

# **\*TM 9-2815-205-24**

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## **TECHNICAL MANUAL FIELD AND SUSTAINMENT MAINTENANCE FOR**

### **6V53/6V53T ENGINES, DIESEL WITH CONTAINERS**

**MODEL 5063-5299**

**NSN 2815-00-124-5390**

**NSN 2815-01-295-7458**

**MODEL 5063-5392**

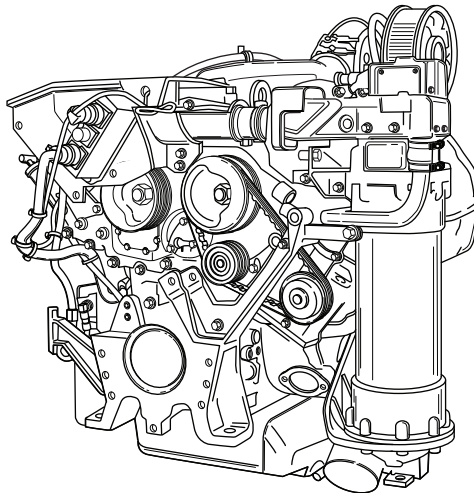
**NSN 2815-01-246-0903**

**MODEL 5063-5393**

**NSN 2815-01-248-7644**

**MODEL 5063-539L**

**NSN 2815-01-412-2715**



**\*SUPERSEDURE NOTICE** - This manual supersedes TM 9-2815-205-34 dated 10 October 2005, including all changes.

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**HEADQUARTERS, DEPARTMENT OF THE ARMY  
25 FEBRUARY 2013**



## WARNING SUMMARY

This warning summary contains general safety warnings and hazardous materials warnings that must be understood and applied during operation and maintenance of this equipment. Failure to observe these precautions could result in serious injury or death to personnel. Also included are explanations of safety and hazardous materials icons used within the technical manual.

### FIRST AID

In case of emergency, refer to FM 4-25.11 (First Aid) and seek medical aid.

### EXPLANATION OF SAFETY WARNING ICONS



**ELECTRICAL** - electrical wire to hand with electricity symbol running through hand shows that shock hazard is present.



**FLYING PARTICLES** - arrows bouncing off face with face shield shows that particles flying through the air will harm face.



**HEAVY OBJECT** - human figure stooping over heavy object shows physical injury potential from improper lifting technique.



**HEAVY PARTS** - foot with heavy object on top shows that heavy parts can crush and harm.



**HEAVY PARTS** - heavy object pinning human figure against wall shows that heavy, moving parts present a danger to life or limb.



**HOT AREA** - hand over object radiating heat shows that part is hot and can burn.

## WARNING SUMMARY - Continued

### EXPLANATION OF SAFETY WARNING ICONS - Continued



**MOVING PARTS** - hand with fingers caught between gears shows that the moving parts of the equipment present a danger to life or limb.



**SHARP OBJECT** - pointed object in hand shows that a sharp object presents a danger to limb.

### GENERAL SAFETY WARNINGS DESCRIPTION

#### WARNING



Before testing, remove jewelry such as rings, bracelets, wristwatches, and neck chains that may catch on equipment or cause electrical shorts. Failure to comply may result in injury or death to personnel.

#### WARNING



High voltage is present. Do not touch ignition coil or air heater assembly while performing test. Failure to comply may result in injury to personnel.

#### WARNING



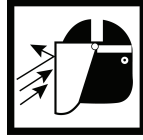
Compressed air used for cleaning purposes will not exceed 30 psi (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.



## WARNING SUMMARY - Continued

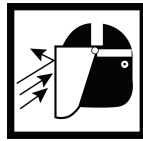
### GENERAL SAFETY WARNINGS DESCRIPTION - Continued

#### WARNING



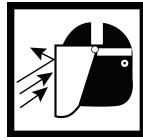
Wear eye protection and stand clear of air release ports when purging air from container. Make certain air pressure is fully vented before disassembly. Failure to comply may result in injury to personnel.

#### WARNING



Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler during high-pressure air-leak test. Failure to comply may result in injury to personnel.

#### WARNING



Use caution when removing snap ring. Parts are under spring pressure and may cause injury to personnel.

#### WARNING

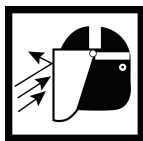


Parts are under spring pressure and may become airborne. Wear eye protection and use care when removing or installing retaining ring. Failure to comply may result in injury to personnel.

## WARNING SUMMARY - Continued

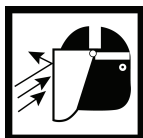
### GENERAL SAFETY WARNINGS DESCRIPTION - Continued

#### WARNING



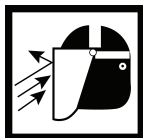
Spring is under compression. Wear eye protection and use care when removing spring. Failure to comply may result in injury to personnel.

#### WARNING



Restrain cam follower body and roller during removal from holding fixture. Follower pin is seated on top of spring loaded plunger in holding fixture and a sudden release could eject cam follower. Failure to comply may result in injury to personnel.

#### WARNING



Wear eye protection when working with pressurized air system. Make certain air pressure is fully vented before disassembly. Sudden release of air pressure can throw debris. Failure to comply may result in injury to personnel.

#### WARNING



Rings are extremely sharp. Do not grasp or graze sharp edges of oil control rings with bare hands. Failure to comply may result in injury to personnel.

## WARNING SUMMARY - Continued

### GENERAL SAFETY WARNINGS DESCRIPTION - Continued

#### WARNING



Hot metal components dissipate heat quickly. Wear heat-resistant gloves when handling heated parts. If you receive burns, immerse burn in cold water and seek medical aid. Failure to comply may result in injury to personnel.

#### WARNING



A protective shield must be installed on turbocharger inlet prior to running engine without built-in inlet screen or air cleaners. The turbocharger creates a strong suction at high engine speeds and can pull hands or clothing into spinning blades. Failure to comply may result in injury to personnel.

#### WARNING



Use care when using a press. Improper tools or tools not properly aligned may cause injury to personnel or damage to parts or equipment. Failure to comply may result in injury to personnel and/or damage to equipment.

#### WARNING



Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

## WARNING SUMMARY - Continued

### GENERAL SAFETY WARNINGS DESCRIPTION - Continued

#### WARNING



Starter motor is heavy. Provide adequate support to electric starter to prevent injury to personnel during removal. Failure to comply may result in injury to personnel.

#### WARNING



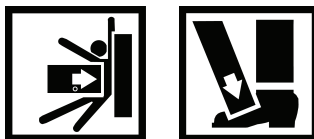
If hoist and sling are not available, use two or more personnel to remove crankshaft. Crankshaft is heavy and awkward to handle. Serious injury can result if crankshaft is dropped. Failure to comply may result in injury to personnel.

#### WARNING



Oil cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during removal. Failure to comply may result in injury to personnel.

#### WARNING

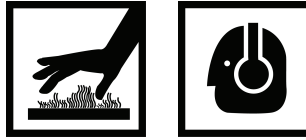


Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

## WARNING SUMMARY - Continued

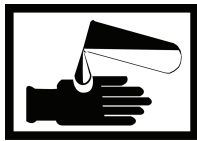
### GENERAL SAFETY WARNINGS DESCRIPTION - Continued

#### WARNING

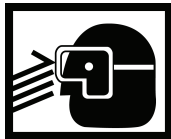


Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

### EXPLANATION OF HAZARDOUS MATERIALS ICONS



**CHEMICAL** - drops of liquid on hand shows that the material will cause burns or irritation to human skin or tissue.



**EYE PROTECTION** - person with goggles shows that the material will injure the eyes.



**FIRE** - flame shows that a material may ignite and cause burns.



**POISON** - skull and crossbones shows that a material is poisonous or is a danger to life.



**VAPOR** - human figure in a cloud shows that material vapors present a danger to life or health.

## WARNING SUMMARY - Continued

### HAZARDOUS MATERIALS DESCRIPTION

#### WARNING



Mercury is a toxic material. Avoid contact with skin. Clean up any spilled mercury. Dispose of small amounts of mercury by wiping with aluminum foil. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Always hold injector so that fuel spray cannot penetrate skin. Fuel oil which enters blood stream may cause serious infection. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Do not operate diesel fuel injector nozzle tester without shield. Fuel spray can penetrate skin. Fuel oil entering blood stream may cause serious infection. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Use Tech Solv 340 only with adequate ventilation. Vapors in high concentrations are anesthetic and dangerous to life. Avoid prolonged or repeated contact with skin. Do not take internally. Failure to comply may result in injury, illness, or death to personnel.

## WARNING SUMMARY - Continued

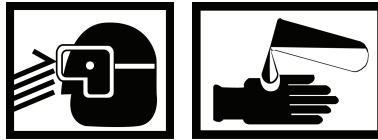
### HAZARDOUS MATERIALS DESCRIPTION - Continued

#### WARNING



Position exhaust piping to carry toxic carbon monoxide exhaust gases away from test area. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Coolant system cleaning solution contains acid. Wear protective goggles and equipment. Avoid contact with skin, eyes, and clothing. Always pour acid into water. Water poured into acid will spatter the acid. If contact is made, flush area with water and seek medical aid immediately. Failure to comply may result in injury to personnel.

#### WARNING



Coolant system cleaning solution is an acid. Wear protective goggles and equipment. Avoid contact with skin, eyes, and clothing. If contact is made, flush area with water and seek medical aid immediately. Failure to comply may result in injury to personnel.

## WARNING SUMMARY - Continued

### HAZARDOUS MATERIALS DESCRIPTION - Continued

#### WARNING



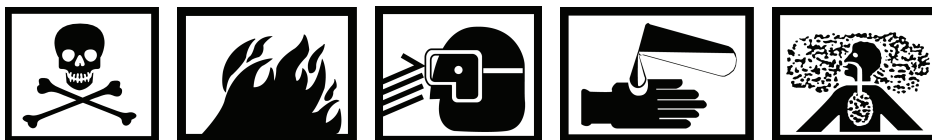
Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon removing compound. Provide adequate ventilation. Avoid inhaling fumes and contact with skin. If compound is splashed on skin, flush with water and wash with alcohol. Alcohol containing 2 or 3 percent camphor is preferable. If contact with eyes is made, flush eyes with water and get medical aid immediately. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Dry cleaning solvent MIL-PRF-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100–138°F (38–59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and seek medical aid. If contact with eyes is made, wash with water and get medical aid immediately. Failure to comply may result in injury, illness, or death to personnel.

#### WARNING



Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.



## LIST OF EFFECTIVE PAGES/WORK PACKAGES

NOTE: This manual supersedes TM 9-2815-205-34 dated 10 October 2005, including all changes. Zero in the "Change No." column indicates an original page or work package.

Date of issue for the original manual is:

Original 25 February 2013

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HEADQUARTERS, DEPARTMENT OF THE ARMY  
Washington, DC, 25 FEBRUARY 2013

**TECHNICAL MANUAL**  
**FIELD AND SUSTAINMENT MAINTENANCE**  
**FOR**

**6V53/6V53T ENGINES, DIESEL WITH CONTAINERS**

**MODEL 5063-5299**

**NSN 2815-00-124-5390**

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**MODEL 5063-539L**

**NSN 2815-01-412-2715**

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## HOW TO USE THIS MANUAL

### OVERVIEW

This is a maintenance technical manual to be used in support of the repair of the 6V53/6V53T Diesel Engine Series used on U.S. Army vehicles. This manual is organized by chapters and work packages. The work packages contain instructions and procedures to remove, replace, or repair components or assemblies. Use the table of contents to guide you through the manual.

### TABLE OF CONTENTS

The table of contents will give you a quick reference to chapters and work packages that you will use often. A summary of the organization of this manual is as follows:

### WARNINGS, CAUTIONS, AND NOTES

Throughout this manual you will see warnings, cautions, and notes. An explanation for each follows:

- A **WARNING** shall precede the text of any procedure involving a clear danger to the person doing that procedure.
- A **CAUTION** shall precede the text of any procedure involving a clear risk of damage to the equipment.
- A **NOTE** is used to highlight essential procedures, conditions, or statements which serve to make a procedure clearer or easier to accomplish.

### MANUAL CONTENT

There is one general information work package, six chapters, a glossary, and an alphabetical index. Each chapter is divided into work packages with specific topics. The chapters are identified by a single Arabic number. The work packages within the chapters are identified by a six digit Arabic number. The contents of the chapters and work packages are listed below.

Work Package 0001 00 - This work package contains type of manual, engine model numbers and equipment names, purpose of equipment, and lists of special forms and nomenclature.

Chapter 1 - This chapter contains introductory information, supporting data for repair parts, special tools, and specific descriptive engine data for each model engine used in the M113 Family of Vehicles (FOV).

Chapter 2 - This chapter contains work packages with instructions on where to find Field Maintenance Level troubleshooting procedures for the 6V53/6V53T Diesel Engine Series.

Chapter 3 - This chapter contains work packages with instructions on where to find Sustainment Level troubleshooting procedures for the 6V53/6V53T Diesel Engine Series.

Chapter 4 - This chapter contains work packages with detailed instructions for Field Maintenance Level repair, testing, preservation, packaging, preparation for shipment or storage, instructions for manufactured tools, and torque limits of the 6V53/6V53T Diesel Engine Series.

Chapter 5 - This chapter contains work packages with detailed instructions for Sustainment Level engine repair of major components of the 6V53/6V53T Diesel Engine Series.

## HOW TO USE THIS MANUAL - Continued

Chapter 6 - This chapter contains work packages with the following:

1. References - Technical manuals and other publication you may have to refer to while working on the engine.
2. Expendable and Durable Items List - Supplies and materials you will need while working on the engine.
3. Tool Identification List - All common tool sets and supplemental sets and special tools/fixtures you will need while working on the engine.
4. Mandatory Replacement Parts List - A written record of the functional testing of the engine assembly.
5. Engine Repair Specifications - A summary of the measurements needed for Direct and General Support repair of the engine assembly.

### ILLUSTRATIONS

Locator views are included wherever necessary. These will help you locate the item which the procedure is referencing.

A “~” symbol represents the outside surface of a piece of equipment.

Broken leader arrows indicate the item is either inside or under the equipment and cannot be seen.

### INDEXING

An indexing work package is provided in this manual to help you locate information quickly:

Alphabetical Index - An alphabetical listing of the content of this manual.

### PARTS INFORMATION

The Repair Parts and Special Tools List (RPSTL) for the 6V53/6V53T Diesel Engine Series is covered in TM 9-2815-205-24P. It includes an introduction Work Package (WP) with instructions and descriptions needed to effectively use the RPSTL.

### DA FORM 2028

DA Form 2028 is used to report errors and to recommend improvements for the tasks in this manual.

### METRIC CONVERSION CHART

The metric conversion chart converts english measurements to metric equivalents. Measurements in this manual are provided in both english and metric units.

**CHAPTER 1**

**FIELD AND SUSTAINMENT MAINTENANCE LEVEL  
GENERAL INFORMATION, EQUIPMENT DESCRIPTION, AND  
THEORY OF OPERATION  
FOR  
6V53/6V53T DIESEL ENGINES**





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## FIELD MAINTENANCE GENERAL INFORMATION

---

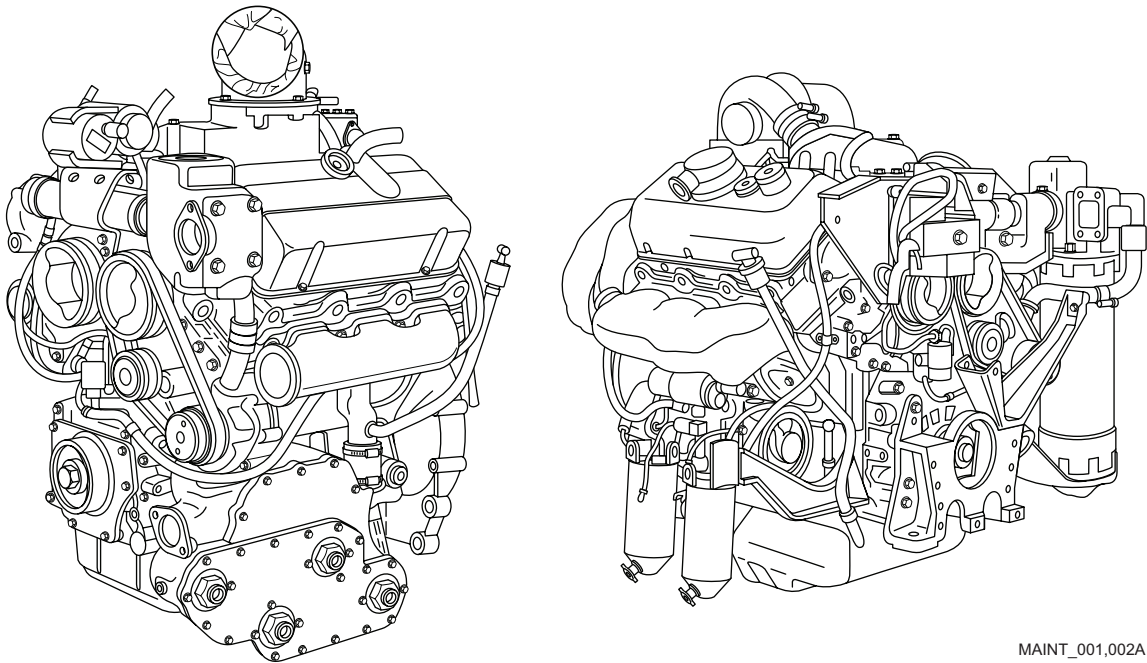
### SCOPE

This technical manual contains the information necessary for corrective maintenance and adjustments of the Series 6V53/6V53T Diesel Engine. The engine is used in the power pack of armored personnel carriers and assault vehicles.

Type of Manual: Field and Sustainment Maintenance Level

Model Number and Equipment Name: 5063-5299, 5063-5392, 5063-5393, and 5063-539L 6V53/6V53T Diesel Engines with Containers.

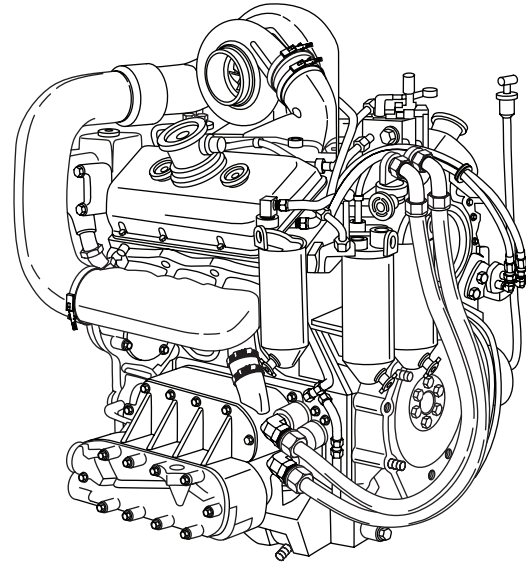
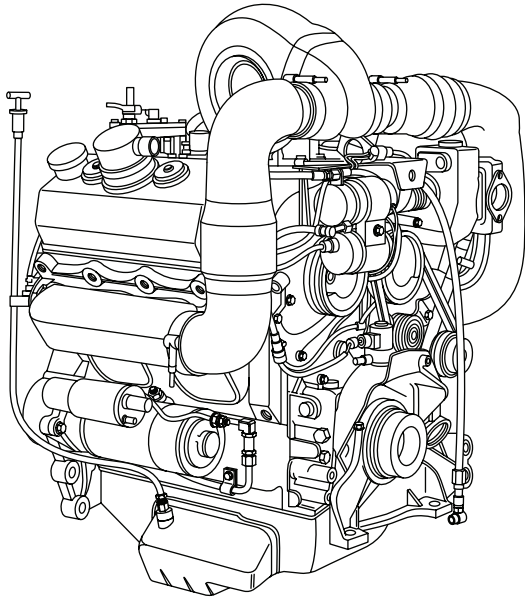
Purpose of Equipment: The engine powers the M113 Family of Vehicles (FOV).



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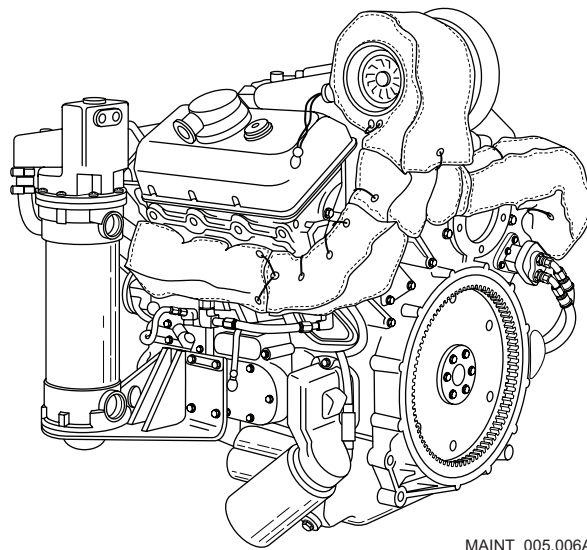
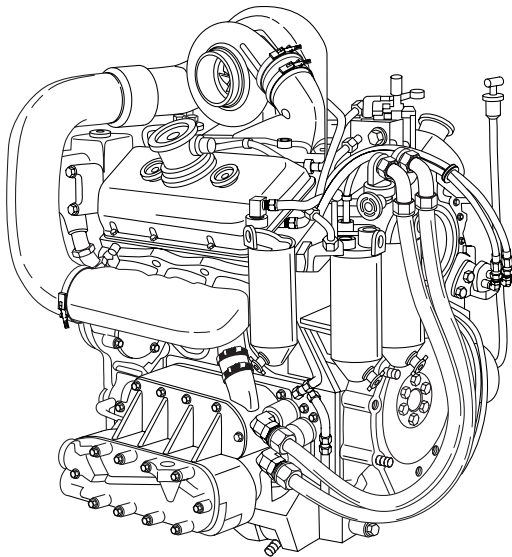
Figure 1. Model 5063-5299.

SCOPE - Continued



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Figure 2. Model 5063-5392.



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Figure 3. Model 5063-5393.

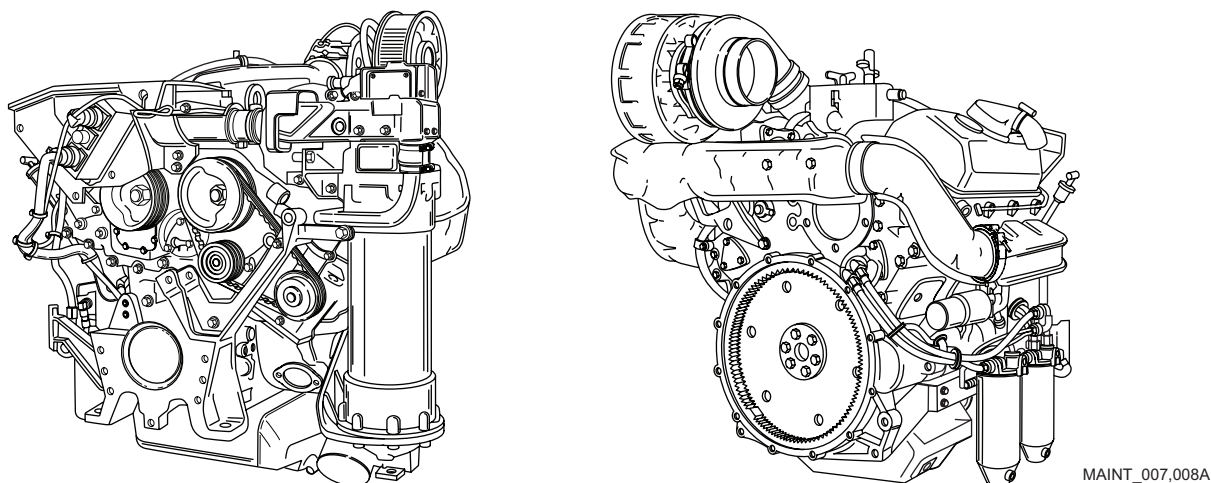
**SCOPE - Continued**

Figure 4. Model 5063-539L.

**MAINTENANCE FORMS, RECORDS, AND REPORTS**

Department of the Army forms, records, and procedures used for equipment maintenance will be those prescribed by DA PAM 750-8. Functional Users Manual for The Army Maintenance Management System (TAMMS).

**REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR)**

If your 6V53/6V53T Diesel Engine needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you do not like about your equipment. Let us know why you do not like the design or performance.

All non-Aviation/Missile EIRs and PQDRs must be submitted through the Product Data Reporting and Evaluation Program (PDREP) Web site. The PDREP site is: <https://www.pdrep.csd.disa.mil/>.

If you do not have Internet access, you may submit your information using an SF 368 (Product Quality Deficiency Report). You can send your SF 368 using email, regular mail, or fax using the addresses/fax numbers specified in DA PAM 750-8, The Army Maintenance Management System (TAMMS) Users Manual. We will send you a reply.

**CORROSION PREVENTION AND CONTROL (CPC)**

Corrosion Prevention and Control (CPC) of Army material is a continuing concern. It is important that any corrosion problems with this item be reported so that the problem can be corrected and improvements can be made to prevent the problem in future items.

## CORROSION PREVENTION AND CONTROL (CPC) - Continued

Corrosion specifically occurs with metals. It is an electrochemical process that causes the degradation of metals. It is commonly caused by exposure to moisture, acids, bases, or salts. An example is the rusting of iron. Corrosion damage in metals can be seen, depending on the metal, as tarnishing, pitting, fogging, surface residue, and/or cracking. Plastics, composites, and rubbers can also degrade. Degradation is caused by thermal (heat), oxidation (oxygen), solvation (solvents), or photolytic (light, typically UV) processes. The most common exposures are excessive heat or light. Damage from these processes will appear as cracking, softening, swelling, and/or breaking.

If a corrosion problem is identified, it can be reported using SF 368, Product Quality Deficiency Report. Use of keywords such as "corrosion," "rust," "deterioration," or "cracking" will ensure that the information is identified as a CPC problem.

The form should be submitted to Commander, U.S. Army TACOM Life Cycle Management Command, ATTN: AMSRD-TAR-E/PDQR, MS 268, 6501 E. 11 Mile Road, Warren, MI 48397-5000.

## DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE

For procedures to destroy this equipment to prevent its use by the enemy, refer to TM 750-244-6, Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use.

## PREPARATION FOR STORAGE OR SHIPMENT

Refer to (WP 0079) for procedures to prepare the engine for storage or shipment.

## LIST OF ABBREVIATIONS/ACRONYMS

*Table 1. List of Abbreviations/Acronyms.*

<u>Abbreviations</u>	<u>Explanation</u>
AA	Arithmetical Average
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
bhp	Brake Horsepower
C	Celsius
CAGE (FSCM)	Commercial and Government Entity
CAGEC	Commercial and Government Entity Code
cc	Cubic Centimeter
CPC	Corrosion Prevention Control
dc	Direct Current
dia	Diameter
ECP	Engineering Change Proposal

## LIST OF ABBREVIATIONS/ACRONYMS - Continued

*Table 1. List of Abbreviations/Acronyms - Continued.*

EIR	Equipment Improvement Recommendation
F	Fahrenheit
FOV	Family of Vehicles
GPM	Gallons Per Minute
hp	Horsepower
ID	Inside Diameter
kPa	Kilopascals
kg	Kilogram
lb-ft	Pound-foot, pound-feet
lb-in	Pound-inch
L	Liter
MIL PRF	Military Performance Specification
mm	Millimeter
MTOE	Modified Table of Organization and Equipment
N·m	Newton·meter
NSN	National Stock Number
OD	Outside Diameter
pk	Package
psi	Pounds per square inch
qt	Quart
qty	Quantity
rpm	Revolutions Per Minute
RPSTL	Repair Parts and Special Tools List
TACOM	Tank-automotive and Armaments Command
TAMMS	The Army Maintenance Management System

**LIST OF ABBREVIATIONS/ACRONYMS - Continued***Table 1. List of Abbreviations/Acronyms - Continued.*

TM	Technical Manual
TMDE	Test, Measurement, and Diagnostic Equipment
tu	Tube
V	Volt
WP	Work Package

**QUALITY OF MATERIAL**

Material used for replacement, repair, or modification must meet the requirements of this TM 9-2815-205-24. If quality of material requirements are not stated in this TM 9-2815-205-24, the material must meet the requirements of the drawings, standards, specifications, or approved engineering change proposals applicable to the subject equipment.

**ENGINEERING CHANGE PROPOSALS (ECP)**

Engineering change proposals (ECPs) will be submitted using STA 1692 or STA 1695 (Engineering Change Proposal [Short Form]). Completed forms should be mailed direct to: Commander, U.S. Army TACOM Life Cycle Management Command. The postal mail address is U.S. Army TACOM Life Cycle Management Command, ATTN: AMSRD-TAR-E/PDQR, MS 268, 6501 E. 11 Mile Road, Warren, MI 48397-5000. A reply will be furnished to you.

**REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT****SUPPORTING DATA FOR REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT****COMMON TOOLS AND EQUIPMENT**

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE), CTA 50-970, Expendable/Durable Items (Except: Medical, Class V, Repair Parts, and Heraldic Items), or CTA 8-100, Army Medical Department Expendable Items, as applicable to your unit.

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

The special tools, TMDE, and support equipment required to accomplish the maintenance procedures peculiar to this technical manual are listed and illustrated in Repair Parts and Special Tools List (TM 9-2815-205-24P).

The fabricated tools required to accomplish the maintenance procedures peculiar to this technical manual are listed in (WP 0081) along with fabrication instructions.

**REPAIR PARTS**

Repair parts are listed and illustrated in Repair Parts and Special Tools List (TM 9-2815-205-24P).

**END OF WORK PACKAGE**

---

**FIELD MAINTENANCE  
EQUIPMENT DESCRIPTION AND DATA**

---

**EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES**

The Series 6V53/6V53T Diesel Engine is a two cycle, fuel injected, V-type, liquid cooled, six cylinder diesel engine with water cooled cylinder liners. Cylinders are numbered one, two, and three on left and right starting from the front of the engine. Terms "right", "left", "front", and "rear" are defined as viewed from the rear or flywheel end of the engine.

The 6V53/6V53T Diesel Engine is an internal combustion power unit where the heat energy of the fuel is converted into work energy inside the cylinder. This particular engine has a two stroke cycle. A two stroke engine completes one cycle (intake, compression, power, and exhaust) every time the piston goes up and down - up being one stroke and down being the return stroke. The air intake and exhaust functions are accomplished during the compression and power strokes.

The engine has a blower to force air into the chambers for both intake and exhaust functions. In addition, all models except 5063-5299 have a turbocharger to pressurize air (called supercharging) to increase airflow and allow higher fuel input. When the piston is halfway down, the exhaust valves open. Shortly thereafter, the piston drops below a row of inlet ports in the cylinder liner wall. Pressurized air is then forced through the cylinder. During this process, all of the exhaust gases are removed (or scavenged) from the cylinder. When the exhaust valves close, during the piston's upward stroke, fresh air is trapped in the cylinder and compressed.

Injection of fuel into the cylinder begins with the piston near its highest point and continues into the power stroke. The intense heat created by the high compression of air immediately ignites the fine fuel spray. This combustion continues until all the injected fuel is burned. The resulting pressure forces the piston downward on its power stroke. When the piston is about halfway down, the exhaust valves open. Shortly thereafter, the piston drops below the ports, and the cylinder is again swept with clean scavenging air. This entire combustion cycle is completed in each cylinder for each revolution of the crankshaft.

The engine serial number is stamped on the right side, upper front corner of cylinder block in front of the cylinder head. An option label is affixed to one valve rocker arm cover which carries the engine serial number, model number, tune-up specifications, and list of optional equipment used on the engine.

## LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS

### Water Pump

The water pump (Figure 1, Item 7) is mounted on the top of the oil cooler and driven by belts from the camshaft front pulley. It circulates coolant through the cylinder block, cylinder heads, and oil cooler.

### Valve Rocker Covers

The valve rocker covers (Figure 1, Item 2) enclose the valve and injector rocker arm mechanisms located on top of cylinder heads.

### Engine Oil Cooler

The engine oil cooler (Figure 1, Item 6) is mounted on lower left side of engine block. It uses engine coolant to cool engine oil. Models 5063-5299 and 5063-5392 have the transmission coolers in the same housing.

### Transmission Oil Cooler

The transmission oil cooler (Figure 1, Item 4) is included with the engine for models 5063-5393 and 5063-539L. It is mounted on left side of the engine block. It uses engine coolant to cool transmission oil.

### Exhaust Manifolds

The exhaust manifolds (Figure 1, Item 5) are attached directly to cylinder heads. For all, except model 5063-5299, they route exhaust gases through attached exhaust piping to the turbocharger.

### Oil Level Gauge Rod

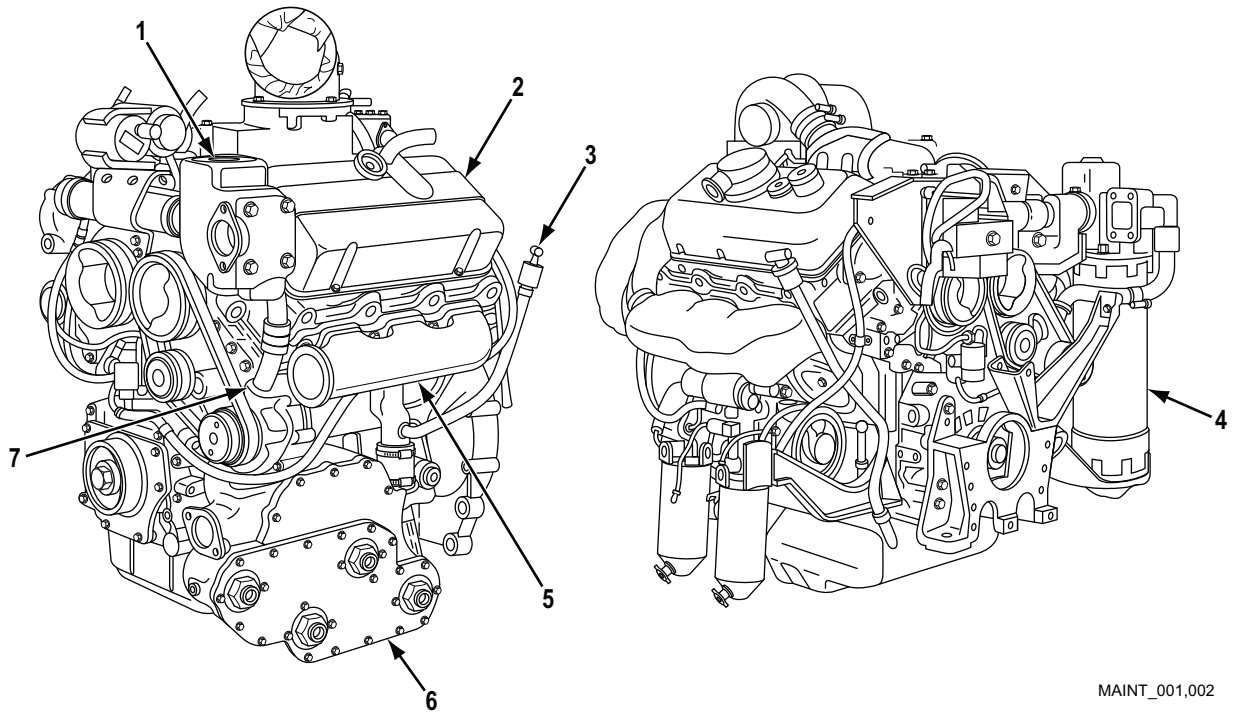
The oil level gauge rod (Figure 1, Item 3) is mounted differently on each model engine. On model 5063-5299, it is mounted on the left rear of the cylinder head. On model 5063-5392, it is mounted on the right rear of the cylinder head. On models 5063-5393 and 5063-539L, it is mounted on the right front of the cylinder head.

### Thermostat and Housing Assembly

The thermostat and housing assembly (Figure 1, Item 1) is mounted on the front of the left cylinder head and connected to the right cylinder head with crossover tube. It controls coolant temperature by restricting coolant flow to the radiator.



LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS - Continued



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Figure 1. Major Components (Front View).

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**LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS - Continued****Oil Filter**

The oil filter (Figure 2, Item 17) is mounted on the lower left side of engine block for all except model 5063-5392. Model 5063-5392 has it mounted near the left rear cylinder head. It filters the engine lubrication oil.

**Governor**

The governor (Figure 2, Item 9) is mounted on the rear end of the blower and driven from a blower drive gear. It is used to control the idle and maximum engine operating speeds.

**Oil Pan**

The oil pan (Figure 2, Item 15) is mounted on the bottom of the cylinder block. It provides a reservoir for engine oil.

**Starter**

The starter (Figure 2, Item 14) is mounted on right side of flywheel housing. It is an electric starter and engages the flywheel ring gear.

**Flywheel**

The flywheel (Figure 2, Item 16) is mounted on the rear of the crankshaft. It is used to provide true alignment of transmission flex plate.

**Fuel Strainer**

The fuel strainer (Figure 2, Item 11) is mounted differently on each model engine. On model 5063-5299, it is remote mounted. On model 5063-5392, it is mounted near the left rear corner of the engine. On models 5063-5393 and 5063-539L, it is mounted on the lower right side. It filters fuel to fuel pump.

**Fuel Filter**

The fuel filter (Figure 2, Item 10) is mounted adjacent to the fuel strainer. It filters fuel to fuel inlet manifold.

**Turbocharger**

The turbocharger (Figure 2, Item 8) is mounted on the rear of the engine (models 5063-5393 and 5063-539L) or on the blower (model 5063-5392). It increases engine power by delivering high pressure air to the blower using exhaust gas energy. Model 5063-5299 has no turbocharger.

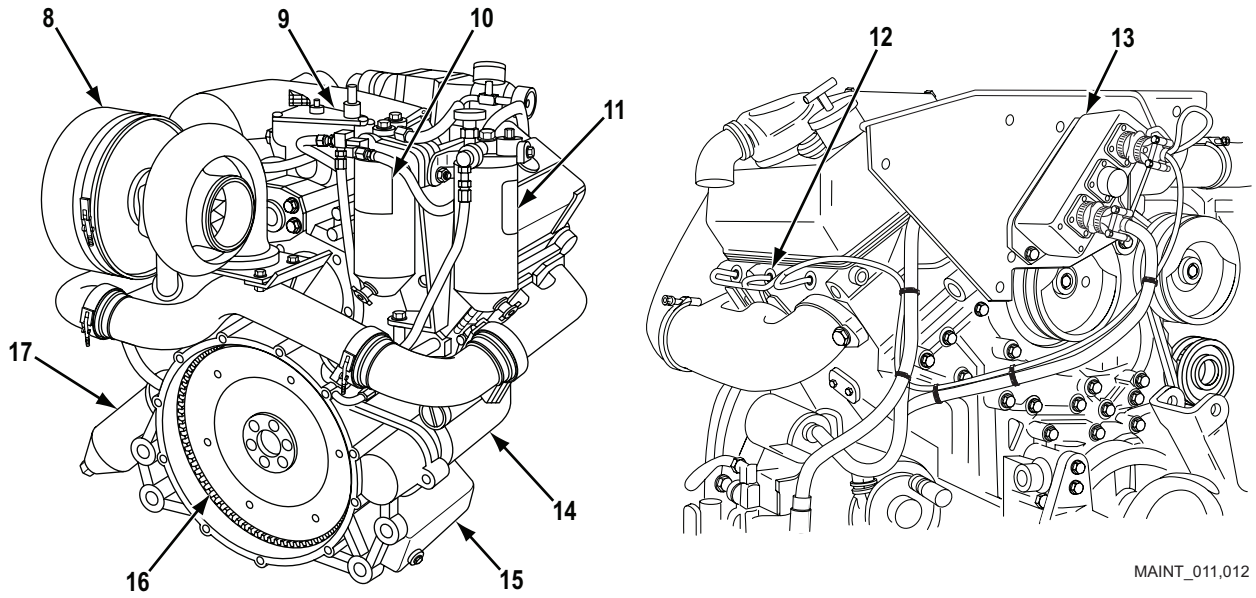
**Glow Plugs**

The glow plugs (Figure 2, Item 12) screw into the cylinder head and protrude into the combustion chamber for model 5063-539L. They improve cold weather startability by heating the combustion chamber of each cylinder.

**Glow Plug Controller**

The glow plug controller (Figure 2, Item 13) is attached to a bracket located on the upper front cover. It is a control module used to regulate the glow plug duty cycle for cold starting applications on model 5063-539L.

LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS - Continued



MAINT\_011,012

Figure 2. Major Components (Rear View).

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**LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS - Continued****Fuel Pump**

The fuel pump (Figure 3, Item 23) is attached to the flywheel housing and driven off the right side camshaft gear. It supplies low pressure fuel to fuel inlet manifolds in cylinder heads.

**Blower**

The blower (Figure 3, Item 18) is mounted on top of the cylinder block. It supplies a constant volume of fresh air per revolution to the cylinders.

**Cylinder Heads**

The cylinder heads (Figure 3, Item 19) are mounted on top of each cylinder side. They contain fuel manifolds, exhaust valves, injectors, and injector and valve operating mechanisms.

**Camshafts**

The camshafts (Figure 3, Item 22) are located on top of each cylinder side. They actuate injector and exhaust valve operating mechanisms.

**Cylinder Block**

The cylinder block (Figure 3, Item 20) is the main structural part. It provides rigidity and ensures alignment of all load bearing assemblies.

**Crankshaft**

The crankshaft (Figure 3, Item 25) is attached to the bottom of the cylinder block. It transfers the engine load through the flywheel and supplies oil to piston assemblies.

**Piston and Connecting Rod Assemblies**

There are three piston and connecting rod assemblies (Figure 3, Item 24) located in each side. Pistons are cooled and lubricated by oil pressure fed up through drilled connecting rods.

**Oil Pump**

The oil pump (Figure 3, Item 26) is mounted inside the lower front engine cover. It pumps oil throughout the engine for lubrication and cooling.

**Bypass Valve**

The bypass valve (Figure 3, Item 21) is located in the rear end plate of the blower. It increases fuel efficiency by reducing the amount of engine power required to operate the blower at above idle speeds when the turbocharger is supplying sufficient air flow to sustain an adequate air/fuel ratio for models 5063-5392, 5063-5393 and 5063-539L.

**LOCATIONS AND DESCRIPTIONS OF MAJOR COMPONENTS - Continued**

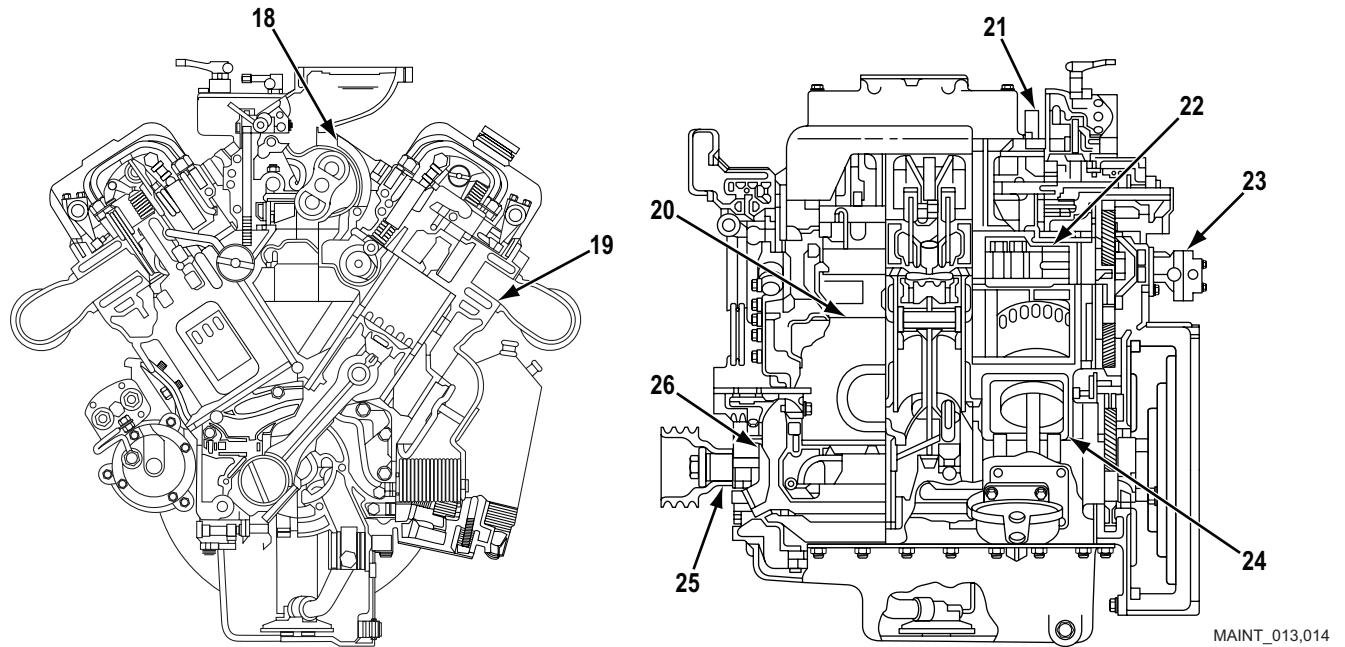


Figure 3. Major Components (Internal).

**DIFFERENCES BETWEEN MODELS**

Table 1 summarizes the differences between the four models of the Series 6V53/6V53T Diesel Engine covered in this manual.

**Table 1. Differences Between Models.**

Description	5063-5299	5063-5392	5063-5093	5063-539L
Turbocharger	None	TV7303	TV7303	TV7303
Piston Type	Trunk	Crosshead	Crosshead	Crosshead
Injectors	N50	5C55	5C55	5C55
Turbocharger Location	— —	Air Inlet Housing	Rear Bracket	Rear Bracket
Oil Cooler	3 Element	2 Element	1 Element (Engine). Tube-in-shell (Transmission)	1 Element (Engine). Tube-in-shell (Transmission)
Filter Locations	Remote	Engine	Engine	Engine
Rocker Cover	Stamped Steel	Die Cast Aluminum	Die Cast Aluminum	Die Cast Aluminum

**DIFFERENCES BETWEEN MODELS - Continued***Table 1. Differences Between Models - Continued.*

Description	5063-5299	5063-5392	5063-5093	5063-539L
Blower Group	Traditional	BypassValve in Rear Endplate	BypassValve in Rear Endplate	BypassValve in Rear Endplate
Starting Aid	Air Box Heater	Air Box Heater	Air Box Heater	Glow Plugs

**EQUIPMENT DATA**

Table 2 provides general information pertaining to the operational, mechanical, and environmental characteristics of all four models of the Series 6V53/6V53T Diesel Engine.

Table 3 provides specific information pertaining to the operational, mechanical, and environmental characteristics for each of the four models of the Series 6V53/6V53T Diesel Engine.

*Table 2. General Equipment Data for All Models.*

<b>General Specifications</b>	
Type	Diesel, Two-cycle
Manufacturer	Detroit Diesel Corporation (formerly Detroit Diesel Allison Division of GMC)
No. of Cylinders	6
Crankshaft Rotation (from Front)	Clockwise
Firing Order	1L-3R-3L-2R-2L-1R
Total Displacement	318 cu in. (6.7 L)
Bore	3.875 in. (98 mm)
Stroke	4.5 in. (114 mm)
Exhaust Valves per Cylinder	4
No. of Main Bearings	4
<b>Engine Speed Ratings</b>	
Maximum Governed Speed, Full Load	2800 rpm
Idle Speed	600 to 700 rpm
Maximum No-load Speed	2950 to 2990 rpm
<b>Engine Fuel System</b>	

**EQUIPMENT DATA - Continued****Table 2. General Equipment Data for All Models - Continued.**

Fuel Pump	Gear Type
Supply Pressure (to Injectors)	50 to 70 psi (345 to 483 kPa)
<b>Engine Lubrication System</b>	
Oil Pump	Gear Type
Operating Pressure (at 2800 rpm)	50 to 70 psi (345 to 483 kPa)
Minimum Operating Pressure (at 1800 rpm)	30 psi (207 kPa)
Normal Operating Temperature	200 to 250° F (93 to 121° C)
<b>Cooling System</b>	
Type	Liquid
Coolant Flow (at 2800 rpm)	143 gpm (541 L/min)

## EQUIPMENT DATA - Continued

Table 3. Specific Equipment Data for Each Model.

Item	5063-5299	5063-5392	5063-5093	5063-539L
<b>Mechanical Characteristics</b>				
Length: in. (cm)	32.0 (81.3)	39.0 (99.1)	39.0 (99.1)	39.0 (99.1)
Width: in. (cm)	35.0 (88.9)	36.5 (92.7)	40.0 (101.6)	40.0 (101.6)
Height: in. (cm)	44.4 (112.8)	41.5 (105.4)	42.8 (108.7)	42.8 (108.7)
Weight: lb (Kg)	1335 (605.6)	1695 (768.8)	1745 (791.5)	1745 (791.5)
Compression Ratio	21:1	18:1	18:1	18:1
<b>Engine Systems Characteristics</b>				
Oil Capacity, Refill: qt (L)	18 (17)	16 (15)	16 (15)	16 (15)
Oil Capacity, Dry: qt (L)	22 (21)	18 (71)	18 (71)	18 (71)
Coolant Capacity: gal. (L)	8.5 (32.2)	8.5 (32.2)	13.3 (50.3)	13.3 (50.3)
Coolant Operating Temperatures: °F (°C)	160 to 185 (75 to 85)	160 to 200 (75 to 93)	160 to 200 (75 to 93)	160 to 200 (75 to 93)
<b>Performance Data (at 2800 rpm Full Load)</b>				
Maximum Air Inlet Restriction: in. Water (kPa)	None	20 (5.0)	20 (5.0)	20 (4.2)
Maximum Exhaust Back Pressure: in. Mercury (kPa)	4.0 (13.5)	2.5 (8.4)	2.5 (8.4)	2.5 (8.4)
Min. Air Box Pressure with Restrictions: psi (kPa)	9.3 (64)	44 (303)	44 (303)	44 (303)
Horsepower	210	275	275	275

END OF WORK PACKAGE



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## FIELD MAINTENANCE THEORY OF OPERATION

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### ENGINE SYSTEMS

#### General

The 6V53/6V53T Diesel Engine is an internal combustion power unit where the heat energy of fuel is converted into work energy inside the cylinder. In a 6V53/6V53T Diesel Engine, air alone is compressed in the cylinder. After compression, a charge of fuel is sprayed into the cylinder where ignition is accomplished by the heat of compression.

#### Fuel System

The fuel system consists of a fuel pump, strainer (primary filter), filter (secondary filter), injectors, and related fuel lines. The intense heat created by the high compression of the air immediately ignites the fine fuel spray. A restricted fitting is located at the fuel return to maintain pressure within the fuel system. The fuel pump draws fuel from the vehicle tank through the strainer and forces it through the filter. From the filter, fuel goes through the fuel inlet passage in the cylinder head and fuel tubes into the injectors. The fuel passes through a filter element within the injector to a chamber where it is metered, displaced, and atomized through the fuel injector spray tip into the combustion chamber. Excess fuel not injected cools the injectors and returns through the fuel tubes to the fuel tank.

#### Lubrication System

The lubrication system consists of an oil intake screen and tube assembly, oil pump, pressure regulator, oil filter, bypass valve, and oil cooler. The gear type oil pump is bolted to the back of the lower front cover and is driven directly by the crankshaft. Lubricating oil is picked up from the oil pan by the pump. From the pump, it passes from the lower front cover through short gallery passages in the cylinder block to the oil filter adapter plate. From the adapter plate, oil flows through the oil filter, through the oil cooler, back through the lower front cover, and into the cylinder block oil galleries for distribution to the various engine bearings. The drains for the cylinder heads and other engine parts lead back to the oil pan. Clean engine oil is assured by a replaceable oil filter. Should the filter become clogged, oil will flow through a bypass valve in the adapter plate directly to the oil cooler. If the oil cooler becomes clogged, oil will flow directly through a bypass valve in the lower front cover to the cylinder block oil galleries. A regulator valve located in the lower front cover maintains a stabilized oil pressure at all engine speeds.

#### Cooling System

The engine cooling system includes a centrifugal-type water pump, oil cooler water jacket, thermostat housing, water manifold, bypass line, and cylinder block water jacket. The radiator and fan are located in the cooling system of the vehicle. The water pump draws coolant from the radiator and circulates it through the oil cooler, cylinder block, and cylinder heads to the thermostat housing. During the warm-up period, the thermostat blocks coolant flow to the radiator. During this period, the pump circulates the coolant through the bypass system to the cylinder block and cylinder heads. As the coolant reaches the designated operating temperature, the thermostat opens and the coolant is circulated through the radiator.

#### Air Induction System

The air induction system consists of a blower, cylinder block air box, cylinder liner intake ports, and exhaust valve ports. All engines, except model 5063-5299, also have a turbocharger. The blower forces air into the cylinders (called scavenging) and sweeps out the burned gases through the exhaust valve ports. This air also cools the

## ENGINE SYSTEMS - Continued

internal engine parts, particularly the exhaust valves. The turbocharger forces additional pressurized air into the cylinders (called supercharging) to allow burning of more fuel for additional power.

### Crankcase Ventilation System

For model 5063-5299, the crankcase ventilation system consists of a breather tube assembly, a filtering element in a collector, and crankcase vapor passages. For models 5063-5392, 5063-5393, and 5063-539L, the crankcase ventilation system consists of filtering elements in the rocker arm covers and crankcase vapor passages.

Seepage of a small amount of air past the piston rings maintains a slight pressure in the engine crankcase. This air sweeps up through the engine to draw off oil vapors through the breather elements.

### Electrical System

The electrical system consists of a starter, air box heater or glow plug cold start system, and related wiring.

The starter is equipped with a shift lever and solenoid plunger, totally enclosed to protect it against dirt, and a sprag overrunning clutch. Pressing the starting switch energizes the starter solenoid, which engages the starter pinion with the teeth of the flywheel ring gear. The starter drives the pinion and rotates the engine. When the engine begins to operate, the sprag clutch permits the pinion to overrun on its shaft until the starting switch is released, which prevents overspeeding of the starter.

The air box heater heats the air entering the cylinders to assist in ignition of fuel at low ambient temperatures. A fuel and air mixture is sprayed into the air box and a spark ignites a flame. The flame heats the incoming engine air which is fed directly into the cylinders.

The glow plug cold start system is an alternative means to assist in engine starting at low ambient temperatures. It consists of glow plugs, which are installed in the cylinder heads, and a controller that regulates the starting cycle and preglow/afterglow duration.

### Gear Train

The gear train consists of a crankshaft gear, idler gear, fuel pump drive gear, and two camshaft gears. Models 5063-5393 and 5063-539L, also have a hydraulic pump drive gear. The gear train is located between the rear end plate and flywheel housing. All gear train gears are helical. The crankshaft gear is pressed and keyed to the crankshaft. The idler gear rotates on a stationary hub. The camshaft gears are pressed and keyed to their respective camshafts and secured by their retaining nut and locking plate. The camshaft gears mesh with each other and run at the same speed as the crankshaft gear. The stamped timing marks on the face of the gears show proper timing. The overflow oil from the camshaft pockets, camshaft end bearings, and idler gear bearings lubricates the gear train. Oil from the cylinder block oil gallery lubricates the fuel pump drive gear, hydraulic pump drive gear, and idler gear bearings.

### Governor

The limiting-speed, mechanical governor is mounted between the blower and flywheel housing. The governor holds the injector racks in the advanced fuel position for starting when the speed control lever is in the idle position. Immediately after starting, the governor moves the injector racks to control idle and maximum engine speed during operation.

## OPERATIONAL DESCRIPTION

### General

This particular engine series has a two stroke cycle (sometimes called a two cycle). A two stroke engine completes one cycle (intake, compression, power, and exhaust) every time the piston goes up and down - up

## **ENGINE SYSTEMS**

being one stroke and down being the return stroke. The air intake and exhaust functions are accomplished during the compression and power strokes as explained below.

### **Scavenging**

The blower, which is an air pump that is gear driven from the crankshaft, forces air into the air box. Each cylinder has a row of ports in the cylinder wall opening to the air box and located at the bottom of the piston stroke. When the top of the piston moves down and uncovers the ports, air in the air box is forced through the ports. The air then flows toward the exhaust valves and produces a scavenging effect, leaving the cylinder full of fresh air when the piston returns and covers the ports.

### **Compression**

As the piston continues the upward stroke, the exhaust valves close and the piston compresses the charge of fresh air. The fuel injector injects the required amount of fuel into the cylinder shortly before the piston reaches its highest point and continues into the power stroke.

### **Power**

The heat generated from compression ignites the fine fuel spray to start combustion. Combustion continues until the injected fuel has all burned. The resulting pressure forces the piston downward on its power stroke.

### **Exhaust**

When the piston is approximately halfway down, the exhaust valves open and most of the high pressure exhaust gases escape. Shortly thereafter, the piston drops below the inlet ports in the cylinder wall. Pressurized air is then forced through the cylinder. During this process, the remaining exhaust gases are removed (or scavenged) from the cylinder.

## **END OF WORK PACKAGE**



**CHAPTER 2**

**FIELD MAINTENANCE LEVEL  
TROUBLESHOOTING PROCEDURES  
FOR  
6V53/6V53T DIESEL ENGINES**



**FIELD MAINTENANCE  
TROUBLESHOOTING PROCEDURES INTRODUCTION**

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**GENERAL INFORMATION****How To Use**

This technical manual contains the information necessary to troubleshoot and perform corrective maintenance and adjustments of the Series 6V53/6V53T Diesel Engine at the Field Maintenance Level support.

**END OF WORK PACKAGE**





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**FIELD MAINTENANCE  
TROUBLESHOOTING PROCEDURES**

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**INITIAL SETUP:****References**

WP 0073  
WP 0049  
WP 0050  
WP 0051  
WP 0012

**References (cont.)**

WP 0023  
WP 0024  
WP 0055  
WP 0053  
WP 0062

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**TROUBLESHOOTING INSTRUCTIONS**

1. Read all attached records to determine the history of the engine failure.
2. Verify all components are present and properly mounted. Examine for loose or missing hardware.
3. Before performing maintenance on a malfunctioning component, perform a complete visual inspection to determine the general condition of the component. Component or assembly malfunction with the component removed from the engine is an inspection procedure within the applicable maintenance work package.

**TROUBLESHOOTING PROCEDURE****CYLINDER COMPRESSION TEST****SYMPTOM**

Low compression pressure in a cylinder.

**MALFUNCTION**

Cylinder head gasket leak.

**CORRECTIVE ACTION**

Replace cylinder head gasket(s) (WP 0073).

**FUEL FLOW TEST****SYMPTOM**

Low fuel flow.

**MALFUNCTION**

Fuel line pinched or kinked.

**CORRECTIVE ACTION**

Replace fuel line(s), as required (WP 0049) , (WP 0050) , or (WP 0051).

**FUEL FLOW TEST - Continued****MALFUNCTION**

Fuel restrictor fitting missing.

**CORRECTIVE ACTION**

Install new fuel junction block or fuel spill fitting (WP 0012) or (WP 0073).

**MALFUNCTION**

Fuel filter or fuel filter strainer plugged.

**CORRECTIVE ACTION**

Replace fuel filter and fuel strainer (WP 0023) or (WP 0024).

**FUEL PRESSURE TEST****SYMPTOM**

Low fuel pressure.

**MALFUNCTION**

Fuel pump relief valve problem.

**CORRECTIVE ACTION**

Replace fuel pump (WP 0055).

**MALFUNCTION**

Fuel pump is bad.

**CORRECTIVE ACTION**

Replace fuel pump (WP 0055).

**CRANKCASE PRESSURE TEST****SYMPTOM**

High crankcase pressure.

**MALFUNCTION**

Exhaust back pressure high.

**CORRECTIVE ACTION**

Remove restriction in exhaust system.

**CRANKCASE PRESSURE TEST - Continued****MALFUNCTION**

Obstruction to breather.

**CORRECTIVE ACTION**

Clear obstruction to breather.

**MALFUNCTION**

Plugged breather.

**CORRECTIVE ACTION**

Replace breather (WP 0053).

**MALFUNCTION**

Blower-to-block gasket leaking.

**CORRECTIVE ACTION**

Replace blower-to-block gasket (WP 0062).

**MALFUNCTION**

Cylinder head gasket leak.

**CORRECTIVE ACTION**

Replace cylinder head gasket(s) (WP 0073).

**AIR BOX PRESSURE TEST****SYMPTOM**

Low air box pressure.

**MALFUNCTION**

High air inlet restriction.

**CORRECTIVE ACTION**

Remove restriction from air inlet.

**AIR BOX PRESSURE TEST - Continued**

**MALFUNCTION**

Air inlet screen clogged.

**CORRECTIVE ACTION**

Replace air inlet screen.

**END OF WORK PACKAGE**

**CHAPTER 3**

**SUSTAINMENT MAINTENANCE LEVEL  
TROUBLESHOOTING PROCEDURES  
FOR  
6V53/6V53T DIESEL ENGINES**



## SUSTAINMENT MAINTENANCE TROUBLESHOOTING PROCEDURES INTRODUCTION

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### GENERAL INFORMATION

#### How To Use

This technical manual contains the information necessary to troubleshoot and perform corrective maintenance and adjustments of the 6V53/6V53T Series Diesel Engines at the Sustainment Maintenance Level-Below Depot support.

1. Refer to (WP 0007) for the initial procedures to isolate faults of the engine when removing it from the container.
2. Refer to (WP 0101) to isolate faults of the engine when mounted on a test stand.

### END OF WORK PACKAGE





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## SUSTAINMENT MAINTENANCE TROUBLESHOOTING PROCEDURES

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### INITIAL SETUP:

#### References

WP 0099  
WP 0100  
WP 0101  
WP 0094  
WP 0095  
WP 0073  
WP 0083  
WP 0049  
WP 0050  
WP 0051  
WP 0012

#### References (cont.)

WP 0023  
WP 0024  
WP 0055  
WP 0053  
WP 0062  
WP 0085  
WP 0086  
WP 0096  
WP 0098  
WP 0084

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### TROUBLESHOOTING INSTRUCTIONS

Refer to (WP 0099) and prepare engine for running.

Refer to (WP 0100) and adjust engine controls.

Refer to (WP 0101) and ensure engine meets all performance standards.

### TROUBLESHOOTING PROCEDURE

#### CYLINDER COMPRESSION TEST

##### SYMPTOM

Low compression pressure in a cylinder.

##### MALFUNCTION

Piston or piston ring problem.

##### CORRECTIVE ACTION

1. Inspect piston and piston rings through liner ports.
2. If rings broken or stuck, replace rings.
3. If hole or crack in piston, replace piston (WP 0094) or (WP 0095).

##### MALFUNCTION

Cylinder head compression gasket leak.

##### CORRECTIVE ACTION

Replace cylinder head compression gaskets (WP 0073).

**CYLINDER COMPRESSION TEST - Continued****MALFUNCTION**

Cylinder head assembly problem.

**CORRECTIVE ACTION**

1. Inspect injector tubes, exhaust valves, and exhaust valve seats for possible leaks.
2. Repair cylinder head assembly as required (WP 0083).

**FUEL FLOW TEST****SYMPTOM**

Low fuel flow.

**MALFUNCTION**

Fuel line pinched or kinked.

**CORRECTIVE ACTION**

Replace fuel line(s), as required (WP 0049) , (WP 0050) , or (WP 0051).

**MALFUNCTION**

Fuel restrictor fitting missing.

**CORRECTIVE ACTION**

Install new fuel junction block or fuel spill fitting (WP 0012) or (WP 0073).

**MALFUNCTION**

Fuel filter or fuel filter strainer plugged.

**CORRECTIVE ACTION**

Replace fuel filter and fuel strainer (WP 0023) or (WP 0024).

**FUEL PRESSURE TEST****SYMPTOM**

Low fuel pressure.

**MALFUNCTION**

Fuel pump relief valve problem.

**CORRECTIVE ACTION**

Replace relief valve assembly (WP 0055).

**FUEL PRESSURE TEST - Continued****MALFUNCTION**

Fuel pump is bad.

**CORRECTIVE ACTION**

Inspect fuel pump. Repair or replace fuel pump as required (WP 0055).

**CRANKCASE PRESSURE TEST****SYMPTOM**

High crankcase pressure.

**MALFUNCTION**

Exhaust back pressure high.

**CORRECTIVE ACTION**

Remove restriction in exhaust system.

**MALFUNCTION**

Obstruction to breather.

**CORRECTIVE ACTION**

Clear obstruction to breather.

**MALFUNCTION**

Plugged breather.

**CORRECTIVE ACTION**

Replace breather (WP 0053).

**MALFUNCTION**

Piston or piston ring problem.

**CORRECTIVE ACTION**

1. Inspect pistons and piston rings through liner ports.
2. If rings broken or stuck, replace rings
3. If hole or crack in piston, replace piston (WP 0094) or (WP 0095).

**CRANKCASE PRESSURE TEST - Continued****MALFUNCTION**

Blower-to-block gasket leaking.

**CORRECTIVE ACTION**

Replace blower-to-block gasket (WP 0062).

**MALFUNCTION**

Blower problem.

**CORRECTIVE ACTION**

1. Inspect blower motor seals.
2. Repair or replace blower as required (WP 0085).

**MALFUNCTION**

Turbocharger problem.

**CORRECTIVE ACTION**

Inspect turbocharger shaft seals. Repair or replace turbocharger as required (WP 0086).

**MALFUNCTION**

Cylinder head compression gasket leak.

**CORRECTIVE ACTION**

Replace cylinder head compression gasket(s) (WP 0073).

**MALFUNCTION**

Piston, rod, and liner assembly problem.

**CORRECTIVE ACTION**

1. Inspect pistons, piston pin retainers, connecting rods, and liners.
2. Replace parts as required. Replace piston rings (WP 0094) , (WP 0095) , or (WP 0096).

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**AIR BOX PRESSURE TEST****SYMPTOM**

Low air box pressure.

**MALFUNCTION**

High air inlet restriction.

**CORRECTIVE ACTION**

Remove restriction from air inlet.

**MALFUNCTION**

Air box gasket leaking.

**CORRECTIVE ACTION**

Replace air box gasket (WP 0098).

**MALFUNCTION**

Air inlet screen clogged.

**CORRECTIVE ACTION**

Replace air inlet screen.

**MALFUNCTION**

Blower bypass valve stuck open.

**CORRECTIVE ACTION**

Replace blower bypass valve (WP 0085).

**MALFUNCTION**

Blower problem.

**CORRECTIVE ACTION**

Inspect blower rotors. Repair or replace blower as required (WP 0085).

**MALFUNCTION**

Turbocharger defective.

**CORRECTIVE ACTION**

1. Inspect turbocharger.
2. Repair or replace turbocharger asrequired (WP 0086).

**AIR BOX PRESSURE TEST - Continued****SYMPTOM**

Air box pressure high.

**MALFUNCTION**

Liner port clogged.

**CORRECTIVE ACTION**

Clean liner ports. If clogging severe, replace liner as required (WP 0096).

**MALFUNCTION**

Blower bypass valve stuck closed.

**CORRECTIVE ACTION**

Replace blower bypass valve (WP 0085).

**BRAKE HORSEPOWER ACCEPTANCE****SYMPTOM**

Low brake horsepower.

**MALFUNCTION**

Engine controls out of adjustment

**CORRECTIVE ACTION**

Adjust engine controls (WP 0100).

**MALFUNCTION**

Faulty fuel injectors

**CORRECTIVE ACTION**

Test, repair, or replace fuel injectors as required (WP 0084).

**END OF WORK PACKAGE**

**CHAPTER 4**

**FIELD MAINTENANCE LEVEL  
MAINTENANCE INSTRUCTIONS  
FOR  
6V53/6V53T DIESEL ENGINES**





**FIELD MAINTENANCE  
LUBRICATION INSTRUCTIONS**

**INITIAL SETUP:**

Not Applicable

**LUBRICATION ORDER**

LUBRICANTS/COMPONENTS		CAPACITIES (APPROX)	EXPECTED TEMPERATURES*			INTERVALS
			Above +32°F (Above 0° C)	+40°F to -10°F (+5°C to -23°C)	0°F to -65°F (-18°C to -54°C)	
OE/HDO (MIL-PRF-2104) OR OEA (MIL-PRF-46167) (MIL-PRF-21260)	LUBRICATING OIL, INTERNAL COMBUSTION ENGINE	18 qts	OE/HDO-15/40	OE/HDO-15/40	OEA	D- Daily OC- On Condition
	Engine PRESERVATION OIL		PE 30-1	PE 30-1		

\*FOR ARCTIC OPERATION, REFER TO FM 9-207

MAINT-Lubrication Instructions

Figure 1. Lubrication Instructions.

**END OF WORK PACKAGE**



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## FIELD MAINTENANCE GENERAL MAINTENANCE PROCEDURES

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Multimeter, Digital  
(WP 0104, Table 1, Item 70)

**References (cont.)**

TM 9-214  
WP 0106  
TM 9-237  
MIL-PRF-907  
WP 0104

**Materials/Parts**

Antiseize Compound (WP 0103, Table 1, Item 4)  
Engine Oil (WP 0103, Table 1, Item 27)

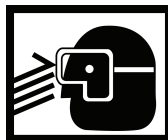
**References**

TM 9-247

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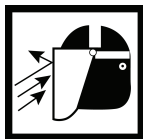
**CLEANING****Scope**

1. Procedures for cleaning will be the same for a great percentage of parts and components. To avoid repetition of instructions, the general procedures for cleaning are detailed below. See TM 9-247 for additional information pertaining to cleaning.
2. Clean all parts before inspection, after repair, and before assembly.
3. Hands should be kept free of grease which can collect dust and dirt.
4. After cleaning, all parts should be covered or wrapped in plastic to protect them from dust and dirt.

**Castings****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

1. Clean inner and outer surfaces of casting and all areas subject to oil and grease with cleaning solvent.
2. Remove sludge and gum deposits from castings with a stiff brush.

**CLEANING - Continued****WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

3. Use filtered compressed air to blow out and dry all tapped holes in castings.

**Oil Passages**

1. Clean passages with wire or suitable probe to break up any sludge or gum deposits.
2. Wash passages by flushing with dry cleaning solvent.
3. Dry passages by blowing them out with compressed air.

**Oil Seals, Cables, and Flexible Hoses****CAUTION**

Do not allow cleaning solvent to be in contact with seals, cables, and flexible hoses. Cleaning solvent will cause leather, rubber, and synthetic materials to dry out, rot, and become stiff.

Clean oil seals, cables, and flexible hoses with soap, water, and a stiff brush.

**Ball Bearings**

1. After removing surface oil and gum deposits, place bearings in hot oil (140° F or 60° C) to loosen congealed oil and grease.
2. Wipe bearing dry; do not use compressed air.
3. After cleaning, coat bearings with a light film of oil and wrap in paper until parts are inspected and assembled.
4. See TM 9-214 for information on care and maintenance of bearings.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA****Scope**

Procedures for inspection will be the same for a great percentage of the parts and components. To avoid repetition of instructions, the general procedures for inspection are detailed in paragraphs below. The engines are precision built and repair specifications found in (WP 0106) for the component parts have been fixed at extremely close tolerances. Be sure to use modern inspection equipment for inspecting component parts having extremely close tolerances where cracks and other damage cannot be spotted visually.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued****Castings**

1. Inspect all ferrous and nonferrous castings for cracks using a magnifying glass and a strong light.
2. Check particularly, areas adjacent to studs, pipe plugs, threaded inserts and in sharp corners and fillets for cracks using a magnifying glass and a strong light.
3. Inspect machined surfaces of castings for nicks, burrs or raised metal.
4. Mark damaged areas for repair with chalk or lumber crayon.
5. Check all mating flanges on housings and supports for warpage with a straight edge or a surface plate.
6. Check all mating flanges for discoloration which may indicate persistent leakage.
7. Inspect all pipe plug and cap screw tapped openings for damaged or stripped threads.
8. Check all castings for conformance to applicable repair specifications in (WP 0106).

