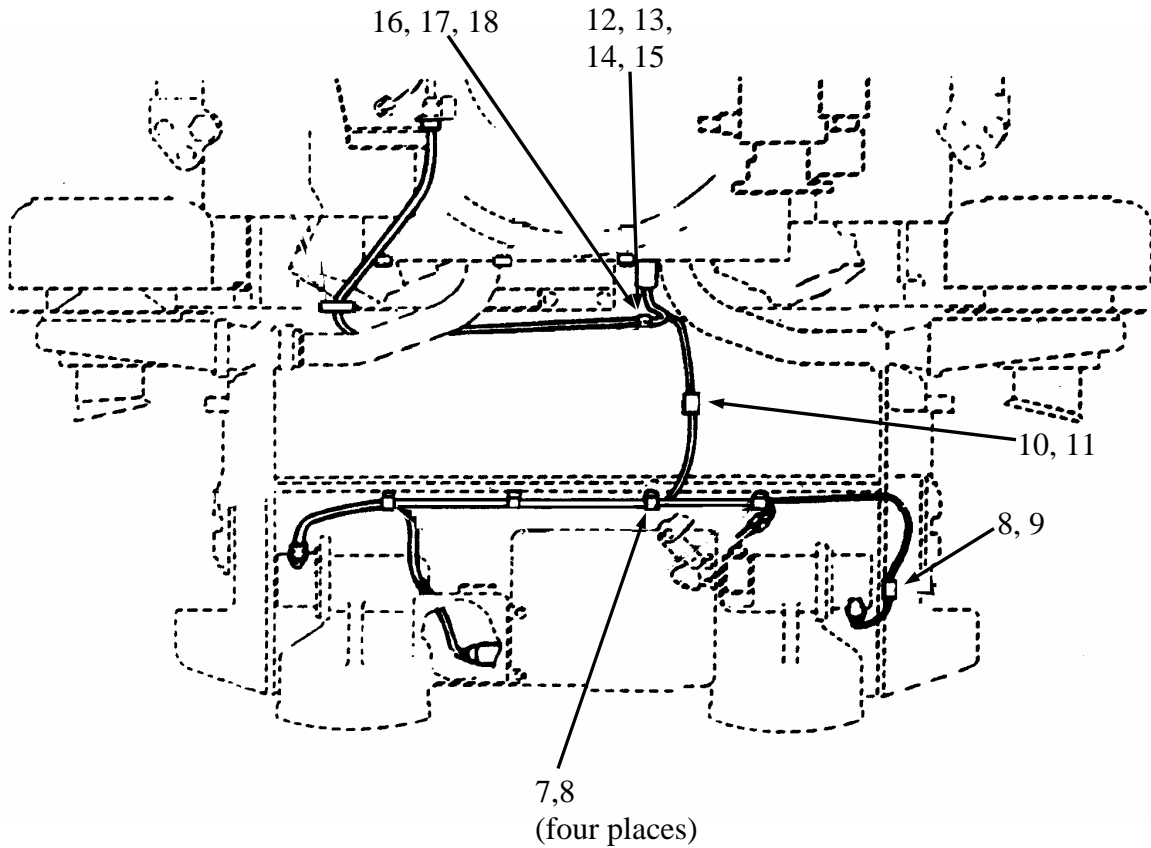
**INSTALLATION**

1. Feed harness (20) through new grommet (19) (item 99, WP 0175) and install into grommet opening.
2. Position harness (20) on transmission.
3. Install fuel solenoid (1) lead.
4. Install transmission high temperature sensor (2) lead.
5. Install transmission neutral switch (3) leads.
6. Install transmission oil pressure sensor (4) lead.
7. Install transmission oil temperature sensor (5) lead.
8. Install harness at disconnect point (near generator) (6).



**INSTALLATION (Continued)**

9. Install loop clamp (7) with new stamped nuts (8) (item 55, WP 0175).
10. Install loop clamp (9) with new stamped nut (8) (item 55, WP 0175).
11. Install loop clamp (10) using retaining nut (11).
12. Install angle bracket (16) using nut (17) and new lock washer (18) (item 92, WP 0175).
13. Install loop clamp (12) using screw (13), nut (14), and lock washer (15).



**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (as needed) (item 91, WP 0175)

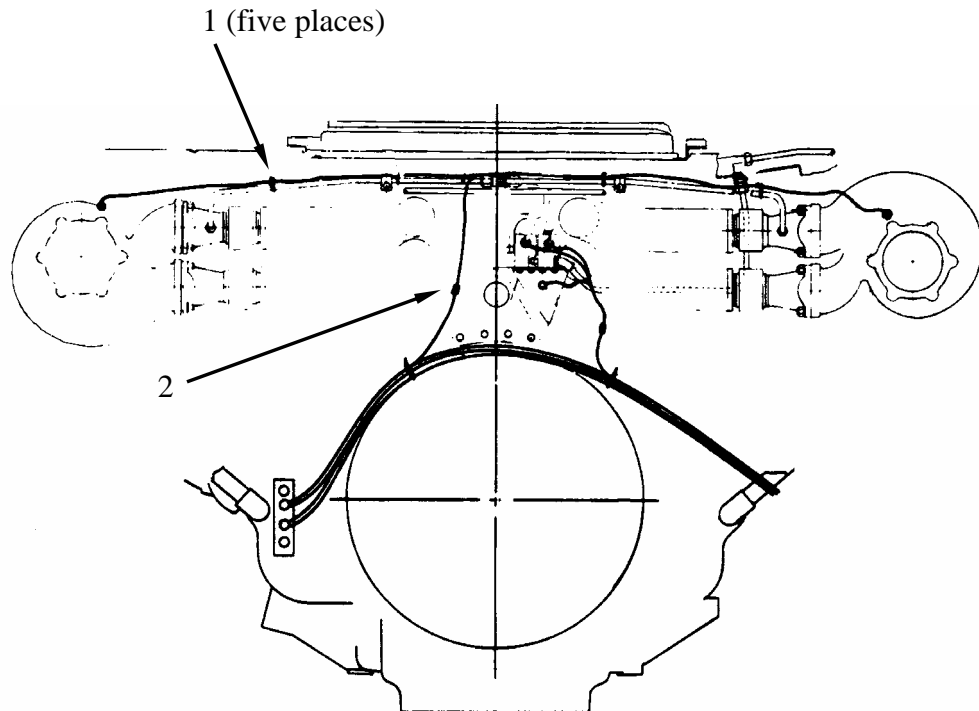
Tie wrap (5)(item 80, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

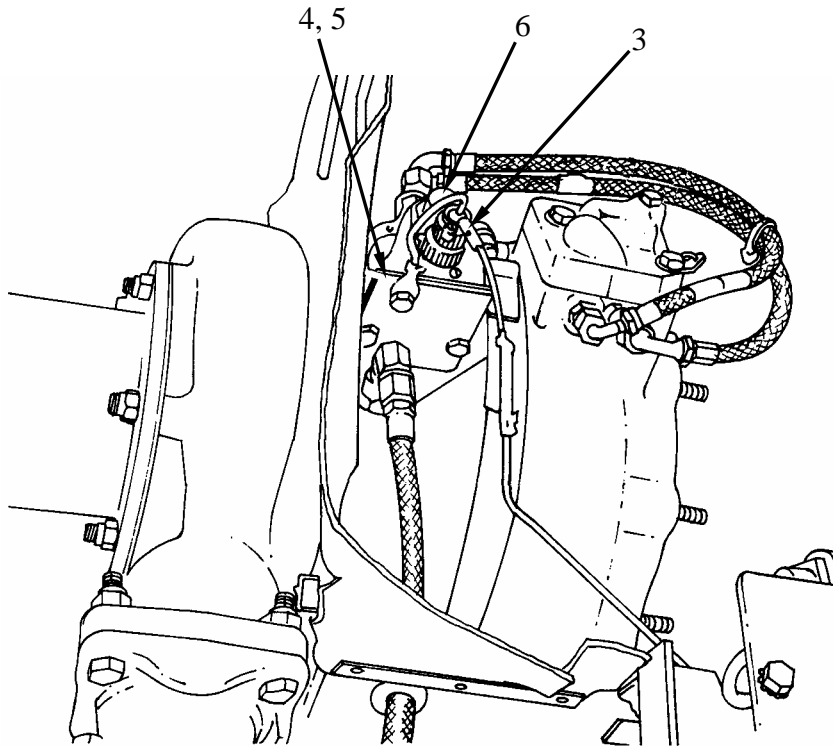
**REMOVAL**

1. Remove dust detector wiring harness.
  - a. Cut and remove five tie wraps (1).
  - b. Unplug electrical harness connector (2).



**REMOVAL (Continued)**

1. Remove dust detector wiring harness (continued).
  - c. Disconnect electrical connectors (3) at dust detector connections.
  - d. Remove screws (4) lock washers (5) securing ground leads (6). Discard lock washers.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

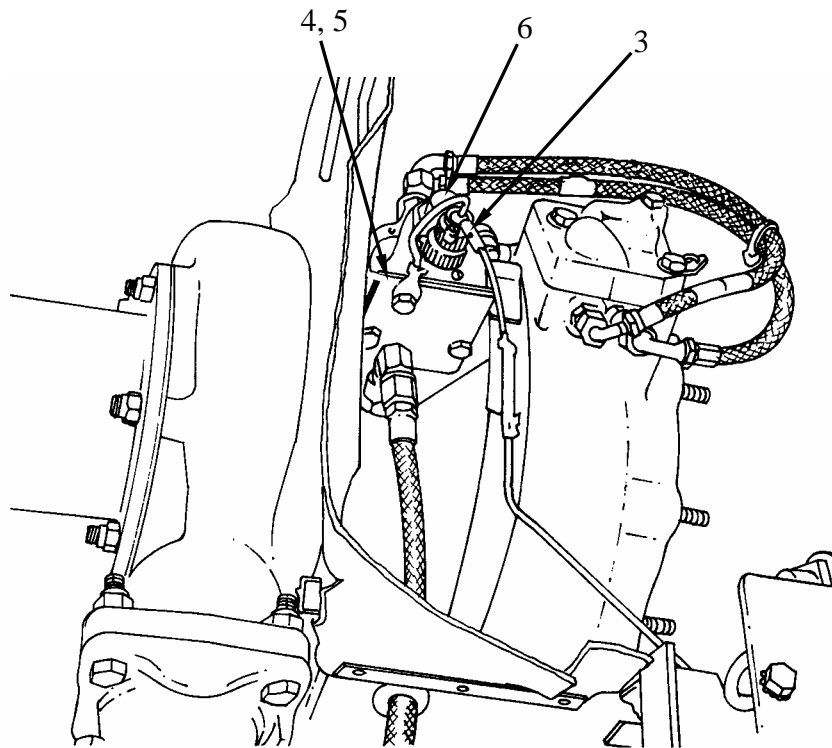
1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable and Repair.

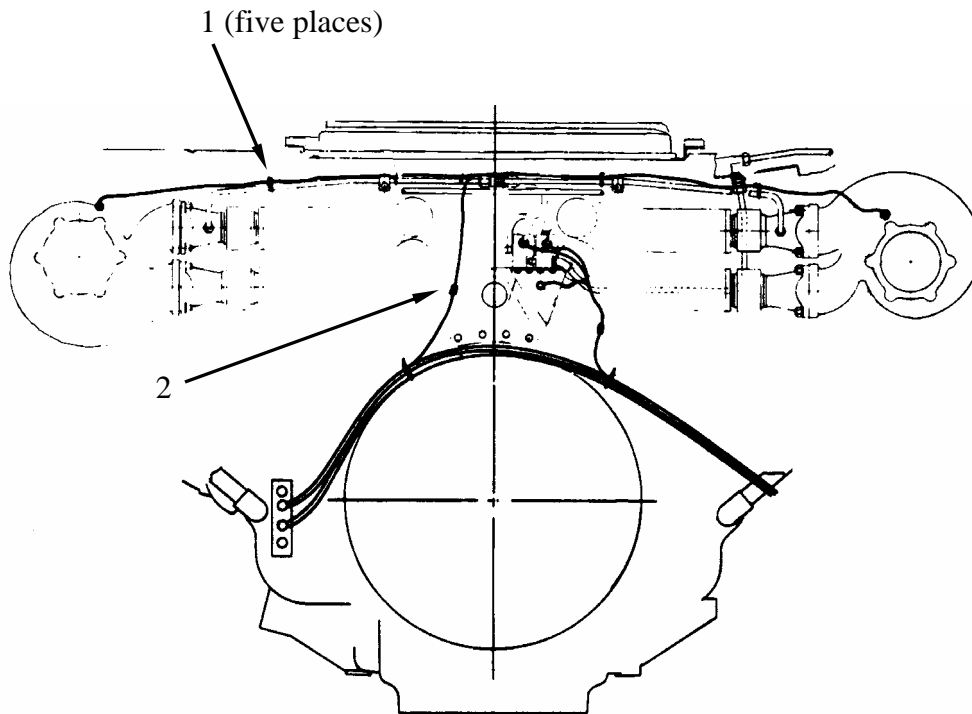
**INSTALLATION**

1. Install dust detector wiring harness.
  - a. Install electrical connectors (3) at dust detector connections.
  - b. Install screws (4) and new lock washers (5) (item 91, WP 0175) to secure ground leads (6).



**INSTALLATION (Continued)**

1. Install dust detector wiring harness (continued).
  - a. Connect electrical harness connector (2).
  - b. Install five tie wraps (1) (item 80, WP 0175).

**END OF WORK PACKAGE**

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**SMOKE GENERATOR WIRING HARNESSSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)**

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**0068 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (as needed) (item 92, WP 0175)

Lock washer (1) (item 93, WP 0175)

Tie wrap (as needed) (item 80, WP 0175)

Tie wrap (1) (item 81, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

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**REMOVAL**

**CAUTION**

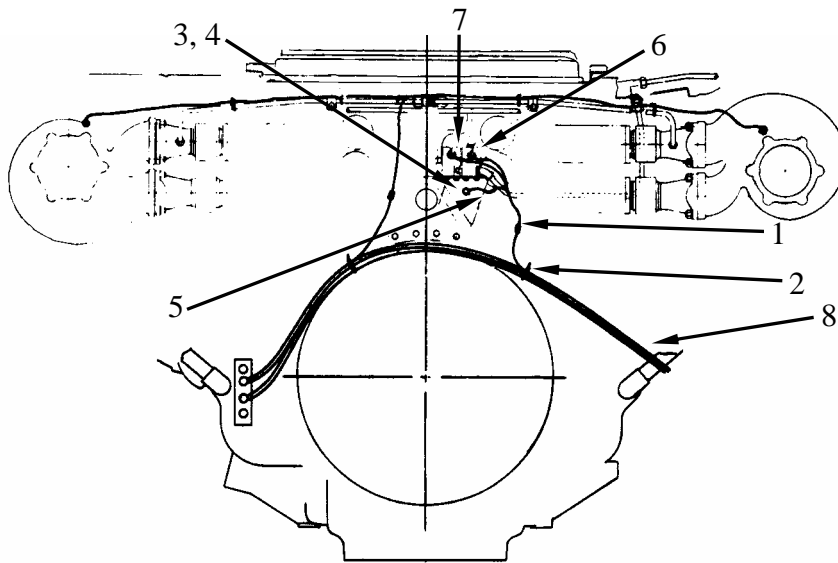
**There are two configurations of the smoke generating system. Early systems use a dual solenoid configuration. Newer/improved systems use a single solenoid system. The newer system removes the two flywheel end mounted solenoids and replaces them with a single solenoid at the damper end of the engine where it is cooler. It was found that fuel, trapped between the two solenoids and heated by the close proximity of the exhaust, expanded and caused internal seals of the solenoids to fail resulting in un-commanded smoke generation and higher fuel consumption. ECR CO-M6185 authorizes the change.**

**NOTE**

**This work package covers the maintenance of the smoke generation wiring harness for the 2DR engine model with single or double fuel solenoid configuration. If you have a dual fuel solenoid configuration requiring repair, it is recommended that you reference ECR CO-M6185 and convert your smoke generation system to the single solenoid configuration.**

**SMOKE GENERATOR WIRING HARNESSSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)****0068 00****REMOVAL (Continued)**

1. Remove dual solenoid smoke generator wiring harness (1).
  - a. Cut and remove tie wrap (2).
  - b. Remove screw (3) and lock washer (4) retaining smoke generator ground lead (5). Discard lock washer.
  - c. Disconnect two electrical connectors (6) from smoke solenoid valves (7).
  - d. Disconnect electrical plug connector (8) at T connection of starter ground circuit.

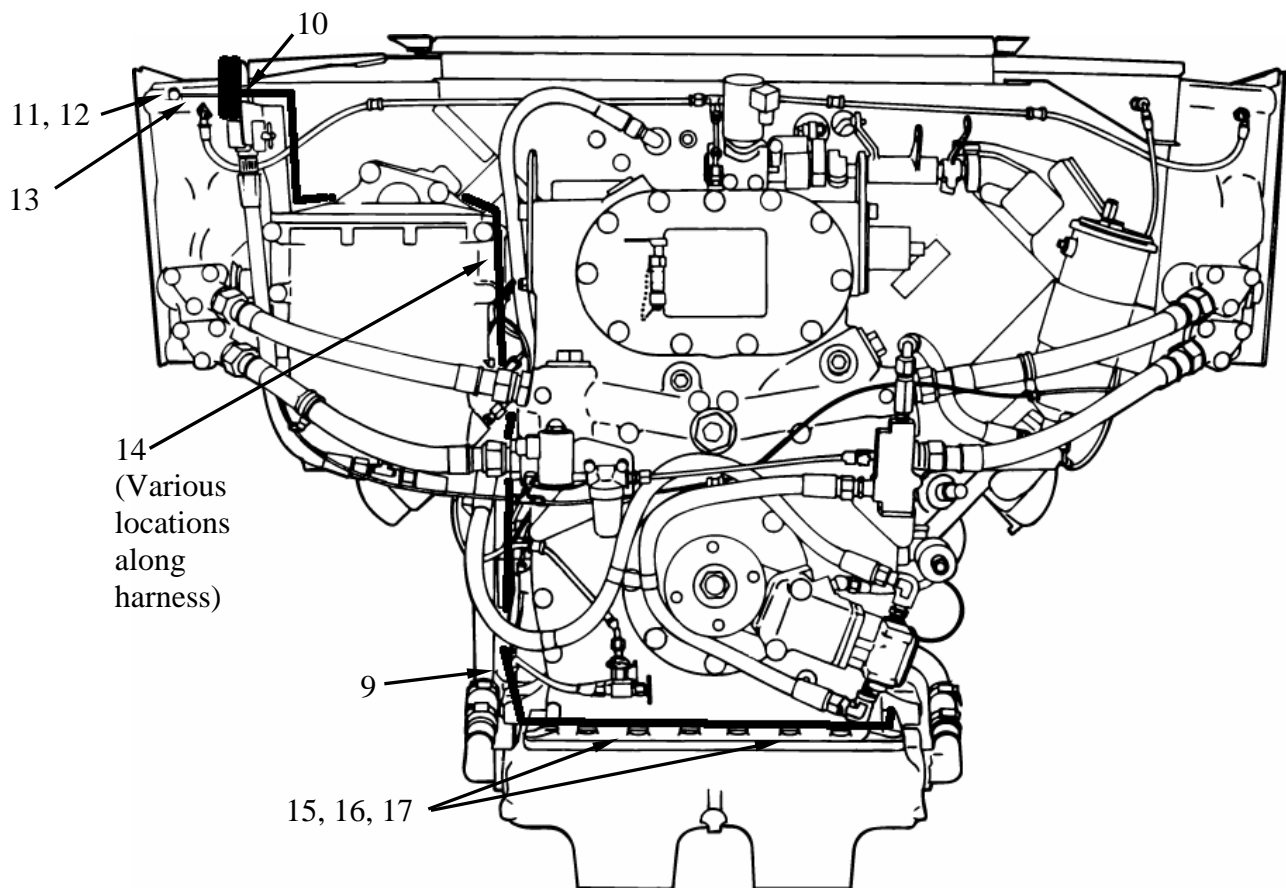


**SMOKE GENERATOR WIRING HARNESSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)**

0068 00

**REMOVAL (Continued)**

2. Remove single solenoid smoke generator wiring harness (9).
  - a. Disconnect electrical connector at solenoid (10).
  - b. Remove screw (11) and lock washer (12) retaining smoke solenoid ground wire (13). Discard lock washer.
  - c. Cut and remove tie wraps (14).
  - d. Remove screws (15), lock washers (16), and loop clamps (17) retaining smoke generator harness (9) along front of engine. Discard lock washers.

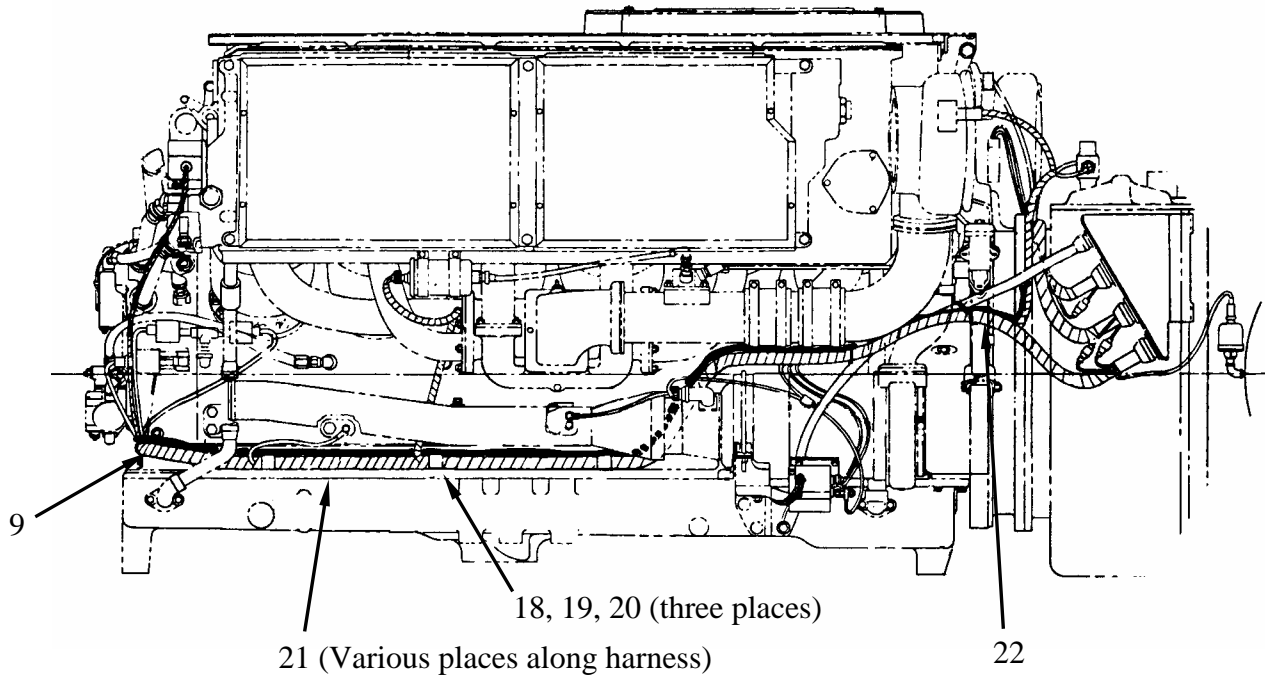


**SMOKE GENERATOR WIRING HARNESSSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)**

0068 00

**REMOVAL (Continued)**

2. Remove single solenoid smoke generator wiring harness (9) (continued).
  - e. Remove screws (18), lock washers (19), and loop clamps (20) retaining smoke generator harness (9) along generator side of engine. Discard lock washers.
  - f. Cut and remove tie wraps (21).
  - g. Disconnect electrical plug connector at T connection (22) of starter ground circuit.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

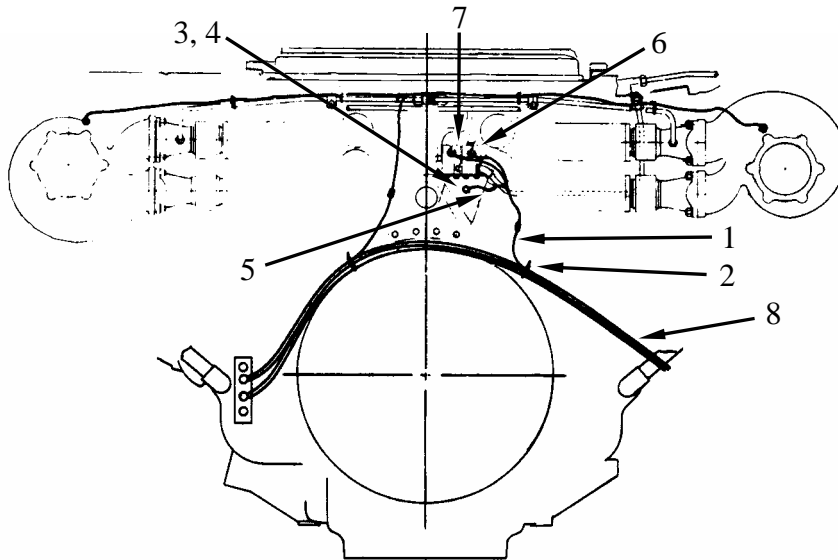
**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable and Repair.



**SMOKE GENERATOR WIRING HARNESSSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)****0068 00****INSTALLATION**

1. Install dual solenoid smoke generator wiring harness (1).
  - a. Position harness (1) in place on engine.
  - b. Connect electrical plug connector (8) at T connection of starter ground circuit.
  - c. Install electrical connectors (6) at smoke generator solenoid valves (7).
  - d. Secure smoke solenoid ground lead (5) with screw (3) and new lock washer (4) (item 93, WP 0175).
  - e. Install new tie wrap (2) (item 81, WP 0175).

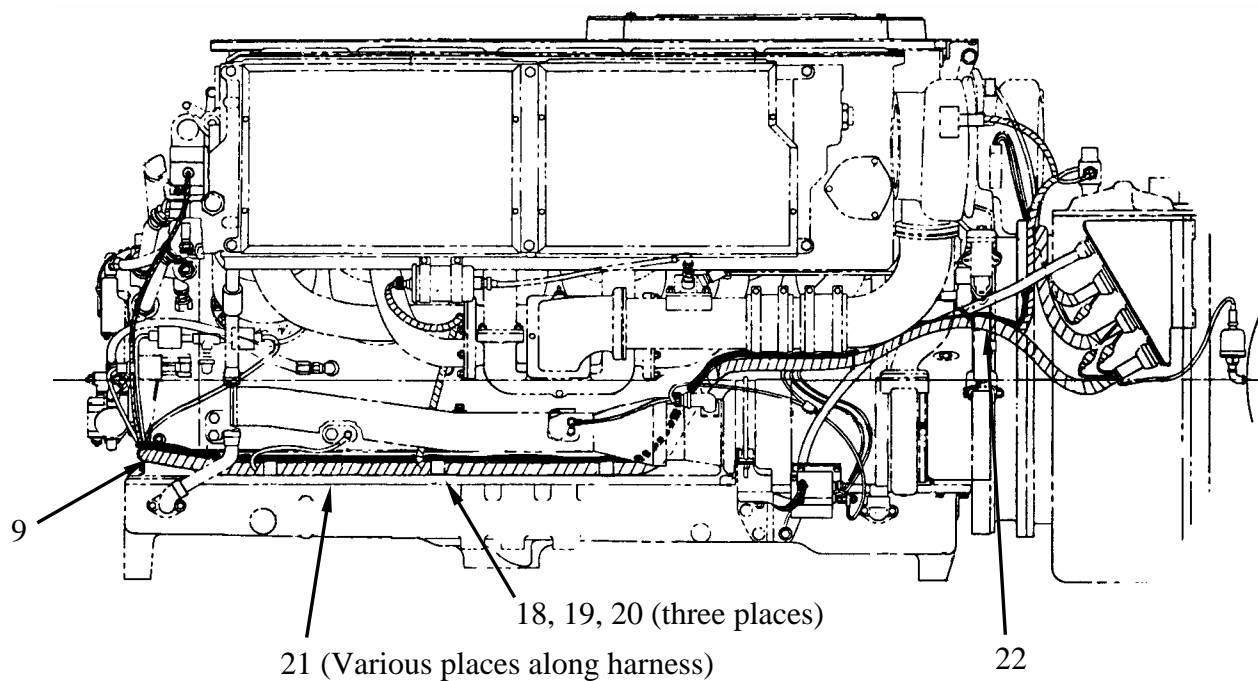


**SMOKE GENERATOR WIRING HARNESSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)**

0068 00

**INSTALLATION (Continued)**

2. Install single solenoid smoke generator wiring harness (9).
  - a. Position harness (9) in place on engine.
  - b. Install electrical plug connector at T connection (22) of starter solenoid ground harness.
  - c. Install wiring harness (9) into loop clamps (20).
  - d. Install three screws (18) and new lock washers (19) (item 92, WP 0175) into loop clamps (20).
  - e. Install new tie wraps (21) (item 80, WP 0175).

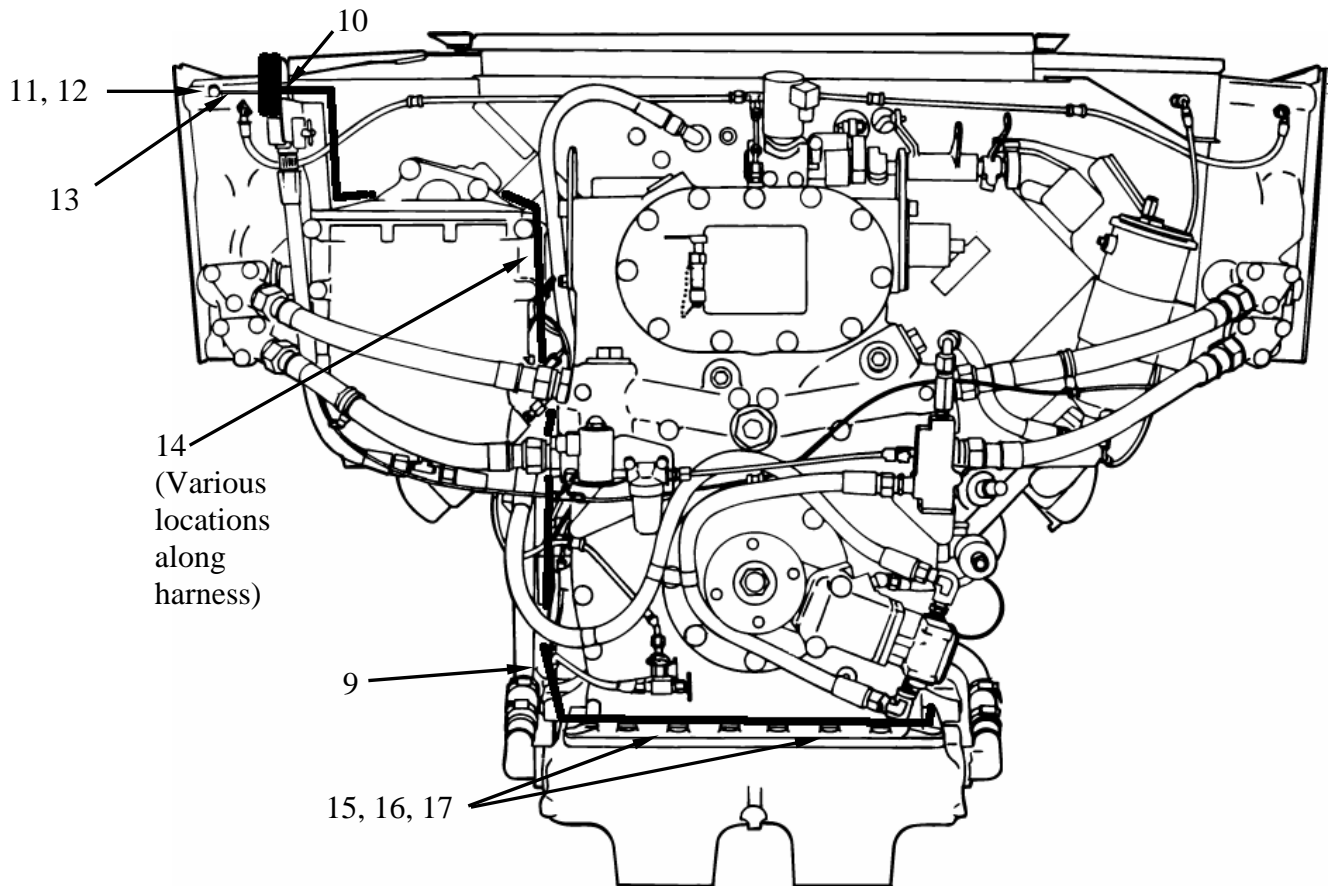


**SMOKE GENERATOR WIRING HARNESSES (2DR) REPLACEMENT  
(PN 12354467, 11672386)**

0068 00

**INSTALLATION (Continued)**

2. Install single solenoid smoke generator wiring harness (9) (continued).
  - e. Install electrical connector at solenoid (10).
  - f. Install ground wire (13) using screw (11) and new lock washer (12) (item 93, WP 0175).
  - g. Install harness (9) into loop clamps (17) using screws (15) and new lock washers (16) (item 92, WP 0175).
  - h. Install new tie wraps (14) (item 80, WP 0175).

**END OF WORK PACKAGE**



**FUEL INJECTION PUMP SHUTOFF LEAD REPLACEMENT (PN 10882641) 0069 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washers (4) (item 84, WP 0175)

Self-locking nut (3) (item 42, WP 0175)

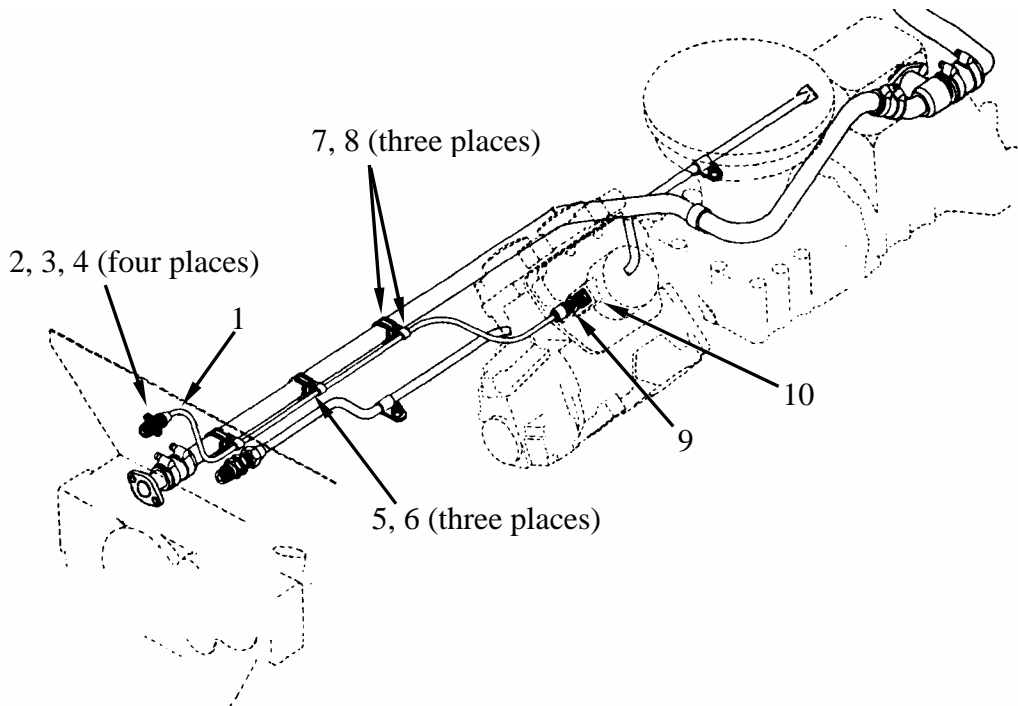
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

Engine front cooling fan and shroud removed WP 0054

**REMOVAL**

1. Remove fuel injection pump shut-off electrical lead (1).
  - a. Remove four machine screws (2), lock washers (3), and nuts (4) securing electrical lead (1) to engine front sheet metal. Discard lock washers.
  - b. Remove three machine screws (5), self-locking nuts (6) securing loop clamps (7, 8) to crankcase case breather tube and electrical lead. Discard self-locking nuts.
  - c. Disconnect electrical connector (9), at fuel injection pump (10).



**FUEL INJECTION PUMP SHUTOFF LEAD REPLACEMENT (PN 10882641) 0069 00**

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**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

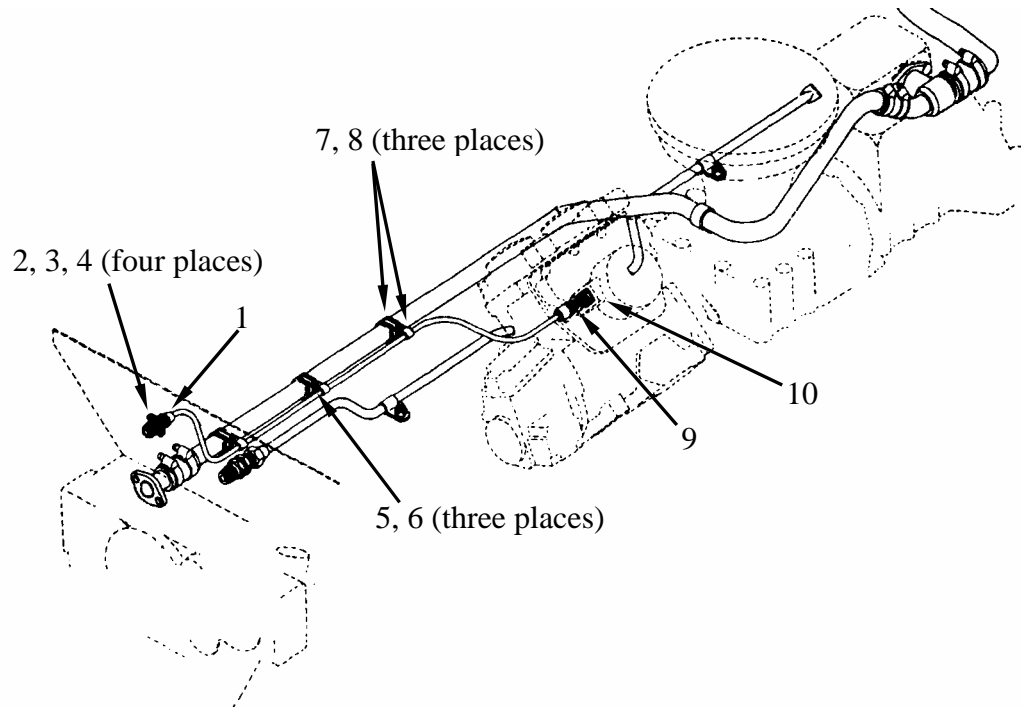
**REPAIR**

1. See Work Package 0056 for Wiring Harness Cable Repair.

**FUEL INJECTION PUMP SHUTOFF LEAD REPLACEMENT (PN 10882641) 0069 00**

**INSTALLATION**

1. Install fuel injection pump shut-off electrical lead (1).
  - a. Install four machine screws (2), new lock washers (3) (item 84, WP 0175), and nuts (4) securing electrical lead (1) to engine front sheet metal.
  - b. Install three machine screws (5), new self-locking nuts (6) (item 42, WP 0175) securing loop clamps (7, 8) to crankcase case breather tube and electrical lead.
  - c. Connect electrical connector (9), at fuel injection pump (10).



**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Inspection and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Vise (item 132, WP 0176)

**Equipment Conditions:**

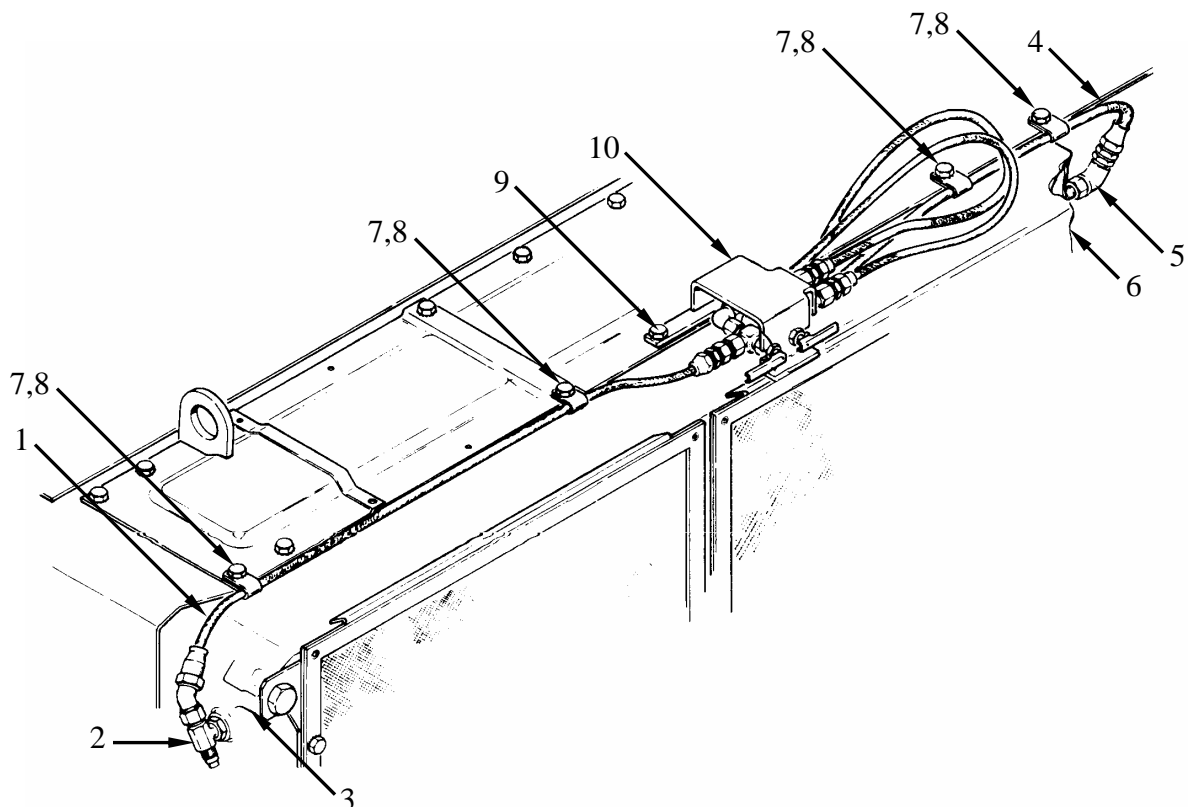
Engine removed from vehicle and placed on a  
flat stationary surface

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

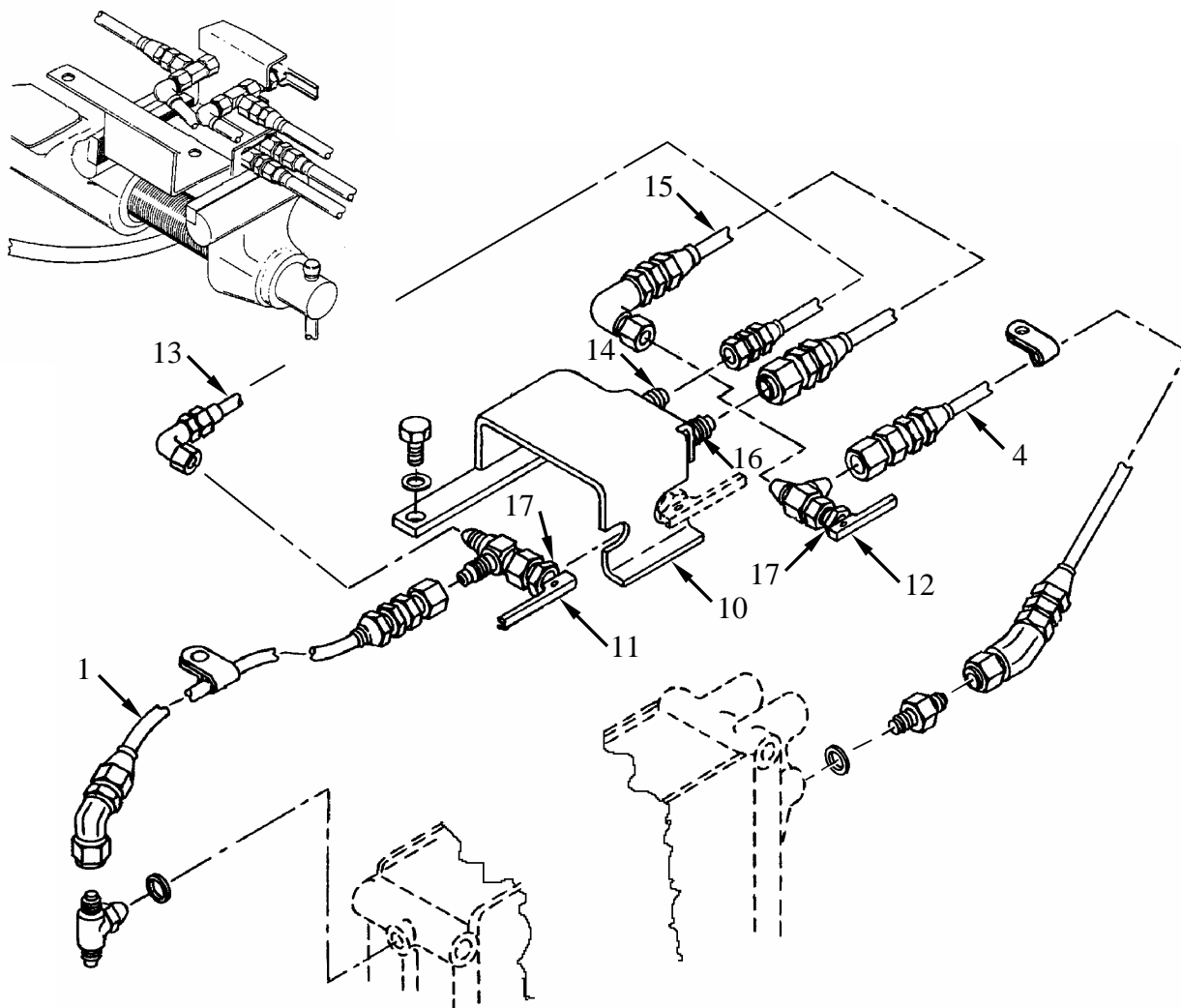
**REMOVAL**

1. Remove oil sampling system (right side of engine).
  - a. Disconnect oil hose (1) from tee (2) at engine oil cooler (3).
  - b. Disconnect oil hose (4) from adapter (5) at transmission oil cooler (6).
  - c. Remove four assembled washer bolts (7) securing four loop clamps (8).
  - d. Remove two assembled washer bolts (9) securing sampling valves mounting bracket (10).
  - e. Remove oil sampling system as an assembly.



**DISASSEMBLY**

1. Remove inlet hoses.
  - a. Place mounting bracket (10) in a vise or other suitable holding device.
  - b. Remove inlet hose (1) from 90-degree fitting of engine oil sampling valve (11).
  - c. Remove inlet hose (4) from 90-degree fitting of transmission oil sampling valve (12).
2. Remove outlet hoses.
  - a. Disconnect engine oil sampling outlet hose (13) from dead end fitting (14) on side of mounting bracket (10).
  - b. Disconnect transmission oil sampling outlet hose (15) from dead end fitting (16) on side of mounting bracket (10).
  - c. Disconnect opposite end of each outlet hose (13, 15) from straight fitting on each oil sampling valve (11, 12), and remove hoses.
3. Remove sampling valves.
  - a. Loosen locking nut (17) on each valve (11, 12) and slide valves out of mounting bracket.



## CLEANING

See Work Package 0028 for Standard Cleaning Procedures.

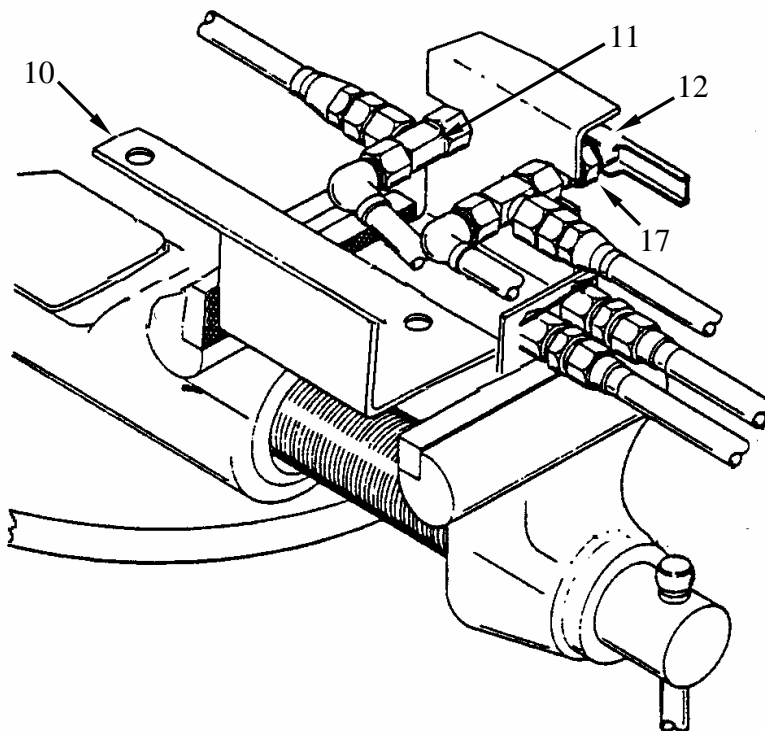
## INSPECTION

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Assure that activation handles of oil sampling valves are secure. If handles are loose or damaged, replace valve.
3. Inspect oil sampling valves for opening and closing action. Valves must open and close freely; if not, replace valve.
4. Check that valves do not leak. Replace any valve that leaks.

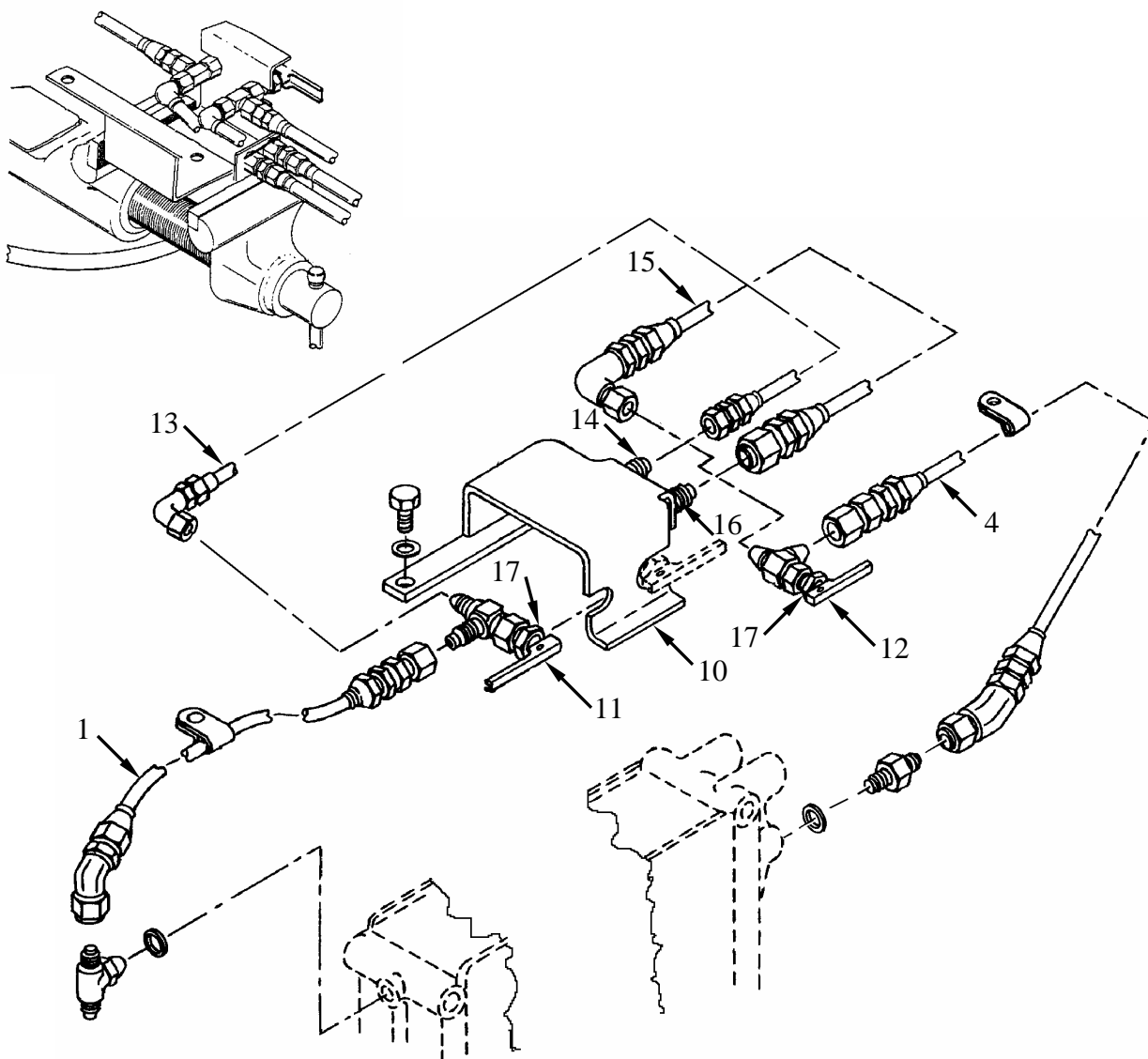
## ASSEMBLY

1. Install valves (11, 12) in bracket (10).
  - a. With bracket (10) clamped in a vise, position valves (11,12) as shown (with the handles and inlet ports facing opposite each other and parallel to bottom flanges of the mounting bracket).
  - b. Secure both valves (11,12) in mounting bracket (10) by tightening locking nut (17) on each valve.



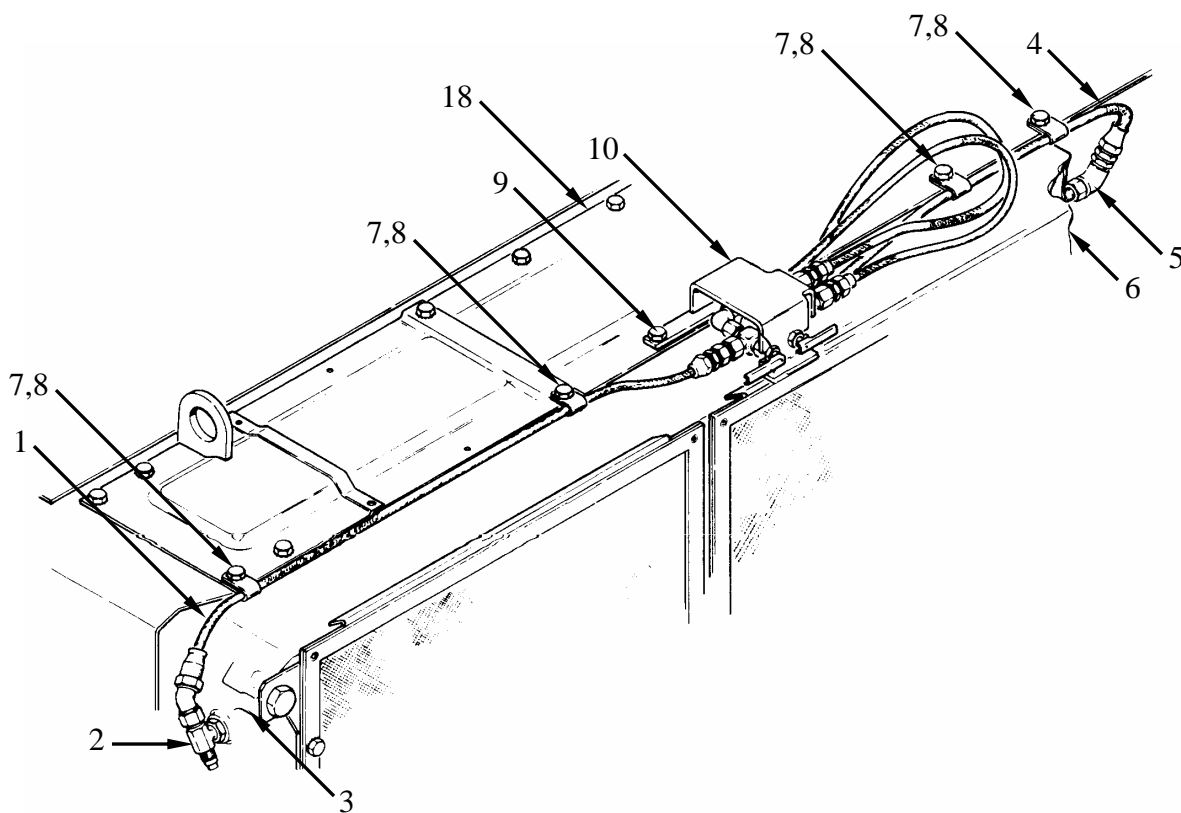
**ASSEMBLY (Continued)**

2. Connect outlet hoses (13, 15) to valves (11, 12).
3. Connect opposite ends of outlet hoses (13, 15) to dead end fittings (14, 16) on side of mounting bracket (10).
  - a. Connect engine oil sampling outlet hose (13) to dead end fitting (14) on side of mounting bracket (10).
  - b. Connect transmission oil sampling outlet hose (15) to dead end fitting (16) on side of mounting bracket (10).
4. Attach engine oil sampling inlet hose (1) to 90-degree fitting of left valve (11).
5. Attach transmission oil sampling inlet hose (4) to 90-degree fitting of right valve (12).



**INSTALLATION**

1. Install oil sampling system (right side of engine).
  - a. Remove oil sampling valve assembly from vise and place in position on right rear cover (18).
  - b. Secure bracket (10) to cover (18) with two assembled washer bolts (9).
  - c. Connect oil hose (1) to tee (2) at engine oil cooler (3).
  - d. Connect oil hose (4) to adapter (5) at transmission oil cooler (6).
  - e. Secure hoses (1, 4) with four loop clamps (8) using four assembled washer bolts (7).

**END OF WORK PACKAGE**



**OIL SAMPLING VALVE REPLACEMENT (2DR)**

0071 00

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Seal washer (item 158, WP 0175)

**Expendable and Durable Items:**

Lubricating oil (item 21, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

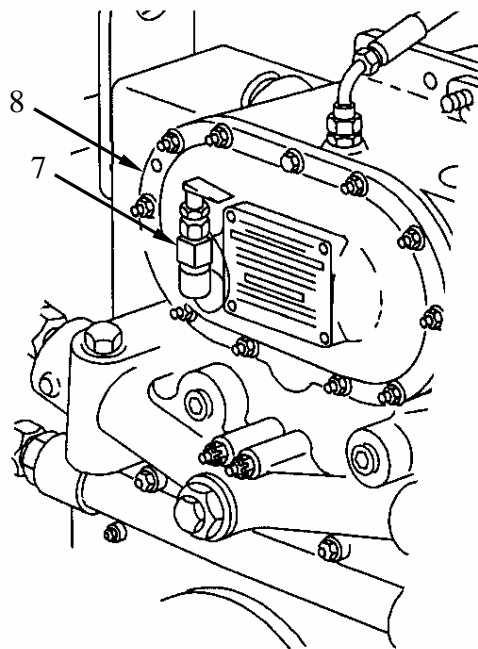
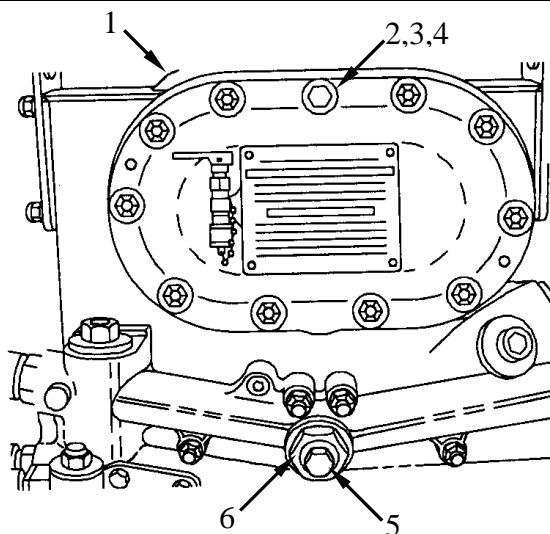
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL****NOTE**

**Step 1 opens an internal passage allowing oil to drain from the engine oil filter housing into the oil pan.**

1. Drain oil filter housing (1).
  - a. Remove oil vent cap screw (2) with flat washer (3) and seal washer (4). Discard seal washer (4).
  - b. Loosen oil drain valve (5) six complete turns to allow drainage into oil pan. Do not loosen oil drain valve adapter (6).
  
2. Remove oil sampling valve (7) from cover (8).

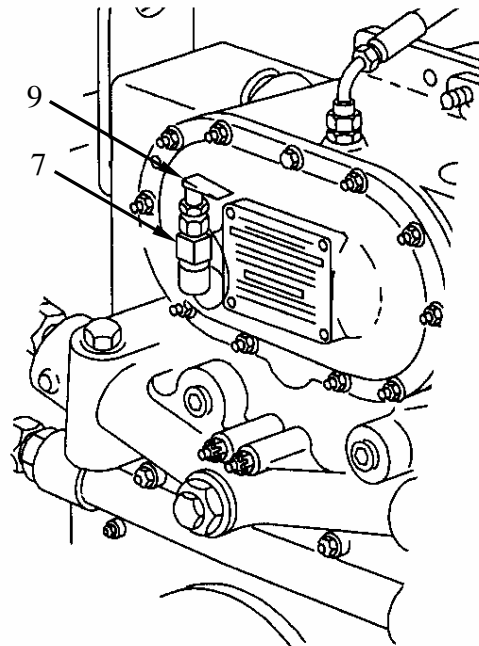
**CLEANING**

See WP 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See WP 0028 for Standard Inspection Procedures.
2. Assure that activation handle (9) of oil sampling valve (7) is secure. If handle is loose or damaged, replace valve.
3. Inspect oil sampling valve (7) for opening and closing action. Valve must open and close freely; if not, replace valve.
4. Check that valve does not leak. Replace any valve that leaks.

**INSTALLATION****CAUTION**

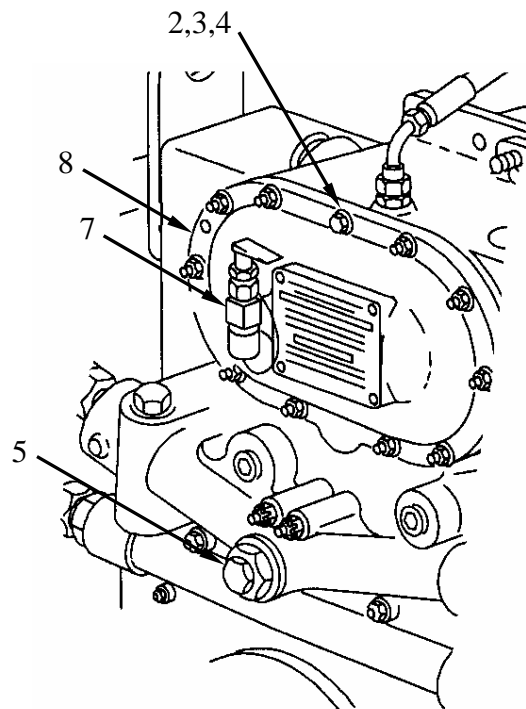
**Make sure oil sampling valve lever is parallel to oil filter cover and that protective cap is installed and secured on sampling valve. Failure to properly position oil sampling valve lever and secure protective cap may result in loss of engine oil and equipment damage.**

1. Install oil sampling valve (7) in cover (8).
2. Install vent cap screw (2).
  - a. Apply lubricant (item 21, WP 0173) to threads of cap screw (2) and install with flat washer (3) and new seal washer (4) (item 158, WP 0175).
  - b. Torque-tighten vent cap screw (2) to 125-150 inch-pounds (14-17 N•m).

**CAUTION**

**Failure to properly tighten drain valve can result in damage to engine. Valve must not be over tightened, nor under tightened.**

3. Apply lubricant to threads of drain plug (5) and torque-tighten to 150 inch-pounds (17 N•m).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Assembly and Installation

**INITIAL SETUP:**

**Tools:**

- Air pressure source
- General mechanic's tool kit (item 121, WP 0176)
- Oil cooler cleaning tool (item 20, WP 0176)
- Thermometer (item 119, WP 0176)
- Suitable container (5-gallon (19-liter) minimum)

**Mandatory Replacement Parts:**

- Gasket (2) (item 330, WP 0175)
- Gasket (2) (item 315, WP 0175)
- Nut, self-locking (6) (item 33, WP 0175)
- O-ring (2) (item 141, WP 0175)

**Expendable and Durable Items:**

- Cleaning compound, solvent (item 8, WP 0173)
- Cloth, abrasive, crocus (item 9, WP 0173)
- Goggles (item 23, WP 0173)
- Lubricating oil, engine (OE 30) as needed (item 27, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and on flat level surface
- Dust ejector tubes removed (WP 0083)

**NOTE**

The oil coolers on each side of the engine are removed in the same manner. Removal of right coolers is described in the following instructions. Your particular engine may have slightly different harness brackets from those illustrated; however, they are mounted in a similar fashion and are removed similarly.

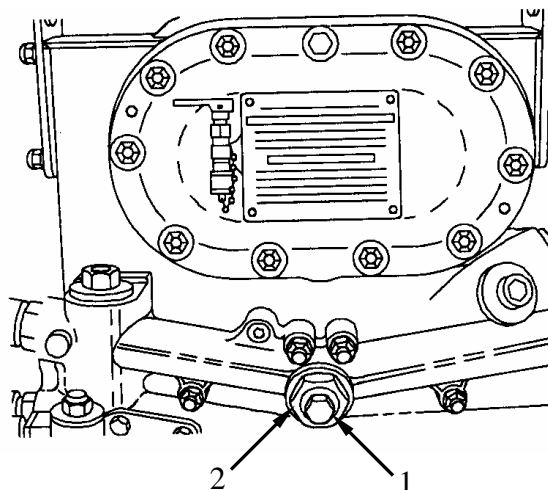
Model AVDS-1790-2DR oil cooler removal and installation instructions are similar to those described below except that this engine is not equipped with a top-mounted engine wiring harness, nor is the oil sampling system on the coolers; instead, a valve on the oil filter/damper housing serves the purpose.

**REMOVAL**

**NOTE**

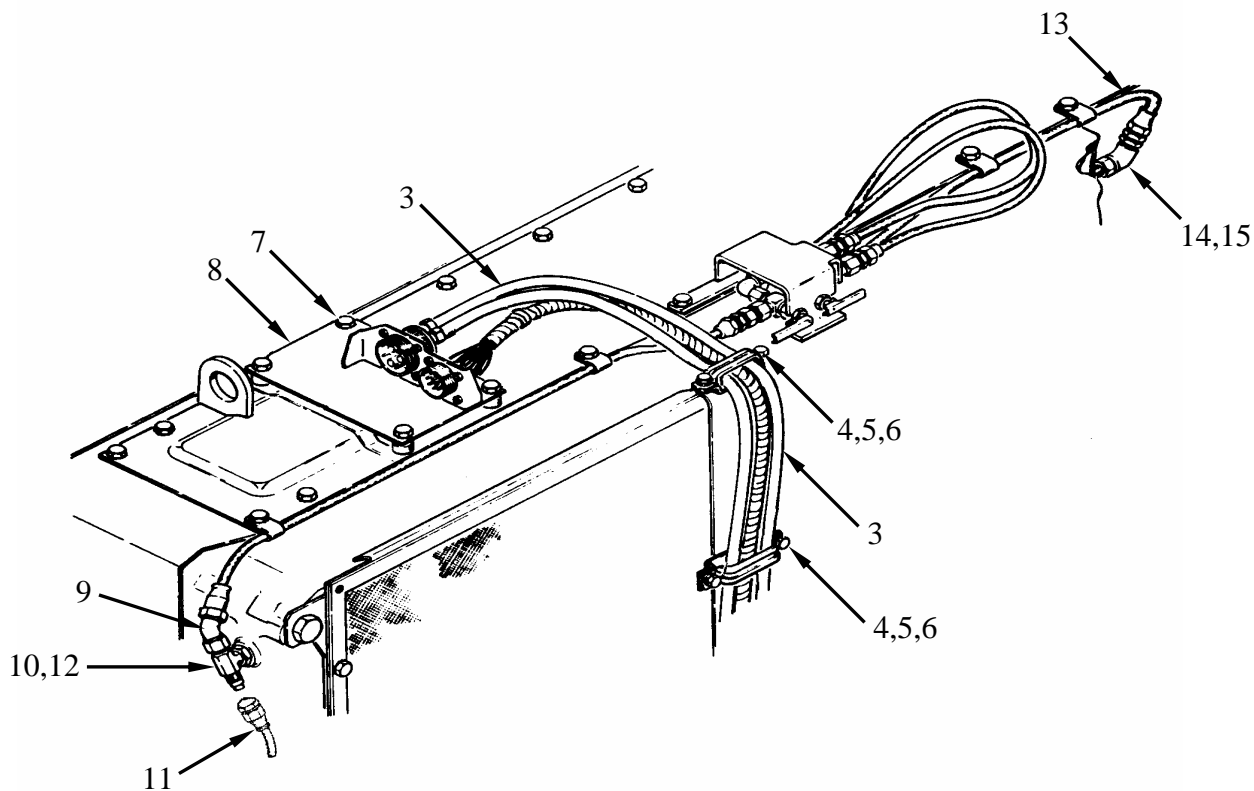
**Step 1 opens an internal passage allowing oil to drain from the engine oil coolers into the oil pan.**

1. Drain engine oil coolers.
  - a. Loosen oil drain valve (1) six complete turns. Do not loosen oil drain valve adapter (2).



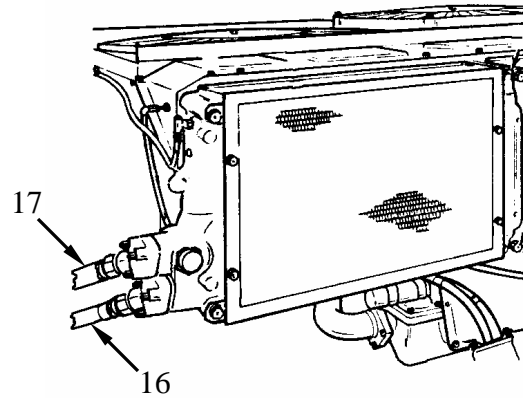
**REMOVAL (Continued)**

2. Move wiring harness (3) aside enough to access oil coolers.
  - a. Remove four cap screws (4) with lock washers (5) to remove two retaining straps (6).
  - b. Remove four assembled washer bolts (7) securing wiring harness bracket (8). Move harness (3) and bracket (8) aside as an assembly.
3. Disconnect engine oil cooler sampling hose (9) at tee (10).
4. Disconnect engine oil cooler vent hose (11) at tee (10).
5. Remove tee (10). Remove and discard O-ring (12) from tee (10).
6. Remove transmission oil sampler hose (13) at adapter fitting (14).
7. Remove adapter (14). Remove and discard O-ring (15) from adapter (14).



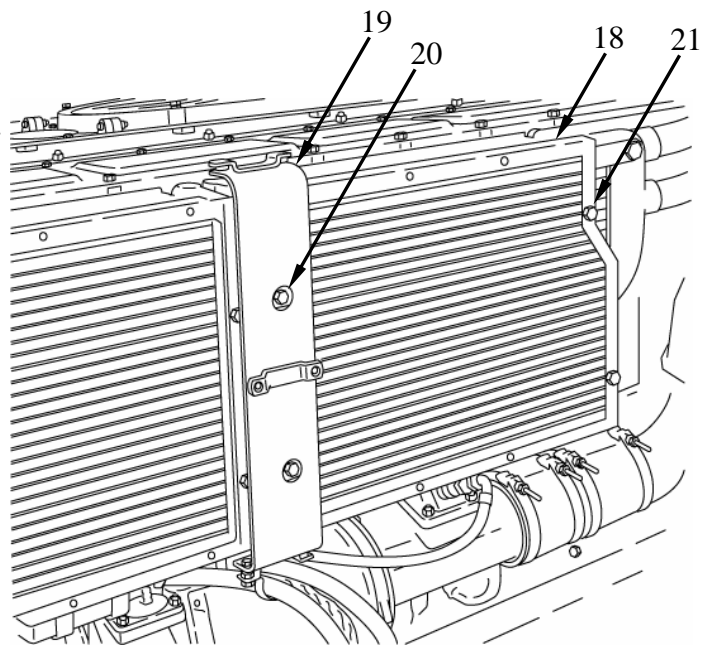
**REMOVAL (Continued)**

8. Disconnect oil cooler inlet hose (16) and oil cooler outlet hose (17).
  - a. Drain oil into a suitable container.



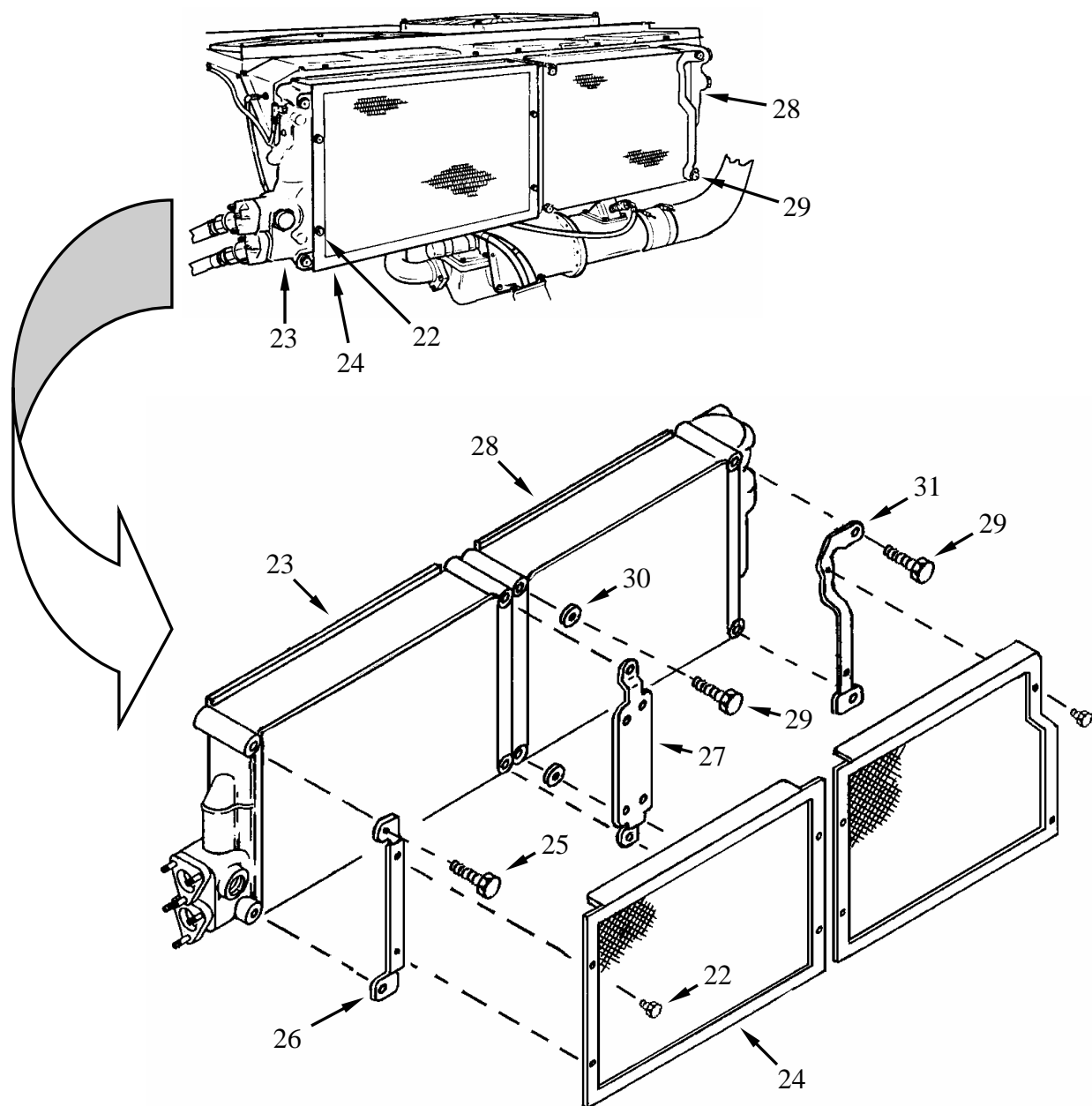
9. Remove transmission oil cooler screen (18).

- a. Remove harness bracket (19).
  - (1) Remove two assembled washer bolts (20).
  - (2) Remove bracket (19).
- b. Remove two assembled washer bolts (21).
- c. Remove transmission oil cooler screen (18).



**REMOVAL (Continued)**

10. Remove four screws (22) to remove engine oil cooler (23) screen (24).
11. Remove engine oil cooler (23).
  - a. Remove four screws (25) two brackets (26, 27) and engine oil cooler (23) as an assembly.
12. Remove transmission oil cooler (28).
  - a. Loosen four screws (29) (two with washers (30) and two with screen bracket (31)).
  - b. Remove screws (29), washers (30), screen bracket (31) and cooler (28) as an assembly.



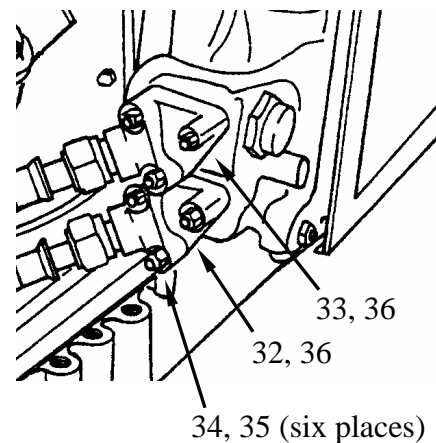
## REMOVAL (Continued)

## NOTE

**Adapter elbows for oil into and out of coolers all look the same. However, one of the elbows is shorter on engine models 2CA and 2DA; it goes on the left bank cooler and is the lower fitting (oil into cooler). Engine model 2DR adapter elbows are all the same length.**

13. Remove inlet (32) and outlet (33) adapter elbows.

- a. Remove six self-locking nuts (34) with flat washers (35). Discard self-locking nuts.
- b. Remove two adapter elbows (32, 33).
- c. Remove and discard gaskets (36).

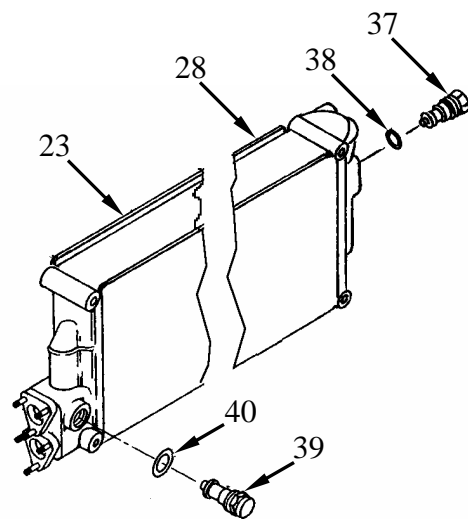


13. Remove transmission oil cooler (27) thermostatic bypass valve (37).

- a. Remove and discard gasket (38).

14. Remove engine oil cooler (23) thermostatic bypass valve (39).

- a. Remove and discard gasket (40).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.
2. Oil cooler cleaning instructions.
  - a. External surfaces of coolers may be cleaned using oil cooler cleaning tool (item 20, WP 0176).

**WARNING****Cleaning Compound Solvent - Compressed air**

- b. Clean thoroughly and blow dry with compressed air at 15 psi pressure.
- c. Flush oil cooler assemblies with cleaning compound solvent (item 8, WP 0173).
  - (1) Blow dry with compressed air at a pressure of 15 psi.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Inspect oil cooler assemblies for dented tubing or bent fins.
  - a. Carefully straighten bent fins with a flat tip screwdriver or other suitable tool.
  - b. If fins cannot be straightened, return cooler to depot for disposition.
3. Inspect gasket contact surfaces for burrs and raised metal.
  - a. Using crocus cloth (item 9, WP 0173) or other suitable medium, blend out burrs and raised metal. If damage will prevent gasket from sealing, return cooler to depot for disposition.

**CAUTION**

**Do not attempt to repair leaks in oil coolers by soldering. Soldering is not an acceptable repair because of the high operating temperature and pressure. Damage to equipment may occur.**

4. Pressure check coolers.
  - a. Seal all oil cooler openings.
  - b. Pump engine oil (OE) (item 27, WP 0173) into coolers at 400 psi hydrostatic pressure.
    - (1) Coolers must hold 400 psi for ten minutes without loss of pressure.
    - (2) Return leaking coolers to depot for disposition.
  - c. Release pressure, drain oil, and flush with cleaning compound solvent (item 8, WP 0173).
5. Inspect engine and transmission oil cooler thermostatic bypass valves for stripped or damaged threads. If found, replace with new valve.

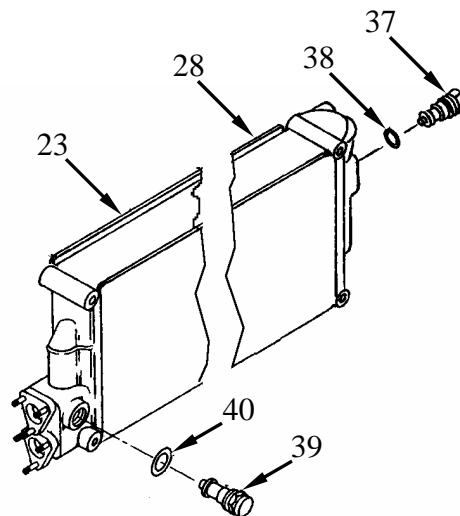
**INSPECTION (Continued)**

6. Check operation of thermostatic bypass valves.
  - a. Immerse valve in warm water. Check temperature of water with an accurate thermometer (item 119, WP 0176). Gradually raise temperature of water to temperature indicated on valve cover.
    - (1) Valves marked 148 °F must travel 1/4-inch between 90 and 150 °F.
    - (2) Valves marked 185 °F must travel 1/4-inch between 110 and 185 °F.
    - (3) Replace valve assembly when travel is less than 1/4 inch.
  - b. Remove valve from water and clean with cleaning compound solvent (item 8, WP 0173) or mineral spirits.
7. Check oil cooler hoses.
  - a. Inspect oil cooler outlet and inlet hoses for breaks in woven shielding. Replace hose if damage is found.
  - b. Test hoses at 400 psi. Replace hoses that do not pass pressure test.
8. Check oil cooler screens.
  - a. Inspect oil cooler screens for cracked or broken mounting brackets. Replace if found.
  - b. Straighten bent screens to as near original shape as possible.
  - c. Check for torn or broken screening. Replace screens that are unserviceable.

**INSTALLATION****NOTE**

**Adapter elbows for oil into and out of coolers all look the same. However, one of the elbows is shorter on engine models 2CA and 2DA; it goes on the left bank cooler and is the lower fitting (oil into cooler). Engine model 2DR adapter elbows are all the same length.**

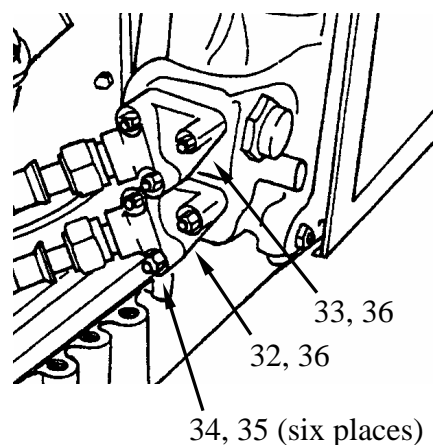
1. Install transmission oil cooler (28) thermostatic bypass valve (37).
  - a. Lubricate and put in place new gasket (38) (item 315, WP 0175).
  - b. Lubricate threads of thermostat (37) and install.
2. Install engine oil cooler (23) thermostatic bypass valve (39).
  - a. Lubricate and put in place new gasket (40) (item 315, WP 0175).
  - b. Lubricate threads of thermostat (39) and install.



**INSTALLATION (Continued)**

3. Install inlet (32) and outlet (33) adapter elbows.

- a. Position two new gaskets (36) (item 330, WP 0175) in place.
- b. Install two adapter elbows (32, 33).
- c. Secure using six new self-locking nuts (34) (item 34, WP 0175) with flat washers (35).

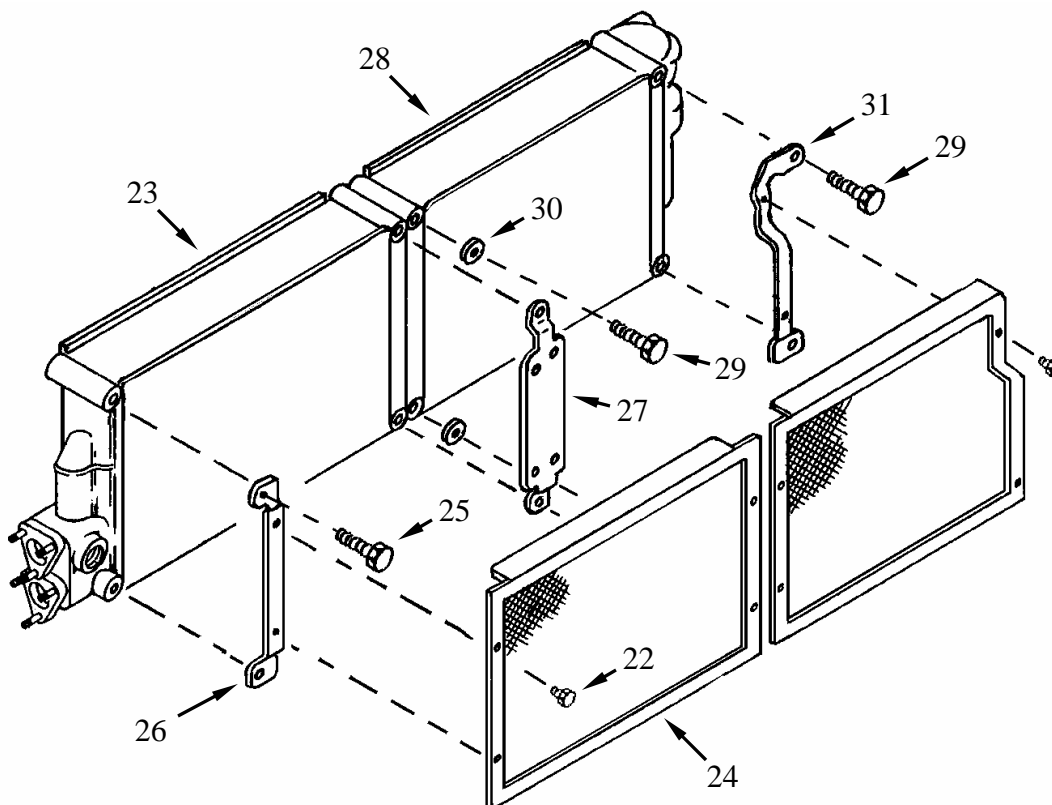


4. Install engine oil cooler (23).

- a. Install screws (25) screen (24) brackets (26, 27) and engine oil cooler (23) as an assembly.
- b. Tighten four screws (25).

5. Install transmission oil cooler (28).

- a. Install screws (29), washers (30), bracket (31) and cooler (28) as an assembly.
- b. Tighten four screws (29) (two with washers (30) and two with bracket (31)).

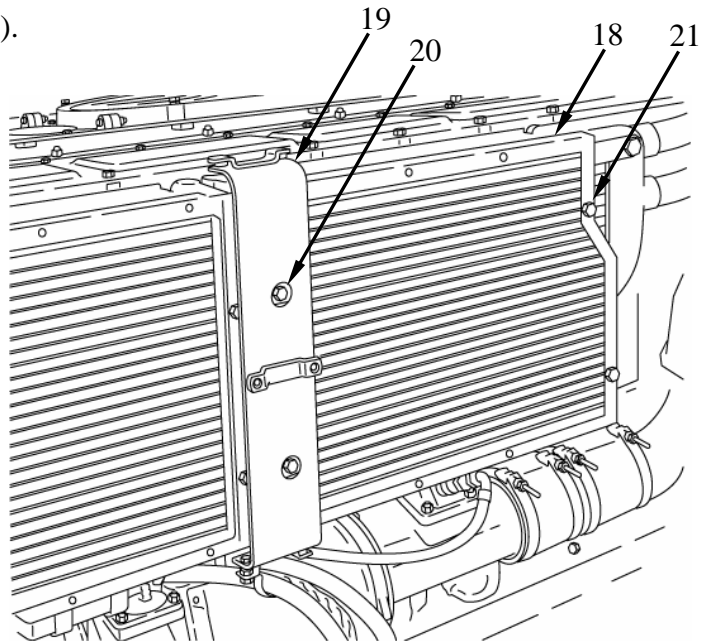




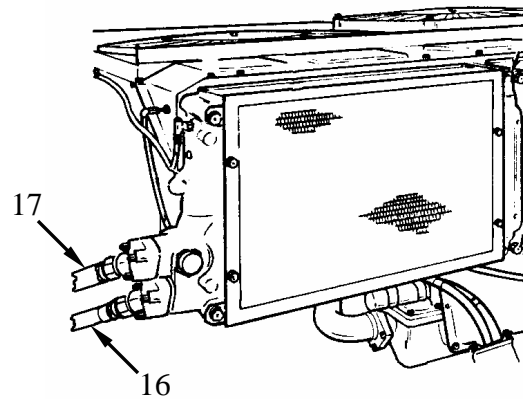
**INSTALLATION (Continued)**

6. Install transmission oil cooler screen (18).

- a. Position transmission oil cooler screen (18) in place.
- b. Secure with two assembled washer bolts (21).
- c. Install harness bracket (19).
  - (1) Position bracket (19).
  - (2) Secure bracket (19) and screen (18) with two assembled washer bolts (20).

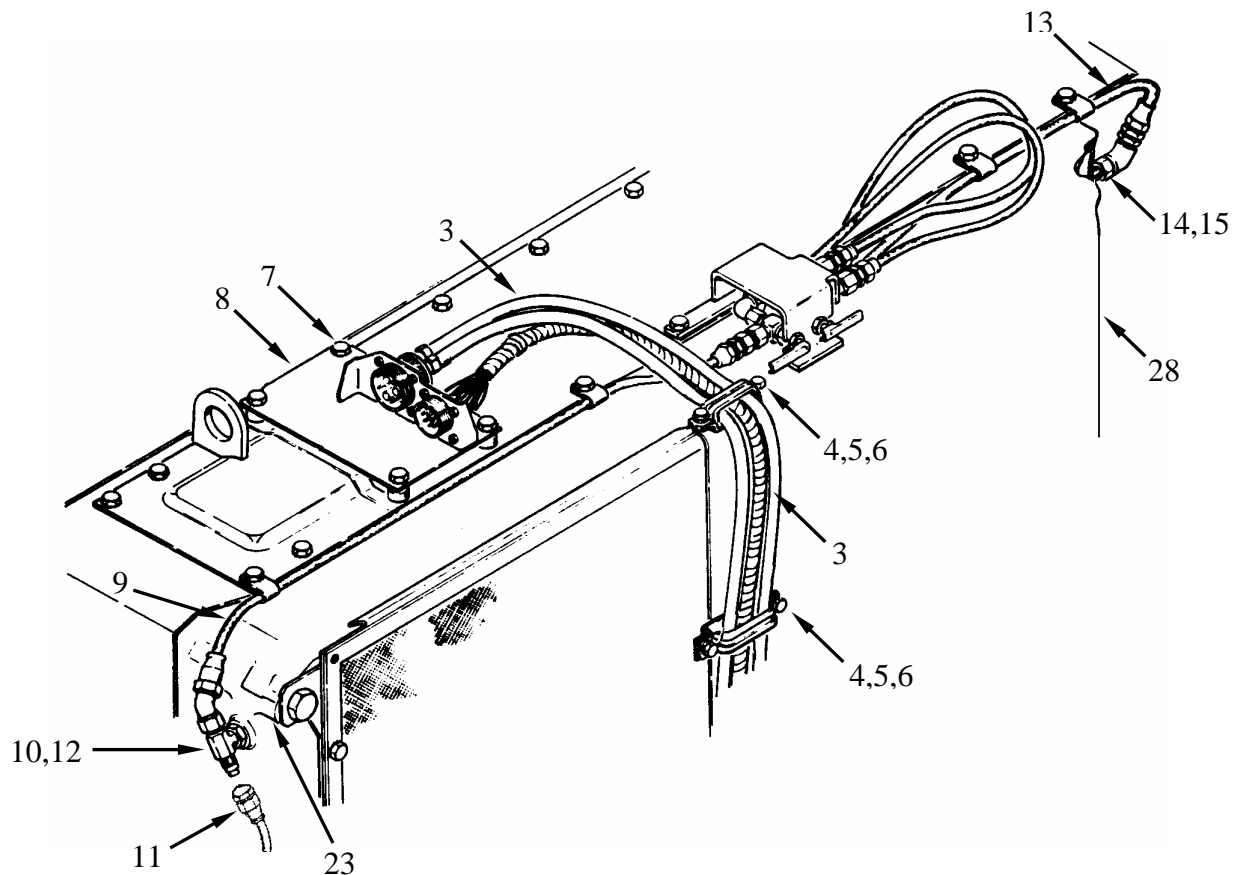


7. Connect oil cooler inlet hose (16) and oil cooler outlet hose (17)



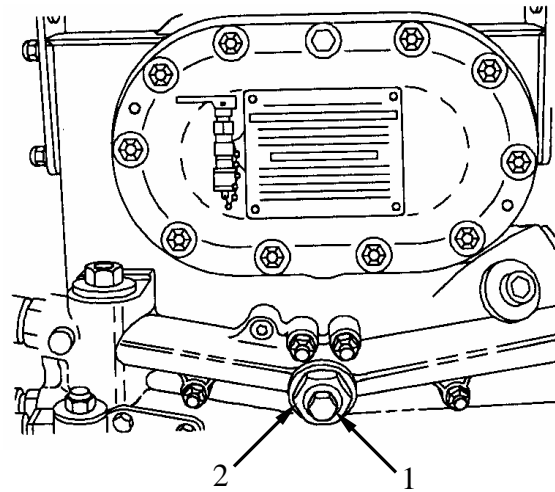
**INSTALLATION (Continued)**

8. Install adapter (14).
  - a. Lubricate new O-ring (15) (item 141, WP 0175) and place on adapter (14).
  - b. Install adapter (14) in transmission cooler (28).
9. Install transmission oil sampler hose (13) to adapter fitting (14).
10. Install tee (10).
  - a. Lubricate and install new O-ring (12) (item 141, WP 0175) onto tee (10).
  - b. Install tee (10) into engine oil cooler (23).
11. Connect engine oil cooler vent hose (11) to tee (10).
12. Connect engine oil cooler sampling hose (9) to tee (10).
13. Position wiring harness (3) in place as illustrated.
  - a. Move harness (3) and bracket (8) into place as an assembly.
  - b. Secure wiring harness bracket (8) with four assembled washer bolts (7).
  - c. Install two retaining straps (6) using four cap screws (4) with lock washers (5).



**INSTALLATION (Continued)**

14. Close drain valve (1).
  - a. Turn oil drain valve (1) until tight (150-inch pounds, 17 N•m) while holding adapter (2) so that adapter does not over tighten.

**CAUTION**

**Before returning the engine to service check oil level. Refer to Work Package 0031.**

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Installation

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Jackscrews (2) (item 71, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)
- Suitable container (1-gallon (4-liter) minimum)

**Mandatory Replacement Parts:**

- Gasket (item 240, WP 0175)
- Oil filter element (2) (item 218, WP 0175)
- Seal washer (item 158, WP 0175)
- Self-locking nut (10) (item 113, WP 0175)

**Expendable Materials:**

- Cleaning cloth (item 10, WP 0173)
- Lubricating oil (item 21, WP 0173)

**Personnel Required:**

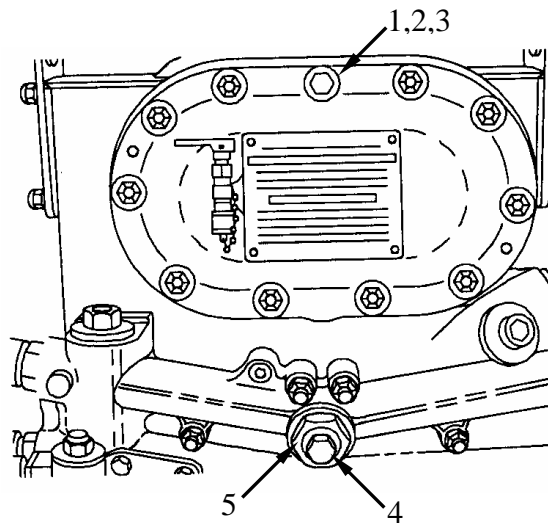
- Track Vehicle Repairer (2) 63H10

**Equipment Condition:**

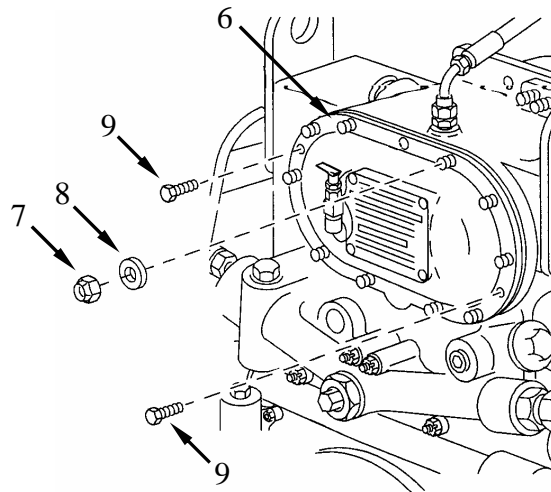
- Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

1. Drain oil filter housing and oil coolers.
  - a. Remove oil vent cap screw (1) with flat washer (2) and seal washer (3). Discard seal washer.
  - b. Loosen oil drain valve (4) six complete turns to allow drainage into oil pan. Do not loosen oil drain valve adapter (5).



2. Remove cover (6).
  - a. Remove ten self-locking nuts (7) with flat washers (8) to remove cover (6). Discard nuts (7).
  - b. Insert two 3/8-24 jackscrews (9) (item 71, WP 0176) in threaded puller holes and tighten alternately to remove cover (6).
  - c. Remove jackscrews (9).



**OIL FILTERS REPLACEMENT****0073 00****REMOVAL (Continued)**

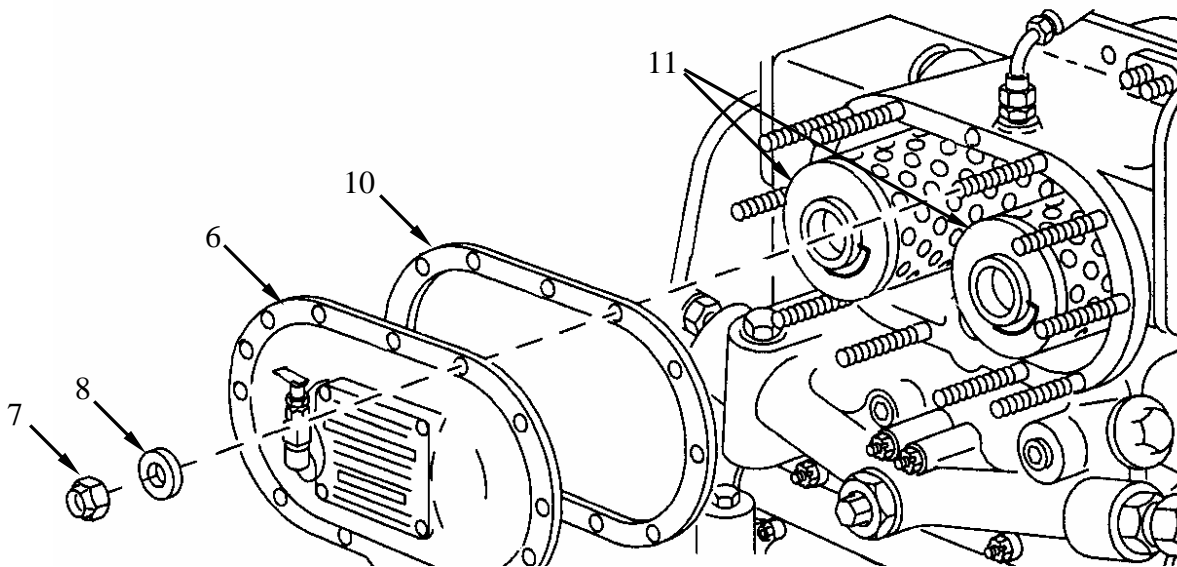
3. Remove and discard gasket (10).
4. Remove and discard oil filter elements (11).

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.
  - a. Clean filter body with a suitable clean, lint-free cloth (item 10, WP 0173) being careful not to drop any foreign particles into drain holes.

**INSTALLATION**

1. Install two new oil filter elements (11) (item 218, WP 0175).
2. Install cover (6) using new cover gasket (10) (item 240, WP 0175) and secure with ten new self-locking nuts (7) (item 113, WP 0175) with flat washers (8).

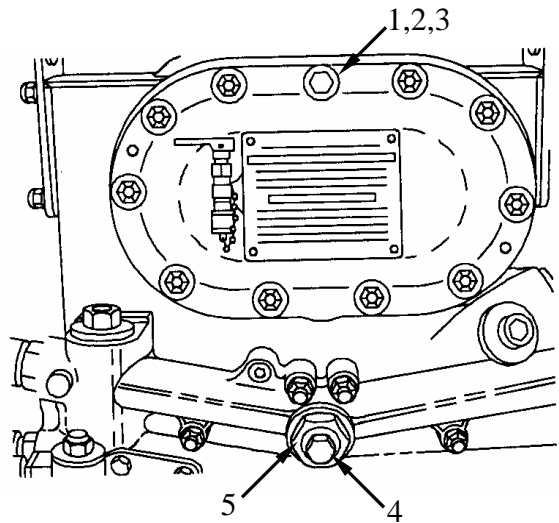


**INSTALLATION (Continued)**

3. Install oil vent cap screw (1).
  - a. Apply lubricant (item 21, WP 0173) to threads of cap screw (1) and install with flat washer (2) and new seal washer (3) (item 158, WP 0175).
  - b. Torque-tighten vent cap screw (1) to 125-150 inch-pounds (14-17 N•m) using torque wrench (item 124, WP 0176).

**CAUTION**

**Failure to properly tighten drain valve can result in damage to engine. Valve must not be over tightened, nor under tightened.**



4. Apply lubricant to threads of drain plug (4) and torque-tighten to 150 inch-pounds (17 N•m) using torque wrench (item 124, WP 0176).

**END OF WORK PACKAGE**





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**DAMPER/OIL FILTER HOUSING RELATED PARTS REPLACEMENT**

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**0074 00****THIS WORK PACKAGE COVERS:**

Removal, Installation

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

General mechanic's tool kit (item 121, WP 0176)

Retaining ring pliers (item 81, WP 0176)

**Mandatory Replacement Parts:**

Gasket (item 106, WP 0175)

Gasket (2) (item 242, WP 0175)

**Personnel Required**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

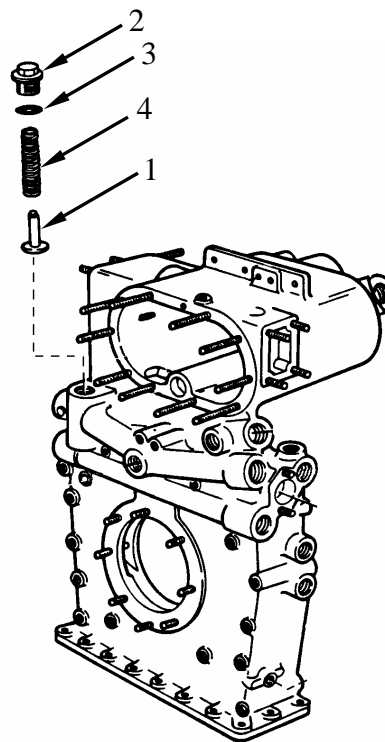
Engine removed from vehicle and placed on a flat stationary surface

Oil filter elements removed (WP 0073)

**REMOVAL****NOTE**

**Early model engines had an oil cooler bypass valve. Later model engines do not have this feature; it was found to be unnecessary. If your engine does not have an oil cooler bypass, skip step 1 and go to step 2.**

1. Remove oil cooler bypass plunger (1).
  - a. Remove plug (2).
  - b. Remove and discard gasket (3).
  - c. Remove spring (4) and plunger (1).

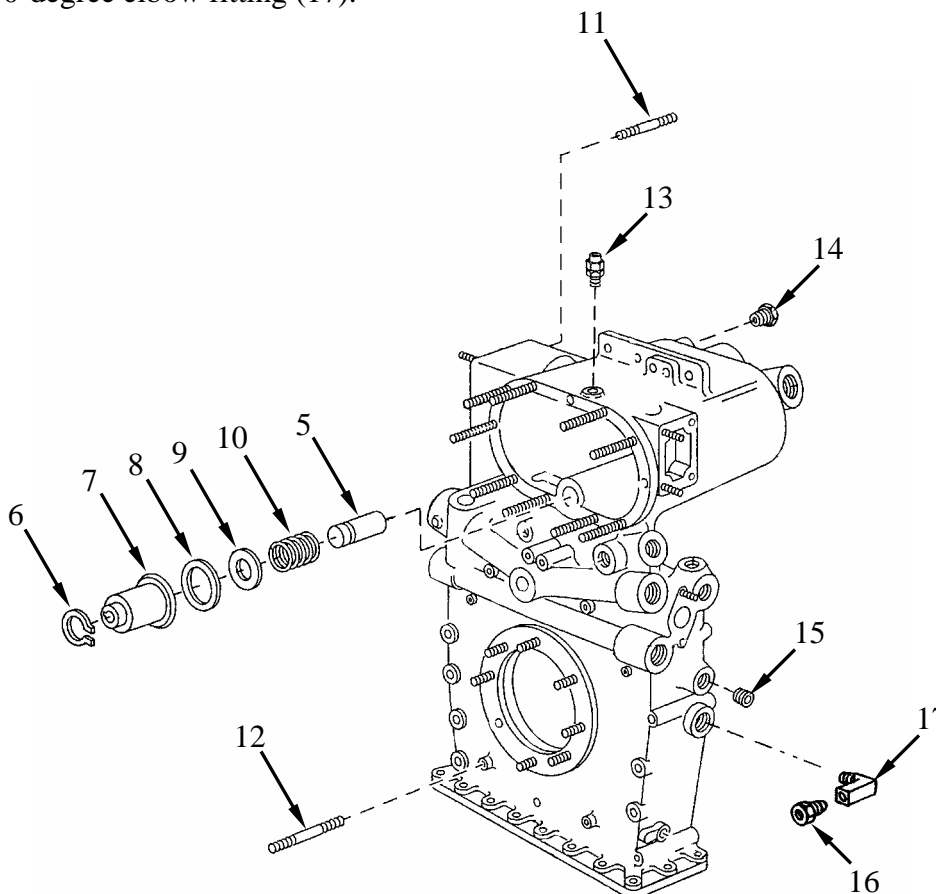


## REMOVAL (Continued)

## NOTE

**The two oil filter supports are identical. Only one is illustrated and described.**

2. Remove oil filter support (5).
  - a. Using retaining ring pliers (item 81, WP 0176), remove retaining ring (6).
  - b. Remove retainer (7).
  - c. Remove and discard oil filter element gasket (8).
  - d. Remove spring seat (9).
  - e. Remove compression spring (10).
  - f. Remove support (5).
3. Remove studs (11, 12) only if there is evidence of stripped threads or other damage.
  - a. Go to Work Package 0028 for procedures.
4. Remove fitting (13).
5. Remove bushings (14, 15, 16).
6. Remove 90-degree elbow fitting (17).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

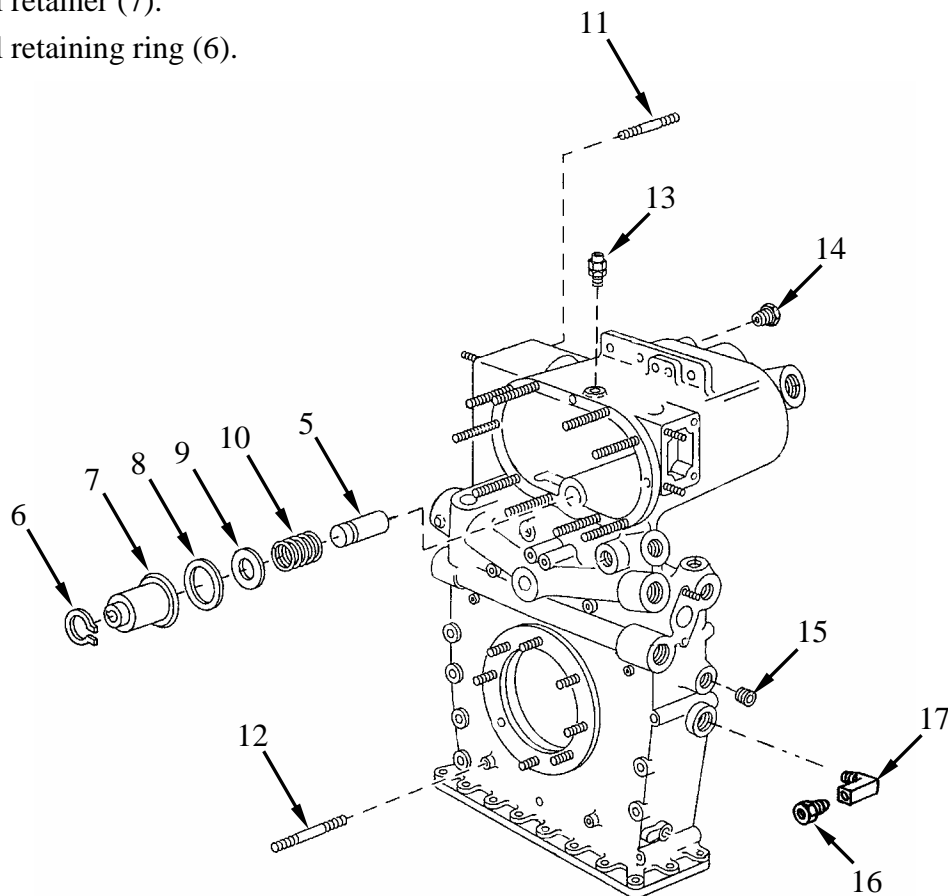
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install fittings (13, 17).
2. Install bushings (14, 15, 16).
3. Install studs (11, 12) if they were removed.
4. Install oil filter support (5).
  - a. Install support (5).
  - b. Install compression spring (10).
  - c. Install spring seat (9).
  - d. Install new gasket (8) (item 242, WP 0175).
  - e. Install retainer (7).
  - f. Install retaining ring (6).

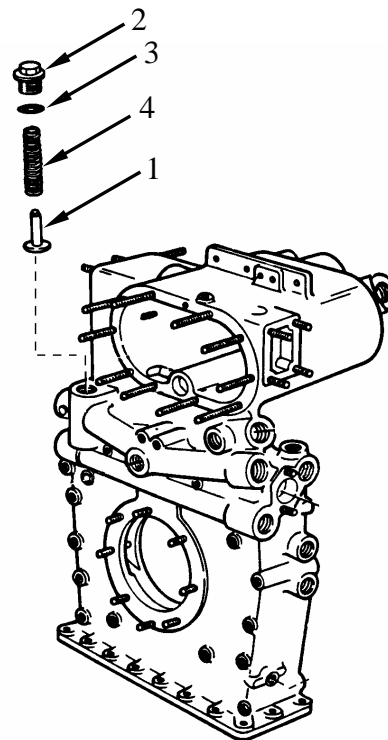


## INSTALLATION (Continued)

## NOTE

Early model engines had an oil cooler bypass valve. Later model engines do not have this feature, it was found to be unnecessary. If your engine does not have an oil cooler bypass, go to End of Work Package.

5. Install oil cooler, bypass plunger (1).
  - a. Install plunger (1) and spring (4).
  - b. Install new gasket (3) (item 106, WP 0175).
  - c. Install plug (2).



**END OF WORK PACKAGE**

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**OIL FILL TUBE REPLACE/REPAIR**

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0075 00

**THIS WORK PACKAGE COVERS:**Removal, Disassembly, Cleaning, Inspection, Assembly and Installation

---

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

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Gasket (item 288 , WP 0175)

Packing (item 285 , WP 0175)

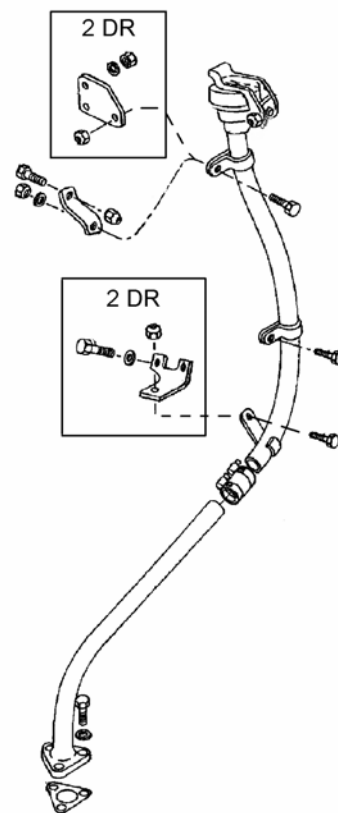
Seal washer (3) (item 303 , WP 0175)

**Equipment Conditions:**Engine removed from vehicle and placed on a flat stationary surface.

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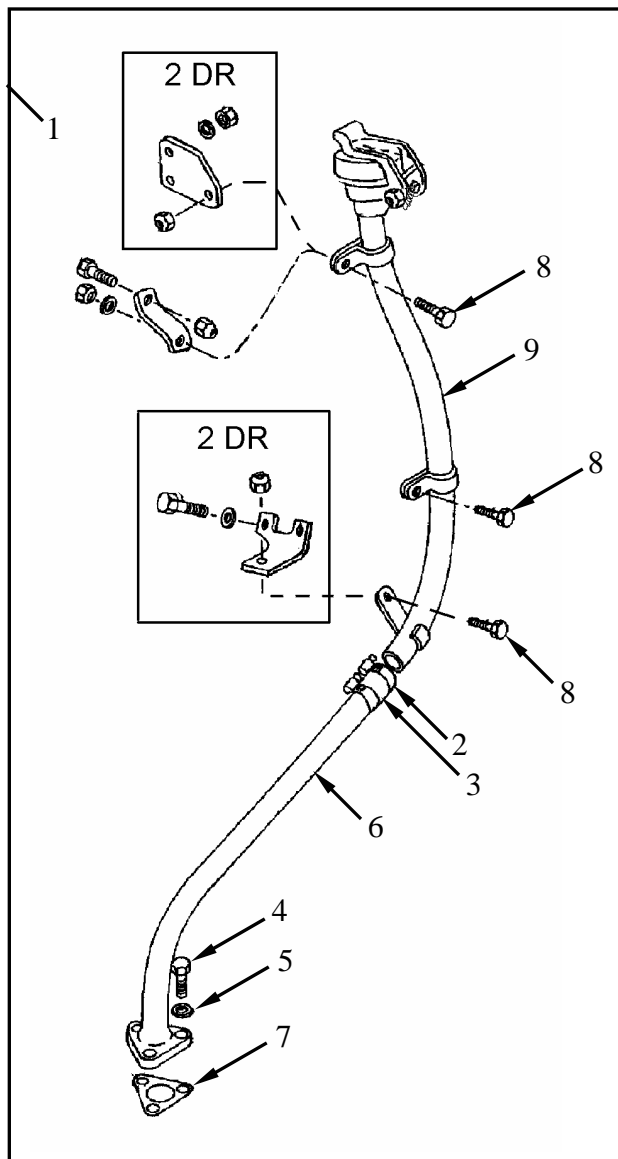
**REMOVAL****NOTE**

The oil filler tube for the 2DR engine has different support brackets than engine models 2CA and 2DA. Removal/replacement procedures are identical to 2CA and 2DA engines except for the support brackets.



**REMOVAL (Continued)**

1. Remove oil filler tube assembly (1).
  - a. Loosen upper clamp (2) at hose (3) connection.
  - b. Remove three cap screws (4) with seal washers (5). Discard seal washers.
  - c. Remove lower oil filler tube (6) with hose (3) and clamps (2) as an assembly.
  - d. Remove and discard gasket (7).
  - e. Remove cap screws (8).
  - f. Remove upper oil filler tube (9).



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**OIL FILL TUBE REPLACE/REPAIR**

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0075 00

**DISASSEMBLY**

1. Remove spring (10).
2. Remove and discard preformed packing (11) from cap (12).

**NOTE**

**Do not remove two cap screws (13) fastening cap (12) to tube (9) unless inspection indicates replacement is necessary. The screws are staked in place.**

3. If necessary, remove two cap screws (13).

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

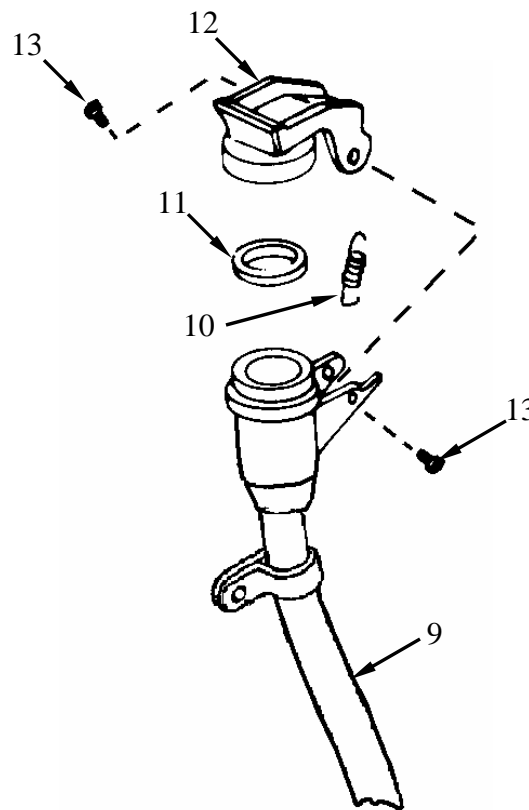
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

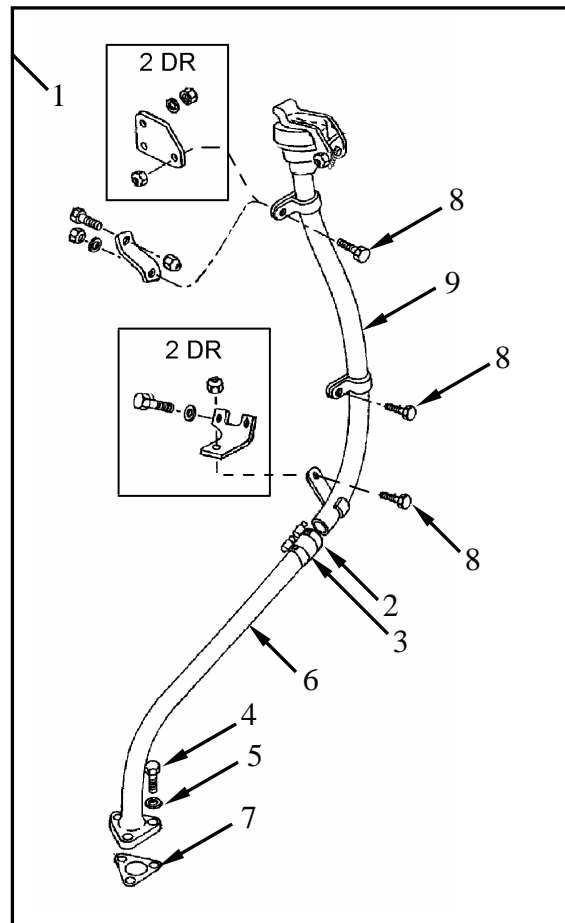
**ASSEMBLY**

1. Install new preformed packing (11) (item 285, WP 0175) in cap (12).
2. Assemble cap (12) to tube (9).
  - a. Position cap (12) over tabs on tube (9) and secure with two screws (13).
  - b. Snug-tighten two screws (13) so that cap (12) can open and close freely.
  - c. Stake screws (13) in place.
3. Install spring (10).



**OIL FILL TUBE REPLACE/REPAIR****0075 00****INSTALLATION**

1. Install oil filler tube assembly (1).
  - a. Install upper oil filler tube (9).
  - b. Secure upper tube (9) with cap screws (8).
  - c. Position new gasket (7) (item 288, WP 0175).
  - d. Install lower oil filler tube (6) with hose (3) and clamps (2) as an assembly.
  - e. Secure lower tube (6) with three cap screws (4) using new seal washers (5) (item 303, WP 0175).
  - f. Tighten upper clamp (2) at hose (3) connection.

**END OF WORK PACKAGE**



**OIL LEVEL GAUGE ROD REPLACEMENT/REPAIR**

**0076 00**

**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Assembly and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Gasket (item 288, WP 0175)

Gasket (item 192, WP 0175)

Lock washer (2) (item 93, WP 0175)

Lock washer (4) (item 85, WP 0175)

O-ring (2) (item 149, WP 0175)

Packing (item 285, WP 0175)

Self-locking nut (3) (item 33, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

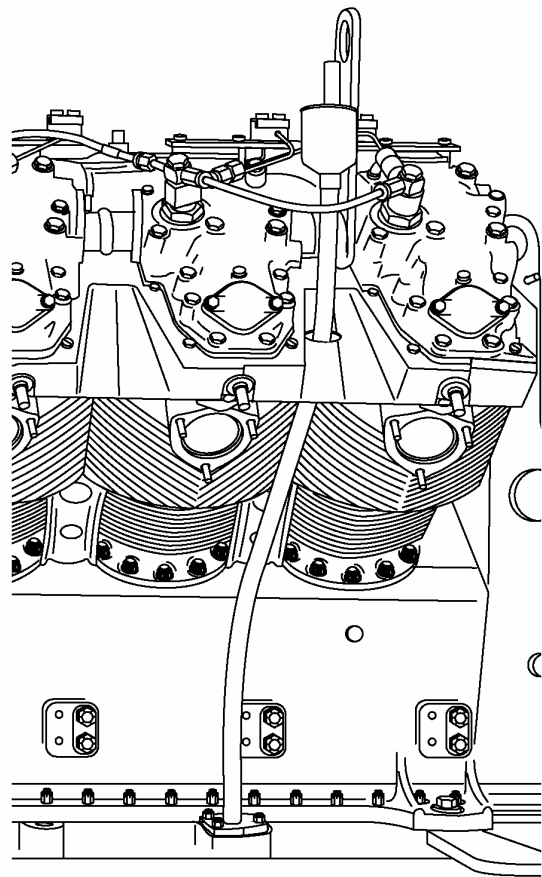
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

**NOTE**

**Engine models 2CA and 2DA locate the oil level tube between cylinders 1 and 2 left side. Engine model 2DR locates the oil level tube between cylinders 2 and 3 left side. Removal/installation procedures are identical.**



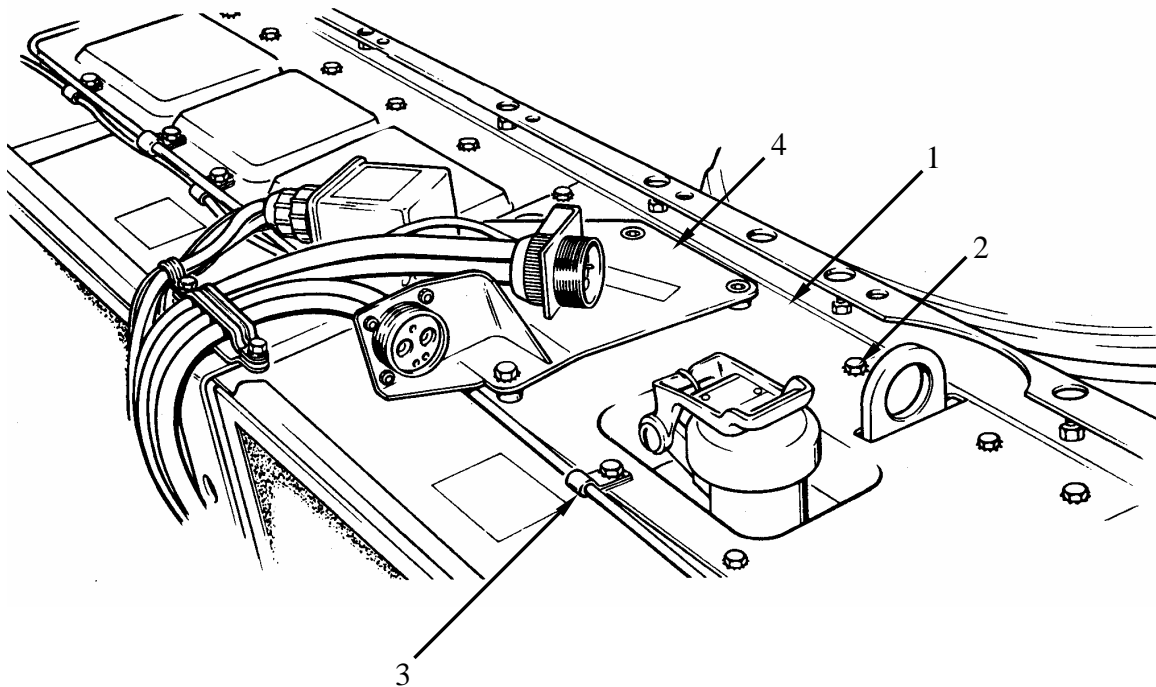
**REMOVAL (Continued)**

1. Remove left front upper cover (1).

**NOTE**

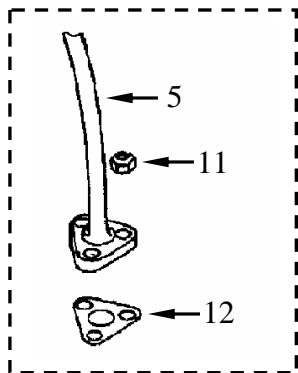
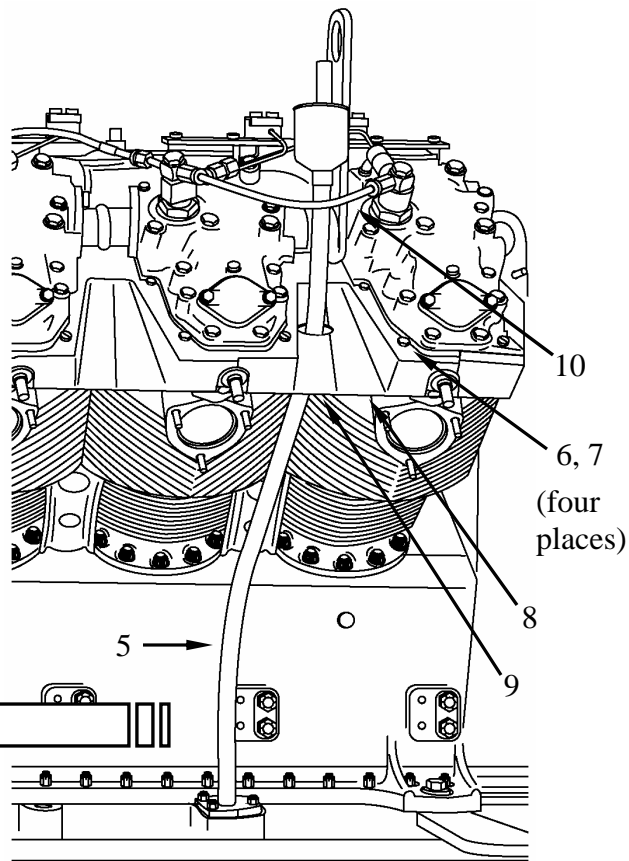
**There are twelve screws that fasten the cover. Some of the screws serve a dual purpose: four also fasten the generator wiring harness bracket, and another secures a clamp for the smoke generating fuel line.**

- a. Remove assembled washer screws (2) to remove cover (1).
- b. Position clamp (3), so that cover (1) will clear it on removal.
- c. Move wiring harness bracket (4) with wires attached aside just enough to remove cover (1).



**REMOVAL (Continued)**

2. Remove oil level indicator tube (5).
  - a. Remove four cap screws (6) with lock washers (7) to remove air baffles (8, 9). Discard lock washers.
  - b. Disconnect one end of fuel return hose (10).
  - c. Remove and discard three self-locking nuts (11).
  - d. Remove oil level indicator tube (5).
  - e. Remove and discard gasket (12).



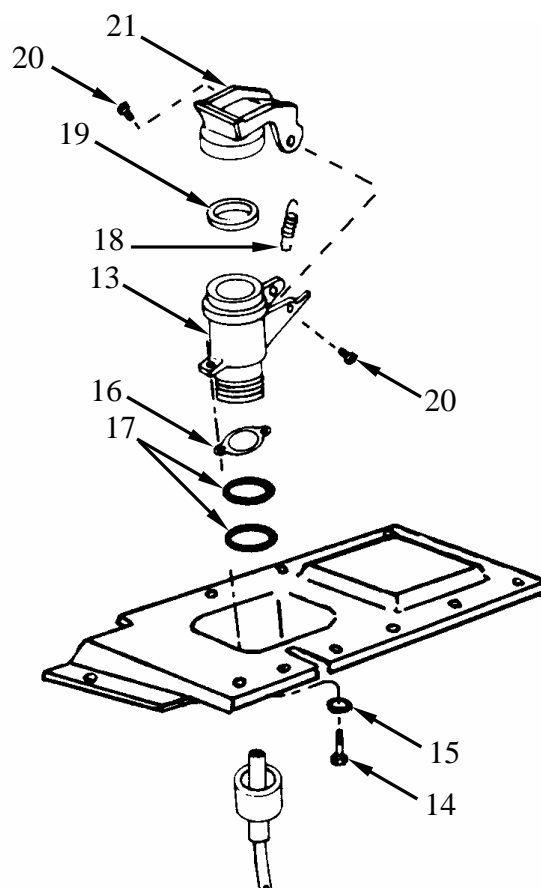
**DISASSEMBLY**

1. Remove oil level indicator tube neck (13).
  - a. Remove two cap screws (14) with lock washers (15). Discard lock washers.
  - b. Remove and discard gasket (16) and two O-rings (17).
2. Remove spring (18).
3. Remove and discard preformed packing (19).

**NOTE**

**Do not remove two cap screws (20) fastening cap (21) to neck (13) unless inspection indicates replacement is necessary. The screws are staked in place.**

3. If necessary, remove two cap screws (20).

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

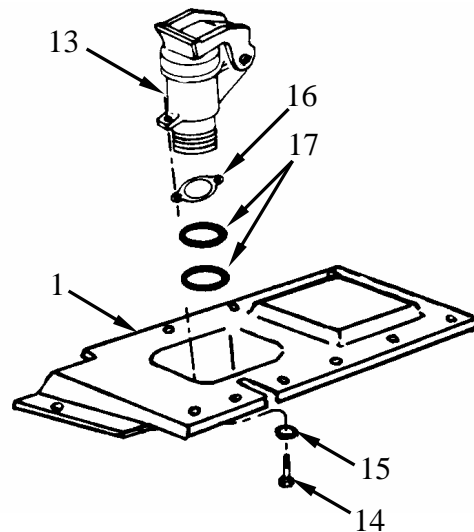
1. See Work Package 0028 for Standard Inspection Procedures.

**ASSEMBLY**

1. Install new preformed packing (19) (item 285, WP 0175) in cap (21).
2. Assemble cap (21) to neck (13).
  - a. Position cap (21) over tabs on neck (13) and secure with two screws (20).
  - b. Snug-tighten two screws (20) so that cap (21) can open and close freely.
  - c. Stake two screws (20) in place.
3. Install spring (18).

**ASSEMBLY (Continued)**

4. Install oil level indicator tube neck (13).
  - a. Position new gasket (16) (item 192, WP 0175) on neck (13).
  - b. Insert neck (13) through cover (1) and secure with two cap screws (14) using two new lock washers (15) (item 93, WP 0175).
  - c. Using Lubriplate (item 23, WP 0173), lubricate and install two new O-rings (17) (item 149, WP 0175) on neck (13).

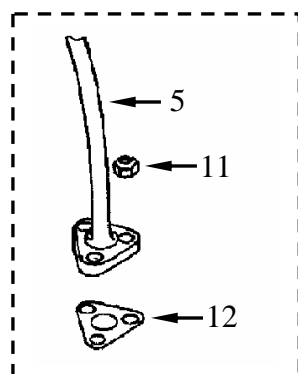
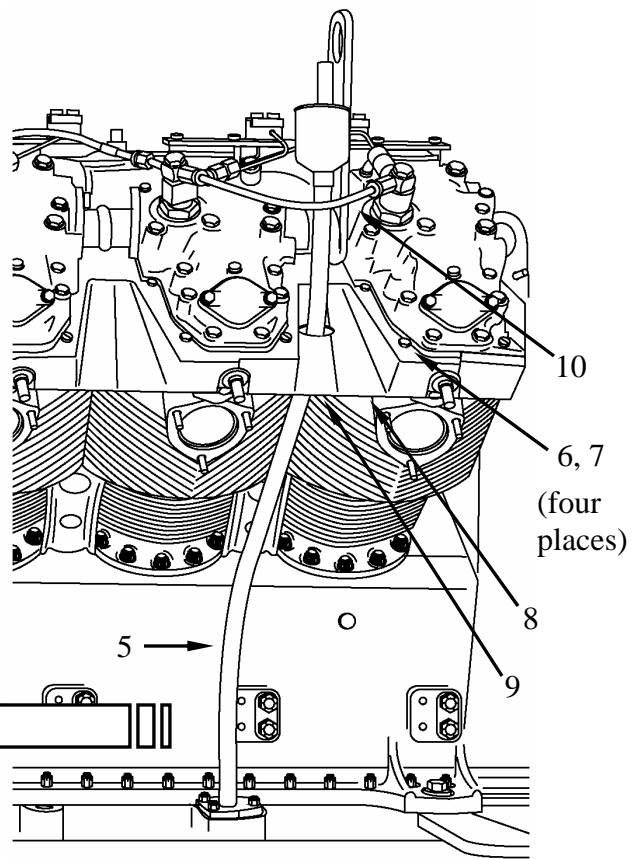


**INSTALLATION**

**NOTE**

**Engine models 2CA and 2DA locate the oil level tube between cylinders 1 and 2 left side. Engine model 2DR locates the oil level tube between cylinders 2 and 3 left side. Removal/installation procedures are identical.**

1. Install oil level indicator tube (5).
  - a. Position new gasket (12) (item 288, WP 0175).
  - b. Install oil level indicator tube (5).
  - c. Secure with three new self-locking nuts (11) (item 33, WP 0175).
  - d. Install air baffles (8, 9).
  - e. Secure with four cap screws (6) using new lock washers (7) (item 85, WP 0175).
  - f. Connect fuel return hose (10).



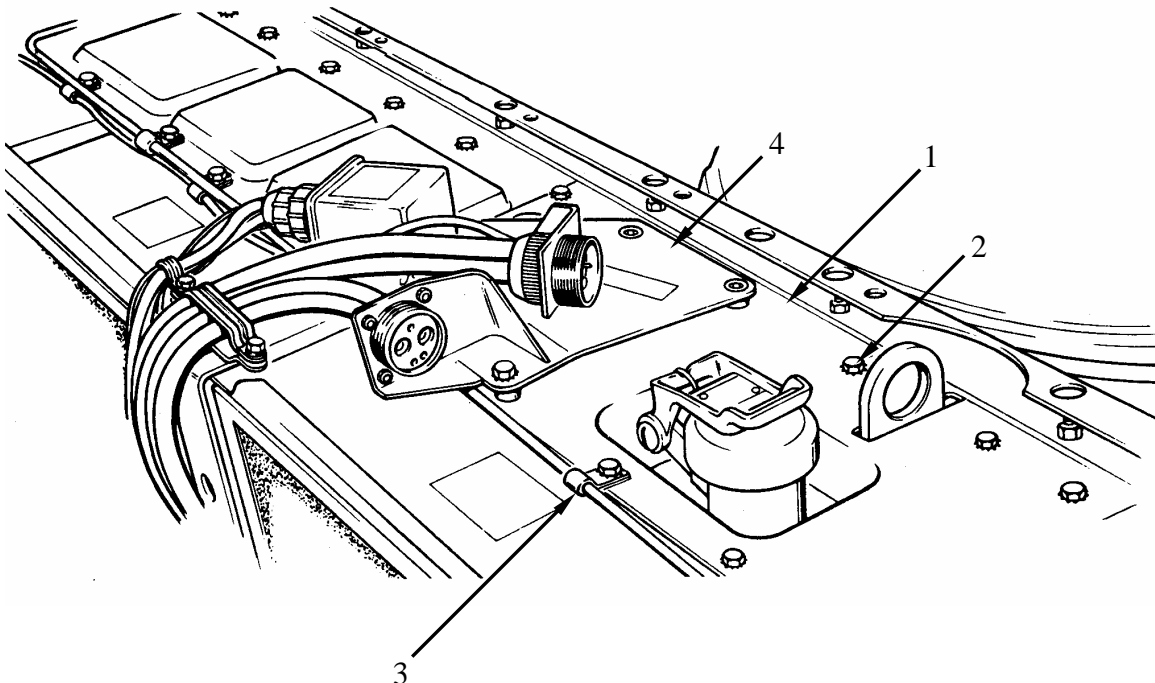
**INSTALLATION (Continued)**

2. Install left front upper cover (1).
  - a. Place cover (1) in position.
  - b. Position clamp (3) as illustrated.
  - c. Move wiring harness bracket (4) with wires attached into position.

**NOTE**

**There are twelve screws that fasten the cover. Some of the screws serve a dual purpose: four also fasten the generator wiring harness bracket, and another secures a clamp for the smoke generating fuel line.**

- d. Secure cover (1) with assembled washer screws (11).

**END OF WORK PACKAGE**

**CYLINDER OIL DRAIN TUBES REPLACEMENT**

**0077 00**

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Container (for residual oil)
- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 200-1000 inch-pounds (item 125, WP 0176)

**Mandatory Replacement Parts:**

- Copper gasket (24) (item 283, WP 0175)
- Gasket (4) (item 159, WP 0175)
- Hose (18) (item 313, WP 0175)
- Lock washer (8) (item 93, WP 0175)

**Expendable and Durable Items:**

- Lubricating oil (item 21, WP 0173)

**Personnel Required:**

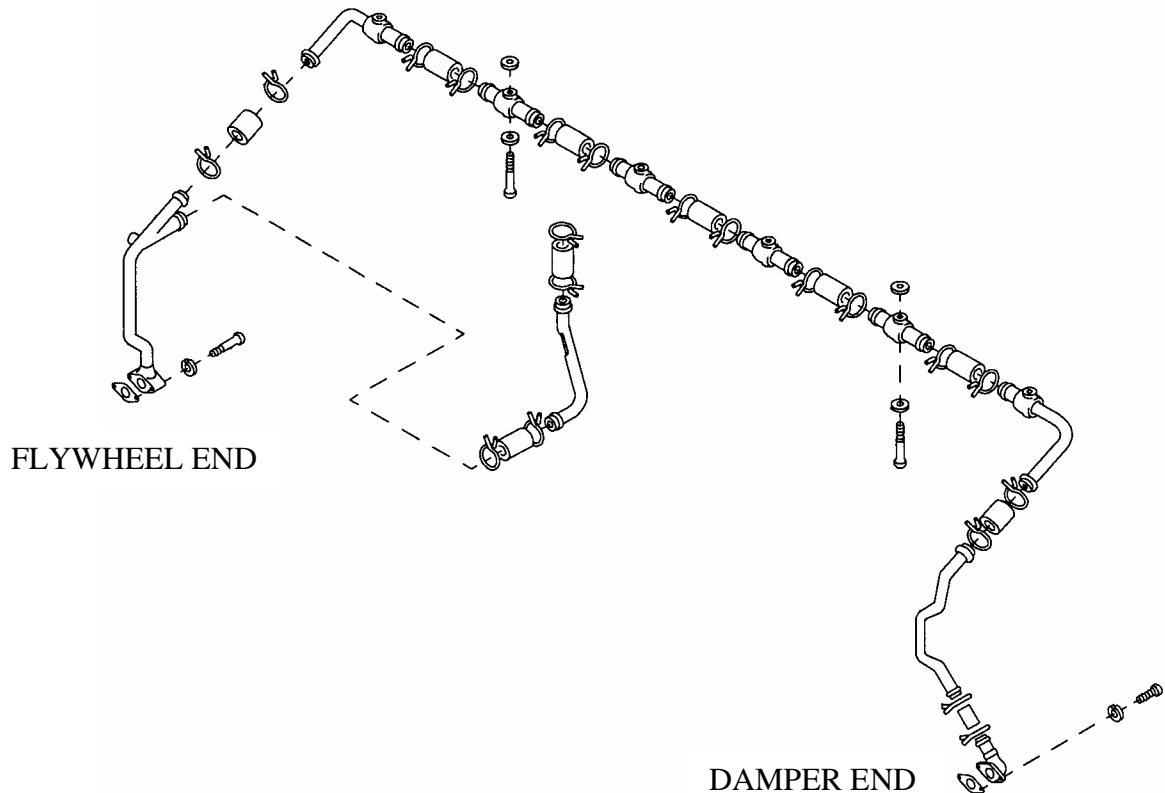
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine oil drained (WP 0031)
- Engine and transmission oil coolers removed (WP 0072)
- Engine generator oil cooling system lines and fittings removed (WP 0091) 650 ampere generator only
- Generator removed (650 Ampere) (WP 0051)
- Generator removed (300 Ampere) (WP0052)
- Starter removed (WP 0049)
- Primary fuel filter removed (WP 0086)
- Fuel/water separator removed (WP 0085)
- Engine oil cooler frames removed (WP 0090)

**REMOVAL**

Right Bank Oil Drain Assembly

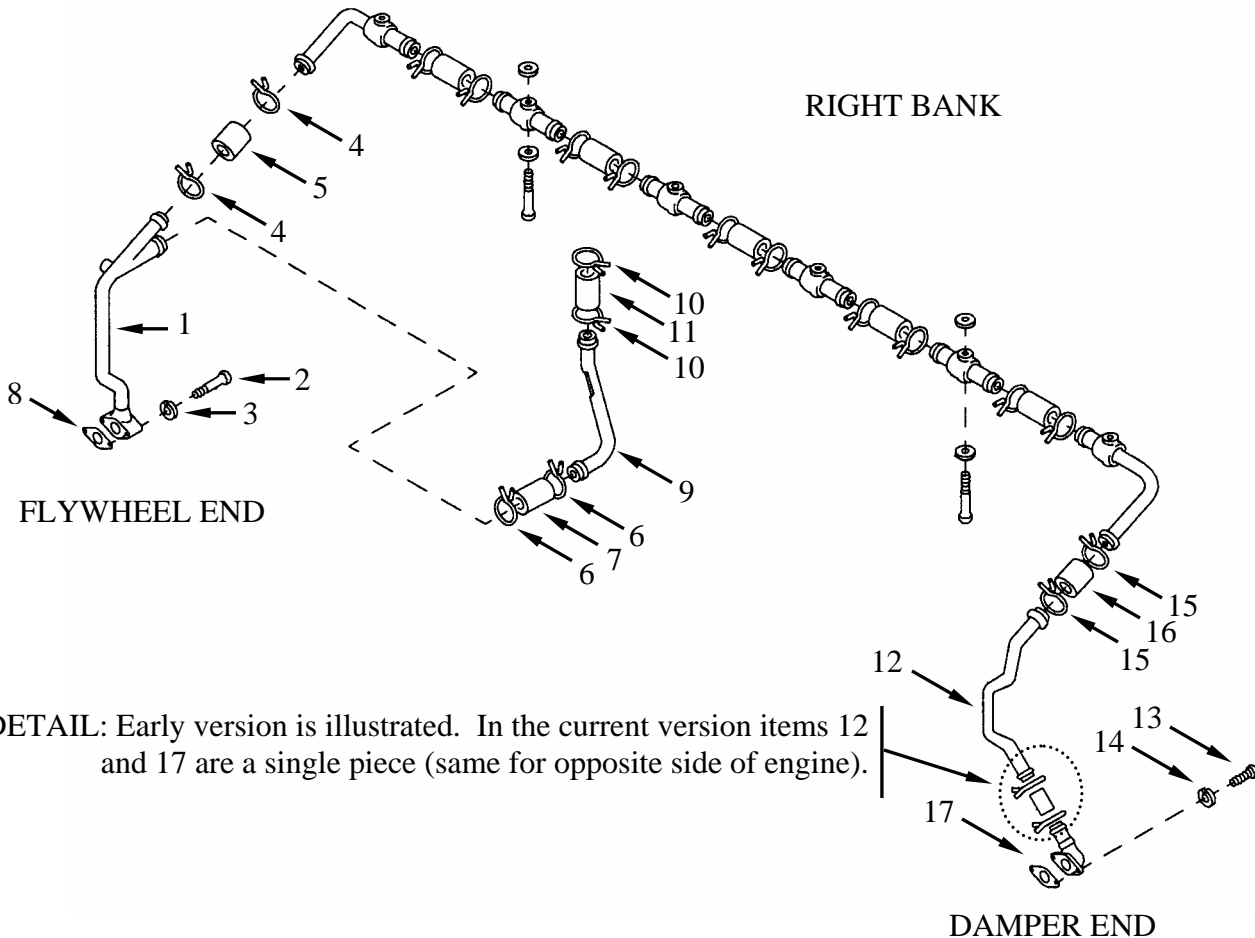


CYLINDER OIL DRAIN TUBES REPLACEMENT

0077 00

REMOVAL (Continued)

1. Remove [right bank flywheel end] oil drain tube (1).
  - a. Remove two cap screws (2) with lock washers (3) attaching oil drain tube (1) to oil pan.
  - b. Relieve tension on clamps (4) and reposition clamps (4) off hose (5).
  - c. Relieve tension on clamps (6) and reposition clamps (6) off hose (7).
  - d. Remove oil drain tube (1).
  - e. Remove gasket (8). Discard gasket and lock washers.
2. Remove [right bank turbosupercharger] oil drain tube (9).
  - a. Relieve tension on clamps (10) and reposition clamps (10) off hose (11).
  - b. Remove tube (9).
3. Remove [right bank damper end] oil drain tube (12).
  - a. Remove two cap screws (13) with lock washers (14).
  - b. Relieve tension on clamps (15) and reposition clamps (15) off hose (16).
  - c. Remove tube (12).
  - d. Remove gasket (17). Discard gasket and lock washers.

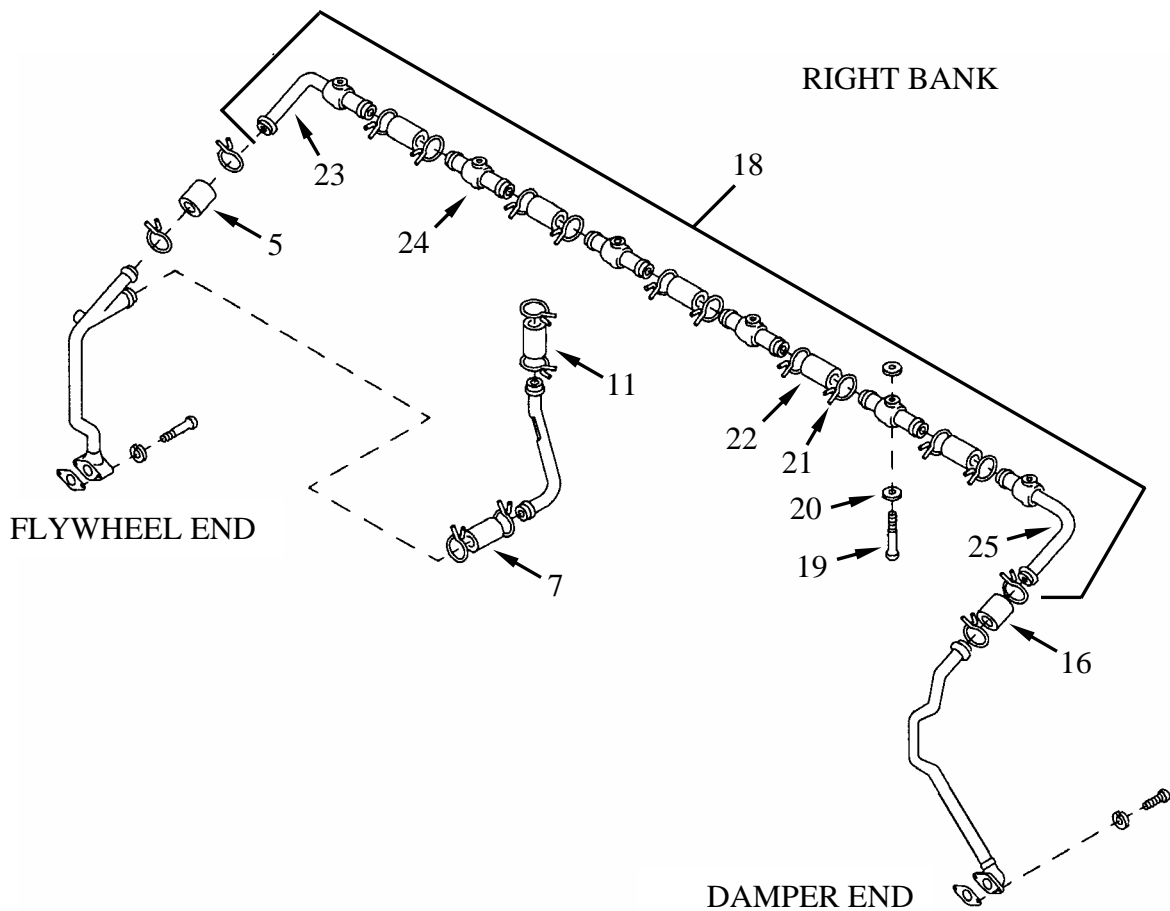


DETAIL: Early version is illustrated. In the current version items 12 and 17 are a single piece (same for opposite side of engine).



**REMOVAL (Continued)**

4. Remove right bank cylinder drain tube assembly (18).
  - a. Remove six fluid passage bolts (19) (one at each cylinder).
    1. As each fluid passage bolt is removed, remove copper gasket (20) on each side of tube. Discard gaskets (20).
  - b. Remove drain tube assembly (18).
  - c. Relieve tension on clamps (21) and reposition clamps (21) off hoses (22).
  - d. Separate tubes (23, 24, and 25) from hoses (22).
5. Discard hoses (5, 7, 11, 16, and 22).

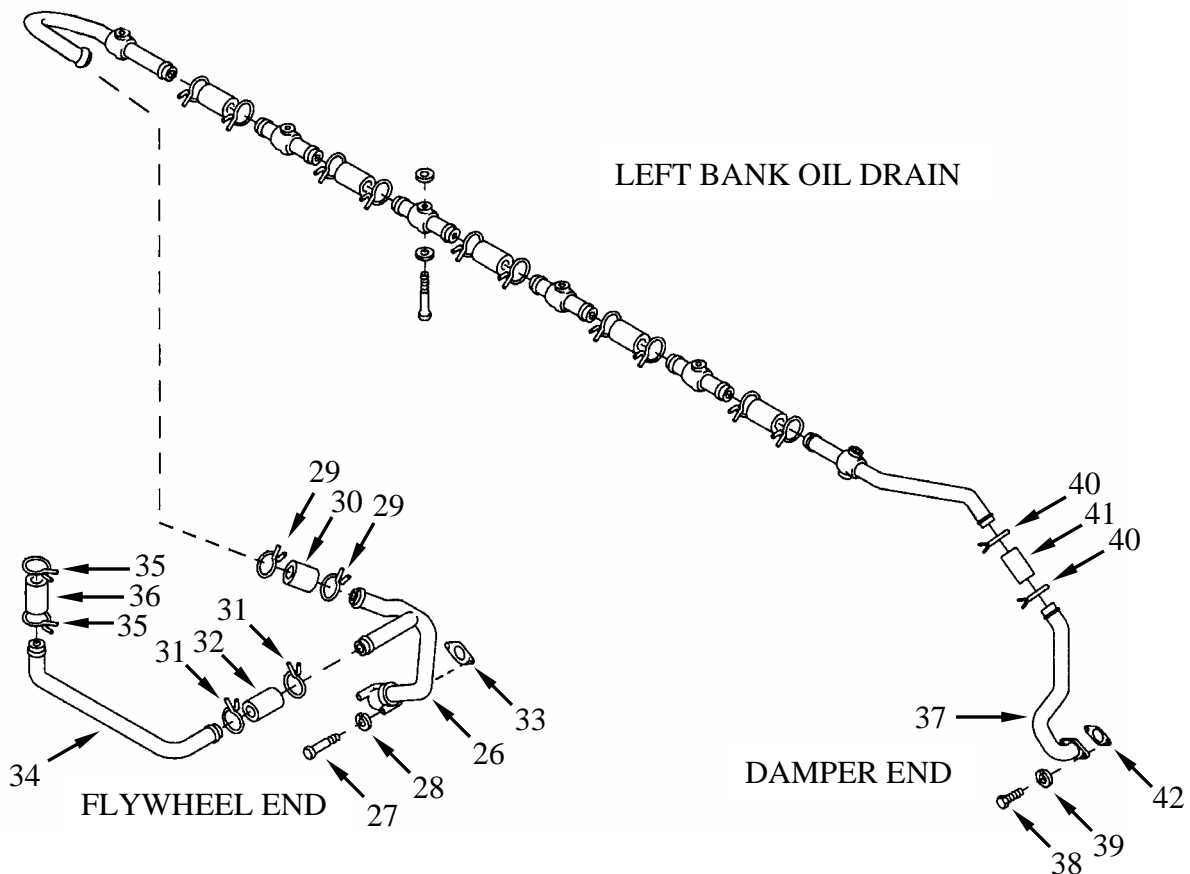


CYLINDER OIL DRAIN TUBES REPLACEMENT

0077 00

REMOVAL (Continued)

6. Remove [left bank flywheel end] oil drain tube (26).
  - a. Remove two cap screws (27) with lock washers (28) attaching oil drain tube (26) to oil pan.
  - b. Relieve tension on clamps (29) and reposition clamps (29) off hose (30).
  - c. Relieve tension on clamps (31) and reposition clamps (31) off hose (32).
  - d. Remove oil drain tube (26).
  - e. Remove gasket (33). Discard gasket and lock washers.
7. Remove [left bank turbosupercharger] oil drain tube (34).
  - a. Relieve tension on clamps (35) and reposition clamps (35) off hose (36).
  - b. Remove tube (34).
8. Remove [left bank damper end] oil drain tube (37).
  - a. Remove two cap screws (38) with lock washers (39).
  - b. Relieve tension on clamps (40) and reposition clamps (40) off hose (41).
  - c. Remove tube (37).
  - d. Remove gasket (42). Discard gasket and lock washers.

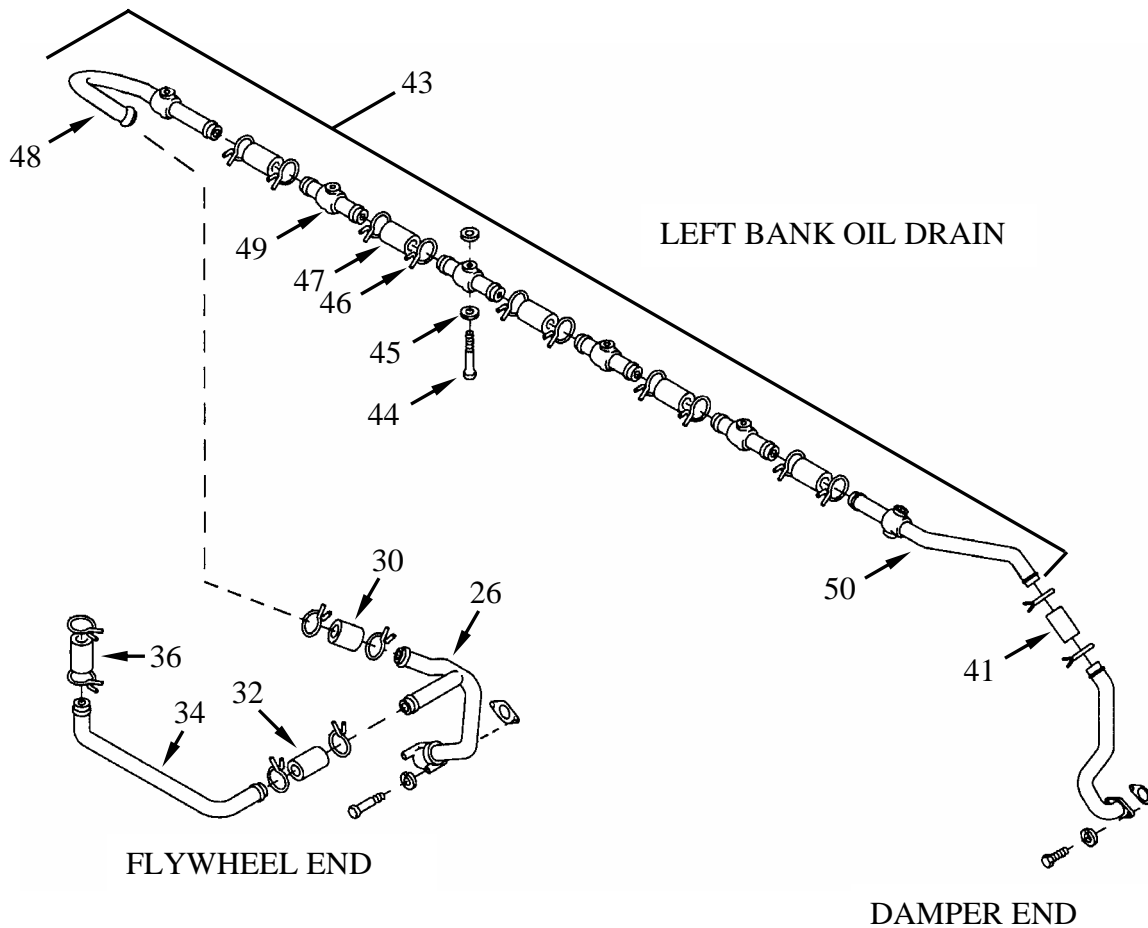


CYLINDER OIL DRAIN TUBES REPLACEMENT

0077 00

REMOVAL (Continued)

9. Remove left bank cylinder drain tube assembly (43).
  - a. Remove six fluid passage bolts (44) (one at each cylinder).
    1. As each fluid passage bolt is removed, remove copper gasket (45) on each side of tube. Discard gaskets (45).
  - b. Remove drain tube assembly (43).
  - c. Relieve tension on clamps (46) and reposition clamps (46) off hoses (47).
  - d. Separate tubes (48, 49, and 50) from hoses (47).
  
10. Separate tubes (34) and (26) from hoses (32) and (36).
  
11. Discard hoses (30, 32, 36, 41, and 47).



**CYLINDER OIL DRAIN TUBES REPLACEMENT**

**0077 00**

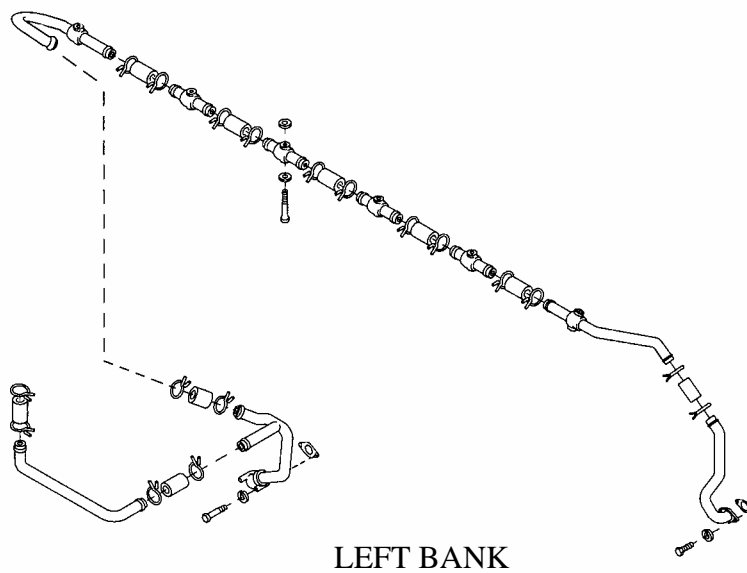
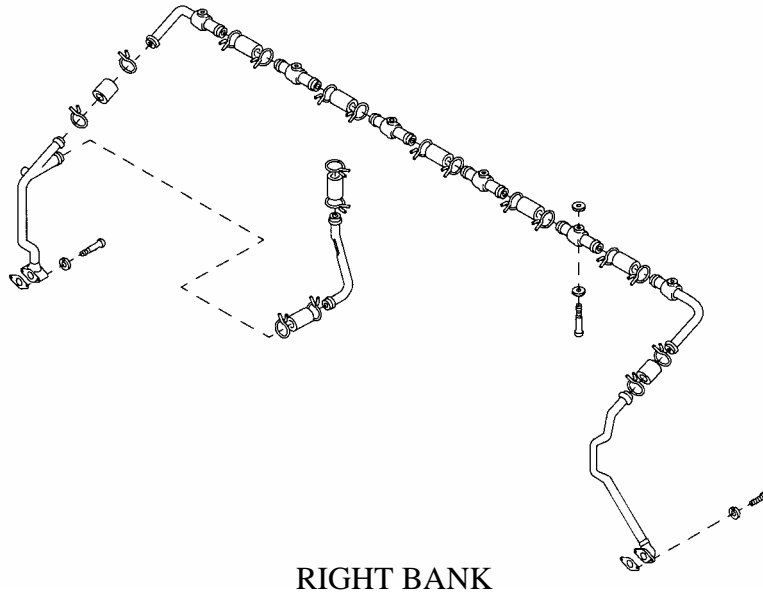
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

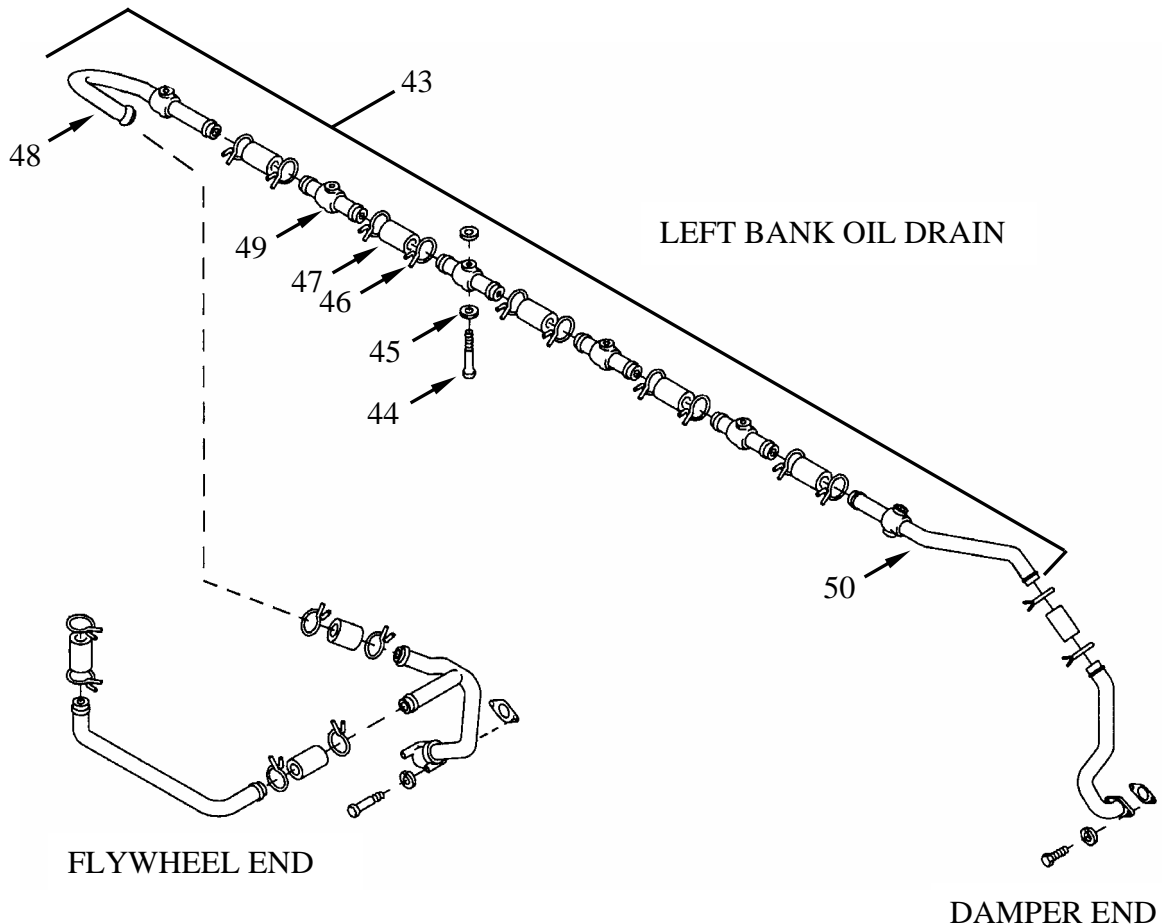


## CYLINDER OIL DRAIN TUBES REPLACEMENT

0077 00

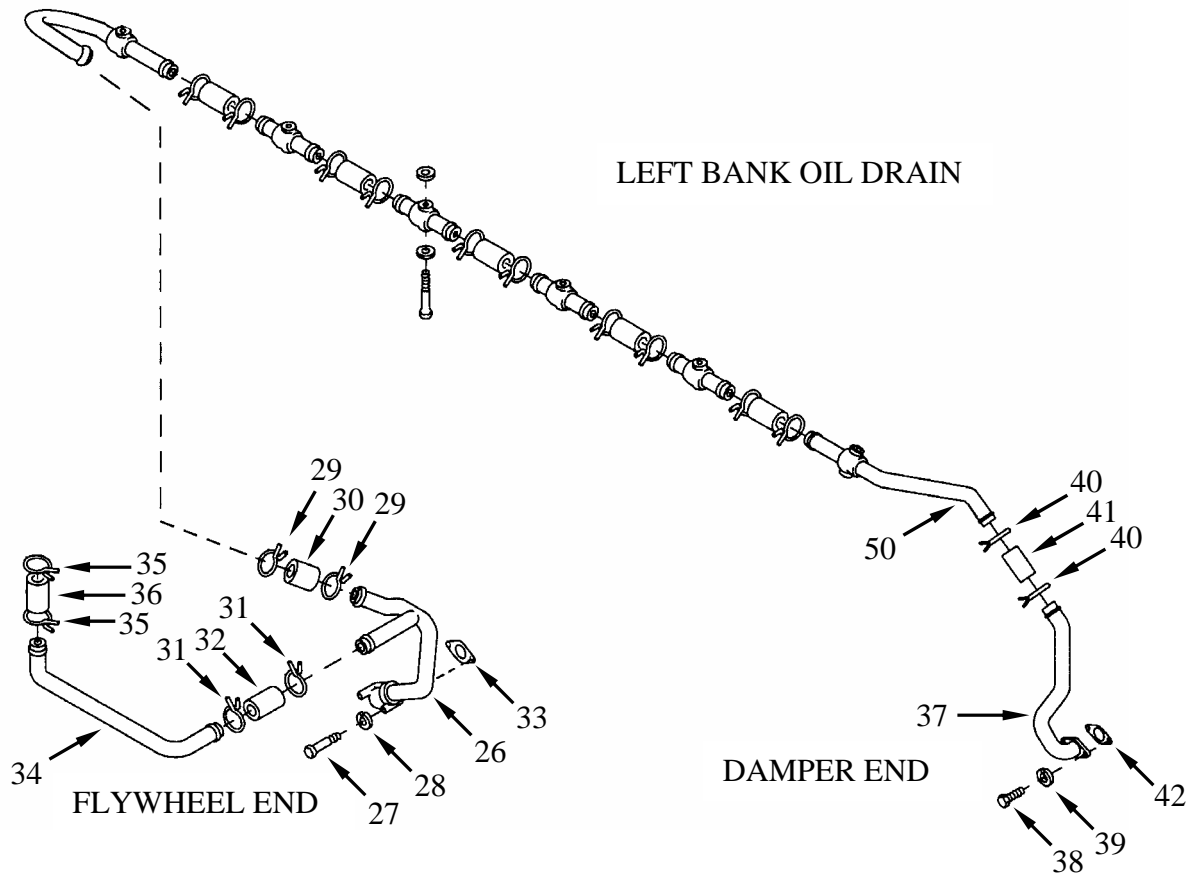
## INSTALLATION

1. Assemble left bank oil drain tube assembly (43).
  - a. Lubricate inside of new hoses (47) (item 313, WP 0175) with lubricating oil (item 21, WP 0173).
  - b. Place clamp (46) on inboard end of tube (48) and position towards fluid passage bolt hole to allow installation of hose (47).
  - c. Install hose (47) on inboard end of tube (48) and position it about half way onto tube.
  - d. Place clamp (46) on inter-cylinder tube (49) and position it towards fluid passage bolt hole.
  - e. Insert tube (49) approximately half way into opposite end of hose (47).
  - f. Repeat procedure for remaining inter-cylinder tubes (49) and end tube (50), leaving clamps (46) loose.
2. Install left bank oil drain tube assembly (43) onto engine.
  - a. Position a new lubricated gasket (45) (item 283, WP 0175) top and bottom of each tube (48, 49, 50) and secure at each cylinder with a fluid passage bolt (44).
  - b. Center hoses (47) at each location and secure with clamps (46).
  - c. Torque-tighten fluid passage bolts to 275-300 inch pounds (31-34 N•m).



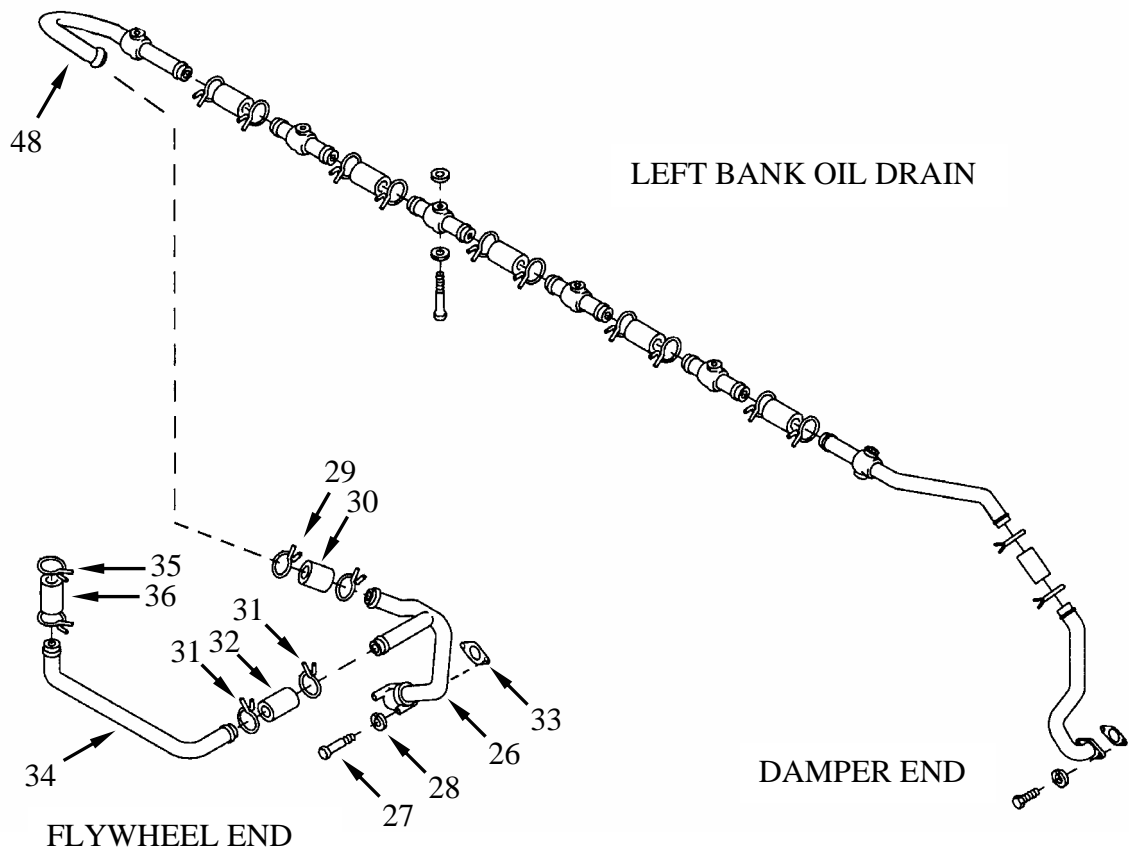
**INSTALLATION (Continued)**

3. Install [left bank damper end] oil drain tube (37).
  - a. Position clamp (40) onto tube (37) far enough towards flange end to be out of the way.
  - b. Install new lubricated hose (41) (item 313, WP 0175) half way onto tube and secure with clamp (40).
  - c. Place a clamp (40) on tube (50) and push hose (41) with tube (37) onto tube (50).
  - d. Install tube (37) to oil pan, using a new gasket (42) (item 159, WP 0175).
  - e. Secure tube (37) to oil pan using two screws (38) with new lock washers (39) (item 93, WP 0175) and at opposite end to tube (50) with clamp (40).
4. Assemble tube (34) to tube (26).
  - a. Position clamps (31) over ends of tubes (34, 26) and slide clamps out of the way.
  - b. Using new, lubricated hose (32) (item 313, WP 0175) (using lubricating oil, item 21, WP 0173), push ends of tubes (34, 26) half way into hose. Do not secure hose (32) with clamps yet.
  - c. Push new, lubricated, hose (30) (item 313, WP 0175) half way onto tube (26) and secure with clamp (29).
  - d. Push new lubricated hose (36) (item 313, WP 0175) onto end of tube (34) and secure with clamp (35).



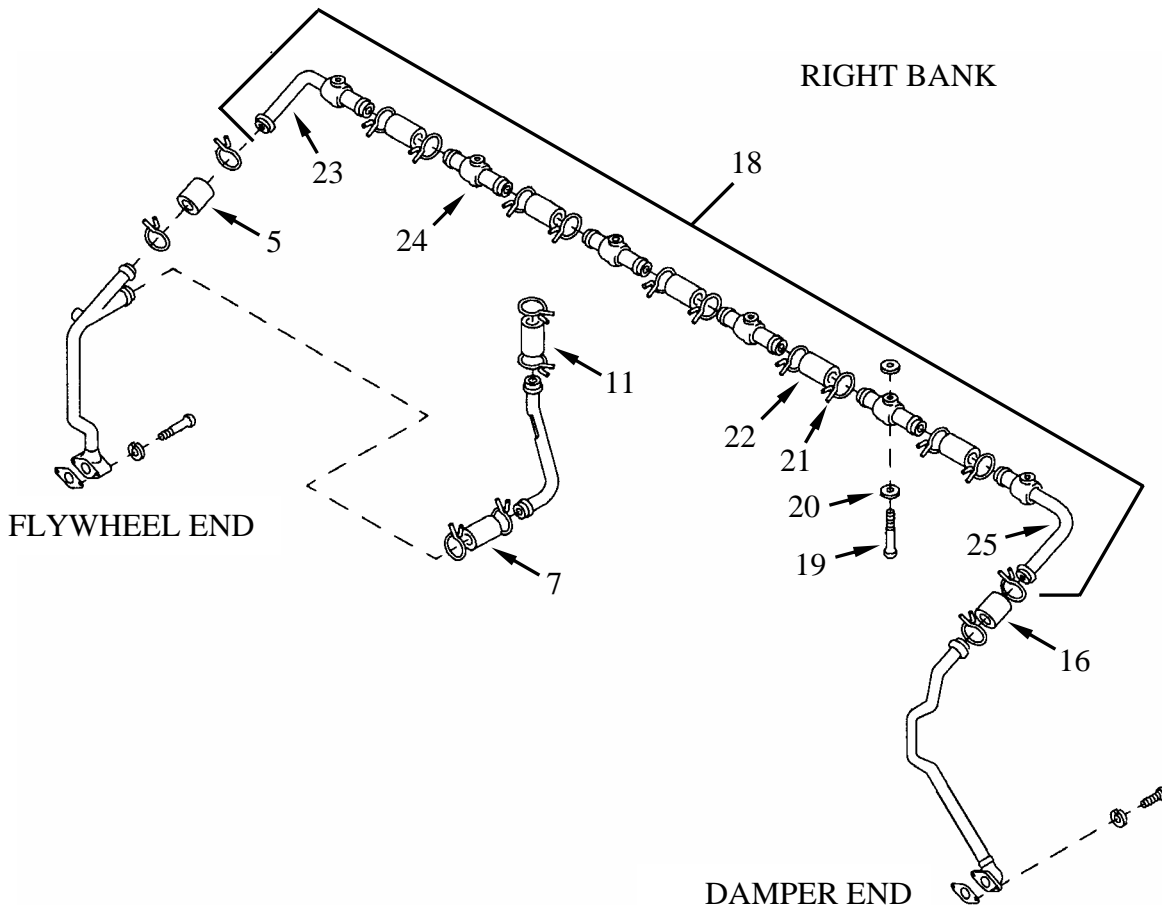
**INSTALLATION (Continued)**

5. Install tubes (34) and (26) as an assembly.
  - a. Position clamp (35) onto turbosupercharger oil drain and clamp (29) onto tube (48).
  - b. Push hoses (36, 30) half way over turbosupercharger oil drain and tube (48) while placing lower end of tube (26) into position on oil pan.
  - c. Place a new gasket (33) (item 159, WP 0175) into position on oil pan.
  - d. Secure tube (26) to oil pan using two screws (27) with new lock washers (28) (item 93, WP 0175).
  - e. Secure hoses (36, 30) with clamps (35, 29).
  - f. Secure hose (32) with clamps (31).



**INSTALLATION (Continued)**

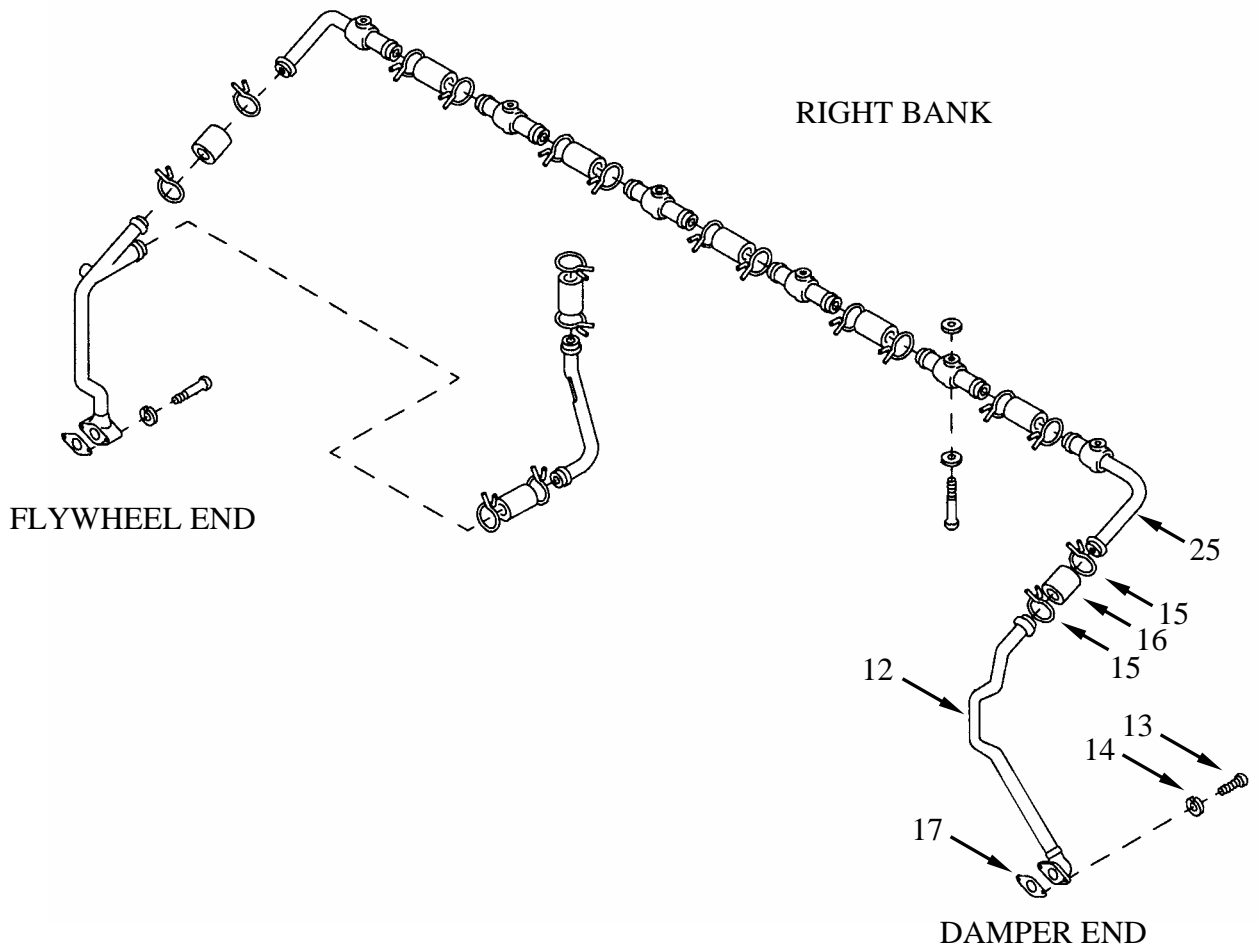
6. Assemble right bank oil drain tube assembly (18).
  - a. Lubricate inside of new hoses (22) (item 313, WP 0175) with lubricating oil (item 21, WP 0173).
  - b. Place clamp (21) on inboard end of tube (23) and position towards fluid passage bolt hole to allow installation of hose (22).
  - c. Install hose (22) on inboard end of tube (23) and position it half way onto tube.
  - d. Place clamp (22) on [inter-cylinder] tube (24) and position it towards fluid passage bolt hole.
  - e. Insert tube (23) half way into opposite end of hose (22).
  - f. Repeat procedure for remaining inter-cylinder tubes (22) and end tube (25), leaving clamps (22) loose.
7. Install right bank oil drain tube assembly (18) onto engine.
  - a. Position a new lubricated gasket (20) (item 283, WP 0175) top and bottom of each tube (23, 24, 25) and secure at each cylinder with a fluid passage bolt (19).
  - b. Center hoses (22) at each location and secure with clamps (21).
  - c. Torque-tighten fluid passage bolts to 275-300 inch-pounds (31-34 N•m).





**INSTALLATION (Continued)**

8. Install [right bank damper end] oil drain tube (12).
  - a. Position clamp (15) onto tube (12) far enough towards flange end to be out of the way.
  - b. Install new lubricated hose (16) (item 313, WP 0175) half way onto tube and secure with clamp (15) with lubricating oil (item 21, WP 0173).
  - c. Place a clamp (15) on tube (25) and push hose (16) with tube (12) onto tube (25).
  - d. Install tube (12) to oil pan, using new gasket (17) (item 159, WP 0175).
  - e. Secure tube (12) to oil pan using two screws (13) with new lock washers (14) (item 93, WP 0175) and at opposite end to tube (25) with clamp (16).

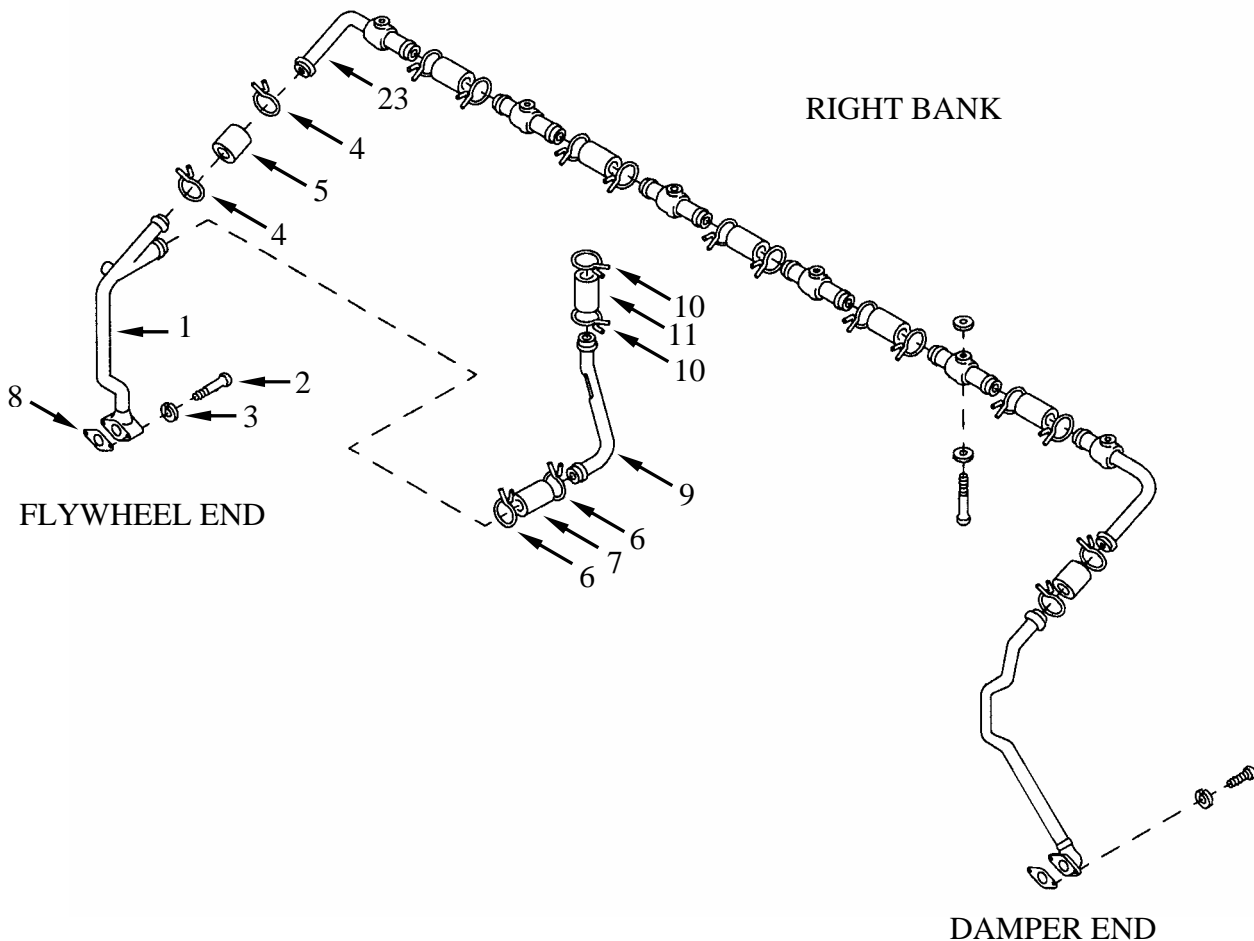


CYLINDER OIL DRAIN TUBES REPLACEMENT

0077 00

INSTALLATION (Continued)

9. Assemble tube (9) to tube (1).
  - a. Push new, lubricated, hoses (7, 11) (item 313, WP 0175) (using lubricating oil, item 21, WP 0173) half way onto ends of tube (9). Secure with clamps (6, 10).
  - b. Position clamp (6) onto end of tube (1), and then push hose (7) with tube (9) onto tube (1). Do not clamp yet.
10. Install tubes (1) and (9) as an assembly.
  - a. Push new, lubricated, hose (5) (item 313, WP 0175) half way onto end of tube (1) and secure with clamp (4).
  - b. Push hose (11) with tube (9) half way over turbosupercharger oil drain and hose (5) with tube (1) onto tube (23) while placing lower end of tube (1) into position on oil pan.
  - c. Place a new gasket (8) (item 159, WP 0175) into position on oil pan.
  - d. Secure tube (1) to oil pan using two screws (2) with new lock washers (3) (item 93, WP 0175).
  - e. Secure hoses (5, 11) with clamps (4, 10).
  - f. Secure hose (7) with clamp (6).



END OF WORK PACKAGE

**ENGINE OIL HOSE ASSEMBLIES, TUBE ASSEMBLIES,  
AND RELATED PARTS REPLACEMENT**

**0078 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Gasket (2) (item 334, WP 0175)

O-ring (2) (item 141, WP 0175)

Self-locking nut (1) (item 33, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

Engine and transmission oil cooler access covers removed (WP 0090)

Engine cooling fans and housings removed (WP 0054)

**Expendable and Durable Items:**

Thread sealing tape (item 41, WP 0173)

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**REMOVAL**

**NOTE**

**Perform only those steps necessary to replace defective parts. Use legend reference guide. Tag all parts prior to removal to aid in installation. Place rags under hose connections to catch any oil that spills during maintenance. Dispose of rags in accordance with standard operating procedure. Note hose and tube routing to aid in installation.**

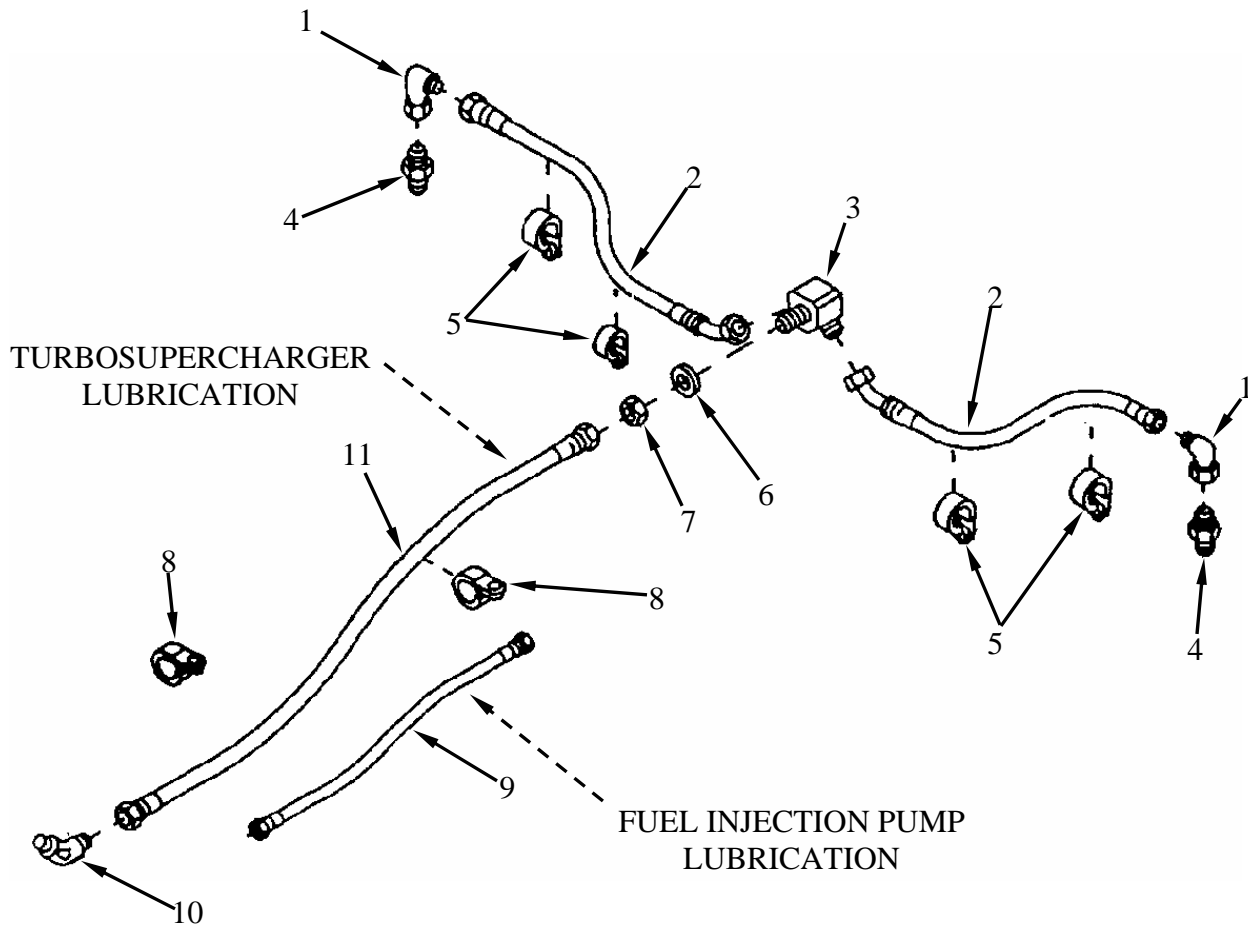
**ENGINE OIL HOSE ASSEMBLIES, TUBE ASSEMBLIES,  
AND RELATED PARTS REPLACEMENT**

**0078 00**

**REMOVAL (Continued)**

- 1 Remove clamps and attaching hardware securing hose assemblies, tube assemblies and fittings as shown in legends and illustrations. Discard self-locking nuts.
- 2 Remove hose assemblies, tube assemblies and fittings in accordance with the following legends and illustrations. Discard O-rings and gaskets.

1	Elbow (2)	5	Clamp (4)	9	Hose (1)
2	Hose (2)	6	Flat washer (1)	10	Elbow (1)
3	Elbow, tee (1)	7	Plain nut (1)	11	Hose (1)
4	Adapter (2)	8	Clamp (2)		

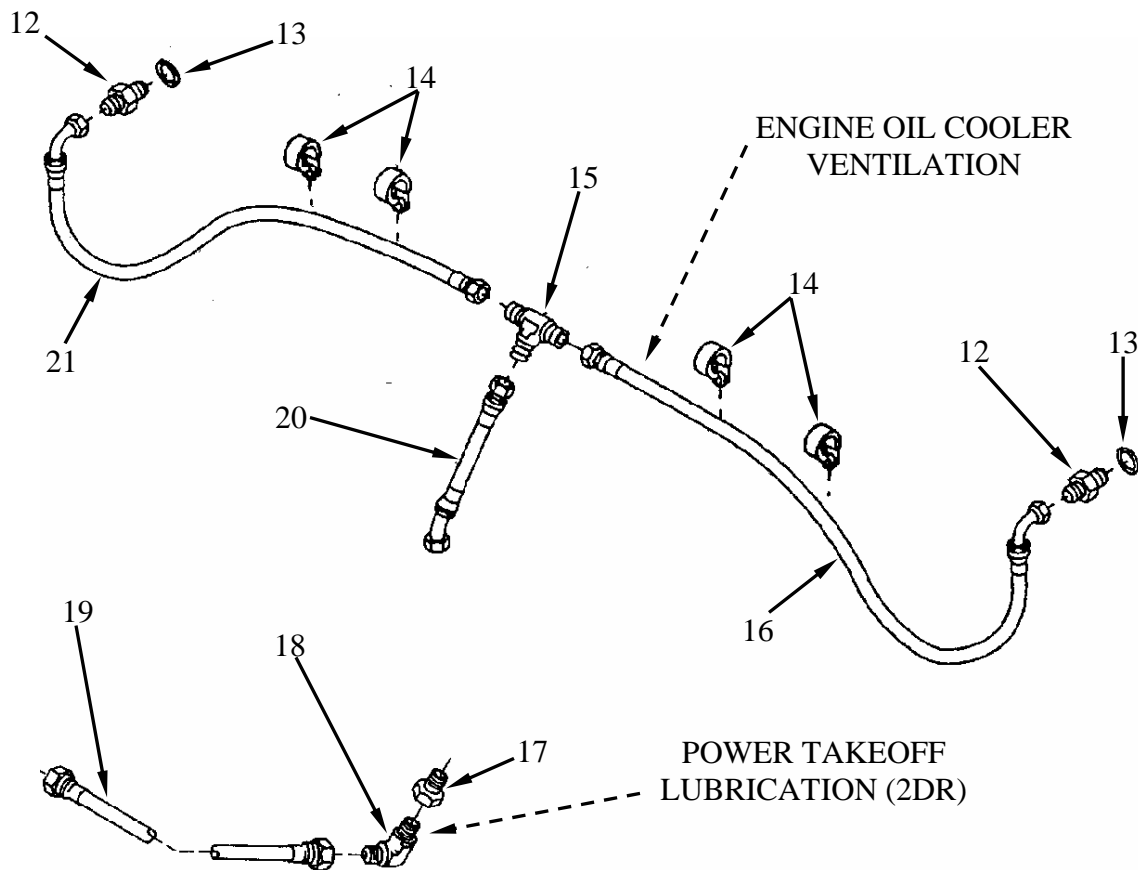


**ENGINE OIL HOSE ASSEMBLIES, TUBE ASSEMBLIES,  
AND RELATED PARTS REPLACEMENT**

0078 00

**REMOVAL (Continued)**

12	Adapter (2)	15	Tee (1)	19	Hose (1)
13	O-ring (2) (item 141, WP 0175)	16	Hose (1)	20	Hose (1)
		17	Adapter (1)	21	Hose (1)
14	Clamp (4)	18	Elbow (1)		

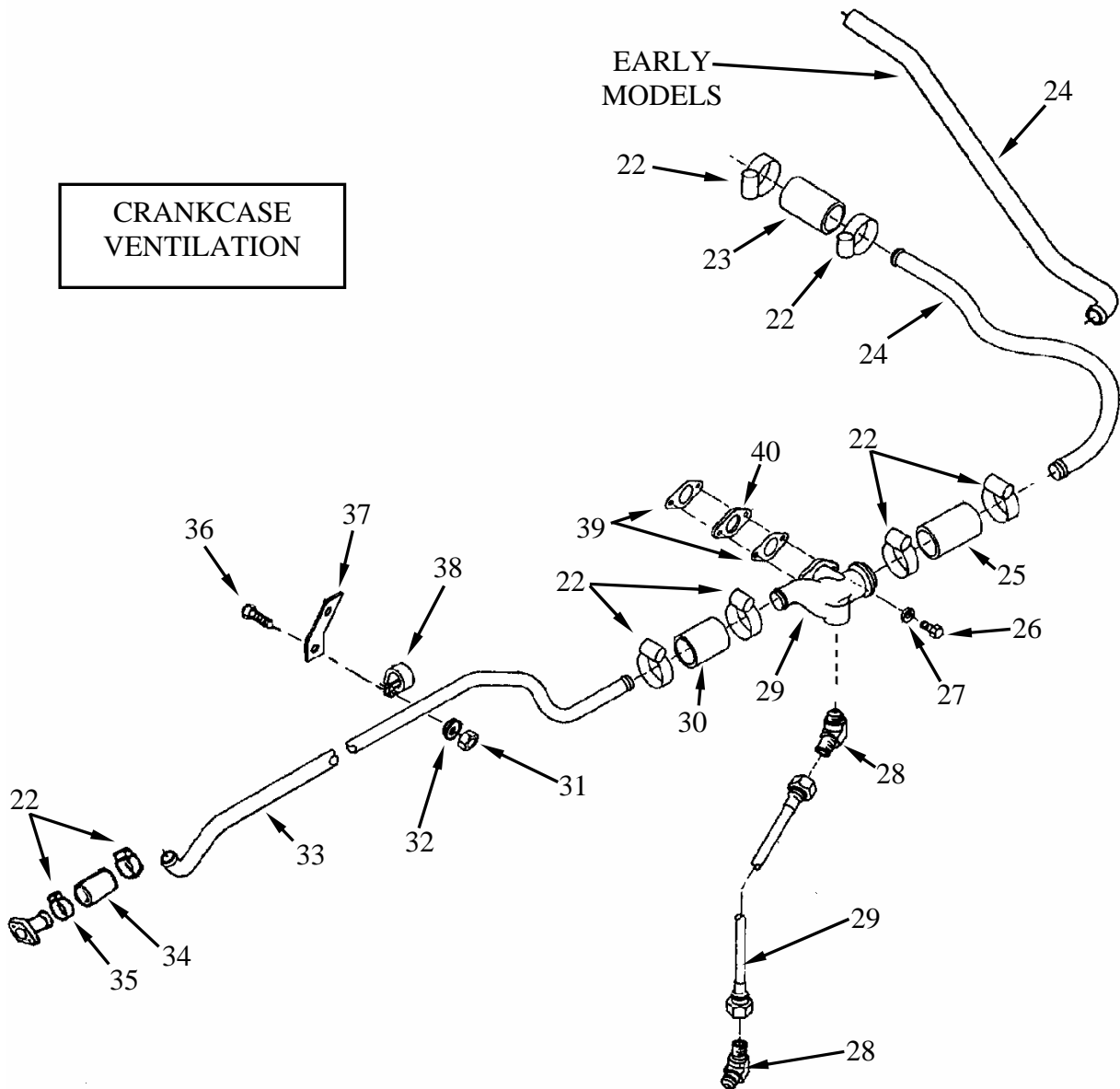


**ENGINE OIL HOSE ASSEMBLIES, TUBE ASSEMBLIES,  
AND RELATED PARTS REPLACEMENT**

**0078 00**

**REMOVAL (Continued)**

22	Clamp (6)	29	Breather (1)	35	Adapter (1)
23	Hose (1)	30	Hose (1)	36	Screw (1)
24	Tube (1)	31	Self locking nut (1) (item 33, WP 0175)	37	Bracket (1)
25	Hose (1)			38	Clamp (1)
26	Screw (2)	32	Flat washer (1)	39	Gasket (2) (item 334, WP 0175)
27	Flat washer (2)	33	Tube (1)		
28	Elbow (2)	34	Hose (1)	40	Spacer plate (1)



**ENGINE OIL HOSE ASSEMBLIES, TUBE ASSEMBLIES,  
AND RELATED PARTS REPLACEMENT**

**0078 00**

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**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

1. Apply thread sealing tape (item 41, WP 0173) to all male pipe threads.
2. Install hose assemblies, tube assemblies and fittings with new gaskets (item 334, WP 175), and O-rings (item 141, WP 0175), in accordance with the legends and illustration.
3. Secure hose assemblies, tube assemblies and fittings with clamps, attaching hardware, flat washers, and new self-locking nut (item 33, WP 0175).

**END OF WORK PACKAGE**





**FUEL INJECTOR TUBE BRACKETS REPLACEMENT**

**0079 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

- Self-locking nuts (54) (item 38, WP 0175)
- Self-locking nuts (1) (item 111, WP 0175)
- Self-locking screws (2) (item 223, WP 0175)

**Expendable and Durable Items:**

- Marker tags (item 39, WP 0173)
- Wiping rags (item 26, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

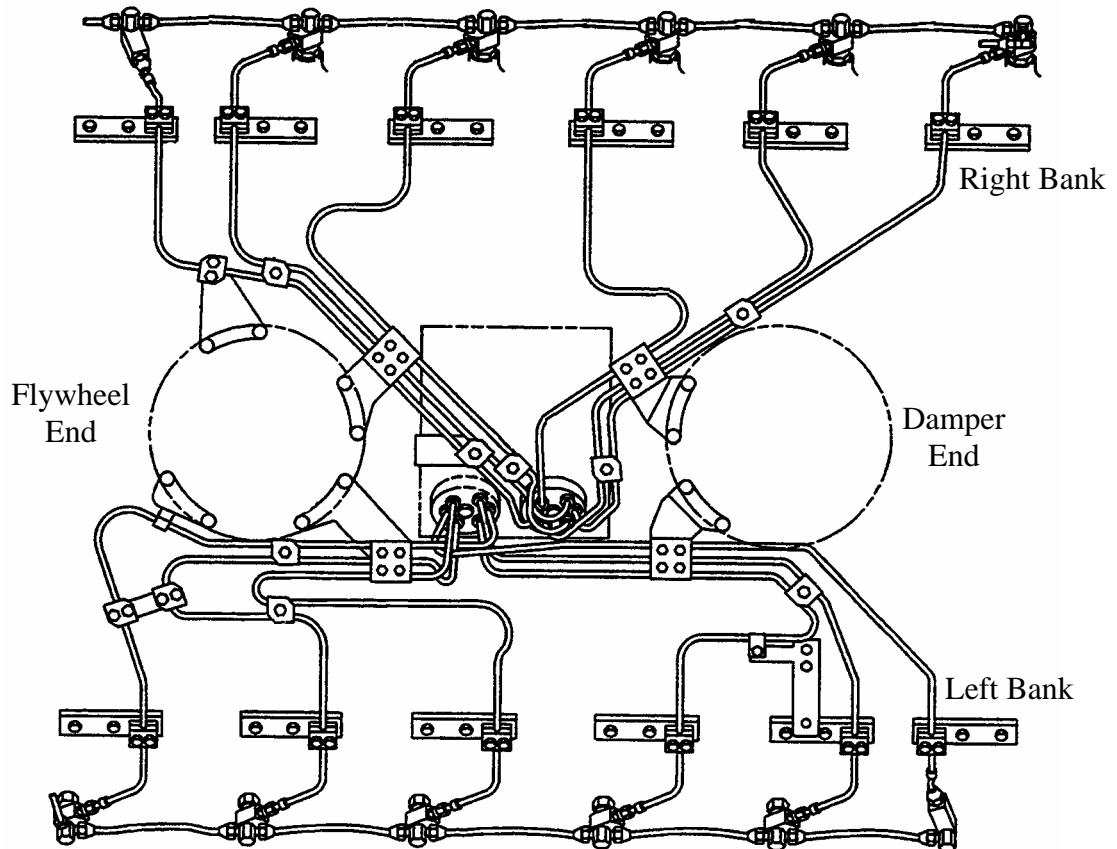
**Equipment Conditions:**

- Engine level on flat stationary surface
- Engine and transmission oil cooler access covers removed (WP 0090)
- Engine cooling fans and housings removed (WP 0054)

**REMOVAL**

**NOTE**

**Only those items that have call-out numbers can be replaced at the Organizational level. See details on following pages.**



FUEL INJECTOR TUBE BRACKETS REPLACEMENT

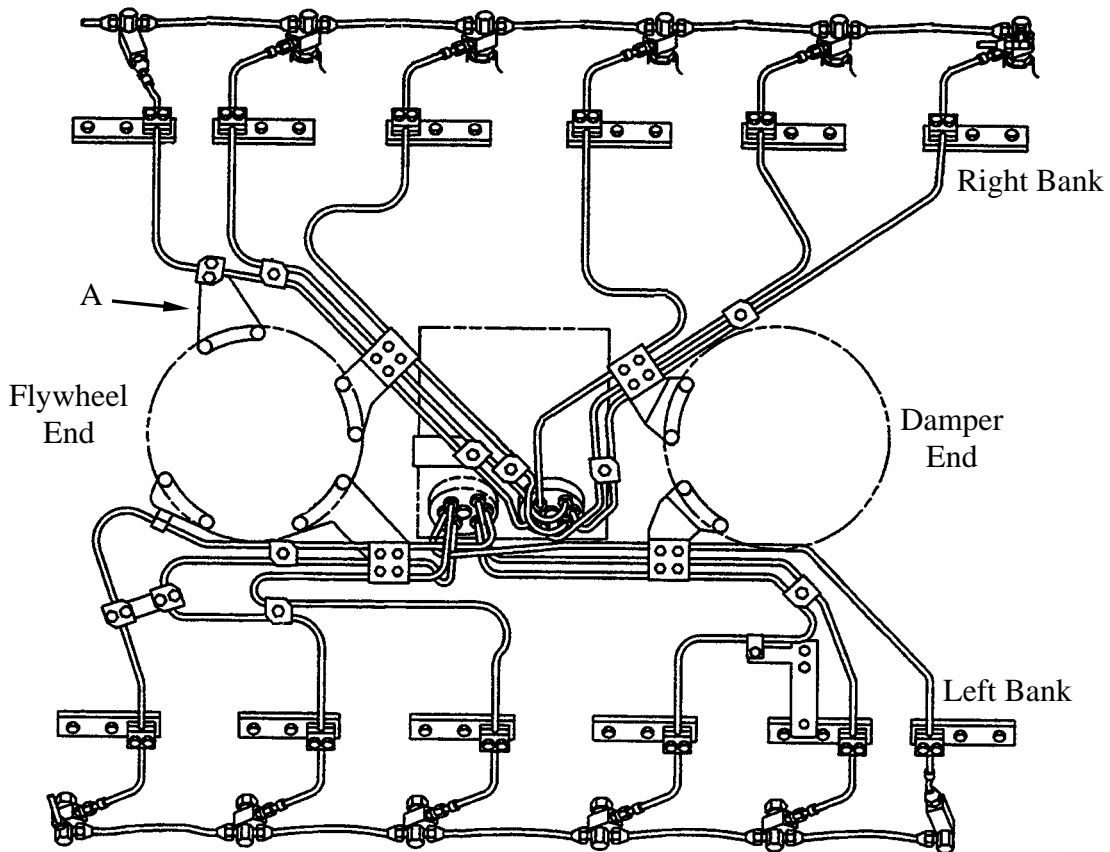
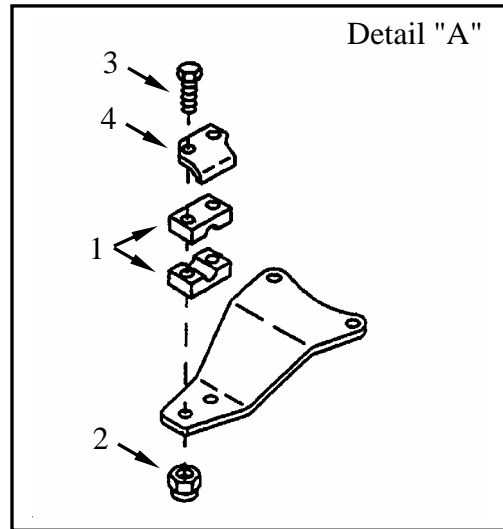
0079 00

REMOVAL (Continued)

1. Remove fairlead halves (1) at detail "A" (one place).

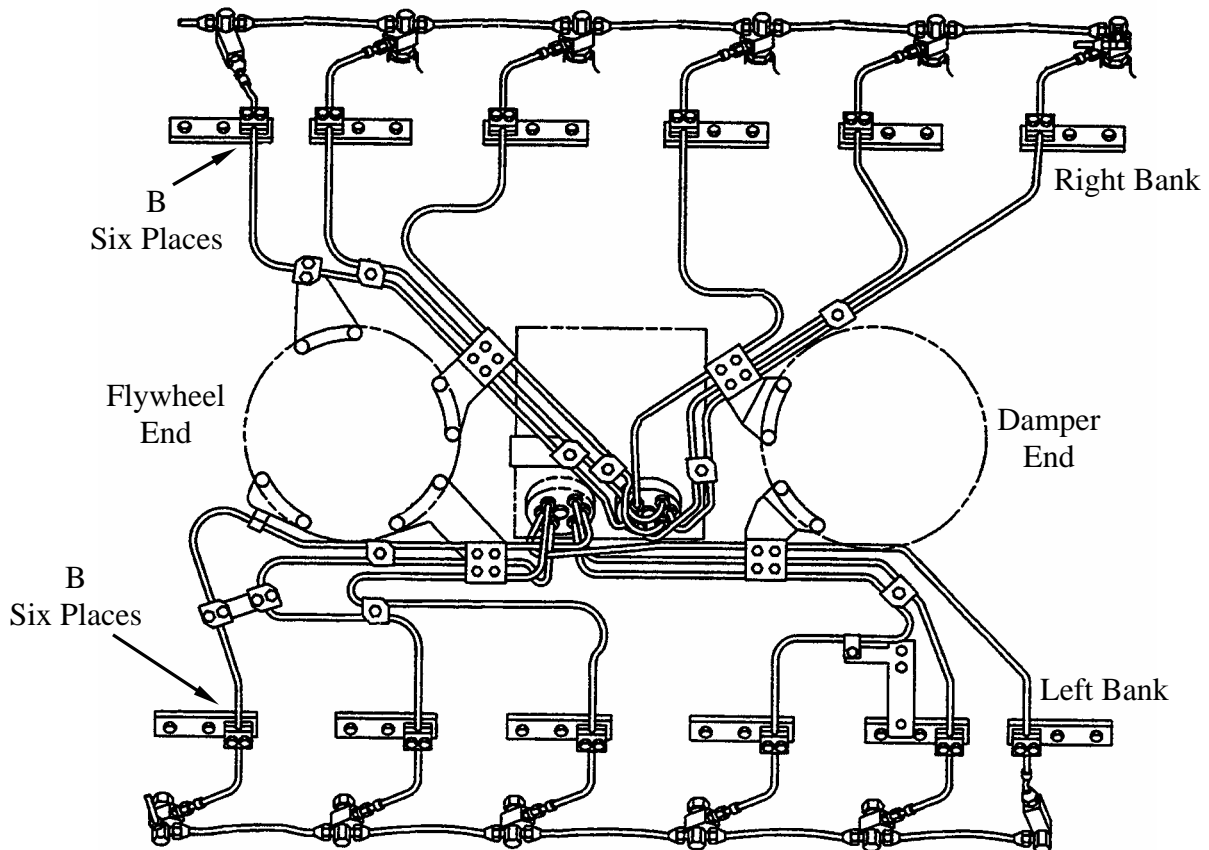
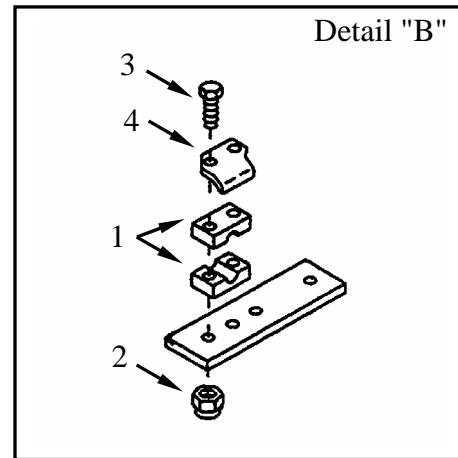
a. Remove two self-locking nuts (2) from screws (3) to remove retainer (4) and top fairlead half (1). Discard self-locking nuts.

b. Slide bottom fairlead half (1) from under fuel line, being careful not to bend fuel line.



**REMOVAL (Continued)**

2. Remove fairlead halves at detail "B" (twelve places).
  - a. Remove two self-locking nuts (2) from screws (3) to remove retainer (4) and top fairlead half (1). Discard self-locking nuts.
  - b. Slide bottom fairlead half (1) from under fuel line, being careful not to bend fuel line.



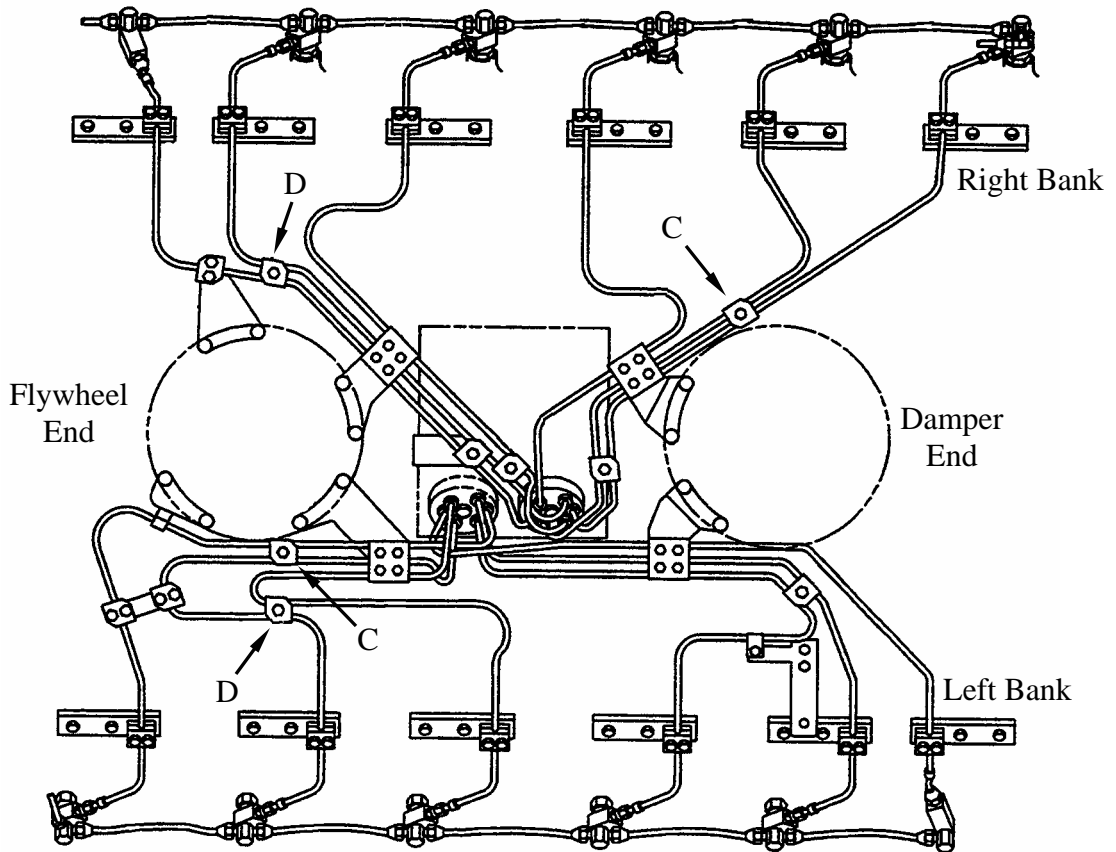
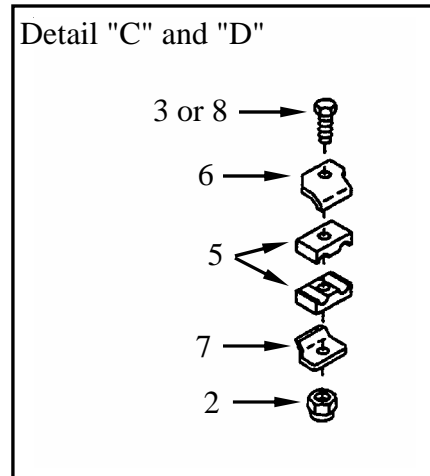
**REMOVAL (Continued)**

3. Remove fairlead halves (5) at detail "C" (two places).

- a. Remove one self-locking nut (2) from screw (3) to remove retainers (6 and 7) and fairlead halves (5). Discard self-locking nut.

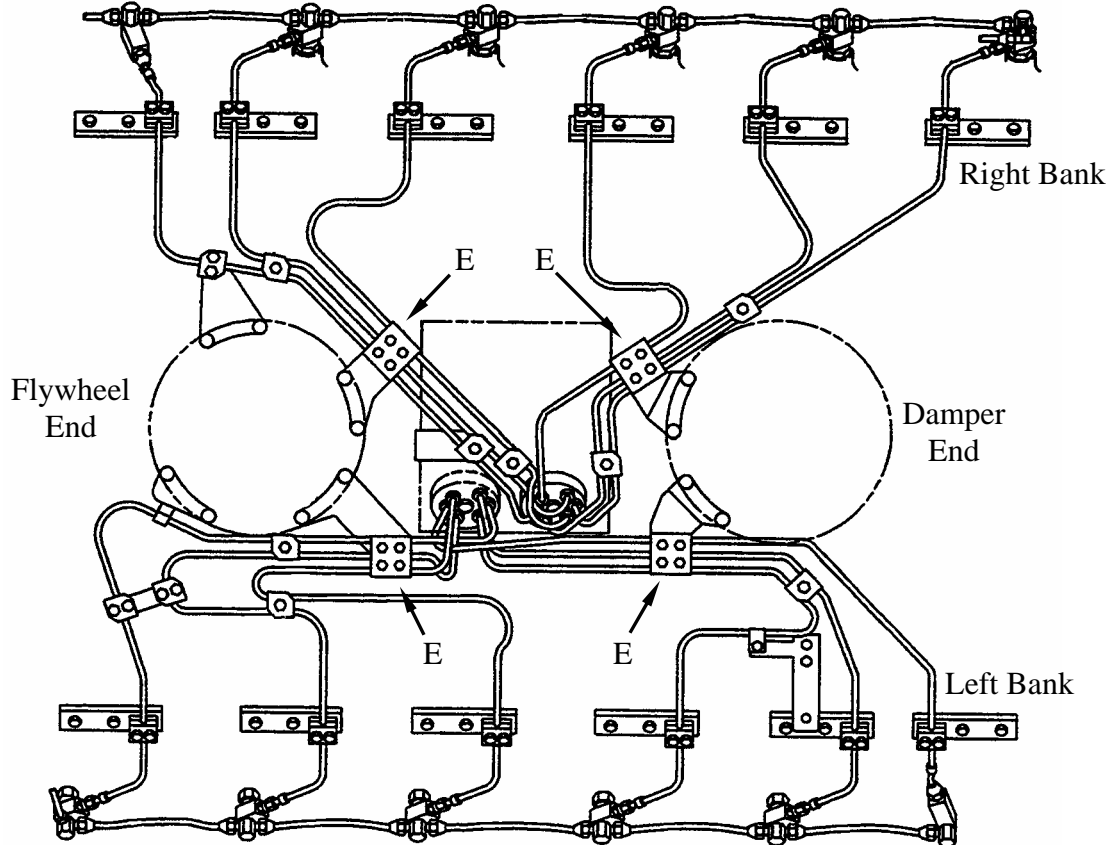
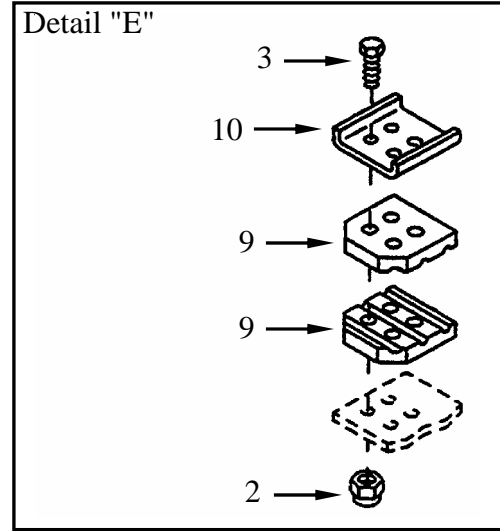
4. Remove fairlead halves (5) at detail "D" (two places).

- a. Remove one self-locking nut (2) from screw (8) to remove retainers (6 and 7) and fairlead halves (5). Discard self-locking nut.



**REMOVAL (Continued)**

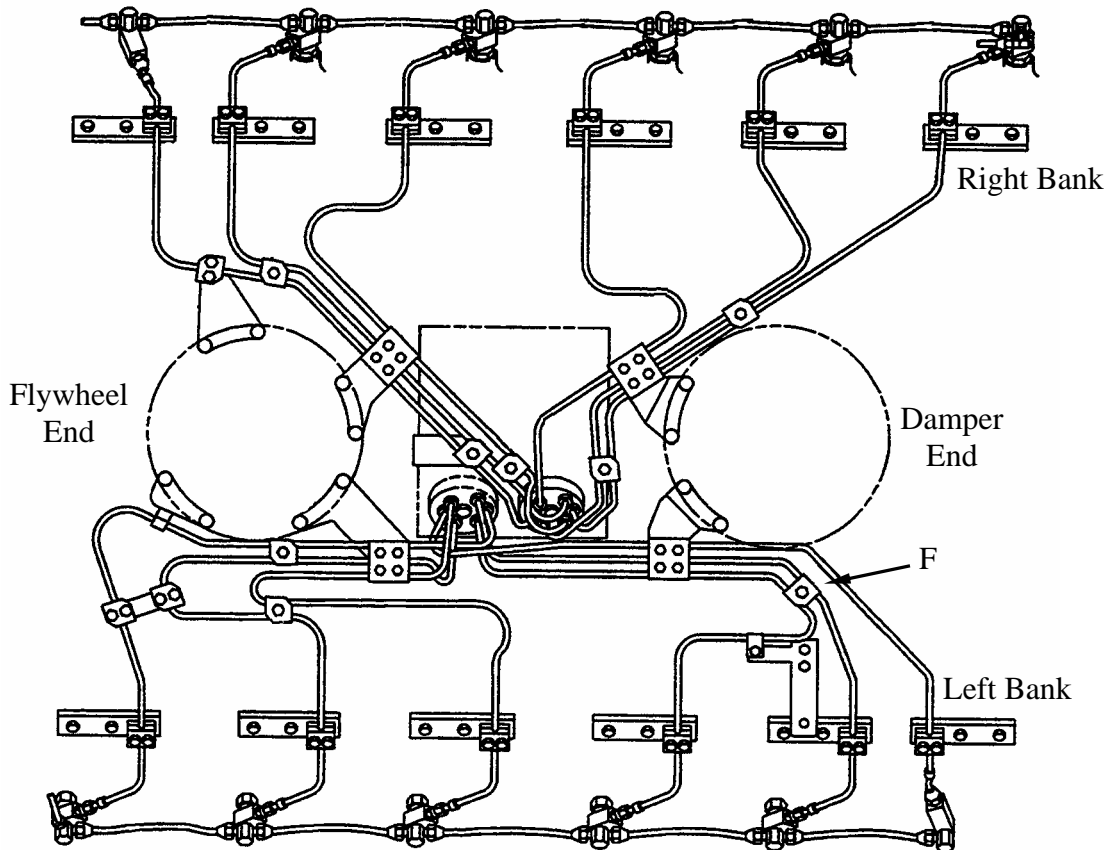
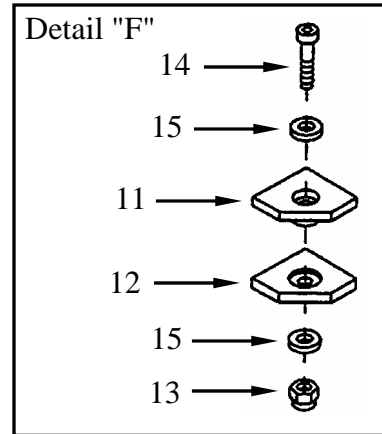
5. Remove fairlead halves (9) at detail "E" (four places).
  - a. Remove four self-locking nuts (2) from screws (3) to remove retainer (10) and top fairlead half (9). Discard self-locking nuts.
  - b. Slide bottom fairlead half (9) from under fuel line, being careful not to bend fuel line.



**REMOVAL (Continued)**

6. Remove clamps (11 and 12) at detail "F" (one place).

- a. Remove one self-locking nut (13) from screw (14) to remove clamps (11, 12) and two flat washers (15). Discard self-locking nut.

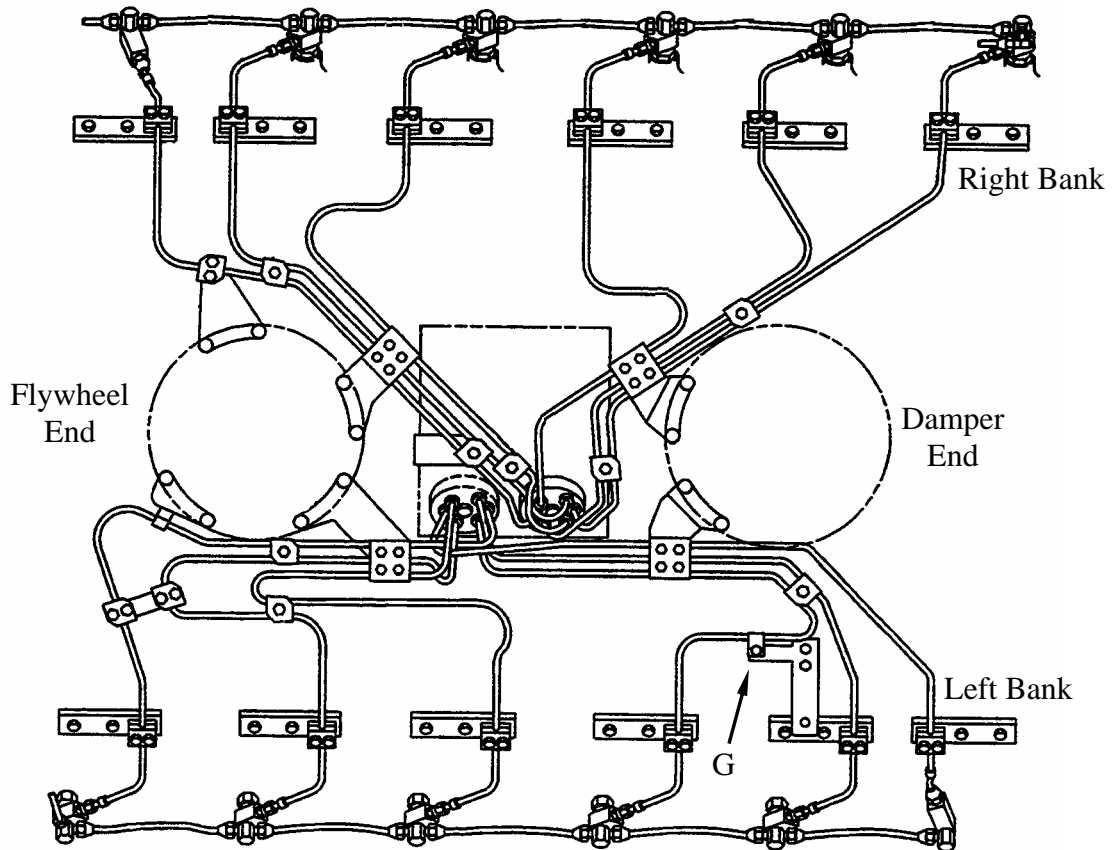
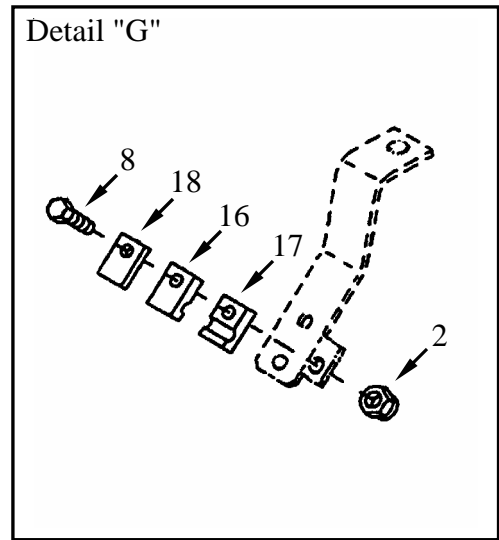


FUEL INJECTOR TUBE BRACKETS REPLACEMENT

0079 00

REMOVAL (Continued)

7. Remove fairlead halves (16 and 17) at detail "G" (one place).
  - a. Remove one self-locking nut (2) from screw (8) to remove plate (18) and fairlead half (16). Discard self-locking nut.
  - b. Slide bottom fairlead half (17) from under fuel line, being careful not to bend fuel line.



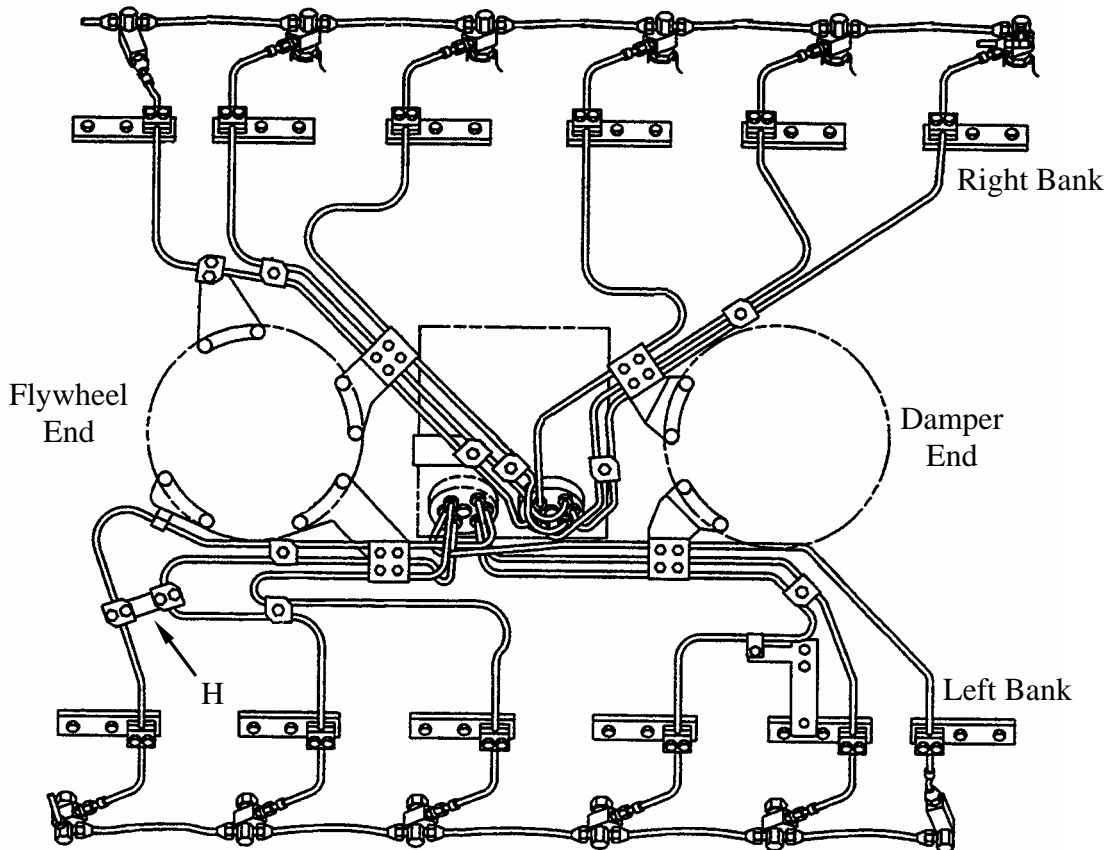
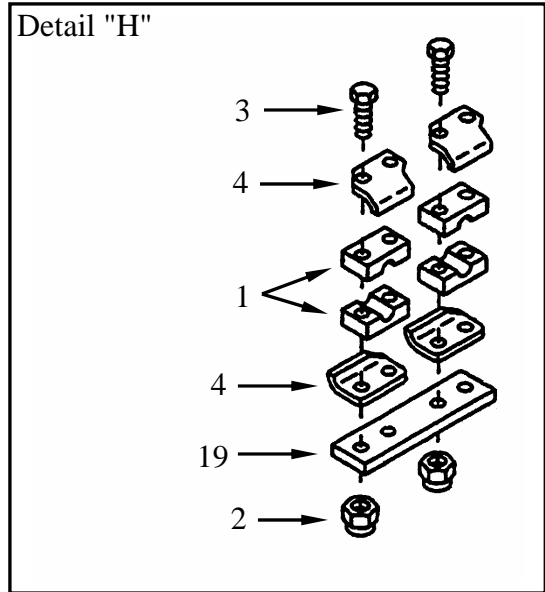
FUEL INJECTOR TUBE BRACKETS REPLACEMENT

0079 00

REMOVAL (Continued)

8. Remove fairlead halves (1) at detail "H" (one place).

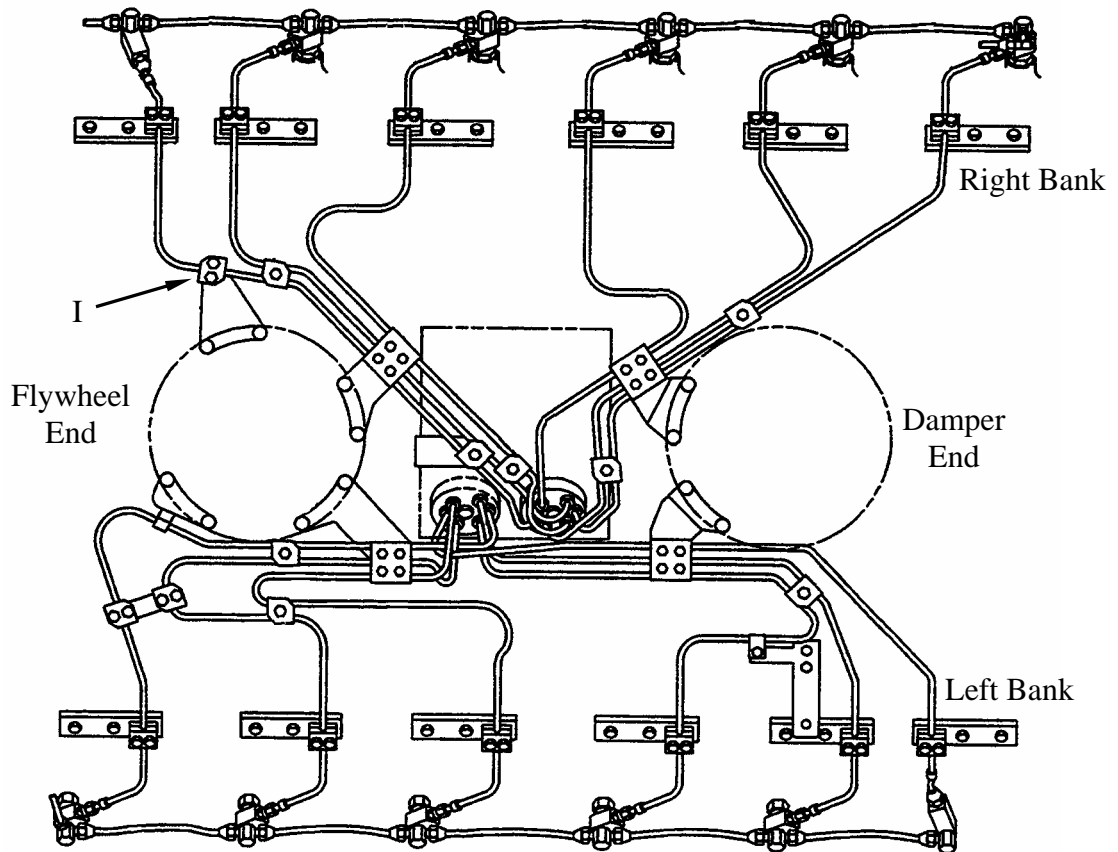
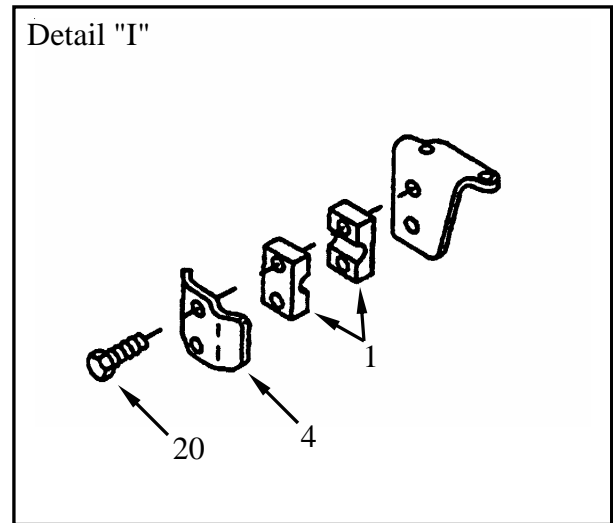
- a. Remove four self-locking nuts (2) from screws (3) to remove retainers (4), fairlead halves (1) and plate (19). Discard self-locking nuts.





**REMOVAL (Continued)**

9. Remove fairlead halves (1) at detail "I" (one place).
  - a. Remove two self-locking screws (20) to remove retainer (4) and outer fairlead half (1). Discard self-locking screws.
  - b. Slide inner fairlead half (1) from behind fuel line, being careful not to bend fuel line.



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

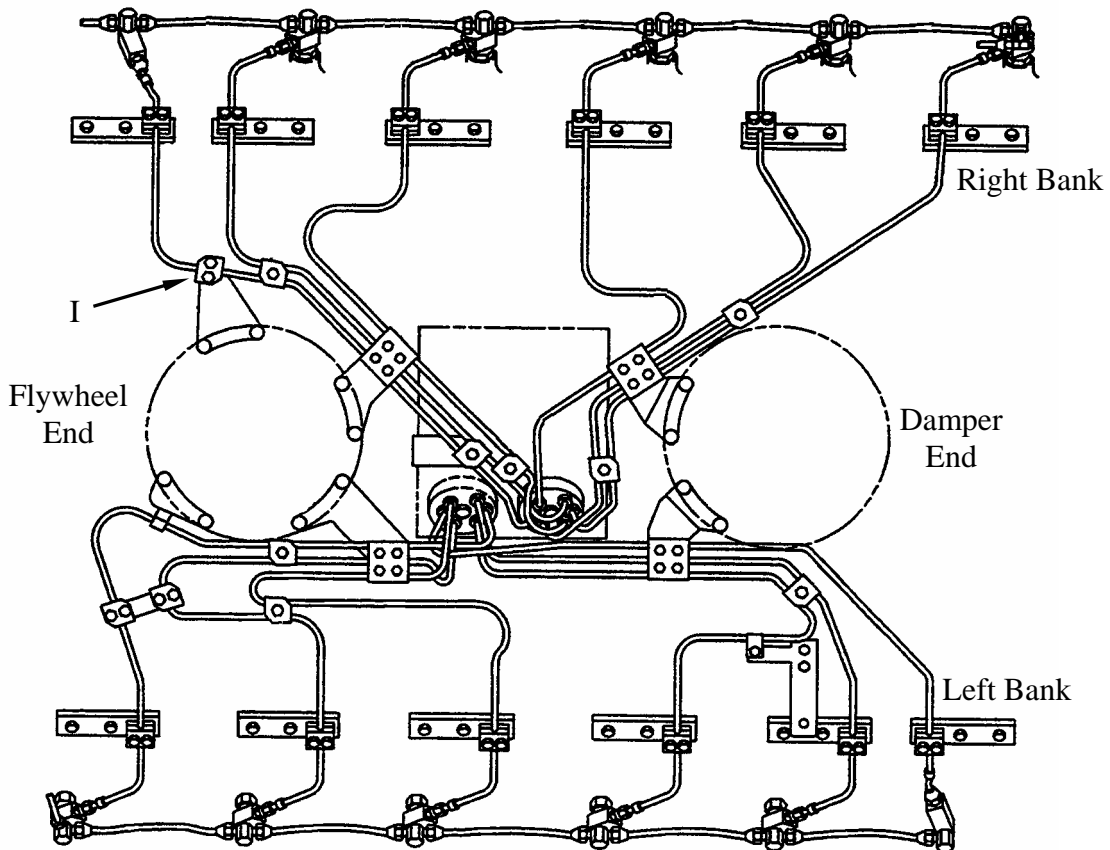
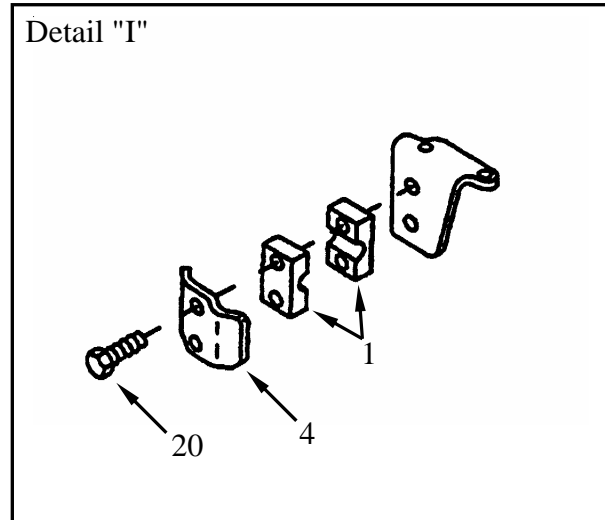
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

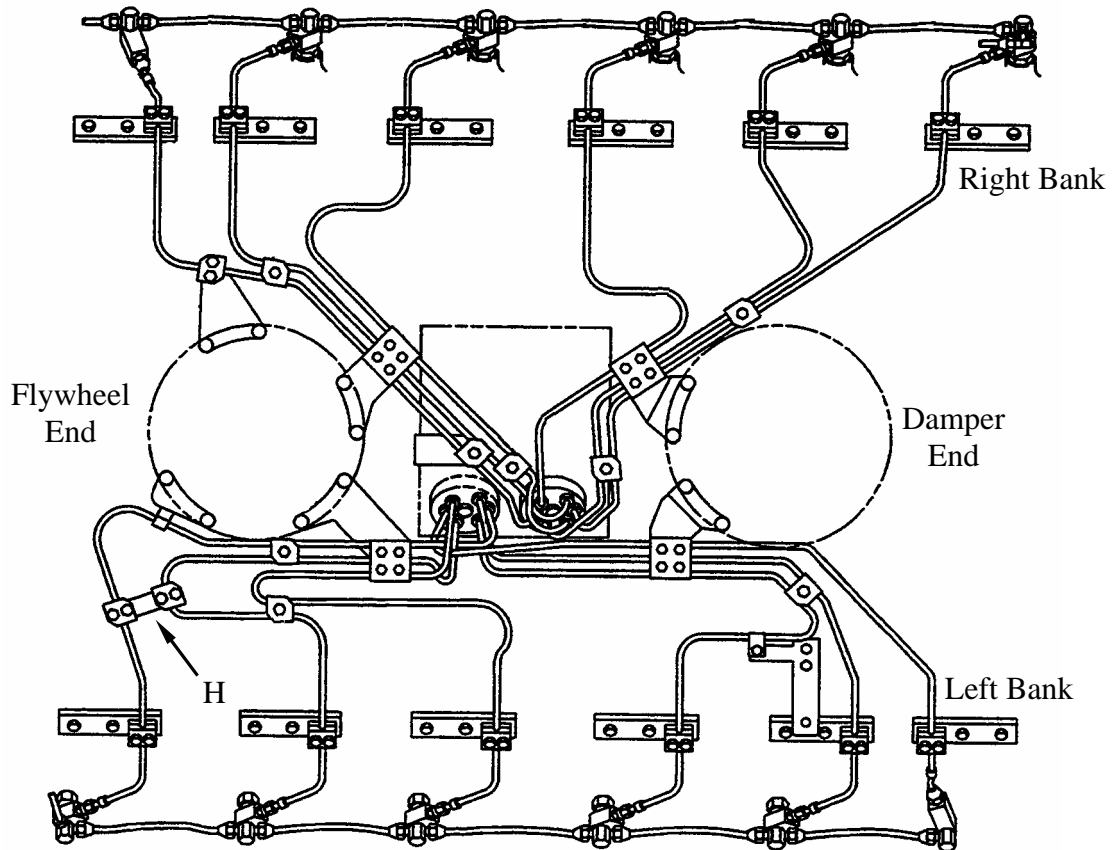
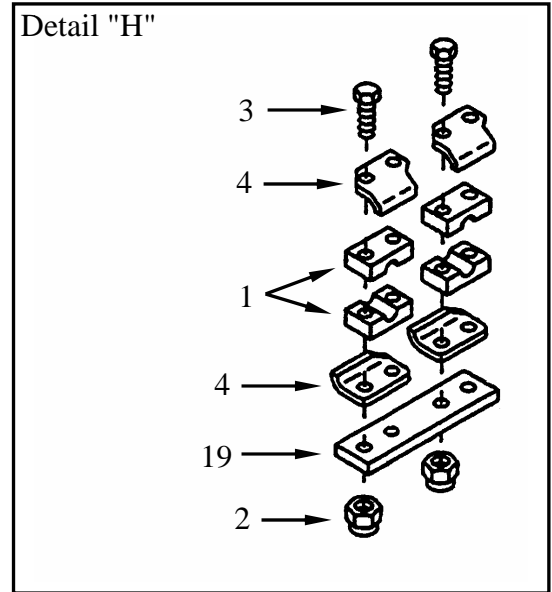
**INSTALLATION**

1. Install fairlead halves (1) at detail "I" (one place).
  - a. Slide inner fairlead half (1) behind fuel line, being careful not to bend fuel line.
  - b. Install outer fairlead half (1) followed by retainer (4) and secure using two new self-locking screws (20) (item 223, WP 0175).



**INSTALLATION (Continued)**

2. Install fairlead halves (1) at detail "H" (one place).
  - a. Install fairlead halves (1), retainers (4), and plate (19) as shown.
  - b. Secure using four screws (3) with new self-locking nuts (2) (item 38, WP 0175).

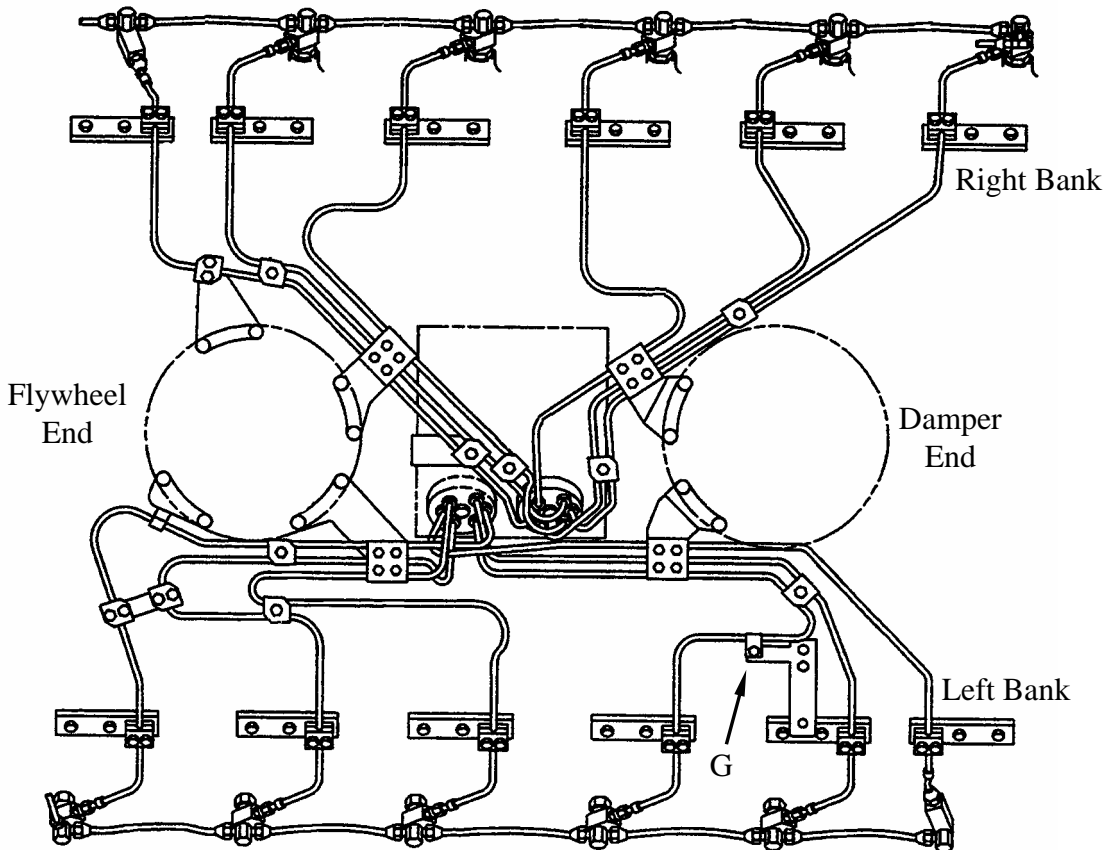
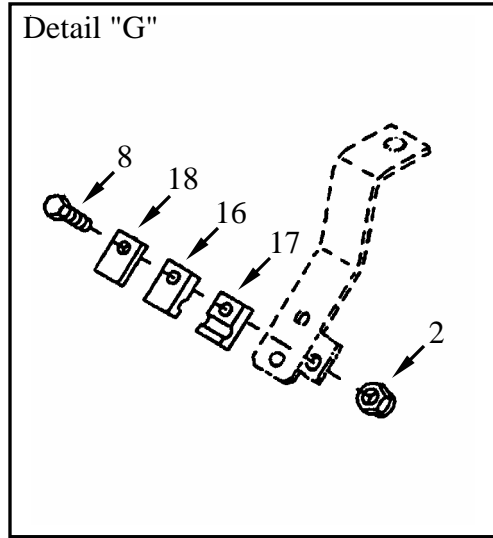


FUEL INJECTOR TUBE BRACKETS REPLACEMENT

0079 00

INSTALLATION (Continued)

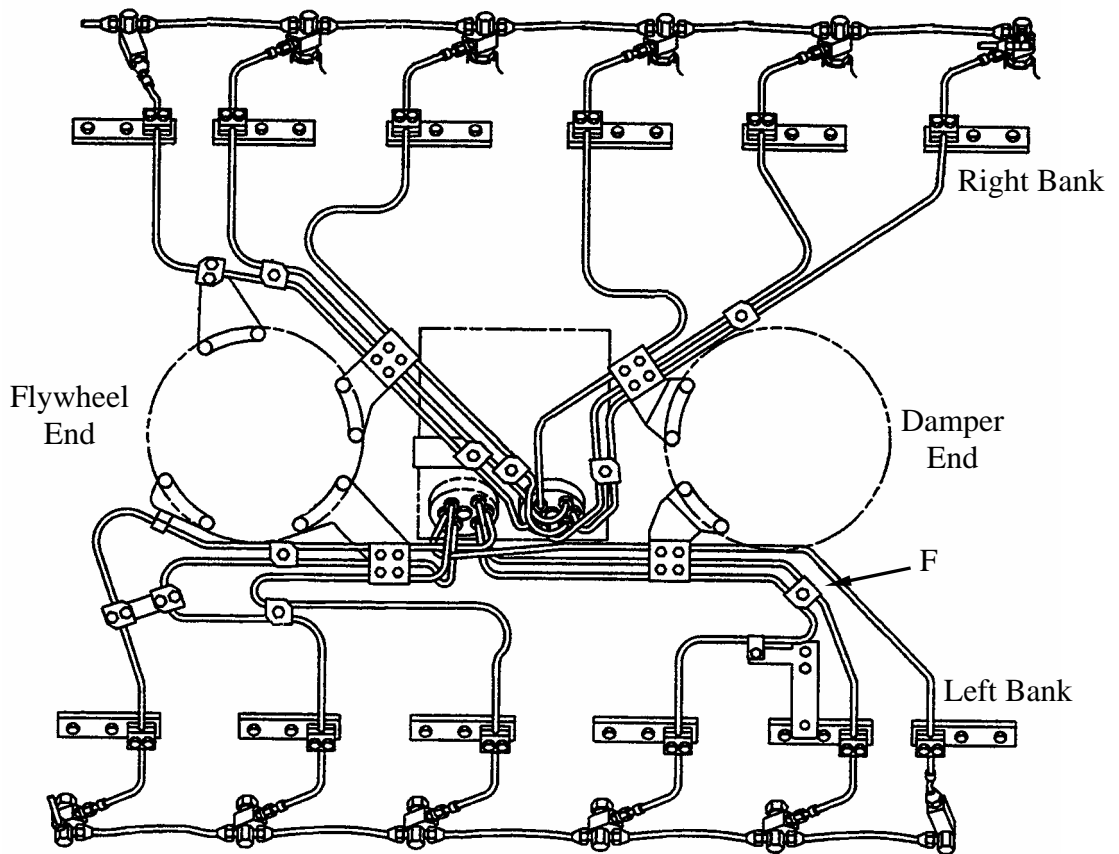
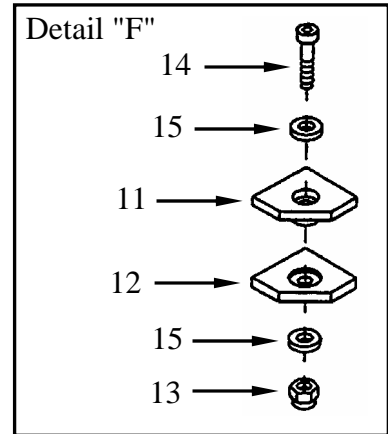
3. Install fairlead halves (16 and 17) at detail "G" (one place).
  - a. Slide bottom fairlead half (17) under fuel line, being careful not to bend fuel line.
  - b. Install fairlead half (16) followed by plate (18) and secure using one screw (8) with a new self-locking nut (2) (item 38, WP 0175).



INSTALLATION (Continued)

4. Install clamps (11 and 12) at detail "F" (one place).

- a. Position clamps (11, 12) as shown.
- b. Secure using one screw (14), two flat washers (15), and a new self-locking nut (13) (item 111 WP 0175).

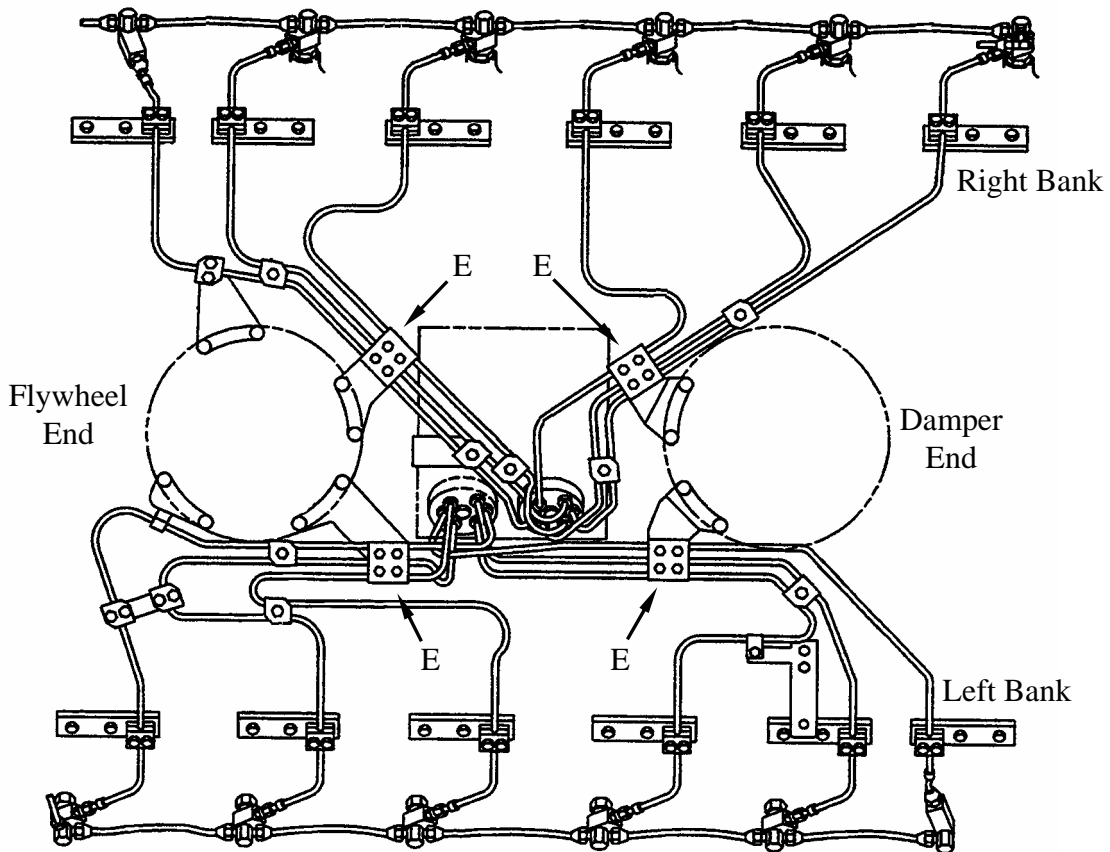
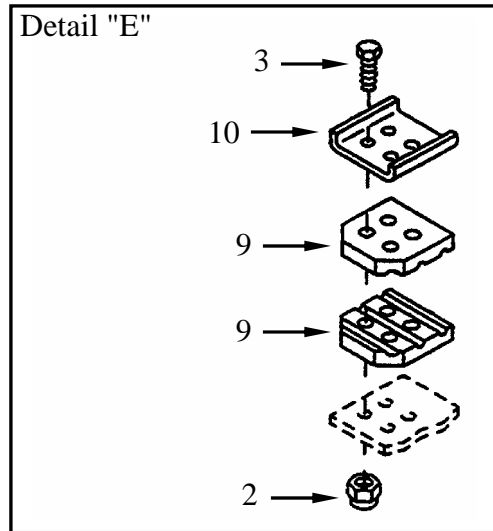


FUEL INJECTOR TUBE BRACKETS REPLACEMENT

0079 00

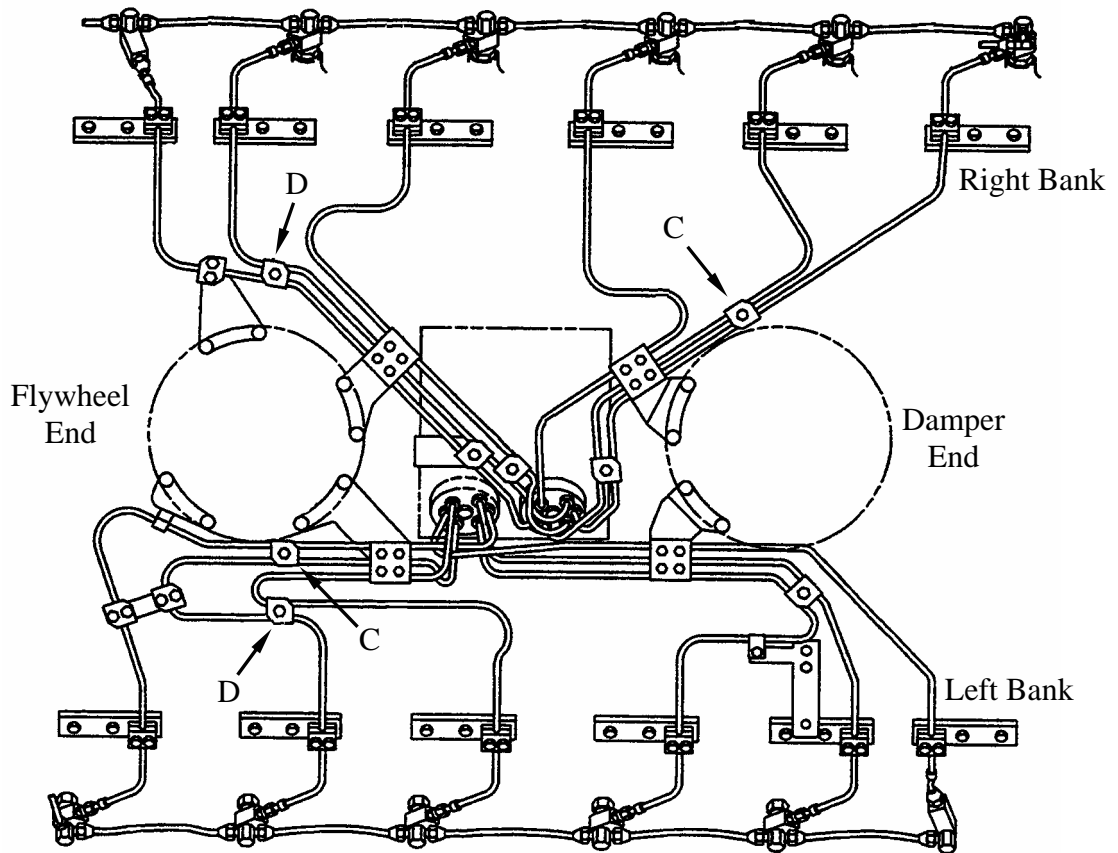
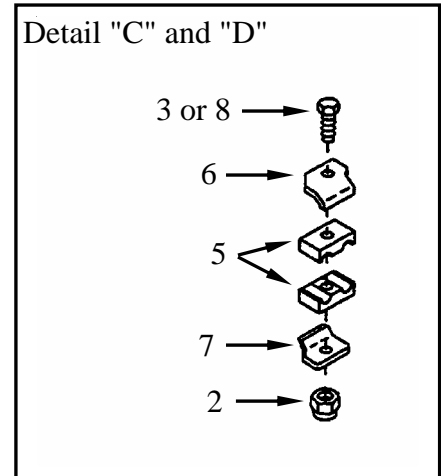
INSTALLATION (Continued)

5. Install fairlead halves (9) at detail "E" (four places).
  - a. Slide bottom fairlead half (9) under fuel line, being careful not to bend fuel line.
  - b. Install top fairlead half (9) followed by retainer (10).
  - c. Secure using four screws (3) with new self-locking nuts (2) (item 38, WP 0175).



**INSTALLATION (Continued)**

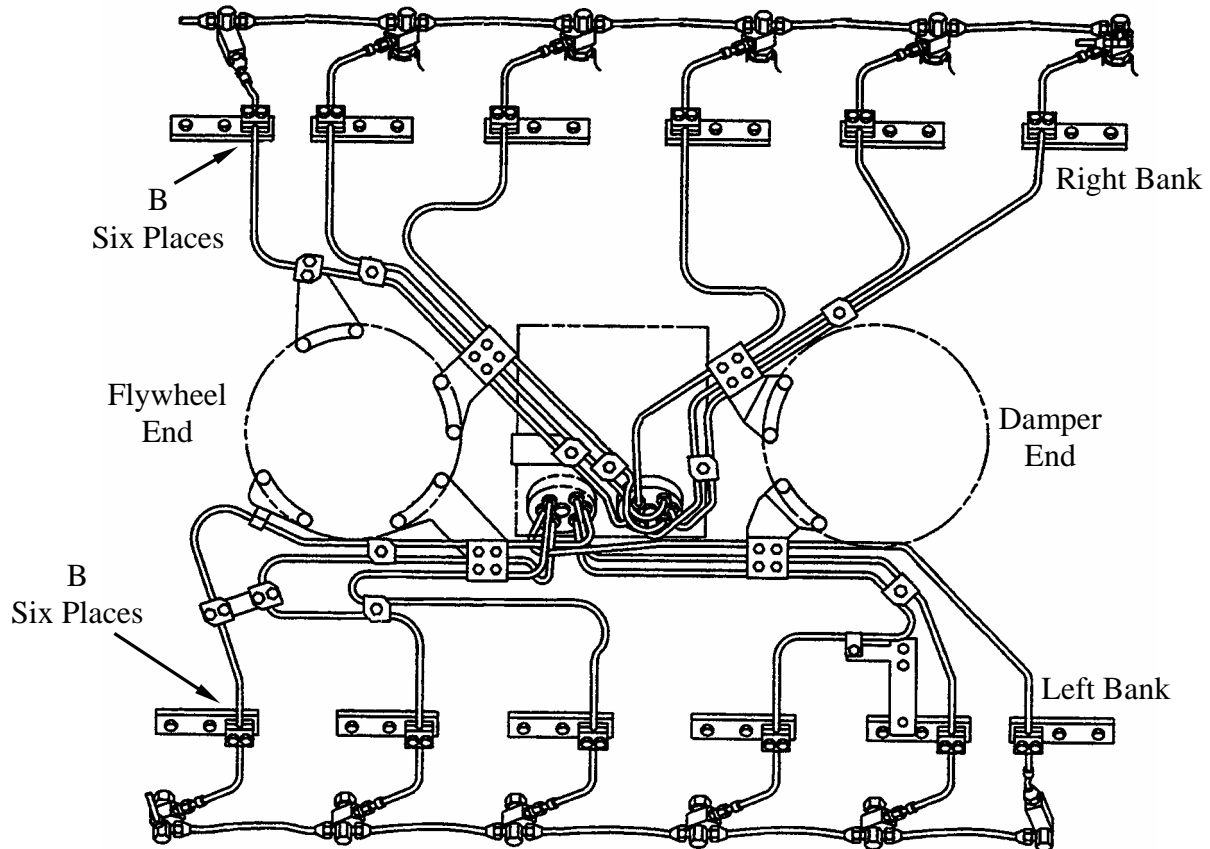
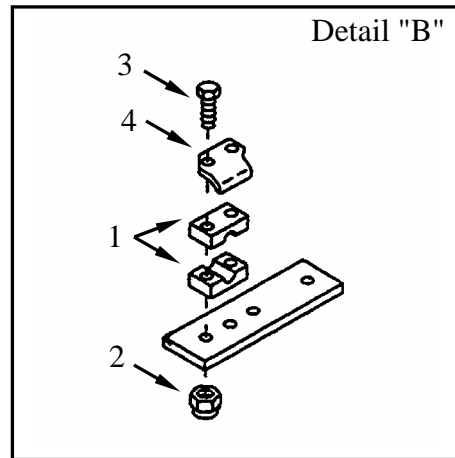
6. Install fairlead halves (5) at detail "D" (two places).
  - a. Install fairlead halves (5) with retainers (6 and 7) as shown.
  - b. Secure using one screw (8) with a new self-locking nut (2) (item 38, WP 0175).
  
7. Install fairlead halves (5) at detail "C" (two places).
  - a. Install fairlead halves (5) with retainers (6 and 7) as shown.
  - b. Secure using one screw (3) with a new self-locking nut (2) (item 38, WP 0175).



**INSTALLATION (Continued)**

8. Install fairlead halves at detail "B" (twelve places).

- a. Slide bottom fairlead half (1) under fuel line, being careful not to bend fuel line.
- b. Install top fairlead half (1) followed by retainer (4).
- c. Secure using two screws (3) with new self-locking nuts (2) (item 38, WP 0175).

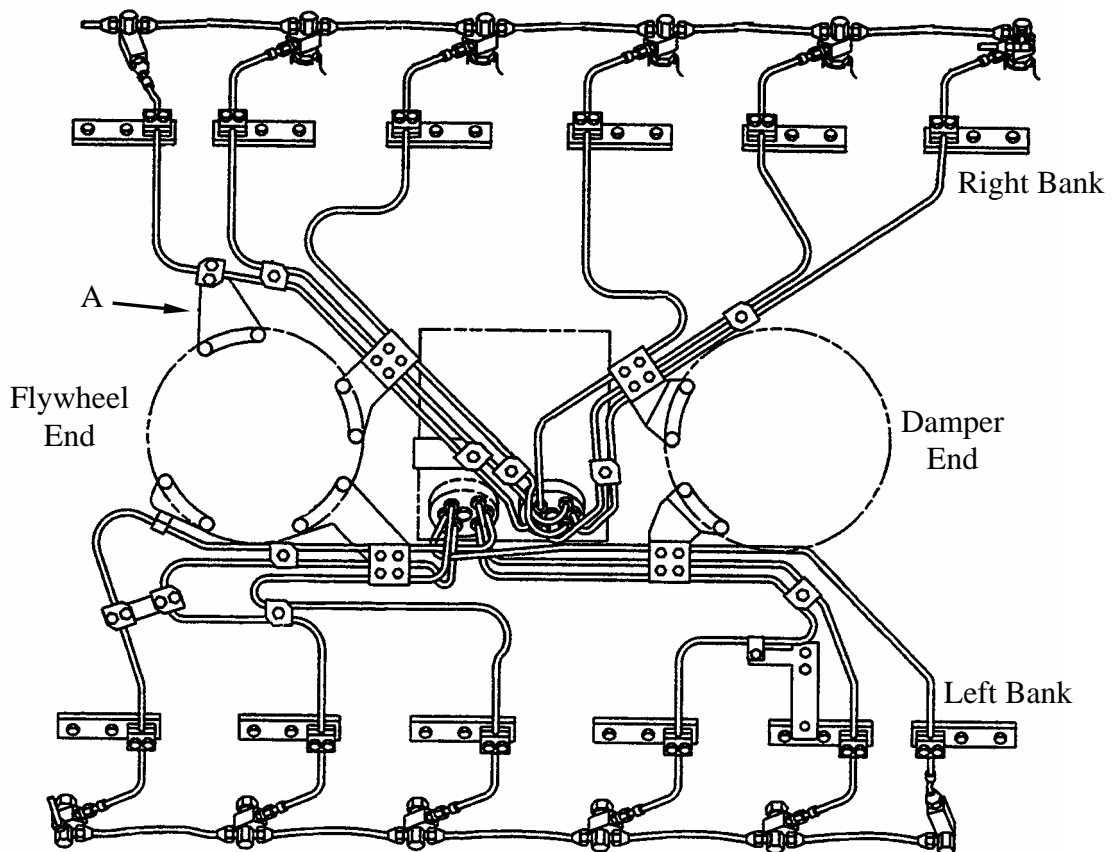
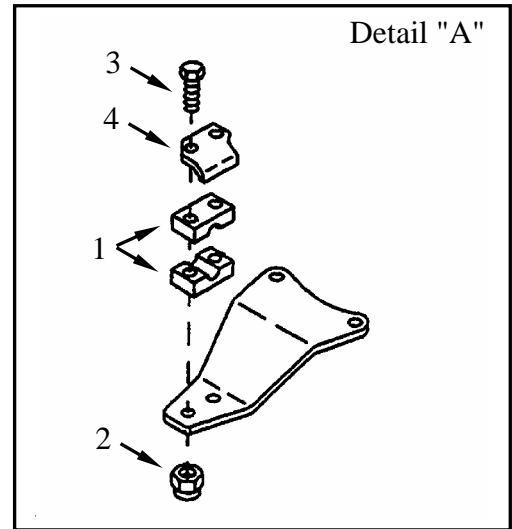




INSTALLATION (Continued)

8. Install fairlead halves (1) at detail "A" (one place).

- a. Slide bottom fairlead half (1) under fuel line, being careful not to bend fuel line.
- b. Install top fairlead half (1) followed by retainer (4).
- c. Secure using two screws (3) with new self-locking nuts (2) (item 38, WP 0175).



END OF WORK PACKAGE



**THIS WORK PACKAGE COVERS**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Torque wrench, 200-1000 inch-pounds (item 125, WP 0176)

**Mandatory Replacement Parts:**

Copper gasket (24) (item 310, WP 0175)  
 Hose (item 120, WP 0175)  
 Hose (item 125, WP 0175)  
 Hose (item 250, WP 0175)  
 Hose (item 251, WP 0175)  
 Self-locking nut (4) (item 30, WP 0175)

**Models 2CA & 2DA unique:**

Self-locking nut (3) (item 42, WP 0175)

**Mandatory Replacement Parts, Continued:****Early Model 2DR unique:**

Hose (item 131, WP 0175)  
 Hose (item 132, WP 0175)  
 Hose (item 176, WP 0175)  
 Lock washer (item 88, WP 0175)  
 Retaining ring (item 8, WP 0175)  
 Self-locking nut (3) (item 42, WP 0175)

**Late Model 2DR unique:**

Hose (item 135, WP 0175)  
 Lock washer (item 88, WP 0175)  
 Self-locking nut (3) (item 42, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine top housing assembly removed (WP 0055)  
 Oil coolers removed (WP 0072)

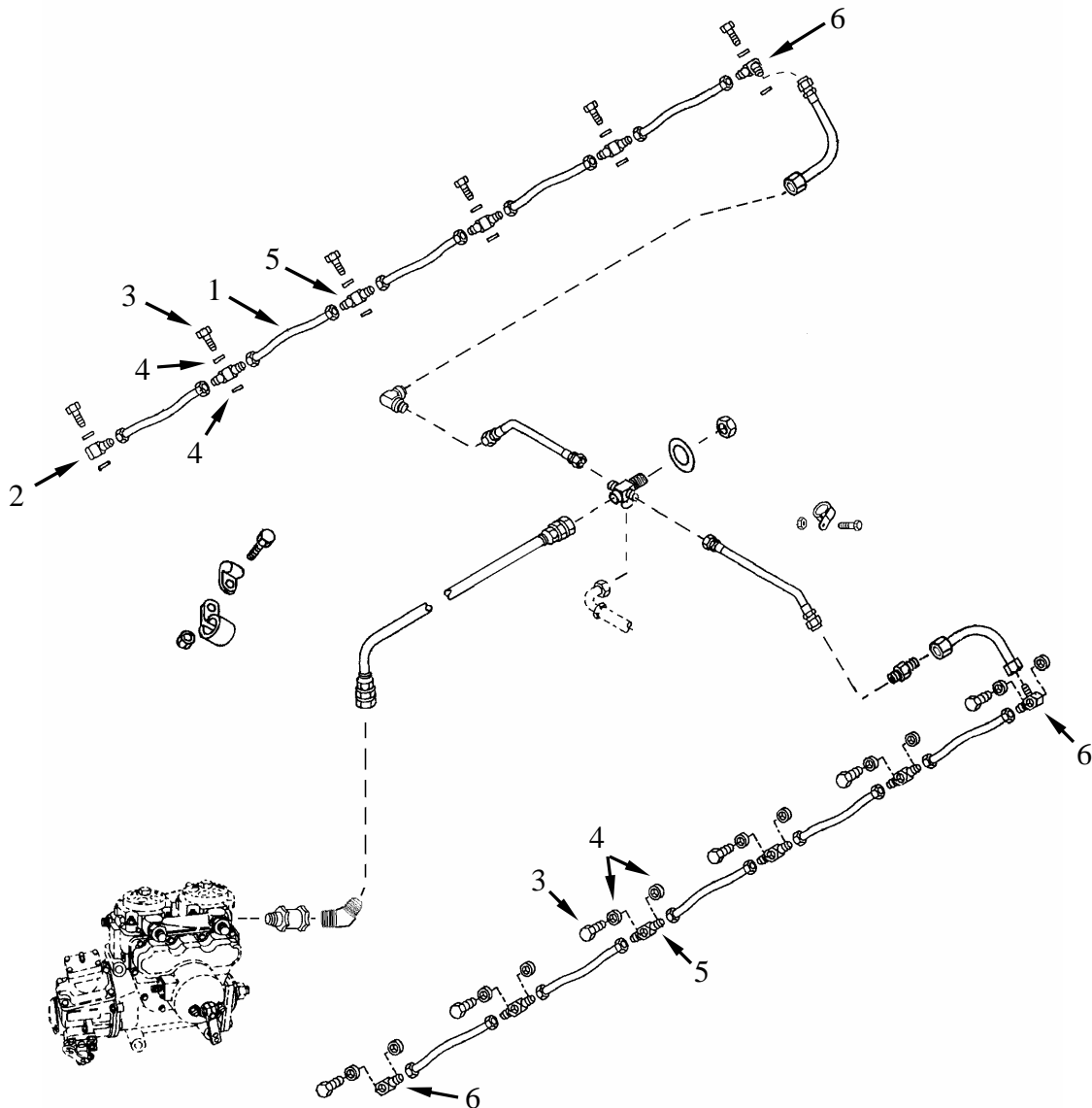
**NOTE**

**Only those items that have call-out numbers can be replaced at the Organizational level.**

**Fuel return hoses connected to the engine cylinders are the same between models 2CA, 2DA, and 2DR. Fuel return hoses in the Vee are the same between 2CA and 2DA, but are different on 2DR. In addition, engine model 2DR has two configurations, an early model and a later model.**

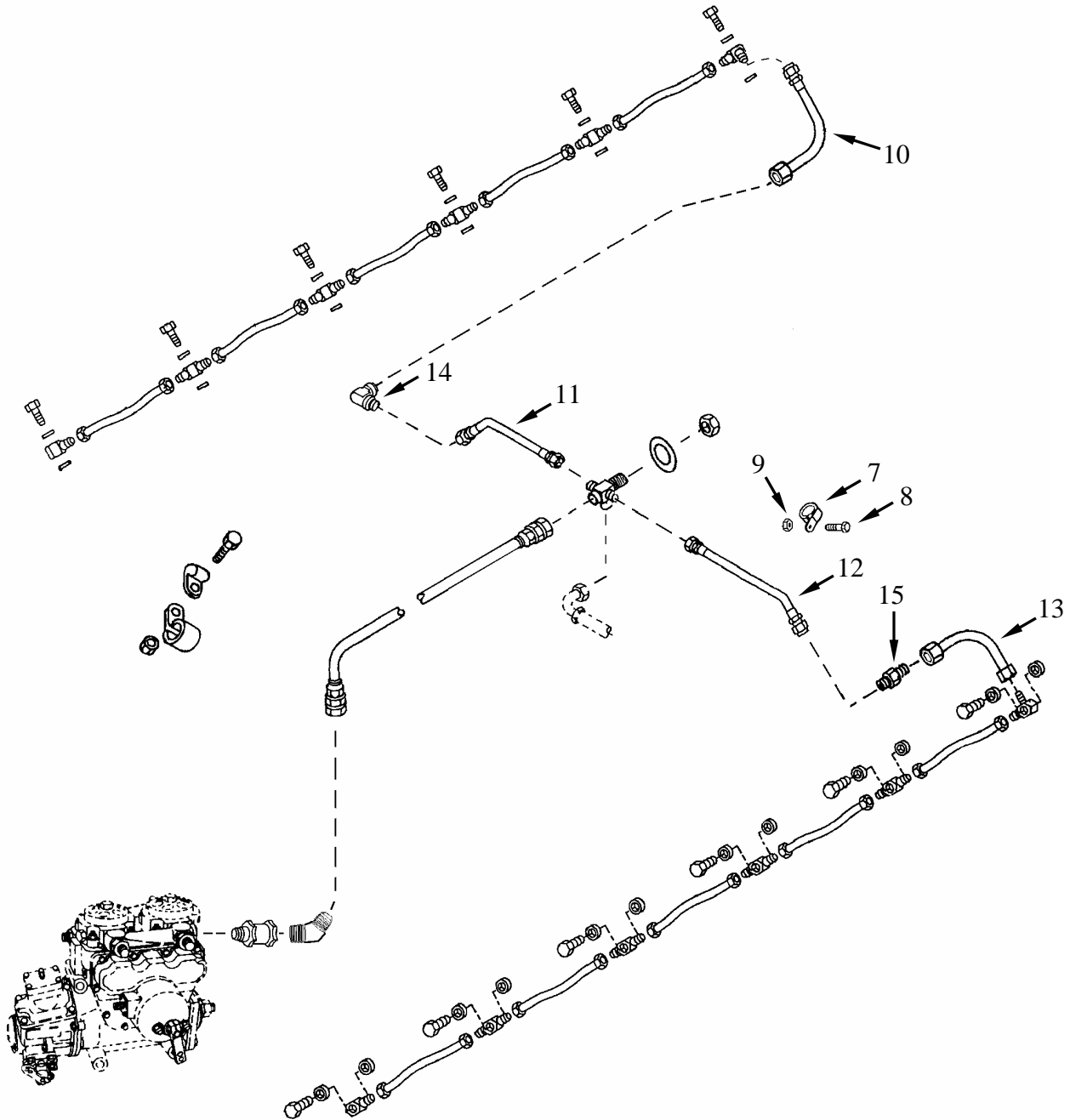
**REMOVAL**

1. Remove and discard ten inter-cylinder hoses (1).
2. Remove end fitting (2) at cylinder number 1 left.
  - a. Remove fluid passage bolt (3).
  - b. Remove fitting (2) and two copper gaskets (4). Discard copper gaskets.
3. Remove eight inter-cylinder-fittings (5).
  - a. Remove fluid passage bolts (3).
  - b. Remove fittings (5) with two copper gaskets (4) at each fitting. Discard copper gaskets.
4. Remove three 90-degree fittings (6).
  - a. Remove fluid passage bolts (3).
  - b. Remove fittings (6) with two copper gaskets (4) at each fitting. Discard copper gaskets.



**REMOVAL (Continued)**

5. Remove four loop clamps (7) by removing screws (8) and self-locking nuts (9). Discard self-locking nuts.
6. Remove hoses (10, 11, 12 and 13).
7. Separate hoses (10, 11) from fitting (14). Discard hoses.
8. Separate hoses (12, 13) from fitting (15). Discard hoses.

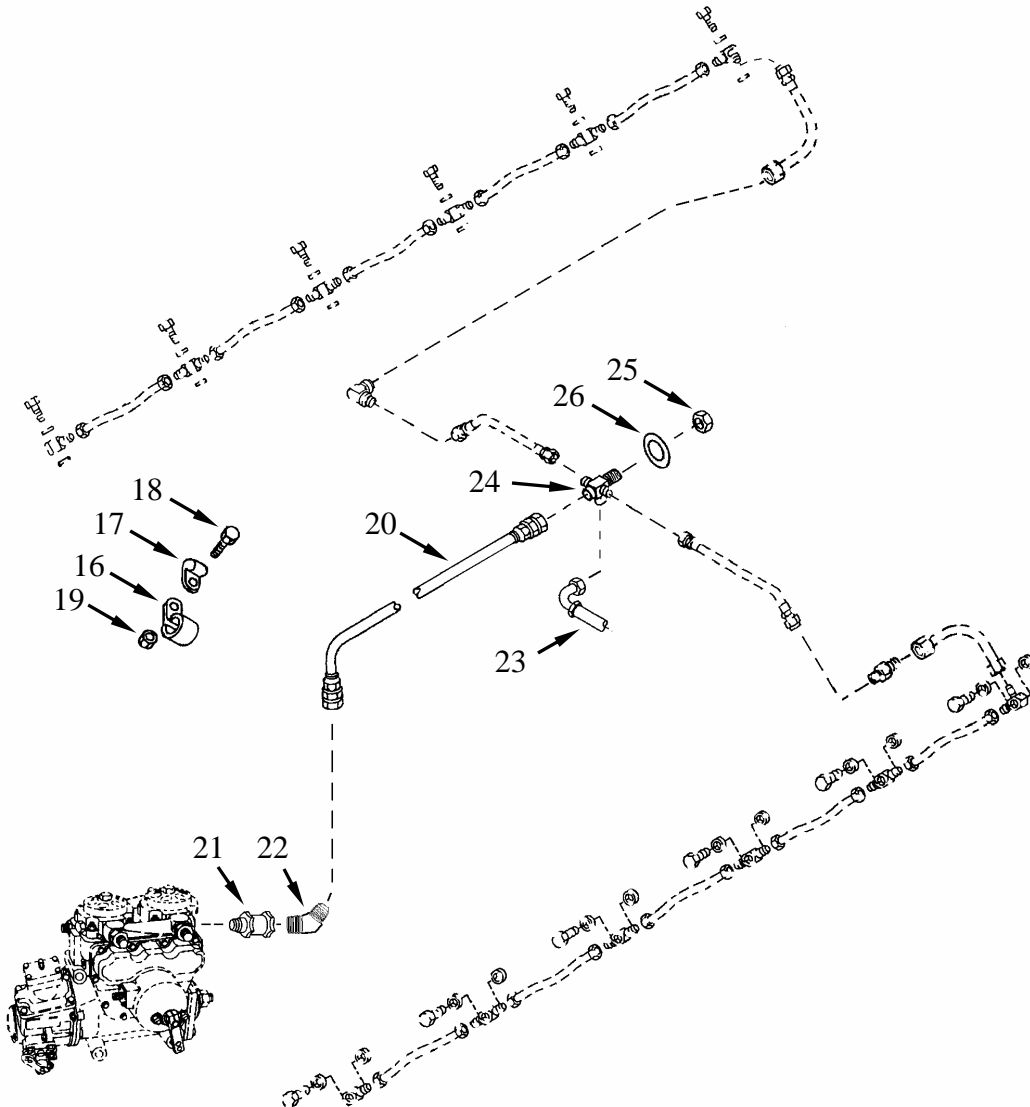


## REMOVAL (Continued)

## NOTE

Steps 9 through 12 are for 2CA and 2DA engine models only.

9. Remove loop clamps (16, 17) by removing screw (18) and self-locking nut (19). Discard self-locking nut.
10. Remove hose (20).
11. Remove 45-degree fitting (21) and check valve (22).
12. Remove cross fitting (24).
  - a. Disconnect hose (23) [fuel return from manifold heaters].
  - b. Remove nut (25).
  - c. Remove flat washer (26) and fitting (24).

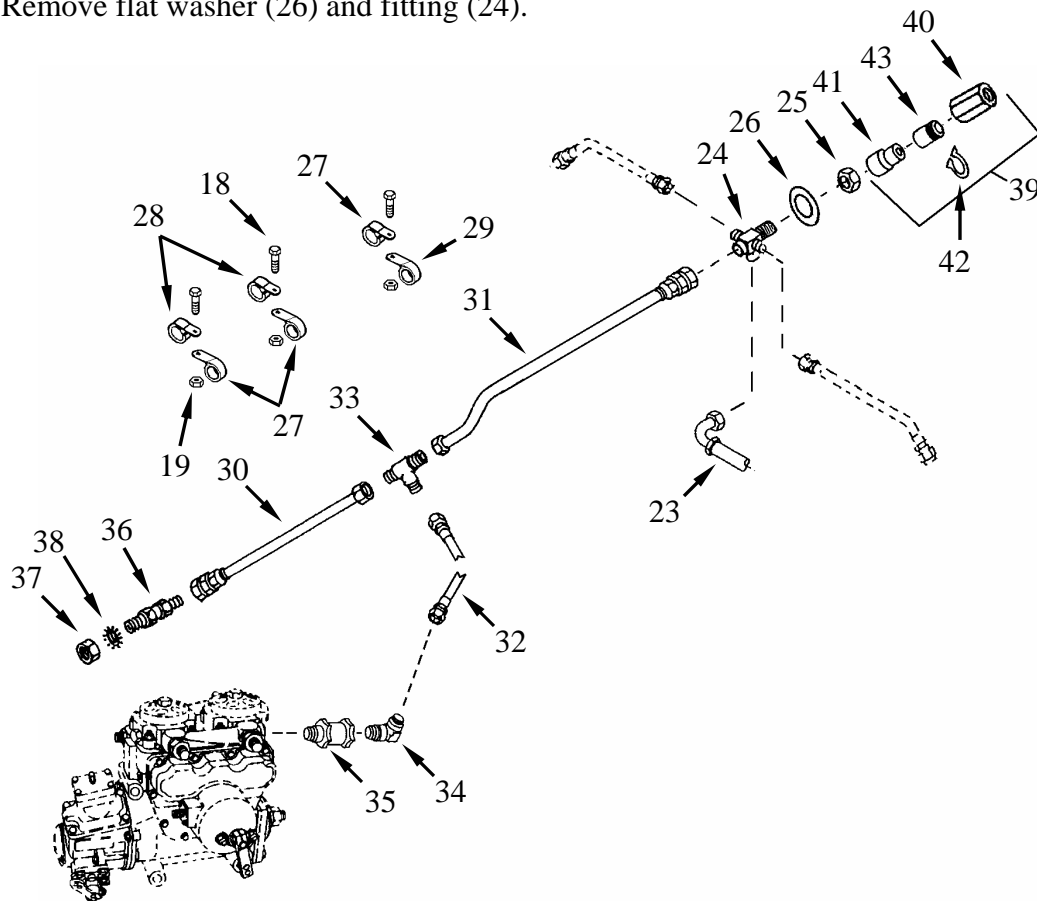


**REMOVAL (Continued)**

**NOTE**

**Steps 13 through 19 are for early 2DR engine models only.**

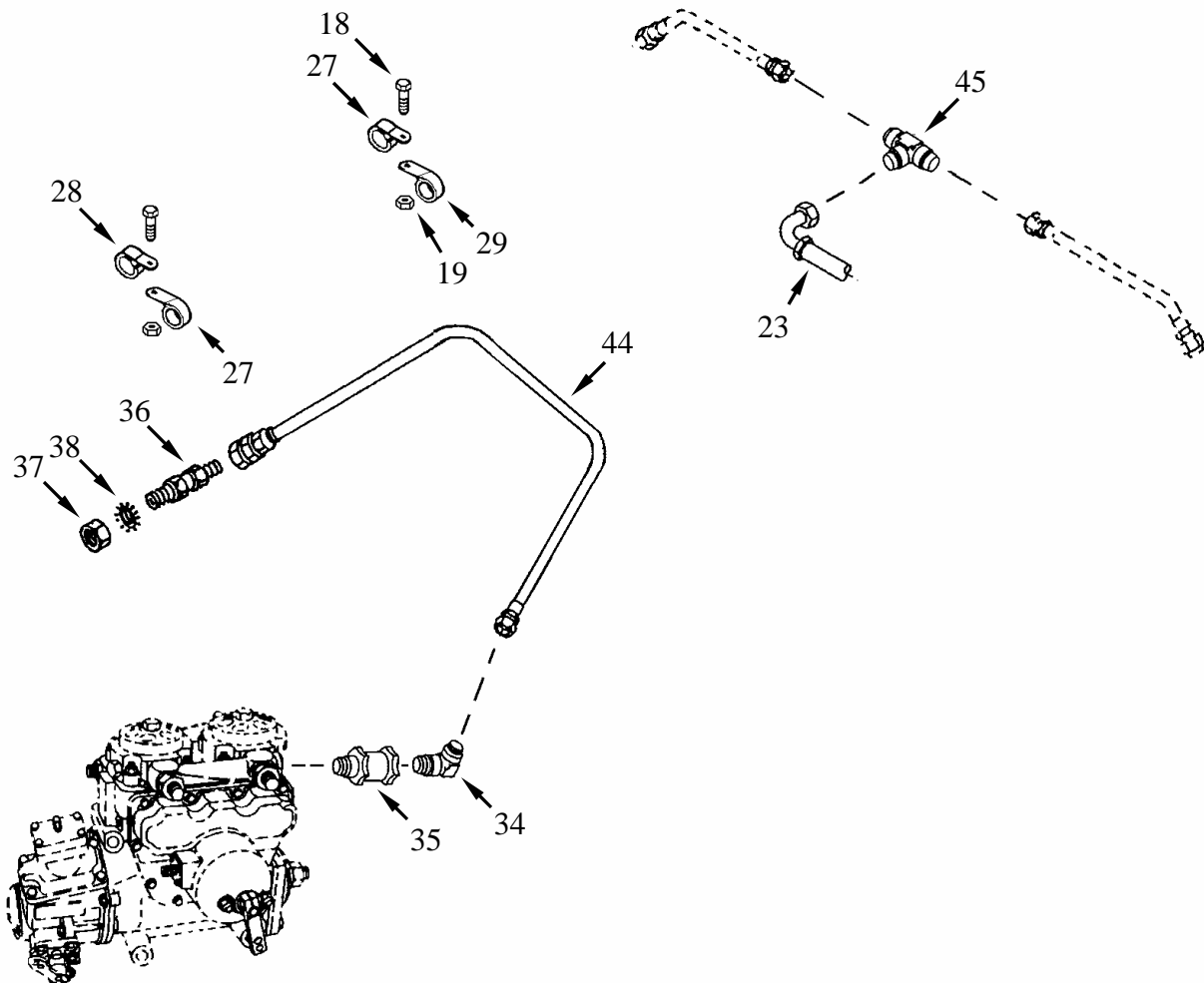
13. Remove loop clamps (27, 28, 29) by removing screws (18) and self-locking nuts (19). Discard self-locking nuts.
14. Remove hoses (30, 31, 32) as an assembly.
15. Separate hoses (30, 31, 32) from tee fitting (33). Discard hoses.
16. Remove elbow (34) and check valve (35).
17. Remove bulkhead fitting (36).
  - a. Remove nut (37) and lock washer (38) to remove fitting (36). Discard lock washer.
18. Remove plug assembly (39).
  - a. Remove nut (40) to remove assembly (39).
  - b. Remove plug (41) from assembly.
  - c. Remove retaining ring (42) to separate sleeve (43) from nut (40). Discard retaining ring.
19. Remove cross fitting (24).
  - a. Disconnect hose (23) [fuel return from manifold heaters].
  - b. Remove nut (25).
  - c. Remove flat washer (26) and fitting (24).



**REMOVAL (Continued)****NOTE**

**Steps 20 through 24 are for late 2DR engine models only.**

20. Remove loop clamps (27, 28, 29) by removing screws (18) and self-locking nuts (19). Discard self-locking nuts.
21. Remove and discard hose (44).
22. Remove elbow (34) and check valve (35).
23. Remove bulkhead fitting (36).
  - a. Remove nut (37) and lock washer (38) to remove fitting (36). Discard lock washer.
24. Disconnect hose (23) [fuel return from manifold heater] from tee fitting (45).

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.



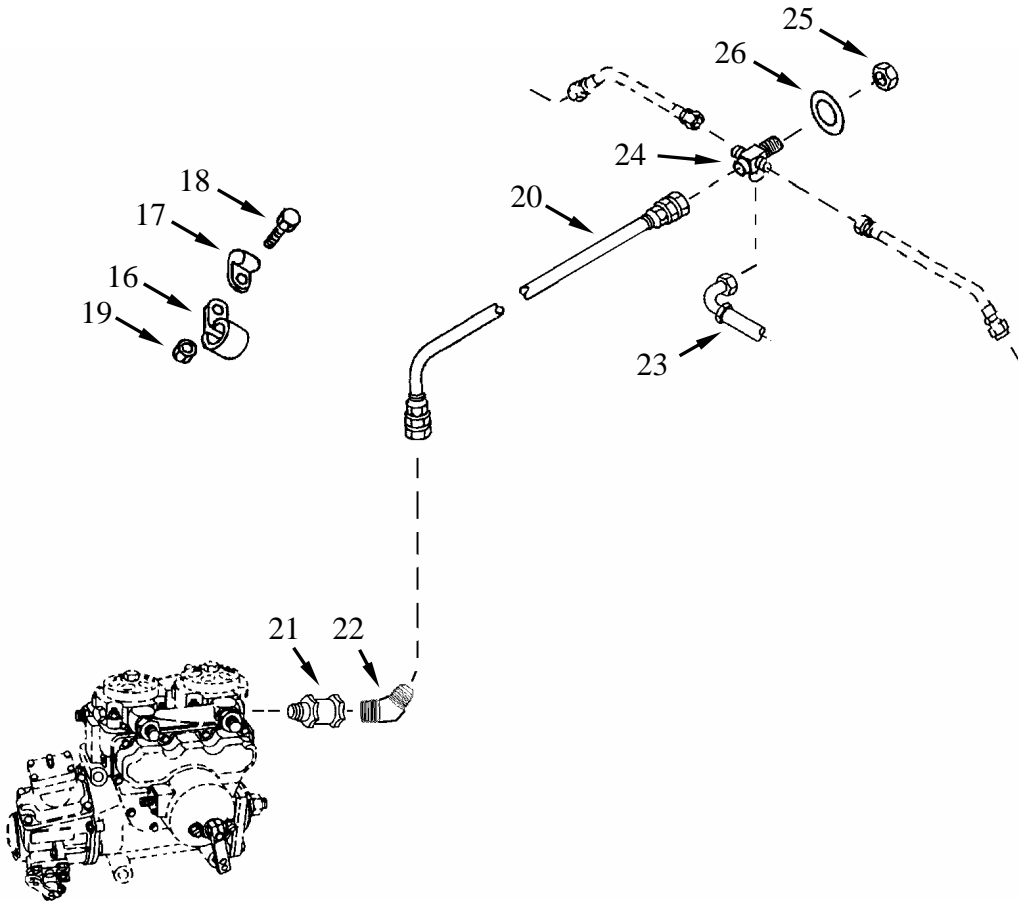
**INSPECTION**

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION****NOTE**

**Steps 1 through 4 are for 2CA and 2DA engine models only.**

1. Install cross fitting (24).
  - a. Install flat washer (26) and fitting (24).
  - b. Secure with nut (25).
  - c. Connect hose (23) [fuel return from manifold heaters].
2. Install check valve (22) and 45-degree fitting (21).
3. Install new hose (20).
4. Install loop clamps (16, 17) and secure using screw (18) with new self-locking nut (19) (item 42, WP 0175).

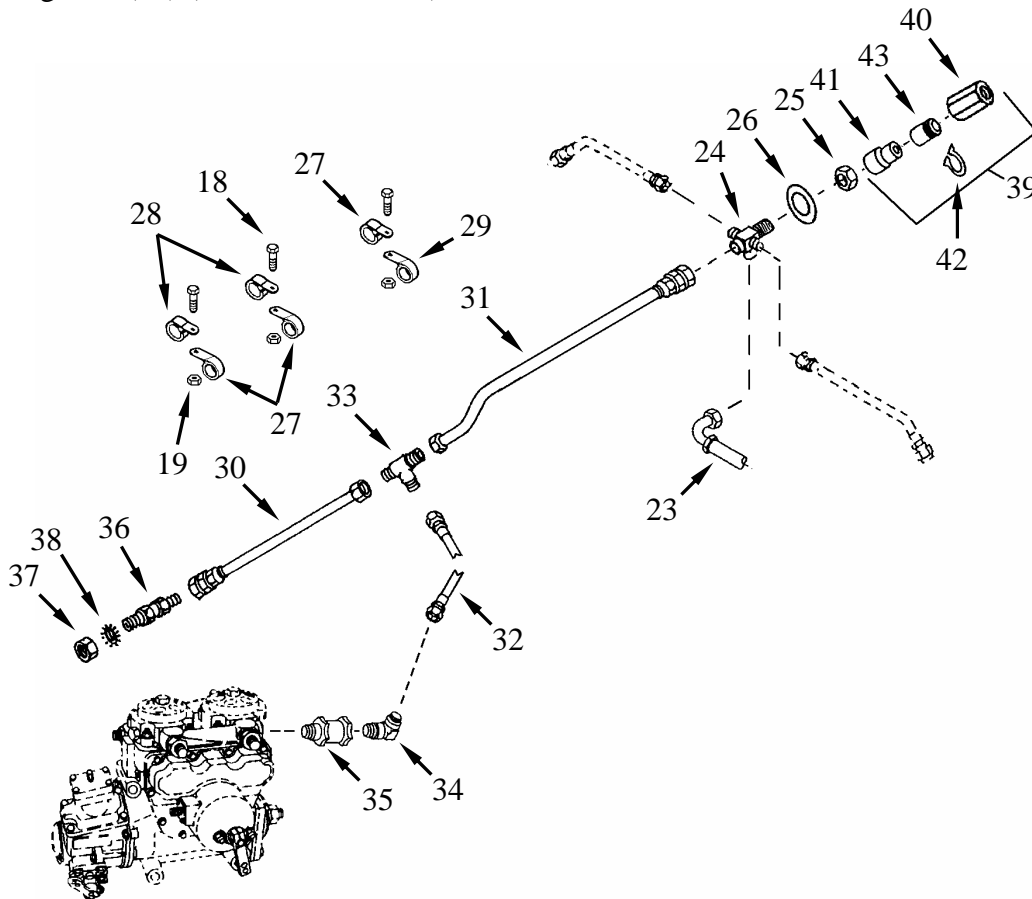


INSTALLATION (Continued)

NOTE

Steps 5 through 11 are for early 2DR engine models only.

5. Install cross fitting (24).
  - a. Install fitting (24) and flat washer (26). Secure with nut (25).
  - b. Connect hose (23) [fuel return from manifold heaters].
6. Install plug assembly (39).
  - a. Slide sleeve (43) into nut (40) and secure using new retaining ring (42) (item 8, WP 0175).
  - b. Insert plug (41) into nut and install the assembly (39).
7. Install bulkhead fitting (36).
  - a. Position fitting (36) through tinwork and secure using nut (37) with new lock washer (38) (item 88, WP 0175).
8. Install check valve (35) and elbow (34).
9. Install new hoses (30) (item 132, WP 0175), (31) (item 131, WP 0175), and (32) (item 176, WP 0175) onto tee fitting (33).
10. Install new hoses (30, 31, 32) as an assembly.
11. Secure hoses (30, 31, 32) with loop clamps (27, 28, 29) using screws (18) with new self-locking nuts (19) (item 42, WP 0175).

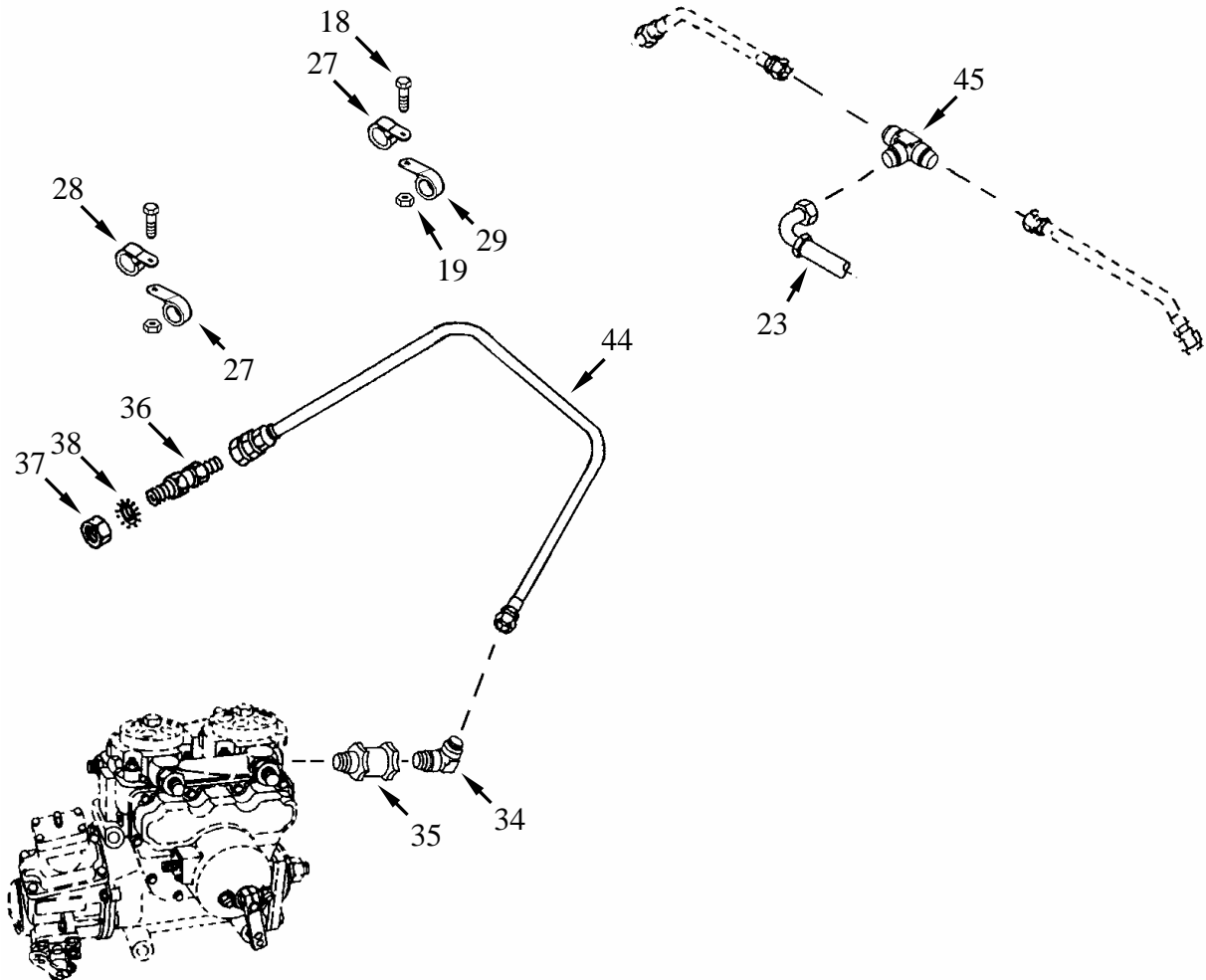


## INSTALLATION (Continued)

## NOTE

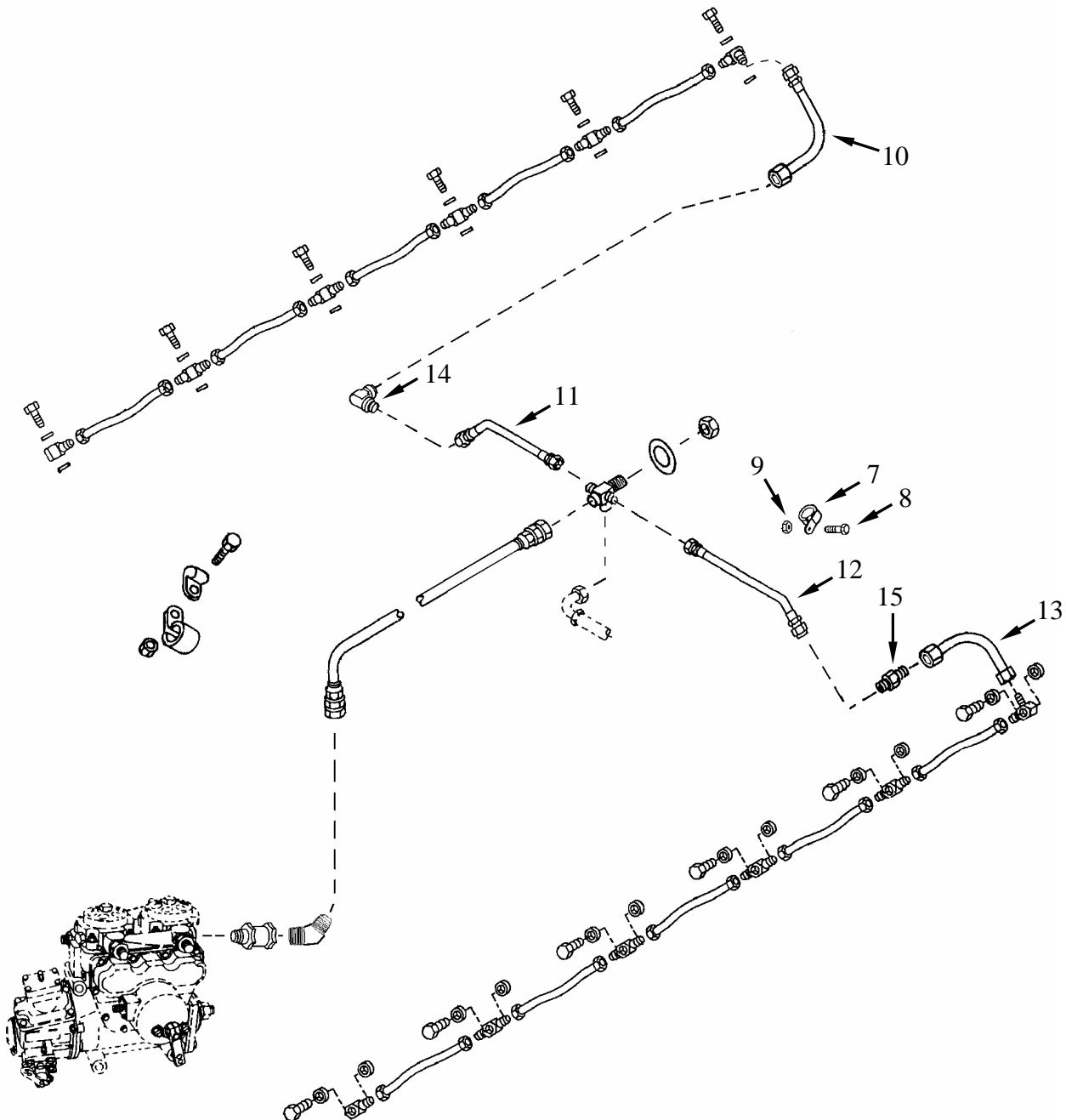
Steps 12 through 16 are for late 2DR engine models only.

12. Connect hose (23) [fuel return from manifold heater] to tee fitting (45).
13. Install bulkhead fitting (36).
  - a. Secure using nut (37) and new lock washer (38) (item 88, WP 0175).
14. Install check valve (35) and elbow (34).
15. Install new hose (44) (item 135, WP 0175).
16. Install loop clamps (27, 28, 29) and secure using screws (18) with new self-locking nuts (19) (item 42, WP 0175).



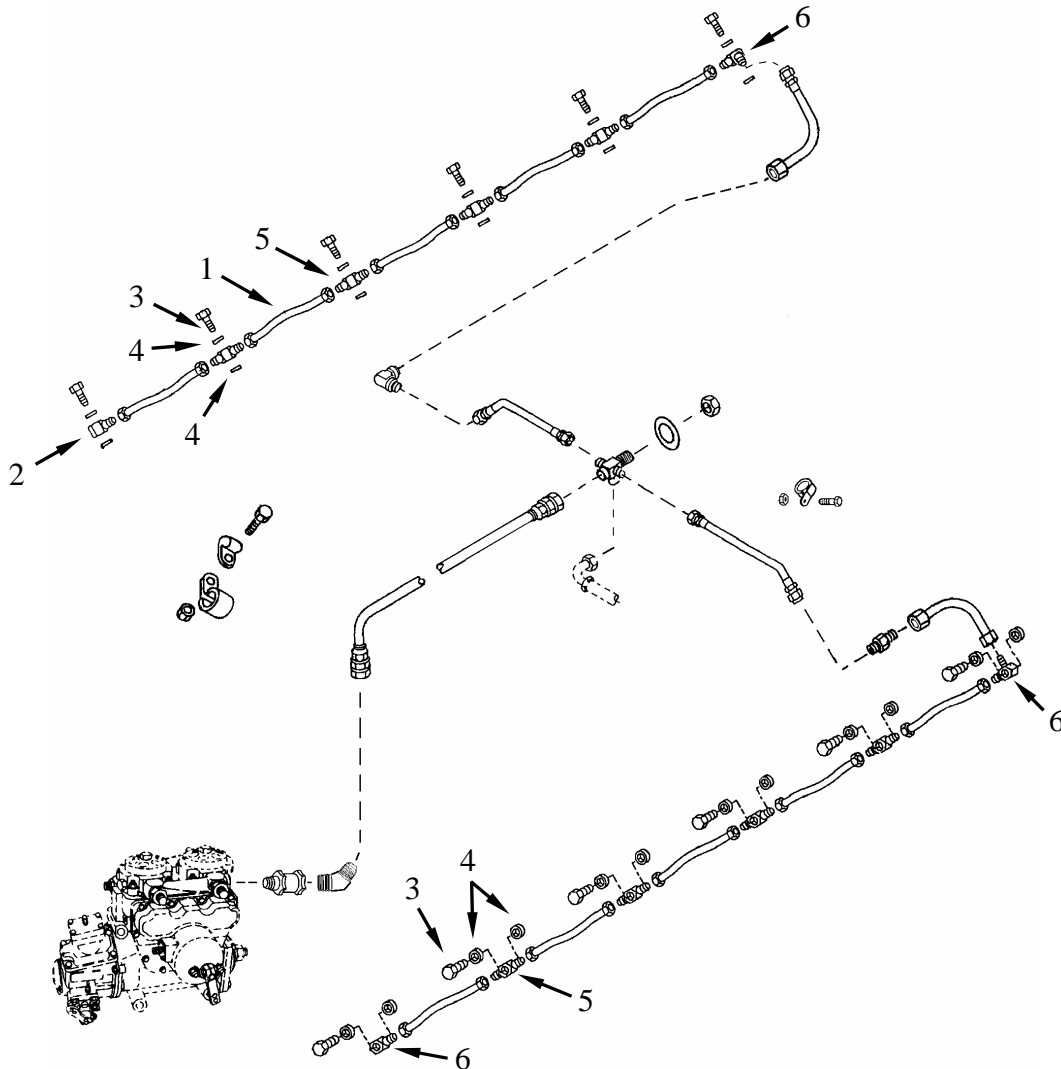
**INSTALLATION (Continued)**

17. Attach new hoses (12) (item 251, WP 0175) and (13) (item 120, WP 0175) to fitting (15).
18. Attach new hoses (10) (item 115, WP 0175) and (11) (item 250, WP 0175) to fitting (14).
19. Install hoses (10, 11, 12 and 13).
20. Install four loop clamps (7) and secure using screws (8) with new self-locking nuts (9) (item 33, WP 0175).



**INSTALLATION (Continued)**

21. Install three 90-degree fittings (6).
  - a. Position fittings (6) with a new copper gasket (4) (item 301, WP 0175) on each side.
  - b. Secure using fluid passage bolts (3). Do not tighten bolts at this time.
22. Install eight inter-cylinder-fittings (5).
  - a. Position fittings (5) with a new copper gasket (4) (item 301, WP 0175) on each side.
  - b. Secure using fluid passage bolts (3). Do not tighten bolts at this time.
23. Install end fitting (2) at cylinder number 1 left.
  - a. Position fitting (2) with a new copper gasket (4) (item 301, WP 0175) on each side.
  - b. Secure using fluid passage bolt (3). Do not tighten bolts at this time.
24. Install ten new inter-cylinder hoses (1) (item 115, WP 0175). Torque tighten all fluid passage bolts (3) to 290-310 inch-pounds (32.8-35.0 N•m).



**END OF WORK PACKAGE**



**FUEL BACKFLOW VALVE REPLACEMENT****0081 00****THIS WORK PACKAGE COVERS:**

Test, Removal, Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (2) (item 92, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**Expendable and Durable Items:**

Container for fuel, minimum 1-gallon capacity

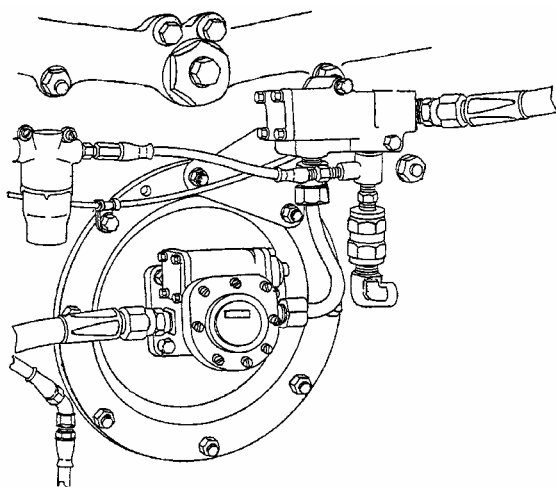
**REMOVAL**

- To determine if your backflow valve is functioning properly, perform the test in WP 0046. The most notable symptom produced by a non-functioning backflow valve is a non-functioning manifold heater.

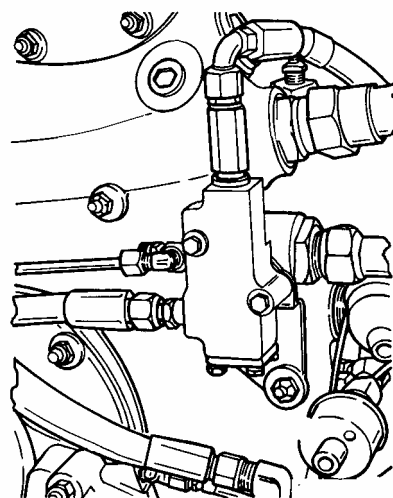
The fuel backflow valve is a dual purpose valve.

- It incorporates a check valve that prevents pressurized fuel generated by the purge pump (wobble pump) from back flowing into the primary fuel filter.
- It incorporates a by-pass valve that limits the fuel pressure to the manifold heaters.

The fuel backflow valve is mounted on the damper housing on all 750 horsepower AVDS-1790 engines. There are two mounting configurations, one on the 2CA and 2DA engines and another on the 2DR engine. In addition, the fuel out of the valve fitting is a straight fitting on the 2DR engine. Removal and installation procedures are similar. The two configurations are illustrated below.



2CA and 2DA Configuration



2DR Configuration

**REMOVAL (Continued)**

1. Disconnect fuel inlet hose (1) and drain fuel into a suitable container.
2. Disconnect manifold heater fuel line (2).

**NOTE**

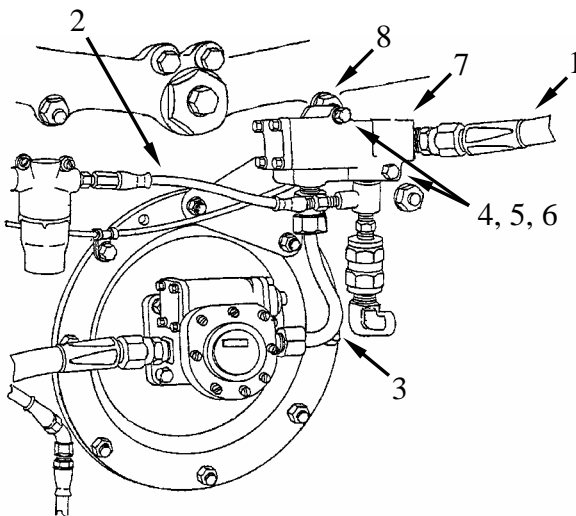
**Metal tube between backflow valve and fuel pump (2CA and 2DA) cannot be removed until backflow valve is loosened from bracket.**

3. Loosen fuel pump fuel inlet tube (3) at both ends.
4. Remove two screws (4) with lock washers (5) and flat washers (6) and remove backflow valve (7) from mounting bracket (8).

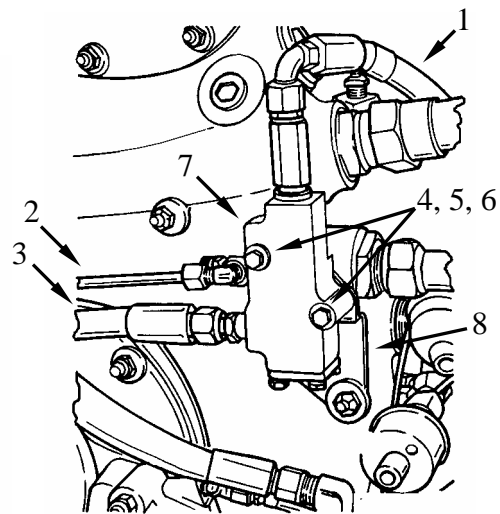
**NOTE**

**Take note of orientation of fittings so that they can be installed in replacement valve as they were in the original.**

5. Remove fittings and save for use in replacement backflow valve.



2CA and 2DA Configuration



2DR Configuration



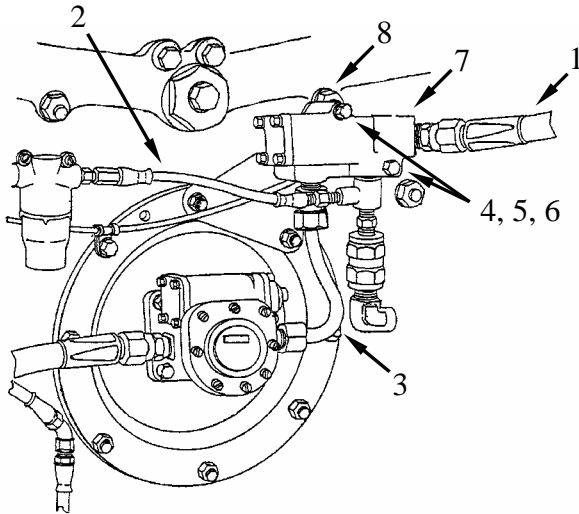
## INSTALLATION

1. Install fittings and orient as they were in the original backflow valve.

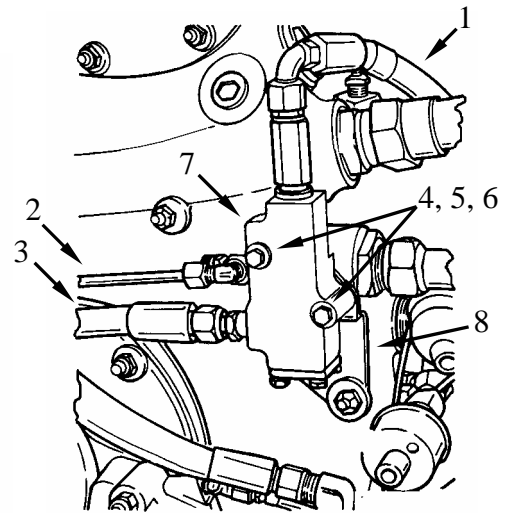
## NOTE

**Metal tube between backflow valve and fuel pump (2CA and 2 DA) must be installed as backflow valve is fastened to bracket.**

2. Install backflow valve (7) onto bracket (8).
  - a. Loosely connect fuel pump fuel inlet tube (3) at both ends.
  - b. Secure backflow valve using two screws (4), new lock washers (5) (item 92, WP 0175), and flat washers (6).
3. Tighten fuel pump fuel inlet tube (3) at both ends.
4. Connect manifold heater fuel line (2).
5. Connect fuel inlet hose (1).



2CA and 2DA Configuration



2CB and 2DR Configuration

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (4) (item 92, WP 0175)

O-Ring (2) (item 75, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

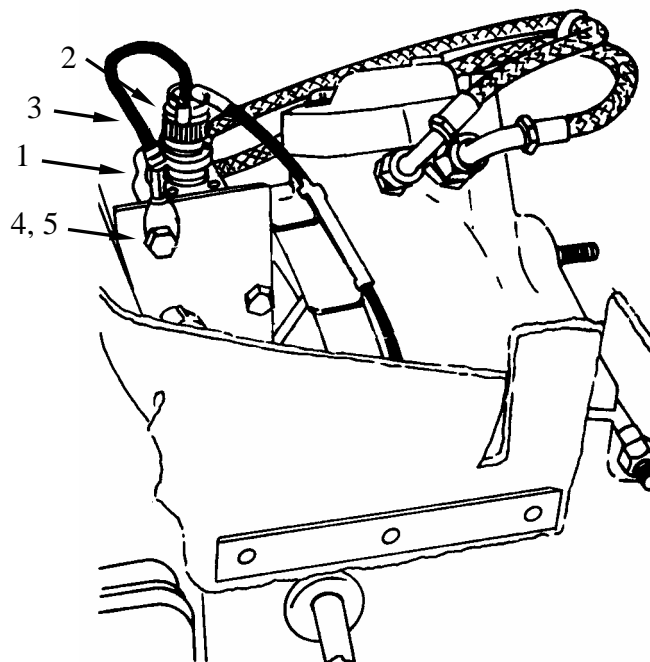
Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

**NOTE**

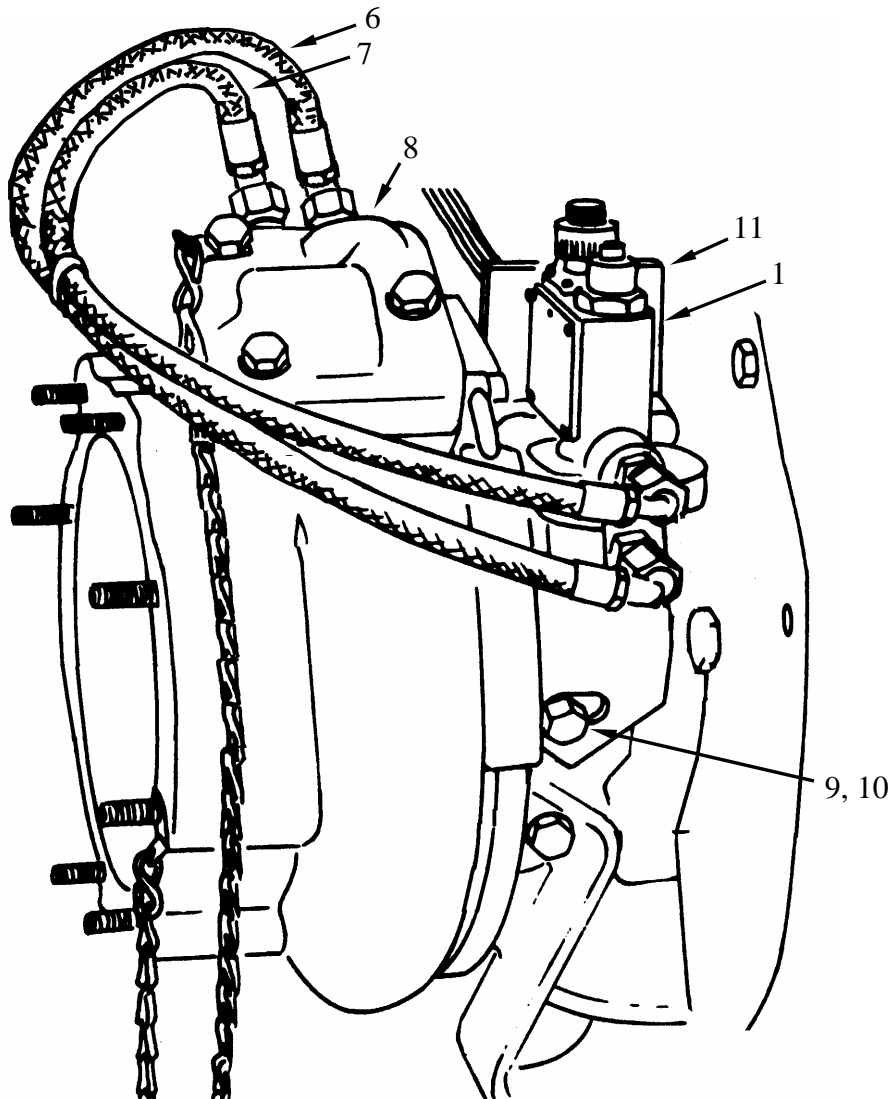
**Similar procedures are required to remove the left and right banks of the dust detector system. For instructional purposes, removal of the right bank of the dust detector system is described.**

1. Remove pressure switch (1).
  - a. Disconnect electrical cable connector (2) from pressure switch (1).
  - b. Disconnect ground wire (3) by removing screw (4) with lock washer (5). Discard lock washer.



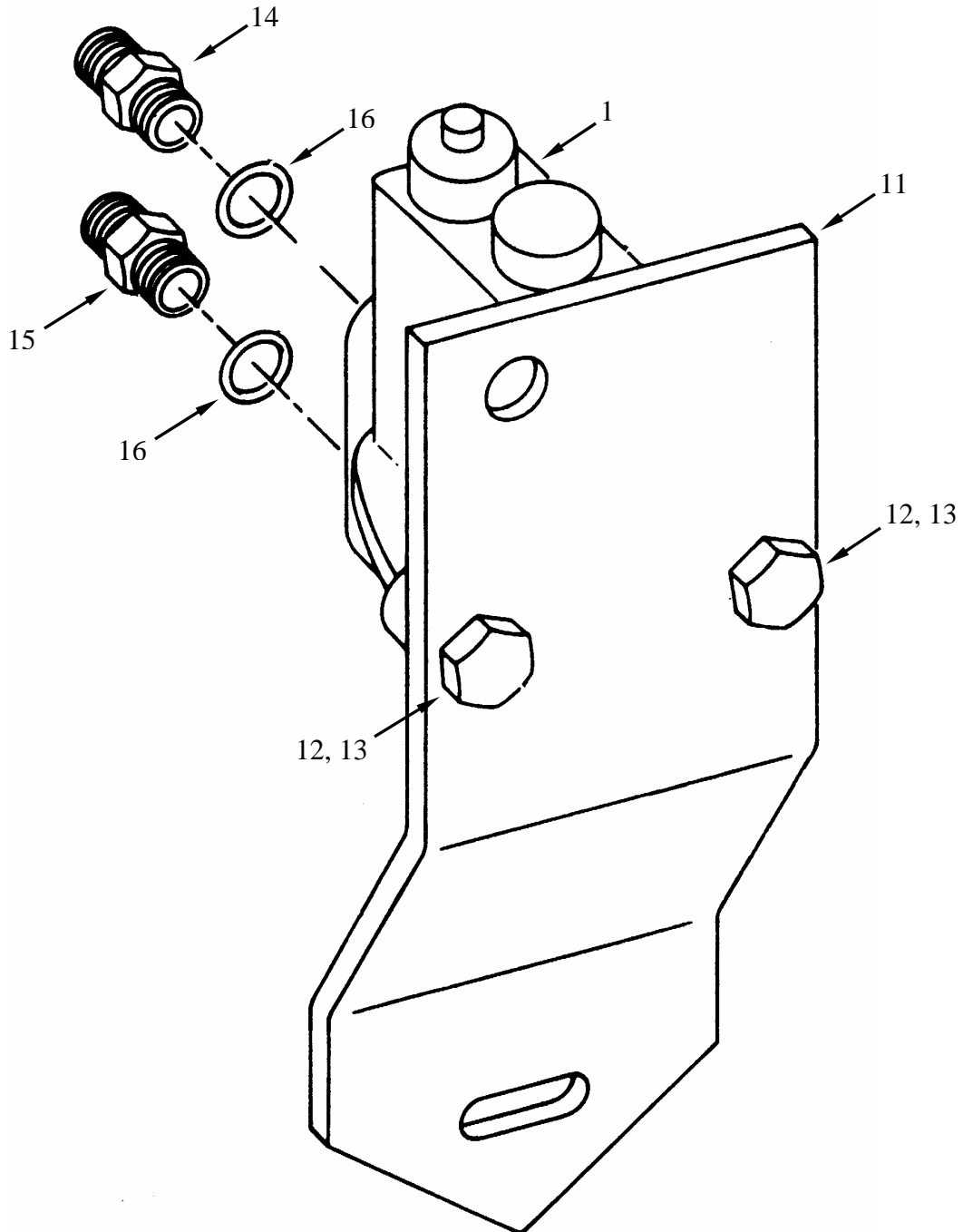
**REMOVAL (Continued)**

1. Remove pressure switch (1) (Continued).
  - c. Disconnect and remove two air pressure hoses (6, 7) from pressure switch (1) and from turbosupercharger (8).
  - d. Remove cap screw (9) with lock washer (10) to remove pressure switch (1) and bracket (11) as an assembly. Discard lock washer.



**REMOVAL (Continued)**

1. Remove pressure switch (1) (Continued).
  - e. Remove two cap screws (12) with lock washers (13) to separate pressure switch (1) from bracket (11). Discard lock washer.
  - f. Remove two adapter fittings (14, 15) with O-rings (16). Discard O-rings.



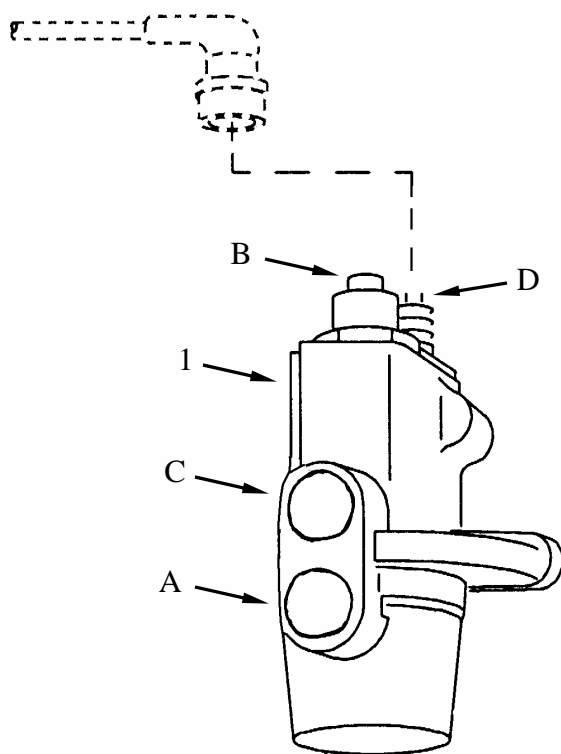
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

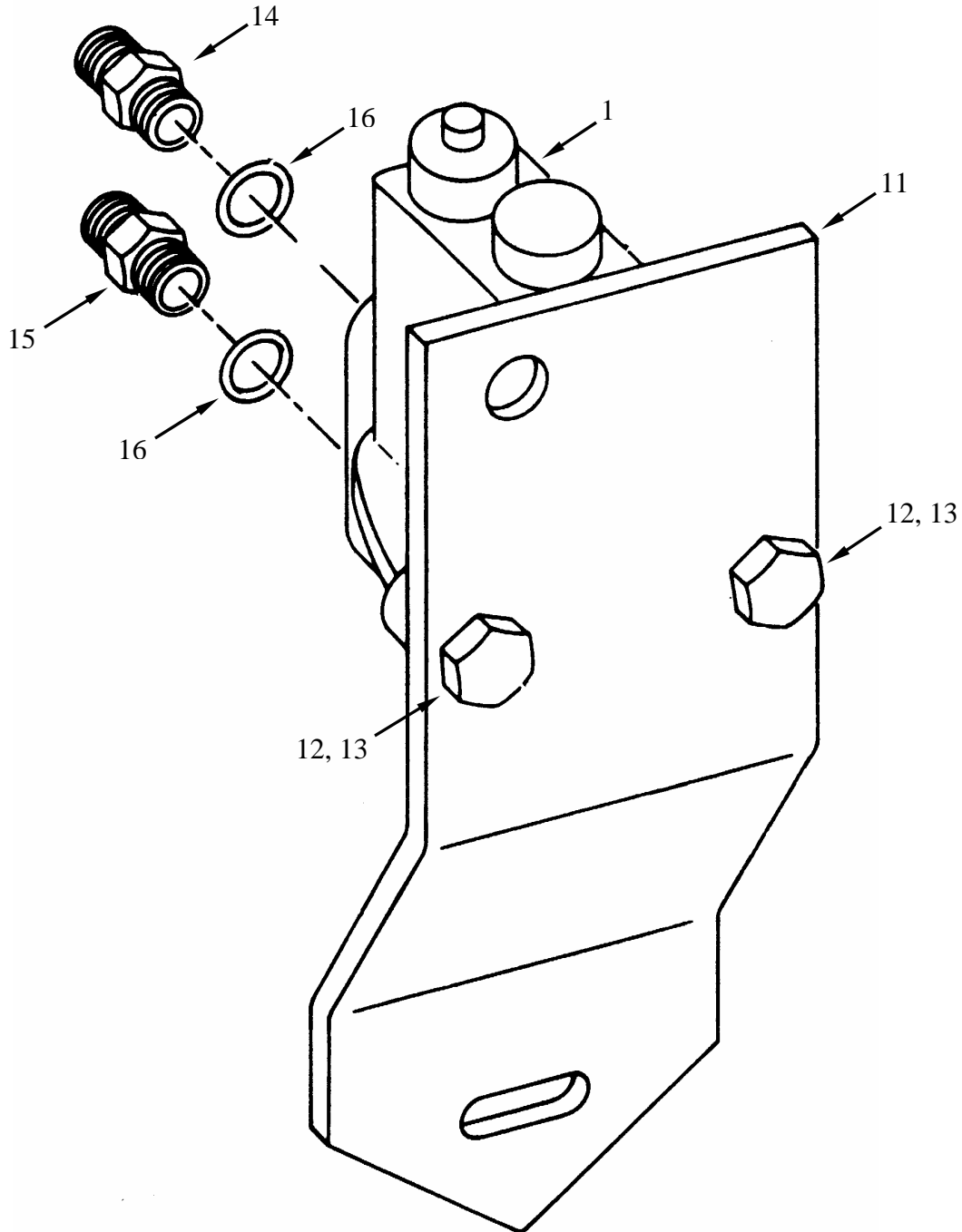
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Check switch (1) pop-up function.
  - a. Apply suction of 5.5 (+/- 0.5) inches mercury to bottom port (A) of pressure switch (1).
  - b. If red indicator (B) does not pop-up, switch must be replaced.
3. Check switch (1) continuity.
  - a. With no pressure on either port (A, C), there must be no continuity across connector pins (D).
  - b. With suction of 5.5 (+/- 0.5) inches mercury at bottom port (A) of pressure switch (1), there must be continuity across pins (D) of switch.
  - c. If switch fails continuity check, it must be replaced.



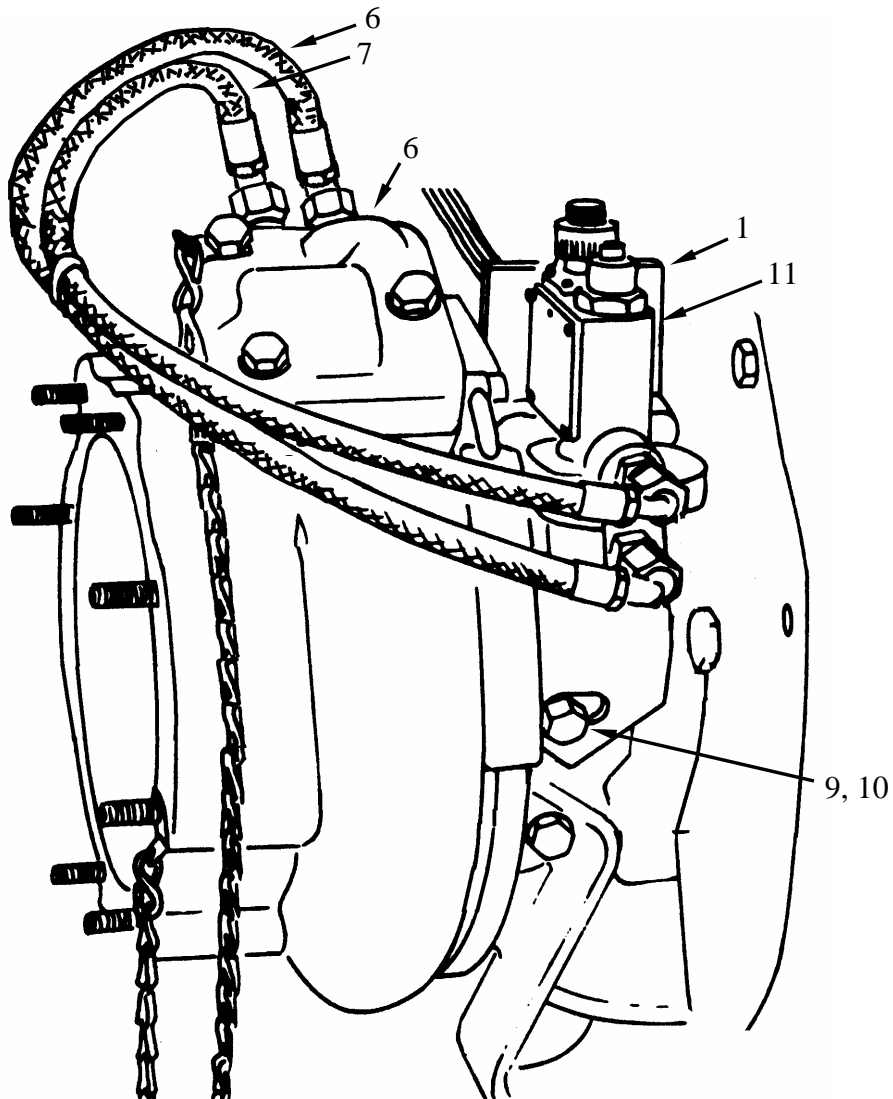
**INSTALLATION**

1. Install fittings.
  - a. Install two adapter fittings (14, 15) with new O-rings (16) (item 75, WP 0175).
2. Install pressure switch (1) onto bracket (11).
  - a. Position pressure switch (1) onto bracket (11) and secure using two cap screws (12) with new lock washers (13) (item 92, WP 0175).



**INSTALLATION (Continued)**

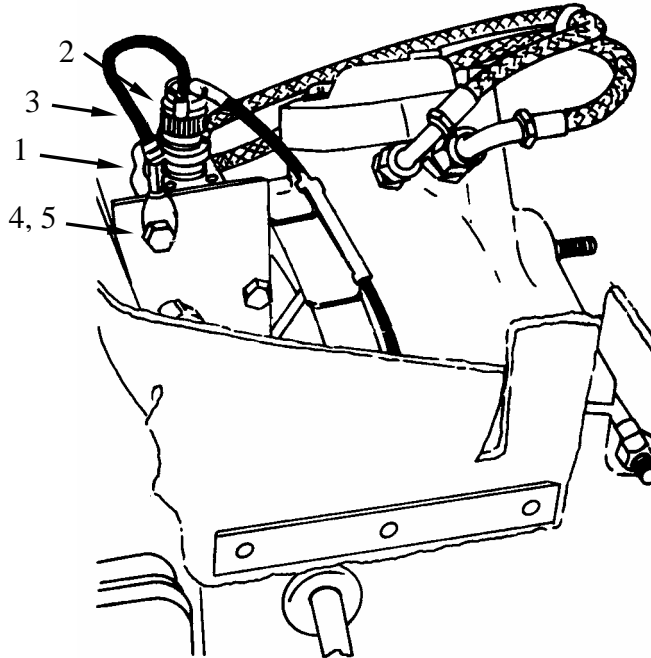
3. Install pressure switch (1).
  - a. Install pressure switch (1) and bracket (11) as an assembly and secure using cap screw (9) with new lock washer (10) (item 92, WP 0175).
  - b. Connect two air pressure hoses (6, 7) to pressure switch (1) and to turbosupercharger (8).





**INSTALLATION (Continued)**

4. Connect electrical cables.
  - a. Connect electrical cable connector (2) to pressure switch (1).
  - b. Connect ground wire (3) using screw (4) with new lock washer (5) (item 92, WP 0175).

**END OF WORK PACKAGE**



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**DUST EJECTOR SYSTEM REPLACEMENT**

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0083 00

**THIS WORK PACKAGE COVERS:**Disassembly, Cleaning, Inspection, Repair, and Assembly

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Gasket (2) (item 260, WP 0175)

Gasket (2) (item 265, WP 0175)

Lock washer (22) (item 89, WP 0175)

Lock washer (2) (item 92, WP 0175)

Lock washer (2) (item 93, WP 0175)

Self-locking nut (5) (item 38, WP 0175)

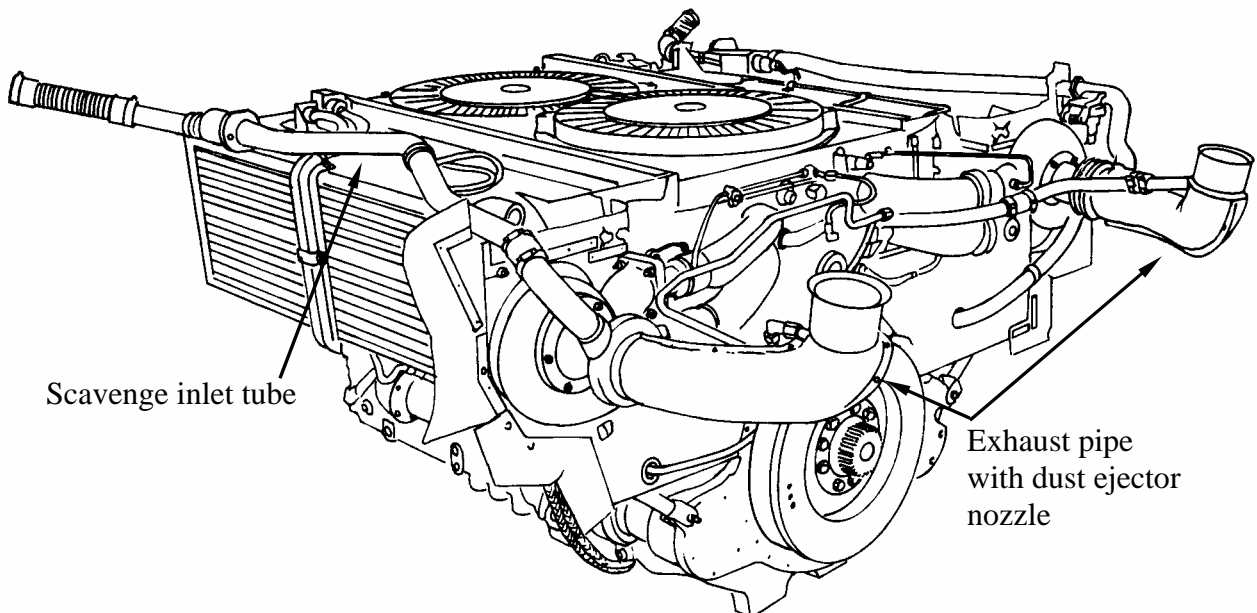
Self-locking nut (12) (item 161, WP 0175)

**Equipment Conditions:**Engine removed from vehicle and placed on a flat stationary surface

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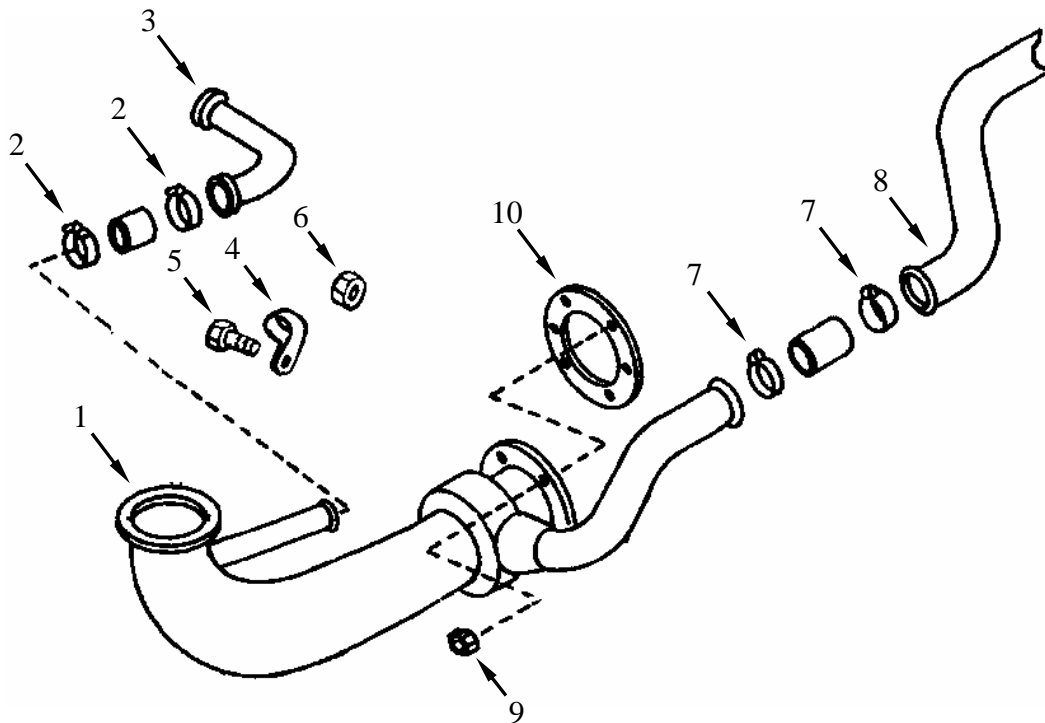
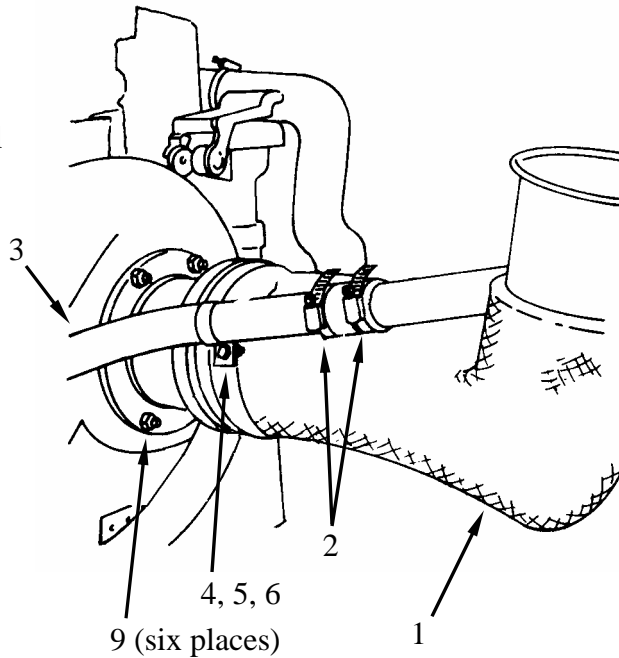
**REMOVAL****NOTE**

Similar procedures are required to remove the left and right banks of the dust ejector system. For instructional purposes, removal of the left bank of the dust ejector system is described. Removal procedures for the right bank dust ejector system is similar; differences are included in the procedure.



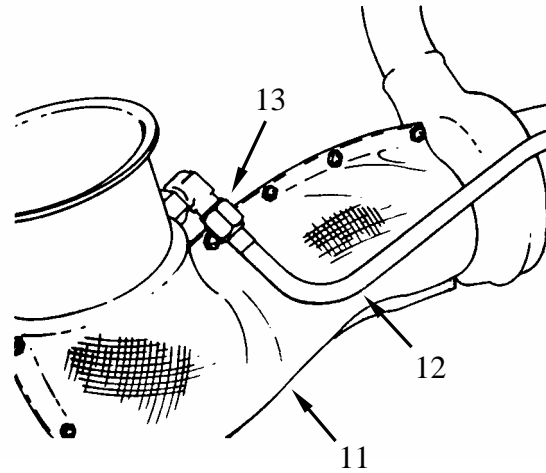
**REMOVAL**

1. Remove left bank ejector tube (1).
  - a. Loosen two hose clamps (2) at engine oil breather tube (3).
  - b. Remove loop clamp (4) by removing screw (5) and self-locking nut (6). Discard nut.
  - c. Loosen two hose clamps (7) at scavenge tube (8).
  - d. Remove six self-locking nuts (9) to remove ejector tube (1) and gasket (10). Discard self-locking nuts and gasket.

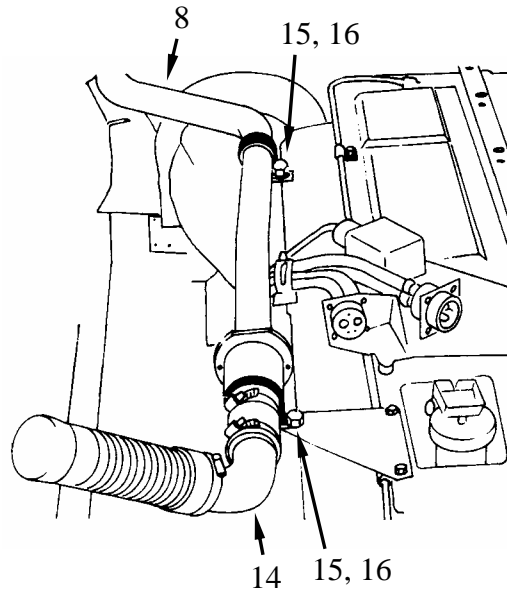


**REMOVAL (Continued)**

2. Remove right bank ejector tube (11).
  - a. Removal procedure is the same as left bank except remove transmission breather tube (12) by loosening nut (13).



3. Remove scavenge tube (8) and exhaust pipe cap (14).
  - a. Remove two screws (15) and self-locking nuts (16). Discard self-locking nuts.
  - b. Remove scavenge tube (8) and exhaust pipe cap (14) as an assembly.

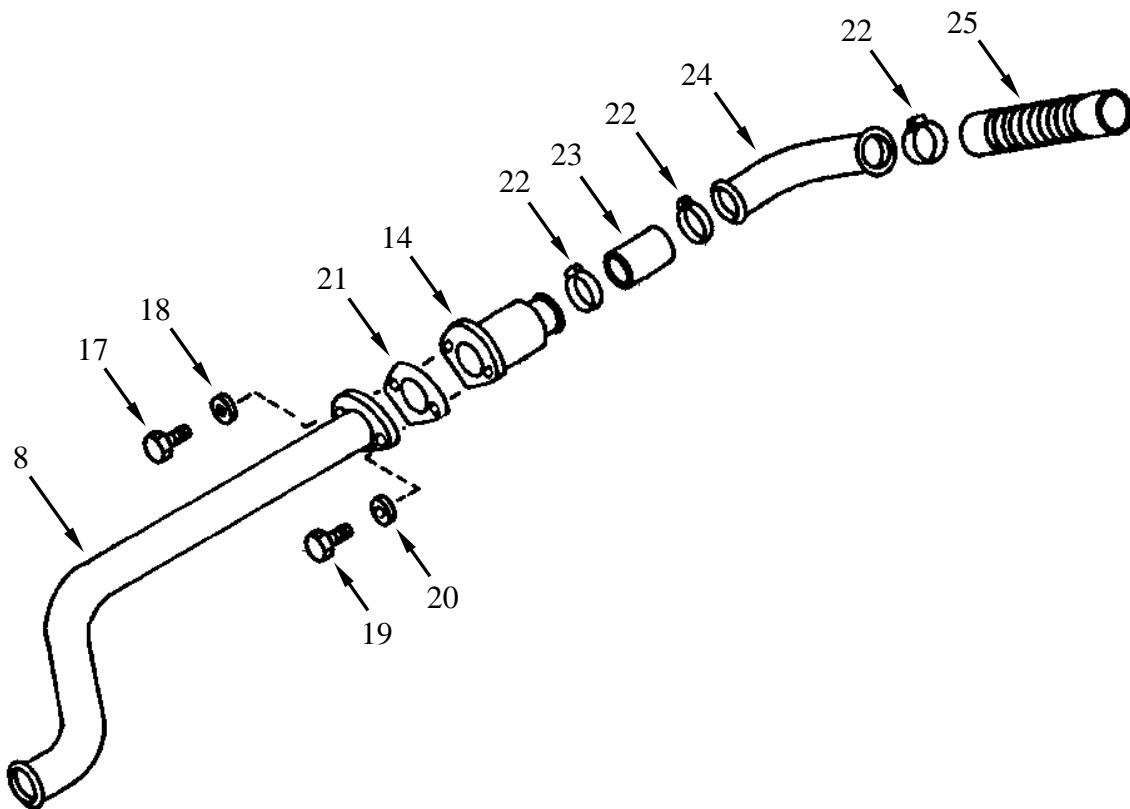


## DISASSEMBLY

## NOTE

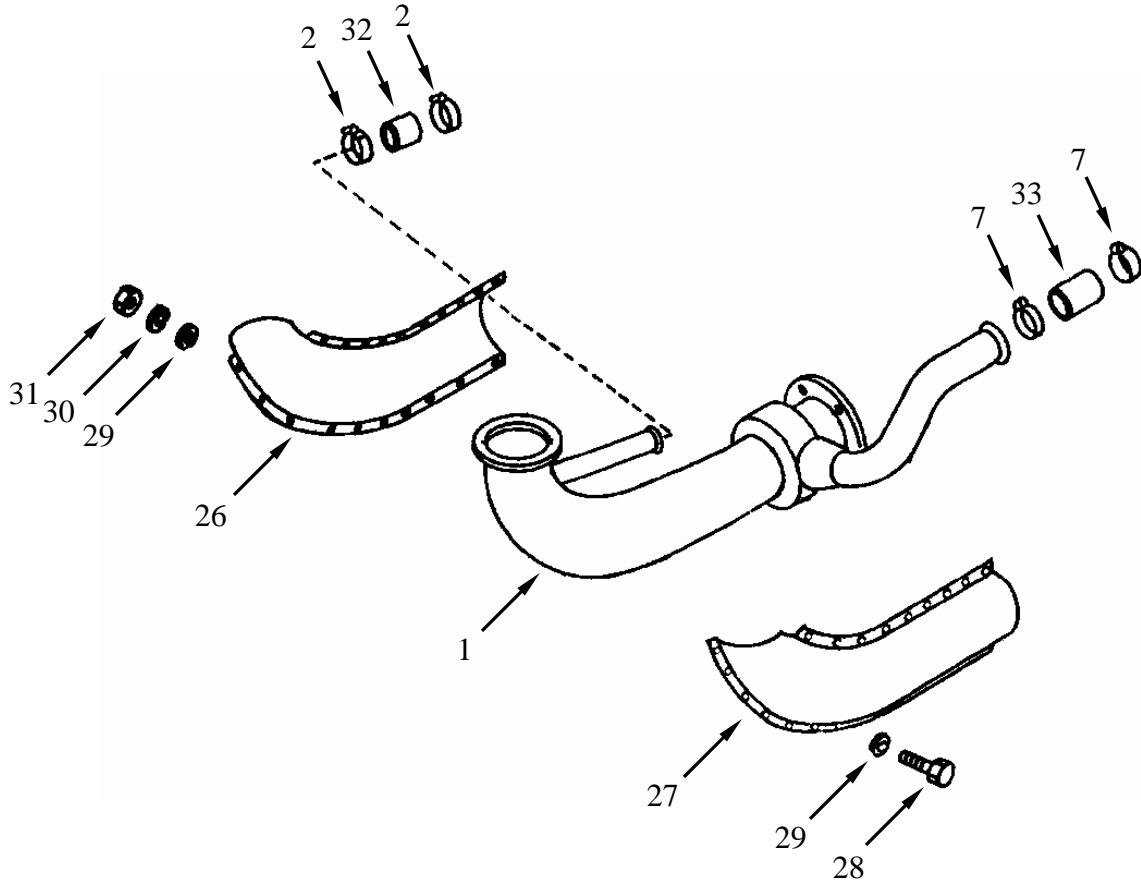
**Disassembly procedures are similar to both banks. For instructional purposes, the left bank is disassembled and illustrated unless otherwise noted.**

1. Separate rear scavenge tube (8) from cap assembly (14).
  - a. Scribe alignment marks on flanges of exhaust pipe cap assembly (14) and rear scavenge tube (8) to aid in assembly.
  - b. Remove screw (17) with lock washer (18), and screw (19) with lock washer (20) to separate exhaust pipe cap assembly (14) from rear scavenge tube (8). Discard both lock washers.
  - c. Remove and discard gasket (21).
2. Loosen hose clamps (22) to separate cap assembly (14), hose connector (23), front scavenge tube (24) and scavenge hose (25).

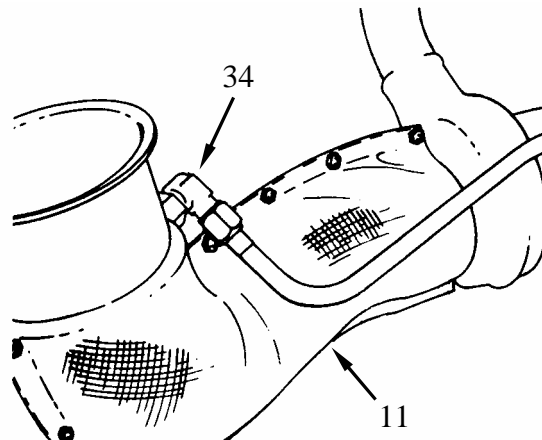


**DISASSEMBLY (Continued)**

3. Remove insulators (26, 27) from ejector tube (1).
  - a. Remove eleven screws (28), flat washers (29), lock washers (30) and nuts (31) to remove insulation halves (26, 27). Discard lock washers.
4. Remove hose connector (32) and clamps (2).
5. Remove hose connector (33) and clamps (7).