**Ball Bearings**

See TM 9-214 for inspection of bearings. Check all bearings for conformance to applicable repair specifications in (WP 0106).

**Studs**

Inspect all studs for stripped or damaged threads, bent or loose condition, and evidence of stretching.

**Gears**

1. Inspect all gears for cracks using a magnifying glass and a strong light.
2. Inspect all gear teeth for wear, sharp fins, burrs, and galled or pitted surfaces.
3. Check all gears for conformance to applicable repair specifications in (WP 0106).

**Bushing and Bushing Type Bearings**

1. Check all bushings and bushing type bearings for secure fit in their respective casting or mating part and for evidence of heating which may be indicated by discoloration of bushing or bearing surface.
2. Inspect bushing and bushing type bearings for wear, burrs, nicks, or out-of-round condition.
3. Check for dirt in lubrication holes or grooves of bushings or bushing type bearings.
4. Holes and grooves must be clean and free from damage to ensure proper lubrication.
5. Check all bushings and bushing type bearings for conformance to applicable repair specifications in (WP 0106).

**Oil Seals**

1. Metal encased oil seals should not be replaced unless inspection indicates damage.
2. Inspect feather edge of oil seal for damage.
3. Check seal for loss of softness and spring.

## INSPECTION-ACCEPTANCE AND REJECTION CRITERIA

### Core Hole Plugs

1. Inspect core hole plugs for evidence of leakage.
2. Replace plugs if leaking or damaged.

### END OF TASK

## REPAIR OR REPLACEMENT

### Scope

Procedures for repair will be the same for a great percentage of parts and components. To avoid repetition of instructions, general procedures for repair are detailed in paragraphs below. After repair, clean all parts thoroughly to prevent metal chips from repair operations, or abrasives used in repair operations, from entering working parts of the engine.

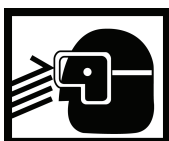
### Castings

#### CAUTION

Avoid damage to casting while using welding equipment. Refer to TM 9-237 for welding instructions.

1. Replace all castings that are cracked or do not conform to tolerances specified in repair specifications found in (WP 0106).

#### WARNING



Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

2. Repair minor damage to machined surfaces with a fine file, emery cloth, or crocus cloth dipped in cleaning solvent.
3. Replace all castings on which machined surfaces are burred or nicked to the point of impairing subsequent assembly or operation.
4. Repair minor warpage of amounting flange or gasket surface by working surface across a sheet of emery cloth held tightly on a surface plate or a flat surface. Finish repair by using crocus cloth in a similar manner.
5. Replace castings having flanges which are warped to the point of impairing assembly or operation.

#### NOTE

Pipe-plug threads in castings must be in good condition to prevent oil or water leakage.

6. Repair damaged pipe or cap screw threads in tapped holes with a thread tap.

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**REPAIR OR REPLACEMENT - Continued****Ball Bearings**

1. Replace all galled, pitted, or damaged ball bearings and any that do not conform to tolerances specified in (WP 0106).
2. See TM 9-214 for maintenance of bearings.

**Studs**

1. Replace all bent or loose studs or studs showing evidence of stretching.
2. Repair minor thread damage with a thread chaser.
3. Remove and replace studs as outlined in Steps 4 and 5 below.
4. Removal:
  - a. Using stud extractor, back studs out slowly to avoid heating and possible seizure.
  - b. When studs are broken off too short to use stud extractor, drill stud and extract with an easy out remover.
  - c. Short studs may also be removed by welding a bar or nut to stud and removing with a wrench.
5. Replacement:
  - a. Only standard studs are supplied for replacement in steel or cast iron castings.
  - b. Unless threads in casting are damaged beyond repair, use standard studs.
  - c. If threaded openings are damaged and retapping will not clean up threads, drill and tap opening in casting and install a threaded insert.

**Gears****NOTE**

Studs may have a coarse thread on one end and a fine thread on the other end. The coarse threads on both ends are used in particular applications and normally the short coarse threaded end is in the aluminum casting. All replacement studs have a special coating and must have a small amount of mica-base antiseize compound MIL-PRF-907 applied on the threads before the studs are installed in casting. Thread replacement stud into opening slowly to prevent overheating.

1. Replace all gears that are cracked, worn, pitted, galled or do not conform to tolerances specified in (WP 0106).
2. Remove sharp fins and burrs from gear teeth with crocus cloth dipped in cleaning solvent.

**Bushing and Bushing Type Bearings**

1. When bushings and bushing type bearings are damaged or worn beyond specified limits (WP 0106), generally associated parts must also be replaced. Reference to Steps (2) and (3) below will be made in Chapter 3 for the particular part in which replacement of bushings and bushing type bearings is required.
2. Removal:

Remove bushing and bushing type bearings by pressing out with a suitable arbor press or with special tools provided. (Refer to (WP 0104) for listing of special tools and equipment).
3. Installation:

**REPAIR OR REPLACEMENT**

- a. Clean repaired parts thoroughly before assembly or installation.
- b. Align bushings or bushing type bearings in casting or retaining cage.
- c. Press into place with arbor press or with the special tools provided.
- d. Bushing type bearings are machined for proper clearance and need no reaming.

**Oil Seals**

1. Oil seals must be replaced during component repair.
2. Removal:  
Press or pry damaged oil seal from casting or adapter. Use care not to damage bore in casting or adapter.
3. Repair:
  - a. When oil seal bore in casting or adapter is burred or damaged to a point where an oil tight seal is impossible, replace casting or adapter.
  - b. Remove slight nicks, burrs, and scratches from bore in casting or adapter with crocus cloth dipped in cleaning solvent.
4. Installation:  
Install new oil seal in bore of casting or adapter using proper oil seal installer tool.

**END OF TASK****DISASSEMBLY****Scope**

Exercise care in all component assembly operations to ensure satisfactory engine performance. Precautionary rules for assembly are outlined below.

**Precautionary Rules**

1. Cleanliness is essential in all component assembly operations.
2. Dirt and dust, even in minute quantities, are abrasive.
3. Parts must be cleaned as specified and kept clean.
4. Wrap or cover parts and components when assembly procedures are not immediately completed.
5. Coat all bearings and all contact surfaces with engine oil OE/HDO-15/40 to ensure lubrication of parts during initial engine starting.
6. Replace all gaskets and preformed packings removed in disassembly. Clean and remove all traces of gasket material from surfaces.
7. Store all fastening hardware (nuts, bolts, screws, lockwashers, and flat washers) in or with the related component to assist in reassembly.

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
CONTAINER TOP REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Sling (2-Point, Adjustable Chain)  
(WP 0104, Table 1, Item 92)

**Materials/Parts (cont.)**

Seal, Nonmetallic (WP 0105, Table 1, Item 5)  
Seal, Nonmetallic (model 5063-5299)  
(WP 0105, Table 1, Item 6)

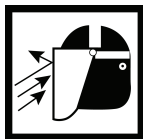
**Personnel Required**

Mechanic  
Helper (H)

**Materials/Parts**

Desiccant (WP 0103, Table 1, Item 12)

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**REMOVAL****WARNING**

Wear eye protection and stand clear of air release ports when purging air from container. Make certain air pressure is fully vented before disassembly. Failure to comply may result in injury to personnel.

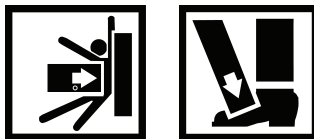
1. Press relief valve (Figure 1, Item 1) to release pressure in shipping container.

**NOTE**

Container (NSN 8145-00-138-7809) for model 5063-5299 uses 20 screws, no flat washers, and 20 nuts.

Container (NSN 2815-01-232-9447) uses 24 screws, 24 flat washers, and 24 nuts.

2. Remove screws (Figure 1, Item 6), flat washers (Figure 1, Item 5), and nuts (Figure 1, Item 4) from shipping container.

**WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

3. Using two adjustable 2-point slings (Figure 1, Item 2), remove upper container half (Figure 1, Item 3).

REMOVAL - Continued

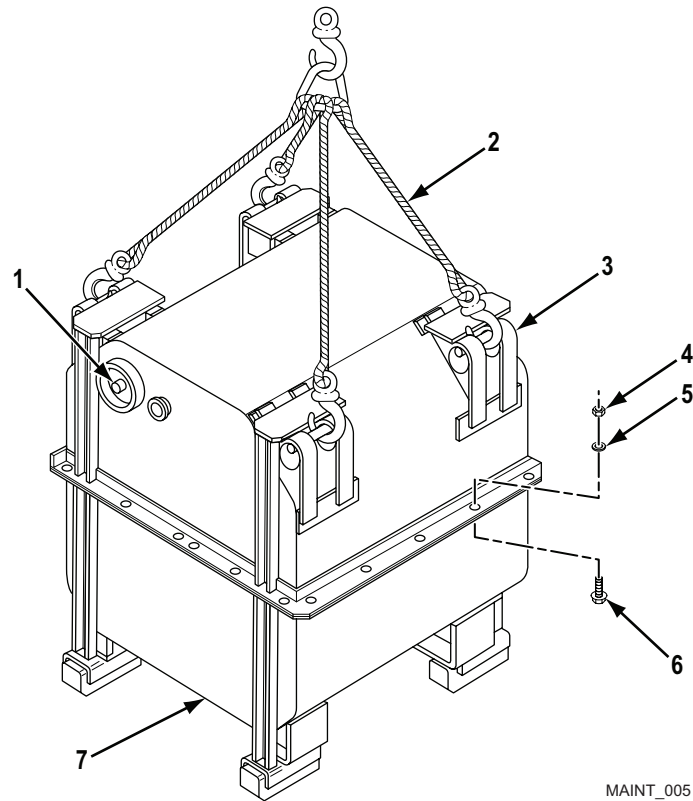


Figure 1. Engine Shipping and Storage Container.

**REMOVAL - Continued**

- Open access cover (Figure 2, Item 10) in upper container half (Figure 2, Item 3) and remove desiccant bags from access port (Figure 2, Item 8). Discard desiccant.

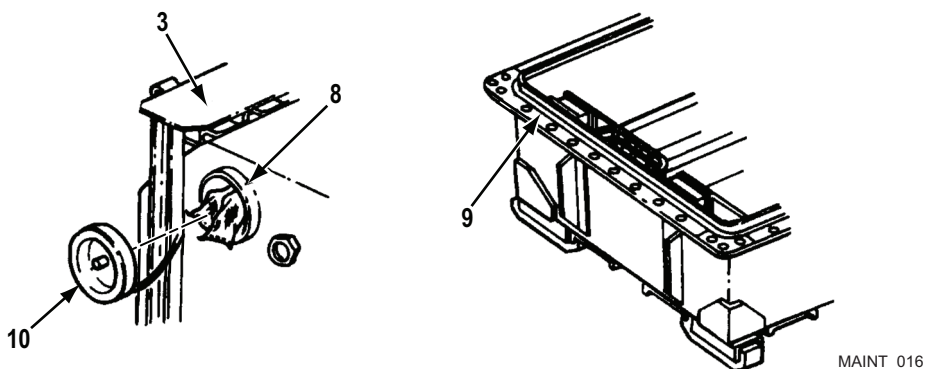


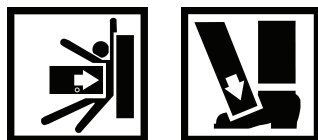
Figure 2. Container and Nonmetallic Seal.

**END OF TASK****INSTALLATION****NOTE**

Container (NSN 8145-00-138-7809) for model 5063-5299 requires 62 units of Class 1 desiccant.

Container (NSN 2815-01-232-9447) requires 128 units of Class 1 desiccant.

- Install Class 1 desiccant through access port (Figure 2, Item 8) in upper container half (Figure 2, Item 3) and screw access cover (Figure 2, Item 10) onto port.

**WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

- Inspect container nonmetallic seal (Figure 2, Item 9) for cuts, cracks, or other damage. Discard nonmetallic seal if unserviceable and install a new nonmetallic seal.

**INSTALLATION - Continued****CAUTION**

Nonmetallic seal must set in groove, or inside screw hole bosses of lower flange, to prevent damage. If seal is not in position, container assembly can damage seal and seal will fail.

**NOTE**

Container (NSN 8145-00-138-7809) for model 5063-5299 uses 20 screws, no flat washers, and 20 nuts. Torque screws to 54–59 lb-ft (73–80 N·m).

Container (NSN 2815-01-232-9447) uses 24 screws, 24 flat washers, and 24 nuts. Torque screws to 31–37 lb-ft (42–50 N·m).

- Using two adjustable 2-point slings (Figure 1, Item 2), install upper container half (Figure 1, Item 3), screws (Figure 1, Item 6), flat washers (Figure 1, Item 5), and nuts (Figure 1, Item 4) on lower container half (Figure 1, Item 7). Tighten screws (Figure 1, Item 6) progressively around perimeter of container. Torque screws (Figure 1, Item 6) to values noted above.
- Allow container to stand for a minimum of 12 hours. Then check humidity indicator (Figure 3, Item 11) and verify that air pressure is maintained.

**NOTE**

Under moisture-free conditions, the humidity indicator will show blue in color. Pink indicates excessive moisture in container.

- If humidity indicator (Figure 3, Item 11) is pink, remove upper container half (Figure 3, Item 3), replace all desiccant bags, and replace container nonmetallic seal (Figure 2, Item 9). Install upper container half (Figure 3, Item 3) and test container as indicated in Steps 3–5.

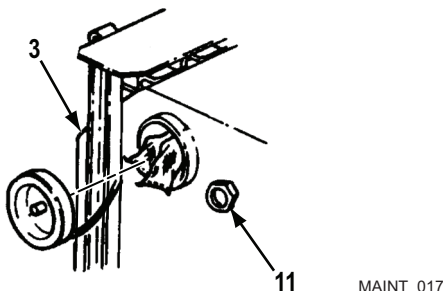


Figure 3. Upper Container Half.

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**TRANSMISSION OIL COOLER REPLACEMENT (MODELS 5063-5393, 5063-539L)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Pressure Testing Kit, Oil Coolers  
(WP 0081, Figure 6)  
Wrench, Torque, Dial, 0-175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Gasket (WP 0105, Table 1, Item 141)  
Gasket (WP 0105, Table 1, Item 143)  
Washer, Lock (WP 0105, Table 1, Item 23)  
Washer, Lock (WP 0105, Table 1, Item 179)  
Washer, Lock  
Qty: (16) (WP 0105, Table 1, Item 178)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Cleaning Solvent (WP 0103, Table 1, Item 8)

**Personnel Required**

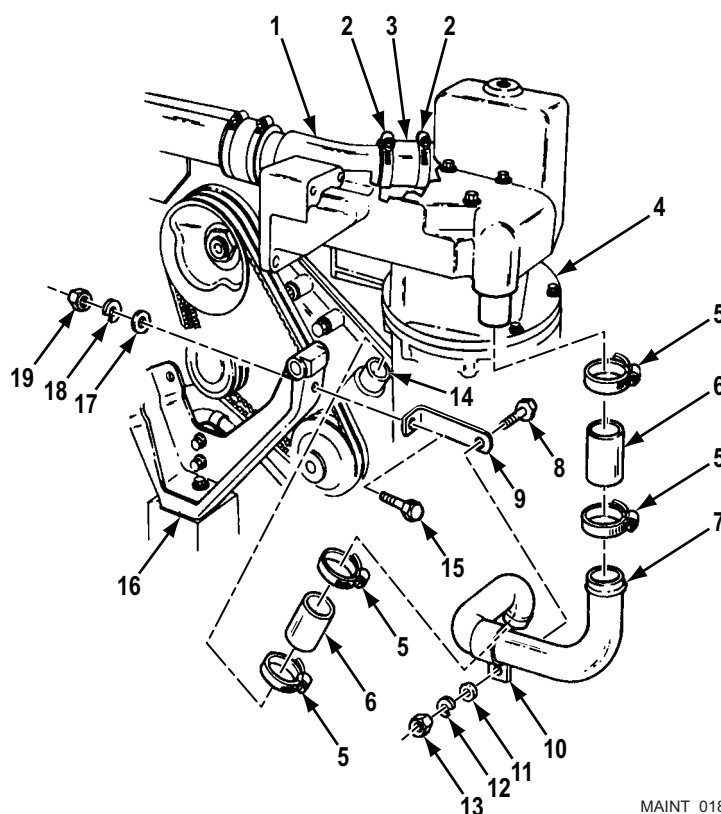
Mechanic  
Helper (H)

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**REMOVAL****NOTE**

Ensure transmission oil cooler is drained.

1. Loosen two hose clamps (Figure 1, Item 2) and hose (Figure 1, Item 3) between transmission oil cooler assembly (Figure 1, Item 4) and water outlet housing (Figure 1, Item 1).
2. Remove screw (Figure 1, Item 8), flat washer (Figure 1, Item 11), lockwasher (Figure 1, Item 12), and nut (Figure 1, Item 13) from clamp (Figure 1, Item 10) and bracket (Figure 1, Item 9) on tube (Figure 1, Item 7). Discard lockwasher.
3. Remove bolt (Figure 1, Item 15), bracket (Figure 1, Item 9), flat washer (Figure 1, Item 17), lockwasher (Figure 1, Item 18), and nut (Figure 1, Item 19) from fan support bracket (Figure 1, Item 16). Discard lockwasher.
4. Loosen four hose clamps (Figure 1, Item 5) on two hoses (Figure 1, Item 6) on tube (Figure 1, Item 7) between water pump (Figure 1, Item 14) and transmission cooler top (Figure 1, Item 4). Slide clamps and hoses onto tube and remove tube. Remove hoses and clamps from tube.



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Figure 1. Transmission Oil Cooler Mounting Hardware Removal.

5. Remove eight screws (Figure 2, Item 27), eight lockwashers (Figure 2, Item 26), and eight flat washers (Figure 2, Item 25) from bottom of transmission oil cooler bracket (Figure 2, Item 24). Discard lockwashers.



## REMOVAL - Continued

## WARNING



Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

6. Loosen screws in bracket (Figure 2, Item 23) to allow movement of transmission oil cooler (Figure 2, Item 4).
7. Loosen two screws (Figure 2, Item 20), two lockwashers (Figure 2, Item 21), and two flat washers (Figure 2, Item 22) securing bracket (Figure 2, Item 23) to transmission oil cooler assembly (Figure 2, Item 4) and gasket (Figure 2, Item 28). Discard gasket.
8. Remove hose (Figure 2, Item 3) and two clamps (Figure 2, Item 2) from transmission oil cooler and engine water outlet housing (Figure 2, Item 1).

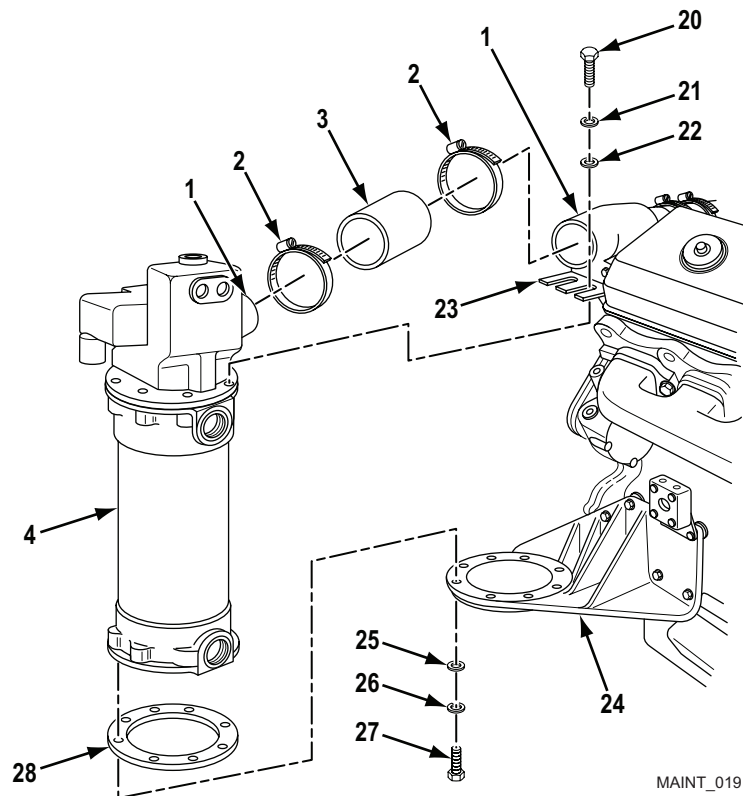


Figure 2. Transmission Oil Cooler Removal.

END OF TASK

**DISASSEMBLY**

1. Remove two long bolts (Figure 3, Item 29), two lockwashers (Figure 3, Item 30), and two flat washers (Figure 3, Item 31) from water outlet housing (Figure 3, Item 1). Discard lockwashers.
2. Remove four short bolts (Figure 3, Item 34), four lockwashers (Figure 3, Item 35), four flat washers (Figure 3, Item 36), water outlet housing (Figure 3, Item 1), and gasket (Figure 3, Item 37) from top of oil cooler (Figure 3, Item 38). Discard gasket and lockwashers.
3. If necessary, remove pipe plug (Figure 3, Item 32) and two pipe plugs (Figure 3, Item 33) from transmission oil cooler water outlet housing (Figure 3, Item 1).

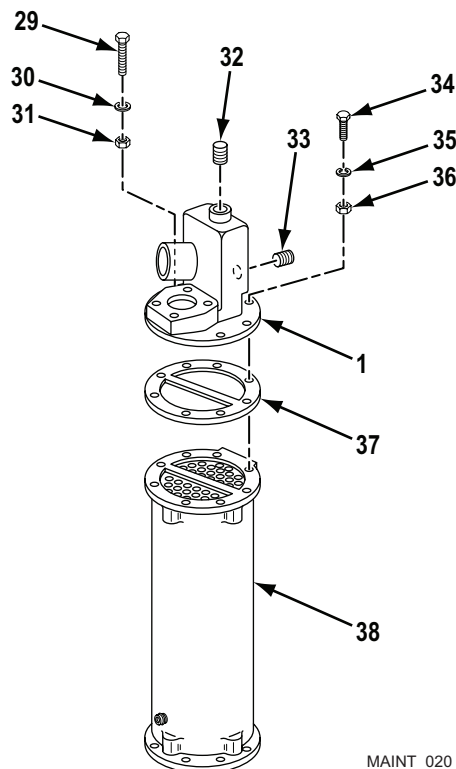


Figure 3. Transmission Oil Cooler Disassembly.

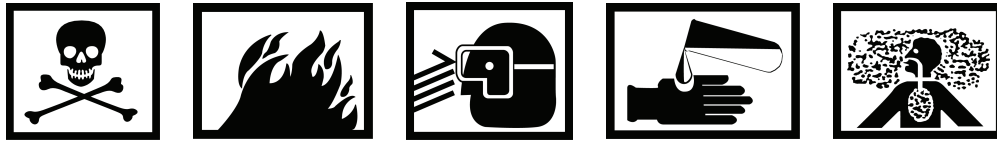
**END OF TASK****CLEANING**

1. Position oil cooler (Figure 4, Item 38) in a vertical position. Ensure oil cooler is adequately supported for cleaning operation.

**CAUTION**

Do not use 1-1/4 NPT reducer bushing. Oil cooler port is not tapered and damage will result.

2. Install fabricated machine-threaded plug (Figure 4, Item 39) from oil coolers pressure testing kit in bottom port of oil cooler (Figure 4, Item 38).
3. Connect air line to fabricated machine-threaded plug (Figure 4, Item 39).

**CLEANING - Continued****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

4. With air pressure off, pour 2.5 quarts (2.4 liters) of cleaning solvent into upper port of oil cooler.
5. Slowly apply 20 PSI (138 kPa) of air pressure and allow air to enter oil cooler for 10 minutes.

**NOTE**

Refer to local procedures and plans for storage and disposal of drained fluids.

6. Shut off air supply. Remove air line and carefully drain cleaning solvent.
7. Move fabricated machine-threaded plug (Figure 4, Item 39) and air line to upper port in oil cooler (Figure 4, Item 38).
8. Apply air pressure of 20 PSI (138 kPa) to upper port until remaining solvent is forced out of lower port.
9. Invert transmission oil cooler and repeat Steps 4–8 until cleaning solvent comes out clear in each direction.

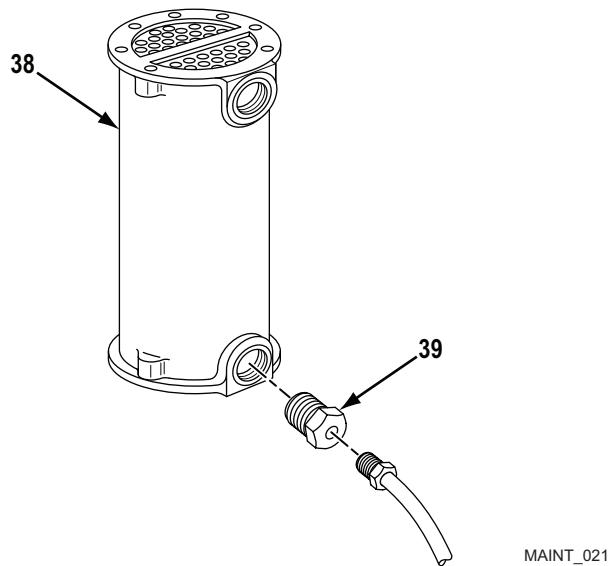


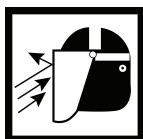
Figure 4. Transmission Oil Cooler Cleaning.

**END OF TASK**

**TEST AND INSPECTION****CAUTION**

Do not use 1-1/4 NPT reducer bushing or pipe plug in oil cooler ports. Oil cooler ports are not tapered and damage will result.

1. Install fabricated machine-threaded plug (Figure 5, Item 39) in one port and standard machine-threaded plug (Figure 5, Item 40) from oil coolers pressure testing kit in other port of oil cooler (Figure 5, Item 38).
2. Connect air line to fabricated machine-threaded plug (Figure 5, Item 39) and pressurize oil cooler (Figure 5, Item 38) to 75 PSI (517 kPa).
3. Submerge transmission oil cooler (Figure 5, Item 38) in a container of water heated to 180°F (82°C). Leaks will be indicated by air bubbles in the tubes. Replace oil cooler if it leaks.
4. Release air pressure and remove air line and both machine-threaded plugs (Figure 5, Item 40).

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

5. Dry oil cooler (Figure 5, Item 38) with compressed air.

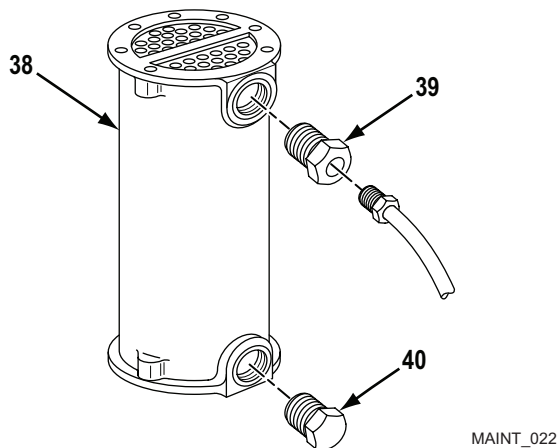


Figure 5. Transmission Oil Cooler Test and Inspection.

**END OF TASK**

**ASSEMBLY****NOTE**

Water outlet housing is installed on oil cooler end opposite oil drain plug with housing reservoir directly above oil inlet port.

Two long bolts (Figure 6, Item 29) are installed in holes 90 degrees counterclockwise from oil inlet port.

1. Install new gasket (Figure 6, Item 37), transmission oil cooler water outlet housing (Figure 6, Item 1), two long bolts (Figure 6, Item 29), two new lockwashers (Figure 6, Item 30), and two flat washers (Figure 6, Item 31) in oil cooler (Figure 6, Item 38). Do not tighten bolts.
2. Install four short bolts (Figure 6, Item 34), four new lockwashers (Figure 6, Item 35), and four flat washers (Figure 6, Item 36), in transmission oil cooler. Torque bolts (Figure 6, Item 34) to 13–17 lb-ft (18–23 N·m).
3. If removed, install pipe plug (Figure 6, Item 32) and two pipe plugs (Figure 6, Item 33) in water outlet housing (Figure 6, Item 1).

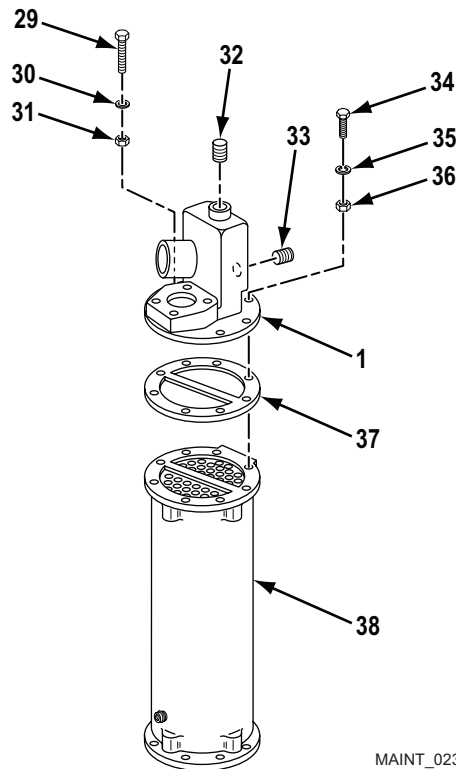


Figure 6. Transmission Oil Cooler Assembly.

**END OF TASK**

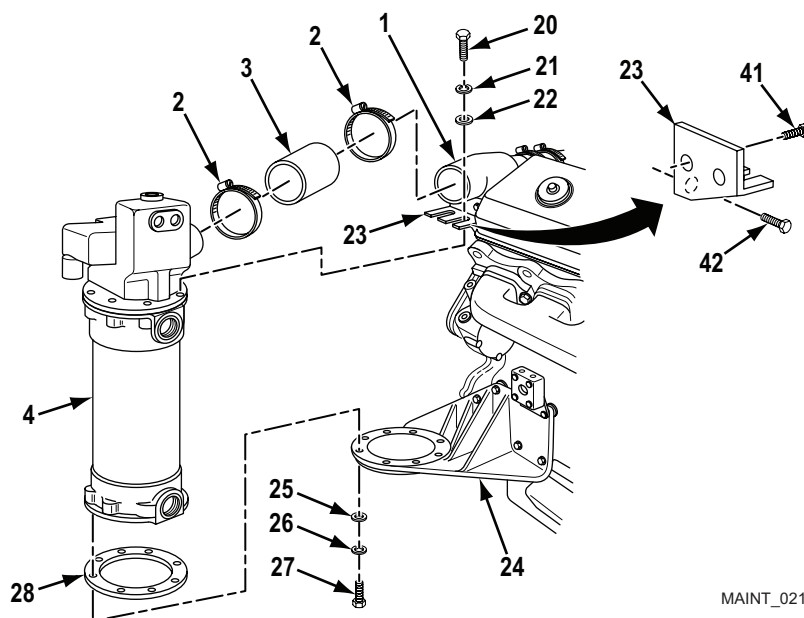
**INSTALLATION**

1. Slide hose (Figure 7, Item 3) and two clamps (Figure 7, Item 2) onto transmission oil cooler and engine water outlet housing (Figure 7, Item 1).

**WARNING**

Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

2. Use gasket adhesive to hold new gasket (Figure 7, Item 28) on transmission oil cooler bracket (Figure 7, Item 24) and install transmission oil cooler assembly (Figure 7, Item 4) on bracket with ports facing rear of engine.
3. Loosely install eight flat washers (Figure 7, Item 25), eight new lockwashers (Figure 7, Item 26), and eight screws (Figure 7, Item 27) securing bottom of transmission oil cooler assembly (Figure 7, Item 4) to bracket (Figure 7, Item 24).
4. Slide other end of hose (Figure 7, Item 3) over top of transmission oil cooler assembly (Figure 7, Item 4). Position and tighten clamps (Figure 7, Item 2) on ends of hose.
5. Guide two flat washers (Figure 7, Item 22), two new lockwashers (Figure 7, Item 21), and two screws (Figure 7, Item 20) onto bracket (Figure 7, Item 23).
6. Torque screws (Figure 7, Item 27) and (Figure 7, Item 20) to 13–17 lb-ft (18–23 N·m).
7. Torque screws (Figure 7, Item 41) and (Figure 7, Item 42) to 30–35 lb-ft (41–47 N·m).



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Figure 7. Transmission Oil Cooler Installation.

**INSTALLATION - Continued**

8. If removed, install clamp (Figure 8, Item 10) on tube (Figure 8, Item 7).
9. Slide two hoses (Figure 8, Item 6) and four clamps (Figure 8, Item 5) onto tube (Figure 8, Item 7) and then over water pump (Figure 8, Item 14) and transmission cooler (Figure 8, Item 4) connections. Tighten clamps securely.
10. Install bracket (Figure 8, Item 9), bolt (Figure 8, Item 15), new lockwasher (Figure 8, Item 18), flat washer (Figure 8, Item 17), and nut (Figure 8, Item 19) to fan support bracket (Figure 8, Item 16). Torque bolt to 30–35 lb-ft (41–47 N·m).
11. Install screw (Figure 8, Item 8), clamp (Figure 8, Item 10), flat washer (Figure 8, Item 11), new lockwasher (Figure 8, Item 12), and nut (Figure 8, Item 13) to bracket (Figure 8, Item 9). Torque screw to 46–50 lb-ft (62–68 N·m).

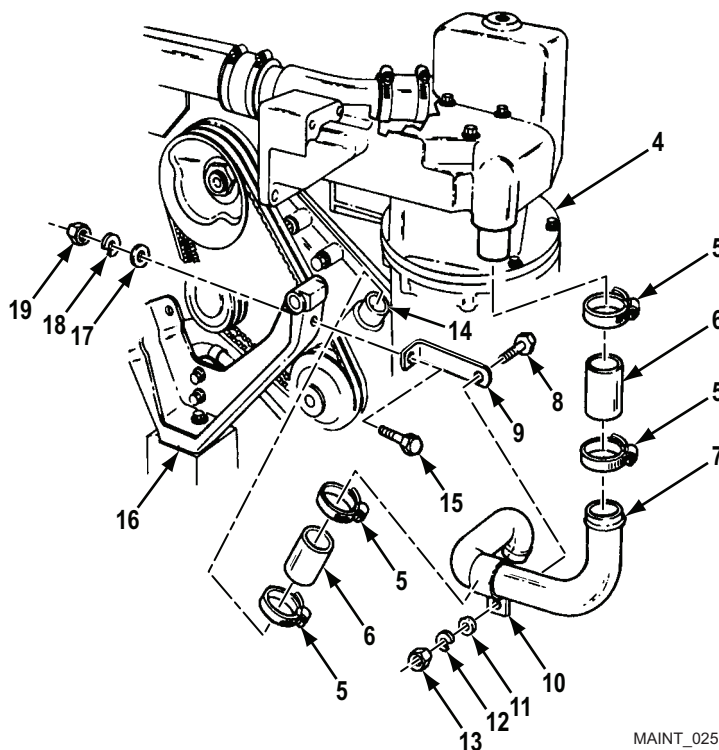


Figure 8. Transmission Oil Cooler Installation.

**END OF TASK**

**END OF WORK PACKAGE**





**FIELD MAINTENANCE**  
**FUEL JUNCTION BLOCK AND LINES REPLACEMENT (MODELS 5063-5393, 5063-539L)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

**Materials/Parts**

Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

---

**REMOVAL**

1. On model 5063-5393, disconnect fuel hose (Figure 1, Item 1) from elbow (Figure 1, Item 2) on fuel junction block (Figure 1, Item 9).
2. Disconnect fuel hose (Figure 1, Item 7) from adaptor (Figure 1, Item 8) at tee fitting (Figure 1, Item 3) in fuel junction block (Figure 1, Item 9).
3. Disconnect and remove fuel hose (Figure 1, Item 7) from elbow (Figure 1, Item 6).
4. Remove transducer (Figure 1, Item 5) from elbow (Figure 1, Item 4) on fuel junction block (Figure 1, Item 9).
5. Remove adaptor (Figure 1, Item 8) and elbow (Figure 1, Item 4) from tee fitting (Figure 1, Item 3).

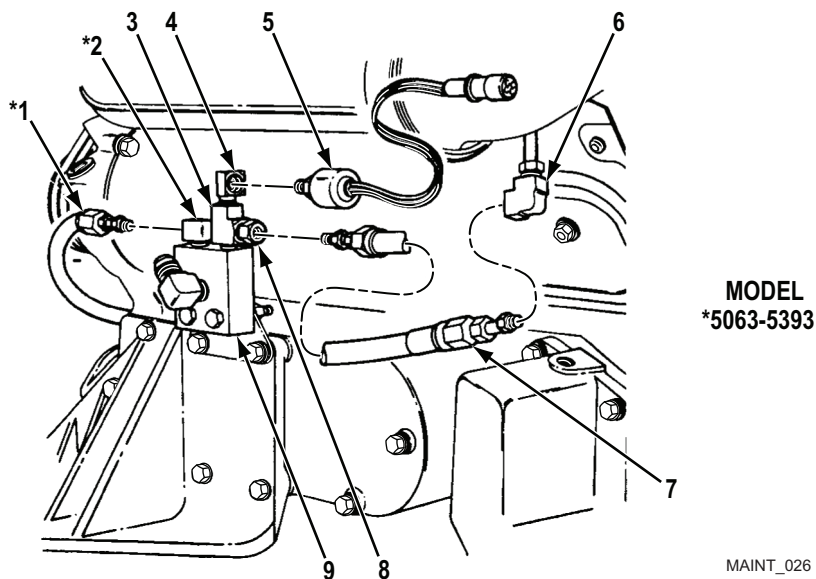


Figure 1. Fuel Injection Box and Lines Removal and Installation (1 of 2).

**NOTE**

Model 5063-539L has no elbow at top of junction block.

6. Remove elbows (Figure 2, Items 2 and 15) and tee (Figure 2, Item 3) from fuel junction block (Figure 2, Item 9).
7. Remove two screws (Figure 2, Item 13), two lockwashers (Figure 2, Item 11), fuel junction block (Figure 2, Item 9), and two nuts (Figure 2, Item 10) from bracket (Figure 2, Item 12). Discard lockwashers.

**NOTE**

Model 5063-539L has two plugs.

8. If necessary, remove plug (Figure 2, Item 14) from fuel junction block (Figure 2, Item 9).

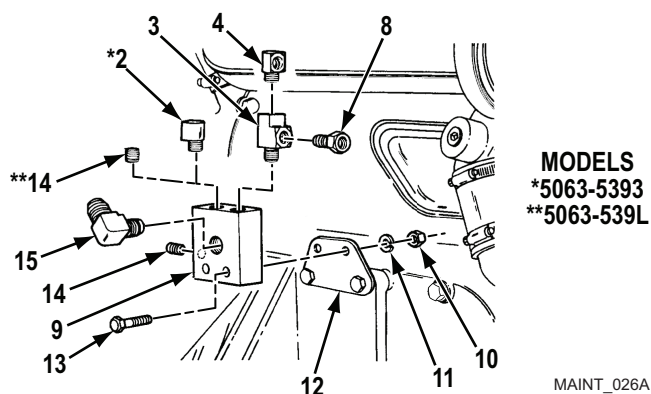
**REMOVAL - Continued**

Figure 2. Fuel Injection Box and Lines Removal and Installation (2 of 2).

**END OF TASK****INSTALLATION**

1. Install two screws (Figure 2, Item 13), fuel junction block (Figure 2, Item 9), two new lockwashers (Figure 2, Item 11), and two nuts (Figure 2, Item 10) on bracket (Figure 2, Item 12). Torque screws to 30–35 lb-ft (41–47 N·m).

**NOTE**

Model 5063-539L has two plugs in junction block.

2. If removed, install plug (Figure 2, Item 14) in fuel junction block (Figure 2, Item 9).
3. Install tee fitting (Figure 2, Item 3) in top of fuel junction block (Figure 2, Item 9).

**NOTE**

Model 5063-539L has no elbow on top of junction block.

4. On model 5063-5393, install elbow (Figure 2, Item 2) in top of fuel junction block (Figure 2, Item 9) and elbow (Figure 2, Item 15) in side of junction block.
5. Install elbow (Figure 2, Item 4) in top of tee fitting (Figure 2, Item 3) and adaptor (Figure 2, Item 8) in side of tee fitting.
6. Connect fuel hose (Figure 1, Item 7) to adaptor (Figure 1, Item 8) on fuel junction block (Figure 1, Item 9) and to elbow (Figure 1, Item 6). Tighten hose connection.
7. Install transducer (Figure 1, Item 5) in elbow (Figure 1, Item 4) on fuel junction block (Figure 1, Item 9).
8. On model 5063-5393, connect fuel hose (Figure 1, Item 1) to elbow (Figure 1, Item 2) in fuel junction block (Figure 1, Item 9). Tighten hose connection.

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
COOLANT PUMP AND IDLER PULLEY ASSEMBLY REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Tensionmeter, Dial Indicator  
(WP 0104, Table 1, Item 103)  
Straight Edge (WP 0104, Table 1, Item 101)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**References**

WP 0012

**Equipment Condition**

Water by-pass hose removed  
(models 5063-5393 and 5063-539L)  
(WP 0011)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 74)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 178)

---

**REMOVAL**

1. Remove two screws (Figure 1, Item 5) and two flat washers (Figure 1, Item 4) securing idler pulley assembly (Figure 1, Item 7) to engine.
2. Remove idler pulley assembly (Figure 1, Item 7) and two drive belts (Figure 1, Item 6).

**NOTE**

For models 5063-5393 and 5063-539L, water by-pass hose and two clamps were removed in (WP 0011).

3. Loosen two hose clamps (Figure 1, Item 3) securing hose (Figure 1, Item 2) to coolant pump (Figure 1, Item 8) and water by-pass tube (Figure 1, Item 1). Slide hose and clamps onto coolant pump.

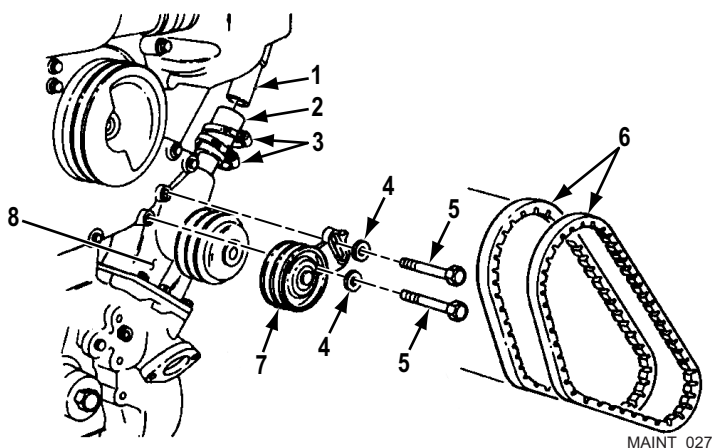


Figure 1. Coolant Pump Idler Pulley and Belts Removal.

**NOTE**

For model 5063-5393, it will be necessary to remove fuel line clamp from screw at front lower position of coolant pump mounting to oil cooler. It may also be necessary to disconnect the fuel line, routed across the front of the coolant pump, from the fuel junction block in (WP 0012).

4. Remove four screws (Figure 2, Item 10), four lockwashers (Figure 2, Item 11), four flat washers (Figure 2, Item 12), and socket head screw (Figure 2, Item 9), securing coolant pump (Figure 2, Item 8) to oil cooler (Figure 1, Item 14). Discard lockwashers.
5. Remove coolant pump (Figure 2, Item 8) and gasket (Figure 2, Item 13). Discard gasket.
6. For all except models 5063-5393 and 5063-539L, remove hose (Figure 2, Item 2) and two clamps (Figure 2, Item 3) from coolant pump (Figure 2, Item 8).

**END OF TASK**

**INSTALLATION****NOTE**

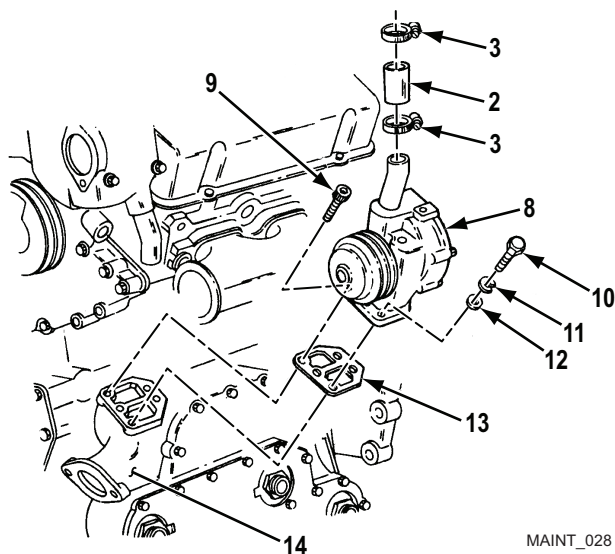
For models 5063-5393 and 5063-539L, water by-pass hose and two clamps will be installed in (WP 0011).

1. Slide hose (Figure 2, Item 2) and two clamps (Figure 2, Item 3) onto coolant pump (Figure 2, Item 8).
2. Position new coolant pump gasket (Figure 2, Item 13) to oil cooler (Figure 2, Item 14).

**NOTE**

For model 5063-5393, it will be necessary to install fuel line clamp under screw at front lower position when mounting coolant pump to oil cooler.

3. Install coolant pump (Figure 2, Item 8), four flat washers (Figure 2, Item 12), four new lockwashers (Figure 2, Item 11), four screws (Figure 2, Item 10), and socket head screw (Figure 2, Item 9) on oil cooler (Figure 2, Item 14). Torque socket head screw and four screws to 13–17 lb-ft (18–23 N·m).



MAINT\_028

Figure 2. Coolant Pump Removal.

**INSTALLATION - Continued**

4. For all models except 5063-5393 and 5063-539L, slide hose (Figure 3, Item 2) and two hose clamps (Figure 3, Item 3), on coolant pump (Figure 3, Item 8), onto water by-pass tube (Figure 3, Item 1). Tighten clamps securely.
5. Install two drive belts (Figure 3, Item 6) on left camshaft pulley (Figure 3, Item 16) and coolant pump pulley (Figure 3, Item 15).
6. Install idler pulley assembly (Figure 3, Item 7), two flat washers (Figure 3, Item 4), and two screws (Figure 3, Item 5).
7. If necessary, connect the fuel line, routed across the front of the coolant pump, to the fuel junction block (WP 0011).

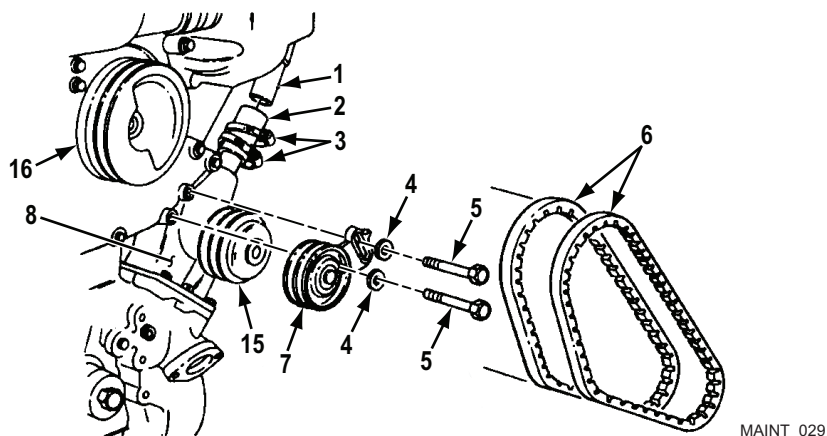


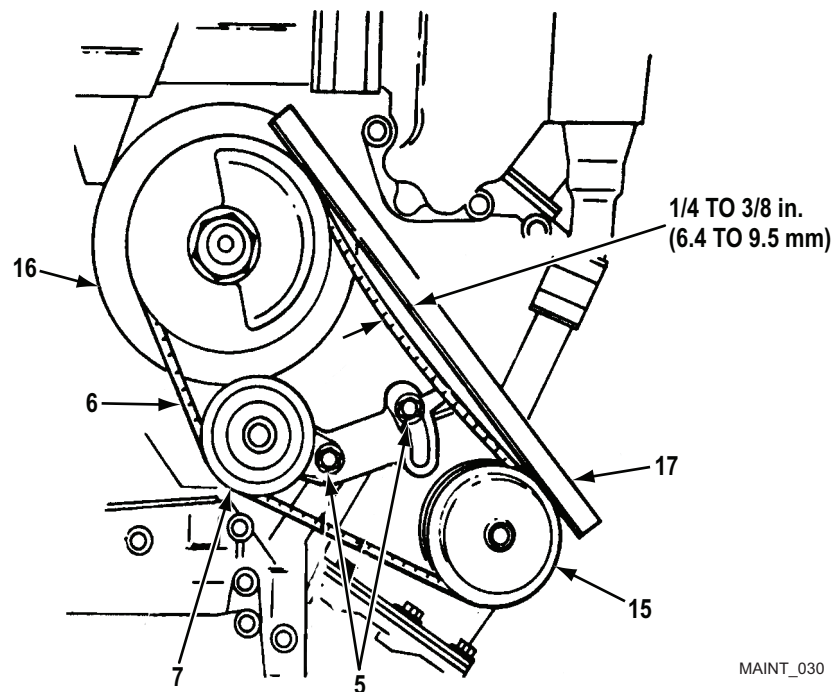
Figure 3. Coolant Pump Idler Pulley and Drive Belt Installation.

**END OF TASK**



**ADJUSTMENT**

1. Loosen two screws (Figure 4, Item 5) on idler pulley assembly (Figure 4, Item 7).
2. Pry upward on tang of idler pulley assembly (Figure 4, Item 7) to get 1/4 to 3/8 inch (6.4 to 9.5 mm) deflection on drive belts (Figure 4, Item 6) midway between pulleys (Figure 4, Items 15 and 16) while applying a firm push with thumb. Tighten two screws (Figure 4, Item 5).
3. Check for proper tension by using straight edge (Figure 4, Item 17) to measure deflection across drive belts at pulleys (Figure 4, Items 15 and 16). If dial indicator tensionmeter is available, check for 40–50 lbs (173–217 N·m) tension. If necessary, readjust tension, and then torque two screws to 30–35 lb-ft (41–47 N·m).



MAINT\_030

Figure 4. Coolant Pump Drive Belt Adjustment.

**END OF TASK****FOLLOW ON TASK**

Install water by-pass hose (models 5063-5393 and 5063-539L) (WP 0011).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**OIL LEVEL GAUGE ROD REPLACEMENT (MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Washer, Lock  
Qty: (3) (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Remove oil gauge rod (Figure 1, Item 1) from tube assembly (Figure 1, Item 8).
2. Unscrew tube assembly (Figure 1, Item 8) from adaptor (Figure 1, Item 7) in left side of oil pan.
3. Remove screw (Figure 1, Item 9), lockwasher (Figure 1, Item 6), nut (Figure 1, Item 5), clip (Figure 1, Item 10), and tube assembly (Figure 1, Item 8) from bracket (Figure 1, Item 2) on flywheel housing. If necessary, remove clip from tube assembly (Figure 1, Item 8). Discard lockwasher.
4. Remove two screws (Figure 1, Item 4), two lockwashers (Figure 1, Item 3), and bracket (Figure 1, Item 2) from left side of flywheel housing. Discard lockwashers.

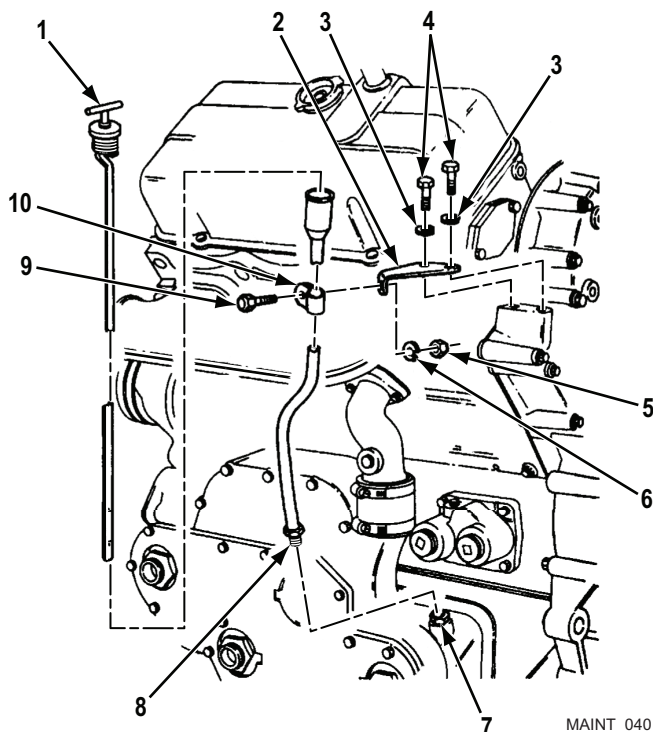


Figure 1. Oil Level Gauge Rod Removal and Installation.

**END OF TASK**

**INSTALLATION**

1. If removed, install clip (Figure 1, Item 10) on tube assembly (Figure 1, Item 8). Loosely install tube assembly in adaptor (Figure 1, Item 7).
2. Install bracket (Figure 1, Item 2), two new lockwashers (Figure 1, Item 3), and two screws (Figure 1, Item 4) on flywheel housing. Torque screws to 16–20 lb-ft (22–27 N·m).
3. Install screw (Figure 1, Item 9), clip (Figure 1, Item 10), tube assembly (Figure 1, Item 8), new lockwasher (Figure 1, Item 6), and nut (Figure 1, Item 5) on bracket (Figure 1, Item 2). Torque screw to 30–35 lb-ft (41–47 N·m).
4. Tighten tube assembly (Figure 1, Item 8) at adaptor (Figure 1, Item 7).

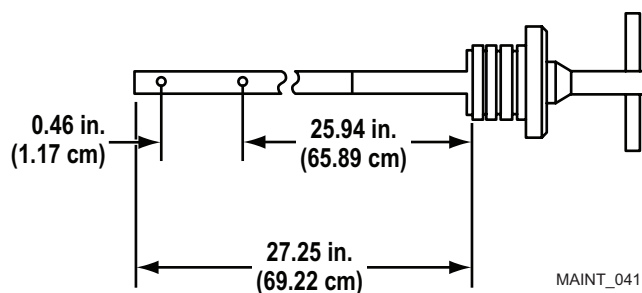


Figure 2. Oil Level Gauge Rod Cutting Instructions.

**NOTE**

A replacement oil gauge rod is 61 inches (155 cm) when packaged.

5. Cut and mark a new oil gauge rod as shown in Figure 2.
6. Install oil gauge rod (Figure 1, Item 1) in tube assembly (Figure 1, Item 8).

**END OF TASK**

**END OF WORK PACKAGE**



**FIELD MAINTENANCE**  
**OIL LEVEL GAUGE ROD REPLACEMENT (MODEL 5063-5392)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Washer, Lock (WP 0105, Table 1, Item 23)

---

**REMOVAL**

1. Remove oil gauge rod (Figure 1, Item 1) from tube assembly (Figure 1, Item 2).
2. Unscrew fitting of tube assembly (Figure 1, Item 2) from adaptor (Figure 1, Item 3) in rear right side of oil pan.
3. Remove bolt (Figure 1, Item 6), lockwasher (Figure 1, Item 5), flat washer (Figure 1, Item 4), clip (Figure 1, Item 7), and tube assembly (Figure 1, Item 2) from right side of flywheel housing. If necessary, remove clip from tube assembly. Discard lockwasher.

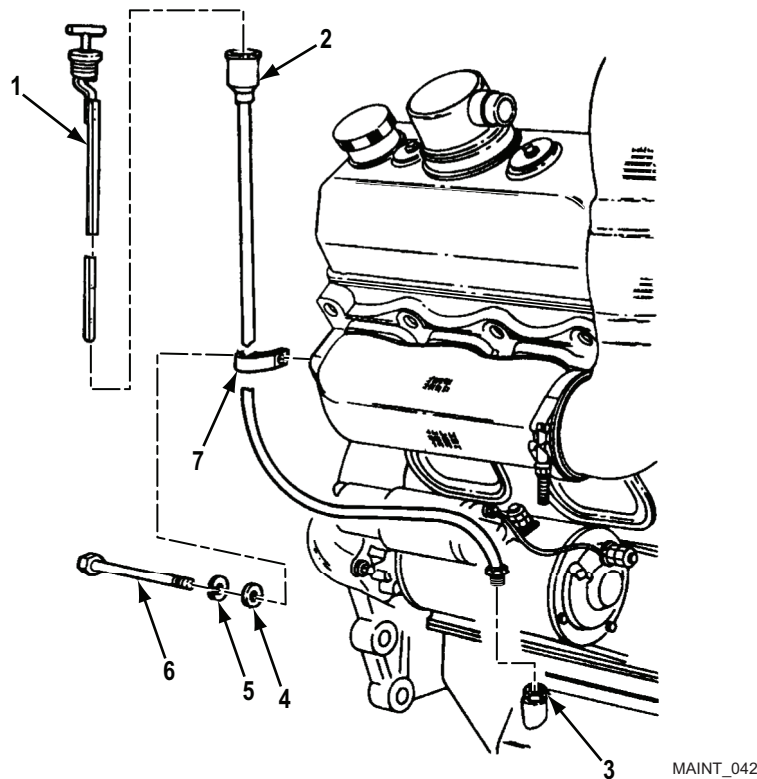


Figure 1. Oil Level Gauge Rod Removal and Installation (Model 5063-5392).

**END OF TASK**



**INSTALLATION**

1. If removed, install clip (Figure 1, Item 7) on tube assembly (Figure 1, Item 2). Loosely install tube assembly in adaptor (Figure 1, Item 3).

**NOTE**

Bolt (Figure 1, Item 6) may already be installed, in right side of flywheel housing, to accommodate the torque sequence when installing the flywheel housing to the cylinder block. Remove as required for clip installation.

2. Install flat washer (Figure 1, Item 4), new lockwasher (Figure 1, Item 5), and bolt (Figure 1, Item 6) through clip (Figure 1, Item 7). Torque bolt to 30–35 lb-ft (41–47 N·m).
3. Tighten connection at adaptor (Figure 1, Item 3) and tube assembly (Figure 1, Item 2).
4. Install oil gauge rod (Figure 1, Item 1) in tube assembly (Figure 1, Item 2).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
OIL LEVEL GAUGE ROD REPLACEMENT  
(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Nut, Self-locking (WP 0105, Table 1, Item 171)

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## REMOVAL

1. Remove oil gauge rod (Figure 1, Item 6) from tube assembly (Figure 1, Item 4).
2. Unscrew tube assembly (Figure 1, Item 4) from adaptor (Figure 1, Item 5) in front right side of oil pan.
3. Remove locknut (Figure 1, Item 1), clip (Figure 1, Item 2), and tube assembly (Figure 1, Item 4) from right front exhaust manifold stud (Figure 1, Item 3). Replace locknut on stud. If necessary, remove clip from tube assembly.
4. Remove adaptor (Figure 1, Item 5) from oil pan.

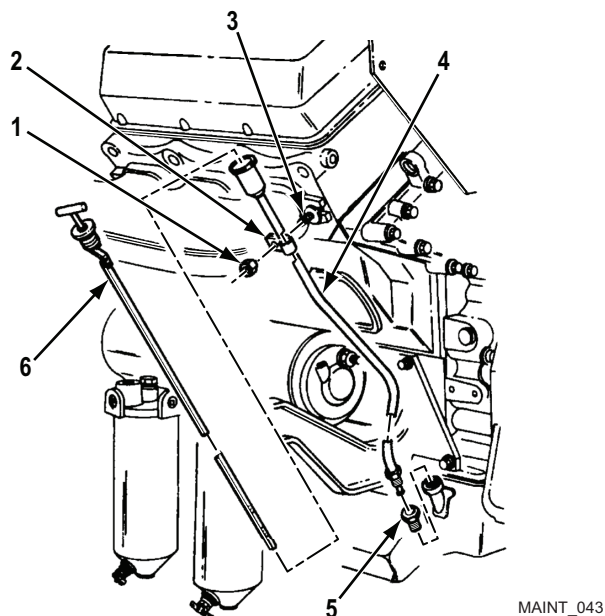


Figure 1. Oil Level Gauge Rod Removal and Installation (Models 5063-5393 and 5063-539L).

## END OF TASK

## INSTALLATION

1. Install adaptor (Figure 1, Item 5) in right side of oil pan.
2. If removed, install clip (Figure 1, Item 2) on tube assembly (Figure 1, Item 4). Loosely install tube assembly in adaptor (Figure 1, Item 5).
3. Remove locknut (Figure 1, Item 1) from right front exhaust manifold stud (Figure 1, Item 3). Discard locknut. Install clip (Figure 1, Item 2), tube assembly (Figure 1, Item 4), and new locknut (Figure 1, Item 1) onto exhaust manifold stud (Figure 1, Item 3). Securely tighten tube assembly to adaptor (Figure 1, Item 5). Torque locknut to 30–35 lb-ft (41–47 N·m).
4. Install oil gauge rod (Figure 1, Item 6) in tube assembly (Figure 1, Item 4).

## END OF TASK

## END OF WORK PACKAGE

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**FIELD MAINTENANCE  
OIL FILTER ADAPTOR REPLACEMENT  
(MODEL 5063-5299)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Gasket  
(WP 0105, Table 1, Item 75)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Remove four screws (Figure 1, Item 4), four lockwashers (Figure 1, Item 5), and four flat washers (Figure 1, Item 6) from oil filter adaptor (Figure 1, Item 7) on rear left cylinder block. Discard lockwashers.
2. Using a soft head hammer, tap the oil filter adaptor (Figure 1, Item 7) and remove adaptor and gasket (Figure 1, Item 1). Discard gasket.
3. If engine is out of container, remove bolt (Figure 1, Item 3) and flat washer (Figure 1, Item 2) from flywheel housing.

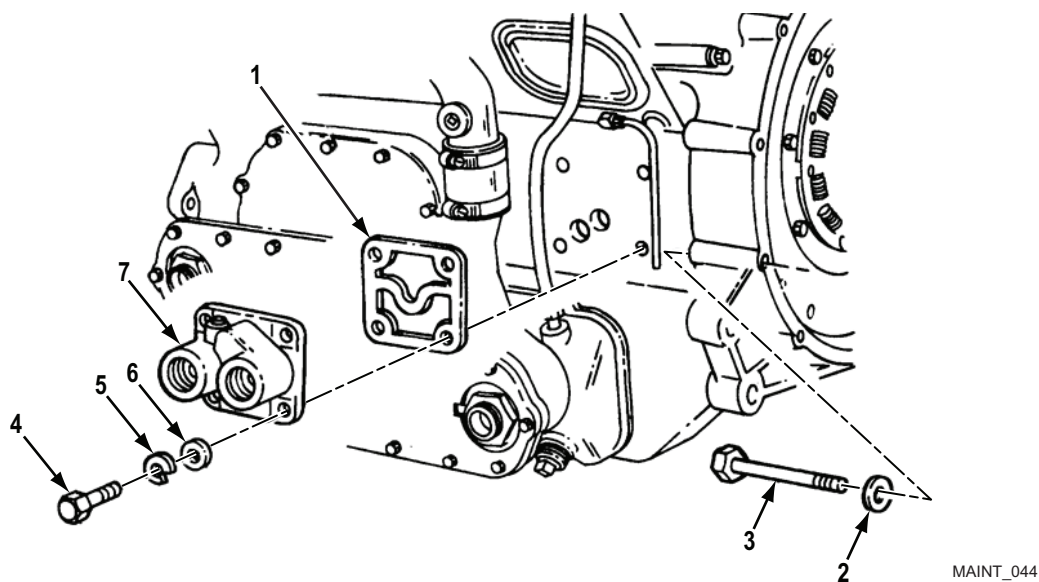


Figure 1. Oil Filter Adaptor Removal and Installation.

**END OF TASK****INSTALLATION**

1. If engine is out of container, install bolt (Figure 1, Item 3) and flat washer (Figure 1, Item 2) in flywheel housing at eight o'clock position.
2. Install new gasket (Figure 1, Item 1), oil filter adaptor (Figure 1, Item 7), four flat washers (Figure 1, Item 6), four new lockwashers (Figure 1, Item 5), and four screws (Figure 1, Item 4) on rear left side of cylinder block. Torque screws to 30–35 lb-ft (41–47 N·m).

**END OF TASK****END OF WORK PACKAGE**

---

**FIELD MAINTENANCE**  
**OIL FILTER ASSEMBLY AND ADAPTER REPLACEMENT**  
**(MODEL 5063-5392)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

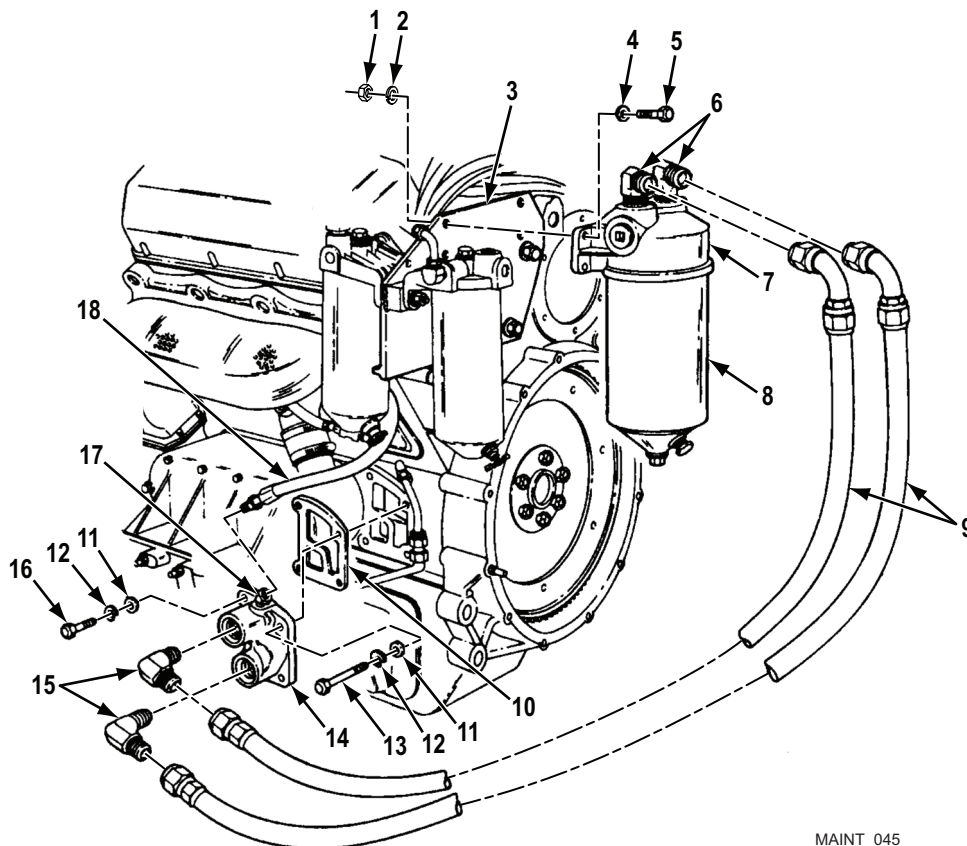
**Materials/Parts**

Gasket (WP 0105, Table 1, Item 34)  
Washer, Lock  
Qty: (8) (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Disconnect two hose assemblies (Figure 1, Item 9) from two elbows (Figure 1, Item 6) on oil filter head (Figure 1, Item 7). Remove two hose assemblies (Figure 1, Item 9) from two elbows (Figure 1, Item 15) on oil filter adaptor (Figure 1, Item 14).
2. Remove four screws (Figure 1, Item 5), four flat washers (Figure 1, Item 4), four lockwashers (Figure 1, Item 2), four nuts (Figure 1, Item 1), and oil filter assembly (Figure 1, Item 8) from bracket (Figure 1, Item 3). Discard lockwashers.
3. Disconnect turbocharger oil supply hose (Figure 1, Item 18) from elbow (Figure 1, Item 17) on top of oil filter adaptor (Figure 1, Item 14).
4. If necessary, remove two elbows (Figure 1, Item 15) from oil filter adaptor (Figure 1, Item 14).
5. Remove two short screws (Figure 1, Item 16), two long screws (Figure 1, Item 13), four lockwashers (Figure 1, Item 12), and four flat washers (Figure 1, Item 11) from oil filter adaptor (Figure 1, Item 14) on rear left side of cylinder block. Discard lockwashers.
6. Remove oil filter adaptor (Figure 1, Item 14) and gasket (Figure 1, Item 10) by tapping with a soft head hammer to break seal. If necessary, remove elbow (Figure 1, Item 17) from adaptor (Figure 1, Item 14). Discard gasket.



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Figure 1. Oil Filter Assembly and Adaptor Removal/Installation.

**END OF TASK**



**INSTALLATION**

1. If removed, install elbow (Figure 1, Item 17) on adaptor (Figure 1, Item 14).
2. Install new gasket (Figure 1, Item 10), oil filter adaptor (Figure 1, Item 14), four flat washers (Figure 1, Item 11), four new lockwashers (Figure 1, Item 12), two short screws (Figure 1, Item 16), and two long screws (Figure 1, Item 13) to left side rear of cylinder block. Torque screws to 30–35 lb-ft (41–47 N·m).
3. If removed, install two elbows (Figure 1, Item 15) in oil filter adaptor (Figure 1, Item 14).
4. Install four screws (Figure 1, Item 5), four flat washers (Figure 1, Item 4), oil filter assembly (Figure 1, Item 8), four new lockwashers (Figure 1, Item 2), and four nuts (Figure 1, Item 1) on bracket (Figure 1, Item 3). Torque screws to 30–35 lb-ft (41–47 N·m).
5. Connect two hose assemblies (Figure 1, Item 9) to two elbows (Figure 1, Item 15) in oil filter adaptor (Figure 1, Item 14) and to two elbows (Figure 1, Item 6) in oil filter head (Figure 1, Item 7). Tighten connections securely.
6. Connect turbocharger oil supply hose (Figure 1, Item 18) to elbow (Figure 1, Item 17) on top of oil filter adaptor (Figure 1, Item 14). Tighten hose connection securely.

**END OF TASK****END OF WORK PACKAGE**



**FIELD MAINTENANCE**  
**OIL FILTER ASSEMBLY AND ADAPTOR REPLACEMENT**  
**(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
 (WP 0104, Table 1, Item 113)  
 Wrench, Oil Filter  
 (WP 0104, Table 1, Item 118)  
 Wrench, Torque, Dial, 0–175 Lb-Ft  
 (WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Filter Element, Fluid  
 (WP 0105, Table 1, Item 163)  
 Gasket (WP 0105, Table 1, Item 34)  
 Oil, Engine SAE 15/40  
 (WP 0103, Table 1, Item 27)  
 Washer, Lock  
 Qty: (4) (WP 0105, Table 1, Item 23)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

**REMOVAL**

1. Disconnect turbocharger oil supply hose (Figure 1, Item 1) from elbow (Figure 1, Item 8) in oil filter and adaptor assembly (Figure 1, Item 3).
2. If necessary, remove elbow (Figure 1, Item 8) from oil filter and adaptor assembly (Figure 1, Item 3).
3. Remove two short screws (Figure 1, Item 5), two long screws (Figure 1, Item 4), four lockwashers (Figure 1, Item 6), four flat washers (Figure 1, Item 7), gasket (Figure 1, Item 2), and oil filter and adaptor assembly (Figure 1, Item 3) from rear left side of cylinder block. Discard lockwashers and gasket.

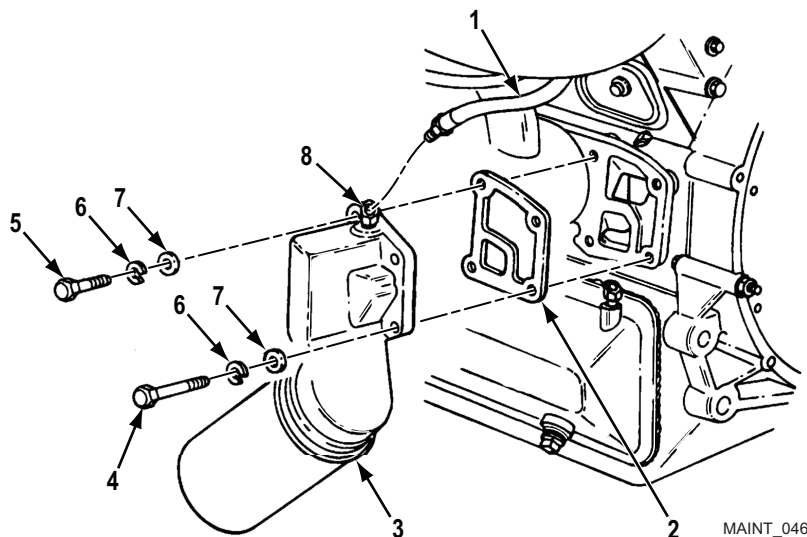


Figure 1. Oil Filter Assembly Removal.

**END OF TASK**

**DISASSEMBLY**

1. Using an oil filter wrench, remove oil filter spin-on element (Figure 2, Item 9) from adapter (Figure 2, Item 10). Discard oil filter element.
2. If necessary, remove nipple (Figure 2, Item 11) from adapter (Figure 2, Item 10).

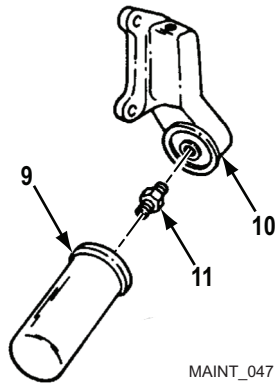
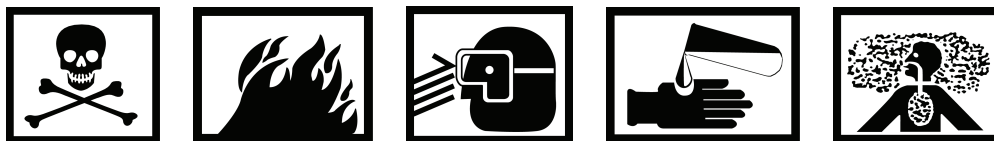
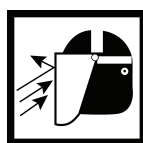


Figure 2. Oil Filter Assembly Disassembly/Assembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean parts with dry cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect all parts for damage and excessive wear. Replace as necessary.

**END OF TASK****ASSEMBLY**

1. If removed, install nipple (Figure 2, Item 11) in adapter (Figure 2, Item 10). Torque nipple to 70–80 lb-ft (95–108 N·m).
2. Lightly coat seal of oil filter spin-on element (Figure 2, Item 9) with clean engine oil.

**CAUTION**

Do not use mechanical means to tighten spin-on oil filter. Over-tightening will damage seal and filter.

3. Place oil filter spin-on element (Figure 2, Item 9) on adapter nipple (Figure 2, Item 11) and tighten by hand until seal contacts adapter (Figure 2, Item 10). Then turn oil filter element an additional two-thirds revolution.

**END OF TASK**

**INSTALLATION**

1. Install new gasket (Figure 3, Item 2), oil filter and adaptor assembly (Figure 3, Item 3), four flat washers (Figure 3, Item 7), four new lockwashers (Figure 3, Item 6), two short screws (Figure 3, Item 5), and two long screws (Figure 3, Item 4) on rear left side of cylinder block. Torque screws to 30–35 lb-ft (41–47 N·m).
2. If removed, install elbow (Figure 3, Item 8) in oil filter and adaptor assembly (Figure 3, Item 3).
3. Connect turbocharger oil supply hose (Figure 3, Item 1) to elbow (Figure 3, Item 8) in oil filter and adaptor assembly (Figure 3, Item 3). Tighten hose connection securely.

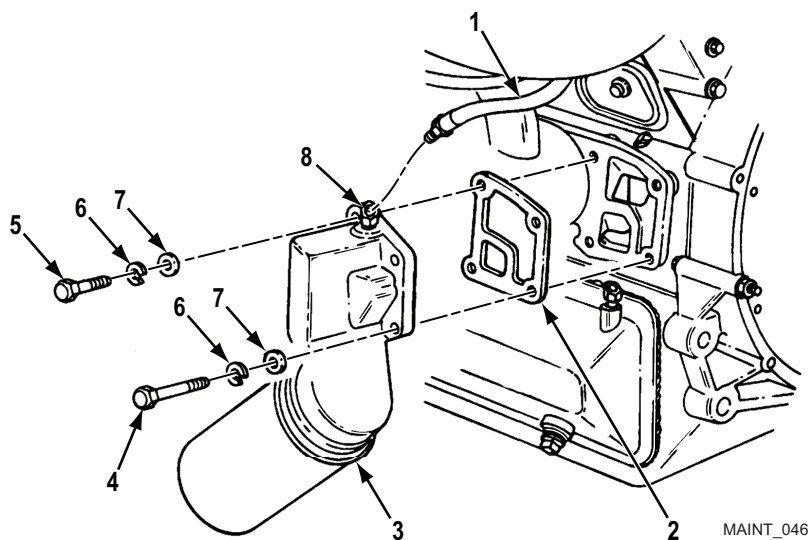


Figure 3. Oil Filter Assembly Installation.

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**ENGINE/TRANSMISSION OIL COOLER REPLACEMENT**  
**(MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pressure Testing Kit, Oil Cooler  
(WP 0081, Figure 6)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 21)  
Gasket (WP 0105, Table 1, Item 52)  
Gasket (WP 0105, Table 1, Item 77)  
Gasket Qty: (4) (WP 0105, Table 1, Item 79)  
Gasket (WP 0105, Table 1, Item 124)  
Hydrochloric Acid (WP 0103, Table 1, Item 20)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oxalic Acid (WP 0103, Table 1, Item 40)

**Materials/Parts (cont.)**

Plug, Pipe (WP 0103, Table 1, Item 41)  
Reducer, Pipe (WP 0103, Table 1, Item 45)  
Stud, Oil Cooler  
Qty: (2) (WP 0103, Table 1, Item 63)  
Tech Solv 340 (WP 0103, Table 1, Item 65)  
Washer, Key  
Qty: (4) (WP 0105, Table 1, Item 78)  
Washer, Lock  
Qty: (27) (WP 0105, Table 1, Item 178)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Coolant pump removed (WP 0013)

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**REMOVAL**

1. Loosen two hose clamps (Figure 1, Item 9) on hose (Figure 1, Item 10) over water outlet elbow (Figure 1, Item 5).
2. Remove long bolt (Figure 1, Item 13) through clip (Figure 1, Item 14) on hose (Figure 1, Item 11), short bolt (Figure 1, Item 8), two lockwashers (Figure 1, Item 7), two flat washers (Figure 1, Item 6), water outlet elbow (Figure 1, Item 5), hose (Figure 1, Item 10), two hose clamps (Figure 1, Item 9), and gasket (Figure 1, Item 4) from cylinder block. Remove two hose clamps (Figure 1, Item 9) and hose (Figure 1, Item 10) from elbow (Figure 1, Item 5). Discard gasket and lockwashers.
3. If necessary, remove pipe plug (Figure 1, Item 12) from water outlet elbow (Figure 1, Item 5).
4. Remove five bolts (Figure 1, Item 1), five lockwashers (Figure 1, Item 2), and five flat washers (Figure 1, Item 3) from upper section of oil cooler assembly (Figure 1, Item 15). Discard lockwashers.
5. Install two guide studs (Figure 1, Item 16) in positions (A) and (B) through oil cooler assembly (Figure 1, Item 15).

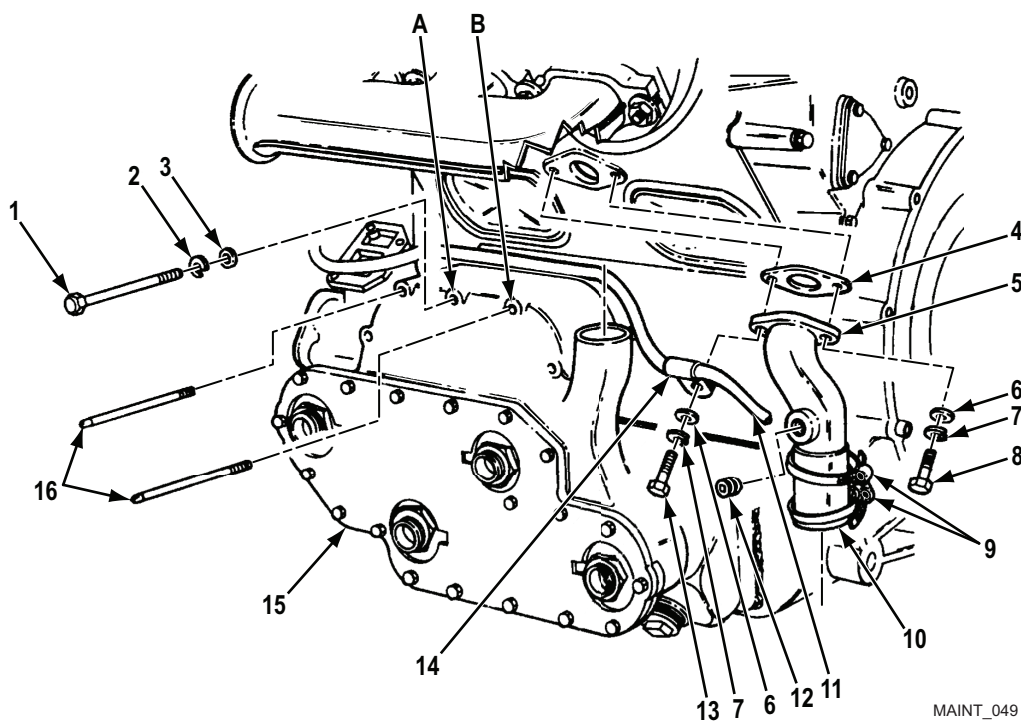


Figure 1. Oil Cooler Assembly Removal.



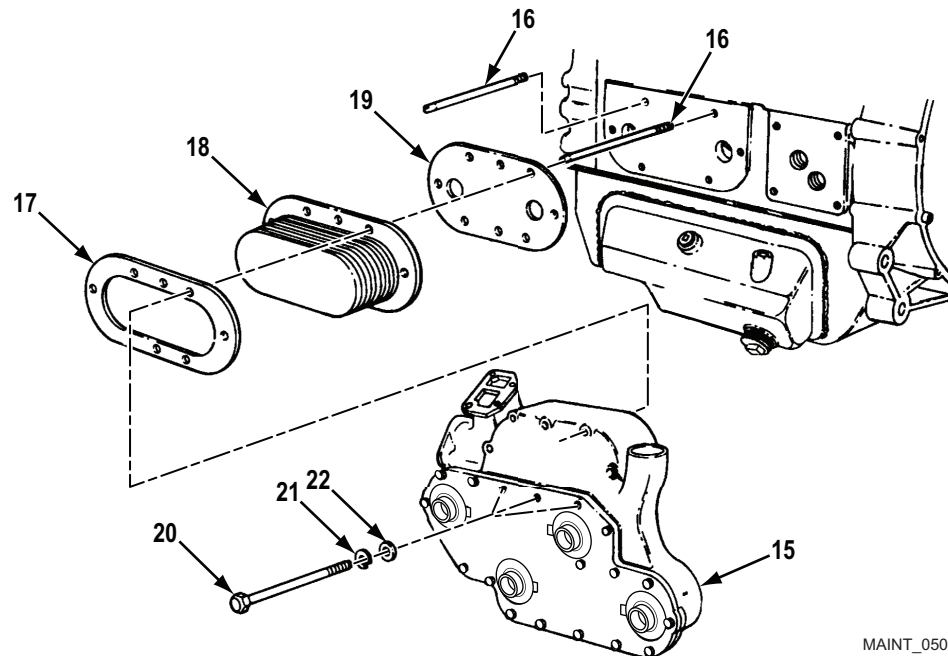
## REMOVAL - Continued

## WARNING



Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel to avoid injury. Failure to comply may result in injury to personnel.

6. Remove three bolts (Figure 2, Item 20), three lockwashers (Figure 2, Item 21), three flat washers (Figure 2, Item 22), transmission oil cooler assembly (Figure 2, Item 15), and gasket (Figure 2, Item 19) from cylinder block. Discard gasket and lockwashers.
7. Remove engine oil cooler element (Figure 2, Item 18) and gasket (Figure 2, Item 17) from oil cooler assembly (Figure 2, Item 15). Discard gasket.
8. Remove two guide studs (Figure 2, Item 16) from cylinder block.



MAINT\_050

Figure 2. Oil Cooler Assembly and Element Removal.

END OF TASK

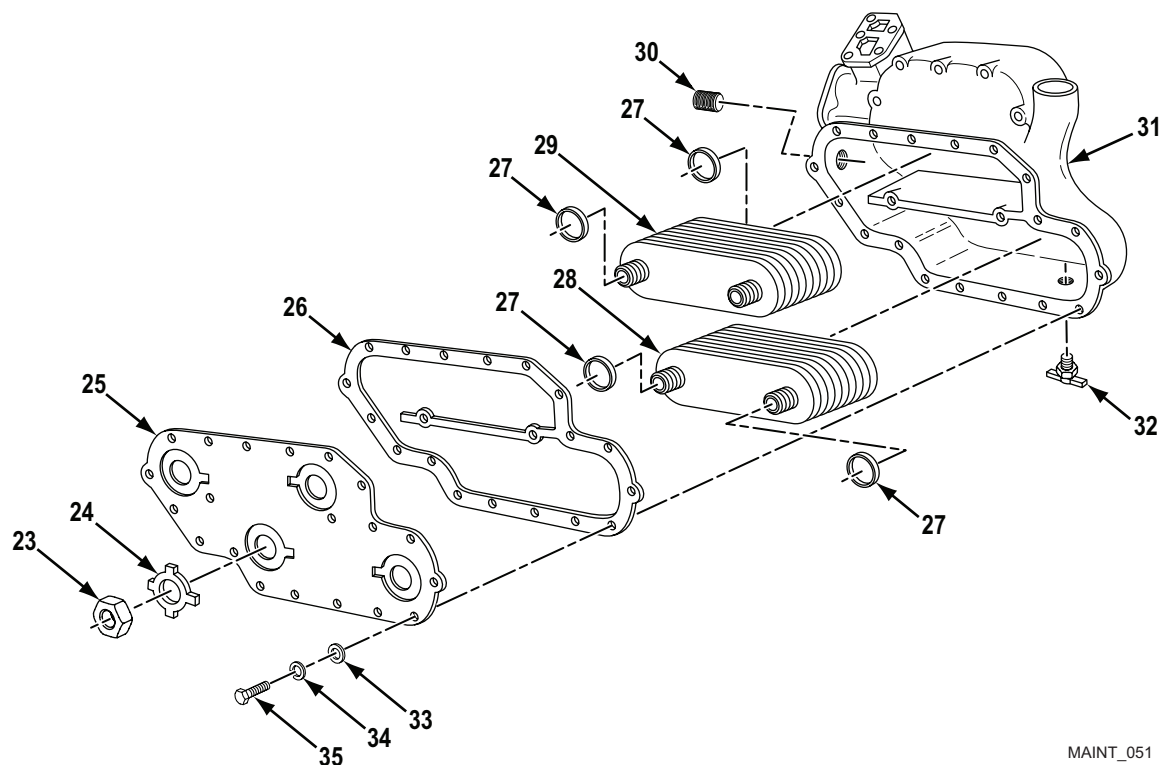
**DISASSEMBLY**

1. Bend tangs on four key washers (Figure 3, Item 24) away from sides of nuts (Figure 3, Item 23). Remove four nuts (Figure 3, Item 23) and four key washers (Figure 3, Item 24). Discard key washers.
2. Remove 17 bolts (Figure 3, Item 35), 17 lockwashers (Figure 3, Item 34), and 17 flat washers (Figure 3, Item 33) fastening cover (Figure 3, Item 25) to cooler housing (Figure 3, Item 31). Discard lockwashers.
3. Tap cover (Figure 3, Item 25) to loosen from cooler housing (Figure 3, Item 31). Remove cover (Figure 3, Item 25) and gasket (Figure 3, Item 26). Discard gasket.

**CAUTION**

Do not drop or damage oil coolers during removal. Any damage causing a leak in coolers can result in coolant in the engine oil.

4. Remove transmission oil cooler (Figure 3, Item 29) and differential oil cooler (Figure 3, Item 28) from cooler housing (Figure 3, Item 31).
5. Remove four gaskets (Figure 3, Item 27) from transmission oil cooler (Figure 3, Item 29) and differential oil cooler (Figure 3, Item 28). Discard gaskets.
6. If necessary, remove pipe plug (Figure 3, Item 30) and draincock (Figure 3, Item 32) from cooler housing (Figure 3, Item 31).



MAINT\_051

Figure 3. Oil Cooler Assembly/Disassembly.

**END OF TASK**

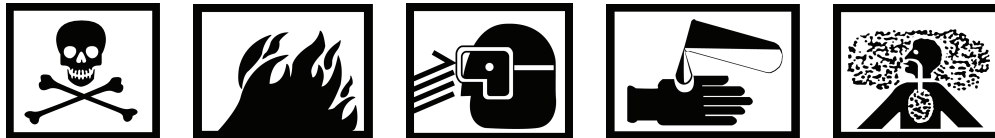
**CLEANING****WARNING**

Use Tech Solv 340 only with adequate ventilation. Vapors in high concentrations are anesthetic and dangerous to life. Avoid prolonged or repeated contact with skin. Do not take internally. Failure to comply may result in injury, illness, or death to personnel.

**NOTE**

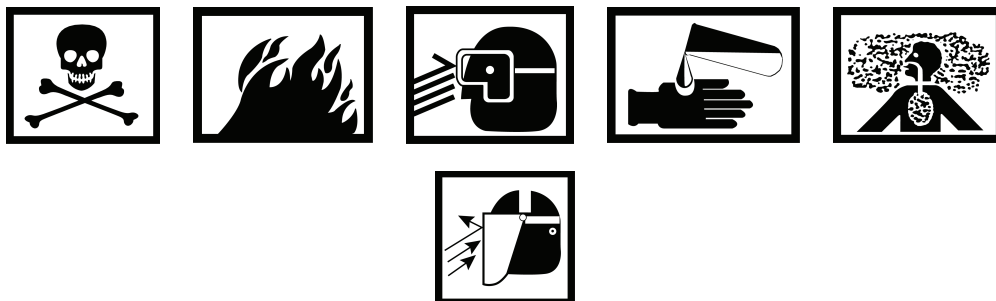
Do not clean cooler if engine or transmission has had metal particles enter oil system. Instead, replace oil cooler.

1. Oil cooler – oil side: Pump Tech Solv 340 solution through oil cooler on oil side to remove carbon and sludge.

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

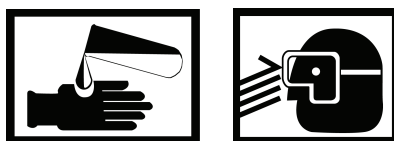
2. If oil passages are badly clogged, pump cleaning solvent through oil cooler and flush thoroughly with clean, hot water.

**CLEANING - Continued****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

3. Clean oil cooler housing and cover with cleaning solvent and dry with compressed air.

**WARNING**

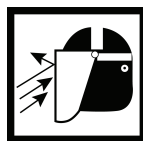
Coolant system cleaning solution contains acid. Wear protective goggles and equipment. Avoid contact with skin, eyes, and clothing. Always pour acid into water. Water poured into acid will spatter the acid. If contact is made, flush area with water and seek medical aid immediately. Failure to comply may result in injury to personnel.

4. Oil cooler - water side: Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound (0.22 kg) of oxalic acid for each 2.5 gallons (9.4 L) of solution.
5. Immerse oil coolers in solution.
6. Watch cleaning process carefully. Remove oil coolers from solution when bubbling stops (usually 30 to 60 seconds).
7. Flush oil coolers in clean hot water.
8. After cleaning oil coolers, dip in light oil.

**END OF TASK**

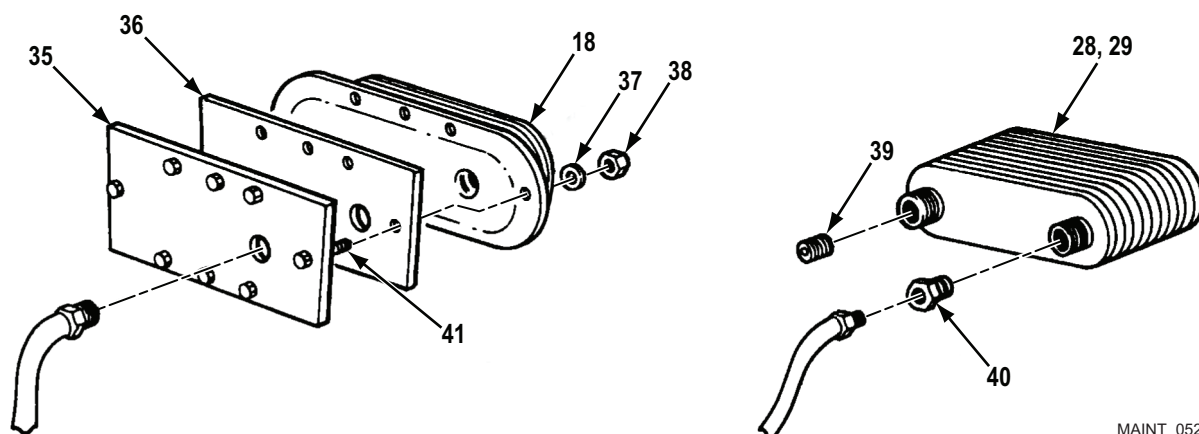
## TEST AND INSPECTION

## WARNING



Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler during high-pressure air-leak test. Failure to comply may result in injury to personnel.

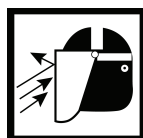
1. Engine oil cooler - Install rubber gasket (Figure 4, Item 36), fabricated blocking plate (Figure 4, Item 35), eight 5/16 inch diameter bolts (Figure 4, Item 41), flat washers (Figure 4, Item 37), and nuts (Figure 4, Item 38) on flanged side of engine oil cooler (Figure 4, Item 18).
2. Connect air line to blocking plate (Figure 4, Item 35) and apply pressure of 75 PSI (517 kPa) to oil cooler.
3. Submerge oil cooler assembly in a container of water heated to 180°F (82°C). Air bubbles in water indicate leaks. Replace oil cooler if leaks appear.
4. Release air pressure on oil cooler assembly. Remove plate, gasket, and hose from oil cooler.



MAINT\_052

Figure 4. Oil Cooler Assembly Cleaning/Test and Inspection.

## WARNING



Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

5. Dry oil cooler with compressed air.
6. Transmission and differential oil coolers - Plug one hole in transmission oil cooler (Figure 4, Item 29) with 3/4-14 NPT pipe plug (Figure 4, Item 39). Install 3/4-1/4 inch reducer bushing (Figure 4, Item 40) in other hole of oil cooler.

**TEST AND INSPECTION - Continued**

7. Connect air line to inlet hole in oil cooler. Pressurize oil cooler to 75 PSI (517 kPa).
8. Submerge oil cooler in a container of water heated to 180°F (82°C). Air bubbles in the water indicate a leak. Replace any transmission oil cooler with a leak.
9. Release pressure on transmission oil cooler assembly. Remove plug, reducer bushing (Figure 4, Item 40), and air hose from transmission oil cooler.
10. Dry transmission oil cooler with compressed air.
11. Repeat Steps 6–10 for differential oil cooler (Figure 4, Item 28).

**END OF TASK****ASSEMBLY**

1. If removed, install pipe plug (Figure 5, Item 30) in side of oil cooler housing (Figure 5, Item 31) and draincock (Figure 5, Item 32) in bottom of cooler housing.
2. Place new gasket (Figure 5, Item 26) on oil cooler housing (Figure 5, Item 31).

**CAUTION**

Install oil coolers in correct position to prevent any foreign particles and sludge from entering engine or transmission. Inlet opening is marked "FROM" on cover and "IN" on oil cooler. Outlet opening is marked "TO" on cover and "OUT" on oil cooler.

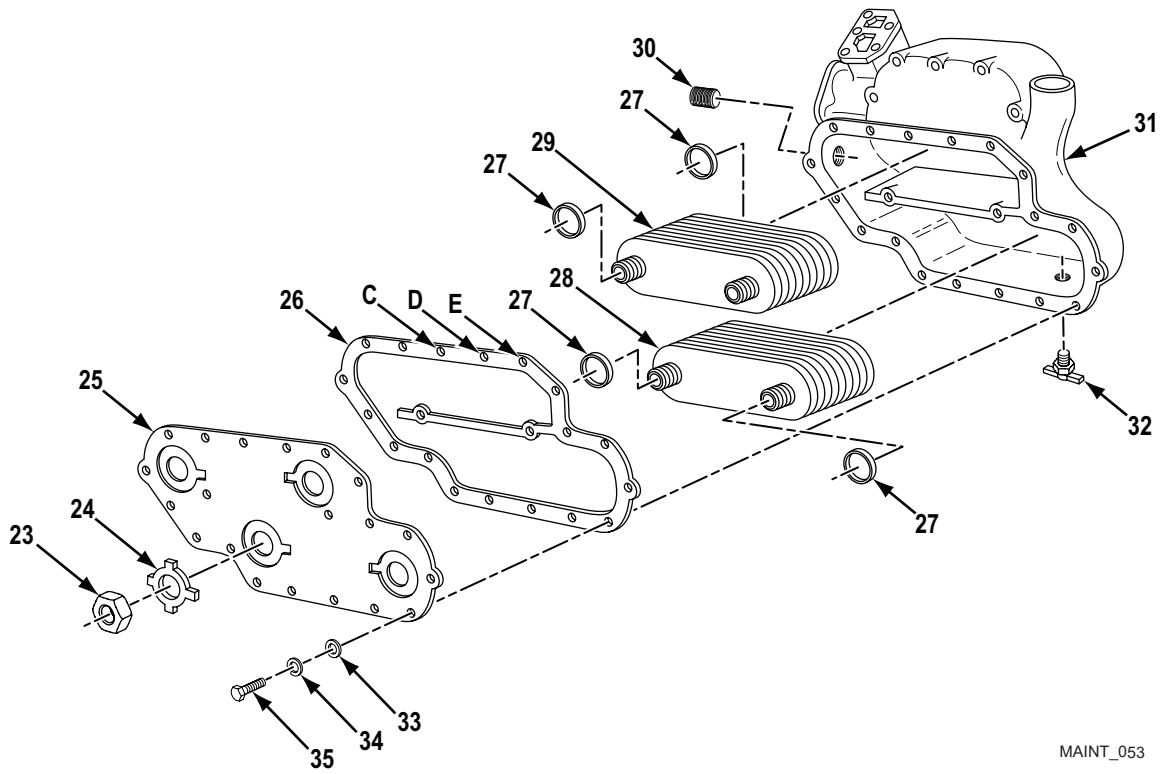
3. Place four new gaskets (Figure 5, Item 27) around inlet and outlet openings of transmission oil cooler (Figure 5, Item 29) and differential oil cooler (Figure 5, Item 28).
4. Place cover (Figure 5, Item 25) over inlet and outlet connectors of oil coolers.
5. Install four new key washers (Figure 5, Item 24) and four nuts (Figure 5, Item 23) on inlet and outlet connectors of oil coolers. Do not tighten nuts.
6. Place assembly of cover (Figure 5, Item 25), transmission oil cooler (Figure 5, Item 29), and differential oil cooler (Figure 5, Item 28) in oil cooler housing (Figure 5, Item 31).

**NOTE**

Do not install bolts in locations (C), (D), and (E).

7. Install cover (Figure 5, Item 25), 17 flat washers (Figure 5, Item 33), 17 new lockwashers (Figure 5, Item 34), and 17 bolts (Figure 5, Item 35) on oil cooler housing (Figure 5, Item 31). Torque bolts to 13–17 lb-ft (18–23 N·m).
8. Torque nuts (Figure 5, Item 23) to 50–60 lb-ft (68–82 N·m). Bend short tangs on key washers (Figure 5, Item 24) against nuts (Figure 5, Item 23).

ASSEMBLY - Continued



MAINT\_053

Figure 5. Oil Cooler Assembly, Assembly.

END OF TASK

**INSTALLATION**

1. Install two guide studs (Figure 6, Item 16) into cylinder block at positions (A) and (B).
2. Install new gasket (Figure 6, Item 19), oil cooler element (Figure 6, Item 18), and new gasket (Figure 6, Item 17) on guide studs (Figure 6, Item 16) with port marked "IN" toward front of engine and slide gaskets (Figure 6, Items 19 and 17) and element (Figure 6, Item 18) against cylinder block.
3. Position oil cooler assembly (Figure 6, Item 15) on guide studs (Figure 6, Item 16) and slide up against cylinder block.
4. Install three flat washers (Figure 6, Item 22), three new lockwashers (Figure 6, Item 21), and three bolts (Figure 6, Item 20) in oil cooler assembly (Figure 6, Item 15). Torque bolts to 13–17 lb-ft (18–23 N·m).

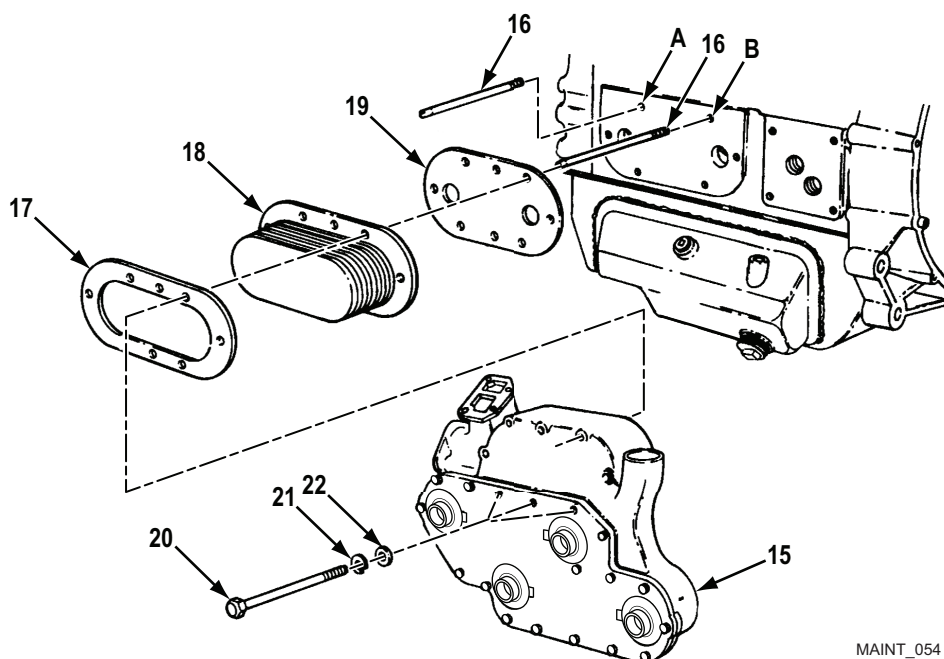
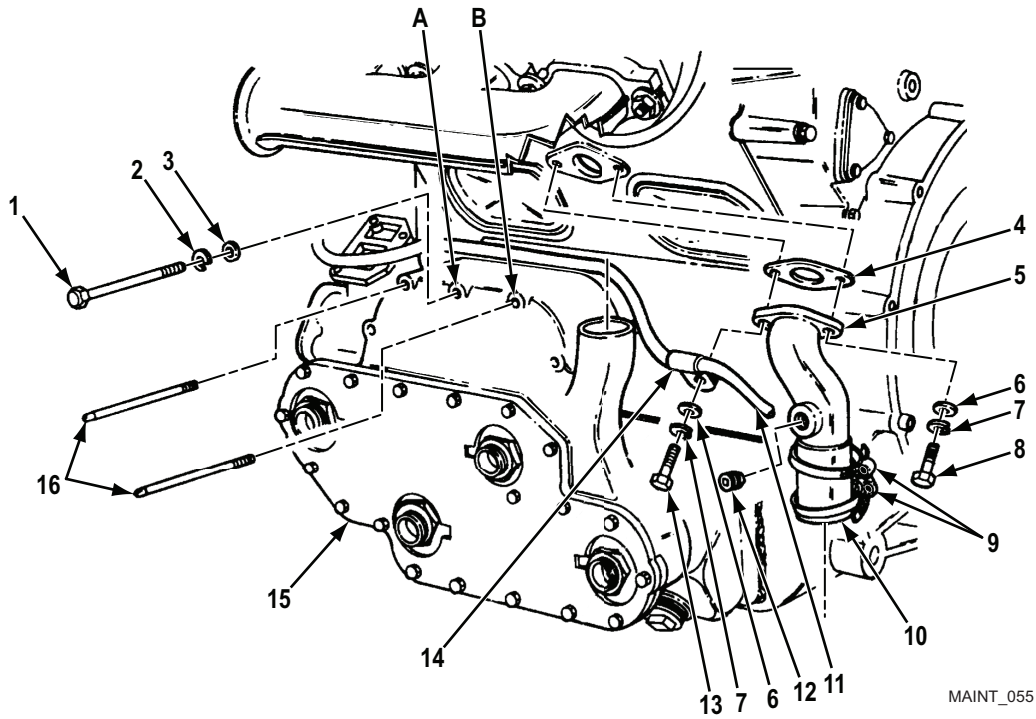


Figure 6. Oil Cooler Element Installation.

5. Remove two guide studs (Figure 7, Item 16) and install five flat washers (Figure 7, Item 3), five new lockwashers (Figure 7, Item 2), and five bolts (Figure 7, Item 1) in oil cooler assembly (Figure 7, Item 15). Torque bolts to 13–17 lb-ft (18–23 N·m).
6. If removed, install pipe plug (Figure 7, Item 12) in elbow (Figure 7, Item 5).
7. Slide hose (Figure 7, Item 10) and two clamps (Figure 7, Item 9) onto oil cooler assembly (Figure 7, Item 15).
8. Slide elbow (Figure 7, Item 5) into hose (Figure 7, Item 10) and install new gasket (Figure 7, Item 4), elbow (Figure 7, Item 5), two flat washers (Figure 7, Item 6), two new lockwashers (Figure 7, Item 7), long bolt (Figure 7, Item 13) through clip (Figure 7, Item 14) on hose (Figure 7, Item 11), and short bolt (Figure 7, Item 8) on cylinder block. Torque bolts to 13–17 lb-ft (18–23 N·m).
9. Adjust hose (Figure 7, Item 10) and two clamps (Figure 7, Item 9) between elbow (Figure 7, Item 5) and oil cooler assembly (Figure 7, Item 15) with clamp adjusting screws facing front of engine. Tighten clamps securely.



**INSTALLATION - Continued**



MAINT\_055

Figure 7. Oil Cooler Assembly Installation.

**END OF TASK**

**FOLLOW ON TASK**

Install coolant pump (WP 0013).

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
ENGINE/TRANSMISSION OIL COOLER REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pressure Testing Kit, Oil Cooler  
(WP 0081, Figure 6)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 33)  
Gasket (WP 0105, Table 1, Item 35)  
Gasket Qty: (2) (WP 0105, Table 1, Item 36)  
Gasket (WP 0105, Table 1, Item 52)  
Hydrochloric Acid (WP 0103, Table 1, Item 20)  
Oil, Engine SAE 15/40  
(WP 0103, Table 1, Item 27)  
Oxalic Acid (WP 0103, Table 1, Item 40)

**Materials/Parts (cont.)**

Tech Solv 340 (WP 0103, Table 1, Item 65)  
Washer, Lock  
Qty: (19) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**Personnel Required**

Mechanic  
Helper (H)

**References**

WP 0081

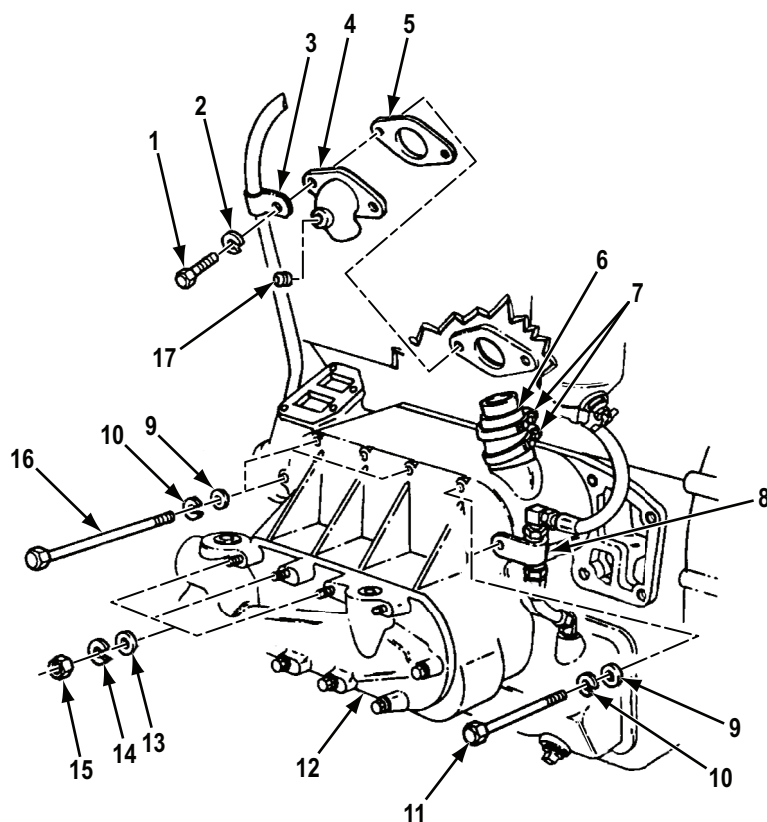
**Equipment Condition**

Coolant pump removed (WP 0013)  
Oil filter adaptor removed (WP 0018)

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**REMOVAL**

1. Loosen two hose clamps (Figure 1, Item 7) and slide hose (Figure 1, Item 6) down onto oil cooler assembly (Figure 1, Item 12).
2. Remove two bolts (Figure 1, Item 1) through clip (Figure 1, Item 3), two lockwashers (Figure 1, Item 2), elbow (Figure 1, Item 4), and gasket (Figure 1, Item 5) from cylinder block. Discard gasket and lockwashers. If necessary, remove clip (Figure 1, Item 3) from air box heater fuel line.
3. Remove hose (Figure 1, Item 6) and two clamps (Figure 1, Item 7) from oil cooler assembly (Figure 1, Item 12).
4. If necessary, remove pipe plug (Figure 1, Item 17) from elbow (Figure 1, Item 4).
5. Remove two short bolts (Figure 1, Item 11), four long bolts (Figure 1, Item 16), six lockwashers (Figure 1, Item 10), and six flat washers (Figure 1, Item 9) from oil cooler assembly (Figure 1, Item 12) and clip (Figure 1, Item 8).
6. Remove four nuts (Figure 1, Item 15), four lockwashers (Figure 1, Item 14), and four flat washers (Figure 1, Item 13) from oil cooler assembly (Figure 1, Item 12). Discard lockwashers.



MAINT\_056

Figure 1. Engine/Transmission Hardware Removal.

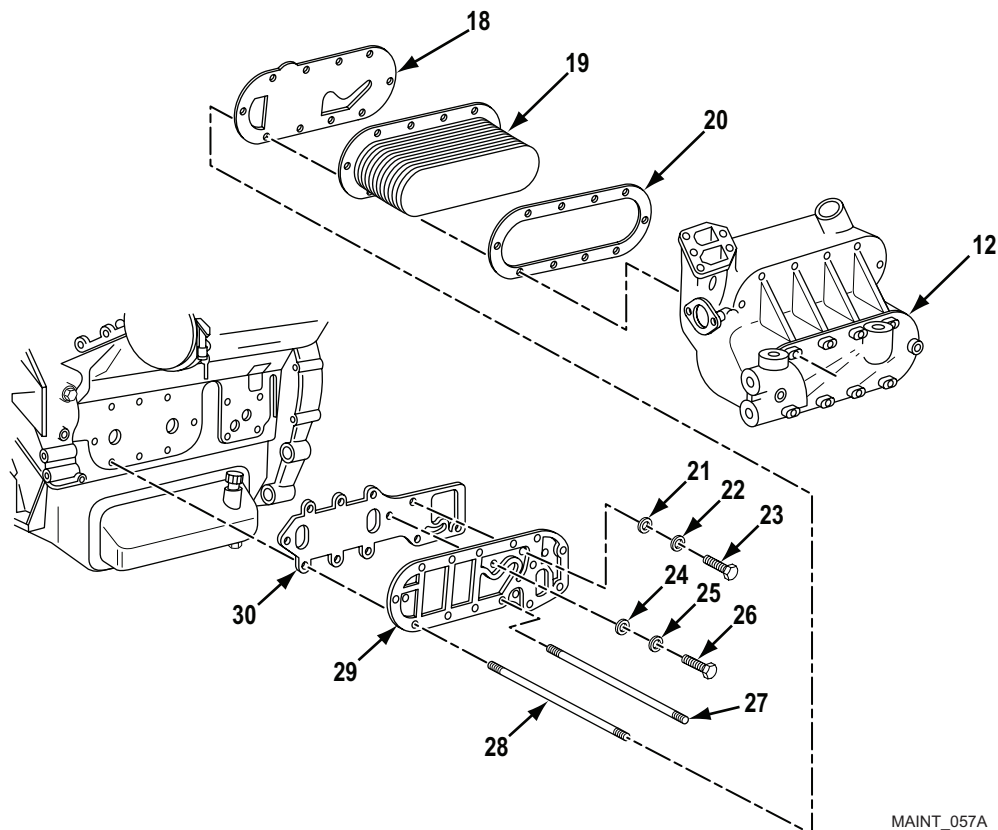
## REMOVAL - Continued

## WARNING



Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

7. Remove oil cooler assembly (Figure 2, Item 12) and gasket (Figure 2, Item 18). Discard gasket.
8. Remove oil cooler element (Figure 2, Item 19) and gasket (Figure 2, Item 20) from oil cooler assembly (Figure 2, Item 12). Discard gasket.
9. Remove three long studs (Figure 2, Item 28) and short stud (Figure 2, Item 27) from cylinder block.
10. Remove two large screws (Figure 2, Item 23), two lockwashers (Figure 2, Item 22), two flat washers (Figure 2, Item 21), small bolt (Figure 2, Item 26), lockwasher (Figure 2, Item 25), flat washer (Figure 2, Item 24), oil cooler adaptor (Figure 2, Item 29), and gasket (Figure 2, Item 30) from cylinder block. Discard gasket and lockwashers.



MAINT\_057A

Figure 2. Engine/Transmission Oil Cooler Removal.

END OF TASK

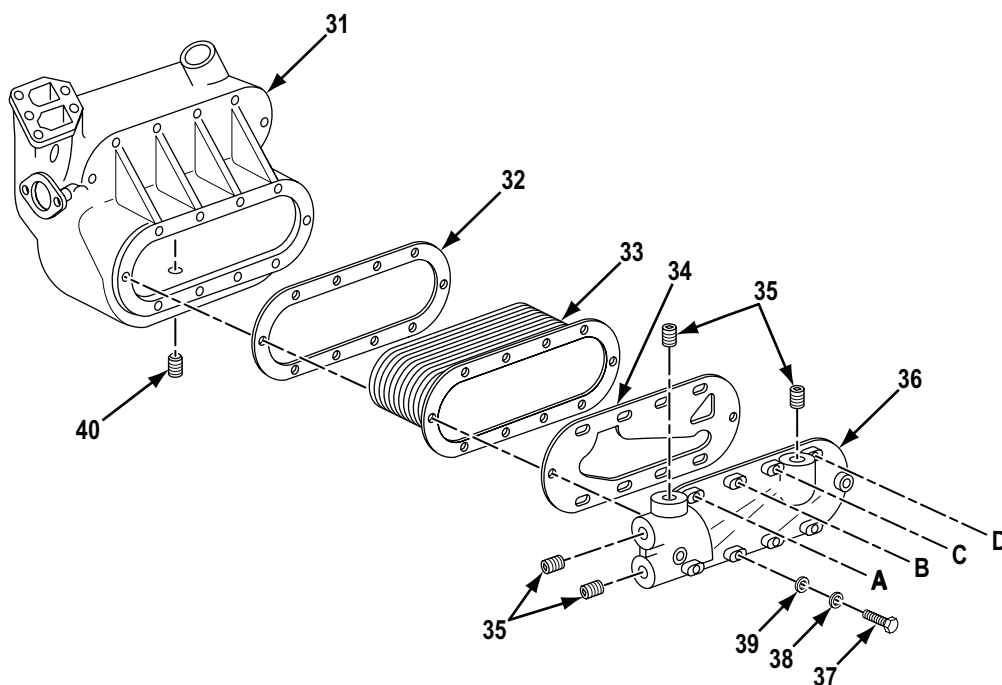
**DISASSEMBLY**

1. Remove six bolts (Figure 3, Item 37), six lockwashers (Figure 3, Item 38), six flat washers (Figure 3, Item 39), and cover (Figure 3, Item 36) from oil cooler housing (Figure 3, Item 31). Discard lockwashers.

**CAUTION**

Do not drop or damage oil coolers during removal. Any damage causing a leak in oil cooler can result in coolant in the engine oil.

2. Remove gasket (Figure 3, Item 34), transmission oil cooler (Figure 3, Item 33), and gasket (Figure 3, Item 32) from oil cooler housing (Figure 3, Item 31). Discard gaskets.
3. If necessary, remove four pipe plugs (Figure 3, Item 35) from cover (Figure 3, Item 36).
4. If necessary, remove pipe plug (Figure 3, Item 40) from bottom of oil cooler housing (Figure 3, Item 31).



MAINT\_058

Figure 3. Engine/Transmission Oil Cooler Disassembly.

**END OF TASK**

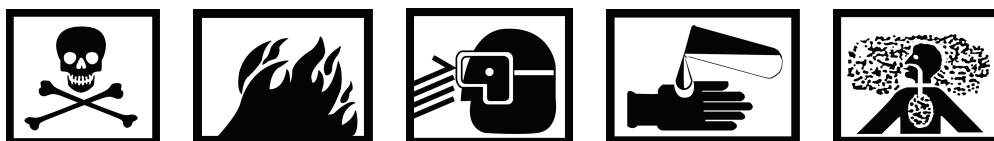
**CLEANING****WARNING**

Use Tech Solv 340 only with adequate ventilation. Vapors in high concentrations are anesthetic and dangerous to life. Avoid prolonged or repeated contact with skin. Do not take internally. Failure to comply may result in injury, illness, or death to personnel.

**NOTE**

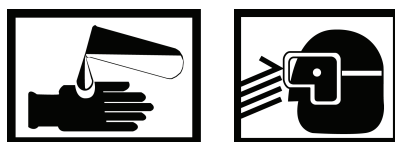
Do not clean oil cooler if engine or transmission has had metal particles enter oil system. Instead, replace oil cooler.

1. Oil Coolers - Oil Side: Pump Tech Solv 340 solution through oil cooler to remove carbon and sludge.

**WARNING**

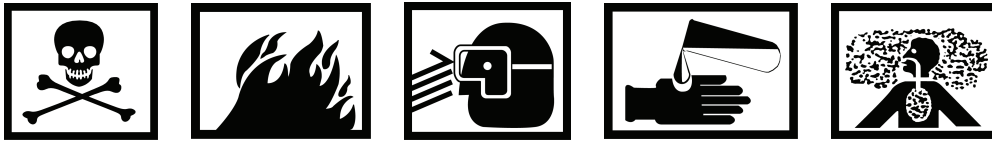
Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

2. If oil passages are badly clogged, pump cleaning solvent through oil cooler and flush thoroughly with clean, hot water.

**WARNING**

Coolant system cleaning solution contains acid. Wear protective goggles and equipment. Avoid contact with skin, eyes, and clothing. Always pour acid into water. Water poured into acid will spatter the acid. If contact is made, flush area with water and seek medical aid immediately. Failure to comply may result in injury to personnel.

3. Oil Coolers - Water Side: Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound (0.22 Kg) of oxalic acid for each 2.5 gallons (9.4 L) of solution.
4. Immerse oil coolers in solution.
5. Watch cleaning process carefully. Remove oil coolers from solution when bubbling stops (usually 30 to 60 seconds).
6. Flush oil coolers in clean hot water.
7. After cleaning oil cooler, dip in light oil.

**CLEANING - Continued****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

8. Clean oil cooler housing and cover with cleaning solvent and dry with compressed air.

**END OF TASK****TEST AND INSPECTION****WARNING**

Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler during high-pressure air-leak test. Failure to comply may result in injury to personnel.

1. Install rubber gasket (Figure 4, Item 42), fabricated blocking plate (Figure 4, Item 41), 10-5/16 inch diameter screws (Figure 4, Item 45), flat washers (Figure 4, Item 44), and nuts (Figure 4, Item 43) from pressure testing kit (WP 0081, Figure 6) on transmission oil cooler (Figure 4, Item 33) or engine oil cooler (Figure 4, Item 19).
2. Connect air line to blocking plate (Figure 4, Item 41) and apply pressure of 75 PSI (517 kPa) to oil cooler.



## TEST AND INSPECTION - Continued

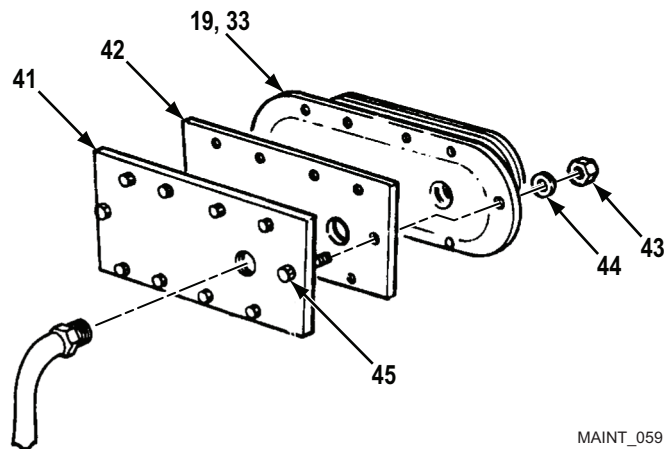
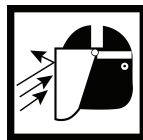


Figure 4. Engine/Transmission Oil Cooler Test and Inspection.

3. Submerge oil cooler assembly in a container of water heated to 180°F (82°C). Air bubbles in water indicate leaks. Replace oil cooler if leaks appear.
4. Release air pressure on cooler assembly. Remove blocking plate, rubber gasket, and hose from oil cooler.

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

5. Dry oil cooler with compressed air.

**END OF TASK**

**ASSEMBLY**

1. If removed, install pipe plug (Figure 5, Item 40) in bottom of oil cooler housing (Figure 5, Item 31).
2. Place new gasket (Figure 5, Item 32) on oil cooler housing (Figure 5, Item 31).

**NOTE**

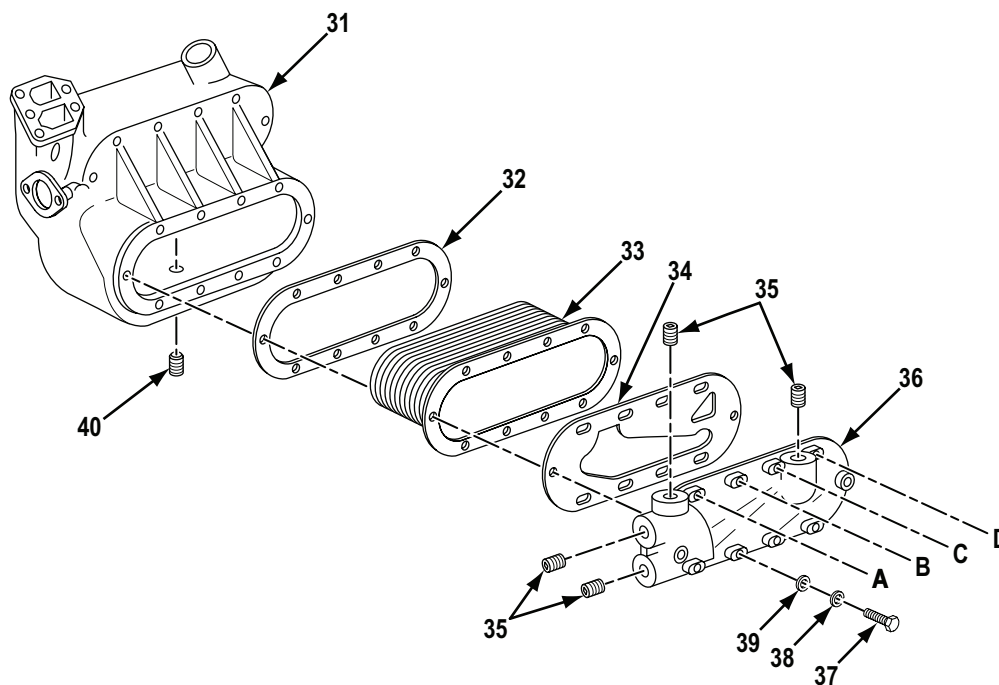
Inlet opening is marked "FROM" on cover and "IN" on oil cooler. Outlet opening is marked "TO" on cover and "OUT" on oil cooler. Oil coolers must be installed in correct position to prevent any foreign particles and sludge from entering engine or transmission.

3. Carefully place transmission oil cooler (Figure 5, Item 33) inside oil cooler housing (Figure 5, Item 31).

**NOTE**

Do not install bolts in locations (Figure 5, Item A), (Figure 5, Item B), (Figure 5, Item C), and (Figure 5, Item D).

4. Install new gasket (Figure 5, Item 34), cover (Figure 5, Item 36), six flat washers (Figure 5, Item 39), six new lockwashers (Figure 5, Item 38), and six bolts (Figure 5, Item 37) on transmission oil cooler (Figure 5, Item 33) and oil cooler housing (Figure 5, Item 31). Torque bolts to 13–17 lb-ft (18–23 N·m).
5. If removed, install four pipe plugs (Figure 5, Item 35) in cover (Figure 5, Item 36).



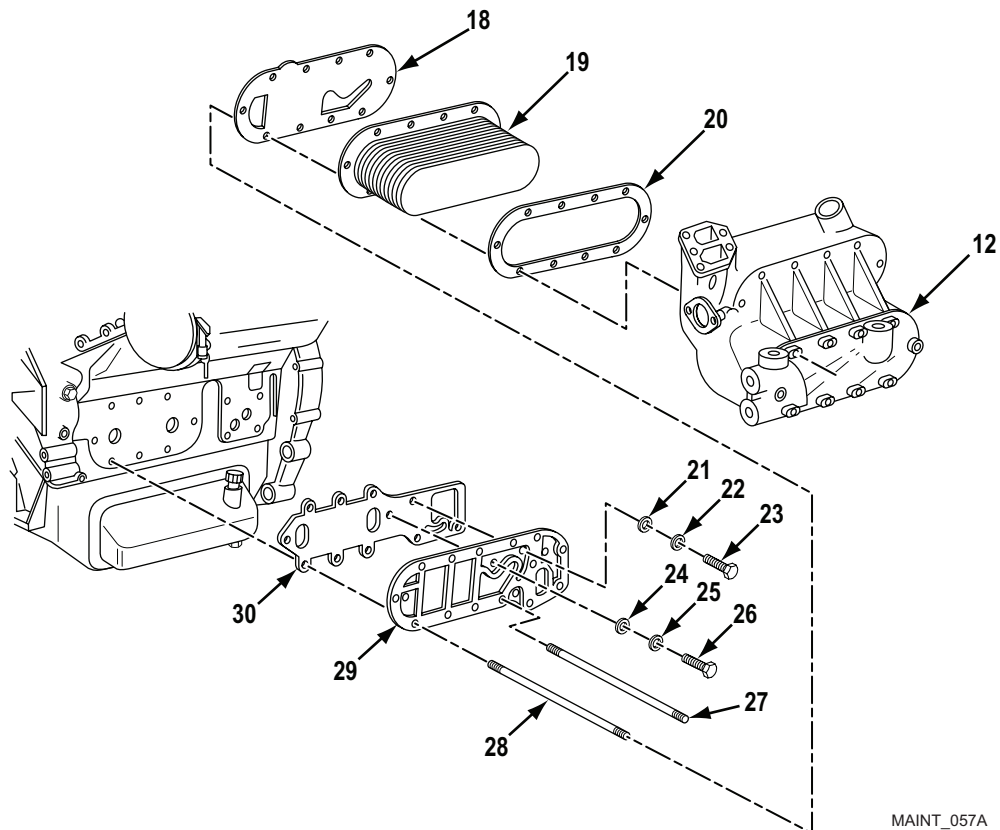
MAINT\_060

Figure 5. Engine/Transmission Oil Cooler Assembly.

**END OF TASK**

**INSTALLATION**

1. Install new gasket (Figure 6, Item 30), oil cooler adaptor (Figure 6, Item 29), two flat washers (Figure 6, Item 21), two new lockwashers (Figure 6, Item 22), two large screws (Figure 6, Item 23), flat washer (Figure 6, Item 24), new lockwasher (Figure 6, Item 25), and small bolt (Figure 6, Item 26) on cylinder block.
2. Torque two screws (Figure 6, Item 23) to 30–35 lb-ft (41–47 N·m) and bolt (Figure 6, Item 26) to 13–17 lb-ft (18–23 N·m).
3. Install two studs (Figure 6, Item 28) in positions (Figure 5, Item A) and (Figure 5, Item B) to act as guides.
4. Position new gasket (Figure 6, Item 18), oil cooler element (Figure 6, Item 19), and new gasket (Figure 6, Item 20) on two studs (Figure 6, Item 28) with port marked "IN" toward front of engine and slide gaskets (Figure 6, Items 18 and 20) and element (Figure 6, Item 19) up against oil cooler adaptor (Figure 6, Item 29).
5. Position oil cooler assembly (Figure 6, Item 12) on two studs (Figure 6, Item 28) and slide up against oil cooler adaptor (Figure 6, Item 29).



MAINT\_057A

Figure 6. Engine/Transmission Oil Cooler Installation.

**INSTALLATION - Continued**

6. Install four flat washers (Figure 7, Item 9), four new lockwashers (Figure 7, Item 10), two short bolts (Figure 7, Item 11) with lower rear bolt through clip (Figure 7, Item 8), and two long bolts (Figure 7, Item 16) in oil cooler assembly (Figure 7, Item 12).
7. Remove two guide studs (Figure 6, Item 28) and install remaining two flat washers (Figure 7, Item 9), two new lockwashers (Figure 7, Item 10), and two long bolts (Figure 7, Item 16).
8. Install three long studs (Figure 6, Item 28) and short stud (Figure 6, Item 27) on oil cooler assembly (Figure 7, Item 12).
9. Install four flat washers (Figure 7, Item 13), four new lockwashers (Figure 7, Item 14), and four nuts (Figure 7, Item 15) on studs (Figure 6, Items 27 and 28).
10. Torque two bolts (Figure 7, Item 11) and four bolts (Figure 7, Item 16) to 13–17 lb-ft (18–23 N·m). Torque four nuts (Figure 7, Item 15) to 15–19 lb-ft (20–26 N·m).
11. Slide hose (Figure 7, Item 6) and two clamps (Figure 7, Item 7) onto oil cooler assembly (Figure 7, Item 12).
12. If removed, install pipe plug (Figure 7, Item 17) in elbow (Figure 7, Item 4). If removed, install clip (Figure 7, Item 3) on air box heater fuel line (Figure 7, Item 46).

**NOTE**

Front bolt (Figure 7, Item 1) is installed through clip (Figure 7, Item 3), on fuel line (Figure 7, Item 46), into elbow (Figure 7, Item 4).

13. Slide elbow (Figure 7, Item 4) into hose (Figure 7, Item 6) and install new gasket (Figure 7, Item 5), elbow (Figure 7, Item 4), two new lockwashers (Figure 7, Item 2), and two bolts (Figure 7, Item 1) on cylinder block. Torque bolts to 13–17 lb-ft (18–23 N·m).
14. Adjust hose (Figure 7, Item 6) and two clamps (Figure 7, Item 7) between elbow (Figure 7, Item 4) and oil cooler assembly (Figure 7, Item 12) with clamp adjusting screws facing front of engine. Tighten clamps securely.

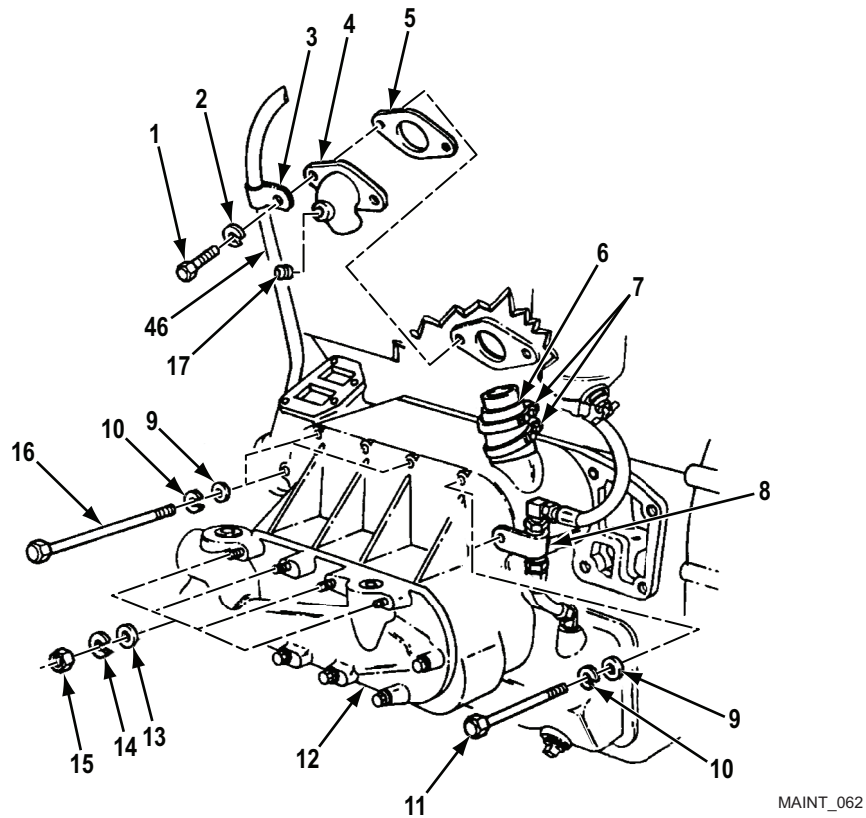
**INSTALLATION - Continued**

Figure 7. Engine/Transmission Oil Cooler Hardware Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install oil filter adaptor (WP 0018).
2. Install coolant pump (WP 0013).

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
ENGINE OIL COOLER REPLACEMENT  
(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pressure Testing Kit, Oil Cooler Core  
(WP 0081, Figure 5)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket Qty: (2) (WP 0105, Table 1, Item 21)  
Gasket (WP 0105, Table 1, Item 52)  
Gasket (WP 0105, Table 1, Item 61)  
Gasket (WP 0105, Table 1, Item 124)  
Hydrochloric Acid (WP 0103, Table 1, Item 20)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oxalic Acid (WP 0103, Table 1, Item 40)  
Stud, Oil Cooler  
Qty: (2) (WP 0103, Table 1, Item 63)  
Tech Solv 340 (WP 0103, Table 1, Item 65)

**Materials/Parts (cont.)**

Washer, Lock  
Qty: (13) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**References**

WP 0098

**Equipment Condition**

Transmission oil cooler removed (WP 0011)  
Fuel junction block removed (WP 0012)  
Coolant pump removed (WP 0013)  
Oil filter assembly and adaptor removed  
(WP 0019)

**REMOVAL**

1. Loosen two hose clamps (Figure 1, Item 8) and slide hose (Figure 1, Item 7) down onto oil cooler assembly (Figure 1, Item 9).
2. For model 5063-5393, remove two bolts (Figure 1, Item 1) through clip (Figure 1, Item 3), two lockwashers (Figure 1, Item 2), elbow (Figure 1, Item 5), and gasket (Figure 1, Item 6) from cylinder block. Discard gasket and lockwashers.
3. Remove hose (Figure 1, Item 7) and two clamps (Figure 1, Item 8) from oil cooler assembly (Figure 1, Item 9).
4. If necessary, remove pipe plug (Figure 1, Item 4) from elbow (Figure 1, Item 5).
5. Remove two bolts (Figure 1, Item 18), two lockwashers (Figure 1, Item 19), two flat washers (Figure 1, Item 20), and bracket (Figure 1, Item 21) from transmission oil cooler bracket (Figure 1, Item 14). Discard lockwashers.
6. Remove five screws (Figure 1, Item 15), five lockwashers (Figure 1, Item 16), five flat washers (Figure 1, Item 17), and transmission oil cooler bracket (Figure 1, Item 14) from oil cooler assembly (Figure 1, Item 9). Discard lockwashers.

**CAUTION**

Support oil cooler assembly during removal. Cooler element is fragile and damage can result from dropping.

7. Remove three bolts (Figure 1, Item 13) through clip (Figure 1, Item 10), three lockwashers (Figure 1, Item 12), three flat washers (Figure 1, Item 11), and oil cooler assembly (Figure 1, Item 9) from cylinder block. Discard lockwashers.

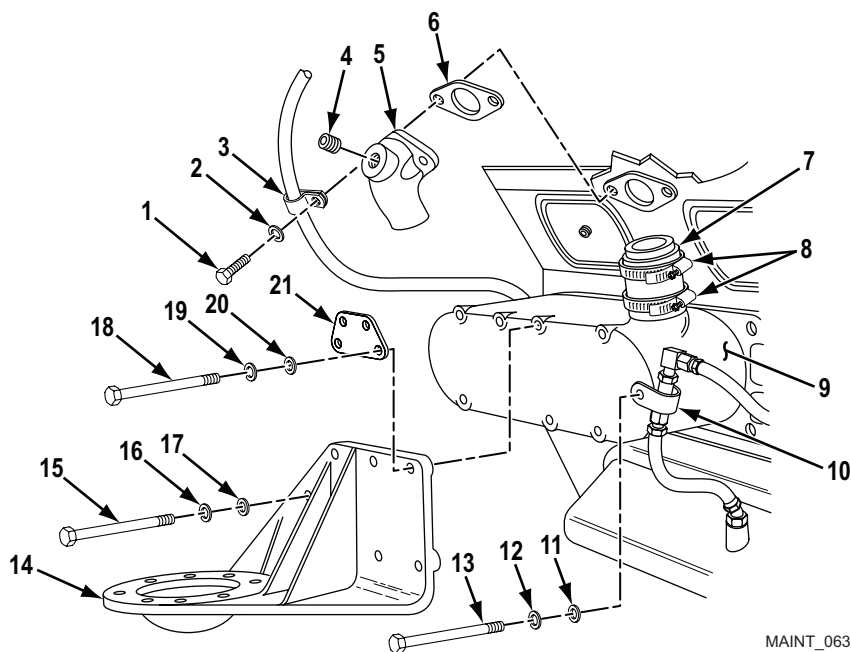


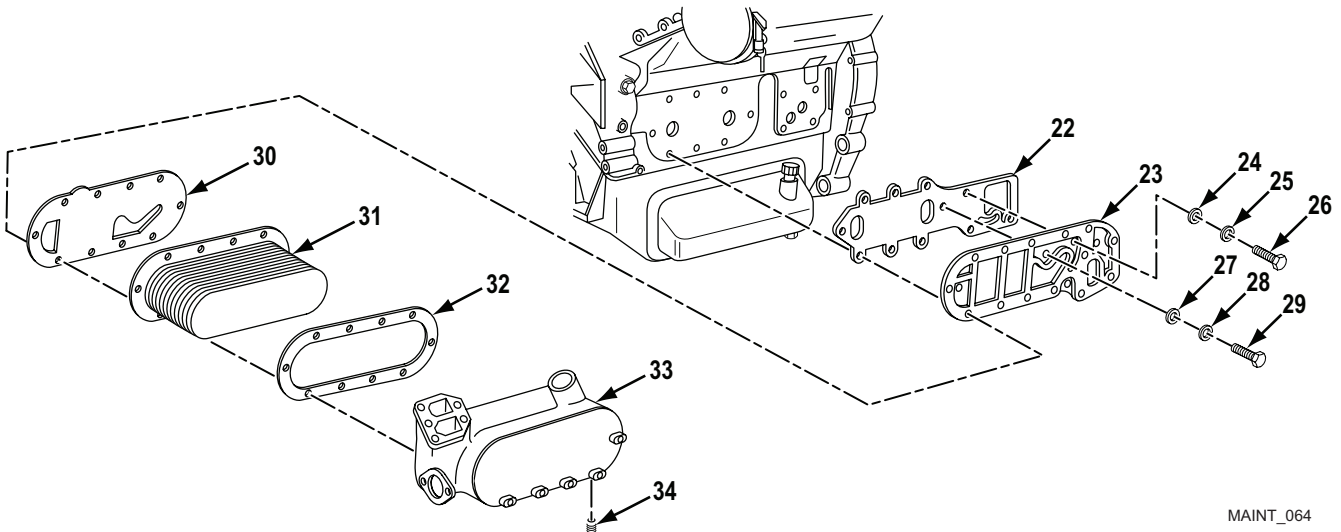
Figure 1. Engine Oil Cooler Hardware Removal.

8. Remove gasket (Figure 2, Item 30), oil cooler element (Figure 2, Item 31), and gasket (Figure 2, Item 32) from oil cooler housing (Figure 2, Item 33). Discard gaskets.



**REMOVAL - Continued**

9. Remove two large screws (Figure 2, Item 26), two lockwashers (Figure 2, Item 25), two flat washers (Figure 2, Item 24), small bolt (Figure 2, Item 29), lockwasher (Figure 2, Item 28), flat washer (Figure 2, Item 27), oil cooler adaptor (Figure 2, Item 23), and gasket (Figure 2, Item 22) from cylinder block. Discard gasket and lockwashers.
10. If necessary, remove pipe plug (Figure 2, Item 34) from bottom of engine oil cooler housing (Figure 2, Item 33).



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Figure 2. Engine Oil Cooler Removal.