6. Remove elbow (34) from right bank ejector tube (11).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

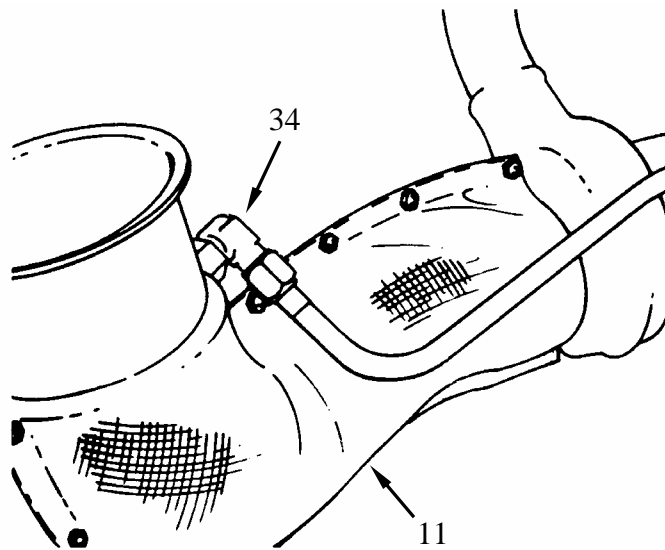
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**ASSEMBLY**

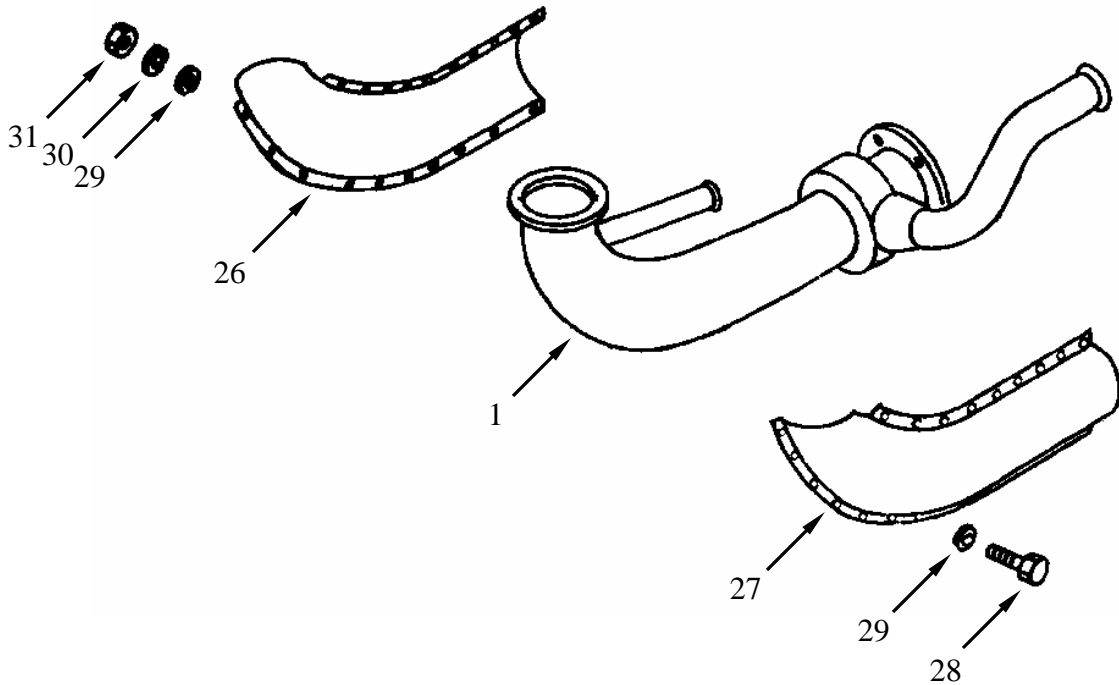
1. Install elbow (34) into right bank ejector tube (11).



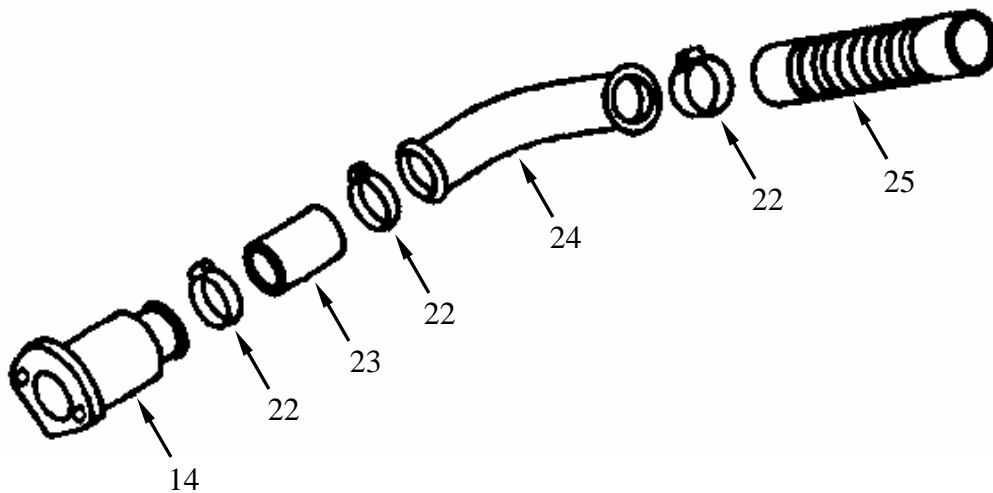


**ASSEMBLY (Continued)**

2. Install insulators (26, 27) onto ejector tube (1).
  - a. Secure insulation halves (26, 27) using eleven screws (28), flat washers (29), new lock washers (30) (item 89, WP 0175) and nuts (31).

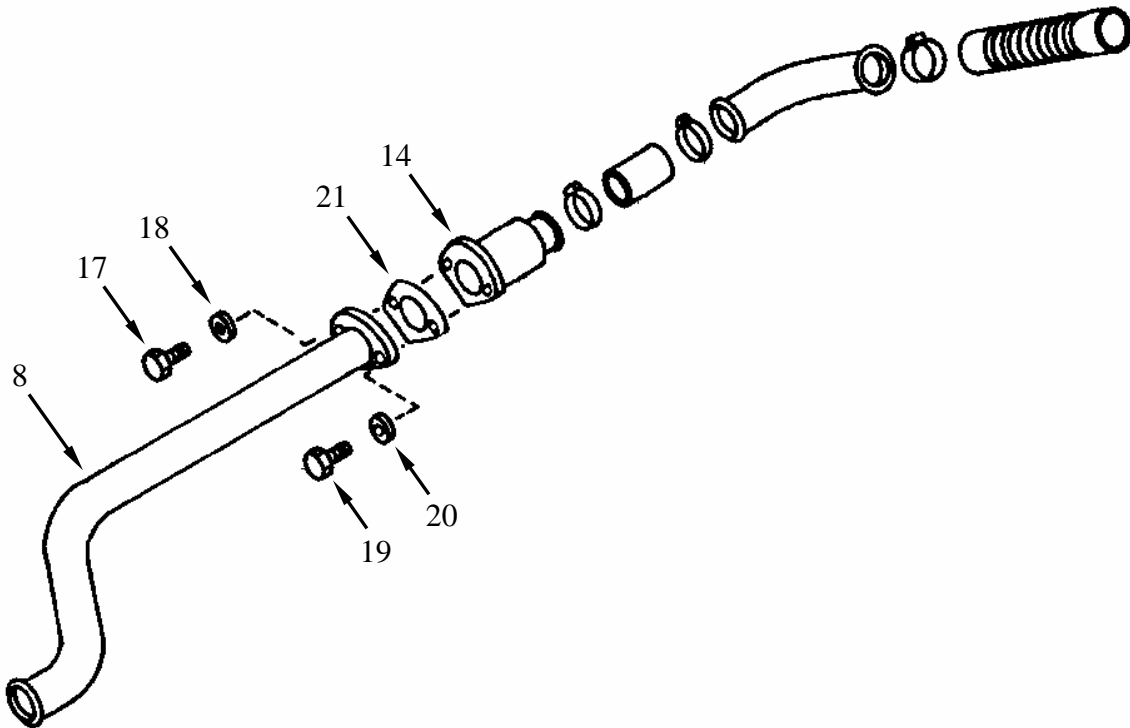


3. Assemble scavenge hose (25), front scavenge tube (24), and cap assembly (14) using hose connector (23) and clamps (22).



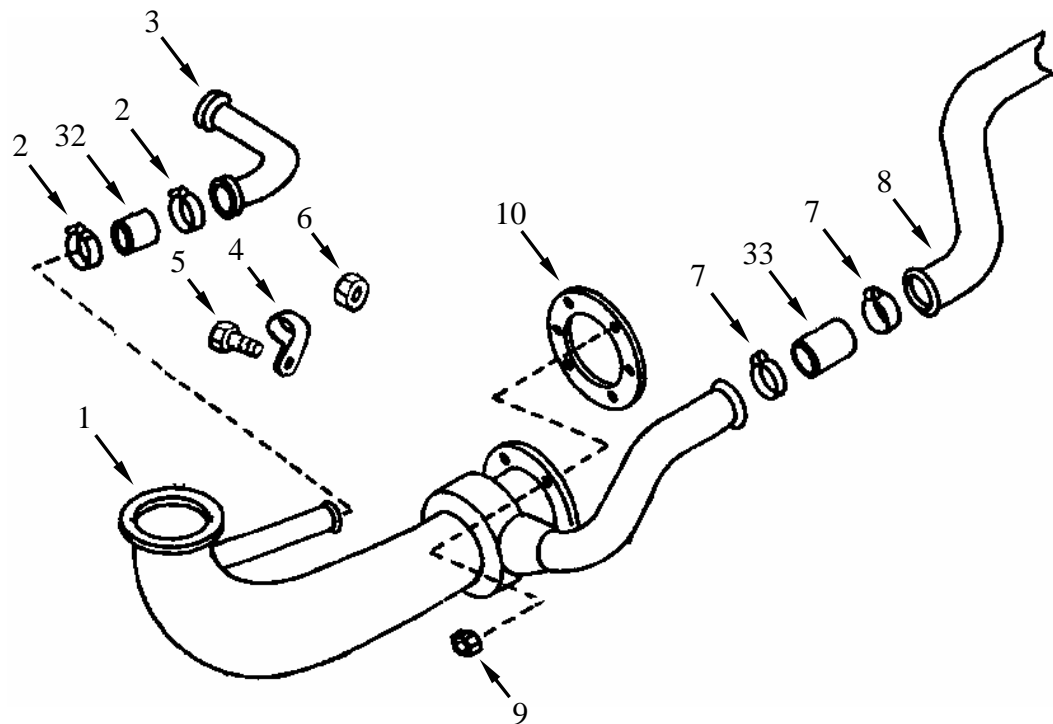
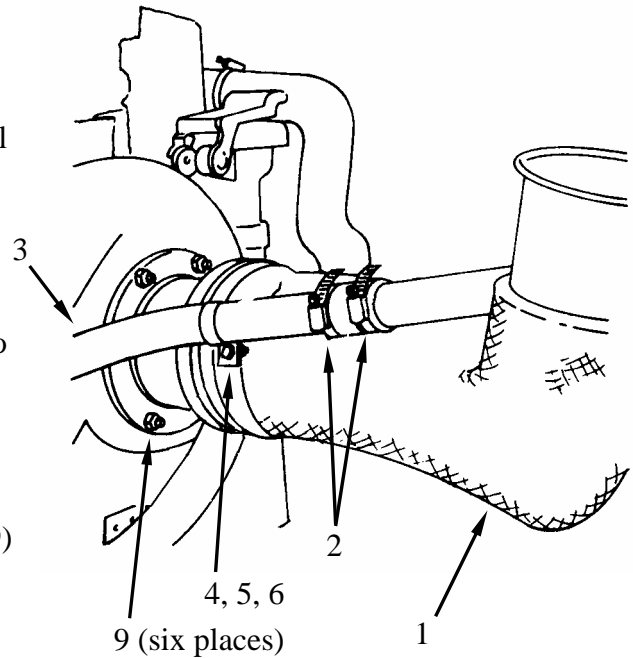
**ASSEMBLY (Continued)**

4. Assemble rear scavenge tube (8) to cap assembly (14).
  - a. Place a new gasket (21) (item 260, WP 0175) in position.
  - b. Align rear scavenge tube (8) to cap assembly (14) using scribe alignment marks on flanges.
  - c. Secure exhaust pipe cap assembly (14) to rear scavenge tube (8) using screw (17) with new lock washer (18) (item 92, WP 0175) and screw (19) with new lock washer (20) (item 93, WP 0175).



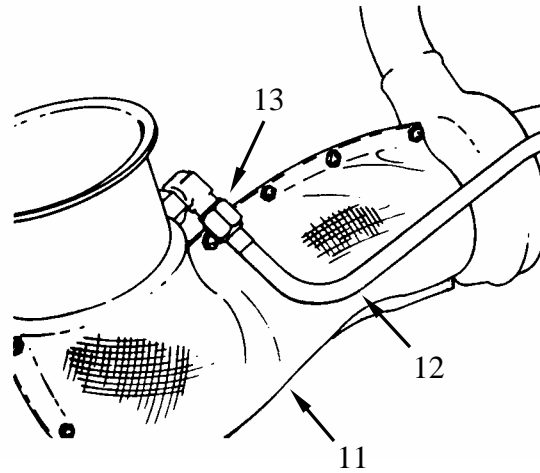
**INSTALLATION**

1. Install left bank ejector tube (1).
  - a. Slide connector hose (32) over engine oil breather tube (3), then position two hose clamps (2) loosely on connector hose.
  - b. Slide connector hose (33) over scavenge port of ejector tube (1), then position two hose clamps (7) loosely on connector hose.
  - c. Place tube (1) with new gasket (10) (item 265, WP 0175) in position and secure using six new self-locking nuts (9) (item 161, WP 0175).
  - d. Install loop clamp (4) and secure using screw (5) and new self-locking nut (6) (item 38, WP 0175).

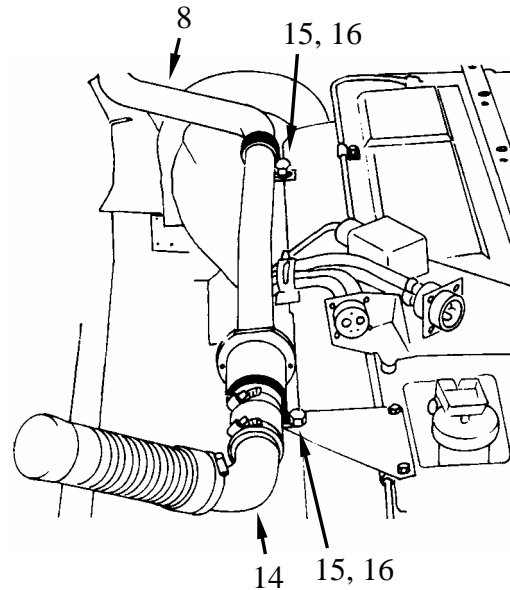


**DUST EJECTOR SYSTEM REPLACEMENT****0083 00****INSTALLATION (Continued)**

2. Install right bank ejector tube (11).
  - a. Installation procedure is the same as left bank except install transmission breather tube (12) by fastening nut (13).



3. Install scavenge tube (8) and exhaust pipe cap (14).
  - a. Place scavenge tube (8) and exhaust pipe cap (14) into position as an assembly.
  - b. Secure using two screws (15) and new self-locking nuts (16) (item 38, WP 0175).

**END OF WORK PACKAGE**

**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND WIRING HARNESS REPLACEMENT**

0084 00

**THIS WORK PACKAGE COVERS:**

Removal, Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

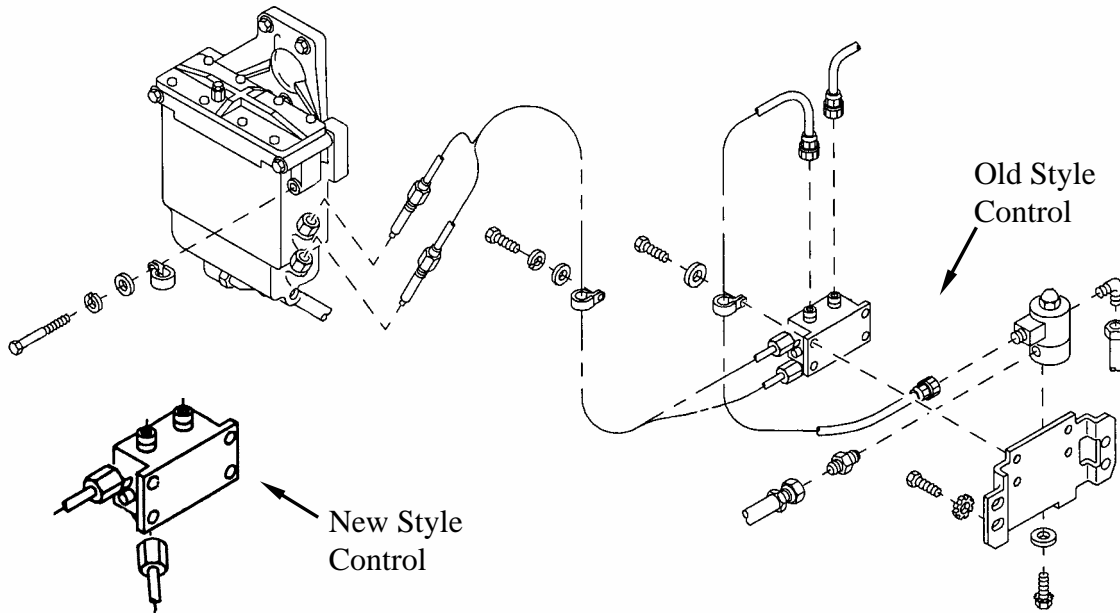
Lock washer (4) (item 93, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface



**WARNING**



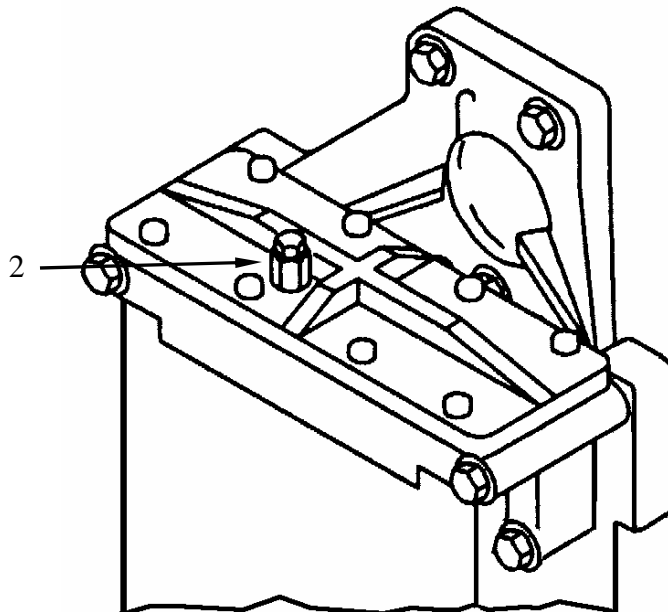
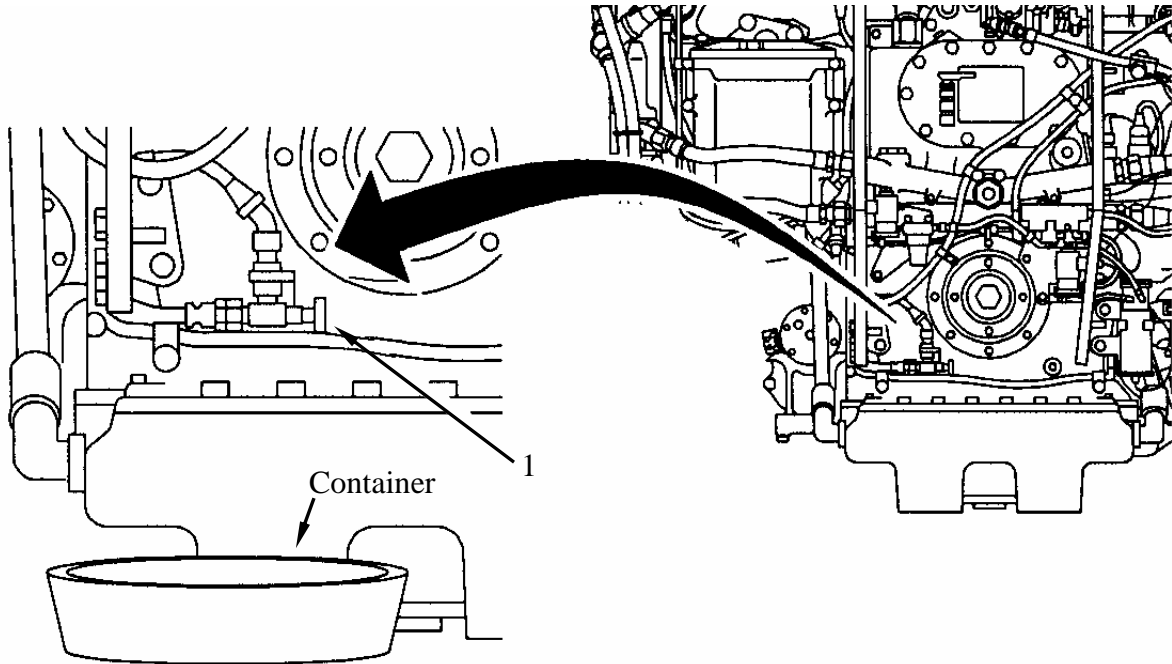
**FIRE HAZARD - Diesel fuel is combustible. Do not smoke or allow open flames or sparks in areas where diesel fuel and combustible materials are used or stored. DEATH or severe injury may result if personnel fail to observe this precaution. If you are burned, seek medical aid immediately.**

**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT**

0084 00

**REMOVAL**

1. Open drain cock (1) and bleeder valve (2) then drain fuel into a suitable container.



**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT**

0084 00

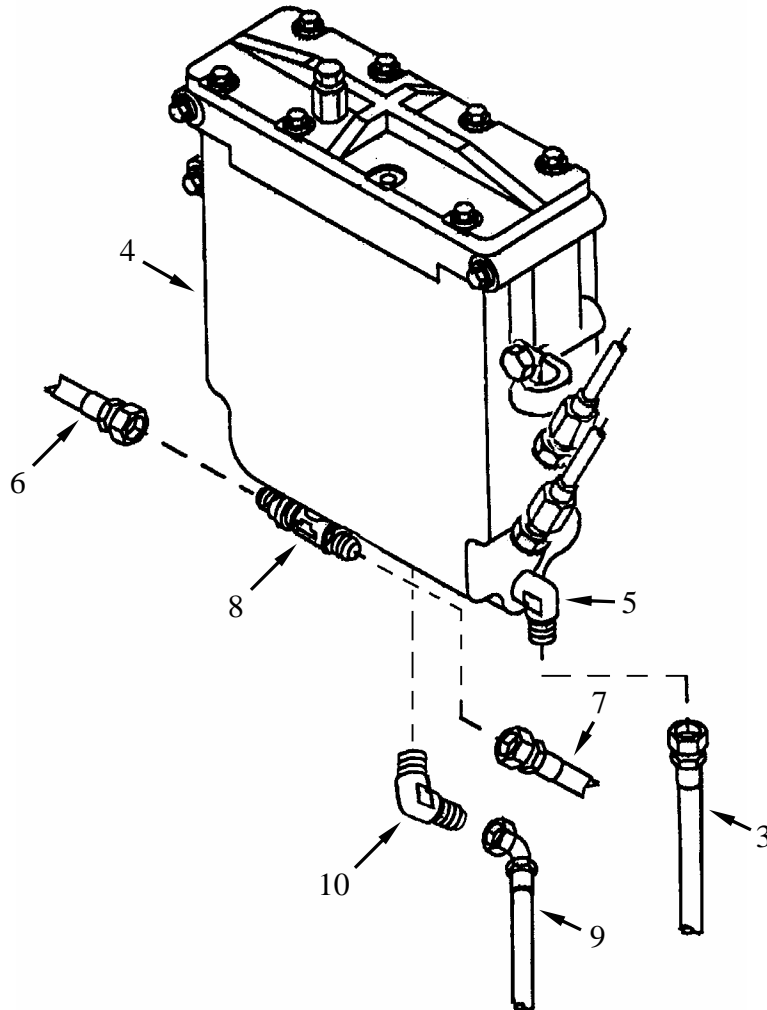
**REMOVAL (Continued)**

2. Disconnect fuel hose (3) leading into water separator (4).
3. Remove inlet elbow (5) and save for installation on replacement separator (4).

**NOTE**

**Fuel out fitting is a tee on engines equipped with a smoke generating system. On engines without a smoke generating system the fuel out fitting is a 90-degree elbow. The tee fitting configuration is illustrated.**

4. Disconnect fuel out hose (6) to smoke system.
5. Disconnect fuel out hose (7) to fuel injection pump.
6. Remove tee fitting (8) and save for installation on replacement fuel/water separator (4).
7. Disconnect fuel drain hose (9).
8. Remove and retain drain elbow (10).



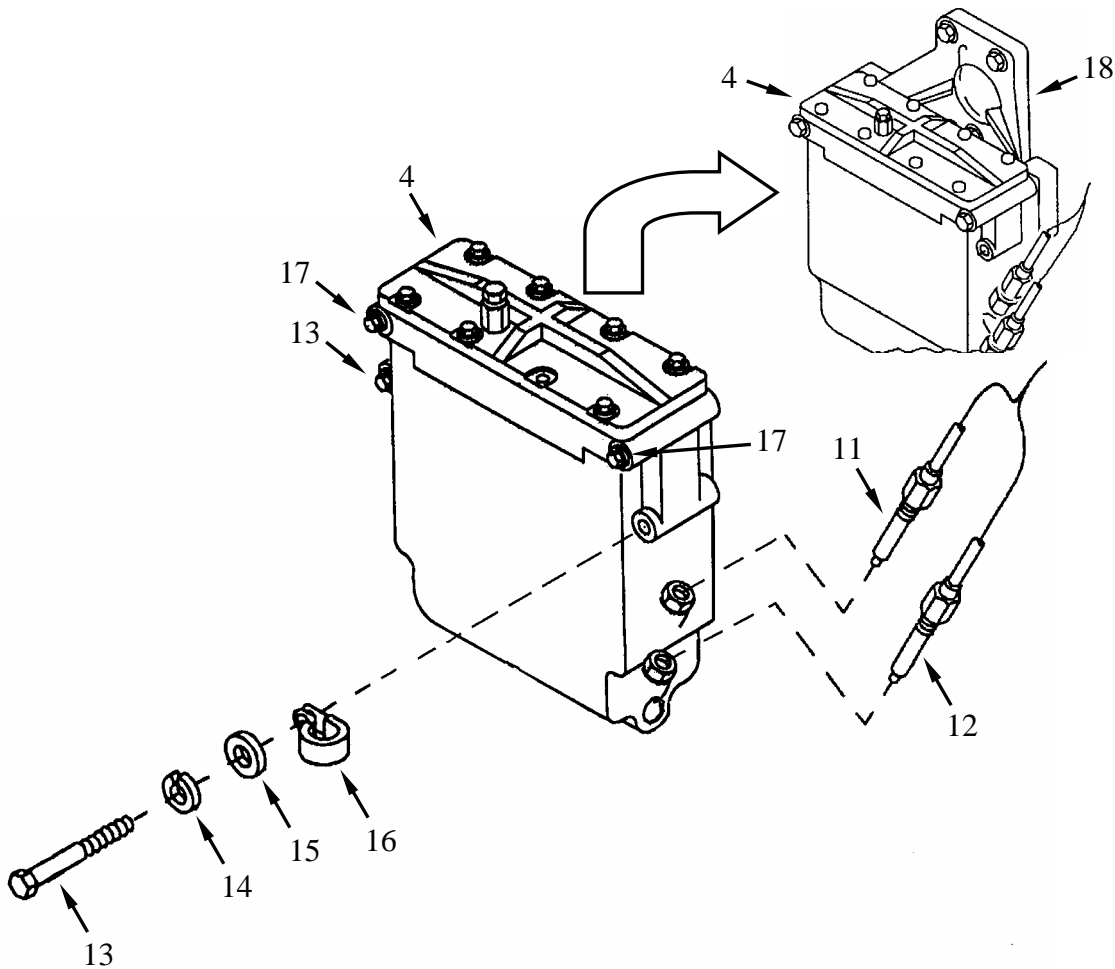
**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT**

0084 00

**REMOVAL (Continued)****CAUTION**

**Do not attempt to remove probes from control module. They are permanently affixed, removal will destroy the module.**

9. Remove two water level probes (11, 12).
  - a. Remove screw (13), with lock washer (14) and flat washer (15) to remove cushioned clamp (16). Discard lock washer.
  - b. Loosen, but do not remove remaining mounting screws (13, 17).
  - c. Pull fuel water separator (4) away from mounting bracket (18).
  - d. Mark probes for location, then remove two water level probes (11, 12) from fuel water separator (4).
10. Remove water separator (4).
  - a. Remove mounting screws (13, 17) to remove separator.





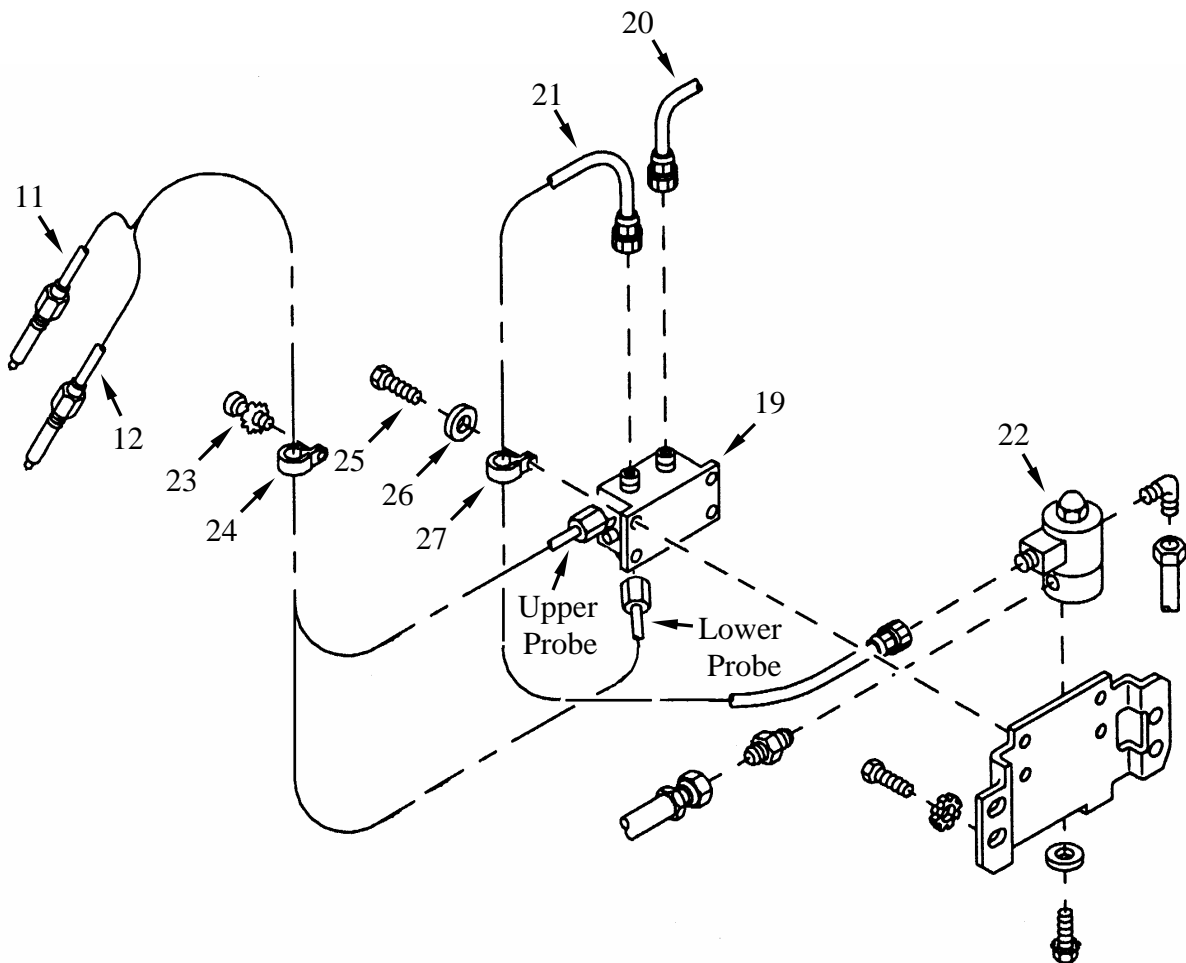
**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT**

0084 00

**REMOVAL (Continued)****CAUTION**

**Do not attempt to remove probes from control module. They are permanently affixed, removal will destroy the module.**

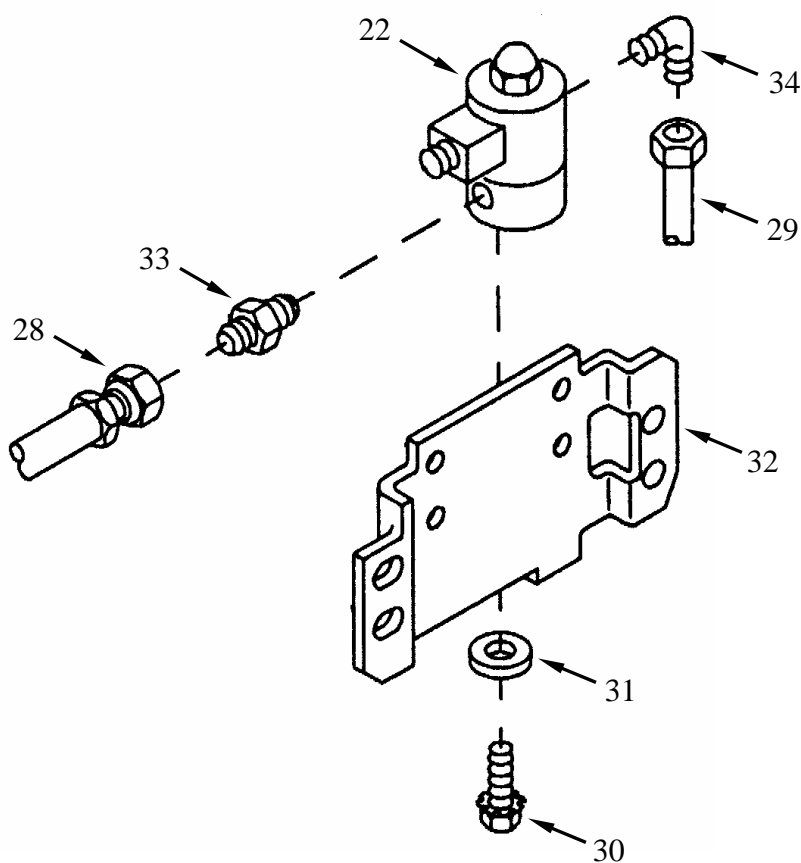
11. Remove control module (19).
  - a. Disconnect wiring harness electrical lead (20) at module (19)
  - b. Disconnect electrical lead (21) from control module and at solenoid valve (22).
  - c. Remove two assembled washer screws (23) and cushioned clamps (24) securing probe (11, 12) leads.
  - d. Remove one screw (25) with flat washer (26) and cushioned clamp (27).
  - e. Remove three screws (25) with flat washers (26) and remove control module (19).



**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT****0084 00****REMOVAL (Continued)**

12. Remove solenoid valve (22).

- a. Disconnect filter drain hose (28) from solenoid valve (22).
- b. Remove drain tube (29).
- c. Remove two assembled lock washer screws (30) with flat washers (31) to remove solenoid valve (22) from bracket (32).
- d. Remove fitting (33) from solenoid valve "IN" opening, and elbow (34) from "OUT" opening.

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

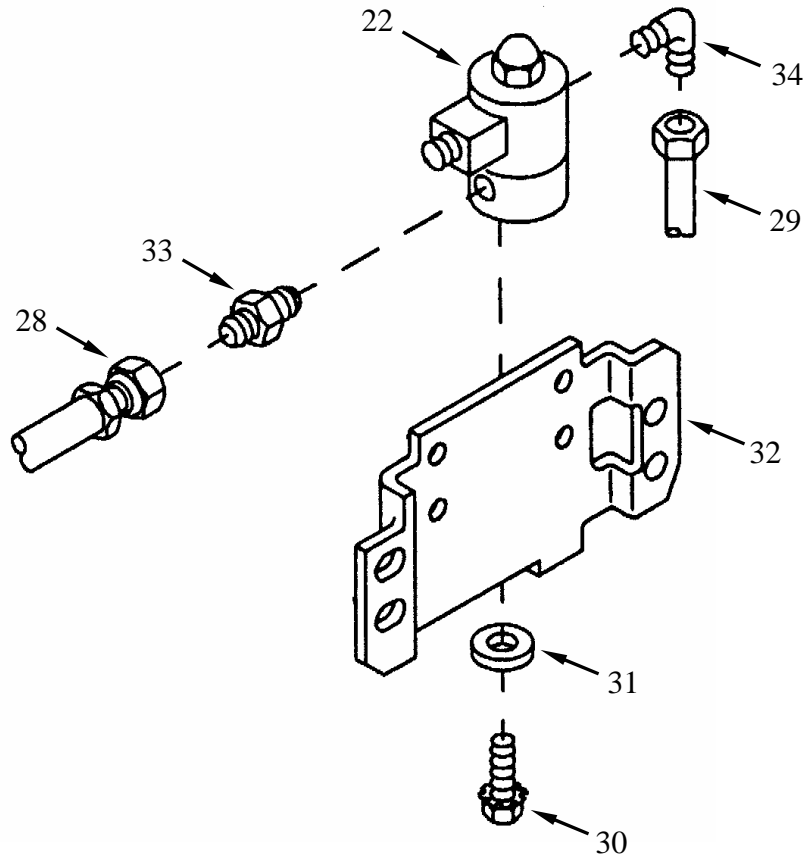
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT****0084 00****INSTALLATION**

1. Install solenoid valve (22).
  - a. Install fitting (33) in solenoid valve "IN" opening and elbow (3) in "OUT" opening.
  - b. Install solenoid valve (22) to bracket (32) using two assembled lock washer screws (30) with flat washers (31).
  - c. Install drain tube (29).
  - d. Connect filter drain hose (28) to solenoid valve (22).

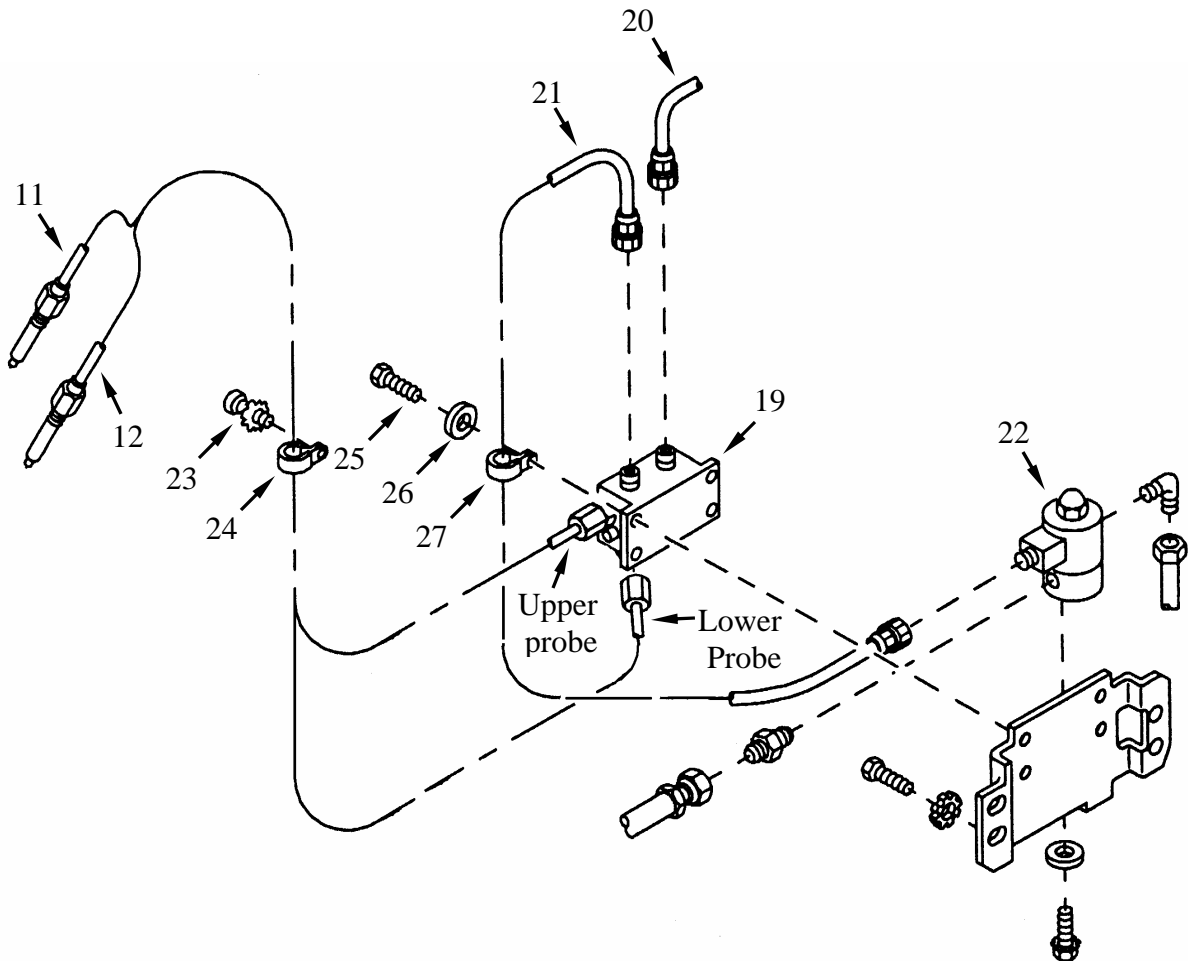


**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND WIRING HARNESS REPLACEMENT**

0084 00

**INSTALLATION (Continued)**

2. Install control module (19).
  - a. Install control module (19) using three screws (25) with flat washers (26).
  - b. Install cushioned clamp (27) using one screw (25) with flat washer (26).
  - c. Install two assembled washer screws (23) and cushioned clamps (24) securing probe (11, 12) leads.
  - d. Connect electrical lead (21) to control module and at solenoid valve (22).
  - e. Connect wiring harness electrical lead (20) at module (19).



## FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND WIRING HARNESS REPLACEMENT

0084 00

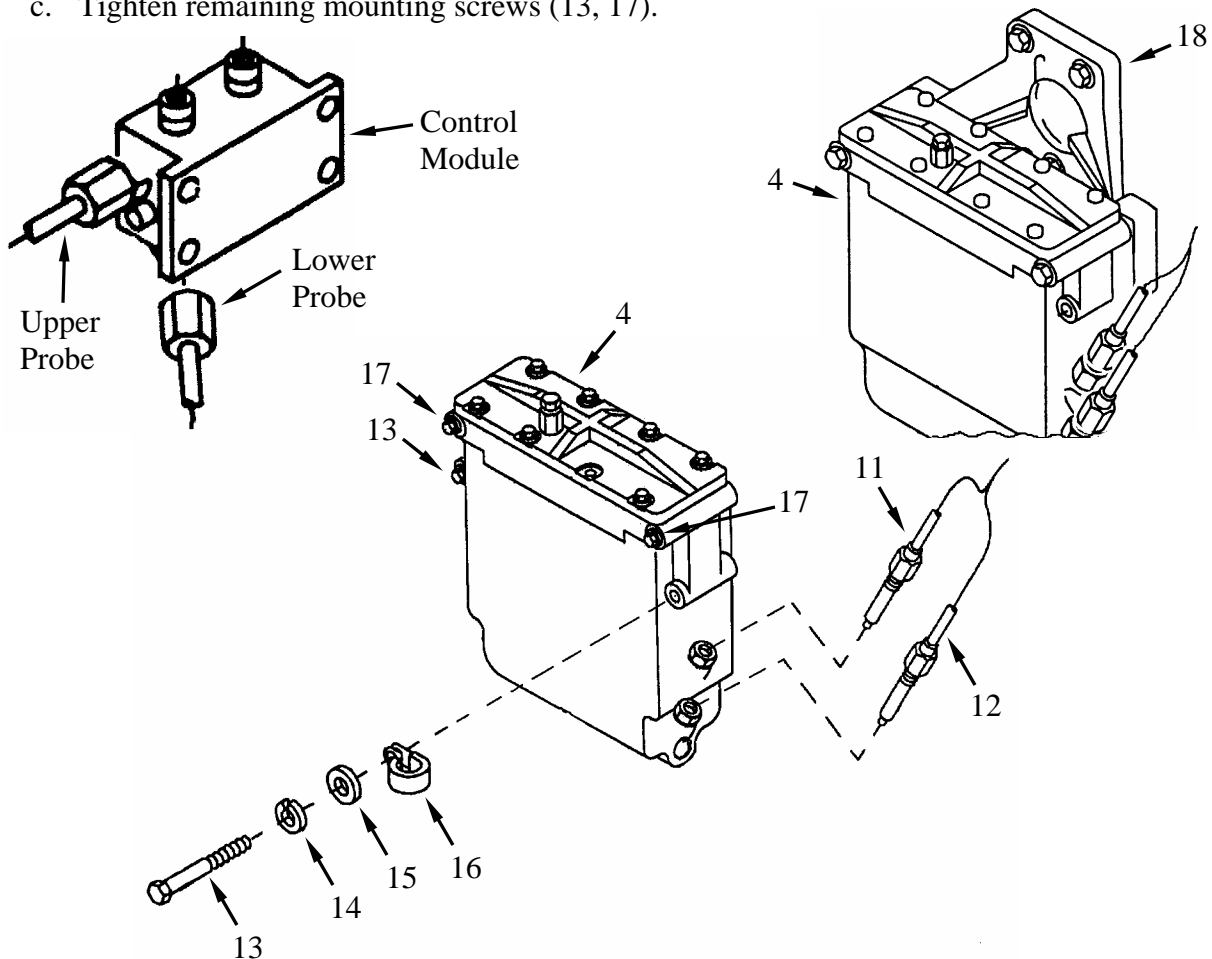
### INSTALLATION (Continued)

3. Install water separator (4).
  - a. Place separator in position and loosely secure using three mounting screws (13, 17) with flat washers (15) and new lock washers (14) (item 93, WP 0175), leaving space between water separator (4) and mounting bracket (18).

#### **CAUTION**

**Probes must be installed in proper separator ports. Probe with lead attached to side of control module must be installed in upper separator port. Failure to comply will result in improper functioning of fuel/water separator.**

4. Install two water level probes (11, 12).
  - a. Install two water level probes (11, 12) in fuel water separator (4).
  - b. Install screw (13), new lock washer (14) (item 93, WP 0175), flat washer (15), and cushioned clamp (16).
  - c. Tighten remaining mounting screws (13, 17).



**FUEL/WATER SEPARATOR AUTOMATIC DRAIN SYSTEM AND  
WIRING HARNESS REPLACEMENT**

0084 00

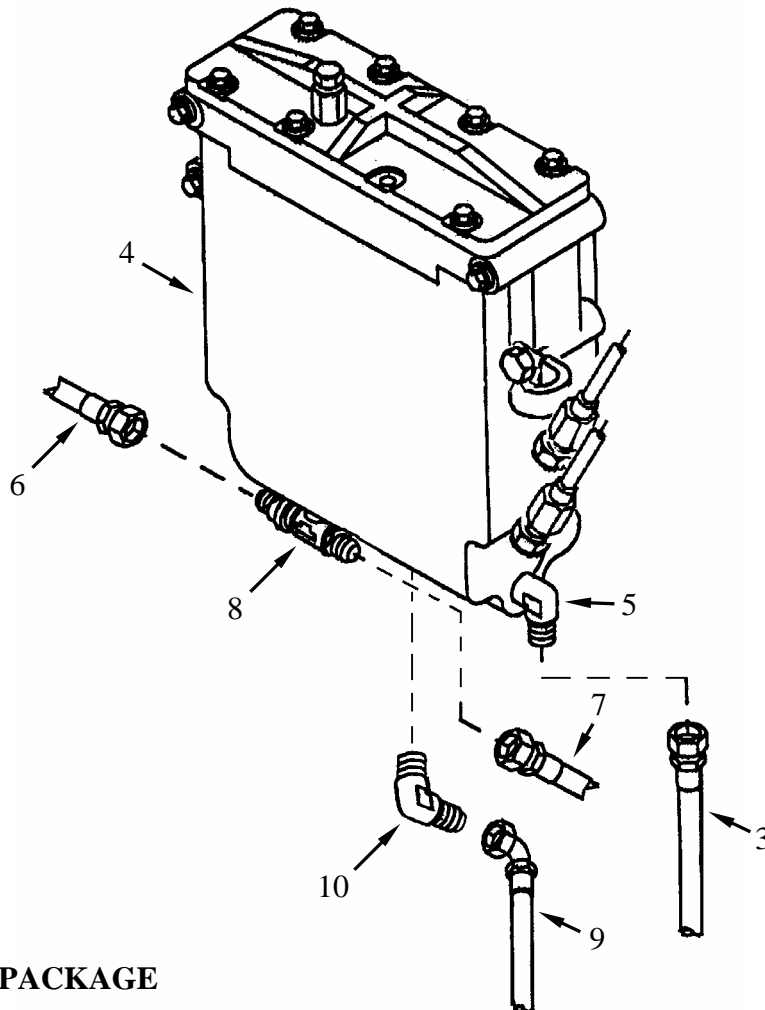
**INSTALLATION (Continued)**

5. Install drain elbow (10) and hose (9).

**NOTE**

**Fuel out fitting is a tee on engines equipped with a smoke generating system. On engines without a smoke generating system the fuel out fitting is a 90-degree elbow. The tee fitting configuration is illustrated.**

6. Install tee fitting (8).
7. Install hose (7) (fuel out to fuel injection pump).
8. Install hose (6) (fuel out to smoke system).
9. Install inlet elbow (5).
10. Install hose (3) (fuel into water separator).
11. Bleed air from filter and fuel lines by opening bleeder valve (2) and running electric fuel pump (see appropriate vehicle operators manual) until fuel runs out of bleeder valve (2).

**END OF WORK PACKAGE**

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**FUEL/WATER SEPARATOR REPAIR/FILTER ELEMENT REPLACEMENT 0085 00**

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**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Suitable container (2.0 gal. (7.5 L) minimum capacity)  
 Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Expendable and Durable Items:**

Cleaning compound, solvent (item 8, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**Mandatory Replacement Parts:**

Gasket (1) (item 197, WP 0175)  
 Filter element, inner (1) (item 195, WP 0175)  
 Filter element, outer (2) (item 196, WP 0175)  
 Lock washer (8) (item 92, WP 0175)  
 Lock washer (4) (item 93, WP 0175)

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**DISASSEMBLY**

**WARNING**



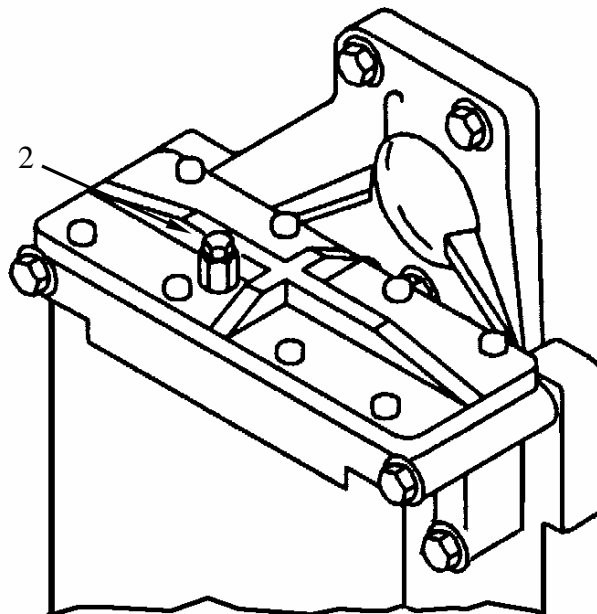
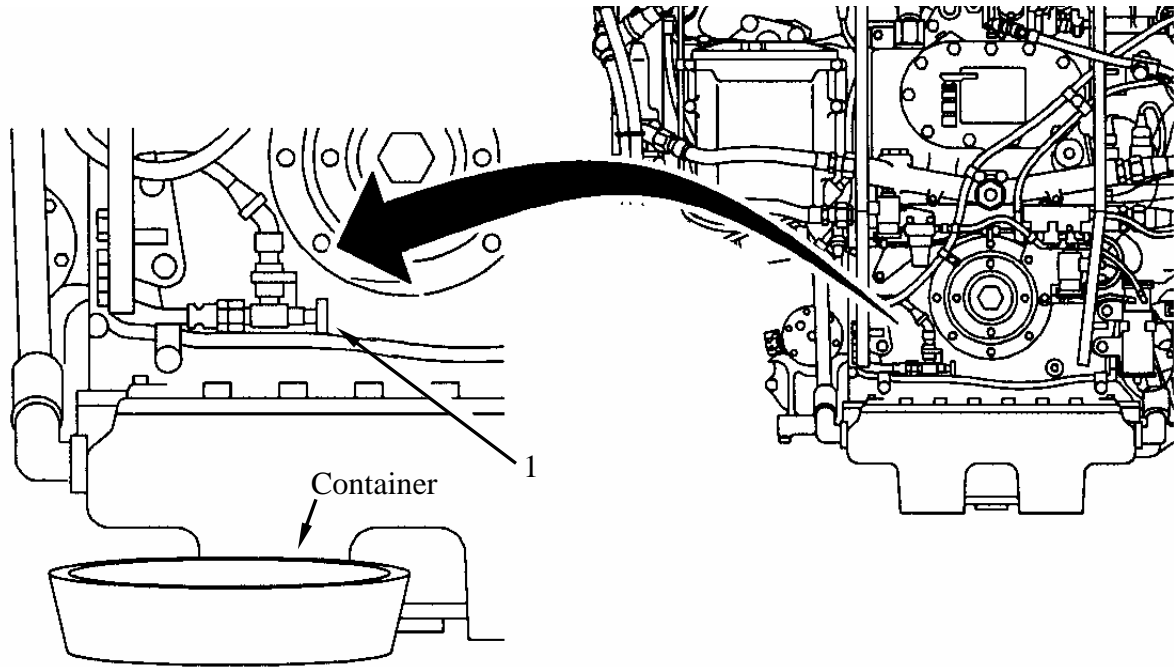
**FIRE HAZARD - Diesel fuel is combustible. Do not smoke or allow open flames or sparks in areas where diesel fuel and combustible materials are used or stored. DEATH or severe injury may result if personnel fail to observe this precaution. If you are burned, seek medical aid immediately.**

**CAUTION**

**The fuel/water separator must be removed from engine to thoroughly clean or replace parts not otherwise accessible. Never clean inside of separator when connected to fuel lines. Unseen particles could enter fuel lines and damage pumps and injectors. Cap fuel lines when removed from separator.**

**REMOVAL**

1. Open drain cock (1) and bleeder valve (2) then drain fuel into a suitable container.





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**FUEL/WATER SEPARATOR REPAIR/FILTER ELEMENT REPLACEMENT 0085 00**

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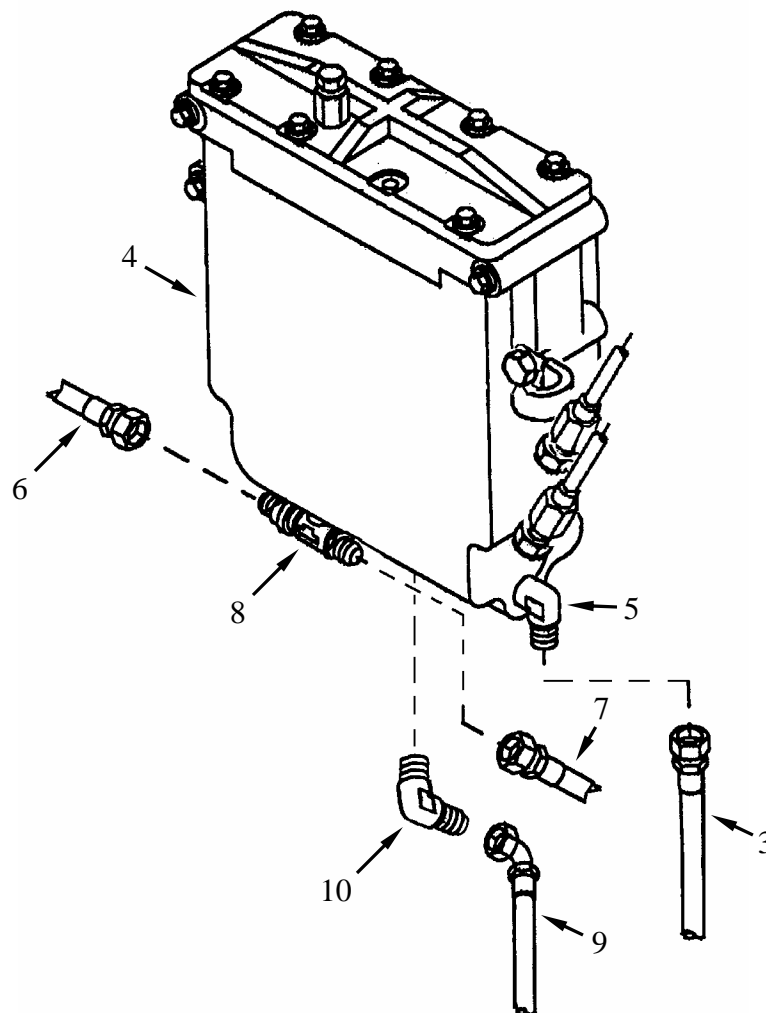
**REMOVAL (Continued)**

2. Disconnect fuel hose (3) leading into water separator (4).
3. Remove inlet elbow (5) and save for installation on replacement separator (4).

**NOTE**

**Fuel out fitting is a tee on engines equipped with a smoke generating system. On engines without a smoke generating system, the fuel out fitting is a 90-degree elbow. The tee fitting configuration is illustrated.**

4. Disconnect fuel out hose (6) to smoke system.
5. Disconnect fuel out hose (7) to fuel injection pump.
6. Remove tee fitting (8) and save for installation on replacement fuel/water separator (4).
7. Disconnect fuel drain hose (9).
8. Remove and retain drain elbow (10).

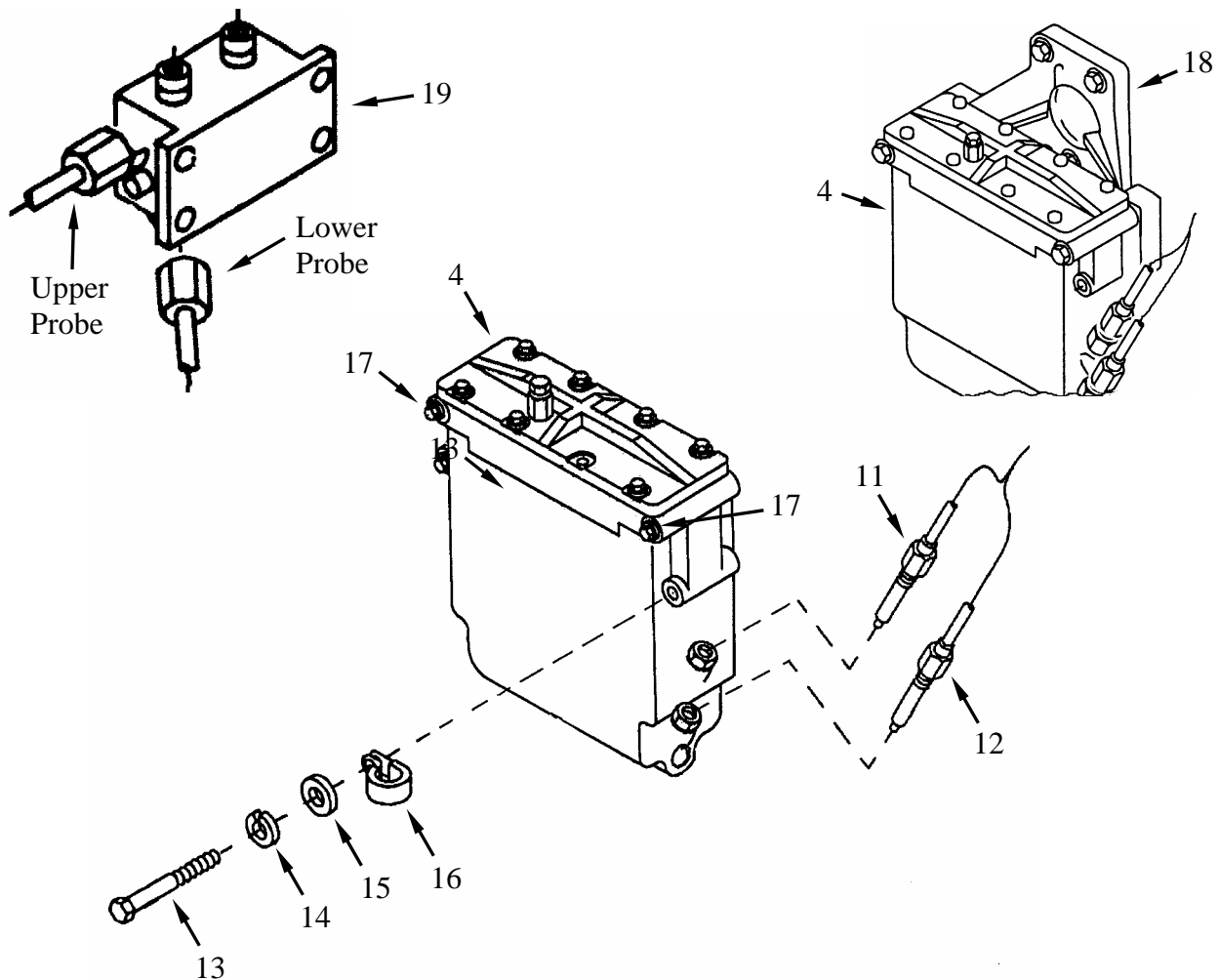


REMOVAL (Continued)

**CAUTION**

**Do not attempt to remove probes from control module. They are permanently affixed, removal will destroy the module.**

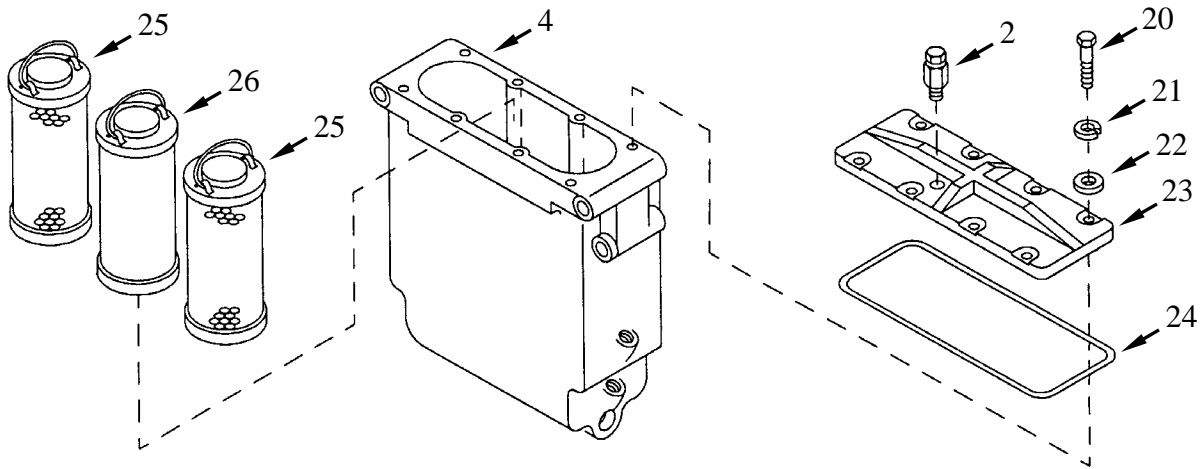
9. Remove two water level probes (11, 12) from separator (4).
  - a. Remove screw (13), with lock washer (14) and flat washer (15) to remove cushioned clamp (16). Discard lock washer.
  - b. Loosen, but do not remove remaining mounting screws (13, 17).
  - c. Pull fuel water separator (4) away from mounting bracket (18).
  - d. Mark probes for location, then remove two water level probes (11, 12) from fuel water separator (4) and place out of the way. Do not remove probes from control module (19).
10. Remove water separator (4).
  - a. Remove mounting screws (13, 17) to remove separator.



**FUEL/WATER SEPARATOR REPAIR/FILTER ELEMENT REPLACEMENT 0085 00**

**DISASSEMBLY**

1. Remove eight screws (20), with lock washers (21), and flat washers (22), to remove cover (23) and gasket (24). Discard lock washers and gasket.
2. Remove two outer elements (25) and inner element (26). It may be necessary to turn elements while removing to get them out easily. Discard elements.
3. Remove bleeder valve (2) from cover (23).



**WARNING**



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.
2. Clean all metal parts, fittings, hose ends, separator, bleeder valve, cover and inner element (26) with cleaning solvent (item 8, WP 0173). Remove sludge and gum with scraper or stiff brush.

**INSPECTION**

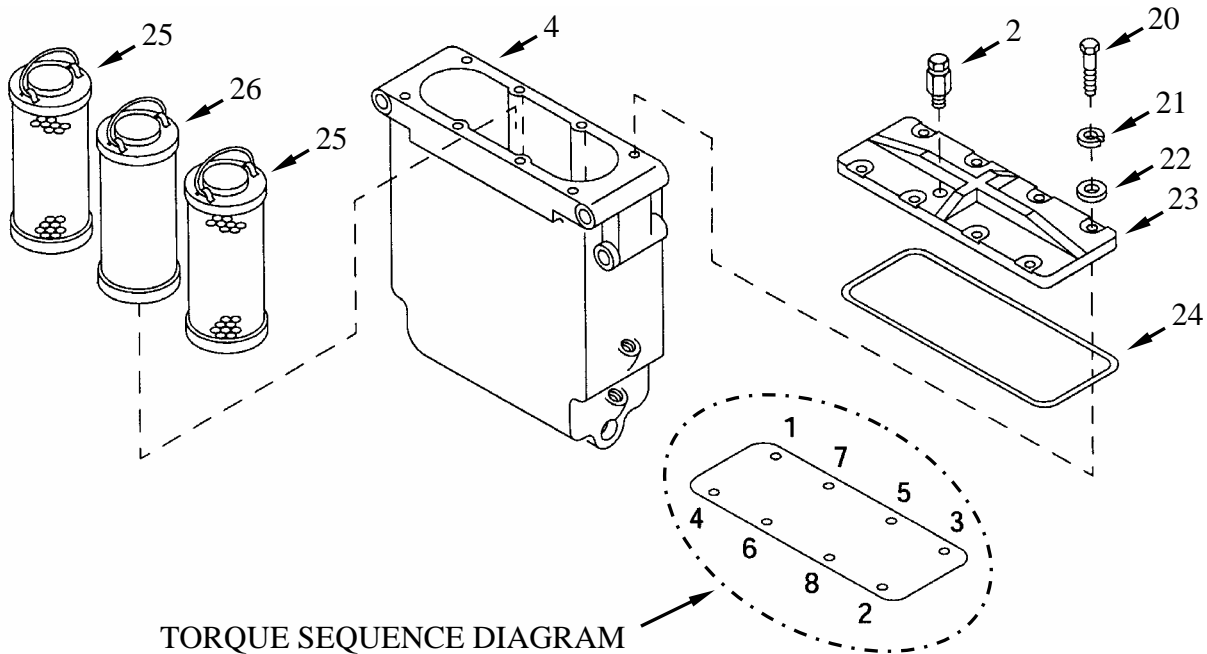
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Check bleeder valve (2) and mounting port in cover (23) to be sure that there is no blockage.

**FUEL/WATER SEPARATOR REPAIR/FILTER ELEMENT REPLACEMENT 0085 00**

**ASSEMBLY**

1. Install bleeder valve (2) in cover (23).
  
2. Install two new outer elements (25) (item 196, WP 0175) and new inner element (26) (item 195, WP 0175).
  
3. Install cover (23).
  - a. Place new gasket (24) (item 197, WP 0175) in position.
  
  - b. Install cover (23) and secure using eight screws (20), with new lock washers (21) (item 92, WP 0175) and flat washers (22).
  
  - c. Torque screws to 144 inch-pounds (16.27 N•m) in accordance with torque sequence diagram.



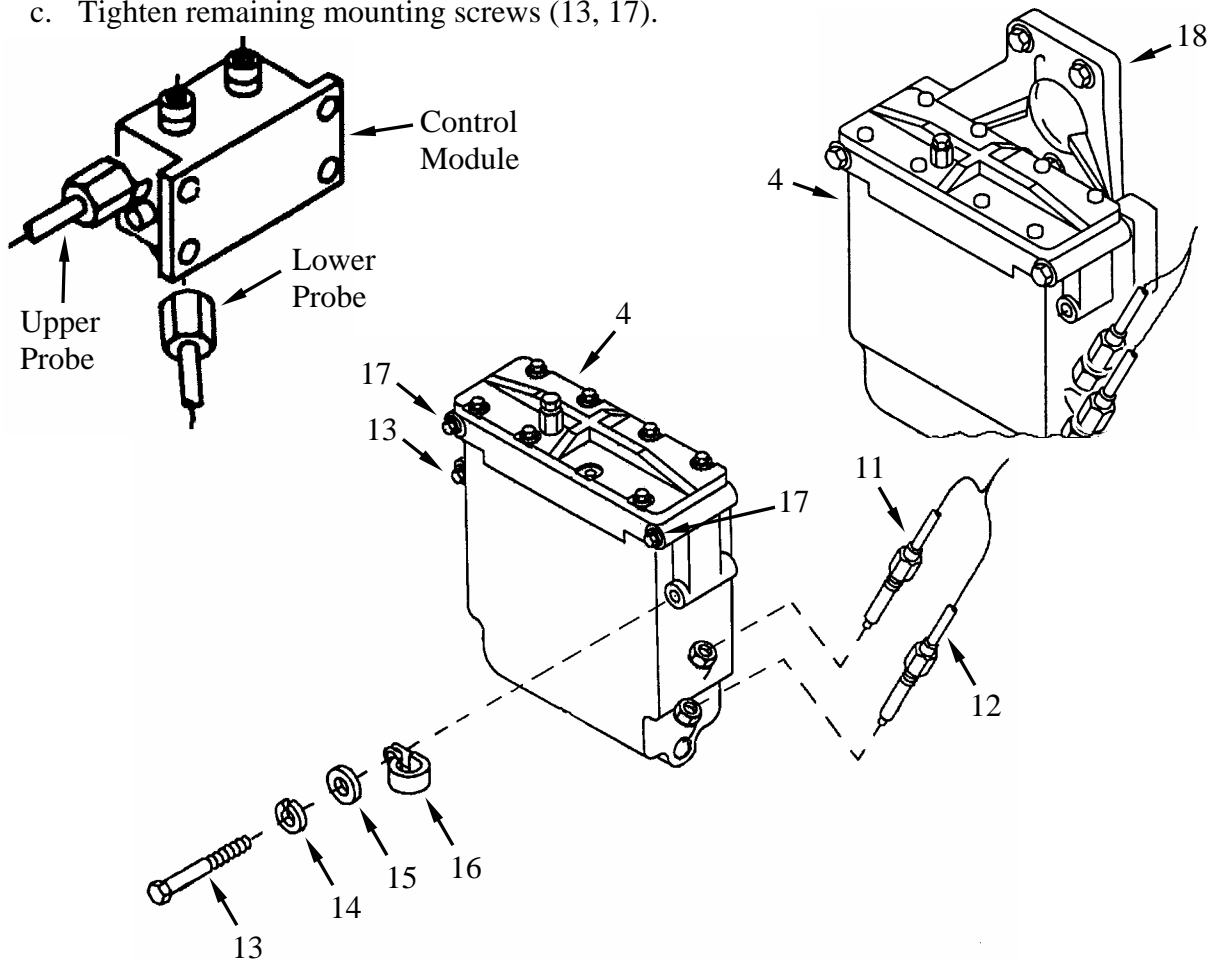
**INSTALLATION**

1. Install water separator (4).
  - a. Place separator in position and loosely secure using three mounting screws (13, 17) with flat washers (15) and new lock washers (14) (item 93, WP 0175), leaving space between water separator (4) and mounting bracket (18).

**CAUTION**

**Probes must be installed in proper separator ports. Probe with lead attached to side of control module must be installed in upper separator port. Failure to comply will result in improper functioning of fuel/water separator.**

2. Install two water level probes (11, 12).
  - a. Install two water level probes (11, 12) in fuel water separator (4).
  - b. Install screw (13), new lock washer (14) (item 93, WP 0175), flat washer (15), and cushioned clamp (16).
  - c. Tighten remaining mounting screws (13, 17).



**FUEL/WATER SEPARATOR REPAIR/FILTER ELEMENT REPLACEMENT 0085 00**

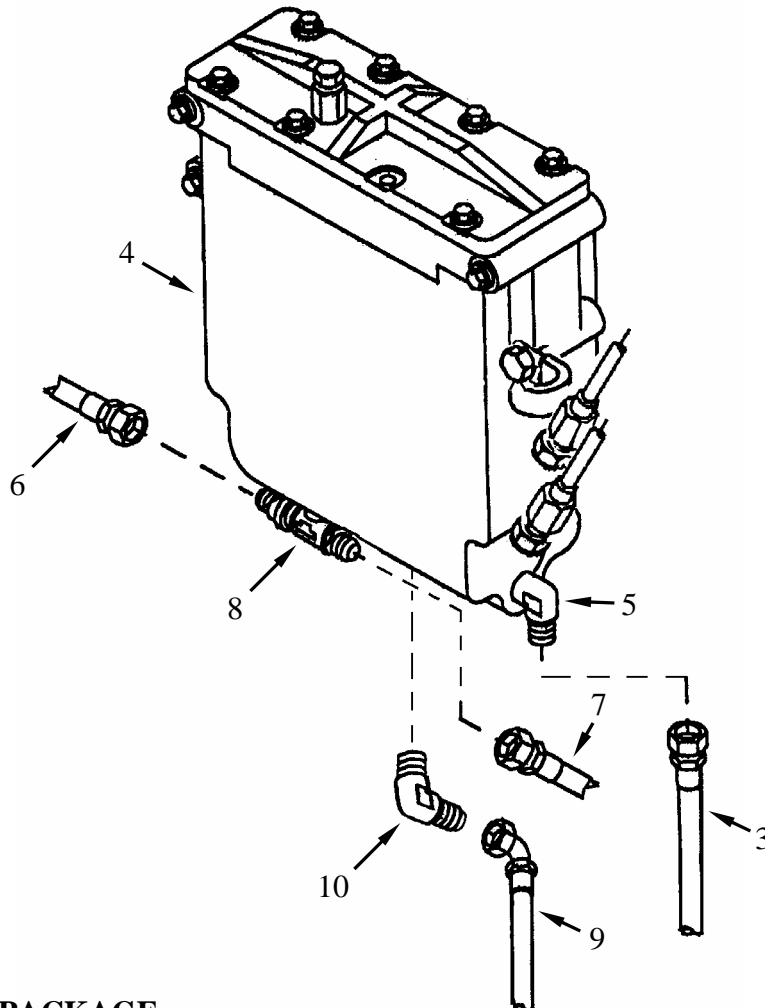
**INSTALLATION (Continued)**

3. Install drain elbow (10) and hose (9).

**NOTE**

**Fuel out fitting is a tee on engines equipped with a smoke generating system. On engines without a smoke generating system the fuel out fitting is a 90-degree elbow. The tee fitting configuration is illustrated.**

4. Install tee fitting (8).
5. Install hose (7) (fuel out to fuel injection pump).
6. Install hose (6) (fuel out to smoke system).
7. Install inlet elbow (5).
8. Install hose (3) (fuel into water separator).
9. Bleed air from filter and fuel lines by opening bleeder valve (2) and running electric fuel pump (see appropriate vehicle operators manual) until fuel runs out of bleeder valve (2).



**END OF WORK PACKAGE**

**PRIMARY FUEL FILTER REPAIR/ELEMENT REPLACEMENT****0086 00****THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning/Inspecting, Assembly, Installation

**INITIAL SETUP:****Tools:**

Container for fuel, minimum 1 gallon (3.8 liter) capacity

General mechanic's tool kit (item 121, WP 0176)

Torque wrench, 0-300 inch-pounds (item 124, WP 1076)

**Mandatory Replacement Parts:**

Filter element (item 217, WP 0175)

Gasket (item 198, WP 0175)

Gasket (item 199, WP 0175)

O-ring (item 4, WP 0175)

Self-locking nut (2) (item 38, WP 0175)

Self-locking nut (item 112, WP 0175)

**Expendable and Durable Items:**

Cleaning compound, solvent (item 8, WP 0173)

Thread sealing tape (item 41, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL****WARNING**

**FIRE HAZARD - Diesel fuel is combustible. Do not smoke or allow open flames or sparks in areas where diesel fuel and combustible materials are used or stored. DEATH or severe injury may result if personnel fail to observe this precaution. If you are burned, seek medical aid immediately.**

**CAUTION**

**Filter must be removed from engine to thoroughly clean or replace parts not otherwise accessible. Never clean inside of filter when connected to fuel lines. Unseen particles could enter fuel lines and damage pumps and injectors.**

**NOTE**

**The different engine models orient the inlet and outlet hoses differently. Take note of the orientation of these hoses for installation.**

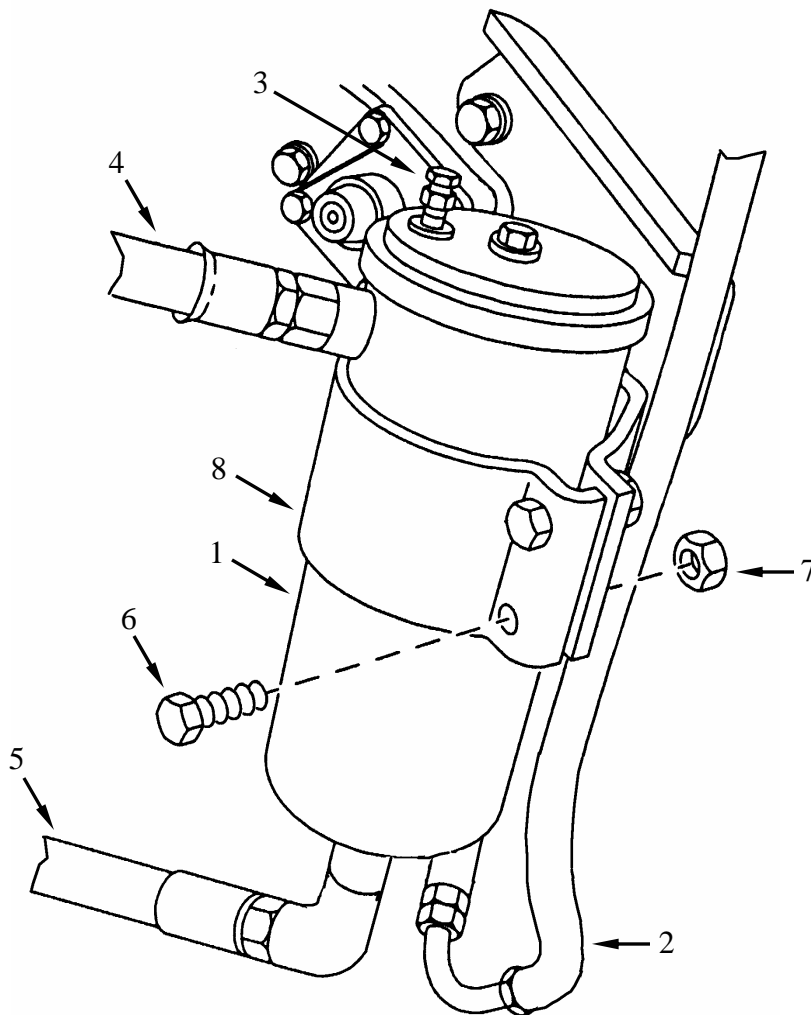
**REMOVAL (Continued)**

1. Drain filter body (1)
  - a. Place suitable container under fuel filter body (1).
  - b. Remove hose assembly (2) and open bleeder valve (3) to drain filter body (1).
2. Disconnect fuel filter inlet hose (4) and outlet hose (5).

**CAUTION**

**When removing or installing filter body, be sure to avoid damaging fluid filter line fitting. Turn filter body so fitting will slide through bracket channel where screws and nuts are located.**

3. Remove two screws (6), with self-locking nuts (7) and slide filter body (1) out of bracket (8). Discard self-locking nuts.
4. If new filter body (1) will be installed, remove bleeder valve (3) for installation in new unit.



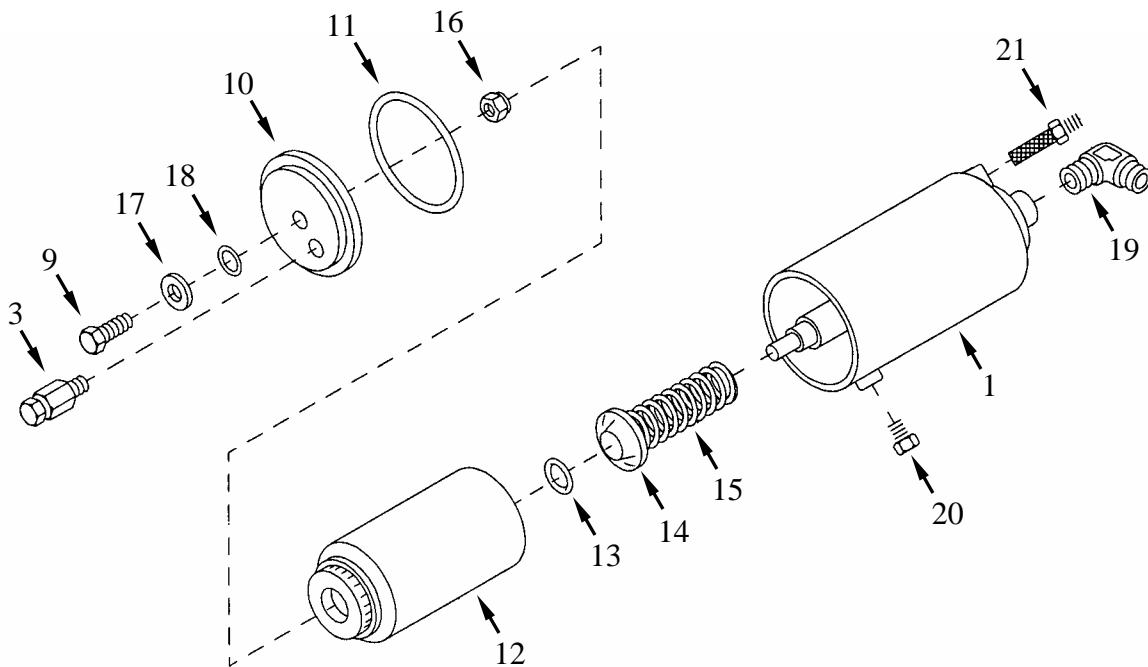


## DISASSEMBLY

## NOTE

The following steps provide for a complete disassembly/assembly of the fuel filter. Perform only those steps necessary for maintenance or replacement of defective parts.

1. Loosen screw (9) to remove filter cover (10) and gasket (11). Discard gasket.
2. Remove filter element (12), O-ring (13), element retainer (14), and helical spring (15) from inside filter body (1). Discard filter element and O-ring.
3. Remove self-locking nut (16), screw (9), flat washer (17), gasket (18) and bleeder valve (3). Discard self-locking nut and gasket.
4. Remove elbow (19), connector (20) and fluid filter (21) from filter body (1).



**WARNING**



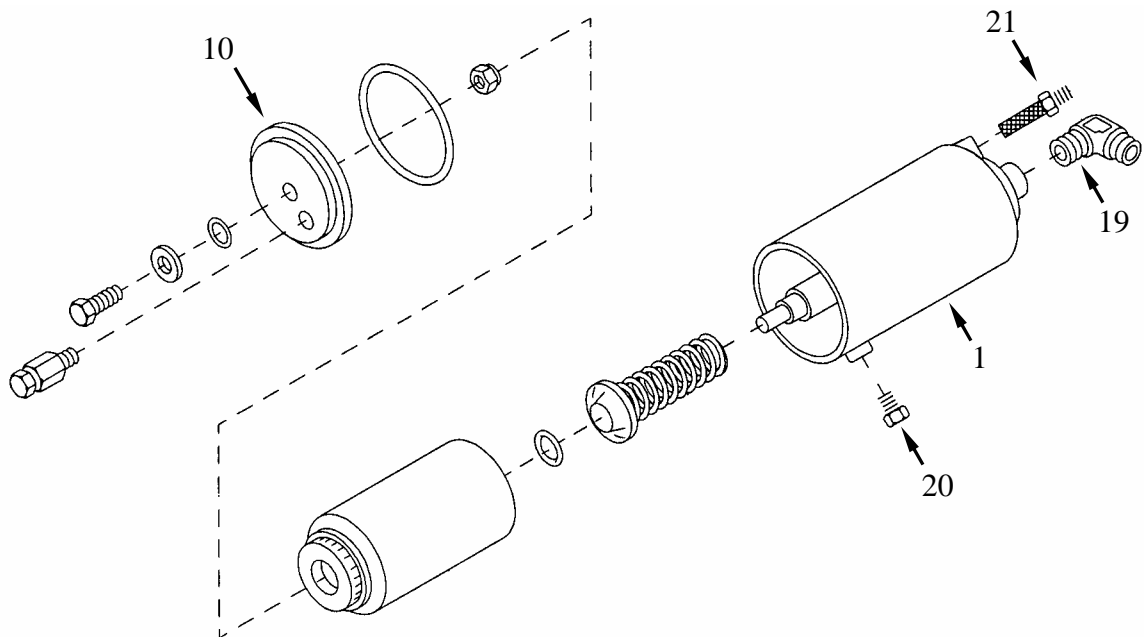
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.
2. Clean all metal filter parts, elbow (19), connector (20), fluid filter (21), inside filter body (1) and cover (10) with cleaning solvent (item 8, WP 0173). Remove sludge and gum with scraper or stiff brush.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Check fluid filter (21) and mounting port in filter body (1) to be sure that there is no blockage.



## ASSEMBLY

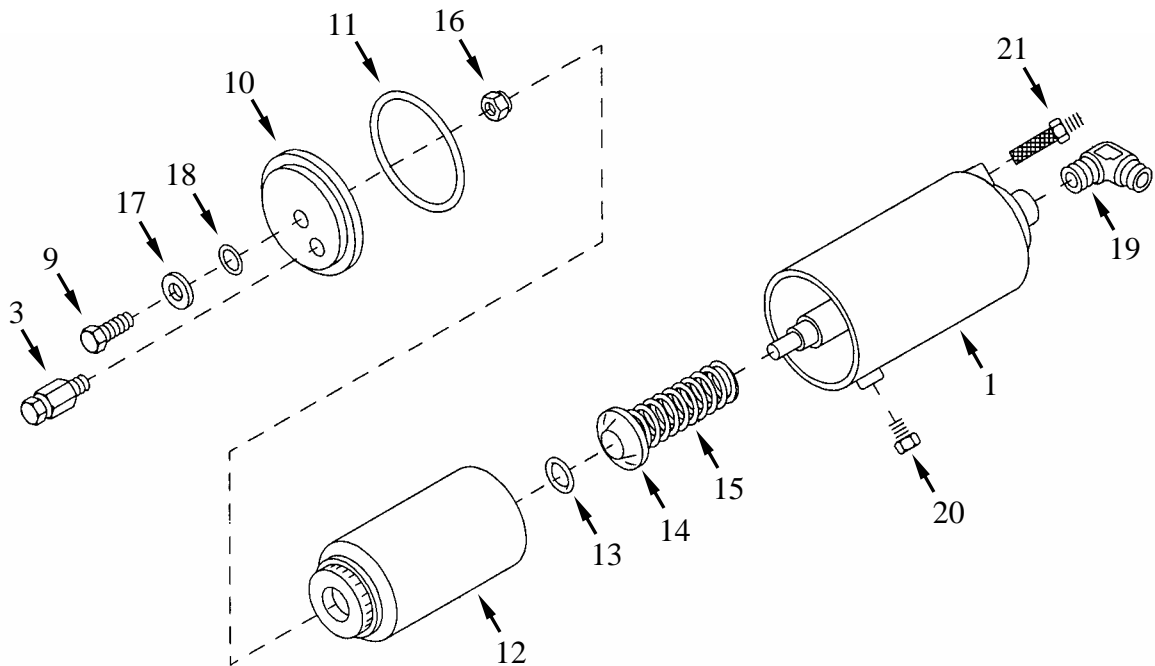
1. Install helical spring (15), element retainer (14), new O-ring (13) (item 4, WP 0175) and new filter element (12) (item 217, WP 0175) inside filter body (1).

## NOTE

**Do not tighten self-locking nut on filter cover screw. It should be just snug enough to hold screw yet still allow screw to turn to secure cover.**

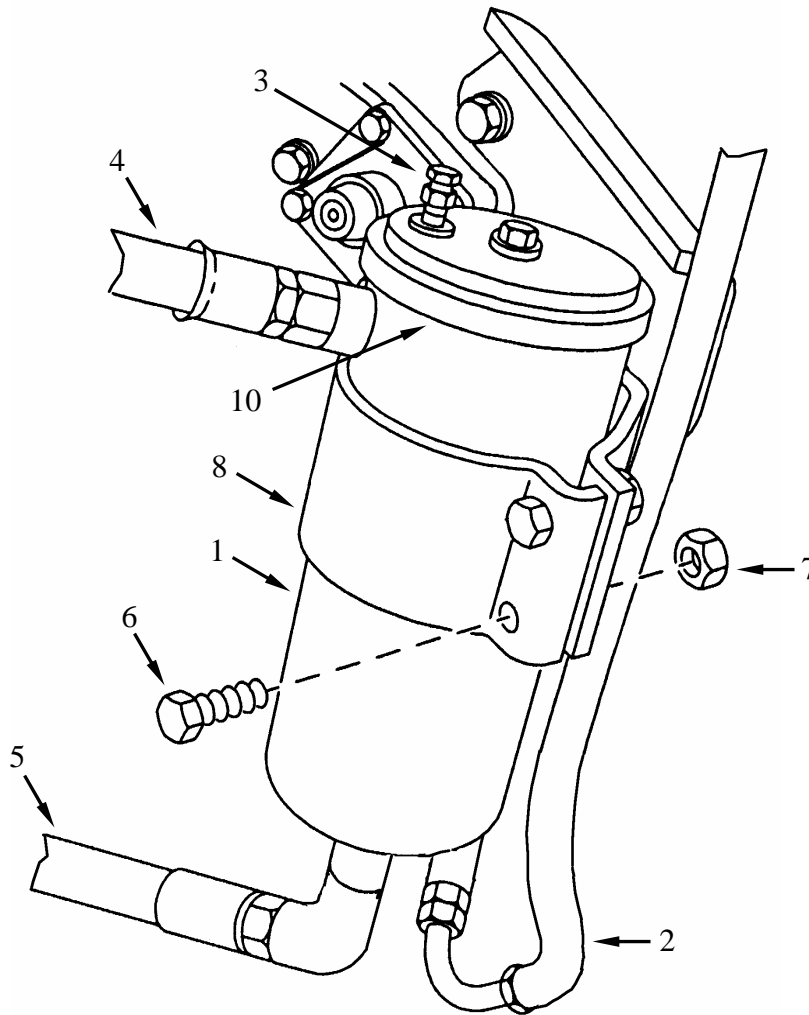
**Use thread sealing tape (item 41, WP 0173) on all threaded fittings except filter cover screw.**

2. Install bleeder valve (3), new gasket (18) (item 199, WP 0175), flat washer (17), screw (9) and new self-locking nut (16) (item 112, WP 0175) to filter cover (10).
3. Install filter cover (10) using a new gasket (11) (item 198, WP 0175).
  - a. Torque screw (9) to 85-95 inch-pounds (9.7-10.7 N•m).
5. Install elbow (19), connector (20), and fluid filter fitting (21) on filter body (1).



**INSTALLATION**

1. Slide filter body (1) in bracket (8), install two screws (6) and two new self-locking nuts (7) (item 38, WP 0175).
2. Connect fuel filter inlet hose (4) and outlet hose (5) to filter body (1).
3. Install hose assembly (2) to bottom of filter body (1).
4. If installing new filter body, remove plug from new cover (10) and install bleeder valve (3) previously removed from old filter. Install plug in old filter cover (10).

**FOLLOW-ON MAINTENANCE**

Refer to appropriate vehicle manual.

1. Bleed air from filter and lines by running electric fuel pump until fuel flows from bleeder valve (3). Tighten bleeder valve screw.
2. Check for leaks at all connections, turn off fuel pump.

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, and Assembly

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Element (filter) (item 274, WP 0175)

Lock washer (2) (item 85, WP 0175)

Lock washer (2) (item 91, WP 0175)

O-ring (item 78, WP 0175)

**Expendable and Durable Items:**

Cleaning compound, solvent (item 8, WP 0173)

**Personnel Required**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

**WARNING**

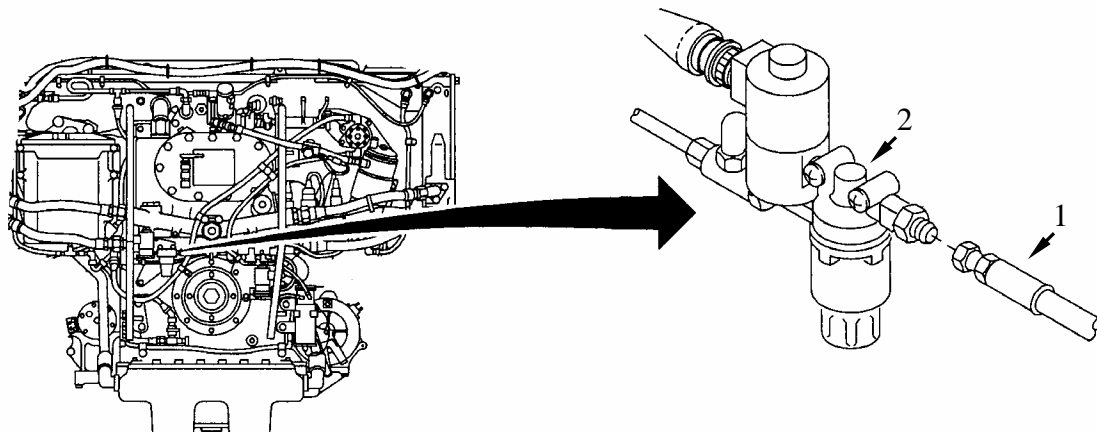


**FIRE HAZARD - Diesel fuel is combustible. Do not smoke or allow open flames or sparks in areas where diesel fuel and combustible materials are used or stored. DEATH or severe injury may result if personnel fail to observe this precaution. If you are burned, seek medical aid immediately.**

**NOTE**

**The following steps provide for a complete replacement of the manifold heater fuel filter and solenoid. Perform only those steps necessary for maintenance of defective parts.**

1. Disconnect fuel hose (1) from manifold heater filter (2).

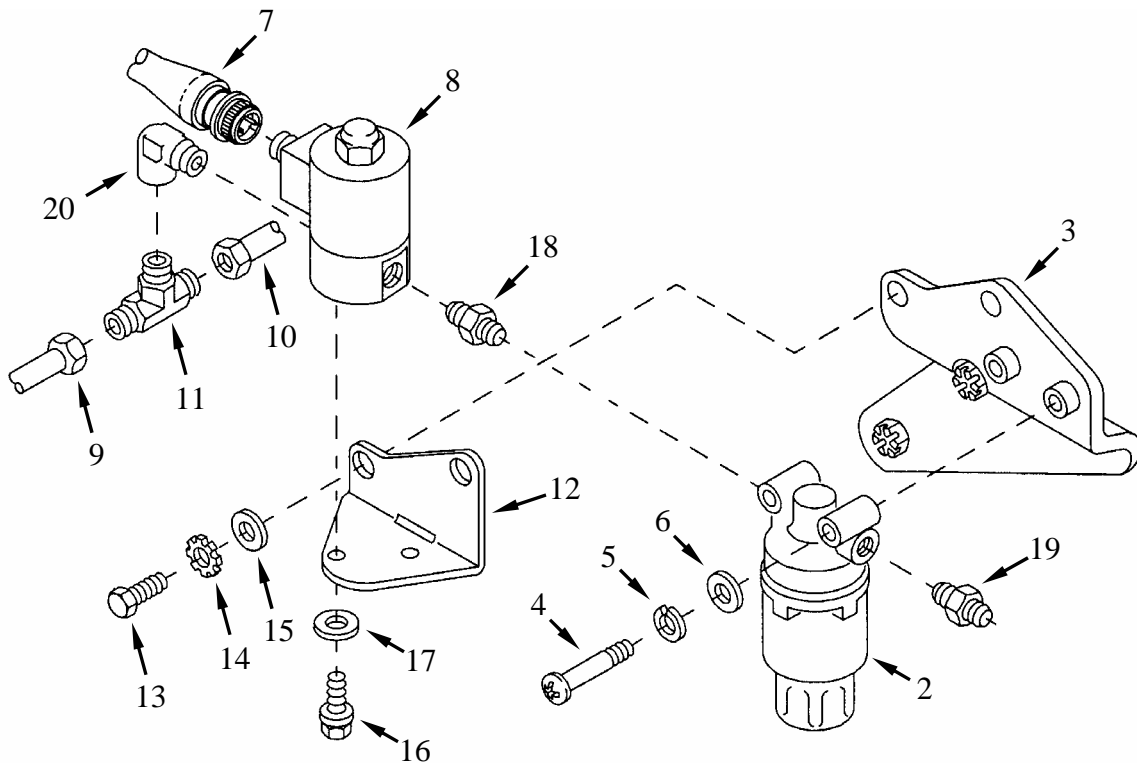


**REMOVAL (Continued)**

2. Disconnect filter (2) from bracket (3).
  - a. Remove two screws (4), with lock washers (5) and flat washers (6) to disconnect fuel filter (2). Discard lock washers.
3. Disconnect electrical connector (7) from solenoid valve (8).
4. Remove tubes (9, 10) from tee (11).
5. Remove solenoid valve (8) from bracket (12).
  - a. Remove two screws (13) with lock washers (14) and flat washers (15) to separate bracket (12) from bracket (3). Discard lock washers.
  - b. Remove two screws (16) with flat washers (17) to remove solenoid valve (8) from bracket (12).
6. Separate solenoid valve (8) from filter (2) at fitting (18).

**DISASSEMBLY**

1. Remove fittings.
  - a. Remove fitting (18) from fuel filter (2).
  - b. Remove fitting (19) from fuel filter (2).
  - c. Remove tee (11) and elbow (20) from solenoid valve (11).
  - d. Separate tee (11) from elbow (20).

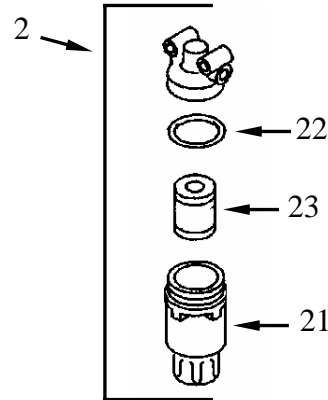


**DISASSEMBLY (Continued)**

**CAUTION**

**The manifold heater fuel filter must be removed from the engine to thoroughly clean or replace parts not otherwise accessible. Never clean inside of filter when connected to fuel lines. Unseen particles could enter fuel lines and damage heater nozzles. Cap fuel lines when removed from filter.**

2. Disassemble fuel filter (2).
  - a. Remove sediment bowl (21).
  - b. Remove and discard O-ring (22).
  - c. Remove and discard element (23).



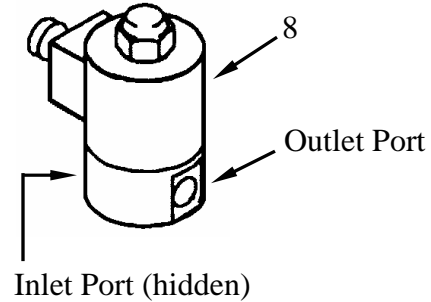
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

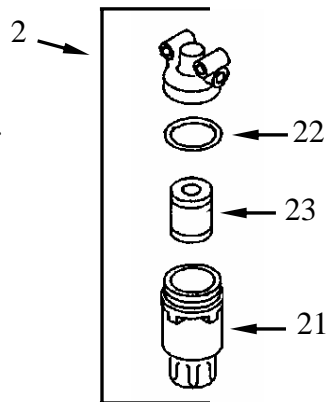
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Inspect inlet and outlet ports of solenoid (8). If felt filters are found, remove and discard them. Felt filters are not required and should be removed.



**ASSEMBLY**

1. Assemble fuel filter (2).
  - a. Install new element (23) (item 274, WP 0175).
  - b. Install new O-ring (22) (item 78, WP 0175).
  - c. Install sediment bowl (21).

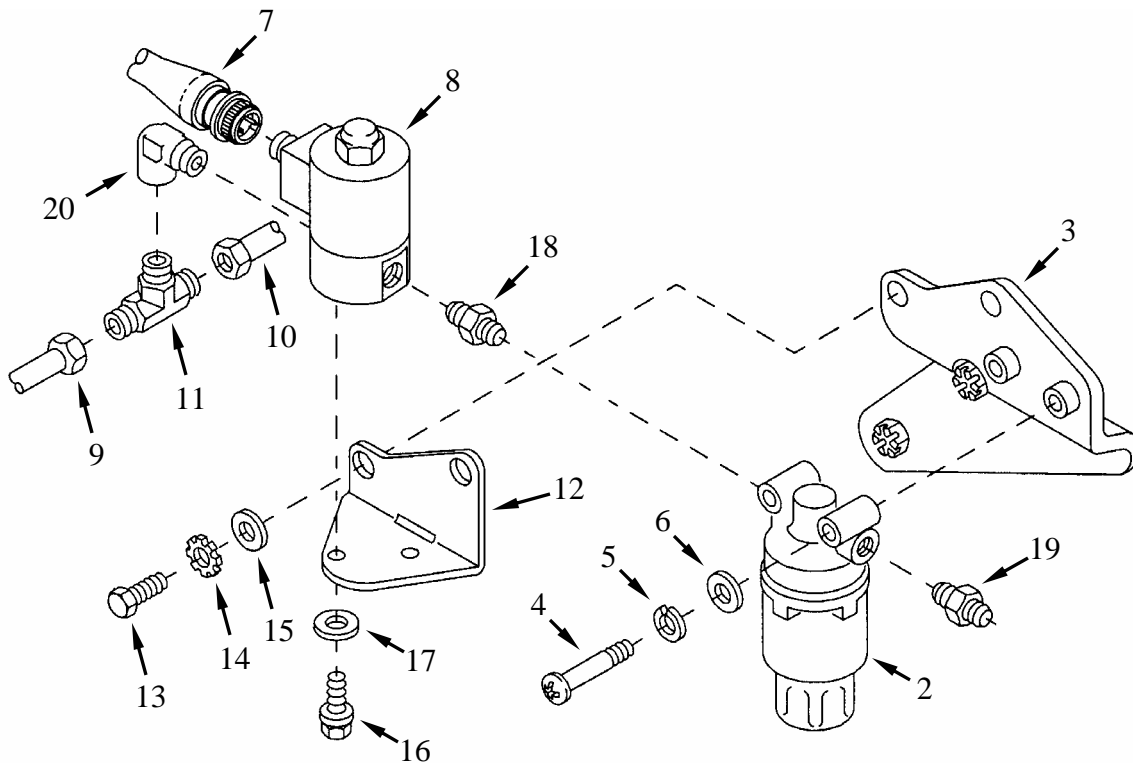


**ASSEMBLY (Continued)**

2. Install fittings.
  - a. Install fitting (19) into fuel filter (2).
  - b. Install fitting (18) into fuel filter (2).
  - c. Install tee (11) into elbow (20).
  - d. Install tee (11) and elbow (20) as an assembly into solenoid valve (11).

**INSTALLATION**

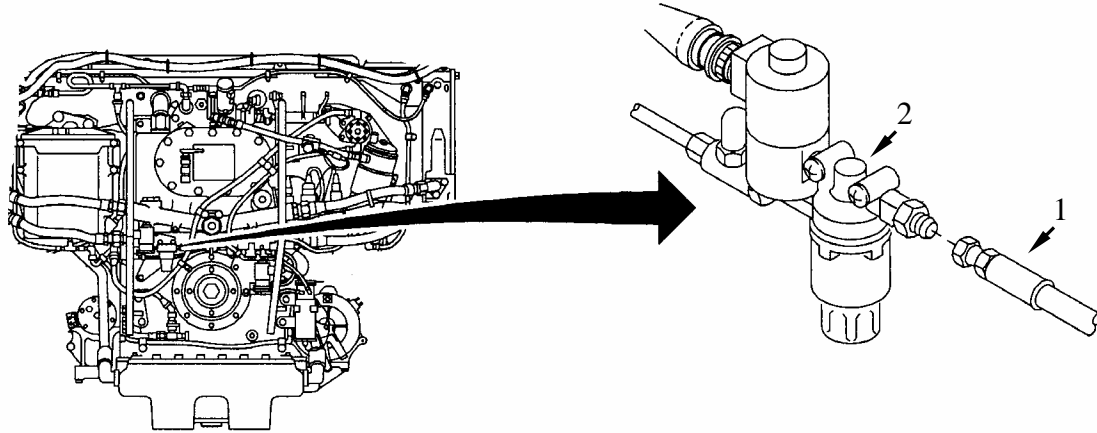
1. Install solenoid valve (8) to filter (2) at fitting (18).
2. Install solenoid valve (8) to bracket (12) using two screws (16) with flat washers (17).
3. Install solenoid valve (8) and bracket (12) as an assembly to bracket (3) using two screws (13), with new lock washers (14) (item 85, WP 0175) and flat washers (15).
4. Secure filter (2) to bracket (3) using two screws (4), with new lock washers (5) (item 91, WP 0175) and flat washers (6).
5. Install tubes (9, 10) to tee (11).
6. Connect electrical connector (7) to solenoid valve (8).





**INSTALLATION (Continued)**

7. Connect fuel hose (1) to manifold heater filter (2).

**END OF WORK PACKAGE**



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**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Assembly, and Installation

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (2) (item 107, WP 0175)
- Gasket (2) (item 326, WP 0175)
- Self-locking nuts (10) (item 32, WP 0175)
- Self-locking nuts (8) (item 33, WP 0175)
- Self-locking nut (2) (item 37, WP 0175)
- Self-locking nuts (2) (item 38, WP 0175)
- Self-locking nut (12) (item 113, WP 0175)

**Expendable and Durable Items:**

- Air supply
- Cleaning solvent (item 8, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

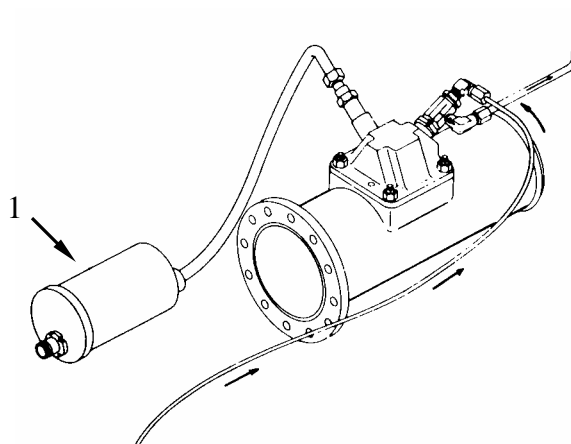
- Engine removed from vehicle and placed on a flat stationary surface
- 

**REMOVAL**



**WARNING**

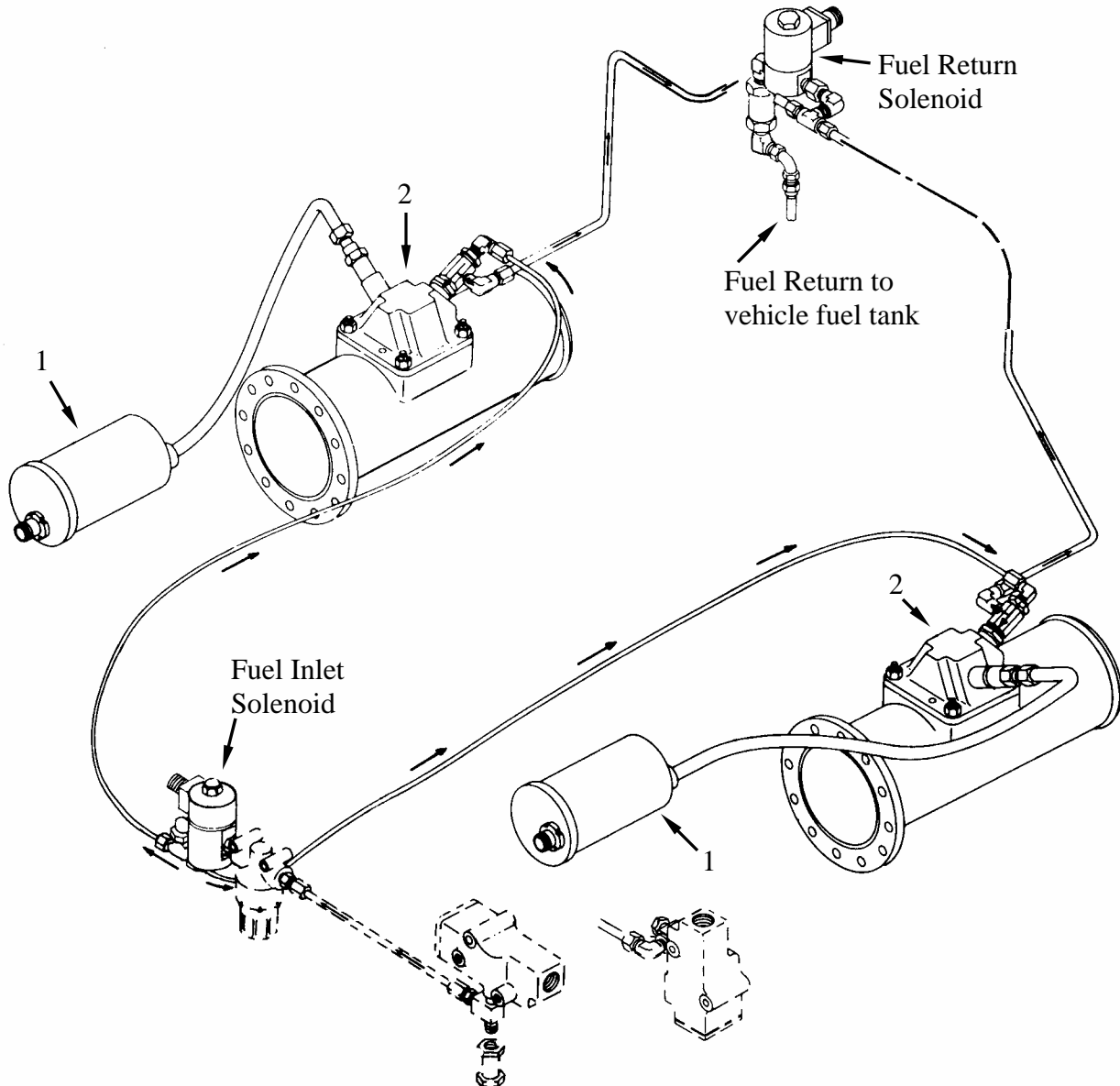
**The intake manifold heater ignition coils (1) are capable of producing extremely high voltage. The output of this ignition system is sufficient to cause a dangerous electrical shock. Never touch any uncovered or live connections.**



REMOVAL (Continued)

NOTE

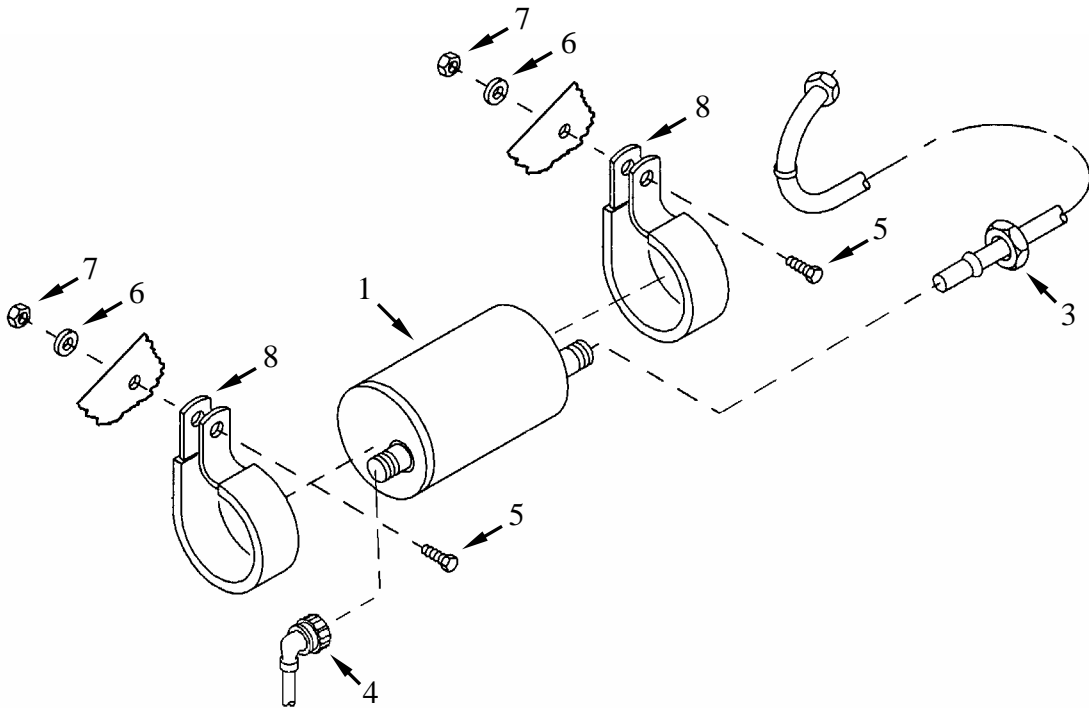
The heater assembly (2) and ignition coil (1) on each side of the engine are removed in the same manner. For instructional purposes, removal of the left heater assembly and ignition coil are described in this work package.



MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00

**REMOVAL (Continued)**

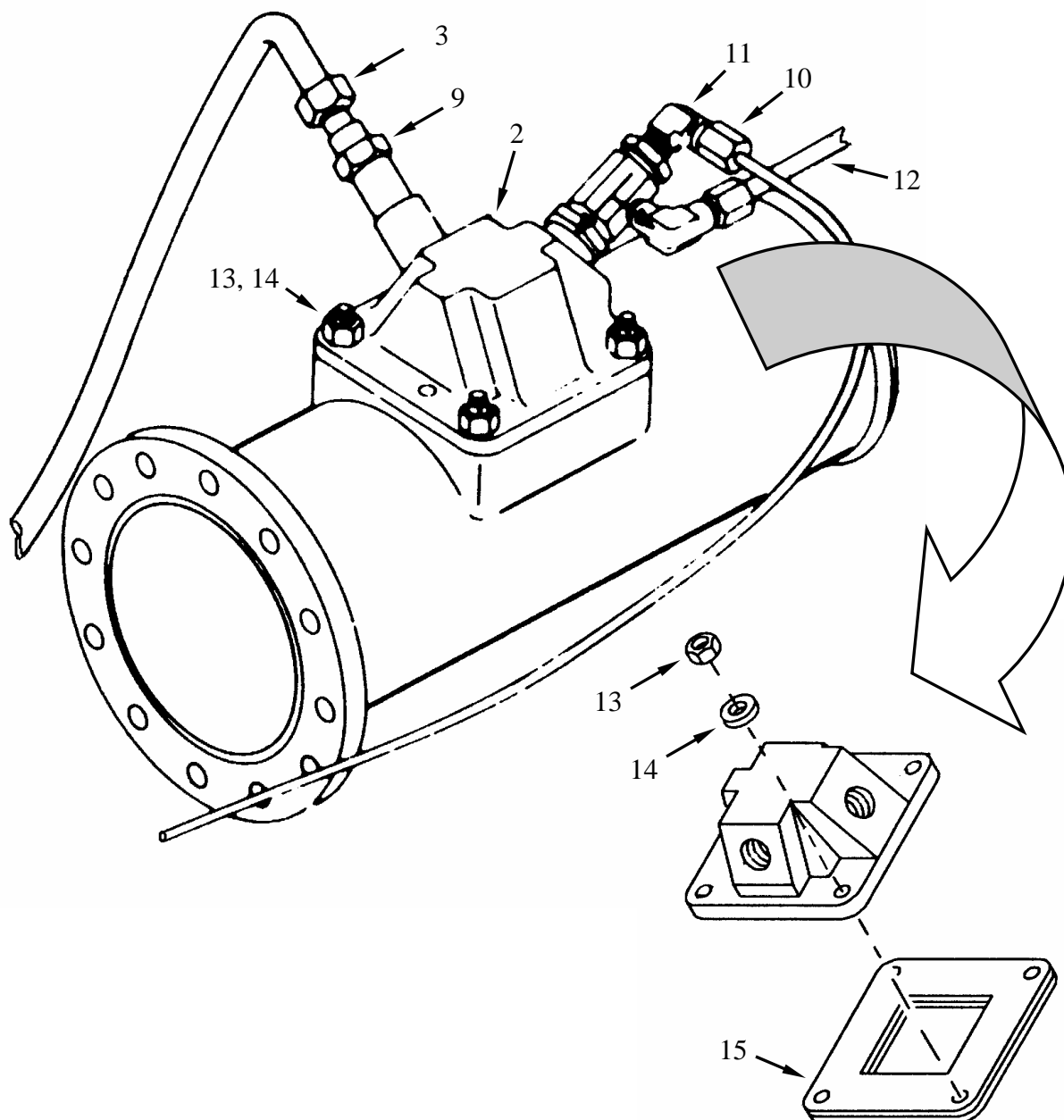
1. Remove ignition coil (1).
  - a. Disconnect manifold heater spark plug electrical lead (3) and wiring harness electrical lead (4) from ignition coil (1).
  - b. Remove two screws (5), flat washers (6) and self-locking nuts (7) to remove ignition coil (1) with clamps (8) as an assembly. Discard self-locking nuts.
  - c. Remove two clamps (8) from coil (1).



MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00

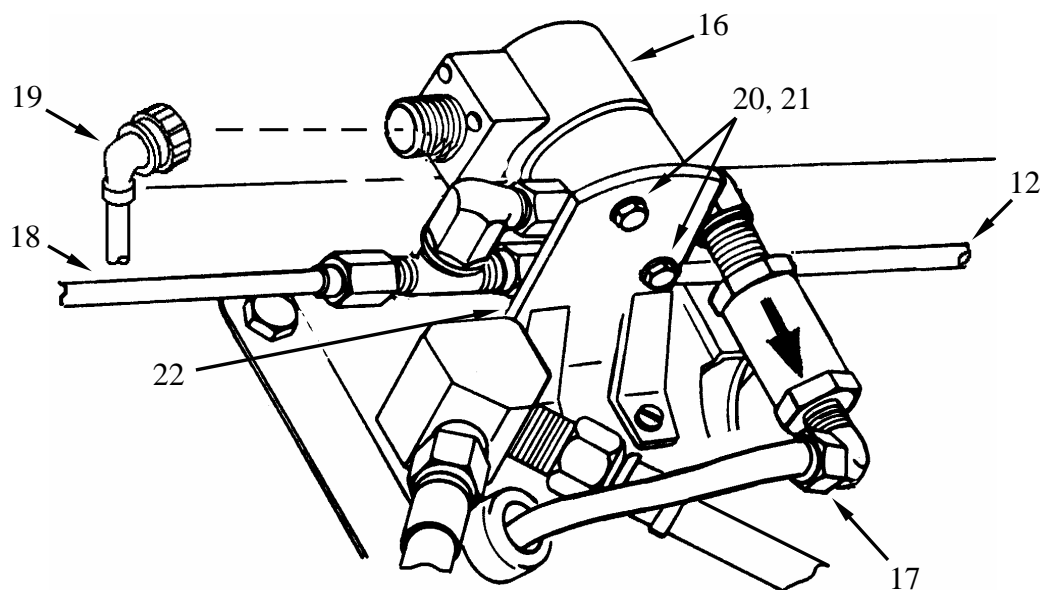
**REMOVAL (Continued)**

2. Remove heater assembly (2).
  - a. Disconnect spark plug lead (3) at spark plug (9).
  - b. Disconnect fuel inlet hose (10) from elbow (11).
  - c. Disconnect fuel return tube (12).
  - d. Remove four self-locking nuts (13) with flat washers (14) to remove manifold heater assembly (2).
  - e. Remove and discard gasket (15).



**REMOVAL (Continued)**

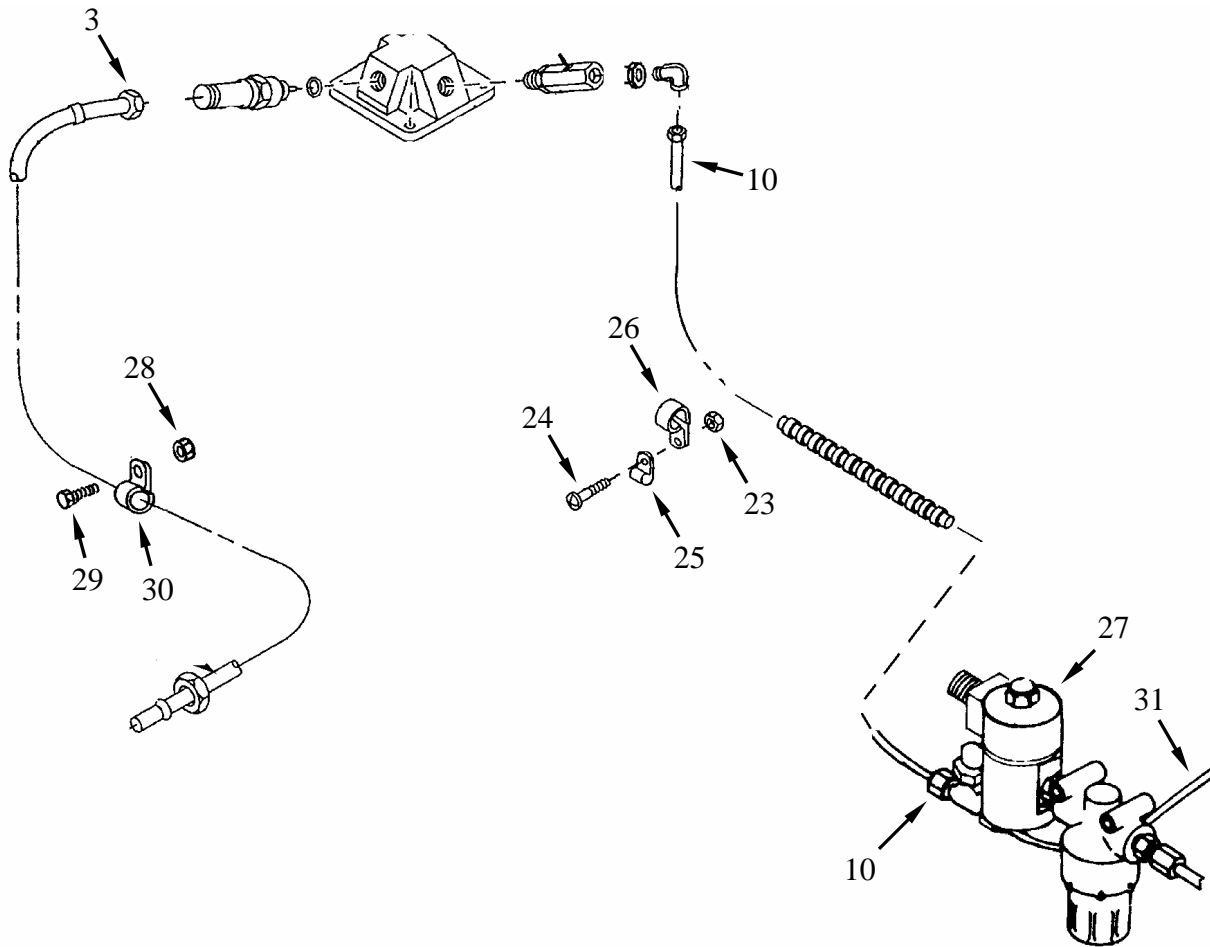
3. Remove fuel return solenoid valve (16) located at rear of engine.
  - a. Disconnect fuel solenoid outlet hose (17) and inlet tubes (12, 18).
  - b. Disconnect electrical lead (19).
  - c. Remove two assembled washer bolts (20) with flat washers (21) to remove solenoid valve (16) and associated fittings from bracket (22) as an assembly.



MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00

**REMOVAL (Continued)**

4. Remove left bank, fuel-into-nozzle hose (10).
  - a. Remove five self-locking nuts (23), screws (24) and clamps (25) from clamps (26).
  - b. Disconnect hose (10) from fuel inlet solenoid (27) at damper end of engine.
5. Remove spark plug electrical lead (3).
  - a. Remove self-locking nut (28), screw (29) and clamp (30) to remove lead (3).
6. Remove right bank, fuel-into-nozzle hose (31) and spark plug lead in a similar manner.

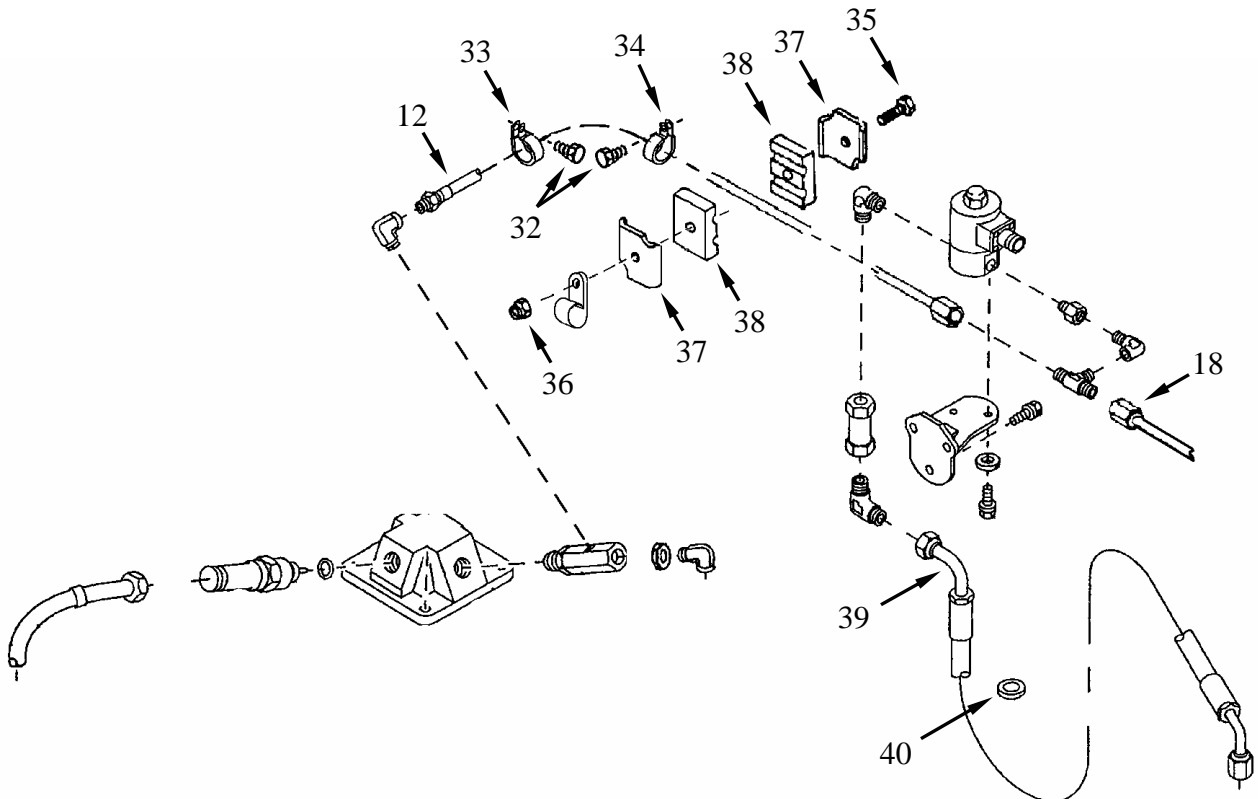




MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00

**REMOVAL (Continued)**

7. Remove left bank fuel return tube (12).
  - a. Remove two screws (32) to remove clamps (33, 34).
  - b. Remove screw (35) self-locking nut (36), two straps (37) and two fairlead halves (38). Discard nut.
8. Remove right bank fuel return tube (18) in a similar manner.
9. Remove fuel return hose (39).
10. Remove grommet (40).



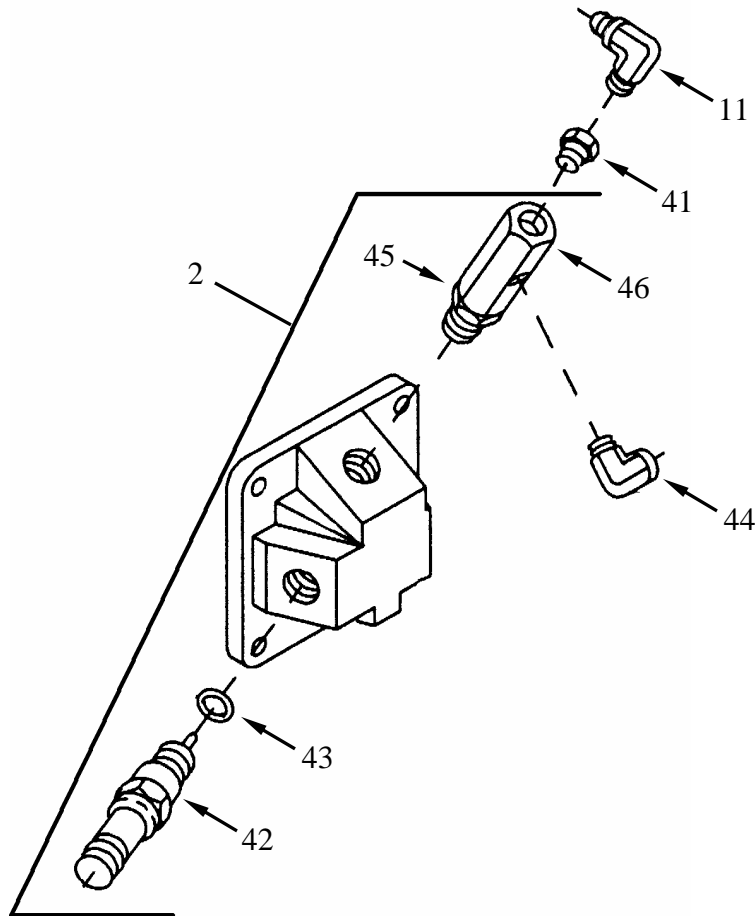
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**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

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**DISASSEMBLY**

1. Remove inlet elbow (11) and bushing (41).
  
2. Disassemble heater assembly (2).
  - a. Remove spark plug (42) and gasket (43). Discard gasket.
  
  - b. Remove outlet elbow (44).
  
  - c. Loosen jam nut (45) and then remove nozzle (46).



**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

**CLEANING**

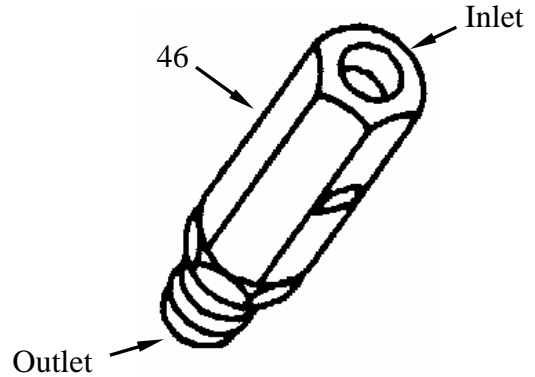
1. See Work Package 0028 for General Cleaning Procedures.

**WARNING**

**Cleaning Solvent, Compressed Air**



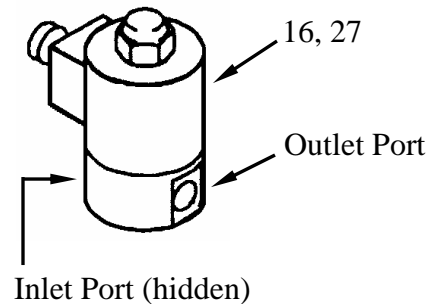
2. Check that nozzle (46) orifice is clean (use cleaning solvent (item 8, WP 0173), do not use any type of probe). Use compressed air to blow through nozzle from inlet end. Observe that atomization occurs.



**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

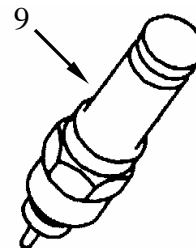
1. See Work Package 0028 for General Inspection Procedures.
2. Inspect inlet and outlet ports of fuel inlet solenoid (27) and fuel return solenoid (16). If felt filters are found, remove and discard them. Felt filters are not required and should be removed.



**NOTE**

**The flame heater spark plug can be cleaned in the same manner as any automotive spark plug.**

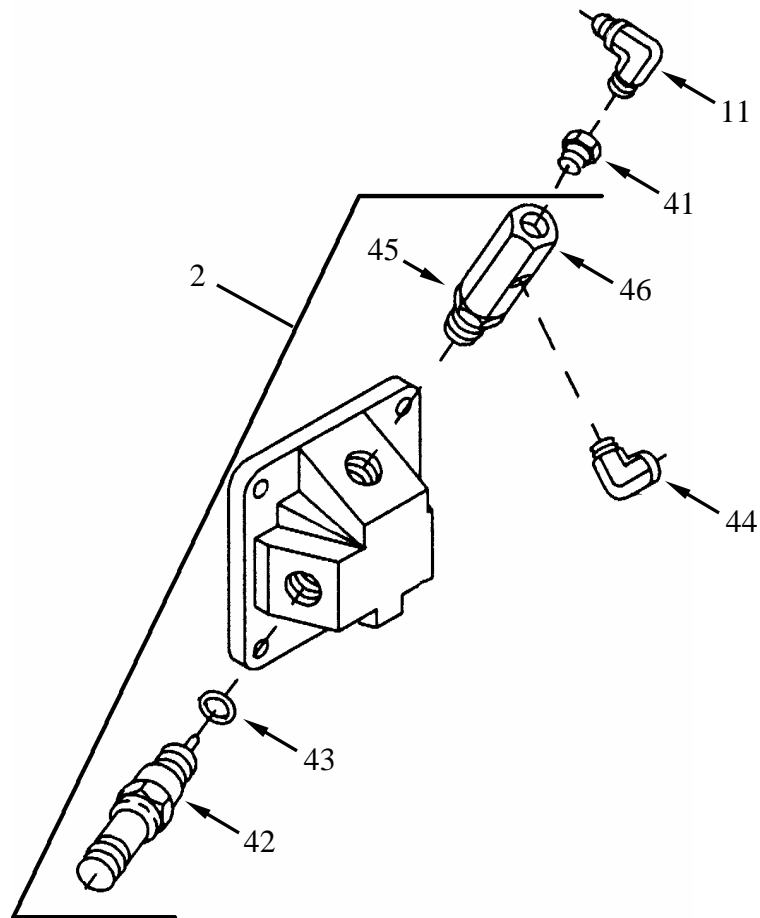
3. Check spark plug (9) gap.
  - a. Set spark plug (9) gap to 0.094-0.114 inch (2.3876-2.8956 mm).



**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

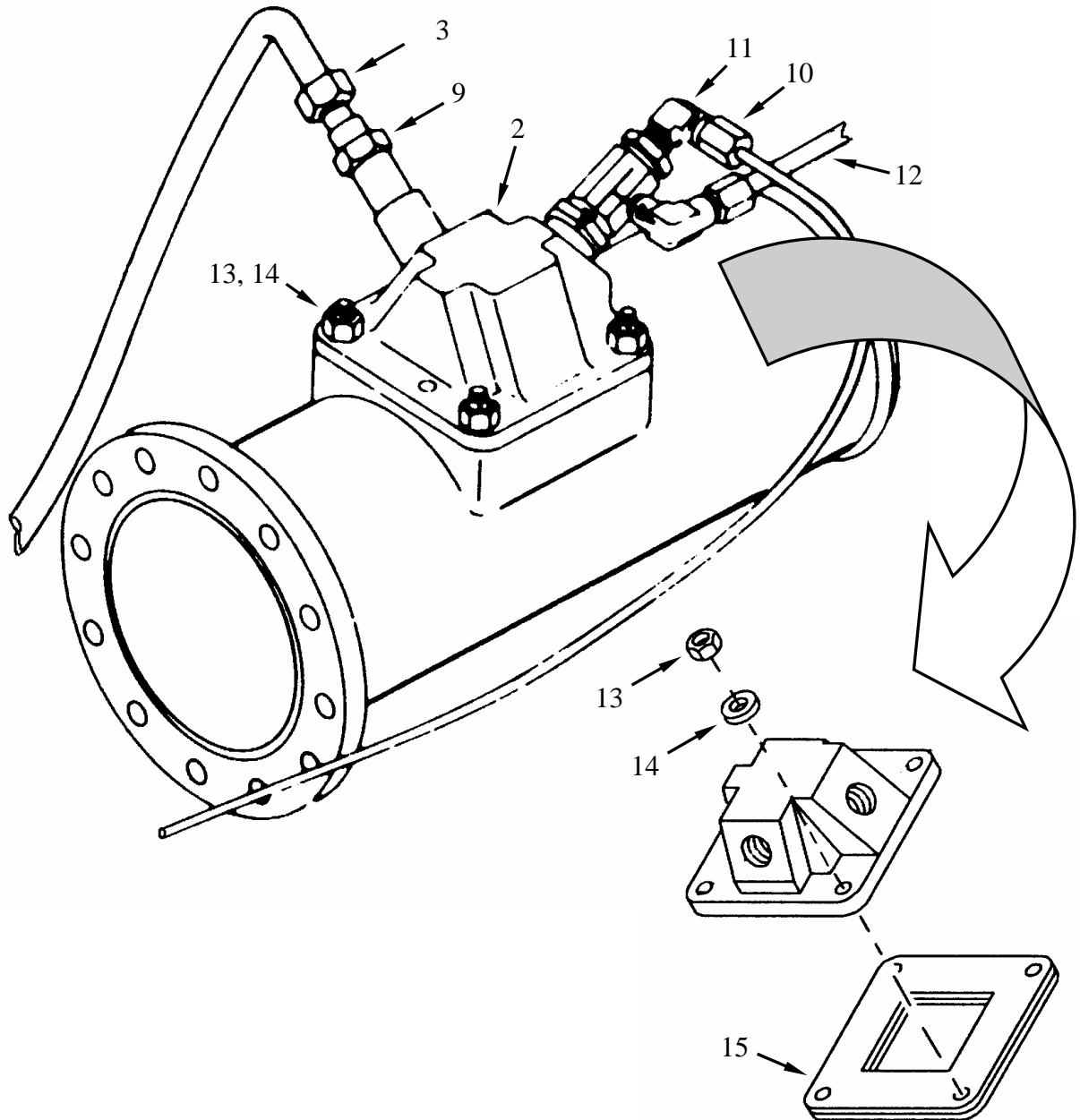
**ASSEMBLY**

1. Assemble heater assembly (2).
  - a. Install nozzle (46) and tighten jam nut (45).
  - b. Install outlet elbow (44).
  - c. Install spark plug (42) using new gasket (43) (item 107, WP 0175).
2. Install bushing (41) and inlet elbow (11).



**INSTALLATION**

1. Install heater assembly (2).
  - a. Position heater assembly (2) in place over a new gasket (15) (item 326, WP 0175).
  - b. Secure using four new self-locking nuts (13) (item 33, WP 0175) with flat washers.
  - c. Connect fuel return tube (12).
  - d. Connect fuel inlet hose (10) to elbow (11).
  - e. Connect spark plug lead (3) to spark plug (9).



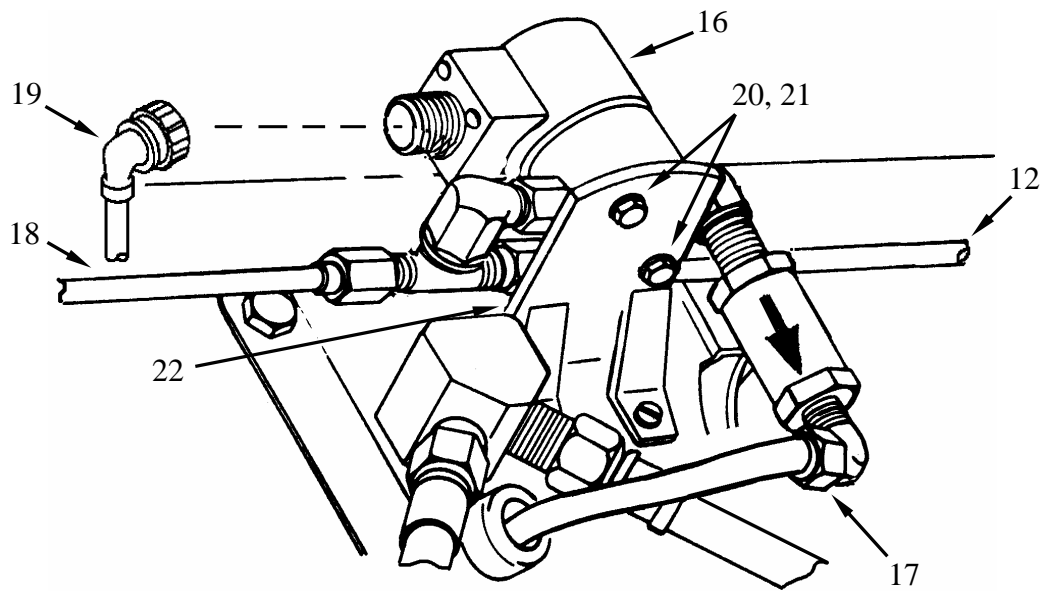
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**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

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**INSTALLATION (Continued)**

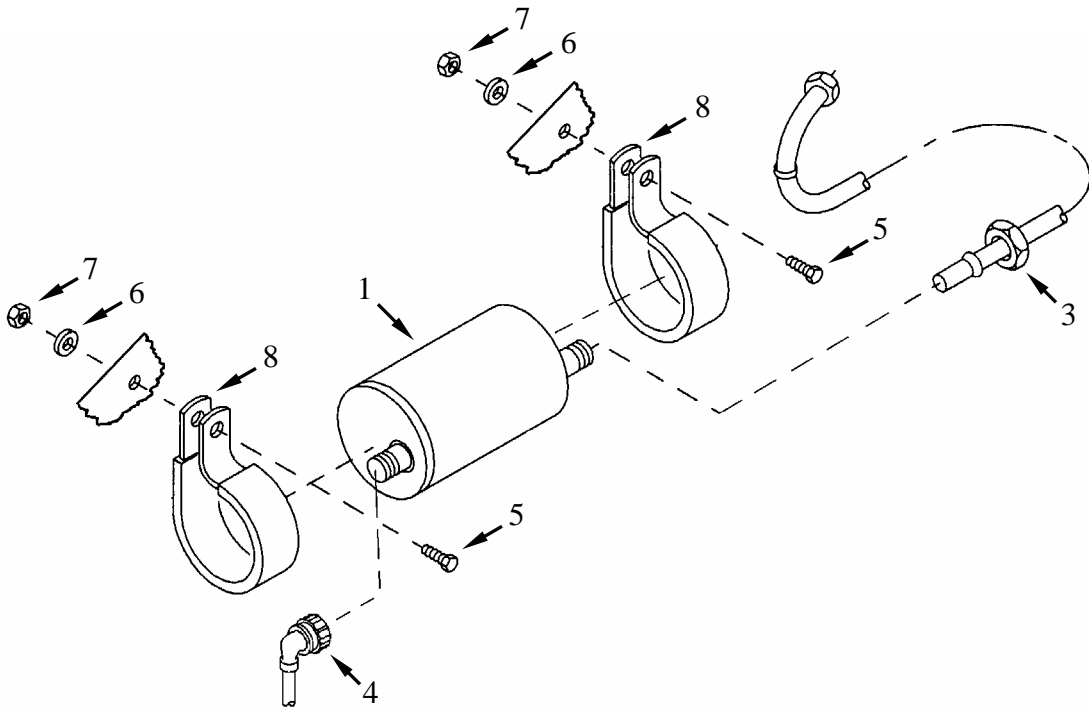
2. Install fuel return solenoid valve (16) located at rear of engine.
  - a. Install solenoid valve (16) and associated fittings onto bracket (22) as an assembly and secure using two assembled washer bolts (20) with flat washers (21).
  - b. Connect electrical lead (19).
  - c. Connect fuel solenoid outlet hose (17) and inlet tubes (12, 18).



**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

**INSTALLATION (Continued)**

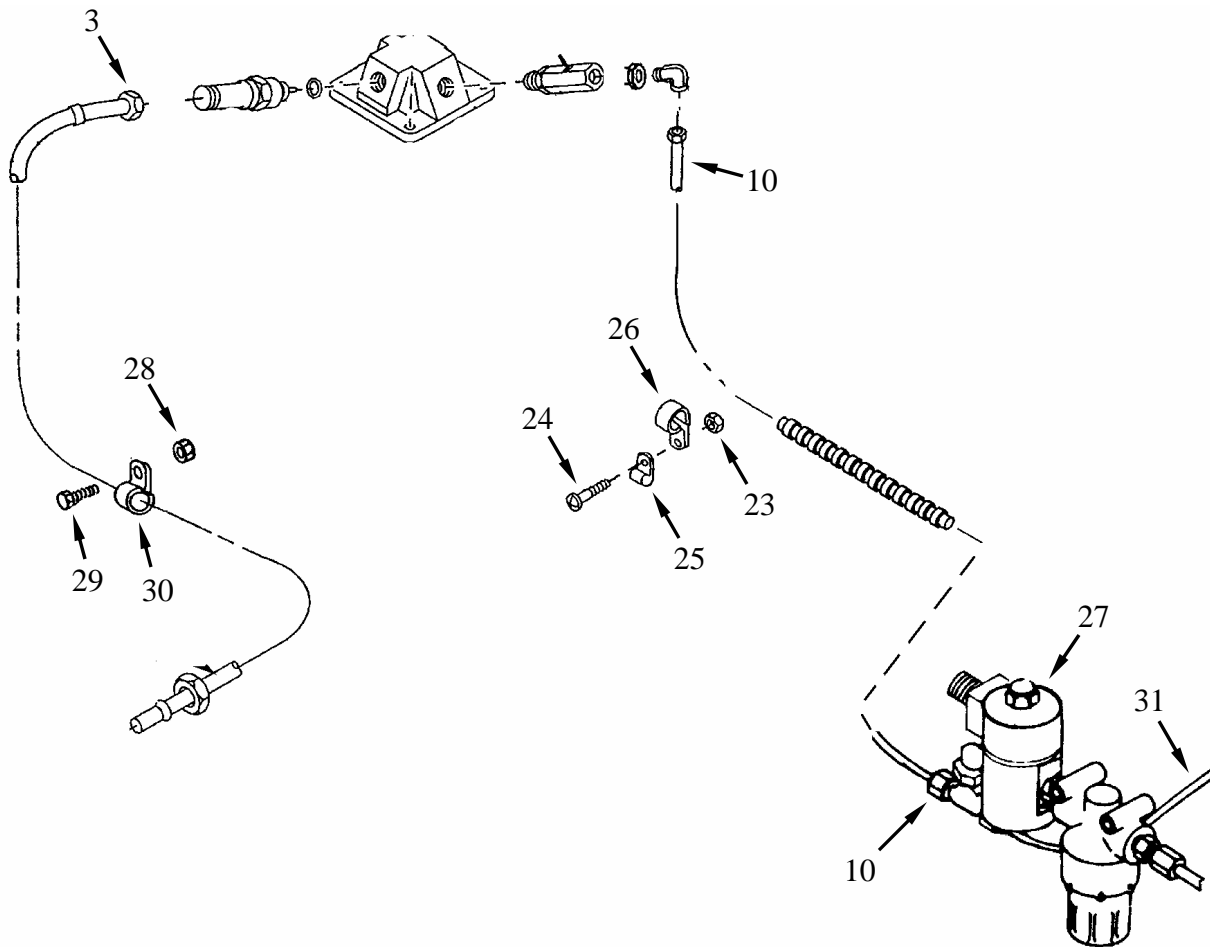
3. Install ignition coil (1).
  - a. Install two clamps (8) onto coil (1).
  - b. Install ignition coil (1) with clamps (8) as an assembly and secure using two screws (5), flat washers (6) and new self-locking nuts (7) (item 113, WP 0175).
  - c. Connect manifold heater spark plug electrical lead (3) and wiring harness electrical lead (4) to ignition coil (1).



MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00

INSTALLATION (Continued)

4. Connect left bank, fuel-into-nozzle hose (10).
  - a. Connect hose (10) to fuel inlet solenoid (27) at damper end of engine.
  - b. Secure hose using five clamps (25) attached to clamps (26) with screws (24) and self-locking nuts (23) (item 32, WP 0175).
5. Secure spark plug electrical lead (3) using clamp (30) fastened with screw (29) and self-locking nut (28) (item 37, WP 0175).
6. Install right bank, fuel-into-nozzle hose (31) and spark plug lead in a similar manner.

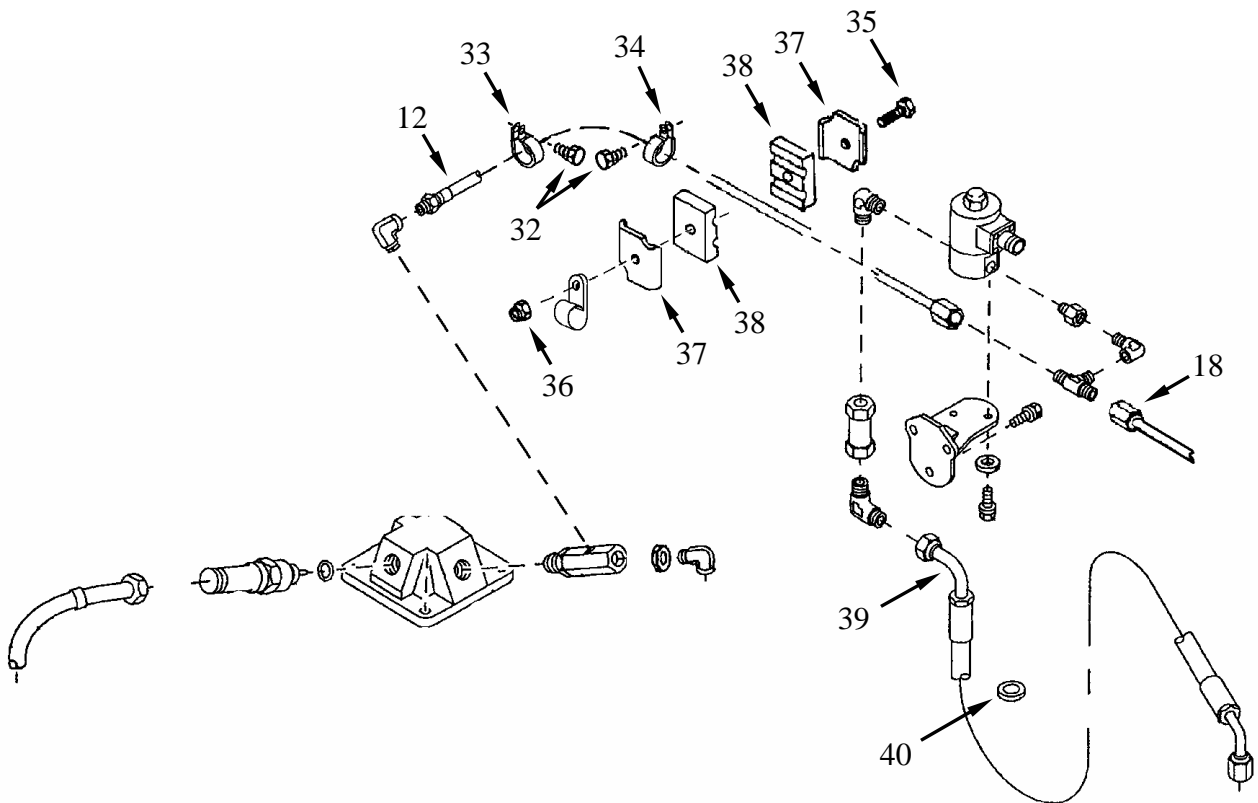




**MANIFOLD HEATER ASSEMBLY AND RELATED PARTS REPLACEMENT 0088 00**

**INSTALLATION (Continued)**

7. Secure left bank fuel return tube (12).
  - a. Install two clamps (33, 34) and secure using screws (32).
  - b. Install two straps (37) and two fairlead halves (38), secure using screw (35) and self-locking nut (36) (item 38, WP 0175).
8. Secure right bank fuel return tube (18) in a similar manner.
9. Install grommet (40).
10. Install fuel return hose (39).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit, (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Lock washer (4) (item 92, WP 0175)

**Equipment Conditions:**

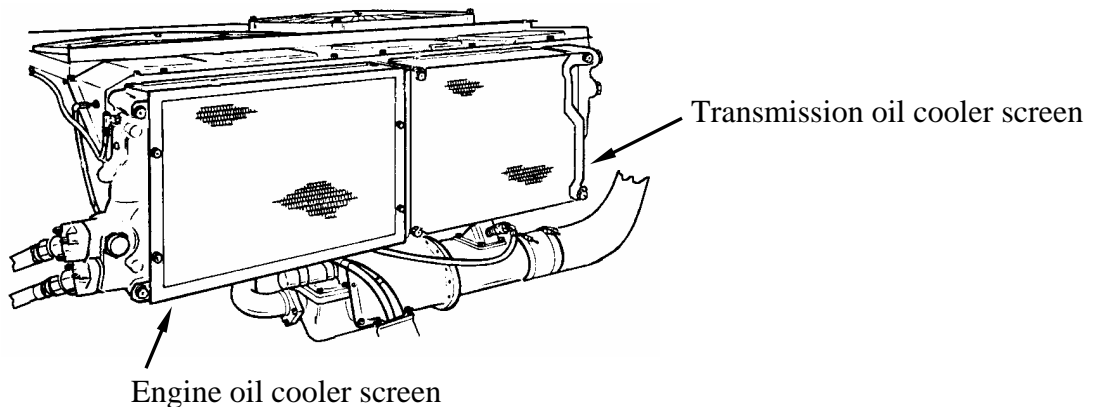
Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

**NOTE**

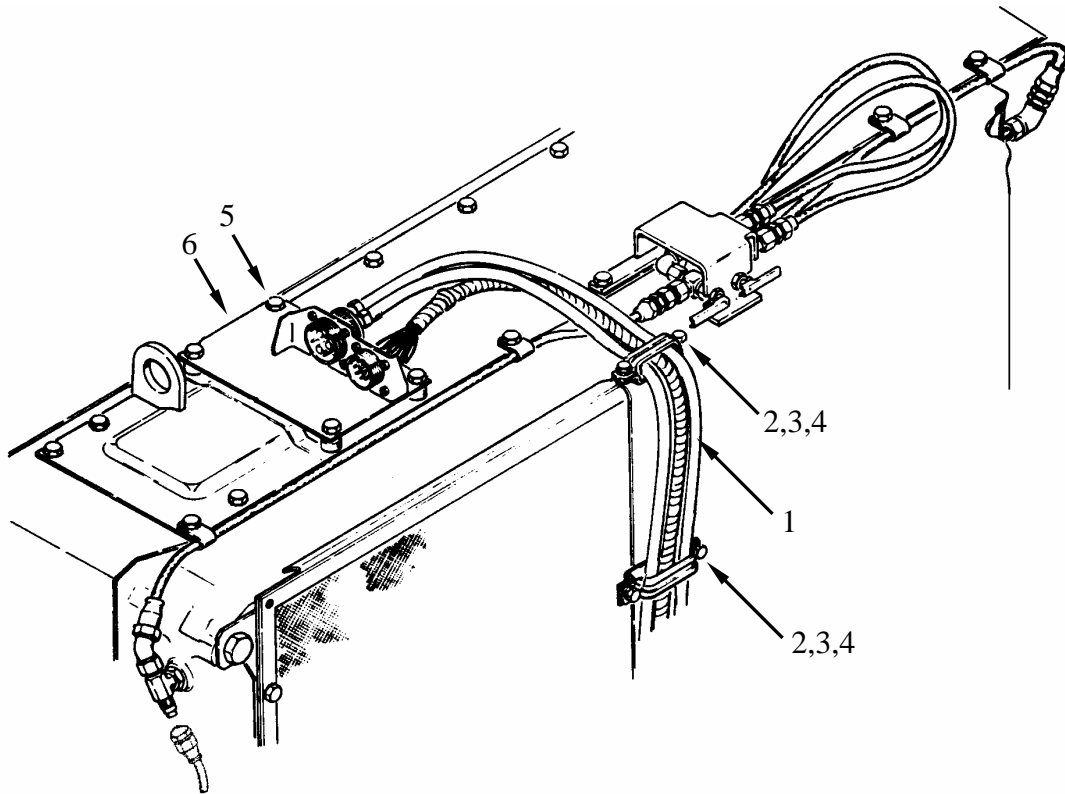
The oil cooler screens on each side of the engine are removed in the same manner. Removal of right oil cooler screens is described in the following instructions. Your particular engine may have slightly different harness brackets from those illustrated; however, they are mounted in a similar fashion and are removed similarly.

Model AVDS-1790-2DR oil cooler screen removal and installation instructions are similar to those described in this work package except that this engine is not equipped with a top-mounted engine wiring harness, nor is the oil sampling system on the coolers; instead, a valve on the oil filter/damper housing serves this purpose.



**REMOVAL**

1. Move wiring harness (1) aside enough to access oil cooler screens.
  - a. Remove four cap screws (2) with lock washers (3) to remove two retaining straps (4). Discard lock washers.
  - b. Remove four assembled washer screws (5) securing wiring harness bracket (6). Move harness (1) and bracket (6) aside as an assembly.

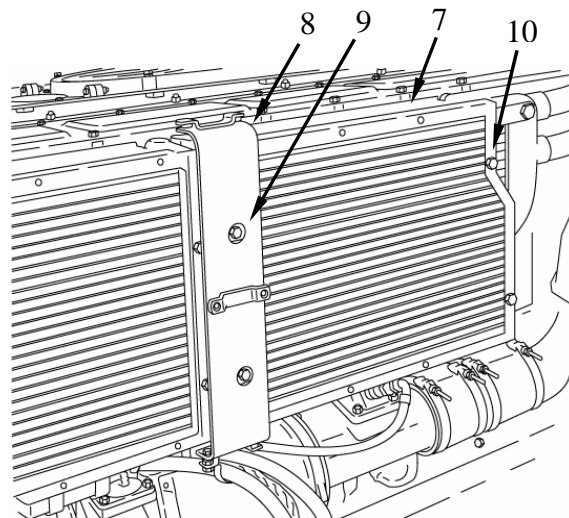


2. Remove transmission oil cooler screen (7).

**NOTE**

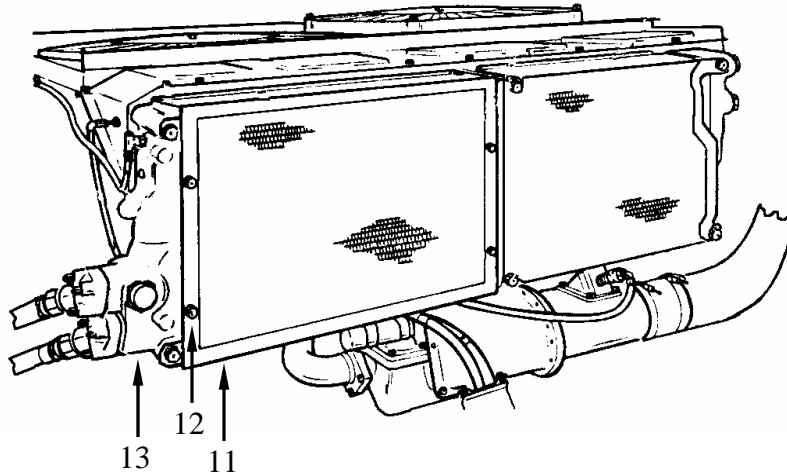
**Bracket (8) screws (9) also hold one end of transmission oil cooler screen (7).**

- a. Remove harness bracket (8).
  - (1) Remove two assembled washer screws (9).
  - (2) Remove bracket (8).
- b. Remove two assembled washer screws (10).
- c. Remove transmission oil cooler screen (7).



**REMOVAL (Continued)**

3. Remove engine oil cooler screen (11).
  - a. Remove four screws (12) to remove engine oil cooler (13) screen (11).

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

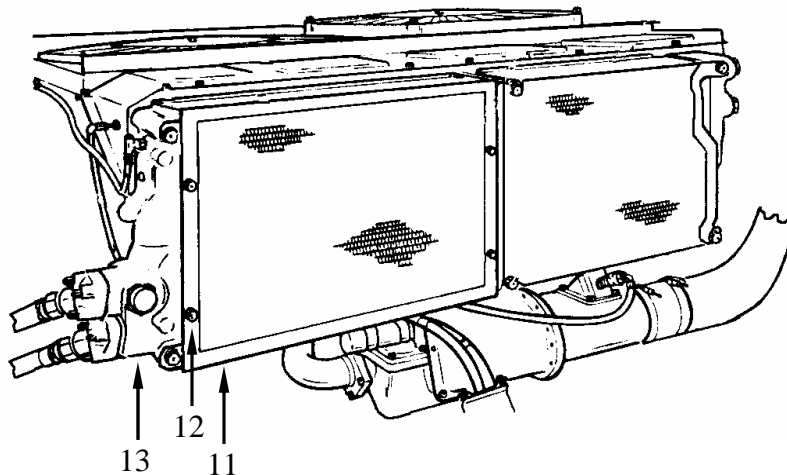
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

1. Install engine oil cooler screen (11).
  - a. Use four screws (12) to fasten engine oil cooler (13) screen (11).



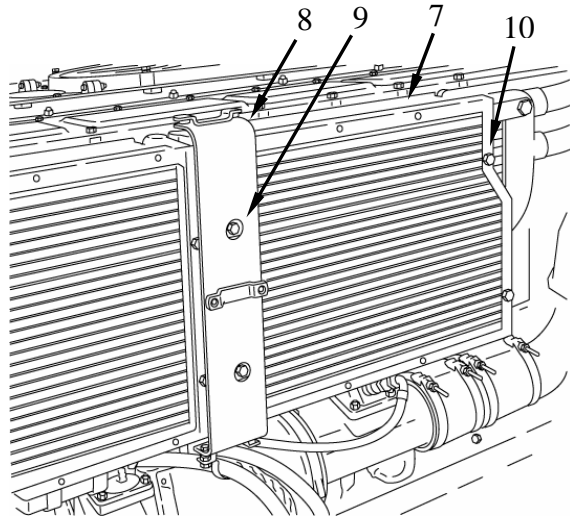
**INSTALLATION (Continued)**

2. Install transmission oil cooler screen (7).

**NOTE**

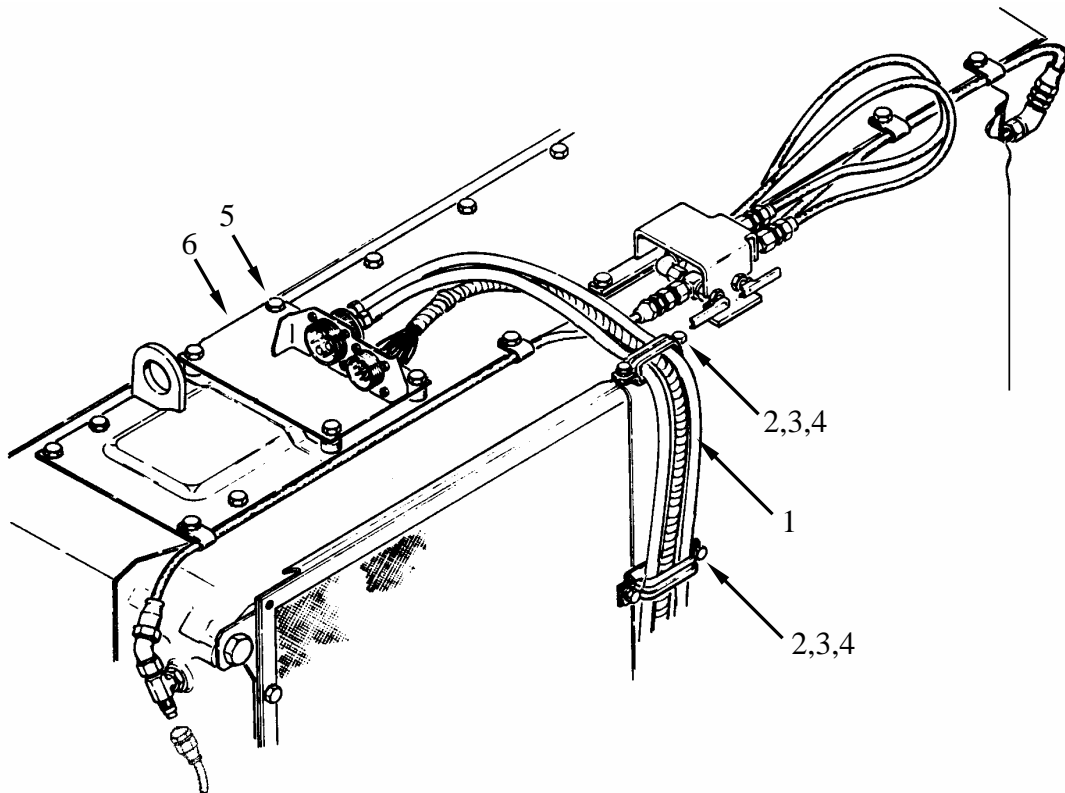
**Bracket (8) screws (9) also hold one end of transmission cooler screen (7).**

- a. Position transmission oil cooler screen (7) in place.
- b. Secure using two assembled washer screws (10).
- c. Install harness bracket (8) and secure using two assembled washer screws (9).



3. Secure wiring harness (1).

- a. Move harness (1) and bracket (6) into position as an assembly, secure bracket (6) using four assembled washer screws (5).
- b. Secure harness (1) with two retaining straps (4). Fasten straps using four cap screws (2) with new lock washers (3) (item 92, WP 0175).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal/Installation, Cleaning, Inspection, and Repair

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Welding shop trailer mounted (item 104,  
WP 0176)

**Expendable and Durable Items:**

Safety goggles (item 17, WP 0173)

**Mandatory Replacement Parts:**

Grommet (12) (item 100, WP 0175)  
Self-locking nut (24) (item 33, WP 0175)  
Self-locking nut (12) (item 40, WP 0175)  
Self-locking nut (12) (item 113, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a  
flat stationary surface  
Engine and transmission oil coolers removed  
(WP 0072)  
Oil fill tube removed (WP 0075)  
Oil level gauge rod removed (WP 0076)  
Oil sampling system removed (Engines 2CA  
and 2DA only) (WP 0070)

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**REMOVAL/INSTALLATION**

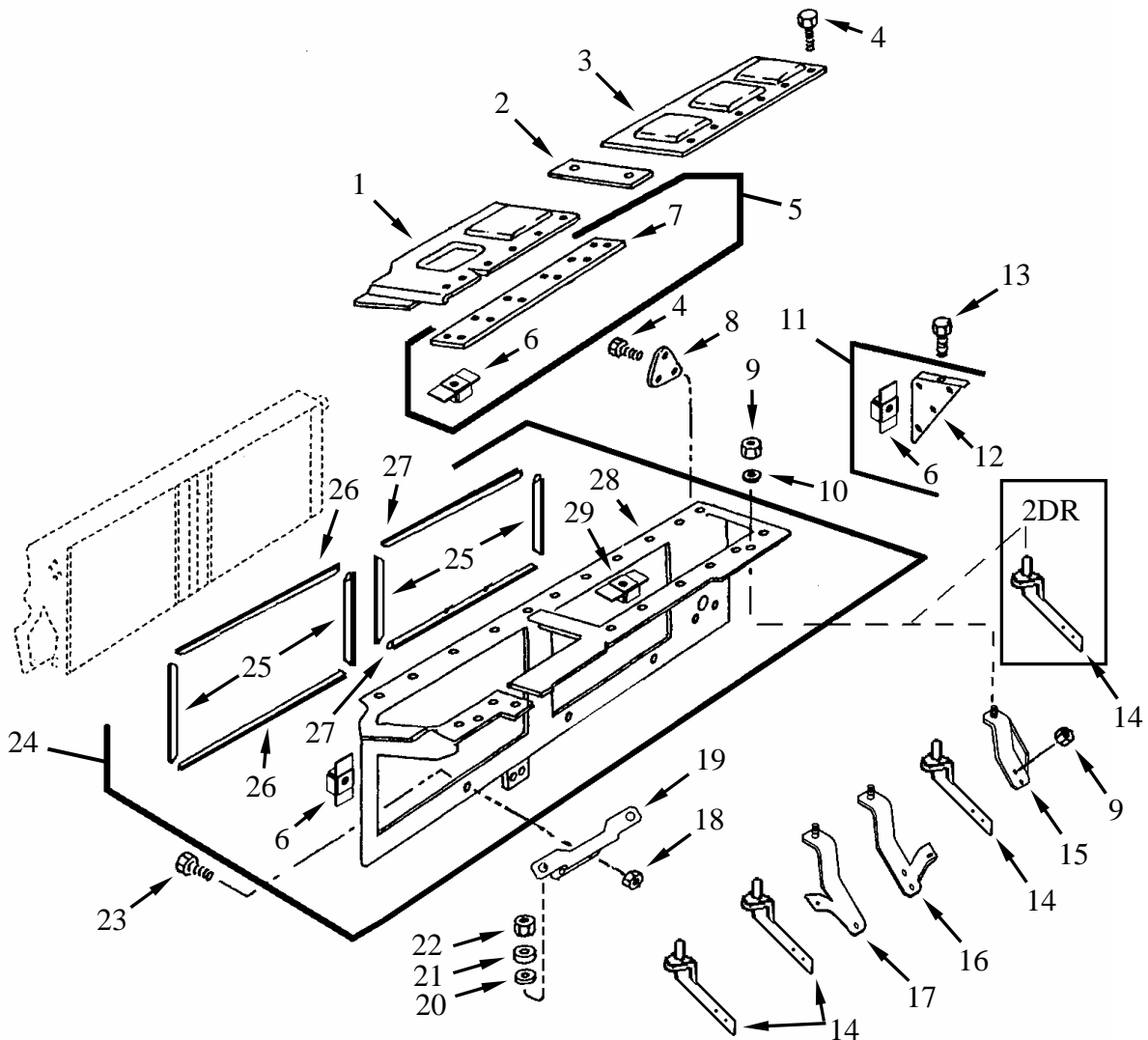
**NOTE**

**Perform only those steps necessary to replace defective parts. Use  
legend reference and illustration as a guide.**

**REMOVAL/INSTALLATION (Continued)**

1. Remove/install left bank components per the following legend and illustration. Discard all self-locking nuts and grommets and replace with new on installation.

1	Access cover (1)	11	Cover assembly (1)	20	Grommet (6)
2	Retaining strap (1)	12	Cover (1)		(item 100, WP 0175)
3	Access cover (1)	13	Washer screw (2)	21	Spacer sleeve (6)
4	Washer screw (17)	14	Bracket (3) (1,2,5L cylinders)	22	Self-locking nut (6)
5	Plate assembly (1)	14	Bracket (1) (6L cylinder) 2DR		(item 40, WP 0175)
6	Caged nut (40)	15	Bracket (1) (6L cylinder) 2DA, 2CA	23	Screw (6)
7	Plate (1)	16	Bracket (1) (4L cylinder)	24	Bracket assembly (1)
8	Access cover (1)	17	Bracket (1) (3L cylinder)	25	Rubber strip (4)
9	Self-locking nut (18)	18	Self-locking nut (6)	26	Rubber strip (2)
	(item 33, WP 0175)	19	Support (3)	27	Rubber strip (2)
10	Flat washer (6)			28	Frame (1)
				29	Caged nut (2)

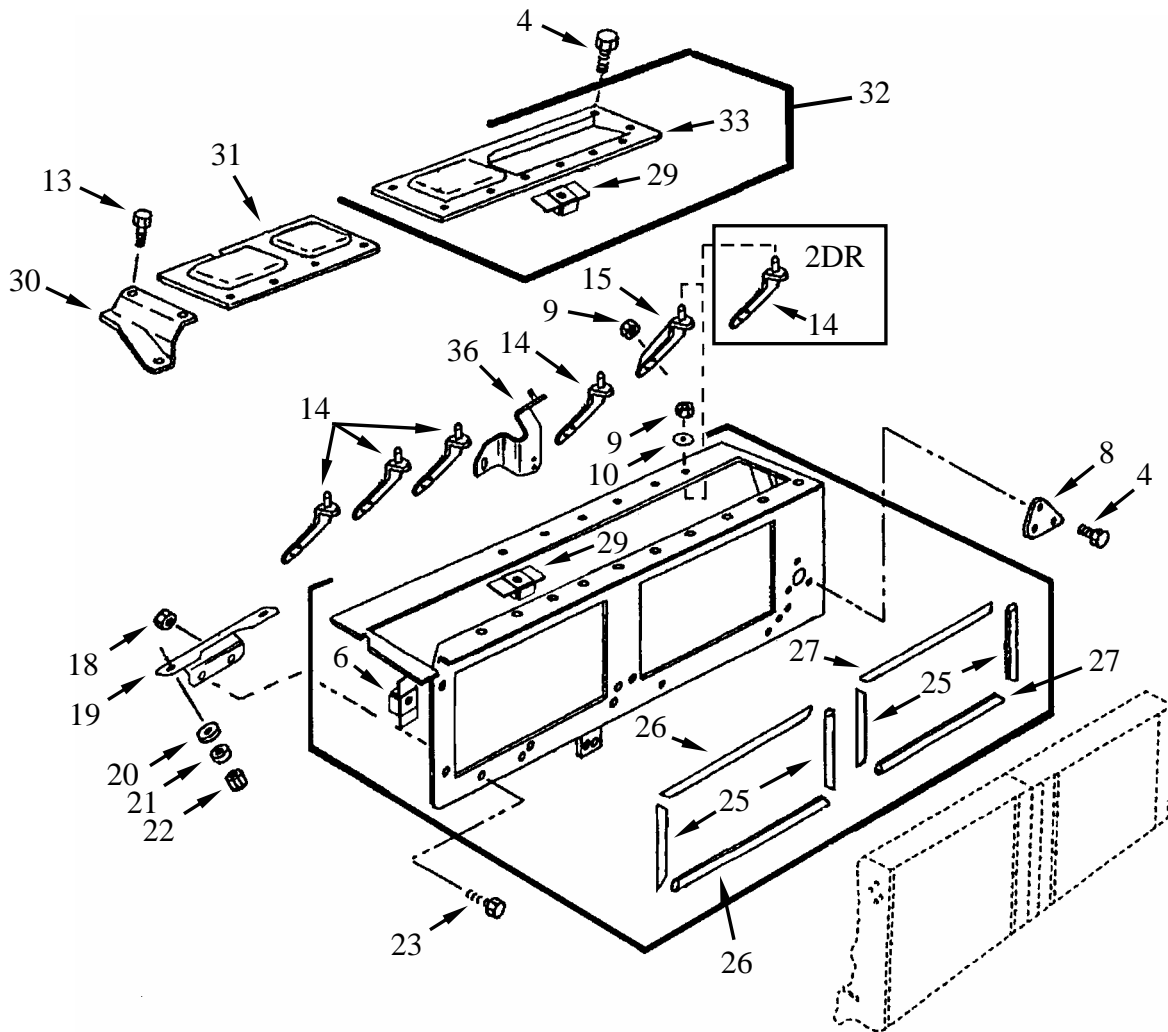




**REMOVAL/INSTALLATION (Continued)**

2. Remove/install right bank components per the following legend and illustration. Discard all self-locking nuts and grommets and replace with new on installation.

4	Washer screw (17)	18	Self-locking nut (6)	26	Rubber strip (2)
6	Caged nut (40)		(item 113, WP 0175)	27	Rubber strip (2)
8	Access cover (1)	19	Support (3)	29	Caged nut (4)
9	Self-locking nut (18)	20	Grommet (6)	30	Cover (1)
	(item 33, WP 0175)		(item 100, WP 0175)	31	Access cover (1)
10	Flat washer (6)	21	Spacer sleeve (6)	32	Cover assembly (1)
13	Washer screw (3)	22	Self-locking nut (6)	33	Access cover (1)
14	Bracket (4) (1,2,3,5R cylinders)		(item 42, WP 0175)	34	Frame assembly (1)
14	Bracket (1) (6R cylinder) 2DR	23	Screw (6)	35	Frame (1)
15	Bracket (1) (6R cylinder) 2DA, 2CA	25	Rubber strip (4)		



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

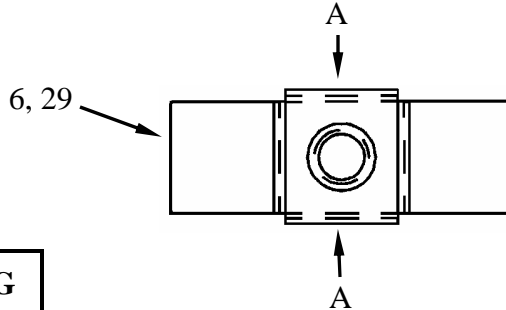
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**REPAIR**

1. Replace plate (6 or 29) nuts.
  - a. Caged nuts (6 or 29) may be replaced by bending tabs (A), on either side, open and replacing caged nuts.



**Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals. Follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment used, a suitable fire extinguisher kept nearby, and requirements of TC 9-237 strictly followed.**

- b. If caged nut (6 or 29) tabs (A) are damaged, caged nuts may be chiseled loose and a new caged nut spot welded in place.

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Suitable oil drain container

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)  
 Marker tags (item 39, WP 0173)

**Mandatory Replacement Parts:**

O-ring (item 73, WP 0175)  
 O-ring (item 143, WP 0175)  
 Tie-wraps (v) (item 81, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

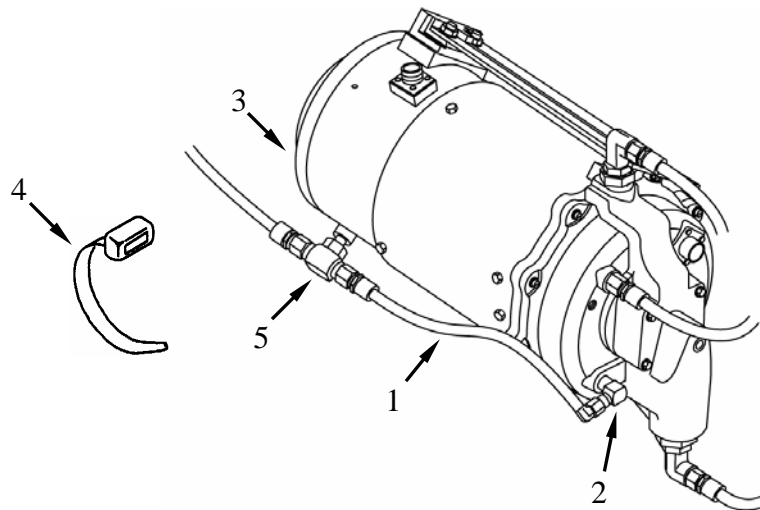
**REMOVAL**

**NOTE**

**Tag all lines and fittings prior to removal to aid in installation.**

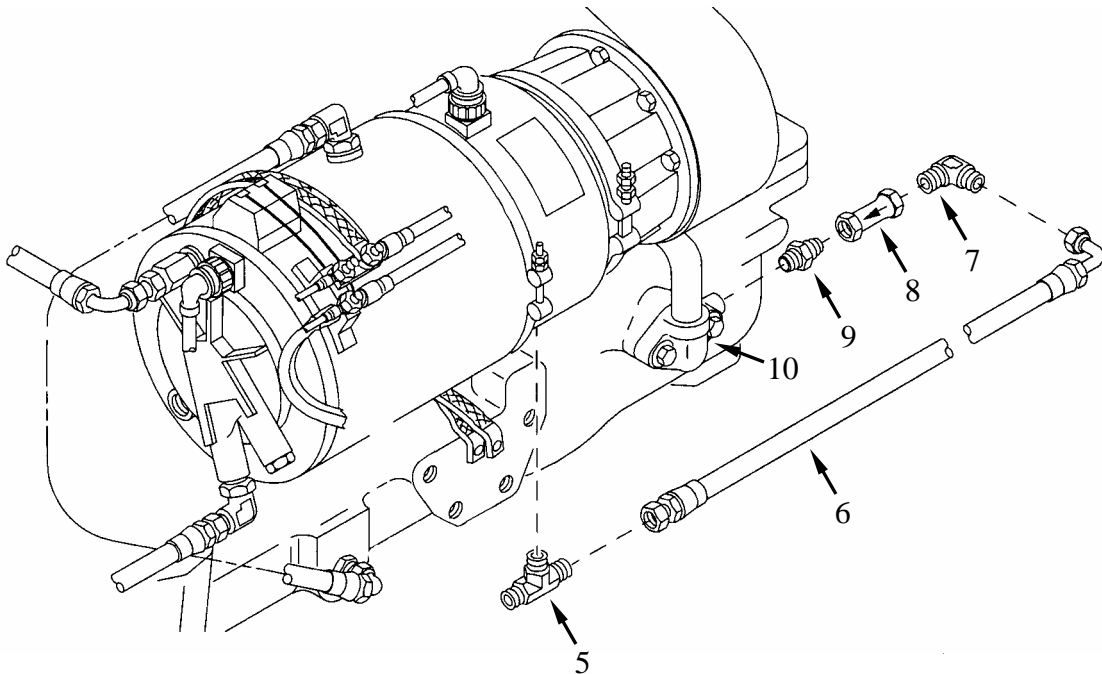
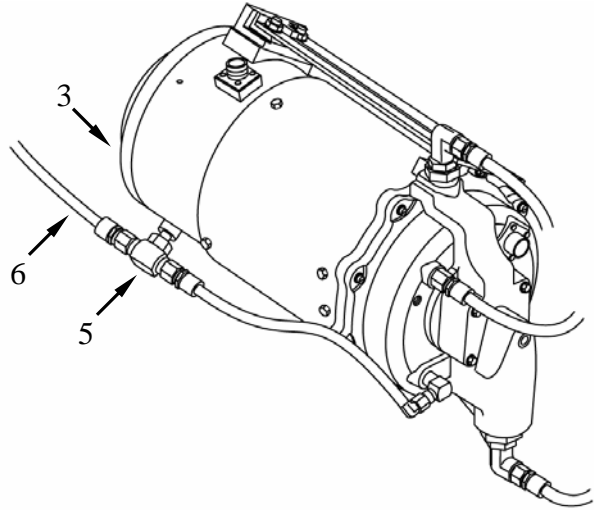
**The 650 ampere generators are available from two different sources; Honeywell and Ormat. Both generators carry the same NSN but have different part numbers. Check your RPSTL. Both applications are illustrated when there are noticeable differences.**

1. Remove hose (1) from elbow (2). Allow hose to drain into suitable container.
2. Remove elbow (2) from generator (3).
3. Remove and discard tie-wraps (4) securing hose (1) if they have been used.
4. Remove hose (1) from tee connector (5).



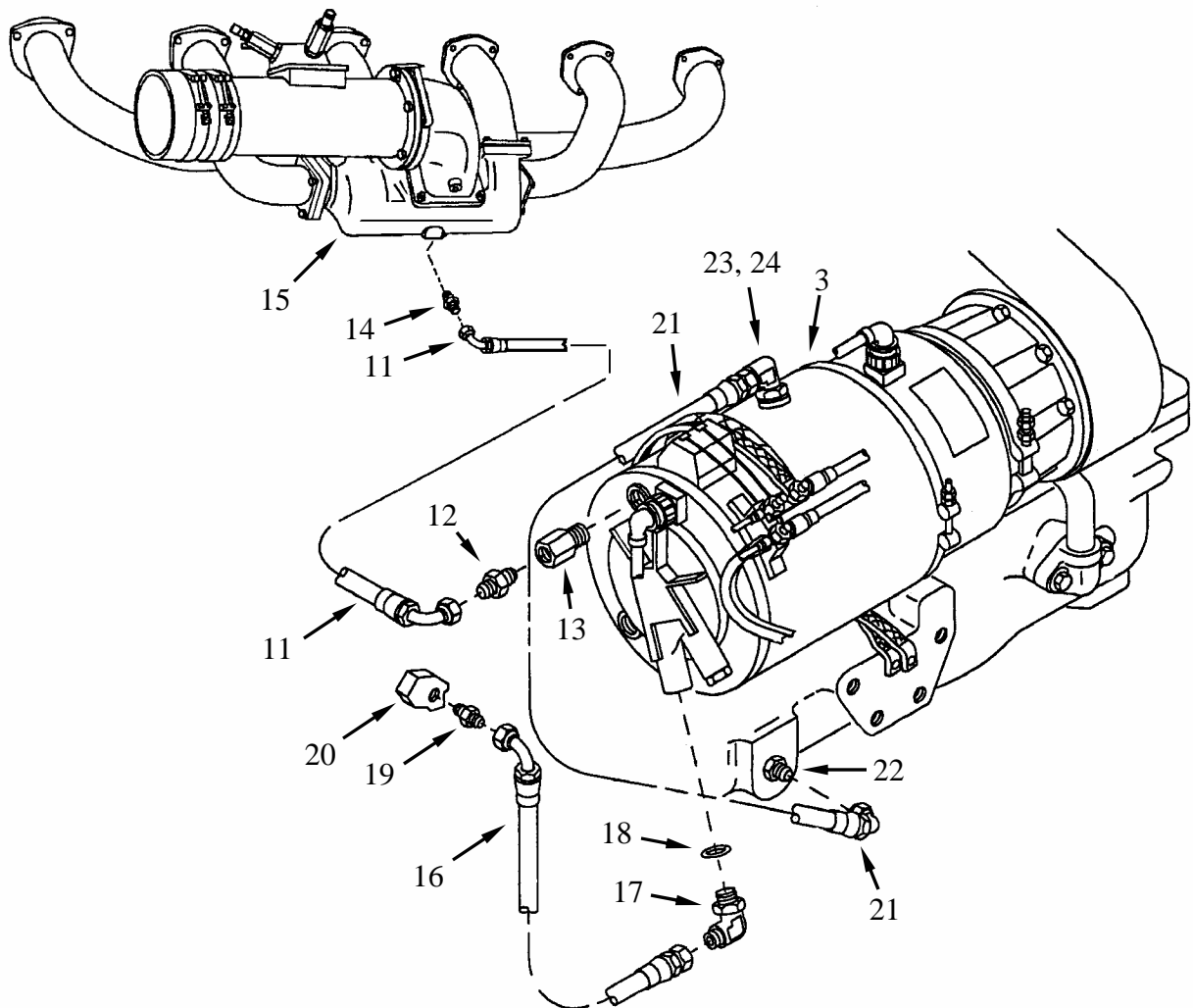
**REMOVAL (Continued)**

5. Remove hose (6) from tee connector (5).  
Allow hose to drain into suitable container.
6. Remove tee connector (5) from generator (3).
7. Remove hose (6) from elbow (7).
8. Remove elbow (7) from check valve (8).
9. Remove check valve (8) from adapter (9).
10. Remove adapter (9) from drain back tube (10).



**REMOVAL (Continued)**

11. Remove vent hose (11) from adapter fitting (12).
12. Remove adapter fitting (12) from orifice fitting (13).
13. Remove orifice fitting (13) from generator (3).
14. Remove vent hose (11) from fitting (14) in air intake manifold (15).
15. Remove fitting (14) from air intake manifold (15).
16. Remove oil pressure hose (16) from elbow (17). Allow hose to drain into suitable container.
17. Remove elbow (17) and O-ring (18) from generator (3). Discard O-ring.
18. Remove hose (16) from fitting (19).
19. Remove fitting (19) from crankcase (20).
20. Remove oil return hose (21) from fitting (22). Allow hose to drain into suitable container.
21. Remove oil return hose (21) from fitting (23).
22. Remove fitting (22) and fitting (23) with O-ring (24). Discard O-ring (24).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

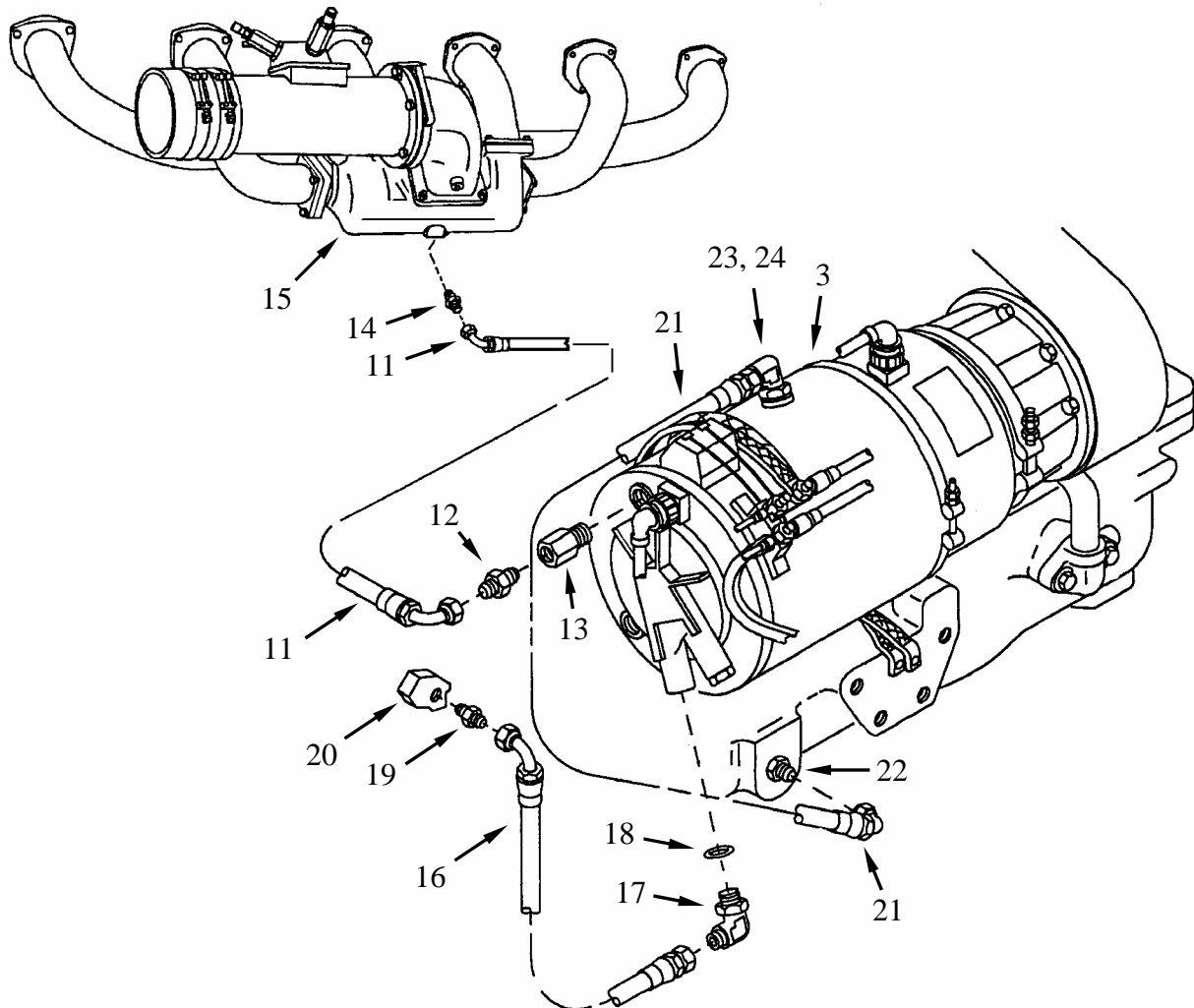
**INSPECTION**

All parts must be inspected with care. Replace parts if damaged.

1. See Work Package 0028 for General Inspection Procedures.

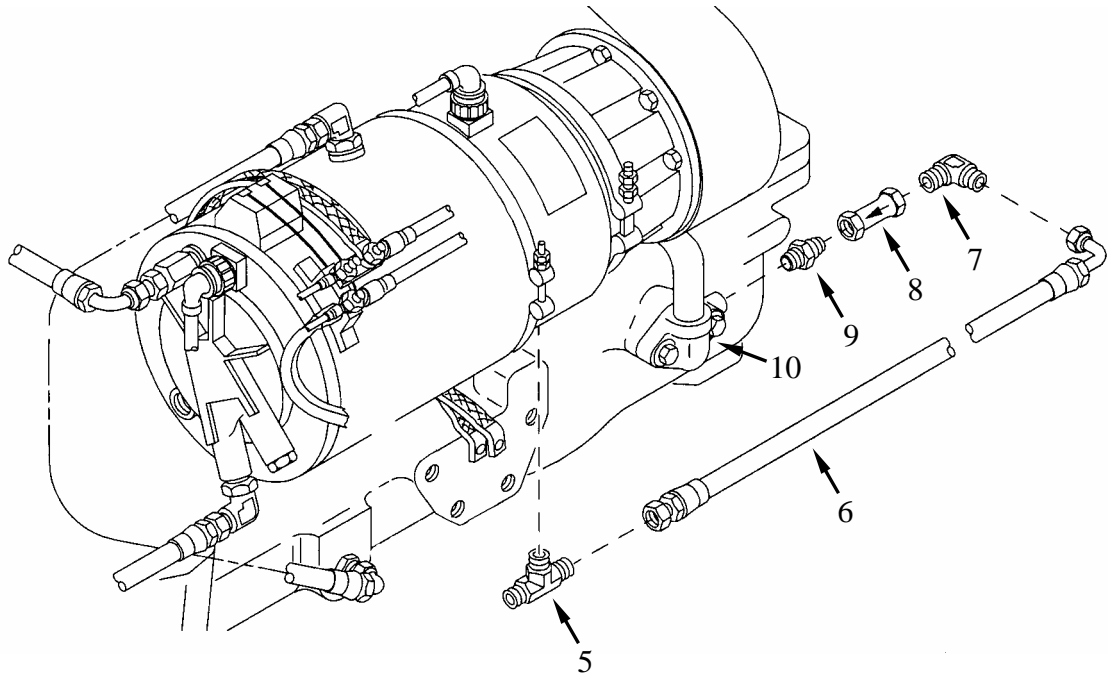
**INSTALLATION**

1. Install fitting (22) and fitting (23) with new O-ring (24) (item 143, WP 0175).
2. Install return hose (21) to fittings (22) and (23).
3. Install fitting (19) into crankcase (20).
4. Install elbow (17) with new O-ring (18) (item 73, WP 0175) into generator (3).
5. Install hose (16) to fittings (19) and (17).
6. Install fitting (14) into air intake manifold (15).
7. Install orifice fitting (13) onto generator (3) and adapter fitting (12) into orifice fitting (13).
8. Install vent hose (11) to fittings (14 and 12).

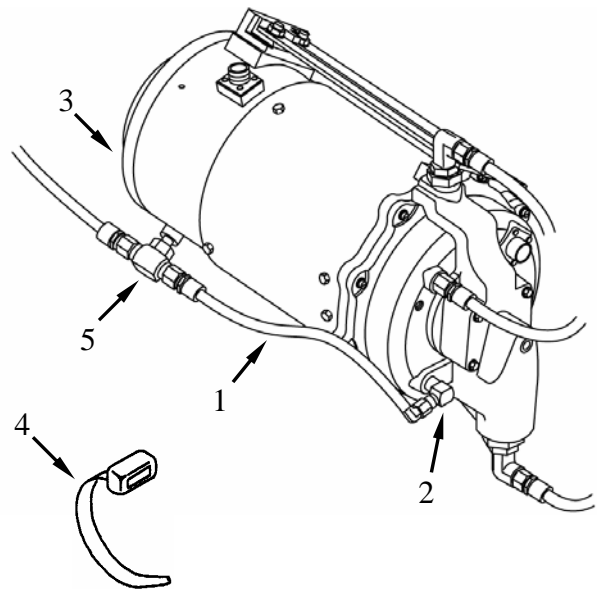


**INSTALLATION (Continued)**

9. Install adapter (9) into drain back tube (10).
10. Install check valve (8) into adapter (9).
11. Install elbow (7) into check valve (8)



12. Install tee connector (5) into generator (3)
13. Install hose (6) to tee connector (5) and to elbow (7).
14. Install elbow (2) onto generator (3).
15. Install hose (1) to elbow (2) and to tee fitting (5).
16. Secure hoses as needed with tie-wraps (4) (item 81, WP 0175).



**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Expendable and Durable Items:**

Marker tag (item 39, WP 0173)

Thread sealing tape (item 29, WP 0173)

**Equipment Conditions:**

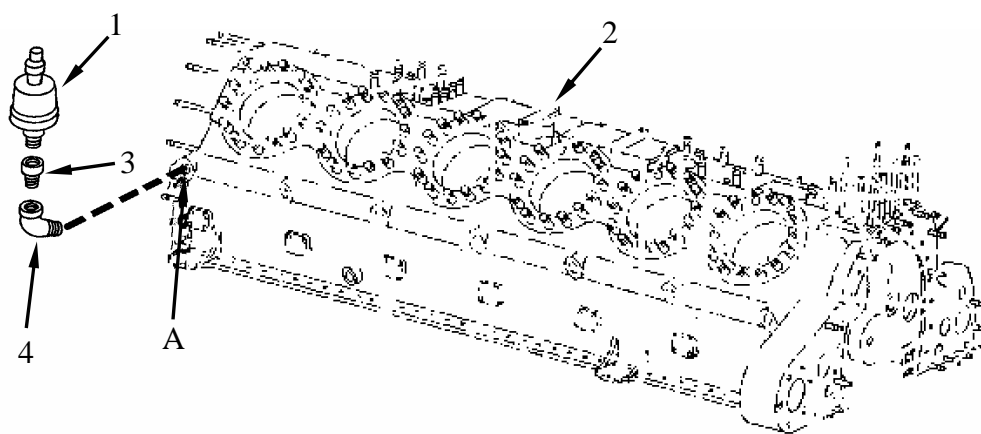
Engine removed from vehicle and placed on a flat stationary surface.

Wiring harness disconnected and marked (WP 0057 for 2CA) (WP 0058 for 2DA).

**REMOVAL****NOTE**

Use marker tags (item 39, WP 0173) on all electrical leads to aid in proper connection at installation. Incorrect connection of wiring harness leads can cause false engine readings.

1. Remove switch (1) at crankcase (2).
  - a. Remove engine oil pressure sending unit (1) from pipe reducer (3).
  - b. Remove pipe reducer (3) from pipe elbow (4).
  - c. Remove pipe elbow (4) from crankcase oil galley port (A).



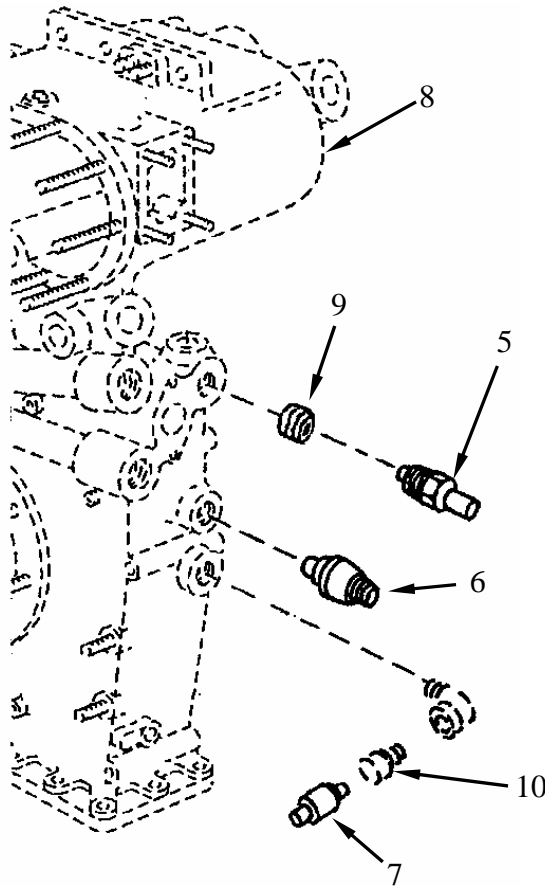
**REMOVAL (Continued)**

- Remove switches (5, 6, 7) at vibration damper housing (8).

**NOTE**

**It is not necessary to remove bushing (9) unless damage or other circumstances necessitate.**

- Remove engine oil temperature sending unit (5) from bushing (9).
- If necessary, remove bushing (9) from damper housing (8).
- Remove engine oil high temperature switch (6) from damper housing (8).
- Remove engine oil low pressure switch (7) from pipe reducer (10).

**CLEANING**

See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

- See Work Package 0028 for Standard Inspection Procedures.

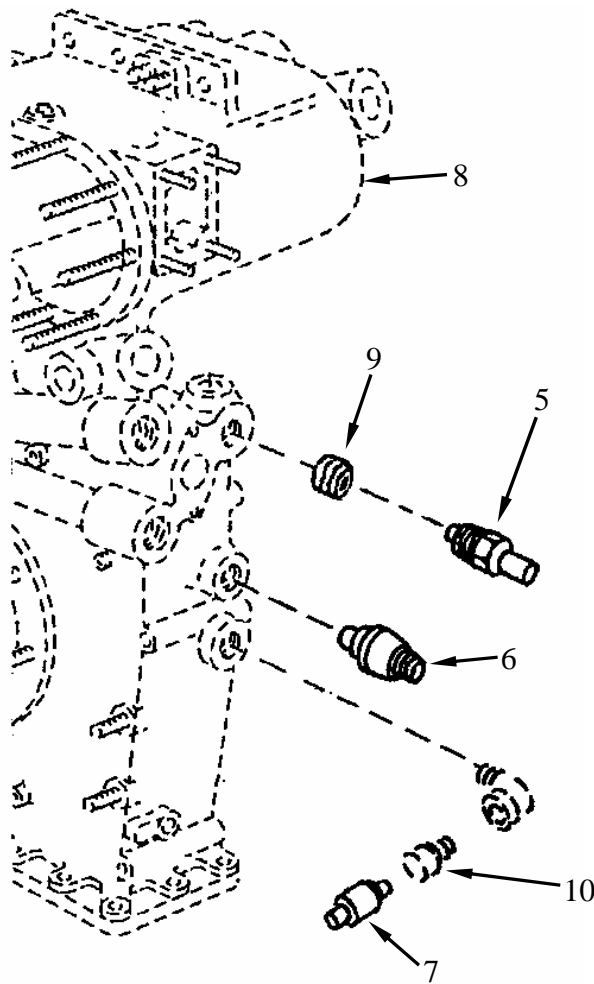
## INSTALLATION

## NOTE

Use thread sealing product (item 29, WP 0173) on all threaded connections.

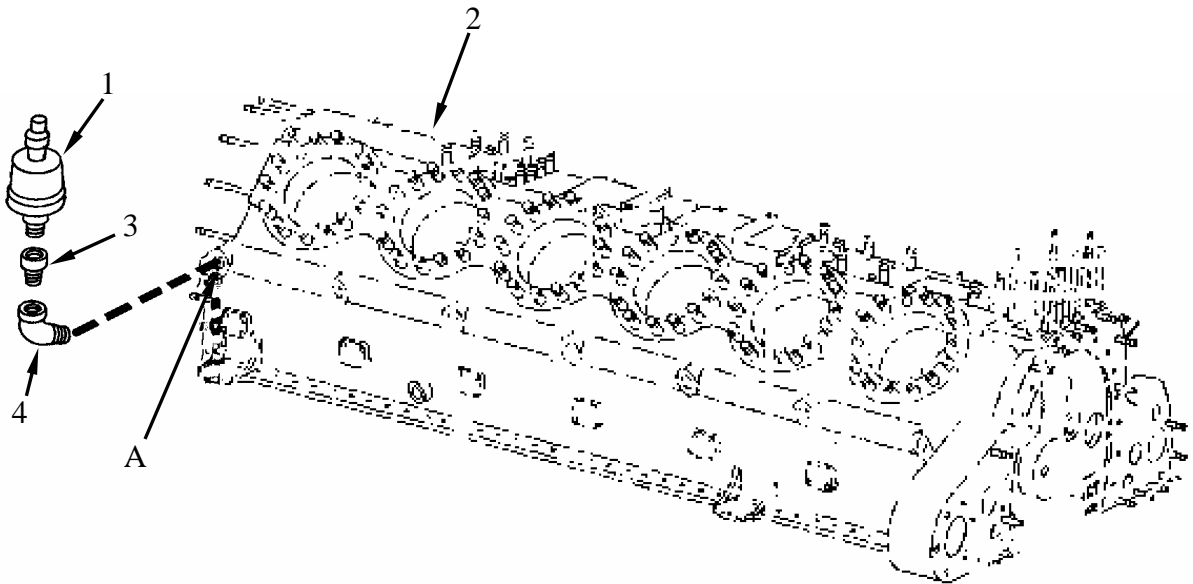
Adjoining threaded connections that might be disturbed during the disassembly process should be removed, cleaned, and resealed during reassembly.

1. Install switches (5, 6, 7) at vibration damper housing (8).
  - a. If removed, install bushing (9) into damper housing (8).
  - b. Install engine oil temperature sending unit (5) into bushing (9).
  - c. Install engine oil high temperature switch (6) into damper housing (8).
  - d. Install engine oil low pressure switch (7) into pipe reducer (10).



**INSTALLATION (Continued)**

2. Install switch (1) at crankcase (2).
  - a. Install pipe elbow (4) into crankcase (2) oil galley port (A).
  - b. Install pipe reducer (3) into pipe elbow (4).
  - c. Install engine oil pressure sending unit (1) into pipe reducer (3).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Expendable and Durable Items:**

Marker tag (item 39, WP 0173)

Thread sealing tape (item 41, WP 0173)

**Equipment Conditions:**

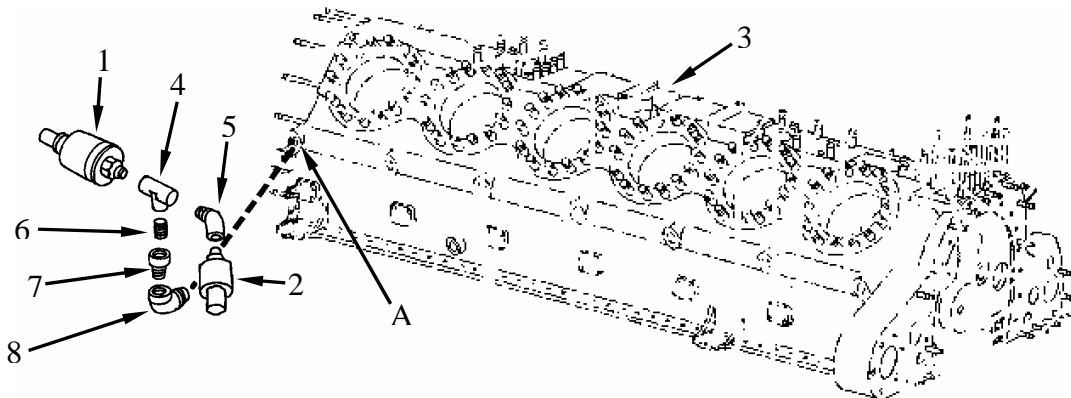
Engine removed from vehicle and placed on a flat stationary surface.

Wiring harness disconnected and marked (WP 0059).

**REMOVAL****NOTE**

**Use marker tags (item 39, WP 0173), on all electrical leads to aid in proper connection at installation. Incorrect connection of wiring harness leads can cause false engine readings.**

1. Remove switches (1, 2) at crankcase (3).
  - a. Remove engine oil pressure sending unit (1) from tee (4).
  - b. Remove auxiliary generator switch (2) from pipe elbow (5).
  - c. Remove pipe elbow (5) from tee (4).
  - d. Remove tee (4) from pipe nipple (6).
  - e. Remove pipe nipple (6) from pipe reducer (7).
  - f. Remove pipe reducer (7) from pipe elbow (8).
  - g. Remove pipe elbow (8) from crankcase oil galley port (A).



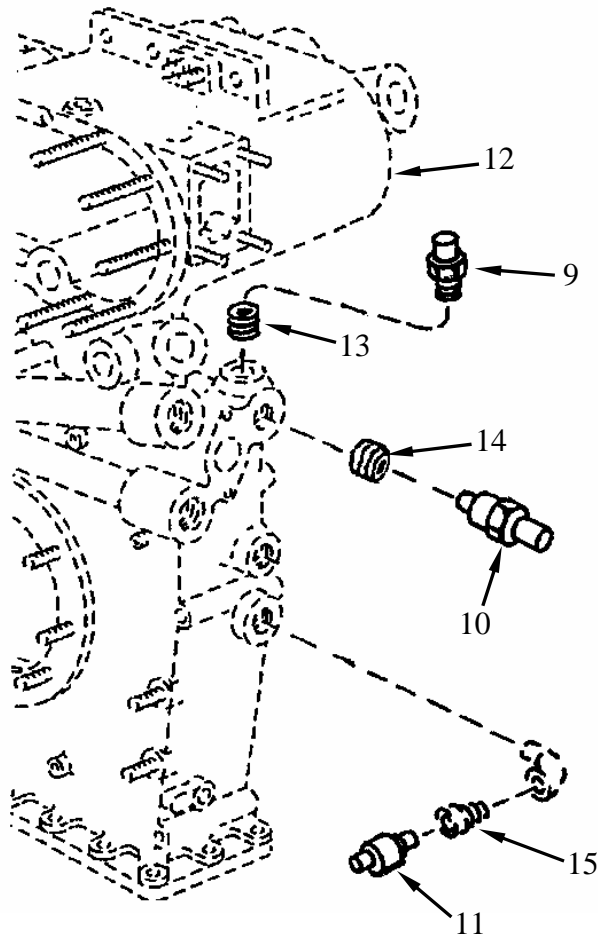
**REMOVAL (Continued)**

2. Remove switches (9, 10, 11) at vibration damper housing (12).

**NOTE**

**It is not necessary to remove bushing (13) or pipe reducer (14) unless damage or other circumstances necessitate.**

- a. Remove engine oil temperature sending unit (9) from bushing (13).
- b. If necessary, remove bushing (13) from damper housing (12).
- c. Remove engine oil high temperature switch (10) from pipe reducer (14).
- d. If necessary, remove pipe reducer (14) from damper housing (12).
- e. Remove engine oil low pressure switch (11) from pipe reducer (15).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

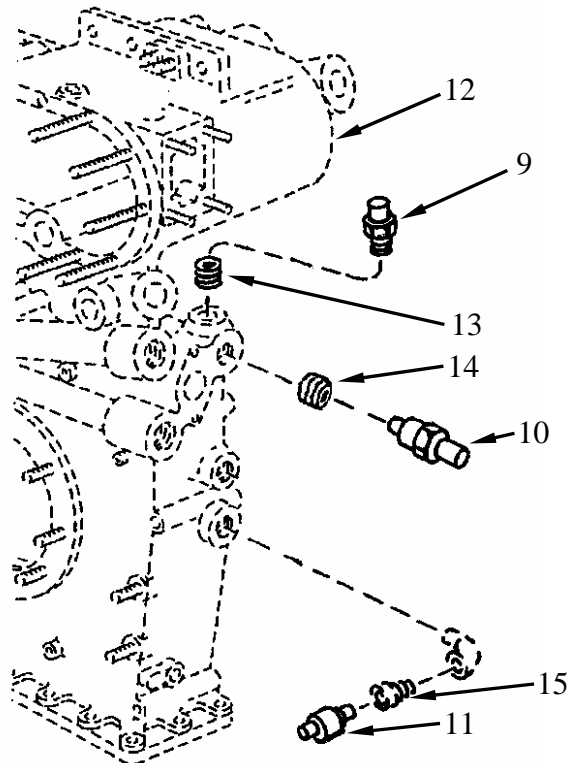
1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION****NOTE**

**Use thread sealing (item 41, WP 0173) product on all threaded connections.**

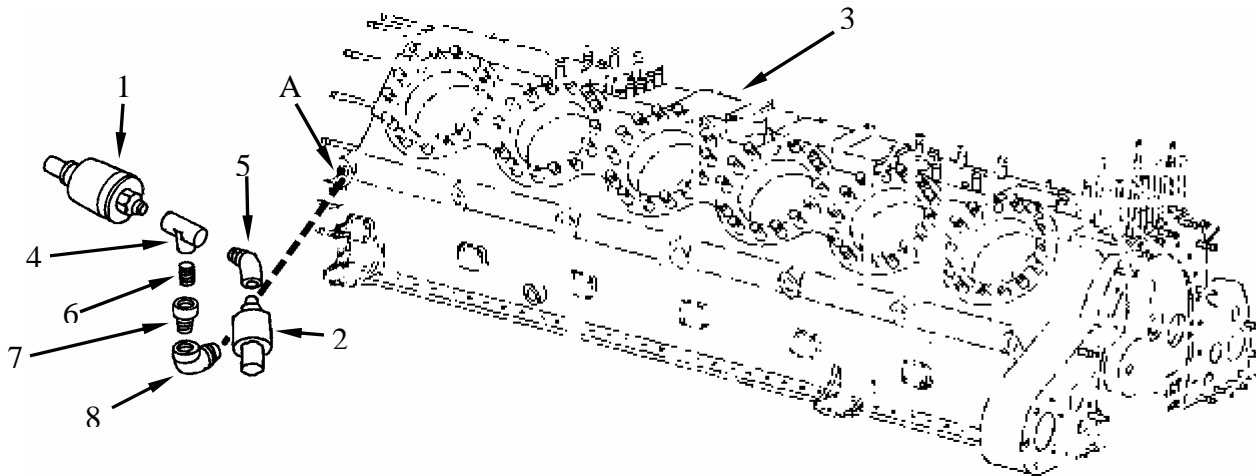
**Adjoining threaded connections that might be disturbed during the disassembly process should be removed, cleaned and resealed during reassembly.**

1. Install switches (9, 10, 11) at vibration damper housing (12).
  - a. If removed, install pipe reducer (13) into damper housing (12).
  - b. Install engine oil temperature sending unit (9) into pipe reducer (13).
  - c. If removed, install pipe reducer (14) into damper housing (12).
  - d. Install engine oil high temperature switch (10) into bushing (14).
  - e. Install engine oil low pressure switch (11) into pipe reducer (15).



**INSTALLATION (Continued)**

2. Install switches (1, 2) at crankcase (3).
  - a. Install pipe elbow (8) into crankcase oil galley port (A).
  - b. Install pipe reducer (7) into pipe elbow (8).
  - c. Install pipe nipple (6) into pipe reducer (7).
  - d. Install tee (4) into pipe nipple (6).
  - e. Install pipe elbow (5) into tee (4).
  - f. Install auxiliary generator switch (2) into pipe elbow (8).
  - g. Install engine oil pressure sending unit (1) into tee (4).

**END OF WORK PACKAGE**



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**SMOKE GENERATION SYSTEM REPLACEMENT**

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0094 00

**THIS WORK PACKAGE COVERS:**Removal, Cleaning, Inspection, and Installation

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (item 87, WP 0175)  
Self-locking nut (2) (item 37, WP 0175)  
Self-locking nut (2) (item 38, WP 0175)

**Expendable and Durable Items:**

Anti-seize compound (item 5, WP 0173)  
Thread sealing tape (item 41, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

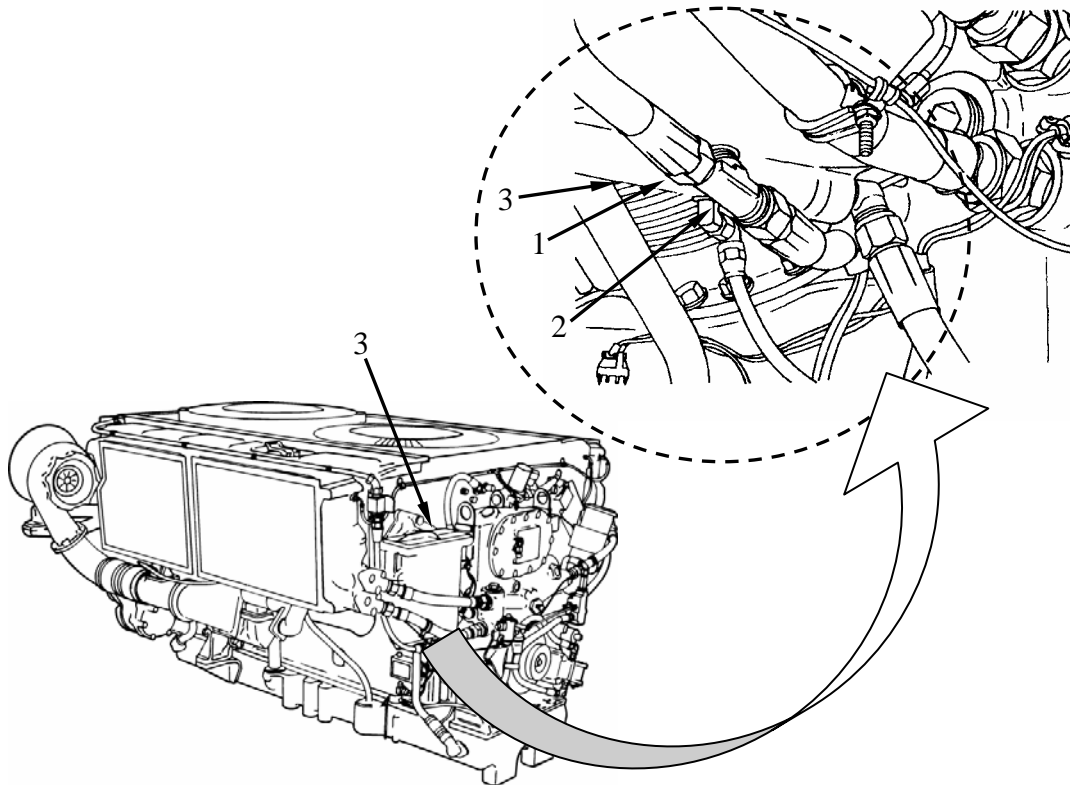
**Equipment Conditions:**

Fuel/water separator filter housing drained (WP0084)

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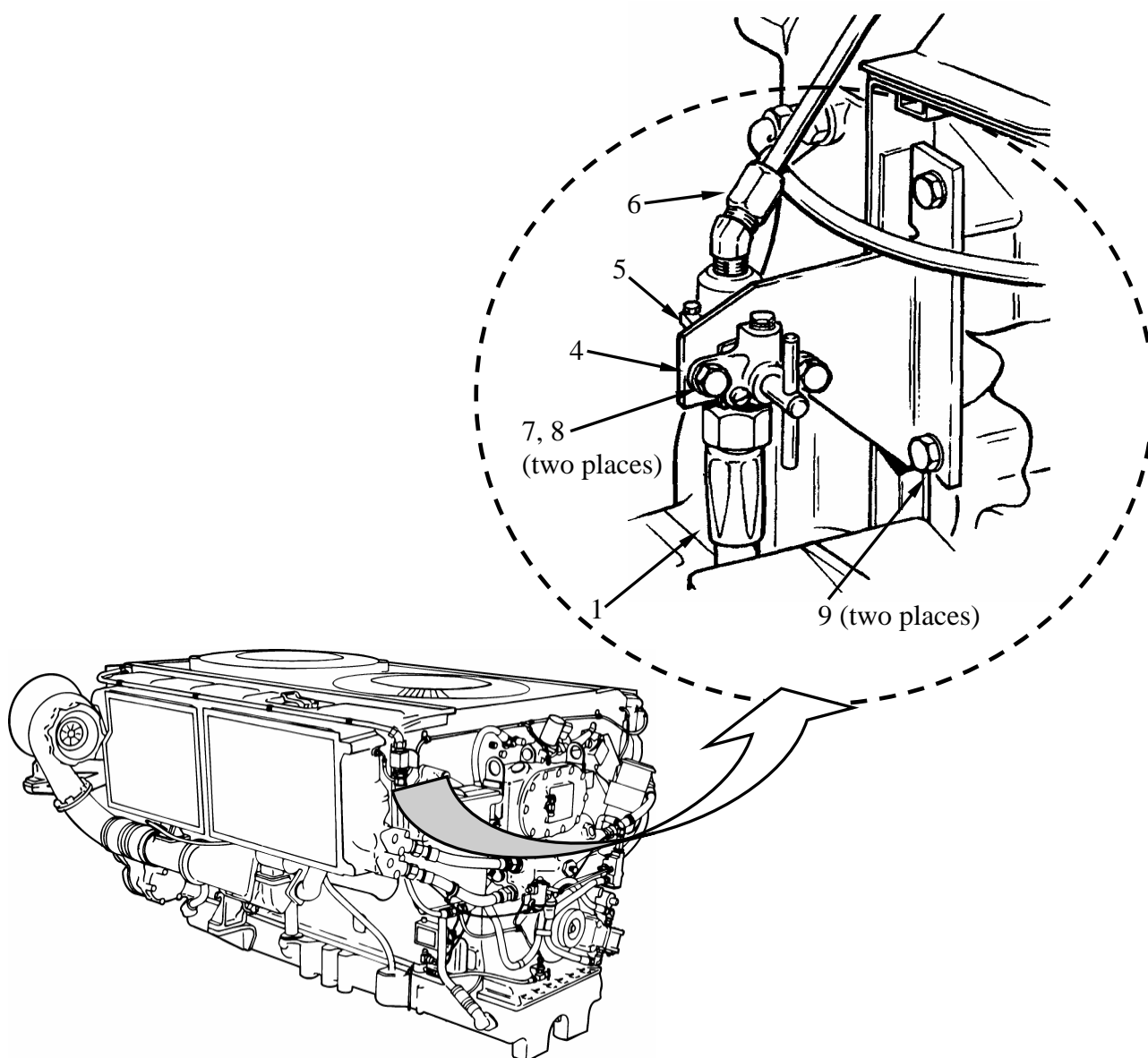
**REMOVAL**

1. Remove smoke generator fuel line (1).
  - a. Remove smoke generator fuel line (1) from tee fitting (2) at bottom of secondary fuel filter housing (3).



**REMOVAL (Continued)**

1. Remove smoke generator fuel line (1) (continued).
  - b. Disconnect fuel line (1) at manual fuel shutoff valve (4) inlet.
2. Remove manual fuel shutoff valve (4) from mounting bracket (5).
  - a. Disconnect fuel line (6) at manual fuel shutoff valve (4) outlet.
  - b. Remove two screws (7) with self-locking nuts (8). Discard self-locking nuts.
3. Remove manual fuel shutoff valve mounting bracket (5).
  - a. Remove two assembled washer screws (9) and remove bracket (5).

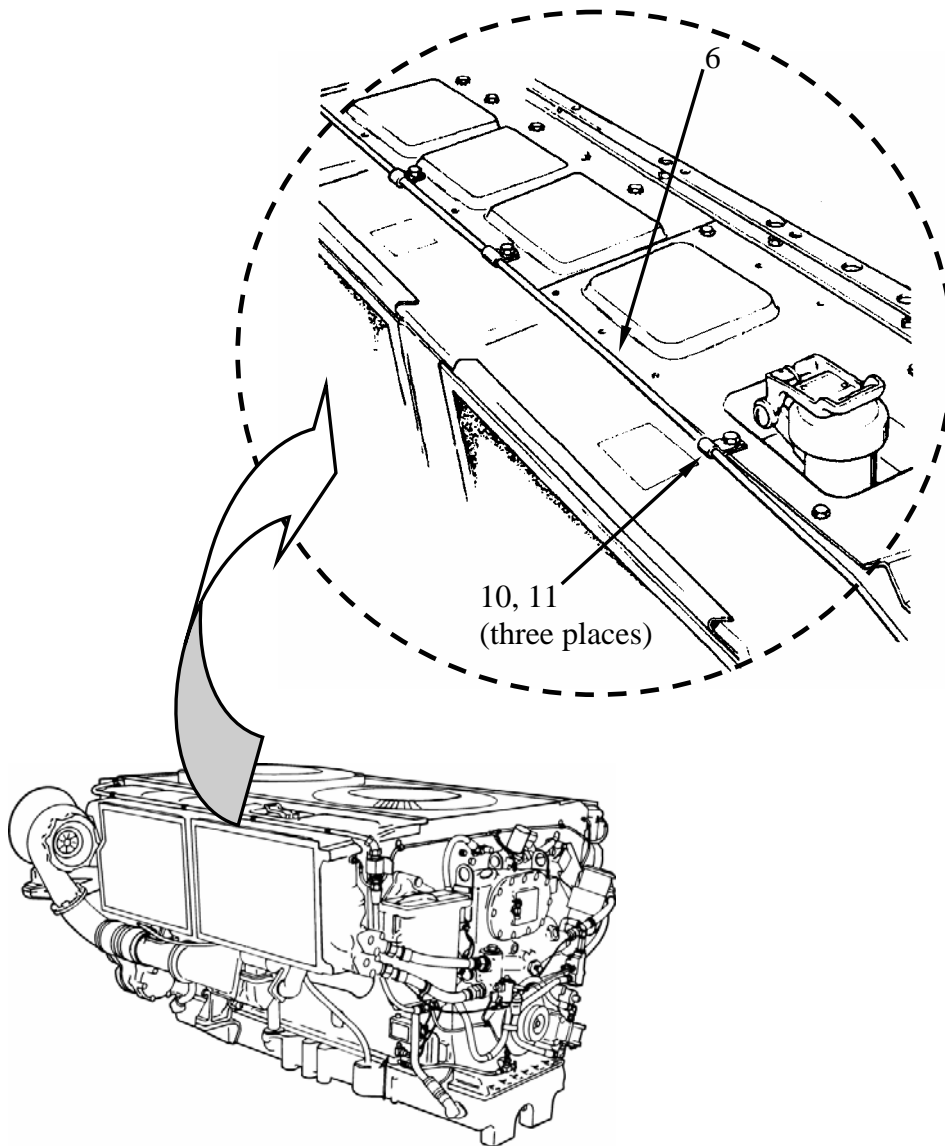


**REMOVAL (Continued)**

4. Remove fuel line (6) at top of engine.
  - a. Remove assembled washer screws (10) with loop clamps (11).

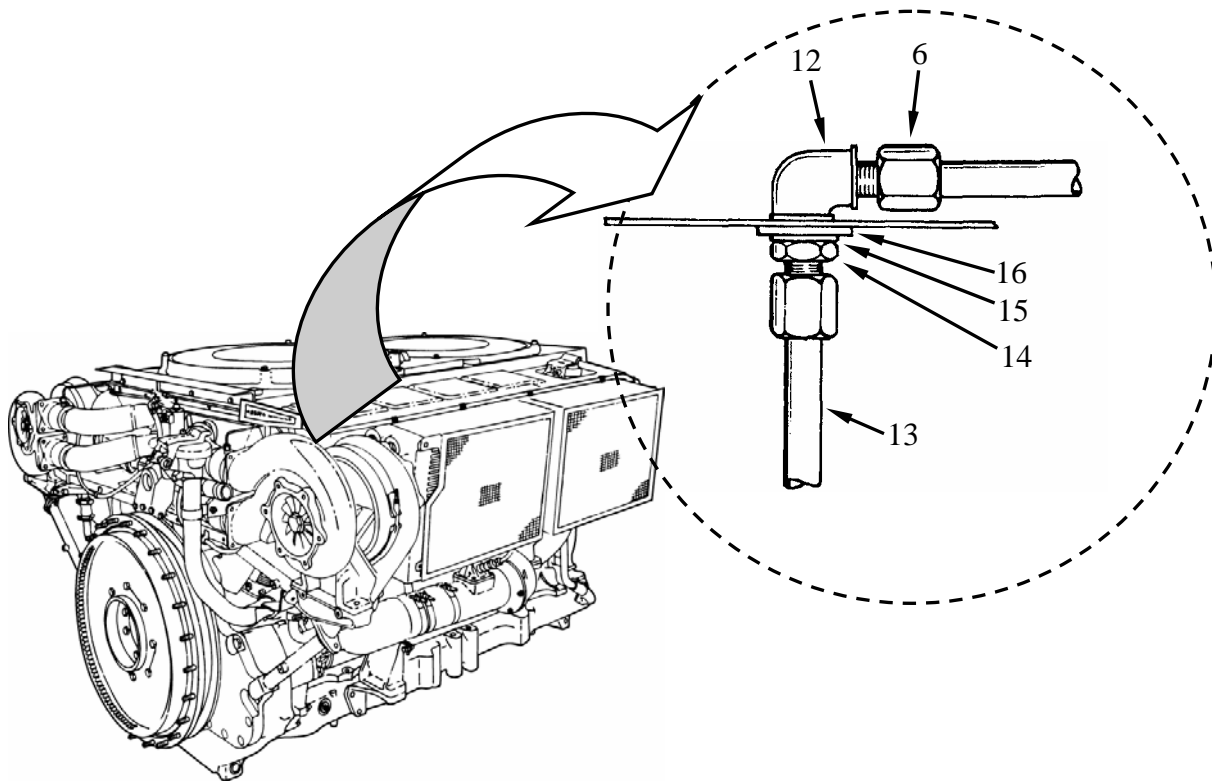
**NOTE**

The 2CA and 2DA engine models use three screws (10) and loop clamps (11), while the 2DR model uses four.



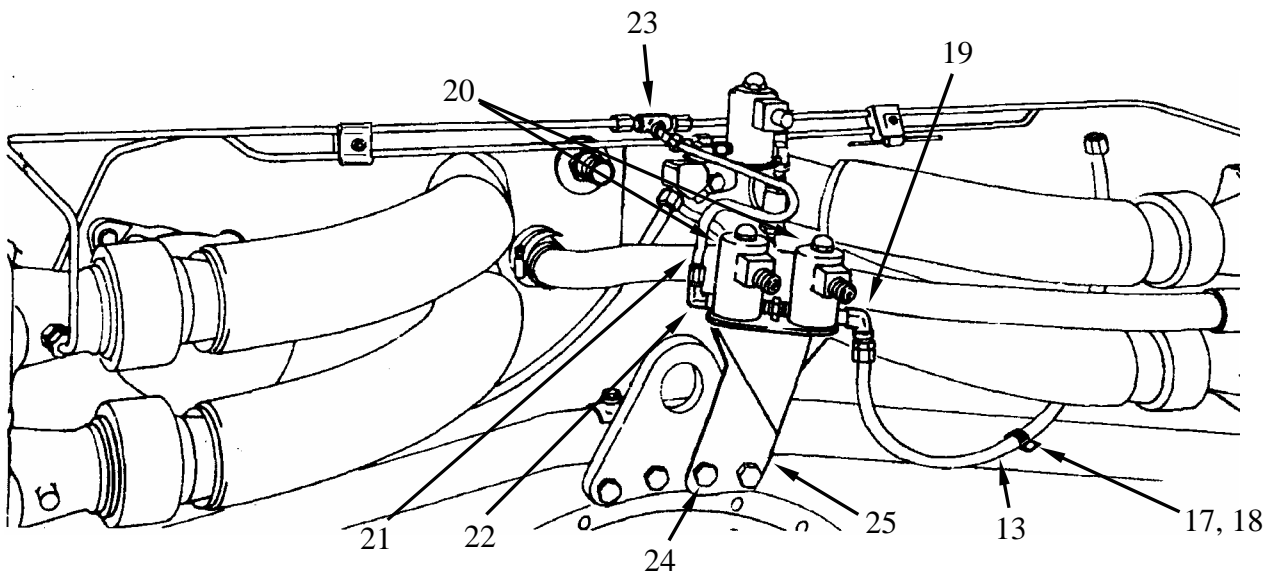
**REMOVAL (Continued)**

5. Remove fuel line bulkhead elbow (12).
  - a. Disconnect fuel line (6) from elbow fitting (12).
  - b. Disconnect fuel line (13) from opposite end of elbow fitting (12).
  - c. Remove nut (14), lock washer (15), and flat washer (16) from elbow fitting (12).
  - d. Remove elbow fitting (12), discard lock washer (15).



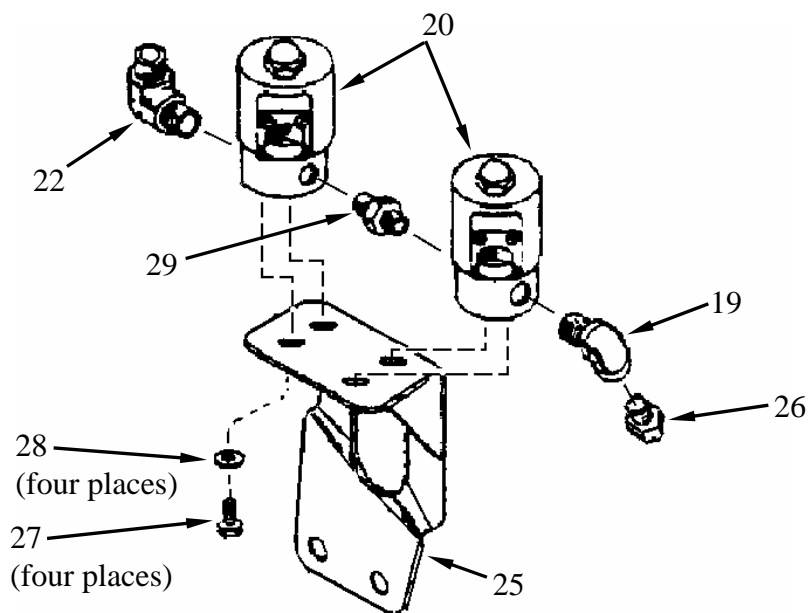
**REMOVAL (Continued)**

6. Remove fuel line (13) to smoke solenoids.
  - a. Remove screw (17) and loop clamp (18) retaining fuel line (13).
  - b. Disconnect fuel line (13) from elbow fitting (19).
7. Remove smoke generation solenoids (20).
  - a. Disconnect fuel line (21) from outlet elbow fitting (22).
  - b. Disconnect fuel line (21) from tee fitting (23).
  - c. Remove retaining screws (24) from solenoid bracket (25).



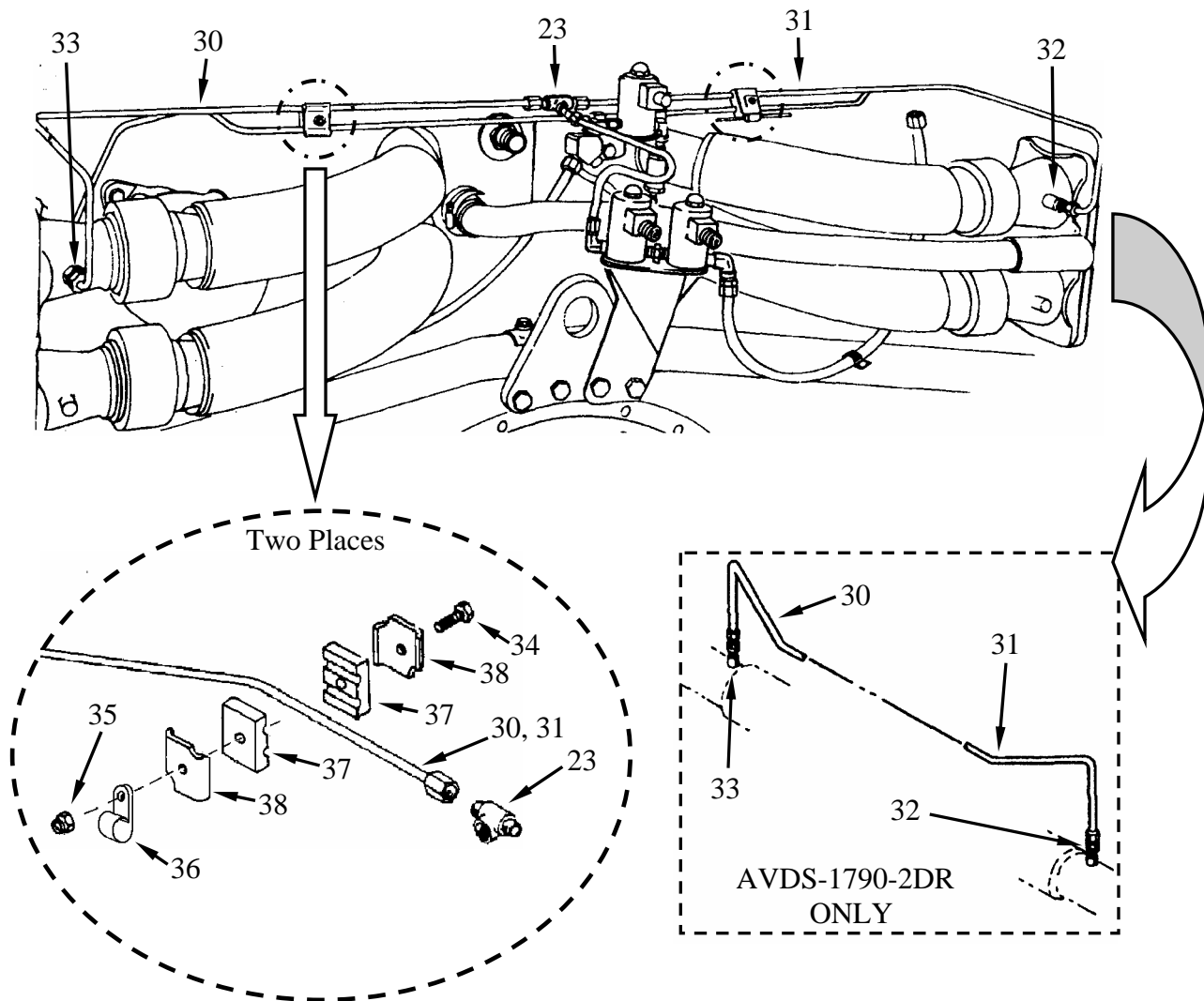
**REMOVAL (Continued)**

8. Disassemble solenoid bracket assembly.
  - a. Place solenoid bracket (25) into a vice.
  - b. Remove adapter (26) from elbow (19).
  - c. Remove elbow (19) from solenoid (20).
  - d. Remove elbow (22) from solenoid (20).
  - e. Remove four screws (27) with flat washers (28) holding solenoids (20) to bracket (25).
  - f. To separate the two solenoids (20), twist solenoids (20) in opposite directions until one solenoid (20) has become free of the pipe nipple (29) that joins the solenoids (20) together.
  - g. Remove pipe nipple (29) from remaining solenoid (20).



**REMOVAL (Continued)**

9. Remove fuel lines (30, 31) between tee fitting (23) and exhaust pipe connections (32, 33).
  - a. Disconnect fuel lines (30, 31) from tee fitting (23).
  - b. Remove screws (34) with self-locking nuts (35) and loop clamp (36). Discard self-locking nut.
  - c. Separate fairlead halves (37) and retaining straps (38) from fuel lines (30, 31).
  - d. Disconnect fuel line (31) at left exhaust pipe connection (32).
  - e. Disconnect fuel line (30) at right exhaust pipe connection (33).



## REMOVAL (Continued)

## NOTE

There are two configurations of the smoke generating system. Early systems use a dual solenoid configuration. It was found that fuel, trapped between the two solenoids and heated by the close proximity of the exhaust, expanded and caused internal seals of the solenoids to fail resulting in un-commanded smoke generation and higher fuel consumption. Newer, improved systems use a single solenoid system. The newer system removes the two flywheel-end mounted solenoids and incorporates a single solenoid at the damper end of the engine where it is cooler. Engineering Release Record (ERR) CO-M6185 authorizes converting to the single solenoid configuration.

10. Removal of components for the single solenoid system is done in the same manner as those on the double solenoid system.

## NOTE

Parts unique to the single solenoid smoke generation system are underlined in the illustration below:

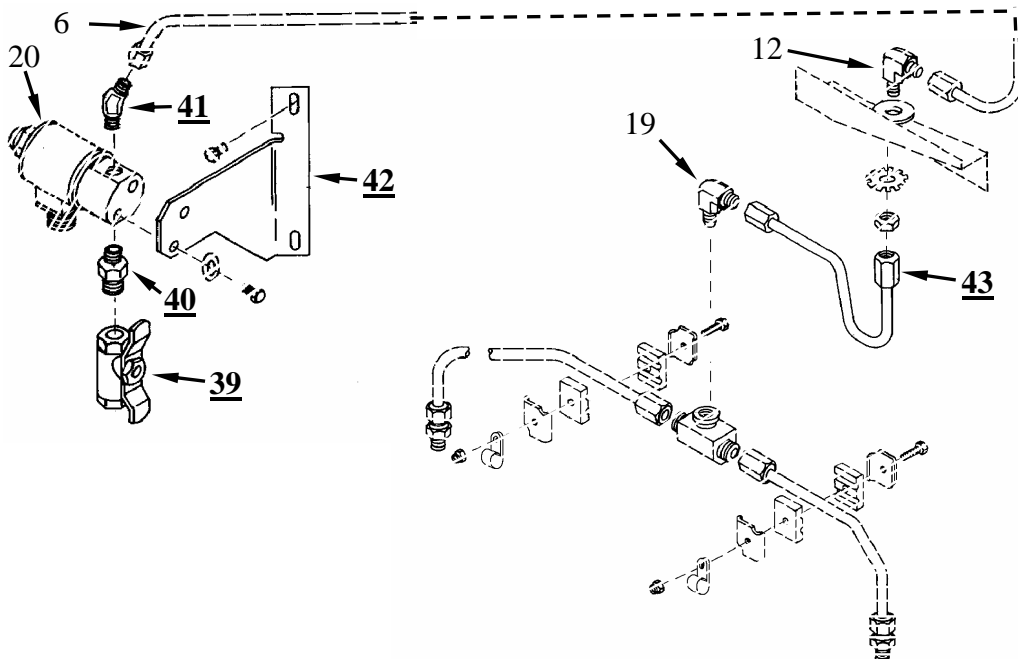
Manual shutoff valve (39).

Adapter (40) between manual shutoff valve and solenoid (20).

Elbow (41) between solenoid (20) and fuel line (6).

Mounting bracket (42).

Fuel line (43) located between bulkhead elbow (12) and elbow fitting (19).





### CLEANING

1. See Work Package 0028 for Standard Cleaning Procedures.

### INSPECTION

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

### INSTALLATION

#### NOTE

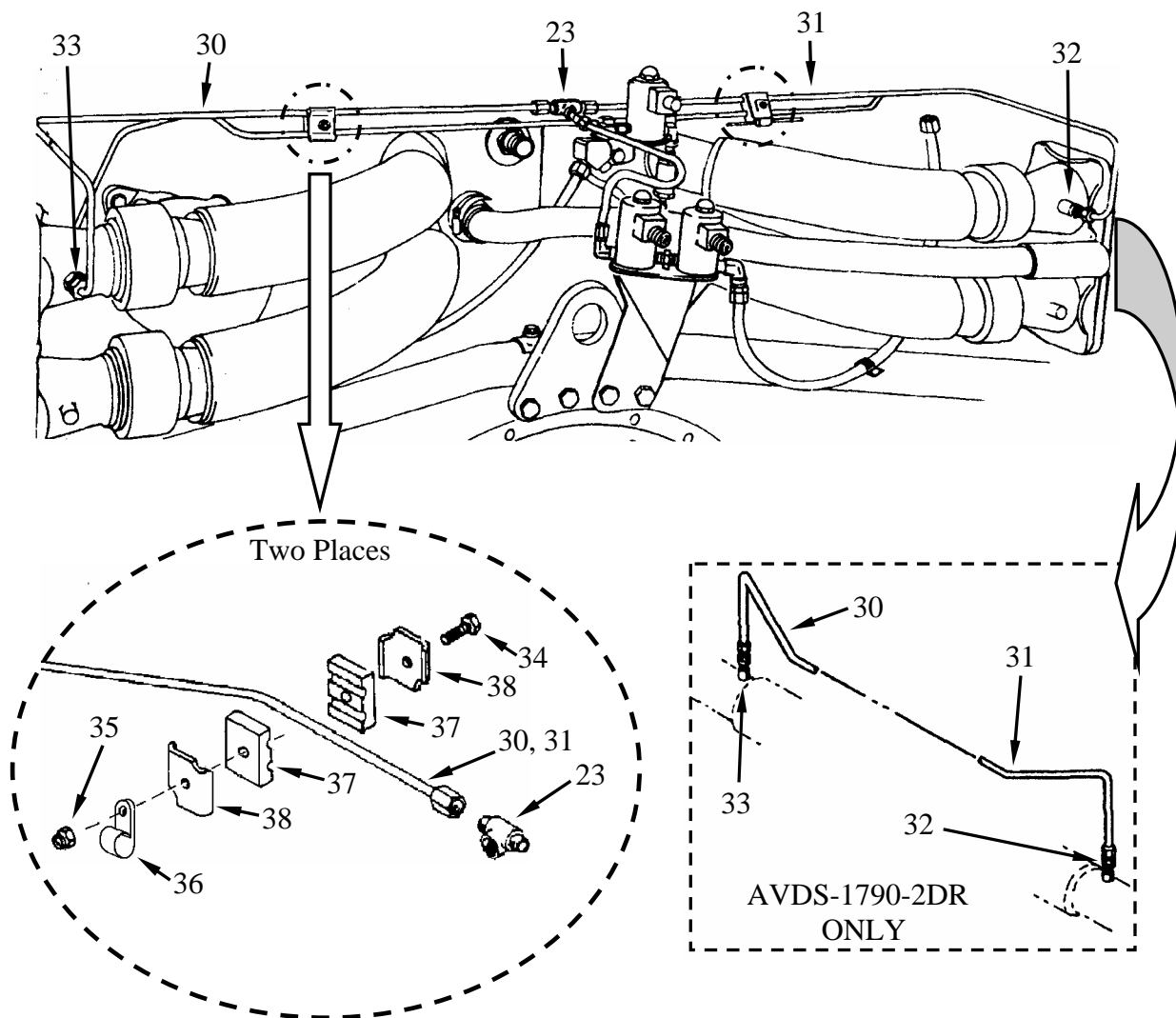
**Use thread sealing product on threaded pipe connections with the exception of fuel line connections at exhaust pipes.**

#### CAUTION

**Use anti-seize compound (C5A or equivalent) on threaded connection between fuel lines and exhaust pipes. Failure to comply may lead to seized fittings in exhaust pipes.**

**INSTALLATION (Continued)**

1. Install fuel lines (30, 31) between tee fitting (23) and exhaust pipe connections (32, 33).
  - a. Install fuel line (31) into left exhaust pipe connection (32).
  - b. Install fuel line (30) into right exhaust pipe connection (33).
  - c. Install fuel lines (30, 31) onto tee fitting (23).
  - d. Assemble fairlead halves (37) and retaining straps (38) onto fuel lines (30, 31).
  - e. Install screws (34) with new self-locking nuts (35) (item 38, WP 0175) and loop clamps (36).



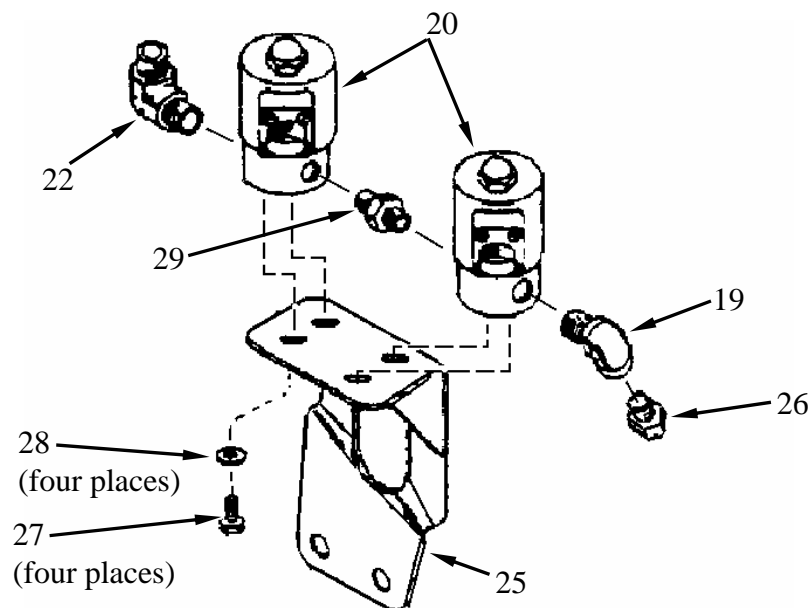
**INSTALLATION (Continued)**

2. Assemble solenoid bracket components.
  - a. Install pipe nipple (29) into one solenoid (20).
  - b. Install second solenoid (20) onto pipe nipple (29).
  - c. Place solenoid bracket (25) into a vice.
  - d. Install four screws (27) with flat washers (28) to secure solenoids (20) to bracket (25).
  - e. Install elbow (19) into solenoid (20).
  - f. Install adapter (26) into elbow (19).
  - g. Install elbow (22) into solenoid (20).

**NOTE**

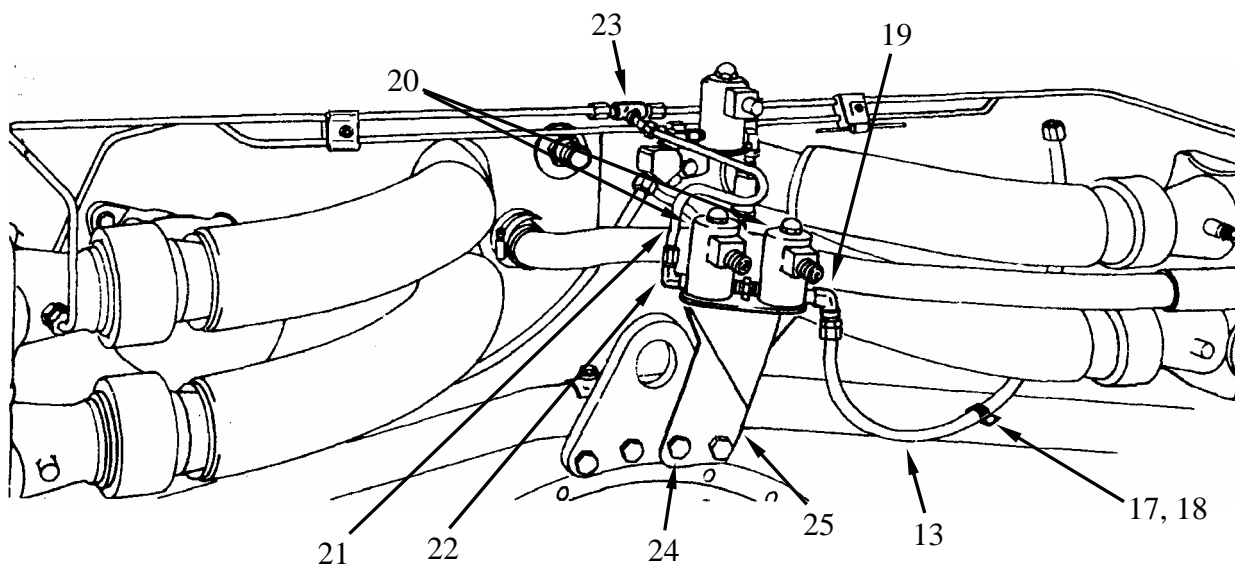
**Check position of electrical connectors on new solenoid valves. Hold the valve with the inlet port marked "IN" to the right and the outlet port marked "OUT" to the left. The electrical connectors must be approximately 45 degrees from the inlet ports and pointing toward you.**

**If the connectors must be repositioned, place the valves in a soft jawed vise. Loosen the acorn nut on top of the valves. Rotate the connectors and tighten acorn nuts to 50 inch-pounds (5.65 N•m). Remove and discard protective covers and felt filtering disks (if present) from inlet and outlet ports.**



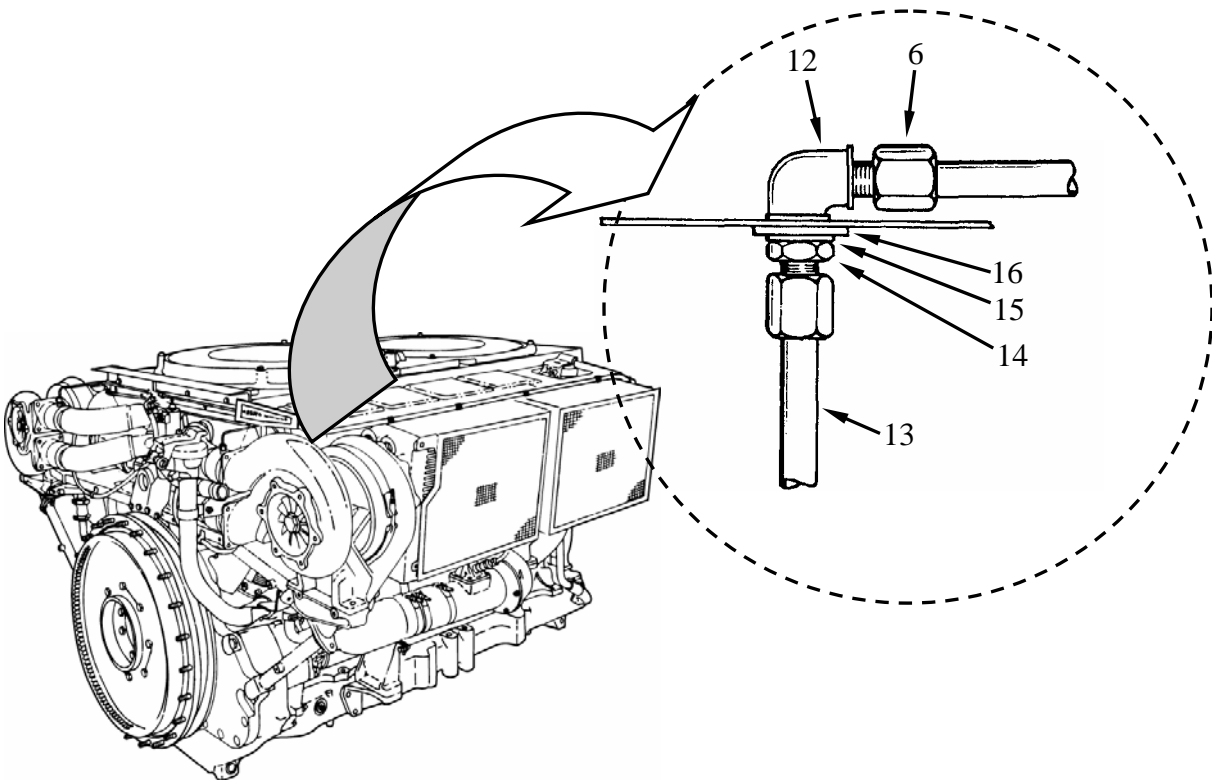
**INSTALLATION (Continued)**

3. Install smoke generation solenoids (20) and bracket (25) assembly.
  - a. Install solenoid bracket (25) with retaining screws (24).
  - b. Install fuel line (21) at tee fitting (23).
  - c. Install fuel line (21) to outlet elbow fitting (22).
  
4. Install fuel line (13) to smoke solenoids (20).
  - a. Install fuel line (13) onto elbow fitting (19).
  - b. Secure fuel line (13) with loop clamp (18) and screw (17).



**INSTALLATION (Continued)**

5. Install bulkhead fuel line elbow (12).
  - a. Position elbow fitting (12), into bulkhead.
  - b. Install nut (14), new lock washer (15) (item 87, WP 0175), and flat washer (16) onto elbow fitting (12).
  - c. Install fuel line (13) onto elbow fitting (12).
  - d. Install fuel line (6) onto elbow fitting (12).

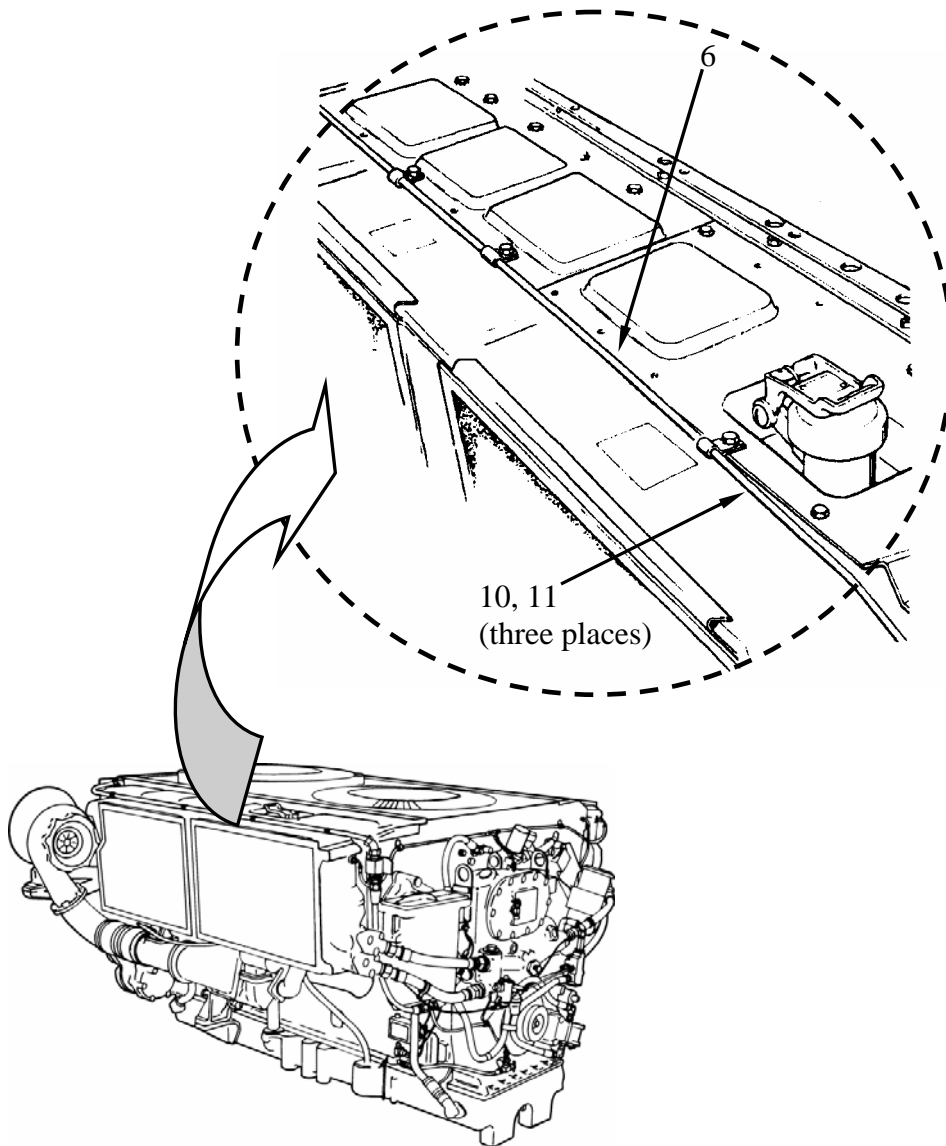


**INSTALLATION (Continued)**

6. Install fuel line (6) at top of engine.
  - a. Install fuel line (6) using assembled washer screws (10) with loop clamps (11).

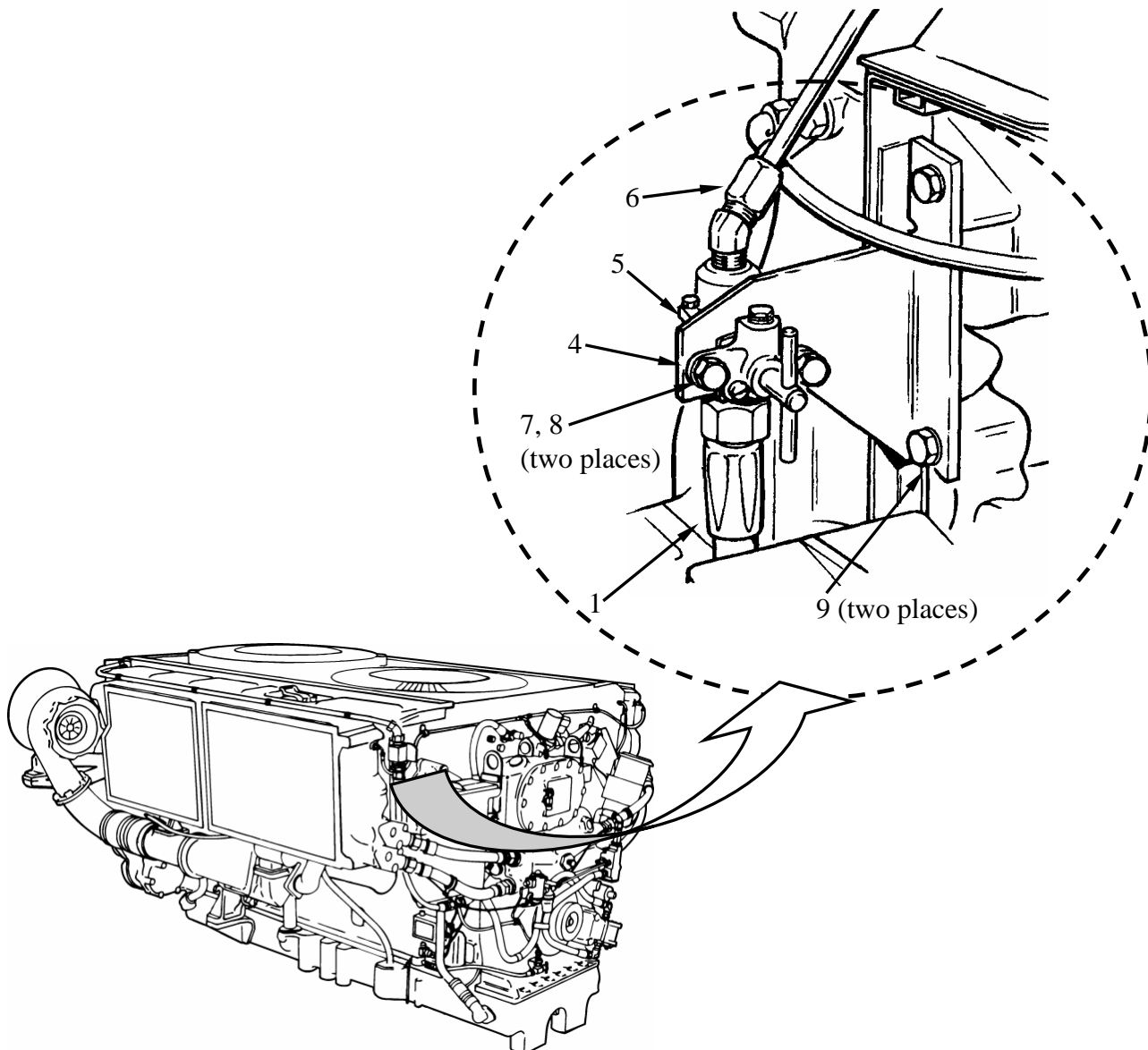
**NOTE**

**2CA and 2DA engine models use three screws (10) and loop clamps (11), while 2DR model uses four.**



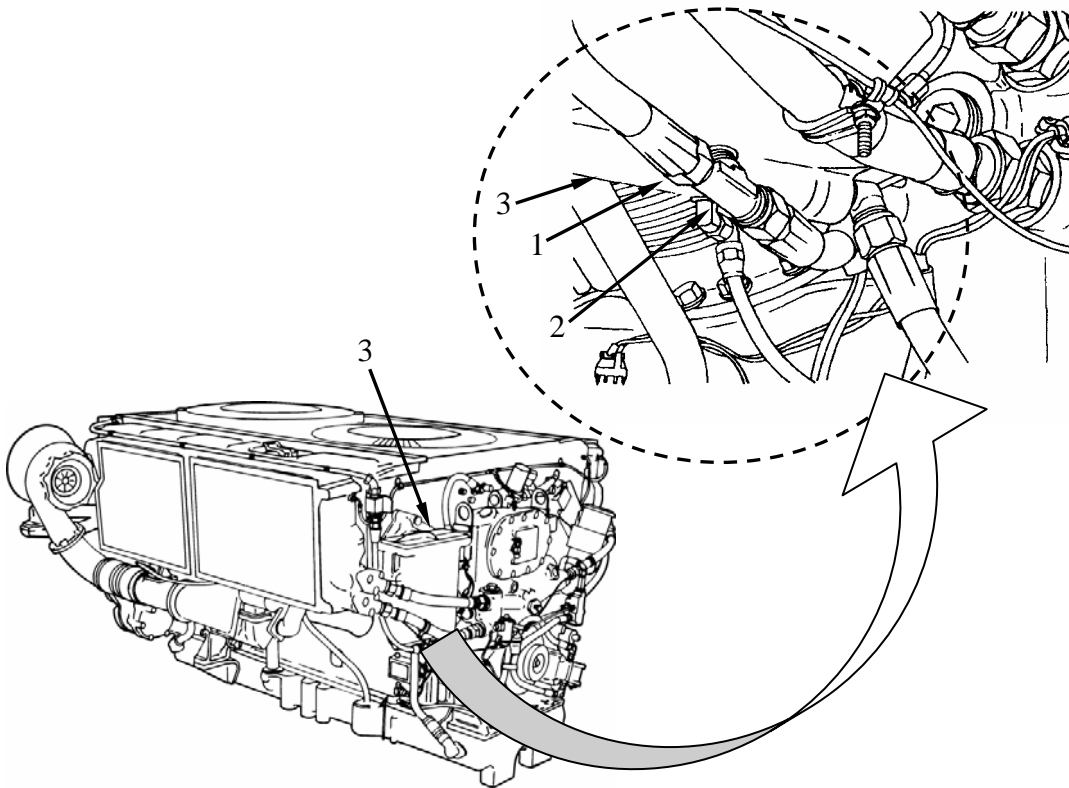
**INSTALLATION (Continued)**

7. Install manual fuel shutoff valve mounting bracket (5).
  - a. Install two assembled washer screws (9) to secure bracket (5).
8. Install manual fuel shutoff valve (4) into mounting bracket (5).
  - a. Install two screws (7) with new self-locking nuts (8) (item 37, WP 0175).
9. Install smoke generator fuel lines (1, 6) at manual shutoff valve (4).
  - a. Install fuel line (6) at manual fuel shutoff valve (4) outlet.
  - b. Install fuel line (1) at manual fuel shutoff valve (4) inlet.



**INSTALLATION (Continued)**

10. Install smoke generator fuel line (1).
  - a. Install smoke generator fuel line (1) at tee fitting (2) on the bottom of the secondary fuel filter housing (3).

**END OF WORK PACKAGE**



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**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

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**0095 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124,  
WP 0176)

**Mandatory Replacement Parts:**

Lock washer (2) (item 94, WP 0175)  
Self-locking nut (1) (item 33, WP 0175)  
Self-locking nut (3) (item 282, WP 0175)

**Expendable and Durable Items:**

Engine oil, as needed (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a  
flat stationary surface

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**REMOVAL**

**NOTE**

**Similar procedures are required to remove the left and right turbosupercharger and transmission cooling shrouds. For instructional purposes, removal of the left turbosupercharger and transmission cooling shrouds are described.**

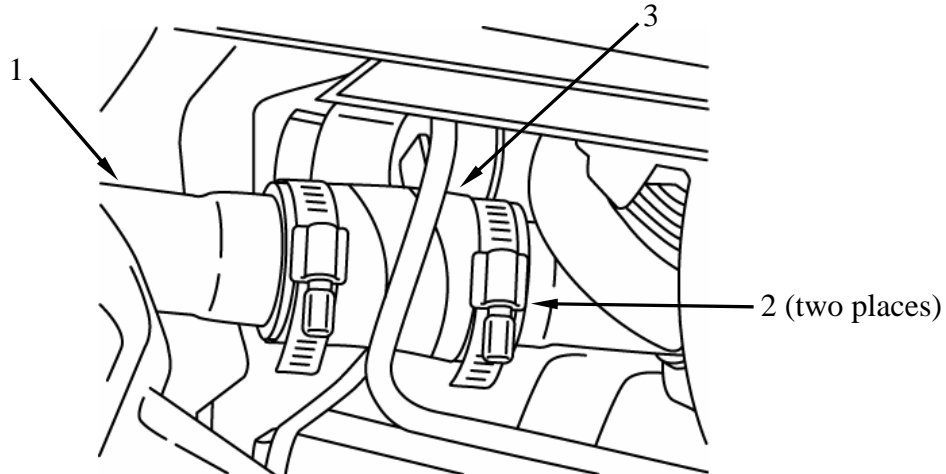
**Removal procedures for the right turbosupercharger and transmission cooling shrouds are the same except for the oil filler tube removal and installation.**

**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

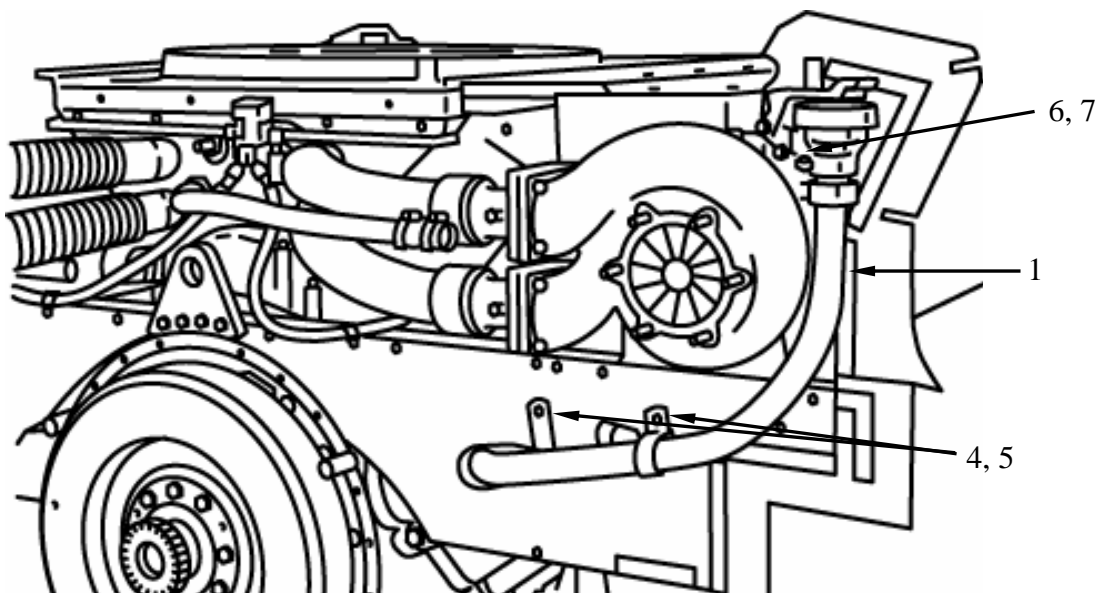
**0095 00**

**REMOVAL (Continued)**

1. Remove engine oil filler tube (1).
  - a. Loosen hose clamps (2) on oil filler tube hose (3).



- b. Remove two screws (4) with lock washers (5). Discard lock washers.
- c. Remove screw (6) secured with self-locking nut (7). Discard self-locking nut.
- d. Remove upper oil filler tube (1).

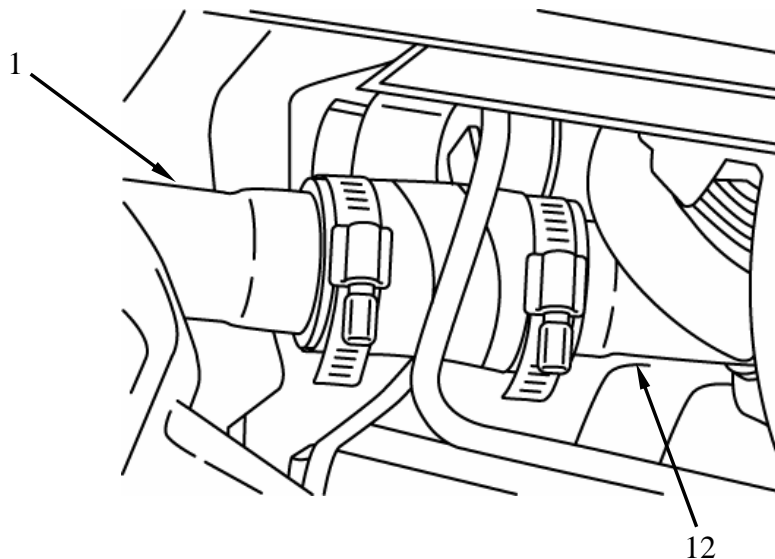
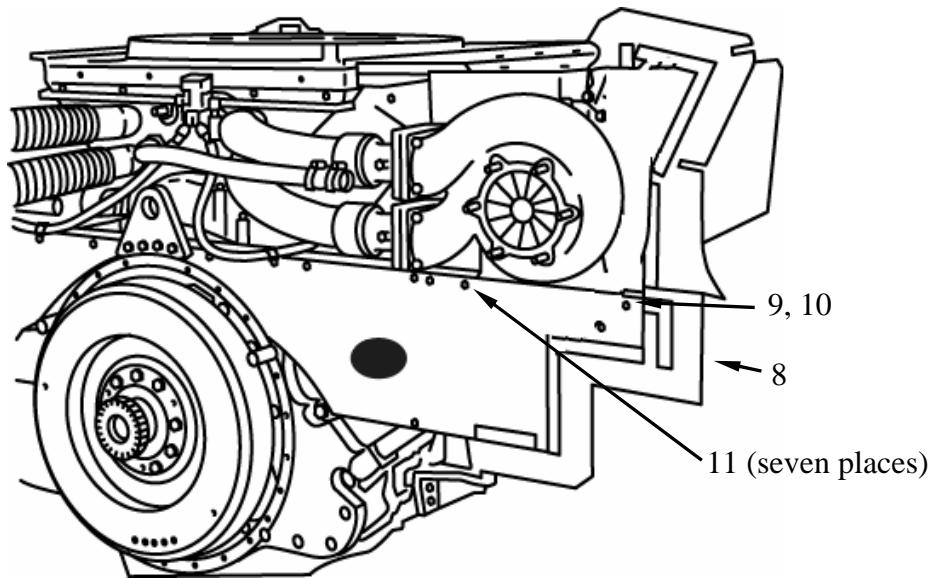


**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

0095 00

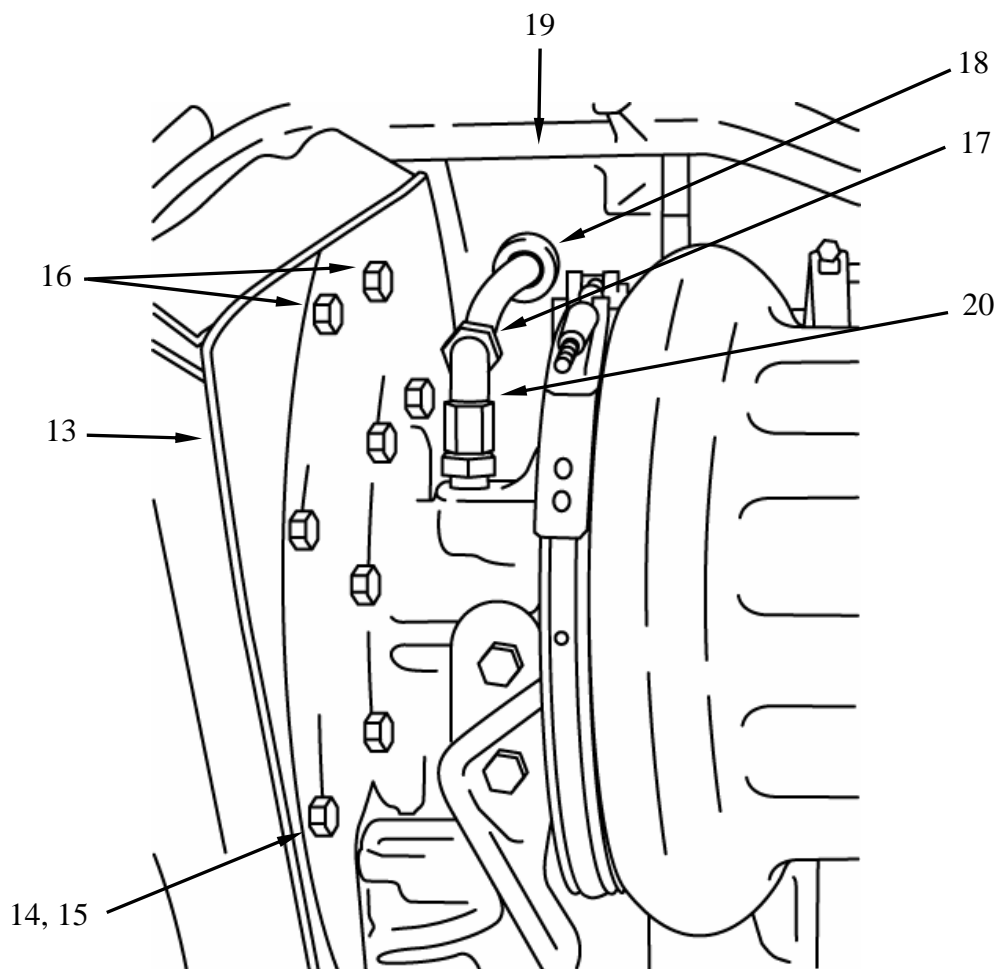
**REMOVAL (Continued)**

2. Remove transmission cooling air shroud (8).
  - a. Remove one self-locking nut (9) and screw (10). Discard nut.
  - b. Remove seven assembled washer bolts (11).
  - c. Remove transmission cooling air shroud (8).
  - d. Seal off the lower oil filler tube (12) with a clean cloth or suitable cover to prevent contamination (upper tube (1) was removed in step 1d).



**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)****0095 00****REMOVAL (Continued)**

3. Remove turbosupercharger outer shroud (13).
  - a. Remove screw (14) secured with self-locking nut (15). Discard self locking nut.
  - b. Remove two assembled washer bolts (16), and remove turbosupercharger outer shroud plate (13).
4. Remove turbosupercharger oil inlet hose (17).
  - a. Disconnect turbosupercharger oil inlet hose (17).
  - b. Remove grommet (18).
  - c. Pull oil inlet hose (17) through opening in inner shroud (19).
  - d. Seal oil inlet elbow (20) and oil inlet hose (17) to prevent contamination.



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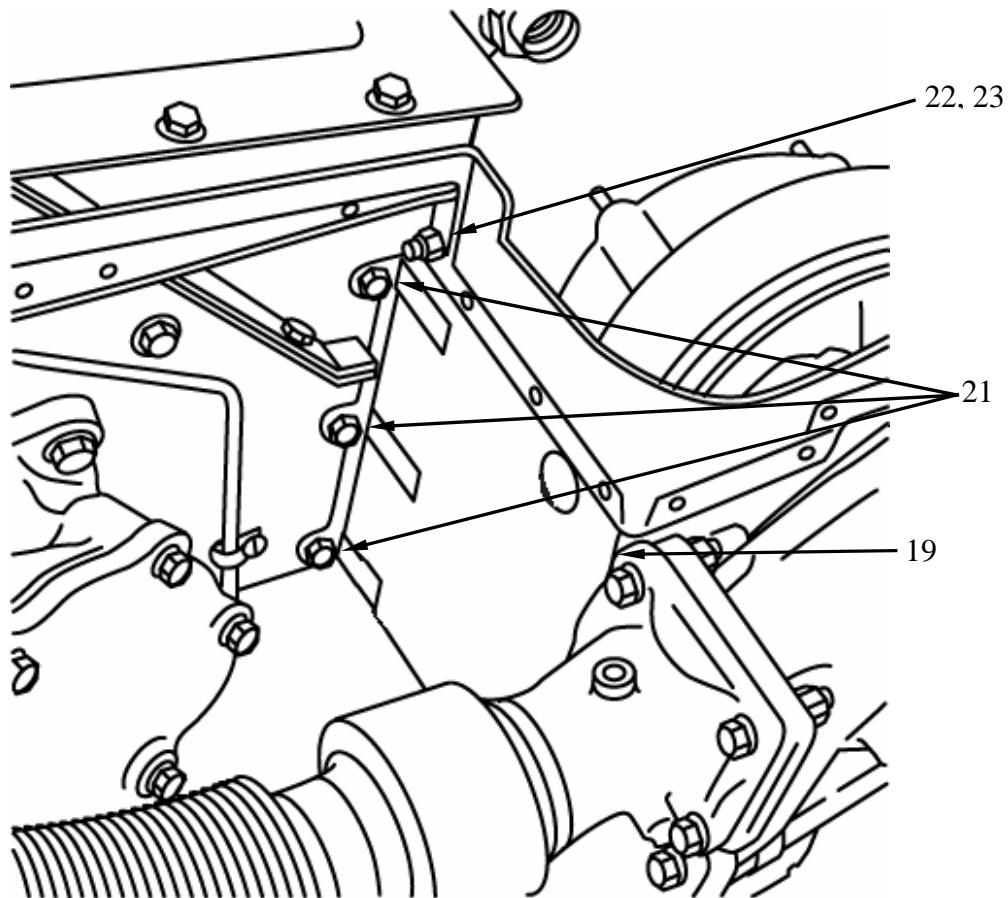
**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

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0095 00

**REMOVAL (Continued)**

5. Remove turbosupercharger inner shroud (19).
  - a. Remove three assembled washer bolts (21).
  - b. Remove one self-locking nut (22) and screw (23). Discard nut.
  - c. Remove inner shroud plate (19).



**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)****0095 00****CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

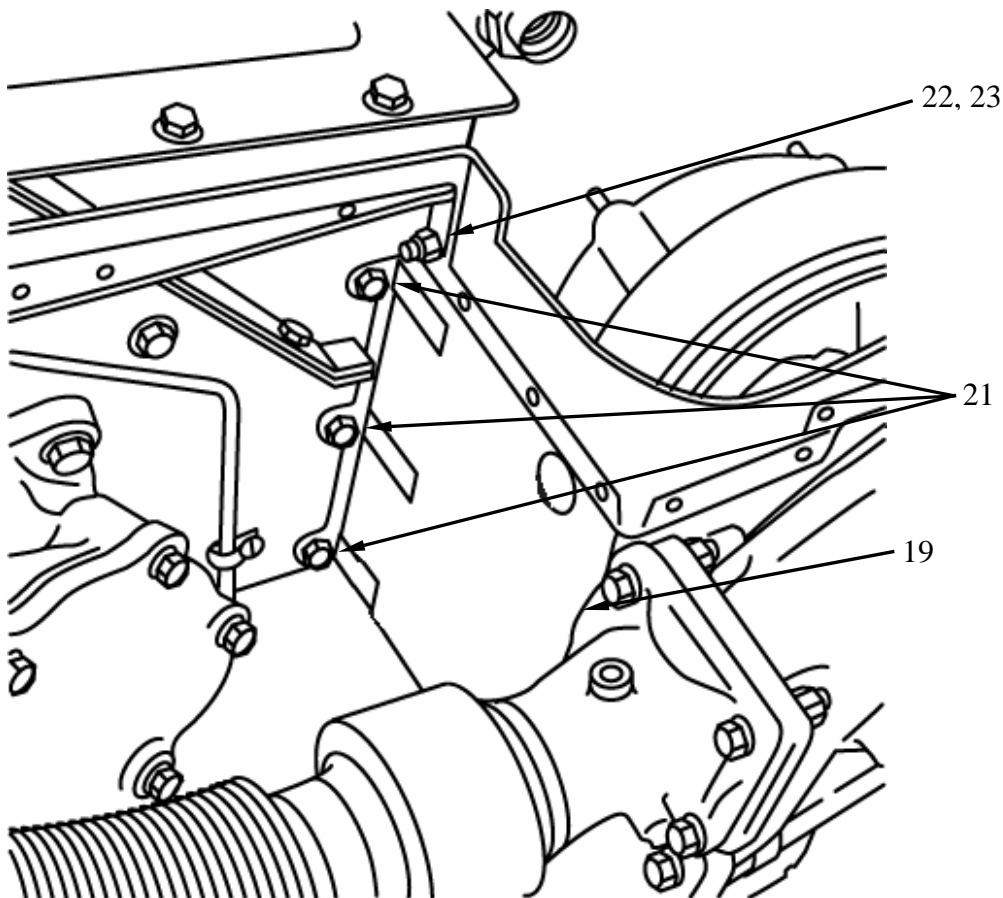
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install inner cooling shroud (19).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to three assembled washer bolts (21).
  - b. Install inner shroud plate (19) to oil cooler frame with three assembled washer bolts (21).
  - c. Install inner shroud plate (19) to upper access cover using new self-locking nut (22) (item 282, WP 0175) and screw (23).

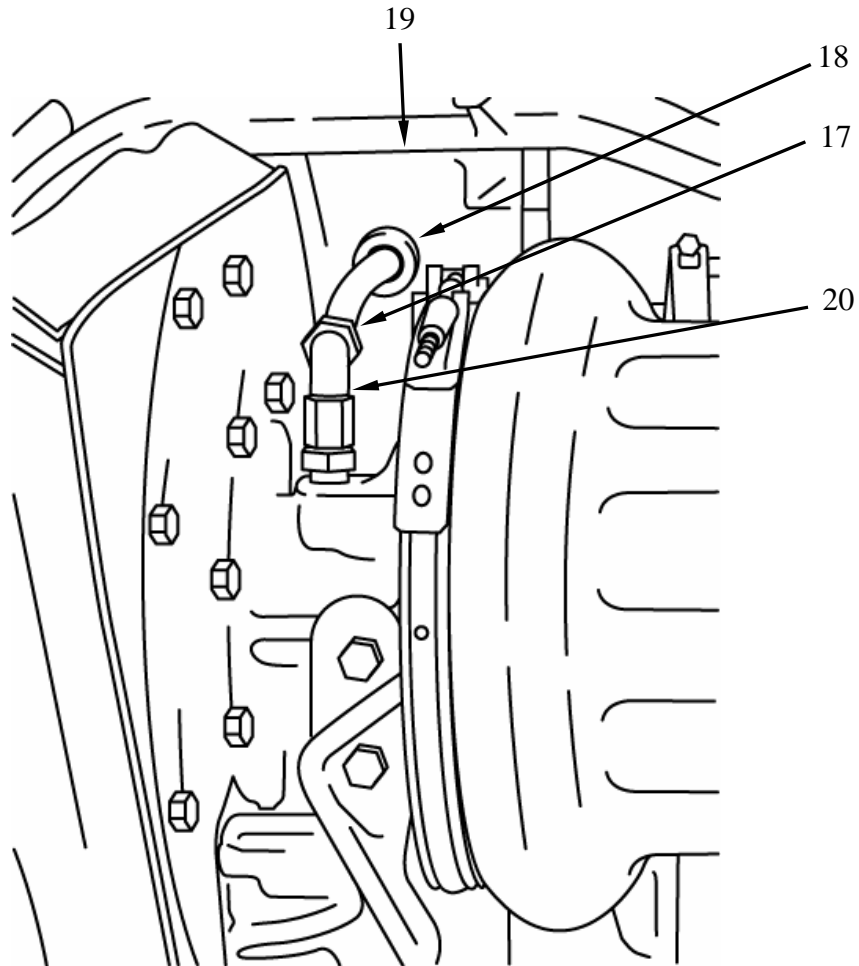


**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

0095 00

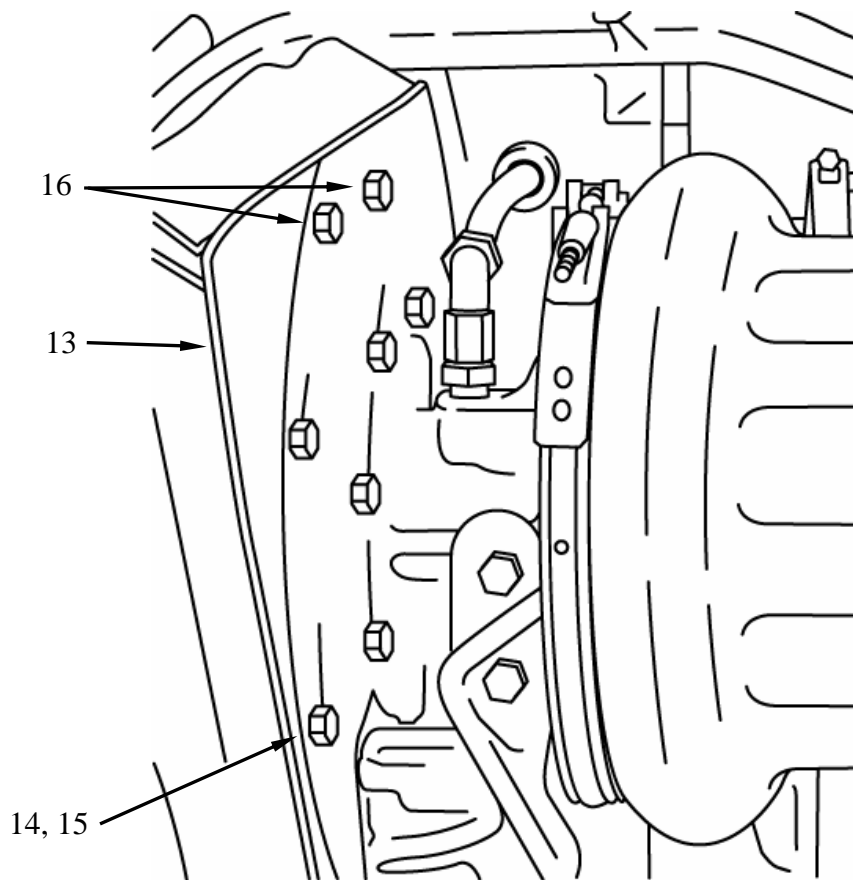
**INSTALLATION (Continued)**

2. Install turbosupercharger oil supply hose (17).
  - a. Feed oil inlet hose (17) through shroud (19).
  - b. Install oil inlet hose grommet (18).
  - c. Connect oil inlet supply hose (17) to elbow (20) in turbosupercharger.



**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)****0095 00****INSTALLATION (Continued)**

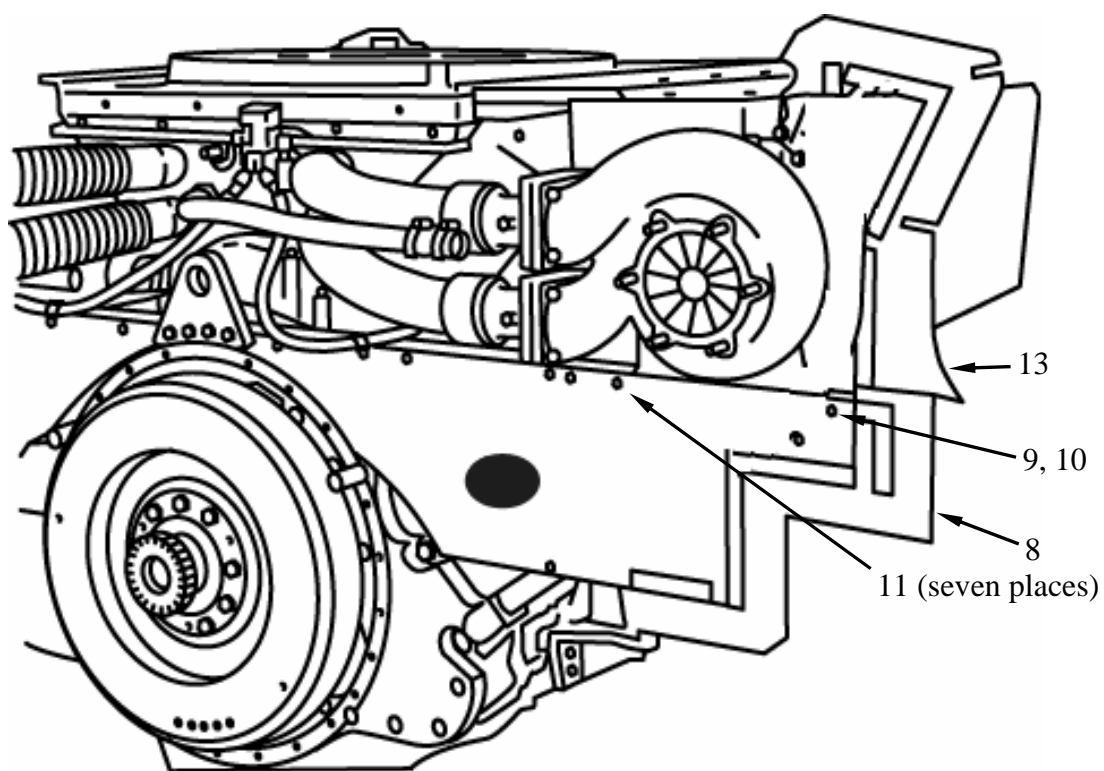
3. Install outer cooling shroud (13).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to two screws (16).
  - b. Secure outer shroud plate (13) to turbosupercharger heat shield using screw (14) with new self-locking nut (15) (item 282, WP 0175).
  - c. Secure outer shroud plate (13) to turbosupercharger using two assembled washer bolts (16).





**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)****0095 00****INSTALLATION (Continued)**

4. Install transmission cooling air shroud (8).
  - a. Secure transmission cooling air shroud (8) using seven assembled washer bolts (11).
  - b. Secure turbosupercharger outer shroud (13) using screw (10) with one new self-locking nut (9) (item 282, WP 0175).

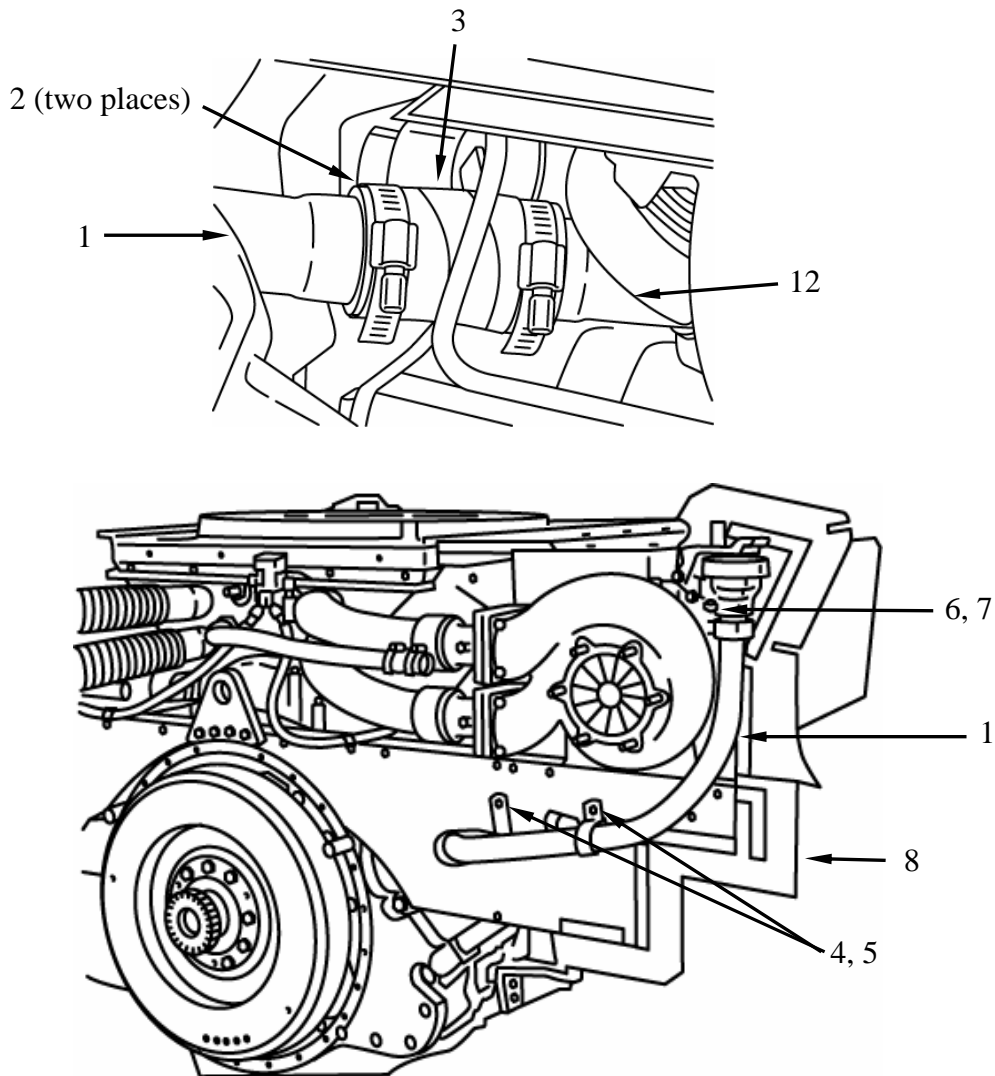


**TURBOSUPERCHARGER AND TRANSMISSION  
SHROUDS REPLACEMENT (2CA & 2DA)**

**0095 00**

**INSTALLATION (Continued)**

5. Install engine oil filler tube (1).
  - a. Remove protective cover previously installed onto lower oil filler tube (12) opening.
  - b. Install upper oil filler tube (1) through transmission cooling air shroud (8).
  - c. Insert lower end of tube (1) into oil filler hose (3).
  - d. Secure upper oil filler tube using one screw (6) with new self-locking nut (7) (item 33, WP 0175).
  - e. Secure upper oil filler tube (1) using two screws (4) with new lock washers (5) (item 94, WP 0175).
  - f. Tighten hose clamps (2) at oil filler tube connections (1, 12).



**END OF WORK PACKAGE**

**EXHAUST MANIFOLD CLAMPS REPLACEMENT**

**0096 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (2) (item 93, WP 0175)

Lock washer (2) (item 94, WP 0175)

Self-locking nut (2) (item 33, WP 0175)

Self-locking nut (1) (item 36, WP 0175)

Self-locking nut (107) (item 118, WP 0175)

**Mandatory Replacement Parts**

**(Continued):**

Self-locking nut (2) (item 161, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface

Cooling fans and housings removed (WP 0054)

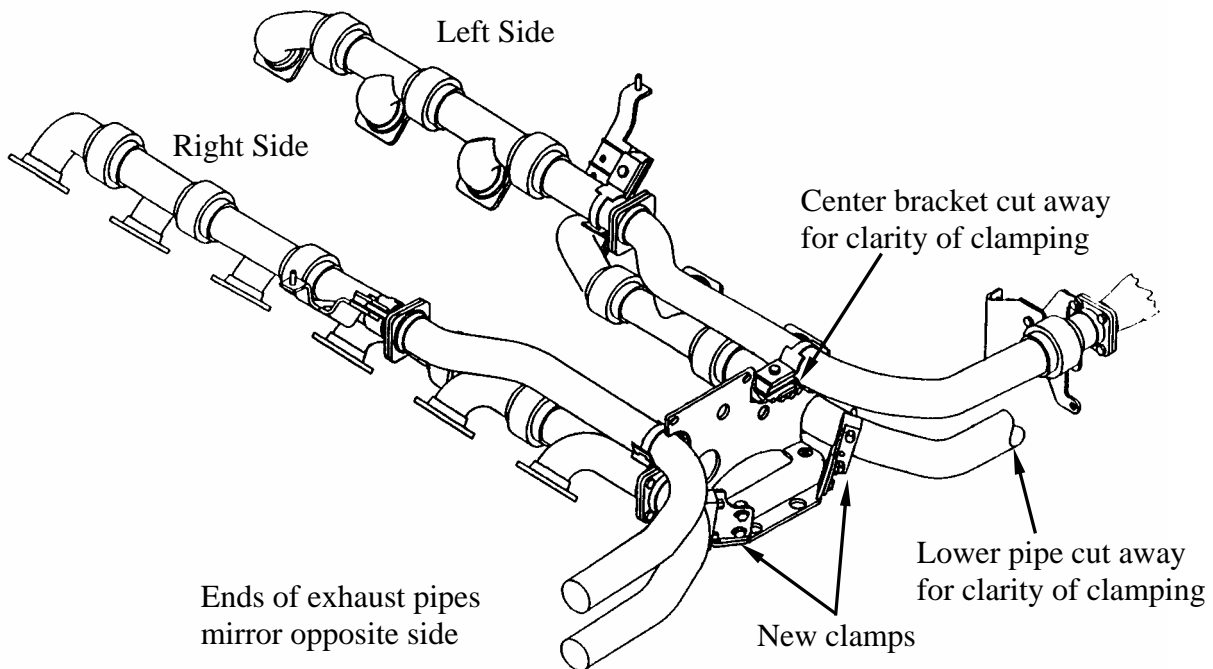
**REMOVAL**

**NOTE**

**This work package covers removal of the latest exhaust system clamping. This work package details the left side procedure only; the right side is the same.**

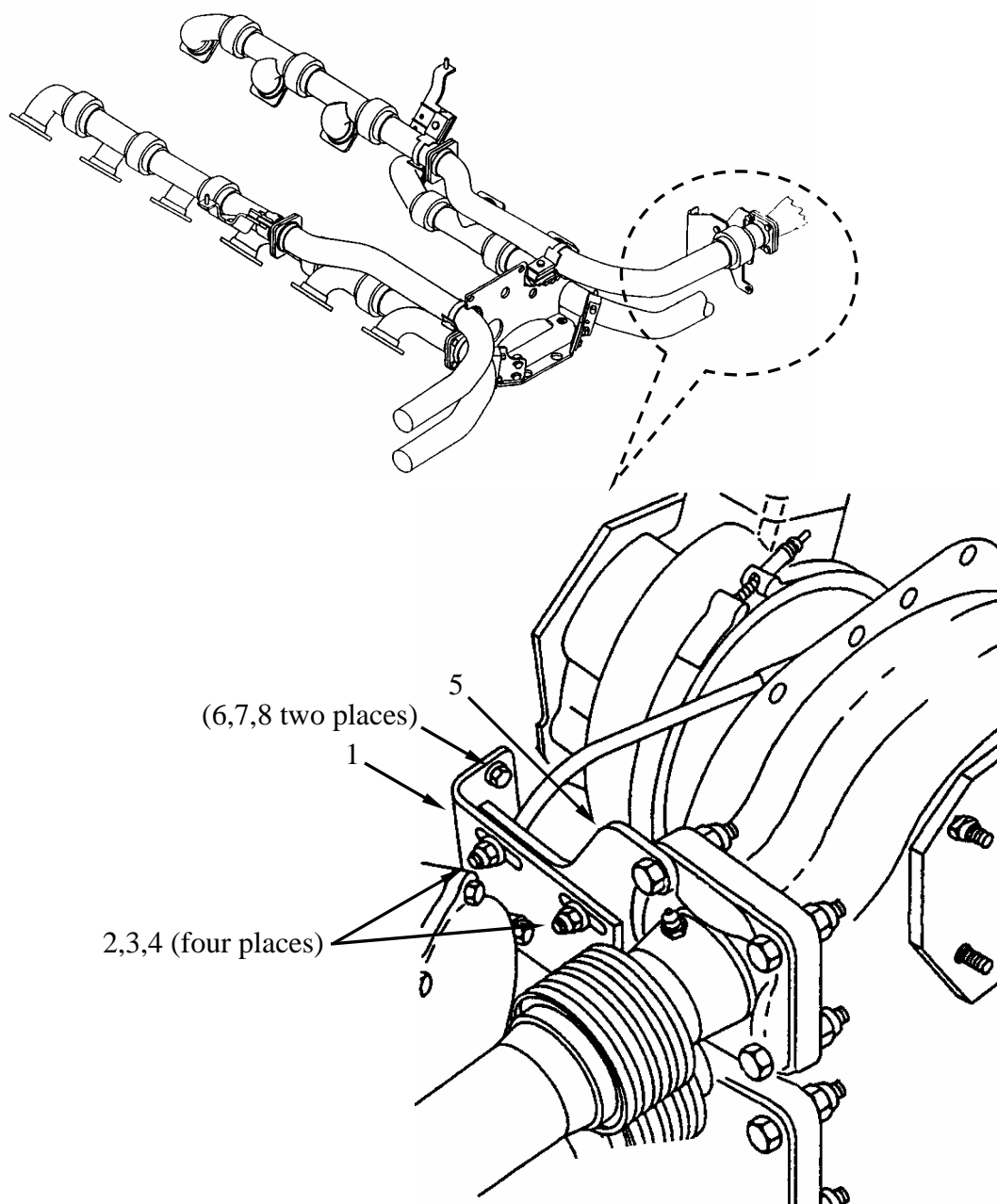
**CAUTION**

**New clamps will not fit the old exhaust pipes at the center bracket, lower pipe positions, both left and right sides.**



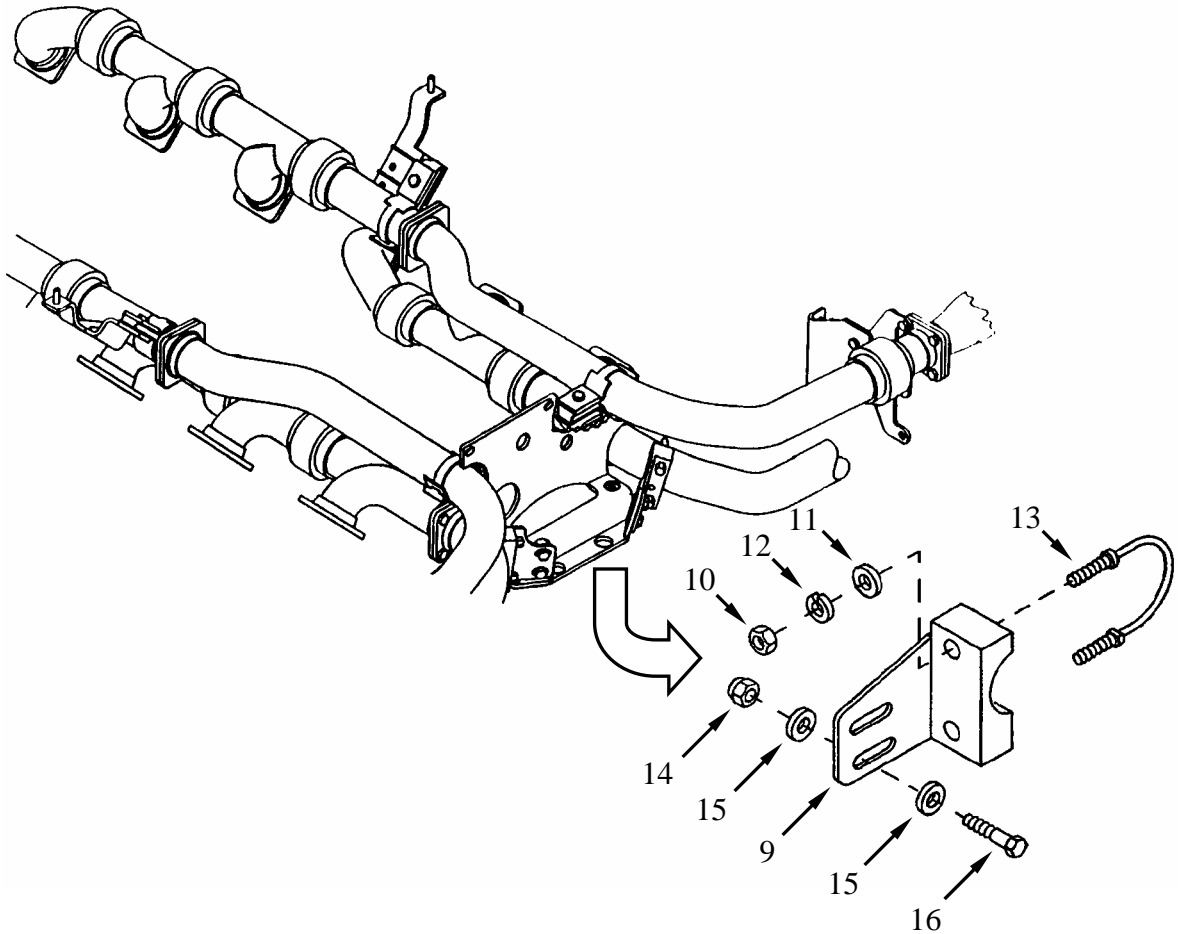
**REMOVAL (Continued)**

1. Remove support bracket (1).
  - a. Remove four self-locking nuts (2), flat washers (3) and screws (4) securing bracket (1) to bracket (5). Discard self-locking nuts.
  - b. Remove two screws (6) with flat washers (7) and lock washers (8) to remove bracket (1) from engine shrouding. Discard lock washers.



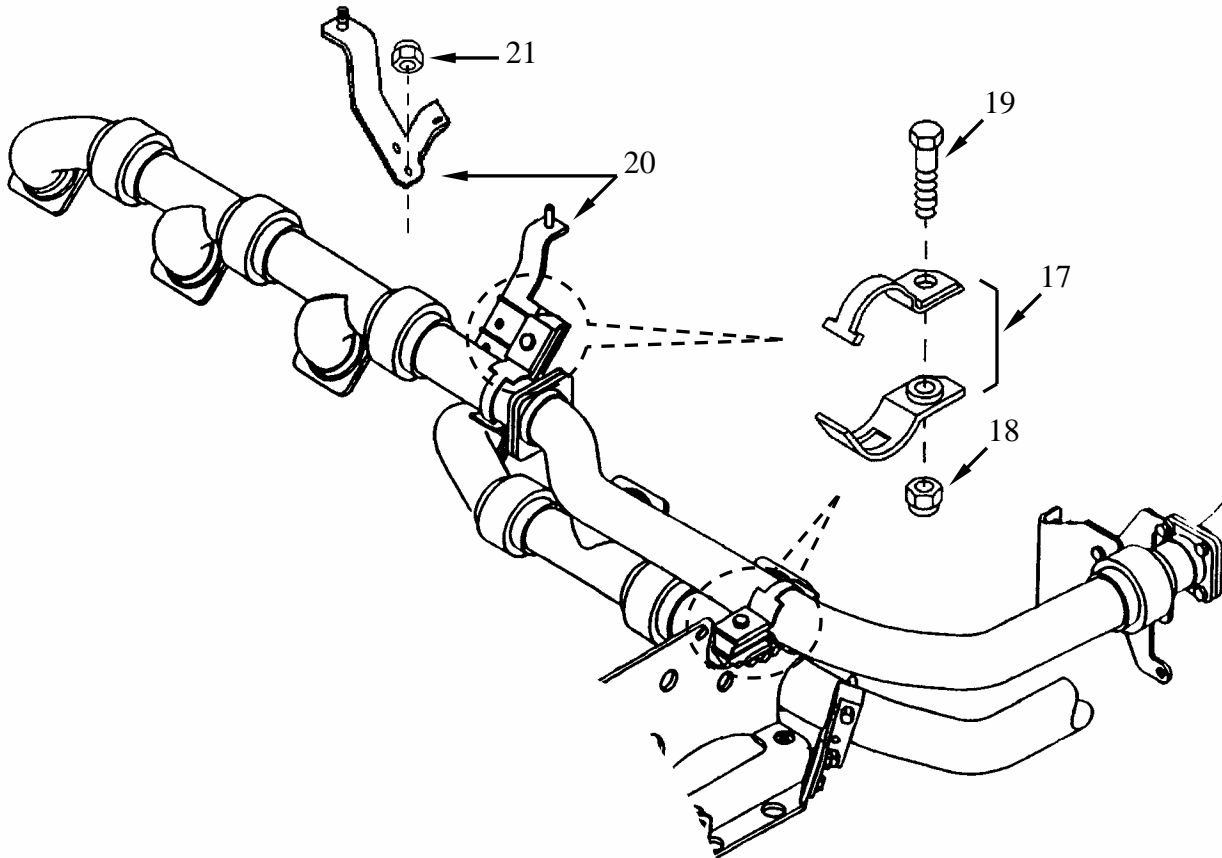
**REMOVAL (Continued)**

2. Remove bracket (9).
  - a. Remove two nuts (10) with flat washers (11) and lock washers (12) securing U-bolt (13) to bracket (9). Discard lock washers.
  - b. Remove U-bolt (13).
  - c. Remove two self-locking nuts (14), four flat washers (15) and two screws (16) to remove bracket (9). Discard self-locking nuts.



**REMOVAL (Continued)**

3. Remove two clamp assemblies (17).
  - a. Remove self-locking nut (18), screw (19) and clamp assemblies (17) inside engine shrouding. Discard self-locking nuts.
4. Remove bracket (20).
  - a. Remove two self-locking nuts (21) to remove bracket (20).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

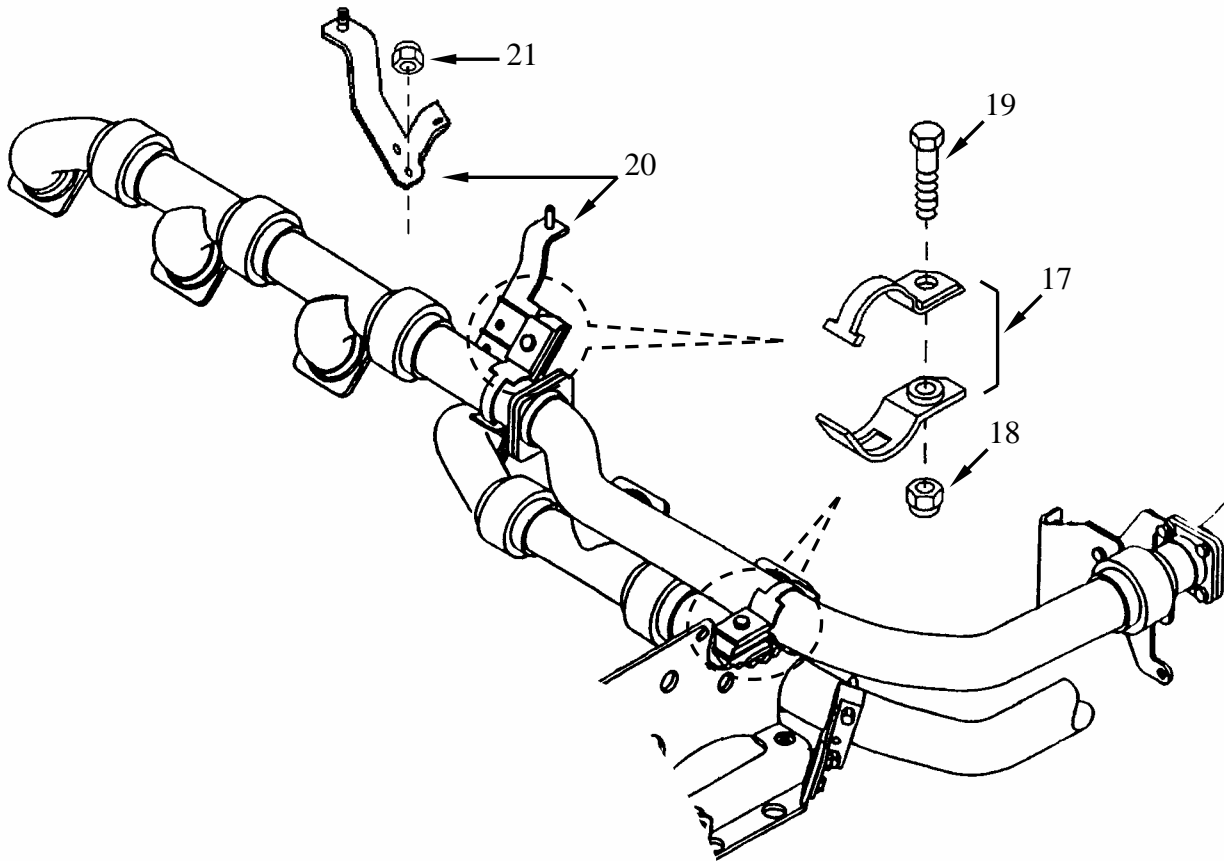
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

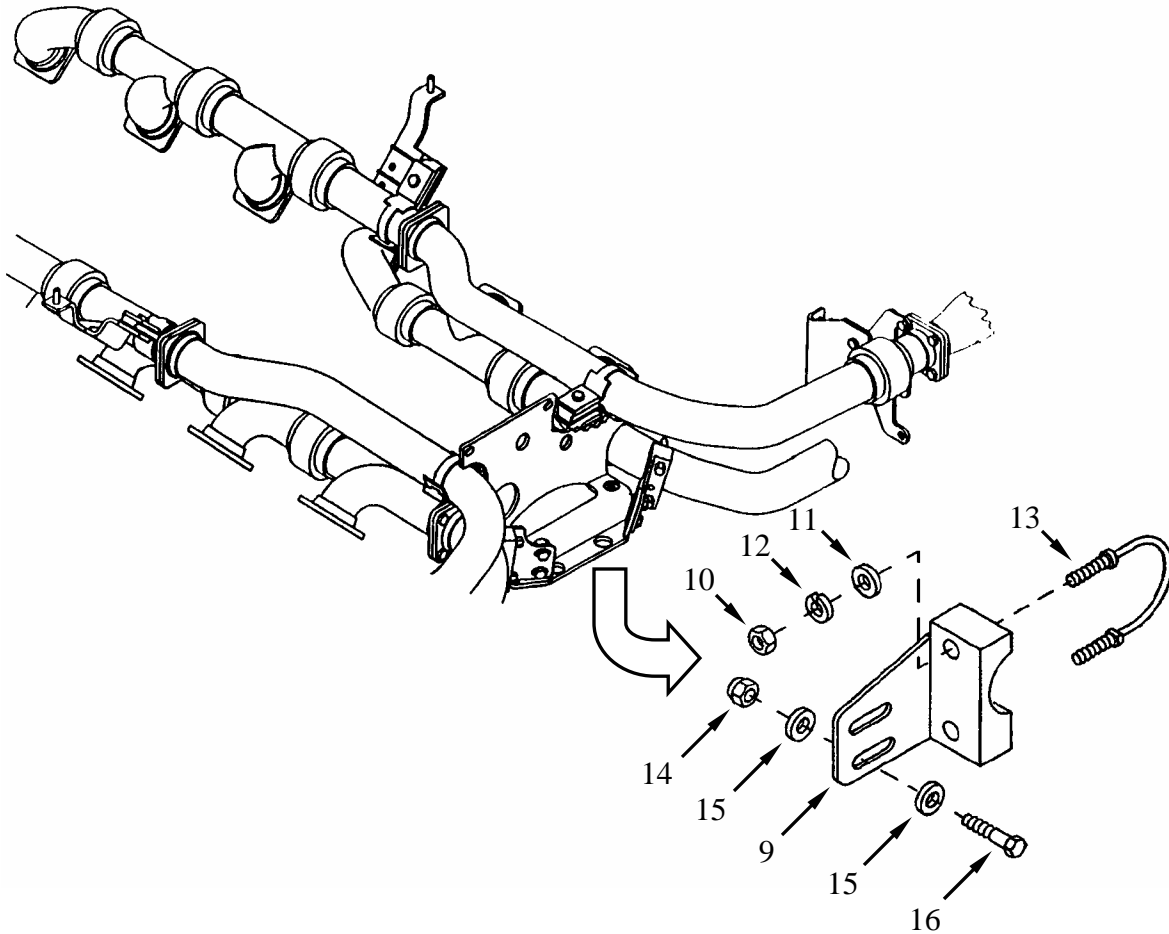
**INSTALLATION**

1. Install bracket (20).
  - a. Position bracket (20) and secure with two new self-locking nuts (21) (item 33, WP 0175).
2. Install two clamp assemblies (17).
  - a. Position clamps (17) and secure each with a new self-locking nut (18) (item 36, WP 0175) and screw (19).



**INSTALLATION (Continued)**

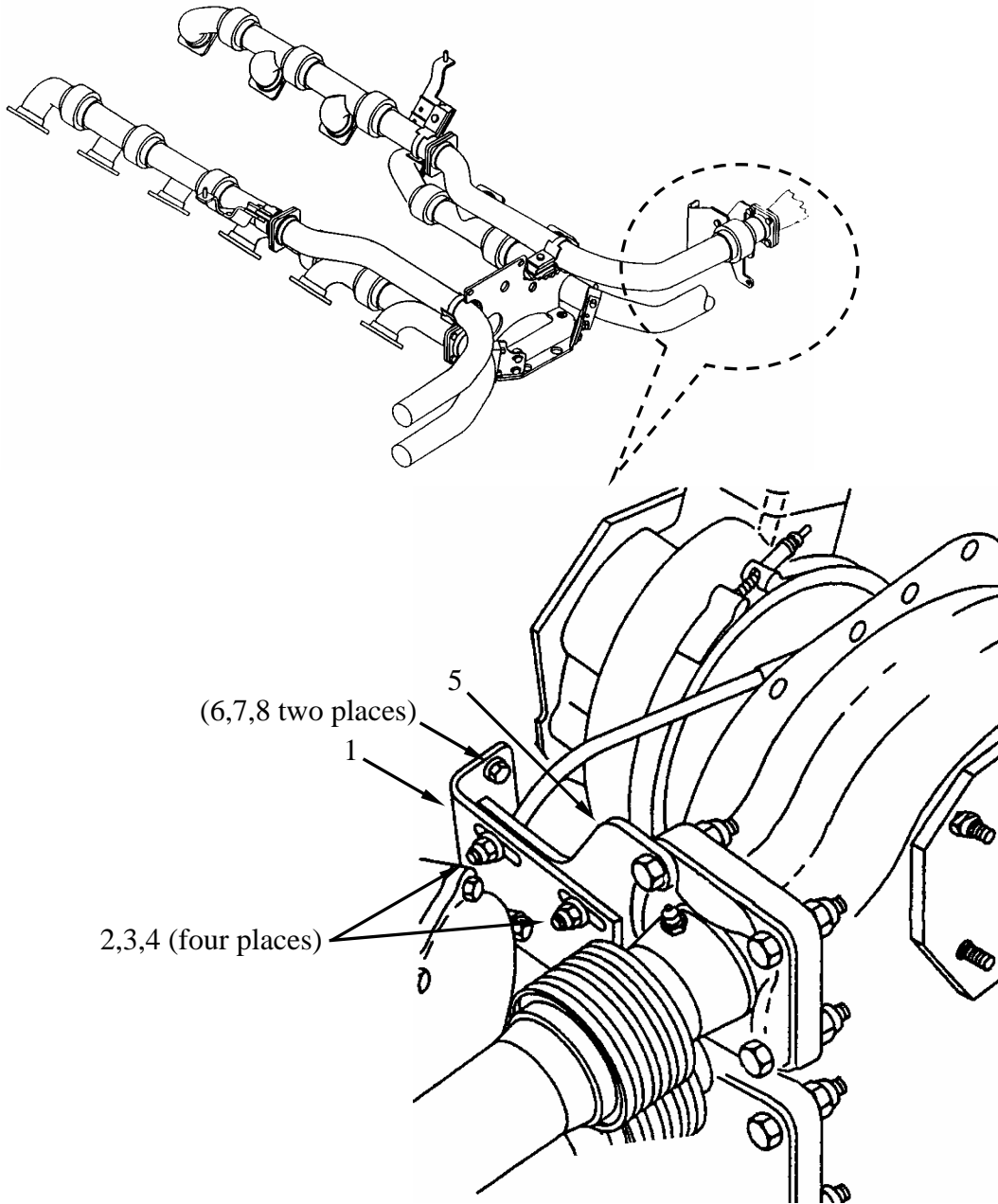
3. Install bracket (9).
  - a. Place bracket (9) into position and secure using two new self-locking nuts (14) (item 161, WP 0175), four flat washers (15) and two screws (16).
  - b. Install U-bolt (13).
  - c. Secure U-bolt (13) to bracket (9) using two nuts (10) with flat washers (11) and new lock washers (12)





**INSTALLATION (Continued)**

4. Install support bracket (1).
  - a. Fasten bracket (1) to engine shrouding using two screws (6) with flat washers (7) and new lock washers (8) (item 94, WP 0175).
  - b. Fasten bracket (1) to bracket (5) using four new self-locking nuts (2) (item 113, WP 0175), flat washers (3) and screws (4).



**END OF WORK PACKAGE**



**FIRE EXTINGUISHER TUBE REPLACEMENT**

**0097 00**

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Expendable and Durable Items:**

**Mandatory Replacement Parts:**

Lock washer (item 88, WP 0175)

Self-locking nut (item 32, WP 0175)

Self-locking nut (2) (item 140, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface

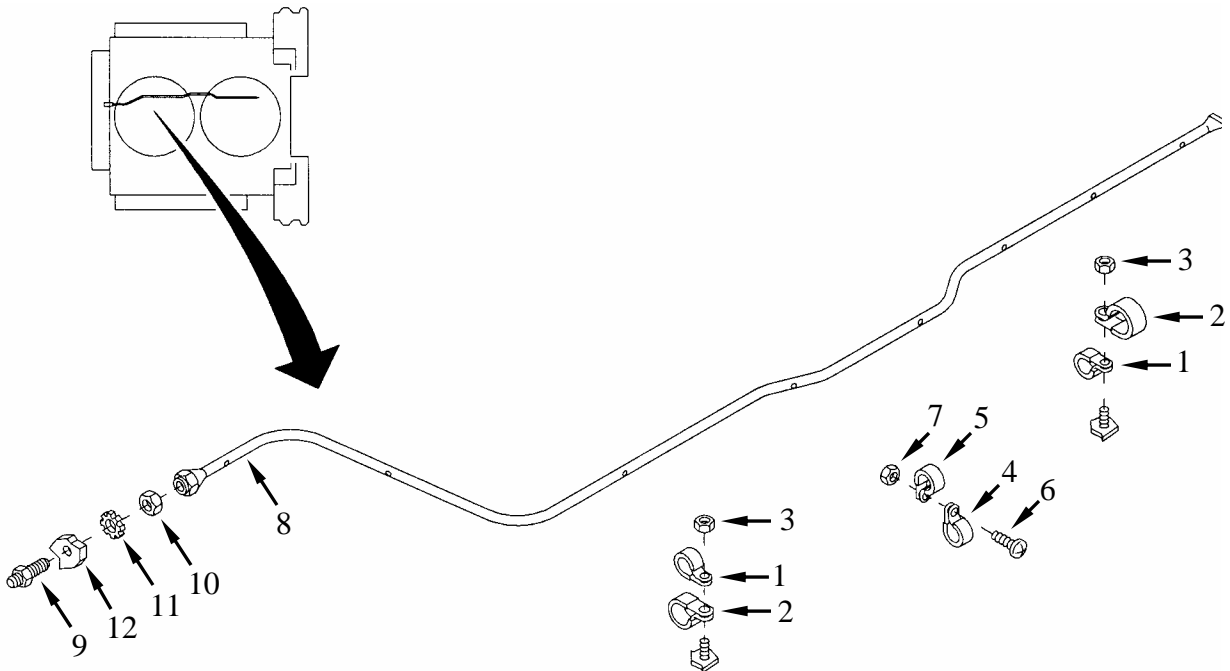
Engine top shroud removed (WP 0055)

Left side fuel injector lines removed (WP 0113).

Oil breather tubes removed (WP 0078).

**REMOVAL**

1. Remove four loop clamps (1, 2).
  - a. Remove and discard two self-locking nuts (3).
2. Remove two loop clamps (4, 5).
  - a. Remove screw (6) and self-locking nut (7). Discard self-locking nut.
3. Remove fire extinguisher tube (8) from bulkhead fitting (9).
4. Remove nut (10), lock washer (11), and bulkhead fitting (9) from engine shroud (12). Discard lock washer.



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

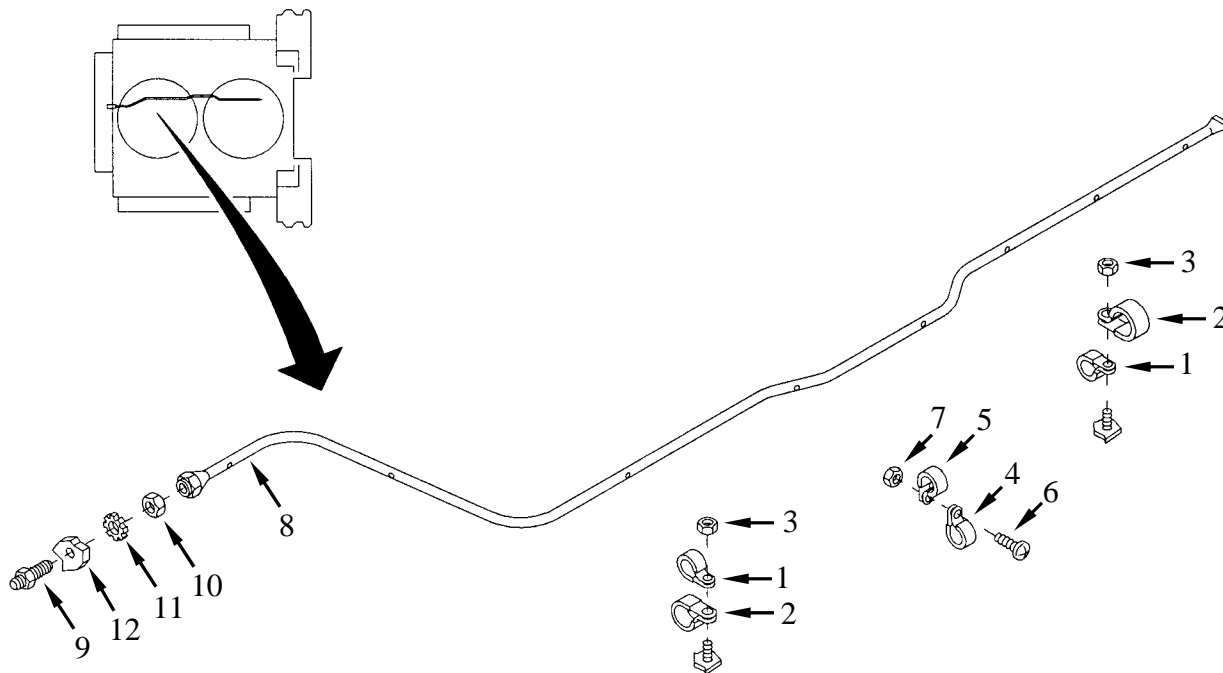
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

1. Install bulkhead fitting (9) into engine shroud (12).
  - a. Secure using nut (10) with new lock washer (11) (item 88, WP 0175).
2. Install fire extinguisher tube (8) onto bulkhead fitting (9).
3. Install two loop clamps (4, 5).
  - a. Secure using screw (6) and new self-locking nut (7) (item 32, WP 0175).
4. Install four loop clamps (1, 2).
  - a. Secure using two self-locking nuts (3) (item 140, WP 0175).



**END OF WORK PACKAGE**

**TM 9-2815-220-24**

**CHAPTER 7**

**DIRECT SUPPORT MAINTENANCE**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



**THIS WORK PACKAGE COVERS:**

Removal, Installation

**INITIAL SETUP:**

**Tools:**

- Air pressure source
- Engine multiple-leg sling:
  - For 2CA or 2DA, use item 38, WP 0176
  - For 2DR, use item 37 WP 0176
- Four-leg sling (for container) (item 105, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Hoist

**Tools (Continued):**

- Pneumatic tire valve repair tool (item 98, WP 0176)

**Personnel Required:**

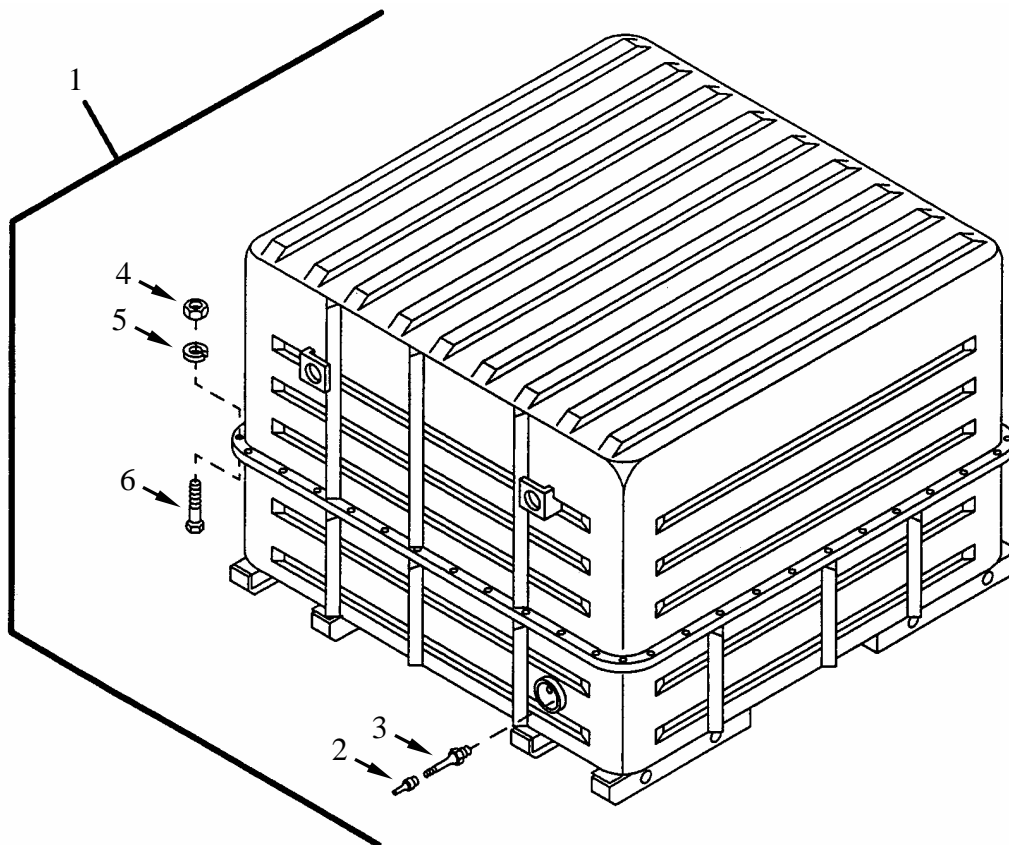
- Track Vehicle Repairer (63H10), and Helper

**Equipment Condition:**

- Engine out of vehicle and separated from transmission

**REMOVAL**

1. Release air pressure from container assembly (1) by removing the valve core (2) from pneumatic valve (3) using pneumatic tire valve repair tool.
2. Remove 48 nuts (4), lock washers (5), and screws (6) from container assembly (1). Retain parts for reassembly.

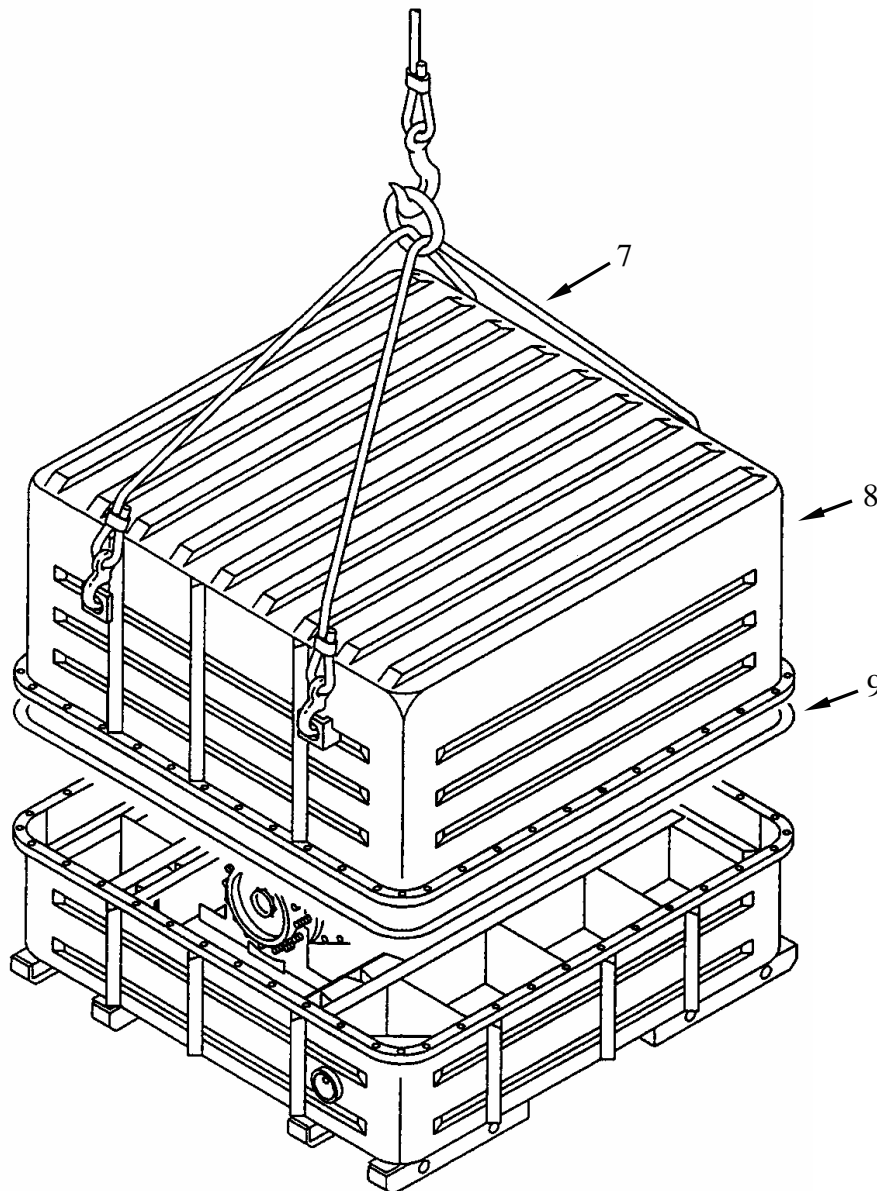


## REMOVAL (Continued)

**WARNING**

**Hanging loads, heavy parts, and overhead equipment could kill or injure you. Keep away from hanging loads, heavy parts, and overhead equipment. Use suitable lifting devices to move hanging loads and heavy parts. Always use helper to guide you.**

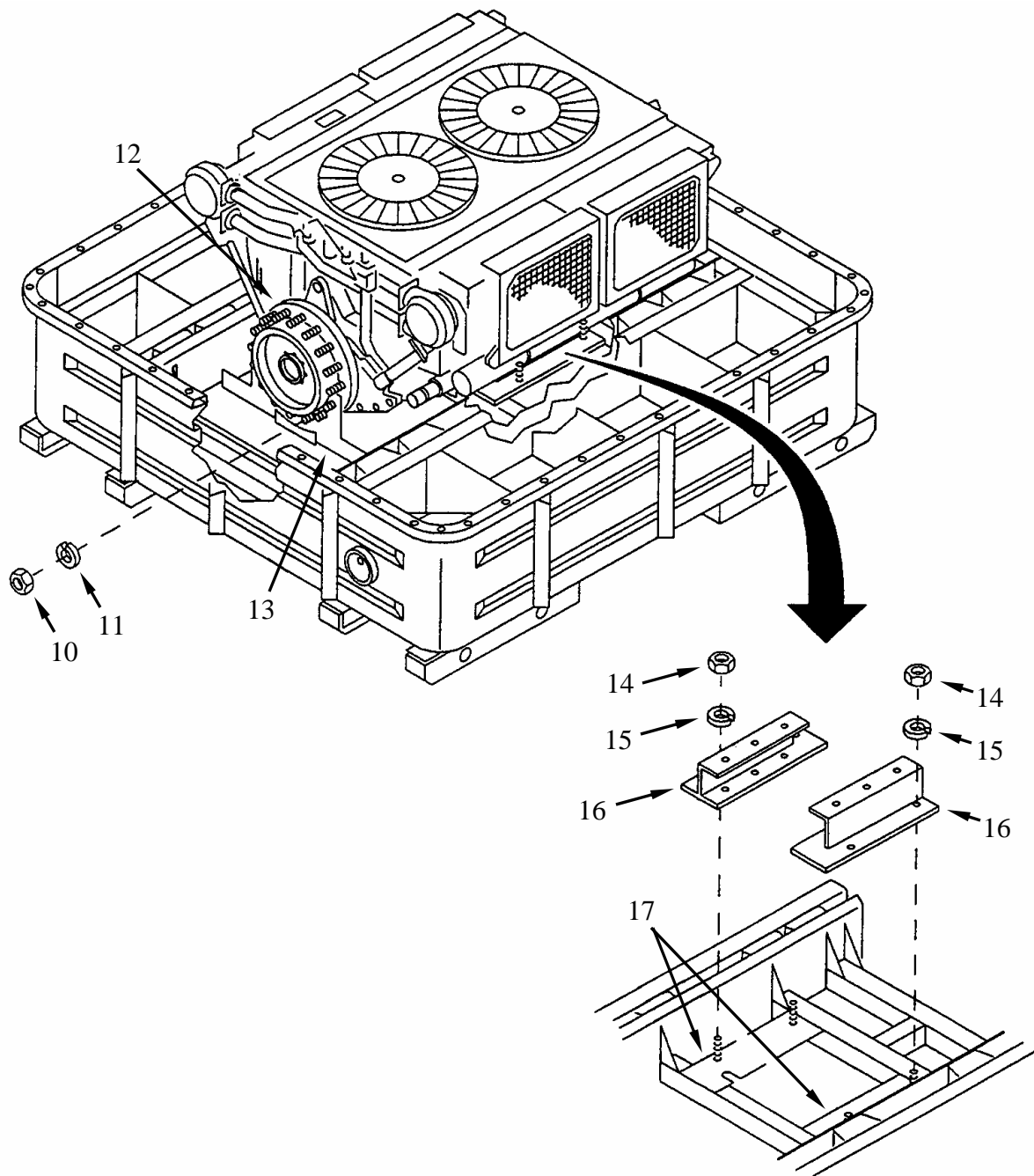
3. Attach sling (7) (item 105, WP 0176) to upper half of container (8) and to hoist.
4. With a helper to guide the load, remove upper half of container (8) and sealing gasket (9). Retain sealing gasket for reassembly.





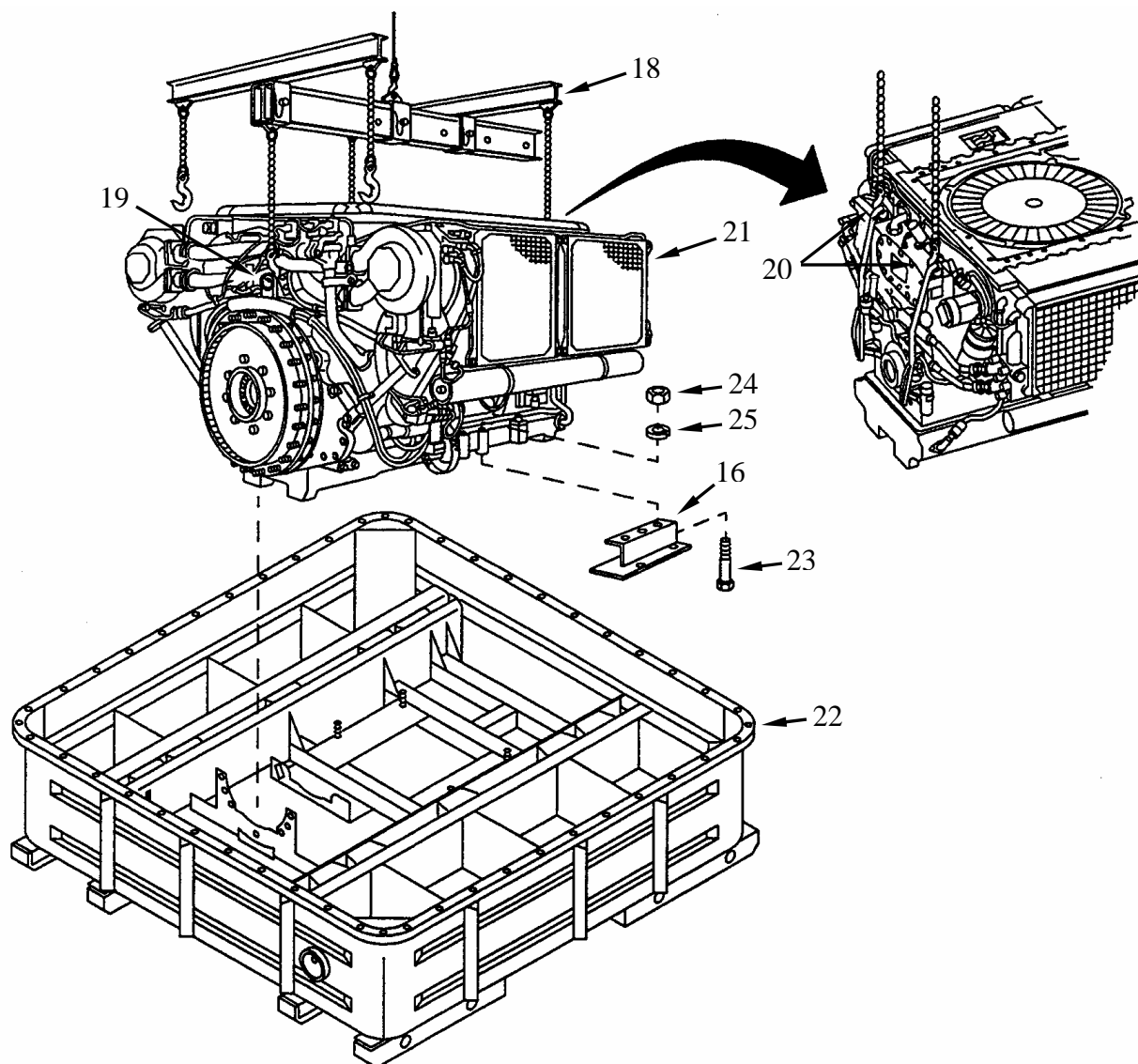
**REMOVAL (Continued)**

5. Remove seven nuts (10) with lock washers (11) securing transmission adapter (12) to support flange (13). Retain parts for reassembly.
6. Remove four nuts (14) with lock washers (15) securing engine mounting brackets (16) to mounting flanges (17). Retain parts for reassembly.



**REMOVAL (Continued)**

7. Attach engine sling assembly (18) (item 37 or 38, WP 0176) to hoist and to lifting eyes (19 and 20).
8. With a helper to guide load, carefully remove engine (21) from lower container half (22).
9. Lower engine (21) onto a flat surface, ensuring that it sits level.
10. Remove engine sling assembly (18) from engine (21) and hoist.
11. Remove six screws (23), nuts (24) and lock washers (25) from engine mount brackets (16). Retain parts for reassembly.
12. Slide engine mount brackets (16) off of engine (21). Retain with container for reassembly.
13. Inspect parts for damage and replace as required.

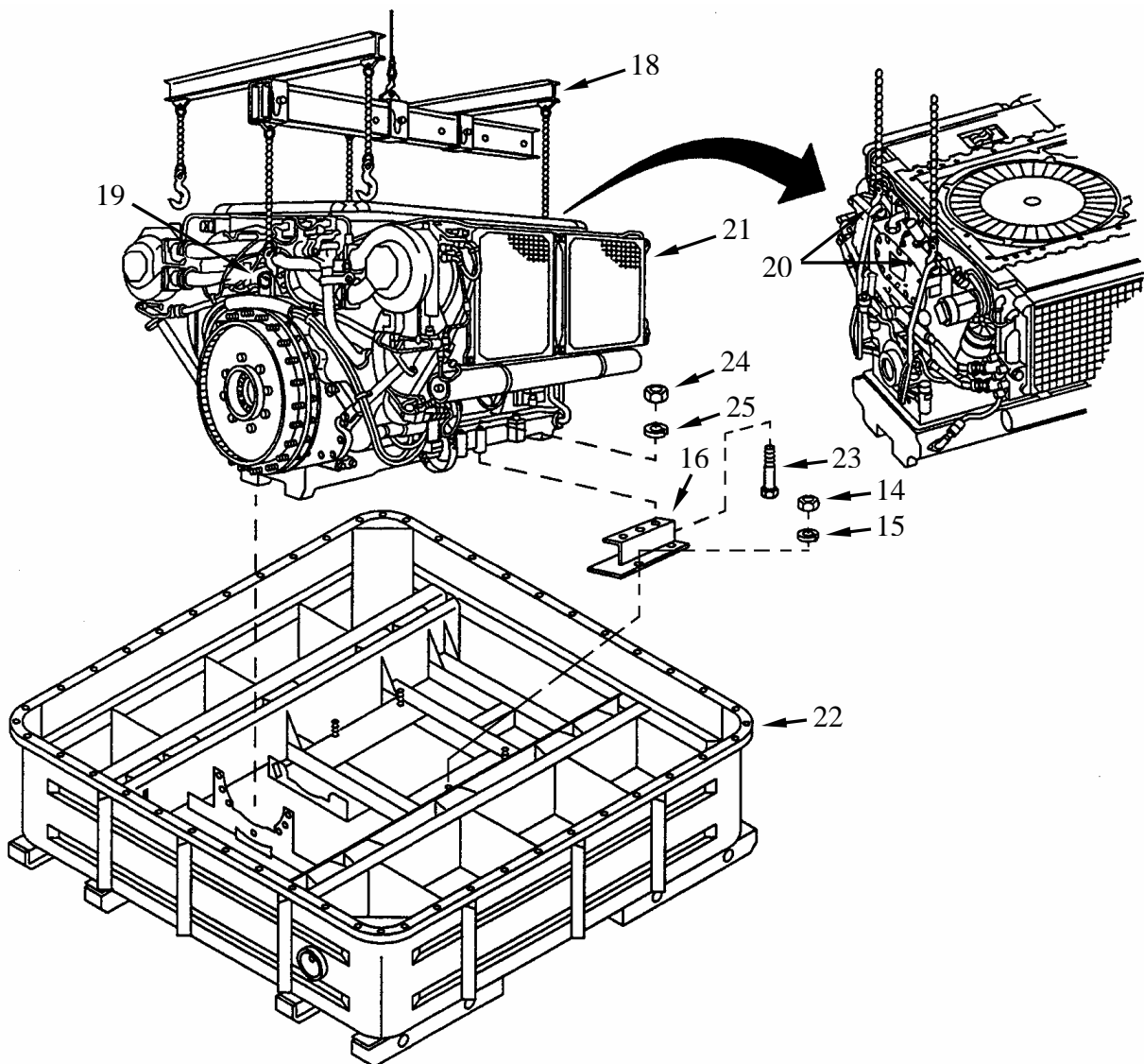


## INSTALLATION

1. Secure engine mount brackets (16) to engine (21) using six screws (23) with lock washers (25) and nuts (24).

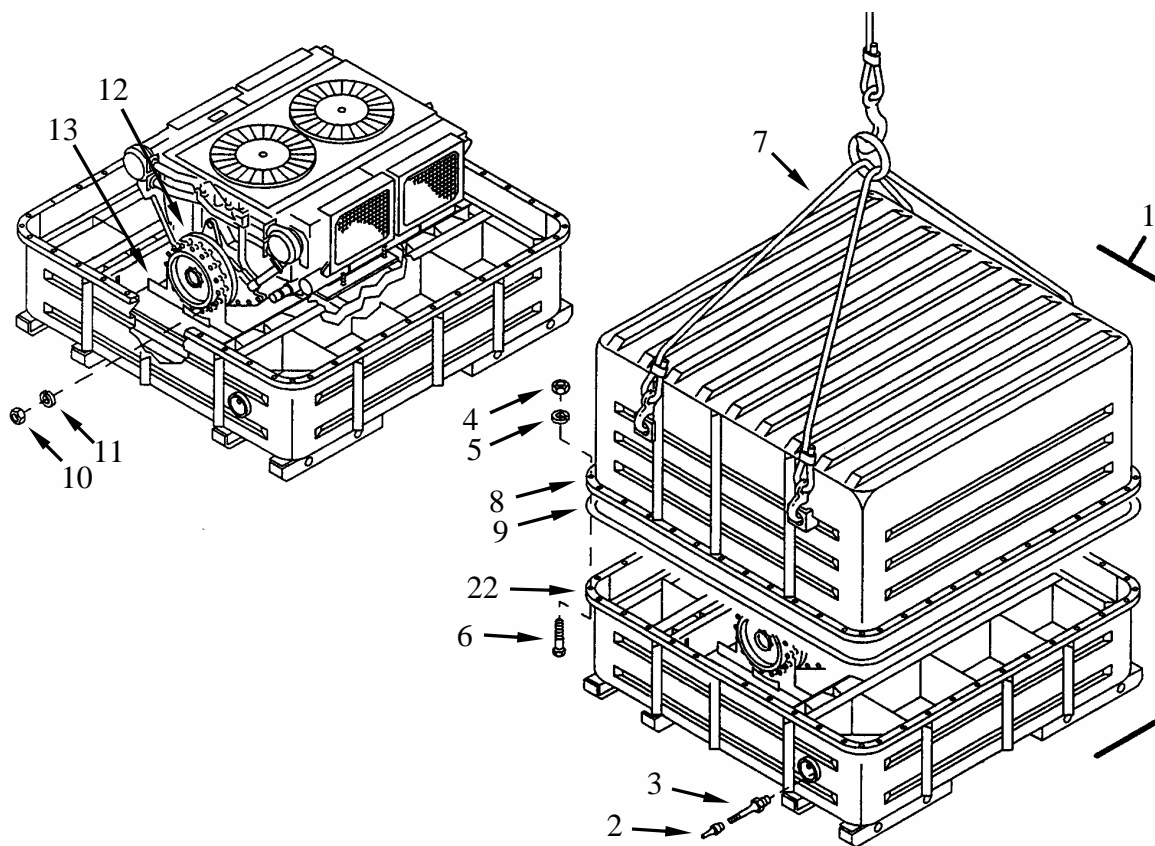
**WARNING**

2. Attach engine sling assembly (18) (item 37 or 38, WP 0176) to hoist and to lifting eyes (19 and 20).
3. With a helper to guide the load, carefully lift engine (21) and lower into container half (22), aligning holes in mounting brackets (16) and mounting flanges (17).
4. Remove engine sling assembly (18) from engine (21) and hoist.



**INSTALLATION (Continued)**

5. Secure engine mounting brackets (16) to mounting flanges (17) using four nuts (14) with lock washers (15).
6. Secure transmission adapter (12) to support flange (13) using seven nuts (10) with lock washers (11).
7. Attach gasket (9) to upper half of container (8).
8. Attach sling (7) (item 105, WP 0176) to upper half of container (8) and to hoist.
9. With helper to guide the load, carefully lower container upper half (8) in place over lower half (22).
10. Secure container halves (8) and (22) using 48 screws (6), and nuts (4) with lock washers (5).
11. Remove sling (7) from container half (8) and from hoist.
12. Install valve core (2) into pneumatic valve (3) then fill container assembly (1) to 5 psi (34.475 kPa) gauge pressure using clean dry air.

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Gasket (item 309, WP 0175)  
 Gasket (2) (item 327, WP 0175)  
 Lock washer (2) (item 94, WP 0175)  
 Self-locking nut (7) (item 33, WP 0175)  
 Self-locking nut (3) (item 282, WP 0175)  
 Self-locking nut (2) (item 41, WP 0175)  
 Self-locking nut (8) (item 161, WP 0175)

**Expendable and Durable Items:**

Anti-seize compound (item 5, WP 0173)  
 Engine oil, as needed (item 21, WP 0173)  
 Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat stationary surface  
 Dust Ejector System removed (WP 0083)  
 Dust detector pressure switch, bracket, and lines removed (WP 0082)

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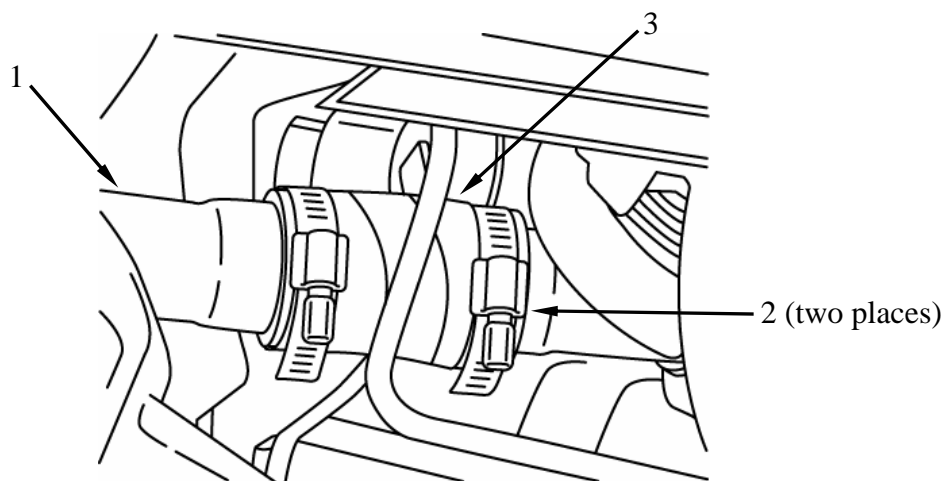
**REMOVAL**

**NOTE**

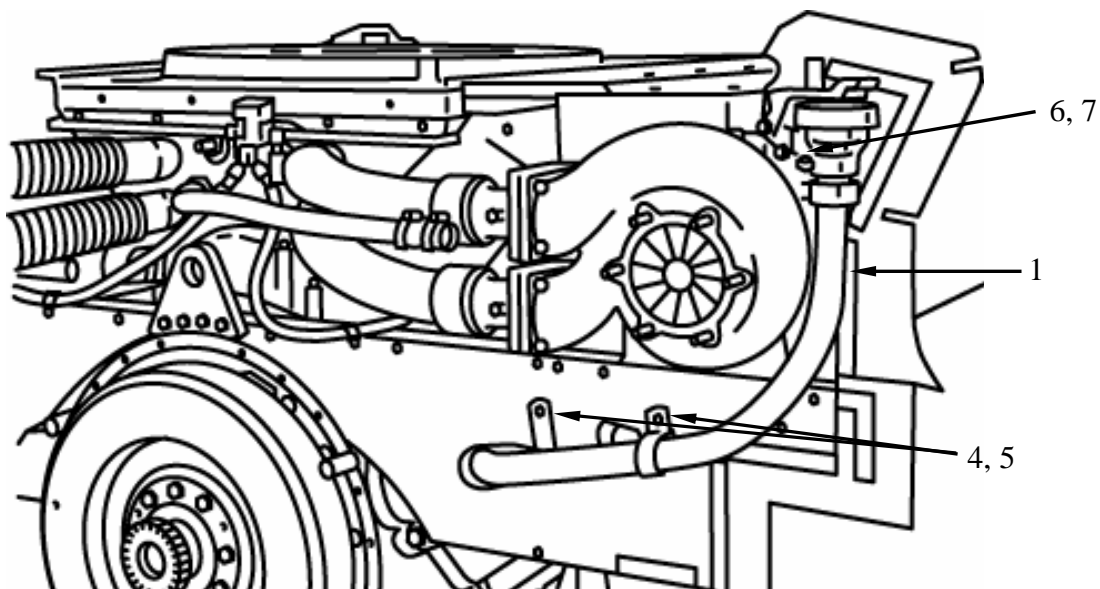
**Similar procedures are required to remove the left and right turbosuperchargers. For instructional purposes, removal of the left turbosupercharger is described. Removal procedures for the right turbosupercharger are the same, except for the oil filler tube installation.**

**REMOVAL (Continued)**

1. Remove engine oil filler tube (1).
  - a. Loosen hose clamps (2) on oil filler tube hose (3).

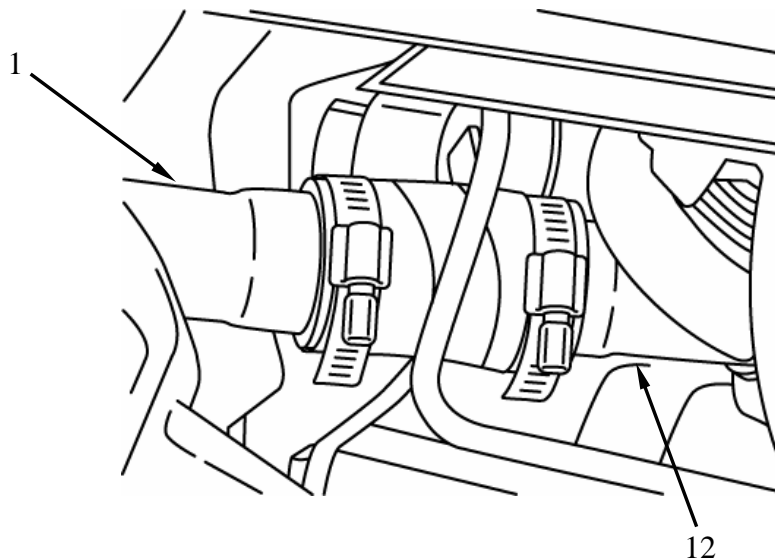
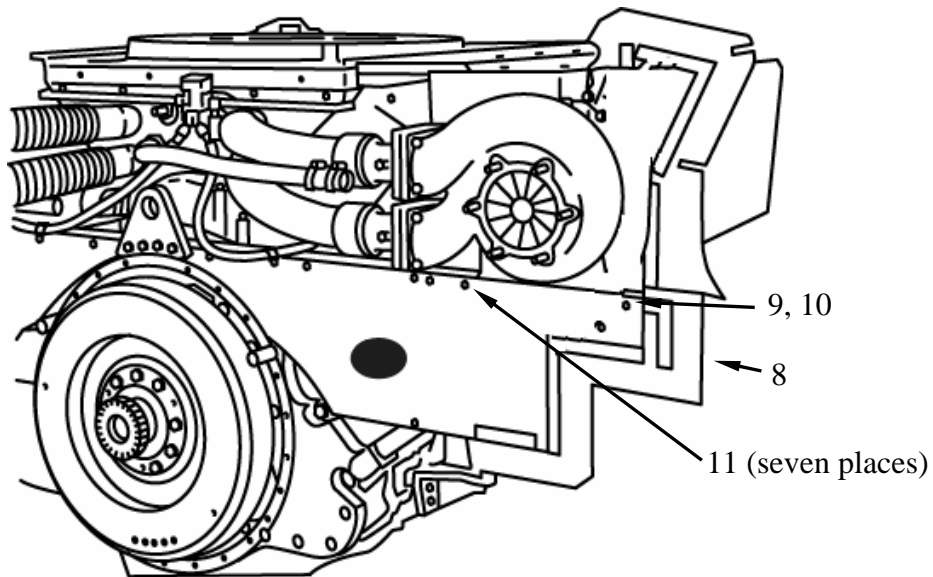


- b. Remove two screws (4) with lock washers (5). Discard lock washers.
  - c. Remove screw (6) secured with self-locking nut (7). Discard nut.
  - d. Remove upper oil filler tube (1).



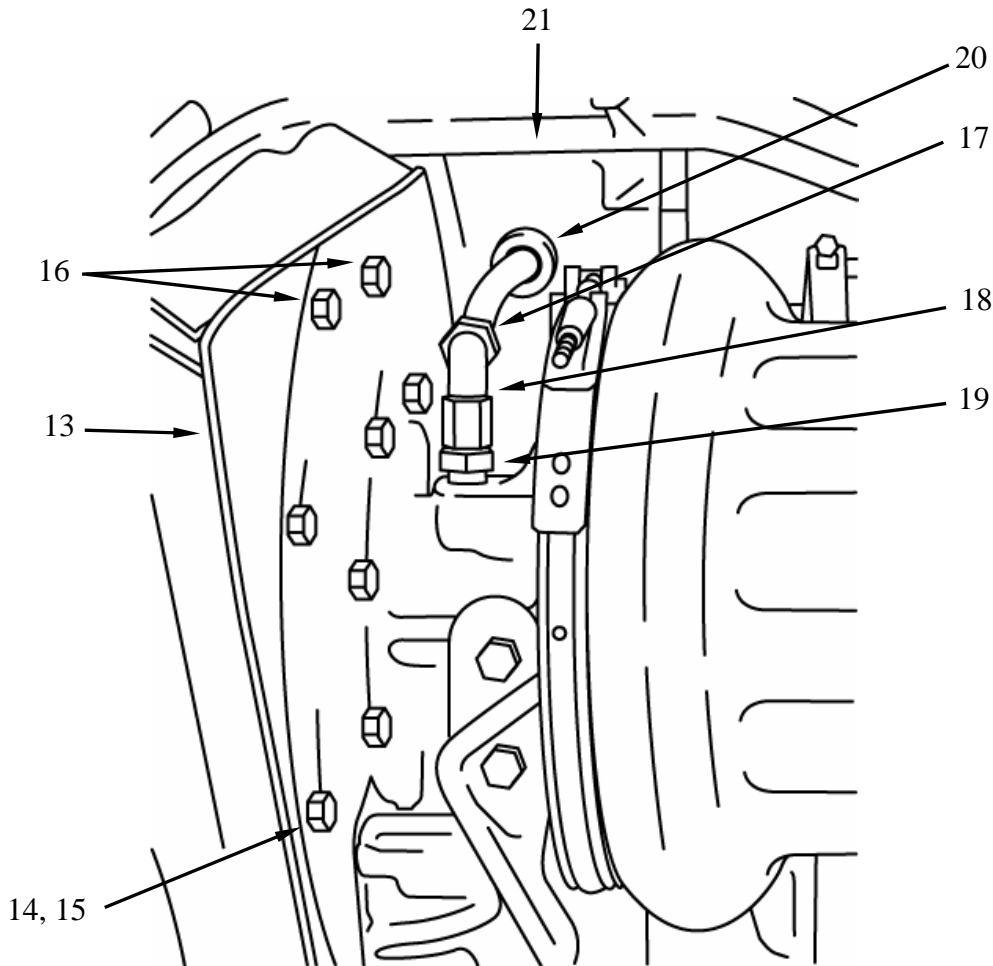
**REMOVAL (Continued)**

2. Remove lower left cooling air shroud (8).
  - a. Remove one self-locking nut (9) and screw (10). Discard nut.
  - b. Remove seven assembled washer bolts (11).
  - c. Remove lower left rear shroud plate (8).
  - d. Seal off the lower oil filler tube (12) with a clean cloth or suitable cover to prevent contamination (upper tube was removed in step 1d).



**REMOVAL (Continued)**

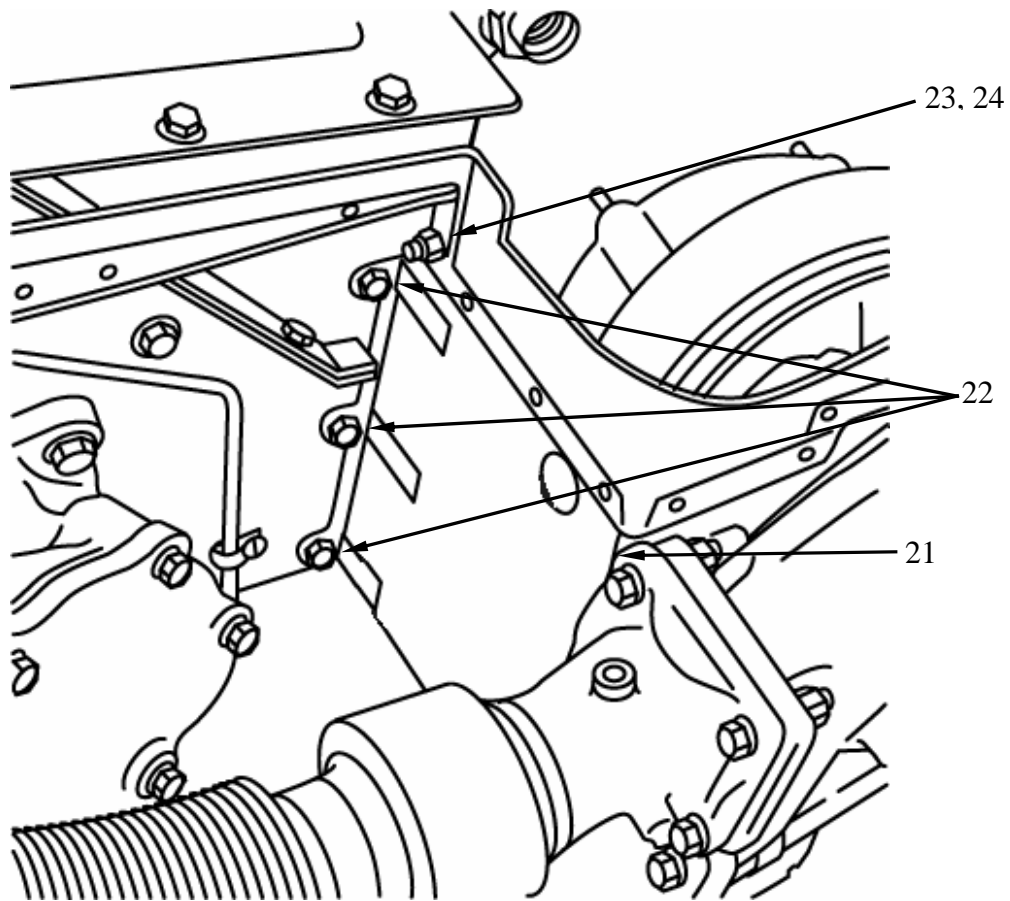
3. Remove turbosupercharger outer shroud (13).
  - a. Remove screw (14) secured with self-locking nut (15). Discard nut.
  - b. Remove two assembled washer bolts (16), and remove turbosupercharger outer shroud plate (13).
4. Remove turbosupercharger oil inlet hose (17).
  - a. Disconnect turbosupercharger oil inlet hose (17).
  - b. Remove oil inlet elbow (18) and nipple (19), retain for use in replacement turbosupercharger.
  - c. Remove grommet (20).
  - d. Pull oil inlet hose (17) through opening in inner shroud (21).





**REMOVAL (Continued)**

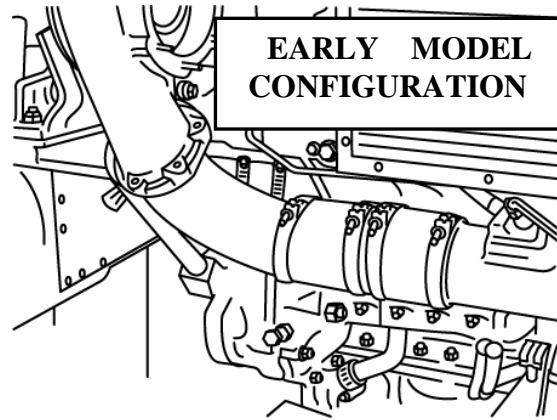
5. Remove turbosupercharger inner shroud (21).
  - a. Remove three assembled washer bolts (22).
  - b. Remove one self-locking nut (23) and screw (24). Discard nut.
  - c. Remove inner shroud plate (21).



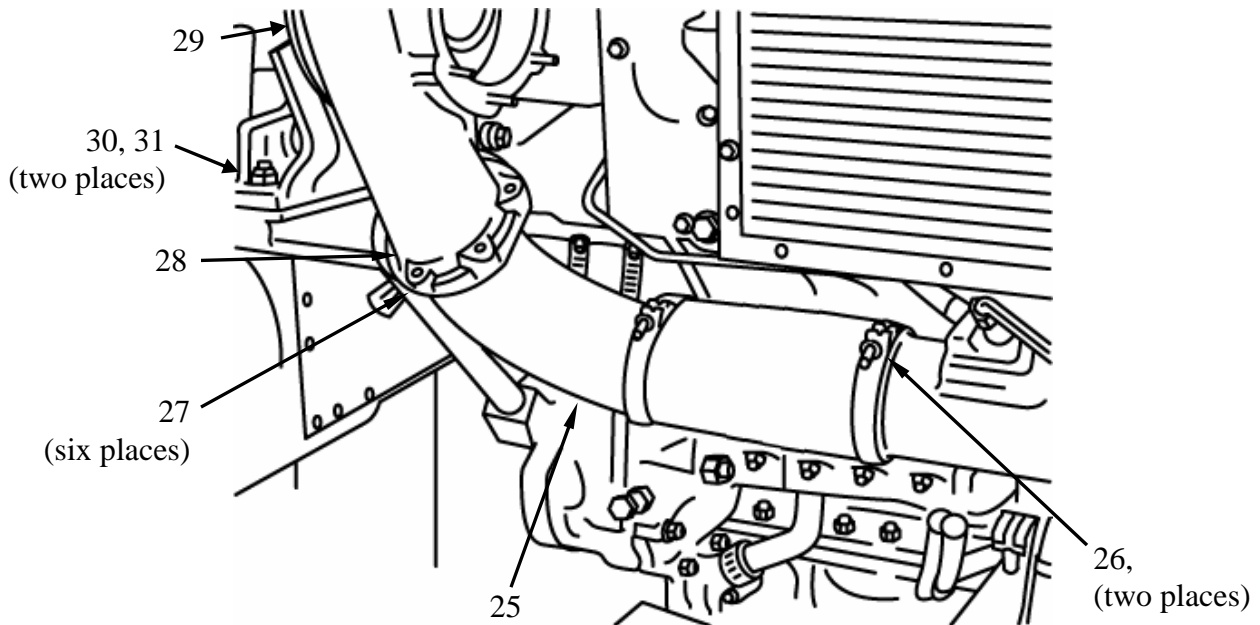
REMOVAL (Continued)

**CAUTION**

Early models may have a two-piece hose connection between the air outlet elbow and intake manifold. If your engine has the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number 11682625). Failure to comply may lead to premature engine failure due to dust ingestion.

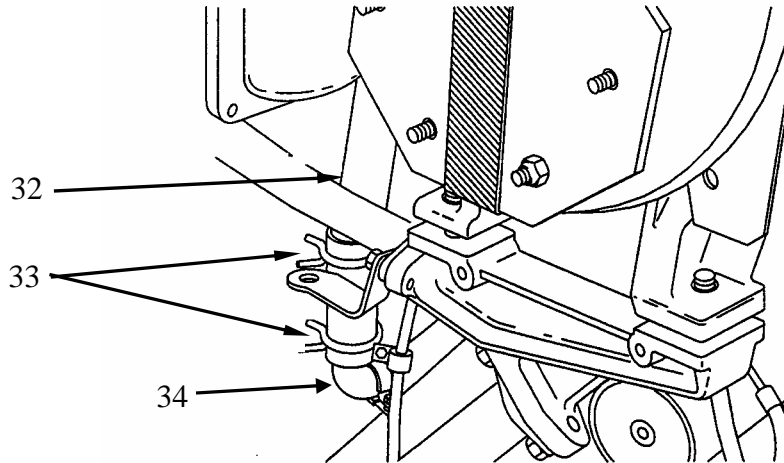


6. Remove air outlet elbow (25).
  - a. Loosen self-locking nuts on hose clamps (26).
  - b. Remove six self-locking nuts (27) and remove air outlet elbow (25). Discard nuts.
  - c. Remove and discard air outlet elbow gasket (28).
  
7. Remove turbosupercharger (29) mounting nuts.
  - a. Remove two self-locking nuts (30) with flat washers (31) at turbosupercharger mounting base studs. Discard locking nuts.

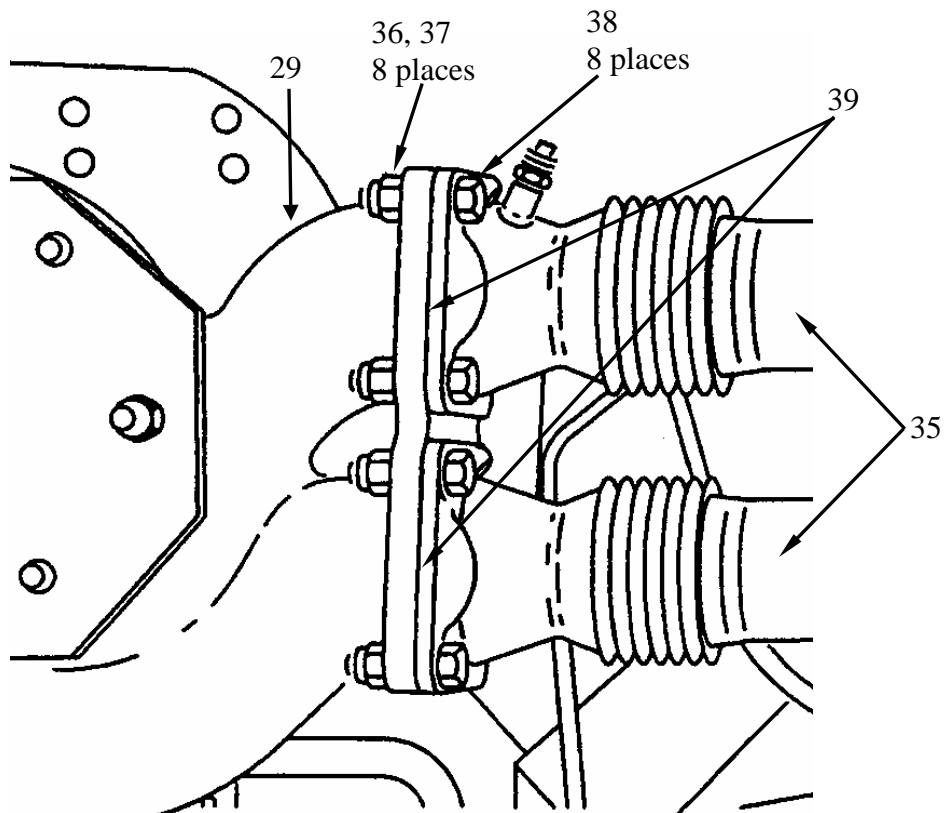


**REMOVAL (Continued)**

8. Loosen turbosupercharger oil drain (32).
  - a. Loosen two hose clamps (33) at turbosupercharger oil drain (32) and connecting line (34).

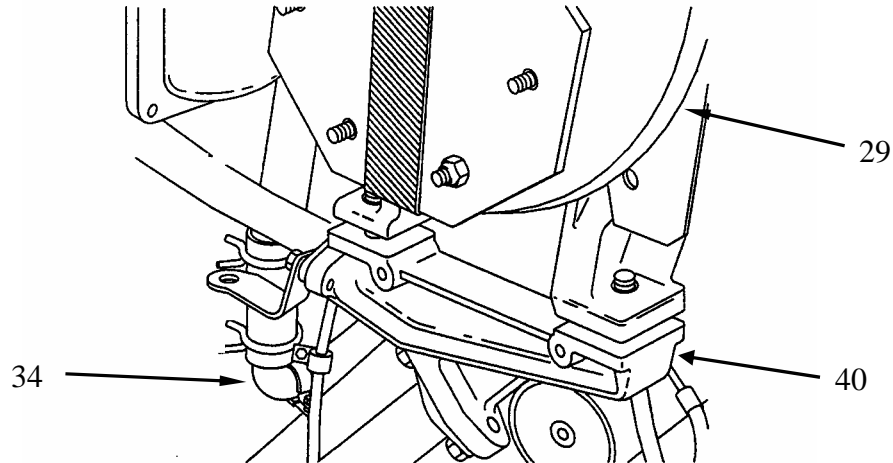


9. Remove exhaust pipes (35).
  - a. Remove eight self-locking nuts (36), flat washers (37) and screws (38). Discard nuts.
  - b. Separate exhaust pipes (35) from turbosupercharger (29).
  - c. Remove and discard two gaskets (39).



**REMOVAL (Continued)**

10. Remove turbosupercharger (29) from base assembly (40).
11. Seal off oil drain tube (34) with a clean cloth or other suitable cover to prevent contamination.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

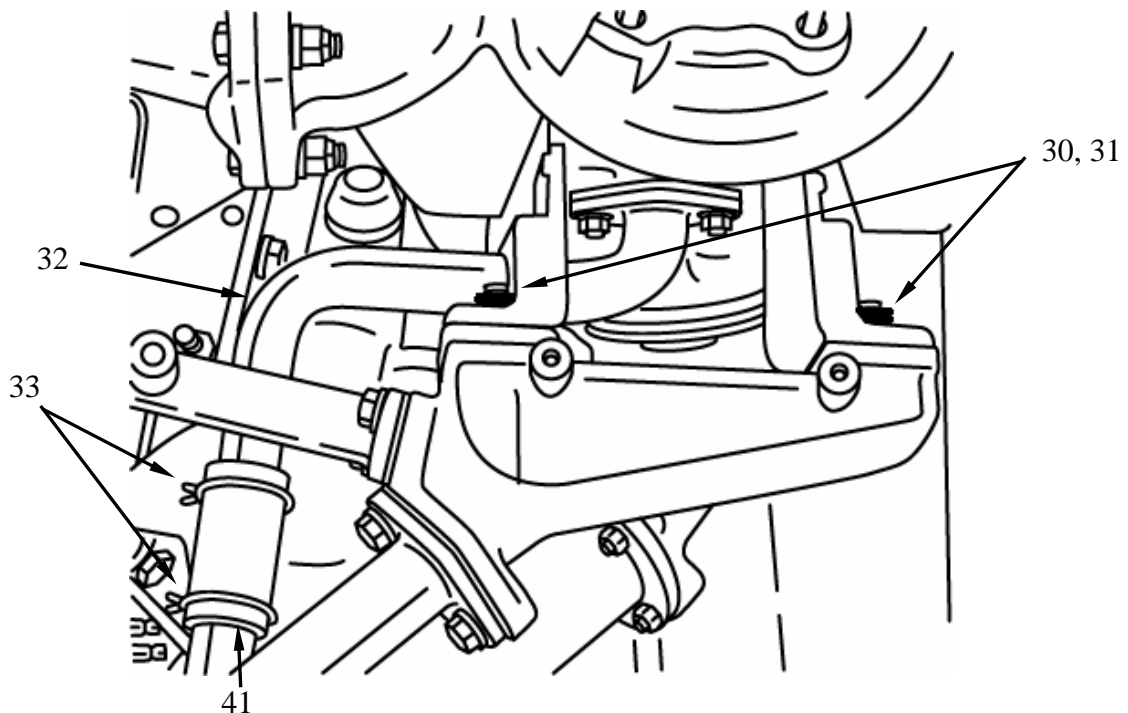
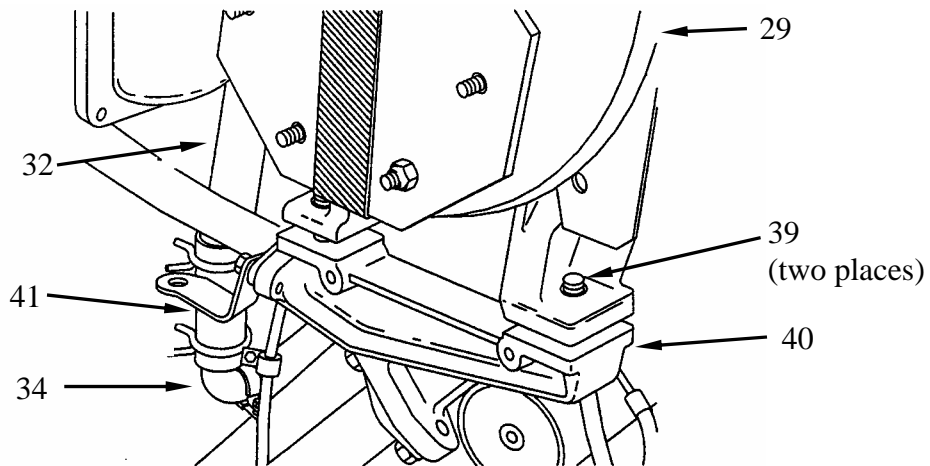
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

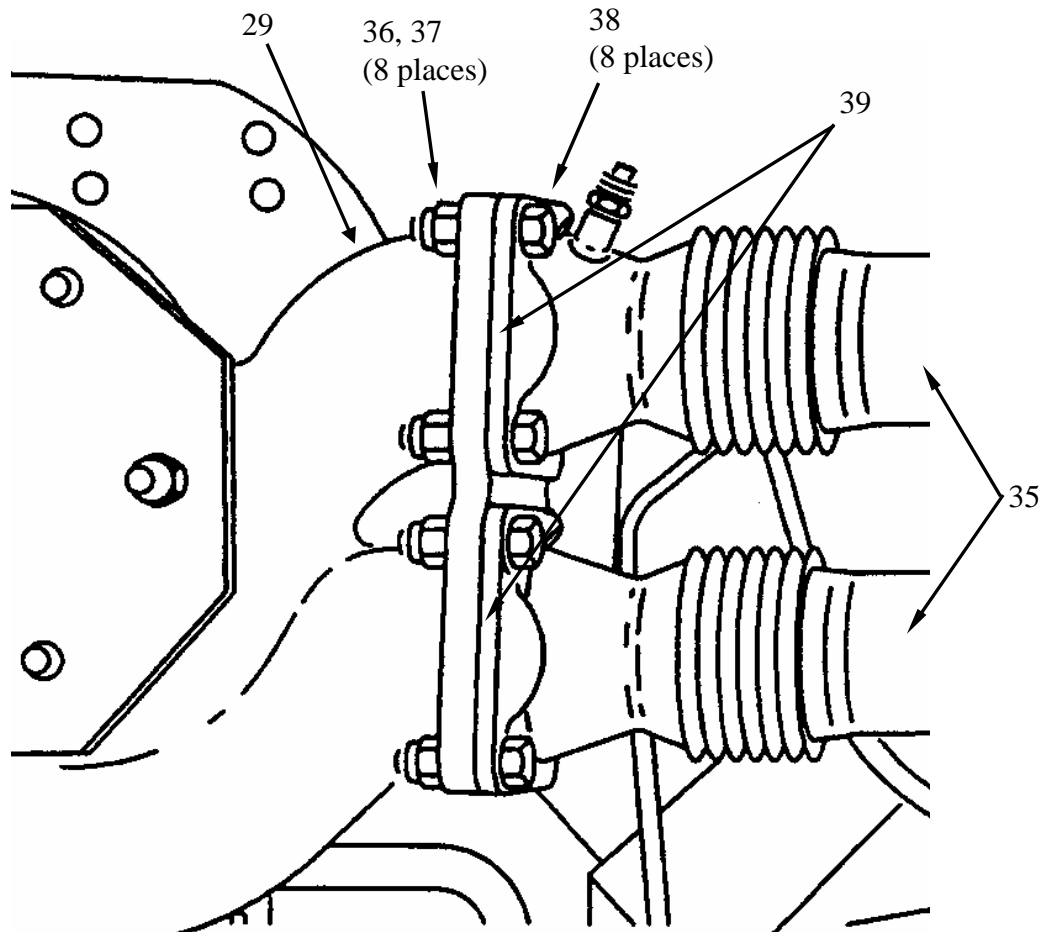
**INSTALLATION**

1. Install turbosupercharger (29).
  - a. Remove protective cover previously installed onto lower oil filler tube (34).
  - b. Position turbosupercharger (29) onto mounting base (40).
  - c. Insert turbosupercharger oil drain tube (32) into oil drain tube hose (41) and connecting drain tube (34).
  - d. Secure turbosupercharger (29) to mounting base using two new self-locking nuts (30) (item 41, WP 0175) with flat washers (31). Do not tighten at this time.
  - e. Secure oil drain tube (32) to oil drain hose (41) with hose clamps (33).



**INSTALLATION (Continued)**

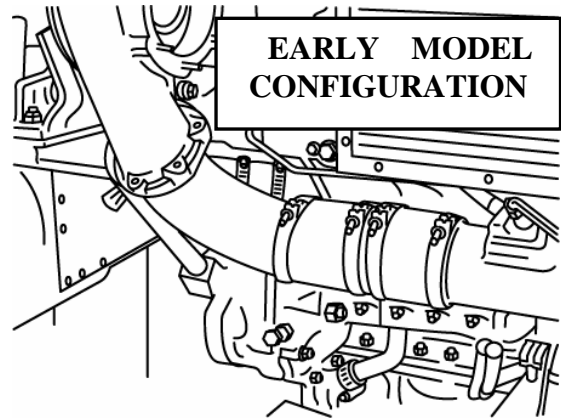
2. Install exhaust pipes (35).
  - a. Lubricate eight screws (38) with antiseize compound (item 5, WP 0173).
  - b. Position two new exhaust gaskets (39) (item 327, WP 0175).
  - c. Secure exhaust pipes (35) to turbosupercharger housing (29) using eight new self-locking nuts (36) (item 161, WP 0175), flat washers (37), and screws (38). Do not tighten screws at this time.



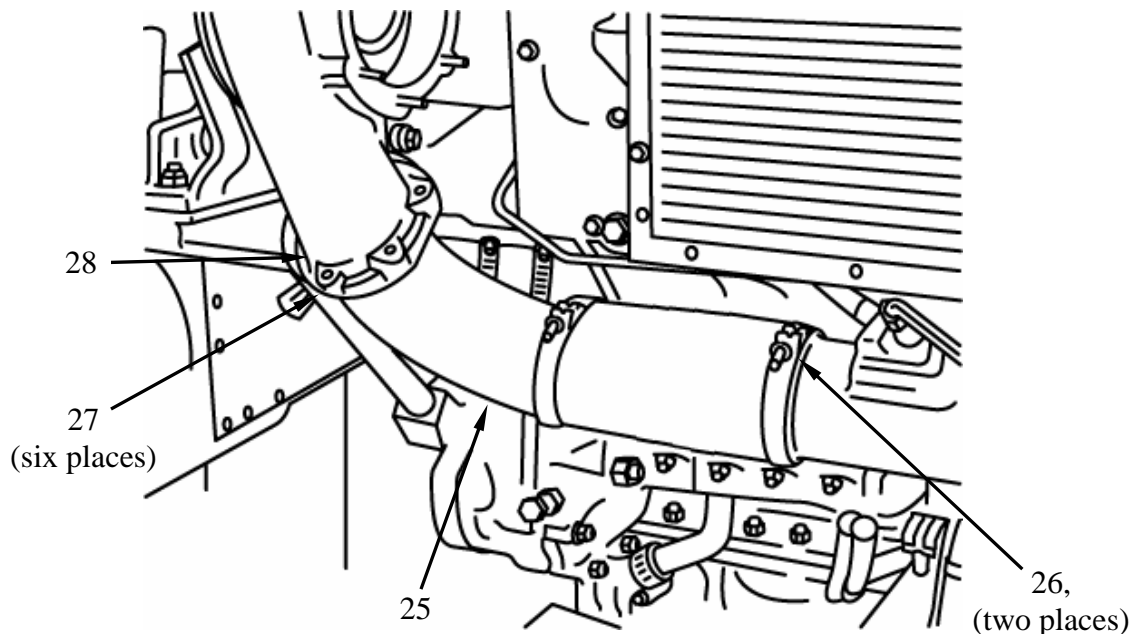
## INSTALLATION (Continued)

**CAUTION**

Early models may have a two-piece hose connection between the air outlet elbow and intake manifold. If your engine has the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number 11682625). Failure to comply may lead to premature engine failure due to dust ingestion.

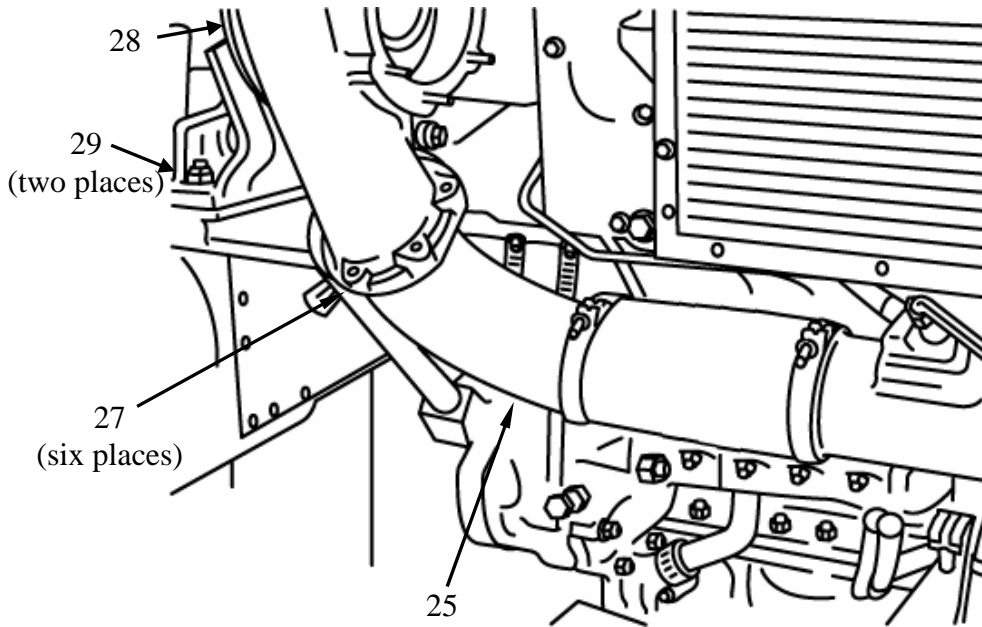


3. Install air outlet elbow (25).
  - a. Install air outlet elbow (25) with new gasket (28) (item 309, WP 0175) and secure using six new self-locking nuts (27) (item 33, WP 0175). Do not tighten at this time.
  - b. Reposition and tighten hose clamps (26) until spring bottoms, then back-off 1 to 1-1/2 turns.

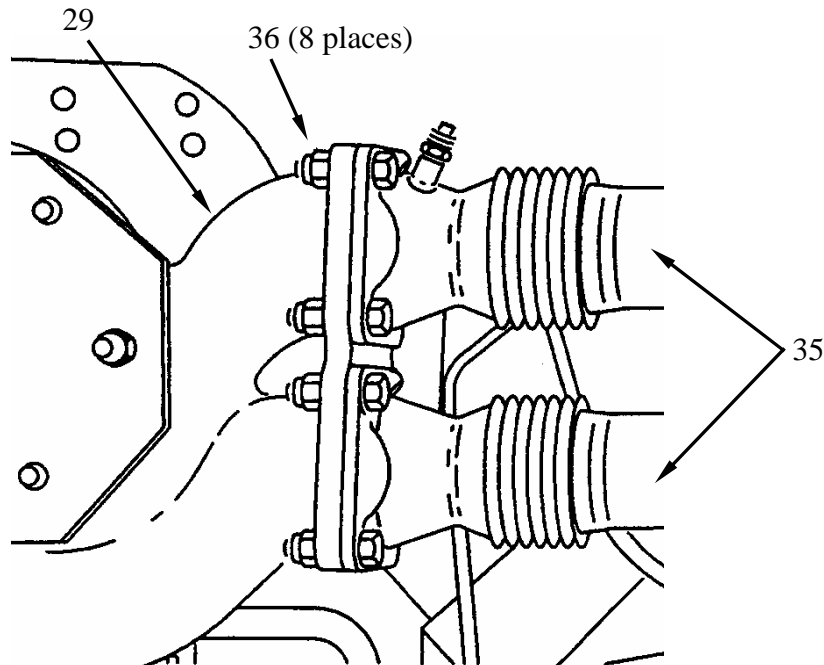


**INSTALLATION (Continued)**

3. Install air outlet elbow (25) (continued).
  - c. Tighten remaining assembled parts at this time.
    - (1) Tighten turbosupercharger base self-locking nuts (29).
    - (2) Tighten self-locking nuts (27) at air outlet elbow (25).



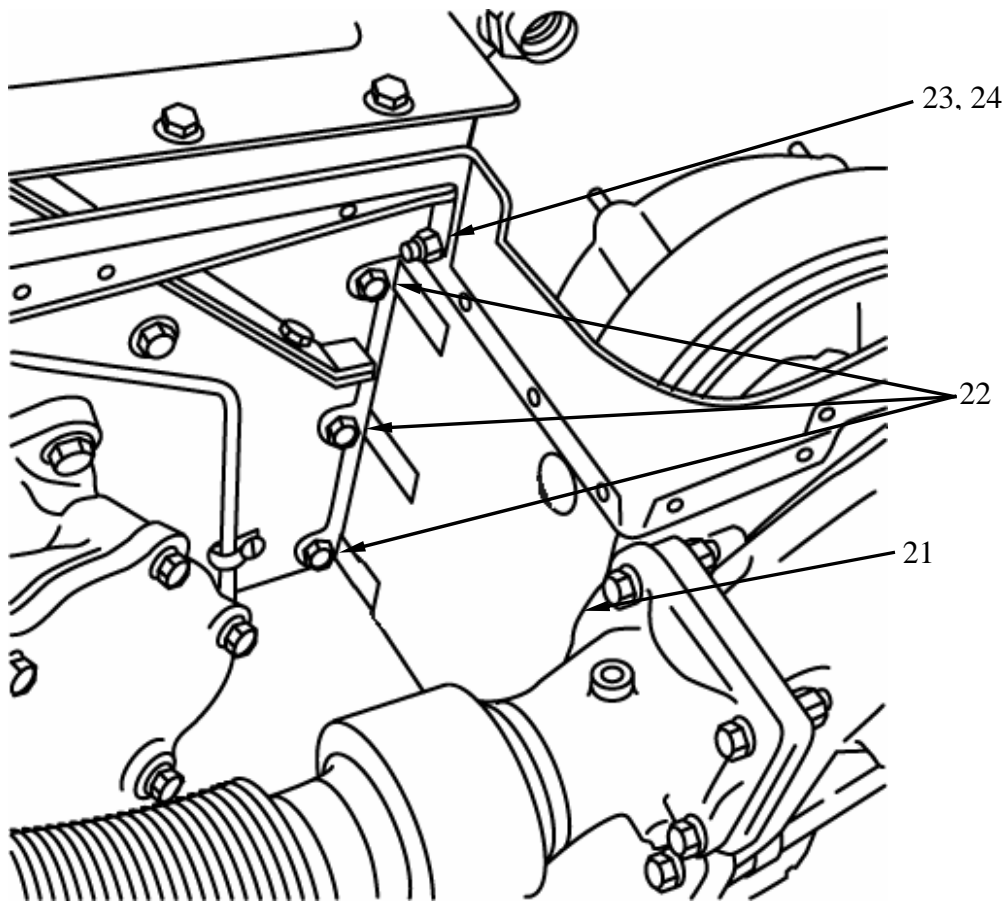
- (3) Tighten self-locking nuts (36) at exhaust pipes (35) to turbosupercharger housing (29).





**INSTALLATION (Continued)**

4. Install inner cooling shroud (21).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to three assembled washer bolts (22).
  - b. Install inner shroud plate (21) to oil cooler frame with three assembled washer bolts (22).
  - c. Install inner shroud plate (21) to upper access cover using self-locking nut (23) (item 282, WP 0175) and screw (24).

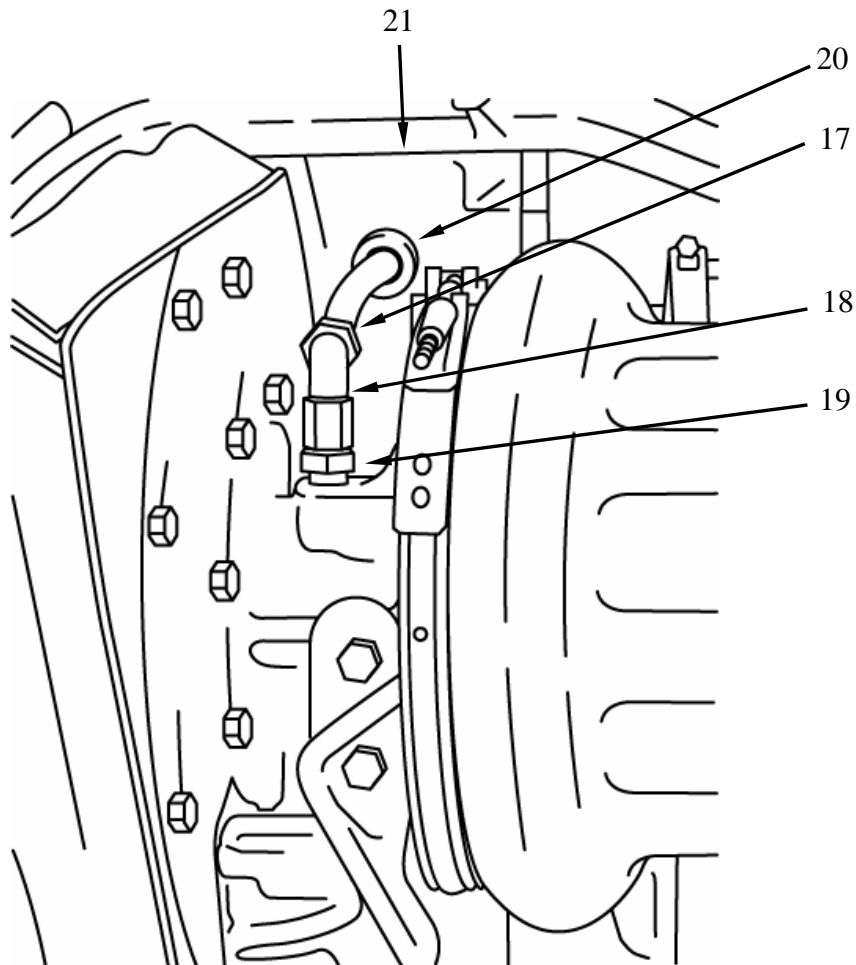


## INSTALLATION (Continued)

## NOTE

**New turbosuperchargers do not come with oil supply hose fittings. Old fittings must be reused or new fittings acquired when installing a new turbosupercharger.**

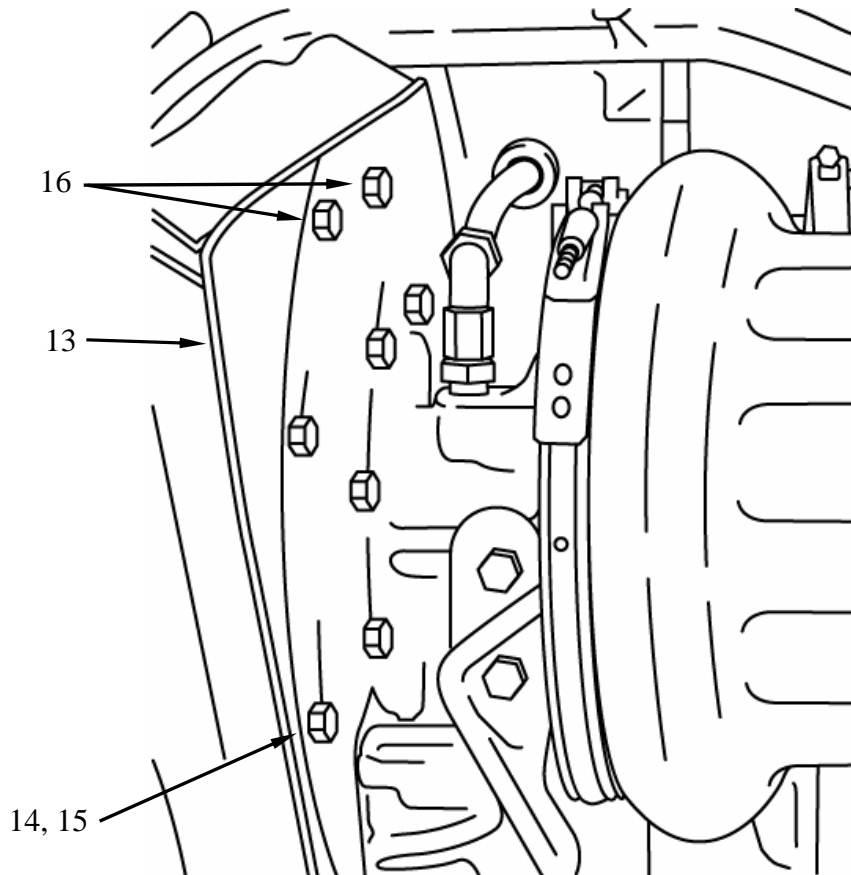
5. Install turbosupercharger oil supply hose (17).
  - a. Feed oil inlet hose (17) through shroud (21).
  - b. Install oil inlet hose grommet (20).
  - c. Apply a small amount of engine oil (item 21, WP 0173) to oil inlet adapter (19) and oil inlet elbow (18).
  - d. Install oil inlet adapter (19) and oil inlet elbow (18) in turbosupercharger.
  - e. Connect oil inlet supply hose (17).



**INSTALLATION (Continued)**

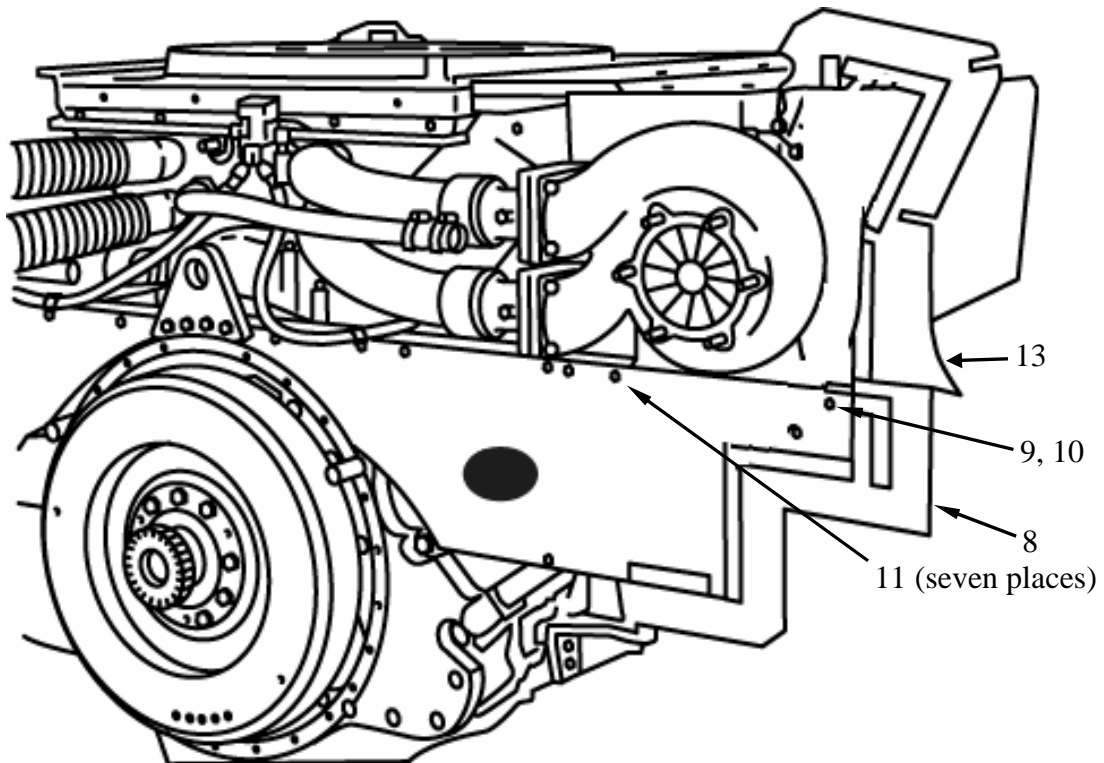
6. Install outer cooling shroud (13).

- a. Apply a small amount of Lubriplate (item 23, WP 0173) to two screws (16).
- b. Secure outer shroud plate (13) to turbosupercharger heat shield using screw (14), with new self-locking nut (15) (item 282, WP 0175).
- c. Secure outer shroud plate (13) to turbosupercharger using two assembled washer bolts (16).



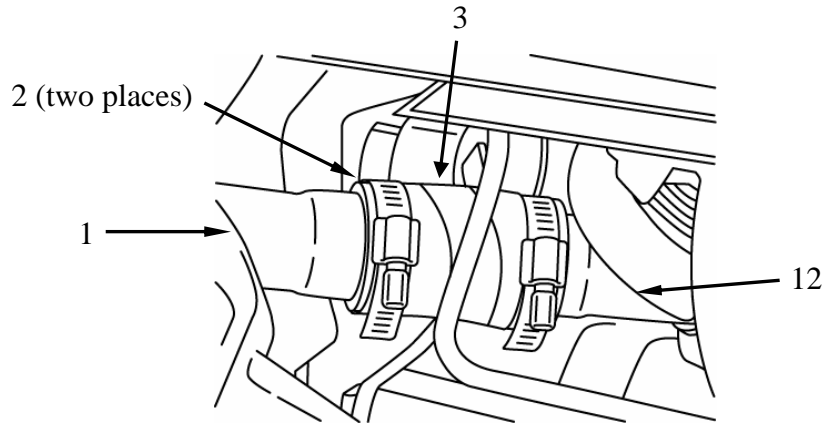
**INSTALLATION (Continued)**

7. Install lower left rear shroud plate (8).
  - a. Secure lower left rear shroud plate (8) using seven assembled washer bolts (11).
  - b. Secure turbosupercharger outer shroud (13) using one new self-locking nut (9) (item 282, WP 0175) and screw (10).

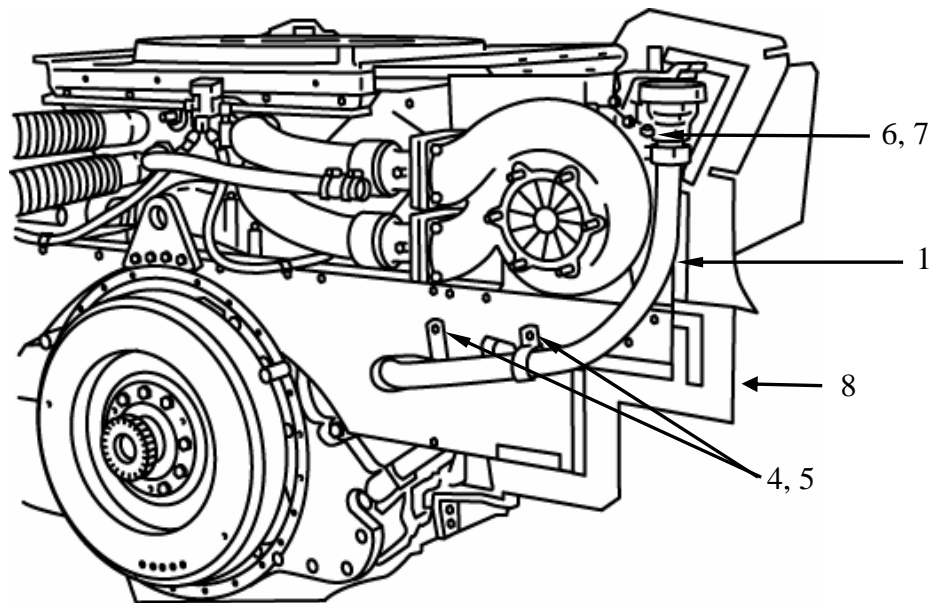


**INSTALLATION (Continued)**

8. Install engine oil filler tube (1).
  - a. Remove protective cover previously installed onto lower oil filler tube (12) opening.
  - b. Install upper oil filler tube (1) through lower left rear shroud plate (8).
  - c. Insert lower end of tube (1) into oil filler hose (3).



- d. Secure upper oil filler tube using one screw (6) with new self-locking nut (7) (item 33, WP 0175).
- e. Secure upper oil filler tube (1) using two screws (4) with new lock washers (5) (item 94, WP 0175).
- f. Tighten hose clamps (2) at oil filler tube connection (1).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Expendable and Durable Items:**

Antiseize compound (item 5, WP 0173)

Engine oil, as needed (item 21, WP 0173)

**Equipment Conditions:**

Engine level on flat surface

Dust detector pressure switch, bracket, and lines removed (WP 0082)

**Mandatory Replacement Parts:**

Gasket (1) (item 279, WP 0175)

Gasket (2) (item 327, WP 0175)

Self-locking nut (2) (item 140, WP 0175)

Self-locking nut (7) (item 33, WP 0175)

Self-locking nut (2) (item 41, WP 0175)

Self-locking nut (6) (item 161, WP 0175)

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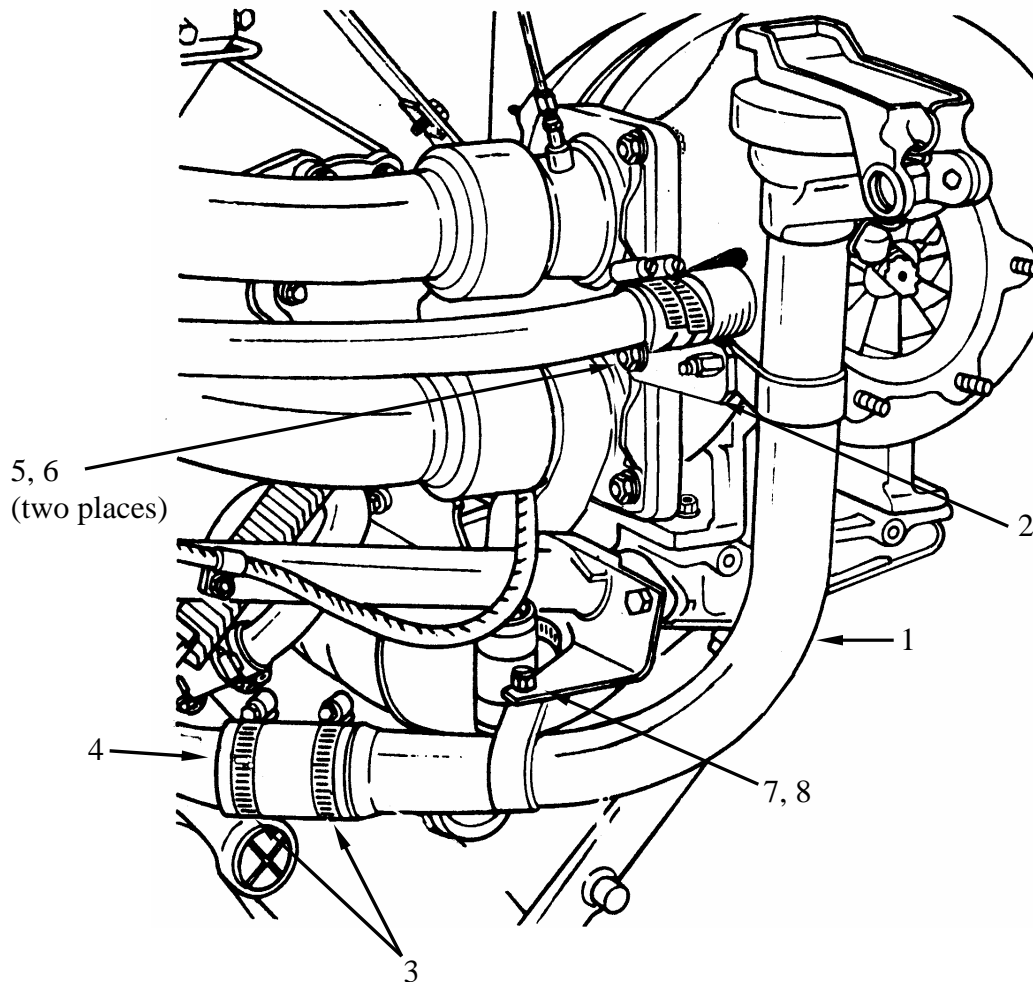
**REMOVAL**

**NOTE**

**Similar procedures are required to remove the left and right turbosuperchargers. For instructional purposes the left turbosupercharger is described. Removal procedures for the right turbosupercharger are the same, except for the oil filler tube installation.**

**REMOVAL (Continued)**

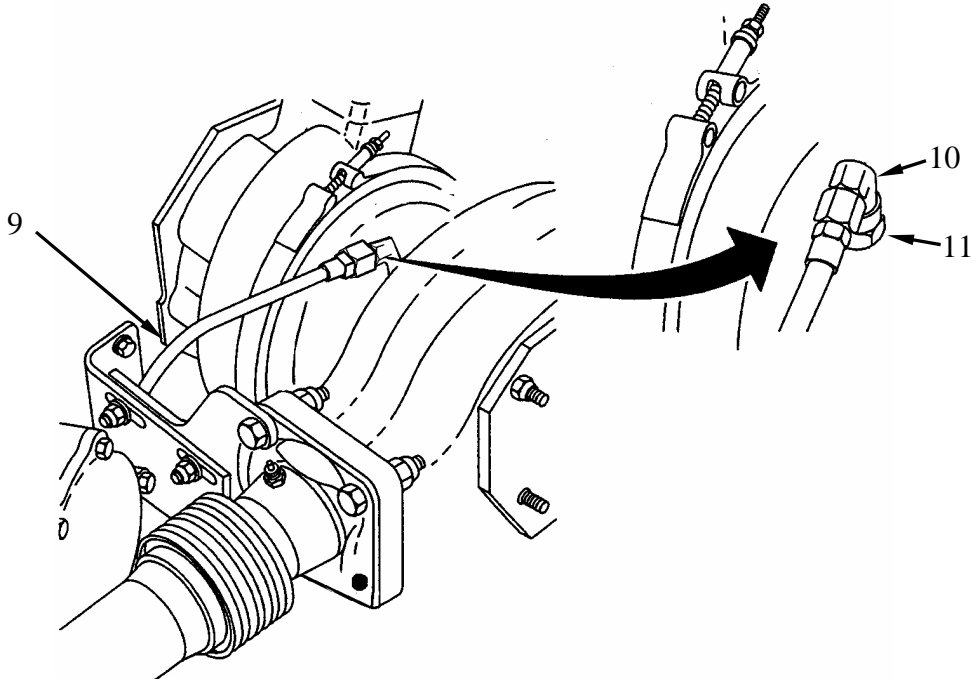
1. Remove engine oil filler tube (1) and bracket (2).
  - a. Loosen hose clamps (3) on oil filler tube hose (4).
  - b. Remove two screws (5) with self-locking nuts (6). Discard self-locking nuts.
  - c. Remove screw (7) and self-locking nut (8).
  - d. Remove upper oil filler tube (1).





**REMOVAL (Continued)**

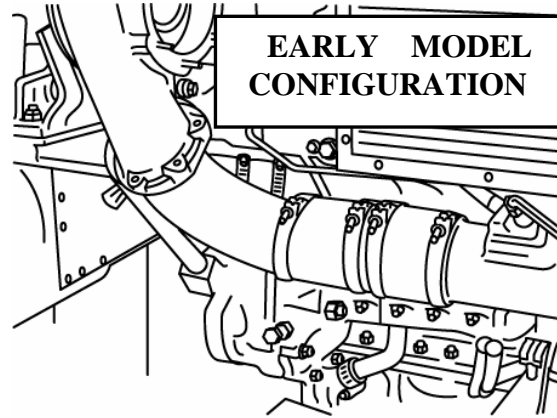
2. Remove turbosupercharger oil inlet hose (9) and elbow fittings (10, 11).
  - a. Disconnect turbosupercharger oil inlet hose (9).
  - b. Remove oil inlet elbow (10) and adapter (11), retain for use in replacement turbosupercharger.



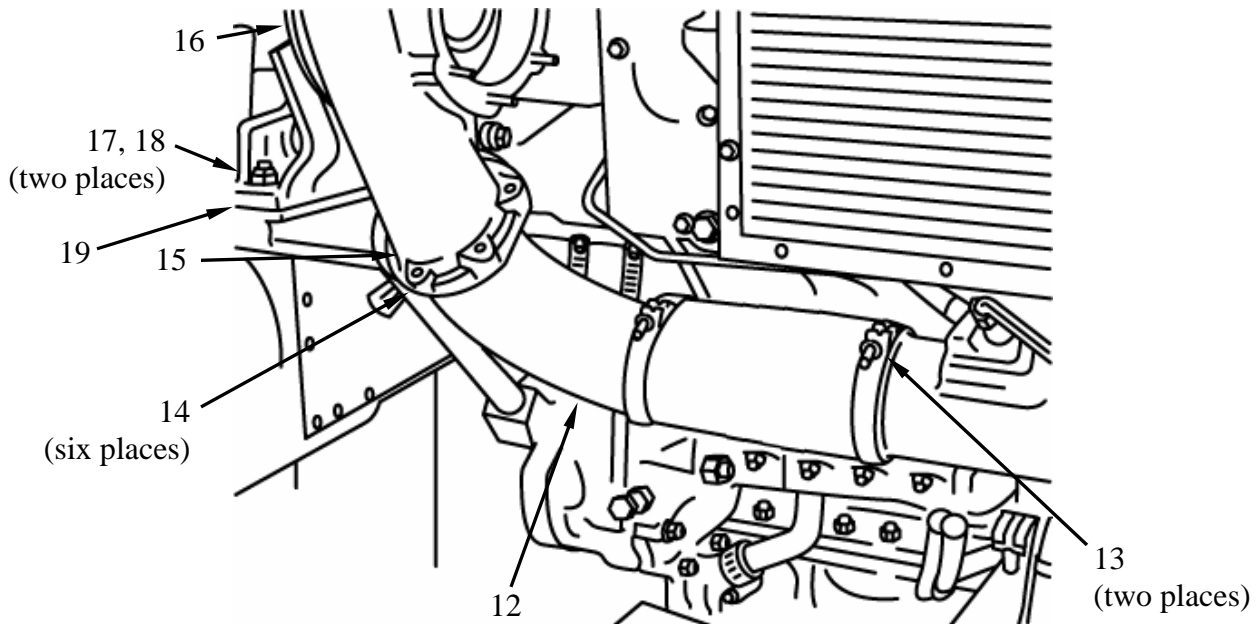
REMOVAL (Continued)

**CAUTION**

Early models may have a two-piece hose connection between the air outlet elbow and intake manifold. If your engine the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number (11682625) ). Failure to comply may lead to premature engine failure due to dust ingestion.

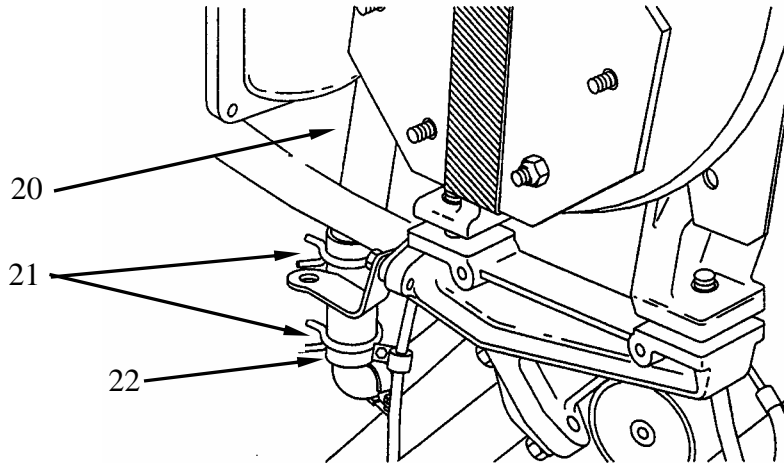


3. Remove air outlet elbow (12).
  - a. Loosen self-locking nuts on hose clamps (13).
  - b. Remove six self-locking nuts (14) and remove air outlet elbow (12) with gasket (15) (not shown).
  - c. Discard air outlet elbow gasket (15) and self-locking nuts.
4. Remove turbosupercharger (16) mounting nuts (17).
  - a. Remove two self-locking nuts (17) with flat washers (18) at turbosupercharger mounting base (19). Discard self-locking nuts.

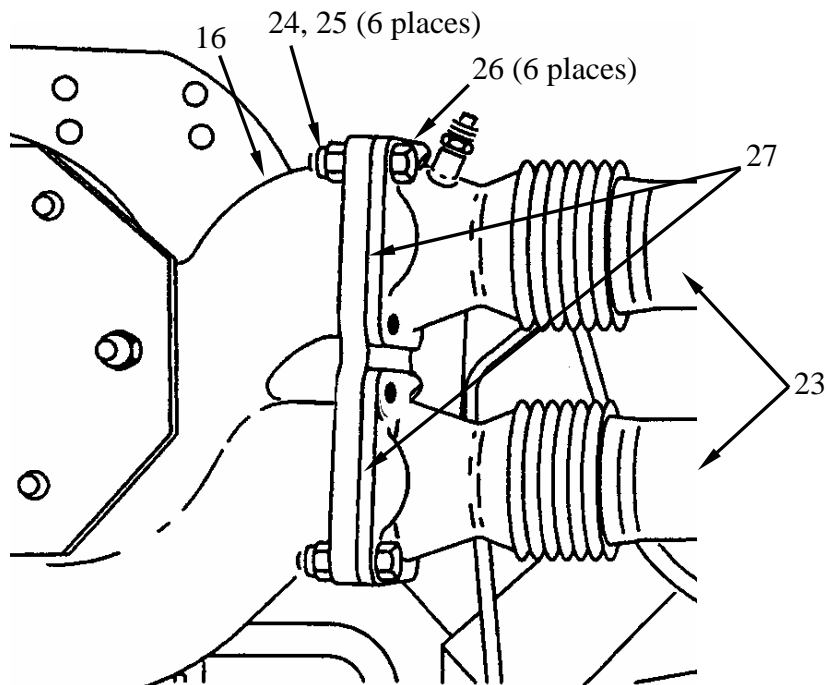


**REMOVAL (Continued)**

5. Loosen turbosupercharger oil drain tube (20).
  - a. Loosen two hose clamps (21) at turbosupercharger oil drain hose (22) and slide off hose.

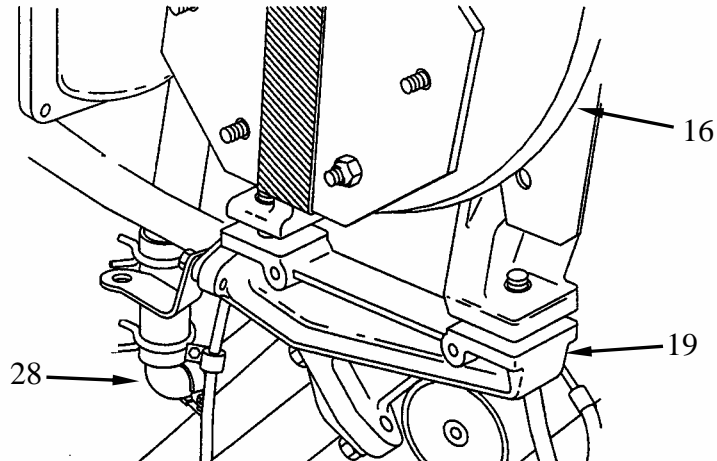


6. Remove exhaust pipes (23).
  - a. Remove six remaining self-locking nuts (24), flat washers (25) and screws (26). Discard self-locking nuts.
  - b. Separate exhaust pipes (23) from turbosupercharger (16).
  - c. Remove and discard two gaskets (27) (not shown).



**REMOVAL (Continued)**

7. Remove turbosupercharger (16) from base assembly (19)
8. Seal off lower oil drain tube (28) with a clean cloth or other suitable cover to prevent contamination.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

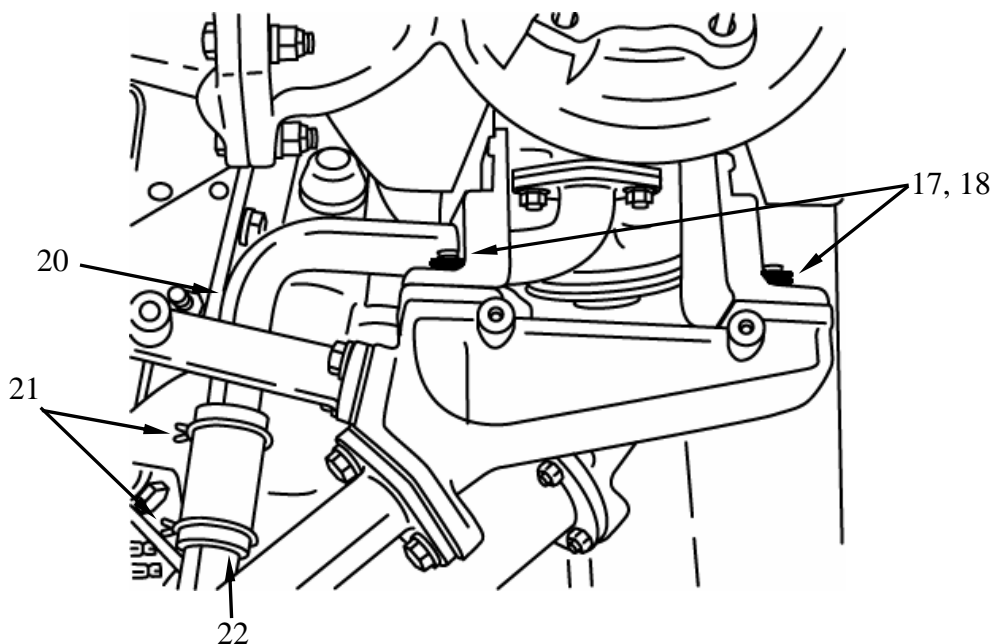
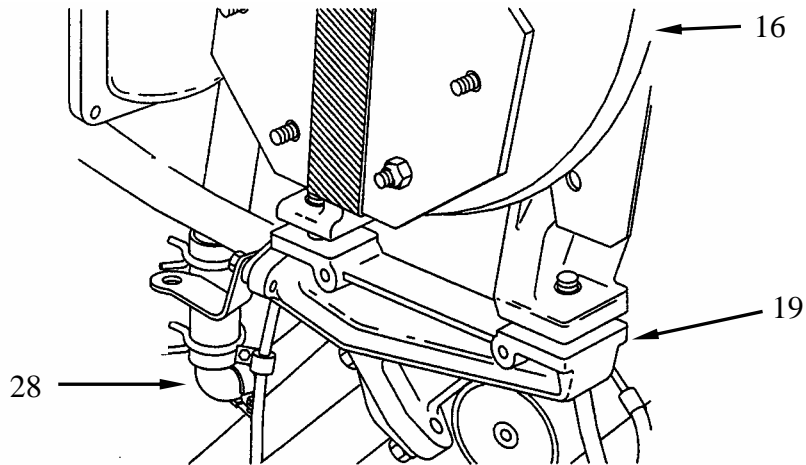
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

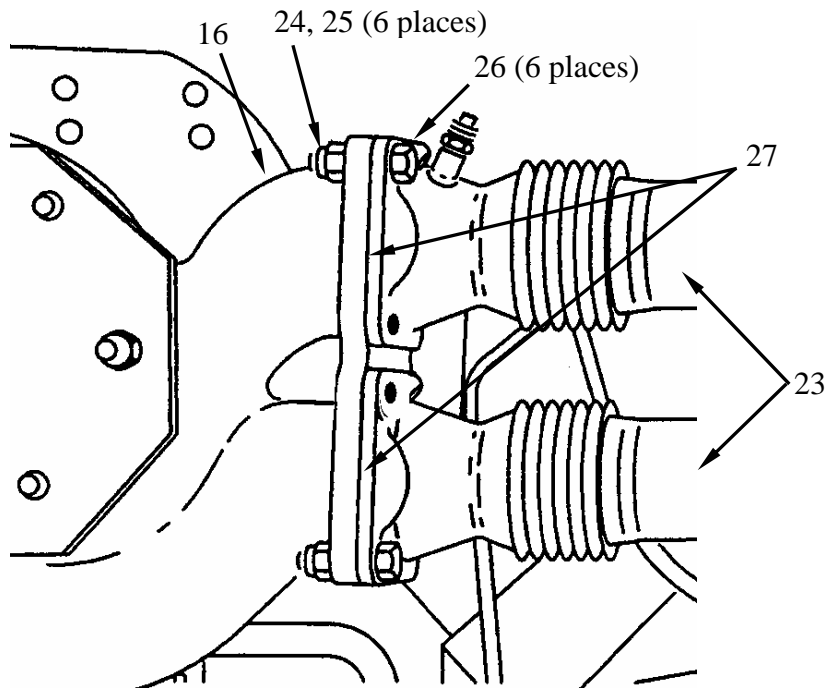
**INSTALLATION**

1. Install turbosupercharger (16).
  - a. Remove protective cover previously installed onto lower oil filler tube (28).
  - b. Position turbosupercharger (16) onto mounting base (19).
  - c. Insert turbosupercharger oil drain tube (20) into oil drain tube hose (22) and lower drain tube (28).
  - d. Secure turbosupercharger to mounting base using two new self-locking nuts (17) (item 41, WP 0175) with flat washers (18). Do not tighten at this time.
  - e. Secure oil drain tube (20) and lower drain tube (28) to oil drain hose (22) with hose clamps (21).



**INSTALLATION (Continued)**

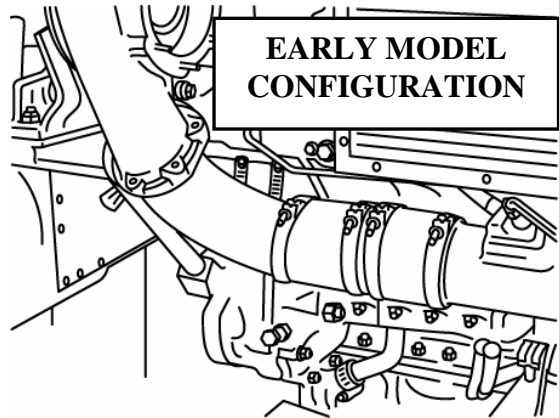
2. Install exhaust pipes (23).
  - a. Lubricate six screws (26) with antiseize compound (item 5, WP 0173).
  - b. Position two new exhaust gaskets (27) (item 327, WP 0175).
  - c. Secure exhaust pipes (23) to turbosupercharger housing (16) using six new self-locking nuts (24) (item 161, WP 0175), flat washers (25), and screws (26). Do not tighten screws at this time.



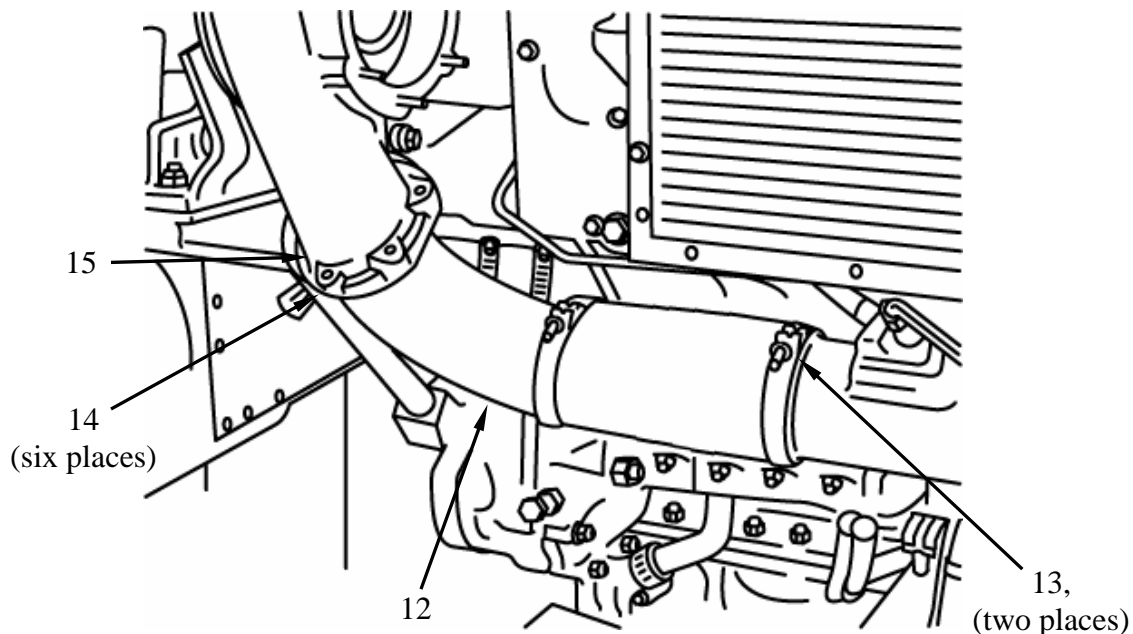
## INSTALLATION (Continued)

**CAUTION**

Early models may have a two-piece hose connection between the air outlet elbow and intake manifold. If your engine has the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number 11682625). Failure to comply may lead to premature engine failure due to dust ingestion.



3. Install air outlet elbow (12).
  - a. Install air outlet elbow (12) with new gasket (15) (item 279, WP 0175) and secure using six new self-locking nuts (14) (item 33, WP 0175). Do not tighten at this time.
  - b. Reposition and tighten hose clamps (13) until spring bottoms, then back-off 1 to 1-1/2 turns.

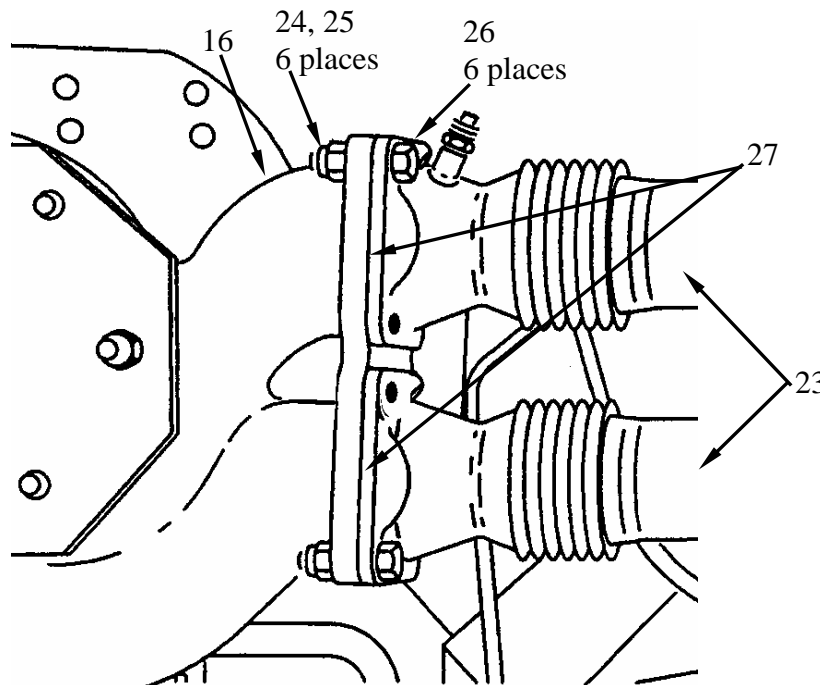
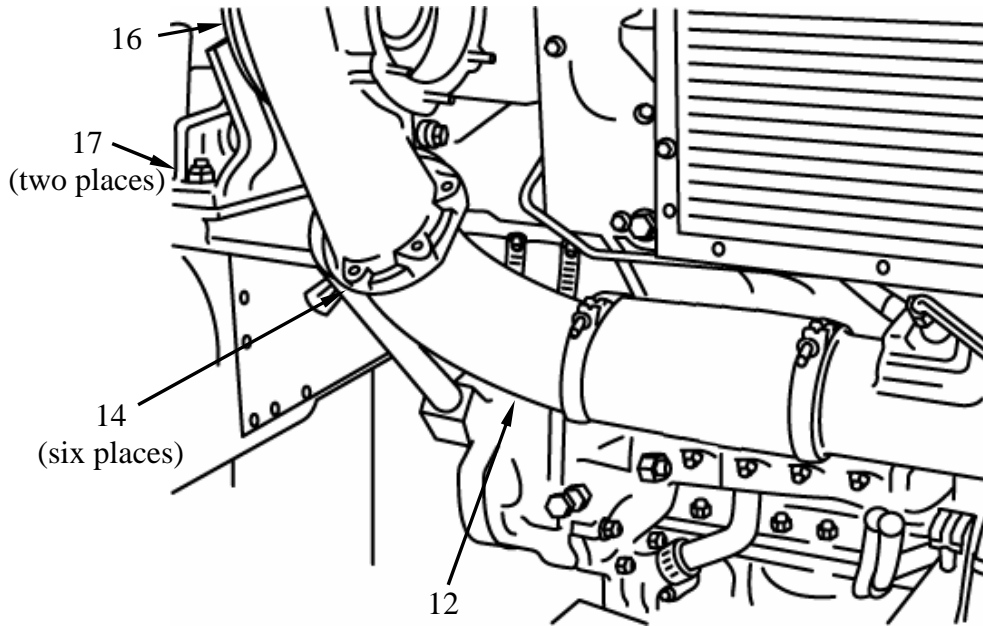


**INSTALLATION (Continued)**

3. Install air outlet elbow (12) (continued).

c. Tighten remaining assembled parts at this time.

- (1) Tighten turbosupercharger base self-locking nuts (17).
- (2) Tighten self-locking nuts (14) at air outlet elbow (12).
- (3) Tighten self-locking nuts (24) at exhaust pipes (23) to turbosupercharger housing (16).



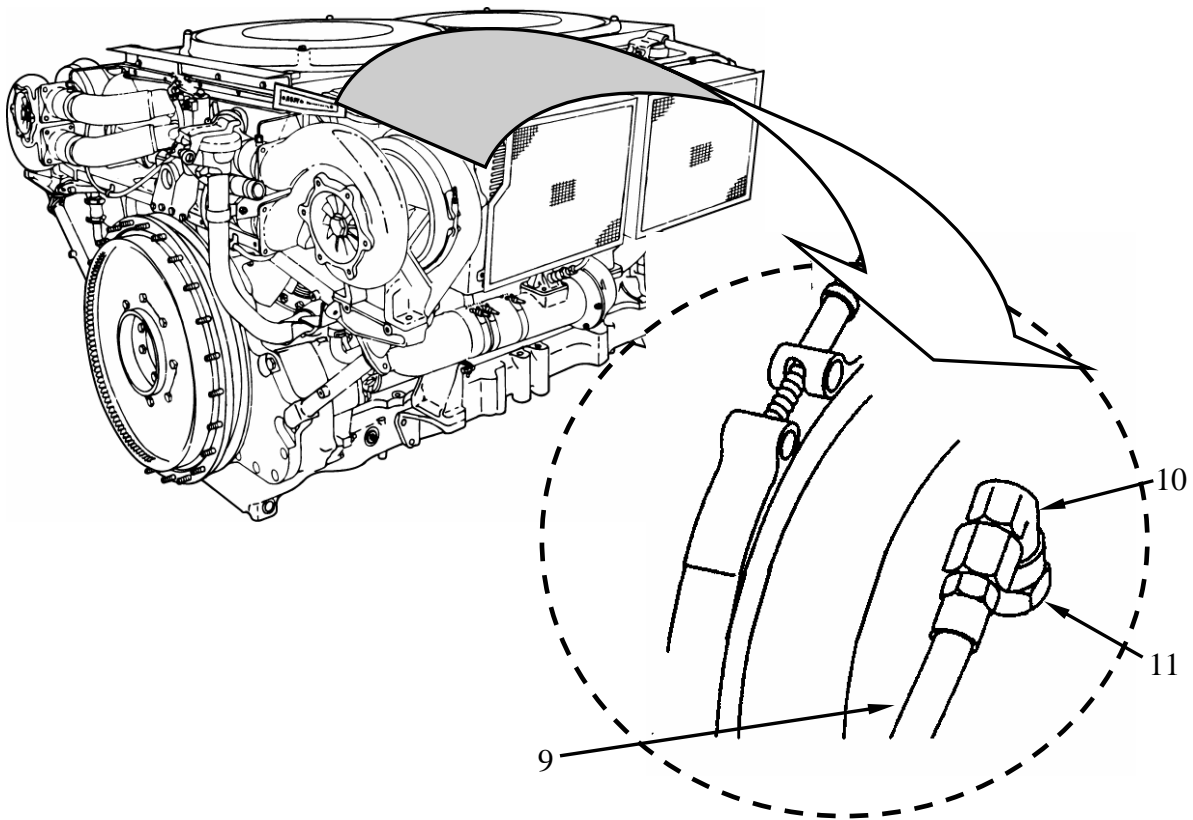


## INSTALLATION (Continued)

## NOTE

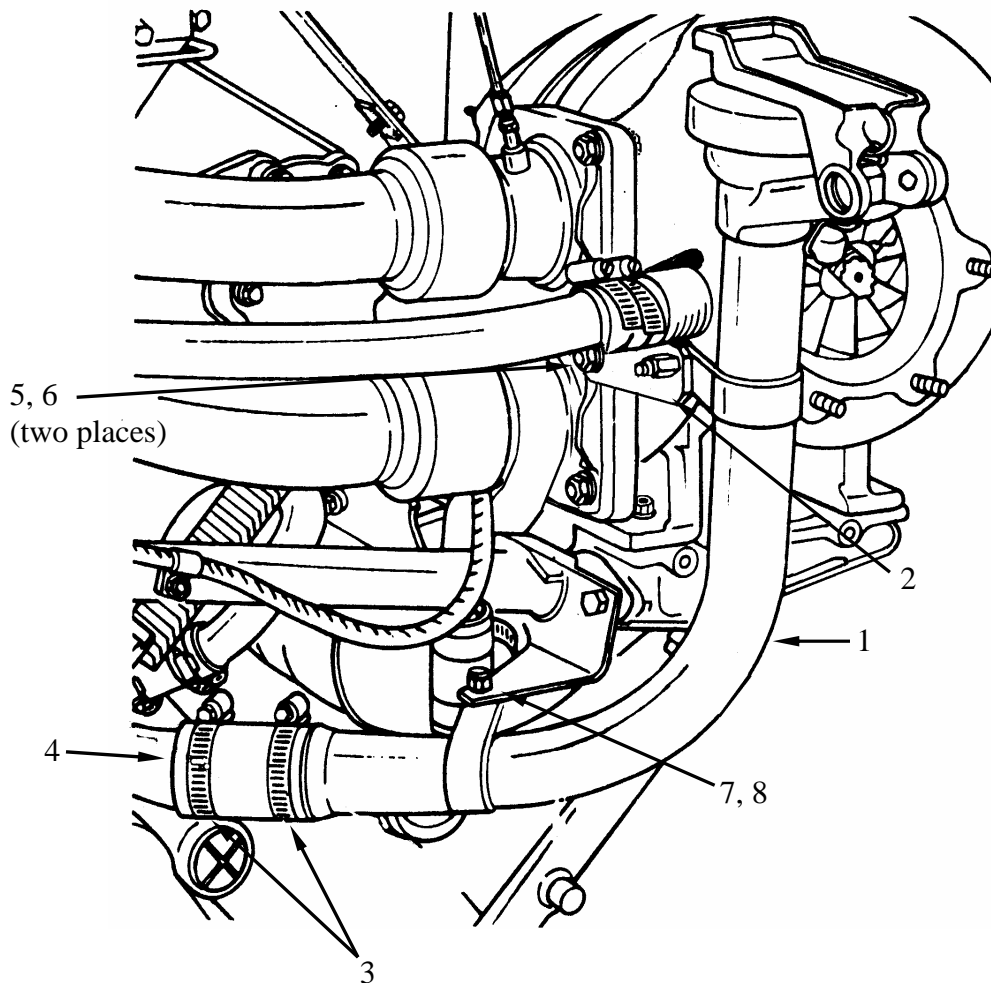
**New turbosuperchargers do not come with oil supply hose fittings. Old fittings must be reused or new fittings acquired when installing a new turbosupercharger.**

4. Install turbosupercharger oil supply hose (9).
  - a. Add a small amount of engine oil (item 21, WP 0173) to turbosupercharger oil supply inlet adapter (11) to provide lubrication during initial start-up.
  - b. Install oil inlet adapter (11) and oil inlet elbow (10) in turbosupercharger.
  - c. Connect oil inlet supply hose (9) to elbow (10).



**INSTALLATION (Continued)**

5. Install engine oil filler tube (1) and bracket (2).
  - a. Install upper oil filler tube (1) into filler tube hose (4).
  - b. Install screw (7) secured with new self-locking nut (8) (item 33, WP 0175). Do not tighten at this time.
  - c. Lubricate two screws (5) with antiseize compound (item 5, WP 0173).
  - d. Install two screws (5) with new self-locking nuts (6) (item 140, WP 0175).
  - e. Tighten screw (7).
  - f. Tighten hose clamps (3) on oil filler tube hose (4).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

- O-ring (1) (item 319, WP 0175)
- Lock washer (17) (item 95, WP 0175)
- Self-locking nut (2) (item 28, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

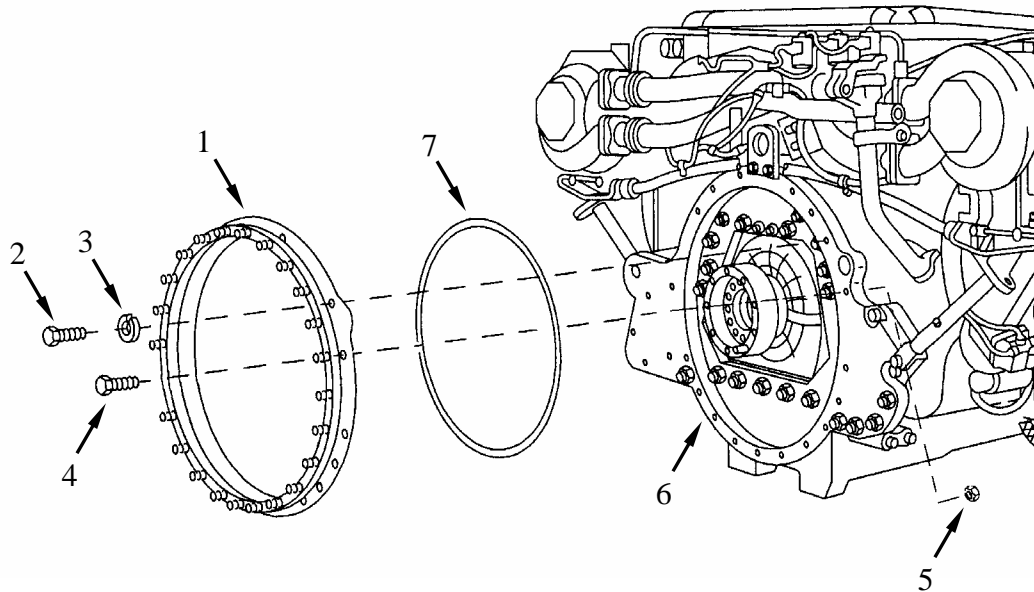
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine level on flat surface
- Flywheel removed (WP 0103)

**REMOVAL**

1. Remove spacer (1).
  - a. Remove 17 screws (2) with lock washers (3). Discard lock washers.
  - b. Remove two screws (4) with self-locking nuts (5). Discard self-locking nuts.
  - b. Remove transmission spacer ring (1) from transmission adapter (6).
  - c. Remove and discard O-ring (7) from spacer (1).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

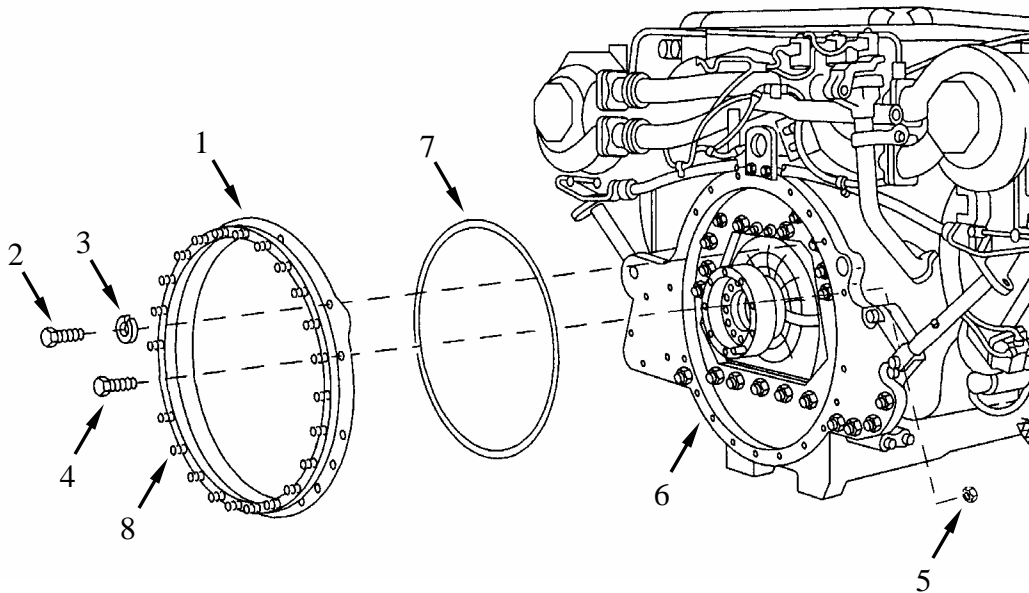
**REPAIR**

1. Replace damaged, bent, or stripped studs (8). Refer to Work Package 0028 for procedures and to the following table for stud size and setting height.

Location	Setting Height	Quantity Required	Stud Size and Length
8	1-5/16	24	1/2-13 (3/4) X 1/2-20 (13/16) X 1-5/16

**INSTALLATION**

1. Apply Lubriplate (item 23, WP 0173) to new O-ring (7) (item 319, WP 0175) and install on spacer (1).
2. Place spacer (1) into position and secure using 17 screws (2) with new lock washers (3) (item 95, WP 0175).
3. Install two screws (4) and secure with new self-locking nuts (5) (item 28, WP 0175).
4. Torque 19 screws (2, 4) to 23-27 foot-pounds (31-37 N•m).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

- Dial indicator (item 65, WP 0176)
- Eye bolt (item 11, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Splined wrench (engine turning tool) (item 136, WP 0176)
- Suitable lifting device
- Torque wrench, 500 - 2500 inch/pounds (item 126, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine level on flat surface

**FLYWHEEL RUN-OUT**

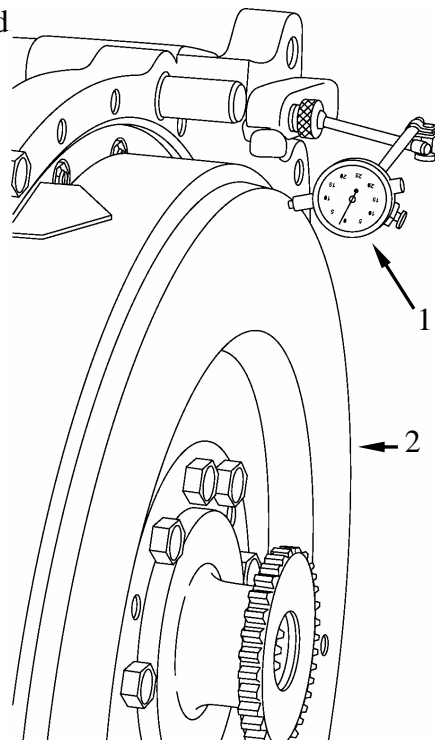
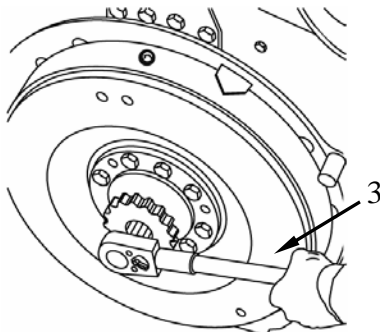
**CAUTION**

**Flywheel run-out must be checked prior to removal of the old flywheel and after installation of a new flywheel. The first check is to determine if the old flywheel is OK, and the second check is to determine if the new flywheel meets the run-out criteria.**

1. Affix dial indicator (1) (item 65, WP0176) as illustrated
2. Observe dial indicator (1) while rotating flywheel (2) with turning tool (3) (item 136, WP 0176).
  - a. Dial indicator must not indicate more than 0.015-inch of flywheel run-out.
  - b. If run-out exceeds 0.015-inch, the flywheel must be replaced.

**NOTE**

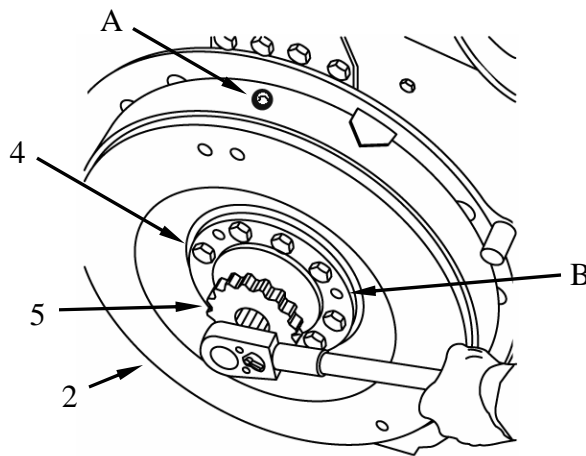
**Check run-out of crankshaft flange if flywheel run-out exceeds limits.**



**REMOVAL****NOTE**

**Early engine models used lock plates to secure the flywheel/spur gear fastening screws. If you encounter lock plates, remove and discard. They are no longer used. Torque for the flywheel/spur gear fasteners has been raised to 1300-1350 inch-pounds (146.8-152.5 N•m).**

1. Position flywheel (2) so that lifting hole (A) is at top center.
2. Remove nine screws (4) attaching flywheel (2) and spur gear (5).
3. Pull spur gear (5).
  - a. Install three of the removed mounting screws (4) into puller holes (B) provided in spur gear (5).
  - b. Alternately tighten the three screws (4) to pull spur gear (5).
  - c. Remove three screws (4) from spur gear (5).



## REMOVAL (Continued)

**WARNING**

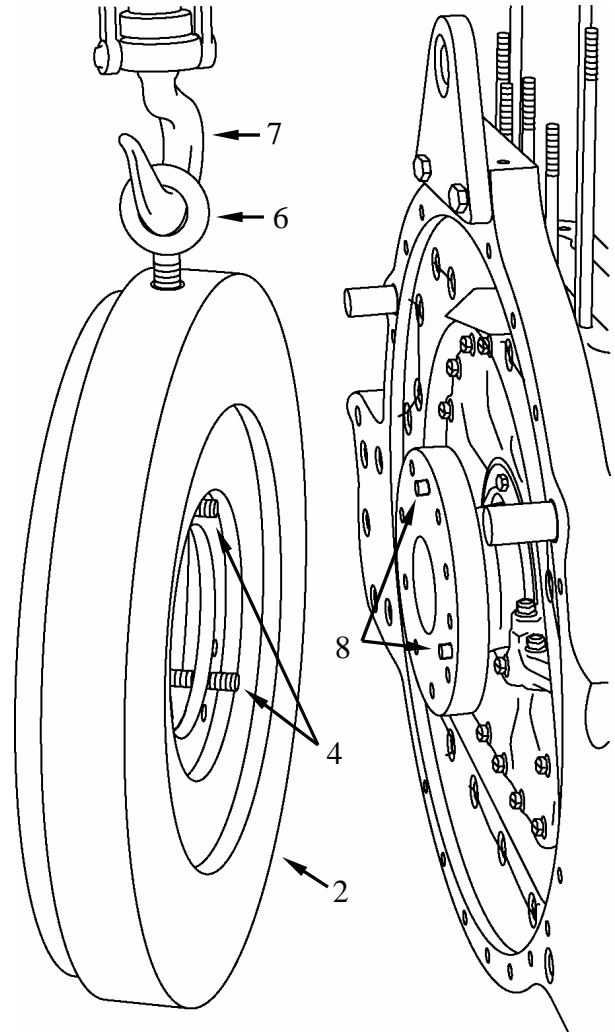
Flywheel is heavy. Be sure that lifting device is attached and do not allow flywheel to swing about uncontrolled. Failure to comply may result in personal injury.

4. Pull flywheel (2).
  - a. Install three of the removed mounting screws (4) into puller holes provided in flywheel (2).

**CAUTION**

Use care in removing flywheel from dowel pins so as not to cause binding. Damage may occur to dowel pin or flywheel hole.

- b. Alternately tighten three screws (4) to pull flywheel (2) just enough to install eyebolt (6) (item 65, WP 0176).
- c. Attach a suitable lifting device (7) to eyebolt (6) and take out slack.
- d. Continue to alternately tighten screws (4) until flywheel (2) is free from dowel pins (8) in crankshaft.
- e. Place flywheel on wooden pallet or other suitable safe location, then remove three screws (4) and eyebolt (6).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

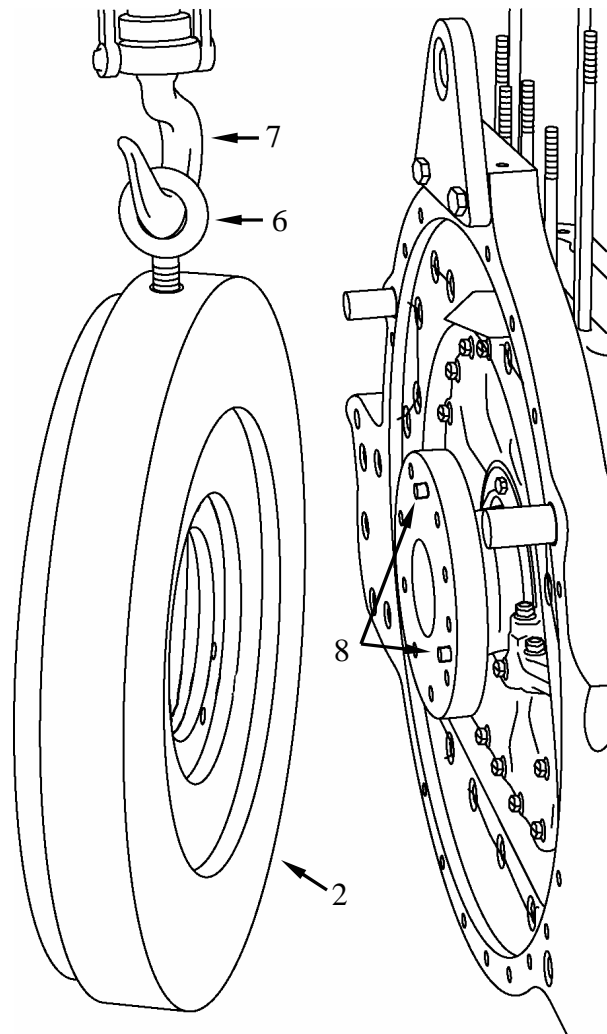
1. Install eyebolt (6) (item 65, WP 0176) in threaded hole of flywheel (2).

**WARNING**

**Flywheel is heavy. Be sure that lifting device is attached and do not allow flywheel to swing about uncontrolled. Failure to comply may result in personal injury.**

2. Install flywheel (2).

- a. Attach a suitable lifting device (7) and align dowel pin holes in flywheel (2) with dowel pins (8) in crankshaft.
- b. Rotate crankshaft as necessary to align dowel pins (8) with holes in flywheel (2).



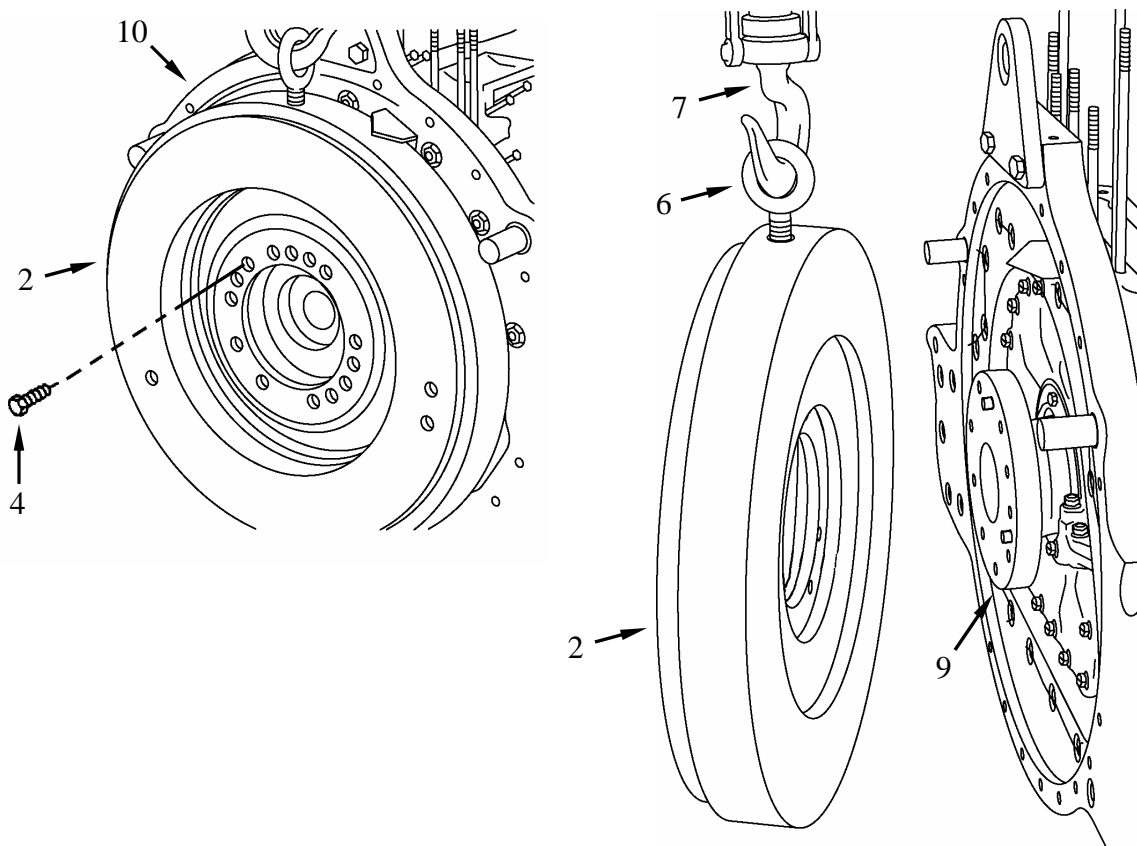


## INSTALLATION (Continued)

## NOTE

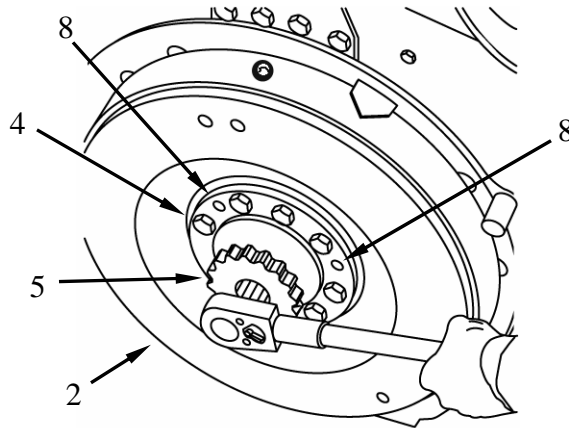
**Eye bolt must be removed from flywheel before flywheel is drawn tight against flange on crankshaft to permit flywheel to clear transmission adapter lifting eye.**

2. Install flywheel (2) (Continued).
  - c. Position aligned flywheel (2) against flange on crankshaft (9) and temporarily install three equally spaced mounting screws (4).
  - d. Alternately tighten screws (4) to draw flywheel (2) toward flange on crankshaft (9) while watching that eyebolt (6) does not contact transmission adapter (10).
  - e. When eyebolt (6) is near transmission adapter (10), disconnect lifting device (7) and remove eyebolt.
  - f. Continue to tighten mounting screws (4) until flywheel is tight against crankshaft (9) flange, and then remove screws (4).



**INSTALLATION (Continued)**

3. Install spur gear (5).
  - a. Place spur gear (5) in position on dowel pins (8) which protrude through flywheel (2).
  - b. Fasten spur gear (5) and flywheel (2) to crankshaft with nine screws (4).
  - c. Using torque wrench, 500 - 2500 inch/pounds, (item 126, WP0176) alternately tighten screws (4) to 1300-1350 inch-pounds (146.8-152.5 N•m).
  - d. Go to beginning of this work package and check flywheel run-out if a new flywheel was installed.

**END OF WORK PACKAGE**

**FLYWHEEL AND ADAPTER REPLACEMENT (2DR)****0103 00****THIS WORK PACKAGE COVERS:**

Run-out Check, Removal, Installation

**INITIAL SETUP:****Tools:**

- Dial indicator (item 65, WP 0176)
- Eye bolt (item 11, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 500-2500 inch-pounds (item 126, WP 0176)
- Suitable lifting device

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

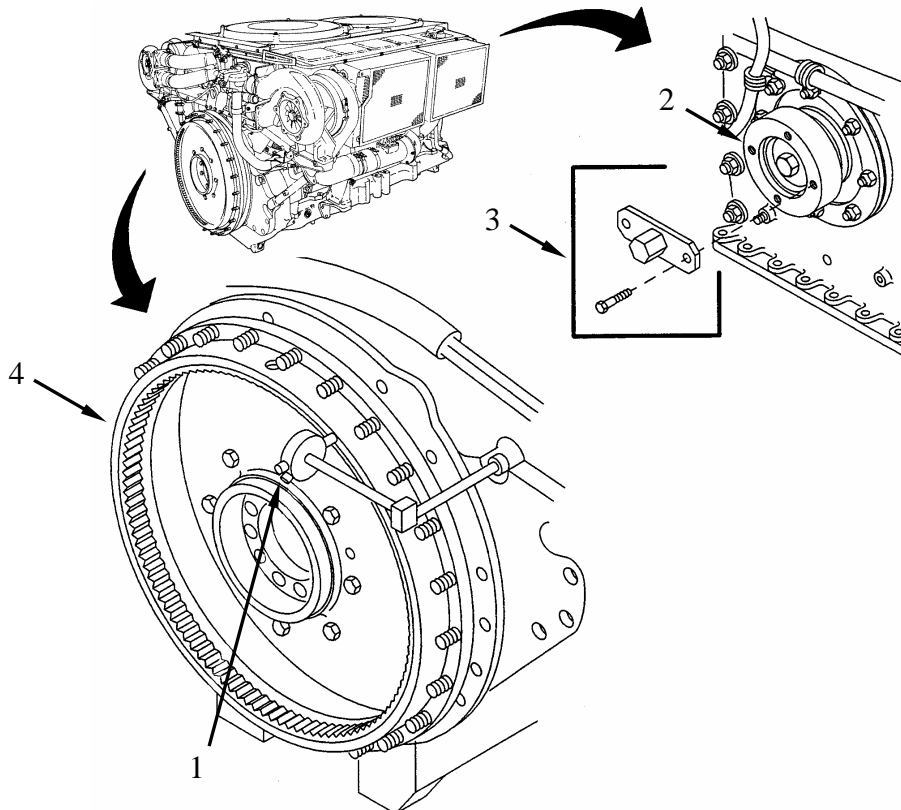
- Engine removed from vehicle and placed on a flat stationary surface

**Fabricated Tools:**

- Engine turning tool (damper end) (item 3, WP 0177)

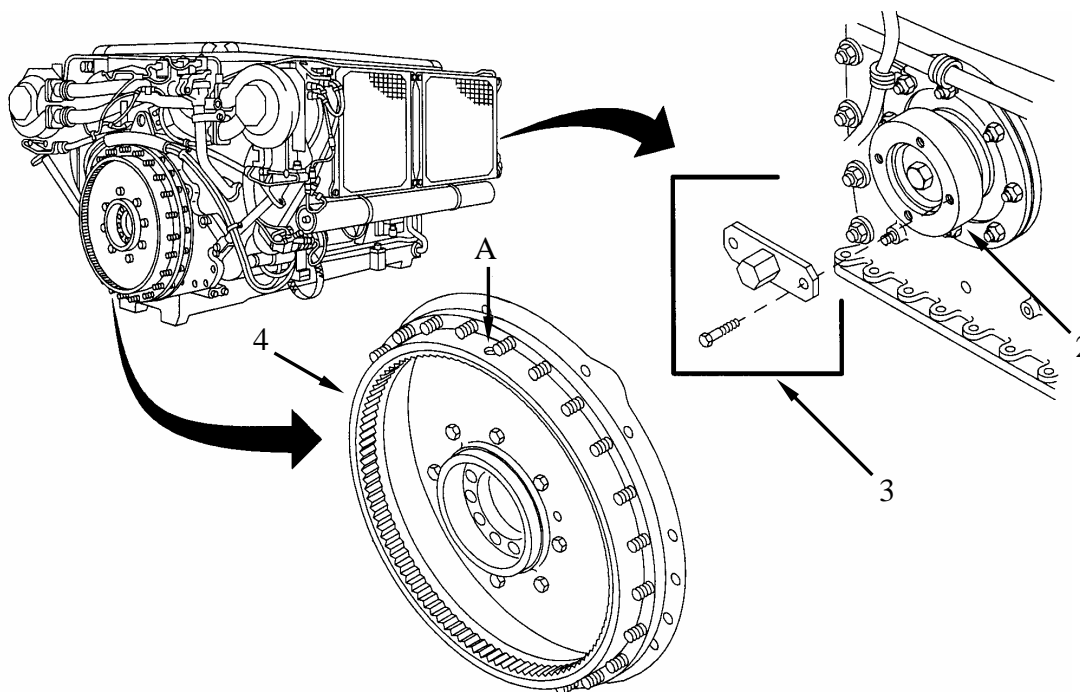
**RUN-OUT CHECK**

1. Affix dial indicator (1) (item 65, WP0176) as illustrated.
2. Observe dial indicator (1) while rotating engine PTO shaft (2) with turning tool (3) (item 3, WP 0177).
  - a. Dial indicator must not indicate more than 0.015-inch flywheel (4) run-out.
  - b. If run-out exceeds 0.015-inch, the flywheel must be replaced.



**REMOVAL**

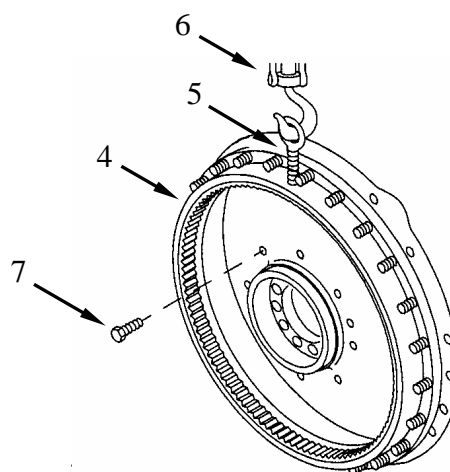
1. Position flywheel (4) for removal.
  - a. Rotate PTO shaft (2) with turning tool (3).
  - b. Position flywheel (4) so that lifting eyebolt hole (A) is at top center.



2. Install eyebolt (5) (item 11, WP 0176) and attach hoist (6).
3. Remove eight screws (7) from flywheel (4).

**NOTE**

**Early model engines had safety wire securing the flywheel fasteners. Remove and discard the wire and do not safety wire upon reinstallation. Instead, increase the torque of the fastener to 1300-1350 inch-pounds (146.8-152.5 N•m).**



## REMOVAL (Continued)

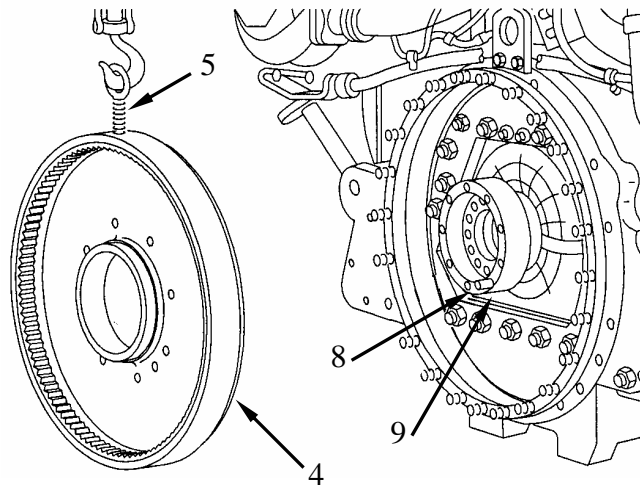
**WARNING**

Flywheel is heavy. Be sure that lifting device is attached and do not allow flywheel to swing about uncontrolled. Failure to comply may result in personal injury.

**CAUTION**

Use care in removing flywheel from dowel pins so as not to cause binding. Damage may occur to dowel pin or flywheel hole.

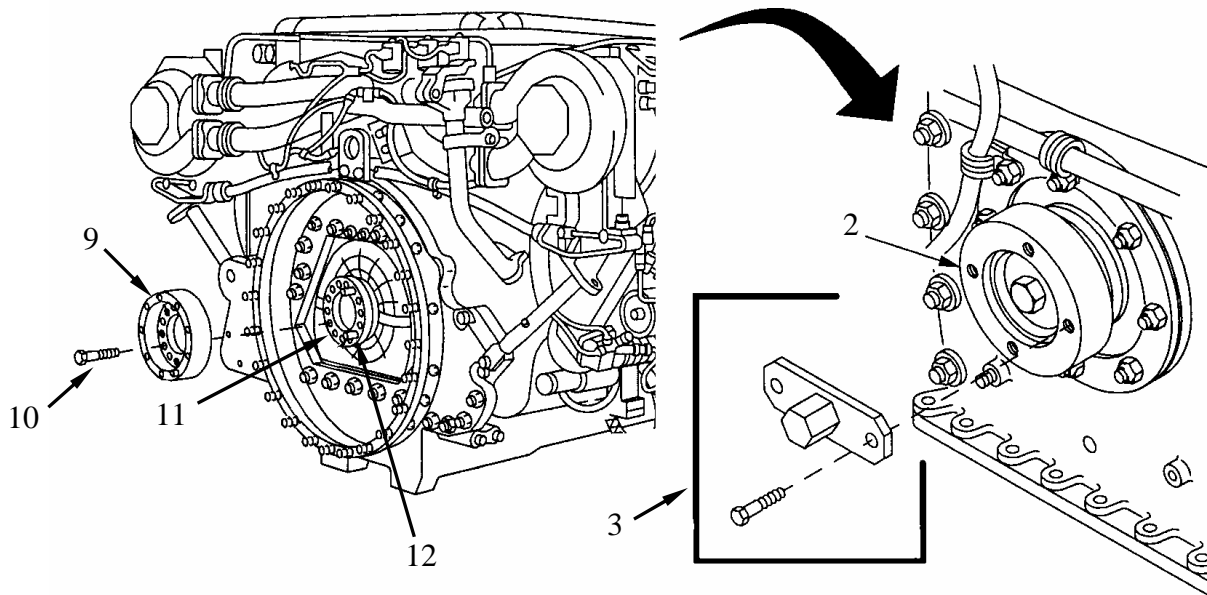
4. Remove flywheel (4) from dowel pin (8) in adapter (9).
5. Remove eyebolt (5).



**REMOVAL (Continued)****NOTE**

**Early model engines had lock plates securing the adapter fasteners. Remove and discard the lock plates. Lock plates are not used upon reinstallation; instead, increase the torque of the fastener to 1300-1350 inch-pounds (146.8-152.5 N•m).**

6. Remove adapter (9)
  - a. Use engine turning tool (3) to prevent PTO shaft (2) from turning.
  - b. Remove screws (10) securing adapter (9) to crankshaft (11).
  - c. Install three of the removed screws (10) into the threaded puller holes of adapter (9).
  - d. Alternately tighten screws (10) to pull adapter (9) from dowel pins (12) in crankshaft (11).

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

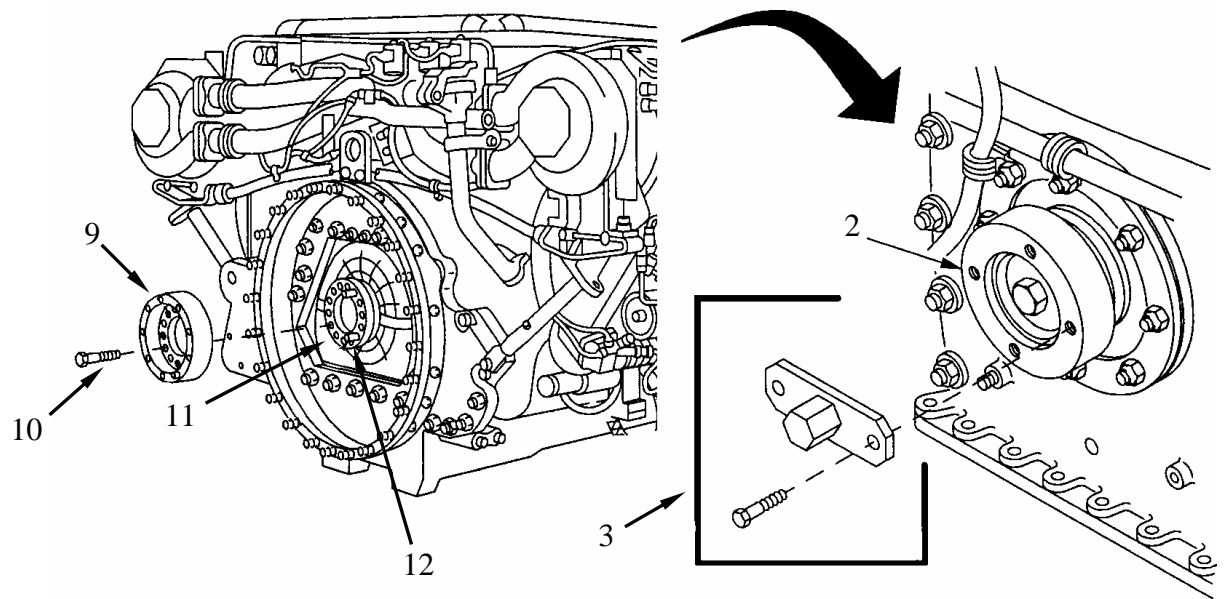
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

1. Install adapter (9).
  - a. Use engine turning tool (3) (item 3, WP 0177) on PTO coupling (2) to prevent crankshaft (11) from turning.
  - b. Place adapter (9) onto dowel pins (12) in crankshaft (11).
  - c. Install screws (10) securing adapter (9) to crankshaft (11) and tighten alternately to draw adapter to crankshaft.
  - d. Torque-tighten screws (10) to 1300-1350 inch-pounds (146.8-152.5 N•m), using torque wrench (item 126, WP 0176).

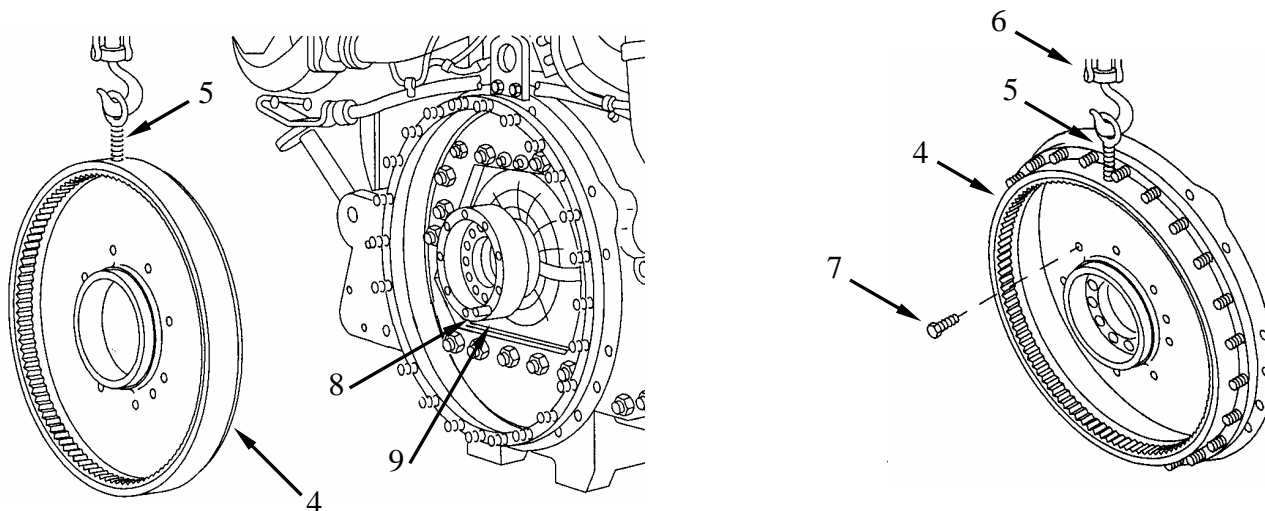


## INSTALLATION (Continued)

**WARNING**

**Flywheel is heavy. Be sure that lifting device is attached and do not allow flywheel to swing about uncontrolled. Failure to comply may result in personal injury.**

2. Install flywheel (4).
  - a. Install eye bolt (5) (item 11, WP 0176) in threaded hole provided in flywheel (4), and attach to hoist (6).
  - b. Turn crankshaft as necessary to align dowel pin (8) with hole in flywheel (4).
  - c. Slide flywheel (4) onto adapter (9).
  - d. Apply lubricant (item 23, WP 0173) to threads of eight screws (7) prior to installation.
  - e. Secure flywheel (4) with eight screws (7) and alternately torque to 1300-1350 inch-pounds (146.8-152.5 N•m).
  - f. Remove eye bolt (5).
3. Go to beginning of work package and recheck flywheel run-out.



**END OF WORK PACKAGE**



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**ROCKER ARM ASSEMBLY AND COVER REPLACEMENT**

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**0104 00****THIS WORK PACKAGE COVERS:**Removal, Cleaning, Inspection, and Installation

---

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

- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-300 inch pounds (item 124, WP 0176)
- Torque wrench, 200-1000 inch pounds (item 125, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (2) (item 291, WP 0175)
- Gasket (2) (item 350, WP 0175)
- Seal washer (4) (item 194, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)
- Sealant (item 33, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine on flat stationary surface
- Fuel/water separator removed (WP 0084)
- Fuel injector tubes removed (WP 0113)
- Cylinder oil drain back tubes removed (WP 0077)
- Engine oil cooler frames removed (0090)
- Fuel nozzle and holder removed (WP 0114)

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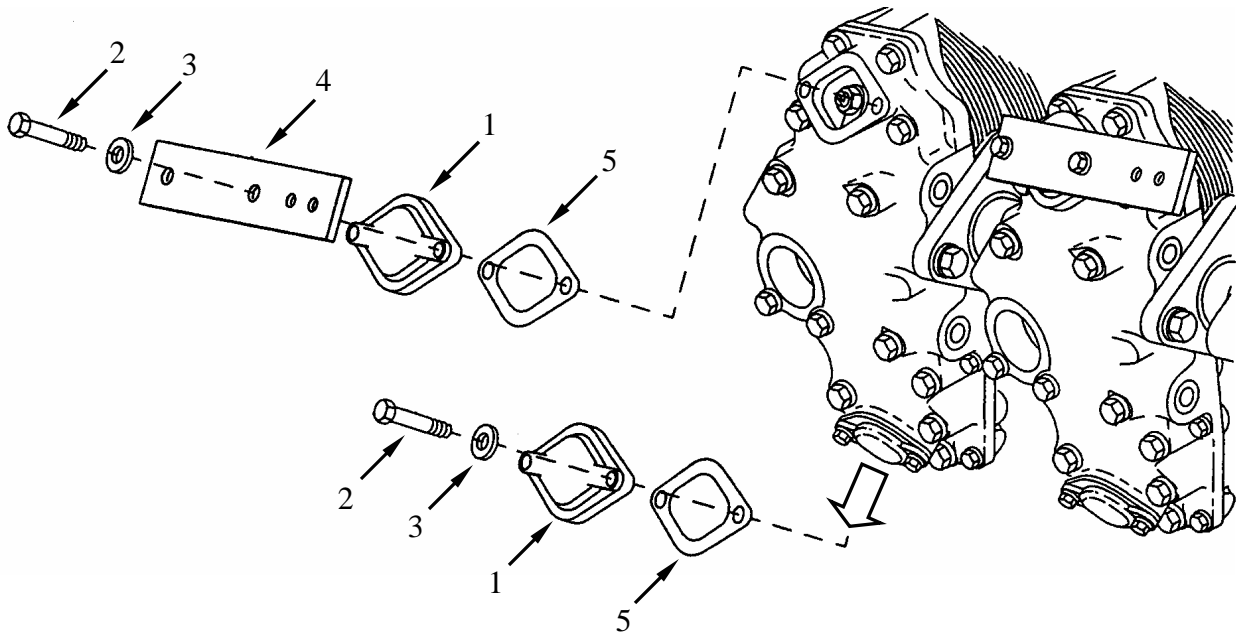
**REMOVAL****NOTE**

**The engine has twelve rocker arm assemblies and covers. The following procedures apply to one or all covers. If covers only need to be removed from one bank, major assemblies can be removed from just one bank.**

**Fuel/water separator need not be removed if rocker cover for cylinder 1L is not going to be removed.**

**REMOVAL (Continued)**

1. Remove upper access cover (1).
  - a. Remove two screws (2) with flat washers (3).
  - b. Remove fuel injection clamp spacer plate (4).
  - c. Remove cover (1) and gasket (5). Discard gasket.
  
2. Remove lower access cover (1).
  - a. Remove two screws (2) with flat washers (3).
  - b. Remove cover (1) and gasket (5). Discard gasket.



## REMOVAL (Continued)

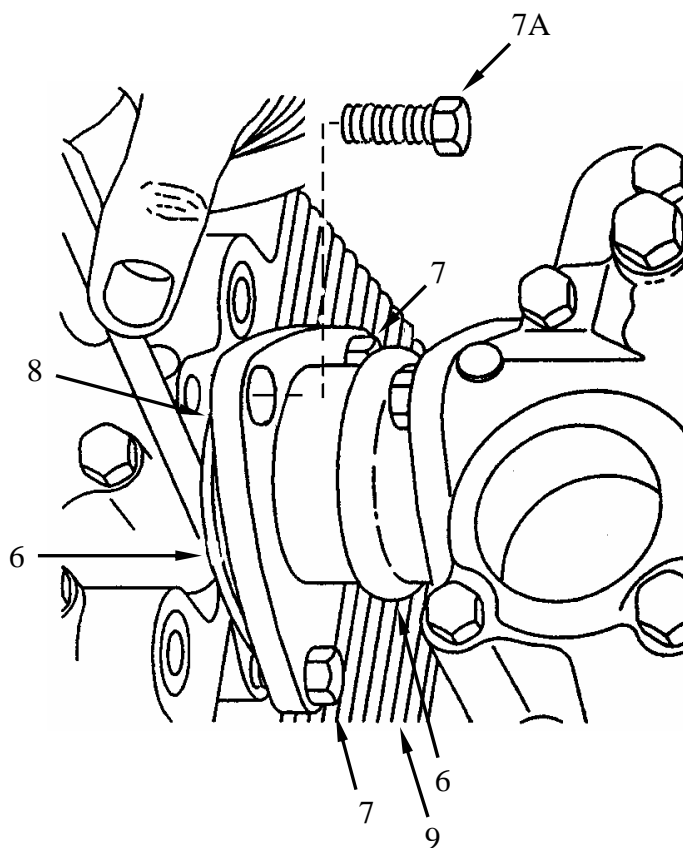
## NOTE

Step 3 applies to both sides of all except the end cylinders. On the end cylinders (1 and 6, left and right), step 3 applies to the inboard side only.

CAUTION

Inter-cylinder sleeves are made of a rubber-type material and are easily damaged. The cylinder and rocker cover are made of aluminum and also are easily damaged. Take care when separating the sleeve from the cylinder not to damage either. Failure to comply may result in an oil leak.

3. Loosen inter-cylinder sleeves (6).
  - a. Remove the top screw (7A), and loosen the bottom two screws (7) securing the flange (8) to the cylinder (9).
  - b. Move flange (8) away from cylinder (9) as far as the loosened screws will allow.
  - c. Using a piece of shim stock or other suitable tool, carefully separate inter-cylinder sleeve (6) from cylinder.



## REMOVAL (Continued)

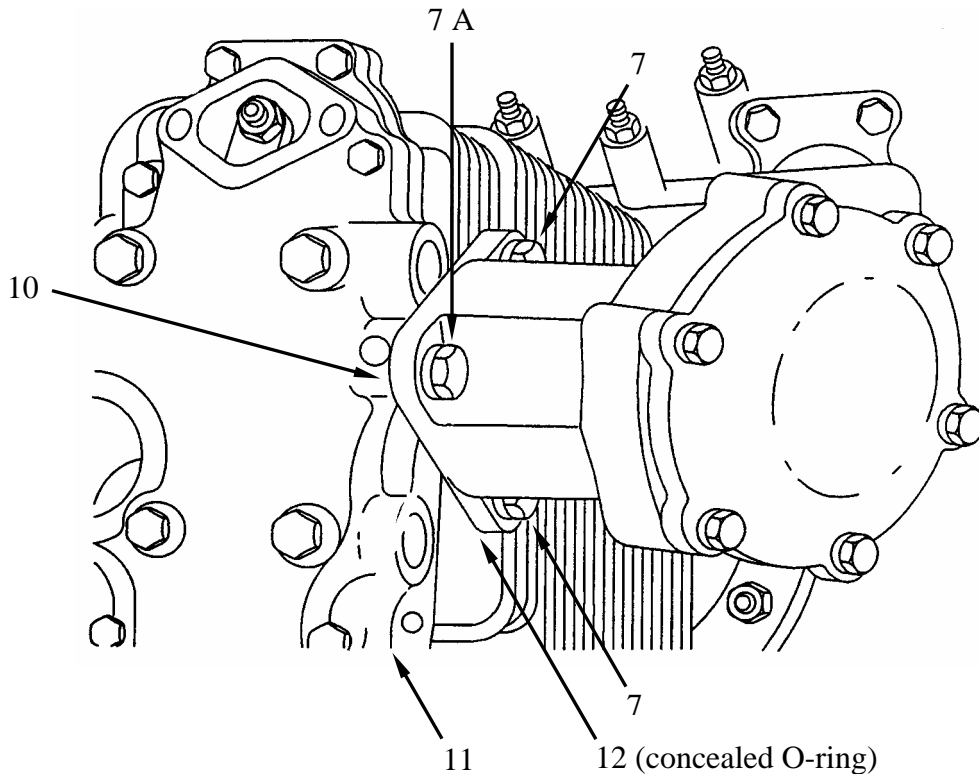
## NOTE

Step 4 applies only to cylinder number 6 left and right.

**CAUTION**

There is a concealed O-ring in the camshaft drive housing where the housing mates to the cylinder. Be careful not to damage this O-ring when separating the housing from the cylinder. If O-ring is damaged, camshaft will have to be removed to replace the O-ring (refer to General Support WP 0146).

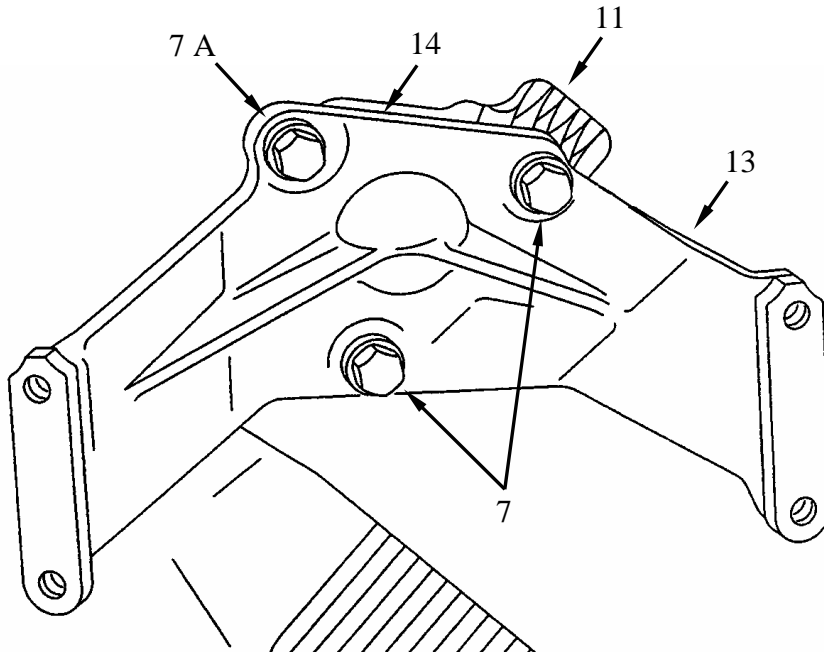
4. Separate camshaft drive housing (10) from rocker arm cover (11).
  - a. Remove top screw (7A) and loosen two lower screws (7) on outboard side of rocker arm cover (11).
  - b. Carefully separate housing (10) from rocker arm cover assembly (11) being careful not to damage O-ring (12).



**REMOVAL (Continued)****NOTE**

**Step 5 applies only to cylinder number 1 left.**

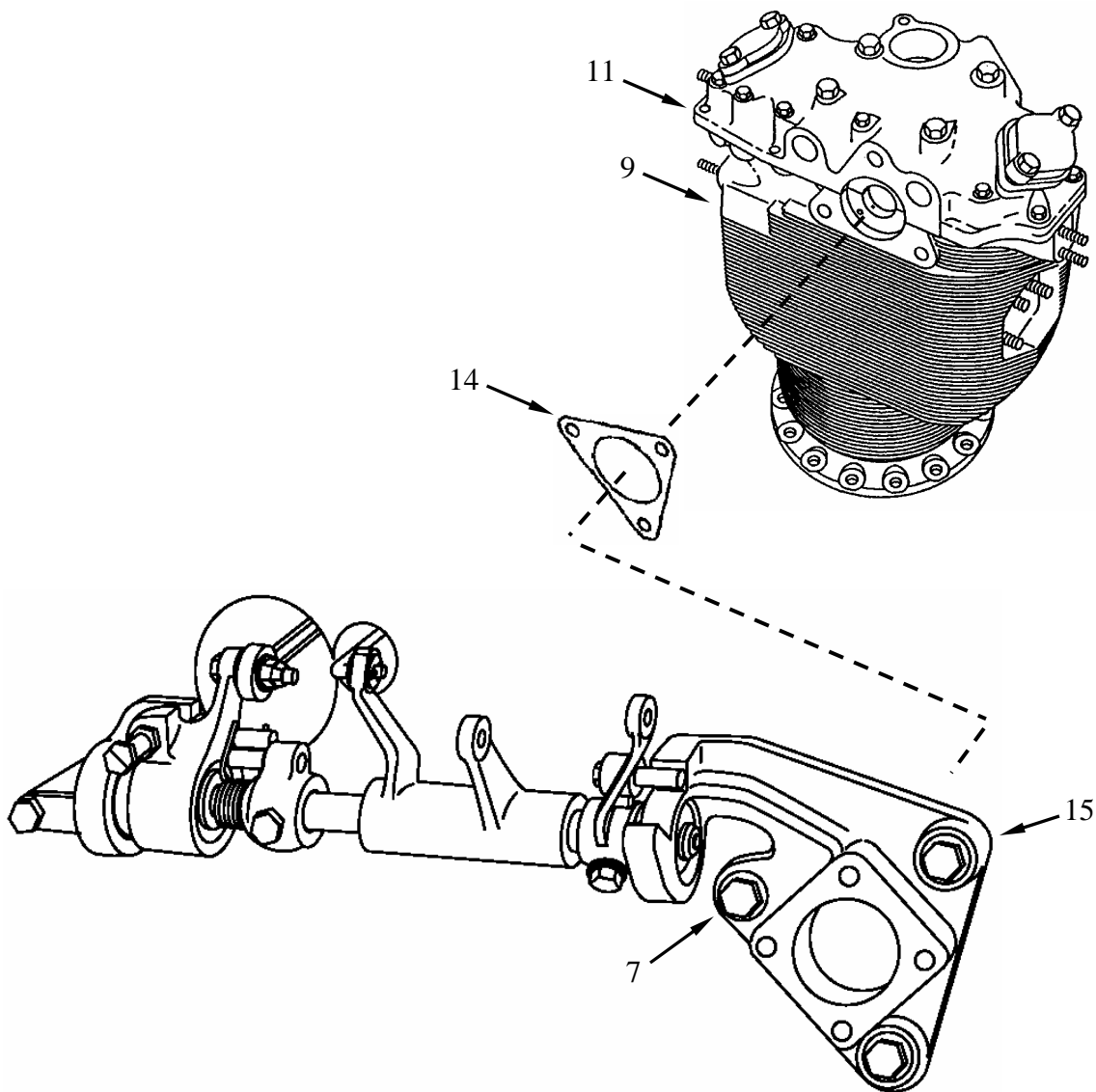
5. Separate fuel filter bracket (13) from rocker arm cover.
  - a. Remove screw (7 A) and loosen two screws (7) on outboard side of rocker arm cover (11).
  - b. Carefully separate bracket (13) and gasket (14, hidden) from rocker arm cover (11). Discard gasket.



**REMOVAL (Continued)****NOTE**

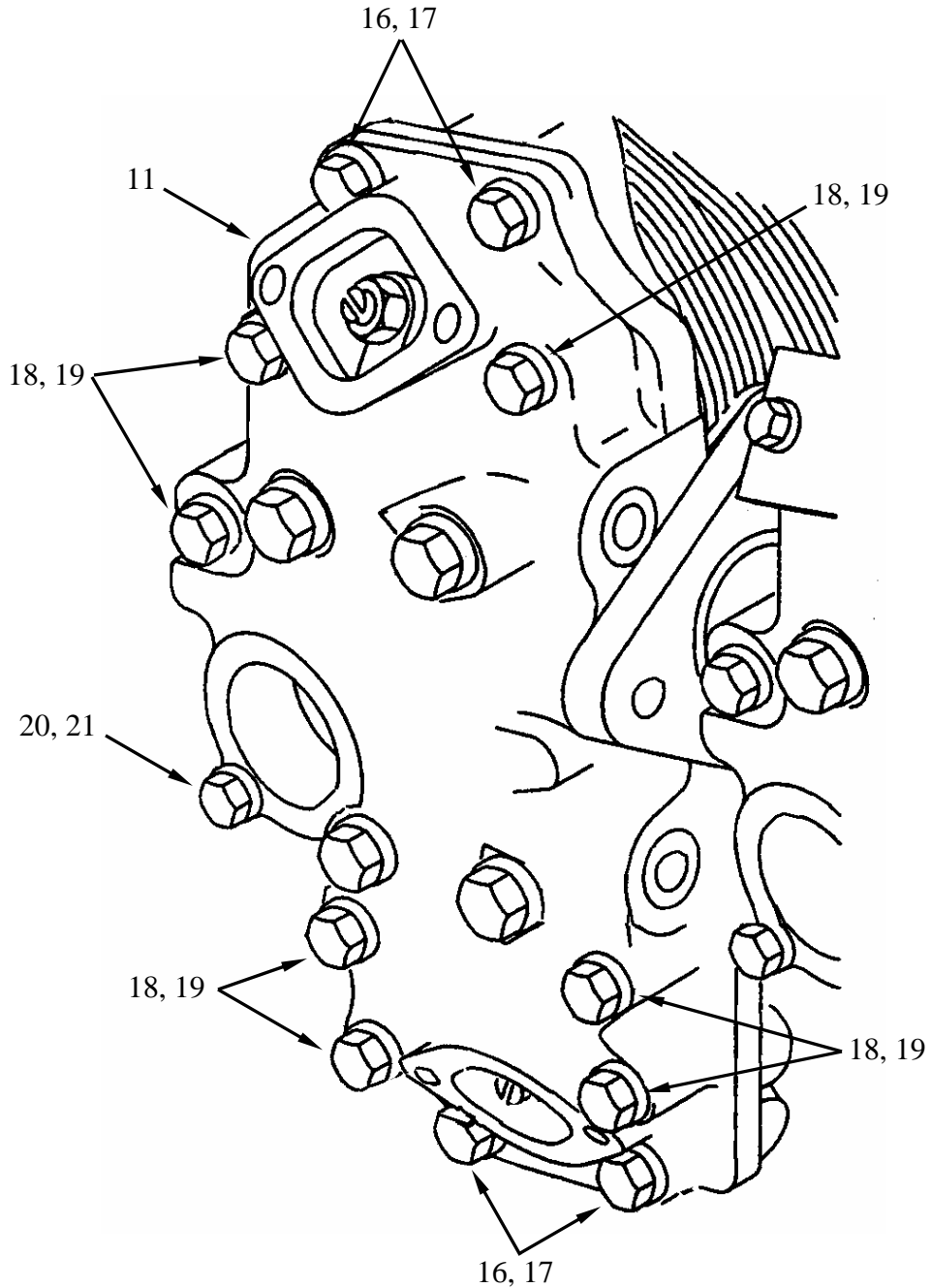
**Step 6 applies only to cylinder number 1 right.**

6. Separate camshaft end plate (15) from rocker cover (11) and from cylinder (9).
  - a. Remove screw three screws (7).
  - b. Carefully separate end plate (15) and gasket (14). Discard gasket.



**REMOVAL (Continued)**

7. Remove rocker arm cover (11) secondary fasteners.
  - a. Remove four screws (16) with flat washers (17).
  - b. Remove seven screws (18) with flat washers (19).
  - c. Remove one screw (20) with flat washer (21).

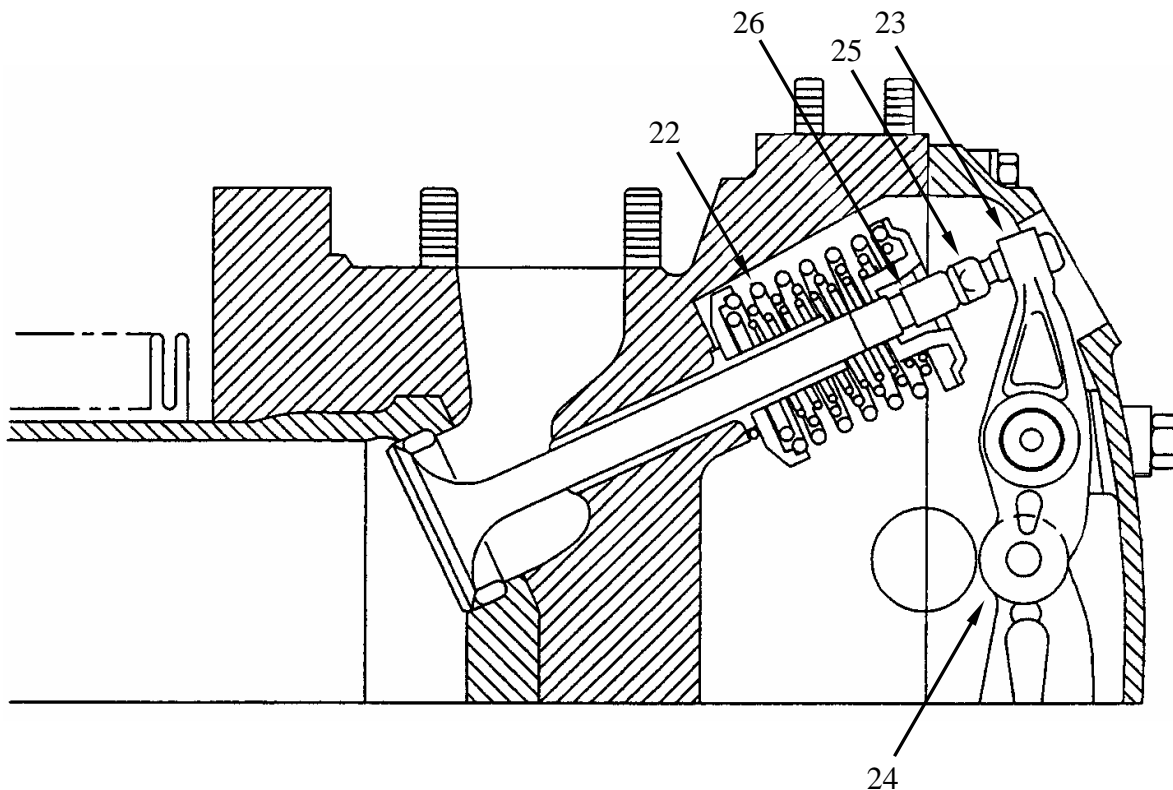


## REMOVAL (Continued)

**CAUTION**

**Do not remove the last four screws (primary fasteners) until valve spring pressure has been relieved. Valve spring pressure must be relieved at each cylinder as the rocker arm cover for that cylinder is removed. Failure to comply may damage cylinder threads that retain rocker arm cover.**

8. Release valve spring (22) tension.
  - a. Release the tension on valve rocker arms (23) and valve springs (22) by rotating engine crankshaft until rocker arm rollers (24) are on camshaft base circle (valves are closed).
  - b. Check rocker arms (23) for free movement between adjusting screw pads (25) and valve stems (26) on both exhaust and intake valves. If movement (clearance) cannot be felt, rotate engine crankshaft until clearance is evident.
  - c. When clearance is obtained between adjusting screw pads (25) and valve stems (26), rocker arm rollers (24) are on camshaft base circle, and valve spring tension is relieved.





## REMOVAL (Continued)

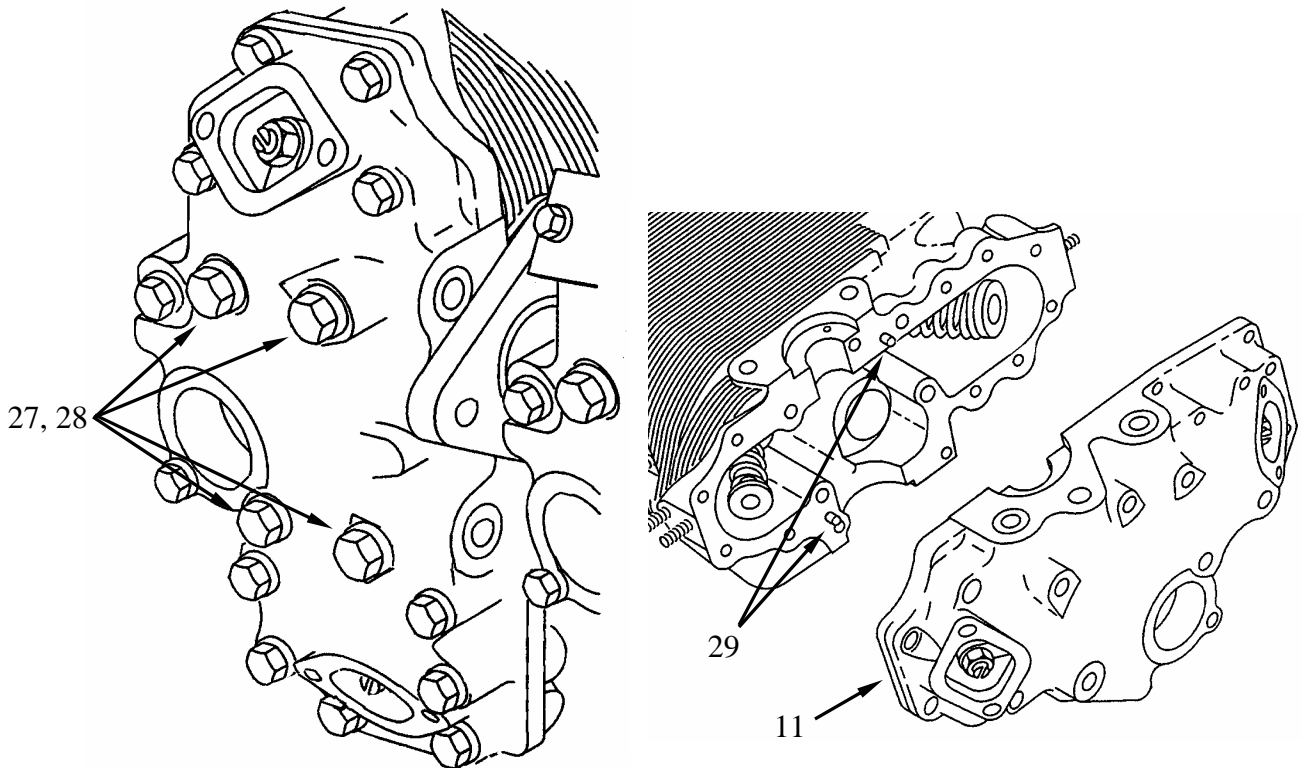
**CAUTION**

The cylinder and rocker arm cover are machined as an assembly. The number on the rocker arm cover must match with its mating number on the cylinder to ensure camshaft bearing alignment and running clearance. If rocker arm cover is damaged, entire cylinder and rocker arm cover must be replaced.

**NOTE**

Cylinders are equipped with replaceable camshaft bearings. The bearing half in each cover should remain with the cover.

9. Remove rocker arm cover (11).
  - a. Remove four screws (27) with seal washers (28). Discard seal washers.
  - b. Carefully lift cover (11) from cylinder dowels (29).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

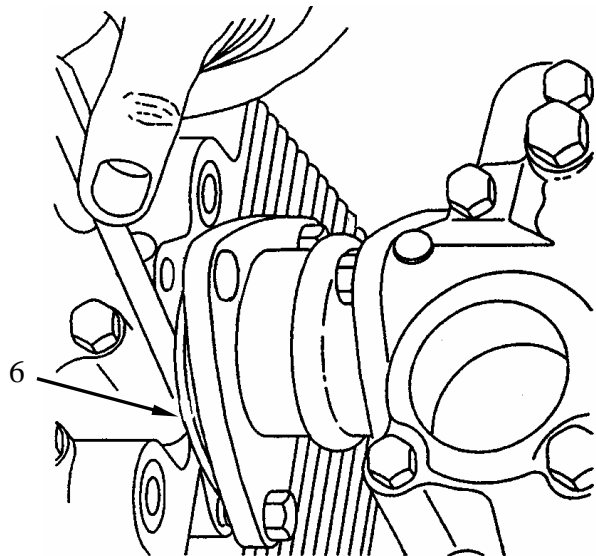
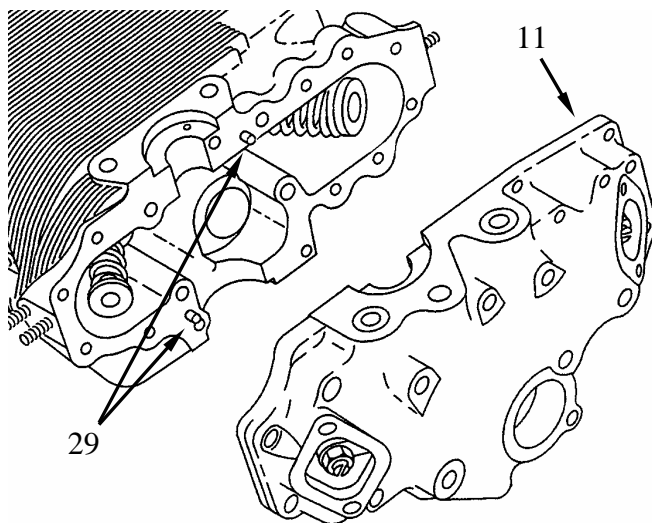
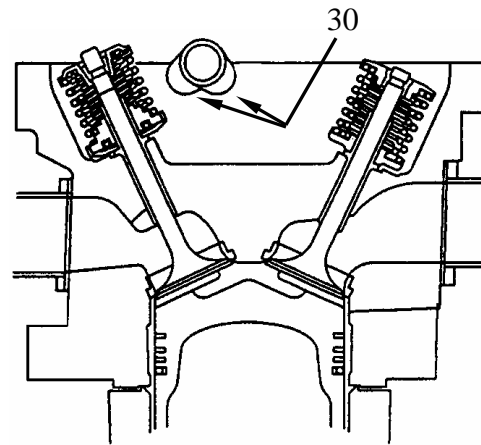
1. See Work Package 0028 for General Inspection Procedures.

**NOTE**

**Specific repair procedures for the rocker arm and cover are in WP 0105.**

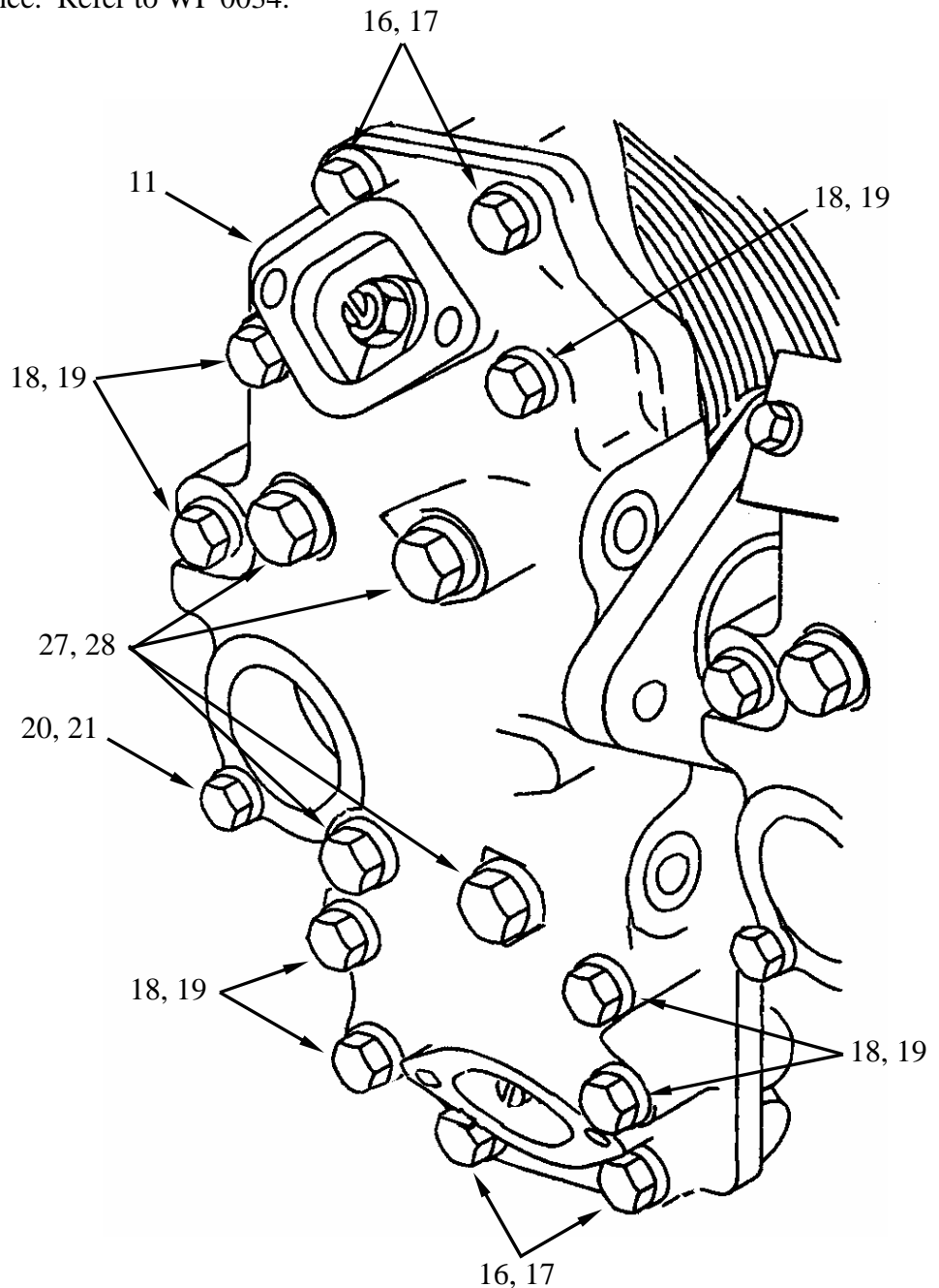
**INSTALLATION**

1. Rotate crankshaft until camshaft lobes (30) for intake and exhaust valves are pointed towards the crankshaft (base circle up).
2. Apply a light film of sealant (item 33, WP 0173) on mating surface of valve rocker arm cover (11).
3. Assure that identifying numbers on rocker arm cover and cylinder match.
4. Assure that camshaft bearing half is installed in cover.
5. Position rocker arm cover (11) in place over dowel pins (29) and tap gently to seat cover.
  - a. Assure that lip of inter-cylinder sleeves (6) are not folded under rocker arm cover (11).



**INSTALLATION (Continued)**

6. Lubricate (using item 23, WP 0173) screws (16, 18, 20, and 27).
7. Install four screws (27) with new thread seal washers (28) (item 194, WP 0175).
  - a. Alternately tighten, then torque to 23-27 foot-pounds (2.6-3 N•m) (using item 127, WP 0176).
8. Install screws (16, 18, and 20) with flat washers (17, 19, and 21).
  - a. Alternately tighten, then torque, screws (16, 18, and 20) to 150-175 inch-pounds (17-20 N•m) (using item 124, WP 0176).
9. Adjust valve clearance. Refer to WP 0034.

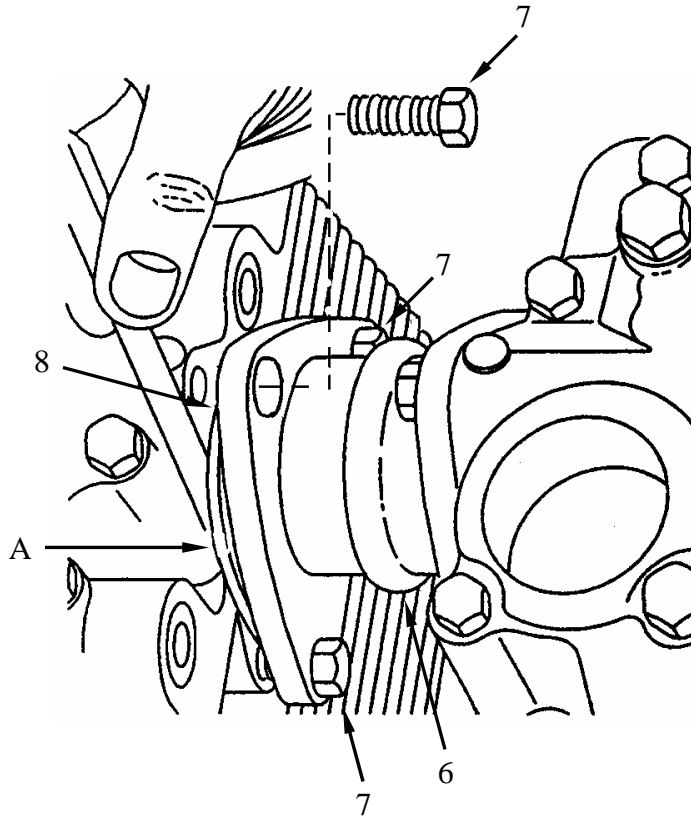


## INSTALLATION (Continued)

## NOTE

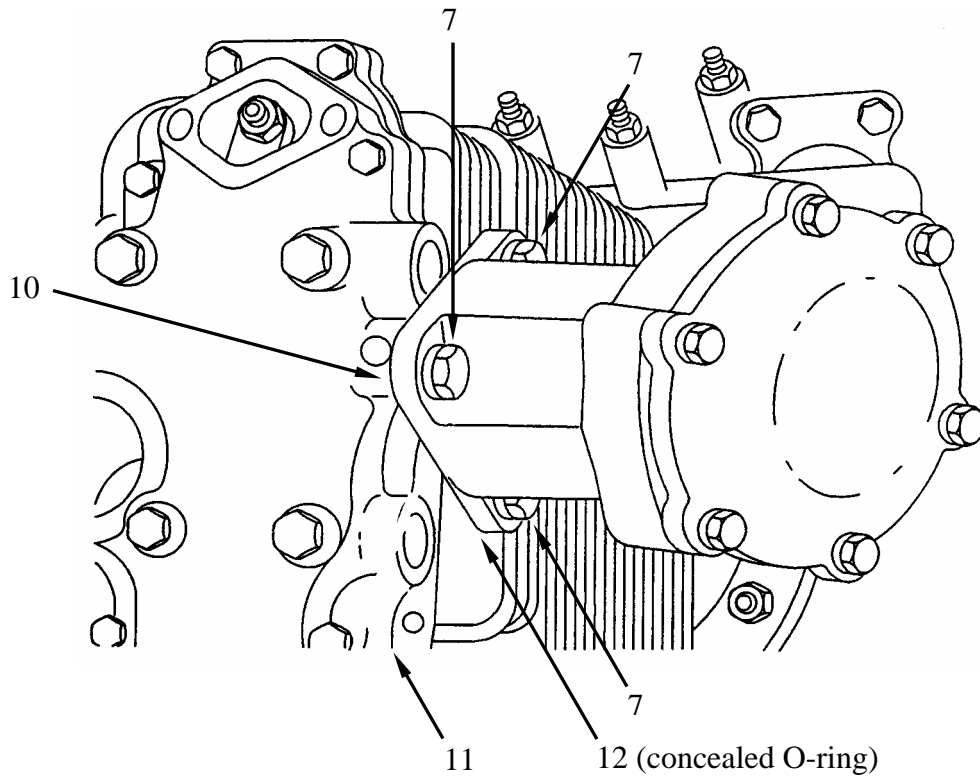
**One side of one inter-cylinder sleeve is illustrated and installed.  
Repeat procedure for remaining sleeves.**

10. Secure inter-cylinder sleeves (6).
  - a. Assure that sleeve (6) lip (A) is in place and not wrinkled.
  - b. Position flange (8) against cylinder and secure with screws (7).
  - c. Torque screws (7) to 400-450 inch-pounds (45.2-50.8 N•m) (using item 125, WP 0176).



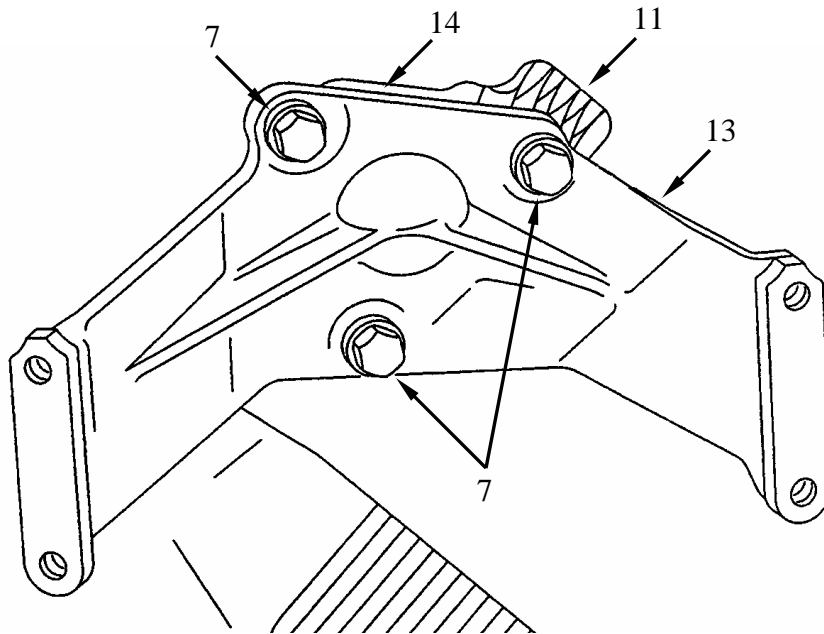
**INSTALLATION (Continued)**

11. Install camshaft drive housings (10) at cylinders 6 right and left.
  - a. Assure that O-ring (12) is not damaged and is in place. If O-ring is damaged go to WP 0146 to remove camshaft.
  - b. Position housing (10) against cylinder and secure with screws (7).
  - c. Torque screws (7) to 400-450 inch-pounds (45.2-50.8 N•m) (using item 125, WP 0176).



**INSTALLATION (Continued)**

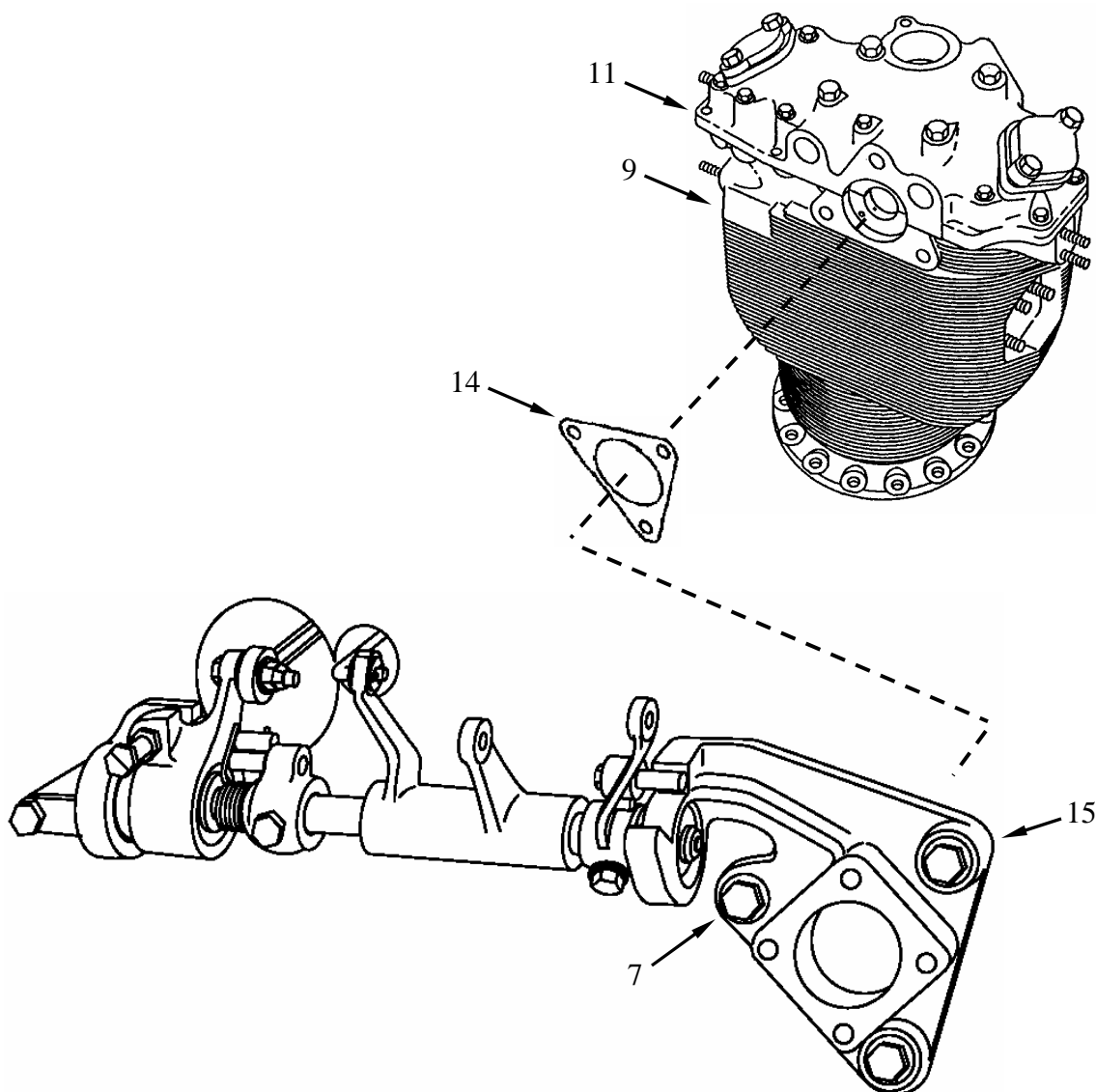
12. Install fuel/water separator bracket (13) at cylinder number 1 left.
  - a. Place a new gasket (14) (item 291, WP 0175) into position between rocker arm cover (11) and bracket (13).
  - b. Position bracket (13) over gasket (14) and secure with screws (7).
  - c. Torque screws (7) to 400-450 inch-pounds (45.2-50.8 N•m) (using item 125, WP 0176).



**INSTALLATION (Continued)**

13. Install camshaft end plate (15) at cylinder 1 right.

- a. Place a new gasket (14) (item 291, WP 0175) between rocker arm cover and end plate (15).
- b. Secure end plate (15) to cylinder (9) and to rocker arm cover (11) using three screws (7).
- c. Torque screws (7) to 400-450 inch-pounds (45.2-50.8 N•m) (using item 125, WP 0176).



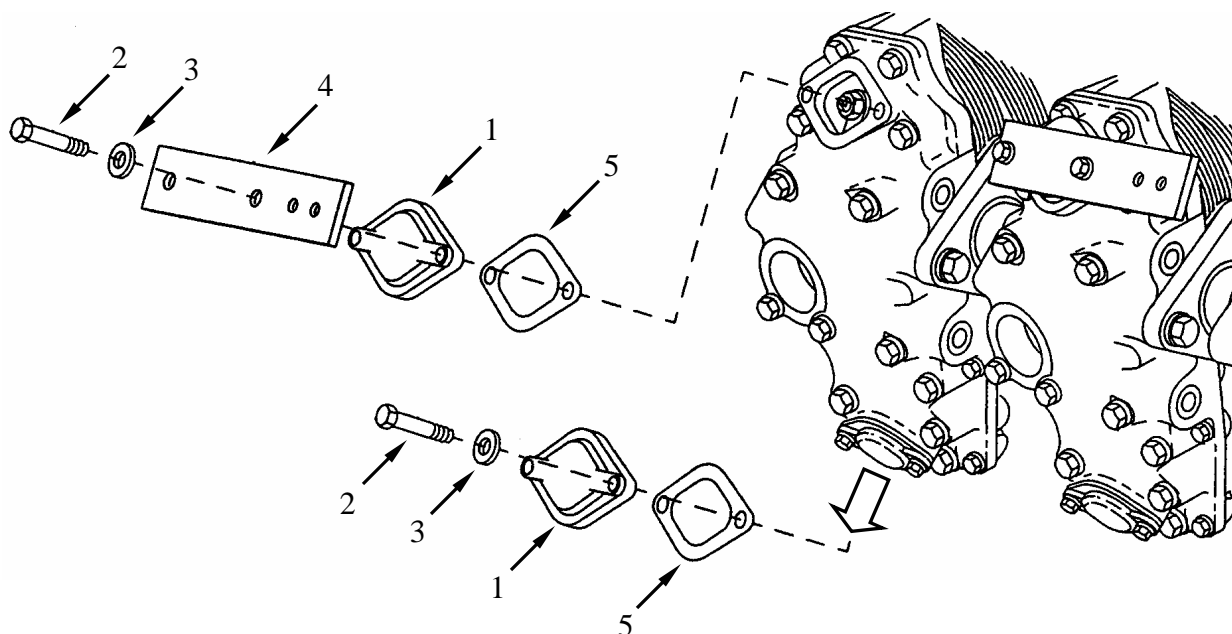
**INSTALLATION (Continued)**

## 14. Install upper access cover (1).

- a. Place new gasket (5) (item 350, WP 0175) into position followed by access cover (1) and fuel injection clamp spacer plate (4).
- b. Secure using two screws (2) with flat washers (3).
- c. Torque screws (2) to 150-175 inch-pounds (17-19.8 N•m) (using item 124, WP 0176).

## 2. Install lower access cover (1).

- a. Place new gasket (5) (item 350, WP 0175) into position followed by access cover (1).
- b. Secure using two screws (2) with flat washers (3).
- c. Torque screws (2) to 150-175 inch-pounds (17-19.8 N•m) (using item 124, WP 0176).

**END OF WORK PACKAGE**



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**ROCKER ARM ASSEMBLY AND COVER REPAIR**

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**0105 00****THIS WORK PACKAGE COVERS:**Inspection, Repair

---

**INITIAL SETUP:****Tools:**

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Machinist vise (item 132, WP 0176)  
Magnifying glass (item 73, WP 0175)  
Outside micrometer caliper set (item 17,  
WP 0176)  
Telescoping gauge set (item 54, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**Rocker arm cover assemblies removed  
(WP 0104)

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**CAUTION**

**The cylinder and rocker arm cover are machined as an assembly. The number on the rocker arm cover must match with its mating number on the cylinder to ensure camshaft bearing alignment and running clearance. If a rocker arm cover is damaged, the entire cylinder and rocker arm cover must be replaced.**

**NOTE**

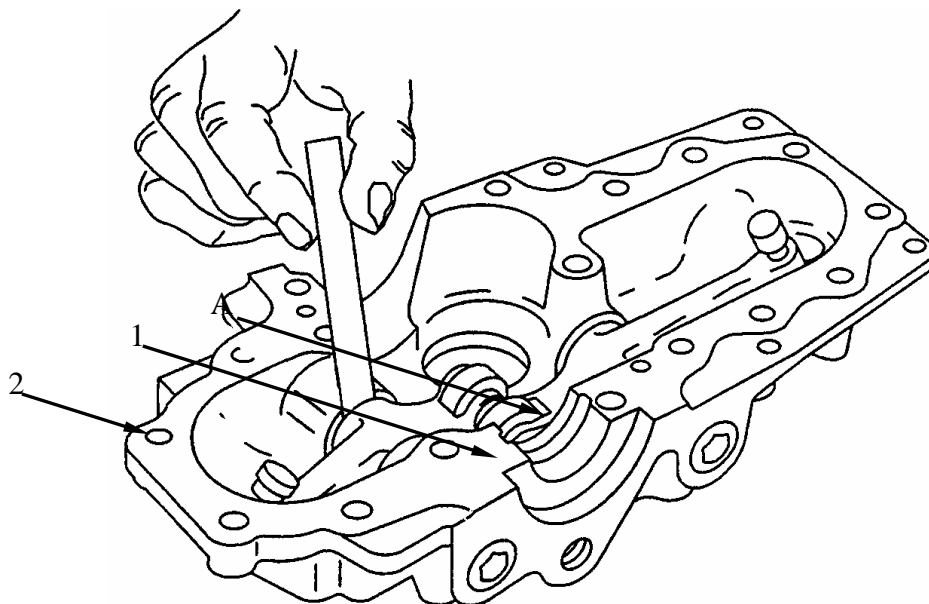
**The engine has 12 rocker arm cover assemblies. The following procedures apply to one or all covers. This procedure shows the replacement of the exhaust rocker arm only.**

**Each rocker arm cover assembly contains both exhaust and intake rocker arms. Both rocker arms are removed, repaired, and installed in the same manner. In addition, clearances and specifications provided in this work package apply to both intake or exhaust components.**

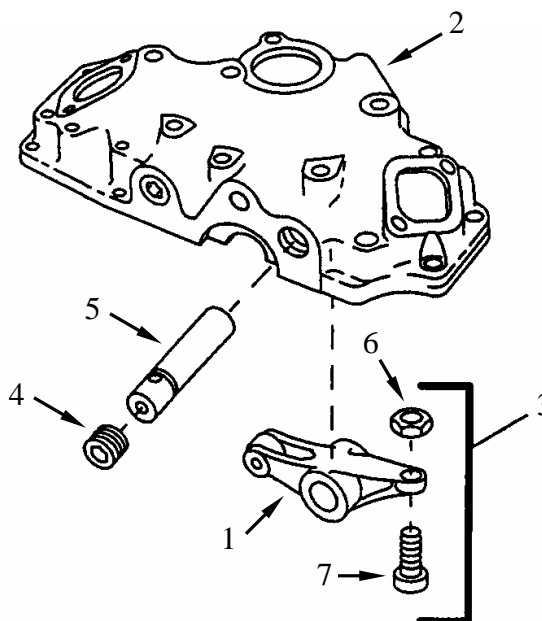
**DISASSEMBLY**

1. Check rocker arm (1) side clearance.
  - a. Check side clearance (A) between rocker arm cover (2) and rocker arm (1), using a feeler gauge. Replace rocker arms that do not meet the specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Side clearance between rocker arm cover and rocker arm)	0.0060 (0.1524)	0.0140 (0.3556)	0.0200 (0.508)



2. Remove rocker arm assembly (3) from cover (2).
  - a. Remove machine thread plug (4).
  - b. Remove straight shaft (5) and rocker arm assembly (3) from rocker arm cover (2).
3. Remove jam nut (6) and adjusting screw (7) from rocker arm (1).



**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

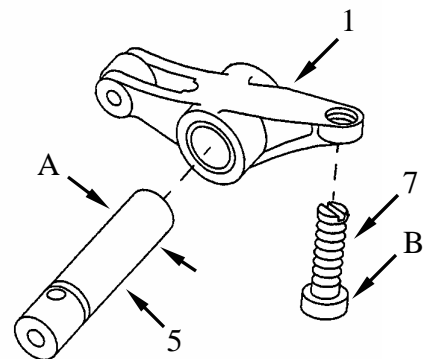
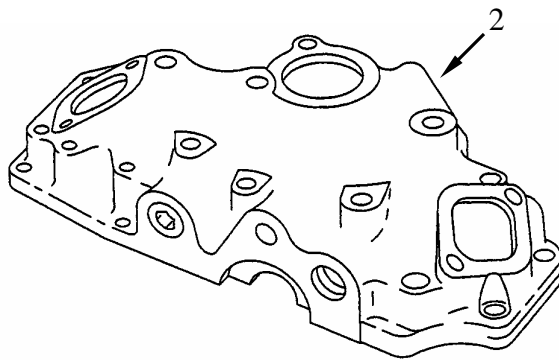
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Inspect rocker arm cover (2) for cracks using a magnifying glass (item 73, WP 0176) and a strong light. Replace any cracked rocker arm cover.
3. Check straight shaft (5) for cracks, scores, and metal pick up or plugged oil passages. Replace any cracked, deeply scored, or plugged straight shafts.
4. Measure outside diameter of straight shaft (5) using outside micrometer (item 17, WP 0176). Replace straight shafts that do not meet the following limits:

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Shaft diameter)	0.7480 (18.9992)	0.7485 (19.0119)	0.7470 (18.9738)

5. Inspect adjusting screw (7) for stripped or damaged threads. Replace adjusting screw if damaged.
6. Check adjusting screw (7) by turning in and out of rocker arm (1). Replace adjusting screw (7) that does not turn freely.
7. Check swivel pad (B) for free rotation on adjusting screw (7). Replace adjusting screw (7) if swivel pad (A) does not rotate freely.



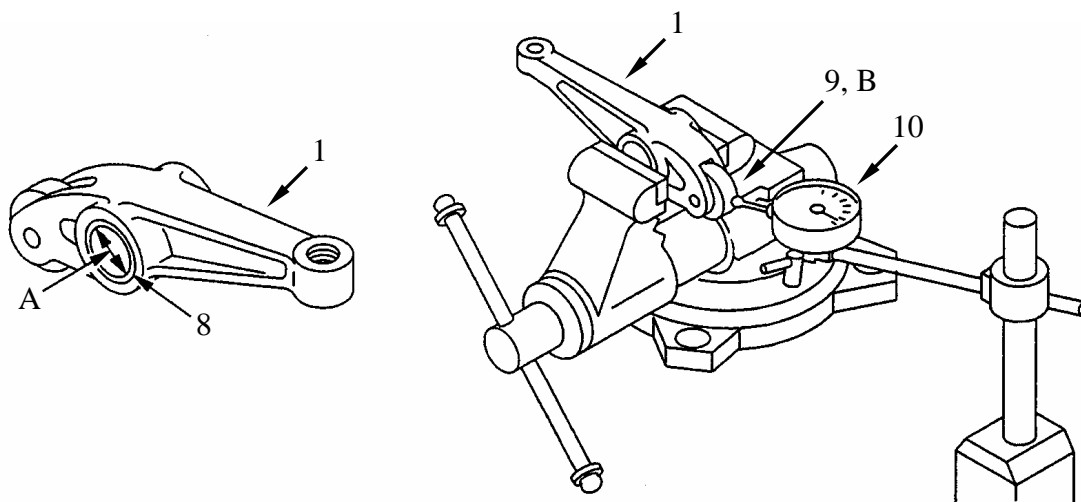
**INSPECTION (Continued)**

8. Inspect rocker arm (1) bearing sleeve (8) for scoring or looseness. Replace loose or scored bearing sleeves. Refer to WP 0028
9. Measure the diameter (A) of bearing sleeve (8) using telescoping gauge set (item 54, WP 0176). Replace bearing sleeves that do not meet the following limits. Refer to WP 0028.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Inside diameter)	0.7495 (19.0373)	0.7505 (19.0627)	0.7520 (19.1008)

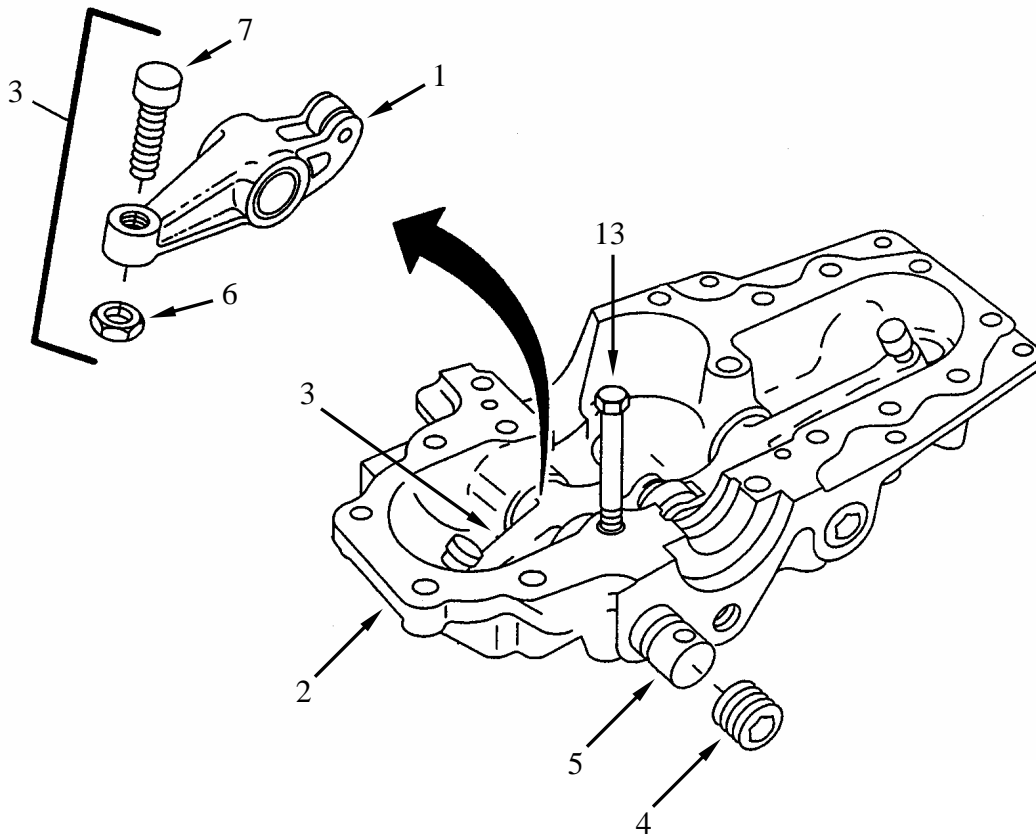
10. Inspect rocker arm roller (9) for flat spots on roller surface. Replace rocker arm if rollers are damaged.
11. Measure rocker arm roller (9) radial clearance (B).
  - a. Mount rocker arm (8) securely in a soft-jawed vise (item 132, WP 0176).
  - b. Set dial indicator (10) (item 65, WP 0176) against contact surface of roller (9).
  - c. Grasp roller and pull forward as far as possible. Set dial to zero and then push roller back as far as possible. Dial indicator reading is radial clearance (B).
  - d. Replace rocker arm if rollers do not meet the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
B (Roller radial clearance)	0.0020L (0.0508)	0.0030L (0.0762)	0.0055L (0.1397)



**ROCKER ARM ASSEMBLY AND COVER REPAIR****0105 00****ASSEMBLY**

1. Install adjusting screw (7) and jam nut (6) in rocker arm (1).
2. Position rocker arm assembly (3) in rocker arm cover (2) and insert straight shaft (5) through bore in rocker arm cover (2) and bore in rocker arm assembly (3).
3. Use a rocker arm cover bolt (13) to align hole in straight shaft (5) with bolt hole in rocker arm cover (2).
4. Push straight shaft (5) into position without turning to retain alignment.
5. Install machine thread plug (4) in rocker arm cover (2).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, and Assembly

**INITIAL SETUP:****Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Slide hammer (puller) (item 88, WP 0176)
- Spring tester (item 118, WP 0176)

**Fabricated Items:**

- Valve sleeve remover (item 7, WP 0177)

**Mandatory Replacement Parts:**

- Gasket (2) (item 106, WP 0175)
- Gasket (1) (item 160, WP 0175)
- Self-locking nut (2) (item 33, WP 0175)

**Personnel Requirements:**

- Track Vehicle Repairer (1) 63H10

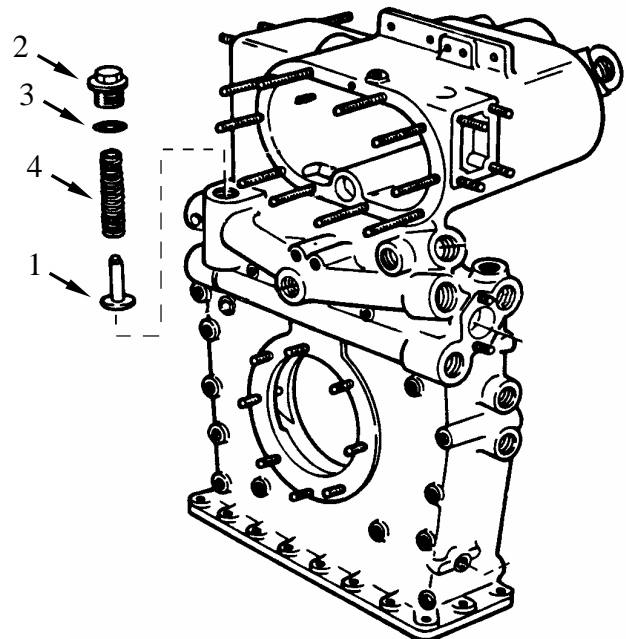
**Equipment Conditions:**

- Engine level on flat surface

**DISASSEMBLY**

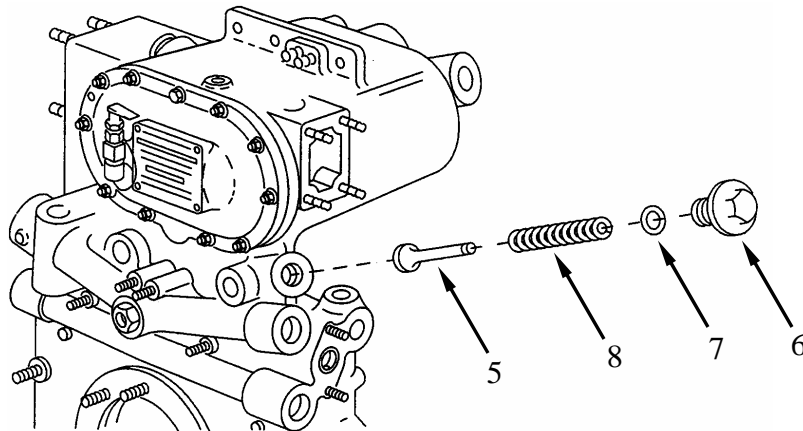
**Early model engines had an oil cooler bypass valve. Later model engines do not have this feature; it was found to be unnecessary. If your engine does not have an oil cooler bypass, skip step 1 and go to step 2.**

1. Remove oil cooler bypass valve (1).
  - a. Remove plug (2).
  - b. Remove and discard gasket (3).
  - c. Remove spring (4) and plunger (1).



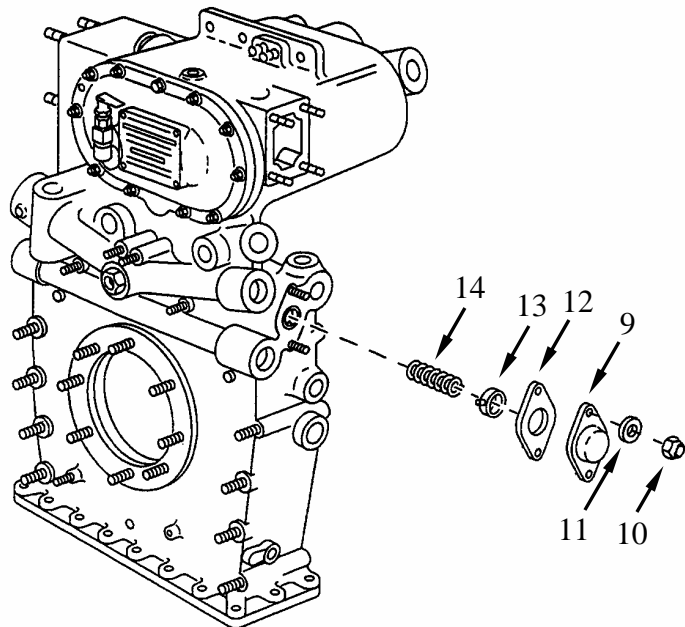
**REMOVAL (Continued)**

2. Remove oil filter by-pass valve (5).
  - a. Remove machine thread plug (6).
  - b. Remove and discard gasket (7).
  - c. Remove spring (8) and by-pass valve (5).

**WARNING**

The pressure regulator valve access cover is spring-loaded. Exercise care when removing cover. Failure to comply may result in personnel injury from flying parts.

3. Remove oil pressure regulator valve access cover (9).
  - a. Remove two self-locking nuts (10) with flat washers (11). Discard self-locking nuts.
  - b. Remove access cover (9), gasket (12), valve stop plate (13) and spring (14). Discard gasket.

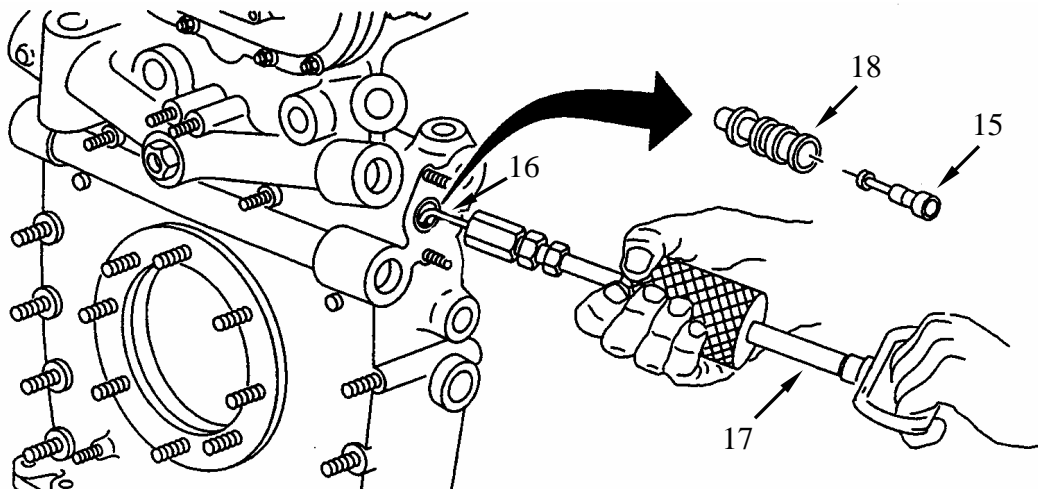




**REMOVAL (Continued)****NOTE**

The oil pressure sleeve may be difficult to remove because of varnish from oil. An improvised tool used with a slide hammer puller may be used to assist in removing oil pressure sleeve.

4. Remove oil pressure regulator valve (15).
  - a. Insert hook end of valve sleeve remover (16) (item 7, WP 0177) and slide hammer (17) (item 88, WP 0176) into hole in oil pressure sleeve (18), and gently tap until oil pressure sleeve (18) is free.
  - b. Remove pressure regulator valve (15) from sleeve (16).

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

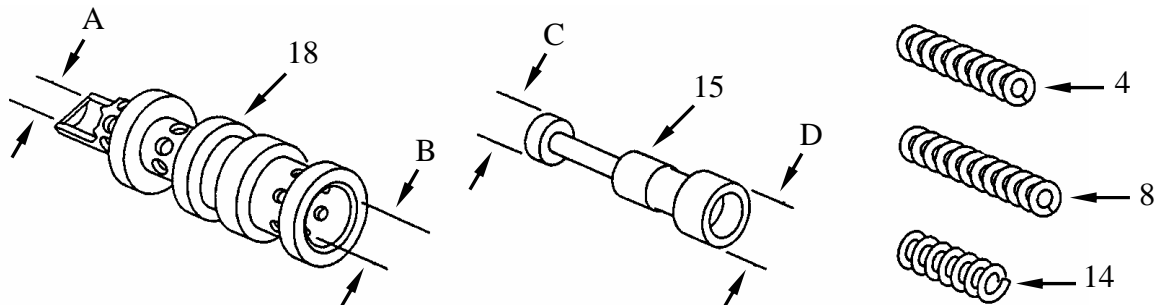
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSPECTION (Continued)**

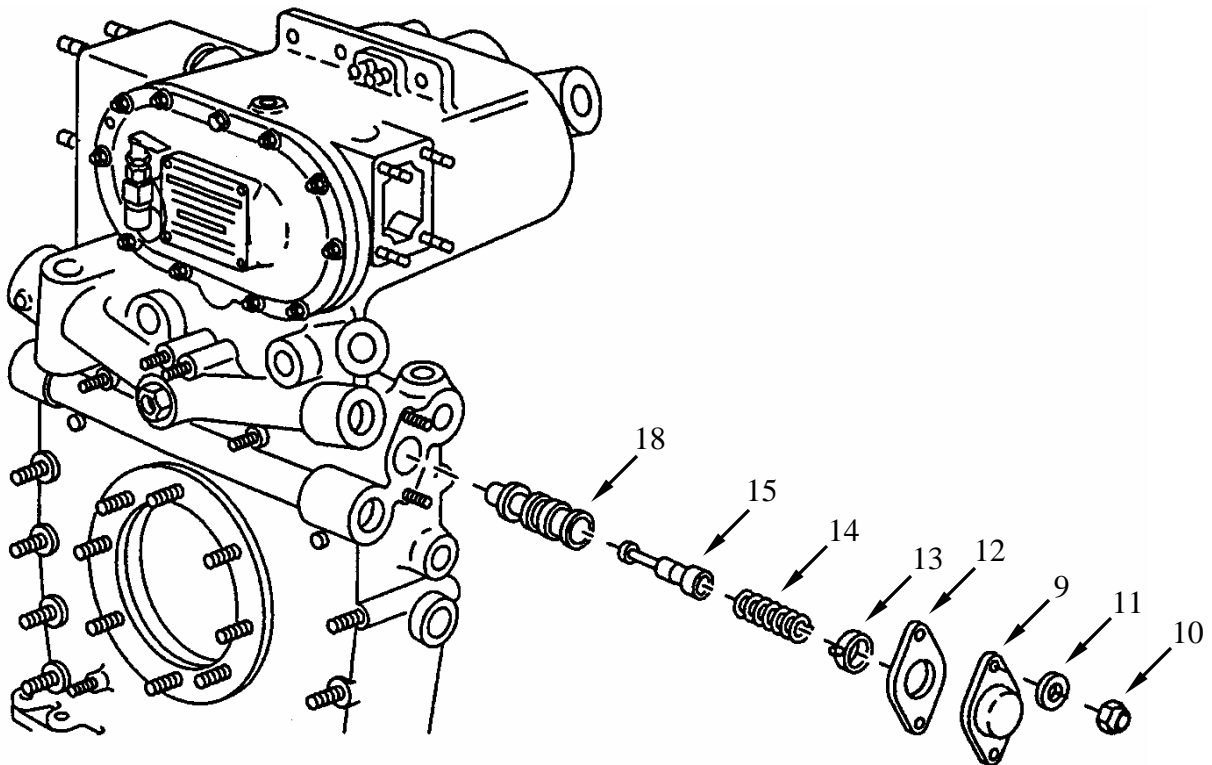
1. Measure inside diameters (A and B) of sleeve (18) using inside micrometer (item 16, WP 0176). Replace sleeve if not within specifications in the following table.
2. Measure outside diameters (C and D) of pressure regulator valve (15) using outside micrometer (item 17, WP 0176). Replace valve if not within specifications in the following table.
3. Check springs (4) [cooler by-pass], (8) [filter by-pass], and (14) [pressure regulator] against the following limits using a spring tester (item 118, WP 0176). Replace any spring that is not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter - small)	0.8125 (20.6375)	0.8135 (20.6629)	0.8145 (20.6883)
B (inside diameter - large)	1.1865 (30.1371)	1.885 (47.879)	1.1905 (30.238)
C (outside diameter - small)	0.8095 (20.5613)	0.8105 (20.5867)	0.8085 (20.5359)
D (outside diameter - large)	1.1840 (30.0736)	1.1850 (30.099)	1.1830 (30.0482)
4 (spring - cooler by-pass)	Free length: Scale reading at 2.838 inch (71.9 mm) length: Maximum solid height:	3.38-inch (85.9)  178.2 lb (80.8 kg)  2.40-inch (61.0)	none  +/- 9 lb ( kg)  none
8 (spring - filter by-pass)	Free length: Scale reading at 2.81 inch (71.374 mm) length: Maximum solid height:	4.28-inch (108.712)  52.3 lb (23.744 kg)  2.26-inch (57.4294)	none  +/- 5 lb (2.27 kg)  none
14 (spring - pressure regulator)	Free length: Scale reading at 1.825 inch (46.355 mm) length: Maximum solid height:	2.83 in (71.882)  29.3 lb (13.303 kg)  1.284 in (32.6136)	none  +/- 3 pounds  none



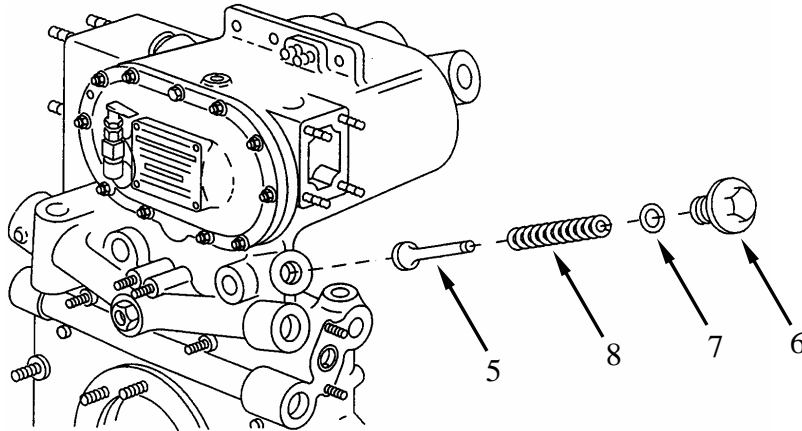
**ASSEMBLY**

1. Install oil pressure sleeve (18).
2. Install oil pressure regulator valve (15).
3. Install spring (14), valve stop plate (13).
4. Install access cover (9).
  - a. Place new gasket (12) (item 160, WP 0175) in position followed by cover (9).
  - b. Secure using two new self-locking nuts (10) (item 33, WP 0175) with flat washers (11).

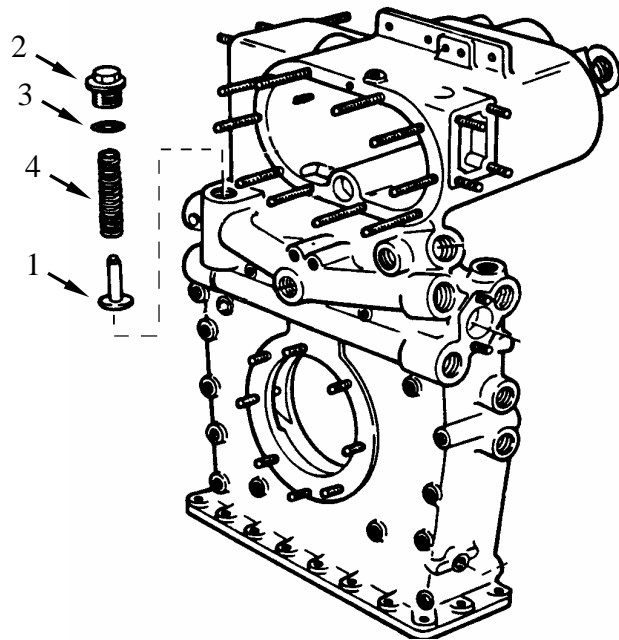


**ASSEMBLY (Continued)**

5. Install oil filter by-pass valve (5).
6. Position spring (8) on by-pass valve (5).
7. Install machine thread plug (6) with new gasket (7) (item 106, WP 0175).



8. On early models install oil cooler bypass valve (1).
  - a. Position spring (4) on plunger (1).
  - b. Install plug (2) with new gasket (3) (item 106, WP 0175).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Inspection, Installation

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**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 200-1000 inch-pounds (item 125, WP 0176)

**Mandatory Replacement Parts:**

Gasket (2) (item 327, WP 0175)  
Gasket (8) (item 363, WP 0175)  
Lock washer (2) (item 94, WP 0175)  
Lock washer (2) (item 93, WP 0175)  
Self-locking nut (42) (item 161, WP 0175)  
Self-locking nut (4) (item 113, WP 0175)  
Self-locking nut (2) (item 36, WP 0175)  
Self-locking nut (2) (item 140, WP 0175)

**Expendable and Durable Items:**

Antiseize compound (item 5, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine level on flat surface  
Cooling fans and vanes removed (WP 0054)  
Top shroud removed (WP 0055)  
Fuel injector tubes, brackets and associated parts removed (WP 0113)  
Rear shrouds removed (WP 0128)  
Exhaust smoke generating tubes removed (WP 0094)

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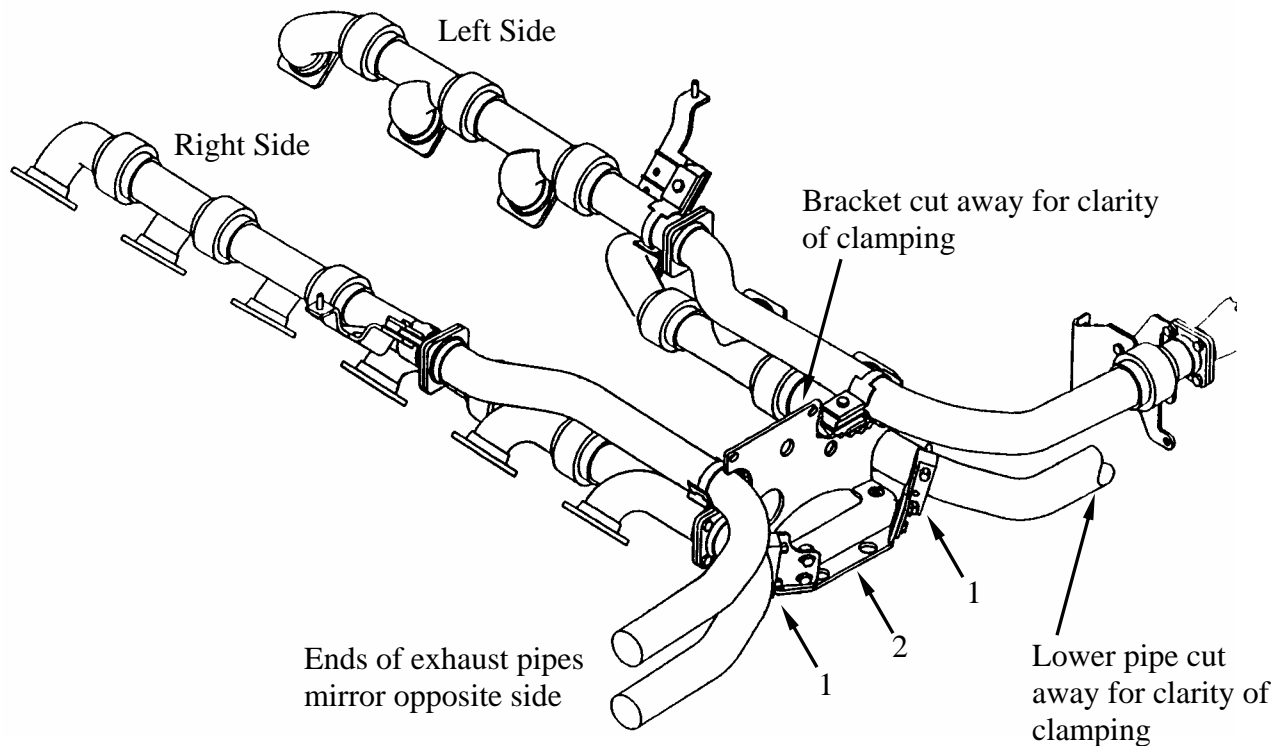
**REMOVAL****NOTE**

Early model exhaust manifolds were not clamped outside of the engine cooling shrouds. If you have an early model exhaust system, you should consider upgrading to the new system. The new exhaust pipes are made of heavier material, are more reliable, and have a superior clamping system. In addition, the parts manual carries only the newer exhaust manifolds and the new clamping system.

This work package covers removal of the new exhaust system with the new clamping. The old exhaust system removal and replacement are identical with the exception of the clamping. This work package details the left side procedure only; the right side is the same.

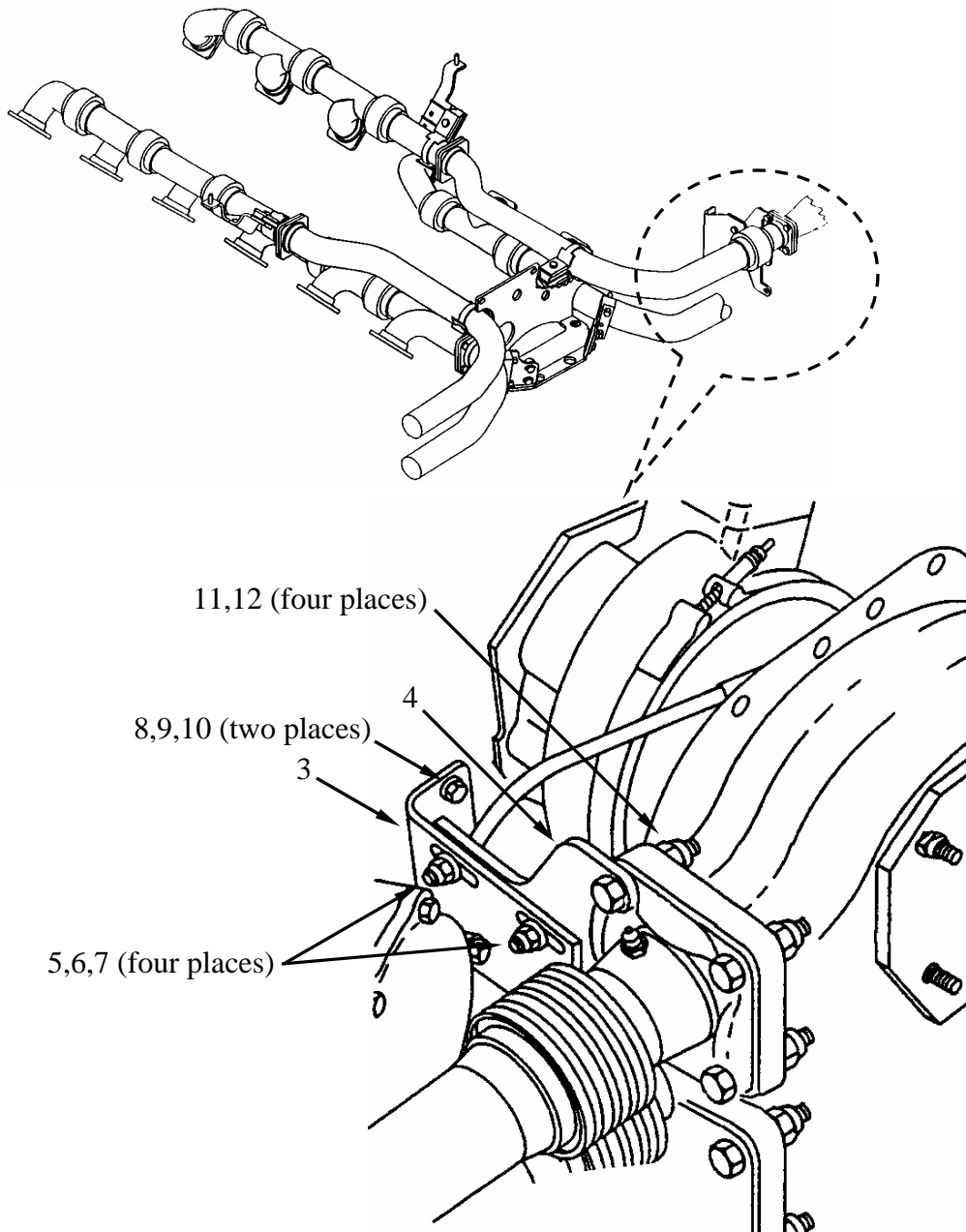
**CAUTION**

New clamps (1) will not fit the old exhaust pipes at the center bracket (2), lower pipe positions, both left and right sides.



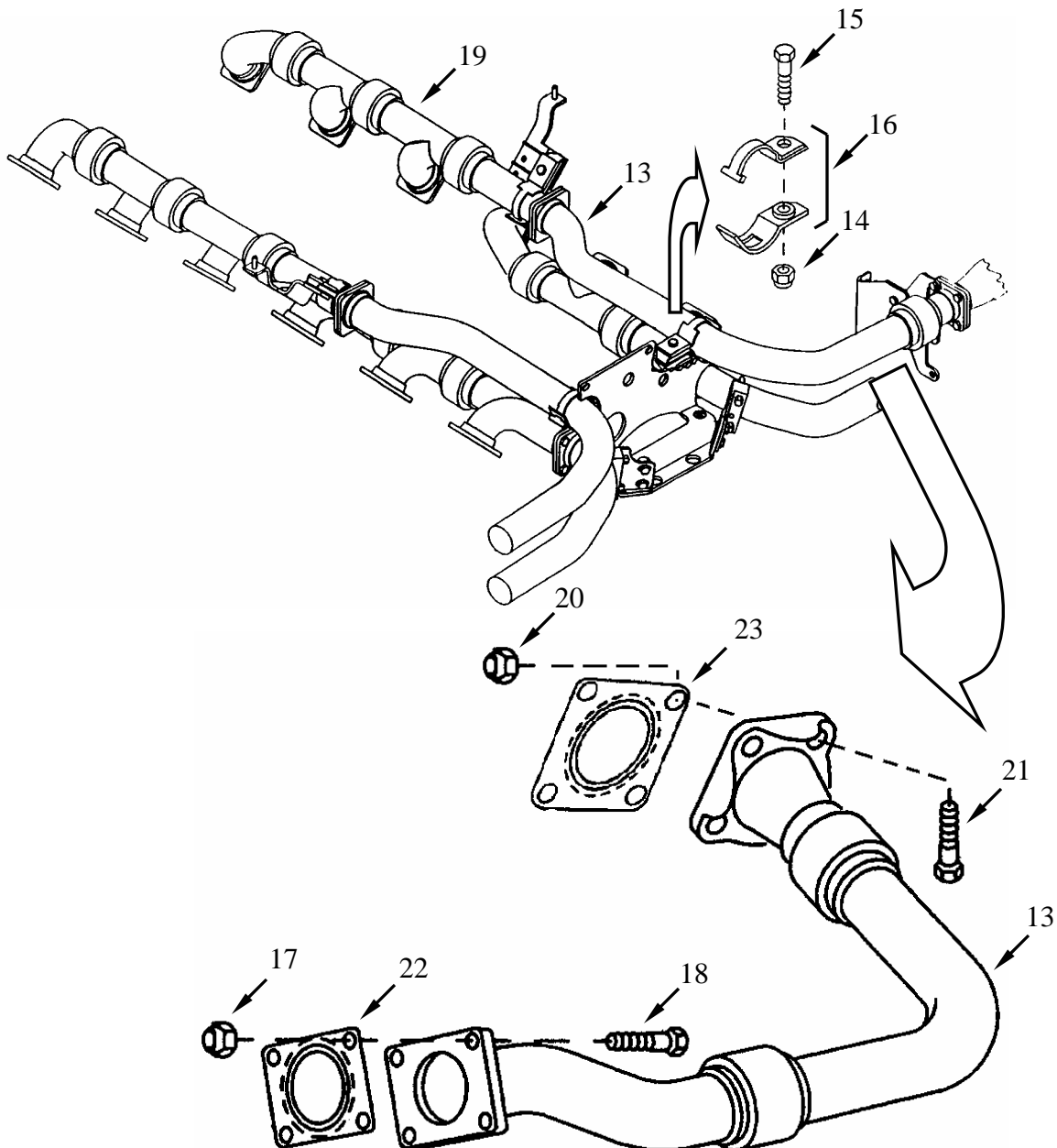
**REMOVAL (Continued)**

1. Remove bracket (3) and bracket (4) at turbocharger.
  - a. Remove four self-locking nuts (5), flat washers (6) and screws (7) securing bracket (3) to bracket (4). Discard self-locking nuts.
  - b. Remove two screws (8) with flat washers (9) and lock washers (10) to remove bracket (3) from engine shrouding. Discard lock washers.
  - c. Remove four self-locking nuts (11) and screws (12) and remove bracket (4) from turbocharger. Discard self-locking nuts.



**REMOVAL (Continued)**

2. Remove exhaust elbow (13) leading to cylinders 1, 2, and 3 [left side].
  - a. Remove self-locking nut (14), screw (15) and clamp assembly (16) inside engine shrouding. Discard self-locking nut.
  - b. Remove four self-locking nuts (17) and screws (18) securing elbow (13) to cylinders 1-2-3 exhaust manifold (19). Discard self-locking nuts.
  - c. Remove remaining two self-locking nuts (20) and screws (21) securing elbow (13) to turbocharger. Discard self-locking nuts.
  - d. Remove elbow (13) and gaskets (22 and 23). Discard gaskets.





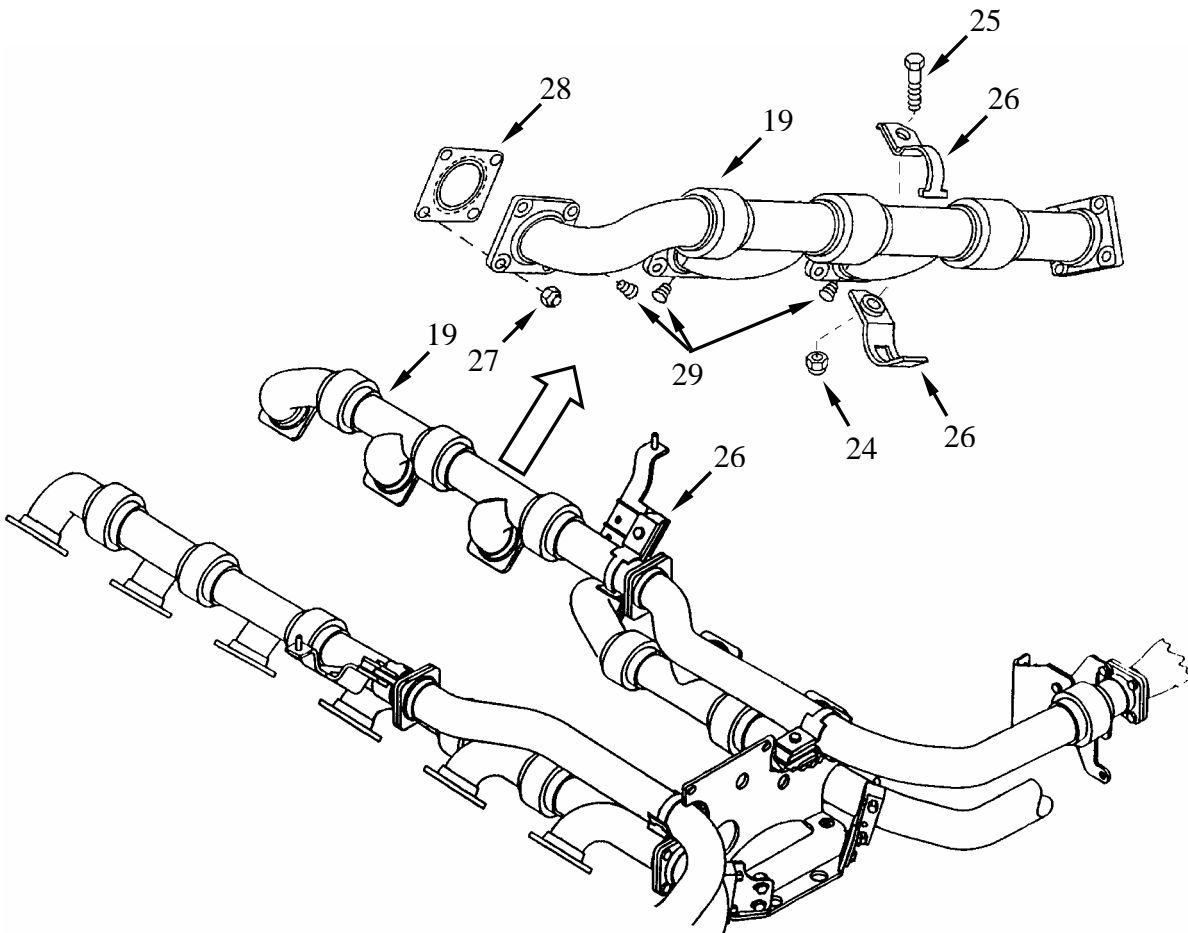
**REMOVAL (Continued)**

3. Remove 1-2-3 left exhaust manifold (19).
  - a. Remove self-locking nut (24), screw (25) and clamp assembly (26) at manifold (19). Discard self-locking nut.
  - b. Remove twelve self-locking nuts (27) from exhaust manifold (19) at cylinders 1-2-3 left. Discard self-locking nuts.
  - c. Remove exhaust manifold (19) and three gaskets (28). Discard gaskets.

**NOTE**

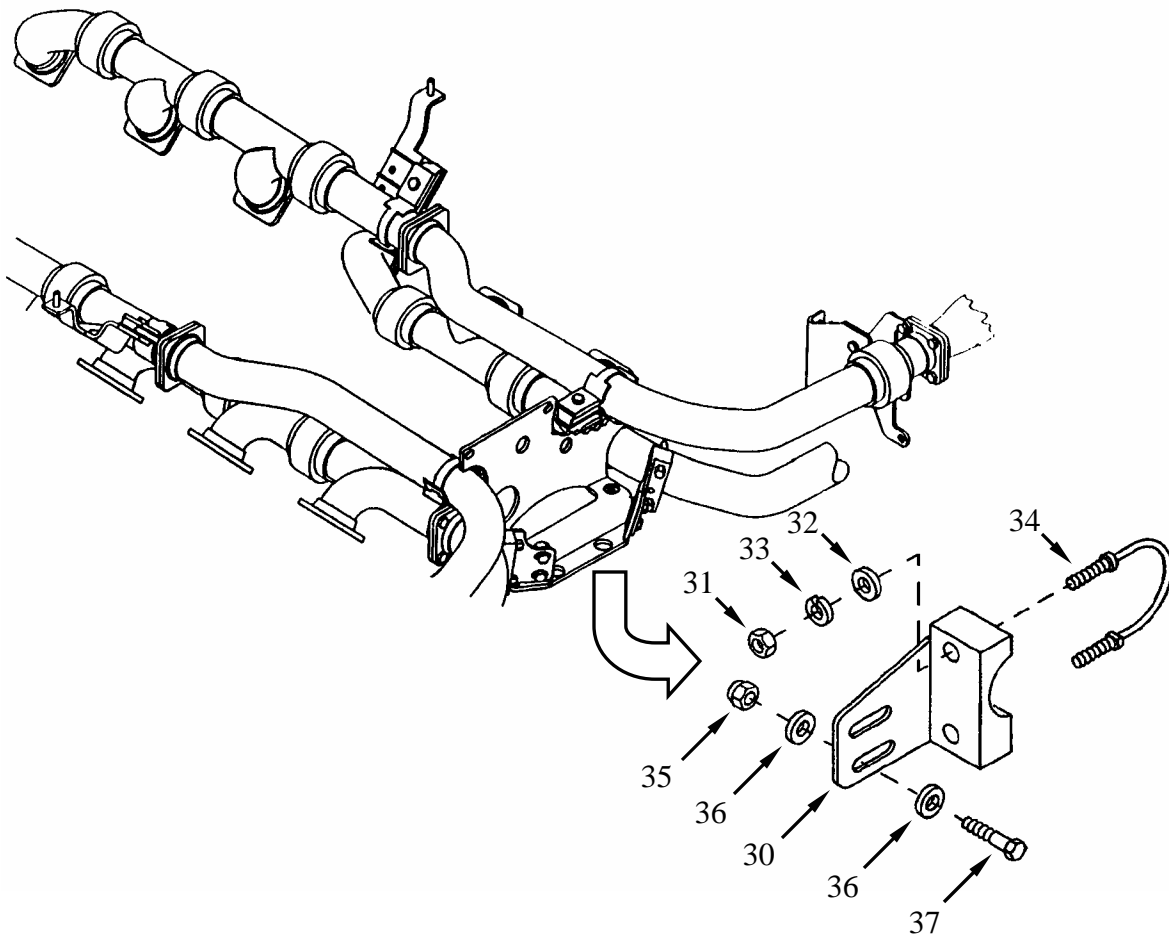
**Remove pipe plugs only if required. Typically exhaust plugs are very difficult to remove.**

4. Remove and discard three pipe plugs (29) from exhaust manifold (19).



**REMOVAL (Continued)**

5. Remove bracket (30).
  - a. Remove two nuts (31) with flat washers (32) and lock washers (33) securing U-bolt (34) to bracket (30). Discard lock washers.
  - b. Remove U-bolt (34).
  - c. Remove two self-locking nuts (35), four flat washers (36) and two screws (37) to remove bracket (30). Discard self-locking nuts.



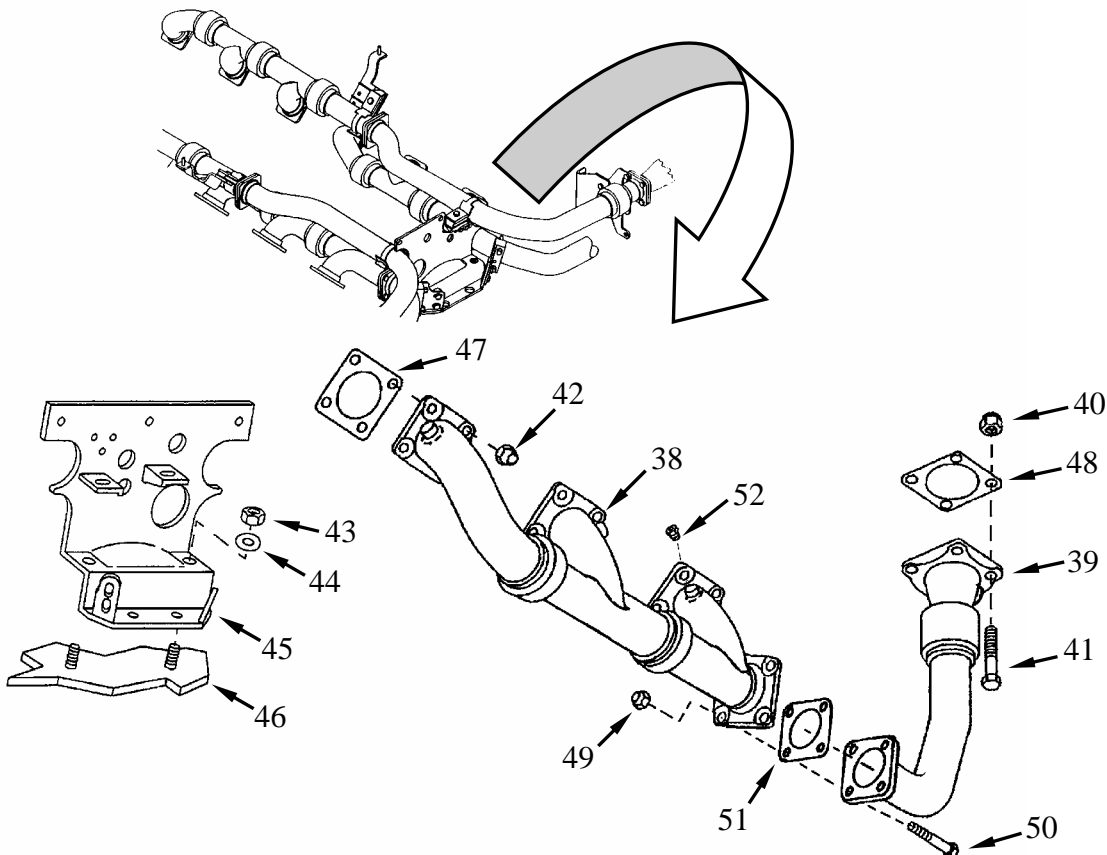
**REMOVAL (Continued)**

5. Remove 4-5-6 left exhaust manifold (38) and elbow (39).
  - a. Remove remaining two self-locking nuts (40) and screws (41) securing manifold (38) to turbocharger. Discard self-locking nuts.
  - b. Remove twelve self-locking nuts (42) from exhaust manifold (38). Discard self-locking nuts.
  - c. Remove two self-locking nuts (43) with flat washers (44) and lift plate (45) off studs (46). Move plate (45) aside enough to remove exhaust manifold (38). Discard self-locking nuts.
  - d. Remove exhaust manifold (38) and elbow (39) as an assembly.
  - e. Remove three gaskets (47) and one gasket (48). Discard gaskets.
6. Separate manifold (38) from elbow (39).
  - a. Remove four self-locking nuts (49) and screws (50) securing elbow (39) to manifold (38).
  - b. Remove and discard gasket (51).

**NOTE**

**Remove pipe plugs only if required. Typically exhaust plugs are very difficult to remove.**

7. Remove three pipe plugs (52). Discard pipe plugs.



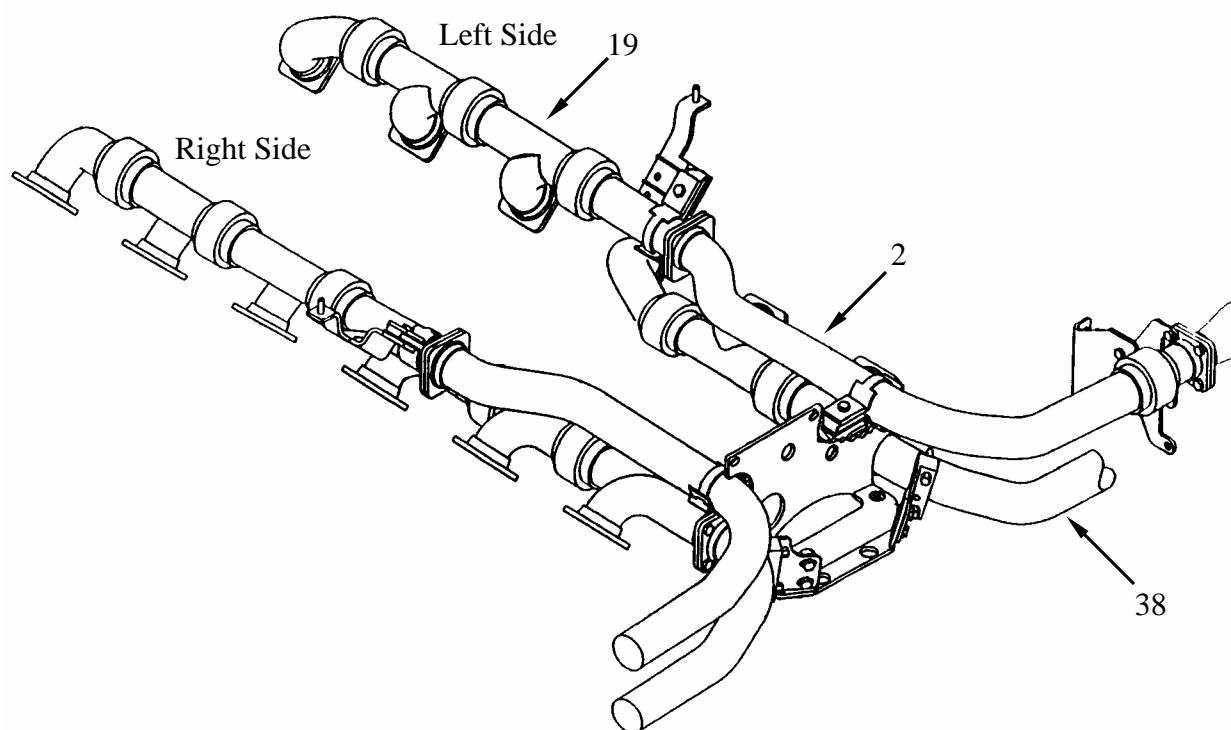
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

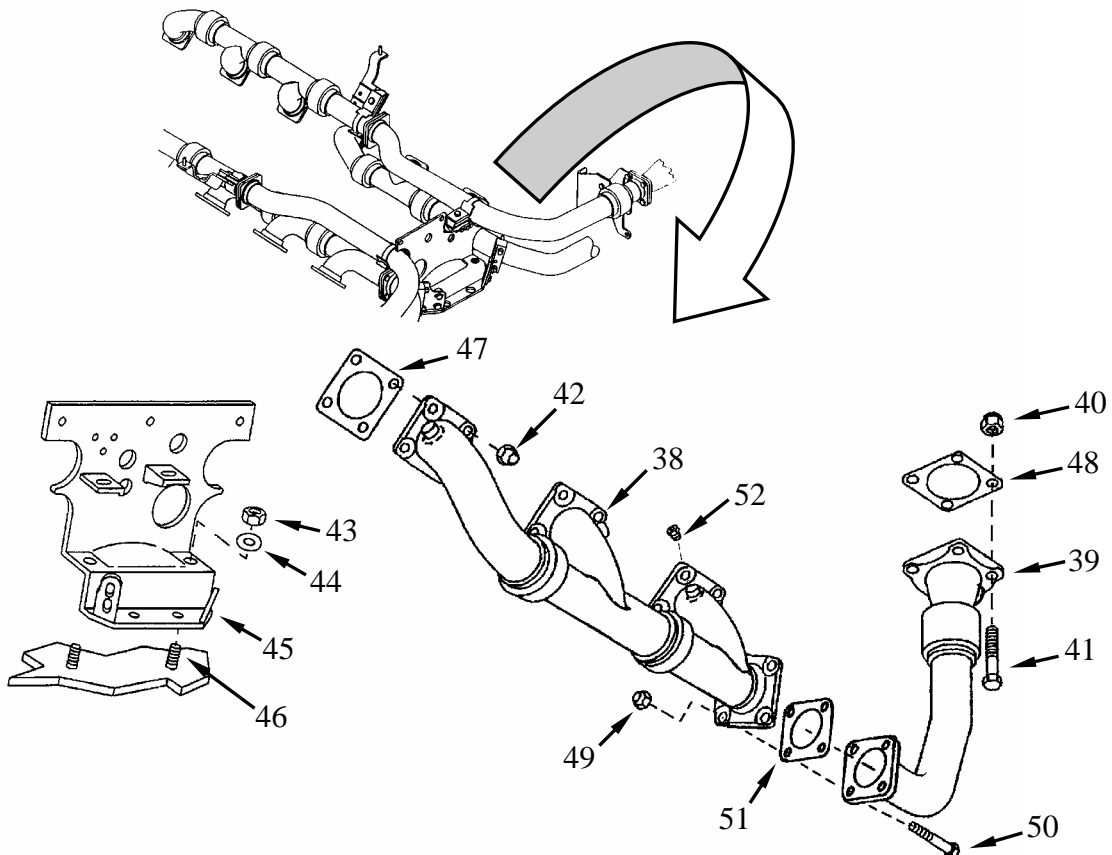
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Visually inspect exhaust manifolds (19, 38) and elbow (2) for cracks, broken welds, damaged bellows, or bent flanges. Replace damaged parts.



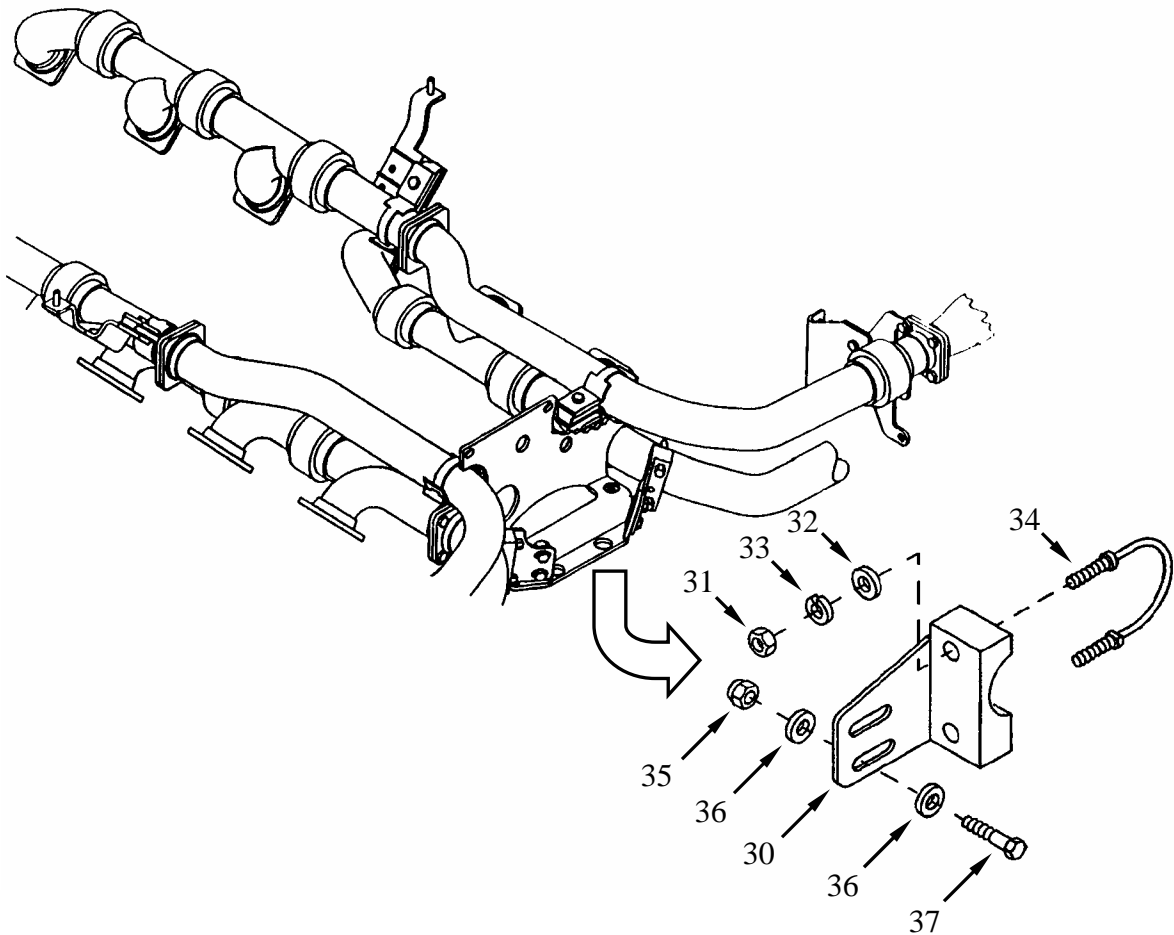
**INSTALLATION**

1. If removed, apply anti-seize compound (item 5, WP 0173) to three new pipe plugs (52) and install in exhaust manifold (38).
2. Install elbow (39) to manifold (38).
  - a. Install elbow (39) to manifold (38) with a new a new gasket (51) (item 363, WP 0175) in position.
  - b. Secure using four screws (50) and new self-locking nuts (49) (item 161, WP 0175).
3. Install 4-5-6 left exhaust manifold (38) and elbow (39) as an assembly.
  - a. Install three new gaskets (47) (item 363, WP 0175) onto cylinders 4-5-6 left and put manifold (38) into position.
  - b. Install new gasket (48) (item 327, WP 0175) and secure with manifold (38) to turbocharger using two new self-locking nuts (40) (item 161, WP 0175) and screws (39). Do not tighten self-locking nuts (40) at this time.
  - c. Secure manifold (38) to cylinders 4-5-6 left with twelve new self-locking nuts (42) (item 161, WP 0175). Torque-tighten nuts (42) to 275 inch-pounds (31 N•m), using torque wrench (item 125, WP 0176).
4. Install plate (45) on studs (46) with two new self-locking nuts (43) (item 140, WP 0175) and flat washers (44).



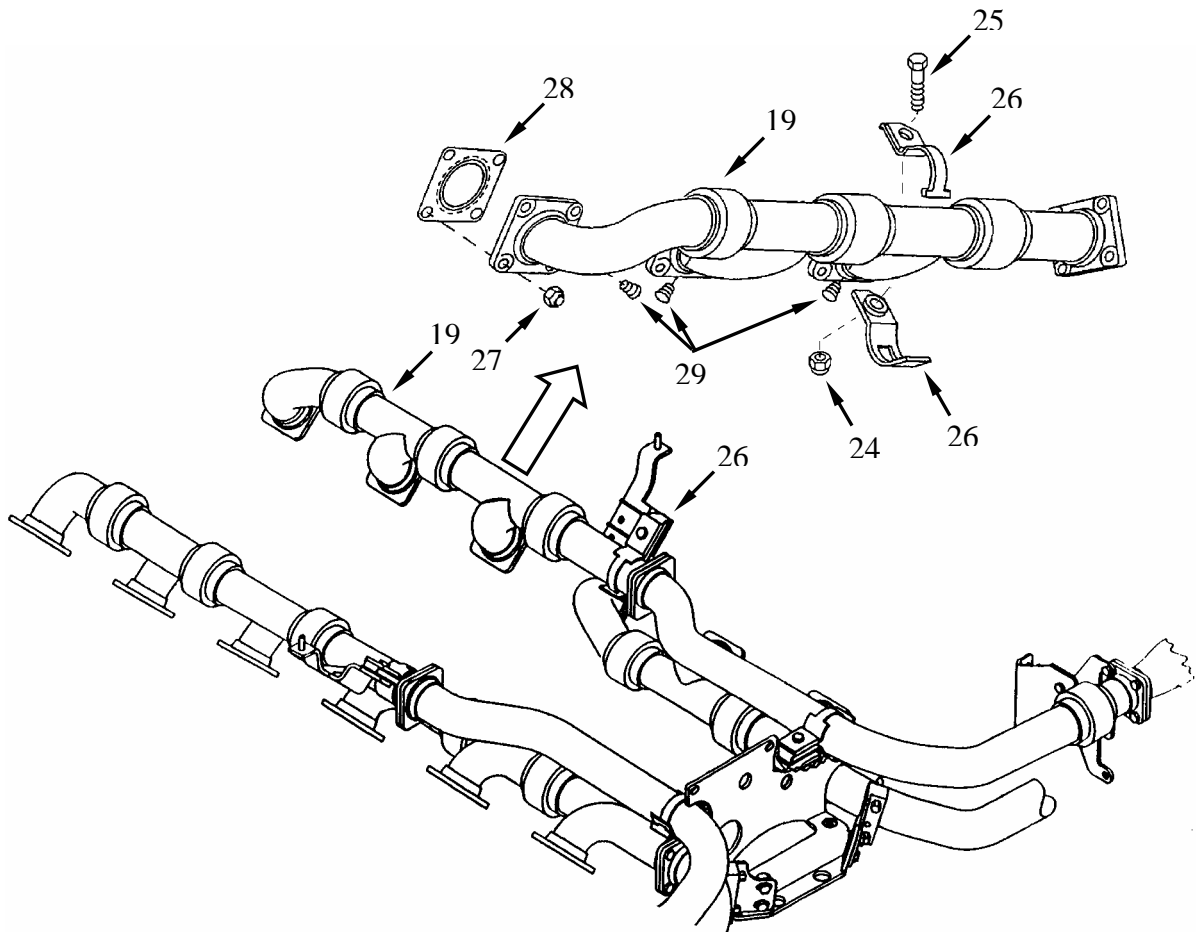
**INSTALLATION (Continued)**

5. Install exhaust bracket (30).
  - a. Place bracket (30) into position and secure using two new self-locking nuts (35) (item 161, WP 0175), four flat washers (36) and two screws (37).
  - b. Install U-bolt (34) and secure using two nuts (31) with flat washers (32) and new lock washers (33) (item 93, WP 0175) securing U-bolt (34) to bracket (30).



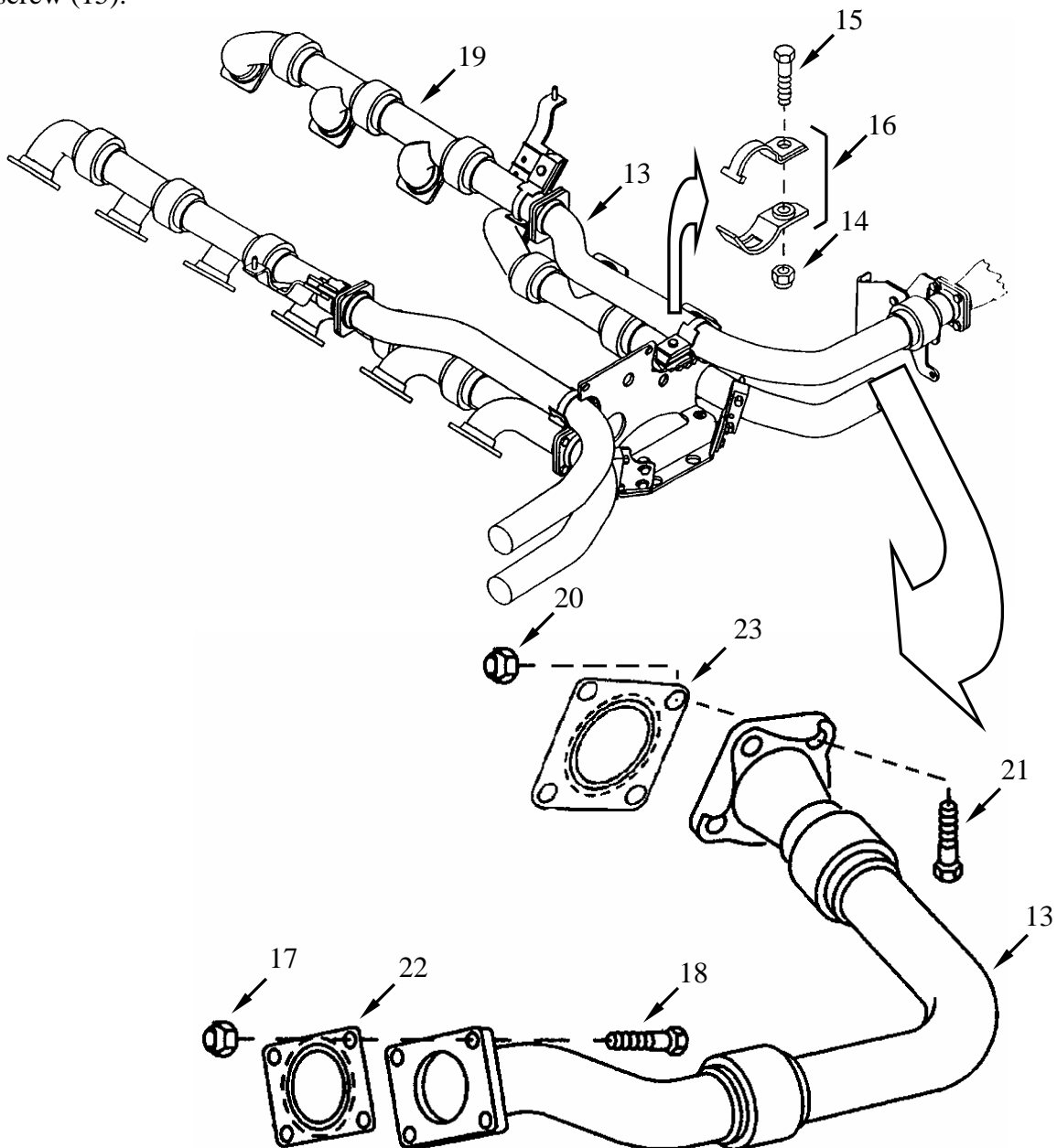
**INSTALLATION (Continued)**

6. If removed, apply anti-seize compound (item 5, WP 0173) to three new pipe plugs (29) and install in exhaust manifold (19).
7. Install 1-2-3 left exhaust manifold (19).
  - a. Install three new gaskets (28) (item 363, WP 0175) onto cylinders 1-2-3 left and put manifold (19) into position.
  - b. Secure manifold (19) to cylinders 1-2-3 left with twelve new self-locking nuts (27) (item 161, WP 0175). Torque-tighten nuts (27) to 275-inch pounds (31 N•m) using torque wrench (item 125, WP 0176).
  - c. Install clamp assembly (26) to manifold (19) using new self-locking nut (24) (item 36, WP 0175), screw (25).



**INSTALLATION (Continued)**

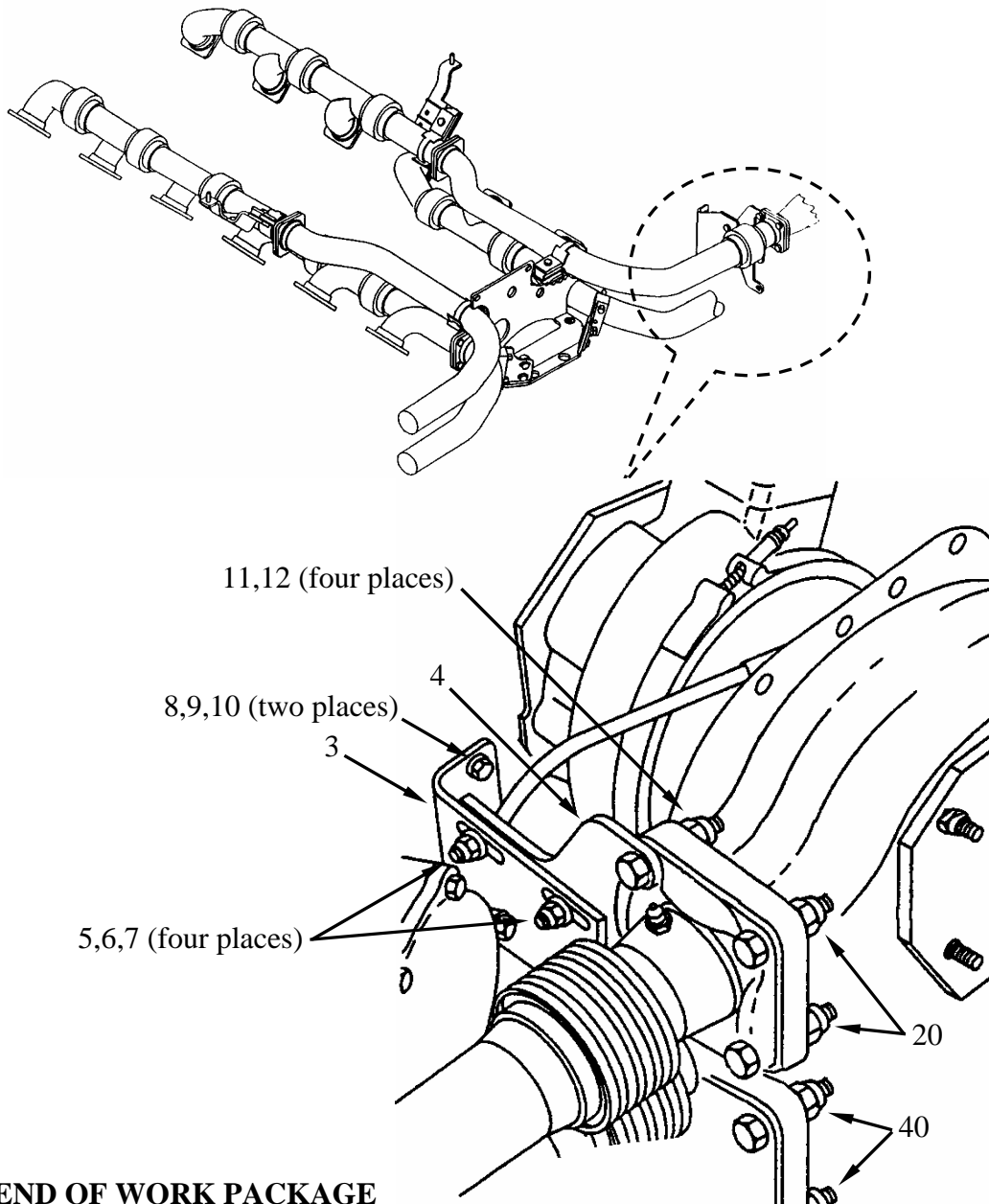
8. Install exhaust elbow (13) leading to cylinders 1-2-3 left side.
  - a. Install elbow (13) with new gaskets (22) (item 363, WP 0175) and (23) (item 327, WP 0175).
  - b. Secure elbow (13) to turbocharger using two self-locking nuts (20) (item 161, WP 0175) and screws (21). Do not tighten nuts at this time.
  - c. Secure elbow (13) to cylinders 1-2-3 exhaust manifold (19), using four new self-locking nuts (17) (item 161, WP 0175), and screws (18).
  - d. Install clamp assembly (16) using new self-locking nut (14) (item 36, WP 0175) and screw (15).





**INSTALLATION (Continued)**

9. Install bracket (3) and bracket (4) at turbocharger.
  - a. Install bracket (4) to turbocharger using four new self-locking nuts (11) (item 161, WP 0175) and screws (12). Do not tighten at this time.
  - b. Install two screws (8) with flat washers (9) and new lock washers (10) (item 94, WP 0175) to fasten bracket (3) to engine shrouding.
  - c. Install four new self-locking nuts (5) (item 113, WP 0175), flat washers (6) and screws (7) to fasten bracket (3) to bracket (4).
  - d. Tighten self-locking nuts (11, 20, 40).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Assembly, Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (2) (item 284, WP 0175)
- Gasket (1) (item 326, WP 0175)
- Gasket (1) (item 333, WP 0175)
- Gasket (1) (item 336, WP 0175)
- Gasket (6) (item 337, WP 0175)
- Lock washer (18) (item 93, WP 0175)
- O-ring (item 150, WP 0175)
- O-ring (item 155, WP 0175)
- Self-locking nut (46) (item 33, WP 0175)

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface
- Vent line removed to 650 Ampere generator (WP 0091) when removing right side intake manifold
- Turbo outlet elbow assembly removed (Left Bank WP 0114) (Right Bank WP 0120)

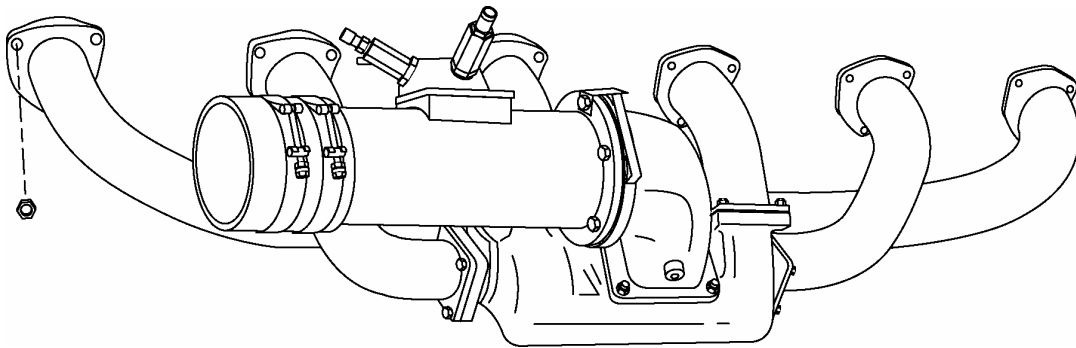
**Personnel Requirement:**

Track Vehicle Repairer (1) 63H10

**NOTE**

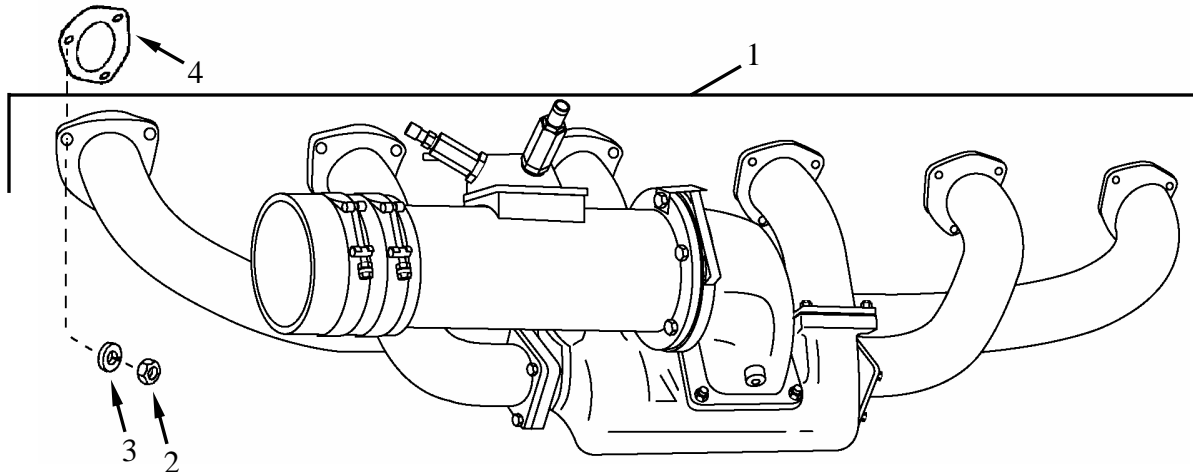
**For instructional purposes, replacement of the right intake manifold assembly is described in this section. The left intake manifold assembly is replaced in the same manner.**

**REMOVAL**



**REMOVAL (Continued)**

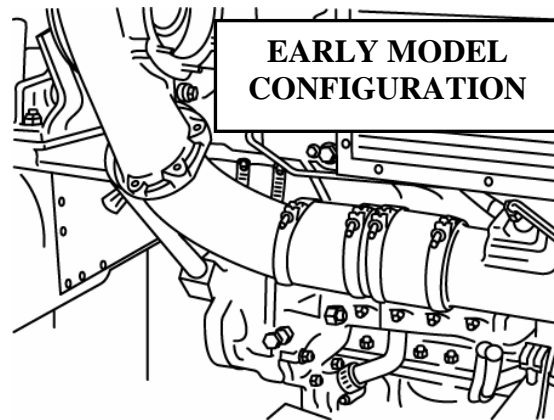
1. Remove intake manifold assembly (1).
  - a. Remove eighteen nuts (2) with lock washers (3) and remove intake manifold assembly.
  - b. Remove and discard six cylinder flange gaskets (4).



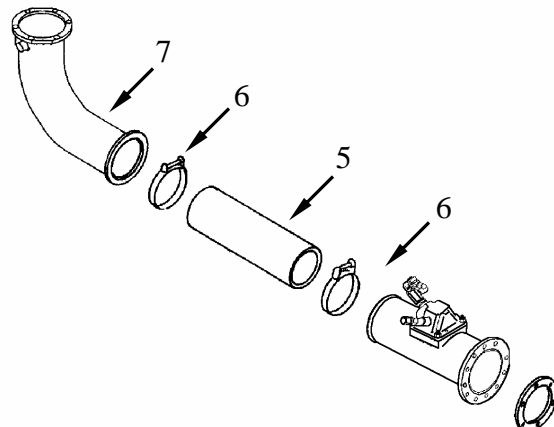
**DISASSEMBLY**

**CAUTION**

Early model engines may have a two-piece hose connection between the air outlet elbow and intake manifold. If your engine has the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number 11682625). Failure to comply may lead to premature engine failure due to dust ingestion.

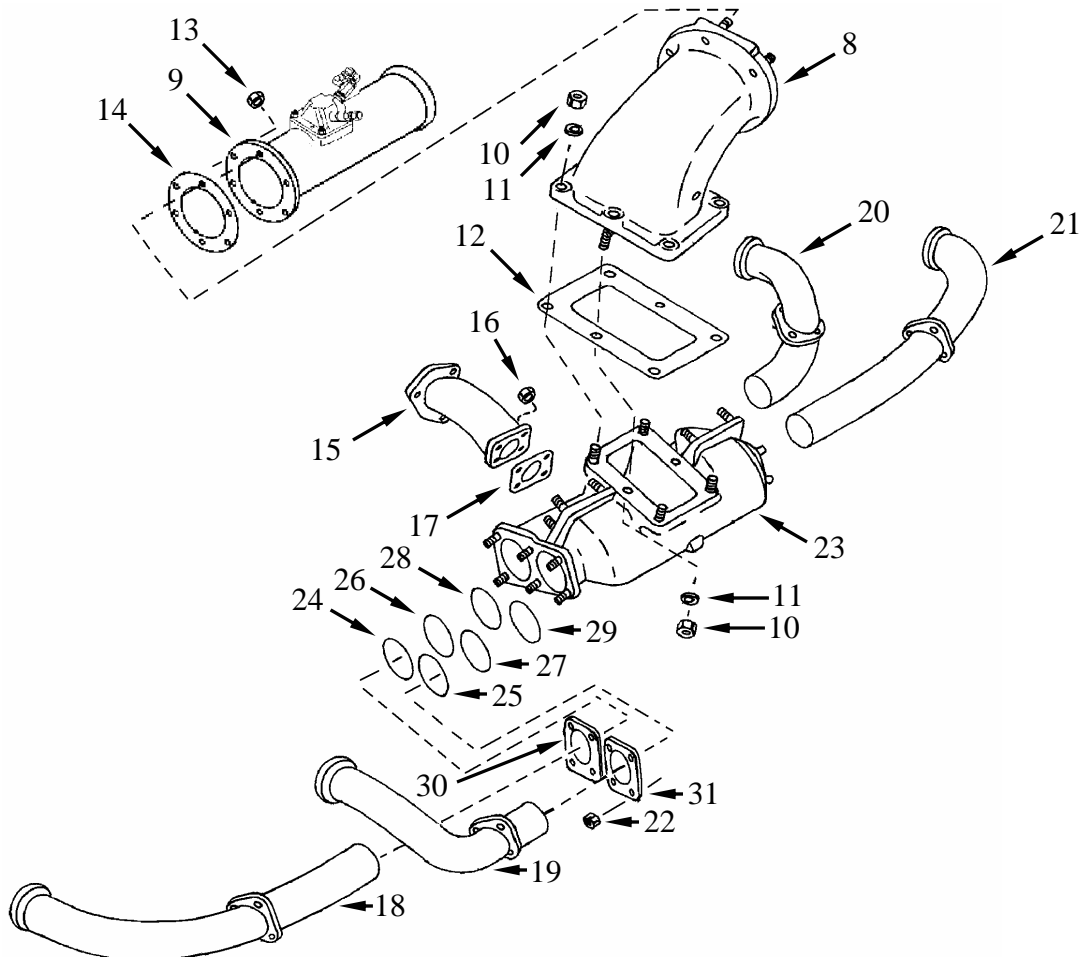


1. Remove hose (5) with clamps (6) if not already removed with turbocharger outlet elbow (7).



**DISASSEMBLY (Continued)**

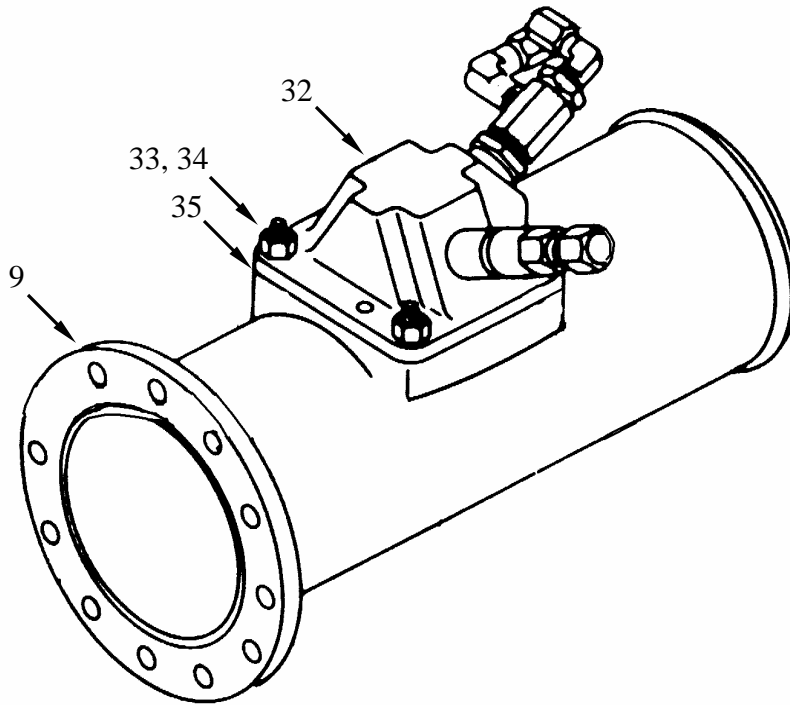
2. Remove intake manifold elbow (8) and heater tube (9).
  - a. Remove six self-locking nuts (10) with flat washers (11) to remove intake manifold elbow (8) and heater tube (9) as a unit. Discard self-locking nuts.
  - b. Remove and discard gasket (12).
  - c. Remove six self-locking nuts (13) to separate heater tube (9) from elbow (8). Discard gasket (14) and self-locking nuts (13).
3. Remove two tubes (15).
  - a. Remove eight self-locking nuts (16) and intake manifold tubes (15). Discard self-locking nuts.
  - b. Remove and discard two gaskets (17).
4. Remove tubes (18, 19, 20, and 21).
  - a. Remove twelve self-locking nuts (22) securing tubes (18, 19, 20, and 21) to intake manifold (23) and remove tubes. Discard self-locking nuts.
  - b. Remove spring tension washers (24, 25), spacer rings (26, 27), O-rings (28, 29), and flanges (30, 31) from tubes. Discard O-rings.



**DISASSEMBLY (Continued)****NOTE**

**Manifold heaters are disassembled in work package 0088.**

5. Remove heater assembly (32) from heater tube (9).
  - a. Remove four self-locking nuts (33) with flat washers (34). Discard self-locking nuts.
  - b. Remove heater assembly (32) from tube (9).
  - c. Remove and discard gasket (35).

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

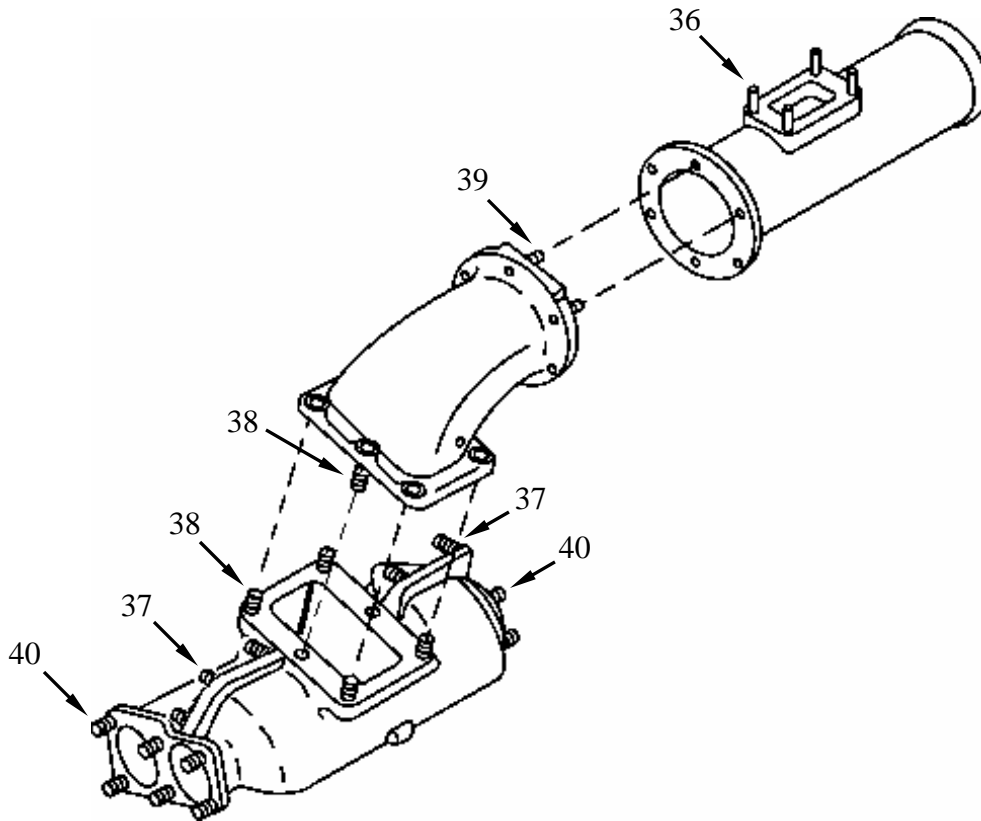
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**REPAIR**

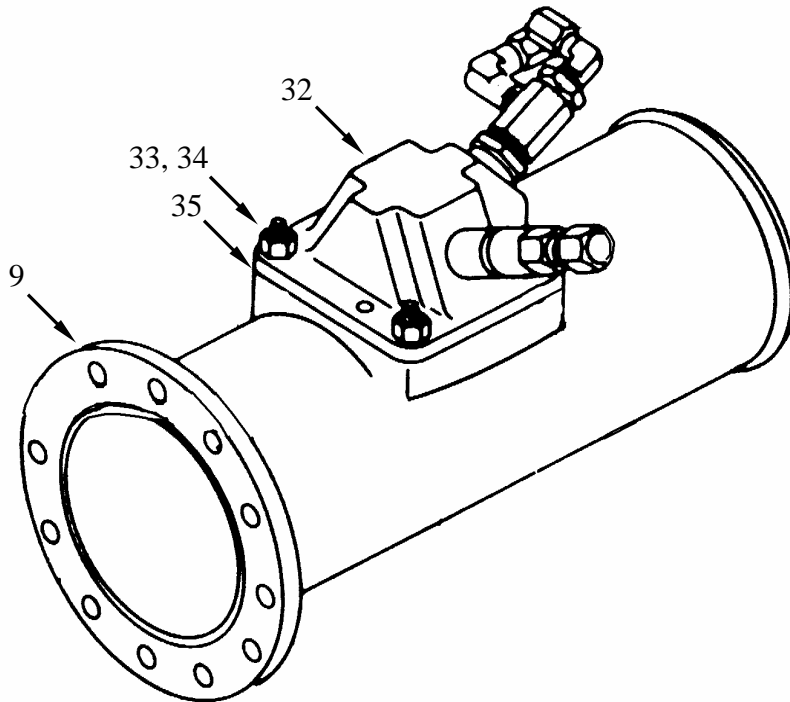
1. Replace stripped, bent, or otherwise damaged studs (36 through 40).
  - a. Refer to Work Package 0028 for procedure and to the following table for height settings.

Location	Setting Height	Quantity Required	Stud Size and Length
36	1-3/8	8	5/16-24(25/32) x 5/16-24(19/32) x 1-7/16
37	13/16	16	5/16-18 (9/16) X 5/16-24 (11/16) X 1-3/8
38	1	12	5/16-18 (3/4) X 5/16-24 (23/32) X 1-5/8
39	25/32	12	5/16-18 (11/16) X 5/16-24 (9/16)X 1-5/16
40	23/32	24	5/16-18 (11/16) x 5/16-24 (9/16)x 1-5/16



**ASSEMBLY**

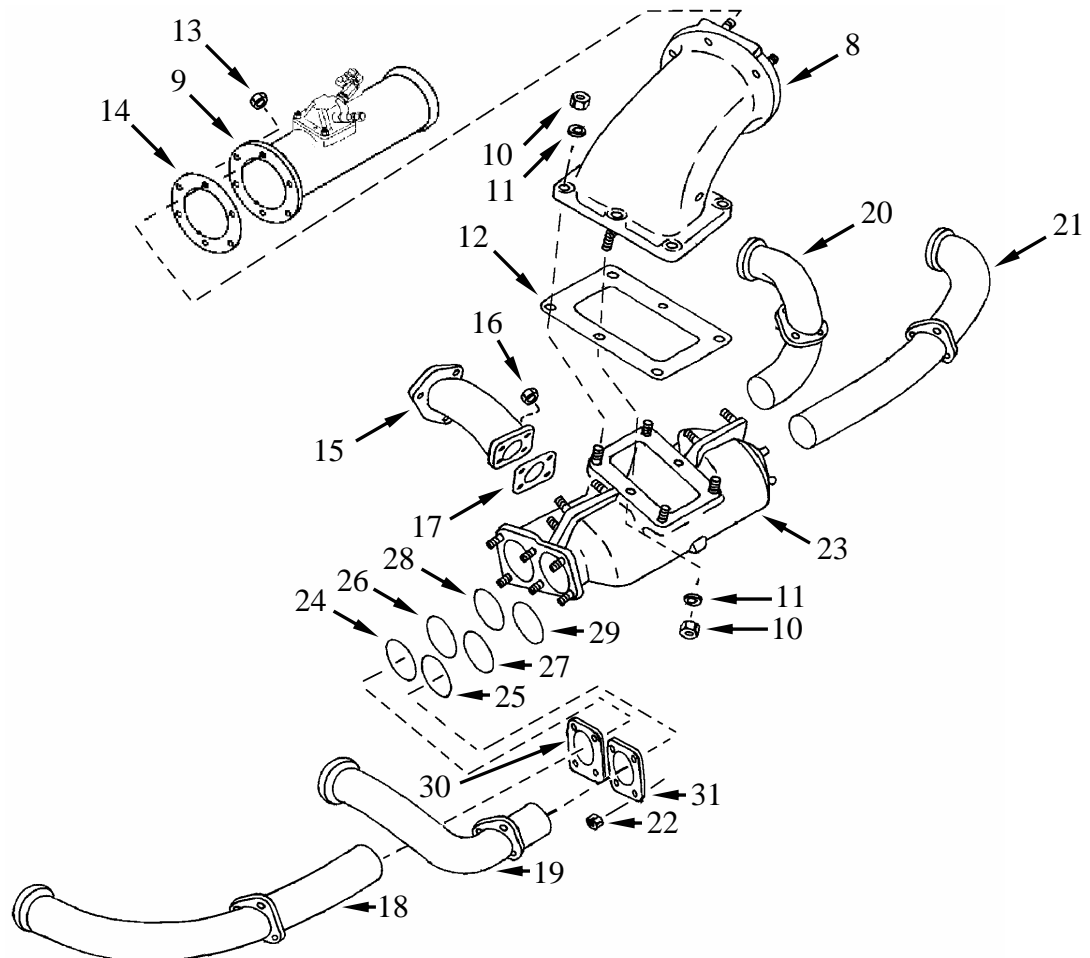
1. Install heater assembly (32) onto heater tube (9).
  - a. Position heater assembly (32) onto tube (9) with new gasket (35) (item 326, WP 0175) in place.
  - b. Secure using four new self-locking nuts (33) (item 33, WP 0175) with flat washers (34).





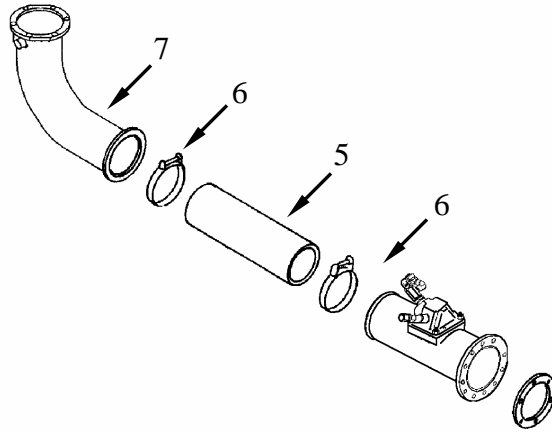
**ASSEMBLY (Continued)**

2. Install four tubes (18, 19, 20, and 21) to manifold (23).
  - a. Install spring tension washers (24, 25), spacer rings (26, 27), new O-rings (28) (item 155, WP 0175) and (29) (item 150, WP 0175), and flanges (30, 31) onto tubes (18, 19, 20, and 21).
  - b. Secure tubes to manifold (23) using twelve new self-locking nuts (22) (item 33, WP 0175).
3. Install two tubes (15) to manifold (23).
  - a. Place two new gaskets (17) (item 284, WP 0175) in position.
  - b. Secure intake manifold tubes (15) to manifold (23) using eight new self-locking nuts (16) (item 33, WP 0175).
4. Install intake manifold elbow (8) and heater tube (9).
  - a. Install new gasket (12) (item 333, WP 0175).
  - b. Install heater tube (9) onto elbow (8) using new gasket (14) (item 336, WP 0175) and six new self-locking nuts (13) (item 33, WP 0175).
  - c. Install intake manifold elbow (8) and heater tube (9) as a unit. Secure using six new self-locking nuts (10) (item 33, WP 0175), with flat washers (11).



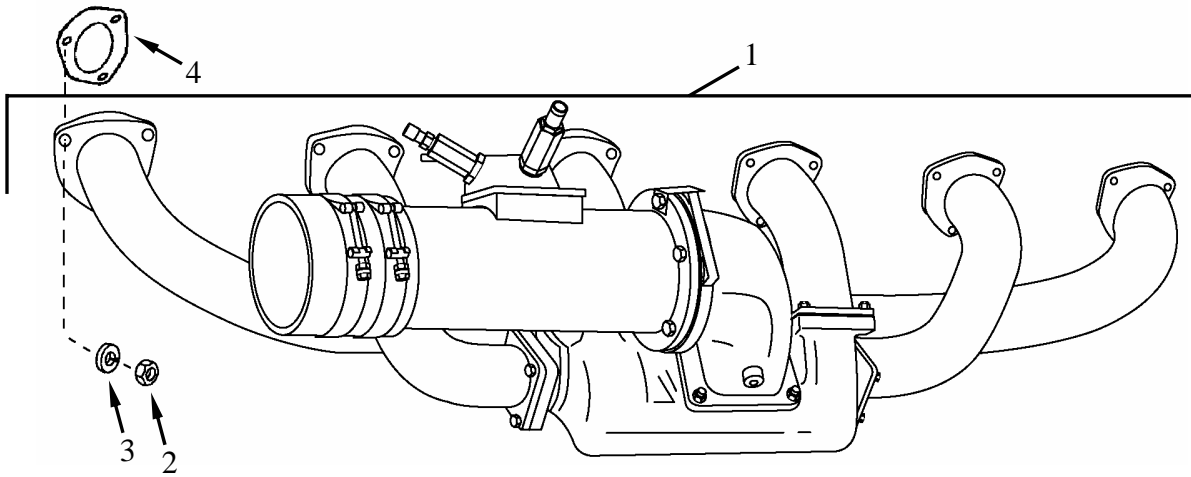
**ASSEMBLY (Continued)**

5. Install turbocharger outlet elbow (7).
  - a. Install hose (5) onto heater tube (9) and secure with clamp (6).
  - b. Turbocharger outlet elbow (7) will be installed with turbocharger installation.



**INSTALLATION**

1. Install intake manifold assembly (1).
  - a. Install six new cylinder flange gaskets (4) (item 337, WP 0175).
  - b. Place intake manifold assembly (1) in position on cylinders over new gaskets.
  - c. Secure using eighteen nuts (2) with new lock washers (3) (item 93, WP 0175).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Installation

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

- General mechanic's tool kit (item 121, WP 0176)
- Mechanical puller (2) (item 90, WP 176)
- Torque wrench, 0-600 ft-lb (item 128, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (1) (item 349, WP0175) [
- Self locking nuts(8) (item 140, WP 0175)

**Expendable Materials:**

- Cleaning compound solvent (item 8, WP 0173)
- Crocus cloth (item 9, WP 0173)

**Expendable Materials (Continued):**

- Lubriplate (item 23, WP 0173)
- Sealing compound, silicone sealant (item 30, WP 0173)

**Personnel Required:**

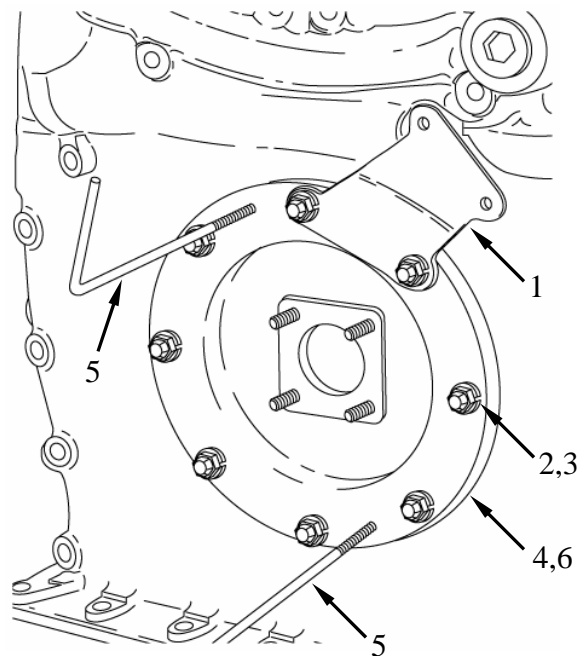
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface
- Fuel back-flow valve removed (WP 0081)

**REMOVAL**

1. Remove back-flow valve bracket (1).
  - a. Remove two self-locking nuts (2) with flat washers (3). Discard self-locking nuts (3).
  - b. Remove bracket (1).
2. Remove fuel supply pump mounting adapter (4).
  - a. Remove six self-locking nuts (2) with flat washers (3). Discard self-locking nuts.
  - b. Remove adapter using two mechanical pullers (5) (item 90, WP 0176).
  - c. Remove and discard gasket (6).

**CLEANING**

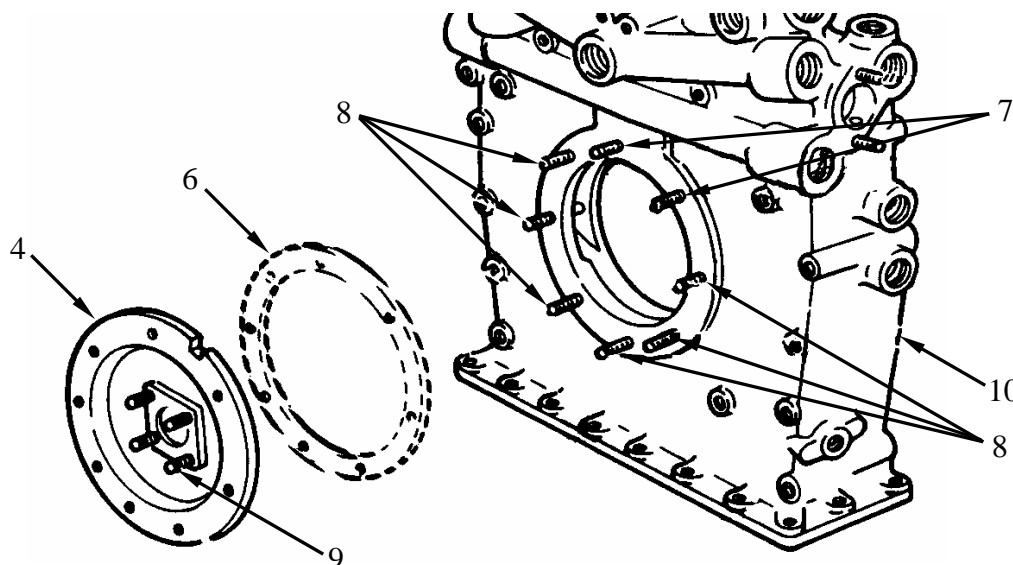
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

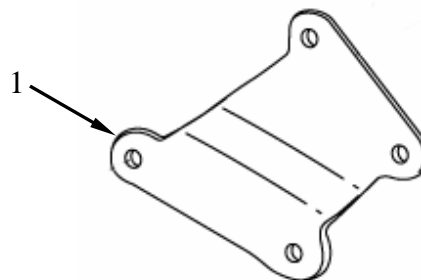
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Check that studs (7,8,9) are not bent, stripped or otherwise damaged.
  - a. See Work Package 0028 for stud replacement procedures.
  - b. Refer to the following table for stud size and setting height.

Location	Stud Size and Length	Number Required	Setting Height inch (mm)
7	3/8-16(7/8) X 3/8-24(15/16) X 1-3/4	2	1-3/16 (30.1625)
8	3/8-16(7/8) X 3/8-24(15/16) X 1-3/4	6	1-1/16 (26.9875)
9	3/8-16(13/16) X 3/8-24(11/16) X 1-5/8	4	15/16 (23.8125)

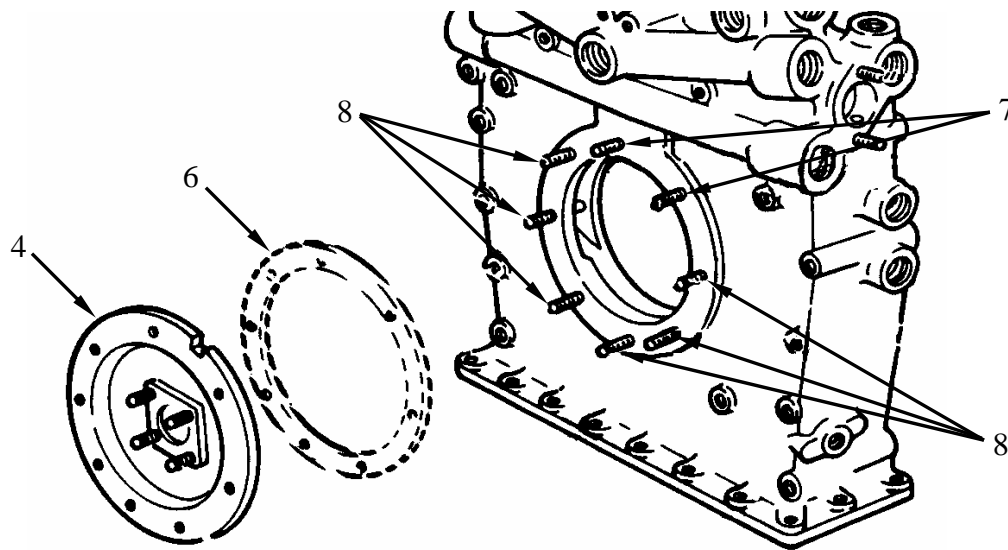


3. Check that back-flow valve bracket (1) is not bent, cracked or otherwise damaged.
  - a. Replace bracket (1) if damaged.
4. Check mounting surface of both adapter (4) and damper housing (10).
  - a. Look for scratches, nicks, or other damage that would prevent gasket (6) from sealing.
    - (1) Polishing with crocus cloth (item 9, WP 0173) wetted in cleaning solvent (item 8, WP 0173) may repair minor imperfections.
    - (2) Replace adapter (4) or damper housing (10) if damage cannot be repaired.

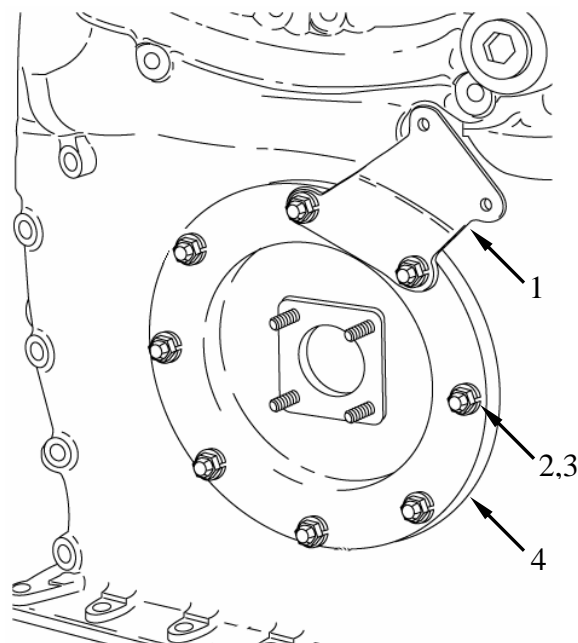


**INSTALLATION**

1. Install fuel supply pump mounting adapter (4).
  - a. Place new gasket (6) (item 349, WP 0175) in position over studs (7,8,9).
  - b. Place adapter (4) into position over gasket (6).



2. Install back-flow valve bracket (1).
  - a. Place bracket (1) into position as shown.
  - b. Secure adapter (4) and bracket (1) using six new self-locking nuts (2), (item 140, WP 0175) with flat washers (3).



**END OF WORK PACKAGE**



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**FUEL SUPPLY PUMP DRIVE COUPLING AND ADAPTER REPLACEMENT 0110 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Installation

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**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Retaining ring pliers (item 79, WP 0176)  
 Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface  
 Fuel back-flow valve removed (WP 0081)  
 Fuel Supply Pump Mounting Adapter Removed (WP 0109)

**Mandatory Replacement Parts:**

Retaining ring (1) (item 17, WP 0175)

**Expendable Materials:**

Lubriplate (item 23, WP 0173)

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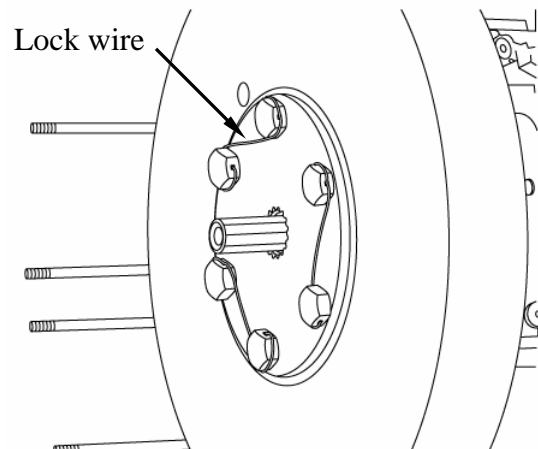
**NOTE**

**This work package describes how to remove the fuel pump drive coupling and adapter with the damper housing not removed. The cap screws that fasten the fuel pump drive coupling adapter also secure the damper. The damper will remain in position with these cap screws removed. The procedure is the same whether the damper housing is removed or not - only the equipment conditions change.**

**REMOVAL**

**NOTE**

**Early model engines had lock wire securing adapter mounting cap screws. Lock wire is no longer required in this location. If encountered, remove and do not replace.**



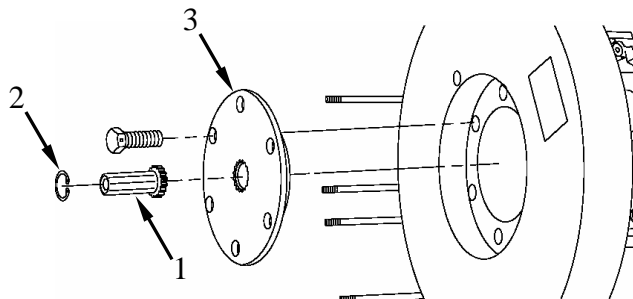
**FUEL SUPPLY PUMP DRIVE COUPLING AND ADAPTER REPLACEMENT 0110 00**

**REMOVAL (Continued)**

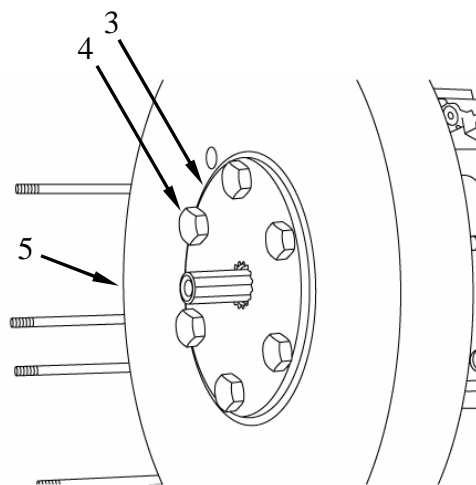
**NOTE**

**If adapter is removed first, the coupling can be removed from the reverse side without removing the retaining ring.**

1. Remove fuel pump drive coupling (1).
  - a. Using retaining ring pliers (item 79, WP 0176), remove retaining ring (2) from adapter (3). Discard retaining ring.
  - b. Slide coupling (1) out of adapter (3).



2. Remove adapter (3).
  - a. Remove six screws (4) attaching adapter (3) and damper (5) to crankshaft.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

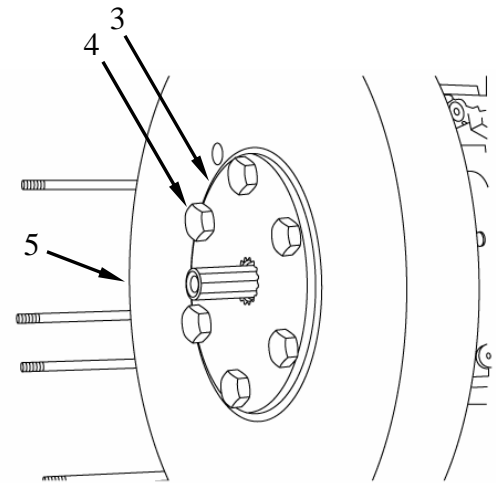
1. See Work Package 0028 for Standard Inspection Procedures.



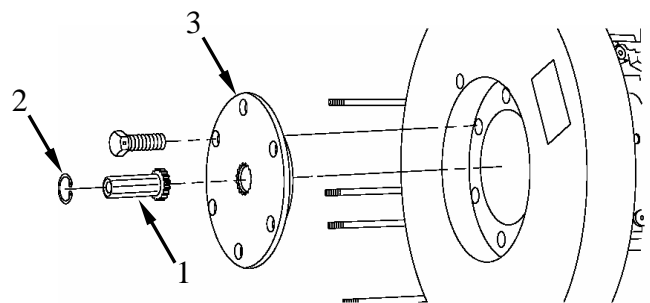
**FUEL SUPPLY PUMP DRIVE COUPLING AND ADAPTER REPLACEMENT 0110 00**

**INSTALLATION**

1. Install adapter (3).
  - a. Place adapter in position and secure with six screws (4), attaching adapter (3), and damper (5) to crankshaft.
  - b. Torque-tighten six screws (4) to 80-85 foot-pounds (110-116 N•m) using torque wrench (item 127, WP 0176).



2. Install fuel pump drive coupling (1).
  - a. Lubricate (item 16, WP 0173) splined end of coupling (1).
  - b. Slide coupling (1) into adapter (3).
  - c. Secure with new retaining ring (2) (item 17, WP 0175).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Assembly, and Installation

---

**INITIAL SETUP:**

**Tools and Special Tools:**

Alignment tool:

For early spur gear shaft (3/4-16 inch threads):  
use item 8 (WP 0176) [Part No. 11684212]

For late spur gear shaft (7/8-14 inch threads):  
use item 9 (WP 0176) [Part No. 12275768]

Dial indicator (item 65, WP 0176)

General mechanic's tool kit (item 121, WP 0176)

Holding bar and puller tool (item 64, WP 0176)

Mechanical Puller (exhaust valve guide puller) (2)  
(item 86, WP 0176)

Micrometer caliper set, inside (item 16, WP 0176)

Micrometer caliper set, outside (item 17,  
WP 0176)

Torque wrench, 0-600 ft-lb (item 128, WP 0176)

**Mandatory Replacement Parts:**

Cotter pin (2) (item 54, WP 0175)

Cotter pin (1) (item 48, WP 0175)

Gasket (1) (item 349, WP 0175)

Nut, self-locking (1) (item 139, WP 0175)

Nut, self-locking (8) (item 140, WP 0175)

O-ring (item 138, WP 0175)

Seal (item 224, WP 0175)

**Expendable Materials:**

Cleaning compound, solvent (item 8, WP 0173)

Lubriplate (item 23, WP 0173)

Rags, wiping (item 26, WP 0173)

Silicone sealant (item 33, WP 0173)

**Equipment Conditions:**

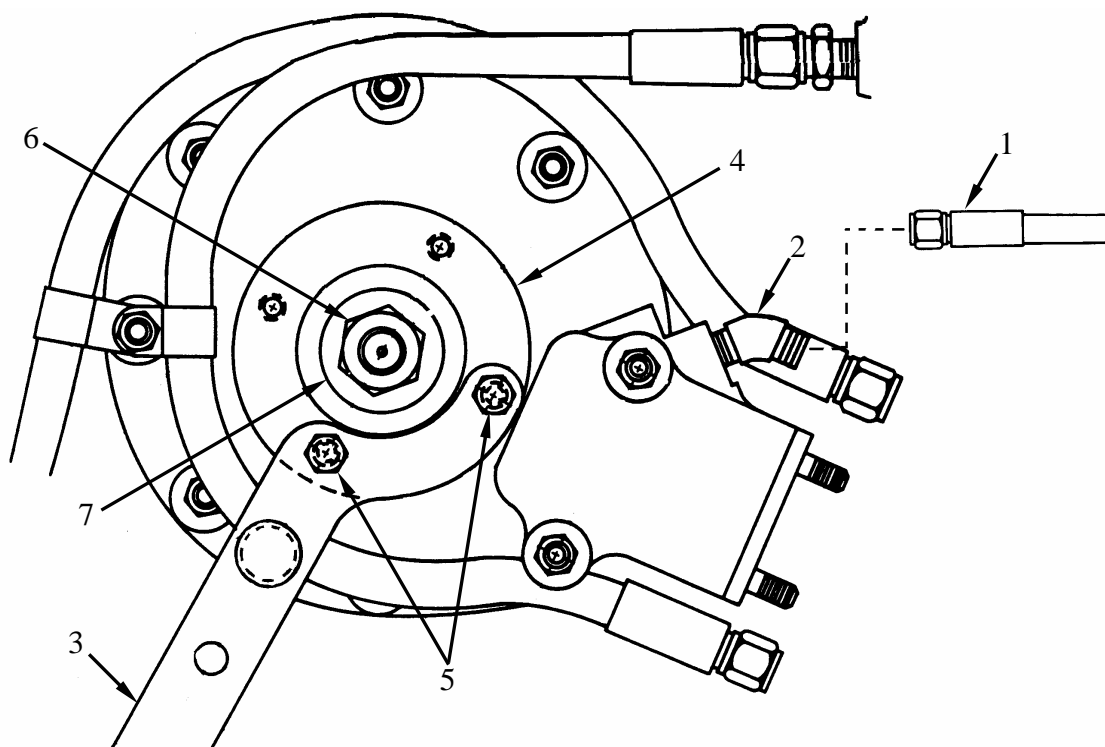
Engine level on flat surface

Fuel Supply Pump removed (WP 0048)

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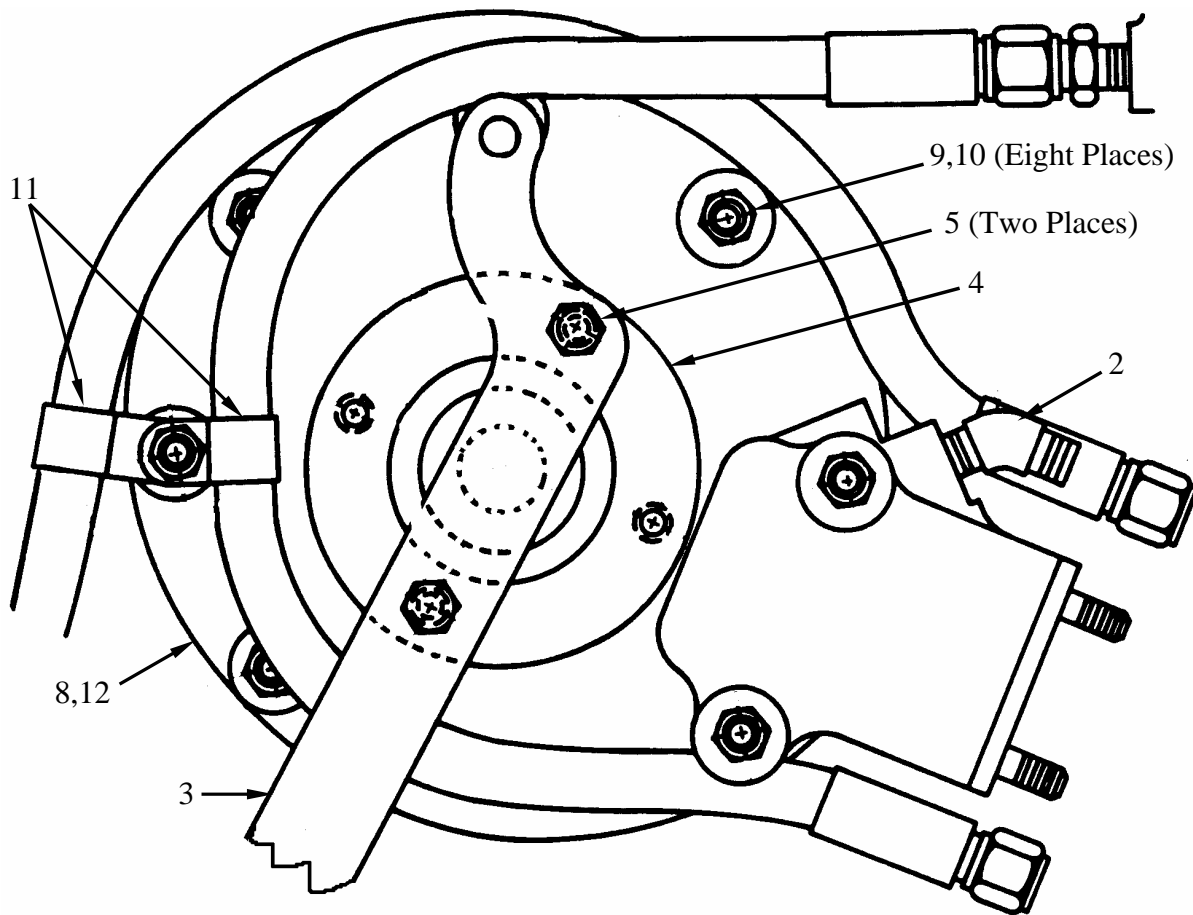
**REMOVAL**

1. Disconnect oil inlet hose (1) at 45-degree elbow (2).
2. Install holding bar/puller tool (3) (item 64, WP 0176).
  - a. Position holding bar/puller tool (3) on power takeoff drive (PTO) coupling (4) as shown.
  - b. Secure with two 7/16-20 x 1-1/2 inch cap screws (5) from PTO coupling.
3. Remove PTO drive coupling (4) self locking nut (6).
  - a. Secure holding bar/puller tool (3) to prevent PTO drive coupling (4) from turning.
  - b. Remove self-locking nut (6) and flat washer (7). Discard self-locking nut.
  - c. Remove holding bar/puller tool (3).



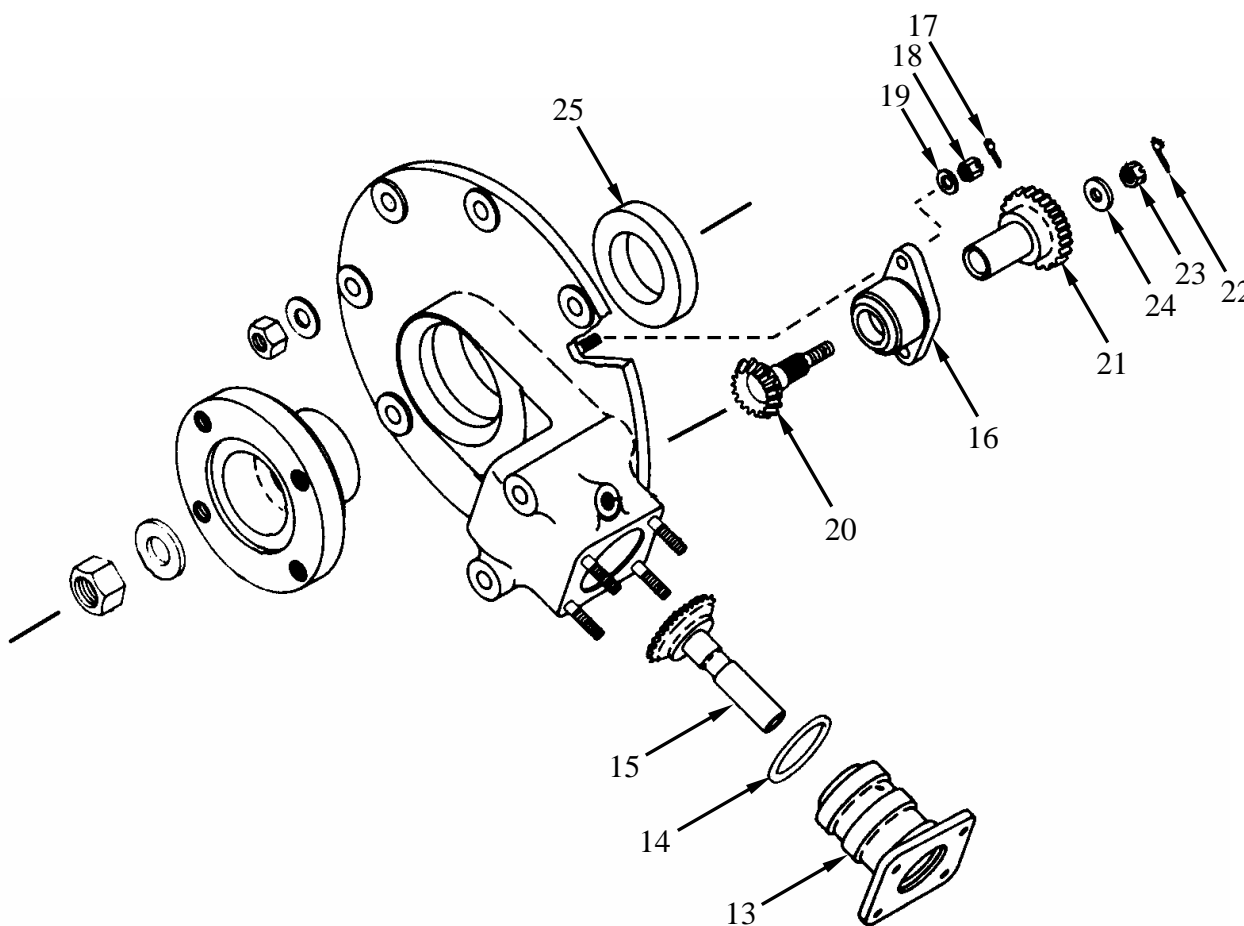
**REMOVAL (Continued)**

4. Remove PTO drive coupling (4).
  - a. Position holding bar/puller tool (3) on PTO drive coupling (4) with boss against gear shaft, and secure with two 7/16-20 x 1-1/2-inch cap screws (5).
  - b. Alternately tighten the two cap screws (5) to remove (pull) the PTO drive coupling (4).
  - c. Remove holding bar/puller tool (3).
5. Remove PTO housing (8).
  - a. Remove eight self-locking nuts (9) with flat washers (10). Discard self-locking nuts.
  - b. Remove fuel hose clamps (11).
  - c. Remove PTO drive housing (8). Use two mechanical pullers if necessary to assist in housing removal.
  - d. Remove and discard mounting gasket (12) (hidden).
6. Remove 45° elbow (2) from housing (8).



**DISASSEMBLY**

1. Remove fuel pump bevel gear shaft adapter (13).
  - a. Remove and discard O-ring (14).
  - b. Separate bevel gear shaft (15) from adapter (13).
2. Remove fuel pump drive bevel gear shaft adapter (16).
  - a. Remove and discard two cotter pins (17).
  - b. Remove two hexagon slotted nuts (18) with flat washers (19).
  - c. Remove fuel pump drive bevel gear shaft adapter (16).
3. Separate drive bevel gear shaft (20) from spur gear (21).
  - a. Remove and discard cotter pin (22).
  - b. Remove slotted nut (23) with flat washer (24).
  - c. Separate drive bevel gear shaft (20) from spur gear (21).
4. Remove and discard seal (25).



**CLEANING**

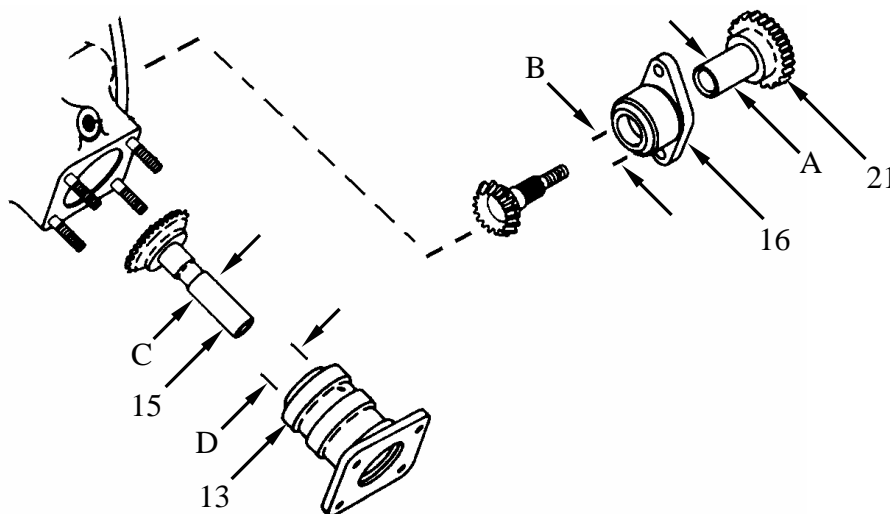
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Take critical measurements. Replace any part that does not meet the limits specified in the following table.
  - a. Using micrometer (item 17, WP 0176), measure outside shaft diameter (A) of spur gear (21).
  - b. Using micrometer (item 16, WP 0176), measure inside diameter (B) of adapter (16) bore.
  - c. Calculate fit of spur gear shaft (21) in adapter (16) by subtracting measurement A from B. See "Calculation a." in table below for limits.
  - d. Measure outside shaft diameter (C) of bevel gear shaft (15).
  - e. Measure inside diameter (D) of adapter (13) bore.
  - f. Calculate fit of gear shaft (15) in adapter (13) by subtracting measurement C from D. See "Calculation b." in table below for limits.

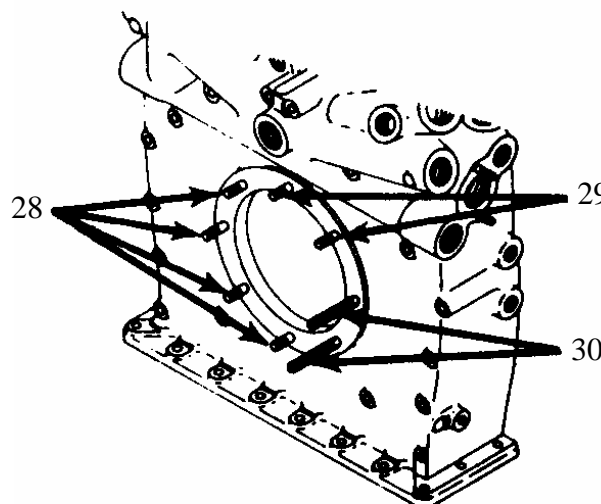
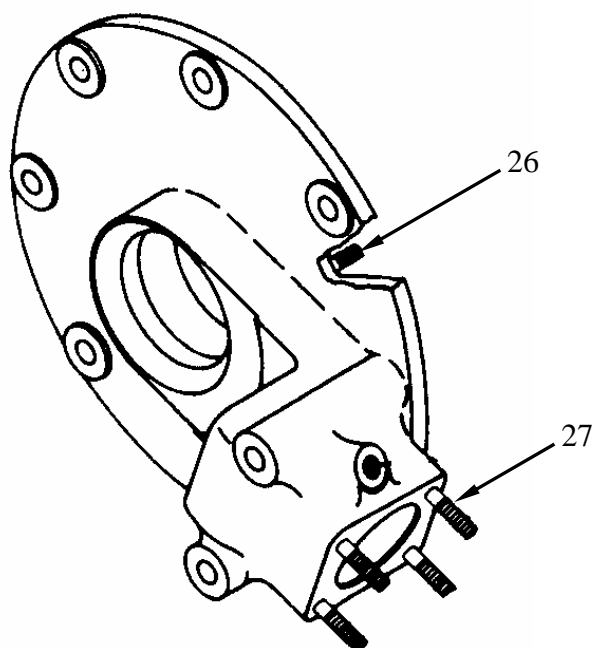
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A	0.8090 (20.5486)	0.8100 (20.574)	0.8085 (20.5359)
B	0.8120 (20.6248)	0.8130 (20.6502)	0.8145 (20.6883)
Calculation a.	0.0020 (0.0508)	0.0040 (0.1016)	0.0050 (0.1270)
C	0.7465 (18.9611)	0.7475 (18.9865)	0.7460 (18.9484)
D	0.7495 (19.0373)	0.7505 (19.0627)	0.7510 (19.0754)
Calculation b.	0.0020 (0.0508)	0.0040 (0.1016)	0.0050 (0.1270)



**INSPECTION (Continued)**

3. Inspect studs (26 through 30).
  - a. Look for bent, stripped or otherwise damaged studs (26,27,28).
  - b. If any stud needs replacement, go to Work Package 0028 for standard instructions and refer to the following table for stud size and setting height.

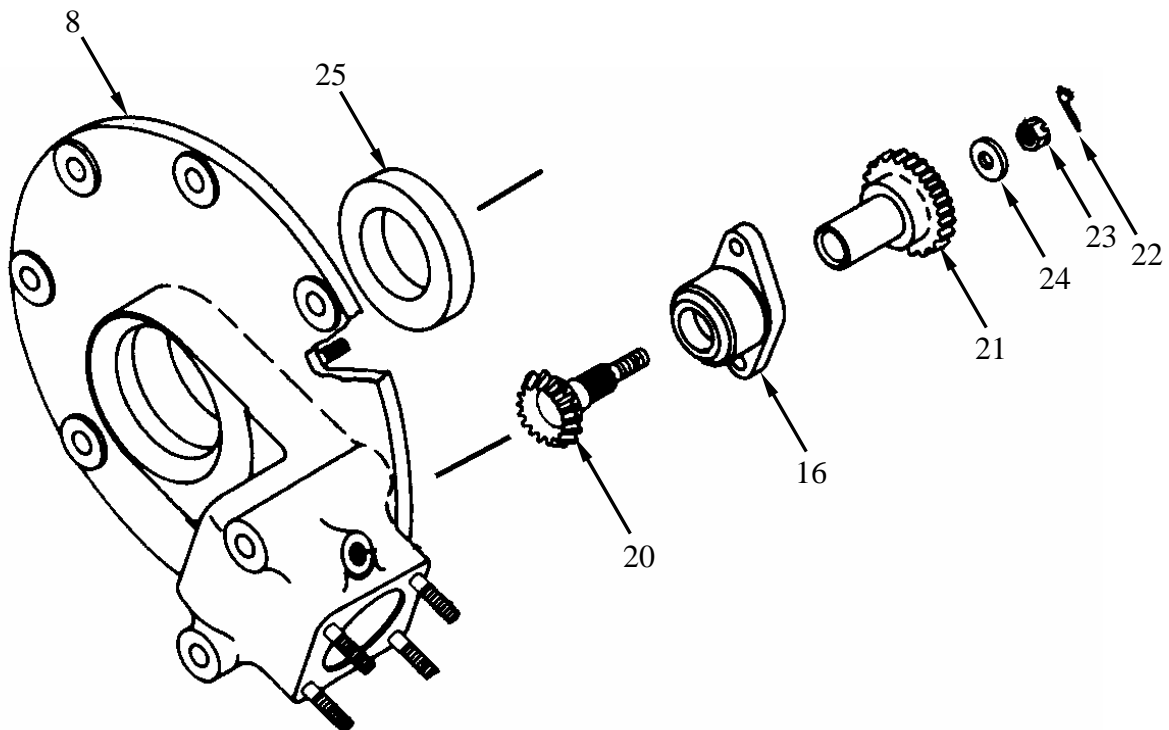
Location	Stud Size and Length	Number Required	Setting Height
26	1/4-20(37/64) X 1/4-28(35/64) X 1-3/16	2	23/32
27	5/16-18(49/64) X 5/16-24(53/64) X 1-25/32	4	1-1/8
28	3/8-16(7/8) X 3/8-24(15/16) X 1-3/4	4	1-1/16
29	3/8-16(7/8) X 3/8-24(27/64) X 1-3/4	2	1-1/16
30	3/8-16(13/16) X 3/8-24(15/16) X 4-11/16	2	4-1/16





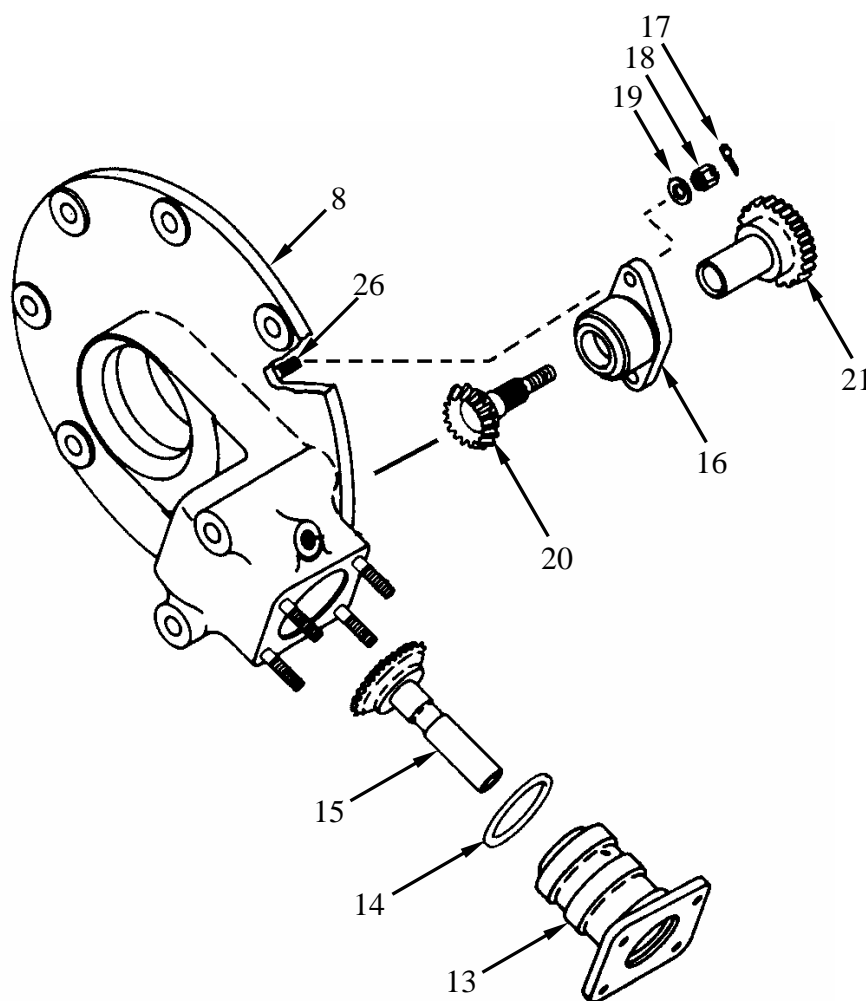
**ASSEMBLY**

1. Install new seal (25) (item 224, WP 0173).
  - a. Apply a bead of silicone sealant (item 33, WP 0173) on wall of casting where seal will be installed.
  - b. Install seal in PTO/fuel pump housing (8) with lip of seal facing inwards (towards engine).
  
2. Assemble spur gear (21) and drive bevel gear assembly (20) into adapter (16).
  - a. Lubricate spur gear (20) with Lubriplate (item 23, WP 0173) and slide into adapter (16).
  - b. Install bevel gear shaft (20) through spur gear (21).
  - c. Secure with slotted nut (23) using flat washer (24).
  - d. Using dial indicator (item 53, WP 0170), check endplay between spur gear (21) and adapter (16).
    - (1) Endplay must not exceed 0.007 inch.
  - e. Install new cotter pin (22) (item 48, WP 0175).



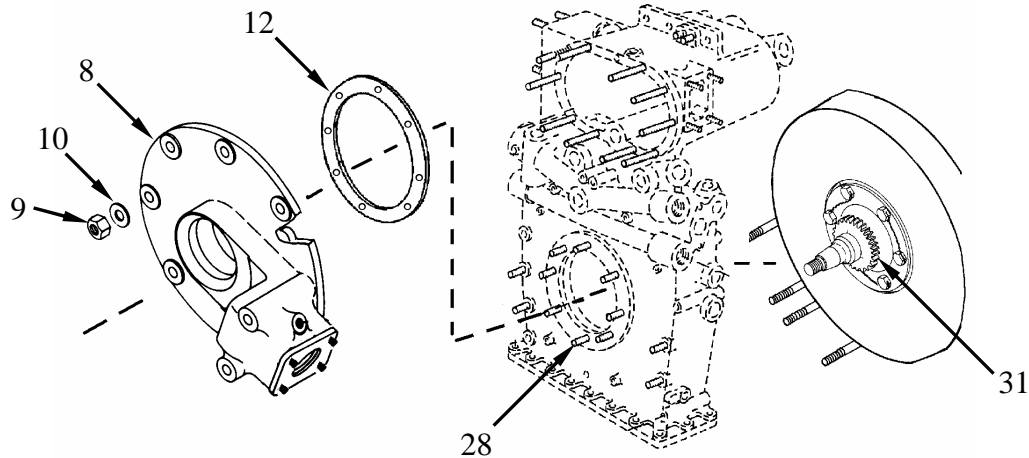
**ASSEMBLY (Continued)**

3. Install fuel pump drive adapter (16).
  - a. Install fuel pump drive adapter (16) and gears (20, 21) as an assembly on PTO housing (8) studs (26).
  - b. Secure with two slotted nuts (18) using flat washers (19).
  - c. Install two new cotter pins (17) (item 54, WP 0175).
4. Install gear shaft adapter (13).
  - a. Install new O-ring (14) (item 138, WP 0175) in groove of adapter (13).
  - b. Lubricate bevel gear shaft (15) with Lubriplate (item 23, WP 0173), and install in adapter (13).
  - c. Install adapter (13) and gear shaft (15) as an assembly into the PTO housing (8).
  - d. Check to be certain the bevel gear shafts (15 and 20) are properly meshed.



**INSTALLATION**

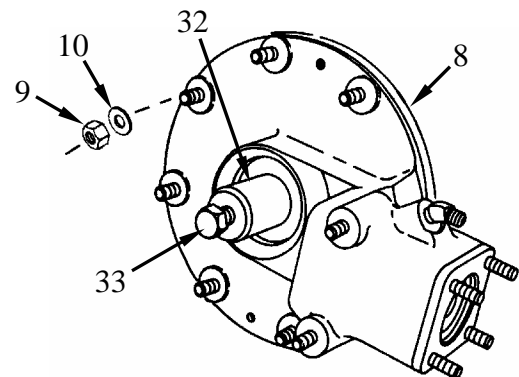
1. Install PTO/fuel supply pump, drive housing (8).
  - a. Position housing (8) on studs (28) using new mounting gasket (12) (item 349, WP 0175).



**CAUTION**

**There are two versions of spur gear (31): the early version has 3/4-16 threads, and the later version has 7/8-14 threads. The PTO coupling is installed exactly the same on either version. However, the torque procedure and alignment tools are different. Be sure to follow the torque instructions and use the alignment tool for the version that you have.**

- b. Install alignment tool (32).
  - (1) Use alignment tool (item 6, WP 0176) with early spur gear shaft (3/4-16 inch threads).
  - (2) Use alignment tool (item 7, WP 0176) with late spur gear shaft (7/8-14 inch threads).
  - (3) Remove puller screw (33) from alignment tool.
  - (4) Insert alignment tool (32) in PTO housing (8) until firmly seated on the spur gear shaft (31) taper.
- c. With the alignment tool (32) firmly seated on the spur gear shaft (31), install seven new self-locking nuts (9) (item 140, WP 0175) with flat washers (10). Do not install self-locking nut and flat washer on stud located at the 9 o'clock position.
- d. Install puller screw (33) and turn clockwise to remove alignment tool.



## INSTALLATION (Continued)

## NOTE

Drive coupling taper and spur gear shaft taper areas must be wiped dry with cleaning compound to assure maximum friction.

2. Install PTO drive coupling (4).

**WARNING**

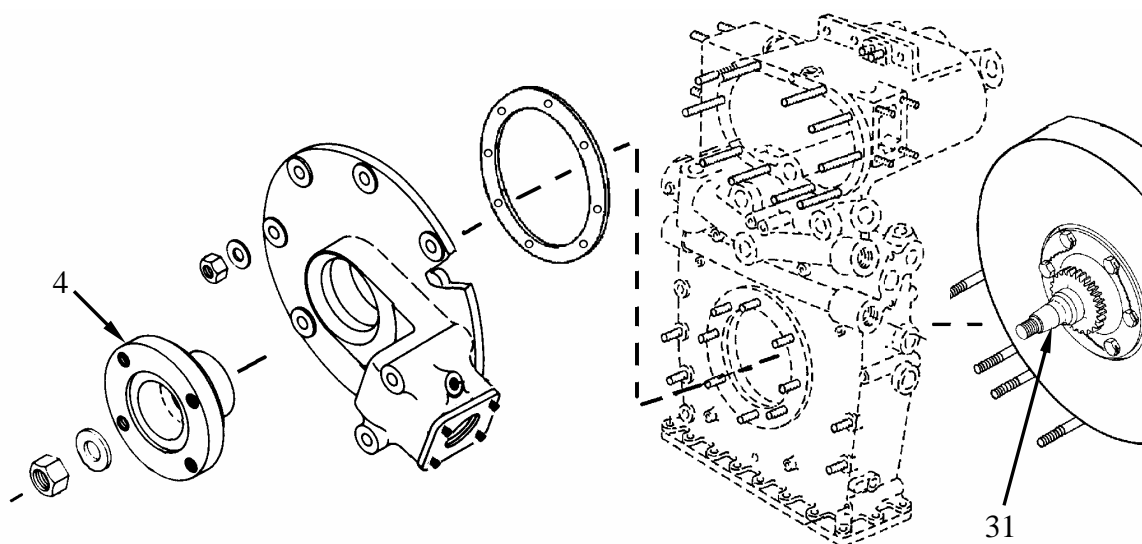
Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.

Ensure there is good airflow when using solvent, and work area is away from heat and flames.



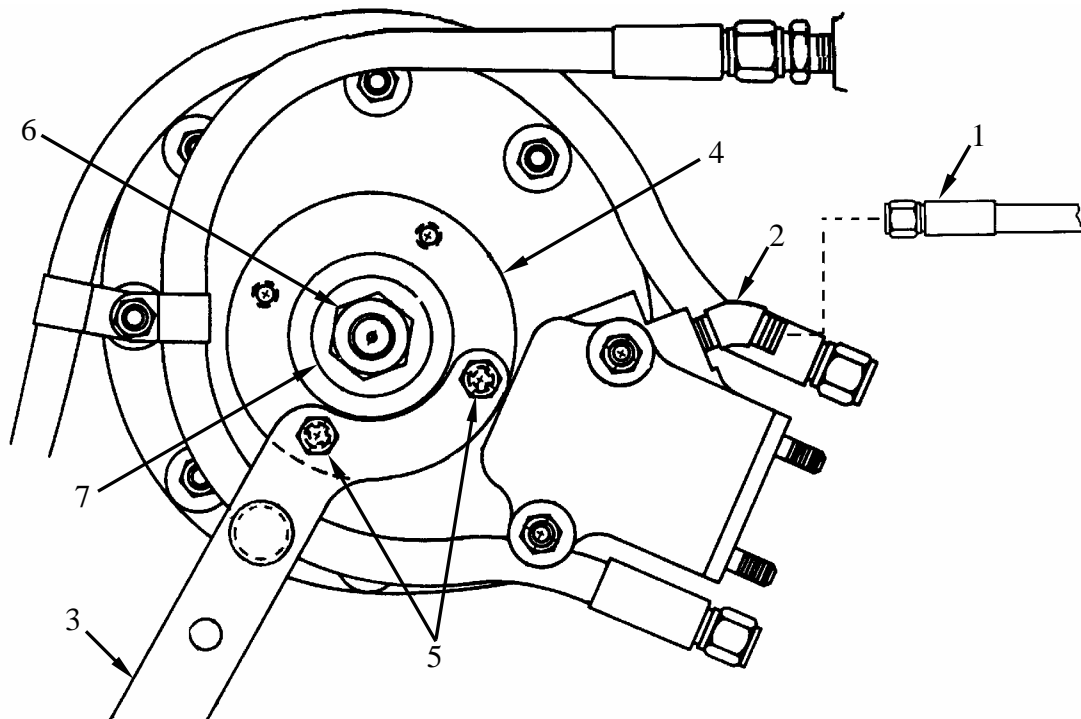
- Keep fire extinguisher nearby.
- Do not breathe solvent fumes.
- Avoid skin contact. See Warning in front of Manual.

- a. Prepare spur gear shaft (31) by wiping clean and dry using cleaning compound (item 8, WP 0173) with a shop cloth (item 26, WP 0173).
- b. Place coupling (4) onto shaft (31).
- c. Carefully lubricate (item 23, WP 0173) gear shaft (31) threads making sure that taper on both parts remains clean and dry.



**INSTALLATION (Continued)**

2. Install PTO drive coupling (4) (Continued).
  - d. Install holding bar/puller tool (3) (item 64, WP 0176).
    - (1) Position holding bar/puller tool (3) on PTO drive coupling (4) as shown.
    - (2) Secure with two 7/16-20 x 1-1/2 inch cap screws (5).
  - e. Install nut (6) with flat washer (7).
  - f. Secure holding bar/puller tool to prevent PTO coupling (4) from turning.
  - g. Torque-tighten self-locking nut (6) using torque wrench (item 128, WP 0176):
    - (1) For early spur gear shaft (3/4-16 inch threads), note the prevailing nut torque (before nut bottoms against the flat washer), and add 190 foot-pounds (258 N·m) torque to complete the torque tightening procedure.
    - (2) For late spur gear shaft (7/8-14 inch threads), torque-tighten to 280-290 foot-pounds (380-393 N·m).
  - h. Remove holding bar/puller tool (3).
3. Connect oil inlet hose (1) at 45-degree elbow (2).
4. Install two fuel hose clamps (11) and secure with new self-locking nut (9) (item 140, WP 0175) using flat washer (10).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Assembly

**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Torque wrench, 0-175-foot pounds (item 127, WP 0176)

**Expendable and Durable Items:**

Locking wire (item 43, WP 0173)

**Personnel Requirements:**

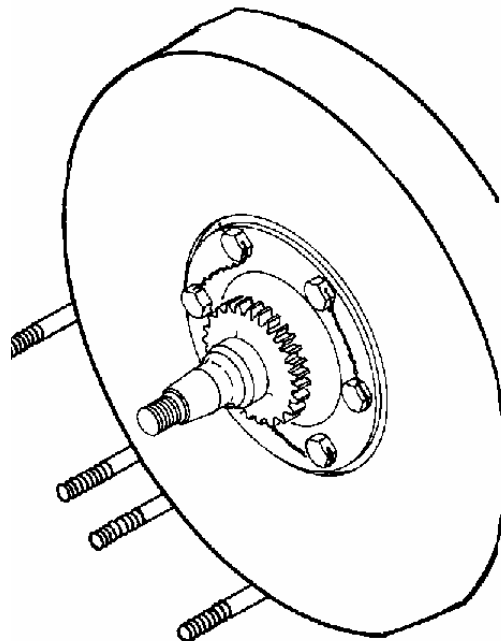
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface  
 PTO/Fuel Pump Drive Housing Removed (WP 0111)

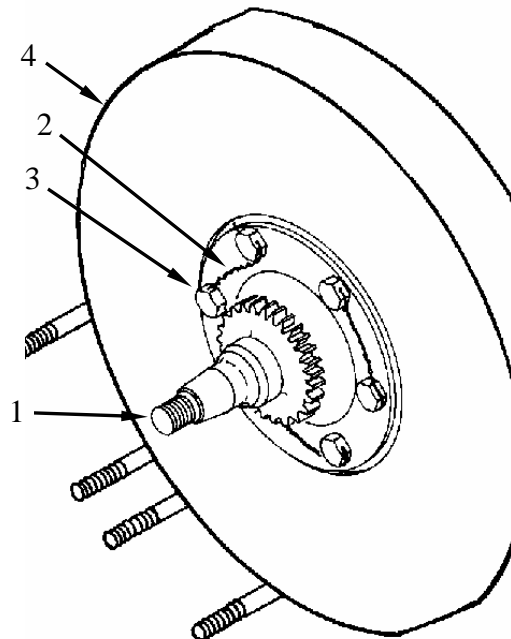
**NOTE**

This work package describes how to remove the PTO drive shaft with the damper housing not removed. The cap screws that fasten the PTO drive shaft also secure the damper. The damper will remain in position with these cap screws removed. The procedure is the same whether the damper housing is removed or not - only the equipment conditions change.



**REMOVAL**

1. Remove PTO drive shaft (1).
  - a. Remove lock wire (2) securing six screws (3).
  - b. Remove six screws (3) fastening PTO drive shaft (1) and damper (4) to crankshaft.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

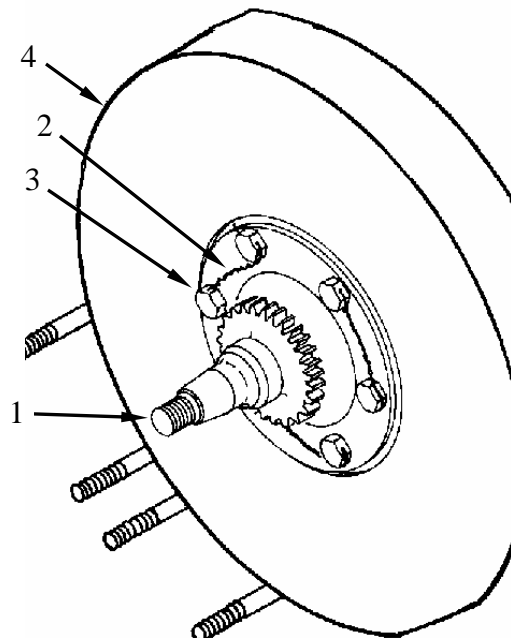
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install PTO drive shaft (1).
  - a. Place drive shaft (1) in position.
  - b. Secure with six screws (3).
  - c. Torque-tighten screws (3) to 80-85 foot-pounds (110-116 N•m) using torque wrench (item 127, WP 0176).
  - d. Secure six (3) screws using lock wire (4).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Crowfoot attachment (item 27, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Plug gauge set (item 53, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Fabricated Items:**

- Bending tool (2) (item 13, WP 0177)

**Mandatory Replacement Parts:**

- Self-locking nut (31) (item 38, WP 0175)
- Self-locking nut (item 111, WP 0175)
- Self-locking screw (2) (item 223, WP 0175)

**Expendable and Durable Items:**

- Goggles (item 27, WP 0173)
- Lubricating oil (item 21, WP 0173)
- Lubriplate (item 23, WP 0173)
- Cap, Plastic Tubing (Tool Crib)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

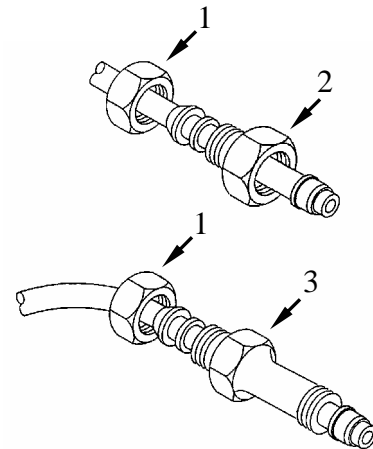
**Equipment Conditions:**

- Engine level on flat surface
- Top housing assembly removed (WP 0055)
- Fuel injection tube brackets removed (WP 0079)

**REMOVAL**

**CAUTION**

Both ends of each fuel injection tube have a support nut (1) that must be loosened prior to loosening the compression nut (2) [nozzle end] or compression connector (3) [pump end]. The compression nut or compression connector must be held in place while loosening the support nut. Failure to comply may result in damage to fuel injection tubes.



**NOTE**

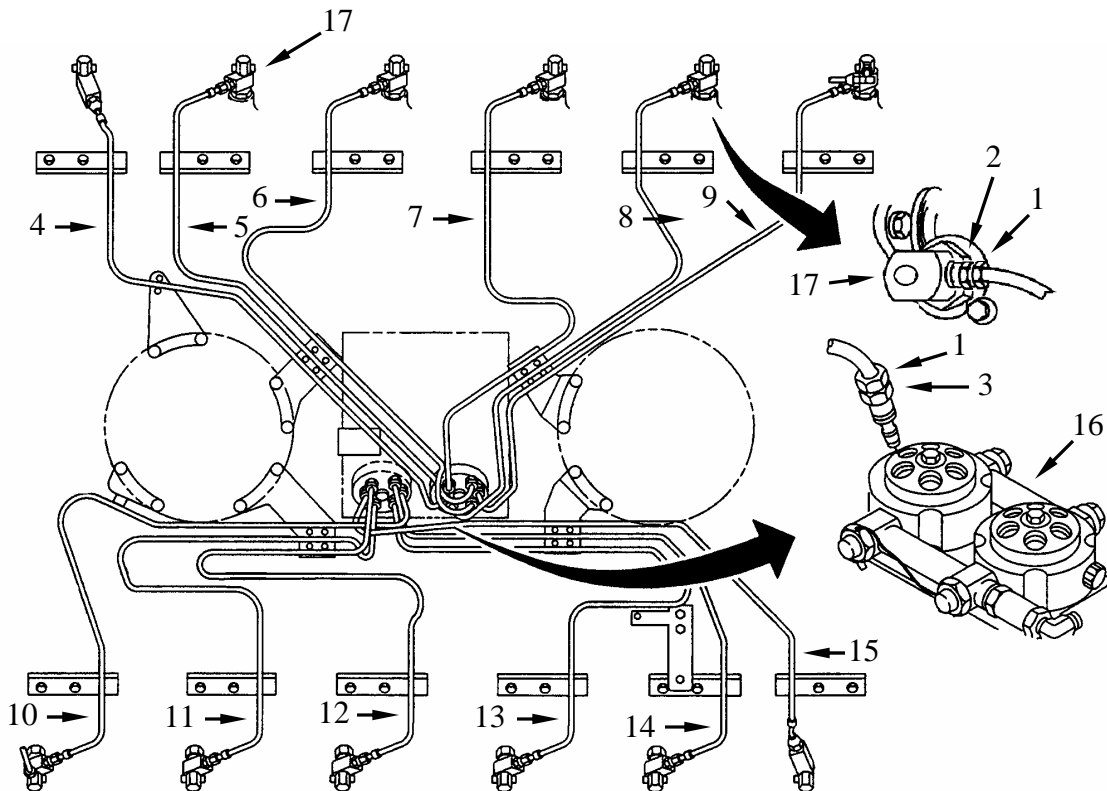
Each fuel injection tube is unique and must be returned to its original position. Each tube is marked for cylinder location.

## FUEL INJECTION TUBES REPLACEMENT

0113 00

## REMOVAL (Continued)

1. Remove 12 fuel injection tubes (4-15).
  - a. Loosen 12 support nuts (1) at fuel injection pump (16) and one at each nozzle (17).
  - b. Remove fuel injection tube compression nuts (2) at each nozzle (17) using crowfoot attachment socket wrench (item 27, WP 0176).
  - c. Remove fuel injection compression connectors (3) from fuel injection pump (16).
2. Plug fuel openings to prevent entrance of dirt.
  - a. Plug all fuel injection pump (16) openings.
  - b. Plug all nozzle (17) openings.



## CLEANING

1. See Work Package 0028 for General Cleaning Procedures.

WARNING



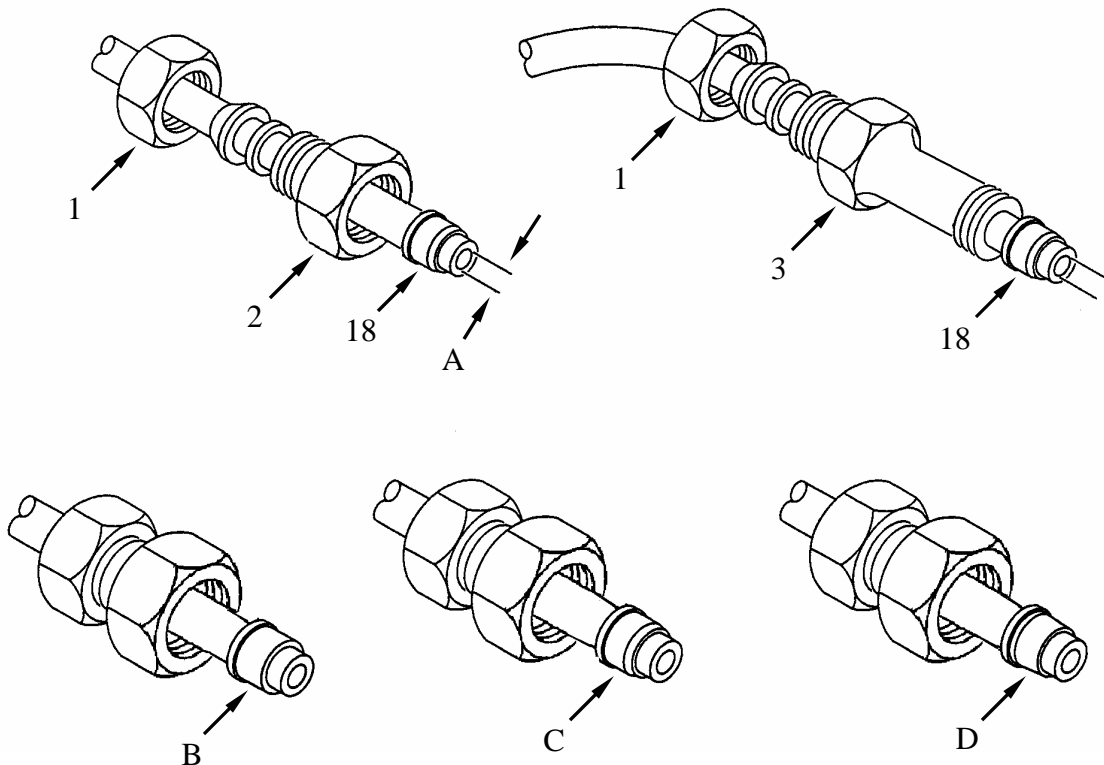
Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

2. Blow out fuel injection tubes (4-15) with compressed air.
  - a. Plug tube ends with plugs or caps to assure cleanliness until ready for use.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Measure the inside diameter (A) of each tube and discard any that are not between 0.0815 and 0.0865 inch (2.070 mm - 2.197 mm) using plug gauge set (item 53, WP 0176).
3. Inspect tubes for cracks, splits, or kinks. Discard tube if damage is found.
4. Inspect compression sleeves (18), support nuts (1), compression nuts (2), and compression connectors (3) for defects or damage.
  - a. Refer to illustrated examples (B, C, D) for comparison of compression sleeves (18). New sleeve (B) has not been seated, used sleeve (C) has been seated and properly tightened-no damage, used sleeve (D) is serviceable but has been over tightened-limited reusable value remaining.
  - b. Discard tube assembly if damage is found.



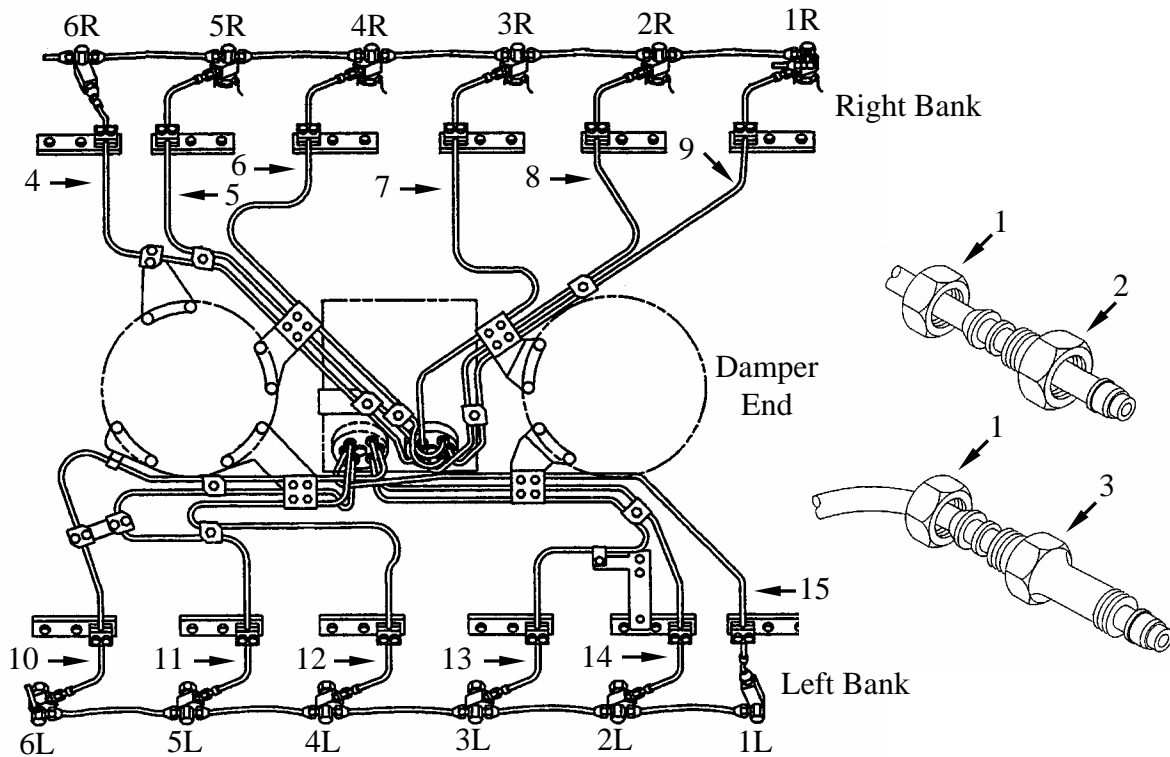
INSTALLATION

**CAUTION**

Special care must be taken to ensure that all injector tubes terminate at the proper cylinder.

Incorrect connection of the injector tubes to a wrong cylinder or injection pump port will result in damage to piston rings, cylinder walls, and severe damage to the engine if operated under load.

1. Install fuel injection tubes (4-15) in 4R, 1R, 2R, 6R, 3R, 5R, 3L, 5L, 6L, 1L, 2L, and 4L sequence, starting at the fuel injection pump end for each tube. Complete the following steps for each tube assembly in sequence:
  - a. Apply a drop of lubricating oil (item 21, WP 0173) on the threads of compression nut (2), compression connector (3), and two support nuts (1).
  - b. Remove plugs from fuel injection pump ports and nozzle openings.



**INSTALLATION (Continued)**

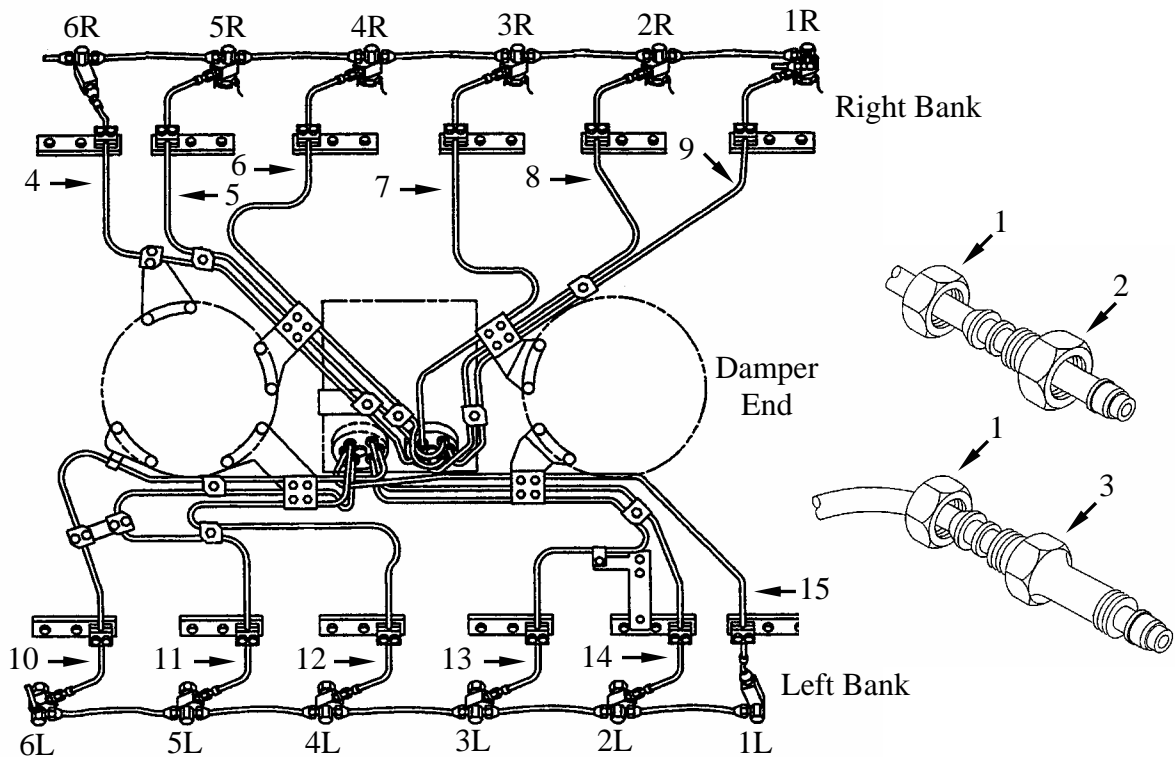
1. Install fuel injection tubes (4-15) in 4R, 1R, 2R, 6R, 3R, 5R, 3L, 5L, 6L, 1L, 2L, and 4L sequence, starting at the fuel injection pump end for each tube. Complete the following steps for each tube assembly in sequence: (Continued).

**CAUTION**

**Over tightening will damage the compression sleeve and cause fuel leaks. Over tightening can fracture the sleeve and result in injector tube failure. Tube assemblies must be visually aligned between the bolt holes on the cylinder head mounting brackets. Hold the lines in this aligned position while torque tightening the compression connectors at the pump end of the tubes.**

**The compression connector (3) must be held in place while tightening the support nut (1). Failure to comply may result in damage to fuel injection tubes.**

- c. Tighten compression connector (3) to 35 foot-pounds (48 N•m) using torque wrench (item 127, WP 0176).
- d. Tighten support nut (1) to 125 inch-pounds (14 N•m) using torque wrench (item 124, WP 0176).
- e. Attach compression nut (2) and support nut (1) to the nozzle and tighten finger-tight.



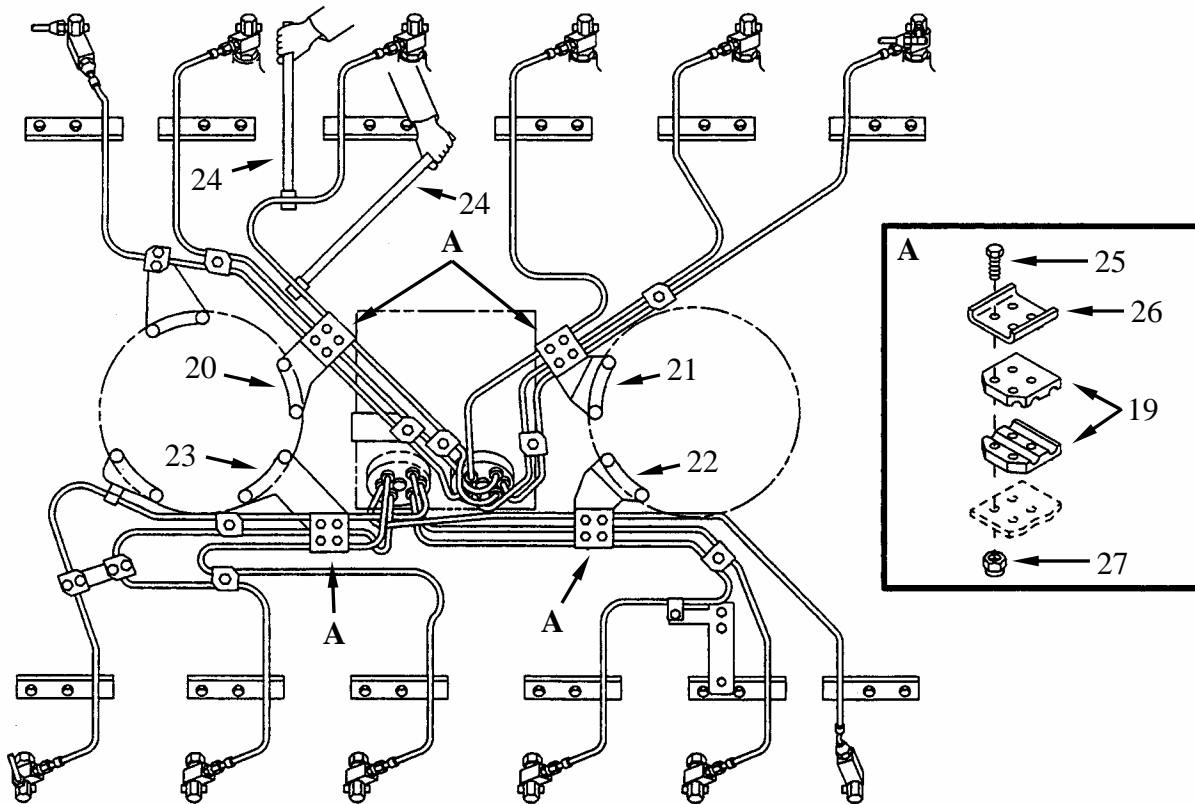
**INSTALLATION (Continued)**

2. Install four fairlead halves (19) between tube assemblies and four double-angle brackets (20, 21, 22, and 23) with cut-off corners adjacent to manifolds (see detail A).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

3. Assure that fairlead halves (19) are aligned with bracket (20, 21, 22, and 23) holes and align tubes to fit within 1/8 inch (3.175 mm) in any direction with fairlead halves. Use two bending tools (24) (item 13, WP 0177).
4. Install four fairlead halves (19) on top of fuel injection tubes (see detail A).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of 16 screws (25).
  - b. Install retainers (26), using screws (25) and new self-locking nuts (27) (item 38, WP 0175), onto four double-angle brackets (20, 21, 22, and 23).
  - c. Tighten 16 screws (25) to 160-180 inch-pounds (18-20 N•m).



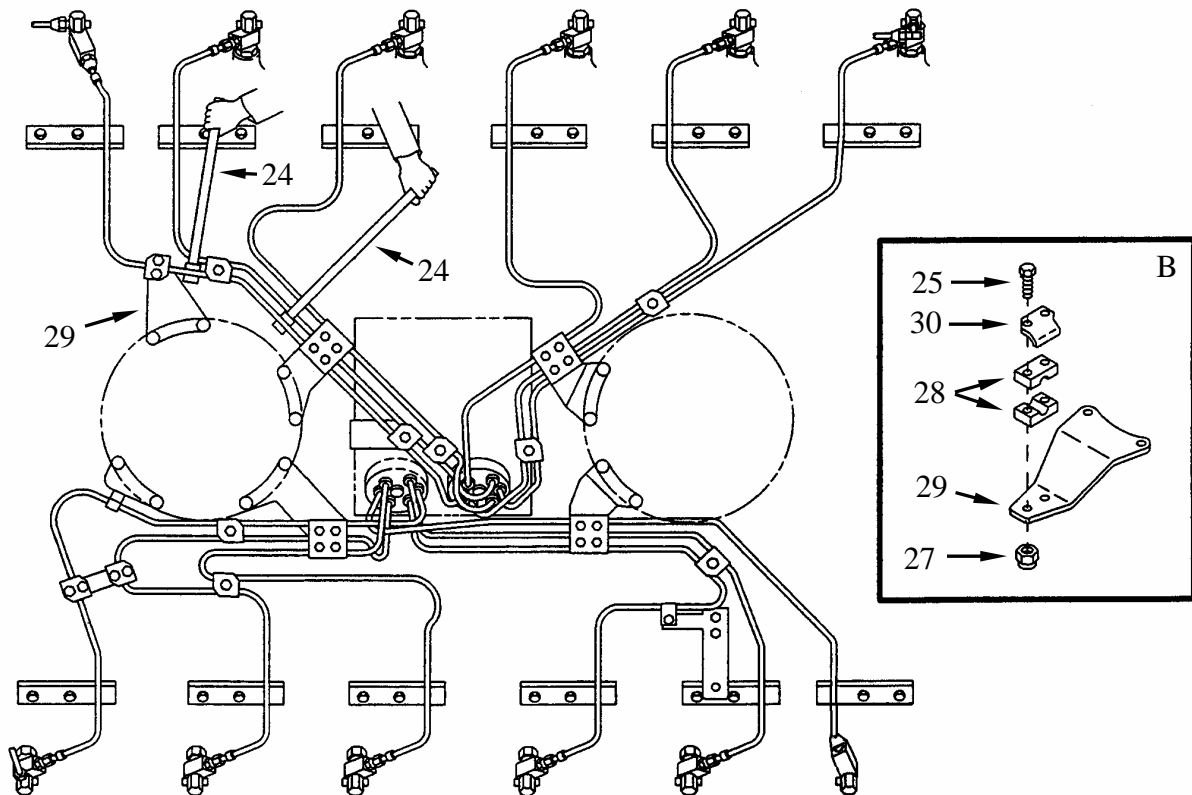
**INSTALLATION (Continued)**

5. Install lower fairlead half (28) between tube assembly and double-angle bracket (29) (see detail B).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

6. Assure that fairlead half (28) is aligned with bracket (29) holes and align tube to fit within 1/8 inch (3.175 mm) in any direction with fairlead half. Use two bending tools (24) (item 13, WP 0177).
7. Install upper fairlead half (28) on top of fuel injection tube (see detail B).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of two screws (25).
  - b. Install retainer (30), using screws (25) and new self-locking nuts (27) (item 38, WP 0175), onto double-angle bracket (29).
  - c. Tighten two screws (25) to 160-180 inch-pounds (18-20 N•m).



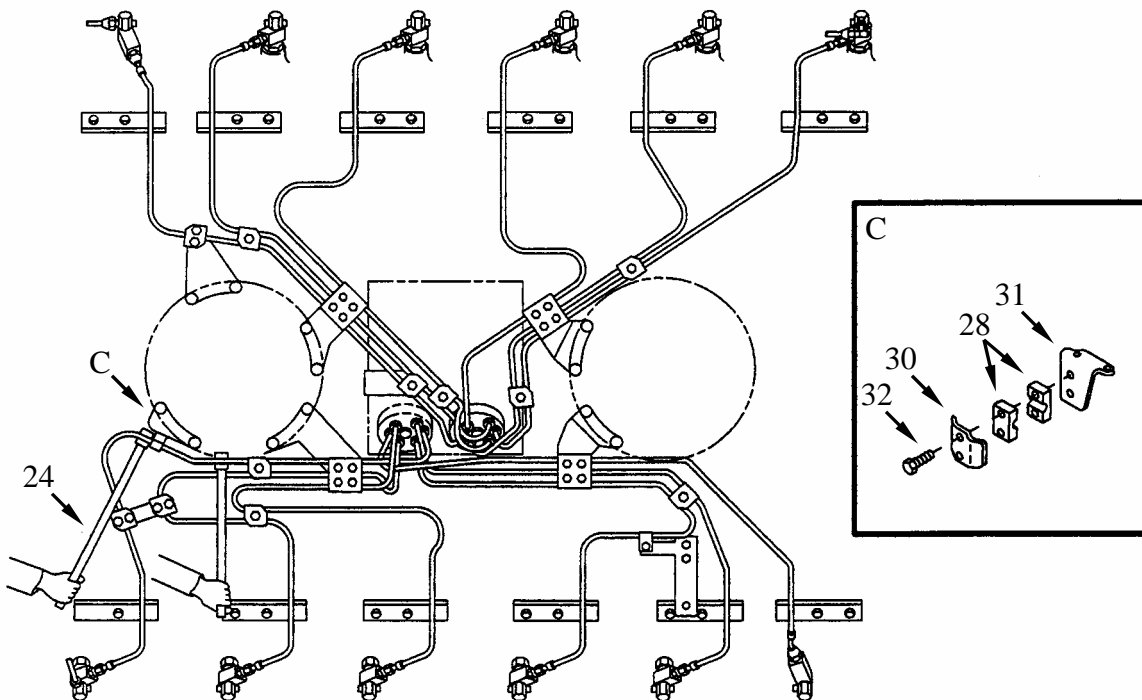
**INSTALLATION (Continued)**

8. Install inner fairlead half (28) between tube assembly and angle bracket (31) (see detail C).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

9. Assure that fairlead half (28) is aligned with bracket (31) holes and align tube to fit within 1/8 inch (3.175 mm) in any direction with fairlead half. Use two bending tools (24) (item 13, WP 0177).
10. Install outer fairlead half (28) (see detail C).
- Apply a small amount of Lubriplate (item 23, WP 0173) to threads of two new self-locking screws (32) (item 223, WP 0175).
  - Install retainer (30) using two screws (32) to secure to angle bracket (31).
  - Tighten two screws (32) to 160-180 inch-pounds (18-20 N•m).





**INSTALLATION (Continued)**

11. Check that all tube assemblies have 1/8 inch (3.175 mm) minimum clearance to each other at pump end. Bend tubes as necessary, with bending tools (24) (item 13, WP 0177) to obtain clearance.

**CAUTION**

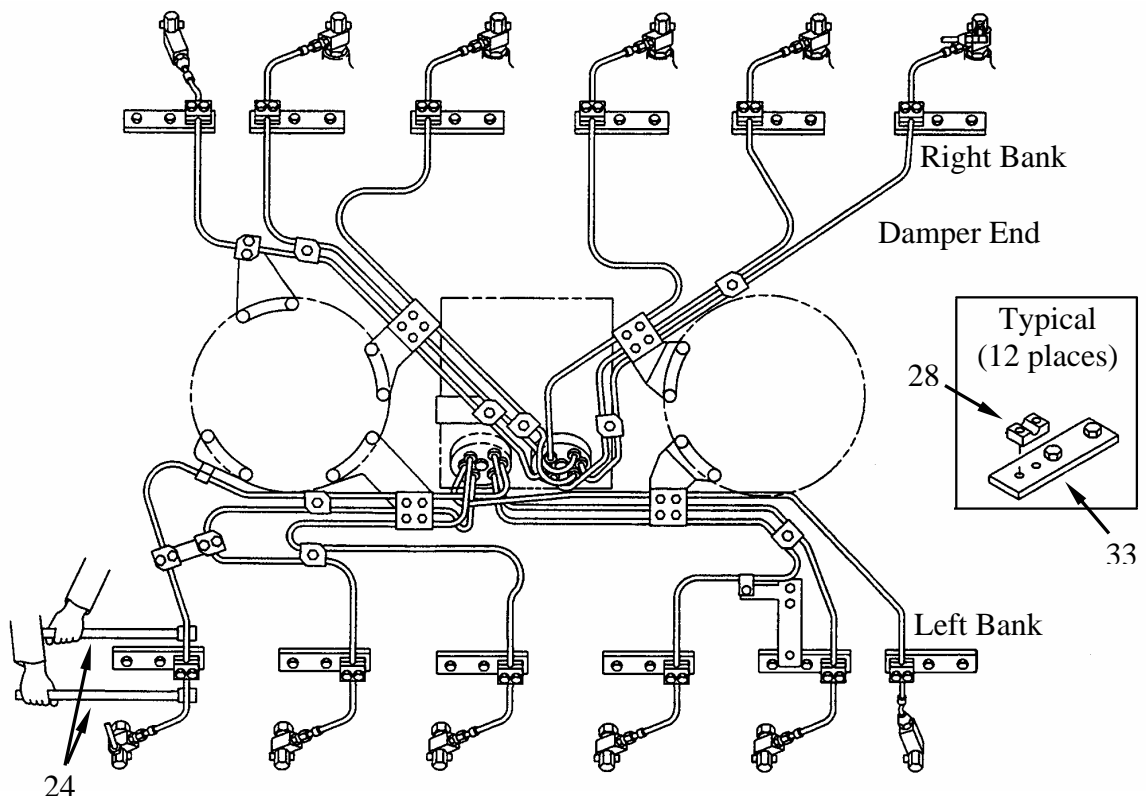
**When bending of tube assemblies is required at the pump end, the compression connector and support nut must be re-torqued. Tighten compression connector to 35 foot-pounds (48 N•m). Tighten support nut to 125 inch-pounds (14 N•m).**

12. Install 12 lower fairlead halves (28) between tube assemblies and brackets (33) at each cylinder.

**CAUTION**

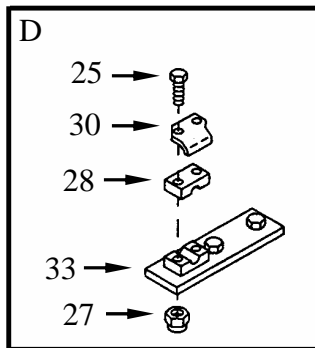
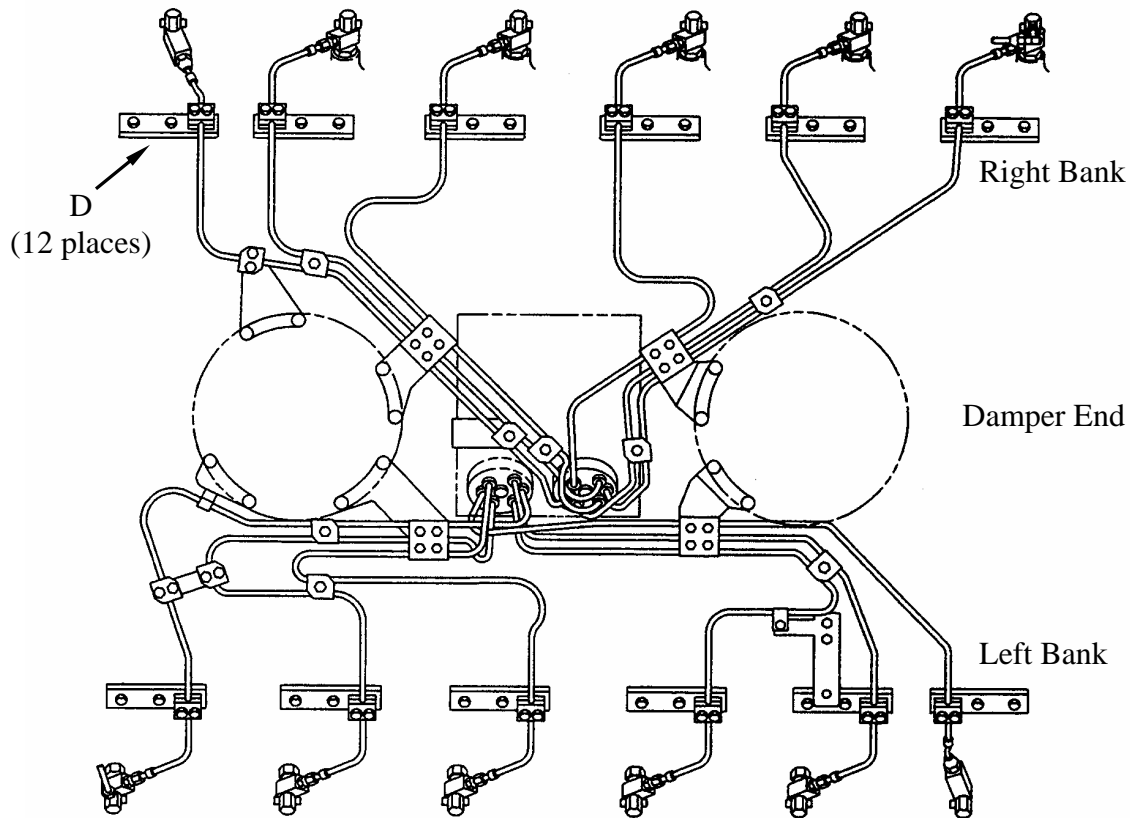
**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

13. Assure that fairlead halves (28) are aligned with bracket (33) holes and align tube to fit within 1/8 inch (3.175 mm) in any direction with fairlead half. Use two bending tools (24).