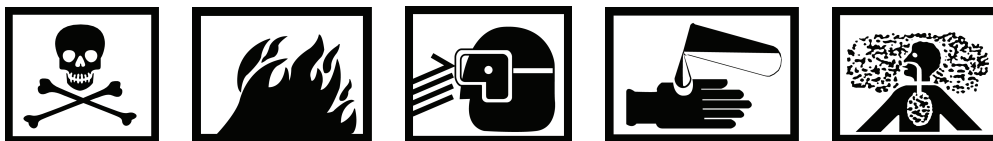
**END OF TASK****CLEANING****WARNING**

Use Tech Solv 340 only with adequate ventilation. Vapors in high concentrations are anesthetic and dangerous to life. Avoid prolonged or repeated contact with skin. Do not take internally. Failure to comply may result in injury, illness, or death to personnel.

**NOTE**

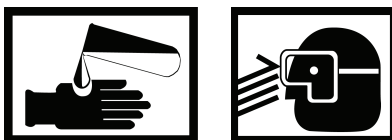
Do not clean an oil cooler if metal particles from engine or transmission have entered oil system. Instead, replace oil cooler.

1. Oil cooler element - Oil side - Pump Tech Solv 340 solution through oil cooler element (Figure 3, Item 31) to remove sludge.

**CLEANING - Continued****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

2. If oil passages are badly clogged, circulate cleaning solvent through oil cooler element and flush thoroughly with clean, hot water.

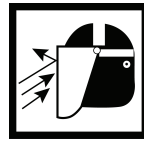
**WARNING**

Coolant system cleaning solution is an acid. Wear protective goggles and equipment. Avoid contact with skin, eyes, and clothing. If contact is made, flush area with water and seek medical aid immediately. Failure to comply may result in injury to personnel.

3. Oil cooler element - Water side - Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound (0.2 kg) of oxalic acid for each 2.5 gallons (9.5 liters) of solution.
4. Immerse oil cooler element in solution.
5. Watch cleaning process carefully. Remove oil cooler element from solution when bubbling stops (usually takes 30 to 60 seconds).
6. Flush oil cooler element in clean hot water.
7. After cleaning oil cooler element, dip in light oil.

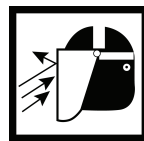
**END OF TASK**

## TEST AND INSPECTION

**WARNING**

Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler during high-pressure air-leak test. Failure to comply may result in injury to personnel.

1. Using engine oil cooler core pressure testing kit, see (WP 0081, Figure 5), place rubber gasket (Figure 3, Item 36), fabricated blocking plate (Figure 3, Item 35), 10 bolts (Figure 3, Item 39), 10 flat washers (Figure 3, Item 38), and 10 nuts (Figure 3, Item 37) over flanged side of oil cooler element (Figure 3, Item 31) with threaded hole at inlet opening in oil cooler.
2. Connect air line to steel plate (Figure 3, Item 35) and apply pressure of 75 PSI (517 kPa) to oil cooler element (Figure 3, Item 31).
3. Submerge oil cooler assembly in a container of water heated to 180°F (82°C). Air bubbles in the water indicate leaks. Replace oil cooler if it leaks.
4. Release air pressure on cooler assembly. Remove steel plate (Figure 3, Item 35), rubber gasket (Figure 3, Item 36), and hose from oil cooler element (Figure 3, Item 31).

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

5. Dry oil cooler with compressed air.

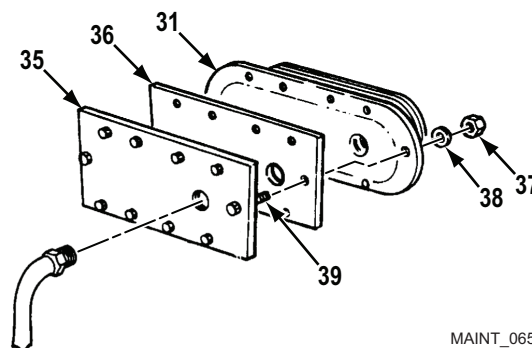


Figure 3. Engine Oil Cooler Test and Inspection.

**END OF TASK**

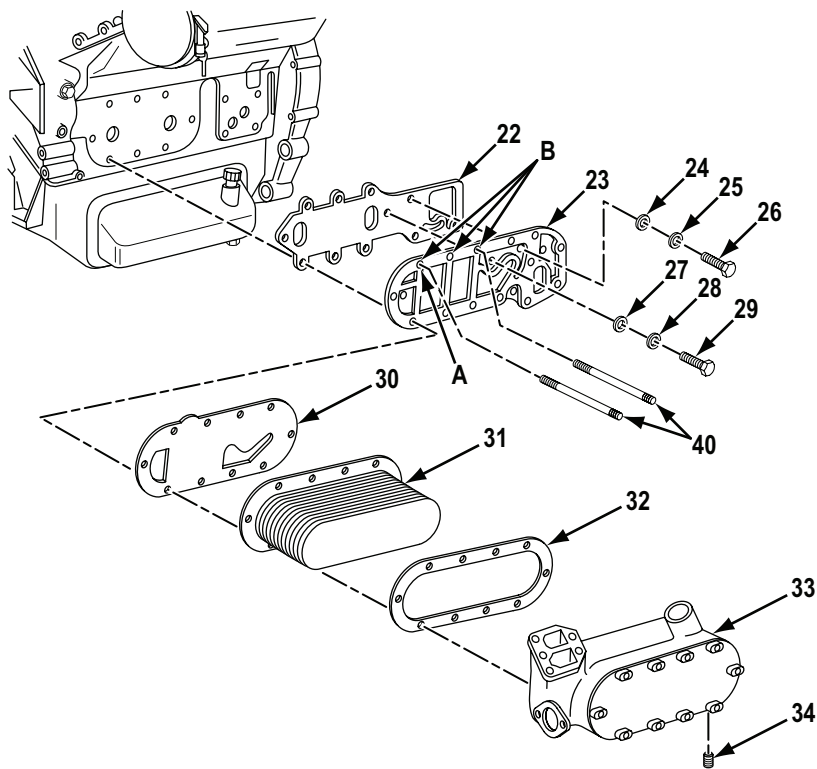
**INSTALLATION**

1. If removed, install pipe plug (Figure 4, Item 34) in bottom of oil cooler housing (Figure 4, Item 33).
2. Install two oil cooler studs (Figure 4, Item 40) in positions (A) and (B).
3. Install new gasket (Figure 4, Item 22), oil cooler adaptor (Figure 4, Item 23), two flat washers (Figure 4, Item 24), two new lockwashers (Figure 4, Item 25), two large screws (Figure 4, Item 26), flat washer (Figure 4, Item 27), new lockwasher (Figure 4, Item 28), and small bolt (Figure 4, Item 29) on cylinder block. Torque two screws (Figure 4, Item 26) to 30–35 lb-ft (41–47 N·m) and bolt (Figure 4, Item 29) to 13–17 lb-ft (18–23 N·m).

**NOTE**

Some older oil cooler elements have "IN" and "OUT" stamped on the ports. If the element is so marked, install the port marked "IN" toward front of engine.

4. Install new gasket (Figure 4, Item 30), oil cooler element (Figure 4, Item 31), and new gasket (Figure 4, Item 32) on oil cooler studs (Figure 4, Item 40) and slide gaskets (Figure 4, Items 30 and 32) and element (Figure 4, Item 31) up against cylinder block.
5. Place oil cooler housing (Figure 4, Item 33) on studs (Figure 4, Item 40) and slide up against cylinder block.



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Figure 4. Engine Oil Cooler Installation.

**INSTALLATION - Continued****NOTE**

Center bolt (Figure 5, Item 13) is installed through clip (Figure 5, Item 10) into oil cooler assembly (Figure 5, Item 9).

6. Loosely install three flat washers (Figure 5, Item 11), three new lockwashers (Figure 5, Item 12), and three bolts (Figure 5, Item 13) on oil cooler assembly (Figure 5, Item 9). Remove two oil cooler studs (Figure 4, Item 40).
7. Install transmission oil cooler bracket (Figure 5, Item 14), five flat washers (Figure 5, Item 17), five new lockwashers (Figure 5, Item 16), and five bolts (Figure 5, Item 15) on oil cooler assembly (Figure 5, Item 9).
8. Install bracket (Figure 5, Item 21), two flat washers (Figure 5, Item 20), two new lockwashers (Figure 5, Item 19), and two bolts (Figure 5, Item 18) on transmission oil cooler bracket (Figure 5, Item 14).
9. Torque two bolts (Figure 5, Item 18), five bolts (Figure 5, Item 15), and three bolts (Figure 5, Item 13) to 13–17 lb-ft (18–23 N·m).
10. Slide hose (Figure 5, Item 7) and two clamps (Figure 5, Item 8) onto oil cooler assembly (Figure 5, Item 9).
11. If removed, install pipe plug (Figure 5, Item 4) in elbow (Figure 5, Item 5).
12. Insert elbow (Figure 5, Item 5) into hose (Figure 5, Item 7) and install new gasket (Figure 5, Item 6), elbow (Figure 5, Item 5), two new lockwashers (Figure 5, Item 2), and two bolts (Figure 5, Item 1) on cylinder block. On model 5063-5393, the front (left) bolt goes through clip (Figure 5, Item 3) on hose (Figure 5, Item 40). Torque bolts to 13–17 lb-ft (18–23 N·m).
13. Adjust hose (Figure 5, Item 7) and two clamps (Figure 5, Item 8) between elbow (Figure 5, Item 5) and oil cooler assembly (Figure 5, Item 9) with clamp adjusting screws facing front of engine. Tighten clamps securely.

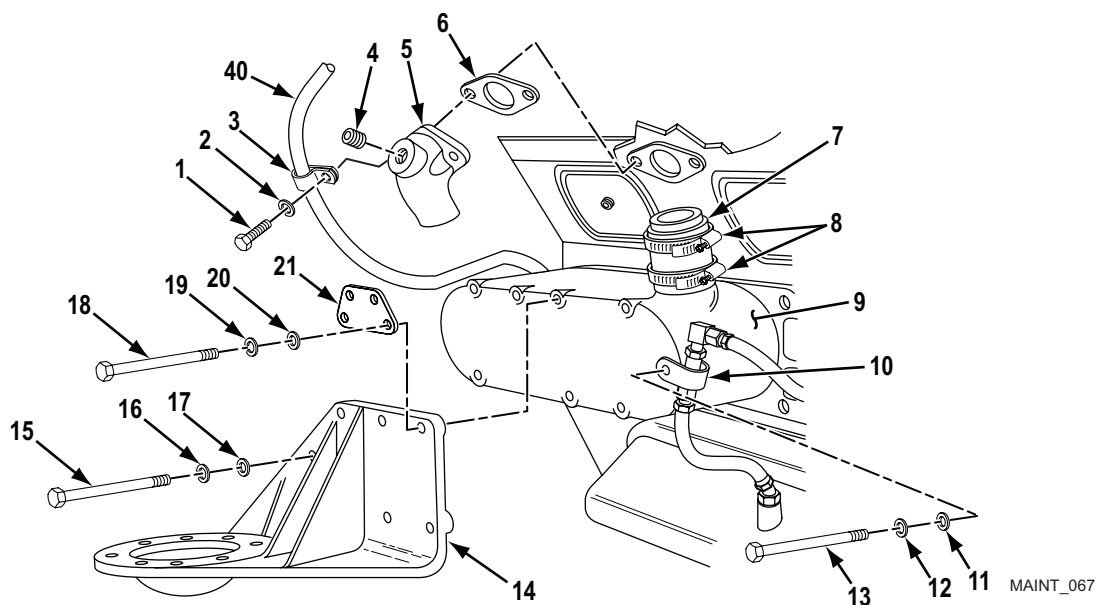


Figure 5. Engine Oil Cooler Hardware Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install oil filter assembly and adaptor (WP 0019).
2. Install coolant pump (WP 0013).
3. Install fuel junction block (WP 0012).
4. Install transmission oil cooler (WP 0011).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
FUEL FILTERS AND MOUNTING BRACKET REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)

**References**

WP 0031

**Equipment Condition**

Oil filter assembly removed (WP 0018)

**Materials/Parts**

Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 180)

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**REMOVAL**

1. Disconnect hose assembly (Figure 1, Item 4) from elbow (Figure 1, Item 5) on fuel strainer assembly (Figure 1, Item 9).
2. If necessary, remove elbow (Figure 1, Item 5) from fuel strainer assembly (Figure 1, Item 9).
3. Disconnect hose assembly (Figure 1, Item 1) from tee (Figure 1, Item 14) on fuel filter assembly (Figure 1, Item 11).
4. Disconnect hose assembly (Figure 1, Item 3) from connector (Figure 1, Item 2) on fuel filter assembly (Figure 1, Item 11).
5. If necessary, remove pipe plug (Figure 1, Item 15) from tee (Figure 1, Item 14) in fuel filter assembly (Figure 1, Item 11).
6. If necessary, remove two pipe plugs (Figure 1, Item 13), connector (Figure 1, Item 2), and tee (Figure 1, Item 14) from fuel filter assembly (Figure 1, Item 11).

**NOTE**

It may be necessary to remove two screws (Figure 1, Item 12) from upper section of fuel filter assembly, to remove the lower canister due to interference (WP 0031).

7. Remove two nuts (Figure 1, Item 8), two lockwashers (Figure 1, Item 7), and two flat washers (Figure 1, Item 6) from two screws (Figure 1, Item 12), fastening fuel filter assembly (Figure 1, Item 11) and fuel strainer assembly (Figure 1, Item 9) to filter mounting bracket (Figure 1, Item 10). Remove fuel strainer (Figure 1, Item 9) and fuel filter (Figure 1, Item 11) assemblies. Discard lockwashers.

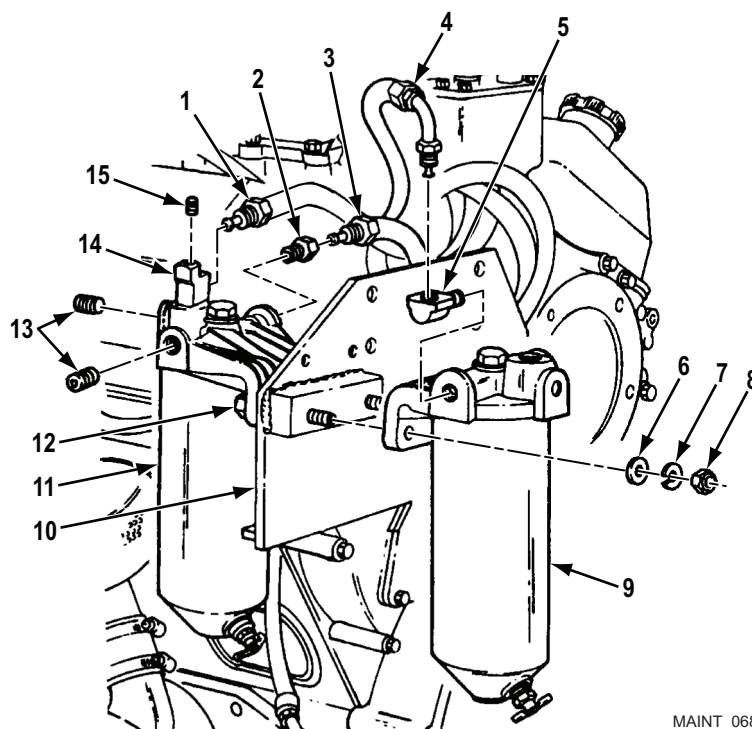
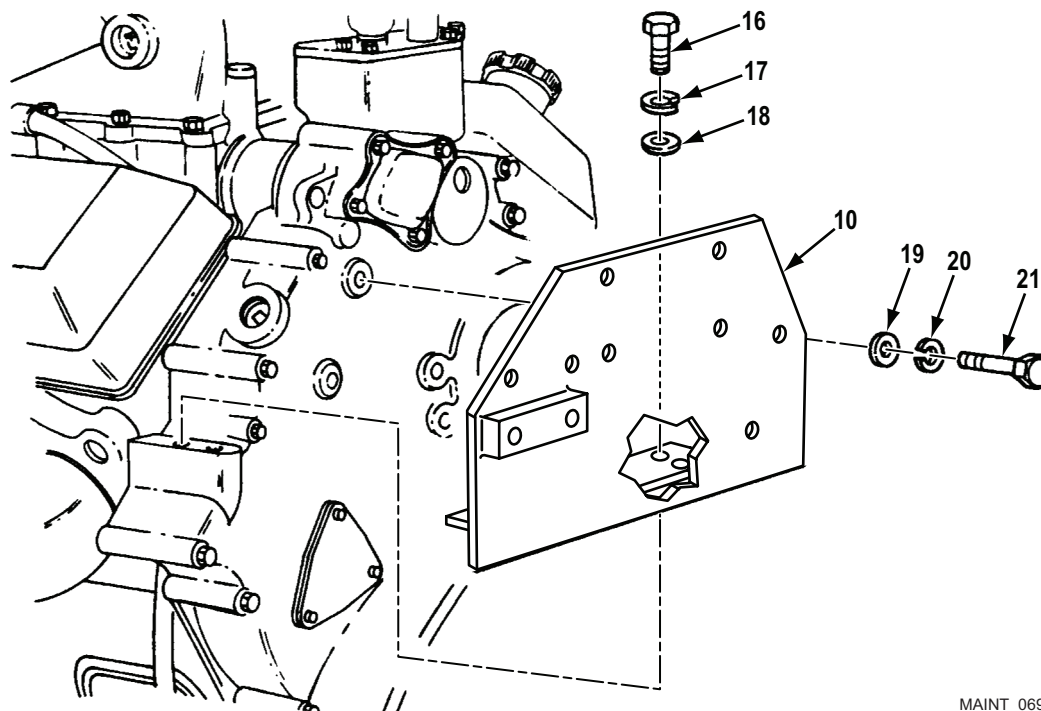


Figure 1. Fuel Filter Removal/Installation.



**REMOVAL - Continued**

8. Remove two short screws (Figure 2, Item 16), two lockwashers (Figure 2, Item 17), two flat washers (Figure 2, Item 18), two long screws (Figure 2, Item 21), two lockwashers (Figure 2, Item 20), two flat washers (Figure 2, Item 19), and filter mounting bracket (Figure 2, Item 10). Discard lockwashers.



MAINT\_069

Figure 2. Fuel Filter Mounting Bracket Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install filter mounting bracket (Figure 2, Item 10), two flat washers (Figure 2, Item 19), two new lockwashers (Figure 2, Item 20), two long screws (Figure 2, Item 21) (into side of flywheel housing), two flat washers (Figure 2, Item 18), two new lockwashers (Figure 2, Item 17), and two short screws (Figure 2, Item 16) (into top of flywheel housing). Torque screws (Figure 2, Item 21) to 71–75 lb-ft (96–102 N·m) and screws (Figure 2, Item 16) to 30–35 lb-ft (41–47 N·m).

**NOTE**

If two screws (Figure 1, Item 12) in upper section of fuel filter assembly have been removed, remove the lower canister to install screws due to interference (WP 0031).

2. Install two screws (Figure 1, Item 12), fuel filter assembly (Figure 1, Item 11), fuel strainer assembly (Figure 1, Item 9), two flat washers (Figure 1, Item 6), two new lockwashers (Figure 1, Item 7), and two nuts (Figure 1, Item 8) on filter mounting bracket (Figure 1, Item 10). Torque nuts to 30–35 lb-ft (41–47 N·m).
3. If removed, install two pipe plugs (Figure 1, Item 13), connector (Figure 1, Item 2), and tee (Figure 1, Item 14) on fuel filter assembly (Figure 1, Item 11).
4. If removed, install pipe plug (Figure 1, Item 15) in tee (Figure 1, Item 14) on fuel filter assembly (Figure 1, Item 11).

**INSTALLATION - Continued**

5. If removed, install elbow (Figure 1, Item 5) in fuel strainer assembly (Figure 1, Item 9).
6. Connect hose assembly (Figure 1, Item 1) from fuel pump outlet to tee (Figure 1, Item 14) on fuel filter assembly (Figure 1, Item 11). Tighten hose connection.
7. Connect hose assembly (Figure 1, Item 3) from left cylinder head to connector (Figure 1, Item 2) on fuel filter assembly (Figure 1, Item 11). Tighten hose connection.
8. Connect hose assembly (Figure 1, Item 4) from fuel pump inlet to elbow (Figure 1, Item 5) on fuel strainer assembly (Figure 1, Item 9). Tighten hose connection.

**END OF TASK****FOLLOW ON TASK**

Install oil filter assembly (WP 0018).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**FUEL FILTERS AND MOUNTING BRACKETS REPLACEMENT**  
**(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)

**Materials/Parts (cont.)**

Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 178)  
Washer, Lock (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 182)

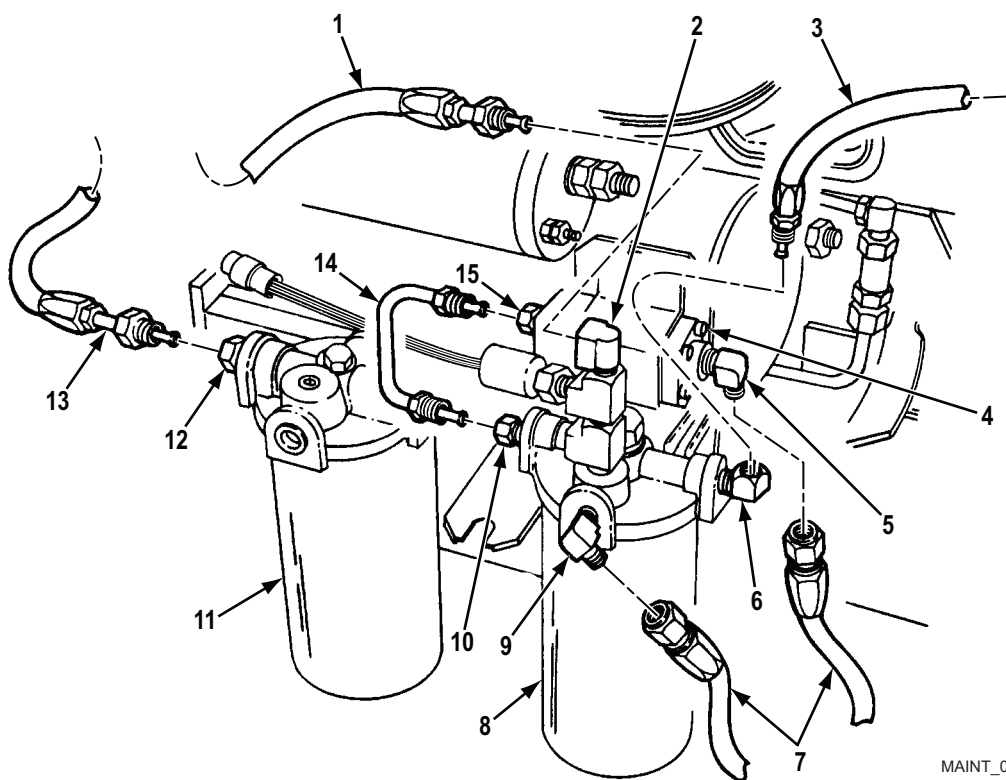
**Materials/Parts**

Nut, Self-locking  
Qty: (8) (WP 0105, Table 1, Item 167)

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**REMOVAL**

1. Disconnect hose assembly (Figure 1, Item 13) at connector (Figure 1, Item 12) on fuel strainer assembly (Figure 1, Item 11).
2. Disconnect hose assembly (Figure 1, Item 3) at elbow (Figure 1, Item 6) on fuel filter assembly (Figure 1, Item 8).
3. Disconnect hose assembly (Figure 1, Item 1) at elbow (Figure 1, Item 2) on fuel filter assembly (Figure 1, Item 8).
4. Disconnect hose assembly (Figure 1, Item 7) at elbow (Figure 1, Item 9) on fuel filter assembly (Figure 1, Item 8) and at elbow (Figure 1, Item 5) on pressure switch (Figure 1, Item 4). Remove hose assembly.
5. Disconnect tube assembly (Figure 1, Item 14) at connector (Figure 1, Item 10) on fuel filter assembly (Figure 1, Item 8) and at connector (Figure 1, Item 15) on pressure switch (Figure 1, Item 4). Remove tube assembly.

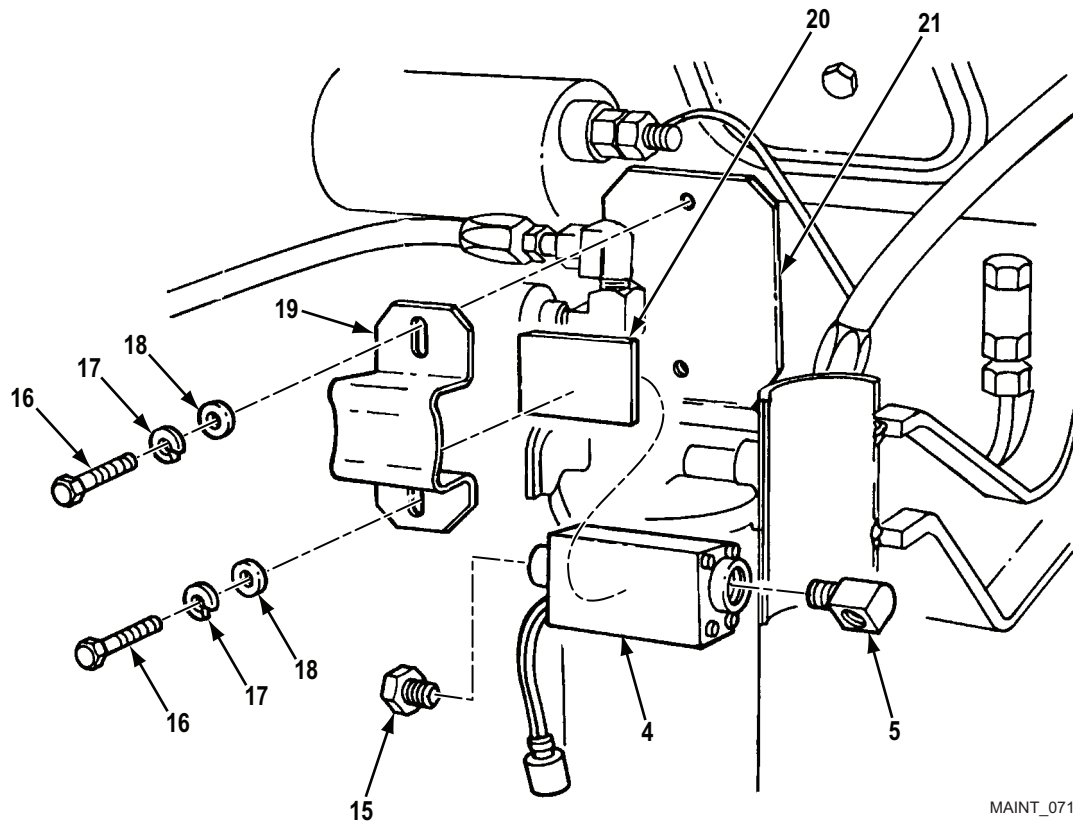


MAINT\_070

Figure 1. Fuel Filter Assembly Removal.

**REMOVAL - Continued**

6. Remove two bolts (Figure 2, Item 16), two lockwashers (Figure 2, Item 17), two flat washers (Figure 2, Item 18), pad (Figure 2, Item 20), pressure switch (Figure 2, Item 4), and pad bracket (Figure 2, Item 19) from pressure switch bracket (Figure 2, Item 21). Discard lockwashers.
7. If necessary, remove elbow (Figure 2, Item 5) and connector (Figure 2, Item 15) from pressure switch (Figure 2, Item 4).

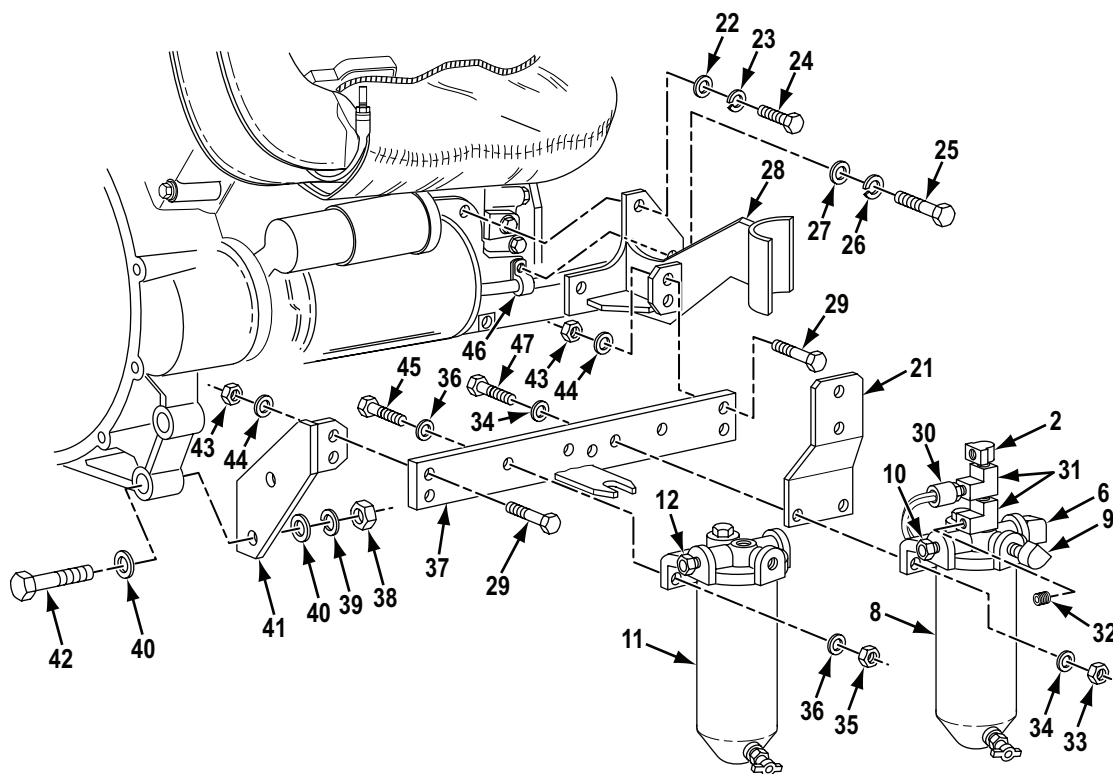


MAINT\_071

Figure 2. Fuel Pressure Switch Removal.

**REMOVAL - Continued**

8. Remove two screws (Figure 3, Item 45), four flat washers (Figure 3, Item 36), two locknuts (Figure 3, Item 35), and fuel strainer assembly (Figure 3, Item 11) from center mounting bracket (Figure 3, Item 37). Discard locknuts.
9. Remove two screws (Figure 3, Item 47), four flat washers (Figure 3, Item 34), two locknuts (Figure 3, Item 33), fuel filter assembly (Figure 3, Item 8), and pressure switch bracket (Figure 3, Item 21) from center mounting bracket (Figure 3, Item 37). Discard locknuts.
10. Remove four screws (Figure 3, Item 29), four flat washers (Figure 3, Item 44), four locknuts (Figure 3, Item 43), and center bracket (Figure 3, Item 37) from end bracket (Figure 3, Item 28) and end bracket (Figure 3, Item 41). Discard locknuts.
11. Remove two screws (Figure 3, Item 42), four flat washers (Figure 3, Item 40), two lockwashers (Figure 3, Item 39), two nuts (Figure 3, Item 38), and end bracket (Figure 3, Item 41) from engine flywheel housing. Discard lockwashers.
12. Remove two small bolts (Figure 3, Item 24), two lockwashers (Figure 3, Item 23), two flat washers (Figure 3, Item 22), large screw (Figure 3, Item 25), lockwasher (Figure 3, Item 26), flat washer (Figure 3, Item 27), and end bracket (Figure 3, Item 28) from side of cylinder block. Discard lockwashers.
13. If necessary, remove connector (Figure 3, Item 12) from fuel strainer assembly (Figure 3, Item 11).
14. If necessary, remove elbow (Figure 3, Item 6), elbow (Figure 3, Item 2), elbow (Figure 3, Item 9), connector (Figure 3, Item 10), transducer (Figure 3, Item 30), two tees (Figure 3, Item 31), and pipe plug (Figure 3, Item 32) from fuel filter assembly (Figure 3, Item 8).



MAINT\_072

Figure 3. Fuel Filter Assembly Mounting Bracket Removal/Installation.

**END OF TASK**

**INSTALLATION**

1. Install lower small bolt (Figure 3, Item 24) through clip (Figure 3, Item 46) on air box drain tube.
2. Install end bracket (Figure 3, Item 28), two flat washers (Figure 3, Item 22), two new lockwashers (Figure 3, Item 23), two small bolts (Figure 3, Item 24), flat washer (Figure 3, Item 27), new lockwasher (Figure 3, Item 26), and large screw (Figure 3, Item 25) on side of cylinder block. Torque two bolts (Figure 3, Item 24) to 13–17 lb-ft (18–23 N·m) and torque screw (Figure 3, Item 25) to 30–35 lb-ft (41–47 N·m).
3. Install two screws (Figure 3, Item 42), four flat washers (Figure 3, Item 40), end bracket (Figure 3, Item 41), two new lockwashers (Figure 3, Item 39), and two nuts (Figure 3, Item 38) on engine flywheel housing. Torque screws to 240–250 lb-ft (326–340 N·m).
4. Install four screws (Figure 3, Item 29), center mounting bracket (Figure 3, Item 37), four flat washers (Figure 3, Item 44), and four new locknuts (Figure 3, Item 43) on end bracket (Figure 3, Item 28) and end bracket (Figure 3, Item 41). Torque screws to 30–35 lb-ft (41–47 N·m).
5. Install two screws (Figure 3, Item 47), pressure switch bracket (Figure 3, Item 21), fuel filter assembly (Figure 3, Item 8), four flat washers (Figure 3, Item 34), and two new locknuts (Figure 3, Item 33) on center mounting bracket (Figure 3, Item 37). Torque screws to 30–35 lb-ft (41–47 N·m).
6. Install two screws (Figure 3, Item 45), fuel strainer assembly (Figure 3, Item 11), four flat washers (Figure 3, Item 36), and two new locknuts (Figure 3, Item 35) on center mounting bracket (Figure 3, Item 37). Torque screws to 30–35 lb-ft (41–47 N·m).
7. If removed, install elbow (Figure 3, Item 6), elbow (Figure 3, Item 9), connector (Figure 3, Item 10), two tees (Figure 3, Item 31), transducer (Figure 3, Item 30), elbow (Figure 3, Item 2), and pipe plug (Figure 3, Item 32) on fuel filter assembly (Figure 3, Item 8) as shown.
8. If removed, install connector (Figure 3, Item 12) on fuel strainer assembly (Figure 3, Item 11).

**INSTALLATION - Continued**

9. If removed, install elbow (Figure 4, Item 5) and connector (Figure 4, Item 15) in pressure switch (Figure 4, Item 4).
10. Install pressure switch (Figure 4, Item 4), pad (Figure 4, Item 20), pad bracket (Figure 4, Item 19), two flat washers (Figure 4, Item 18), two new lockwashers (Figure 4, Item 17), and two bolts (Figure 4, Item 16) on pressure switch bracket (Figure 4, Item 21). Loosely tighten bolts.
11. Connect tube assembly (Figure 5, Item 14) to connector (Figure 5, Item 10) on fuel filter assembly (Figure 5, Item 8) and to connector (Figure 5, Item 15) on pressure switch (Figure 5, Item 4). Tighten tube connections.
12. Torque two bolts (Figure 4, Item 16) to 13–17 lb-ft (18–23 N·m).

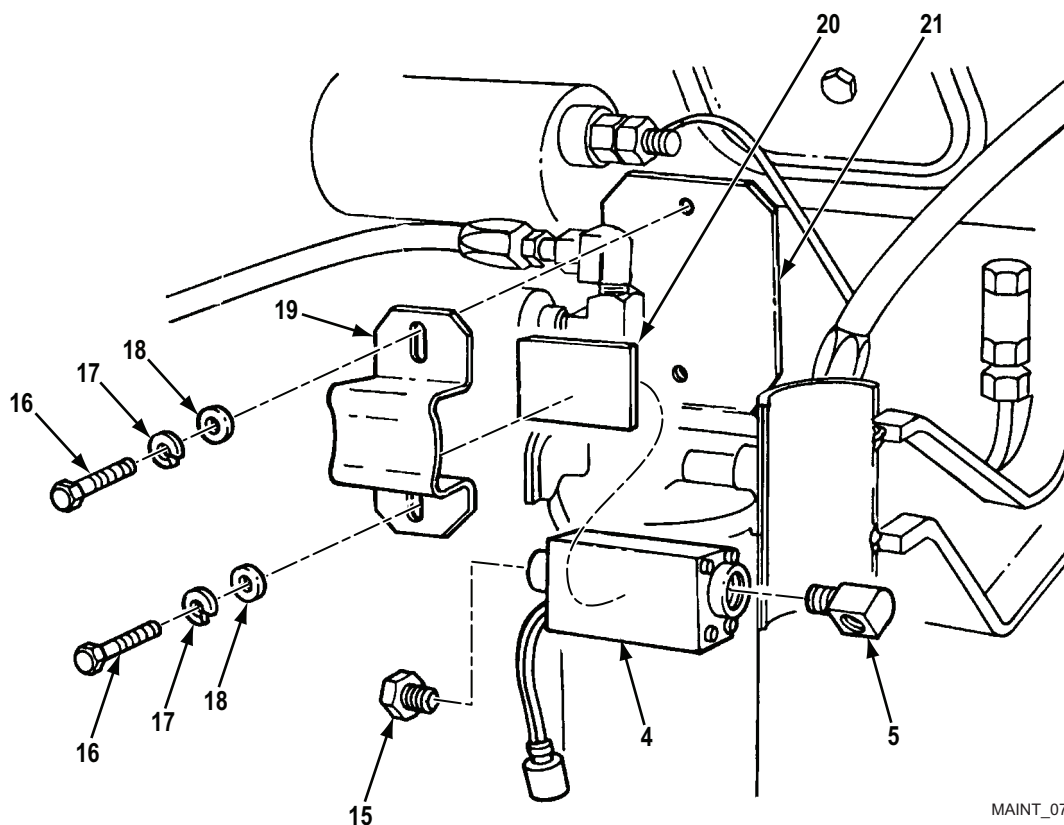
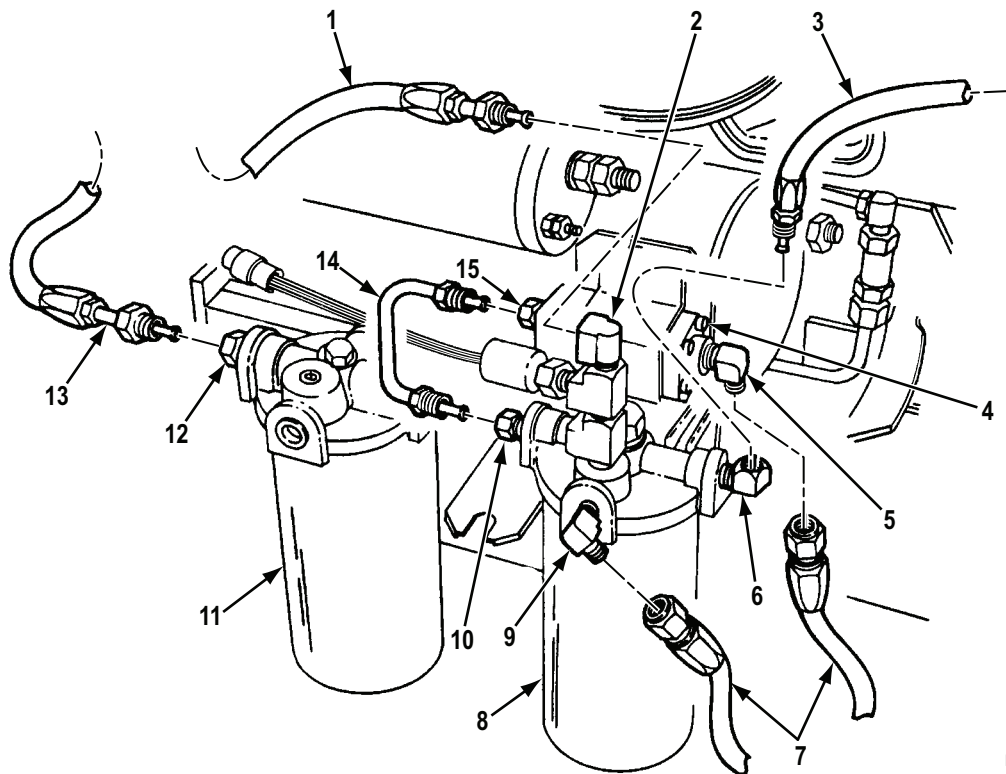


Figure 4. Pressure Switch Installation.



**INSTALLATION - Continued**

13. Connect hose assembly (Figure 5, Item 7) to elbow (Figure 5, Item 9) on fuel filter assembly (Figure 5, Item 8) and to elbow (Figure 5, Item 5) on pressure switch (Figure 5, Item 4). Tighten hose connections.
14. Connect hose assembly (Figure 5, Item 1) to elbow (Figure 5, Item 2) on fuel filter assembly (Figure 5, Item 8). Tighten hose connection.
15. Connect hose assembly (Figure 5, Item 4) to elbow (Figure 5, Item 6) on fuel filter assembly (Figure 5, Item 8). Tighten hose connection.
16. Connect hose assembly (Figure 5, Item 13) to connector (Figure 5, Item 12) on fuel strainer assembly (Figure 5, Item 11). Tighten hose connection.



MAINT\_074

Figure 5. Fuel Filters Assembly Installation.

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**TURBOCHARGER OIL SUPPLY LINE REPLACEMENT**  
**(MODELS 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**References**

WP 0018  
WP 0019

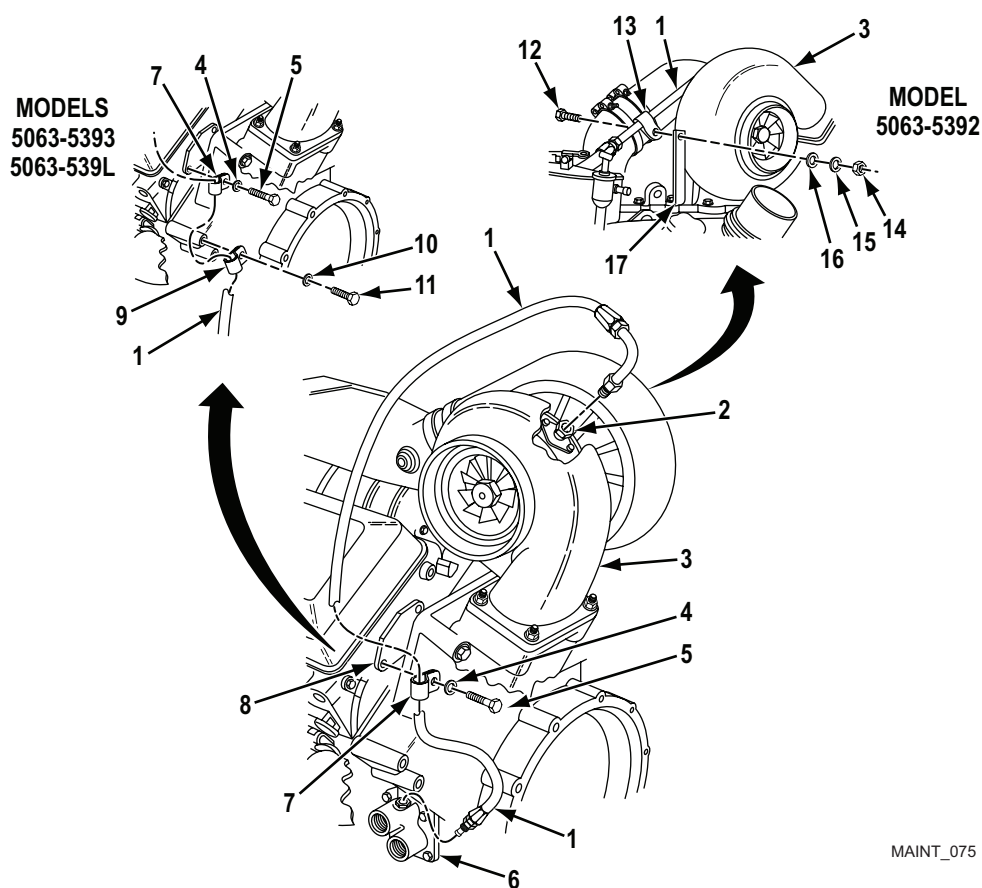
**Materials/Parts**

Washer, Lock (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Disconnect hose assembly (Figure 1, Item 1) from connector (Figure 1, Item 2) in top of turbocharger (Figure 1, Item 3).
2. Remove screw (Figure 1, Item 5) and lockwasher (Figure 1, Item 4) from clip (Figure 1, Item 7) on hose assembly (Figure 1, Item 1) at plate (Figure 1, Item 8) on rear of left cylinder head. Discard lockwasher. If necessary, remove clip (Figure 1, Item 7) from hose assembly (Figure 1, Item 1).
3. For model 5063-5392, remove screw (Figure 1, Item 12), flat washer (Figure 1, Item 16), lockwasher (Figure 1, Item 15), and nut (Figure 1, Item 14) from clip (Figure 1, Item 13) on hose assembly (Figure 1, Item 1) and from bracket (Figure 1, Item 17) on air inlet housing. Discard lockwasher. If necessary, remove clip (Figure 1, Item 13) from hose assembly (Figure 1, Item 1).
4. For models 5063-5393 and 5063-539L, remove screw (Figure 1, Item 11) and lockwasher (Figure 1, Item 10) from clip (Figure 1, Item 9) on hose assembly (Figure 1, Item 1) at left side of flywheel housing. Replace screw and lockwasher. If necessary, remove clip from hose assembly.
5. Disconnect hose assembly (Figure 1, Item 1) from oil filter adaptor (Figure 1, Item 6). Refer to (WP 0018) for model 5063-5392 or (WP 0019) for models 5063-5393 and 5063-539L.



MAINT\_075

Figure 1. Turbocharger Oil Supply Line Removal/Installation.

**END OF TASK**

**INSTALLATION**

1. Connect hose assembly (Figure 1, Item 1) to connector (Figure 1, Item 2) in top of turbocharger (Figure 1, Item 3). Tighten securely.
2. Connect hose assembly (Figure 1, Item 1) to oil filter adaptor (Figure 1, Item 6). Refer to (WP 0018) for model 5063-5392 or (WP 0019) for models 5063-5393 and 5063-539L.
3. Remove screw (Figure 1, Item 5) and lockwasher (Figure 1, Item 4) from plate (Figure 1, Item 8) at rear of left cylinder head and install screw (Figure 1, Item 5) and new lockwasher (Figure 1, Item 4) in clip (Figure 1, Item 7) and plate (Figure 1, Item 8). Torque screw to 30–35 lb-ft (41–47 N·m).
4. For model 5063-5392: If removed, install clip (Figure 1, Item 13) on hose assembly (Figure 1, Item 1). Install screw (Figure 1, Item 12), flat washer (Figure 1, Item 16), new lockwasher (Figure 1, Item 15), and nut (Figure 1, Item 14) in clip on hose assembly and in bracket (Figure 1, Item 17) on air inlet housing. Torque screw to 30–35 lb-ft (41–47 N·m).
5. For models 5063-5393 and 5063-539L: If removed, install clip (Figure 1, Item 9) on hose assembly (Figure 1, Item 1). Remove screw (Figure 1, Item 11) and new lockwasher (Figure 1, Item 10) located at left side of flywheel housing. Install screw (in clip on hose assembly) and new lockwasher on flywheel housing. Torque screw to 30–35 lb-ft (41–47 N·m).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
ELECTRIC STARTER REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Fuel filters and mounting bracket removed  
(WP 0023)  
Glow plug harness disconnected removed  
(Model 5063-539L) (WP 0044)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 73)

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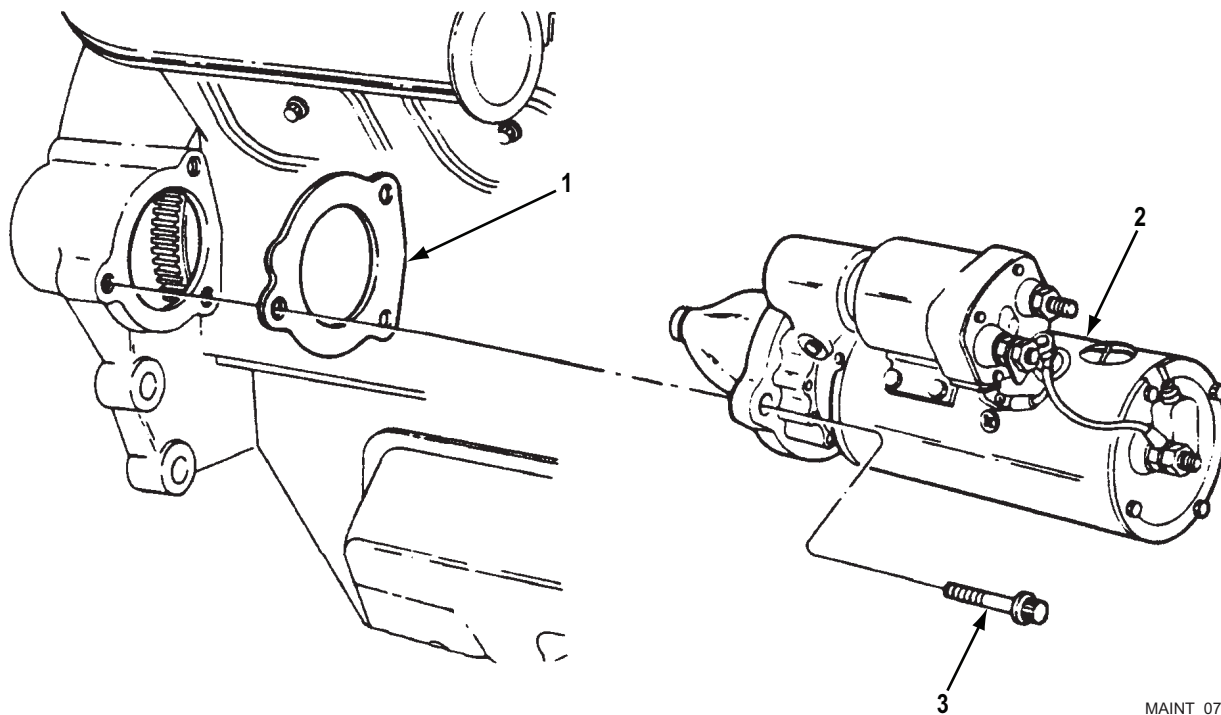
**REMOVAL****WARNING**

Starter motor is heavy. Provide adequate support to electric starter to prevent injury to personnel during removal. Failure to comply may result in injury to personnel.

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L have a gasket between electric starter and flywheel housing.

Remove three bolts (Figure 1, Item 3), electric starter (Figure 1, Item 2), and gasket (Figure 1, Item 1) from flywheel housing. Discard gasket.



MAINT\_076

Figure 1. Starter Removal/Installation.

**END OF TASK**



**INSTALLATION****WARNING**

Starter motor is heavy. Provide adequate support to electric starter to prevent injury to personnel during removal. Failure to comply may result in injury to personnel.

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L have a gasket between electric starter and flywheel housing.

Install new gasket (Figure 1, Item 1), electric starter (Figure 1, Item 2), and three bolts (Figure 1, Item 3) on flywheel housing. Torque bolts to 95–105 lb-ft (129–144 N·m).

**END OF TASK****FOLLOW ON TASK**

1. Install glow plug harness (WP 0044).
2. Install mounting bracket and fuel filters (WP 0023).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
AIR BOX DRAINS REPLACEMENT  
(MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

**Equipment Condition**

Electric starter removed  
(WP 0026)

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**REMOVAL****NOTE**

Air box drains are located on both sides of cylinder block below rear air box covers.

1. Remove two air box drain tube assemblies (Figure 1, Item 2) from two elbows (Figure 1, Item 1), one on each side of cylinder block.
2. Remove two elbows (Figure 1, Item 1) from cylinder block, one in each side.

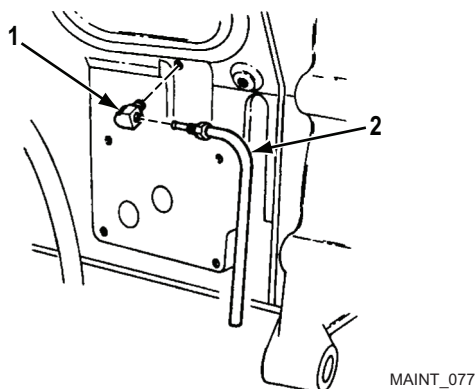


Figure 1. Air Box Drains Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install two elbows (Figure 1, Item 1) in cylinder block with port facing rear, one in each side.
2. Install two air box drain tube assemblies (Figure 1, Item 2) in two elbows (Figure 1, Item 1), one on each side of cylinder block. Tighten securely.

**END OF TASK**

**FOLLOW ON TASK**

Install electric starter (WP 0026).

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
AIR BOX DRAINS REPLACEMENT  
(MODELS 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Fuel filters and mounting brackets removed  
(models 5063-5393 and 5063-539L)  
(WP 0023)  
Electric starter removed (WP 0026)

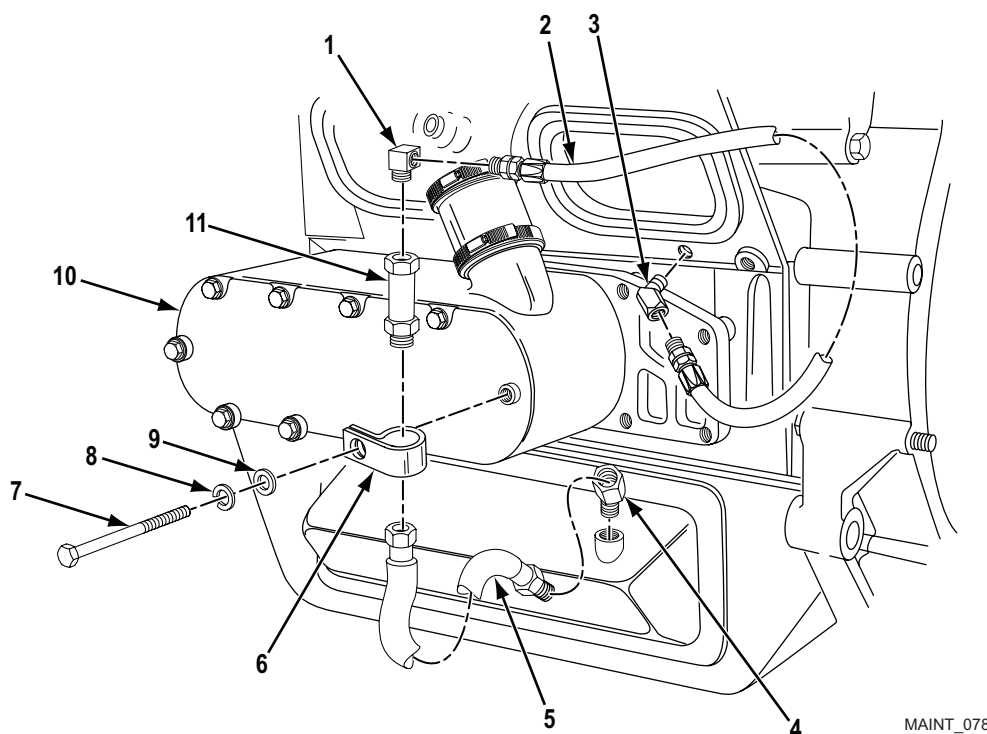
**Materials/Parts**

Sealing Compound  
(WP 0103, Table 1, Item 56)  
Washer, Flat Qty: (2) (WP 0105, Table 1, Item 95)  
Washer, Lock  
Qty: (3) (WP 0105, Table 1, Item 178)

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**REMOVAL**

1. Remove upper hose assembly (Figure 1, Item 2) from elbow (Figure 1, Item 1), in check valve (Figure 1, Item 11), and brass elbow (Figure 1, Item 3) on rear left cylinder block.
2. Remove lower hose assembly (Figure 1, Item 5) from check valve (Figure 1, Item 11) and elbow (Figure 1, Item 4) on rear left oil pan.
3. If oil cooler has not been removed, remove screw (Figure 1, Item 7), lockwasher (Figure 1, Item 8), and flat washer (Figure 1, Item 9) from clip (Figure 1, Item 6) on oil cooler (Figure 1, Item 10). Discard lockwasher.
4. Remove elbow (Figure 1, Item 1) from check valve (Figure 1, Item 11), brass elbow (Figure 1, Item 3) from left side of cylinder block, and elbow (Figure 1, Item 4) from left side of oil pan. If necessary, remove clip (Figure 1, Item 6) from check valve (Figure 1, Item 11).



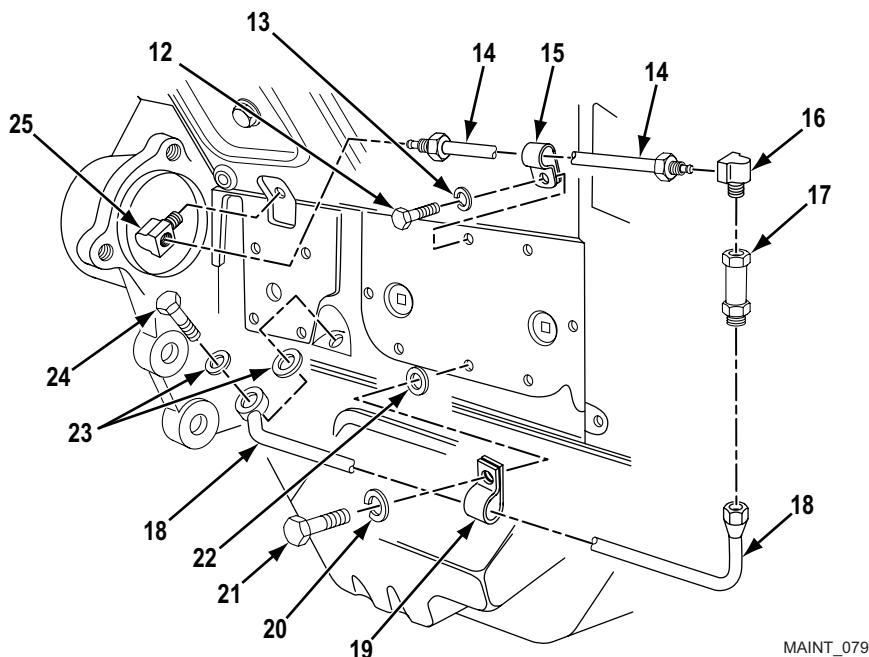
MAINT\_078

Figure 1. Air Box Drains Removal.

5. Remove bolt (Figure 2, Item 12) and lockwasher (Figure 2, Item 13) from clip (Figure 2, Item 15) on upper tube assembly (Figure 2, Item 14). Discard lockwasher.
6. Remove upper tube assembly (Figure 2, Item 14) from elbow (Figure 2, Item 16), in check valve (Figure 2, Item 17), and elbow (Figure 2, Item 25) in rear right cylinder block. If necessary, remove clip (Figure 2, Item 15) from tube assembly.
7. Disconnect lower tube assembly (Figure 2, Item 18) from check valve (Figure 2, Item 17). Remove check valve.
8. Remove elbow (Figure 2, Item 16) from check valve (Figure 2, Item 17) and elbow (Figure 2, Item 25) from cylinder block.
9. For model 5063-5392, remove bolt (Figure 2, Item 21), lockwasher (Figure 2, Item 20), and spacer (Figure 2, Item 22) from clip (Figure 2, Item 19) on lower tube assembly (Figure 2, Item 18). Discard lockwasher.

**REMOVAL - Continued**

10. Remove adaptor (Figure 2, Item 24), two copper flat washers (Figure 2, Item 23), and lower tube assembly (Figure 2, Item 18) from cylinder block. If necessary, remove clip (Figure 2, Item 19) from tube assembly. Discard flat washers.



MAINT\_079

Figure 2. Air Box Drains Removal/Installation.

**END OF TASK****INSTALLATION**

1. Loosely install lower tube assembly (Figure 2, Item 18), adaptor (Figure 2, Item 24), and two new copper flat washers (Figure 2, Item 23) on right side of cylinder block.
2. Coat threads on elbow (Figure 2, Item 25) with sealing compound and install elbow into cylinder block with port facing toward front of engine.
3. Install elbow (Figure 2, Item 16) in top of check valve (Figure 2, Item 17) and tighten securely.
4. Loosely connect lower tube assembly (Figure 2, Item 18) to bottom of check valve (Figure 2, Item 17). If removed, install clip (Figure 2, Item 19) on lower tube assembly (Figure 2, Item 18).
5. Loosely install upper tube assembly (Figure 2, Item 14) in elbow (Figure 2, Item 25) and elbow (Figure 2, Item 16) in check valve (Figure 2, Item 17). If removed, install clip (Figure 2, Item 15) on upper tube assembly (Figure 2, Item 14).
6. Install new lockwasher (Figure 2, Item 13) and bolt (Figure 2, Item 12) through clip (Figure 2, Item 15) into cylinder block.
7. For model 5063-5392, install spacer (Figure 2, Item 22), new lockwasher (Figure 2, Item 20), and bolt (Figure 2, Item 21) through clip (Figure 2, Item 19) into cylinder block.

**INSTALLATION - Continued**

8. Securely tighten tube assembly (Figure 2, Item 14) and tube assembly (Figure 2, Item 18). Torque adaptor (Figure 2, Item 24) to 14–16 lb-ft (19–22 N·m). Torque bolt (Figure 2, Item 12) and bolt (Figure 2, Item 21) to 13–17 lb-ft (18–23 N·m).
9. Coat threads on brass elbow (Figure 3, Item 3) with sealing compound and install in left side of cylinder block. Tighten securely with port facing rear and downward at a 45 degree angle.
10. Install elbow (Figure 3, Item 4) in oil pan and tighten securely with port facing outward from engine.
11. Install elbow (Figure 3, Item 1) in top of check valve (Figure 3, Item 11) and tighten securely. If removed, install clip (Figure 3, Item 6) on check valve.
12. Connect upper hose assembly (Figure 3, Item 2) to brass elbow (Figure 3, Item 3) in cylinder block. Tighten securely.
13. Connect lower hose assembly (Figure 3, Item 5) to elbow (Figure 3, Item 4) in oil pan. Tighten securely.
14. If oil cooler (Figure 3, Item 10) is installed, install screw (Figure 3, Item 7) through clip (Figure 3, Item 6), new lockwasher (Figure 3, Item 8), and flat washer (Figure 3, Item 9) in oil cooler. Torque screw to 13–17 lb-ft (18–23 N·m).
15. Connect hose assembly (Figure 3, Item 2) to elbow (Figure 3, Item 1), in check valve (Figure 3, Item 11), and hose assembly (Figure 3, Item 5) to bottom of check valve (Figure 3, Item 11). Tighten securely.

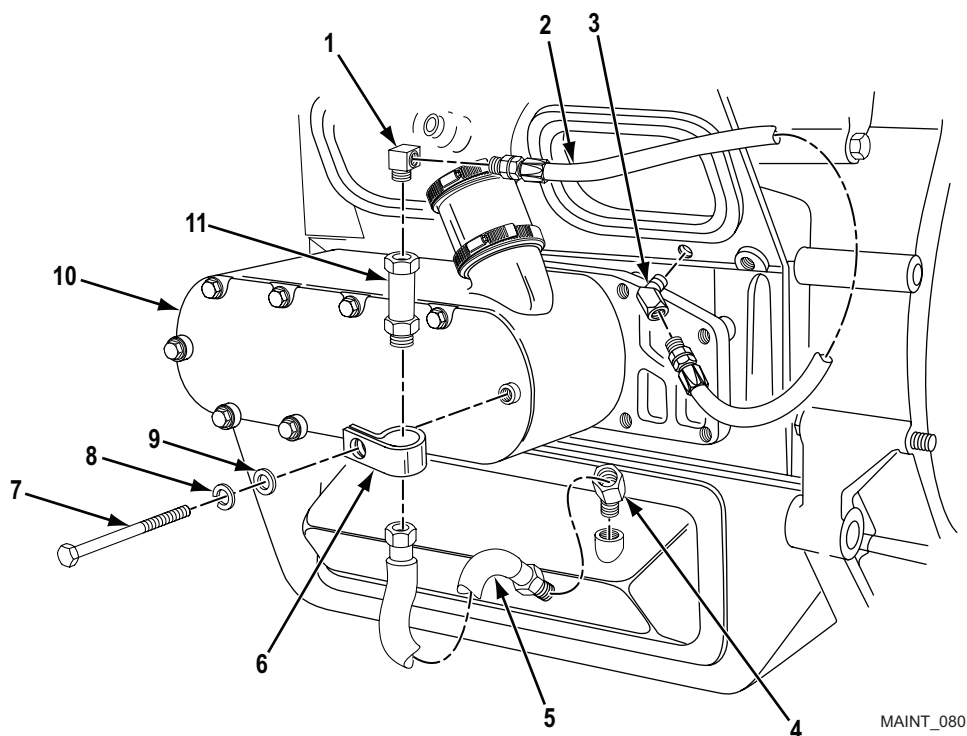


Figure 3. Air Box Drains Installation.

**END OF TASK**



**FOLLOW ON TASK**

1. Install electric starter (WP 0026).
2. Install mounting brackets and fuel filters (models 5063-5393 and 5063-539L) (WP 0023).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**CRANKCASE VENTILATION COLLECTOR REPLACEMENT (MODEL 5063-5299)**

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**INITIAL SETUP:**

**Tools and Special Tools**

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

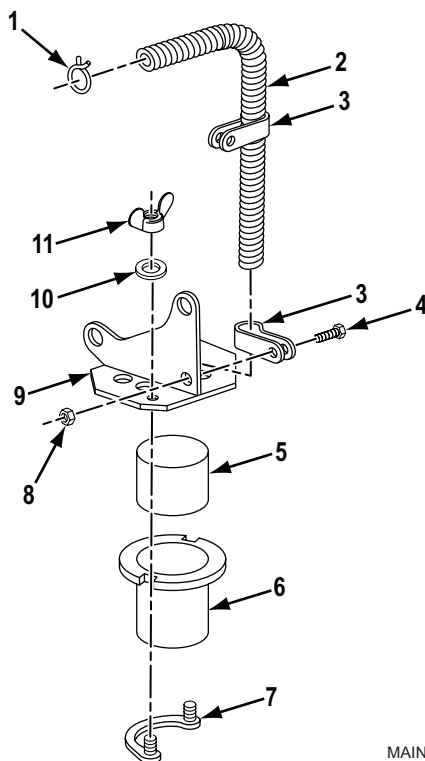
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**NOTE**

The crankcase ventilation collector is part of the basic engine for model 5063-5299 but is retained with the vehicle. It is mounted on the transmission housing and connected to the rocker arm covers with the engine in the vehicle.

**DISASSEMBLY**

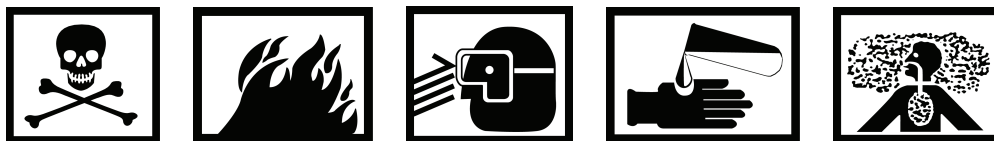
1. Remove two wing nuts (Figure 1, Item 11), two flat washers (Figure 1, Item 10), retainer (Figure 1, Item 7), filter element (Figure 1, Item 5), and drain receptacle (Figure 1, Item 6) from bracket (Figure 1, Item 9).
2. Remove machine screw (Figure 1, Item 4), lower loop clamp (Figure 1, Item 3), and nut (Figure 1, Item 8) from bracket (Figure 1, Item 9).
3. If necessary, remove two loop clamps (Figure 1, Item 3) and hose clamp (Figure 1, Item 1) from hose (Figure 1, Item 2).



MAINT\_081

Figure 1. Crankcase Ventilation Collector Disassembly/Assembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

1. Clean drain receptacle, bracket, and filter element with dry cleaning solvent and dry with compressed air.
2. Remove obstructions in hose using compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Check drain receptacle, retainer, and bracket for cracks or broken parts.

**END OF TASK****ASSEMBLY**

1. If removed, install two loop clamps (Figure 1, Item 3) and hose clamp (Figure 1, Item 1) on hose (Figure 1, Item 2).
2. Install machine screw (Figure 1, Item 4), lower loop clamp (Figure 1, Item 3), and nut (Figure 1, Item 8) on bracket (Figure 1, Item 9).
3. Install drain receptacle (Figure 1, Item 6), filter element (Figure 1, Item 5), retainer (Figure 1, Item 7), two flat washers (Figure 1, Item 10), and two wing nuts (Figure 1, Item 11) on bracket (Figure 1, Item 9).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**OIL FILTER ASSEMBLY REPLACEMENT**  
**(MODELS 5063-5299, 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Filter Element, Fluid  
(WP 0105, Table 1, Item 162)  
Gasket (WP 0105, Table 1, Item 7)  
Gasket Set (WP 0105, Table 1, Item 116)

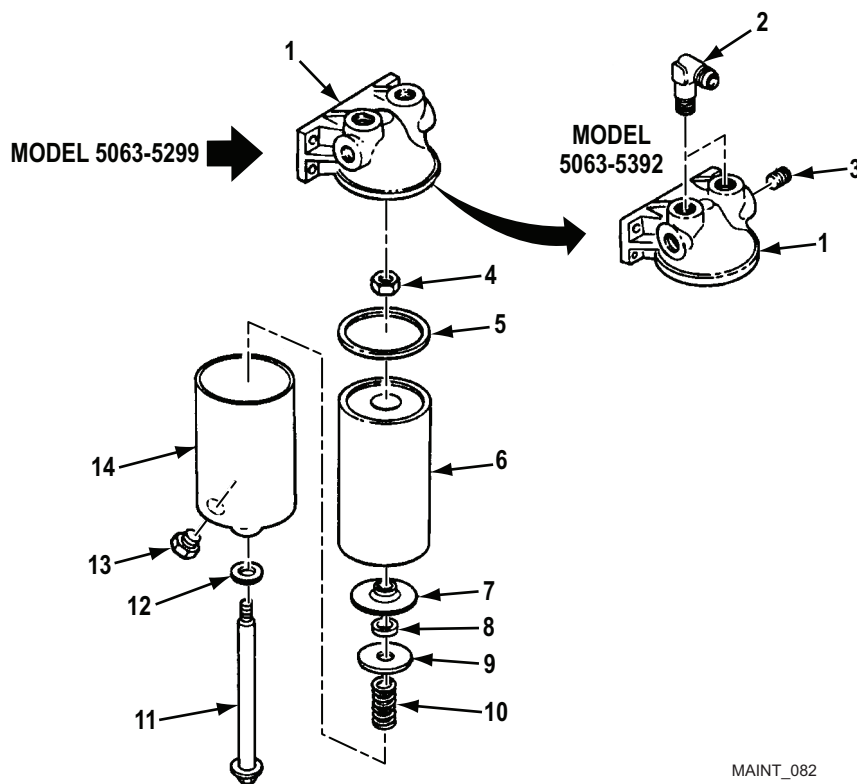
**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

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**DISASSEMBLY**

1. Remove drain plug (Figure 1, Item 13) from bottom of oil filter cover (Figure 1, Item 14).
2. Back out shoulder bolt (Figure 1, Item 11) and separate filter head (Figure 1, Item 1) from cover (Figure 1, Item 14).
3. Remove gasket (Figure 1, Item 5) from filter head (Figure 1, Item 1). Discard gasket.
4. Remove oil filter element (Figure 1, Item 6) from cover (Figure 1, Item 14). Discard filter element.
5. Remove nut (Figure 1, Item 4), retainer (Figure 1, Item 7), o-ring (Figure 1, Item 8), spacer (Figure 1, Item 9), and spring (Figure 1, Item 10) from shoulder bolt (Figure 1, Item 11) in cover (Figure 1, Item 14).
6. Remove shoulder bolt (Figure 1, Item 11) from cover (Figure 1, Item 14) and gasket set (Figure 1, Item 12) from shoulder bolt (Figure 1, Item 11). Discard gasket.
7. For model 5063-5392: If necessary, remove two elbows (Figure 1, Item 2) and two plugs (Figure 1, Item 3) from filter head (Figure 1, Item 1).