**INSTALLATION (Continued)**

14. Install upper fairlead halves (28) at each cylinder (see detail D).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of two screws (25).
  - b. Install retainer (30), using screws (25) and new self-locking nuts (27) (item 38, WP 0175), onto bracket (33).
  - c. Tighten two screws (25) to 160-180 inch-pounds (18-20 N•m).



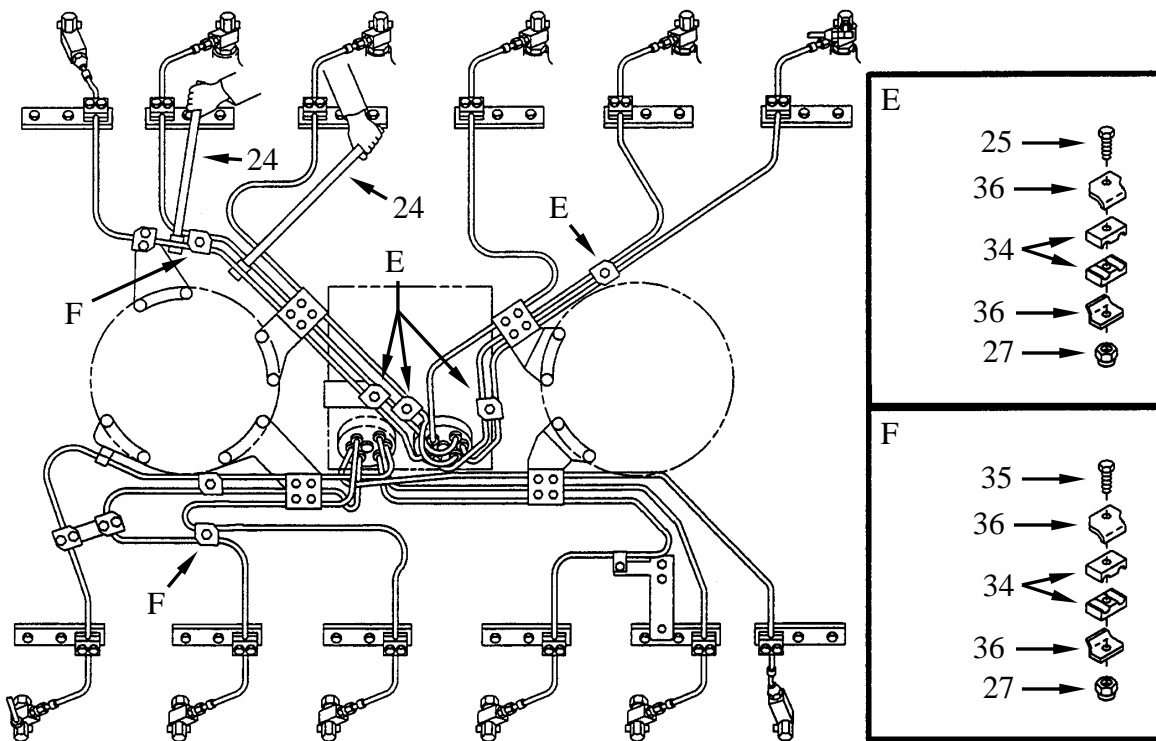
INSTALLATION (Continued)

15. Install floating clamps in locations shown in illustration (see details E and F).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

- Assure that fairlead halves (34) are aligned with tubes to fit within 1/8 inch (3.175 mm) in any direction. Use two bending tools (24) (item 13, WP 0177).
- Apply a small amount of Lubriplate (item 23, WP 0173) to threads of four screws (25) and two screws (35).
- Install retainers (36), using screws (25-detail E) and (35-detail F) with new self-locking nuts (27) (item 38, WP 0175).
- Tighten two screws (25, 35) to 160-180 inch-pounds (18-20 N•m).



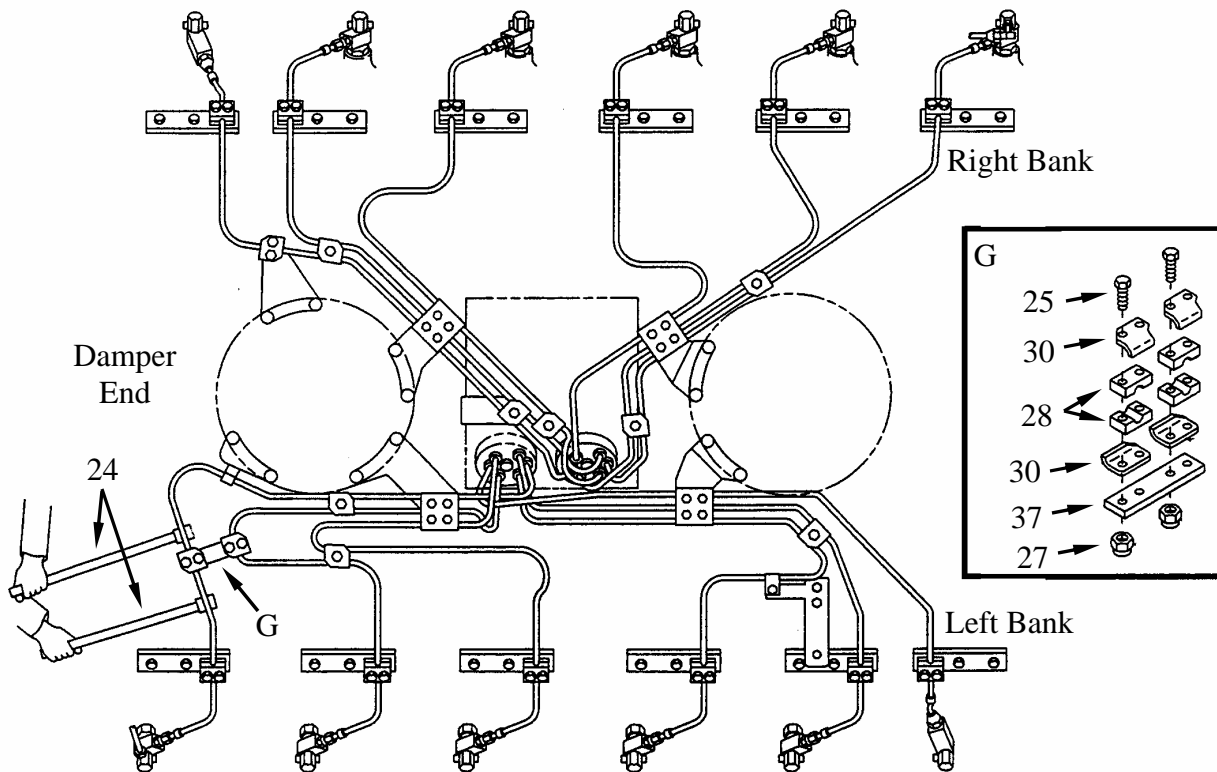
INSTALLATION (Continued)

16. Install floating clamps in location shown in illustration (see detail G).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

- a. Assure that fairlead halves (28) are aligned with tubes to fit within 1/8 inch (3.175 mm) in any direction. Use two bending tools (24) (item 13, WP 0177).
- b. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of four screws (25).
- c. Install retainers (30) fairlead halves (28), and strap (37) using screws (25) with new self-locking nuts (27) (item 38, WP 0175).
- d. Tighten screws (25) to 160-180 inch-pounds (18-20 N•m).



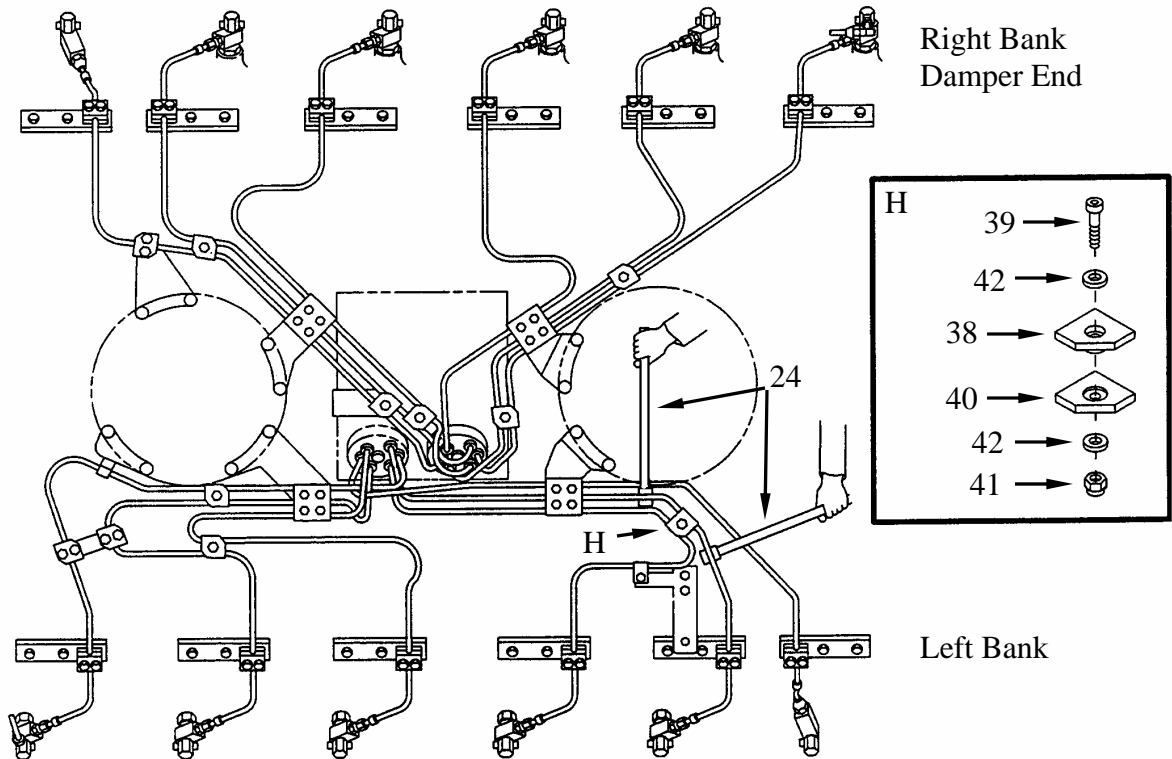
INSTALLATION (Continued)

17. Install floating clamp in location shown in illustration (see detail H).

**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

- a. Assure that clamp half (38) does not interfere with cooling fan and that tubes are parallel with each other. Use two bending tools (24) (item 13, WP 0177).
- b. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of one screw (39).
- c. Install clamp halves (38, 40), using screw (39) with new self-locking nut (41) (item 111, WP 0175) and two flat washers (42) as shown.
- d. Tighten screw (39) to 75-100 inch-pounds (8.5-11.3 N•m).



**INSTALLATION (Continued)**

18. Install lower fairlead half (43) between tube assembly and angle bracket (44) (see detail I).

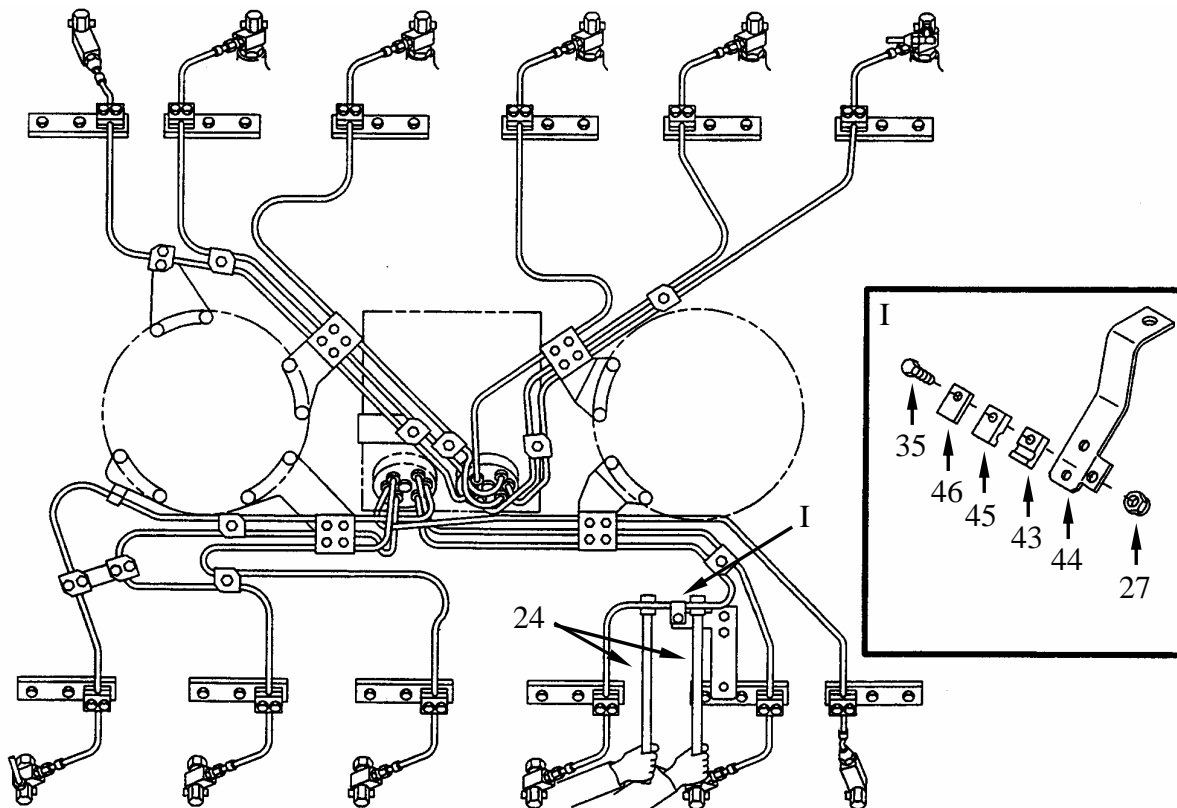
**CAUTION**

**When bending injection tubes is required, be careful not to nick tubing. The bending tools are designed to allow bending without nicks.**

19. Assure that fairlead half (43) is aligned with bracket (44) holes and align tube to fit within 1/8 inch (3.175 mm) in any direction with fairlead half. Use two bending tools (24) (item 13, WP 0177).

20. Install upper fairlead half (45) (see detail I).

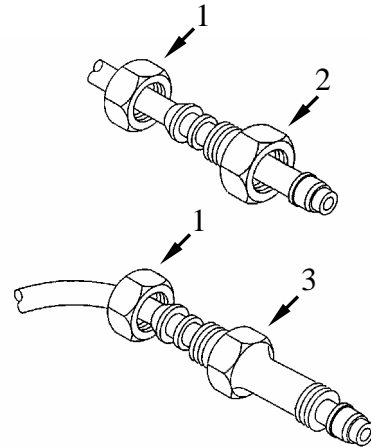
- a. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of screw (35).
- b. Install fairlead half (45) and retainer (46) using screw (35) with new self-locking nut (27) (item 38, WP 0175).
- c. Tighten screw (35) to 160-180 inch-pounds (18-20 N•m).



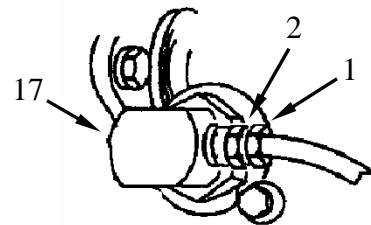
## INSTALLATION (Continued)

**CAUTION**

Support nuts (1) on ends of each fuel injection tube must be tightened after the compression nut (2) [nozzle end] or compression connector (3) [pump end] has been torque tightened. The compression nut or compression connector must be held in place while tightening the support nut. Failure to comply may result in damage to fuel injection tubes.



21. Tighten injector tube compression nuts (2) to 300 inch-pounds (34 N•m) at each nozzle (17).
22. Tighten support nuts (1) to 125 inch-pounds (14 N•m) at each nozzle (17).

**CAUTION**

Inspect all lines and clamps for 1/8 inch (3.175 mm) minimum clearance with exhaust manifold, fan towers, and cooling fans. Contact of fuel lines to each other is not permissible.

**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Crowfoot attachment, fuel injection nozzle (item 31, WP 0176)
- Fuel injection nozzle tester (item 46, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Machinist's Vise (item 132, WP 0176)
- Mechanical puller (item 44, WP 0176)
- Nozzle carbon cutter (item 33, WP 0176)
- Socket (for nozzle) (item 45, WP 0176)
- Torque wrench, 200-1000 inch-pounds (item 125, WP 0176)
- Torque wrench, 500-2500 inch-pounds (item 126, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)
- Tube, attaching nozzle (item 129, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (1) (item 272, WP 0175)
- O-ring (1) (item 147, WP 0175)

**Mandatory Replacement Parts (Continued):**

- Spring (1) (item 168, WP 0175)
- O-ring (1) (item 151, WP 0175)

**Expendable and Durable Items:**

- Anti-seize compound (item 5, WP 0173)
- Carbon removing compound (item 7, WP 0173)
- Cleaning cloth (item 10, WP 0173)
- Diesel fuel, as required (item 12, WP 0173)
- Goggles (item 17, WP 0173)
- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

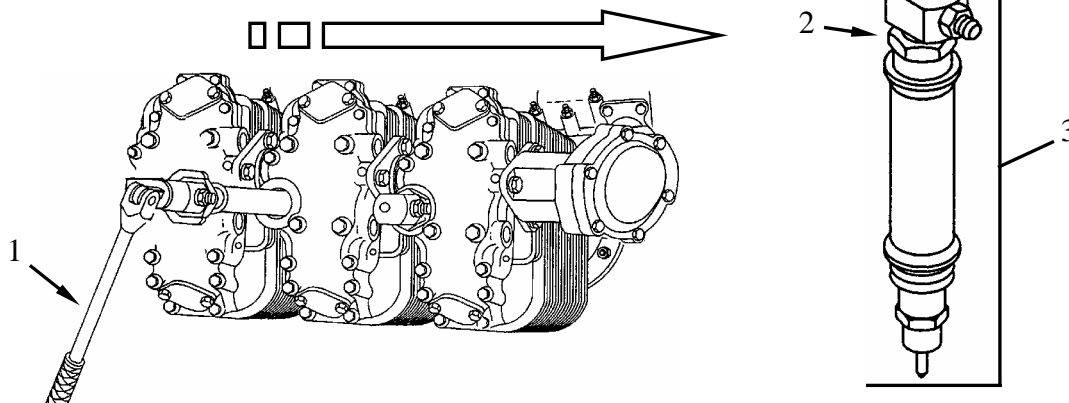
- Clean engine level on flat surface
- Fuel injection tubes, brackets and associated parts removed (WP 0079)
- Fuel Injection fuel return hoses removed (WP 0080)

**REMOVAL**

**NOTE**

**Procedure is the same for each of 12 fuel injection nozzle assemblies. If all the fuel injection nozzle assemblies are not to be removed, it is not necessary to remove all of the fuel injection tubes and injection fuel return lines.**

1. Using wrench (1) on retainer (2), loosen and remove fuel injection nozzle assembly (3).

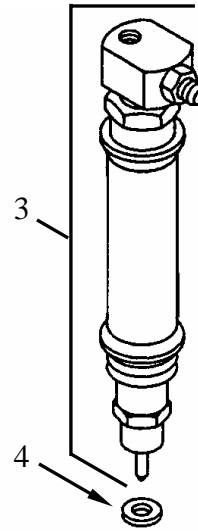


**REMOVAL (Continued)**

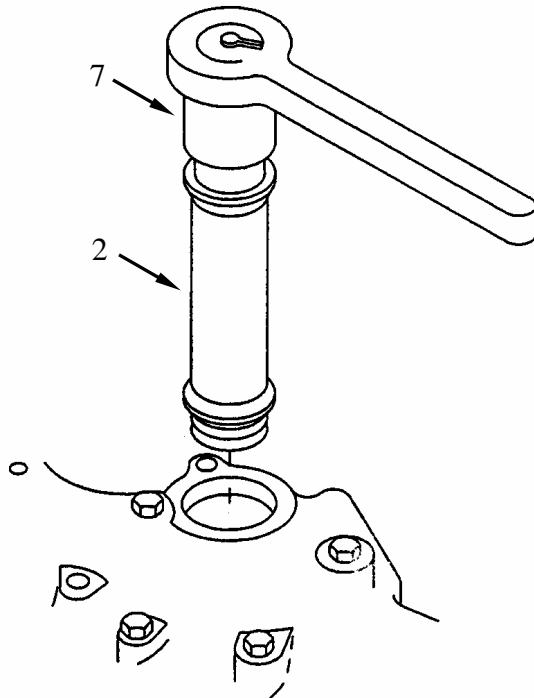
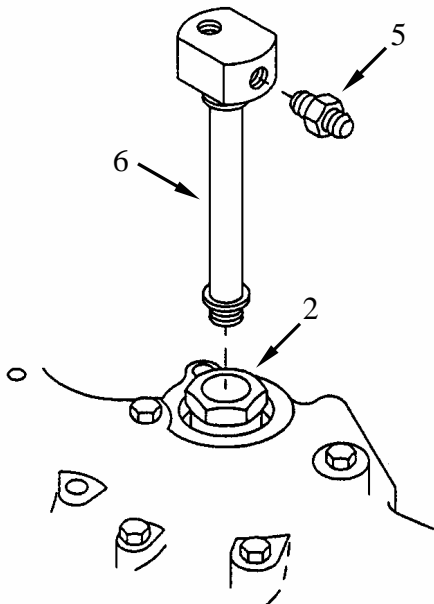
2. Remove and discard steel gasket (4) from nozzle assembly (3).

**NOTE**

**In some cases, when the nozzle has heavy carbon deposits, the nozzle will have to be pulled with a special puller. If this is the case, proceed with the following steps. If not, proceed to "TEST".**

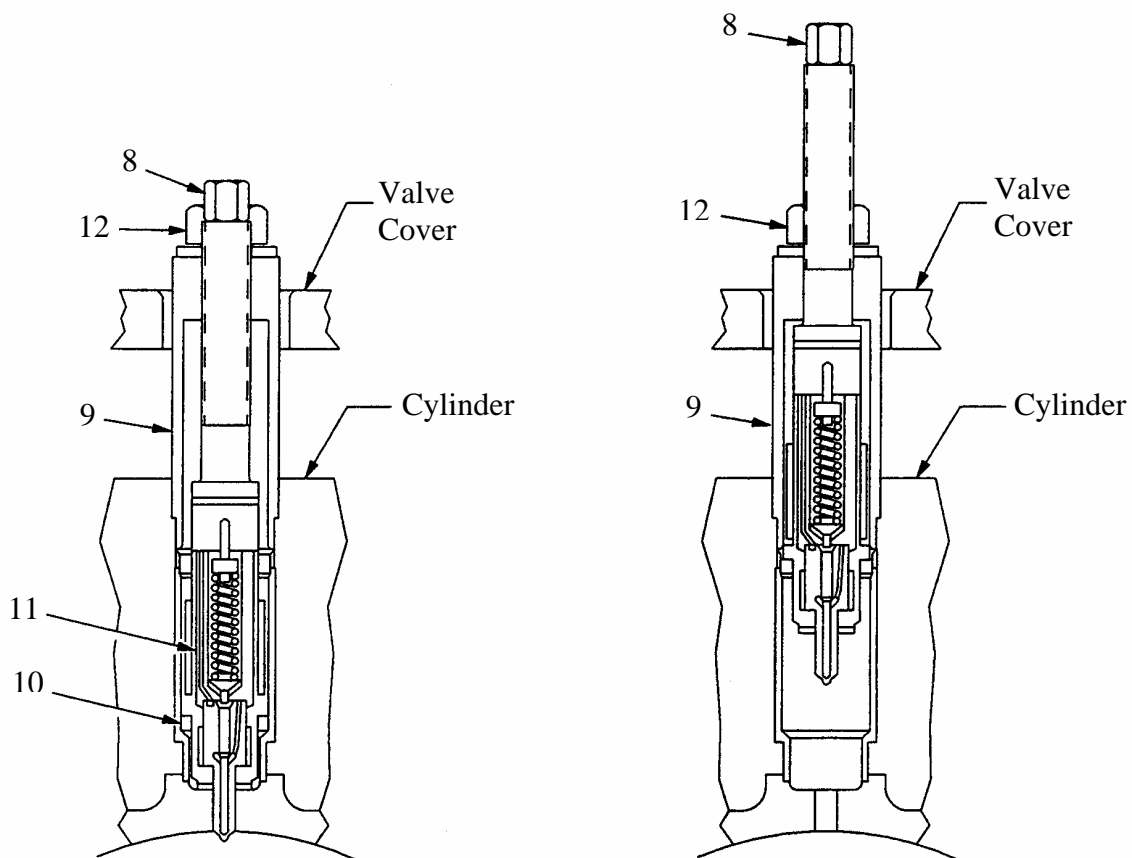


3. Remove fuel inlet fitting (5) from body (6) and remove body (6) from retainer (2).
4. Using socket wrench (7) remove retainer (2) from engine.



**REMOVAL (Continued)**

5. Turn shaft (8) of mechanical puller (9) (item 44, WP 0176) counterclockwise to the end of its thread.
6. Install mechanical puller (9) over nut (10) and rest on spacer (11).
7. Turn mechanical puller (9) clockwise to engage nut (10) threads. Continue turning until shaft (8) bottoms out.
8. Using crowfoot attachment (item 31, WP 0176), turn puller plain nut (12) clockwise to remove nut (10) and associated parts.

**NOTE**

If the nozzle was removed with a special puller, nozzle will need to be reassembled prior to testing. Perform steps 5 through 9 of "ASSEMBLY".

## TEST

## NOTE

If nozzle passes test, there is no need to disassemble nozzle. Testing must be performed after disassembly and repair to confirm repair.

**CAUTION**

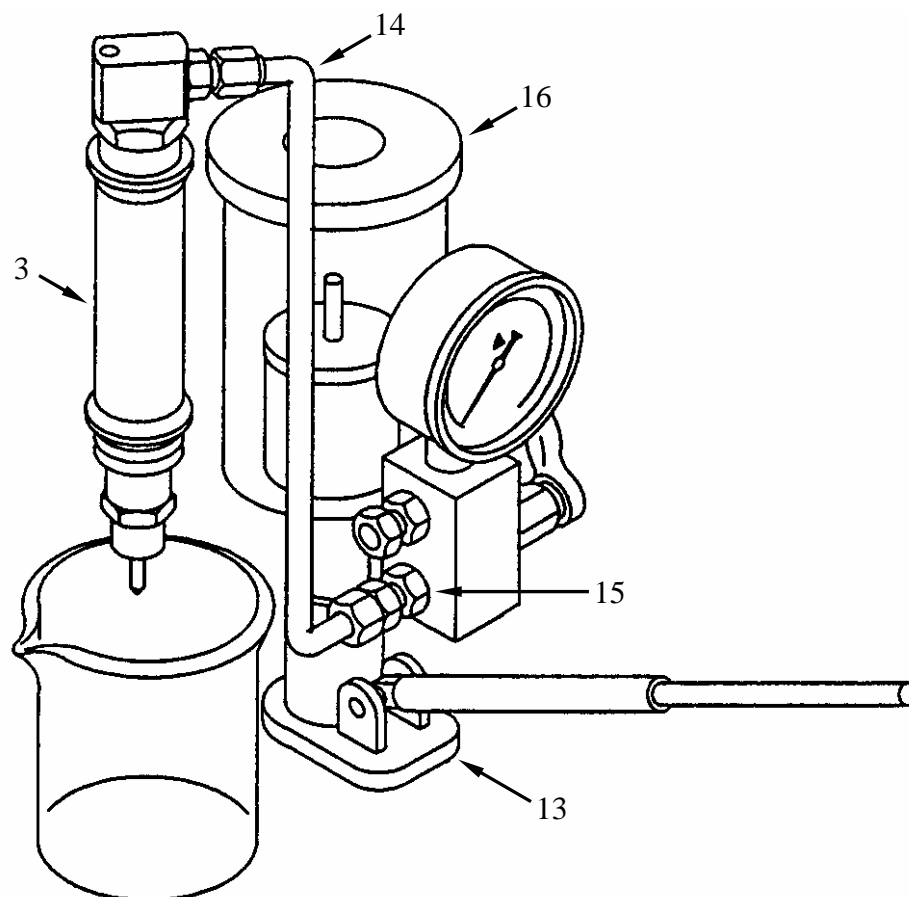
Do not allow dirt to enter nozzle fuel inlet opening.

1. Clean exterior of nozzle assembly (3) to remove carbon and dirt. Refer to WP 0028.
2. Mount fuel injection nozzle assembly (3) on fuel injection nozzle tester (13) (item 46, WP 0176).
3. Connect metal tube attaching assembly (14) (item 129, WP 0176), to lower connection (15) on fuel injection nozzle tester.

**WARNING**

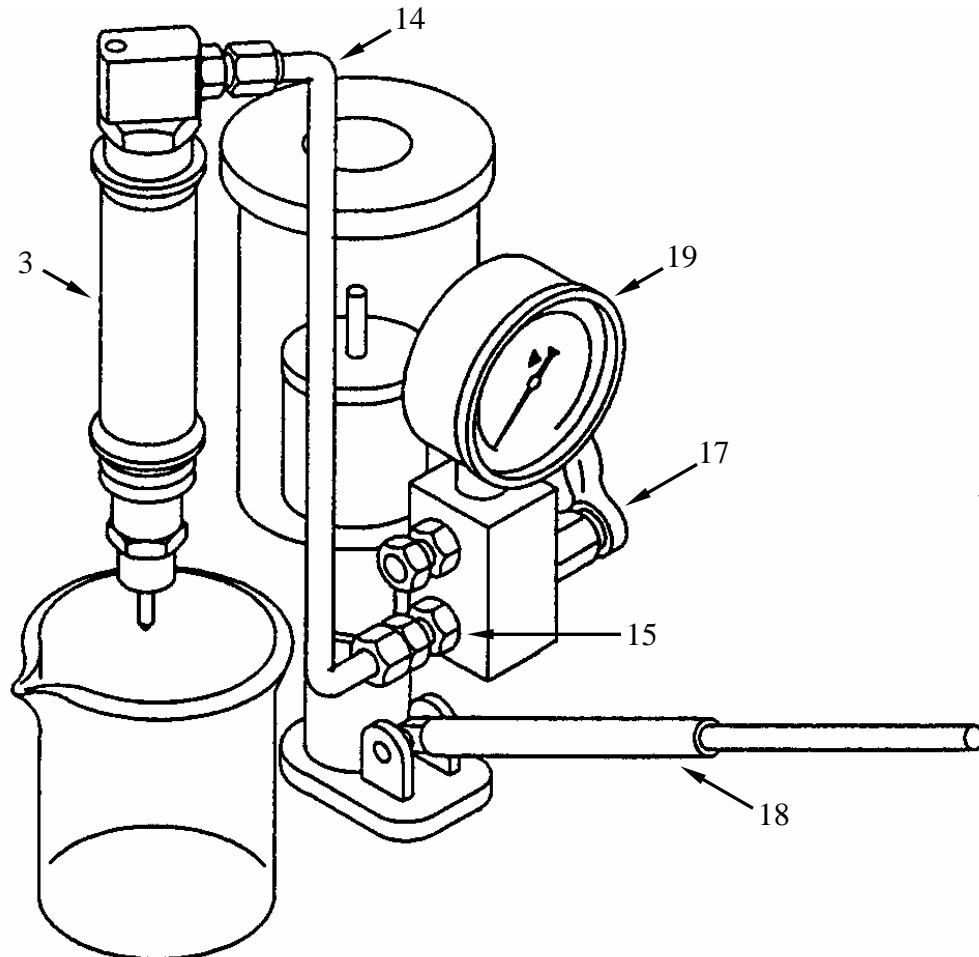
The penetrating power of atomized fuel under pressure is sufficient to puncture the skin and may cause blood poisoning leading to loss of fingers. Keep hands away from nozzle during test.

4. Fill reservoir (16) with sufficient fuel (item 12, WP 0173) to perform test.



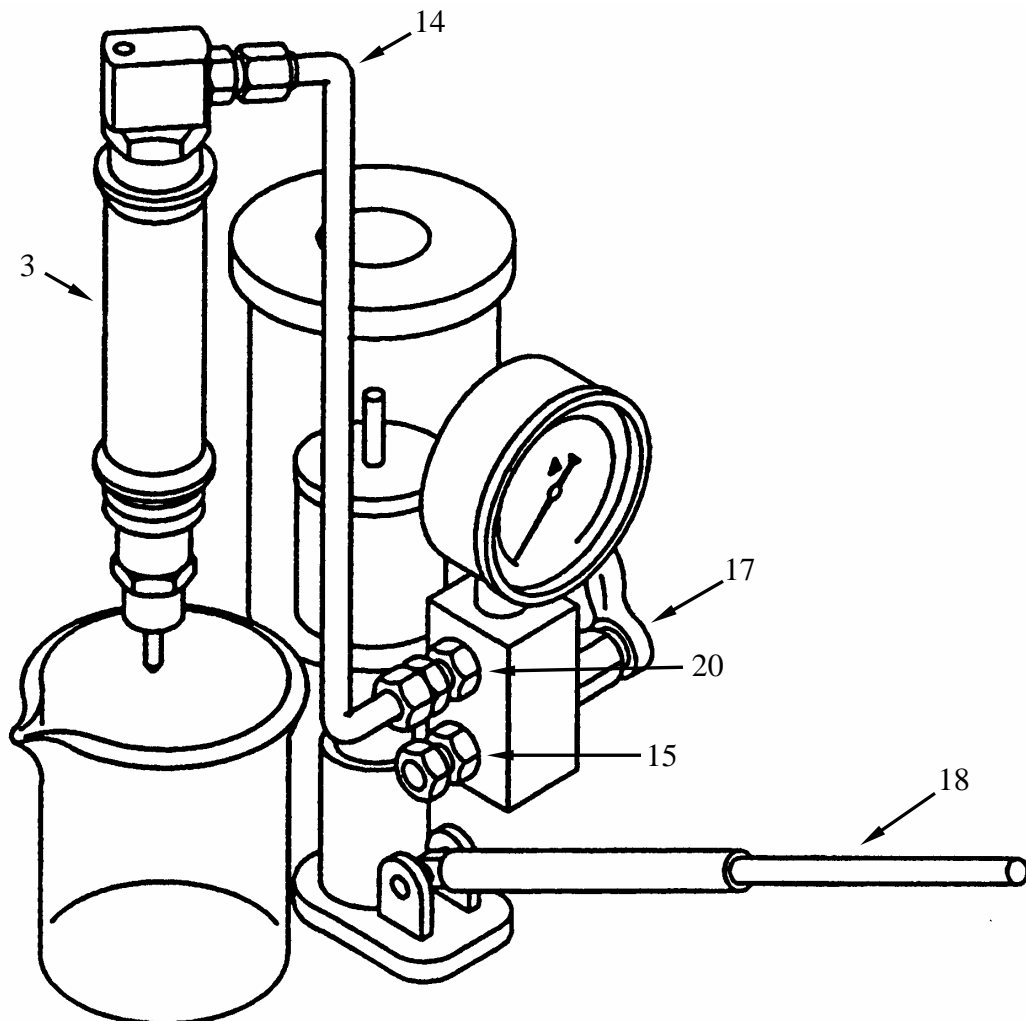
**TEST (Continued)**

5. Close pressure gauge valve (17) and actuate the pump handle (18) rapidly (approximately 25 strokes per minute) to expel air from nozzle assembly (3).
6. Check valve opening pressure.
  - a. Open pressure gauge valve (17) and actuate tester slowly to raise pressure. When nozzle opens, gauge (19) pressure must be between 3550 and 3650 psi (24476-25166 kPa) (maximum).
  - b. If the proper gauge reading is not achieved, nozzle assembly (3) must be disassembled and spring adjusting shims added or removed to obtain the proper pressure reading. Perform "DISASSEMBLY" and "REPAIR," then repeat "TEST".
7. Check nozzle spray pattern.
  - a. Close pressure gauge valve (17) and actuate tester at approximately 15 strokes per minute.
  - b. The spray pattern must have eight individual sprays. The amount of spray from each must be uniform, and angles between the sprays must be uniform.
  - c. If spray pattern is not acceptable, disassemble, clean and flush each nozzle hole thoroughly (go to "DISASSEMBLE" and to "REPAIR"). Reassemble and repeat test.



**TEST (Continued)**

8. Check nozzle seat leakage.
  - a. Disconnect metal tube assembly (14) from lower connector (15) and move to upper connector (20).
  - b. Dry the nozzle tip with a cloth (item 10, WP 0173).
  - c. Open pressure gauge valve (17) and actuate tester slowly to build up pressure to 300 psi (20685 kPa) below the valve opening pressure and hold for 5 seconds.
  - d. If drops of fuel form at spray orifices, or if fuel issues as a stream at 300 psi (2068.5 kPa) below the valve opening pressure (3550 psi), close the pressure gauge valve (17) and actuate the pump handle (18) rapidly eight to ten times. Repeat steps 8b and 8c. If drops form or fuel issues as a stream, the nozzle and holder assembly (3) is leaking and must be repaired. Go to Disassembly and Repair in this work package.
9. After successful testing, remove the nozzle assembly from test stand and install protective caps and plugs.



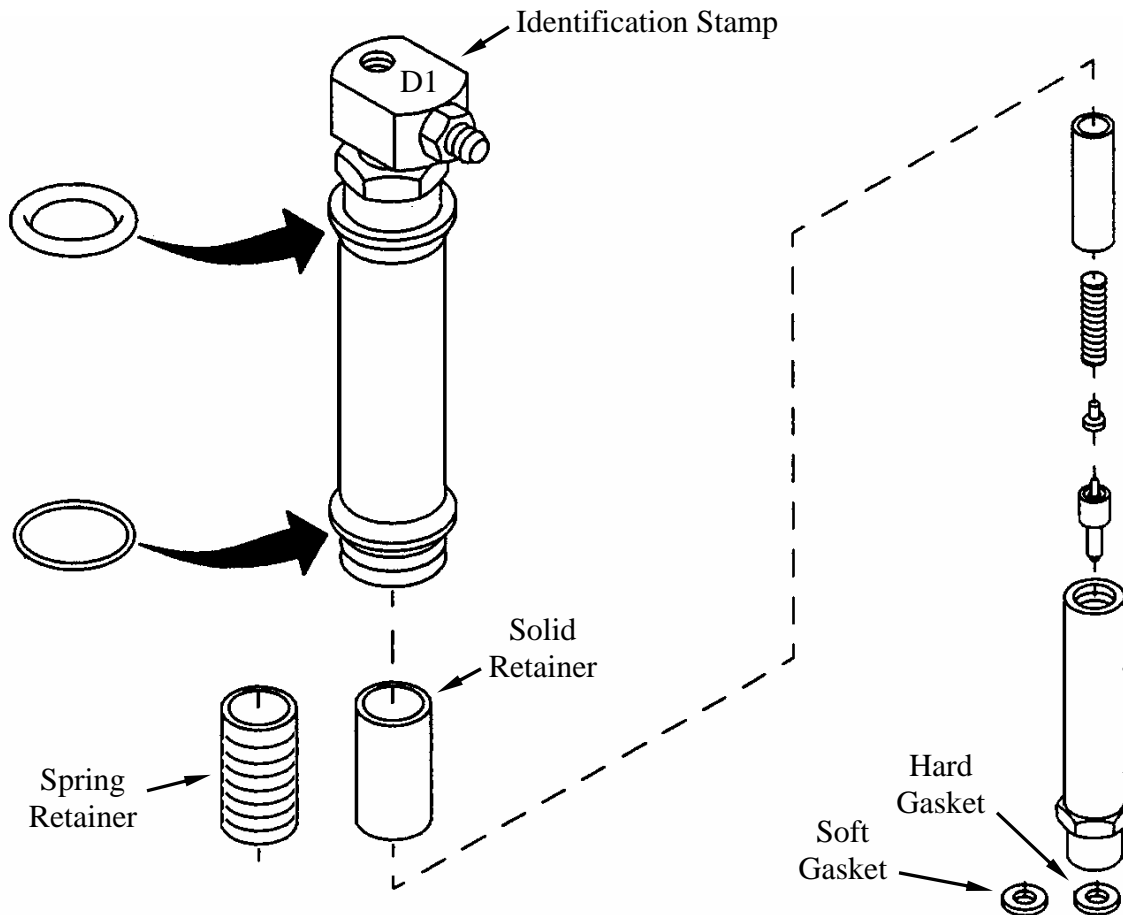
**DISASSEMBLY****NOTE**

**Fuel Injection Nozzle Assemblies** NSN 2910-01-037-4984 are now being manufactured with a retaining sleeve and hard (steel) nozzle gasket. The new nozzle assemblies are identified by stamping 'D1' on the body top. The correct installation torque for the nozzle assembly using the retainer sleeve and hard steel gasket is 1275-1325 inch-pounds, using torque wrench (item 125, WP 0176).

During repair the retaining sleeve replaces the retaining spring. The hard steel gasket replaces the soft (copper) gasket. The correct installation torque for the nozzle assembly using the spring sleeve and soft copper gasket is 490-510 inch-pounds.

**CAUTION**

**Do not mix soft gaskets with solid retaining sleeves or hard gaskets with spring retaining sleeves. Apply the correct torque for the application; 1275-1325 inch-pounds for the solid retainer with hard gasket and 490-510 inch-pounds for the spring retainer with soft gasket.**



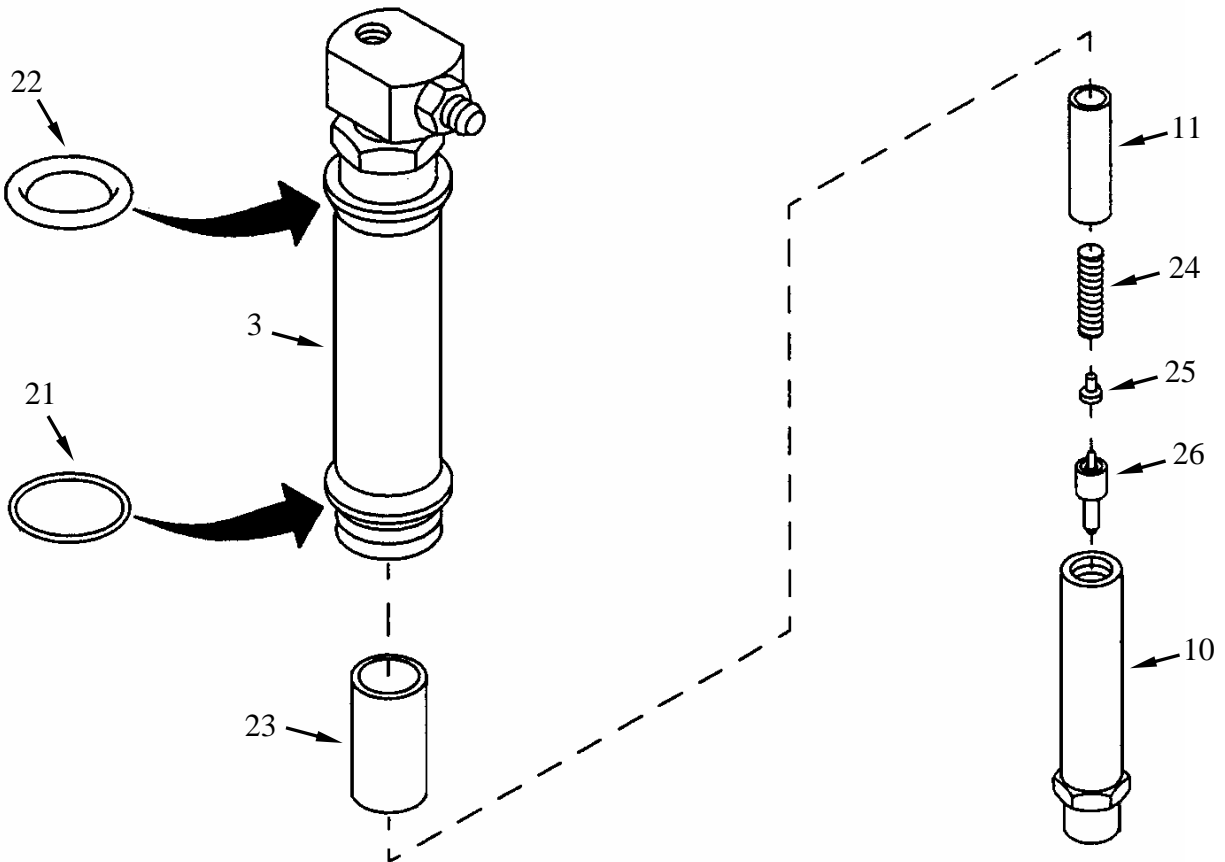
**DISASSEMBLY (Continued)**

1. Place fuel injection nozzle assembly (3) in a machinist's vise.
2. Remove and discard two O-rings (21 and 22).

**CAUTION**

**Do not drop any of the internal pieces when removing nut. Damage to parts may occur.**

3. Loosen nut (10), but do not remove.
4. Remove fuel injection nozzle assembly (3) from vise and lay on bench.
5. Remove nut (10), sleeve (23), spring (24), seat (25), spacer (11), and nozzle tip (26) from nozzle assembly (3). Discard spring.





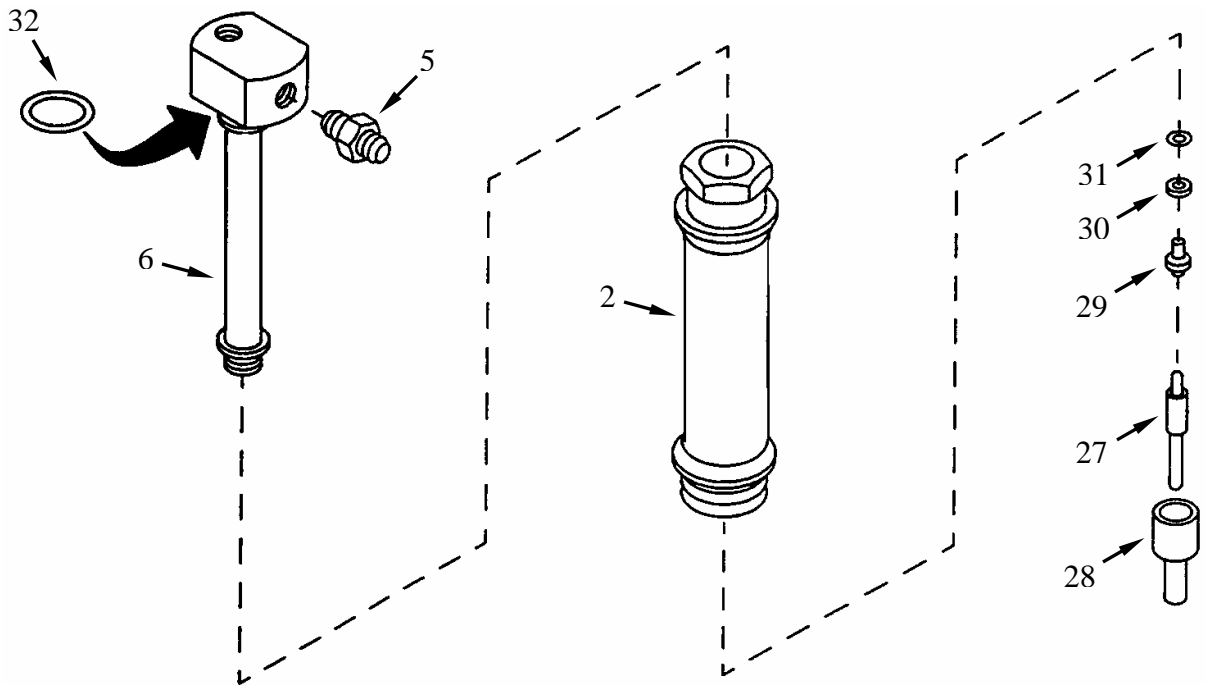
**DISASSEMBLY (Continued)****CAUTION**

The nozzle tip is an assembly that consists of a mated nozzle valve and nozzle body. If damage occurs to either piece, both pieces must be replaced.

**NOTE**

It may be necessary to soak the nozzle tip in carbon removing compound to separate.

6. Separate nozzle valve (27) from nozzle body (28).
7. Remove seat (29), shims (30), and spacer ring (31) from body (6).
8. Remove retainer (2) and O-ring (32) from body (6). Discard O-ring.
9. Remove fuel inlet fitting (5) from body (6).



## CLEANING



**WARNING**

**Carbon-Removing Compound is mildly toxic. Compound evaporates and fumes should not be inhaled. Continued contact with compound can cause skin problems.**

- **Avoid inhalation of fumes. Provide adequate ventilation.**
- **Avoid contact with skin.**
- **Use goggles, rubber gloves, and rubber apron**
- **If compound is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor is preferred.**

**CAUTION**

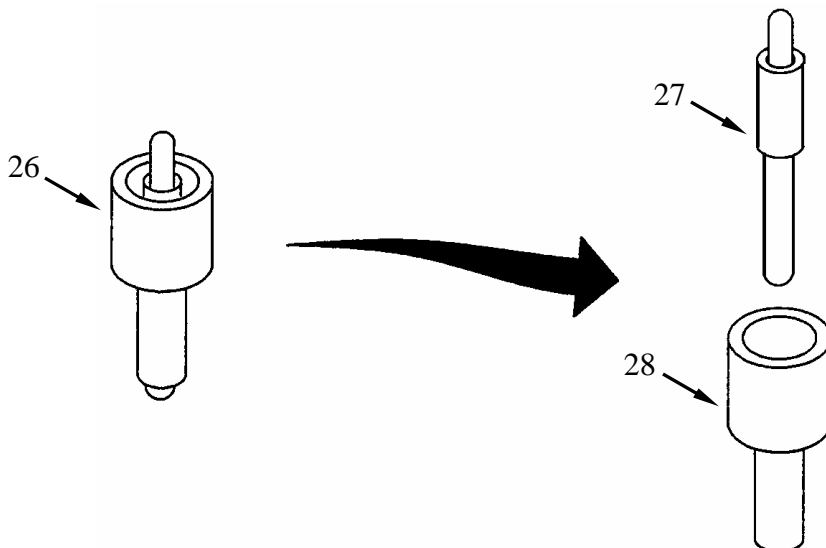
**Do not use sharp tools, wire brushes or abrasive materials to clean the nozzle valve or nozzle body. Do not clean orifices with cleaning wire as this method will distort nozzle orifices and also may block opening due to wire breakage.**

1. Soak nozzle valve (27) and nozzle body (28) in carbon removing compound (item 7, WP 0173) to remove major carbon deposits. Remaining carbon deposits should be removed using a soft cloth (item 10, WP 0173) or felt pad.
2. Make sure spray orifices in nozzle tip (26) are clear.

**CAUTION**

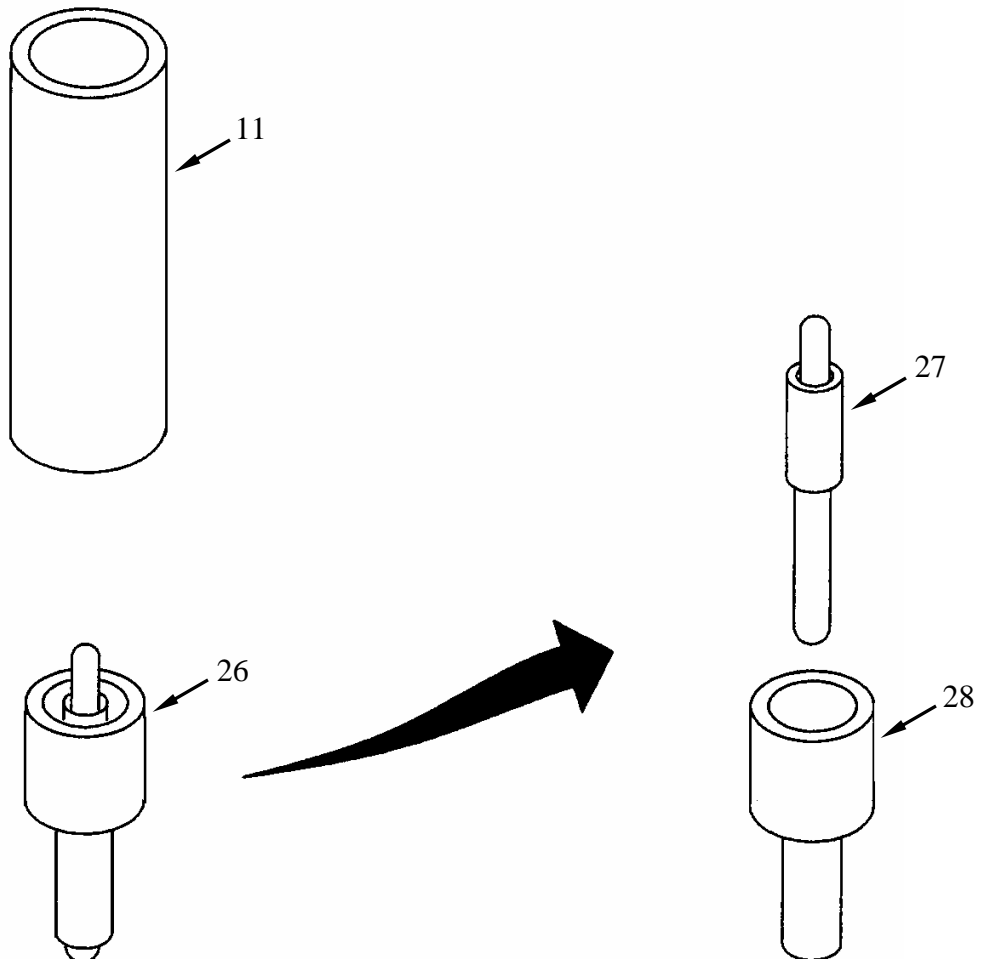
**Be sure hands are kept free from accumulation of grease which will cause collection of dust and grit on parts.**

3. Clean all remaining nozzle components in accordance with procedures in Work Package 0028.
4. Cover or wrap all parts after cleaning to protect them from dirt accumulation.



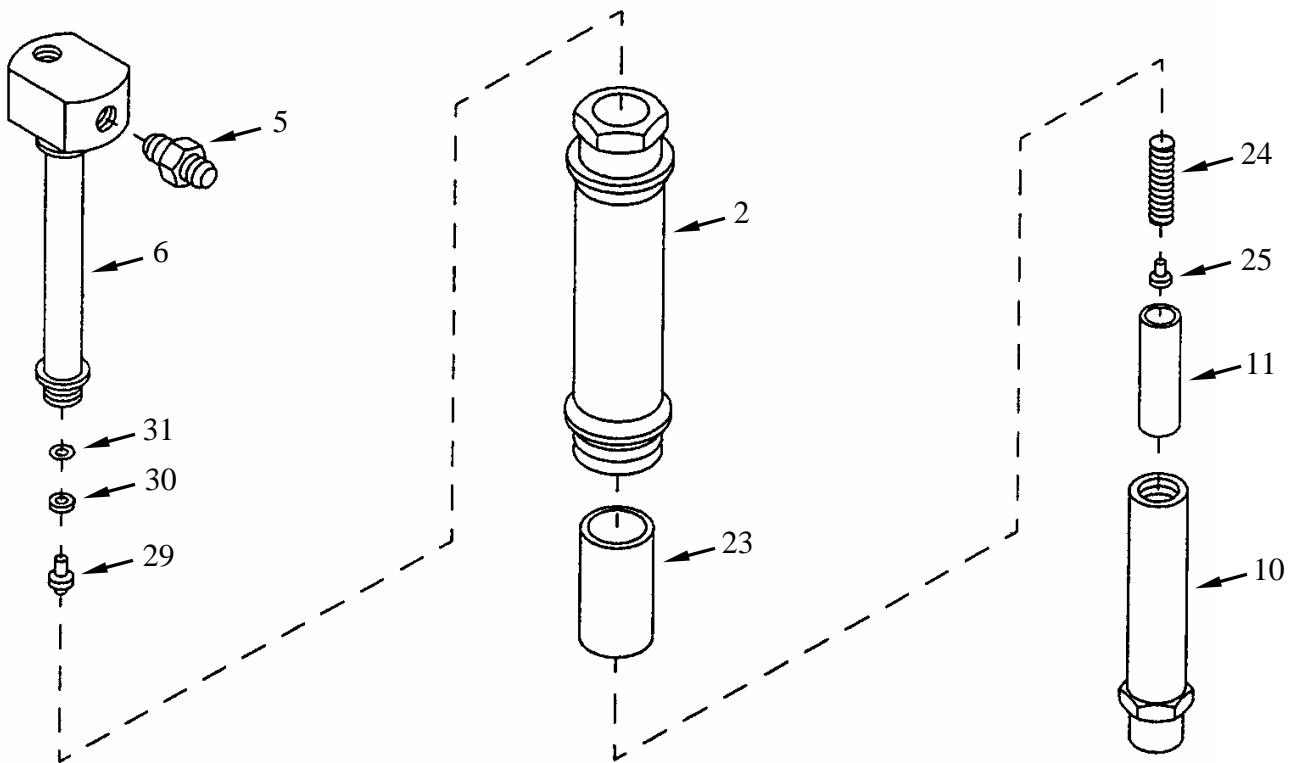
**INSPECTION**

1. Inspect seat of nozzle valve (27) for evidence of wear, distortion due to pounding, discoloration due to overheating, and pitting. Reject if found.
2. Inspect the valve stem of nozzle valve (27) for scratches and discoloration. Reject if found.
3. Check the fit of nozzle valve (27) in nozzle body (28) by lifting the valve about one-third of its length out of the body. The valve should slide back to its seat without aid when the nozzle tip (26) is held at a 45-degree angle. Reject both pieces if they fail this test.
4. Inspect eight spray orifices in the nozzle tip (26) and the drilled passage for freedom of obstructions. Replace if obstructed.
5. Inspect lapped sealing surfaces of nozzle body (28) for cracks, scratches, discoloration, wear, pitting and evidence of pounding. Reject if found.
6. Inspect the lapped sealing surfaces on the ends of the spacer (11) for scratches, discoloration, and cracks. Reject if found.
7. Inspect the area around the center hole on nozzle end of spacer (11) for evidence of wear and pounding by the nozzle body (28). Maximum allowable depth of wear or distortion due to pounding at this area is 0.003 inch (.0762 mm).



**INSPECTION (Continued)**

8. Assure that drilled passages in spacer (11) are not obstructed. Reject if any found obstruction cannot be cleared.
9. Inspect spring (24) for cracks and evidence of wear. Reject if found.
10. Inspect sleeve (23) for cracks, and for evidence of discoloration due to excessive heat. Reject if found.
11. Inspect seat (29), seat (25), shims (30), and spacer ring (31) for cracks, scratches, and evidence of pounding. Reject if found.
12. Inspect body (6) and retainer (2) for cracks, burrs, nicks, and raised metal. Inspect sealing surfaces for scratches and discoloration. Inspect threaded areas and tapped openings for stripped or damaged threads. Reject if found.
13. Inspect nut (10) and fuel inlet fitting (5) for nicks, burrs, raised metal surfaces, and cracks. Inspect threaded area inside nut (10) for stripped or damaged threads. Inspect the gasket area on end of nut (10) for deep scratches. Reject if found.

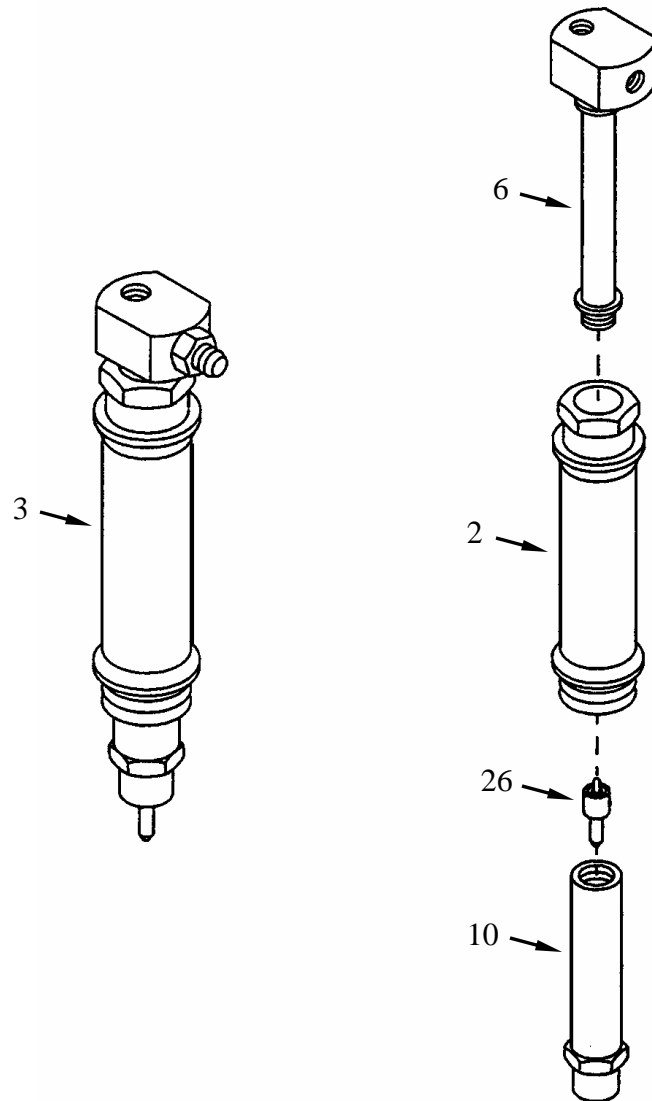


**REPAIR**

1. Replace nozzle tip (26) when body seat or valve seat is badly worn, pounded, pitted, or when nozzle body orifices are clogged.
2. Replace nozzle tip (26) when lapped sealing surfaces are nicked, scratched or cracked.

**NOTE**

**Repair of remaining nozzle assembly (3) components is limited to cleaning the threads on the body (6), retainer (2), and nut (10). See WP 0028 for standard repair procedures. It is not practical to attempt repairs to any remaining parts on fuel injection nozzle assembly (3). If inspection revealed damage to any of the remaining parts, replace the complete fuel injection nozzle assembly (3).**

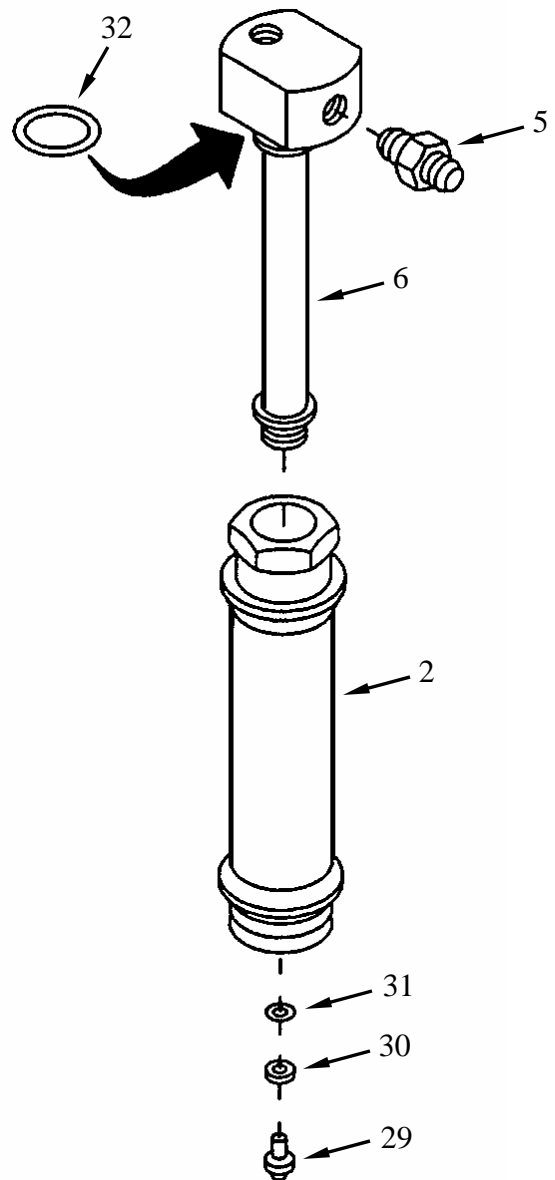


## ASSEMBLY

## NOTE

During assembly, the addition or removal of spring adjusting shims (to obtain the correct gauge pressure reading on the nozzle tester) may require various shim combinations available in the shim sets. The nozzle assembly must be completely assembled, torque tightened and checked again on the nozzle tester to assure proper spacer combination and pressure reading. This procedure may have to be repeated several times before achieving a satisfactory reading.

1. Install fuel inlet fitting (5) into body (6) and torque to 70-75 foot-pounds (95-102 N•m).
2. Clamp body (6) in soft-jawed vise.
3. Install a new O-ring (32) (item 151, WP 0175) on body (6).
4. Install retainer (2) on body (6).
5. Install spacer ring (31), shims (30), and fuel injection nozzle seat (29) on body (6).

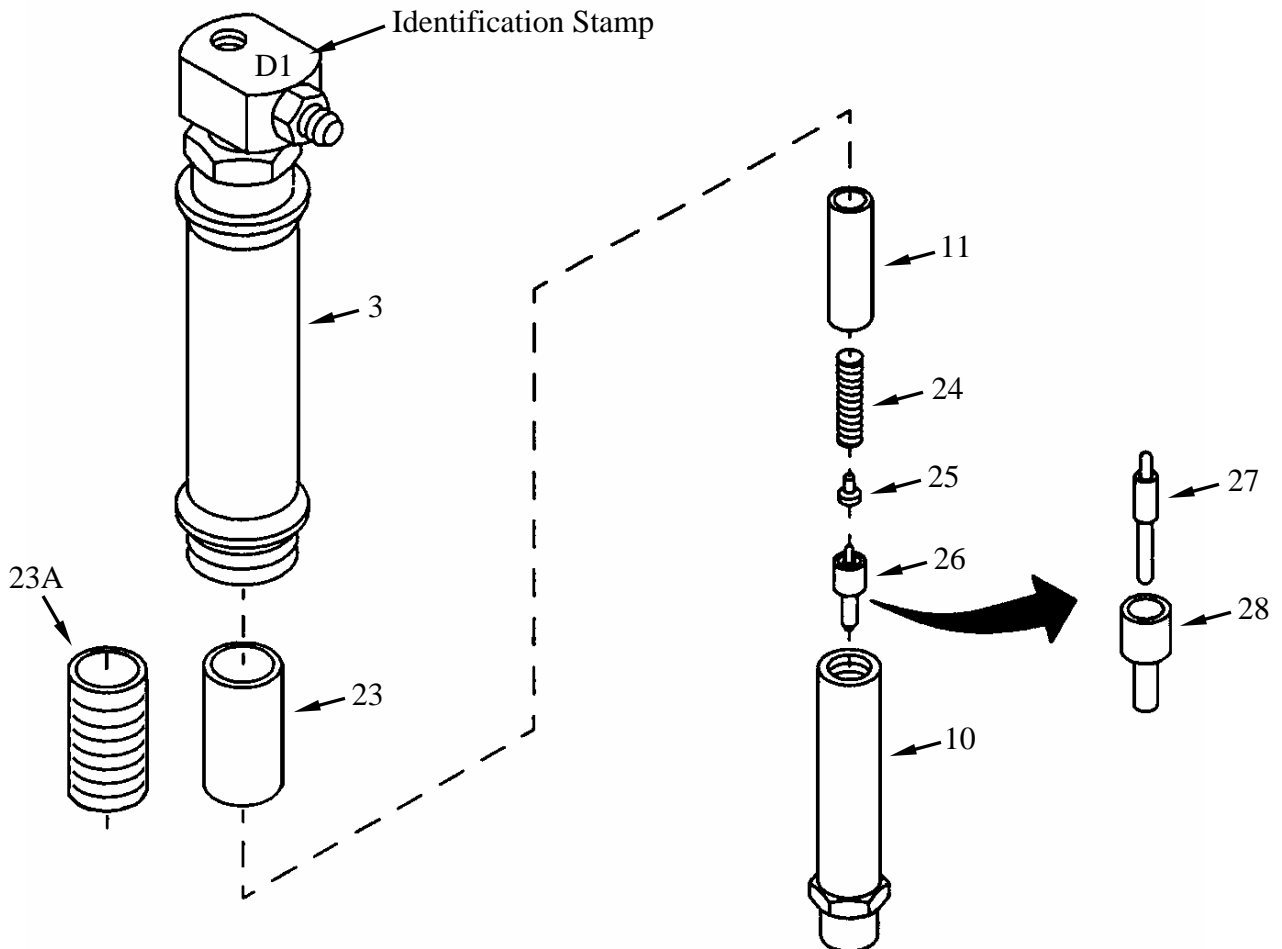


## ASSEMBLY (Continued)

## NOTE

**If you have the spring type retainer (23A) rather than the solid retainer (23), discard the spring type retainer and use the new solid type. Be sure to replace the soft gasket with a hard steel gasket and mark the body top "D1".**

5. Install nozzle valve (27) in nozzle body (28).
6. Install nozzle tip (26), spacer (11), seat (25), new spring (24) (item 168, WP 0175), and sleeve (23) in nut (10).
7. While holding nut (10) and associated parts together as an assembly, install nut (10) on nozzle and holder (3).
8. Torque nut (10) to 87-92 foot-pounds (118 -125 N•m), using torque wrench (item 127, WP 0176).
9. Test nozzle and holder (3) and adjust to achieve proper specifications. Refer to "TEST" in this work package.



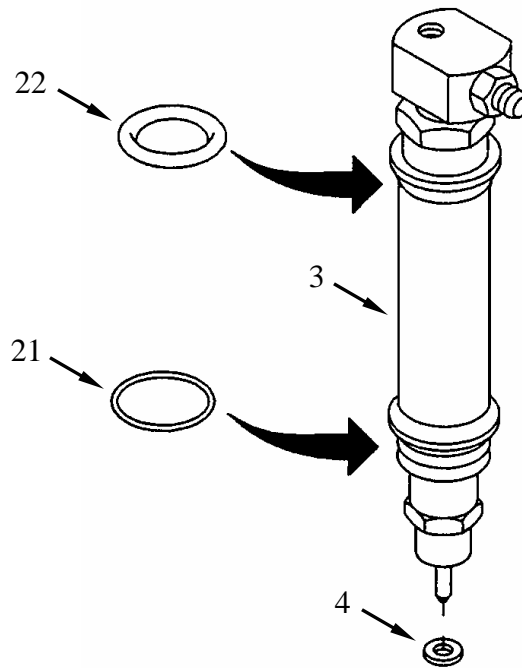
**INSTALLATION**

1. Install new O-rings (21) (item 178, WP 0175) and (22) (item 147, WP 0175) on fuel injection nozzle assembly (3).

**CAUTION**

**Whenever the nozzle assembly has been removed from the cylinder, a new gasket must be used when installing assembly in cylinder head. The flat steel gasket conforms to the specific contours of the nozzle cylinder head seat in each individual installation. Because of this, it is the only approved gasket for this function and must not be reused.**

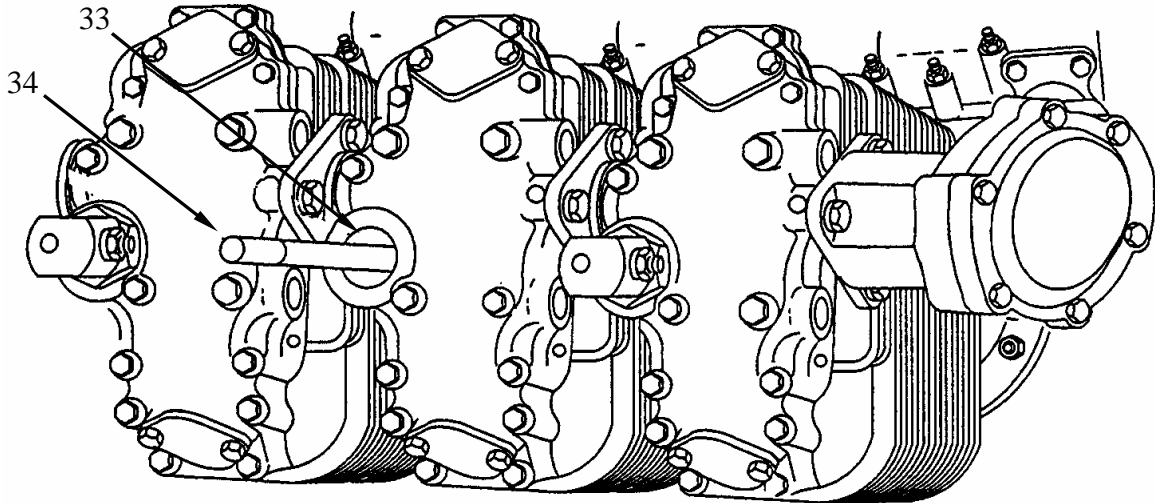
2. Apply a thin coating of Lubriplate (item 23, WP 0172) on new gasket (4) (item 272, WP 0175) to retain washer in position, and install on fuel injection nozzle assembly (3).



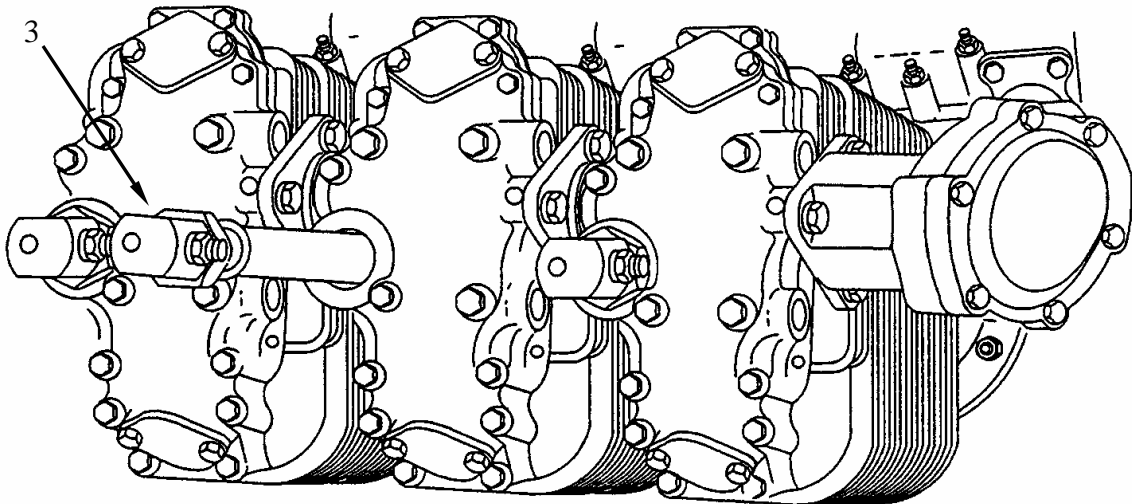


**INSTALLATION (Continued)**

3. Check to be sure cylinder (33) nozzle seat is free from excessive carbon deposits and that the seat face is free from surface roughness.
4. Remove carbon deposits and/or surface roughness using nozzle carbon cutter (34) (item 33, WP 0175).

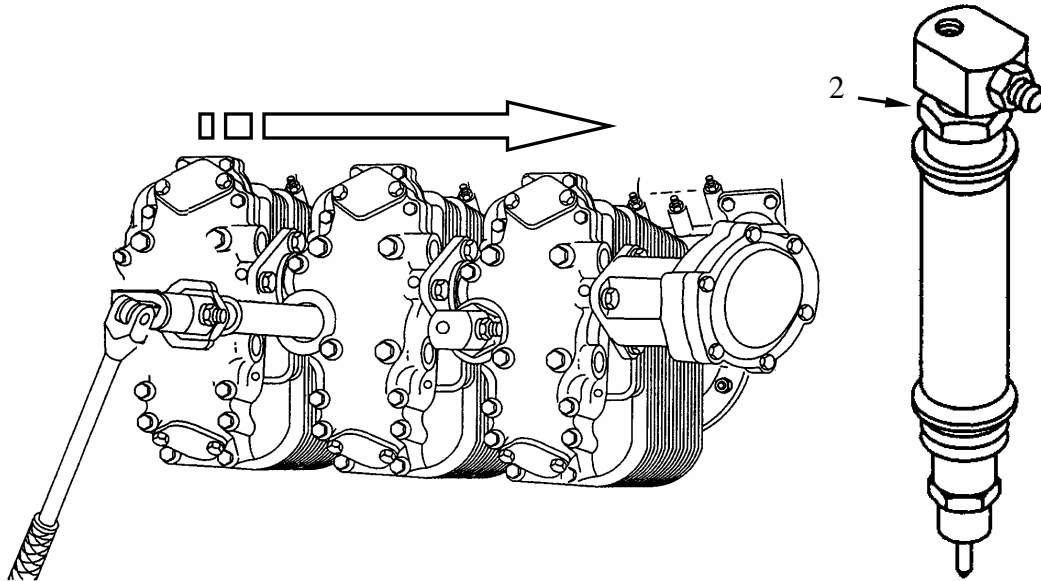


5. Apply a small amount of anti-seize compound (item 5, WP 0172) to threads of fuel injection nozzle assembly (3) and install in cylinder.



**INSTALLATION (Continued)**

6. Install fuel injection tube and torque tube nuts before tightening fuel injection nozzle retainer (2). Refer to WP 0113.
7. Tighten fuel injection nozzle retainer (2) to 106-110 foot pounds (144-149 N•m).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Crowfoot attachment (item 28, WP 0176)
- Drift punches (2) (item 91, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Splined wrench, (item 136, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Fabricated Items:**

- Engine flywheel turning tool (item 4, WP 0177)
- Engine front turning tool (item 3, WP 0177)
- Fuel coupling grease insert adapter (item 15, WP 0177)

**Mandatory Replacement Parts:**

- Gasket (2) (item 291, WP 0175)
- Lock washers (4) (item 90, WP 0175)
- O-ring (1) (item 65, WP 0175)

**Mandatory Replacement Parts (cont):**

- Pipe plug (2) (item 7, WP 0175)
- Safety pin (2) (item 1, WP 0175)
- Self-locking nut (4) (item 35, WP 0175)
- Spring (item 258.1, WP 0175)

**Expendable and Durable Items:**

- Lubricant (item 18, WP 0173)
- Lubriplate (item 23, WP 0173)

**Personnel Required:**

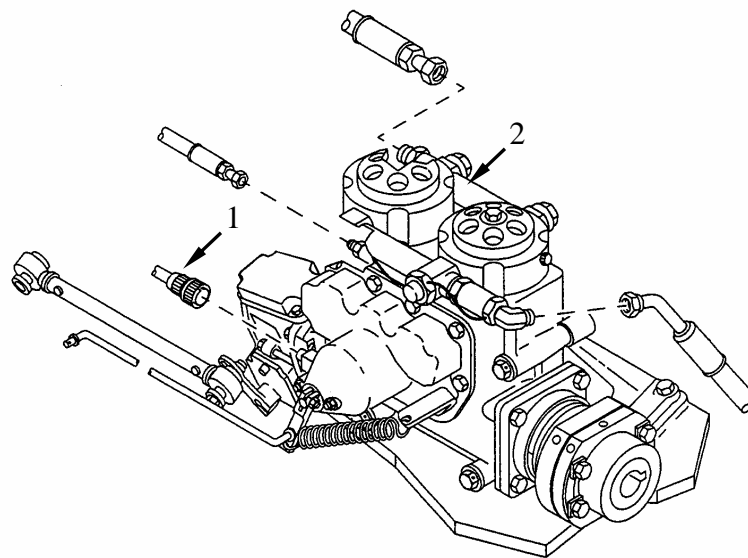
- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine level on flat surface
- Fuel injection tubes removed (WP 0079)

**REMOVAL**

1. Disconnect fuel shutoff electrical lead (1) from fuel injection pump (2).

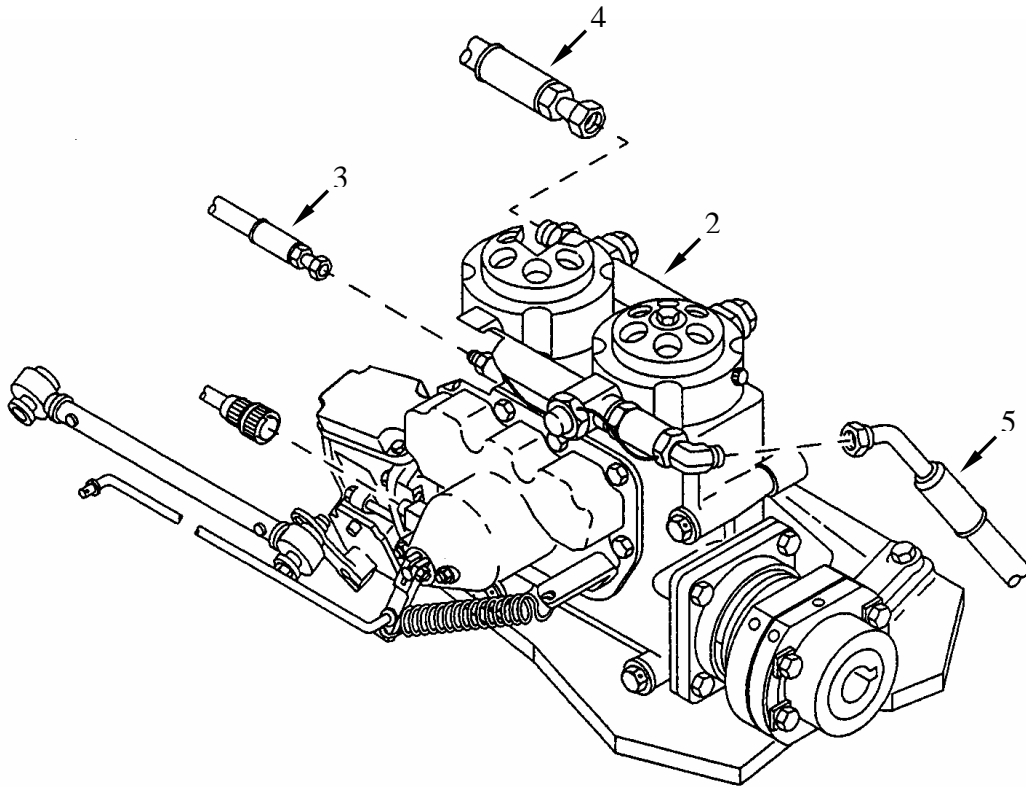


**REMOVAL (Continued)**

2. Disconnect oil inlet hose (3), fuel inlet hose (4), and fuel return hose (5) from fuel injection pump (2).

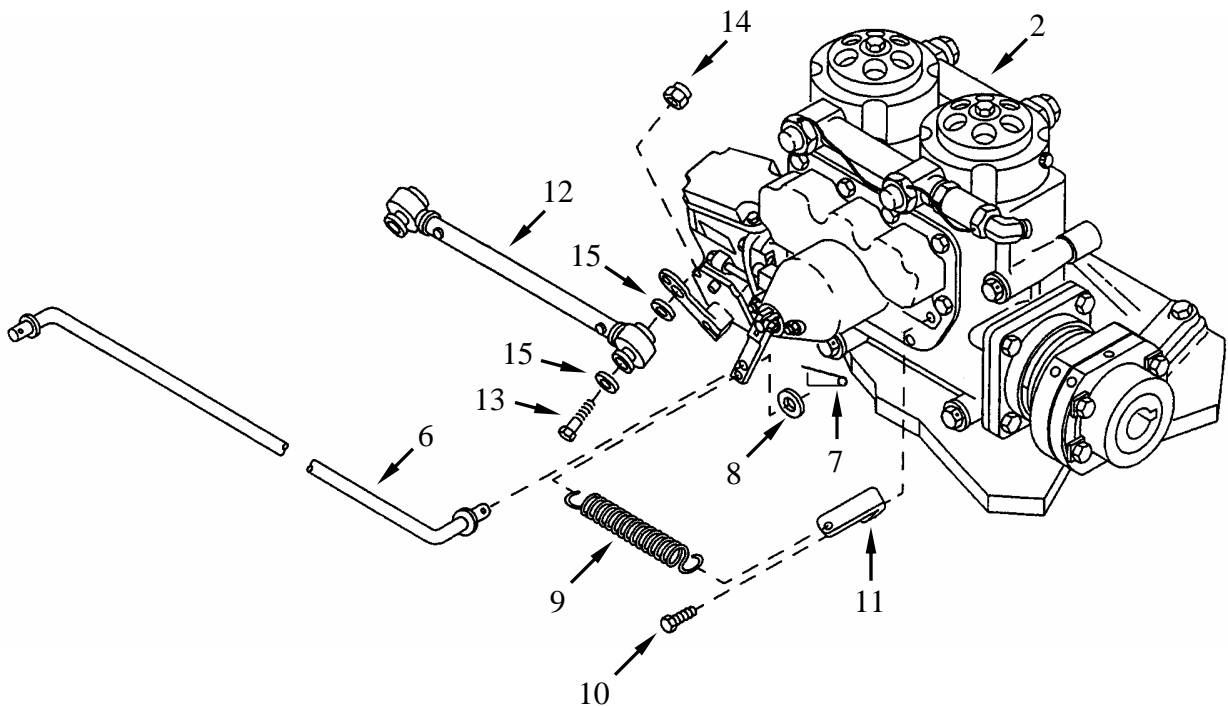
**NOTE**

Fuel return hose (5) pictured is for 2CA and 2DA engine configurations. Engine model 2DR has a straight end on the fuel return hose and a 90-degree fitting at the injection pump (see WP 0080, Fuel Injection Nozzle Return Hoses).



**REMOVAL (Continued)**

3. Disconnect manual fuel shutoff rod (6).
  - a. Remove safety retaining pin (7) and flat washer (8).
  - b. Remove manual fuel shutoff rod (6) from fuel injection pump (2).
4. Disconnect spring (9).
  - a. Remove two screws (10), angle bracket (11), and spring (9) as an assembly. Discard spring.
5. Disconnect throttle/governor control rod assembly (12).
  - a. Remove screw (13), self-locking nut (14), and two spacers (15), to disconnect governor control rod assembly (12). Discard self-locking nut.

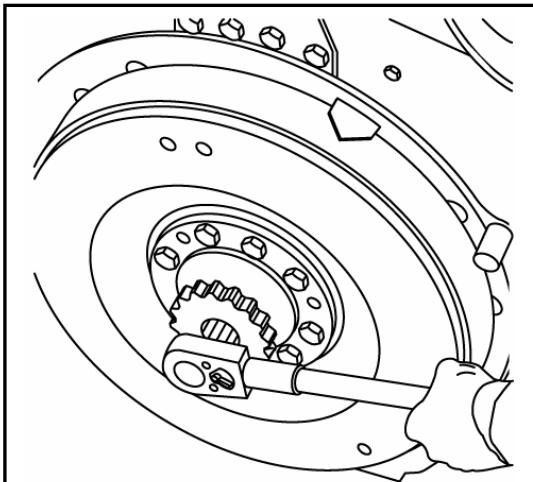


REMOVAL (Continued)

NOTE

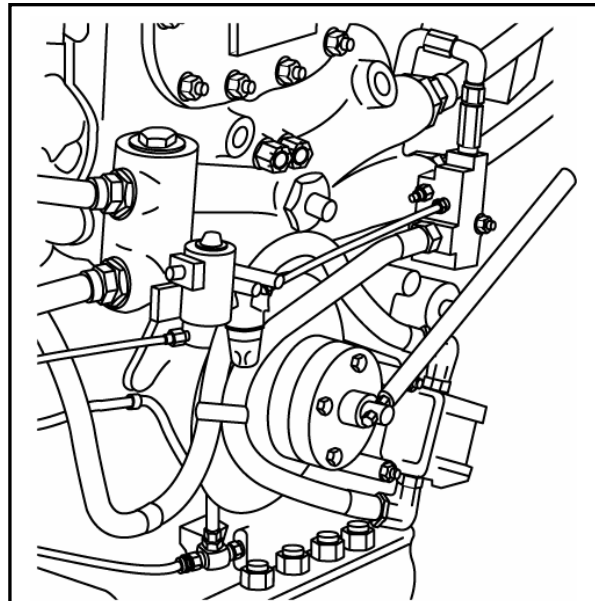
Model 2DR crankshaft may be turned from the flywheel or from the power takeoff coupling.

Flywheels on models 2CA and 2DA are the same. Flywheels on 2DRs are different and require different turning tools.



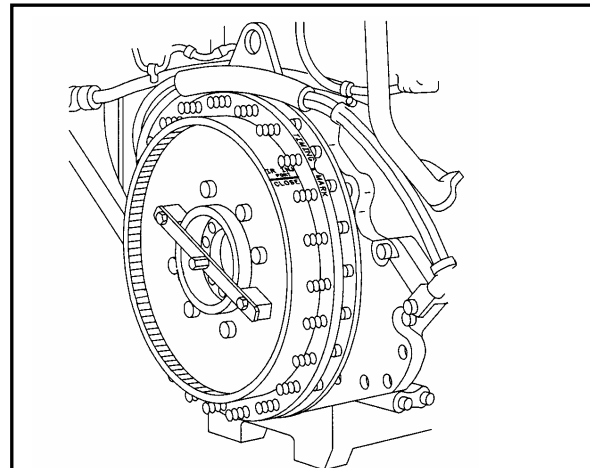
Model 2CA and 2DA  
Flywheel Turning Tool:

Transmission spur gear should already be in place on flywheel, if not place in position and secure with two bolts. Use splined turning tool (splined wrench, item 136, WP 0176) to turn engine crankshaft.



Model 2DR Front Turning Tool:

Position improvised engine turning tool (item 3, WP 0177) on power takeoff coupling and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.



Model 2DR Flywheel Turning Tool:

Position improvised engine turning tool (item 4, WP 0177) on flywheel, and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.

**REMOVAL (Continued)**

6. Turn flywheel using appropriate turning tool until fuel injection pump coupling sleeves (16 and 17) are aligned in position shown using timing marks (A).
7. Remove timing plug (18) and look for white tooth in hole. If tooth is not visible, rotate engine with turning tool another 360 degrees until tooth is visible.

**CAUTION**

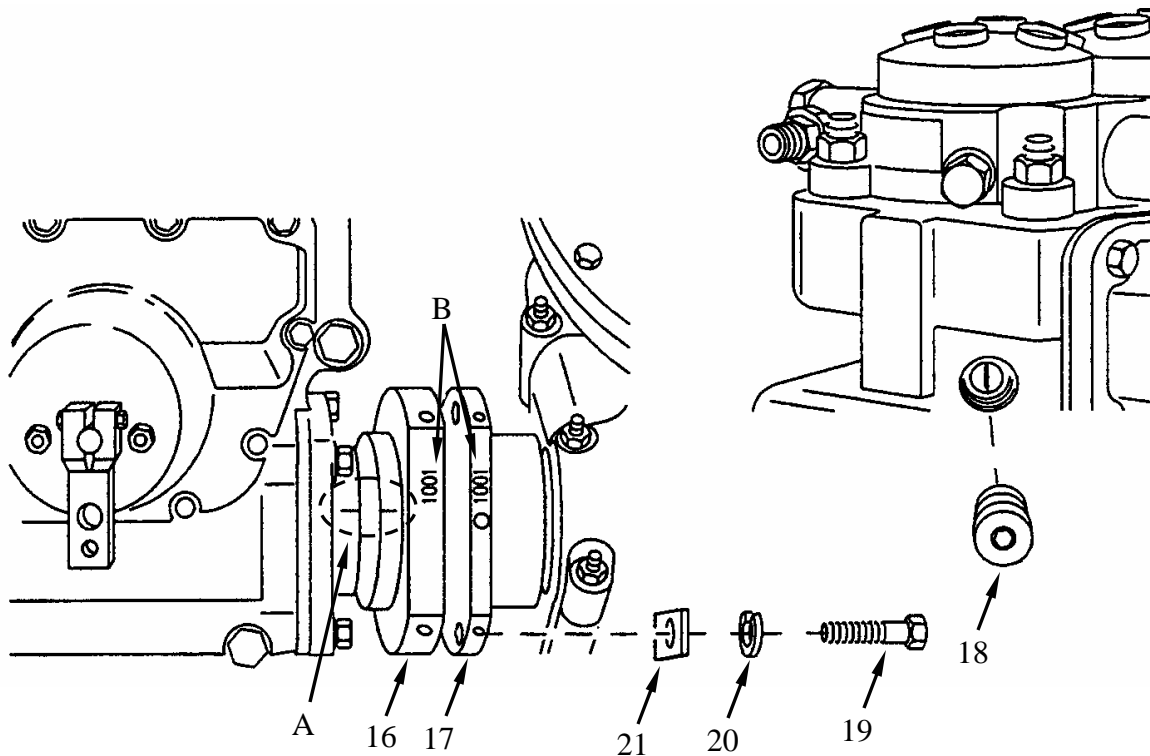
**Fuel injection pump coupling sleeves and hubs must be identified with identical marks to prevent non-mating of parts. The sleeves and hubs are matched for each assembly and must not be interchanged between assemblies.**

8. Stamp identification marks (B) on both coupling sleeves (16 and 17).

**NOTE**

**Rotate engine enough to remove inaccessible bolt from coupling. Remove bolt from coupling then rotate engine back to previous location (with tooth visible in inspection hole and timing marks aligned).**

9. Remove four bolts (19), four lock washers (20), and four spacers (21). Discard lock washers.
10. Separate coupling sleeves (16 and 17).

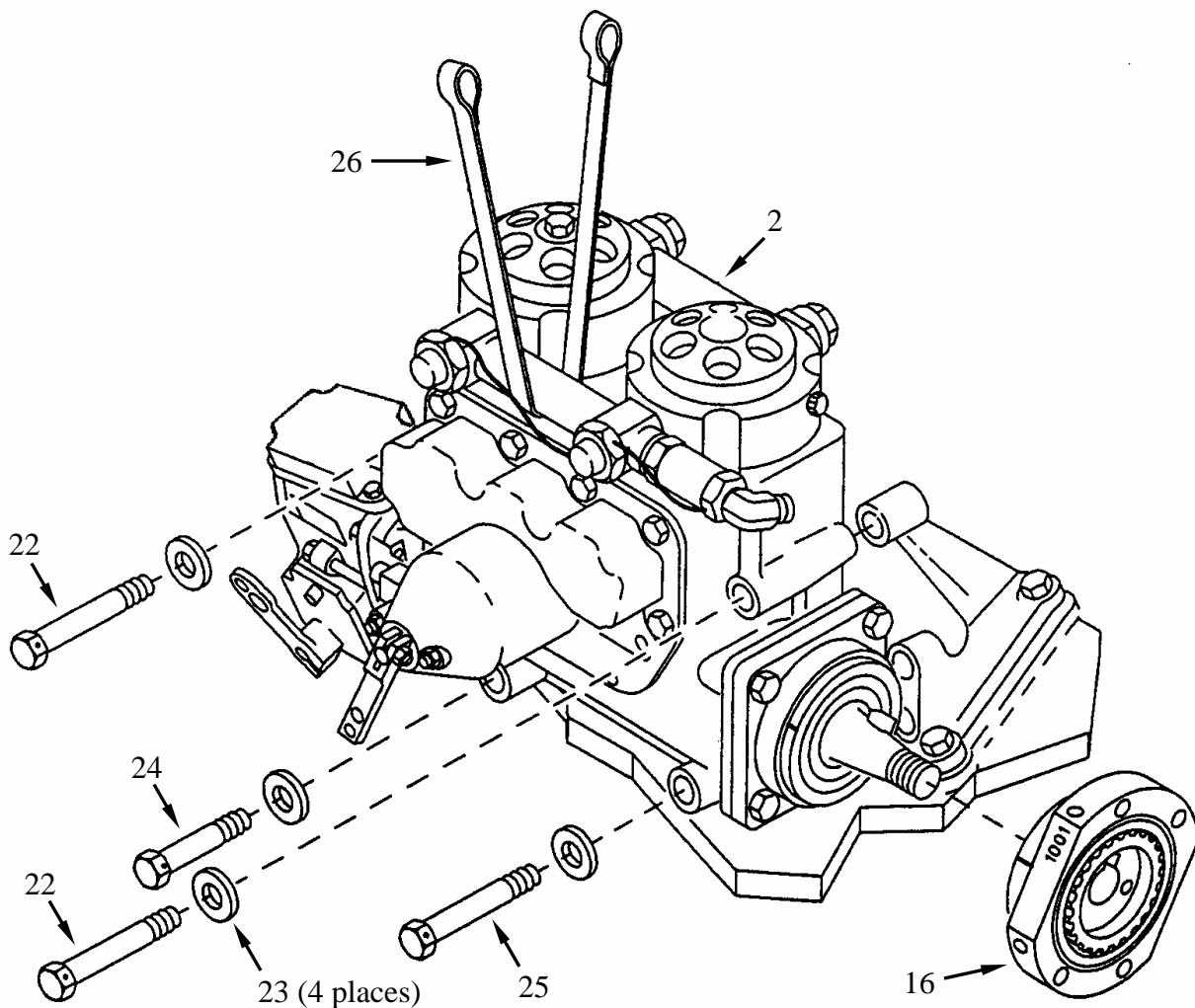


## REMOVAL (Continued)

## NOTE

**Injection pump mounting screws are of different length. In addition, the lower rear mounting screw cannot be removed from pump until pump is removed.**

11. Remove two mounting screws (22) with recessed washers (23) from fuel injection pump (2).
12. Remove one mounting screw (24) with recessed washer (23).
13. Loosen one mounting screw (25) until threads are free.
14. Attach sling (26) as shown and remove fuel injection pump (2) from mounting bracket.
15. Remove sling (26), mounting screw (25) with recessed washer (23) from fuel injection pump (2).
16. Remove coupling sleeve (16) from fuel injection pump (2). Refer to WP 0116.





**REMOVAL (Continued)**

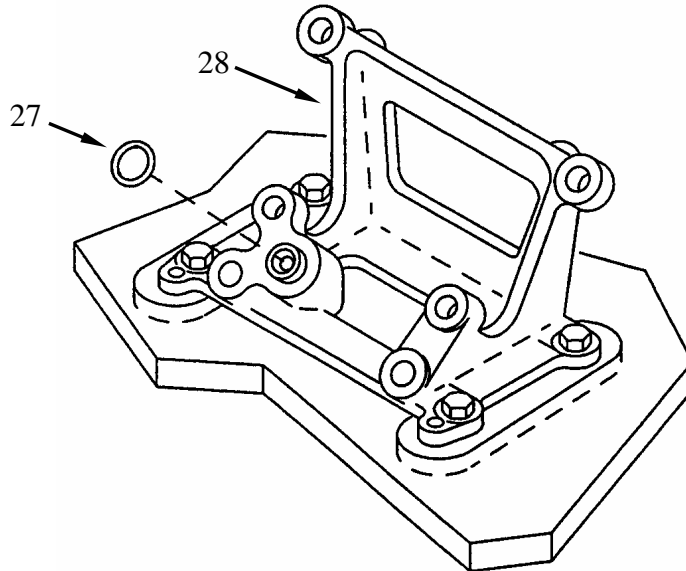
17. Remove and discard O-ring (27) from mounting bracket (28).

**REPAIR**

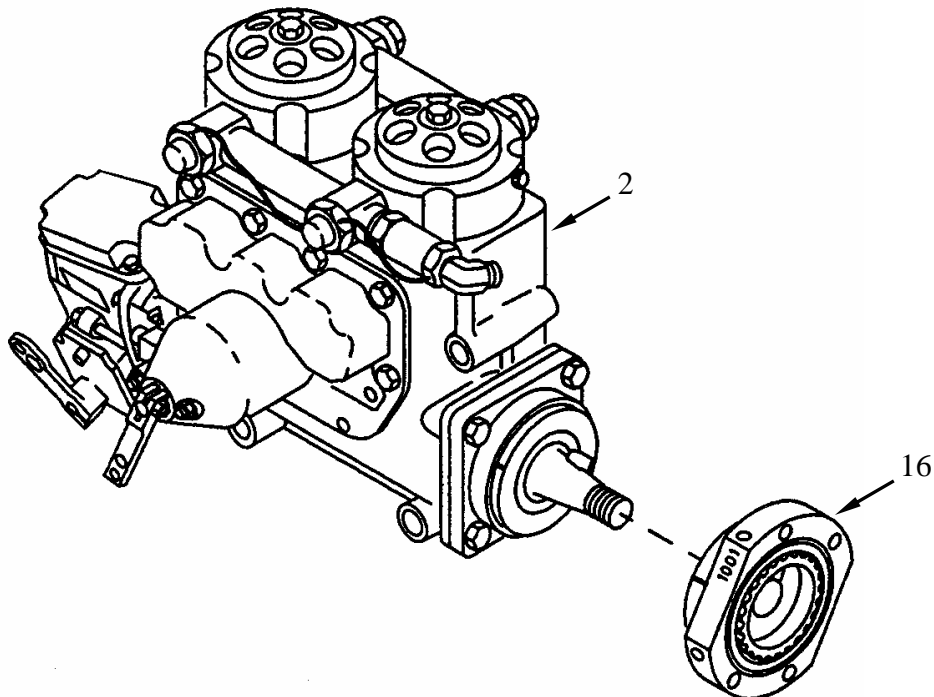
Refer to TM 9-2910-212-34&P for repair of fuel injection pump assembly.

**INSTALLATION**

1. Install new O-ring (27) (item 65, WP 0175) onto mounting bracket (28).

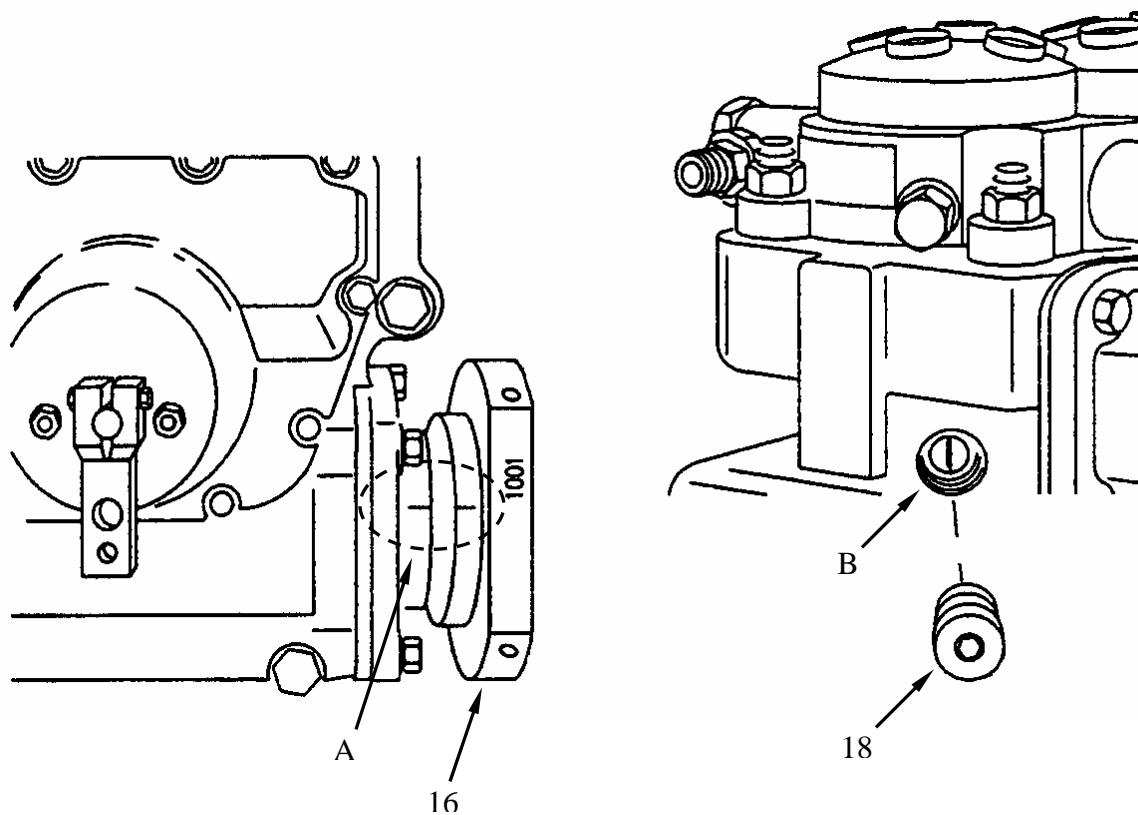


2. Install coupling sleeve (16) on fuel injection pump (2). Refer to WP 0116.



**INSTALLATION (Continued)**

3. Orient injection pump (2) timing marks.
  - a. Turn coupling sleeve (16) until timing marks (A) are in alignment.
  - b. Marked gear tooth (B) should be visible in the pump timing hole. If it is not visible, turn coupling sleeve 360 degrees until marked gear tooth (B) is visible and external timing marks (A) are aligned.
  - c. Install timing plug (18).

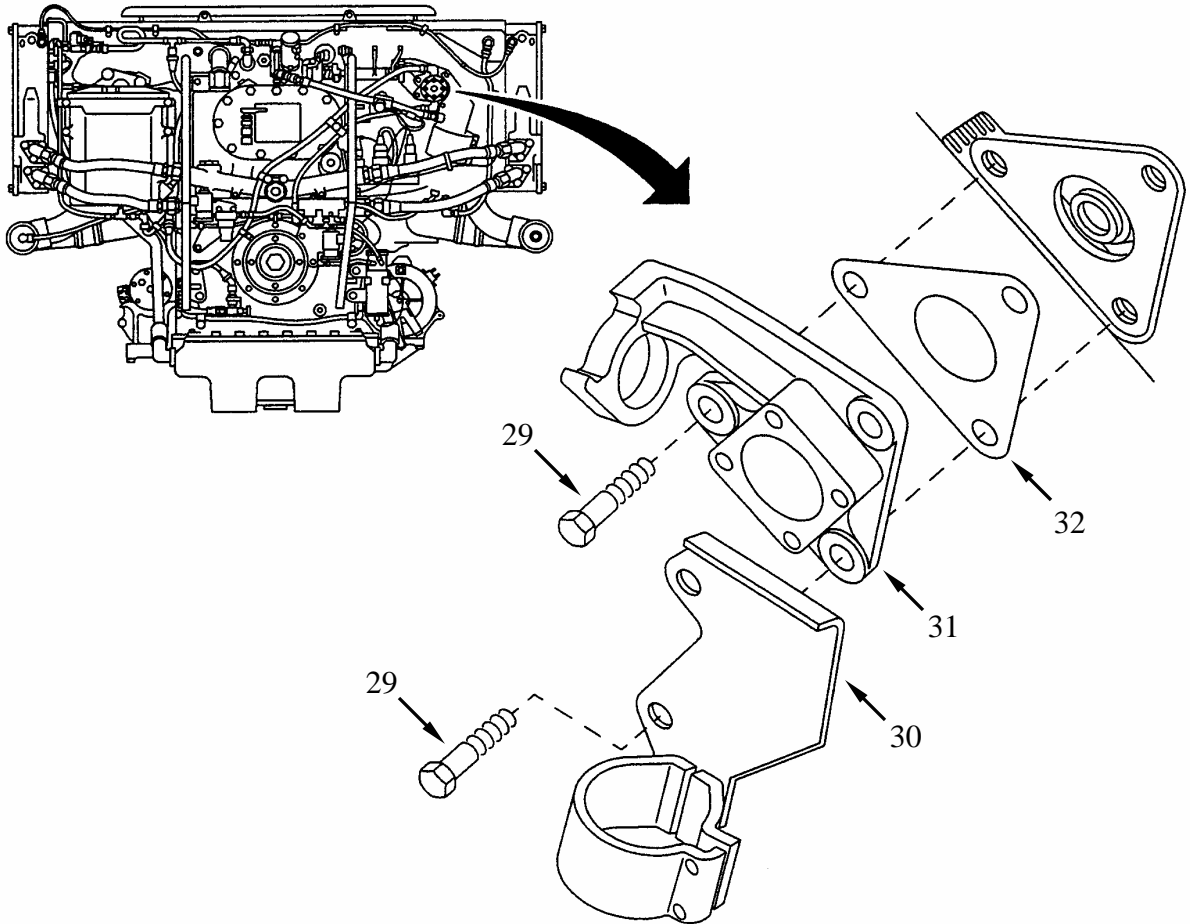


## INSTALLATION (Continued)

**CAUTION**

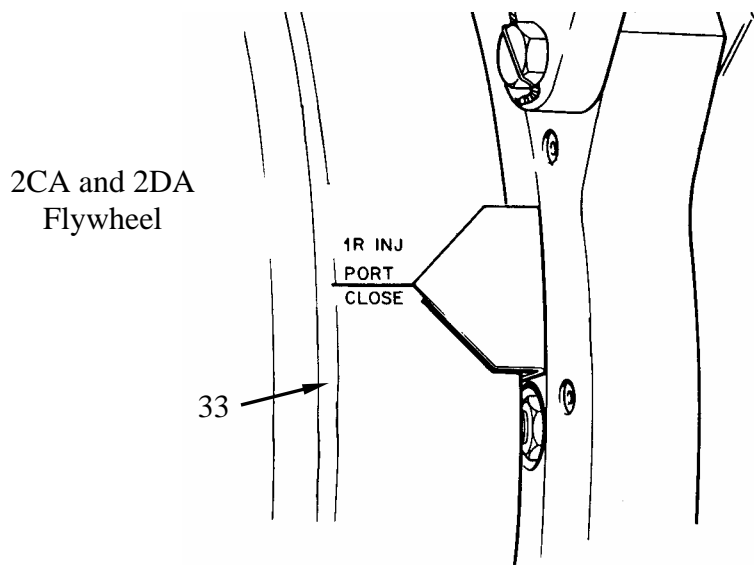
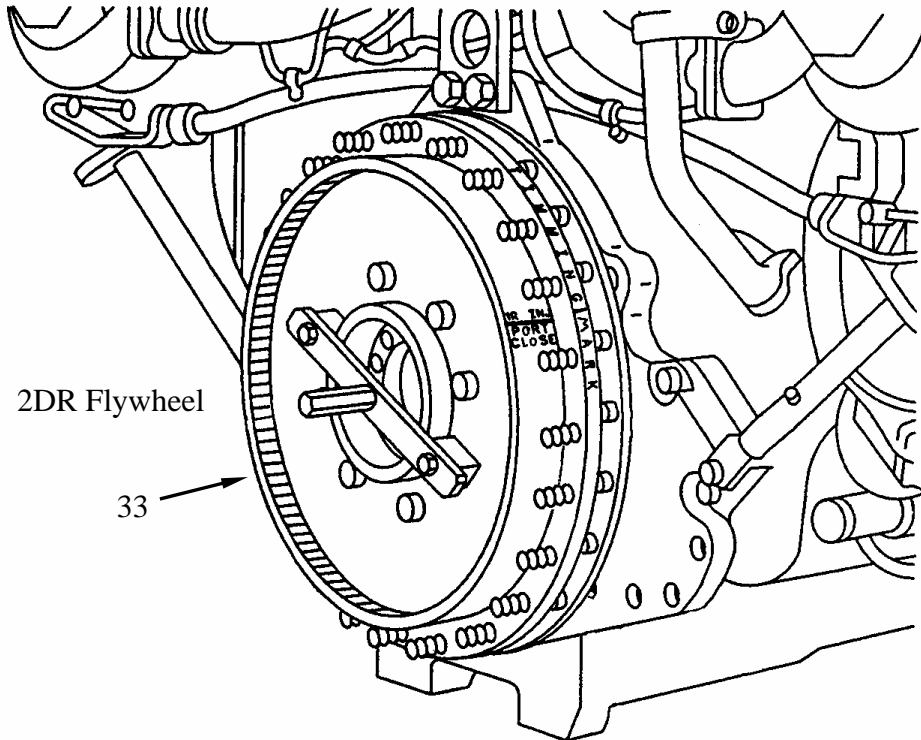
Before the fuel injection pump can be installed on the engine, the engine valve timing must be correct (refer to WP 0035). In addition, number one right bank cylinder must be on the compression stroke.

4. Assure that number one, right bank cylinder, is on the compression stroke.
  - a. Remove three screws (29) to remove primary fuel filter bracket (30), adapter assembly (31), and gasket (32). Discard gasket.



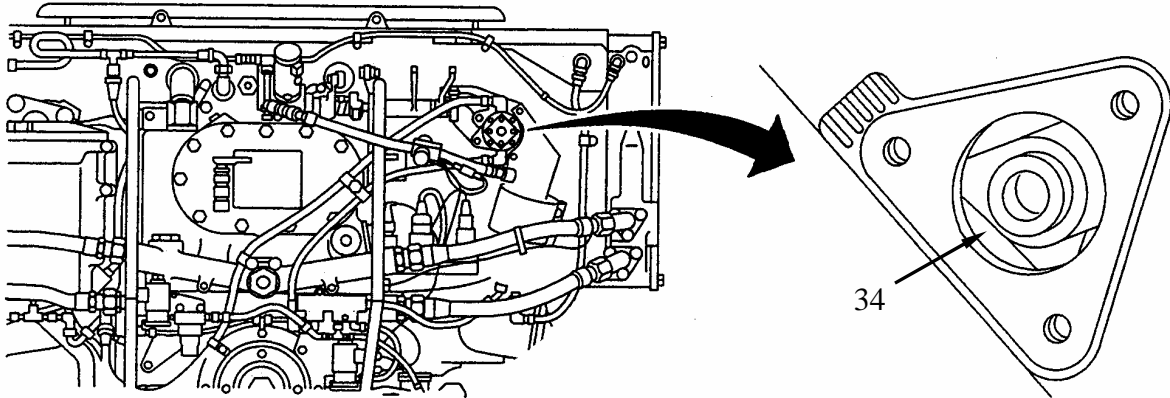
**INSTALLATION (Continued)**

4. Assure that number one, right bank cylinder, is on the compression stroke (Continued).
  - b. Turn flywheel (33) until "1R INJ PORT CLOSE" mark is aligned with timing mark.

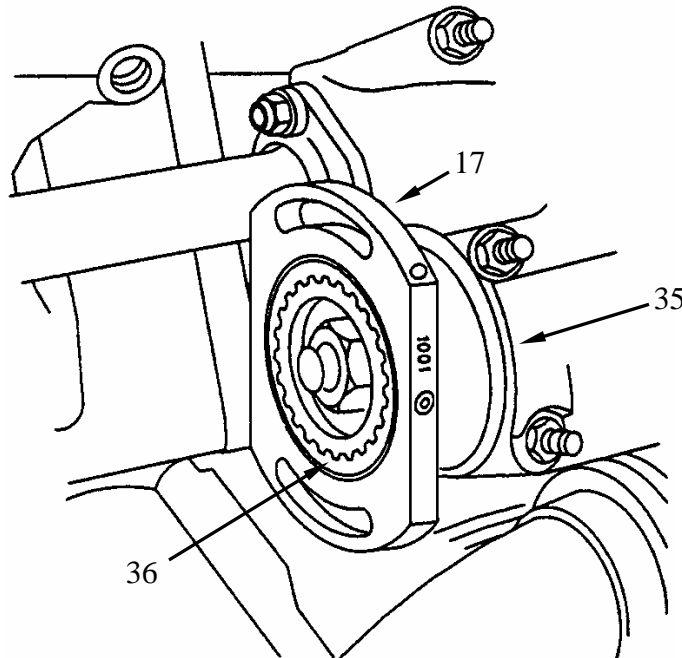


**INSTALLATION (Continued)**

4. Assure that number one, right bank cylinder, is on the compression stroke (Continued).
  - c. Check to see that camshaft (34) lobes on cylinder 1R are pointed towards crankshaft.
  - d. If camshaft (34) lobes do not point towards crankshaft, rotate flywheel 360 degrees until "1R INJ PORT CLOSE" mark once again is aligned with timing mark and camshaft lobes on cylinder 1R do point towards crankshaft.



5. Push coupling sleeve (17) toward rear fan/accessory drive housing (35) until sleeve clears hub (36).



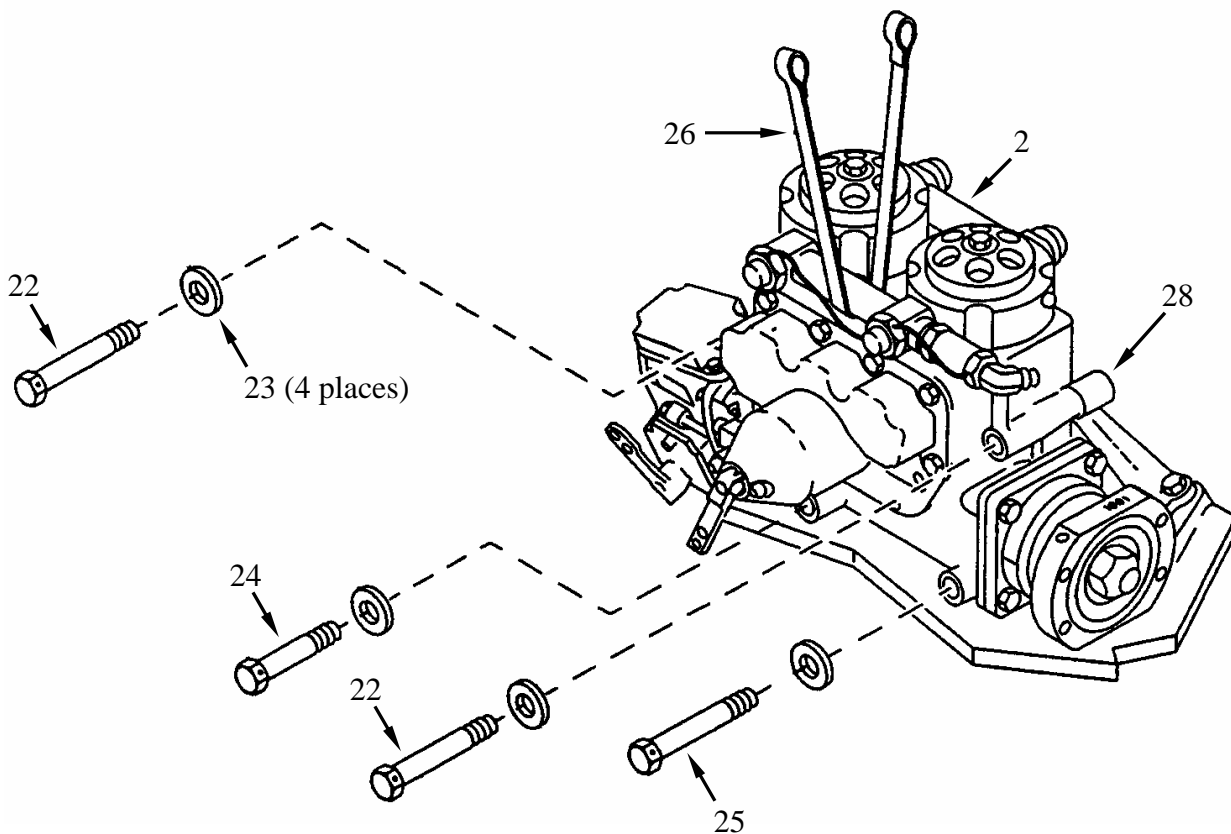
**INSTALLATION (Continued)**

6. Apply a small amount of Lubriplate (item 23, WP 0173) to mounting screw (25) and recessed washer (23).

**NOTE**

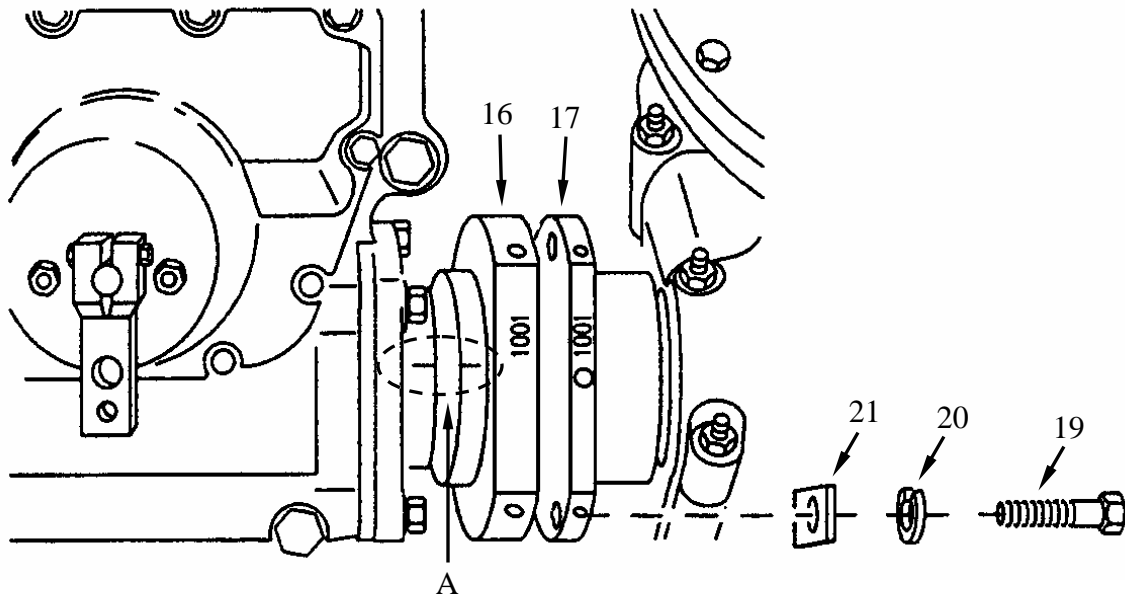
**Lower rear bolt (25) cannot be installed after fuel injection pump is in place.**

7. Install mounting screw (25) and recessed washer (23) in lower rear hole of fuel injection pump (2).
8. Install sling (26) on fuel injection pump (2) and finger tighten screw (25) as you install pump in position on mounting bracket (28).
9. Apply a small amount of Lubriplate (item 23, WP 0173) to mounting screws (22, 24), and three recessed washers (23).
10. Secure fuel injection pump (2) with four mounting screws (22, 24, 25) with recessed washers (23).
11. Tighten four mounting screws (22, 24, 25) to 50-52 foot-pounds (68-71 N•m), using torque wrench (item 127, WP 0176).



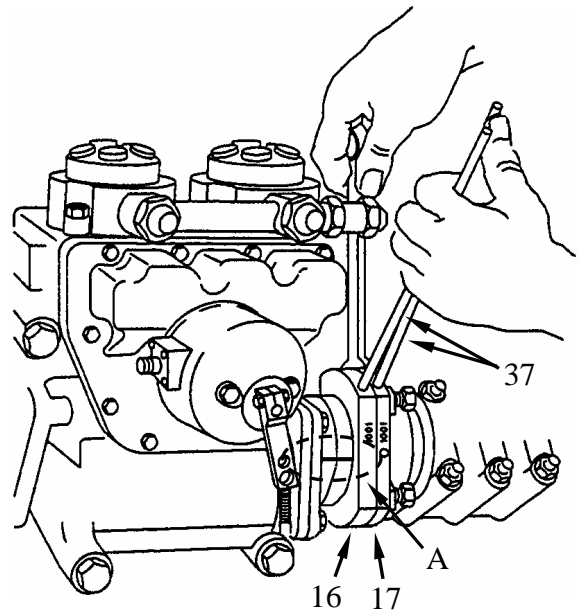
**INSTALLATION (Continued)**

12. Position fuel injection pump coupling sleeves (16 and 17) as shown, making sure timing marks (A) remain in alignment. Drive sleeve (17) may be pushed back to disengage from spline, rotated, then pulled forward to re-engage.
13. Apply a small amount of Lubriplate (item 23, WP 0173) to the threads of four screws (19).
14. Install four screws (19) with new lock washers (20) (item 90, WP 0175), spacers (21) to couple sleeves (16, 17).



15. Remove backlash from drive shaft coupling (17).

- a. Position two 5/16 drift punches (37) in sleeves (16, 17) alignment holes. Hold coupling sleeve (16) stationary with timing marks (A) aligned, then rotate coupling sleeve (17) counterclockwise, as viewed from damper end of engine, to remove backlash from pump drive shaft.



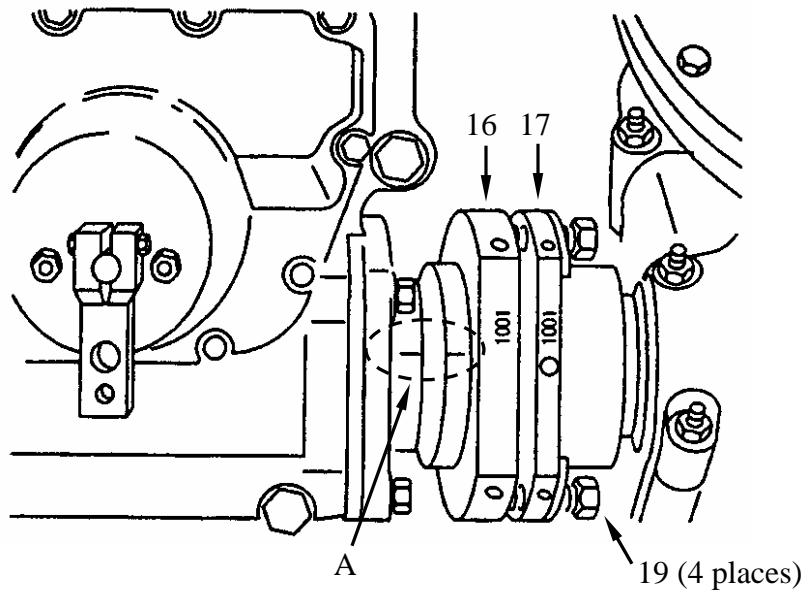
## INSTALLATION (Continued)

**CAUTION**

When flat sides of coupling sleeves (16 and 17) do not align (with backlash removed), the coupling sleeves must be separated and the drive sleeve (17) reset. Drive sleeve (17) may be pushed back to disengage from spline, rotated, then pulled forward to re-engage.

16. Fasten coupling halves (16, 17).

- a. With backlash removed, timing marks (A) aligned and the flat sides of coupling sleeves (16 and 17) aligned, tighten four bolts (19) to 23-27 foot-pounds (31-37 N•m).





**INSTALLATION (Continued)**

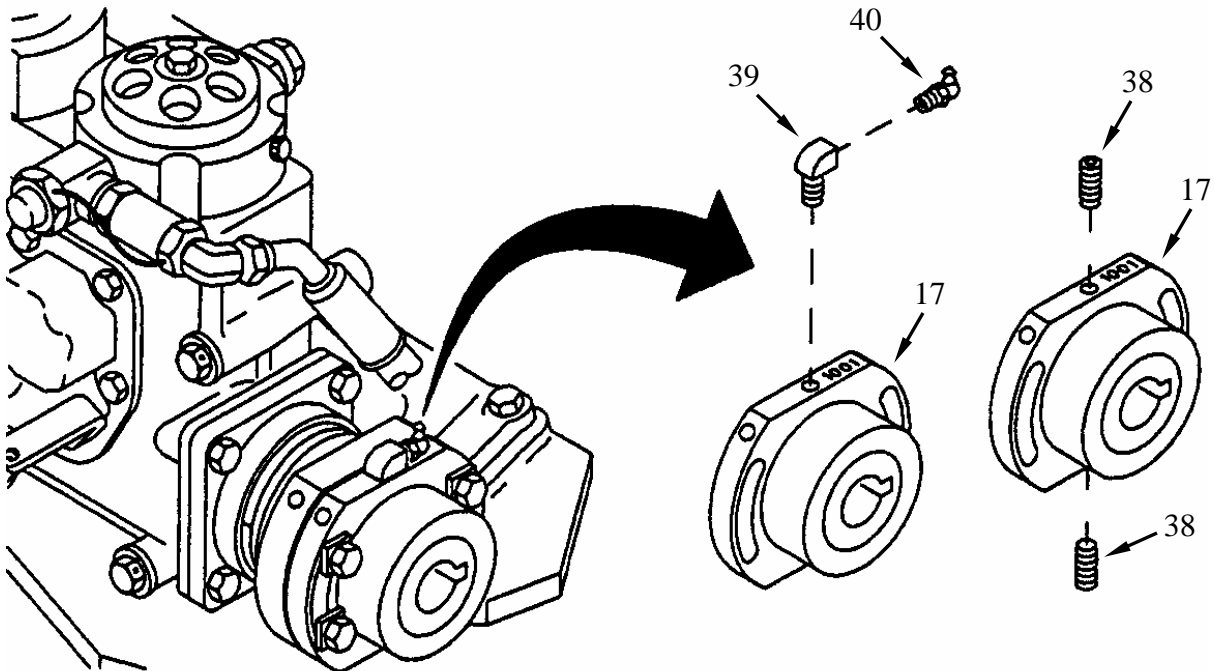
17. Lubricate assembled coupling sleeves (16, 17).

- a. Remove and discard two pipe plugs (38) from sleeve (17).
- b. Install adapter (39) (item 15, WP 0177) and lubrication fitting (40) into sleeve (17).

**CAUTION**

**Overfilling of coupling cavity will result in failure of coupling seals.  
Use of improper grease will result in premature failure of coupling.  
Use only Mobile/Exxon PolyRex EM (PN 98GN42).**

- c. Lubricate coupling through lubrication fitting (40) with 33 to 35 cc's of grease (item 9, WP 0173). Discontinue adding lubrication as soon as it shows in the hole on opposite side of coupling.
- d. Remove adapter (39) and lubrication fitting (40) and install two new pipe plugs (38) (item 7, WP 0175).



**INSTALLATION (Continued)**

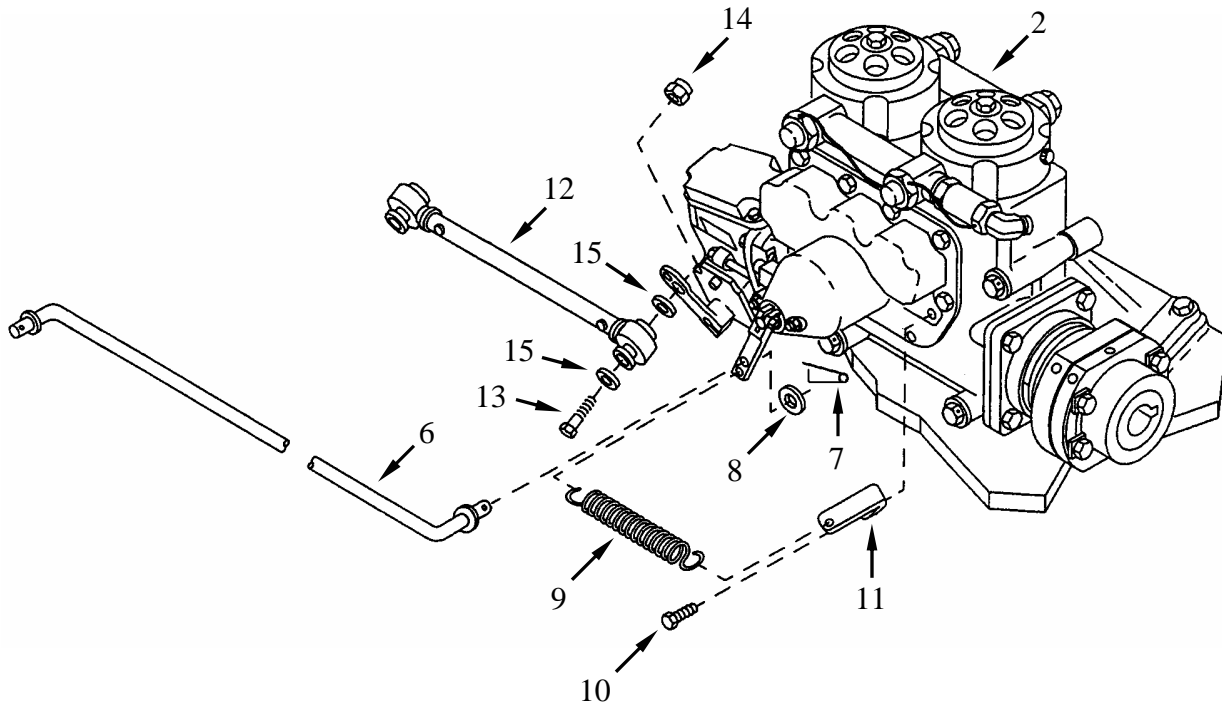
18. Install governor control rod assembly (12).

- a. Secure using screw (13) with two spacers (15) and new self-locking nut (14) (item 35, WP 0175).

19. Install spring (9).

- a. Install new spring (9) (item 258.1, WP 0175) onto angle bracket (11).
- b. Install angle bracket (11) with spring (9) as an assembly onto fuel injection pump (2).
- c. Secure angle bracket (11) to fuel injection pump (2) with two screws (10).

20. Install manual fuel shutoff rod (6) using new safety retaining pin (7) (item 1, WP 0175) and flat washer (8).



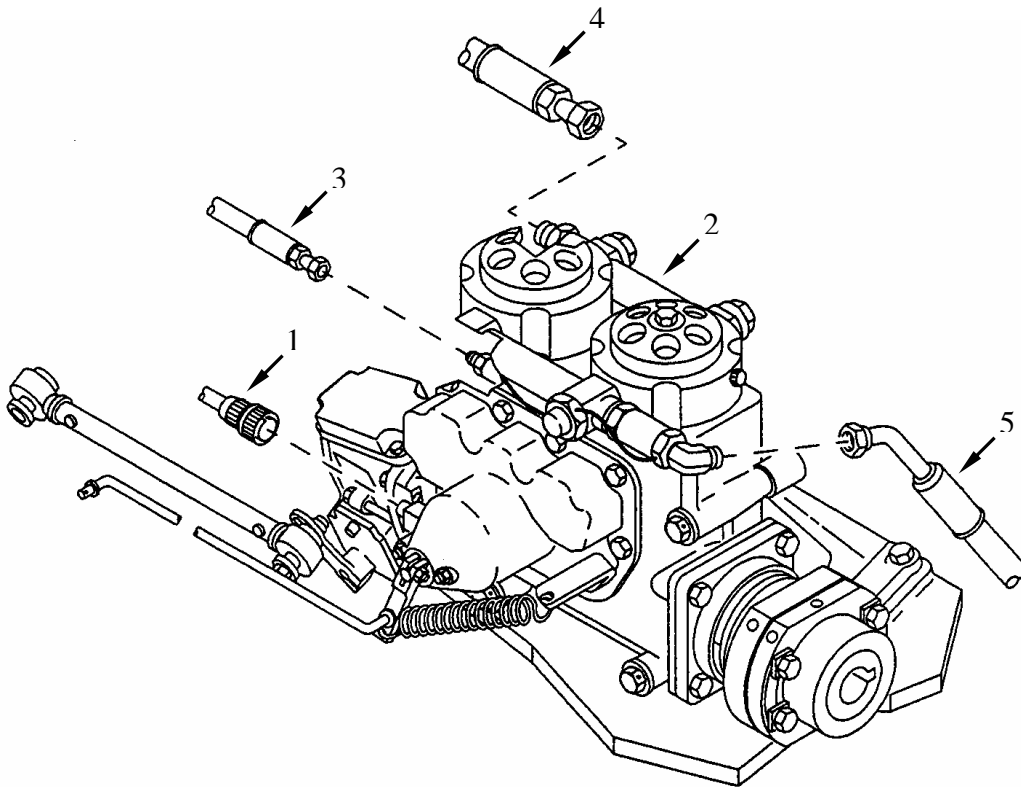
## INSTALLATION (Continued)

21. Install oil inlet hose (3), fuel inlet hose (4), and fuel return hose (5) to fuel injection pump (2).

## NOTE

**Fuel return hose (5) pictured is for 2CA and 2DA engine configurations. Engine model 2DR has a straight end on the fuel return hose and a 90-degree fitting at the injection pump (see WP 0080, Fuel Injection Nozzle Return Hoses).**

22. Connect fuel shutoff electrical lead (1) to fuel injection pump (2).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Dial indicator (item 65, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Machinist's vise (item 132, WP 0176)
- Torque wrench, 0-175 (item 127, WP 0176)

**Fabricated Items:**

- Coupling puller (item 6, WP 0177)

**Mandatory Replacement Parts:**

- Lock washer (2) (item 97, WP 0175)
- O-ring (1) (item 71, WP 0175)
- O-ring (2) (item 169, WP 0175)
- Pipe plug (2) (item 7, WP 0175)
- Woodruff key (2) (item 359, WP 0175)

**Expendable Materials:**

- Grease (item 24, WP 0173)
- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine level on flat surface
- Fuel injection pump assembly removed (WP 0115)

**REMOVAL**

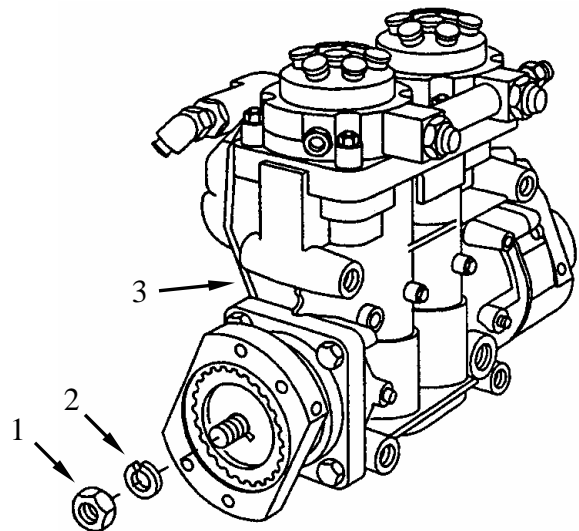
**CAUTION**

**Make sure coupling sleeves and hubs are stamped with identification marks to prevent non-mating of parts. The sleeves and hubs are matched for each assembly and must not be interchanged between assemblies.**

**NOTE**

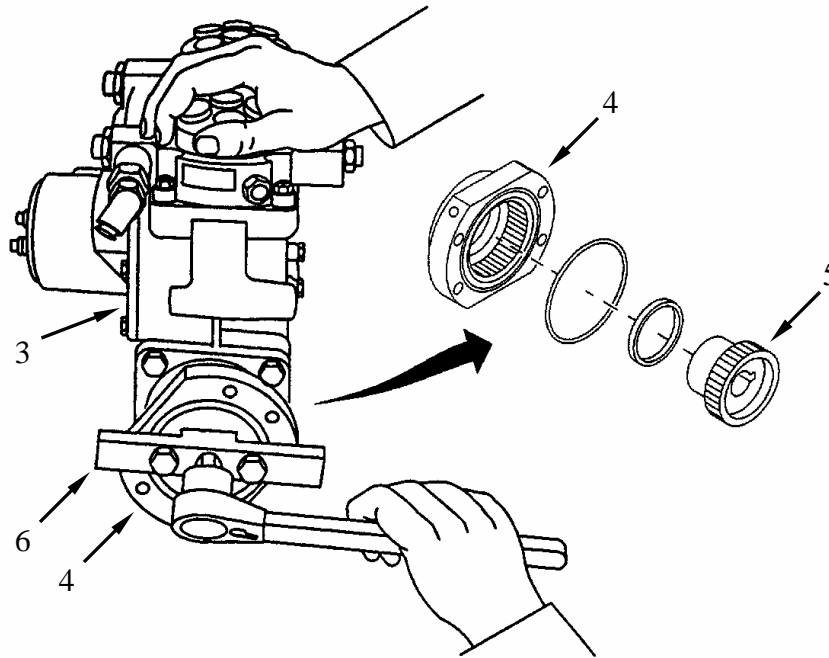
**Coupling sleeve must be in a rigid position to remove nut.**

1. Remove plain nut (1) and lock washer (2) from fuel injection pump (3).

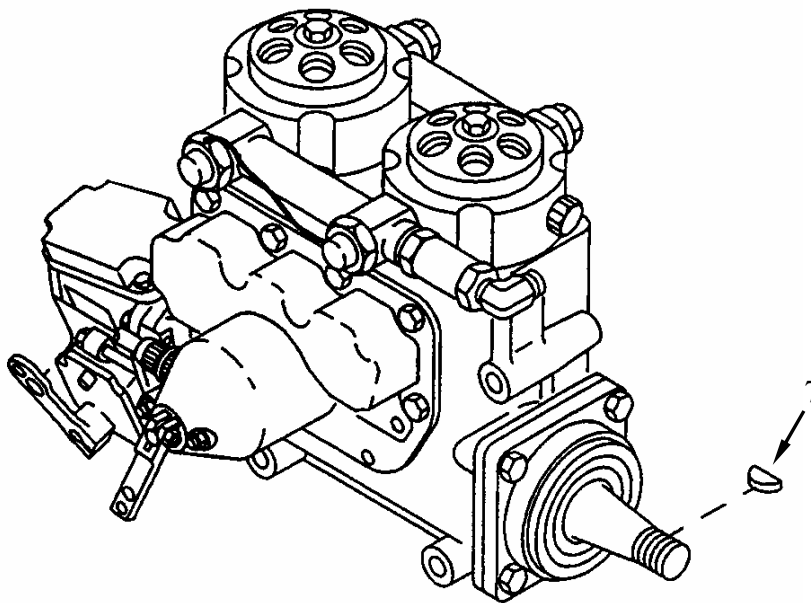


**REMOVAL (Continued)**

2. Remove sleeve (4) and hub (5) from fuel injection pump (3), using coupling puller (6) (item 6, WP 0177).

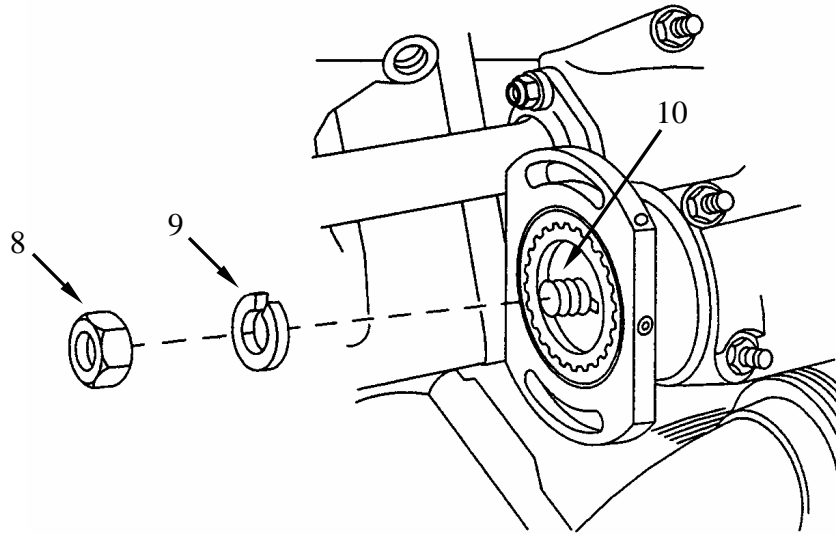


3. Remove and discard woodruff key (7).

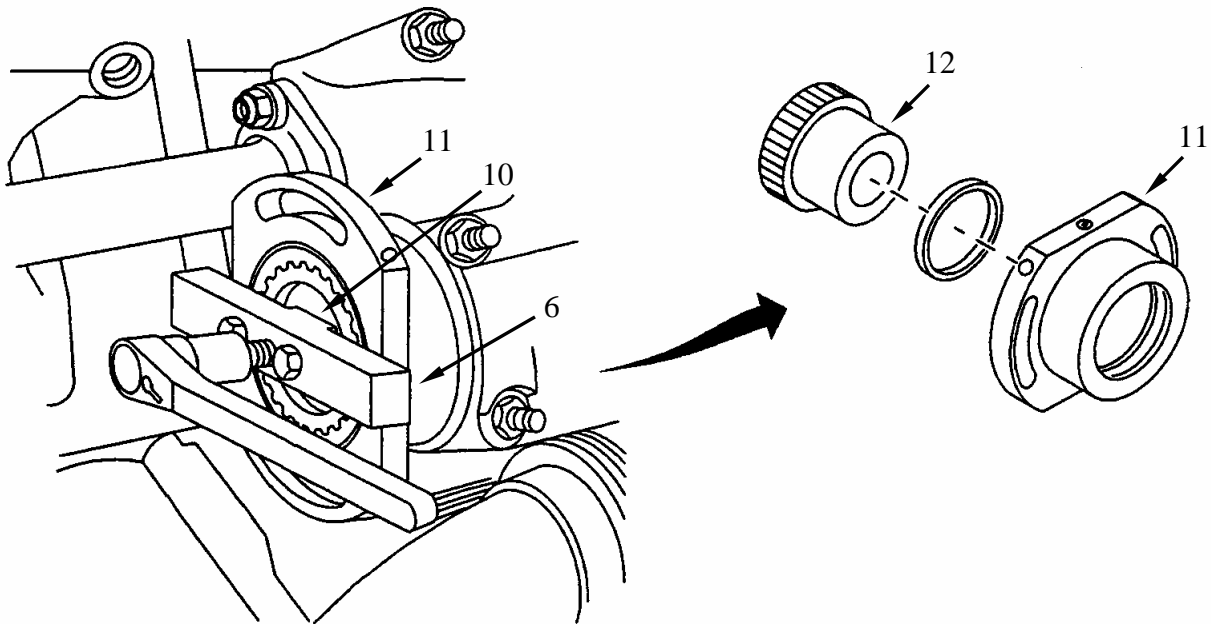


**REMOVAL (Continued)**

4. Remove plain nut (8) and lock washer (9) from accessory drive housing spur gear shaft (10).

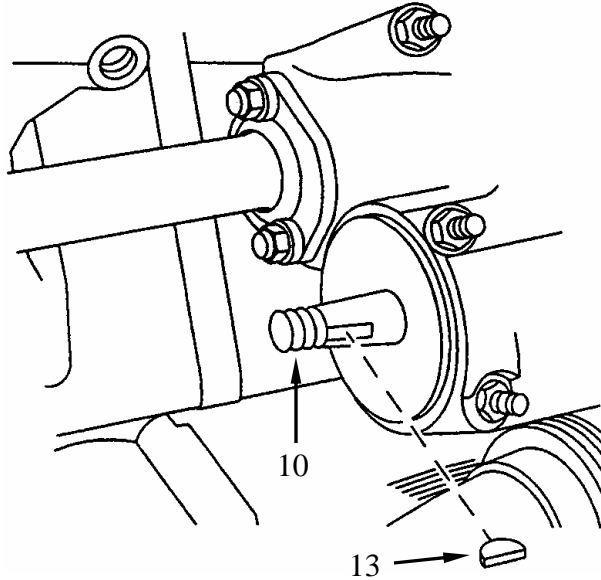


5. Remove sleeve (11) and hub (12) from accessory drive housing spur gear shaft (10), using coupling puller (6).



**REMOVAL (Continued)**

6. Remove and discard woodruff key (13) from accessory drive housing spur gear shaft (10).

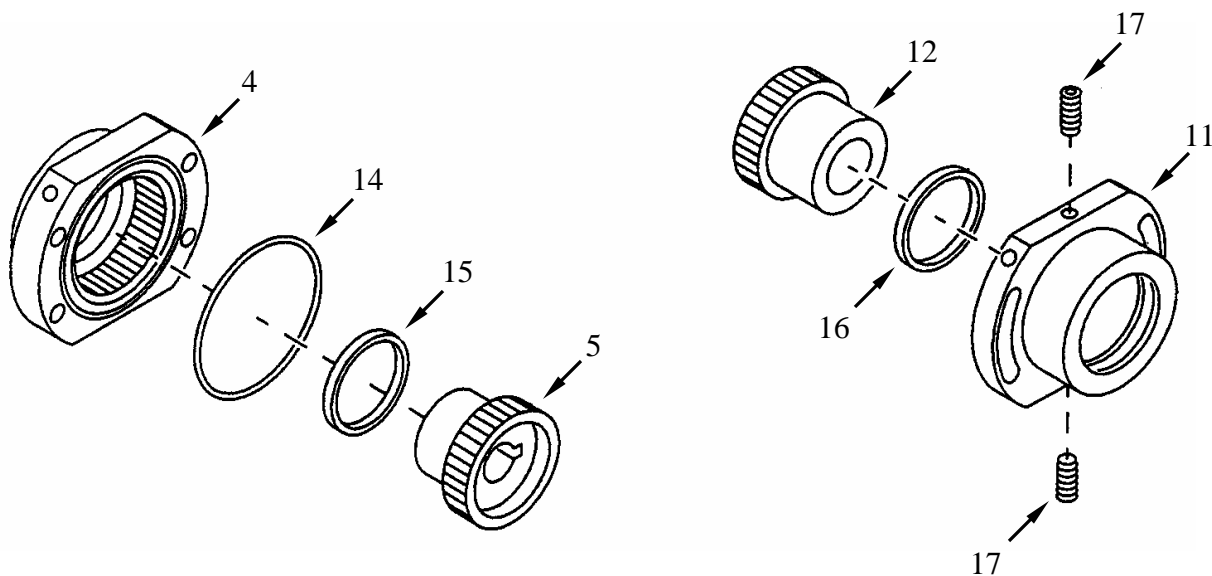


**DISASSEMBLY**

1. Separate sleeve (4), hub (5), and O-rings (14 and 15). Discard O-rings.
2. Separate sleeve (11), hub (12), and O-ring (16). Discard O-ring.
3. Remove and discard two pipe plugs (17).

**CAUTION**

**Keep sleeves and hubs together as they are matched sets and are not interchangeable.**





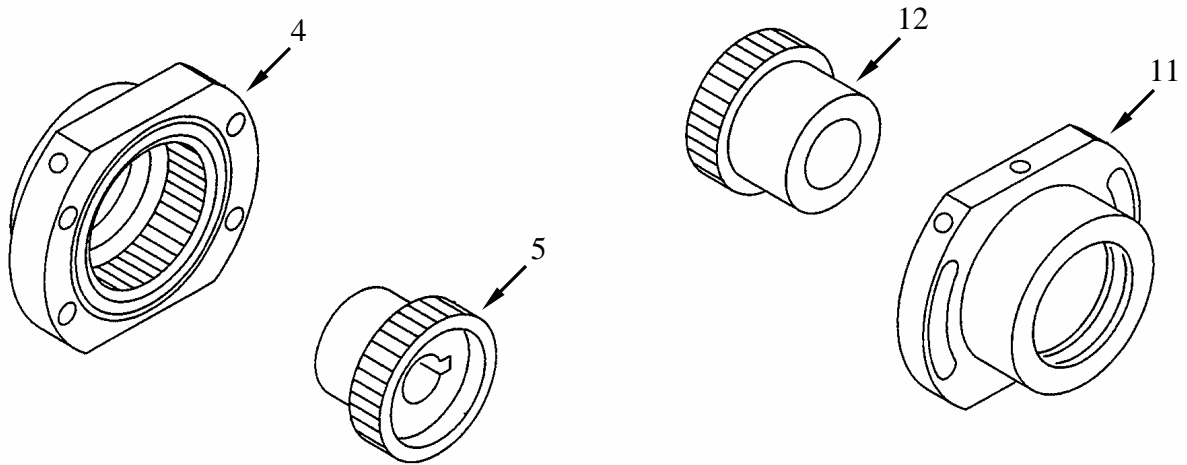
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.
2. Clean coupling shaft assembly parts (4, 5, 11, and 12) free of grease.

**INSPECTION**

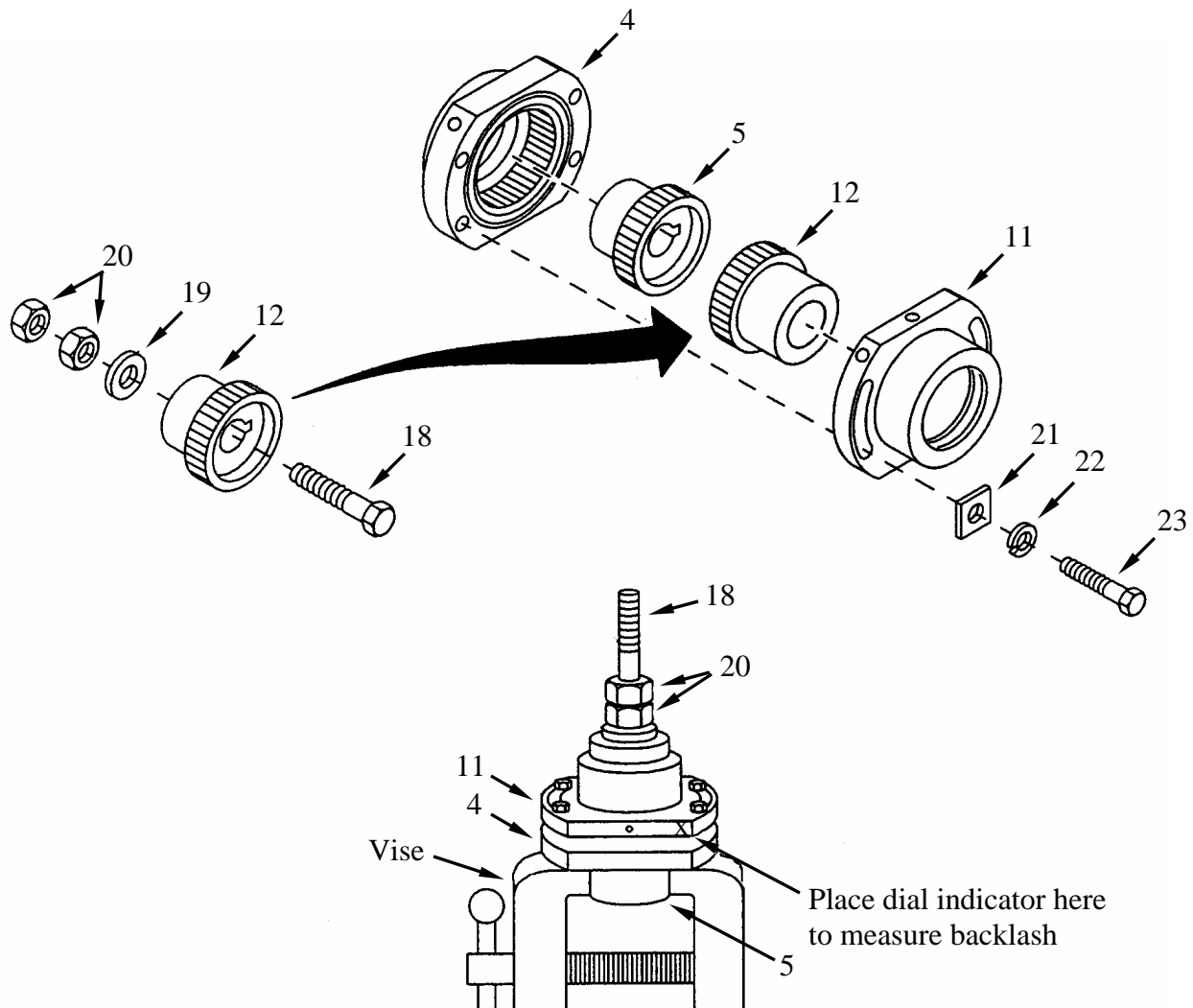
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Inspect sleeves (4 and 11), and hubs (5 and 12), for wear, mutilation, and fit with mating parts. Mating parts must match without binding. Replace complete coupling if damage or binding is found.



**INSPECTION (Continued)**

3. Check backlash of assembled coupling.
  - a. Install screw (18), flat washer (19), and two nuts (20) in hub (12).
  - b. Temporarily assemble two hubs (5 and 12) and two sleeves (4 and 11) using four spacers (21), four lock washers (22), and four screws (23).
  - c. Clamp hub (5) in machinist's vise.
  - d. Using bolt (18) as a turning device, check backlash between hubs (5 and 12) at a point 1-5/16-inches (3.3375mm) from shaft center on any of the four flats. If backlash exceeds 0.006-inches (0.1524 mm), replace flexible shaft coupling assembly.
4. Remove assembly from vise and remove four screws (23), four lock washers (22), four spacers (21), two sleeves (4 and 11), two hubs (5 and 12), two nuts (20), flat washer (19), and screw (18). Discard lock washers.



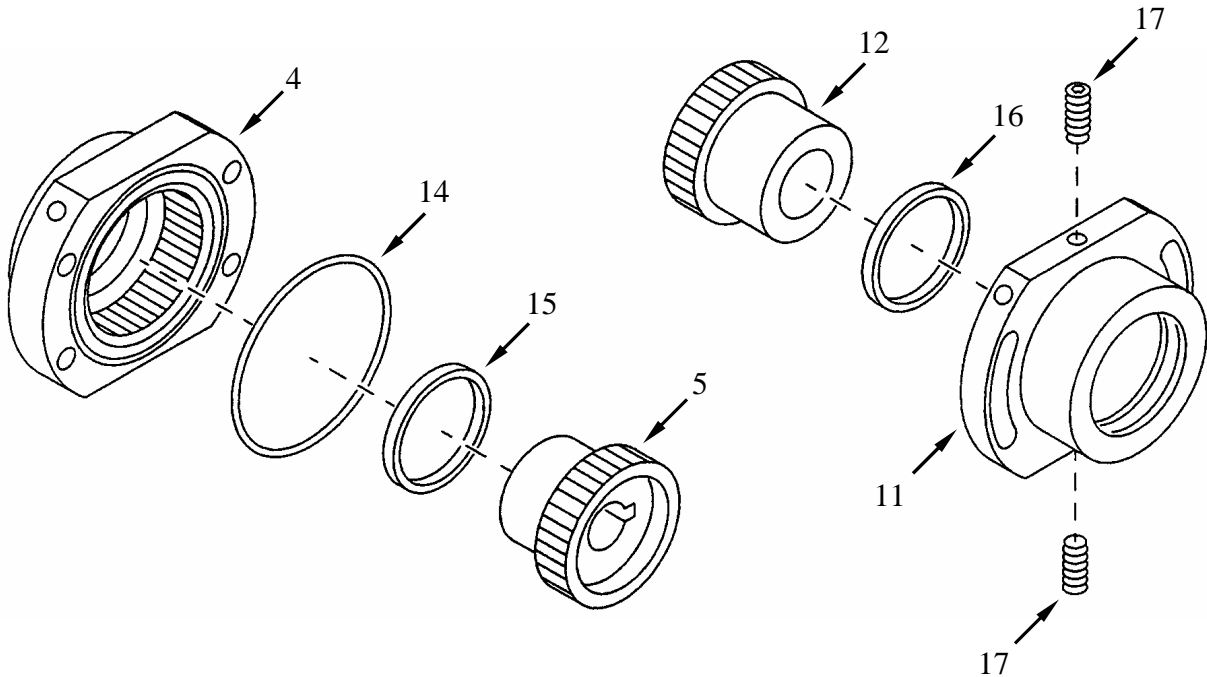
**ASSEMBLY**

1. Install new O-rings (14) (item 71, WP 0175) and (15) (item 167, WP 0175) on hub (5).
2. Lightly lubricate all surfaces of hub (5) using item 24, WP 0173.
3. Install hub (5) into sleeve (4).
4. Install new O-ring (16) (item 167, WP 0175) on hub (12).
5. Lightly lubricate all surfaces of hub (12) using item 24, WP 0173.
6. Install hub (12) into sleeve (11).

**NOTE**

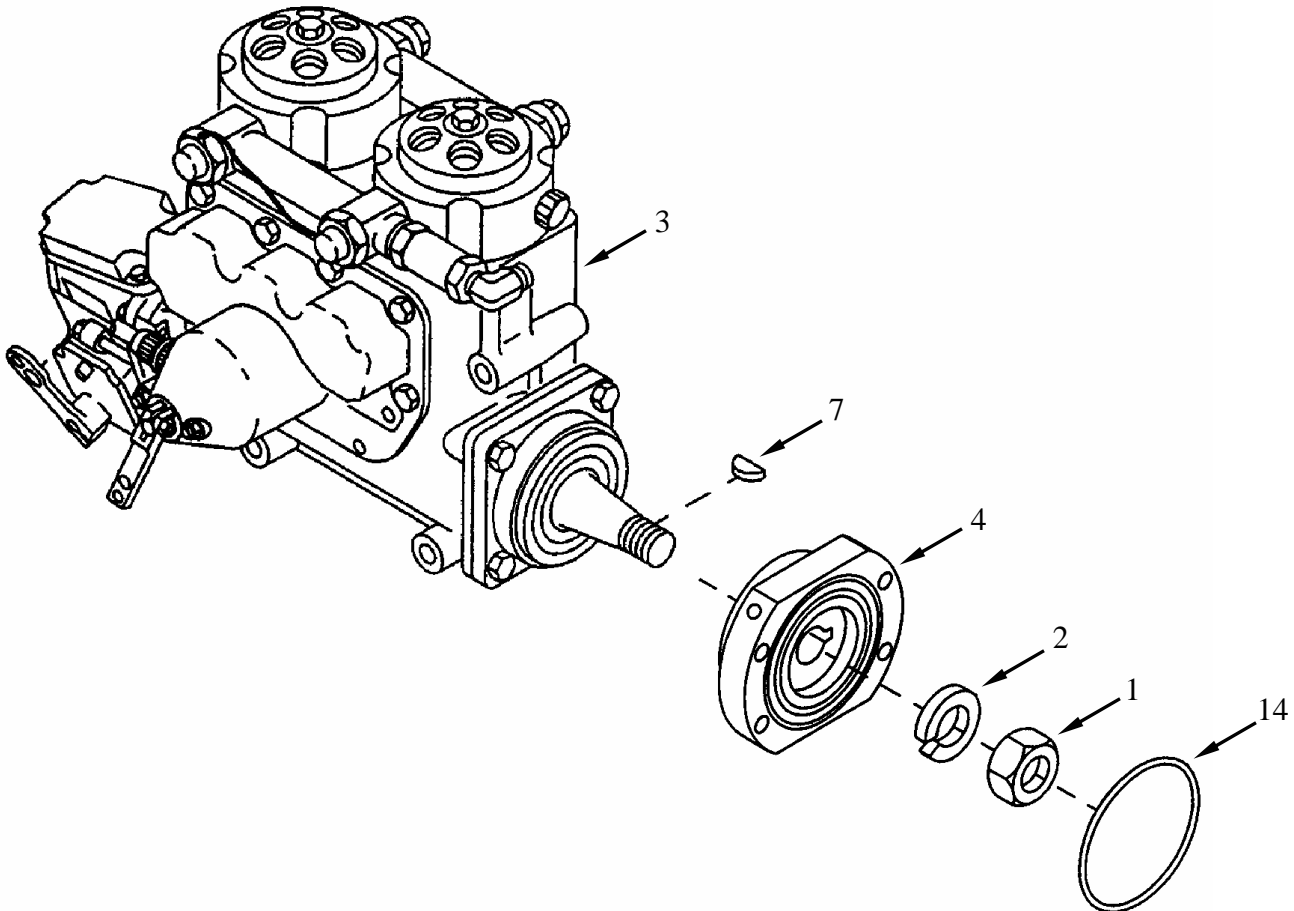
**Plugs will be permanently installed when coupling is greased during installation of fuel injection pump. Refer to WP 0115.**

7. Loosely install two new pipe plugs (17) (item 7, WP 0175).



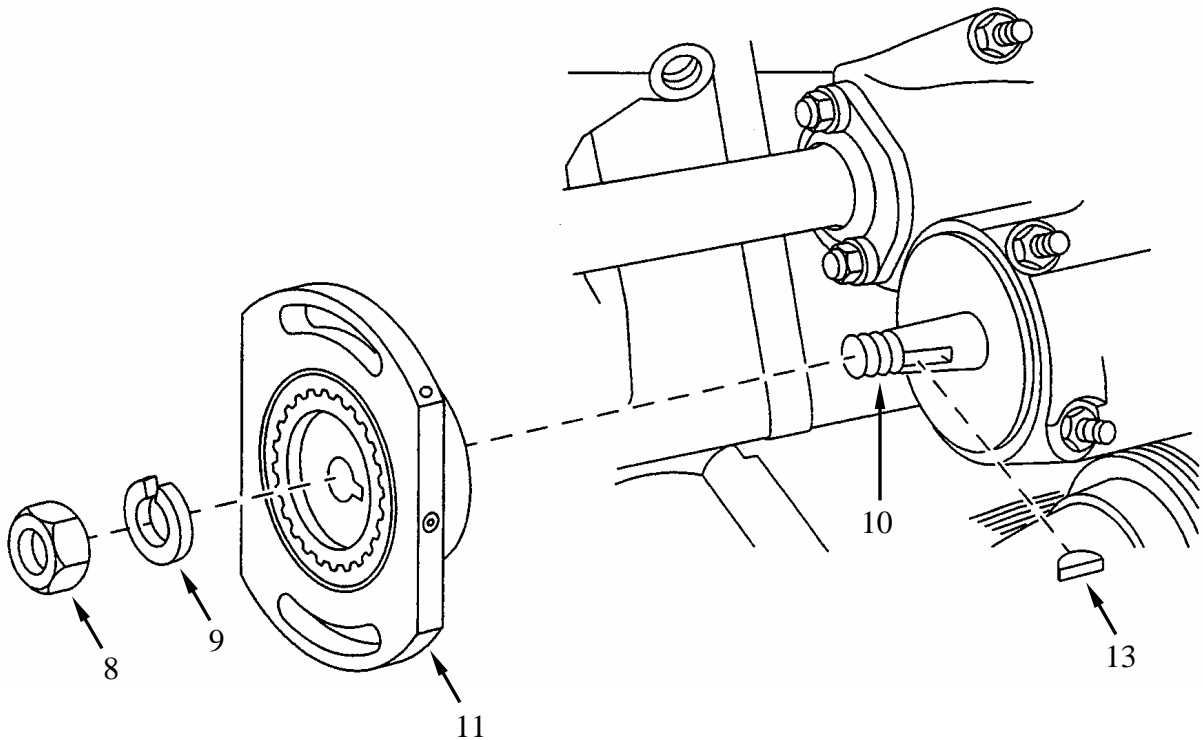
**INSTALLATION**

1. Install a new woodruff key (7) (item 359, WP 0175) on shaft of fuel injection pump (3).
2. Install assembled sleeve (4) on fuel injection pump (3).
3. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of shaft on fuel injection pump (3).
4. Secure coupling half with new lock washer (2) (item 97, WP 0175) and plain nut (1).
5. Tighten plain nut (1) to 79-87 foot-pounds (107-118 N•m).
6. Insure that O-ring (14) is in groove in face of sleeve (4). Use a light coating of Lubriplate (item 23, WP 0173) to hold O-ring in position.



**INSTALLATION (Continued)**

7. Install a new woodruff key (13) (item 359, WP 0175) on accessory drive housing gear shaft (10).
8. Install assembled sleeve (11), with O-ring and hub as an assembly, on accessory drive housing gear shaft (10).
9. Apply a small amount of Lubriplate (item 23, WP 0173) to threads of accessory drive housing gear shaft (10).
10. Secure coupling half with new lock washer (9) (item 97, WP 0175) and plain nut (8).
11. Tighten plain nut (8) to 145-154 foot-pounds (197-209 N•m).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (4) (item 94, WP 0174)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

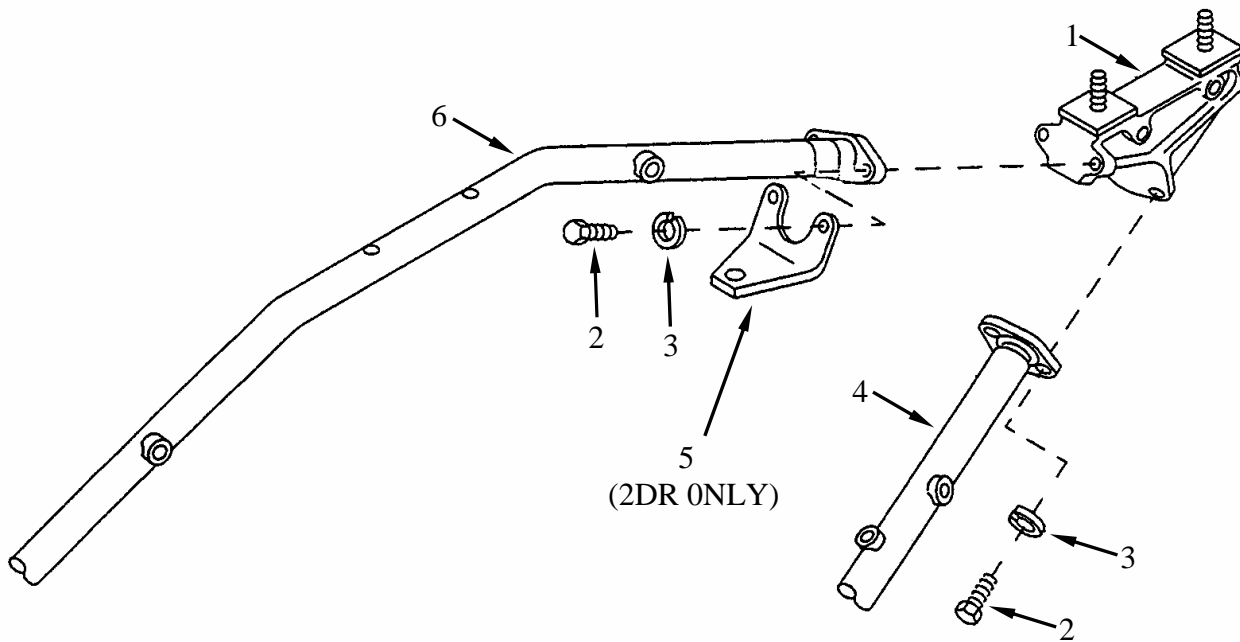
**Equipment Conditions:**

Engine level on flat surface

Turbocharger assembly (L.B.) removed (WP 0099, 2CA/2DA) (WP 0100, 2DR)

**REMOVAL**

1. Remove turbosupercharger base assembly (1).
  - a. Remove two screws (2) with lock washers (3) securing mounting base support (4) to mounting base assembly (1). Discard lock washers (3).
  - b. Remove two screws (2), with lock washers (3) [and for 2DR only, oil filler tube bracket (5)] from turbocharger tie rod (6). Discard lock washers (3).
  - c. Remove turbosupercharger base (1).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

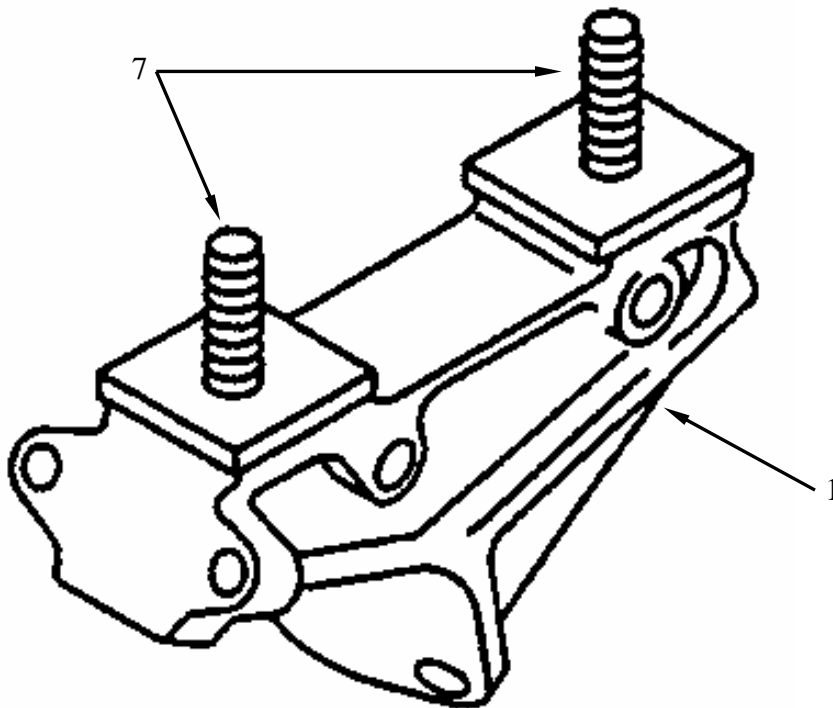
All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. Repair turbosupercharger base assembly.
  - a. Replace damaged, bent, or stripped studs (7) in base assembly (1). Refer to WP 0028.

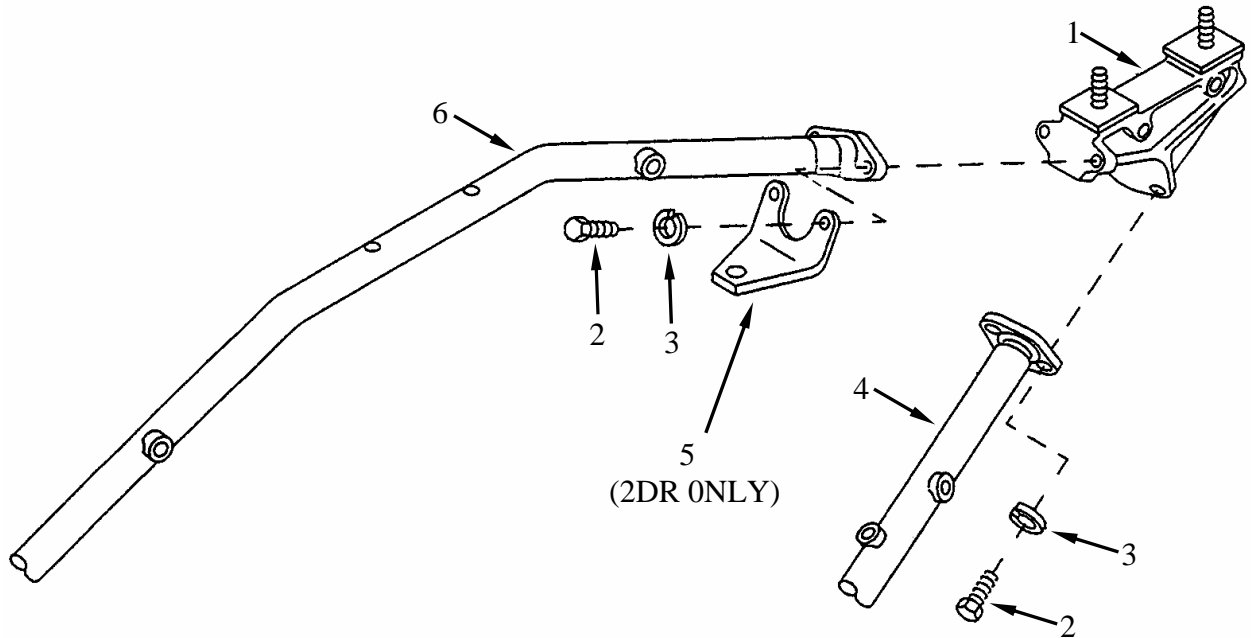
Location	Setting Height (inches)	Quantity Required	Stud Size and Length (inches)
7	1-3/8	2	1/2-20 (7/8) x 1/2-20 (15/16) x 2-1/8





**INSTALLATION**

1. Install turbosupercharger base assembly (1).
  - a. Apply a small amount of lubricant (item 23, WP 0173) to four screws (2)
  - b. Position base assembly (1) onto mounting base support (4) and turbocharger tie rod (6).
  - c. Install two screws (2) with new lock washers (3) (item 94, WP 0175) [and for 2DR only, oil filler tube bracket (5)] securing turbocharger tie rod (6) to base assembly (1).
  - d. Install two screws (2) with new lock washers (3) (item 94, WP 0175) to secure mounting base support (4) to base assembly (1).
  - e. Tighten four screws (2) to 156-180 inch-pounds (18-20 N•m), using torque wrench (item 124, WP0176).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (4) (item 94, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

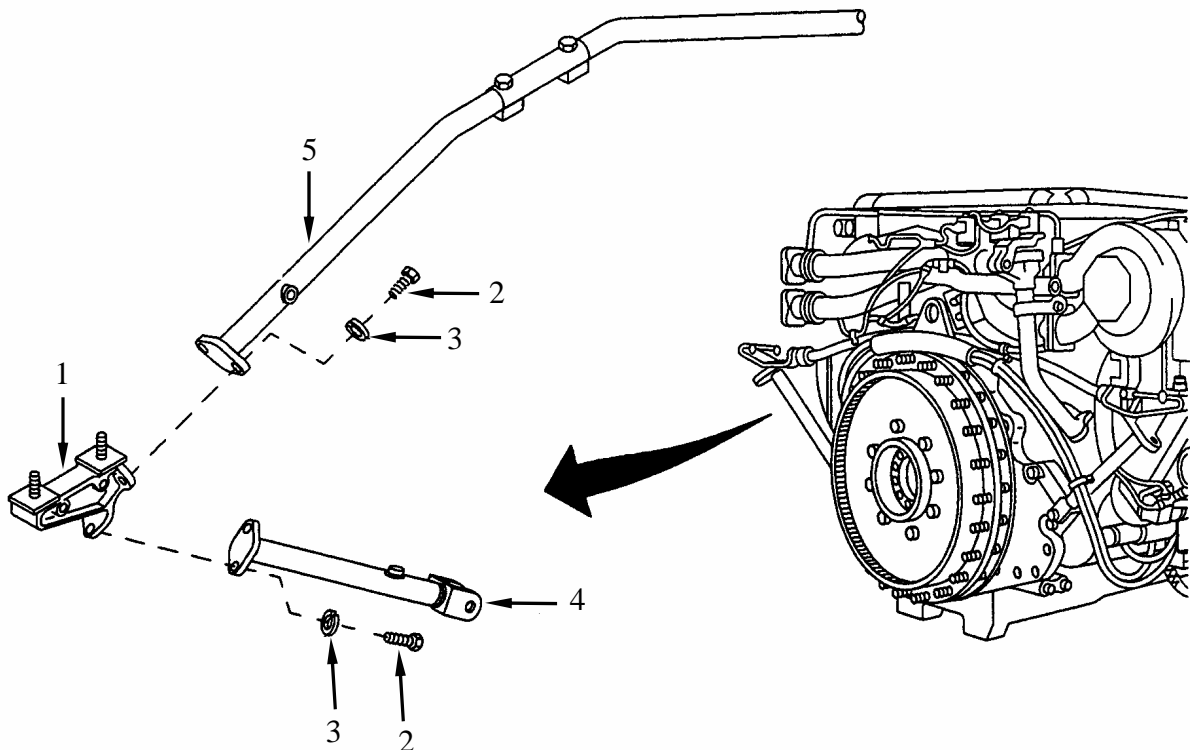
**Equipment Conditions:**

Engine level on flat surface

Turbocharger assembly (L.B.) removed (WP 0099, 2CA/2DA) (WP0100, 2DR)

**REMOVAL**

1. Remove turbosupercharger base assembly (1).
  - a. Remove two screws (2) with lock washers (3) securing mounting base support (4) to mounting base assembly (1). Discard lock washers (3).
  - b. Remove two screws (2), with lock washers (3) from turbocharger tie rod (5). Discard lock washers (3).
  - c. Remove turbosupercharger base (1).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

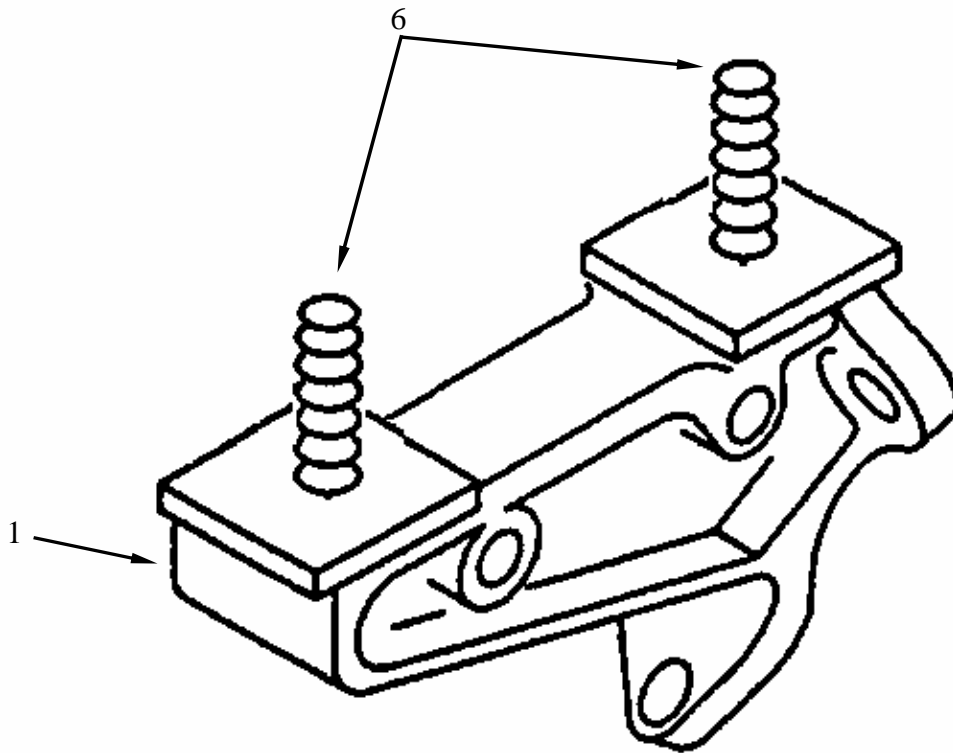
All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

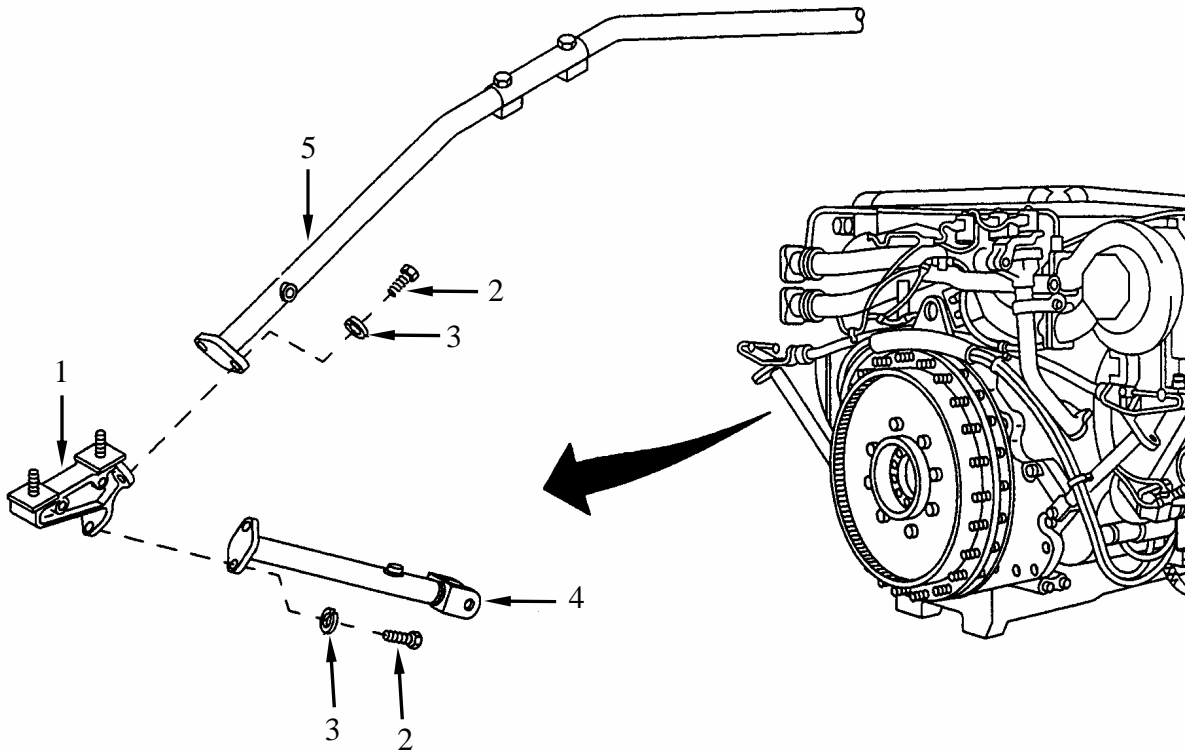
1. Repair turbosupercharger base assembly
  - a. Replace damaged, bent, or stripped studs (6) in base assembly (1). Refer to WP 0028.

Location	Setting Height (inches)	Quantity	Stud Size and Length (inches)
6	1-3/8	2	1/2-20 (7/8) x 1/2-20 (15/16) x 2-1/8



**INSTALLATION**

1. Install turbosupercharger base assembly (1).
  - a. Apply a small amount of lubricant (item 23, WP 0173) to four screws (2).
  - b. Position base assembly (1) onto mounting base support (4), and turbocharger tie rod (5).
  - c. Install two screws (2) with new lock washers (3) (item 94, WP 0175) to secure turbocharger tie rod (5) to base assembly (1).
  - d. Install two screws (2) with new lock washers (3) (item 94, WP 0175) to secure mounting base support (4) to base assembly (1).
  - e. Tighten four screws (2) to 156-180 inch-pounds (18-20 N•m), using torque wrench (item 124, WP 0176).

**END OF WORK PACKAGE**



**TURBOSUPERCHARGER TIE ROD, SUPPORTS, AND ASSOCIATED PARTS REPLACEMENT**

0119 00

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

- Lock washer (2) (item 94, WP 0175)
- Cotter pin (2) (item 51, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

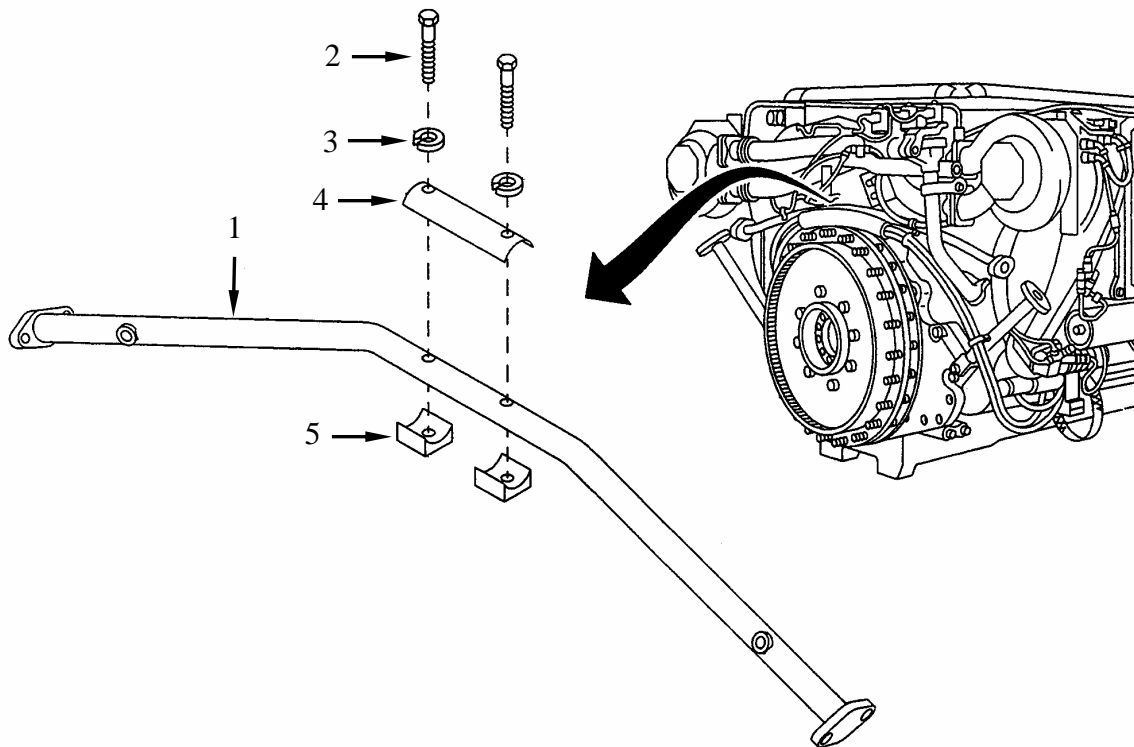
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine level on flat surface
- Turbosupercharger base assembly (L.B.) removed (WP 0117)
- Turbosupercharger base assembly (R.B.) removed (WP 0118)
- Engine lifting eye removed (WP 0131)
- Turbocharger oil hose clamps removed (WP 0099 & 0100)

**REMOVAL**

1. Remove turbosupercharger tie rod assembly (1).
  - a. Remove two screws (2) with lock washers (3). Discard lock washers (3).
  - b. Remove retaining strap (4), turbocharger tie rod (1), and two tie rod clamp seats (5).

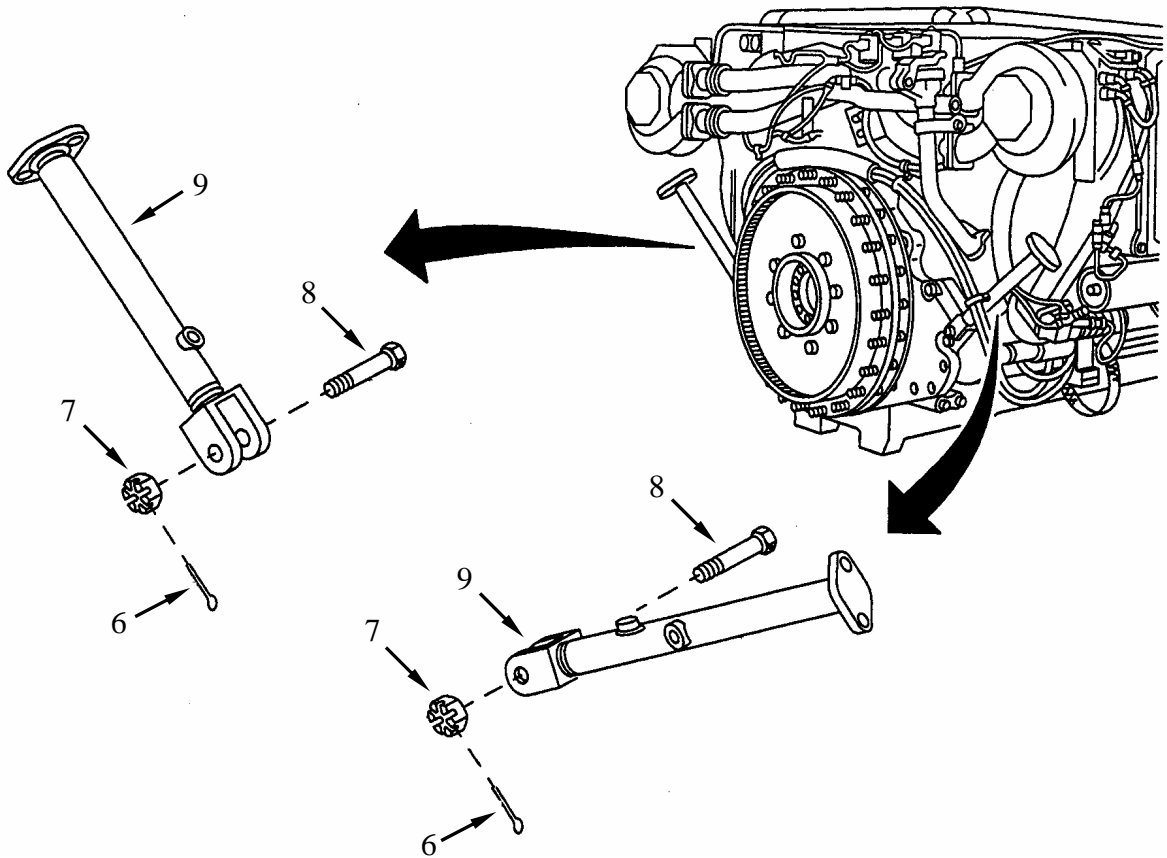


**TURBOSUPERCHARGER TIE ROD, SUPPORTS, AND ASSOCIATED PARTS  
REPLACEMENT**

0119 00

**REMOVAL (Continued)**

2. Remove base supports.
  - a. Remove two cotter pins (6), slotted plain nuts (7), and close-tolerance bolts (8). Discard cotter pins.
  - b. Remove turbocharger base supports (9).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

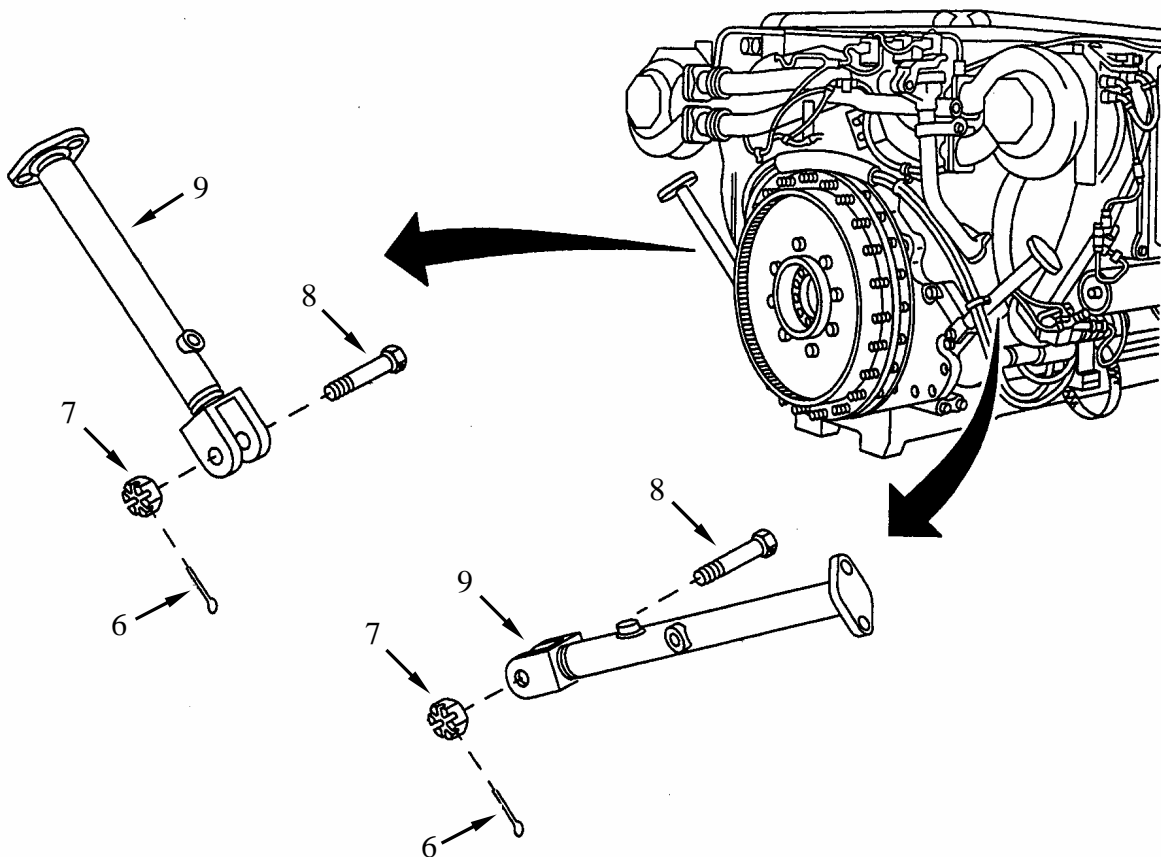


**TURBOSUPERCHARGER TIE ROD, SUPPORTS, AND ASSOCIATED PARTS  
REPLACEMENT**

0119 00

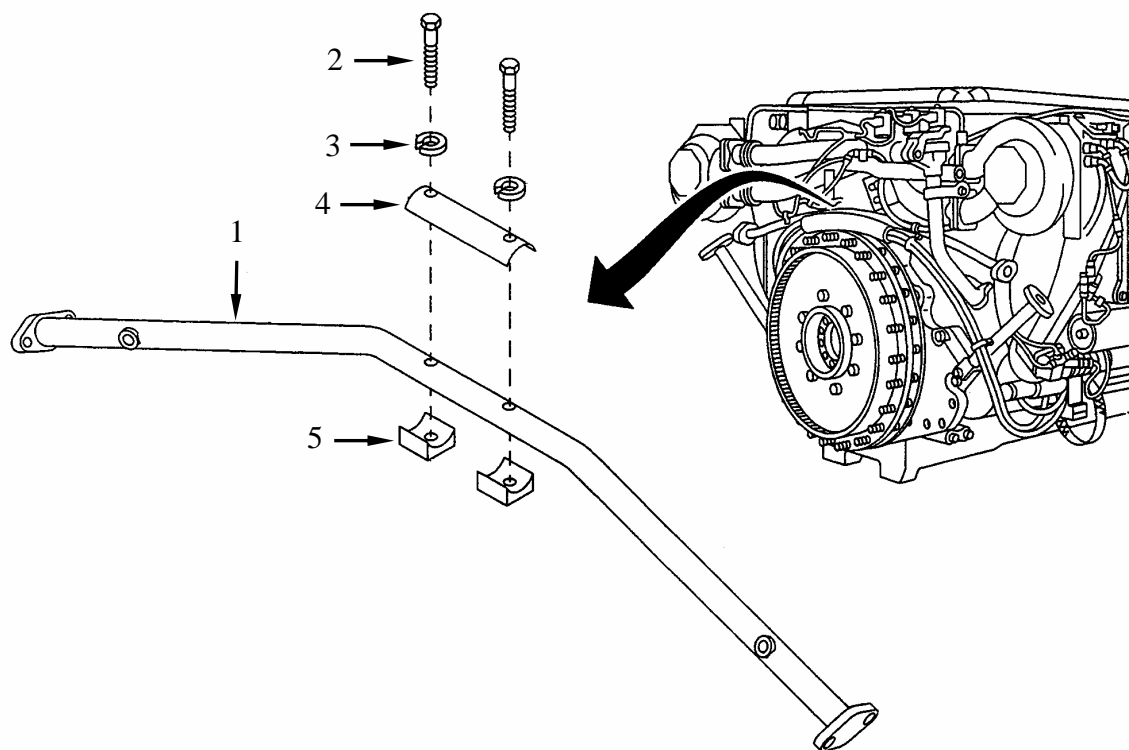
**INSTALLATION**

1. Install base supports (9).
  - a. Apply a small amount of lubricant (item 23, WP 0173) to two screws (8).
  - b. Install base supports (9) and secure with close-tolerance bolts (8), and slotted plain nuts (7).
  - c. Tighten slotted plain nuts (7) to 33-39 foot-pounds (41-52 N•m), using torque wrench (item 127, WP 0176).
  - d. Secure two slotted plain nuts (7) with new cotter pins (6) (item 51, WP 0175).



**TURBOSUPERCHARGER TIE ROD, SUPPORTS, AND ASSOCIATED PARTS  
REPLACEMENT****0119 00****INSTALLATION (Continued)**

2. Install tie rod assembly.
  - a. Apply a small amount of lubricant (item 23, WP 0173) to two screws (2).
  - b. Place tie rod (1) and seat (5) in position.
  - c. Secure tie rod clamp seats (5), tie rod (1) and retaining strap (4) with two screws (1) using new lock washers (3) (item 94, WP 0175).
  - d. Tighten screws (2) to 23-27 foot-pounds, (31-37 N•m), using torque wrench (item 127, WP0176).

**END OF WORK PACKAGE**

**TURBOSUPERCHARGER COMPRESSOR OUTLET ELBOW REPLACEMENT**

0120 00

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Mandatory Replacement Parts:**

Gasket (2) (item 309, WP 0175)

Self locking nut (6) (item, 33, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

**REMOVAL**

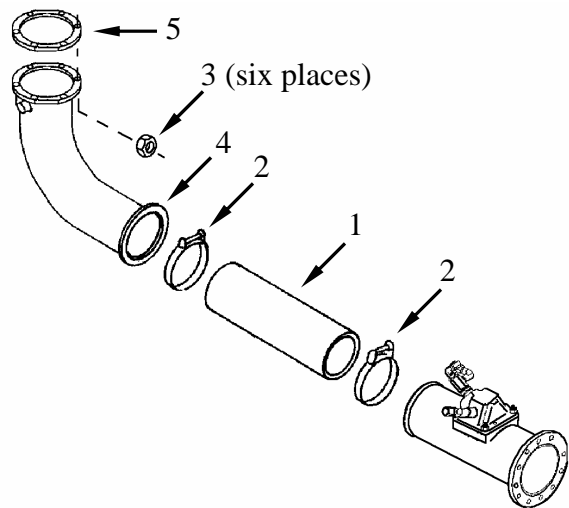
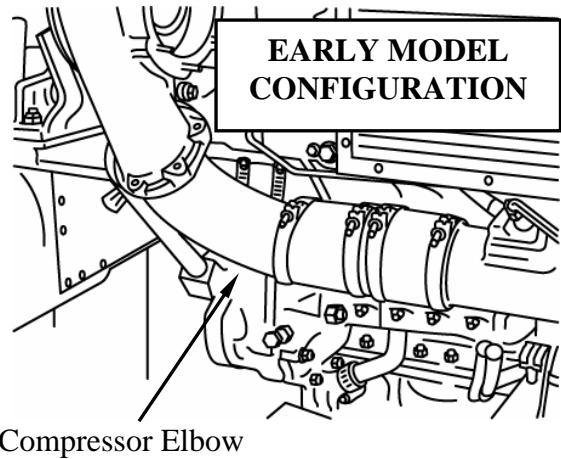
**CAUTION**

Early model engines may have a two-piece hose connection between the turbocharger compressor outlet elbow and intake manifold. If your engine has the two-piece hose connection, you should replace the existing (two hose and intermediate pipe) set-up with the one-piece hose (part number 11682625). Failure to comply may lead to premature engine failure due to dust ingestion.

**NOTE**

Left and right bank turbocharger compressor elbows are replaced in a similar manner. For instructional purposes, the left bank is described.

1. Loosen hose (1) clamps (2).
2. Remove six self-locking nuts (3) and remove compressor outlet elbow (4) and hose (1) as an assembly.
3. Separate elbow (4) and clamps (2) from hose (1).
4. Remove and discard gasket (5).



**TURBOSUPERCHARGER COMPRESSOR OUTLET ELBOW  
REPLACEMENT**

0120 00

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

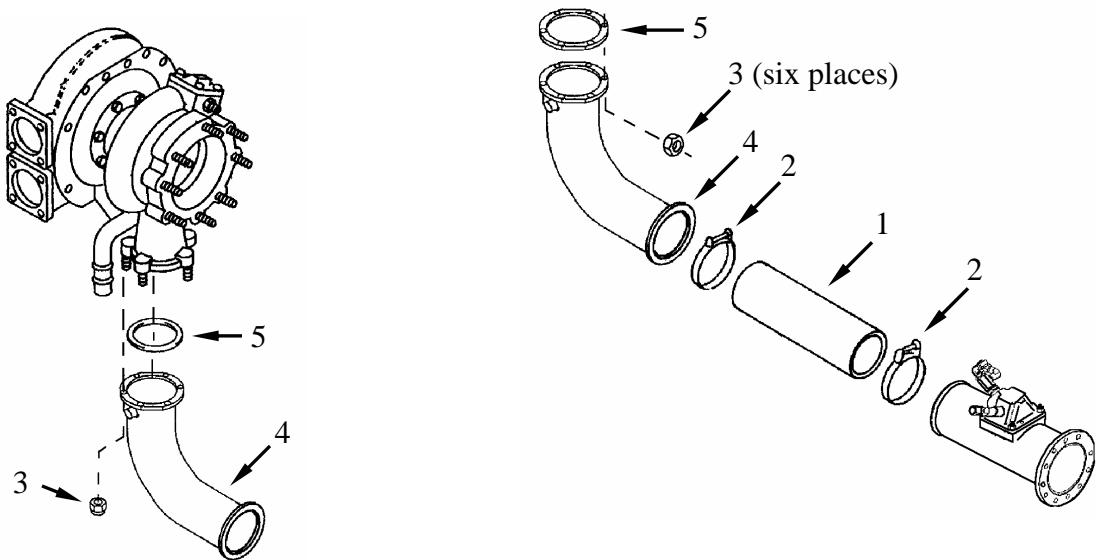
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.

**INSTALLATION**

1. Lubricate hose (1) and assemble on elbow (4).
2. Loosely position clamps (2) on hose (1).
3. Position a new gasket (5) (item 309, WP 0175) in place and install with elbow (4) and hose (1) as an assembly.
4. Secure compressor outlet elbow (4) using six new self-locking nuts (3) (item 33, WP 0175).
5. Tighten hose clamps (2).



**END OF WORK PACKAGE**

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**FUEL/WATER SEPARATOR CONTROL MOUNTING PLATE  
REPLACEMENT**

---

0121 00

**THIS WORK PACKAGE COVERS:**Removal, Cleaning, Inspection, and Installation

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**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-175 foot-pounds (item 127,  
WP 0176)

**Mandatory Replacement Parts:**

Lock washers (4) (item 86, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

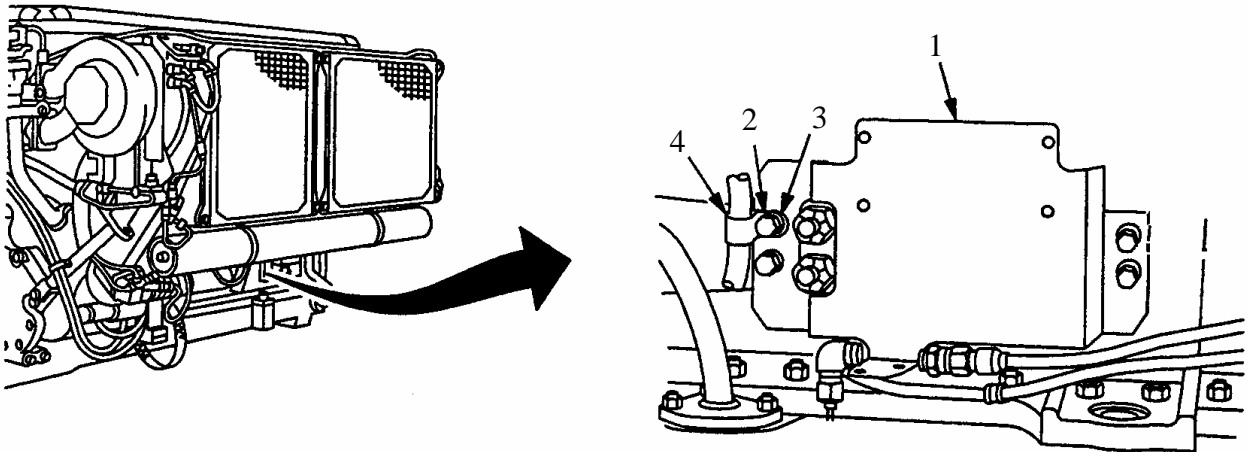
Engine level on flat surface

Water separator control and water solenoid  
valve removed (WP 0084)

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**REMOVAL**

1. Remove fuel/ water separator control mounting plate (1).
  - a. Remove four bolts (2) with lock washers (3), clamp (4), and mounting plate (1) from engine. Discard lock washers.



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**FUEL/WATER SEPARATOR CONTROL MOUNTING PLATE  
REPLACEMENT**

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0121 00

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

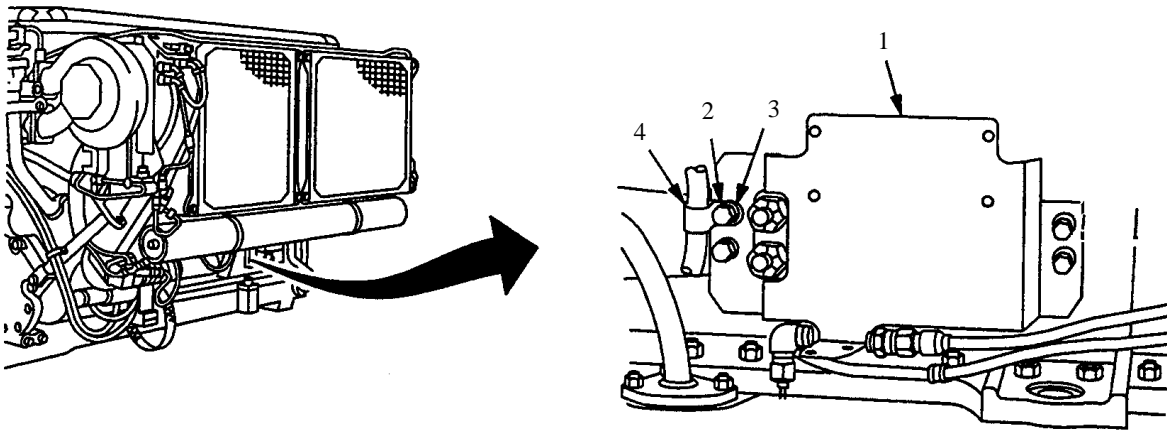
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install fuel/ water separator control mounting plate (1).
  - a. Apply a small amount of Lubriplate (item 23, WP 0173) to four bolts (2).
  - b. Position fuel/ water separator control mounting plate (1) onto engine block.
  - c. Install four bolts (2) with new lock washers (3) (item 86, WP 0175), and clamp (4).
  - d. Tighten four bolts (2) to 13 to 15 foot-pounds (18-20 N•m), using torque wrench (item 127, WP 0176).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Test, Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

**INITIAL SETUP:**

**Tools:**

- Dial indicator (item 65, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Mechanical gear puller kit (item 85, WP 0176)
- Micrometer caliper set, inside (item 16, WP 0176)
- Micrometer caliper set, outside (item 17, WP 0176)
- Reamer (item 92, WP 0176)
- Snap ring pliers (item 81, WP 0176)
- Spring tester (item 117, WP 0176)
- Vise (item 132, WP 0176)

**Expendable and Durable Items:**

- Safety goggles (item 17, WP 0173)

**Mandatory Replacement Parts:**

- Bearing (2) (item 309, WP 0175)
- Lock washer (2) (item 89, WP 0175)

**Mandatory Replacement Parts (Continued)**

- Retaining ring (2) (item 21, WP 0175)
- Retaining ring (4) (item 12, WP 0175)
- Retaining ring (6) (item 8, WP 0175)
- Self-locking nut (item 38, WP 0175)
- Spring (item 264, WP 0175)
- Woodruff key (2) (item 103, WP 0175)

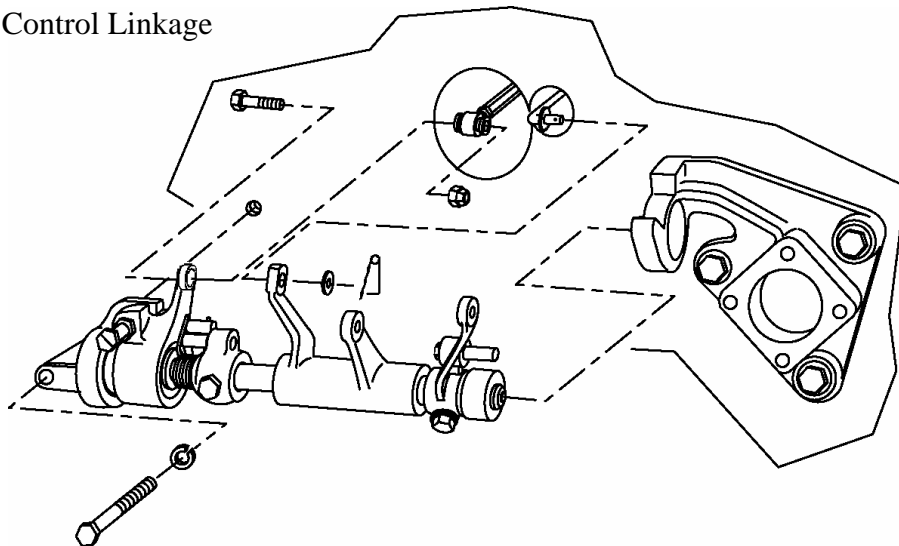
**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

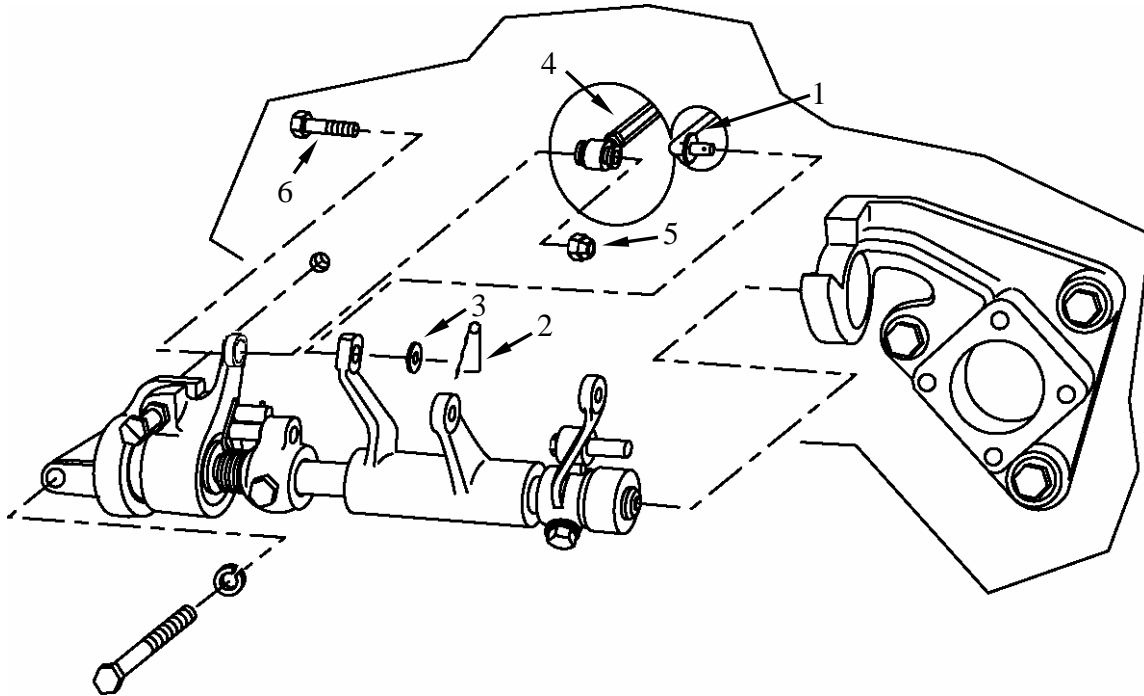
- Engine removed from vehicle and placed on a flat stationary surface

Throttle Control Linkage

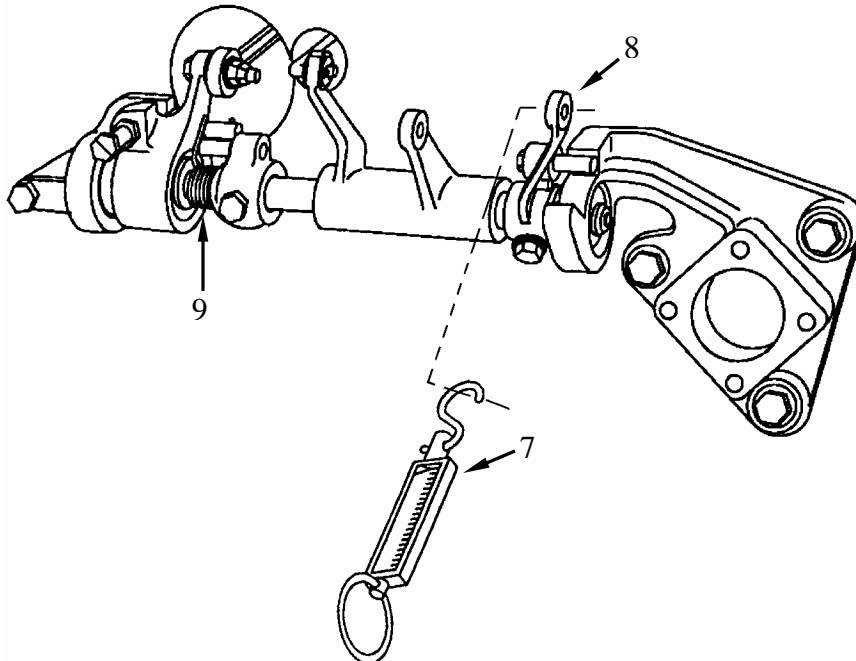


**TEST**

1. Disconnect rigid connecting link (1) by removing safety pin (2) and flat washer (3).
2. Disconnect control rod assembly (4) by removing self-locking nut (5) and screw (6). Discard self-locking nut.



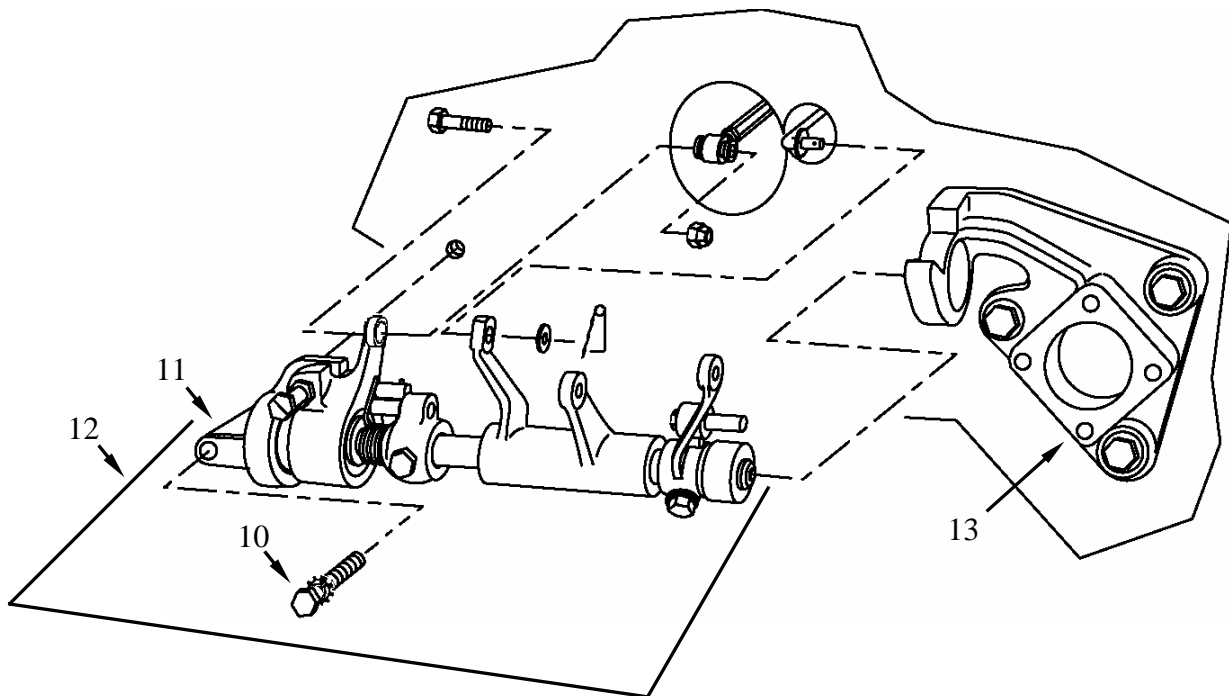
3. Connect spring tester (7) (item 117, WP 0175) to throttle lever assembly (8) and test force required to move throttle lever assembly (8). Replace spring (9) if measured force is not  $34 \pm 4$  pounds ( $15.4 \pm 1.8$  kg). Note that if repair is necessary, this spring is a mandatory replacement item.





**REMOVAL**

1. Remove two assembled washer screws (10) securing cross shaft bracket assembly (11) to damper housing.
2. Remove cross shaft assembly (12) as a unit by sliding assembly out of pump drive adapter (13).



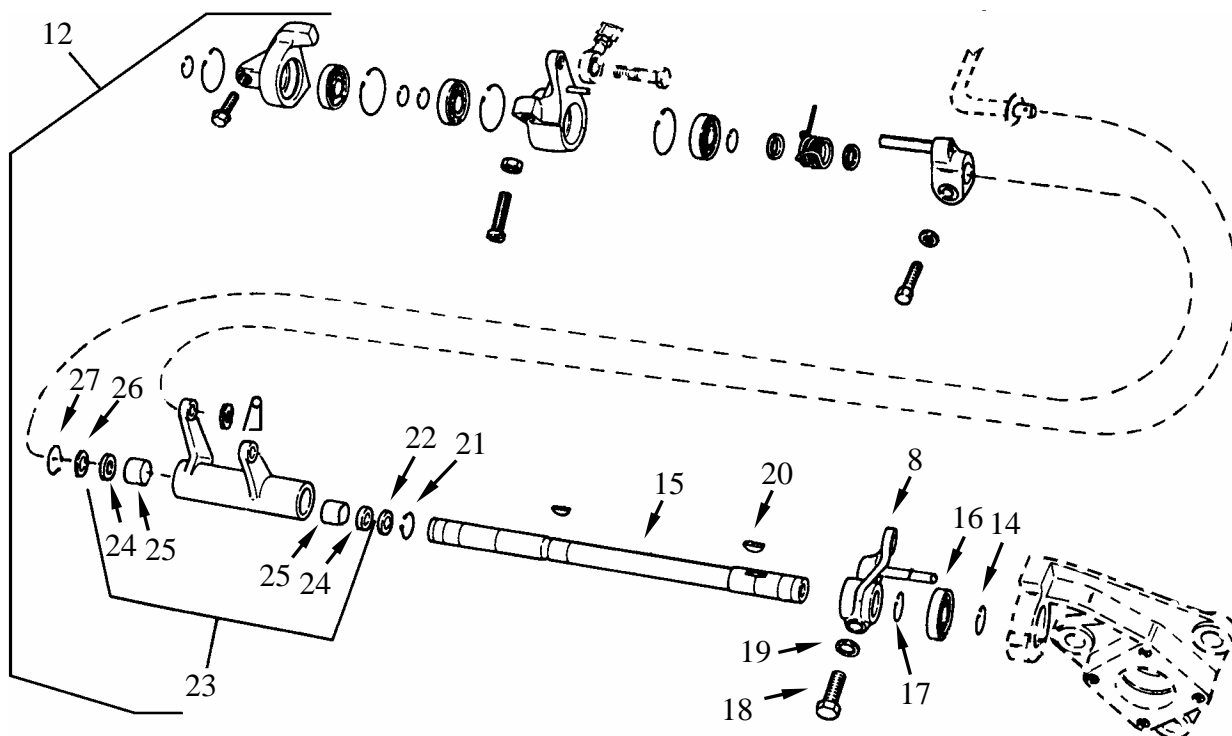
## DISASSEMBLY

## WARNING



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

1. Place throttle cross shaft assembly (12) in a machinist's vise and remove retaining ring (14) from straight shaft (15). Discard retaining ring.
2. Remove bearing (16) using a suitable puller then remove retaining ring (17) from straight shaft (15). Discard retaining ring and bearing.
3. Remove screw (18) and lock washer (19) from throttle lever assembly (8). Discard lock washer.
4. Remove throttle lever assembly (8) and woodruff key (20) from straight shaft (15). Discard woodruff key.
5. Remove retaining ring (21) and flat washer (22) from straight shaft (15). Discard retaining ring.
6. Remove manual fuel shutoff lever assembly (23) from straight shaft (15). Plain seals (24) and sleeve bearings (25) will be replaced in "Repair" of this work package.
7. Remove flat washer (26) and retaining ring (27) from straight shaft (15). Discard retaining ring.



**DISASSEMBLY (Continued)**

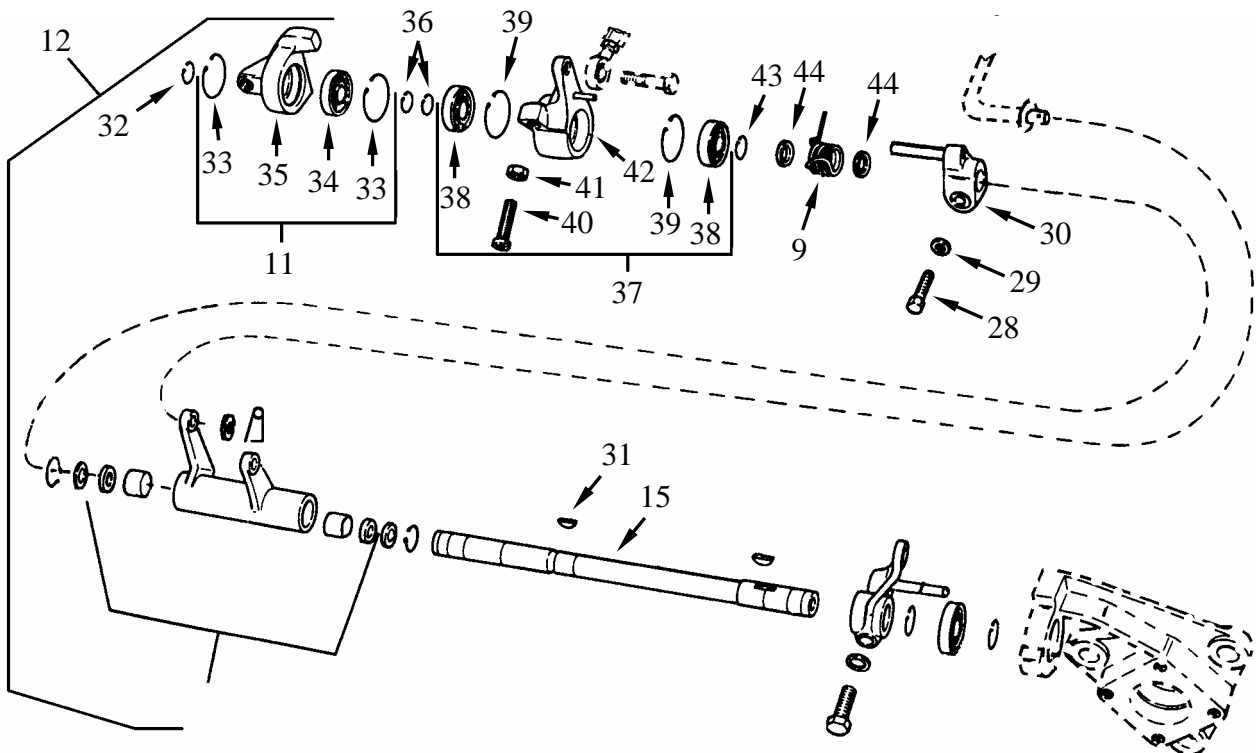
8. Remove screw (28) and lock washer (29) from throttle lock control lever assembly (30). Discard lock washer.
9. Remove throttle control lever assembly (30) and woodruff key (31) from straight shaft (15). Discard woodruff key.

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

10. Remove retaining ring (32) and using a suitable puller remove bracket assembly (11) from cross shaft assembly (12). Discard retaining ring.
11. Remove and discard two retaining rings (33) and bearing (34) from lever (35).
12. Remove and discard two retaining rings (36).
13. Using a suitable puller remove governor control lever assembly (37).
14. Remove and discard two bearings (38) and two retaining rings (39)
15. Remove adjusting screw (40) and lock nut (41) from lever (42).
16. Remove retaining ring (43), two washers (44), and spring (9). Discard retaining ring and spring.



**CLEANING**

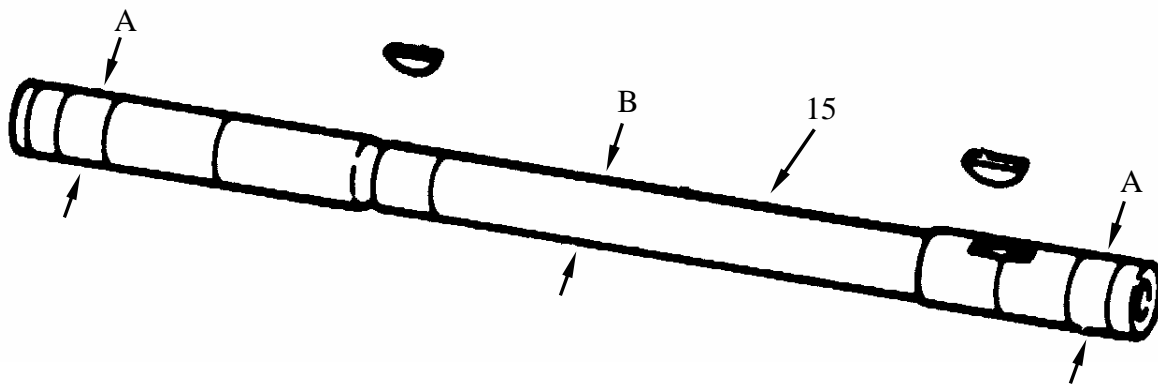
1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

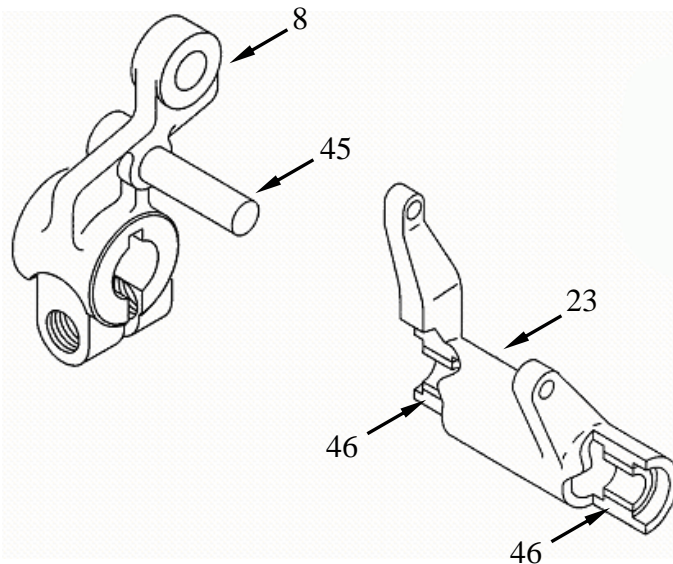
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Measure outside diameter of straight shaft (15) at points (A and B), using outside micrometer (item 17, WP 0176).
  - a. Replace shaft if measurement is not within limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Bearing areas)	0.6249 (15.87)	0.6252 (15.88)	0.6246 (15.86)
B (Fuel shutoff lever)	0.6232 (15.83)	0.6252 (15.88)	0.6217 (15.79)



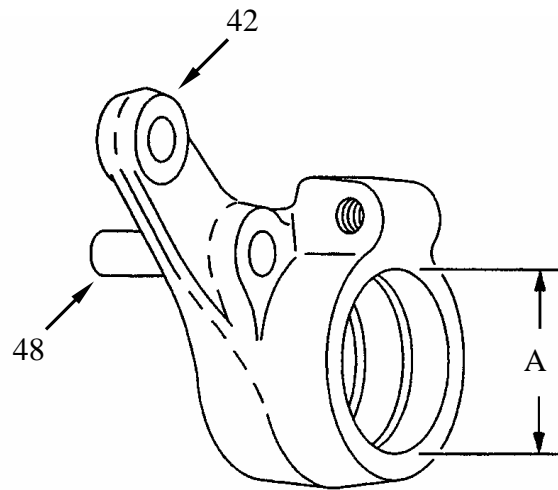
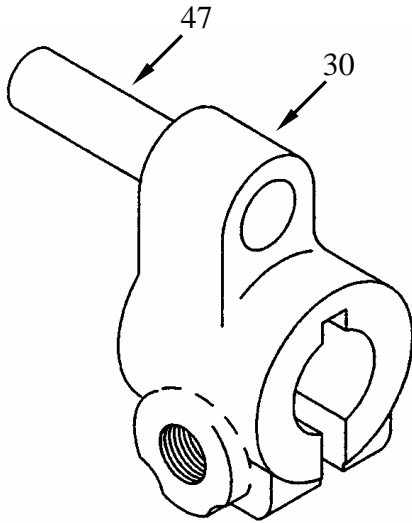
3. Visually inspect throttle lever housing (8) and pin (45).
4. Visually inspect fuel shutoff lever assembly (23). Refer to WP 0028. (Sleeve bearings (46) will be replaced in "Repair" of this work package.)



**INSPECTION (Continued)**

5. Visually inspect throttle lock control lever (30) and pin (47). Refer to WP 0028.
6. Visually inspect governor cross shaft control lever (42) and pin (48). Refer to WP 0028.
7. Measure inside diameter (A) of governor cross shaft control lever (42) housing. Replace if not within the limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (lever housing)	1.3740 (34.8996)	1.3746 (34.9148)	1.3751 (34.9275)



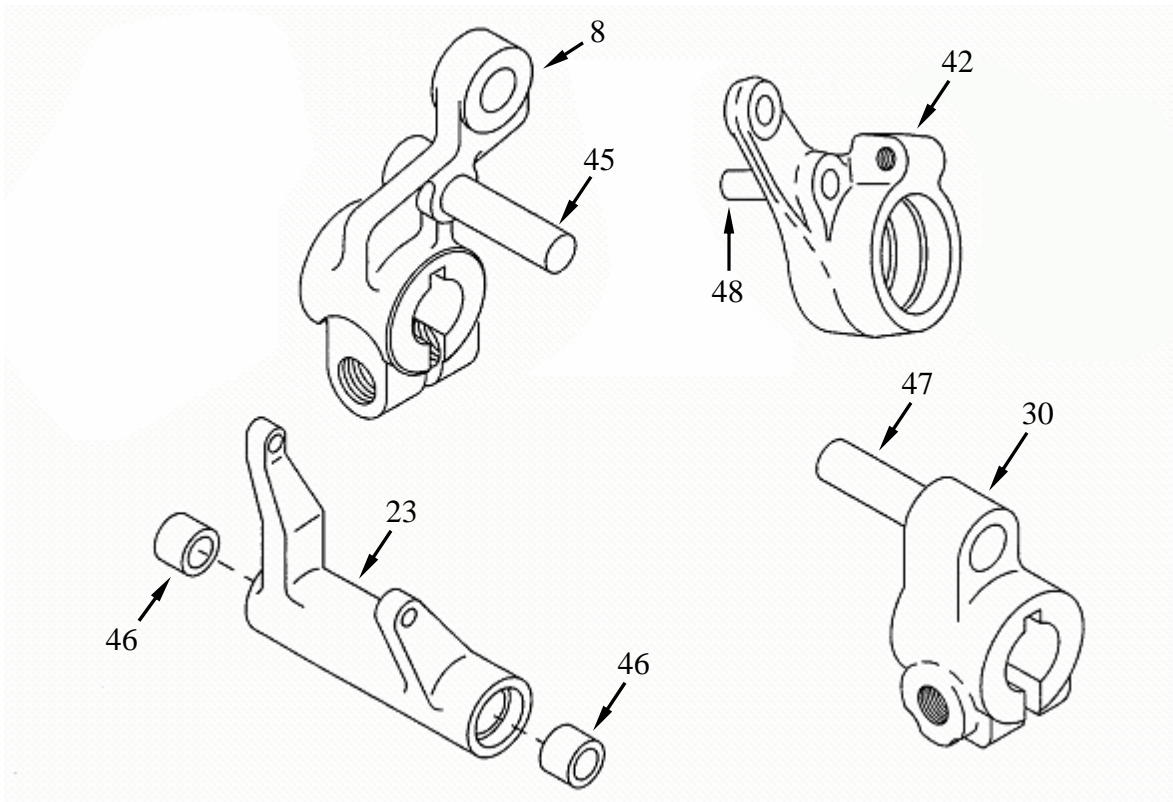
**REPAIR**

1. Replace loose, bent, or damaged pins (45, 47, and 48) from throttle lever (8), throttle lock lever (30) and governor control lever (42) respectively. Refer to WP 0028.
2. Replace sleeve bearings (46).
  - a. Remove and discard two sleeve bearings (46) in fuel shutoff lever assembly (23).
  - b. Install two new sleeve bearings (46) in fuel shutoff lever assembly (23).

**NOTE**

**Sleeve bearings must be installed 0.250 inch (6.35 mm) inboard of end surface of lever.**

- c. Ream two sleeve bearings (46) to a diameter of 0.6270-0.6290 inch (15.926-15.977 mm), using reamer (item 92, WP 0176).



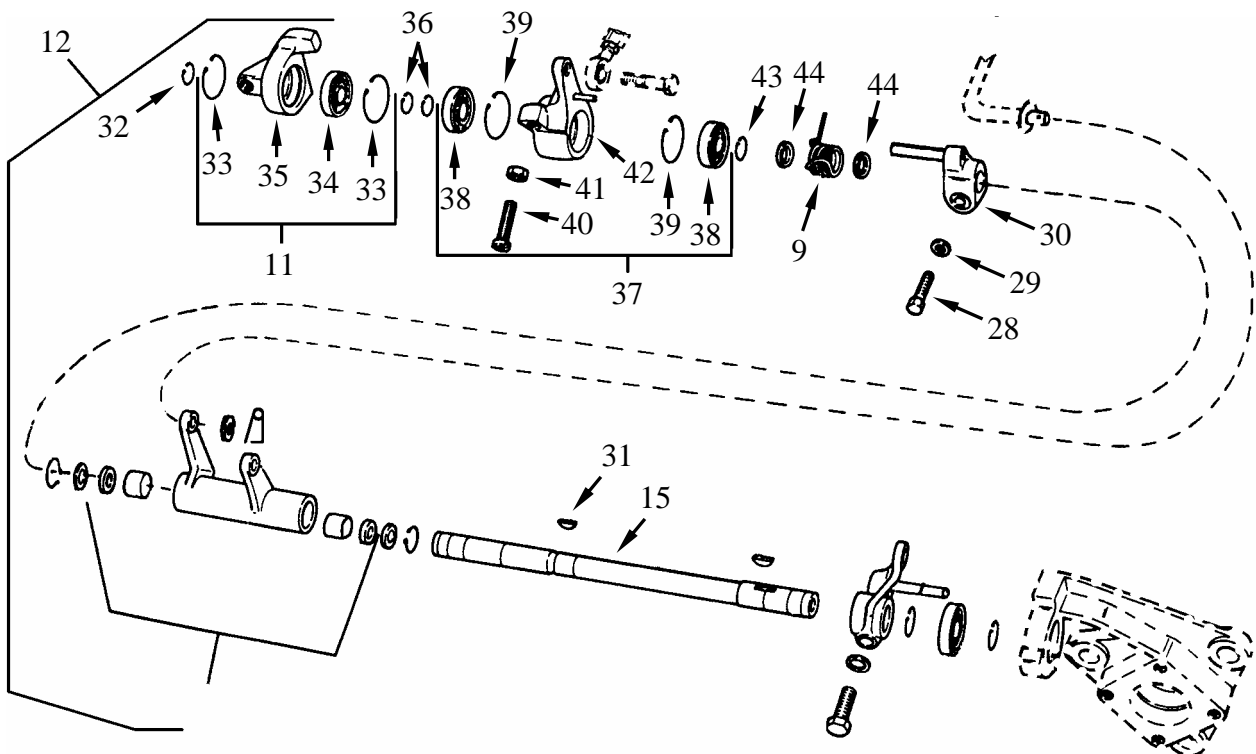
ASSEMBLY

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

1. Install new woodruff key (31) (item 103, WP 0175) onto straight shaft (15).
2. Install throttle control lever assembly (30) over woodruff key (31).
  - a. Secure using screw (28) and new lock washer (29) (item 89, WP 0175).
3. Install one washer (44), new spring (9) (item 264, WP 0175), and second washer (44) followed by a new retaining ring (43) (item 8, WP 0175).
4. Assemble governor control lever assembly (37).
  - a. Install two new retaining rings (39) (item 12, WP 0175) then two new bearings (38) (item 309, WP 0175) in lever (42) using a suitable press.
  - b. Install adjusting screw (40) and lock nut (41) onto lever (42).
5. Install governor control lever assembly (37) onto straight shaft (15).
6. Install two new retaining rings (36) (item 8, WP 0175) on straight shaft (15).
7. Install one new retaining ring (33) (item 12, WP 0175), bearing (34), and second new retaining ring (33) into lever (35).
8. Install bracket assembly (11) onto cross shaft assembly (12) and secure with new retaining ring (32) (item 8, WP 0175).

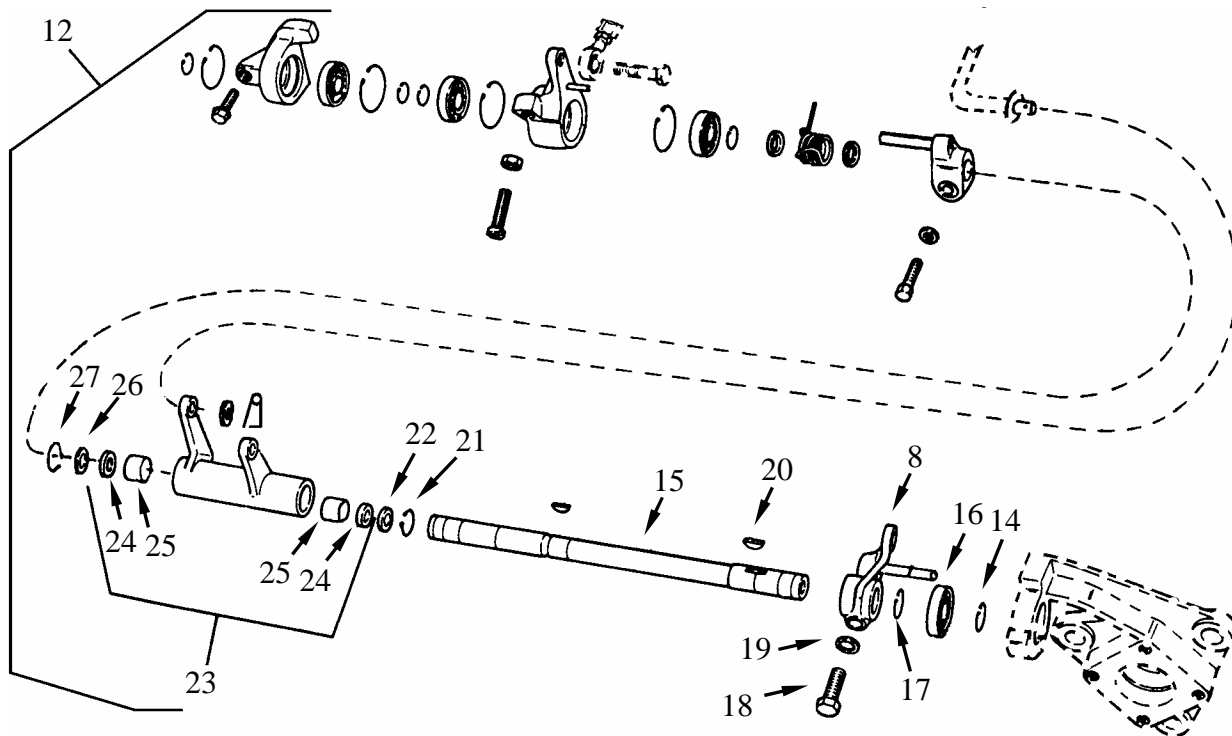


## ASSEMBLY (Continued)

**WARNING**

**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

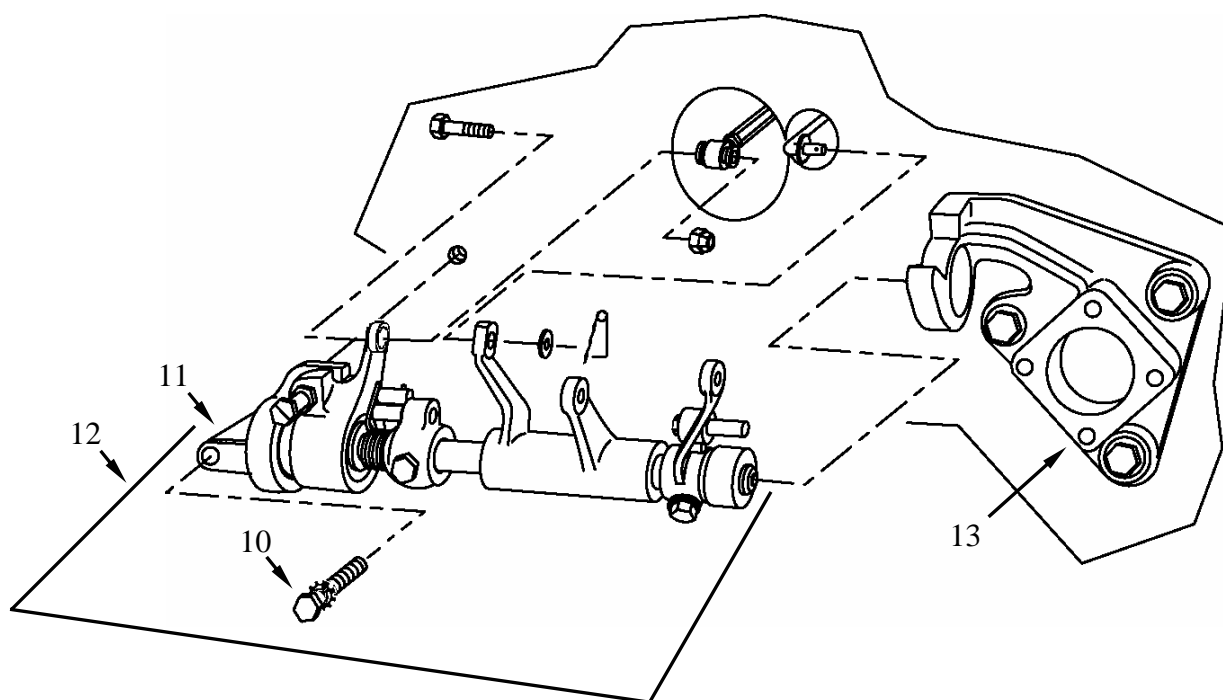
9. Install new retaining ring (27) (item 21, WP 0175) and flat washer (26) onto straight shaft (15).
10. Install manual fuel shutoff lever assembly (23), with (15) two plain seals (24) and two sleeve bearings (25) installed, onto straight shaft (15).
11. Install flat washer (22) and new retaining ring (21) (item 21, WP 0175) onto straight shaft (15).
12. Install new woodruff key (20) (item 103, WP 0175) onto straight shaft (15).
13. Install throttle lever assembly (8) over new woodruff key (20) and straight shaft (15).
  - a. Secure with screw (18) and new lock washer (19) (item 89, WP 0175).
14. Install new retaining ring (17) (item 8, WP 0175) onto straight shaft (15) followed by bearing (16), then install new retaining ring (14) (item 8, WP 0175).





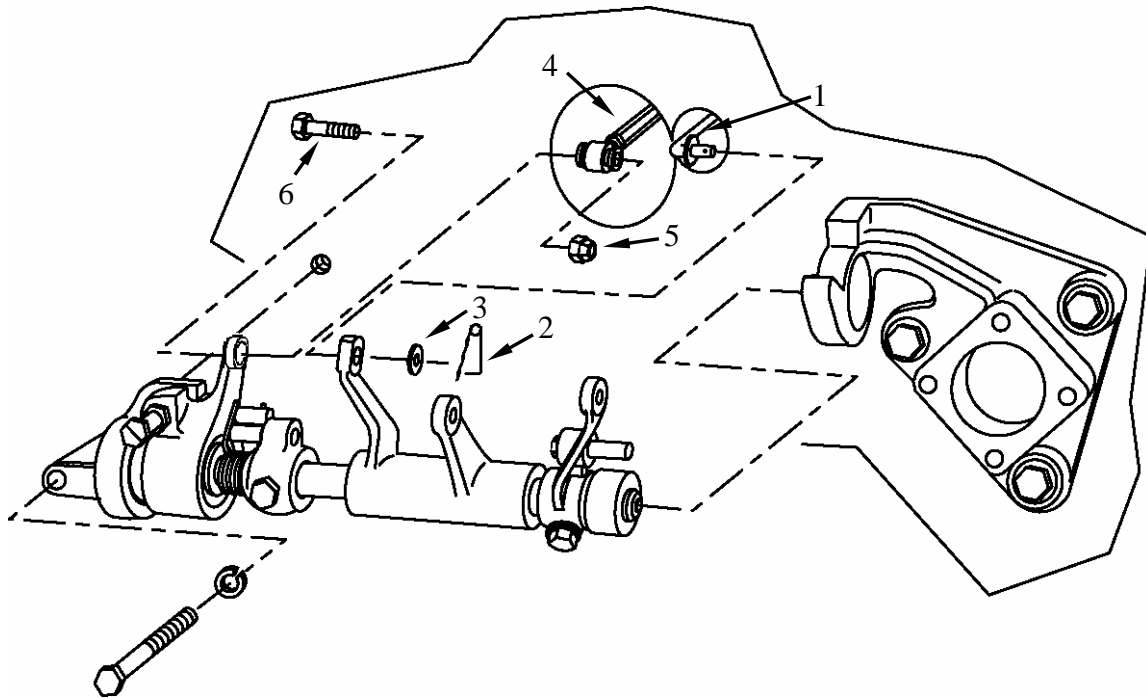
**INSTALLATION**

1. Install cross shaft assembly (12) as a unit by sliding assembly into pump drive adapter (13).
  - a. Secure to damper housing using two assembled washer screws (10).



**INSTALLATION (Continued)**

2. Connect rigid connecting link (1) using flat washer (3) and safety pin (2).
3. Connect control rod assembly (4) using new self-locking nut (5) (item 38, WP 0175) and screw (6).

**END OF WORK PACKAGE**

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**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

---

**0123 00**

**THIS WORK PACKAGE COVERS:**

Test, Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

---

**INITIAL SETUP:**

**Tools:**

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Mechanical gear puller kit (item 88, WP 0176)  
Micrometer caliper set, inside (item 16, WP 0176)  
Micrometer caliper set, outside  
(item 17, WP 0176)  
Reamer (item 92, WP 0176)  
Snap ring pliers (item 81, WP 0176)  
Spring tester (item 117, WP 0176)  
Vise (item 132, WP 0176)

**Mandatory Replacement Parts:**

Bearing (2) (item 22, WP 0175)  
Bearing (4) (item 322, WP 0175)  
Gasket (1) (item 187, WP 0175)  
Gasket (1) (item 188, WP 0175)  
Lock washer (7) (item 92, WP 0175)  
Lock washer (2) (item 93, WP 0175)  
Pin, retaining, safety (1) (item 1, WP 0175)  
Plain seal (1) (item 189, WP 0175)

**Mandatory Replacement Parts (Continued)**

Plain seal (2) (item 226, WP 0175)  
Plain seal (1) (item 275, WP 0175)  
Retaining ring (2) (item 21, WP 0175)  
Retaining ring (3) (item 12, WP 0175)  
Retaining ring (6) (item 8, WP 0175)  
Self-locking nut (1) (item 38, WP 0175)  
Sleeve bearing (2) (item 25, WP 0175)  
Spring (1) (item 221, WP 0175)  
Spring (1) (item 264, WP 0175)  
Spring pin (1) (item 24, WP 0175)  
Woodruff key (2) (item 103, WP 0175)

**Expendable and Durable Items:**

Safety goggles (item 17, WP 0173)

**Personnel Required**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

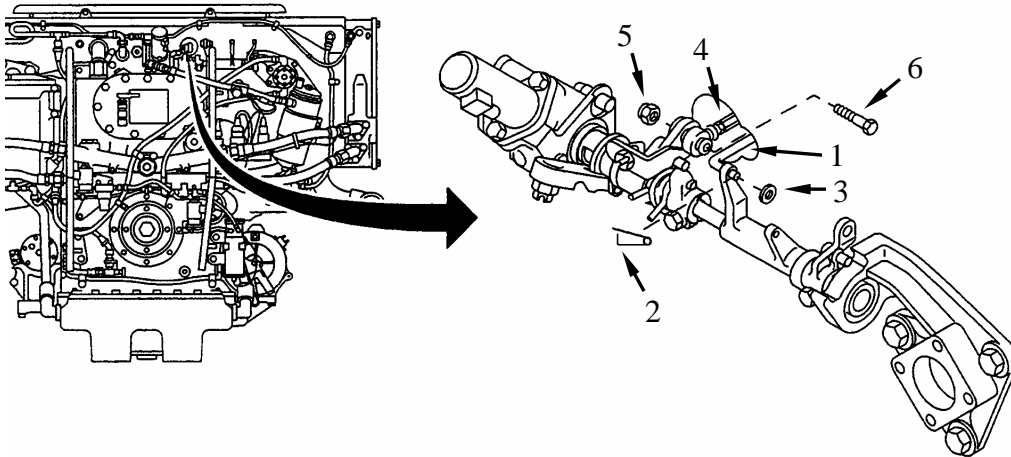
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**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

**TEST**

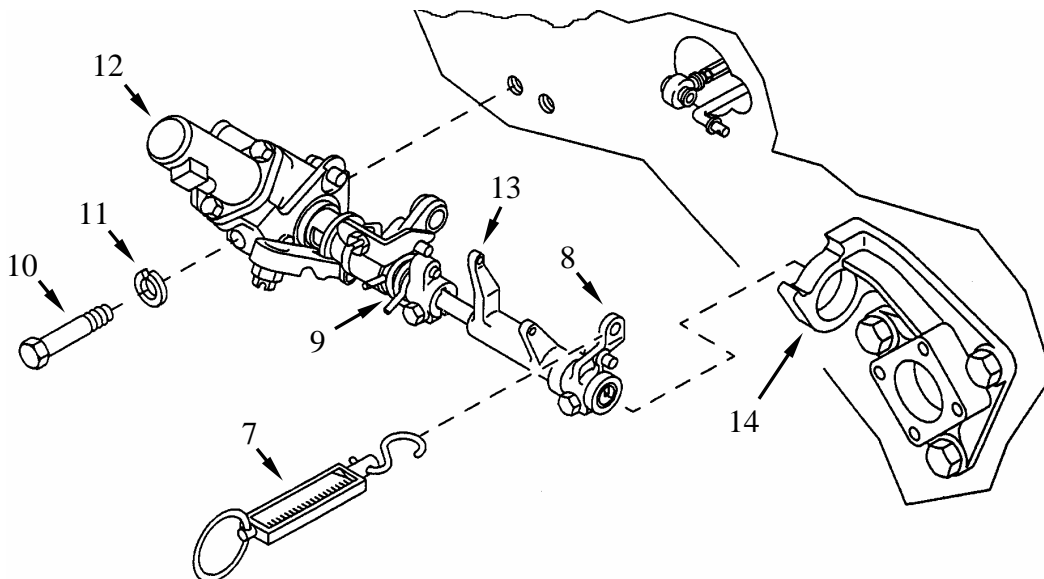
1. Disconnect rigid connecting link (1) by removing safety pin (2) and flat washer (3).
2. Disconnect control rod assembly (4) by removing self-locking nut (5) and screw (6). Discard self-locking nut.



3. Connect spring tester (7) (item 117, WP 0176) to throttle lever assembly (8) and test force required to move throttle lever assembly (8). Replace spring (9) if measured force is not  $34 \pm 4$  pounds ( $15.4 \pm 1.8$  kg). Note that if repair is necessary, this spring is a mandatory replacement item.

**REMOVAL**

1. Remove two screws (10) with lock washers (11) securing solenoid housing assembly (12) to damper housing. Discard lock washers.
2. Remove throttle control assembly (13) as a unit by sliding assembly out of pump drive adapter (14).



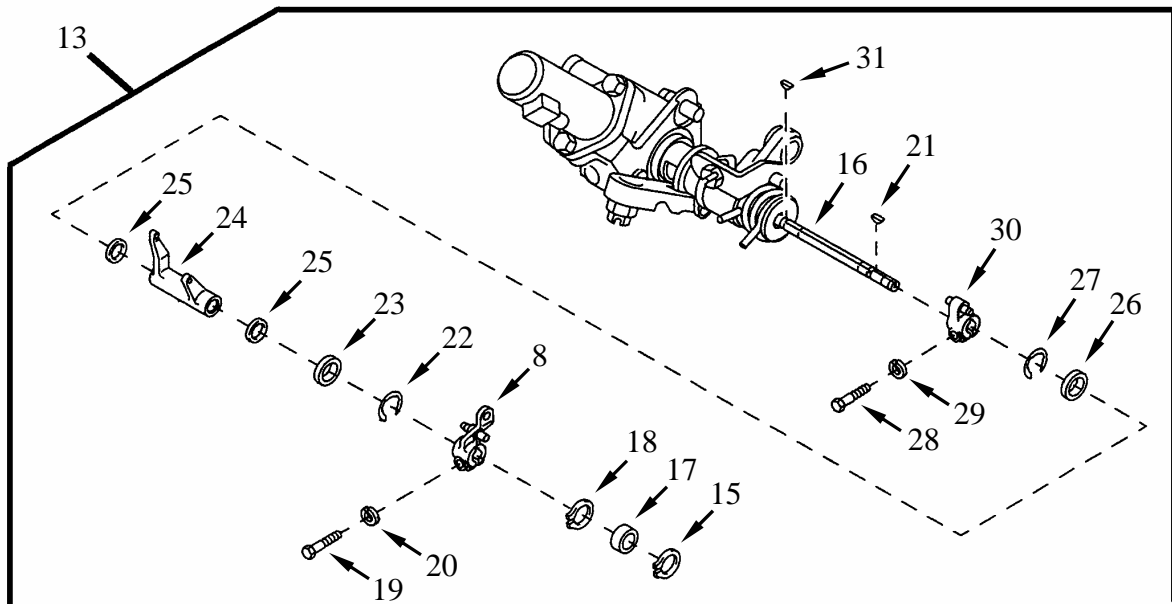
**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

**DISASSEMBLY****WARNING**

**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

1. Place throttle control assembly (13) in a machinist's vise (item 132, WP 0176) and remove retaining ring (15) from straight shaft (16), using snap ring pliers (item 81, WP 0176). Discard retaining ring.
2. Remove bearing (17) using a suitable puller then remove retaining ring (18) from straight shaft (16). Discard retaining ring and bearing.
3. Remove screw (19) and lock washer (20) from throttle lever assembly (8). Discard lock washer.
4. Remove throttle lever assembly (8) and woodruff key (21) from straight shaft (16). Discard woodruff key.
5. Remove retaining ring (22) and flat washer (23) from straight shaft (16). Discard retaining ring.
6. Remove fuel shutoff lever assembly (24) from straight shaft (16).
7. Remove and discard two plain seals (25) from fuel shutoff lever assembly (24).
8. Remove flat washer (26) and retaining ring (27) from straight shaft (16). Discard retaining ring.
9. Remove screw (28) and lock washer (29) from throttle lock control lever assembly (30). Discard lock washer.
10. Remove throttle lock control lever assembly (30) and woodruff key (31) from straight shaft (16). Discard woodruff key.



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

**DISASSEMBLY (Continued)**

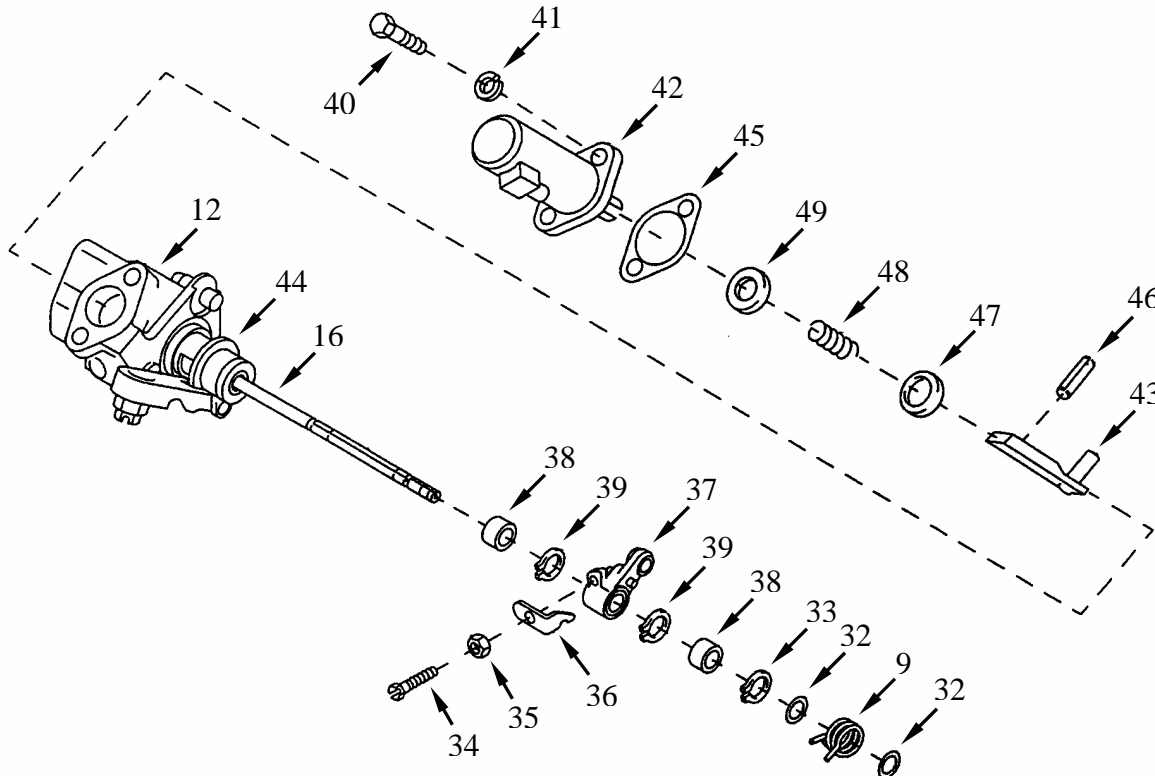
11. Remove two throttle control spacers (31) and spring (9) from straight shaft (15). Discard spring.

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

12. Remove retaining ring (33) from straight shaft (16). Discard retaining ring.
13. Remove machine screw (34), plain nut (35), and angle bracket (36) from governor cross shaft control lever assembly (37).
14. Remove governor cross shaft control lever assembly (37), two bearings (38), and two retaining rings (39) as an assembly, using a suitable puller (item 85, WP 0176), from straight shaft (16).
15. Remove two retaining rings (39) and two bearings (38) from governor cross shaft control lever assembly (37). Discard retaining rings and bearings.
16. Remove two machine screws (40) and two lock washers (41) securing electrical solenoid (42) to solenoid housing assembly (12). Discard lock washers.
17. Disengage rigid connecting link (43) from solenoid control housing (44) and remove electrical solenoid (42) with gasket (45). Discard gasket.
18. Remove spring pin (46), rigid connecting link (43), spring retainer (47), spring (48), and spring retainer (49) from electrical solenoid (42). Discard spring pin and spring.



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

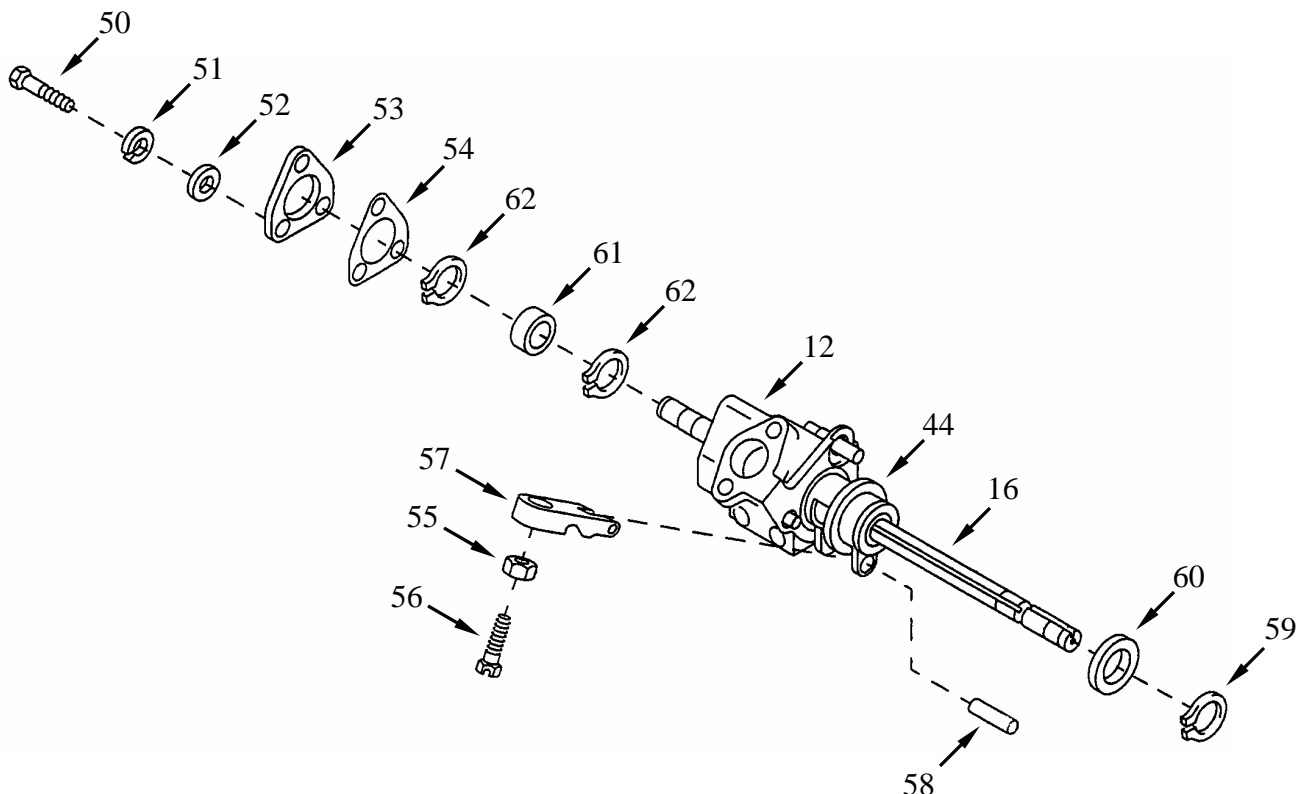
**DISASSEMBLY (Continued)**

19. Remove three screws (50), with lock washers (51), and flat washers (52) securing access cover (53) to solenoid housing assembly (12). Discard lock washers.
20. Remove access cover (53) and gasket (54). Discard gasket.
21. Loosen plain nut (55) and remove machine screw (56) from solenoid stop control (57).
22. Remove solenoid stop control (57) from pin (58) in solenoid control housing (44).

**WARNING**

**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

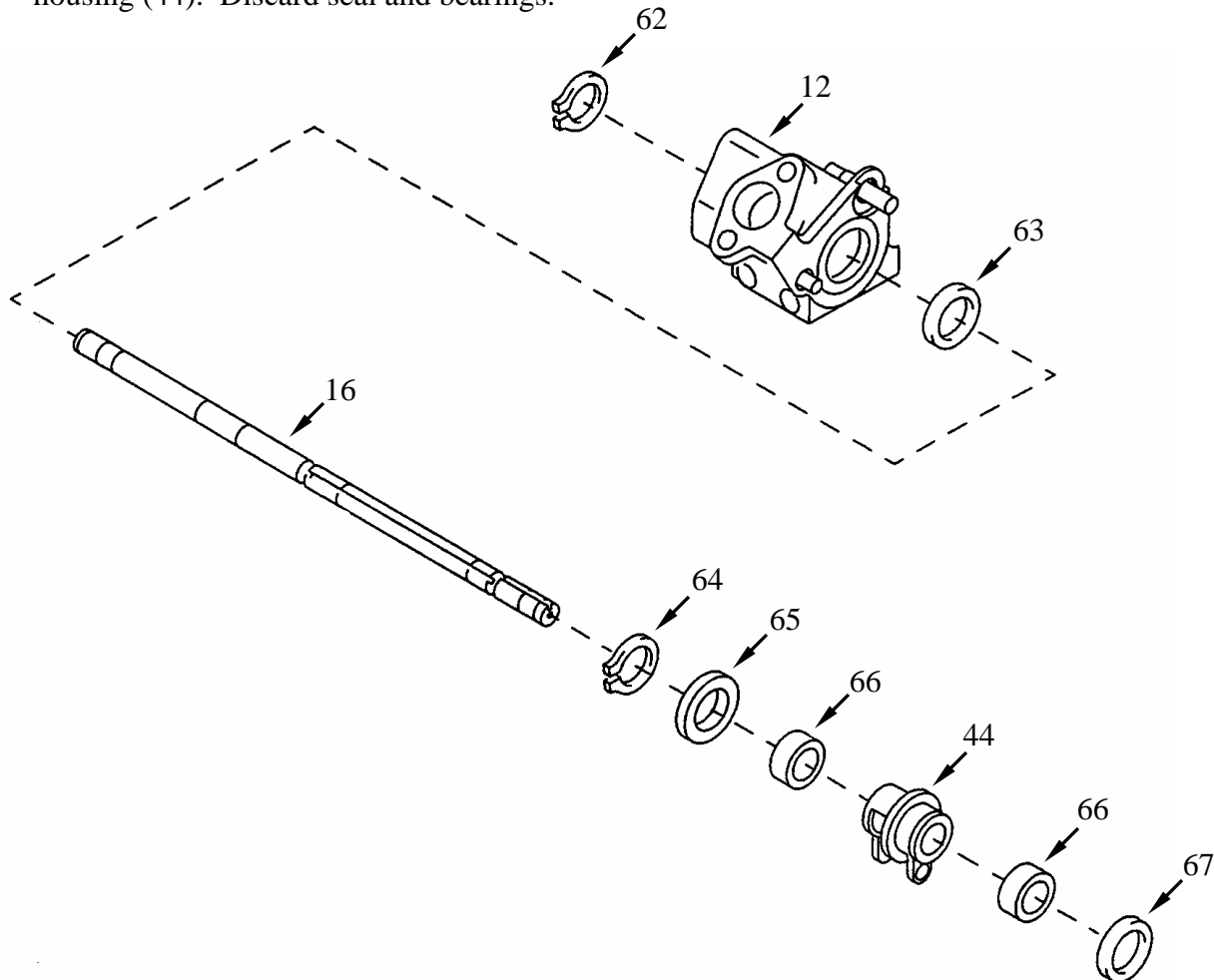
23. Remove outer retaining ring (59) and flat washer (60) from straight shaft (16). Discard retaining ring.
24. Slide straight shaft (16) through solenoid housing assembly (12) and solenoid control housing (44) until bearing (61) and two retaining rings (62) are exposed.
25. Remove and discard outer retaining ring (62).
26. Remove and discard bearing (61) using a suitable puller (item 85, WP 0176).



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)****0123 00****DISASSEMBLY (Continued)****WARNING**

**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

27. Remove inner retaining ring (62) and separate solenoid control housing (44) from solenoid housing (12). Discard retaining ring.
28. Remove solenoid housing (12) with plain encased seal (63) from straight shaft (16).
29. Remove and discard plain encased seal (63) from solenoid housing (12).
30. Remove inner retaining ring (64) and flat washer (65) securing solenoid control housing (44) to straight shaft (16). Discard retaining ring.
31. Remove solenoid control housing (44) with two needle bearings (66) and plain encased seal (67), from straight shaft (16).
32. Remove plain encased seal (67) and two needle bearings (66) from solenoid control housing (44). Discard seal and bearings.





**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

**INSPECTION**

**CLEANING**

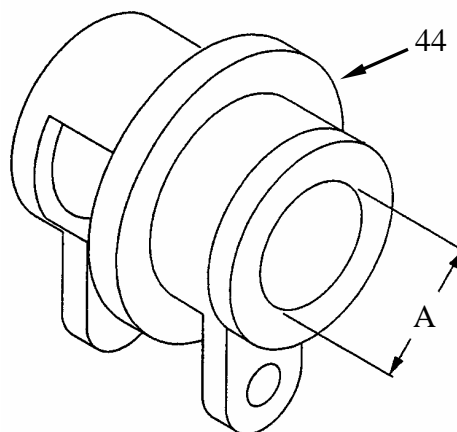
1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

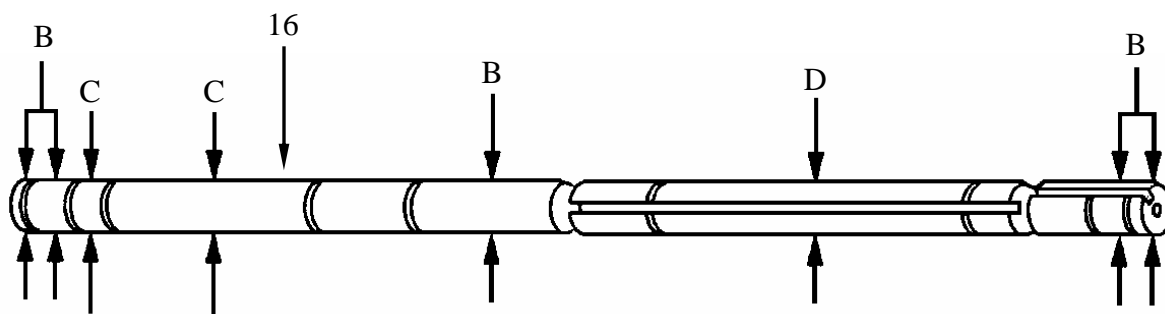
1. See Work Package 0028 for General Inspection Procedures.

2. Measure inside diameter (A) of solenoid control housing (44), using inside micrometer (item 16, WP 0176).
  - a. Replace solenoid control housing if measurement is not between 0.8120 inch (20.62 mm) and 0.8130 inch (20.65 mm).



3. Measure outside diameter of straight shaft (16) at points (B, C, and D), using outside micrometer (item 17, WP 0176).
  - a. Replace shaft if measurement is not within limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
B (Bearing areas)	0.6249 (15.87)	0.6252 (15.88)	0.6246 (15.86)
C (main shaft)	0.6245 (15.86)	0.6252 (15.88)	0.6240 (15.85)
D (Fuel shutoff lever)	0.6232 (15.83)	0.6252 (15.88)	0.6217 (15.79)



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

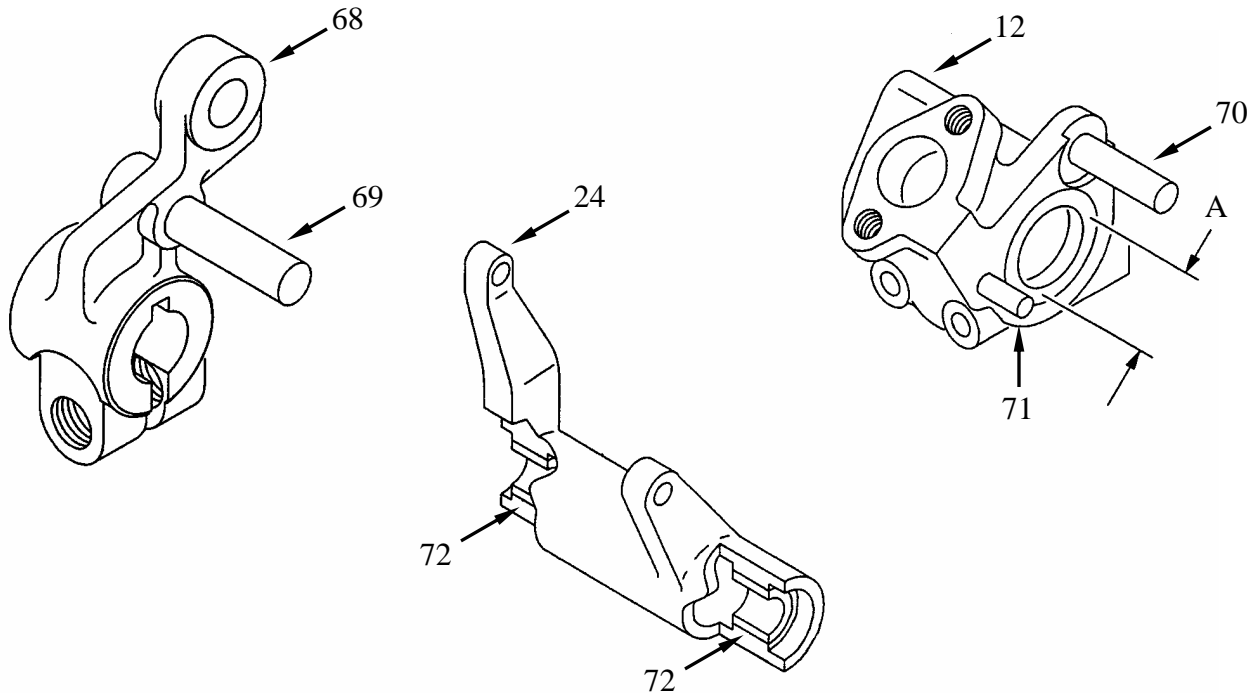
**0123 00**

**INSPECTION (Continued)**

4. Visually inspect throttle lever housing (68), pin (69), solenoid housing assembly (12) and pins (70 and 71). Refer to WP 0028.
5. Measure inside diameter (A) of solenoid housing (12). Replace solenoid housing (12) if not within limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (solenoid housing)	1.3750 (34.925)	1.3756 (34.940)	1.3758 (34.945)

6. Visually inspect fuel shutoff lever assembly (24). Refer to WP 0028. (Sleeve bearings (72) will be replaced in "Repair" of this work package.)



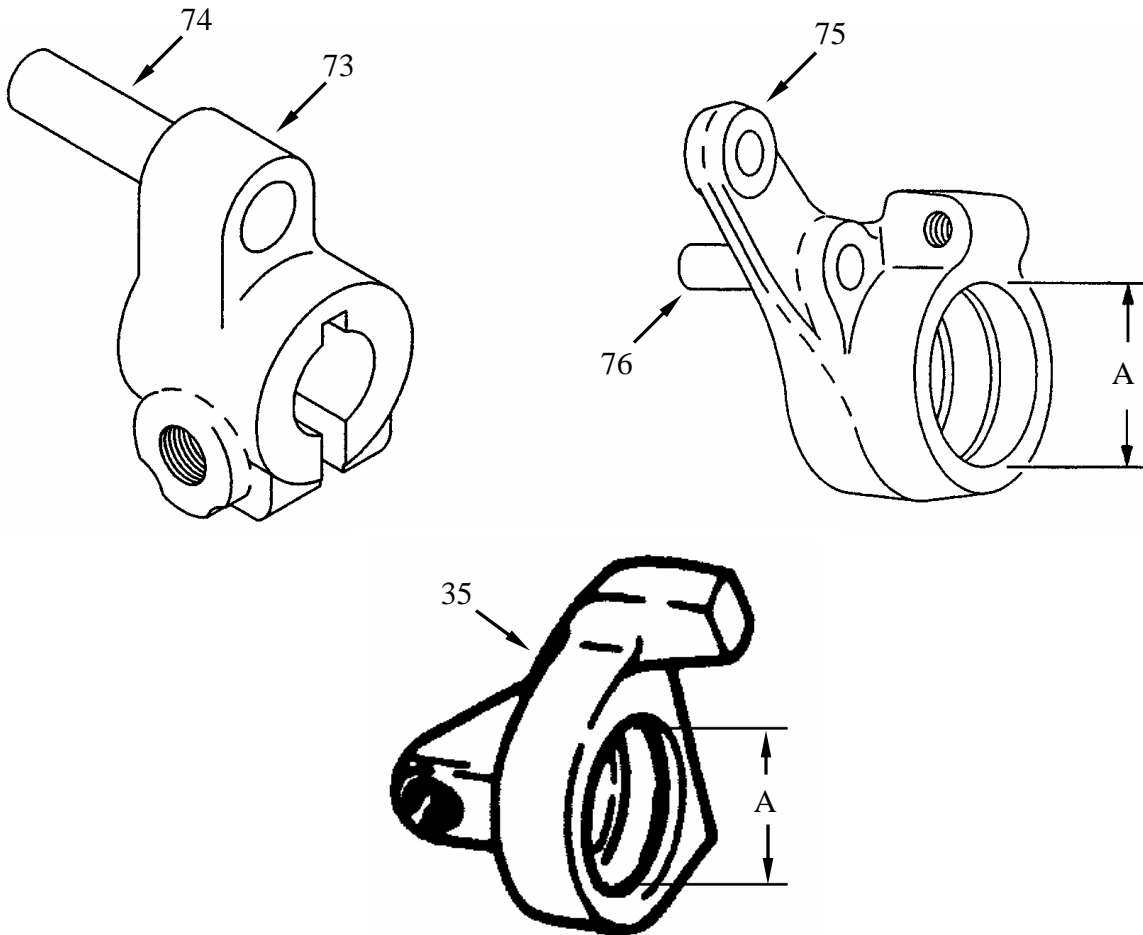
**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

**INSPECTION (Continued)**

7. Visually inspect throttle lock control lever housing (73) and pin (74). Refer to WP 0028.
8. Visually inspect governor cross shaft control lever housing (75) and pin (76). Refer to WP 0028.
9. Measure inside diameter (A) of governor cross shaft control lever housing (75) and cross shaft bracket (35). Replace if not within the limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter)	1.3740 (34.8996)	1.3746 (34.9148)	1.3751 (34.9275)



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

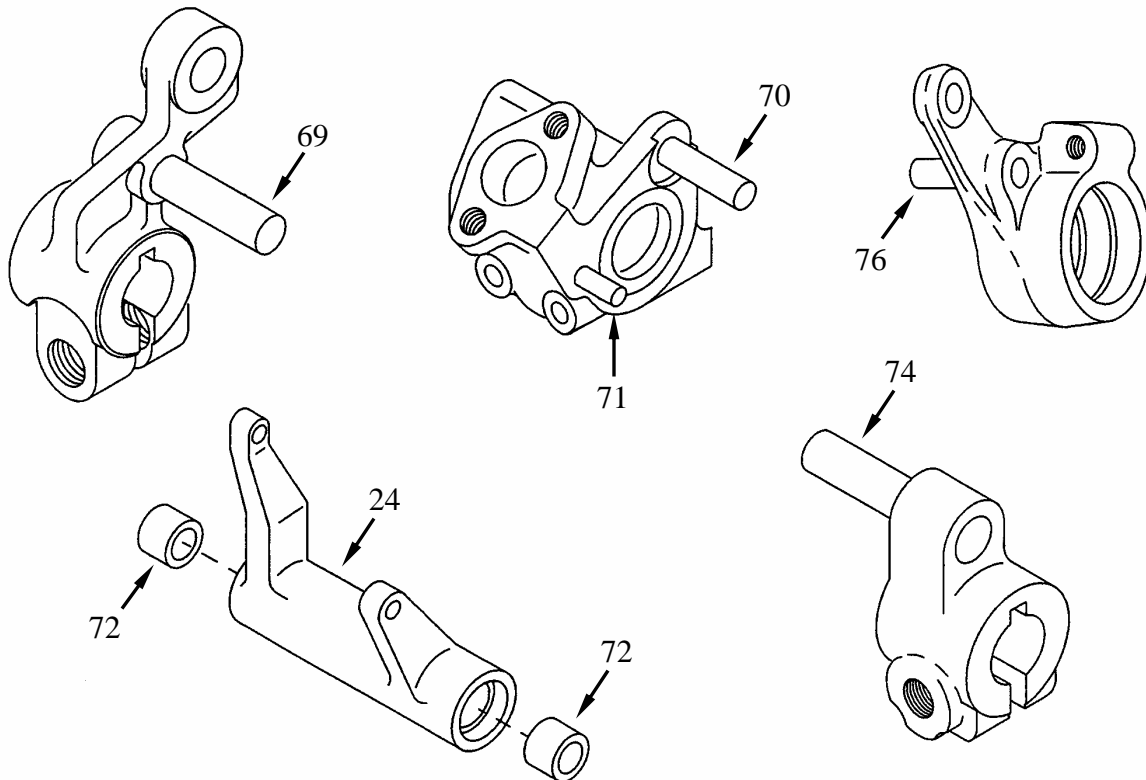
**REPAIR**

1. Replace loose, bent, or damaged pins (69, 70, 71, 74, and 76). Refer to WP 0028.
2. Replace sleeve bearings (72).
  - a. Remove and discard two sleeve bearings (72) in fuel shutoff lever assembly (24).
  - b. Install two new sleeve bearings (72) (item 25, WP 0175) in fuel shutoff lever assembly (24).

**NOTE**

**Sleeve bearings must be installed 0.250 inch (6.35 mm) inboard of end surface of lever.**

- c. Ream two sleeve bearings (72) to a diameter of 0.6270-0.6290 inch (15.926-15.977 mm), using reamer (item 92, WP 0176).



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

**ASSEMBLY**

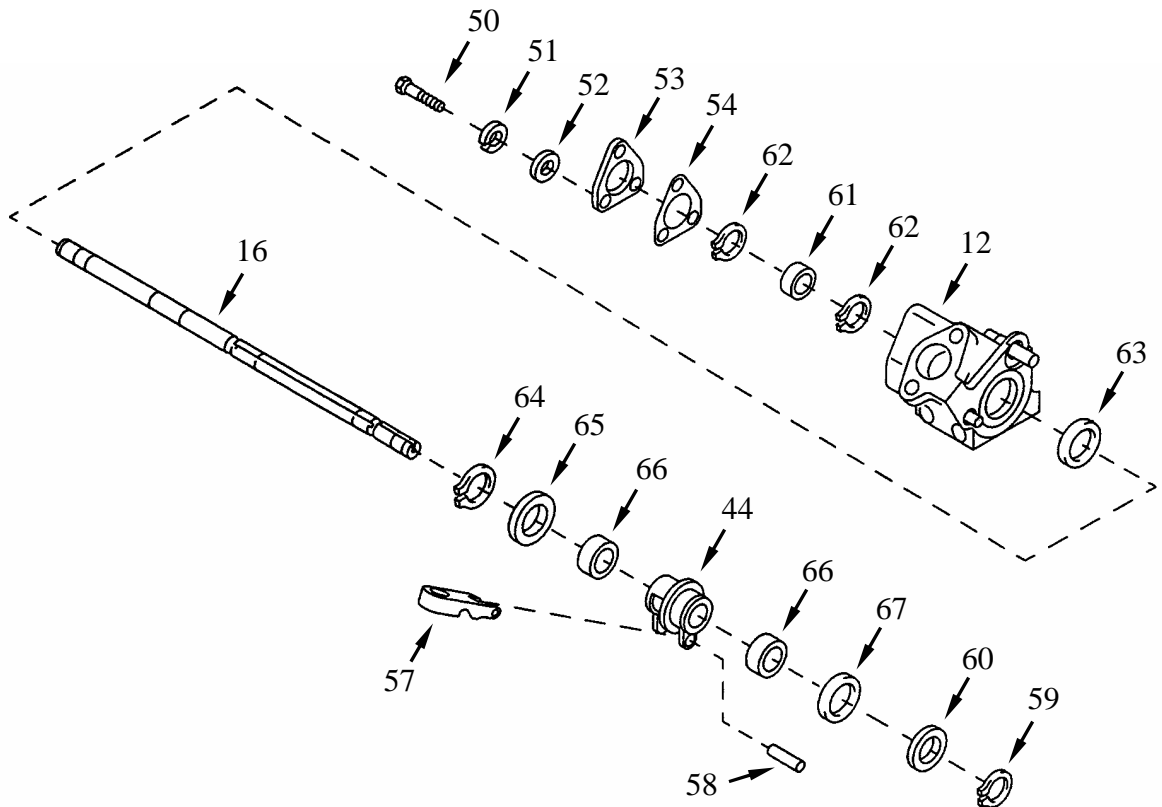
1. Install two new needle bearings (66) (item 22, WP 0175) and a new plain encased seal (67) (item 275, WP 0175) in solenoid control housing (44).

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

2. Install solenoid control housing (44) on straight shaft (16) with two flat washers (60 and 65) and new retaining rings (59) (item 12, WP 0175) and (64) (item 8, WP 0175), using snap ring pliers (item 81, WP 0176).
3. Install solenoid stop control (57) on pin (58) in solenoid control housing (44).
4. Install a new plain encased seal (63) (item 189, WP 0175) in solenoid housing assembly (12).
5. Install a new retaining ring (62) (item 8, WP 0175) on straight shaft (16) then install solenoid housing assembly (12) on straight shaft (16) and over solenoid control housing (44).
6. Install new bearing (61) (item 322, WP 0175) in solenoid housing assembly (12) and secure to straight shaft (16) with a new retaining ring (62) (item 8, WP 0175).
7. Install new gasket (54) (item 188, WP 0175) and access cover (53) on solenoid housing assembly (12).
8. Secure access cover (53) to housing assembly (12) using three screws (50), with new lock washers (51) (item 92, WP 0175), and three flat washers (52).



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

**ASSEMBLY (Continued)**

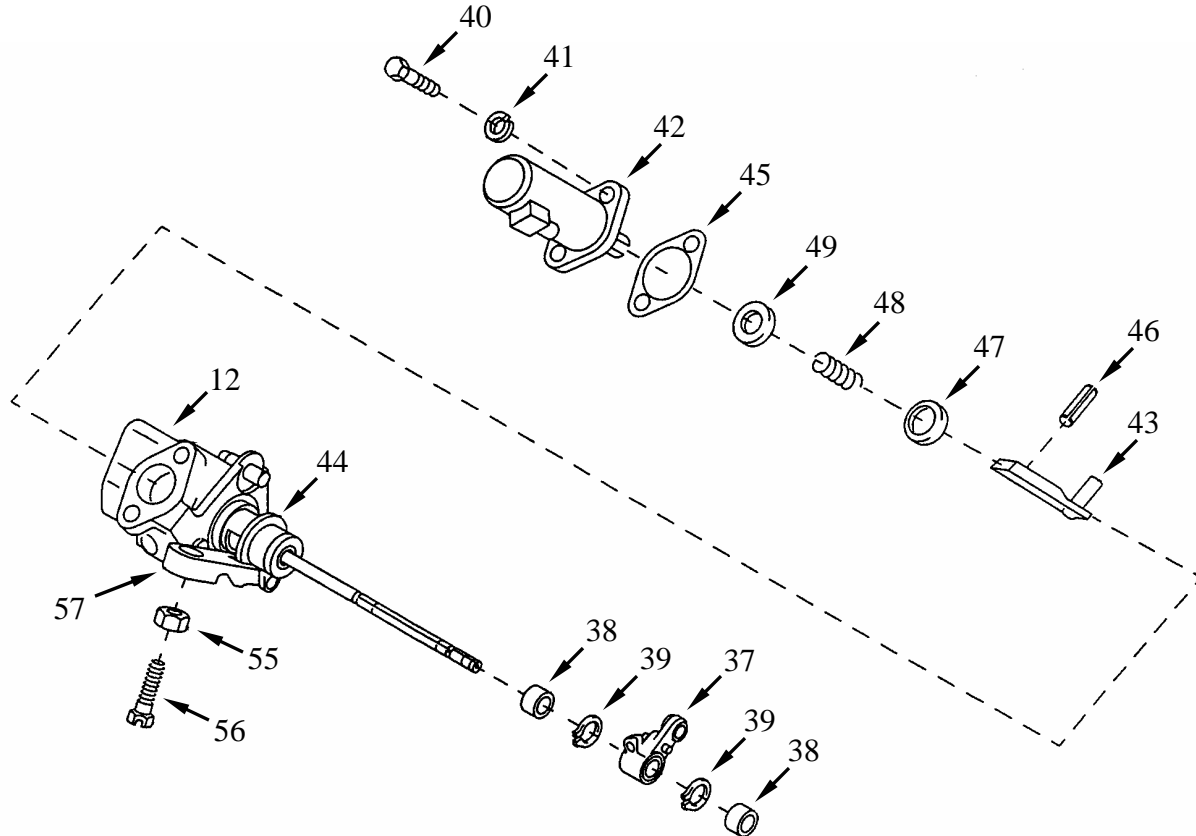
9. Install machine screw (56) and plain nut (55) in solenoid stop control (57).
10. Install spring retainer (49), new spring (48) (item 221, WP 0175), spring retainer (47), rigid connecting link (43), and new spring pin (46) (item 24, WP 0175) on electrical solenoid (42).
11. Install a new gasket (45) (item 187, WP 0175) on electrical solenoid (42).
12. Install electrical solenoid (42) on solenoid housing assembly (12) while engaging rigid connecting link (43) with solenoid control housing (44).
13. Secure electrical solenoid (42) to solenoid housing assembly (12) using two screws (40) and two new lock washers (41) (item 92, WP 0175).

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

14. Install two new retaining rings (39) (item 12, WP 0175) and two new bearings (38) (item 322, WP 0175) in remote control lever (37).



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

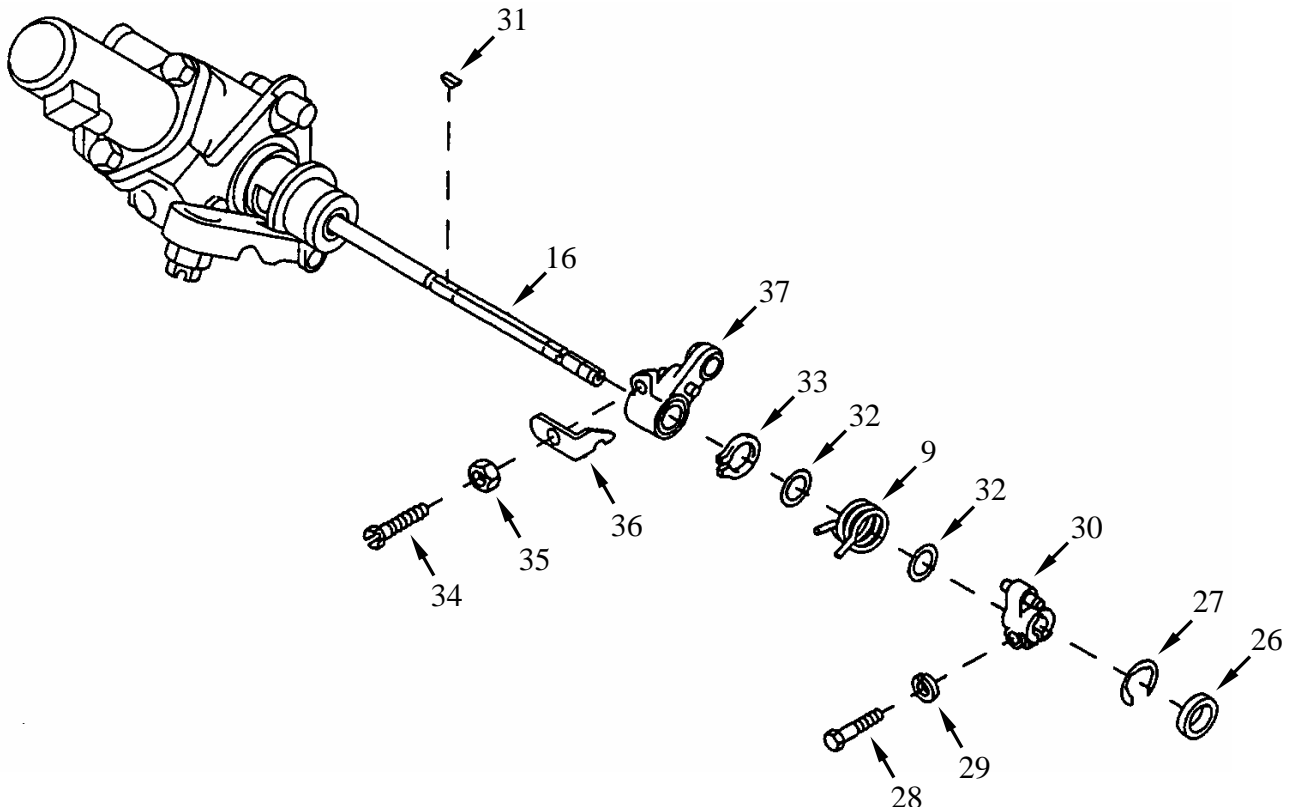
**ASSEMBLY (Continued)**

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

15. Install assembled remote control lever (37) on straight shaft (16) and secure with a new retaining ring (33) (item 8, WP 0175), using snap ring pliers (item 81, WP 0176).
16. Install angle bracket (36) on remote control lever (37) using machine screw (34) and plain nut (35).
17. Install two throttle control spacers (32) and new spring (9) (item 264, WP 0175) on straight shaft (16).
18. Install a new woodruff key (31) (item 103, WP 0175) on straight shaft (16).
19. Install remote control lever (30) on straight shaft (16).
20. Install screw (28) and a new lock washer (29) (item 93, WP 0175) on remote control lever (30).
21. Install a new retaining ring (27) (item 21, WP 0175) and flat washer (26) on straight shaft (16).



**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

**ASSEMBLY (Continued)**

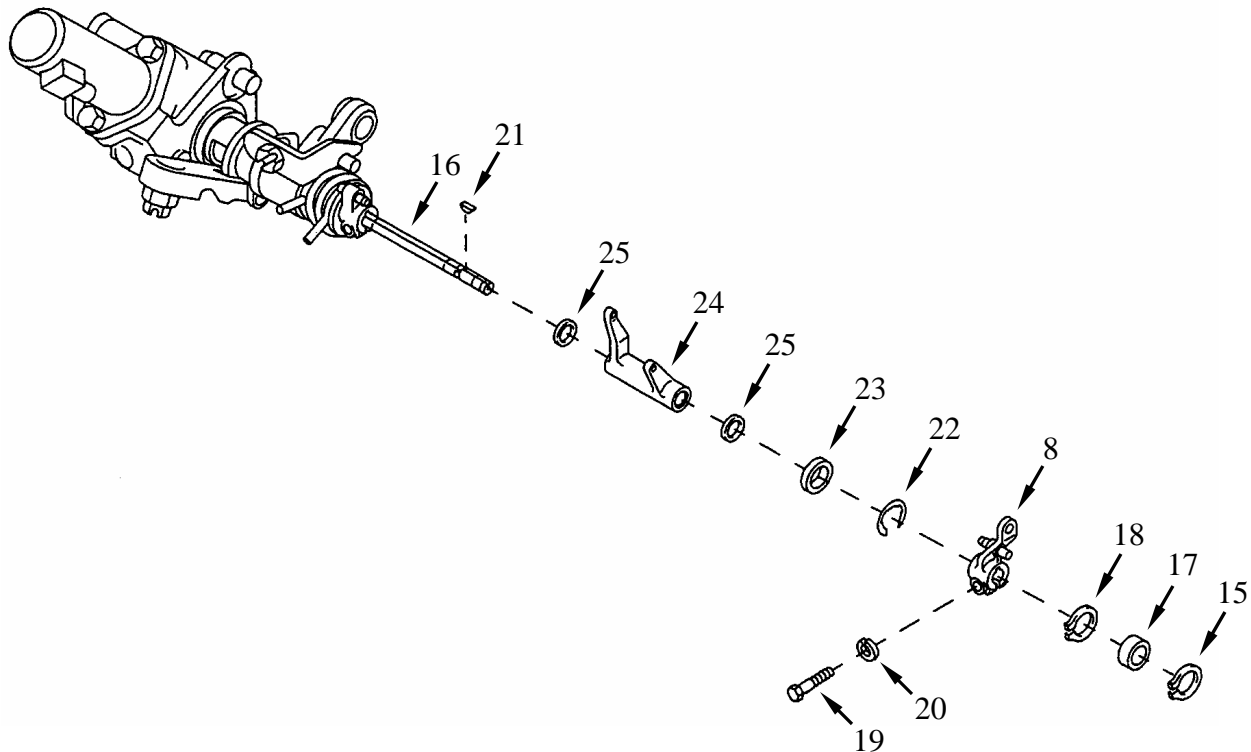
22. Install two new plain seals (25) (item 226, WP 0175) in fuel shutoff lever assembly (24).

**WARNING**



**Retaining rings are spring tension devices: take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

23. Install fuel shutoff lever assembly (24) on straight shaft (16) and secure with flat washer (23) and a new retaining ring (22) (item 21, WP 0175).
24. Install a new woodruff key (21) (item 103, WP 0175) on straight shaft (16).
25. Install remote control lever (8) on straight shaft (16).
26. Install screw (19) and a new lock washer (20) (item 93, WP 0175) on remote control lever (8).
27. Install a new retaining ring (18) (item 8, WP 0175), new bearing (17) (item 322, WP 0175), and new retaining ring (15) (item 8, WP 0175) on straight shaft (16).





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**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

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0123 00

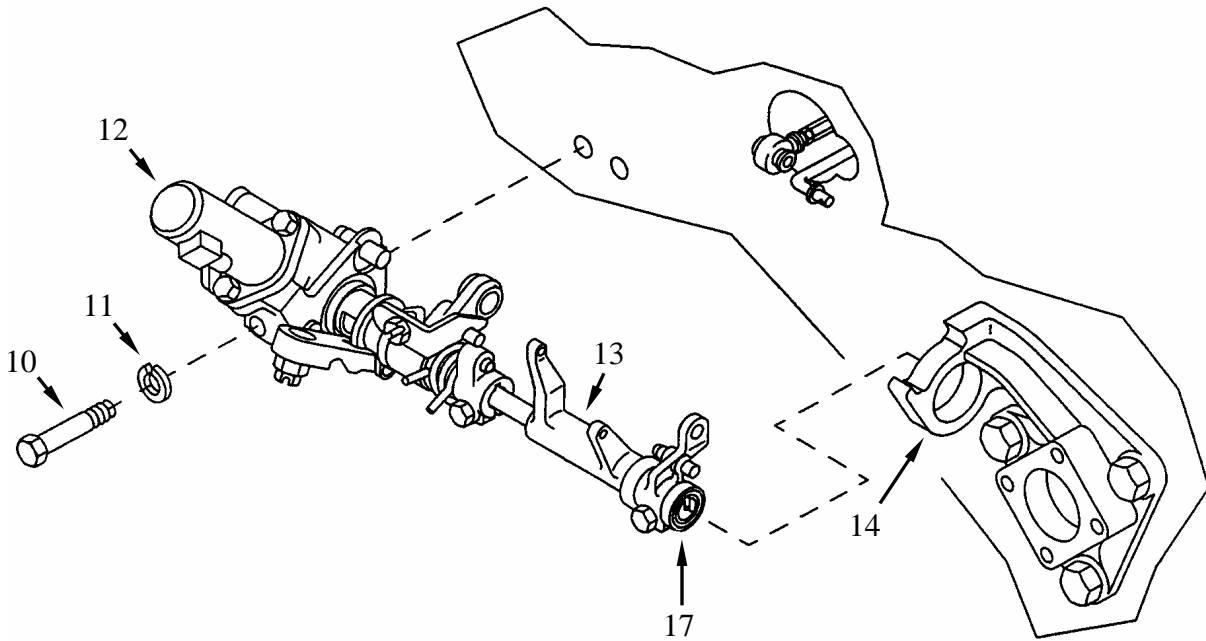
**INSTALLATION**

1. Install throttle control assembly (13) by sliding bearing (17) in pump drive adapter assembly (14).

**NOTE**

**Throttle control assembly may have to be tapped with a soft hammer to install bearing in pump drive adapter assembly.**

2. Secure solenoid housing assembly (12) using two screws (10) with new lock washers (11) (item 92, WP 0175).

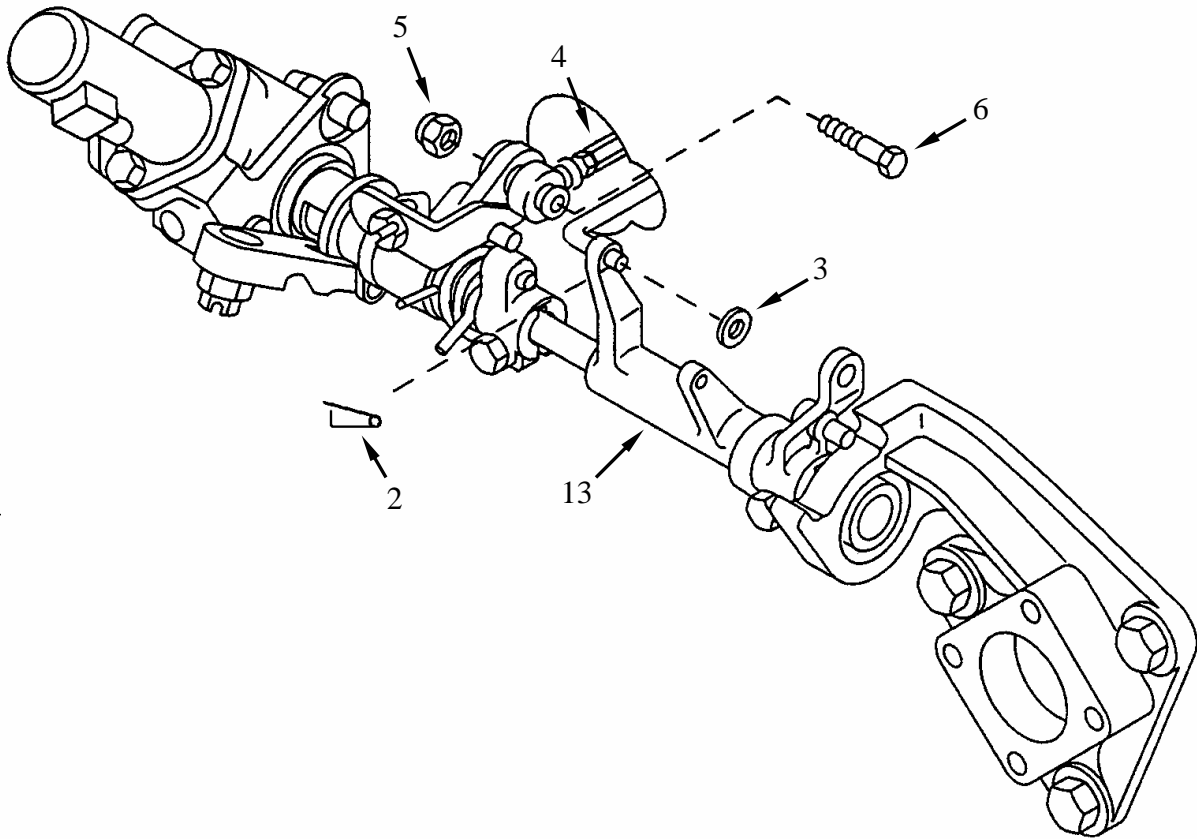


**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

**0123 00**

**INSTALLATION (Continued)**

3. Attach control rod assembly (4) to throttle control assembly (13) using screw (6) and a new self-locking nut (5) (item 38, WP 0175).
  
4. Attach rigid connecting link (1) to throttle control assembly (13) using flat washer (3) and safety pin (2) (item 1, WP 0175).

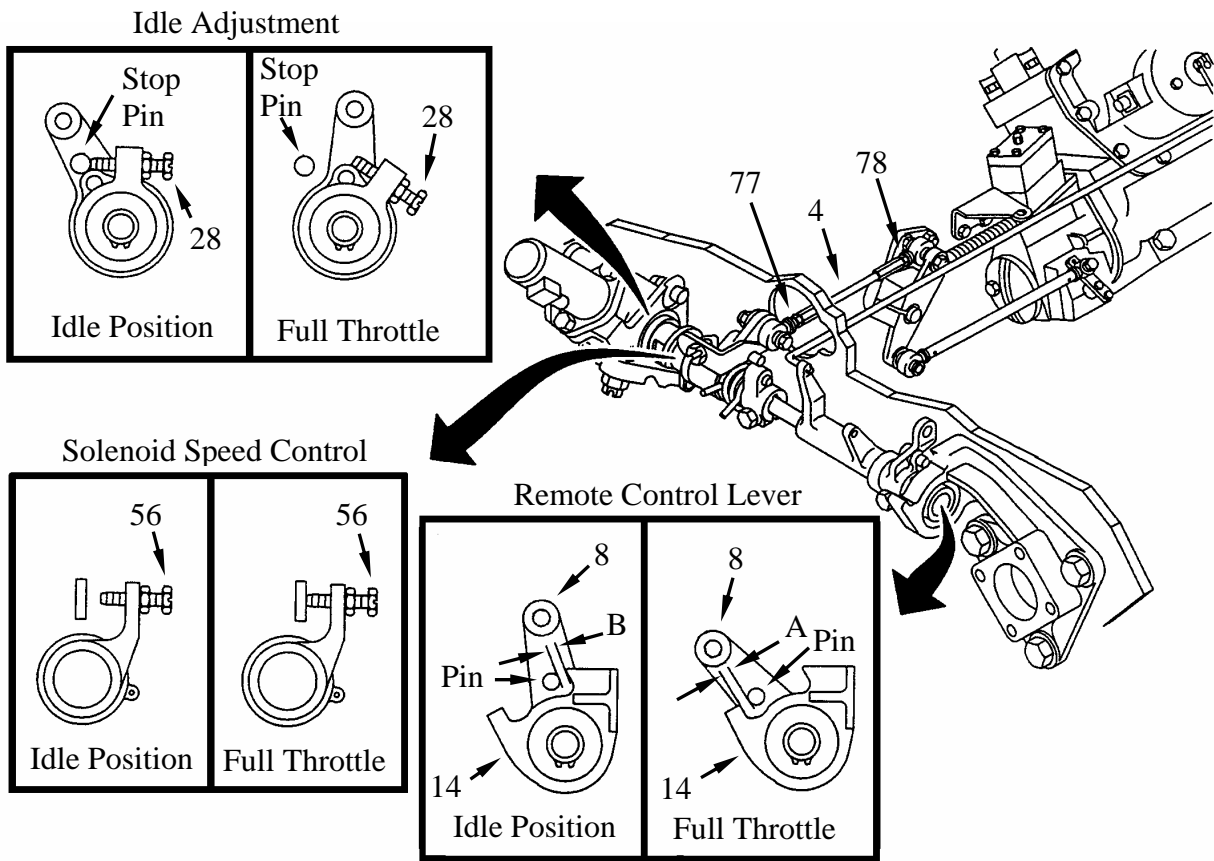


**THROTTLE CONTROL SOLENOID ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR (2DR)**

0123 00

**ADJUSTMENT**

1. With the throttle linkage in full throttle position (A), clearance between stop pin of remote control lever (8) and pump drive adapter assembly (14) must be 1/8 inch (3.175 mm) nominal.
2. With the throttle linkage in idle position (B), clearance between stop pin of remote control lever (8) and pump drive adapter assembly (14) must be 3/16 inch (4.7625 mm) minimum.
3. When the foregoing clearances are not met, loosen lock nuts (77, right-hand thread) and (78, left-hand thread) on control rod assembly (4), and adjust as necessary to obtain required clearance.
4. Tighten lock nuts (77 and 78) after adjustment.



**NOTE**

**Engine idle adjustment and solenoid speed control adjustments are made with the engine running. Engine idle is controlled with the idle adjustment screw (28), and solenoid speed control is adjusted with solenoid speed adjustment screw (56). See Work Package 0043.**

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121 WP 0176)  
 Snap ring pliers (item 81, WP 0176)  
 Outside micrometer caliper set (item 17, WP 0176)  
 Telescoping gauge set (item 54, WP 0176)  
 Spring tester (item 117, WP 0176)

**Mandatory Replacement Parts:**

Bearing (2) (item 322, WP 0175)  
 Lock washers (4) (item 93, WP 0175)  
 Pin, retaining, safety (2) (item 1, WP 0175)  
 Retaining rings (4) (item 12, WP 0175)  
 Retaining rings (2) (item 21, WP 0175)

**Mandatory Replacement Parts:**

Self-locking nuts (3) (item 33, WP 0175)  
 Self-locking nuts (4) (item 38, WP 0175)  
 Spring (1) (item 258, WP0175)  
 Woodruff key (1) (item 103, WP 0175)

**Expendable Materials**

Safety goggles (item 17, WP 0173)  
 Lubricant (item 21, WP 0173)

**Personnel Required**

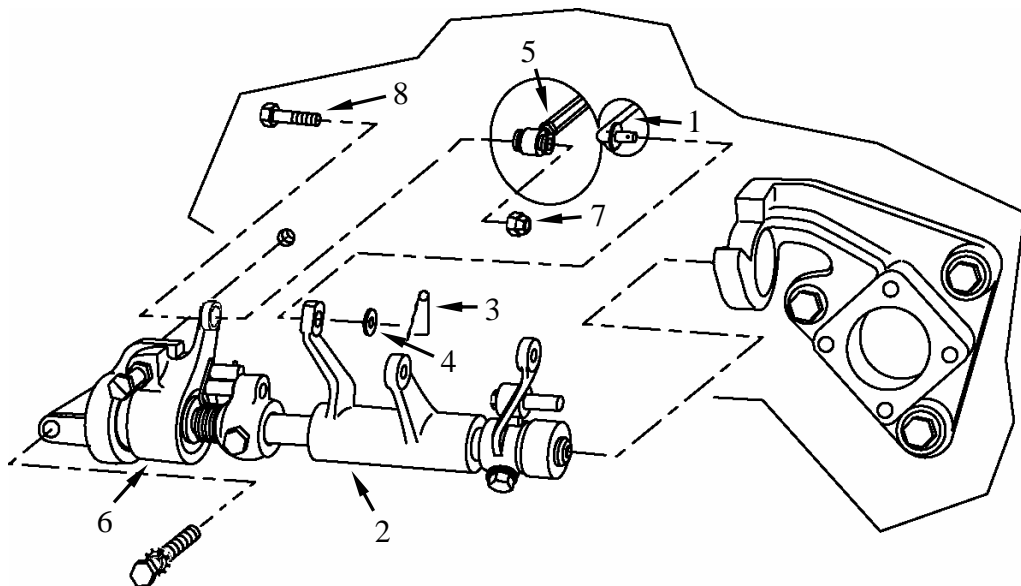
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface  
 Fans and covers removed (0054)

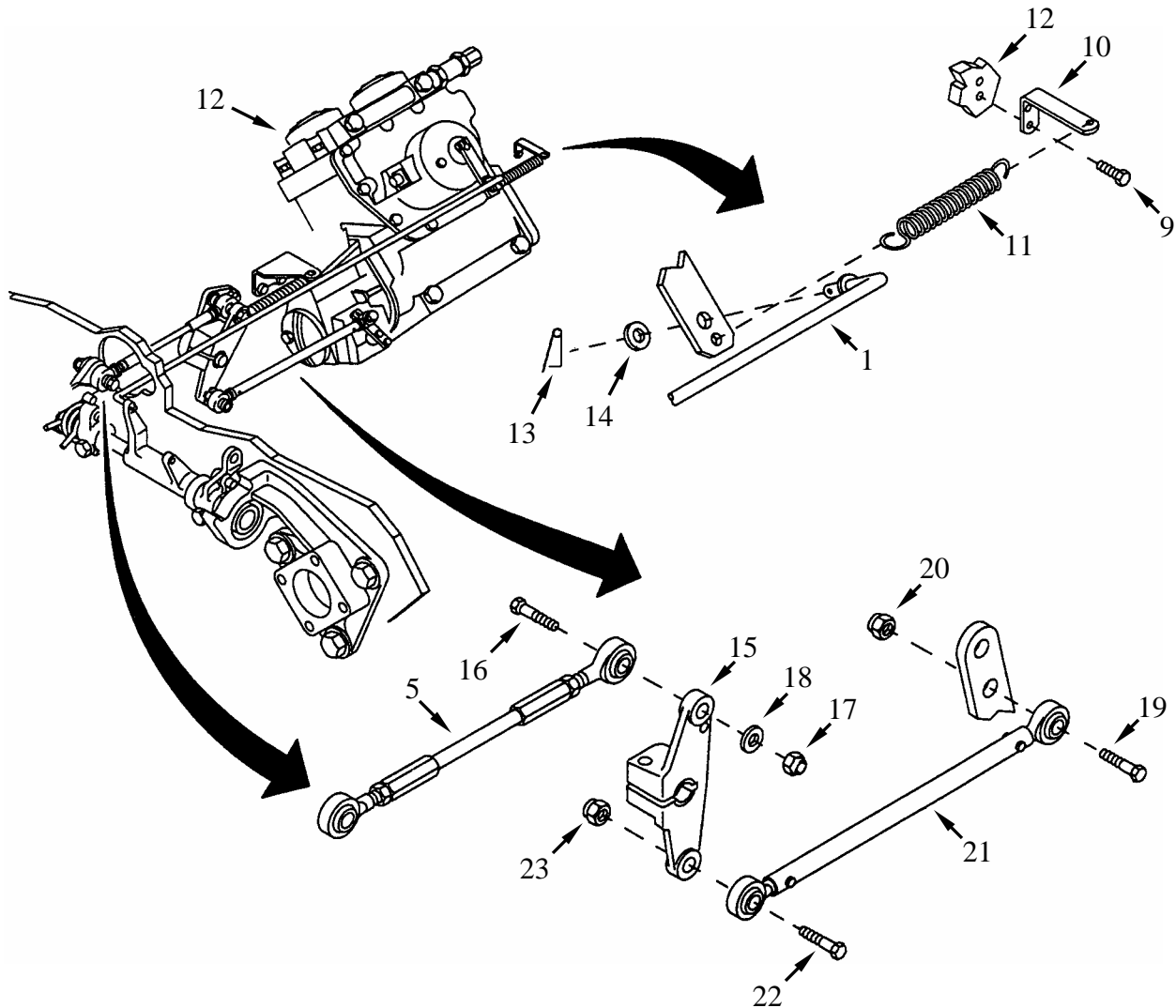
**REMOVAL**

1. Disconnect rigid connecting link (1) from remote control lever (2) by removing safety pin (3) and flat washer (4).
2. Disconnect control rod assembly (5) from remote lever (6) by removing self-locking nut (7) and screw (8). Discard self-locking nut.



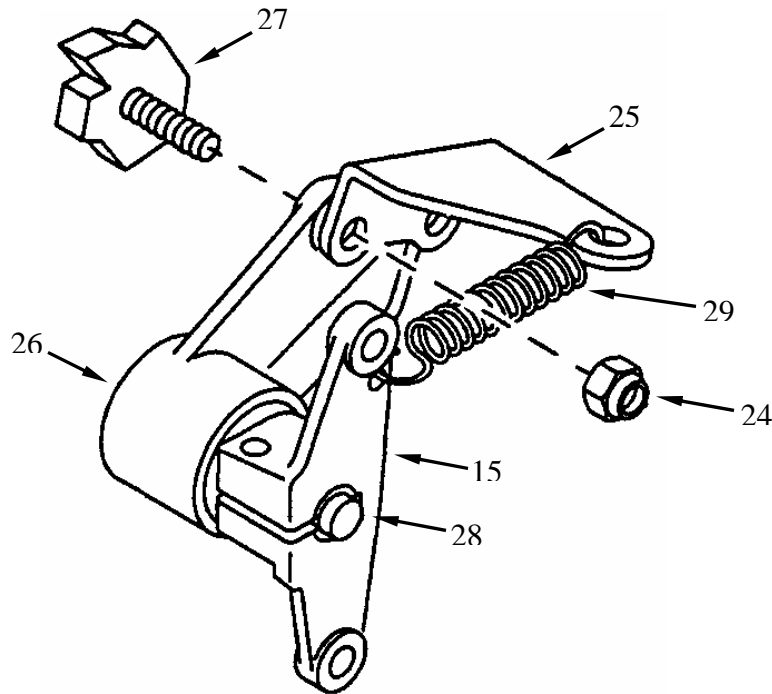
**REMOVAL (Continued)**

3. Remove two screws (9), angle bracket (10), and spring (11) from injection pump (12).
4. Disconnect and remove rigid connecting link (1) from injection pump (12) by removing safety pin (13) and flat washer (14).
5. Disconnect and remove control rod assembly (5) from bell crank (15) by removing screw (16), self-locking nut (17), and flat washer (18). Discard self-locking nut.
6. Remove screw (19) and self-locking nut (20) from governor control rod (21) at injection pump (12). Discard self-locking nut.
7. Disconnect and remove governor control rod assembly (21) from bell crank (15) by removing screw (22) and self-locking nut (23). Discard self-locking nut.



**REMOVAL (Continued)**

8. Remove three self-locking nuts (24) securing angle bracket (25) and rotating eye bracket (26) to fan housing (27). Discard self-locking nuts.
9. Remove rotating eye bracket (26), straight shaft (28), bell crank (15), angle bracket (25), and spring (29) as a unit.



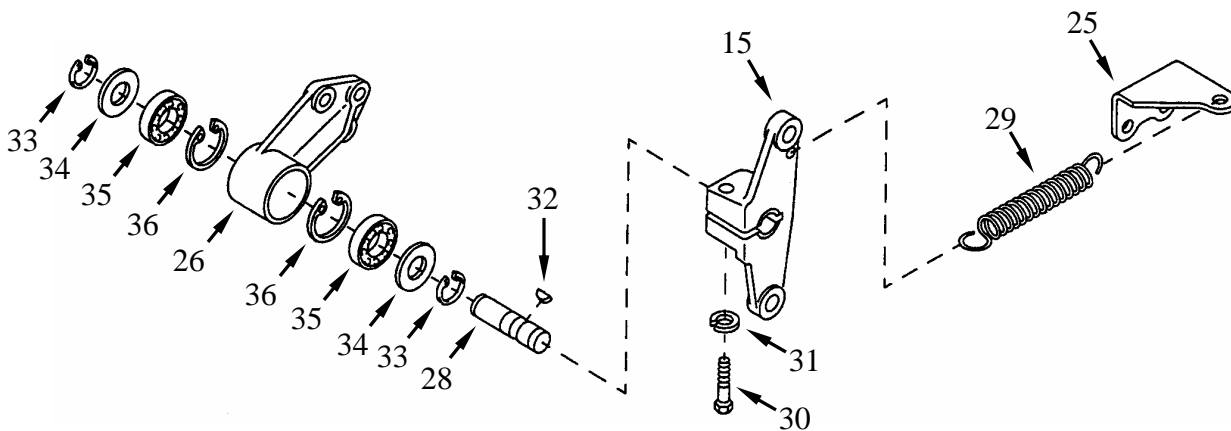
**DISASSEMBLY**

1. Remove and discard spring (29) from angle bracket (25) and from rotating eye bracket (26).
2. Remove screw (30) and lock washer (31) from bell crank (15). Discard lock washer.
3. Remove bell crank (15) and woodruff key (32) from straight shaft (28). Discard woodruff key.

**WARNING**

**Retaining rings are spring tension devices, take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

4. Remove two retaining rings (33), and two bearing shields (34) from straight shaft (28). Discard retaining rings.
5. Remove straight shaft (28) from rotating eye bracket (26).
6. Remove and discard two ball bearings (35) and two retaining rings (36) from rotating eye bracket (26).





**CLEANING**

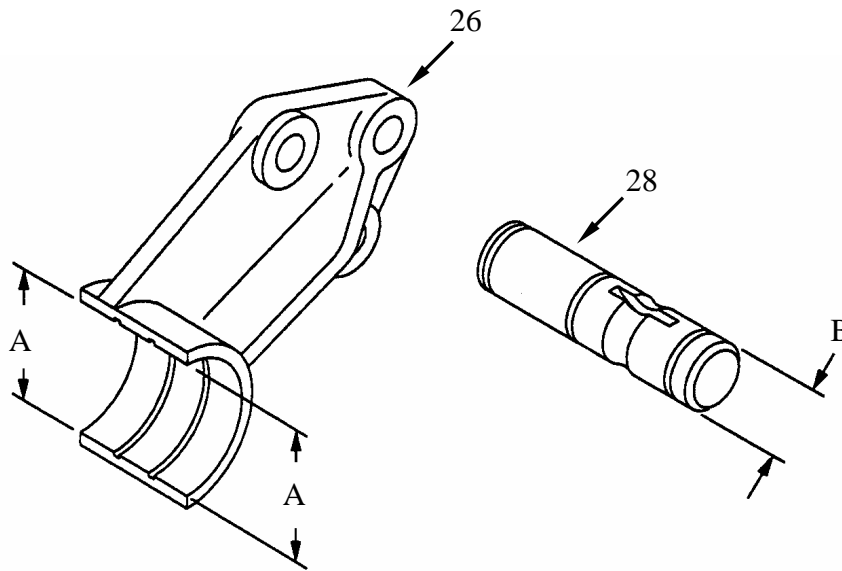
1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 00 for General Inspection Procedures.
2. Measure inside diameter (A) of rotating eye bracket (26), using inside micrometer (item 16, WP 0175). Replace rotating eye bracket if not within limits in the following table.
3. Measure outside diameter (B) of straight shaft (28), using outside micrometer (item 17, WP 01756). Replace straight shaft if not within limits in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter)	1.3740 (34.9996)	1.3746 (34.918)	1.3748 (34.9299)
B (outside diameter)	0.6249 (15.8724)	0.6252 (15.8860)	0.6248 (15.8699)



**NOTE**

**Inspection and repair of throttle/governor control rod assembly (adjustable) (21) and throttle/governor control rod (rigid) are covered in separate work packages (WP 0125 and 0126 respectively).**

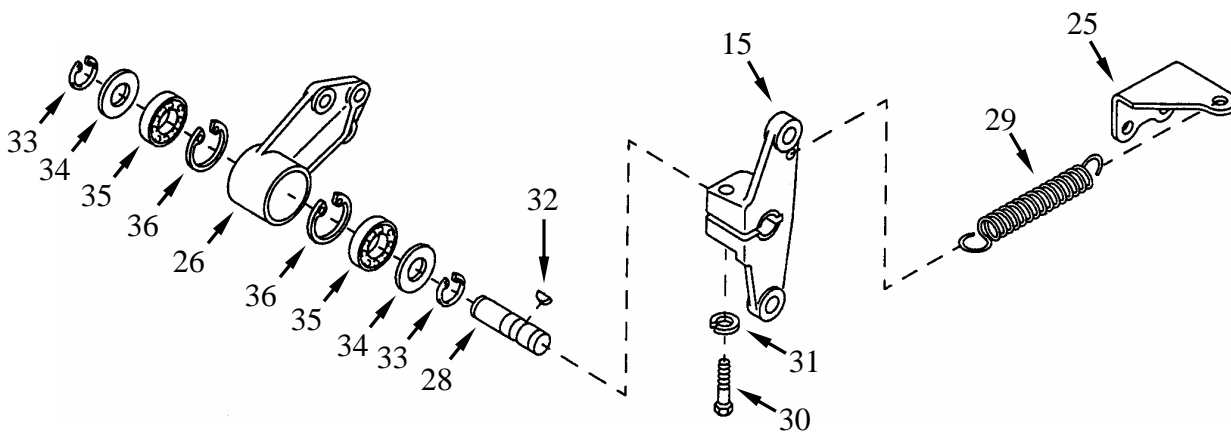
## ASSEMBLY

## WARNING



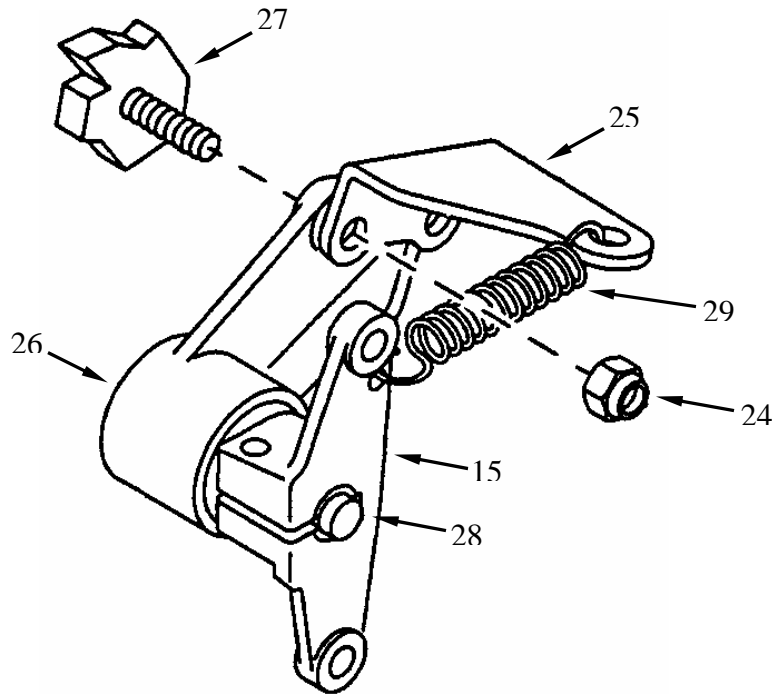
**Retaining rings are spring tension devices, take care when removing or installing them. They can slip or break and become airborne causing eye damage or other bodily harm.**

1. Install two new retaining rings (36) (item 12, WP1075) and two new ball bearings (35) (item 322, WP 0175) into rotating eye bracket (26).
2. Install straight shaft (28) into rotating eye bracket (26).
3. Install two bearing shields (34) and two new retaining rings (33) (item 21, WP 0175) on straight shaft (28).
4. Install new woodruff key (32) (item 103, WP 0175) in straight shaft (28).
5. Install bell crank (15) onto straight shaft (28).
  - a. Secure using screw (30) and new lock washer (31) (item 93, WP 0175).
6. Attach new spring (29) (item 258, WP 0175) to angle bracket (25) and to rotating eye bracket (26).



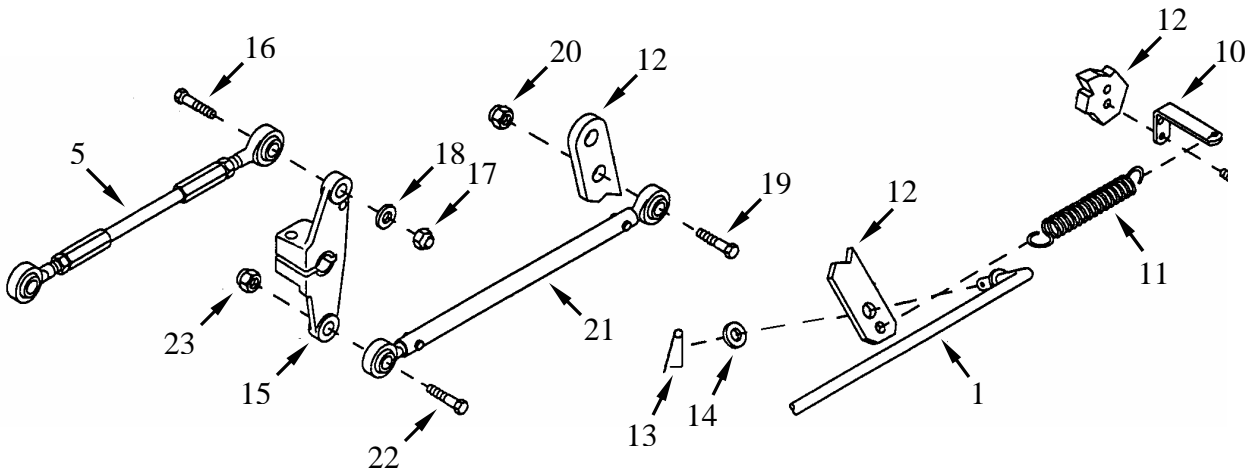
**INSTALLATION**

1. Install assembled rotating eye bracket (26), straight shaft (28), bell crank (15), angle bracket (25), and spring (29) as a unit on fan housing.
  - a. Secure using three new self-locking nuts (24) (item 33, WP0175)



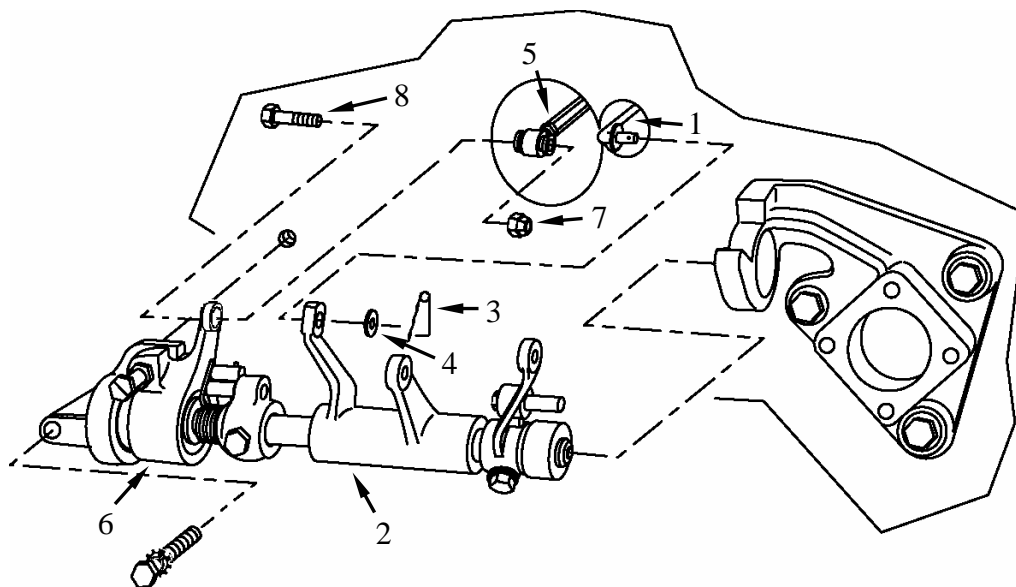
**INSTALLATION (Continued)**

2. Go to Work Package 0125 "Governor Control Rod Assembly Repair" for inspection and repair of governor control rod assembly (21).
3. Attach governor control rod assembly (21) to bell crank (15) using screw (22) and a new self-locking nut (23) (item 38, WP 0175).
4. Attach governor control rod assembly (21) to metering pump (12) using screw (19), and a new self-locking nut (20) (item 38, WP 0175).
5. Go to Work Package 0123 "Throttle Control Rod Assembly Repair" for inspection and repair of control rod assembly (5).
6. Attach throttle control rod assembly (5) to bell crank (15) using screw (16), flat washer (18), and a new self-locking nut (17) (item 38, WP 0175).
7. Attach rigid connecting link (1) to metering pump (12) using flat washer (14) and safety pin (13) (item 1, WP 0175).
8. Attach spring (11) to injection pump (12) and to angle bracket (10).
9. Install angle bracket (10), with spring (11) attached, to metering pump (12) using two screws (9).



**INSTALLATION (Continued)**

10. Attach control rod assembly (5) to remote control lever (6) using screw (8) and a new self-locking nut (7) (item 38, WP 0175).
11. Attach rigid connecting link (1) to remote control lever (2) using flat washer (4) and safety pin (3) (item 1, WP 0175).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Cleaning, Inspection, and Repair

---

**INITIAL SETUP:**

**Tools:**

- Dial indicator (item 65, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)

**Personnel Required**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine removed from vehicle and placed on a flat stationary surface
  - Throttle linkage and associated parts removed (WP 0124)
- 

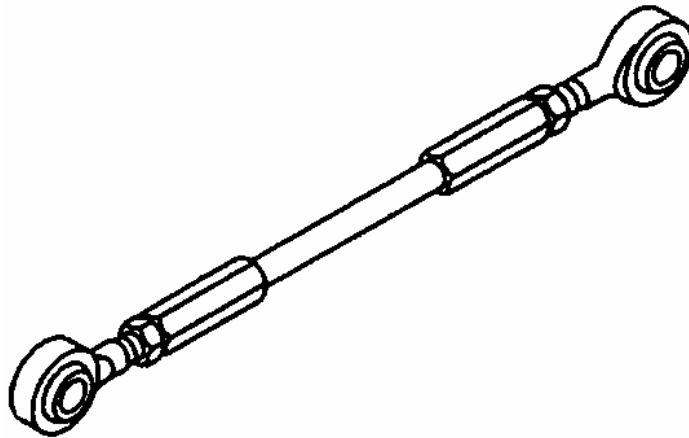
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

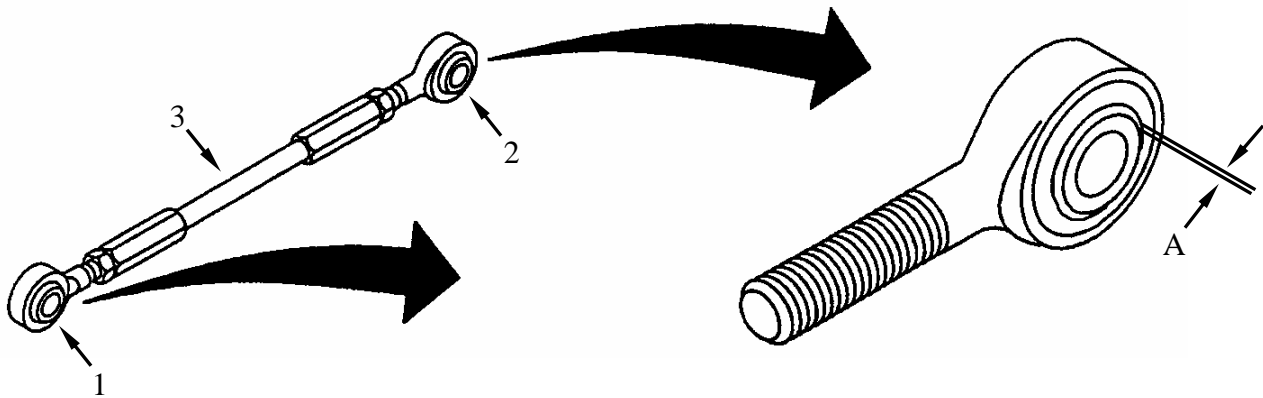
1. See Work Package 0028 for General Inspection Procedures.



**INSPECTION (Continued)**

2. Measure the clearance (A) between ball and socket (endplay) of two rod end/bearings (1, 2) at ends of governor control rod (3) using a dial indicator (item 65, WP 0176). Replace rod end/bearing if not within the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Bearing endplay)	0.0005 (0.0127)	0.0015 (0.0381)	0.0020 (0.0508)

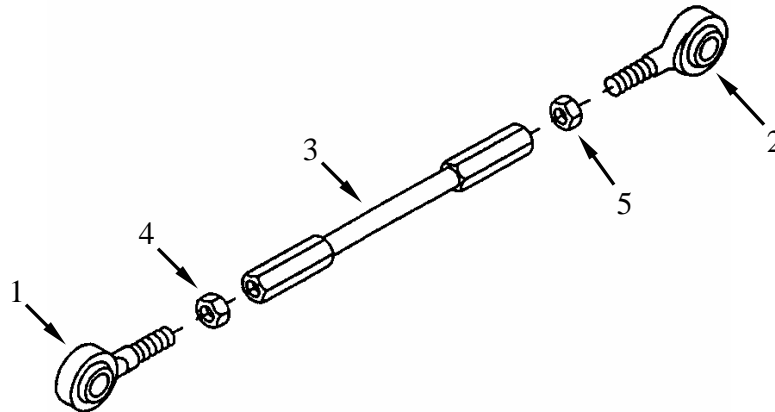


**REPAIR**

**NOTE**

**Either rod end/bearing (1 or 2) can be repaired in the same manner, only one end is described. One end is right-hand thread, and the opposite end is left-hand thread.**

1. Remove rod end/bearing (1 or 2) from control rod (3) by loosening nut (4 or 5) and then turning rod end/bearing.
2. Install new rod end/bearing (1 or 2), then set length to approximately 10.92 inches (277.3680 mm) and tighten nut (4, 5).



**END OF WORK PACKAGE**



**THROTTLE/GOVERNOR CONTROL ROD (RIGID) ASSEMBLY REPAIR**

**0126 00**

**THIS WORK PACKAGE COVERS:**

Inspection and Repair

**INITIAL SETUP:**

**Tools:**

- Dial indicator (item 65, WP 0176)
- Drill bit, 1/8-inch (item 10, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Portable electric drill (item 34, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

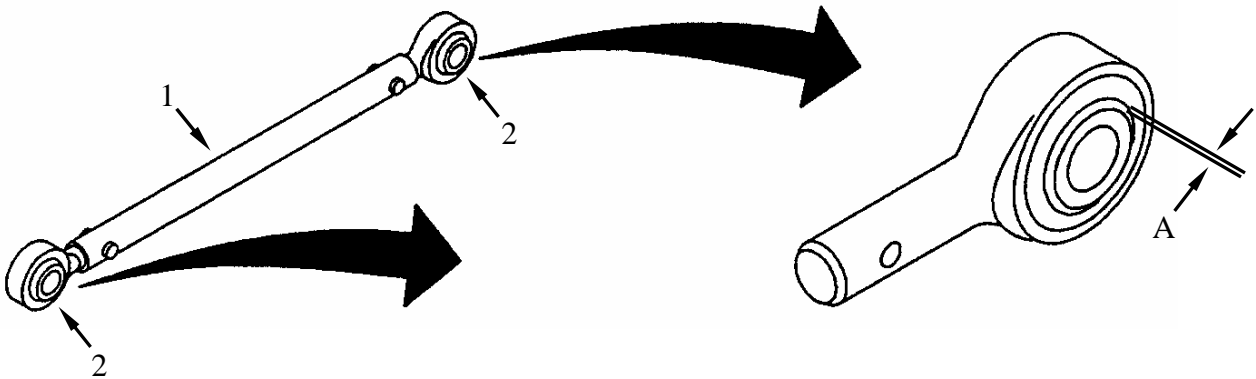
- Engine removed from vehicle and placed on a flat stationary surface
- Throttle linkage and associated parts removed (WP 0122 2CA, 2DA) (WP 0123 2DR)

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Measure the clearance (A) between ball and socket (endplay) of two rod end/bearings (1) at each end of governor control rod (2), using dial indicator (item 65, WP 0176). Replace rod end/bearing if not within the following limits.

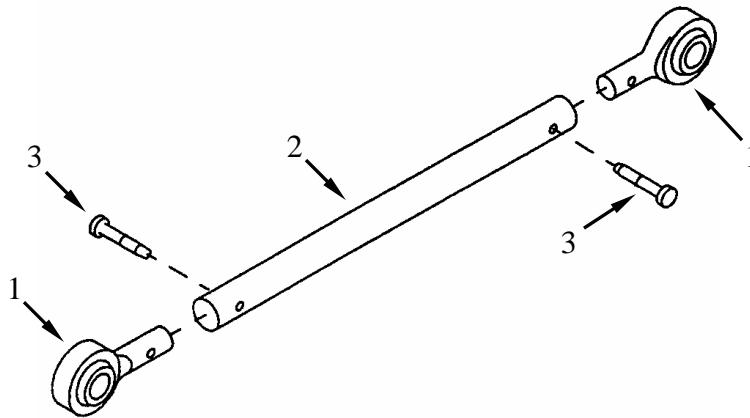
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Bearing endplay)	0.0005 (0.0127)	0.0015 (0.0381)	0.0020 (0.0508)



**REPAIR (AS REQUIRED)****NOTE**

**Either end can be repaired in the same manner, only one end is described.**

1. Remove rod end/bearing (1) from control rod (2).
  - a. Drill out solid rivet (3) with 1/8-inch drill and portable electric drill (items 10 & 34, WP 0176). Discard solid rivets.
2. Install new rod end/bearing (1) (NSN: 3120-01-435-2828) and secure to control rod (2) with new solid rivet (3) (NSN: 5320-00-061-8215).

**END OF WORK PACKAGE**

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**CYLINDER DEFLECTORS AND SHROUDS REPLACEMENT**

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**0127 00****THIS WORK PACKAGE COVERS**Removal, Cleaning, Inspection, and Installation

---

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (2) 63H10

**Mandatory Replacement Parts:**

Gasket (2) (item 288, WP 0175)

Lock washer (2) (item 88, WP 0175)

Lock washer (4) (item 84, WP 0175)

Lock washer (32) (item 85, WP 0175)

Lock washer (1) (item 85, WP 0175)

Lock washer (3) (item 92, WP 0175)

Lock washer (1) (item 92, WP 0175)

Seal washer (3) (item 303, WP 0175)

Self-locking nut (1) (item 42, WP 0175)

Self-locking nut (3) (item 33, WP 0175)

Self-locking nut (1) (item 32, WP 0175)

Self-locking nut (13) (item 281, WP 0175)

**Equipment Conditions:**

Engine level on flat surface

Exhaust manifolds and associated parts (R. B. or L.B.) removed (WP 0107)

Intake manifolds removed (WP 0108)

Engine shrouds removed (WP 0127)

Cooler frames removed (WP0090)

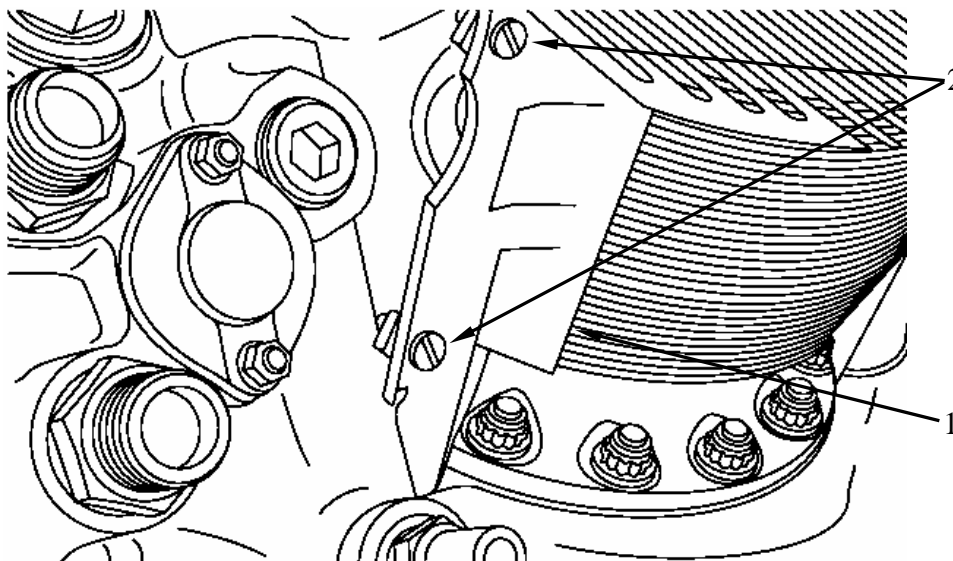
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**REMOVAL****NOTE**

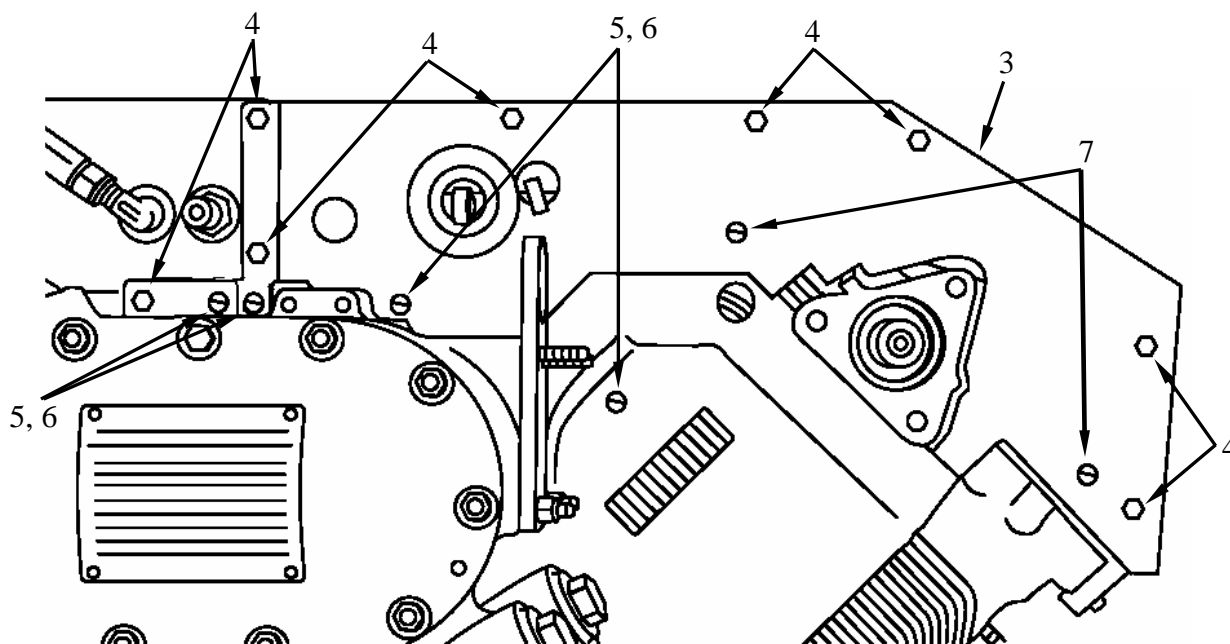
**Removal of cylinder deflectors and shrouds are similar between left and right engine banks. For instructional purposes, only one side of the engine will be addressed during removal and installation processes. Exceptions will be noted and called out as the work is being performed.**

**REMOVAL (Continued)**

1. Remove barrel shroud (1).
  - a. Remove two machine screws (2) and remove cylinder barrel shroud (1) at number 1 cylinder.

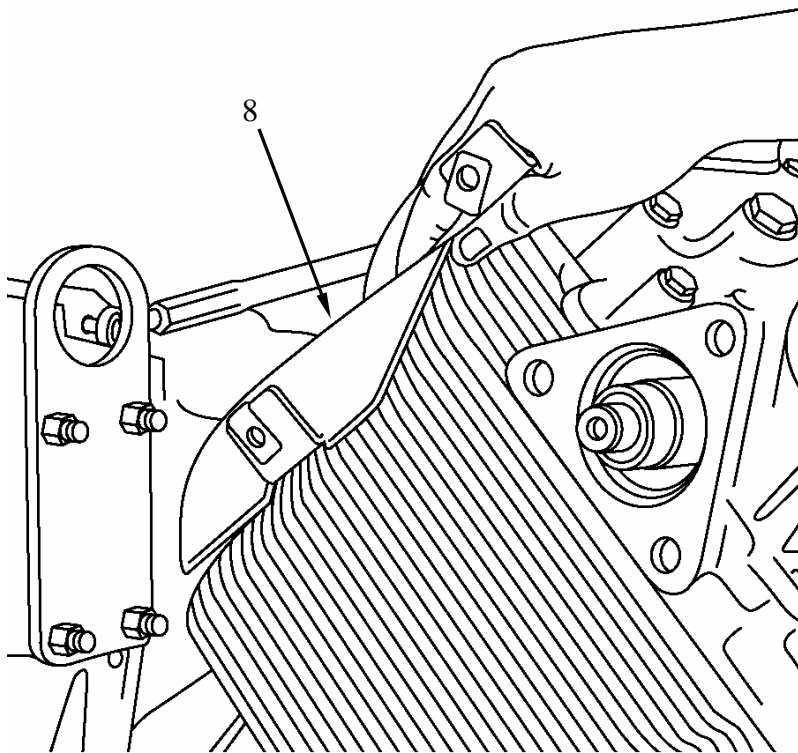


2. Remove front shroud (3).
  - a. Remove eight assembled washer screws (4), four machine screws (5) with lock washers (6) and two machine screws (7). Discard lock washers.



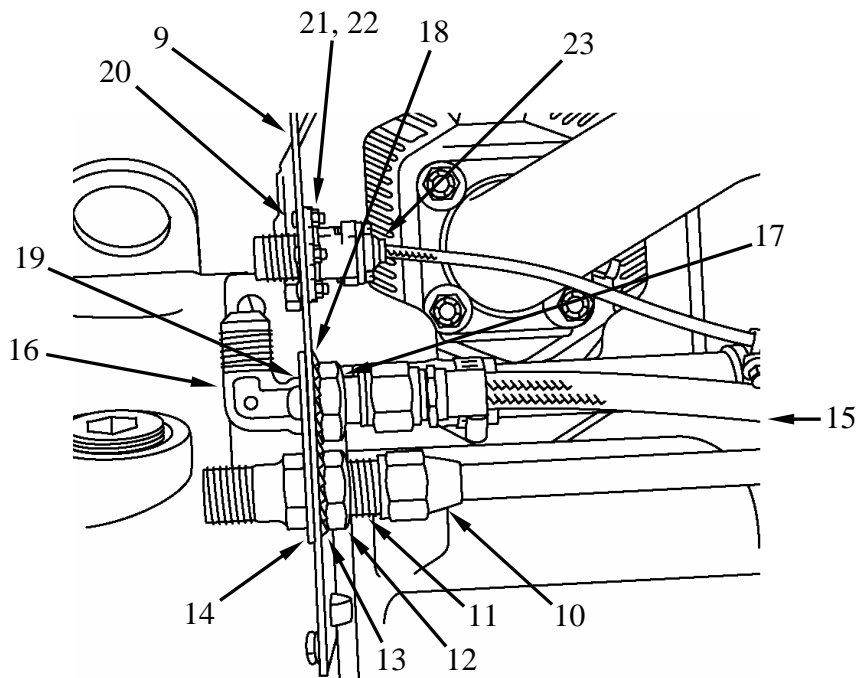
**REMOVAL (Continued)**

3. Remove number 1 cylinder baffle (8).
  - a. After front shroud is removed, lift and remove cylinder number 1 baffle (8).



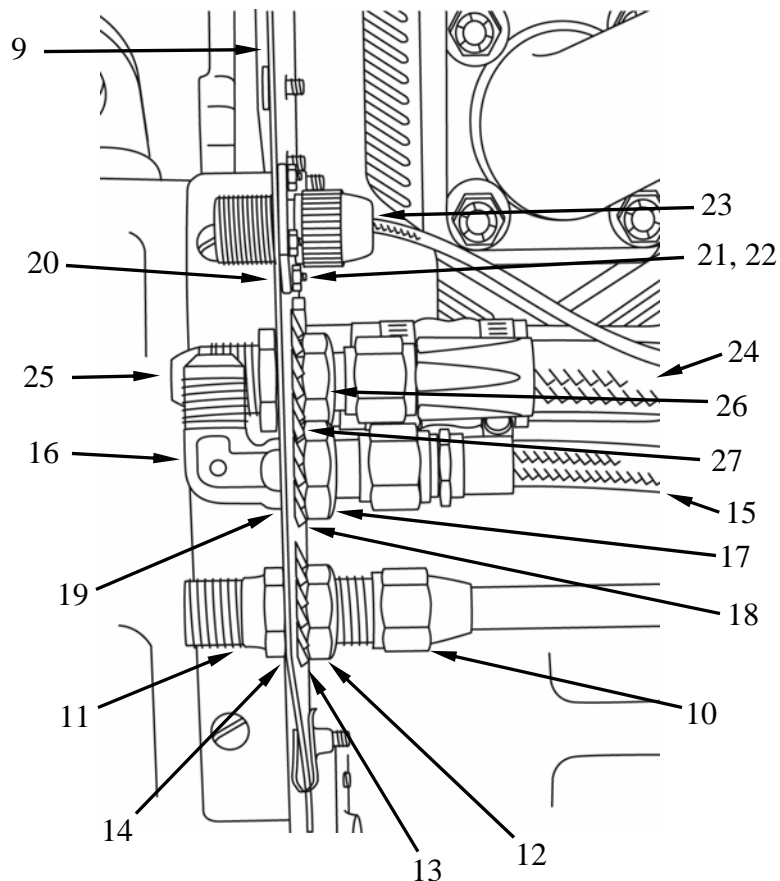
**REMOVAL (Continued)**

4. Disconnect lines and hoses from front bulkhead shroud (9). (For models 2CA and 2DA, do step 4. For model 2DR, go to step 5.)
  - a. Disconnect fire extinguisher tube (10) from bulkhead adapter (11).
  - b. Remove bulkhead adapter nut (12) with lock washer (13). Discard lock washer.
  - c. Remove adapter (11) with flat washer (14) from shroud.
  - d. Disconnect fuel injection pump fuel inlet hose (15) from bulkhead elbow (16).
  - e. Remove nut (17) with lock washer (18). Remove elbow (16) with flat washer (19) from shroud. Discard lock washer.
  - f. Remove four machine screws (20) with lock washers (21) and nuts (22). Remove injection pump fuel cut-off lead (23) from shroud. Discard lock washers.



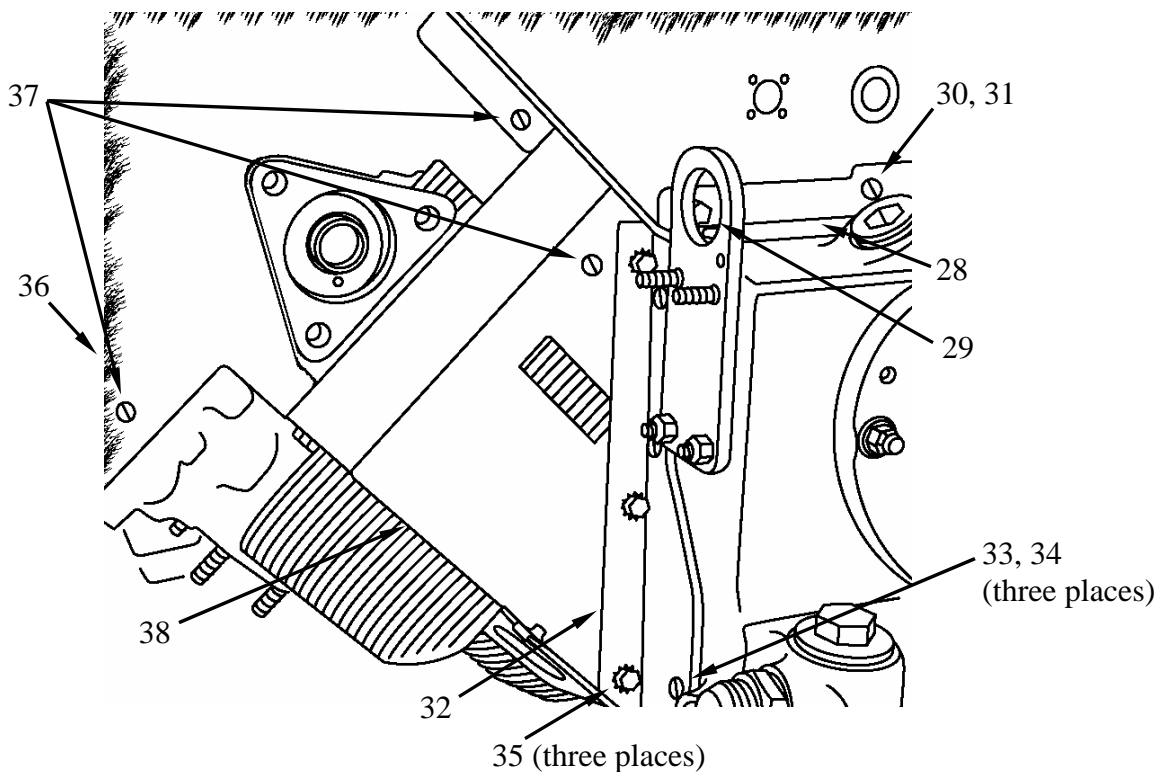
**REMOVAL (Continued)**

5. Disconnect lines and hoses from front bulkhead shroud (9) (for model 2DR).
  - a. Disconnect fire extinguisher tube (10) from fire extinguisher bulkhead adapter (11).
  - b. Remove bulkhead adapter nut (12) with lock washer (13). Remove adapter (11) with flat washer (14) from shroud. Discard lock washer.
  - c. Disconnect fuel injection pump fuel inlet hose (15) from bulkhead elbow (16).
  - d. Remove nut (17) with lock washer (18). Remove elbow (16) with flat washer (19) from shroud. Discard lock washer.
  - e. Remove four machine screws (20) with lock washers (21) and nuts (22). Remove fuel injection pump fuel cut-off lead (23) from shroud. Discard lock washers.
  - f. Disconnect fuel return hose (24) from bulkhead adapter (25).
  - g. Remove bulkhead adapter nut (26) with lock washer (27). Remove adapter (25) from shroud. Discard lock washer.



**REMOVAL (Continued)**

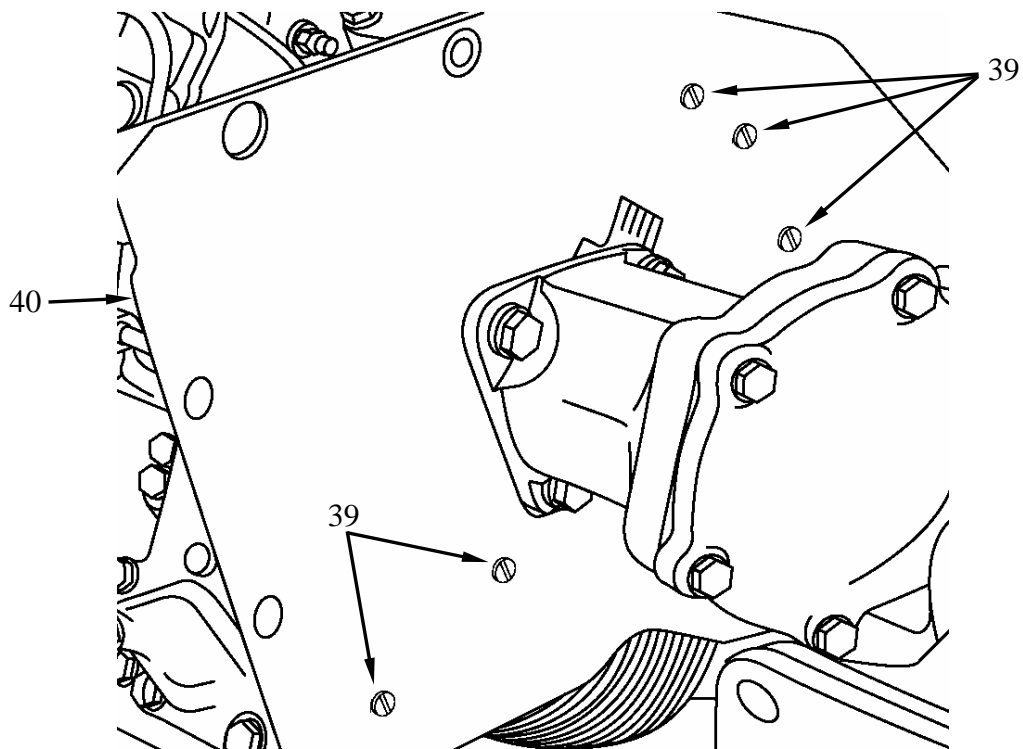
6. Remove top filler plate (28).
  - a. Remove assembled washer bolt (29) and machine screw (30) with lock washer (31). Discard lock washer.
7. Remove side filler plate (32).
  - a. Remove three machine screws (33) with lock washers (34). Discard lock washers.
  - b. Remove three assembled washer bolts (35) and remove side filler plate (32).
8. Remove left front cylinder shroud (36).
  - a. Remove machine screws (37) attaching baffle (38) to front shroud (36).
  - b. Remove cylinder shroud (36).