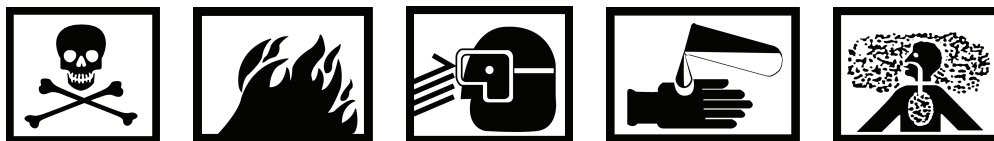


MAINT\_082

Figure 1. Oil Filter Disassembly/Installation.

**END OF TASK**



**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Clean parts with dry cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect all parts for damage and excessive wear. Replace as necessary.

**END OF TASK****ASSEMBLY**

1. For model 5063-5392: If removed, install two elbows (Figure 1, Item 2) and two plugs (Figure 1, Item 3) in filter head (Figure 1, Item 1).
2. Insert shoulder bolt (Figure 1, Item 11) into new gasket set (Figure 1, Item 12) and cover (Figure 1, Item 14). Slide spring (Figure 1, Item 10), spacer (Figure 1, Item 9), o-ring (Figure 1, Item 8), and retainer (Figure 1, Item 7) onto shoulder bolt and install nut (Figure 1, Item 4).
3. Slide new oil filter element (Figure 1, Item 6) over shoulder bolt (Figure 1, Item 11) in cover (Figure 1, Item 14). Install new gasket (Figure 1, Item 5) in filter head (Figure 1, Item 1).
4. Install cover (Figure 1, Item 14) and shoulder bolt (Figure 1, Item 11) on filter head (Figure 1, Item 1). Torque bolt to 50–60 lb-ft (68–81 N·m).
5. Install drain plug (Figure 1, Item 13) in bottom of oil filter cover (Figure 1, Item 14).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
FUEL FILTER AND STRAINER REPAIR**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Gasket (WP 0105, Table 1, Item 114)  
Gasket (WP 0105, Table 1, Item 164)  
Ring, Retaining (WP 0105, Table 1, Item 112)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Filter Element, Fluid  
(WP 0105, Table 1, Item 169)  
Filter Element, Fluid  
(WP 0105, Table 1, Item 186)  
Gasket (WP 0105, Table 1, Item 113)

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**DISASSEMBLY**

1. Fuel primary filter assembly (strainer).
  - a. If necessary, remove three plugs (Figure 1, Item 20) from strainer head (Figure 1, Item 17).
  - b. Remove drain cock (Figure 1, Item 13) from shell assembly (Figure 1, Item 14).

**NOTE**

Do not remove the element seat, spring, seal, and spring seat from the strainer shell assembly. Service these parts as an assembly.

The small gasket and large gasket are included with the filter element.

- c. Remove bolt (Figure 1, Item 19), small gasket (Figure 1, Item 18), filter element (Figure 1, Item 15), large gasket (Figure 1, Item 16), and shell assembly (Figure 1, Item 14) from strainer head (Figure 1, Item 17). Discard gaskets and filter element.
2. Fuel secondary filter assembly (filter).
    - a. Remove drain cock (Figure 1, Item 12) from filter body (Figure 1, Item 11).
    - b. Remove bolt (Figure 1, Item 1), small gasket (Figure 1, Item 2), filter body (Figure 1, Item 11), filter element (Figure 1, Item 5), and large gasket (Figure 1, Item 4) from filter head (Figure 1, Item 3). Discard filter element and gaskets.
    - c. Remove retaining ring (Figure 1, Item 6), seat (Figure 1, Item 7), gasket (Figure 1, Item 8), spring seat (Figure 1, Item 9), and spring (Figure 1, Item 10) from filter body (Figure 1, Item 11). Discard gasket and retaining ring.

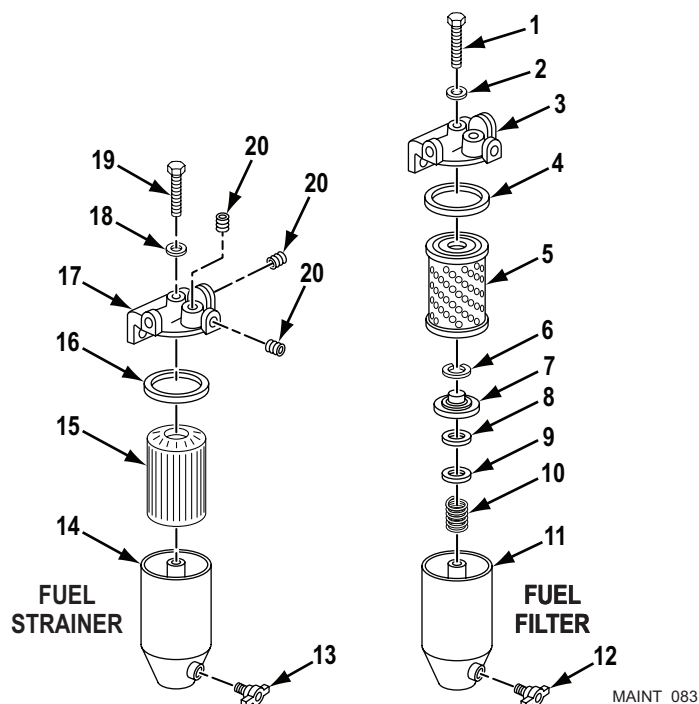
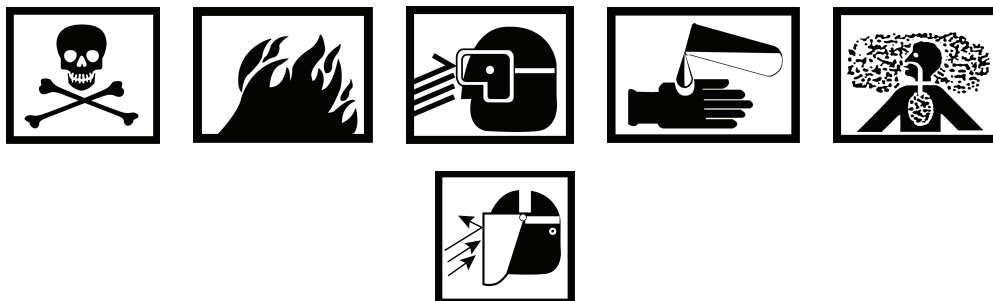


Figure 1. Fuel Filter Assembly, Disassembly/Assembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash shell assembly and filter body thoroughly with dry cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Examine shell assembly for cracks or hardening, replace if defective.

**END OF TASK****ASSEMBLY****NOTE**

A cast letter "P" (primary) is on top of strainer head.

The filter element, small gasket, and large gasket are provisioned together.

1. Fuel primary filter assembly (strainer).
  - a. Place filter element (Figure 1, Item 15) over center stud in shell assembly (Figure 1, Item 14) and push down until seated.
  - b. Place new large gasket (Figure 1, Item 16) in recess of strainer head (Figure 1, Item 17).
  - c. Place new filter element (Figure 1, Item 15) and shell assembly (Figure 1, Item 14) under strainer head (Figure 1, Item 17) and install new gasket (Figure 1, Item 18) and bolt (Figure 1, Item 19). Tighten bolt just enough to prevent fuel leakage.
  - d. Install drain cock (Figure 1, Item 13) in shell assembly (Figure 1, Item 14).
  - e. Install three plugs (Figure 1, Item 20) in strainer head (Figure 1, Item 17).

**ASSEMBLY - Continued****NOTE**

A cast letter "S" (secondary) is on top of filter head.

2. Fuel secondary filter assembly (filter).
  - a. Install spring (Figure 1, Item 10), spring seat (Figure 1, Item 9), new gasket (Figure 1, Item 8), seat (Figure 1, Item 7), and new retaining ring (Figure 1, Item 6) in filter body (Figure 1, Item 11).
  - b. Place new filter element (Figure 1, Item 5) over center stud in filter body (Figure 1, Item 11) and push against seat (Figure 1, Item 7).
  - c. Place new large gasket (Figure 1, Item 4) in recess of filter head (Figure 1, Item 3).
  - d. Place new filter element (Figure 1, Item 5) and filter body (Figure 1, Item 11) under filter head (Figure 1, Item 3) and install small new gasket (Figure 1, Item 2) and bolt (Figure 1, Item 1). Tighten bolt just enough to prevent fuel leakage.
  - e. Install drain cock (Figure 1, Item 12) in filter body (Figure 1, Item 11).

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**ENGINE REMOVAL FROM/INSTALLATION INTO CONTAINER**  
**(MODEL 5063-5299, NSN 2815-00-124-5390)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Sling, Beam-Type (WP 0104, Table 1, Item 93)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Container top removed (WP 0010)

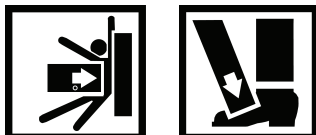
**Personnel Required**

Mechanic  
Helper (H)

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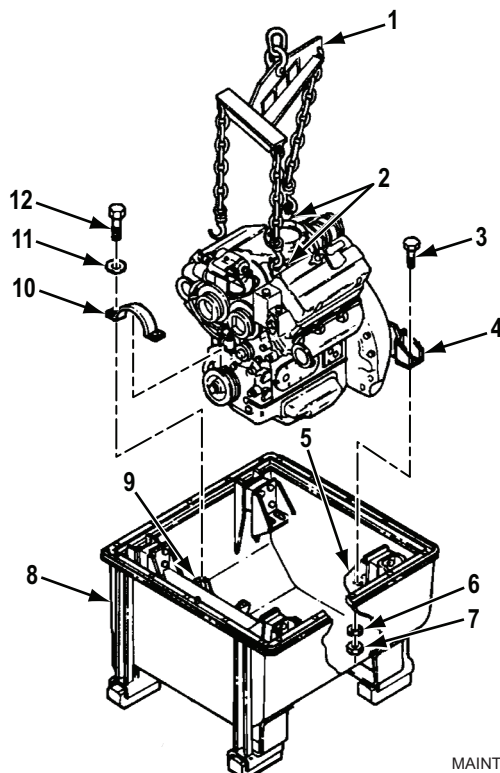
**REMOVAL**

1. Attach beam-type sling (Figure 1, Item 1) to lifting brackets (Figure 1, Item 2) and support engine with lifting device.
2. Remove two screws (Figure 1, Item 12), two flat washers (Figure 1, Item 11), and retaining strap (Figure 1, Item 10) from front support (Figure 1, Item 9).
3. Remove four screws (Figure 1, Item 3), four flat washers (Figure 1, Item 6), and four nuts (Figure 1, Item 7) fastening rear engine support (Figure 1, Item 4) to container support (Figure 1, Item 5).

**WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

4. Remove engine from lower half of container (Figure 1, Item 8).



MAINT\_084

Figure 1. Engine Removal from Container.



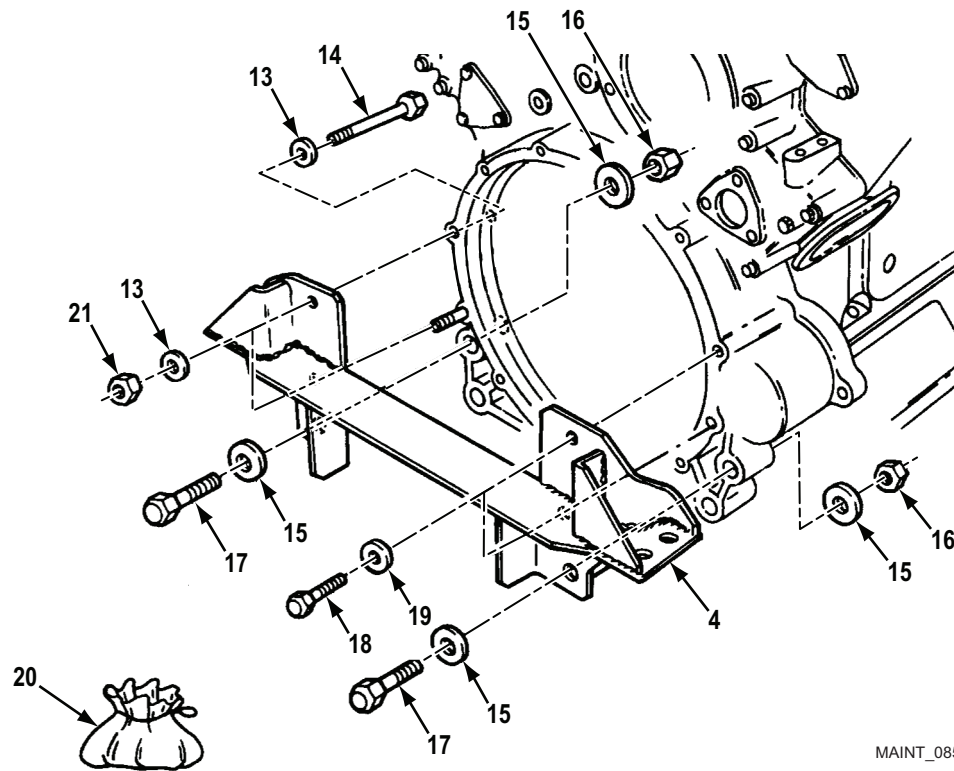
**REMOVAL - Continued****CAUTION**

Always install top of container on bottom of container (WP 0010) after the engine has been removed to avoid weather damage of container.

**NOTE**

Screw installed in the flywheel housing at eight o'clock position cannot be removed when the oil filter adapter is installed due to interference.

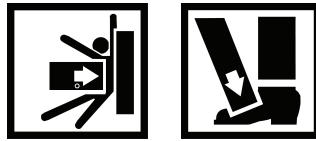
5. With engine supported by sling (Figure 1, Item 1), remove two screws (Figure 2, Item 18) and two flat washers (Figure 2, Item 19) from right side of engine support (Figure 2, Item 4). Remove two screws (Figure 2, Item 14), four flat washers (Figure 2, Item 13), and two nuts (Figure 2, Item 21) from left side.
6. Remove remaining two screws (Figure 2, Item 17), four flat washers (Figure 2, Item 15), two nuts (Figure 2, Item 16), and engine support from engine. Place screws, washers, and nuts in mailbag (Figure 2, Item 20) and store engine support and mailbag in lower half of container.



MAINT\_085

Figure 2. Engine Removal from Container (Engine Support).

**END OF TASK**

**INSTALLATION****WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

1. Attach a beam-type sling (Figure 4, Item 1) to lifting brackets (Figure 4, Item 2) and support engine with lifting device.
2. Remove mailbag (Figure 3, Item 20) and engine support (Figure 3, Item 4) from bottom of container. Remove screws, washers, and nuts from mailbag.

**NOTE**

Use two flat washers (Figure 3, Item 22) between engine boss and engine support (Figure 3, Item 4) to mount engines with serial numbers up to 6D-16046 only. When not used, secure extra washers to support with locking wire or tape.

3. Install two screws (Figure 3, Item 17), four flat washers (Figure 3, Item 15), engine support (Figure 3, Item 4), and two nuts (Figure 3, Item 16) to rear of engine.
4. Install two screws (Figure 3, Item 14), four flat washers (Figure 3, Item 13), and two nuts (Figure 3, Item 21) in support at left side rear of engine.
5. Install two screws (Figure 3, Item 18) and two flat washers (Figure 3, Item 19) in support at right side rear of engine.
6. Torque two screws (Figure 3, Item 17) to 107–118 lb-ft (145–160 N·m). Torque two screws (Figure 3, Item 18) and (Figure 3, Item 14) to 22–24 lb-ft (30–33 N·m).

INSTALLATION - Continued

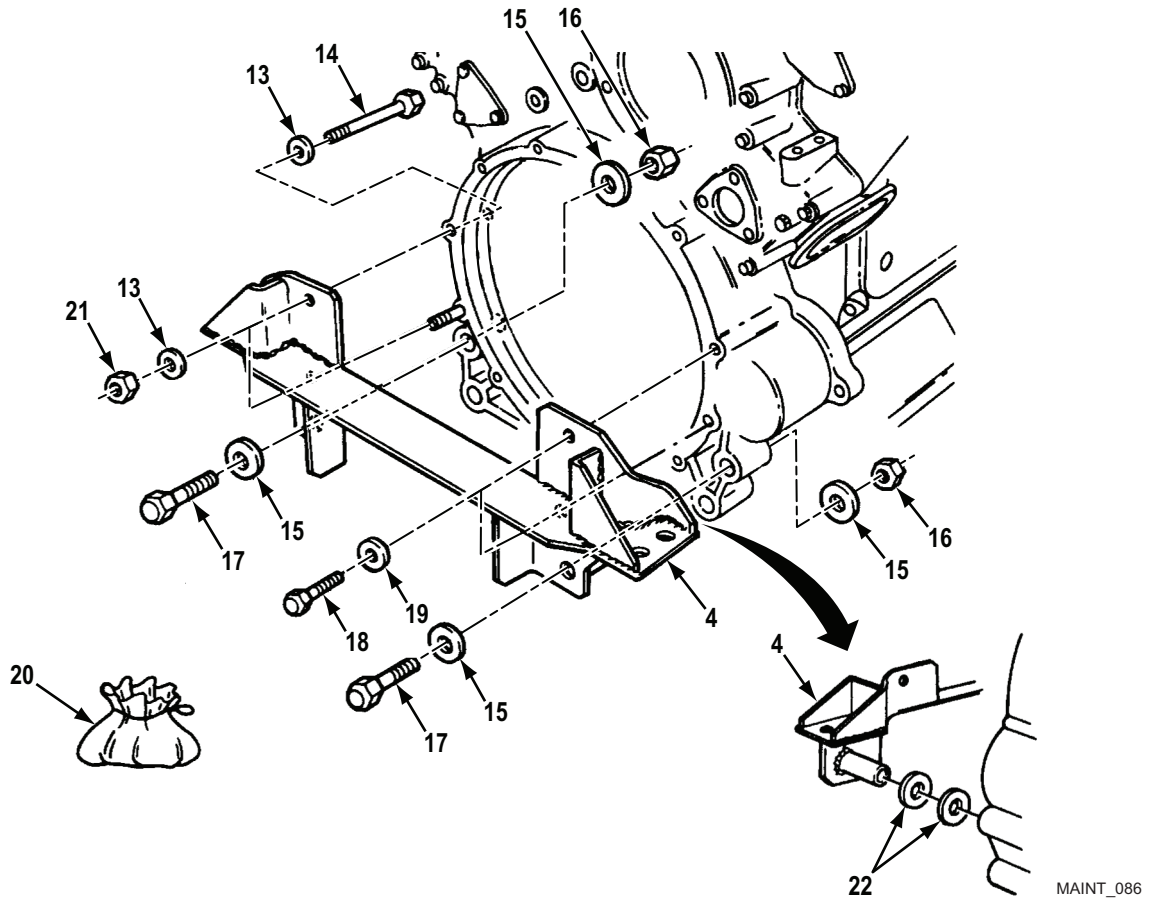


Figure 3. Engine Installation into Container (Engine Support).

**INSTALLATION - Continued**

7. Install engine in lower half of container (Figure 4, Item 8).
8. Install four screws (Figure 4, Item 3), four flat washers (Figure 4, Item 6), and four nuts (Figure 4, Item 7) in rear support (Figure 4, Item 4) to connect support (Figure 4, Item 4) to two engine supports (Figure 4, Item 5). Torque screws (Figure 4, Item 3) to 107–118 lb-ft (145–160 N·m).
9. Install retaining strap (Figure 4, Item 10), two flat washers (Figure 4, Item 11), and two screws (Figure 4, Item 12) on engine front support (Figure 4, Item 9). Torque two screws (Figure 4, Item 12) to 24–29 lb-ft (33–39 N·m). Remove beam-type sling (Figure 4, Item 1).

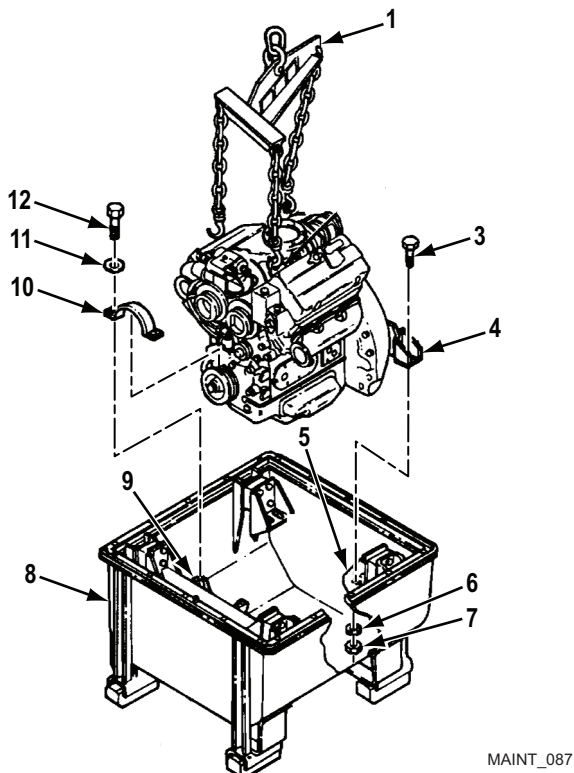


Figure 4. Engine Installation into Container.

**END OF TASK**

**FOLLOW ON TASK**

Install container top (WP 0010).

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**ENGINE REMOVAL FROM/INSTALLATION INTO CONTAINER**  
**(ALL EXCEPT MODEL 5063-5299, NSN 2815-00-124-5390)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Sling, Beam-Type (WP 0104, Table 1, Item 93)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Container top removed (WP 0010)

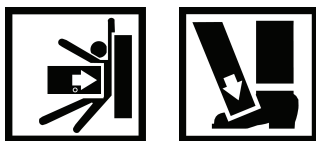
**Materials/Parts**

Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 179)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 180)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 181)

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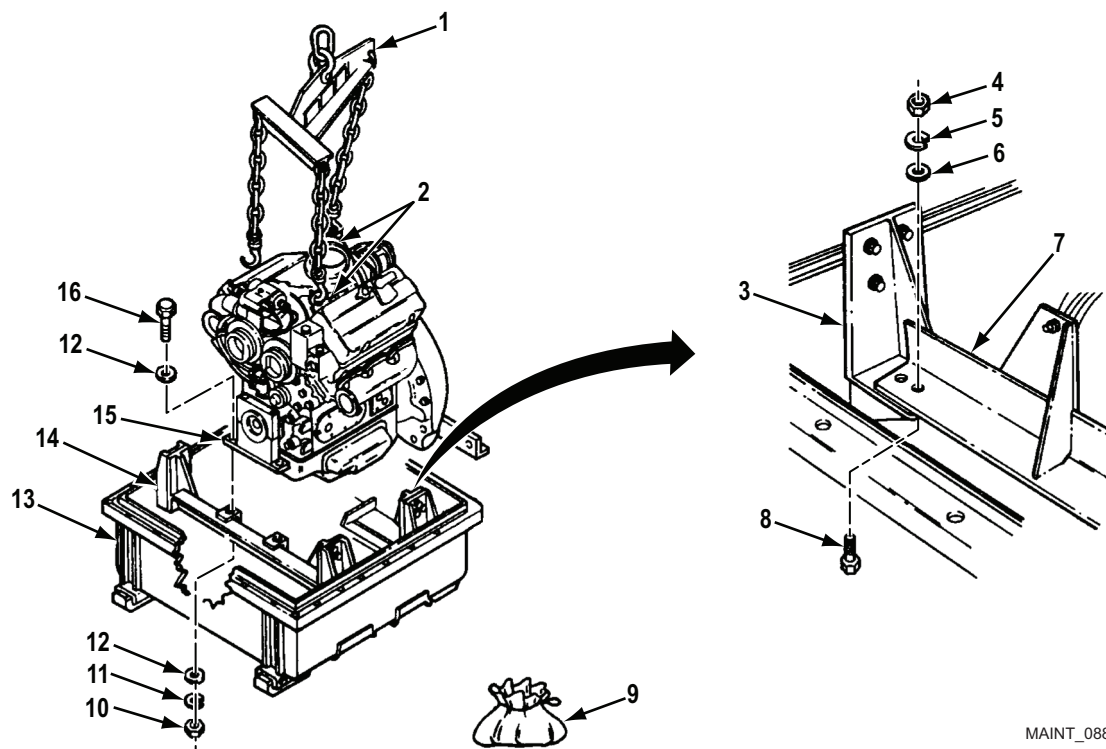
**REMOVAL**

1. Attach beam-type sling (Figure 1, Item 1) to lifting brackets (Figure 1, Item 2) and support engine with lifting device.
2. Remove two screws (Figure 1, Item 16), two nuts (Figure 1, Item 10), two lockwashers (Figure 1, Item 11), and four flat washers (Figure 1, Item 12) connecting trunnion assembly (Figure 1, Item 15) to forward container support (Figure 1, Item 14). Store screws, washers, and nuts in mailbag (Figure 1, Item 9) in lower half of container (Figure 1, Item 13). Discard lockwashers.
3. Remove four screws (Figure 1, Item 8), four nuts (Figure 1, Item 4), four lockwashers (Figure 1, Item 5), and four flat washers (Figure 1, Item 6) connecting rear support (Figure 1, Item 7) to two container mounting brackets (Figure 1, Item 3). Discard lockwashers.

**WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

4. Remove engine from lower half of container (Figure 1, Item 13).



MAINT\_088

Figure 1. Engine Removal from Lower Half of Container.

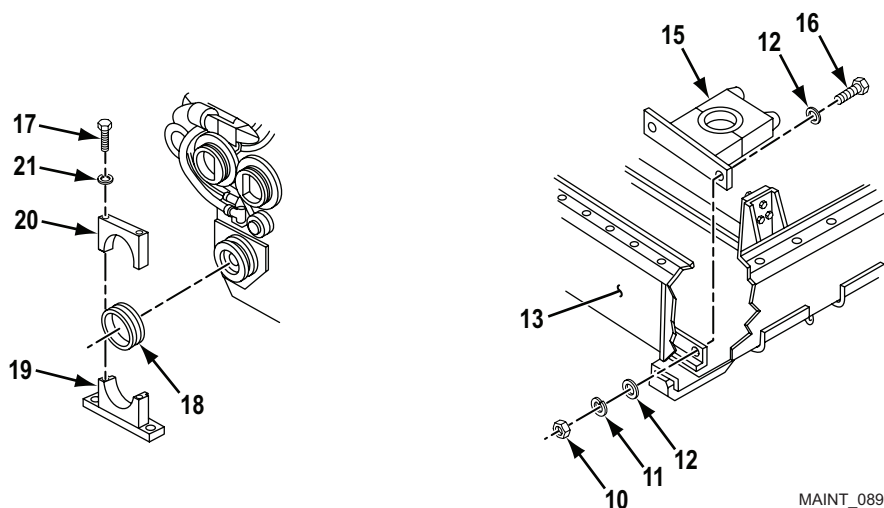
## REMOVAL - Continued

## NOTE

Do not discard preformed packing (Figure 2, Item 18) found on front trunnion of model 5063-5299. Store this packing in container trunnion block and use for shipping purposes only. Use a new packing when installing engine in vehicle.

Steps 5–7 apply only to model 5063-5299, NSN 2815-01-295-7458.

5. Remove two screws (Figure 2, Item 17), two lockwashers (Figure 2, Item 21), upper shipping trunnion block (Figure 2, Item 20), preformed packing (Figure 2, Item 18), and lower shipping trunnion block (Figure 2, Item 19) from front of engine. Discard lockwashers.
6. Install two screws (Figure 2, Item 17), two lockwashers (Figure 2, Item 21), upper shipping trunnion block (Figure 2, Item 20), and preformed packing (Figure 2, Item 18) on lower shipping trunnion block (Figure 2, Item 19). Tighten screws.
7. Install two screws (Figure 2, Item 16), four flat washers (Figure 2, Item 12), two lockwashers (Figure 2, Item 11), two nuts (Figure 2, Item 10) (located in mailbag), and shipping trunnion assembly (Figure 2, Item 15) on lower half of container (Figure 2, Item 13). Tighten screws.



MAINT\_089

Figure 2. Engine Trunnion Block Removal.

**REMOVAL - Continued****CAUTION**

Always install top of container on bottom of container (WP 0010) after the engine has been removed to avoid weather damage of container.

**NOTE**

Screw installed in the flywheel housing at eight o'clock position cannot be removed when the oil filter adapter is installed due to interference.

8. Remove four short screws (Figure 3, Item 25), two long screws (Figure 3, Item 22), two nuts (Figure 3, Item 26), six lockwashers (Figure 3, Item 24), and rear support (Figure 3, Item 7) from engine flywheel housing (Figure 3, Item 23). Store screws, washers, and nuts in mailbag (Figure 4, Item 9). Store mailbag and rear support in lower half of container (Figure 4, Item 13). Discard lockwashers.

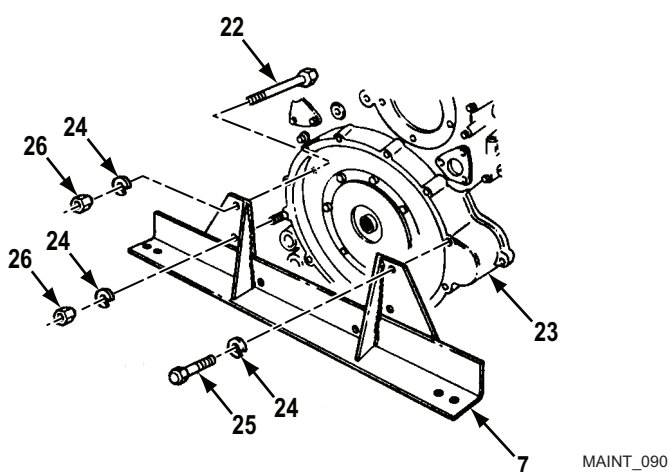
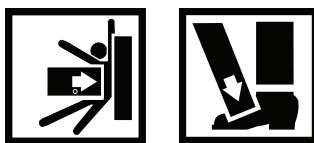


Figure 3. Engine Rear Support Removal.

**END OF TASK****INSTALLATION****WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

1. Attach beam-type sling (Figure 4, Item 1) to lifting brackets (Figure 4, Item 2) and support engine with lifting device.



**INSTALLATION - Continued**

2. Install rear support (Figure 3, Item 7), six new lockwashers (Figure 3, Item 24), four short screws (Figure 3, Item 25), two long screws (Figure 3, Item 22), and two nuts (Figure 3, Item 26) on engine flywheel housing (Figure 3, Item 23). Torque screws to 14–17 lb-ft (19–23 N·m). All screws, washers, and nuts are contained in mailbag (Figure 4, Item 9).

**NOTE**

Step 3 applies only to model 5063-5299, NSN 2815-01-295-7458.

3. Remove two screws (Figure 4, Item 16), two new lockwashers (Figure 4, Item 11), four flat washers (Figure 4, Item 12), and two nuts (Figure 4, Item 10) from shipping trunnion assembly (Figure 4, Item 15) in lower half of container. Store screws, washers, and nuts in mailbag (Figure 4, Item 9).

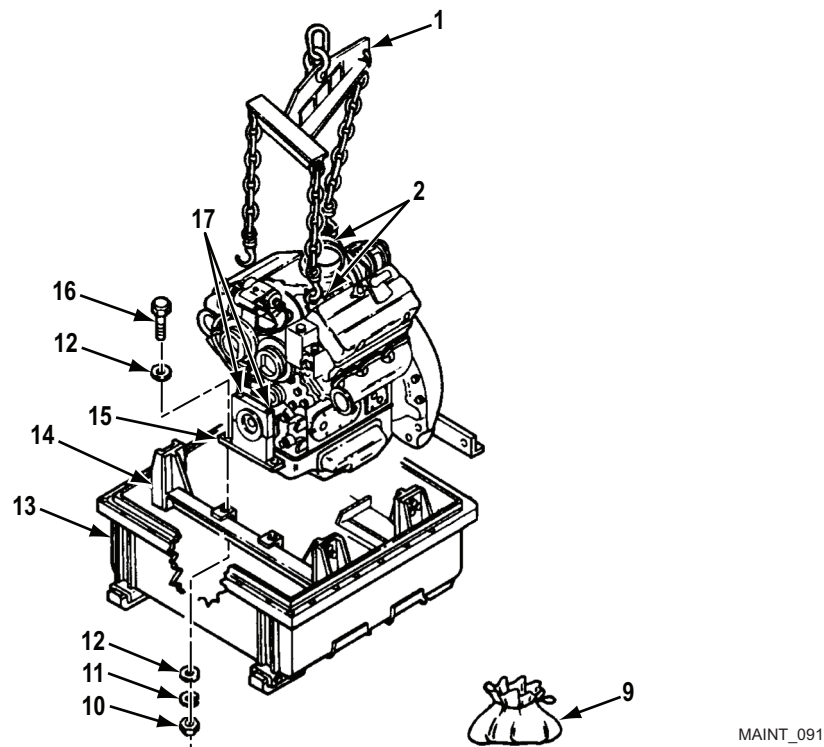


Figure 4. Engine Installation to Lower Half of Container.

**INSTALLATION - Continued****NOTE**

Steps 4 and 5 apply only to model 5063-5299, NSN 2815-01-295-7458.

4. Remove two screws (Figure 5, Item 17), two lockwashers (Figure 5, Item 21), and upper shipping trunnion block (Figure 5, Item 20) from lower shipping trunnion block (Figure 5, Item 19). Remove preformed packing (Figure 5, Item 18) from lower shipping trunnion block and install on front of engine.
5. Install lower shipping trunnion block (Figure 5, Item 19), upper shipping trunnion block (Figure 5, Item 20), two screws (Figure 5, Item 17), and two new lockwashers (Figure 5, Item 21) over preformed packing (Figure 5, Item 18) on engine. Hand tighten screws.
6. Install engine in lower half of container (Figure 5, Item 13).
7. Install two screws (Figure 5, Item 16), two new lockwashers (Figure 5, Item 11), four flat washers (Figure 5, Item 12), and two nuts (Figure 5, Item 10) (from mailbag) into trunnion (Figure 5, Item 15) and forward container support (Figure 5, Item 14). Torque screws to 71–83 lb-ft (96–113 N·m).

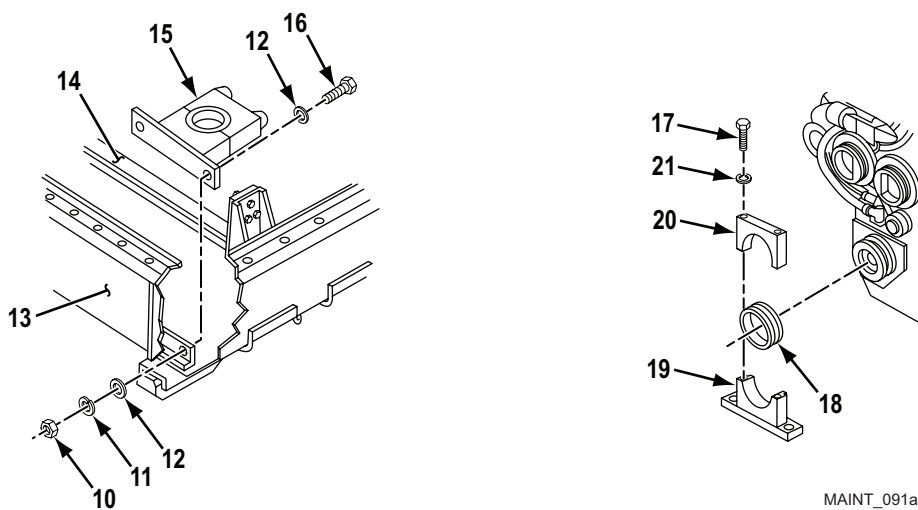


Figure 5. Engine Trunnion Block Installation.

8. Install four screws (Figure 6, Item 8), four flat washers (Figure 6, Item 6), four new lockwashers (Figure 6, Item 5), and four nuts (Figure 6, Item 4), in rear support (Figure 6, Item 7) and connect rear support to container mounting brackets (Figure 6, Item 3). Torque screws to 31–37 lb-ft (42–50 N·m). Remove beam-type sling (Figure 4, Item 1) from engine.
9. For model 5063-5299, torque two screws (Figure 5, Item 17) in shipping trunnion (Figure 5, Item 15) to 23–28 lb-ft (31–38 N·m).

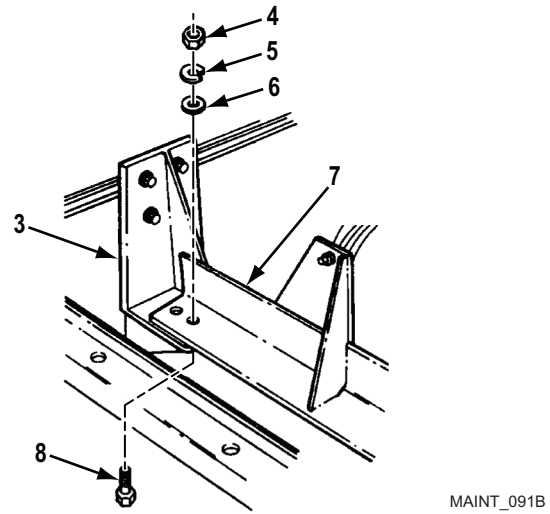
**INSTALLATION - Continued**

Figure 6. Engine Rear Support Installation.

**END OF TASK**

**FOLLOW ON TASK**

Install container top (WP 0010).

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**ADJUSTMENT, ENGINE INSTALLATION, AND ENGINE REMOVAL TO MAINTENANCE STAND**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Stand, Maintenance (WP 0104, Table 1, Item 99)  
Sling, Beam-Type (WP 0104, Table 1, Item 93)  
Stand, Sub-Assy., Maint. Aug. (Cradle)  
(WP 0104, Table 1, Item 100)  
Drain Unit, Waste Oil  
(WP 0104, Table 1, Item 23)  
Brackets, Engine Mounting  
(WP 0104, Table 1, Item 12) (4)

**Materials/Parts**

Washer, Lock  
Qty: (8) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 179)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Container top removed (WP 0010)  
Transmission oil cooler removed (models  
5063-5393 and 5063-539L) (WP 0011)  
Fuel junction block and lines removed (models  
5063-5393 and 5063-539L) (WP 0012)  
Coolant pump and idler pulley assembly removed  
(WP 0013)  
Oil level gauge rod removed (model 5063-5299)  
(WP 0014)

**Equipment Condition (cont.)**

Oil level gauge rod removed (model 5063-5392)  
(WP 0015)  
Oil level gauge rod removed (models 5063-5393  
and 5063-539L) (WP 0016)  
Oil filter adaptor removed (model 5063-5299)  
(WP 0017)  
Oil filter assembly and adaptor removed  
(model 5063-5392) (WP 0018)  
Oil filter assembly and adaptor removed (models  
5063-5393 and 5063-539L) (WP 0019)  
Engine/transmission oil cooler removed  
(model 5063-5299) (WP 0020)  
Engine/transmission oil cooler removed  
(model 5063-5392) (WP 0021)  
Engine oil cooler removed (models 5063-5393  
and 5063-539L) (WP 0022)  
Fuel filters and mounting bracket removed  
(model 5063-5392) (WP 0023)  
Fuel filters and mounting brackets removed  
(models 5063-5393 and 5063-539L)  
(WP 0024)  
Turbocharger oil supply line removed (all except  
model 5063-5299) (WP 0025)  
Electric starter removed (WP 0026)  
Air box drains removed (model 5063-5299)  
(WP 0027)  
Air box drains removed (models 5063-5392,  
5063-5393, and 5063-539L) (WP 0028)  
Engine removed from container  
(model 5063-5299) (WP 0032)  
Engine removed from container (WP 0033)

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## ADJUSTMENT

1. Assemble engine cradle (Figure 1, Item 3) and maintenance stand (Figure 1, Item 10) together using hole location number 5 (Figure 1, Item 11).
2. Install four engine mounting brackets (Figure 1, Item 9), eight bolts (Figure 1, Item 6), eight flat washers (Figure 1, Item 8), and eight new lockwashers (Figure 1, Item 7) to engine block (two bolts per bracket). Leave brackets loose for adjustment.

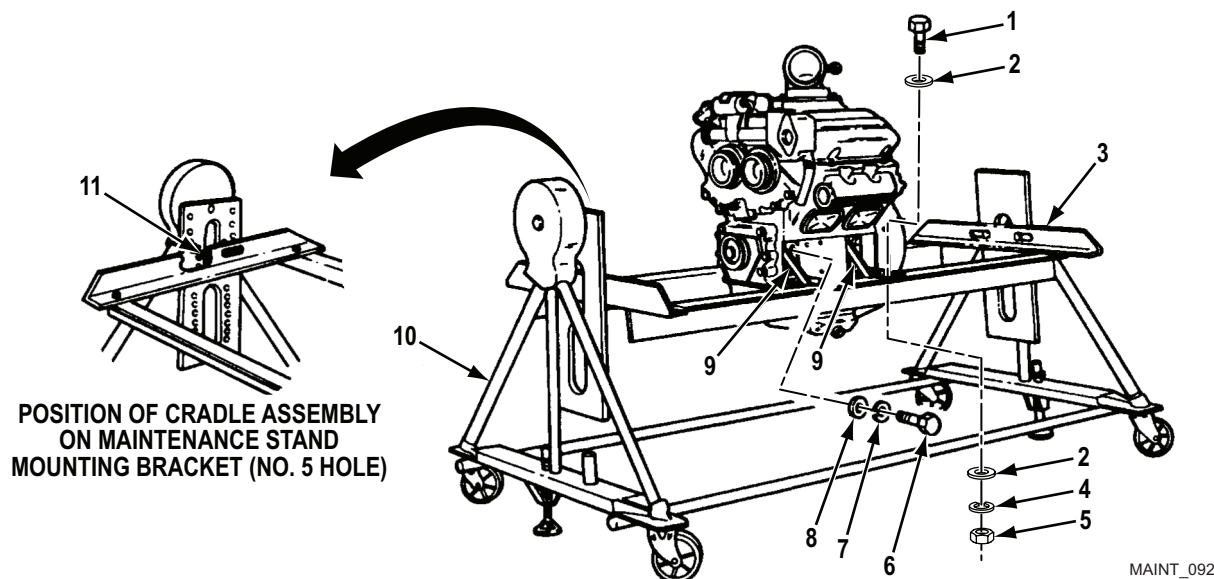


Figure 1. Engine Maintenance Stand View.

## END OF TASK

## INSTALLATION

1. Attach a beam-type sling to engine lifting brackets and lift engine onto maintenance stand (Figure 1, Item 10).
2. Install four bolts (Figure 1, Item 1), four new lockwashers (Figure 1, Item 4), eight flat washers (Figure 1, Item 2), and four nuts (Figure 1, Item 5) in four mounting brackets (Figure 1, Item 9) and side rails of cradle (Figure 1, Item 3). Tighten stand and bracket bolts.

## END OF TASK

## REMOVAL

1. Attach beam-type lifting sling to engine lifting brackets with engine on maintenance stand (Figure 1, Item 10).
2. Remove four bolts (Figure 1, Item 1), four lockwashers (Figure 1, Item 4), eight flat washers (Figure 1, Item 2), and four nuts (Figure 1, Item 5) connecting four mounting brackets (Figure 1, Item 1) to side rails of cradle (Figure 1, Item 3). Discard lockwashers.

**REMOVAL - Continued**

3. Remove eight bolts (Figure 1, Item 6), eight flat washers (Figure 1, Item 7), eight lockwashers (Figure 1, Item 8), and four mounting brackets (Figure 1, Item 9) from engine block. Discard lockwashers.

**END OF TASK****FOLLOW ON TASK**

1. Install engine to container (models 5063-5299, 5063-5392, 5063-5393, and 5063-539L) (WP 0033).
2. Install engine to container (model 5063-5299) (WP 0032).
3. Install air box drains (models 5063-5392, 5063-5393, and 5063-539L) (WP 0028).
4. Install air box drains (model 5063-5299) (WP 0027).
5. Install electric starter (WP 0026).
6. Install turbocharger oil supply line (all except model 5063-5299) (WP 0025).
7. Install fuel filters and mounting brackets (models 5063-5393 and 5063-539L) (WP 0024).
8. Install fuel filters and mounting bracket (model 5063-5392) (WP 0023).
9. Install engine oil cooler (models 5063-5393 and 5063-539L) (WP 0022).
10. Install engine/transmission oil cooler (model 5063-5392) (WP 0021).
11. Install engine/transmission oil cooler (model 5063-5299) (WP 0020).
12. Install oil filter assembly and adaptor (models 5063-5393 and 5063-539L) (WP 0019).
13. Install oil filter assembly and adaptor (Model 5063-5392) (WP 0018).
14. Install oil filter adaptor (model 5063-5299) (WP 0017).
15. Install oil level gauge rod (models 5063-5393 and 5063-539L) (WP 0016).
16. Install oil level gauge rod (model 5063-5392) (WP 0015).
17. Install oil level gauge rod (model 5063-5299) (WP 0014).
18. Install coolant pump and idler pulley assembly (WP 0013).
19. Install fuel junction block and lines (models 5063-5393 and 5063-539L) (WP 0012).
20. Install transmission oil cooler (models 5063-5393 and 5063-539L) (WP 0011).
21. Install container top (WP 0010).

**END OF TASK****END OF WORK PACKAGE**





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**FIELD MAINTENANCE  
TURBOCHARGER REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pliers, Wire Twister (WP 0104, Table 1, Item 72)  
Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)

**Materials/Parts (cont.)**

Gasket (WP 0105, Table 1, Item 144)  
Nut, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 168)  
Tape, Masking (WP 0103, Table 1, Item 64)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 179)  
Wire (WP 0103, Table 1, Item 70)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 37)

**References**

WP 0037

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**REMOVAL**

1. Cut wires (Figure 1, Item 1) on insulator set (Figure 1, Item 4). Remove insulator set from turbocharger (Figure 1, Item 7). Discard wires.
2. Loosen two clamps (Figure 1, Item 19) and hose (Figure 1, Item 20) at turbocharger air outlet. Slide clamps and hose onto air inlet housing (Figure 1, Item 18).

**NOTE**

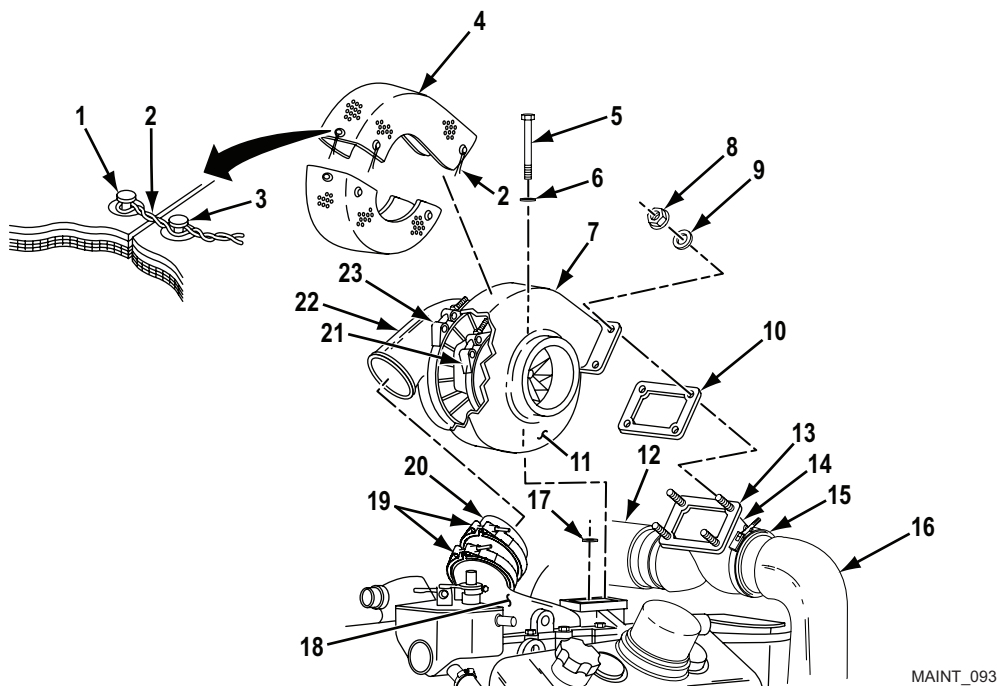
If studs come loose from tee during removal of locknuts, replace studs (WP 0037).

3. Remove four locknuts (Figure 1, Item 8), four special washers (Figure 1, Item 9), and turbocharger (Figure 1, Item 7) from exhaust tee (Figure 1, Item 14). Discard locknuts.
4. Loosen compressor housing coupling (Figure 1, Item 23) and rotate outlet of compressor housing (Figure 1, Item 22) away from air inlet housing.

**CAUTION**

Tape all openings of turbocharger after removal from engine to keep foreign particles from entering and damaging turbocharger blades.

5. Remove two screws (Figure 1, Item 5), two lockwashers (Figure 1, Item 6), and turbocharger (Figure 1, Item 7) from air inlet housing (Figure 1, Item 18). Discard lockwashers.
6. Remove gasket (Figure 1, Item 17) from air inlet housing (Figure 1, Item 18) and gasket (Figure 1, Item 10) from exhaust tee (Figure 1, Item 14). Discard gaskets.
7. Remove two clamps (Figure 1, Item 19) and hose (Figure 1, Item 20) from air inlet housing (Figure 1, Item 18).



MAINT\_093

Figure 1. Turbocharger Removal/Installation.

**END OF TASK**

**INSTALLATION**

1. Slide two clamps (Figure 1, Item 19) and hose (Figure 1, Item 20) on air inlet housing (Figure 1, Item 18).
2. Install new gasket (Figure 1, Item 17) in counter bore of air inlet housing (Figure 1, Item 18).
3. Install new gasket (Figure 1, Item 10) over studs (Figure 1, Item 13) on exhaust tee (Figure 1, Item 14).
4. Loosen couplings (Figure 1, Items 23 and 21) on turbocharger (Figure 1, Item 7) and four couplings (Figure 1, Item 15) on exhaust tubes (Figure 1, Items 16 and 12).
5. Install turbocharger (Figure 1, Item 7) on studs (Figure 1, Item 13) in exhaust tee (Figure 1, Item 14). Rotate compressor housing (Figure 1, Item 22), exhaust tee (Figure 1, Item 14), or turbine housing (Figure 1, Item 11) as required to align components.
6. Install turbocharger (Figure 1, Item 7), two new lockwashers (Figure 1, Item 6), and two screws (Figure 1, Item 5) on air inlet housing (Figure 1, Item 18). Torque screws to 46–50 lb-ft (62–68 N·m).
7. Install four special washers (Figure 1, Item 9) and four new locknuts (Figure 1, Item 8) on studs (Figure 1, Item 13). Torque locknuts to 35–39 lb-ft (47–53 N·m).
8. Adjust two clamps (Figure 1, Item 19) and hose (Figure 1, Item 20) over air outlet connection of turbocharger (Figure 1, Item 7). Tighten clamps.
9. Torque nut on compressor housing coupling (Figure 1, Item 23) to 110–130 lb-in (12–15 N·m). Torque nut on turbine housing coupling (Figure 1, Item 21) to 152–168 lb-in (17–19 N·m).
10. Tighten four exhaust tube couplings (Figure 1, Item 15).
11. Install insulator set (Figure 1, Item 4) on turbocharger (Figure 1, Item 7) and fasten together using new wire (Figure 1, Item 1) and wire twister pliers as follows:
  - a. Loop new wire around first capstan (Figure 1, Item 1) and apply two twists using wire twister pliers.
  - b. While holding insulator set in place by hand, place ends of new wire on each side of adjacent capstan (Figure 1, Item 3) and apply at least two twists using wire twister pliers.
  - c. Trim new wire 3/4 inch (20 mm) from second capstan.
  - d. Repeat Steps 11.a. – 11.c. for remaining pairs of capstans.

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
TURBOCHARGER REPLACEMENT  
(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pliers, Wire Twister (WP 0104, Table 1, Item 72)  
Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)

**Materials/Parts (cont.)**

Nut, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 168)  
Tape, Masking (WP 0103, Table 1, Item 64)  
Wire (WP 0103, Table 1, Item 70)

**References**

WP 0038

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 144)

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**REMOVAL**

1. On models 5063-5393 and 5063-539L, cut wires (Figure 1, Item 5) on insulation blanket (Figure 1, Item 4). Remove blanket from turbocharger (Figure 1, Item 15) and discard wires.
2. Loosen two clamps (Figure 1, Item 6) and hose (Figure 1, Item 3) connecting turbocharger (Figure 1, Item 15) to air inlet housing (Figure 1, Item 7).
3. Loosen two clamps (Figure 1, Item 8) and hose (Figure 1, Item 10) connecting turbocharger oil drain tube (Figure 1, Item 14) to oil drain elbow (Figure 1, Item 9).

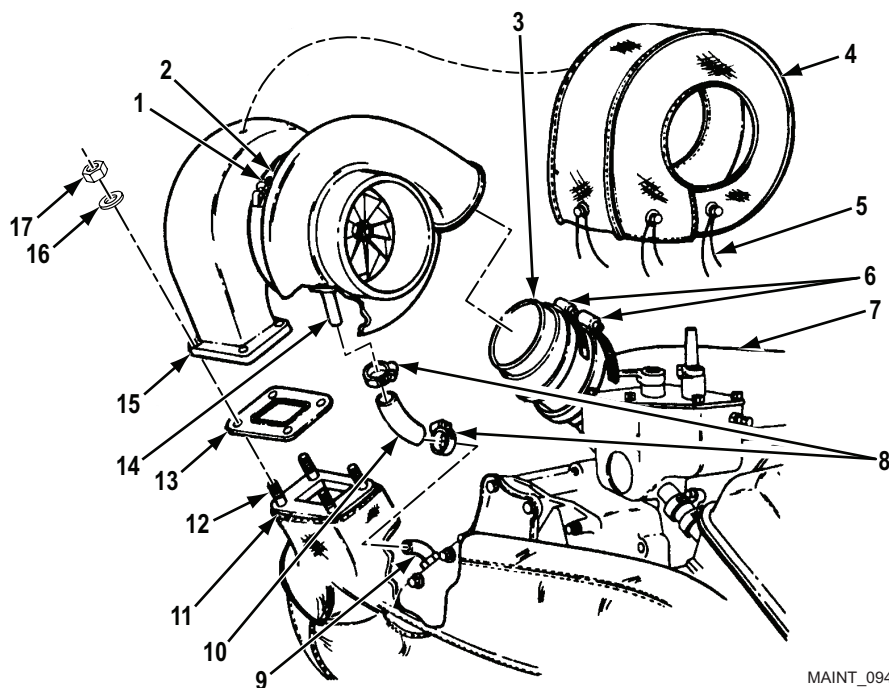
**CAUTION**

Tape all openings of turbocharger after removal to keep foreign particles from entering and damaging turbocharger blades.

**NOTE**

If studs come loose from tee during removal of locknuts, replace studs (WP 0038).

4. On models 5063-5393 and 5063-539L, remove four locknuts (Figure 1, Item 17), four special washers (Figure 1, Item 16), turbocharger (Figure 1, Item 15), and gasket (Figure 1, Item 13) from exhaust tee (Figure 1, Item 11). Discard locknuts and gasket.
5. Remove two clamps (Figure 1, Item 8) and hose (Figure 1, Item 10) from elbow (Figure 1, Item 9).
6. Remove two clamps (Figure 1, Item 6) and hose (Figure 1, Item 3) from air inlet housing (Figure 1, Item 7).



MAINT\_094

Figure 1. Turbocharger Removal/Installation.

**END OF TASK**

**INSTALLATION**

1. Slide two clamps (Figure 1, Item 8) and hose (Figure 1, Item 10) onto elbow (Figure 1, Item 9).
2. Slide two clamps (Figure 1, Item 6) and hose (Figure 1, Item 3) onto air inlet housing (Figure 1, Item 7).
3. On models 5063-5393 and 5063-539L, place new gasket (Figure 1, Item 13) and turbocharger (Figure 1, Item 15) over four studs (Figure 1, Item 12) in exhaust tee (Figure 1, Item 11). Install four special washers (Figure 1, Item 16) and four locknuts (Figure 1, Item 17) on studs. Torque locknuts to 35–39 lb-ft (47–53 N·m).
4. Loosen coupling (Figure 1, Item 1) on compressor housing of turbocharger (Figure 1, Item 15).
5. Adjust two clamps (Figure 1, Item 6) and hose (Figure 1, Item 3) between turbocharger (Figure 1, Item 15) and air inlet housing (Figure 1, Item 7). Tighten clamps.
6. Torque nut (Figure 1, Item 2) on compressor housing coupling (Figure 1, Item 1) to 110–130 lb-in (12–15 N·m).
7. Adjust two clamps (Figure 1, Item 8) and hose (Figure 1, Item 10) between oil drain tube (Figure 1, Item 14) and elbow (Figure 1, Item 9). Tighten clamps.
8. On models 5063-5393 and 5063-539L, install insulation blanket (Figure 1, Item 4) on turbocharger (Figure 1, Item 15). Fasten blanket together using new wire (Figure 1, Item 5) and wire twister pliers as follows:
  - a. Loop new wire around first capstan (Figure 2, Item 18) and apply two twists using wire twister pliers.
  - b. While holding insulation blanket in place by hand, place ends of new wire on each side of adjacent capstan (Figure 2, Item 19) and apply at least two more twists using wire twister pliers.
  - c. Trim new wire 3/4 inch (20 mm) from second capstan.
  - d. Repeat Steps 10.a. – 10.c. for remaining pairs of capstans on blanket.

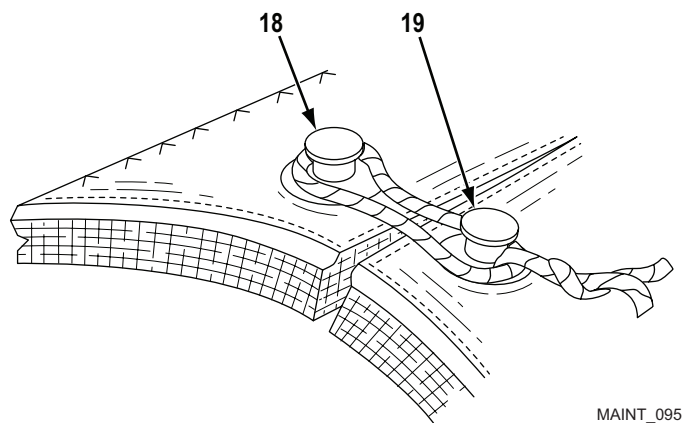


Figure 2. Insulation Blanket Installation.

**END OF TASK**

**END OF WORK PACKAGE**





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**FIELD MAINTENANCE  
EXHAUST TUBES AND TEE REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Pliers, Wire Twister (WP 0104, Table 1, Item 72)

**Equipment Condition**

Turbocharger removed (WP 0035)

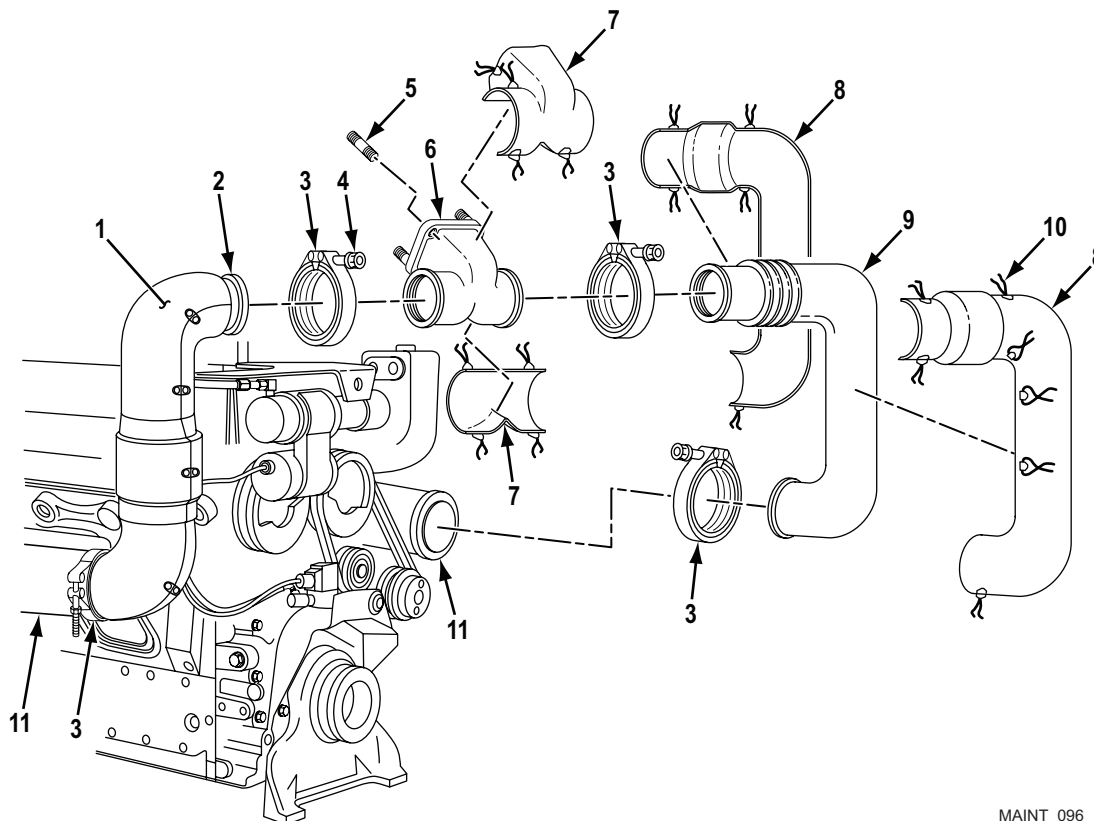
**Materials/Parts**

Wire (WP 0103, Table 1, Item 70)

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**REMOVAL**

1. Cut wires (Figure 1, Item 10) on insulator sets (Figure 1, Items 1, 8, and 7). Remove insulator sets from exhaust tubes (Figure 1, Items 2 and 9) and exhaust tee (Figure 1, Item 6). Discard wires.
2. Loosen four couplings (Figure 1, Item 3) on exhaust tubes (Figure 1, Items 2 and 9). Slide couplings onto exhaust tubes and remove couplings, exhaust tubes, and exhaust tee.
3. If necessary, remove four studs (Figure 1, Item 5) from exhaust tee (Figure 1, Item 6).



MAINT\_096

Figure 1. Exhaust Tubes and Tee Removal/Installation.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Check for cracks on exhaust tube flanges.

**END OF TASK****INSTALLATION**

1. If removed, install four studs (Figure 1, Item 5) in exhaust tee (Figure 1, Item 6).
2. Install right exhaust tube (Figure 1, Item 2), left exhaust tube (Figure 1, Item 9), exhaust tee (Figure 1, Item 6), and four couplings (Figure 1, Item 3) on exhaust manifolds (Figure 1, Item 11). Tighten nuts (Figure 1, Item 4) on couplings until compressed.

**INSTALLATION - Continued**

3. Install insulator set (Figure 1, Item 1) on exhaust tube (Figure 1, Item 2), insulator set (Figure 1, Item 8) on exhaust tube (Figure 1, Item 9), and insulator set (Figure 1, Item 7) on exhaust tee (Figure 1, Item 6). Fasten insulator sets together using new wire (Figure 1, Item 10) and wire twister pliers as follows:
  - a. Loop new wire around first capstan (Figure 2, Item 12) and apply two twists using wire twister pliers.
  - b. While holding insulator set in place by hand, place ends of new wire on each side of adjacent capstan (Figure 2, Item 13) and apply at least two more twists using wire twister pliers.
  - c. Trim new wire 3/4 inch (20 mm) from second capstan.
  - d. Repeat Steps 3.a. – 3.c. for remaining pairs of capstans on insulator sets.

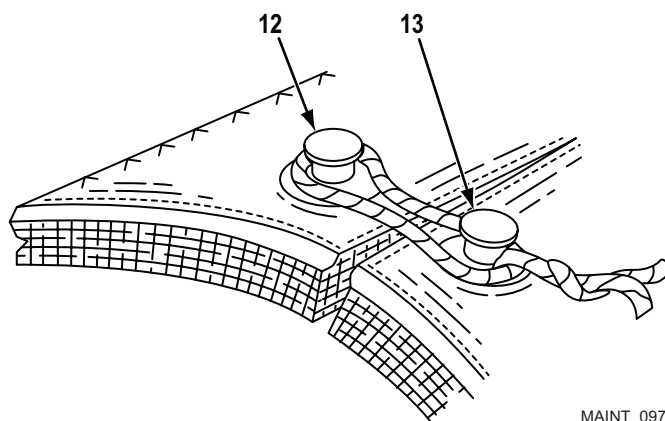


Figure 2. Insulator Set Installation.

**END OF TASK**

**FOLLOW ON TASK**

Install turbocharger (WP 0035).

**END OF TASK**

**END OF WORK PACKAGE**



**FIELD MAINTENANCE**  
**TURBOCHARGER MOUNTING BRACKET AND EXHAUST TUBES REPLACEMENT**  
**(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
 (WP 0104, Table 1, Item 113)  
 Wrench, Torque, Dial, 0–175 Lb-Ft  
 (WP 0104, Table 1, Item 120)  
 Pliers, Wire Twister (WP 0104, Table 1, Item 72)

**Materials/Parts (cont.)**

Washer, Lock (WP 0105, Table 1, Item 179)  
 Washer, Lock  
 Qty: (2) (WP 0105, Table 1, Item 180)  
 Wire (WP 0103, Table 1, Item 70)

**Materials/Parts**

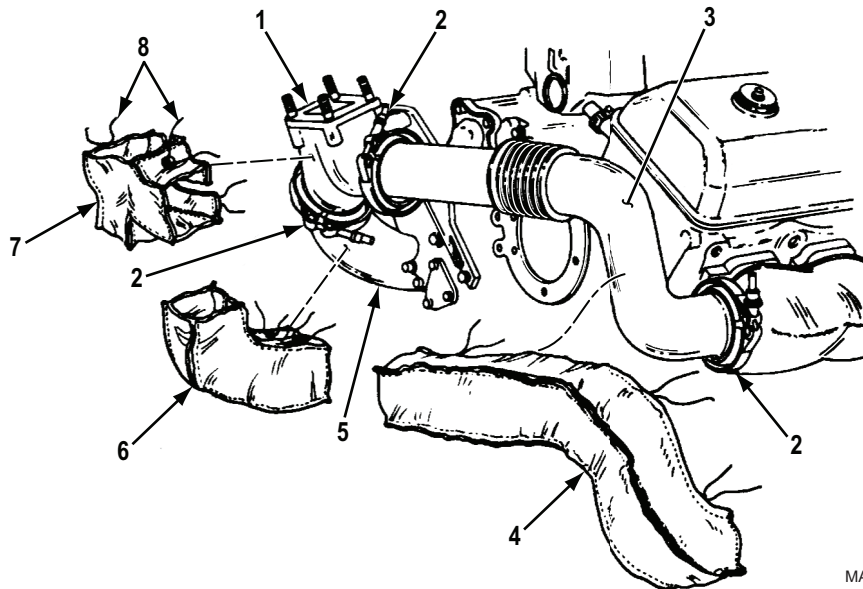
Washer, Lock  
 Qty: (5) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed (WP 0036)

**REMOVAL**

1. Cut wires (Figure 1, Item 8) on insulation blankets (Figure 1, Items 7, 6, and 4). Remove insulation blankets from exhaust tee (Figure 1, Item 1), left exhaust tube (Figure 1, Item 5), and right exhaust tube (Figure 1, Item 3) and discard wires.



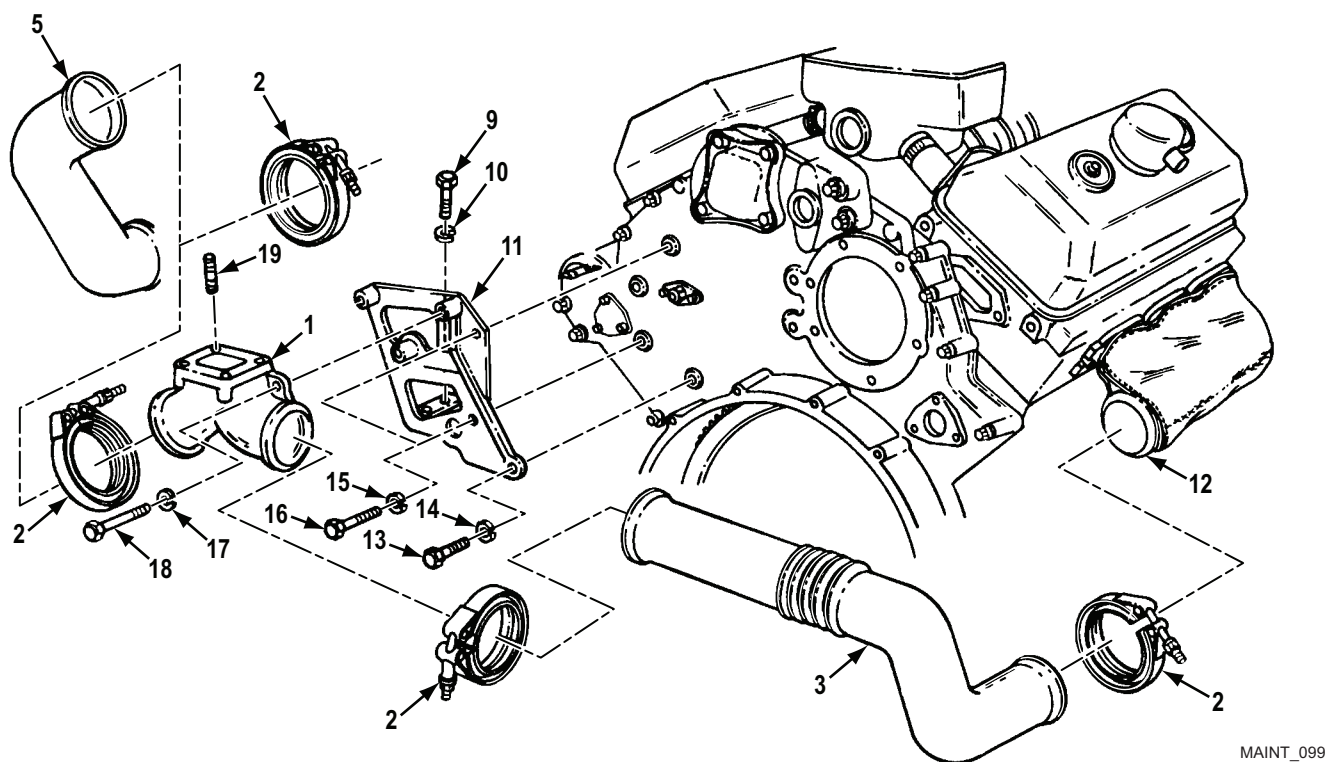
MAINT\_098

Figure 1. Turbocharger Mounting Bracket and Exhaust Tube Insulation Blanket Removal.

**REMOVAL - Continued****NOTE**

Remove nut from T-bolt to loosen coupling. Keep nut and T-bolt together with coupling.

2. Loosen four couplings (Figure 2, Item 2) on exhaust tubes (Figure 2, Items 5 and 3). Loosen three screws (Figure 2, Item 18) on exhaust tee (Figure 2, Item 1). Slide couplings onto exhaust tubes and remove tubes and couplings.
3. Remove three screws (Figure 2, Item 18), three lockwashers (Figure 2, Item 17), and exhaust tee (Figure 2, Item 1) from support bracket (Figure 2, Item 11). Discard lockwashers.
4. If necessary, remove four studs (Figure 2, Item 19) from exhaust tee (Figure 2, Item 1).
5. Remove two screws (Figure 2, Item 9), two lockwashers (Figure 2, Item 10), screw (Figure 2, Item 13), lockwasher (Figure 2, Item 14), two screws (Figure 2, Item 16), two lockwashers (Figure 2, Item 15), and support bracket (Figure 2, Item 11) from flywheel housing. Discard lockwashers.



MAINT\_099

Figure 2. Turbocharger Mounting Bracket and Exhaust Tube Removal/Installation.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Check for cracks on exhaust tube flanges and turbocharger support bracket.

**END OF TASK**

## INSTALLATION

1. Install support bracket (Figure 2, Item 11), two new lockwashers (Figure 2, Item 10), two small screws (Figure 2, Item 9), new lockwasher (Figure 2, Item 14), screw (Figure 2, Item 13), two new lockwashers (Figure 2, Item 15), and two large screws (Figure 2, Item 16) on flywheel housing. Torque screws (Figure 2, Item 9) to 30–35 lb-ft (41–47 N·m), screw (Figure 2, Item 13) to 46–50 lb-ft (62–68 N·m), and screws (Figure 2, Item 16) to 71–75 lb-ft (96–102 N·m).
2. If removed, install four studs (Figure 2, Item 19) in exhaust tee (Figure 2, Item 1).
3. Loosely install exhaust tee (Figure 2, Item 1), three new lockwashers (Figure 2, Item 17), and three screws (Figure 2, Item 18) on support bracket (Figure 2, Item 11). Do not tighten screws.
4. Install exhaust tube (Figure 2, Item 5), exhaust tube (Figure 2, Item 3), and four couplings (Figure 2, Item 2) between exhaust manifolds (Figure 2, Item 12) and exhaust tee (Figure 2, Item 1).

## NOTE

Align exhaust tubes and exhaust tee properly before tightening couplings and exhaust tee fastening screws.

5. Alternately tighten couplings (Figure 2, Item 2) and screws (Figure 2, Item 18). Torque screws to 30–35 lb-ft (41–47 N·m). Tighten couplings until springs are completely compressed.
6. Install insulation blanket (Figure 3, Item 7) on exhaust tee (Figure 3, Item 1), insulation blanket (Figure 3, Item 6) on left exhaust tube (Figure 3, Item 5), and insulation blanket (Figure 3, Item 4) on right exhaust tube (Figure 3, Item 3). Fasten blankets together using wire (Figure 3, Item 8) and wire twister pliers as follows:

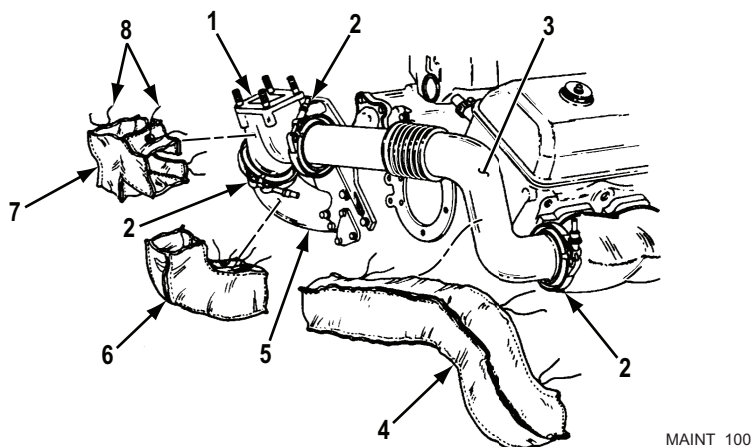


Figure 3. Turbocharger Mounting Bracket and Exhaust Tube Insulation Blanket Installation.

**INSTALLATION - Continued**

- a. Loop new wire around first capstan (Figure 4, Item 20) and apply two twists using wire twister pliers.
- b. While holding insulation blanket in place by hand, place ends of new wire on each side of adjacent capstan (Figure 4, Item 21) and apply at least two more twists using wire twister pliers.
- c. Trim new wire 3/4 inch (20 mm) from second capstan (Figure 4, Item 21).

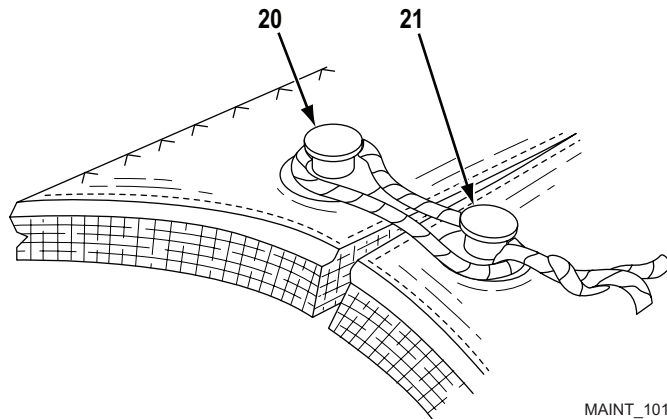


Figure 4. Insulation Blanket Installation.

- d. Repeat Steps 6.a. – 6.c. for remaining pairs of capstans on all blankets.

**END OF TASK****FOLLOW ON TASK**

Install turbocharger (WP 0036).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
EXHAUST MANIFOLDS REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pliers, Wire Twister (WP 0104, Table 1, Item 72)

**Equipment Condition (cont.)**

Exhaust tube couplings removed (models  
5063-5393 and 5063-539L) (WP 0038)  
Glow plug harness brackets removed (model  
5063-539L) (WP 0045)

**Materials/Parts**

Gasket Qty: (2) (WP 0105, Table 1, Item 47)  
Locknut Qty: (8) (WP 0105, Table 1, Item 171)  
Wire (WP 0103, Table 1, Item 70)

**Equipment Condition**

Exhaust tube couplings removed  
(model 5063-5392) (WP 0037)

---

**REMOVAL****NOTE**

Models 5063-5392, 5063-5393, and 5063-539L have insulator sets or insulation covers on exhaust manifolds.

Right and left exhaust manifolds and insulation covers are identical. Use same procedure to remove both sides.

1. Cut and remove wires (Figure 1, Item 8) connecting capstans on exhaust manifold insulation cover (Figure 1, Item 7). Discard wires.
2. Remove exhaust manifold insulation cover (Figure 1, Item 7) from exhaust manifold (Figure 1, Item 5).

**NOTE**

Model 5063-539L has two brackets (Figure 1, Item 6) located on the second and third studs of the right and left sides.

3. Remove four locknuts (Figure 1, Item 1), bracket (Figure 1, Item 6), four spring washers (Figure 1, Item 2), exhaust manifold (Figure 1, Item 5), and gasket (Figure 1, Item 3) from cylinder head. Discard locknuts and gasket.
4. For model 5063-539L, remove four locknuts (Figure 1, Item 1), two brackets (Figure 1, Item 6), four spring washers (Figure 1, Item 2), exhaust manifold (Figure 1, Item 5), and gasket (Figure 1, Item 3) from cylinder head. Discard locknuts and gasket.

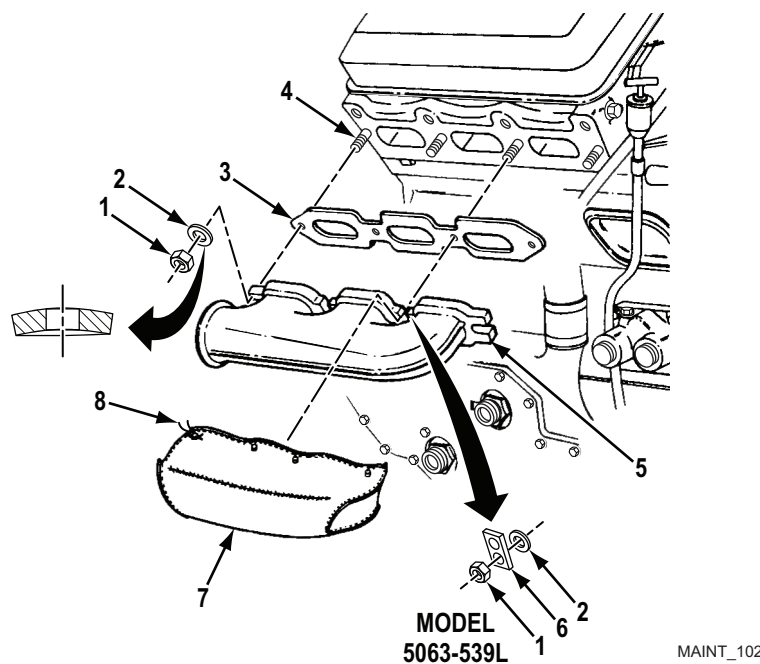


Figure 1. Exhaust Manifold Removal/Installation.

5. Repeat Steps 1–4 for opposite manifold.

**END OF TASK**

**CLEANING**

Remove loose scale, gasket material, and carbon from exhaust manifolds.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Check for cracks on exhaust manifolds at holding lug areas.
2. Check for holes or rusted areas on the exhaust manifold. Discard manifolds with holes.

**END OF TASK****INSTALLATION****NOTE**

On models 5063-5392 and 5063-5299, exhaust manifold outlet is at front of engine. Exhaust manifold outlet is at rear of engine on remaining models.

Install exhaust manifold spring washers with crown side facing nut.

Model 5063-539L has two brackets (Figure 1, Item 6) located on the second and third studs of the right and left sides.

1. Install new gasket (Figure 1, Item 3), exhaust manifold (Figure 1, Item 5), bracket (Figure 1, Item 6), one spring washer (Figure 1, Item 2), and one nut (Figure 1, Item 1) over studs (Figure 1, Item 4) in cylinder head. Install remaining three spring washers (Figure 1, Item 2) and three nuts (Figure 1, Item 1) on studs.
2. For model 5063-539L, install new gasket (Figure 1, Item 3), exhaust manifold (Figure 1, Item 5), two brackets (Figure 1, Item 6), four spring washers (Figure 1, Item 2), and four new locknuts (Figure 1, Item 1) over studs (Figure 1, Item 4) in cylinder head.
3. Starting with the center stud and working alternately toward each end of manifold, torque locknuts (Figure 1, Item 1) to 30–35 lb-ft (41–47 N·m).

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L have insulating covers on exhaust manifolds.

4. Place insulation cover (Figure 1, Item 7) over exhaust manifold (Figure 1, Item 5).

**INSTALLATION - Continued**

5. Using new wire (Figure 2, Item 8) and wire twister pliers, install insulation cover (Figure 2, Item 2) as follows:
  - a. Loop new wire around first capstan (Figure 2, Item 9) and apply two twists using wire twister pliers.
  - b. While holding insulation cover in place by hand, place ends of new wire on each side of adjacent capstan (Figure 2, Item 10) and apply at least two more twists using wire twister pliers.
  - c. Trim new wire 3/4 inch from second capstan (Figure 2, Item 10).

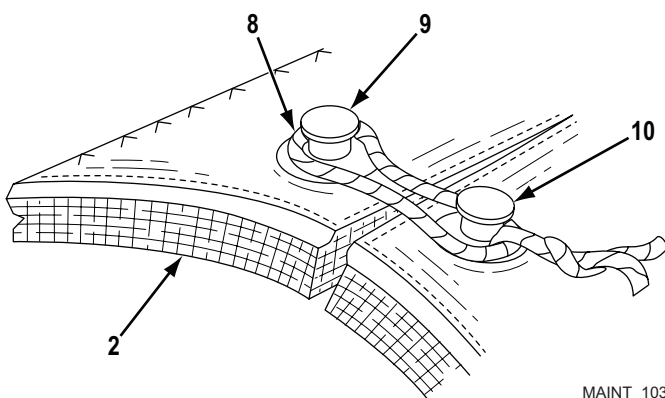


Figure 2. Insulation Cover Installation.

- d. Repeat Steps 5.a. – 5.c. for remaining pairs of capstans.
6. Repeat Steps 1–5 for opposite manifold.

**END OF TASK****FOLLOW ON TASK**

1. Install glow plug harness brackets (model 5063-539L) (WP 0045).
2. Install exhaust tube couplings (models 5063-5393 and 5063-539L) (WP 0038).
3. Install exhaust tube couplings (model 5063-5392) (WP 0037).

**END OF TASK****END OF WORK PACKAGE**

**FIELD MAINTENANCE  
ENGINE LIFTER BRACKETS REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 23)

---

**REMOVAL**

1. Remove two screws (Figure 1, Item 3), two lockwashers (Figure 1, Item 2), and lifting bracket (Figure 1, Item 1) from front of left cylinder head. Discard lockwashers.
2. Remove two screws (Figure 1, Item 4), two lockwashers (Figure 1, Item 5), and lifting bracket (Figure 1, Item 6) from rear of right cylinder head. Discard lockwashers.

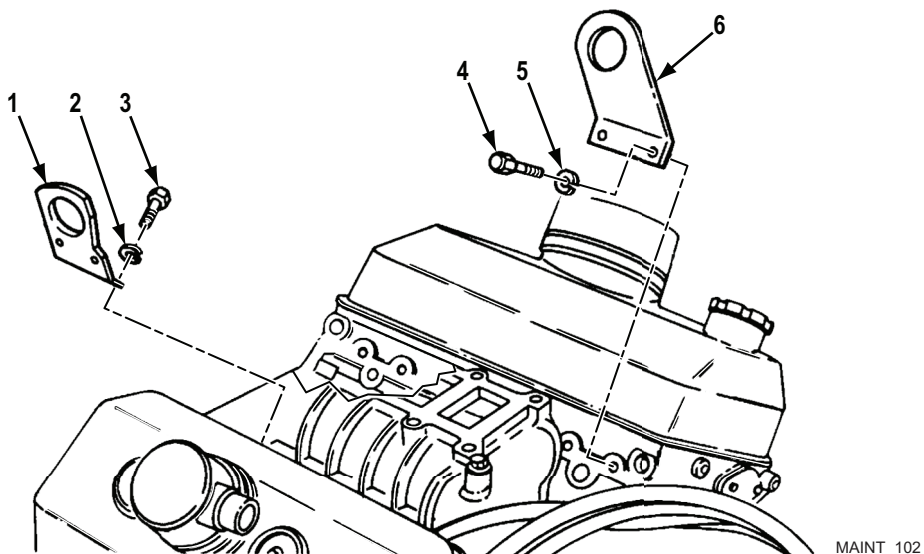


Figure 1. Engine Lifting Bracket Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install lifting bracket (Figure 1, Item 1), two new lockwashers (Figure 1, Item 2), and two screws (Figure 1, Item 3) on front of left cylinder head.
2. Install lifting bracket (Figure 1, Item 6), two new lockwashers (Figure 1, Item 5), and two screws (Figure 1, Item 4) to rear of right cylinder head.
3. Torque all lifting bracket bolts to 30–35 lb-ft (41–47 N·m).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**ENGINE FRONT MOUNTING BRACKET REPLACEMENT**  
**(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

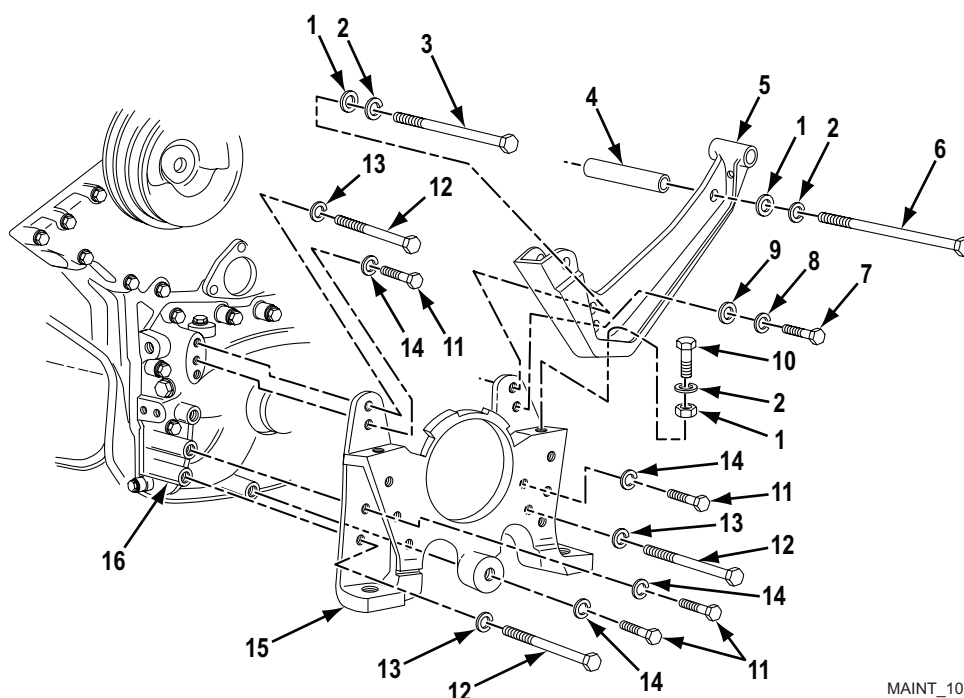
**Materials/Parts**

Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 179)

---

**REMOVAL**

1. Remove long screw (Figure 1, Item 6), mid-sized screw (Figure 1, Item 3), short screw (Figure 1, Item 10), three lockwashers (Figure 1, Item 2), three flat washers (Figure 1, Item 1), large diameter screw (Figure 1, Item 7), lockwasher (Figure 1, Item 8), flat washer (Figure 1, Item 9), spacer (Figure 1, Item 4), and bracket (Figure 1, Item 5) from front of engine. Discard lockwashers.
2. Remove five short screws (Figure 1, Item 11), five lockwashers (Figure 1, Item 14), three long screws (Figure 1, Item 12), three lockwashers (Figure 1, Item 13), and engine bracket (Figure 1, Item 15) from lower front cover (Figure 1, Item 16). Discard lockwashers.



MAINT\_105

Figure 1. Engine Front Mounting Bracket Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install engine bracket (Figure 1, Item 15), five new lockwashers (Figure 1, Item 14), five short screws (Figure 1, Item 11), three new lockwashers (Figure 1, Item 13), and three long screws (Figure 1, Item 12) on lower front cover (Figure 1, Item 16). Torque screws (Figure 1, Item 12) to 30–35 lb-ft (41–47 N·m) and screws (Figure 1, Item 11) to 46–50 lb-ft (62–68 N·m).
2. Install bracket (Figure 1, Item 5), spacer (Figure 1, Item 4), three flat washers (Figure 1, Item 1), three new lockwashers (Figure 1, Item 2), long screw (Figure 1, Item 6), mid-sized screw (Figure 1, Item 3), short screw (Figure 1, Item 10), flat washer (Figure 1, Item 9), new lockwasher (Figure 1, Item 8), and large diameter screw (Figure 1, Item 7) on bracket (Figure 1, Item 15). Torque screw (Figure 1, Item 7) to 46–50 lb-ft (62–68 N·m) and screws (Figure 1, Items 3, 6, and 10) to 30–35 lb-ft (41–47 N·m).

**END OF TASK****END OF WORK PACKAGE**



**FIELD MAINTENANCE**  
**AIR BOX HEATER HARDWARE REPLACEMENT**  
**(MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
 (WP 0104, Table 1, Item 113)  
 Wrench, Torque, Dial, 0–175 Lb-Ft  
 (WP 0104, Table 1, Item 120)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
 Washer, Flat (WP 0105, Table 1, Item 117)

**Materials/Parts (cont.)**

Washer, Lock (WP 0105, Table 1, Item 175)  
 Washer, Lock  
 Qty: (3) (WP 0105, Table 1, Item 176)  
 Washer, Lock  
 Qty: (6) (WP 0105, Table 1, Item 23)  
 Washer, Lock  
 Qty: (2) (WP 0105, Table 1, Item 179)

**REMOVAL**

1. Remove screw (Figure 1, Item 8), lockwasher (Figure 1, Item 9), and flat washer (Figure 1, Item 7) securing hose clip (Figure 1, Item 6) to lower front cover. Discard lockwasher.
2. Disconnect fuel inlet hose assembly (Figure 1, Item 4) from elbow (Figure 1, Item 1) at fuel solenoid valve (Figure 1, Item 2) and from tee (Figure 1, Item 5). Remove hose assembly from engine.
3. If necessary, remove clip (Figure 1, Item 6), clip (Figure 1, Item 3), and wirewrap (Figure 1, Item 10) from hose assembly (Figure 1, Item 4).

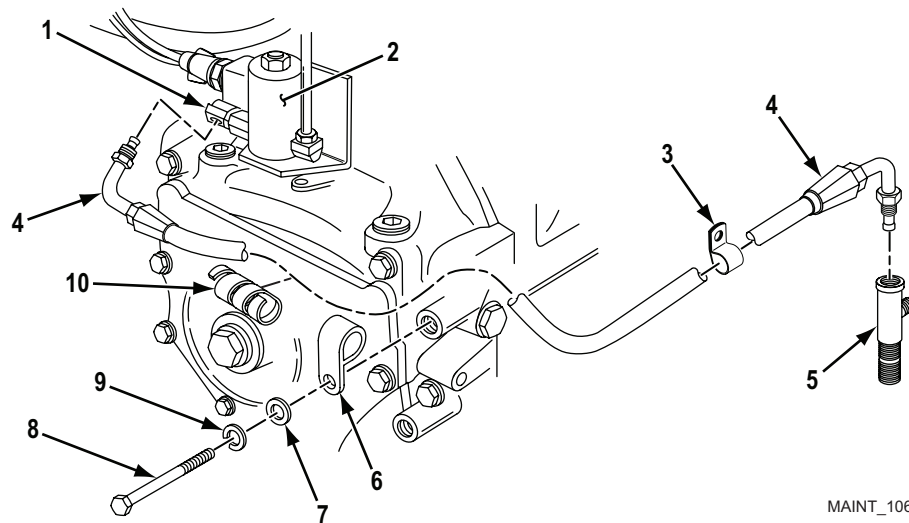


Figure 1. Air Box Heater Fuel Line Removal.

**REMOVAL - Continued**

4. Disconnect hose assembly (Figure 2, Item 12) from check valve (Figure 2, Item 11) and then from elbow (Figure 2, Item 31) at air box heater body (Figure 2, Item 30). If necessary, remove adapter (Figure 2, Item 42) from hose.
5. Disconnect connector (Figure 2, Item 32) from solenoid valve (Figure 2, Item 2) and connector (Figure 2, Item 26) from ignition coil (Figure 2, Item 25).
6. Remove nut (Figure 2, Item 17), nut (Figure 2, Item 18), lockwasher (Figure 2, Item 16), and lockwasher (Figure 2, Item 19) from terminal (Figure 2, Item 14) and terminal (Figure 2, Item 21). Disconnect wiring harness lead (Figure 2, Item 15) and lead (Figure 2, Item 20) from air pump (Figure 2, Item 45). Discard lockwashers.
7. Remove bolt (Figure 2, Item 33) and copper flat washer (Figure 2, Item 35) connecting ground wires (Figure 2, Item 34) to air box heater body (Figure 2, Item 30) in upper front cover. Discard copper flat washer.
8. Remove screw (Figure 2, Item 38), lockwasher (Figure 2, Item 39), and flat washer (Figure 2, Item 40) securing clip (Figure 2, Item 41) to upper front cover. Discard lockwasher. If necessary, remove clip (Figure 2, Item 41) from air hose (Figure 2, Item 12).
9. Disconnect ignition coil cable (Figure 2, Item 13) from ignition coil (Figure 2, Item 25) and igniter (Figure 2, Item 29).
10. Remove nut (Figure 2, Item 28), lockwasher (Figure 2, Item 27), screw (Figure 2, Item 22), and flat washer (Figure 2, Item 23) securing clip (Figure 2, Item 24), bracket assembly (Figure 2, Item 44), and support (Figure 2, Item 43). Discard lockwasher. If necessary, remove clip from harness plug.
11. Remove wire wrap (Figure 2, Item 37) from harness assembly (Figure 2, Item 36), ignition coil cable (Figure 2, Item 13), and air hose (Figure 2, Item 12). Remove air hose, ignition cable, and harness assembly from engine.

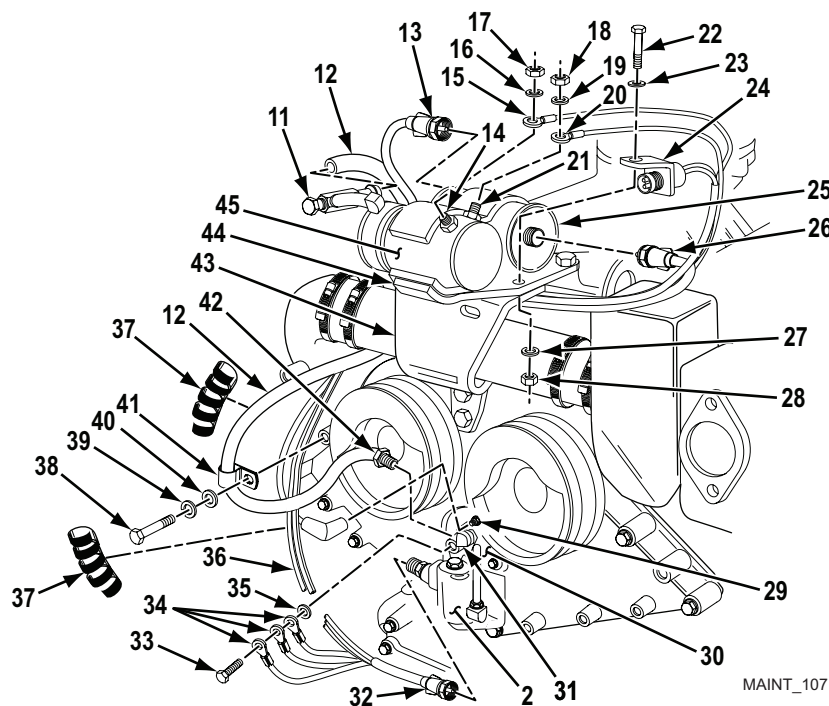


Figure 2. Air Box Heater Components Removal.

**REMOVAL - Continued**

12. Remove fuel line (Figure 3, Item 46) from elbow (Figure 3, Item 47) at solenoid valve (Figure 3, Item 2) and from elbow (Figure 3, Item 48) at air box heater body (Figure 2, Item 30).
13. For access to screws (Figure 3, Item 54), loosen nut on top of solenoid (Figure 3, Item 2) and rotate coil housing.
14. Remove two screws (Figure 3, Item 54), two lockwashers (Figure 3, Item 53), two flat washers (Figure 3, Item 52) and solenoid bracket (Figure 3, Item 49) from upper front cover. Discard lockwashers.
15. Remove two screws (Figure 3, Item 51) and two lockwashers (Figure 3, Item 50) from solenoid valve (Figure 3, Item 2) and bracket assembly (Figure 3, Item 49). Discard lockwashers.
16. If necessary, remove elbow (Figure 3, Item 1), elbow (Figure 3, Item 47), and adapter (Figure 3, Item 55) from solenoid valve (Figure 3, Item 2).

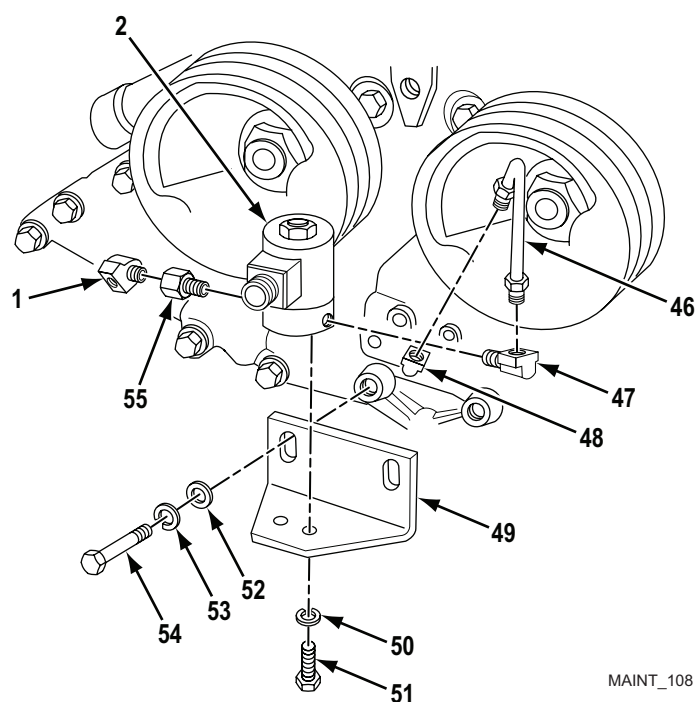


Figure 3. Air Box Solenoid and Mounting Bracket Removal.

**REMOVAL - Continued**

17. For model 5063-5299: disconnect hose assembly (Figure 4, Item 70) from elbow (Figure 4, Item 63) at air pump (Figure 4, Item 45) and remove hose assembly. If necessary, remove tee (Figure 4, Item 56), adapter (Figure 4, Item 58), adapter (Figure 4, Item 71), and pipe nipple (Figure 4, Item 57) from hose.
18. Remove two screws (Figure 4, Item 60), two hardened washers (Figure 4, Item 59), and bracket assembly (Figure 4, Item 44) from top of blower (Figure 4, Item 69).
19. Remove nut (Figure 4, Item 67), lockwasher (Figure 4, Item 68), flat washer (Figure 4, Item 62), and screw (Figure 4, Item 61) securing bracket assembly (Figure 4, Item 44) and support (Figure 4, Item 43). Discard lockwasher.
20. Remove two screws (Figure 4, Item 64), two lockwashers (Figure 4, Item 65), two flat washers (Figure 4, Item 66), and support (Figure 4, Item 43) from front of engine. Discard lockwashers.

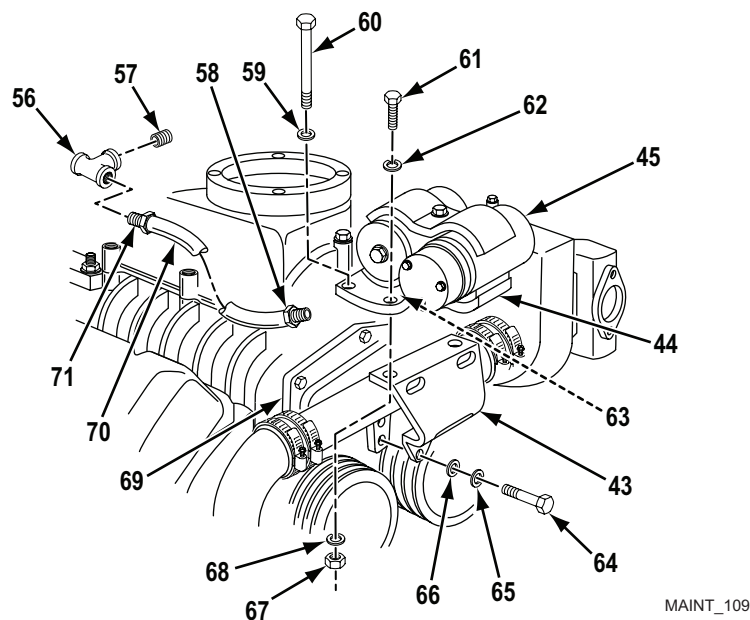
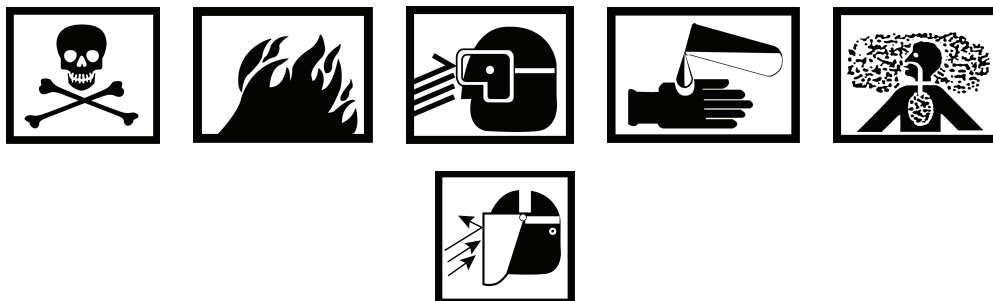


Figure 4. Air Box Heater Air Pump Hardware Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean fuel solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.

**END OF TASK****TEST AND INSPECTION**

1. Inspect hoses for cuts, tears, kinks, or damage.
2. Inspect wiring harness for cuts, tears, burns, or damage.
3. Test solenoid.
  - a. Apply a 24 V dc power source to solenoid valve (Figure 5, Item 2) and listen for valve to "click" to confirm if valve is opening and closing as power is applied. If no indication of movement is present, replace solenoid valve.
  - b. Disconnect power source from solenoid valve (Figure 5, Item 2).

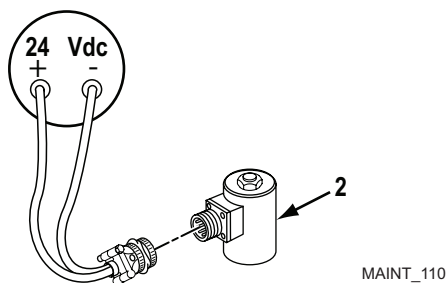
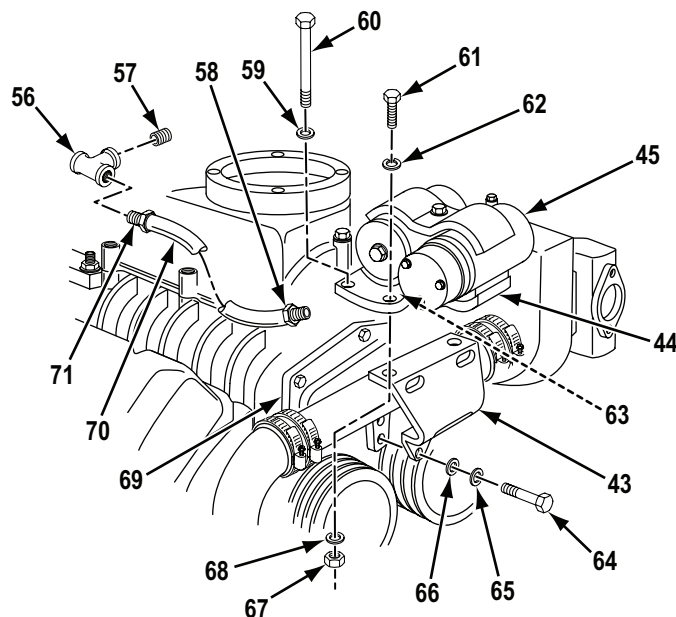


Figure 5. Air Box Solenoid Test.

**END OF TASK**

**INSTALLATION**

1. Loosely install support (Figure 6, Item 43), two flat washers (Figure 6, Item 66), two new lockwashers (Figure 6, Item 65), and two screws (Figure 6, Item 64) on upper front cover.
2. Loosely install bracket assembly (Figure 6, Item 44), screw (Figure 6, Item 61), flat washer (Figure 6, Item 62), new lockwasher (Figure 6, Item 68), and nut (Figure 6, Item 67) on support (Figure 6, Item 43).
3. Install two hardened washers (Figure 6, Item 59) and two screws (Figure 6, Item 60) on bracket assembly (Figure 6, Item 44) into blower (Figure 6, Item 69). Torque two screws (Figure 6, Item 64) to 46–50 lb-ft (62–68 N·m), nut (Figure 6, Item 67) to 30–35 lb-ft (41–47 N·m), and screws (Figure 6, Item 60) to 55–60 lb-ft (75–81 N·m).
4. For model 5063-5299:
  - a. If removed, install pipe nipple (Figure 6, Item 57) and tee (Figure 6, Item 56). Install adapter (Figure 6, Item 58) and adapter (Figure 6, Item 71) into hose.
  - b. Connect hose assembly (Figure 6, Item 70) to elbow (Figure 6, Item 63) on air pump (Figure 6, Item 45) and then to tee (Figure 6, Item 56).



MAINT\_111

Figure 6. Air Box Heater Air Pump Hardware Installation.

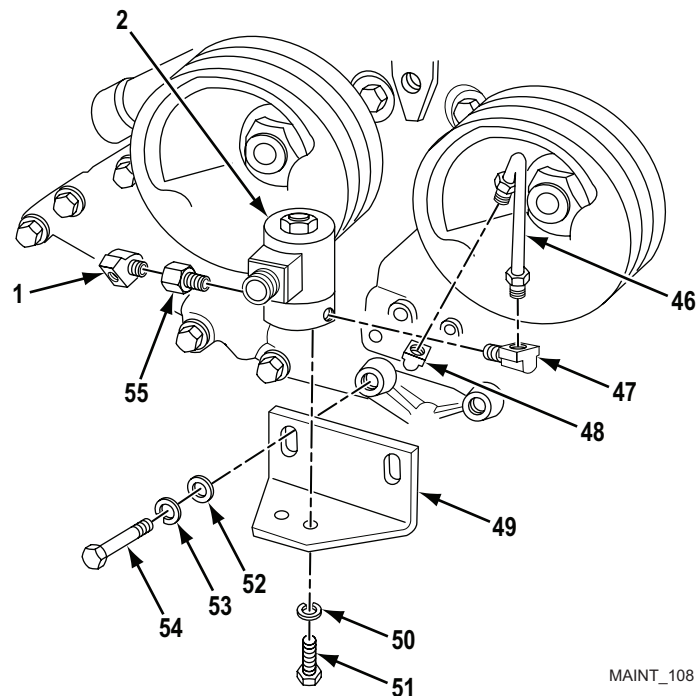
**INSTALLATION - Continued**

5. If removed, install elbow (Figure 7, Item 47) (inlet port), adapter (Figure 7, Item 55), and elbow (Figure 7, Item 1) (outlet port) to solenoid valve (Figure 7, Item 2).
6. Install solenoid valve (Figure 7, Item 2), two new lockwashers (Figure 7, Item 56) and two screws (Figure 7, Item 51) on bracket (Figure 7, Item 49) with fuel inlet facing right side. Tighten screws.

**NOTE**

For access to screws, loosen nut on top of solenoid and rotate coil housing. Rotate connector toward right side and securely tighten nut after bracket is installed.

7. Install solenoid valve bracket (Figure 7, Item 49), two flat washers (Figure 7, Item 52), two new lockwashers (Figure 7, Item 53), and two screws (Figure 7, Item 54) on upper front cover. Torque screws to 30–35 lb-ft (41–47 N·m).
8. Install fuel line (Figure 7, Item 46) in elbow (Figure 7, Item 47), at solenoid valve (Figure 7, Item 2), and in elbow (Figure 7, Item 48) on air box heater body (Figure 7, Item 30). Tighten connections.



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Figure 7. Air Box Solenoid and Mounting Bracket Installation.

**INSTALLATION - Continued**

9. Wind wire wrap (Figure 8, Item 37) around ignition coil cable (Figure 8, Item 13), air hose (Figure 8, Item 12), and harness assembly (Figure 8, Item 36). If removed, install clip (Figure 8, Item 41) on air hose (Figure 8, Item 12).

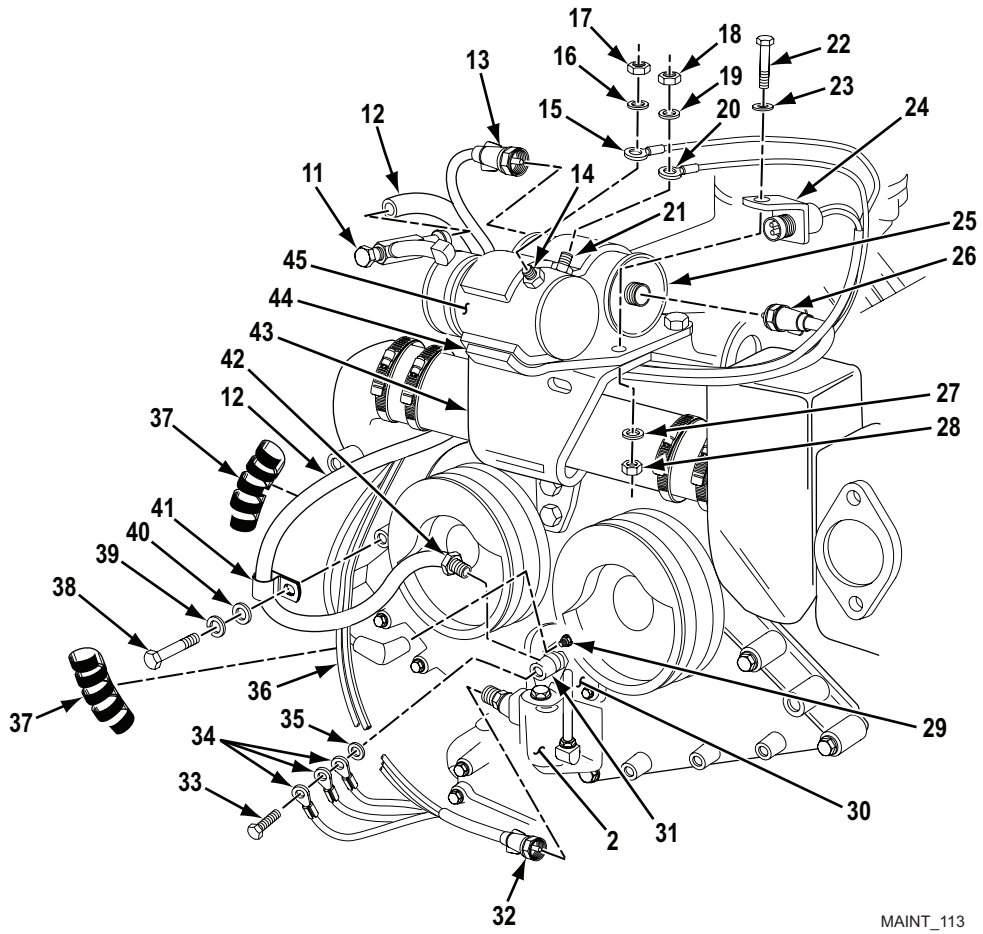
**NOTE**

Position wiring harness and hose assembly around engine components and brackets as shown.

10. If removed, install adapter (Figure 8, Item 42) into hose assembly (Figure 8, Item 12). Connect hose assembly to check valve (Figure 8, Item 11) and adapter end to elbow (Figure 8, Item 31) at air box heater body (Figure 8, Item 30). Tighten connections.
11. Install connector (Figure 8, Item 32) in solenoid (Figure 8, Item 2) and connector (Figure 8, Item 26) in ignition coil (Figure 8, Item 25).
12. Install wiring harness lead (Figure 8, Item 15), new lockwasher (Figure 8, Item 16), and nut (Figure 8, Item 18) on terminal (Figure 8, Item 14). Install lead (Figure 8, Item 20), new lockwasher (Figure 8, Item 19), and nut (Figure 8, Item 18) on terminal (Figure 8, Item 21) on air pump (Figure 8, Item 45). Tighten nuts securely.
13. Install ground wires (Figure 8, Item 34), new copper flat washer (Figure 8, Item 35), and bolt (Figure 8, Item 33) on air box heater body (Figure 8, Item 30). Torque bolt to 13–17 lb-ft (18–23 N·m).
14. Install clip (Figure 8, Item 41), on air hose (Figure 8, Item 12), flat washer (Figure 8, Item 40), new lockwasher (Figure 8, Item 39), and screw (Figure 8, Item 38) on upper front cover. Torque screw to 30–35 lb-ft (41–47 N·m).
15. Connect boot end of ignition coil cable (Figure 8, Item 13) to igniter (Figure 8, Item 29) and connector end of ignition coil cable to ignition coil (Figure 8, Item 25).
16. Install screw (Figure 8, Item 22), flat washer (Figure 8, Item 23), new lockwasher (Figure 8, Item 27), and nut (Figure 8, Item 28) in bracket (Figure 8, Item 44) and support (Figure 8, Item 43). Torque nut to 30–35 lb-ft (41–47 N·m).



INSTALLATION - Continued



MAINT\_113

Figure 8. Air Box Heater Components Installation.

**INSTALLATION - Continued**

17. If removed, install clip (Figure 9, Item 6), clip (Figure 9, Item 3), and wire wrap (Figure 9, Item 10) on hose assembly (Figure 9, Item 4).
18. Connect fuel inlet hose assembly (Figure 9, Item 4) to elbow (Figure 9, Item 1) in solenoid valve (Figure 9, Item 2) and tee (Figure 9, Item 5). Tighten connection.
19. Install clip (Figure 9, Item 6), flat washer (Figure 9, Item 7), new lockwasher (Figure 9, Item 9), and screw (Figure 9, Item 8) on lower front cover. Torque screw to 30–35 lb-ft (41–47 N·m).

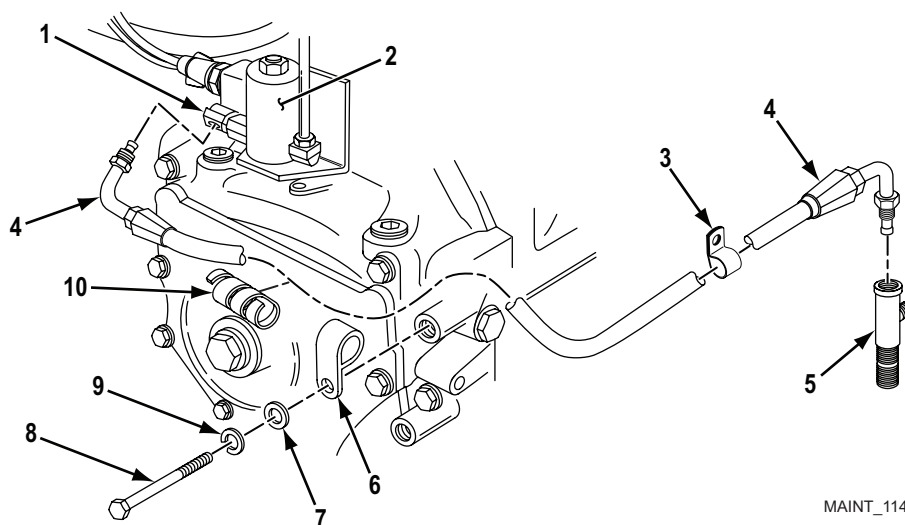


Figure 9. Air Box Heater Fuel Line Installation.

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
AIR BOX HEATER HARDWARE REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Washer, Flat (WP 0105, Table 1, Item 117)

**Materials/Parts (cont.)**

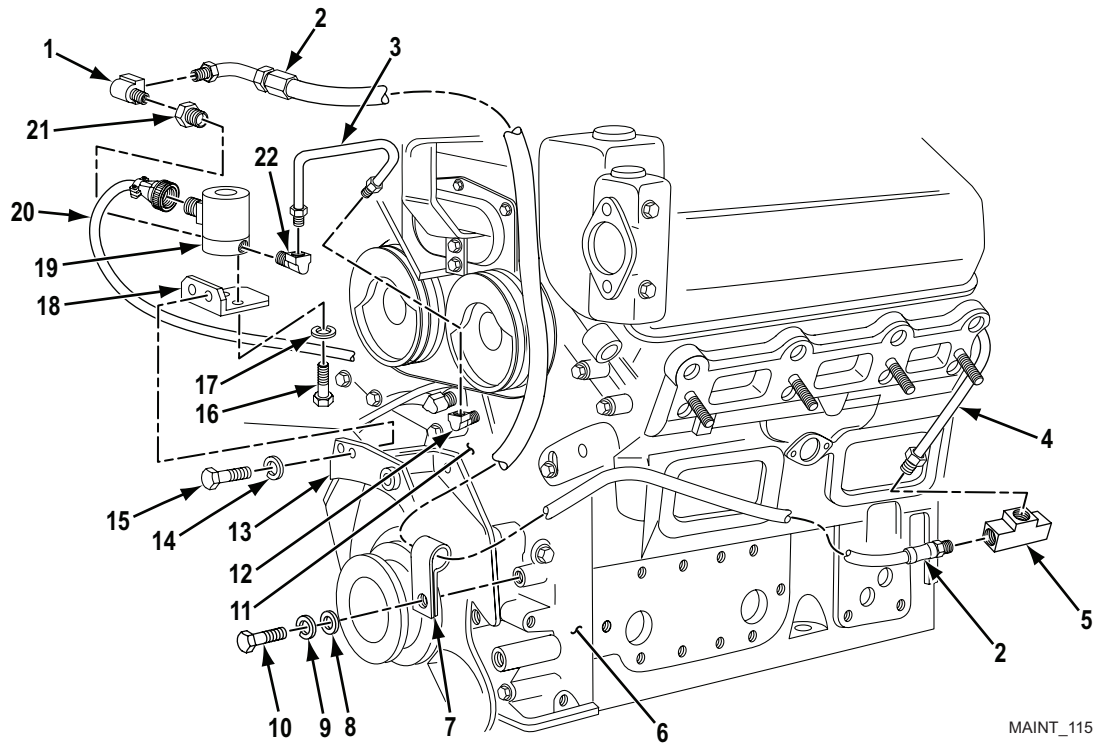
Washer, Lock (WP 0105, Table 1, Item 175)  
Washer, Lock  
Qty: (5) (WP 0105, Table 1, Item 176)  
Washer, Lock (WP 0105, Table 1, Item 177)  
Washer, Lock  
Qty: (9) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 179)

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**REMOVAL**

1. Remove screw (Figure 1, Item 10), lockwasher (Figure 1, Item 9), flat washer (Figure 1, Item 8), and loop clamp (Figure 1, Item 7) on lower front cover (Figure 1, Item 6). Discard lockwasher.
2. Disconnect hose assembly (Figure 1, Item 2) from elbow (Figure 1, Item 1) in solenoid valve (Figure 1, Item 19).
3. Disconnect hose assembly (Figure 1, Item 2) from tee (Figure 1, Item 5). Disconnect tee from fuel spill tube (Figure 1, Item 4).
4. Disconnect harness assembly (Figure 1, Item 20) from fuel solenoid valve (Figure 1, Item 19).
5. Disconnect tube assembly (Figure 1, Item 3) from elbow (Figure 1, Item 22) in solenoid valve (Figure 1, Item 19) and from elbow (Figure 1, Item 12) in air box heater (Figure 1, Item 11).
6. Remove two machine screws (Figure 1, Item 15), two lockwashers (Figure 1, Item 14), and mounting bracket (Figure 1, Item 18) from engine bracket (Figure 1, Item 13). Discard lockwashers.
7. Remove two machine screws (Figure 1, Item 16), two lockwashers (Figure 1, Item 17), and solenoid valve (Figure 1, Item 19) from mounting bracket (Figure 1, Item 18). Discard lockwashers.
8. If necessary, remove elbow (Figure 1, Item 1), elbow (Figure 1, Item 22), and adapter (Figure 1, Item 21) from solenoid valve (Figure 1, Item 19).

REMOVAL - Continued



MAINT\_115

Figure 1. Air Box Heater Hardware Removal.

**REMOVAL - Continued**

9. Remove bolt (Figure 2, Item 37), copper flat washer (Figure 2, Item 36), and grounding wires of harness assembly (Figure 2, Item 20) from air box heater (Figure 2, Item 11). Discard copper flat washer.
10. Remove screw (Figure 2, Item 39), lockwasher (Figure 2, Item 40), flat washer (Figure 2, Item 41), and loop clamp (Figure 2, Item 42) from front cover (Figure 2, Item 32). Discard lockwasher.
11. Disconnect air hose (Figure 2, Item 45) from check valve (Figure 2, Item 47) and adapter (Figure 2, Item 35) from elbow (Figure 2, Item 34) in air box heater (Figure 2, Item 11). If necessary, remove adapter from hose.
12. Disconnect ignition wire (Figure 2, Item 33) from ignition coil (Figure 2, Item 30) and spark igniter (Figure 2, Item 31).
13. Remove two nuts (Figure 2, Items 43 and 44) and disconnect two leads of harness assembly (Figure 2, Item 20) from air pump (Figure 2, Item 26).
14. Disconnect harness assembly (Figure 2, Item 20) from ignition coil (Figure 2, Item 30).
15. Remove nut (Figure 2, Item 50), lockwasher (Figure 2, Item 49), screw (Figure 2, Item 46), and clip (Figure 2, Item 48) from angle bracket (Figure 2, Item 27). Discard lockwasher. If necessary, remove clip from harness assembly (Figure 2, Item 20).
16. Remove nut (Figure 2, Item 29), lockwasher (Figure 2, Item 28), two flat washers (Figure 2, Item 23), screw (Figure 2, Item 24), and clip (Figure 2, Item 25) from angle bracket (Figure 2, Item 27). Discard lockwasher.
17. Remove clip (Figure 2, Item 42) and wire wrap (Figure 2, Item 38) holding harness assembly (Figure 2, Item 20), ignition wire (Figure 2, Item 33), and air hose (Figure 2, Item 45) together. Remove air hose, ignition cable, and harness assembly from engine.

REMOVAL - Continued

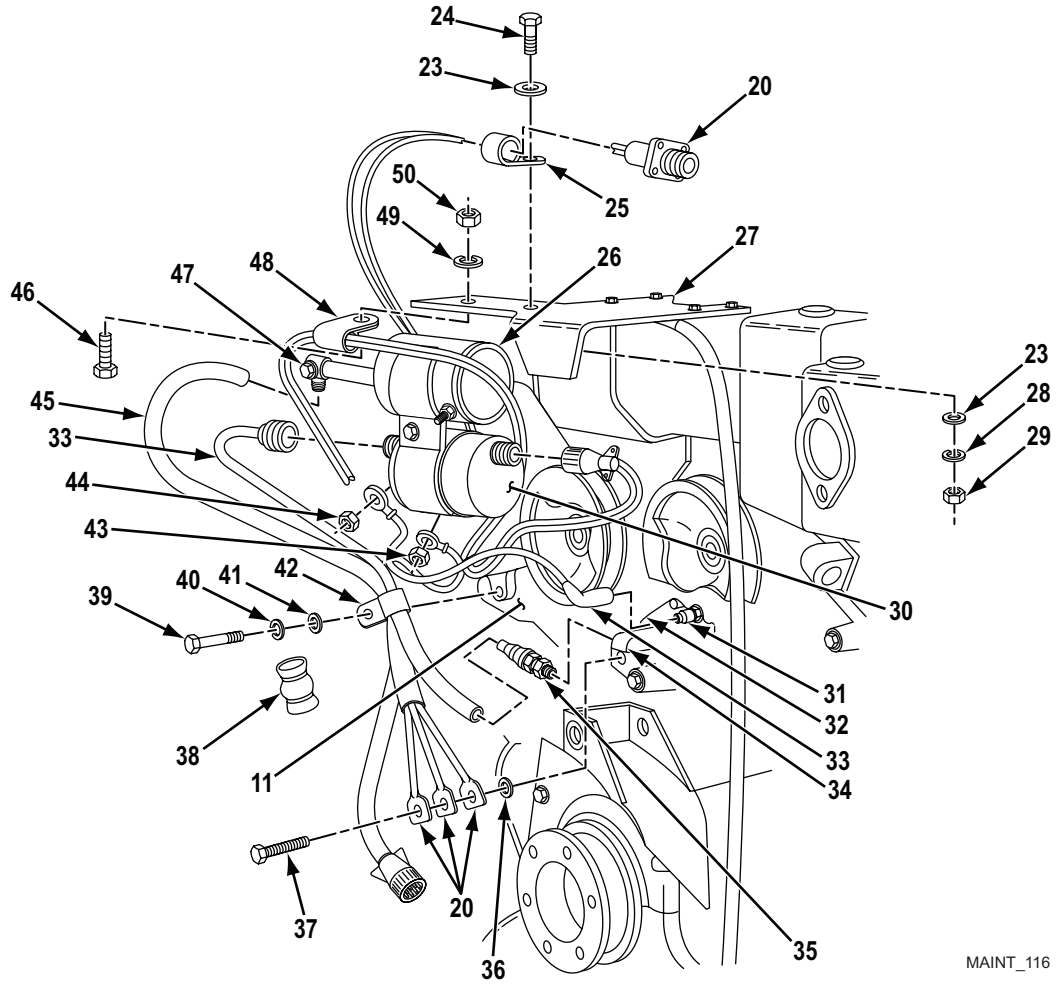
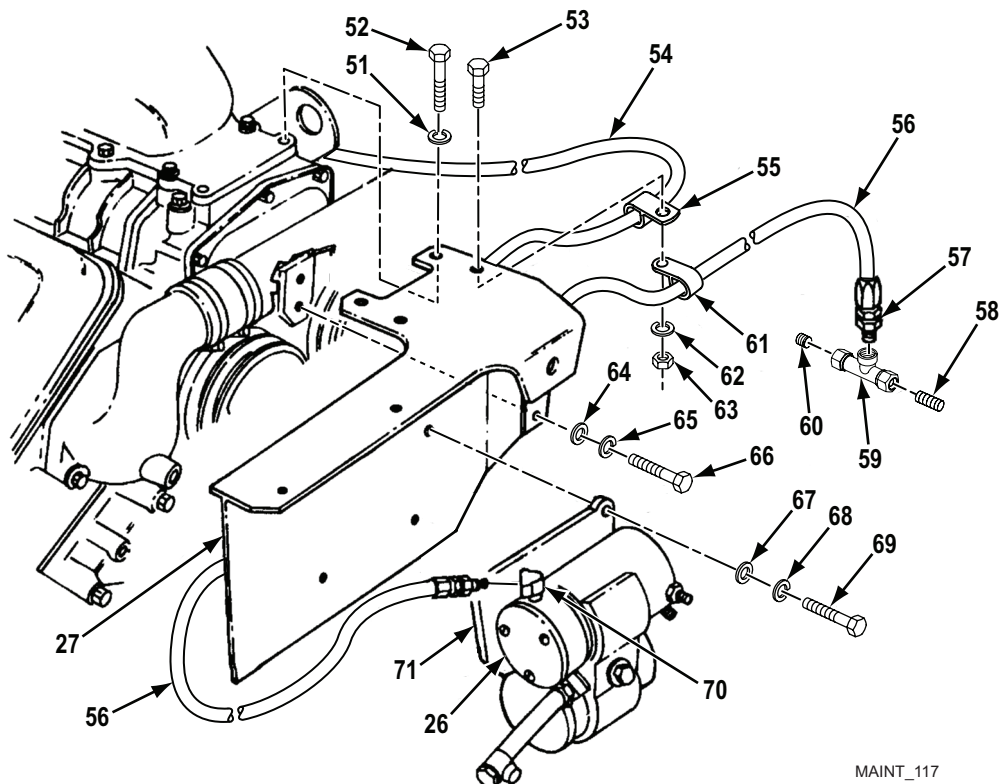


Figure 2. Air Box Heater Electrical Hardware Removal.

MAINT\_116

**REMOVAL - Continued**

18. Remove two nuts (Figure 3, Item 63), two lockwashers (Figure 3, Item 62), two screws (Figure 3, Item 53), loop clamp (Figure 3, Item 61) on air hose assembly (Figure 3, Item 56), and two loop clamps (Figure 3, Item 55) on fuel hose assembly (Figure 3, Item 54) from angle bracket (Figure 3, Item 27). Discard lockwashers.
19. Disconnect air hose assembly (Figure 3, Item 56) from elbow (Figure 3, Item 70) at air pump (Figure 3, Item 26). Remove hose assembly from engine. If necessary, remove loop clamp (Figure 3, Item 61), pipe nipple (Figure 3, Item 58), pipe plug (Figure 3, Item 60), pipe tee (Figure 3, Item 59), and connector (Figure 3, Item 57) from hose assembly.
20. Remove four screws (Figure 3, Item 69), four lockwashers (Figure 3, Item 68), four flat washers (Figure 3, Item 67), and bracket assembly (Figure 3, Item 71) from angle bracket (Figure 3, Item 27). Discard lockwashers.
21. Remove two long screws (Figure 3, Item 52) and two lockwashers (Figure 3, Item 51) from top of angle bracket (Figure 3, Item 27). Remove two short screws (Figure 3, Item 66), two lockwashers (Figure 3, Item 65), and two flat washers (Figure 3, Item 64) from front of bracket. Remove bracket from engine. Discard lockwashers.

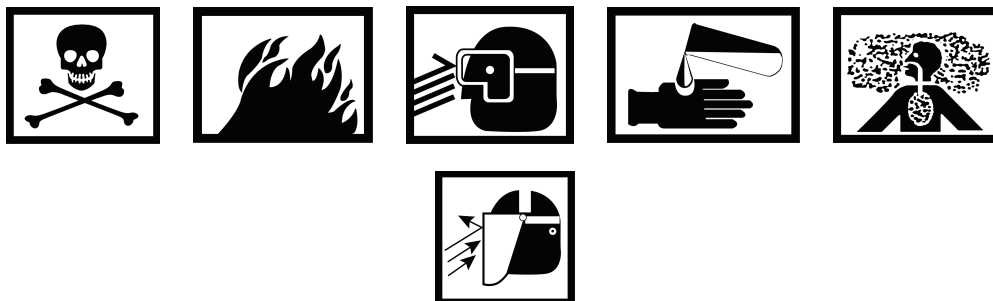


MAINT\_117

Figure 3. Air Box Heater Air Pump and Mounting Bracket Removal.

**END OF TASK**



**CLEANING****WARNING**

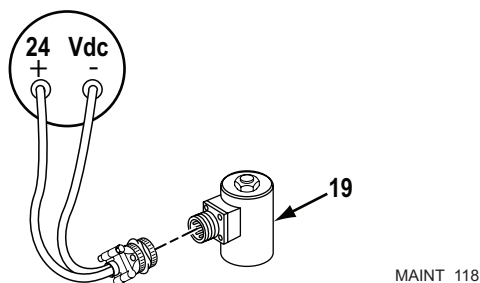
Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.

**END OF TASK****TEST AND INSPECTION**

1. Inspect hoses for cuts, tears, kinks, or damage.
2. Inspect wiring harness for cuts, tears, burns, or damage.
3. Solenoid Test.
  - a. Apply a 24 V dc power supply to the solenoid valve (Figure 4, Item 19) several times and listen for the solenoid valve to "click" to determine if it functions. If there is no indication of valve movement, replace unit.
  - b. Disconnect power supply from solenoid valve (Figure 4, Item 19).



MAINT\_118

Figure 4. Air Box Heater Solenoid Test.

**END OF TASK**

**INSTALLATION**

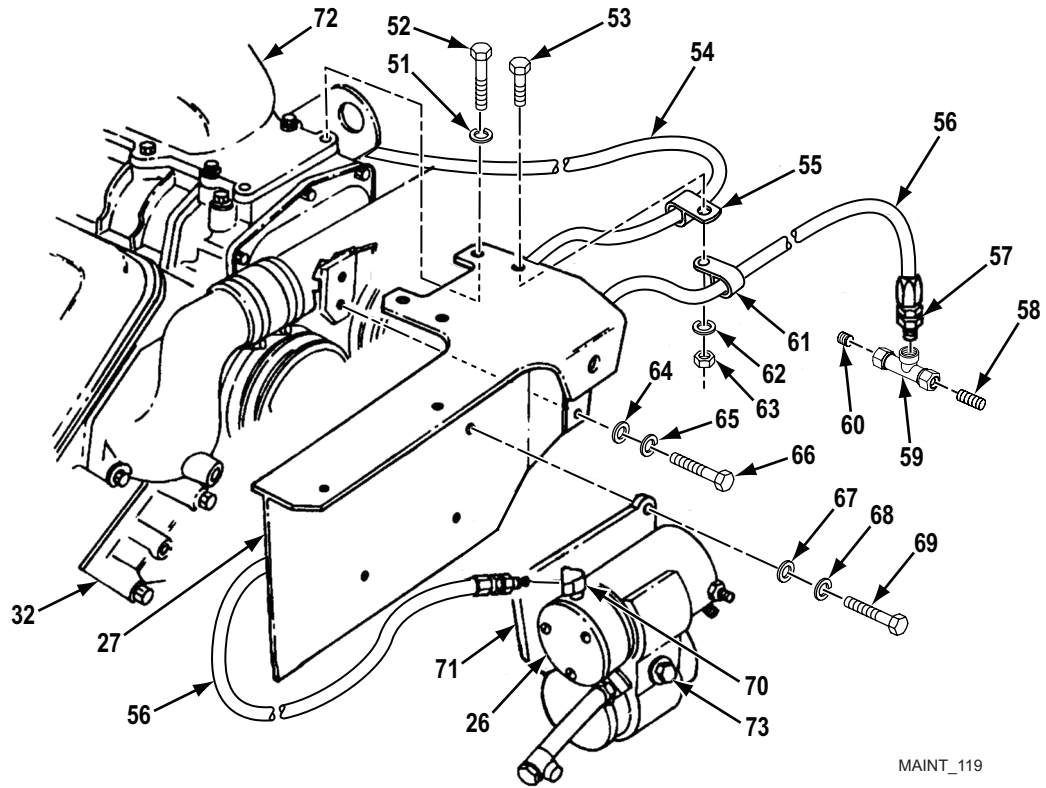
1. Lay harness assembly (Figure 6, Item 20) in position on front of engine.
2. Place angle bracket (Figure 5, Item 27) over front of air inlet housing (Figure 5, Item 72) and against upper front cover (Figure 5, Item 32). Install two new lockwashers (Figure 5, Item 51) and two long screws (Figure 5, Item 52) in top of bracket and install two flat washers (Figure 5, Item 64), two new lockwashers (Figure 5, Item 65), and two short screws (Figure 5, Item 66) in front of bracket. Torque screws (Figure 5, Item 52) to 16–20 lb-ft (22–27 N·m) and screws (Figure 5, Item 66) to 46–50 lb-ft (62–68 N·m).

**NOTE**

To torque screws (Figure 5, Item 69), it is necessary to loosen center bolt (Figure 5, Item 73) on bracket assembly (Figure 5, Item 71) and move air pump (Figure 6, Item 15) and ignition coil (Figure 6, Item 14). Torque center bolt to 60–96 lb-in (7–11 N·m).

3. Install bracket assembly (Figure 5, Item 71), four flat washers (Figure 5, Item 67), four new lockwashers (Figure 5, Item 68), and four screws (Figure 5, Item 69) on angle bracket (Figure 5, Item 27). Torque bolts to 30–35 lb-ft (41–47 N·m).
4. If removed, install loop clamp (Figure 5, Item 61), connector (Figure 5, Item 57), tee (Figure 5, Item 59), pipe nipple (Figure 5, Item 58), and pipe plug (Figure 5, Item 60) on air inlet hose (Figure 5, Item 56). Connect hose to elbow (Figure 5, Item 70) in air pump (Figure 5, Item 26). Tighten connection.
5. Install two screws (Figure 5, Item 53), two loop clamps (Figure 5, Item 55) on top of bracket, loop clamp (Figure 5, Item 61) on bottom of bracket, two new lockwashers (Figure 5, Item 62), and two nuts (Figure 5, Item 63) on angle bracket (Figure 5, Item 27). Torque screws to 30–35 lb-ft (41–47 N·m).

INSTALLATION - Continued



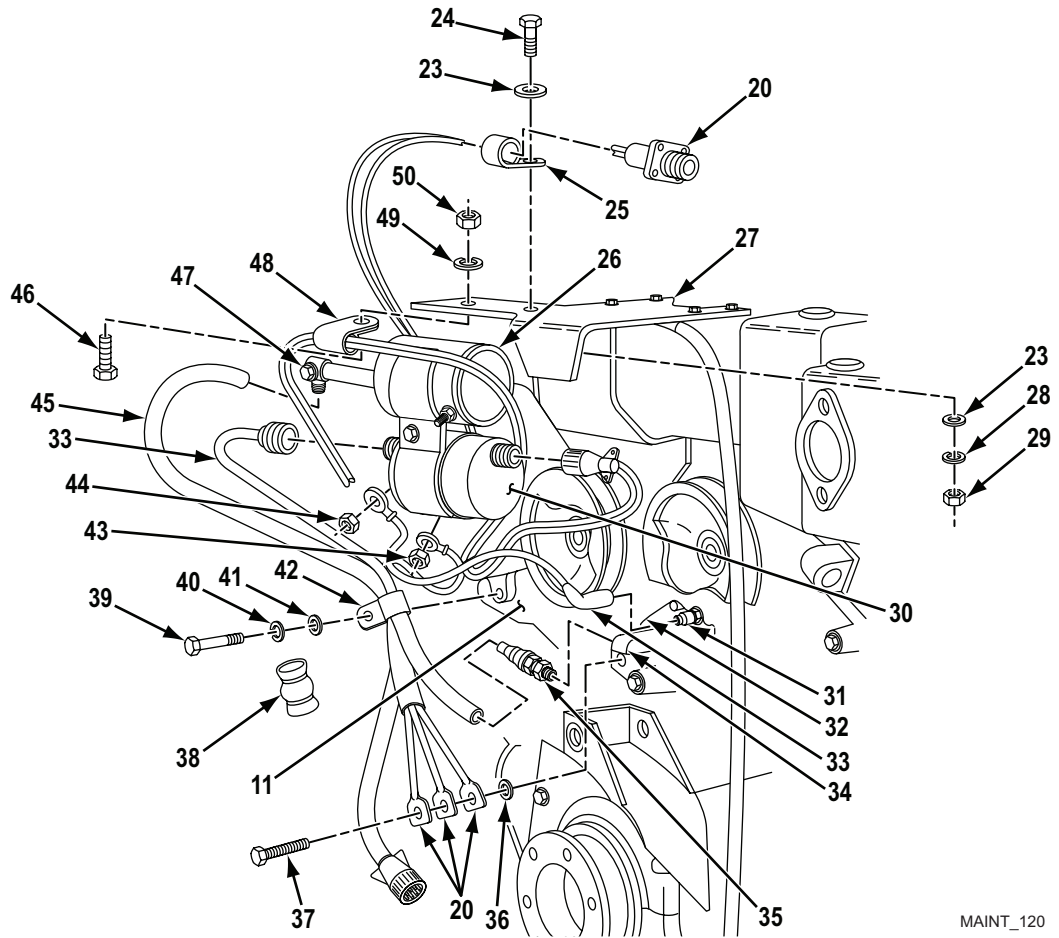
MAINT\_119

Figure 5. Air Box Heater Air Pump and Mounting Bracket Installation.