**REMOVAL (Continued)**

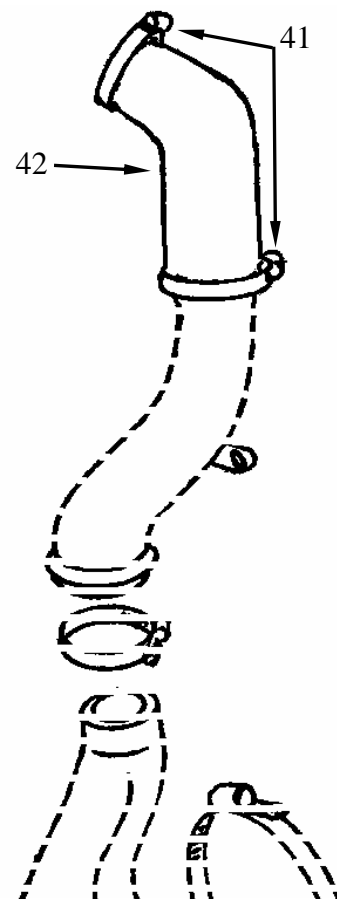
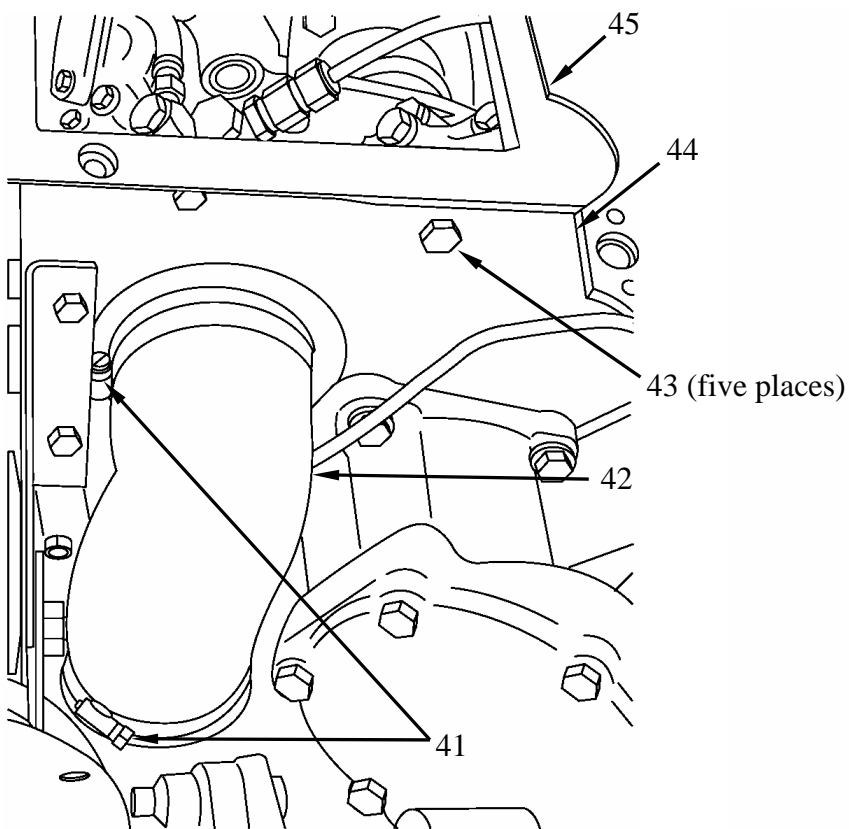
9. Remove rear shroud. (For models 2CA and 2DA, do step 9. For model 2DR, go to step 10.)
  - a. Remove five machine screws (39) and remove right rear shroud (40).



**REMOVAL (Continued)**

10. Remove rear shroud (for model 2DR).

- a. Remove two hose clamps (41) and remove generator outlet preformed hose (42).
- b. Remove five assembled screws (43). Remove generator shroud plate (44) from cooler frame (45).

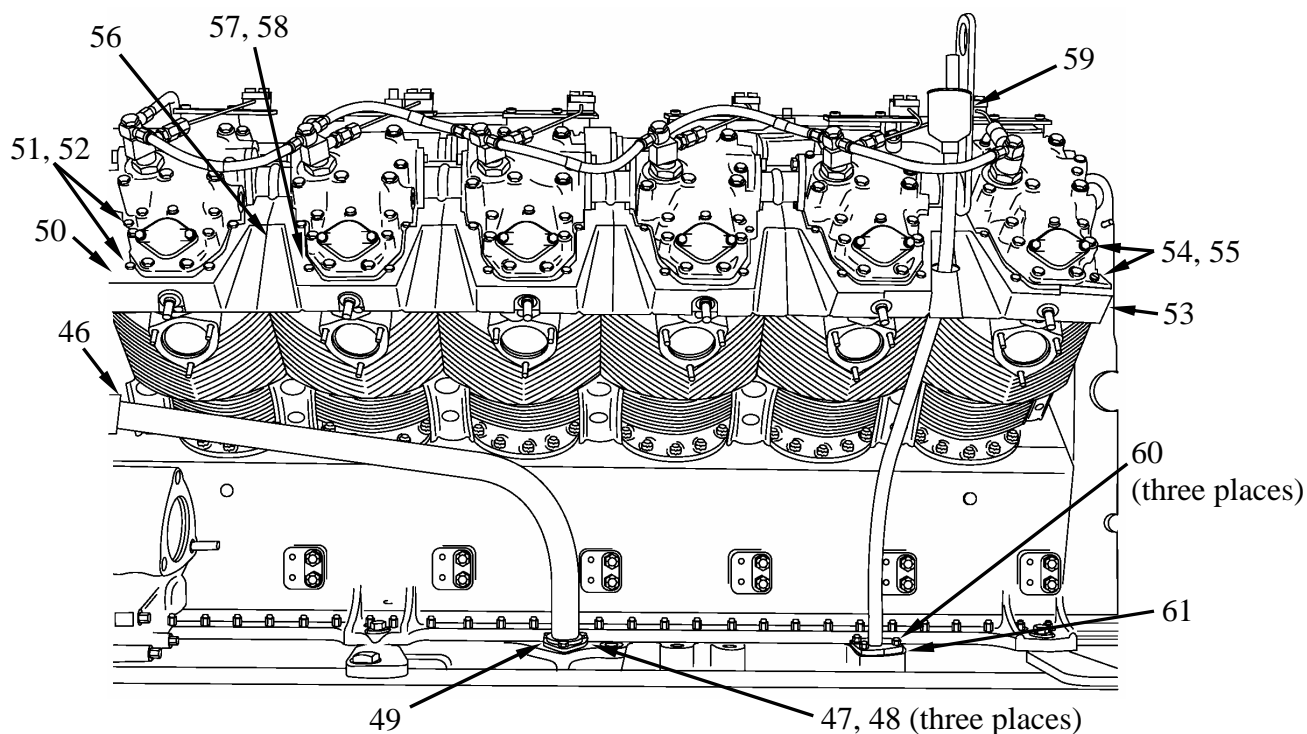


**REMOVAL (Continued)**

11. Remove oil filler tube (46).
  - a. Remove three screws (47) with seal washers (48) and remove lower oil filler tube assembly (46). Discard gasket (49) and seal washers (48).
12. Remove flywheel end shroud plate (50).
  - a. Remove two screws (51) with lock washers (52) and remove flywheel end cylinder head shroud plate (50). Discard lock washers.
13. Remove damper end shroud plate (53).
  - a. Remove two screws (54) with lock washers (55) and remove damper end cylinder head shroud plate (53). Discard lock washers.
14. Remove inter-cylinder head shroud plates (56).
  - a. Remove twenty screws (57) with lock washers (58) and remove inter-cylinder head shroud plates (56). Discard lock washers.
15. Remove oil level indicator tube (59).
  - a. Remove three self-locking nuts (60) and remove oil level indicator tube (59). Discard self-locking nuts.
  - b. Remove and discard gasket (61).

**NOTE**

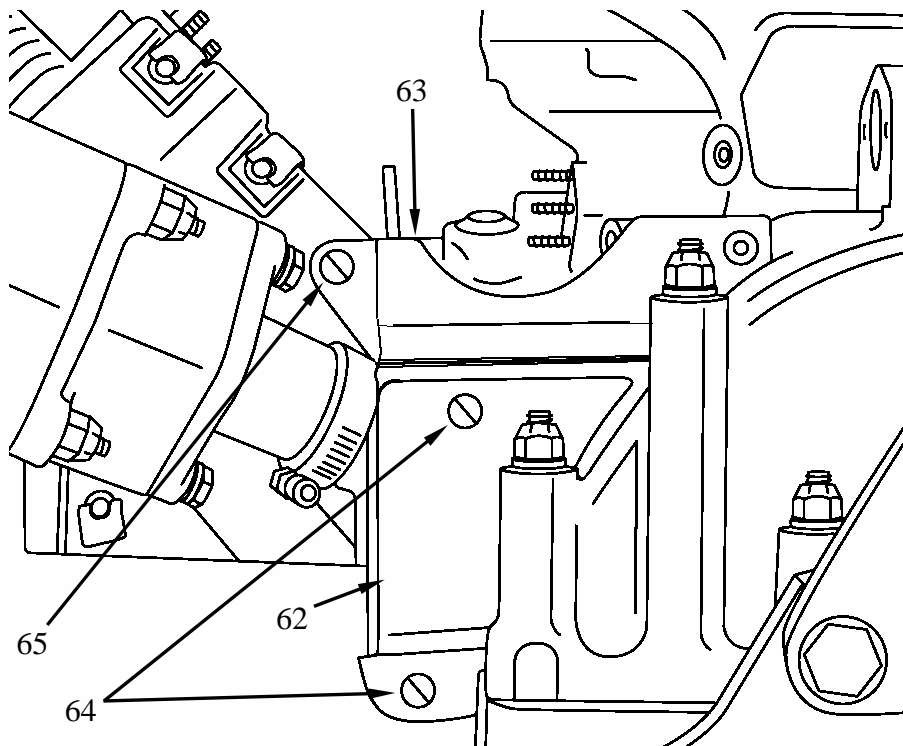
**Removal instructions for the cylinder head plates, oil filler tube and oil lever indicator tube on Model AVDS-1790 2DR are similar to above except that the oil level indicator tube is located between cylinder numbers 2L and 3L instead of 1L and 2L.**



**REMOVAL (Continued)**

16. Remove camshaft drive shrouds (62, 63).

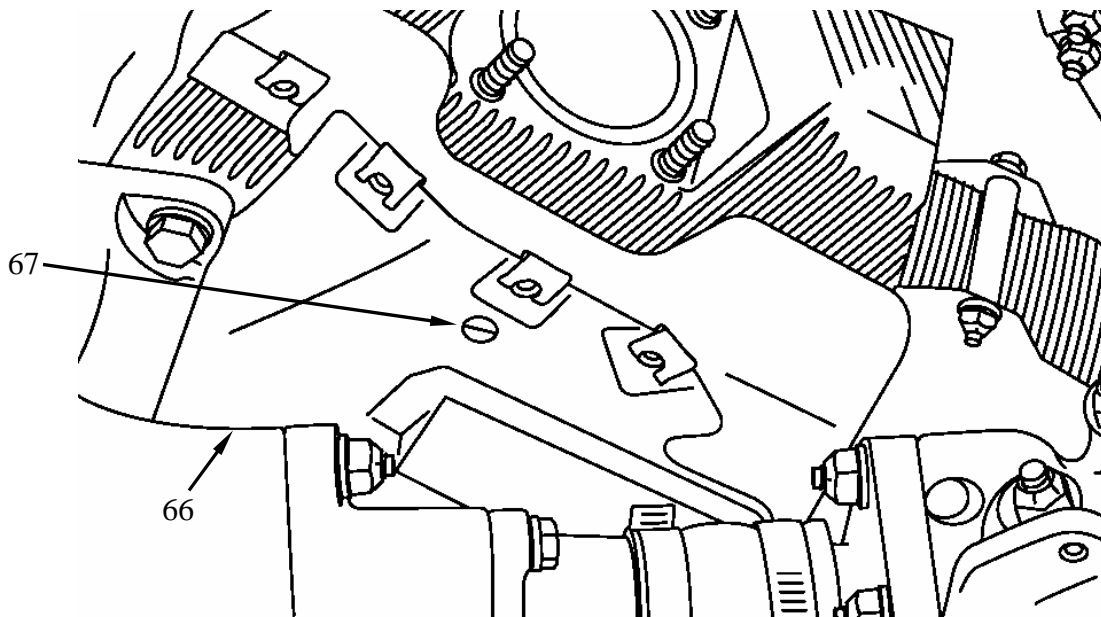
- a. Remove two machine screws (64) and remove lower camshaft shroud (62).
- b. Remove machine screw (65) and remove upper camshaft shroud (63).



**REMOVAL (Continued)**

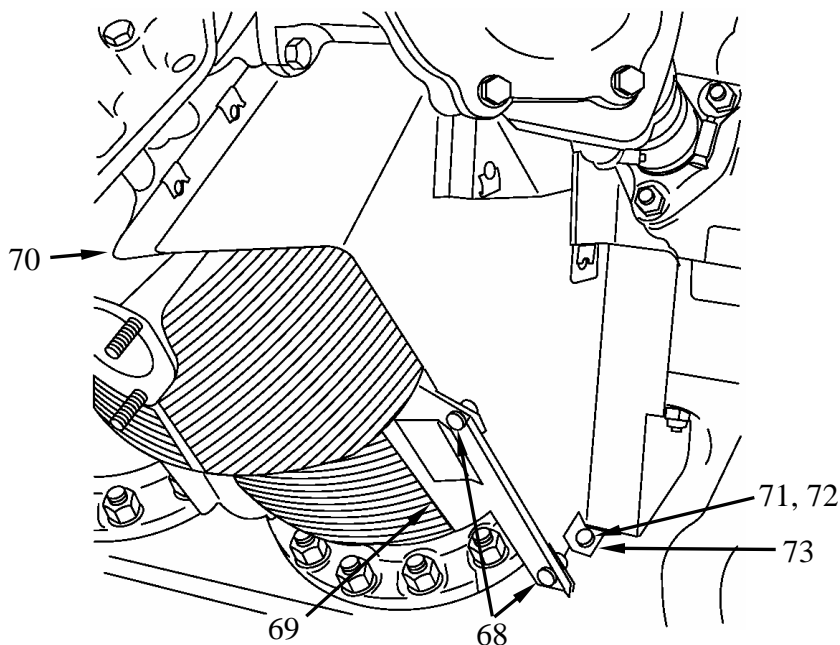
17. Remove lower engine shroud (66).

- a. Remove machine screw (67) and remove lower engine shroud (66).



18. Remove two machine screws (68) to remove cylinder number 6 base shroud (69) and lower rear shroud (70).

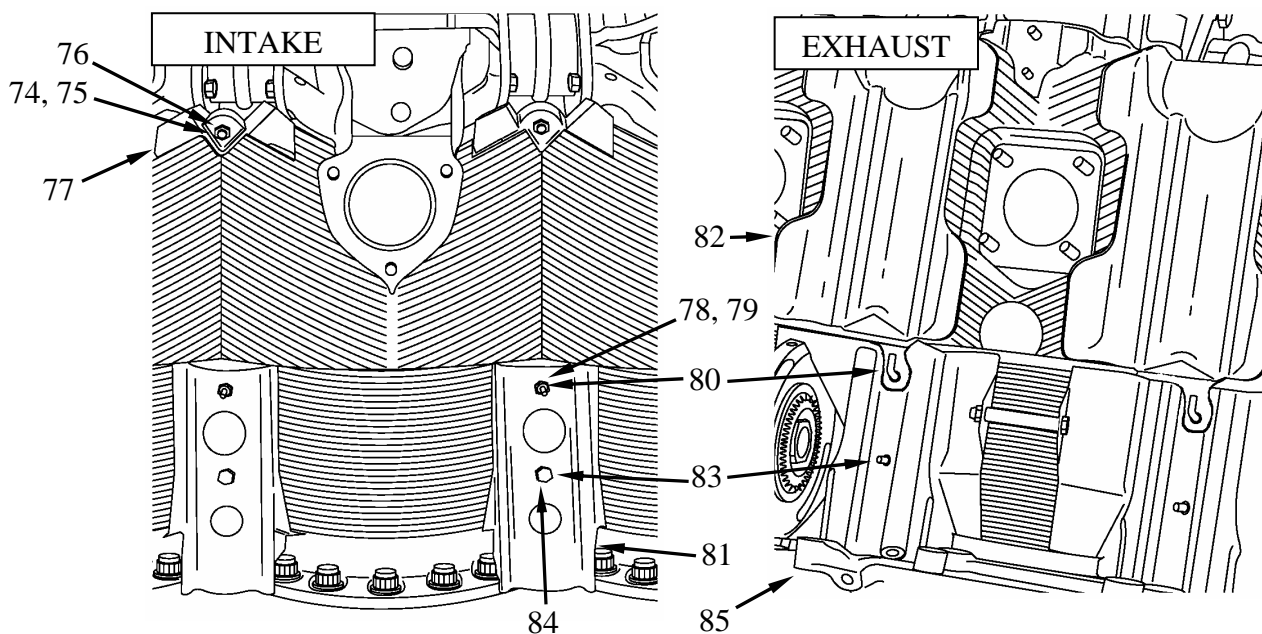
19. Remove machine screw (71) with lock washer (72) and spring clip (73) from crankcase. Discard lock washer.



**REMOVAL (Continued)**

20. Remove inter-cylinder air deflectors and straps.

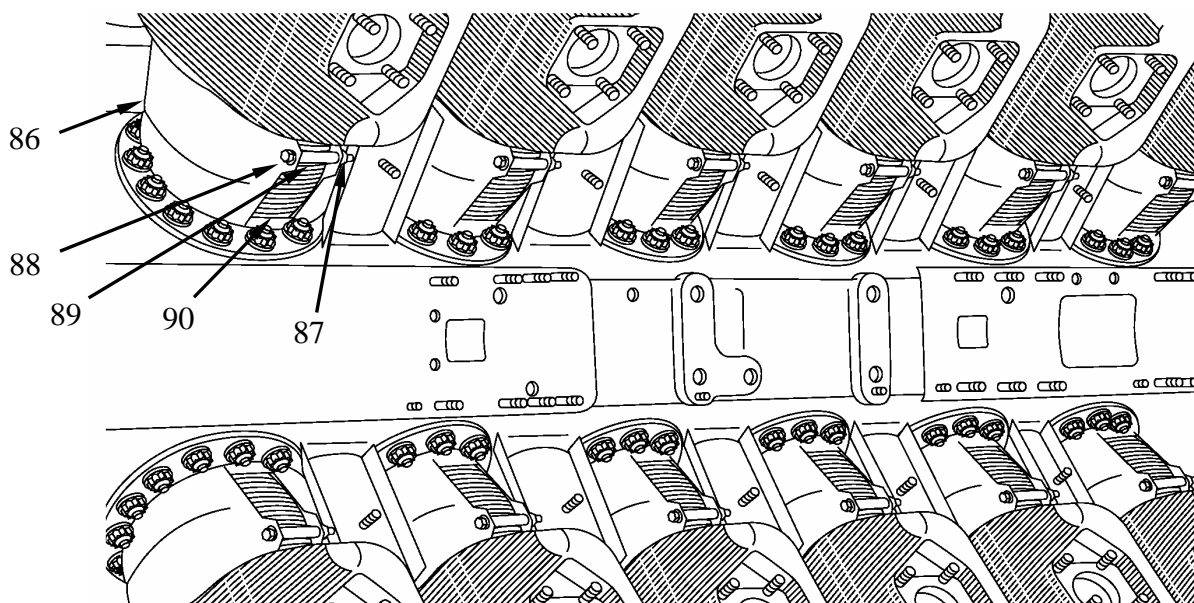
- a. Remove self-locking nuts (74) with flat washers (75) from hook screws (76) and remove inter-cylinder cylinder head deflectors (77) and hook screws (76). Discard self-locking nuts.
- b. Remove self-locking nuts (78) with flat washers (79) on the lower hook screws (80) fastening the lower cylinder deflector straps (81) to the inter-cylinder deflectors (82). Discard self-locking nuts.
- c. Remove screw (83) with flat washer (84) at lower mounting hole of lower cylinder deflector straps (81).
- d. Remove lower cylinder deflector straps (81), inter-cylinder head deflector (77), inter-cylinder retaining straps (85) and inter-cylinder deflectors (82).



**REMOVAL (Continued)**

21. Remove cylinder air deflectors (86).

- a. Remove twelve self-locking nuts (87), screws (88) and spacers (89) attaching cylinder air deflectors to cylinder assemblies (90). Discard self-locking nuts.
- b. Remove cylinder air deflectors (86).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

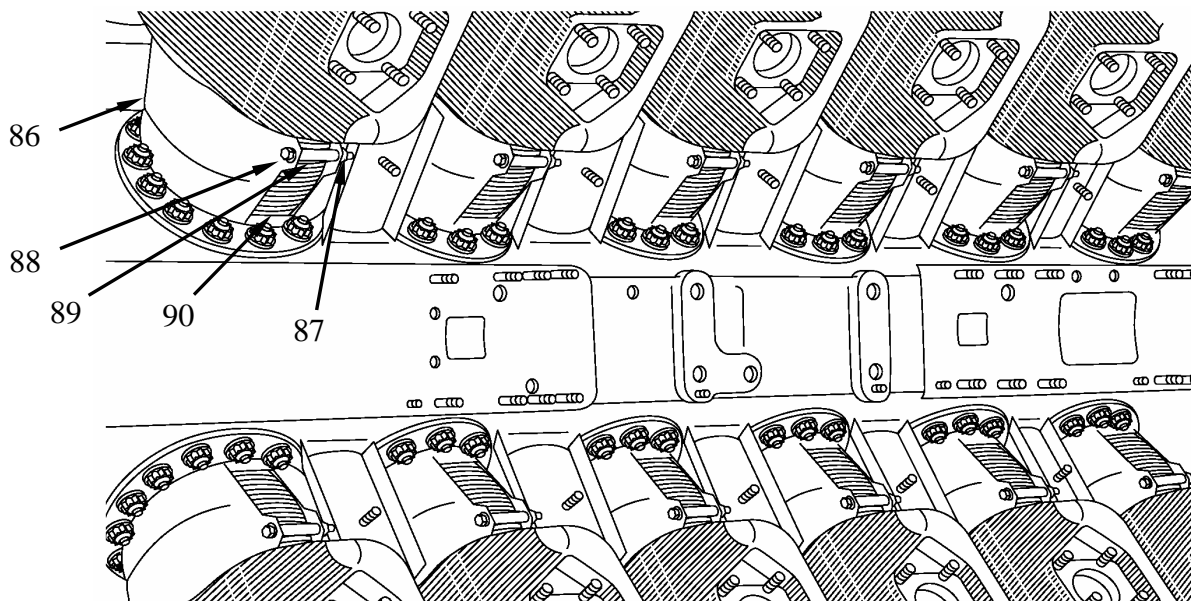
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install cylinder air flow deflectors, straps, access covers, and baffles.
  - a. Position air flow deflectors (86) onto cylinder bases (90).
  - b. Install twelve screws (88) and spacers (89) with new self-locking nuts (87) (item 281, WP 0175).





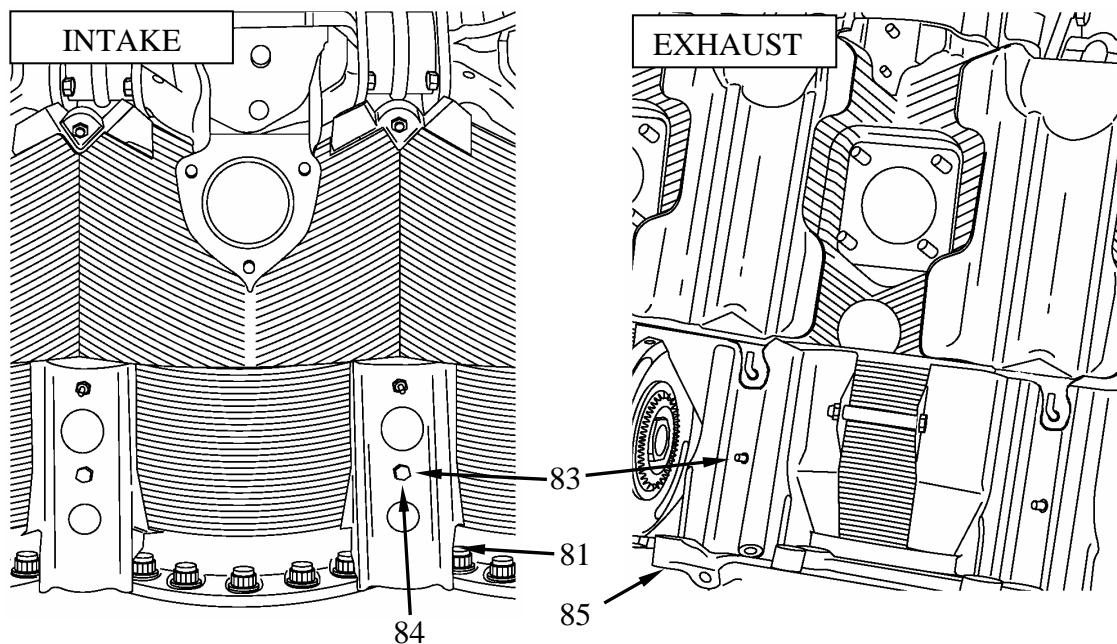
**INSTALLATION (Continued)**

1. Install cylinder air flow deflectors, straps, access covers, and baffles (continued).

**CAUTION**

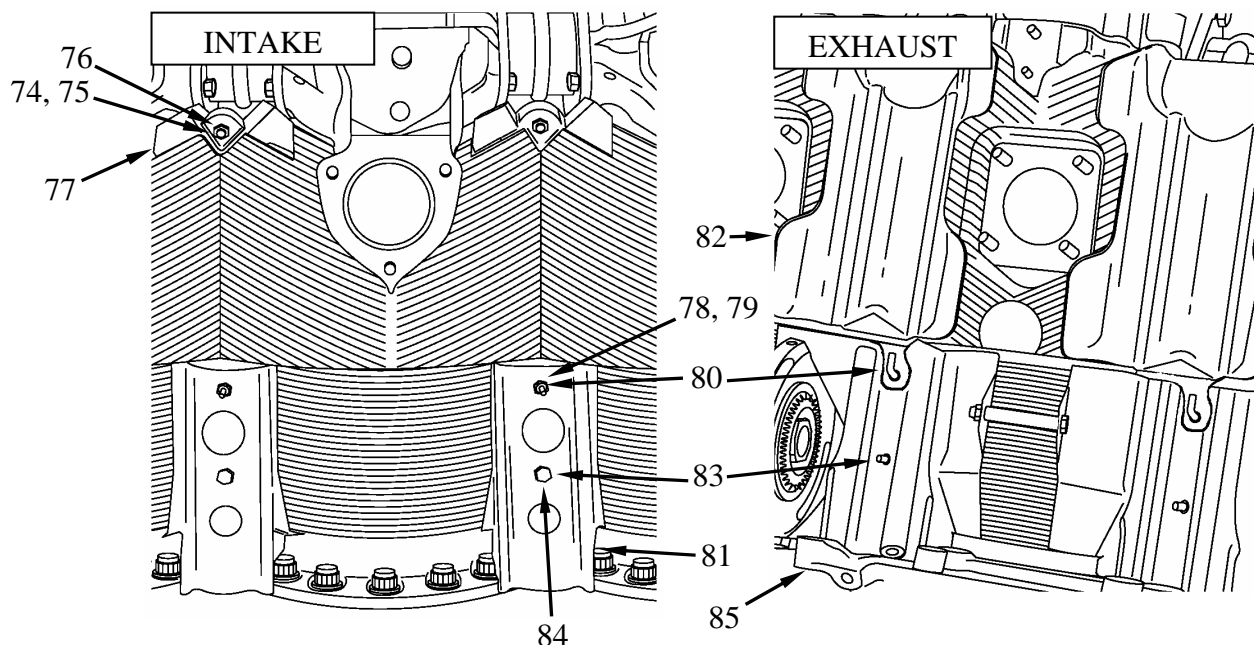
**To keep cylinder air flow deflectors in position, the inter-cylinder retaining straps and lower cylinder deflector straps must fit into the depressions on the cylinder air flow deflectors.**

- c. Position inter-cylinder retaining straps (85) between cylinders on the exhaust side of the cylinders.
- d. Install lower cylinder deflector straps (81) on the intake side of the cylinders to the inter-cylinder retaining strap (85) using retaining bolt (83) and flat washer (84).



**INSTALLATION (Continued)**

1. Install air flow deflectors, straps, access covers, and baffles (continued).
  - e. Install hook screw (80) through lower loop hole in inter-cylinder deflector (82), upper hole in inter-cylinder deflector (85) and ultimately through the upper hole in the lower cylinder deflector straps (81).
  - f. Install new self-locking nut (78) (item 281, WP 0175) with flat washer (79). Do not tighten at this time.
  - g. Position inter-cylinder head deflector (77) between cylinders.
  - h. Position hook screw (76) into upper hole in inter-cylinder deflector (82) and ultimately through the outboard hole in inter-cylinder head deflector (77).
  - i. Install new self-locking nut (74) (item 32, WP 0175) with flat washer (75) onto hook screw (76). Do not tighten at this time.
  - j. Evenly tighten all self-locking nuts ensuring correct positioning of all baffles, straps, and deflectors installed to this point.

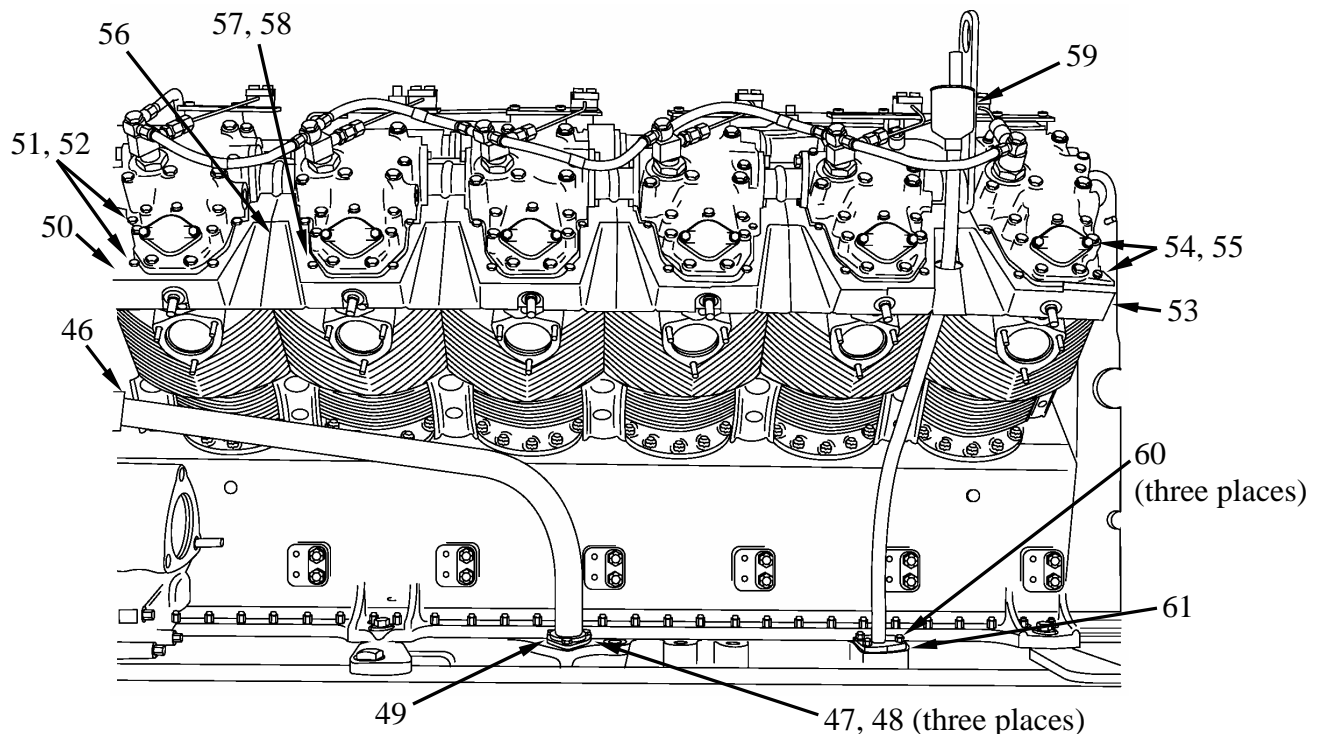


## INSTALLATION (Continued)

## NOTE

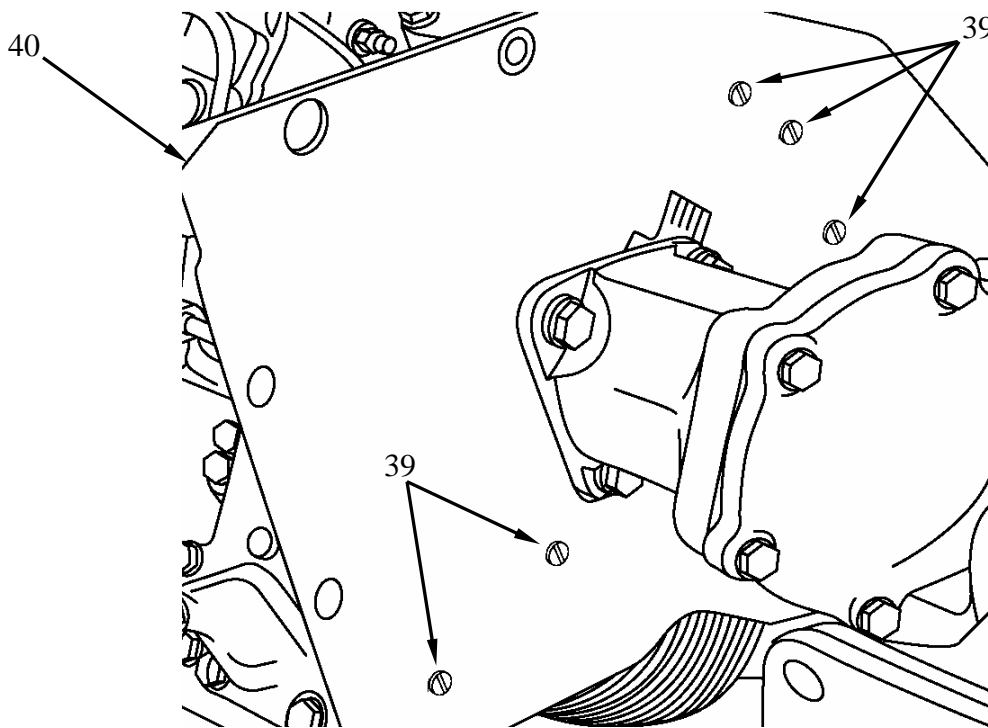
**Model AVDS-1790 2DR engine installation instructions for the cylinder head plates, oil filler tube, and oil level indicator tube are similar except that the oil level indicator tube is located between cylinder numbers 2L and 3L.**

2. Install oil filler tube (46).
  - a. Position oil filler tube (46) onto oil pan with new gasket (49) (item 288, WP 0175).
  - b. Install three screws (47) with new seal washers (48) (item 303, WP 0175).
3. Install oil level indicator tube (59).
  - a. Position oil level indicator tube (59) onto oil pan using new gasket (61) (item 288, WP 0175).
  - b. Secure three with new self-locking nuts (60) (item 33, WP 0175).
4. Install inter-cylinder plates (56) with twenty screws (57) and new lock washers (58) (item 85, WP 0175).
5. Install damper end cylinder head shroud plates (53) using two screws (54) and new lock washers (55) (item 85, WP 0175).
6. Install flywheel end cylinder head shroud plates (50) using two screws (51) and new lock washers (52) (item 85, WP 0175).



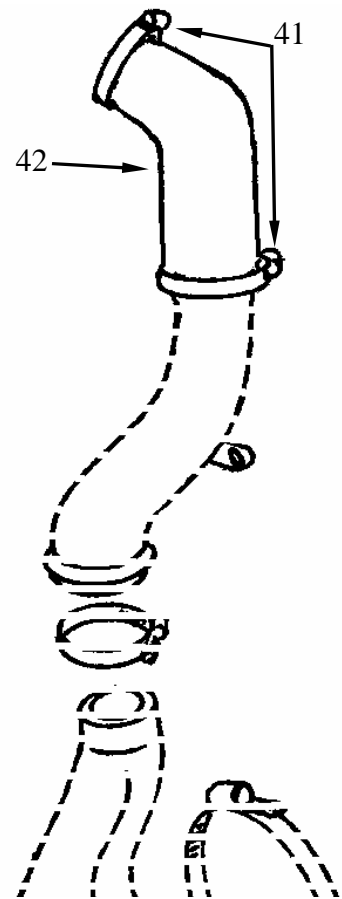
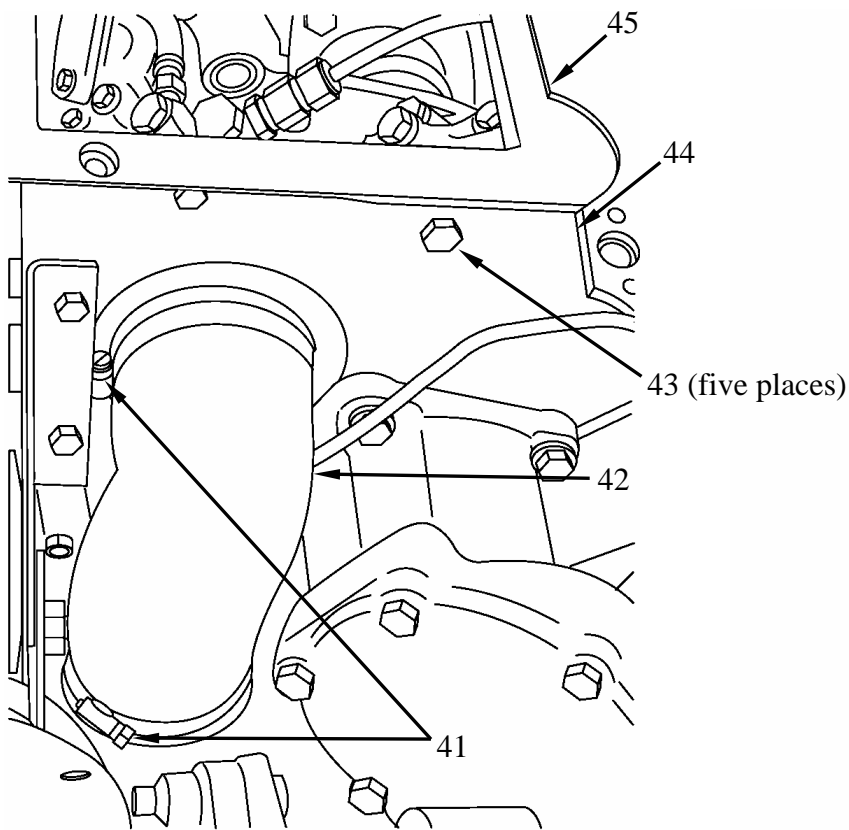
**INSTALLATION (Continued)**

7. Install right rear corner shroud (40). (For models 2CA and 2DA, do step 7. For model 2DR, go to step 8.)
  - a. Install rear shroud (40) on engine and secure to flywheel end cylinder head shroud, numbers 6R and 6L cylinder baffle and to lower rear engine shroud with five machine screws (39).



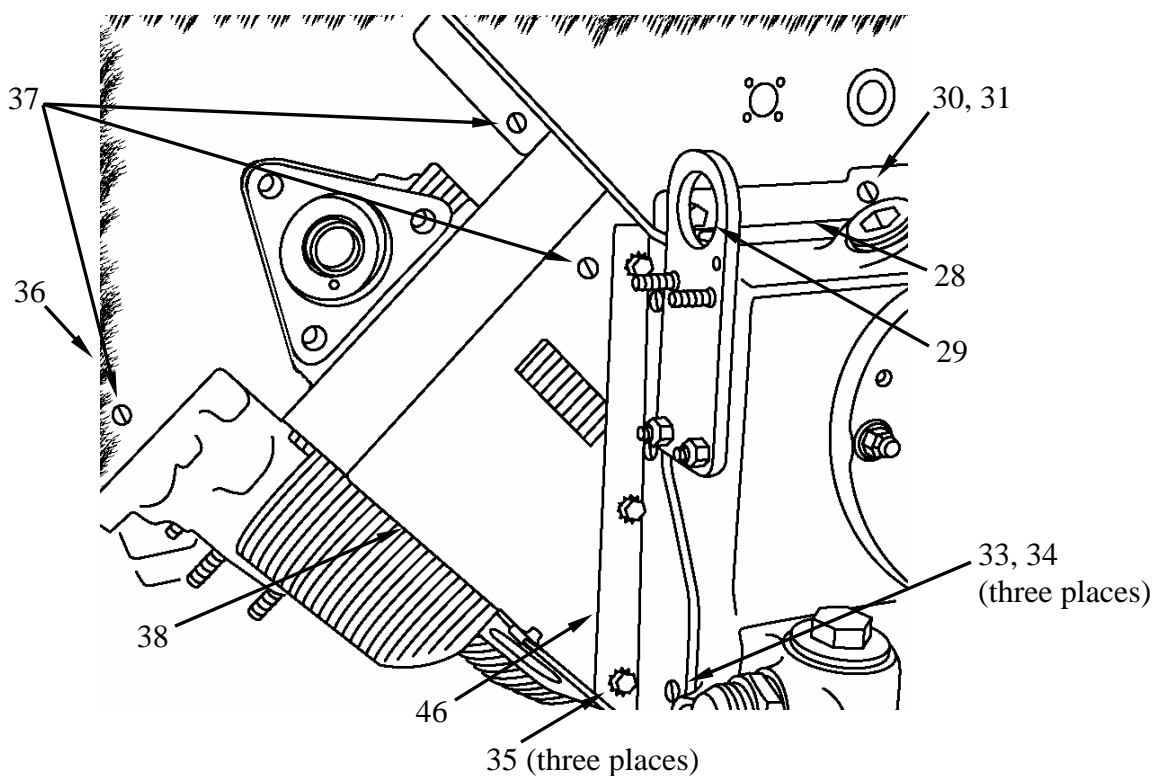
**INSTALLATION (Continued)**

8. Install right rear corner shroud (for model 2DR).
  - a. Install generator outlet preformed hose (42) with two hose clamps (41).
  - b. Install generator shroud plate (44) to cooler frame (45) with five assembled screws (43).



**INSTALLATION (Continued)**

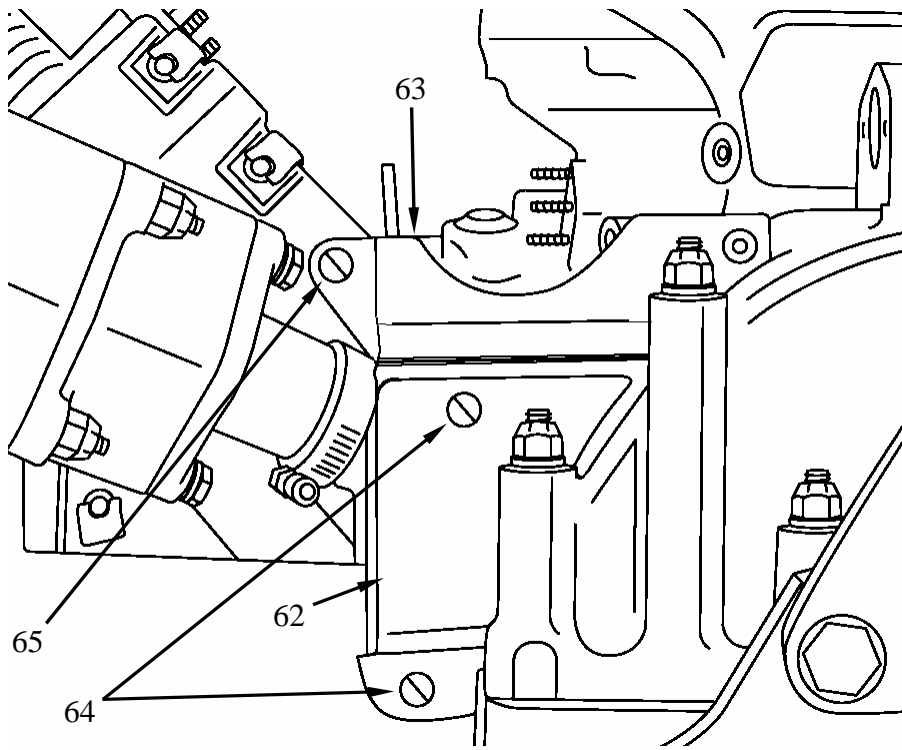
9. Install left front cylinder shroud (36).
  - a. Position cylinder shroud (36) on engine.
  - b. Install machine screws (37) attaching front shroud (36) to baffle (38).
10. Install side filler plate (32).
  - a. Install three machine screws (33) with new lock washers (34) (item 92, WP 0175).
  - b. Install three assembled washer bolts (35) to secure side filler plate (32).
11. Install top filler plate (28).
  - a. Install assembled washer bolt (29) and machine screw (30) with new lock washer (31) (item 85, WP 0175) to secure top filler plate (28).



**INSTALLATION (Continued)**

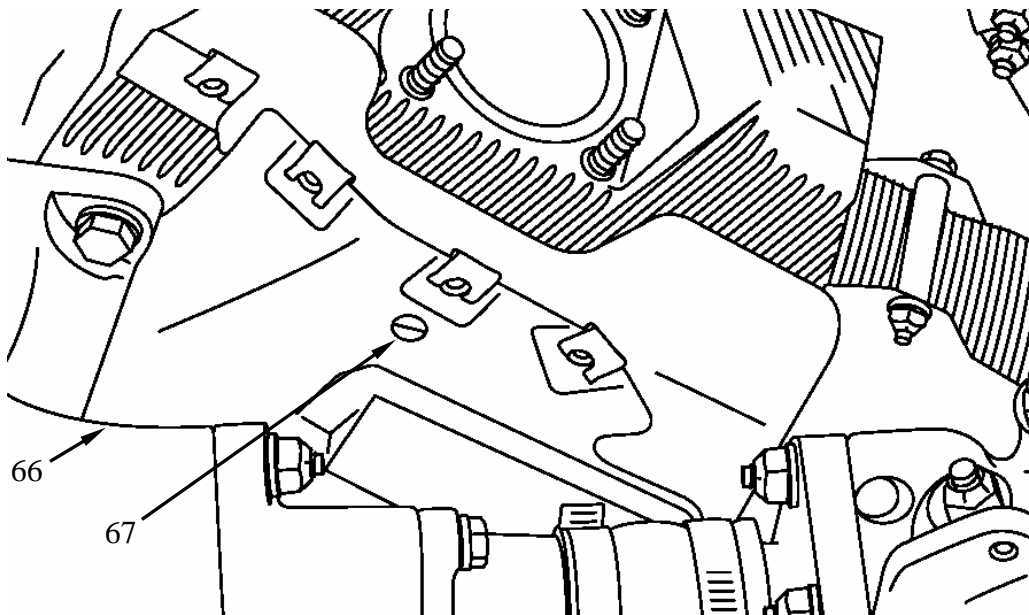
12. Install camshaft drive shrouds (62, 63).

- a. Position lower camshaft shroud (62) and secure with two machine screws (64).
- b. Install upper camshaft shroud (63) using machine screw (65).



**INSTALLATION (Continued)**

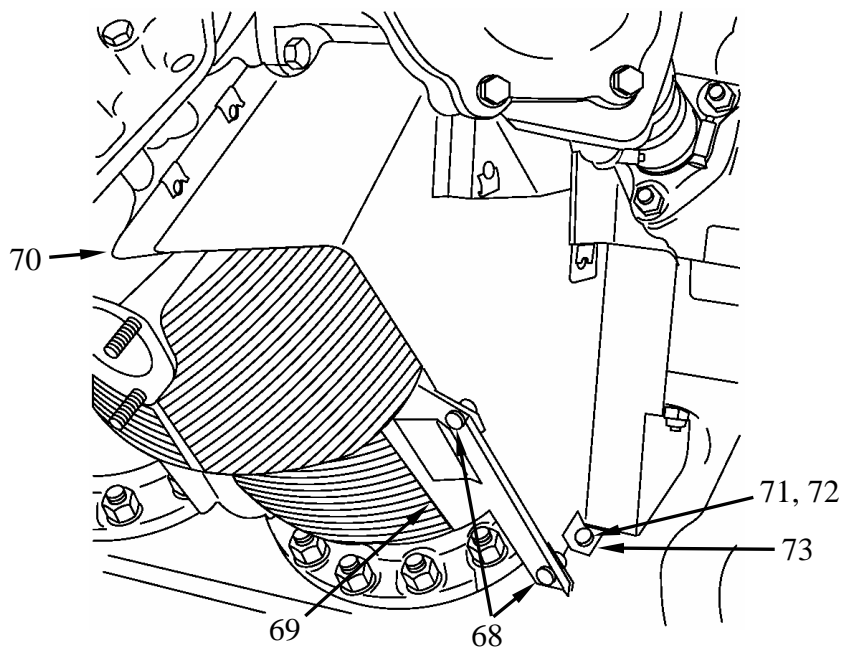
13. Install lower engine shroud (66) using machine screw (67).





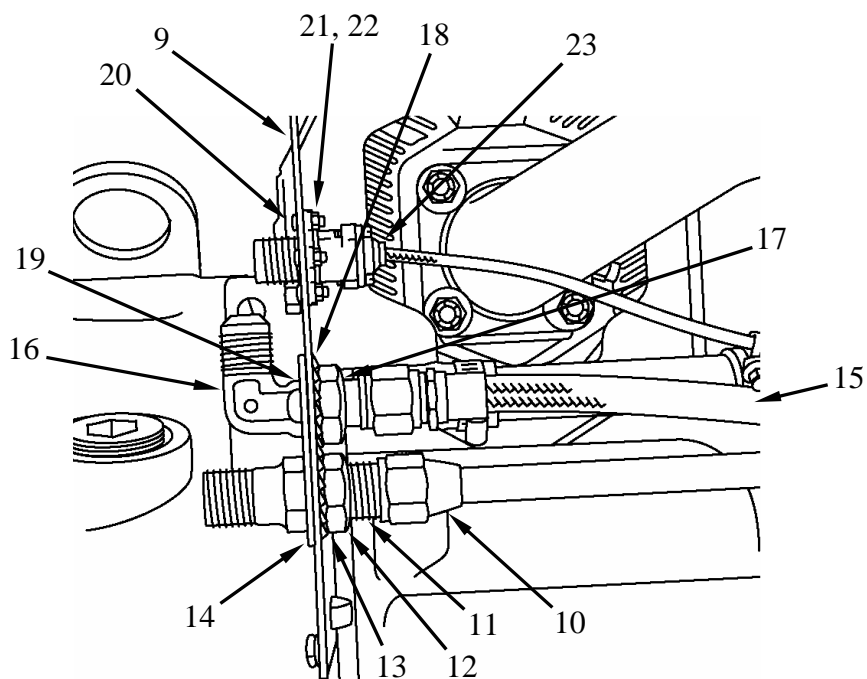
**INSTALLATION (Continued)**

14. Install cylinder number 6 base shroud (69).
  - a. Install spring clip (73) using machine screw (71) and new lock washer (72) (item 92, WP 0175).
  - b. Position lower rear shroud (70) onto spring clip (73).
  - c. Install cylinder number 6 base shroud (69) to the lower rear shroud (70) using two machine screws (68).



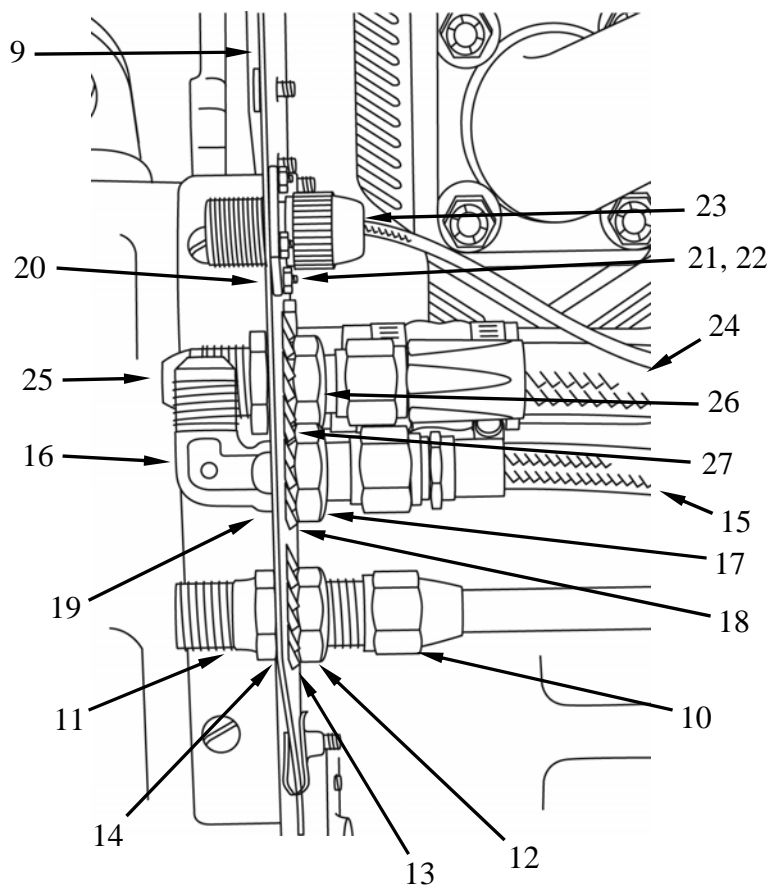
**INSTALLATION (Continued)**

15. Install lines and hoses from front bulkhead shroud (9). (For models 2CA and 2DA, do step 15. For model 2DR, go to step 16.)
  - a. Install fuel injection pump fuel cutoff lead (23) through front bulkhead shroud (9) and secure with four machine screws (20), new lock washers (21) (item 84, WP 0175), and nuts (22).
  - b. Install flat washer (19) on fuel injection pump fuel inlet hose bulkhead elbow (16) and install elbow through bulkhead shroud (9). Secure with new lock washer (18) (item 88, WP 0175) and nut (17).
  - c. Connect fuel injection pump fuel inlet hose (15) to bulkhead elbow (16).
  - d. Install flat washer (14) on fire extinguisher tube adapter (11).
  - e. Install adapter (11) through front shroud (9) and secure with new lock washer (13) (item 88, WP 0175) and nut (12).
  - f. Connect fire extinguisher tube (10) to adapter (11).



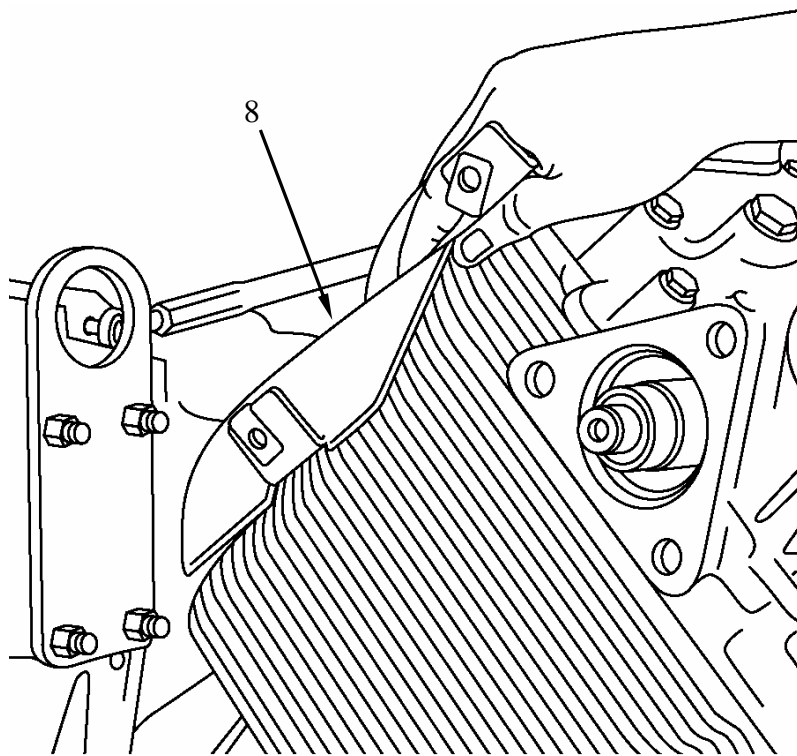
**INSTALLATION (Continued)**

16. Install lines and hoses to front bulkhead shroud (9) (for model 2DR).
- Install fuel return bulkhead adapter (11) onto shroud (9) and secure with nut (12) and new lock washer (13) (item 42, WP 0175).
  - Connect fuel return hose (10) to adapter (11).
  - Install fuel injection pump fuel cutoff lead (23) through shroud (9) and secure with four machine screws (20), new lock washers (21) (item 84, WP 0175) and nuts (22).
  - Install fuel injection pump fuel inlet bulkhead elbow (16) with flat washer (19) through shroud (9) and secure with nut (17) and new lock washer (18) (item 88, WP 0175).
  - Connect fuel injection pump fuel inlet hose (15) to bulkhead elbow (16).
  - Install fire extinguisher bulkhead adapter (11) with flat washer (14) into shroud (9) and secure with nut (12) and new lock washer (13) (item 88, WP 0175).
  - Connect fire extinguisher tube (10) to bulkhead adapter (11).



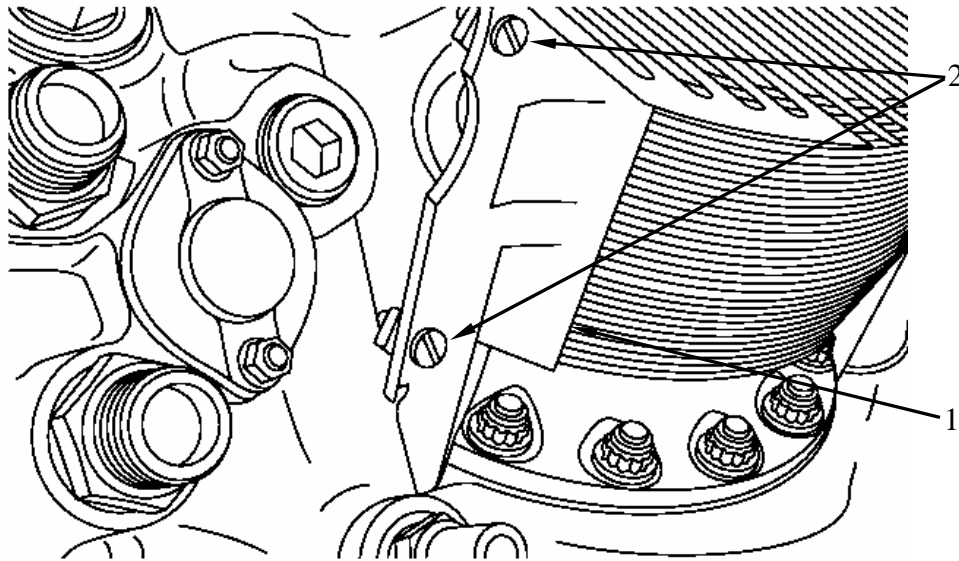
**INSTALLATION (Continued)**

17. Install number 1 cylinder baffle.
  - a. Position number 1 cylinder baffle (8).



**INSTALLATION (Continued)**

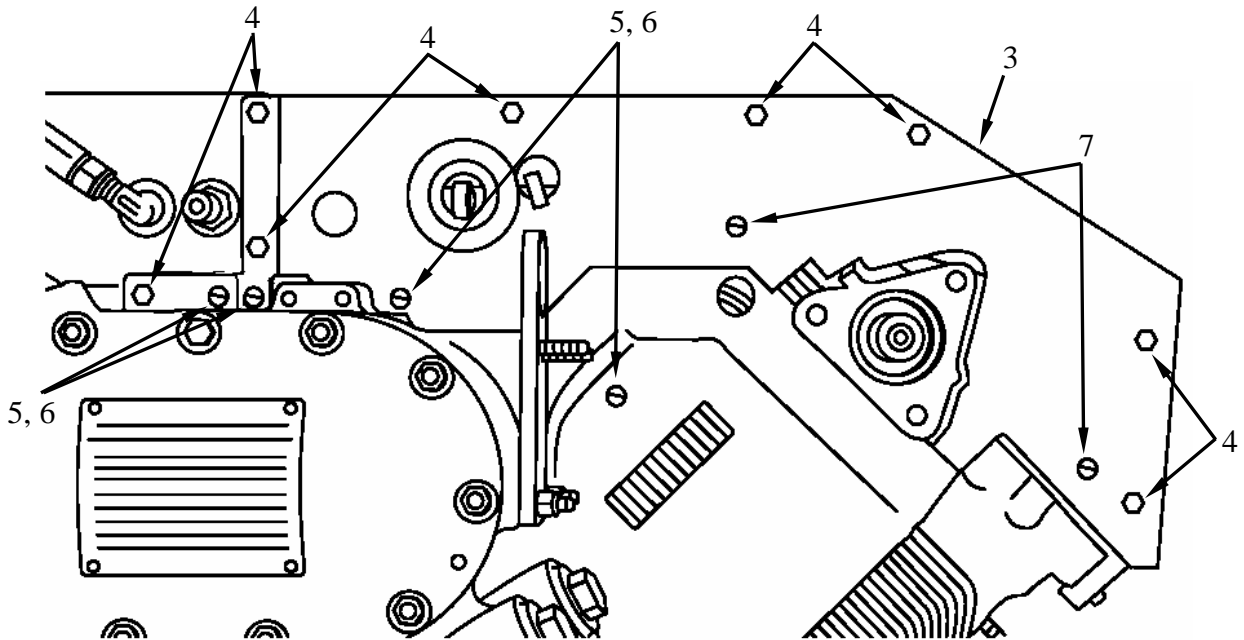
18. Install number 1 cylinder barrel shroud (1).
  - a. Install cylinder barrel shroud (1) at number 1 cylinder using two machine screws (2).



**INSTALLATION (Continued)**

19. Install front shroud (3).

- a. Install eight assembled washer screw (4), four machine screws (5) with new lock washers (6) (item 85, WP 0175) and two machine screws (7).



**END OF WORK PACKAGE**

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**SHROUD REPAIR**

**0128 00**

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**THIS WORK PACKAGE COVERS:**

Cleaning, Inspection, and Repair

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**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Welding shop trailer mounted (item 104,  
WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine removed from vehicle and placed on a  
flat stationary surface  
Shrouds removed (WP 0127)

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**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

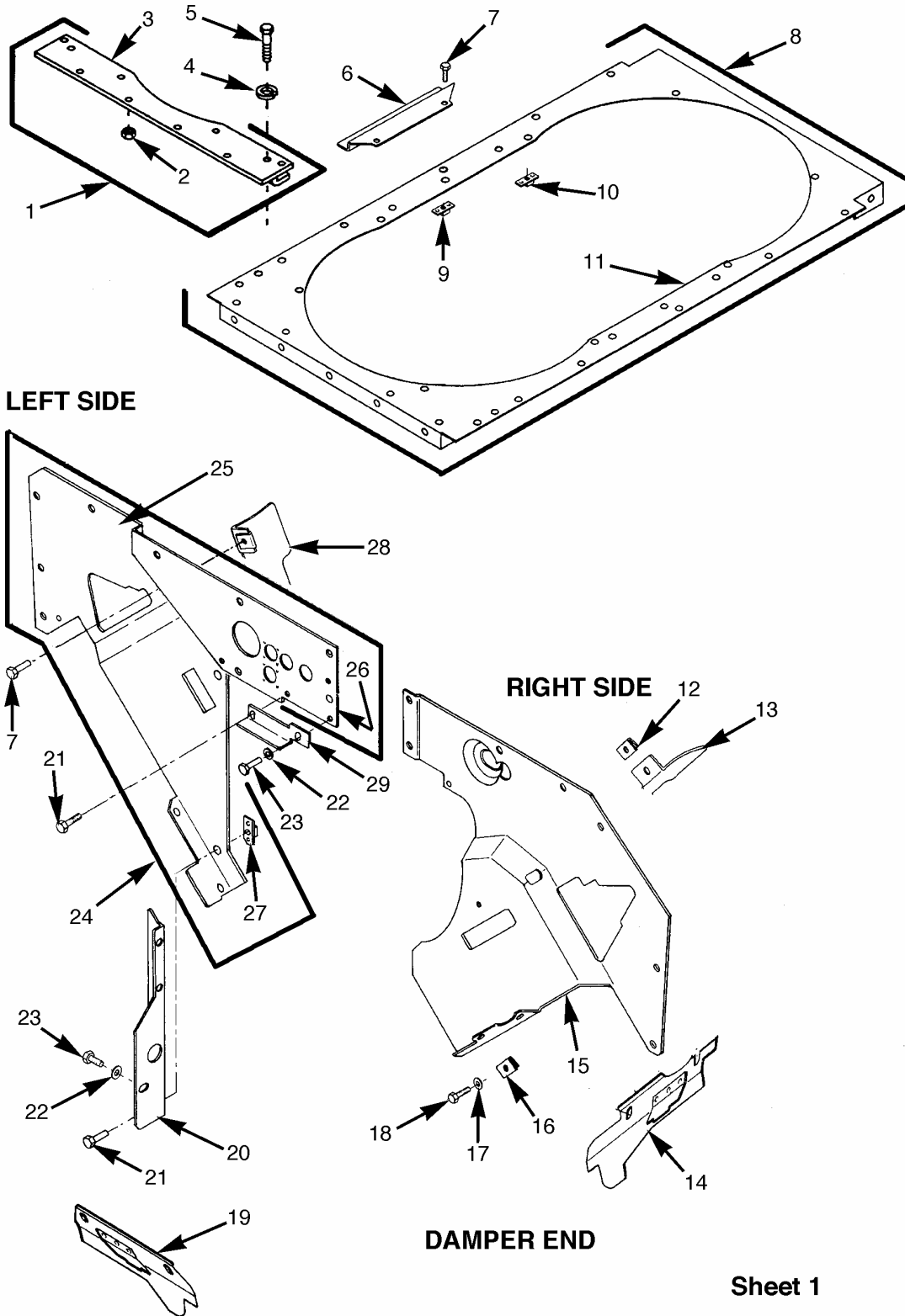
**INSPECTION**

All parts must be inspected with care. Look for damaged, bent, or cracked condition.

1. See Work Package 0028 for General Inspection Procedures.
2. Inspect engine shrouds and associated parts, see Figure 1, Sheets 1 and 2 (Legend is on page following illustration).
3. Inspect transmission shrouds and associated parts, see Figure 2 (Legend is on page following illustration).
4. Inspect cylinder deflectors and plates, see Figure 3 (Legend is on page following illustration).

INSPECTION (Continued)

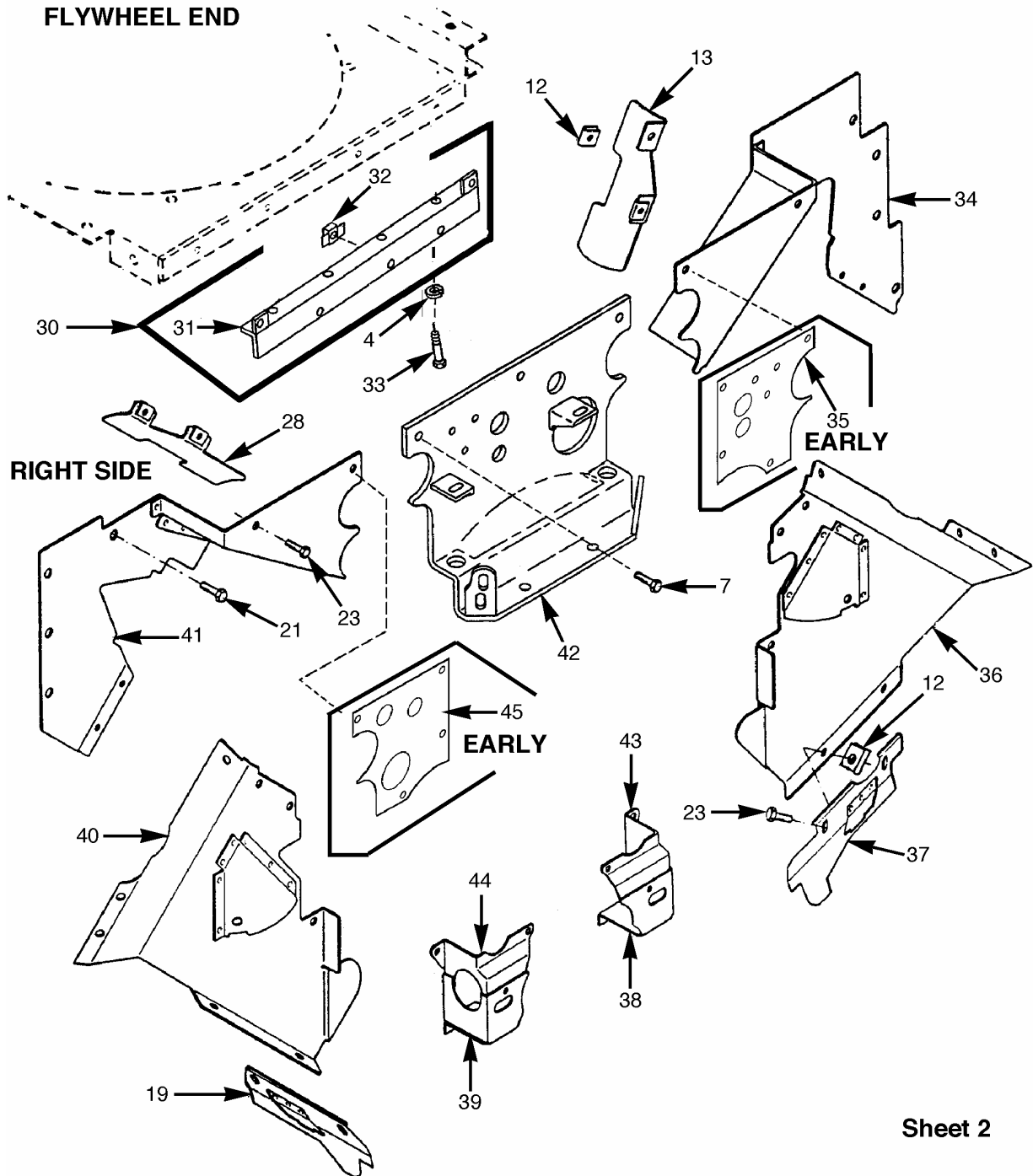
Figure 1, Sheet 1





INSPECTION (Continued)

Figure 1, Sheet 2



## SHROUD REPAIR

0128 00

## INSPECTION (Continued)

## Figure 1 Legend

ITEM	PART NUMBER	DESCRIPTION	EXTENDED DESCRIPTION	QTY	Used On
1	11671485	BRACKET, MOUNTING		1	2DR
2	585811	NUT, PLAIN, WELD		6	2DR
3	11671485-1	BRACKET		1	2DR
4	MS35338-46	WASHER, LOCK		9	2DR
5	B1821BH038F075N	SCREW, CAP,	HEXAGON HEAD	4	2DR
6	8682561	COVER, ACCESS,	COOLING FAN SHROUD	2	
7	7414584	BOLT,	ASSEMBLED WASHER,	16	
8	11684088	SHROUD,	DIESEL ENGINE	1	2CA, 2DA
8	11684201	SHROUD,	DIESEL ENGINE	1	2DR
9	11684093-2	NUT, PLAIN, PLATE,	COOLING FAN SHROUD	30	2CA, 2DA
9	11684093-2	NUT, PLAIN, PLATE,	COOLING FAN SHROUD, TRANSMISSION BRACKET	33	2DR
10	11684093-1	NUT, PLAIN, PLATE,	COOLING FAN SHROUD	18	
11	11684088-1	SHROUD		1	2CA, 2DA
11	11684201-1	SHROUD, ENGINE		1	2DR
12	8764639	NUT, SELF-LOCKING,	PLATE	30	
13	8682757	BAFFLE, AIRFLOW,		2	
14	E2DRS131-001	SHROUD, COOLING,	CYLINDER 1, RIGHT BANK	1	
15	12354450	SHROUD, ENGINE,	DAMPER END, RIGHT BANK	1	2CA, 2DA
15	11683983	SHROUD, ENGINE,	DAMPER END, RIGHT BANK	1	2DR
16	7744858	CLIP,	SPRING TENSION, ENGINE SHROUD PLATES	3	
17	MS35338-44	WASHER, LOCK,	ENGINE SHROUD PLATE CLIPS	3	
18	MS35303-3	SCREW, CAP,	HEXAGON HEAD, ENGINE SHROUD PLATE CLIPS	3	
19	8761270	SHROUD, CYLINDER,	COOLING, 1R and 6L	2	
20	11683976	PLATE,	ENGINE SHROUD, FILLER, SIDE, DAMPER END	1	
21	425640	SCREW,	ASSEMBLED WASHER,	13	
22	MS35335-33	WASHER, LOCK,	SHROUD	10	
23	10898763	SCREW, MACHINE		41	
24	12354473	PLATE, MOUNTING,	LEFT BANK, DAMPER END	1	

## SHROUD REPAIR

0128 00

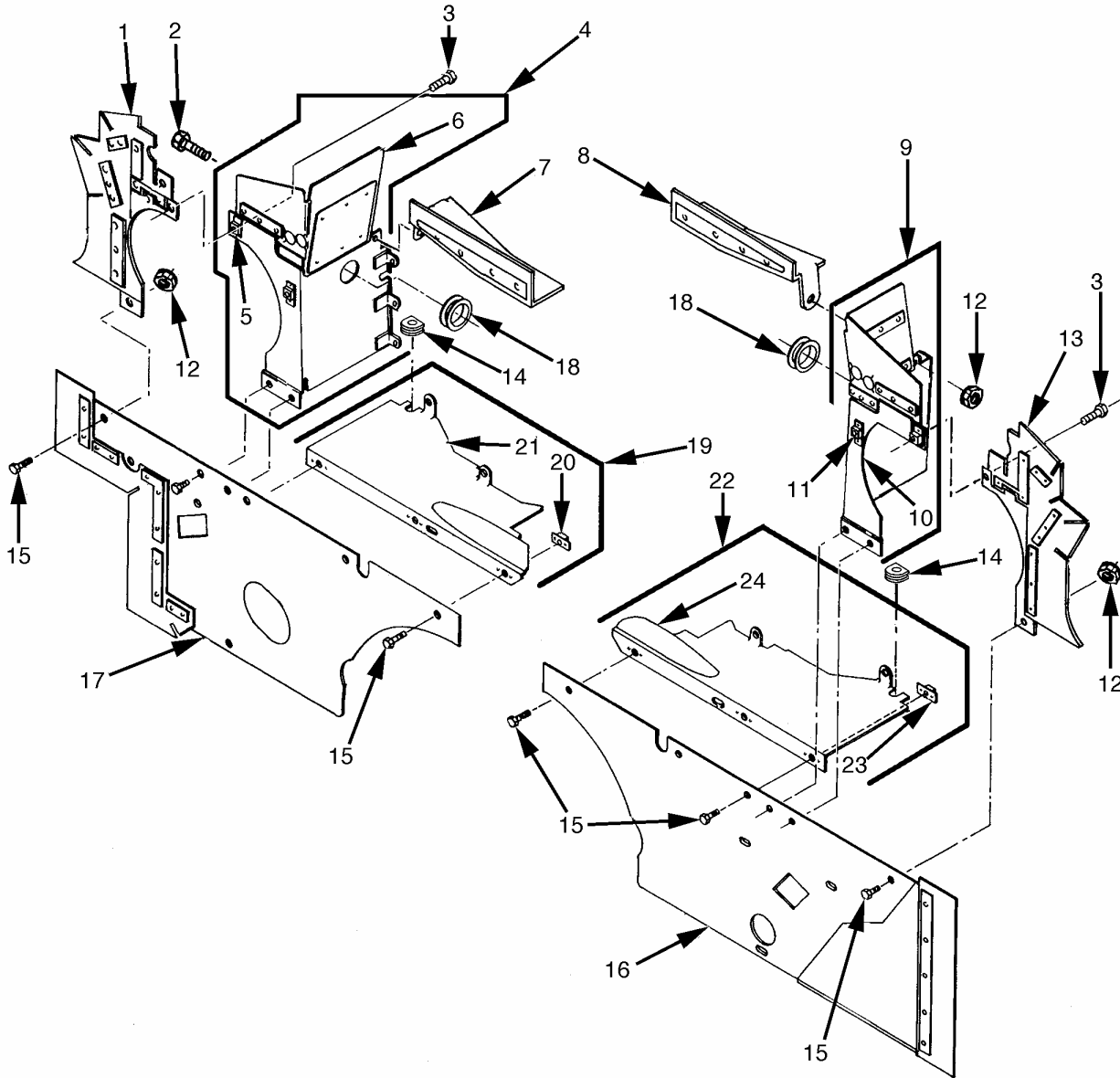
## INSPECTION (Continued)

## Figure 1 Legend (Continued)

ITEM	PART NUMBER	DESCRIPTION	EXTENDED DESCRIPTION	QTY	Used On
25	11683938	PLATE,	ENGINE SHROUD, LEFT BANK, DAMPER END	1	
26	12354474	PLATE,	ENGINE SHROUD, LEFT BANK, DAMPER END	1	
27	11684093-1	NUT, PLAIN, PLATE,	BRACKET, TRANSMISSION	4	
28	8682756	BAFFLE, AIRFLOW,	ENGINE, CYLINDER AIR, NO.1 LEFT BANK AND NO. 6 RIGHT BANK	2	
29	11683974	PLATE,	ENGINE SHROUD, FILLER, TOP, DAMPER END	1	
30	11684224	BRACKET, LEVER,	LINKAGE	1	2DR
31	11684224-1	BRACKET,	TRANSMISSION	1	2DR
32	11684093-2	NUT, PLAIN, PLATE,	TRANSMISSION BRACKET	3	2DR
33	B1821BH038F113N	SCREW, CAP,	HEXAGON HEAD, COOLER	4	2DR
34	11683936	PLATE, MOUNTING,	UPPER, LEFT BANK	1	
35	11684264	SHROUD,	COOLING MANIFOLD, LEFT BANK (EARLY)	1	
36	8682626	BAFFLE, AIRFLOW,	LOWER, LEFT BANK	1	
37	8761269	ADAPTER,	GENERATOR TO AIR DUCT,	2	
38	11684265	SHROUD,	FAN COOLING, LOWER, LEFT BANK	1	
39	11684266	SHROUD, COOLING,	ENGINE, LOWER, RIGHT BANK	1	
40	8682623	SHROUD, COOLING,	ENGINE, LOWER, RIGHT BANK	1	
41	11684026	SHROUD,	AIR DEFLECTING, UPPER, RIGHT BANK	1	2DA
41	11684092	PLATE, MOUNTING,	FLYWHEEL END, UPPER, RIGHT BANK	1	2CA, 2DR
42	12354414	GUARD,	MUFFLER	1	
43	12354416	SHROUD,	CAMSHAFT DRIVE, UPPER, LEFT	1	
44	12354415	SHROUD,	CAMSHAFT DRIVE, UPPER, RIGHT BANK	1	
45	10898756	SHROUD,	EXHAUST MANIFOLD, RIGHT BANK (EARLY)	1	

INSPECTION (Continued)

Figure 2



## SHROUD REPAIR

0128 00

## INSPECTION (Continued)

## Figure 2 Legend

ITEM	PART NUMBER	DESCRIPTION	EXTENDED DESCRIPTION	QTY	Used On
1	12314599	PLATE,	TURBOSUPERCHARGER SHROUD ASSEMBLY, OUTER, LEFT BANK	1	2CA, 2DA
2	425640	SCREW,	ASSEMBLED WASHER	14	2CA, 2DA
3	MS90726-31	BOLT, MACHINE,	TURBOSUPERCHARGER OUTER SHROUD PLATES	7	2CA, 2DA
4	12354435	PLATE,	SHROUD, TURBOSUPERCHARGER, INNER, LEFT BANK	1	2CA, 2DA
5	11684093-1	NUT, PLAIN,	PLATE, TURBOSUPERCHARGER SHROUD PLATE, INNER, LEFT BANK	4	2CA, 2DA
6	12354434	PLATE		1	2CA, 2DA
7	12275727	GUARD,	MECHANICAL DRIVE, UPPER, LEFT BANK	1	2CA, 2DA
8	11683977	SHROUD,	TRANSMISSION, UPPER, RIGHT BANK	1	2CA, 2DA
9	12354432	PLATE,	SHROUD, TURBOSUPERCHARGER, INNER, RIGHT BANK	1	2CA, 2DA
10	12354431	PLATE		1	2CA, 2DA
11	11684093-1	NUT, PLAIN,	PLATE, TURBOSUPERCHARGER SHROUD PLATE, INNER RIGHT BANK	4	2CA, 2DA
12	503345	NUT, SELF-LOCKING,	HEXAGON, TURBOSUPERCHARGER OUTER SHROUD	7	2CA, 2DA
13	12314598	PLATE,	TURBOSUPERCHARGER SHROUD ASSEMBLY, OUTER, RIGHT BANK	1	2CA, 2DA

**SHROUD REPAIR**

**0128 00**

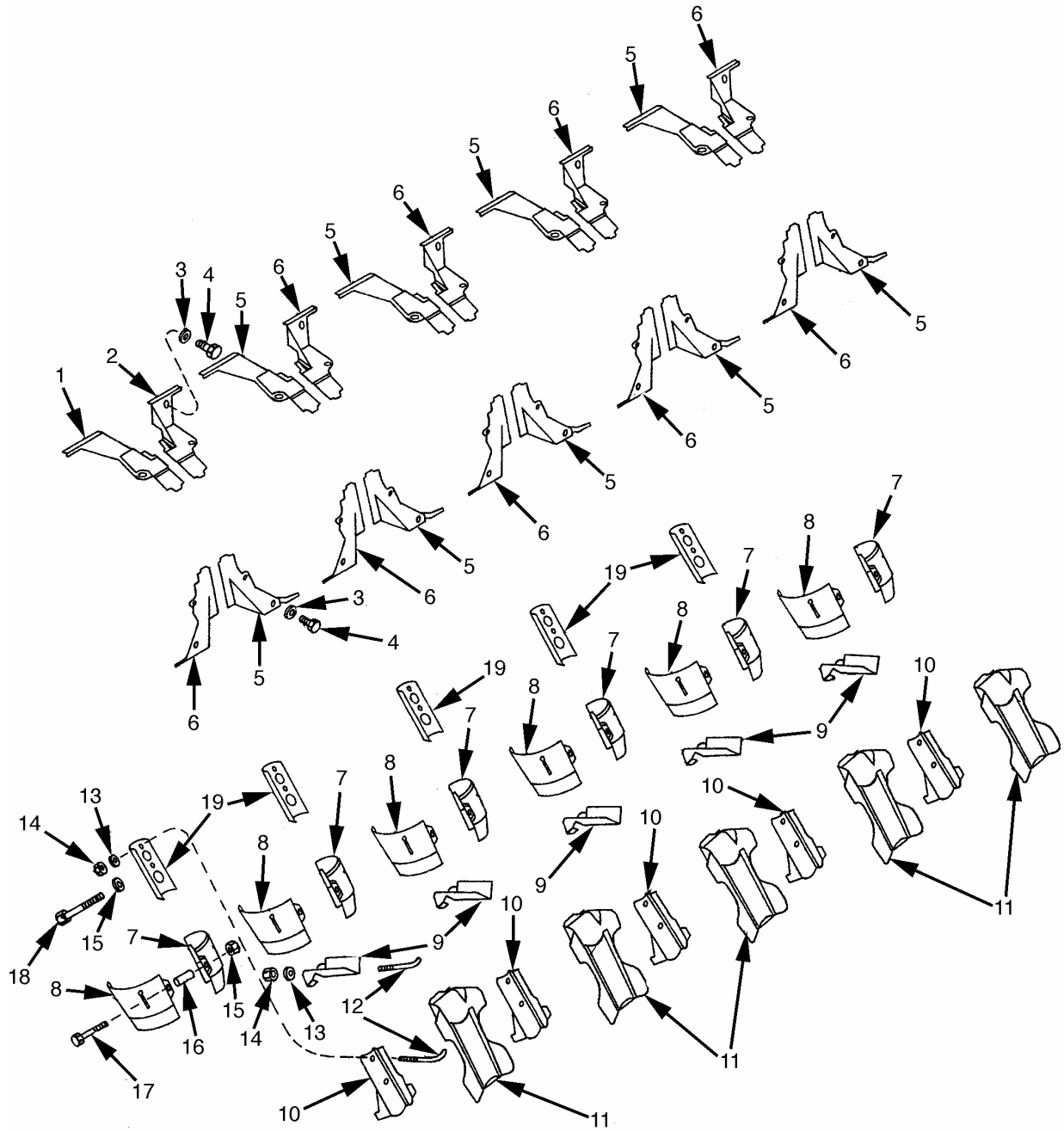
**INSPECTION (Continued)**

**Figure 2 Legend (Continued)**

ITEM	PART NUMBER	DESCRIPTION	EXTENDED DESCRIPTION	QTY	Used On
14	10935447	GROMMET,	NONMETALLIC, TRANSMISSION SHROUD LOWER TO MANIFOLD HEATER FUEL RETURN TUBES, LEFT AND RIGHT BANKS	2	2CA, 2DA
15	7414584	BOLT,	ASSEMBLED WASHER, TRANSMISSION SHROUD PLATES	16	2CA, 2DA
16	10865247	PLATE,	MOUNTING, INTERMEDIATE, RIGHT BANK	1	2CA, 2DA
17	11641919	PLATE,	MOUNTING, INTERMEDIATE, LEFT BANK	1	2CA, 2DA
18	MS35490-16	GROMMET,	NONMETALLIC, TURBOSUPERCHARGER SHROUD PLATES	2	2CA, 2DA
19	12354438	SHROUD,	TRANSMISSION, LOWER, LEFT BANK	1	2CA, 2DA
20	11684093-1	NUT, PLAIN,	PLATE, TRANSMISSION SHROUD, LOWER, LEFT BANK	3	2CA, 2DA
21	12354437	SHROUD		1	2CA, 2DA
22	12354440	SHROUD,	TRANSMISSION, LOWER, RIGHT BANK	1	2CA
22	12354451	SHROUD,	TRANSMISSION, LOWER, RIGHT BANK	1	2DA
23	11684093-1	NUT, PLAIN,	PLATE, TRANSMISSION SHROUD, LOWER, RIGHT BANK	3	2CA, 2DA
24	12354442	SHROUD		1	2DA
24	12354439	SHROUD		1	2CA

INSPECTION (Continued)

**Figure 3**



INSPECTION (Continued)

Figure 3 Legend

ITEM	PART NUMBER	DESCRIPTION	EXTENDED DESCRIPTION	QTY	Used On
1	11684004-2	BRACKET,	RIGHT BANK	1	2CA, 2DA
1	11684221-2	BRACKET,	ENGINE ACCESSORY	1	2DR
2	11684221-1	SHROUD,		1	2DR
2	11684004-1	BRACKET,	LEFT BANK	1	2CA, 2DA
3	MS35335-33	WASHER, LOCK,	CYLINDER SHROUD PLATES	40	
4	MS35303-3	SCREW, CAP,	CYLINDER SHROUD PLATES	40	
5	11684003-2	BRACKET,	RIGHT BANK	9	
6	11684003-1	BRACKET,	LEFT BANK	9	
7	8682701	DEFLECTOR, AIRFLOW,	CYLINDER AIR, RIGHT BANK	12	
8	8682700	DEFLECTOR, AIRFLOW,	CYLINDER AIR, LEFT BANK	12	
9	8682492	DEFLECTOR AIR,		10	
10	8761164	STRAP, RETAINING,	CYLINDER AIR DEFLECTOR	1	
11	8682620	BAFFLE, AIRFLOW,	INTER CYLINDER AIR	10	
12	7744720	BOLT, HOOK,	CYLINDER AIR DEFLECTOR	20	
13	NAS1149F0363P	WASHER, FLAT,		30	
14	MS21044N3	NUT, SELF-LOCKING,	INTER CYLINDER AIR BAFFLE	20	
15	503339	NUT, SELF-LOCKING,	CYLINDER AIR DEFLECTOR	12	
16	8761268	SPACER, SLEEVE,	CYLINDER AIR DEFLECTOR	12	
17	B1821BH025F250N	SCREW, CAP,	HEXAGON	12	
18	8761432	BOLT, MACHINE,	RETAINING STRAP AND ACCESS COVER	10	
19	8682702	COVER, ACCESS,	AIR DEFLECTOR, OUTER	10	

REPAIR

1. Straighten bent shrouds or plates as near to original shape as possible. Replace cracked or badly broken shrouds and plates.



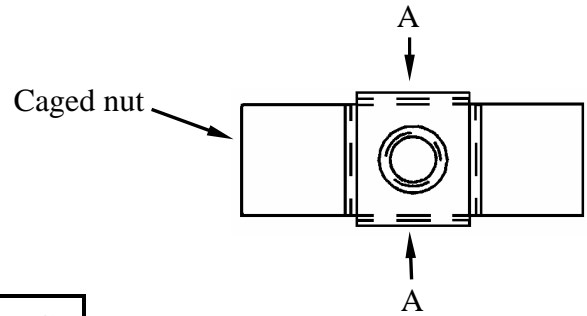
REPAIR (Continued)

2. Replace caged nuts (as required). Figure 1, items 9 & 32.

Figure 1, items 10 & 27.

Figure 2, items 5, 11, 20, and 23.

- a. Caged nuts may be replaced by bending tabs (A) on either side open and replacing caged nuts.

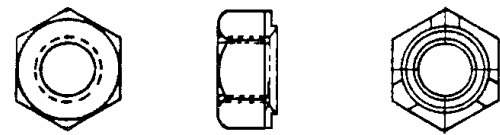


**Unsafe welding practices can cause serious injury from fire, explosions, or harmful agents. Allow only authorized personnel to weld or cut metals. Follow safety precautions in TC 9-237. Protective clothing and goggles must be worn, adequate protective equipment used, a suitable fire extinguisher kept nearby, and requirements of TC 9-237 strictly followed.**

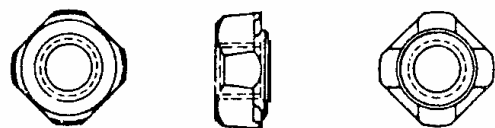
- b. If caged nut tabs (A) are damaged, caged nuts may be chiseled loose and a new caged nut spot welded in place.

3. Replace weld nut (Figure 1, item 2).

- a. If weld nuts are damaged they may be chiseled or ground loose and a new weld nut welded in place. Note that weld nuts may be hexagon or square shaped.



Hexagon Weld Nut



Square Weld Nut

END OF WORK PACKAGE



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**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

---

**0129 00**

**THIS WORK PACKAGE COVERS:**

Disassembly, Inspection, Repair, Assembly

---

**INITIAL SETUP:**

**Tools:**

Arbor press (item 8, WP 0176)  
 General mechanic's tool kit (item 121, WP 0176)  
 Inside micrometer caliper set (item 16, WP 0176)  
 Machinist's vise (item 132, WP 0176)  
 Mechanical puller (2) (item 90, WP 0176)  
 Outside micrometer caliper set (item 17, WP 0176)  
 Spacer sleeve (item 109, WP 0176)  
 Telescoping gauge set (item 54, WP 0176)  
 Torque wrench, 0-175 foot-pounds (item 127, WP 0176)  
 Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Bearing (2) (item 295, WP 0175)  
 Bearing (6) (item 193, WP 0175)  
 Bearing, ball (1)(item 298, WP 0175)  
 Gasket (2) (item 257, WP 0175)  
 O-ring (2) (item 72, WP 0175)  
 Pin, Grooved (2) (item 192.1, WP 0175)

**Mandatory Replacement Parts (cont'):**

Retaining ring (2) (item 20, WP 0175)  
 Seal, plain (1) (item 191, WP 0175)  
 Self-locking nuts (83) (item 38, WP 0175)  
 Self-locking screws (2) (item 223, WP 0175)  
 Spring (3) (item 354, WP 0175)

**Expendable and Durable Items:**

Cleaning compound, solvent (item 8, WP 0173)  
 Cloth, abrasive, crocus (item 9, WP 0173)  
 Goggles (item 17, WP 0173)  
 Grease (item 19, WP 0173)  
 Lubricating oil, engine (item 21, WP 0173)  
 Lubriplate (item 23, WP 0173)  
 Wire, non-electrical (item 44, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine level on flat surface  
 Fans and covers removed (WP 0054)

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**NOTE**

**Front and rear fan drive friction clutches are interchangeable and are removed and repaired in a similar manner. For instructional purposes, this procedure covers repair of one fan drive friction clutch.**

**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

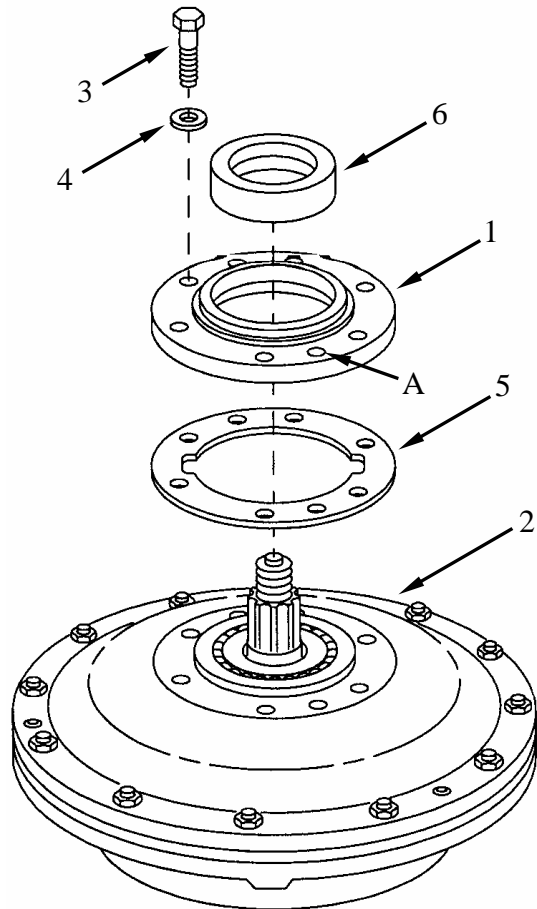
**0129 00**

**REMOVAL**

**CAUTION**

**Do not attempt to pry seal housing from fan tower: both the seal housing and fan tower are made of aluminum and are easily damaged.**

1. Remove seal housing (1) from fan tower (2).
  - a. Remove six screws (3) with flat washers (4) securing seal housing (1).
  - b. Install two mechanical pullers (item 90, WP 0175) in threaded holes (A) of seal housing. Alternately tighten pullers to remove seal housing (1).
  - c. Remove and discard gasket (5).
  - d. Remove seal (6) from oil seal housing (1). Discard seal.

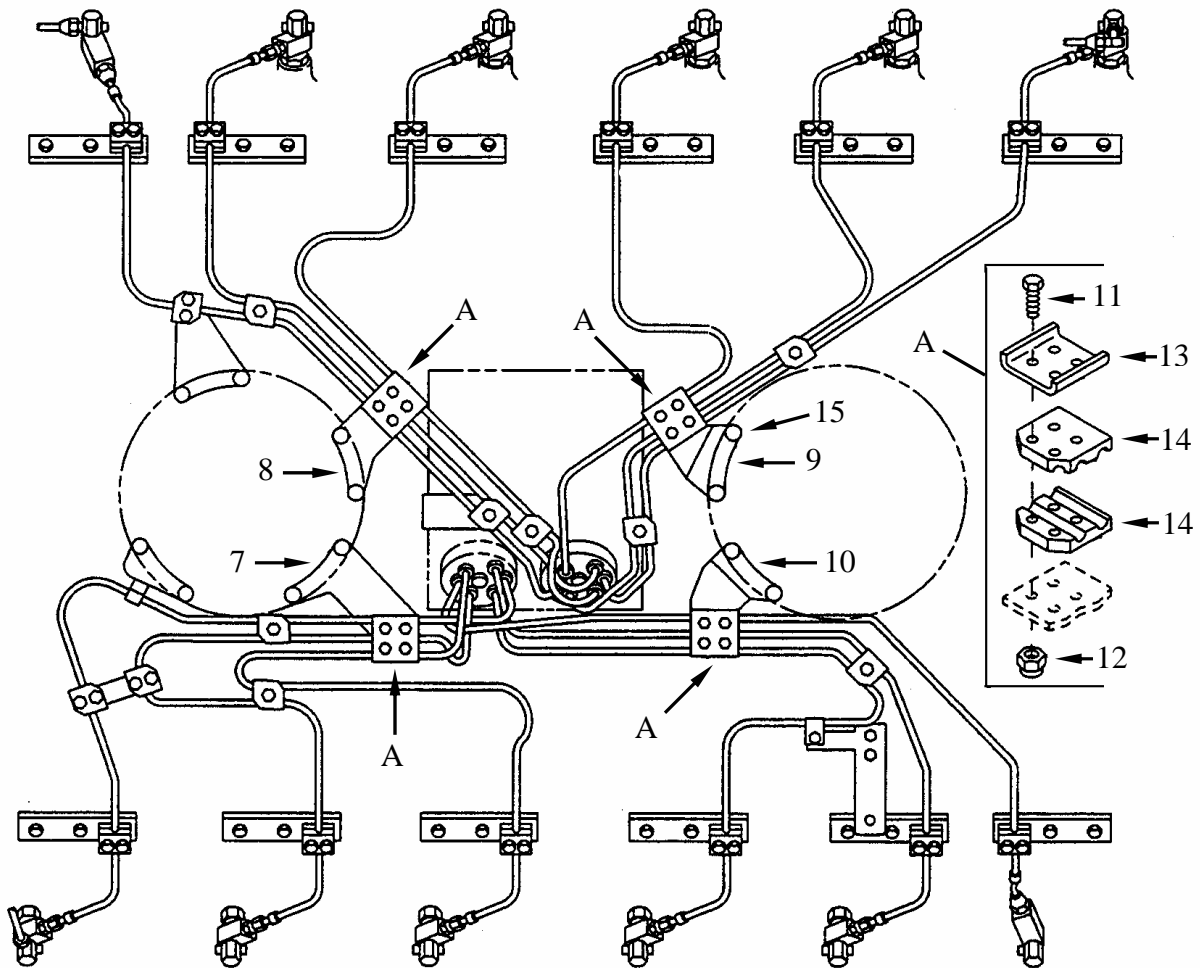


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**REMOVAL (Continued)**

2. Remove double angle brackets (7, 8, 9, and 10) (Detail A).
  - a. Remove 16 screws (11) and self-locking nuts (12). Discard self-locking nuts.
  - b. Remove four retaining straps (13) and eight fairlead halves (14).
  - c. Remove eight self-locking nuts (15) to remove double angle brackets (7, 8, 9, and 10).

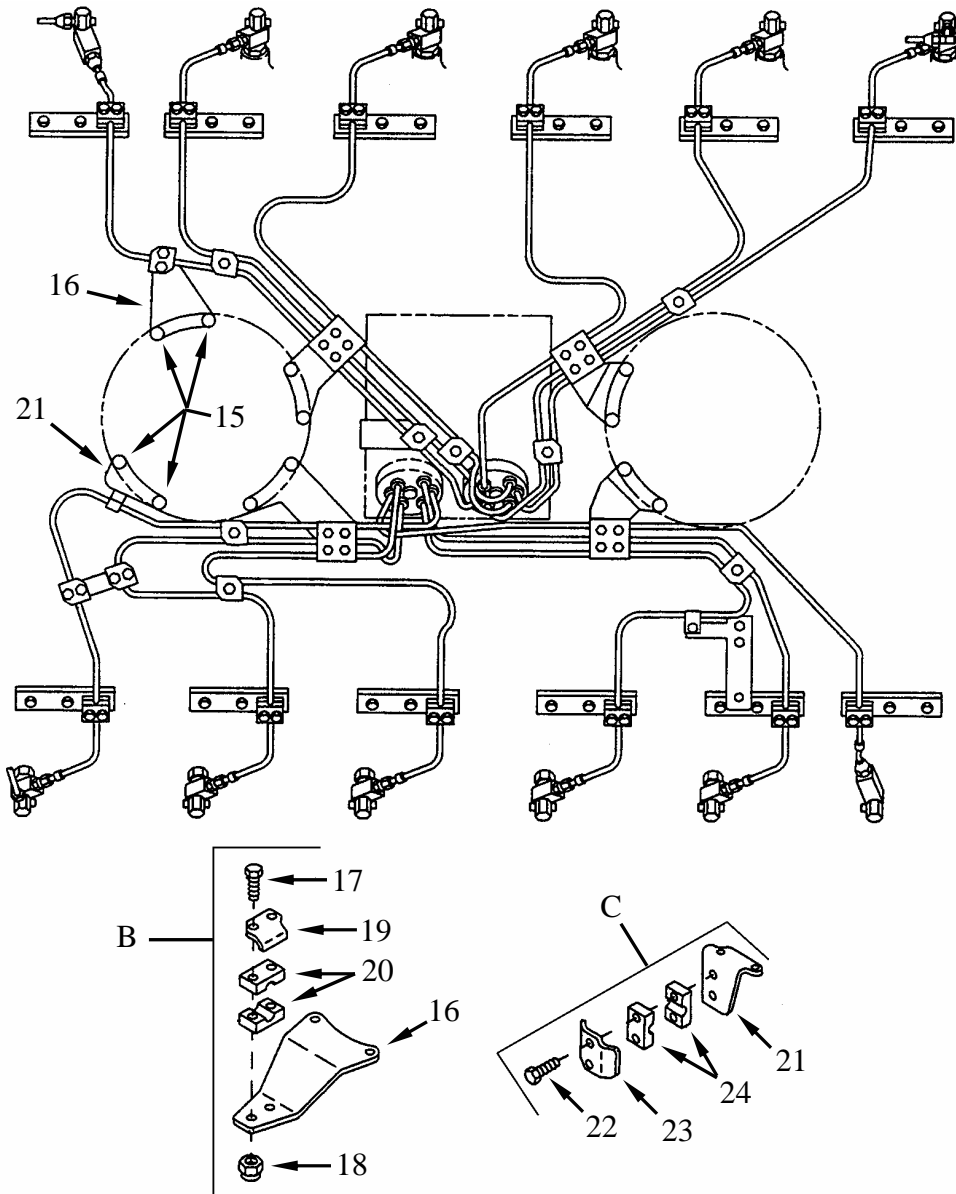


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**REMOVAL (Continued)**

3. Remove double-angle bracket (16) (Detail B).
  - a. Remove two screws (17) and self-locking nuts (18). Discard self-locking nuts.
  - b. Remove retaining strap (19) and two fairlead halves (20).
  - c. Remove two self-locking nuts (15) to remove double-angle bracket (16). Discard nuts.
4. Remove angle bracket (21) (Detail C).
  - a. Remove and discard two self-locking screws (22).
  - b. Remove retaining strap (23) and two fairlead halves (24).
  - c. Remove two self-locking nuts (15) to remove angle bracket (21). Discard nuts.



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**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

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0129 00

**REMOVAL (Continued)**

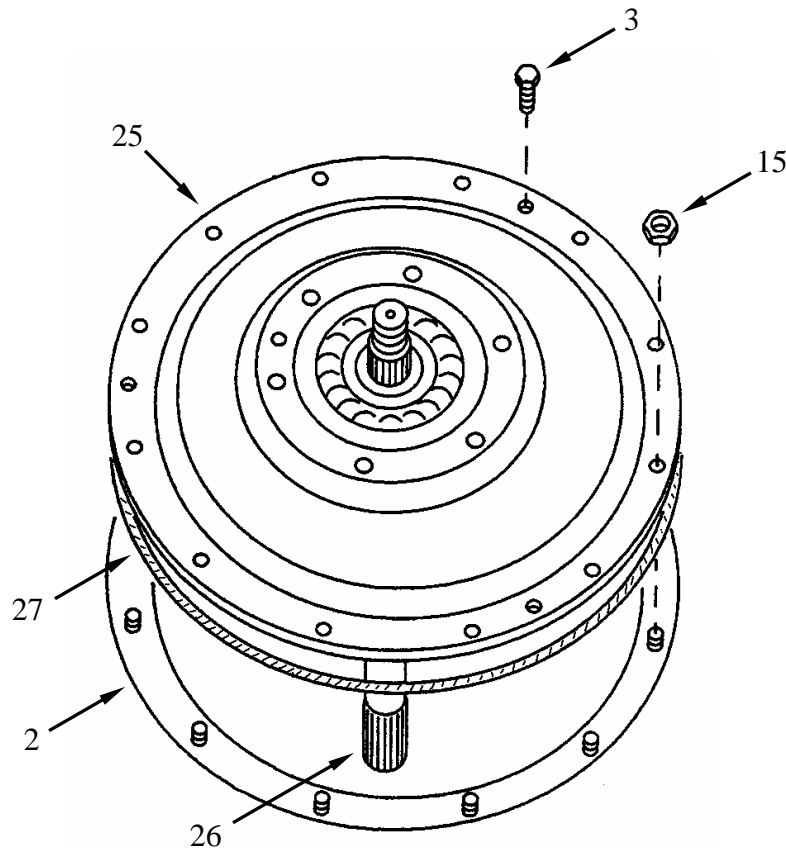
5. Remove access cover (25).

- a. Remove and discard remaining two self-locking nuts (15) securing cover (25).

**NOTE**

**Three of the (5/16-24) screws (3) removed from seal housing may be used as jack screws to remove access cover.**

- b. Install three screws (3) as jack screws in threaded holes provided in access cover (25).
- c. Alternately tighten jack screws (3) and remove access cover (25) and friction clutch (26) as a unit from fan tower (2).
- d. Remove jack screws (3) from access cover (25).
- e. Remove and discard O-ring (27).

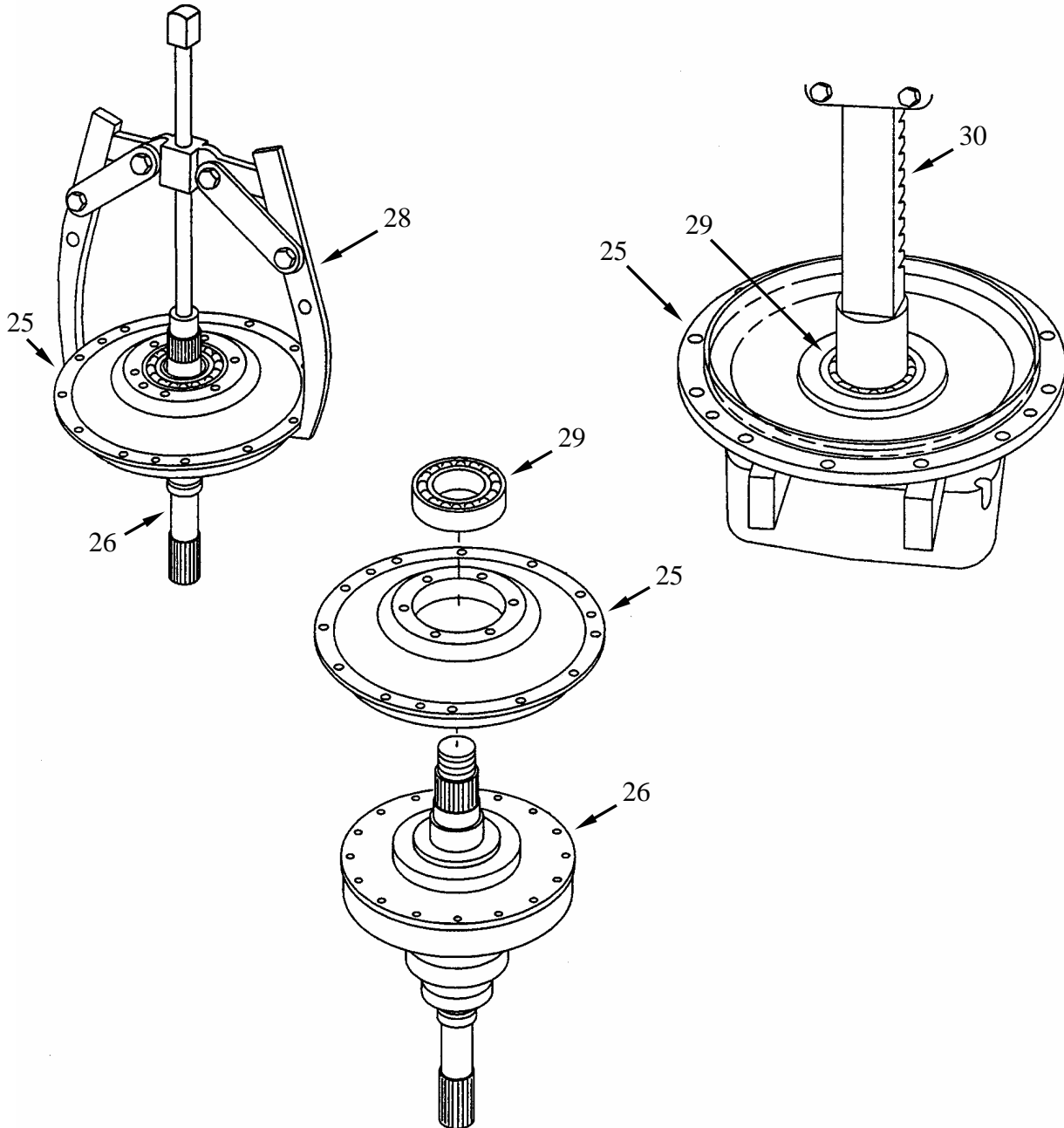


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**DISASSEMBLY**

1. Separate access cover (25) from friction clutch (26) using a gear puller (28).
2. Remove ball bearing (29) from access cover (25) using an arbor press (30). Discard ball bearing.





**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

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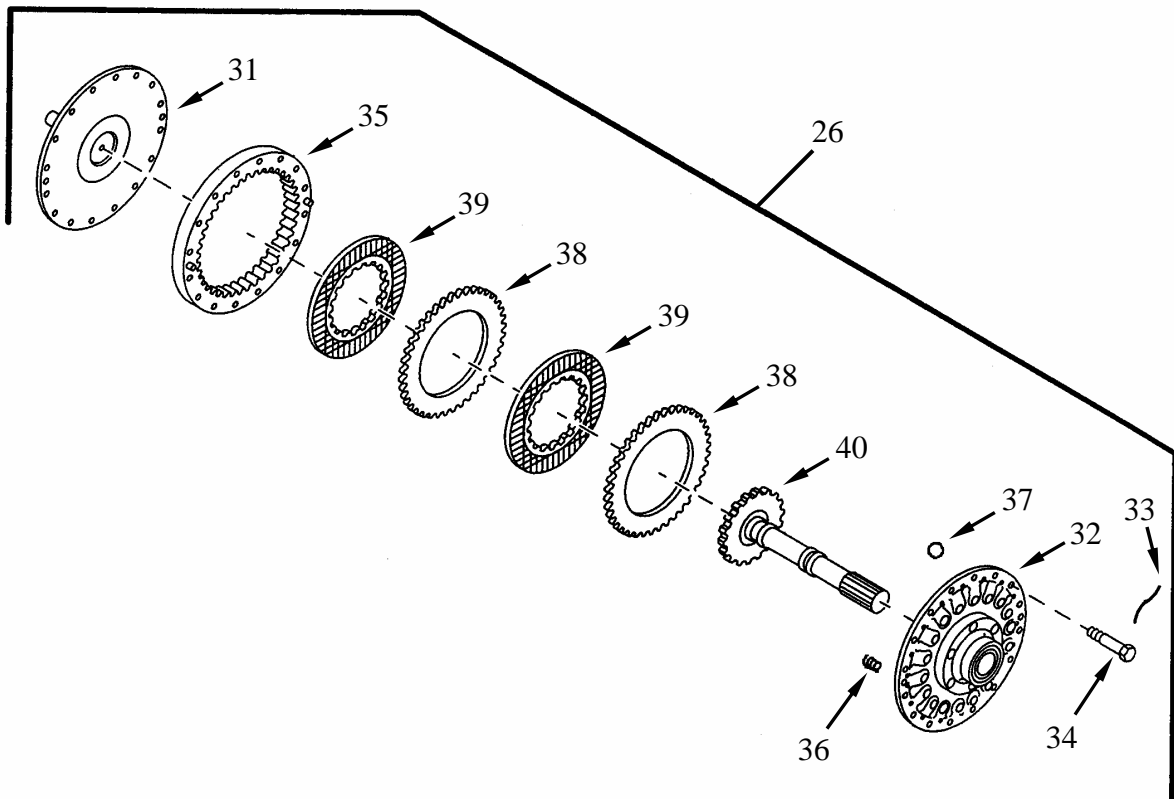
**DISASSEMBLY (Continued)**

3. Separate flange (31) from hub (32).
  - a. Place clutch assembly (26) in machinist's vice with hub (32) up.
  - b. Cut, remove, and discard locking wire (33) from 16 screws (34).
  - c. Remove 14 of the 16 screws (34) securing fan drive hub assembly (32) to flange (31). Leave two oppositely positioned screws (34) in place.
  - d. Alternately loosen the remaining two screws (34) until flange (31) and housing assembly (35) comes off hub (32) as a unit.

**NOTE**

**Early model clutch assemblies used 15 ball bearings. On assembly, use only six of the ball bearings. Doing so will increase gear train life.**

4. Remove three springs (36) and six ball bearings (37) from fan drive hub assembly (32). Discard springs and ball bearings.
5. Remove four clutch disks (38, 39).
6. Remove shaft assembly (40) from fan drive hub assembly (32).
7. Separate housing assembly (35) from flange (31).

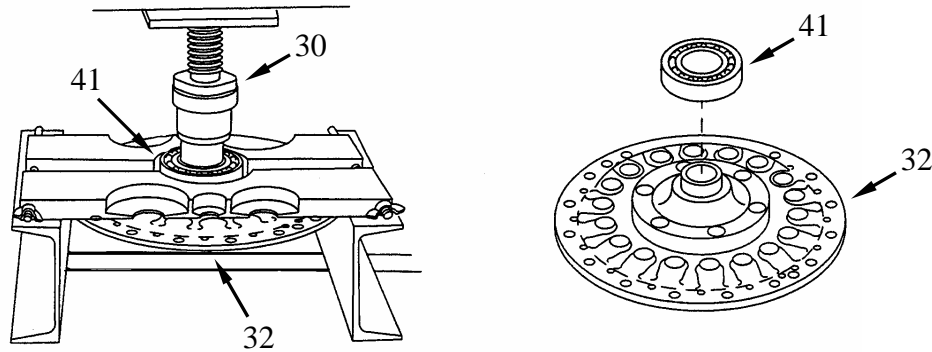


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

**0129 00**

**DISASSEMBLY (Continued)**

8. Press fan drive hub assembly (32) from ball bearing (41) using an arbor press (30) (item 8, WP 0176). Discard bearing.



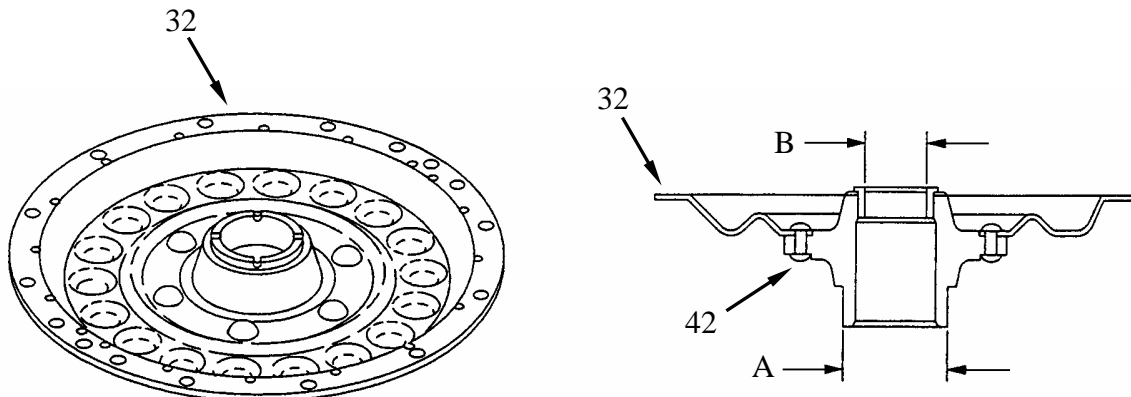
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

1. All parts must be inspected with care (WP 0028).
2. Inspect fan drive hub assembly (32) for warpage or loose rivets (42). Replace fan drive hub assembly if defects are found.
3. Inspect fan drive hub assembly (32) for raised metal or pitted surfaces caused by ball wear. Replace fan drive hub assembly if defects are found.
4. Measure outside diameter (A) of fan drive hub assembly (32), using outside micrometer (item 17, WP 0176). Replace fan drive hub assembly if not within specifications in the following table.
5. Measure inside diameter (B) of fan drive hub assembly (32), using inside micrometer (item 16, WP 0176). Replace fan drive hub assembly if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (bearing surface)	1.7718 (45.0037)	1.7722 (45.0138)	1.7716 (44.99864)
B (inside diameter)	1.1470 (29.1338)	1.1480 (29.1592)	1.1490 (29.1846)



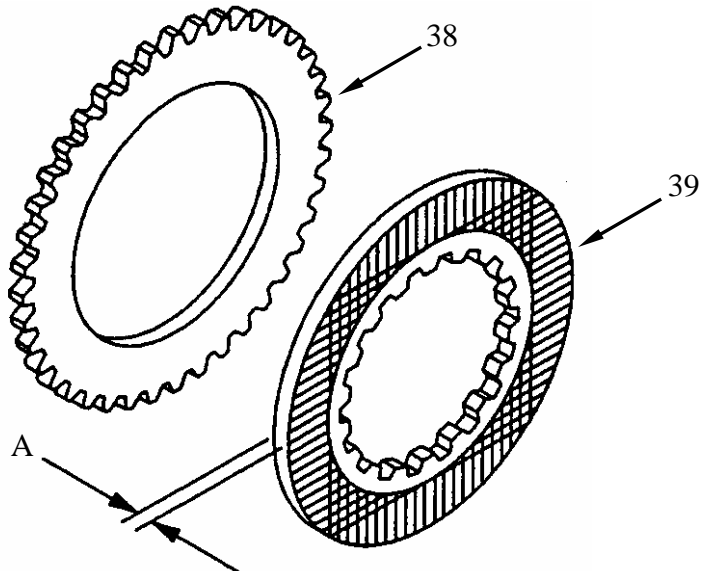
**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

**0129 00**

**INSPECTION (Continued)**

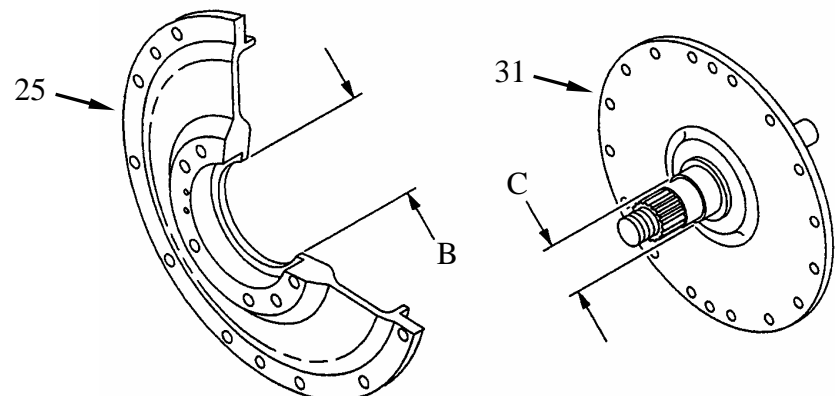
6. Inspect clutch disks (38, 39) for excessive heat distortion, cracks, warpage, or other abrasive damage. Replace clutch disks if defects are found.
7. Measure thickness (A) of two clutch disks (39), using outside micrometer (item 17, WP 0176). Replace clutch disks if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (thickness of clutch disk)	0.1900 (4.8260)	0.1860 (4.7244)	0.1840 (4.6736)



8. Measure inside diameter (B) of access cover (25). Replace access cover if not within specifications in the following table.
9. Measure outside diameter (C) of flange (31). Replace flange if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (access cover)	3.1496 (79.9998)	3.1503 (80.0176)	3.1506 (80.0252)
B (flange)	1.3781 (35.0037)	1.3785 (35.0139)	1.3779 (34.9986)



**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

**0129 00**

**INSPECTION (Continued)**

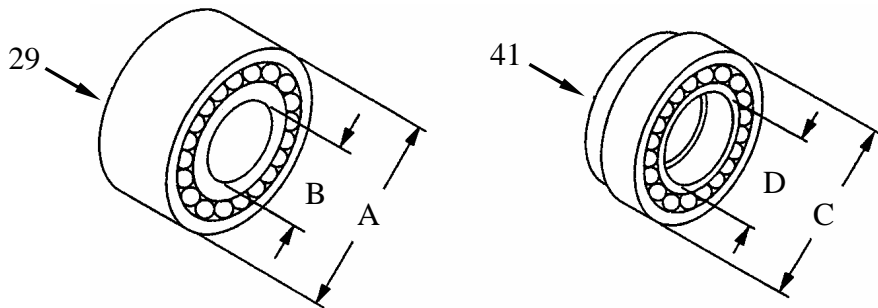
10. Replace cover bearing (29).

- a. Use a new bearing (29) (item 295, WP 0175) that meets specifications (A, B) in the following table.

11. Replace hub bearing (41).

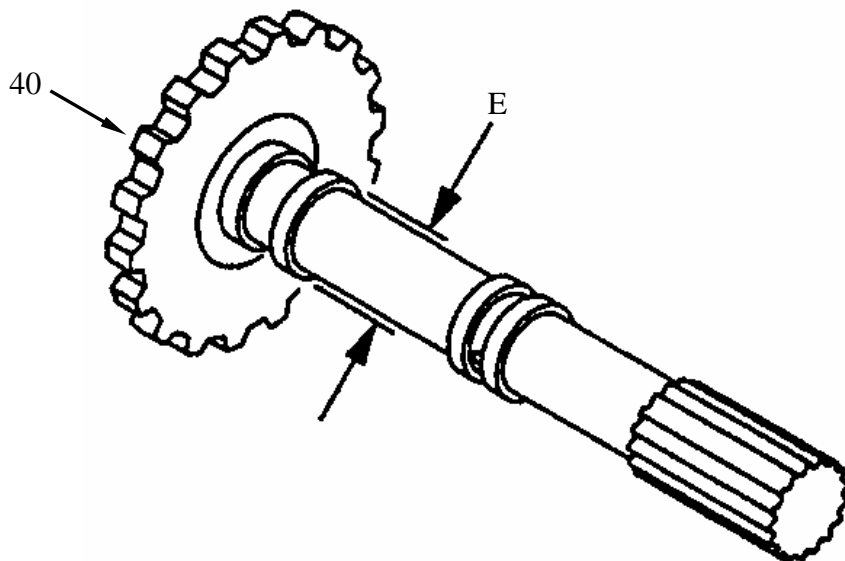
- a. Use a new bearing (41) (item 298, WP 0175) that meets specifications (C, D) in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (outside diameter)	3.1491 (79.987)	3.1496 (79.998)	None
B (inside diameter)	1.3775 (34.9885)	1.3780 (35.0012)	None
C (outside diameter)	2.9523 (74.9884)	2.9528 (75.0011)	None
D (inside diameter)	1.7712 (44.9884)	1.7717 (45.0011)	None



12. Measure outside diameter (E) of shaft assembly (40), using outside micrometer (item 17, WP 0176). Replace shaft assembly if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
E (outside diameter)	1.1450 (29.0830)	1.1460 (29.1084)	1.1440 (29.0576)



## FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS REPLACE/REPAIR

0129 00

### INSPECTION (Continued)

13. Inspect housing assembly (35) for loose or damaged grooved pins (43) (item 192.1, WP 0175).  
Replace grooved pins if defects are found.

### REPAIR

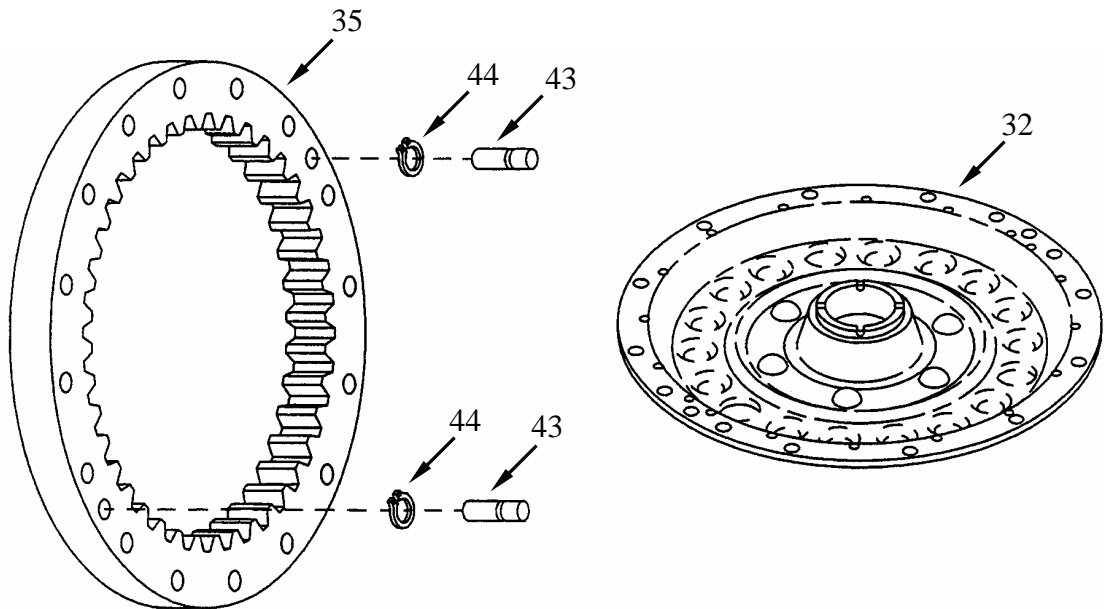


1. Repair minor raised metal or pitted surfaces caused by ball wear on fan drive hub assembly (32) by polishing with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
2. Remove two grooved pins (43) from housing assembly (35) using an arbor press.
3. Remove and discard retaining rings (44) from two grooved pins (43).
4. Install two new retaining rings (44) (item 20, WP 0175) on two grooved pins (43).

### CAUTION

**When pressing grooved pins (43) into housing (35) take care to stop pressing the instant the retaining ring (44) contacts the surface of the housing. The retaining rings are small and are easily damaged.**

5. Install two grooved pins (43) in housing assembly (35) using an arbor press (item 8, WP 0176), until retaining rings (44) contact housing assembly (35).

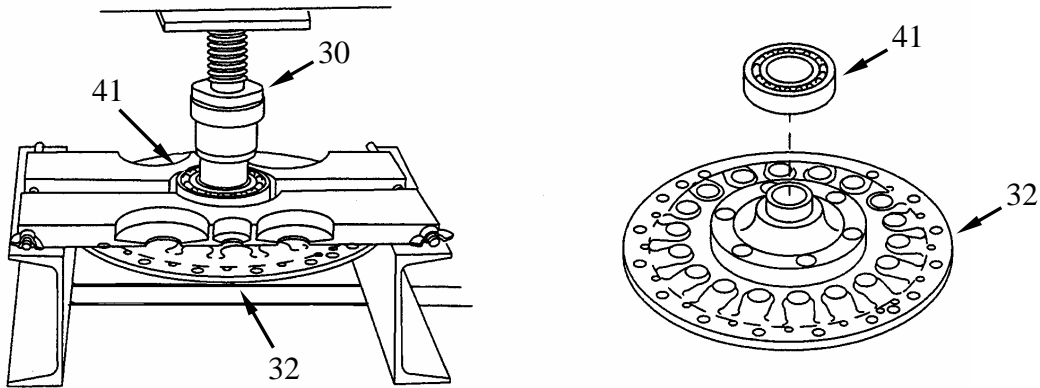


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**ASSEMBLY**

1. Press new ball bearing (41) (item 298, WP 0175) on hub assembly (32) using an arbor press (30).

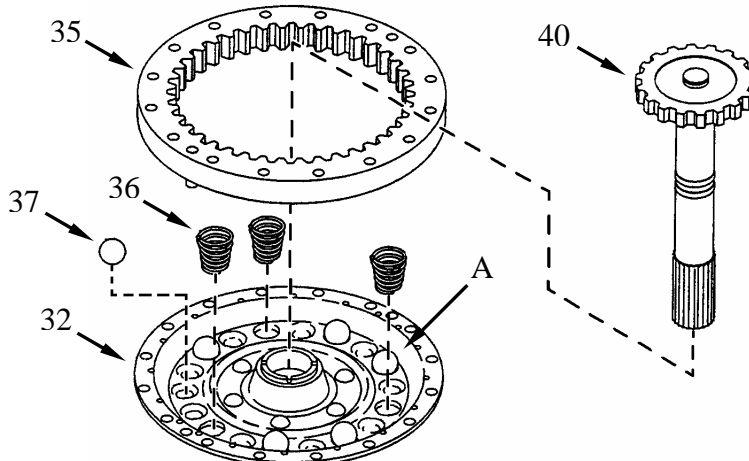


2. Place a dab of Lubriplate (item 23, WP 0173) in each ball pocket (A) to help keep ball bearings in place during assembly.
3. Install shaft assembly (40) in fan drive hub (32).
4. Mount shaft assembly (40) with hub (32) in a machinist's vise.
5. Install housing assembly (35) on fan drive hub (32) assuring that screw holes align.

**NOTE**

**There are three pockets for the springs and fifteen for the ball bearings in the hub assembly. The pockets for the springs have a flat bottom while those for the ball bearings are rounded. Be sure to place the springs and ball bearings in the correct pockets. Use only six ball bearings, and space them evenly (skip every other pocket).**

6. Position six new ball bearings (37) (item 193, WP 0175) and three new springs (36) (item 354, WP 0175) in fan drive hub assembly (32) pockets.



**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

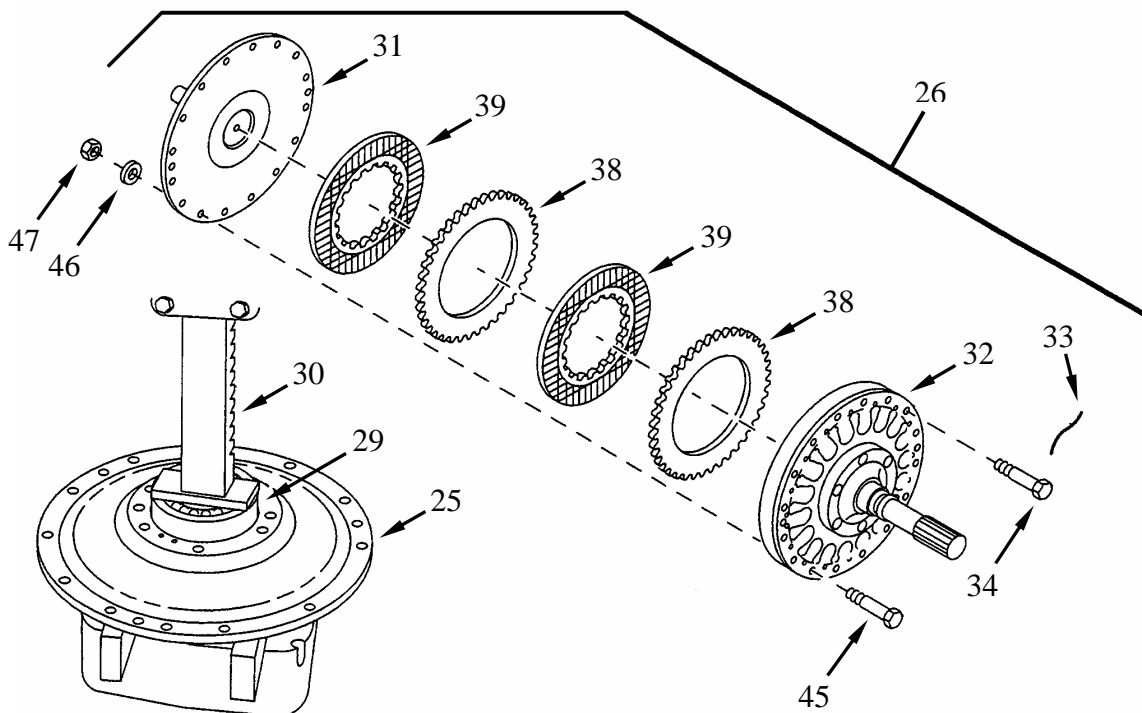
**ASSEMBLY (Continued)**

7. Lubricate four clutch disks (38, 39) with lubricating oil (item 21, WP 01073).
8. Install four clutch disks (38, 39) in fan drive hub assembly (32) in the order shown.
9. Install flange (31) over clutch disks and on fan drive hub assembly (32) being sure to align screw holes.

**NOTE**

**Compressing the clutch assembly can be accomplished by temporarily using undersized screws with flat washers and nuts to draw the assembly together.**

10. Assemble clutch assembly (26).
  - a. Equally space four temporary screws (45) through friction clutch assembly (26) and secure using four flat washers (46) and nuts (47). Alternately tighten the four nuts (47) to draw the friction clutch (26) together.
  - b. Install 12 screws (34) and torque to 150-160 inch-pounds (17-18 N•m).
  - c. Remove four nuts (47), flat washers (46) and screws (45).
  - d. Install remaining 4 screws (34) and torque to 150-160 inch-pounds (17-18 N•m), using torque wrench (item 124, WP 0176).
  - e. Install new locking wire (33) (item 44, WP 0173).
11. Press new ball bearing (29) (item 295, WP 0175) in access cover (25) using an arbor press (30) (item 8, WP 0176).



**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

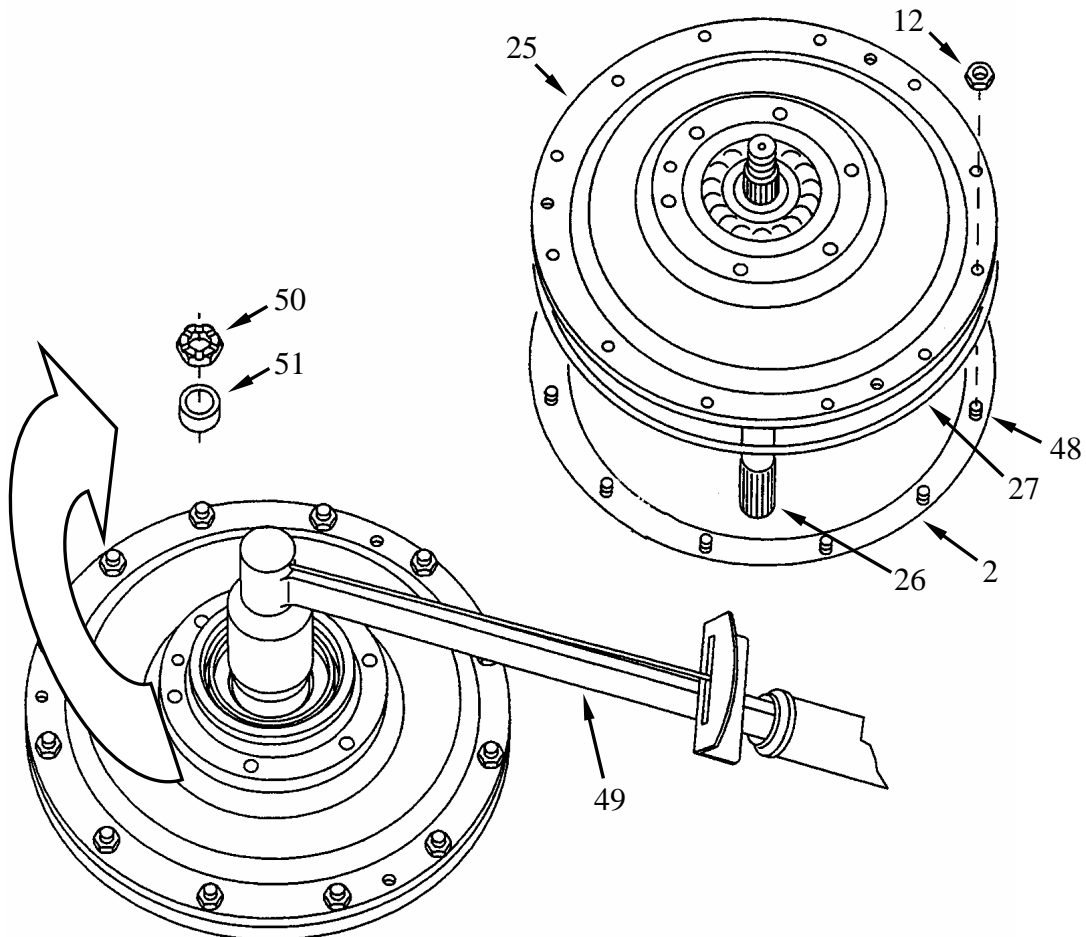
**INSTALLATION**

1. Install assembled friction clutch (26) into fan tower (2).
2. Install a new O-ring (27) (item 72, WP 0175) on cover (25) and install on fan tower (2) over friction clutch (26).
3. Apply a small amount of Lubriplate (item 23, WP 0173) to studs (48).

**NOTE**

**Remaining self-locking nuts are installed on long studs when injection line brackets are installed.**

4. Install eight (on front fan clutch) or four (on rear fan clutch) new self-locking nuts (12) (item 38, WP 0175), on short studs, securing access cover (25). Hand-tighten only at this time.
5. Check the slip torque of fan drive friction clutch.
  - a. Rotate clutch drive by using a torque wrench (49) (item 127, WP 0175) on fan nut (50) with spacer sleeve (51) (item 109, WP 0175) installed.
  - b. Slip torque value must be between 25 and 42 foot-pounds (34-57 N•m).
  - c. Investigate cause if the fan clutch test failed (repeat repair). If test passed, go to step 6.



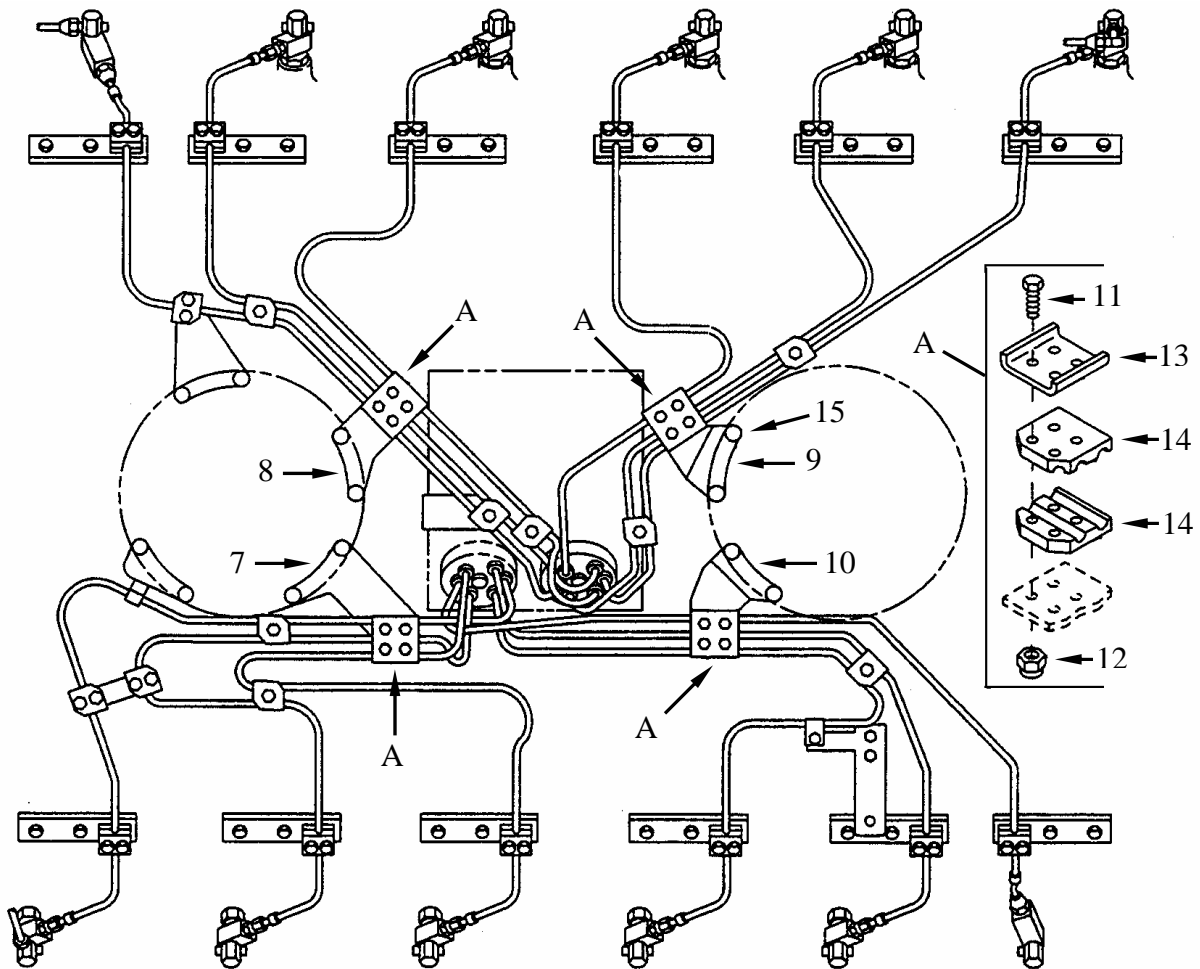


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**INSTALLATION (Continued)**

6. Install double angle brackets (7, 8, 9, and 10) (Detail A).
  - a. Place double angle brackets (7, 8, 9, and 10) in position and secure using eight new self-locking nuts (15) (item 38, WP 0175).
  - b. Install four retaining straps (13) and eight fairlead halves (14).
  - c. Secure retaining straps (13) using 16 screws (11) and new self-locking nuts (12) (item 38, WP 0175).

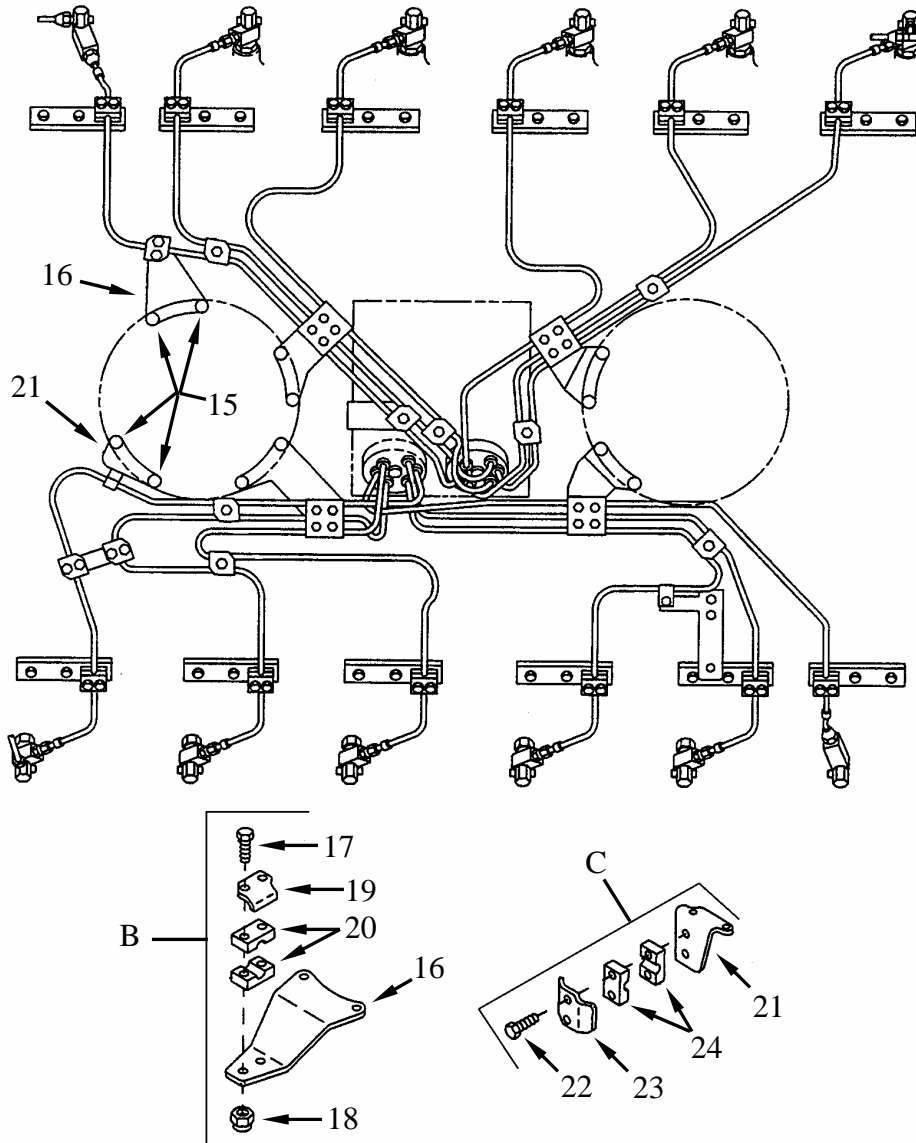


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**INSTALLATION (Continued)**

7. Install double-angle bracket (16) (Detail B).
  - a. Place double-angle bracket (16) in position and secure using two new self-locking nuts (15) (item 38, WP 0175).
  - b. Place retaining strap (19) and two fairlead halves (20) in position.
  - c. Secure using two screws (17) and new self-locking nuts (18) (item 38, WP 0175).
8. Install angle bracket (21) (Detail C).
  - a. Place angle bracket (21) in position and secure using two new self-locking nuts (15) (item 38, WP 0175).
  - b. Place retaining strap (23) and two fairlead halves (24) in position.
  - c. Secure using two new self-locking screws (22) (item 223, WP 0175).

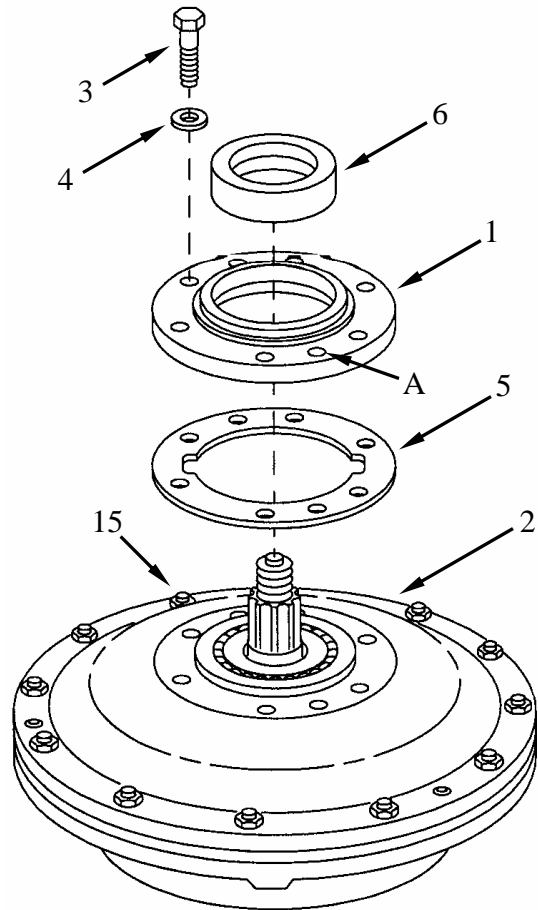


**FAN DRIVE CLUTCH ASSEMBLY AND ASSOCIATED PARTS  
REPLACE/REPAIR**

0129 00

**INSTALLATION (Continued)**

9. Torque-tighten 24 self-locking nuts (15) to 150-175 inch-pounds (17-19.8 N•m).
10. Install new seal (6) in seal housing (1).
  - a. Install seal (6) (item 191, WP 0175) in housing (1) with lip of seal towards bottom of housing and felt towards top.
11. Install seal housing (1) on fan tower (2).
  - a. Assuring that mating surfaces are clean, place new gasket (5) (item 257, WP 0175) on fan tower.
  - b. Install oil seal housing (1).
  - c. Secure using six screws (3) with flat washers (4).

**END OF WORK PACKAGE**



**TM 9-2815-220-24**

**CHAPTER 8**

**GENERAL SUPPORT MAINTENANCE**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



**THIS WORK PACKAGE COVERS:**

Installation, Removal

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**INITIAL SETUP:**

**Tools and Special Tools:**

Engine lifting sling for Models 2CA & 2DA  
(item 38, WP 0176)

Engine lifting sling for Model 2DR  
(item 37, WP 0176)

General mechanic's tool kit (item 121, WP 0176)

Maintenance stand (item 111, WP 0176)

**Equipment Conditions:**

Starter and cradle removed (WP 0049)

Generator, bracket and oil hoses removed  
(650 ampere, WP 0051) or  
(300 ampere, WP 0052)

Oil drained (WP 0031)

Oil pan removed (WP 0152)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

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**WARNING**



**AVDS-1790-2 series engines weigh approximately 5,000 pounds.**

- **Be careful not to place any part of your body underneath a lifted engine.**
- **Insure that the lifting device you are using is rated for at least 5,000 pounds.**

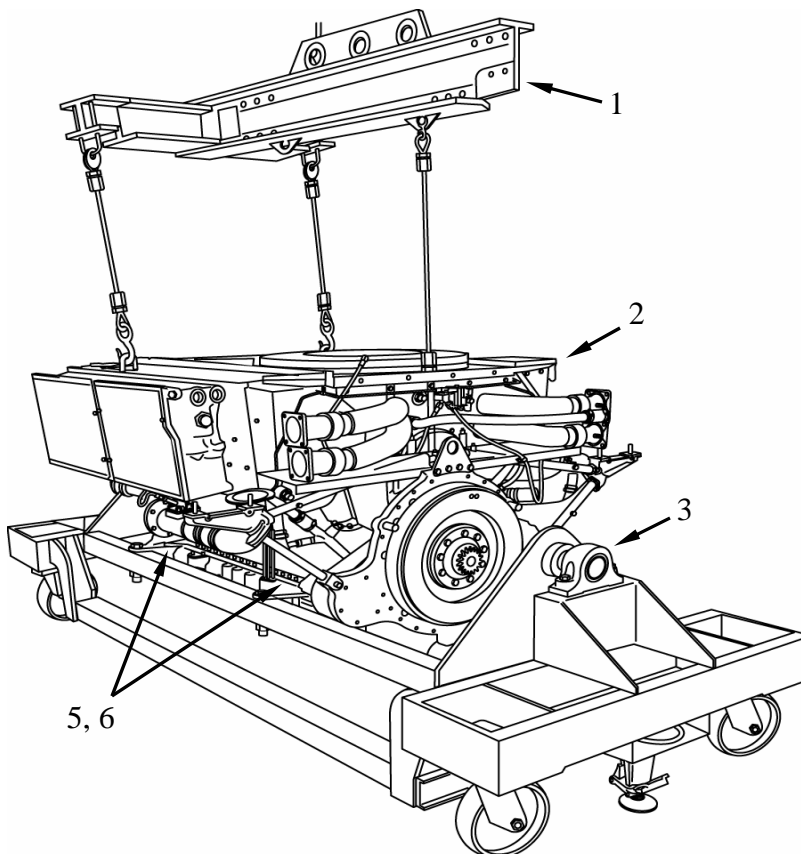
## INSTALLATION (ON STAND)



**Use of incorrect sling can cause lifting point failure leading to injury or even death of personnel.**

- Engine models 2CA and 2DA use sling Part Number 12257229 (item 38, WP 0176). The front lifting points are as illustrated.
- Engine model 2DR uses sling Part Number 11671664 (item 37, WP 0176). The front lifting points are not illustrated: the 2DR front lifting points are located on the damper housing.

1. Attach sling (1) to hoist and to engine (2).
2. Lift engine (2) just high enough that helper can roll stand (3) under engine.
3. Lower engine (2) onto stand (3) as helper guides in place.
4. Secure engine (2) to stand (3) with four screws (5) with flat washers (6) furnished with stand.
5. Remove sling (1) from engine (2) and from hoist.





## REMOVAL (FROM STAND)

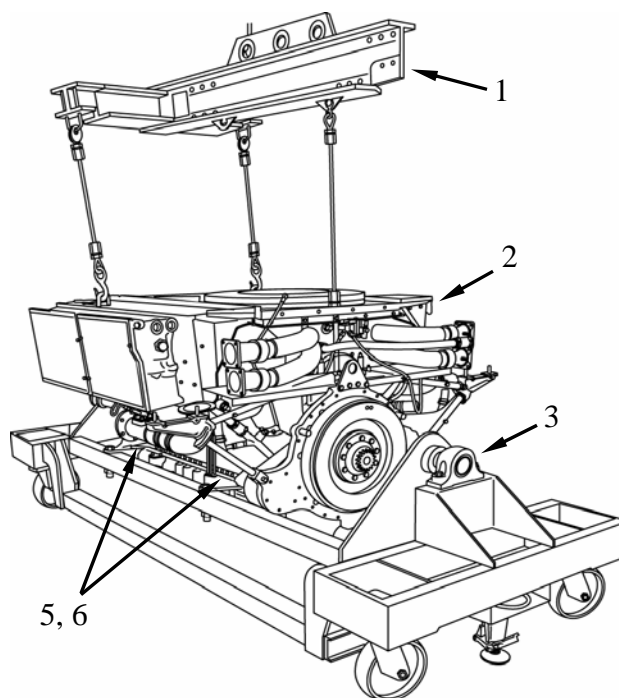
**WARNING**

Use of incorrect sling can cause lifting point failure leading to injury or even death of personnel.

Engine models 2CA and 2DA, use sling Part Number 12257229 (item 38, WP 0176). The front lifting points are as illustrated.

Engine model 2DR uses sling Part Number 11671664 (item 37, WP 0176). The front lifting points are not illustrated: the 2DR front lifting points are located on the damper housing.

1. Attach sling (1) to hoist and to engine (2) at lifting eyes.
2. Take slack out of sling (1).
3. Remove four screws (5) with flat washers (6) from stand (3).
4. With helper guiding engine (2), lift engine out of stand (3).
5. Move stand (3) from under engine (2).
6. With helper guiding engine (2), lower engine onto flat surface.
7. Remove sling (1) from engine (2) and hoist.



**END OF WORK PACKAGE**



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**CRANKCASE/TRANSMISSION ADAPTER ASSEMBLY REPLACE/REPAIR 0131 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Assembly, Installation

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**INITIAL SETUP:**

**Tools:**

- Arbor press (item 8, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-175 ft-lb (item 127, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (1) (item 332, WP 0175)
- Resilient mount (2) (item 308, WP 0175)
- Self-locking nut (2) (item 140, WP 0175)
- Self-locking nut (4) (item 35, WP 0175)
- Self-locking nut (15) (item 41, WP 0175)

**Expendable and Durable Items:**

- Lubricating oil (item 21, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (1) 63H10

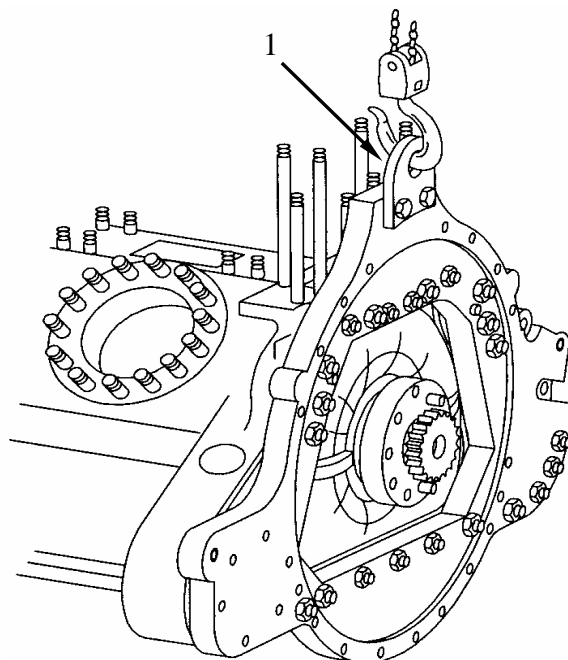
**Equipment Conditions:**

- Engine on maintenance stand WP 0130)
- 2DR: Transmission spacer ring removed (WP 0101)
- 2CA & 2DA: Turbosuperchargers removed (WP 0099)
- 2DR: Turbosupercharger Assembly Replacement (WP 0100)
- Turbo tie rod and supports removed (WP 0119)
- Generator adapter removed (WP 0155 for 300 Ampere; WP 0156 for 650 Ampere)

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**REMOVAL**

1. Attach hoist to lifting eye (1). Take slack out of hoist.



## REMOVAL (Continued)

## NOTE

Early model engines used slotted nuts with safety wire to secure the crankcase adapter to the crankcase. If your engine has these fasteners, cut, remove and discard the safety wire. Then remove and discard the slotted nuts; use the self-locking nuts listed in mandatory replacement parts for assembly.

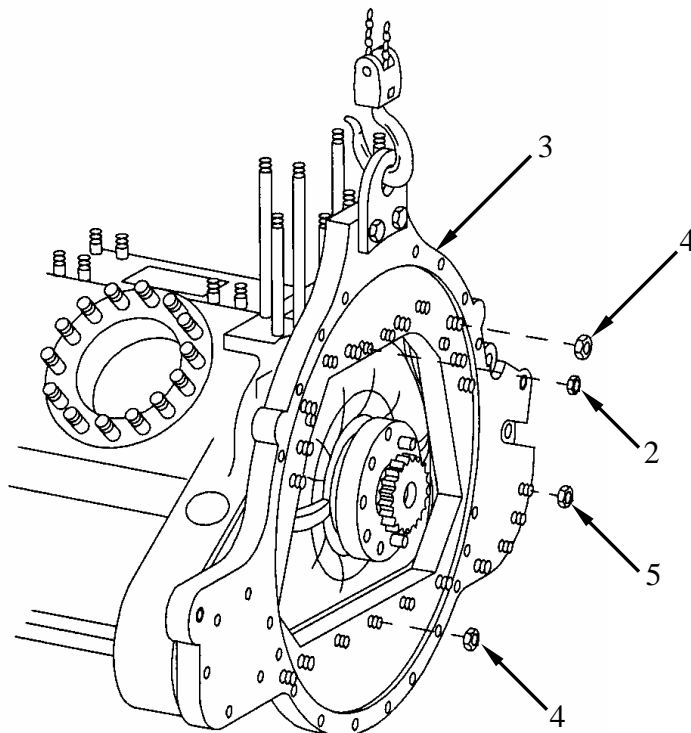
2. Remove and discard two self-locking nuts (2) at top of adapter (3).
3. Remove and discard 15 self-locking nuts (4) securing adapter (3) to crankcase.
4. Remove and discard four self-locking nuts (5) attaching adapter (3) to crankcase at starter pad.

## WARNING



Crankcase adapter is heavy. Take care when removing it so that it does not swing around and injure personnel or equipment.

5. Loosen adapter (3) with a 3/4-inch brass punch and ball peen hammer.

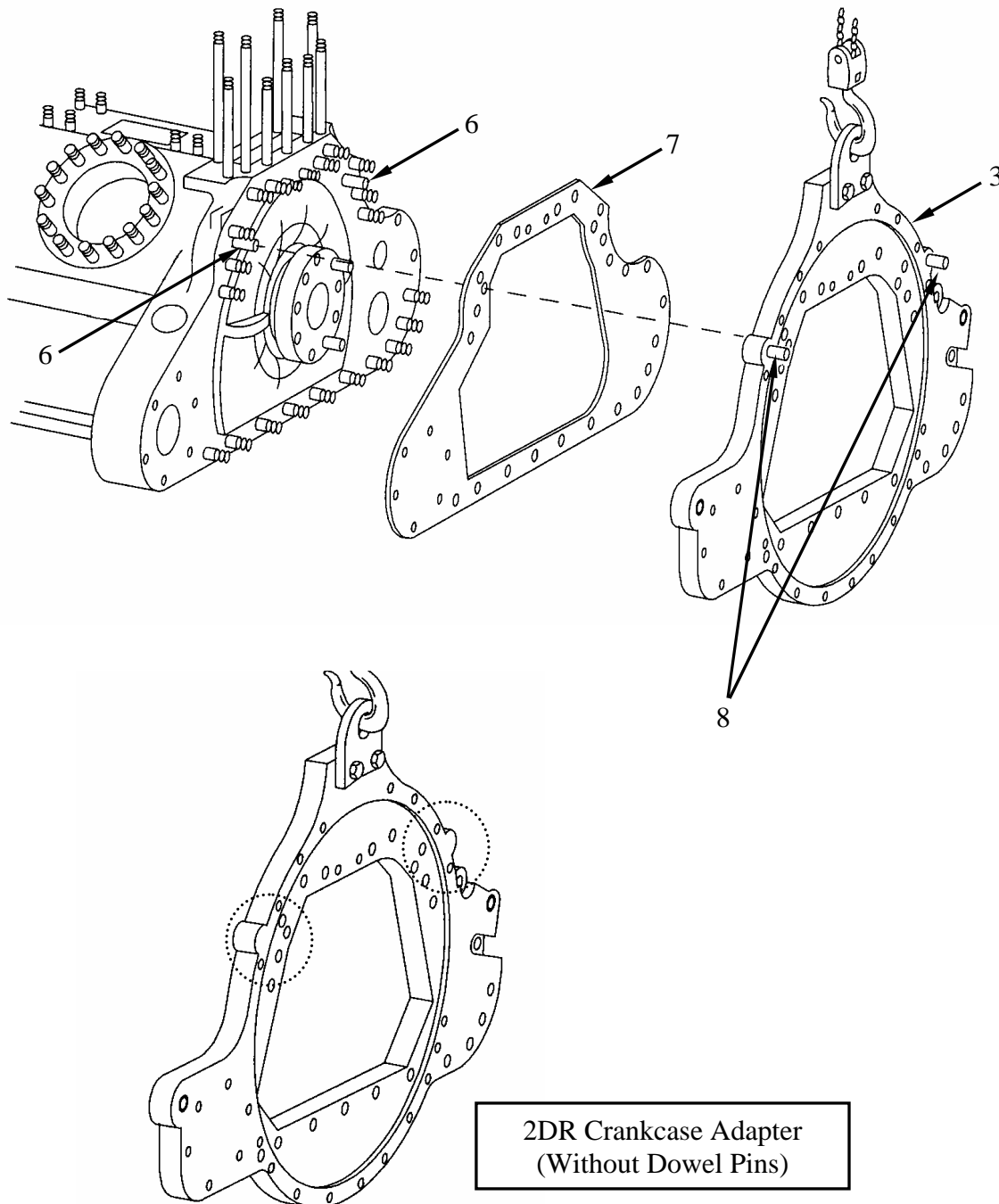


**REMOVAL (Continued)**

6. Using hoist, slide adapter (3) off dowel pins (6).
7. Remove and discard gasket (7).

**NOTE**

**The 2DR crankcase adapter does not have alignment dowel pins (8).**

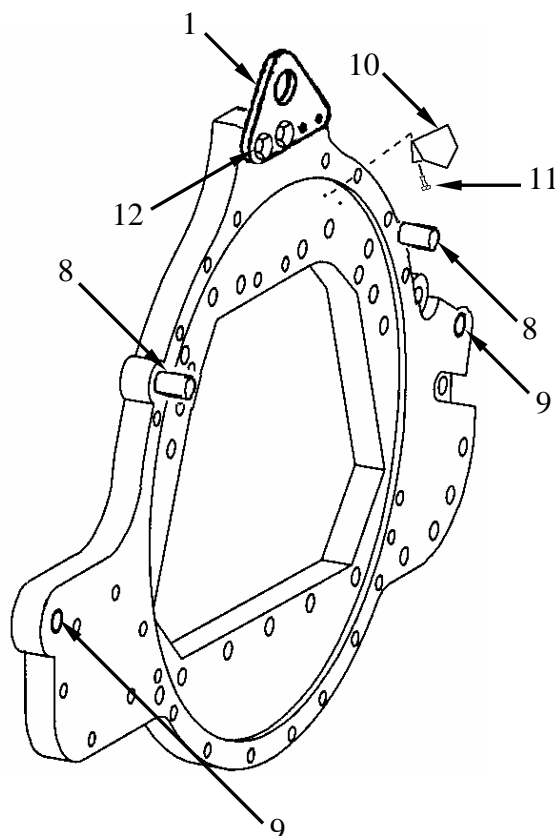


2DR Crankcase Adapter  
(Without Dowel Pins)

**DISASSEMBLY****NOTE**

**Early model engines used lock wire on the timing pointer mounting bolts. If lock wire is present cut and discard.**

1. Remove timing pointer (10) (2CA, 2DA only).
  - a. Remove two cap screws (11) to remove pointer (10).
2. Using an arbor press (item 8, WP 0176), remove and discard two dowel pins (8) (2DA and 2CA only).
3. Using an arbor press, remove and discard two resilient mounts (9).
4. Remove lifting eye (1).
  - a. Remove two remaining cap screws (12) to remove lifting eye (1).

**CLEANING**

1. See WP 0028 for Standard Cleaning Procedures.

**INSPECTION**

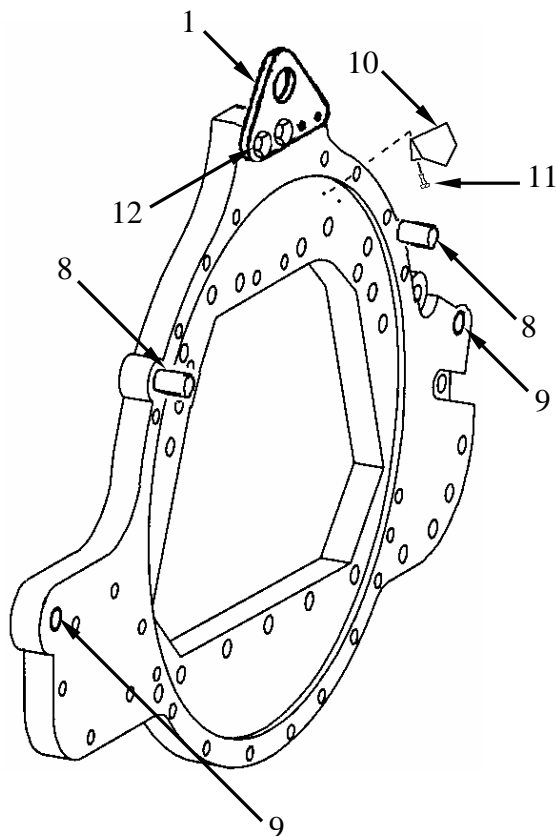
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See WP 0028 for Standard Inspection Procedures.
2. Inspect dowel pins (8) (2CA, 2DA only).
  - a. Look for looseness; replace if found.
  - b. Look for any signs of damage; replace if found.
3. Inspect resilient mounts (9) for damage.
  - a. Look for signs of separation of the rubber to bushing; replace if found.

Look for damaged bushing in resilient mount; replace if found.

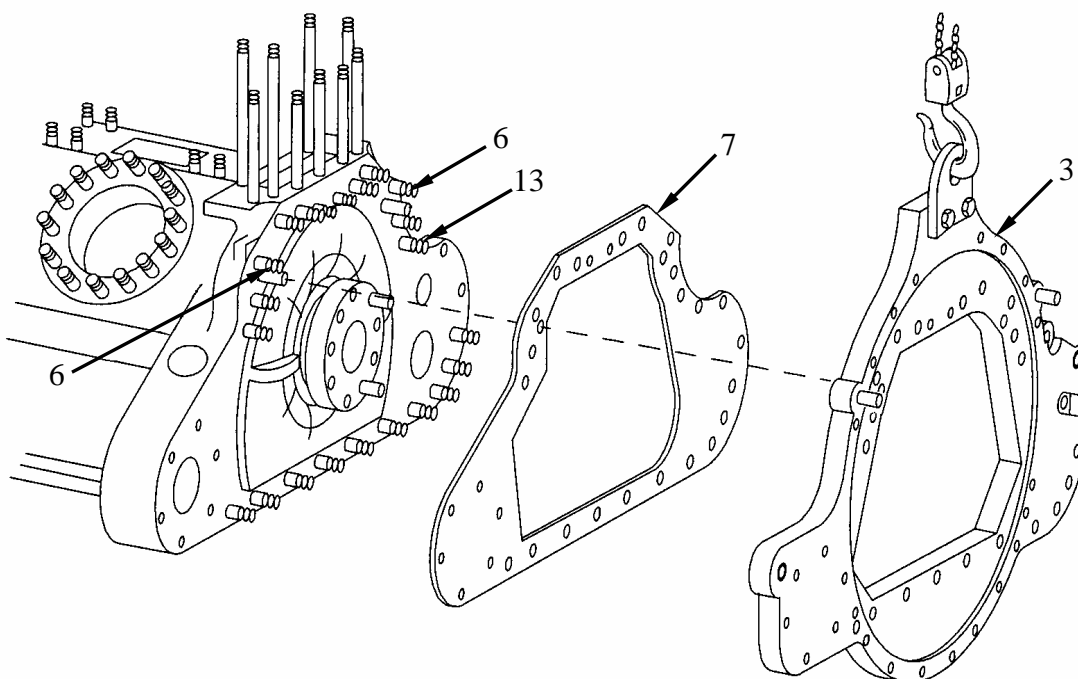
**ASSEMBLY**

1. Install lifting eye (1).
  - a. Secure lifting eye (1) with two cap screws (12) as shown. The remaining two cap screws will be installed with the fuel and smoke generator solenoids.
2. Using an arbor press, install two new resilient mounts (9) (item 308, WP 0175) chilled to 32°F (0°C).
3. Using an arbor press, install two dowel pins (8).
4. Install timing pointer (10).
  - a. Secure timing pointer (10) with two cap screws (11).



**INSTALLATION**

1. Install new gasket (7) (item 332, WP 0175) over engine studs (13) and dowels (6).
2. Attach hoist to lifting eye (1) and lift into position.
3. Slide crankcase adapter (3) over dowel pins (6) and studs (13).



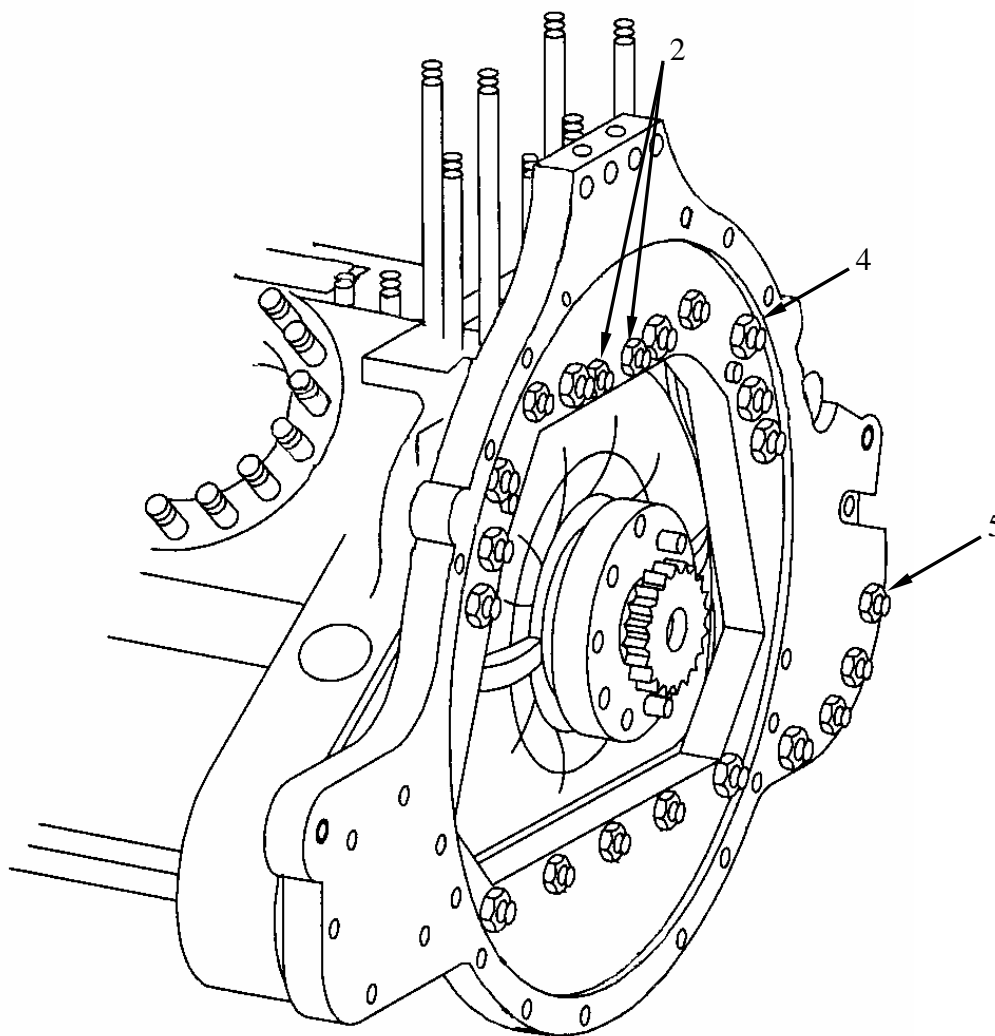
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**CRANKCASE/TRANSMISSION ADAPTER ASSEMBLY REPLACE/REPAIR 0131 00**

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**INSTALLATION (Continued)**

4. Apply lubricating oil (item 21, WP 0173) to all crankcase adapter (3) mounting studs (2,4,5).
5. Secure crankcase adapter (3) with 21 new self-locking nuts (2,4,5). Snug tighten only at this time.
6. Remove hoist.
7. Torque tighten 15 self-locking nuts (4) (item 41, WP 0175) to 46-50 ft-lb (62-68 N·m), using torque wrench (item 127, WP 0176).
8. Torque tighten 4 self-locking nuts (5) (item 35, WP 0175) to 33-38 ft-lb (45-51 N·m).
9. Torque tighten 2 self-locking nuts (2) (item 140, WP 0175) to 23-27 ft-lb (31-37 N·m).

**END OF WORK PACKAGE**



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**FRONT LIFTING EYES AND GUIDES REPLACEMENT**

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0132 00

**THIS WORK PACKAGE COVERS:**Removal, Installation

---

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Mandatory Replacement Parts:**

Gasket (1) (item 182, WP 0175)

Self-locking nut (8) (item 140, WP 0175)

Self-locking nut (4) (item 34, WP 0175)

**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface

(2DR) Throttle control solenoid removed for maintenance of right lifting eye (WP 0123)

---

**REMOVAL****NOTE**

**Engine Model 2DR does not have installation guide bars. It does have front lifting eyes and an hour meter as illustrated. In addition, on the right side it has a spacer plate in place of the installation guide bar.**

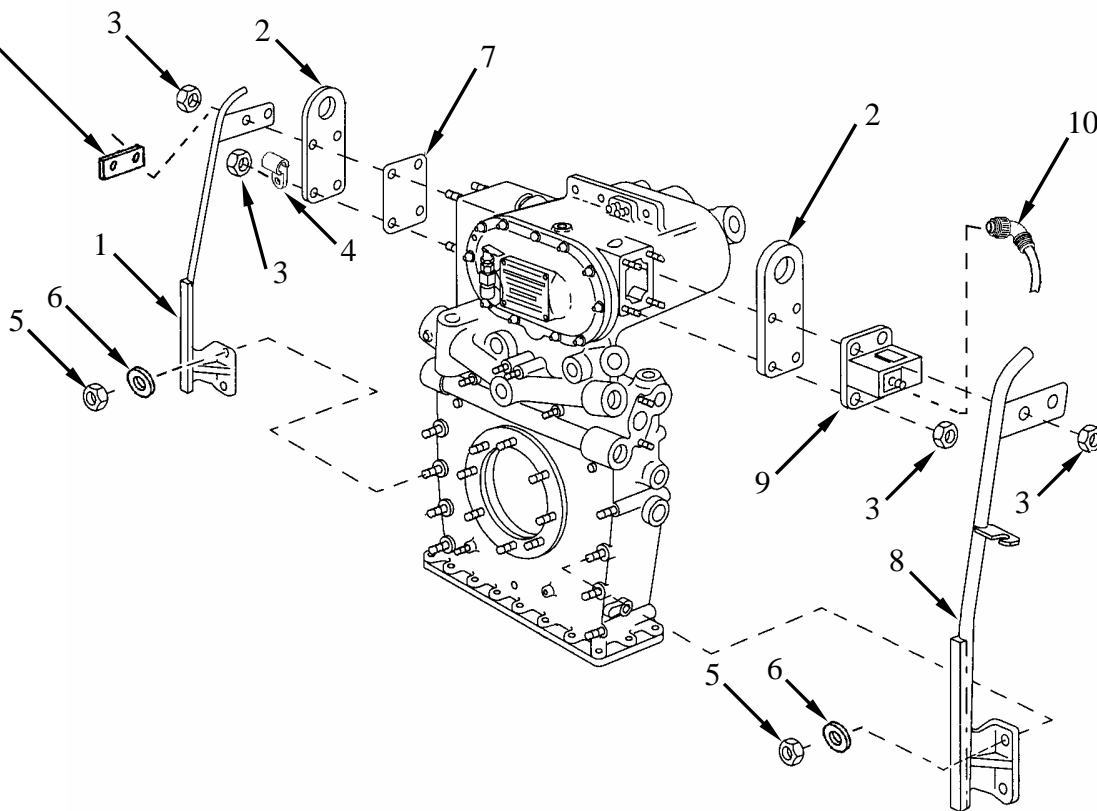
**Removal of lifting eyes is the same as for models 2CA and 2DA with the exception of not having installation guide bars.**

**Early models 2CA and 2DA have hour meter mounted as illustrated. Later models have the hour meter mounted on the engine top, right side.**

**REMOVAL (Continued)**

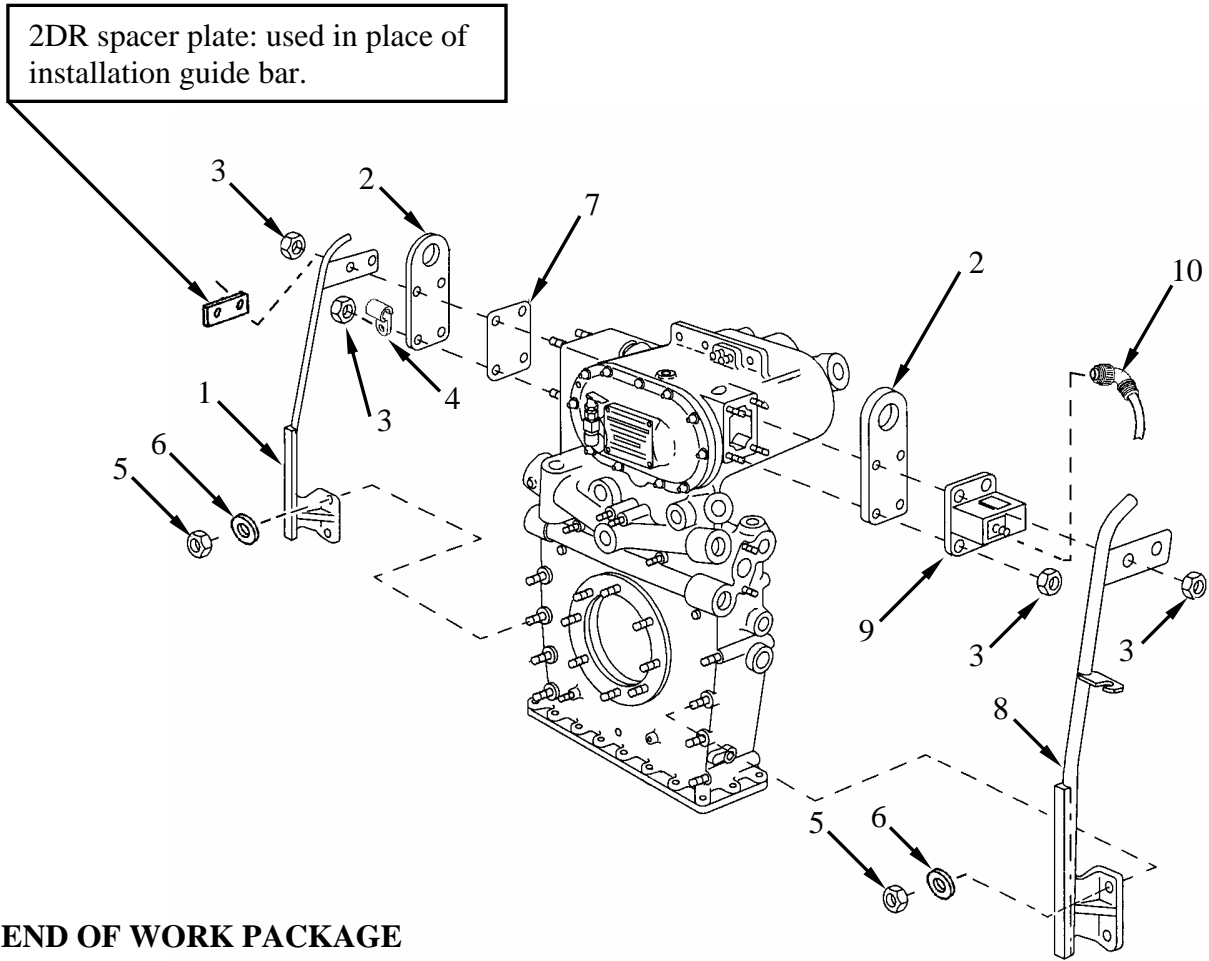
1. Remove left installation guide bar (1) and lifting eye (2).
  - a. Remove and discard four self-locking nuts (3).
  - b. Remove cushioned clamp (4) securing fuel return hose.
  - c. Remove and discard two self-locking nuts (5).
  - d. Remove two flat washers (6) then remove left installation guide bar (1). Retain flat washers (6) for installation.
  - e. Remove lifting eye (2) and gasket (7) from left side of damper housing. Discard gasket (7).
2. Remove right installation guide bar (8), lifting eye (2) and hour meter (9).
  - a. Disconnect hour meter (9) electrical connector (10).
  - b. Remove and discard four self-locking nuts (3).
  - c. Remove and discard two self-locking nuts (5).
  - d. Remove two flat washers (6) and right installation guide bar (8). Retain flat washers (6) for installation.
  - e. Remove hour meter (9).
  - f. Remove lifting eye (2) from right side of damper housing.

2DR spacer plate: used in place of installation guide bar.



INSTALLATION

1. Install left installation guide bar (1) and lifting eye (2).
  - a. Place new gasket (7) (item 182, WP 0175) and lifting eye (2) over studs on left side of damper housing as illustrated.
  - b. Put left installation guide bar (1) in place and secure on lower studs with two new self-locking nuts (5) (item 34, WP 0175) using flat washers (6).
  - c. Put cushioned clamp (4) securing fuel return hose in place and secure with four new self-locking nuts (3) (item 140, WP 0175).
2. Install right installation guide bar (8), lifting eye (2) and hour meter (9).
  - a. Put lifting eye (2) in place on right side of damper housing.
  - b. Put hour meter (9) in place on damper housing.
  - c. Put right installation guide bar (8) in place and secure with two new self-locking nuts (5) (item 34, WP 0175) using two flat washers (6) at lower end of installation guide bar.
  - d. Secure top end of installation guide (8) bar with four new self-locking nuts (3) (item 140, WP 0175).
  - e. Connect hour meter (9) electrical connector (10).



END OF WORK PACKAGE



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

- Box wrench (item 32, WP 0176)
- Chain lift assembly (item 18, WP 0176)
- Crankcase protectors (item 25, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Piston ring compressor (item 21, 22, 23, WP 0176)
- Retaining ring pliers (item 81, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)
- Torque wrench adapter (item 4, WP 0176)
- Torque wrench adapter (item 5, WP 0176)
- Splined wrench, For Model 2CA or 2DA: (item 136, WP 0176) (Flywheel turning tool)

**Fabricated Tools:**

- For Model 2DR: Engine front turning tool (item 3, WP 0177), or Engine flywheel turning tool (item 4, WP 0177)

**Mandatory Replacement Parts:**

- O-ring (item 79, WP 0175)

**Expendable Materials:**

- Lubricating oil (preservation oil) (item 21, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

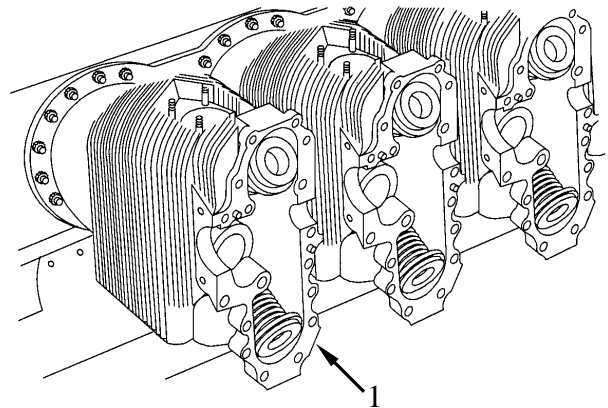
- Engine on maintenance stand (WP 0130)
- Camshaft assembly removed
  - For left bank (WP 0149)
  - For right bank (WP 0150)
- Exhaust manifolds removed (WP 0107)
- Intake manifold assembly removed (WP 0108)
- Cylinder deflectors and shrouds removed (WP 0127)

**REMOVAL**

**NOTE**

**Single or multiple cylinder assemblies can be removed from each bank. If cylinder assemblies only need to be removed from one bank, major assemblies can be removed from just one bank.**

1. Rotate maintenance stand so that cylinders (1) are horizontal.



REMOVAL (Continued)

**CAUTION**

Before removing cylinder assemblies, check the breaking torque of all cylinder base nuts attaching each cylinder assembly to the crankcase. This check is necessary to determine whether cylinder mounting studs have stretched. All stretched studs must be replaced.

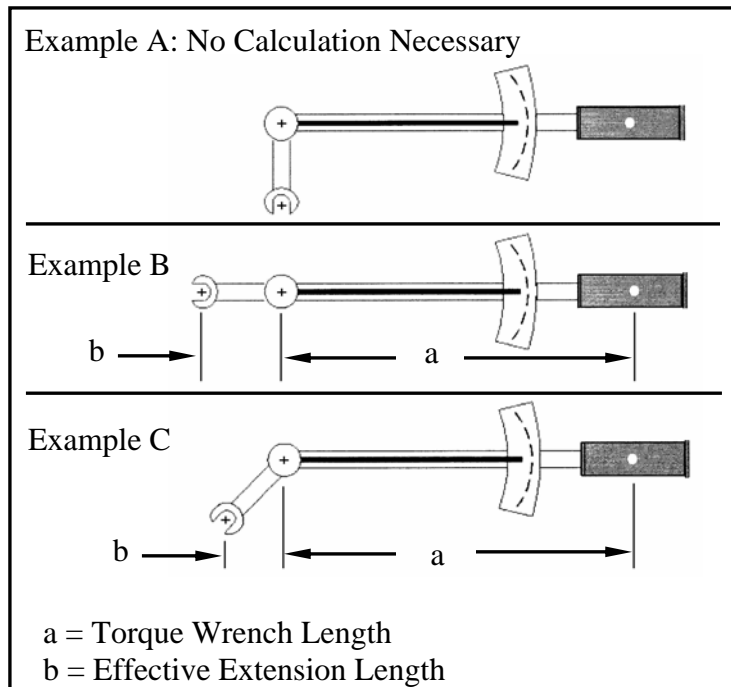
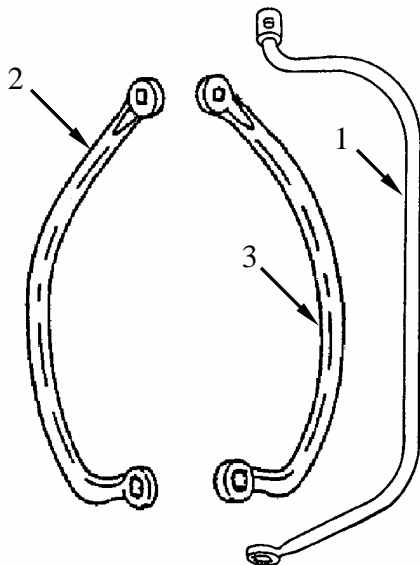
There are three different base nut wrenches. Cylinder base nut (box) wrench (1) (item 32, WP 0176) can be used with a torque wrench with no compensation of the torque wrench reading because the input and output of the wrench is aligned with the fastener to be tightened. (Not illustrated.)

Torque readings must be calculated when base nut wrenches (torque wrench adapters) (2, 3) (items 4 and 5, WP 0176) are used except when used as in example A.

Calculations must be made to compensate for the offset of the torque wrench to the fastener being tightened as in examples B and C.

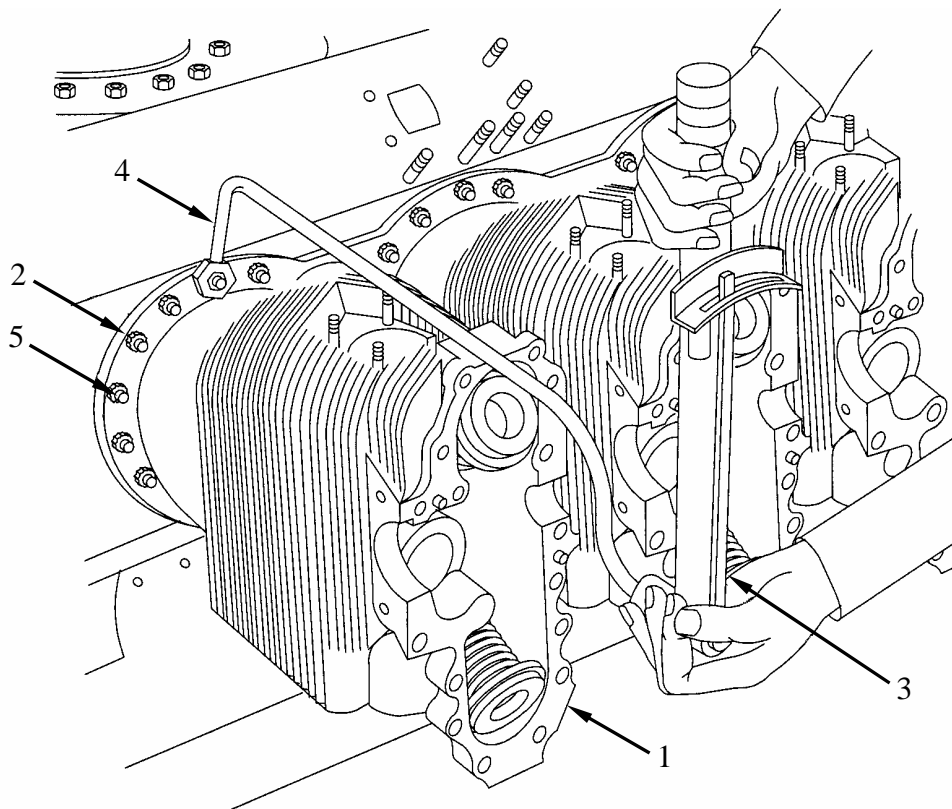
Use the wrench that gives the best fit for each cylinder base nut.

$$\text{Calculated Torque} = \frac{\text{Desired Torque Multiplied by Torque Wrench Length (a)}}{\text{Torque Wrench Length (a) Added to Effective Extension Length (b)}}$$



**REMOVAL (Continued)**

2. Check breaking torque of all cylinder (1) base nuts (2).
  - a. Using torque wrench (3) (item 127, WP 0176) and cylinder base nut wrench (4) (item 4, 5, or 32 WP 0176), check breaking torque of each cylinder base nut (2).
  - b. When torque required to break a base nut loose is less than 70 foot-pounds (95 N•m), remove nut, apply lubricating oil (item 21, WP 0173) to stud (5), install nut and tighten to a torque of 70-72 foot-pounds (95-97 N•m).
  - c. When base nut does not tighten to the required torque, stud is stretching and must be replaced. Mark stud for replacement. Go to WP 0028, Standard Maintenance Instructions, when ready to replace stretched studs.
3. After checking the breaking torque, remove all base nuts except one on each side of cylinder mounting flange. The remaining two base nuts on each cylinder are removed after piston has been positioned for cylinder removal.



REMOVAL (Continued)

**CAUTION**

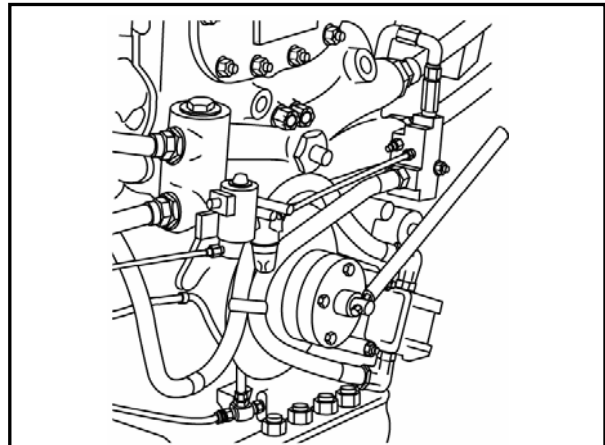
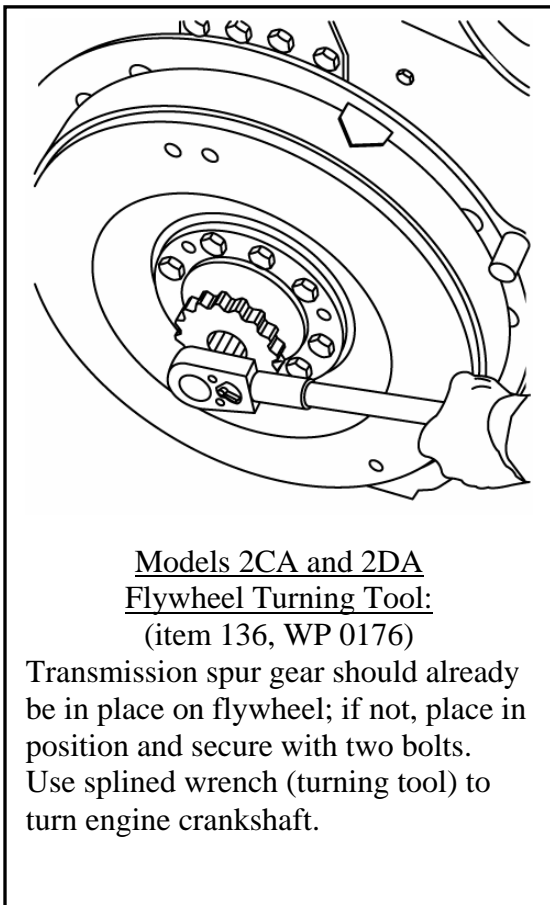
Before removing each cylinder assembly, the crankshaft must be turned to position the piston of the cylinder being removed to top center. Make certain each piston is properly positioned before attempting cylinder removal. Damage to piston may occur.

**NOTE**

Model 2DR crankshaft may be turned from the flywheel or from the power takeoff coupling.

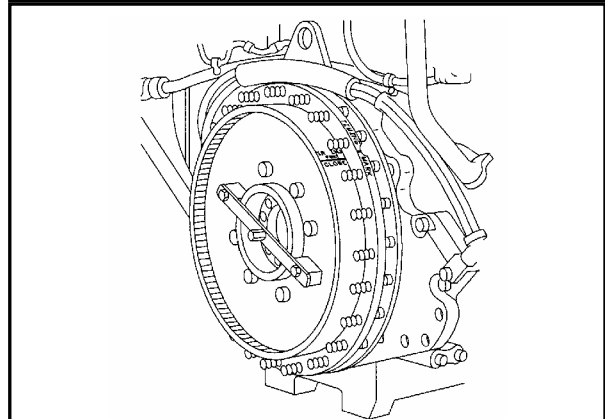
Flywheels on models 2DR are different and require different turning tools than those for engine models 2CA and 2DA.

4. Install proper turning tool for your engine model as shown.



Model 2DR Front Turning Tool:  
(item 3, WP 0177)

Position fabricated engine turning tool on power takeoff coupling and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.



Model 2DR Flywheel Turning Tool:  
(item 4, WP 0177)

Position fabricated engine turning tool on flywheel and secure with four 7/16-20 UNF x 1-1/2 inch machine bolts. Use a 1-1/4 inch socket and a 3/4-inch breaker bar to turn engine crankshaft.



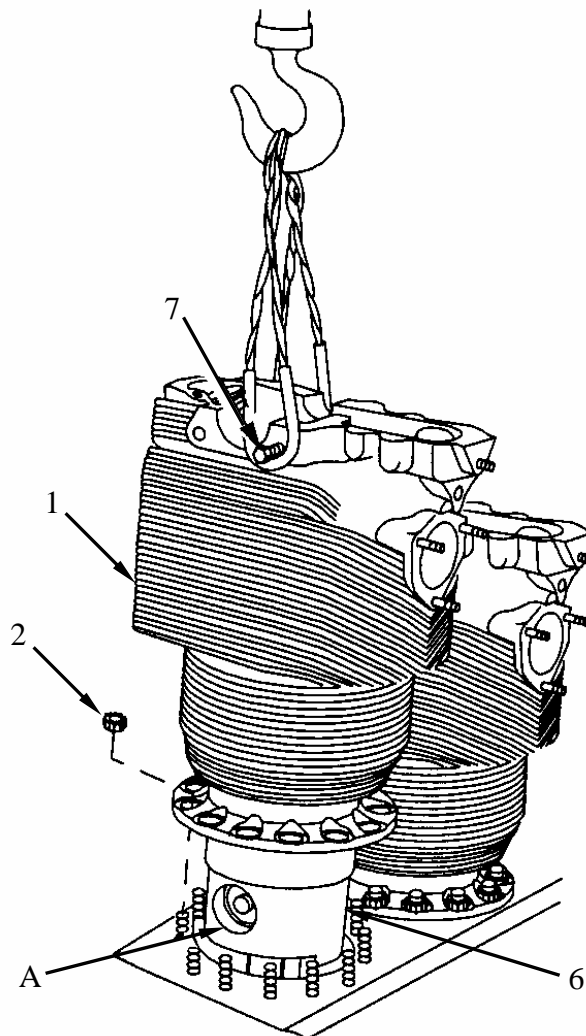
**REMOVAL (Continued)**

5. Rotate maintenance stand so that cylinder assemblies are vertical.

**NOTE**

**For ease of disassembly, the following pistons are at top center together: (1 & 6) (2 & 5) (3 & 4) on either bank.**

6. Position piston (6) in cylinder for removal.
  - a. Rotate crankshaft and observe when connecting rod has raised the piston to top center.
7. Remove cylinder assembly (1).
  - a. Attach a suitable lifting sling to top of cylinder assembly using two 7/16 x 1-1/4 inch cap screws (7), then attach to lifting sling (item 18, WP 0176).
  - b. Remove last two cylinder base nuts (2).
  - c. Carefully lift cylinder assembly until it is just above piston pin bore (A).

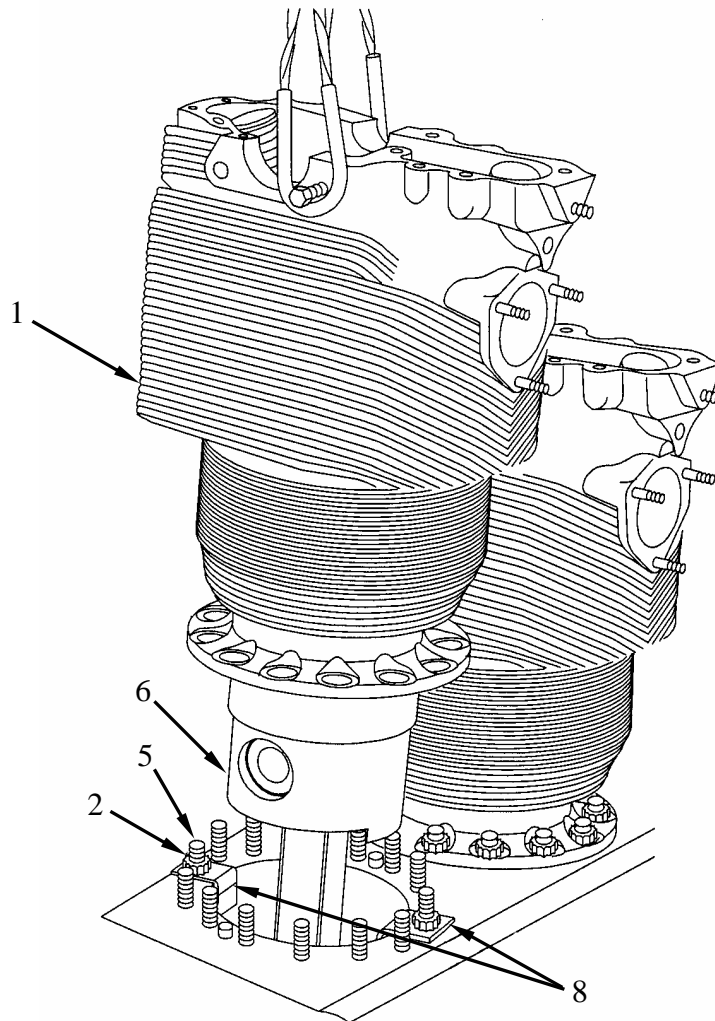


## REMOVAL (Continued)

**CAUTION**

**Crankcase protectors (item 25, WP 0176) are installed on each cylinder pad before removing cylinder assembly from piston. The protector guards against damage to cylinder pad and mounting studs in the event connecting rods should strike the pad as cylinder is lifted from piston.**

8. Install crankcase protectors (8) (item 25, WP 0176).
  - a. Position two protectors (8) on cylinder mounting studs (5) and secure with two cylinder base nuts (2).
9. Remove cylinder assembly (1).
  - a. With a helper to catch the piston (6), lift the cylinder assembly (1) the rest of the way off.



## REMOVAL (Continued)

## NOTE

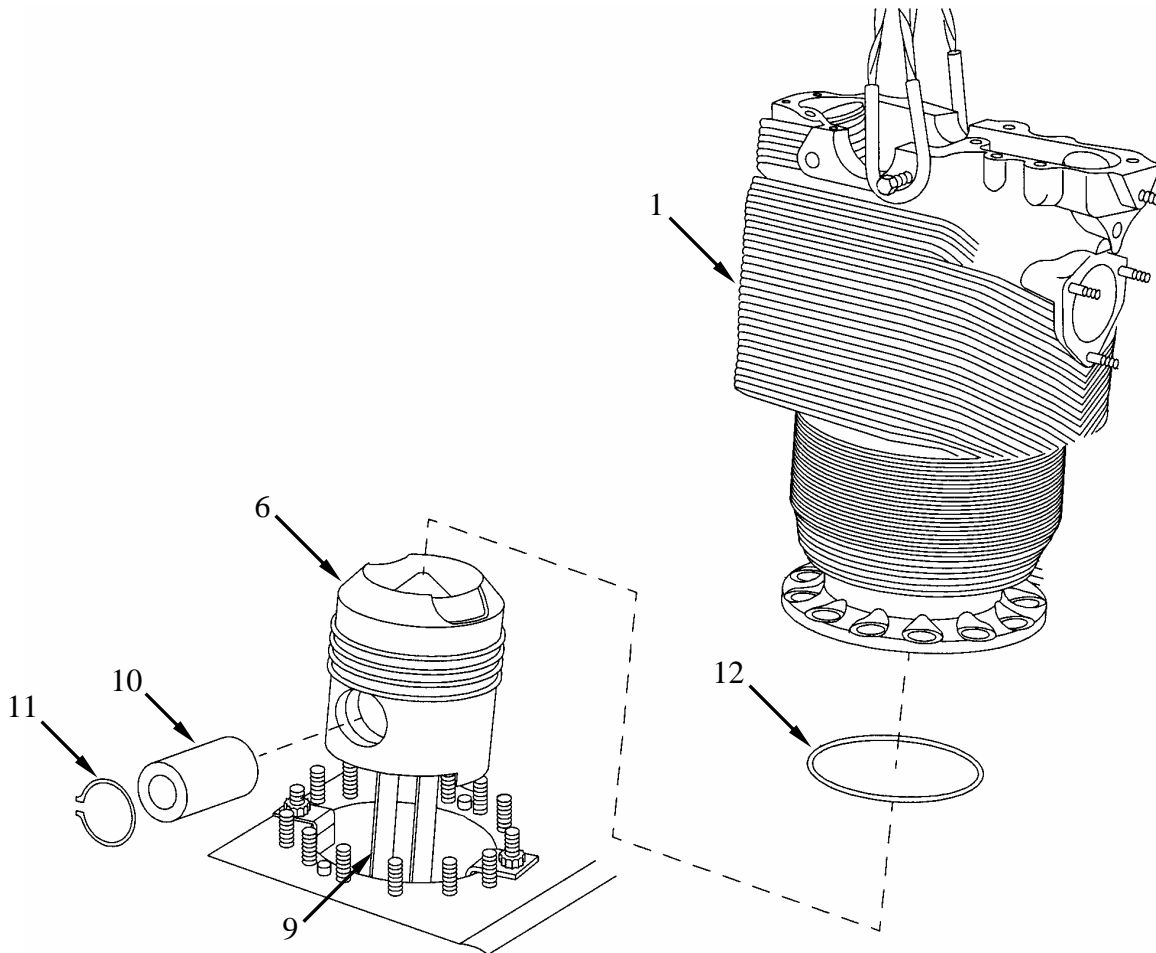
Replaceable camshaft bearing halves should remain with the cylinder.

When carbon deposits make removal of piston pin difficult, tap end of piston pin using a brass drift and ball peen hammer.

10. Remove piston (6) from connecting rod (9).
  - a. Remove two piston pin retaining rings (11) using retaining ring pliers (item 81, WP 0176).
  - b. Remove piston pin (10) from piston, and remove piston (6) from connecting rod (9).
  - c. Reinstall piston pin (10) in piston after it is removed from the connecting rod.
  - d. Secure piston pin (10) in piston with two retaining rings (11).
11. Remove and discard O-ring (12) from cylinder assembly.

CAUTION

Do not remove crankcase protectors (item 25, WP 0176) until crankshaft and connecting rods have been removed. Damage to crankcase can occur.



**CLEANING**

1. See WP 0028 for Standard Cleaning Procedures.
  - a. Specific instructions for cleaning of cylinders are covered in WP 0135, Cylinder Assembly Repair.

**INSPECTION**

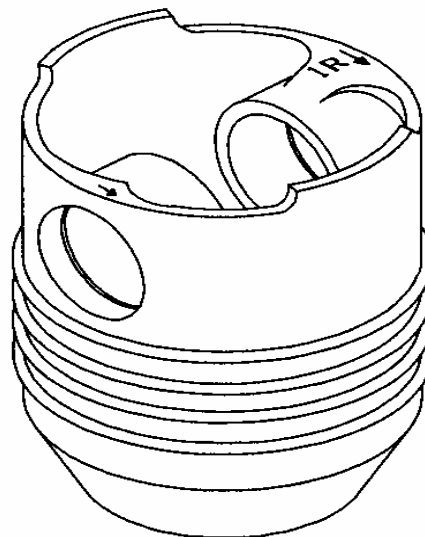
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See WP 0028 for Standard Inspection Procedures.
  - a. Specific instructions for inspection of cylinders are covered in WP 0135, Cylinder Assembly Repair.

**INSTALLATION****NOTE**

**Pistons are marked for orientation and identification to assure the pistons are installed with proper orientation and in their original location. Cylinder assemblies are also marked for original location.**

- The piston boss is stamped with arrows for proper orientation when installed in the cylinder assembly. The arrows on the piston pin bosses must be pointed up, or to the exhaust outlet port.
- The piston boss is also stamped with the cylinder location to identify the cylinder from which the piston was removed and to assure piston will be returned to its original cylinder.
- Cylinders are stamped with position markings at the intake valve side (bottom) of valve rocker arm cover flange.
- Markings of any piston or cylinder must be renewed if position marks and/or arrows are not entirely legible.
- Replacement piston must be marked to the corresponding cylinder it is to be used with.
- Always keep piston pin with its respective piston.

**CAUTION**

**When replacing damaged or worn pistons, it is important that all of the engine pistons are the same size (oversize) and same weight; all should have identical oversize and weight code markings.**

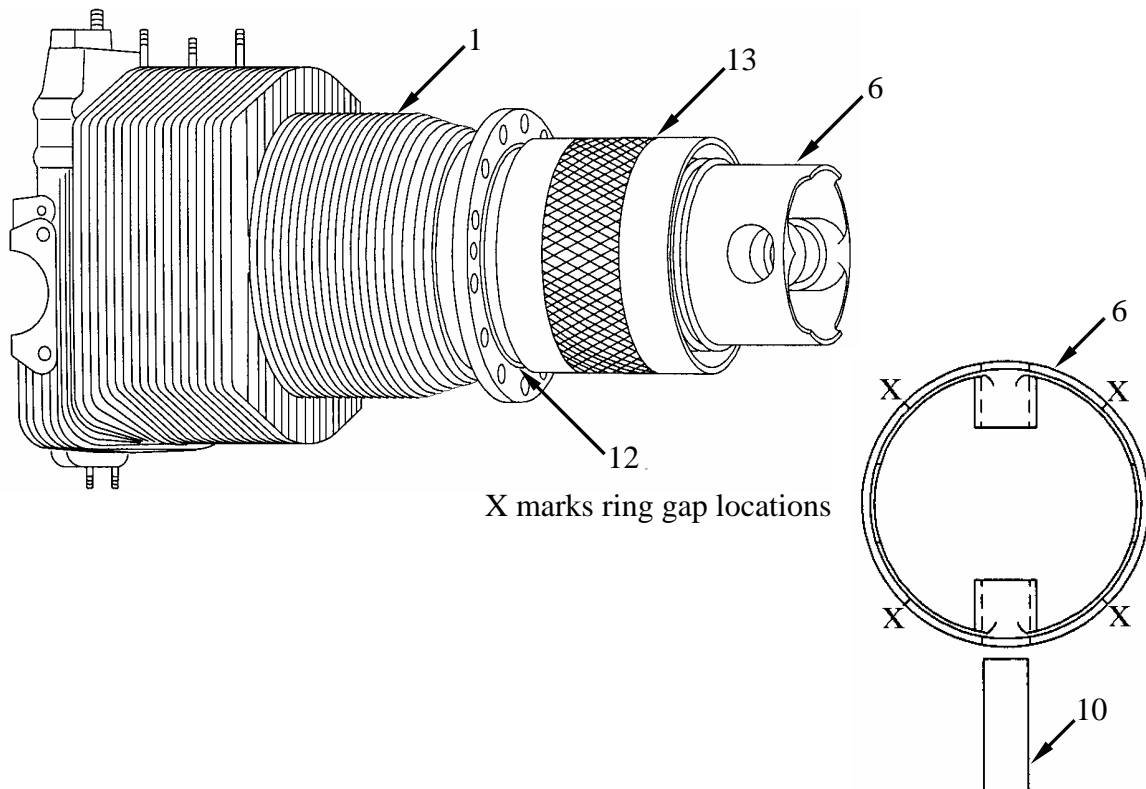
**INSTALLATION (Continued)**

1. Rotate maintenance stand so cylinder assembly (1) is vertical.
2. Install new O-ring (12) on cylinder (1) base.
  - a. Apply light coat of lubricating oil (item 21, WP 0173) to new O-ring (12) (item 79, WP 0175).
  - b. Position O-ring (12) on cylinder (1) base making sure that it is not twisted or otherwise improperly seated.

**NOTE**

**Assembly of piston rings to piston is covered in WP 0142, Pistons, Rings, and Associated Parts Replace/Repair.**

3. Install piston (6) into cylinder assembly (1).
  - a. Coat sides of piston (6) with lubricating oil (item 21, WP 0173).
  - b. Stagger the four piston ring gaps 90 degrees apart from each other and ensure ring gaps do not line up with piston pin (10) (see illustration below).
  - c. Install piston (6) and rings in cylinder assembly (1) using piston ring compressor (13) (item 21, WP 0176). The piston position number must always correspond to the cylinder number marked on intake valve side of valve rocker flange. The arrow on the piston boss must be directed toward the exhaust port outlet.
  - d. Guide piston (6) and rings into cylinder assembly (1) until all piston rings have entered the cylinder bore.
  - e. Slide the piston ring compressor (13) from piston (6).



**INSTALLATION (Continued)**

4. Rotate engine crankshaft until connecting rod (9) is at the top of its stroke.

**CAUTION**

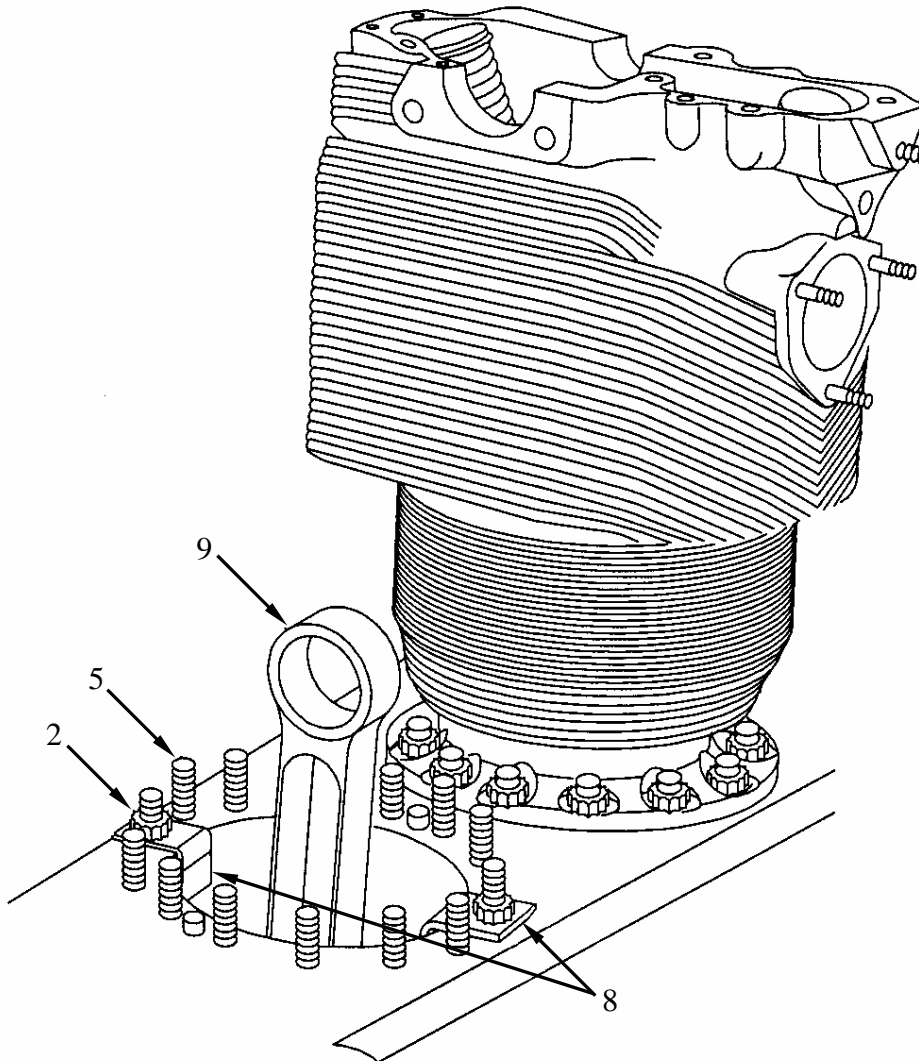
**Lubricating oil (item 21, WP 0173) must extend across face of washer nut in order to obtain reliable torque.**

5. Coat cylinder mounting studs (5) on crankcase with lubricating oil (item 21, WP 0173).

**CAUTION**

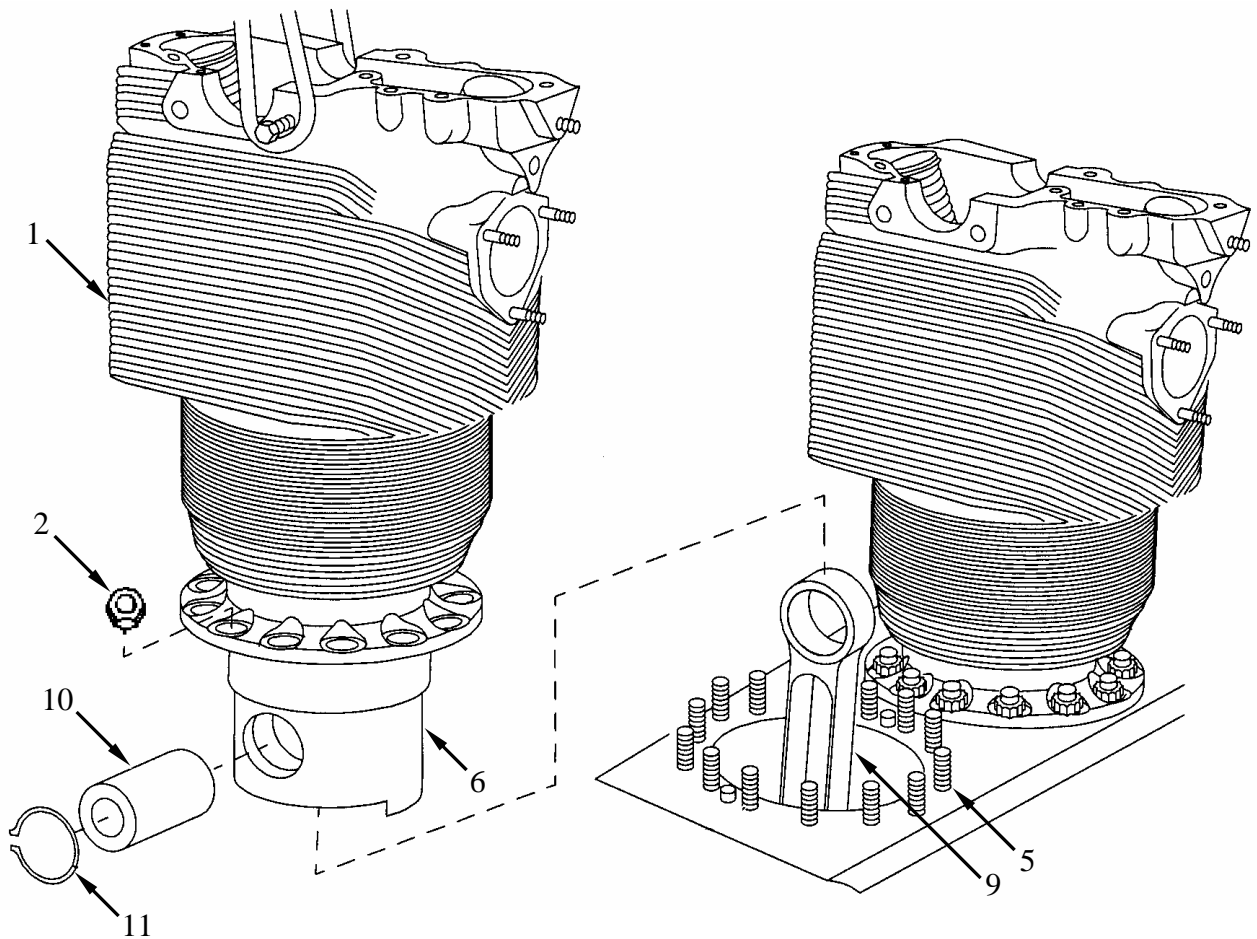
**When removing crankcase protectors (8) from cylinder mounting studs (5), be careful not to allow connecting rod (9) to forcibly drop against the crankcase cylinder mounting surface or mounting studs. Damage may occur.**

6. Remove two base nuts (2) and two crankcase protectors (8).



**INSTALLATION (Continued)**

7. Position piston (6) in cylinder (1) so that piston pin (10) is just outside of cylinder as shown.
  - a. Remove one piston pin (10) retaining ring (11).
  - b. Remove piston pin (10) from piston (6) while piston is still in cylinder.
  - c. Using suitable lifting device, place piston (6) and cylinder (1) over connecting rod (9).
  - d. Insert piston pin (10) through connecting rod (9) and piston (6).
  - e. Secure piston pin (10) with retaining ring (11) assuring that retaining ring at opposite end of piston pin is in place.
  - f. Lower cylinder (1) over piston (6) and onto crankcase studs (5).
  - g. Temporarily secure with two base nuts (2) positioned approximately 180 degrees apart.



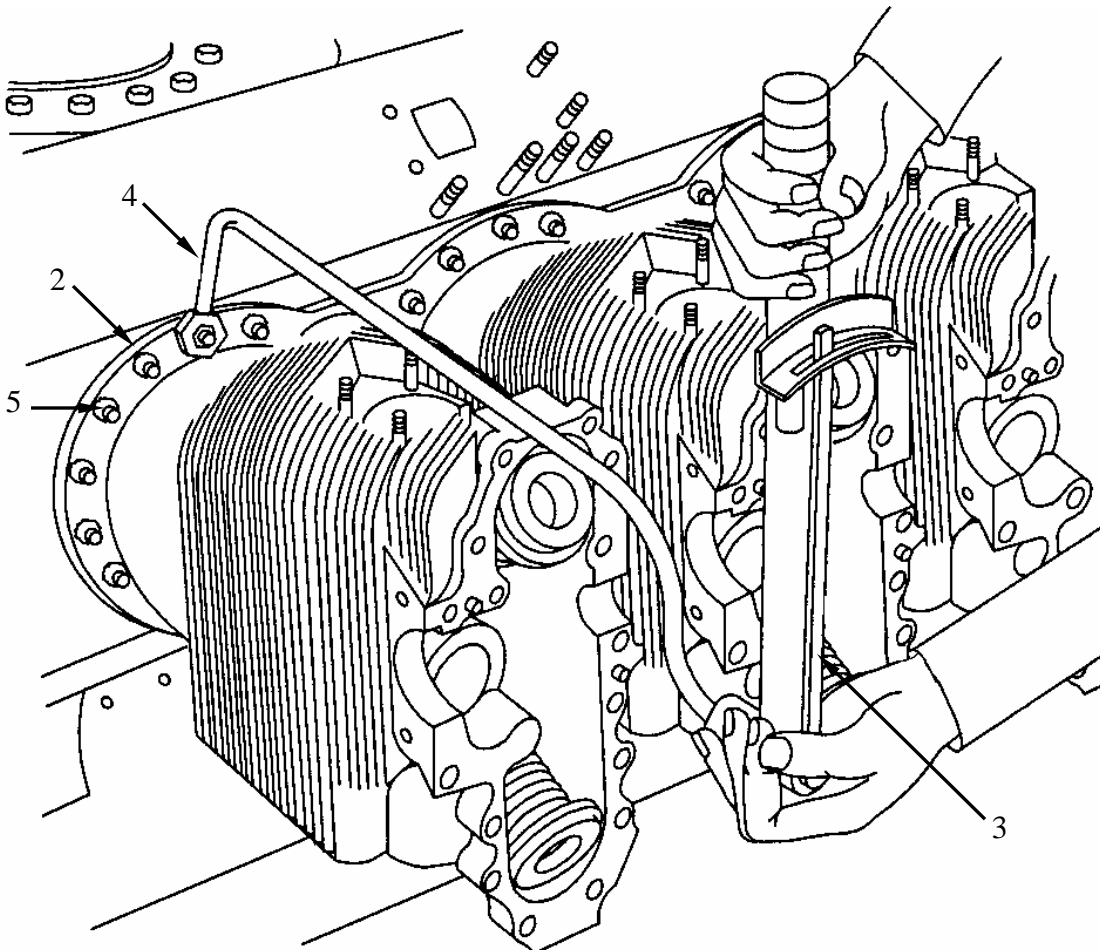
## INSTALLATION (Continued)

## NOTE

When more than one cylinder assembly is installed, each cylinder may be installed and temporarily secured with two base nuts as described prior to final torque procedure.

There are three different base nut wrench adapters. Use the adapter that gives the best fit for each base nut.

8. Install remaining cylinder base nuts (2).
  - a. Assure that all cylinder, mounting studs (5) have been lightly coated lubricating oil (item 21, WP 0173).
  - b. Install all remaining base nuts (2).
  - c. Alternately torque-tighten all cylinder base nuts (2) to 70-72 foot-pounds (95-97 N•m), using torque wrench (item 127, WP 0176).



END OF WORK PACKAGE



**ROCKER ARM COVER REPAIR**

**0134 00**

**THIS WORK PACKAGE COVERS:**

Repair

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Expendable and Durable Items:**

Cleaning compound, solvent (item 8, WP 0173)

**Equipment Conditions:**

Rocker arm cover removed (WP 0104)

Cloth, abrasive, crocus (item 9, WP 0173)

**REPAIR**

**CAUTION**

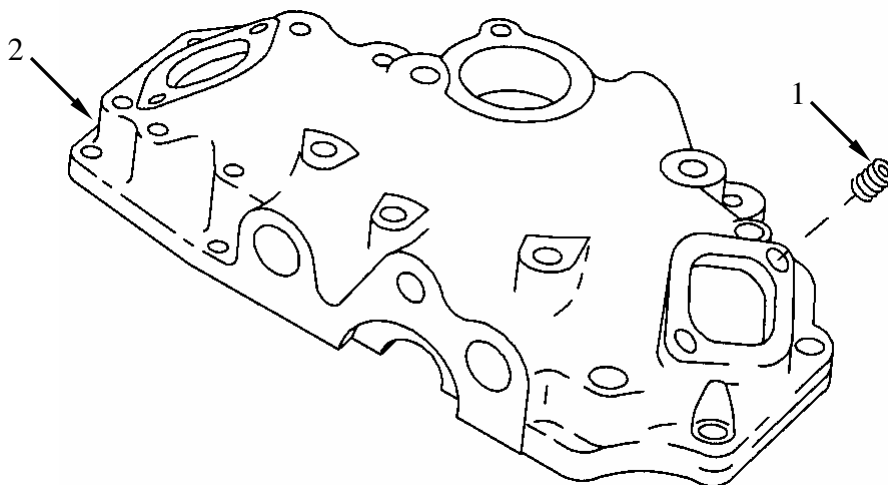
**The cylinder and rocker arm cover is machined as an assembly. Numbers on the rocker arm cover must match numbers on the cylinder to ensure camshaft bearing alignment and running clearance. If rocker arm cover is damaged, the entire cylinder and rocker arm cover must be replaced.**

1. Replace any defective screw thread inserts (1) (refer to WP 0028, Standard Maintenance Procedures).

**WARNING**



2. Remove minor nicks, burrs, or scratches from mating surfaces of valve cover (2) with abrasive cloth (item 9, WP 0173) dipped in cleaning compound solvent (item 8, WP 0173).
3. Replace valve covers (2) that are cracked, have deep scratches, or nicks that cannot be removed by polishing.



**END OF WORK PACKAGE**



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**CYLINDER ASSEMBLY REPAIR**

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0135 00

**THIS WORK PACKAGE COVERS:**Disassembly, Cleaning, Inspection, Repair, Assembly

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**INITIAL SETUP:****Tools:**

Exhaust valve guide puller (item 86, WP 0176)  
Exhaust valve guide replacer (item 99, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Grinding Kit, valve seat, electric (item 60, WP 0176)  
Hand reamer (exhaust, finish) (item 93, WP 0176)  
Hand reamer (exhaust, rough) (item 95, WP 0176)  
Hand reamer (intake, finish) (item 94, WP 0176)  
Hand reamer (intake, rough) (item 96, WP 0176)  
Inside micrometer caliper set (item 16, WP 0176)  
Intake valve guide puller (item 87, WP 0176)  
Intake valve guide replacer (item 100, WP 0176)  
Nozzle carbon cutter (item 33, WP 0176)  
Outside micrometer caliper set (item 17, WP 0176)  
Oven (item 47, WP 0176)  
Pilot reamer bushing (exhaust valve guide) (item 14, WP 0176)

**Tools (Continued):**

Pilot reamer bushing (intake valve guide) (item 15, WP 0176)  
Telescoping gauge set (item 54, WP 0176)  
Valve lifter assembly (item 72, WP 0176)  
Valve removing and inserting stand (item 112, WP 0176)

**Expendable Materials:**

Carbon removing compound (item 7, WP 0173)  
Cleaning compound, solvent (item 8, WP 0173)  
Crocus cloth (item 9, WP 0173)  
Lubricating oil (item 21, WP 0173)  
Prussian blue paste (item 25, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**Cylinder assembly removed (WP 0133 Cylinder Assembly Replacement)

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**CAUTION**

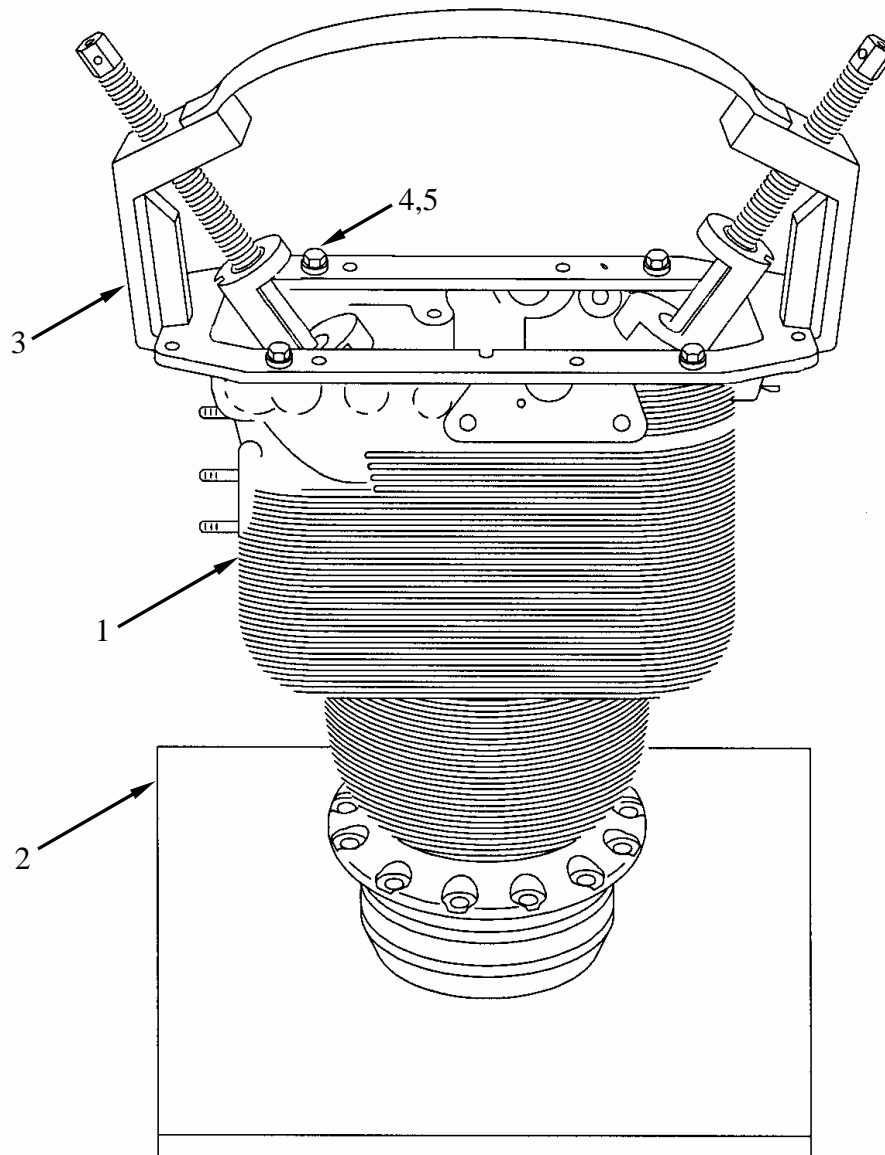
**The rocker arm covers are machined with cylinder assemblies as matched units. The covers are stamped with matching letters and numbers to correspond with the letter and number stamped on the cylinder assembly. Keep covers with their respective cylinder assemblies. Failure to comply will result in premature failure.**

**NOTE**

**Replace cylinder assembly when valve rocker arm cover is cracked or has deep scratches or nicks which cannot be removed by polishing (see page 16 this work package).**

**DISASSEMBLY**

1. Place cylinder assembly (1) on valve removing and inserting stand (2) (item 112, WP 0176).
2. Install valve lifter assembly (3) (item 72, WP 0176) to cylinder assembly (1).
  - a. Secure with four 5/16 x 1.375 (7.9375 x 34.9250 mm) rocker cover screws (4) and four 5/16-inch (7.9375 mm) flat washers (5).



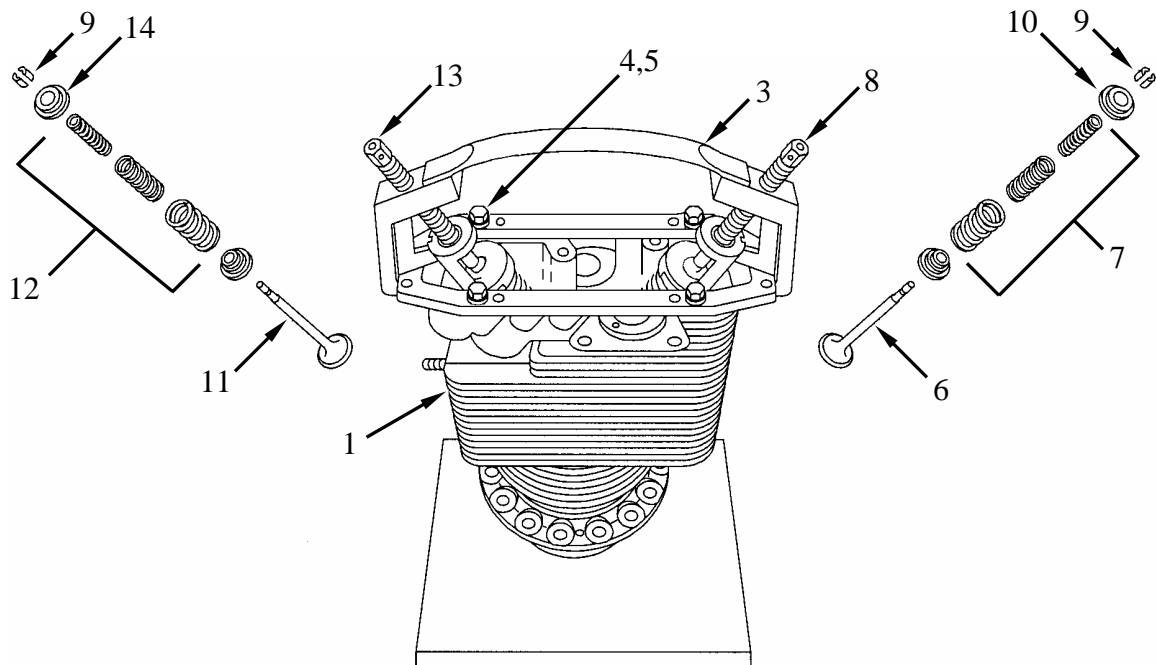
## DISASSEMBLY (Continued)

<p><b>WARNING</b></p>
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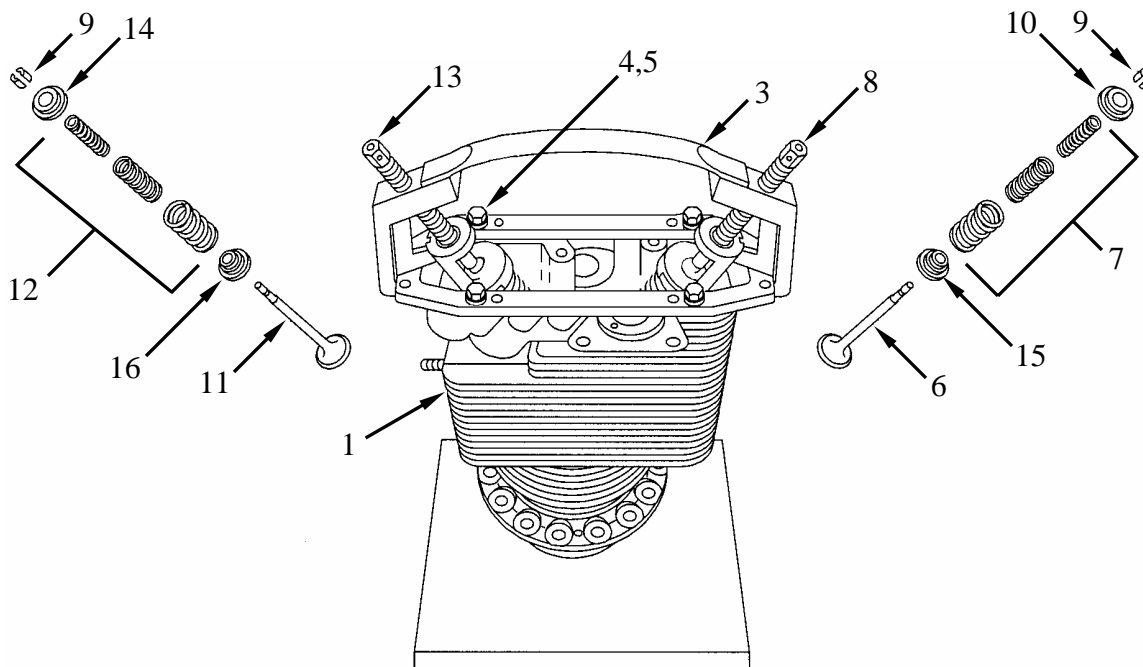
Valves and locks are under heavy spring tension. Exercise extreme care when removing locks, seats, and springs. Each valve spring set consists of three separate springs. Failure to comply may result in injury.

3. Remove exhaust valve (6).
  - a. Compress exhaust valve springs (7) by turning screw (8).
  - b. Remove two valve spring locks (9) from the groove in exhaust valve (6) stem.
  - c. Tap exhaust valve spring retainer (10) to free valve spring locks (9).
  - d. Carefully loosen screw (8) to release valve springs (7).
4. Remove intake valve (11).
  - a. Compress intake valve springs (12) by turning screw (13).
  - b. Remove two valve spring locks (9) from the groove in intake valve (11) stem.
  - c. Tap valve spring retainer (14) to free valve spring locks (9).
  - d. Carefully loosen screw (13) to release valve springs (12).
5. Remove valve lifter assembly (3).
  - a. Remove four rocker cover screws (4) with flat washers (5).
  - b. Remove valve lifter assembly (3) from cylinder assembly (1).



**DISASSEMBLY (Continued)**

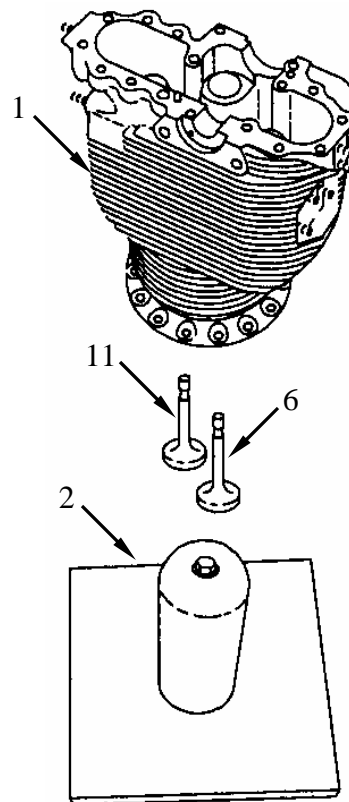
6. Remove exhaust valve spring retainer (10), three springs (7), and rotor (15) from exhaust valve (6).
7. Remove valve spring retainer (14), three springs (12), and seat (16) from intake valve (11).



**CAUTION**

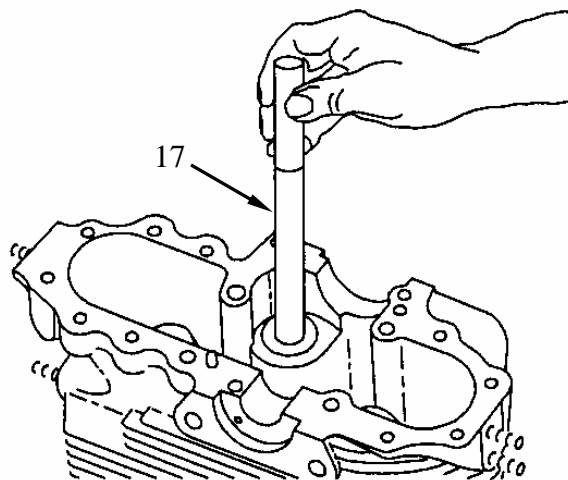
**Make certain valves do not drop out when removing cylinder from valve removing and inserting stand or damage could occur.**

8. Remove valves from cylinder assembly (1).
  - a. Remove cylinder assembly (1) from valve removing and inserting stand (2).
  - b. Place cylinder assembly (1) on its side and remove intake valve (11) and exhaust valve (6) through cylinder bore.



**CLEANING**

1. See WP 0028 for Standard Cleaning Procedures.
2. Remove heavy carbon deposits from combustion chamber with a scraper or blunt tool that will not nick or scratch the surface. Remove only the heavy carbon deposits. Surface need not be cleaned to a mirror finish.
3. Clean carbon from fuel injector nozzle seat using nozzle carbon cutter (17) (item 33, WP 0176).

**WARNING****Carbon-Removing Compound is mildly toxic**

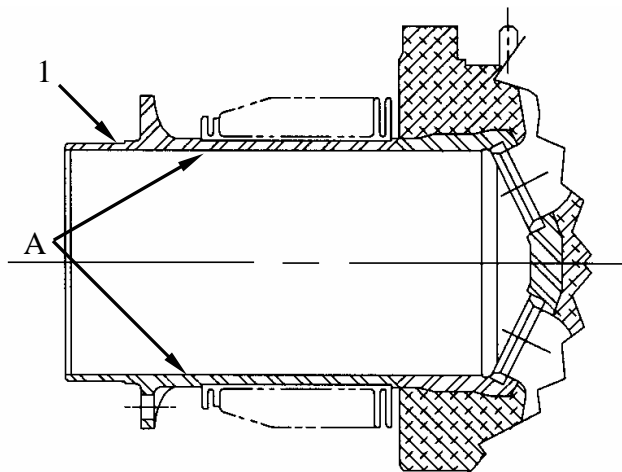
- Avoid inhalation of fumes. Provide adequate ventilation.
- Avoid contact with skin.
- Use goggles, rubber gloves, and rubber apron
- If compound is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor is preferred.

4. Soak cylinder assembly (1) in carbon-removing compound (item 7, WP 0173) to remove carbon and other foreign material from dome and valve ports.

**INSPECTION**

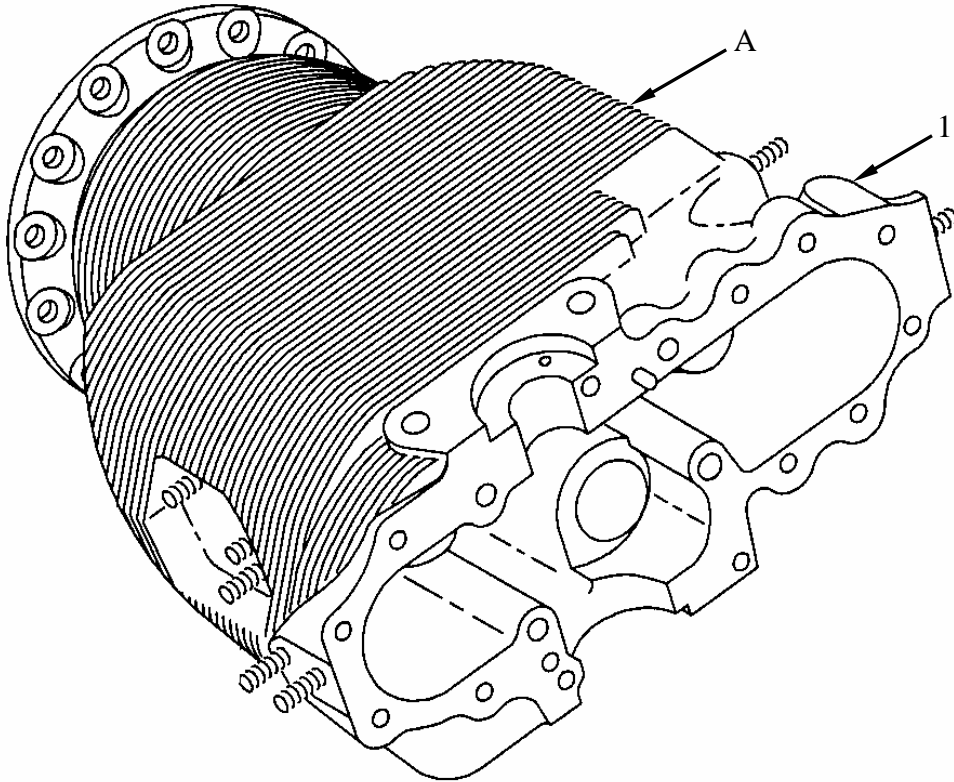
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See WP 0028 for Standard Inspection Procedures.
2. Inspect cylinder (1) bore (A).
  - a. Replace any cylinder whose bore (A) has excessive scratches, scoring, or ring ridge.
  - b. Replace any cylinder whose bore (A) is glazed or smooth.



**INSPECTION (Continued)**

3. Inspect cylinder (1) cooling fins (A) for any damage.
  - a. If any damage is found, mark for repair.
  - b. Replace any cylinder (1) that has more than 6.25 total square inches (403.1875 square mm) of missing fin area (A).



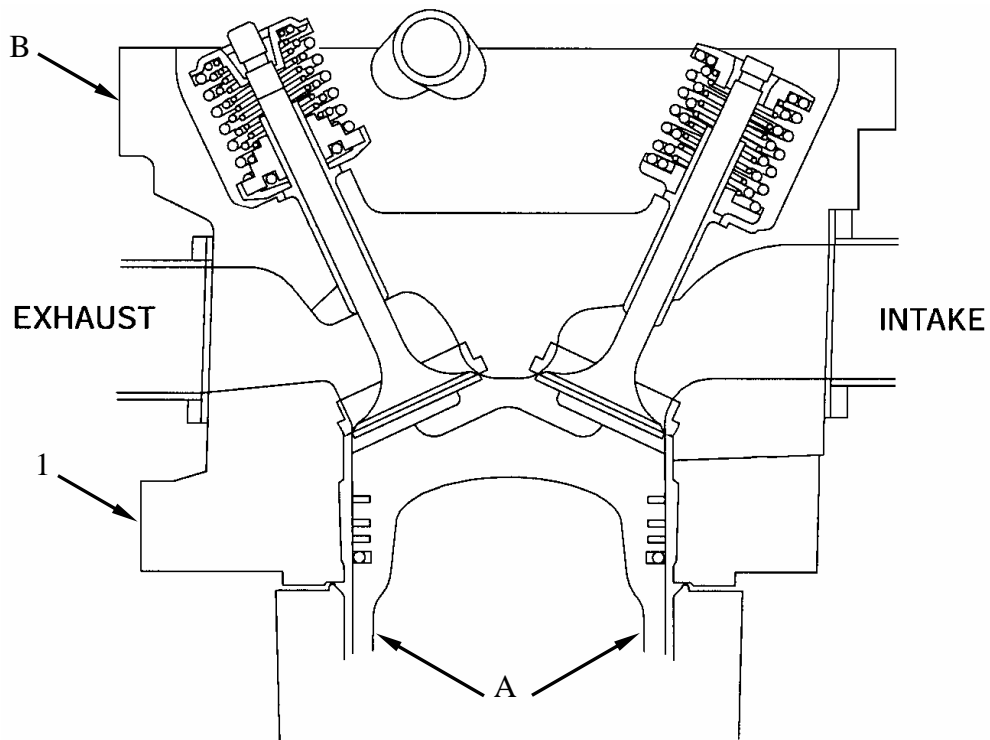


INSPECTION (Continued)

NOTE

Cylinder bore (A) size is identified by a stamped part number (B) located on exhaust port side of the cylinder assembly (1). See the following table.

Part Number	Bore Size	Bore Diameter
10951304	Standard	5.751-5.753
10951304-1	1.010 Oversize	5.761-5.763
10951304-2	1.020 Oversize	5.771-5.773
10951304-3	1.030 Oversize	5.781-5.783
10951304-4	1.040 Oversize	5.791-5.793

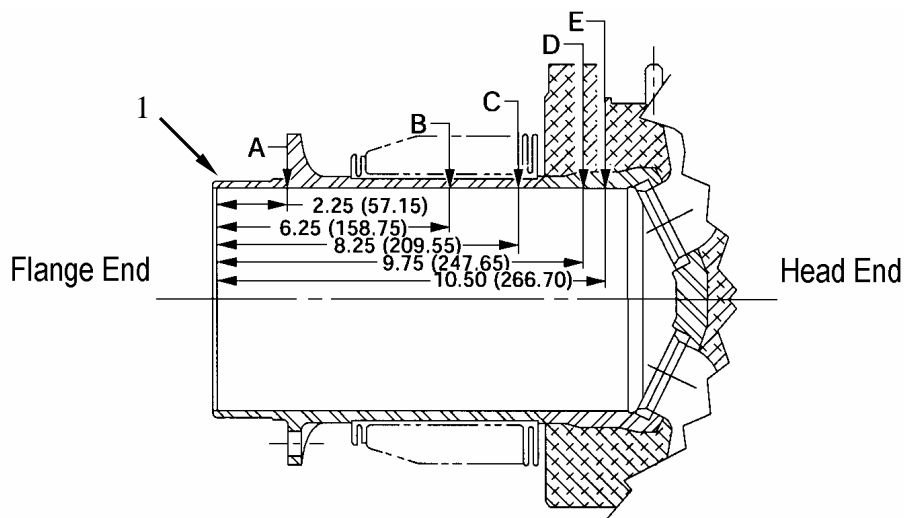


**INSPECTION (Continued)**

4. Measure cylinder (1) bore at room temperature.
  - a. Take first set of measurements at points A through E. Measure diameter approximately parallel to line of valves.
  - b. Take second set of measurements 90 degrees to first set.
  - c. Average the measurements.
  - d. If head end average measurements exceed flange end average measurements, replace cylinder.

**NOTE**

**Cylinder bores may taper slightly (smaller at head end) at room temperature. The tapered section expands and is essentially straight at operating temperature.**

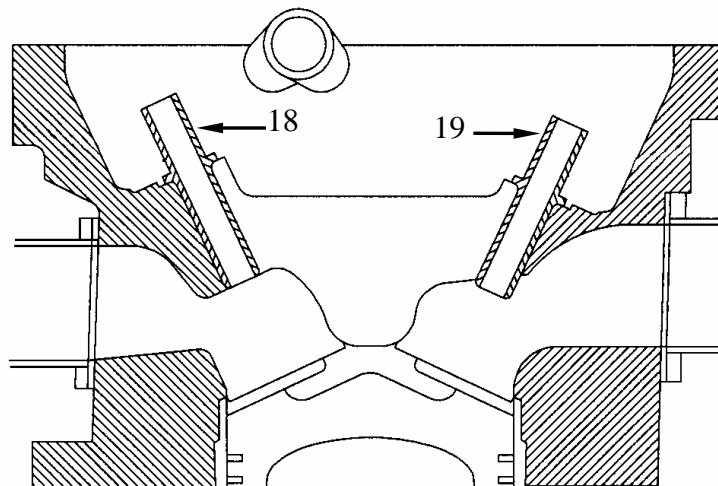


5. Compare measurement sets.
  - a. At each point (A through E), measurements must be within 0.003 inch (0.0762 mm) of each other. If the difference exceeds 0.003 inch (0.0762 mm), the cylinder is out-of-round and must be replaced.
  - b. Compare the measurements to limits in the following table. If cylinder is out of limits, replace cylinder.

Cylinder Bore (average of A-E)	Size and Fit of New Parts inches (mm)		Wear Limits inches (mm)
Standard bore diameter	5.7510 (146.0754)	5.7530 (146.1262)	5.7600 (146.304)
0.0100 (0.25) oversize bore	5.7610 (146.3294)	5.7630 (146.3802)	5.7700 (146.558)
0.0200 (0.50) oversize bore	5.7710 (146.5834)	5.7730 (146.6342)	5.7800 (146.812)
0.0300 (0.762) oversize bore	5.7810 (146.8374)	5.7830 (146.8882)	5.7900 (147.066)
0.0400 (1.01) oversize bore	5.7910 (147.0914)	5.7930 (147.1422)	5.8000 (147.32)
Maximum out-of-round	0.0020 (0.0508)		0.0030 (0.0762)

**INSPECTION (Continued)**

6. Inspect valve guides (18, 19).
  - a. Look for cracks, galling, erosion, or scuffing.
  - b. If any cracks, galling, erosion, or scuffing is found, replace guides.
  
7. Check guides against limits specified in the following table.
  - a. If guides are out of limits, they must be replaced.



Point of Measurement	Size and Fit of New Parts		Wear Limits
	inches (mm)		
Inside diameter of intake valve guide	0.4995 (12.6873)	0.5005 (12.7127)	0.5035 (12.7889)
Outside diameter of intake valve stem	0.4975 (12.6365)	0.4980 (12.6492)	0.4970 (12.6238)
Fit of intake valve stem in guide	0.0015L (0.0381)	0.0030L (0.0762)	0.0065L (0.1651)
Inside diameter of exhaust valve guide	0.5615 (14.2621)	0.5625 (14.2875)	0.5655 (14.3637)
Outside diameter of exhaust valve stem	0.5570 (14.1478)	0.5580 (14.1732)	0.5565 (14.1351)
Fit of exhaust valve stem in guide	0.0035L (0.0889)	0.0055L (0.1397)	0.0090L (0.2286)

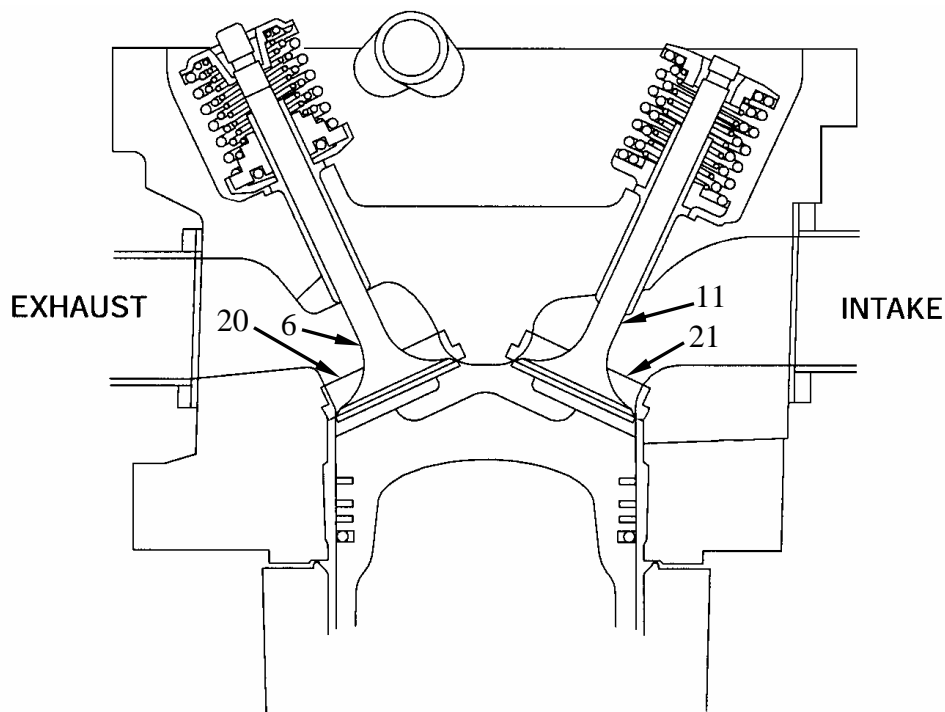
**INSPECTION (Continued)**

8. Inspect valve seat inserts (20, 21) for cracks, pitted surfaces, or looseness.

**NOTE**

**If valve seats are cracked, loose, or damaged beyond repair, the cylinder must be replaced.**

9. Lightly blue face of two valve seats (20, 21) with Prussian blue (item 25, WP 0173), and place a new valve (6, 11) into position on valve seat.
10. Rotate valves (6, 11) one-half turn on insert and check for Prussian blue contact. Valve seats (20, 21) must show contact all around (360 degrees), as indicated by Prussian blue transfer, to qualify as serviceable. Valve seats that do not show 360-degree contact must be marked for repair (grinding).



**REPAIR**

1. Replace any cracked, galled, eroded, or scuffed intake and exhaust valve guides or guides that do not conform to limits specified in table under Inspection step 7.

**NOTE**

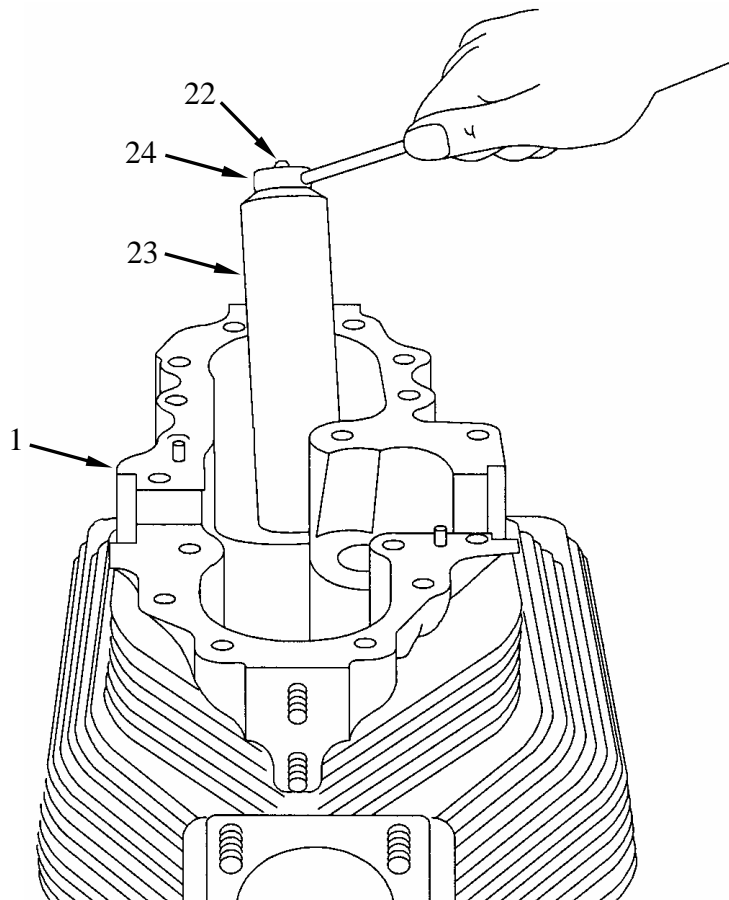
**The intake and exhaust valve guides are removed from the cylinder in the same manner. However, a different puller is used for each: Puller 10882953 (item 87, WP 0176) is used for intake valve guides, and puller 10882954 (item 86, WP 0176) is used for exhaust.**

2. Remove valve guide.
  - a. Insert screw (22) of puller (23) through the valve guide and the puller.
  - b. Install nut (24) on end of puller screw (22).
  - c. Place entire assembly in oven (item 47, WP 0176) and heat to 350 °F (176 °C) maximum.

**WARNING**

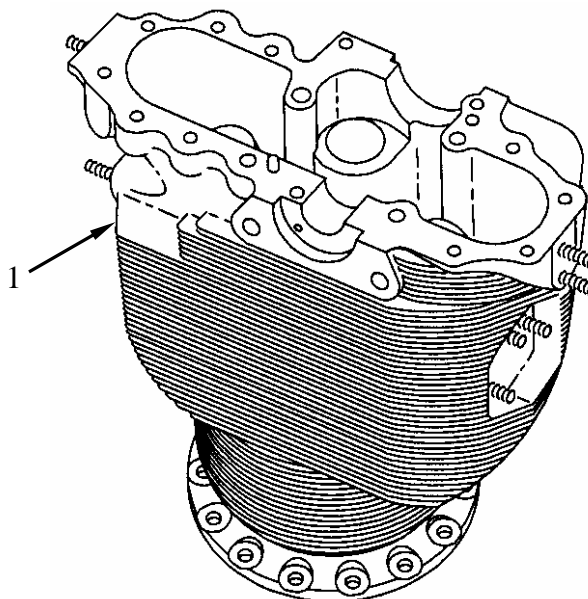
**Wear gloves when handling heated parts.**

- d. Remove assembly from oven and tighten nut (24) to remove valve guide from cylinder assembly (1).



**REPAIR (Continued)**

3. Check valve guide bores in cylinder assembly (1). If not within the following limits, cylinder assembly (1) must be replaced.



Point of Measurement	Size and Fit of New Parts		Wear Limits
	inches (mm)		
Outside diameter of intake valve guide	0.6890 (17.5006)	0.6895 (17.5133)	None
Inside diameter of intake valve guide bore in cylinder head	0.6870 (17.4498)	0.6880 (17.4752)	None
Fit of intake valve guide in bore	0.0010T (0.0254)	0.0025T (0.0635)	None
Outside diameter of exhaust valve guide	0.7525 (19.1135)	0.7530 (19.1262)	None
Inside diameter of exhaust valve guide bore in cylinder	0.7495 (19.0373)	0.7505 (19.0627)	None
Fit of exhaust valve guide in bore	0.0020T (0.0508)	0.0035T (0.0889)	None

**WARNING**



**Wear gloves when handling heated or chilled parts.**

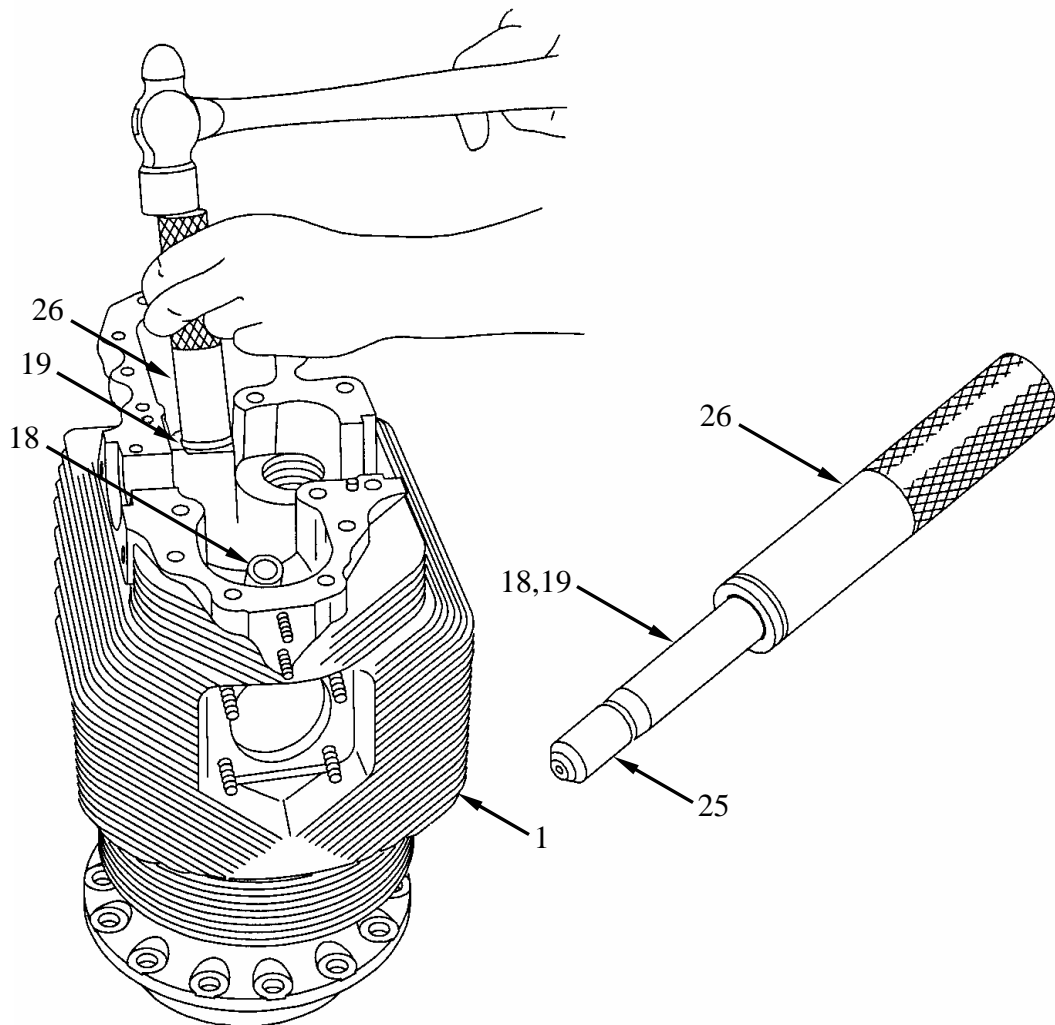
4. Heat cylinder assembly to 350 °F (176 °C) maximum and chill valve guides for 1 hour minimum in dry ice or 3 hours minimum at -40 °F (-40 °C) before installing.

**NOTE**

**The intake and exhaust valve guides are installed in the cylinder in the same manner. A separate replacer is used for each. Replacer 10883052 (item 100, WP 0176) is used for intake valve guides, and 10883053 (item 99, WP 0176) is used for exhaust.**

**REPAIR (Continued)**

5. Install valve guide (18 or 19).
  - a. Remove ferrule (25) from end of valve guide replacer (26) (use item 100 for intake, item 99 for exhaust, WP 0176).
  - b. Place new valve guide (18 or 19) over replacer with short end of guide entering hollow replacer handle. Replace ferrule (25) to retain guide on replacer (26).
  - c. Place assembled valve guide (18 or 19) and replacer (26) into valve guide bore in cylinder assembly (1).
  - d. Carefully drive valve guide (18 or 19) into cylinder assembly (1) until flange on valve guide (18 or 19) is positioned against top face of guide bore.
  - e. Remove ferrule (25) and withdraw replacer (26) from valve guide (18 or 19).



## REPAIR (Continued)

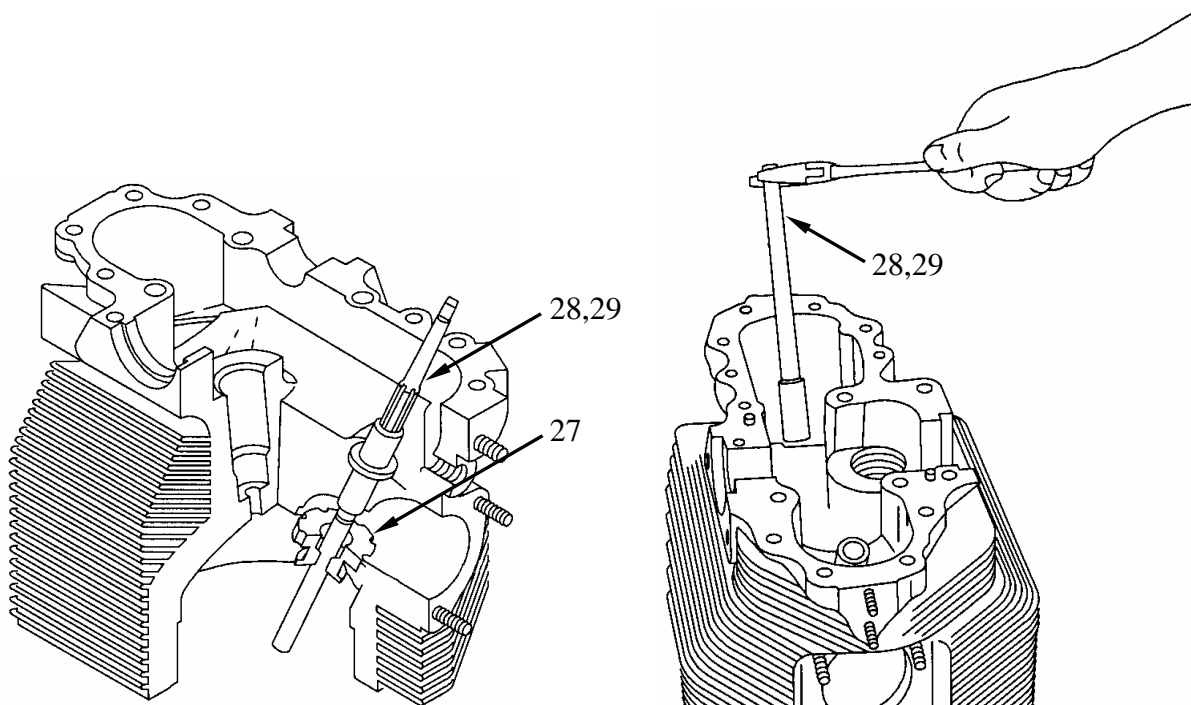
**CAUTION**

After new valve guides are installed, they must be reamed to specified size to assure proper clearance between valve guide and valve stem.

**NOTE**

The intake and exhaust valve guides are reamed in the same manner. Separate reamers and bushings are used for each. Reamer bushing 11642088 (item 15, WP 0176) is used for intake valve guide, and 11642089 (item 14, WP 0176) is used for exhaust guide.

6. Ream valve guides.
  - a. Install reamer bushing (27) (use item 15 for intake, item 14 for exhaust, WP 0176) and hand reamer (28).
  - b. Ream intake valve guide with rough hand reamer (28) (item 96, WP 0176) and then with finish reamer (29) (item 94, WP 0176).
  - c. Ream exhaust valve guide with rough hand reamer (item 95, WP 0176) and then with finish reamer (item 93, WP 0176) (similar to illustration).





REPAIR (Continued)

NOTE

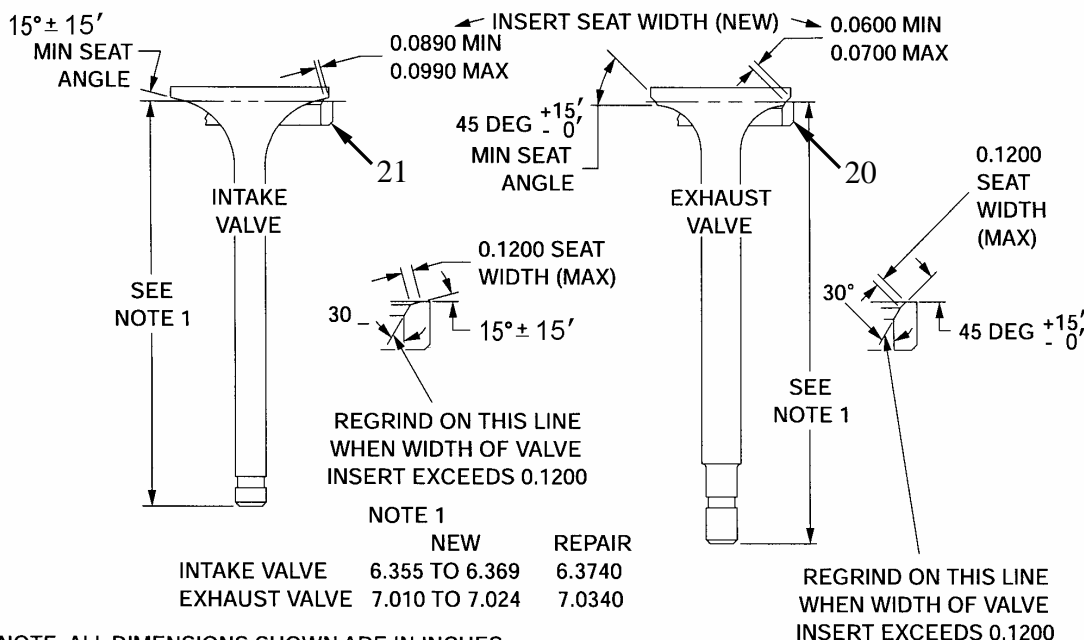
**Repair valve seat inserts that did not show 360-degree contact with valve face at inspection.**

7. Grind exhaust valve seat (20) using valve seat grinding kit (item 60, WP 0176) and 45-degree angle grinding stone.
8. Grind intake valve seat (21) using valve seat grinding kit (item 60, WP 0176) and 15-degree angle grinding stone.

**CAUTION**

**After grinding any valve seat insert, contact area must be checked. Keep valve seat area as near as possible to center of valve face. Valves should never seat at the top or bottom of the valve face area. Premature failure will result if contact area is not correctly located.**

9. Check contact area of valve seat inserts.
  - a. Lightly blue face of two valve seats (20,21) with Prussian blue (item 25, WP 0173) and place a new or reconditioned valve (6,11) into position on valve seat.
  - b. Rotate valves (6,11) one-half turn on insert and check for Prussian blue contact. Valve seats (20,21) must show contact all around (360 degrees), as indicated by Prussian blue transfer, to qualify as serviceable.
  - c. When 360-degree contact is obtained, conform seat of insert to width specified (intake 0.089/0.099-inch) (exhaust 0.060/0.070-inch) by grinding inner wall and/or exposed face of insert to angles specified.



**REPAIR (Continued)**

10. Repair cylinder (1) cooling fins.

- a. Straighten bent cooling fins (A) as near as possible to their original spacing.
- b. Use a fine mill file to remove sharp corners of broken cooling fins (A). Do not remove more metal than necessary to produce a smoothly blended edge on the damaged fin.

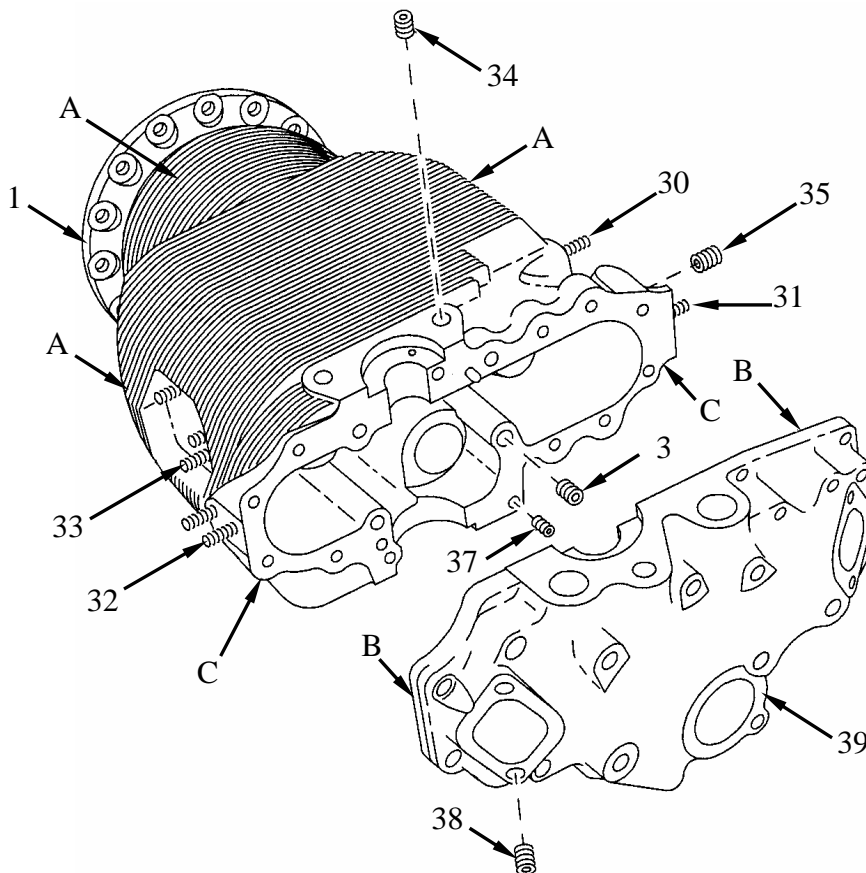
11. Replace damaged, bent, or stripped studs (30,31,32, or 33). Refer to WP 0028.

Callout	Setting Height	Quantity	Stud Dimensions
30	31/31 (24.6062)	3	5/16-18 (13/16) x 5/16-24 (19/32) x 1-11/16
31	1-3/32 (27.7813)	1	7/16-14 (25/32) x 7/16-20 (1-1/64) x 1-27/32
32	21/32 (16.6688)	2	5/16-18 (11/16_ x 5/16-24 (9/16) x 1-5/16
33	31/32 (24.6062)	4	3/8-16 (53/64) x 3/8-24 (7/8) x 1-3/4

12. Replace defective screw thread inserts (34,35,36,37 or 38). Refer to WP 0028.



13. Repair scratches or nicks on mating surface (B) of valve rocker arm cover (39) and cylinder (1) mating surface (C) by polishing with crocus cloth (item 9, WP 0173) dipped in cleaning compound (item 8, WP 0173).



## ASSEMBLY

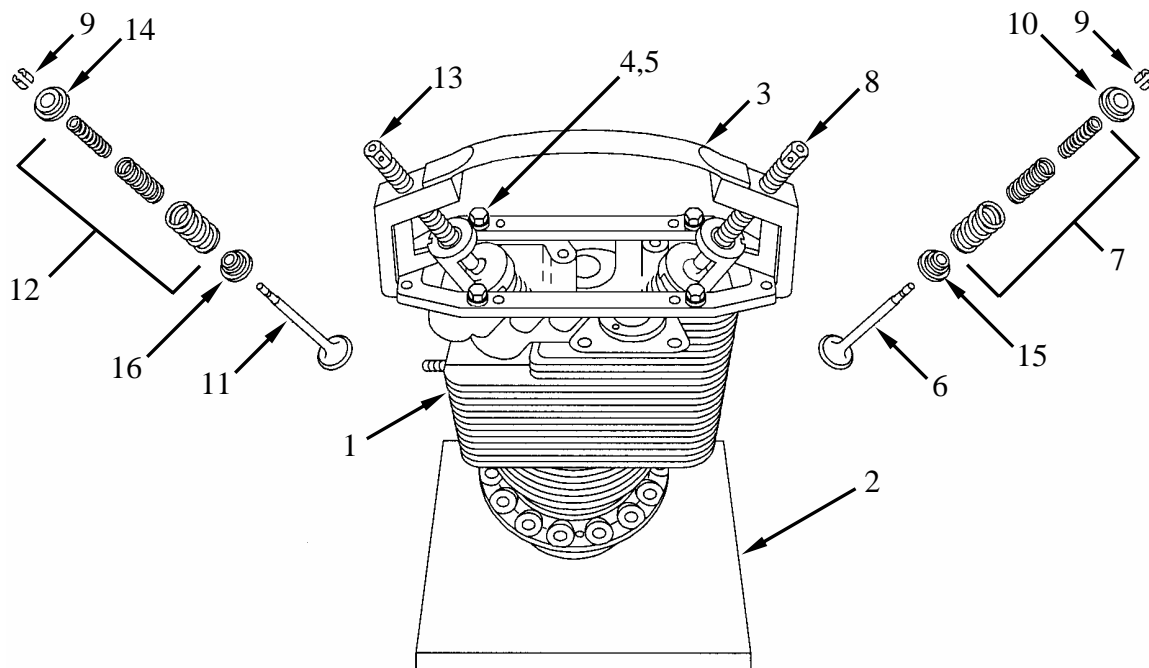
1. Install valves.
  - a. Apply lubricating oil (item 21, WP 0173) to valve stems and install intake valve (11) and exhaust valve (6) in their respective guides in cylinder assembly (1).
  - b. Hold valves in position and place cylinder (1) on valve removing and inserting stand (2) (item 112, WP 0176).
  - c. Install exhaust valve rotor (15), outer, intermediate, and inner exhaust valve springs (7), and exhaust valve spring retainer (10) over the exhaust valve (6) stem.
  - d. Install intake valve spring seat (16), outer, intermediate, and inner intake valve springs (12), and intake valve spring retainer (14) over the intake valve (11) stem.
  - e. Position valve lifter assembly (3) (item 72, WP 0176) on cylinder assembly (1) and secure with four 5/16 x 1.375 (7.9375 x 34.9250 mm), rocker cover screws (4) and four 5/16-inch (7.9375 mm) flat washers (5).

**WARNING**



**Valves and locks are under heavy spring tension. Exercise extreme care when installing locks, seats, and springs. Each valve spring set consists of three separate springs. Failure to comply may result in injury.**

- f. Compress exhaust and intake valve springs (7,12) and retainers (10,14) with screws (8 and 13) then install two valve spring locks (9) in the groove of each valve (6,11) stem.
- g. Release valve spring compression and remove four rocker cover screws (4) with flat washers (5) and valve lifter assembly (3) from cylinder (1).
- h. Remove cylinder (1) from valve removing and inserting stand (2).



## ASSEMBLY (Continued)

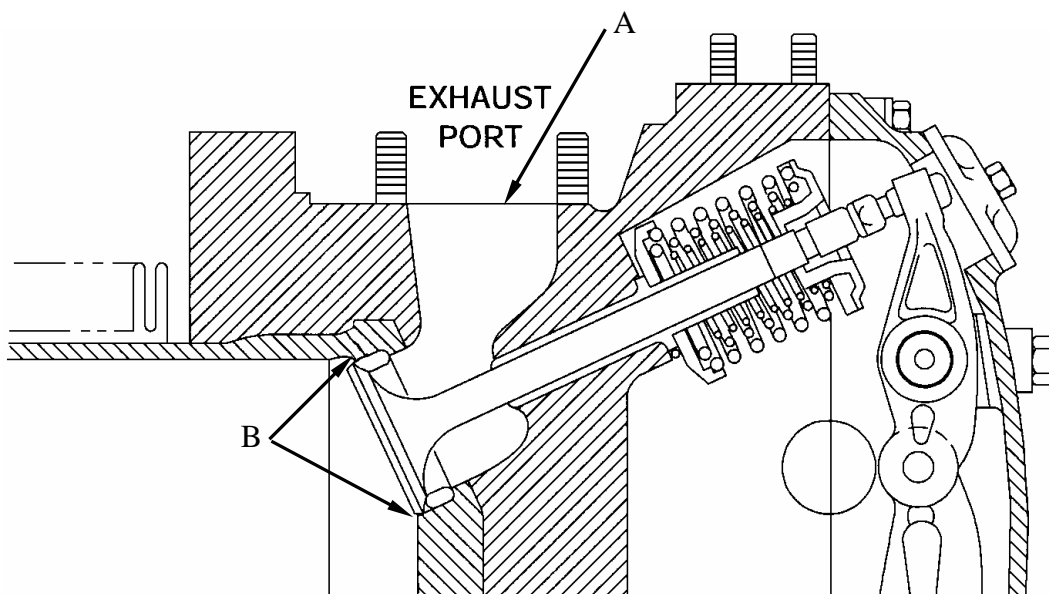
## NOTE

All cylinders that have had valves ground should be leak tested as follows to assure proper seating of the valve to the valve seat.

## WARNING



2. Check valves for leakage.
  - a. Place cylinder (1) on its side with intake or exhaust port up.
  - b. Fill valve port (A) with cleaning compound (item 8, WP 0173).
  - c. Observe valve seat area (B) (inside of cylinder) for fluid leakage.
  - d. No leakage is allowed. If any leakage is detected, grind valve or replace cylinder.



END OF WORK PACKAGE

**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

**0136 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

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**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Mechanical puller (2) (item 89, WP 0176)  
Torque wrench, 0-150 in-lb (item 123, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
(2CA, 2DA) Flywheel and spur-gear removed  
(WP 0102)  
(2DR) Flywheel and adapter removed  
(WP 0103)

**Mandatory Replacement Parts:**

Gasket (item 348, WP 0175)  
Self-locking nuts (4) (item 38, WP 0175)  
Seal (item 365, WP 0175)

**Expendable Materials:**

Sealing compound, silicone sealant (item 33,  
WP 0173)  
Silicone compound DC4-207 (item 34,  
WP 0173)

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**REMOVAL**

**NOTE**

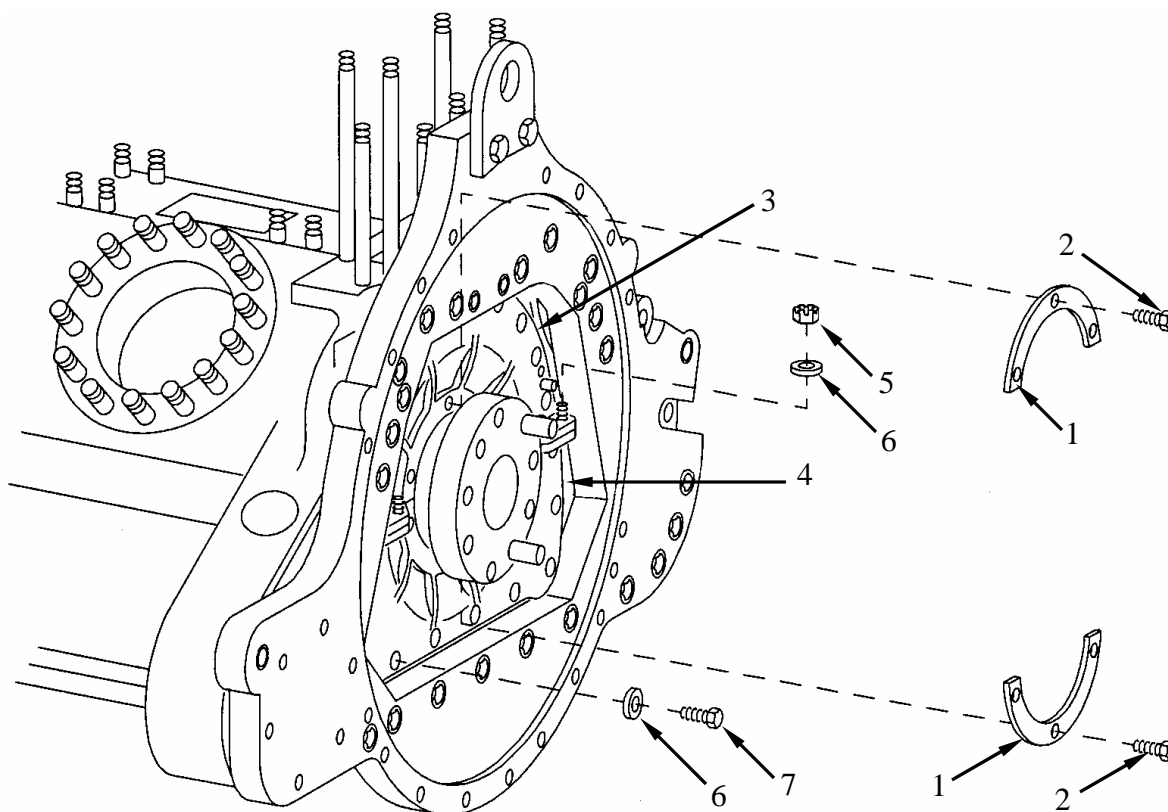
**Early engine models had safety wire on the oil seal retainer plates and oil seal housing. If you encounter safety wire, remove and discard it. On installation, do not replace safety wire as it is no longer used.**

**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

0136 00

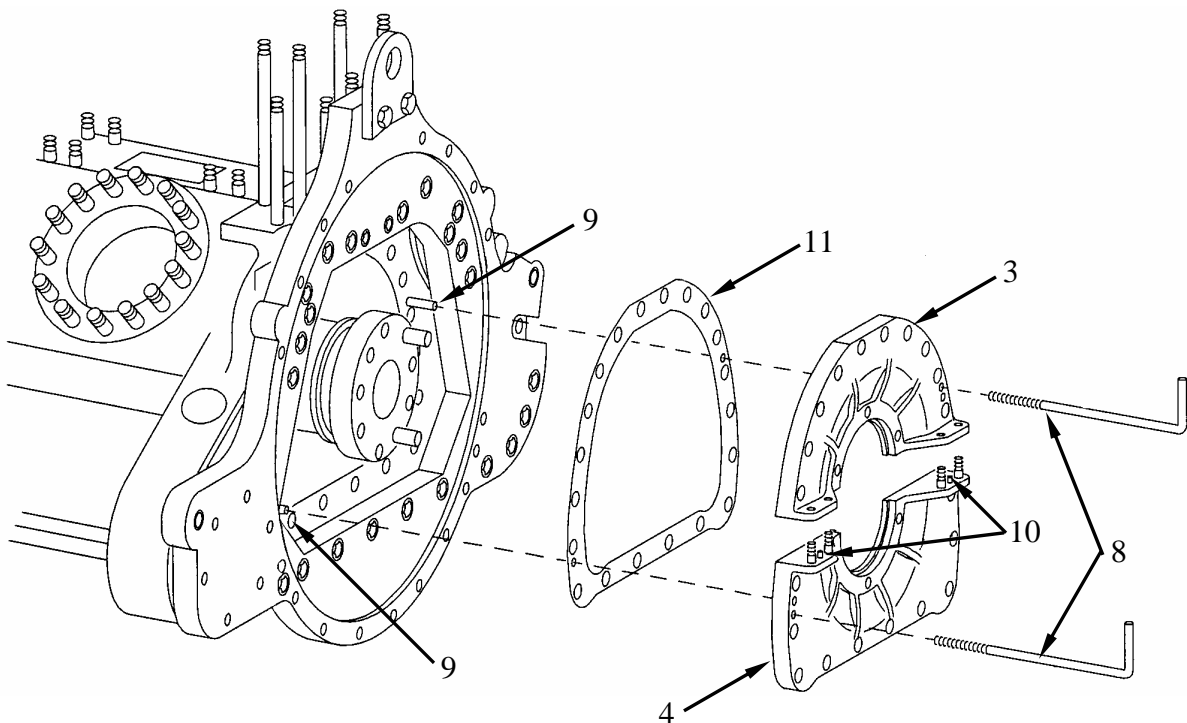
**REMOVAL (Continued)**

1. Remove oil seal retainers (1).
  - a. Remove three bolts (2) attaching oil seal retainer (1) to oil seal housing cap (3).
  - b. Remove three bolts (2) attaching oil seal retainer (1) to oil seal housing (4).
  - c. Remove two retainers (1).
2. Remove oil seal housing (4) and cap (3).
  - a. Remove four nuts (5) with flat washers (6) attaching oil seal cap to oil seal housing. Discard nuts (5).
  - b. Remove twenty machine bolts (7) with flat washers (6) attaching oil seal cap (3) and housing (4) to crankcase assembly.



**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT****0136 00****REMOVAL (Continued)**

2. Remove oil seal housing (4) and housing cap (3) (continued).
  - c. Install two mechanical pullers (8) (item 89, WP 0176) and pull housing (4) and cap (3), as an assembly, from dowel pins (9).
  - d. Remove mechanical pullers (8).
  - e. Separate oil seal cap (3) from pins (10) in housing (4) and remove both housing and cap.
  - f. Remove and discard gasket (11).

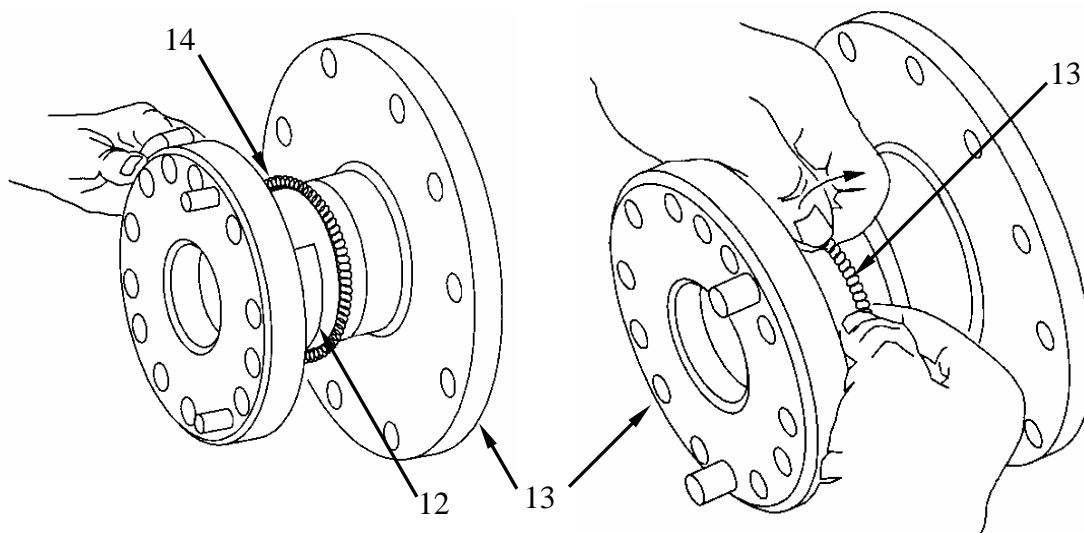


**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

0136 00

**REMOVAL (Continued)**

3. Remove oil seal (12) from crankshaft (13).
  - a. Remove spring (14) from lip in oil seal (12) and slide it out of the way.
  - b. Remove split oil seal (12) from crankshaft (13).
  - c. Position spring (14) so ends can be seen.
  - d. Twist male end of spring (14) clockwise and female end counterclockwise and remove spring from crankshaft.
  - e. Discard oil seal and spring.

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 00 for General Inspection Procedures.

**REPAIR****CAUTION**

**The oil seal housing and cap are machined with the engine crankcase and are mating parts. Always keep the oil seal housing and cap as an assembly with the crankcase. Failure to comply may result in premature failure of the oil seal.**



**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

0136 00

**REPAIR (Continued)**

1. Replace bent, stripped, or otherwise damaged studs (15). See WP 0028.

Callout	Setting Height	Quantity
15	31/31 (24.6062)	4
Stud Dimensions		
5/16-18 (51/64) x 5/16-24 (21/32) x 1-5/8		

2. Replace defective screw thread inserts (16). See WP 0028.
3. Replace loose or damaged dowel pins (9,10). See WP 0028.

**INSTALLATION**

1. Install new oil seal (12) (item 285, WP 0169) onto crankshaft (13).

**CAUTION**

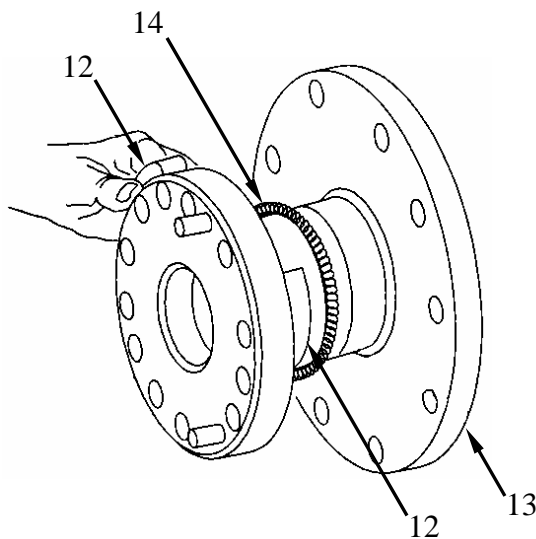
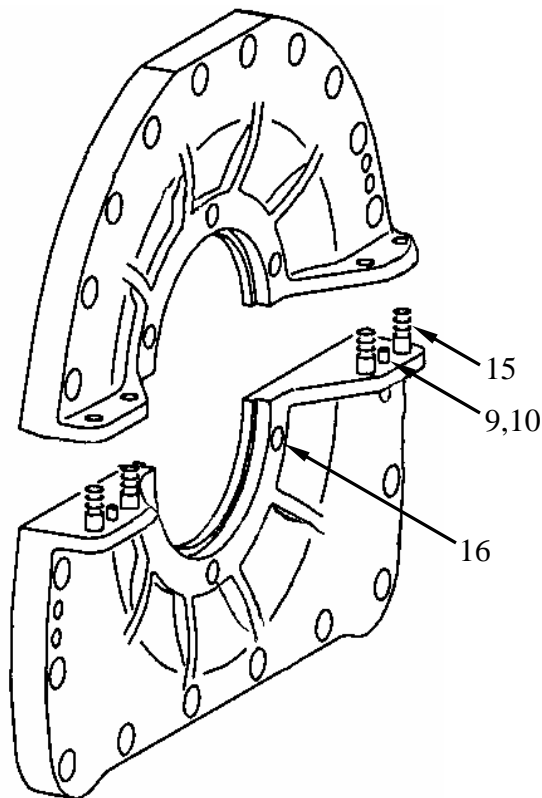
**One end of seal spring must be turned 2-1/2 turns in relation to the opposite end for proper engagement. Failure to comply may lead to crank seal leakage.**

- a. Install new oil seal spring (14) onto crankshaft (13). Pre-load spring by twisting the male end counterclockwise and the female end clockwise, then insert the male end into the female end and release.
- b. Apply silicone compound (item 34, WP 0173) to crankshaft (13) before installing new split oil seal (12).

**NOTE**

**Groove in split oil seal must face damper end of crankshaft.**

- c. Install new split oil seal (12) onto crankshaft (13).
- d. Position oil seal spring (14) in split oil seal (12) so that splits in each piece are 180 degrees apart.

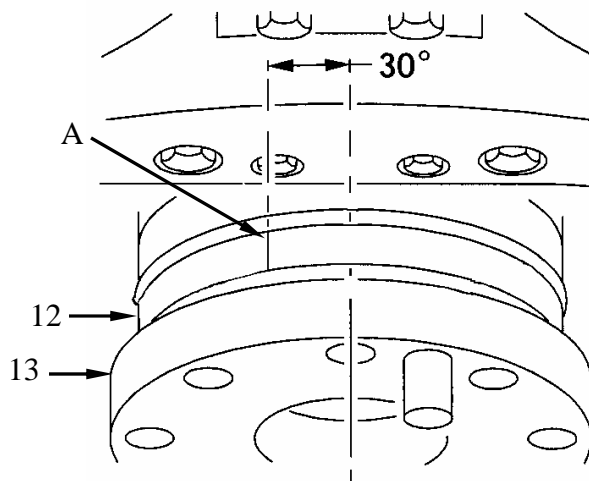


**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

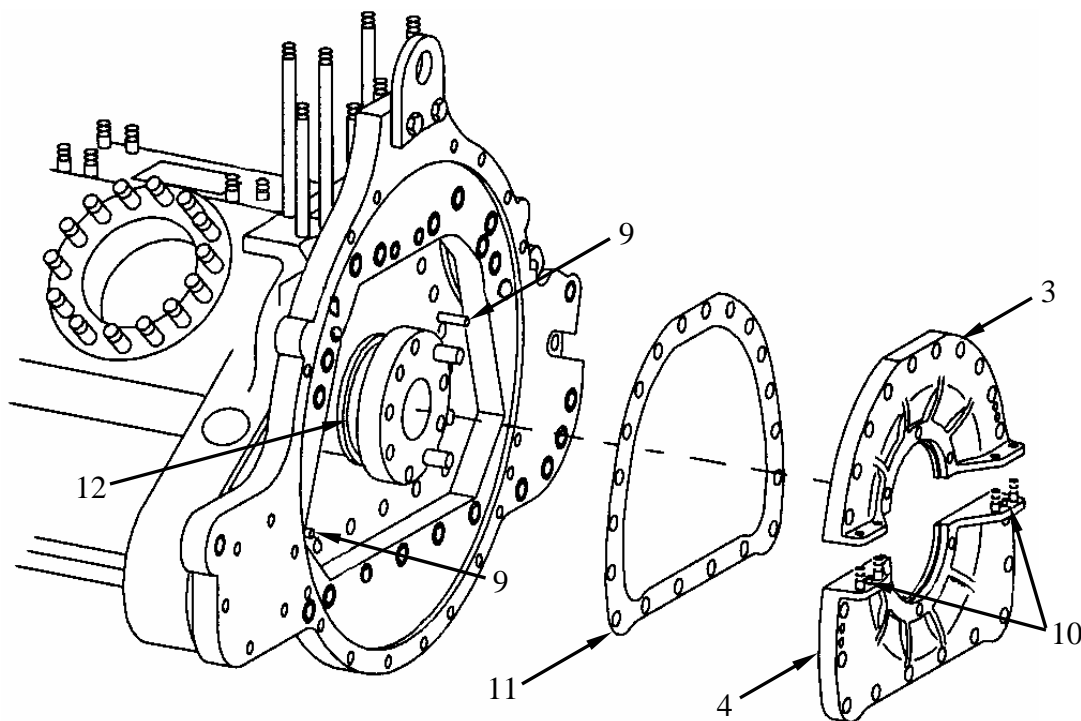
0136 00

**INSTALLATION (Continued)**

1. Install oil seal (12) (item 365, WP 0175) onto crankshaft (13) (continued).
  - e. Apply silicone compound (item 34, WP 0173) to outside of split oil seal (12).
  - f. Apply a coating of silicone compound (item 34, WP 0173) around lip and outer surface of oil seal (12).
  - g. Make sure that ends (A) of oil seal (12) join approximately 30 degrees from centerline of crankshaft (13).



2. Install new gasket (11) (item 348, WP 0175).
3. Install housing (4) and cap (3).
  - a. Apply a 1/4-inch bead of sealant (item 33, WP 0173) to oil seal housing (4) where it mates with oil seal cap (3).
  - b. Install oil seal housing (4) and cap (3) over crankshaft seal (12) and onto dowel pins (10).
  - c. Slide housing (4), cap (3), and seal (12) as an assembly onto dowel pins (9).

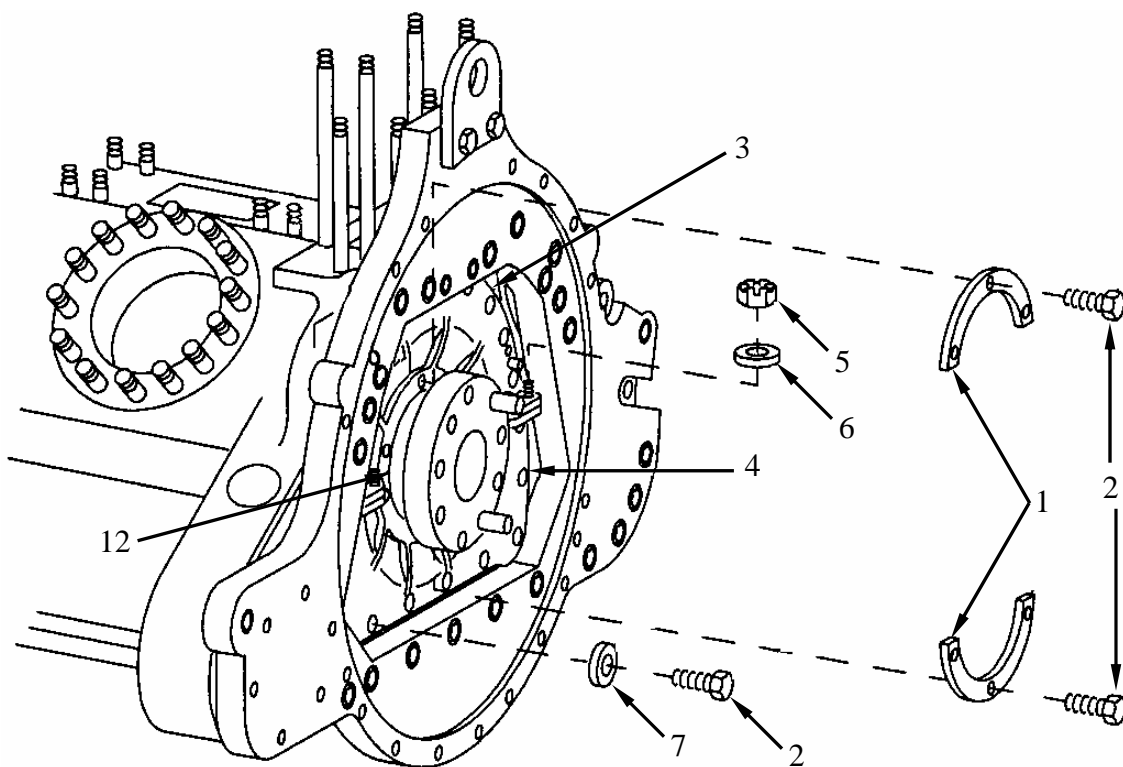


**OIL SEAL HOUSING ASSEMBLY AND ASSOCIATED PARTS  
REPLACEMENT**

0136 00

**INSTALLATION (Continued)**

3. Install housing (4) and cap (3) (continued).
  - c. Secure oil seal cap (3) and oil seal housing (4) to crankcase with 20 screws (7) with flat washers (6). Torque to 150-175 inch pounds (17-20 N·m).
  - d. Secure oil seal cap (3) to oil seal housing (4) with four new self-locking nuts (5) (item 38, WP 0175) with flat washers (6). Torque to 150-175 inch pounds (17-20 N·m), using torque wrench (item 123, WP 0176).
  - e. Install oil seal retainers (1) over oil seal (12) and secure to cap (3) and housing (4) using six screws (2). Torque to 150-175 inch pounds (17-20 N·m).

**END OF WORK PACKAGE**



**CRANKCASE REPAIR**

**0137 00**

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**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, Assembly

---

**INITIAL SETUP:**

**Tools and Special Tools:**

Brass welding probes (item 17, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Inside micrometer caliper set (item 16, WP 0176)  
Outside micrometer caliper set (item 17,  
WP 0176)  
Stud remover and setter (item 115, WP 0176)  
Telescoping gauge set (item 54, WP 0176)  
Thread die and tap set (item 120, WP 0176)  
Torque wrench, 0-175 ft-lb (item 127, WP 0176)  
Torque wrench, 0-600 ft-lb (item 128, WP 0176)

**Expendable Materials:**

Cleaning compound, solvent (item 8, WP 0173)  
Engine oil (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)  
Sealing compound (item 32, WP 0173)  
Teflon pipe sealant (item 41, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine disassembled (WP 0178)

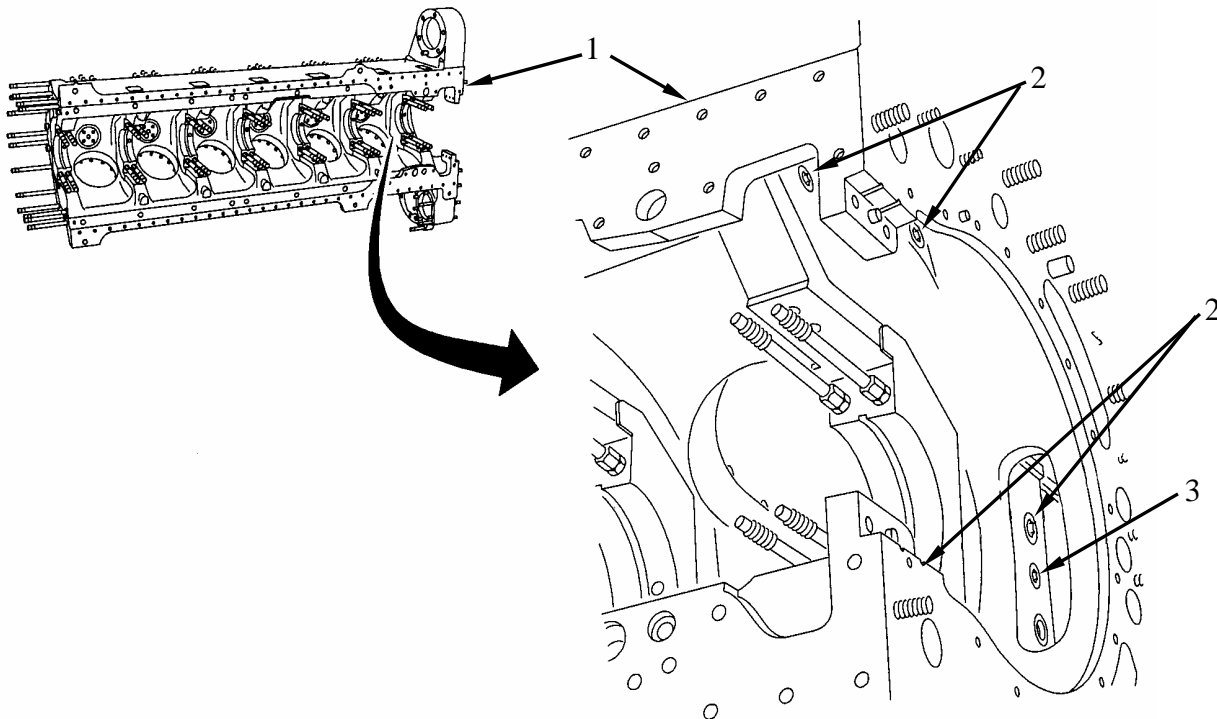
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**NOTE**

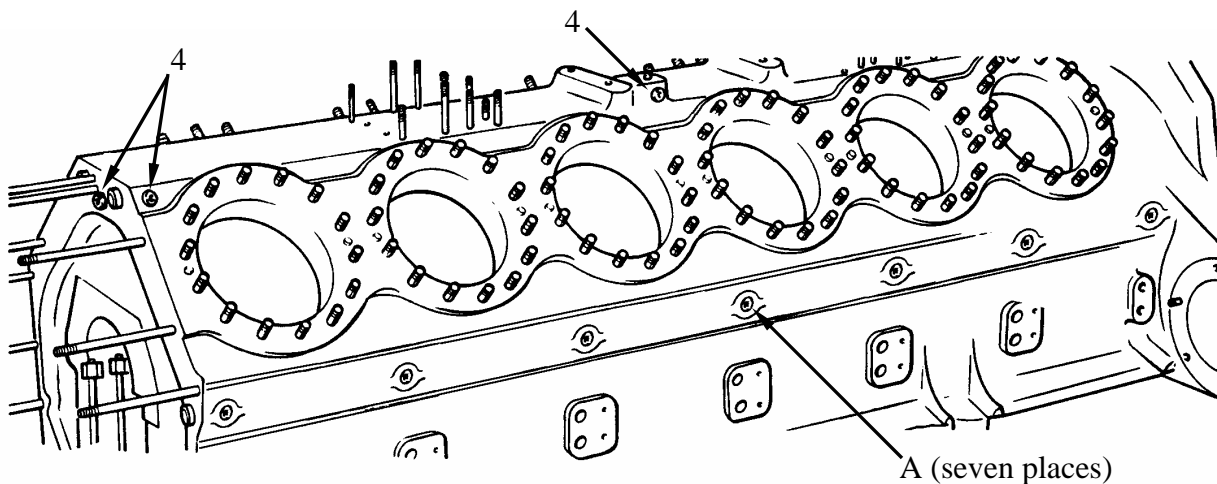
**The engine nameplate, located on the right side of the crankcase, contains the engine serial number, model, fuel, and oil specification. Any modifications to this information and the addition of repair or modification kit data must be incorporated either on the engine name plate or on a modification tag mounted on a designated location elsewhere on the engine.**

**DISASSEMBLY**

1. Remove five pipe plugs.
  - a. From inside of crankcase (1) at the flywheel end remove four main oil gallery pipe plugs (2), and one fan tower drain pipe plug (3).

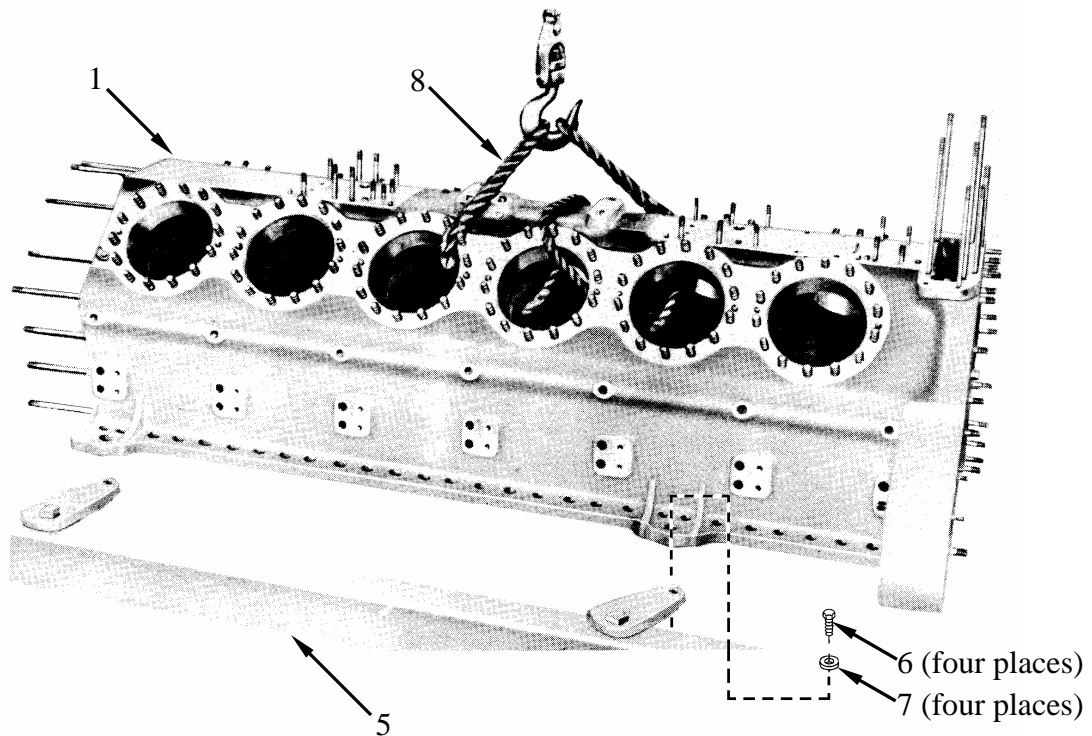


- b. Remove three pipe plugs (4) from crankcase as illustrated.
  - c. There are seven main gallery ports (A) along the right side of crankcase; remove pipe plugs and/or fittings. Note location of fittings for installation.

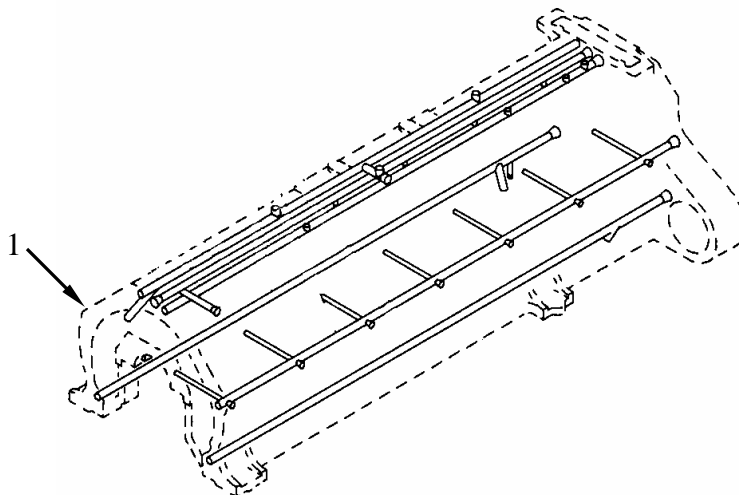


**DISASSEMBLY (Continued)**

2. Remove crankcase (1) from engine maintenance stand (5).
  - a. Remove four bolts (6) with flat washers (7) attaching crankcase to maintenance stand.
  - b. Attach a rope sling (8), with weight equally balanced, and remove crankcase from stand.

**CLEANING**

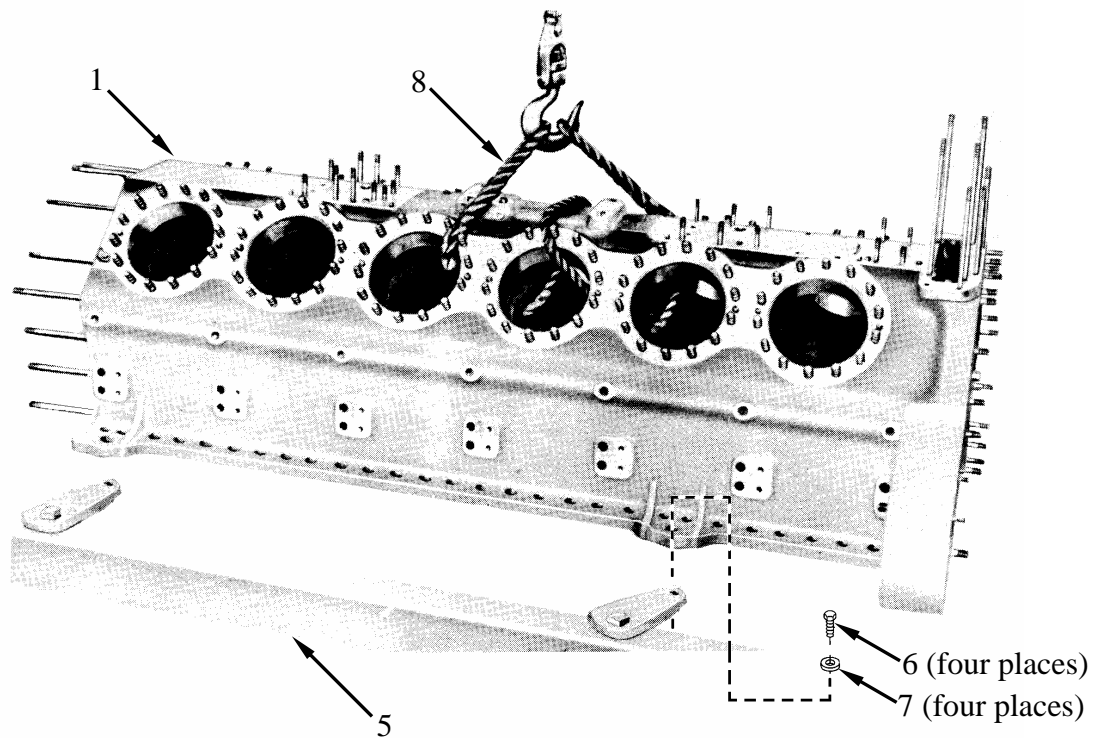
1. See Work Package 0028 for Standard Cleaning Procedures.
2. Thoroughly clean crankcase (1).
3. Clean crankcase oil passages using compressed air and brass wire probes (item 17, WP 0170).



**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Install crankcase (1) on maintenance stand (5).
  - a. Attach a rope sling (8), with weight equally balanced, and place crankcase on stand.
  - b. Secure with four screws (6) using flat washers (7).



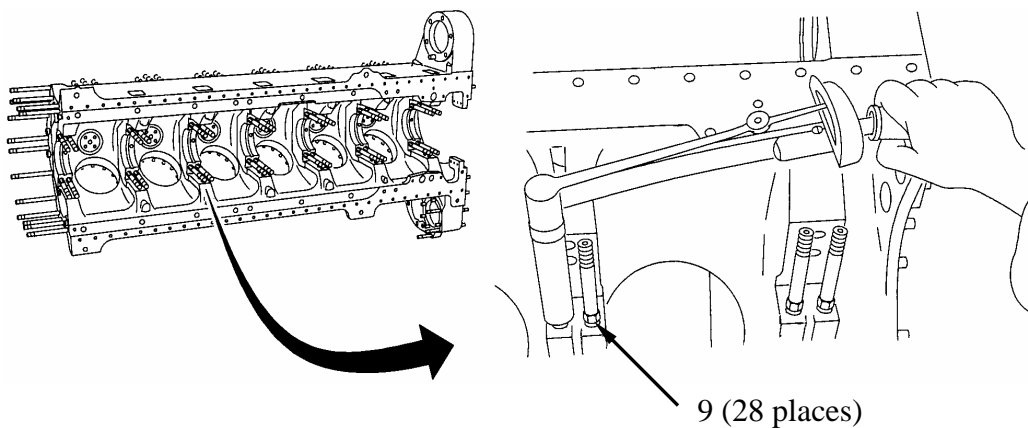


INSPECTION (Continued)

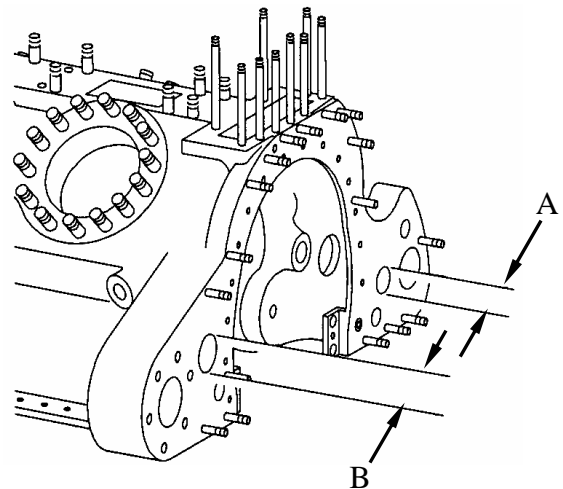
**CAUTION**

**Do not tighten studs (9) beyond 208 foot-pounds. Damage to crankcase or stud may occur.**

3. Check main bearing cap stud (9) torque.
  - a. Studs (9) must be tight at 38 foot-pound minimum torque. Studs that reach setting height before reaching 38 foot-pounds torque must be replaced.
  - b. Mark studs (9) that do not tighten at 38 foot-pounds of torque for replacement.



4. Check inside diameter of starter idler gear shaft bore (A). Replace crankcase if measurements are not within limits (see table below).
5. Measure inside diameter of generator idler gear shaft bore (B). Replace crankcase if measurements are not within limits (see table below).



**REPAIR STANDARDS:**

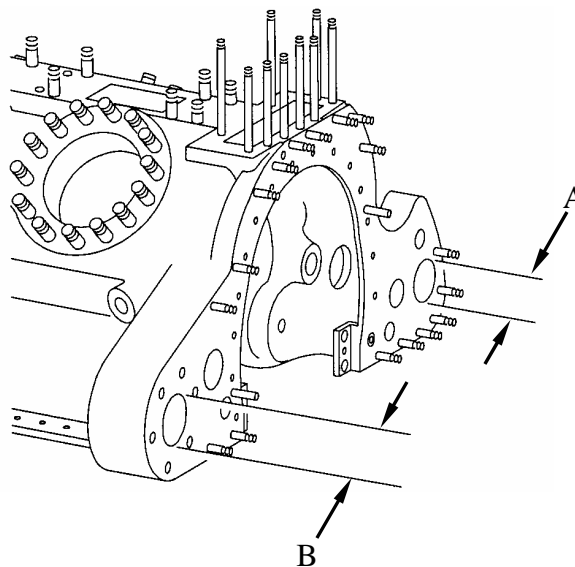
Location	Point of Measurement	Size and Fit of New Parts min./max. [inches (mm)]		Wear Limits
A	Inside diameter of starter idler gear shaft bore in crank case	1.1808 (29.99232)	1.1818 (30.01772)	1.1824 (30.03296)
B	Inside diameter of generator idler gear shaft bore in crank case	1.1808 (29.99232)	1.1818 (30.01772)	1.1824 (30.03296)

**CRANKCASE REPAIR**

0137 00

**INSPECTION (Continued)**

6. Measure inside diameter of starter bearing bore (A) in crankcase. Replace crankcase if measurements are not within limits (see table below).
7. Measure inside diameter of generator bearing bore (B) in crankcase. Replace crankcase if measurements are not within limits (see table below).

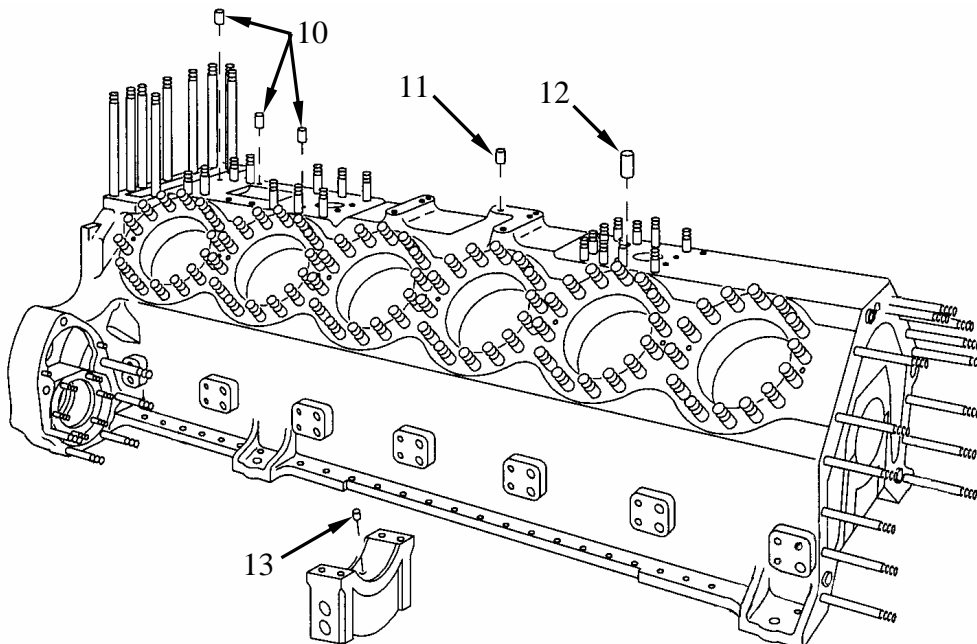


**REPAIR STANDARDS:**

Location	Point of Measurement	Size and Fit of New Parts		Wear Limits
		min./max. [inches (mm)]		
A	Inside diameter of starter bearing bore in crank case	2.8346 (71.9984)	2.8353 (72.01662)	2.8356 (72.02424)
B	Inside diameter of generator bearing bore in crank case	2.8346 (71.9984)	2.8353 (72.01662)	2.8356 (72.02424)

**REPAIR**

1. Replace bent or otherwise damaged oil transfer tubes (10, 11).
2. Replace bent or otherwise damaged bushing (12) (WP 0028).
3. Replace loose or damaged dowel pins (13).

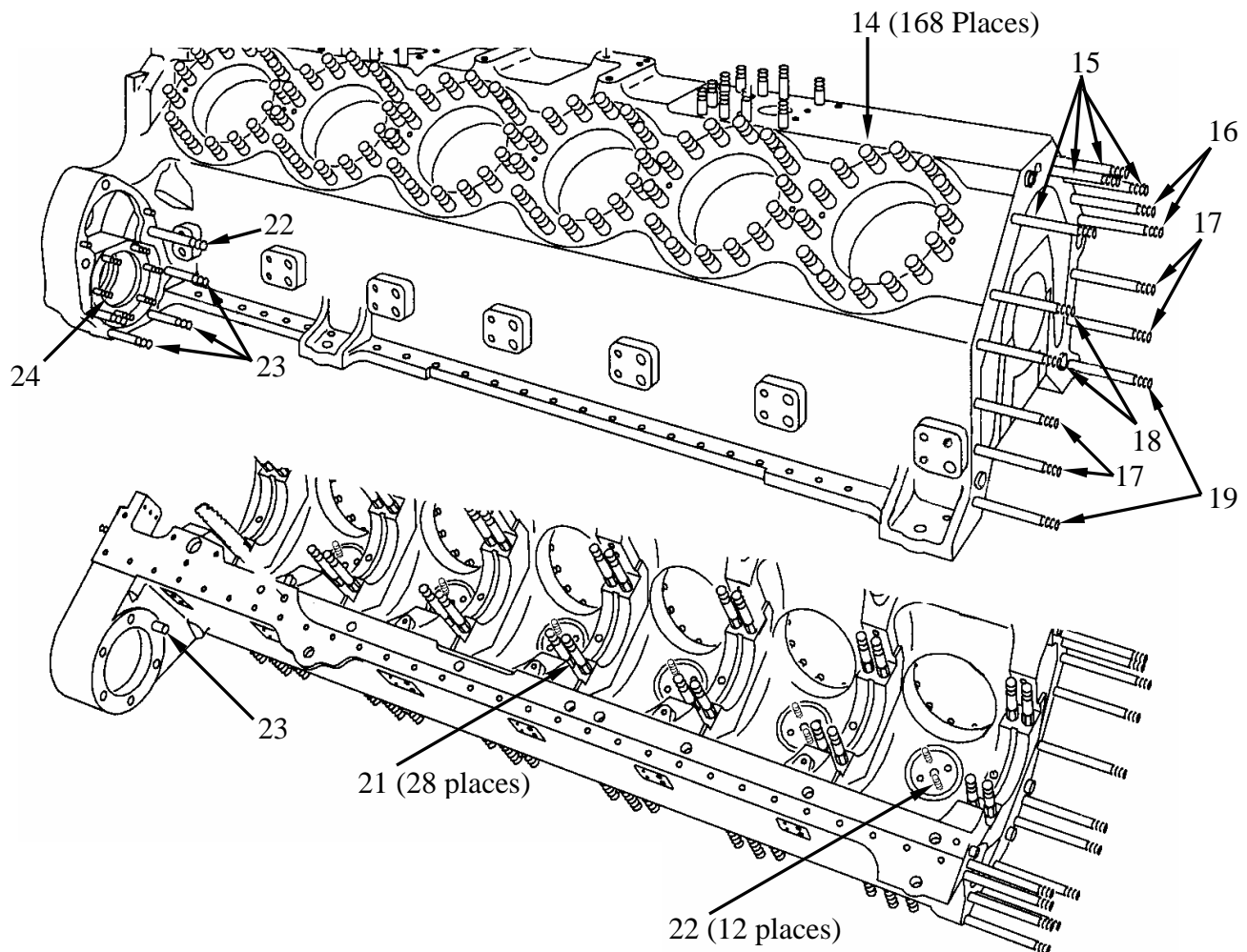


REPAIR (Continued)

4. Replace stripped, bent, or otherwise damaged studs (14 through 23).

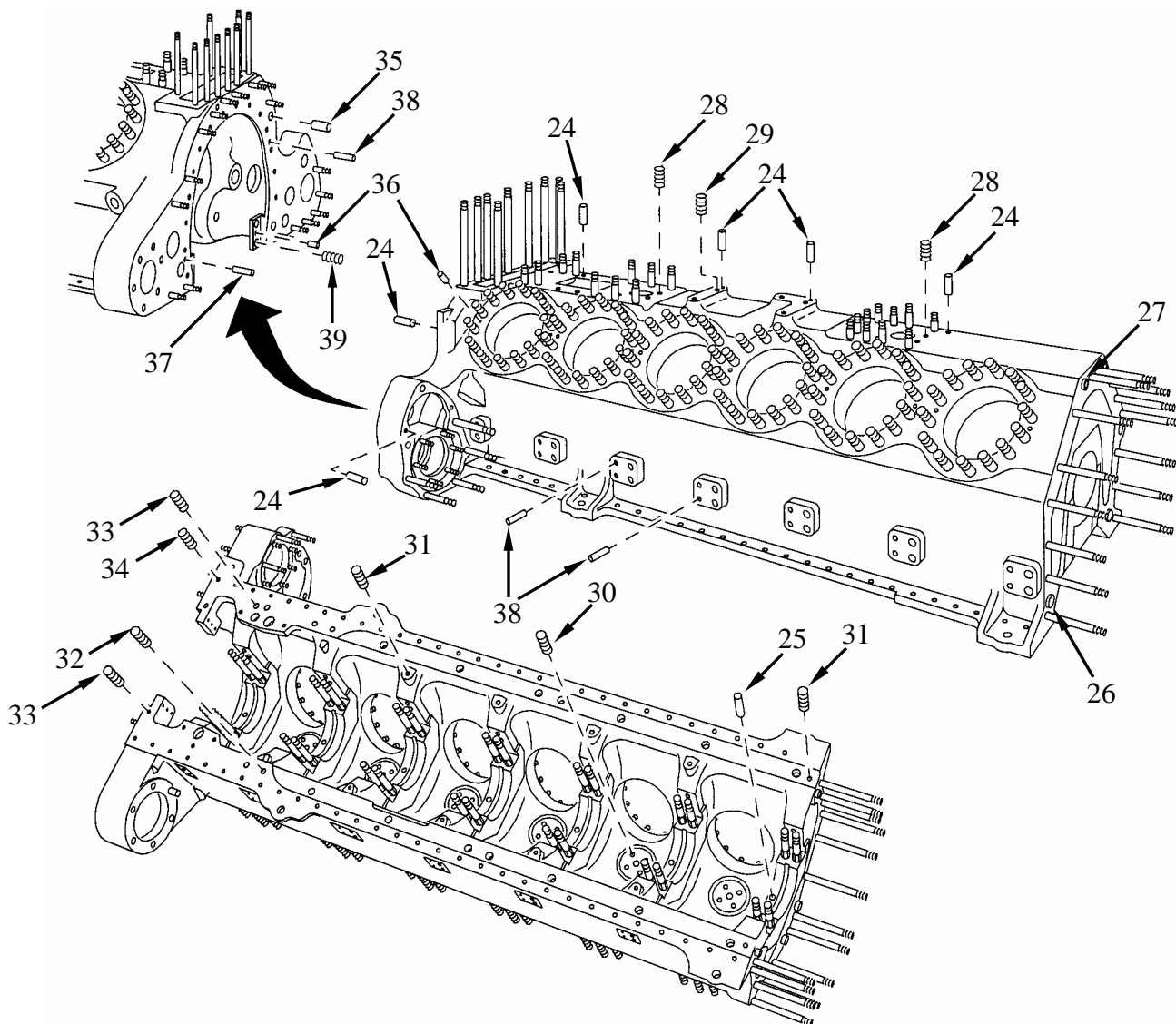
a. Refer to work package 0028 for procedure and to the following table for height settings.

Location	Setting Height	Quantity Required	Stud Size and Length
14	15/16	168	1/2-13 (63/64) X 1/2-20 (3/4) X 2-1/8
15	5-1/2	8 (6 on 2DR)	3/8-16 (1) X 3/8-24 (1-3/16) X 6-1/4
16	5-1/16	4	3/8-16 (27/32) X 3/8-24 (1) X 6
17	5-1/4	2 (4 on 2DR)	3/8-16 (3/4) X 3/8-16 (1) X 5-7/8
18	4-19/32	1	5/8-11 (1-11/32) X 5/8-18 (29/32) X 5-1/2
19	2-1/2	4	3/8-16 (15/16) X 3/8-24 (11/16) X 3-1/8
20	1/2	6	5/16-18 (1/2) X 5/16-24 (7/16) X 1
21	6-5/64	28	9/16-12 (1-3/8) X 9/16-18 (1-13/64) X 8-3/4
22	17/32	12	5/16-18 (19/32) X 5/16-24 (17/32) X 1-1/8
23	15/16	1	7/16-14 (1) X 7/16-20 (3/4) X 1-3/4



**REPAIR (Continued)**

5. Replace loose or damaged pins (24, 25) (WP 0028, Standard Maintenance Instructions).
6. Replace damaged or bent oil transfer tubes (26, 27) (WP 0028).
7. Replace defective screw thread inserts (28 through 34) (WP 0028).
8. Replace loose or damaged dowel pins (35, 36, 37) (WP 0028).
9. Replace defective screw thread inserts (38, 39) (WP 0028).

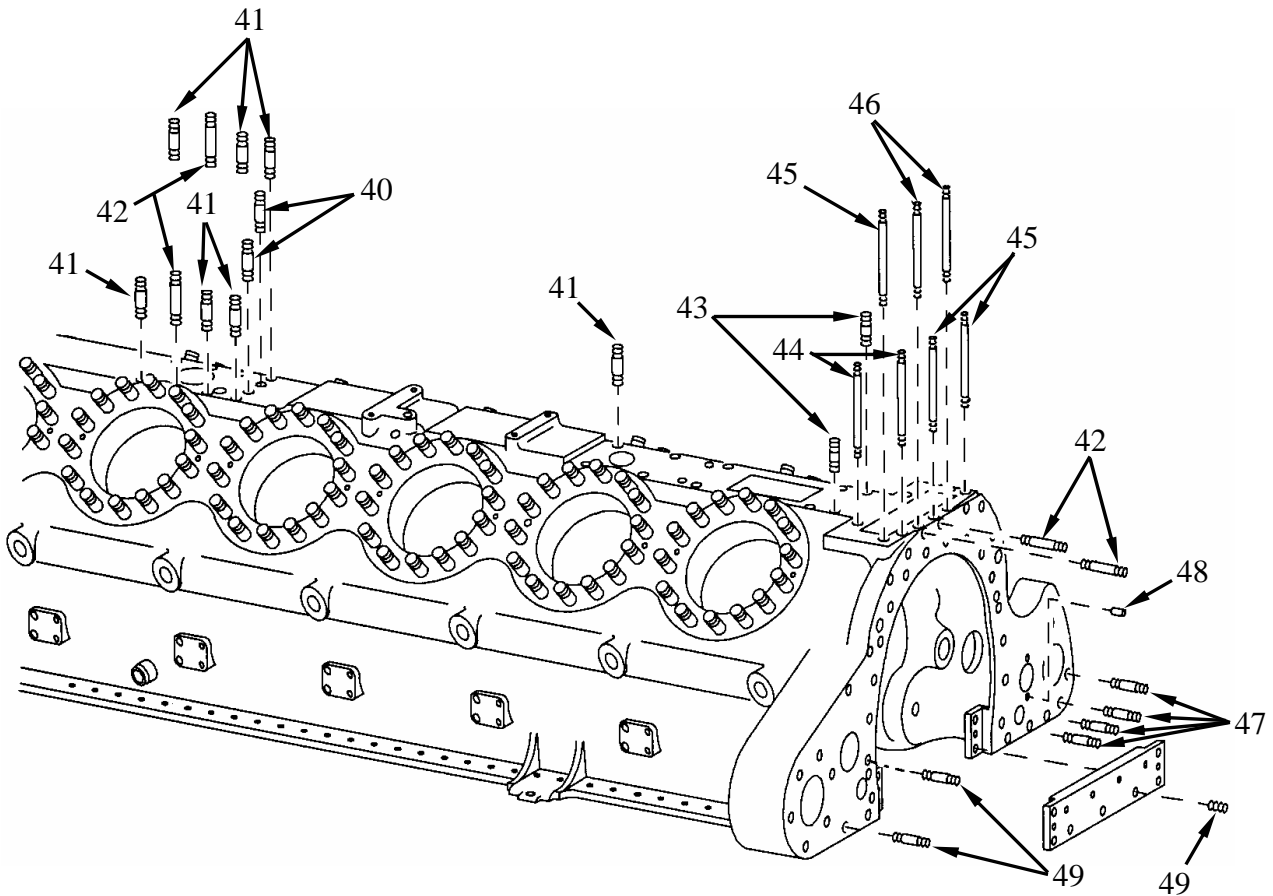


REPAIR (Continued)

10. Replace stripped, bent, or otherwise damaged studs (40 through 49).

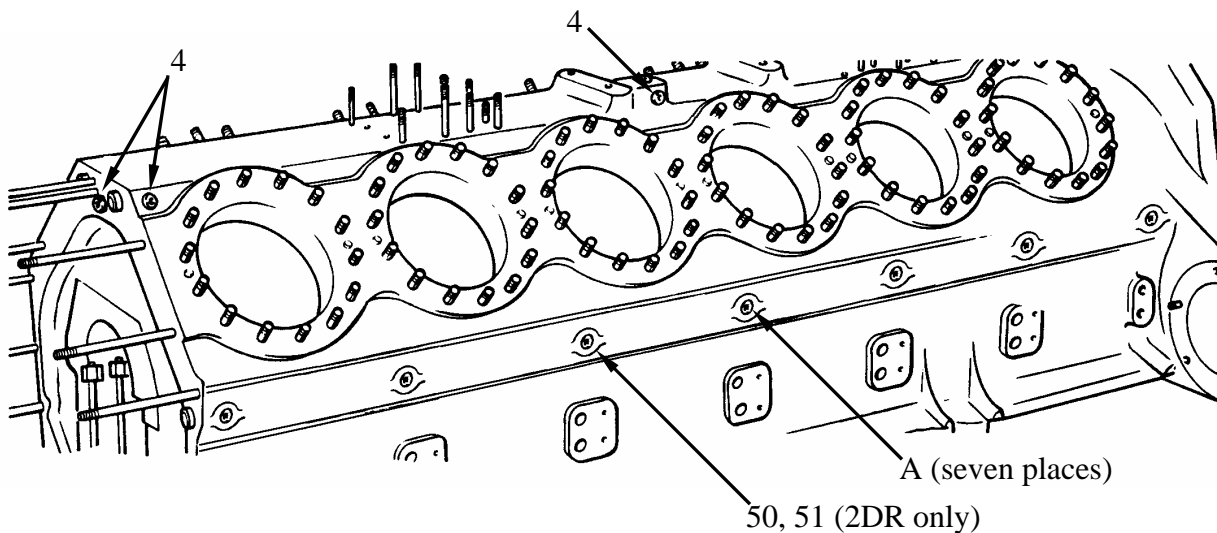
- a. Go to work package 0028 for procedure.
- b. Refer to the following table for stud size and height settings.

Callout #	Setting Height	Quantity Required	Stud Size and Length
40	31/32	4	3/8-16 (27/32) X 3/8-24 (7/8) X 1-3/4
41	1-5/8	12	3/8-16 29(32/) X 3/8-24 (11/16) X 2-1/4
42	2-29/64	4	3/8-16 (15/16) X 3/8-24 (13/16) X 3-1/4
43	1-7/32	2	3/8-16 (15/16) X 3/8-24 (13/16) X 2
44	8-5/16	4	3/8-16 (15/16) X 3/8-24 (13/16) X 9-1/8
45	6-1/8	3	3/8-16 (15/16) X 3/8-24 (16/3/16) X 6-7/8
46	5-7/16	2	3/8-16 (15/16) X 3/8-24 (13/16) X 6-1/4
47	1-11/32	4	7/16-14 (1) X 7/16-20 (3/4) X 2-1/4
48	9/16	4	5/16-18 (19/32) X 5/16-24 (17/32) X 1-1/8
49	1-1/8	15	1/2-13 (13/16) X 1/2-20 (15/16) X 2-1/4

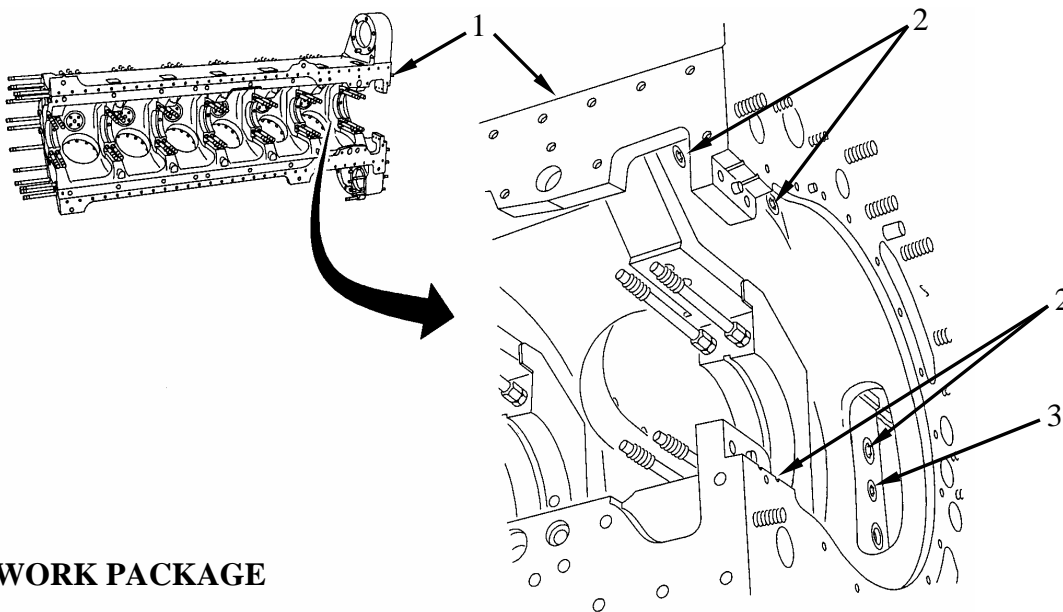


**ASSEMBLY**

1. Install oil gallery pipe plugs and/or fitting using Teflon pipe sealant.
  - a. There are seven main gallery ports (A) along the right side of crankcase.
  - b. On engine models 2CA and 2DA, install pipe plugs in all seven ports (A).
  - c. On engine model 2DR, install bushing (50) and 90-degree fitting (51) in port as illustrated. Orient fitting (51) so that outlet points towards damper end of crankcase. Install pipe plugs in remaining ports (A).
2. Install three pipe plugs (4) into crankcase as illustrated using Teflon pipe sealant.



3. Install five pipe plugs using Teflon pipe sealant.
  - a. On inside of crankcase (1) at the flywheel end install four main oil gallery pipe plugs (2), and one fan tower drain pipe plug (3).



**END OF WORK PACKAGE**

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**CRANKSHAFT MAIN BEARINGS INSPECTION**

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0138 00

**THIS WORK PACKAGE COVERS:**Inspection

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

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Jackscrew (crankcase spreading tool)  
(item 110, WP 0176)  
Mechanical puller adapter (item 2, WP 0176)  
Micrometer caliper set, inside (item 16, WP 0176)  
Micrometer caliper set, outside  
(item 17, WP 0176)  
Slide hammer puller assembly (item 88, WP 0176)  
Torque wrench, 0-175 foot pound  
(item 127, WP 0176)

**Expendable Materials:**

Lubricating oil, engine (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)  
Prussian blue paste (item 25, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Crankshaft removed (WP 0139)

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**INSPECTION****CAUTION**

**Main bearing halves (used or new) must be inspected according to procedures in this work package. Failure to comply may result in premature failure of engine.**

**NOTE**

**Used crankshaft main bearing halves were and removed and marked when the crankshaft was removed (WP 0139).**

**CAUTION**

**Main bearing halves should be installed in their original location when they are reused. Use new bearings when a visual inspection indicates bearings are unserviceable. Use only new or serviceable bearings for main bearing bore check.**

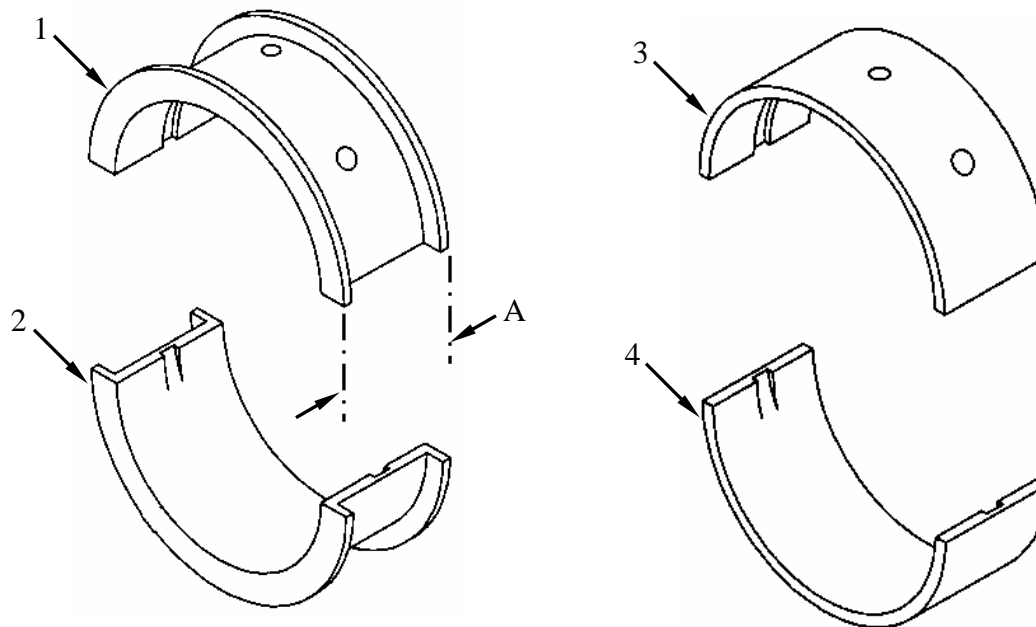
**INSPECTION (Continued)**

1. Visually inspect used main bearing halves (1, 2, 3, and 4) to the following table. If any bearing is questionable, replace it.

Basis for Bearing Rejection	Acceptable Bearing Flaws
Separation of bearing metal, or signs of possible separation.	Fine scratches on bearing surface.
Pitting or any other form of destruction to bearing surface.	Minute pieces of metal and dirt particles embedded in bearing surface with a concentration of less than 5 percent. (Do not attempt to remove such particles.)
Raised metal at edges of scratches.	
Pieces of metal or dirt particles embedded in bearing surface with a concentration of 5 percent or more of the surface area.	

2. Measure outside width (A) of main thrust bearing (1, 2) using micrometer (item 17, WP 0176). Replace bearings that do not meet the following limits:

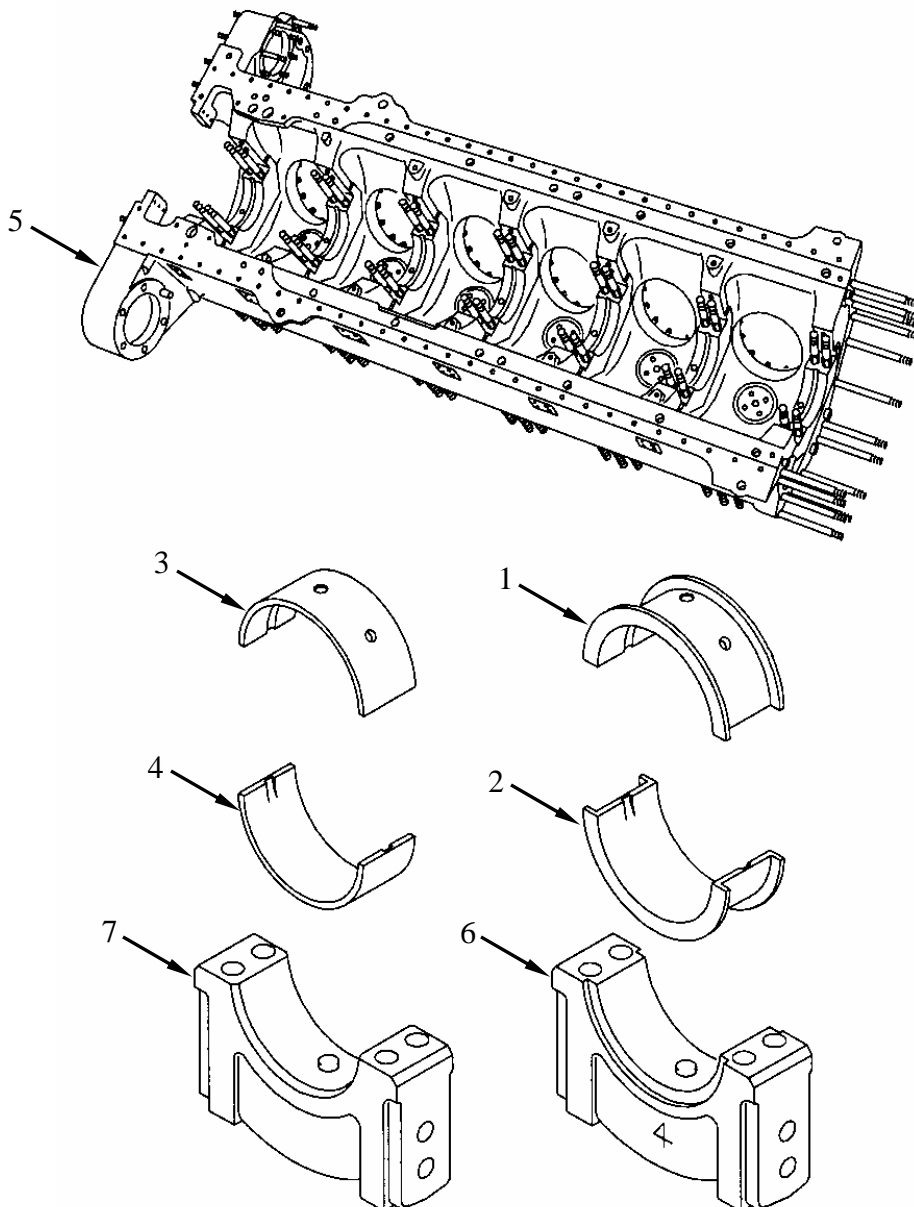
Point of Measurement	Sizes and Fits of New Parts		Wear Limits
	inches (mm)		
A (Outside width of main thrust bearing)	2.4860 (63.1444)	2.4880 (63.1952)	2.4840 (63.0936)





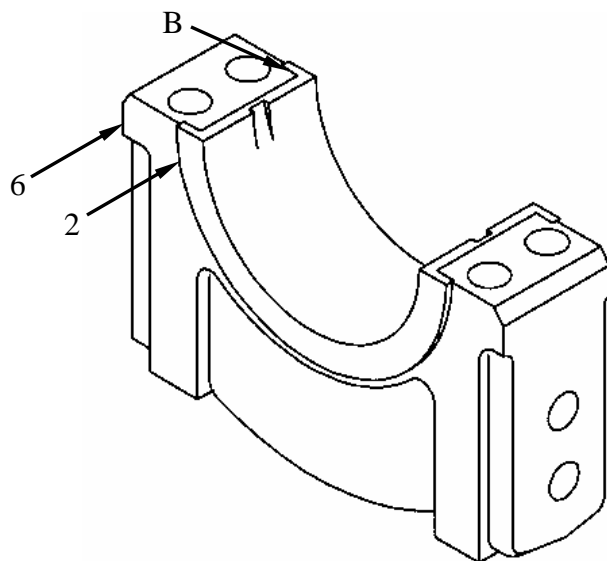
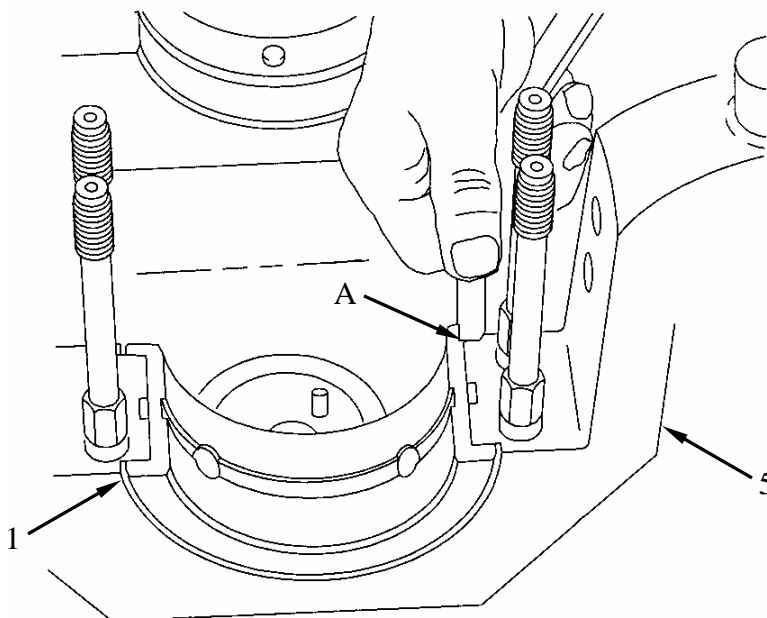
**INSPECTION (Continued)**

3. Spread a thin coat of Prussian blue (item 25, WP 0173) over backs of upper and lower main bearing halves (1, 2, 3, 4). Contact pattern will be checked after inside diameter of installed bearings has been checked.
4. Install bearings (1, 2, 3, 4) in their original locations.
  - a. Install bearings (1, 3) in crankcase (5).
  - b. Install bearing (2) in center (thrust) main bearing cap (6).
  - c. Install bearings (4) in main bearing caps (7).



**INSPECTION (Continued)**

5. Check side clearance of center main bearing halves (1,2).
  - a. Using a feeler gauge, check clearance between bearing (1) flange and number 4 main bearing journal in crankcase (5).
  - b. Using a feeler gauge, check clearance between bearing (2) flange and number 4 main bearing cap.
  - c. Replace bearings that do not measure within 0.004 to 0.008-inch (0.1016-0.2032 mm) clearance.

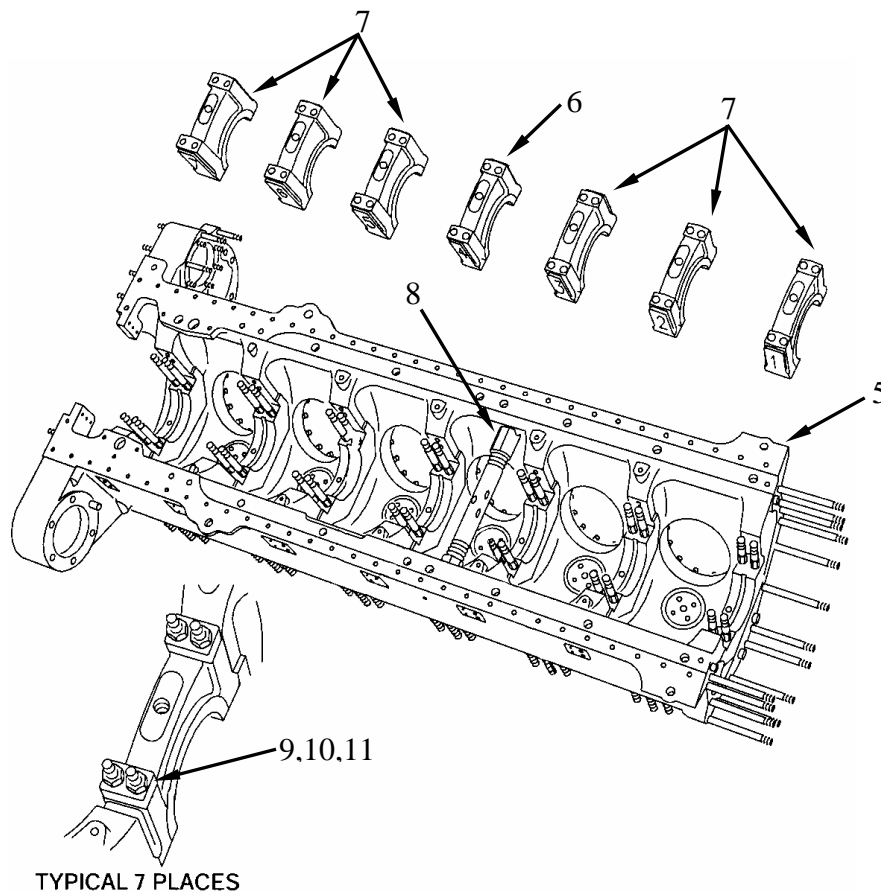


## INSPECTION (Continued)

**CAUTION**

**The main bearing caps and main bearing halves must be installed in their original position according to location number identification on the cap and bearing half. The side of each main bearing cap identified as "fly end" must be installed toward rear of crankcase (flywheel end).**

6. Install main bearing caps (6, 7).
  - a. Coat mating surfaces of main bearing caps (6, 7) and machined surfaces of crankcase (12) with lubricant (item 21, WP 0173).
  - b. Install main bearing caps (6, 7) (with bearing halves installed) on studs in crankcase.
  - c. Use jackscrew (crankcase spreading tool) (8) (item 110, WP 0176) to spread crankcase just enough so that each bearing cap (6, 7) will slide into position. Jackscrew must be repositioned for each bearing cap location.
  - d. Remove jackscrew (8).
  - e. Apply Lubriplate (item 23, WP 0173) to threads of 28 studs (9), 14 washers plates (10), and 28 slotted nuts (11).
  - f. Install washers (10) and nuts (11). Finger tighten nuts (11) only at this time.

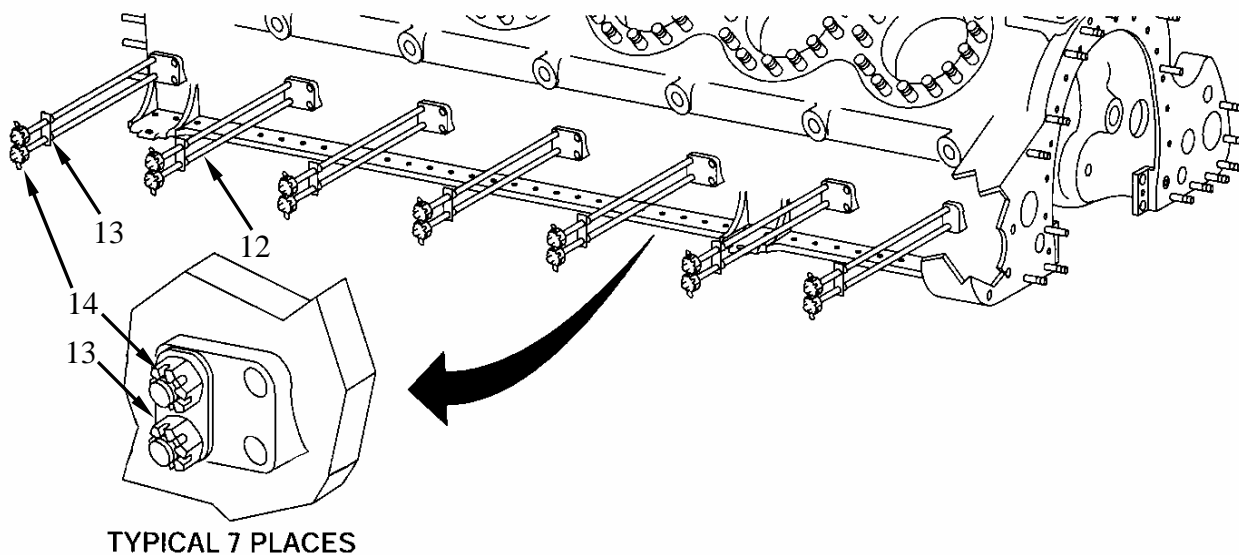


## INSPECTION (Continued)

## NOTE

To avoid interference with the starter driven gear shaft, it is necessary to install lower number 7 tie rod from the right side of block. Care should be taken so that tie rods extend equally on both sides of block.

7. Install fourteen tie rods (12).
  - a. Install seven washer plates (13) and slotted nuts (14) onto tie rods (12).
  - b. Push tie rods (12) with washer plates and nuts (14) through crankcase (5).
  - c. Install remaining seven washer plates (13) and slotted nuts (14) onto opposite end of tie rods (12). Finger tighten only at this time.