**INSTALLATION - Continued**

6. Install three ground wires of harness assembly (Figure 6, Item 20), new copper flat washer (Figure 6, Item 36), and bolt (Figure 6, Item 37) in air box heater (Figure 6, Item 11). Torque bolt to 13–17 lb-ft (18–23 N·m).
7. Connect ignition wire (Figure 6, Item 33) to spark igniter (Figure 6, Item 31) and ignition coil (Figure 6, Item 30).
8. If removed, install adapter (Figure 6, Item 35) in air hose (Figure 6, Item 45). Connect hose to check valve (Figure 6, Item 47) and adapter on hose to elbow (Figure 6, Item 34) in air box heater (Figure 6, Item 11).
9. Install terminal of harness assembly (Figure 6, Item 20), clip (Figure 6, Item 25), screw (Figure 6, Item 24), two flat washers (Figure 6, Item 23), new lockwasher (Figure 6, Item 28), and nut (Figure 6, Item 29) to top of angle bracket (Figure 6, Item 27). Torque nut to 30–35 lb-ft (41–47 N·m).
10. If removed, install clip (Figure 6, Item 48) on harness assembly (Figure 6, Item 20). Install screw (Figure 6, Item 46), new lockwasher (Figure 6, Item 49), and nut (Figure 6, Item 50) to bottom of angle bracket (Figure 6, Item 27). Torque nut to 7–9 lb-ft (10–12 N·m).
11. Install wire wrap (Figure 6, Item 38) and clip (Figure 6, Item 42) around harness assembly (Figure 6, Item 20), ignition wire (Figure 6, Item 33), and air hose (Figure 6, Item 45).
12. Install clip (Figure 6, Item 42), flat washer (Figure 6, Item 41), new lockwasher (Figure 6, Item 40), and screw (Figure 6, Item 39) on upper front cover (Figure 6, Item 32). Torque screw to 30–35 lb-ft (41–47 N·m).

INSTALLATION - Continued



MAINT\_120

Figure 6. Air Box Heater Electrical Hardware Installation.

**INSTALLATION - Continued**

13. If removed, install elbow (Figure 7, Item 22) in outlet port and adapter (Figure 7, Item 21) in inlet port of solenoid valve (Figure 7, Item 19). Install elbow (Figure 7, Item 1) in adapter.
14. Install solenoid valve (Figure 7, Item 19), two new lockwashers (Figure 7, Item 17), and two machine screws (Figure 7, Item 16) on mounting bracket (Figure 7, Item 18) with fuel inlet facing right side of engine. Tighten screws.
15. Loosely install mounting bracket (Figure 7, Item 18), two new lockwashers (Figure 7, Item 14), and two machine screws (Figure 7, Item 15) on engine bracket (Figure 7, Item 13).
16. Connect harness assembly (Figure 7, Item 20) to solenoid valve (Figure 7, Item 19) and ignition coil (Figure 7, Item 30).
17. Install two leads of harness assembly (Figure 6, Item 20) and two nuts (Figure 6, Items 43 and 44) on air pump (Figure 6, Item 26).
18. Connect tube assembly (Figure 7, Item 3) to elbow (Figure 7, Item 22), in solenoid valve (Figure 7, Item 19), and to elbow (Figure 7, Item 12), in air box heater (Figure 7, Item 11). Tighten connections and two machine screws (Figure 7, Item 15).
19. Connect hose assembly (Figure 7, Item 2) to elbow (Figure 7, Item 1) in solenoid valve (Figure 7, Item 19) and tee (Figure 7, Item 5) to fuel spill tube (Figure 7, Item 4). Tighten connections.
20. Install loop clamp (Figure 7, Item 7), flat washer (Figure 7, Item 8), new lockwasher (Figure 7, Item 9), and screw (Figure 7, Item 10) in lower front cover (Figure 7, Item 6). Torque screw to 30–35 lb-ft (41–47 N·m).

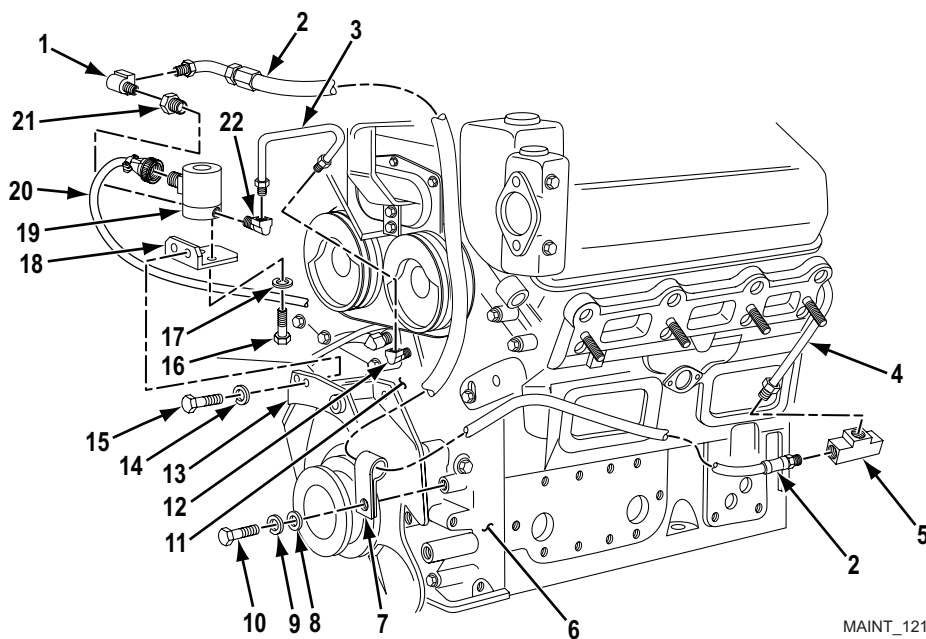


Figure 7. Air Box Heater Hardware Installation, Continued.

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
AIR BOX HEATER HARDWARE REPLACEMENT  
(MODEL 5063-5393)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Cleaning Solvent  
(WP 0103, Table 1, Item 8)  
Washer, Flat (WP 0105, Table 1, Item 117)  
Washer, Lock (WP 0105, Table 1, Item 175)

**Materials/Parts (cont.)**

Washer Lock  
Qty: (3) (WP 0105, Table 1, Item 176)  
Washer, Lock  
Qty: (10) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 179)

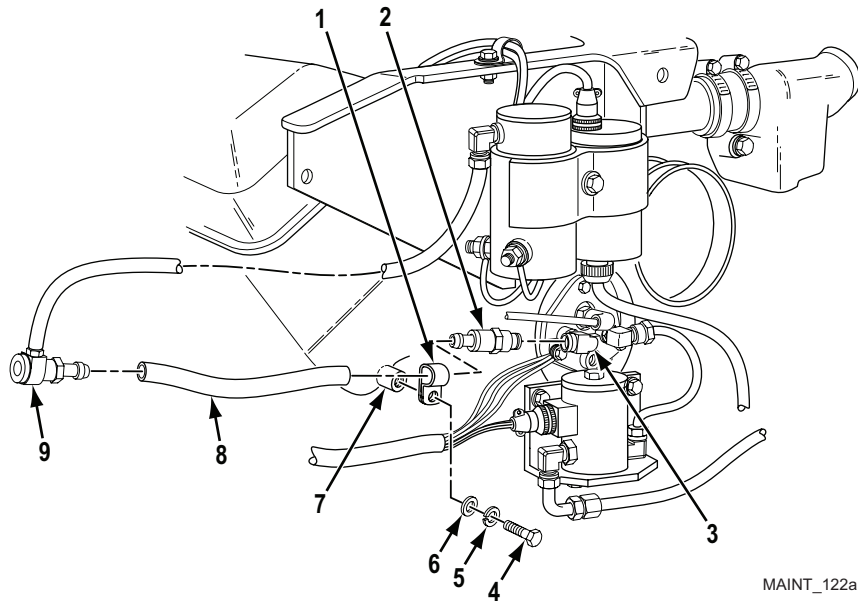
**Equipment Condition**

Upper bracket on front support removed  
(WP 0041)

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**REMOVAL**

1. Remove screw (Figure 1, Item 4), lockwasher (Figure 1, Item 5), flat washer (Figure 1, Item 6), and loop clamp (Figure 1, Item 1), on check valve (Figure 1, Item 9), from upper front cover (Figure 1, Item 7). Discard lockwasher.
2. Disconnect hose (Figure 1, Item 8) from check valve (Figure 1, Item 9) and adapter (Figure 1, Item 2) from elbow (Figure 1, Item 3). If necessary, remove adapter (Figure 1, Item 2) from hose.



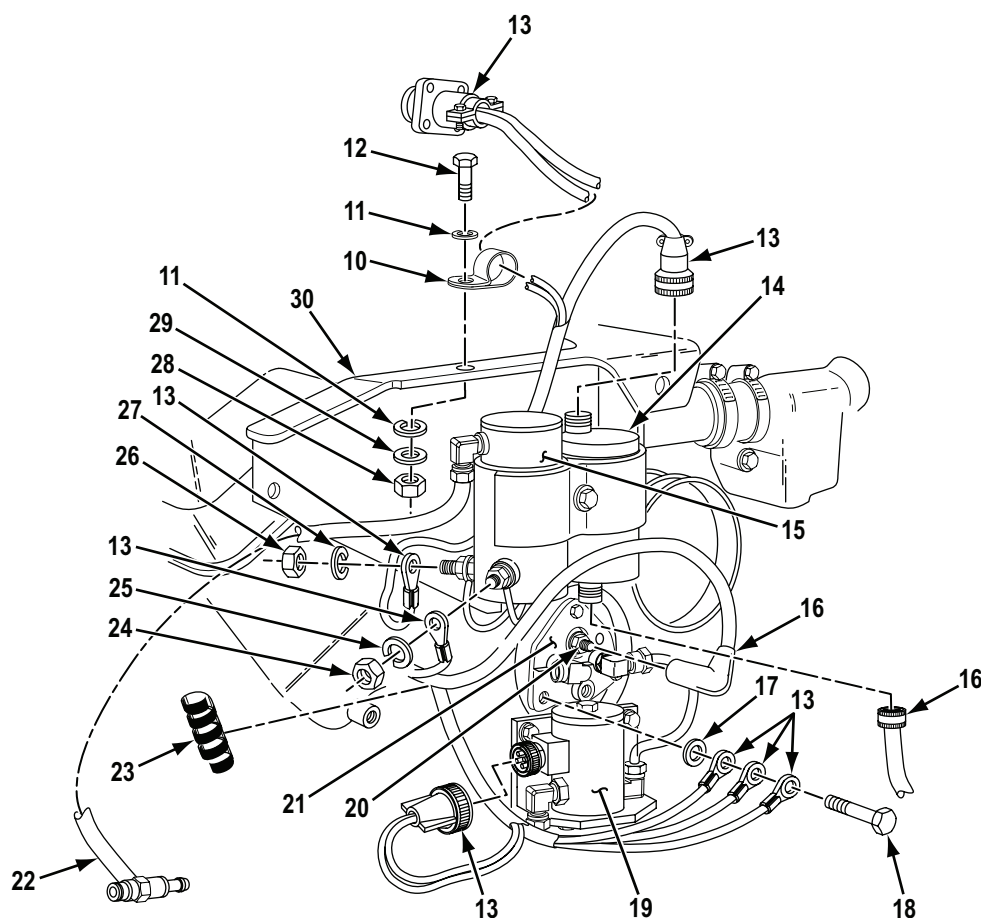
MAINT\_122a

Figure 1. Air Box Heater Hose and Adapter Removal.



**REMOVAL - Continued**

3. Remove bolt (Figure 2, Item 18), copper flat washer (Figure 2, Item 17), and ground wires of harness assembly (Figure 2, Item 13) from air box heater (Figure 2, Item 21). Discard copper flat washer.
4. Disconnect lead on harness assembly (Figure 2, Item 13) from solenoid valve (Figure 2, Item 19).
5. Disconnect ignition wire (Figure 2, Item 16) from bottom of ignition coil (Figure 2, Item 14) and spark igniter (Figure 2, Item 20).
6. Remove nut (Figure 2, Item 26), lockwasher (Figure 2, Item 27), nut (Figure 2, Item 24), and lockwasher (Figure 2, Item 25) from air pump (Figure 2, Item 15) and disconnect two leads of harness assembly (Figure 2, Item 13). Discard lockwashers.
7. Disconnect lead on harness assembly (Figure 2, Item 13) from top of ignition coil (Figure 2, Item 14).
8. Remove nut (Figure 2, Item 28), lockwasher (Figure 2, Item 29), two flat washers (Figure 2, Item 11), screw (Figure 2, Item 12), and clip (Figure 2, Item 10) from mounting bracket (Figure 2, Item 30). Discard lockwasher.
9. Remove wire wrap (Figure 2, Item 23) from ignition wire (Figure 2, Item 16), harness assembly (Figure 2, Item 13), and hose (Figure 2, Item 22).
10. Remove ignition wire (Figure 2, Item 16) and harness assembly (Figure 2, Item 13) from engine.



MAINT\_122

Figure 2. Air Box Heater Hardware Removal.

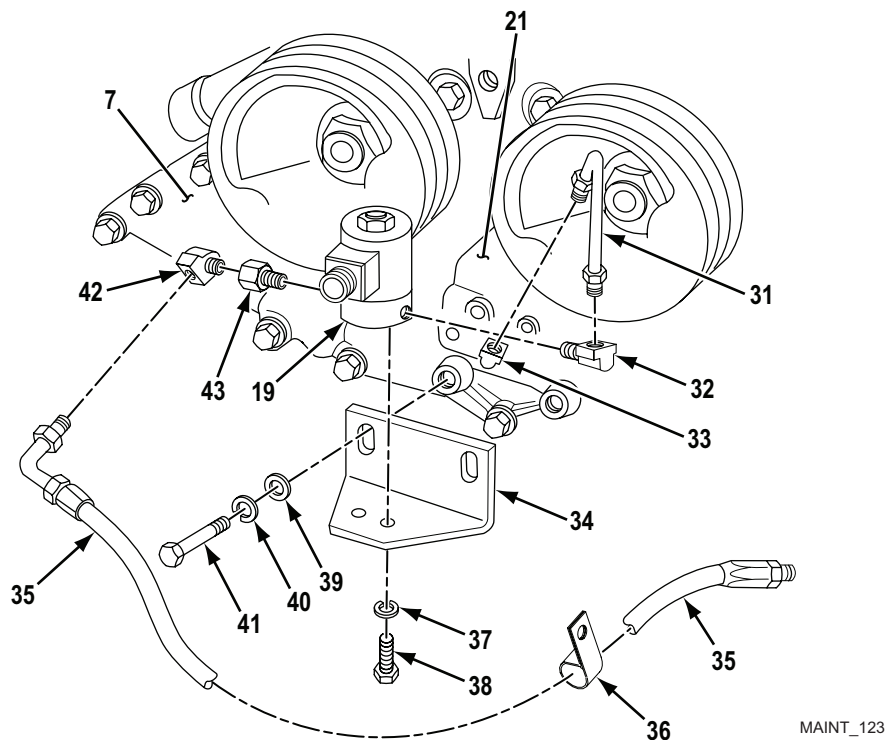
**REMOVAL - Continued**

11. Disconnect hose assembly (Figure 3, Item 35) from elbow (Figure 3, Item 42) in solenoid valve (Figure 3, Item 19). Remove hose assembly from engine. If necessary, remove loop clamp (Figure 3, Item 36) from hose assembly.
12. Remove tube assembly (Figure 3, Item 31) from elbow (Figure 3, Item 32), in solenoid valve (Figure 3, Item 19), and elbow (Figure 3, Item 33) in air box heater (Figure 3, Item 21).

**NOTE**

For access to screws, loosen nut on top of solenoid and rotate coil housing.

13. Remove two screws (Figure 3, Item 41), two lockwashers (Figure 3, Item 40), two flat washers (Figure 3, Item 39), and solenoid bracket (Figure 3, Item 34) from front cover (Figure 3, Item 7). Discard lockwashers.
14. Remove two machine screws (Figure 3, Item 38), two lockwashers (Figure 3, Item 37), and solenoid valve (Figure 3, Item 19) from solenoid bracket (Figure 3, Item 34). Discard lockwashers.
15. If necessary, remove elbow (Figure 3, Item 42), elbow (Figure 3, Item 32), and adapter (Figure 3, Item 43) from solenoid valve (Figure 3, Item 19).



MAINT\_123

Figure 3. Air Box Heater Solenoid and Mounting Bracket Removal.

**REMOVAL - Continued**

16. Remove four screws (Figure 4, Item 53), four lockwashers (Figure 4, Item 52), four flat washers (Figure 4, Item 51), and bracket assembly (Figure 4, Item 50) from mounting bracket (Figure 4, Item 30). Discard lockwashers.
17. Remove two long screws (Figure 4, Item 44), two lockwashers (Figure 4, Item 45), and two flat washers (Figure 4, Item 46) from top of mounting bracket (Figure 4, Item 30). Remove two short screws (Figure 4, Item 49), two lockwashers (Figure 4, Item 48), and two flat washers (Figure 4, Item 47) from front of mounting bracket. Remove mounting bracket from engine. Discard lockwashers.

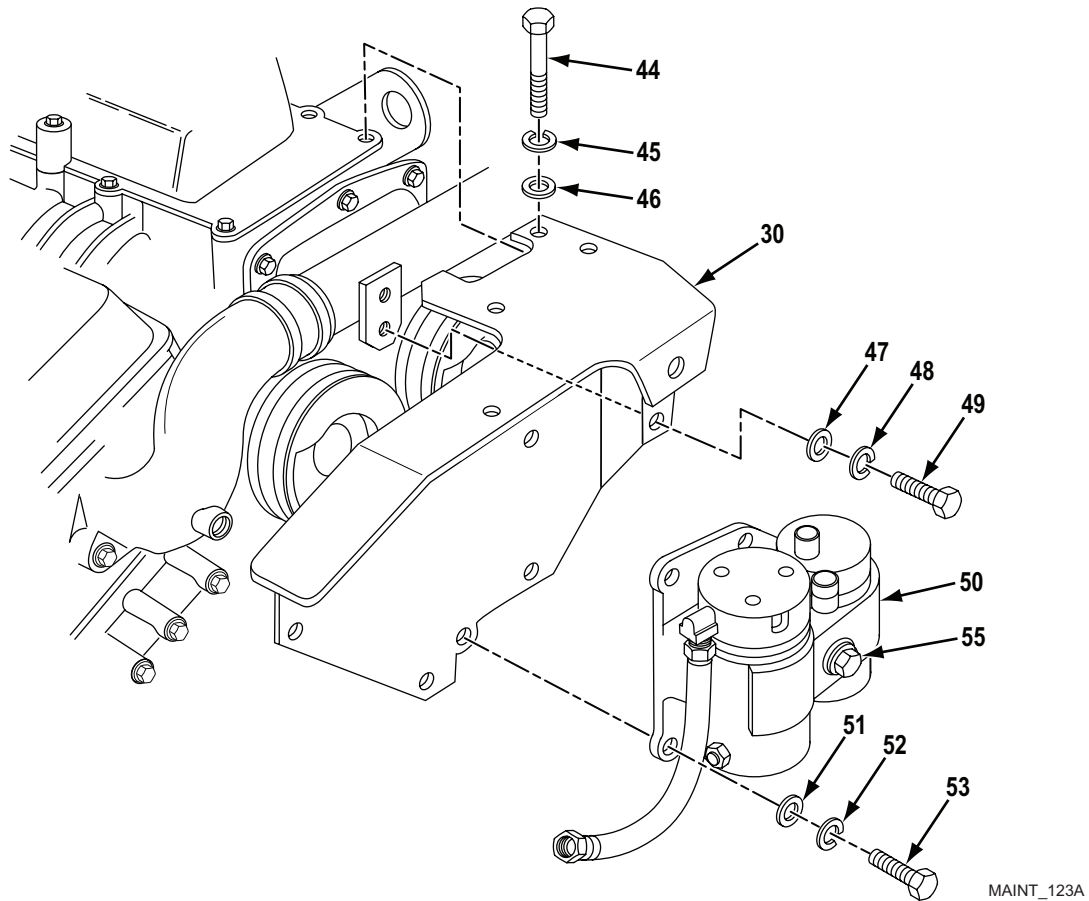
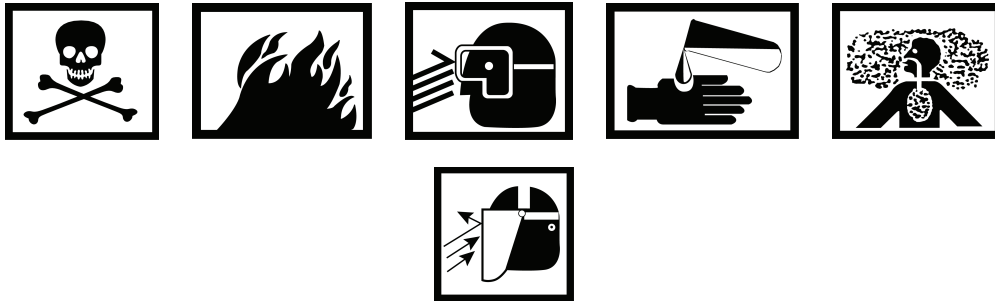


Figure 4. Air Box Heater Air and Mounting Bracket Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean fuel solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.

**END OF TASK**

**TEST AND INSPECTION**

1. Inspect hoses for cuts, tears, kinks, or damage.
2. Inspect wiring harness for cuts, tears, burns, or damage.
3. Test Solenoid.
  - a. Apply a 24 V dc power supply to solenoid valve (Figure 5, Item 19) several times and listen for valve to "click" to determine if valve functions. If there is no indication of valve movement, replace unit.
  - b. Disconnect power supply from solenoid valve (Figure 5, Item 19).

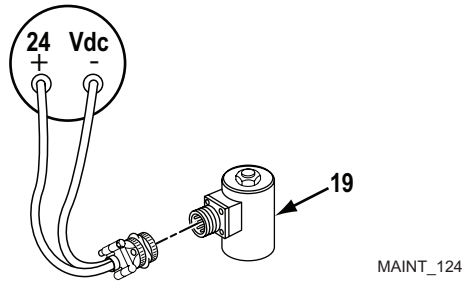


Figure 5. Air Box Heater Solenoid Test.

**END OF TASK**

**INSTALLATION**

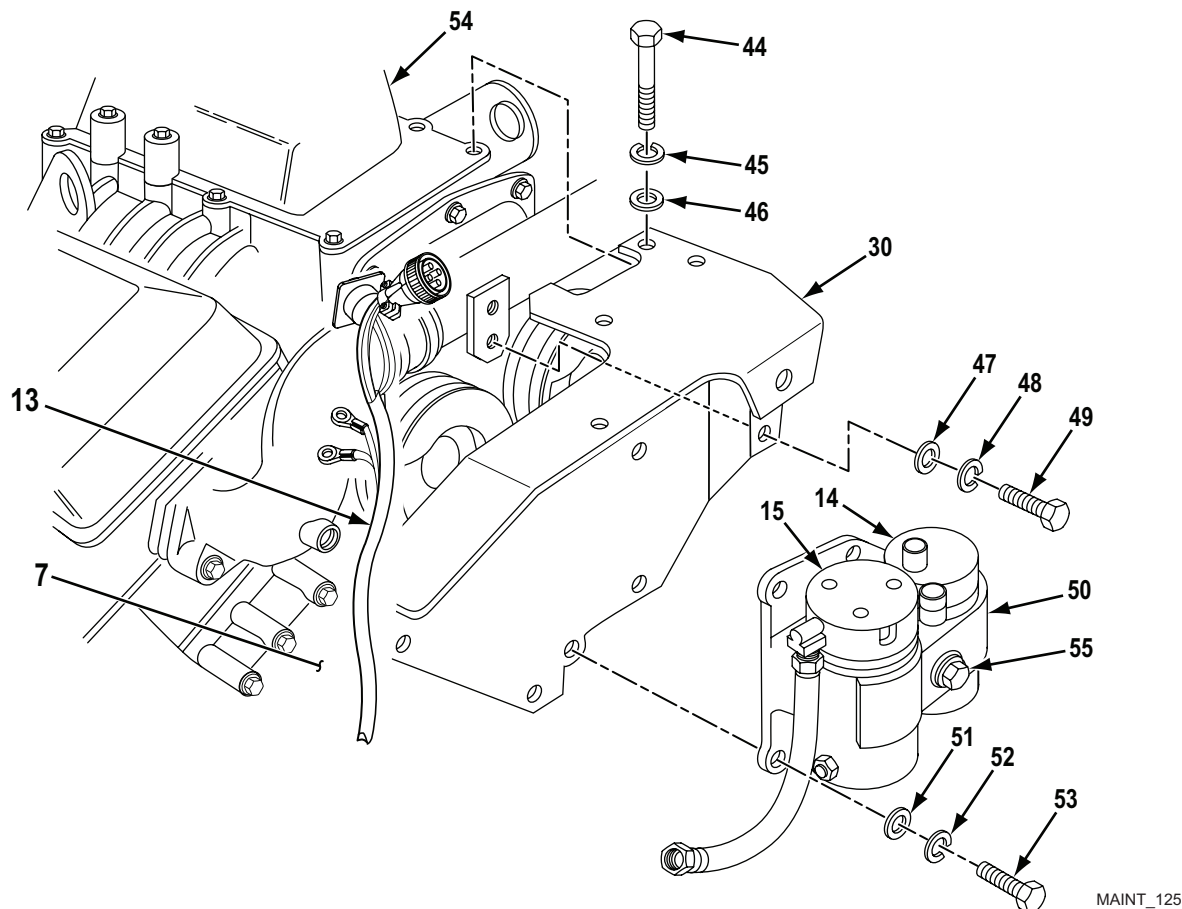
1. Lay harness assembly (Figure 6, Item 13) in position on front of engine.
2. Place mounting bracket (Figure 6, Item 30) over front of air inlet housing (Figure 6, Item 54) and against upper front cover (Figure 6, Item 7). Install two flat washers (Figure 6, Item 46), two new lockwashers (Figure 6, Item 45), and two long screws (Figure 6, Item 44) into top of bracket and install two flat washers (Figure 6, Item 47), two new lockwashers (Figure 6, Item 48), and two short screws (Figure 6, Item 49) into front of bracket. Torque screws (Figure 6, Item 44) to 16–20 lb-ft (22–27 N·m) and screws (Figure 6, Item 49) to 46–50 lb-ft (62–68 N·m).

**NOTE**

To torque screws, it is necessary to loosen center bolt (Figure 6, Item 55) on bracket assembly and move air pump (Figure 6, Item 15) and ignition coil (Figure 6, Item 14).

Torque center bolt to 60–96 lb-in (7–11 N·m).

3. Install bracket assembly (Figure 6, Item 50), four flat washers (Figure 6, Item 51), four new lockwashers (Figure 6, Item 52), and four screws (Figure 6, Item 53) on mounting bracket (Figure 6, Item 30). Torque bolts to 30–35 lb-ft (41–47 N·m).



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Figure 6. Air Box Heater Air Pump and Mounting Bracket Installation.

**INSTALLATION - Continued**

4. Install solenoid valve (Figure 7, Item 19), two new lockwashers (Figure 7, Item 37), and two machine screws (Figure 7, Item 38) on bracket (Figure 7, Item 34) with inlet port facing right side of engine. Tighten screws.
5. If removed, install elbow (Figure 7, Item 32) in outlet port and install adapter (Figure 7, Item 43) and elbow (Figure 7, Item 42) in inlet port of solenoid valve (Figure 7, Item 19).
6. Loosely install solenoid bracket (Figure 7, Item 34), two flat washers (Figure 7, Item 39), two new lockwashers (Figure 7, Item 40), and two screws (Figure 7, Item 41) on front cover.
7. Install tube assembly (Figure 7, Item 31) in elbow (Figure 7, Item 32), of solenoid valve (Figure 7, Item 19), and in elbow (Figure 7, Item 33) of air box heater (Figure 7, Item 21). Tighten connections. Torque screws (Figure 7, Item 41) to 30–35 lb-ft (41–47 N·m).
8. If removed, install loop clamp (Figure 7, Item 36) on hose assembly (Figure 7, Item 35).
9. Connect hose assembly (Figure 7, Item 35) to elbow (Figure 7, Item 42). Tighten connection.

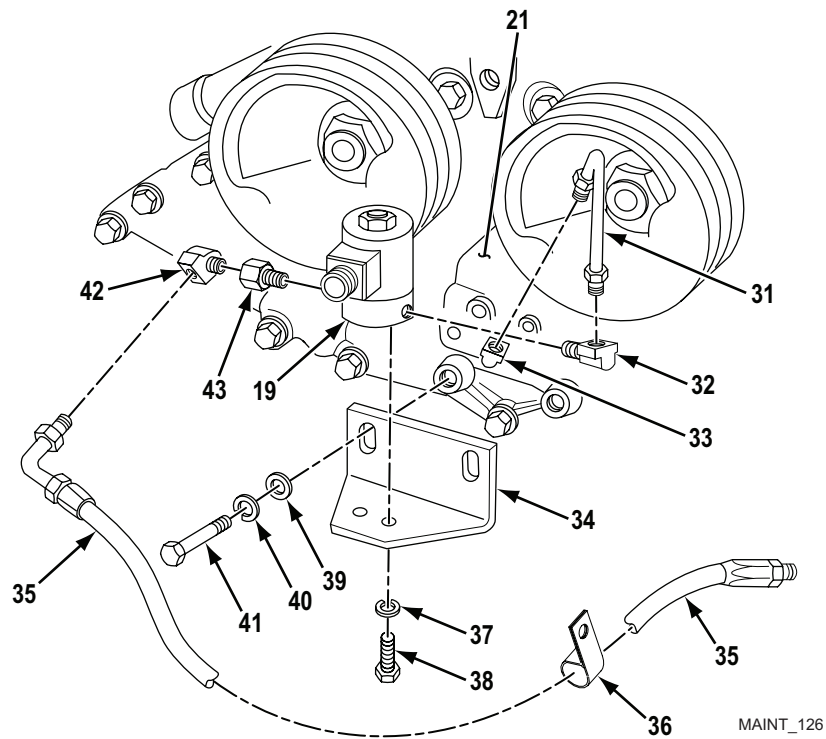


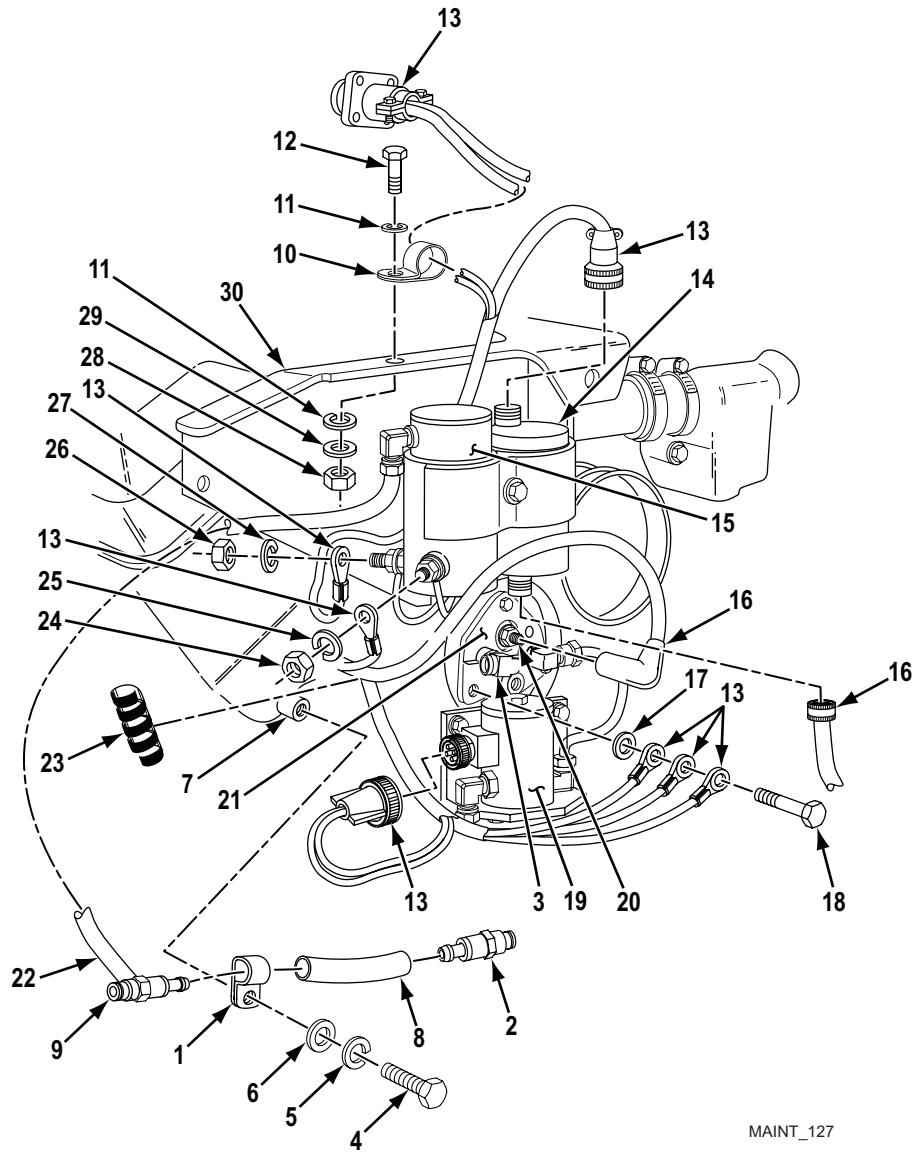
Figure 7. Air Box Heater Solenoid and Mounting Bracket Installation.

**INSTALLATION - Continued**

10. Connect terminals of harness assembly (Figure 8, Item 13) to solenoid valve (Figure 8, Item 19) and top of ignition coil (Figure 8, Item 14).
11. Install two leads of harness assembly (Figure 8, Item 13), two new lockwashers (Figure 8, Items 25 and 27), and two nuts (Figure 8, Items 24 and 26) on air pump (Figure 8, Item 15).
12. Install three ground wires of harness assembly (Figure 8, Item 13), new copper flat washer (Figure 8, Item 17), and bolt (Figure 8, Item 18) in air box heater (Figure 8, Item 21). Torque bolt to 13–17 lb-ft (18–23 N·m).
13. Install terminal of harness assembly (Figure 8, Item 13), clip (Figure 8, Item 10), screw (Figure 8, Item 12), two flat washers (Figure 8, Item 11), new lockwasher (Figure 8, Item 29), and nut (Figure 8, Item 28) in top of bracket (Figure 8, Item 30). Torque nut to 30–35 lb-ft (41–47 N·m).
14. Connect ignition wire (Figure 8, Item 16) to spark igniter (Figure 8, Item 20) and bottom of ignition coil (Figure 8, Item 14).
15. If removed, install adapter (Figure 8, Item 2) in hose (Figure 8, Item 8).
16. Install check valve (Figure 8, Item 9) in hose (Figure 8, Item 8). Connect adapter (Figure 8, Item 2) to elbow (Figure 8, Item 3) in air box heater (Figure 8, Item 21). Tighten adapter.
17. Place check valve (Figure 8, Item 9) in loop clamp (Figure 8, Item 1) and install loop clamp, flat washer (Figure 8, Item 6), new lockwasher (Figure 8, Item 5), and screw (Figure 8, Item 4) into front cover (Figure 8, Item 7). Torque screw to 30–35 lb-ft (41–47 N·m).
18. Install wire wrap (Figure 8, Item 23) around ignition wire (Figure 8, Item 16), hose (Figure 8, Item 22), and harness assembly (Figure 8, Item 13).



INSTALLATION - Continued



MAINT\_127

Figure 8. Air Box Heater Mounting Hardware Installation.

END OF TASK

FOLLOW ON TASK

Install upper bracket on front support (WP 0041).

END OF TASK

END OF WORK PACKAGE



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**FIELD MAINTENANCE  
GLOW PLUGS, CONTROLLER, AND HARNESS REPLACEMENT  
(MODEL 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)  
Multimeter, Digital (WP 0104, Table 1, Item 70)  
Tester, Glow Plug Controller (WP 0081)

**Materials/Parts (cont.)**

Washer, Lock (WP 0105, Table 1, Item 24)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 179)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 180)

**Materials/Parts**

Antiseize Compound (WP 0103, Table 1, Item 4)

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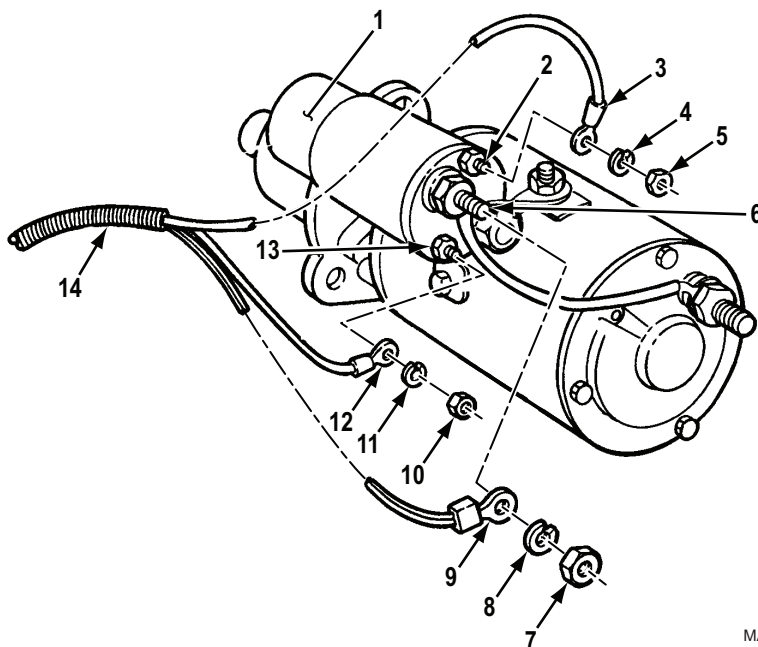
## REMOVAL

## WARNING



Before testing, remove jewelry such as rings, bracelets, wristwatches, and neck chains that may catch on equipment or cause electrical shorts. Failure to comply may result in injury or death to personnel.

1. Disconnect glow plug power harness (Figure 1, Item 14) by removing nut (Figure 1, Item 7) and lockwasher (Figure 1, Item 8) securing red double lead power connection (Figure 1, Item 9) at battery terminal (Figure 1, Item 6) on solenoid (Figure 1, Item 1). Remove lead and reinstall nut and lockwasher.
2. Remove nut (Figure 1, Item 10) and lockwasher (Figure 1, Item 11) securing orange switch lead connection (Figure 1, Item 12) at switch terminal (Figure 1, Item 13) on solenoid (Figure 1, Item 1). Remove lead and reinstall nut and lockwasher.
3. Remove nut (Figure 1, Item 5) and lockwasher (Figure 1, Item 4) securing blue or black ground lead connection (Figure 1, Item 3) to ground terminal (Figure 1, Item 2) on solenoid (Figure 1, Item 1). Remove lead and reinstall nut and lockwasher.



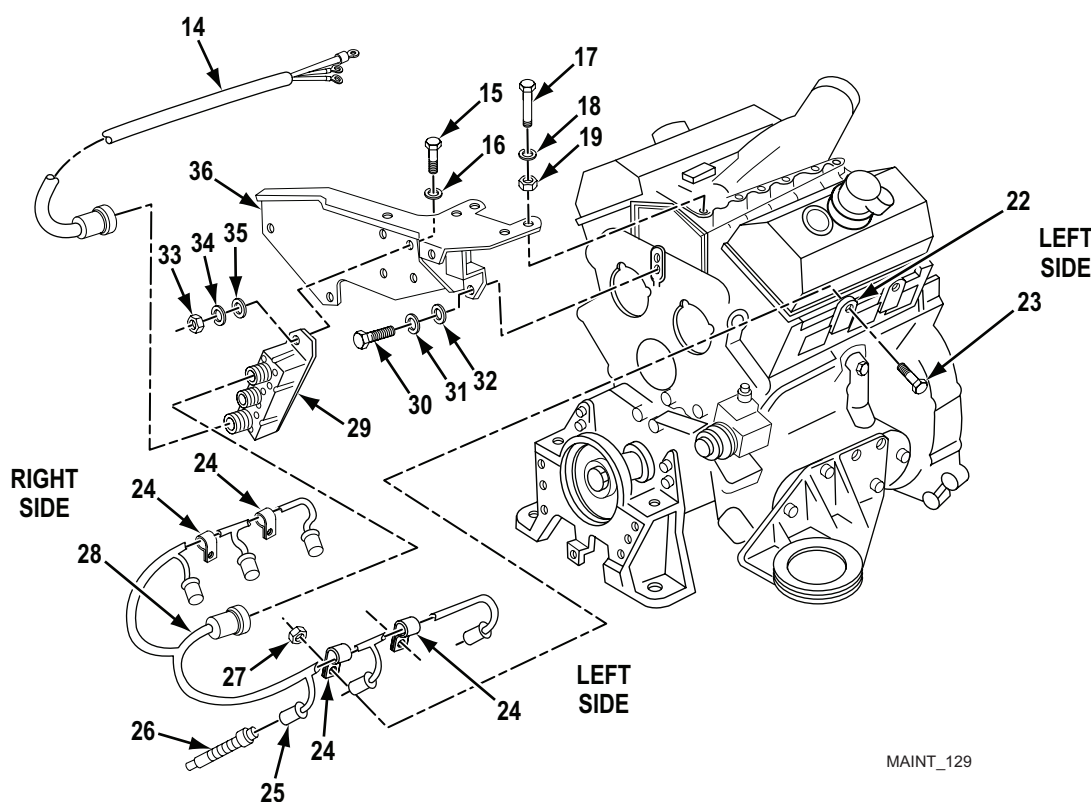
MAINT\_128

Figure 1. Glow Plug Power Harness Removal.

4. Disconnect and remove glow plug power harness (Figure 2, Item 14) from glow plug controller (Figure 2, Item 29).
5. Remove two bolts (Figure 2, Item 23) and two nuts (Figure 2, Item 27) securing two clips (Figure 2, Item 24) to two brackets (Figure 2, Item 22) on glow plug harness (Figure 2, Item 28) to left cylinder head.
6. Disconnect three plug ends (Figure 2, Item 25) of glow plug harness (Figure 2, Item 28) at glow plugs (Figure 2, Item 26) from left cylinder head.

**REMOVAL - Continued**

7. Remove three glow plugs (Figure 2, Item 26) from left cylinder head.
8. Repeat Steps 5–7 above for the opposite side.
9. Disconnect and remove glow plug harness (Figure 2, Item 28) from glow plug controller (Figure 2, Item 29).
10. If necessary, remove four clips (Figure 2, Item 24) from glow plug harness (Figure 2, Item 28).
11. Remove two bolts (Figure 2, Item 15), two lockwashers (Figure 2, Item 16) four flat washers (Figure 2, Item 35), two nuts (Figure 2, Item 33) and glow plug controller (Figure 2, Item 29) from mounting bracket (Figure 2, Item 36) on front of engine. Discard lockwashers.
12. Remove two short screws (Figure 2, Item 30) two lockwashers (Figure 2, Item 31), and two flat washers (Figure 2, Item 32) from front of mounting bracket (Figure 2, Item 36). Remove two long screws (Figure 2, Item 17), two lockwashers (Figure 2, Item 18), and two flat washers (Figure 2, Item 19) from top of mounting bracket. Remove mounting bracket from engine. Discard lockwashers.



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Figure 2. Glow Plug Controller and Mounting Hardware Removal.

**END OF TASK**

## TEST AND INSPECTION

1. Connect multimeter positive lead (Figure 3, Item 37) to end and negative lead (Figure 3, Item 38) to body of glow plug (Figure 3, Item 26). Measure resistance. Discard glow plug if resistance is lower than 2 ohms or greater than 5 ohms.

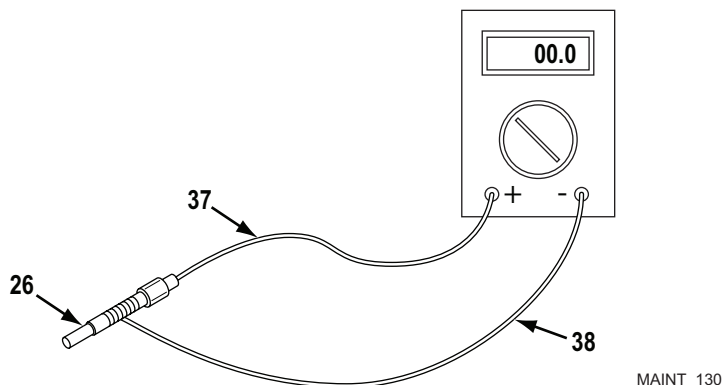


Figure 3. Glow Plug Resistance Check.

2. Using a multimeter, check continuity between pin "A" of socket (Figure 4, Item 39) and blue or black (ground) end of lead. Discard glow plug power harness (Figure 4, Item 14) if no continuity is recorded.

### NOTE

The orange lead on the power harness has a built-in diode which allows current flow in one direction only. Ensure that connections are correct when testing continuity.

3. Check continuity across pin "F" of socket (Figure 4, Item 39) and orange (crank input) end of lead. Connect positive lead of multimeter to orange end of lead and negative lead to pin "F". If no continuity is recorded, discard glow plug power harness (Figure 4, Item 14).
4. Check continuity between pins "B" and "E" of socket (Figure 4, Item 39) and red (power) end of lead. Discard glow plug power harness (Figure 4, Item 14) if no continuity is recorded.

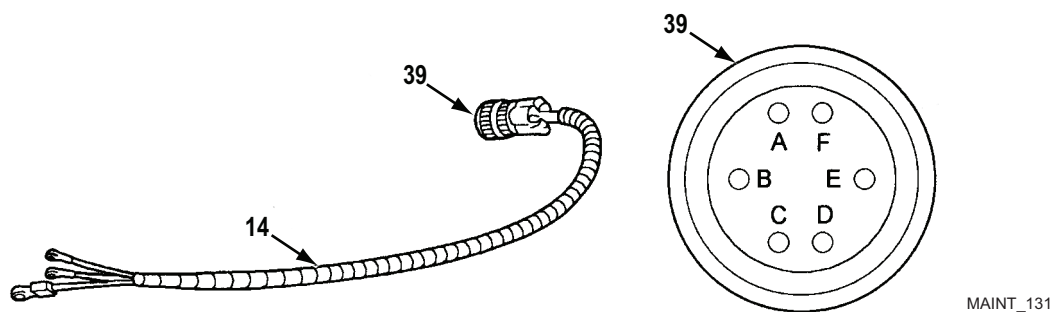


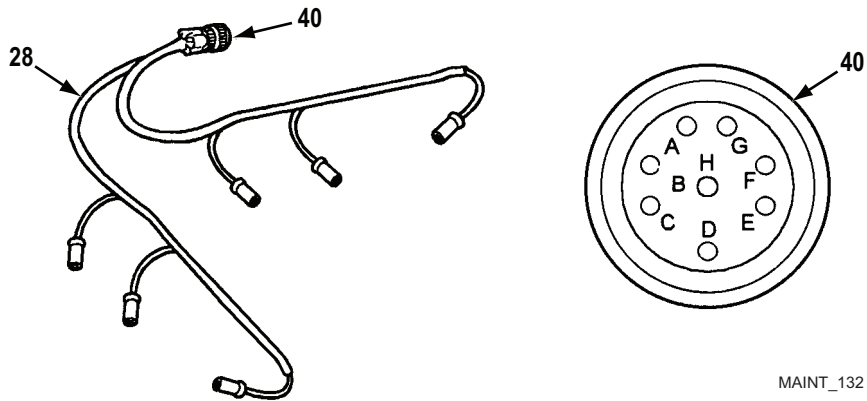
Figure 4. Glow Plug Power Harness Check.

TEST AND INSPECTION - Continued

**NOTE**

The wire number is determined by the length of the lead measured from the end of the socket to the end of the glow plug boot.

- Using a multimeter, check continuity of each lead between each pin in socket (Figure 5, Item 40) and plug end connection of the glow plug harness (Figure 5, Item 28). See Table 1 to determine the wire length, wire number, and pin. Discard glow plug harness if no continuity is observed on any lead.



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Figure 5. Glow Plug Harness Check.

**Table 1. Glow Plug Harness Pins and Lead Lengths.**

Wire Number	Pin	Wire Length-Inches (mm)
1R	H	48.00 (1219.2)
2R	G	43.80 (1112.5)
3R	F	38.55 (979.2)
1L	A	51.00 (1295.4)
2L	B	46.80 (1188.7)
3L	C	41.55 (1055.4)

**TEST AND INSPECTION - Continued**

6. Connect glow plug controller (Figure 6, Item 29) to the glow plug controller tester (Figure 6, Item 42).

**NOTE**

Glow plug system will not function at temperatures above 185°F (85°C).

The automatic cycler will operate the glow plugs at temperatures below 52°F (11°C)

The glow plug controller has a temperature sensor override on the test diagnostic pin.

The manual override energizes the glow plugs at temperatures below 185°F (85°C).

The automatic cycle includes 34 to 38 sec of preglow (wait lamp on), 58 to 62 sec of standby (wait lamp flashing), and 58 to 62 sec of afterglow following cranking of starter (wait lamp on).

If the starter switch is not engaged within 60 sec following preheat, the glow plug controller will turn itself off.

Both the glow plug controller and glow plug controller tester are designed for use on both six and eight-cylinder engines. Glow plug pins and indicator lamps for 4L and 4R are not used on the model 5063–539L engine.

7. Apply 4.5 to 5.0 V dc to test diagnostics pin (Figure 6, Item 42) to simulate a temperature below 52°F (11°C).
8. Connect a 24 V dc power source (Figure 6, Item 43) to the glow plug controller tester (Figure 6, Item 42) and turn on master power switch (Figure 6, Item 40). The wait lamp (Figure 6, Item 41) and glow plug indicator lamps (Figure 6, Item 42) should remain off.

**NOTE**

The manual override switch applies 4.5 to 5.0 V dc current to a diagnostic pin to simulate a temperature of 52°F (11°C) or lower.

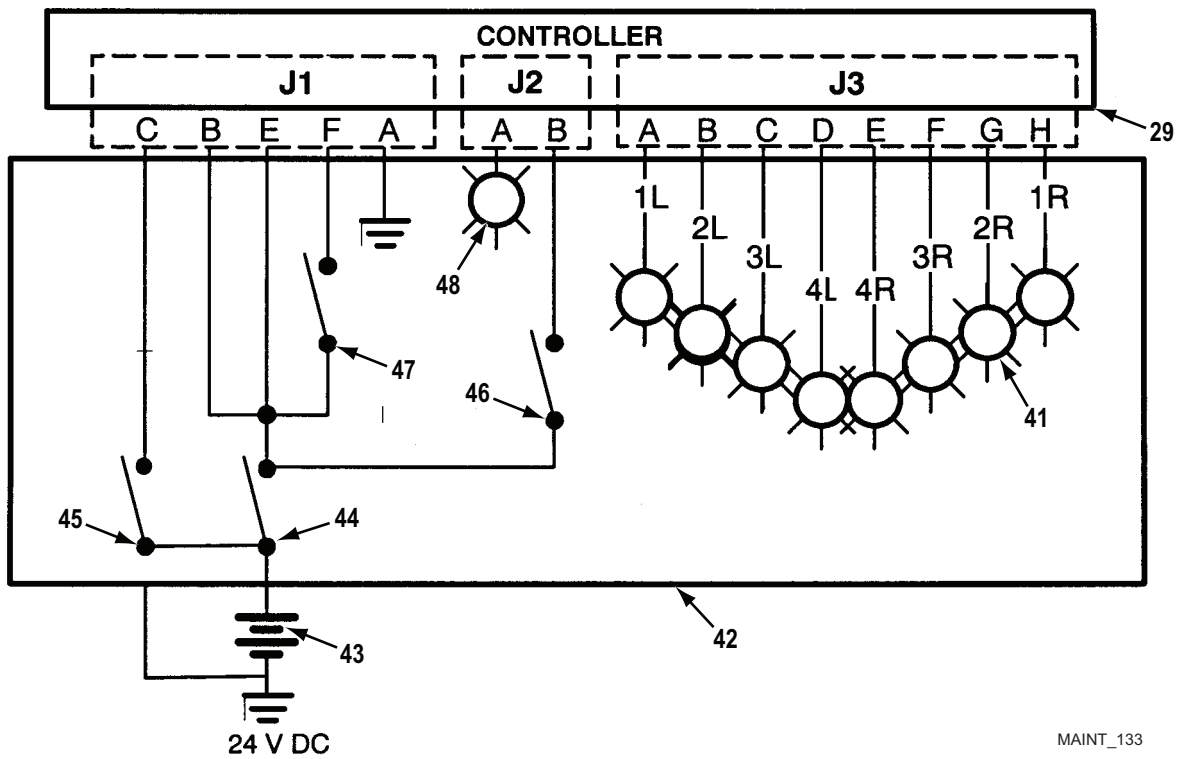
9. Turn on manual override switch (Figure 6, Item 43).
10. Monitor preglow period as follows:
  - a. Push glow plug switch (Figure 6, Item 44) momentarily.
  - b. Using stop watch, record time wait lamp (Figure 6, Item 41) remains continuously lit. Proper time is 34 to 38 sec. Monitor condition of glow plug indicator lamps (Figure 6, Item 42). Lamps should remain on.
11. Monitor standby period as follows:

Using stop watch, record time wait lamp (Figure 6, Item 41) remains flashing following Step 5. Proper time is 58 to 62 sec and lamp should go out. Monitor glow plug indicator lamps (Figure 6, Item 42). Glow plug indicator lamps should remain energized when wait lamp is flashing. Glow plug indicator lamps should go out when the wait lamp goes out indicating the glow plug controller would supply sufficient power for the glow plugs (Figure 7, Item 26) to reach their optimum operating temperature.



**TEST AND INSPECTION - Continued**

12. Monitor afterglow period as follows:
  - a. Push glow plug switch (Figure 6, Item 44) momentarily and wait until wait lamp (Figure 6, Item 41) flashes. Push starter switch (Figure 6, Item 45), hold for approximately 5 sec, and release. Wait lamp and glow plug indicator lamps (Figure 6, Item 42) should remain on.
  - b. Using stop watch, record time wait lamp (Figure 6, Item 41) remains continuously lit following flashing of standby period. Proper time is 58 to 62 sec until wait lamp and glow plug indicator lamps (Figure 6, Item 42) should go out.
13. If glow plug controller (Figure 6, Item 29) passes Steps 5–7, controller is operational.



MAINT\_133

Figure 6. Glow Plug Controller Check.

**END OF TASK**

## INSTALLATION

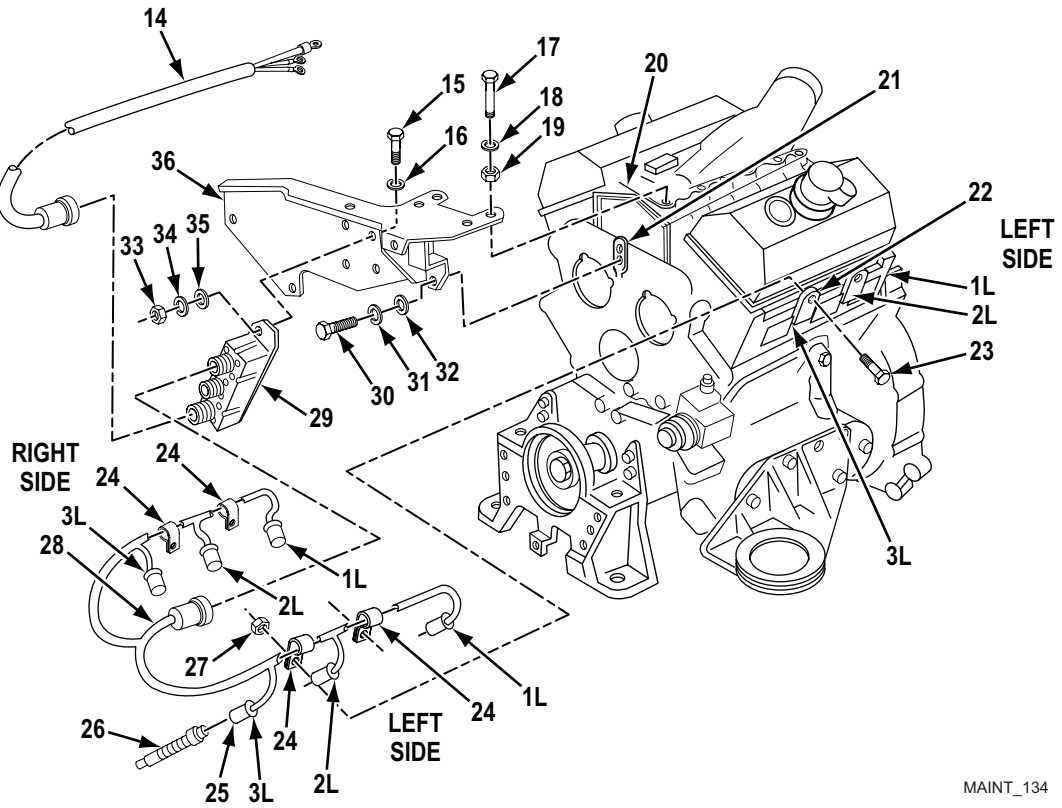
1. Place mounting bracket (Figure 7, Item 36) over front of air inlet housing (Figure 7, Item 20) and against upper front cover (Figure 7, Item 21).
2. Install two flat washers (Figure 7, Item 19), two new lockwashers (Figure 7, Item 18), and two long screws (Figure 7, Item 17) into top of bracket and install two flat washers (Figure 7, Item 32), two new lockwashers (Figure 7, Item 31), and two short screws (Figure 7, Item 30) into front of bracket. Torque screws (Figure 7, Item 17) to 16–20 lb-ft (22–27 N·m) and screws (Figure 7, Item 30) to 46–50 lb-ft (62–68 N·m).
3. Secure glow plug controller (Figure 7, Item 29) to mounting bracket (Figure 7, Item 36) with four flat washers (Figure 7, Item 35), two new lockwashers (Figure 7, Item 16), two nuts (Figure 7, Item 33) and two short bolts (Figure 7, Item 15). Torque screws to 13–17 lb-ft (18–23 N·m).
4. If removed, install two clips (Figure 7, Item 24) on each side of glow plug harness (Figure 7, Item 28).
5. Connect glow plug harness (Figure 7, Item 28) to glow plug controller (Figure 7, Item 29). Tighten securely.
6. Apply antiseize compound to threads of three glow plugs (Figure 7, Item 26) and install glow plugs in left cylinder head. Torque plugs to 132–156 lb-in (15–18 N·m).

### NOTE

The lead locations and sides of the glow plug harness are identified by the length of the lead. The longest lead goes on the left rear position (3L), the next longest lead goes to 2L position, and the shortest lead goes to 1L position. The same applies to the right side. Correct installation of wires is necessary for proper diagnostics to aid in locating a failed glow plug.

7. Install three ends (Figure 7, Item 25) of glow plug harness (Figure 7, Item 28) to corresponding glow plug (Figure 7, Item 26) locations in left cylinder head.
8. Secure glow plug harness (Figure 7, Item 28) to two brackets (Figure 7, Item 22) on left cylinder head with two bolts (Figure 7, Item 23) and two nuts (Figure 7, Item 27). Torque bolts to 30–35 lb-ft (41–47 N·m).

INSTALLATION - Continued



MAINT\_134

Figure 7. Glow Plug Controller and Mounting Hardware Installation.

9. Repeat Steps 5–8 above for opposite side.
10. Connect glow plug power harness (Figure 7, Item 14) to glow plug controller (Figure 7, Item 29).

**INSTALLATION - Continued****NOTE**

When connecting glow plug power harness to starter solenoid, ensure wires are connected to correct terminals for appropriate manufacturer of starter.

11. Connect glow plug power harness (Figure 8, Item 14) to starter solenoid (Figure 8, Item 1) as follows:
  - a. Remove nut (Figure 8, Item 5) and lockwasher (Figure 8, Item 4) from ground terminal (Figure 8, Item 2) on solenoid. Discard lockwasher. Attach blue or black ground lead connection (Figure 8, Item 3) and secure with nut and new lockwasher. Tighten connection.
  - b. Remove nut (Figure 8, Item 10) and lockwasher (Figure 8, Item 11) from switch terminal (Figure 8, Item 13) on solenoid (Figure 8, Item 1). Discard lockwasher. Attach orange switch lead connection (Figure 8, Item 12) and secure with nut and new lockwasher. Tighten connection.
  - c. Remove nut (Figure 8, Item 7) and lockwasher (Figure 8, Item 8) from battery terminal (Figure 8, Item 6) on solenoid (Figure 8, Item 1). Discard lockwasher. Attach red double lead power connection (Figure 8, Item 9) and secure with nut and new lockwasher. Tighten connection.

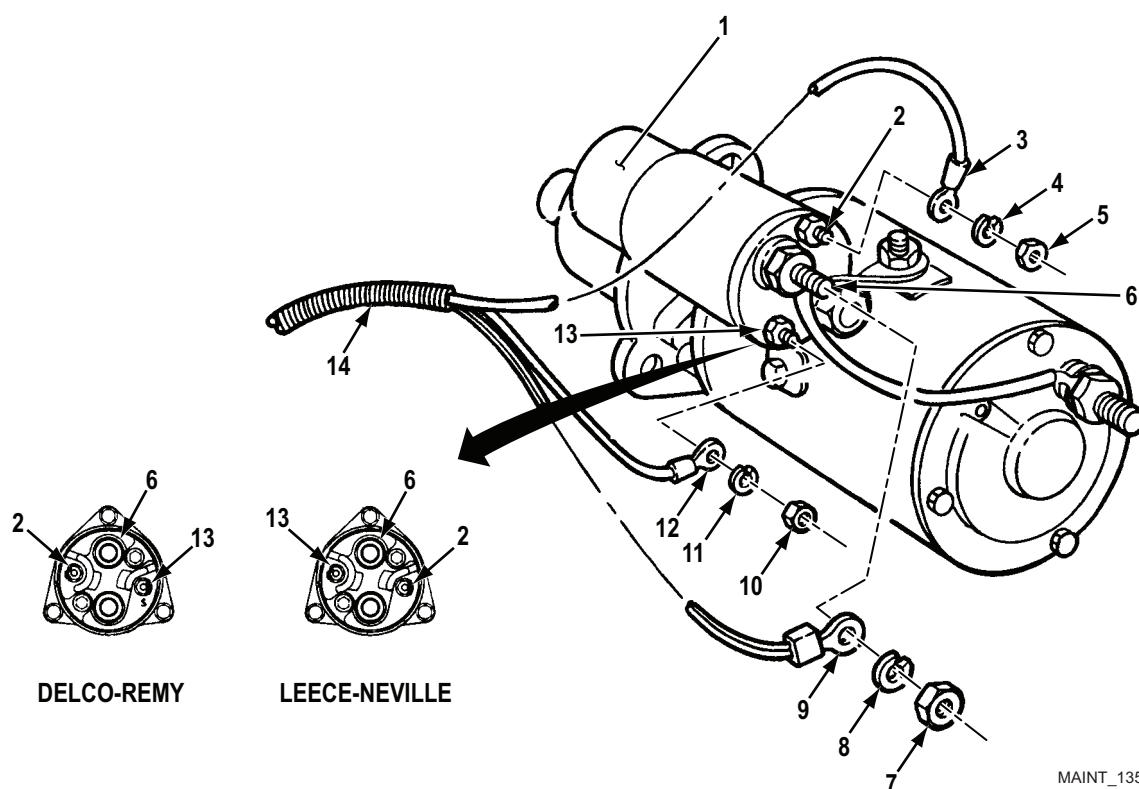


Figure 8. Glow Plug Power Harness Installation.

**END OF TASK**

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**AIR BOX HEATER REPLACEMENT (MODELS 5063-5299, 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Gage Set, Thickness  
(WP 0104, Table 1, Item 47)

**Equipment Condition (cont.)**

Fuel lines, air lines, solenoid, and electrical  
harness disconnected from air box heater  
(model 5063-5392) (WP 0043)  
Fuel lines, air lines, solenoid, and electrical  
harness disconnected from air box heater  
(model 5063-5393) (WP 0044)

**Materials/Parts**

Bolt, Locking  
Qty: (3) (WP 0105, Table 1, Item 122)  
Cleaning Solvent  
(WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 42)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Packing, Preformed  
(WP 0105, Table 1, Item 43)  
Washer, Flat  
Qty: (2) (WP 0105, Table 1, Item 117)

**Equipment Condition**

Fuel lines, air lines, solenoid, and electrical  
harness disconnected from air box heater  
(model 5063-5299) (WP 0042)

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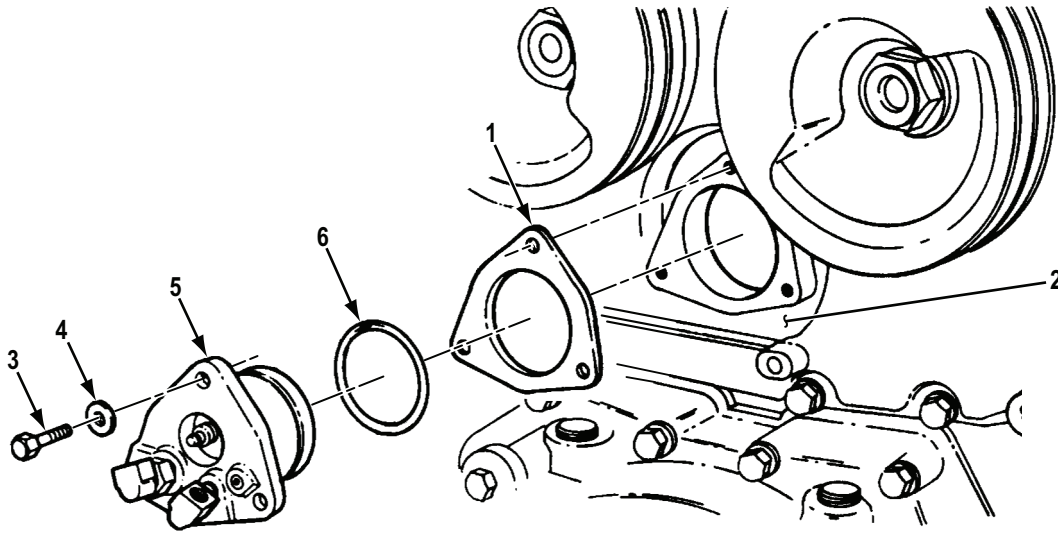
**REMOVAL****NOTE**

Model 5063-539L has a special air heater hole plug and no air box heater.

For all models except model 5063-539L, one bolt and copper flat washer fastening air box heater to front cover were removed during removal of ground wire.

1. For all models except model 5063-539L, remove two bolts (Figure 1, Item 3) and two copper flat washers (Figure 1, Item 4) from air box heater (Figure 1, Item 5). Discard copper flat washers.
2. For model 5063-539L, remove three flange head locking bolts (Figure 1, Item 3) from air heater hole plug (Figure 1, Item 5). Discard three locking bolts.
3. Remove air box heater (Figure 1, Item 5), preformed packing (Figure 1, Item 6), and gasket (Figure 1, Item 1) from engine front cover (Figure 1, Item 2). Discard preformed packing and gasket.
4. For model 5063-539L, remove air heater hole plug (Figure 1, Item 5), preformed packing (Figure 1, Item 6), and gasket (Figure 1, Item 1) from engine front cover (Figure 1, Item 2). Discard preformed packing and gasket.

REMOVAL - Continued



MAINT\_136

Figure 1. Air Box Heater Removal.

END OF TASK

**DISASSEMBLY**

1. Remove nozzle (Figure 2, Item 7) from air box heater (Figure 2, Item 5).
2. Remove igniter (Figure 2, Item 8) from air box heater (Figure 2, Item 5).
3. Remove elbow (Figure 2, Item 10) and connector (Figure 2, Item 11) from air inlet port of air box heater (Figure 2, Item 5).
4. Remove elbow (Figure 2, Item 9) from fuel inlet port of air box heater (Figure 2, Item 5).

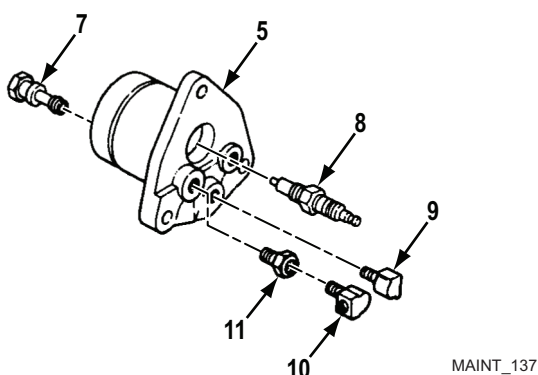
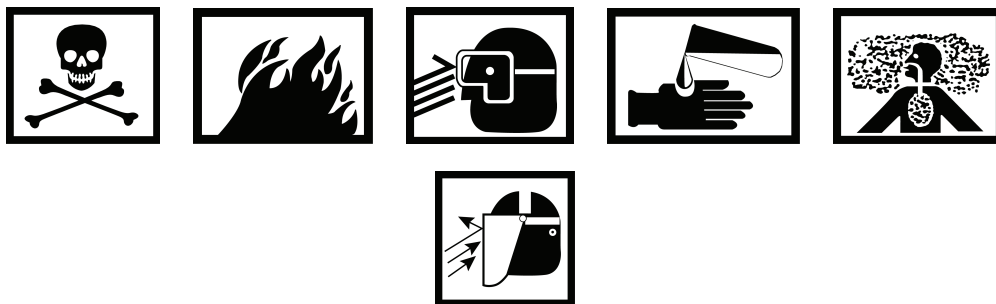


Figure 2. Air Box Heater Disassembly.

**END OF TASK****CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean air box heater and fuel nozzle with cleaning solvent and dry with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect igniter, nozzle, and air box heater for cracks, pitting, or wear.

**END OF TASK****ASSEMBLY**

1. Install nozzle (Figure 2, Item 7) in air box heater (Figure 2, Item 5). Tighten securely.
2. Install igniter (Figure 2, Item 8) in air box heater (Figure 2, Item 5). Tighten securely.
3. Install elbow (Figure 2, Item 9) in fuel inlet port of air box heater (Figure 2, Item 5).
4. Install connector (Figure 2, Item 11) and elbow (Figure 2, Item 10) in air inlet port of air box heater (Figure 2, Item 5).

**END OF TASK****ADJUSTMENT****NOTE**

Test igniter and ignition coil simultaneously (WP 0043) and (WP 0044).  
Using a thickness gage, adjust igniter-wire air gap to 0.080 inch (2.03 mm) (Figure 3).

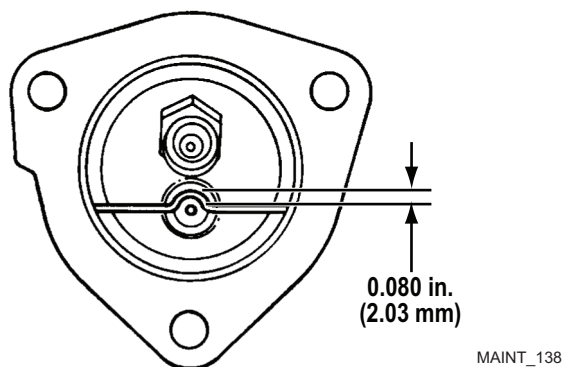


Figure 3. Air Box Heater Adjustment.