**CAUTION**

The procedure for tightening main bearing cap nuts incorporates both torque and stud stretch. The untorqued height of the studs must first be measured, then the studs are torqued incrementally to a final value, and finally the stretch of the stud is measured. Stud stretch is defined as the difference between the untorqued height and the torqued height of the studs.

Any stud that exceeds the maximum stretch (0.024 inch, or 0.6096 mm) prior to obtaining the minimum torque (58 foot-pounds, or 79 N•m) must be replaced.

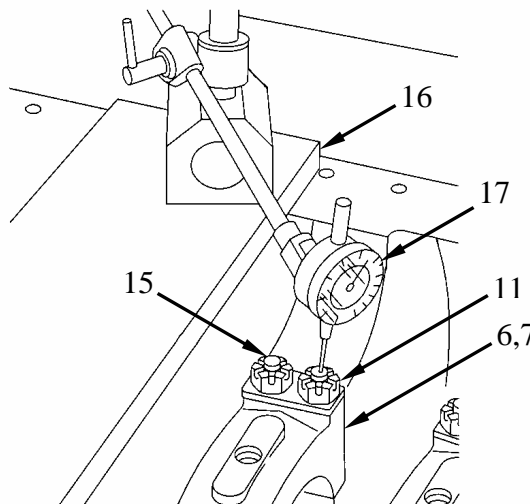
Any stud that reaches maximum torque (69 foot-pounds, or 94 N•m) prior to obtaining minimum stretch (0.019 inch, or 0.4826 mm) must be replaced.

Do not disturb dial indicator setting or position used for checking stud stretch. Incorrect stretch measurement will result if indicator setting is changed - which could result in premature failure of engine parts.

**INSPECTION (Continued)**

## 8. Tighten main bearing cap (6,7) nuts (11).

- a. Make sure that nuts (11) are loose, then measure and record the height of four main bearing cap (7) studs (15) at number 4 location. Use a flat surface plate (16) and dial indicator (17) (item 65, WP 0176).



- b. At number 4 main cap (7), in a crosshatch pattern, torque-tighten four slotted nuts (11) to 42 foot-pounds (57 N•m) using torque wrench (item 127, WP 0176). Using the same crosshatch pattern, torque-tighten the same four nuts (11) to 58 foot-pounds (79 N•m).

- c. Using a flat surface plate (16) and dial indicator (17) (item 65, WP 0176), measure and record the height of four main bearing cap studs (15) at number 4 location. Subtract the first reading from the second, this is the stud stretch.

- d. Tighten nuts (11) to attain a stretch of 0.019 to 0.024 inch (0.4826 to 0.6096 mm).

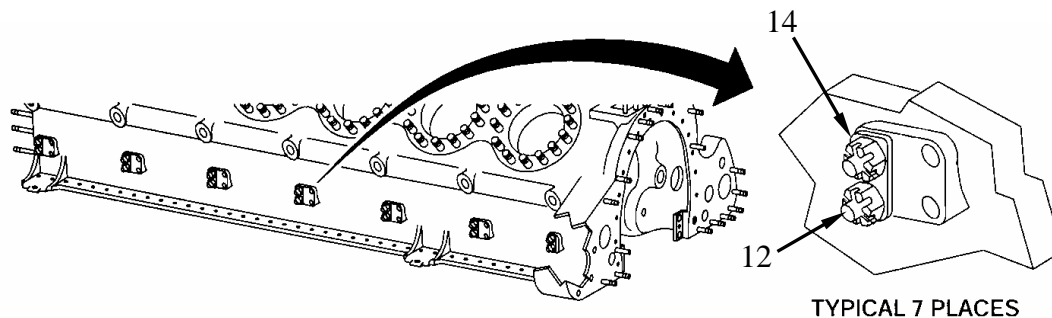
- e. Any stud that exceeds the maximum stretch (0.024 inch, or 0.6096 mm) prior to the nut obtaining minimum torque (58 foot-pounds, or 79 N•m) must be replaced.

- f. Any stud that its nut reaches maximum torque (69 foot-pounds, or 94 N•m) prior to obtaining minimum stretch (0.019 inch, or 0.4826 mm) may be loosened and tried again. Loosening of a single nut is not allowed; all nuts on that bearing cap must be loosened. If the condition exists after the second try, the stud must be replaced.

- g. Repeat for remaining caps in the following order: 3, 5, 2, 6, 1, and 7.

**INSPECTION (Continued)**

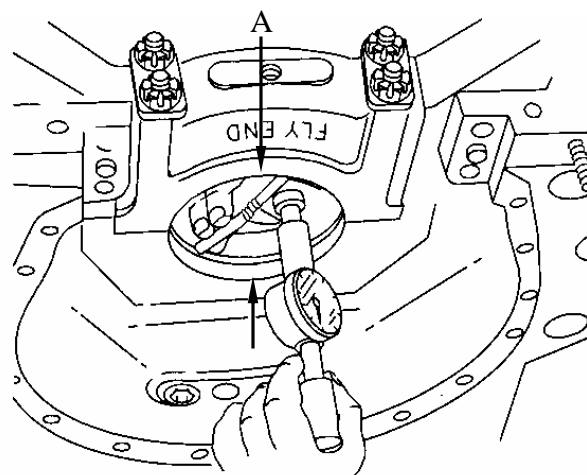
9. Torque-tighten tie rod (12) slotted nuts (14).
  - a. With the aid of a helper holding slotted nuts (14) on the opposite side of crankcase, torque-tighten 14 slotted nuts (14) on tie rods (12) to 53 foot-pounds (72 N•m).



**NOTE**

**New bearings must also be checked to assure they meet the following limits.**

10. Measure the inside diameter (A) of the main bearing bore with bearing halves in place at all seven main bearing locations, 90 degrees to the split line. Replace bearings that do not meet the following limits:



Bearing	Sizes and Fits of New Parts		Wear Limits
	inches (mm)		
Standard size	4.2520 (108.0008)	4.2539 (108.0491)	4.2549 (108.0745)
0.003 (0.0762) undersize	4.2490 (107.9246)	4.2509 (107.9729)	4.2519 (107.9983)
0.010 (0.254) undersize	4.2420 (107.7468)	4.2439 (107.7951)	4.2449 (107.8205)

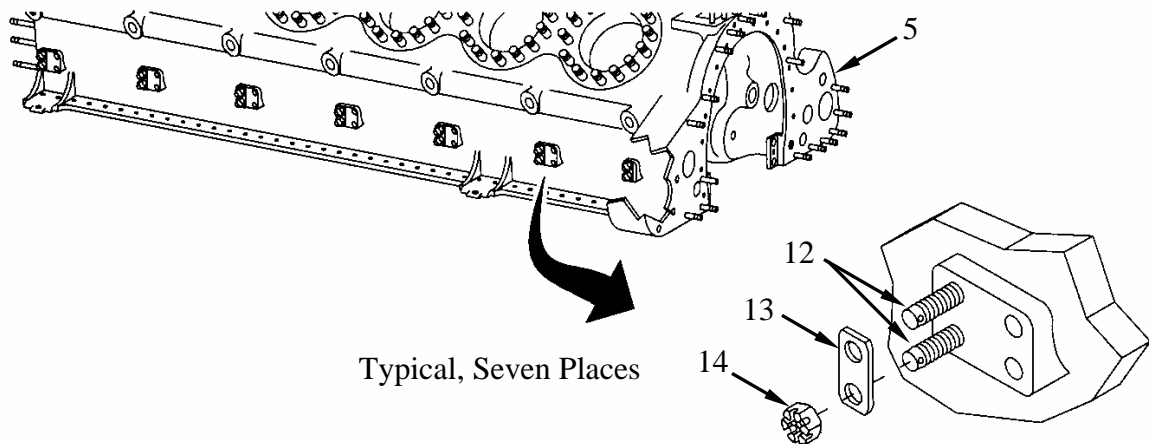
INSPECTION (Continued)

11. Remove tie rods (12) from crankcase (5).

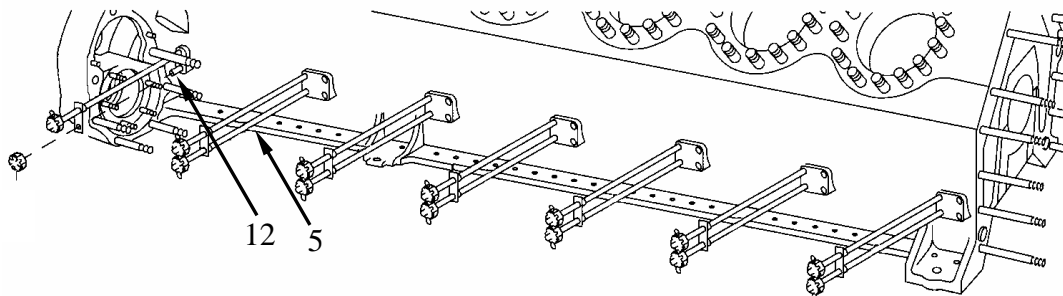
NOTE

**For ease of disassembly, tie rods are pushed through the crankcase from the right side of the crankcase except for the lower tie rod nearest the flywheel end of the crankcase (number 7 main bearing). This tie rod must be pushed through from the left side due to interference of the starter driven gear-shaft.**

- a. Have helper hold slotted nuts on opposite side of crankcase as necessary to keep tie rods (12) from turning while removing nuts (14).
- b. Remove six washer-plates (13) from right side of crankcase (5).



- c. Using a suitable brass rod, push thirteen tie rods (12) through the crankcase (5) and remove from the left side.
- d. Using a suitable brass rod, push the lower tie rod (12), at number 7 main bearing, through the crankcase (5) and remove from the right side.



## INSPECTION (Continued)

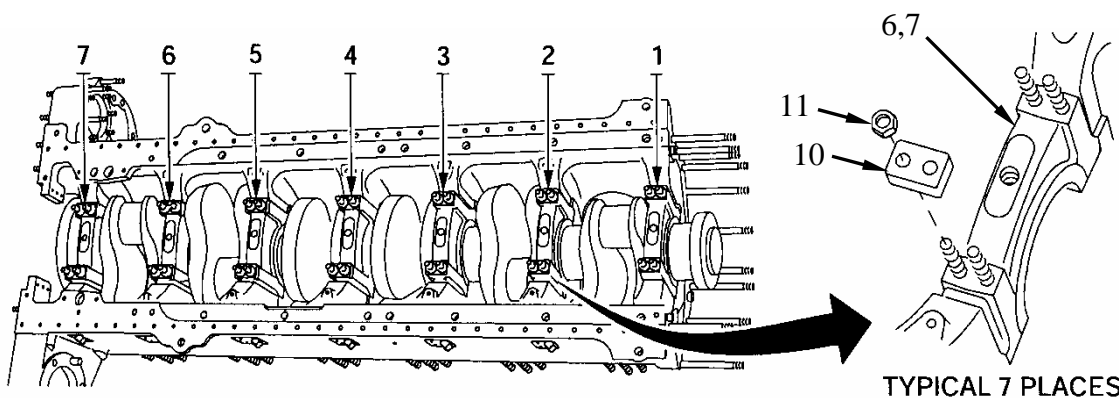
**CAUTION**

The main bearing caps are marked 1 through 7 (front to rear) to identify their locations. Identifying numbers also appear on bearing web inside crankcase. The caps are not interchangeable with each other and must be returned to their original positions during installation. Failure to comply may result in premature engine failure.

**NOTE**

The removal procedure for any one main bearing cap is identical to any other main bearing cap, only 6 and 7 are described.

12. Remove main bearing cap (6, 7).
  - a. Remove eight slotted nuts (11).
  - b. Remove four washer-plates (10).





**INSPECTION (Continued)**

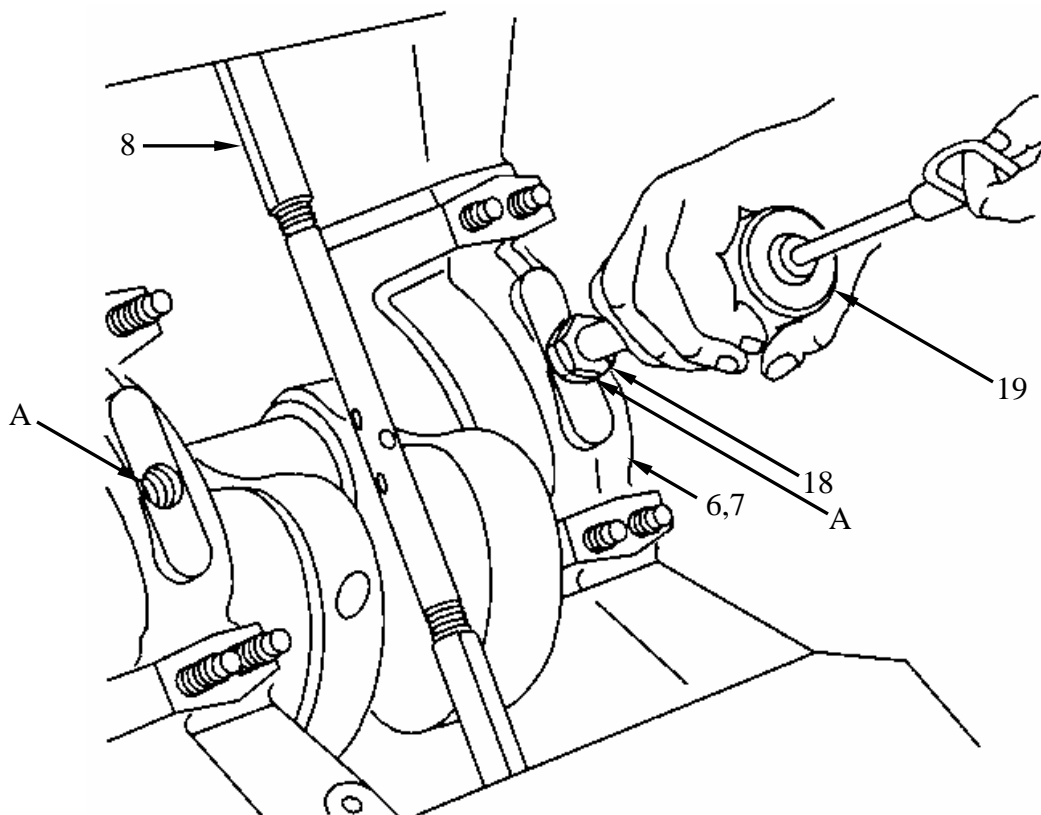
12. Remove main bearing caps (6, 7) (Continued).

- c. Install jackscrew (crankcase spreading tool) (8) (item 110, WP 0176) midway between two main bearing caps (6, 7) and tighten just enough to release pressure of crankcase from ends of main bearing caps.
- d. Install mechanical puller adapter (18) (item 2, WP 0176) onto slide hammer (19) (item 88, WP 0176).
- e. Install adapter (18) into threaded hole (A) provided in main bearing caps (6, 7).

**CAUTION**

**Use caution when removing main bearing caps so that bearing half does not accidentally drop out. Bearing halves can be easily damaged.**

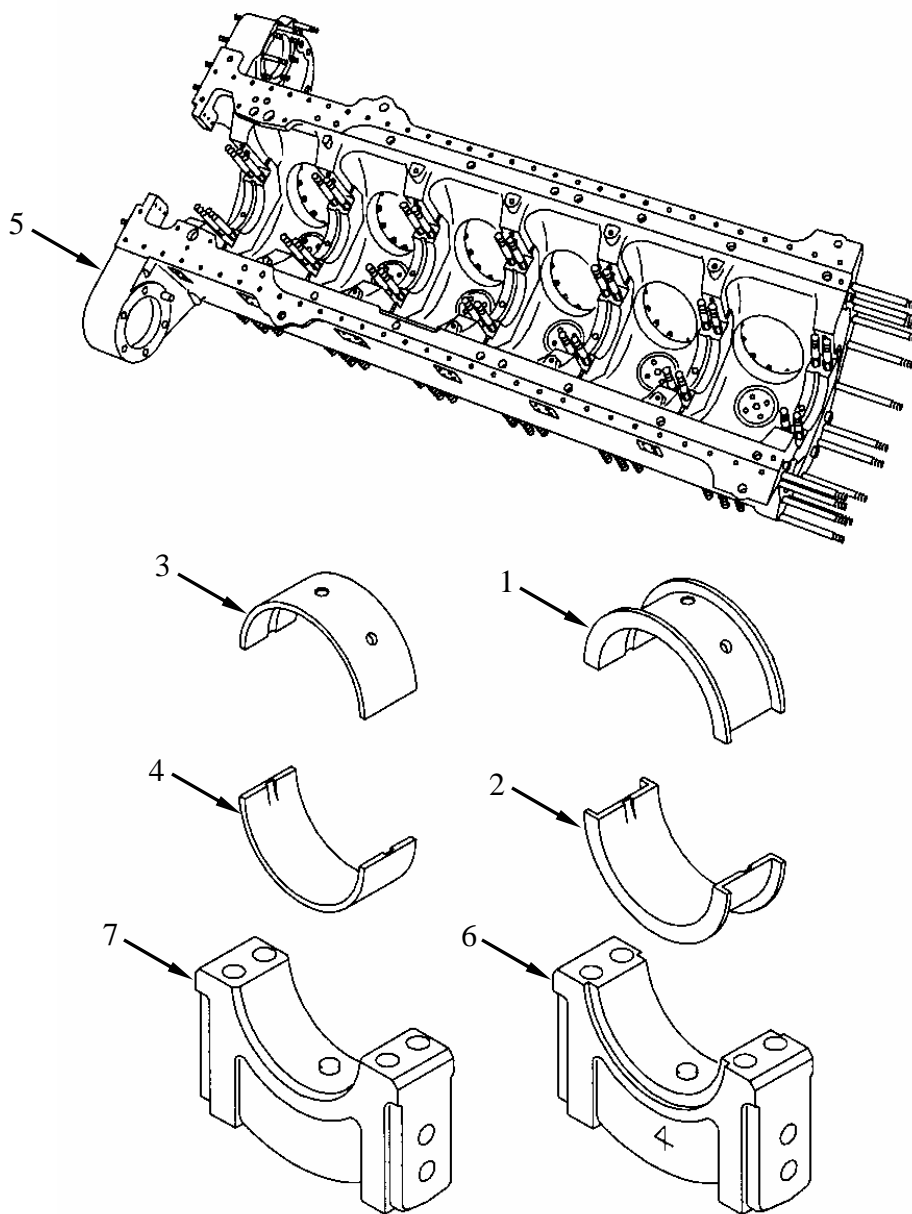
- f. Gently tap main bearing caps (6, 7) free of crankcase using the slide hammer (19).
- g. Repeat for remaining caps.
- h. Remove jackscrew (8).



**INSPECTION (Continued)**

13. Inspect main bearing (1, 2, 3, 4) contact surfaces.

- a. Remove bearing halves (1, 2, 3, 4) from cap (6) and crankcase (5).
- b. Inspect bearing half backs as indicated by Prussian blue transfer.
- c. Replace bearings halves that do not make 75 percent contact with bearing bores. Repeat steps 1-12 with new bearings.



**END OF WORK PACKAGE**

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**CRANKSHAFT REPLACE/REPAIR**

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**0139 00****THIS WORK PACKAGE COVERS:**Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

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

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Jackscrew (crankcase spreading tool) (item 110, WP 0176)  
Magnifier (item 73, WP 0176)  
Mechanical puller adapter (item 2, WP 0176)  
Micrometer caliper set, inside (item 16, WP 0176)  
Micrometer caliper set, outside (item 17, WP 0176)  
Probes, brass wire, 1/8-in. (item 13, WP 0176)  
Slide hammer puller assembly (item 88, WP 0176)  
Sling, crankshaft (item 26, WP 0176)  
Torque wrench, 0-175 foot pound (item 127, WP 0176)  
V-block (2) (item 131, WP 0176)

**Mandatory Replacement Parts:**

Bearing, half (item 339, WP 0175)  
Bearing, half (item 340, WP 0175)  
Bearing, half (item 341, WP 0175)  
Bearing, half (item 342, WP 0175)  
Bearing, half (item 343, WP 0175)  
Bearing, half (item 344, WP 0175)  
Bearing, half (item 346, WP 0175)  
Bearing, half (item 345, WP 0175)  
Bearing, half (item 355, WP 0175)  
Bearing, half (item 356, WP 0175)  
Bearing, half (item 357, WP 0175)  
Bearing, half (item 358, WP 0175)  
Pin, cotter (6) (item 49, WP 0175)  
Pin, cotter (28) (item 521, WP 0175)

**Expendable Materials:**

Cleaning compound, solvent (item 8, WP 0173)  
Crocus cloth (item 9, WP 0173)  
Lubricating oil, OE30 (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)  
Wire, non-electrical (item 44, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Oil pan assembly removed (WP 0152)  
Oil pressure compartment baffle removed (WP 0153)  
Crankshaft damper and oil filter housing removed (WP 0151)  
Crankshaft damper removed (WP 0140)  
Oil seal housing assembly removed (WP 0136)  
Crankshaft oil seal removed (WP 0136)  
Accessory drive spur gear removed (WP 0141)  
Cylinder assemblies removed (WP 0133)  
Connecting rod assemblies removed (WP 0143)

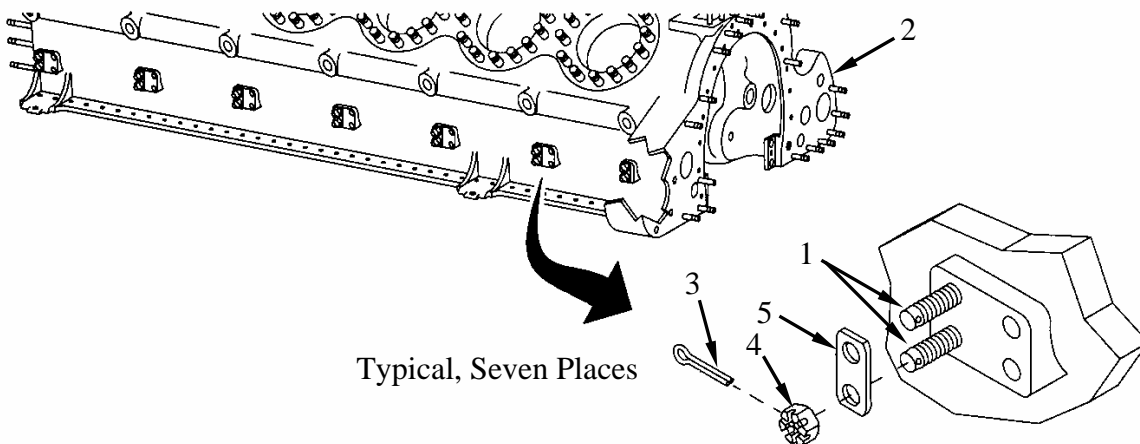
**REMOVAL**

1. Remove tie-rods (1) (through bolts) from crankcase (2).

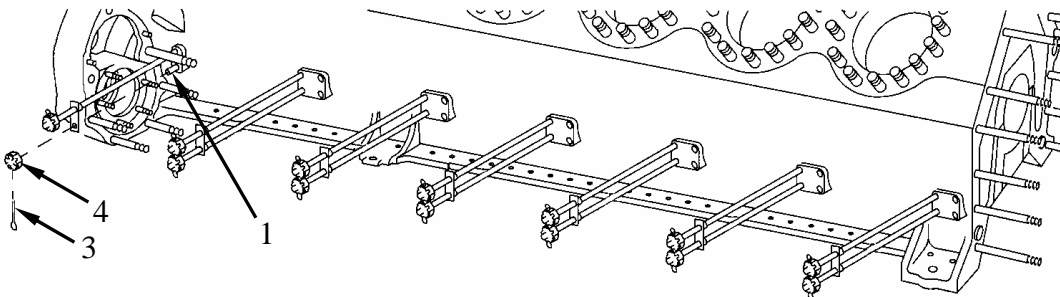
**NOTE**

**For ease of disassembly, tie-rods are pushed through the crankcase from the right side of the crankcase except for the lower tie-rod nearest the flywheel end of the crankcase (number 7 main bearing). This tie-rod must be pushed through from the left side due to interference of the starter driven gear shaft.**

- a. Remove thirteen cotter pins (3) and thirteen slotted nuts (4) from right side of crankcase. Have helper hold slotted nuts on opposite side of crankcase as necessary to keep tie-rods from turning while removing nuts. Discard cotter pins.
- b. Remove six washer-plates (5) from right side of crankcase.

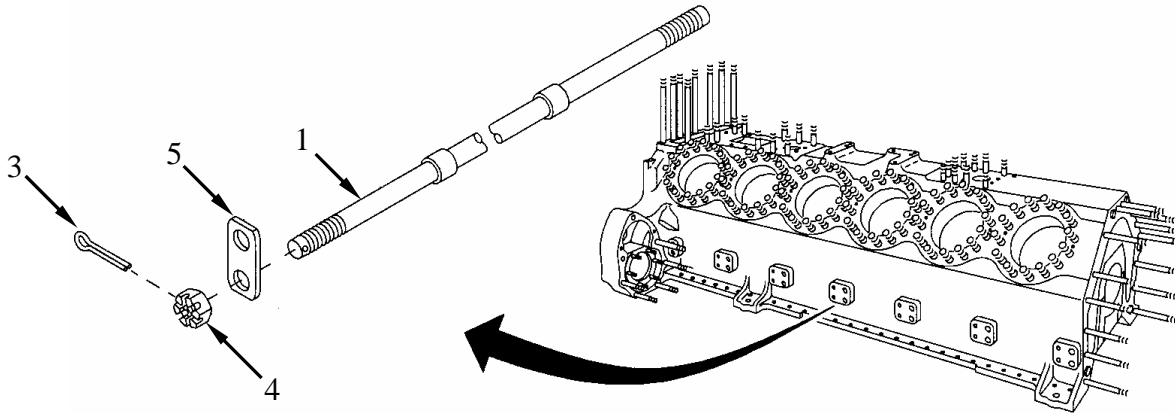


- c. Remove one cotter pin (3) and one slotted nut (4) from left side of crankcase at the lower tie-rod nearest the flywheel end of the crankcase. Discard cotter pin.
- d. Using a suitable brass rod, push thirteen tie-rods (1) through the crankcase and remove from the left side.
- e. Using a suitable brass rod, push the lower tie-rod (1) at number 7 main bearing through the crankcase and remove from the right side.



**REMOVAL (Continued)**

2. Separate cotter pins (3), slotted nuts (4), and washer-plates (5) from tie-rods (1). Discard cotter pins (3).



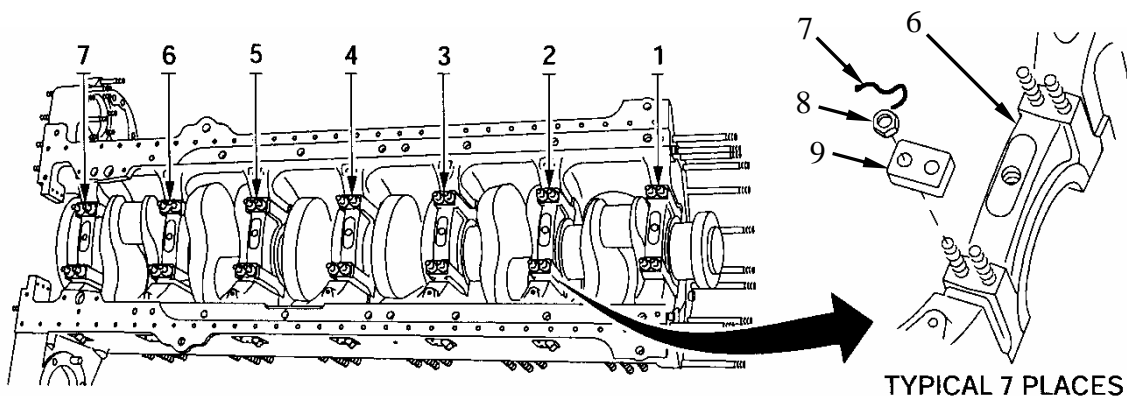
**CAUTION**

The main bearing caps are marked 1 through 7 (front to rear) to identify their locations. Identifying numbers also appear on bearing web inside crankcase. The caps are not interchangeable with each other and must be returned to their original positions during installation. Failure to comply may result in premature engine failure.

**NOTE**

The removal procedure for any one main bearing cap is identical to any other main bearing cap, only one is described.

3. Remove main bearing caps (6).
  - a. Remove lock wire (7) and four slotted nuts (8). Discard lock wire.
  - b. Remove two washer-plates (9).



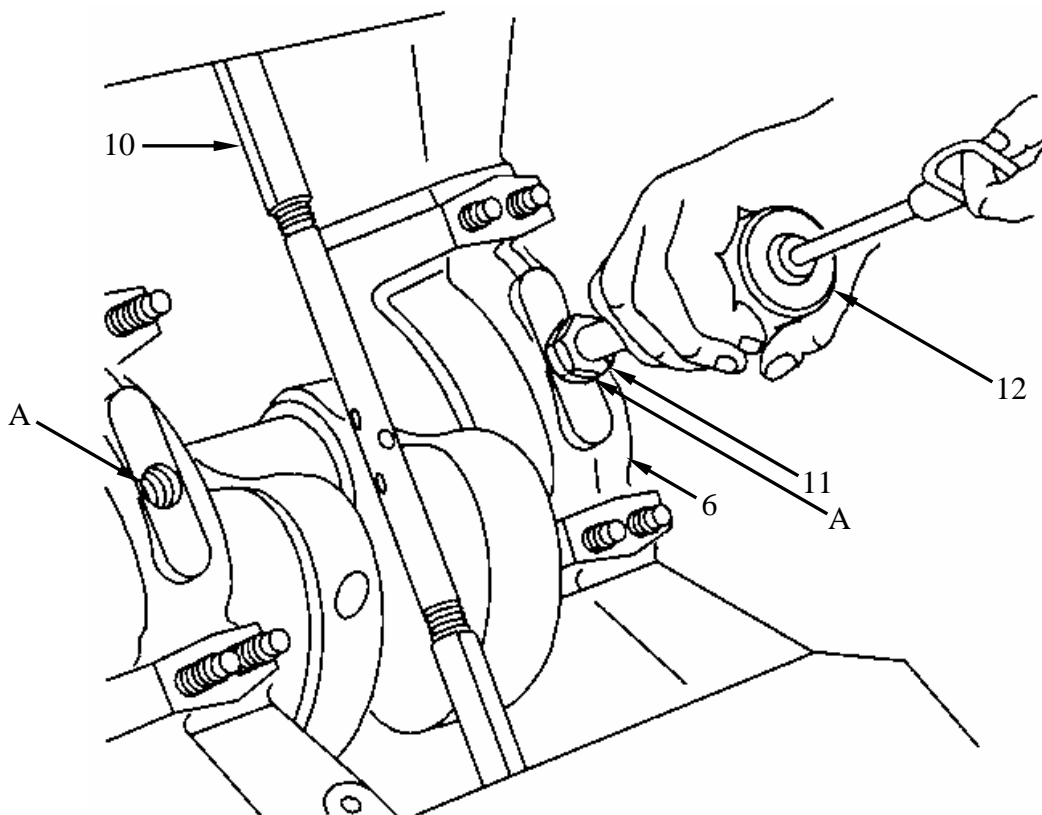
**REMOVAL (Continued)**

3. Remove main bearing caps (6) (Continued).
  - c. Install jackscrew (crankcase spreading tool) (10) (item 110, WP 0176) midway between two main bearing caps (6), and tighten just enough to release pressure of crankcase from ends of main bearing caps.
  - d. Install mechanical adapter (11) (item 2, WP 0176) onto slide hammer (12) (item 88, WP 0176).
  - e. Install mechanical adapter (11) into threaded hole (A) provided in main bearing cap (6).

**CAUTION**

**Use caution when removing main bearing caps so that bearing half does not accidentally drop out. Bearing halves can be easily damaged.**

- f. Gently tap the main bearing cap (6) free of the crankcase using the slide hammer (12).
- g. Repeat procedure for remaining main bearing caps (6).
- g. Remove crankcase spreading tool (10).

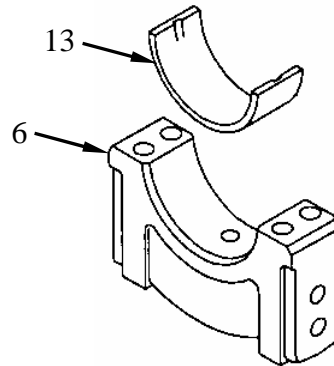


## REMOVAL (Continued)

**CAUTION**

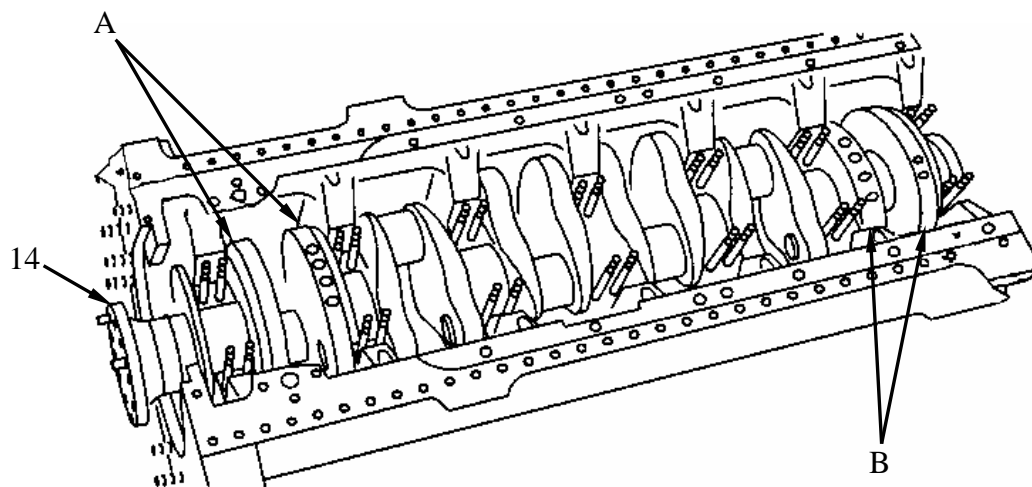
Do not use a scribe or other sharp instrument for marking bearing halves; use a grease pencil instead. Failure to comply may result in premature failure of bearing.

4. Mark lower half of main bearing.
  - a. Separate the lower main bearing half (13) from its bearing cap (6).
  - b. Using a shop rag and suitable cleaner, wipe back of bearing half.
  - c. Mark back of lower main bearing half (13) with its respective location using a grease pencil, for example "1 cap," "2 cap" and so on.

**CAUTION**

The crankshaft counterweights for connecting rod bearing journals 1R, 1L, 6R, and 6L must be in the up position so the crankshaft will clear the sides of the crankcase when it is removed or damage may occur.

5. Rotate crankshaft (14) until counterweights (A and B) are in the position shown.

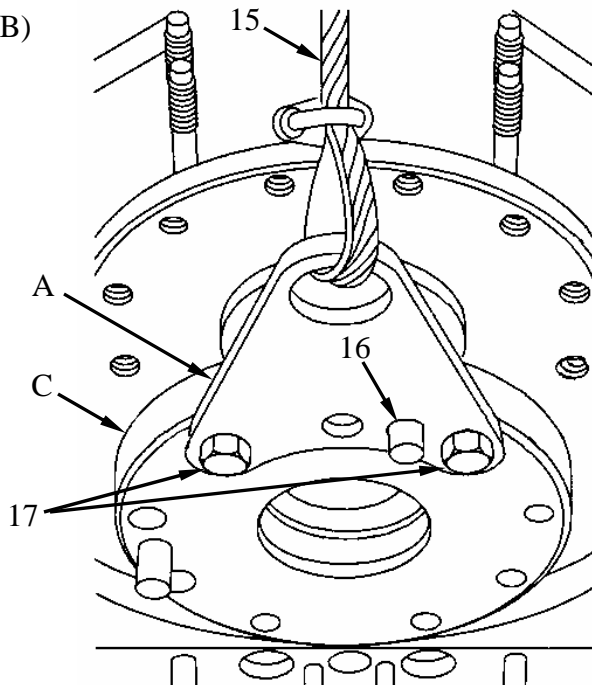


REMOVAL (Continued)

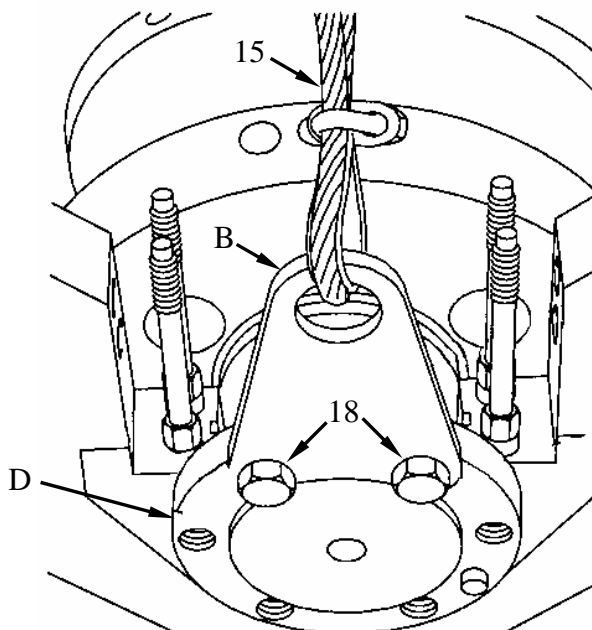
NOTE

The crankshaft sling (15) consists of a cable and two adapters. The adapter with the dowel pin hole attaches to the crankshaft flywheel flange. The other adapter attaches to the opposite end of the crankshaft.

6. Install sling (15) (item 26, WP 0176) adapters (A, B) onto crankshaft.
  - a. Install adapter (A) over flywheel flange dowel pin (16) and secure to flange (C) with two flywheel mounting bolts (17).



- b. Install sling (15) adapter (B) on damper flange (D) of crankshaft and secure with two damper mounting bolts (18).





## REMOVAL (Continued)

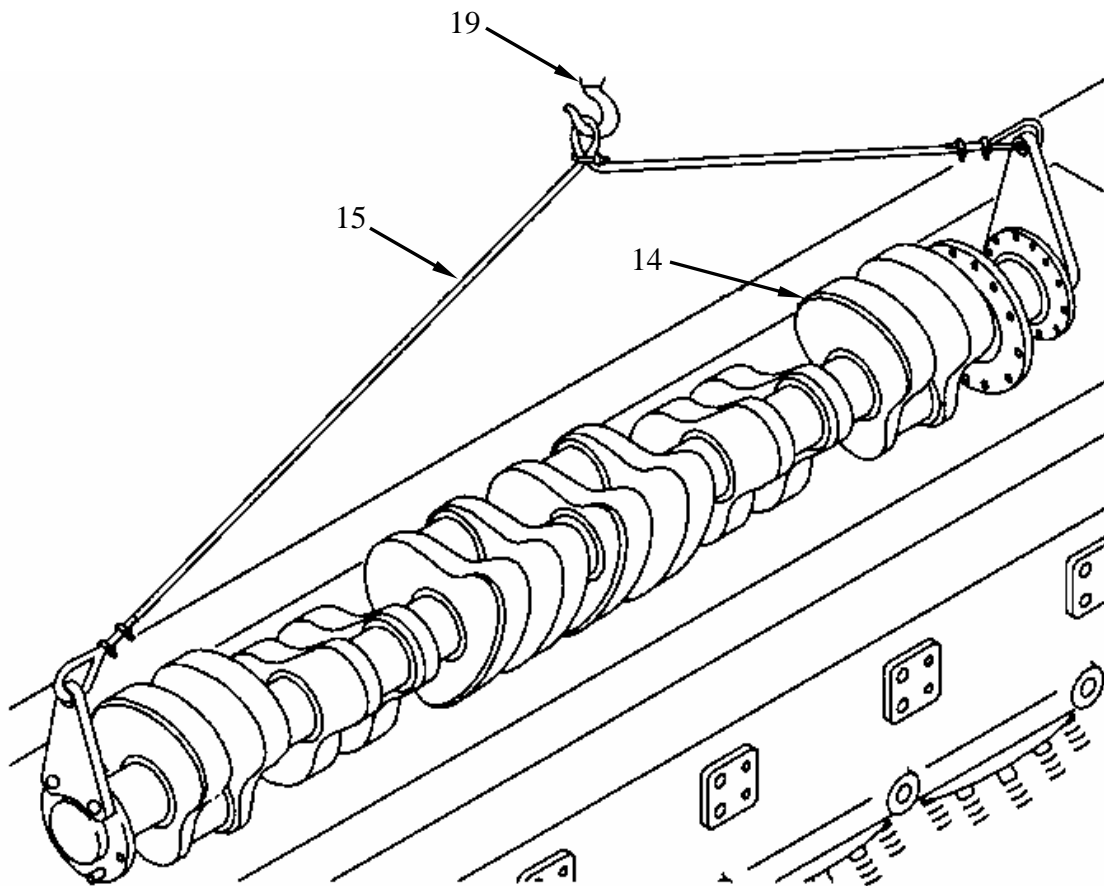
**WARNING**

Crankshaft is heavy, take care when removing crankshaft not to pinch fingers or drop crankshaft. Failure to comply could lead to personal injury.

**CAUTION**

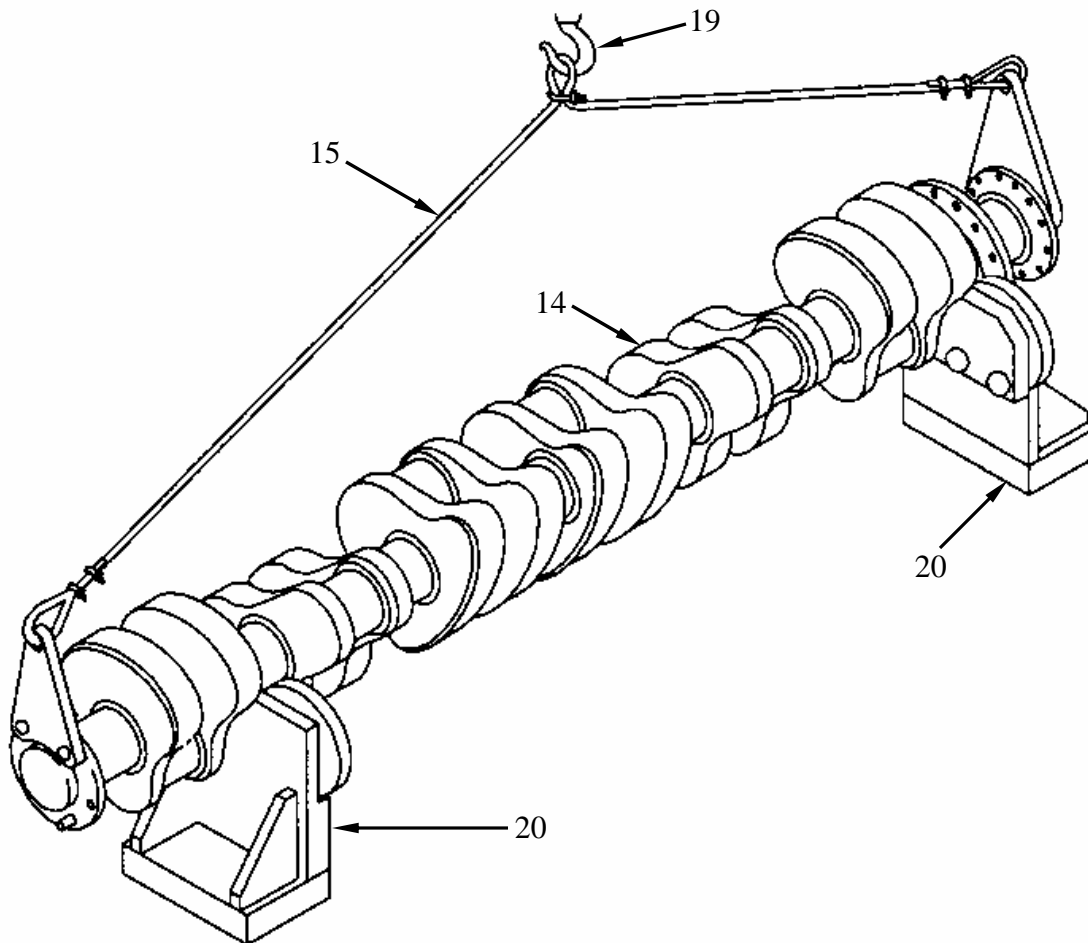
Exercise care when removing crankshaft to prevent damage to the main bearing cap studs and crankshaft journals. Before removing crankshaft, place cardboard, plastic tubes, or duct tape over main bearing studs for protection. Failure to comply could result in damage to studs or journals.

7. Attach sling (15) to hoist (19) and remove crankshaft (14).

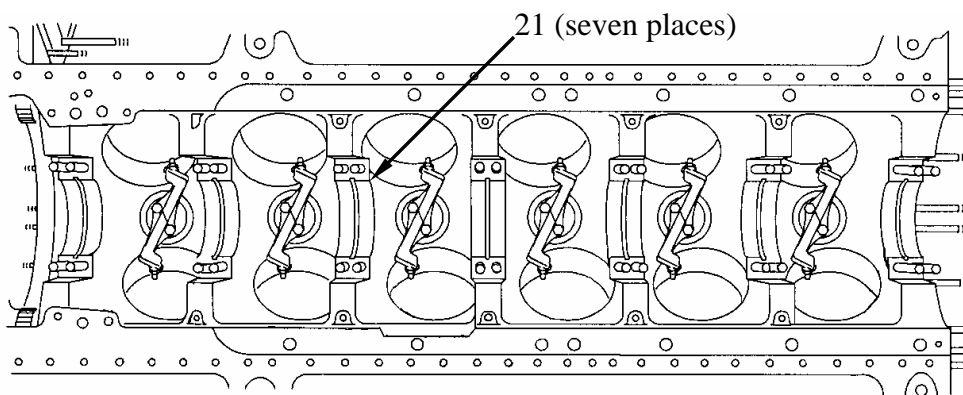


**REMOVAL (Continued)**

8. Place crankshaft (14) on suitable V-blocks or stand (20) (item 131, WP 0176) with crankshaft resting on main bearing journals.
9. Remove sling (15) from hoist (19) and crankshaft (14).



10. Remove seven upper main bearing halves (21) from bearing bores in crankcase.
  - a. Mark back of upper main bearing half (21) with its respective location using a grease pencil, for example "1 case," "2 case" and so on.



## DISASSEMBLY

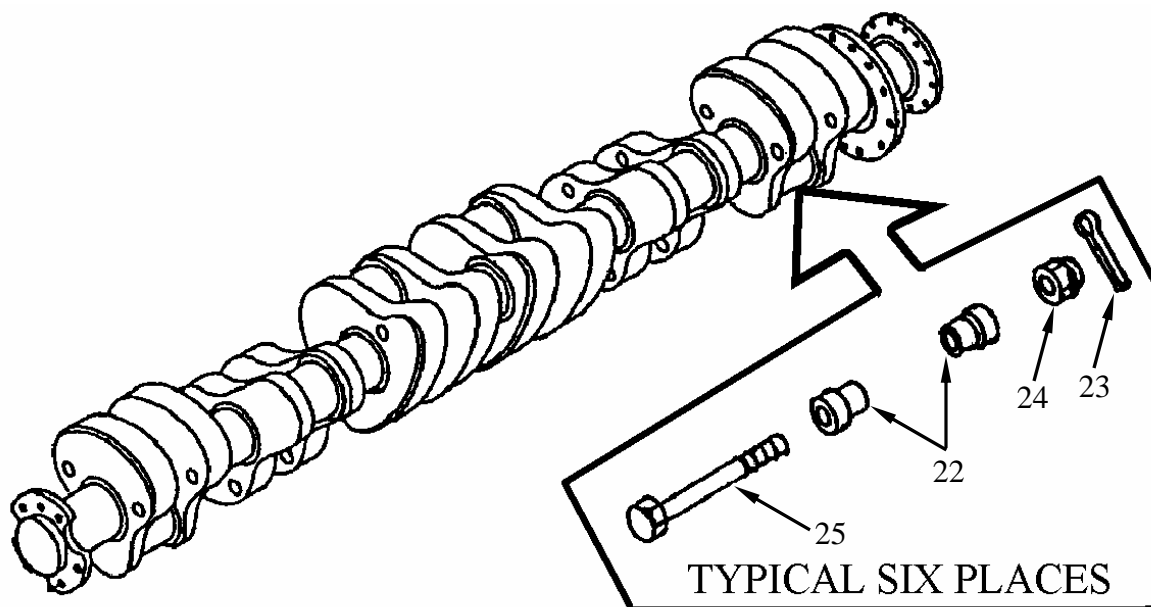
## NOTE

If your crankshaft is the solid crankpin type, skip the rest of this page and go to Cleaning.

Early model crankshafts (part number 8682734) had hollow crankpins (connecting rod journals). The early model crankshafts have become obsolete and are replaced with the newer type (part number 12544249) which has solid crankpins. If your engine has the old style crankshaft, and it is in serviceable condition, it may be used. The crankshafts are directly interchangeable; no special treatment is required when exchanging them.

All crankpin retaining plugs are removed the same way, only one is described.

1. Remove retaining plug (22).
  - a. Remove cotter pin (23). Discard cotter pin.
  - b. Remove slotted nut (24).
  - c. Remove screw (25) securing retaining plugs (22) in crankshaft connecting rod journal.
  - d. Remove two retaining plugs (22) from crankshaft connecting rod journal.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**WARNING**

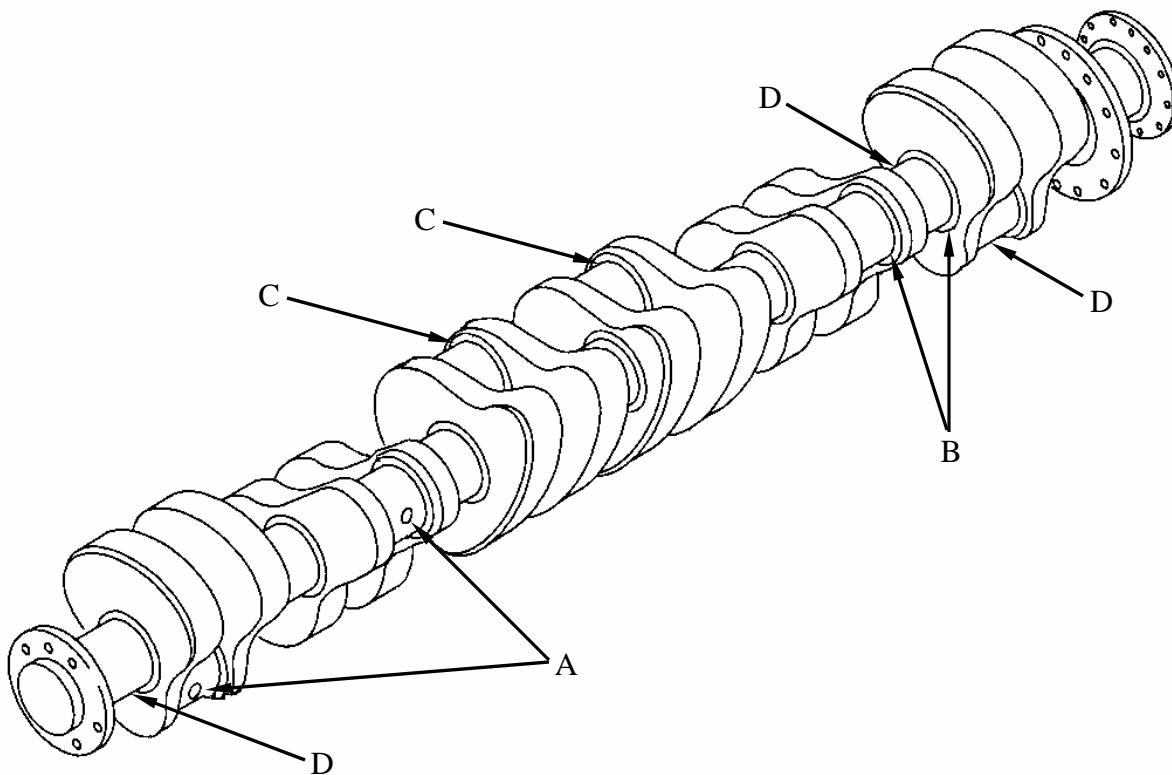
**Compressed air used for cleaning purposes must not exceed 30 psi (207 kPa). Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.). Failure to comply may result in personal injury.**

2. Clean crankshaft oil passages (A) with compressed air and brass wire probes (item 13, WP 0176).

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Visually inspect crankshaft (14).
  - a. Look for cracks with a magnifying glass (item 73, WP 0176) and a strong light. Pay particular attention to areas around crankshaft oil holes (A) and fillets (B) adjacent to crankshaft counter weights. Replace any crankshaft that has cracks.
  - b. Check connecting rod journal radii (C) of crankshaft for wear or damage. Mark minor defects for future repair.
  - c. Check main and connecting rod journals (D) for nicks, burrs, grooves, scratches, galling, scuffing, or discoloration. Mark minor defect areas for future repair.



**INSPECTION (Continued)**

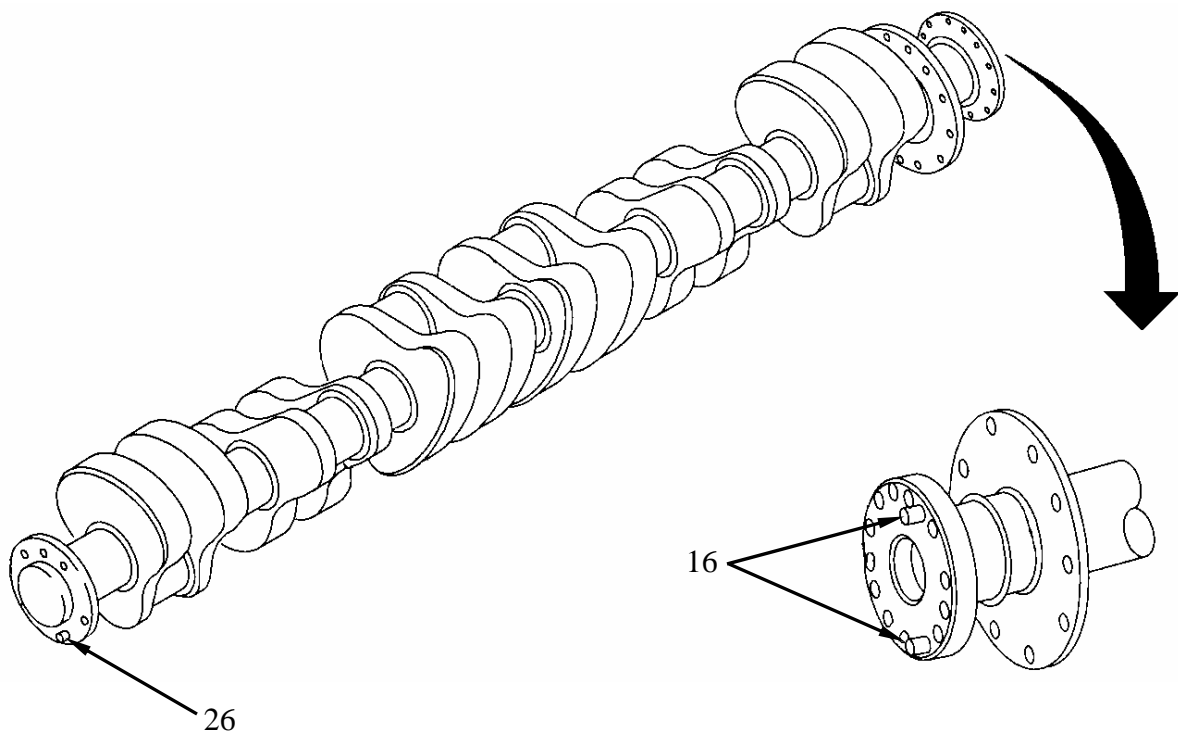
3. Check dowel pins (16, 26).

- a. Insure that dowel pins (16, 26) are secure in crankshaft flanges, are not out of round, and are not bent.
- b. Measure diameter of (two) dowel pins (16). Mark for repair if not within specifications in the following table.

Outside Diameter of Dowel Pins (Flywheel End)	Minimum	Maximum
Standard	0.6255	0.6257
0.005 oversize	0.6305	0.6307
0.010 oversize	0.6355	0.6357

- c. Measure diameter of dowel pin (26). Mark for repair if not within specifications in the following table.

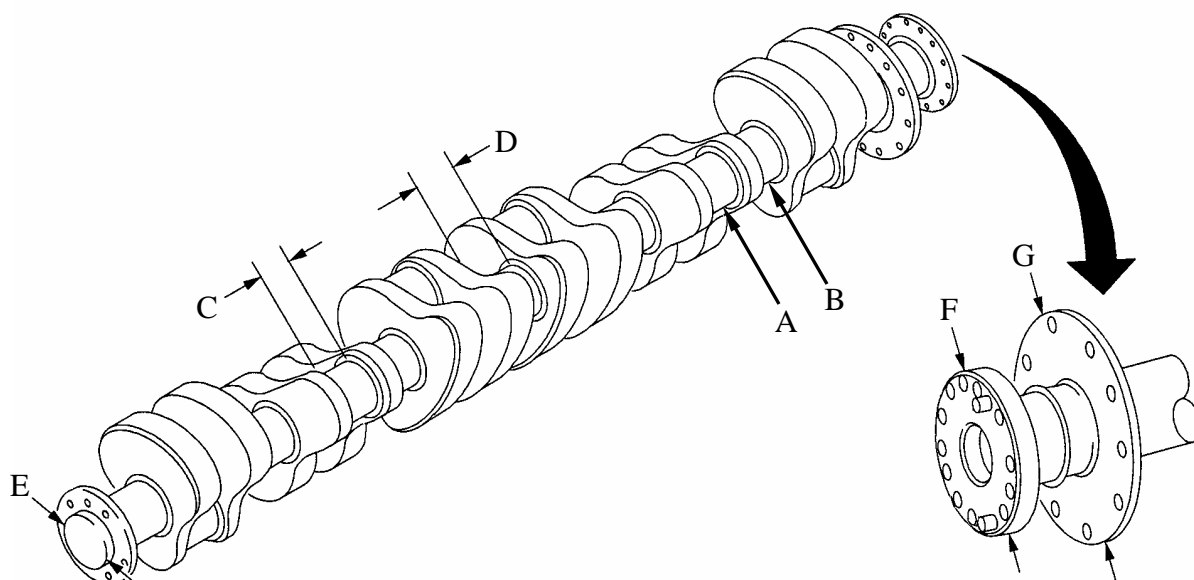
Outside Diameter of Dowel Pin (Damper End)	Minimum	Maximum
Standard	0.5001	0.5003



**INSPECTION (Continued)**

4. Take crankshaft critical measurements. Replace crankshaft that does not meet the limits specified in the following table.
  - a. Measure outside diameter of six connecting rod journals (A).
  - b. Measure outside diameter of seven main bearing journals (B).
  - c. Measure inside width of six connecting rod journals (C).
  - d. Measure inside width of main thrust bearing journal (D).
  - e. Measure outside diameter of damper hub (E).
  - f. Measure diameter of flywheel hub (F).
  - g. Measure outside diameter of accessory drive gear mounting flange (G).

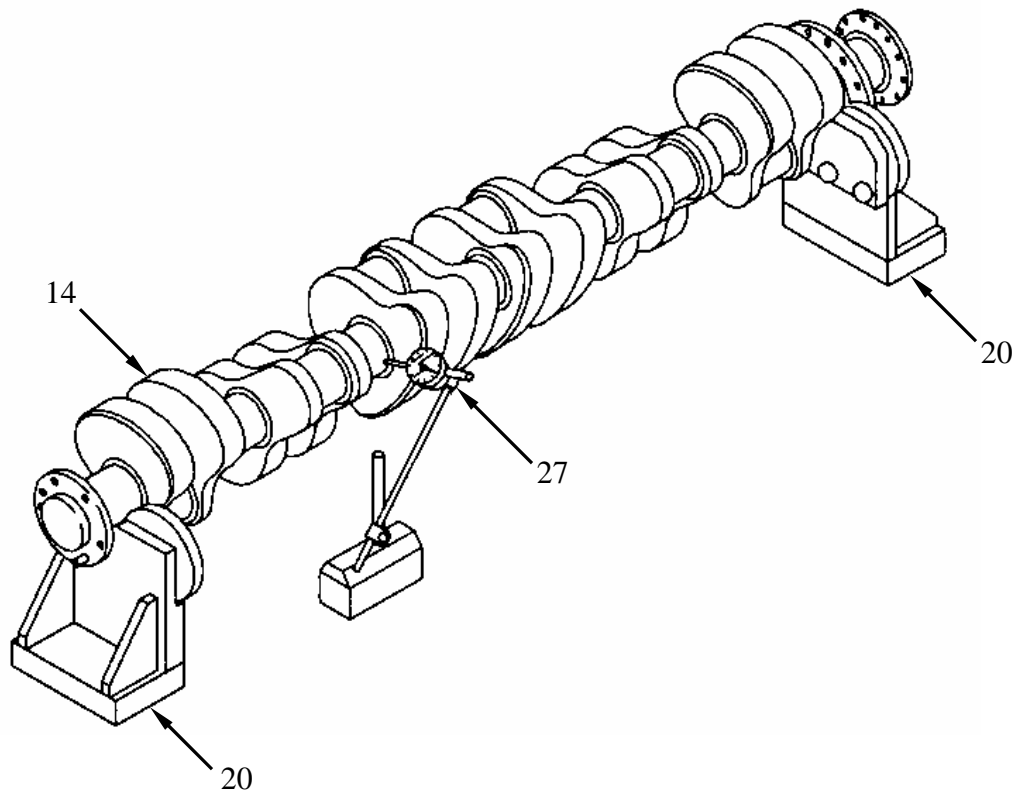
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A	Standard	3.7495 (95.2373)	3.7505 (95.2627)
	Undersize 0.003 (0.0762)	3.7465 (95.1611)	3.7475 (95.1865)
	Undersize 0.010 (0.254)	3.7395 (94.9833)	3.7405 (95.0087)
B	Standard	4.2495 (107.9373)	4.2505 (107.9627)
	Undersize 0.003 (0.0762)	4.2465 (107.8611)	4.2475 (107.8865)
	Undersize 0.010 (0.254)	4.2395 (107.6833)	4.2405 (107.7087)
C	3.1470 (79.9338)	3.1510 (80.0354)	3.1520 (80.0608)
D	2.4990 (63.4746)	2.5010 (63.5254)	2.5030 (63.5762)
E	4.2490 (107.9246)	4.2510 (107.9754)	4.2475 (107.8865)
F	7.9980 (203.1492)	7.9990 (203.1746)	7.9970 (203.1238)
G	9.7480 (247.5992)	9.7500 (247.6500)	9.7470 (247.5738)



**INSPECTION (Continued)**

## 5. Check crankshaft run-out.

- a. With crankshaft (14) on V-blocks (item 131, WP 0176) or suitable stand (20), supported on end journals, check the run-out at main journal number 4 using a dial indicator (27) (item 65, WP 0176).
- b. Replace crankshaft if run-out is more than 0.025 inch (0.635 mm).



**REPAIR**

1. Remove minor imperfections.
  - a. Polishing with crocus cloth (item 9, WP 0173) wetted in cleaning compound (item 8, WP 0173) may repair minor imperfections in crankshaft journals.
  - b. Replace crankshafts that are deeply scratched, nicked, burred, scuffed, or galled.

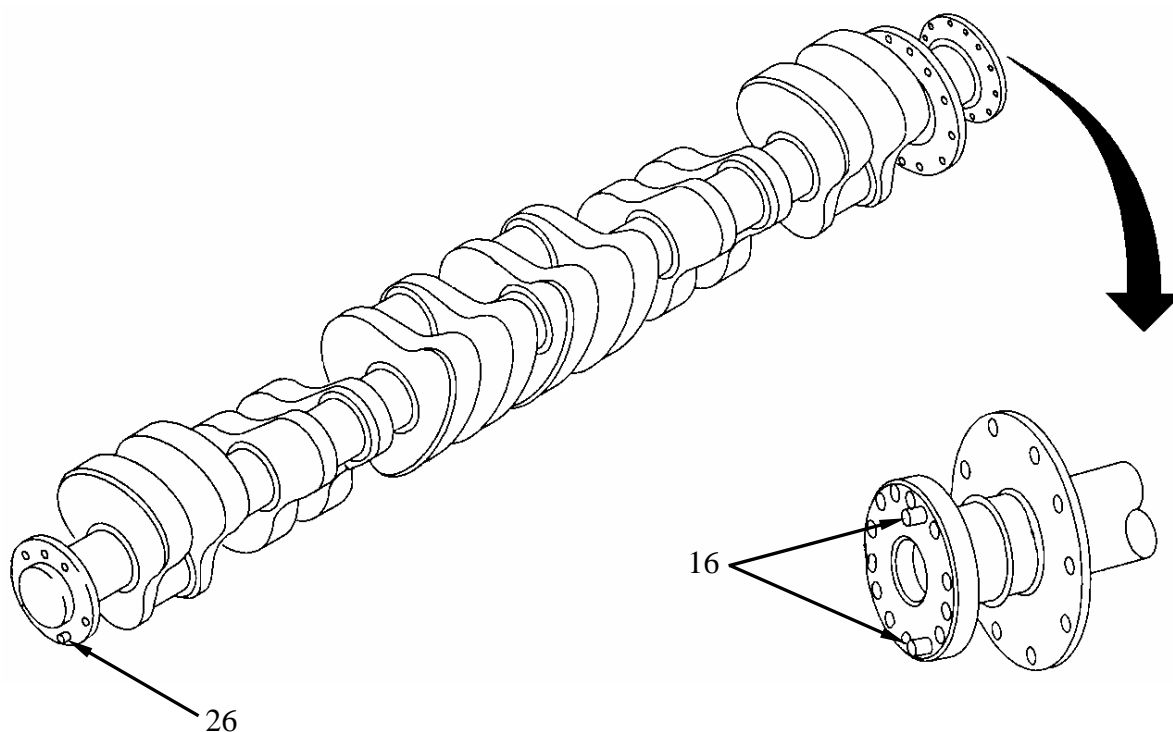
**NOTE**

**Do not remove dowel pins from ends of crankshaft unless inspection indicates replacement is necessary.**

**Dowel pins in flywheel flange end are secured with setscrews in early model crankshafts. It is not necessary to use setscrew when replacing dowels.**

**Dowel pins are available in 0.005 and 0.010 inch oversize for the flywheel end flange. When oversize dowel pins are used, ream flange and mating parts (flywheel and transmission drive gear shaft) to necessary oversize dimension and install oversized pin in crankshaft flange.**

2. Replace dowel pins (16, 26).
  - a. Replace dowel pins that do not fit securely, are bent, or out of round.
  - b. Replace dowel pins that do not meet measurement specifications in inspection section of this work package.



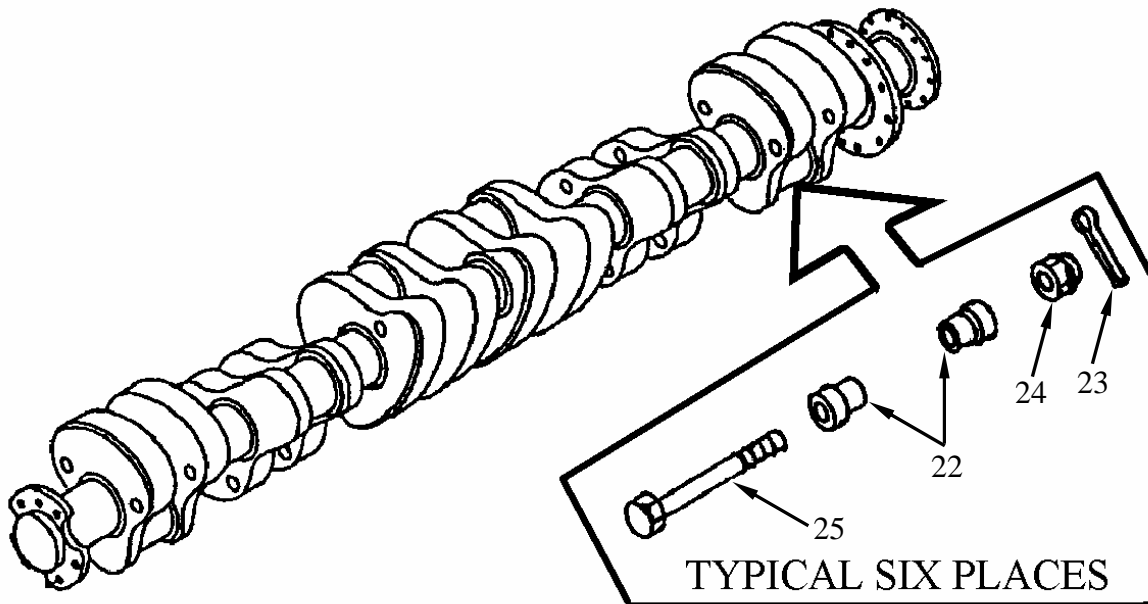


## ASSEMBLY

## NOTE

**If your crankshaft is the solid crankpin type, skip this page and go to Installation.**

1. Install retaining plugs (22).
  - a. Position twelve retaining plugs, one in each end of bore, through six crankshaft connecting rod journals.
  - b. Install six screws (25) and slotted nuts (24) securing plugs (22).
  - c. Install six new cotter pins (23) (item 49, WP 0175) securing slotted nuts (24).



## INSTALLATION

**NOTE**

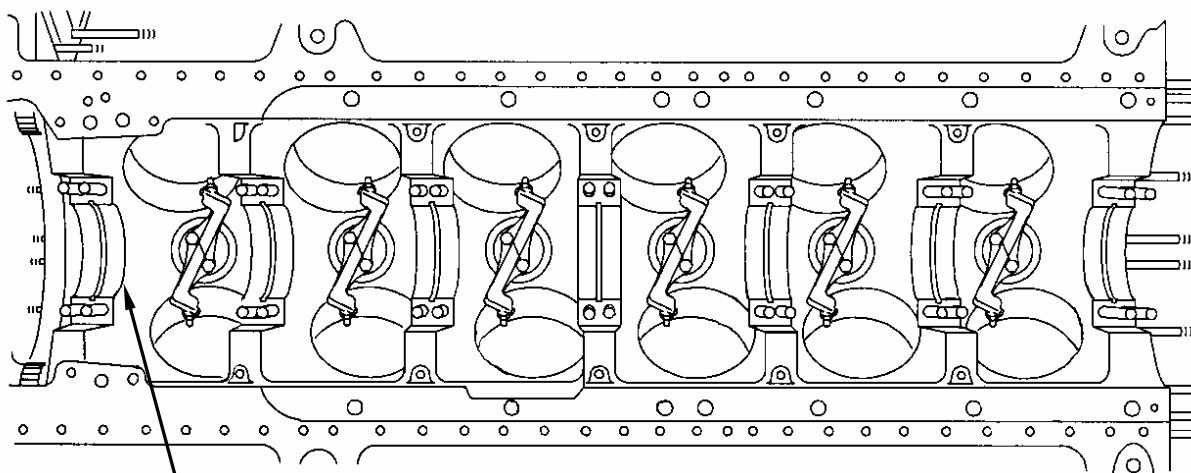
The crankshaft may be installed with all 12 connecting rods in place on the crankshaft. See Work Package 0143 for connecting rod installation instructions.

**CAUTION**

If the crankshaft is going to be installed with the rods in place, make sure 12 crankcase protectors are installed to protect the crankcase.

Main bearing halves (used or new) must be inspected according to WP 0138 (Crankshaft Main Bearing Inspection) prior to installation.

1. Install main bearing halves (21) after completing Work Package 0138.
  - a. Install upper main bearing halves (21) in accordance with their respective location marks.
  - b. Make sure the main thrust bearing half goes in number 4 main journal.
  - c. Coat upper main bearing halves (21) with lubricant (item 21, WP 0173).



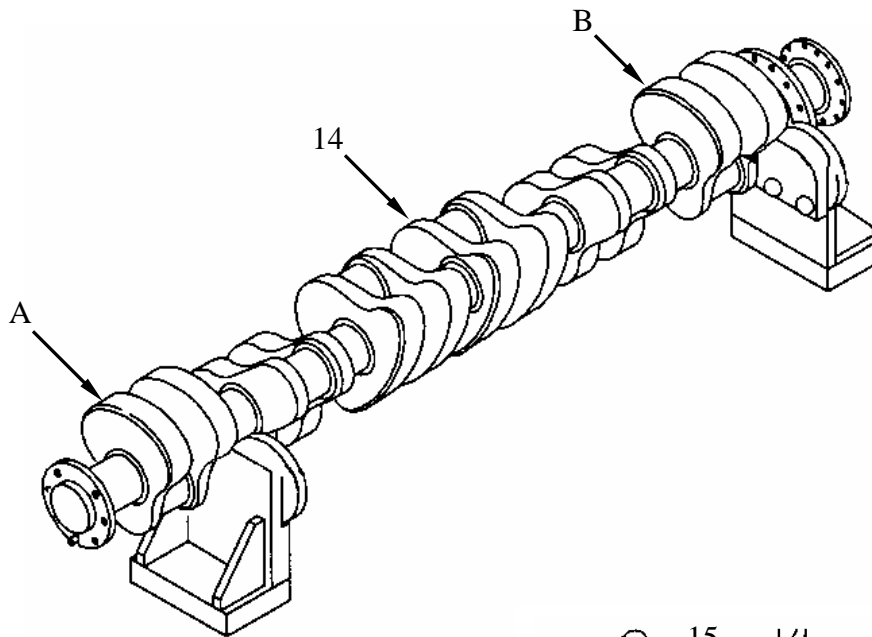
21 (seven places)

## INSTALLATION (Continued)

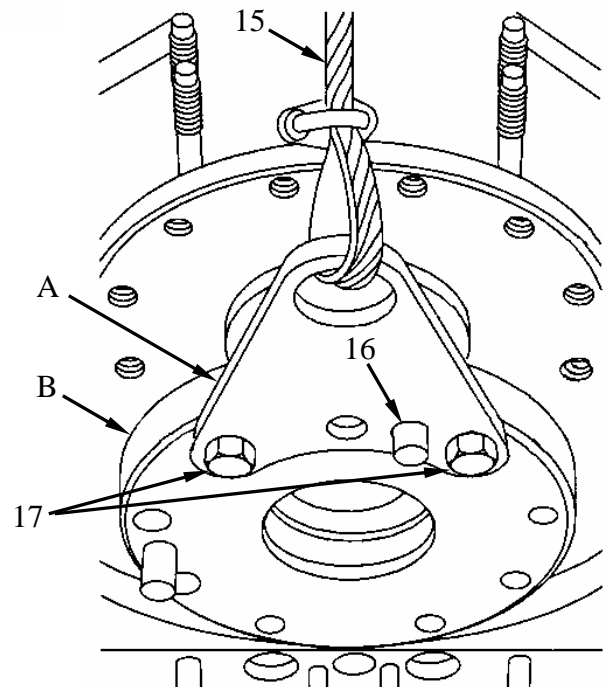
**CAUTION**

The crankshaft counterweights for connecting rod bearing journals 1 (left and right) and 6 (left and right) must be in the up position so the crankshaft will clear the sides of the crankcase when it is installed or damage will occur.

2. Install lifting sling (15).
  - a. Rotate crankshaft (14) until counterweights (A and B) are in the "up" position as shown.

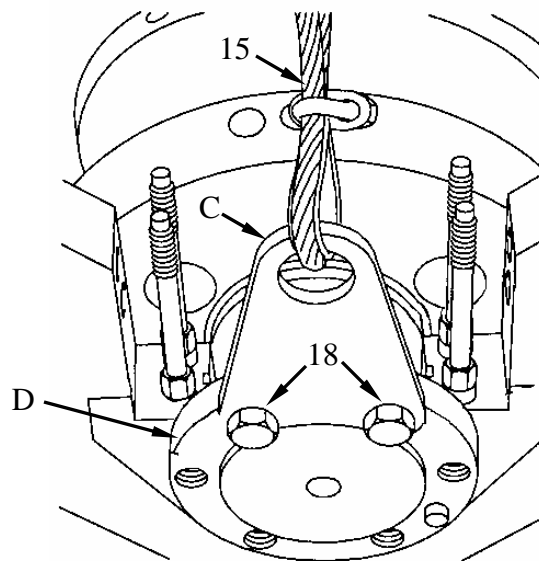


- b. Install sling (15) (item 26, WP 0176) adapter (A) with dowel pin hole over flywheel flange dowel pin (16) and secure to flange (B) with two flywheel mounting bolts (17).



**INSTALLATION (Continued)**

2. Install lifting sling (15) (Continued).
  - c. Install sling (15) adapter (C) on damper flange (D) of crankshaft and secure with two damper mounting bolts (18).



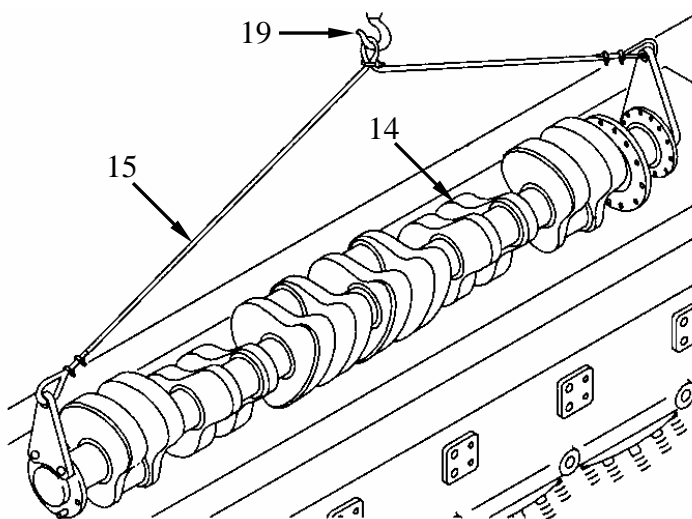
**WARNING**

**Crankshaft is heavy, take care when lifting crankshaft not to pinch fingers or drop crankshaft. Failure to comply could lead to personal injury.**

**CAUTION**

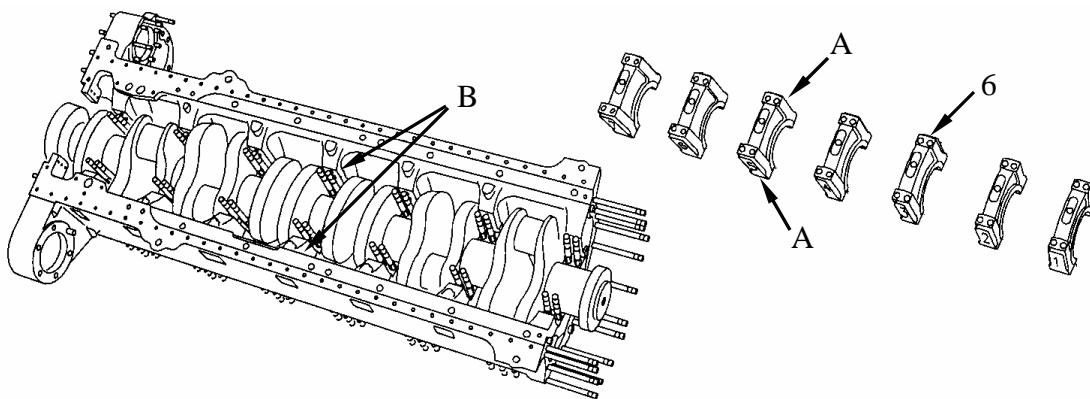
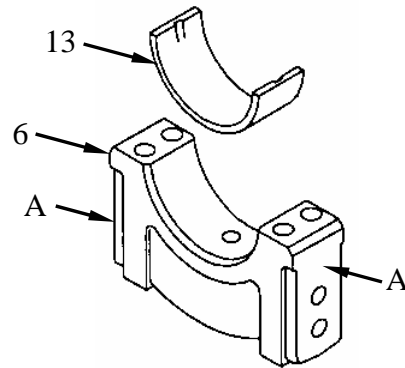
**Exercise care when installing crankshaft to prevent damage to the main bearing cap studs and crankshaft journals. Before installing crankshaft, place cardboard, plastic tubes, or duct tape over main bearing studs for protection. Failure to comply could result in damage to studs or journals.**

3. Install crankshaft (14) into crankcase (2).
  - a. Attach sling (15) to hoist (19).
  - b. Carefully lower crankshaft (14) into crankcase.
  - c. Detach sling (15) from hoist (19) and from crankshaft (14).



**INSTALLATION (Continued)**

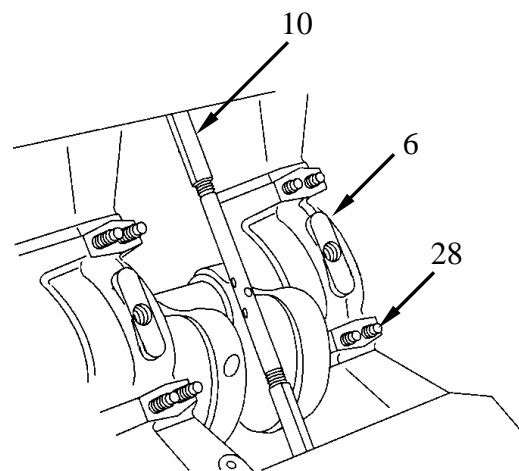
4. Install main bearing caps (6).
  - a. Install seven lower main bearing halves (13) into main bearing caps (6) in accordance with respective location marks.
  - b. Coat mating surfaces (A) of main bearing (6) caps, crankcase webs (B), and lower main bearing halves (13) with lubricant (item 21, WP 0173).



**CAUTION**

**Main bearing caps and bearing halves must be installed in their original position. The side of each main bearing cap that is marked as "fly end" must be installed toward rear of crankcase (flywheel end). Failure to comply may result in premature failure.**

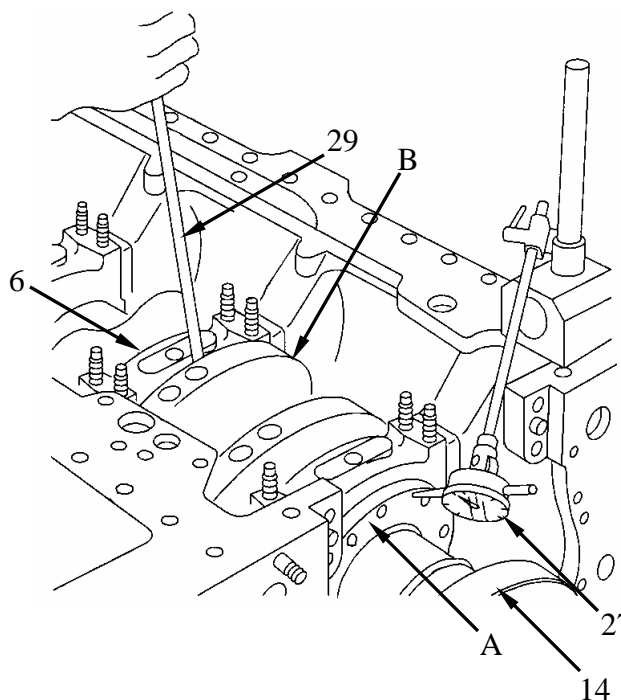
- c. Place main bearing caps (6) over crankcase studs (28) and lower into position.
- d. Use jackscrew (10) (item 110, WP 0176) to spread crankcase just enough so that each bearing cap (6) will slide into position. Jackscrew must be repositioned for each bearing cap location.
- e. Remove jackscrew (10).



**INSTALLATION (Continued)**

5. Determine crankshaft (14) endplay.

- a. Mount a dial indicator (27) (item 65, WP 0176) on crankcase so indicator point contacts accessory drive gear mounting flange (A) on crankshaft (14).
- b. Using a heavy screwdriver (29) or other suitable tool, wedge between main bearing cap (6) and crankshaft (14) counterweight (B); push crankshaft toward front end.
- c. Set indicator (27) on zero ("0") reading.
- d. Push crankshaft toward the rear of crankcase and check indicator endplay reading.
- e. Endplay must be from 0.011 to 0.019 inch (0.2794 to 0.4826 mm).
- f. When endplay exceeds limits, remove bearing caps and crankshaft. Refer to Removal steps 3 through 7.
- g. Install new main thrust bearing halves. Install bearing cap number 4 and recheck thrust bearing bore. Refer to WP 0138 (Crankshaft Bearings Replacement).
- h. Install bearing halves and crankshaft, then recheck endplay to make sure it is within limits. Refer to Installation steps 1 through 5.

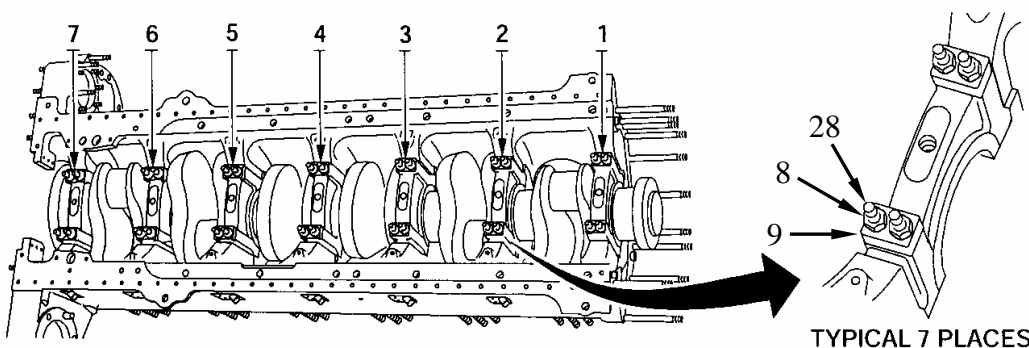


**NOTE**

**Washer plates have a flat side and a rounded side. Install with flat side against crankcase.**

6. Install washer plates (9).

- a. Apply Lubriplate (item 23, WP 0173) to threads of 28 studs (28).
- b. Install 14 washer plates (9) and 28 slotted nuts (8) but do not tighten nor install new lock wire at this time.



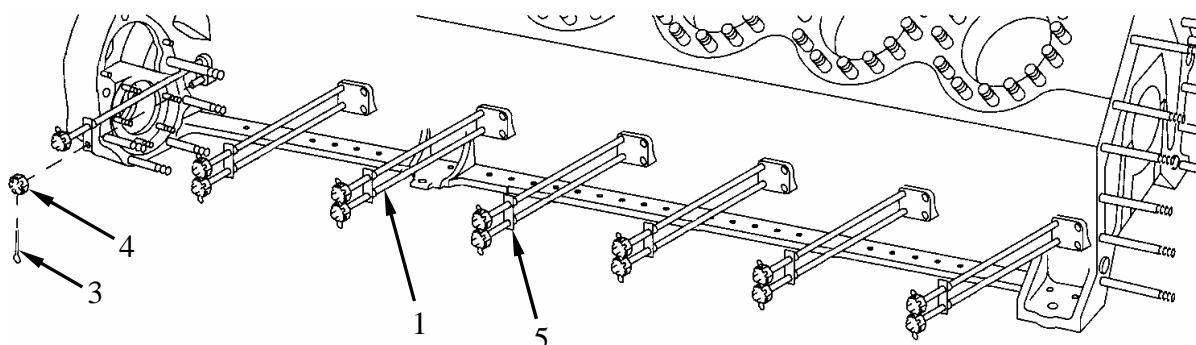
## INSTALLATION (Continued)

## NOTE

To avoid interference with the starter driven gear shaft, it is necessary to install lower number 7 tie-rod from the right side of crankcase.

Care should be taken so tie-rods extend equally on both sides of crankcase.

7. Install 14 tie-rods (1) through crankcase.
8. Install seven washer plates (5), 14 slotted nuts (4), and 14 new cotter pins (3) (item 28, WP 0175).



9. Install seven washer plates (5) and 14 slotted nuts (4) onto opposite end of tie-rods. Do not tighten slotted nuts nor install new cotter pins at this time.

**CAUTION**

The procedure for tightening main bearing cap nuts incorporates both torque and stud stretch. The untorqued height of the studs must first be measured, then the studs are torqued incrementally to a final value, and finally the stretch of the stud is measured. Stud stretch is defined as the difference between the untorqued height and the torqued height of the studs.

Any stud that exceeds the maximum stretch (0.024 inch, or 0.6096 mm) prior to obtaining the minimum torque (58 foot-pounds, or 79 N•m) must be replaced.

Any stud that reaches maximum torque (69 foot-pounds, or 94 N•m) prior to obtaining minimum stretch (0.019 inch, or 0.4826 mm) must be replaced.

Do not disturb dial indicator setting or position used for checking stud stretch. Incorrect stretch measurement will result if indicator setting is changed - which could result in premature failure of engine parts.

**INSTALLATION (Continued)**

## 10. Tighten main bearing cap (6) nuts (8).

a. Make sure that nuts are loose (6), then measure and record the height of four main bearing cap studs (28) at number 4 location. Use a flat surface plate (30) and dial indicator (27).

b. At number 4 main cap (6), in a crosshatch pattern, torque-tighten four slotted nuts (8) to 42 foot-pounds (57 N•m). Using the same crosshatch pattern, torque-tighten the same four nuts (8) to 58 foot-pounds (79 N•m).

c. Using a flat surface plate (30) and dial indicator (27) (item 65, WP 0176), measure and record the height of four main bearing cap studs (28) at number 4 location. Subtract the first reading from the second, this is the stud stretch.

d. Tighten nuts (8) to align with safety wire hole in stud and attain a stretch of 0.019 to 0.024 inch (0.4826 to 0.6096 mm).

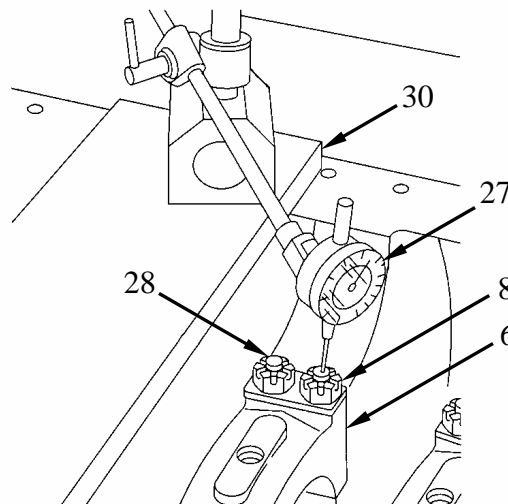
e. Any stud that exceeds the maximum stretch (0.024 inch, or 0.6096 mm) prior to the nut obtaining minimum torque (58 foot-pounds, or 79 N•m) must be replaced.

f. Any stud that its nut reaches maximum torque (69 foot-pounds, 94 N•m) prior to obtaining minimum stretch (0.019 inch, or 0.4826 mm) may be loosened and tried again. Loosening of a single nut is not allowed; all nuts on that bearing cap must be loosened. If the condition exists after the second try, the stud must be replaced.

g. Repeat for remaining caps in the following order 3,5,2,6,1, and 7.

h. Secure 28 slotted nuts (8) with new lock wire (7) (item 44, WP 0173).

## 11. Install accessory drive gear and oil seal housing (see Work Package 0158).

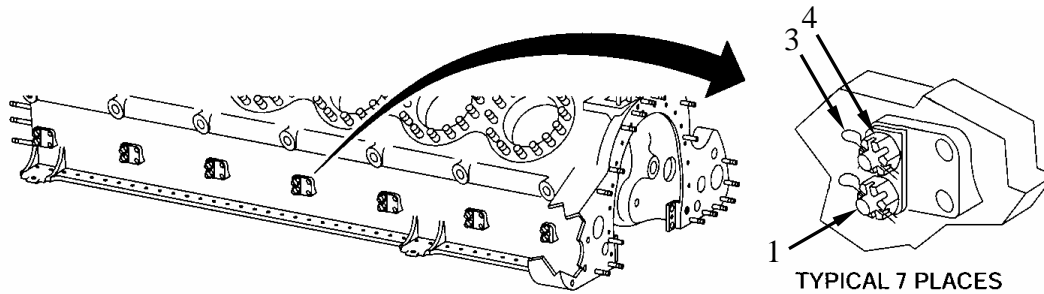




## INSTALLATION (Continued)

12. Torque-tighten tie-rod (1) slotted nuts (4).

- a. With the aid of a helper holding slotted nuts (4) on the opposite side of crankcase, torque-tighten 14 slotted nuts (4) on tie-rods (1) to 53 foot pounds (72 N•m).
- b. Apply additional torque to align slotted nut with hole in tie-rod if required.
- c. Install 14 new cotter pins (3) (item 521, WP 0175) to secure slotted nuts (4).



**END OF WORK PACKAGE**



**CRANKSHAFT DAMPER REPAIR**

**0140 00**

**THIS WORK PACKAGE COVERS:**

Removal, Inspection, Repair, Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Mechanical puller (3) (item 90, WP 0176)

**Expendable Materials:**

- Cleaning compound, solvent (item 8, WP 0173)
- Cloth, abrasive, crocus (item 9, WP 0173)

**Fabricated Items**

- Tapered bolt (item 16 WP 0177)

**Personnel Requirements:**

- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- 2CA, 2DA: Fuel Supply Pump removed (WP 0048)
- 2CA, 2DA: Fuel Supply Pump Drive removed (WP 0110)
- 2DR: Fuel Supply Pump removed (WP 0049)
- 2DR: Power Takeoff Drive Shaft removed (WP 0111)
- Damper Housing removed (WP 0151)

**REMOVAL**

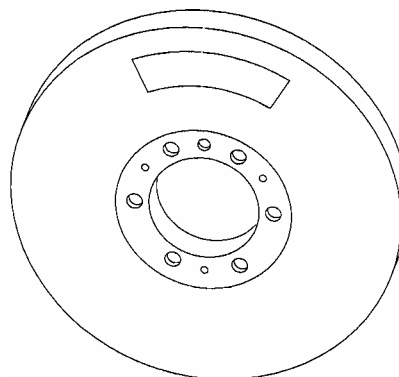


**The crankshaft damper is heavy and awkward. It requires a two-man lift or a suitable lifting device. Use a 4-1/4 to 4-1/2-inch long bolt with the head cut off and tapered (item 16 WP 0177) to facilitate installation and removal.**

**CAUTION**

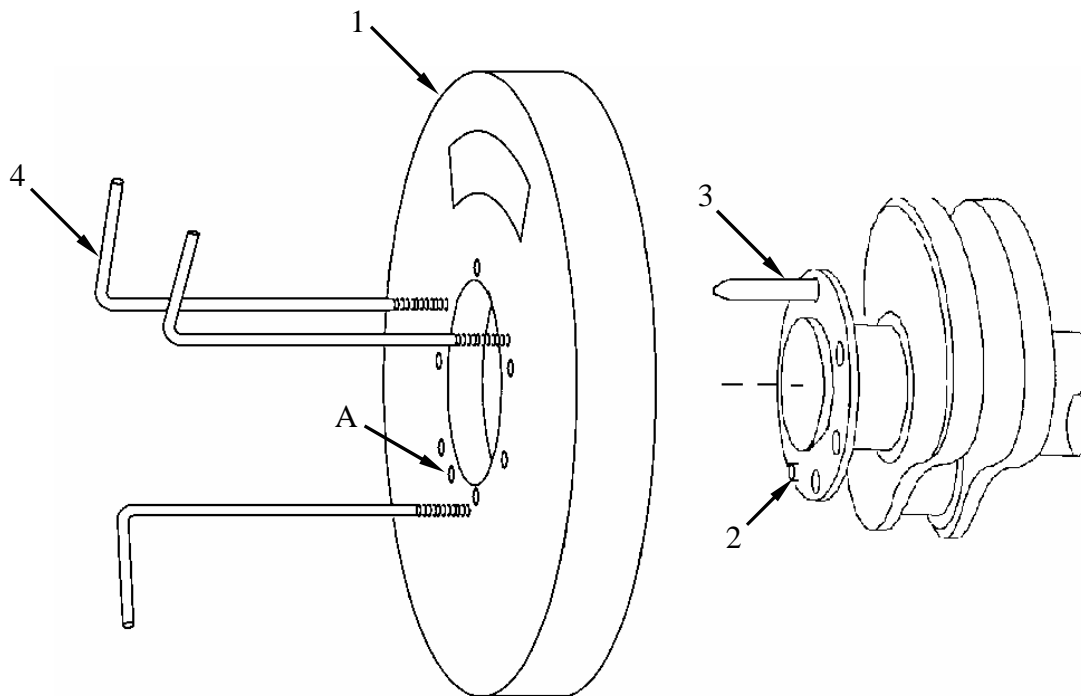
**The vibration damper wheel is not a flywheel. It has hydraulic oil inside. Prying or hammering on it to help in removal or installation will damage it.**

**Do not use pry bars, drifts, or hammers to install or remove the damper wheel.**



**REMOVAL (Continued)**

1. Remove vibration damper.
  - a. Position crankshaft and damper (1) so that one mounting bolthole is at the 12 o'clock position and dowel pin (2) hole (A) is at approximately the 7 o'clock position.
  - b. Insert tapered bolt (3) (item 16 WP 0177) in bolt hole at the 12 o'clock position.
  - c. Install three mechanical pullers (4) (item 77, WP 0170) into screw holes provided in vibration damper (1).
  - d. Alternately tighten pullers (4) to pull damper (1) from dowel pin (2) in flange of crankshaft just until damper (1) is free of dowel (2) in crankshaft flange and resting on tapered bolt (3).
  - e. Remove mechanical pullers (4).
  - f. Insert lifting strap through center of damper (1) and attach to suitable lifting device.
  - g. Lift just enough to relieve load on tapered bolt (3) and slide damper (1) free of bolt.



**CLEANING**

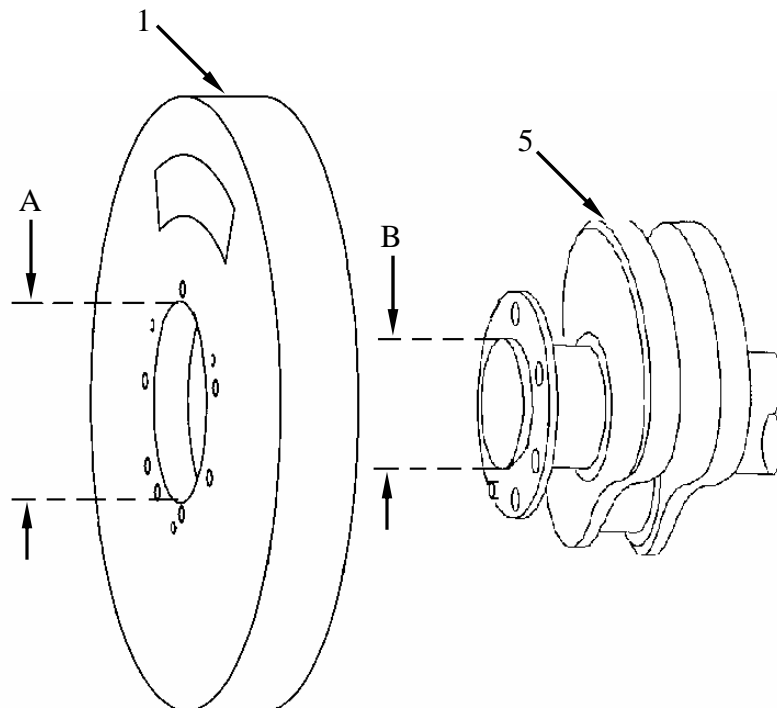
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Visually inspect the vibration damper (1) for dents or distortion on the outer surfaces. Mark minor imperfections for repair.
3. Inspect vibration damper (1) for evidence of leaking. Replace damper if any evidence of leakage is found.
4. Measure the inside diameter of damper bore (A).
5. Measure the outside diameter of crankshaft (5) hub (B).
6. Replace vibration damper if not within the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Pilot bore inside diameter)	4.2515 (107.9881)	4.2525 (108.0135)	4.2535 (108.0389)
B (Crankshaft hub outside diameter)	4.2490 (107.9246)	4.2510 (107.9754)	4.2475 (107.8865)
Fit of bore (A) to hub (B)	0.0005L (0.0127)	0.0035L (0.0889)	0.0060L (0.1524)



## REPAIR

**WARNING**

Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.

Ensure there is good airflow when using solvent, and work area is away from heat and flames.



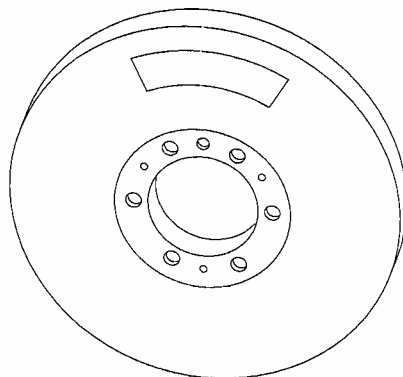
- Keep fire extinguisher nearby.
- Do not breathe solvent fumes.
- Avoid skin contact. See Warning in front of Manual.

1. Remove minor imperfections of the vibration damper with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173). Replace damper when imperfections cannot be removed.
2. Replace vibration damper when dented, distorted, or if evidence of leaking is present.

## INSTALLATION

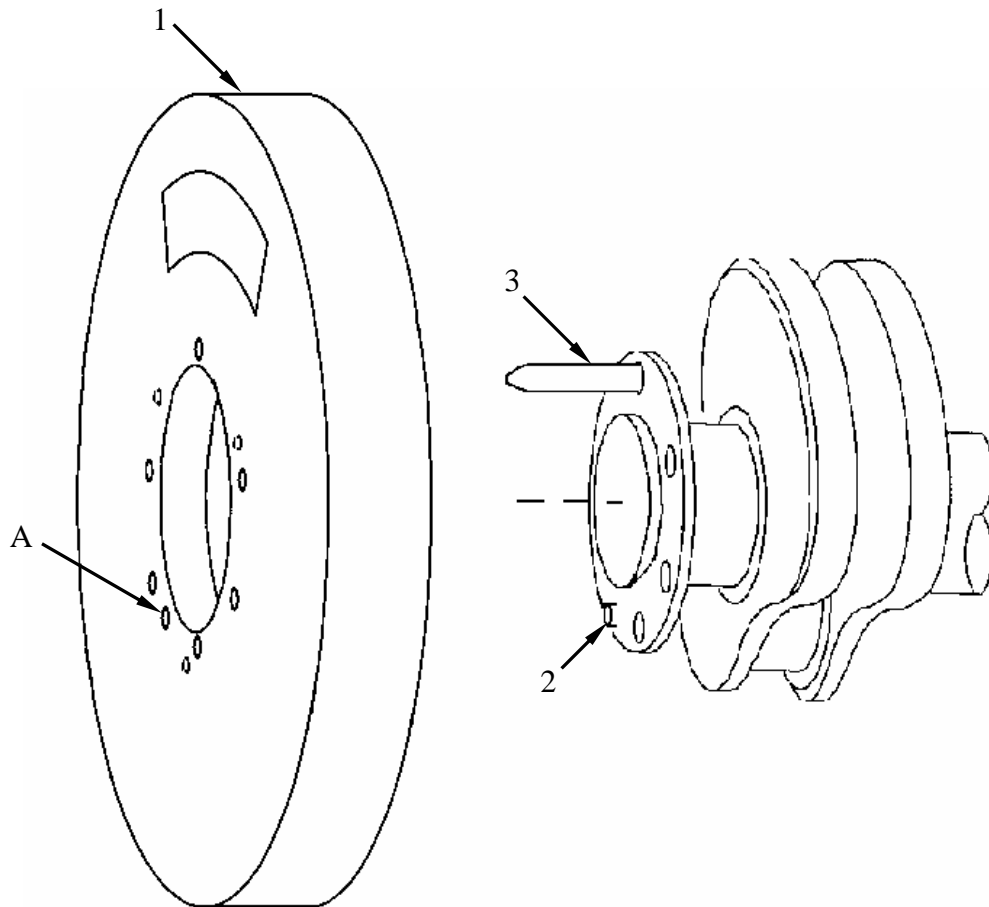
**WARNING**

The crankshaft damper is heavy and awkward. It requires a two-man lift or a suitable lifting device. Use a 4-1/4 to 4-1/2-inch long bolt with the head cut off and tapered (item 16 WP 0177) to facilitate installation and removal.



**INSTALLATION (Continued)**

1. Install vibration damper.
  - a. Position crankshaft and damper (1) so that one mounting bolthole is at the 12 o'clock position and dowel pin (2) hole (A) is at approximately the 7 o'clock position.
  - b. Insert tapered bolt (item 16 WP 0177) (3) in bolt hole at the 12 o'clock position.
  - c. Insert lifting strap through center of damper (1) and attach to suitable lifting device.
  - d. Lift just enough to align damper wheel on tapered bolt (3) and slide damper (1) onto bolt.
  - e. Remove lifting device and strap.
  - f. Slide damper (1) forward until seated on hub and dowel pin (2).

**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Torque wrench, 0-175 ft-lb (item 127, WP 0176)
- Wire twisting pliers (item 82, WP 0176)

**Expendable Materials:**

- Lubriplate (item 23, WP 0173)
- Sealing compound, silicone sealant (RTV) (item 33, WP 0173)
- Wire, non-electrical (item 44, WP 0173)

**Personnel Requirements:**

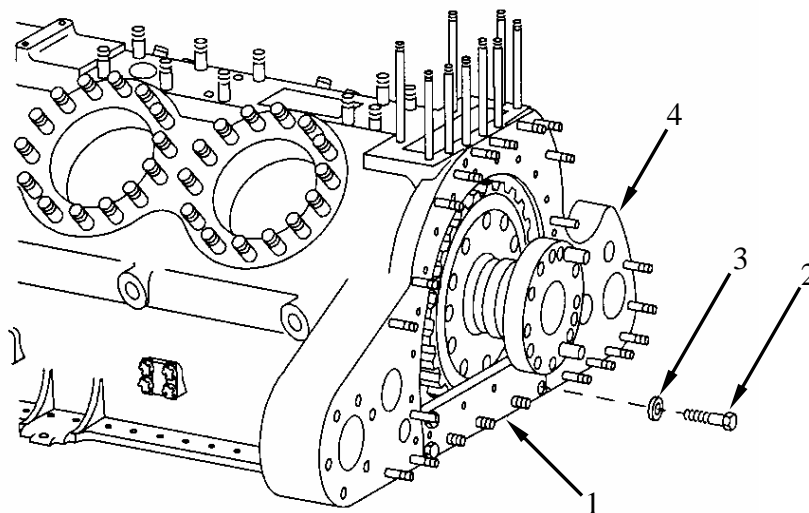
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Crankcase/Transmission adapter assembly removed (WP 0131)
- Oil seal housing assembly removed (WP 0136)
- Oil pan assembly removed (WP 0152)
- 2CA, 2DA: Flywheel removed (WP 0102)
- 2DR: Flywheel and Adapter removed (WP 0103)
- 2DR: Transmission Spacer Ring removed (WP 0101)

**REMOVAL**

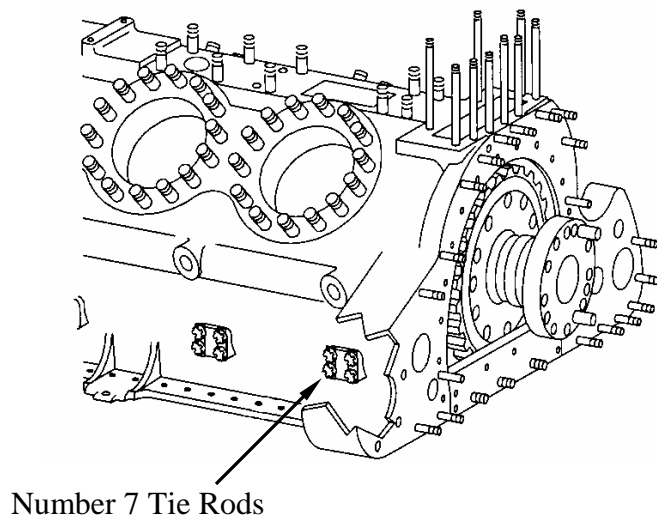
1. Remove oil seal housing support (1).
  - a. Remove four screws (2) with flat washers (3) attaching housing support (1) to crankcase (4).



REMOVAL (Continued)

NOTE

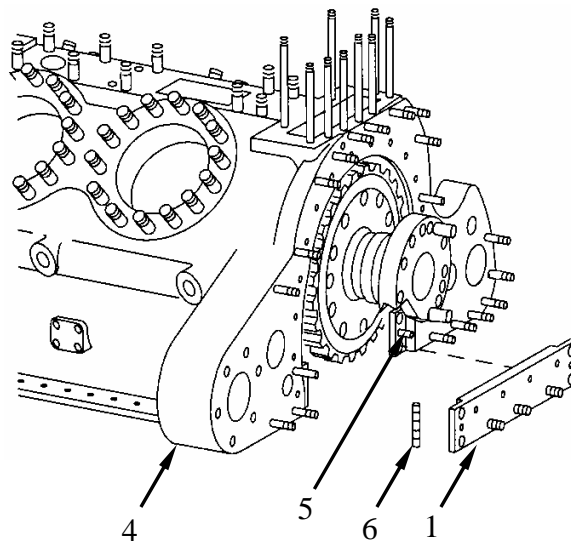
It may be necessary to loosen number 7 main bearing tie rod nuts before removing support.



NOTE

Early model engines had candlewick packing to seal the support at the crankcase parting line. This packing is no longer required; instead use RTV sealant (item 33, WP 0173).

1. Remove oil seal housing support (1)  
(Continued).
- b. Remove oil seal housing support (1)  
from dowel pins (5) and crankcase (4).
- c. Remove and discard candlewick  
packing (6).

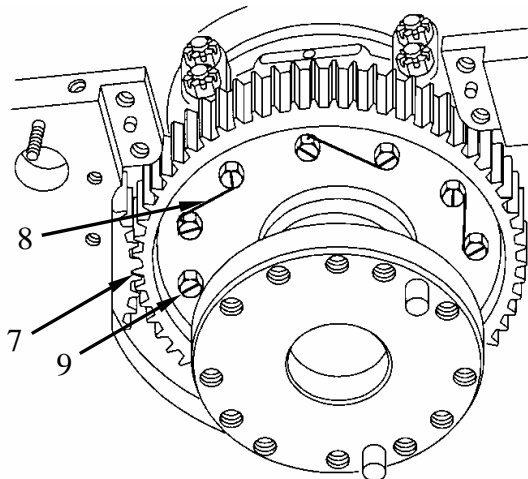


**ACCESSORY DRIVE GEAR REPLACEMENT**

**0141 00**

**REMOVAL (Continued)**

2. Remove accessory drive gear (7).
  - a. Remove and discard lock wire (8).
  - b. Remove 12 screws (9).
  - c. Remove gear (7).



**CLEANING**

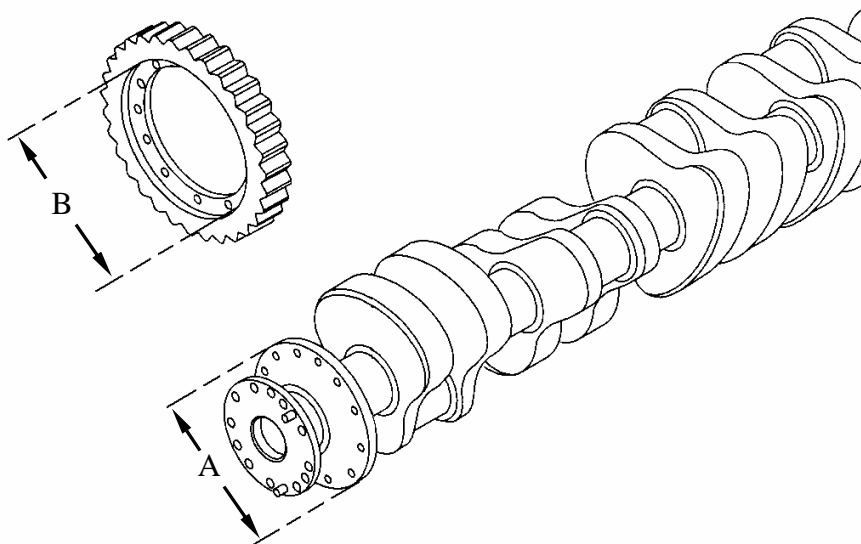
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or if wear exceeds allowable limits.

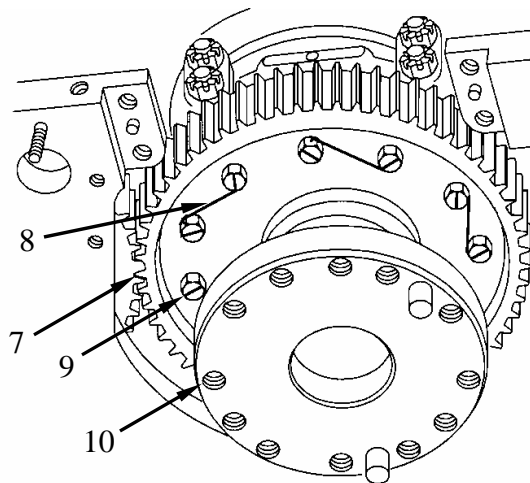
1. See Work Package 0028 for Standard Inspection Procedures.
2. Measure accessory drive gear (7) and replace if it does not meet the following limits:

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Outside diameter of mounting flange on crankshaft)	9.7480 (247.5992)	9.7495 (247.6373)	9.7470 (247.5738)
B (Inside diameter of pilot bore in accessory drive gear)	9.7500 (247.65)	9.7520 (247.7008)	9.7530 (247.7262)

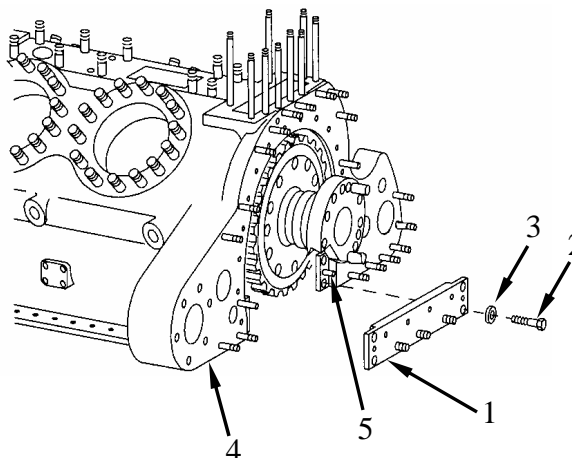


**INSTALLATION**

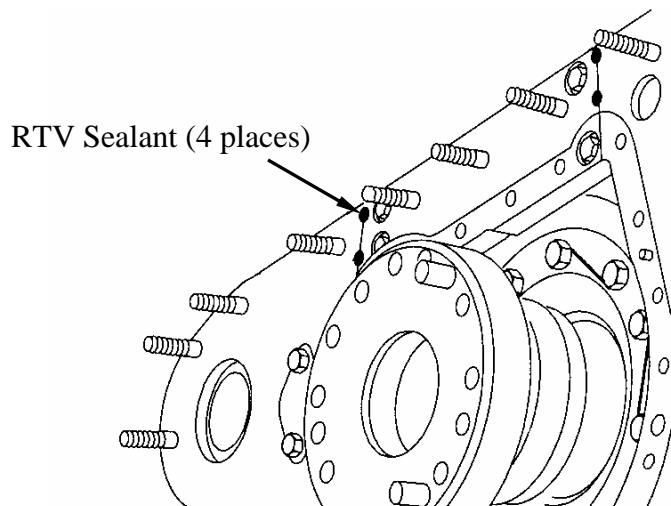
1. Install accessory drive gear (7).
  - a. Position gear (7) on crankshaft (10).
  - b. Apply lubricant (item 23, WP 0173) to threads of 12 screws (9).
  - c. Install and alternately tighten 12 screws (9) to secure gear (7) onto crankshaft (10).
  - d. Alternately torque-tighten 12 screws (9) to 52 foot-pounds (71 N•m).
  - e. Secure screws (9) with new lock wire (8) (item 44, WP 0173).



2. Install oil seal housing support (1).
  - a. Apply a bead of RTV sealant (item 33, WP 0173) to both sides of support (1) where it mates with crankcase (4).
  - b. Install oil seal housing support (1) on dowel pins (5).
  - c. Secure oil seal housing support (1) to crankcase (4) using four screws (2) with flat washers (3).



- d. Apply RTV sealant (item 33, WP 0173) into the openings at the crankcase and support parting line.



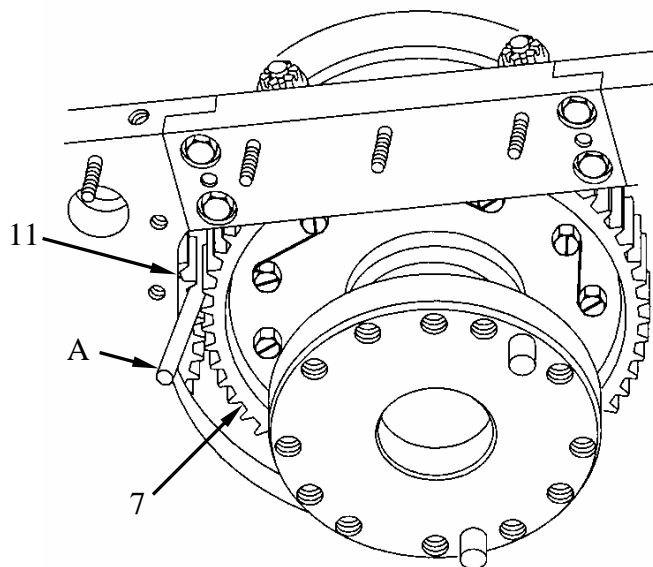
**ACCESSORY DRIVE GEAR REPLACEMENT**

**0141 00**

**INSTALLATION (Continued)**

3. Check backlash between accessory drive gear (7) and starter idler gear (11).
  - a. Replace gear(s) (7, 11) if backlash is not within specifications.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Backlash between accessory drive gear and starter idler gear)	0.004 (0.1016)	0.009 (0.2286)	0.012 (0.3048)



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, Assembly

**INITIAL SETUP:**

**Tools and Special Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Magnifying glass (item 73, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Piston ring gauges: (WP 0176)
  - 0.010 and 0.030 in. oversize (item 49)
  - Standard and 0.020 in. oversize (item 52)
  - Standard and 0.040 in. oversize (item 50)
  - Top ring groove (item 51)
- Ring remover and replacer (item 78, WP 0176)
- Telescoping gauge set (item 54, WP 0176)
- Inspection kit, dye (item 35, WP 0176)

**Expendable Materials:**

- Carbon-removing compound (item 7, WP 0173)
- Cleaning compound, solvent (item 8, WP 0173)
- Cloth, abrasive, crocus (item 9, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Cylinder assembly and piston removed (WP 0133)

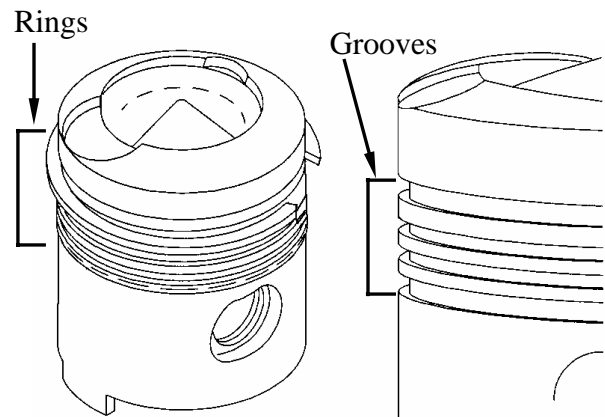
**DISASSEMBLY**

**WARNING**



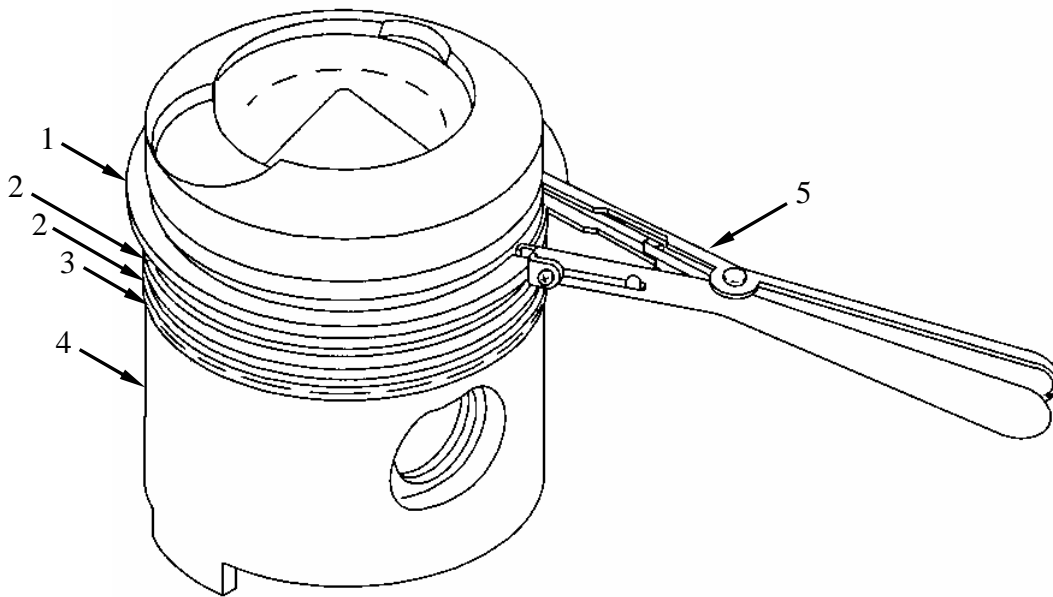
**Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon removing compound. Provide adequate ventilation. Avoid inhalation of fumes and skin contact. If compound is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor is preferable.**

1. Check to see if piston rings are free in piston grooves before removal.
  - a. Soak pistons with stuck rings in carbon removing compound (item 7, WP 0173). Rings must be loose in their respective grooves prior to removal.

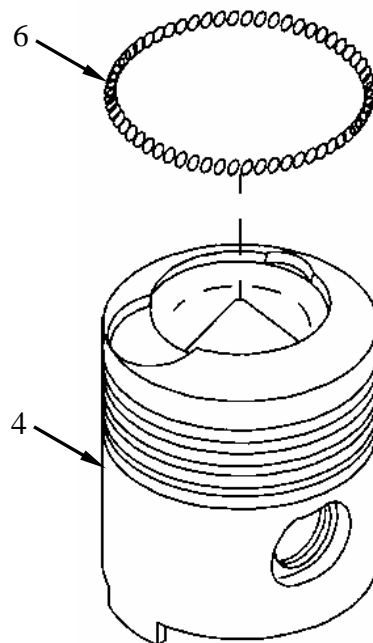


**DISASSEMBLY (Continued)**

2. Remove rings (1, 2, 3) from piston (4).
  - a. Place jaws of remover and replacer (5) (item 78, WP 0176) in the end gap of upper piston ring (1).
  - b. Spread ring (1), lift out of groove, and remove from piston.
  - c. Mark rings for identification showing piston number and groove location.
  - d. Remove two intermediate compression rings (2) and oil control ring (3) in the same manner.



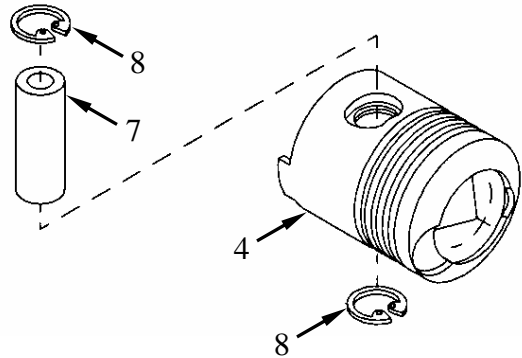
3. Remove oil control ring (3) expander spring (6) by separating at parting line.





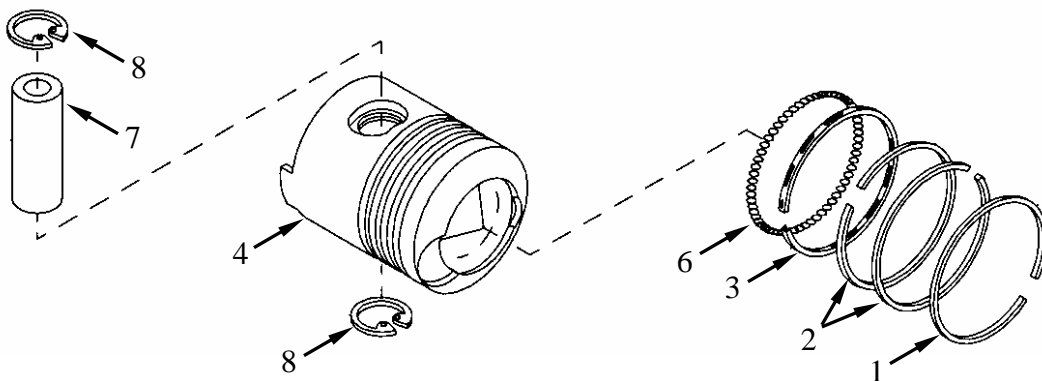
**DISASSEMBLY (Continued)**

4. Remove piston pin (7).
  - a. Remove retaining rings (8) and piston pin (7).
  - b. Mark piston pin (7) for identification showing piston (4) number.

**CLEANING****WARNING**

Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon removing compound. Provide adequate ventilation. Avoid inhalation of fumes and skin contact. If compound is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor is preferable.

1. Clean pistons (4), pins (7), retaining rings (8) piston rings (1, 2, 3) and expansion spring (6) by soaking in carbon removing compound (item 5, WP 0167).

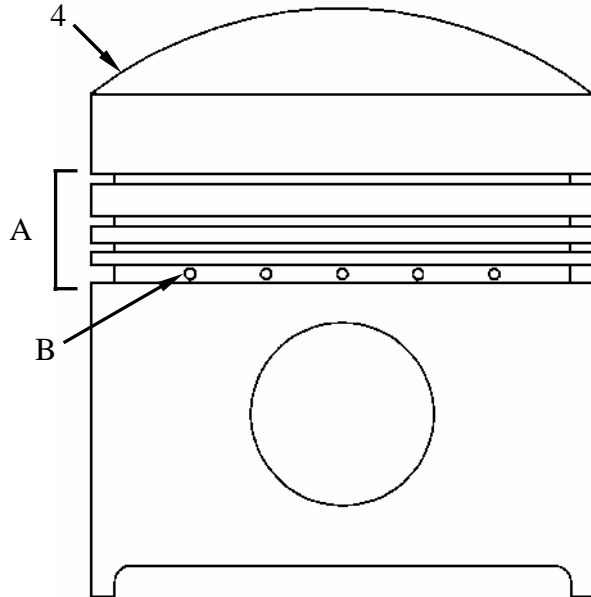


CLEANING (Continued)

**CAUTION**

**Be careful not to scratch or gouge ring grooves and lands on piston. Failure to comply may result in premature failure.**

2. Scrape remaining carbon deposits from piston (4) ring grooves (A) with a scraper or broken piston ring.
3. Clean oil drain holes (B) in oil ring grooves of piston.



**WARNING**



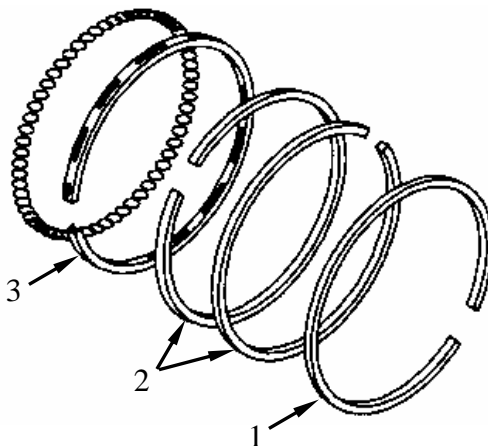
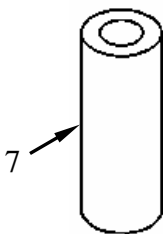
**Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.**

**Ensure there is good airflow when using solvent, and work area is away from heat and flames.**



- **Keep fire extinguisher nearby.**
- **Do not breathe solvent fumes.**
- **Avoid skin contact. See Warning in front of Manual.**

4. Clean carbon from piston pins (7) with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
5. Scrape any remaining carbon from the ends (in the gap) of piston rings (1, 2, 3).



INSPECTION

**CAUTION**

**It is important that all pistons be the same size and weight. Failure to comply may result in premature failure.**

1. Inspect the top of the piston for oversize and weight code identification stamps.

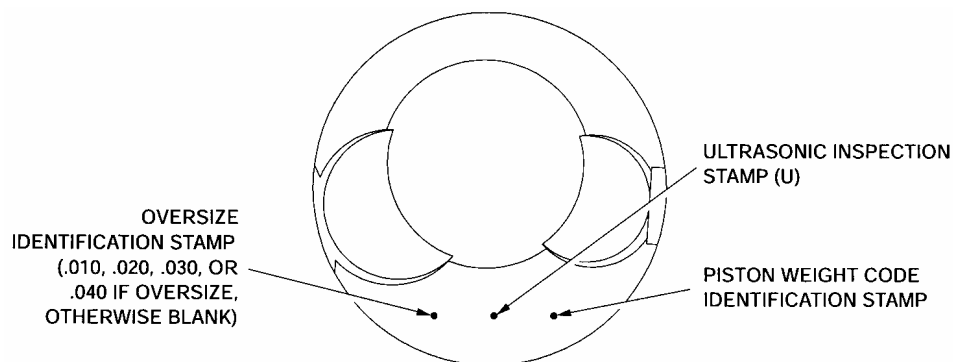
**NOTE**

**Early pistons supplied as individual spare parts were not stamped to indicate weight. To insure that all pistons used for replacement are properly matched by weight, all pistons that are not coded must be weighed and code stamped before being installed in an engine. If the weight code is missing or not legible, weigh the piston and metal-stamp the weight identification code at the location shown, using 0.25-inch (6.35-mm) high characters in accordance with the following table.**

Stamp Code	Piston Weight Pounds
5	7.75
	7.76
	7.77
4	7.78
	7.79
	7.80
3	7.81
	7.82
	7.83
2	7.84
	7.85
	7.86
1	7.87
	7.88
	7.89
A	7.90
	7.91
	7.92

Stamp Code	Piston Weight Pounds
B	7.93
	7.94
	7.95
C	7.96
	7.97
	7.98
D	7.99
	8.00
	8.01
E	8.02
	8.03
	8.04
F	8.05
	8.06
	8.07
G	8.08
	8.09
	8.10

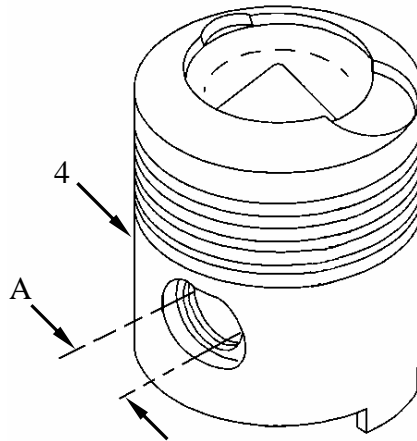
Stamp Code	Piston Weight Pounds
H	8.11
	8.12
	8.13
J	8.14
	8.15
	8.16
K	8.17
	8.18
	8.19
L	8.20
	8.21
	8.22
M	8.23
	8.24
	8.25



**INSPECTION (Continued)**

**NOTE**

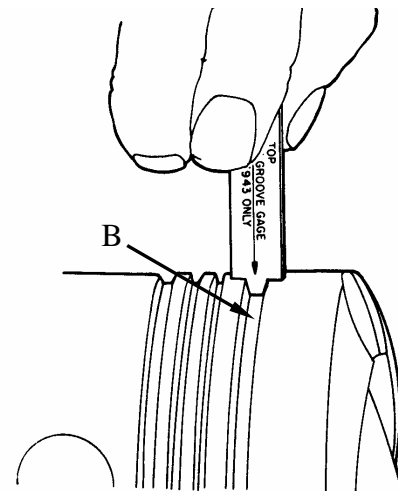
**If dye inspection kit (item 35, WP 0176) is available, use of that inspection method to check for cracks is preferred.**



2. Inspect piston (4) for cracks, flaws or distortion.
  - a. Use a magnifying glass and a strong light. Small cracks will show under the light as irregular or dark streaks. Replace piston if any cracks are found.
  - b. Inspect piston (4) for damage or broken ring lands. Replace piston if damage or broken lands are found.
3. Measure the inside diameter of piston pin bore (A). Replace pistons (4) that do not meet the following limits.

Location	Sizes and Fits of New Parts - inches (mm)		Wear Limits
A (Inside diameter of piston pin bore)	2.1268 (54.0207)	2.1270 (54.0258)	2.1280 (54.0512)

4. Check the top (tapered) ring groove by one of two methods.
  - a. Top groove (B) may be checked with gauge (item 51, WP 0176).
    - (1) Insert gauge in top groove.
    - (2) If the shoulder of the gauge touches the ring land, the piston must be discarded.
  - b. Top groove may also be checked by measuring over two 0.11547-inch (2.932938-mm) diameter roll pins. Replace pistons that do not meet the following limits.



Location	Sizes and Fits of New Parts - inches (mm)		Wear Limits
STD	5.7140 (145.1356)	5.7240 (145.3896)	5.7040 (144.8816)
0.0100 oversize	5.7240 (145.3896)	5.7340 (145.6436)	5.7140 (145.1356)
0.0200 oversize	5.7340 (145.6436)	5.7440 (145.8976)	5.7240 (145.3896)
0.0300 oversize	5.7440 (145.8976)	5.7540 (146.1516)	5.7340 (145.6436)
0.0400 oversize	5.7540 (146.1516)	5.7640 (146.4056)	5.7440 (145.8976)

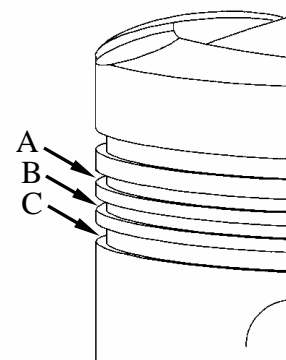
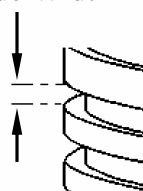
**INSPECTION (Continued)**

**NOTE**

**Piston ring locations are numbered from the top down.**

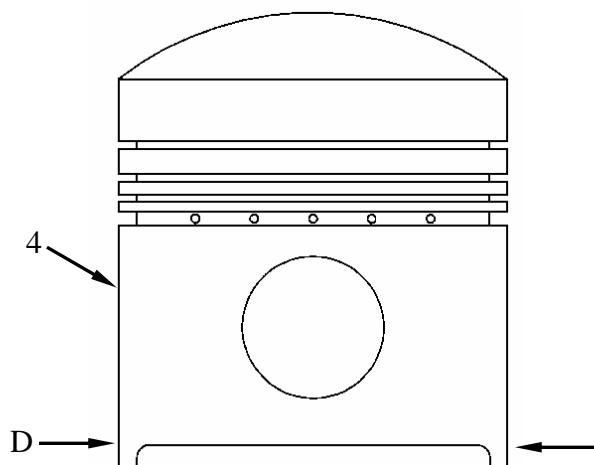
5. Check the second (A), third (B), and fourth (C) ring grooves against limits specified below.
  - a. Replace pistons that do not meet the following limits.

Inside Width



Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Inside groove width)	0.0990 (2.5146)	0.1000 (2.54)	0.1035 (2.6289)
B (Inside groove width)	0.0980 (2.4892)	0.0990 (2.5146)	0.1025 (2.6035)
C (Inside groove width)	0.1880 (4.7752)	0.1890 (4.8006)	1.1910 (30.2514)

6. Measure piston (4) skirt.
  - a. Measure the piston diameter at the bottom of the skirt 90 degrees to piston pin (D).
  - b. Replace pistons that do not meet the following limits.



Location and Size	Sizes and Fits of New Parts inches (mm)		Wear Limits
D (Standard)	5.7410 (145.8214)	5.7420 (145.8468)	5.7380 (145.7452)
D (0.0100-inch oversize)	5.7510 (146.0754)	5.7520 (146.1008)	5.7480 (145.9992)
D (0.0200-inch oversize)	5.7610 (146.3294)	5.7620 (146.3548)	5.7580 (146.2532)
D (0.0300-inch oversize)	5.7710 (146.5834)	5.7720 (146.6088)	5.7680 (146.5072)
D (0.0400-inch oversize)	5.7810 (146.8374)	5.7820 (146.8628)	5.7780 (146.7612)

**INSPECTION (Continued)**

7. Visually inspect piston rings.
  - a. Look for scuffing, scoring, chipping, scratches or abrasions. Pay particular attention to rings that were found to be sticking in the piston ring grooves.
  - b. Replace any rings that are scuffed, scored, chipped, or abraded.

**NOTE**

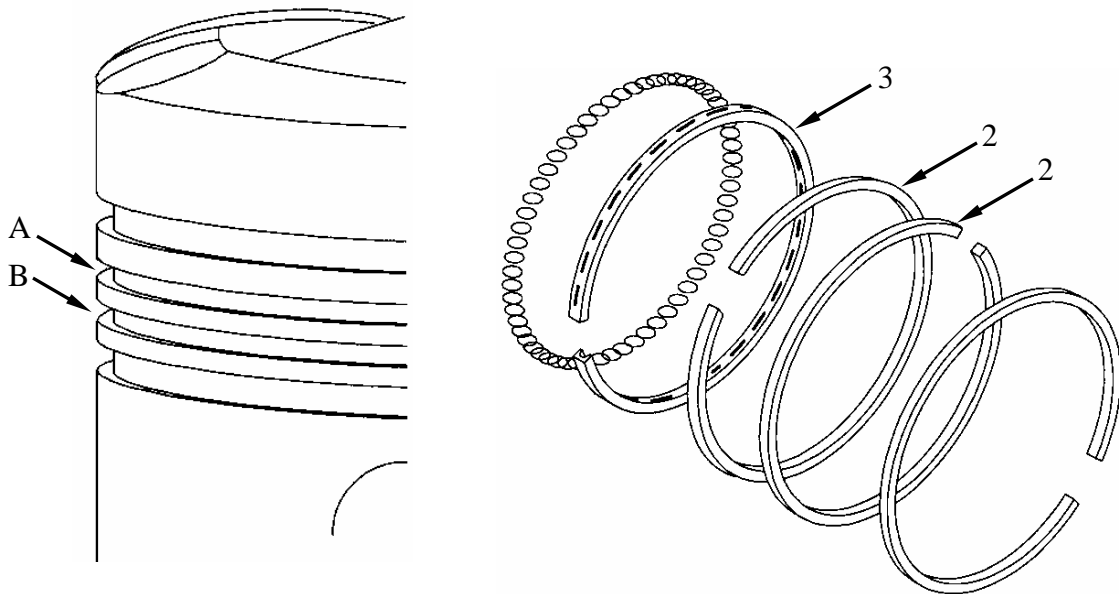
**The width of the top piston ring cannot be accurately measured. When ring is installed in fixture, the end gap is the only measurement for the top ring.**

8. Measure the width of intermediate compression rings (2) and oil control ring (3). Replace rings that do not meet the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
2 (Compression ring width)	0.0925 (2.3495)	0.0935 (2.3749)	None
2 (Clearance when installed in second (A) ring groove)	0.0055L (0.1397L)	0.0075L (0.1905L)	0.0110 (0.2794)
2 (Clearance when installed in third (B) ring groove)	0.0045L (0.1143L)	0.0065L (0.1651L)	0.0100 (0.254)
3 (Oil control ring width)	0.1855 (4.7117)	0.1865 (4.7371)	None
3 (Clearance when installed)	0.0015L (0.0381L)	0.0035L (0.0889L)	0.0055L (0.1397L)

**NOTE**

**Clearances (A and B) will be measured with a thickness gauge at assembly.**



**INSPECTION (Continued)**

9. Measure ring end gap.

- a. Place each ring (1, 2, 3, 4) one at a time, in the appropriate ring gauge (9) (standard or oversize).

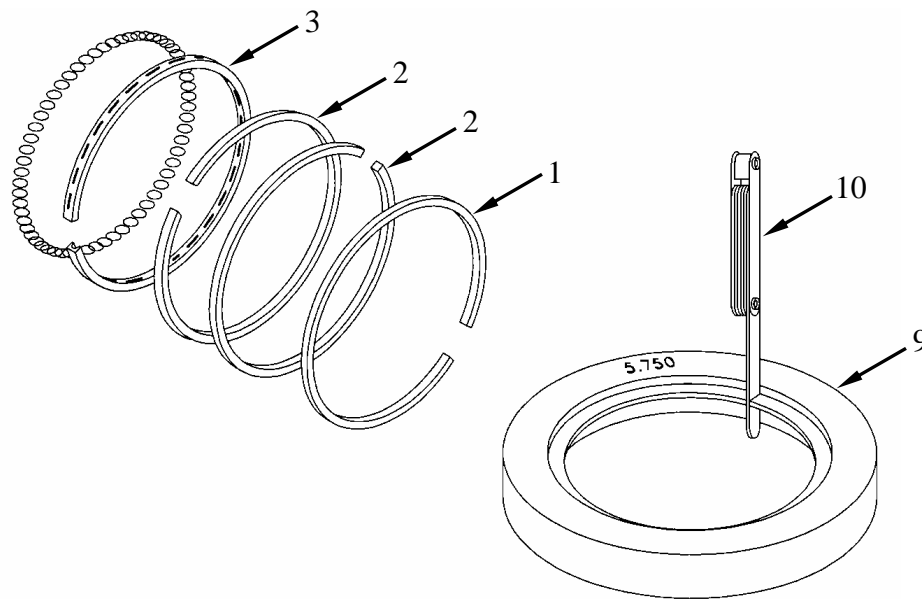
**NOTE**

**Ring gauges are identified according to ring size. Some gauges are dual purpose tools; i.e., each side for a different size ring. Select the proper ring gauge from the following table.**

Gauge Identification	Ring Size Identification	Ring Gauge
5.7500 and 5.7700	Standard and 0.020 in. oversize	Item 48 (WP 0176)
5.7600 and 5.7800	0.010 and 0.030 in. oversize	Item 45 (WP 0176)
0.7500 and 5.7900	Standard and 0.040 in. oversize	Item 46 (WP 0176)

- b. Measure end gap with a thickness gauge (10) (item 54, WP 0176). Replace rings that do not meet the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
1. (Top compression ring)	0.0250 (0.635)	0.0350 (0.889)	0.0350 (0.889)
2. (Intermediate compression rings – 2nd and 3rd groove)	0.0250 (0.635)	0.0350 (0.889)	0.0350 (0.889)
3. (Oil control ring)	0.0350 (0.889)	0.0450 (1.143)	0.0450 (1.143)

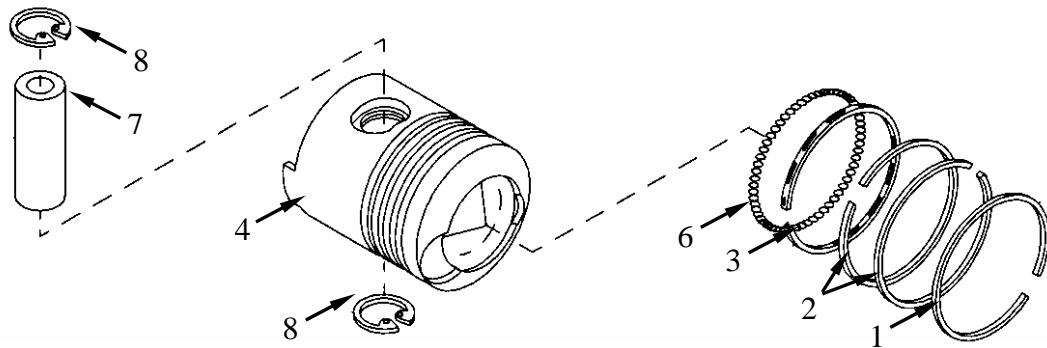


**INSPECTION (Continued)**

10. Inspect piston pin (7).

a. Check diameter of piston pins (7) against limits specified below.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Diameter of pin)	2.1250 (53.975)	2.1252 (53.9800)	2.1248 (53.9699)
Fit of pin to bore	0.0016L (0.0406L)	0.0020L (0.0508L)	0.0032L (0.08128L)



**REPAIR**

**WARNING**



**Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.**

**Ensure there is good airflow when using solvent, and work area is away from heat and flames.**



- **Keep fire extinguisher nearby.**
- **Do not breathe solvent fumes.**
- **Avoid skin contact. See Warning in front of Manual.**

1. Remove minor burrs, nicks or scratches from pistons (4) with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
2. Replace pistons (4) that are distorted, cracked, worn, or abraded.
3. Replace pistons (4) if oil holes in the ring grooves cannot be cleared or if lands are damaged or broken.
4. Replace pistons (4) that are badly burred or scratched.
5. Replace piston rings (1, 2, 3, or 4) that are scuffed, chipped, scratched, or showing signs of abrasion.
6. Replace oil control rings (3) if drain holes cannot be cleared.



## ASSEMBLY

## NOTE

Piston rings are marked to indicate which side goes up. Check marking on rings and install the upper (tapered) compression ring and the two intermediate compression rings with the marking "TOP" or "•" mark toward the piston dome. Oil control rings are symmetrical and may be installed with either side up.

Piston rings should be installed starting with the lowermost ring so that no ring has to pass over another during installation. During installation, expand rings only enough to slide ring over body of piston and into the proper groove.

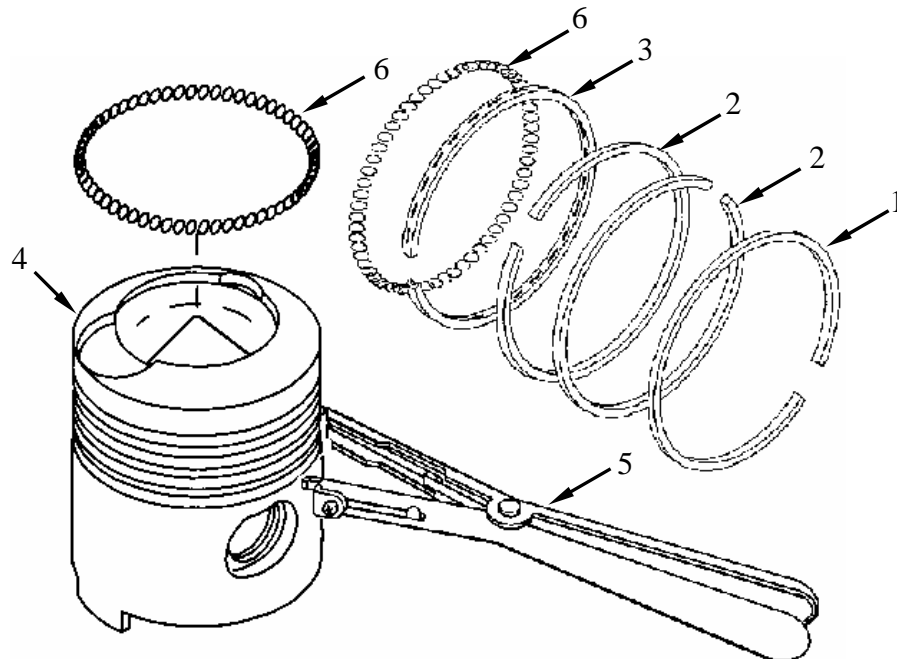
Install all rings using remover and replacer (item 78, WP 0176) as shown.

1. Install oil control ring (3).
  - a. Install expander spring (6) in groove number four of piston (4) by joining at parting line.

**CAUTION**

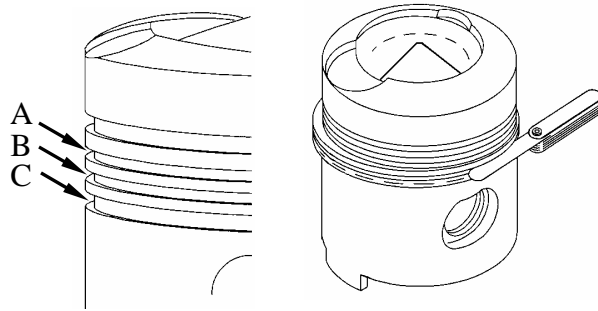
Use care in installing rings to avoid damaging ring lands or distorting rings. Rings are easily broken, do not expand any more than necessary to accomplish installation.

- b. Using remover and replacer (5) (item 78, WP 0176), install oil control ring (3) over expander spring (6) in groove four of piston (4).
2. Install compression rings (1, 2) lowermost first, in a similar manner.



**ASSEMBLY (Continued)**

3. Measure ring "side" clearance.
  - a. Measure side clearance (A, B, C) of the bottom three rings.
  - b. Replace rings that do not meet the specifications below.

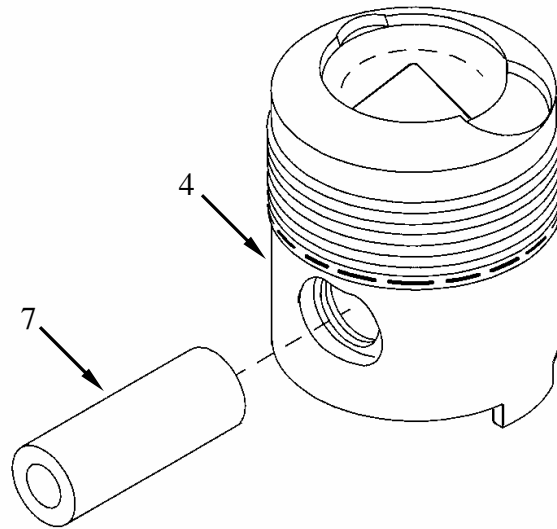


Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Second ring groove)	0.0055L (0.1397L)	0.0075L (0.1905L)	0.0110 (0.2794)
B (Third ring groove)	0.0045L (0.1143L)	0.0065L (0.1651L)	0.0100 (0.2794)
C (Fourth ring groove)	0.0015L (0.0381L)	0.0035L (0.0889L)	0.0055L (0.1397L)

**NOTE**

**Piston pin retaining rings need not be installed until the piston and cylinder are installed on the engine.**

4. Install piston pin (7) in bore of piston (4).



**END OF WORK PACKAGE**

**CONNECTING ROD ASSEMBLY REPAIR**

**0143 00**

**THIS WORK PACKAGE COVERS:**

Removal, Inspection, Repair, Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

- Dial indicator (item 65, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Telescoping gauge set (item 54, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)
- Torque wrench, 320-1600 inch-pounds, or Torque wrench, 0-600 foot-pounds (item 128, WP 0176)
- V-blocks (2) (item 131, WP 0176)

**Fabricated Tools:**

- Connecting rod fixture (Connecting Rod Bearing Replacement Tool Kit (item 5, WP 0177)

**Expendable Materials:**

- Cleaning compound, solvent (item 8, WP 0173)
- Lubriplate (item 23, WP 0173)
- Prussian blue paste (item 25, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (1) 63H10

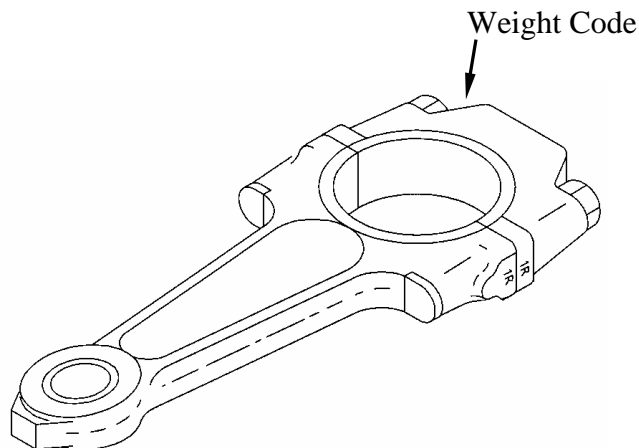
**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Cylinder assembly and piston removed (WP 0133)
- Oil pan assembly removed (WP 0152)
- Oil pump assembly removed (WP 0153)
- Oil pressure compartment baffle and associated parts removed (WP 0153)

**DISASSEMBLY**

**CAUTION**

**Connecting rods are weight sensitive. They come in matched sets with the weight code stamped on the crankshaft end of each rod. Be sure that the code letter is the same for all 12 connecting rods.**



**DISASSEMBLY (Continued)**

The engine has 12 connecting rods. The following procedures apply to one or all. If the connecting rods for cylinders 5L, 5R, 6L, and 6R are not to be removed, the oil pump and baffle may be left in place.

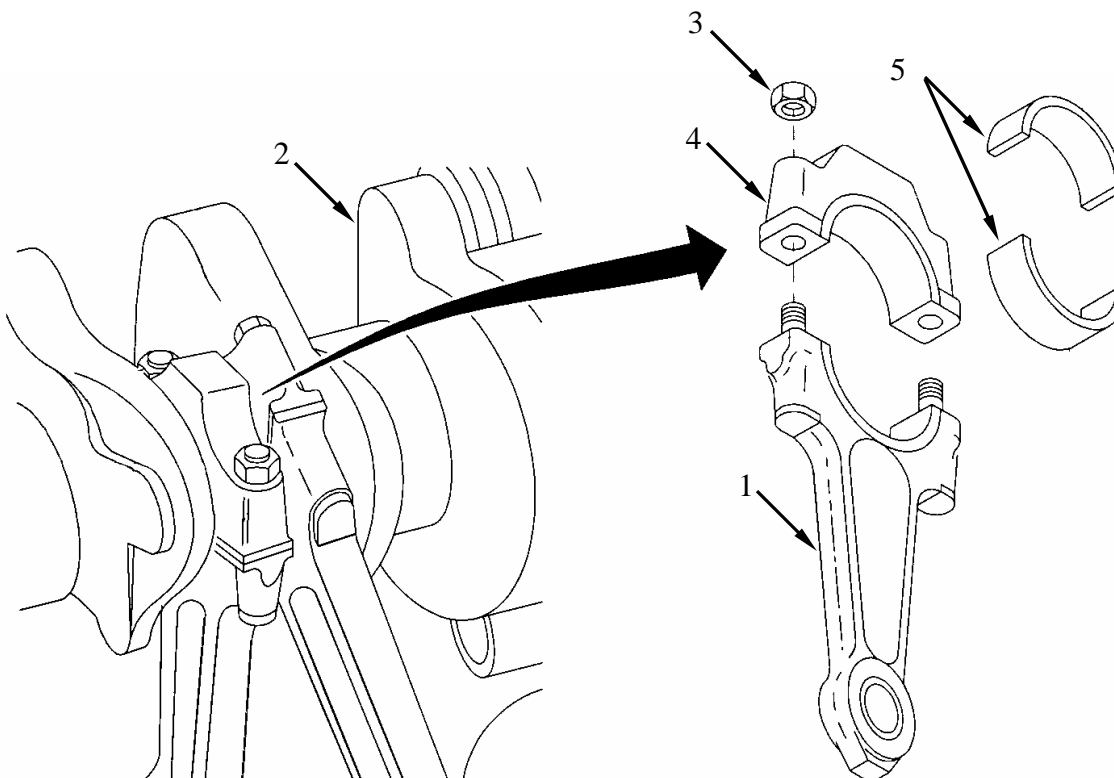
**CAUTION**

**Care must be exercised in handling of the connecting rods to avoid nicks and scratches that can act as stress risers and lead to premature failure. Do not use a scribe or other sharp instrument for marking connecting rod bearing halves.**

1. Remove connecting rod (1) from crankshaft (2).
  - a. Remove two nuts (3) attaching cap (4) to connecting rod.
  - b. Remove cap (4), bearing halves (5), and connecting rod (1) from crankshaft (2).
  - c. Remove bearing halves (5) from cap (4).

**CAUTION**

**After bearings are removed, reassemble connecting rod and cap as they are a matched set and must be kept together for inspection and assembly. If subsequent inspection indicates the bearings are reusable, they must be reassembled in their original positions. Failure to comply may result in premature failure.**



## DISASSEMBLY (Continued)

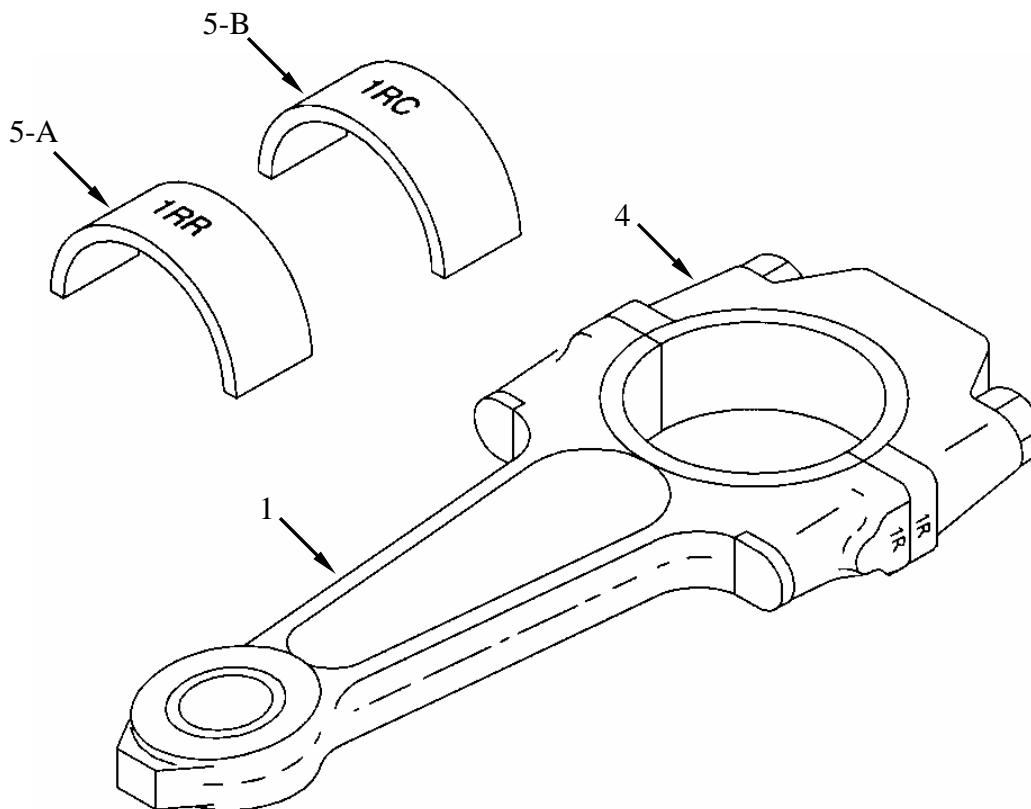
## NOTE

Connecting rods and caps are stamped with a location number on the side of one of the bosses. For example, "1R" would identify connecting rod and cap for number one cylinder on the right bank. Identifying serial numbers are located on the side opposite of the cylinder location numbers.

2. Identify bearing (5) location.
  - a. Mark the two bearing halves (5) with a grease pencil or suitable marker to indicate their location. For example, the connecting rod bearing half (A) for cylinder "1R" should be marked "1RR" {1 right rod} and the cap bearing half (B) should be marked "1RC" {1 right cap}.

## NOTE

If connecting rod (1) or cap (4) markings are obliterated, stamp connecting rods and caps so that they can be installed in their original positions.



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

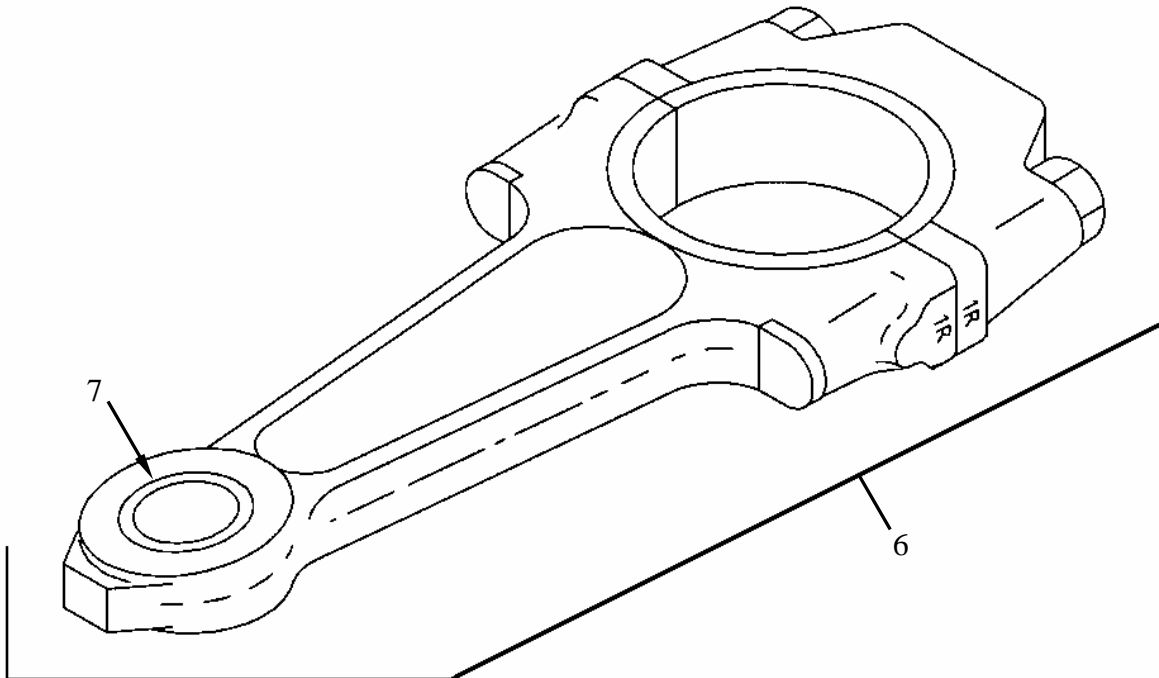
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Visually inspect rod assembly (6) for cracks and for twisted or bent condition. Replace cracked, bent, or twisted rods.

**CAUTION**

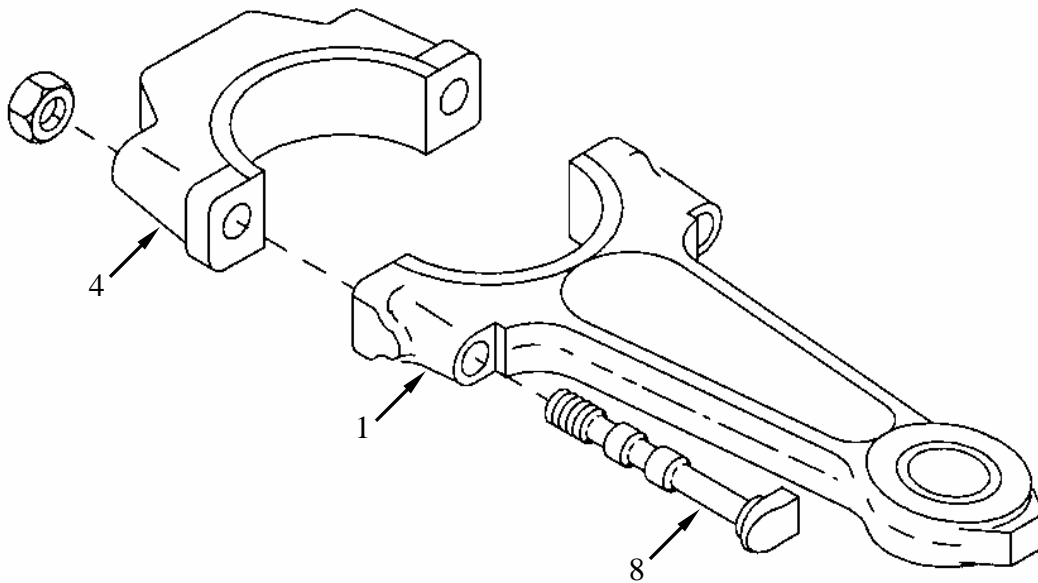
**Under no circumstances can connecting rods be straightened. Destroy any rod found damaged to ensure it will not be reused in an engine.**

3. Inspect piston pin sleeve bearing (7) for pitting, galling, scoring, or discoloration. Mark damaged bearings for replacement.

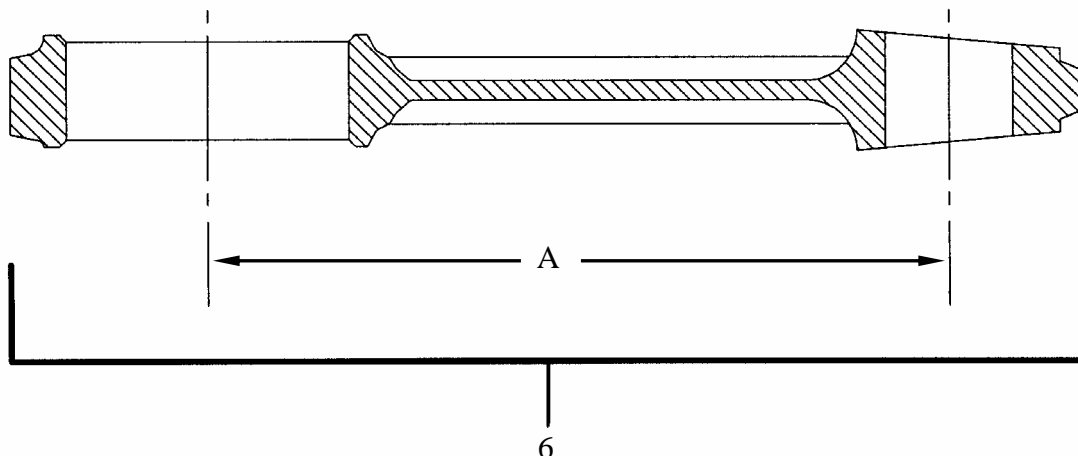


**INSPECTION (Continued)**

4. Inspect rod bolts (8) for damaged threads, galled pilot diameters, cracks, scratches or any evidence of stretching. Replace any damaged bolts.
5. Check that bolts (8) fit snugly in rod (1) and cap (4). Replace bolts that have more than 0.0009-inch (0.02286-mm) clearance.



6. Check dimension (A) between centerline of small and large end bores of assembled connecting rod (6).
  - a. Dimension (A) must be 10.998 to 11.002 inches (279.3492 to 279.4508 mm).
  - b. Destroy any rod that does not meet this limit to insure it will not be used in an engine.

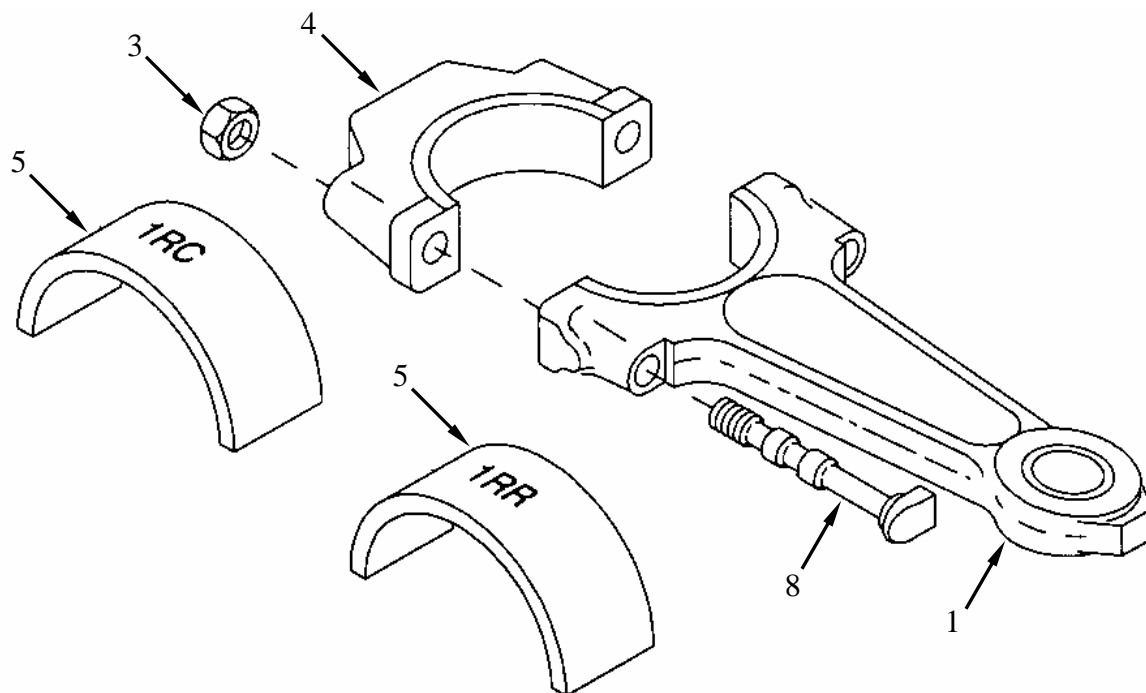


**INSPECTION (Continued)**

7. Inspect connecting rod (1) bearings (5, 7).
  - a. Visually inspect connecting rod bearing halves (5).

BASIS FOR BEARING REJECTION	ACCEPTABLE BEARING FLAWS
Separation of bearing metal, or signs of possible separation.	Fine scratches on bearing surface.
Pieces of metal or dirt particles embedded in bearing surface with a concentration of 5 per cent or more of the surface area.	Minute pieces of metal and dirt particles embedded in bearing surface with a concentration of less than 5 per cent. (Do not attempt to remove such particles.)
Pitting or any other form of destruction to bearing surface.	
Raised metal at edges of scratches.	

- b. Apply a thin coating of Prussian blue (item 25, WP 0173) to the backs of the connecting rod bearing halves (5) to check contact area (after dimensional check).
- c. Install bearing halves (5) in their respective connecting rods (1) and caps (4) according to the location markings.
- d. Apply lubricant (item 23, WP 0173) to rod bolt (8) threads and nut (3) seat.
- e. Assemble rod (1) and cap (4) and torque-tighten progressively, first to 100-150 inch-pounds, then to 600-650 inch-pounds (50-54 foot-pounds, or 68-73 N•m), and finally to 1250-1300 inch-pounds (104-108 foot-pounds, or 141-147 N•m).



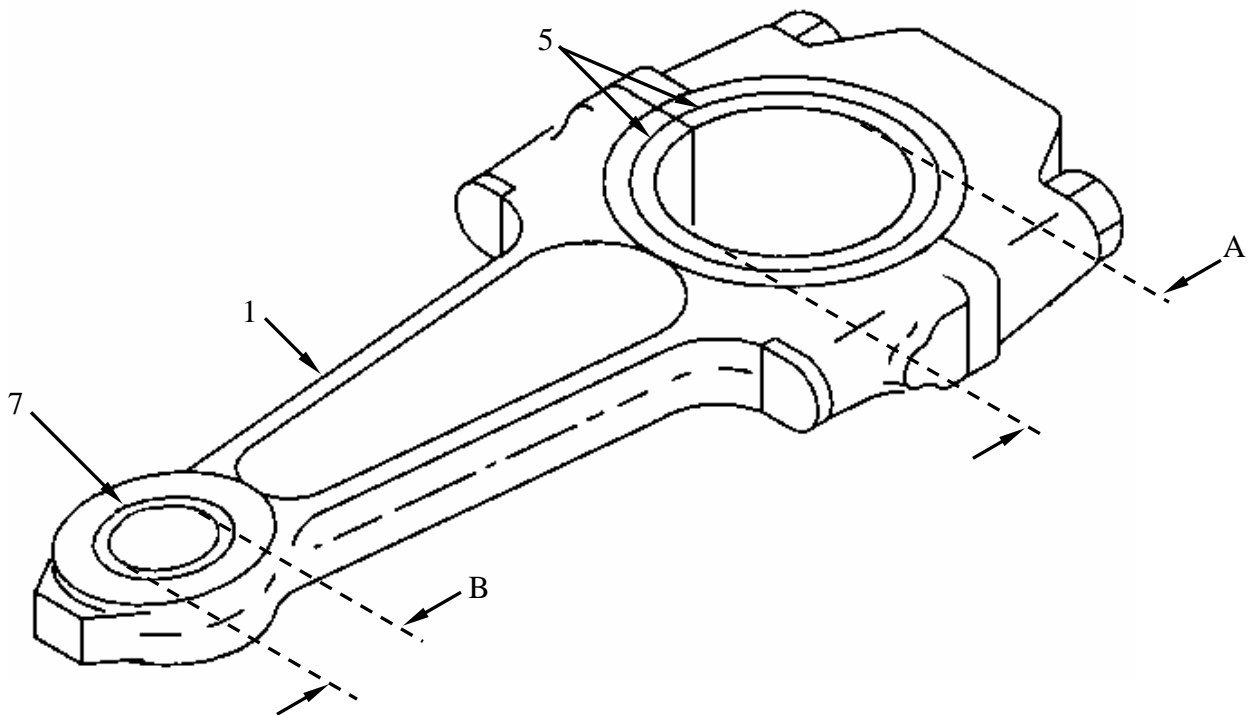


**INSPECTION (Continued)**

7. Inspect connecting rod (1) bearings (5,7) (Continued).

- f. Measure inside diameter of connecting rod bearings. Replace bearings that do not meet the following limits.

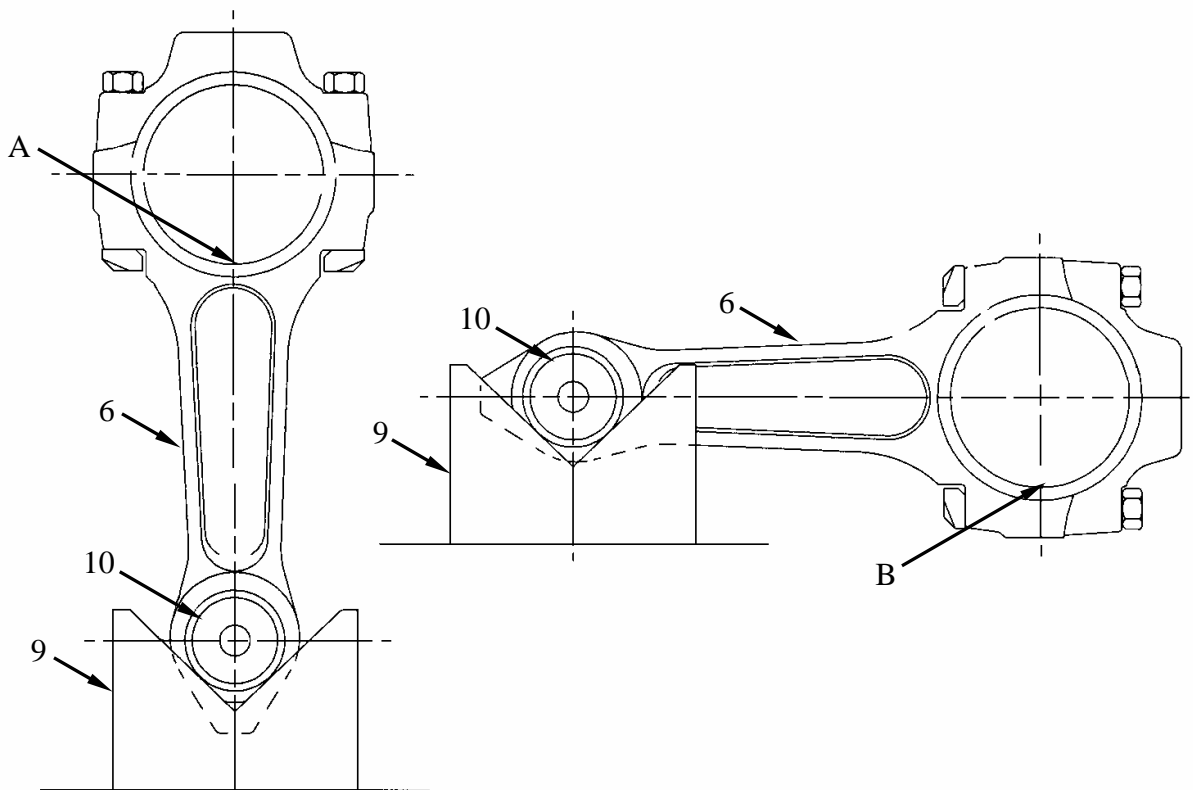
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Diameter at proper torque) Standard 0.003 (0.0762 mm) Undersize 0.010 (0.2540 mm) Undersize	3.7525 (95.3135)	3.7540 (95.3516)	3.7550 (95.3770)
	3.7495 (95.2373)	3.7510 (95.2754)	3.7520 (95.3008)
	3.7425 (95.0595)	3.7440 (95.0976)	3.7450 (95.1230)
B (Diameter of sleeve bearing)	2.1275 (54.0385)	2.1277 (54.0436)	2.1248 (53.9699)



**INSPECTION (Continued)**

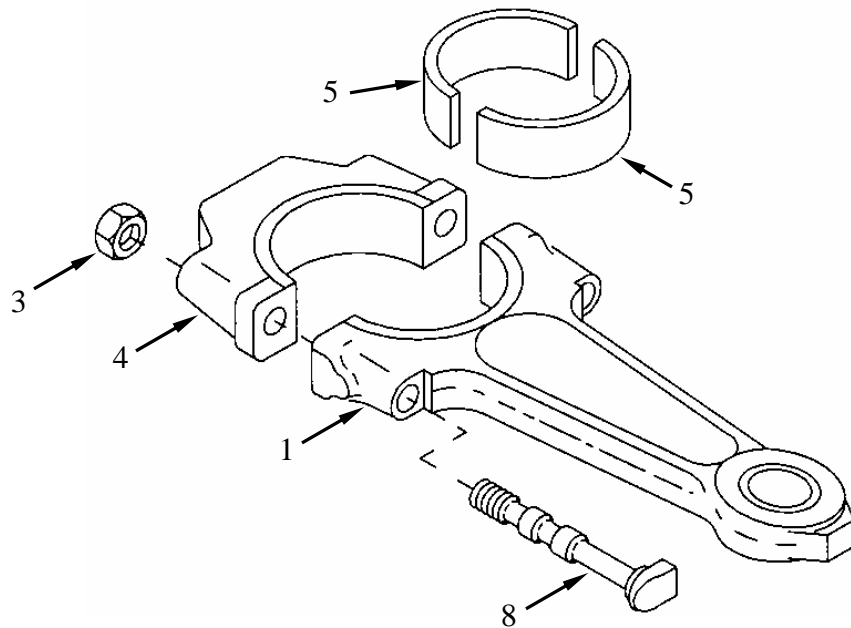
8. Check connecting rod assembly (6) for straightness.
  - a. Check connecting rod assembly (6) for parallelism and twist by setting in two V-blocks (9) using a new piston pin (10).
  - b. Measure bearing from side to side with a dial indicator (item 65, WP 0176). Replace rod assemblies that do not meet the following limits.

Location	Limits with <u>New</u> Piston Pin Bushing inches (mm)	Limits with <u>Used</u> Piston Pin Bushing inches (mm)
A Parallelism of connecting rod	0.0005 per inch (0.0127 per mm) of bearing width	0.0010 per inch (0.0254 per mm) of bearing width
B Twist of connecting rod	0.0005 per inch (0.0127 per mm) of bearing width	0.0010 per inch (0.0254 per mm) of bearing width



**INSPECTION (Continued)**

9. Check contact of bearing halves (5).
  - a. Remove two nuts (3) from rod bolts (8).
  - b. Remove cap (4).
  - c. Remove bearing halves (5) from cap (4) and rod (1).
  - d. Check contact of bearing halves (5) between rod (1) and cap (4) as shown by Prussian blue transfer. Replace any bearing that does not make at least 75 per cent contact.



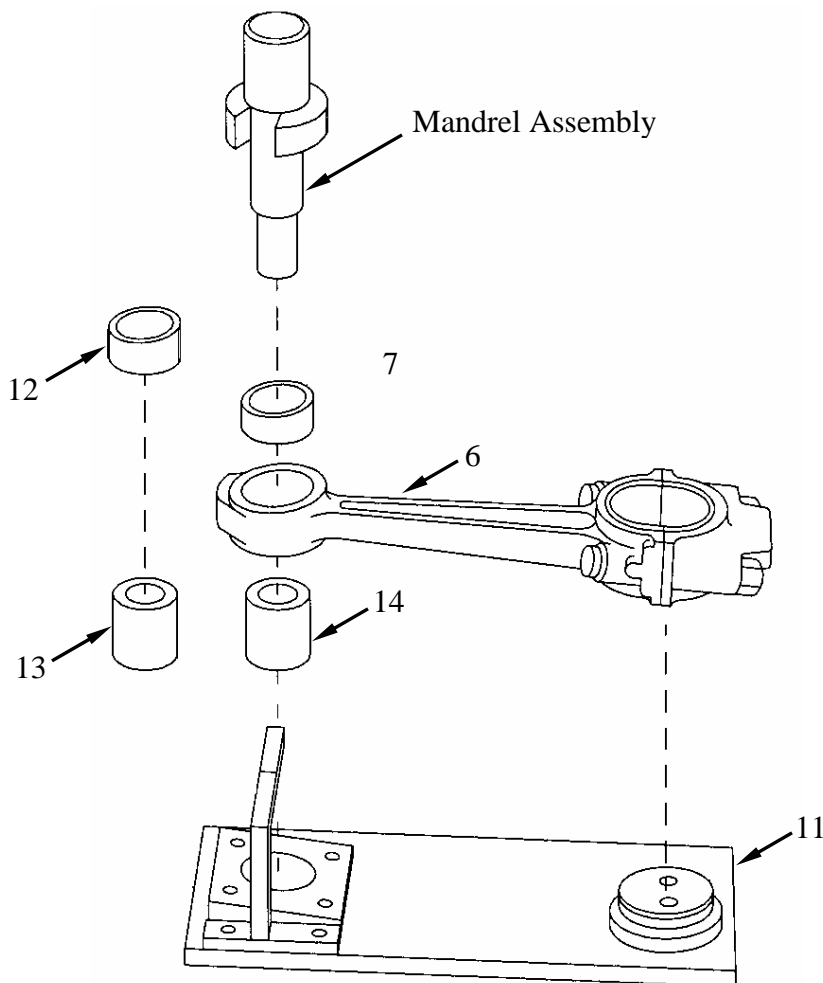
## REPAIR

1. Replace worn or damaged connecting rod sleeve-bearing (7).
  - a. Remove old sleeve bearing (7) using fixture (11) with sleeve (12) and guide (13).

**WARNING**

**Wear gloves when handling hot or cold parts. Failure to comply may result in personal injury.**

- b. Heat connecting rod (1) to 250 °F (121.1 °C) for approximately 20 minutes.
- c. Chill sleeve-bearing (7) to 35 °F (-1.6 °C).
- d. Place connecting rod (1) on fixture (11) (item 5, WP 0177).
- e. Install sleeve-bearing (7) using fixture (11) and guide (14).
- f. Burnish to seat bearing (12), then finish ream to 2.1275 to 2.1277 inches (54.0385 to 54.04358 mm). Check that bore centers are maintained as in step 6 of Inspection.

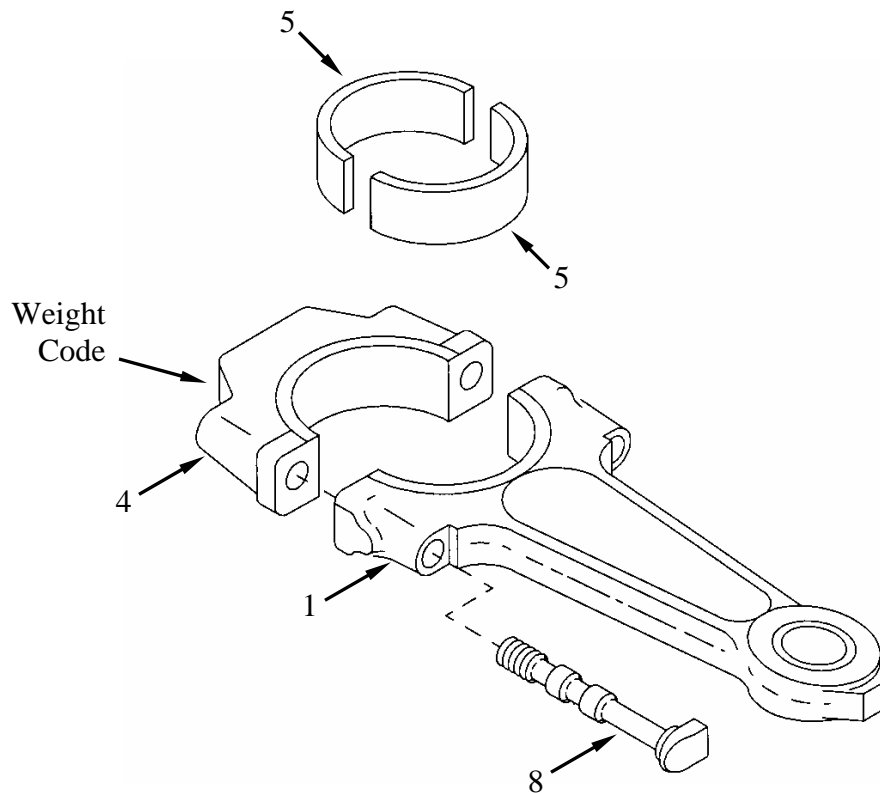


## ASSEMBLY

**CAUTION**

**Connecting rods are weight sensitive. They come in matched sets with the weight code stamped on the crankshaft end of each rod. Be sure that the code letter is the same for all 12 connecting rods.**

1. Position connecting rod bearing halves (5) in their respective rod (1) and cap (4).
2. Install two connecting rod bolts (8).
  - a. Position bolts (8) in connecting rod (1) making certain each bolt is properly seated in the recess provided.



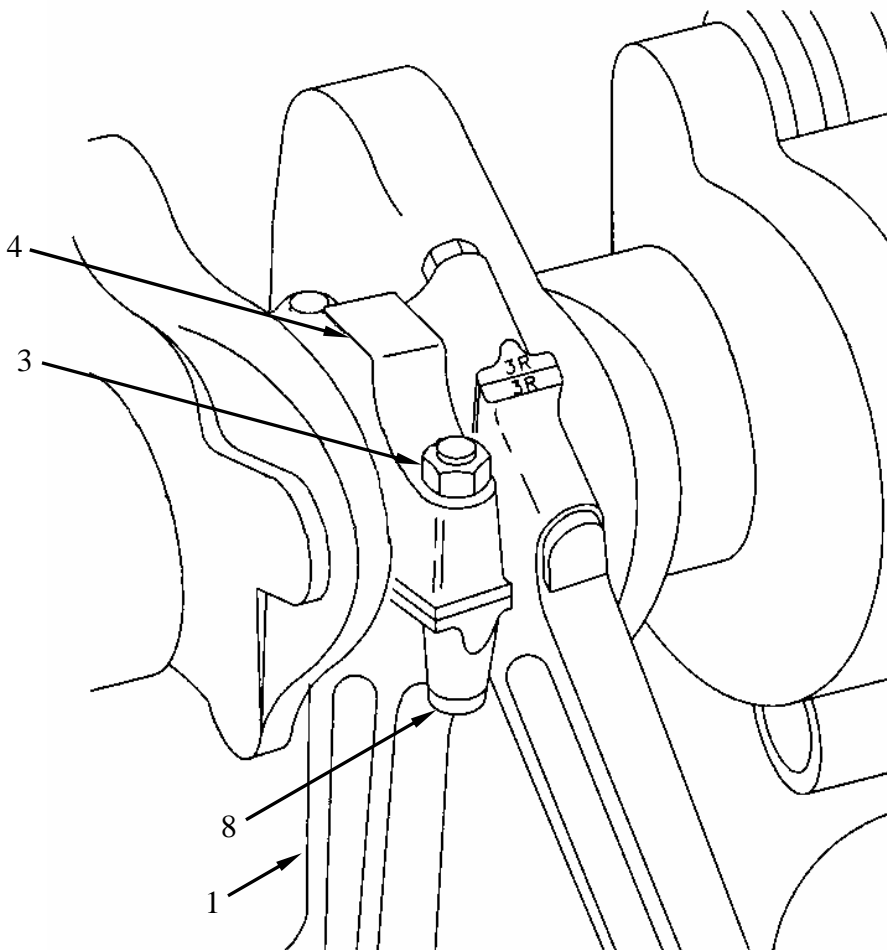
**ASSEMBLY (Continued)**

- 3 Position connecting rod (1) on crankshaft in proper location according to identification number.

**CAUTION**

**Connecting rod numbers begin at the damper end of the crankshaft. Right bank rods are installed on the damper end of each crankshaft journal and left bank rods are on the flywheel end. All location numbers must be visible from the oil pan opening when crankshaft and rods are installed in the crankcase.**

4. Position connecting rod cap (4) with bearing installed on journal, and mate it with the corresponding rod (1).
5. Secure rod (1) and cap (4) with two rod bolts (8) and hexagon nuts (3).
  - a. Apply Lubriplate (item 23, WP 0173) to rod bolt (8) threads and nut (3) seat.
  - b. Tighten both nuts alternately to 100-150 inch-pounds, then to 600-650 inch-pounds (50-54 foot-pounds, or 68-73 N•m), and finally to 1250-1300 inch-pounds (104-108 foot-pounds, or 141-147 N•m).



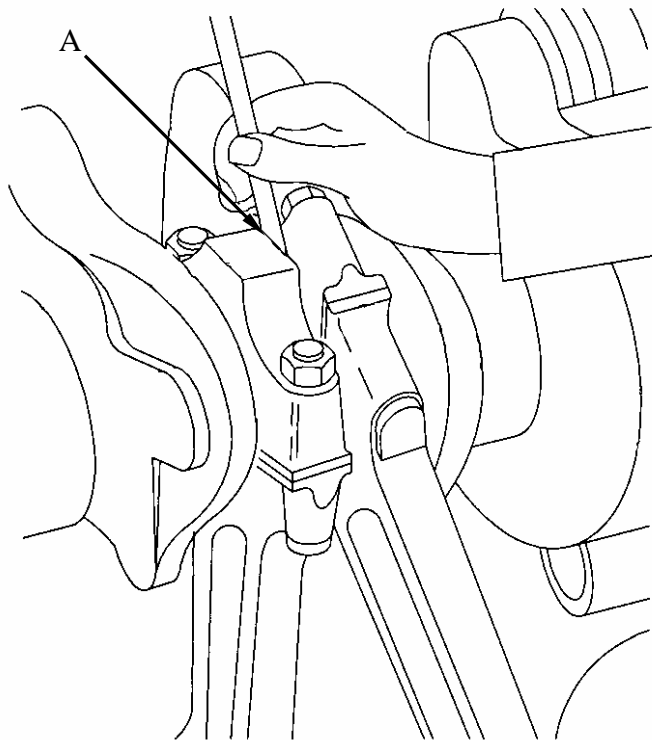
**CONNECTING ROD ASSEMBLY REPAIR**

**0143 00**

**ASSEMBLY (Continued)**

6. Using a feeler gauge as shown, check the side clearance (A) of each pair of connecting rods against limits specified in the following table.
  - a. Disassemble and replace connecting rods and bearings as necessary to obtain the proper clearance.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Side clearance of two rods on crankshaft journal)	0.0090L (0.2286L)	0.0170L (0.4318L)	0.0200L (0.508L)



**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Disassembly, Assembly, and Installation

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

General mechanic's tool kit (item 121, WP 0176)

Machinist vise (item 132, WP 0176)

Torque wrench, 0-150 in-lb (item 123, WP 0176)

**Expendable Materials:**

Lubriplate (item 23, WP 0173)

Wire, non-electrical (item 43, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)

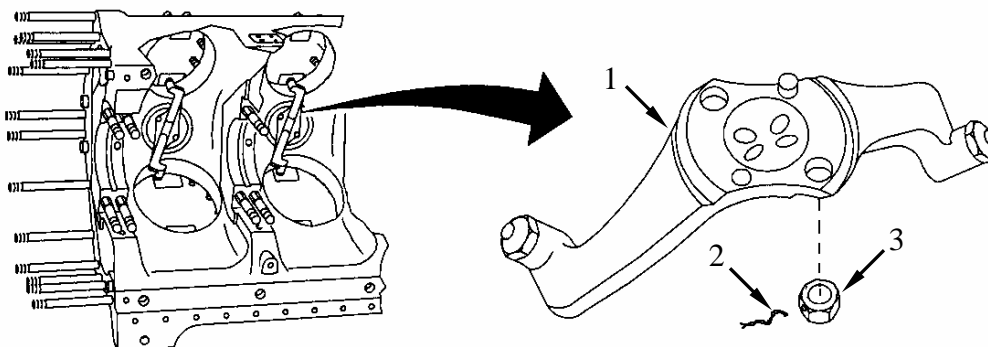
Crankshaft removed (WP 0139)

Cylinder assembly and piston removed  
(WP 0133)

**REMOVAL****NOTE**

**The engine has six piston oil sprayer assemblies. The following procedures will apply to one or all assemblies. Piston oil sprayers are not peculiar to location; they are interchangeable from one location to another.**

1. Remove oil sprayer assembly (1).
  - a. Cut and remove locking wire (2). Discard wire.
  - b. Remove two slotted nuts (3).
  - c. Remove sprayer assembly (1).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.
2. Make sure oil passages in oil sprayer body (4) and oil holes in nozzle (5) are clean and free of obstructions. Replace sprayer body (4) or nozzle (5) when they cannot be cleared of obstructions.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

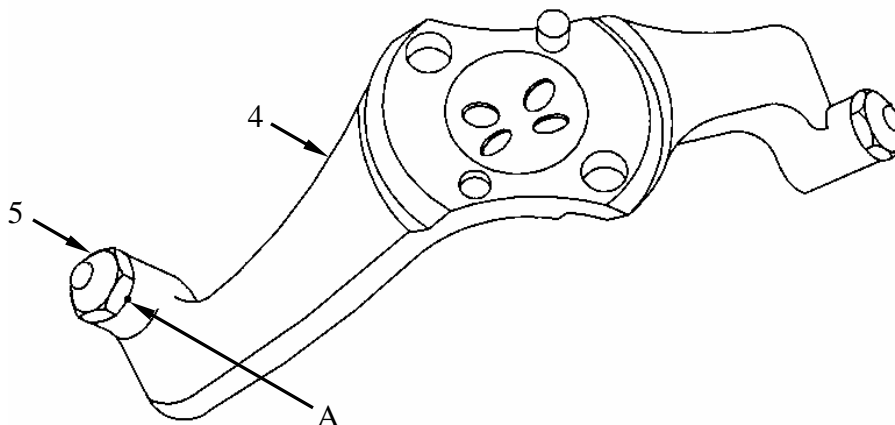
**DISASSEMBLY****NOTE**

**Do not remove nozzles unless the nozzle or sprayer cannot be cleaned without disassembly. The piston oil sprayer assembly has two nozzles. The following procedure applies to one or both.**

1. Remove nozzle (5).
  - a. Position piston oil sprayer body (4) in a machinist vise (item 132, WP 0176) and remove nozzle (5).

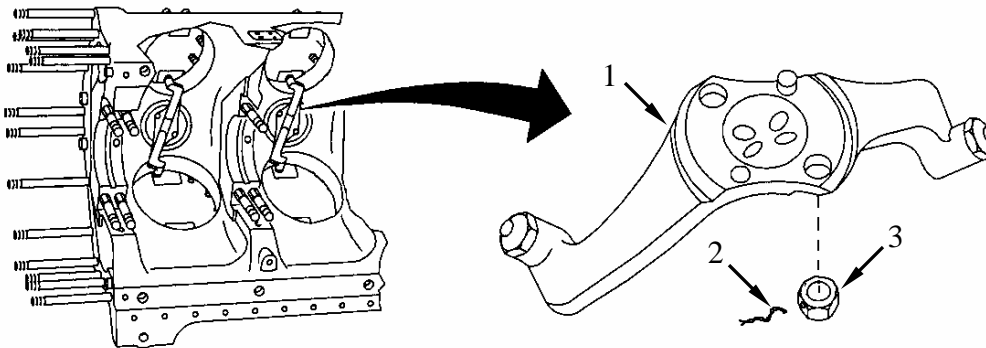
**ASSEMBLY**

1. Install nozzle (5).
  - a. Position sprayer body (4) in a machinist vise and install nozzle (5).
  - b. Tighten nozzle (5) and stake on three flats (A) at 120 degrees apart.



**INSTALLATION**

1. Lubricate threads of two slotted nuts (3) with Lubriplate (item 23, WP 0173)
2. Install piston oil sprayer assembly (1) and secure with two slotted nuts (3).
  - a. Torque-tighten slotted nuts (3) to 125-150-inch pounds (14-17 N•m).
  - b. Secure slotted nuts (3) with locking wire (2) (item 43, WP 0173).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Cleaning, Inspection, and Repair

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

- General mechanic's tool kit (item 121, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Spring resiliency tester (item 118, WP 0176)

**Expendable Materials:**

- Prussian blue paste (item 25, WP 0173)

**Personnel Requirements:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Cylinder assembly removed (WP 0133)
- Valves removed (WP 0135)

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

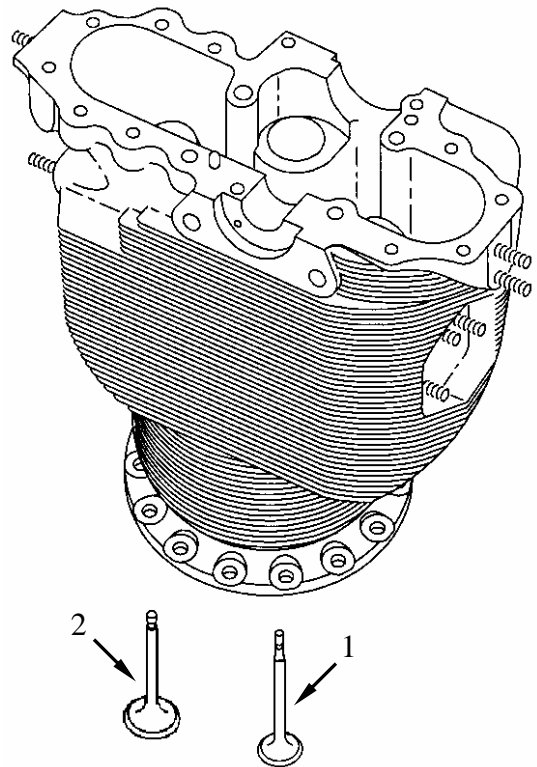
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Inspect exhaust (1) and intake (2) valves for evidence of pitting, imperfect seating, cracks, or warping of valve head. Replace damaged valves.

**NOTE**

**Heavy discoloration, burning, erosion, or heavy carbon deposit on valve face indicates a warped valve. A light frosted appearance or minor discoloration on valve face does not indicate a warped or unserviceable valve.**

3. Inspect exhaust (1) and intake (2) valve stems and the locking groove in the stems for pitting, scoring, cracks, or damaged ends. Replace valves if damage is found.



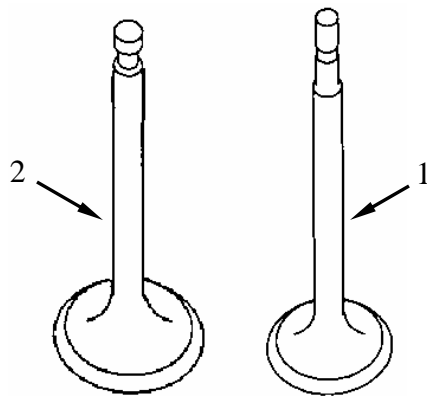
INSPECTION (Continued)

NOTE

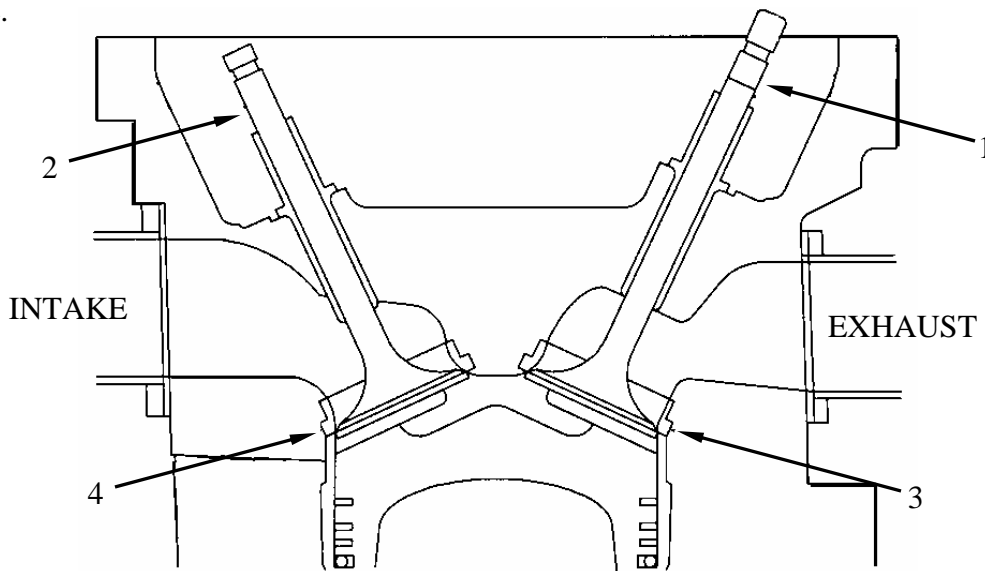
**Do not interpret termination of chrome plating on stem as indication of a cracked valve stem.**

4. Measure outside stem diameters of exhaust (1) and intake (2) valves. Replace valves that do not meet specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (exhaust valve stem)	0.5570 (14.1478)	0.5580 (14.1732)	0.5565 (14.1351)
B (intake valve stem)	0.4975 (12.6365)	0.4980 (12.6492)	0.4970 (12.6238)



5. Lightly blue face of valve inserts (3 and 4) with Prussian blue (item 25, WP 0173) and place valves (1 and 2) into position on valve seat insert.
6. Rotate valves (1 and 2) one-half turn on insert and check for Prussian blue contact. Valve must show full contact (360°), as indicated by Prussian blue transfer, to qualify as a serviceable valve. Valves that are not too badly damaged may be ground to be made serviceable.

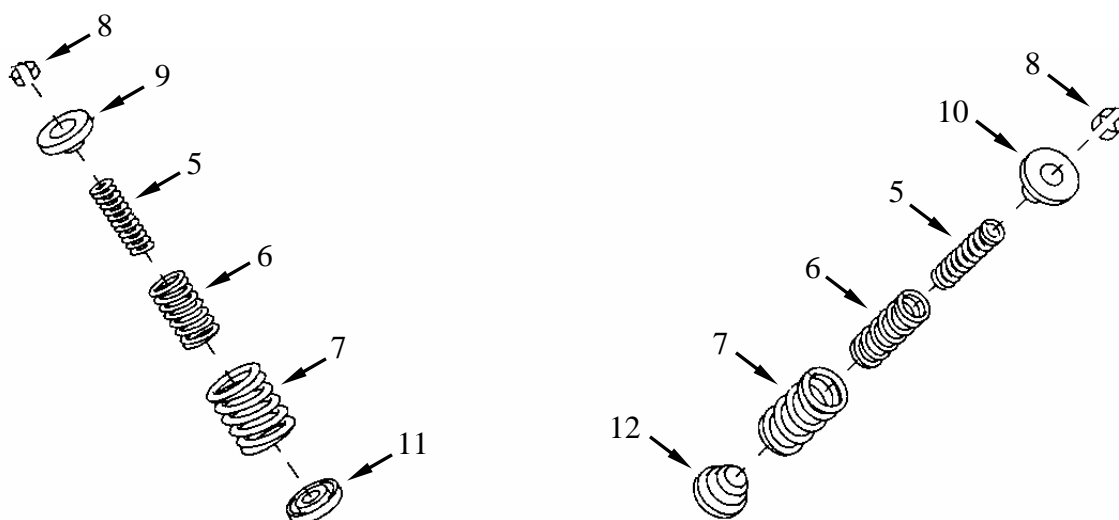


**INSPECTION (Continued)**

7. Inspect inner spring (5), intermediate spring (6), and outer spring (7) for wear, cracks, collapse, or other evidence of failure. Replace springs when worn, cracked, or otherwise damaged.
8. Measure springs (5, 6, and 7) using a valve spring tester. Replace springs that do not meet specifications in the following table.

Location	Sizes and Fits of New Parts pounds (Kg)		Wear Limits
Inner valve spring (small)	Scale reading at 1.3-inch (33.020)	43.9 (19.9306)	+/- 4.39 (1.9930)
	Scale reading at 2.07-inch (52.578)	26.2 (11.8948)	+/- 1.31 (0.5947)
	Maximum solid height	1.28 inch (32.5 mm)	none
intermediate valve spring (medium)	Scale reading at 1.56-inch (39.624)	81.4 (36.9224)	+/- 8.14 (3.6995)
	Scale reading at 2.26-inch (57.404)	51.7 (23.4718)	+/- 2.60 (1.1804)
	Maximum solid height 1.4 (0.6356)	1.34 inch (34.036 mm)	none
Outer valve spring (large)	Scale reading at 1.56-inch (39.624)	134.2 (60.9268)	+/- 13.42 (6.0926)
	Scale reading at 2.26-inch (57.404)	85.4 (38.7716)	+/- 4.27 (1.9385)
	Maximum solid height 85.4 (38.7716)	1.47 inch (37.338 mm)	none

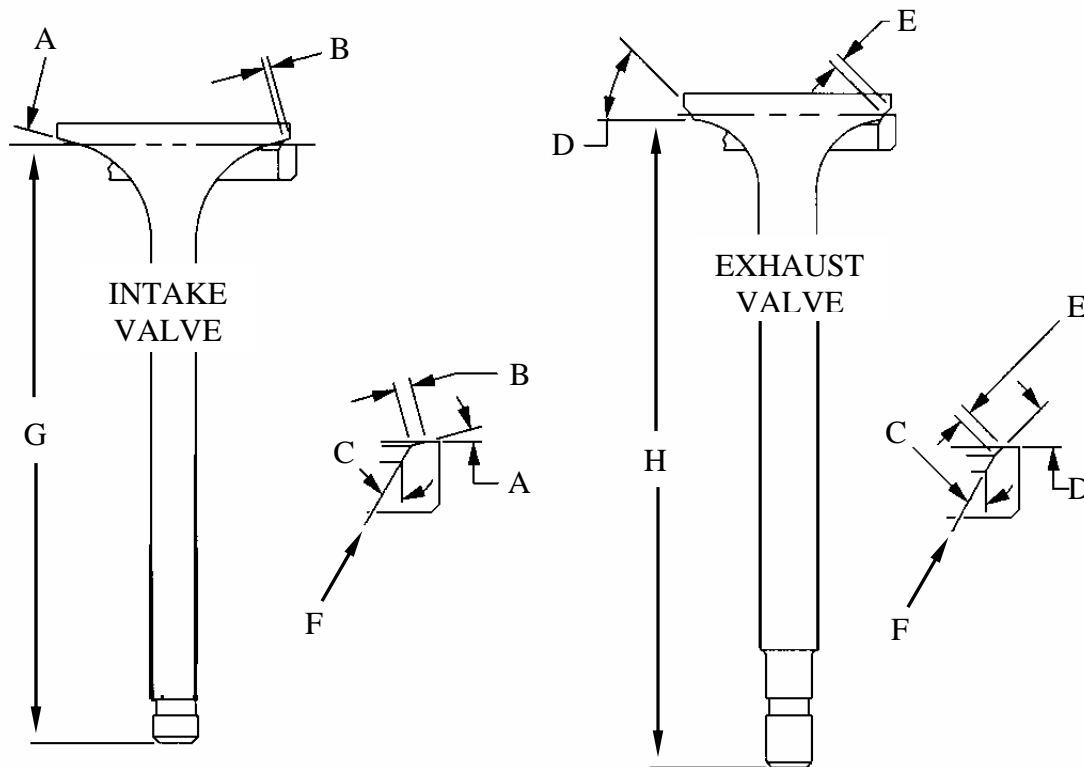
9. Inspect spring retainer locks (8) for wear or cracks. Worn locks will have ridges on top face. Replace locks that are worn or cracked.
10. Inspect lock retainers (9, 10), and seat (11) for wear and cracks. Replace if worn or cracked.
11. Check rotor (12) by rotating inner section and inspect for wear or cracks. Replace rotor if inner section does not rotate freely or is worn or cracked.



**REPAIR**

1. Discard valves (intake or exhaust) that do not conform to the limits specified under inspection (faces are badly warped, cracked, pitted, or burned; stems or locking grooves are badly pitted, scored, or scratched).
2. Reface slightly pitted or burned valves (1 and 2) that do not have 360° of contact revealed at inspection. Reface to specifications (A through F) in the following table.
3. Recheck refaced valves (1 and 2) for 360° contact (repeat inspection steps 5 and 6).
4. Check valve length (G and H) from seat contact to tip of stem. Discard valve if length is not within limits specified in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Intake valve seat angle)	15° ± 15'		
B (Intake valve seat width)	0.0890 (2.260)	0.0990 (2.514)	0.1200 (3.048)
C (back grind angle)	30°		
D (Exhaust valve seat angle)	45° +15'/-0'		
E (Exhaust valve seat width)	0.0600 (1.524)	0.0700 (1.778)	0.1200 (3.048)
F Regrind on this line when width of seat exceeds 0.120-inch (3.048mm)			
G (intake valve length)	6.355 (161.417)	6.369 (161.773)	6.3740 (161.900)
H (exhaust valve length)	7.010 (178.054)	7.024 (178.410)	7.0340 (178.664)



**END OF WORK PACKAGE**



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**CAMSHAFT, DRIVE GEARS, AND ASSOCIATED PARTS REPLACEMENT 0146 00**

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**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Assembly, and Installation

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**INITIAL SETUP:**

**Tools and Special Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Inside micrometer caliper set (item 16, WP 0176)  
 Mechanical puller (item 89, WP 0176)  
 Outside micrometer caliper set  
 (item 17, WP 0176)  
 Retaining ring pliers (item 79, WP 0176)  
 Telescoping gauge set (item 54, WP 0176)  
 Thickness gauge blade (item 55, WP 0176)  
 Thickness gauge blade (item 56, WP 0176)  
 Thickness gauge blade (item 57, WP 0176)  
 Torque wrench, 0-175 foot-pounds  
 (item 127, WP 0176)

**Mandatory Replacement Parts:**

Air duct hose (item 181, WP 0175)  
 Gasket ( item 361 WP 0175)  
 Inter-cylinder sleeve (5) (item 248, WP 0175)  
 Lock washer (3) (item 95, WP 0175)  
 Lock washer (2) (item 93, WP 0175)

**Mandatory Replacement Parts (Continued)**

O-ring (item 69, WP 0175)  
 O-ring (item 61, WP 0175)  
 O-ring (item 5, WP 0175)  
 Self-locking nut (4) (item 139, WP 0175)

**Expendable Materials:**

Lubriplate (item 23, WP 0173)  
 Prussian blue paste (item 25, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Rocker arm covers removed (WP 0104)  
 Fuel/water separator filter bracket removed for  
 left side camshaft replacement (WP 0164)  
 Shrouds removed (WP 0055)

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**CAUTION**

**Camshaft valve timing must be accomplished after completion of this work package (Work Package 0035, Intake and Exhaust Valve Timing).**

**REMOVAL**

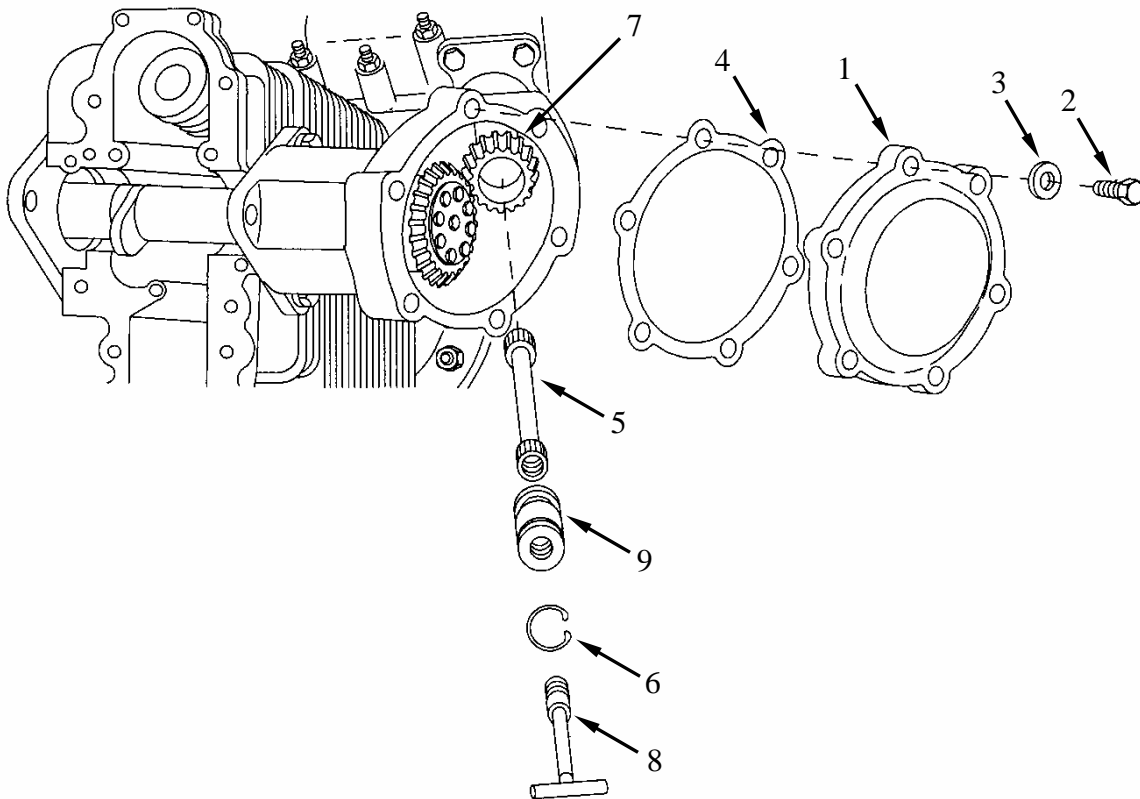
**NOTE**

**Left and right bank camshafts, drive gears and associated parts are replaced the same way. This work package replaces only one. The differences will be noted in the work package.**

**Cylinders are equipped with replaceable camshaft bearings. The bearing half in the cover should remain with the cover.**

**REMOVAL (Continued)**

1. Remove access cover (1)
  - a. Remove six screws (2) with flat washers (3) securing access cover (1).
  - b. Remove access cover (1) and gasket (4). Discard gasket.
  
2. Remove quill shaft (5).
  - a. Using retaining ring pliers (item 79, WP 0176), remove retaining ring (6) from bevel gear shaft (7). Discard retaining ring.
  - b. Using mechanical puller (8) (item 89, WP 0176), remove lubrication fitting (9).
  - c. Using mechanical puller (8), remove quill shaft (5).

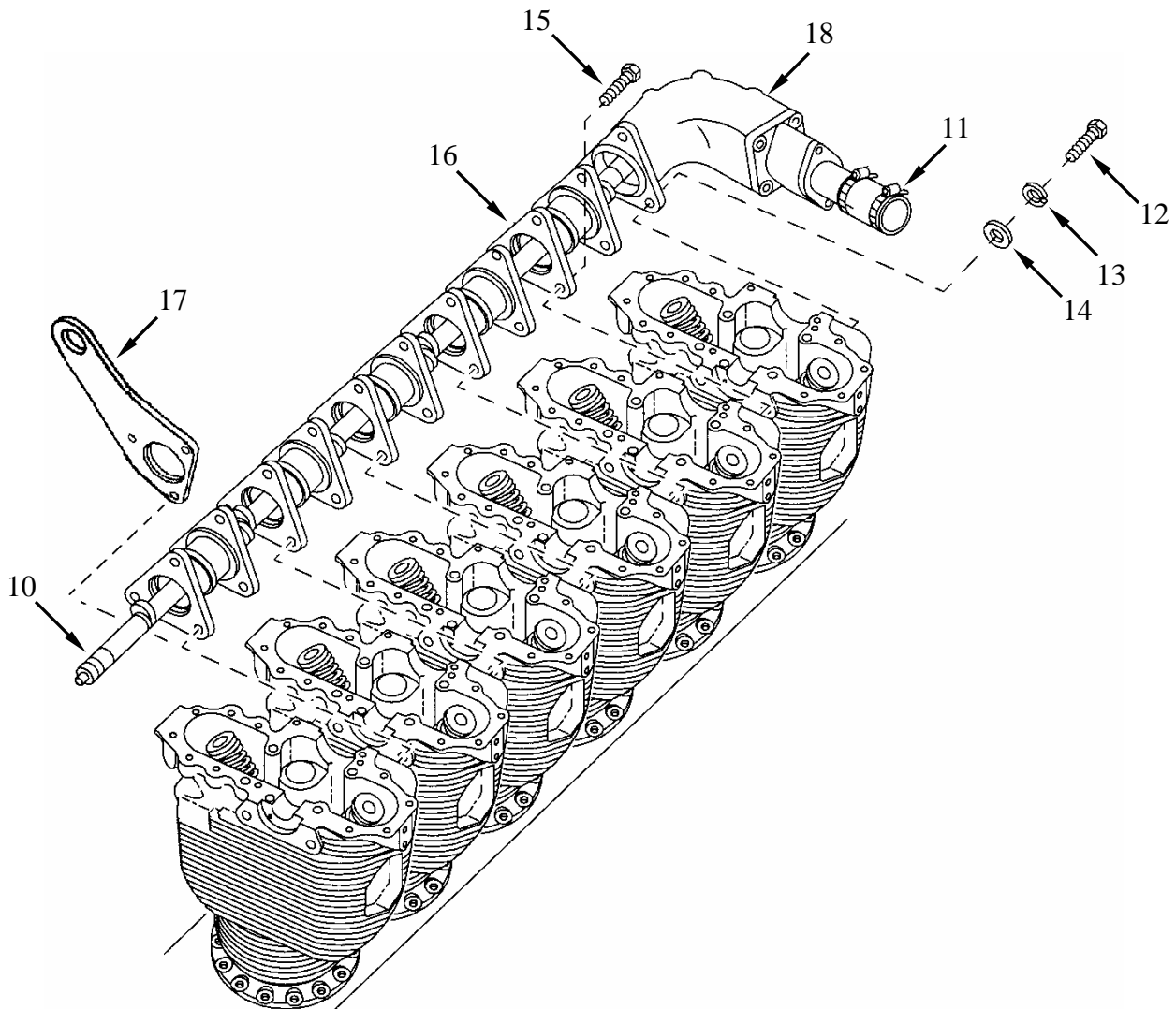


## REMOVAL (Continued)

## NOTE

Engine models 2CA and 2DA have lifting eyes in place of one camshaft flange on each side of the engine at cylinder number 1, left and right. Model 2DR does not.

3. Remove camshaft (10).
  - a. Loosen one hose clamp (11).
  - b. Remove two screws (12), with lock washers (13) and flat washers (14). Discard lock washers.
  - c. Remove 20 screws (15) from camshaft flanges (16) or lifting eye (17).
  - d. Remove camshaft (10) drive gear housing (18) and associated parts as an assembly.



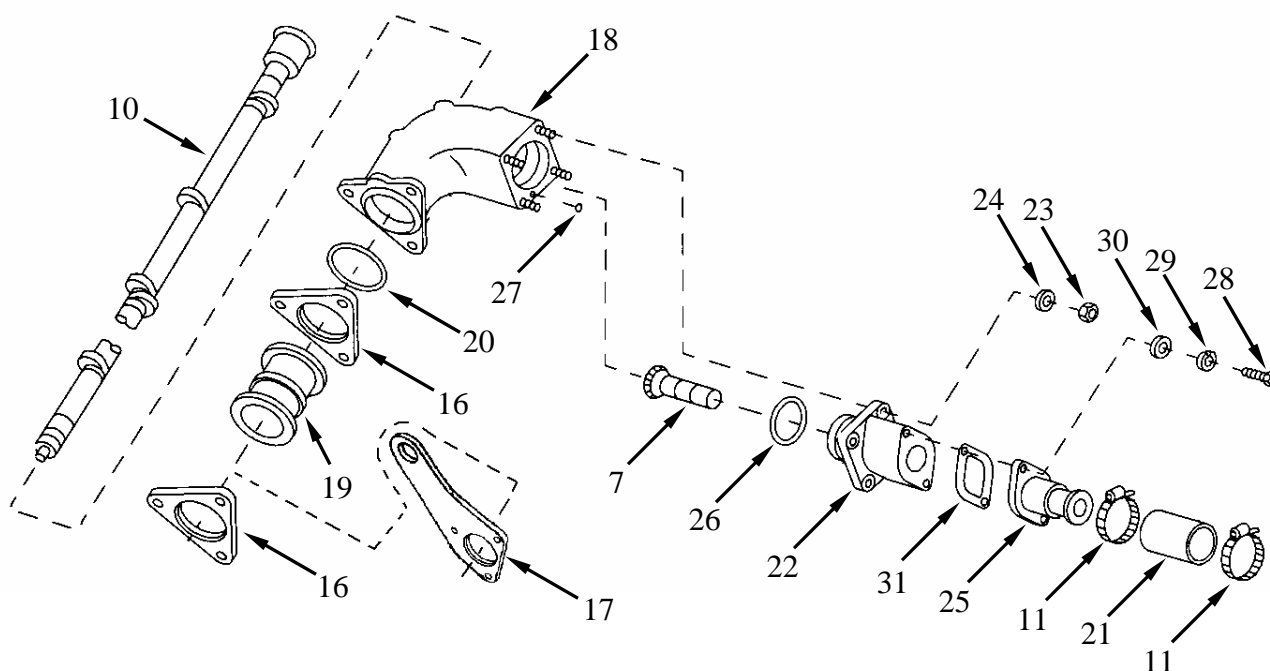
**DISASSEMBLY**

1. Remove and separate camshaft flanges (16) lifting eye (17) (2CA and 2DA engines only) and five inter-cylinder sleeves (19). Discard inter-cylinder sleeves.
2. Remove and discard O-ring (20).
3. Remove two hose clamps (11) and hose (21). Discard hose.

**CAUTION**

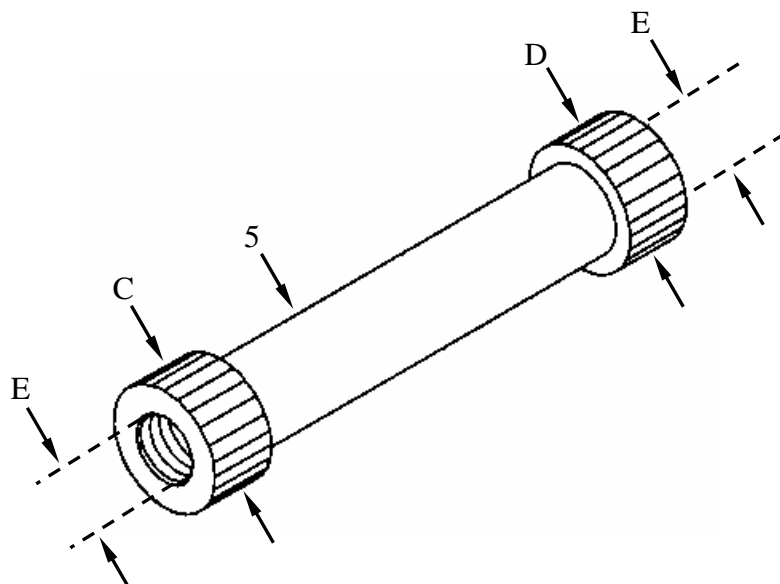
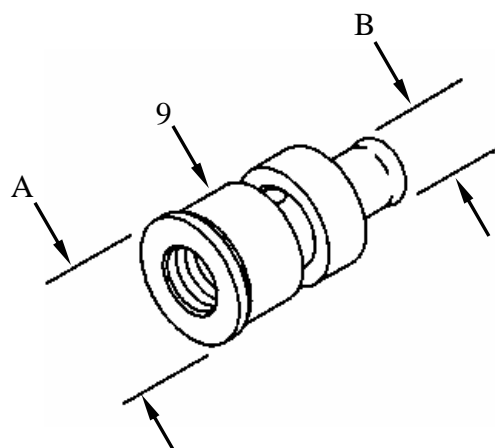
**Take care when removing gear adapter that bevel gear shaft does not fall out. If gear shaft falls out and lands on cement floor, it could be damaged.**

4. Remove gear adapter (22).
  - a. Remove four self-locking nuts (23) with flat washers (24). Discard self-locking nuts.
  - b. Remove gear adapter (22), hose adapter (25), and bevel gear shaft (7) as an assembly.
  - c. Remove bevel gear shaft (7) from adapter (22).
  - d. Remove and discard two O-rings (26,27).
5. Remove hose adapter (25).
  - a. Remove two screws (28), with lock washers (29) and flat washers (30). Discard lock washers.
  - b. Remove hose adapter (25) and gasket (31) from gear adapter (22). Discard gasket.
6. Remove camshaft assembly (10) from drive housing (18).



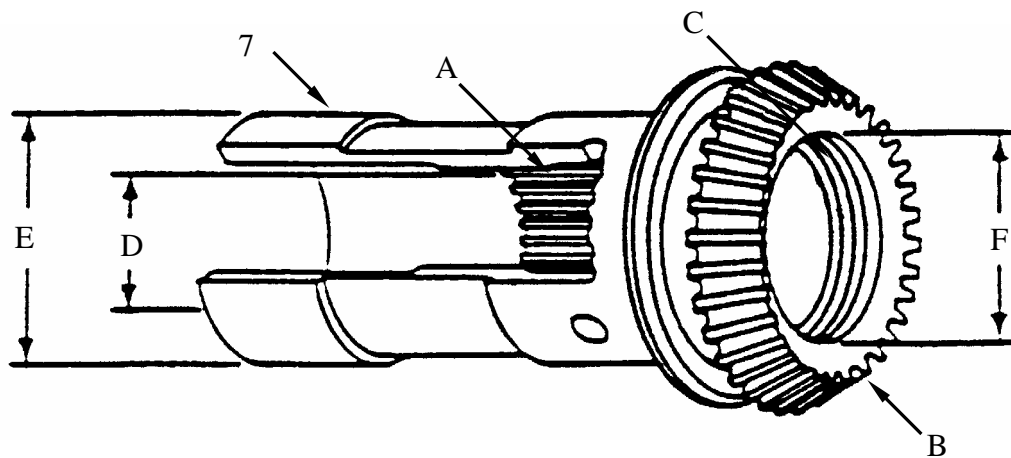
**INSPECTION**

1. Measure and record outside diameter (A) of lubrication fitting (9). Measurement will also be used for fit [0.0020 inch, L (0.0508 mm, L)] to bevel gear shaft (7).
  - a. Reject lubrication fitting (9) if dimension is less than 1.2695 inches (32.2453 mm).
2. Measure and record outside diameter (B) of lubrication fitting (9). Measurement will also be used for fit [0.0050 inch, L (0.127 mm, L)] to quill shaft (5).
  - a. Reject lubrication fitting (9) if dimension (B) is less than 0.6265 inch (15.9131 mm).
3. Inspect quill shaft (5).
  - a. Visually inspect quill shaft (5).
    - (1) Check splines (C, D). Look for obvious damage (severe wear, broken teeth, or heat damage). If any is found, discard quill shaft (5).
  - b. Measure and record inside diameter (E) at both ends of quill shaft (5). Reject shaft if dimension is greater than 0.6315 inch (16.0401 mm).
  - c. Measure outside diameter (C) of quill shaft spline at threaded end over two 0.0800-inch (2.032-mm) pins. Reject shaft if dimension is less than 1.2852 inches (32.64408 mm).
  - d. Measure outside diameter (D) of quill shaft spline at non-threaded end over two 0.0800-inch (2.032-mm) pins. Reject shaft if dimension is less than 1.1184 inches (28.40736 mm).
  - e. Calculate fit of lubrication fitting (9) to quill shaft (5).
    - (1) Subtract dimension (B) measured in step 2 from dimension (E).
    - (2) Reject both pieces if fit is looser than 0.0050 inch (0.127 mm).



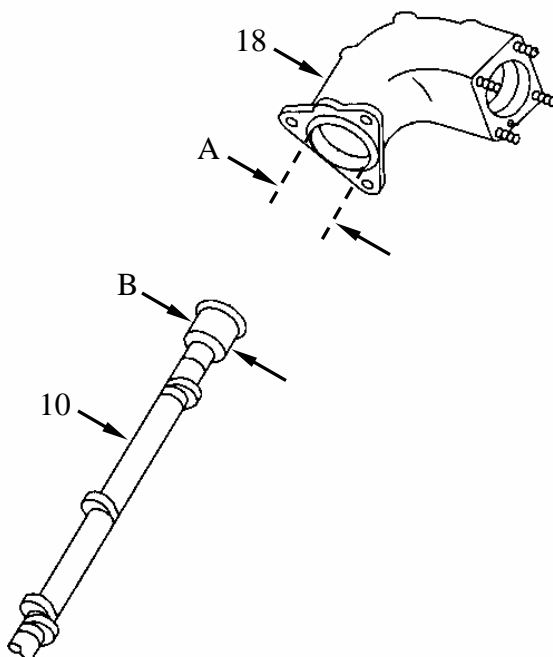
**INSPECTION (Continued)**

4. Inspect bevel gear shaft (7).
  - a. Visually inspect gear shaft (7).
    - (1) Check internal spline (A) and external gear teeth (B). Look for obvious damage (severe wear, broken teeth, or heat damage). If any is found discard bevel gear shaft (7).
    - (2) Inspect snap ring groove (C) to assure that snap ring will remain in place. If snap ring groove (C) is washed out at edges, discard gear shaft (7).
  - b. Measure internal spline (A) diameter (D) between two 0.0600-inch (1.524-mm) diameter pins.
    - (1) Reject gear shaft if dimension is greater than 1.1055 inches (28.0797 mm).
  - c. Measure and record outside diameter (E) of gear shaft (7).
    - (1) Reject gear shaft if dimension is less than 1.6215 inches (41.1861 mm).
    - (2) Measurement will also be used for fit of gear shaft (7) to adapter (22) in step 6c.
  - d. Measure and record inside diameter (F) of gear shaft (7).
    - (1) Reject gear shaft if dimension is greater than 1.2725 inches (32.3215 mm).
  - e. Calculate fit of lube fitting (9) to bevel gear shaft (7).
    - (1) Subtract measurement (A) taken in step 1 from measurement (F) of step 4d.
    - (2) Reject both pieces if fit is looser than 0.0020 inch (0.0508 mm).



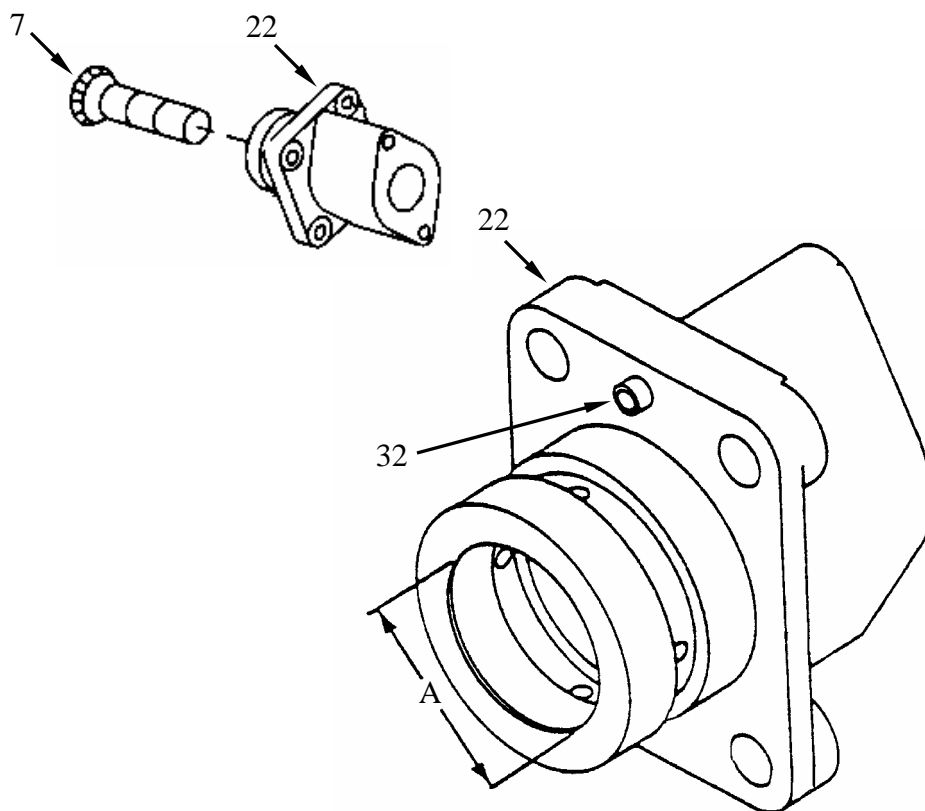
**INSPECTION (Continued)**

5. Inspect drive housing (18).
  - a. Visually inspect drive housing (18).
    - (1) Reject for nicks, scratches, or raised metal on contact surfaces that would prevent sealing to mating pieces. Mark minor damage for repair.
    - (2) Look for missing or damaged studs and inserts. Mark for repair.
  - b. Measure and record inside diameter (A) (camshaft opening) of drive housing (18).
    - (1) Reject drive housing if dimension is larger than 2.5015 inches (63.5381 mm).
    - (2) Dimension will be used for fit to large journal on end of camshaft (10).
  - c. Measure diameter (B) of large journal on end of camshaft (10).
    - (1) Reject camshaft (10) if diameter is smaller than 2.4960 inches (63.3984 mm).
  - d. Calculate fit of camshaft (10) to drive housing (18).
    - (1) Subtract dimension (B) of step 5c from dimension (A) of step 5b.
    - (2) Fit must not be looser than 0.0060 inch (0.1524 mm).



**INSPECTION (Continued)**

6. Inspect adapter (22).
  - a. Visually inspect adapter (22).
    - (1) Reject for nicks, scratches, or raised metal on contact surfaces that would prevent sealing to mating pieces. Mark minor damage for repair.
    - (2) Check that oil transfer tube (32) is in place and not damaged. Mark damaged tube for repair.
  - b. Measure and record inside diameter (A) of adapter (22).
    - (1) Reject adapter if dimension (A) is greater than 1.6270 inches (41.3258 mm).
  - c. Calculate fit of bevel gear shaft (7) to adapter (22).
    - (1) Subtract dimension E measured in step 4c from dimension (A) measured in step 6b.
    - (2) Fit must not be looser than 0.0060 inch (0.1524 mm).





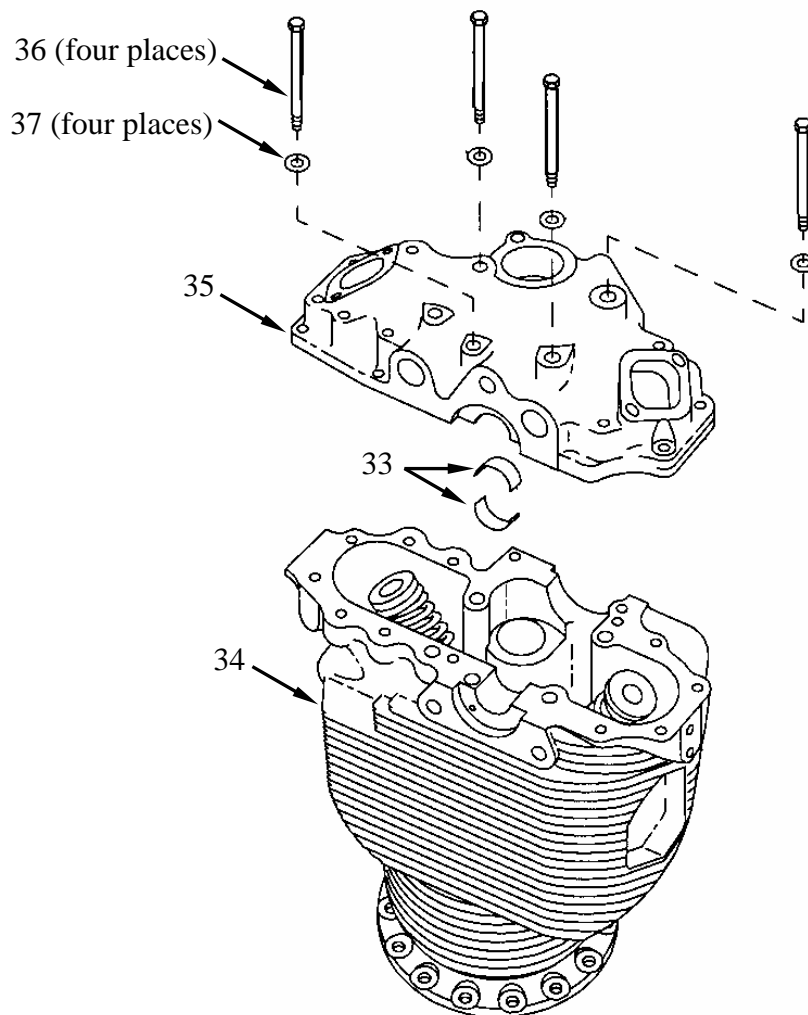
**INSPECTION (Continued)**

7. Inspect camshaft bearing halves (33).
  - a. Look for pitting, galling, burrs or nicks.
  - b. Replace bearing sleeves that show pitting, galling, burrs, nicks or any other forms of destruction to the bearing surface.

**NOTE**

**Fine scratches on bearing sleeves are not cause for rejection.**

8. Perform "Installed" checks of bearing halves (33).
  - a. Spread a thin coat of Prussian blue (item 25, WP 0173) over the backs of the bearing halves (33) and install in their original location on cylinder assembly (34) and rocker cover (35).
  - b. Lubricate (using Lubriplate, item 23, WP 0173) four screws (36). Secure rocker cover (35) to its matching cylinder assembly (34) with four lubricated screws (36) and four used seal washers (37).
  - c. Torque four screws (36) to 23-27 foot-pounds (31-37 N•m).

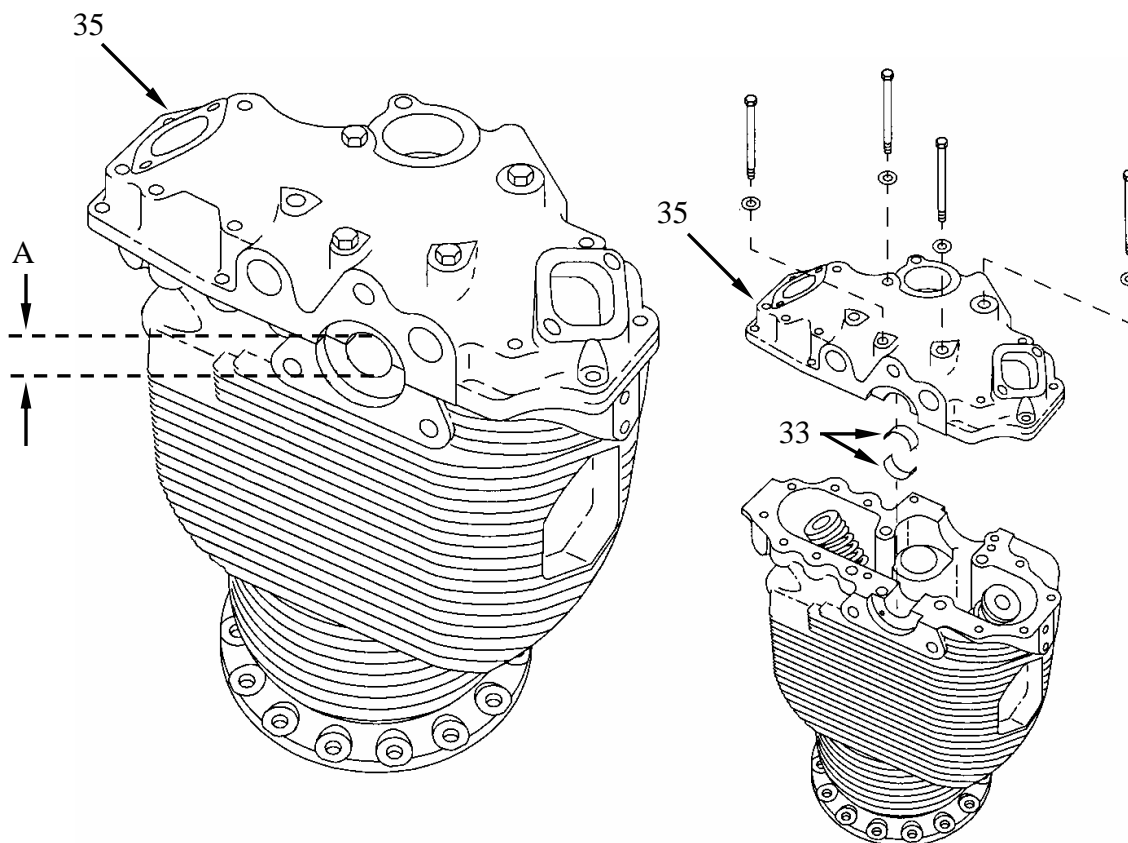


**INSPECTION (Continued)**

- 8. Perform "Installed" checks of bearing halves (33) (Continued).
  - d. Measure inside diameter (A) of installed bearing halves (33).
    - (1) Replace bearing halves (33) if not within the following limits.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Installed bearing diameter)	1.3115 (33.3121)	1.3135 (33.3629)	1.3140 (33.3756)
Fit of bearing halves to camshaft journal	0.0015L (0.0381L)	0.0045L (0.1143L)	0.0055L (0.1397L)

- e. Remove rocker cover (35) and bearing halves (33).
- f. Inspect bearing halves (33) for Prussian blue transfer, and replace bearing sleeves that do not make at least 75 per cent contact.
- g. Repeat procedure if any bearing half (33) is replaced.



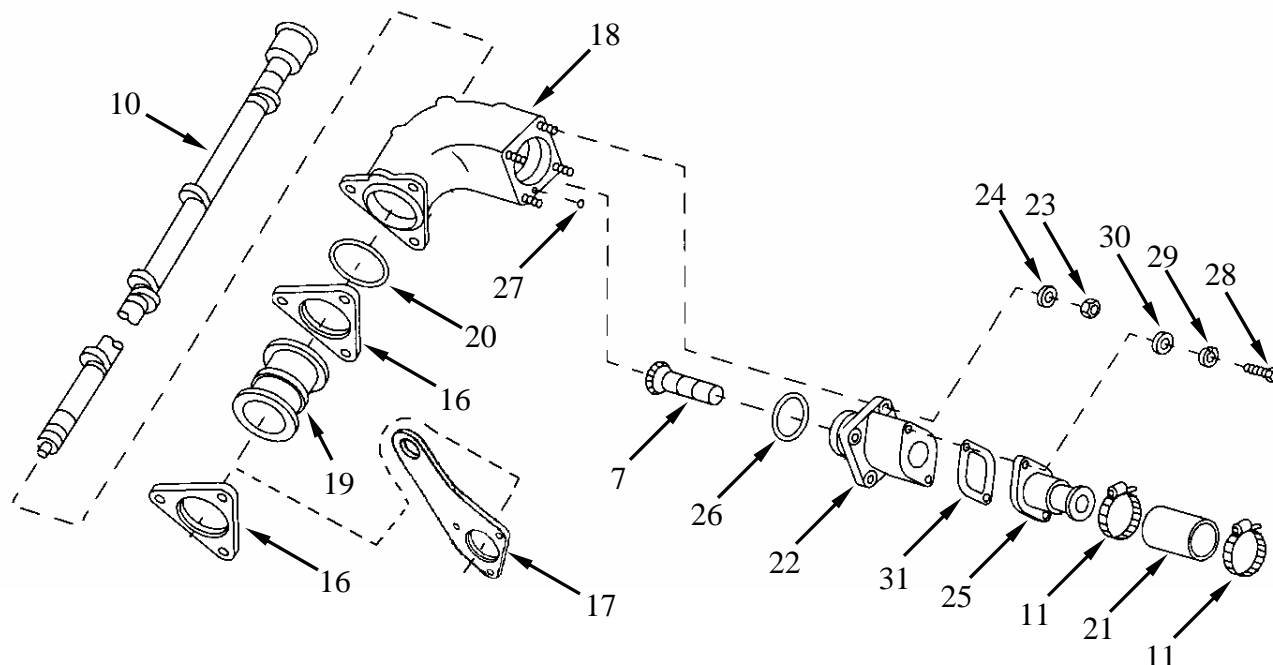
**ASSEMBLY**

1. Install camshaft assembly (10) into drive housing (18).
2. Install hose adapter (25) to gear adapter (22).
  - a. Install hose adapter (25) using new gasket (31) (item 361, WP 0175) to gear adapter (22).
  - b. Secure using two screws (28), with two new lock washers (29) (item 95, WP 0175) and flat washers (30).
  - c. Install new hose (21) (item 181, WP 0175) and secure with one hose clamp (11). Snug-tighten second hose clamp to opposite end of hose.

**CAUTION**

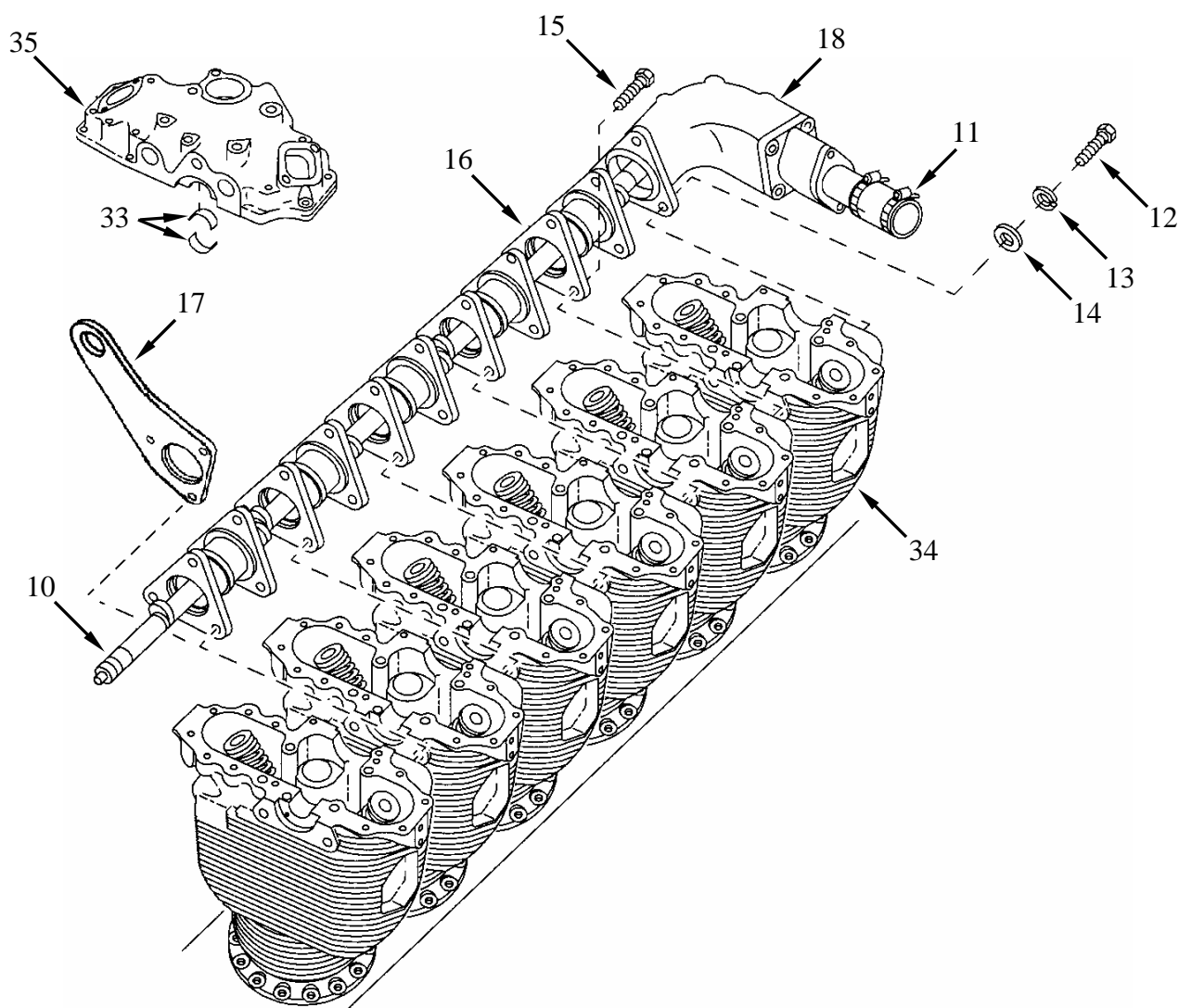
**Take care when installing gear adapter that bevel gear shaft does not fall out. If gear shaft falls out and lands on cement floor, it could be damaged.**

3. Install gear adapter (22).
  - a. Using Lubriplate (item 23, WP 0173), lubricate and install two new O-rings (26,27) (items 61 and 69, respectively, WP 0175).
  - b. Lubricate and then insert bevel gear shaft (7) into gear adapter (22).
  - c. Install gear adapter (22), hose adapter (25), and bevel gear shaft (7) as an assembly.
  - d. Secure using four new self-locking nuts (23) (item 139, WP 0173) with flat washers (24).
4. Lubricate and install new O-ring (20) (item 5, WP 0175).
5. Install camshaft flanges (16) lifting eye (17) (2CA and 2DA engines only) and five new inter-cylinder sleeves (19) (item 248, WP 0175).



**INSTALLATION**

1. Install camshaft bearing halves (33) in each matching cylinder (34) and cover (35).
2. Place camshaft (10) drive gear housing (18) and associated parts as an assembly onto cylinders.
3. Attach drive housing (18) to cylinder 6L or 6R (34).
  - a. Secure using two screws (12), with new lock washers (13) (item 95, WP 0175) and flat washers (14). Do not tighten screws (12) at this time.
4. Install 20 screws (15) into camshaft flanges (16) or lifting eye (17) (2CA and 2DA engine models). Do not tighten screws (15) at this time.
5. Tighten hose clamp (11).



FOLLOW-ON MAINTENANCE

**CAUTION**

Camshaft valve timing must be accomplished upon completion of this work package.

- Perform camshaft valve timing (WP 0035).

**END OF WORK PACKAGE**



**CAMSHAFT DRIVE ADAPTER REPAIR**

**0147 00**

**THIS WORK PACKAGE COVERS:**

Inspection, Repair

**INITIAL SETUP:**

**Tools and Special Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Camshaft, drive gears, and associated parts removed (WP 0146)

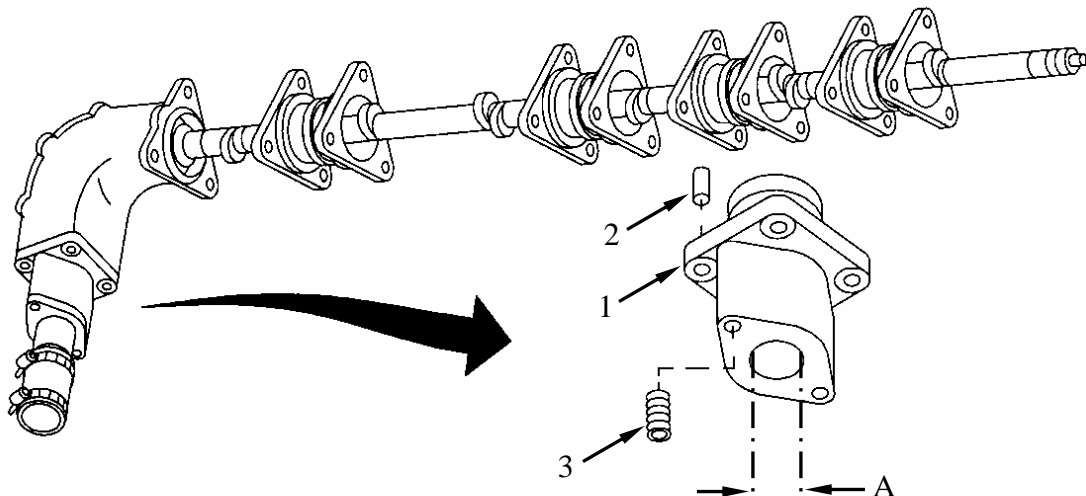
**INSPECTION**

**NOTE**

**Left and right camshaft drive adapters are the same and have the same part number.**

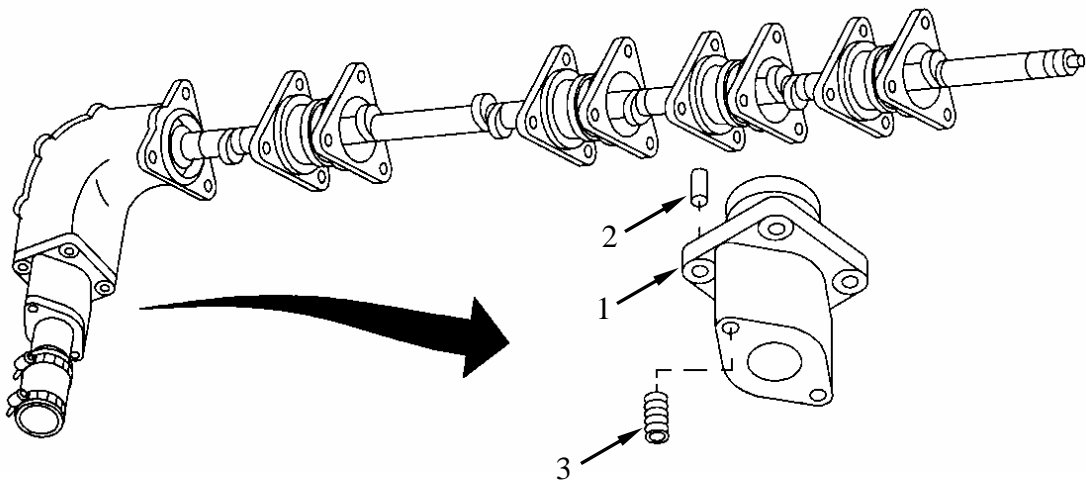
1. Inspect adapter (1) for cracks or damage. Refer to WP 0028.
2. Inspect oil transfer tube (2) and screw thread inserts (3). Refer to WP 0028.
3. Measure inside diameter (4) of bore in adapter (1) against the following limits.

Point of Measurement	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Inside diameter of bore as shown)	1.6250 (41.275)	1.6260 (41.3004)	1.6270 (41.3258)



**CAMSHAFT DRIVE ADAPTER REPAIR****0147 00****REPAIR**

1. Replace adapter (1) if not within specified limits.
2. Replace defective oil transfer tube (2).
3. Replace defective screw thread inserts (3). Refer to WP 0030.

**END OF WORK PACKAGE**



**CAMSHAFT DRIVE HOUSING REPAIR**

**0148 00**

**THIS WORK PACKAGE COVERS:**

Inspection, Repair

**INITIAL SETUP:**

**Tools and Special Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Telescoping gauge set (item 54, WP 0176)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Camshaft, drive gears, and associated parts removed (WP 0146)

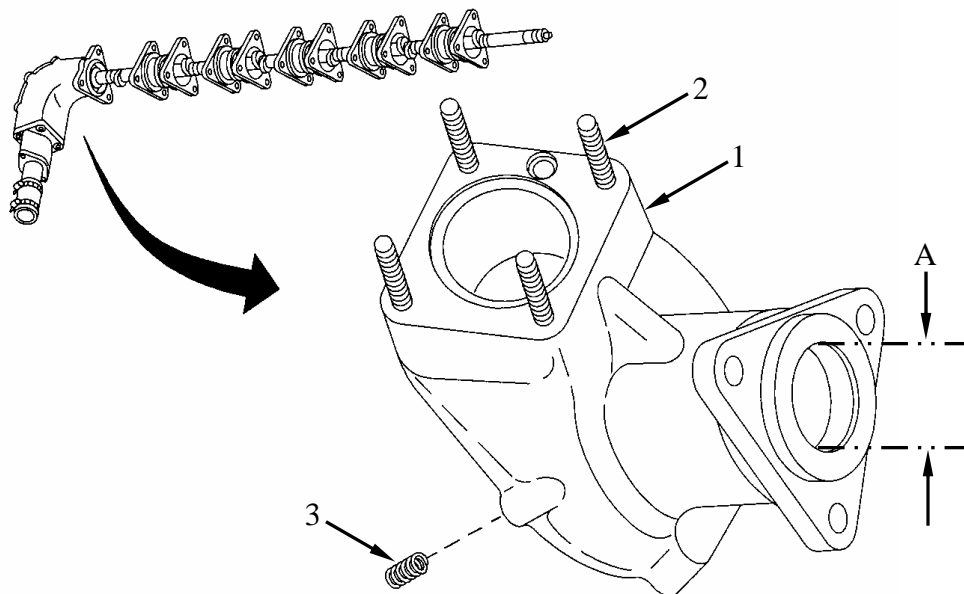
**INSPECTION**

**NOTE**

**Left and right camshaft drive housings are mirror images of each other. They have different part numbers, but all repair procedures and measurements are identical.**

1. Inspect housing (1) for cracks or damage. Refer to WP 0028.
2. Inspect studs (2) and screw thread inserts (3). Refer to WP 0028.
3. Measure inside diameter (4) of bearing surface in housing (1) against the following limits.

Point of Measurement	Sizes and Fits of New Parts		Wear Limits
	inches (mm)		
A (Inside diameter of bearing surface)	2.5000 (63.5)	2.5010 (63.5254)	2.5015 (63.5381)

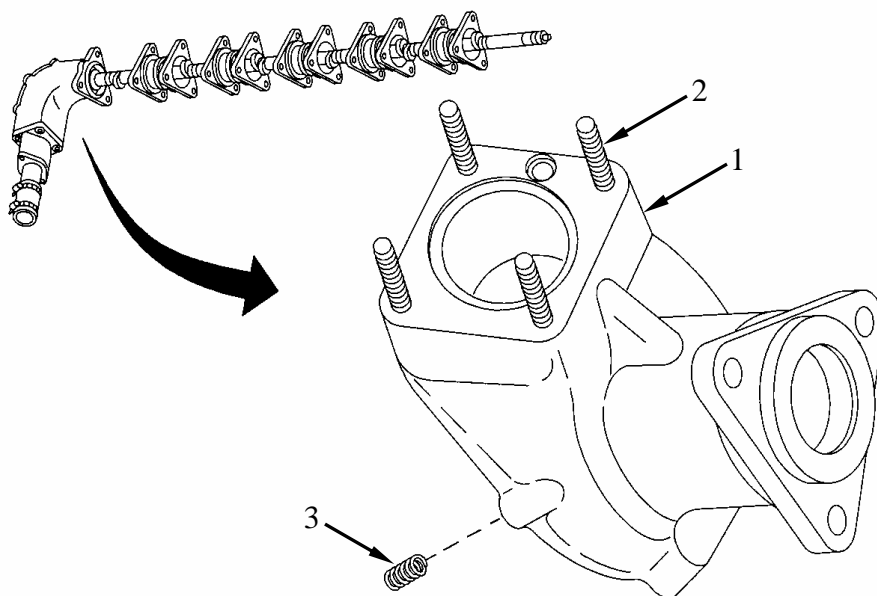


**REPAIR**

1. Replace housing (1) if not within specified limits.
2. Replace damaged, bent or stripped studs (2).
  - a. Refer to the following table for stud dimensions and to WP 0028 for procedures.

Setting Height inches (mm)	Quantity	Stud Size and Length
1.156 (29.3624)	4	SAE: 3/8-16 (15/16) X 3/8-24 (13/16) X 1-15/16 Metric: 9.375-16 (23.45) X 9.375-24 (20.3) X 45.3

3. Replace defective screw thread inserts (3). Refer to WP 0028.



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Disassembly, Inspection, Repair, Assembly

**INITIAL SETUP:**

**Tools and Special Tools:**

- Dial indicator (item 65, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Machinist's vise (item 132, WP 0176)
- Magnifier (item 73, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Thread die and tap set (item 120, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)
- V-block (2) (item 131, WP 0176)

**Expendable Materials:**

- Cleaning compound, solvent (item 8, WP 0173)
- Cloth, abrasive, crocus (item 9, WP 0173)
- Lubriplate (item 23, WP 0173)
- Wire, non-electrical (item 44, WP 0173)

**Personnel Requirements:**

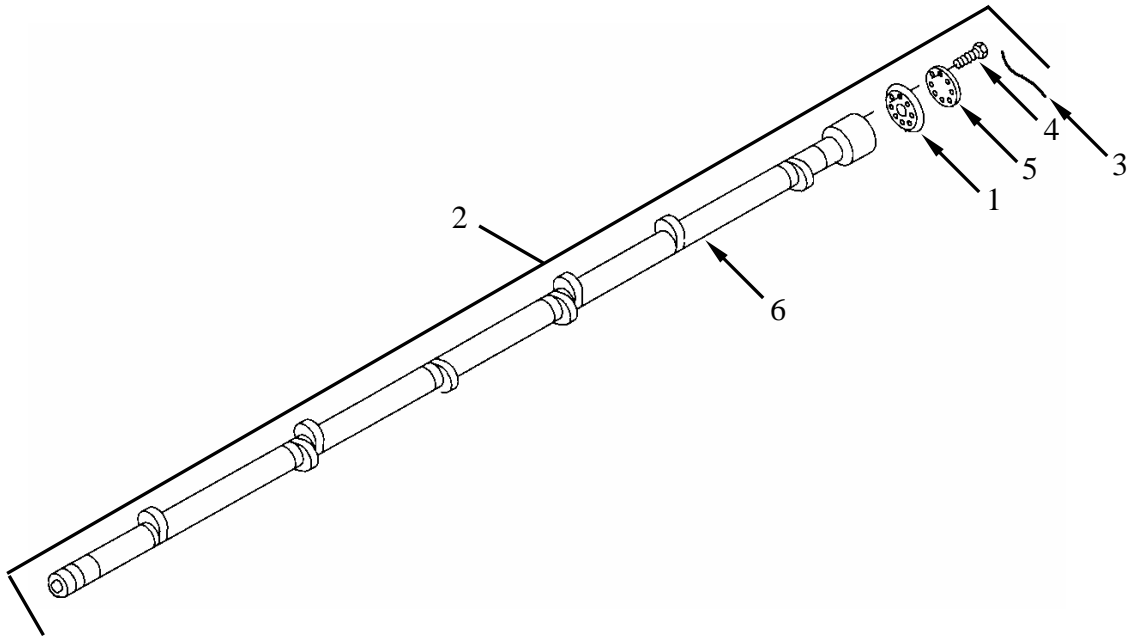
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Camshaft, drive gears, and associated parts removed (WP 0146)

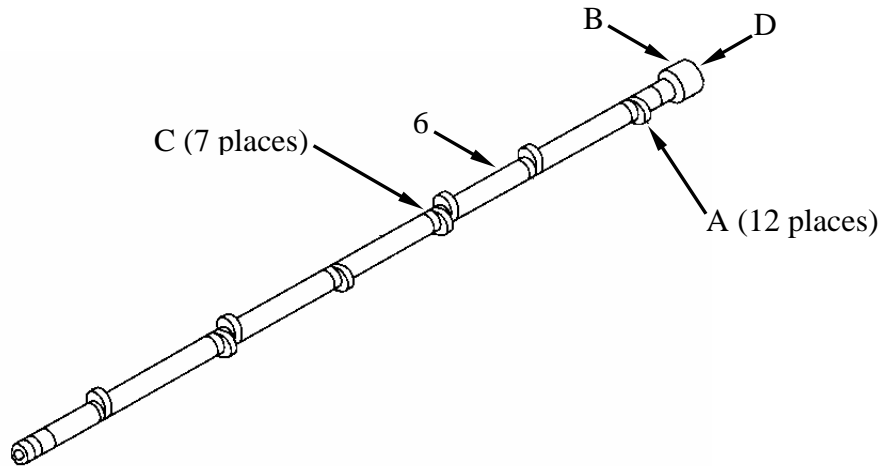
**DISASSEMBLY**

1. Remove bevel gear (1).
  - a. Place camshaft assembly (2) in a soft-jawed vise (item 132, WP 0176).
  - b. Cut, remove, and discard lock wire (3).
  - c. Remove eight screws (4), cover (5), and bevel gear (1) from camshaft (6).



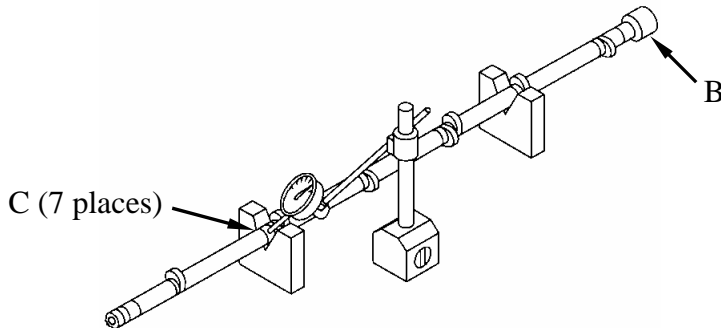
**INSPECTION**

1. Visually inspect camshaft (6).
  - a. Look for cracks with a magnifying glass (item 73, WP 0176) and a strong light. Pay particular attention to areas around camshaft lobes (A). Replace cracked camshafts.
  - b. Inspect camshaft lobes (A) and camshaft journals (B, C) for wear, scuffing and scoring. Replace camshaft when lobes or bearing surfaces are badly worn, scuffed or scored. Mark light scuffing or scoring for repair.
  - c. Inspect camshaft for stripped or damaged threads in tapped holes (D). Replace camshaft if any stripped threads are found. Mark damaged threads for repair.



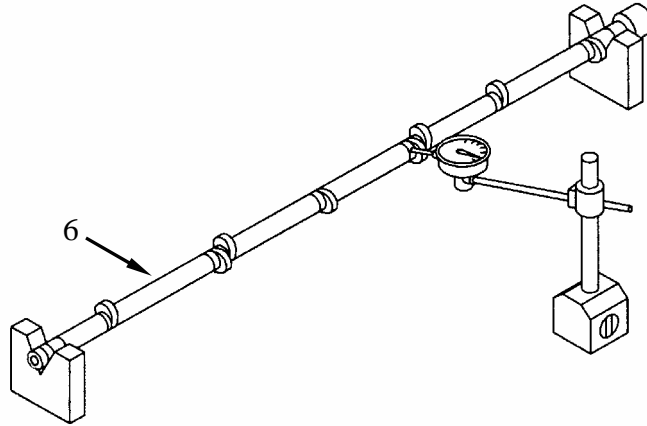
2. Measure camshaft (6).
  - a. Using micrometer (item 17, WP 0176), measure outside diameter of large journal (B).
  - b. Measure outside diameter of seven smaller journals (C).
  - c. Check camshaft (6) journals (B, C) for out-of-roundness with a dial indicator (full indicator reading with V-block directly under journal).
  - d. Reject any camshaft that does not meet the limits specified in the following table.

Location	Sizes and Fits of New Parts: inches (mm)		Wear Limits
B (Large journal diameter)	2.4965 (63.4111)	2.4975 (63.4365)	2.4960 (63.3984)
C (Small journal diameters)	1.3090 (33.2486)	1.3100 (33.274)	1.3085 (33.2359)
B, C (Journal roundness)	0.0010 (0.0254)		0.0020 (0.0508)

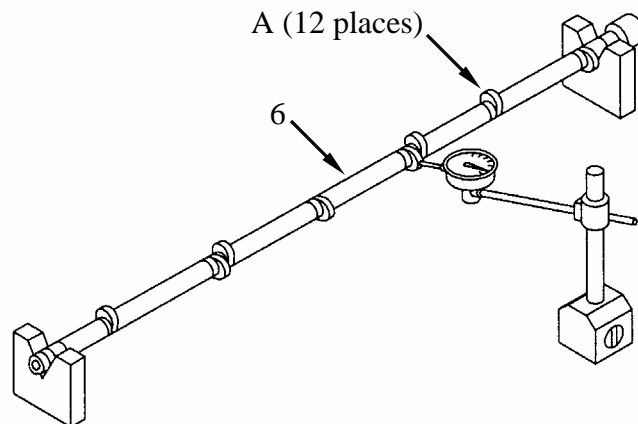


**INSPECTION (Continued)**

3. Check camshaft (6) run-out (straightness of camshaft).
  - a. Position camshaft with end journals on V-blocks (item 131, WP 0176).
  - b. Using dial indicator, measure run-out of center journal (full indicator readout).
  - c. Reject camshaft if run-out exceeds 0.015-inches (0.381-mm).



4. Measure lift of camshaft (6) lobes (A).
  - a. Zero dial indicator on base circle of lobe.
  - b. Rotate camshaft to reach maximum lift.
  - c. Reject camshaft if any lobe does not attain a lift of 0.4140 inch (10.5156 mm).



## REPAIR

**WARNING**

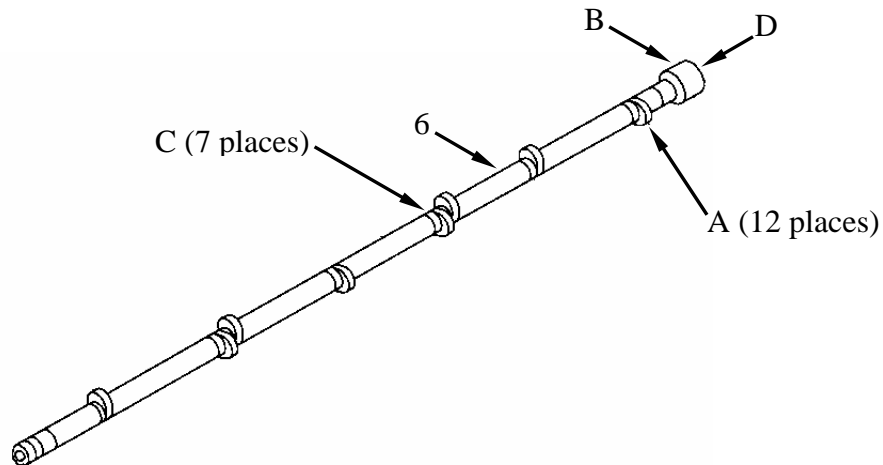
Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.

Ensure there is good airflow when using solvent, and work area is away from heat and flames.



- Keep fire extinguisher nearby.
- Do not breathe solvent fumes.
- Avoid skin contact. See Warning in front of Manual.

1. Remove light scuffing or scoring from camshaft (6) lobes (A) and bearing surfaces (B, C) with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
2. Repair damaged threads (D) with a thread chaser tap (item 120, WP 0176).



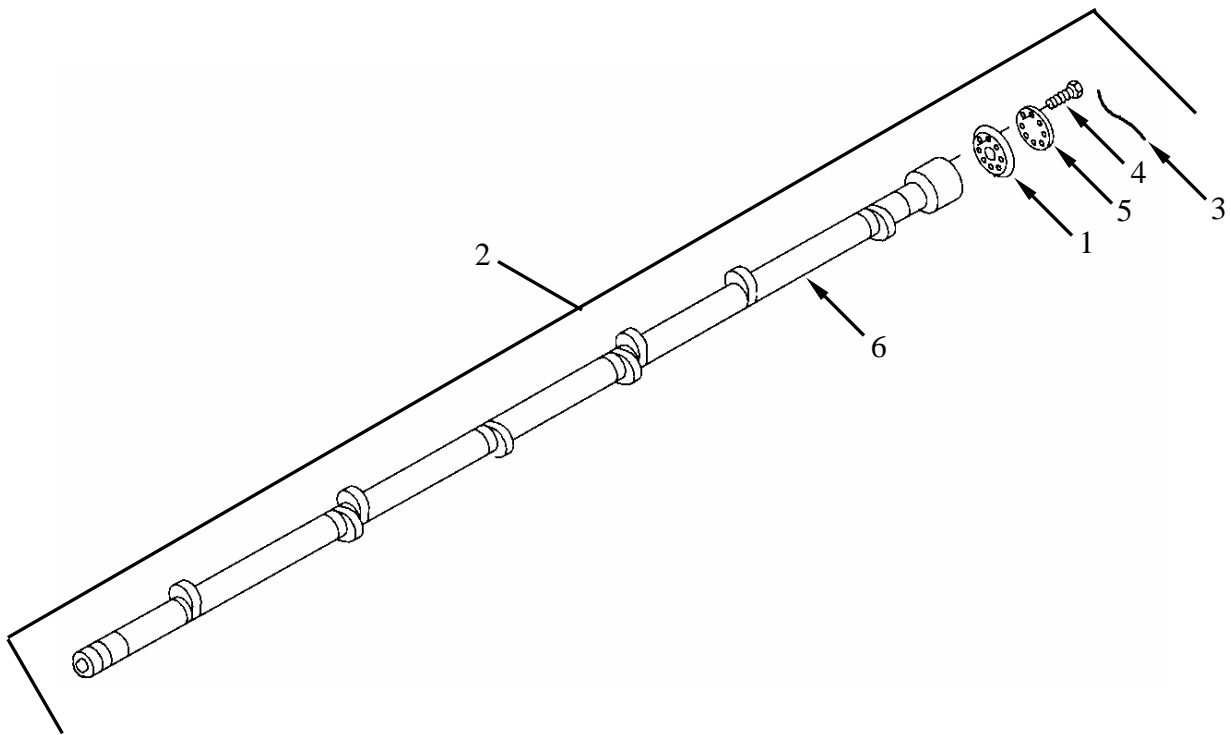
**ASSEMBLY**

1. Install bevel gear (1).
  - a. Place camshaft (6) in a soft-jawed vise (item 132, WP 0176).
  - b. Lubricate eight screws (4) with Lubriplate (item 23, WP 0173).

**CAUTION**

**Bevel gear and cover must be properly aligned with camshaft before installing screws or camshaft will be damaged. Two of the screw holes are slightly closer together on each of the pieces. Properly align these screw holes before installing screws.**

- c. Install bevel gear (1) and cover (5) with eight screws (4).
- d. Torque alternately eight screws (4) to 23-27 foot-pounds (31-37 N•m).
- e. Secure with new lock wire (3) (item 44, WP 0173).

**END OF WORK PACKAGE**





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**CAMSHAFT ASSEMBLY, RIGHT BANK, REPAIR**

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**0150 00****THIS WORK PACKAGE COVERS:**Disassembly, Inspection, Repair, Assembly

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

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Machinist's vise (item 132, WP 0176)  
Magnifier (item 73, WP 0176)  
Outside micrometer caliper set  
(item 17, WP 0176)  
Thread die and tap set (item 120, WP 0176).  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)  
V-block (2) (item 131, WP 0176)

**Expendable Materials:**

Cleaning compound, solvent (item 8, WP 0173)  
Cloth, abrasive, crocus (item 9, WP 0173)  
Lubriplate (item 23, WP 0173)  
Wire, non-electrical (item 44, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

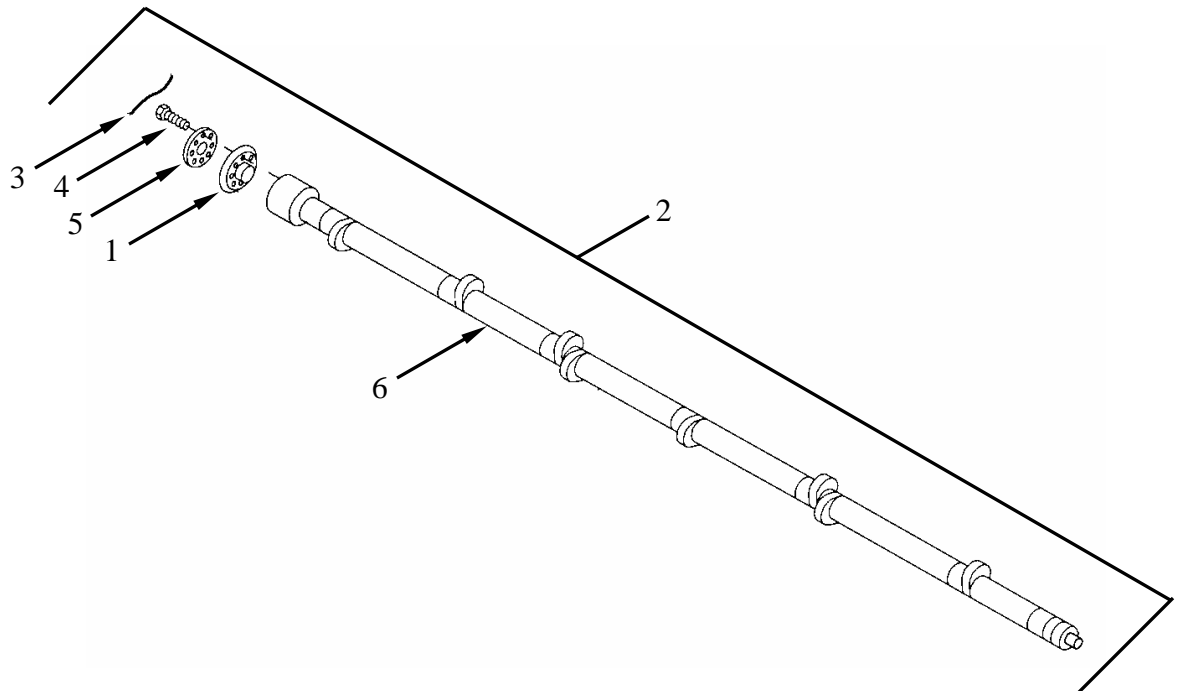
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Camshaft, drive gears, and associated parts  
removed (WP 0146)

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**DISASSEMBLY**

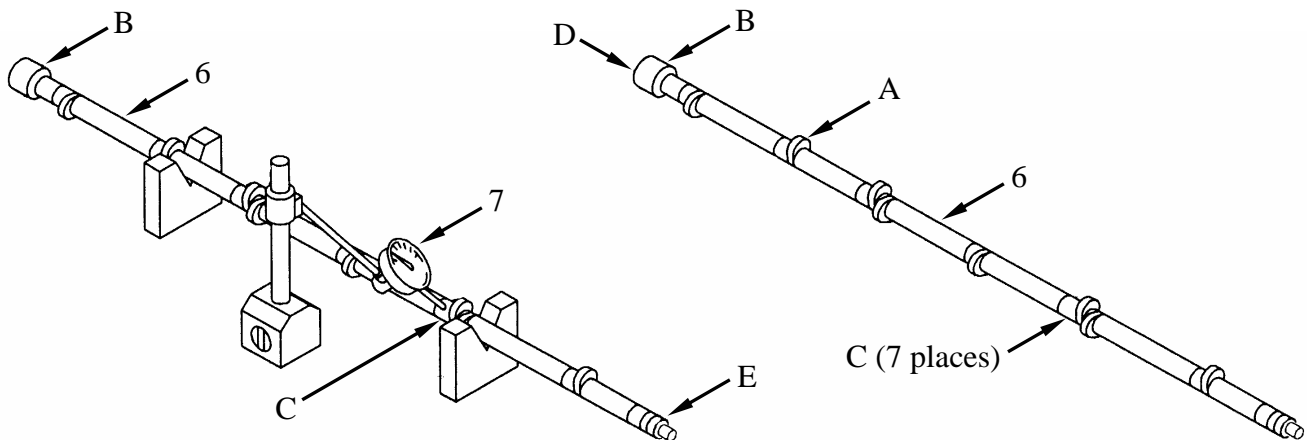
1. Remove bevel gear (1).
  - a. Place camshaft assembly (2) in a soft-jawed vise (item 132, WP 0176).
  - b. Cut, remove, and discard lock wire (3).
  - c. Remove eight screws (4), cover (5), and bevel gear (1) from camshaft (6).



**INSPECTION**

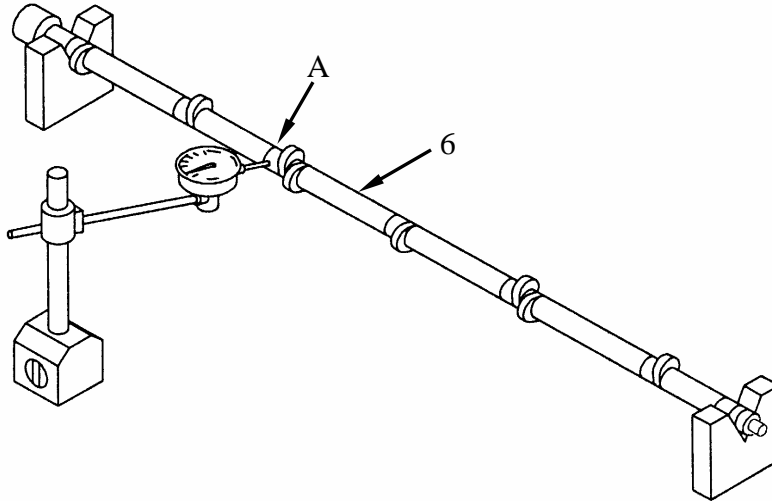
1. Visually inspect camshaft (6).
  - a. Look for cracks with a magnifying glass (item 73, WP 0176) and a strong light. Pay particular attention to areas around camshaft lobes (A). Replace any camshaft that has cracks.
  - b. Inspect camshaft lobes (A) and camshaft journals (B, C) for wear, scuffing and scoring. Replace camshaft when lobes or journals are badly worn, scuffed or scored. Mark light scuffing or scoring for repair.
  - c. Inspect camshaft for stripped or damaged threads in tapped holes (D). Replace camshaft if any stripped threads are found. Mark damaged threads for repair.
2. Measure camshaft (6).
  - a. Using micrometer (item 17, WP 0176), measure outside diameter of large journal (B).
  - b. Measure outside diameter of seven smaller journals (C).
  - c. Measure outside diameter of camshaft (D) at pilot bearing interface.
  - d. Check camshaft (6) journals (B, C) for out-of-roundness with a dial indicator (7) (full indicator reading with V-block directly under journal).
  - e. Reject any camshaft that does not meet the limits specified in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
B (Large journal diameter)	2.4965 (63.4111)	2.4975 (63.4365)	2.4960 (63.3984)
C (Small journal diameters)	1.3090 (33.2486)	1.3100 (33.274)	1.3085 (33.2359)
D (Pilot bearing interface)	1.3090 (33.2486)	1.3100 (33.274)	1.3085 (33.2359)
B, C (Journal roundness)	0.0010 (0.0254)		0.0020 (0.0508)

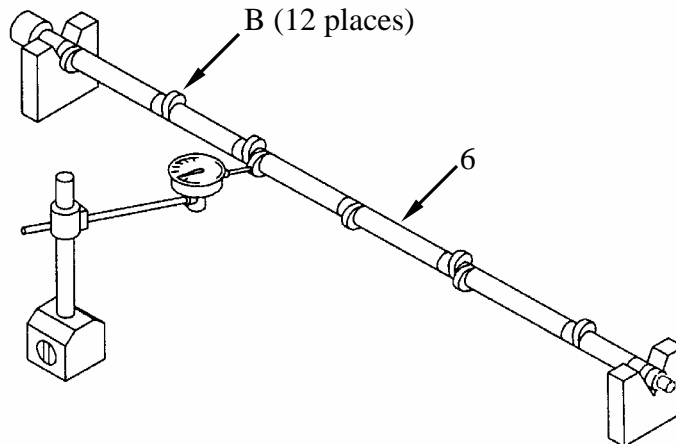


**INSPECTION (Continued)**

3. Check camshaft (6) run-out (straightness of camshaft).
  - a. Position camshaft with end journals on V-blocks (item 131, WP 0176).
  - b. Using dial indicator, measure run-out of center journal (A) (full indicator readout).
  - c. Reject camshaft if run-out exceeds 0.015 inches (0.381 mm).



4. Measure lift of camshaft (6) lobes (B).
  - a. Zero dial indicator on base circle of lobe.
  - b. Rotate camshaft (6) to reach maximum lift.
  - c. Reject camshaft (6) if any lobe (B) does not attain a lift of 0.4140 inch (10.5156 mm).



## REPAIR

**WARNING**

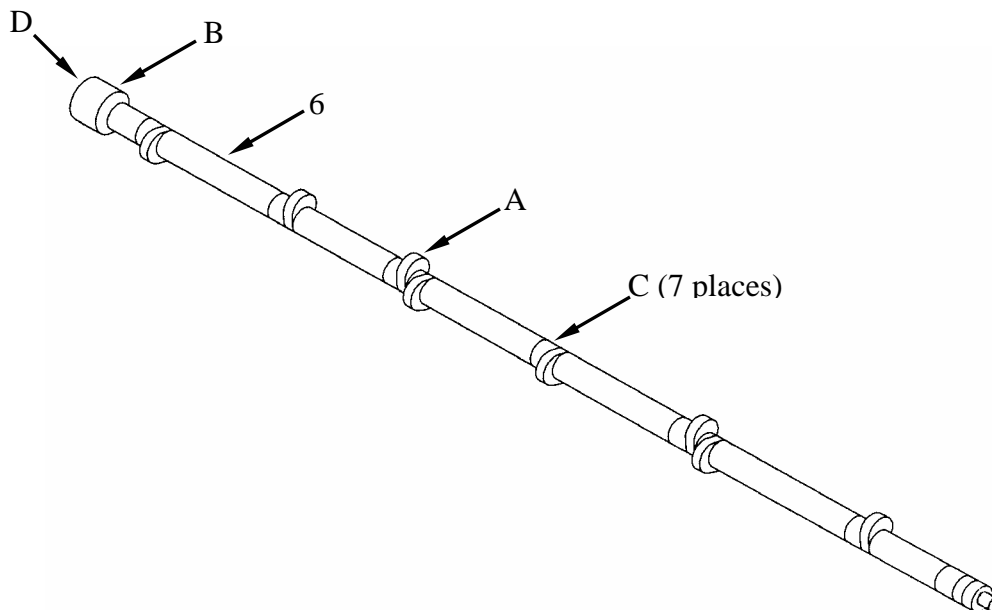
Cleaning solvent is mildly toxic. Solvent evaporates and both the fumes and liquid are flammable. Continued contact with solvent can cause skin problems.

Ensure there is good airflow when using solvent, and work area is away from heat and flames.



- Keep fire extinguisher nearby.
- Do not breathe solvent fumes.
- Avoid skin contact. See Warning in front of Manual.

1. Remove light scuffing or scoring from camshaft (6) lobes (A) and bearing surfaces (B, C) with crocus cloth (item 9, WP 0173) dipped in cleaning solvent (item 8, WP 0173).
2. Repair damaged threads (D) with a thread chaser tap (item 120, WP 0176).



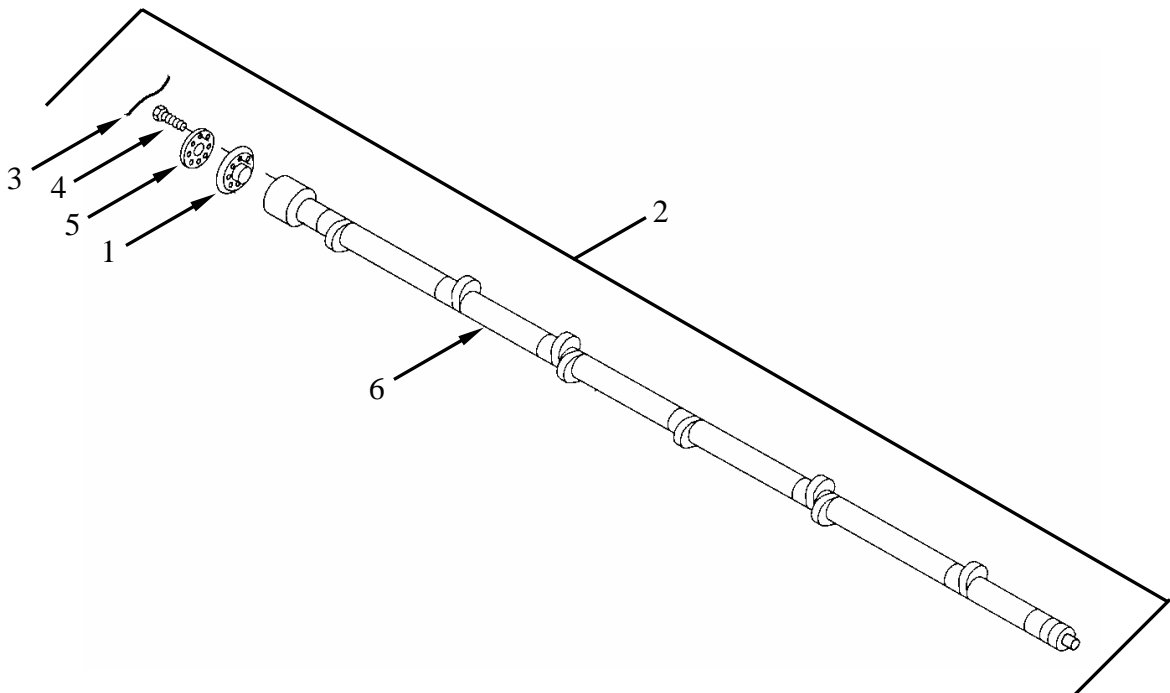
**ASSEMBLY**

1. Install bevel gear (1).
  - a. Place camshaft (6) in a soft-jawed vise.
  - b. Lubricate eight screws (4) using Lubriplate (item 23, WP 0173).

**CAUTION**

**Bevel gear and cover must be properly aligned with camshaft before installing screws or camshaft will be damaged. Two of the screw holes are slightly closer together on each of the pieces. Properly align these screw holes before installing screws.**

- c. Install bevel gear (1) and cover (5) with eight screws (4).
- d. Torque alternately eight screws (4) to 23-27 foot-pounds (31-37 N•m).
- e. Secure with new lock wire (3) (item 44, WP 0173).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

**INITIAL SETUP:**

**Tools and Special Tools:**

- Four leg sling (item 105, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)
- Torque wrench, 500-2500 inch-pounds (item 128, WP 0176)

**Mandatory Replacement Parts:**

- Gasket (item 105, WP 0175)
- Gasket (item 331, WP 0175)
- O-ring (item 142, WP 0175)
- O-ring (2)(item 145, WP 0175)
- O-ring (3)(item 148, WP 0175)
- Pipe plug (1) (item 255, WP 0175)
- Pipe plug (1) (item 276, WP 0175)
- Pipe plug (2) (item 278, WP 0175)
- Pipe plug (4) (item 56, WP 0175)
- Pipe plug (5) (item 170, WP 0175)
- Self-locking nuts (2) (item 33, WP 0175)
- Self-locking nuts (16) (item 34, WP 0175)

**Expendable Materials:**

- Lubriplate (item 23, WP 0173)
- Sealing compound, silicone sealant (item 33, WP 0173)

**Personnel Required:**

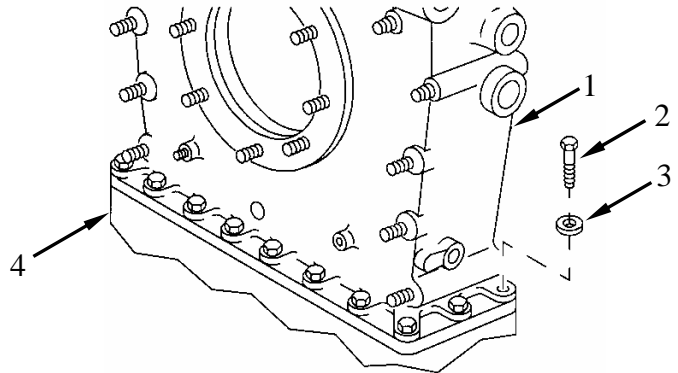
- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Wiring harness removed (for 2CA use WP 0057), (for 2DA use WP0058), (for 2DR use WP 0059)
- Engine on maintenance stand (WP 0130)
- Fans, covers, and top deck removed (WP 0054 and WP0055)
- Throttle control solenoid assembly and associated parts removed (WP 0125, WP 0126 and WP 0123)
- Fuel/water separator bracket assembly removed (WP 0164)
- Heater fuel filter mounting bracket removed (WP 0166)
- 2CA, 2DA: Pump drive adapter assembly removed (WP 0110)
- Manifold heater pump, fuel back flow valve, brackets and lines removed (WP 0081)
- Manifold heater solenoids and lines removed (WP 0088)
- Fuel/water separator drain cock and lines removed (WP 0084)
- 2CA, 2DA: Engine installation guides removed (WP 0132)
- 2DR: Power take-off housing and associated parts removed (WP 0111)
- Engine and transmission oil coolers and lines removed (WP 0072)
- Oil cooler frames and shrouds removed (WP 0090)
- Breather tube removed (WP 0078)
- Oil lines to turbo and fuel injection pump removed (WP 0078)

**REMOVAL**

1. Remove damper/oil filter housing (1).
  - a. Remove 12 screws (2) with flat washers (3) securing damper/oil filter housing (1) to oil pan (4).



- b. Remove self-locking nuts (5) with flat washers (6). Discard self-locking nuts.
  - c. Attach suitable lifting sling and hoist to lifting eyes (7).

**WARNING**



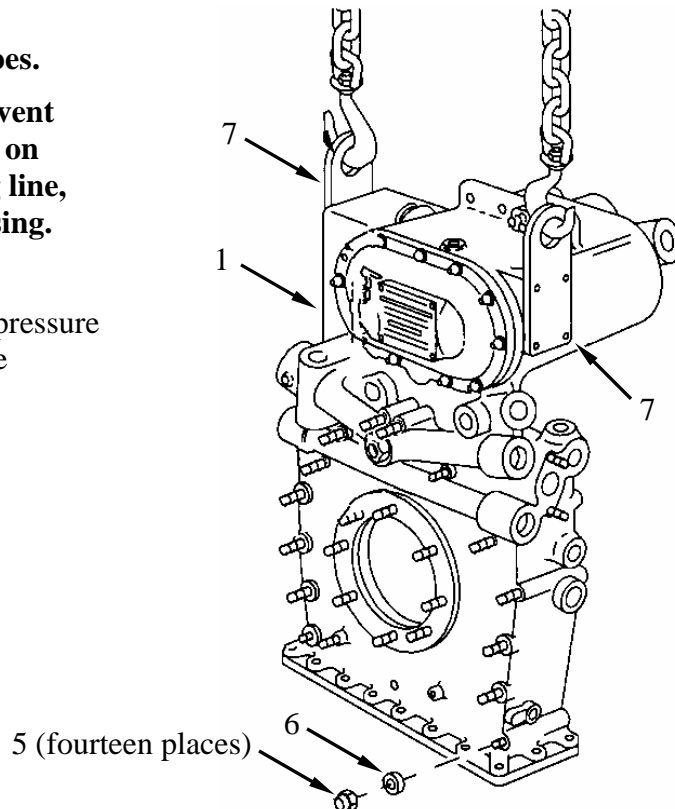
**Damper/oil filter housing is heavy, use suitable lifting device. Take care that damper/oil filter housing does not swing on hoist and injure personnel.**

**CAUTION**

**Do not allow damper/oil filter housing to rest on studs after housing is separated from crankcase and oil transfer tubes.**

**Caution must be taken to prevent damage to machined surfaces on the oil pan, crankcase parting line, and the damper/oil filter housing.**

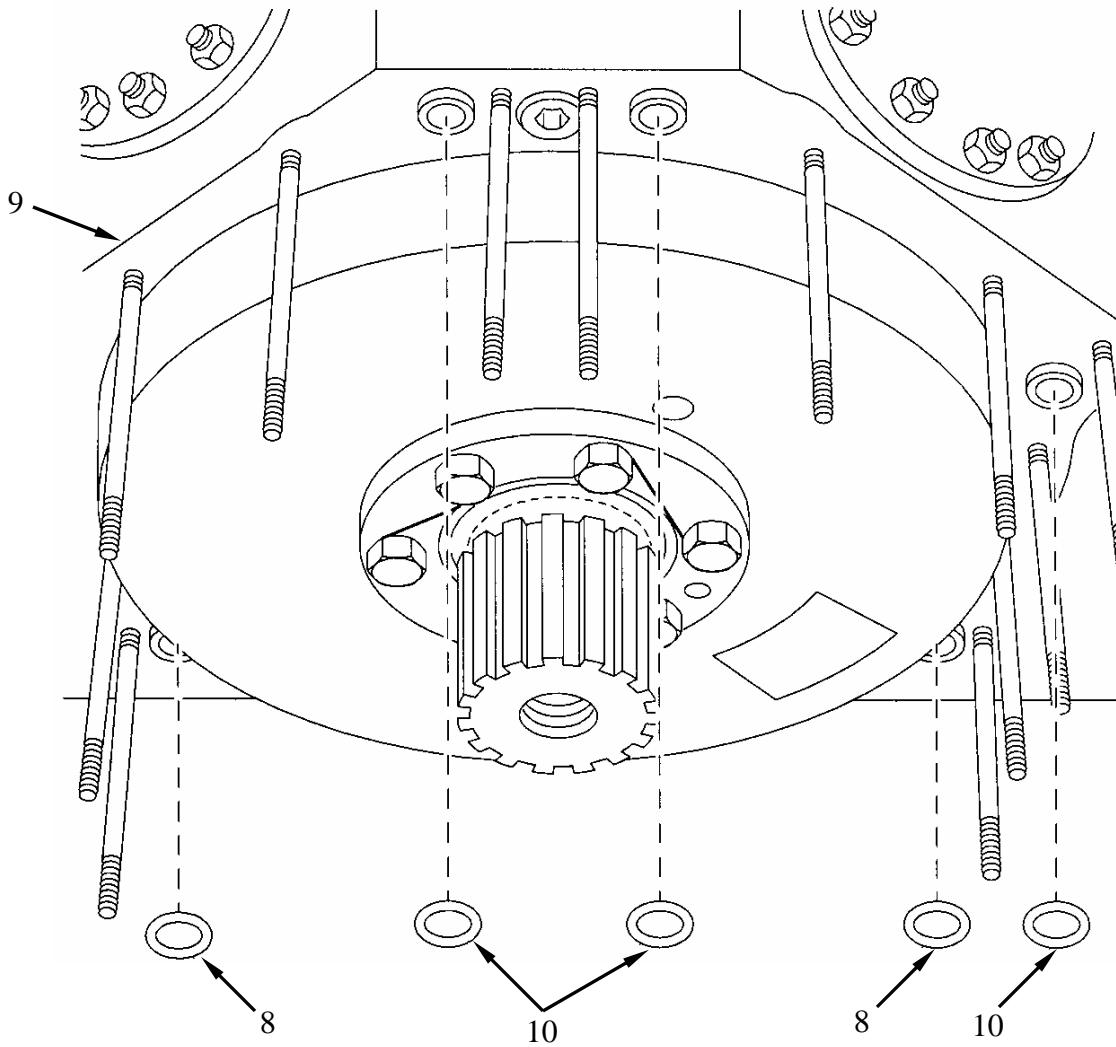
- d. With a slight amount of lifting pressure from hoist, carefully remove the damper/oil filter housing (1).





**REMOVAL (Continued)**

1. Remove damper/oil filter housing (1) (Continued):
  - e. Remove and discard two O-rings (8) from crankcase (9).
  - f. Remove and discard three O-rings (10) from crankcase (9).



**DISASSEMBLY**

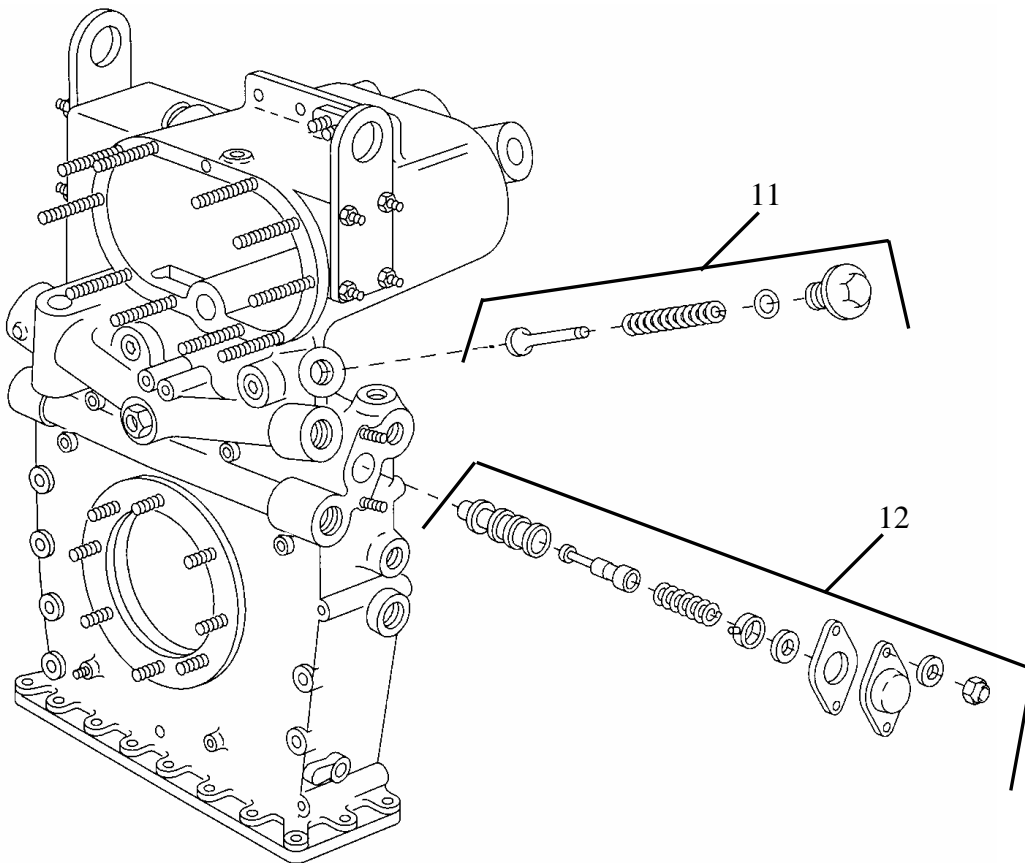
1. Remove adapters, bushings, reducers, elbows, sending units, oil filters and associated parts from oil filter cavity of damper/oil filter housing (1) (WP 0092 and WP 0093).

**WARNING**



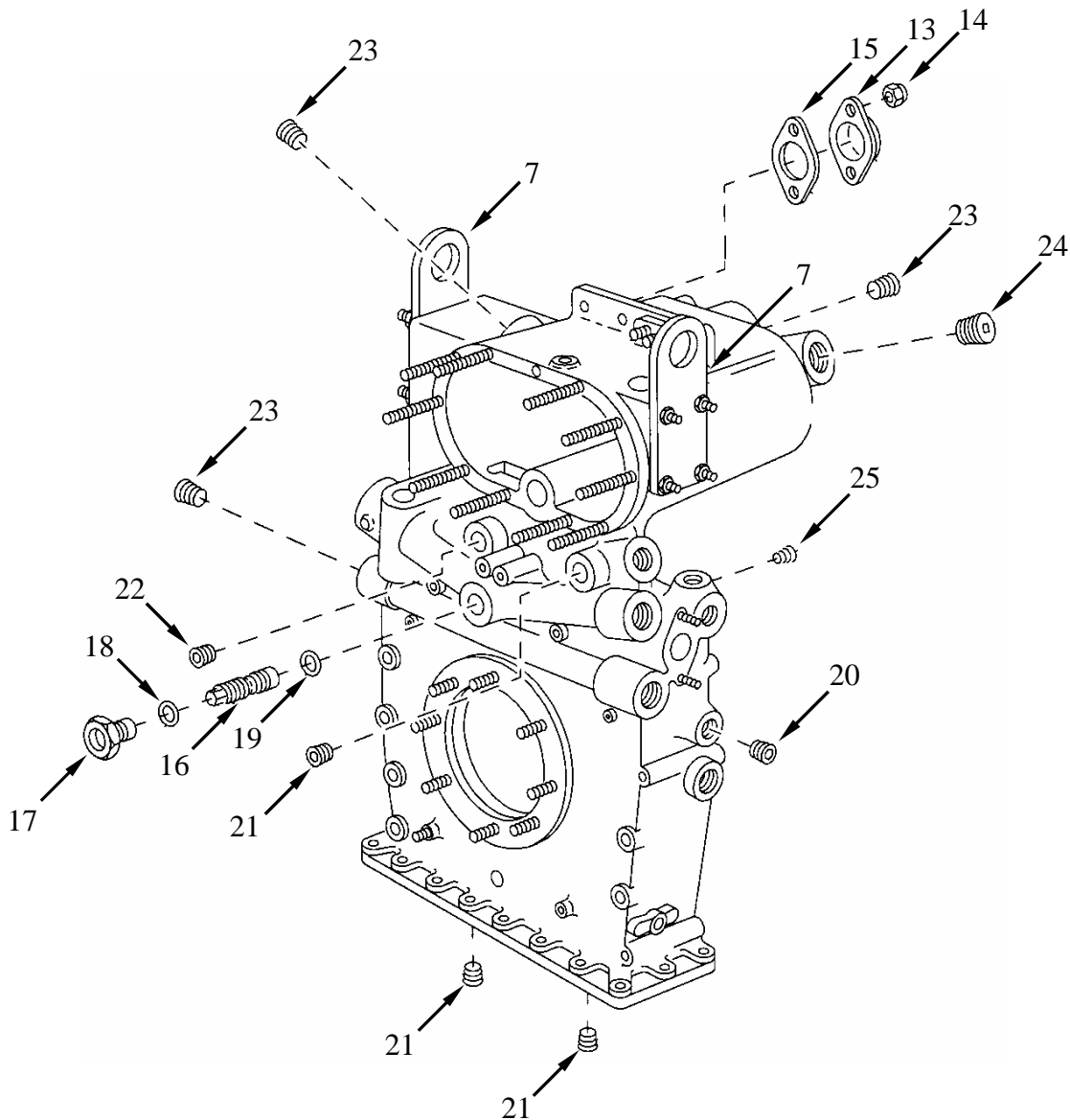
**The oil pressure regulator valve (11) cover is spring loaded. Exercise care when removing cover.**

2. Refer to (WP 0106) to remove oil pressure regulator valve (11) and oil filter bypass valve (12) from damper/oil filter housing (1).



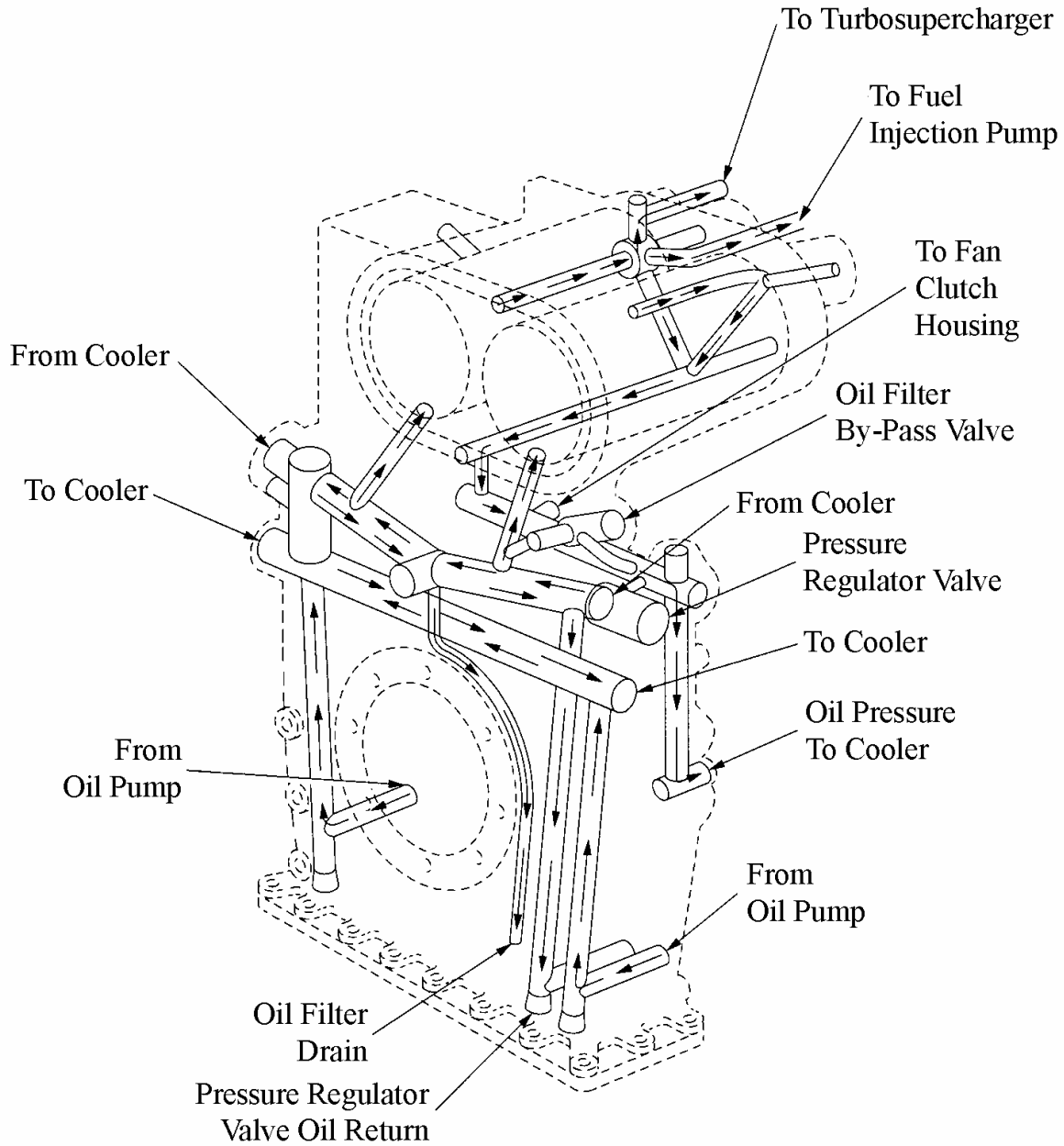
**DISASSEMBLY (Continued)**

3. Remove breather vent cover (13).
  - a. Remove two self-locking nuts (14), breather vent cover (13), and gasket (15). Discard self-locking nuts (14) and gasket (15).
4. Remove oil filter cavity drain valve (16).
  - a. Remove straight adapter (17), gasket (18), valve (16), and O-ring (19) as an assembly. Discard gasket and O-ring.
5. Remove bushing (20).
6. Remove and discard 13 pipe plugs: four at (21), one at (22), five at (23), two at (24), and one at (25).
7. Remove two engine lifting eyes (7) (WP 0132).



**CLEANING**

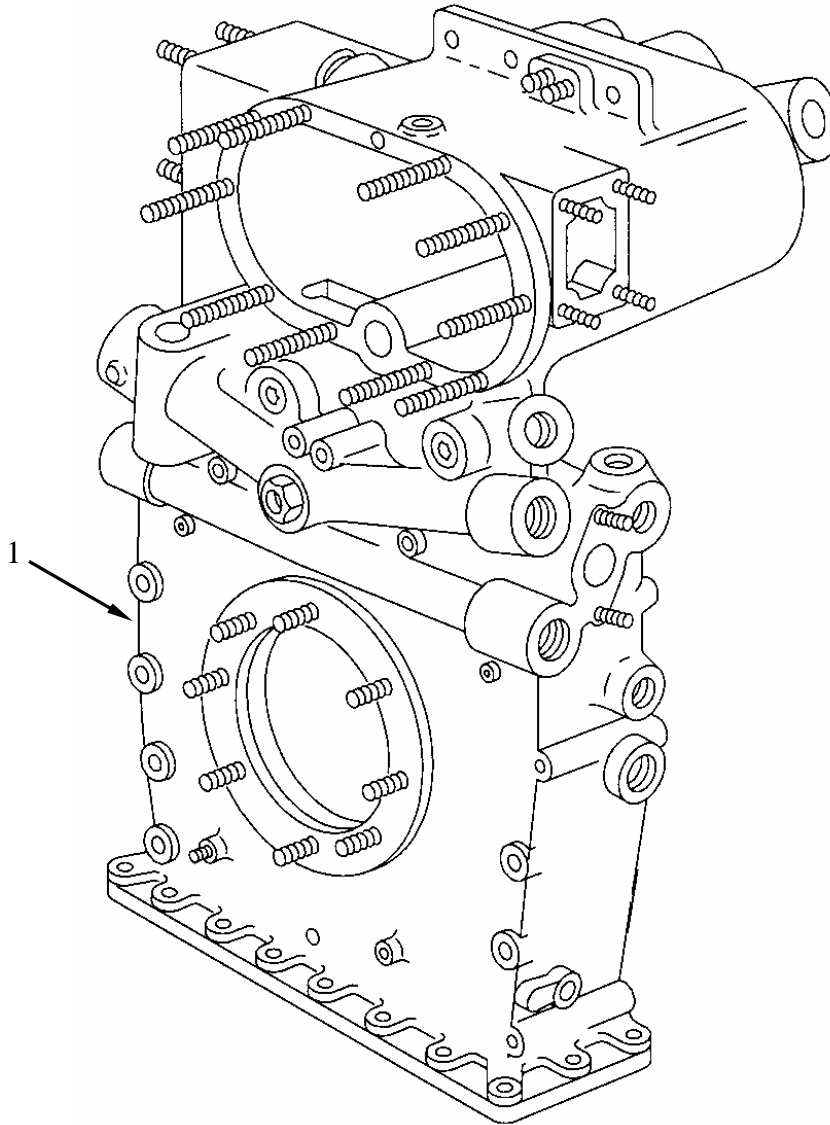
1. See Work Package 0028 for Standard Cleaning Procedures.
2. Make certain all oil passages in damper/oil filter housing (1) are clear and free of obstructions.



**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. Inspect damper/oil filter housing (1) according to standard inspection procedures in Work Package 0028.



**REPAIR**

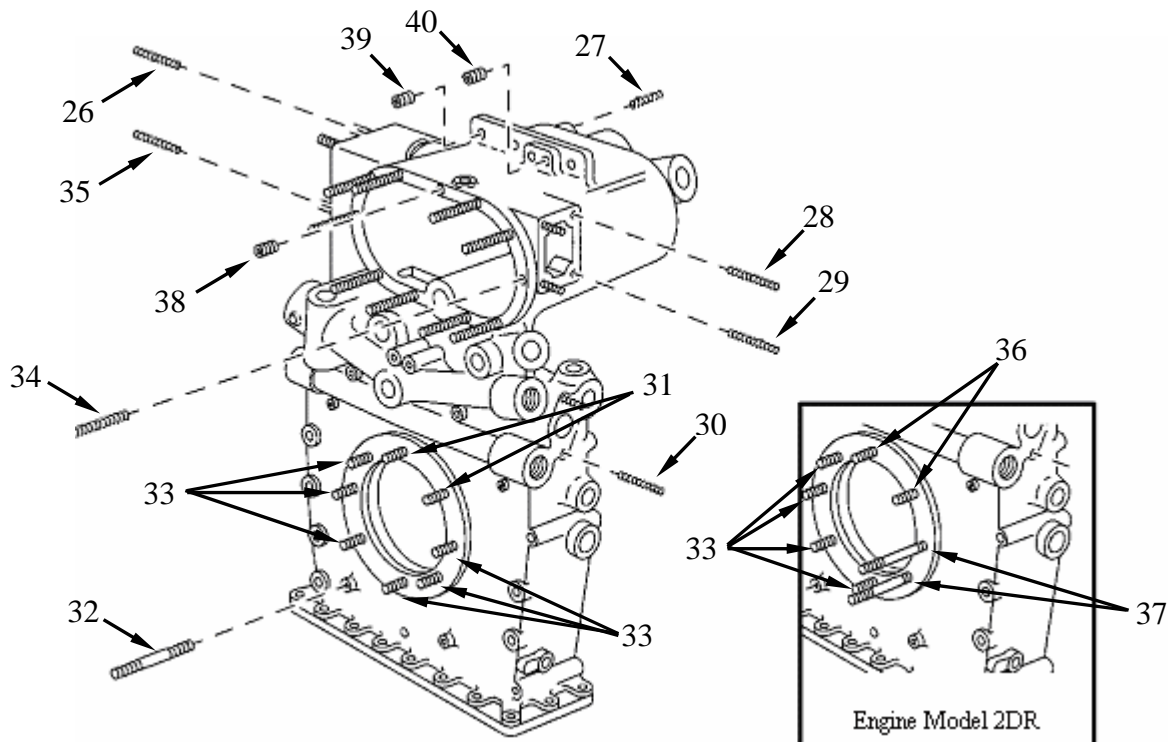
1. Replace damaged, bent, or stripped, studs (26 through 37).

a. Refer to the following table for height settings and Work Package 0028 for procedures.

Location	Setting Height inch (mm)	Quantity	Stud Size and Length diameter(length of thread) X overall length
26	1-1/4 (31.7500)	2	3/8-16(15/16) X 3/8-24(13/16) X 1-15/16
27	25/32 (19.8438)	2	5/16-18(11/16) X 5/16-24(9/16) X 1-5/16
28	1-7/16 (36.5125)	2	3/8-16(15/16) X 3/8-24(13/16) X 2-3/32
29	1-3/32 (27.7813)	2	3/8-16(27/32) X 3/8-24(7/8) X 1-3/4
30	27/32 (21.4312)	2	5/16-18(3/4) X 5/16-24(18/32) X 1-1/2
31	1-3/16	2	3/8-16(7/8) X 3/8-24(15/16) X 1-3/4
32	13/16 (20.6375)	1	3/8-16(3/4) X 3/8-24(9/16) X 1-13/32
33	1-3/32 (27.7813)	8	3/8-16(27/32) X 3/8-24(7/8) X 1-3/4
34	1-13/32 (35.7188)	10	3/8-16(15/16) X 3/8-24(13/16) X 2-3/32
35	7/8 (22.2250)	2	5/16-18(3/4) X 5/16-24(19/32) X 1-1/2
36	1-1/16	2	3/8-16(7/8) X 3/8-24(27/32) X 1-3/4
37	4-1/16	2	3/8-16(13/16) X 3/8-24(15/16) X 4-11/16

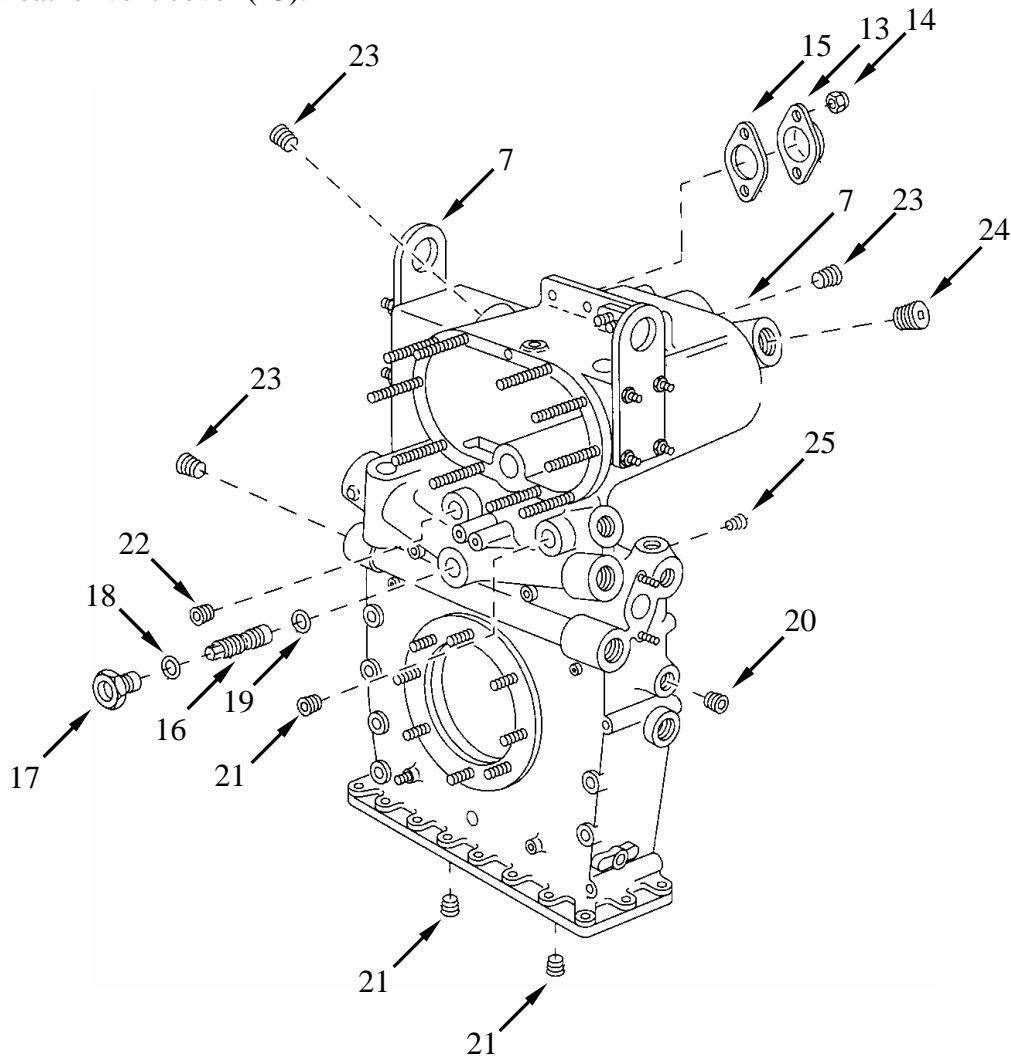
2. Replace defective screw thread inserts (38, 39, and 40).

a. Refer to WP 0029 for helical-coil; and WP 0030 for thread insert, replacement procedures.



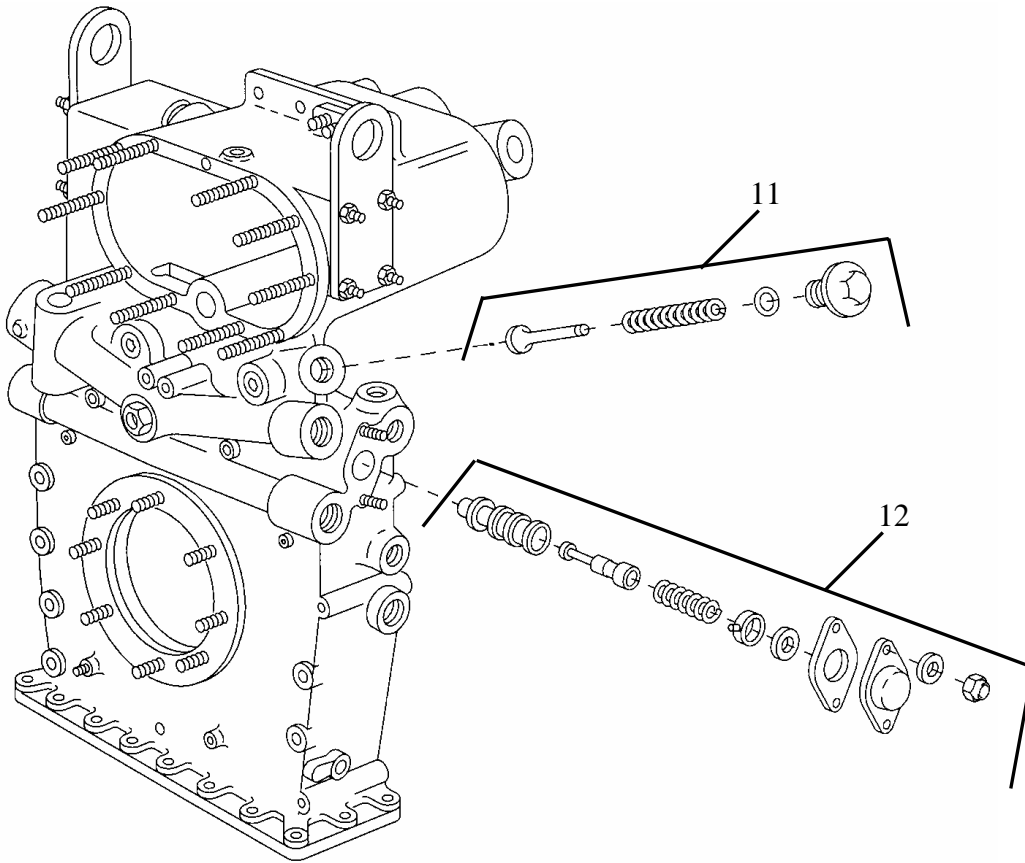
**ASSEMBLY**

1. Install two engine lifting eyes (7) (WP 0132).
  - a. Position new gasket (15) (item 331 WP 0175) and vent cover (13) in place.
  - b. Secure using two new self-locking nuts (item 33, WP 0175).
2. Install bushing (20).
3. Install 13 pipe plugs: four at (21) (item 56, WP 0175), one at (22) (item 255, WP 0175), five at (23) (item 170 WP 0175), two at (24) (item 278, WP 0175), and one at (25) (item 276, WP 0175).
4. Install oil filter cavity drain valve (16).
  - a. Lubricate new O-ring (19) (item 142, WP 0175) with Lubriplate (item 23, WP 0173). Install straight adapter (17), new gasket (18) (item 105, WP 0175), drain valve (16), and new O-ring (19) as an assembly.
  - b. Torque-tighten straight adapter (17) to 950-1000 inch-pounds (107-113 N•m).
  - c. Torque-tighten drain valve (16) to 135-150 inch-pounds (15-17 N•m).
5. Install breather vent cover (13).



**ASSEMBLY (Continued)**

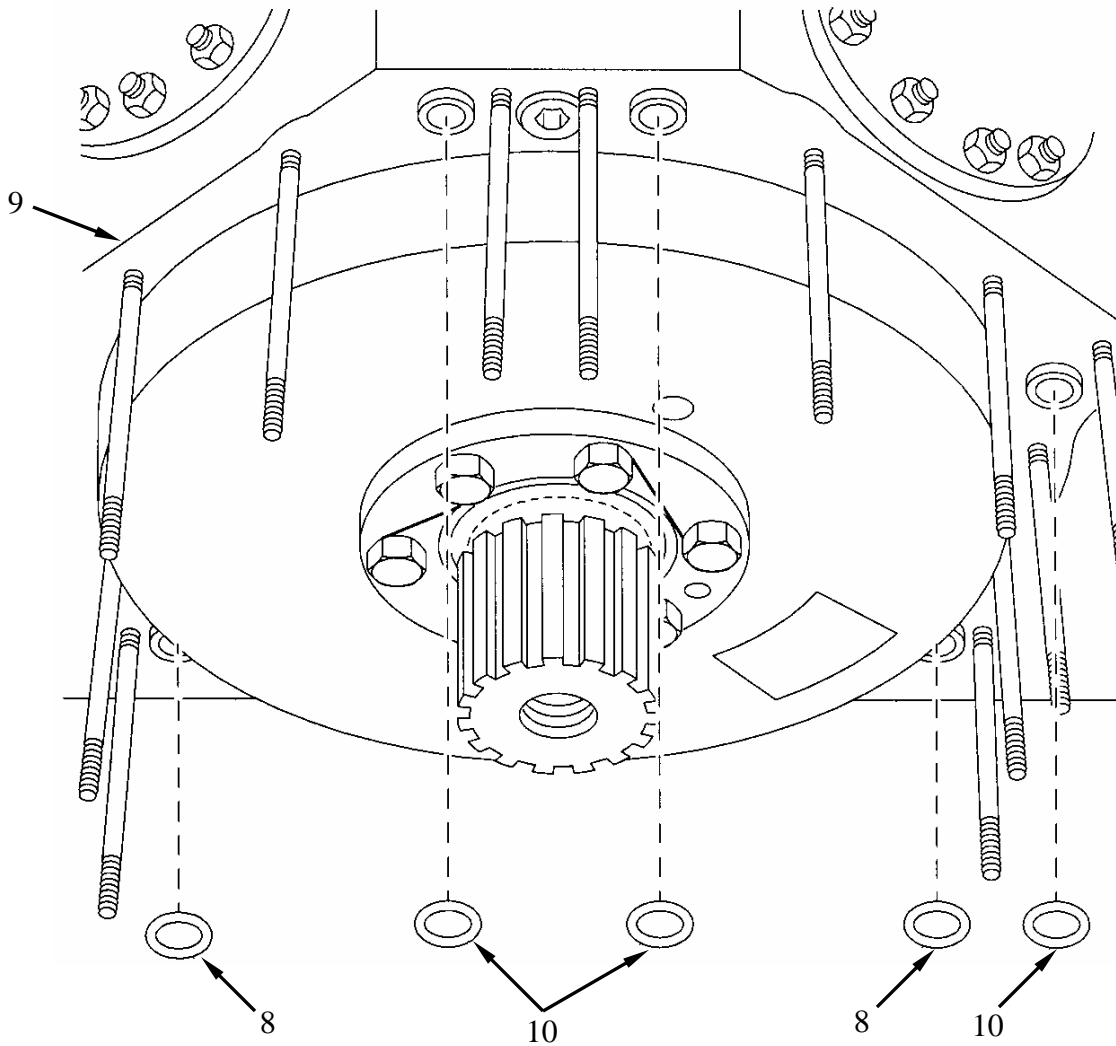
5. Install oil pressure regulator valve (11) and oil filter bypass valve (12) (WP 0106) onto damper/oil filter housing (1).
  
6. Install adapters, bushings, reducers, elbows, sending units, oil filters and associated parts onto oil filter cavity of damper/oil filter housing (1) (WP 0092 and WP 0093).





**INSTALLATION**

1. Install damper/oil filter housing (1).
  - a. Coat with Lubriplate (item 23, WP 0173) three new O-rings (10) (item 148, WP 0173) and install onto crankcase (9).
  - b. Coat with Lubriplate two new O-rings (8) (item 145, WP 0173) and install onto crankcase (9).



**INSTALLATION (Continued)**

1. Install damper/oil filter housing (1) (Continued):
  - c. Apply a 1/16- to 1/8-inch bead of sealant (item 33, WP 0173) at the split line (A) and the mating surfaces of the damper housing (1) and the crankcase assembly (40).
  - d. Attach suitable lifting sling (item 105, WP 0176) and hoist to lifting eyes (7).

**WARNING**

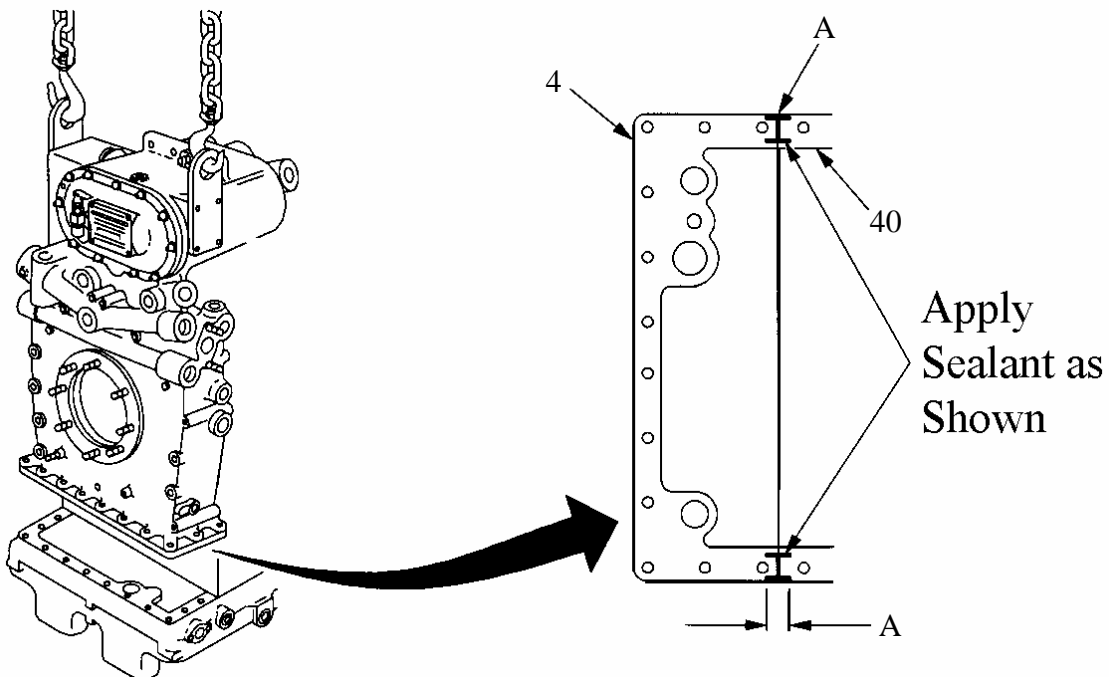
**Damper/oil filter housing is heavy, use suitable lifting device. Take care that damper/oil filter housing does not swing on hoist and injure personnel.**

**CAUTION**

**Do not allow damper/oil filter housing to rest on studs while housing is separated from crankcase and oil transfer tubes.**

**Caution must be taken to prevent damage to machined surfaces on the oil pan, crankcase parting line, and the damper/oil filter housing.**

- e. Lift damper/oil filter housing (1) just enough to clear oil pan (4) and carefully slide into position.



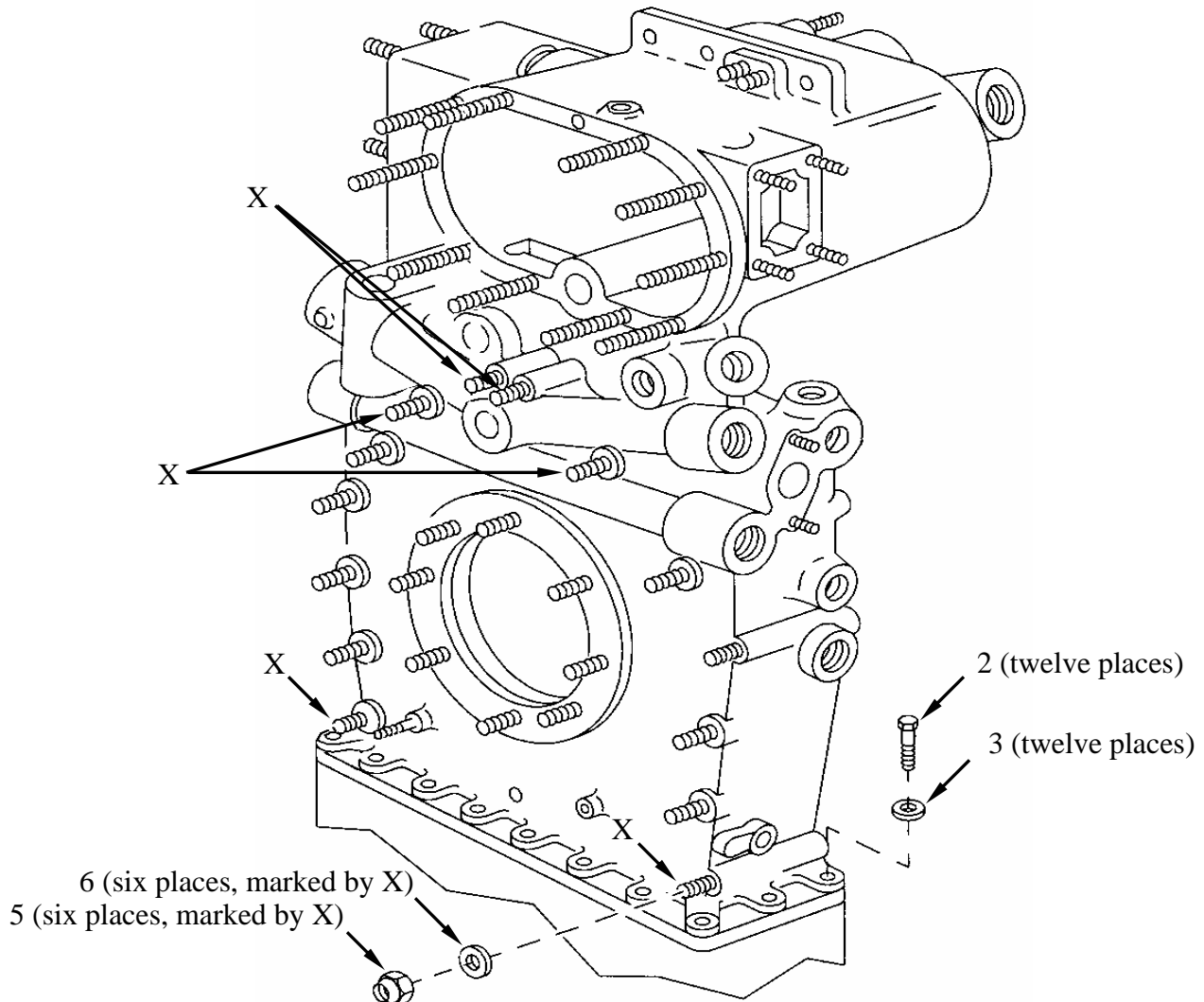
## INSTALLATION (Continued)

1. Install damper/oil filter housing (1) (Continued):

**NOTE**

**There are fourteen studs that secure the damper/oil filter housing to the crankcase. Some of the studs also secure various brackets and hose clamps. At this time only torque the studs indicated, the remaining studs will be torque-tightened at the time of bracket installation.**

- f. Apply Lubriplate (item 23, WP 0173) to threads of six mounting studs (X).
- g. Secure housing (1) using six new self-locking nuts (5) (item 34, WP 0175) with flat washers (6). Torque six self-locking nuts (5) to 225-250 inch-pounds (25-28 N•m).
- h. Apply Lubriplate to threads of 12 screws (2) and install with flat washers (3). Torque screws to 150-175 inch pounds (17-20 N•m).



**END OF WORK PACKAGE**



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**OIL PAN ASSEMBLY REPLACE/REPAIR**

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**0152 00****THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

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

Dial indicator (item 65, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Pliers, retaining ring (item 79, WP 0176)  
Sling assembly  
(For 2CA/2DA, item 38, WP 0176)  
(For 2DR, item 37, WP 0176)  
Stand, maintenance and overhaul  
(item 111, WP 0176)  
Torque wrench (item 124, WP 0176)  
Torque wrench (item 127, WP 0176)

**Expendable Materials:**

Lubriplate (item 23, WP 0173)  
Sealing compound, silicone sealant  
(item 33, WP 0173)

**Mandatory Replacement Parts:**

Expansion plug (2) (item 220, WP 0175)  
Gasket (2) (item 237, WP 0175)  
Gasket (item 238, WP 0175)  
Gasket (item 241, WP 0175)  
Gasket (2) (item 3, WP 0175)  
Gasket (item 244, WP 0175)

**Mandatory Replacement Parts, Continued**

Gasket (item 239, WP 0175)  
Lock washer (8) (item 94, WP 0175)  
Pipe plug (6) (item 255, WP 0175)  
Pipe plug (1) (item 277, WP 0175)  
Pipe plug (2) (item 278, WP 0175)  
Pipe plug (3) (item 170, WP 0175)  
Retaining Ring (2) (item 19, WP 0175)  
Retaining Ring (item 18, WP 0175)  
Self-locking nuts (56) (item 34, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

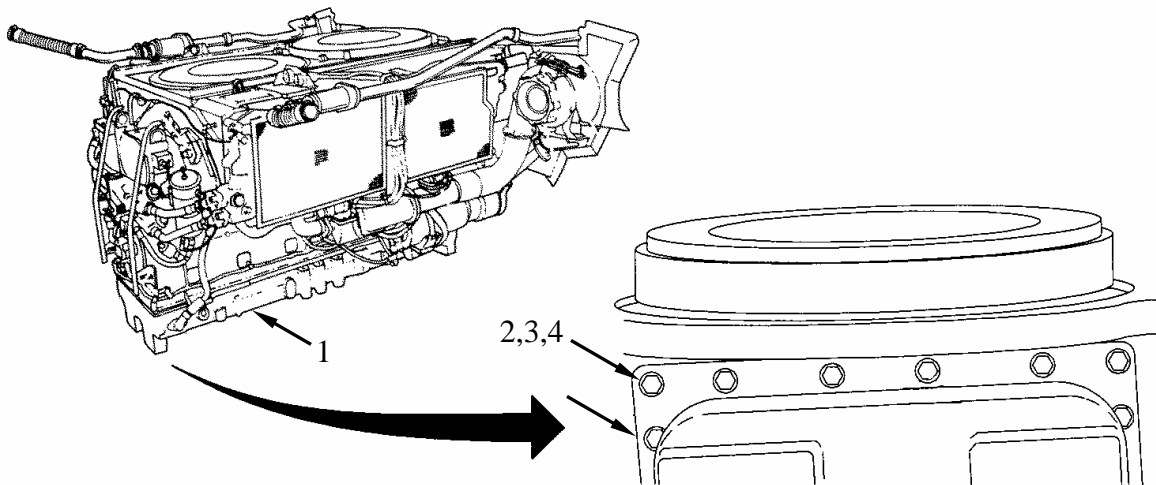
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Oil fill tube removed (WP 0075)  
Oil gauge rod tube removed (WP 0076)  
Cylinder oil drain tubes removed (WP 0077)

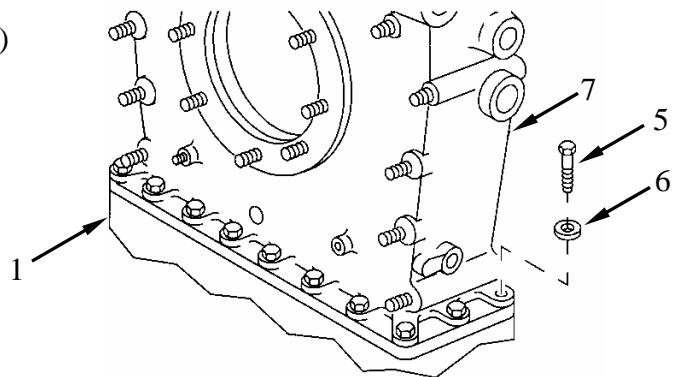
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**REMOVAL**

1. Remove oil pan (1).
  - a. Remove eight screws (2), with lock washers (3) and flat washers (4) from bottom of oil pan (1). Discard lock washers (3).



- b. Remove 12 screws (5) with flat washers (6) securing damper housing (7) to oil pan (1).



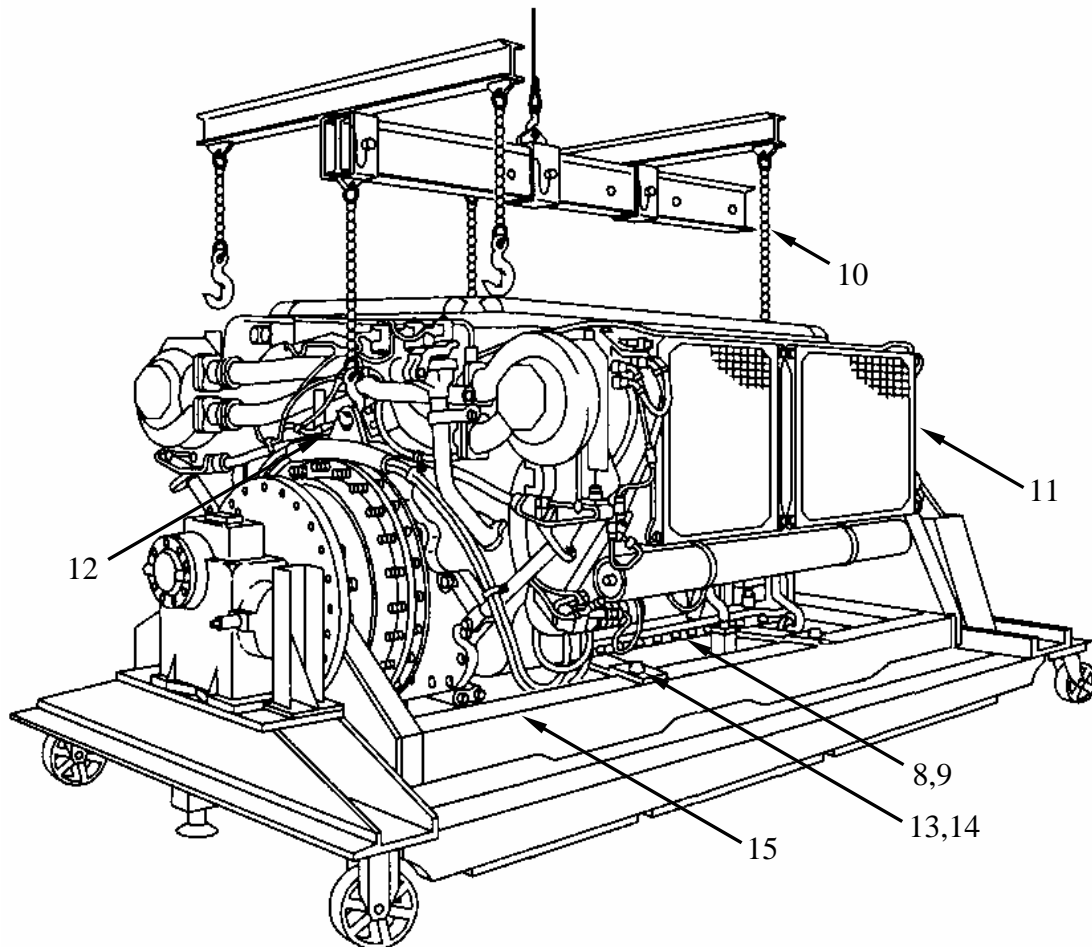
**REMOVAL (Continued)**

1. Remove oil pan (1). (Continued)

**CAUTION**

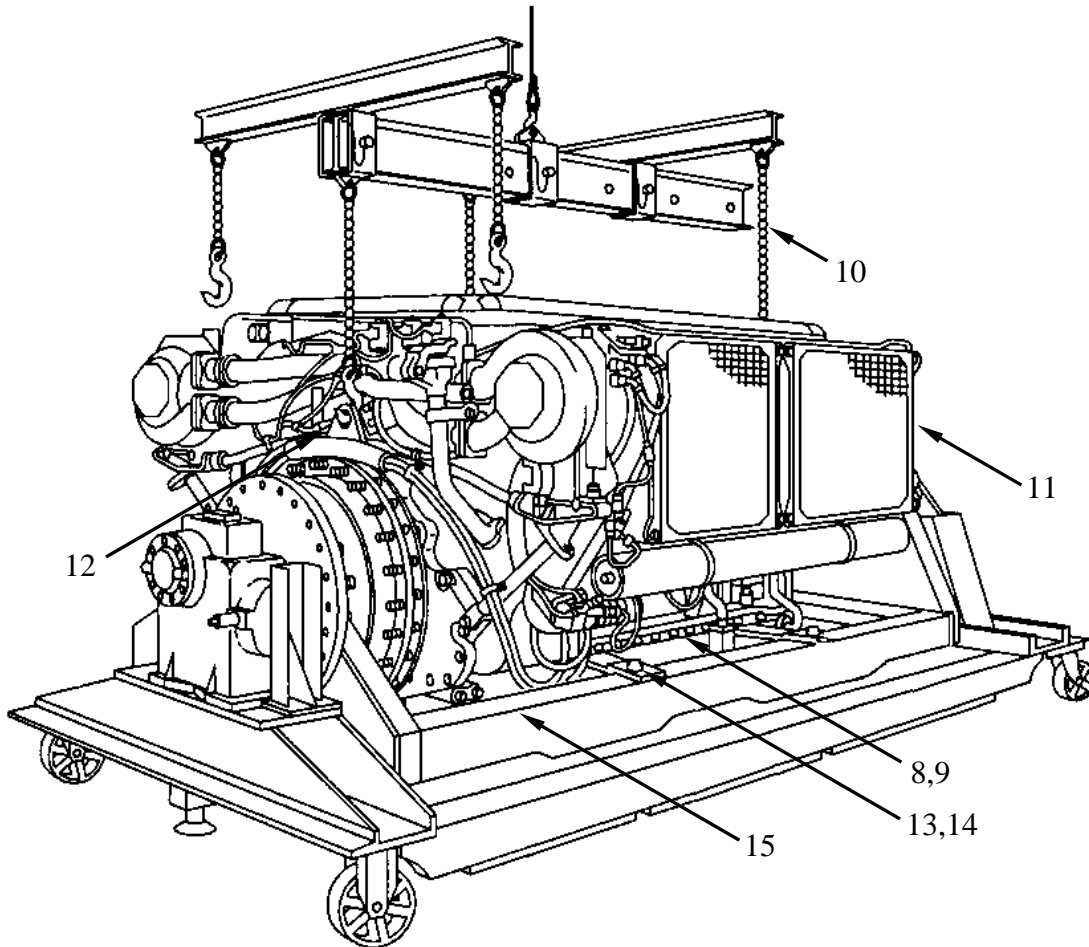
**Leave one nut and washer installed on each side of the oil pan, near the center, to prevent oil pan from falling and being damaged.**

- c. Remove 27 of 28 self-locking nuts (8) with flat washers (9) from each side of oil pan (1). Discard self-locking nuts.
- d. Attach sling assembly (10) (for 2CA, DA use item 38, for 2DR use item 37, WP 0176) to engine (11) lifting eyes (12) and to a suitable lifting device.
- e. Take slack out of lifting device and remove four screws (13) with flat washers (14) securing engine to maintenance stand (15).



**REMOVAL (Continued)**

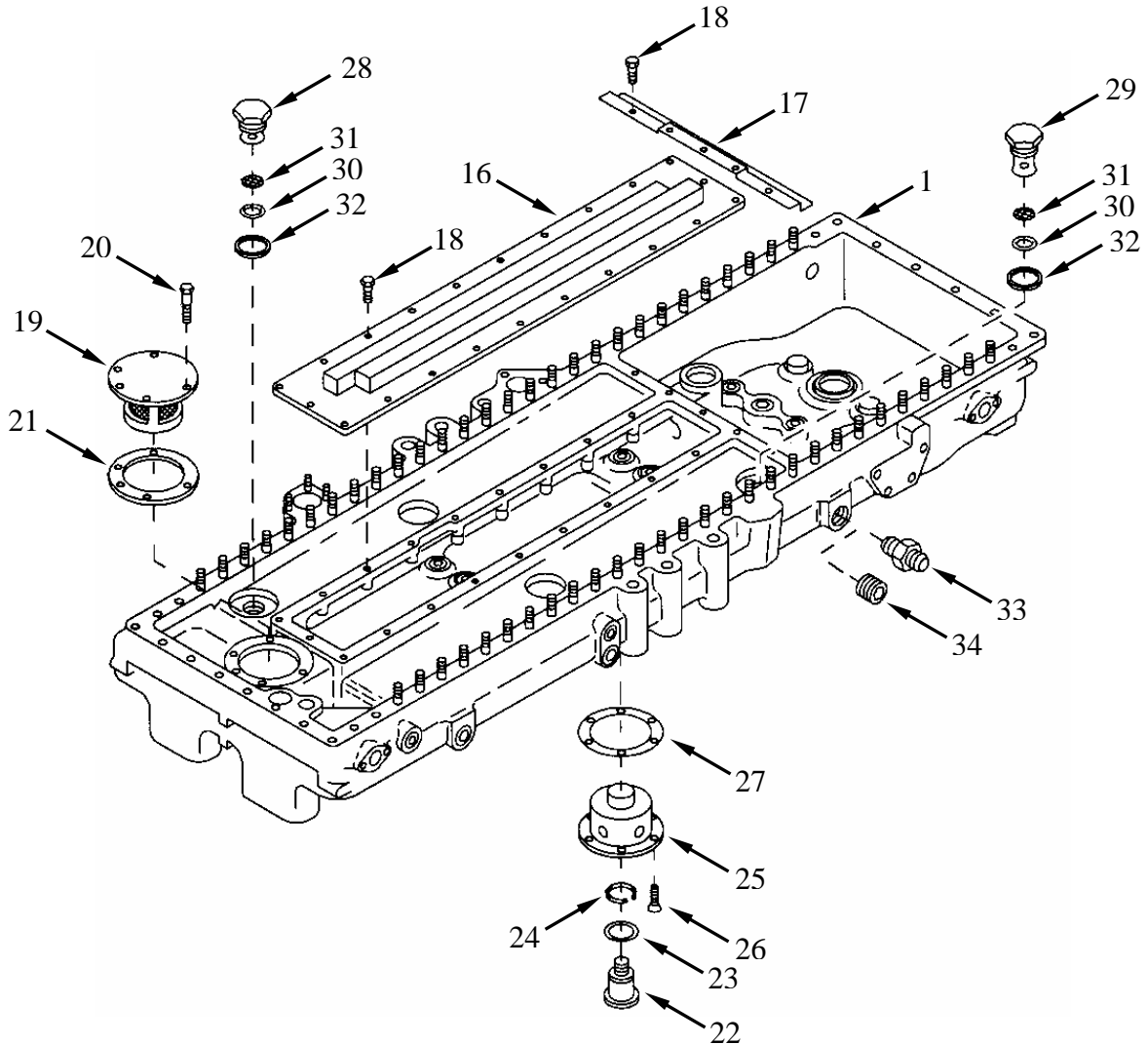
1. Remove oil pan (1). (Continued)
  - f. Lift engine (11) with oil pan (1) attached from maintenance stand (15) and set on a flat, level surface.
  - g. Remove remaining two self-locking nuts (8) with flat washers (9) securing oil pan (1) to engine (15). Discard self-locking nuts.
  - h. Lift engine (11) off of oil pan (1).
  - i. Mount engine (11) onto maintenance stand (15) (item 111, WP 0176).
    - (1) Secure engine (11) to maintenance stand (15) with four screws (13) with flat washers (14).
  - j. Remove sling assembly (10).





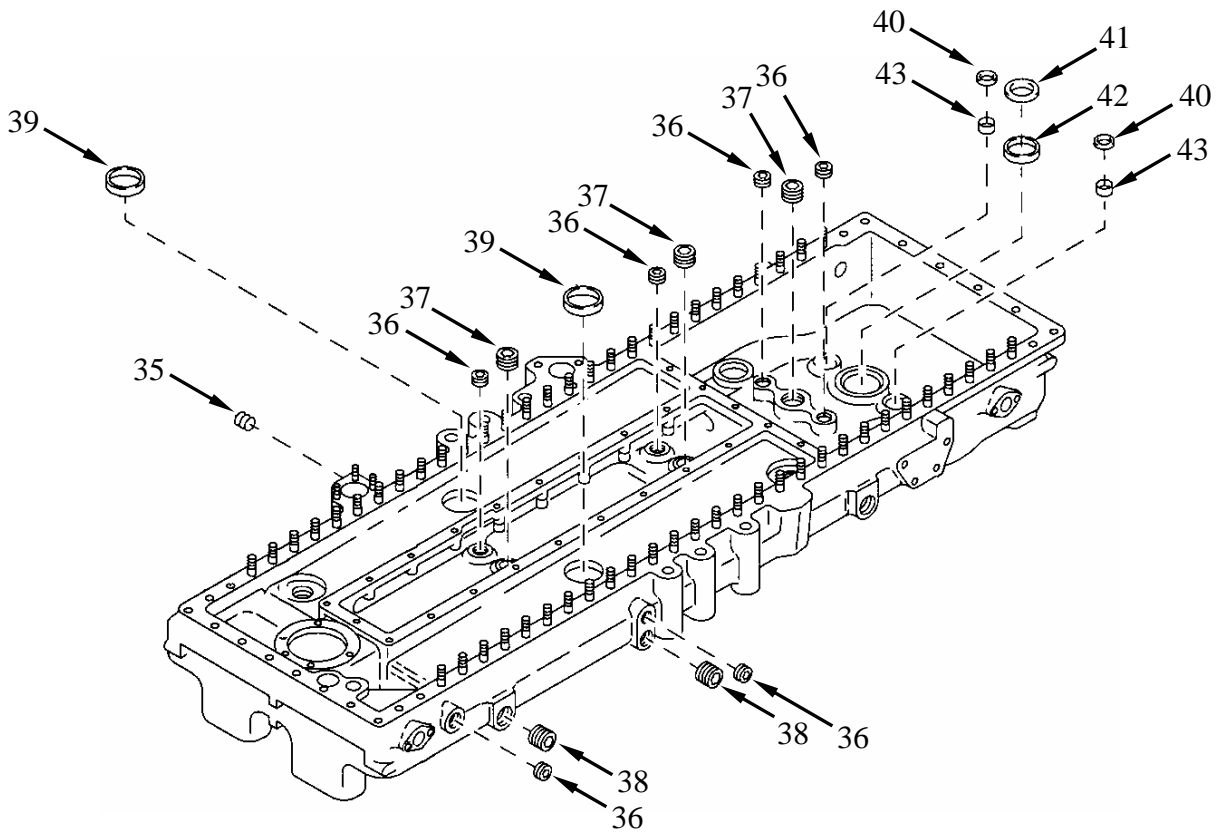
**DISASSEMBLY**

1. Remove cover (16) and bracket (17).
  - a. Remove 24 screws (18) securing cover (16) and bracket (17) to oil pan (1).
2. Remove scavenge screen (19).
  - a. Remove five screws (20) securing scavenge screen (19).
  - b. Remove scavenge screen (19) and gasket (21). Discard gasket.
3. Remove plug (22), gasket (23), and retaining ring (24). Discard gasket and retaining ring.
4. Remove adapter (25).
  - a. Remove six screws (26), adapter (25), and gasket (27). Discard gasket.
5. Remove two intake screen adapters (28 and 29).
  - a. Remove two retaining rings (30), two screens (31), and two gaskets (32). Discard retaining rings and gaskets.
6. Remove oil return fitting (33) on engines using a 650-ampere generator, or remove pipe plug (34) on engines using a 300-ampere generator. Discard pipe plug (34).



**DISASSEMBLY (Continued)**

7. Remove and discard 12 pipe plugs:  
One at (35), six at (36), three at (37), and two at (38).
8. Remove and discard two expansion plugs (39).
9. Remove and discard two gaskets (40) and one gasket (41).
10. Remove one oil transfer tube (42) and two oil transfer tubes (43).



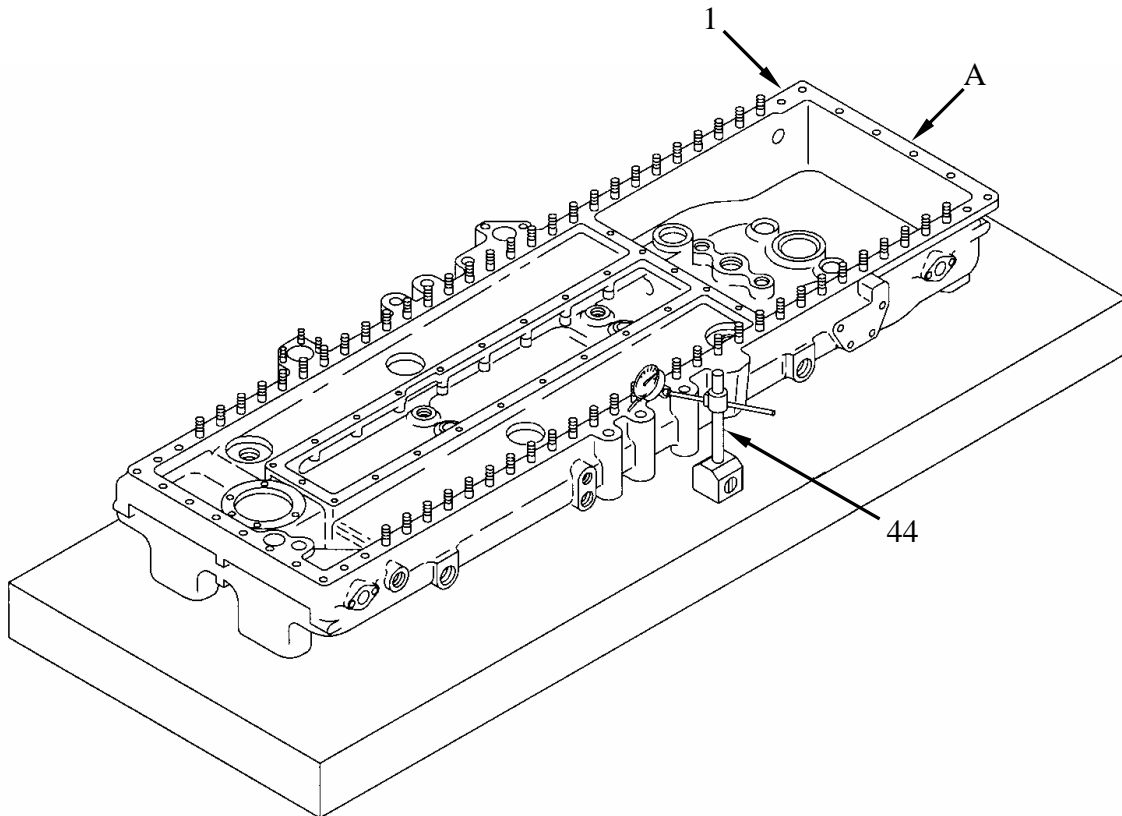
**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.
2. Assure that all oil passages are cleaned according to Work Package 0028.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Check the oil pan (1) mounting flange (A) for flatness using a dial indicator (44) (item 65, WP 0176). Replace oil pan if mounting flange is out of flat by more than 0.003 inch (0.0762 mm).



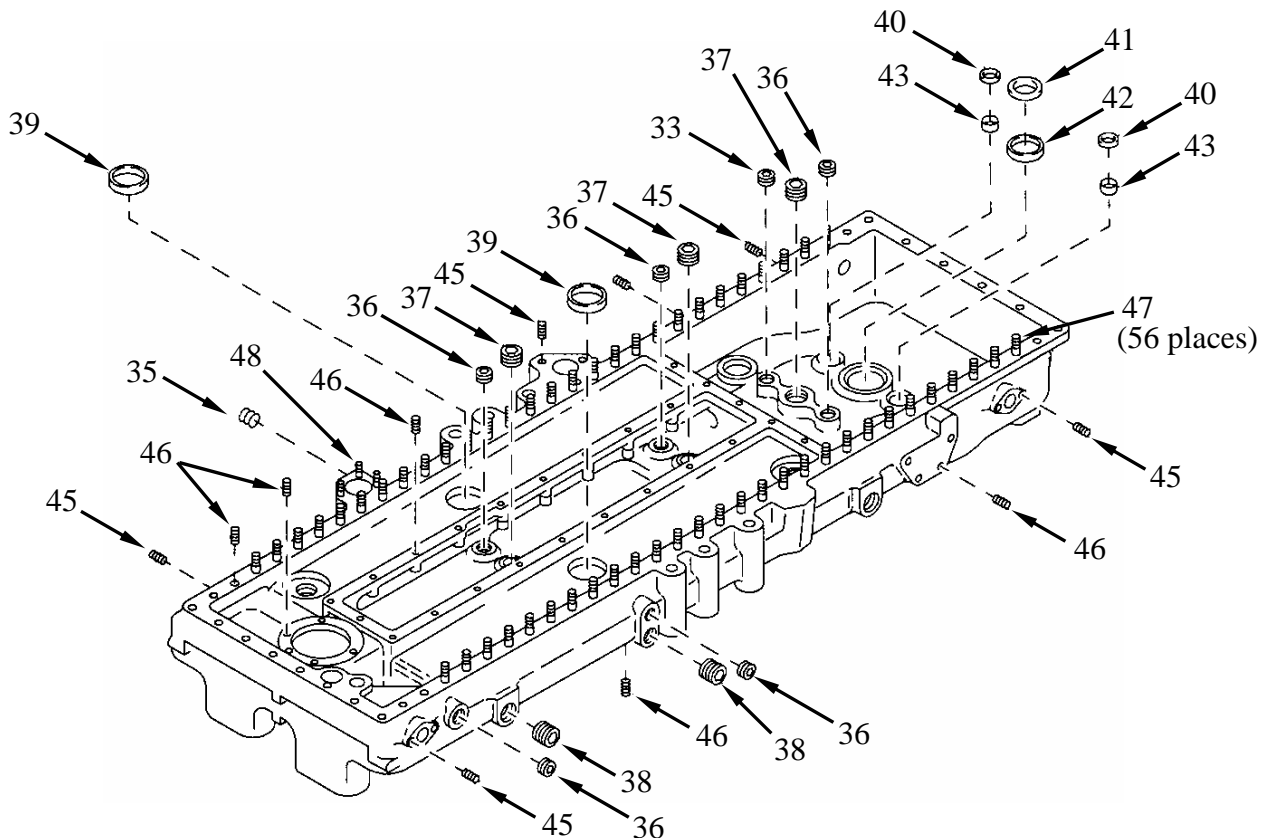
**REPAIR**

1. Replace defective screw thread inserts (45 and 46). Refer to WP 0030.
2. Replace damaged oil transfer tubes (42 and 43).
3. Replace damaged, bent, or stripped studs (47 and 48).
  - a. Refer to the following table for height settings and Work Package 0028 for procedures.

Location	Setting Height inch (mm)	Quantity	Stud Size and Length diameter(length of thread) X overall length
47	1-11/32 (34.1313)	56	3/8-16 (15/16) X 3/8 24 (13/16) X 2-3/32
48	25/32 (19.8438)	3	5/16 18 (3/4) X 5/16 24 (19/32) X 1-7/16

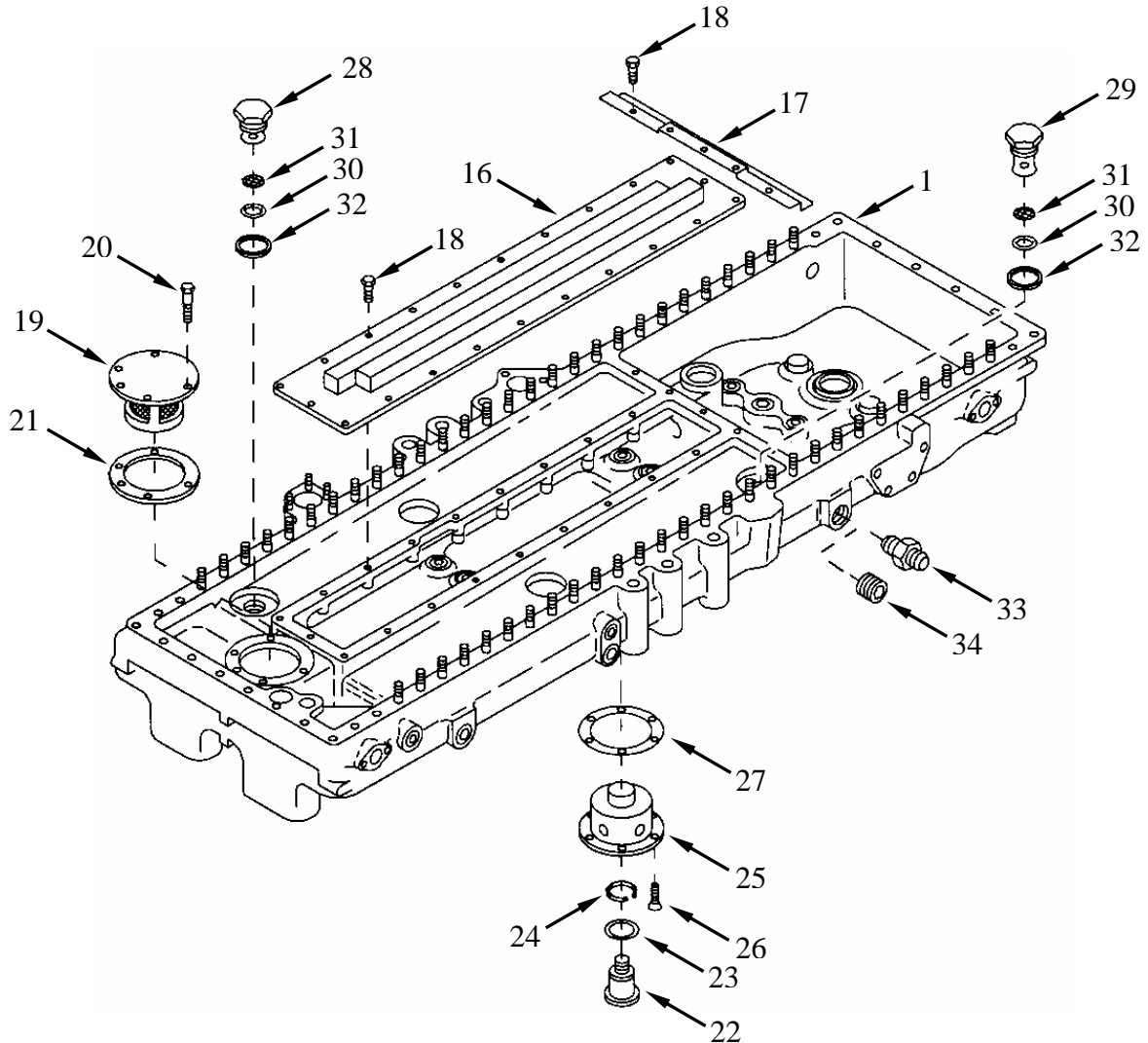
**ASSEMBLY**

1. Install one oil transfer tube (42) and two oil transfer tubes (43).
2. Install two new gaskets (40) (item 237, WP 0175) and one new gasket (41) (item 238, WP 0175).
3. Install two new expansion plugs (39) (item 220, WP 0175).
4. Install 12 pipe plugs: One at (35) (item 277, WP 0175), six at (36) (item 255, WP 0175), three at (37) (item 170, WP 0175), and two at (38) (item 278, WP 0175).



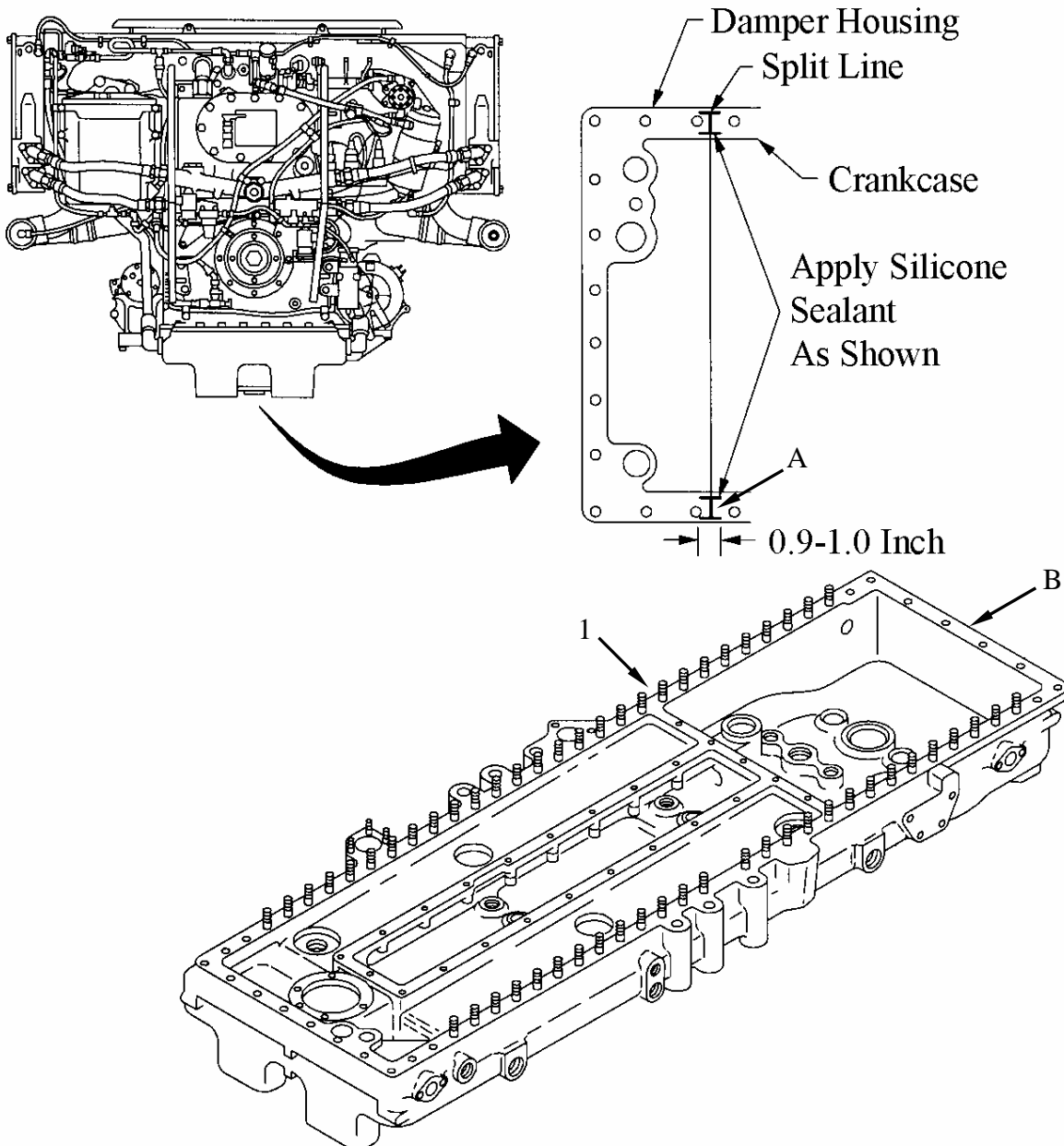
**ASSEMBLY (Continued)**

5. Install oil return fitting (33) on engines using a 650-ampere generator or new pipe plug (34) (item 255, WP 0175) on engines using a 300-ampere generator.
6. Install two intake screen adapters (28 and 29).
  - a. Install screen (31) on each adapter and secure with new retaining ring (30) (item 19, WP 0175).
  - b. Position new gasket (32) (item 3, WP 0175) on each adapter and install adapters (28, 29).
7. Install adapter (25).
  - a. Position new gasket (27) (item 241, WP 0175) on adapter (25).
  - b. Install adapter (25) and secure with six screws (26).
8. Install plug (22), new gasket (23) (item 244, WP 0175), and new retaining ring (24) (item 18, WP 0175) into adapter (25).
9. Install screen (19) using new gasket (21) (item 239, WP 0175), secure with five screws (20).
10. Install cover (16) and bracket (17) and secure with 24 screws (18).



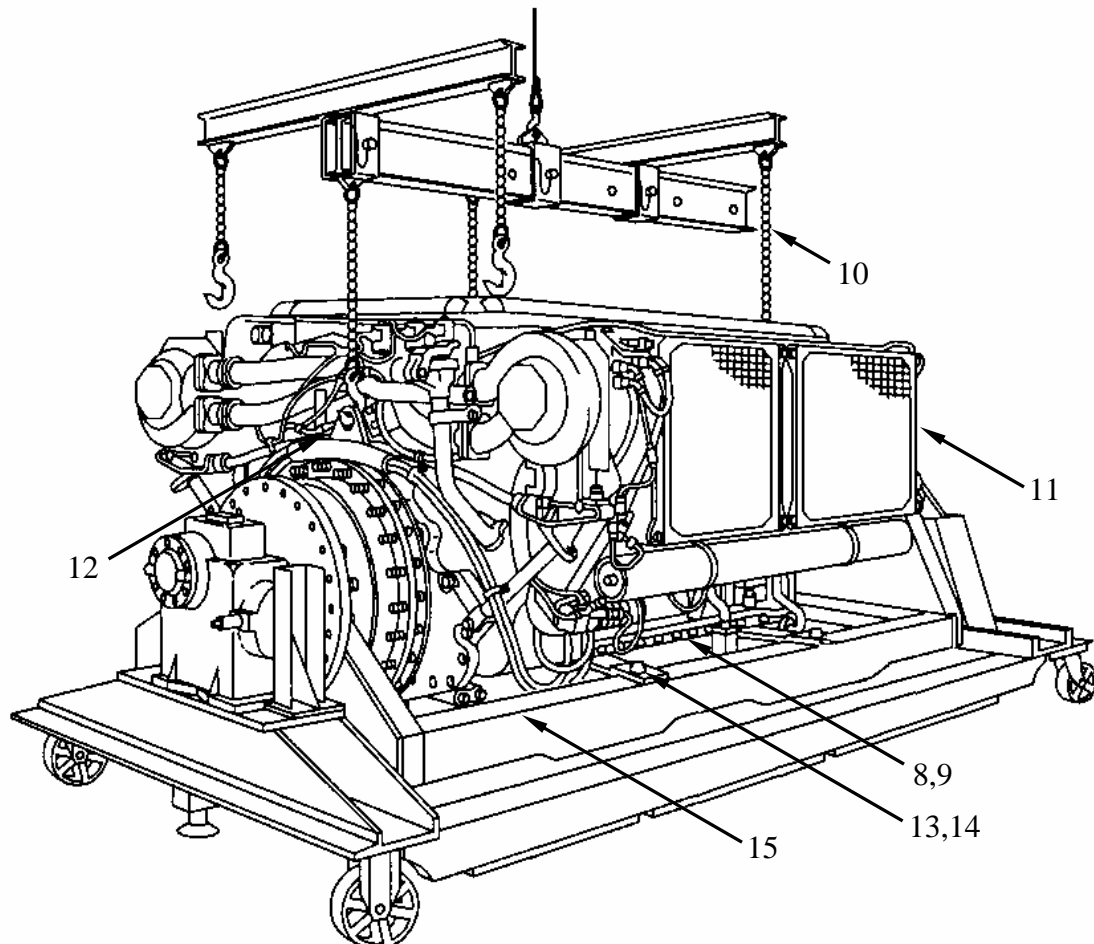
**INSTALLATION**

1. Install oil pan (1).
  - a. Apply a 1/16- to 1/8-inch bead of sealant (item 33, WP 0173) at the split line (A) on the bottom flange of damper housing (7) and of crankcase assembly (49).
  - b. Place oil pan (1) level on flat surface and apply sealant to oil pan mounting flange (B) (item 33, WP 0173).



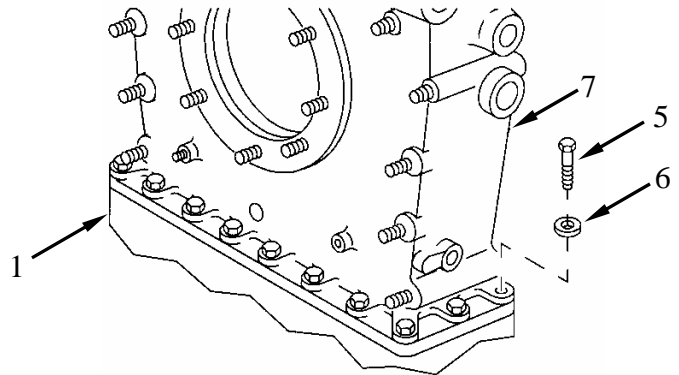
**INSTALLATION (Continued)**

1. Install oil pan. (Continued)
  - c. Attach sling assembly (10) (For 2CA/2DA, item 38, WP 0176) (For 2DR, item 37, WP 0176) to engine (11) lifting eyes (12) and to a suitable lifting device.
  - d. Take slack out of lifting device and remove four screws (13) and four flat washers (14) securing engine to rollover stand (15).
  - e. Lift engine (11) from maintenance stand (15) and carefully lower onto the oil pan (1).
  - f. Install two new self-locking nuts (8) (item 34, WP 0175) with flat washers (9) (one on each side of pan, near the center) to secure oil pan (1) to engine (11).
  - g. Mount engine (11) onto maintenance stand (15) (item 111, WP 0176).
    - (1) Secure engine (11) to maintenance stand (15) with four screws (10) and four flat washers (11).
  - h. Remove sling assembly (10).
  - i. Install 27 new self-locking nuts (8) (item 34, WP 0175) with flat washers (9) on each side of oil pan (1).
  - j. Alternately tighten 56 new self-locking nuts (8) to 275-300 inch pounds (31-33.9 N•m).



**INSTALLATION (Continued)**

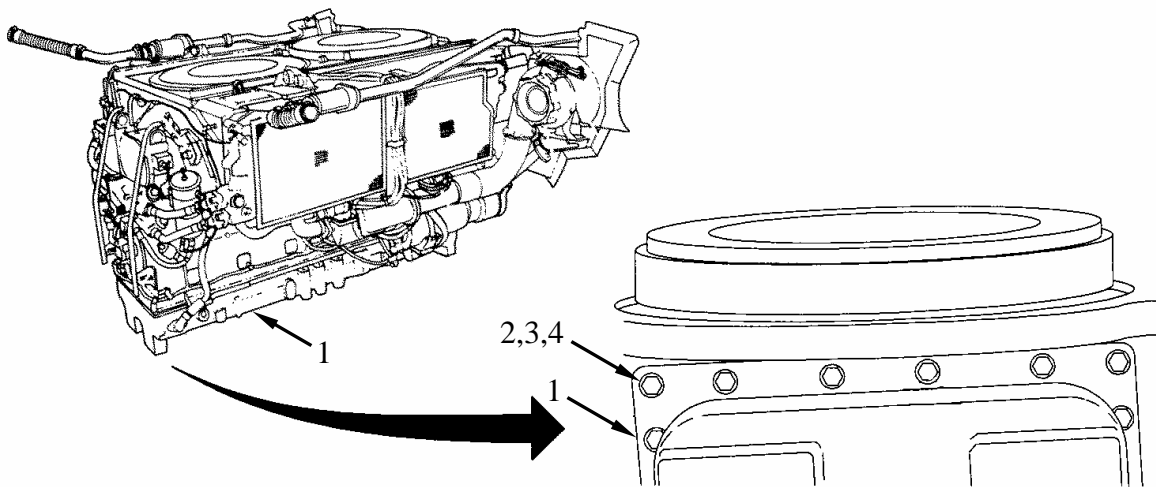
1. Install oil pan. (Continued)
  - k. Apply lubricant (item 23, WP 0173) to 12 screws (5) and install with flat washers (6) to secure damper housing (7) to oil pan (1).



- m. Torque-tighten 12 screws (5) to 150-175 inch pounds (17-19.8 N•m).

- n. Apply lubricant (item 23, WP 0173) to eight screws (2), and install with eight new lock washers (3) (item 94, WP 0175) and flat washers (4) in oil pan (1).

- o. Torque-tighten eight screws (2) to 150-175 inch-pounds (17-19.8 N•m).



**END OF WORK PACKAGE**



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**OIL PUMP REPLACEMENT**

**0153 00**

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**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, and Assembly

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds  
(item 124, WP 0176)  
Wire twisting pliers (item 82, WP 0176)

**Mandatory Replacement Parts:**

Gasket (item 243, WP 0175)  
Lock washer (8) (item 93, WP 0175)  
O-ring (item 142, WP 0175)  
O-ring (2) (item 146, WP 0175)  
Self-locking nut (2) (item 39, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)  
Rubber sheet, cellulide (item 27, WP 0173)  
Rubber sheet, cellulide (item 28, WP 0173)  
Wire non-electrical, 2-pound spool  
(item 44, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

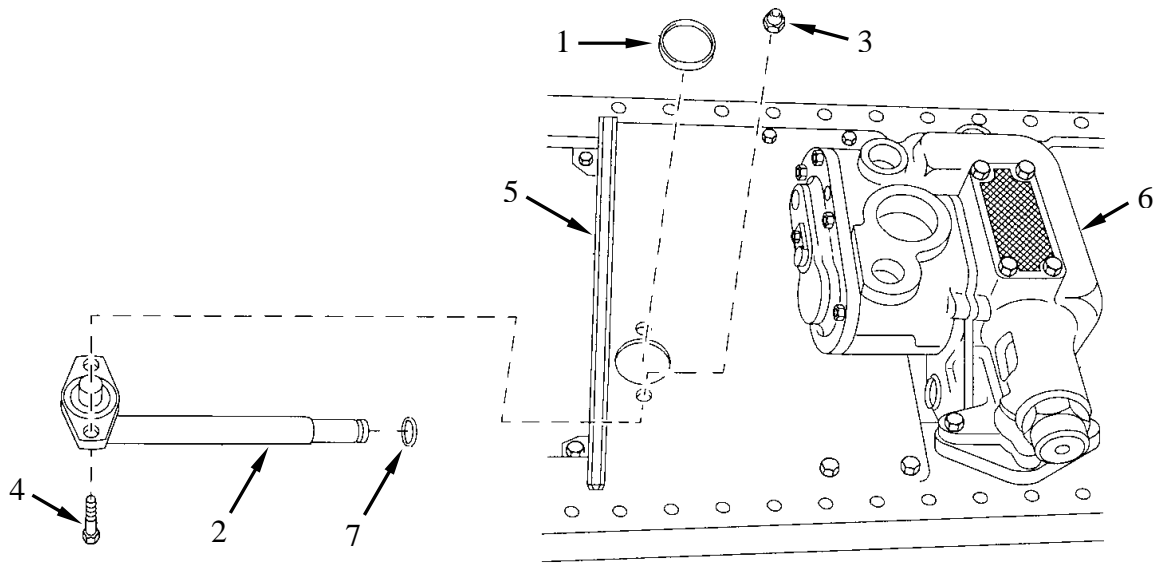
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Oil pan removed (WP 0153)

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**REMOVAL**

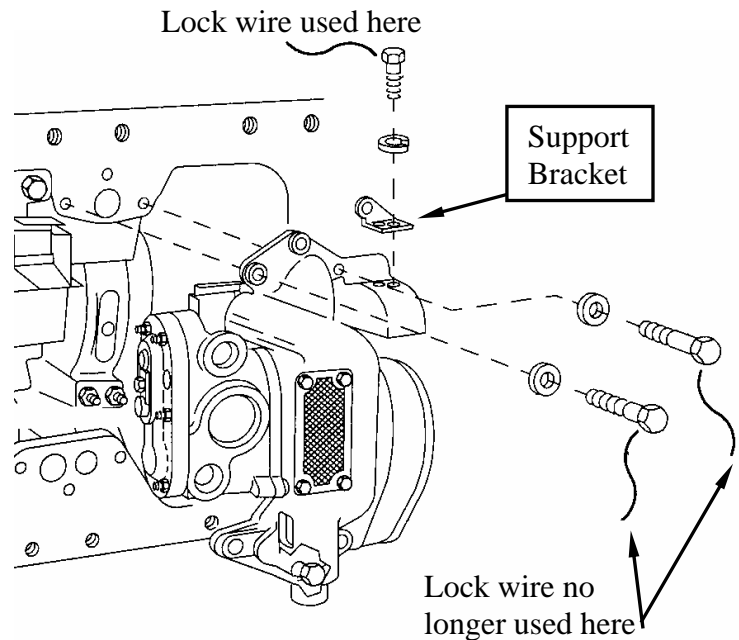
1. Remove and discard gasket (1) from leveling transfer tube (2).
2. Remove transfer tube (2).
  - a. Remove two self-locking nuts (3) and two screws (4). Discard self-locking nuts (3).
  - b. Disengage and remove transfer tube (2) from hole in baffle (5) and from opening in oil pump (6).
  - c. Remove and discard O-ring (7).



**NOTE**

Older engines had lock wire securing screws that fasten the pump to the crankcase. Lock wire is no longer required in this location.

However, lock wire is still used on the two screws securing support bracket.



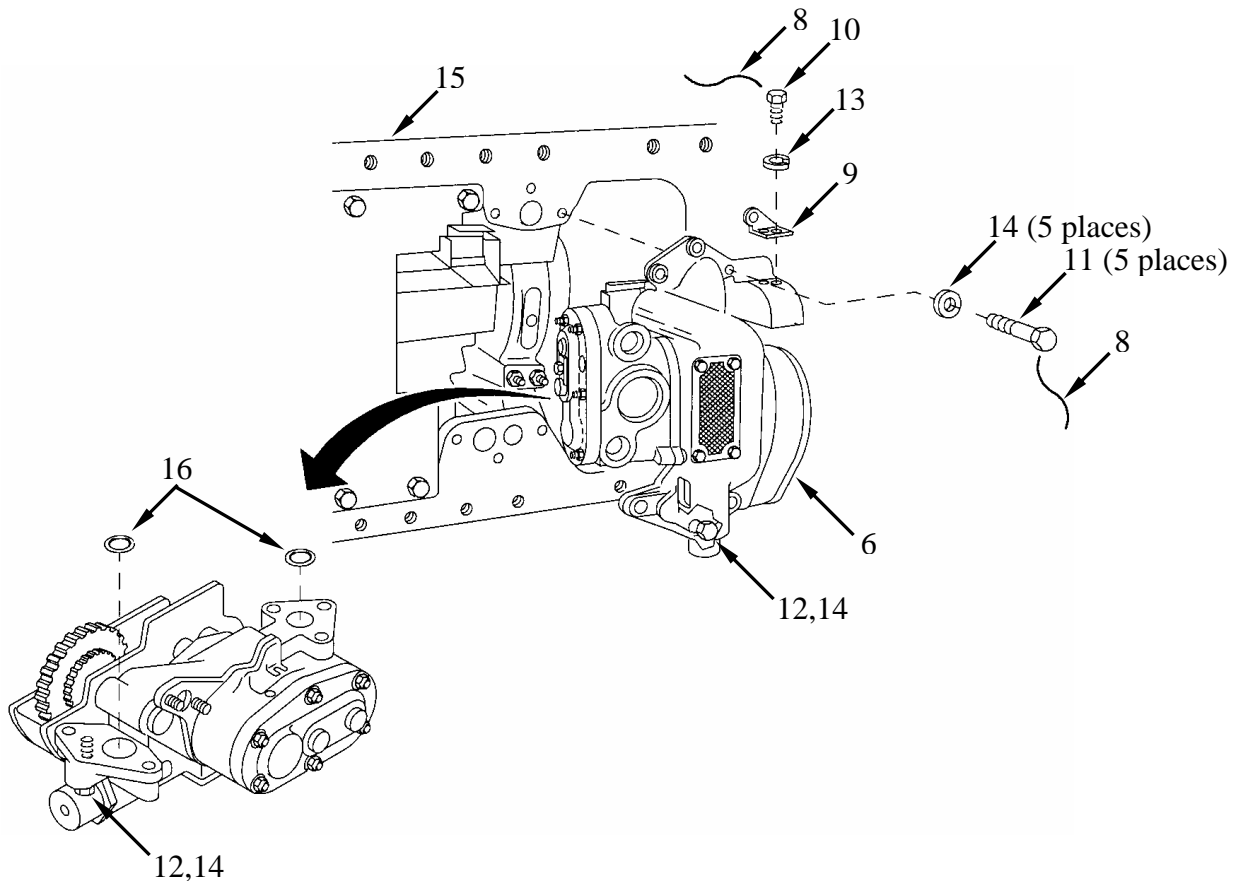
**REMOVAL (Continued)**

3. Remove oil pump (6).
  - a. Remove and discard lock wire (8) from two bracket (9) mounting screws (10) and from six oil pump (6) mounting screws (11, 12).
  - b. Remove bracket (9) mounting screws (10) with lock washers (13). Discard lock washers.
  - c. Remove bracket (9).
    - (1) Remove screw (11) with flat washer (14) securing bracket (9) and pump (6) to crankcase (15).
    - (2) Remove bracket (9).

**NOTE**

**Screw (12) with flat washer (14), behind oil pressure relief valve cap, cannot be removed from oil pump until the oil pump is disassembled.**

- d. Remove remaining four screws (11) with flat washers (14) and loosen one screw (12) with flat washer (14) securing pump (6) to crankcase (15). Remove pump (6).
4. Remove and discard two O-rings (16).

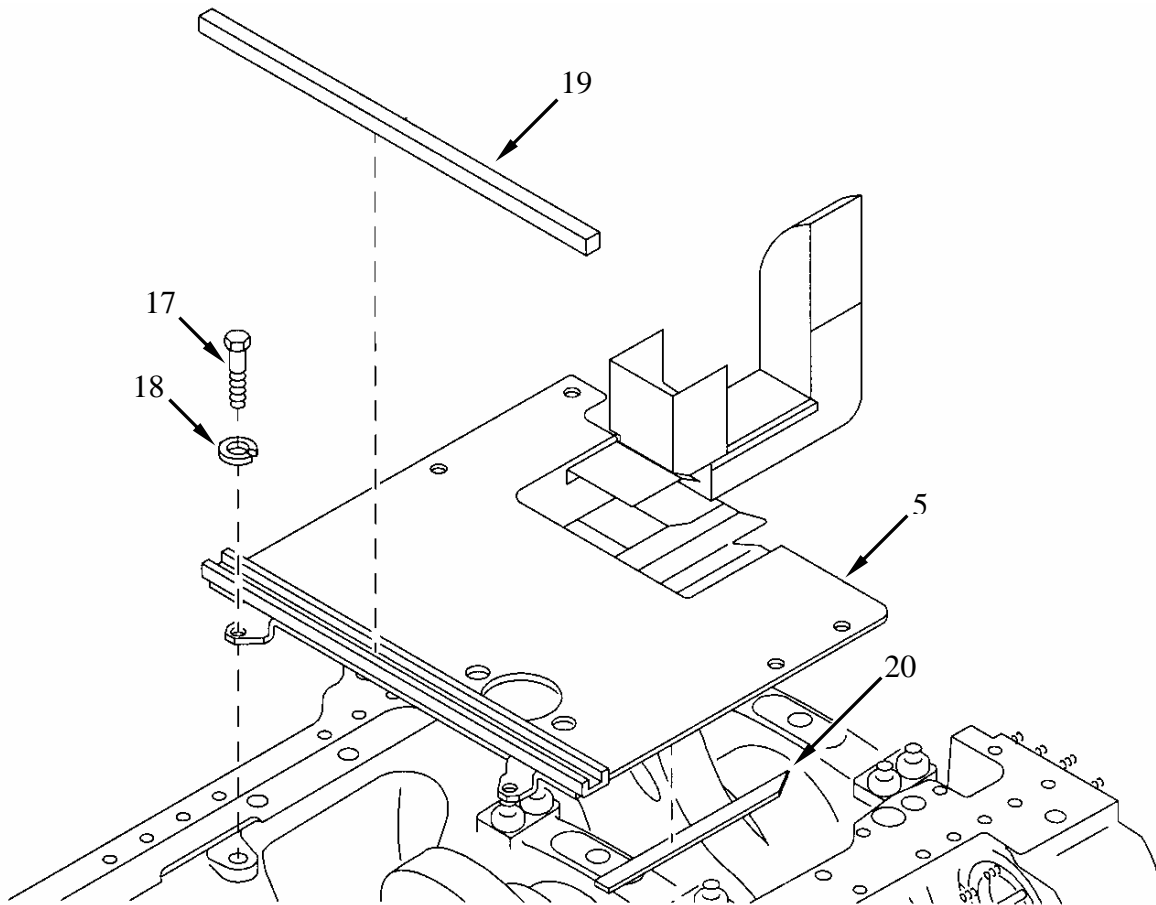


**REMOVAL (Continued)**

5. Remove baffle (5).
  - a. Remove six screws (17) with lock washers (18). Discard lock washers.
  - b. Remove baffle (5).
6. Remove and discard three rubber strips (19, 20) from baffle (5): one at (19) and two at (20).

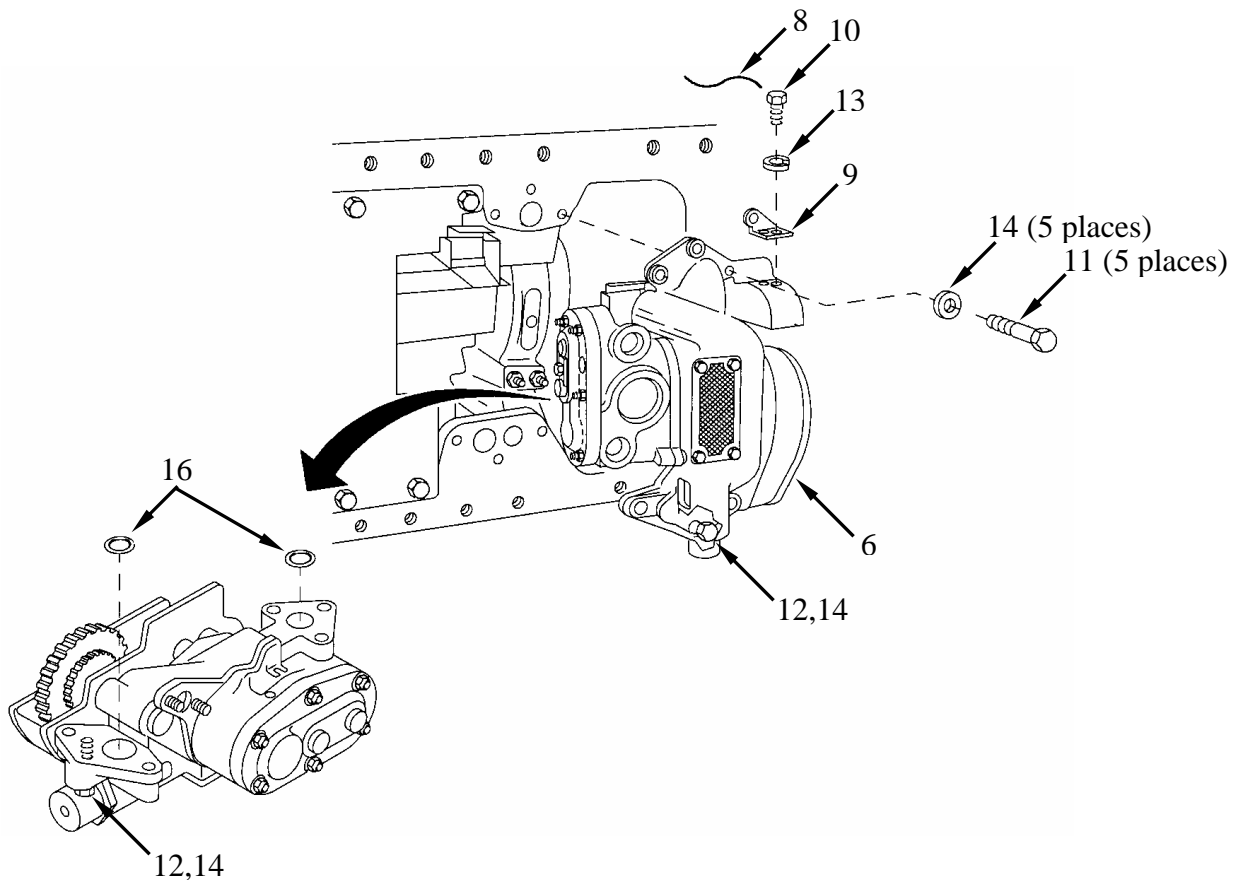
**INSTALLATION**

1. Make and install one new rubber strip (19) from item 27 (WP 0173), and two new rubber strips (20) from item 28 (WP 0173).
2. Install baffle (5).
  - a. Apply lubricant (item 23, WP 0173) to threads of six screws (17).
  - b. Install baffle (5) with six screws (17) using new lock washers (18) (item 93, WP 0175), but do not tighten yet.



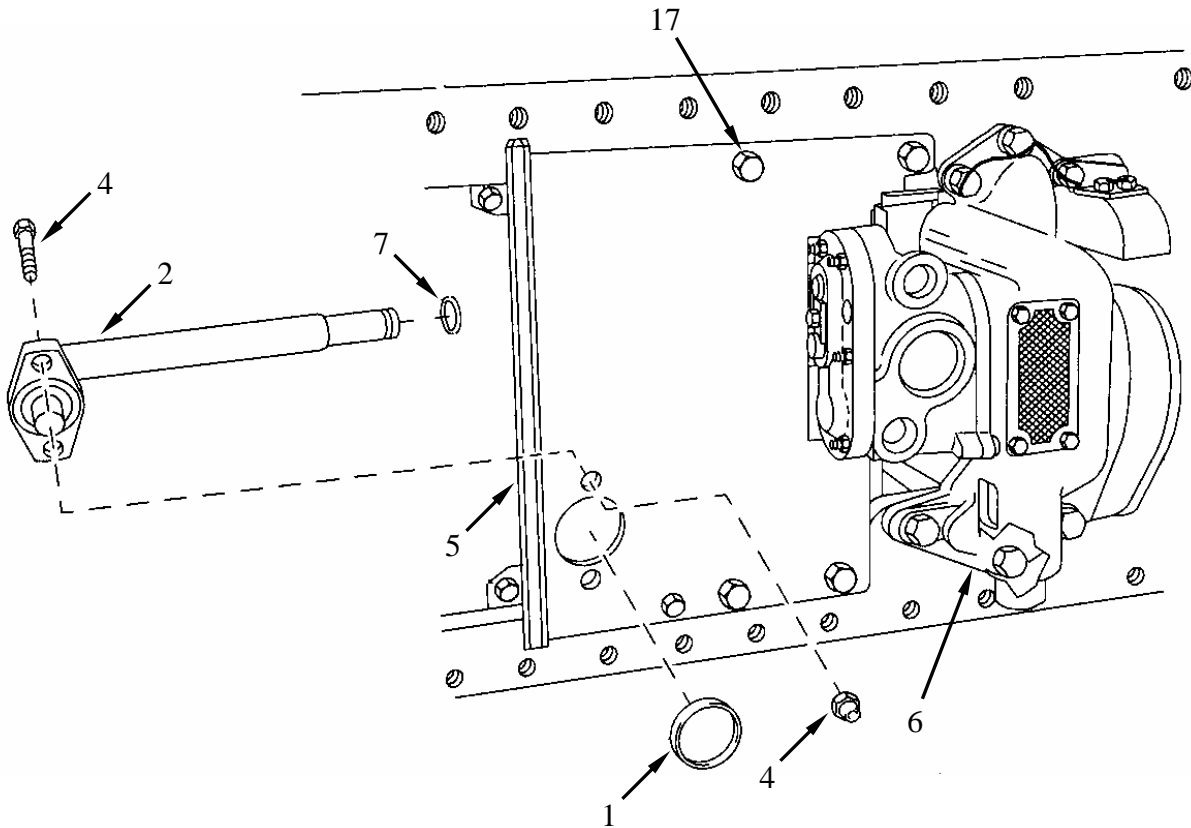
**INSTALLATION (Continued)**

3. Apply lubricant (item 23, WP 0173) to two new O-rings (16) (item 146, WP 0175), and install O-rings on oil pump (6).
4. Install oil pump (6).
  - a. Apply lubricant (item 23, WP 0173) to threads of six screws (11, 12).
  - b. Snug-tighten captive screw (12) with flat washer (14) as pump is being installed.
  - c. Place bracket (9) in position.
  - d. Install five screws (11) using flat washers (14) and snug-tighten.
  - e. Apply lubricant to threads of two screws (10) and install using new lock washers (13) (item 93, WP 0175). Torque-tighten to 120-125 inch-pounds (14 N•m).
  - f. Torque tighten six screws (11, 12) to 275-300 inch-pounds (31-34 N•m).
  - g. Install lock wire (item 44, WP 0173) on two screws (10).



**OIL PUMP REPLACEMENT****0153 00****INSTALLATION (Continued)**

5. Install new O-ring (7) (item 142, WP 0175) on transfer tube (2).
6. Install transfer tube (2).
  - a. Position transfer tube beneath baffle (5), insert into oil pump (6) hole and line up with hole in baffle (5).
  - b. Secure transfer tube (2) to baffle (5) with two new self-locking nuts (3) (item 39, WP 0175) and screws (4).
7. Torque-tighten six screws (17) to 120-125 inch-pounds (14 N•m).
8. Install new gasket (1) (item 243, WP 0175).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Depth micrometer set (item 48, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Machine reamer set (item 92, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Socket wrench (item 107, WP 0176)
- Socket wrench adapter (item 3, WP 0176)
- Spring tester (item 117, WP 0176)
- Telescoping gauge set (item 54, WP 0176)
- Torque wrench, 0-300 inch-pounds (item 124, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Fabricated Item:**

- Modified socket (item 12, WP 0177)

**Mandatory Replacement Parts:**

- Ball bearing (item 246, WP 0175)
- Ball bearing (2) (item 291.1, WP 0175)
- Key washer (item 26, WP 0175)
- Self-locking nut (14) (item 33, WP 0175)
- Self-locking nut (item 219, WP 0175)
- Spring (item 287.1, WP 0175)
- Spring (item 346.1, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)
- Lock wire (item 44, WP 0173)

**Personnel Requirements:**

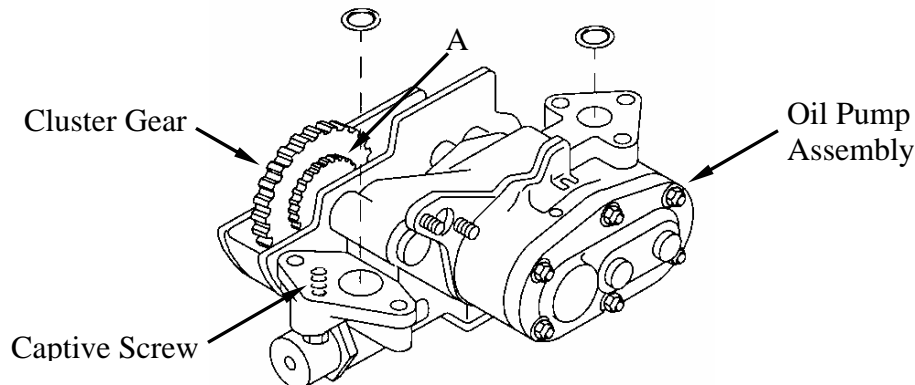
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Oil pump removed (WP 0153)

**DISASSEMBLY**

There are two oil pump assemblies in use and they are interchangeable. The major difference is the drive gears: on the newer model (12468945) the spur gear to cluster gear ratio provides a higher operating speed of the pump. This higher speed increases oil flow capability. If you have the older pump (11683982), it is acceptable for use, but is not supported in the RPSTL nor in the repair manual. You can identify which pump you have by counting teeth (A) on the smaller gear circle of the cluster gear. The high-speed pump has 26 teeth and the older low-speed pump has 24.



**DISASSEMBLY (Continued)**

1. Remove pressure relief valve cap (1).

**NOTE**

**If cap is hard to remove, temporarily install oil pump back on engine with mounting screws to hold oil pump while removing cap.**

- a. Cut, remove and discard lock wire (2).
- b. Remove cap (1), springs (3, 4) and valve (5) as an assembly.
- c. Separate valve (5) and springs (3 and 4) from cap (1). Discard springs.

**NOTE**

**Screw and flat washer are used in mounting oil pump to crankcase.**

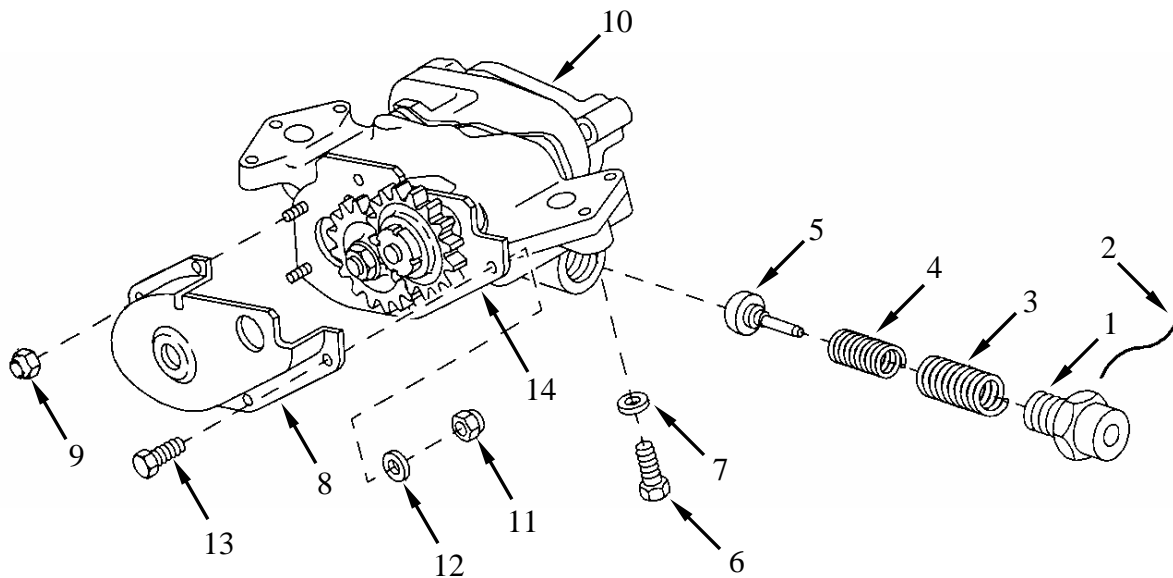
2. Remove screw (6) and flat washer (7).

**CAUTION**

**Do not use prying tool to separate housings. Housings are made of aluminum, have machined surfaces, and are easily damaged. Damage may occur by prying pieces apart.**

3. Remove gear cover (8).

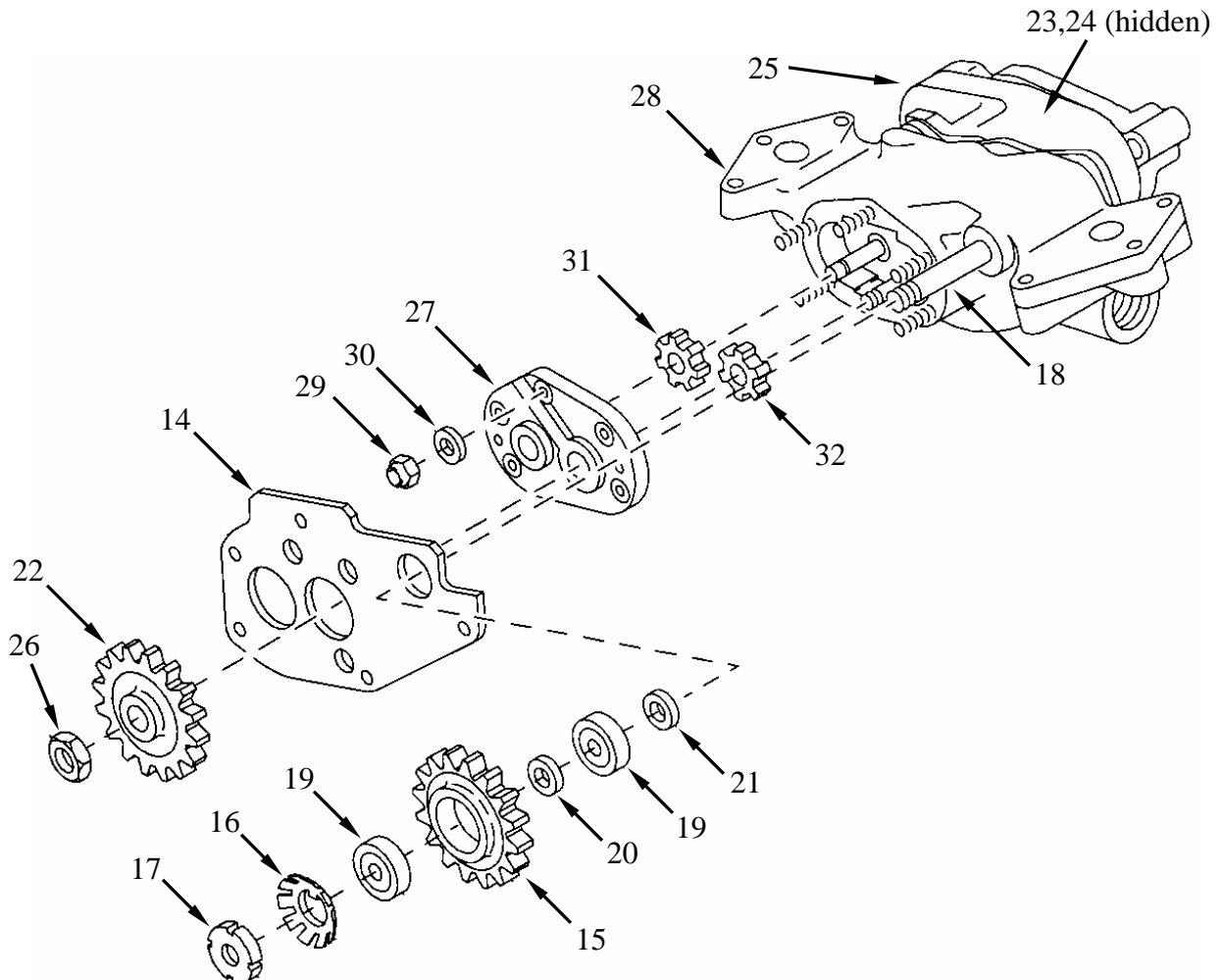
- a. Remove and discard two self-locking nuts (9) attaching cover (8) to pump (10).
- b. Remove three self-locking nuts (11), flat washers (12), and screws (13) attaching access cover (8) to gear plate (14). Discard self-locking nuts.





**DISASSEMBLY (Continued)**

4. Remove cluster gear (15).
  - a. Straighten tabs on key washer (16) and remove nut (17) from shaft (18).
  - b. Remove key washer (16), two ball bearings (19), cluster gear (15), thrust washer (20), thrust bearing (21), and shaft (18). Discard key washer, thrust bearing, and two ball bearings.
5. Remove spur gear (22).
  - a. Position a brass rod or drift between impellers (23 and 24) through opening in scavenge housing (25) to hold spur gear shaft (22) stationary.
  - b. Remove self-locking nut (26), spur gear (22), and gear plate (14). Discard self-locking nut (26).
6. Remove level compartment cover (27) from pressure compartment housing (28).
  - a. Remove three self-locking nuts (29) with flat washers (30) securing cover (27) to housing assembly (28). Discard self-locking nuts.
7. Remove two level compartment impellers (31 and 32) from housing (28).



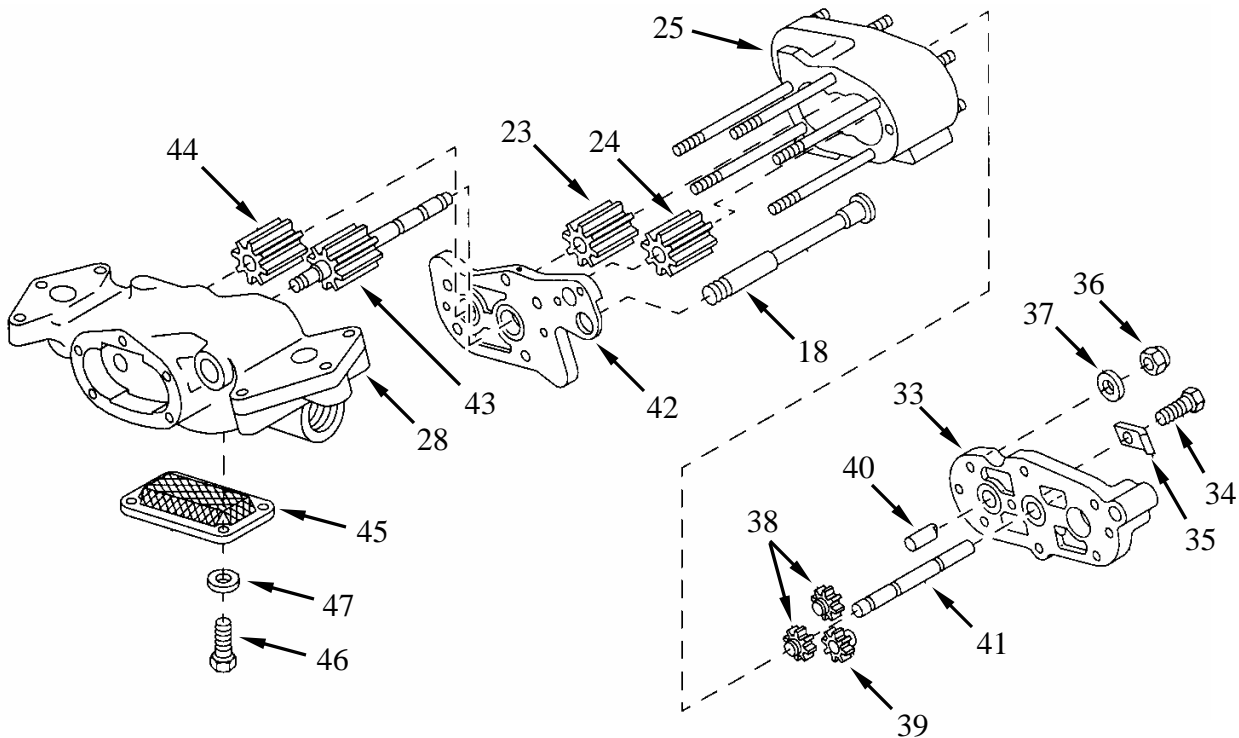
**DISASSEMBLY (Continued)**

8. Remove scavenge compartment cover (33).
  - a. Remove screw (34) securing lock plate (35) to cover (33). Remove lock plate.
  - b. Remove six self-locking nuts (36), with flat washers (37), and cover assembly (33) from scavenge housing (25). Discard self-locking nuts.
9. Remove reserve compartment impellers (38 [two]) and (39 [one]) from scavenge housing assembly (25).

**CAUTION**

**Do not let impeller fall out when separating housings. Damage to impeller may result.**

10. Remove impellers (23 and 24) from scavenge housing (25).
  - a. Remove shafts (40 and 41) from housing (25).
  - b. Separate scavenge housing (25) from pressure housing (28).
  - c. Remove spacer assembly (42) from pressure housing (28).
  - d. Remove gear shaft (43) and impeller (44) from housing assembly (28).
11. Remove screen (45).
  - a. Remove four screws (46) with flat washers (47) to remove screen (46) from pressure housing (28).

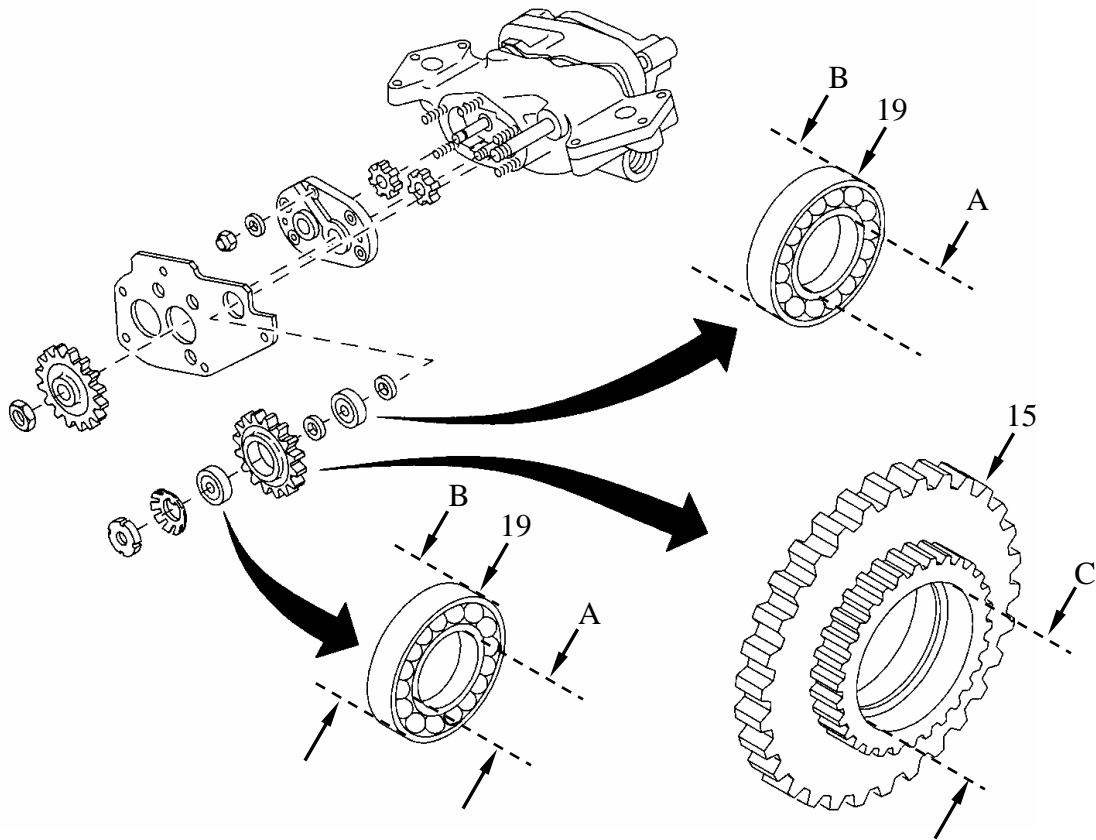


**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Ball bearings (19) are mandatory replacement items.
  - a. Replace ball bearings to specifications in the following table (Inside diameter (A) and outside diameter (B)).
3. Inspect cluster gear (15).
  - a. Reject any gear that has burrs, wear, cracked or broken teeth, or pitting at tooth contact areas. Inspect the mating gear of any defective gear.
  - b. Measure inside diameter (C) on both sides of cluster gear (15). Replace cluster gear if not within specifications in the following table.

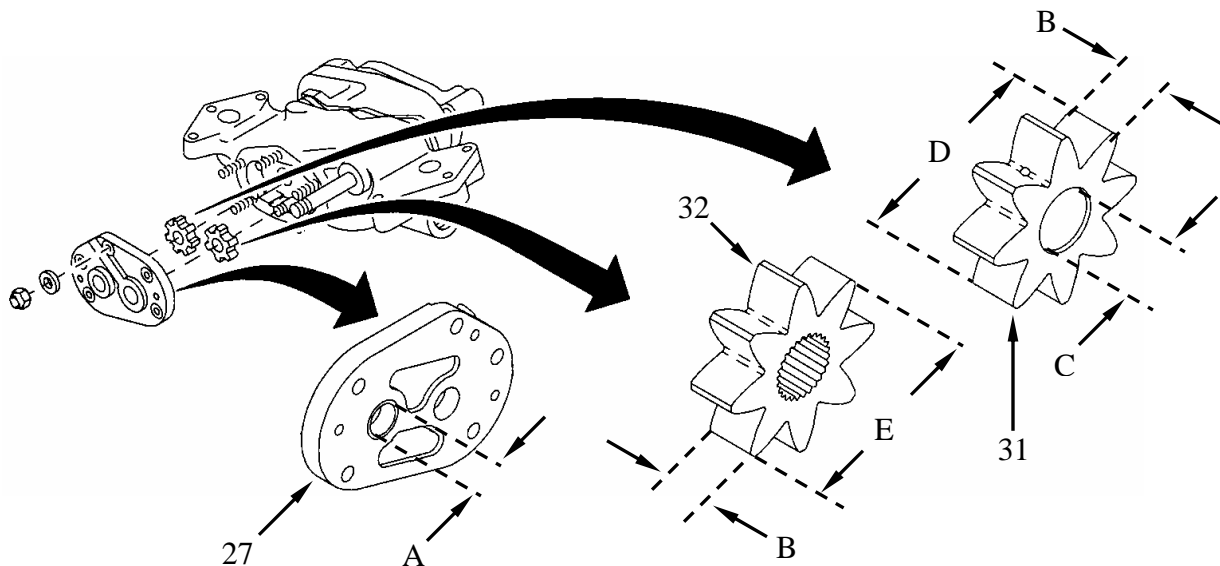
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	0.9839 (24.9910)	0.9843 (25.0012)	None
B	2.0467 (51.9861)	2.0472 (51.9988)	None
C	2.0463 (51.9760)	2.0470 (51.9938)	2.0473 (51.9963)



**INSPECTION (Continued)**

4. Measure inside diameter (A) of bushing (48) in level compartment cover (27). Replace oil pump if not within specifications in the following table.
5. Inspect level compartment impellers (31 and 32).
  - a. Replace pump if any impeller has burrs, wear, cracked or broken teeth, or pitting at tooth contact areas.
  - b. Measure length (B) of impellers (31, 32). Replace oil pump if not within specifications in the following table.
  - c. Measure inside diameter (C) and outside diameter (D) of impeller (31). Replace oil pump if not within specifications in the following table.
  - d. Measure outside diameter (E) of impeller (32). Replace oil pump if not within specifications in the following table.
  - e. Inspect inside teeth of impeller (32). Replace oil pump if teeth have burrs, are worn, cracked or broken, or have pitting at tooth contact areas.

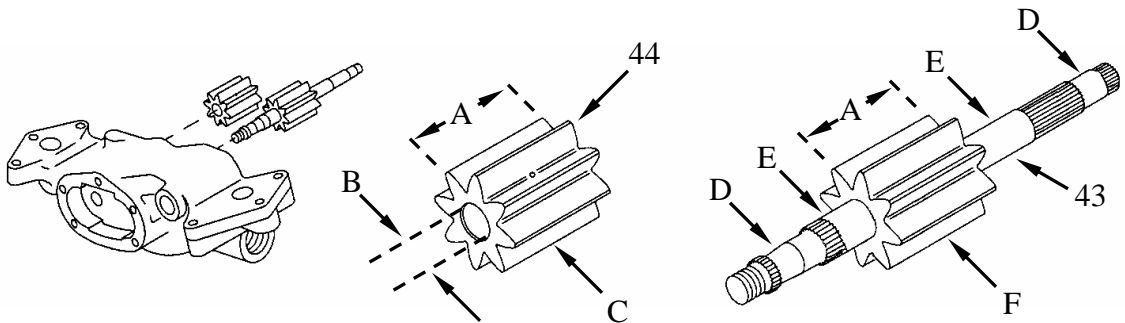
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	0.9850 (25.0190)	0.9860 (25.0444)	0.9870 (25.0698)
B	0.8000 (20.3200)	0.8010 (20.3454)	0.7990 (20.2946)
C	0.9860 (25.0444)	0.9865 (25.0571)	0.9870 (25.0698)
D	2.4774 (62.9259)	2.4778 (62.9361)	2.4769 (62.9158)
E	2.4794 (62.9767)	2.4798 (62.9869)	2.4798 (62.9666)



**INSPECTION (Continued)**

6. Inspect pressure compartment impellers (43 and 44).
  - a. Replace pump if any impeller has burrs, wear, cracked or broken teeth, or pitting at tooth contact areas.
  - b. Measure length (A) of impeller (44) and impeller/shaft (43). Replace oil pump if not within specifications in the following table.
  - c. Measure inside diameter (B) and outside diameter (C) of impeller (44). Replace oil pump if not within specifications in the following table.
  - d. Measure outside diameters (D, E, F) of impeller/shaft (43). Replace oil pump if not within specifications in the following table.

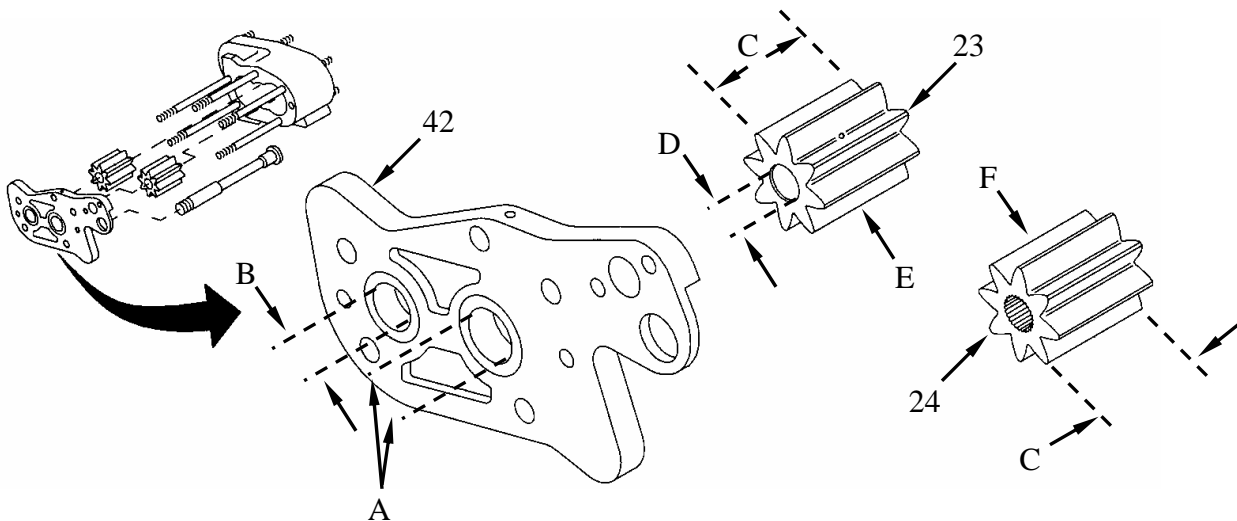
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	2.4280 (61.6712)	2.4290 (61.6966)	2.4275 (61.6585)
B	0.9860 (25.0444)	0.9865 (25.0571)	0.9870 (25.0698)
C	2.4774 (62.9259)	2.4778 (62.9361)	2.4770 (62.9158)
D	0.9835 (24.9809)	0.9840 (24.9936)	0.9832 (24.9732)
E	1.1315 (28.7401)	1.1320 (28.7528)	1.1312 (28.7324)
F	2.4814 (63.0275)	2.4818 (63.0377)	2.4812 (63.0224)



**INSPECTION (Continued)**

7. Measure inside diameters (A, B) of bushings in spacer assembly (42). Replace oil pump if not within specifications in the following table.
8. Inspect scavenge compartment impellers (23 and 24).
  - a. Replace pump if any impeller has burrs, wear, cracked or broken teeth, or pitting at tooth contact areas.
  - b. Measure length (C) of impellers (23 and 24). Replace oil pump if not within specifications in the following table.
  - c. Measure inside (D) and outside (E) diameters of impeller (23). Replace oil pump if not within specifications in the following table.
  - d. Measure outside diameter (F) of impeller (24). Replace oil pump if not within specifications in the following table.

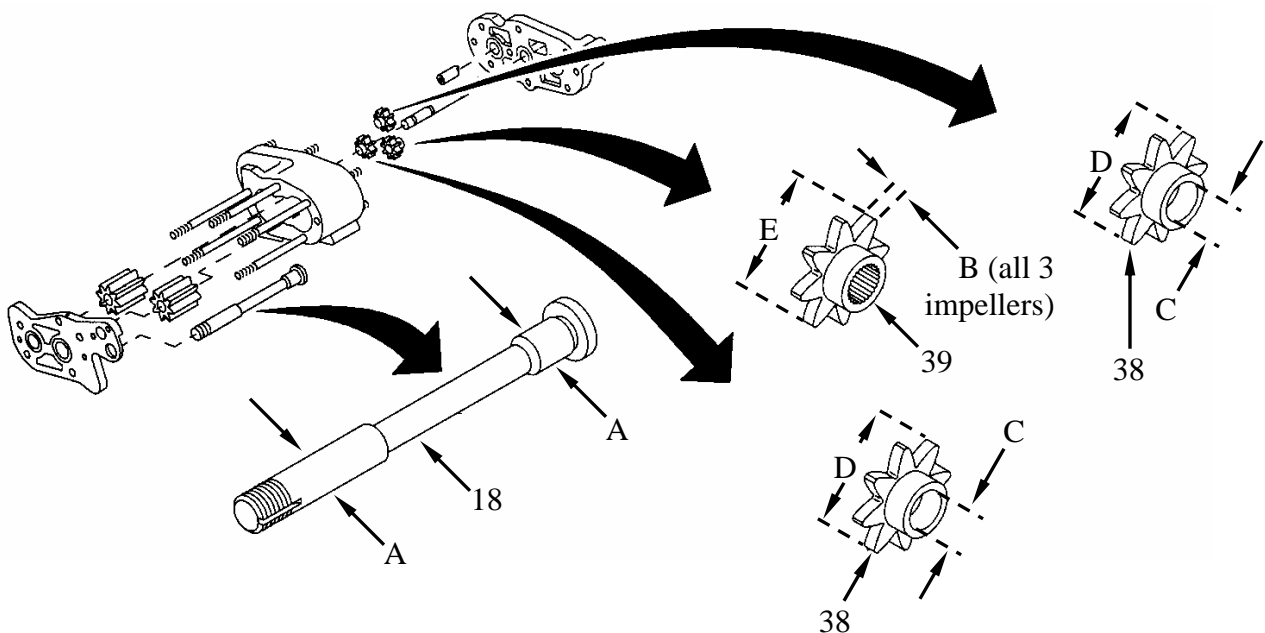
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	1.1330 (28.7782)	1.1340 (28.8036)	1.1350 (28.829)
B	0.9843 (25.0012)	0.9848 (25.0139)	0.9853 (25.0266)
C	3.0410 (77.2414)	3.0420 (77.2668)	3.0405 (77.2287)
D	0.9860 (25.0444)	0.9865 (25.0571)	0.9870 (25.0698)
E	2.4774 (62.9259)	2.4778 (62.9361)	2.4770 (62.9158)
F	2.4794 (62.9767)	2.4798 (62.9869)	2.4790 (62.9666)



**INSPECTION (Continued)**

9. Measure outside diameter (A) of shaft (18). Replace oil pump if not within specifications in the following table.
10. Inspect reserve compartment impellers (38 and 39).
  - a. Replace pump if any impeller has burrs, wear, cracked or broken teeth, or pitting at tooth contact areas.
  - b. Measure length (B) of three impellers (38 and 39). Replace oil pump if not within specifications in the following table.
  - c. Measure inside (C) and outside (D) diameter of two impellers (38). Replace oil pump if not within specifications in the following table.
  - d. Measure outside diameter (E) of impeller (39). Replace oil pump if not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	0.9835 (24.9809)	0.9840 (24.9936)	0.9832 (24.9732)
B	0.2090 (5.3086)	0.2100 (5.3340)	0.2085 (5.2959)
C	0.9860 (25.0444)	0.9865 (25.0571)	0.9870 (25.0698)
D	2.4774 (62.9259)	2.4778 (62.9361)	2.4770 (62.9158)
E	2.4794 (62.9767)	2.4798 (62.9869)	2.4790 (62.9666)

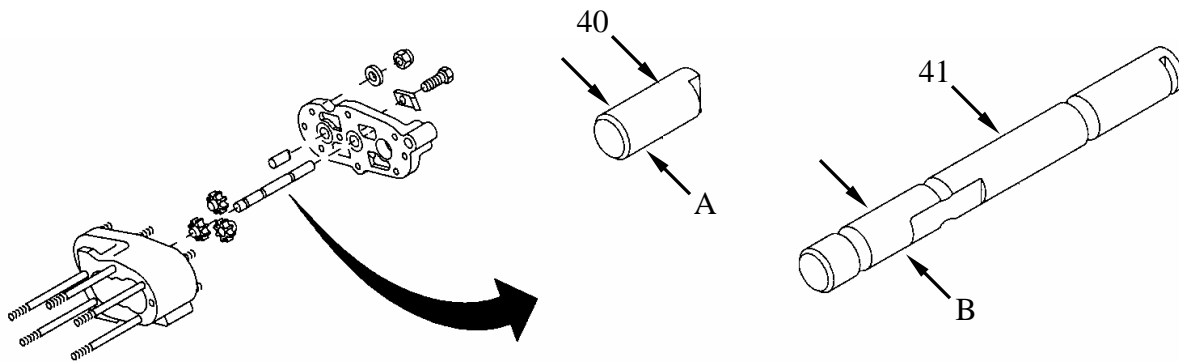


**INSPECTION (Continued)**

11. Measure outside diameter of shafts (40, 41).

- a. Measure outside diameter (A) of reserve impeller shaft (40).
- b. Measure outside diameter (B) of driven impeller shaft (41).
- c. Replace oil pump if not within specifications in the following table.

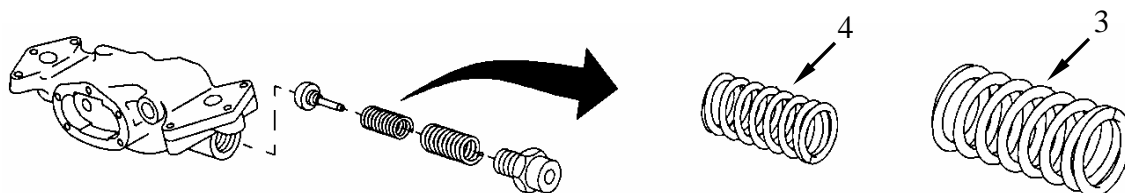
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
	A, B	0.9834 (24.9783)	
A, B	0.9834 (24.9783)	0.9839 (24.9910)	0.9829 (24.9656)



12. Pressure relief springs (3, 4) are mandatory replacement items.

- a. New springs (3 or 4) may be tested with a spring tester to specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
	3 (Outer)	4 (Inner)	
3 (Outer)	Approximate free length: 4.96 inch (125.984)	Approximate free length: 4.27 inch (108.458)	None
	Load at 3.22 inch (81.788): 141.5-156.5 lb (64.241-71.096 kg)	Load at 3.22 inch (81.788): 95-105 lb (43.13-47.67 kg)	
	Maximum solid height: 2.90 inch (73.66)	Maximum solid height: 2.94 inch (74.676)	

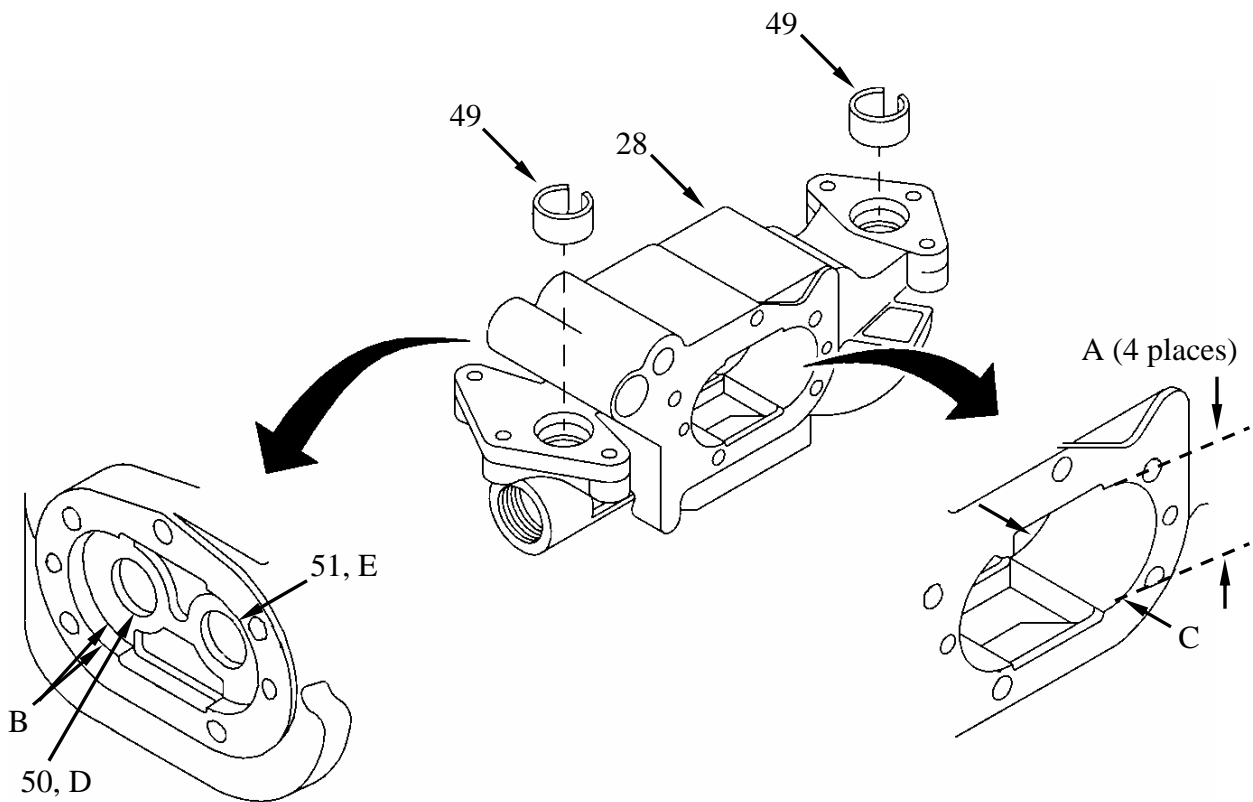




**INSPECTION (Continued)**

13. Visually inspect oil transfer tubes (49) of housing assembly (28) for any damage.
  - a. Replace bent or damaged tubes.
14. Measure the inside diameter (A) of four impeller bores in housing assembly (28). Replace oil pump if not within specifications in the following table.
15. Measure depths (B, C) of impeller bores in housing assembly (28). Replace oil pump if not within specifications in the following table.
16. Measure inside diameters (D, E) of bushings (50, 51) in housing assembly (28). Replace oil pump if not within specifications in the following table.

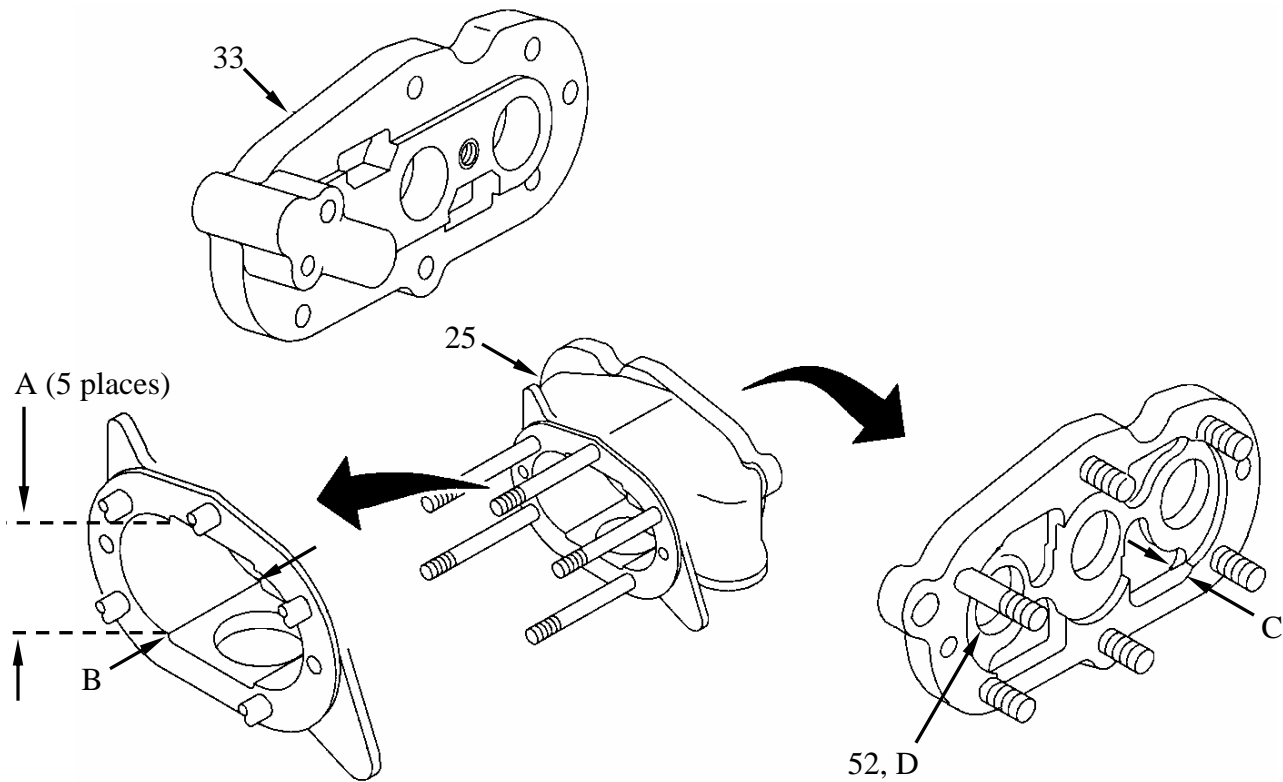
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	2.4850 (63.1190)	2.4862 (63.1494)	2.4875 (63.1825)
B	0.8030 (20.3962)	0.8050 (20.4470)	0.8055 (20.4597)
C	2.4320 (61.7728)	2.4340 (61.8236)	2.4345 (61.8363)
D, E	1.1330 (28.7782)	1.1340 (28.8036)	1.1350 (28.8290)



**INSPECTION (Continued)**

17. Visually inspect scavenge compartment cover assembly (33) for cracks or damage. Replace pump if cover is damaged.
18. Measure the inside diameter (A) of five impeller bores in scavenge housing assembly (25). Replace oil pump if not within specifications in the following table.
19. Measure depth (B) of two impeller bores in housing assembly (25). Replace oil pump if not within specifications in the following table.
20. Measure depth (C) of three impeller bores in housing assembly (25). Replace oil pump if not within specifications in the following table.
21. Measure inside diameter (D) of bushing (52) in housing assembly (25). Replace oil pump if not within specifications in the following table.

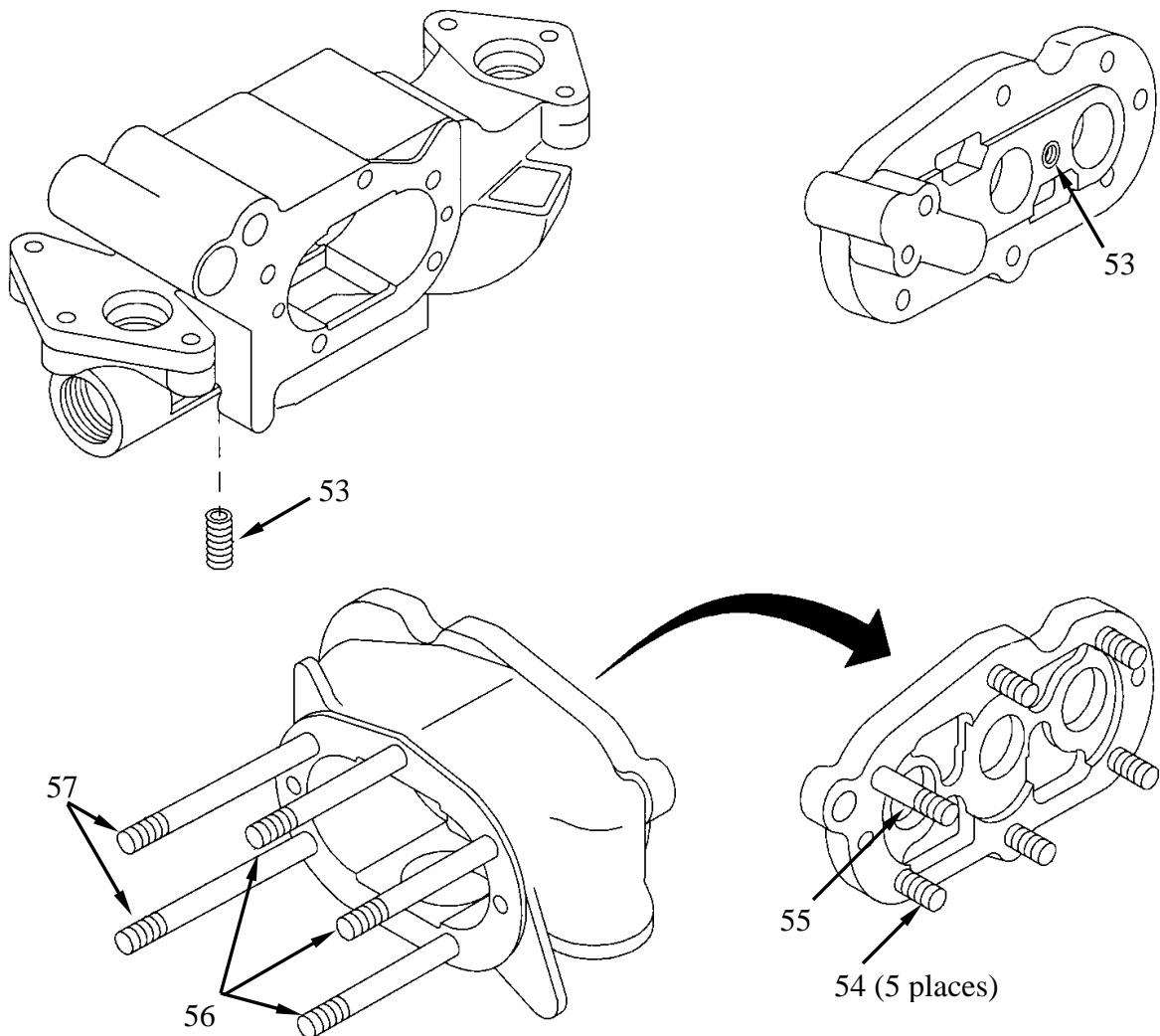
Location	Sizes and Fits of New Parts		Wear Limits
	inches (mm)		
A	2.4850 (63.1190)	2.4862 (63.1494)	2.4875(63.1825)
B	3.0480(77.4192)	3.0500 (77.4700)	3.0505(77.4827)
C	0.2130 (5.4102)	0.2170 (5.5118)	0.2175(5.5245)
D	0.9850(25.019)	0.9860 (25.0444)	0.9870 (25.0698)



**REPAIR**

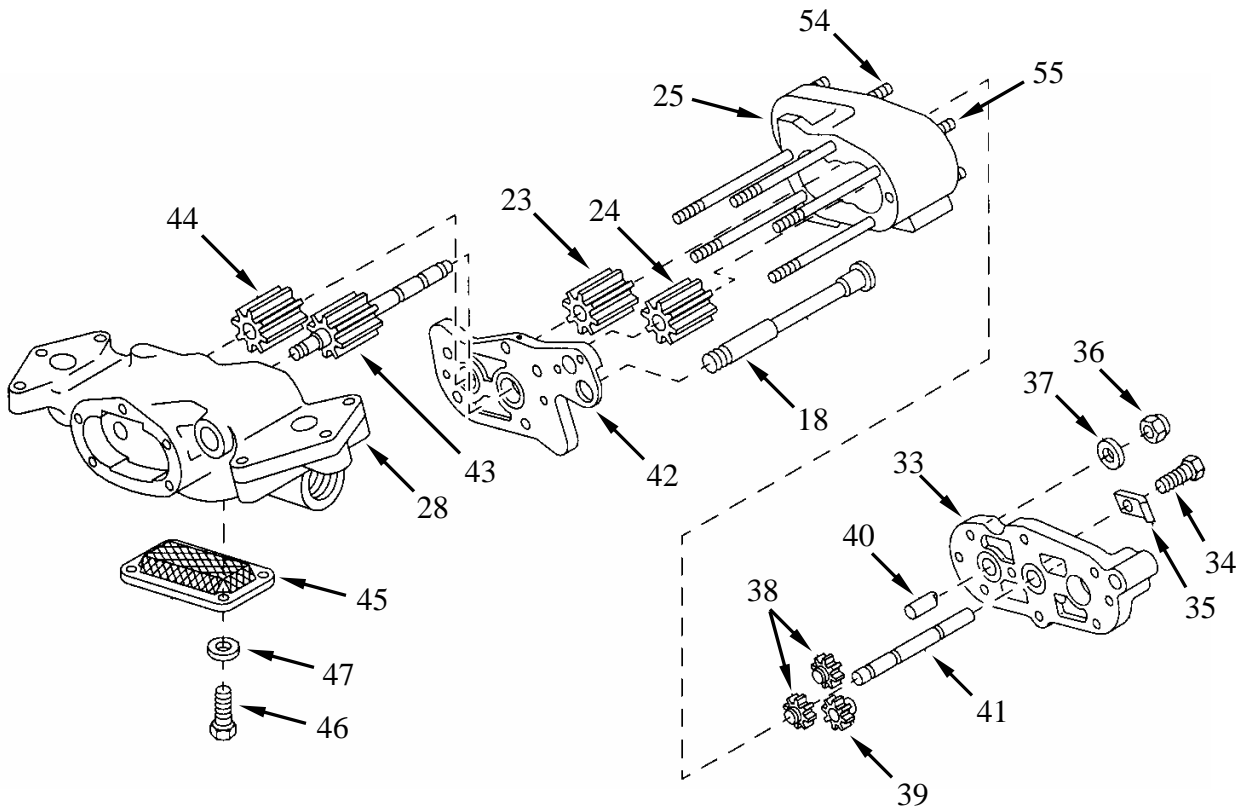
1. Replace defective screw thread inserts (53).
  - a. Refer to Work Package 0030 for thread insert replacement procedures.
2. Replace damaged, bent, or stripped studs (54, 55, 56, 57).
  - a. Refer to Work Package 0028 for stud replacement procedures and the following table for setting heights.

Location	Setting Height inches (mm)	Quantity	Stud Size and Length inches
54	29/32 (23.0188)	5	5/16-18(13/16) X 5/16-24(1/2) X 1-3/8
55	2-3/32 (53.1813)	1	5/16-18(5/8) X 5/16-24(11/16) X 2-9/16
56	5-9/32 (134.1438)	3	5/16-18(13/16) X 5/16-24(9/16) X 5-13/16
57	5-11/16 (144.4625)	2	5/16-18(3/4) X 5/16-24(11/16) X 6-3/16



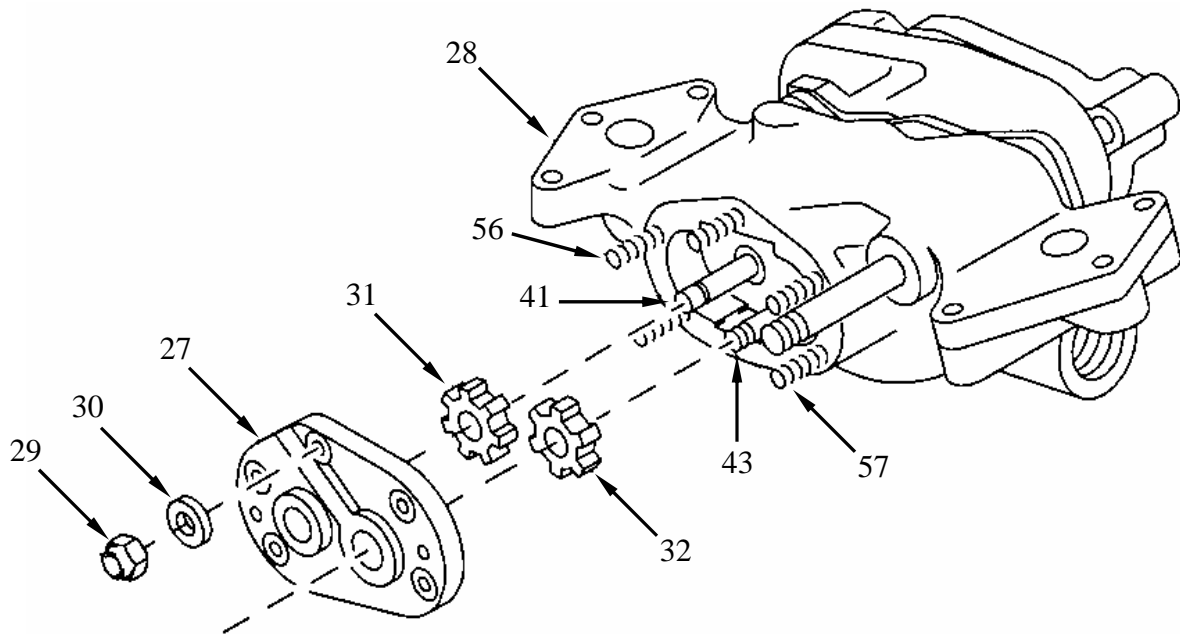
**ASSEMBLY**

1. Install screen (45).
  - a. Secure to pressure housing (28) using four screws (46) with flat washers (47).
2. Install gear shaft (43) and impeller (44) into housing assembly (28).
3. Install spacer (42) onto pressure housing (28).
4. Install impeller driven shaft (41) into scavenge housing (25).
5. Install impeller (24) onto gear shaft (43) after spacer (42).
6. Install impeller (23) onto impeller driven shaft (41) after spacer (42).
7. Install scavenge housing (25) onto pressure housing (28).
8. Install shaft (40) reserve compartment impellers (38 [two]) and (39 [one]) into scavenge housing assembly (25).
9. Install scavenge compartment cover (33).
  - a. Apply lubricant (item 23, WP 0173) to threads of six studs (54, 55).
  - b. Secure cover (33) using six new self-locking nuts (36) (item 33, WP 0175), with flat washers (37).
  - c. Torque self-locking nuts (36) to 125-150 inch-pounds (14-17 N•m).
10. Install lock plate (35).
  - a. Secure with screw (34).



**ASSEMBLY (Continued)**

11. Install impeller (32) on shaft (43) in housing assembly (28) with splines outward.
12. Install impeller (31) on impeller driven shaft (41) in housing assembly (28).
13. Install cover assembly (27) onto housing assembly (28).
  - a. Apply lubricant (item 23, WP 0173) to five studs (56, 57).
  - b. Secure cover assembly (27) to housing assembly (28) using three new self-locking nuts (29) (item 33, WP 0175) (the remaining two nuts are installed with gear cover) with flat washers (30).
  - c. Torque self-locking nuts to 125-150 inch-pounds (14-17 N•m).



**ASSEMBLY (Continued)**

14. Position plate (13) onto cover assembly (27).

**CAUTION**

**Do not insert brass rod or drift between impeller and housing. Damage to housing may occur.**

15. Install spur gear (22) on shaft (43).

- a. Position a brass rod or drift between impellers (23 and 24) through opening in housing assembly (25) to hold gear shaft (43) stationary.
- b. Apply lubricant (item 23, WP 0173) to threads of shaft (43) and install new self-locking nut (26) (item 219, WP 0173).
- c. Torque self-locking nut (26) to 58-65 foot-pounds (79-88 N•m).

16. Install cluster gear (15).

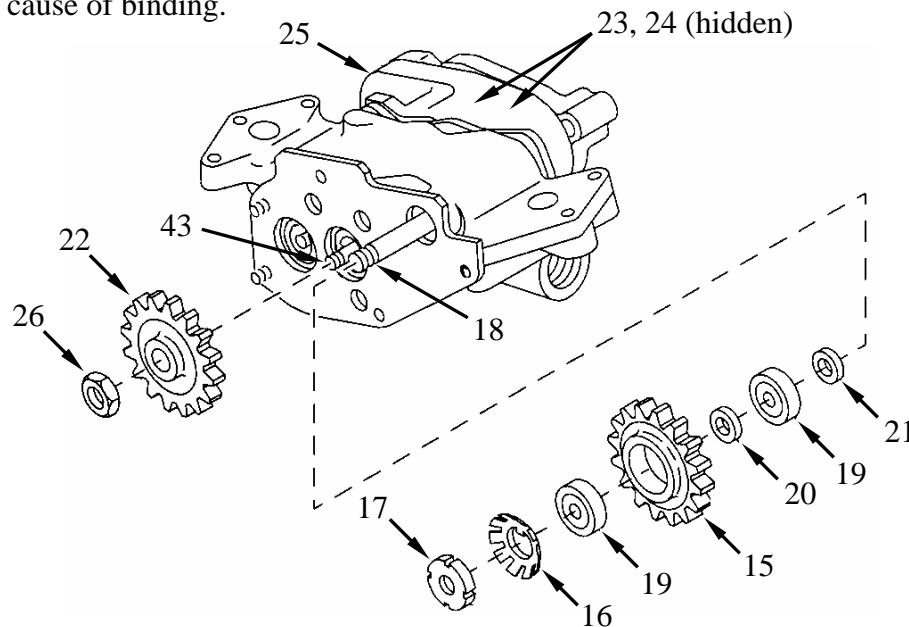
- a. Install new thrust bearing (21) (item 246, WP 0175), new ball bearing (19) (item 291.1, WP 0175), thrust washer (20), cluster gear (15), new ball bearing (19) (item 291.1, WP 0175), and new key washer (16) (item 26, WP 0173) on shaft (18).
- b. Apply lubricant (item 23, WP 0173) to threads of shaft (18) and install nut (17).
- c. Torque nut (17) to 48-52 foot-pounds (65-71 N•m).
- d. Bend tabs of key washer (16) to secure nut (17).

**CAUTION**

**Force required to rotate pump gearing must not exceed 4 inch-pounds (0.452 N•m). Damage to pump or premature failure may occur.**

17. Check rotation force of pump gearing.

- a. Place torque wrench on nut (17).
- b. Rotate shaft. If more than 4 inch-pounds (0.452 N•m) are required to turn shaft, investigate cause of binding.



**ASSEMBLY (Continued)**

18. Install gear cover (8).

- a. Secure to gear plate (14) using three screws (13) with flat washers (12), and new self-locking nuts (11) (item 33, WP 0175).
- b. Secure to pump (10) using two new self-locking nuts (9) (item 33, WP 0175).
- c. Torque self-locking nuts to 125-150 inch-pounds (14-17 N•m).

**NOTE**

**Mounting screw (6) cannot be installed in pump after relief valve is installed.**

19. Place screw (6) and flat washer (7) into housing assembly (28).

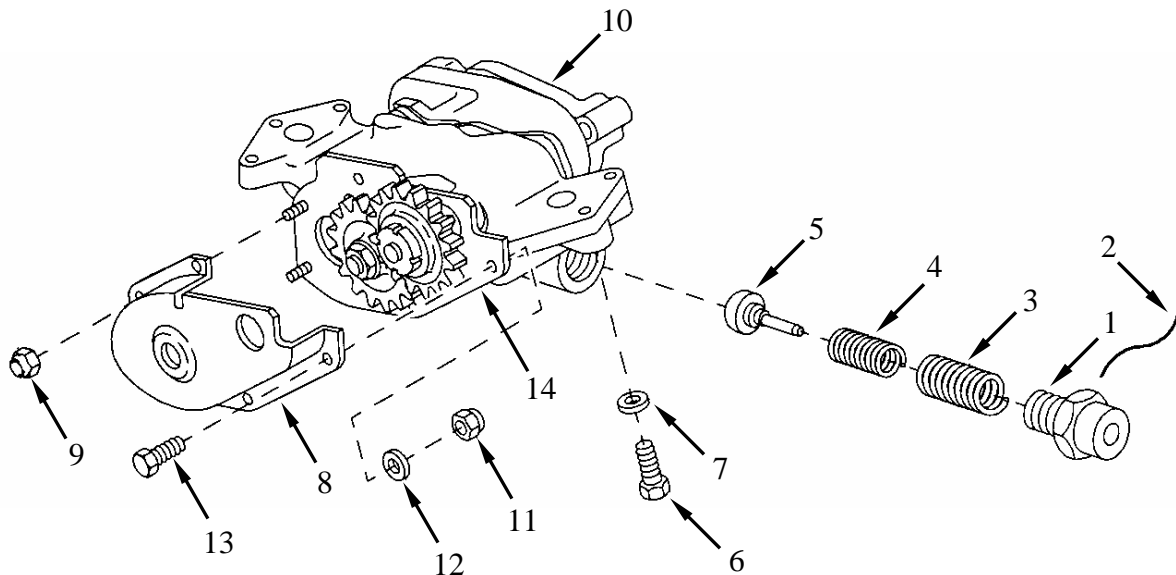
20. Install relief valve (5).

- a. Install valve (5), new inner spring (4) (item 287.1, WP 0175), outer spring (3) (item 346.1, WP 0175), and cap (1) into housing assembly (28).

**NOTE**

**Temporarily install oil pump assembly on engine, if available, to torque cap.**

- b. Using modified socket (item 12, WP 0177) and torque wrench (item 124, WP 0176), torque cap (1) to 150-170 inch-pounds (17-19 N•m).
- c. Secure cap (1) with new lock wire (2) (item 23, WP 0173).



**END OF WORK PACKAGE**





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**GENERATOR DRIVE MECHANISM REPLACE/REPAIR (300 AMPERE)**

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**0155 00**

**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Inspection, Assembly, Installation

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**INITIAL SETUP:**

**Tools:**

Arbor press (item 8, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Generator coupling tool (item 58, WP 0176)  
Inside micrometer caliper set (item 16, WP 0176)  
Mechanical puller adapter (item 2, WP 0176)  
Outside micrometer caliper set (item 17, WP 0176)  
Slide hammer puller assembly (item 88, WP 0176)  
Retaining ring pliers (item 79, WP 0176)  
Telescoping gauge set (item 54, WP 0176)  
Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Expendable and Durable Items:**

Lubricating oil, engine (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)  
Wire, non electrical, 2-pound spool (item 44, WP 0173)

**Mandatory Replacement Parts:**

Bearing (2) (item 293, WP 0175)  
Bearing (1) (item 307, WP 0175)  
Gasket (item 353, WP 0175)  
Lock washer (5) (item 98, WP 0175)  
O-ring (item 63, WP 0175)  
Retaining ring (item 14, WP 0175)  
Seal (item 222, WP 0175)  
Self-locking nut (item 35, WP 0175)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

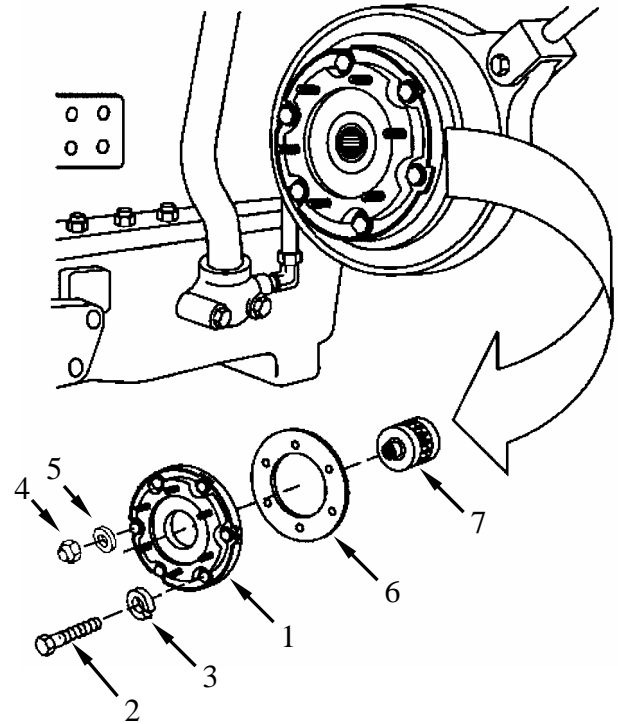
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Accessory drive gear removed (WP 0141)  
Crankshaft removed (WP 0139)  
Generator removed (WP 0052)

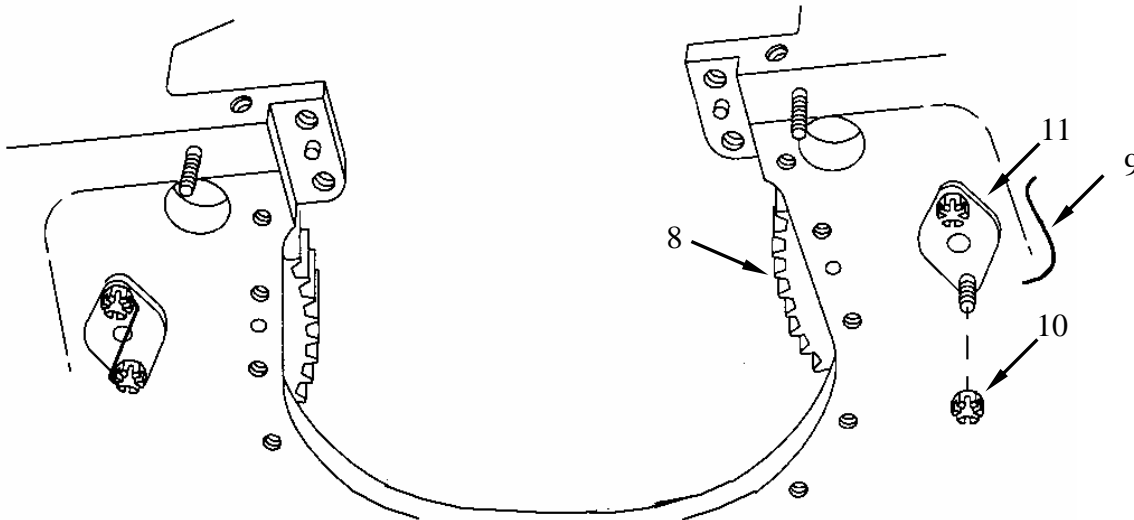
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**REMOVAL**

1. Remove generator drive adapter (1).
  - a. Remove five screws (2) with lock washers (3). Discard lock washers.
  - b. Remove one self-locking nut (4) with flat washer (5). Discard self-locking nut.
  - c. Remove generator drive adapter (1) and gasket (6). Discard gasket.
2. Remove gear and bearing assembly (7).



3. Remove idler spur gear (8).
  - a. Cut and remove locking wire (9) and remove two slotted nuts (10) securing idler shaft (11).



**REMOVAL (Continued)**

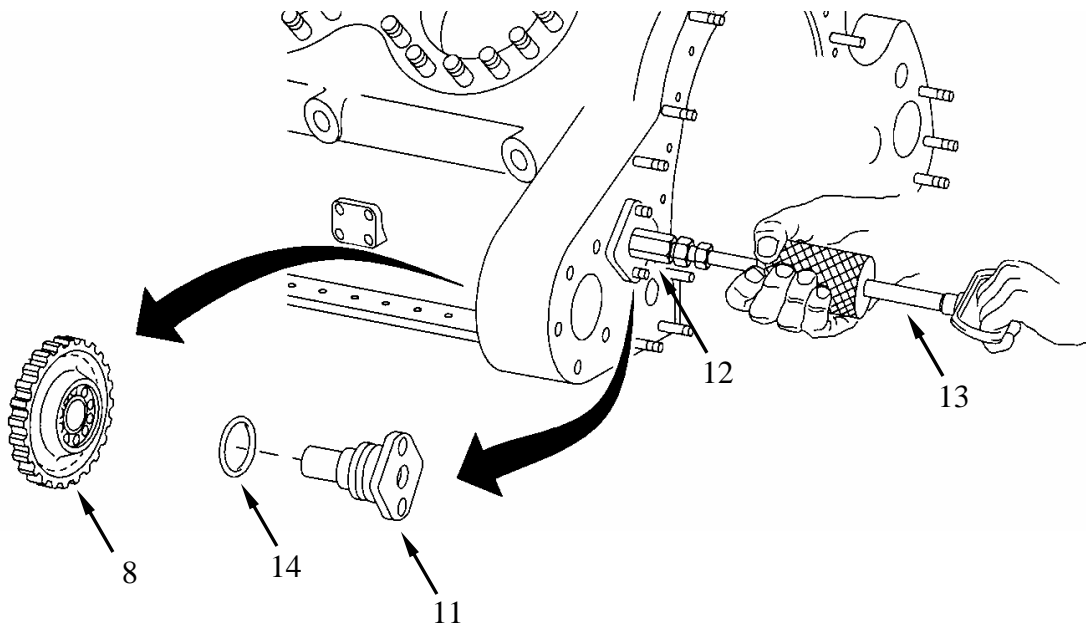
3. Remove idler spur gear (8) (Continued).

b. Attach mechanical puller adapter (12) (item 2, WP 0176) and slide hammer puller (13) (item 88, WP 0176) to idler shaft (11).

c. Support spur gear (8) while using slide hammer puller (13) to remove idler shaft (11).

d. Remove and discard O-ring (14).

e. Remove slide hammer puller (13) and mechanical puller adapter (12) from idler shaft (11).



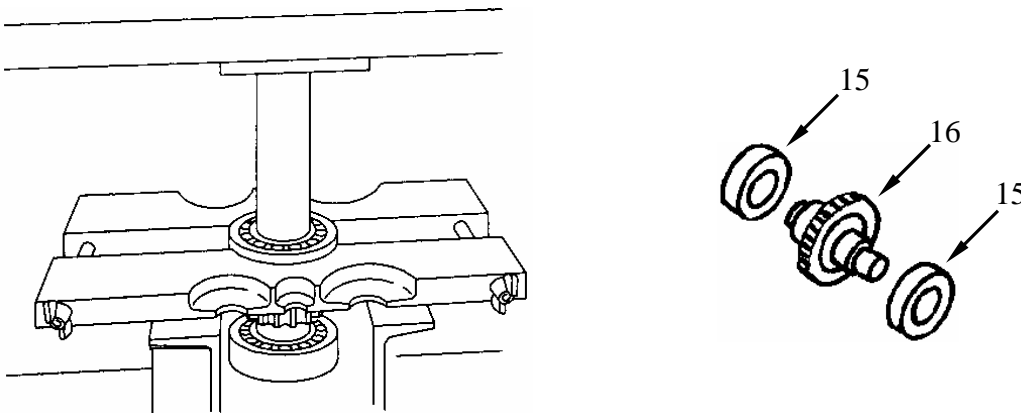
**DISASSEMBLY**

1. Remove and discard bearings (15) from drive gear (16).

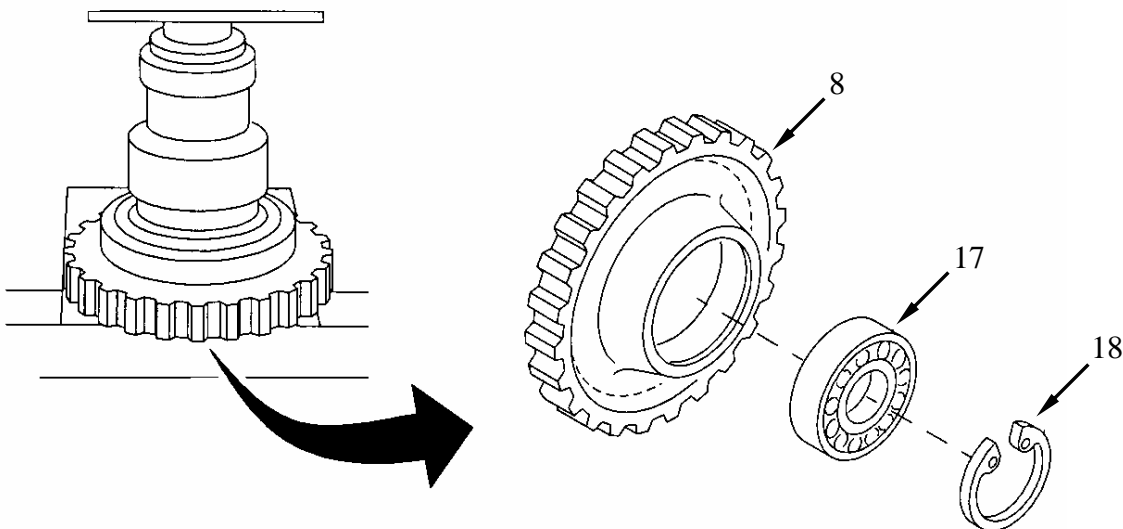
**CAUTION**

**Because the force used to press the bearing (15) from the gear is through the individual balls and not the race, the bearing is destroyed when it is removed. Do not use either bearing (15) once it has been pressed from the gear.**

- a. Using an arbor press (item 8, WP 0176), remove and discard ball bearing (15) from either end of drive gear (16).
- b. Press opposite end ball bearing (15) from drive gear (16) in a similar manner.



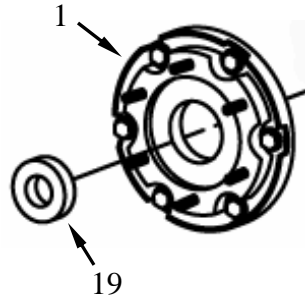
2. Remove bearing (17) from idler spur gear (8).
  - a. Remove and discard retaining ring (18) from spur gear (8).
  - b. Using an arbor press, remove and discard ball bearing (17) from spur gear (8).



**DISASSEMBLY (Continued)**

3. Remove oil seal (19).

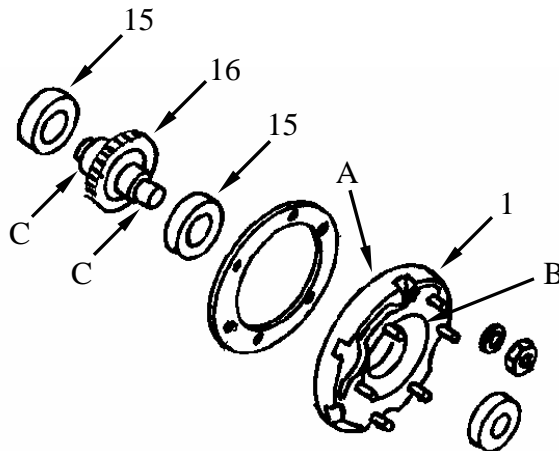
- a. Press seal (19) from adapter (1) using a suitable arbor press. Discard seal.



**INSPECTION**

1. Measure inside diameter (A) of bearing bore in generator adapter (1). Replace generator adapter if it is not within specifications in the following table.
2. Measure inside diameter (B) of oil seal (18) bore in generator adapter (1). Replace generator adapter if it is not within specifications in the following table.
3. Measure outside diameter (C) on both ends of generator drive gear (16). Replace drive gear if it is not within specifications in the following table.

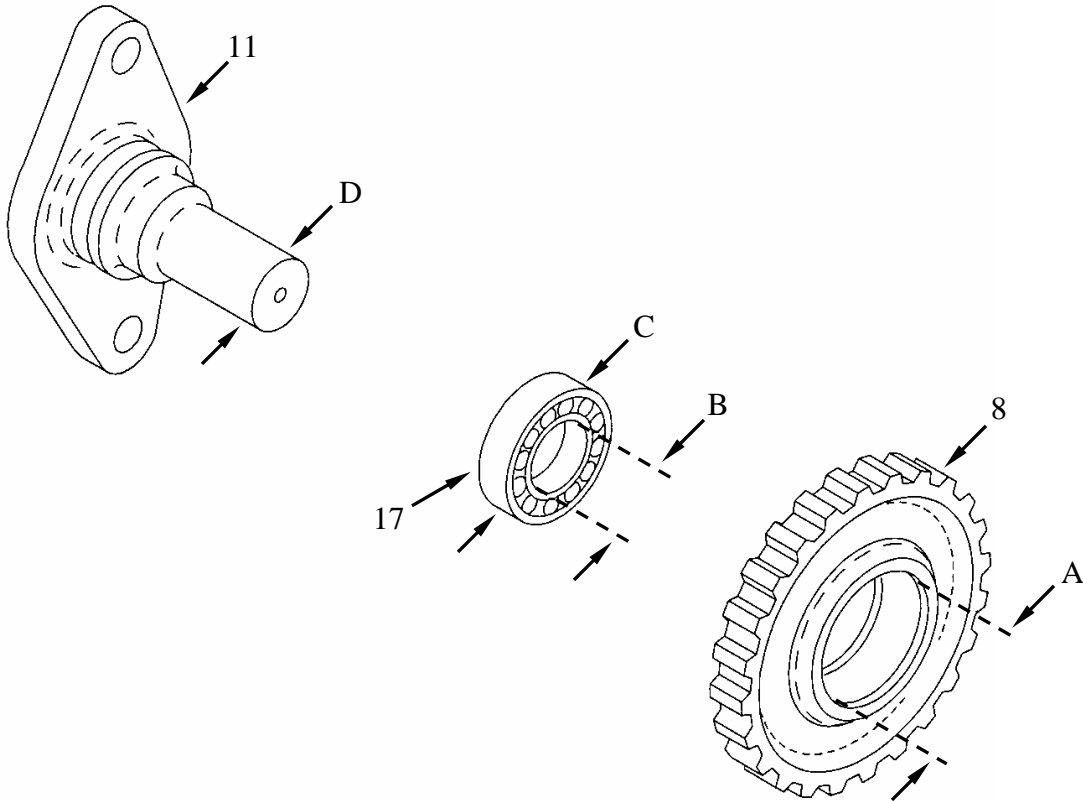
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (Bearing bore)	2.8346 (71.9988)	2.8353 (72.0166)	2.8356 (72.0242)
B (Seal bore)	2.2490 (57.1246)	2.2510 (57.1754)	None
C (Gear bearing hubs)	1.3781 (35.0037)	1.3785 (35.0139)	1.3779 (34.9986)



**INSPECTION (Continued)**

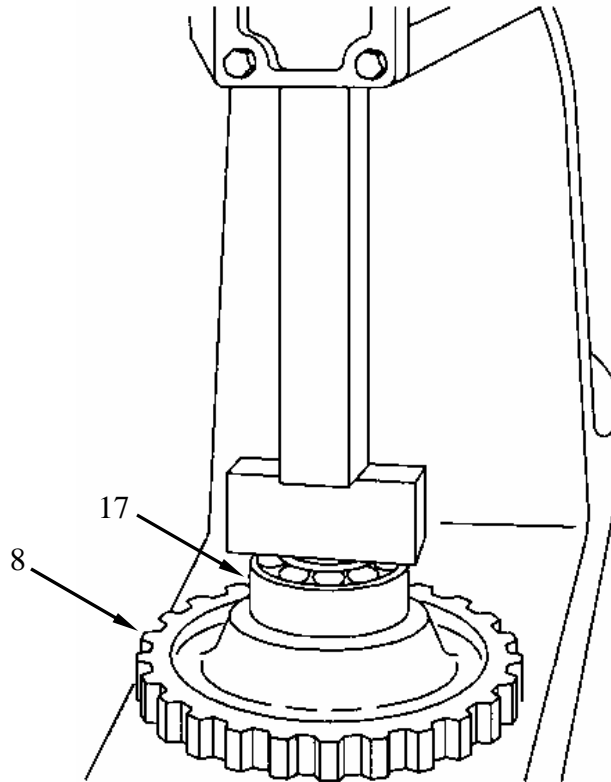
4. Measure inside diameter (A) of idler spur gear (8). Replace spur gear if it is not within specifications in the following table.
5. Replace ball bearing (17).
  - a. Replace ball bearing to specifications (B, C) in the following table.
6. Measure outside diameter (D) of idler shaft (11). Replace shaft if it is not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A	2.8334 (71.9683)	2.8346 (71.9988)	2.8348 (72.0039)
B	1.1807(29.9897)	1.1811 (29.9999)	None
C	2.8341 (71.9861)	2.8346 (71.9988)	None
D	1.1804 (29.9821)	1.1808 (29.9923)	1.1802(29.9770)

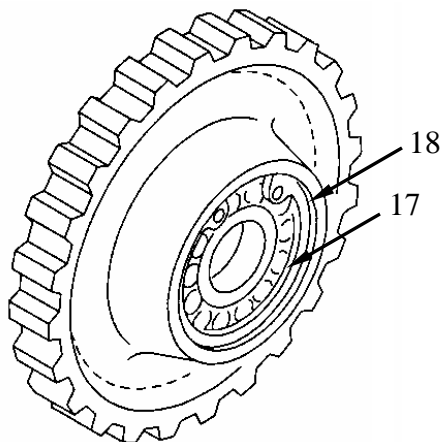


**ASSEMBLY**

1. Install bearing (17).
  - a. Apply lubricant (item 21, WP 0173) to new ball bearing (17) (item 307, WP 0175) and press into spur gear (8).



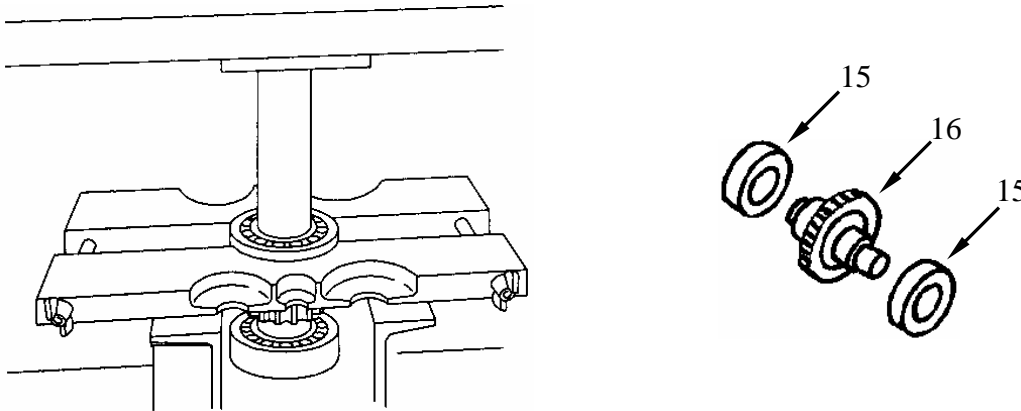
- b. Secure new bearing (17) with new retaining ring (18) (item 14, WP 0175).



**ASSEMBLY (Continued)**

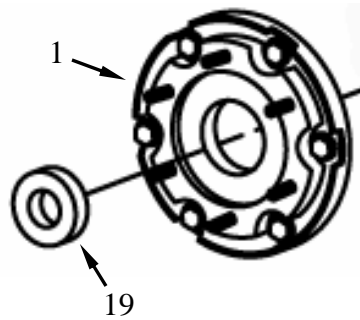
2. Install two new bearings (15).

- a. Apply lubricant (item 21, WP 0173) to two new ball bearings (15) (item 293, WP 0175) and press onto generator drive gear (16).

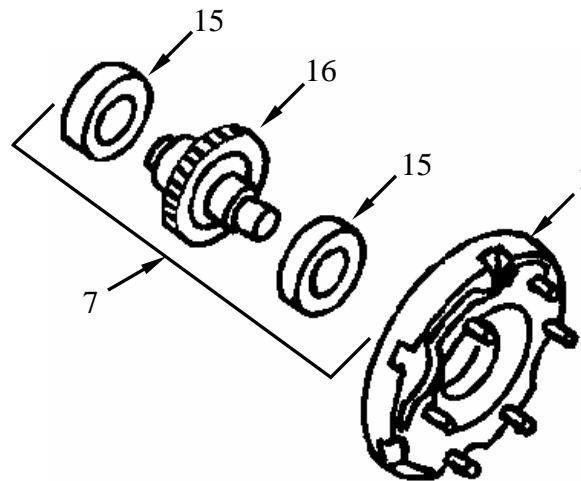


3. Install new seal (19).

- a. Position seal ensuring that lip of seal points inward.
- b. Carefully press new seal (18) (item 222, WP 0175) into housing (1) using a suitable press.



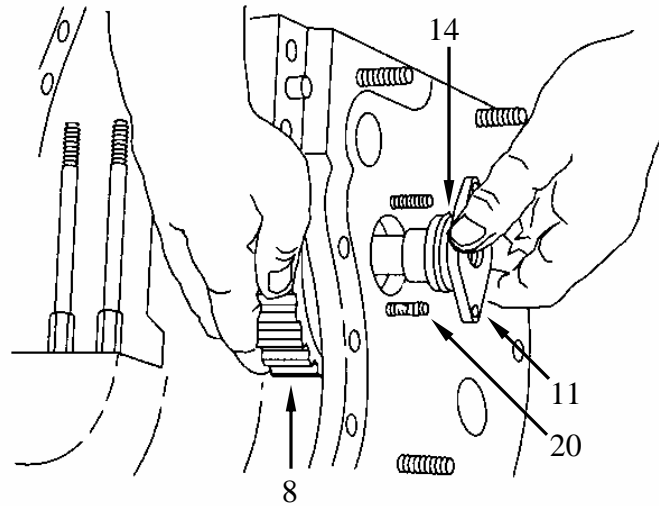
4. Install generator drive gear assembly (7) into drive adapter (1).



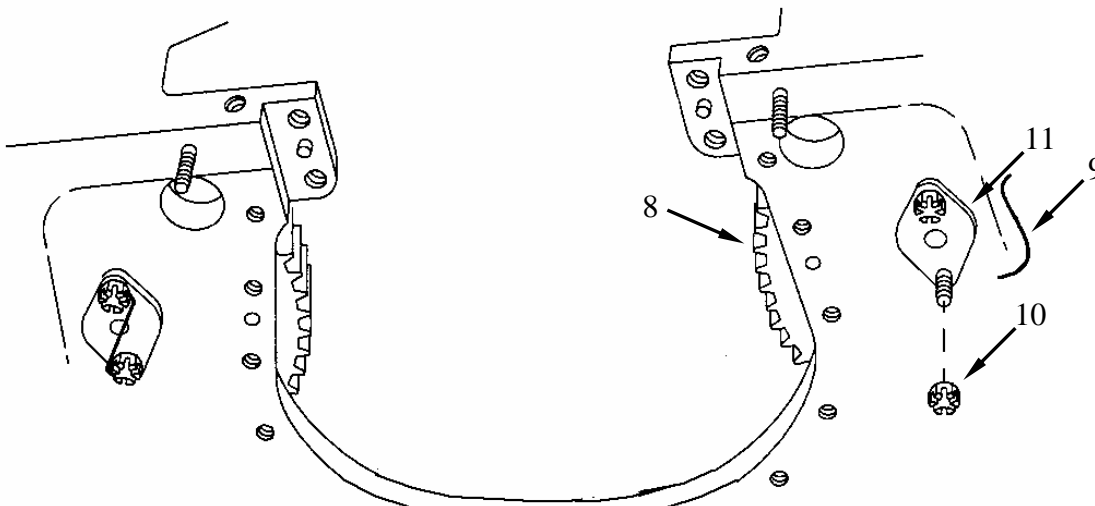


**INSTALLATION**

1. Install idler spur gear (8).
  - a. Apply Lubriplate (item 23, WP 0173) to new O-ring (14) (item 63, WP 0175) and install on idler shaft (11).
  - b. Apply lubricant (item 21, WP 0173) to idler shaft (11).
  - c. Align spur gear (8) with bore in crankcase and install idler shaft (11) through crankcase and spur gear.

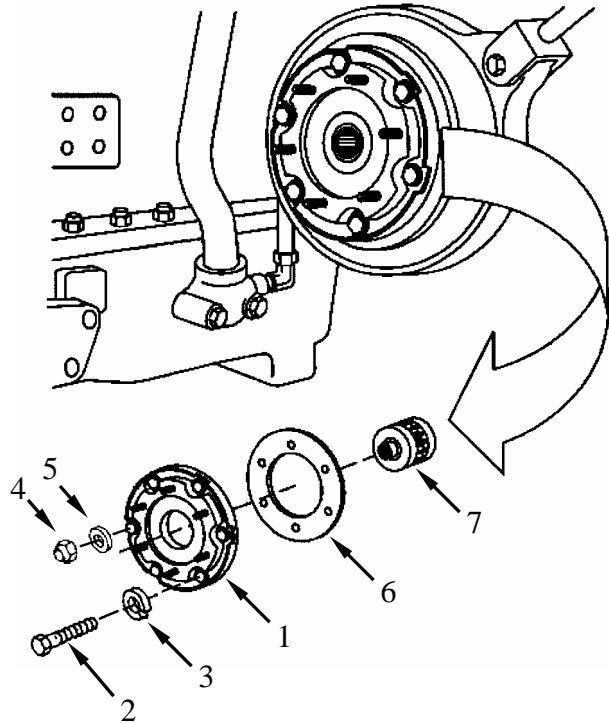


- d. Apply Lubriplate (item 23, WP 0173) to studs (20).
- e. Secure idler shaft (11) using two slotted nuts (10). Torque slotted nuts (10) to 46-50 foot-pounds (62-68 N•m).
- f. Secure two slotted nuts (10) with new lock wire (9) (item 44, WP 0173).



**INSTALLATION (Continued)**

2. Install generator drive adapter (1).
  - a. Apply Lubriplate (item 23, WP 0173) to five screws (2).
  - b. Install generator drive adapter (1), drive assembly (7), and new gasket (6) (item 353, WP 0175).
  - c. Secure using five screws (2) with new lock washers (3) (item 98, WP 0175) and one new self-locking nut (4) (item 35, WP 0175) with flat washer (5).



**END OF WORK PACKAGE**

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**GENERATOR DRIVE MECHANISM REPLACE/REPAIR (650 AMPERE)**

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**0156 00**

**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Inspection, Assembly, Installation

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**INITIAL SETUP:**

**Tools and Special Tools:**

Arbor press (item 8, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Generator coupling tool (item 58, WP 0176)  
Generator holding fixture (item 59, WP 0176)  
Inside micrometer caliper set (item 16, WP 0176)  
Mechanical puller adapter (item 2, WP 0176)  
Outside micrometer caliper set  
(item 17, WP 0176)  
Retaining ring pliers (item 79, WP 0176)  
Slide hammer puller assembly (item 88, WP 0176)  
Telescoping gauge set (item 54, WP 0176)  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)  
Torque wrench, 0-600 foot-pounds  
(item 128, WP 0176)

**Mandatory Replacement Parts:**

Bearing (item 307, WP 0175)  
Gasket (2) (item 353, WP 0175)  
Lock washer (5) (item 98, WP 0175)  
O-ring (item 67, WP 0175)  
Retaining Ring (item 14, WP 0175)  
Self-locking nut (item 35, WP 0175)

**Expendable Materials:**

Lubricating oil, engine (item 21, WP 0173)  
Lubriplate (item 23, WP 0173)  
Wire, non-electrical, 2-pound spool  
(item 44, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (1) 63H10

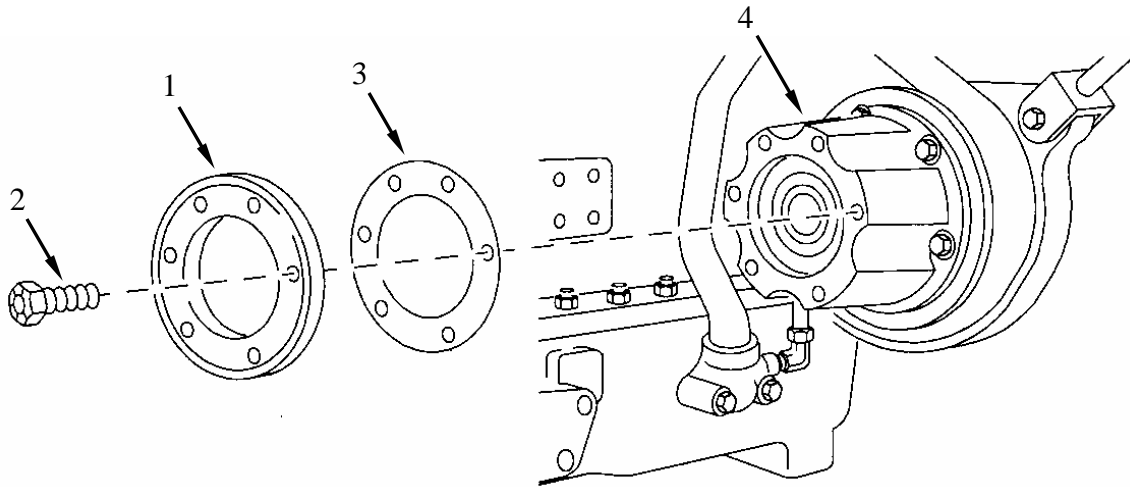
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Accessory drive gear removed (WP 0141)  
Crankshaft removed (WP 0139)  
Generator removed (WP 0051)

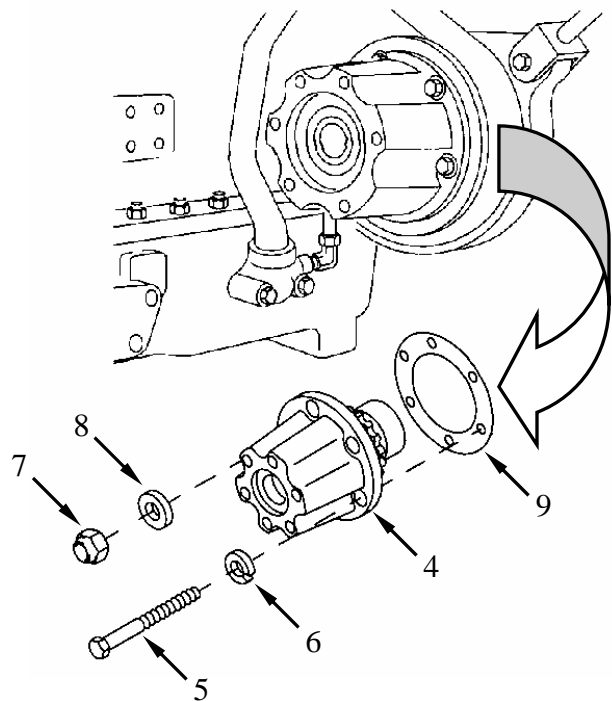
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**REMOVAL**

1. Remove generator end plate (1).
  - a. Remove six screws (2).
  - b. Remove generator end plate (1) and gasket (3) from generator drive adapter (4). Discard gasket.



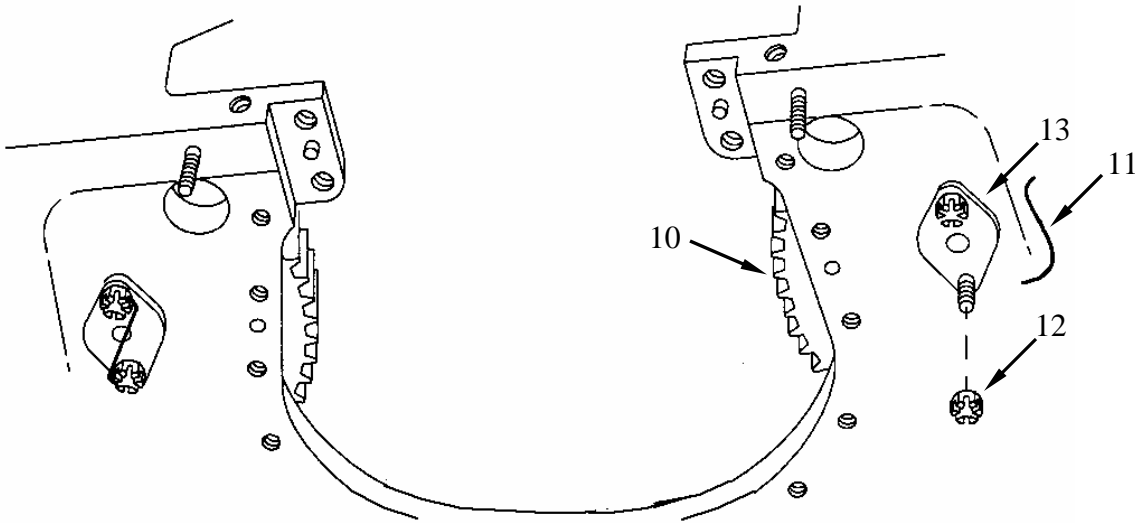
2. Remove generator drive adapter (4).
  - a. Remove five screws (5) with lock washers (6). Discard lock washers.
  - b. Remove one self-locking nut (7) with flat washer (8). Discard self-locking nut.
  - c. Remove generator drive adapter (4) and gasket (9). Discard gasket.



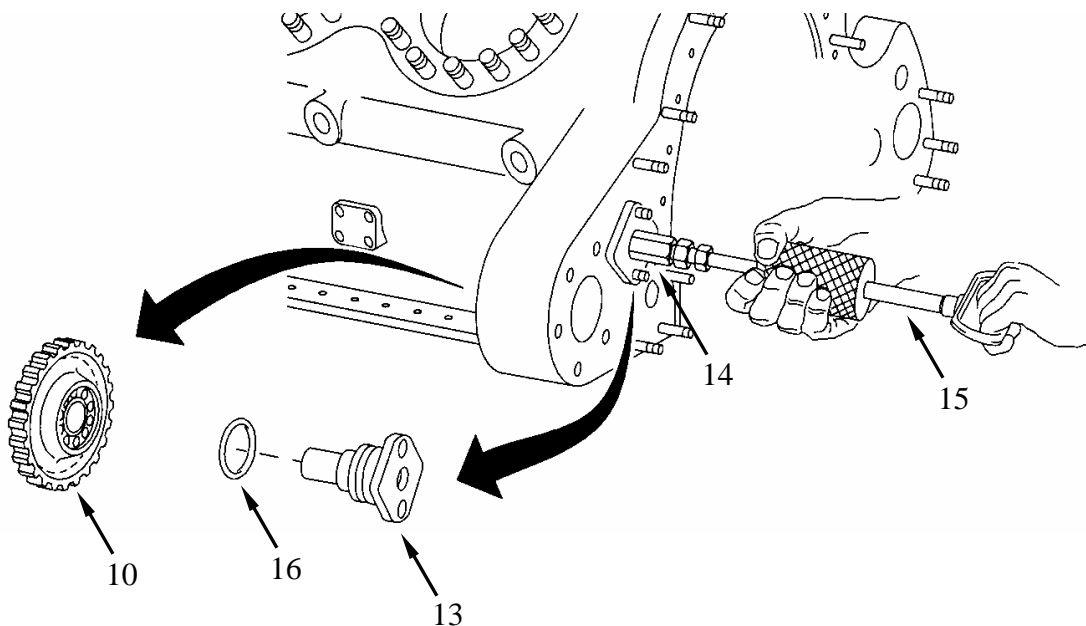
**REMOVAL (Continued)**

3. Remove idler spur gear (10)

- a. Cut and remove locking wire (11) and remove two slotted nuts (12) securing idler shaft (13).

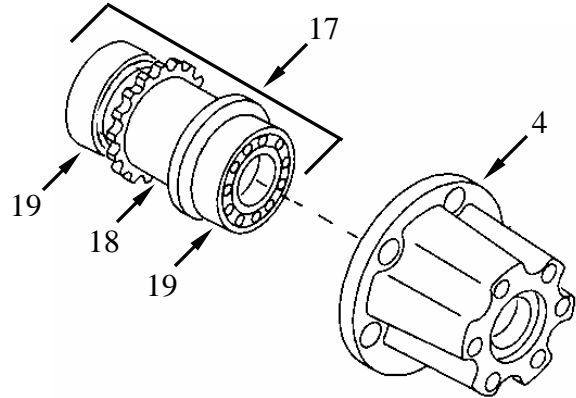


- b. Attach mechanical puller adapter (14) (item 2, WP 0176) and slide hammer puller (15) (item 88, WP 0176) to idler shaft (13).
- c. Support spur gear (10) while using slide hammer puller (15) to remove idler shaft (13).
- d. Remove and discard O-ring (16).
- e. Remove slide hammer puller (15) and mechanical puller adapter (14) from idler shaft (13).



**DISASSEMBLY**

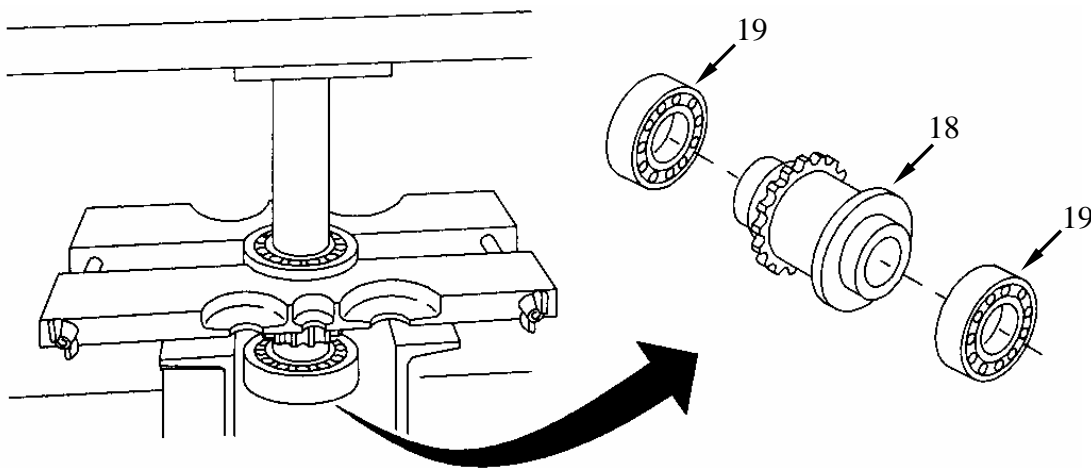
1. Remove generator drive gear assembly (17) from generator drive adapter (4).
  - a. Go to Work Package 0039 and bench test the drive gear (18).
2. Check bearing (19) on each end of drive gear (18).
  - a. Look for broken, cracked or split rings, cracked, broken or loose separators, heat discoloration (brown-blue or blue-black color). Rotate the free race slowly and feel for roughness. If any of these conditions exists, the bearing must be replaced.
  - b. If either bearing needs replacement, go to step 3.
  - c. If both bearings are OK, go to step 4.



**CAUTION**

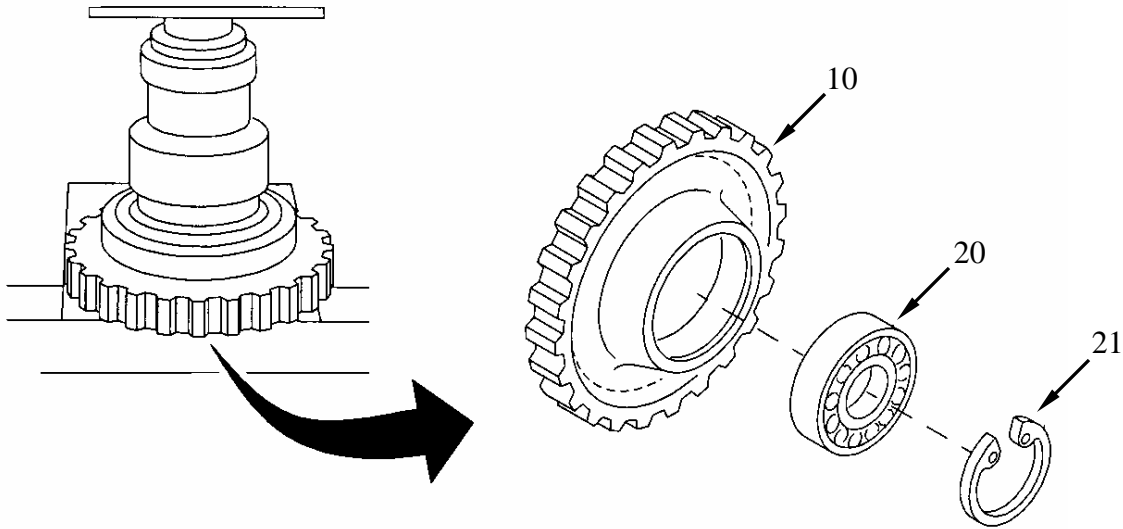
**Because the force used to press the bearing from the gear is through the individual balls and not the race, the bearing is destroyed when it is removed. Do not use either bearing once it has been pressed from the gear.**

3. Remove generator drive gear (18) bearings (19).
  - a. Using an arbor press (item 8, WP 0176), remove and discard ball bearing (19) from either end of drive gear (18).
  - b. Press opposite end ball bearing (19) from drive gear (18) in a similar manner.



**DISASSEMBLY (Continued)**

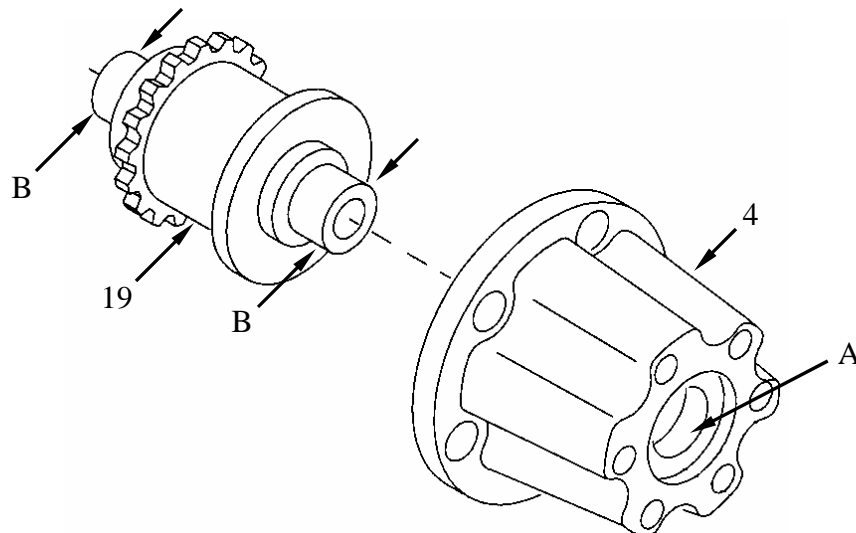
4. Remove bearing (20) from idler spur gear (10).
  - a. Remove retaining ring (21) from spur gear (10). Discard retaining ring.
  - b. Using an arbor press, remove and discard ball bearing (20) from spur gear (10).



**INSPECTION**

1. Measure inside diameter (A) of bearing bore in generator adapter (4). Replace generator adapter if it is not within specifications in the following table.
2. If bearings were removed, measure outside diameter (B) on both ends of generator drive gear (19). Replace drive gear (19) if it is not within specifications in the following table.

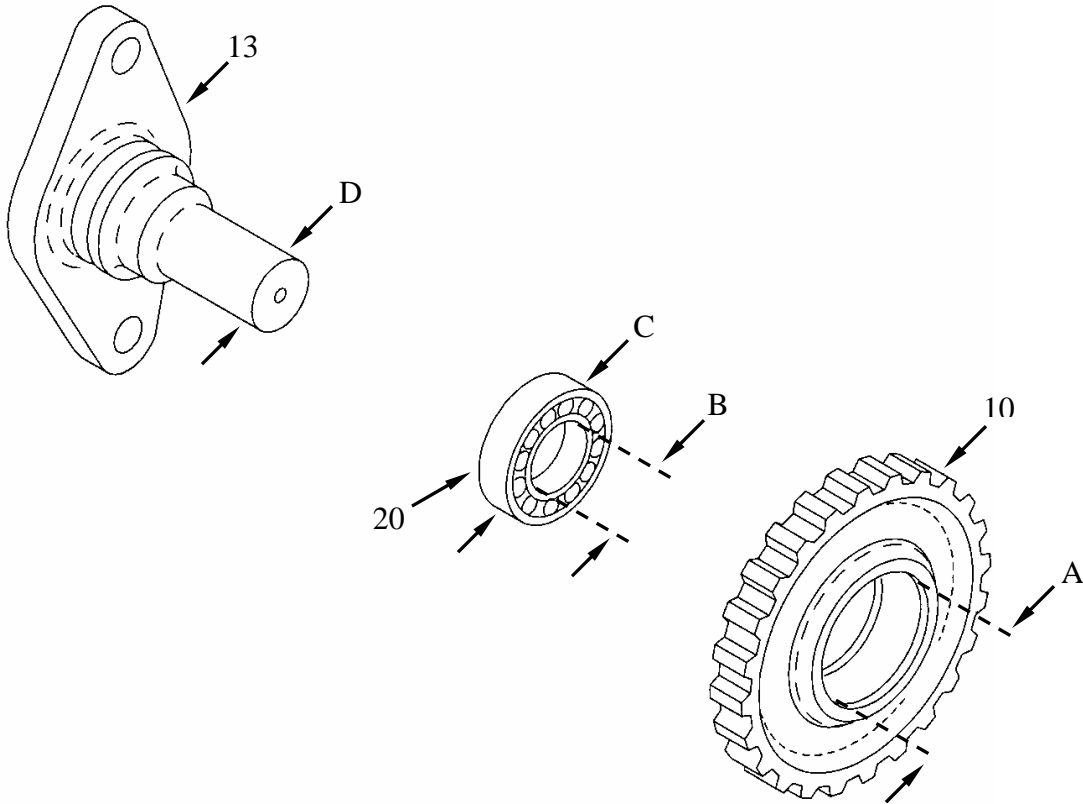
Location	Sizes and Fit of New Parts - inches (mm)		Wear Limits
A	2.8346 (71.9988)	2.8353 (72.0166)	2.8356 (72.0242)
B	1.3781 (35.0037)	1.3785 (35.0139)	1.3779 (34.9986)



**INSPECTION (Continued)**

3. Measure inside diameter (A) of idler spur gear (10). Replace spur gear if it is not within specifications in the following table.
4. Ball bearing (20) is a mandatory replacement item.
  - a. New ball bearing must meet specifications in the following table. Inside diameter is (B) outside diameter is (C).
5. Measure outside diameter (D) of idler shaft (13). Replace shaft if it is not within specifications in the following table.

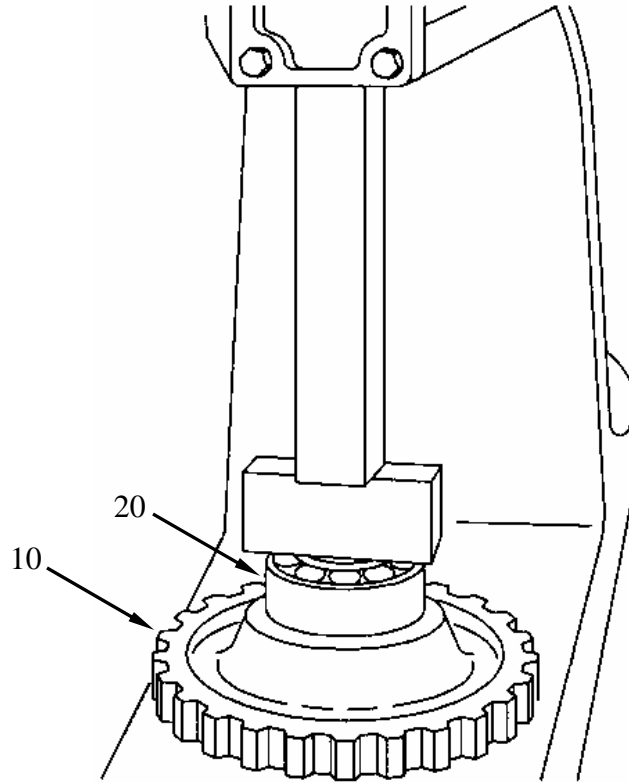
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A	2.8334 (71.9683)	2.8346 (71.9988)	2.8348 (72.0039)
B	1.1807(29.9897)	1.1811 (29.9999)	None
C	2.8341 (71.9861)	2.8346 (71.9988)	None
D	1.1804 (29.9821)	1.1808 (29.9923)	1.1802(29.9770)



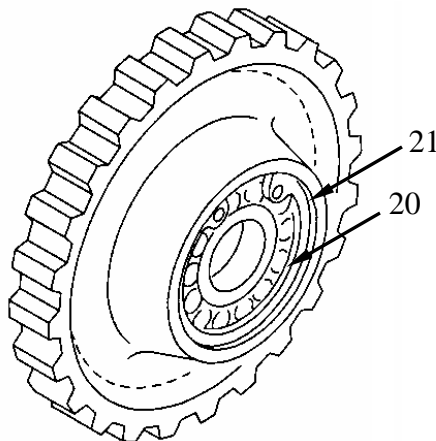


**ASSEMBLY**

1. Install new bearing (20) (item 307, WP 0175).
  - a. Apply lubricant (item 21, WP 0173) to ball bearing (20) and press into spur gear (10).

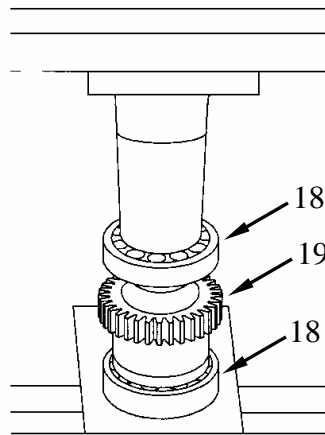


- b. Secure bearing (20) with new retaining ring (21) (item 14, WP 0175).

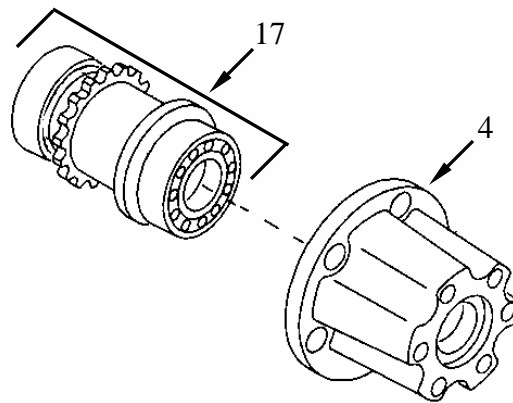


**ASSEMBLY (Continued)**

2. Install two new bearings (19) if old ones were removed.
  - a. Apply lubricant (item 21, WP 0173) to two ball bearings (19) and press onto generator drive gear (18).

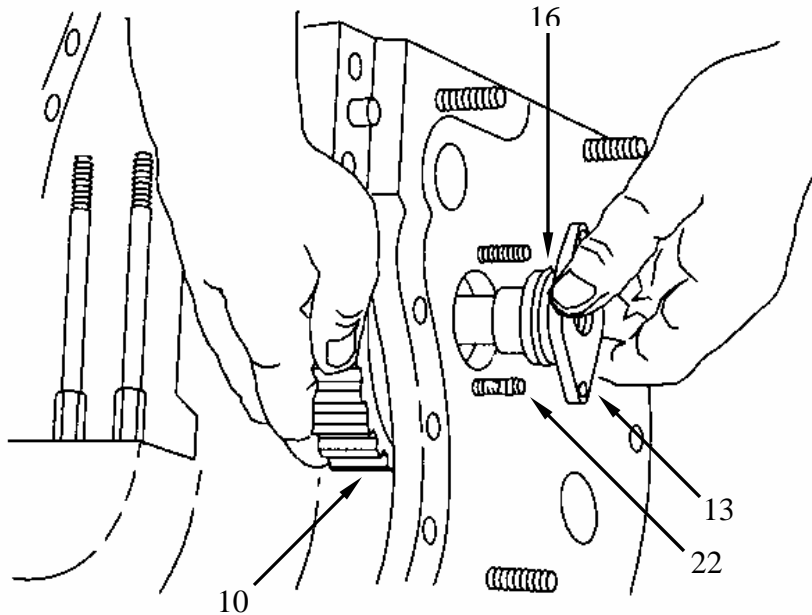


3. Install generator drive gear assembly (17) into drive adapter (4).

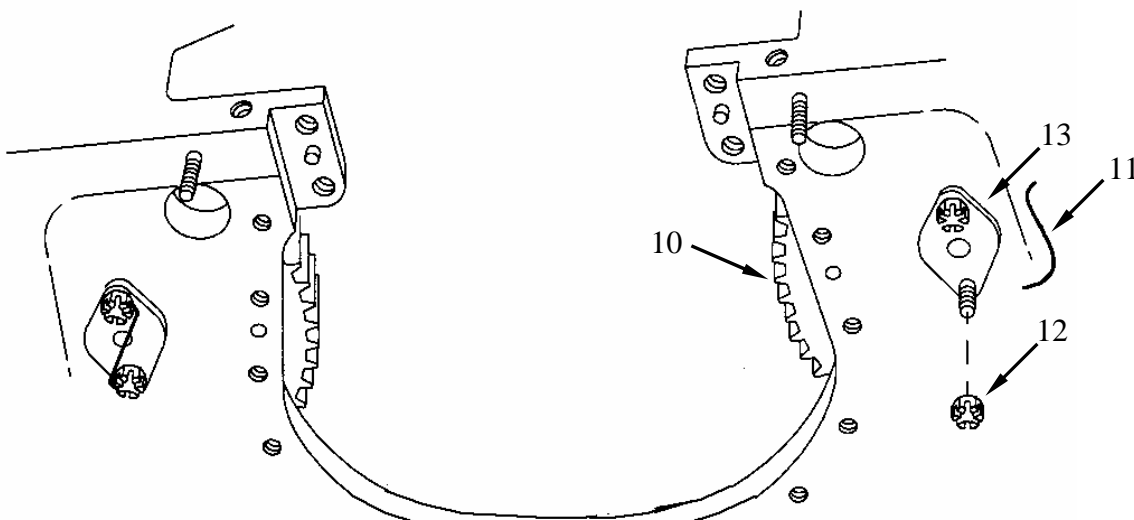


**INSTALLATION**

1. Install idler spur gear (10).
  - a. Install new O-ring (16) (item 67, WP 0175) on idler shaft (13).
  - b. Apply lubricant (item 21, WP 0173) to idler shaft (13).
  - c. Align spur gear (10) with bore in crankcase and install idler shaft (13) through crankcase and spur gear.



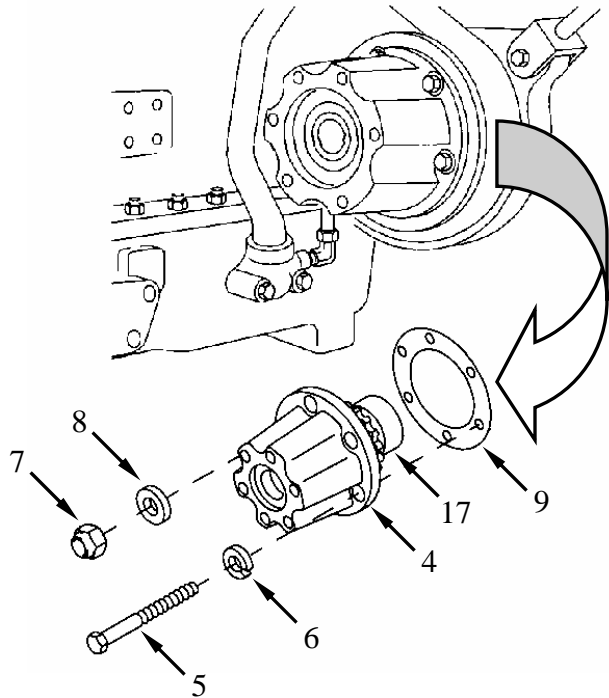
- d. Apply lubricant (item 23, WP 0173) to studs (22).
- e. Secure idler shaft (13) using two slotted nuts (12). Torque slotted nuts (12) to 46-50 foot-pounds (62-68 N•m).
- f. Secure two slotted nuts (12) with new lock wire (11) (item 44, WP 0173).



**INSTALLATION (Continued)**

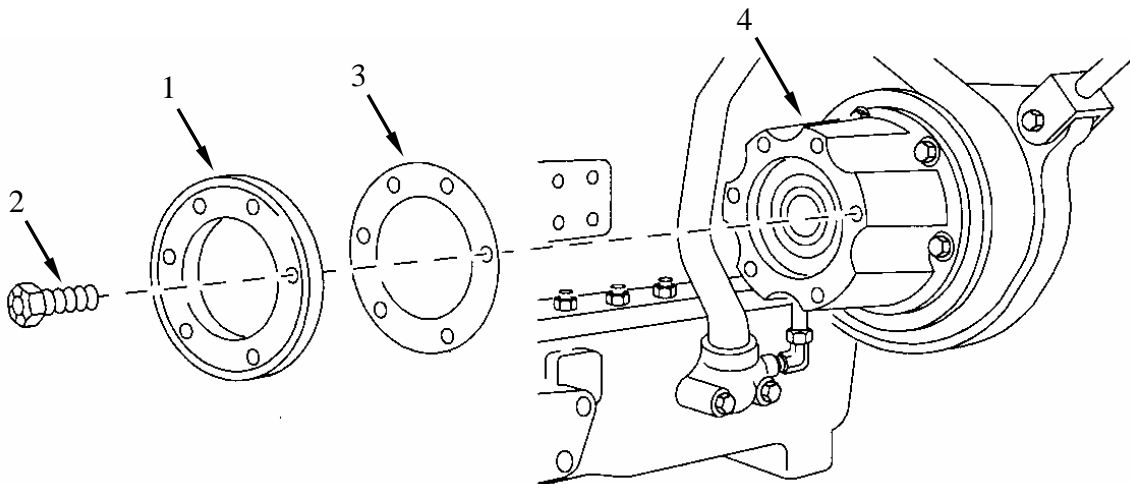
2. Install generator drive adapter (4).

- a. Apply lubricant (item 23, WP 0173) to five screws (5).
- b. Install generator drive adapter (4), drive assembly (17), and new gasket (9) (item 353, WP 0175).
- c. Secure using five screws (5) with new lock washers (6) (item 98, WP 0175) and one new self-locking nut (7) (item 35, WP 0175) with flat washer (8).



3. Install generator end plate (1).

- a. Apply lubricant (item 23, WP 0173) to six screws (2).
- b. Position end plate (1) with new gasket (3) (item 353, WP 0175) onto adapter (4).
- c. Secure end plate (2) with six screws (2).



**END OF WORK PACKAGE**

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**STARTER DRIVE MECHANISM REPAIR**

**0157 00**

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**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

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**INITIAL SETUP:**

**Tools and Special Tools:**

Arbor press (item 8, WP 0176)  
Bolts (3) (item 12, WP 0176)  
General mechanic's tool kit (item 121, WP 0176)  
Inside micrometer caliper set (item 16, WP 0176)  
Mechanical adapter (item 2, WP 0176)  
Outside micrometer caliper set  
(item 17, WP 0170)  
Retaining ring pliers (item 79, WP 0176)  
Slide hammer puller assembly (item 88, WP 0176)  
Telescoping gauge set (item 54, WP 0176)  
Torque wrench, 0-600 foot-pounds  
(item 128, WP 0176)

**Expendable Materials:**

Lubricating oil, engine (item 21, WP 0173)  
Wire, non-electrical, 2-pound spool  
(item 44, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Spur gear (accessory drive) removed (WP 0141)

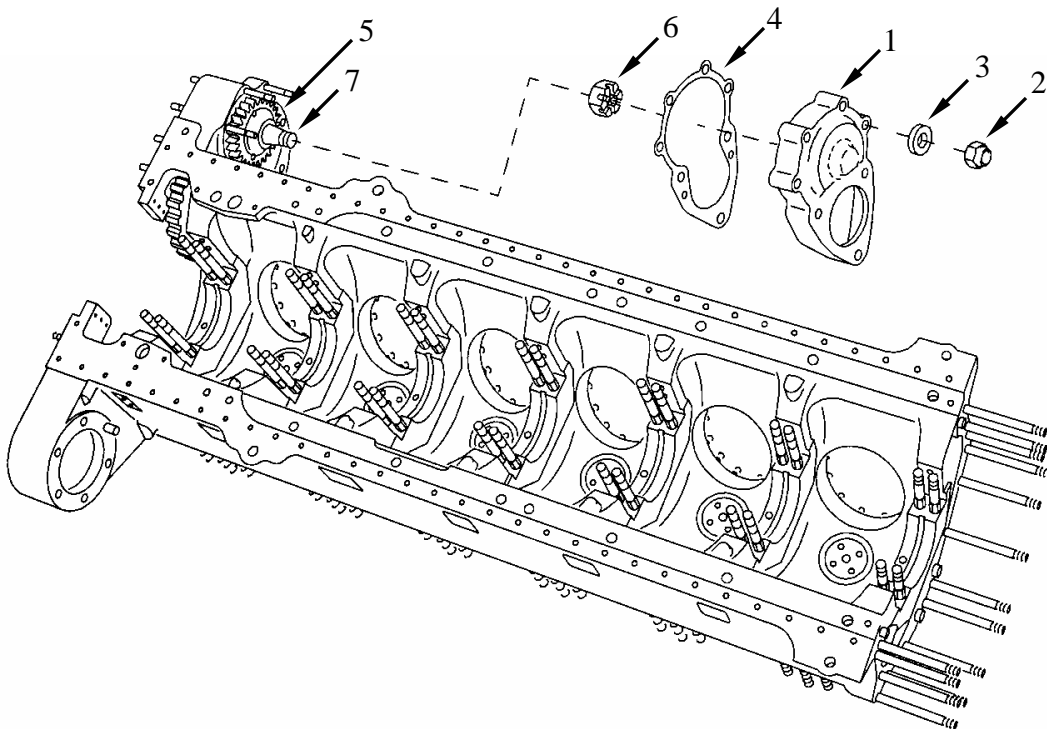
**Mandatory Replacement Parts:**

Gasket (item 184, WP 0175)  
O-ring (item 67, WP 0175)  
O-ring (item 70, WP 0175)  
Retaining ring (item 15, WP 0175)  
Seal (item 216, WP 0175)  
Self-locking nut (4) (item 140, WP 0175)  
Self-locking nut (6) (item 43, WP 0175)

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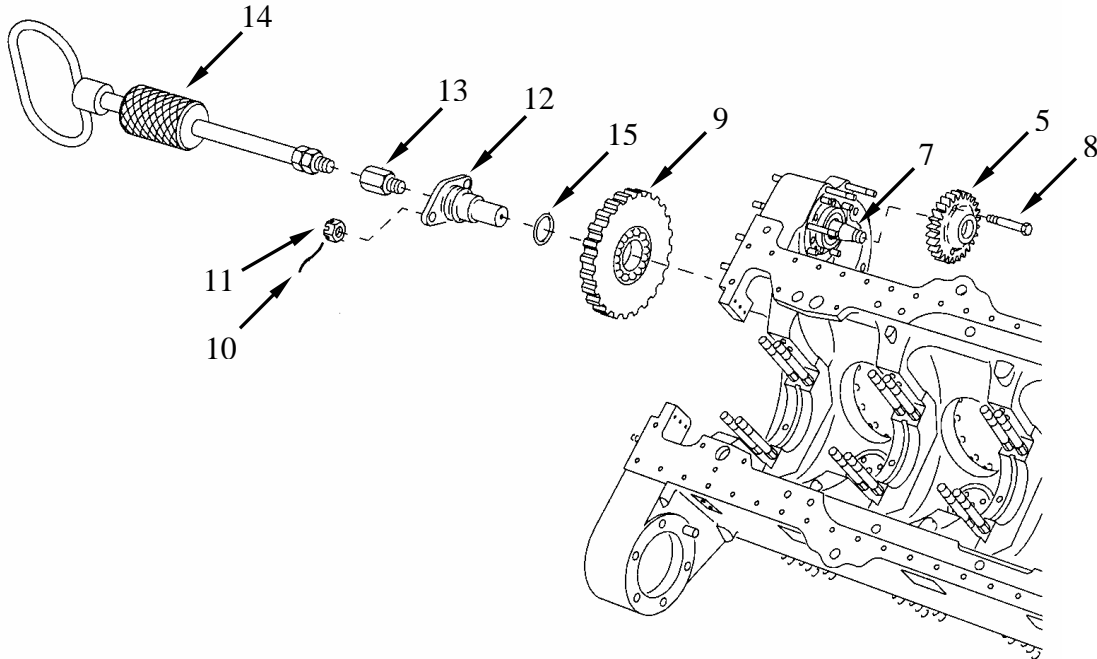
**REMOVAL**

1. Remove starter mounting bracket (1).
  - a. Remove four self-locking nuts (2) with four flat washers (3) from mounting bracket (1). Discard self-locking nuts.
  - b. Remove mounting bracket (1) and gasket (4). Discard gasket.
2. Remove spur gear (5).
  - a. Remove plain slotted nut (6) securing spur gear (5) to spur gear shaft (7).



**REMOVAL (Continued)**

2. Remove spur gear (5) (Continued):
  - b. Install three 5/16-24 X 3-inch bolts (8) (item 12, WP 0176), for use as puller screws, into threaded holes provided in spur gear (5).
  - c. Alternately tighten bolts (8) to pull spur gear (5) from spur gear shaft (7).
  - d. Remove three puller screws (8) from spur gear (5).
3. Remove idler spur gear (9).
  - a. Cut and remove locking wire (10) and remove two slotted nuts (11) securing idler shaft (12).
  - b. Attach mechanical adapter (13) (item 2, WP 0176) and slide hammer puller (14) (item 88, WP 0176) to idler shaft (12).
  - c. Support idler gear (9) while using slide hammer puller (14) to remove idler shaft (12).
  - d. Remove O-ring (15) from idler shaft (12). Discard O-ring.
  - e. Remove slide hammer puller (14) and adapter (13) from idler shaft (12).



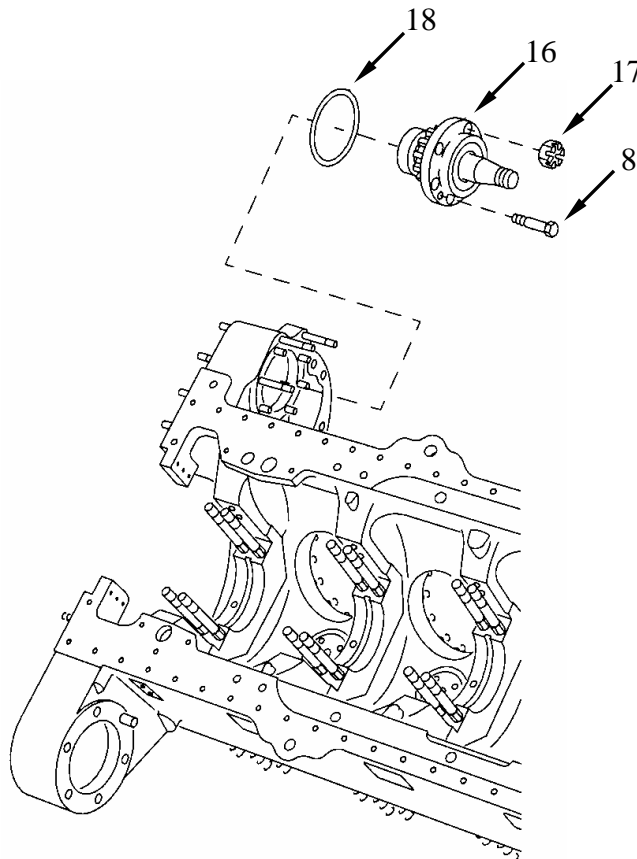
**REMOVAL (Continued)**

4. Remove bearing housing (16).

**NOTE**

**Retaining nuts may be slotted and secured with cotter keys, if so remove and discard. Self-locking nuts will be used on assembly.**

- a. Remove six self-locking nuts (17) securing bearing housing (16). Discard nuts.
- b. Install two 5/16-24 X 3-inch bolts (8) (item 12, WP 0176), for use as puller screws, into threaded holes provided in bearing housing (16).
- c. Alternately tighten bolts (8) to pull bearing housing (16) from crankcase.
- d. Remove and discard O-ring (18).
- e. Remove two puller screws (8) from bearing housing (16).





**DISASSEMBLY**

1. Press spur gear shaft (7) from bearing housing (16), using an arbor press (item 8, WP 0176).
2. Remove plain encased seal (19) from bearing housing (16). Discard seal.
3. Check bearing (20) on each end of gear shaft (7).
  - a. Look for broken, cracked or split rings, cracked, broken or loose separators, heat discoloration (brown-blue or blue-black color). Rotate the free race slowly and feel for roughness. If any of these conditions exists, the bearing must be replaced.
  - b. If either bearing needs replacement, go to step 4. If both bearings are OK, go to step 5.

**CAUTION**

**Because the force used to press the bearing from the gear is through the individual balls and not the race, the bearing is destroyed when it is removed. Do not use bearing once it has been pressed from the gear.**

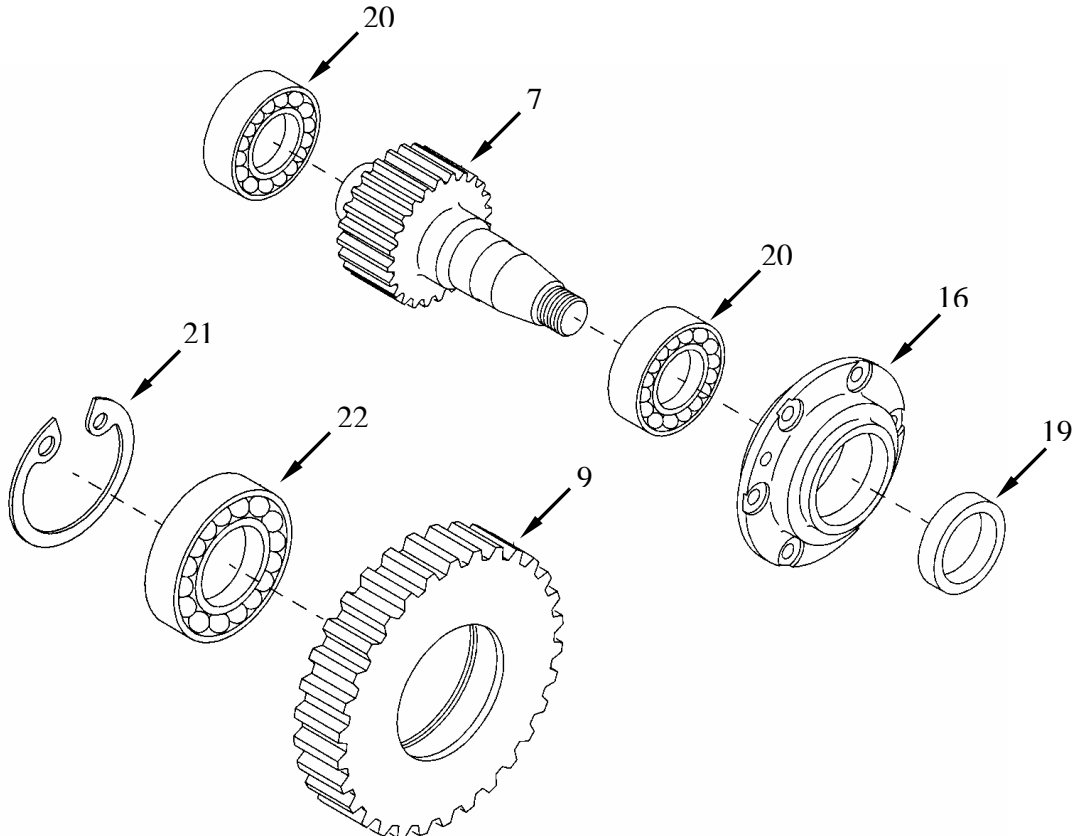
4. Press ball bearings (20) from spur gear shaft (7) using an arbor press.



**WARNING**

**Retaining rings are spring loaded.**

5. Remove retaining ring (21) from idler spur gear (9). Discard retaining ring.
6. Using an arbor press, remove ball bearing (22) from spur gear (9).



**CLEANING**

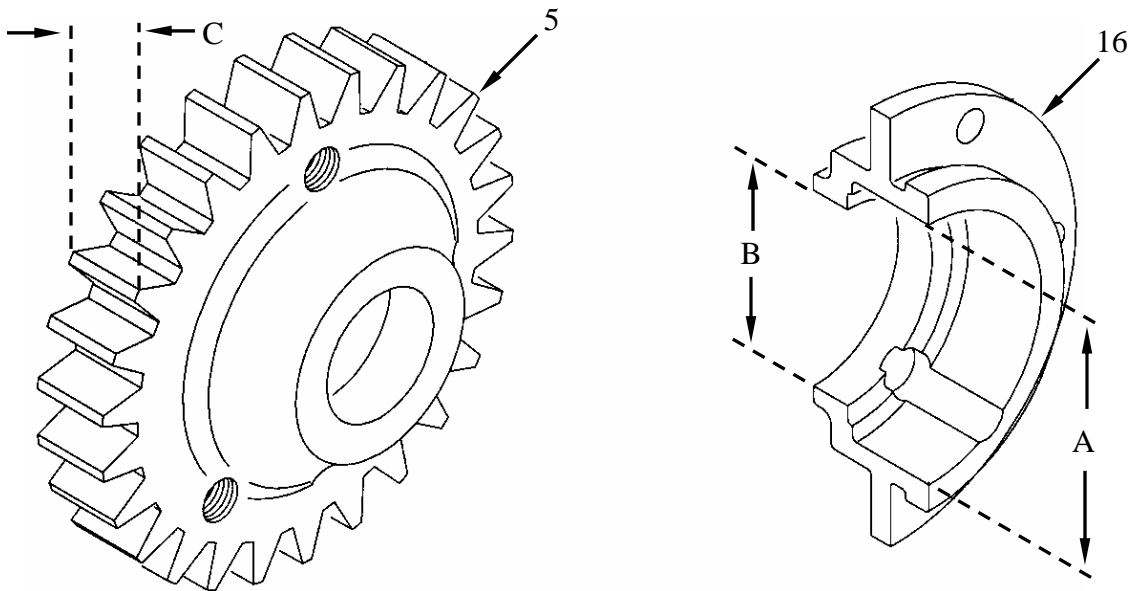
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Measure inside diameter of bearing bore (A) in bearing housing (16). Replace bearing housing if not within specifications in the following table.
3. Measure inside diameter of seal bore (B) in bearing housing (16). Replace bearing housing if not within specifications in the following table.
4. Measure tooth width (C) of spur gear (5). Replace spur gear if not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
	A (bearing bore)	2.8346 (71.9988)	
B (seal bore)	2.1240 (53.9496)	2.1260 (54.0004)	2.1270 (54.0258)
C (gear width)	0.8700 (22.0980)	0.8900 (22.6060)	None

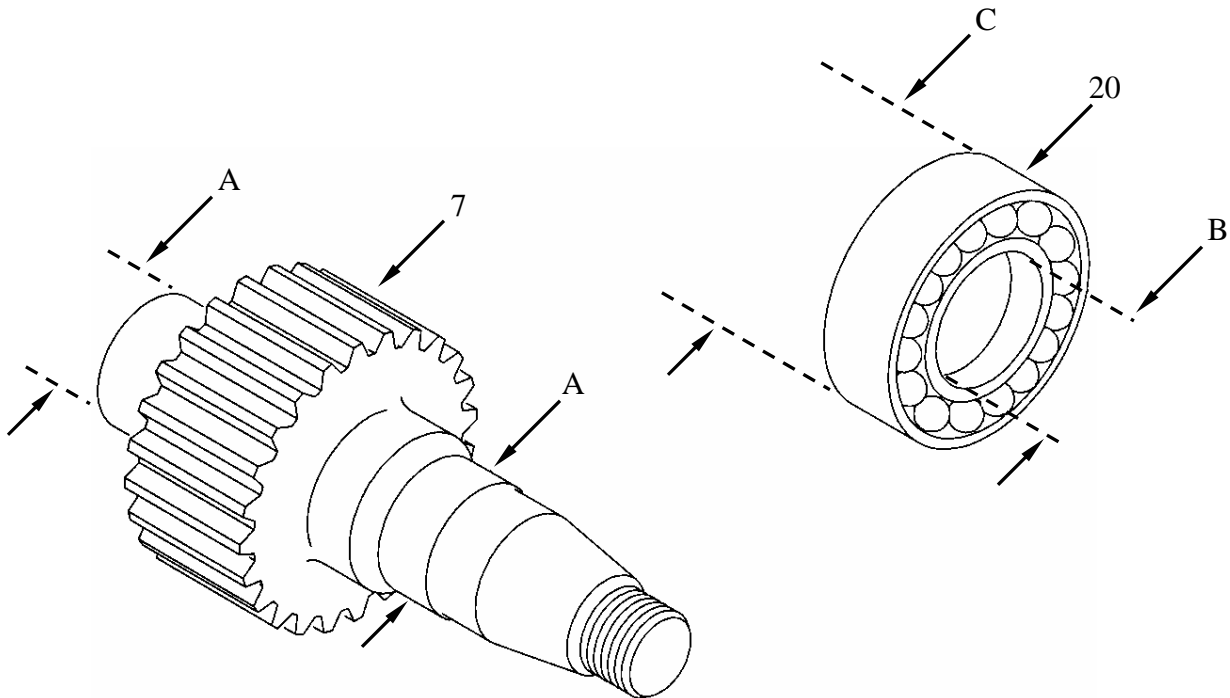


**INSPECTION (Continued)**

5. If bearings (20) were removed, measure outside diameter of bearing hubs (A) on spur gear shaft (7). Replace spur gear shaft if not within specifications in the following table.

a. New bearing dimensions, inside (B) and outside (C), are provided for information purposes only; you need not perform the measurements.

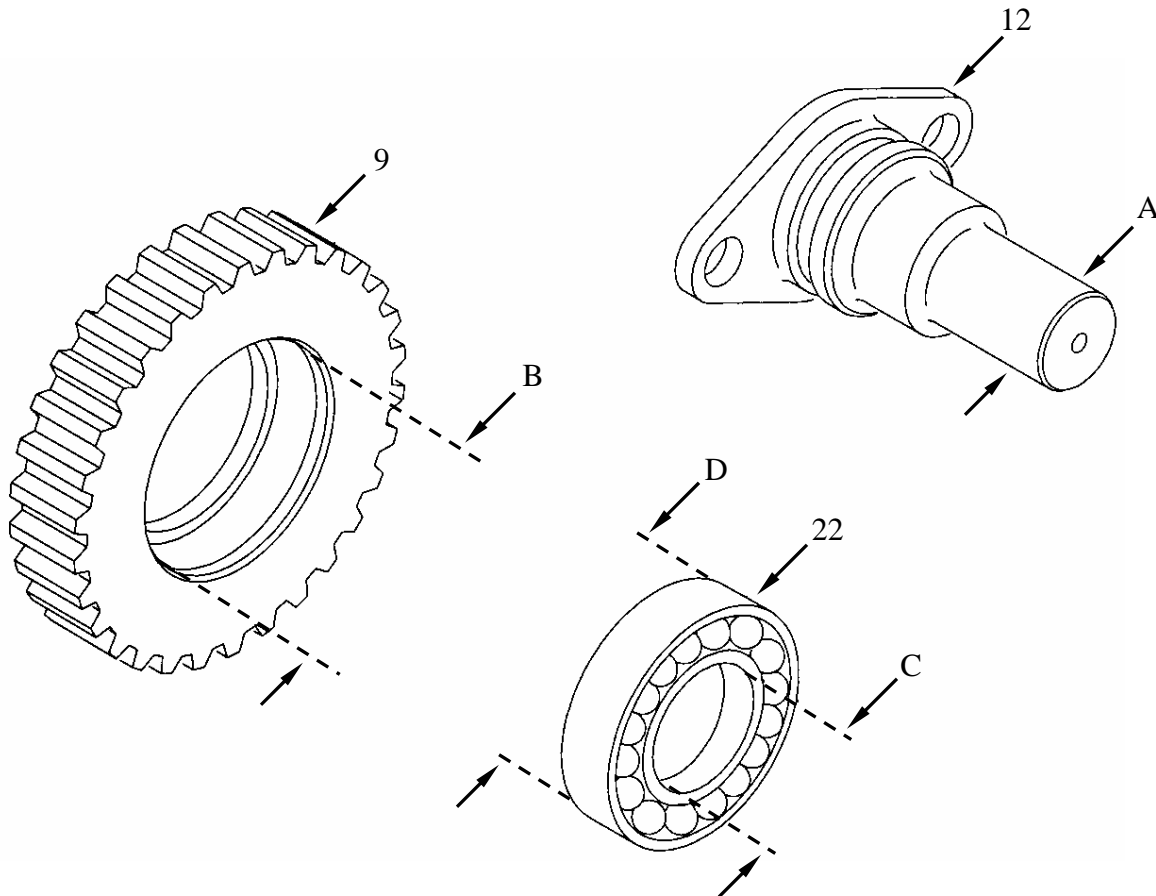
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (bearing hubs)	1.3781 (35.0037)	1.3785 (35.0139)	1.3779 (34.9986)
B (bearing inside)	1.3775 (34.9885)	1.3780 (35.0012)	None
C (bearing outside)	2.8341 (71.9861)	2.8346 (71.9988)	None



**INSPECTION (Continued)**

6. Measure outside diameter (A) of idler shaft (12). Replace shaft if not within specifications in the following table.
7. Measure inside diameter (B) of idler spur gear (9). Replace spur gear if not within specifications in the following table.
8. Inspect bearing (22).
  - a. Look for broken, cracked or split rings, cracked, broken or loose separators, heat discoloration (brown-blue or blue-black color). Rotate the free race slowly and feel for roughness. If any of these conditions exists, the bearing must be replaced.
  - b. New bearing dimensions, inside (C) and outside (D), are provided for information purposes only; you need not perform the measurements.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (idler shaft)	1.1804 (29.9821)	1.1808 (29.9923)	1.1802 (29.9770)
B (gear bore)	3.5419 (89.9642)	3.5433 (89.9998)	3.5440 (90.0176)
C (inside bearing)	1.1807 (29.9897)	1.1811 (29.9999)	None
D (outside bearing)	3.5433 (89.9998)	3.5427 (89.9845)	None



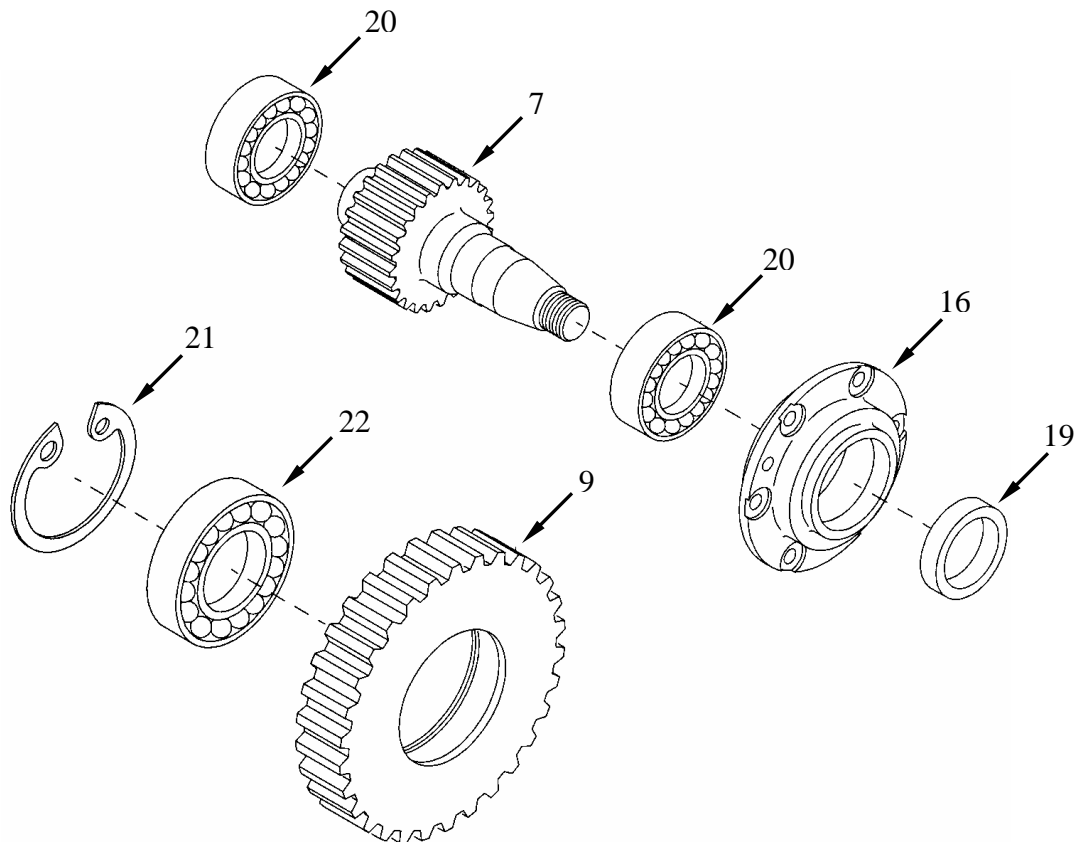
**ASSEMBLY**

1. Install bearings (20) if previously removed.
  - a. Coat ball bearings (20) with engine oil (item 21, WP 0173) and position one on spur gear shaft (7).
  - b. Press either ball bearing (20) on spur gear shaft (7) using a pressing sleeve on inner race of bearing.
  - c. Press ball bearing (20) on opposite end of spur gear shaft (7) in the same manner.
2. Install new plain encased seal (19)
  - a. Coat new plain encased seal (19) (item 216, WP 0175) with engine oil (item 21, WP 0173) and carefully press into bearing housing (16) until seal is tight against seal seat flange.
3. Press spur gear shaft (7) with assembled bearings (20) into bearing housing (16) using an arbor press (item 8, WP 0176).
4. Install ball bearing (22).
  - a. Coat ball bearing (22) with engine oil (item 21, WP 0173) and press into spur gear (9).

**WARNING**

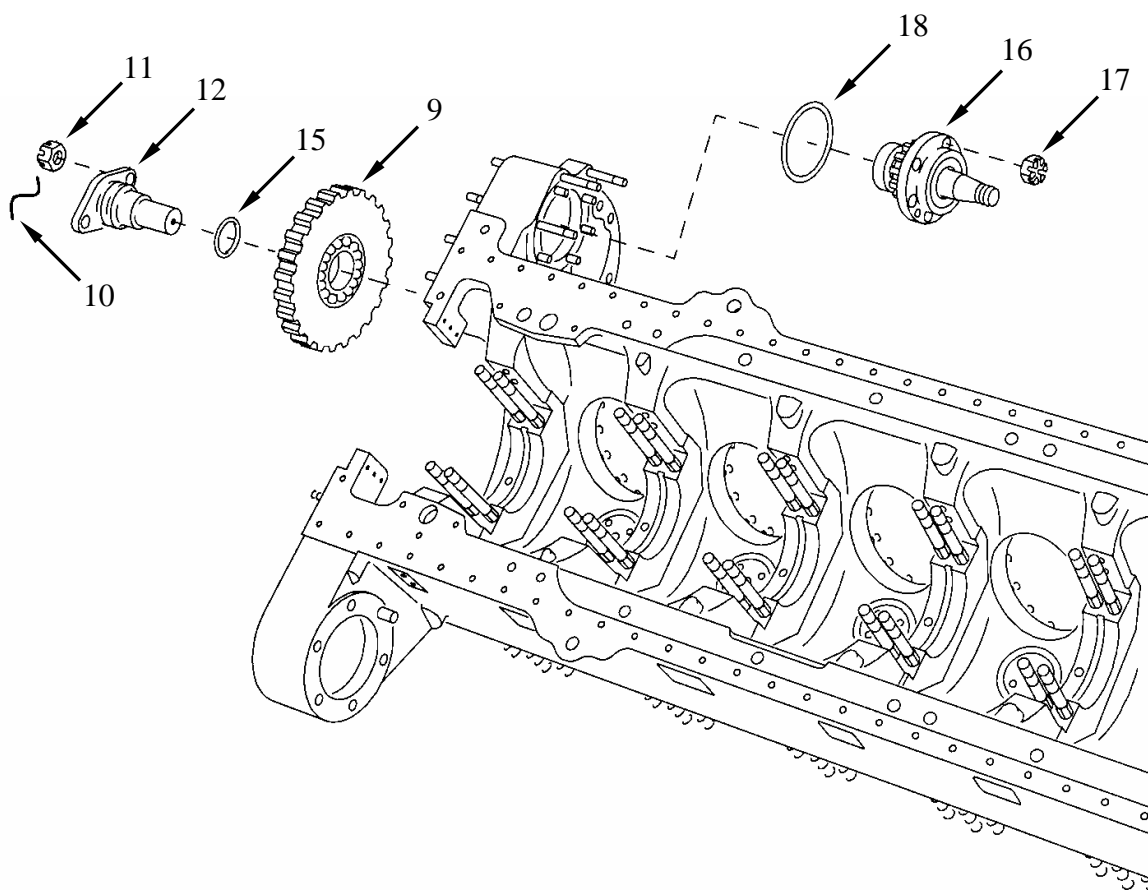
**Retaining rings are spring loaded.**

- b. Secure bearing (22) with new retaining ring (21) (item 15, WP 0173).



**INSTALLATION**

1. Install bearing housing (16).
  - a. Apply lubricant (item 21, WP 0173) to new O-ring (18) (item 70, WP 0173) and install on bearing housing (16) and install onto crankcase.
  - b. Secure bearing housing (16) with six new self locking nuts (17) (item 43, WP 0173).
2. Install idler spur gear (9).
  - a. Apply lubricant (item 21, WP 0173) to new O-ring (15) (item 67, WP 0175) and install on idler shaft (12).
  - b. Align idler spur gear (9) with bore in crankcase and install idler shaft (12) through crankcase and spur gear.
  - c. Fasten idler shaft (12) with two slotted nuts (11).
  - d. Secure nuts (11) with locking wire (10) (item 44, WP 0173).

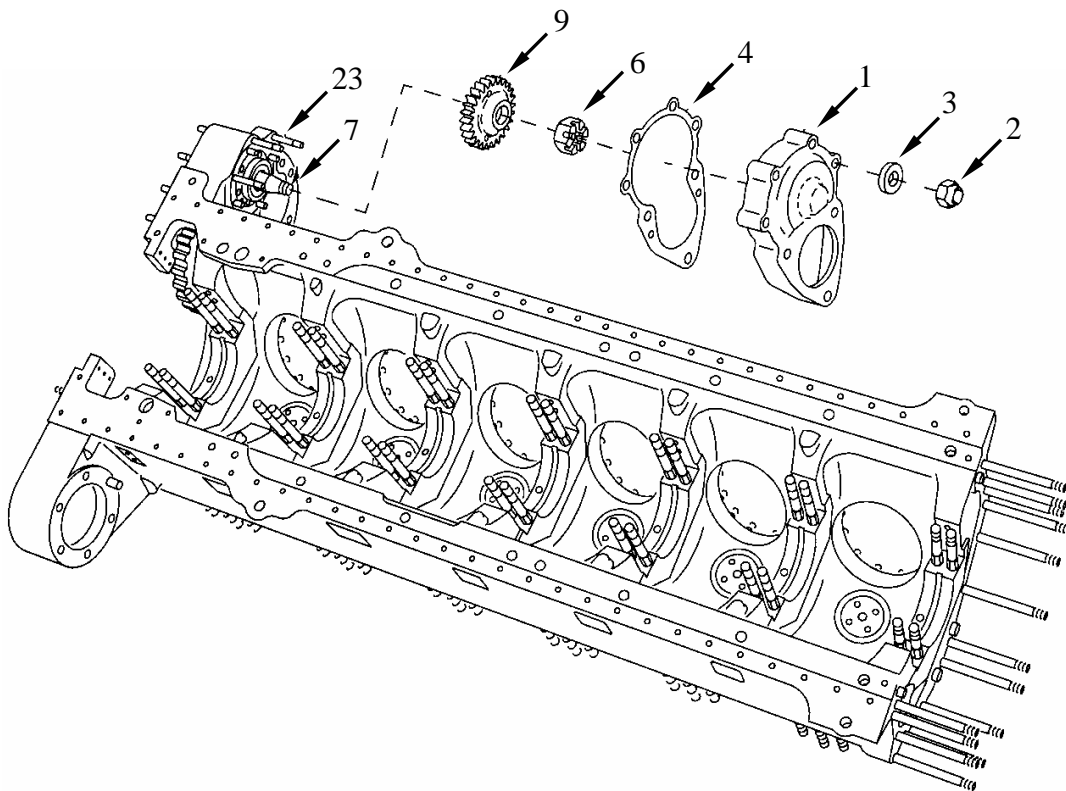


## INSTALLATION (Continued)

## NOTE

Spur gear (9) may have a woodruff key in the original installation. The woodruff key is no longer used, discard it and torque the nut to 500/525 foot-pounds (When woodruff key is used the torque is 300/325 foot-pounds).

3. Install spur gear (9).
  - a. Apply lubricant (item 21, WP 0173) to spur gear shaft (7).
  - b. Position gear (9) onto shaft (7) and secure with plain slotted nut (6).
  - c. Torque slotted nut (6) to 500-525 foot-pounds (678-712 N•m).
4. Install mounting bracket (1).
  - a. Apply lubricant to studs (23).
  - b. Install mounting bracket (1) and new gasket (4) (item 184, WP 0175).
  - c. Secure using four new self-locking nuts (2) (item 140, WP 0175) with flat washers (3).



END OF WORK PACKAGE





**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Inspection, Repair, Assembly, Installation, Adjustment

---

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Inside micrometer caliper set (item 16, WP 0176)  
 Outside micrometer caliper set  
 (item 17, WP 0176)  
 Sling assembly, accessory drive  
 (item 42, WP 0176)  
 Telescoping gauge set (item 54, WP 0176)  
 Torque wrench, 0-175 foot-pounds  
 (item 127, WP 0176)

**Fabricated Tools:**

Engine turning tool (item 3, WP 0177)

**Mandatory Replacement Parts:**

Bearing (item 292, WP 0175)  
 Bearing, roller (item 305, WP 0175)  
 Cotter pin (8) (item 48, WP 0175)  
 Key washer (item 172, WP 0175)  
 O-ring (2) (item 68, WP 0175)  
 O-ring (4) (item 62, WP 0175)  
 Pipe plug (4) (item 77, WP 0175)  
 Retaining ring (item 280, WP 0175)  
 Seal washer (2) (item 194, WP 0175)  
 Seal, plain (item 366, WP 0175)  
 Self-locking nut (34) (item 140, WP 0175)  
 Self-locking nut (9) (item 33, WP 0175)

**Expendable and Durable Items:**

Gasket cement (item 21, WP 0173)  
 Lubricating oil (item 27, WP 0173)  
 Sealant RTV-1473 (item 46, WP 0173)

**Personnel Requirements:**

Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
 Camshaft, drive gears and associated parts  
 removed (WP 0146)  
 Exhaust manifolds and associated parts removed  
 (WP 0107)  
 Breather tubes and oil supply hoses removed  
 (WP 0078)  
 Fuel return lines removed (WP 0080)  
 Fire extinguisher tube removed (WP 0097)  
 Fuel injection pump assembly removed  
 (WP 0115)  
 Inter fan drive shaft and tube moved forward  
 (WP 0169)

REMOVAL

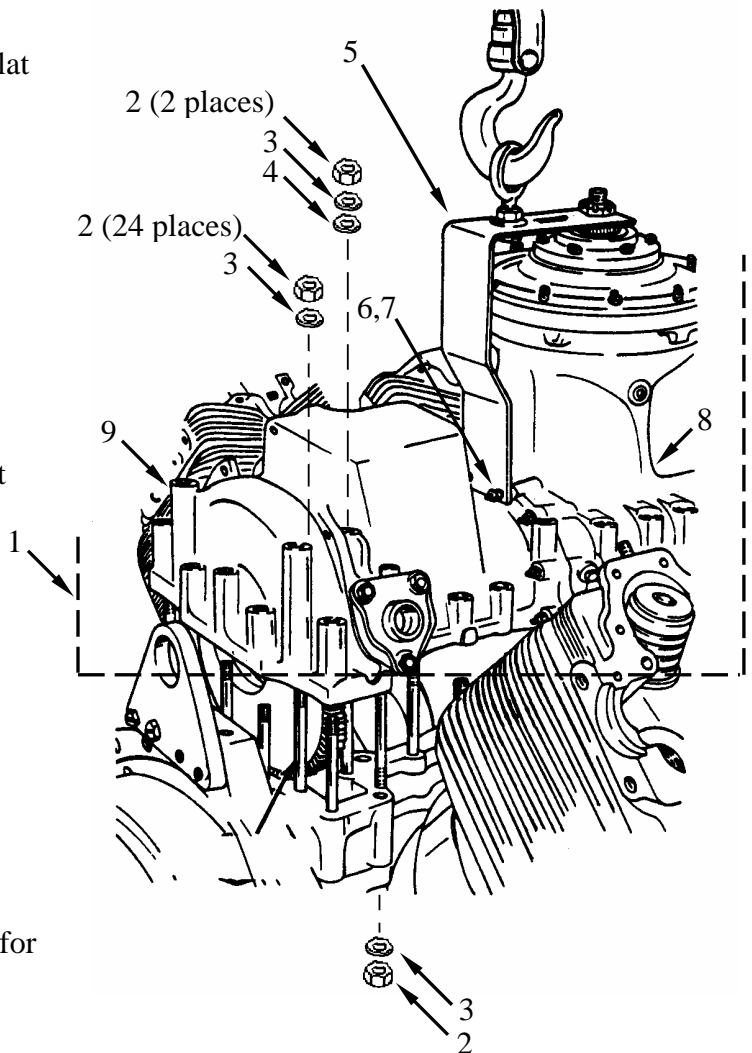
NOTE

One of the 29 self-locking nuts with flat washers that secure the accessory drive housing assembly was removed when the fire extinguisher tube was removed.

Two of the self-locking nuts are accessed from underneath the accessory base assembly.

1. Remove accessory drive assembly (1) fasteners.

- a. Remove 24 self-locking nuts (2) with flat washers (3).
- b. Remove two self-locking nuts (2) with flat washers (3) and seal washers (packing with retainer) (4). (Left side illustrated, right side is mirror image)
- c. Remove two self-locking nuts (2) with flat washers (3) from bottom side of housing (1). (Left side illustrated, right side is mirror image.)
- d. Discard self-locking nuts and seal washers.

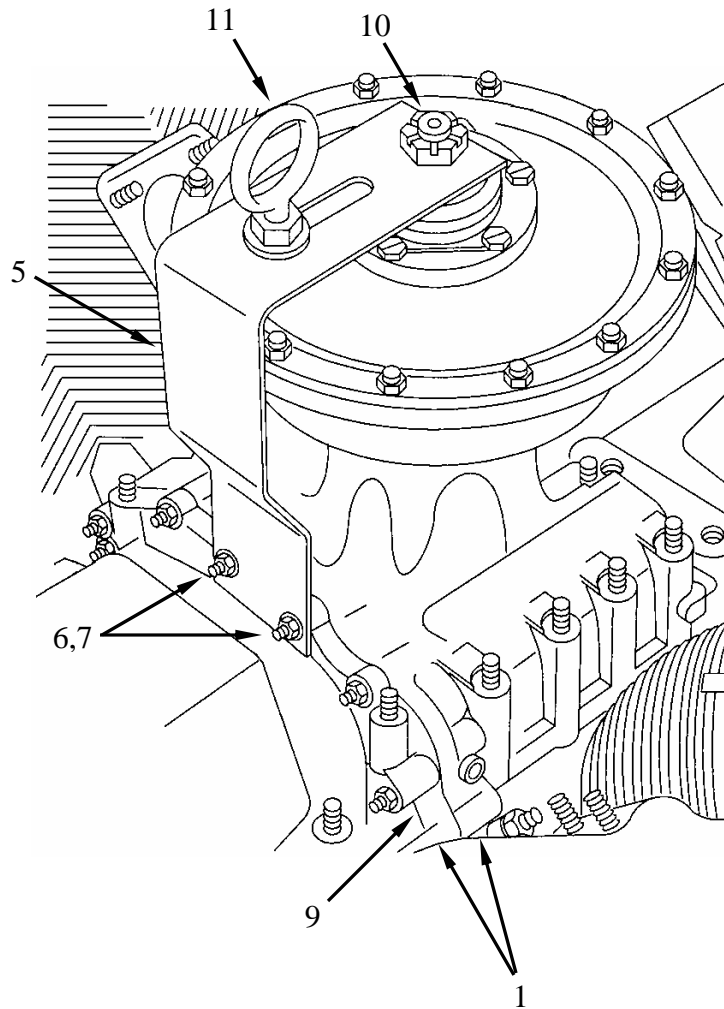


2. Attach lifting sling (5).

- a. Remove two self-locking nuts (6) with flat washers (7) from the top two studs between rear fan drive housing (8) and accessory drive housing (9) to provide for attachment of sling assembly.

**REMOVAL (Continued)**

2. Attach lifting sling (5). (Continued)
  - b. Attach sling (5) (item 96, WP 0170) to accessory housing (9), using two self-locking nuts (6) with flat washers (7).
  - c. Secure opposite end of sling (5) to cooling fan shaft with slotted nut (10).
  - d. Adjust lifting eye (11) in slot of sling (5) to assure balanced position of accessory housing assembly (1).



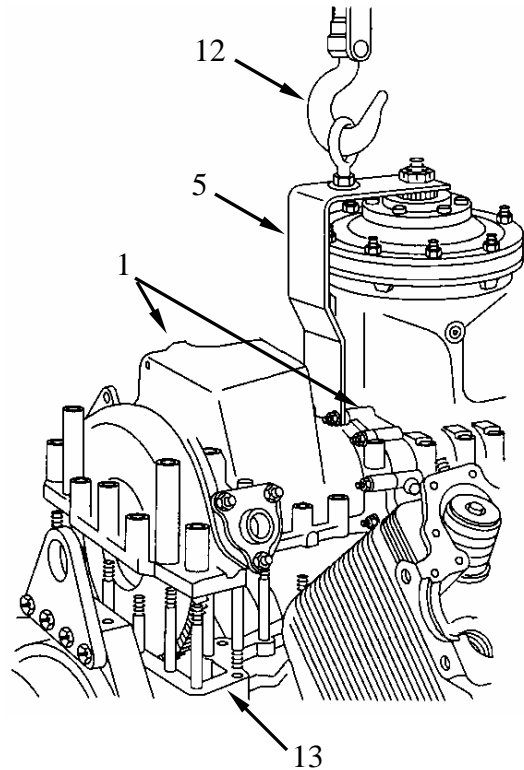
REMOVAL (Continued)

**WARNING**



**Hanging or swinging loads are dangerous; use caution.**

3. Remove accessory drive housing assembly (1).
  - a. Attach accessory drive sling (5) to a suitable hoist (12).
  - b. Lift accessory housing assembly (1) straight up until it clears the long studs of the base assembly (13).
  - c. Remove sling (5) from accessory drive housing assembly (1).

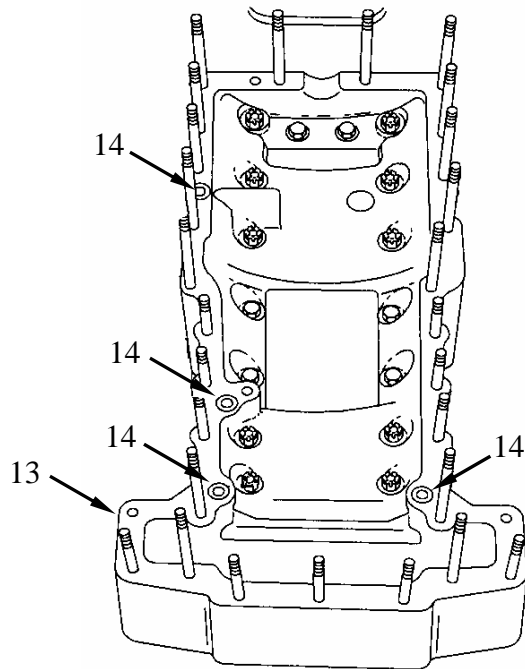
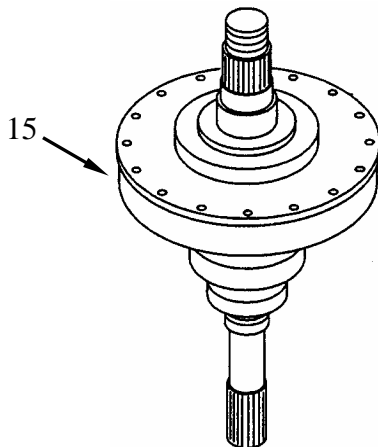


**NOTE**

**Save the two self-locking nuts attaching the sling, to be used later as slaves to reattach sling during installation.**

**DISASSEMBLY**

1. Remove and discard four O-rings (14) from accessory base (13).
2. Remove fan drive clutch assembly (15). Refer to Work Package 0129, Fan Drive Clutch Repair.



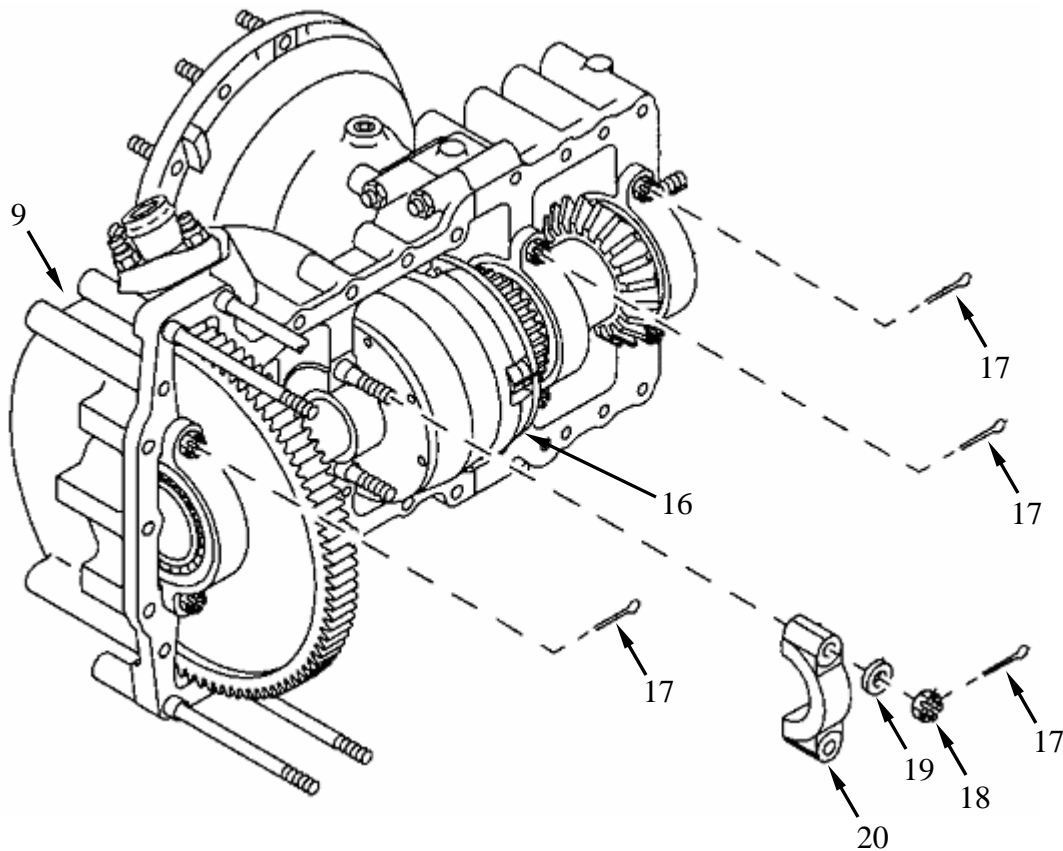
**DISASSEMBLY (Continued)**

3. Remove automatic fuel injection advance control (16).
  - a. Remove and discard eight cotter pins (17).

**CAUTION**

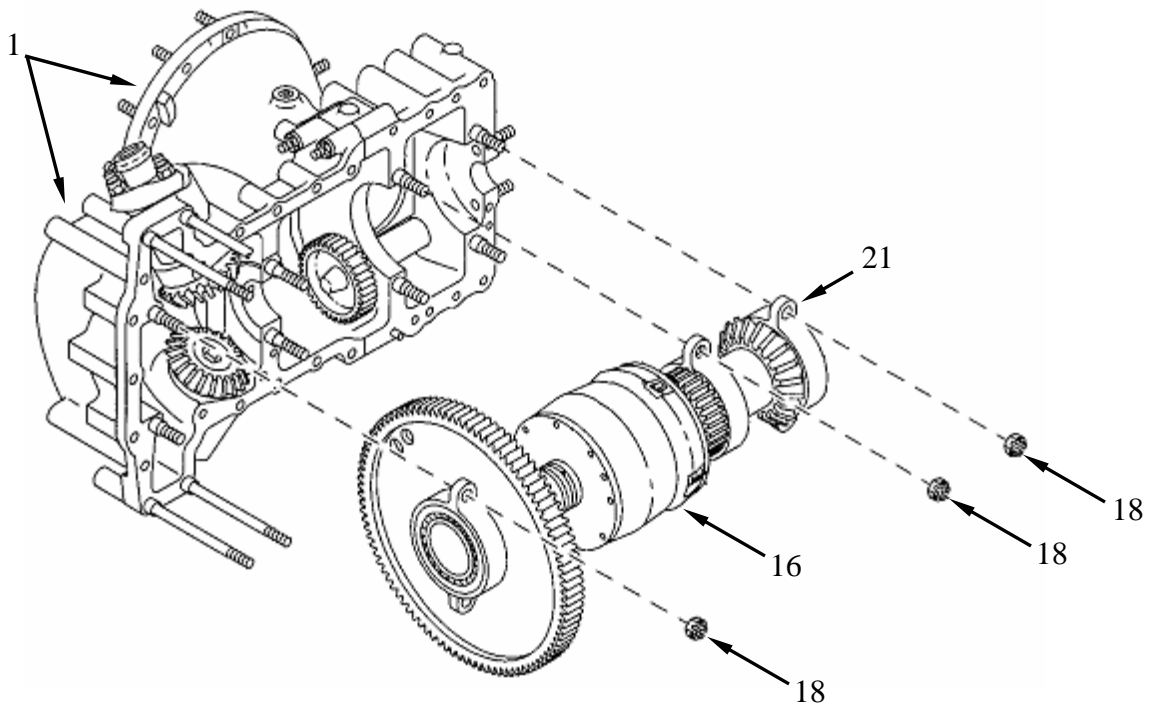
**Bearing cap and housing are machined as a unit. Cap must be kept with housing. Both cap and accessory housing assembly are stamped with corresponding numbers to prevent incorrect mating of parts. Cap should be loosely attached on accessory housing assembly after automatic fuel injection advance control is removed.**

- b. Remove two slotted nuts (18) with flat washers (19) securing bearing cap (20).
  - c. Remove cap (20) from accessory drive housing (9).



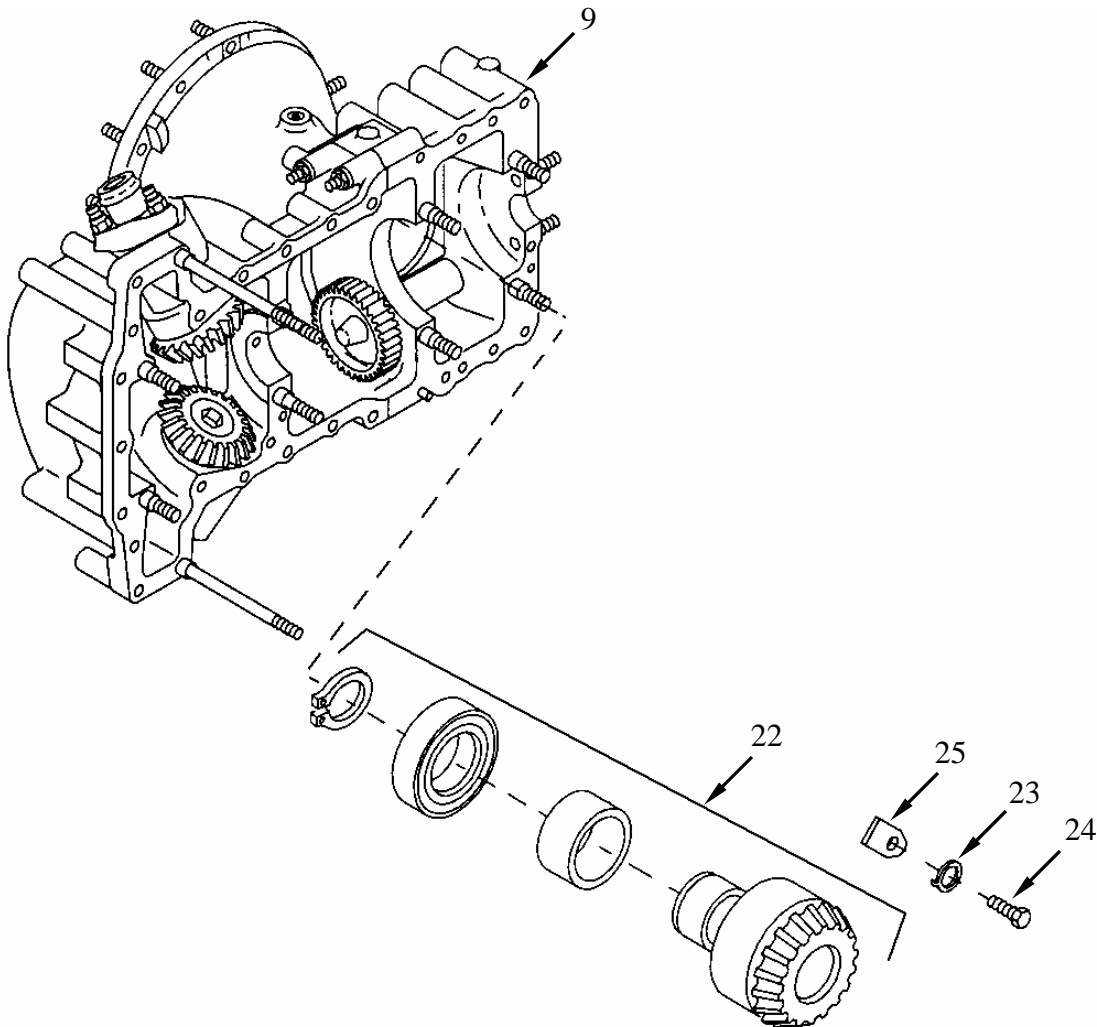
**DISASSEMBLY (Continued)**

3. Remove automatic fuel injection advance control (16). (Continued)
  - d. Remove six slotted nuts (18) securing automatic fuel injection advance control (16) and bevel gear shaft assembly (21).
  - e. Remove automatic fuel injection advance control (16) and bevel gear shaft assembly (21) as a unit from accessory housing assembly (1).
  - f. Go to work package 0168 (Rear Fan Drive Bevel Gear Shaft Assembly Repair) for inspection and repair of bevel gear shaft assembly (21).



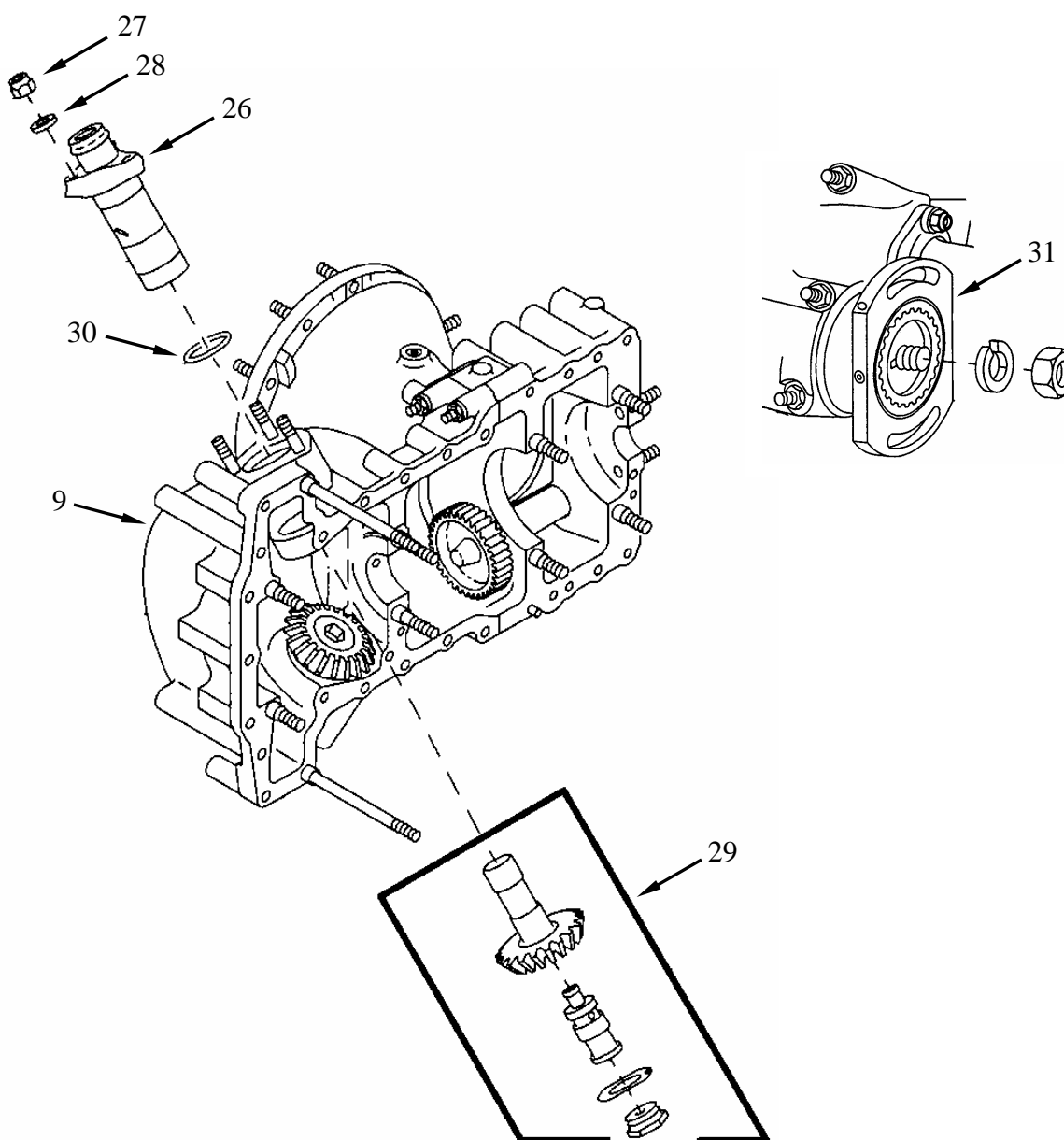
**DISASSEMBLY (Continued)**

4. Remove assembled bevel gear shaft (22).
  - a. Straighten tab on key washer (23) and remove machine bolt (24) with bearing retaining plate (25). Discard key washer.
  - b. Remove assembled bevel gear shaft (22) as a unit from rear fan drive housing (9). Refer to WP 0168 for disassembly and inspection.



**DISASSEMBLY (Continued)**

5. Remove camshaft drive supports (26). (Left side is illustrated right is mirror image.)
  - a. Remove six self-locking nuts (27) with flat washers (28) attaching left and right bank camshaft drive supports (26) to housing (9). Discard self-locking nuts.
  - b. Separate camshaft drive supports (26) from housing (9) and remove left and right gear shaft assemblies (29).
  - c. Remove and discard O-rings (30) from both camshaft drive supports (26).
6. Remove fuel injection pump flexible shaft coupling (31). Refer to WP 0115 for special tools and removal procedure.





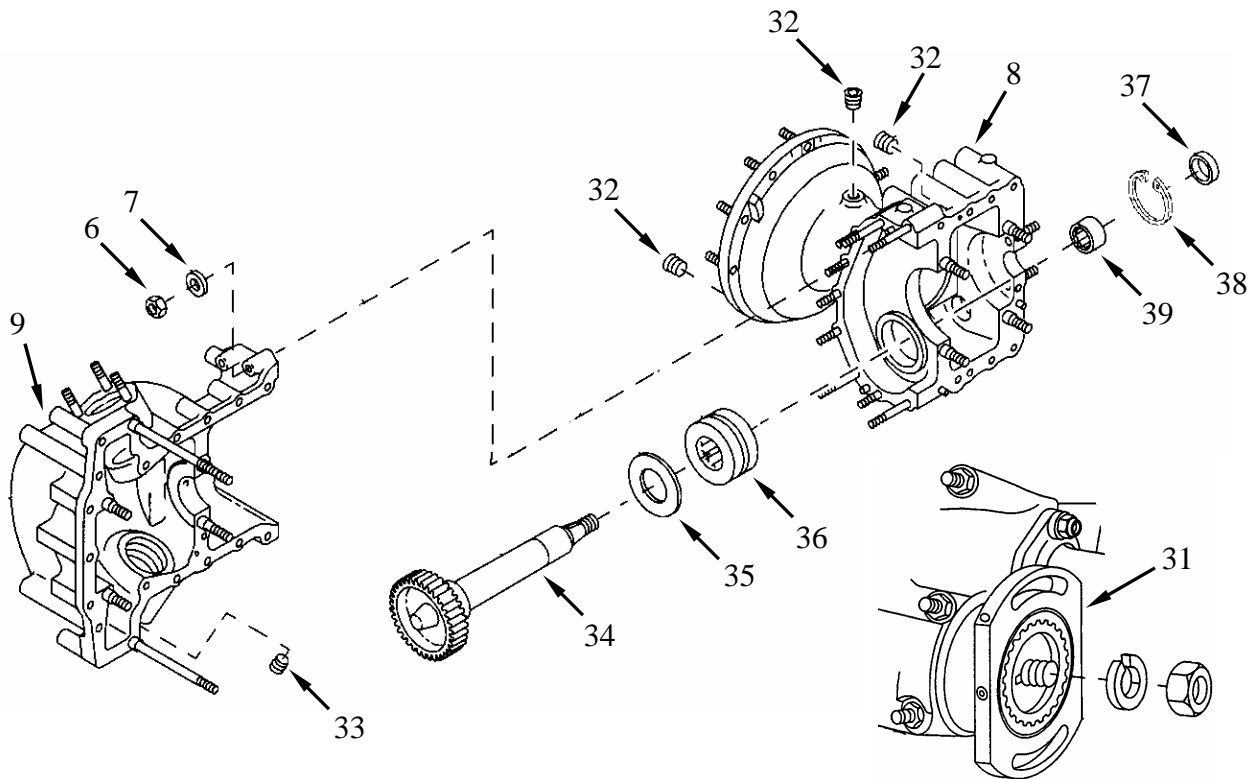
**DISASSEMBLY (Continued)**

7. Separate rear fan drive housing (8) from accessory drive housing (9).

**NOTE**

**Two of the nine self-locking nuts joining the two housings were previously removed with the lifting sling.**

- a. Remove seven self-locking nuts (6) and seven flat washers (7) and separate housing (9) from housing (8). Discard self-locking nuts.
8. Remove three pipe plugs (32) and one pipe plug (33). Discard pipe plugs.
9. Remove spur gear shaft (34) from housing (8).
    - a. Remove recessed washer (35) and bearing (36) from spur gear shaft (34). Discard bearing.
  10. Remove and discard plain encased seal (37), retaining ring (38) and needle roller bearing (39) from housing (8).



**CLEANING**

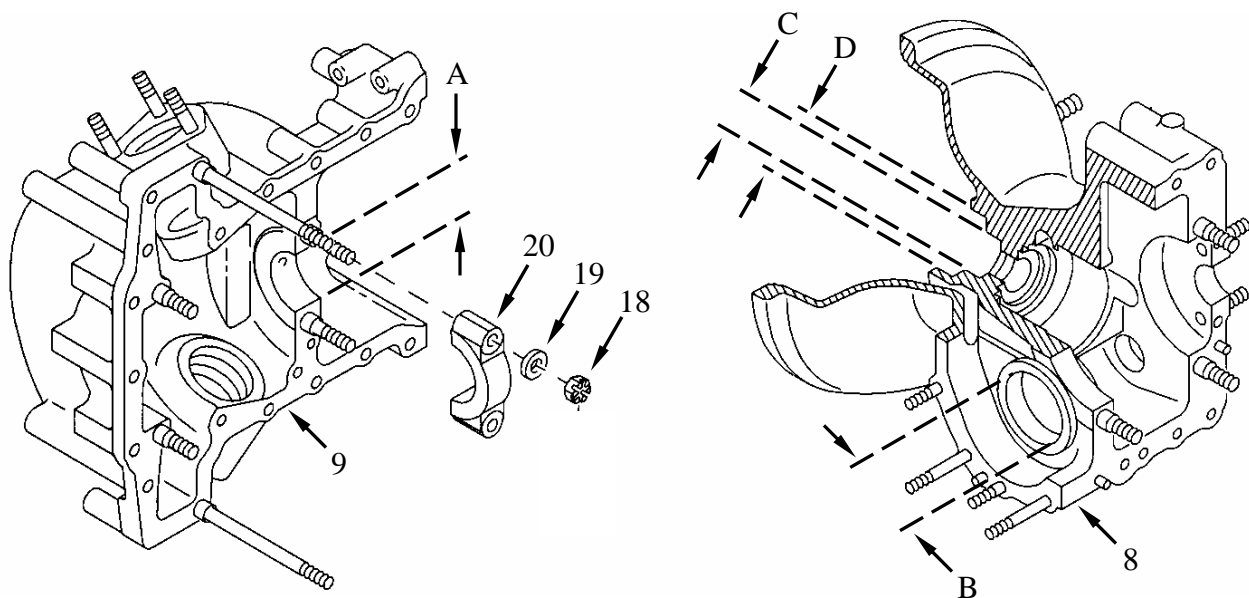
1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Measure inside diameter of accessory drive (9) bearing bore.
  - a. Install bearing cap (20) and secure using two nuts (18) with flat washers (19).
  - b. Tighten two nuts (18) to 275-300 inch-pounds.
  - c. Measure inside diameter (A).
  - d. Replace housing and bearing cap if not within specifications in the following table.
3. Measure inside diameter (B) of liner in rear fan drive housing (8). Replace housing if not within specifications in the following table.
4. Measure inside diameter (C) of small upper liner in housing (8). Replace housing if not within specifications in the following table.
5. Measure inside diameter (D) of large upper bearing bore in housing (8). Replace housing if not within specifications in the following table.

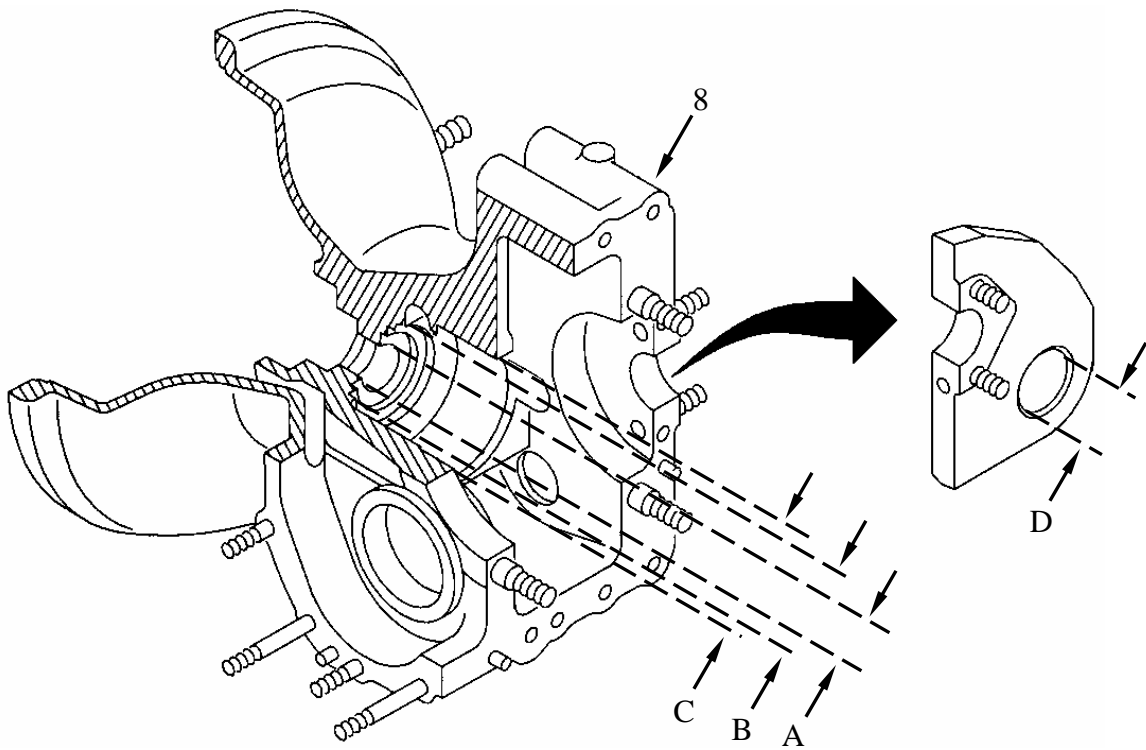
Location	Sizes and Fit of New Parts		Wear Limits
	inches (mm)		
A (accessory housing bore)	2.3770 (60.3758)	2.3780 (60.4012)	2.3790 (60.4266)
B (liner, rear fan housing)	2.4409 (61.9989)	2.4416 (62.0166)	2.4419 (62.0243)
C (upper liner, rear fan housing)	1.1440 (29.0576)	1.1460 (29.1084)	1.1465 (29.1211)
D (bearing bore)	2.9528 (75.0011)	2.9535 (75.0189)	2.9538 (75.0265)



**INSPECTION (Continued)**

6. Measure inside diameter (A) of small through bore in housing (8). Replace housing if not within specifications in the following table.
7. Measure inside diameter (B) of small lower bore in housing (8). Replace housing if not within specifications in the following table.
8. Measure inside diameter (C) of large lower bearing bore in housing (8). Replace housing if not within specifications in the following table.
9. Measure inside diameter (D) of oil seal bore in housing (8). Replace housing if not within specifications in the following table.

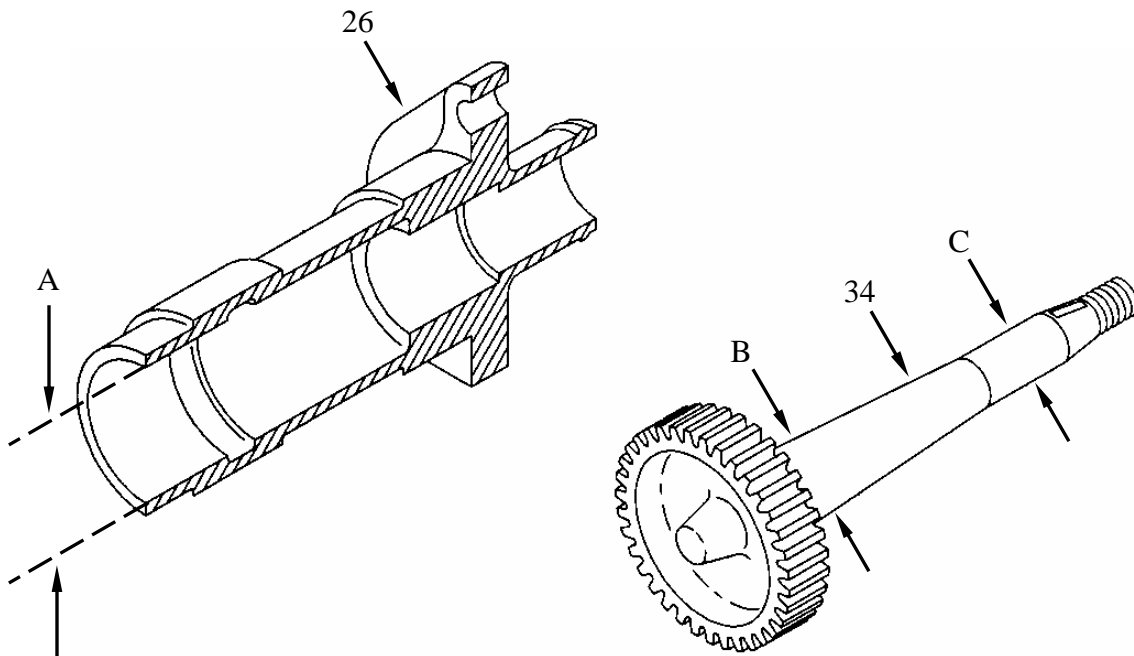
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Through bore)	1.1440 (29.0576)	1.1460 (29.1084)	1.1470 (29.1338)
B (Lower bore)	2.6772 (68.0009)	2.6779 (68.0187)	2.6784 (68.0314)
C (Large lower bore)	3.1496 (79.9999)	3.1503 (80.0176)	3.1508 (80.0303)
D (Oil seal bore)	1.7510 (44.3255)	1.7510 (44.3255)	None



**INSPECTION (Continued)**

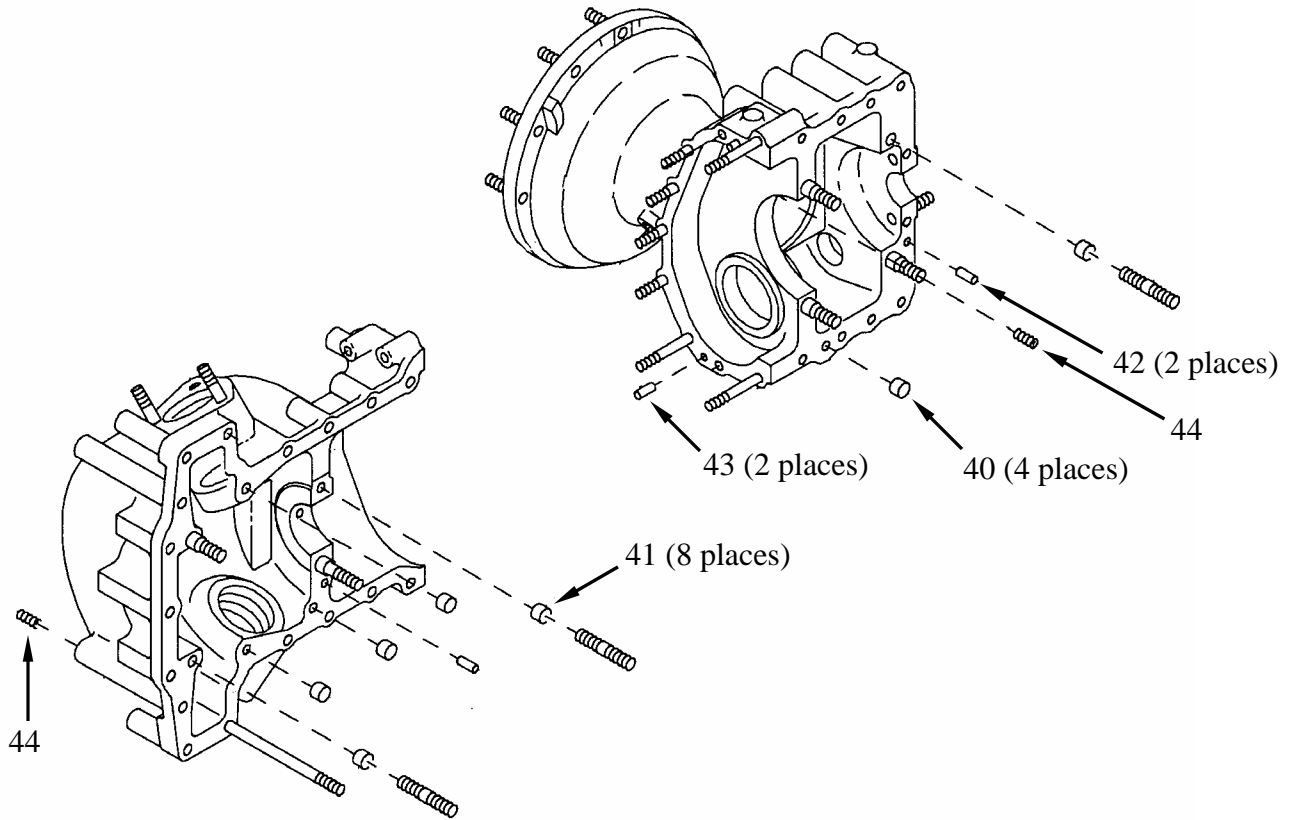
10. Measure inside diameter (A) of both camshaft drive supports (26). Replace camshaft drive supports if not within specifications in the following table.
  
11. Measure bearing diameters (B and C) on spur gear shaft (34). Replace spur gear shaft if not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Camshaft supports)	1.5000 (38.1000)	1.5010 (38.1254)	1.5020 (38.1508)
B (Spur gear shaft)	1.1814 (30.0076)	1.1817 (30.0152)	1.1813 (30.0050)
C (Spur gear shaft)	0.9995 (25.3873)	1.0000 (25.4)	0.9993 (25.3822)



**REPAIR**

1. Replace any damaged oil transfer tube (40 and 41) (refer to WP 0028).
2. Replace any damaged dowel pin (42 and 43) (refer to WP 0028).
3. Replace defective screw thread inserts (44) (refer to WP 0029).



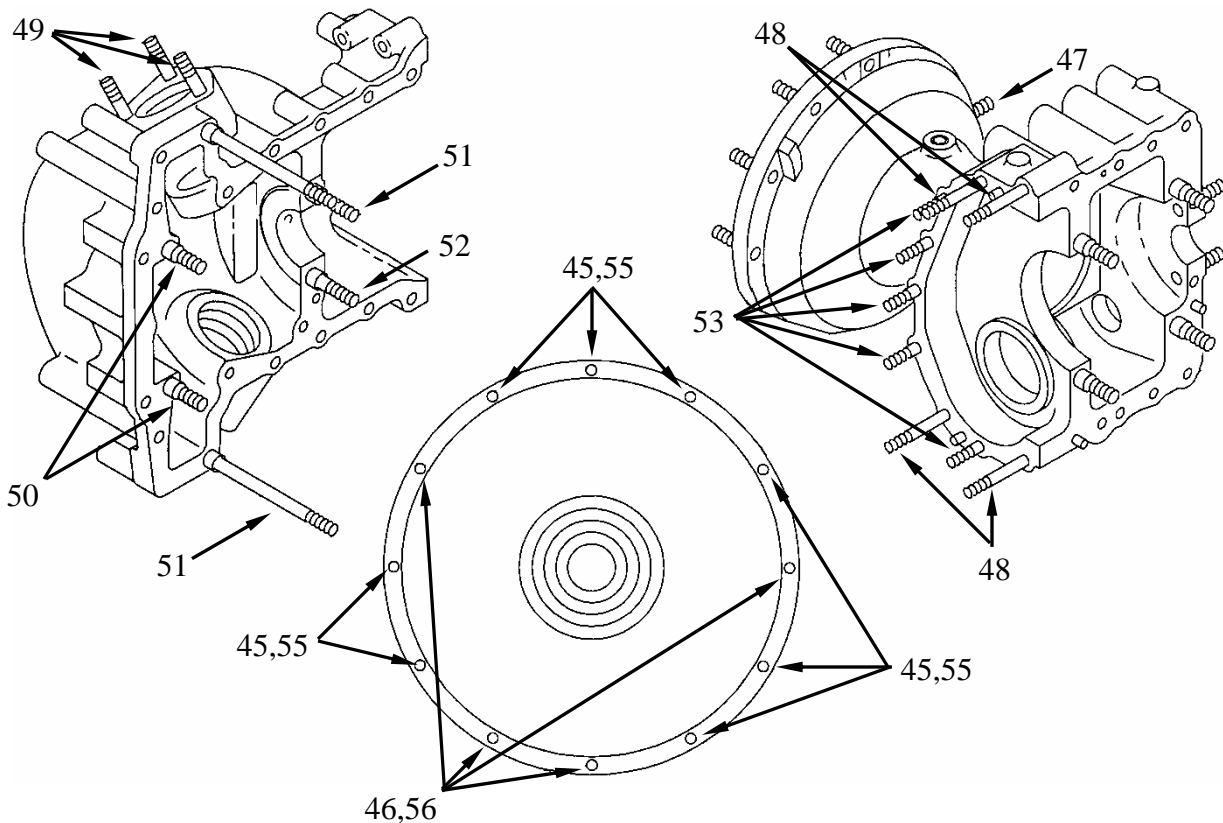
**REPAIR (Continued)**

4. Replace stripped, bent, or otherwise damaged studs (45 through 56).
  - a. Go to Work Package 0028 for procedure.
  - b. Refer to the following table for stud size and height settings.

**NOTE**

**Engine models 2CA and 2DA use studs (44 and 45), on engine model 2DR these studs are replaced with studs (54 and 55).**

Callout #	Setting Height inch (mm)	Quantity Required	Stud Size and Length
45 (2CA-2DA)	29/32 (23.0188)	8	5/16-18(3/4) X 5/16-24(19/32) X 1-3/4
46 (2CA-2DA)	25/32 (19.8438)	4	5/16-18(3/4) X 5/16-24(19/32) X 1-7/16
47	5/8 (15.8750)	1	5/16-18(5/8) X 5/16-24(3/4) X 1-1/8
48	1-11/16 (42.8625)	4	5/16-18(3/4) X 5/16-24(23/32) X 2-5/16
49	1-1/8 (28.5750)	6	3/8-16(15/16) X 3/8-24(13/16) X 1-5/16
50	49/64 (19.4469)	6	3/8-16(27/32) X 3/8-24(7/8) X 1-3/4
51	3-29/32 (99.2188)	2	3/8-16(15/16) X 3/8-24(13/16) X 4-11/16
52	1-25/32(45.2438)	2	3/8-16(13/16) X 3/8-24(27/32) X 2-15/16
53	1 (25.4000)	5	5/16-18(3/4) X 5/16-24(23/32) X 1-5/8
54	1 (25.4000)	2	5/16-18(11/16) X 5/16-24(9/16) X 1-1/2
55 (2DR)	29/32 (23.0188)	8	5/16-18(3/4) X 5/16-24(13/16) X 1-9/16
56 (2DR)	25/32 (19.8438)	4	5/16-18(5/8) X 5/16-24(3/4) X 1-7/16



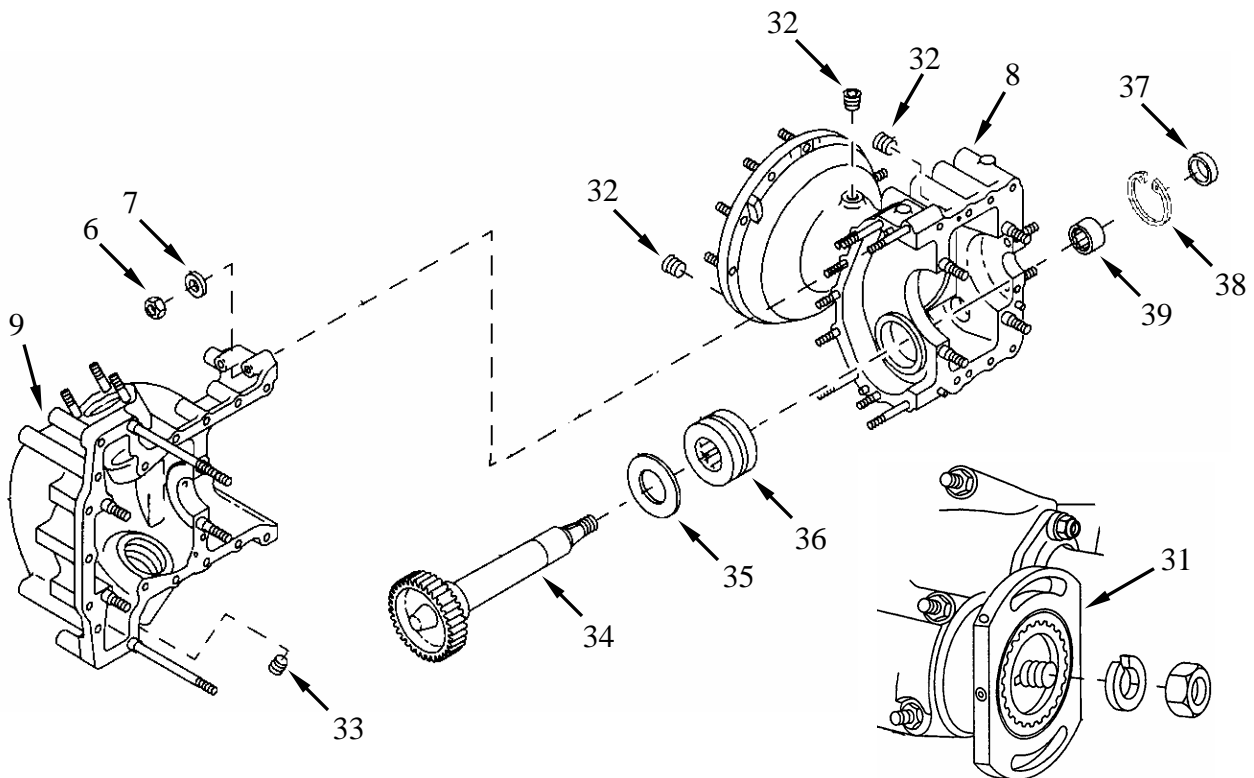
**ASSEMBLY**

1. Install new needle roller bearing (39) (item 305, WP 0175), retaining ring (38) (item 280, WP 0175), and plain encased seal (37) (item 366, WP 0175) into housing (8).
2. Install recessed washer (35), and new bearing (36) (item 292, WP 0175) into housing (8).
3. Install spur gear shaft (34) into housing (8).
4. Install three new pipe plugs (32) (item 77, WP 0175) and one pipe plug (33) (item 77, WP 0175).
5. Apply a thin coat of gasket cement (item 21, WP 0173) on mating surface of housing (9).

**NOTE**

**Top two studs between housings (8 and 9) do not receive nuts and washers at this time so as to allow for attachment of the accessory drive sling.**

6. Assemble housing (9) to housing (8).
  - a. Fasten housings together using seven new self-locking nuts (6) (item 33, WP 0175) with flat washers (7).
7. Install fuel injection pump flexible shaft coupling (31). Refer to WP 0115 for special tools and installation procedure.



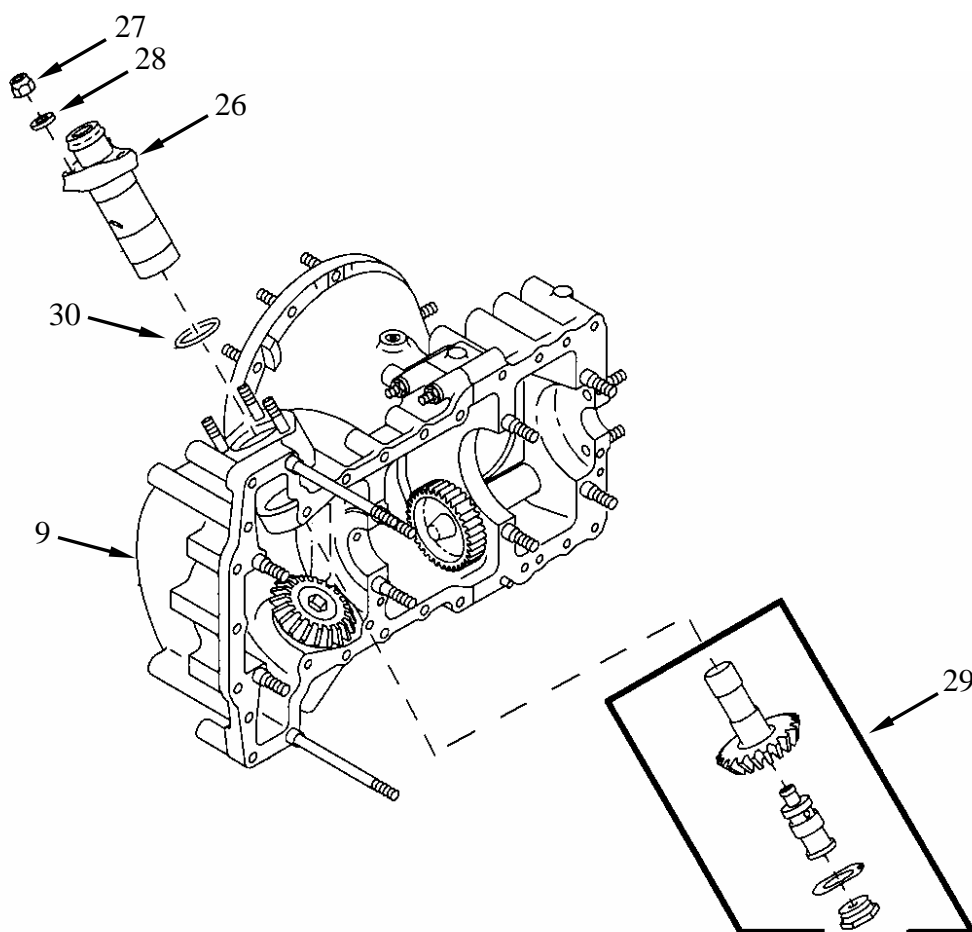
**ASSEMBLY (Continued)**

8. Install camshaft drive gear assemblies (29).
  - a. Position either gear assembly (29) into housing (9).
  - b. Using lubricating oil (item 27, WP 0173), lubricate new O-ring (30) (item 68, WP 0175) onto camshaft drive support (26).

**CAUTION**

**Left and right camshaft supports must be properly positioned in housing or damage to studs will occur. Install left and right camshaft supports so that cutouts on sides of camshaft support are visible.**

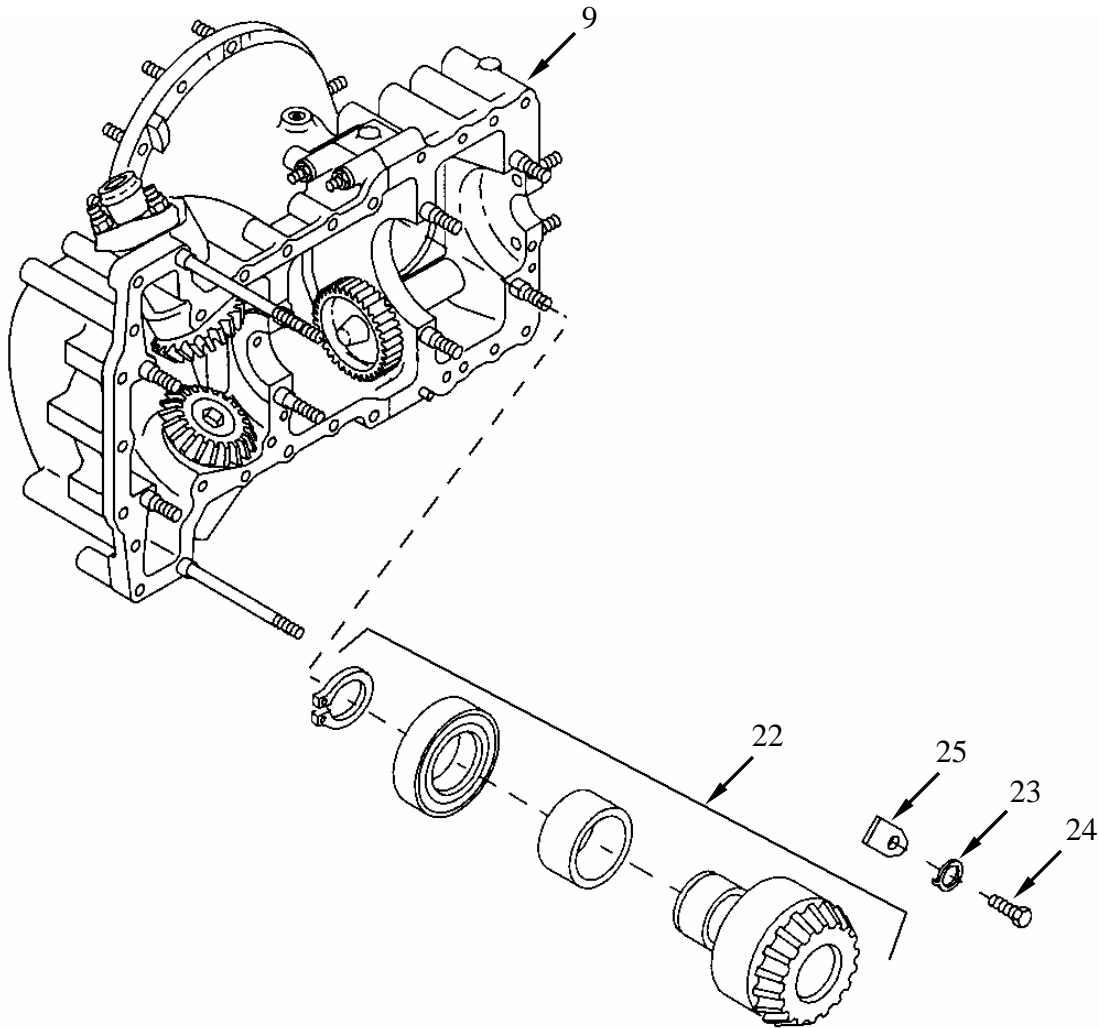
- c. While holding drive gear assembly (29), install support (26). (Left side is illustrated).
- d. Secure support (26) using three new self-locking nuts (27) (item 140, WP 0175) with flat washers (28).
- e. Repeat for opposite side.





**ASSEMBLY (Continued)**

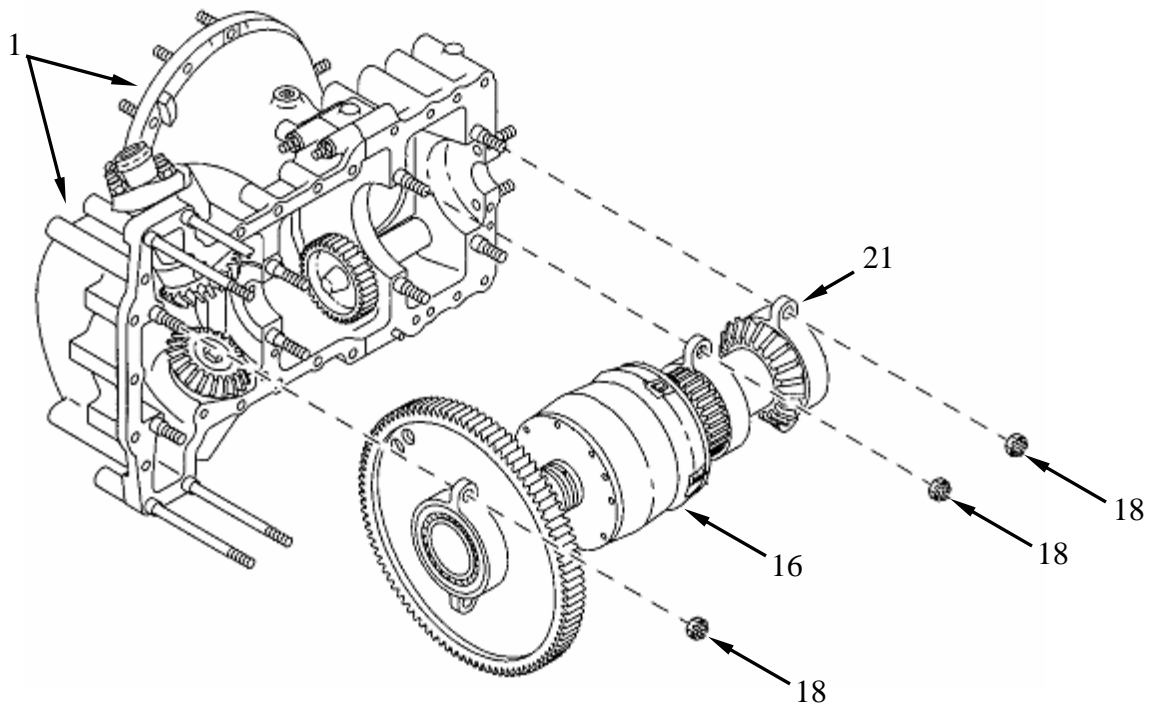
9. Install assembled bevel gear shaft (22).
  - a. Position assembled bevel gear shaft (22) as a unit, into rear fan drive housing (9).
  - b. Secure in place with retaining plate (25).
  - c. Fasten retaining plate (25) using machine bolt (24) and new key washer (23) (item 172, WP 0175).
  - d. Secure machine bolt (24) by bending tab on key washer (23).



**ASSEMBLY (Continued)**

10. Install automatic fuel injection advance control (16).

  - a. Install automatic fuel injection advance control (16) and bevel gear shaft assembly (21) as a unit into accessory housing assembly (1).
  - b. Secure with six slotted nuts (18).



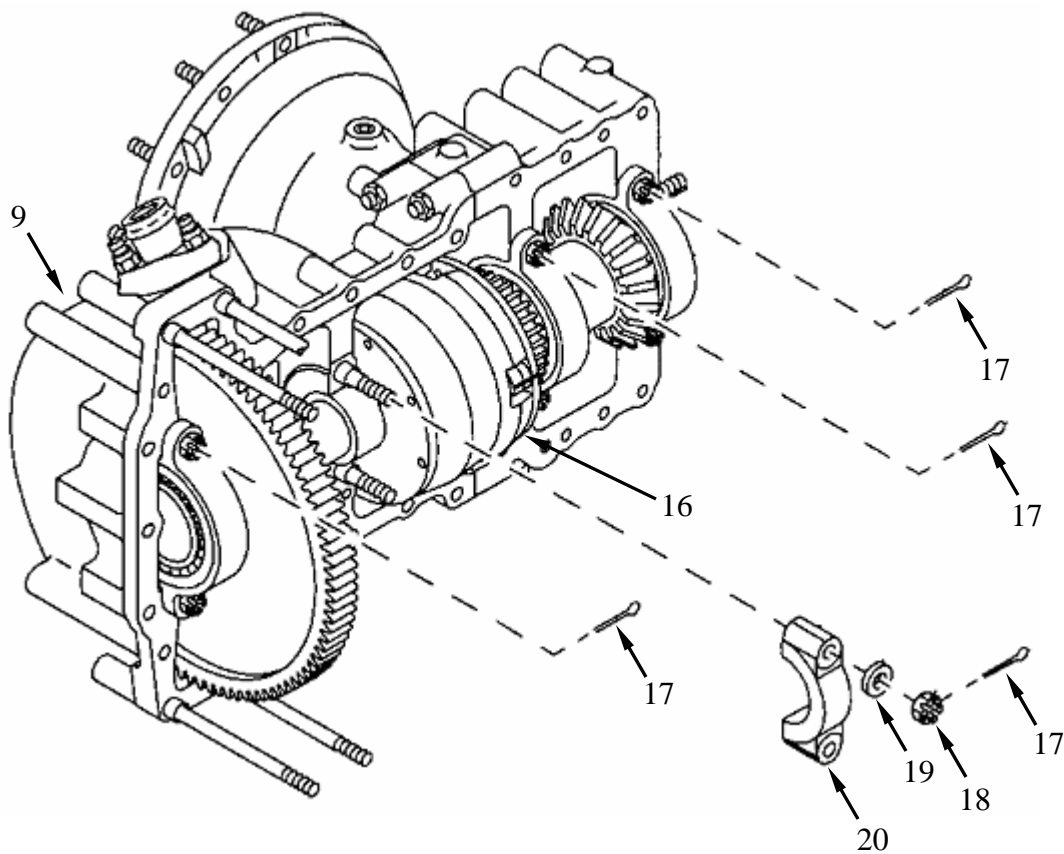
**ASSEMBLY (Continued)**

10. Install automatic fuel injection advance control (16) (Continued).

**CAUTION**

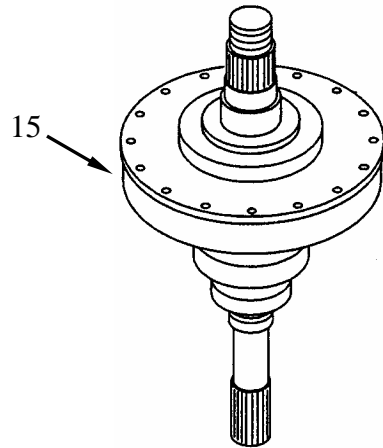
**Bearing cap and housing are machined as a unit. Cap must be kept with housing. Both cap and accessory housing are stamped with corresponding numbers to prevent incorrect mating of parts. Failure to comply may result in premature failure.**

- c. Install bearing cap (20) onto accessory drive housing (9).
- d. Secure bearing cap (20) using two slotted nuts (18) with flat washers (19).
- e. Install eight new cotter pins (17) (item 48, WP 0175).

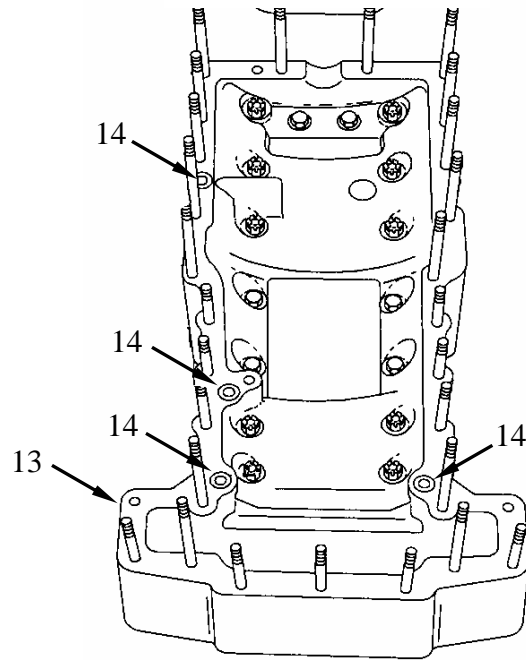


**ASSEMBLY (Continued)**

11. Install fan drive clutch assembly (15) (refer to Work Package 0129, Fan Drive Clutch Repair).

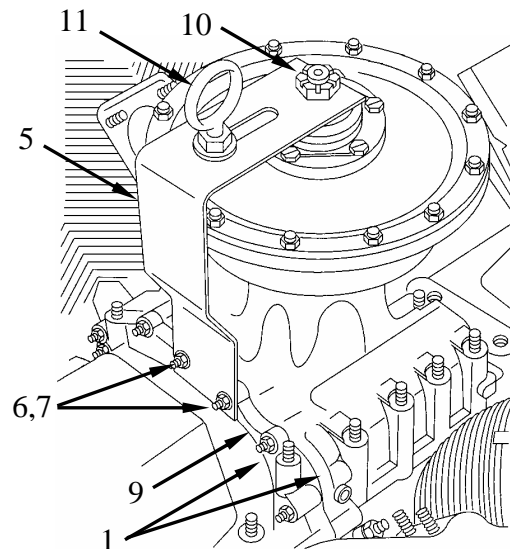


12. Using lubricating oil (item 27, WP 0173), lubricate four new O-rings (14) (item 62, WP 0175) and install onto accessory base (13).



**INSTALLATION**

1. Attach lifting sling (5).
  - a. Attach sling (5) (item 42, WP 0176) to accessory housing (9) using two self-locking nuts (6) with flat washers (7).
  - b. Secure opposite end of sling (5) to cooling fan shaft with slotted nut (10).
  - c. Adjust lifting eye (11) in slot of sling (5) to assure balanced position of accessory housing assembly (1).



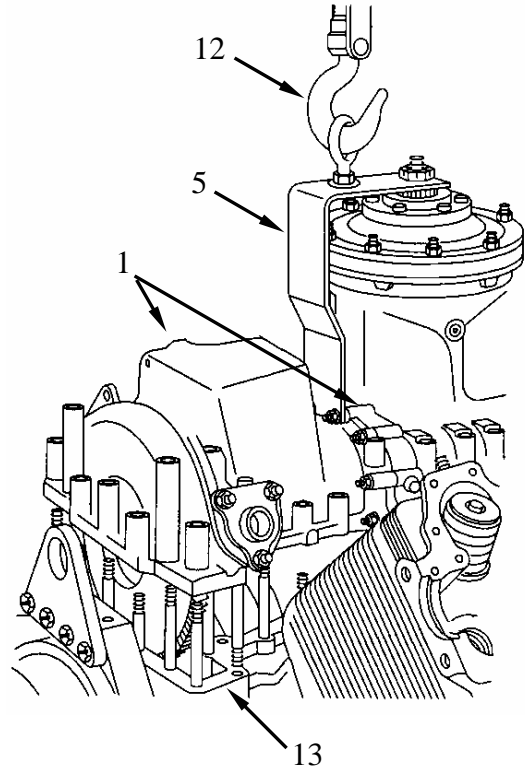
INSTALLATION (Continued)

**WARNING**

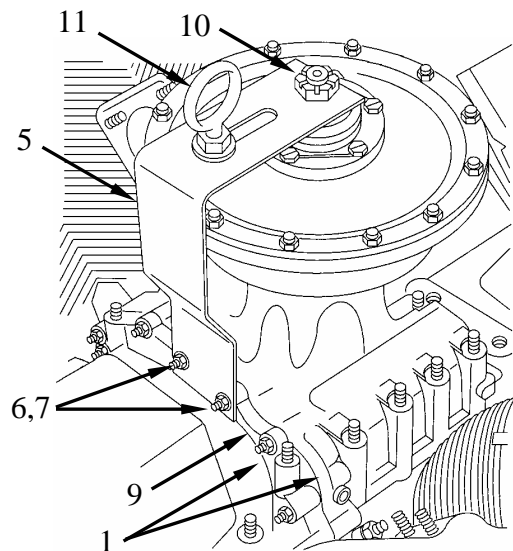


Hanging or swinging loads are dangerous, use caution.

2. Install accessory drive housing assembly (1).
  - a. Apply a thin coat of sealant (item 46, WP 0173) on mounting surface of accessory base (13).
  - b. Attach accessory drive sling (5) to a suitable hoist (12).
  - c. Lift accessory housing assembly (1) high enough to clear the long studs of the base assembly (13).
  - d. Carefully lower assembly (1) into position.



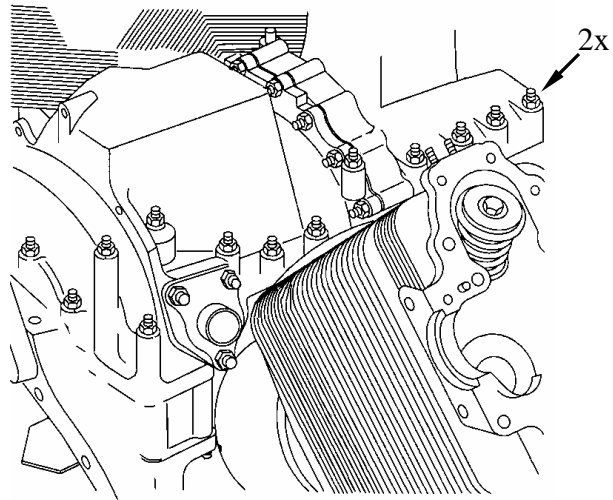
3. Remove lifting sling (5).
  - a. Remove two slave self-locking nuts (6) with flat washers (7) attaching sling (5) to accessory housing (9). Discard slave nuts.
  - b. Remove slotted nut (10) at opposite end of sling (5).
  - c. Remove sling (5).
  - d. Install two new self-locking nuts (6) (item 33, WP 0175) with flat washers (7).



INSTALLATION (Continued)

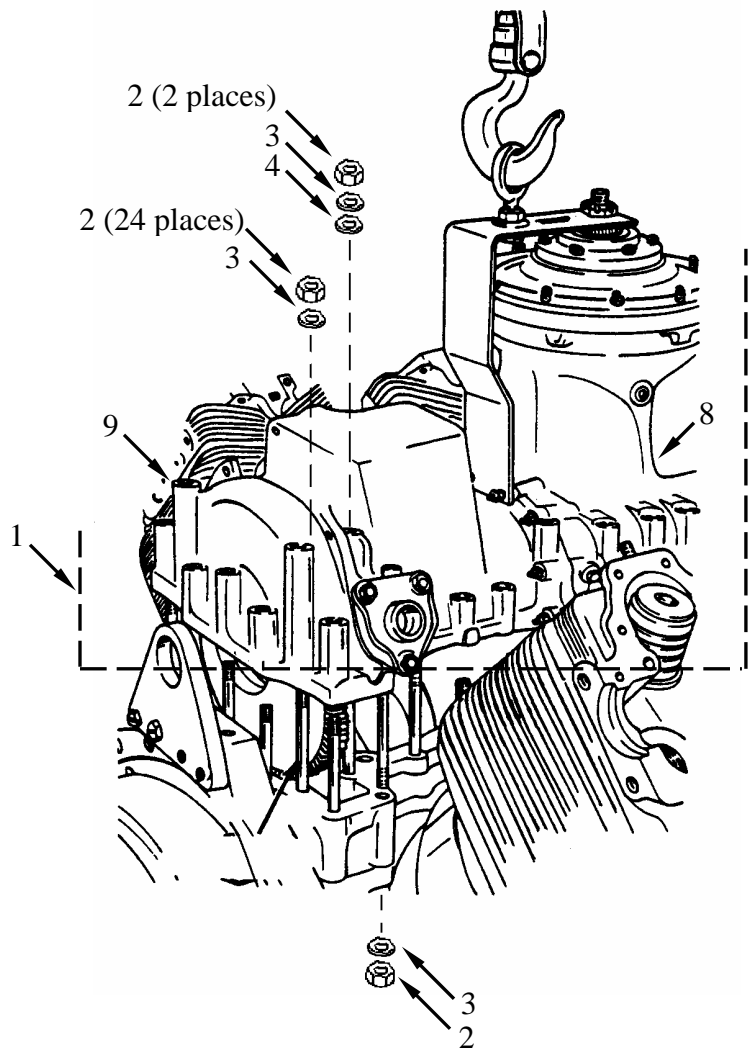
NOTE

One of the 29 self-locking nuts (2x) with flat washers that secure the accessory drive housing will be installed when the fire extinguisher tube is installed. Two of the self-locking nuts are accessed from underneath the accessory base assembly.



4. Attach accessory drive assembly (1).

- a. Install 24 new self-locking nuts (2) (item 140, WP 0175) with flat washers (3).
- b. Install two new self-locking nuts (2) (item 140, WP 0175) with flat washers (3) and new seal washers (4) (item 194, WP 0175). (Left side illustrated; right side is mirror image).
- c. Install two new self-locking nuts (2) (item 140, WP 0175) with flat washers (3) from bottom side of housing (1). (Left side illustrated; right side is mirror image).
- d. Torque-tighten 28 self-locking nuts (2) to 23-25 foot-pounds (31-34 N•m).



END OF WORK PACKAGE

**THIS WORK PACKAGE COVERS:**

Disassembly, Inspection, and Assembly

**INITIAL SETUP:**

**Tools:**

- General mechanic's tool kit (item 121, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Telescoping gauge set (item 54, WP 0176)
- Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

- Key washer (item 172, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 23, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

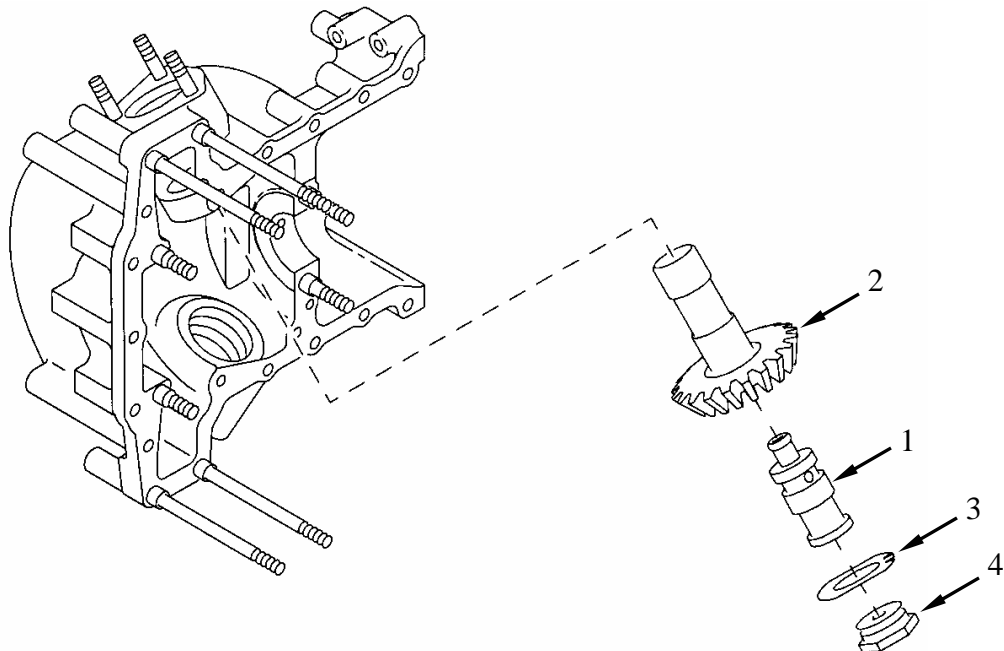
- Engine on maintenance stand (WP 0130)
- Accessory drive housing assembly and associated parts removed (WP 0158)

**NOTE**

**Procedure is the same for left and right bank gear shaft assembly.**

**DISASSEMBLY**

1. Remove plug (1) from gear shaft (2).
  - a. Straighten tab on key washer (3).
  - b. Remove threaded plug (4) and key washer (3). Discard key washer.
  - c. Remove plug (1) from gear shaft (2).



**CLEANING**

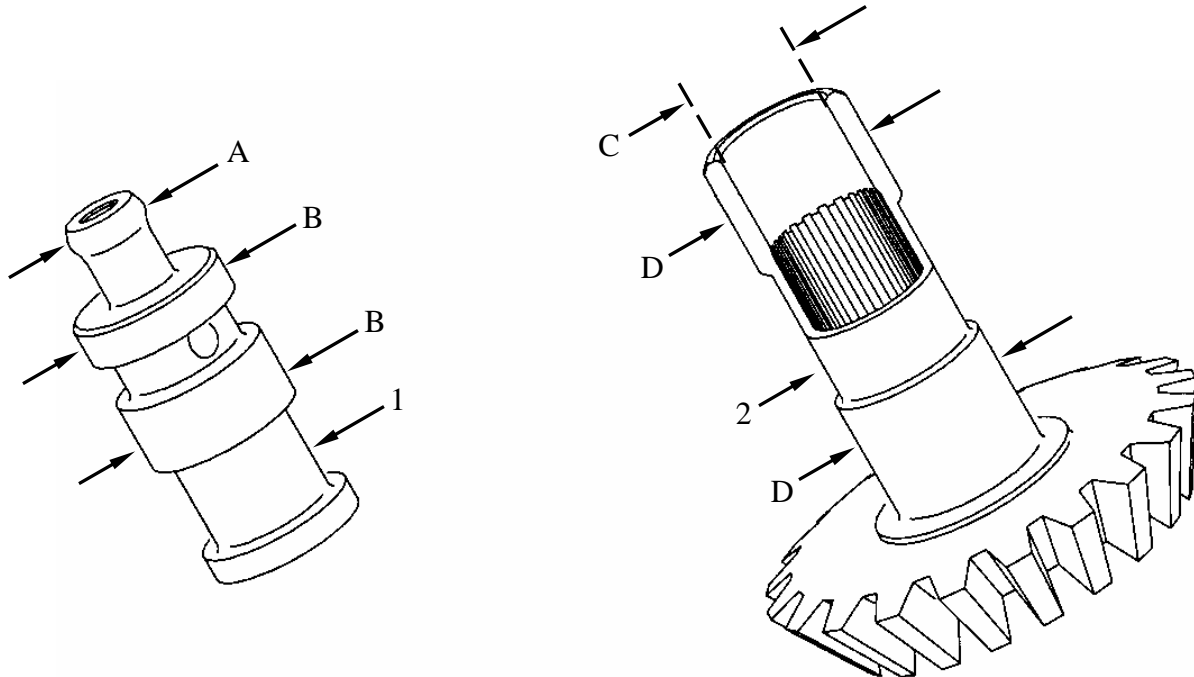
See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Measure outside diameter (A) of plug (1). Replace plug if not within specifications in the following table.
3. Measure spherical outside diameter (B) of plug (1). Replace plug if not within specifications in the following table.
4. Measure outside diameter (C) of gear shaft (2). Replace gear shaft if not within specifications in the following table.
5. Measure inside diameter (D) of gear shaft (2). Replace gear shaft if not within specifications in the following table.

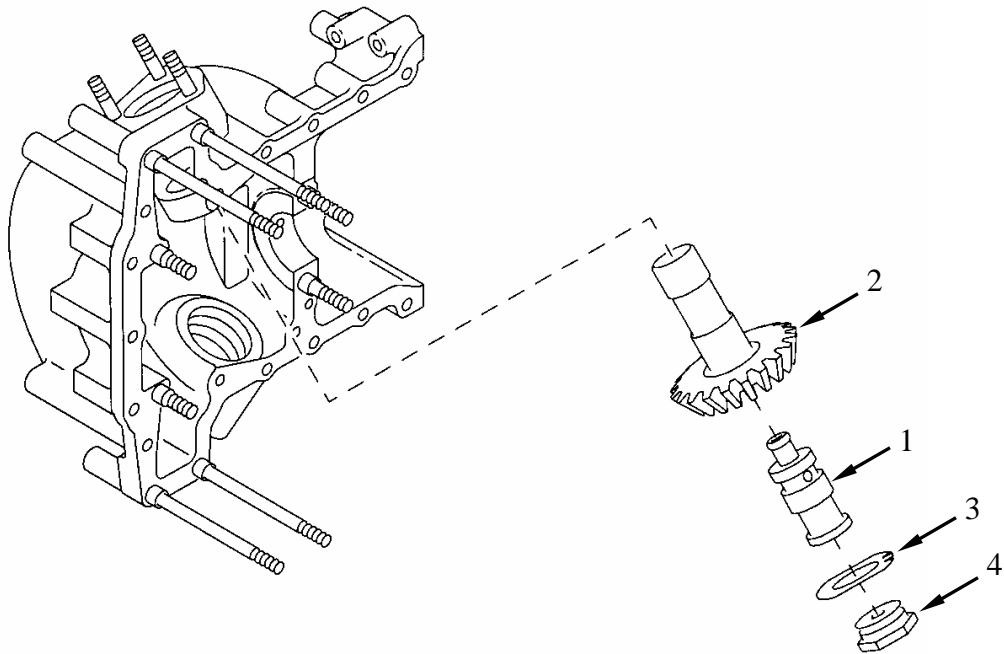
Location	Sizes and Fit of New Parts		Wear Limits
	inches (mm)		
A (Outside diameter of plug)	1.1250 (28.58)	1.1255 (28.59)	None
B (Spherical diameter of plug)	0.6275 (15.94)	0.6280 (15.95)	0.6265 (15.91)
C (Outside diameter of gear shaft)	1.4970 (38.02)	1.4980 (38.05)	1.4960 (38.00)
D (Inside diameter of gear shaft)	1.1260 (28.60)	1.1270 (28.63)	1.1275 (28.64)





**ASSEMBLY**

1. Install plug (1) in gear shaft (2).
  - a. Apply Lubriplate (item 23, WP 0173) to plug (1) and install in gear shaft (2).
  - b. Install plug (4) with new key washer (3) (item 172, WP 0175).
  - c. Torque-tighten plug (4) to 108-117 foot-pounds (146-158 N•m).
  - d. Bend tab on key washer (3) to secure plug (4).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Removal, Disassembly, Cleaning, Inspection, Repair, Assembly, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

Cotter pin (10) (item 48, WP 0175)  
 O-ring (3) (item 62, WP 0175)  
 Pipe plug (4) (item 277, WP 0175) [401752]

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)  
 Pipe thread sealant (item 29, WP 0173)  
 Silicon sealing compound (item 33, WP 0173)

**Personnel Required:**

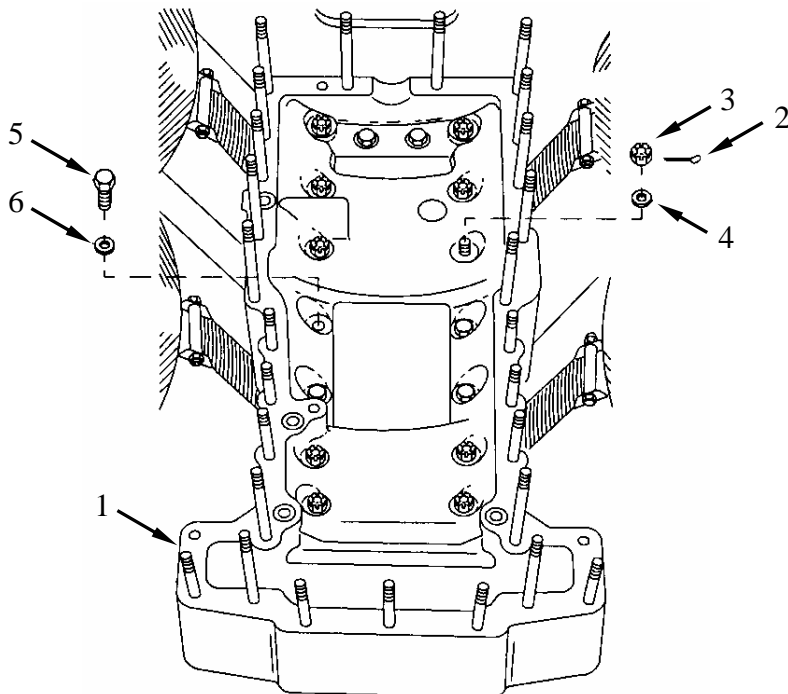
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
 Accessory drive housing assembly and associated parts removed (WP 0158)

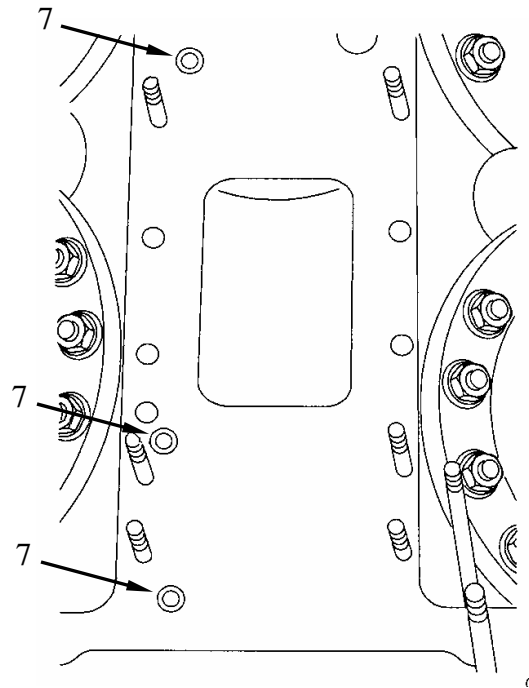
**REMOVAL**

1. Remove accessory drive base (1).
  - a. Remove and discard ten cotter pins (2).
  - b. Remove ten slotted nuts (3) with flat washers (4).
  - c. Remove six screws (5) with flat washers (6).
  - d. Remove accessory base (1) from crankcase.

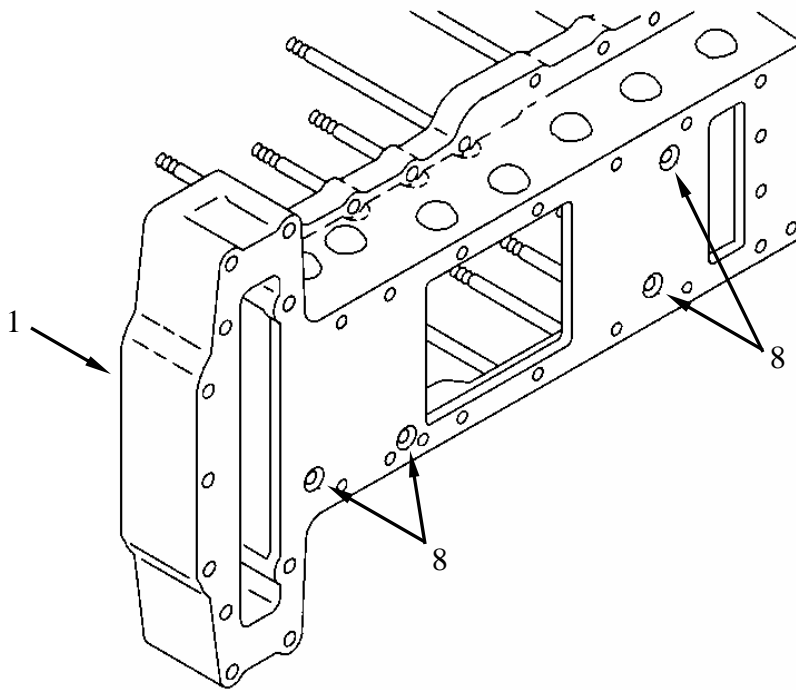


**DISASSEMBLY**

1. Remove and discard three O-rings (7) from crankcase.



2. Remove and discard four pipe plugs (8) from accessory base (1).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

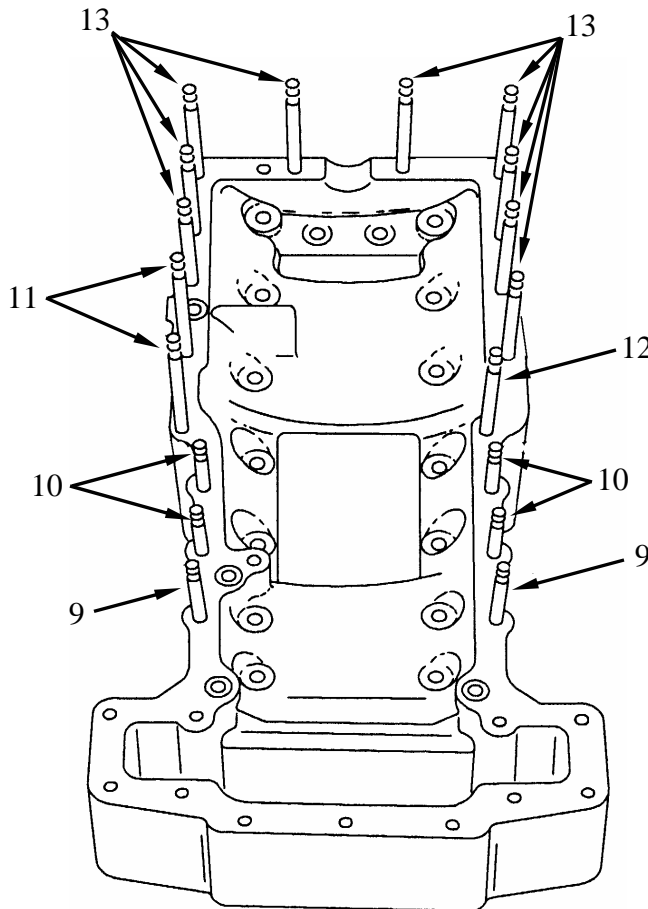
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

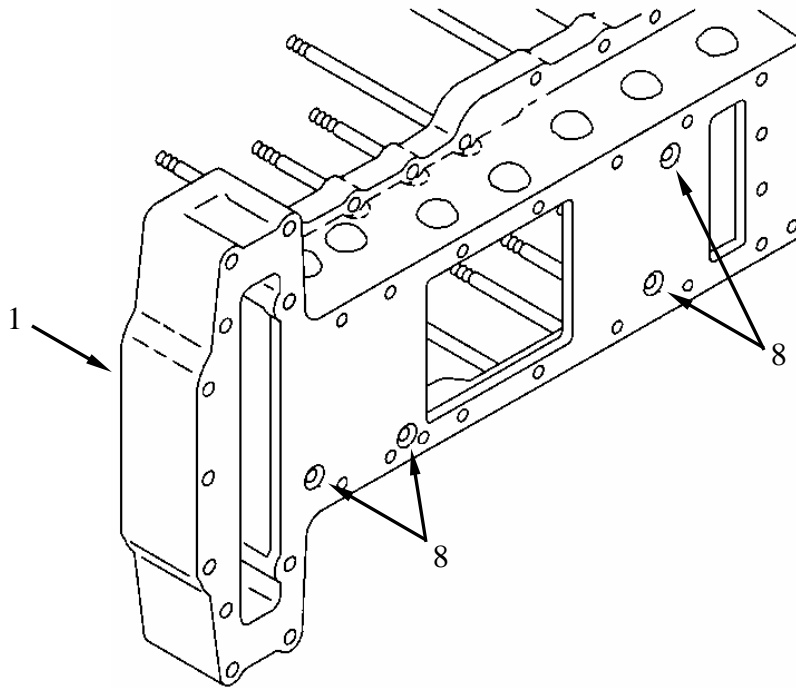
1. Replace stripped, bent, or otherwise damaged studs (9 through 13).
  - a. Refer to Work Package 0028 for procedure and to the following table for height settings.

Location	Setting Height inches (mm)	Quantity Required	Stud Size and Length
9	3-1/2 (88.9000)	2	3/8-16 (27/32) X 3/8-24 (11/16) X 4-5/16
10	2-9/16 (68.0875)	4	3/8-16 (25/32) X 3/8-24 (7/8) X 3-5/16
11	5-1/4 (133.3500)	11	2 3/8-16 (51/64) X 3/8-24 (11/16) X 6
12	4-5/8 (117.4750)	1	3/8-16 (51/64) X 3/8-24 (11/16) X 5-1/4
13	4-1/4 (107.9500)	9	3/8-16 (51/64) X 3/8-24 (11/16) X 5



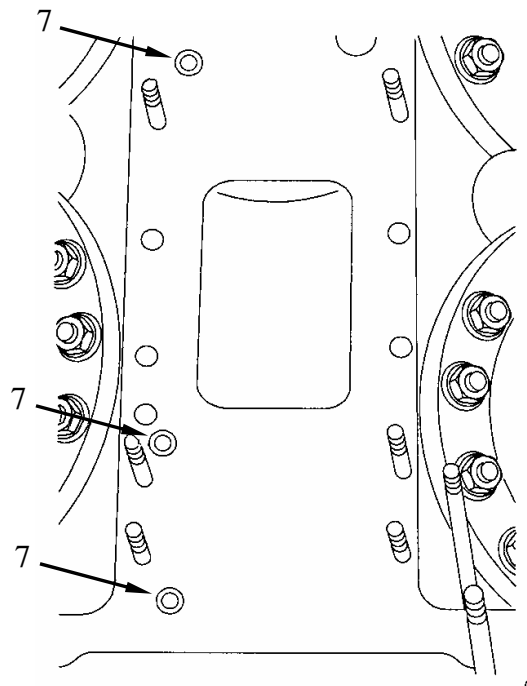
**ASSEMBLY**

1. Install pipe plugs (8).
  - a. Apply pipe thread sealant (item 29, WP 0173) to four new pipe plugs (8) (item 277, WP 0175).
  - b. Install four new pipe plugs (8) in accessory base (1).



**INSTALLATION**

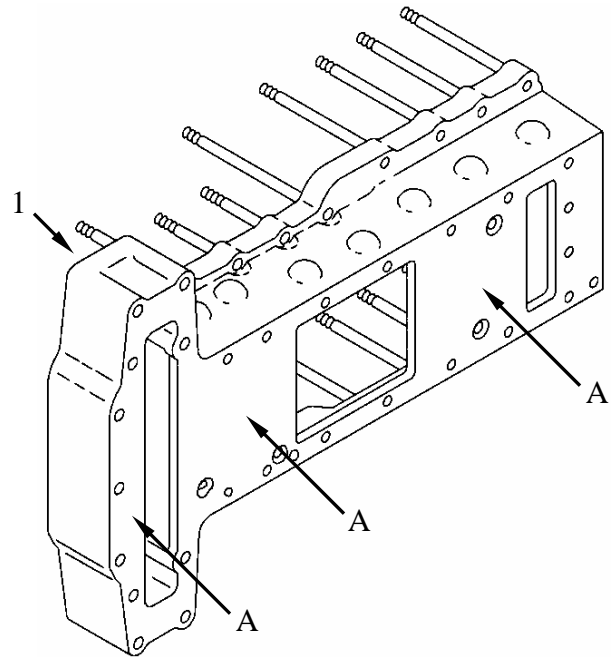
1. Apply Lubriplate (item 23, WP 0173) to three new O-rings (7) (item 62, WP 0175) on crankcase.



INSTALLATION (Continued)

2. Install accessory base (1) onto crankcase.

a. Apply a thin coat of silicon sealing compound (item 33, WP 0173) to bottom mounting surface (A) of accessory base (1).

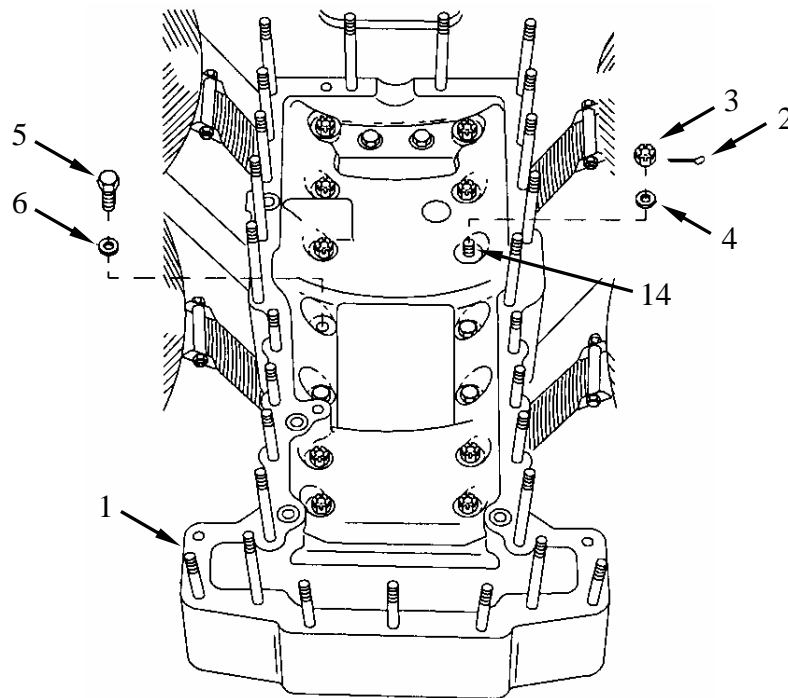


b. Apply Lubriplate (item 23, WP 0173) to six cap screws (5) and ten crankcase studs (14).

c. Secure accessory base (1) to crankcase using six cap screws (5) with flat washers (6), and ten slotted nuts (3) with flat washers (4).

d. Torque-tighten cap screws (5) and slotted nuts (3) to 23-25 foot-pounds (31-34 N•m).

e. Secure slotted nuts (3) with ten new cotter pins (2) (item 48, WP 0175).



END OF WORK PACKAGE





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**FUEL INJECTION ADVANCE CONTROL REPAIR**

**0161 00**

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**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

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**INITIAL SETUP:**

**Tools:**

Arbor press (item 8, WP 0176)  
 Crowfoot attachment, 7/16 (item 29, WP 0176)  
 Fuel injection advance test stand  
 (item 116, WP 0176)  
 General mechanic's tool kit (item 121, WP 0176)  
 Inside micrometer caliper set (item 16, WP 0176)  
 Outside micrometer caliper set  
 (item 17, WP 0176)  
 Retaining ring pliers (item 79, WP 0176)  
 Screwdriver (item 103, WP 0176)  
 Spring resiliency tester (item 117, WP 0176)  
 Telescoping gauge set (item 54, WP 0176)  
 Torque wrench, 0-150 inch-pounds  
 (item 123, WP 0176)  
 Gear puller (item 85, WP 0176)  
 Hammer, soft-faced (item 62, WP 0176)

**Fabricated Items:**

Retaining ring compressor (item 1, WP 0177)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)  
 Non-electrical wire (item 44, WP 0173)

**Mandatory Replacement Parts:**

Bearing (item 7.1, WP 0175)  
 Bearing (item 300, WP 0175)  
 Cotter pin (2) (item 47, WP 0175)  
 Retaining ring (item 290, WP 0175)  
 Retaining ring (2) (item 360, WP 0175)  
 Seal (8) (item 174, WP 0175)  
 Spring (8) (item 174.1, WP 0175)  
 Spring (2) (item 242.1, WP 0175)  
 Roll pin (4) (item 23, WP 0175)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
 Accessory drive and associated parts removed  
 (WP 0158)  
 Advance control removed (WP 0158)  
 Drive shaft (rear fan) removed (WP 0169)

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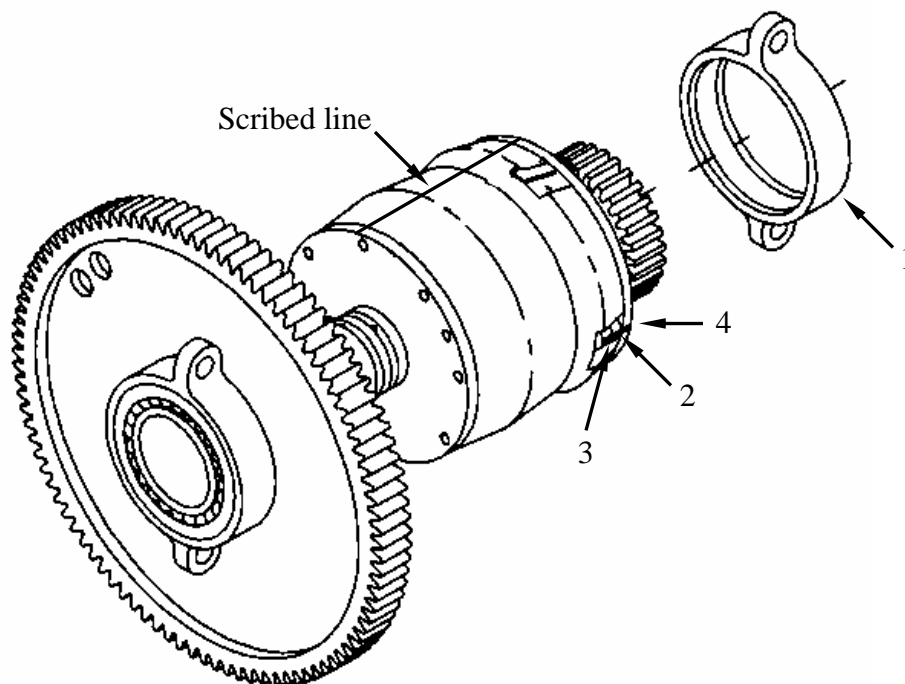
**DISASSEMBLY**

1. Remove bearing support (1).

**NOTE**

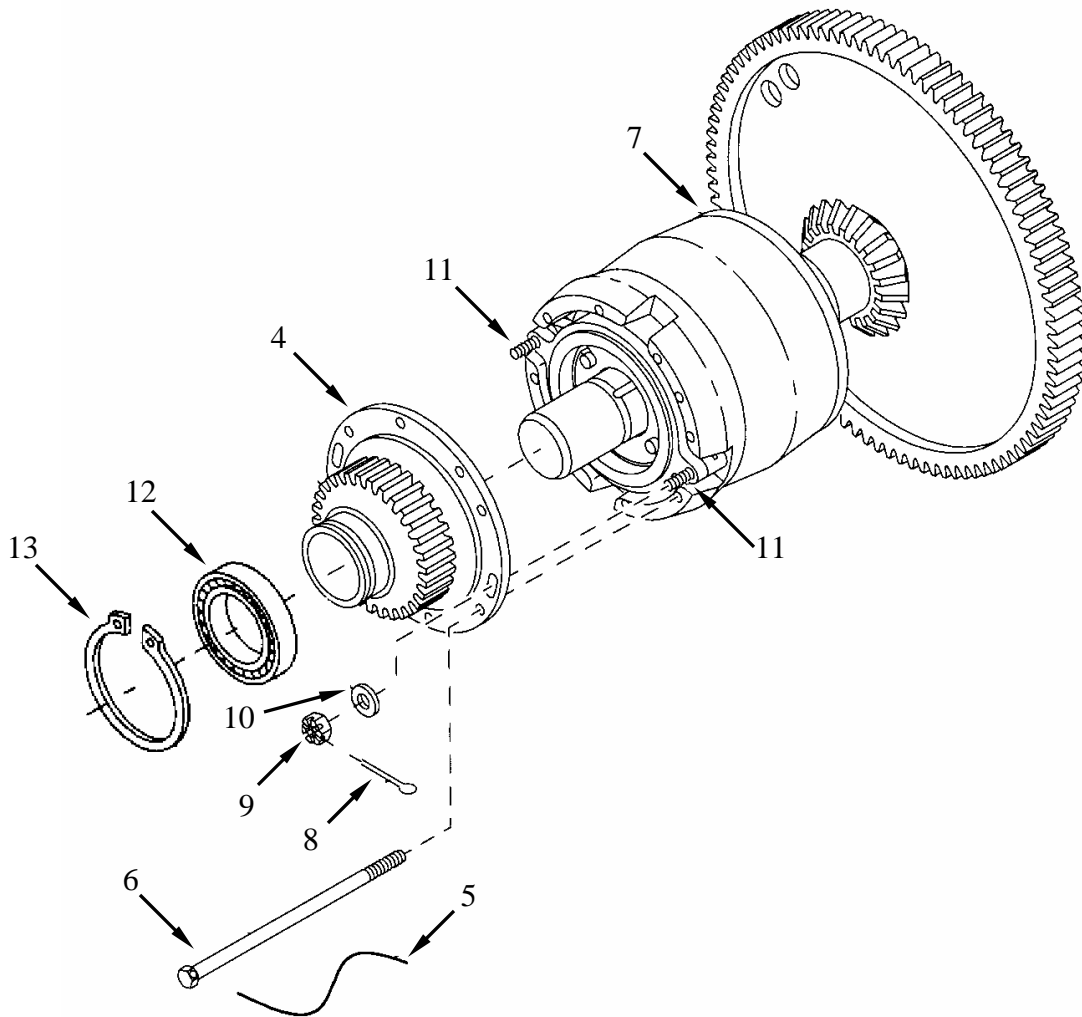
**A straight line may be scribed across the unit as shown, to aid in assembly.**

2. Check alignment marks.
  - a. Before removing machine bolts securing the components of the automatic fuel injection advance control, check alignment and legibility of scribe marks on adjusting ring (2) boss, flyweight assembly (3), and spur gear shaft (4) flange.
  - b. The marks must be aligned to ensure proper assembly. If the scribe marks are not aligned, scribe a new line on the spur gear shaft (4) flange in alignment with the adjusting ring (2) boss, scribe line.
  - c. Identify the new line by using a prick punch dot or some other method of identification. The new spur gear shaft flange mark and adjusting ring boss mark must be in alignment for proper assembly.



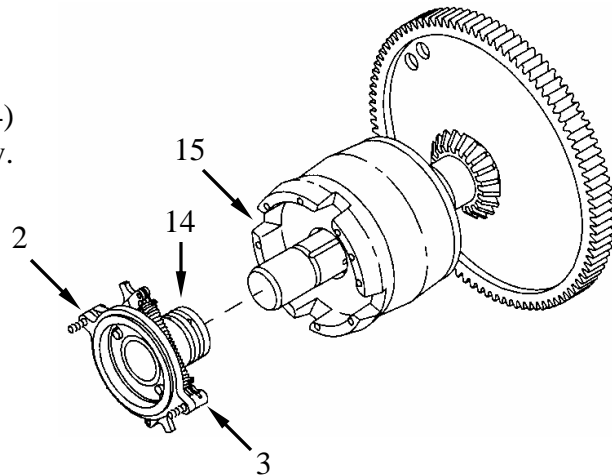
**DISASSEMBLY (Continued)**

3. Remove spur gear shaft (4).
  - a. Cut and remove lock wire (5).
  - b. Remove six machine bolts (6) securing spur gear shaft (4) to cover (7).
  - c. Remove two cotter pins (8), two slotted nuts (9) and two flat washers (10) securing threaded pins (11) to spur gear shaft (4). Discard cotter pins.
  - d. Remove spur gear shaft (4) with ball bearing (12) and retaining ring (13) as an assembly.
4. Remove bearing (12).
  - a. Remove and discard retaining ring (13).
  - b. Using a suitable arbor press remove and discard bearing (12).



**DISASSEMBLY (Continued)**

5. Remove adjusting ring (2), flyweight assembly (3), and fluid regulating valve (14) from flyweight housing (15) as an assembly.
6. Disassemble flyweight assembly (3).

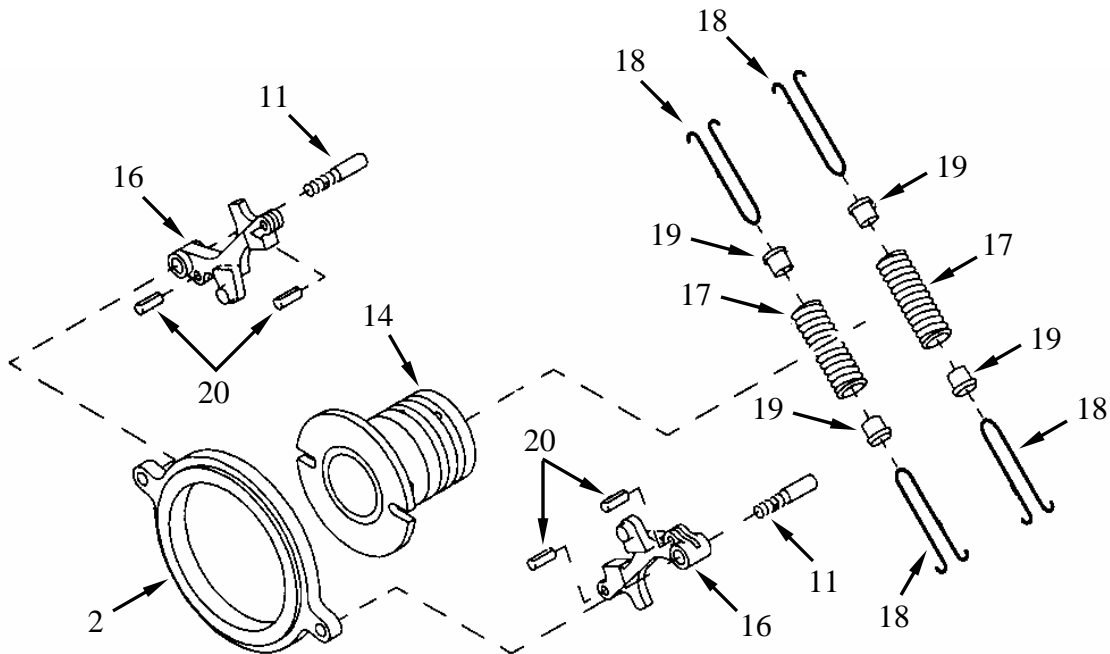


- a. Remove two threaded pins (11) and separate adjusting ring (2) and fluid regulating valve (14).
- b. Remove two flyweights (16), two compression springs (17), four spring retainers (18), and four spring seats (19) from adjusting ring (2) as an assembly. Discard springs.

**NOTE**

**Compression springs and seats are attached to flyweights with roll pins driven through spring retainer loops.**

- c. Disconnect two compression springs (17), with four seats (19) and four spring retainers (18) by driving out four roll pins (20) from two flyweights (16). Discard roll pins.

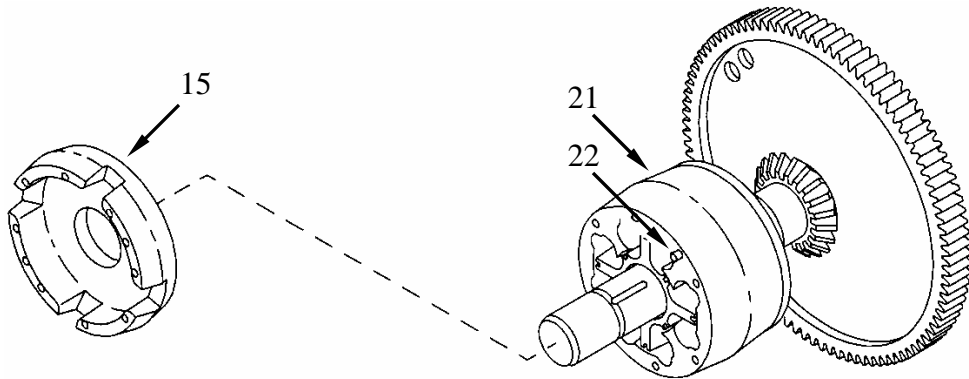


**DISASSEMBLY (Continued)**

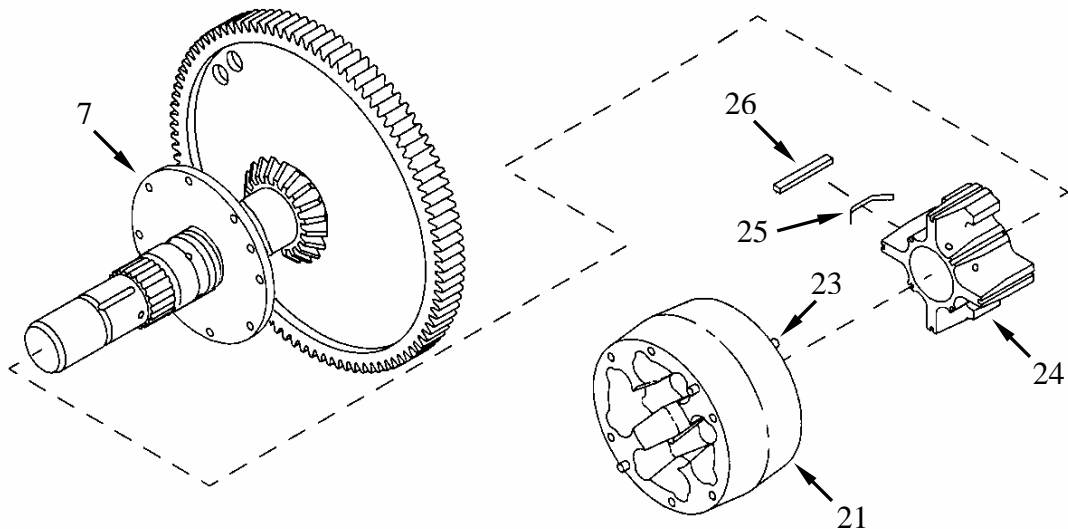
**CAUTION**

**Do not use a prying device to separate housings. Damage to machined surfaces may occur.**

7. Separate flyweight housing (15) from vane housing (21).
  - a. Note the location of dowel pins (22) in vane housing (21) for alignment with holes in flyweight housing (15) during assembly.



8. Separate vane housing (21) from cover (7) noting the location of dowel pins (23) for alignment with holes in cover (7) during assembly.
9. Partially separate vane (24) from housing (21) and remove eight springs (25) and eight seals (26). Discard springs and seals.
10. Remove vane (24) from housing (21).



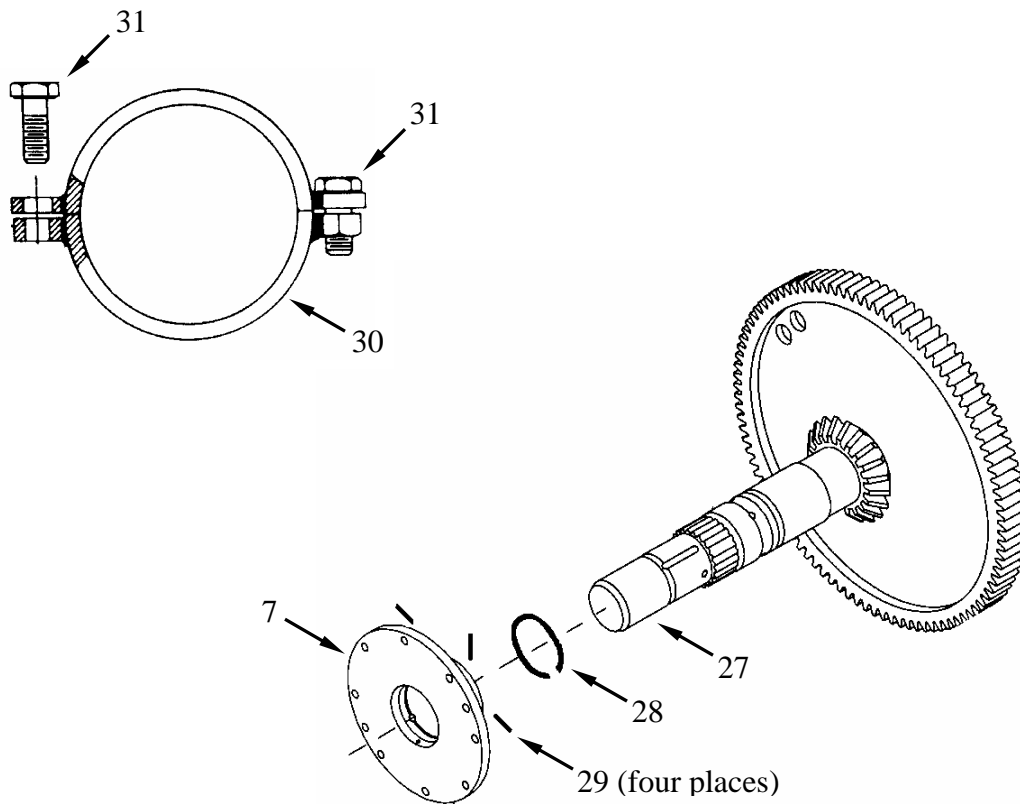
**DISASSEMBLY (Continued)**

11. Remove cover (7) from bevel gear shaft (27).

**CAUTION**

**An internal retaining ring (28) secures cover (7) to the bevel gear shaft (27). Follow the procedure carefully to remove the cover. Improper procedure can cause damage to the cover or the shaft.**

- a. Cut four pins (29) 7/16-inch (approximately) long from 7/32-inch diameter brass brazing rod or other soft material.
- b. Insert the pins (29) in the four equally spaced holes in bearing portion of cover (7).
- c. Install fabricated ring compressing tool (30) (item 1, WP 0177) over the pins.
- d. Tighten bolts (31) sufficiently to compress the cover (7) internal retaining ring (28).
- e. Install bevel gear shaft (27) in a soft jawed vise and, using a gear puller (item 85 WP 0176), remove cover (7).
- f. Remove and discard retaining ring (28) from bevel gear shaft (27).



**DISASSEMBLY (Continued)**

12. Remove plug (32).

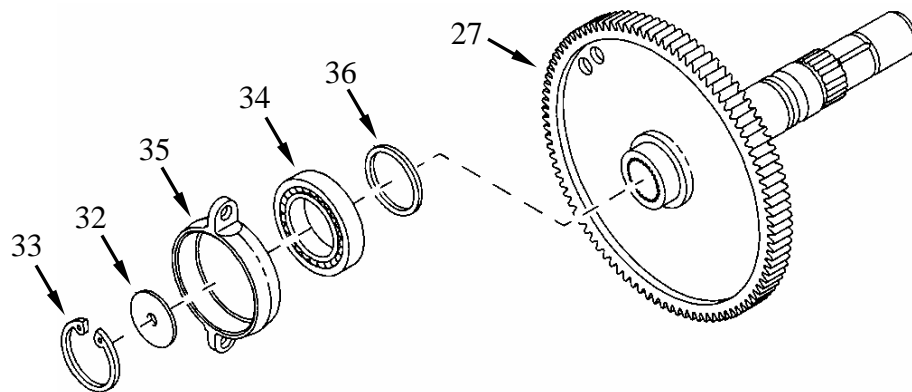
a. Remove and discard retaining ring (33).

b. Remove plug (32).

13. Remove ball bearing (34).

a. Remove eye bracket (35).

b. Remove ball bearing (34) and shims (36) from bevel gear shaft (27). Discard ball bearing.

**CLEANING**

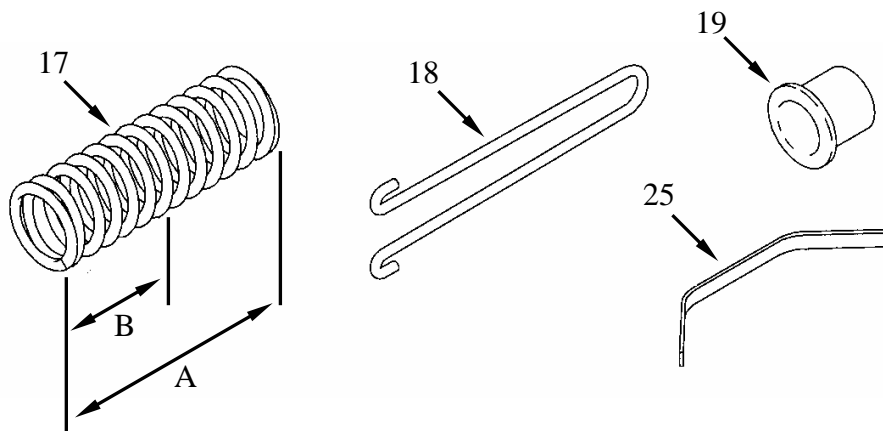
1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Visually inspect spring retainers (18) and seats (19) for cracks, indentations or other damage. Replace any damaged parts.
3. Springs (24) are mandatory replacement items. Replace with new springs (item 242.1, WP 0175) that conform to free length (A) and compressed length (B) in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Free length)	1.6300 (41.402) approximate		None
B (Compressed length)	0.6510 (16.5354) maximum		None
Scale reading at 1.03 inch (26.162 mm)	12.3 pounds	14.9 pounds	None

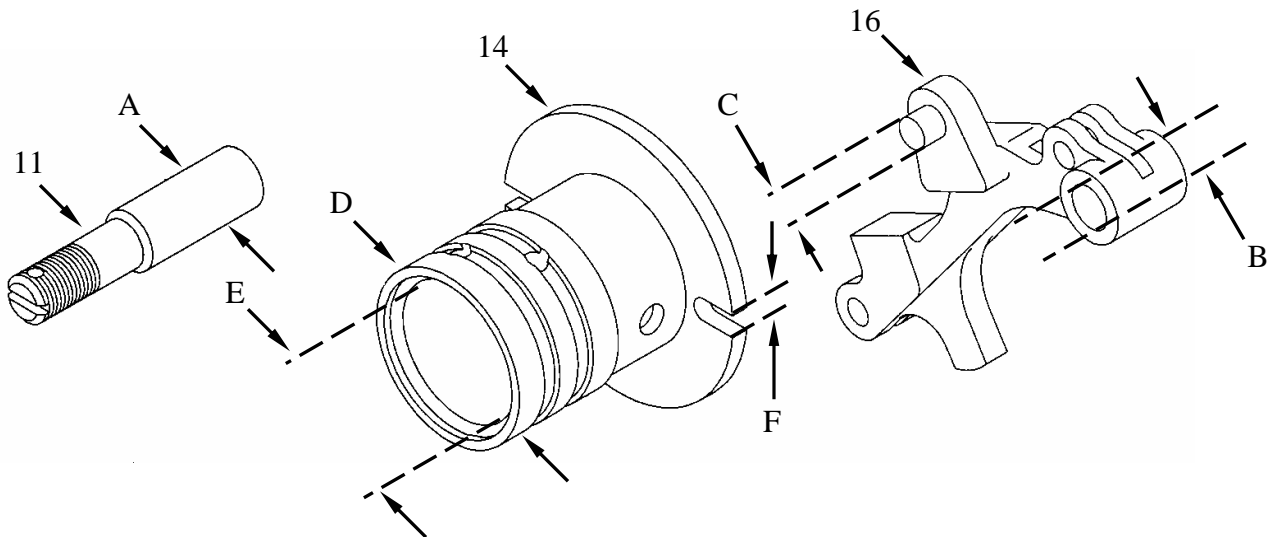




**INSPECTION (Continued)**

4. Measure outside diameter (A) of both threaded pins (11). Replace threaded pins if not within specifications in the following table.
5. Measure inside diameter (B) of hole in two flyweights (16). Replace flyweights if not within specifications in the following table.
6. Measure outside diameter (C) of pin on two flyweights (16). Replace flyweight assemblies if not within specifications in the following table.
7. Measure outside diameter (D) of fluid regulating valve (14). Replace fluid regulating valve if not within specifications in the following table.
8. Measure inside diameter (E) of fluid regulating valve (14). Replace fluid regulating valve if not within specifications in the following table.
9. Measure width of slots (F) in fluid regulating valve (14). Replace fluid regulating valve if not within specifications in the following table.

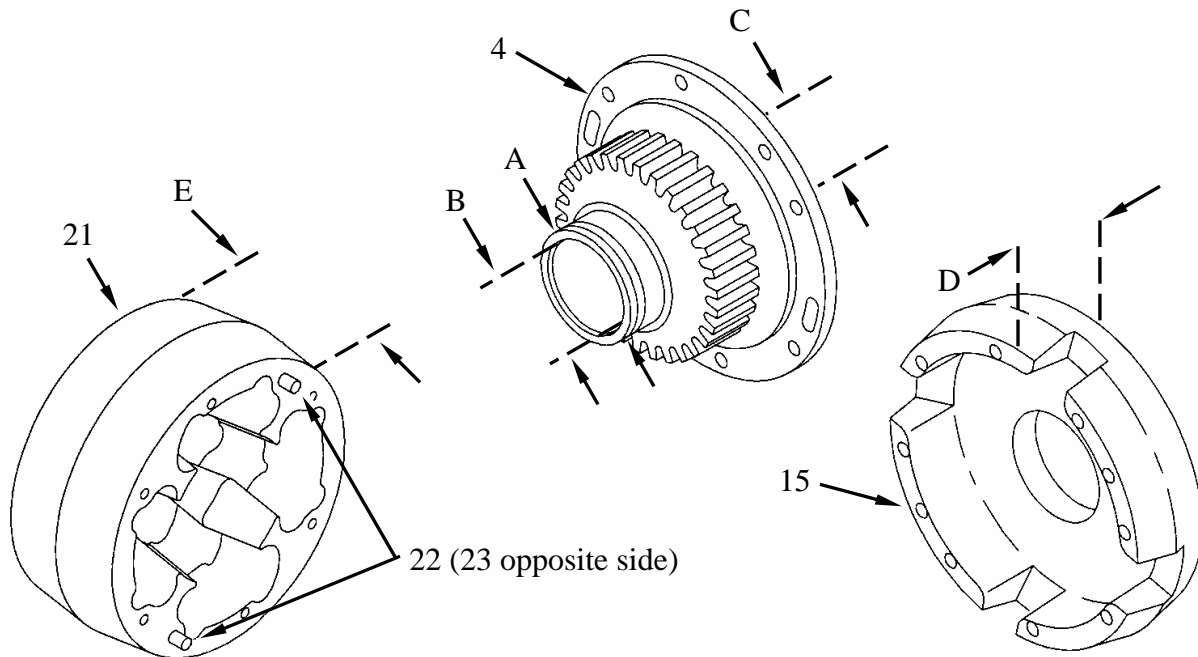
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Threaded pins)	0.3110 (7.8994)	0.3115 (7.9121)	None
B (Flyweight holes)	0.3120 (7.9248)	0.3130 (7.9502)	None
C (Flyweight pins)	0.2500 (6.3500)	0.2510 (6.3754)	0.2490 (6.3246)
D (Regulating valve)	1.8710 (47.5234)	1.8715 (47.5361)	1.8708 (47.5183)
E (Regulating valve)	1.5015 (38.1381)	1.5020 (38.1508)	1.5030 (38.1762)
F (Regulating valve slots)	0.2510 (6.3754)	0.2550 (6.4770)	0.2560 (6.5024)



**INSPECTION (Continued)**

10. Measure outside diameter (A) of bearing surface on spur gear shaft (4). Replace advance unit if shaft (4) is not within specifications in the following table.
11. Measure inside diameter (B) of bearing surface on spur gear shaft (4). Replace advance unit if shaft (4) is not within specifications in the following table.
12. Measure inside diameter (C) of spur gear shaft (4). Replace advance unit if shaft (4) is not within specifications in the following table.
13. Measure width (D) of flyweight housing (15). Replace advance unit if housing (15) is not within specifications in the following table.
14. Inspect vane housing (21) for loose or damaged dowel pins (22, 23).
  - a. Replace damaged dowel pins (WP 0028).
15. Measure width (E) of vane housing (21). Replace advance unit if housing (21) is not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Spur gear shaft)	1.9686 (50.0024)	1.9690 (50.0126)	1.9684 (49.9974)
B (Spur gear shaft)	1.6260 (41.3004)	1.6270 (41.3258)	1.6275 (41.3385)
C (Spur gear shaft)	1.5015 (38.1381)	1.5020 (38.1508)	1.5030 (38.1762)
D (Flyweight housing)	1.2330 (31.3182)	1.2370 (31.4198)	1.2310 (31.2674)
E (Vane housing)	2.1233 (53.9318)	2.1247 (53.9673)	2.1223 (53.9064)



**INSPECTION (Continued)**

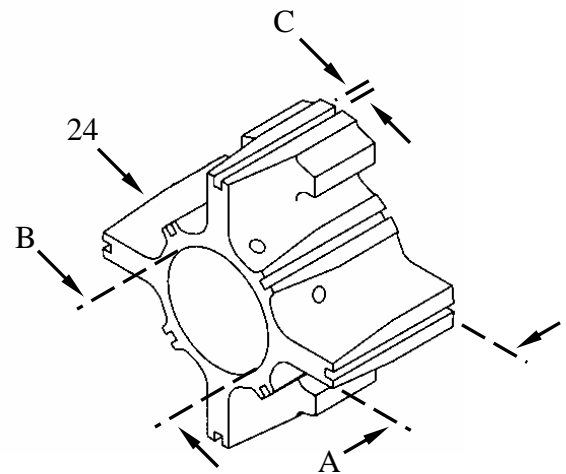
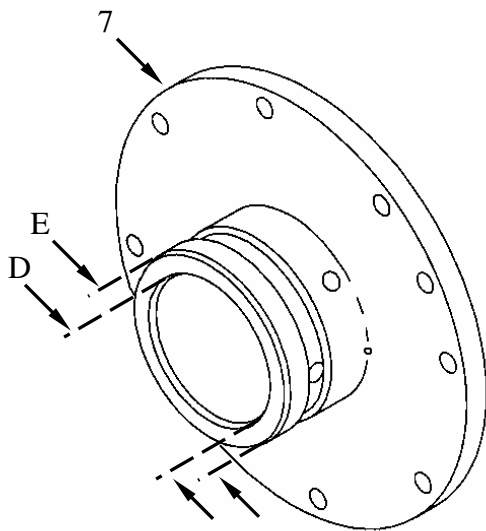
16. Measure vane (24).

- a. Measure width (A), inside diameter (B), and width of slots (C) in vane (24).
- b. Replace advance unit if vane (24) is not within specifications in the following table.

17. Measure cover (7).

- a. Measure inside diameter (D) and outside diameter (E) of cover (7).
- b. Replace advance unit if cover (7) is not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Vane width)	Check concurrently with vane housing to provide 0.0010-0.0015 (0.0254-0.0381) end clearance.		None
B (Vane)	1.8730 (47.5742)	1.8735 (47.5869)	1.8740 (47.5996)
C (Vane slots)	0.1020 (2.5908)	0.1060 (2.6924)	0.1070 (2.7178)
D (Cover)	1.8125 (46.0375)	1.8130 (46.0502)	1.8135 (46.0629)
E (Cover)	2.3735 (60.2869)	2.3745 (60.3123)	2.3730 (60.2742)

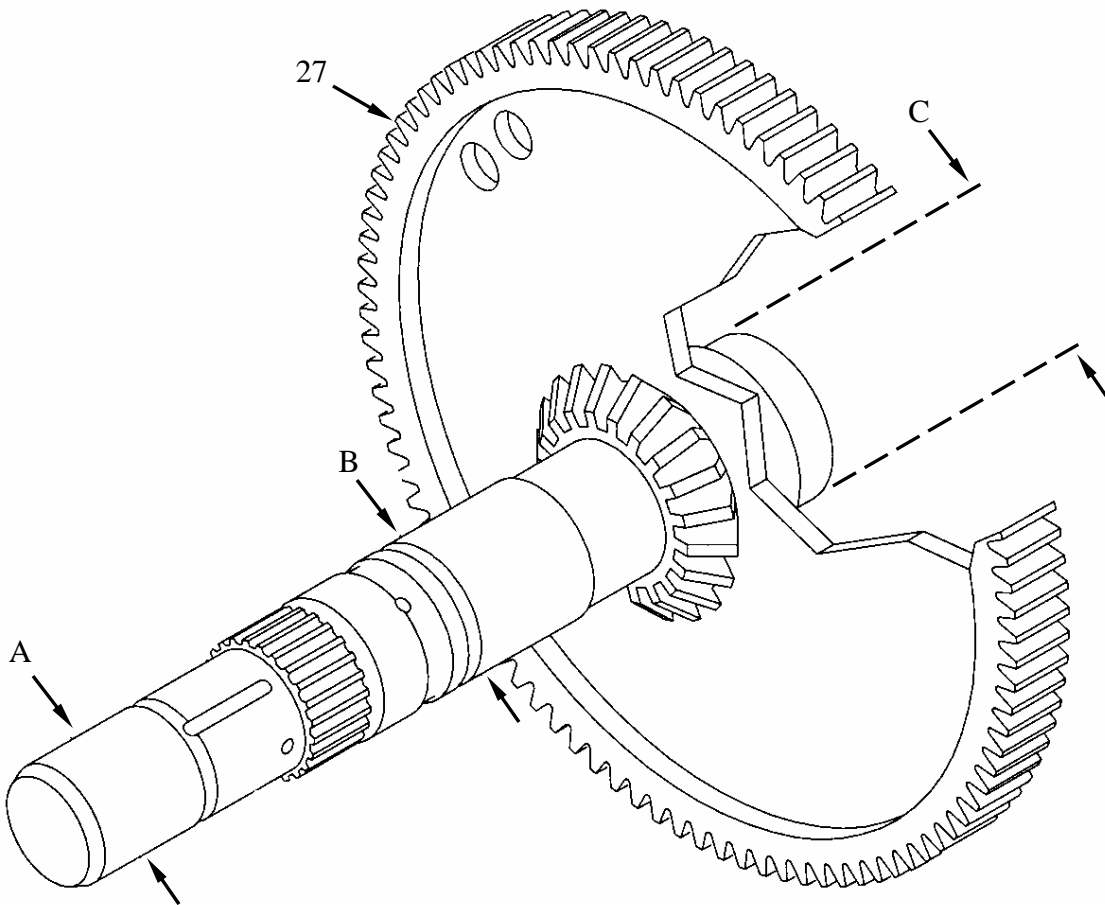


**INSPECTION (Continued)**

18. Measure bevel gear shaft (27).

- a. Measure outside diameters (A) and B.
- b. Measure bearing surface (C).
- c. Replace bevel gear shaft if not within specifications in the following table.

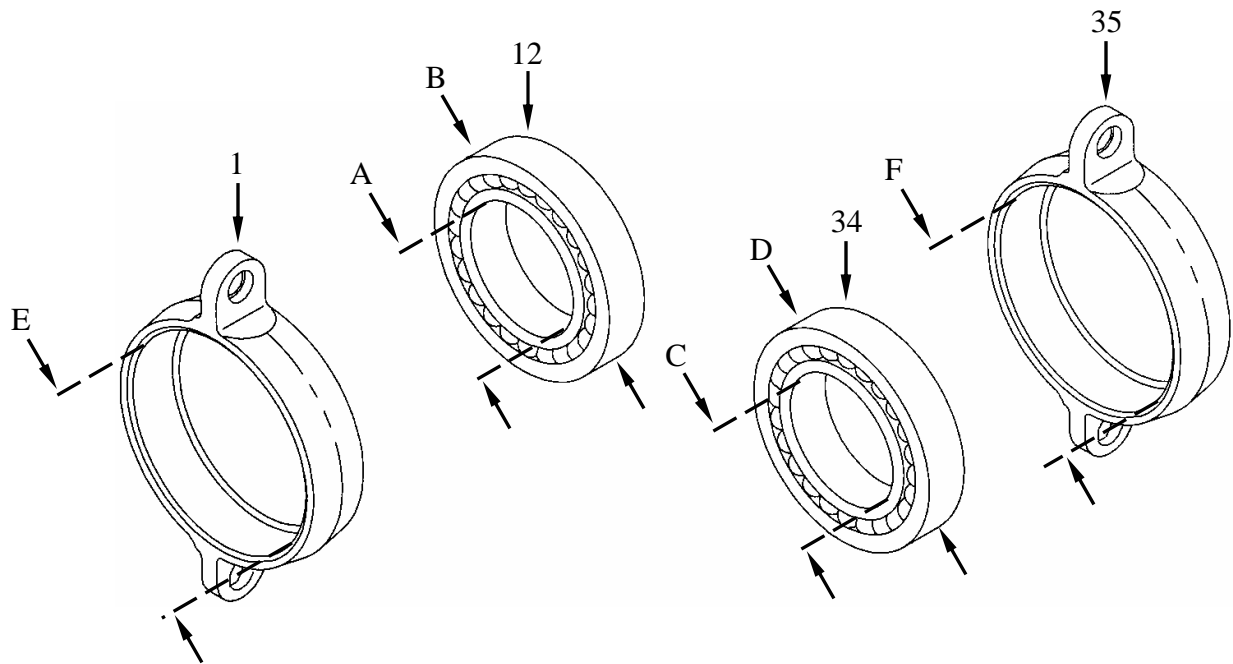
Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Outside diameter)	1.4996 (38.0898)	1.5000 (38.1000)	1.4994 (38.0847)
B (Outside diameter)	1.8115 (46.0121)	1.8120 (46.0248)	1.8110 (45.9994)
C (Bearing surface)	2.1655 (55.0037)	2.1660 (55.0164)	2.1653 (54.9986)



**INSPECTION (Continued)**

- 19. Bearings (12 and 34) are mandatory replacement items.
  - a. New bearing dimensions, (A, B, C, and D), are provided for information purposes only; you need not perform the measurements.
- 20. Measure inside diameter (E) of bearing support (1).
  - a. Replace support if not within specifications in the following table.
- 21. Measure inside diameter (F) of eye bracket (35).
  - a. Replace eye bracket if not within specifications in the following table.

Location	Sizes and Fit of New Parts inches (mm)		Wear Limits
A (Bearing outside diameter)	3.1491 (19.9871)	3.1496 (79.9998)	None
B (Bearing inside diameter)	1.9680 (49.9872)	1.9685 (49.9999)	None
C (Bearing outside diameter)	3.5427 (89.9846)	3.5433 (89.9998)	None
D (Bearing inside diameter)	2.1648 (54.9859)	2.1654 (55.001)	None
E (Bearing support)	3.1495 (79.9973)	3.1501 (80.0125)	3.1504 (80.0201)
F (Eye bracket)	3.5432 (89.9973)	3.5440 (90.0176)	3.5442 (90.0227)



ASSEMBLY

**CAUTION**

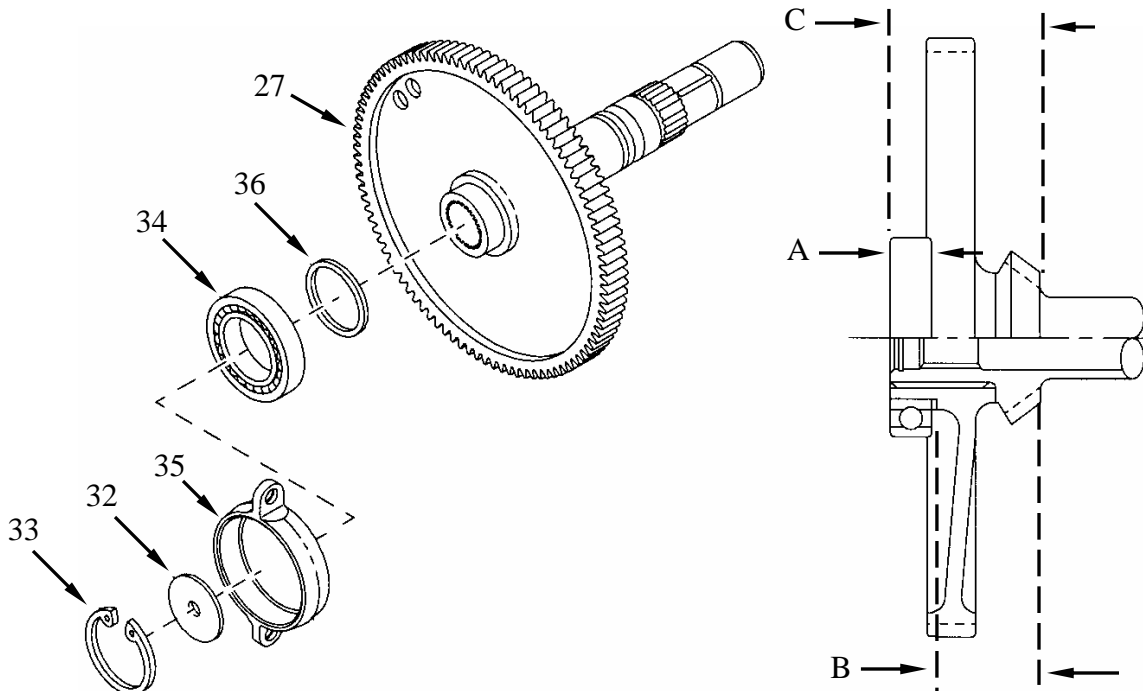
**The bevel gear shaft bearing must be shimmed to assure proper meshing of the bevel gear (endplay). Endplay is assured by controlling dimension C (A + B) and must be between 2.6605 and 2.6625 inches (67.5767 and 67.6275 mm). Failure to comply may result in premature failure.**

1. Determine shim (36) thickness.
  - a. Measure the thickness (A) of ball bearing (34) at its thickest point.
  - b. Measure the thickness (B) from face of bevel gear (27) to bearing seat.
  - c. Add thickness (A) and (B), then subtract from 2.6605 (67.5767 mm) and from 2.6625 inch (67.6275 mm) to arrive at shim dimension range.

**NOTE**

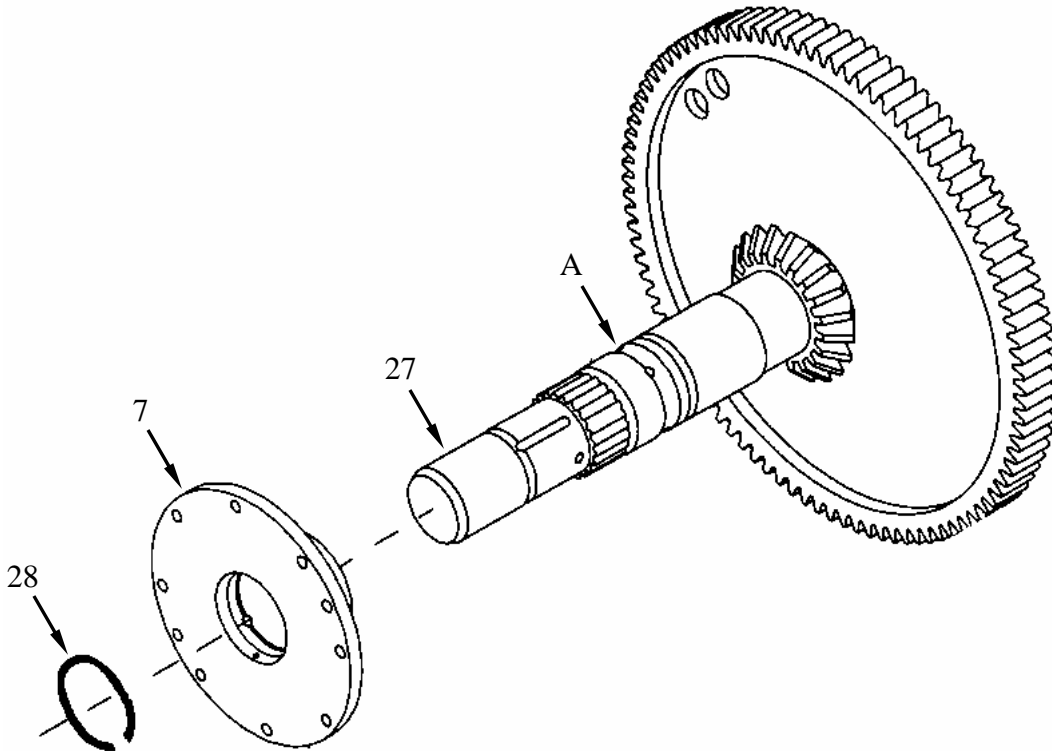
**The shim pack has several 0.002-inch (0.0508-mm) laminations. Shims may be stripped from the pack to obtain dimensions.**

- d. Add or remove 0.002-inch (0.0508 mm) shim laminations from shim pack until required dimension (C) 2.6605-2.6625 inches (67.5767-67.6275 mm) is obtained.
2. Install shim (36) of predetermined thickness on bevel gear shaft (27).
3. Press new ball bearing (34) (item 7.1 WP 0175) (with bearing trademark facing out) on bevel gear shaft (27).
4. Install eye bracket (35) over ball bearing (34) using a soft-faced hammer.
5. Install plug (32).
  - a. Secure plug (32) with new retaining ring (33) (item 290, WP 0175).



**ASSEMBLY (Continued)**

6. Install cover (7) onto bevel gear shaft (27).
  - a. Place accessory driven bevel gear shaft (27) in a soft jawed vise and install vane housing cover (7) on gear shaft beyond the retaining ring groove (A).
  - b. Install new retaining ring (28) (item 360, WP 0175) in groove (A) and pull cover (7) forward until retaining ring is seated in the cover retaining ring groove.



## ASSEMBLY (Continued)

**CAUTION**

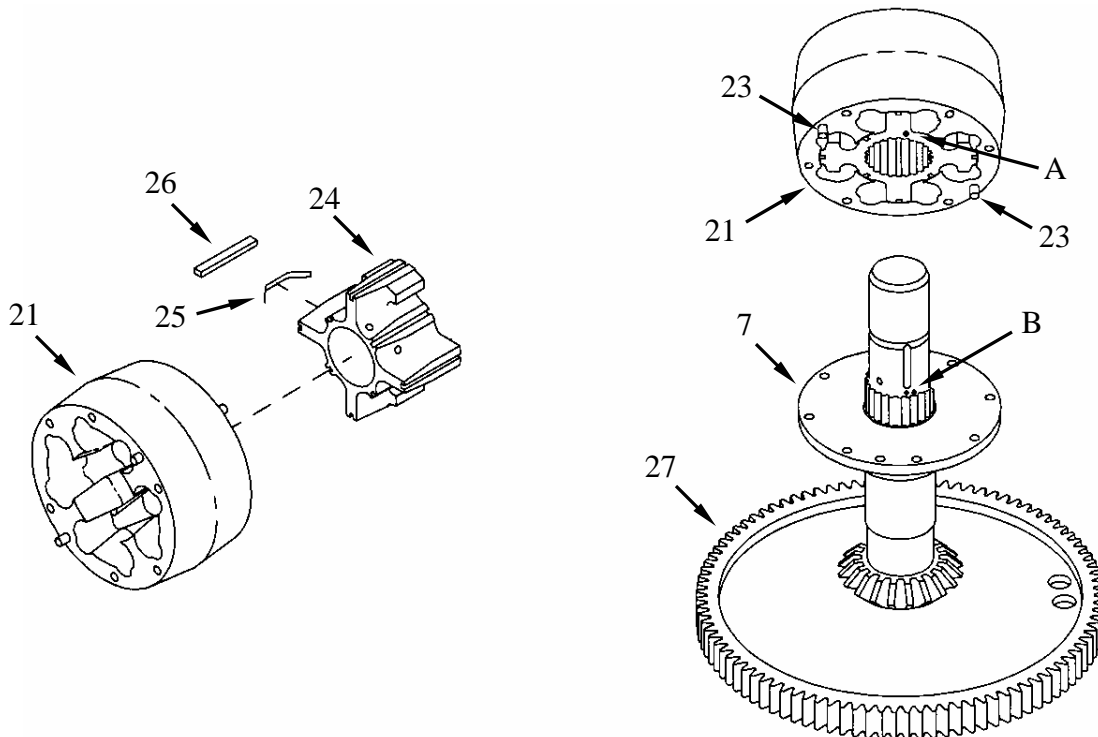
**Vane must have 0.0010 to 0.0015-inch (0.0254 to 0.0381 mm) end clearance with vane housing. Improper clearance will affect operation of advance unit.**

7. Install vane (24) in housing (21).
  - a. Position vane (24) into housing (21).
  - b. Install eight new seals (26) (item 174, WP 0175) into slots in vane.
  - c. Slide springs (25), (item 174.1) between seals (26) and vane (24) as shown. Assure that springs are not exposed, but recessed slightly beyond end of vane.

**NOTE**

**Dowel pins and holes will align in two positions. However, bolt holes in the cover and housing will align in one position only. Make certain that the cover and housing are correctly positioned so that bolt holes are aligned (use scribed line as described in step 1 of Disassembly).**

8. Install housing (21) onto cover (7).
  - a. Assure that alignment dot (A) on housing spline aligns with alignment dot (B) on gear shaft spline.
  - b. Install housing (21), vane (24), springs (25), and seals (26) over bevel gear shaft (27) and onto cover (7) as an assembly.
  - c. Position housing (21) onto cover (7) so that dowel pins (23) align with pin holes, and bolt holes in housing (21) align with threaded holes in cover (7).

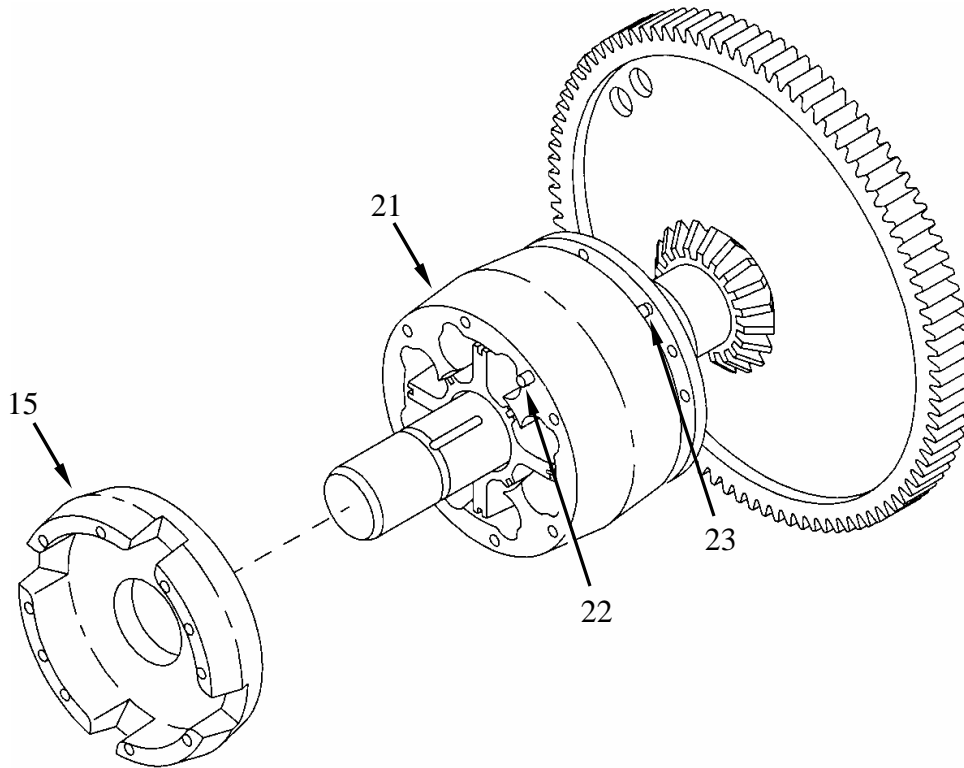




**ASSEMBLY (Continued)**

9. Install flyweight housing (15) onto vane housing (21) while aligning dowel pins (22) and bolt holes.

  - a. Tap housing (15) lightly with a soft hammer to seat dowel pins (22 and 23).



**ASSEMBLY (Continued)**

10. Assemble flyweight assembly (3).

- a. Assemble two spring retainers (18) and two seats (19) onto each new compression spring (17) (item 242.1, WP 0175) to make two spring assemblies (37).

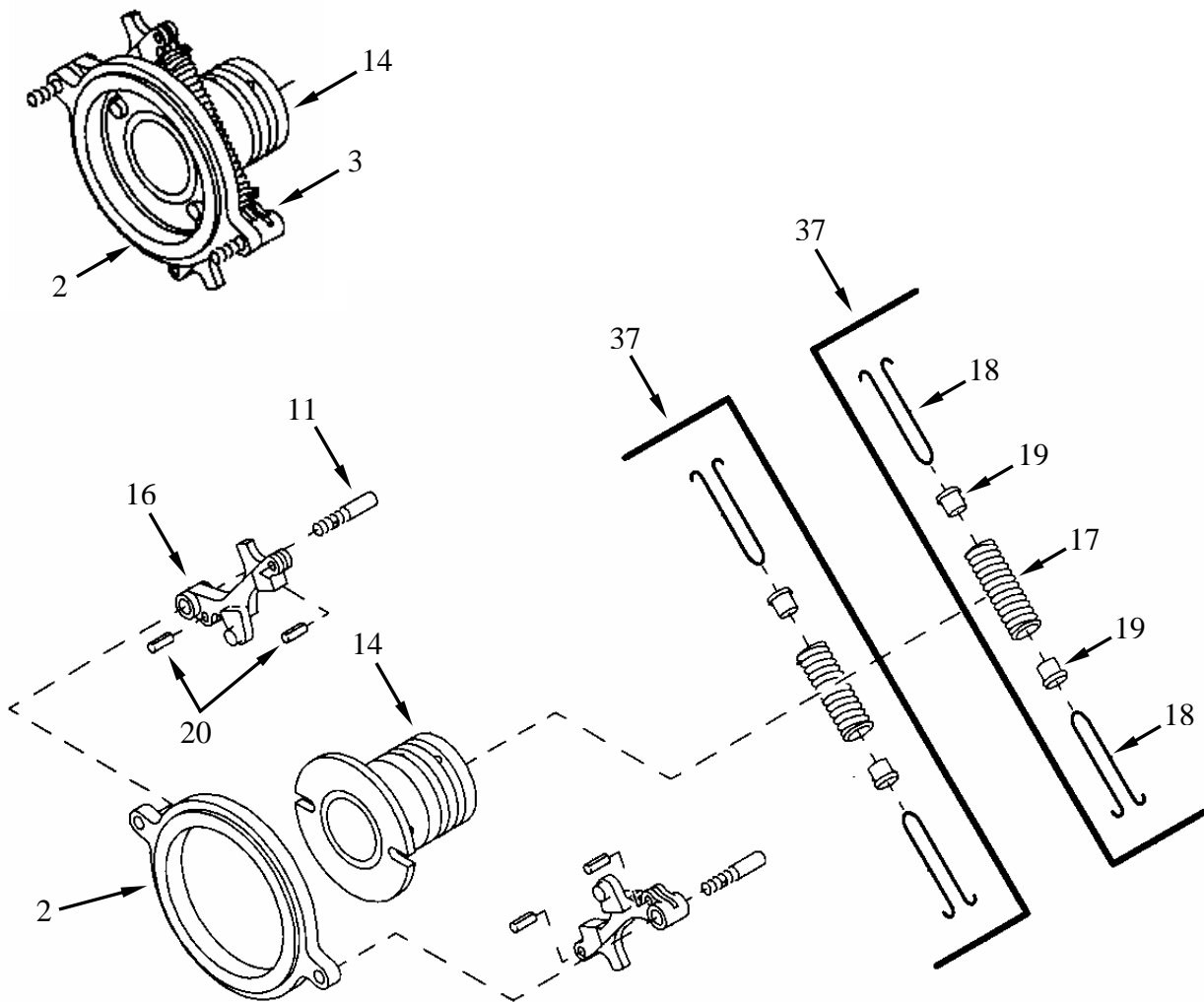
**NOTE**

**Compression springs and seats are attached to slots in flyweight with roll pins driven through retainer loops.**

- b. Install ends (retainer loop) of spring assemblies (37) into slots in flyweights (16) one at a time securing each end with a new roll pin (20) (item 23, WP 0175).

11. Install flyweight assembly (3) onto adjusting ring (2) with two threaded pins (11).

12. Spread flyweight assembly (3) and install fluid regulating valve (14) in adjusting ring (2) so slots in fluid regulating valve are aligned with threaded pins (11).

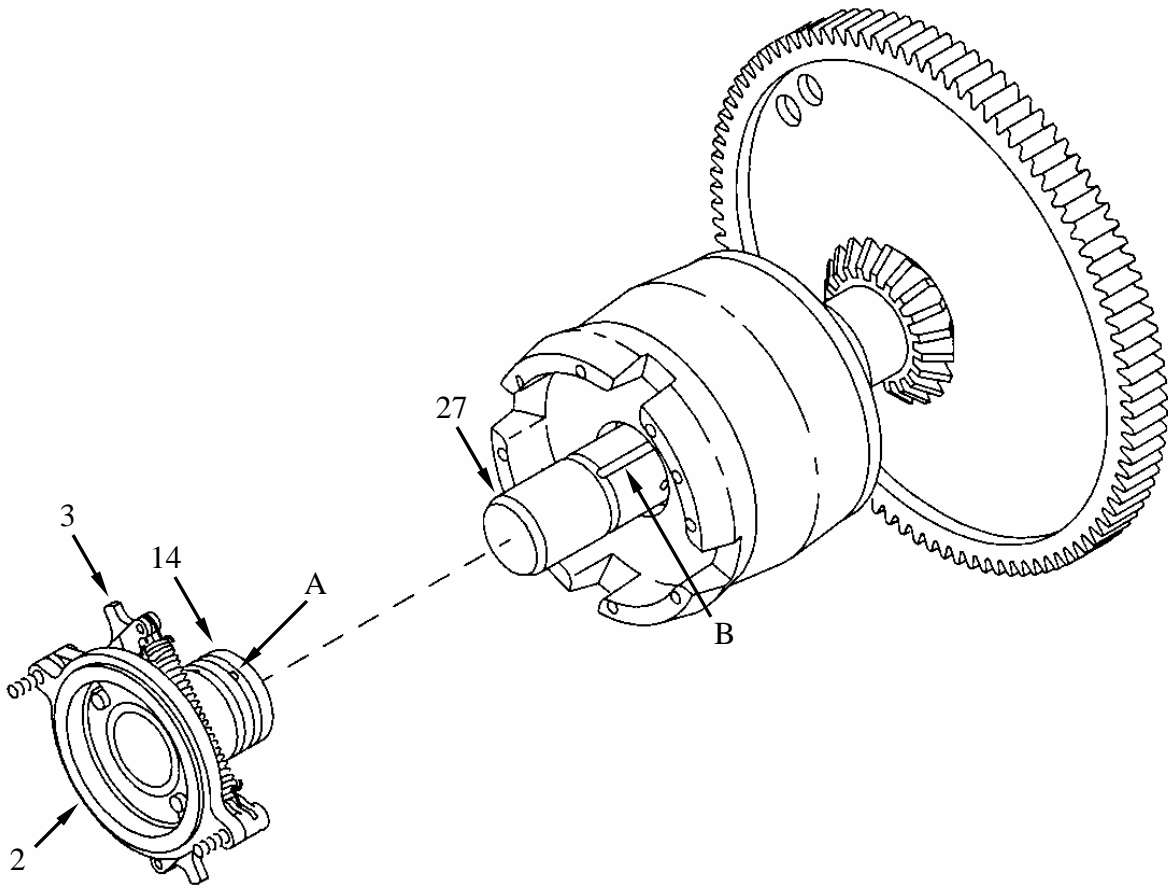


## ASSEMBLY (Continued)

**CAUTION**

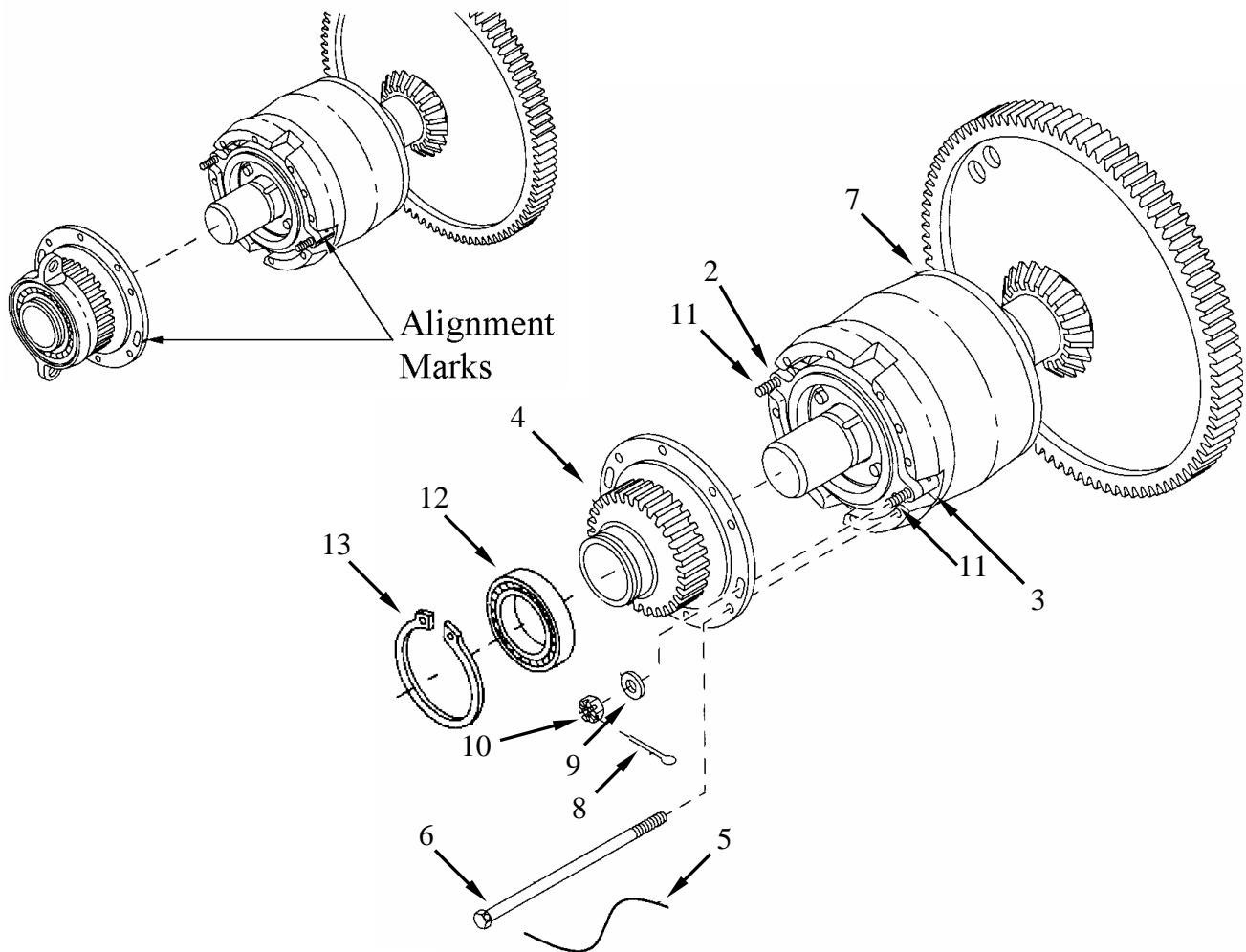
**Oil hole in lower groove of fluid regulating valve and slot in bevel gear shaft must be aligned for proper operation.**

13. Install adjusting ring (2), fluid regulating valve (14), and flyweight assembly (3) onto bevel gear shaft (27) as an assembly.
  - a. Assure the oil hole (A) in lower groove of fluid regulating valve (14) is aligned with slot (B) in bevel gear shaft (27).



**ASSEMBLY (Continued)**

14. Using a suitable arbor press, install new bearing (12) (item 300, WP 0175) and secure with new retaining ring (13) (item 290, WP 0175).
15. Install spur gear shaft (4) making sure to align dowel pins, bolt holes, and scribe lines.
  - a. Install spur gear shaft (4) with ball bearing (12) and retaining ring (13) as an assembly.
  - b. Fasten spur gear shaft (4) to cover (7) using six machine bolts (6).
  - c. Secure machine bolts (6) with new lock wire (5) (item 44, WP 0173).
  - d. Move adjusting ring (2) to align scribe marks on flyweight assembly (3) spur gear shaft (4) flange and adjusting ring (2).
  - e. Apply lubricant (item 23, WP 0173) two threaded pins (11) and install on spur gear shaft (4). Fasten to shaft using two slotted nuts (9) with flat washers (10).
  - g. Secure slotted nuts (9) with two new cotter pins (8) (item 47, WP 0175).
16. Go to work package 0162 (Fuel Injection Advance Control Test).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Before Test, Test, and After Test

**INITIAL SETUP:**

**Tools:**

- Fuel injection advance test stand  
(item 116, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Torque wrench, 0-300 inch-pounds  
(item 124, WP 0176)

**Mandatory Replacement Parts:**

- Cotter pin (2) (item 47, WP 0175)

**Expendable and Durable Items:**

- Lubricating oil, MIL-L-45199  
(item 21 WP 0173)
- Diesel fuel, VV-F-800 (DF-2)  
(item 12, WP 0173)
- Non-electrical wire (item 44, WP 0173)

**Personnel Required:**

- Track Vehicle Repairer (1) 63H10

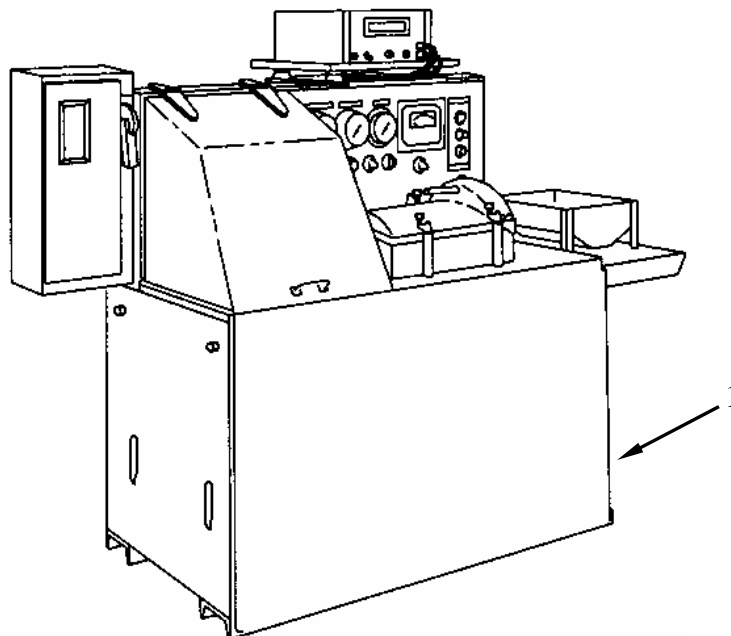
**Equipment Conditions:**

- Repaired/Assembled Fuel Injection Advance Control (WP 0161)

**BEFORE TEST**

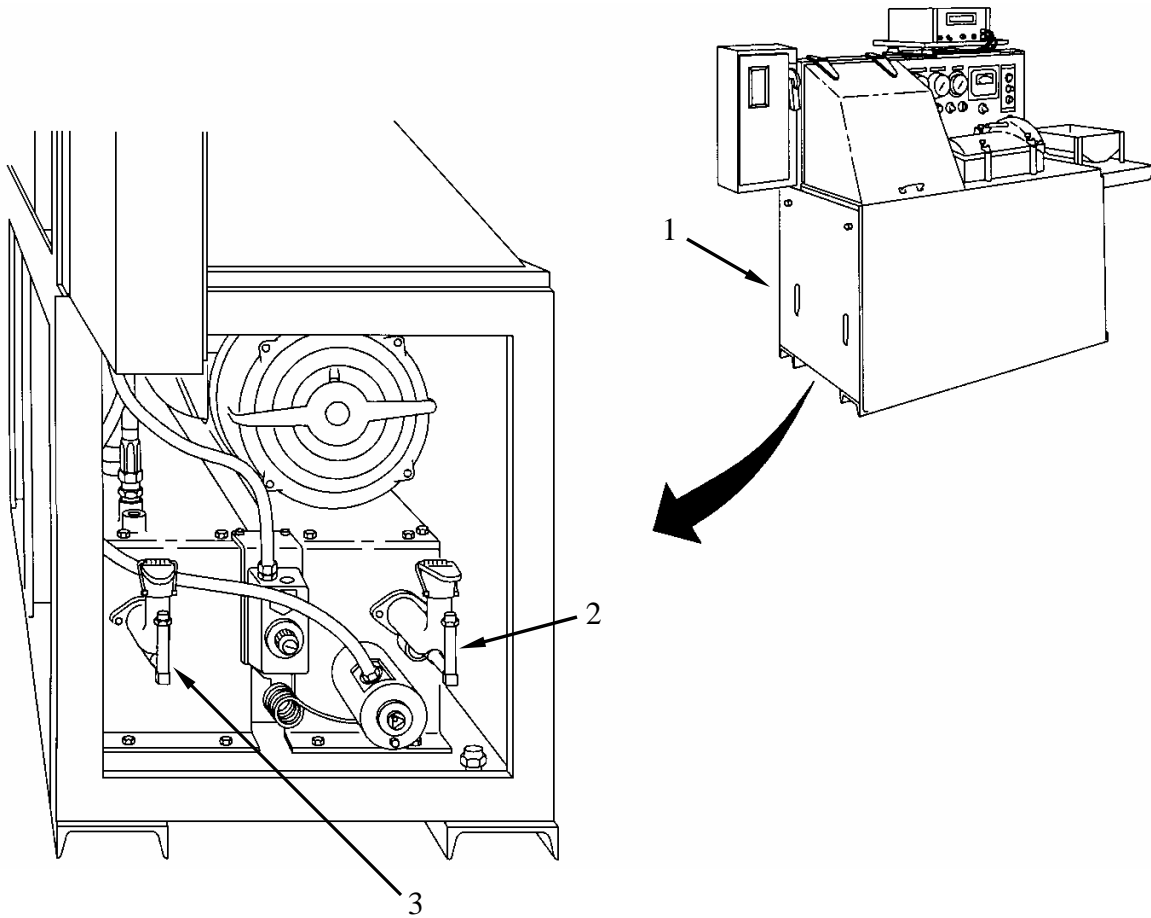
**NOTE**

Testing of the fuel injection pump advance unit is required on all units that have been repaired to ensure optimum engine performance. In addition, testing of the advance unit should be accomplished whenever the engine is overhauled. Testing will be accomplished prior to assembly of the engine rear fan and accessory drive housing assembly. Test stand (1) is designed to check and bench-test the advance characteristics of the fuel injection pump advance unit under conditions simulating engine operation over an operating range of 200 to 2600 rpm.



**BEFORE TEST (Continued)**

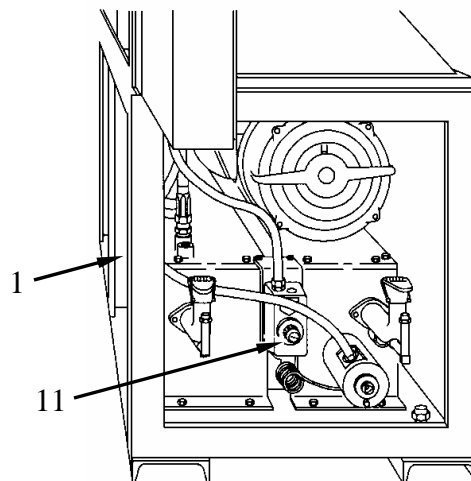
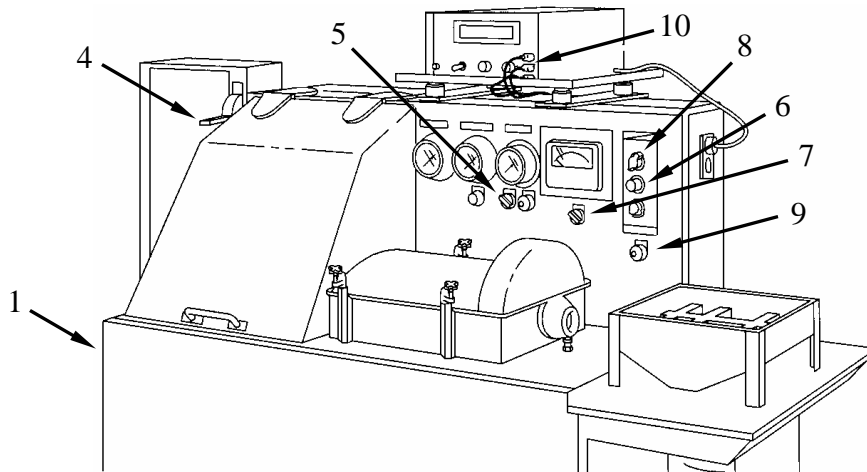
1. Check test stand (1) fluid levels.
  - a. Check fuel level gauge (2).
    - (1) Fill fuel supply tank with fuel, specification VV-F-800 (item 12, WP 0173).
  - b. Check oil level gauge (3).
    - (2) Fill oil supply tank with MIL-L-45199 (Grade 30) oil (item 21, WP 0173).



**BEFORE TEST (Continued)****CAUTION**

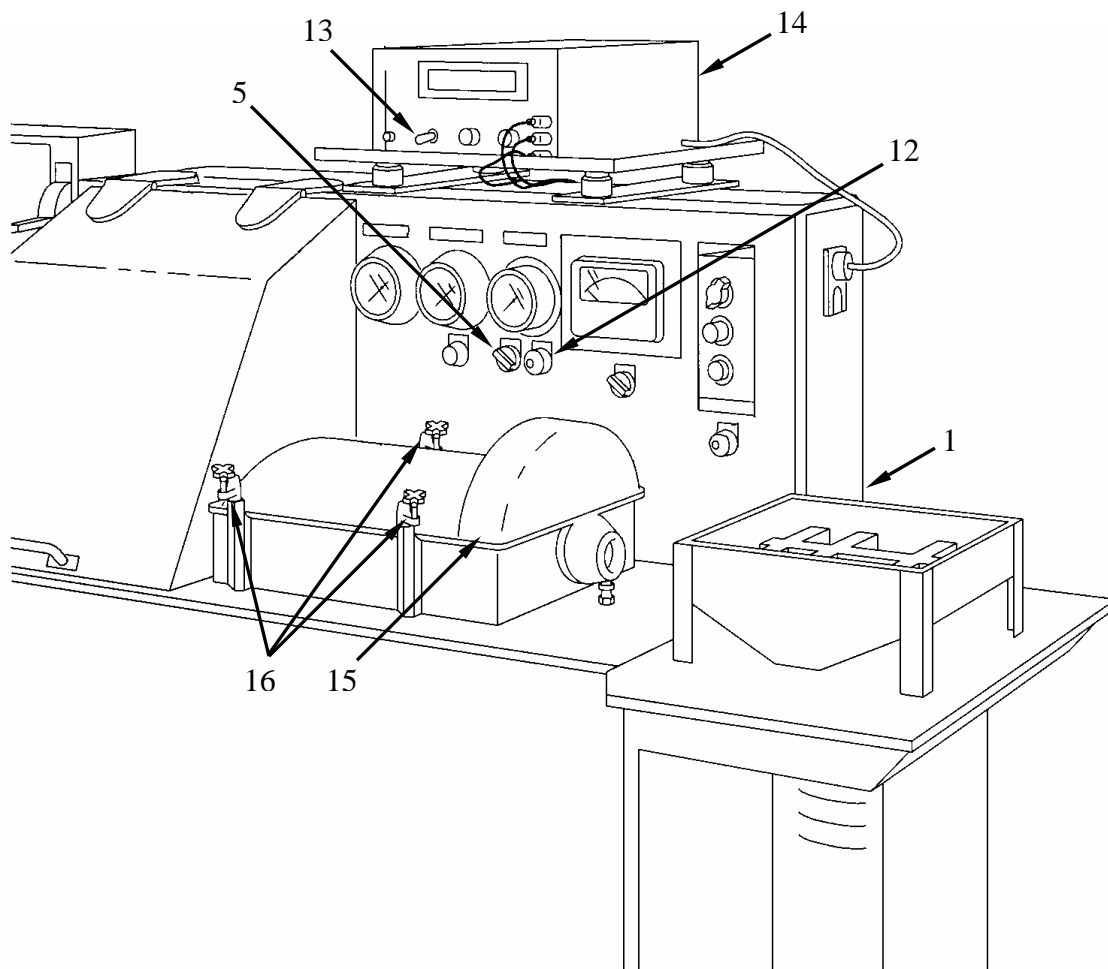
**In order for the test stand to function properly, the following steps must be followed.**

2. Test stand (1) setup.
  - a. Assure that master switch (4) oil heater switch (5), jog run (clutch engage) switch (6), and the motor switch (7) are all in the "OFF" position and that the speed control (8) is at zero (0).
  - b. Turn the master switch (4) to the "ON" position. The power indicator light (9) should be on. If the power indicator light does not light, press the reset button (10). If light does not come on, investigate and correct the fault before proceeding.
  - c. Turn oil heater control (11) to a setting of 200 °F (93.33 °C).



**BEFORE TEST (Continued)**

2. Test stand (1) setup (Continued).
  - d. Turn oil heater switch (5) "ON". The indicator light (12) should light when the heater switch is turned on, and should go out when the oil reaches the selected oil temperature.
  - e. Turn the electronic counter switch (13) "ON" to allow the counter (14) time for "warm-up". The electronic components in the counter will reach operating temperature by the time the test is begun.
3. Remove fixture cover (15).
  - a. Loosen fasteners (16) and remove cover (15) from test stand (1).





**BEFORE TEST (Continued)**

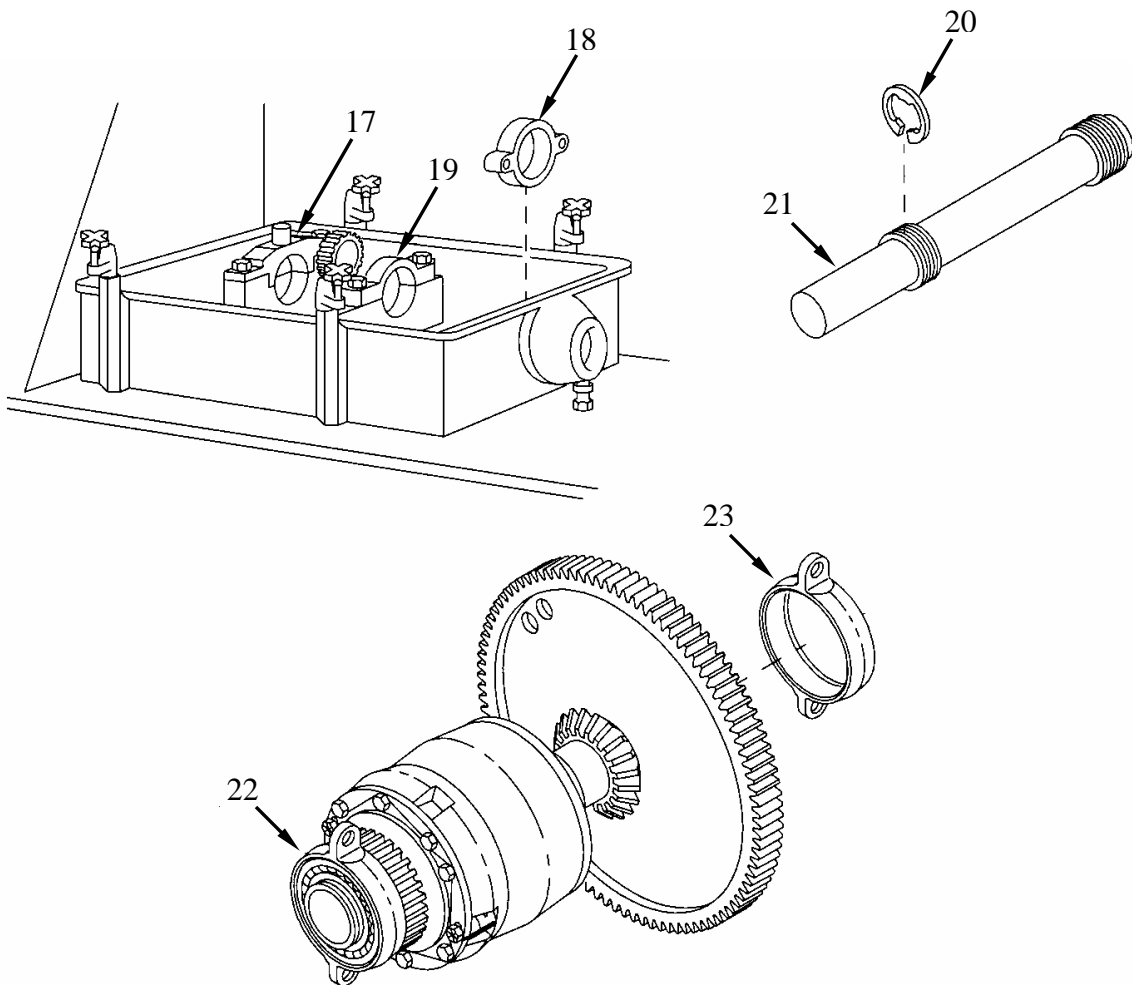
4. Remove both "end" bearing supports (17, 18) and center bearing cap (19) from mounting fixture.

**CAUTION**

Be sure that retaining ring (20) is in place on slave shaft (21). Failure to comply will result in false test readings.

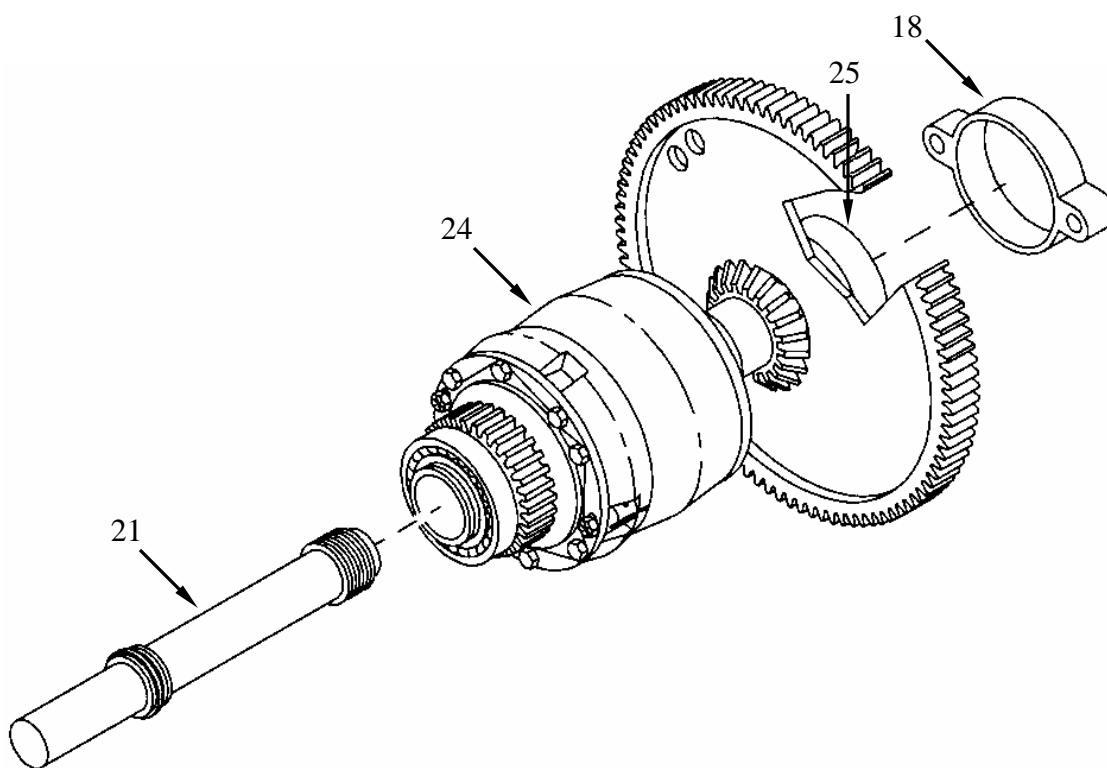
**NOTE**

Bearing support (22) and rotating eye bracket (23) must be removed to install automatic fuel injection advance control in test stand mounting fixture. If not already removed, remove them now.

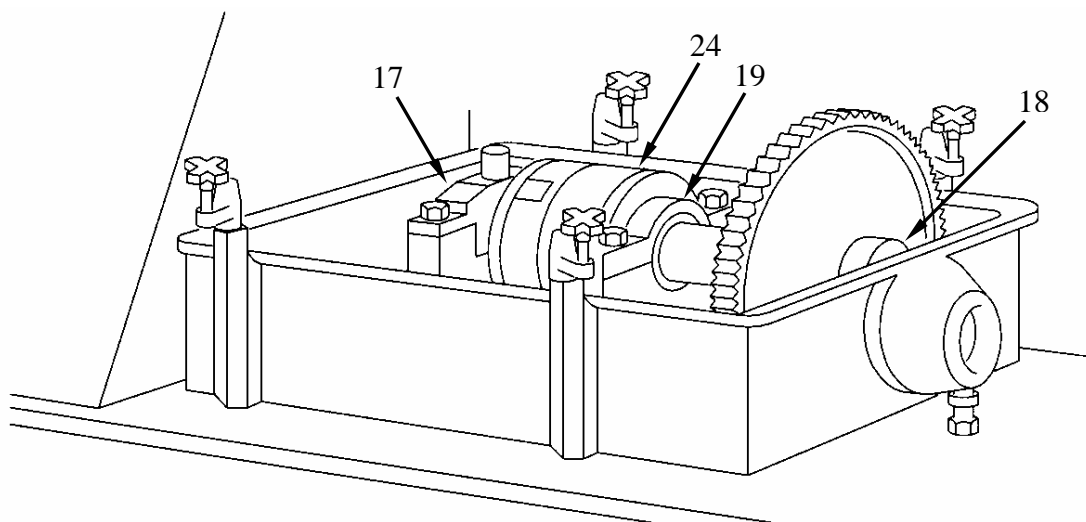


**BEFORE TEST (Continued)**

5. Install slave shaft (21) in small end of advance control (24).
6. Install (test stand) bearing support (18) over ball bearing (25).



7. Install advance control (24) in mounting fixture.
  - a. Position advance control unit (24) into test stand fixture.
  - b. Install center bearing cap (19) and end bearing support (17).
  - c. Secure cap (19) and both bearing supports (17, 18).

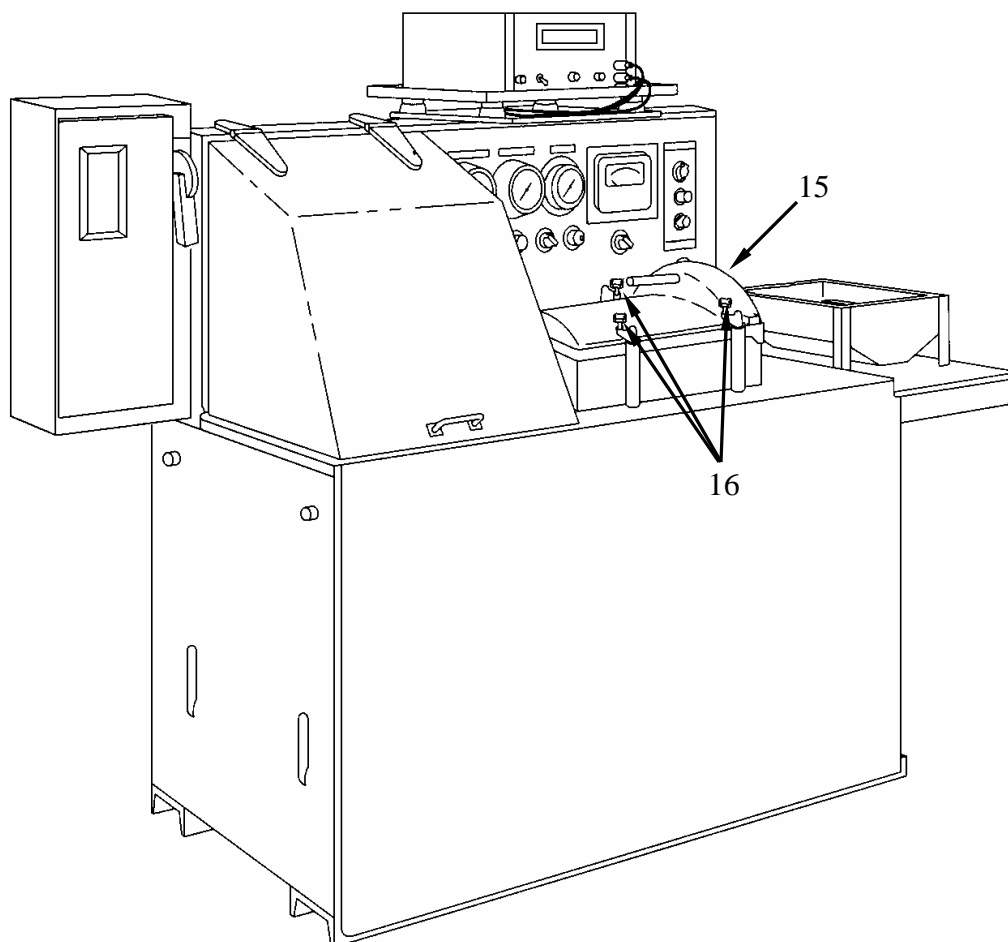


## BEFORE TEST (Continued)

**WARNING**

The test stand fixture cover must be in place and secured any time the unit is being tested. Hot oil and moving parts could cause severe personal injury.

8. Install fixture cover (15) and secure with fasteners (16).



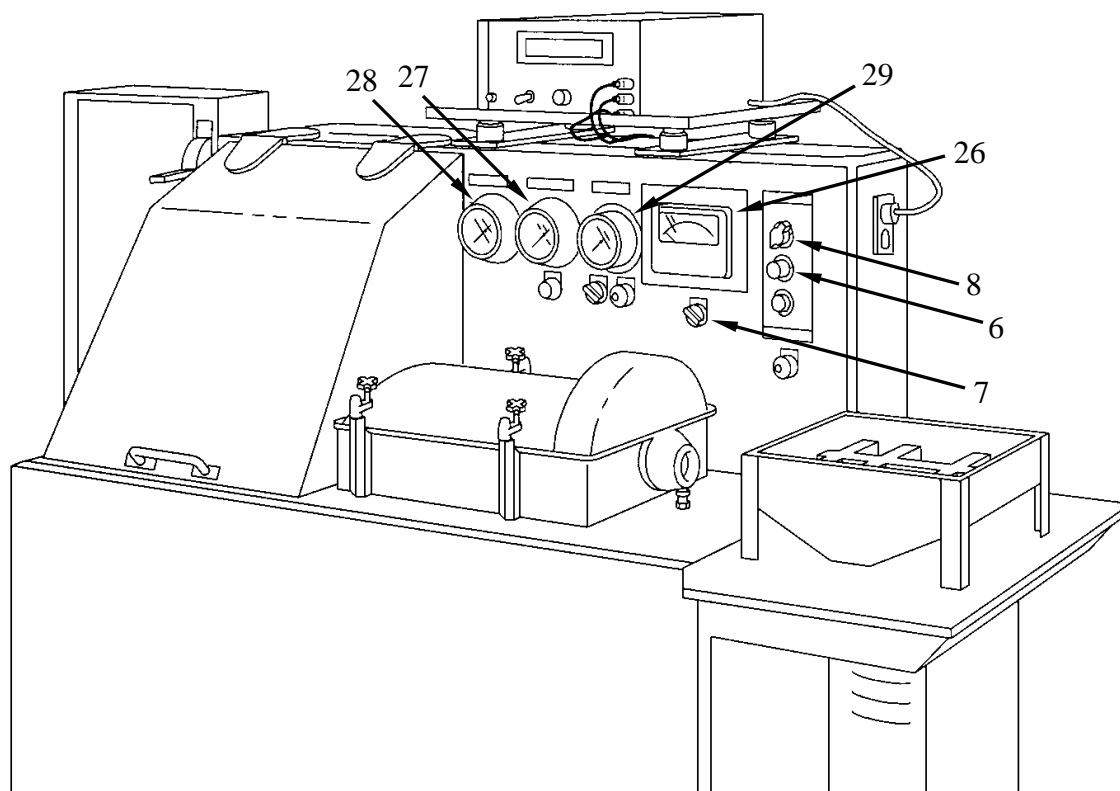
**TEST**

1. Turn motor switch (7) "ON".
2. Push jog/run switch (6) and turn speed regulator control (8) clockwise to obtain a speed of 300 rpm as indicated on tachometer (26).
3. Observe oil pressure indicator gauge (27) and fuel pressure indicator gauge (28).

**CAUTION**

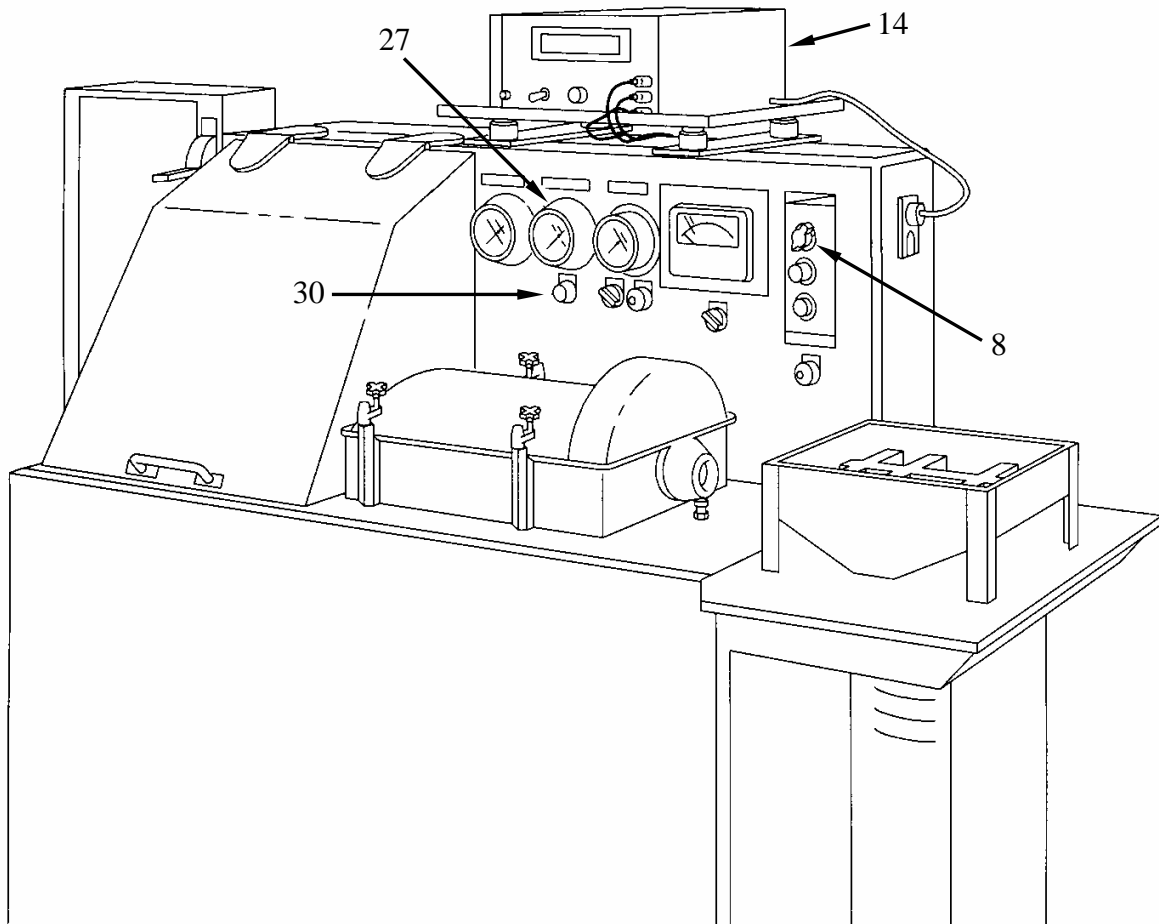
**Turn master switch handle "OFF" if there is no indication of oil or fuel pressure on the gauges. Investigate and correct the deficiency before continuing test. Failure to comply may result in damage to equipment.**

- a. Both gauges should register more than zero (0); however, maximum pressures will not be evident until a speed of 2000 rpm is obtained.
4. Operate test stand at 300 rpm until the oil temperature dial (29) stabilizes at 200 °F (93.33 °C).
    - a. It may require several minutes of running at 300 rpm to warm the entire system to operating temperature.



**TEST (Continued)**

5. Note and record reading from electronic counter (14).
  - a. The next page of this work package has a form for recording this data.
6. Press oil drain switch (30).
  - a. The oil pressure indicator gauge (27) should register zero (0) psi (0 kPa) with the switch depressed.
  - b. Observe electronic counter (14) with the switch depressed. If the counter has changed more than 2 degrees, the advance unit requires adjustment. Refer to adjustment procedure in this work package.
7. Release oil drain switch (30) and turn speed regulator control (8) clockwise to increase the speed to 600 rpm.
  - a. Note and record the electronic counter (14) reading at each 200-rpm increment beginning at 600 rpm and continuing through 2600 rpm.
8. Reduce speed to 600 rpm and recheck electronic counter (14) reading.
  - a. If this reading does not repeat the original reading, repeat the test.



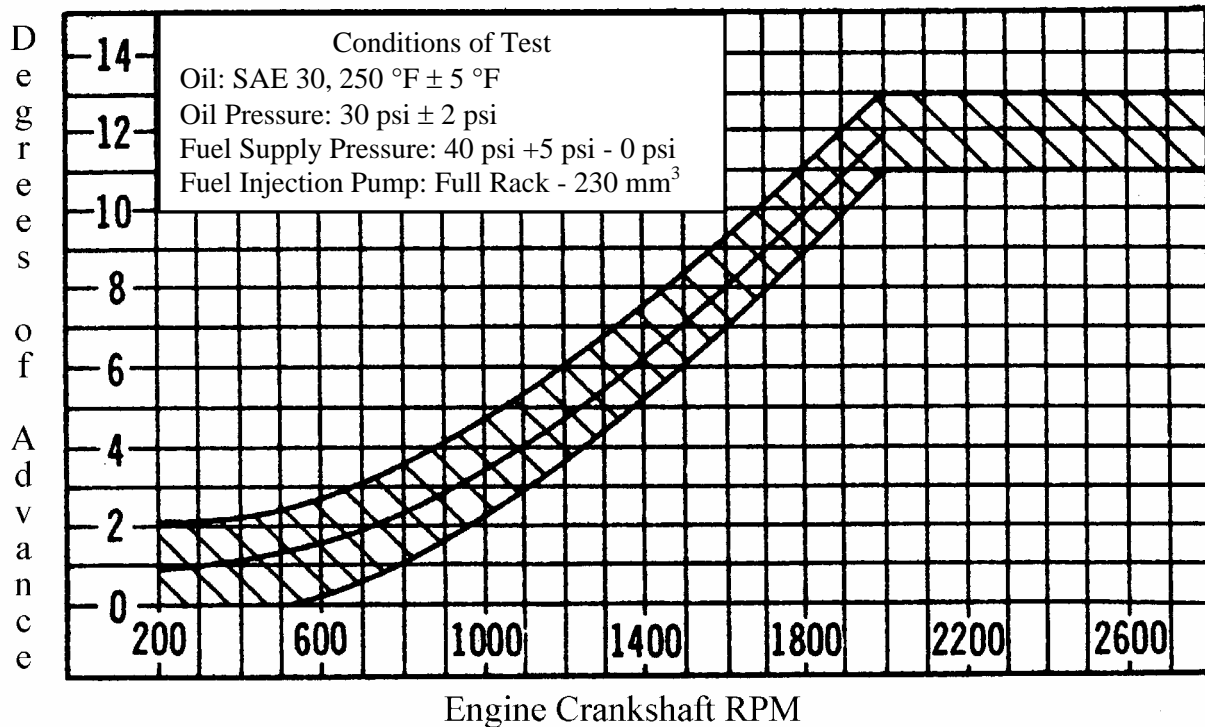
FUEL INJECTION ADVANCE CONTROL TEST

0162 00

TEST (Continued)

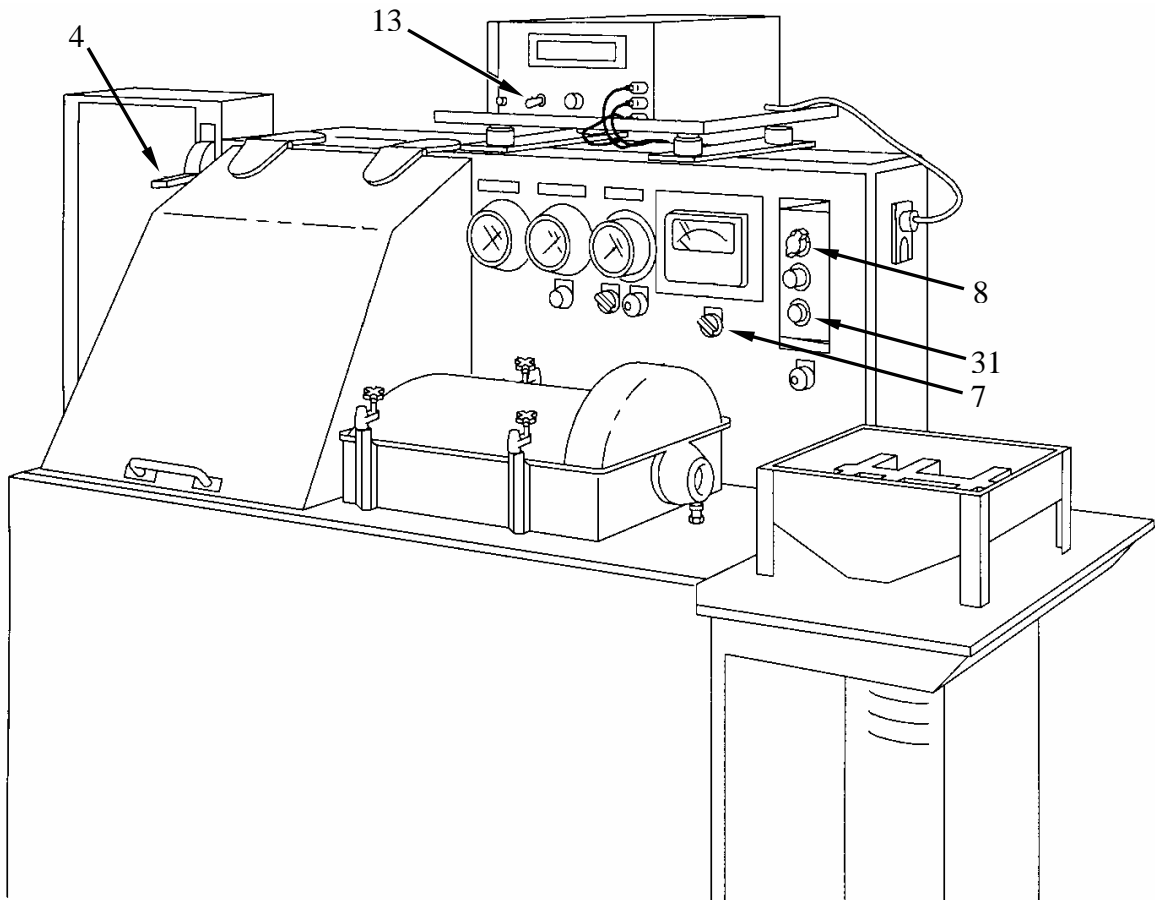
Title: Injection Advance Readings		Engine Model: _____
RPM	Degrees of Advance	Date: _____ Serial Number: _____ Tester: _____ Oil Temperature: _____ Oil Pressure: _____ Remarks: _____ _____ _____ _____ _____
START		
600		
800		
1000		
1200		
1400		
1600		
1800		
2000		
2200		
2400		
2600		

Injection Advance Unit Curve



**TEST (Continued)**

9. Turn speed regulator control (8) to zero (0) to reduce speed and push stop switch (31).
  
10. Turn electronic counter switch (13), motor switch (7), and master switch (4) to the "OFF" position.
  
11. Check the readings taken at each 200 rpm increase against similar points on the approved advance curve.
  - a. If the advance readings fall within the prescribed limits on the curve, the test is complete, go to "After Test" in this work package.
  
  - b. If the readings do not meet the curve limits, go to "Adjustment Procedure" in this work package.



## ADJUSTMENT PROCEDURE

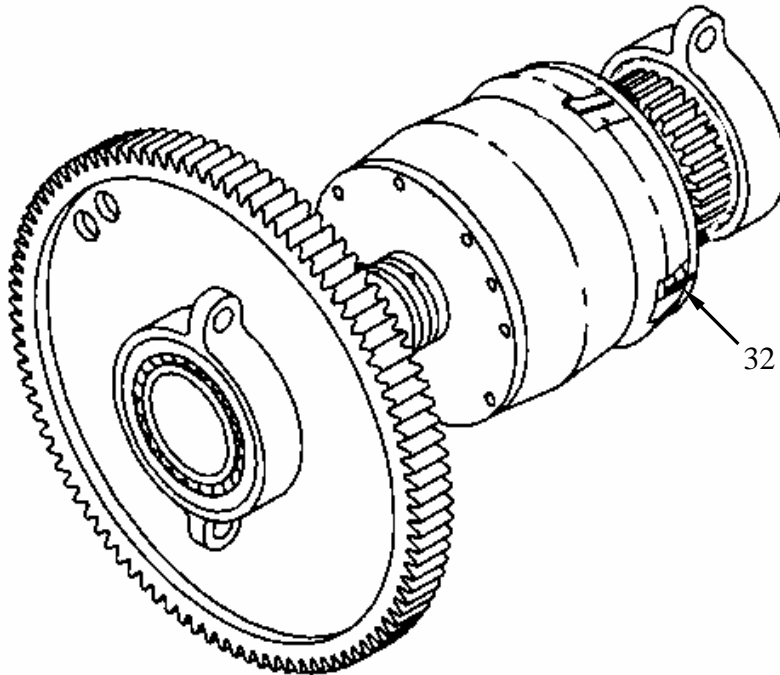
## NOTE

If the advance varies more than 2 degrees at 300 rpm when the oil pressure drain button is depressed, the advance should be retarded slightly. This variance indicates the mechanical retard stop is not in phase with the hydraulic valve.

If advance unit fails to pass the test, it may be adjusted by rotating the adjusting ring (32).

Note whether advance unit advances too soon or too late. Either condition can normally be corrected by rotating the adjusting ring.

Do not turn the adjusting ring more than 1/16 inch (1.5875 mm) during any one adjustment.



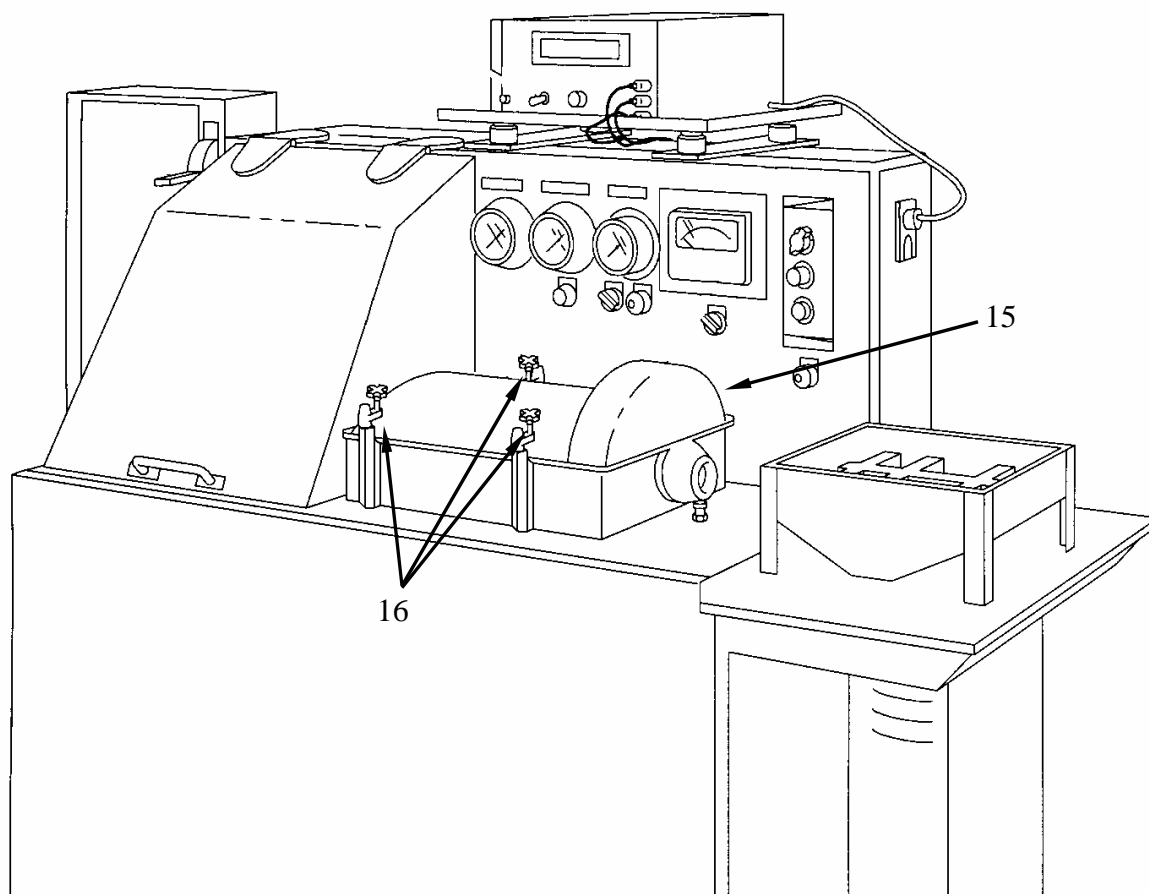


## ADJUSTMENT PROCEDURE (Continued)

**WARNING**

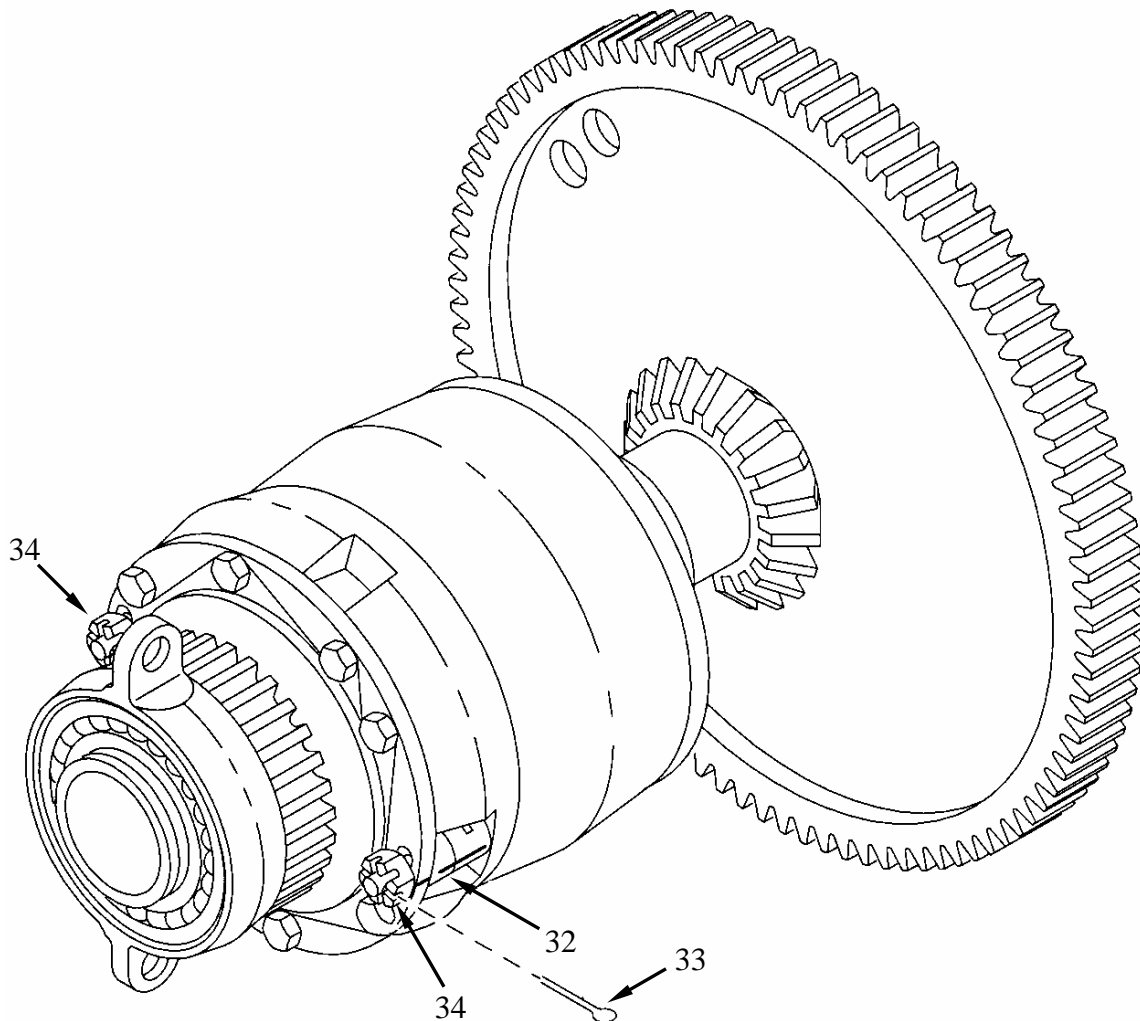
**Injection pump advance unit will be hot following test. Operator should wear gloves when adjusting unit.**

1. Remove fixture cover (15).
  - a. Loosen fasteners (16) and remove cover (15) from test stand (1).



**ADJUSTMENT PROCEDURE (Continued)**

2. Remove and discard two cotter pins (33) and loosen slotted nuts (34) enough to permit adjusting ring (32) to rotate.
3. Make adjustment.
  - a. Move the adjusting ring (32) 1/16 inch (1.5875 mm) toward the rear of test stand (retard position) if the advance unit advanced too soon.
  - b. Move the adjusting ring (32) 1/16-inch (1.5875 mm) in the opposite direction (advance position) toward the operator if the advance unit advanced too late.
4. Tighten two slotted nuts (34) to 110-150 inch-pounds (12-17 N•m).
5. Repeat "Before Test" steps 2 and 8.
6. Repeat "Test".
  - a. When advance readings are within the prescribed limits, install two new cotter pins (33) (item 47, WP 0175) go to "After Test."

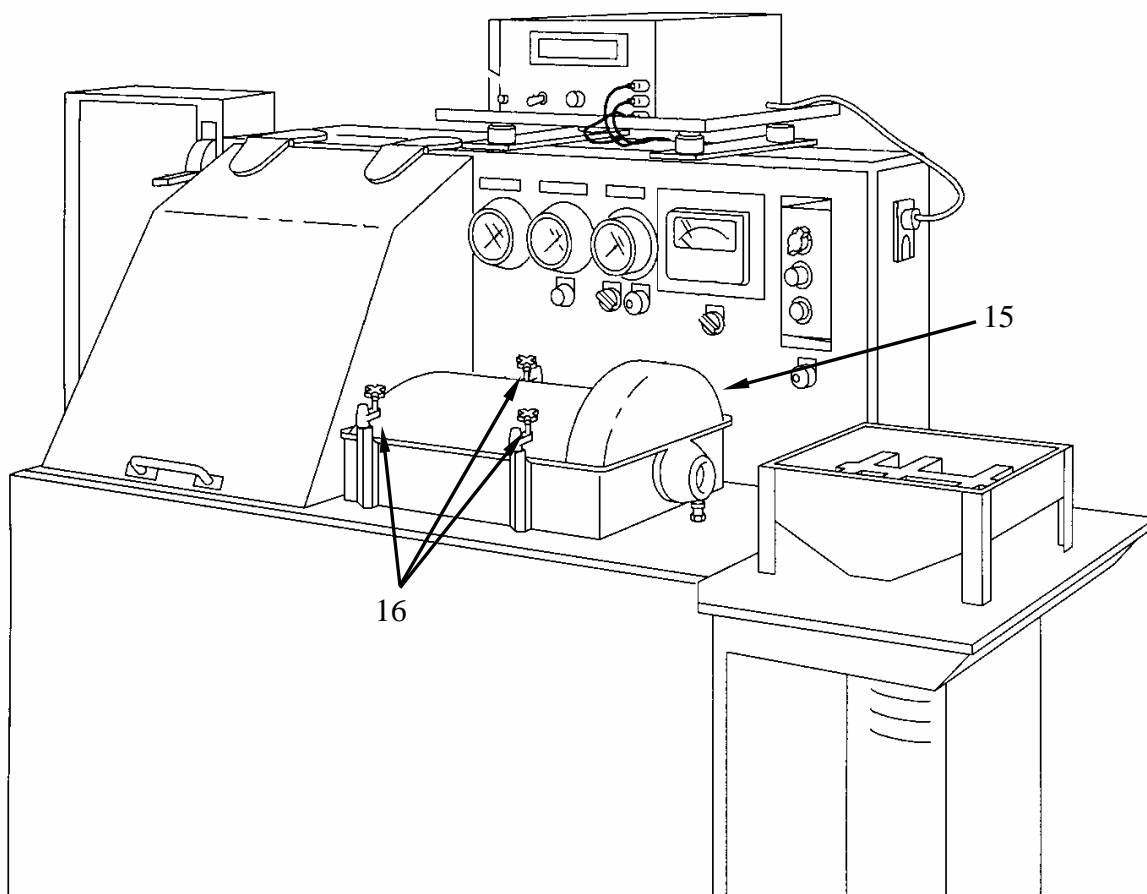


## AFTER TEST

**WARNING**

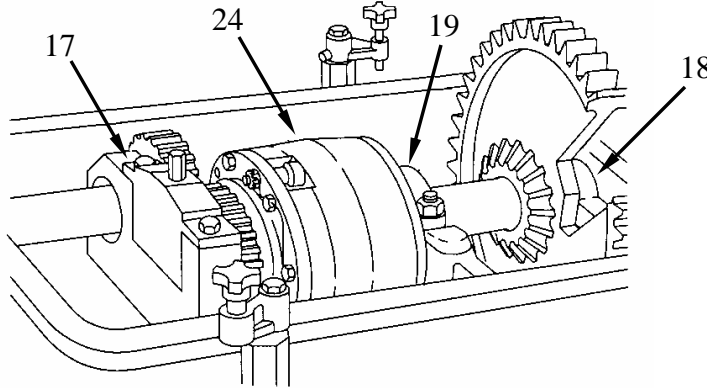
**Injection pump advance unit will be hot following test. Operator should wear gloves when adjusting unit.**

1. Remove fixture cover (15).
  - a. Loosen fasteners (16) and remove cover (15) from test stand (1).

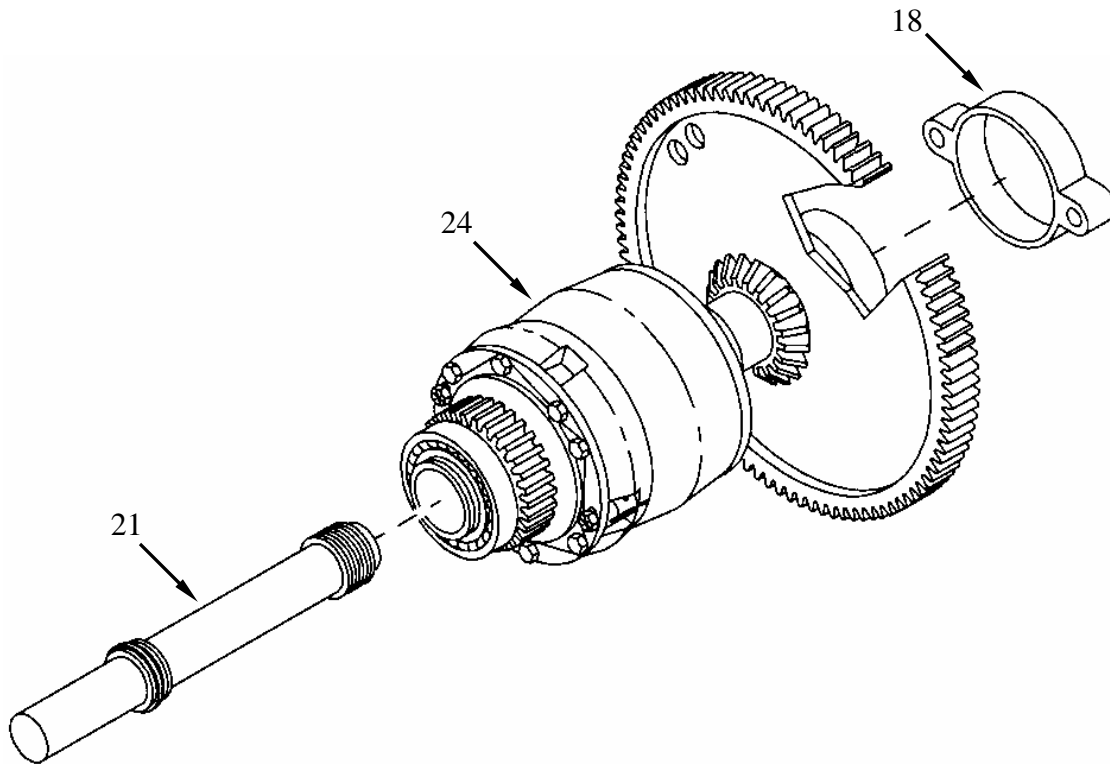


**AFTER TEST (Continued)**

2. Remove both "end" bearing supports (17, 18) and "center" bearing cap (19).

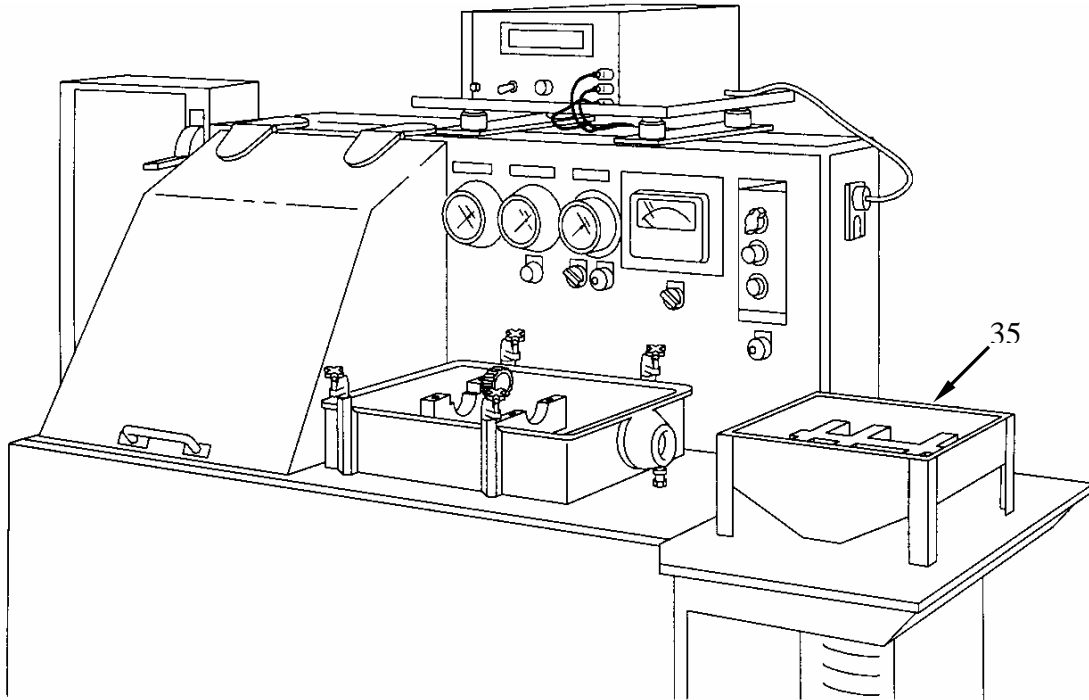


3. Remove injection pump, advance unit (24) from test stand and remove slave shaft (21) and bearing support 18.

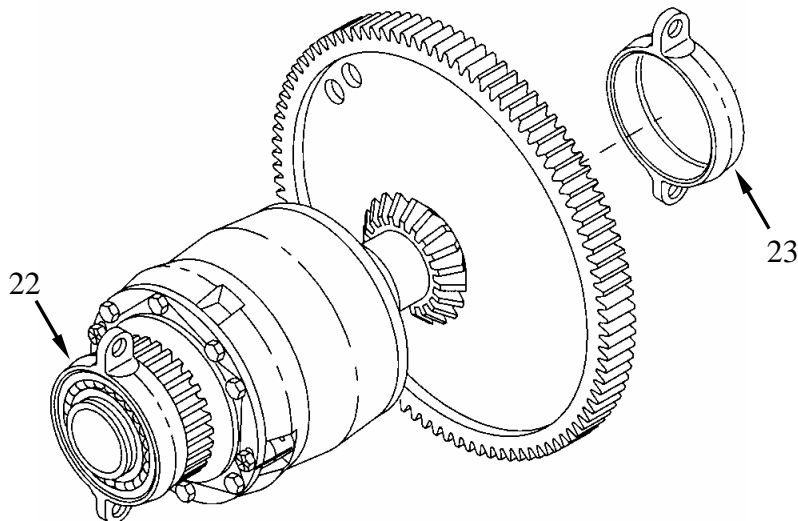


**AFTER TEST (Continued)**

4. Place injection pump, advance unit on drain tray (35) with small gear end up to drain and cool.



5. Install bearing support (22) and eye bracket (23) onto advance control unit (24).
6. Place advance control unit (24) into a clean, dirt-free container, preferably a polyethylene bag, until needed at installation.



**END OF WORK PACKAGE**



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**FUEL INJECTION PUMP BASE REPLACEMENT**

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**0163 00****THIS WORK PACKAGE COVERS:**Removal, Cleaning, Inspection, and Installation

---

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)

**Mandatory Replacement Parts:**

Lock-washers (4) (item 96, WP 0175)  
O-ring (item 64, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

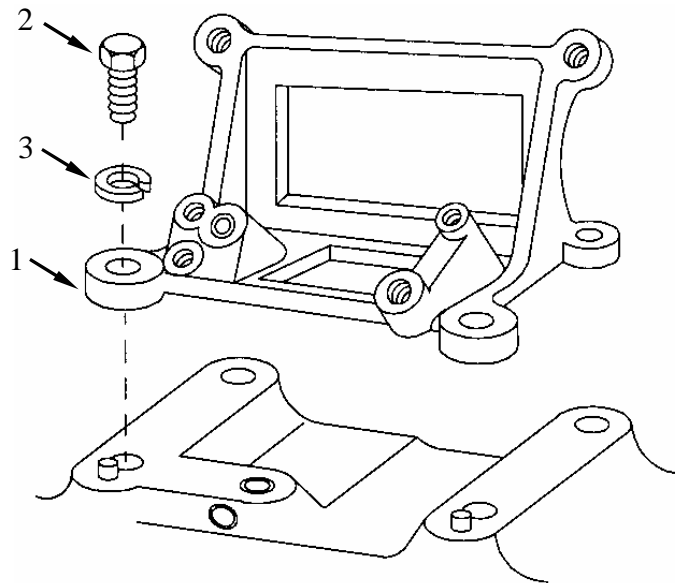
**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Fuel injection pump assembly removed  
(WP 0115)

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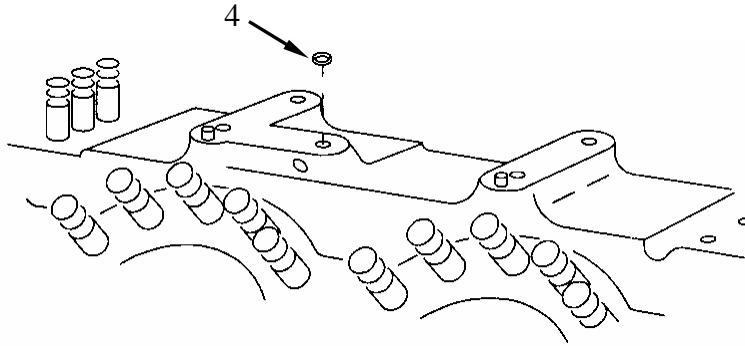
**REMOVAL**

1. Remove fuel injection pump base (1).
  - a. Remove four screws (2) with lock washers (3) from base (1). Discard lock washers.
  - b. Remove base (1) from crankcase.



**REMOVAL (Continued)**

2. Remove O-ring.
- a. Remove and discard O-ring (4) from crankcase.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

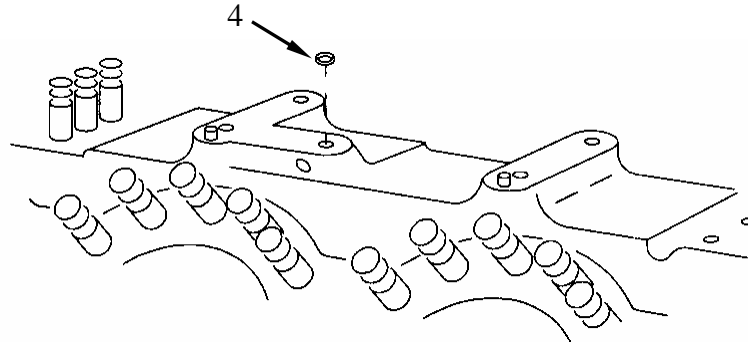
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.
2. Inspect parts for damage and replace as required.

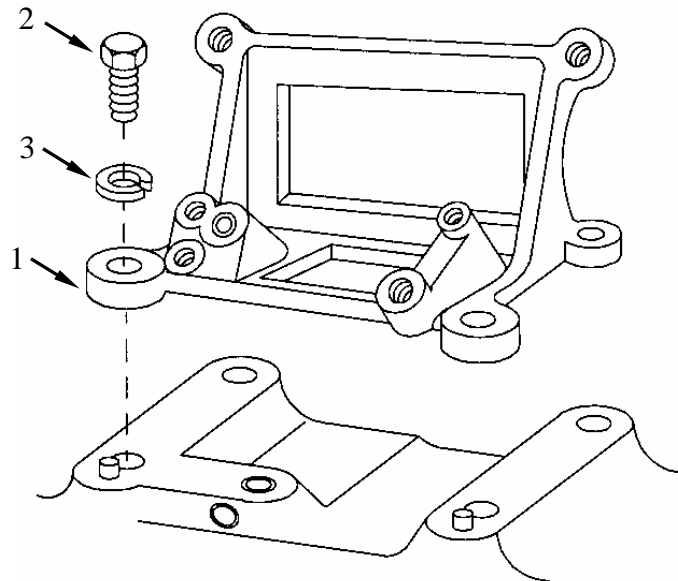


INSTALLATION

1. Install fuel injection pump base.
  - a. Apply Lubriplate (item 23, WP 0173) to new O-ring (4) (item 64, WP 0175).
  - b. Install new O-ring (4) on tube in crankcase.



- c. Lubricate four screws (2) with Lubriplate (item 23, WP 0173).
- d. Secure bracket (1) using four screws (2) with new lock washers (3) (item 96, WP 0175).
- e. Tighten four screws (2) to 56-60 foot-pounds (76-82 N•m).



END OF WORK PACKAGE



**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

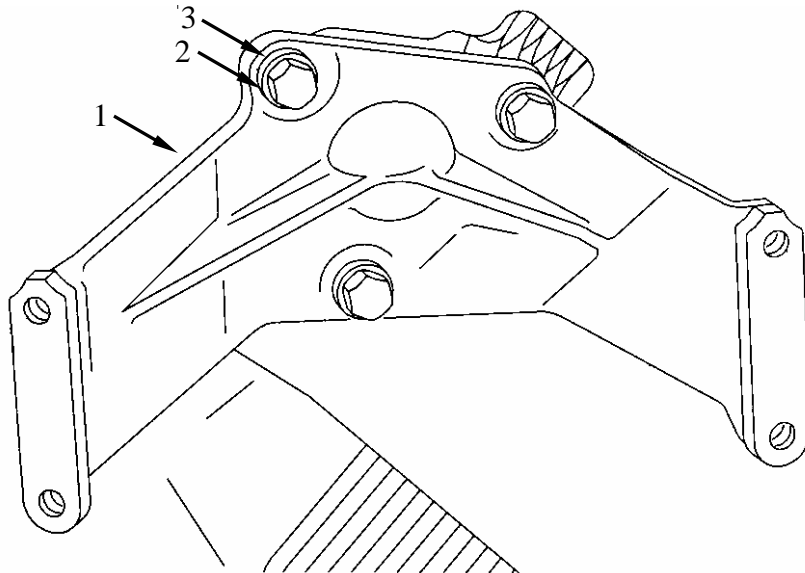
Fuel/water separator removed (WP 0085)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**REMOVAL**

1. Remove filter mounting bracket (1)
  - a. Remove three screws (2), with flat washers (3), and filter mounting bracket (1).



**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

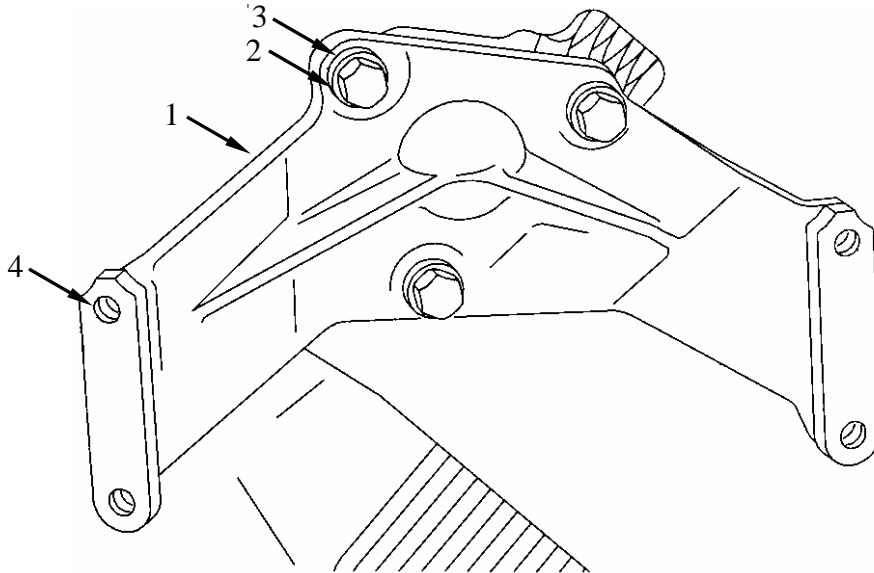
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. Replace any defective screw thread inserts (4) (refer to WP 0030).

**INSTALLATION**

1. Install filter mounting bracket (1)
  - a. Lubricate three screws (2) with Lubriplate (item 23, WP 0173).
  - b. Secure bracket (1) using three screws (2) with flat washers (3).
  - c. Tighten three screws (2) to 33-38 foot-pounds (45-51 N•m).

**END OF WORK PACKAGE**

**PRIMARY FUEL FILTER MOUNTING BRACKET REPLACEMENT****0165 00****THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:****Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

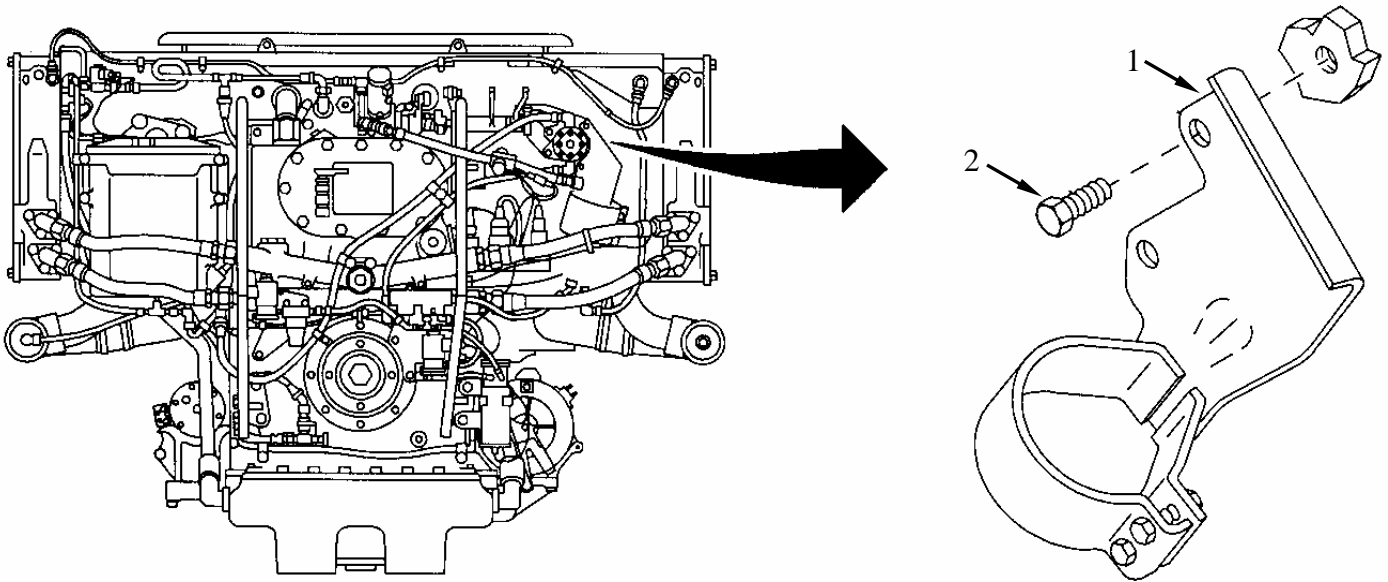
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on flat stationary surface  
Primary fuel filter removed (WP 0086)

**REMOVAL**

1. Remove filter mounting bracket (1).
  - a. Remove two screws (2) and filter mounting bracket (1).

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

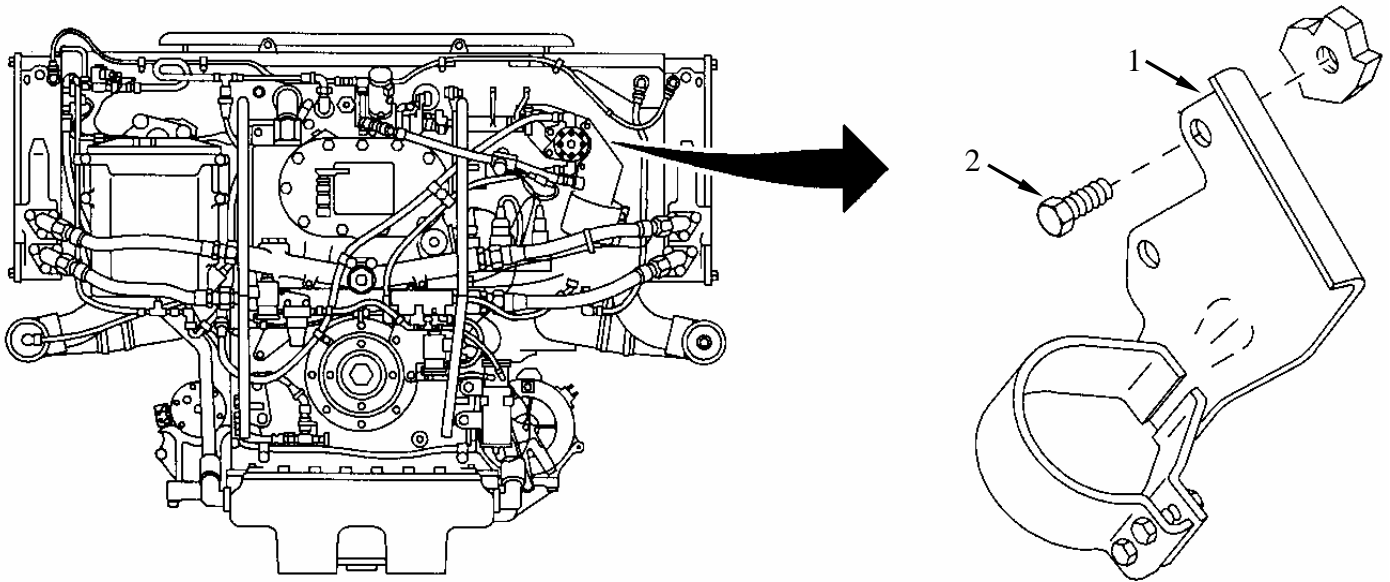
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install filter mounting bracket.
  - a. Apply Lubriplate (item 23, WP 0173) to two screws (2).
  - b. Install filter mounting bracket (1) with two screws (2).
  - c. Tighten two screws to 33-38 foot-pounds (45-51 N•m)

**END OF WORK PACKAGE**

**MANIFOLD HEATER FUEL FILTER MOUNTING BRACKET  
REPLACEMENT**

**0166 00**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
Torque wrench, 0-175 foot-pounds  
(item 127, WP 0176)

**Mandatory Replacement Parts:**

Self-locking nut (2) (item 34, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

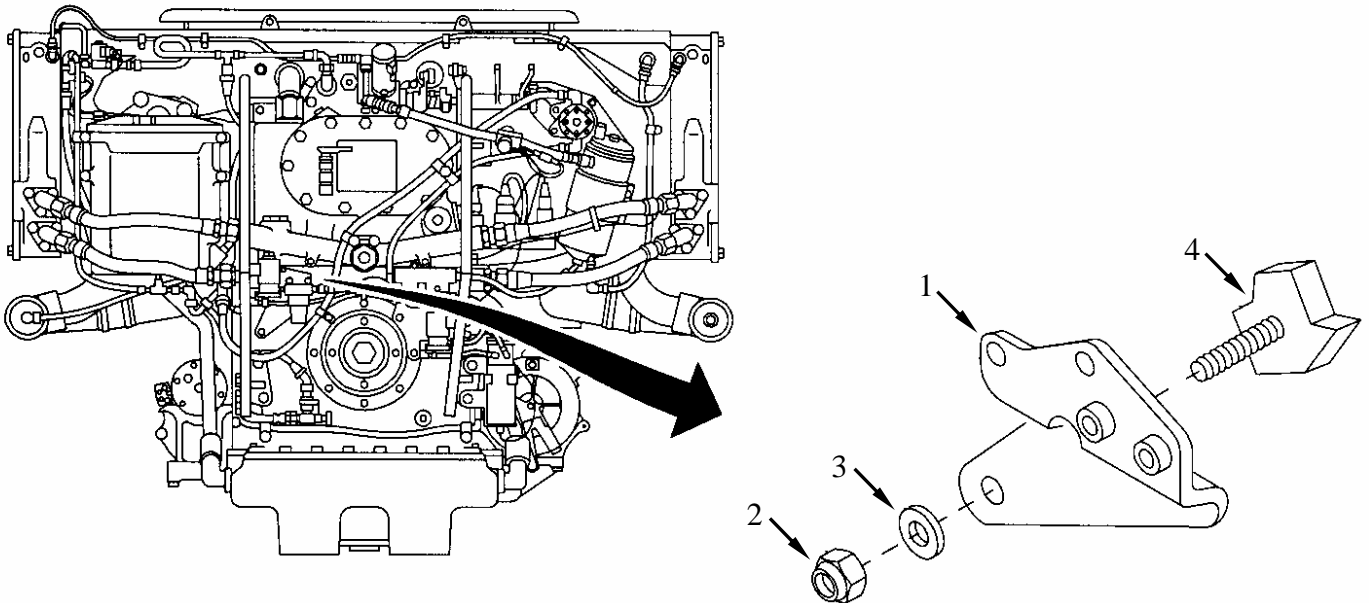
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
Flame heater filter removed (WP 0088)  
Flame heater solenoid valve removed  
(WP 0087)

**REMOVAL**

1. Remove filter mounting bracket (1).
  - a. Remove two self-locking nuts (2) with flat washers (3) securing filter mounting bracket (1) to damper housing (4). Discard self-locking nuts.
  - b. Remove filter mounting bracket (1).



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**MANIFOLD HEATER FUEL FILTER MOUNTING BRACKET  
REPLACEMENT**

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0166 00

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

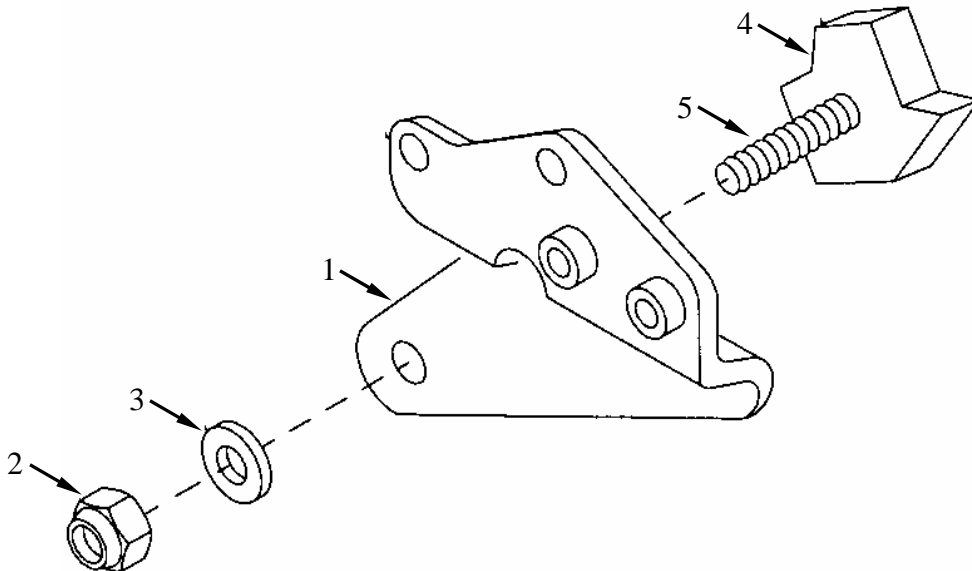
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install filter mounting bracket (1).
  - a. Position filter mounting bracket (1) on damper housing (4).
  - b. Apply a small amount of Lubriplate (item 23, WP 0173) to studs (5) on damper housing (4).
  - c. Install two new self-locking nuts (2) (item 34, WP 0175) with flat washers (3).
  - d. Tighten two self-locking nuts (2) to 19-21 foot-pounds (25-28 N•m).

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Cleaning, Inspection, and Repair

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on flat stationary surface

Fans, Vanes and Housings removed (WP0054)

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

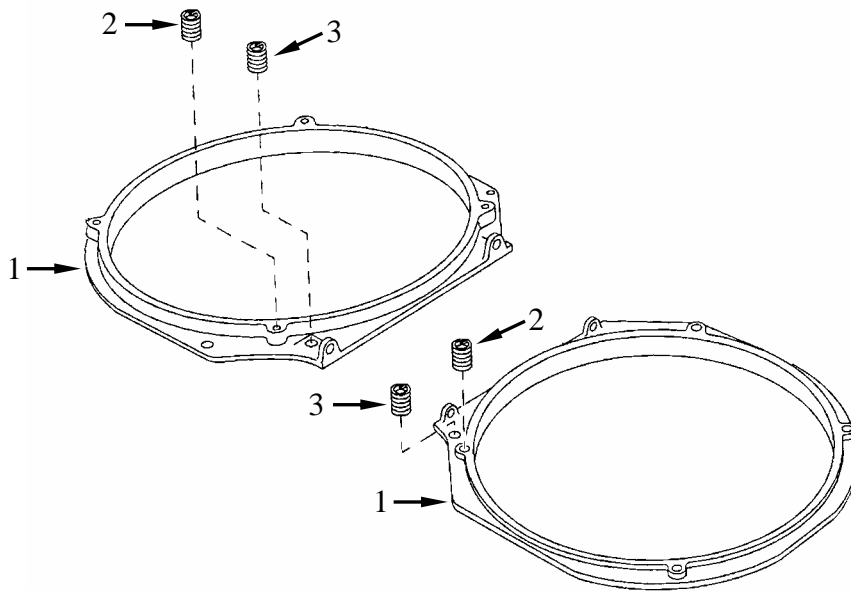
**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

1. Repair fan housings (1)
  - a. Replace defective screw thread inserts (2 and 3) in fan housings (1) (refer to WP 0030).



**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Arbor press (item 8, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Outside micrometer caliper set (item 17, WP 0176)
- Retaining ring pliers (item 79, WP 0176)
- Telescoping gauge set (item 54, WP 0176)

**Mandatory Replacement Parts:**

- Retaining ring (item 287, WP 0175)
- Ball bearing (item 294, WP 0175)
- Ball bearing (item 306, WP 0175)
- Ball bearing (item 297, WP 0175)

**Expendable and Durable Items:**

- Grease (GAA) (item 25, WP 0173)
- Non-electrical wire (item 44, WP 0173)

**Personnel Required:**

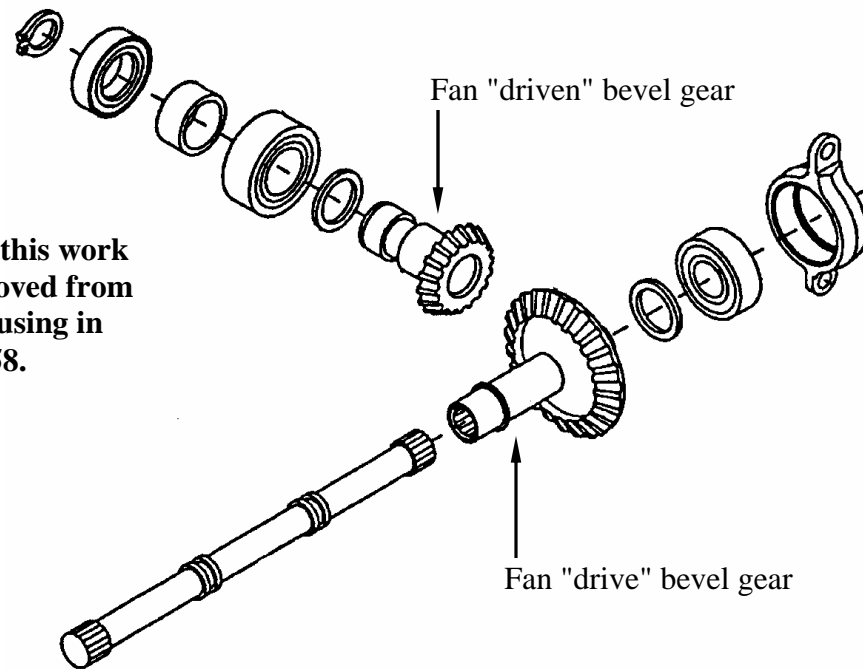
- Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Front Fan Drive and Housing removed (WP 0169)
- Accessory drive housing assembly and associated parts removed (WP 0158)

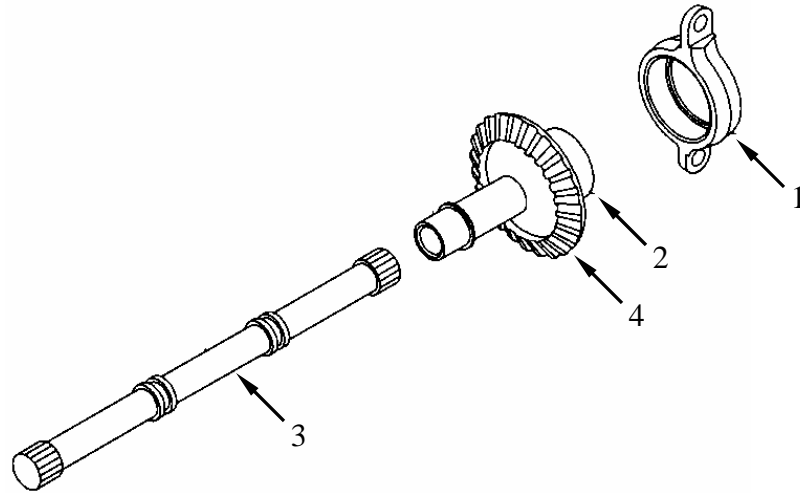
**DISASSEMBLY**

**NOTE**  
 All components in this work package were removed from accessory drive housing in Work Package 0158.

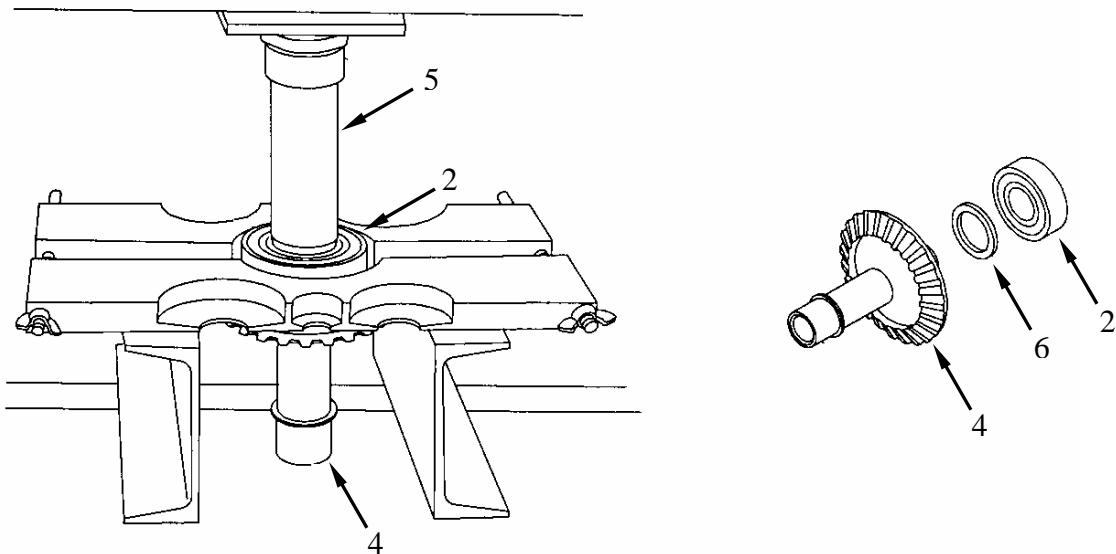


**DISASSEMBLY (Continued)**

1. Remove bearing housing (1) from ball bearing (2).
2. Remove shaft (3) from [drive] bevel gear shaft (4).

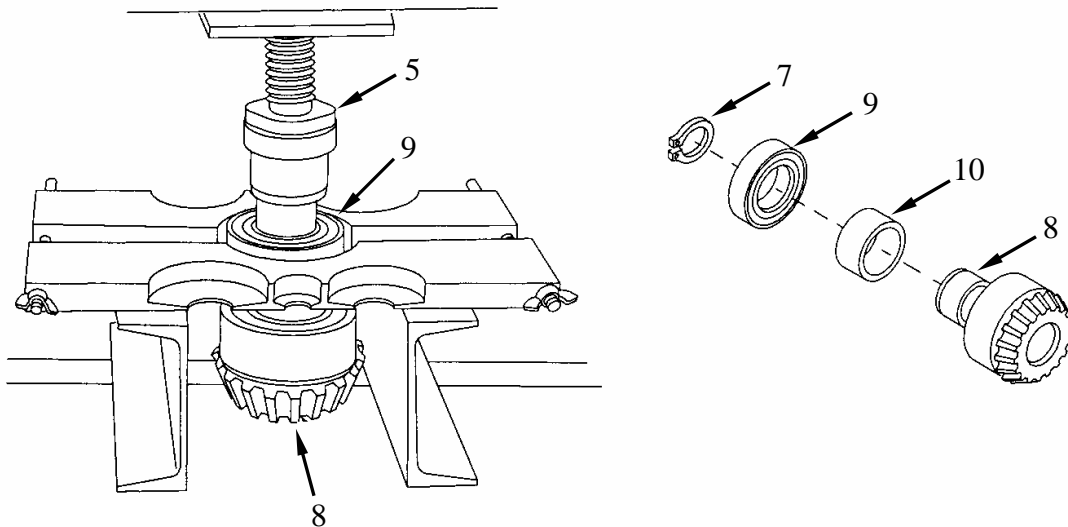


3. Using an arbor press (5), press bevel gear shaft (4) from ball bearing (2). Discard bearing.
  - a. Retain shims (6).

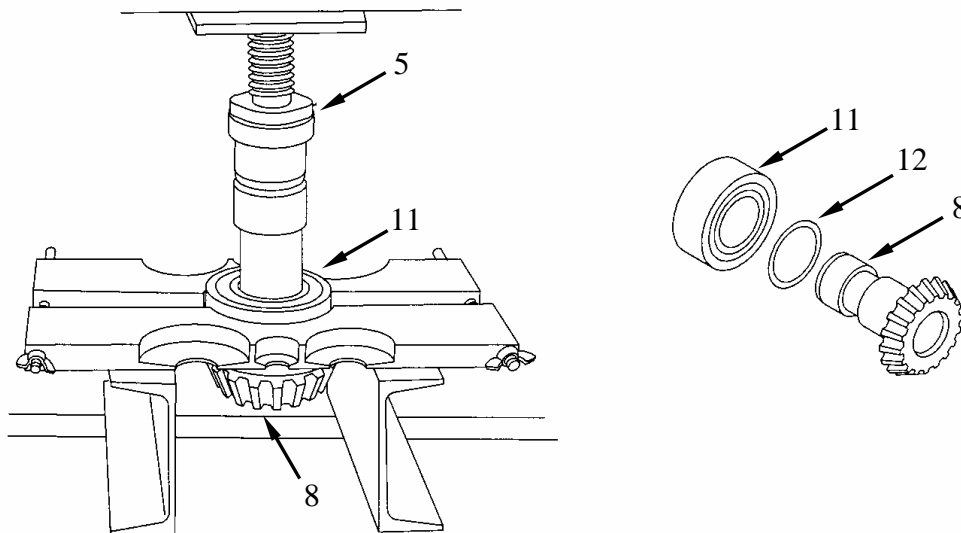


**DISASSEMBLY (Continued)**

4. Remove and discard retaining ring (7) from [driven] bevel gear shaft (8).
5. Using an arbor press (5), press bevel gear shaft (8) from outer ball bearing (9). Discard bearing.
  - a. Remove spacer sleeve (10) from bevel gear shaft (8).



6. Using an arbor press (5), press bevel gear shaft (8) from inner ball bearing (11). Discard bearing.
  - a. Remove and retain shims (12).



**CLEANING**

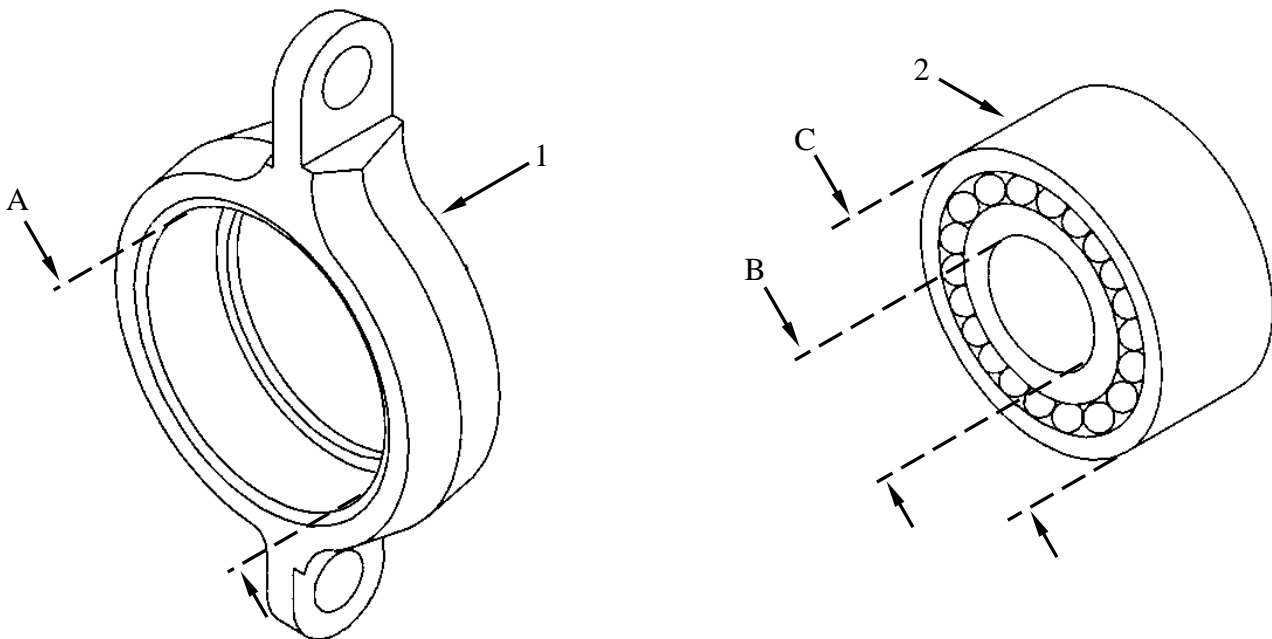
1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Measure inside diameter (A) of bearing housing (1). Replace bearing housing if not within specifications in the following table.
3. Replace bearing (2).
  - a. Use a new bearing (2) (item 294, WP 0175) that meets specifications (B, C) in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (bearing housing)	3.1495 (79.997)	3.1501 (80.012)	3.1504 (80.020)
B (bearing ID)	1.5743 (39.987)	1.5748 (39.999)	none
C (bearing OD)	3.1491 (79.987)	3.1496 (79.999)	none



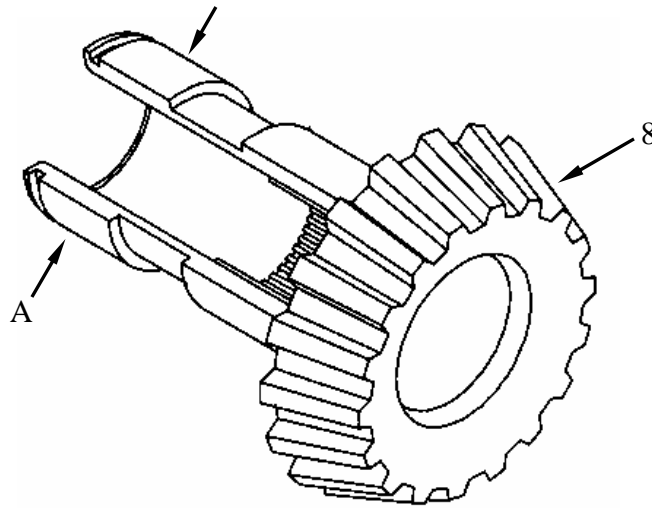
INSPECTION (Continued)

**CAUTION**

**If either the fan drive or driven bevel gear shaft require replacement, both must be replaced. They are a matched set and cannot be replaced individually.**

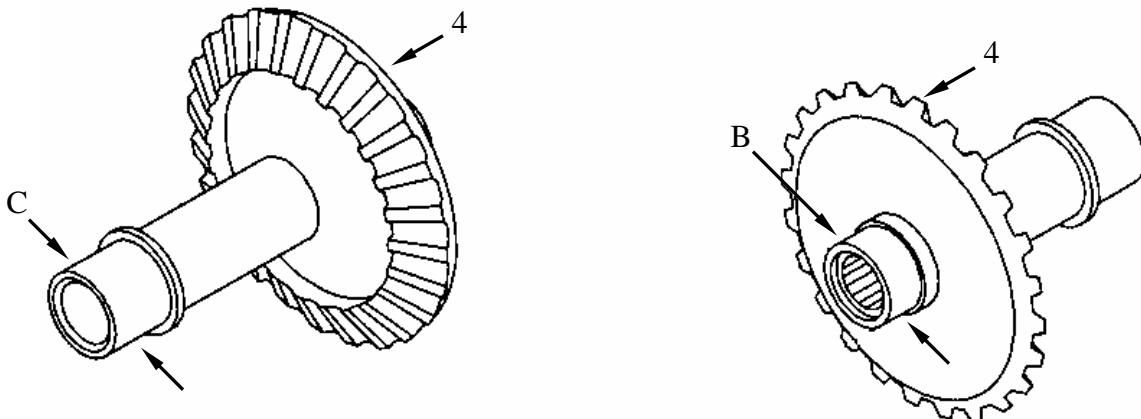
4. Measure outside diameter (A) of bearing surface on [driven] bevel gear shaft (8). Replace bevel gear shaft if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (bearing surface)	1.5749 (40.0025)	1.5753 (40.0126)	1.5747 (39.9973)



5. Measure outside diameters (B, C) of [drive] bevel gear shaft (4). Replace bevel gear shaft if not within specifications in the following table.

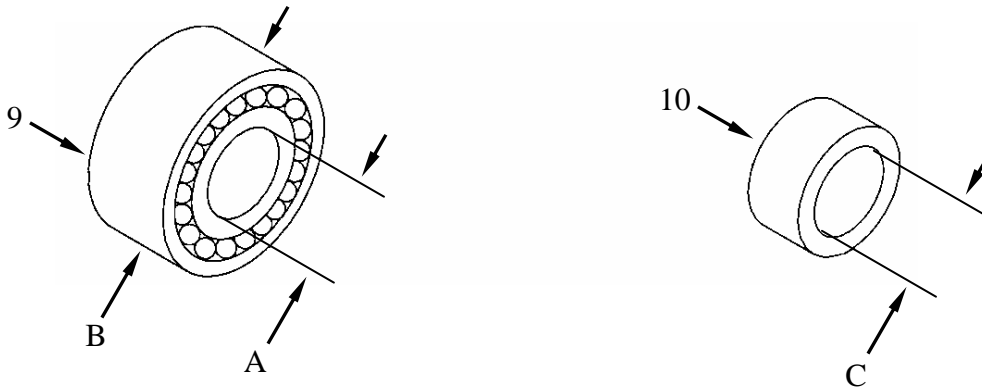
Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
B (outside diameter)	1.5749 (40.0025)	1.5753 (40.0126)	1.5747 (39.9973)
C (outside diameter)	1.6244 (41.2597)	1.6248 (41.2699)	1.6242 (41.2547)



**INSPECTION (Continued)**

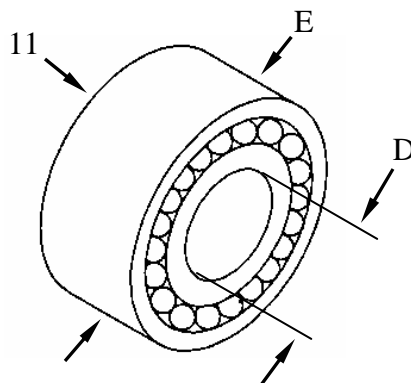
6. Replace bearing (9).
  - a. Use a new bearing (9) (item 306, WP 0175) that meets specifications (A, B) in the following table.
7. Measure spacer sleeve (10) inside diameter (C). Replace sleeve if it does not meet the specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (bearing inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
B (bearing outside diameter)	2.6767 (67.9882)	2.6772 (68.0009)	none
C (sleeve inside diameter)	1.5800 (40.1320)	1.5850 (40.2590)	1.5950 (40.5130)



8. Replace bearing (11).
  - a. Use a new bearing (11) (item 297, WP 0175) that meets specifications (D, E) in the following table.

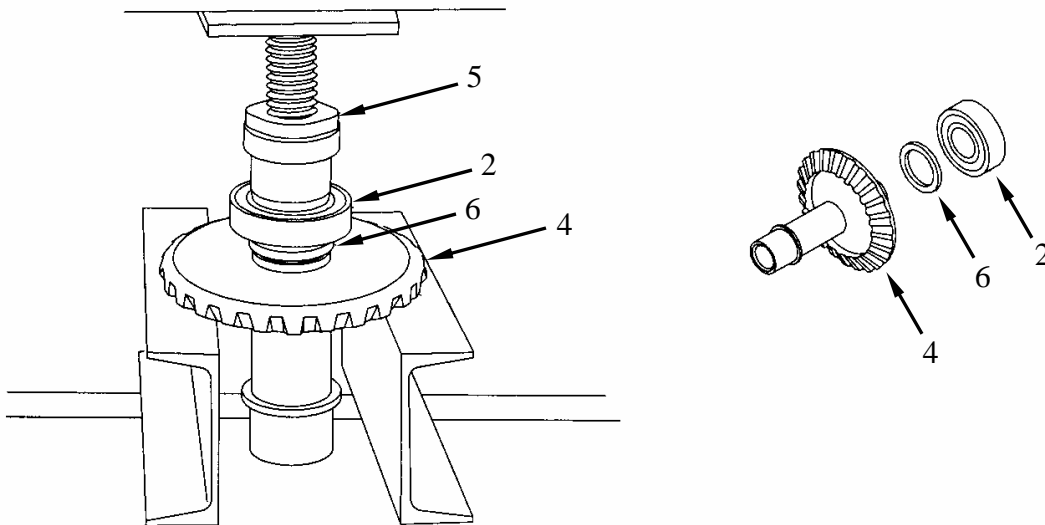
Location	Size and Fits of New Parts inches (mm)		Wear Limits
D (bearing inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
E (bearing outside diameter)	3.1491 (79.9871)	3.1496 (79.9998)	none



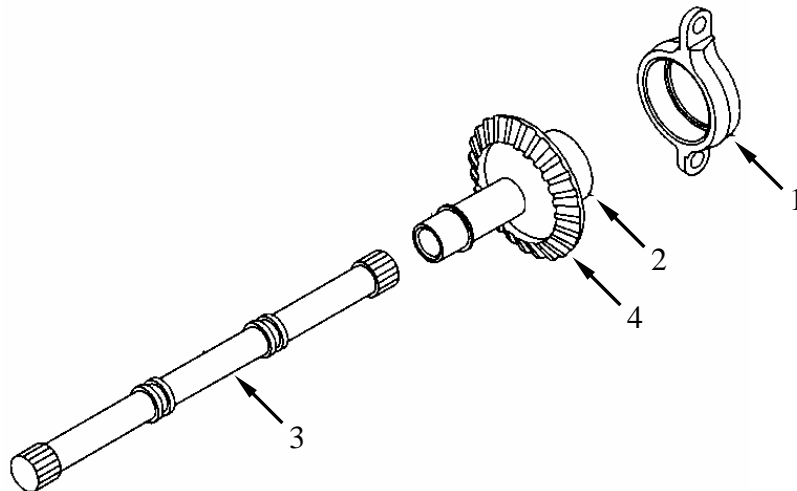


**ASSEMBLY**

1. Determine shim thickness for [drive] bevel gear shaft (4).
  - a. With endplay removed from bearing, measure total thickness of bearing from inner race to outer race.
  - b. Add shims until a total thickness of 0.7891-inch (20.0431 mm) minimum to 0.7911-inch (20.0939-mm) maximum is obtained.
  - c. Old and new shims may be mixed to obtain correct overall thickness.
2. Install bearing (2).
  - a. Position shims (6) of predetermined thickness over bearing hub of bevel gear shaft (4).
  - b. Using an arbor press (5), press new ball bearing (2) (item 294, WP 0175) onto bevel gear shaft (4) with trademark facing outward.

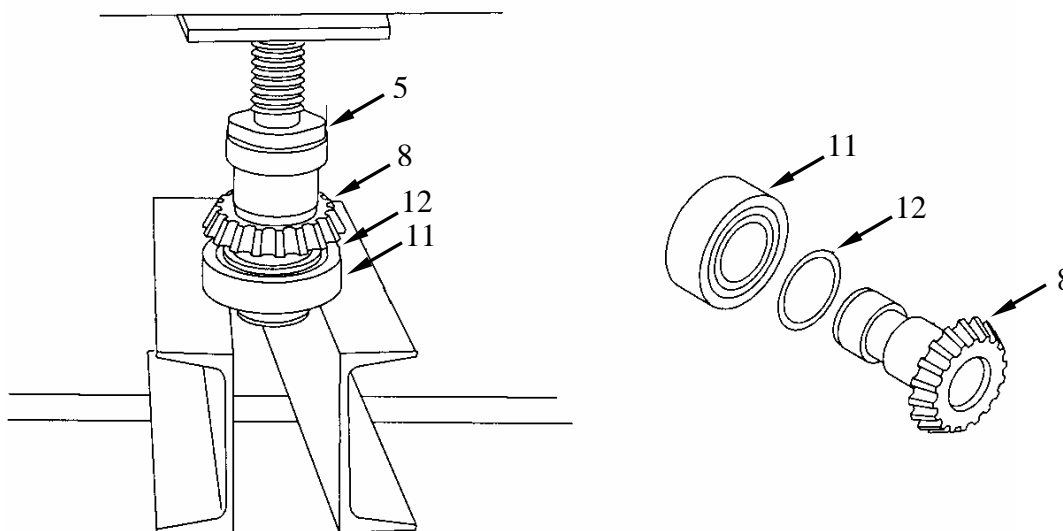


3. Install bearing housing (1) over ball bearing (2).
4. Install shaft (3) into bevel gear shaft (4).

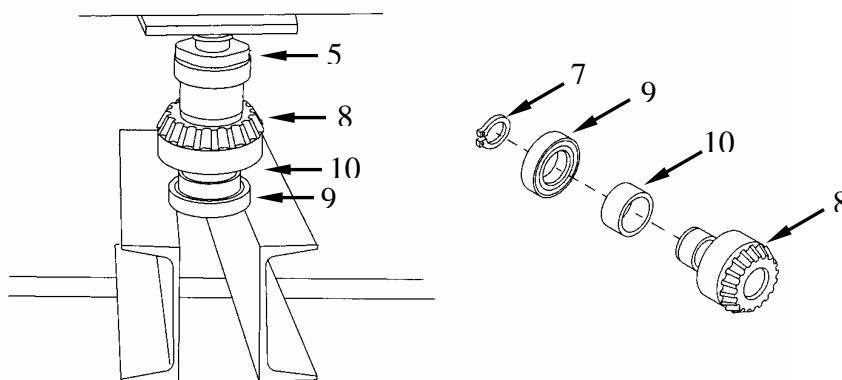


**ASSEMBLY (Continued)**

5. Determine shim thickness for [driven] bevel gear shaft (8).
  - a. With endplay removed from bearing, measure total thickness of bearing from inner race to outer race.
  - b. Add shims until a total thickness of 1.2635-inch (32.0929-mm) minimum to 1.2655-inch (32.1437-mm) maximum is obtained.
  - c. Old and new shims may be mixed to obtain correct overall thickness.
6. Install inner bearing (11).
  - a. Position shims (12) of predetermined thickness on inner race of new ball bearing (11) (item 297, WP 0175).
  - b. Using an arbor press (5), press bevel gear shaft (8) into ball bearing (11).



7. Install spacer (10) onto bevel gear shaft (8).
8. Install outer bearing (9).
  - a. Using an arbor press (5), press bevel gear shaft (8) into new ball bearing (9) (item 306, WP 0175).
  - b. Secure ball bearing (9) to bevel gear shaft (8) with a new retaining ring (7) (item 287, WP 0175).

**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Disassembly, Cleaning, Inspection, Repair, and Assembly

**INITIAL SETUP:**

**Tools:**

- Arbor press (item 8, WP 0176)
- General mechanic's tool kit (item 121, WP 0176)
- Inside micrometer caliper set (item 16, WP 0176)
- Outside caliper set (item 17, WP 0176)
- Retaining ring pliers (item 81, WP 0176)
- Telescoping gauge set (item 54, WP 0176)
- Torque wrench, 200-1000 inch-pounds (item 125, WP 0176)

**Fabricated Items:**

- Lifting tool (item 2, WP 0177)

**Mandatory Replacement Parts:**

- Ball bearing (item 294, WP 0175)
- Ball bearing (item 297, WP 0175)
- Ball bearing (item 306, WP 0175)
- Cotter pin (4) (item 48, WP 0175)
- Hose (item 181, WP 0175)
- Key washer (item 320, WP 0175)
- O-ring (item 62, WP 0175)
- O-ring (2) (item 154, WP 0175)
- Pipe plug (item 277, WP 0175)

**Mandatory Replacement Parts (Continued)**

- Retaining ring (item 17, WP 0175)
- Retaining ring (2) (item 287, WP 0175)
- Self-locking nut (4) (item 24, WP 0175)
- Self-locking nut (9) (item 140, WP 0175)

**Expendable and Durable Items:**

- Lubriplate (item 29, WP 0173)
- Pipe sealant (item 42, WP 0173)
- Sealing compound (item 33, WP 0173)
- Wire, nonelectrical (item 44, WP 0173)

**Personnel Required:**

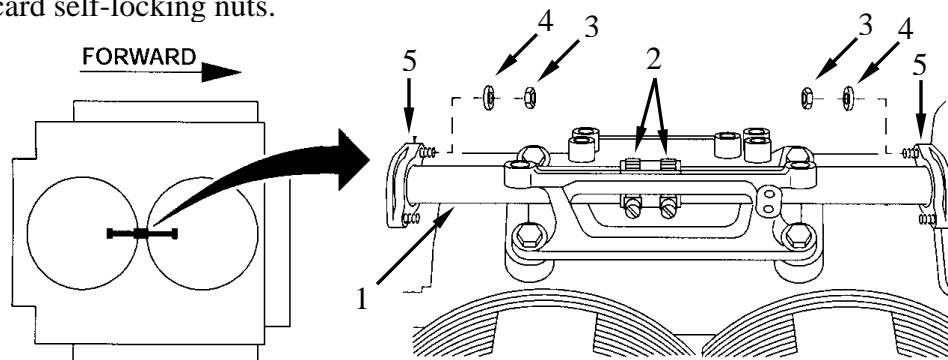
- Track Vehicle Repairer (2) 63H10

**Equipment Conditions:**

- Engine on maintenance stand (WP 0130)
- Breather tubes and oil supply hoses removed (WP 0078)
- Fuel return lines (WP 0080) and fire extinguisher tube removed (0097)
- Fuel injection pump assembly removed (WP 0115)

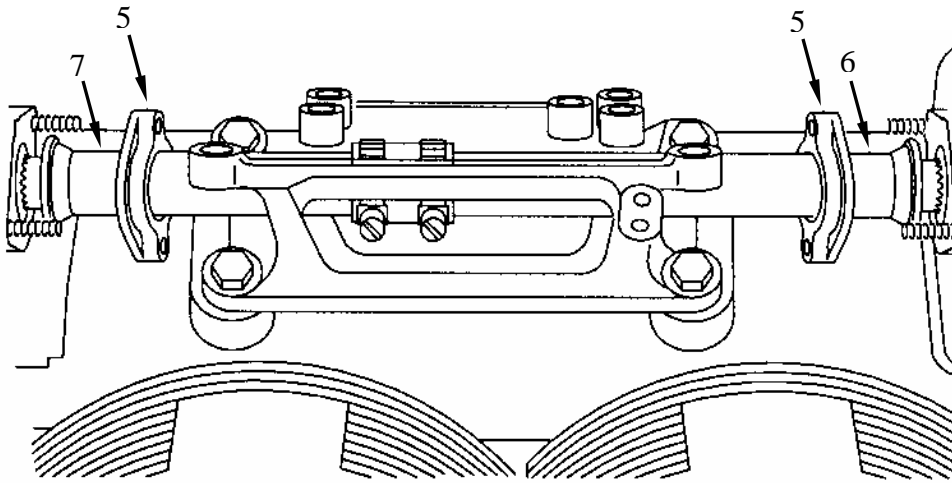
**REMOVAL**

1. Disconnect front fan drive shaft tube assembly (1).
  - a. Loosen two hose clamps (2).
  - b. Remove four self-locking nuts (3) with flat washers (4) securing retaining plates (5). Discard self-locking nuts.

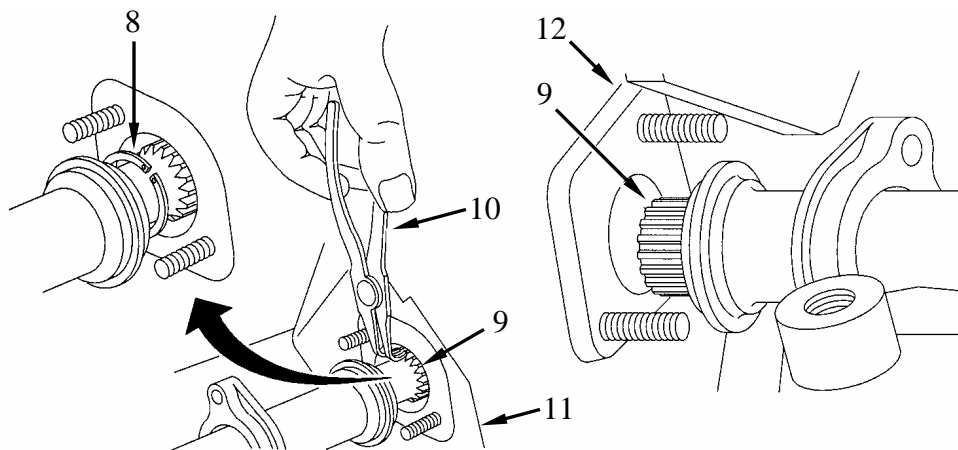


**REMOVAL (Continued)**

1. Disconnect front fan drive shaft tube assembly (1) (Continued).
  - c. Slide both retaining plates (5) towards center of tube assembly (1).
  - d. Push the front and rear metal tube halves (6 and 7) together to access retaining ring (8) at front fan drive housing end of front fan drive shaft (9).



2. Position front fan drive shaft (9) for removal.
  - a. Using retaining ring pliers (10) remove retaining ring (8) from groove in drive shaft (9) and move retaining ring back on shaft.
  - b. Push drive shaft (9) forward into front fan drive housing (11) until opposite end of shaft is exposed at accessory housing (12).

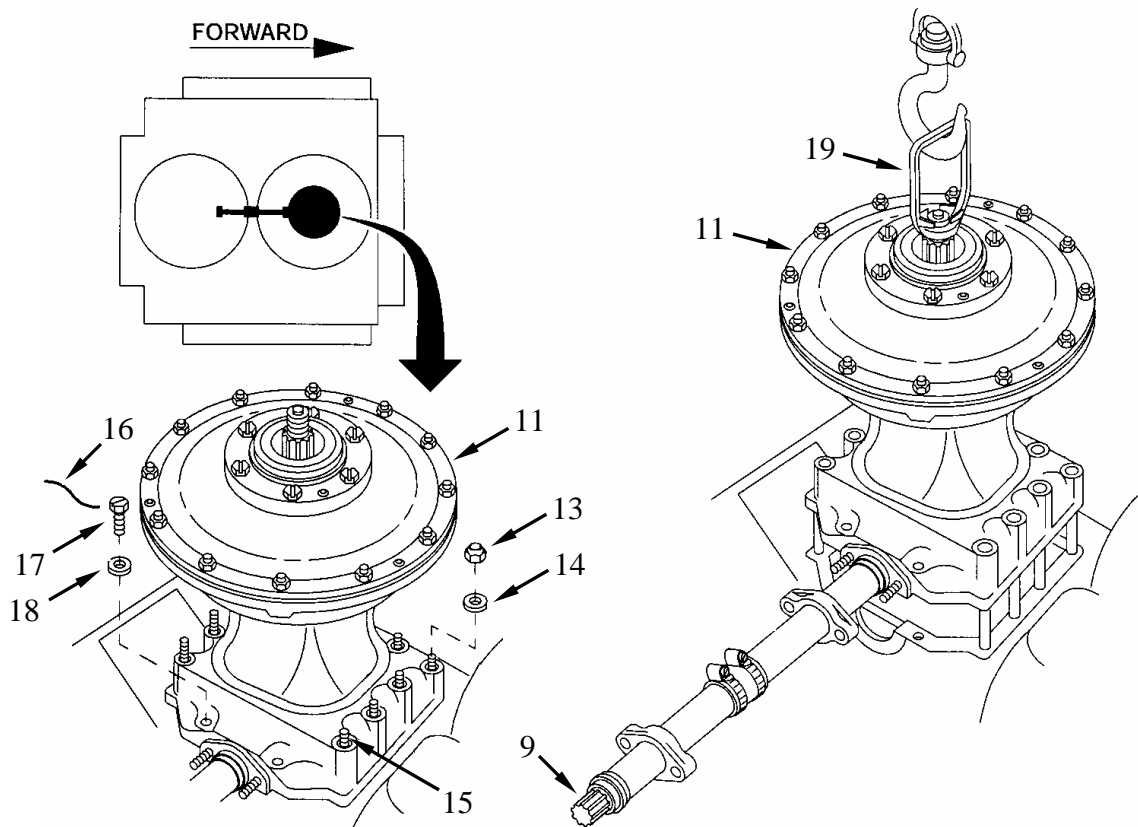


## REMOVAL (Continued)

## NOTE

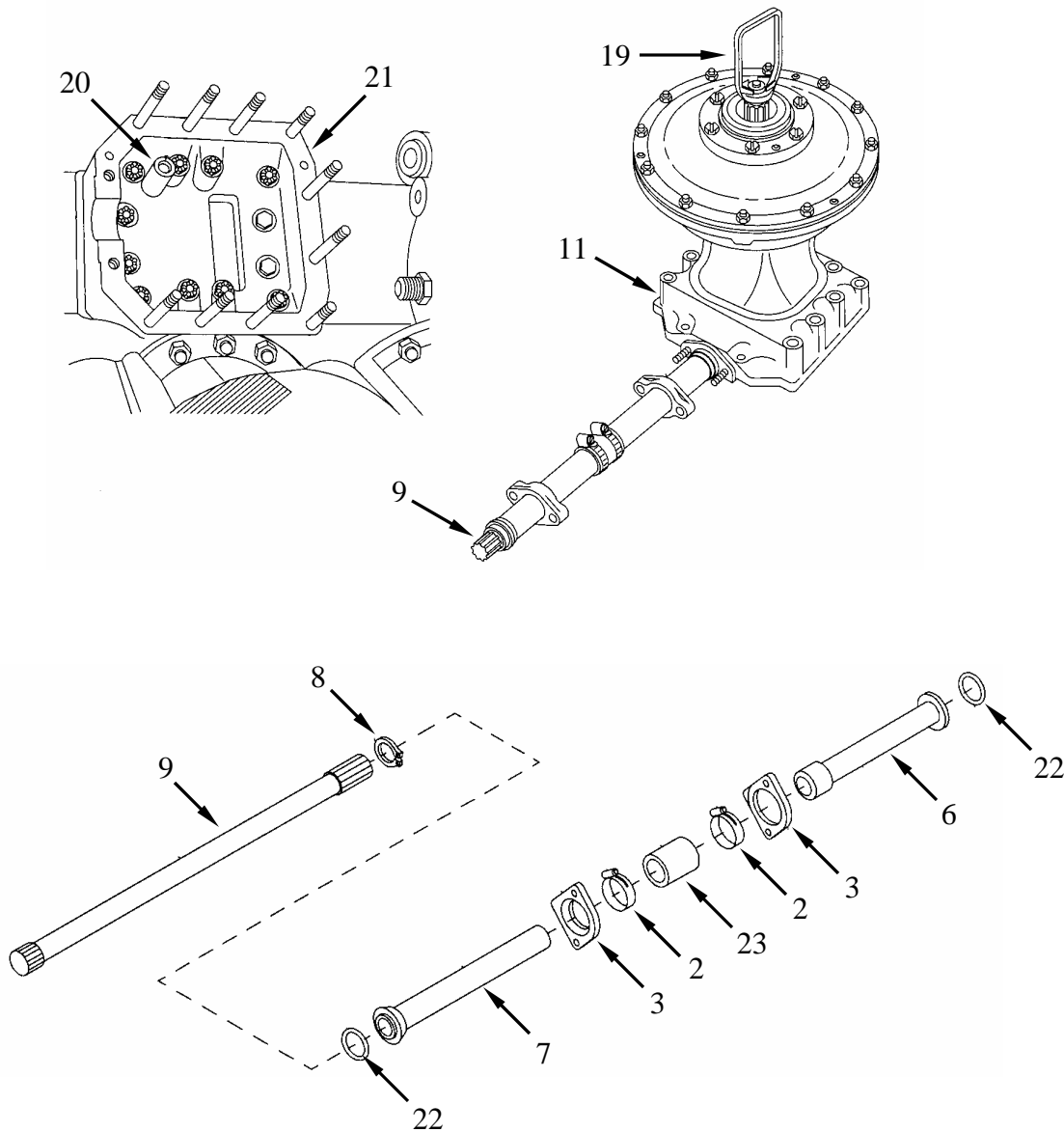
**One self-locking nut was removed from stud (15) when fire extinguisher tube was removed.**

3. Remove nine self-locking nuts (13) with flat washers (14) securing fan drive housing assembly (11) to base. Discard self-locking nuts.
4. Cut and remove locking wire (16), then remove two screws (17) with flat washers (18) from fan drive housing (11).
5. Install lifting tool (19) (item 2, WP 0177) on fan drive housing (11).
6. Remove front fan housing (11) and drive shaft (9) as an assembly.



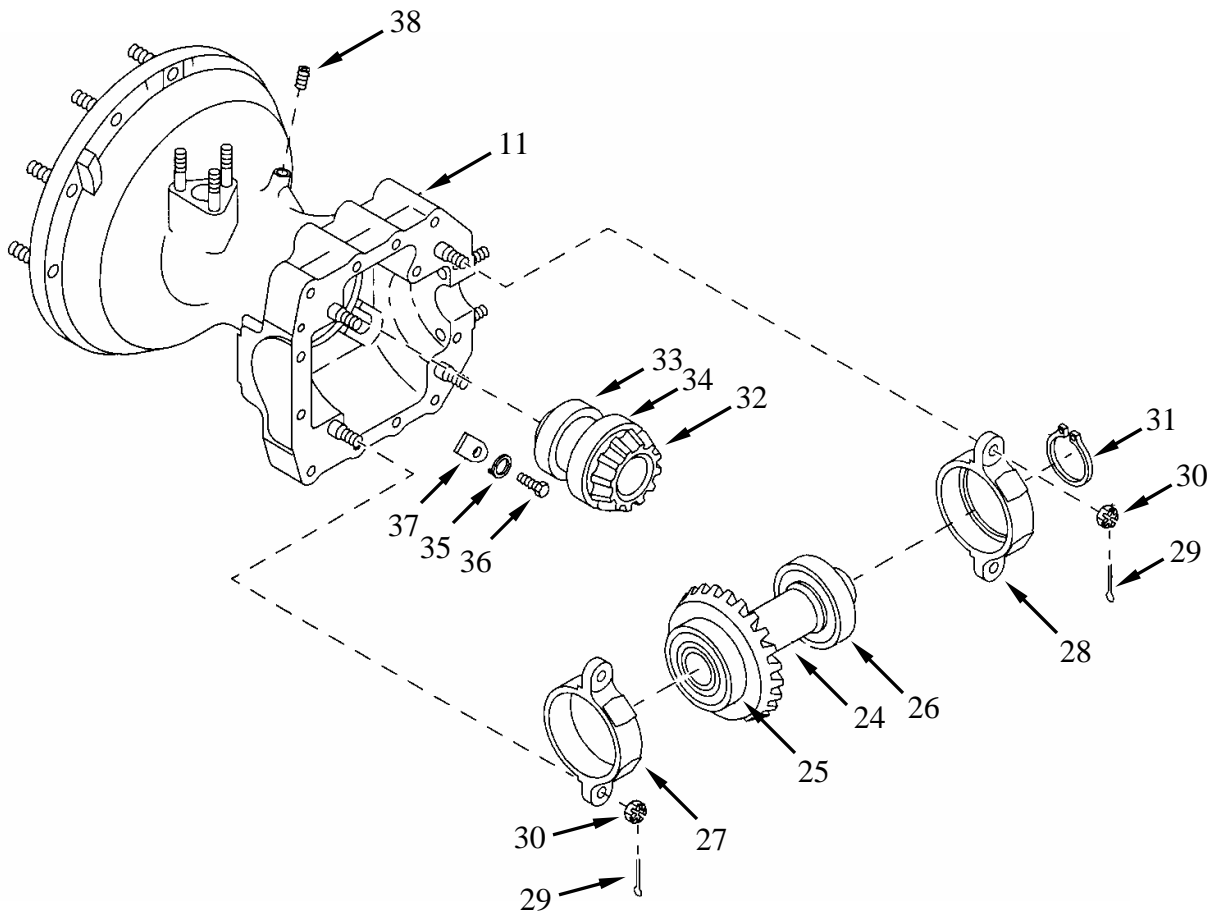
**DISASSEMBLY**

1. Remove and discard O-ring (20) from base assembly (21).
2. Remove lifting tool (19).
3. Remove drive shaft (9) and associated parts from fan drive housing (11) as an assembly.
  - a. Remove drive shaft (9) from tube assembly.
  - b. Remove and discard retaining ring (8) from drive shaft (9).
  - c. Remove and discard O-rings (22) from end of each tube (6,7).
  - d. Remove hose clamps (2), retaining plates (3), and hose (23). Discard hose.



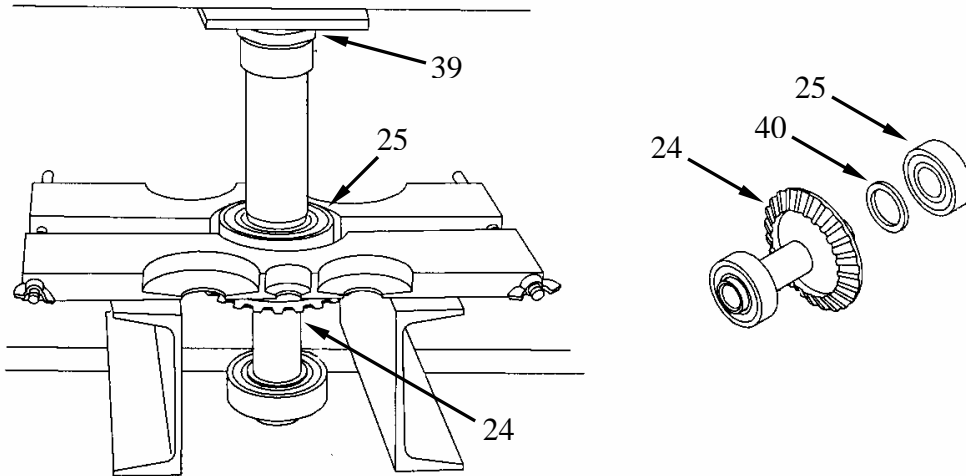
**DISASSEMBLY (Continued)**

4. Remove fan drive clutch assembly. Go to Work Package 0129.
5. Remove [drive] bevel gear shaft (24) with bearings (25,26) and bearing housings (27,28) as a unit.
  - a. Remove and discard four cotter pins (29).
  - b. Remove four slotted nuts (30).
  - c. Remove bevel gear shaft (24) and associated parts as a unit.
  - d. Remove bearing housings (27,28) from ball bearings (25,26).
  - e. Remove and discard retaining ring (31).
6. Remove [driven] bevel gear shaft (32) with bearings (33,34) as a unit.
  - a. Straighten tab on washer key (35).
  - b. Remove machine bolt (36) with bearing retaining plate (37). Discard washer key (35).
7. Remove and discard pipe plug (38) from fan drive housing (11).

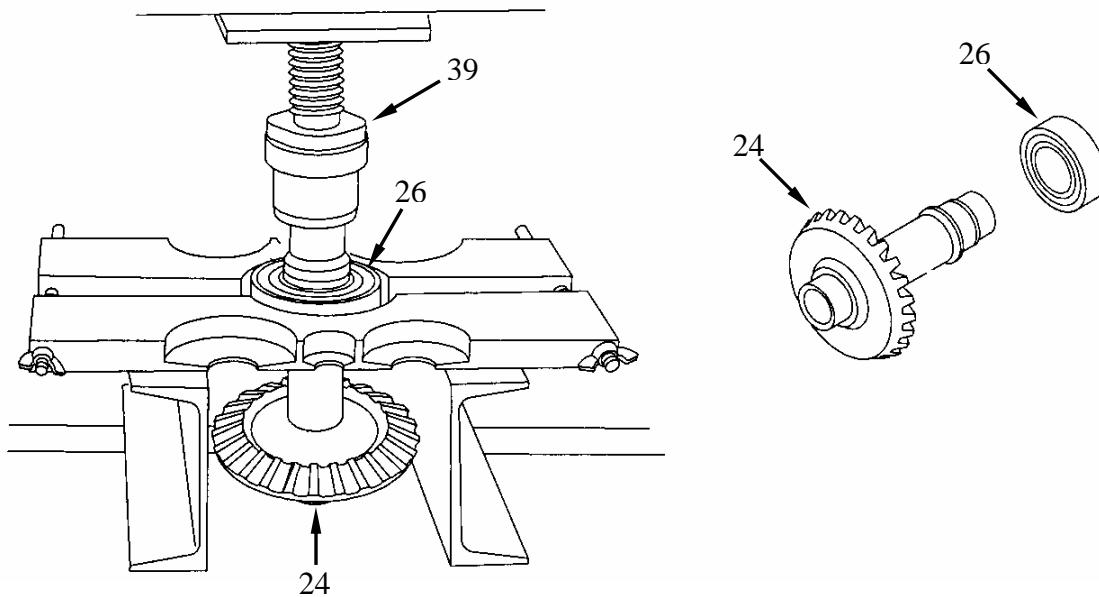


**DISASSEMBLY (Continued)**

8. Using an arbor press (39), press [drive] bevel gear shaft (24) from ball bearing (25).
  - a. Remove and retain shims (40).



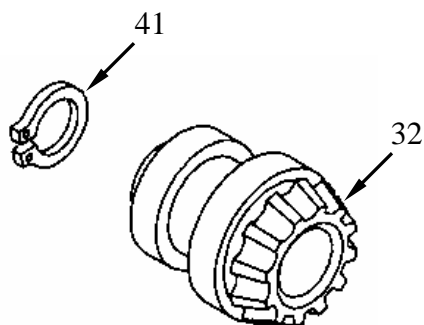
9. Using an arbor press (39), press [drive] bevel gear shaft (24) from ball bearing (26).



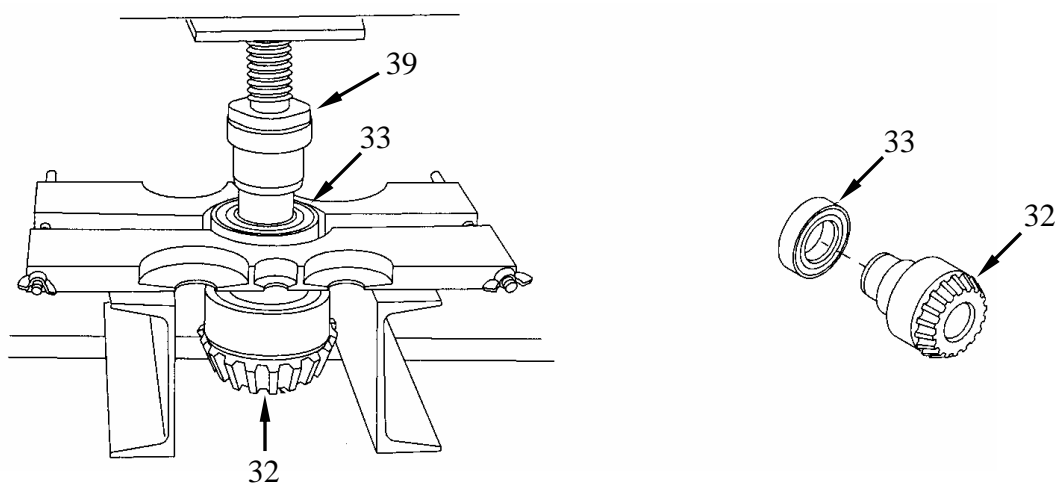


**DISASSEMBLY (Continued)**

10. Remove and discard retaining ring (41) from [driven] bevel gear shaft (32).

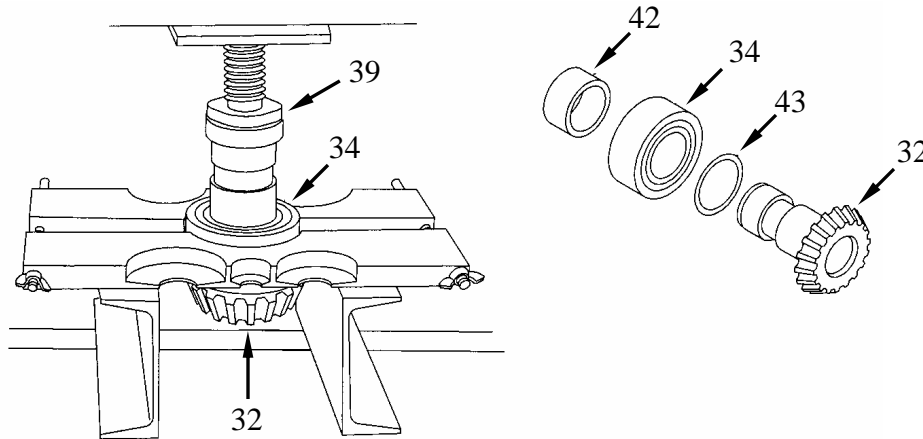


11. Using an arbor press (39), press [driven] bevel gear shaft (32) from outer ball bearing (33).



**DISASSEMBLY (Continued)**

12. Remove sleeve spacer (42) from [driven] bevel gear shaft (32).
13. Using an arbor press (39), press bevel gear shaft (32) from ball bearing (34).
  - a. Remove and retain shims (43).



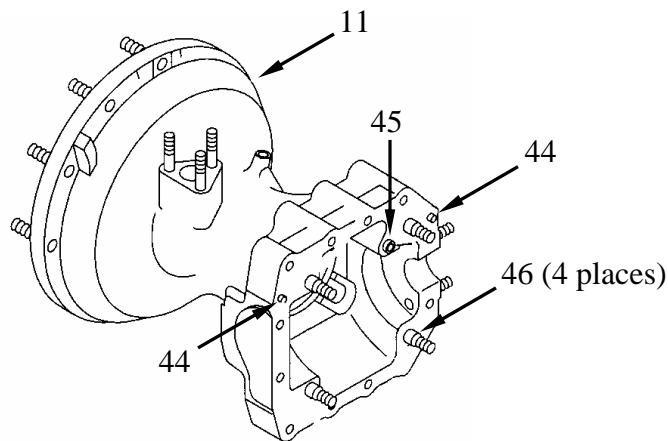
**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

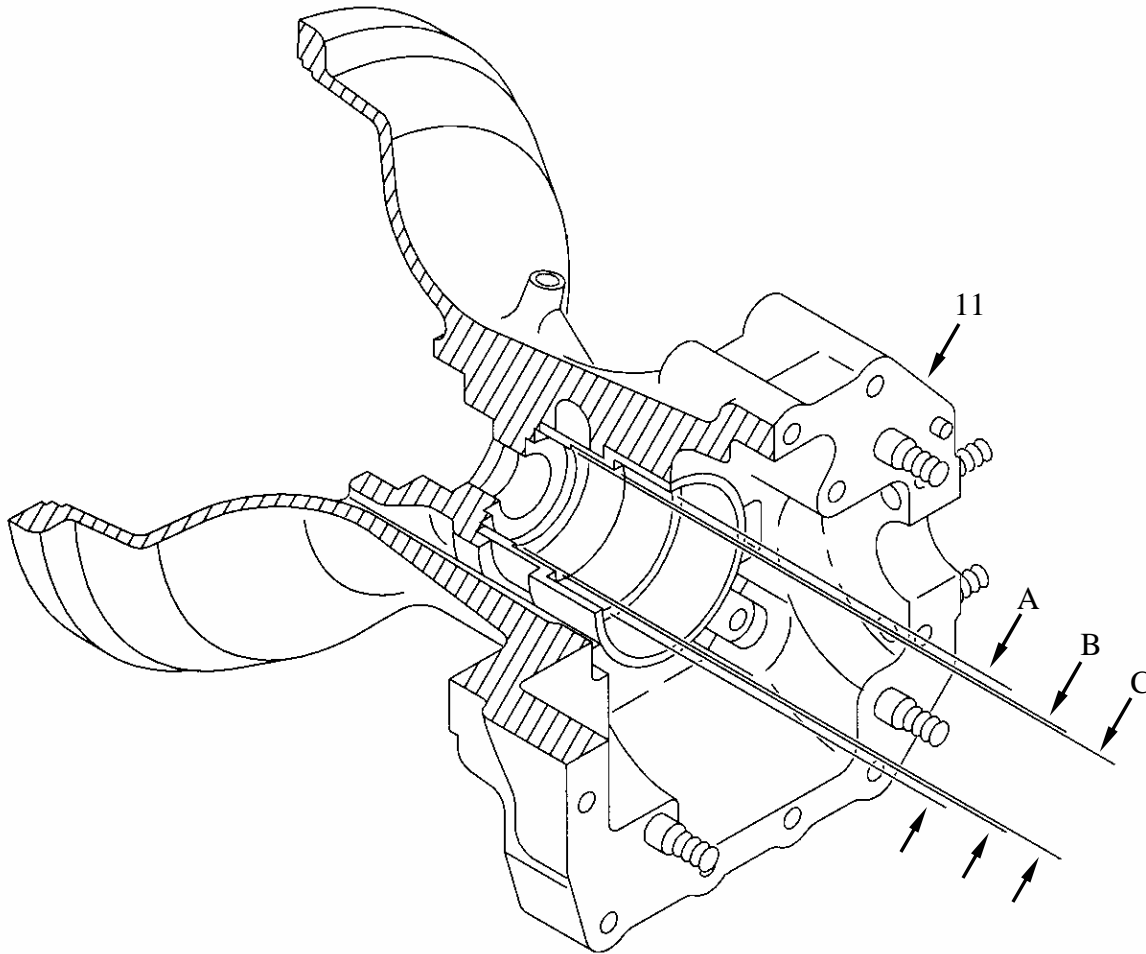
1. See Work Package 0028 for General Inspection Procedures.
2. Visually inspect housing assembly (11).
  - a. Look for loose or damaged dowel pins (44), sleeve spacer (45), or oil transfer tubes (46).



**INSPECTION (Continued)**

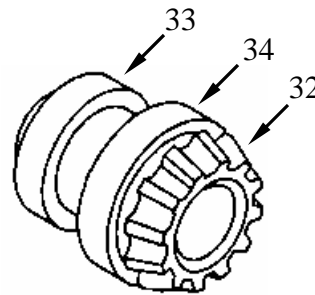
3. Measure inside diameters (A-large), (B-medium) and (C-small) of liner in fan drive housing assembly (11). Replace fan drive housing assembly if not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter-large)	3.1496 (79.9998)	3.1503 (80.0176)	3.1506 (80.0252)
B (inside diameter-medium)	2.9528 (75.0011)	2.9535 (75.0189)	2.9538 (75.0265)
C (inside diameter-small)	2.6772 (68.0008)	2.6779 (68.0186)	2.6782 (68.0262)

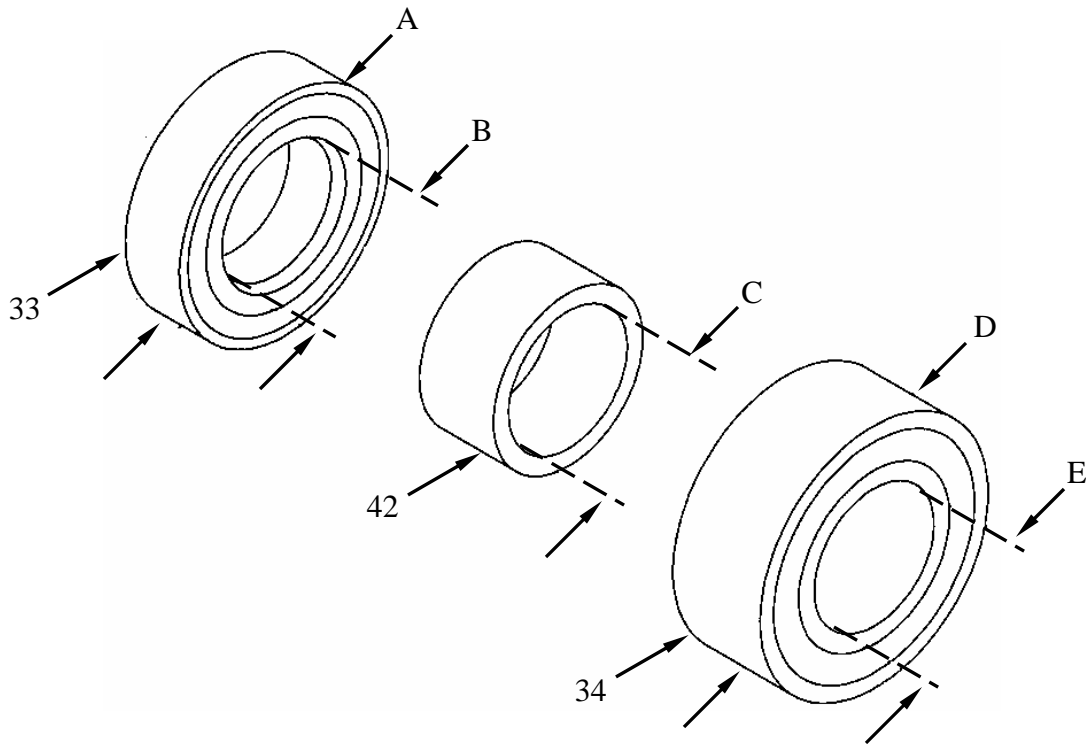


**INSPECTION (Continued)**

4. Replace outer bearing (33) on [driven] bevel gear shaft (32) with a new bearing that meets specifications in the following table (A- outside diameter, B-inside diameter).
5. Measure inside diameter (C) of sleeve spacer (42). Replace sleeve spacer if not within the specifications in the following table.
6. Replace inner bearing (34) on [driven] bevel gear shaft (32) with a new bearing that meets specifications in the following table (D- inside diameter, E-outside diameter).



Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (outside diameter)	2.6767 (67.9881)	2.6772 (68.0008)	none
B (inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
C (inside diameter)	1.5800 (40.1320)	1.5850 (40.2590)	1.5950 (40.5)
D (inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
E (outside diameter)	3.1491 (79.9871)	3.1496 (79.9998)	none



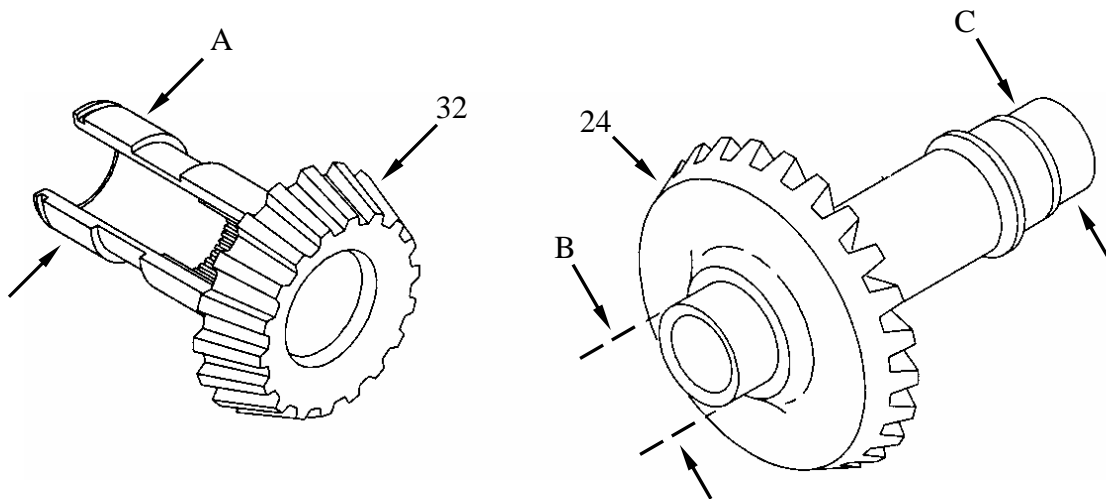
INSPECTION (Continued)

**CAUTION**

**If either fan bevel gear shaft (drive or driven) require replacement, both must be replaced, as they are a matched set and cannot be replaced individually. Failure to comply may result in premature failure.**

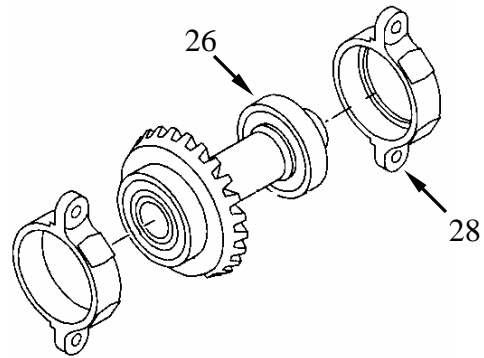
7. Measure bevel gear shafts (24, 32).
  - a. Measure outside diameter (A) of bearing surface on [driven] bevel gear shaft (32).
  - b. Measure outside diameters (B, C) of bearing surface on [drive] bevel gear shaft (24).
  - c. Replace both shafts if either is not within specifications in the following table.

Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (outside diameter)	1.5749 (40.0024)	1.5753 (40.0126)	1.5747 (39.9973)
B (outside diameter)	1.5749 (40.0024)	1.5753 (40.0126)	1.5747 (39.9973)
C (outside diameter)	1.5749 (40.0024)	1.5753 (40.0126)	1.5747 (39.9973)

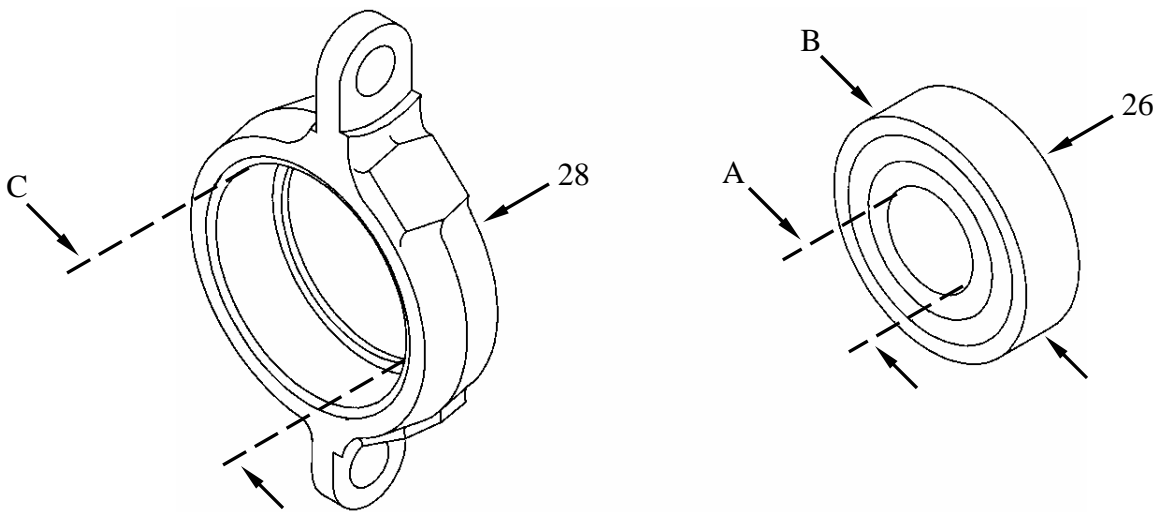


**INSPECTION (Continued)**

8. Replace bearing (26) with a new bearing that meets specifications (A, B) in the following table.
9. Measure inside diameter (C) of bearing bracket (28). Replace bracket if it does not meet specifications in the following table.

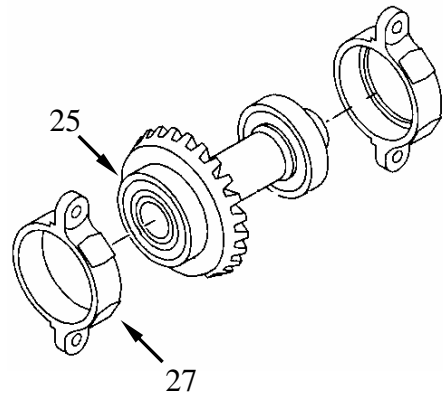


Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
B (outside diameter)	2.6767 (67.9881)	2.6772 (68.0008)	none
C (inside diameter)	2.6771 (67.9983)	2.6777 (68.0135)	2.6780 (68.0212)

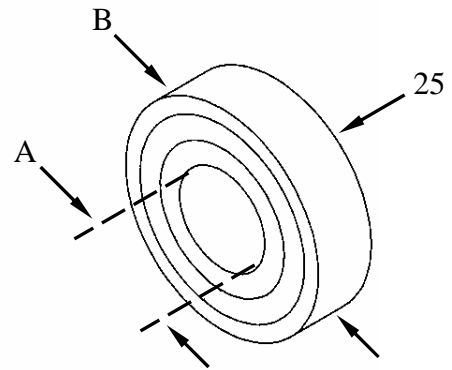
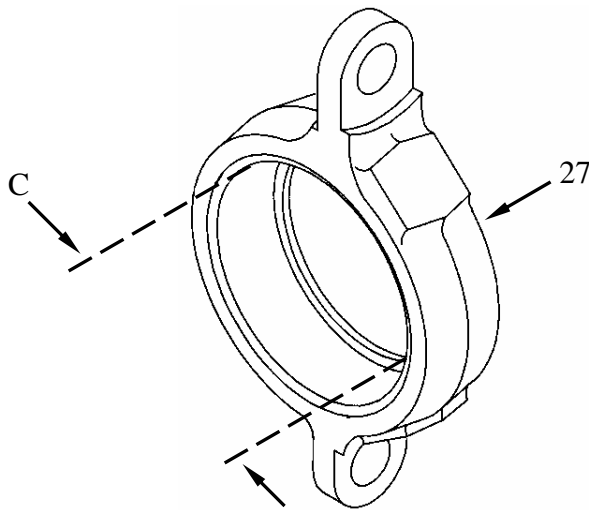


**INSPECTION (Continued)**

- 10. Replace bearing (25) with a new bearing that meets specifications (A, B) in the following table.
- 11. Measure inside diameter (C) of bearing bracket (27). Replace bracket if it does not meet specifications in the following table.

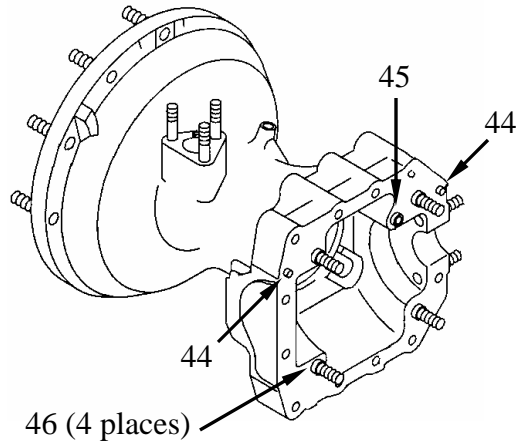


Location	Sizes and Fits of New Parts inches (mm)		Wear Limits
A (inside diameter)	1.5743 (39.9872)	1.5748 (39.9999)	none
B (outside diameter)	3.1491 (79.9871)	3.1496 (79.9998)	none
C (inside diameter)	3.1495 (79.9973)	3.1501 (80.0125)	3.1504 (80.0201)



**INSPECTION (Continued)**

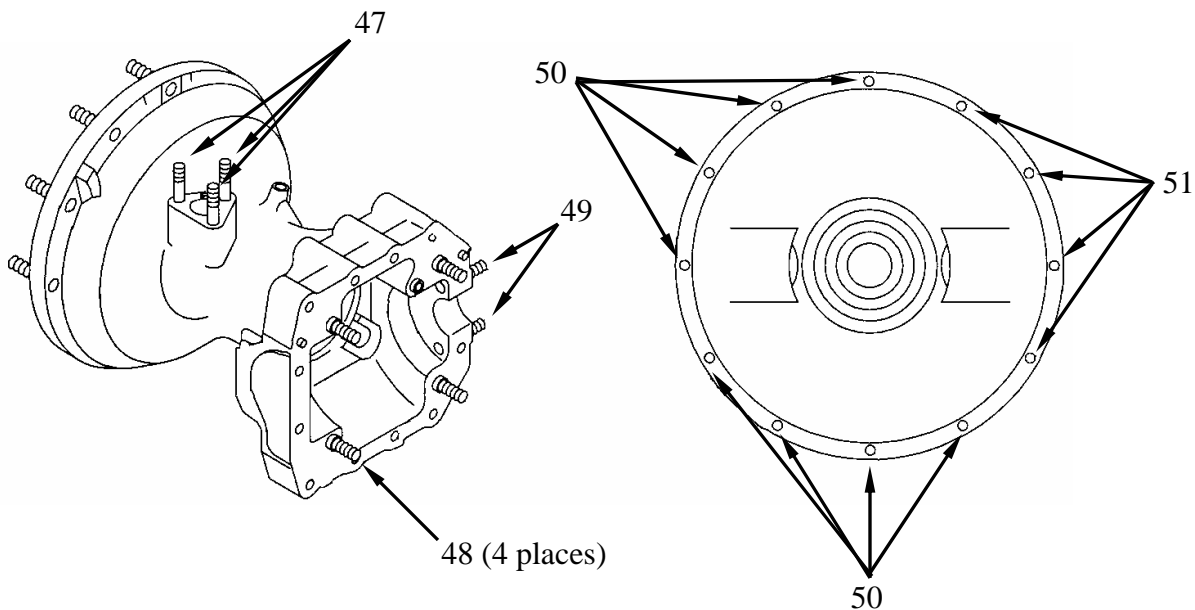
12. Replace any loose or damaged dowel pins (44), tubes (46), or sleeve spacer (45). Refer to WP 0028.



13. Replace damaged, bent, or stripped studs (47,48,49,50 and 51).

a. Refer to WP 0028 for standard procedure and to the following table for stud size and setting height.

Location	Setting Height	Quantity Required	Stud Size and Length
47	7/8 (22.2250 mm)	3	5/16-18(3/4) X 5/16-24(19/32) X 1-1/2
47	3/4 (19.0500 mm)	4	3/8-16(13/16) X 3/8-24(3/4) X 1-7/8
49	1 (25.4000 mm)	2	5/16-18(3/4) X 5/16-24(19/32) X 1-1/2
50	25/32(19.8438 mm)	8	5/16-18(3/4) X 5/16-24(19/32) X 1-7/16
51	29/32 (23.0188 mm)	4	5/16-18(3/4) X 5/16-24(19/32) X 1-9/16





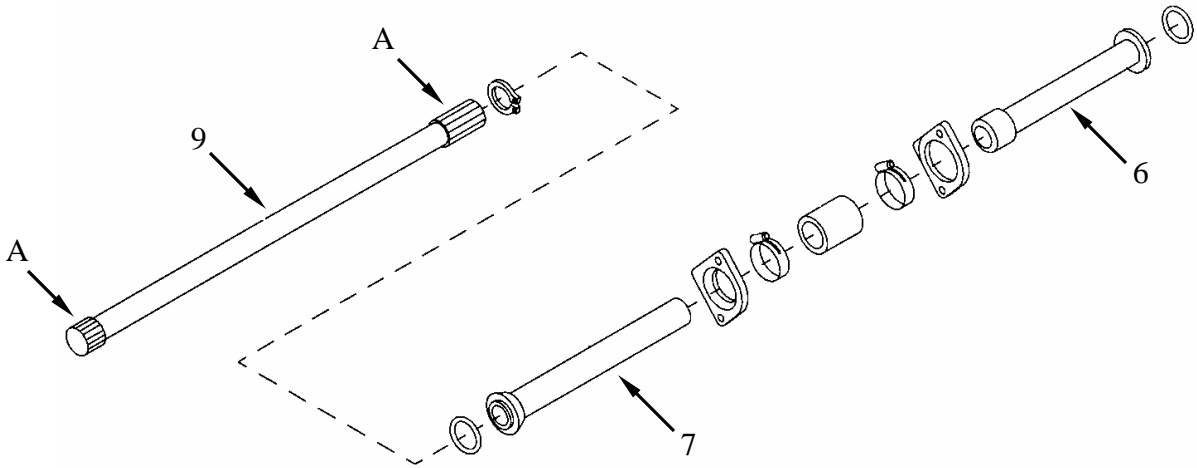
**INSPECTION (Continued)**

14. Inspect front fan drive shaft (9).

- a. Look for burrs, wear, cracked, broken or pitted spline teeth (A). If found, replace shaft and mating gears.

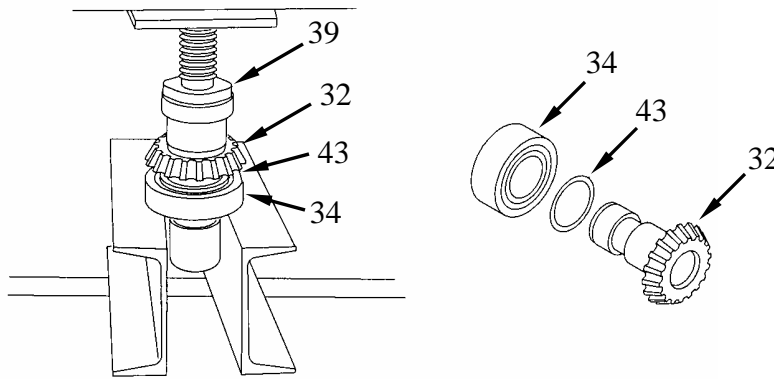
15. Inspect front (6), and rear (7), tube halves.

- a. Look for dents or gouges that would interfere with rotating parts or lead to oil leaks. Replace tubes that are damaged.

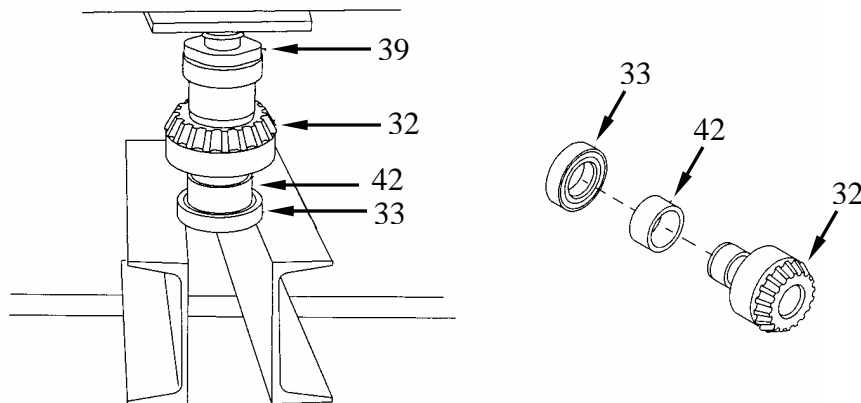


**ASSEMBLY**

1. Determine shim thickness for [driven] bevel gear shaft (32).
  - a. With endplay removed from bearing, measure total thickness of bearing from inner race to outer race.
  - b. Add shims until a total thickness of 1.2635-inch (32.0929 mm) minimum to 1.2655-inch (32.1437 mm) maximum is obtained.
  - c. Old and new shims may be mixed to obtain correct overall thickness.
2. Install new bearing (34).
  - a. Position shims (43) of predetermined thickness on inner race of bearing (34).
  - b. Using an arbor press (39), press bevel gear shaft (32) in to new ball bearing (34) (item 306, WP 0175).

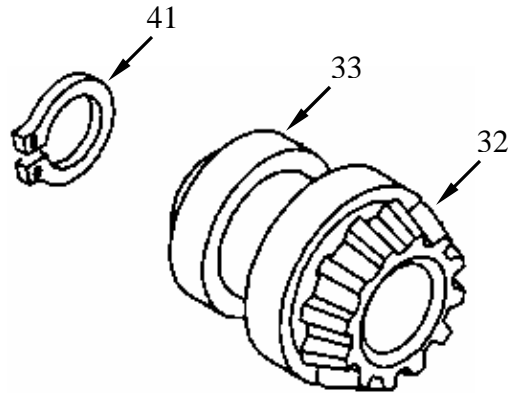


3. Install spacer (42) onto bevel gear shaft (32).
4. Using an arbor press (39), press bevel gear shaft (32) into new ball bearing (33) (item 297, WP 0175).

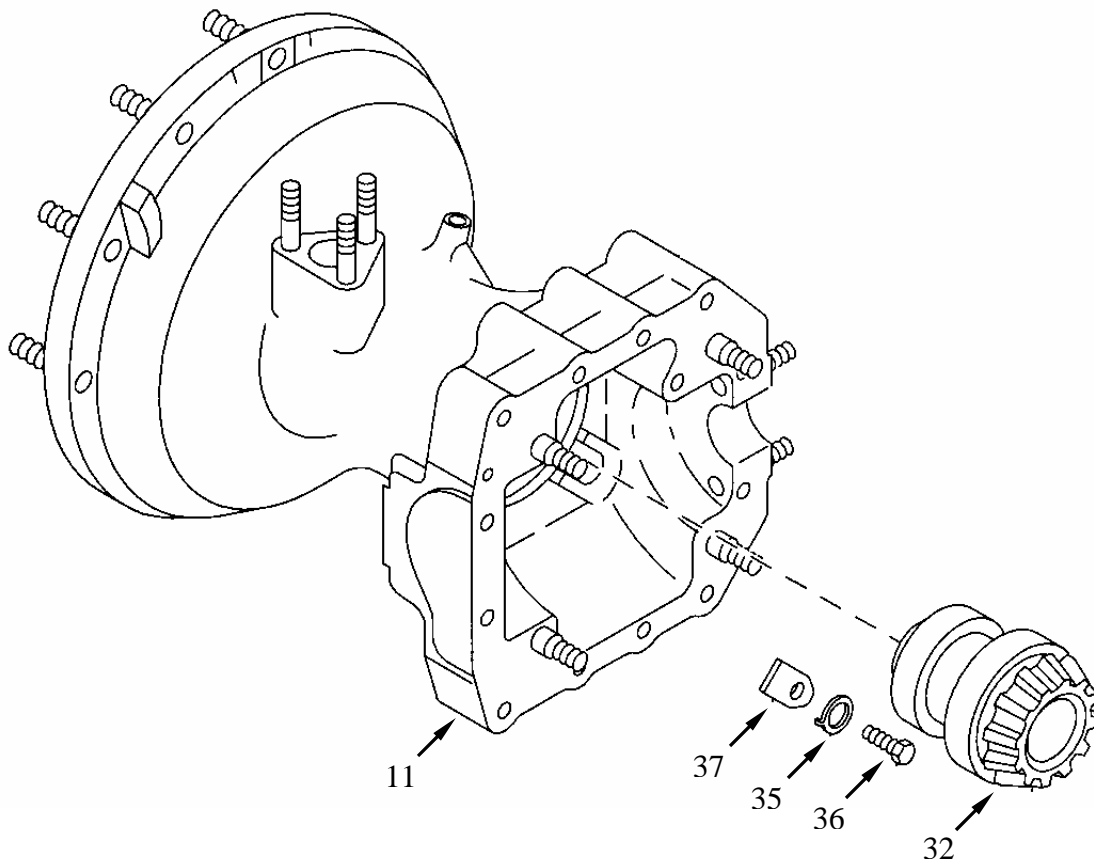


**ASSEMBLY (Continued)**

5. Secure ball bearing (33) to bevel gear shaft (32) with a new retaining ring (41) (item 287, WP 0175).

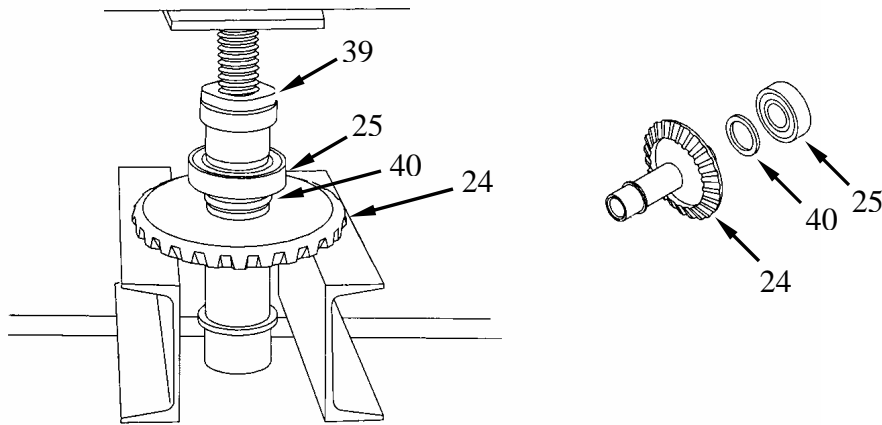


6. Install assembled bevel gear shaft (32) into fan drive housing assembly (11).
  - a. Secure with machine bolt (36), bearing retaining plate (37) and a new washer key (35) (item 320, WP 0175).
  - b. Secure machine bolt (36) by bending tab on washer key (35).

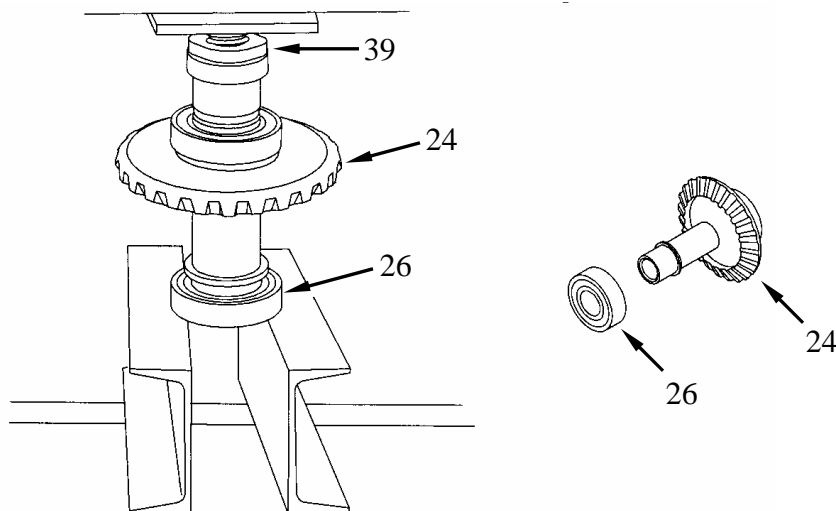


**ASSEMBLY (Continued)**

7. Determine shim thickness for [drive] bevel gear shaft (24).
  - a. With endplay removed from bearing, measure total thickness of bearing from inner race to outer race.
  - b. Add shims until a total thickness of 0.7891-inch (20.0431 mm) minimum to 0.7911-inch (20.0939 mm) maximum is obtained.
  - c. Old and new shims may be mixed to obtain correct overall thickness.
8. Install new bearing (25).
  - a. Position shims (40) of predetermined thickness over hub of bevel gear shaft (24).
  - b. Using an arbor press (39), press new ball bearing (25) (item 294, WP 0175) onto bevel gear shaft (24).

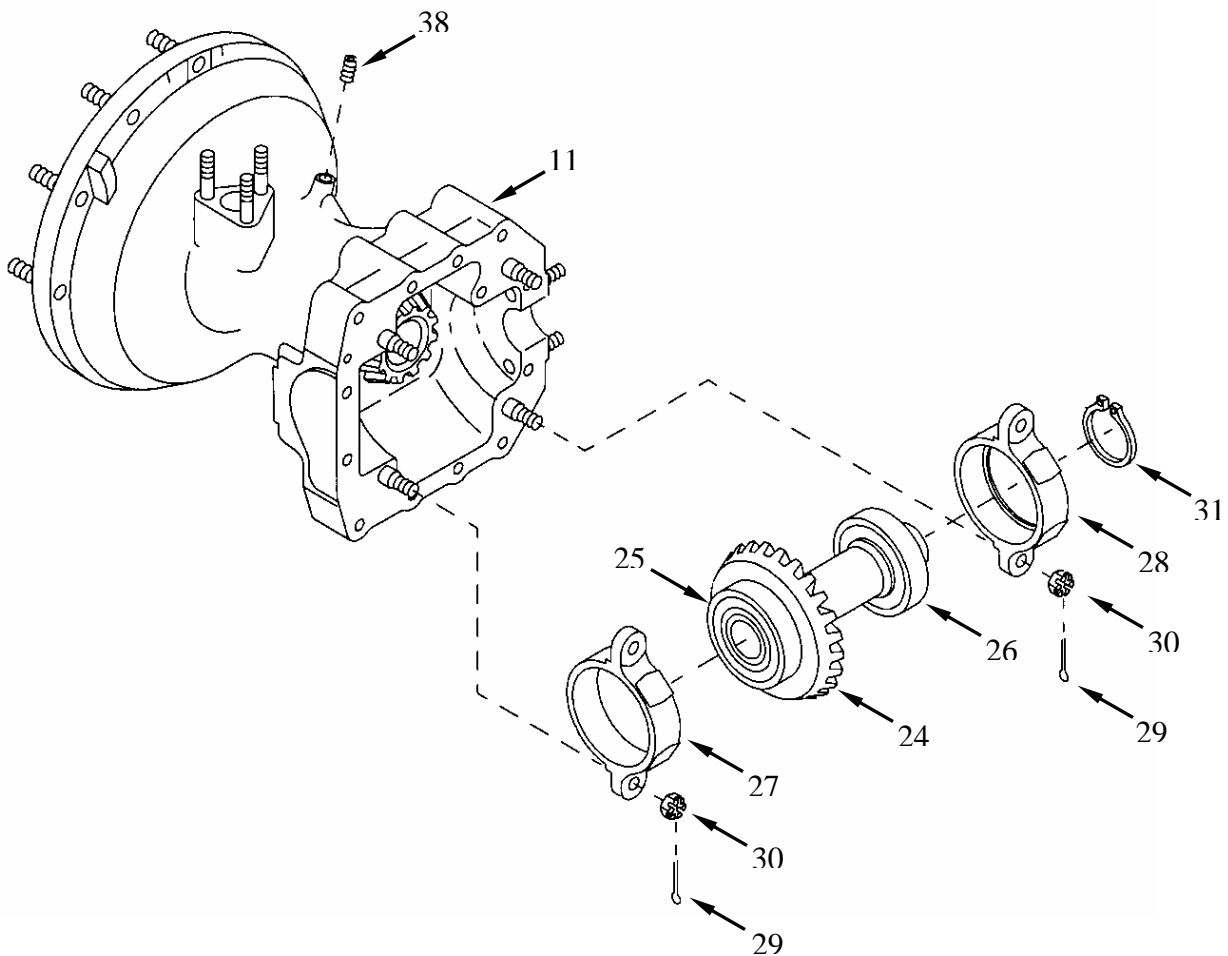


9. Using an arbor press (39), press bevel gear shaft (24) into new ball bearing (26) (item 297, WP 0175).



**ASSEMBLY (Continued)**

10. Secure ball bearing (26) to bevel gear shaft (24) with a new retaining ring (31) (item 287, WP 0175).
11. Install bearing housing (28) on ball bearing (26).
12. Install bearing housing (27) on ball bearing (25).
13. Install assembled bevel gear shaft (24) into fan drive housing assembly (11) and secure with four slotted nuts (30).
  - a. Secure slotted nuts (30) with new cotter pins (29) (item 48, WP 0175).
14. Apply pipe thread compound (item 42, WP 0173) to new pipe plug (38) (item 277, WP 0175) and install in fan drive housing (11).

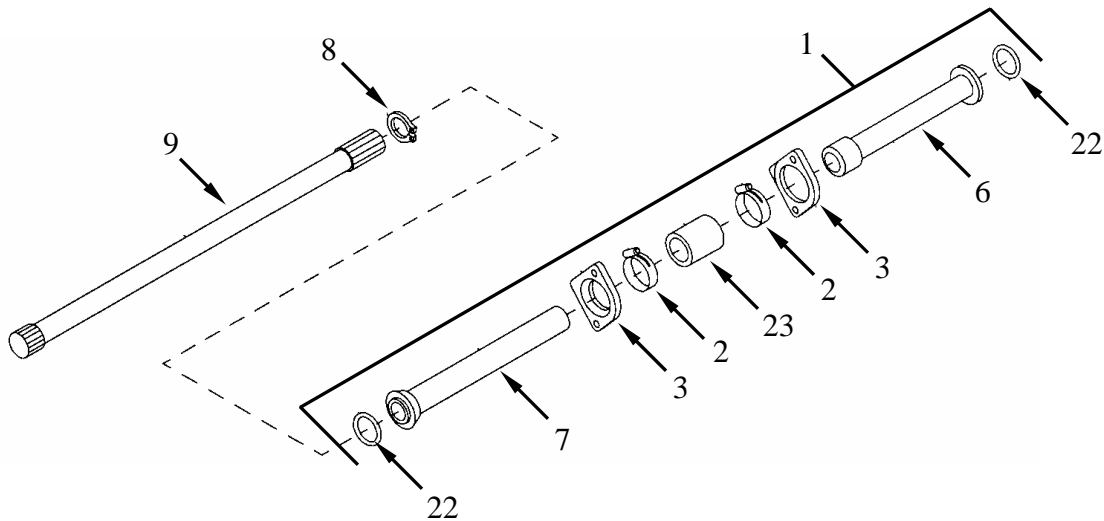


**ASSEMBLY (Continued)**

15. Install fan drive, clutch assembly. Go to Work Package 0129.

16. Assemble tube assembly (1).

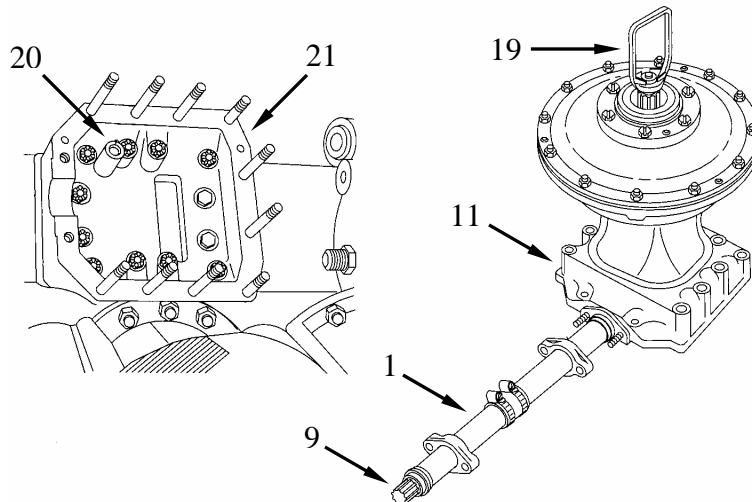
- a. Install one retaining plate (5) and one hose clamp (2) on each tube half (6, 7) and slide forward.
- b. Join tube halves (6 and 7) with a new hose (23) (item 181, WP 0175) and secure loosely with hose clamps (2).
- c. Install a new O-ring (22) (item 154, WP 0175) on each tube half (6,7).
- d. Install a new retaining ring (8) (item 17, WP 0175) onto drive shaft (9) inboard of the ring groove.
- e. Slide shaft (9) into tube assembly (1).



17. Install shaft (9) and tube assembly (1) into fan drive housing assembly (11).

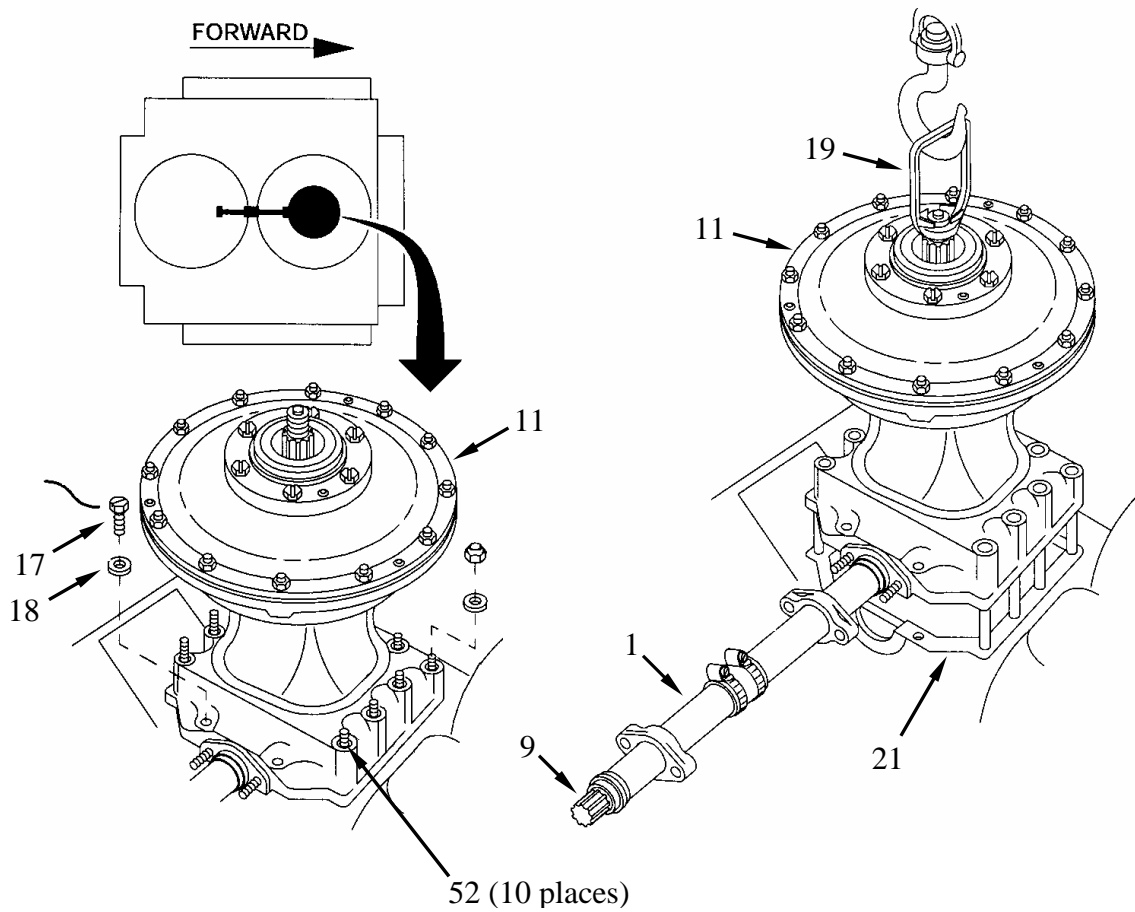
18. Install a new O-ring (20) (item 62, WP 0175) on base assembly (21).

19. Install lifting tool (19) (item 2, WP 0177).



**INSTALLATION**

1. Apply a thin coat of sealing compound (item 33, WP 0173) to base assembly (21).
2. Install fan drive housing assembly (11) with attached shaft (9) and tube assembly (1) onto base assembly (21).
3. Remove lifting tool (19).
4. Apply a small amount of Lubriplate (item 29, WP 0173) to ten base studs (52) and two screws (17).
5. Install two screws (17) with flat washers (18) securing fan drive housing assembly (11) to base.

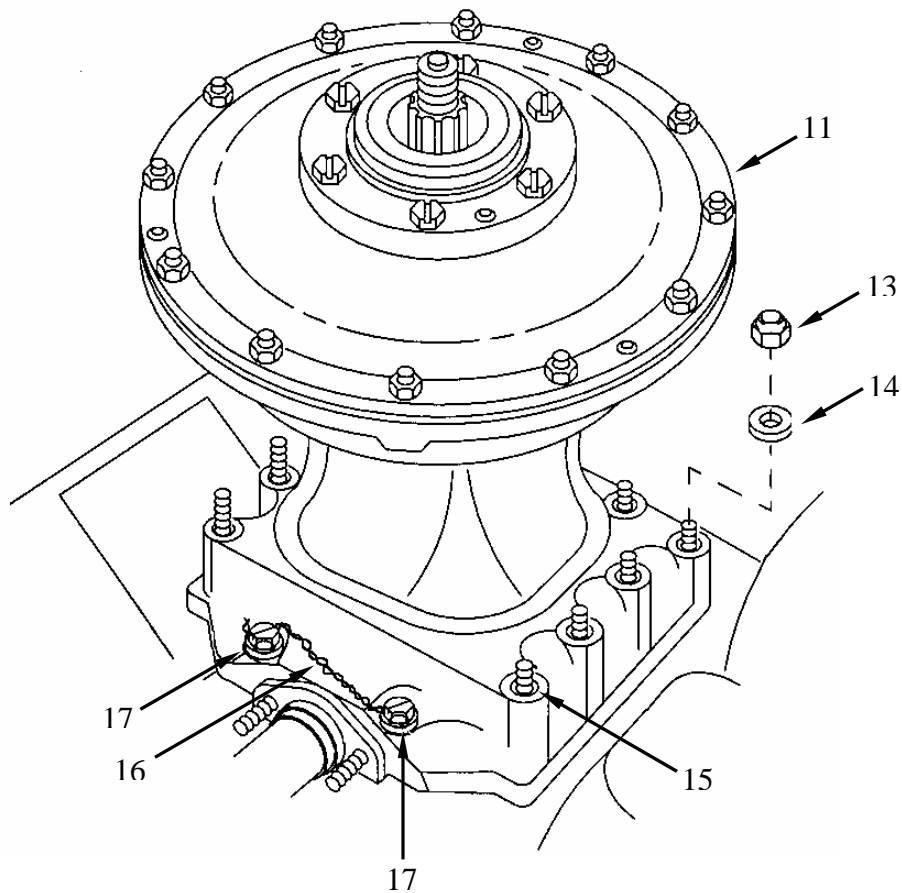


## INSTALLATION (Continued)

## NOTE

**One new self-locking nut will be installed on remaining stud (15) when the fire extinguisher tube is installed.**

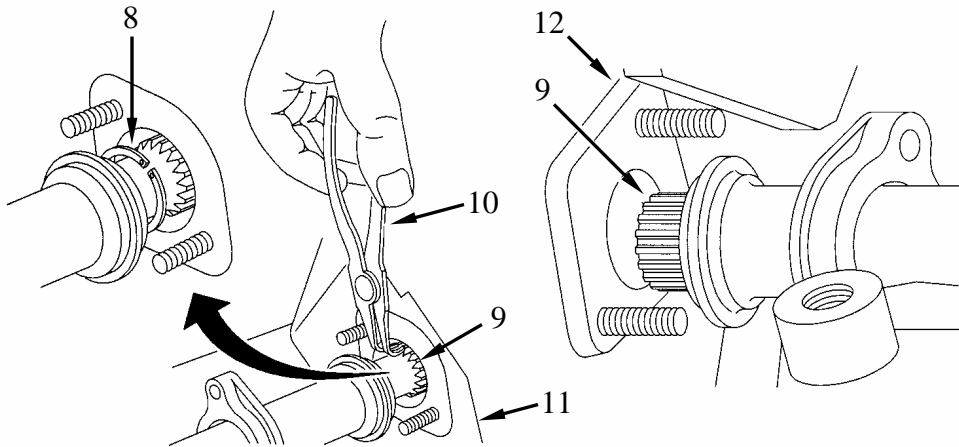
6. Secure fan drive housing (11) to base using nine new self-locking nuts (13) (item 140, WP 0175) with flat washers (14).
7. Tighten nine self-locking nuts (13) and two screws (17) to 275-300 inch-pounds (31-34 N•m).
8. Install new locking wire (16) (item 44, WP 0173) securing two screws (17).



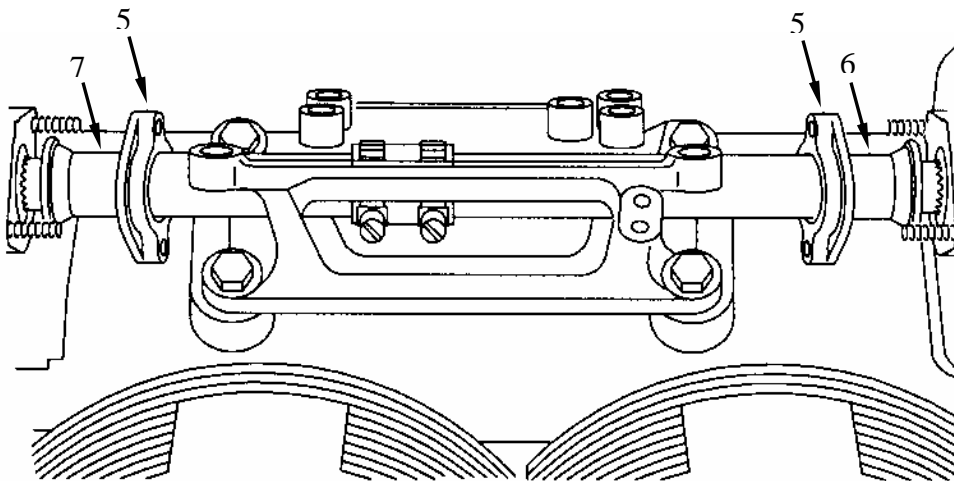


**INSTALLATION (Continued)**

9. Push shaft (9) into rear accessory housing (11) until splines are fully engaged.
10. Using retaining ring pliers (10), position retaining ring (8) into groove of shaft (9) at front fan drive housing (11).

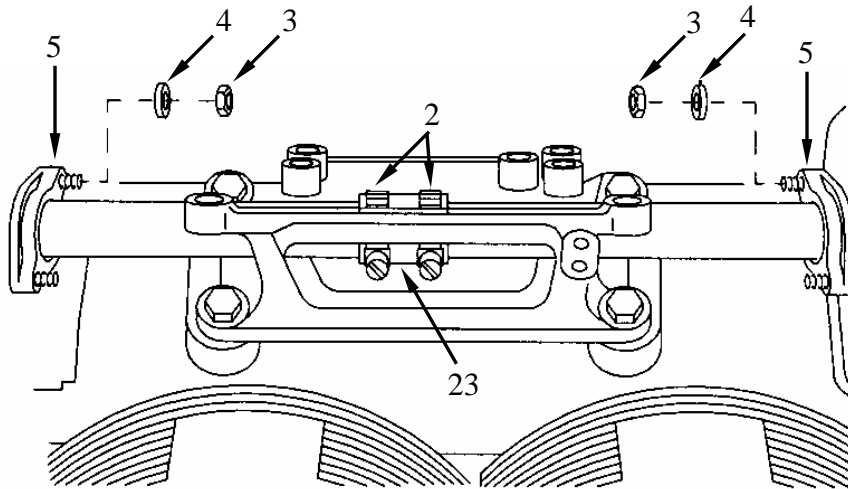


11. Slide tube halves (6,7) and retaining plates (5) into place.



**INSTALLATION (Continued)**

12. Secure two retaining plates (5) with four new self-locking nuts (3) (item 24, WP 0175) with flat washers (4).
  
13. Center hose (23) on tube halves (6,7) then secure by tightening hose clamps (2).



**END OF WORK PACKAGE**

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, Repair, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit (item 121, WP 0176)  
 Torque wrench, 0-175 foot-pounds (item 127, WP 0176)

**Mandatory Replacement Parts:**

Cotter pin (10) (item 48, WP 0175)  
 O-ring (item 63, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)  
 Sealant, RTV-1473 (item 33, WP 0173)

**Personnel Required:**

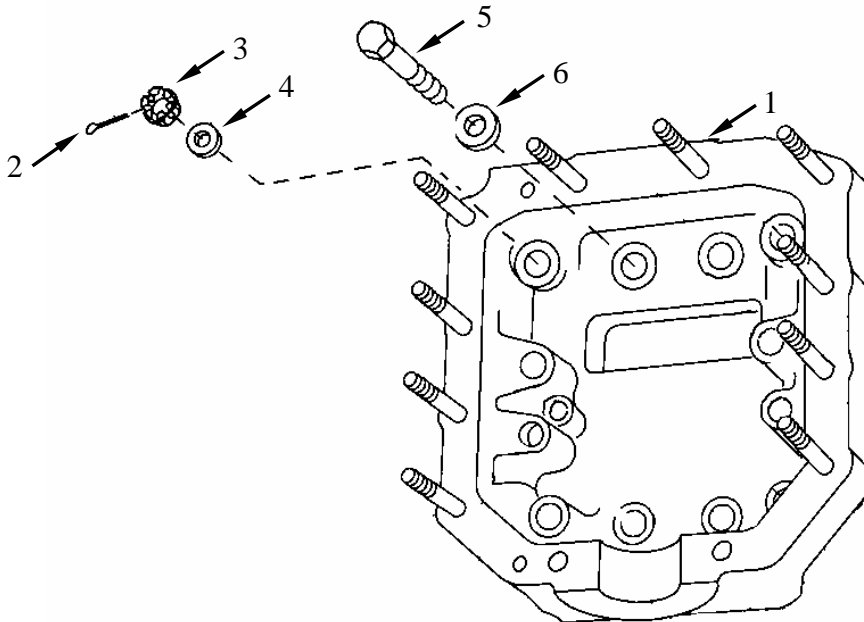
Track Vehicle Repairer (1) 63H10

**Equipment Conditions:**

Engine on maintenance stand (WP 0130)  
 Fan drive housing removed (WP 0169)

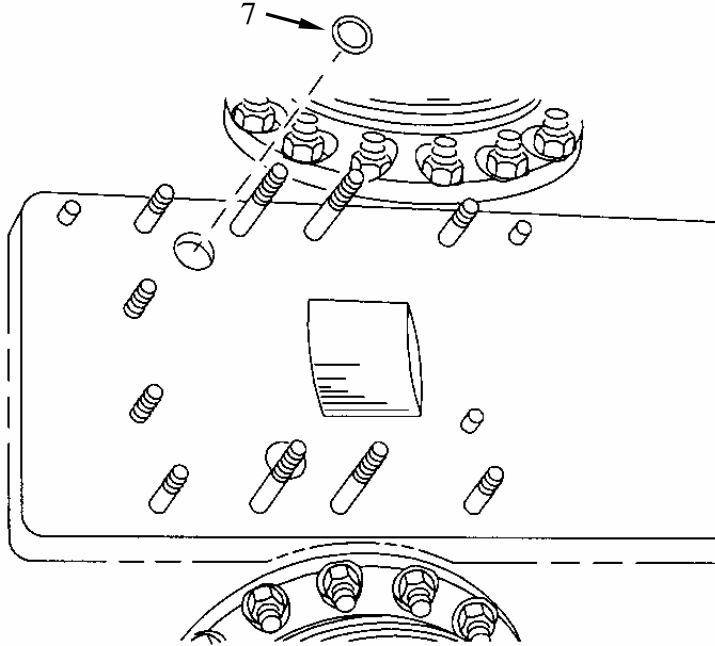
**REMOVAL**

1. Remove fan drive housing base (1).
  - a. Remove and discard ten cotter pins (2).
  - b. Remove ten slotted plain nuts (3) with flat washers (4) securing base (1) to crankcase.
  - c. Remove two screws (5) with flat washers (6) securing base (1) to crankcase.
  - d. Remove base (1) from crankcase.



**REMOVE (Continued)**

- e. Remove and discard O-ring (7) from crankcase.

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

**INSPECTION**

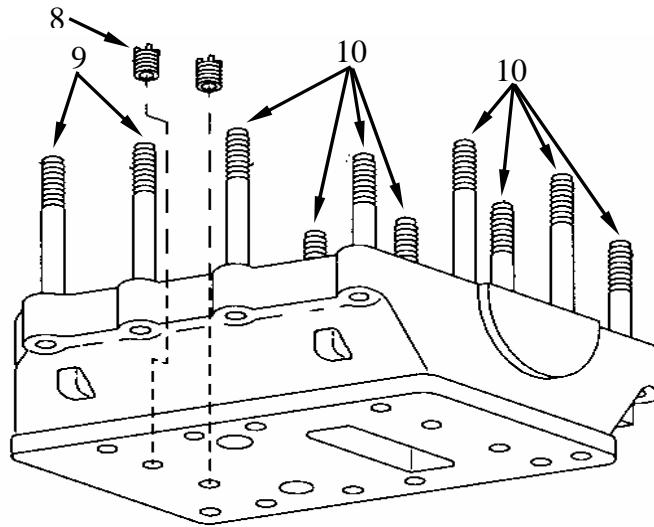
All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**REPAIR**

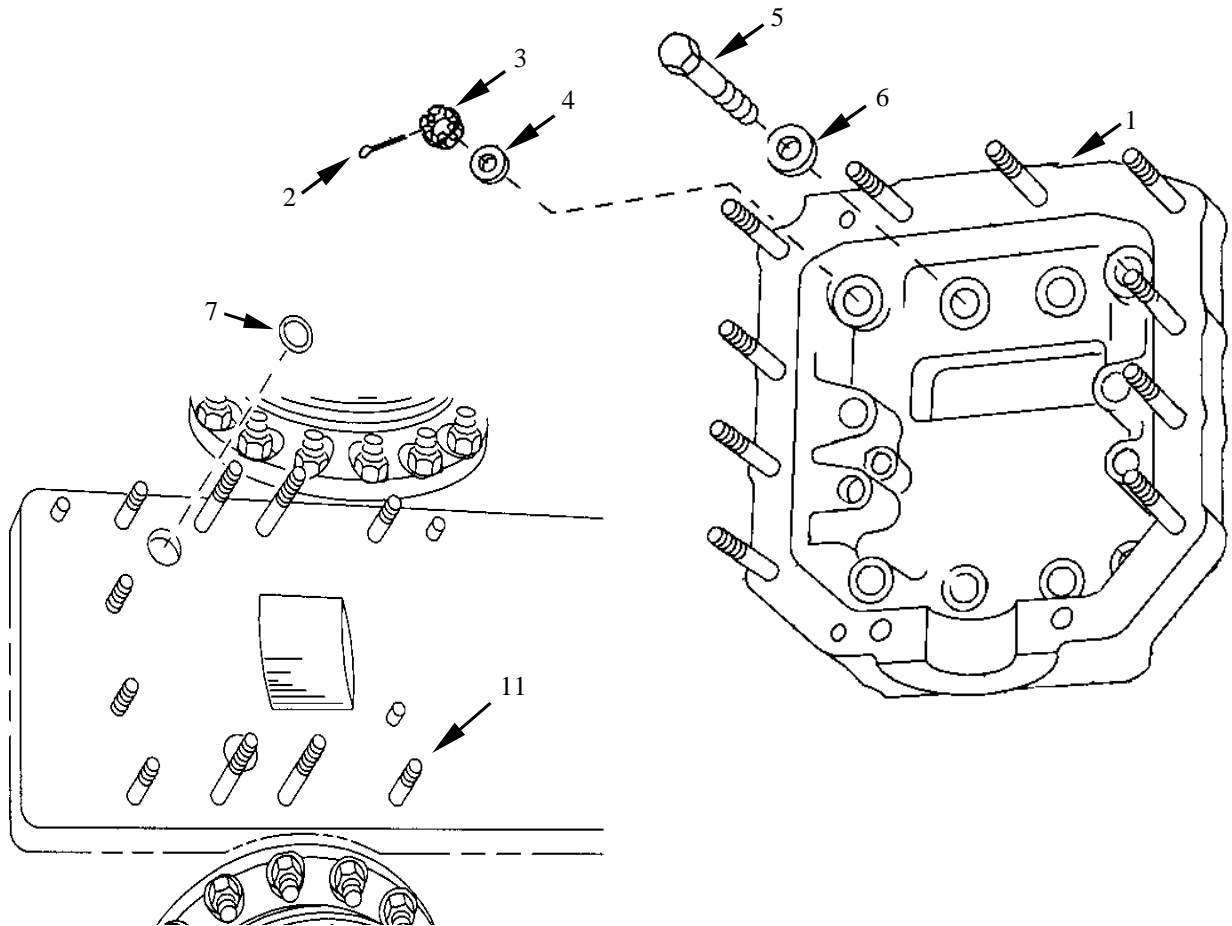
1. Repair fan drive housing base
  - a. Replace defective screw thread inserts (8) (refer to WP 0030).
  - b. Replace damaged, bent or stripped studs (9, and 10) (refer to WP 0028).

Reference Number	Setting Height	Number Required	Stud Size and Length
9	2-1/16 inches	2	3/8-16 (51/64) X 3/8-24 (7/8) X 2-25/32
10	3-1/16 inches	8	3/8-16 (51/64) X 3/8-24 (11/16) X 3-7/8



**INSTALL**

1. Install fan drive housing base.
  - a. Install new O-ring (7) (item 63, WP 0175) into crankcase.
  - b. Apply a thin coat of sealant (item 33, WP 0173) on crankcase mounting surface of base (1).
  - c. Install base (1) over studs (11) and onto crankcase.
  - d. Apply a small amount of Lubriplate (item 23, WP 0173) to ten studs (11), and two screws (5).
  - e. Secure base (1) to crankcase with ten slotted plain nuts (3) and flat washers (4), two screws (5), and flat washers (6).
  - f. Tighten ten slotted nuts (3) and two cap screws (5) to 23-25 foot-pounds (31-34 N•m).
  - g. Secure ten slotted nuts (3) with new cotter pins (2) (item 48, WP 0175).



**END OF WORK PACKAGE**

**LOW VOLTAGE PROTECTION MODULE MOUNTING BRACKET  
REPLACEMENT**

0171 00

**THIS WORK PACKAGE COVERS:**

Removal, Cleaning, Inspection, and Installation

**INITIAL SETUP:**

**Tools:**

General mechanic's tool kit, (item 121, WP 0176)  
Torque wrench, 0-300 inch-pounds (item 124, WP 0176)

**Mandatory Replacement Parts:**

Lock washer (4) (item 86, WP 0175)

**Expendable and Durable Items:**

Lubriplate (item 23, WP 0173)

**Personnel Required:**

Track Vehicle Repairer (1) 63H10

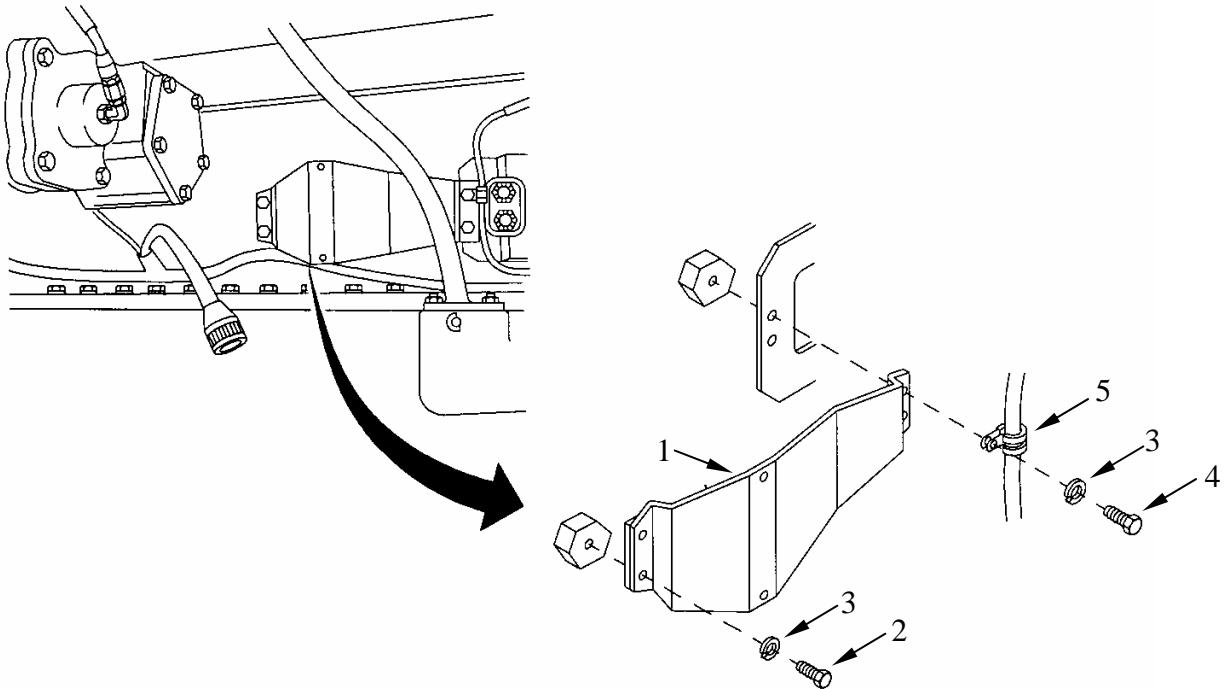
**Equipment Conditions:**

Engine removed from vehicle and placed on a flat stationary surface.

Low voltage protection module removed (WP 0050).

**REMOVAL**

1. Remove low voltage protection module (LVPM) mounting bracket (1).
  - a. Remove two bolts (2) and lock washers (3). Discard lock washers.
  - b. Remove two bolts (4), and lock washers (3), clamp and wiring harness (5) and bracket (1). Discard lock washers.



**LOW VOLTAGE PROTECTION MODULE MOUNTING BRACKET  
REPLACEMENT**

0171 00

**CLEANING**

1. See Work Package 0028 for Standard Cleaning Procedures.

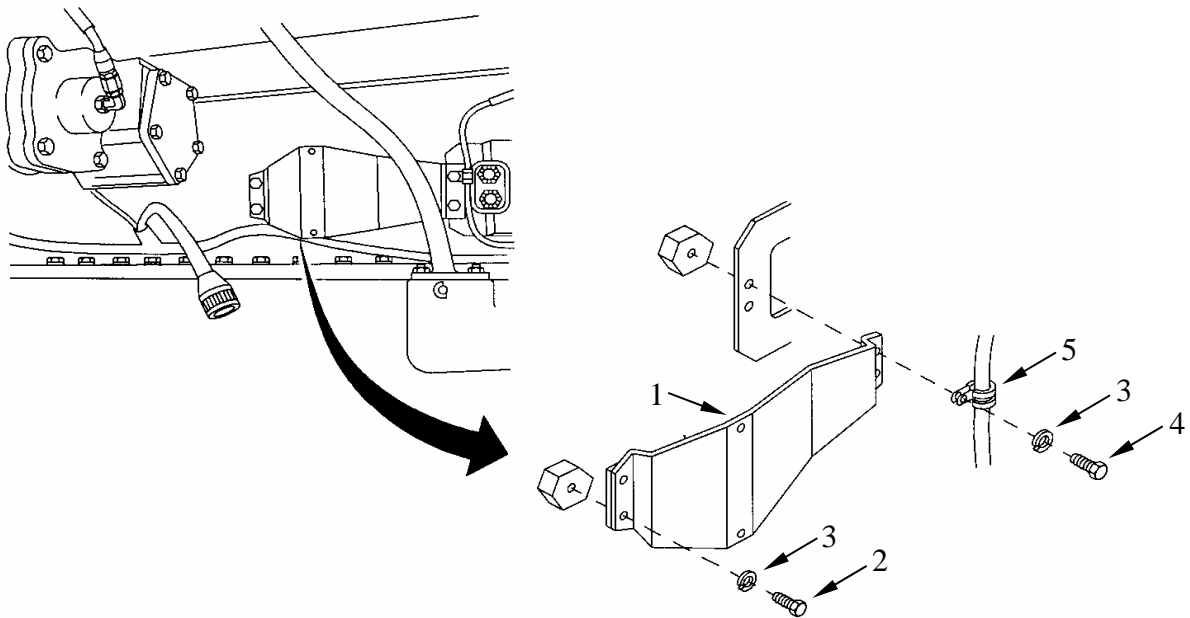
**INSPECTION**

All parts must be inspected with care. Replace part if damage or wear exceeds allowable limits.

1. See Work Package 0028 for Standard Inspection Procedures.

**INSTALLATION**

1. Install starter relay mounting bracket (1).
  - a. Apply a small amount of lubricant (item 23, WP 0173) to four bolts (2), (4).
  - b. Position LVPM bracket (1).
  - c. Install wiring harness and clamp (5), secure bracket with two bolts (4), and two new lock washers (3) (item 86, WP 0175).
  - d. Secure two bolts (2) with two new lock washers (3) (item 86, WP 0175).
  - e. Tighten bolts (2) and (4) to 156 to 180 inch-pounds (18-20 N•m).



**END OF WORK PACKAGE**



**TM 9-2815-220-24**

**CHAPTER 9**

**SUPPORTING INFORMATION**

**FOR**

**AVDS-1790 ENGINE  
MODELS 2CA, 2DA, AND 2DR**



**REFERENCES**

0172 00

**SCOPE**

This work package lists all field manuals, forms, technical manuals, and miscellaneous publications referenced in this manual.

**MAINTENANCE FORMS AND RECORDS**

DA Form 2028	Recommended Changes to Publications
DD Form 6	Packaging Improvement Report
DD Form 1397	Processing and De-processing for Shipment, Storage and Issue of Vehicles and Spare Engines
TM 38-750	The Army Maintenance Management Systems (TAMMS)

**MISCELLANEOUS PUBLICATIONS**

TC 9-237	Operator's Circular Welding Theory and Application
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**PUBLICATION INDEXES**

DA PAM 310-1	Index of Administrative Publications
DA PAM 310-2	Index of Blank Forms
DA PAM 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals, Supply Bulletins, and Lubrication Orders
DA PAM 310-6	Index of Supply Catalogs and Supply Manuals
DA PAM 310-7	Index of Modification Work Orders

**SUPPLY CATALOGS**

SC 4910-95-CL-A63	Sets, Kits, Outfits, and Tools For <u>Shop Equipment, Automotive Maintenance and Repair: Field Maintenance</u> , Supplemental Set No. 2, Less Power (NSN 4910-00-754-0707) (LIN T25756) and Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Supplemental Set No. 2 Map Only (NSN 4910-00-919-0093)
SC 4910-95-CL-A72	Sets, Kits, Outfits, Components List For <u>Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance</u> , Common No. 2, Less Power (NSN 4910-00-754-0650) (LIN W32730) and Shop Equipment, Automotive Maintenance and Repair: Organizational Maintenance, Common No. 2 Map Only (NSN 4910-00-919-0082) (24X Microfiche)

**SUPPLY CATALOGS (Continued)**

- SC 4940-95-CL-B20      Shop Equipment, Fuel and Electrical Systems: Field Maintenance, Basic Less Power (NSN 4910-00-919-0714) (LIN T30414, Formerly 440524) and Map Only (NSN 4910-00-919-0083) (24X Microfiche)
- SC 5180-90-CL-N05      Sets, Kits, Outfits, Components List Tool Kit, General Mechanics (Formerly Tool Kit, Master Mechanic's) (NSN 5180-00-699-5273) (LIN W45060) (24X Microfiche)
- SC 5180-90-CL-N26      Sets, Kits, Outfits Tool Kit for General Mechanic's Automotive (GMTK) (NSN 5180-00-177-7033) (LIN W33004)
- SC 5180-95-CL-B08      Sets, Kits, Outfits, Components List Tool Kit, Automotive Fuel and Electrical Systems Repair (NSN 5180-00-754-0655) (LIN W32456) (24X Microfiche)

**TECHNICAL BULLETIN**

- TB SIG 222              Solder and Soldering

**TECHNICAL MANUALS**

- TM 9-214                Inspection, Care, and Maintenance of Antifriction Bearings
- TM 9-2520-223-34      Direct Support and General Support Maintenance Manual (Including Repair Parts and Special Tools List) for Transmission Cross Drive Assembly, Model CD-850-6A
- TM 9-2910-212-34      Direct Support and General Support Maintenance Manual for Pump, Metering, Fuel Injection Assembly, 10912447 (NSN 2910-00-064-6265) and 11684129 (NSN 2910-00-398-9550) (American Bosch, Model PSB-12 BT)
- TM 9-2910-212-34&P    Direct Support and General Support Maintenance Manual with Repair Parts and Special Tools List for Pump, Metering, Fuel Injection Assembly

## TECHNICAL MANUALS (Continued)

TM 9-2910-213-34	Direct Support and General Support Maintenance Manual for <u>Pump, Fuel, Engine, Assembly</u> (Viking Model FV492) 8725131, 8725282, 8725283, 10882763, and 10882763-1
TM 9-2920-224-35	<u>Generator, Engine, Assembly</u> (AVDS-1790-2DA and -2DR)
TM 9-2920-232-34	Direct Support and General Support Maintenance Manual (Including Repair Parts List) for <u>Starter Engine</u> (Delco-Remy GMC Model 1109972) (NSN2920-00-937-1557) and (Model No. 1990272) (NSN 2920-01-139-3722)
TM 9-2920-252-34&P	Direct Support and General Support Maintenance Manual Including Repair Parts and Special Tools List for <u>650 Ampere Generator Assembly</u> (Bendix Corp., Model 30B95-3-B) (NSN 2920-00-441-8137); <u>Voltage Regulator Assembly</u> (Bendix Corp., Model 24B30-3-B and Electro-Tech Model 1300, NSN 6110-00-467-4000) (AVDS-1790-2CA)
TM 9-2990-205-34&P	Direct Support and General Support Maintenance Manual with Repair Parts and Special Tools List for <u>Turbosupercharger Model 5HDR</u> , NSN 2950-00-397-3384 (11668377-1), NSN 2950-01-167-1700 (187727)
TM 9-2990-206-34&P	Direct Support and General Support Maintenance Manual with Repair Parts and Special Tools List for <u>Turbosupercharger Airesearch Model T18C01</u> , NSN 2950-01-048-8870, (11669107-1), and NSN 2950-01-167-1699, (466392-1)
TM 9-6140-200-14	Operator's, Organizational, Direct Support and General Support Maintenance Manual for <u>Lead-Acid Storage Batteries</u>
TM 43-0139	<u>Painting</u> Instructions for Field Use
TM 750-244-6	Procedures for <u>Destruction of Equipment</u> to Prevent Enemy

**TECHNICAL MANUALS – VEHICLE**

Vehicles with Engines: AVDS-1790-2CA and -2DA:

TM No. Series:

TM 9-2350-258	Tank, Combat, Full Tracked: 105-MM Gun, M48A5
TM 9-2350-215	Tank, Combat, Full Tracked: 105-MM Gun, M60 and M60A1
TM 9-2350-257	Tank, Combat, Full Tracked: 105-MM Gun, M60A1 (RISE)
TM 9-2350-232	Tank, Combat, Full Tracked: 152-MM Gun, M60A2
TM 9-2350-253	Tank, Combat, Full Tracked: 105-MM Gun, M60A3
TM 5-5420-200	Armored Vehicle Launched Bridge: M48A2 AVLB
TM 5-5420-202	Armored Vehicle Launched Bridge: M60A1 AVLB
TM 5-5420-226	Armored Vehicle Launched Bridge: M48A5 AVLB
TM 9-2350-222	Vehicle, Combat Engineer, Full Tracked: M728

Vehicle with Engine: AVDS-1790-2DR:

TM No. Series:

TM 9-2350-256	Recovery Vehicle, Full Tracked: Medium, M88A1
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**END OF WORK PACKAGE**

**SCOPE**

This work package lists expendable and durable items you will need to maintain the AVDS-1790 2CA, 2DA, and 2DR engines.

This listing is for informational purposes only and is not the authority to requisition the listed items. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items), or CTA 8-100, Army Medical Department Expendable/Durable Items.

**EXPLANATION OF COLUMNS**

**Column (1) - Item Number:** This number is assigned to the entry in the list and is referenced in the expendable or durable item number in the INITIAL SETUP part of the work package to identify the item, for example:

“Hard bristle brush (item 6, WP 0173).”

**Column (2) – Level:** This column identifies the lowest level of maintenance that requires the listed item: C = Crew, O = Unit, F = Direct Support, H = General Support, D = Depot.

**Column (3) - National Stock Number (NSN):** This is the NSN assigned to the item which you can use to requisition it.

**Column (4) – Item Name, Description, Commercial and Government Entity Code (CAGEC), and Part Number (P/N):** This column provides the other information you need to identify the item.

**Column (5) – Unit of Measure (U/M):** This measure is expressed by a two-character alphabetical abbreviation (e.g., EA, LB, PR). If the unit of measure differs from the unit of issue as shown in the Army Master Data File (AMDF), requisition the lowest unit of issue that will satisfy your requirement.

## EXPENDABLE AND DURABLE ITEMS LIST

0173 00

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
1	O	8040-01-147-9957	Adhesive: (06090) P/N S1125	KT
2	O	8040-00-522-3429	Adhesive: (81349) MIL-A-46106 (3-ounce tube)	OZ
3	O	8040-00-181-7254	Adhesive, silicone rubber: (81349) MIL-A-25457 (4-oz base plus 4-oz catalyst)	KT
4	O	8040-01-331-7128	Adhesive, silicone rubber: (80244) Type III, MIL-A-46146	OZ
5	F	8030-00-251-3980	Antiseize compound: (73165) C5A	LB
6	O	7920-00-205-2401	Brush, Hard Bristle (80244) 7920-205-2401	EA
7	F	6850-00-162-9964	Carbon removing compound: (81349) MIL-S-12382 Type I	GL
8	O	6850-01-331-3350 (55-gallon drum) 6850-01-331-3349 (5-gallon can)	Cleaning compound, solvent: (81348) P-D-680	
9	O	5350-01-211-4796	Cloth, abrasive, crocus: (61136) PC-MC-8068	SH
10	O	7920-00-044-9281	Cloth, cleaning: (51200) Miraclewipe 110	BX
11	O	7930-00-530-8067	Detergent, general purpose: (81348) P-D-220TY2	GL
12	C	9140-01-412-1311	Diesel fuel: (81348) VV-F-800 (DF-2) (Bulk)	BK
13	F	8010-00-133-5706	Enamel: (Glyptol) (65313) 1201, MIL-E-22118	QT



## EXPENDABLE AND DURABLE ITEMS LIST

0173 00

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
14	O	3439-00-400-1972	Flux, soldering: (81349) MIL-F-14256	PT
15	O	8040-01-038-5043	Gasket cement: (11083) MIL-C-10523, 5H2471	OZ
16	O	8415-00-266-8677	Gloves, Rubber (81349) MILL-DTL-32066	EA
17	O	4240-00-816-3819	Goggles, Industrial (Safety) (74936) WA60-5H0746-0315	EA
18	O		Grease, Injector Coupling: (1DKH2) 98GN42 (14 ounce tube)	CN
19	O	9150-01-305-6879	Grease, automotive, artillery (GAA): (81349) MIL-G-10924C	OZ
20	O	5510-00-274-5377	Lumber, hardwood (81348) P/N MML736 (2x4x8)	BF
21	O	9150-00-680-1106	Lubricating oil, engine: (81349) MIL-L-45199 Grade 2 (OE 30)	GL
22	O	9150-00-231-9045	Lubricating oil (preservation oil): (81349) VV-L-800	GL
23	O	9150-00-140-4434	Lubriplate: (92739) 087-056 (1-pound can)	LB
24	O	6850-01-316-9420	Penetrant, Inspection (Dye Penetrant) (21405) DP-40	GL
25	F	8010-00-652-3626	Prussian blue paste: (81349) MIL-P-30501 (1-ounce tube)	OZ

## EXPENDABLE AND DURABLE ITEMS LIST

0173 00

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
26	O	7920-00-205-1711	Rags, wiping: (58536) A-A-2522GRB (50-pound bale)	LB
27	F	9320-00-576-4981	Rubber sheet, cellulide, Make from bulk: 36 x 36 x .25-inch sheet, (81349) MIL-C-3133, 11678085-1	SH
28	F	9320-01-023-8437	Rubber sheet, cellulide, Make from bulk: 36 x 36 x 0.440-inch sheet, (81349) MIL-C-3133, 11678085-2	SH
29	O	1015-01-255-4144	Sealant, pipe, Teflon: (05972) 05972-592 (50-millileter tube)	ML
30	O	8030-00-081-2286	Sealing compound: (81349) MIL-S-22473	CC
31	O	8030-00-148-9833	Sealing compound (80244) MIL-S-46163TY1GRK	CC
32	O	8030-00-163-5792	Sealing compound: (19207) P/N 11663357	OZ
33	O	8030-01-202-3962	Sealing compound, silicone sealant: (01138) RTV-1473 (30-ounce tube)	OZ
34	O	6850-00-177-5094	Silicone compound: (71984) DC4-207 (MIL-S-8660) (2-ounce tube)	OZ
35	O	1015-01-205-0371	Sleeving, insulation (heat-shrink insulating tubing): (06090) NTFR-1/4-0	FT
36	O	5970-01-494-6827	Sleeving, insulation, electrical (19207) P/N 12352468-13	FT

**EXPENDABLE AND DURABLE ITEMS LIST**

**0173 00**

(1) Item Number	(2) Level	(3) National Stock Number	(4) Item Name, Description, CAGEC, Part Number	(5) U/M
37	O	7930-00-253-0779	Soap, scrubbing, alkaline: (58536) P/N A-A-44 (100-pound drum)	DR
38	O	3439-00-133-1108	Solder, tin alloy, 1-lb spool: (81348) SN60WRAP3	LB
39	O	9905-00-537-8954	Tag, marker: (81349) MIL-T-12755CLRW	EA
40	O	5970-00-419-4291	Tape, insulation, electrical, 108-ft roll: (81349) MIL-I-24391	FT
41	O	6515-01-504-9326	Tape, thread sealing (Teflon) (5X927) 25629LT (1/2 in. x 520 in. roll)	RL
42	O	8010-00-298-3869	Varnish, oil: (81349) MIL-V-13811	PT
43	O	9525-00-990-7799	Wire, nonelectrical: (96906) MS20995NC40 (1-pound spool)	LB
44	O	9525-00-355-6072	Wire, nonelectrical, (96906) MS20995NC32 (2-pound spool)	LB

**END OF WORK PACKAGE**



**THIS WORK PACKAGE COVERS:**

Special torque limits (Table 1), standard screw and nut torque limits (Table 2), standard pipe plug thread torque limits (Table 3), and stud torque limits for assembly in aluminum (Table 4)

**GENERAL**

AVDS-1790-2 series engines require special and standard torque limits for fasteners, studs, and pipe plugs. This work package provides special and standard torque limits for the convenience of the maintainer.

**IMPORTANT**

**Become familiar with this work package and keep it as a handy reference. First check Table 1, Special Torque Limits, for items that are specific to a particular engine part. The special torque list is in alphabetical order for ease of use.**

**If the part that needs to be tightened is not listed in Table 1, use the Standard Torque Tables (Tables 2-4) in this work package.**

**NOTE**

**All torque values – Special and Standard – are with lubrication unless otherwise specified. Torque values for dry fasteners would be different. Pay attention to lubrication notes.**

**LUBRICATION NOTES**

1. Lubricate nut washer face and threads with Lubriplate (item 23, WP 0173).
2. Lubricate tapped hole with Lubriplate.
3. On assemblies subjected to wire or cotter pin alignment, set torque wrench to low limit and torque nut using Lubriplate. To facilitate alignment, it is permissible to tighten nut to first hole beyond this torque.
4. Lubricate all adapter-to-fitting threads and contact surfaces with MIL-L-45199 engine oil (item 21, WP 0173).

**GENERAL (Continued)**

**F.F.F.T. Torque Method**

The abbreviation F.F.F.T. (Flats From Finger Tight) is occasionally used prior to the torque column in the Special Torque Table. This method is used to tighten certain fittings, hose nuts, and tube nuts when a torque wrench is not available. The F.F.F.T. value is in parentheses followed by the proper torque value. Use the torque value whenever possible and verify the F.F.F.T. value at the earliest opportunity if it is used.

The following steps explain this method:

1. Verify size.
2. Install and finger tighten (approximately 30 inch-pounds, or 3.39 N•m). Make sure fastener is seated. This is the starting point for counting the flats on the nut/fitting and equals zero (0) F.F.F.T.
2. Mark flat of nut/fitting and body of mating part with one continuous line using ink-type marker.
3. Apply torque in accordance with the value stated. As an example, a tube with an outside diameter of 1/8-inch requires 2 F.F.F.T. Tighten the tube nut two flats beyond the mark. This would be equivalent to 75-110 inch-pounds (8.47-12.43 N•m) using a torque wrench.
4. Verify torque using torque wrench at earliest opportunity.

**TABLE 1: SPECIAL TORQUE LIMITS**

**NOTE**

**Use Lubriplate (item 23, WP 0173) as a thread lubricant (except when noted otherwise). Avoid excessive amounts of lubricant in blind tapped holes.**

DESCRIPTION	Torque: inch-pounds
Accessory cam drive inner gear shaft (1-7/8-18 plug)	1300-1400
Accessory drive gear to crankshaft (7/16-20 bolts)	400-450
Accessory drive housing and fan tower to bases (3/8-24 nuts)	275-300
Accessory drive housing fan tower base to crankcase (3/8-24 nut and screws)	275-300
Camshaft drive bevel gear and oil return cover to camshaft (3/8-24 bolts)	275-325
Clamps, E-type hose (all) (Lubrication Note number 4 applies)	30-40

**TORQUE LIMIT TABLES**

**0174 00**

**TABLE 1: SPECIAL TORQUE LIMITS (Continued)**

DESCRIPTION		Torque: inch-pounds	
Compression sleeve fitting tube nuts: (Lubrication Note number 4 applies)			
<u>Tube o.d.</u>	<u>Material</u>		
1/8	Plastic w/support	(2 F.F.F.T.)	75-110
1/4	Plastic w/support	(2 F.F.F.T.)	135-150
3/8	Steel	(1-1/4 F.F.F.T.)	215-280
1/2	Steel	(1 F.F.F.T.)	470-550
Connecting rod bolt nuts: alternately tighten 100-150, then 600-650 and then the listed torque			1250-1300
Constant torque clamps Tighten until spring bottoms, then back-off 1 to 1-1/2 turns			
Crankcase through-bolts			640
Crankcase-main bearing stud nuts: 1. First tighten all nuts to 500 inch-pounds 2. Then tighten all nuts to listed torque 3. Check stud stretch: Optimal: .019 - .022 inch 4. Tighten nuts as applicable to obtain proper stretch. 5. Do not exceed .024-inch stretch when aligning wire holes.			700-825
<b>NOTE</b>			
<b>Studs which exceed the stretch limits at less than 700 inch-pounds must be replaced.</b>			
<b>Studs which exceed the stretch limits above 700 inch-pounds must be loosened and re-subjected to steps 1-5.</b>			
<b>Re-torquing any singular stud nut is not allowable. The adjacent stud nut must also be loosened and re-torqued in sequence.</b>			
Cylinder deck studs (1/2-inch), Installation of			450-1000
Cylinder flange base nuts, Installation of			840-860
Cylinder head oil drain tube to cylinder head (1/2-20 bolts)			275-300
Damper housing oil drain valve			135-150
Damper housing to crankcase (3/8-24 nuts)			225-250
Damper to crankshaft			975-1025
Exhaust manifold support bracket bolt/nut			400-425
Fan adapter to fan cap screws			150-175
Fan adapter to fan drive shaft unit			600-625
Fan clutch slip torque			300-350





## TORQUE LIMIT TABLES

0174 00

TABLE 1: SPECIAL TORQUE LIMITS (Continued)

DESCRIPTION	Torque: inch-pounds
Fuel return hoses to injection nozzle, holder adapter elbow and cross-over fittings (Lubrication Note number 4 applies) (2 F.F.F.T.)	135-190
Ground strap to generator at terminal "E"	100-110
Injection line clamps (5/16-24 nut, bolt and screws)	230-250
Lifting eyes to transmission adapter bolts	550-600
Main bearing stud (at initial assembly on new crankcase only, prior to installing main bearings)	450
Oil drain valve adapter to damper housing	950-1000
Oil pan baffle and seal assembly to crankcase (5/16-24 screws)	120-125
Oil pan drain plug	1000-1050
Oil pan mounting bolts into helical coils	150-175
Oil pan mounting nuts to studs	275-300
Oil pump cluster gear shaft spanner (31/32-32 nut)	575-625
Oil pump driven gear to shaft (3/4-16 nut)	700-780
Oil pump housings and covers (5/16-24 nuts)	125-150
Oil pump to crankcase (3/8-24 screws)	275-300
Piston sprayer to crankcase (5/16-24 nuts) or (5/16-24 screws)	125-150
PTO drive adapter 7/8-14 self locking nut (Threads and taper must be dry, clean, and free from oil and grease)	280-290 ft-lb
Starter gear to shaft (1.00-20 nut)	300-325 ft-lb
Turbocharger oil inlet fitting	140-160
Turbocharger:	
a. Compressor wheel retaining nut	600-660
b. Bearing housing to turbine housing bolts	225-250
c. Drain tube to bearing housing	225-250
d. Mounting leg to bearing housing	225-250
e. Compressor housing clamp	84-96
Valve rocker adjusting cover plate (5/16-24 screws)	150-175
Valve rocker adjusting screw lock nut	200-225
Valve rocker cover (5/16-24 bolts and screws)	150-175
Valve rocker cover at cam bearings (3/8-24 (4) screws)	275-325

END OF TABLE 1: SPECIAL TORQUE LIMITS

STANDARD TORQUE LIMIT TABLES

NOTE

All torque values – Special and Standard – are with lubrication unless otherwise specified. Torque values for dry fasteners would be different. Pay attention to lubrication notes.

See Lubrication Notes on page 1 of this work package

1. To use standard torque tables:
  - a. Measure the diameter of the screw, nut, pipe plug, or stud you are installing.
  - b. Use the appropriate table:
    - Screws and nuts (Table 2)
    - Pipe plugs (Table 3)
    - Studs (Table 4)
  - c. Under the heading “Size (Diameter, Inch),” look in the left column until you find the diameter of the nut, bolt, screw, stud or pipe you are installing. Then read across the table to find the proper torque limit.

TABLE 2: STANDARD SCREW AND NUT TORQUE LIMITS

Apply Lubriplate (item 23, WP 0173) to bolts, cap screw threads, contact face of nuts, bolt heads, and cap screws. Avoid excessive amounts of lubricant in blind tapped holes.

NOTE

On assemblies subjected to wire or cotter pin alignment, set torque wrench to low limit and torque nut. To facilitate alignment, it is permissible to tighten nut to first hole beyond torque setting.

Size (Diameter, Inch)	Torque: inch-pounds
1/4	75-100
5/16	150-175
3/8	275-325
7/16	400-450
1/2	550-600
9/16	800-850
3/4	1000-1050

**STANDARD TORQUE LIMIT TABLES**

**TABLE 3: STANDARD PIPE PLUG THREAD TORQUE LIMITS**

Coat pipe plug threads with lubricating oil (item 21, WP 0173), GAA grease (item 25, WP 0172) or equivalent.

<b>Size (Diameter, Inch)</b>	<b>Threads per inch</b>	<b>Torque: inch-pounds</b>
1/8	27	60-80
1/4	18	125-145
3/8	18	185-215
1/2	14	250-280
3/4	14	305-345
1-11	11-1/2	500-1000
1-1/4	11-1/2	1200-1400

**TABLE 4: STUD TORQUE LIMITS FOR ASSEMBLY IN ALUMINUM**

Unless otherwise specified, use Lubriplate (item 23, WP 0173) as a lubricant.

<b>Thread Size (Diameter, Inch)</b>	<b>Minimum Torque: inch-pounds</b>
#10	25
1/4	50
5/16	85
3/8	156
7/16	240
1/2	300
9/16	450
5/8	600
3/4	600

**END OF WORK PACKAGE**



**MANDATORY REPLACEMENT PARTS**

**0175 00**

**SCOPE**

This work package lists all mandatory replacement parts needed to maintain and repair AVDS-1790-2CA, 2DA, and 2DR engines and their reusable shipping and storage container. These parts are referenced in the INITIAL SETUP section and in the procedural steps of relevant work packages. The items on this list must be replaced during maintenance whether they have failed or not. The part list is in part number sequence.

This work package does not list replacement parts for engine accessories. Refer to References (WP 0172) which lists technical manuals for engine accessories.

**EXPLANATION OF COLUMNS**

**Column (1): Item Number:** This number corresponds to the "Mandatory Replacement Parts" in the work package INITIAL SETUP section for cross-referencing to the part number, for example:

"Retaining ring (item 14, WP 0175)" in INITIAL SETUP  
 In WP 0175 (Mandatory Replacement Parts), item 14 is  
 "Ring, retaining" with part number MS16625-1281.

**Column (2): Part Number:** This part number is assigned to the item. Use this part number to request or requisition the part.

**Column (3): NSN:** The NSN (National Stock Number) may also be used to order a part. When an NSN is used to requisition a part, the part you get may have a different part number from that of the part listed. Form, fit, and function will be the same and the part is acceptable to use.

**Column (4): Description:** This column contains the Federal item name of the part.

<b>Item Number</b>	<b>Part Number</b>	<b>NSN</b>	<b>Description</b>
<b>1</b>	AA55488-1	5315-00-223-6113	Pin, retaining, safety
<b>2</b>	AN844-20D	4730-00-277-1987	Adapter
<b>3</b>	AN901-20C	5330-00-196-6714	Gasket
<b>4</b>	AS29513-116	5331-00-248-3850	O-ring
<b>5</b>	AS3582-230	5331-00-990-4143	O-ring
<b>6</b>	B1821BH038F113N	5305-00-269-3237	Screw, cap
<b>7</b>	CC40552MK12	4730-01-314-2874	Plug, pipe
<b>7.1</b>	FFB171/03J10A2E	3110-00-529-9480	Bearing, annular
<b>8</b>	MS16624-1062	5365-00-803-7305	Ring, retaining
<b>9</b>	MS16624-131	5325-00-803-9976	Ring, retaining
<b>10</b>	MS16625-1112	5365-00-801-2500	Ring, retaining

## MANDATORY REPLACEMENT PARTS

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11	MS16625-1125	5365-00-804-2786	Ring, retaining
12	MS16625-1137	5325-00-754-1083	Ring, retaining
13	MS16625-1150	5365-00-804-3891	Ring, retaining
14	MS16625-1281	5365-00-822-2136	Ring, retaining
15	MS16625-1354	5365-00-260-4875	Ring, retaining
16	MS16625-3212	5365-00-202-0194	Ring, retaining
17	MS16626-1112	5365-00-828-7570	Ring, retaining
18	MS16626-1143	5365-00-989-7682	Ring, retaining
19	MS16627-1112	5365-00-558-8482	Ring, retaining
20	MS16632-1031	5365-00-663-1245	Ring, retaining
21	MS16633-1062	5365-00-842-2613	Ring, retaining
22	MS17131-18	3110-00-198-1085	Bearing
23	MS171584	5315-00-576-9629	Pin, roll
24	MS171592	5315-01-135-0181	Pin, spring
25	MS17795-104	3120-00-846-2012	Bearing
26	MS19070-051	5310-00-159-6495	Washer, key
27	MS20365-524A	5310-00-262-6375	Nut, self-locking
28	MS20500-720A	5310-00-493-4020	Nut, self-locking
29	Deleted		
30	MS21042-5	5310-00-807-1469	Nut, self-locking
31	MS21044N10	5310-00-982-6809	Nut, self-locking
32	MS21044N3	5310-00-877-5797	Nut, self-locking
33	MS21044N5	5310-00-088-0553	Nut, self locking
34	MS21044N6	5310-00-950-0039	Nut, self-locking
35	MS21044N7	5310-00-088-0552	Nut, self-locking
36	MS21045-C6	5310-00-059-9264	Nut, self-locking
37	MS21045-4	5310-00-061-7325	Nut, self-locking
38	MS21045-5	5310-00-982-4912	Nut, self-locking
39	MS21045-6	5310-00-982-4908	Nut, self locking
40	MS21045-7	5310-00-274-9364	Nut, self-locking
41	MS21045-8	5310-00-062-4954	Nut, self-locking
42	MS21083N3	5310-00-902-6676	Nut, self-locking
43	MS21083N5	5310-00-660-3381	Nut, self-locking
44	Deleted		
45	Deleted		
46	MS2183N3	5310-00-902-6676	Nut, self-locking
47	MS24665-132	5315-00-839-2325	Pin, cotter
48	MS24665-134	5315-00-839-5820	Pin, cotter
49	MS24665-283	5351-00-842-3044	Pin, cotter
50	MS24665-291	5315-00-019-0777	Pin, cotter
51	MS24665-300	5315-00-234-1863	Pin, cotter

## MANDATORY REPLACEMENT PARTS

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52	MS24665-302	5315-00-234-1864	Pin, cotter
53	MS24665-359	5315-00-013-7214	Pin, cotter
54	MS24665-86	5315-00-239-8019	Pin, cotter
55	MS27151-24	5310-00-489-5663	Nut, stamped
56	MS27769C6	4730-00-278-2966	Plug, pipe
57	MS28741-8-0120	4720-00-274-9335	Hose assembly
58	MS28741-8-0134	4720-00-420-4396	Hose assembly
59	MS28741-8-0240	4720-00-274-9356	Hose assembly
60	MS28741-8-0300	4720-00-461-9797	Hose assembly
61	MS28775-011	5330-00-582-2133	O-ring
62	MS28775-110	5330-00-585-6663	O-ring
63	MS28775-112	5330-00-599-2934	O-ring
64	MS28775-113	5330-00-582-2855	O-ring
65	MS28775-116	5330-00-579-3156	O-ring
66	MS28775-222	5330-00-297-9990	O-ring
67	MS28775-223	5330-00-171-6649	O-ring
68	MS28775-226	5330-00-576-9732	O-ring
69	MS28775-229	5330-00-579-7918	O-ring
70	MS28775-236	5330-00-579-6861	O-ring
71	MS28775-238	5330-00-579-7545	O-ring
72	MS28775-272	5330-01-117-8833	O-ring
73	MS28778-10	5330-00-285-9842	O-ring
74	MS28778-4	5330-00-805-2966	O-ring
75	MS28778-5	5330-00-833-7491	O-ring
76	MS29513-012	5331-00-248-3836	O-ring
77	MS29513-116	5330-00-248-3850	O-ring
78	MS29513-125	5330-00-265-1089	O-ring
79	MS29561-256	5330-00-954-2740	O-ring
80	MS3367-1-9	5975-00-074-2072	Strap, tiedown
81	MS3367-3-0	5975-00-985-6630	Strap, tiedown
82	MS35333-40	5310-00-550-1130	Washer, lock
83	MS35333-41	5310-00-167-0721	Washer, lock
84	MS35335-29	5310-00-616-3554	Washer, lock,
85	MS35335-33	5310-00-209-0786	Washer, lock
86	MS35335-34	5310-00-514-6674	Washer, lock
87	MS35335-38	5310-00-616-6354	Washer, lock
88	MS35335-40	5310-00-275-3683	Washer, lock
89	MS35335-58	5310-00-209-1366	Washer, lock
90	MS35338-42	5310-00-045-3299	Washer, lock
91	MS35338-43	5310-00-045-3296	Washer, lock
92	MS35338-44	5310-00-582-5965	Washer, lock

## MANDATORY REPLACEMENT PARTS

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93	MS35338-44	5310-00-582-5965	Washer, lock
94	MS35338-46	5310-00-637-9541	Washer, lock
95	MS35338-47	5310-00-209-0965	Washer, lock
96	MS35338-48	5310-00-584-5272	Washer, lock
97	MS35338-51	5310-00-584-7888	Washer, lock
98	MS35340-47	5310-00-655-9370	Washer, lock
99	MS35489-27	5325-00-290-1960	Grommet
100	MS35489-74	5325-00-276-6096	Grommet
101	MS35489-97S	5325-01-492-8991	Grommet
102	MS35490-16	5325-01-097-0347	Grommet
103	MS35756-8	5315-00-616-5526	Key, woodruff
104	MS35764-1293	5306-01-046-7990	Screw, self-locking
105	MS35769-35	5330-00-199-5886	Gasket
106	MS35769-47	5330-00-269-2844	Gasket
107	MS35910-1	5310-00-982-6539	Gasket, spark plug
108	MS45904-76	5310-00-061-1258	Washer, lock
109	Deleted		
110	Deleted		
111	MS51922-1	5310-00-088-1251	Nut, self-locking
112	MS51922-17	5310-00-087-4652	Nut, self-locking
113	MS51922-21	5310-00-959-1488	Nut, self-locking
114	MS51922-68	5310-00-225-6409	Nut, self locking
115	MS52104C4-0074	4720-00-475-3435	Hose assembly
116	MS8005E043B	4720-01-155-5061	Hose assembly
117	MS8005E060A	4720-00-601-9351	Hose assembly
118	MS8005E074C	4720-01-415-0979	Hose assembly
119	MS8005E086E180	5325-00-184-9846	Hose assembly
120	MS8005E100C	4720-01-031-0519	Hose assembly
121	MS8005E112F020	4720-01-173-4614	Hose assembly
122	MS8005E140A	4720-01-036-7474	Hose assembly
123	MS8005E140C	4720-01-433-7182	Hose assembly
124	MS8005E145F000	4720-01-173-4145	Hose assembly
125	MS8005E160E270	4720-01-053-2019	Hose assembly
126	MS8005E212C	4720-01-030-8526	Hose assembly
127	MS8005E230F135	4720-01-053-2018	Hose assembly
128	MS8005F092F020	4720-01-173-4615	Hose assembly
129	MS8005F145F000	4720-01-173-4613	Hose assembly
130	MS8005G346BC		Hose
131	MS8005H060A	4720-01-030-8796	Hose assembly
132	MS8005H120A	4720-01-035-6877	Hose assembly
133	MS8005H147C	4720-01-098-0829	Hose assembly



## MANDATORY REPLACEMENT PARTS

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<b>134</b>	MS8005H237F090	4720-01-097-4732	Hose assembly
<b>135</b>	MS8005H494A	4720-01-268-7902	Hose assembly
<b>136</b>	MS80056405BC		Hose assembly
<b>137</b>	MS9068-230	5330-00-990-4143	O-ring
<b>138</b>	MS9241-135	5330-01-213-4808	O-ring
<b>139</b>	M45913/1-14FG5C	5310-00-225-6409	Nut, self-locking
<b>140</b>	M45913/2-6FG5C	5310-00-959-1488	Nut, self-locking
<b>141</b>	M83248/1-012	5330-00-166-0980	O-ring
<b>142</b>	M83248/1-017	5331-00-166-0993	O-ring
<b>143</b>	M83248/1-114	5330-00-166-1063	O-ring
<b>144</b>	M83248/1-118	5330-00-166-1072	O-ring
<b>145</b>	M83248/1-120	5330-00-166-1076	O-ring
<b>146</b>	M83248/1-123	5331-00-167-5112	O-ring
<b>147</b>	M83248/1-126	5330-00-167-5114	O-ring
<b>148</b>	M83248/1-212	5330-00-166-8403	O-ring
<b>149</b>	M83248/1-327	5330-01-005-3213	O-ring
<b>150</b>	M83248/1-331	5331-00-167-5157	O-ring
<b>151</b>	M83248/1-911	5330-00-165-1975	O-ring
<b>152</b>	M83461/1-006	5330-01-107-4956	O-ring
<b>153</b>	M83461/1-111	5330-01-107-3121	O-ring
<b>154</b>	M83461/1-325	5330-01-160-4343	O-ring
<b>155</b>	M83461/1-335	5330-01-160-4348	O-ring
<b>156</b>	Deleted		
<b>157</b>	Deleted		
<b>158</b>	NAS1523-6Y	5330-00-003-9302	Washer, seal
<b>159</b>	SC587195	5330-01-393-9091	Gasket
<b>160</b>	SC8725239	5330-01-393-9087	Gasket
<b>161</b>	SPL51712-6	5310-01-151-2732	Nut, self-locking
<b>162</b>	Deleted		
<b>163</b>	Deleted		
<b>164</b>	Deleted		
<b>165</b>	Deleted		
<b>166</b>	Deleted		
<b>167</b>	Deleted		
<b>168</b>	SR7830		Spring
<b>169</b>	WA29908	5331-01-433-5288	O-ring
<b>170</b>	WW-P-471ACBBDG	4730-01-022-6066	Plug, pipe
<b>171</b>	032505E0140	4720-00-723-7397	Hose assembly
<b>172</b>	10865381	5310-00-239-5848	Washer, key
<b>173</b>	10867369	4720-00-706-9144	Hose assembly
<b>174</b>	10882649		Seal

## MANDATORY REPLACEMENT PARTS

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<b>174.1</b>	10882650		Spring
<b>175</b>	10882768	4710-00-821-0659	Tube assembly
<b>176</b>	10882940	4720-00-792-5393	Hose assembly
<b>177</b>	10883737	5330-00-803-0259	Gasket
<b>178</b>	10883740	4720-00-771-6968	Hose
<b>179</b>	Deleted		
<b>180</b>	10898793-1	4720-00-177-6186	Hose
<b>181</b>	10898794	4720-00-896-6166	Hose
<b>182</b>	10898933	5330-00-899-1504	Gasket
<b>183</b>	Deleted		
<b>184</b>	10912558	5330-00-438-1861	Gasket
<b>185</b>	10935282-1	4720-00-432-1334	Hose
<b>186</b>	10935359	5330-00-078-4866	O-ring
<b>187</b>	10935368	5330-01-031-6954	Gasket
<b>188</b>	10935397	5330-00-586-6071	Gasket
<b>189</b>	10935398		Seal, plain
<b>190</b>	10935447	5325-00-182-4707	Grommet
<b>191</b>	10935537	5330-00-902-3189	Seal, plain
<b>192</b>	10935621	5330-00-410-9803	Gasket
<b>193</b>	10951369	3110-00-462-0392	Bearing
<b>194</b>	1103-8	5330-00-814-6675	Washer, seal
<b>195</b>	11602061	2940-00-808-2421	Element, filter
<b>196</b>	11602062		Element, filter
<b>197</b>	11610232	5330-01-102-4685	O-ring
<b>198</b>	11641744	5330-01-346-4600	Gasket
<b>199</b>	11641857	5330-01-123-2656	Gasket
<b>200</b>	11668067	3120-00-275-1610	Bearing half
<b>201</b>	Deleted		
<b>202</b>	Deleted		
<b>203</b>	Deleted		
<b>204</b>	Deleted		
<b>205</b>	Deleted		
<b>206</b>	Deleted		
<b>207</b>	Deleted		
<b>208</b>	Deleted		
<b>209</b>	Deleted		
<b>210</b>	Deleted		
<b>211</b>	Deleted		
<b>212</b>	Deleted		
<b>213</b>	Deleted		
<b>214</b>	Deleted		

## MANDATORY REPLACEMENT PARTS

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<b>215</b>	Deleted		
<b>216</b>	11668614	5330-00-492-1774	Seal
<b>217</b>	11668618	4330-01-161-5339	Element, filter
<b>218</b>	11668619	4330-00-000-0145	Element, filter
<b>219</b>	11668622	5310-01-014-1087	Nut, self-locking
<b>220</b>	11668623-3	5340-01-014-7060	Plug, expansion
<b>221</b>	11682601	5360-01-011-0732	Spring
<b>222</b>	11668628	5330-00-492-1776	Seal ,plain
<b>223</b>	11668688	5306-01-013-7020	Screw, self-locking
<b>224</b>	11669695	5330-01-196-7948	Seal, plain
<b>225</b>	11682579	4720-00-410-1180	Hose
<b>226</b>	11682694	5330-00-486-0372	Seal, plain
<b>227</b>	Deleted		
<b>228</b>	Deleted		
<b>229</b>	Deleted		
<b>230</b>	Deleted		
<b>231</b>	Deleted		
<b>232</b>	11683972		Bearing half
<b>233</b>	11683972-1		Bearing half
<b>234</b>	11683972-2		Bearing half
<b>235</b>	11684037		Rubber strip
<b>236</b>	11684038		Rubber strip
<b>237</b>	11684039-2	5330-00-492-1784	Gasket
<b>238</b>	11684039-4	5330-00-483-9490	Gasket
<b>239</b>	11684040	5330-00-486-0302	Gasket
<b>240</b>	11684047	5330-01-298-4850	Gasket
<b>241</b>	11684054		Gasket
<b>242</b>	11684058	5330-00-486-0320	Retainer, packing
<b>242.1</b>	11684064	5360-00-410-1983	Spring
<b>243</b>	11684075	5330-00-492-1777	Gasket
<b>244</b>	11684095	5330-00-486-0346	Gasket
<b>245</b>	11684096	2910-01-011-9105	Filter
<b>246</b>	11684104	3120-00-510-4115	Bearing, thrust
<b>247</b>	Deleted		
<b>248</b>	Deleted		
<b>249</b>	Deleted		
<b>250</b>	11684255	4710-01-009-4306	Tube assembly
<b>251</b>	11684256	4710-01-011-9104	Tube assembly
<b>252</b>	11684260	2910-01-022-6967	Element, filter
<b>253</b>	11684261	2910-01-017-1482	Filter
<b>254</b>	11684294	4720-01-026-4828	Hose assembly

## MANDATORY REPLACEMENT PARTS

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<b>255</b>	12Z329PC93	4730-00-555-8291	Plug, pipe
<b>256</b>	120214	5310-00-012-0214	Washer, lock
<b>257</b>	12254235	5330-01-037-0800	Gasket
<b>258</b>	12254331	5360-01-047-9364	Spring
<b>259</b>	12254395		Gasket
<b>260</b>	12275824	5330-01-145-8290	Gasket
<b>261</b>	12275883	4720-01-146-1887	Hose, nonmetallic
<b>262</b>	12275894	5310-01-151-2732	Nut, self-locking
<b>263</b>	12314574	4720-01-146-1888	Hose
<b>264</b>	12314650	5360-01-274-3562	Spring, helical
<b>265</b>	12354303	5330-01-207-6449	Gasket
<b>266</b>	Deleted		
<b>267</b>	Deleted		
<b>268</b>	Deleted		
<b>269</b>	Deleted		
<b>270</b>	Deleted		
<b>271</b>	Deleted		
<b>272</b>	12354456	5330-01-433-5274	Gasket, steel
<b>273</b>	1580154-1	5530-01-171-8249	Gasket
<b>274</b>	1743117	1650-01-378-7277	Element, filter
<b>275</b>	26031-7020	5330-00-286-9942	Seal, plain
<b>276</b>	272977	4730-01-030-4950	Plug, pipe
<b>277</b>	401752	4730-00-044-4689	Plug, pipe
<b>278</b>	444715	4730-00-044-4715	Plug, pipe
<b>279</b>	500241	5330-00-291-2830	Seal
<b>280</b>	501226	5325-00-804-3891	Ring, retaining
<b>281</b>	503339	5310-00-877-5796	Nut, self-locking
<b>282</b>	503345	5310-00-088-0553	Nut, self-locking
<b>283</b>	523557	5310-00-679-5685	Gasket, copper
<b>284</b>	529312	5330-00-679-7063	Gasket
<b>285</b>	550556	5330-00-599-0942	Packing
<b>286</b>	569807-02	2910-00-203-3322	Element, filter
<b>287</b>	583391	5325-00-281-2929	Ring, retaining
<b>287.1</b>	583707	5360-00-679-4966	Spring
<b>288</b>	585094	5330-00-679-4961	Gasket
<b>289</b>	Deleted		
<b>290</b>	586365	5365-00-682-1619	Ring, Retaining
<b>291</b>	586596	5330-00-679-8059	Gasket
<b>291.1</b>	700078	3110-00-144-8518	Bearing, ball
<b>292</b>	700079	3110-00-554-3197	Bearing, ball
<b>293</b>	700080	3110-00-516-5490	Bearing, ball

## MANDATORY REPLACEMENT PARTS

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<b>294</b>	700081	3110-00-554-5302	Bearing, ball
<b>295</b>	700336	3110-00-555-5207	Bearing
<b>296</b>	700580	3110-00-155-6675	Bearing, ball
<b>297</b>	701023		Bearing
<b>298</b>	701024	3110-00-554-2979	Bearing
<b>299</b>	701025	3110-00-529-9480	Bearing, ball
<b>300</b>	701077	3110-01-094-9268	Bearing, ball
<b>301</b>	Deleted		
<b>302</b>	7033684	5330-00-814-6675	O-ring
<b>303</b>	7045881		Washer, seal
<b>304</b>	7084278	5330-00-678-7101	Gasket
<b>305</b>	709460	3110-00-120-4367	Bearing, roller
<b>306</b>	714056	3110-00-554-3899	Bearing
<b>307</b>	714090	3110-00-156-5443	Bearing, ball
<b>308</b>	7320411	5340-00-678-3532	Mount, resilient
<b>309</b>	7320459	5330-00-678-4676	Gasket
<b>310</b>	7323994	5310-00-678-5370	Gasket, copper
<b>311</b>	Deleted		
<b>312</b>	Deleted		
<b>313</b>	7350206	4720-01-495-5215	Hose, nonmetallic
<b>314</b>	7359808	5330-00-291-1720	Seal, nonmetallic
<b>315</b>	7403580	5365-00-740-3580	Gasket
<b>316</b>	7403580-1	5330-01-053-2920	Gasket
<b>317</b>	7414584	5306-00-741-4584	Bolt, assembled washer
<b>318</b>	7415354	5330-00-741-5354	Gasket
<b>319</b>	7723892	5330-00-772-3892	O-ring
<b>320</b>	7767350		Washer, key
<b>321</b>	8357967-4		Hose, nonmetallic
<b>322</b>	8393931	3110-00-227-3620	Bearing
<b>323</b>	8395471-1	3120-01-022-2044	Bearing
<b>324</b>	8666738	5330-01-417-1912	Gasket
<b>325</b>	8682468	5330-00-679-8059	Gasket
<b>326</b>	8682503	5330-00-678-4695	Gasket
<b>327</b>	8682505	5330-00-678-3270	Gasket
<b>328</b>	8682523	5330-00-679-4961	Gasket
<b>329</b>	8682564	5330-00-679-8054	Gasket
<b>330</b>	8682679	5330-00-678-4669	Gasket
<b>331</b>	8682680	5330-00-678-5388	Gasket
<b>332</b>	8682754	5330-00-411-2513	Gasket
<b>333</b>	8682769	5330-00-679-7064	Gasket
<b>334</b>	8682770	5330-00-678-5386	Gasket

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335	8682772		Gasket
336	8682797	5330-00-678-4681	Gasket
337	8682800	5330-00-679-7062	Gasket
338	8717158	5330-00-599-0942	O-ring
339	8724986		Bearing half
340	8724986-1		Bearing half
341	8724987		Bearing half
342	8724987-1		Bearing half
343	8724995		Bearing half
344	8724995-1		Bearing half
345	8724996-1		Bearing half
346	8724996		Bearing half
346.1	8725113	5360-00-679-4964	Spring
347	8725239	5330-00-678-3221	Gasket
348	8725273	5330-01-324-7207	Gasket
349	8725277	5330-00-678-3171	Gasket
350	8725296	5330-01-374-9264	Gasket
351	8744055	5310-00-679-5685	Gasket, copper
352	Deleted		
353	8761081	5330-01-491-3978	Gasket
354	8761260	5360-00-678-3256	Spring
355	8761328		Bearing half
356	8761329		Bearing half
357	8761330		Bearing half
358	8761331		Bearing half
359	8761412	5315-00-282-0341	Key, woodruff
360	8761413	5365-00-678-4257	Ring, retaining
361	8761414	5330-01-393-7137	Gasket
362	8761510	4720-00-678-3285	Hose assembly
363	8761547	5330-01-386-8530	Gasket
364	8764639	5310-00-655-9975	Nut, self-locking
365	8764948	5330-01-229-3452	Seal, plain
366	8764982	5330-00-678-4734	Seal
367	9686981-1	3120-00-529-8347	Bearing, plain

END OF WORK PACKAGE

**INTRODUCTION**

Standard and commonly used tools and equipment having general application to the engines are authorized by the TA (Tables of Allowance) and TOE (Tables of Organization and Equipment).

Special tools and equipment are necessary to perform the field maintenance and repair operations described in this manual. Refer to TM 9-2815-220-24P, which is the authority for requisitioning special tools, kits, and equipment.

Some items are listed by their common nomenclature as well as by the formal nomenclature for ease of reference. When the item is first listed, it is assigned an item number. For example:

(1) Item Number	(2) Description (Alphabetical Order) * = Special Tool	(3) Part Number	(4) NSN (Reference)	(5) Usage
<b>20</b>	Cleaner, Oil Cooler	11641959	4910-00-494-8257	

The next time that item appears, the item's original item number will be shown in parentheses, unbolded. This will let you know that the item is intentionally repeated and that it is not a sequencing error.

(20)	Oil Cooler, Cleaner	11641959	4910-00-494-8257	
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**EXPLANATION OF COLUMNS**

**Column (1) – Item Number.** This number corresponds to the tool item number in the work package “Initial Setup” section for cross-referencing to the part number, for example:

“Arbor press (Item 8, WP 0176).”

**Column (2) – Description.** This column indicates the Federal item name of the tool. Special tools and equipment are preceded by an asterisk (\*); these items are illustrated in TM 9-2815-220-24P.

**Column (3) – Part number.** This part number is assigned to the item. Use this part number to request or requisition the item.

**Column (4) – NSN (Reference).** The NSN is the national stock number assigned to the tool. The NSN can also be used to request or requisition the item.

In parentheses below the NSN is the reference to the supply catalog or publication number that contains the complete description for the referenced tool or equipment.

**Column (5) – Usage.** Information is provided on tool usage, pertinent part or component, or corresponding tool to be used in conjunction with that particular tool.

## TOOL IDENTIFICATION LIST

0176 00

## COMMON AND SPECIAL TOOLS AND EQUIPMENT IDENTIFICATION LIST

(1) Item	(2) Description (Alphabetical Order) * = Special Tool	(3) Part Number	(4) NSN (Reference)	(5) Usage
1	* Adapter, Compression	8743025	4910-00-795-7961 (TM 9-2815-247-34P)	Used with GAUGE-10899180 to check cylinder compression
2	* Adapter, Mechanical Puller: 1/2-20NF to 1/2-13NC x 1-7/8 inch long	8375091	5120-00-837-5091 (TM 9-2815-247-34P)	Used with PULLER- 8708712 to remove starter and generator idler gear shaft and with SPREADING TOOL- 8708361 to remove main bearing caps
3	Adapter, Socket, Wrench	A-A-2172	5120-00-144-5207 (SC 4910-95-CL-A31)	
4	* Adapter, Wrench, Torque	11684130-1	5120-00-466-5948 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder hold down nuts
5	* Adapter, Wrench, Torque	11684130-2	5120-00-018-8690 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder bold down nuts
6	* Alignment Tool for PTO Housing (Model 2DR)	11684212	5120-01-008-7273	Used with early spur gear shaft (3/4-16-inch threads)
7	* Alignment Tool for PTO Housing (Model 2DR)	12275768	5120-01-092-9235	Used with late spur gear shaft (7/8-14-inch threads)
8	Arbor Press, Hand Operated	A-A-51194	3444-00-449-7295 (SC 4910-95-CL-A31)	
9	Bending Tool	X-106695	5120-01-444-3657 (TM 9-2815-247-34P)	
10	Bit, Drill, 1/8-inch	01123	5133-00-227-9650 (SC 4910-95-CL-A72)	
11	* Bolt, Eye: 5/8-11Thread 1-3/8 i.d. x 2-1/2 o.d. x 4-23/32 inch long,	MS51937-7	5306-00-017-6143 (TM 9-2815-247-34P)	Lifting flywheel
12	Bolt, Machine 5/16-24x3inches	B1821BH03 1F300N	5306-00-051-4086 (CTA 50-970)	Used as puller screws, starter drive mechanism



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<b>13</b>	Brass Wire Probes (1/8 inch)	RCUZN-B 0.125	2432-00-252-8353 (CTA 50-970)	
<b>14</b>	* Bushing, Reamer Pilot: Exhaust Valve	11642089	5110-00-003-1010 (TM 9-2815-247-34P)	Used with REAMERS– 7083696 and 7083697 to ream exhaust valve guide hole
<b>15</b>	* Bushing, Reamer Pilot: Intake Valve	11642088	5110-00-460-5831 (TM 9-2815-247-34P)	Used with REAMERS– 7083699 and 7083698 to ream intake valve guide hole
<b>16</b>	Caliper Set, Micrometer, Inside	124BZ	5210-00-221-1921 (SC 4910-95-CL-A63)	
<b>17</b>	Caliper Set, Micrometer, Outside	S436CRLZ	5210-00-554-7134 (SC 4910-95-CL-A63)	
<b>18</b>	Chain, Lift Assembly	624-009- 010-040	3930-01-105-3611 (CTA 50-970)	
<b>19</b>	Clamp, Hose	AA52506-F	4730-00-908-3195 (CTA 50-970)	
<b>20</b>	Cleaner, Oil Cooler	11641959	4910-00-494-8257	
<b>21</b>	* Compressor, Piston Ring	10882888	5120-00-795-7956 (TM 9-2815-247-34P)	Installing standard pistons and rings in cylinders
<b>22</b>	* Compressor: Piston Ring, 0.010 and 0.020 inch Oversize	10882888-1	5120-01-005-3001 (TM 9-2350-253-20-1)	Installing 0.010- or 0.020-inch oversize pistons and rings in cylinders
<b>23</b>	* Compressor: Piston Ring, 0.030 and 0.040 inch Oversize	10882888-2	5120-01-005-3000 (TM 9-2815-220-34P)	Installing 0.030- or 0.040-inch oversize pistons and rings in cylinders
<b>24</b>	* Compression Testing, Cylinder: Gauge Assembly	10899180	4910-00-870-6283 (TM 9-2815-247-34P)	Used with ADAPTER– 8743025 to check cylinder compression
<b>25</b>	* Crankcase Protector: Cylinder Mounting Pads	10882790	4910-00-795-7951 (TM 9-2350-253-20-1)	Protecting crankcase at cylinder removal (1 required per cylinder)
<b>26</b>	* Crankshaft and Connecting Rod Sling	10882958	4910-00-795-7955 (TM 9-2815-247-34P)	Removing and installing engine crankshaft
<b>27</b>	* Crowfoot Attachment, Socket Wrench	FRH-240S	5120-01-335-1162 (TM 9-2815-247-34P)	Removing fuel injection tube nut from nozzle
<b>28</b>	Crowfoot Attachment, Socket Wrench, 3/4	1C2690	5120-00-229-2772 (SC 4910-95-CL-A31)	
<b>29</b>	Crowfoot Attachment, Socket Wrench, 7/16	3308	5120-00-184-8383 (SC 4910-95-CL-A31)	

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30	Crowfoot Attachment, Socket Wrench, 9/16	GGG-W-646	5120-00-222-7975 (SC 4910-95-CL-A31)	
31	* Crowfoot, Attachment: Fuel Injection Nozzle Holder	12254244	5120-01-039-2809 (TM 9-2815-247-34P)	Removing or installing fuel Injection nozzle holders
32	* Cylinder Hold-Down Nut Wrench 1/2-inch drive, 5/8-inch double hex, 21-3/8 inch long	8761562	5120-00-475-5414 (TM 9-2815-220-24P)	Torquing cylinder hold down nuts
33	* Cutter, Carbon, Nozzle	10882949	4910-00-795-7958 (TM 9-2815-247-34P)	Cleaning carbon from fuel Injection nozzle holder seat in cylinder head
(10)	Drill Bit, 1/8-inch	01123	5133-00-227-9650 (SC 4910-95-CL-A72)	
34	Drill, Electric, Portable	PD5130-00-807-3009	5130-00-807-3009 (SC 4910-95-CL-A72)	
35	Dye Inspection Kit	100	6635-00-333-1322 (CTA 50-970)	
36	Electrical Maintenance Kit	5705498	5935-01-344-1073	
37	* Engine Lifting Sling, Beam-Type, Multiple Leg (Model 2DR)	11671664	3490-00-622-7288 (TM 9-2815-220-24P)	
38	* Engine Lifting Sling, Multiple Leg (Models 2CA and 2DA)	12257229	4901-01-048-8706 (TM 9-2815-220-24P)	
39	* Extractor, Screw Thread Insert Tool (7/16 through 1.00)	7751056	5120-00-251-1527 (TM 9-2815-247-34P)	Removing threaded inserts
40	* Extractor, Screw Thread Insert Tool (Number 10 through 3/8)	1227-6	5120-00-723-6833 (TM 9-2815-247-34P)	Removing threaded inserts
41	* Extractor, Screw Thread: Cylinder to Crankcase, 7/16 to 1 inch diameter inserts	7751056	5120-01-251-1527 (TM 9-2350-253-20-1)	
(11)	* Eye, Bolt: 1-3/8 i.d. x 2-1/2 o.d. x 4-23/32 inch long, 5/8-11 Thread	MS51937-7	5306-00-017-6143 (TM 9-2815-247-34P)	Lifting flywheel
42	* Fan Drive and Advance Unit Housing Sling: Removing or Installing	10882945	4910-00-795-7954 (TM 9-2815-247-34P)	Removing and installing rear fan and advance unit housing
43	* Fan Gauge, Rotor: Checking Erosion	12275775	5210-01-099-1477 (TM 9-2815-220-24P)	Checking leading edge of fan rotor for erosion

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44	* Fuel Injection Nozzle Mechanical Puller	12275805	5120-01-119-4172 (TM 9-2815-247-34P)	Removing fuel injection nozzles
45	* Fuel Injection Nozzle Socket: 1-3/8-inch Hex socket, 3/4 inch square drive, 2-inches long	11610171	5120-00-875-9556 (CTA 50-970)	Removing fuel injection nozzle holders
46	Fuel Injection Nozzle Tester (Diesel)	3YFL	4910-00-255-8641 (SC 4940-95-CL-B20)	
47	Furnace, Heat Treat (Oven)	HP244896	3424-00-008-9607 (CTA 50-970)	
48	Gauge, Depth, Micrometer	129-132	5210-00-619-4045 (SC 3470-95-CL-A16)	
(43)	* Gauge, Fan Rotor: Checking Erosion	12275775	5210-01-099-1477 (TM 9-2815-220-24P)	Checking leading edge of fan rotor for erosion
49	* Gauge, Piston Ring: 0.010 and 0.030 inch Oversize	10912589-1	5220-01-005-3003	Checking 0.010- or 0.030-inch oversize piston ring gap
50	* Gauge, Piston Ring: Standard and 0.040 inch Oversize	10912589-2	5220-01-005-3002 (TM 9-2350-253-20-1)	Checking standard or 0.040-inch oversize piston ring gap
51	* Gauge, Piston Ring: Piston Top Ring Groove	12254296	5220-01-084-1230 (TM 9-2815-222-34P)	Checking piston ring top groove
52	* Gauge, Piston Ring Plain, Standard and 0.020 inch Oversize	10912589	5220-00-988-8774 (TM 9-2815-247-34P)	Checking piston ring gap
53	Gauge Set, Plug	B3125	5220-01-266-8697 (CTA 50-970)	
54	Gauge Set, Telescoping	155-903	5210-00-473-9350 (SC 4910-95-CL-A63)	
55	* Gauge, Thickness: 0.010-inch, Intake Valve Clearance	10882615	5210-00-793-7898 (TM 9-2815-247-34P)	
56	* Gauge, Thickness: 0.025-inch, Exhaust Valve Clearance	10882616	5210-00-793-7899 (TM 9-2815-247-34P)	
57	* Gauge, Thickness: 0.100-inch, Intake Valve Timing Clearance	10882617	5210-00-793-7897 (TM 9-2815-247-34P)	

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(24)	* Gauge Assembly: Cylinder Compression Testing	10899180	4910-00-870-6283 (TM 9-2815-247-34P)	Used with ADAPTER–8743025 to check cylinder compression
58	* Generator Coupling Tool, Torque Test: Generator Drive Gear Coupling (Model 2CA)	11684153	5180-01-005-2995 (TM 9-2815-247-34P) Consists of: (1) Support, P/N (19207) 11684152; (1) Ring, P/N (96906) MS16626-1112; (1) Shaft, P/N (19207) 11684151	Torque testing generator drive gear coupling
59	* Generator Holding Tool (Fixture)	11684166	5120-01-005-2996 (TM 9-2815-247-34P)	Checking generator drive gear coupling torque
60	Grinding Kit, Valve Seat, electric	WGG90 TYPE1 Size1	4910-00-473-6437 (CTA 50-970)	
61	Grinding Machine, Valve Face	2075G	4910-00-540-4679 (SC 4910-95-CL-A63)	
62	Hammer, Hand, Soft Face	57-530	5120-01-071-5356 (SC 4910-95-CL-A31)	
63	Heater, Gun Type, Electrical	500A	4940-00-561-1002 (SC 4910-95-A72)	
64	* Holding Bar and Puller Assembly: Power Takeoff (Model 2DR)	12254282	5120-01-043-5205	Power takeoff coupling
65	Indicator, Dial	196A	5210-00-277-8840 (SC 4910-95-CL-A63)	
66	* Inserter, Screw Thread Insert (1/2–13)	7551-8	5120-00-861-1170 (TM 9-2815-247-34P)	
67	* Inserter, Screw Thread Insert (1/2–20)	7552-8	5120-00-672-8897 (TM 9-2815-247-34P)	
68	* Inserter, Screw Thread Insert (3/8–24)	7552-6	5120-00-710-7437 (TM 9-2815-247-34P)	
69	* Inserter, Screw Thread Insert (5/16–24)	3552-5	5120-00-797-2405 (TM 9-2815-247-34P)	
70	* Inserter, Screw Thread Insert (7/16–20)	7552-7	5120-00-797-2407 (TM 9-2815-247-34P)	
(35)	Inspection Kit, Dye	100	6635-00-333-1322 (CTA 50-970)	
71	Jackscrew 3/8-24 x 1-1/2 inch long	MS90726-64	5305-00-269-2807 (TM 9-2350-292-24P)	Used to pull off oil filter housing cover
72	* Lifter Assembly, Valve: Valve Springs	8761535	5120-00-678-5285 (TM 9-2815-247-34P)	Used with STAND–8708419 for removing and installing valves and valve springs

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73	Magnifier	7247968	6650-00-346-9106 (SC 4933-95-CL-A12)	
(36)	Maintenance Kit, Electrical	5705498	5935-01-344-1073	
74	Manometer, Single (Vertical) Tube	CTCTM40	6685-00-149-0807 (CTA 50-970)	
75	Multimeter	T00377	6625-01-139-2512	
(33)	* Nozzle Carbon Cutter	10882949	4910-00-795-7958 (TM 9-2815-247-34P)	Cleaning carbon from fuel Injection nozzle holder seat in cylinder head
(44)	* Nozzle Mechanical Puller (Fuel Injection)	12275805	5120-01-119-4172 (TM 9-2815-247-34P)	Removing fuel Injection nozzles
76	Nut, Plain Hexagon	MS51968-23	5310-00-763-8901 (TM 9-2350-292-24P)	
77	Nut, Plain, Hexagon	MS51968-2	5310-00-768-0319 (TM 9-2350-292-24P)	
(20)	Oil Cooler, Cleaner	11641959	4910-00-494-8257	
(21)	* Piston Ring Compressor	10882888	5120-00-795-7956 (TM 9-2815-247-34P)	Installing standard pistons and rings in cylinders
(22)	* Piston Ring Compressor: 0.010 and 0.020 inch Oversize	10882888-1	5120-01-005-3001 (TM 9-2350-253-20-1)	Installing 0.010- or 0.020-inch oversize pistons and rings in cylinders
(23)	* Piston Ring Compressor: 0.030 and 0.040 inch Oversize	10882888-2	5120-01-005-3000 (TM 9-2815-220-34P)	Installing 0.030- or 0.040-inch oversize pistons and rings in cylinders
(49)	* Piston Ring Gauge: 0.010 and 0.030 inch Oversize	10912589-1	5220-01-005-3003	Checking 0.010- or 0.030-inch oversize piston ring gap
(50)	* Piston Ring Gauge: Standard and 0.040 inch Oversize	10912589-2	5220-01-005-3002 (TM 9-2350-253-20-1)	Checking standard or 0.040-inch-oversize piston ring gap
(51)	* Piston Ring Gauge: Piston Top Ring Groove	12254296	5220-01-084-1230 (TM 9-2815-222-34P)	Checking piston ring top groove
(52)	* Piston Ring Gauge: Plain, Standard and 0.020 inch Oversize	10912589	5220-00-988-8774 (TM 9-2815-247-34P)	Checking piston ring gap
78	* Piston Ring Pliers: Remover and Replacer	7950177	5120-00-494-1846 (TM 9-2815-247-34P)	Removing and installing piston rings
(78)	* Pliers, Piston Ring : Remover and Replacer	7950177	5120-00-494-1846 (TM 9-2815-247-34P)	Removing and installing piston rings

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79	Pliers, Retaining Ring	WT28163	5120-00-752-9755 (TM 9-2815-247-34P)	
(79)	Pliers, Snap Ring	WT28163	5120-00-752-9755 (TM 9-2815-247-34P)	
80	* Pliers, Retaining Ring: Fan Drive Shaft	B107.19	5120-00-752-9755 (TM 9-2350-253-20-1)	Removing or installing inner fan drive shaft retaining ring
81	Pliers, Retaining Ring (Set)	4440R	5120-00-789-0492 (SC 5180-95-CL-B08)	
(81)	Pliers, Snap Ring (Set)	4440R	5120-00-789-0492 (SC 5180-95-CL-B08)	
82	Pliers, Wire Twister	8491162	5120-00-542-4171 (SC 4910-95-CL-A31)	
83	Plug, pipe	MS14314-1	4730-00-011-2578	Fuel/water separator operation tests
84	Pop Riveter (Blind, Hand)	98	5120-00-017-2849 (SC 3470-95-CL-A08)	
(13)	Probes, Brass Wire (1/8 inch)	RCUZN-B 0.125	2432-00-252-8353 (CTA 50-970)	
(25)	* Protector , Crankcase: Cylinder Mounting Pads	10882790	4910-00-795-7951 (TM 9-2350-253-20-1)	Protecting crankcase at cylinder removal (1 required per cylinder)
85	Puller Kit, Universal (Sliding Hammer, 2-1/2 lb)	1178	5120-00-313-9496 (SC 4910-95-CL-A31)	
86	* Puller, Exhaust Valve Guide	10882954	5120-00-448-0401 (TM 9-2815-247-34P)	Removing exhaust valve guides
87	* Puller, Intake Valve Guide	10882953	5120-00-448-0400 (TM 9-2815-247-34P)	Removing intake valve guides
88	* Puller, Mechanical: Slide Hammer, 10-inch long with 1/2-20 UNF-2A Thread	8708712	5120-00-310-4668 (TM 9-2815-247-34P)	Used with ADAPTER– 8375091 to remove starter and generator drive idler gear shaft and with SPREADING TOOL–8708361 to remove main bearing caps removing exhaust valve guides
89	* Puller, Mechanical: T-Handle, 3/4-16 UNF-2A 6-1/2 inch long	8761297	5120-00-678-5282 (TM 9-2815-247-34P)	Removing and installing camshaft drive shaft and upper gear oil transfer plug
(44)	* Puller, Mechanical: Fuel Injection Nozzle	12275805	5120-01-119-4172 (TM 9-2815-247-34P)	Removing fuel Injection nozzles

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<b>90</b>	* Puller, Mechanical: Threaded 5/16-18 UNC-2, 8-1/2 inch long, 2-3/4 inch Handle	5379997	5120-00-473-7222 (TM 9-2815-247-34P)	Removing fan drive oil seal retainer, vibration damper, and crankshaft oil seal housing
(2)	* Puller Adapter, Mechanical: 1/2-20NF-2 to 1/2-13NC x 1-7/8 inch long	8375091	5120-00-837-5091 (TM 9-2815-247-34P)	Used with PULLER– 8708712 to remove starter and generator idler gear shaft and with SPREADING TOOL– 8708361 to remove main bearing caps
<b>91</b>	Punch, Drift, 5/16	B107.48	5120-00-240-8894 (CTA 50-970)	
<b>92</b>	Reamer Set, Machine	SC3455- 95CLA05	3455-00-449-7213 (SC 3470-95-CL-A15)	
<b>93</b>	* Reamer, Hand: Finishing Exhaust Valve Stem Hole. Diameter tapers from 0.557 to 0.562 inch, 13-3/4 inch long	7083697	5110-00-708-3697 (TM 9-2815-247-34P)	Used with BUSHING – 11642089 for finish reaming exhaust valve guide holes
<b>94</b>	* Reamer, Hand: Finishing Intake Valve Stem Hole. Diameter tapers from 0.495 to 0.500 inch, 13-3/4 inch long	7083699	5110-00-708-3699 (TM 9-2815-247-34P)	Used with BUSHING – 11642088 for finish reaming intake valve guide hole
<b>95</b>	* Reamer, Hand: Roughing, Exhaust Valve Stem Hole. Diameter tapers from 0.550 to 0.560 inch, 13-3/4 inch long	7083696	5110-00-708-3696 (TM 9-2815-247-34P)	Used with BUSHING – 11642089 for rough reaming exhaust valve guide hole
<b>96</b>	* Reamer, Hand: Roughing Intake Valve Stem Hole. Diameter tapers from 0.488 to 0.498-inch, 13-3/4 inch long	7083698	5110-00-708-3698 (TM 9-2815-247-34P)	Used with BUSHING – 11642088 for rough reaming intake valve guide holes
<b>97</b>	Regulator Assembly (Air)	06A14A13L 1BB/P7816 42	4930-00-322-5911 (SC 4910-95-CL-A31)	
(78)	* Remover and Replacer: Plier Type: Piston Rings	7950177	5120-00-494-1846 (TM 9-2815-247-34P)	Removing and installing piston rings
<b>98</b>	Repair Tool, Pneumatic Tire Valve	2077	5120-00-308-3809 (SC 4910-95-CL-A72)	
<b>99</b>	* Replacer, Valve Guide: Exhaust Valve	10883053	5120-00-448-7993 (TM 9-2815-247-34P)	Installing exhaust valve guide
<b>100</b>	* Replacer, Valve Guide: Intake Valve	10883052	5180-00-448-0402 (TM 9-2815-247-34P)	Installing intake valve guide

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(79)	Retaining Ring Pliers	WT28163	5120-00-752-9755 (TM 9-2815-247-34P)	
(81)	Retaining Ring Pliers (Set)	4440R	5120-00-789-0492 (SC 5180-95-CL-B08)	
(84)	Riveter, Blind, Hand	98	5120-00-017-2849 (SC 3470-95-CL-A08)	
<b>101</b>	Screw, Cap, Hexagon	B1821BH07 5F400N	5305-00-903-7767 (CTA 50-970)	
<b>102</b>	Screw, Cap, Hexagon	B1821BH02 5F300N	5305-00-267-8962 (TM 9-2350-292-24P)	
<b>103</b>	Screwdriver, Offset	138	5120-00-287-2130 (SC 4910-95-CL-A01)	
<b>104</b>	Shop Equipment, Welding (Trailer mounted)	11022000	3431-01-090-1231 (SC 3431-95-A04)	
(26)	* Sling, Crankshaft and Connecting Rod	10882958	4910-00-795-7955 (TM 9-2815-247-34P)	Removing and installing engine crankshaft
(37)	* Sling, Engine Lifting, Beam-Type: Multiple Leg (Model 2DR)	11671664	3490-00-622-7288 (TM 9-2815-220-24P)	
(42)	* Sling, Fan Drive and Advance Unit Housing : Removing or Installing	10882945	4910-00-795-7954 (TM 9-2815-247-34P)	Removing and installing rear fan and advance unit housing
<b>105</b>	Sling, Four Leg	10952220	4910-00-919-2884 (CTA 50-970)	
(88)	* Slide Hammer Mechanical Puller: 10 inch long with 1/2-20 UNF-2A Thread	8708712	5120-00-310-4668 (TM 9-2815-247-34P)	Used with ADAPTER– 8375091 to remove starter and generator drive idler gear shaft and with SPREADING TOOL–8708361 to remove main bearing caps removing exhaust valve guides
(38)	* Sling, Multiple Leg: Engine Lifting (Models 2CA and 2DA)	12257229	4901-01-048-8706 (TM 9-2815-220-24P)	
(79)	Snap Ring Pliers	WT28163	5120-00-752-9755 (TM 9-2815-247-34P)	
(81)	Snap Ring Pliers (Set)	4440R	5120-00-789-0492 (SC 5180-95-CL-B08)	
<b>106</b>	* Socket: Final Filter Cap	12254213	5120-01-034-1698 (TM 9-2815-220-24P)	Removing fuel injection pump final filter cap



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(45)	* Socket: Fuel Injection Nozzle Holder, 1-3/8 inch Hex socket, 3/4 inch square drive, 2 inch long	11610171	5120-00-875-9556 (CTA 50-970)	Removing fuel Injection nozzle holders
107	Socket Wrench, 2 inch	B107.1 CL1STA	5120-00-199-7770 (SC 4910-95-CL-A31)	
(3)	Socket Wrench Adapter	A-A-2172	5120-00-144-5207 (SC 4910-95-CL-A31)	
108	Soldering Gun	D-550-3	3439-00-618-6623 (SC 4910-95-A72)	
109	* Spacer, Fan Rotor Hub Sleeve (Spacer): Leak Test	10882651	5365-00-795-7952 (TM 9-2815-247-34P)	Retains fan clutch oil seal during fuel injection pump leak test
110	* Spreading Tool, Crankcase (Jack Screw): Bearing Cap Removing or Installing	8708361	5120-00-575-7767 (TM 9-2815-247-34P)	Used with PULLER–8708712 and ADAPTER–8375091 to remove main bearing caps
111	* Stand, Maintenance and Overhaul: Engine	10912260	4910-00-856-4137 (TM 9-2815-247-34P)	
112	* Stand, Valve Removing and Inserting: Cylinder Valves	8708419	4910-00-554-1317 (TM 9-2815-247-34P)	Cylinder stand for removing and installing valves, used with valve spring LIFTER–8761535
113	* Starter Wrench, Open End: (Mounting Nuts) 15/16 inch opening, offset handle, 10 inch long	8761568	5120-00-678-5288 (TM 9-2815-220-24P)	Removing or installing starter mounting nuts
114	* Stone and Holder Assembly: Cylinder hone composed of: 150 grain stone 180 grain stone	5704380 11662775-2 11662775-1	3460-00-689-3368 (TM 9-2815-220-24P)	Honing cylinder bores
115	Stud Remover and Setter	PD 5120-00-288-6578	5120-00-288-6578 (SC 5180-90-CL-N05)	
116	* Test Stand: Fuel Injection Advance Unit	10898928	4910-00-986-9873 (TM 9-2815-247-34P)	Test fuel injection pump advance unit
(46)	Tester, Diesel Fuel Injection Nozzle	3YFL	4910-00-255-8641 (SC 4940-95-CL-B20)	
117	Tester, Spring Resiliency (Fish Scale Type)	DPP80	6635-00-918-2788 (SC 4910-95-CL-A02)	
118	Tester, Spring Resiliency (Compression Type)	SPT	6635-00-641-7346 (SC 4910-95-A63)	

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<b>119</b>	Thermometer, Self-Indicating, Liquid in Glass	762637	6685-00-170-3955	(Oil cooler replacement)
<b>120</b>	Thread Cutting Die and Tap Set	TD2500	5136-00-006-1556 (TM 9-2520-281-34P)	
<b>121</b>	Tool Kit, General Mechanic's	SC5180-90-CL-N26	5180-00-177-7033 (SC 5180-90-CL-N26)	
<b>122</b>	Tool Kit, Slimsert	5705241	5180-01-231-4957 (TM 9-2520-281-34P)	Insert repair kit
<b>123</b>	Torque Wrench, 0-150 inch-pounds	TQ12B	5120-00-230-6380 (SC 4910-95-CL-A31)	
<b>124</b>	Torque Wrench, 0-300 inch-pounds	B107.14M	5120-00-247-2536 (SC 4910-95-CL-A31)	
<b>125</b>	Torque Wrench, 200-1000 inch-pounds	QD21000 Snap-on Tools		
<b>126</b>	Torque Wrench, 500-2500 inch-pounds	QD3R2500	5120-01-355-1739	
<b>127</b>	Torque Wrench, 0-175 foot-pounds	B107.14M	5120-00-640-6364 (SC 4910-95-CL-A31)	
<b>128</b>	Torque Wrench, 0-600 foot-pounds	B107.14M	5120-00-221-7983 (SC 4910-95-CL-A31)	
(4)	* Torque Wrench Adapter	11684130-1	5120-00-466-5948 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder hold down nuts
(5)	* Torque Wrench Adapter	11684130-2	5120-00-018-8690 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder bold down nuts
<b>129</b>	* Tube, Attaching Nozzle: Connector	10882963	4910-00-795-7953 (TM 9-2815-247-34P)	Check fuel Injection nozzles
<b>130</b>	Tubing, Nonmetallic	46115	4720-00-079-1798 (CTA 50-970)	
<b>131</b>	V-Block	A-A-51150TY2S TASZ2	3460-00-725-5076 (SC 4910-95-CL-A63)	
(61)	Valve Face Grinding Machine	2075G	4910-00-540-4679 (SC 4910-95-CL-A63)	
(86)	* Valve Guide Puller, Exhaust	10882954	5120-00-448-0401 (TM 9-2815-247-34P)	Removing exhaust valve guides
(87)	* Valve Guide Puller, Intake	10882953	5120-00-448-0400 (TM 9-2815-247-34P)	Removing intake valve guides
(99)	* Valve Guide Replacer: Exhaust Valve	10883053	5120-00-448-7993 (TM 9-2815-247-34P)	Installing exhaust valve guide
(100)	* Valve Guide Replacer: Intake Valve	10883052	5180-00-448-0402 (TM 9-2815-247-34P)	Installing intake valve guide

TOOL IDENTIFICATION LIST

0176 00

(60)	Valve Seat Grinding Kit, electric	WGG90 TYPE1 Size1	4910-00-473-6437 (CTA 50-970)	
(72)	* Valve Springs Lifter Assembly	8761535	5120-00-678-5285 (TM 9-2815-247-34P)	Used with Stand-8708419 for removing and installing valves and valve springs
<b>132</b>	Vise, Machinist's	504M2	5120-00-293-1439 (SC 4910-95-CL-A31)	
<b>133</b>	Washer, Flat	NAS1149C 1290R	5310-00-167-0809 (TM 9-2350-292-24P)	
<b>134</b>	Washer, Flat	NAS620C41 6L	5310-00-764-9564 (TM 9-2350-292-24P)	
(104)	Welding Equipment (Trailer mounted)	11022000	3431-01-090-1231 (SC 3431-95-A04)	
<b>135</b>	* Wrench, Box and Open End Combination: Generator Mounting Nuts (Models 2DA and 2DR)	10935476	5120-00-789-4881 (TM 9-2815-220-24P)	Removing and installing generator mounting nuts
(32)	* Wrench, Box: Torquing Cylinder Hold-Down Nuts, 1/2-inch drive, 5/8-inch double hex, 21-3/8 inch long	8761562	5120-00-475-5414 (TM 9-2815-220-24P)	Torquing cylinder hold down nuts
(113)	* Wrench, Open End: Starter Mounting Nuts, 15/16 inch opening, offset handle, 10 inch long	8761568	5120-00-678-5288 (TM 9-2815-220-24P)	Removing or installing starter mounting nuts
<b>136</b>	* Wrench, Splined: Engine Turning, 3/4-inch drive with external spline, 2-1/2 inch long (Models 2CA and 2DA)	10882747	5120-00-793-7895 (TM 9-2815-220-24P)	Turning engine at transmission drive gear shaft (2CA, 2DA)
(107)	Wrench, Socket, 2 inch	B107.1 CL1STA	5120-00-199-7770 (SC 4910-95-CL-A31)	
(123)	Wrench, Torque, 0-150 inch-pounds	TQ12B	5120-00-230-6380 (SC 4910-95-CL-A31)	
(124)	Wrench, Torque, 0-300 inch-pounds	B107.14M	5120-00-247-2536 (SC 4910-95-CL-A31)	
(125)	Wrench, Torque, 200-1000 inch-pounds	QD21000 Snap-on Tools		
(126)	Wrench, Torque, 500-2500 inch-pounds	QD3R2500	5120-01-355-1739	
(127)	Wrench, Torque, 0-175 foot-pounds	B107.14M	5120-00-640-6364 (SC 4910-95-CL-A31)	

**TOOL IDENTIFICATION LIST**

**0176 00**

(128)	Wrench, Torque, 0-600 foot-pounds	B107.14M	5120-00-221-7983 (SC 4910-95-CL-A31)	
(4)	* Wrench, Torque, Adapter	11684130-1	5120-00-466-5948 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder hold down nuts
(5)	* Wrench, Torque, Adapter	11684130-2	5120-00-018-8690 (TM 9-2815-220-24P)	Torquing Number 1 left and right cylinder bold down nuts

**END OF WORK PACKAGE**

**ILLUSTRATED LIST OF FABRICATED ITEMS****0177 00****THIS WORK PACKAGE COVERS:**

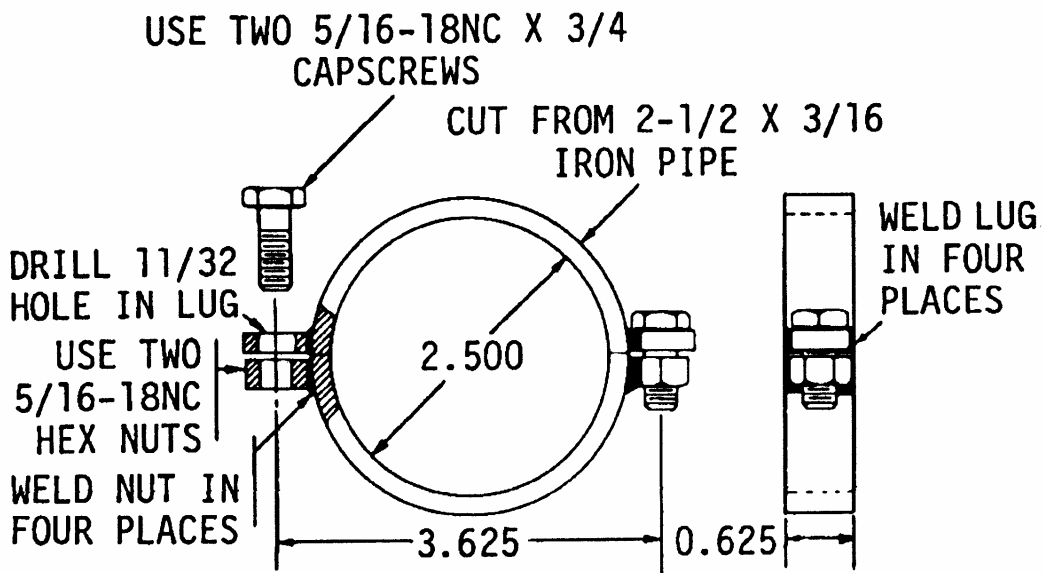
Instructions on how to make items authorized to be fabricated at Direct Support and General Support maintenance.

**FABRICATED TOOLS AND EQUIPMENT**

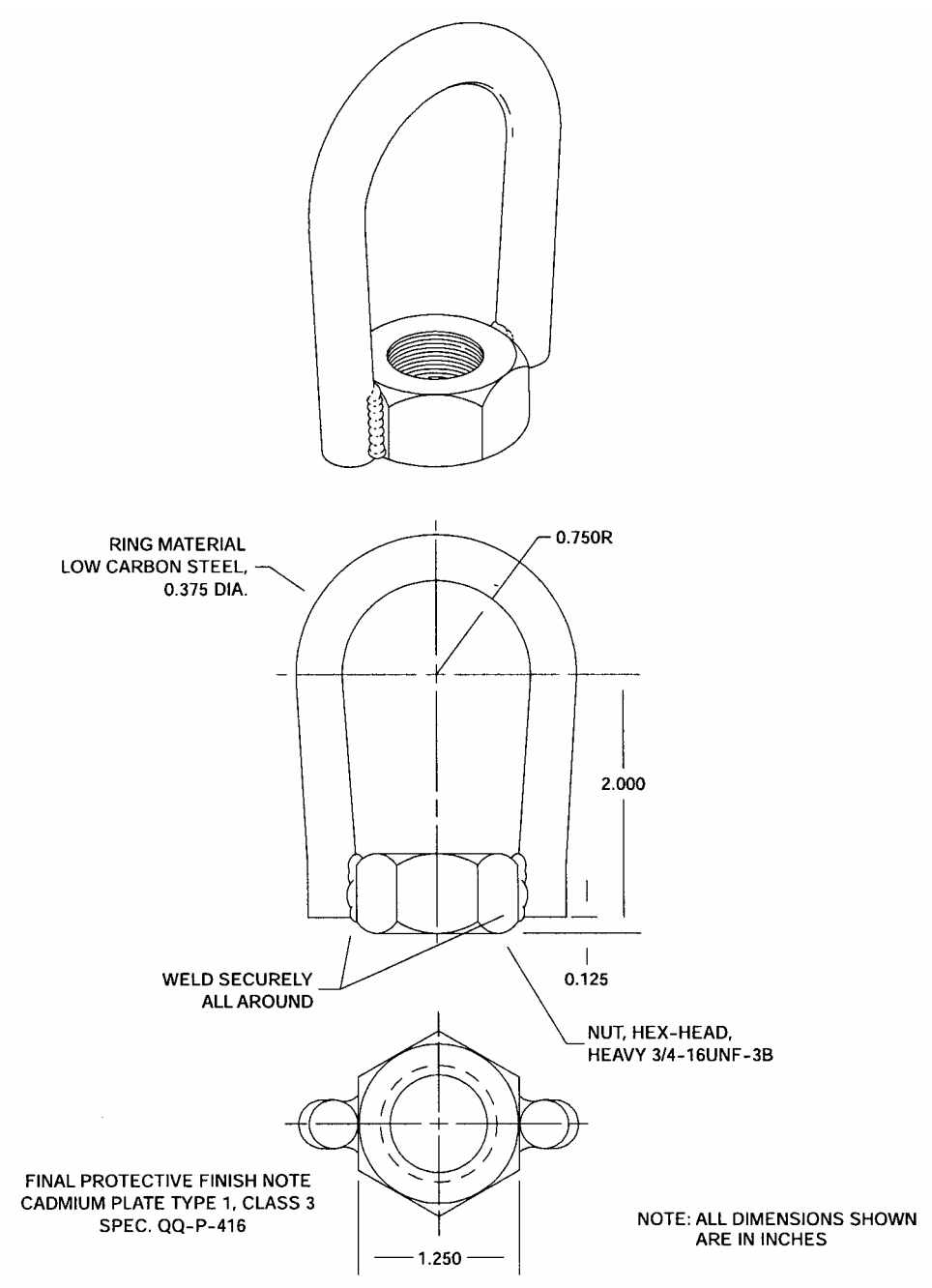
The fabricated tools apply only to Direct Support and General Support.

Principal dimensions are shown on the following illustrations to enable maintenance personnel to fabricate tools locally if desired. These tools are of value to maintenance organizations engaged in repairing engines; however, these fabricated tools are not available for issue.

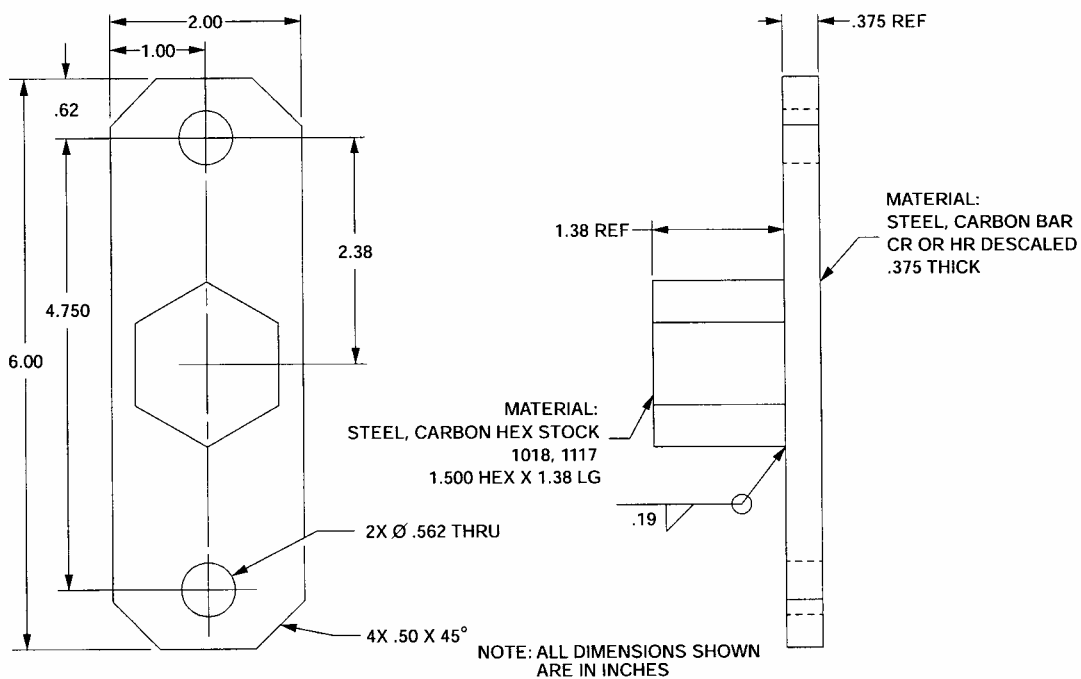
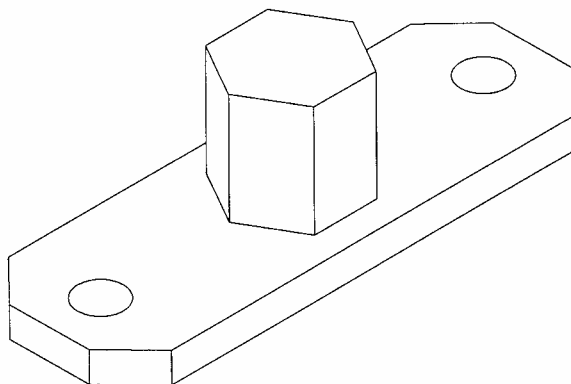
<b>Item</b>	<b>Description</b>
1	Advance Unit Retaining Ring Compressor
2	Front Fan Drive Housing Lifting Tool
3	Engine Front Turning Tool (for Model AVDS-1790-2DR only)
4	Engine Flywheel Turning Tool (for Model AVDS-1790-2DR only)
5	Connecting Rod Bearing Replacement Tool Kit (4 pages)
6	Fuel Injection Pump Coupling Puller
7	Oil Pressure Regulating Valve Sleeve Puller
8	Fuel/Water Separator Test Harness
9	Fuel/Water Separator Jumper Wire
10	Turbosupercharger Covers (Used to cap turbosuperchargers for engine leak tests)
11	Oil Level Gauge Plug (Used to seal dipstick tube opening for engine leak test)
12	Modified Socket (Used to torque oil pump assembly cap)
13	Bending Tool (2 Required) (Used to bend fuel injection lines)
14	Air Valve Adapter
15	Fuel Coupling Grease Insert Adapter
16	Tapered Bolt, 9/16-18 x 4-1/2-inches (Damper removal)



Item 1: Advance Unit Retaining Ring Compressor

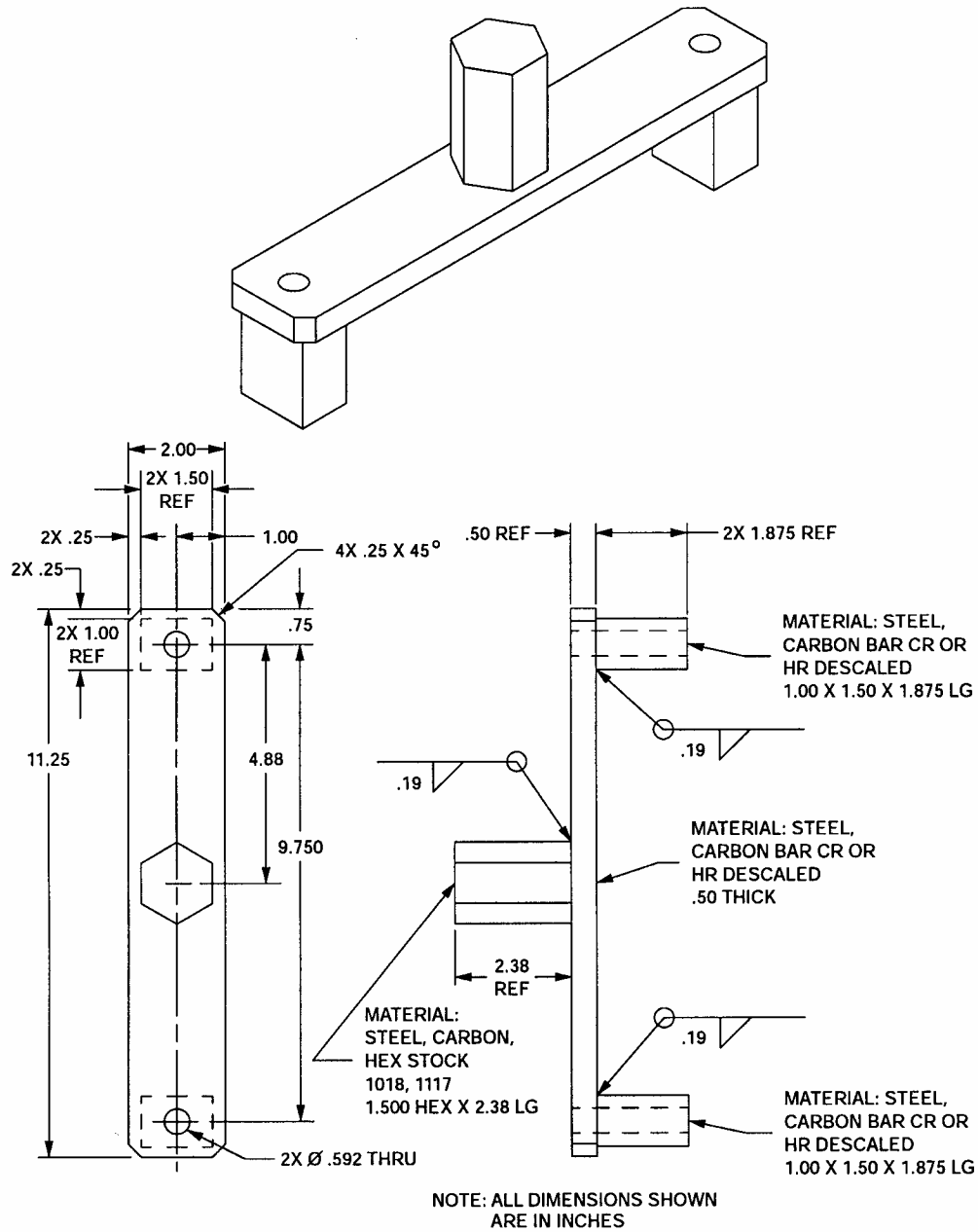


Item 2: Front Fan Drive Housing Lifting Tool

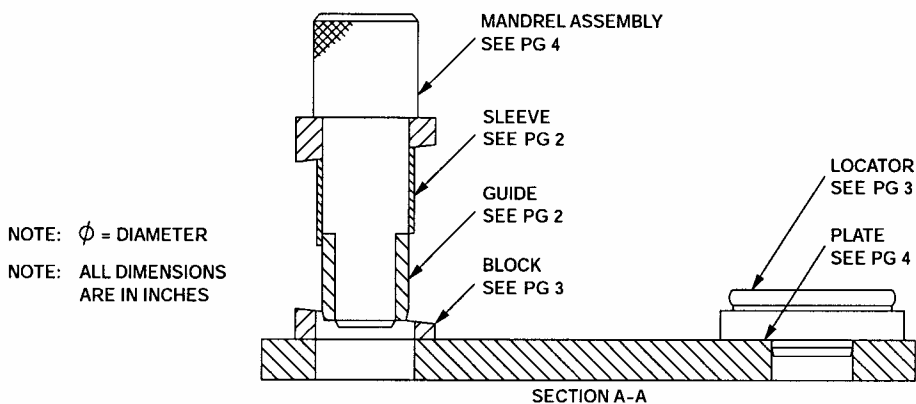
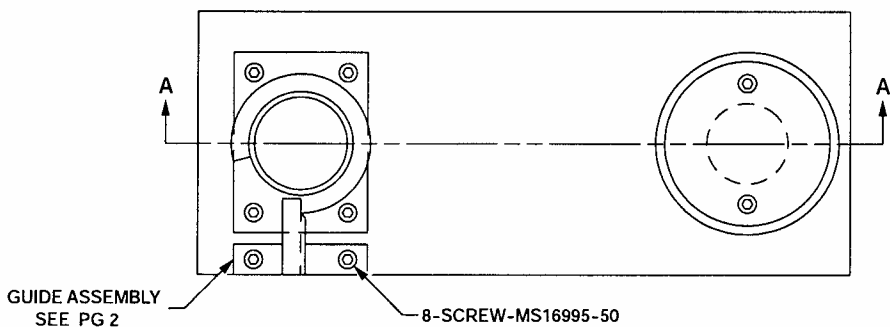


Item 3: Engine Front Turning Tool (for Model AVDS-1790-2DR only)

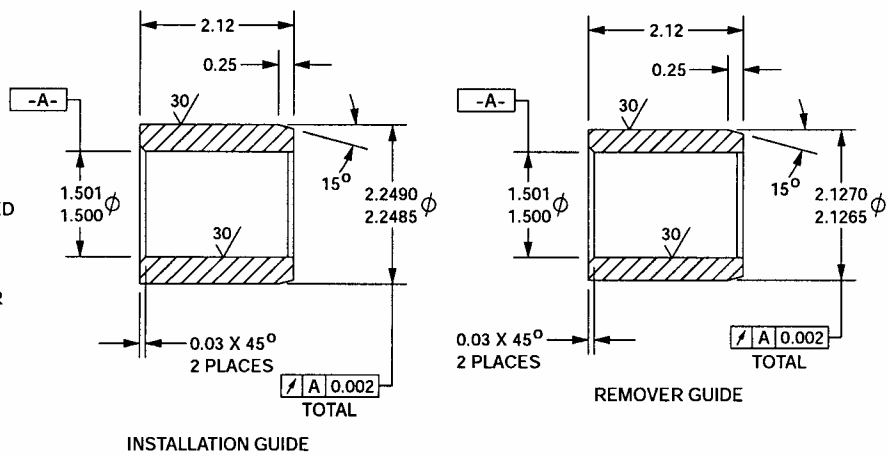




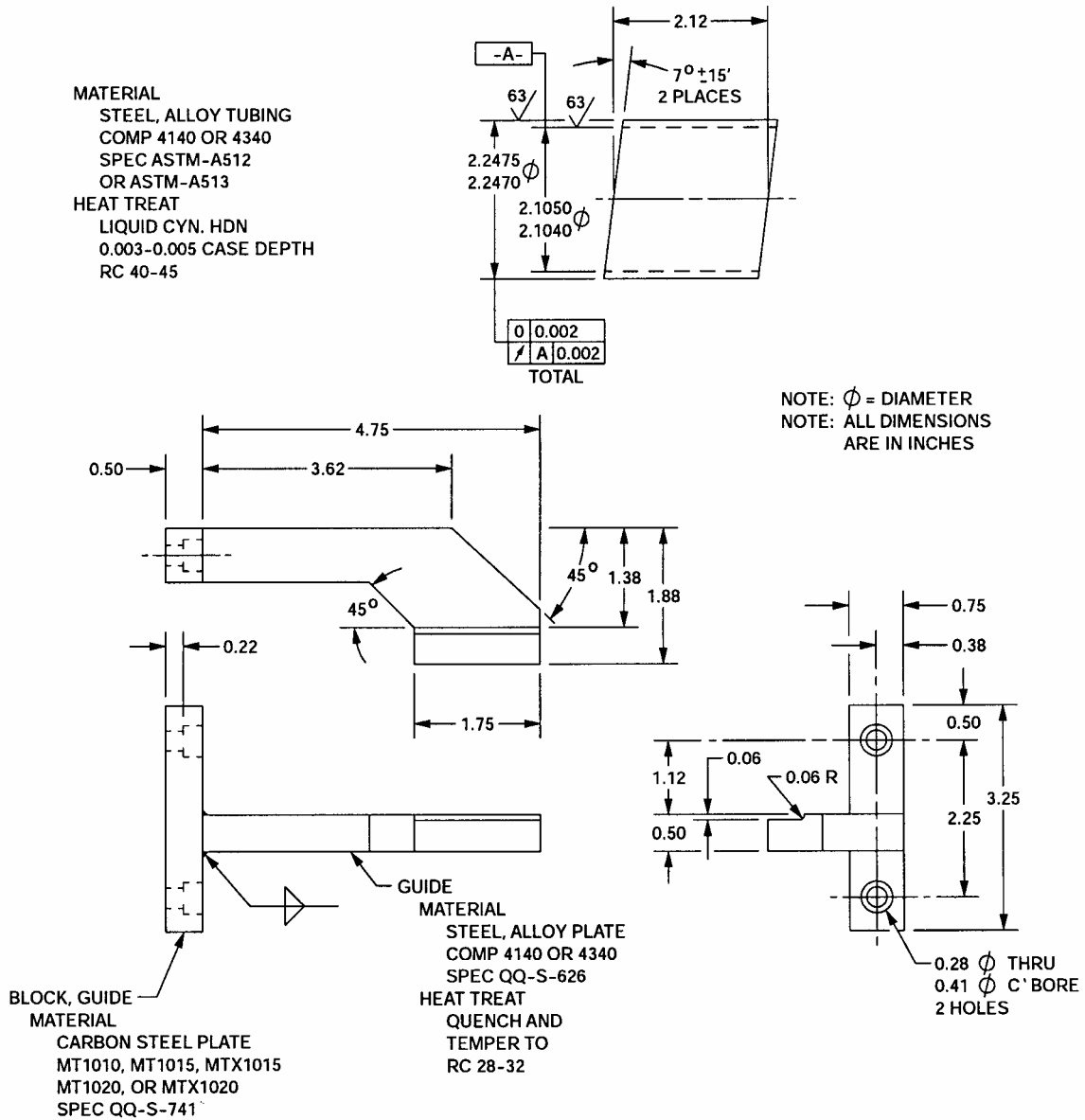
Item 4: Engine Flywheel Turning Tool



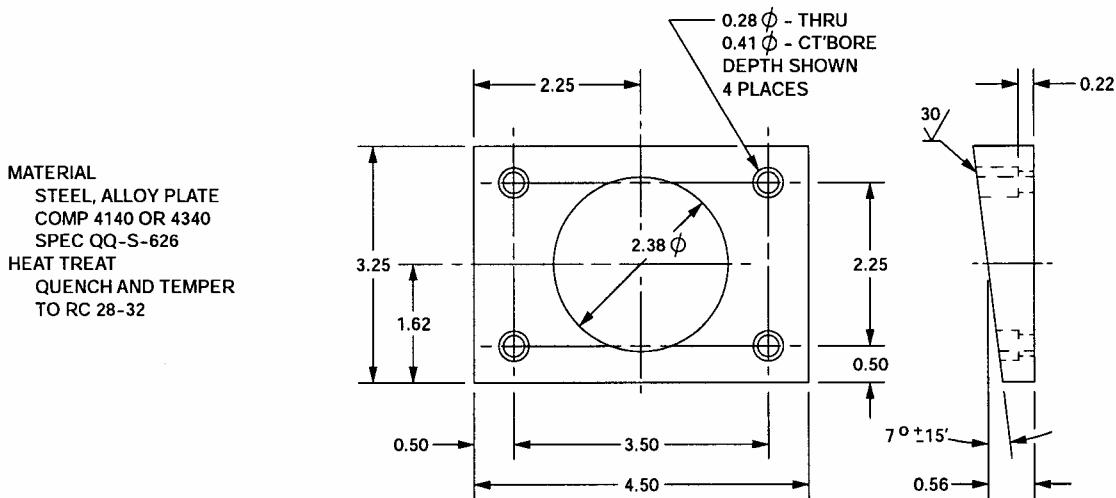
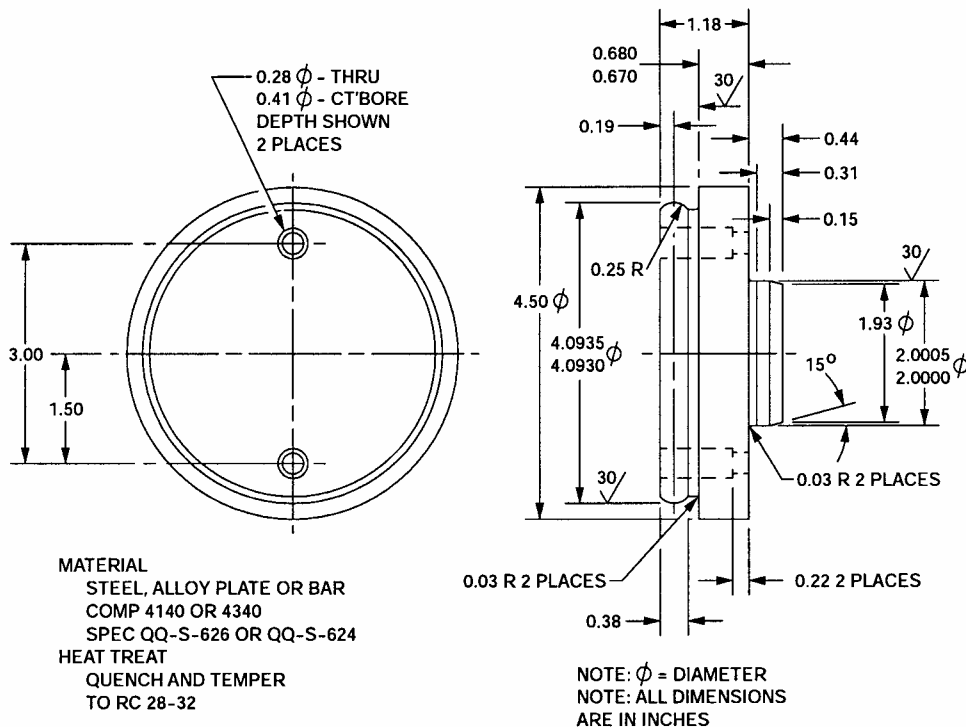
MATERIAL  
STEEL, ALLOY TUBING  
SEAMLESS OR WELDED  
COMP 4140 OR 4340  
SPEC ASTM-A519  
HEAT TREAT  
QUENCH AND TEMPER  
TO RC 28-34



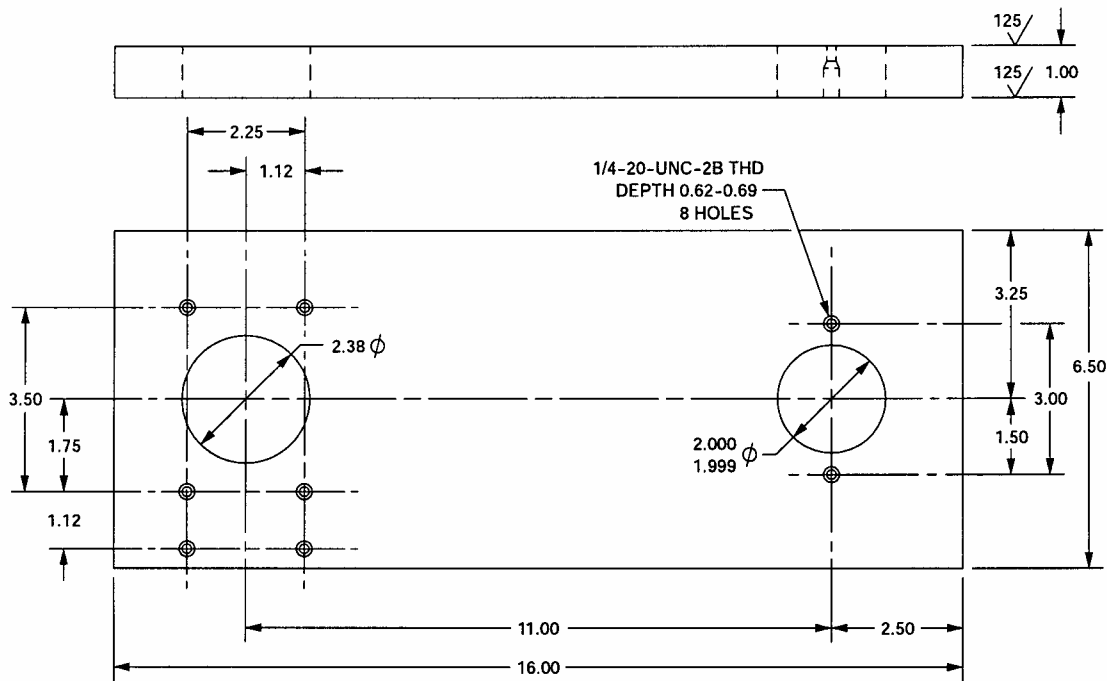
Item 5: Connecting Rod Bearing Replacement Tool (Sheet 1 of 4)



Item 5: Connecting Rod Bearing Replacement Tool (Sheet 2 of 4)

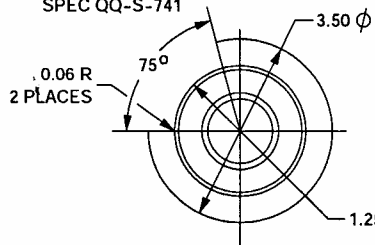


Item 5: Connecting Rod Bearing Replacement Tool (Sheet 3 of 4)



MATERIAL

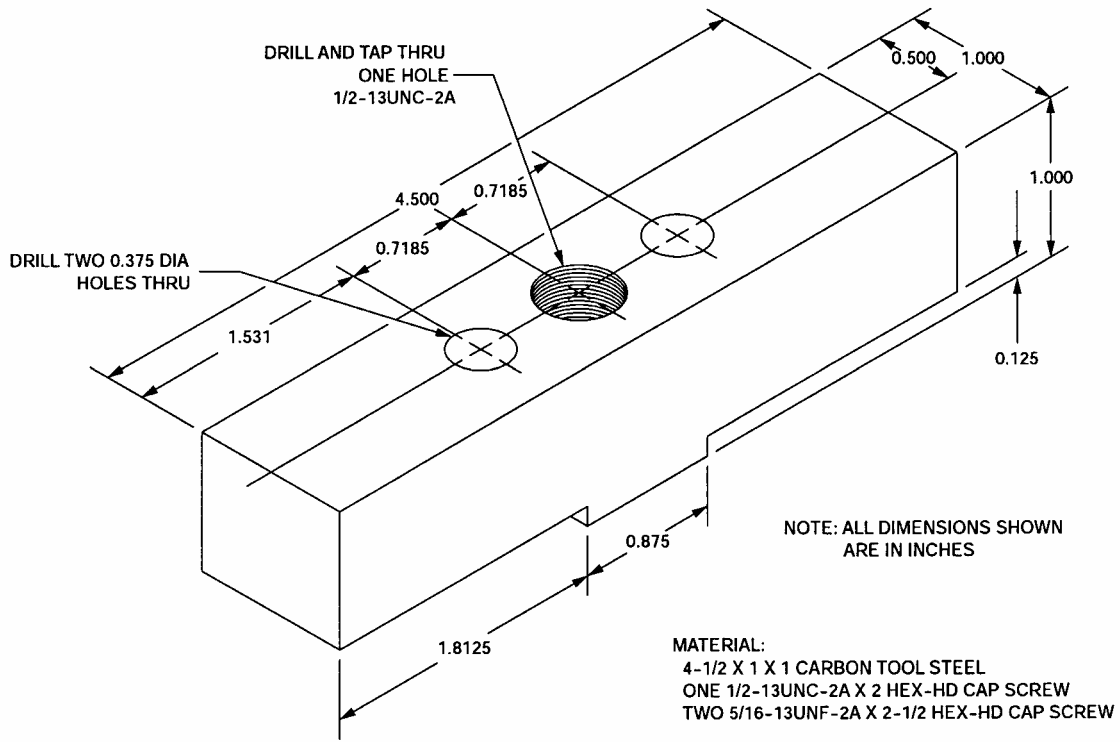
STEEL, CARBON PLATE  
MT1010, MT1015, MTX1015  
MT1020 OR MTX1020  
SPEC QQ-S-741



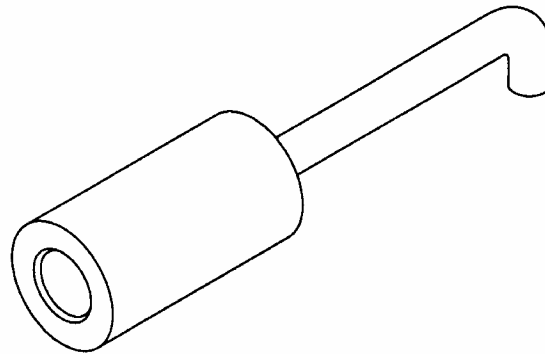
NOTE:  $\phi$  = DIAMETER  
NOTE: ALL DIMENSIONS  
ARE IN INCHES

1.25  $\phi$   
DEPTH-5.00  
OPTION-MACHINE  
CENTER

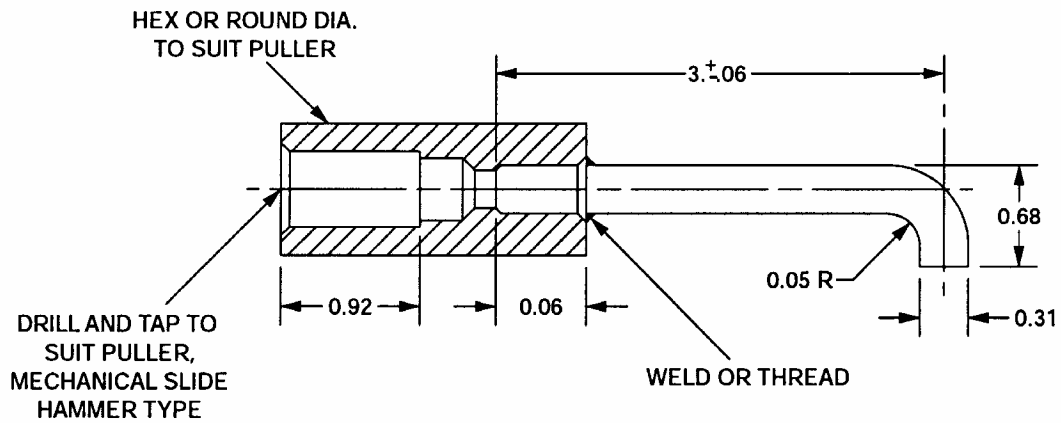
Item 5: Connecting Rod Bearing Replacement Tool (Sheet 4 of 4)



**Item 6: Fuel Injection Pump Coupling Puller**

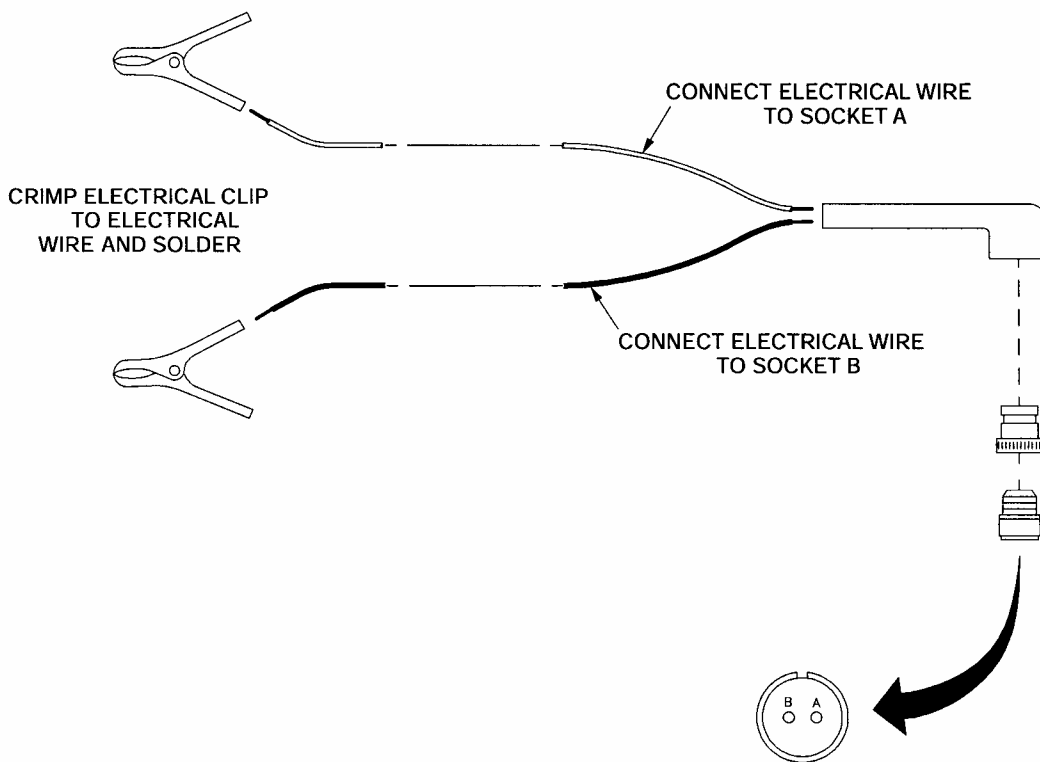


MATERIAL  
STEEL, ALLOY 4140



NOTE: ALL DIMENSIONS SHOWN  
ARE IN INCHES

Item 7: Oil Pressure Regulating Valve Sleeve Puller



ITEM NO	ITEM NAME	QUANTITY	NSN	SIZE (FT)
1	Connector, Plug, Elec	1	5935-00-509-6194	-----
2	Adapter, Cable Clamp	1	5935-01-244-6743	-----
3	Insulation Sleeving	1	5970-01-116-0284	-----
4	Wire, electrical (RED)	1	6145-00-490-4243	4.0 Ft (1.21 m)
5	Wire, Electrical (BLACK)	1	6145-00-267-0840	4.0 Ft (1.21 m)
6	Clip, Electrical (RED)	1	5999-01-094-1905	-----
7	Clip, Electrical (BLACK)	1	5999-01-094-1906	-----

**Item 8: Fuel/Water Separator Test Harness**



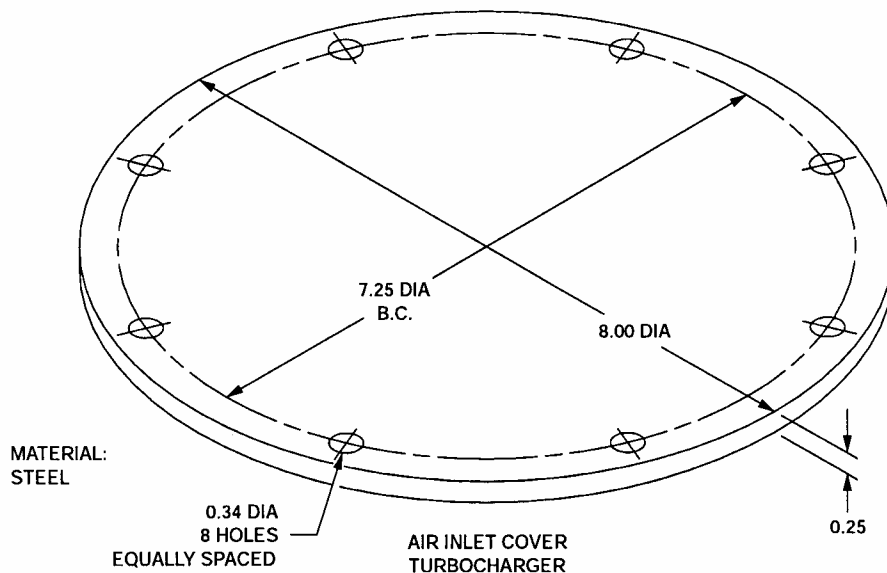
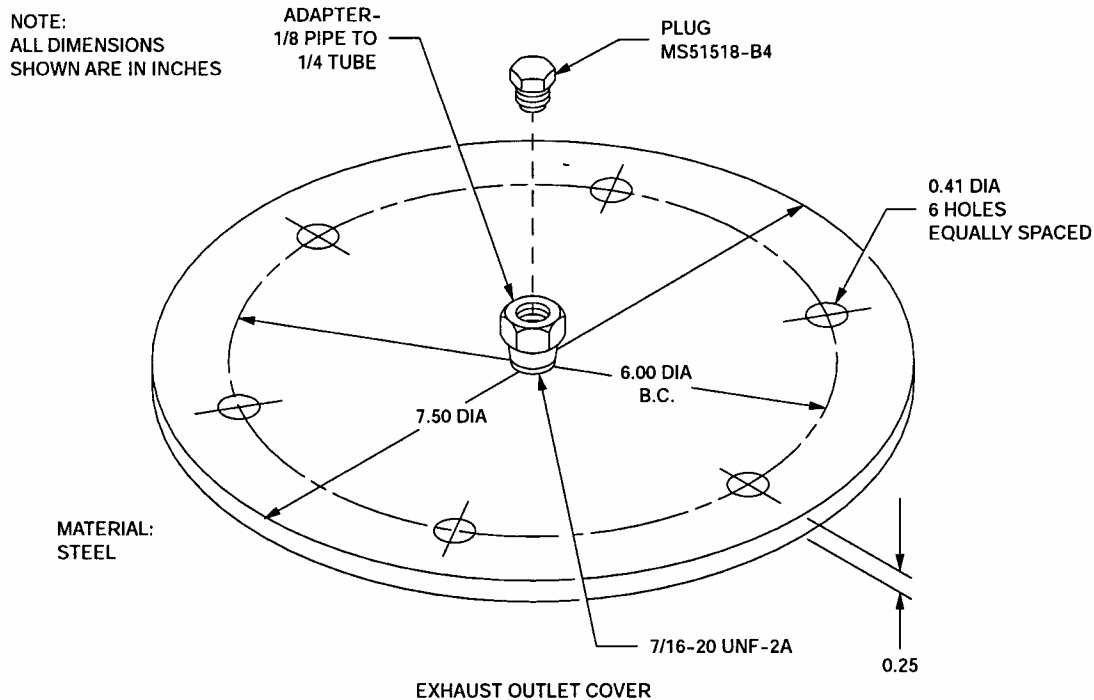


CRIMP ELECTRICAL CLIP  
TO ELECTRICAL WIRE AND SOLDER

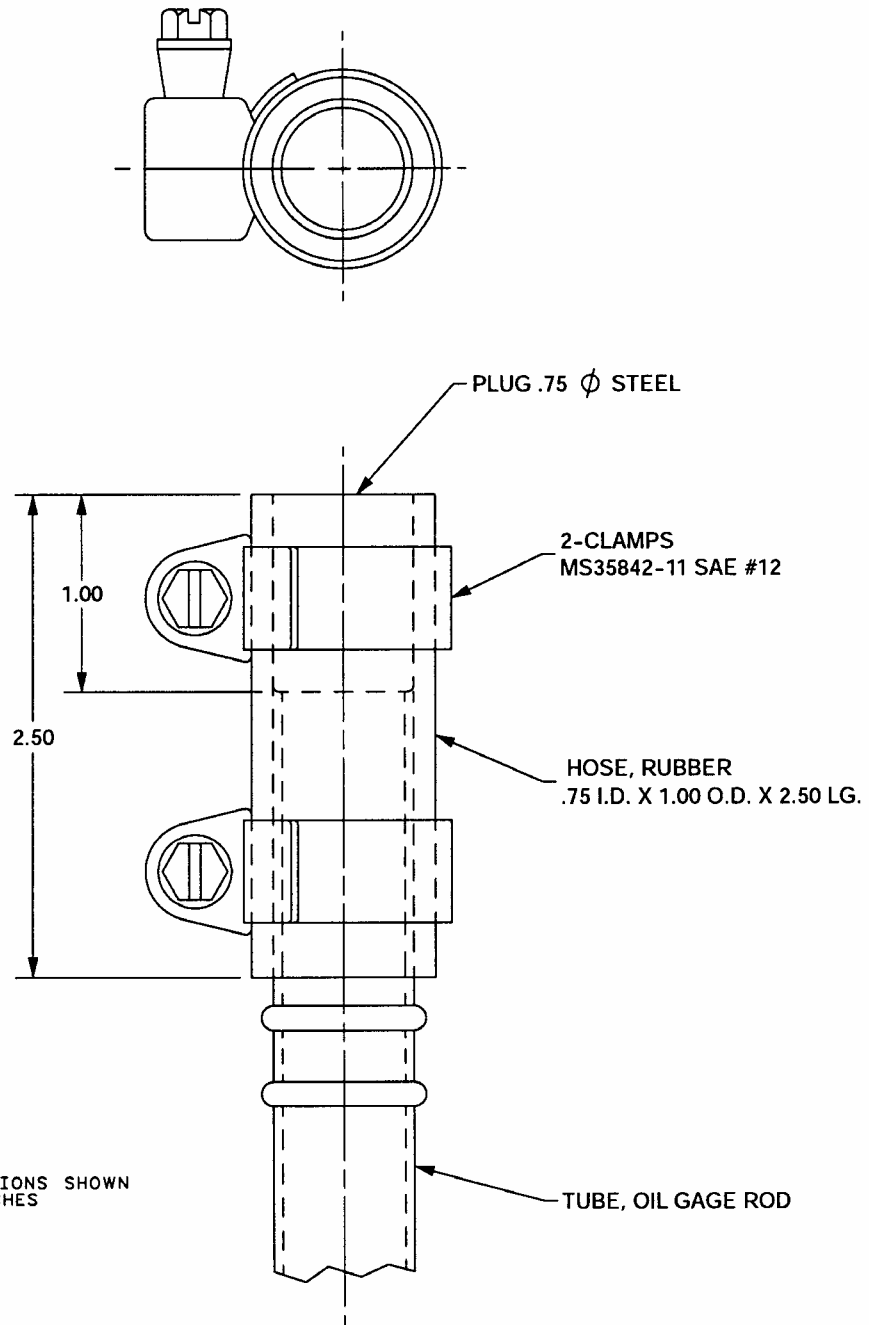
CRIMP ELECTRICAL CLIP  
TO ELECTRICAL WIRE AND SOLDER

ITEM NO	ITEM NAME	QUANTITY	NSN	SIZE (FT)
1	Wire, Electrical (BLACK)	1	6145-00-267-0840	4.0 Ft (1.21 m)
2	Clip, electrical (BLACK)	2	5999-01-094-1906	-----

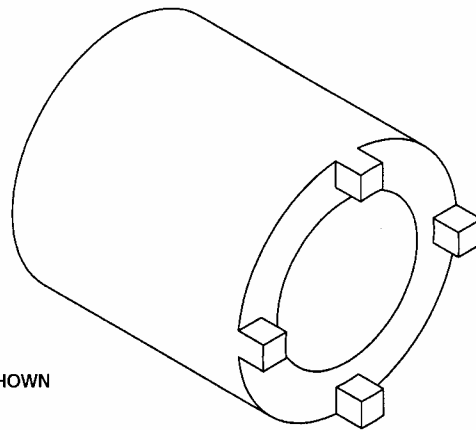
**Item 9: Fuel/Water Separator Jumper Wire**



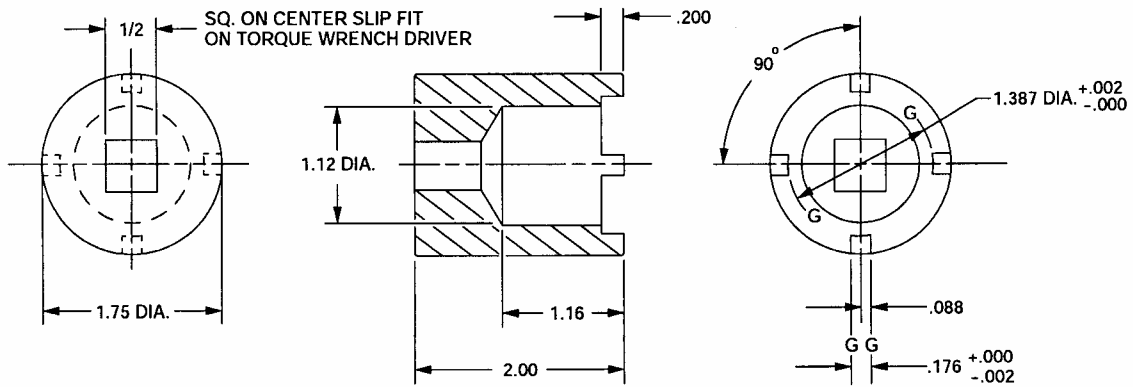
Item 10: Turbosupercharger Covers



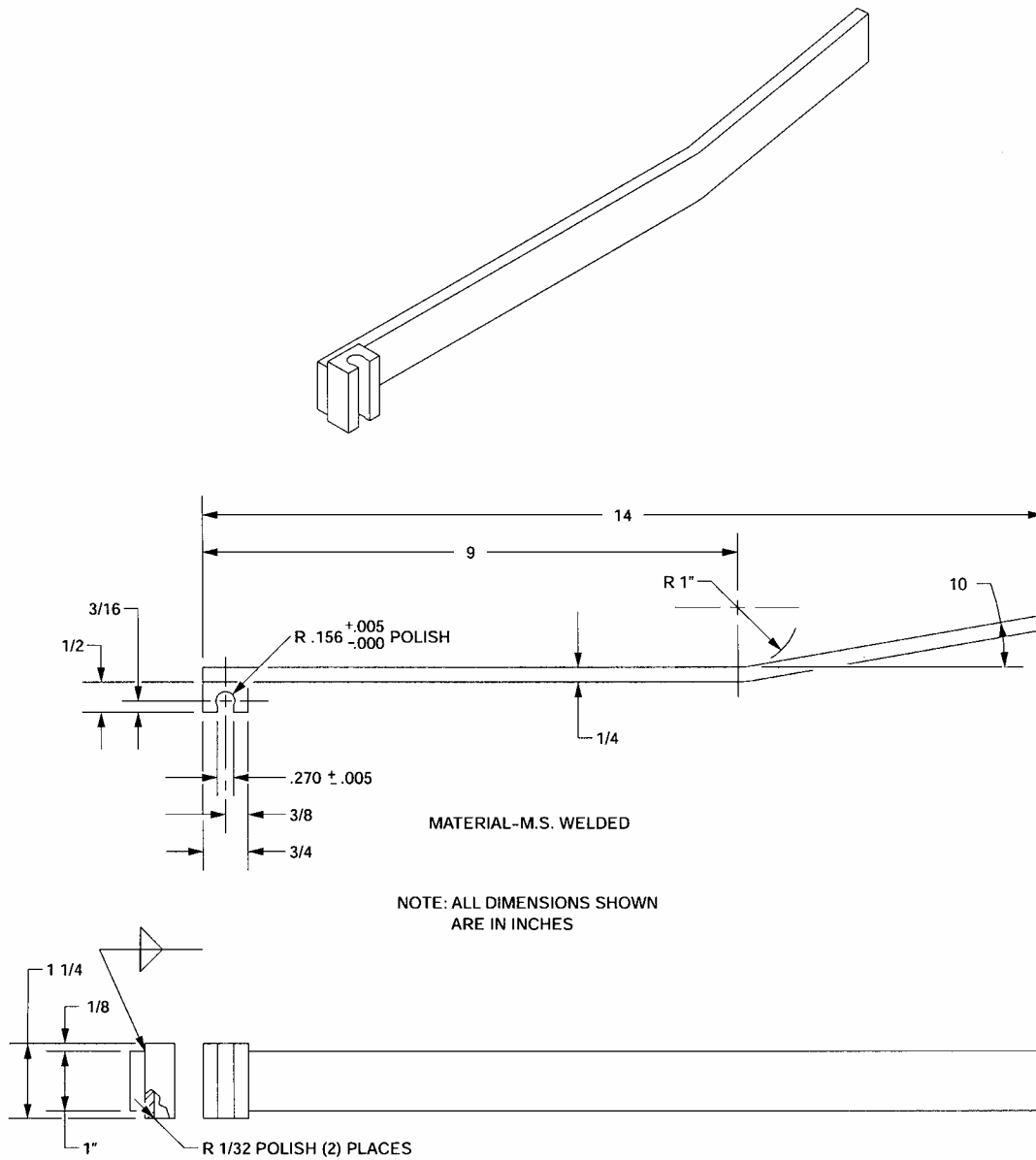
Item 11: Oil Level Gauge Plug



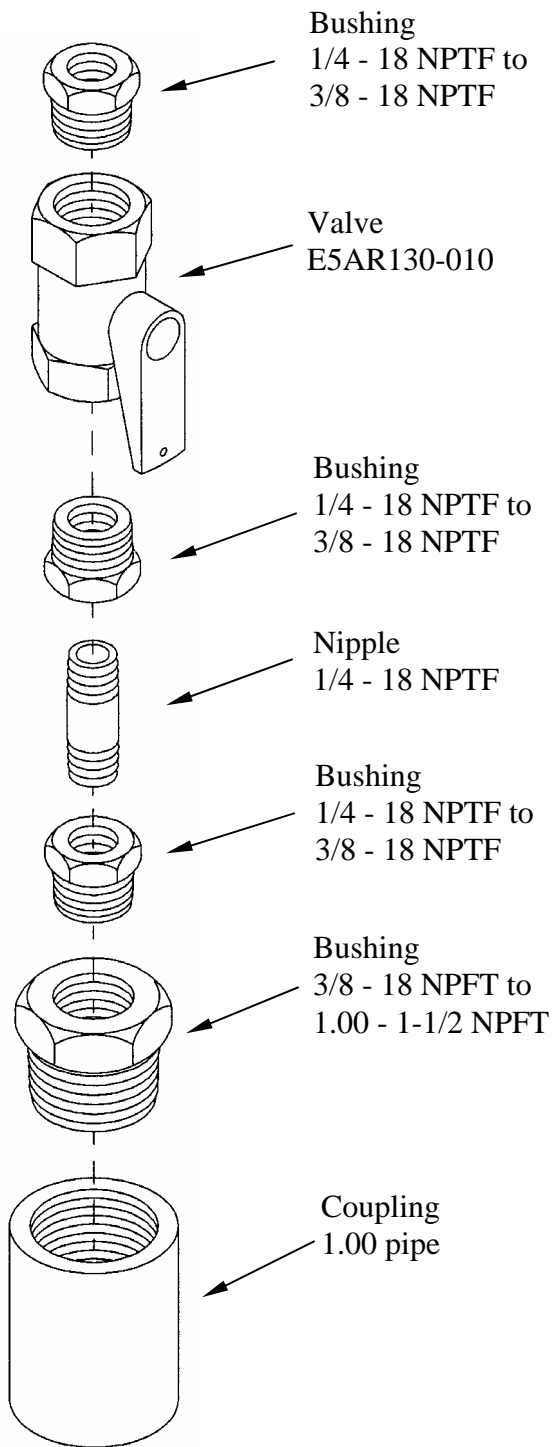
NOTE: ALL DIMENSIONS SHOWN  
ARE IN INCHES



Item 12: Modified Socket



Item 13: Bending Tool (2 Required)



**Item 14: Air Valve Adapter**

Fabricate an adapter from 1/16-27 NPT  
(National Pipe Thread) to 1/8-27 NPT tapered pipe.



**Item 15: Fuel Coupling Grease Insert Adapter**

Fabricate a tapered bolt from a 9/16-18 x 4-1/4 to 4-1/2  
inch long bolt: cut off the head, then taper.



**Item 16: Tapered Bolt, 9/16-18 x 4-1/2-inches (Damper removal)**

**END OF WORK PACKAGE**





**THIS WORK PACKAGE COVERS:**

General, Cleaning, Inspection, and Disassembly/Assembly Sequence Tables

**GENERAL**

The tables in this work package are provided as a guide for the orderly disassembly and subsequent assembly of the AVDS-1790 engine. The work packages have been grouped in sequential order. In some cases there is more than one work package in a group, in those cases there is no preference as to which work package is to be done first, they can be accomplished simultaneously. Before proceeding to the disassembly table, the exterior of the engine must be cleaned and the oil must be drained. Go to Work Package 0031 for the engine oil draining procedure.

**CLEANING**

1. See Work Package 0028 for General Cleaning Procedures.
2. Close all openings on the engine with waterproof tape or suitable plugs and thoroughly clean all external parts and outer surfaces. Make sure no foreign material enters working parts of engine assembly. Wash engine using water under pressure to remove mud and dirt. Remove oil and grease using a stiff brush with cleaning solvent.

**INSPECTION**

All parts must be inspected with care. Replace parts if damage or wear exceeds allowable limits.

1. See Work Package 0028 for General Inspection Procedures.
2. Do a general inspection of each assembly as it is removed from the engine to determine if further disassembly is required.

**TABLE ONE: DISASSEMBLY SEQUENCE**

Work Package Title	WP #	Sequence
Fuel Supply Pump Replacement (2CA, 2DA)	47	1
Fuel Supply Pump Replacement (2DR)	48	1
Starter Motor Replacement	49	2
Low Voltage Starter Protection Module Replacement	50	3
Starter Relay Mounting Bracket Replacement (2DR)	171	3
Generator Replacement (650 Ampere)	51	4
Generator Replacement (300 Ampere)	52	4
Generator Oil Cooling Hoses and Fittings Replacement (650Ampere)	91	4
Wiring Harness and Cable Repair	56	5
Signal Wiring Harness Replacement (2CA)	57	5
Signal Wiring Harness Replacement (2DA)	58	5
Signal Wiring Harness Replacement (2DR)	59	5

TABLE ONE: DISASSEMBLY SEQUENCE (Continued)

Work Package Title	WP #	Sequence
Starter/Smoke Generator/Dust Detector Wiring Harnesses Replacement, Low Voltage Protection Module Top Mounted (2CA, 2DA)	60	6
Starter/Smoke Generator/Dust Detector Wiring Harness Replacement, Low Voltage Protection Module Crankcase Mounted (2CA, 2DA)	61	6
Starter Solenoid Wiring Harness Replacement (2DR)	62	6
Generator Wiring Harness Replacement (2CA)	63	6
Generator Wiring Harness Replacement (2DA)	64	6
Generator Wiring Harness Positive Lead Replacement (2DR)	65	6
Transmission Wiring Harness Replacement (2CA, 2DA)	66	6
Dust Detector Wiring Harness Replacement (2DR)	67	6
Smoke Generator Wiring Harnesses Replacement (2DR)	68	6
Oil Pan Assembly Replace/Repair	152	7
Engine on Maintenance Stand Installation	130	8
Cooling Fans, Vanes, Fan Housings, and Seals Replacement	54	9
Oil Cooler Replacement (Engine and Transmission)	72	10
Oil Cooler Screen Replacement (Engine and Transmission)	89	10
Oil Cooler Access Covers and Frames Replacement (Engine and Transmission)	90	11
Smoke Generating System Replacement	94	11
Top Shroud and Mounting Bracket Replacement	55	11
Turbosupercharger and Transmission Shrouds Replacement	95	11
Cylinder Oil Drain Tubes Replacement	77	12
Throttle Control Solenoid Assembly and Associated Parts Replace/Repair (2DR)	123	13
Throttle/Governor Control Rod Assembly Repair (Adjustable)	125	13
Throttle/Governor Control Rod Assembly Repair (Rigid)	126	13
Manifold Heater Assembly and Related Parts Replacement	88	14
Intake Manifold Assembly Replace/Repair	108	14
Fuel Injection Tube Brackets Replacement	79	15
Fuel Injection Nozzle Return Hoses and Related Parts Replacement	80	15
Fuel Injection Tubes Replacement	113	15
Fuel Injection Nozzle Replace/Repair	114	15
Fuel Injection Pump Shutoff Electrical Lead Replacement	69	16
Fuel Injection Pump Assembly Replacement	115	16
Coupling, Fuel Injection Pump, Replace/Repair	116	16

**TABLE ONE: DISASSEMBLY SEQUENCE (Continued)**

Work Package Title	WP #	Sequence
Throttle Control and Manual Fuel Shutoff Replace/Repair (2CA, 2DA)	122	16
Turbosupercharger Dust Detector System Replacement	82	17
Dust Ejector System Replacement	83	17
Turbosupercharger Assembly Replacement (2CA, 2DA)	99	17
Turbosupercharger Assembly Replacement (2DR)	100	17
Turbosupercharger Base Assembly Replace/Repair (L.B.)	117	17
Turbosupercharger Base Assembly Replace/Repair (R.B.)	118	17
Turbosupercharger Tie Rod, Supports, and Associated Parts Replacement	119	17
Turbosupercharger Compressor Outlet Elbow Assembly Replacement	120	17
Exhaust Manifold Clamps Replacement	96	18
Exhaust Manifolds and Associated Parts Replacement	107	18
Oil Fill Tube Replace/Repair	75	19
Oil Level Gauge Rod Replace/Repair	76	19
Cylinder Deflectors and Shrouds Replacement	127	19
Shroud Repair	128	19
Rocker Arm Cover Repair	134	20
Fuel/Water Separator Automatic Drain System and Wiring Harness Replacement	84	21
Fuel/Water Separator Filter Repair and Element Replacement	85	21
Primary Fuel Filter Repair and Element Replacement	86	21
Fuel/Water Separator Control Mounting Plate Replacement	121	21
Camshaft, Drive Gears, and Associated Parts Replacement	146	21
Camshaft Drive Adapter Repair	147	21
Camshaft Drive Housing Repair	148	21
Camshaft Assembly Repair (L.B.)	149	21
Camshaft Assembly Repair (R.B.)	150	21
Fuel/Water Separator Bracket Assembly Repair	164	21
Primary Fuel Filter Mounting Bracket Replacement	165	21
Oil Sampling System Replacement (2CA, 2DA)	70	22
Oil Sampling Valve Replacement (2DR)	71	22
Oil Filters Replacement	73	22
Damper/Oil Filter Housing Related Parts Replacement	74	22
Fuel Backflow Valve Replacement	81	22
Manifold Heater Fuel Filter and Solenoid Replacement	87	22

TABLE ONE: DISASSEMBLY SEQUENCE (Continued)

Work Package Title	WP #	Sequence
Sending Units and High Temperature Switch Replacement (2CA, 2DA)	92	22
Sending Units and High Temperature Switch Replacement (2DR)	93	22
Damper Housing Oil Control Valves, Replace/Repair	106	22
Fuel Supply Pump Mounting Adapter Replace/Repair	109	22
Fuel Supply Pump Drive, Coupling and Adapter Replacement (2CA, 2DA)	110	22
PTO/Fuel Pump Drive Housing and Coupling Replacement	111	22
PTO Drive Shaft Replacement/Repair	112	22
Front Lifting Eyes and Guides Replacement	132	22
Damper/Oil Filter Housing Assembly Replace/Repair	151	22
Manifold Heater, Fuel Filter Mounting Bracket Replacement	166	22
Fuel Injection Pump Linkage and Associated Parts Replace/Repair	124	23
Front Fan Drive and Housing Repair	169	23
Engine Oil Hose Assemblies, Tube Assemblies and Related Parts Replacement	78	24
Fire Extinguisher Tube Replacement	97	24
Rocker Arm Assembly and Cover Replacement	104	24
Rocker Arm Assembly and Cover Repair	105	24
Accessory Drive Housing Assembly Replace/Repair	158	24
Camshaft Drive, Gear Shaft Repair (Accessory Drive)	159	24
Rear Fan Drive Bevel Gears Repair	168	24
Accessory Drive Housing Base Replace/Repair	160	25
Fuel Injection Pump Base and Associated Parts Replacement	163	25
Fan Drive Housing Base Repair (Damper End)	170	25
Cylinder Assembly Replacement	133	26
Cylinder Assembly Repair	135	26
Pistons, Rings, and Associated Parts Replace/Repair	142	26
Cylinder Valves and Associated Parts Repair	145	26
Transmission Spacer Ring Adapter Replacement (2DR)	101	27
Flywheel and Spur Gear Replacement (2CA, 2DA)	102	27
Flywheel and Adapter Assembly Replacement (2DR)	103	27
Crankcase/Transmission Adapter Assembly Replace/Repair	131	27
Crankshaft Oil Seal Housing and Associated Parts Replacement	136	27
Crankshaft Damper Repair	140	28
Oil Pump Replacement	153	29

## DISASSEMBLY/ASSEMBLY PROCEDURE SEQUENCE

0178 00

**TABLE ONE: DISASSEMBLY SEQUENCE (Continued)**

Work Package Title	WP #	Sequence
Oil Pump Repair	154	29
Crankshaft Main Bearings Inspection	138	30
Crankshaft Replace/Repair	139	31
Accessory Drive Gear Replacement	141	31
Connecting Rod Assembly Repair	143	31
Crankcase Repair	137	32
Piston Lubricating Nozzle Assembly Repair (Oil Squirt)	144	32
Generator Drive Mechanism Repair (300 Ampere Generator)	155	32
Generator Drive Mechanism Repair (650 Ampere Generator)	156	32
Starter Drive Mechanism Repair	157	32
Fan Drive Clutch Assembly and Associated Parts Replace/Repair	129	33
Fuel Injection Advance Control Repair	161	33
Fuel Injection Advance Control Test	162	33
Cooling Fan Housing Repair	167	34

**TABLE TWO: ASSEMBLY SEQUENCE**

Work Package Title	WP #	Sequence
Cooling Fan Housing Repair	167	1
Fan Drive Clutch Assembly and Associated Parts Replace/Repair	129	2
Fuel Injection Advance Control Repair	161	2
Fuel Injection Advance Control Test	162	2
Crankcase Repair	137	3
Piston Lubricating Nozzle Assembly Repair (Oil Squirt)	144	3
Generator Drive Mechanism Repair (300 Ampere Generator)	155	3
Generator Drive Mechanism Repair (650 Ampere Generator)	156	3
Starter Drive Mechanism Repair	157	3
Crankshaft Replace/Repair	139	4
Accessory Drive Gear Replacement	141	4
Connecting Rod Assembly Repair	143	4
Crankshaft Main Bearings Inspection	138	5
Oil Pump Replacement	153	6
Oil Pump Repair	154	6
Crankshaft Damper Repair	140	7
Transmission Spacer Ring Adapter Replacement (2DR)	101	8

TABLE TWO: ASSEMBLY SEQUENCE (Continued)

Work Package Title	WP #	Sequence
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**END OF WORK PACKAGE**



**ABBREVIATIONS****Word Abbreviations:**

ABC	After Bottom Center
AC	Alternating Current
AEPS	Army Electronic Support
ATC	After Top Center
AVDS	Air-Cooled, V-Type, Diesel, Turbosupercharged
BBC	Before Bottom Center
BDC	Bottom Dead Center
BTC	Before Top Center
Clr	Clearance
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
CPC	Corrosion, Prevention and Control
CR	Cold Roll (steel)
CTA	Certified Table of Allowances
Cyn	Cyanide
DA	Department of the Army
DC	Direct Current
DMWR	Depot Maintenance Work Requirement
DS	Direct Support
EIR	Equipment Improvement Report
Eng	Engine
ERR	Engineering Release Record
F.F.F.T.	Flats From Finger Tight (torque method)
GS	General Support
H <sub>2</sub> O	Water
Hd	Head
Hdn	Harden
Hex	Hexagon
HR	Hot Roll (steel)
HR	Hour
INJ	Injection or Injector
INT	Intake

**Word Abbreviations: (Continued)**

L	Looseness of fit (When checking the fit of a part, a range of acceptable values may be provided. The letter L may follow a value.)
L.B.	Left Bank
Lg	Large
Lg	Long
LVPM	Low voltage protection module
MAC	Maintenance Allocation Chart
MRP	Mandatory Replacement Part
MTOE	Modified Table of Organization and Equipment
N.A.	Not applicable
NBC	Nuclear-Biological-Chemical
NC	National Coarse (thread)
NF	National Fine (thread)
NPT	American National Standard Tapered Pipe Thread
NPTF	American National Standard Tapered Pipe Thread
NSN	National Stock Number
PTO	Power takeoff
R.B.	Right Bank
RPSTL	Repair Parts and Special Tools List
SAE	Society of Automotive Engineers
SMR	Source-Maintenance-Recovery
Sq	Square
STD	Standard
T	Tightness of fit (When checking the fit of a part, a range of acceptable values may be provided. The letter T may follow a value.)
TAMMS	The Army Maintenance Management System
TBD	To Be Determined
TDC	Top Dead Center
TNT	Trinitrotoluene is better known by its initials, <u>TNT</u> . It is an important explosive, since it can very quickly change from a solid into hot expanding gases
UNC	Unified National Coarse (thread)
UNF	Unified National Fine (thread)
WP	Work Package

**ABBREVIATIONS (Continued)****Letter Symbols for Units of Measure:**

bhp	brake horsepower
cfm	cubic feet per minute
cu in.	cubic inch(es)
dia	diameter
ft	foot/feet
ft-lb	foot-pound (unit of torque)
gpm	gallon(s) per minute
Hg	inches of mercury (vacuum or pressure measurement)
hp	horsepower
i.d.	inside diameter
i.e.	in other words
in-lb	inch-pound (unit of torque)
kPa	kilopascals
L	liter
mm	millimeter
N•m	Newton meter (torque value)
o.d.	outside diameter
oz	ounce
psi	pounds per square inch
rpm	revolution(s) per minute

**Signs and Symbols:**

@	at
°C	degree(s) Celsius
°F	degree(s) Fahrenheit
'	minute (a measurement of angle)

**GLOSSARY**

actuate	To put into mechanical action or motion
beveled	Slanted
braze	Use of hard solders which have silver, copper or nickel as bases and have melting points above 800 °F
burnish	To rub or polish until smooth or glossy
burr	A thin ridge or area of roughness produced in cutting or shaping
chase	Re-align threads
crocus	A dark red ferric oxide used for polishing metals
extruded	Forced, pressed, or pushed out
F.F.F.T.	Flats From Finger Tight is a torque method used to tighten certain fittings, hose nuts, and tube nuts without having to use a torque wrench (described in WP 0174, Torque Limit Tables)
ferrous	Contains iron
fillets	A concave junction formed where two surfaces meet
galled	Worn away by friction
hone	Sharpen, enlarge, smooth out
land	An area of surface partly machined (as with grooves) that is left without such machining
nonferrous	Does not contain iron
procedural work package	The procedural work package is the part or component's "home" work package. A procedural work package may state "Go to Work Package 0028 for Standard Cleaning Procedures." That referenced work package of standard instructions may direct you to return to the "procedural work package" for detailed instructions or measurements.
race	A track or channel in which something rolls or slides, such as a groove for the balls in a bearing
recess	Indentation
scored	Grooved, scratched, notched
seat	To rest properly upon

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By Order of the Secretary of the Army:

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<b>RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS</b>						Use Part II (reverse) for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE Date you filled out this form.
For use of this form, see AR 25-30; the proponent agency is ODISC4.							
TO: (Forward to proponent of publication or form) (Include ZIP Code) AMSTALC-LPIT / TECH PUBS, TACOM-RI 1 Rock Island Arsenal Rock Island, IL 61299-7630						FROM: (Activity and location) (Include ZIP Code)  Your mailing address	
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PUBLICATION/FORM NUMBER TM 9-2815-220-24				DATE 31 December 2005	TITLE AVDS-1790 2CA, 2DA and 2DR 12-Cylinder Diesel Engines		
ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO. *	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Provide exact wording of recommended changes, if possible).	
	0004 00-2	4-7				Wrong POC is listed.	
							
<i>*Reference to line numbers within the paragraph or subparagraph.</i>							
TYPED NAME, GRADE OR TITLE  Your Name				TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION		SIGNATURE  Your Signature	

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**PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS**

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PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

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## THE METRIC SYSTEM AND EQUIVALENTS

### LINEAR MEASURE

1 centimeter = 10 millimeters = 0.01 meter = 0.3937 inch  
 1 meter = 100 centimeters = 1000 millimeters = 39.37 inches  
 1 kilometer = 1000 meters = 0.621 mile

### SQUARE (sq.) MEASURE

1 sq. centimeter = 100 sq. millimeters = 0.155 sq. inch  
 1 sq. meter = 10,000 sq. centimeters = 10.76 sq. feet  
 1 sq. kilometer = 1,000,000 sq. meters = 0.386 sq. mile

### CUBIC (cu.) MEASURE

1 cu. centimeter = 1000 cu. millimeters = 0.06 cu. inch  
 1 cu. meter = 1 million cu. centimeters = 35.31 cu. feet

### WEIGHTS

1 gram = 0.001 kilograms = 1000 milligrams = 0.035 ounce  
 1 kilogram = 1000 grams = 2.2 pounds  
 1 metric ton = 1000 kilograms = 1 megagram = 1.1 short tons

### LIQUID MEASURE

1 milliliter = 0.001 Liter = 0.0338 fluid ounce  
 1 Liter = 1000 milliliters = 33.82 fluid ounces

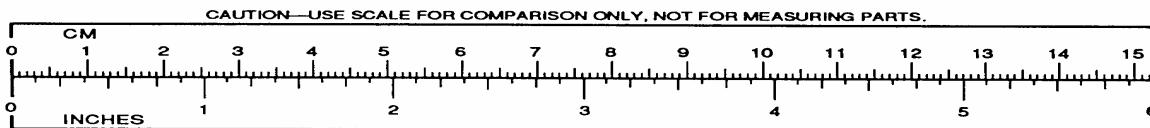
### TEMPERATURE

(Temperature in °F - 32) 0.556 = °C [degree Celsius]  
 212 °F is equivalent to 100 °C  
 90 °F is equivalent to 32.2 °C  
 32 °F is equivalent to 0 °C  
 (Temperature in °C + 32) 1.8 = °F [degree Fahrenheit]

### APPROXIMATE CONVERSION FACTORS

TO CHANGE:	TO:	MULTIPLY BY:
Acres	Square Hectometers	0.405
Centimeters	Inches	0.394
Cubic Feet	Cubic Meters	0.028
Cubic Meters	Cubic Feet	35.311
Cubic Meters	Cubic Yards	1.308
Cubic Yards	Cubic Meters	0.765
Feet	Meters	0.305
Fluid Ounces	Milliliters	29.573
Gallons	Liters	3.785
Grams	Ounces	0.035
Inches	Centimeters	2.540
Kilograms	Pounds	2.205
Kilometers	Miles	0.621
Kilometers per Hour	Miles per Hour	0.621
Kilometers per Liter	Miles per Gallon	2.352
Kilopascals	Pounds per Square Inch	0.145
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Meters	Feet	3.280
Meters	Yards	1.094
Metric Tons	Short Tons	1.102
Miles	Kilometers	1.609

TO CHANGE:	TO:	MULTIPLY BY:
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609
Milliliters	Fluid Ounces	0.034
Newton Meters	Pound-Feet	0.738
Ounces	Grams	28.349
Pints	Liters	0.473
Pound-Feet	Newton-Meters	1.356
Pounds	Kilograms	0.454
Pounds per Square Inch	Kilopascals	6.895
Quarts	Liters	0.946
Short Tons	Metric Tons	0.907
Square Centimeters	Square Inches	0.155
Square Feet	Square Meters	0.093
Square Hectometers	Acres	2.471
Square Inches	Square Centimeters	6.451
Square Kilometers	Square Miles	0.386
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Miles	Square Kilometers	2.590
Square Yards	Square Meters	0.836
Yards	Meters	0.914



PIN: 082888-000