**END OF TASK**

**INSTALLATION**

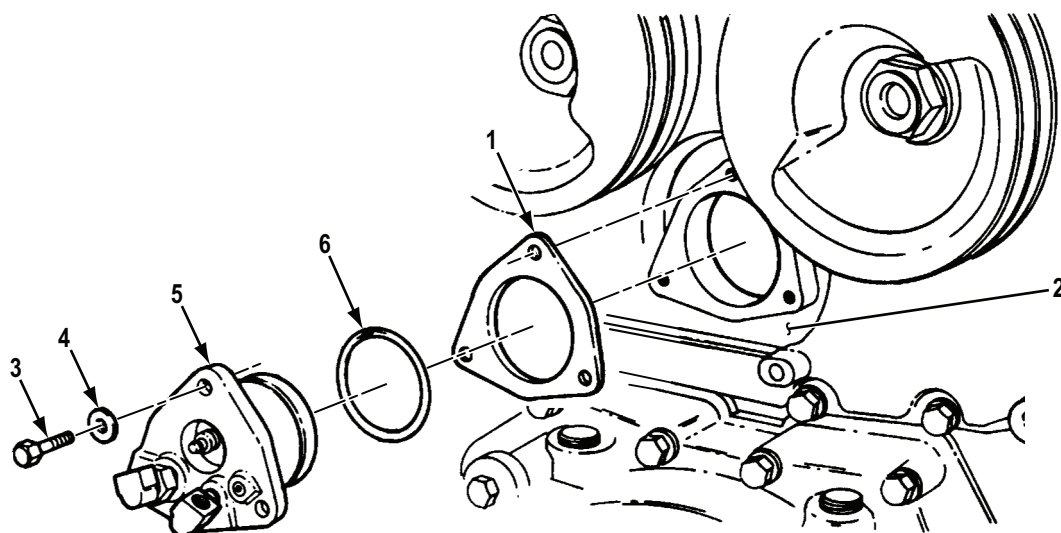
1. For all models except model 5063-539L, position new gasket (Figure 4, Item 1) and new preformed packing (Figure 4, Item 6) on air box heater (Figure 4, Item 5). Lubricate packing with engine oil.

**NOTE**

For all except model 5063-539L, do not install the bolt, in lower left hole (when facing engine), and copper flat washer, fastening air box heater assembly to front cover, until connection of ground wire.

Model 5063-539L has a special air heater hole plug and no air box heater.

2. For model 5063-539L, position new gasket (Figure 4, Item 1) and new preformed packing (Figure 4, Item 6) on air box heater hole plug (Figure 4, Item 5). Lubricate packing with engine oil.
3. For all models except model 5063-539L, install air box heater (Figure 4, Item 5), two new copper flat washers (Figure 4, Item 4), and two bolts (Figure 4, Item 3) in engine front cover (Figure 4, Item 2) with fuel inlet port positioned at bottom. Torque bolts to 13–17 lb-ft (18–23 N·m).
4. For model 5063-539L, install air heater hole plug (Figure 4, Item 5), and three new flange head locking bolts (Figure 4, Item 3) in engine front cover (Figure 4, Item 2). Torque bolts to 13–17 lb-ft (18–23 N·m).



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Figure 4. Air Box Heater Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Fuel lines, air lines, solenoid, and electrical harness connected to air box heater (model 5063-5393) (WP 0044).
2. Fuel lines, air lines, solenoid, and electrical harness connected to air box heater (model 5063-5392) (WP 0043).
3. Fuel lines, air lines, solenoid, and electrical harness connected to air box heater (model 5063-5299) (WP 0042).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT**  
**(MODELS 5063-5299, 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pail, Utility  
(WP 0104, Table 1, Item 71)  
Inserter, Seal (Thermostat Seal)  
(WP 0104, Table 1, Item 61)  
Handle, Driver (Seal Installer)  
(WP 0104, Table 1, Item 50)

**Materials/Parts**

Gasket Qty: (2) (WP 0105, Table 1, Item 49)

**Materials/Parts (cont.)**

Gasket  
(WP 0105, Table 1, Item 53)  
Seal, Plain Encased (WP 0105, Table 1, Item 26)  
Washer, Lock  
Qty: (8) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Air box heater bracket removed  
(model 5063-5299) (WP 0042)  
Air box heater bracket removed  
(model 5063-5392) (WP 0043)

**REMOVAL**

1. Loosen four clamps (Figure 1, Item 20) and two hoses (Figure 1, Item 22) connecting crossover tube (Figure 1, Item 21) to water outlet elbow (Figure 1, Item 4) and water outlet elbow (Figure 1, Item 19). Slide clamps and hoses onto crossover tube. Remove tube, clamps, and hoses.
2. Remove two screws (Figure 1, Item 1), two lockwashers (Figure 1, Item 2), two flat washers (Figure 1, Item 3), right coolant outlet elbow (Figure 1, Item 4), and gasket (Figure 1, Item 5) from cylinder head. Discard lockwashers and gasket.
3. If necessary, remove plug (Figure 1, Item 24) from right coolant outlet elbow (Figure 1, Item 4).
4. Remove four screws (Figure 1, Item 13), four lockwashers (Figure 1, Item 12), four washers (Figure 1, Item 11), thermostat housing cover (Figure 1, Item 15), and gasket (Figure 1, Item 7) from left coolant outlet elbow (Figure 1, Item 19). Discard lockwashers and gasket.
5. Remove thermostat (Figure 1, Item 8), thermostat seal (Figure 1, Item 9), and drain cock (Figure 1, Item 14) from thermostat housing cover (Figure 1, Item 15). Discard seal.
6. For models 5063-5299 and 5063-5392, if necessary, remove plug (Figure 1, Item 10) from top of thermostat housing cover (Figure 1, Item 15).
7. Remove two screws (Figure 1, Item 18), two lockwashers (Figure 1, Item 17), two flat washers (Figure 1, Item 16), left coolant outlet elbow (Figure 1, Item 19), and gasket (Figure 1, Item 6) from cylinder head. Discard lockwashers and gasket.
8. For models 5063-5299 and 5063-5392, if necessary, remove two plugs (Figure 1, Item 23) from left coolant outlet elbow (Figure 1, Item 19).

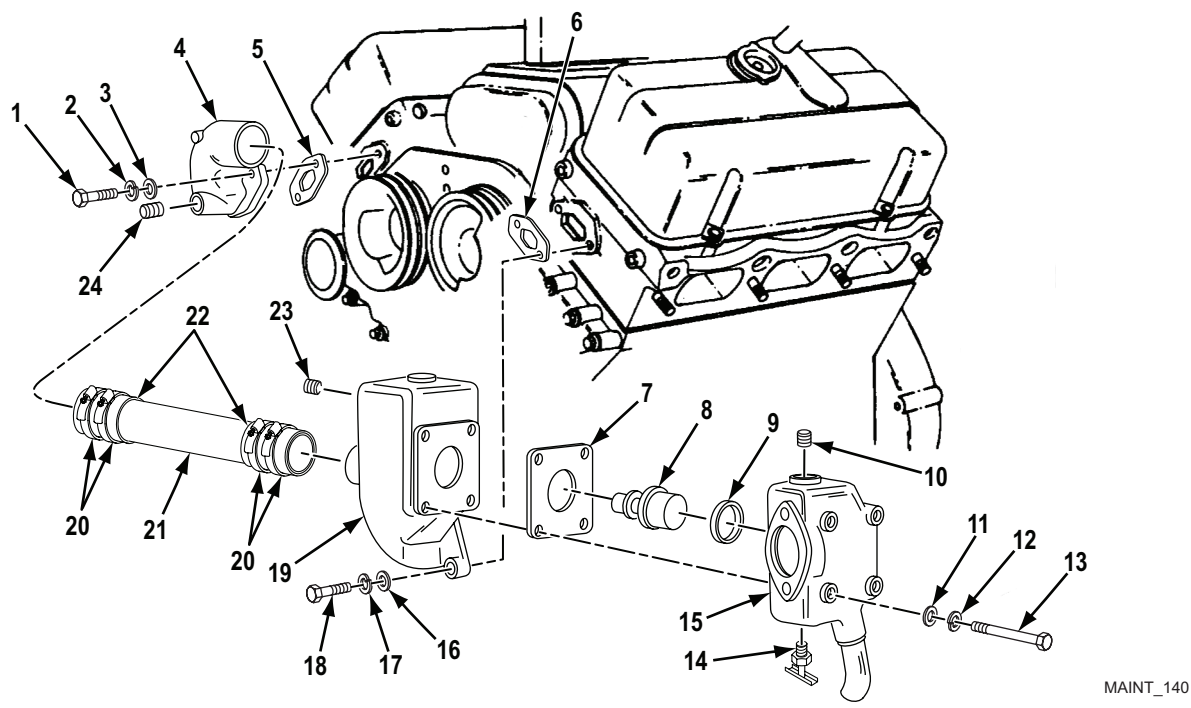
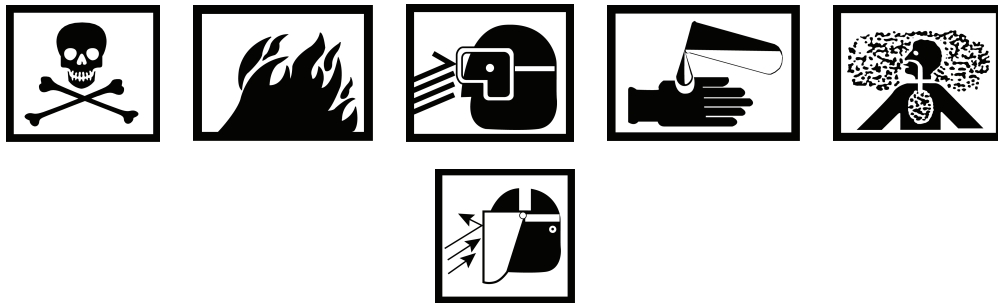


Figure 1. Thermostat Housing and Crossover Tube Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean plugs and metal parts in dry cleaning solvent and dry in compressed air. Clean drain cock with probe.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect crossover tubes for cracks or damage.
2. Inspect hoses for cracks, wear, or damage.
3. Inspect thermostat as follows:
  - a. Immerse thermostat (Figure 2, Item 8) in suitable container or utility pail of water. Do not allow thermostat to touch bottom of container.

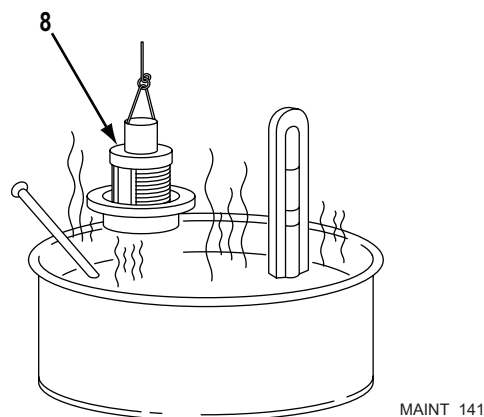


Figure 2. Thermostat Check.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued****NOTE**

On model 5063-5299, the thermostat valve should start opening at 162–167°F (72–75°C). Valve should be fully open at 182°F (83°C).

On model 5063-5392, thermostat valve should start opening at 177–182°F (81–83°C). Valve should be fully open at 197°F (92°C).

- b. Agitate water to maintain an even temperature throughout container. As water is heated, thermostat valve should begin to open. Allow at least 10 minutes for thermostat to react.
- c. Replace thermostat not meeting this requirement.

**END OF TASK****INSTALLATION**

1. Install new gasket (Figure 3, Item 6), left coolant outlet elbow (Figure 3, Item 19), two flat washers (Figure 3, Item 16), two new lockwashers (Figure 3, Item 17), and two screws (Figure 3, Item 18) on front of left cylinder head. Torque screws to 30–35 lb-ft (41–47 N·m).
2. For models 5063-5299 and 5063-5392, if removed, install two plugs (Figure 3, Item 23) in side of left coolant outlet elbow (Figure 3, Item 19).
3. Using seal installer and handle, press new seal (Figure 3, Item 9) in thermostat housing cover (Figure 3, Item 15). Position seal (Figure 3, Item 9) with lip facing toward inside of thermostat housing cover (Figure 3, Item 15).
4. Install thermostat (Figure 3, Item 8) into thermostat housing cover (Figure 3, Item 15).
5. Install new gasket (Figure 3, Item 7), thermostat housing cover (Figure 3, Item 15), four flat washers (Figure 3, Item 11), four new lockwashers (Figure 3, Item 12), and four screws (Figure 3, Item 13) on left coolant outlet elbow (Figure 3, Item 19). Torque screws to 30–35 lb-ft (41–47 N·m).
6. For models 5063-5299 and 5063-5392, if removed, install plug (Figure 3, Item 10) in top of thermostat housing cover (Figure 3, Item 15).
7. Install drain cock (Figure 3, Item 14) in bottom of thermostat housing cover (Figure 3, Item 15).
8. Install new gasket (Figure 3, Item 5), right coolant outlet elbow (Figure 3, Item 4), two flat washers (Figure 3, Item 3), two new lockwashers (Figure 3, Item 2), and two screws (Figure 3, Item 1) on front of cylinder head. Torque screws to 30–35 lb-ft (41–47 N·m).
9. If removed, install plug (Figure 3, Item 24) in right coolant outlet elbow (Figure 3, Item 4).
10. Install crossover tube (Figure 3, Item 21), two hoses (Figure 3, Item 22), and four clamps (Figure 3, Item 20) between coolant outlet elbow (Figure 3, Item 4) and coolant outlet elbow (Figure 3, Item 19). Tighten hose clamps.



## INSTALLATION - Continued

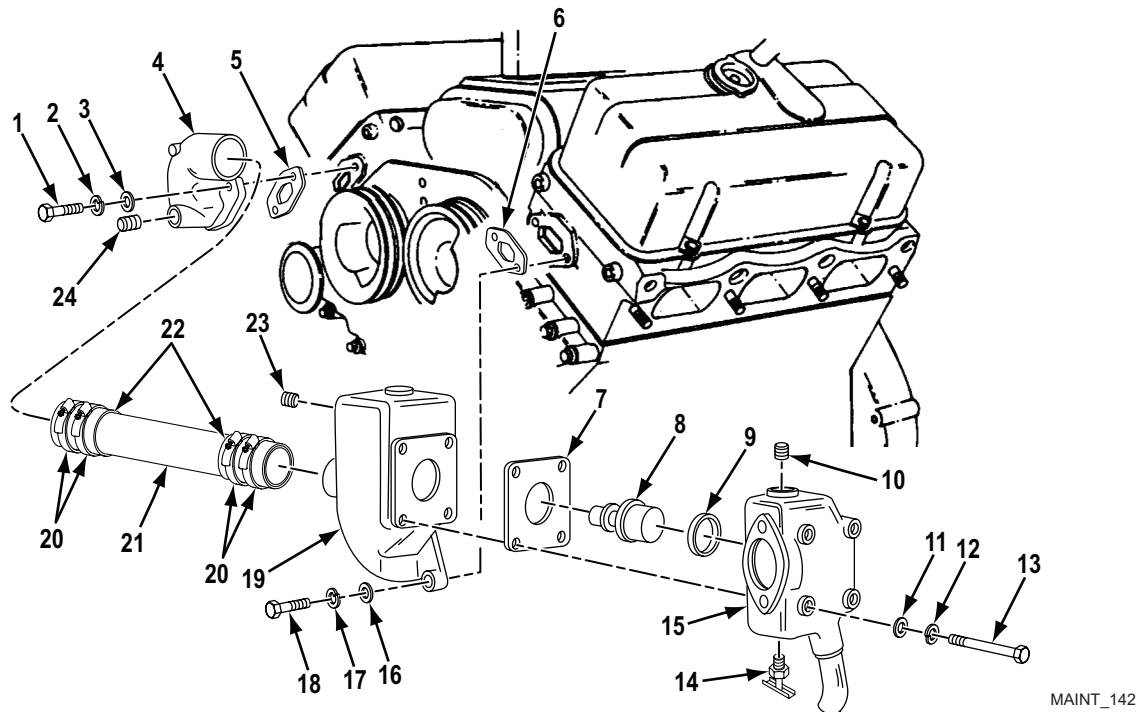


Figure 3. Thermostat Housing and Crossover Tube Installation.

## END OF TASK

## FOLLOW ON TASK

1. Install air box heater bracket (model 5063-5392) (WP 0043).
2. Install air box heater bracket (model 5063-5299) (WP 0042).

## END OF TASK

## END OF WORK PACKAGE



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**FIELD MAINTENANCE**  
**THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT**  
**(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Pail, Utility (WP 0104, Table 1, Item 71)  
Inserter, Seal (Thermostat Seal)  
(WP 0104, Table 1, Item 61)  
Handle, Driver (Seal Installer)  
(WP 0104, Table 1, Item 50)

**Materials/Parts**

Gasket Qty: (2) (WP 0105, Table 1, Item 49)  
Gasket (WP 0105, Table 1, Item 142)

**Materials/Parts (cont.)**

Seal, Plain Encased (WP 0105, Table 1, Item 26)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**References**

WP 0011

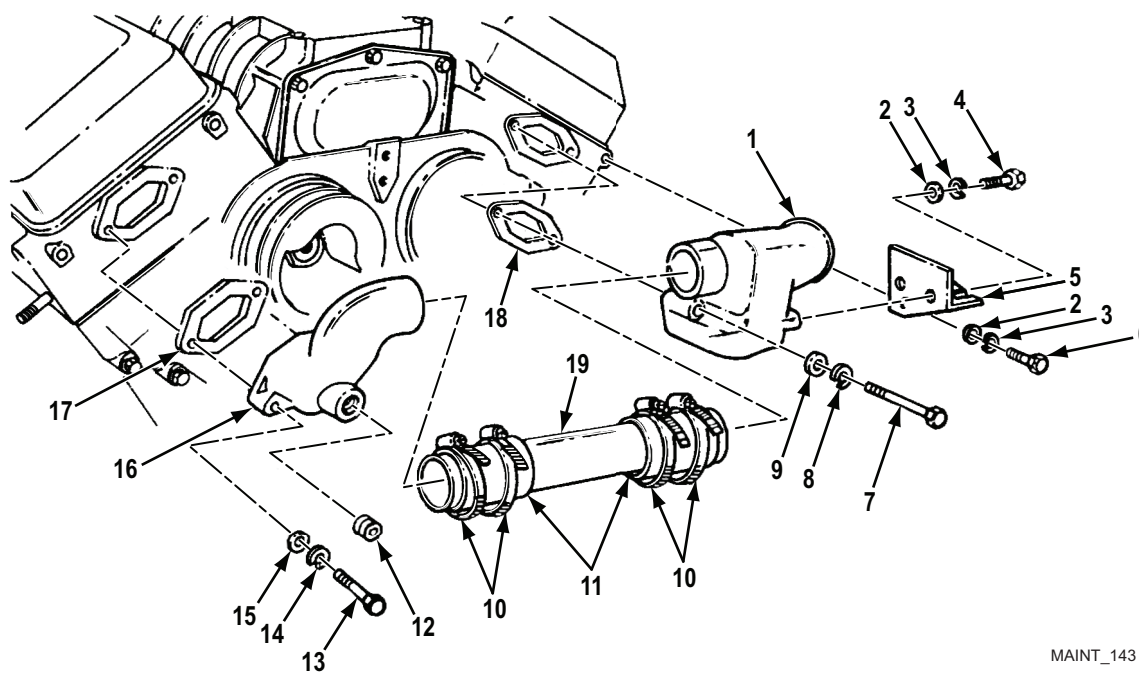
**Equipment Condition**

Air pump assembly bracket and angle bracket  
removed (WP 0044)

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## REMOVAL

1. Loosen four clamps (Figure 1, Item 10) and two hoses (Figure 1, Item 11) connecting crossover tube (Figure 1, Item 19) to water outlet elbow (Figure 1, Item 16) and to water outlet tee (Figure 1, Item 1). Slide clamps and hoses onto crossover tube. Remove tube and slide clamps and hoses off tube.
2. Remove two screws (Figure 1, Item 13), two lockwashers (Figure 1, Item 14), two flat washers (Figure 1, Item 15), water outlet elbow (Figure 1, Item 16), and gasket (Figure 1, Item 17) from right cylinder head. Discard lockwashers and gasket.
3. If necessary, remove plug (Figure 1, Item 12) from water outlet elbow (Figure 1, Item 16).
4. Remove two long screws (Figure 1, Item 4), one short screw (Figure 1, Item 6), three lockwashers (Figure 1, Item 3), three flat washers (Figure 1, Item 2), and bracket (Figure 1, Item 5) from water outlet tee (Figure 1, Item 1). Discard lockwashers.
5. Remove two screws (Figure 1, Item 7), two lockwashers (Figure 1, Item 8), two flat washers (Figure 1, Item 9), water outlet tee (Figure 1, Item 1), and gasket (Figure 1, Item 18) from left cylinder head. Discard gasket and lockwashers.



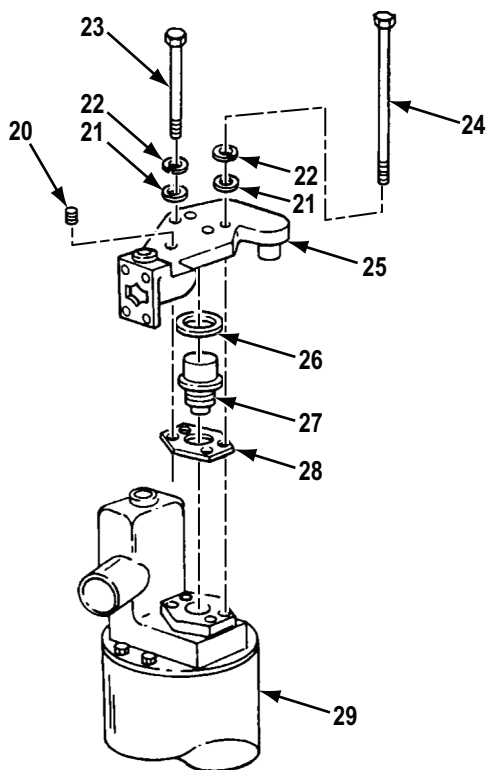
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Figure 1. Thermostat Housing and Crossover Tube Removal.

**REMOVAL - Continued****NOTE**

The transmission oil cooler assembly and thermostat water outlet were removed in (WP 0011) to allow mounting engine on maintenance stand.

6. Remove two short bolts (Figure 2, Item 23), two long bolts (Figure 2, Item 24), four lockwashers (Figure 2, Item 22), four flat washers (Figure 2, Item 21), thermostat water outlet (Figure 2, Item 25), and gasket (Figure 2, Item 28) from top of transmission oil cooler assembly (Figure 2, Item 29). Discard gasket and lockwashers.
7. Remove thermostat (Figure 2, Item 27) and seal (Figure 2, Item 26) from thermostat water outlet (Figure 2, Item 25). Discard seal. If necessary, remove plug (Figure 2, Item 20) from cover.



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Figure 2. Thermostat Removal.

**END OF TASK**

**TEST AND INSPECTION**

1. Immerse thermostat (Figure 3, Item 27) in suitable container or utility pail of water, do not allow thermostat to touch bottom of container.
2. Agitate water to maintain an even temperature throughout container. As water is heated, thermostat valve should begin to open. Allow at least 10 minutes for thermostat to react.

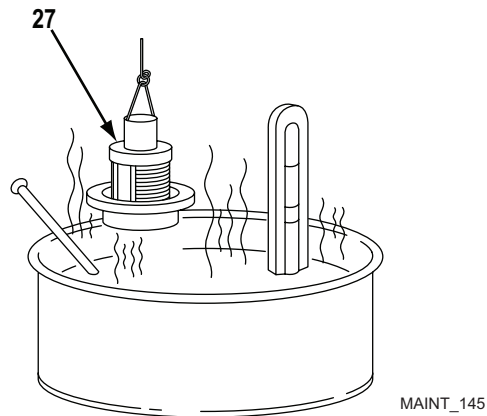


Figure 3. Thermostat Check.

**NOTE**

Thermostat valve should start opening at 177–182°F (81–83°C). Valve should be fully open at 197°F (92°C).

3. Replace thermostat if it does not meet requirements.

**END OF TASK**

**INSTALLATION**

1. Using thermostat seal installer and seal installer handle, press new seal (Figure 4, Item 26) in thermostat water outlet (Figure 4, Item 25). Position seal so lip will face away from thermostat (Figure 4, Item 27).
2. Install thermostat (Figure 4, Item 27) in thermostat water outlet (Figure 4, Item 25). If removed, install plug (Figure 4, Item 20) in outlet.

**NOTE**

The transmission oil cooler assembly (Figure 4, Item 29) and thermostat water outlet (Figure 4, Item 25) were removed in (WP 0011) to allow mounting engine on maintenance stand.

3. Install new gasket (Figure 4, Item 28), thermostat water outlet (Figure 4, Item 25), four new lockwashers (Figure 4, Item 22), four flat washers (Figure 4, Item 21), two short bolts (Figure 4, Item 23), and two long bolts (Figure 4, Item 24) on top of transmission oil cooler assembly (Figure 4, Item 29). Torque bolts to 13–17 lb-ft (18–23 N·m).

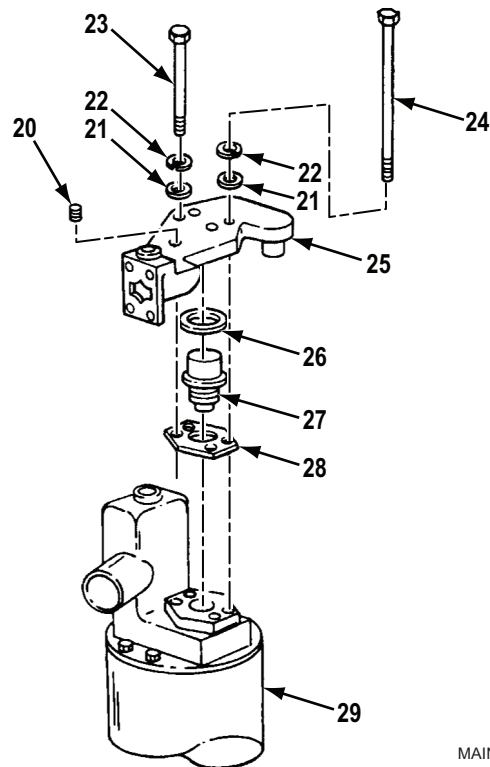
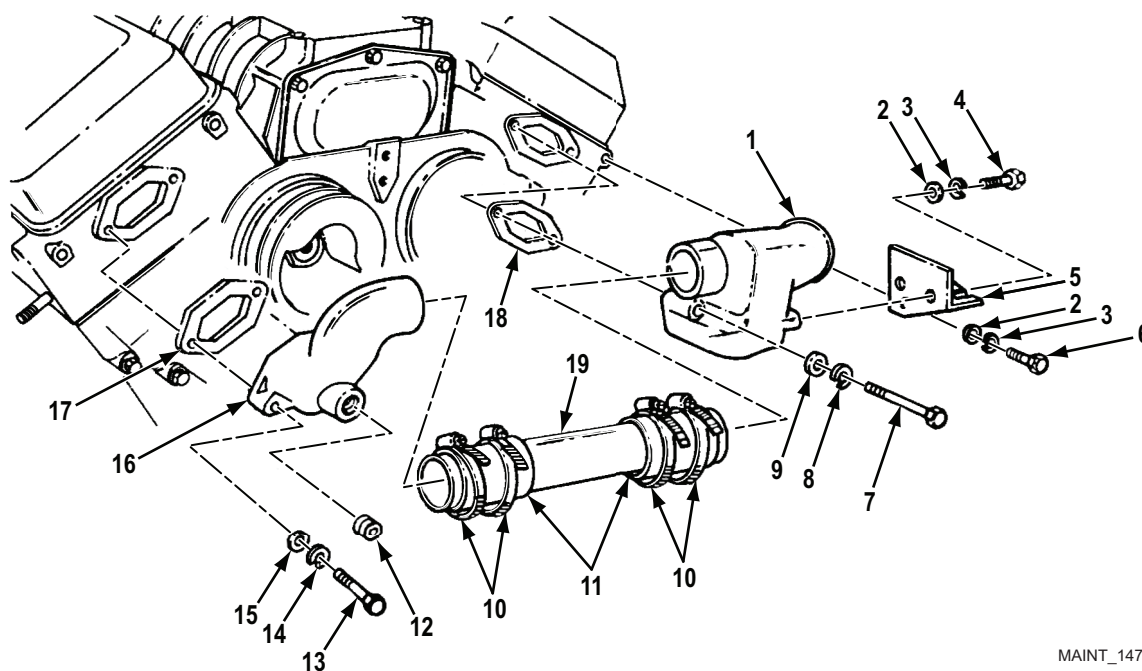


Figure 4. Thermostat Installation.

**INSTALLATION - Continued**

4. Install new gasket (Figure 5, Item 18), water outlet tee (Figure 5, Item 1), two flat washers (Figure 5, Item 9), two new lockwashers (Figure 5, Item 8), and two screws (Figure 5, Item 7) on front of left cylinder head. Torque screws to 30–35 lb-ft (41–47 N·m).
5. Install bracket (Figure 5, Item 5), three flat washers (Figure 5, Item 2), three new lockwashers (Figure 5, Item 3), one short screw (Figure 5, Item 6), and two long screws (Figure 5, Item 4) on water outlet tee (Figure 5, Item 1) and cylinder head. Torque screws to 30–35 lb-ft (41–47 N·m).
6. Install new gasket (Figure 5, Item 17), water outlet elbow (Figure 5, Item 16), two new lockwashers (Figure 5, Item 14), two flat washers (Figure 5, Item 15), and two screws (Figure 5, Item 13) to front of right cylinder head. Torque screws to 30–35 lb-ft (41–47 N·m).
7. If removed, install plug (Figure 5, Item 12) in water outlet elbow (Figure 5, Item 16).
8. Slide two hoses (Figure 5, Item 11) and four clamps (Figure 5, Item 10) onto crossover tube (Figure 5, Item 19). Install crossover tube between water outlet elbow (Figure 5, Item 16) and water outlet tee (Figure 5, Item 1). Slide two hoses and four clamps over connections and tighten clamps.



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Figure 5. Thermostat Housing and Crossover Tube Installation.

**END OF TASK****FOLLOW ON TASK**

Install angle bracket and air pump assembly bracket (WP 0044).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
FUEL LINES  
(MODEL 5063-5299)**

---

**INITIAL SETUP:**

**Tools and Special Tools**

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Air pump support removed (WP 0042)  
Coolant crossover tube removed (WP 0047)

**Materials/Parts**

Washer, Lock (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Remove screw (Figure 1, Item 1), lockwasher (Figure 1, Item 2), flat washer (Figure 1, Item 3), and clip (Figure 1, Item 4), on fuel inlet hose assembly (Figure 1, Item 5), from air inlet housing (Figure 1, Item 6). Discard lockwasher. If necessary, remove clip from hose assembly.

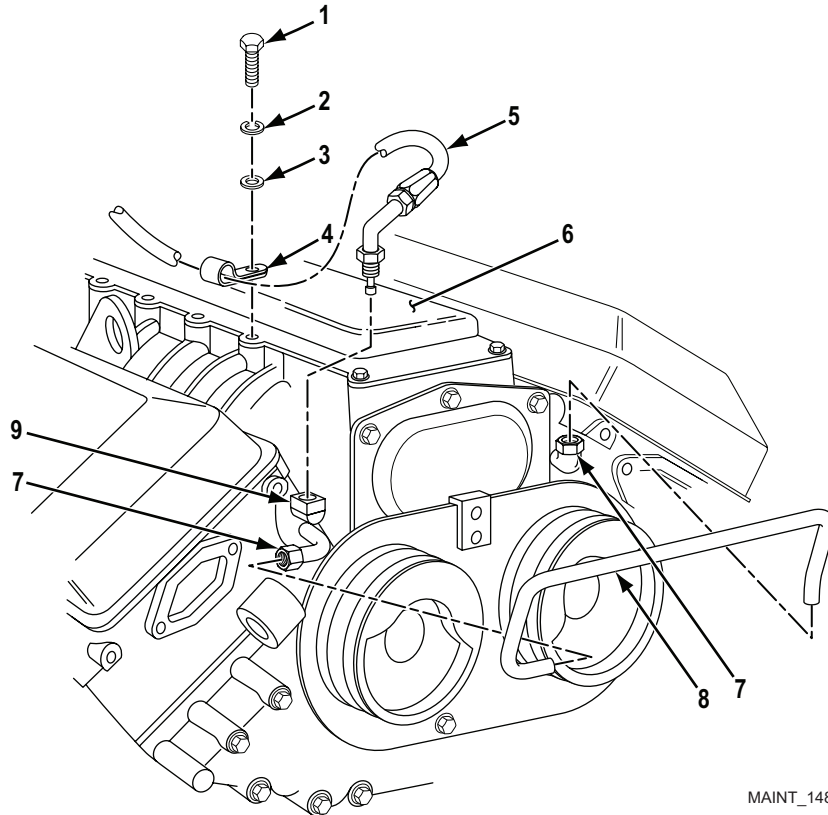


Figure 1. Fuel Line Removal.

**REMOVAL - Continued**

2. Disconnect fuel inlet hose assembly (Figure 2, Item 5) from tee (Figure 2, Item 10) at rear of left cylinder head and from elbow (Figure 1, Item 9) at front of right cylinder head. Remove hose assembly.

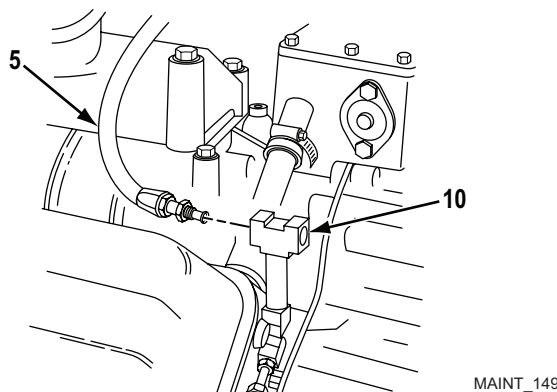


Figure 2. Fuel Line Removal/Installation.

3. Loosen nuts on two elbows (Figure 1, Item 7) at front of cylinder heads and remove fuel crossover tube (Figure 1, Item 8).

**END OF TASK****INSTALLATION**

1. Insert fuel crossover tube (Figure 1, Item 8) into two elbows (Figure 1, Item 7) at front of cylinder heads. Tighten nut on each elbow.
2. Connect fuel inlet hose assembly (Figure 2, Item 5) to elbow (Figure 1, Item 9) at front of right cylinder head and to tee (Figure 2, Item 10) at rear of left cylinder head. Tighten hose connections.
3. If removed, install clip (Figure 1, Item 4) on fuel inlet hose assembly (Figure 1, Item 5).
4. Install clip (Figure 1, Item 4), located on fuel inlet hose assembly (Figure 1, Item 5), flat washer (Figure 1, Item 3), new lockwasher (Figure 1, Item 2), and screw (Figure 1, Item 1) on air inlet housing (Figure 1, Item 6). Torque screw to 16–20 lb-ft (22–27 N·m).

**END OF TASK****FOLLOW ON TASK**

1. Install coolant crossover tube (WP 0047).
2. Install air pump support (WP 0042).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
FUEL LINES REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Air pump assembly and support removed  
(WP 0043)  
Coolant crossover tube removed (WP 0047)

**Materials/Parts**

Washer, Lock (WP 0105, Table 1, Item 23)

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**REMOVAL**

1. Remove screw (Figure 1, Item 1), lockwasher (Figure 1, Item 2), and clip (Figure 1, Item 3), on hose assembly (Figure 1, Item 12), from air inlet housing (Figure 1, Item 4). Discard lockwasher. If necessary, remove clip from hose assembly.
2. Disconnect hose assembly (Figure 1, Item 12) from tee (Figure 1, Item 11) at rear of left cylinder head and from elbow (Figure 2, Item 16) at front of right cylinder head. Remove hose assembly. If necessary, remove two clips (Figure 1, Item 13) from hose assembly.
3. Disconnect hose assembly (Figure 1, Item 10) from tee (Figure 1, Item 11) at rear of left cylinder head. Remove hose assembly.
4. Disconnect hose assembly (Figure 1, Item 6) from elbow (Figure 1, Item 7) in fuel pump (Figure 1, Item 9). Remove hose assembly.
5. Disconnect hose assembly (Figure 1, Item 5) from elbow (Figure 1, Item 8) in fuel pump (Figure 1, Item 9). Remove hose assembly.

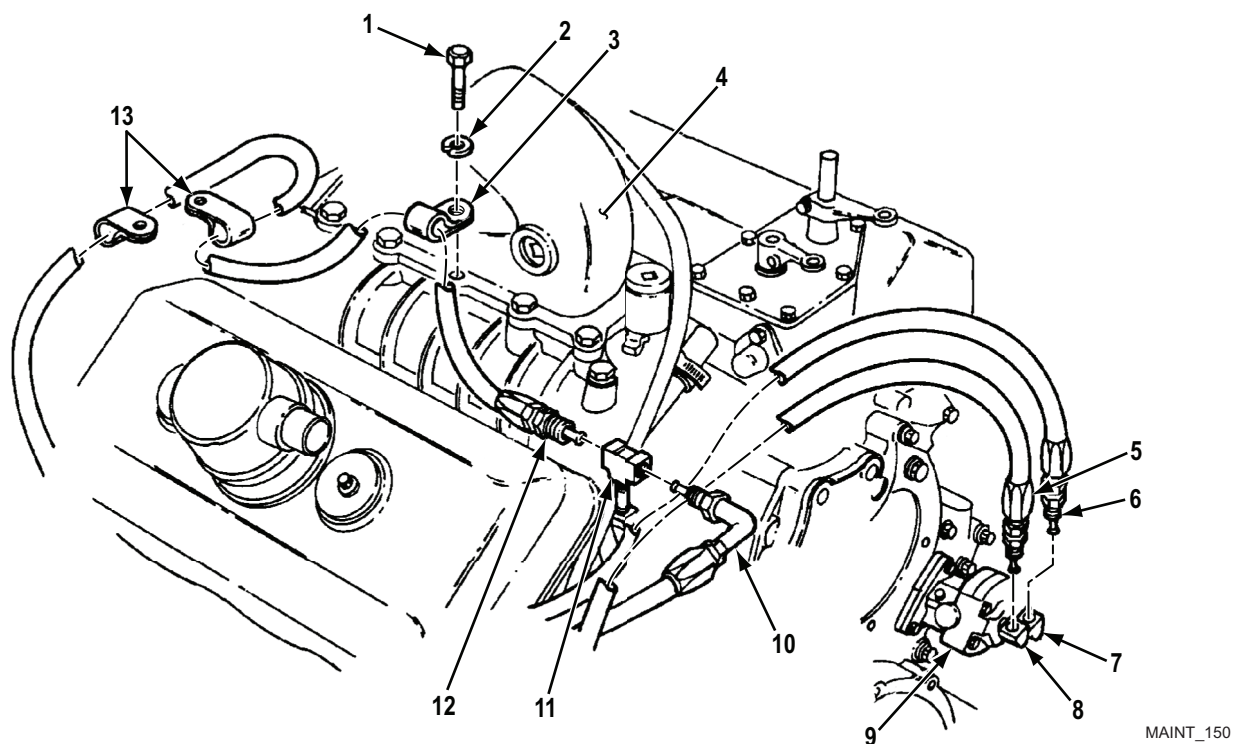


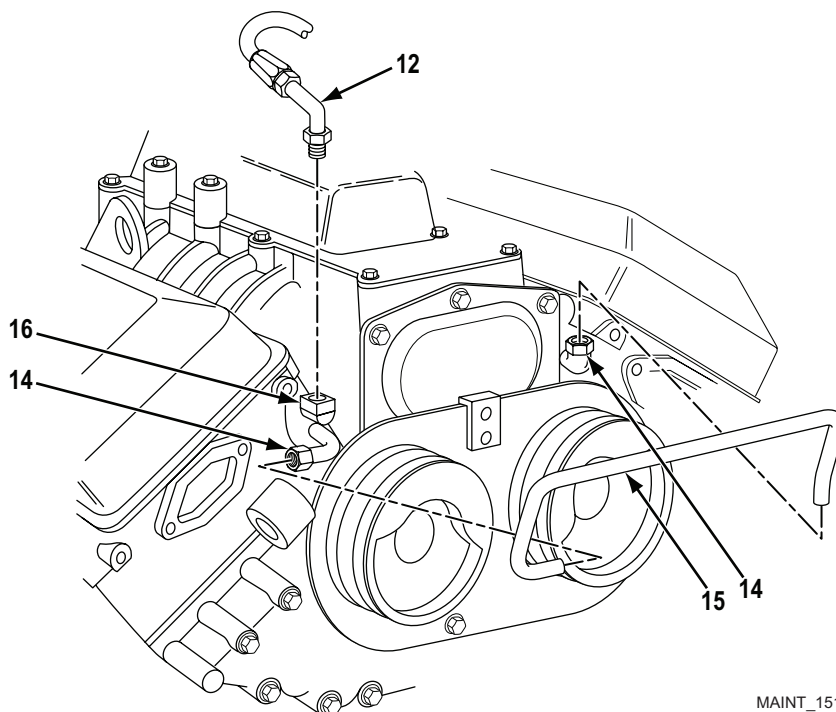
Figure 1. Fuel Line Removal.

6. Loosen nuts on two elbows (Figure 2, Item 14) at front of cylinder heads and remove fuel crossover tube (Figure 2, Item 15).

**END OF TASK**

**INSTALLATION**

1. Insert fuel crossover tube (Figure 2, Item 15) into two elbows (Figure 2, Item 14) at front of cylinder heads. Tighten nut on each elbow.



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Figure 2. Fuel Line Installation.

2. Connect hose assembly (Figure 1, Item 6) to outboard elbow (Figure 1, Item 7) in fuel pump (Figure 1, Item 9). Tighten hose connection.
3. Connect hose assembly (Figure 1, Item 5) to inboard elbow (Figure 1, Item 8) in fuel pump (Figure 1, Item 9). Tighten hose connection.
4. Connect hose assembly (Figure 1, Item 10) to tee (Figure 1, Item 11) in fuel inlet at rear of left cylinder head. Tighten hose connection.
5. If removed, install two clips (Figure 1, Item 13) on hose assembly (Figure 1, Item 12). Connect hose assembly to tee (Figure 1, Item 11) in fuel inlet at rear of left cylinder head and to elbow (Figure 1, Item 16) at front of right cylinder head. Tighten hose connections.
6. If removed, install clip (Figure 1, Item 3) on hose assembly (Figure 1, Item 12).
7. Install clip (Figure 1, Item 3), located on hose assembly (Figure 1, Item 12), new lockwasher (Figure 1, Item 2), and screw (Figure 1, Item 1) in air inlet housing (Figure 1, Item 4). Torque screw to 16–20 lb-ft (22–27 N·m).

**END OF TASK**

**FOLLOW ON TASK**

1. Install coolant crossover tube (WP 0047).
2. Install air pump assembly and support (WP 0043).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
FUEL LINES REPLACEMENT  
(MODELS 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition (cont.)**

Glow plug controller and angle bracket removed  
(model 5063-539L) (WP 0045)  
Coolant crossover tube removed (WP 0048)

**Materials/Parts**

Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Air pump assembly and angle bracket removed  
(model 5063-5393) (WP 0044)

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**REMOVAL**

1. Disconnect inlet hose assembly (Figure 1, Item 3) from elbow (Figure 1, Item 2) in fuel pump (Figure 1, Item 1). Remove hose assembly (Figure 1, Item 3).
2. Disconnect outlet hose assembly (Figure 1, Item 4) from elbow (Figure 1, Item 5) in fuel pump (Figure 1, Item 1). Remove hose assembly (Figure 1, Item 4).

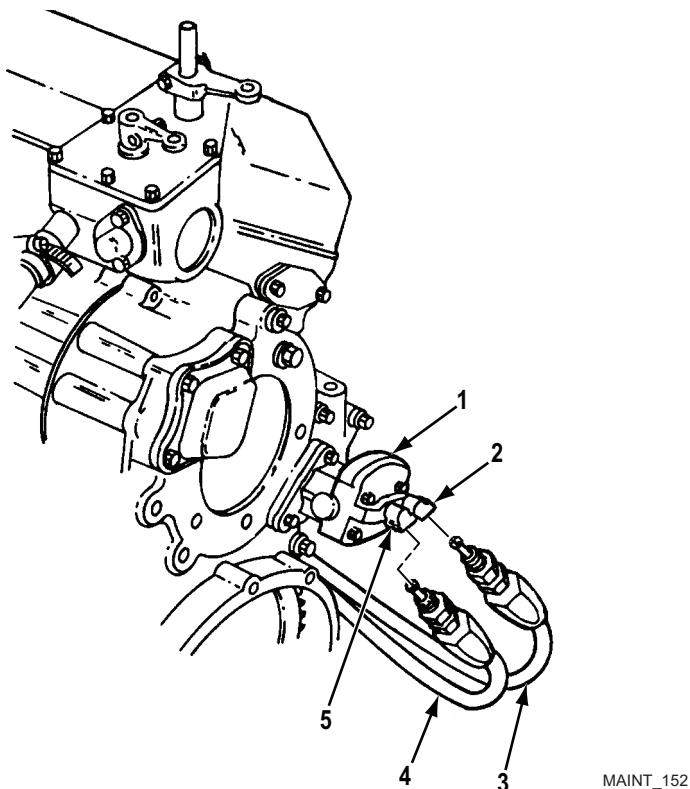


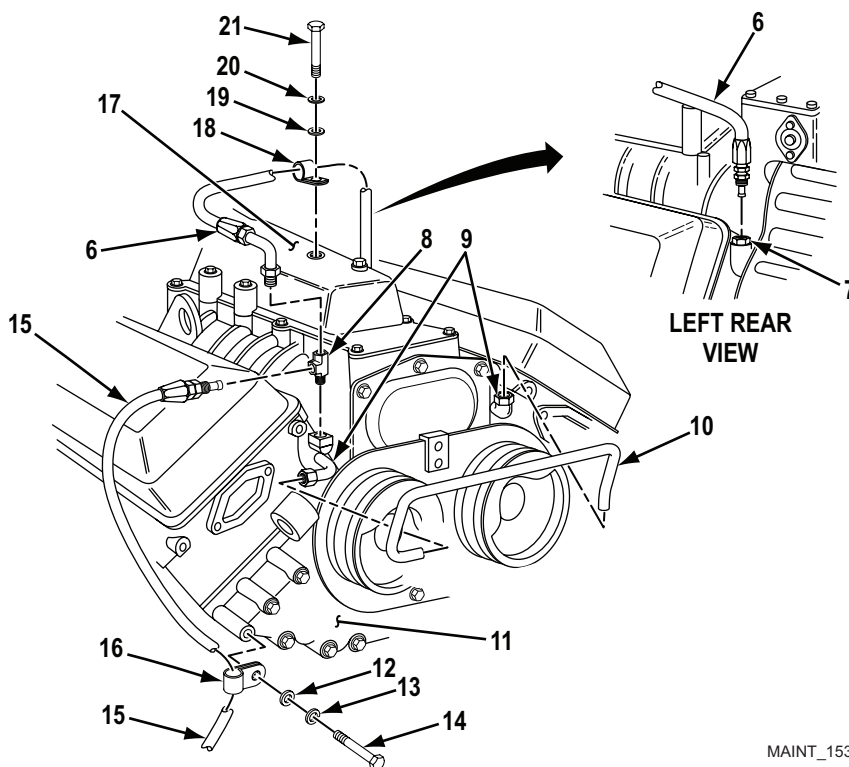
Figure 1. Fuel Line Removal.

3. Remove screw (Figure 2, Item 14), lockwasher (Figure 2, Item 13), flat washer (Figure 2, Item 12), and clip (Figure 2, Item 16), on hose assembly (Figure 2, Item 15), from upper front cover (Figure 2, Item 11). Discard lockwasher (Figure 2, Item 13). If necessary, remove clip (Figure 2, Item 16) from hose assembly (Figure 2, Item 15).
4. Disconnect hose assembly (Figure 2, Item 15) from tee (Figure 2, Item 8) in front of right cylinder head. Remove hose assembly (Figure 2, Item 15).
5. Remove screw (Figure 2, Item 21), lockwasher (Figure 2, Item 20), flat washer (Figure 2, Item 19), and clip (Figure 2, Item 18), on hose assembly (Figure 2, Item 6), from air inlet housing (Figure 2, Item 17). Discard lockwasher (Figure 2, Item 20). If necessary, remove clip (Figure 2, Item 18) from hose assembly (Figure 2, Item 6).
6. Disconnect hose assembly (Figure 2, Item 6) from tee (Figure 2, Item 8), in front of right cylinder head, and from elbow (Figure 2, Item 7) in rear of left cylinder head. Remove hose assembly (Figure 2, Item 6).
7. Loosen nut on two elbows (Figure 2, Item 9), at front of cylinder heads, and remove fuel crossover tube (Figure 2, Item 10).

**END OF TASK**

**INSTALLATION**

1. Insert fuel crossover tube (Figure 2, Item 10) into two elbows (Figure 2, Item 9) at front of cylinder heads. Tighten nut on each elbow (Figure 2, Item 9).
2. If removed, install clip (Figure 2, Item 18) on hose assembly (Figure 2, Item 6). Connect hose assembly (Figure 2, Item 6) to tee (Figure 2, Item 8) in front of right cylinder head and to elbow (Figure 2, Item 7) at rear of left cylinder head. Tighten hose connections.
3. Connect hose assembly (Figure 2, Item 6) to air inlet housing (Figure 2, Item 17) with clip (Figure 2, Item 18), screw (Figure 2, Item 21), new lockwasher (Figure 2, Item 20), and flat washer (Figure 2, Item 19). Torque screw (Figure 2, Item 21) to 16–20 lb-ft (22–27 N·m).
4. Connect hose assembly (Figure 2, Item 15) to tee (Figure 2, Item 8) in front of right cylinder head. Tighten hose connection.
5. If removed, install clip (Figure 2, Item 16) on hose assembly (Figure 2, Item 15). Install clip (Figure 2, Item 16), screw (Figure 2, Item 14), new lockwasher (Figure 2, Item 13), and flat washer (Figure 2, Item 12) on upper front cover (Figure 2, Item 11). Torque screw (Figure 2, Item 14) to 30–35 lb-ft (41–47 N·m).
6. Connect inlet hose assembly (Figure 1, Item 3) to elbow (Figure 1, Item 2) in fuel pump (Figure 1, Item 1). Tighten hose connection.
7. Connect outlet hose assembly (Figure 1, Item 4) to elbow (Figure 1, Item 5) in fuel pump (Figure 1, Item 1). Tighten hose connection.



MAINT\_153

Figure 2. Fuel Line Removal/Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install coolant crossover tube (WP 0048).
2. Install angle bracket and glow plug controller (model 5063-539L) (WP 0045).
3. Install angle bracket and air pump assembly (model 5063-5393) (WP 0044).

**END OF TASK****END OF WORK PACKAGE**

**FIELD MAINTENANCE  
ROCKER ARM COVERS REPLACEMENT  
(MODELS 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

**Materials/Parts**

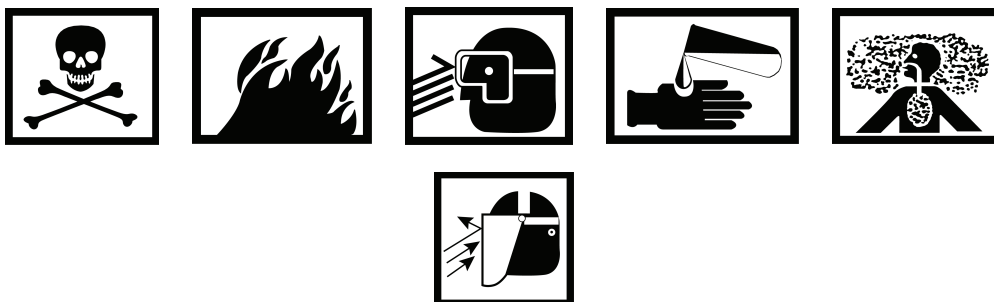
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket Qty: (2) (WP 0105, Table 1, Item 60)

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**REMOVAL****NOTE**

Right and left rocker arm covers are identical except for oil filler hole and breather tube. Use same procedure to remove both covers.

1. Remove four screw and clamp assemblies (Figure 1, Item 3), rocker arm cover (Figure 1, Item 5), and gasket (Figure 1, Item 4) from cylinder head. Discard gasket (Figure 1, Item 4).
2. If necessary, disconnect clip (Figure 1, Item 2) and remove oil filler cap assembly (Figure 1, Item 1) from rocker arm cover (Figure 1, Item 5).

**END OF TASK****CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean rocker arm covers (Figure 1, Item 5) with cleaning solvent and dry with compressed air.

**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect covers (Figure 1, Item 5) for cracks, dents, or other damage.

**END OF TASK****INSTALLATION**

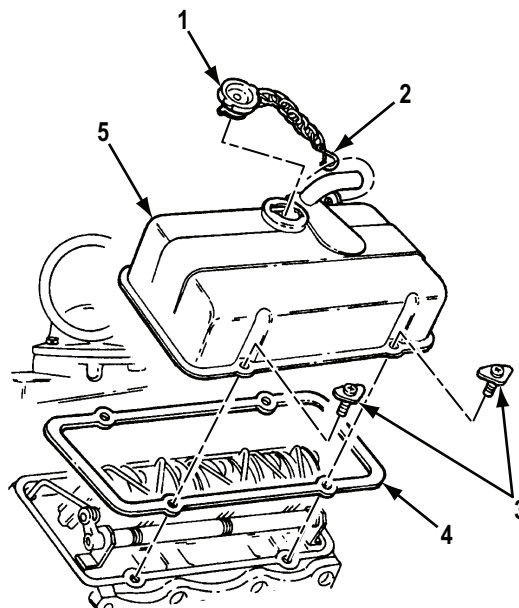
1. If removed, install oil filler cap assembly (Figure 1, Item 1) and clip (Figure 1, Item 2) on rocker arm cover (Figure 1, Item 5).

**NOTE**

Breather tube outlet on rocker arm cover is always inboard.

Rocker arm cover with oil filler hole mounts on left cylinder head.

2. Install new gasket (Figure 1, Item 4), rocker arm cover (Figure 1, Item 5), and four screw and clamp assemblies (Figure 1, Item 3) on each cylinder head. Tighten screws.



MAINT\_154

Figure 1. Rocker Arm Cover Installation.

**END OF TASK****END OF WORK PACKAGE**





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**FIELD MAINTENANCE**  
**ROCKER ARM COVERS AND CRANKCASE BREATHERS REPLACEMENT**  
**(MODELS 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Gasket Qty: (2) (WP 0105, Table 1, Item 132)  
Seal, Plain Qty: (2) (WP 0105, Table 1, Item 32)

**Materials/Parts**

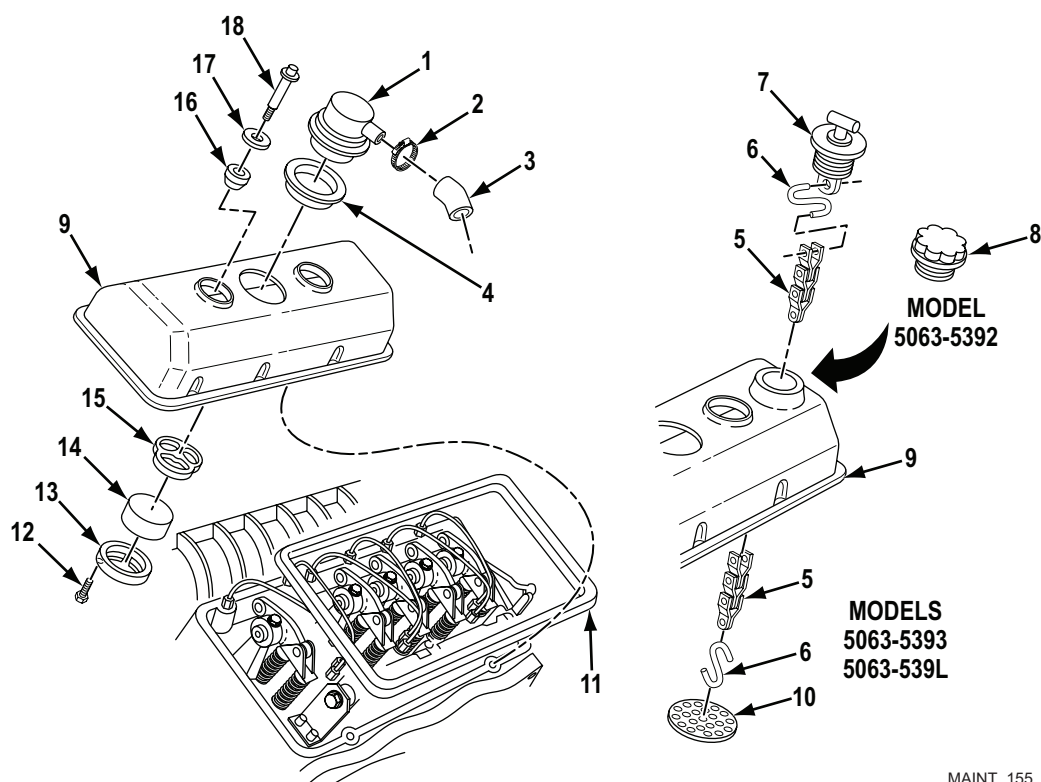
Cleaning Solvent (WP 0103, Table 1, Item 8)

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**REMOVAL****NOTE**

Right and left rocker arm covers are identical except for oil filler hole. Use same procedure to remove both covers.

1. Remove two bolts (Figure 1, Item 18), two flat washers (Figure 1, Item 17), two resilient mounts (Figure 1, Item 16), and rocker arm cover (Figure 1, Item 9) from cylinder head.
2. Remove gasket (Figure 1, Item 11). Discard gasket.
3. On models 5063-5393 and 5063-539L, remove clamp (Figure 1, Item 2) and hose (Figure 1, Item 3) from breather housing (Figure 1, Item 1).



MAINT\_155

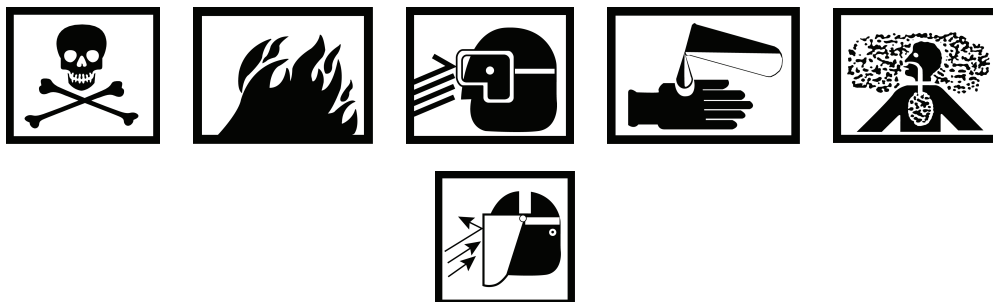
Figure 1. Rocker Arm Cover Removal.

**END OF TASK****DISASSEMBLY**

1. Remove three screws (Figure 1, Item 12) and retainer (Figure 1, Item 13) from breather housing (Figure 1, Item 1). Remove breather housing, filtering disk (Figure 1, Item 14), breather retainer (Figure 1, Item 15), and seal (Figure 1, Item 4) from rocker arm cover (Figure 1, Item 9). Discard seal.
2. On model 5063-5392, unscrew and remove oil filler cap (Figure 1, Item 8) from rocker arm cover (Figure 1, Item 9).
3. On models 5063-5393 and 5063-539L, remove oil filler cap (Figure 1, Item 7) as follows:
  - a. Loosen knob on oil filler cap (Figure 1, Item 7) and remove cap from rocker cover (Figure 1, Item 9).

**DISASSEMBLY - Continued**

- b. If necessary, bend two S-hooks (Figure 1, Item 6) open to disconnect chain (Figure 1, Item 5) from oil filler cap (Figure 1, Item 7) and from strainer element (Figure 1, Item 10).
- c. If necessary, drive strainer element (Figure 1, Item 10) from rocker arm cover (Figure 1, Item 9).

**END OF TASK****CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Clean rocker arm covers and breather housings with cleaning solvent and dry with compressed air.
2. Clean filtering disk with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE and REJECTION CRITERIA**

Inspect covers for cracks, dents, or other damage.

**END OF TASK****ASSEMBLY**

1. On models 5063-5393 and 5063-539L, install oil filler cap (Figure 1, Item 7) as follows:
  - a. If removed, press strainer element (Figure 1, Item 10) into oil filler hole from bottom of rocker arm cover (Figure 1, Item 9) until flush with bottom of bore. Stake strainer element in position.
  - b. If removed, connect chain (Figure 1, Item 5) to oil filler cap (Figure 1, Item 7) and to strainer element (Figure 1, Item 10) with two S-hooks (Figure 1, Item 6). Crimp S-hooks shut.
2. On model 5063-5392, screw oil filler cap (Figure 1, Item 8) into rocker arm cover (Figure 1, Item 9) until cap clicks.

**ASSEMBLY - Continued****NOTE**

On models 5063-5393 and 5063-539L, outlet from breather housings point outboard.

On model 5063-5392, right breather housing outlet points towards front of engine and left breather housing outlet points towards rear of engine.

3. Install breather retainer (Figure 2, Item 15) and filtering disk (Figure 2, Item 14) in breather housing (Figure 2, Item 1).
4. Install new seal (Figure 2, Item 4), breather housing (Figure 2, Item 1), retainer (Figure 2, Item 13), and three screws (Figure 2, Item 12) in rocker arm cover (Figure 2, Item 9). Torque screws to 48–72 lb-in (5–8 N·m).

**END OF TASK****INSTALLATION****NOTE**

Right and left rocker arm covers are identical except for oil filler hole. Use same procedure to remove both covers.

1. Install new gasket (Figure 2, Item 11) in groove at bottom of rocker arm cover (Figure 2, Item 9). First press gasket into corners and then sides.

**NOTE**

On model 5063-5392, oil filler cap is at rear of right rocker arm cover.

On models 5063-5393 and 5063-539L, oil filler cap is at front of right rocker arm cover.

2. Install rocker arm cover (Figure 2, Item 9), two resilient mounts (Figure 2, Item 16), two flat washers (Figure 2, Item 17), and two bolts (Figure 2, Item 18) on cylinder head. Torque bolts to 96–156 lb-in (11–18 N·m).
3. On models 5063-5393 and 5063-539L, install hose (Figure 2, Item 3) and clamp (Figure 2, Item 2) on breather housing (Figure 2, Item 1) with hose pointing downward. Tighten clamp.

INSTALLATION - Continued

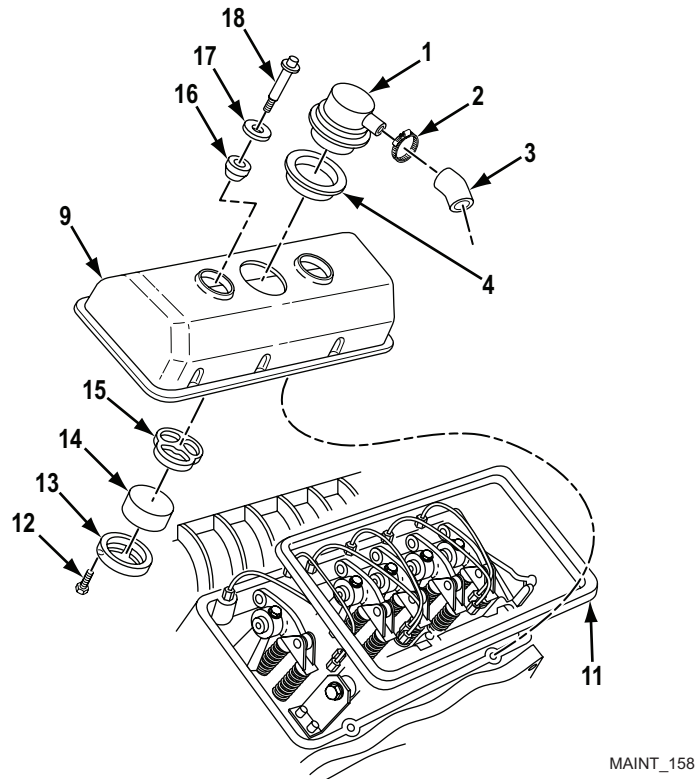


Figure 2. Rocker Arm Cover Installation.

END OF TASK

END OF WORK PACKAGE



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**FIELD MAINTENANCE  
FUEL INJECTOR REMOVAL AND INSTALLATION**

---

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

Tool Kit General Mechanic's  
(WP 0104, Table 1, Item 113)  
Socket, Socket Wrench, 3/4" Dr., 1-1/16"  
(WP 0104, Table 1, Item 95)  
Extension, 3/4" Dr., 4.5" Long  
(WP 0104, Table 1, Item 27)  
Handle, Ratchet, 3/4" Dr., 4.5" Long  
(WP 0104, Table 1, Item 51)  
Cap Set, Protective, Dust and Moisture  
(WP 0104, Table 1, Item 15)  
Wrench, O/End Box, Injector Fuel Line  
(WP 0104, Table 1, Item 119)  
Reamer, Hand (2nd Operation)  
(WP 0104, Table 1, Item 79)  
Adapter, Torque Wrench (Fuel Nut)  
(WP 0104, Table 1, Item 4)  
Wrench, Torque, Dial, 0-175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Wrench, Torque, 0-300 Lb-In  
(WP 0104, Table 1, Item 121)

**Materials/Parts (cont.)**

Grease, GAA (WP 0103, Table 1, Item 17)  
Oil, Cutting (WP 0103, Table 1, Item 26)  
Oil Engine Oil (WP 0103, Table 1, Item 27)  
Rag, Wiping (WP 0103, Table 1, Item 44)  
Washer, Convex (WP 0103, Table 1, Item 66)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Powerpack removed TM 9-2350-277-13&P  
Powerpack mounted on maintenance stand  
TM 9-2350-277-13&P  
Rocker arm covers and crankcase breather  
removed (WP 0052) (WP 0053)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

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## NOTE

This procedure shows one fuel injector on right cylinder head assembly at cylinder #1 and one fuel injector on left cylinder head assembly at cylinder #2. To remove and install fuel injectors, other than those shown, adjust task step procedures where indicated.

## REMOVAL

1. Locate fuel injector (Figure 1, Item 1) to be removed.

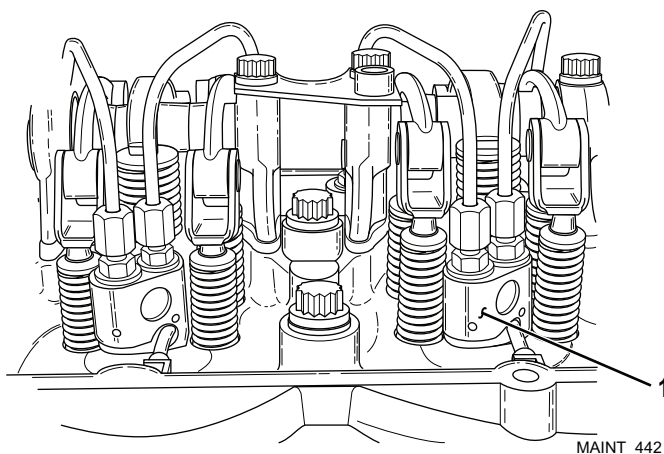


Figure 1. Fuel Injector.

## CAUTION

Rotate engine crankshaft in clockwise direction only. Do not rotate crankshaft in counterclockwise direction using crankshaft bolt. Crankshaft bolt can loosen and serious engine damage may result if crankshaft bolt is not securely tightened to crankshaft.

Manually rotating the engine crankshaft could create ignition and start the engine. When rotating engine crankshaft in clockwise direction, manually hold the fuel shut-off control lever, located on the governor cover assembly, in the fuel shut-off/no fuel position. Visually make sure all fuel injector racks are in the no fuel position.

When the engine crankshaft is being rotated by helper, the mechanic must visually monitor the positions of fuel injector rocker arm, two exhaust valve rocker arms and the three related push rods, which are associated to the fuel injector being removed.

2. Manually rotate engine crankshaft in clockwise direction until pressure of fuel injector rocker arm (Figure 2, Item 3) and two exhaust valve rocker arms (Figure 2, Item 2) are released from fuel injector plunger follower (Figure 3, Item 4) and exhaust valve stems (Figure 3, Item 5). Make sure fuel injector rocker arm (Figure 4, Item 3) and exhaust valve rocker arms (Figure 4, Item 2) are fully released and three push rods (Figure 4, Item 6) are loose, in lowest travel position, and horizontally aligned.



REMOVAL - Continued

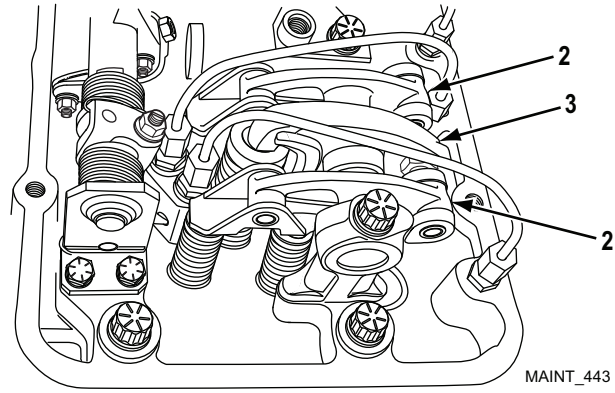


Figure 2. Rocker Arms.

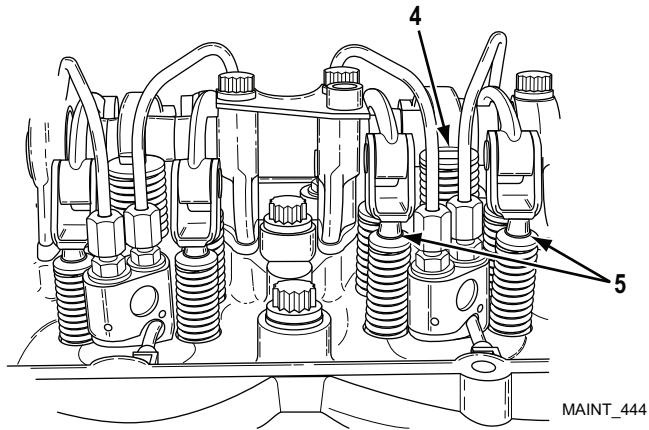


Figure 3. Valve Stems and Fuel Injector Plunger Setup.

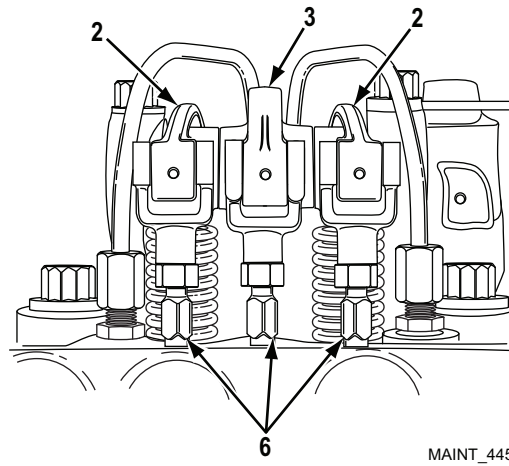


Figure 4. Push Rods Setup and Alignment.

**REMOVAL - Continued****CAUTION**

Cap each injector fuel fitting and nipple immediately after removing fuel tube assembly to keep out dirt.

**NOTE**

Tag and mark fuel supply/return tube assemblies, rocker arm shaft, rocker arm shaft brackets, eye brackets, and associated hardware with location references during removal. This information will be required for correct replacement of items during installation.

3. Loosen two captive nuts (Figure 5, Item 7) on fuel (supply) tube assembly (Figure 5, Item 8) from adapter fitting (Figure 5, Item 10) on fuel injector (Figure 5, Item 1) and fuel (supply) nipple (Figure 5, Item 9) on cylinder head assembly. Remove fuel tube assembly (Figure 5, Item 8).

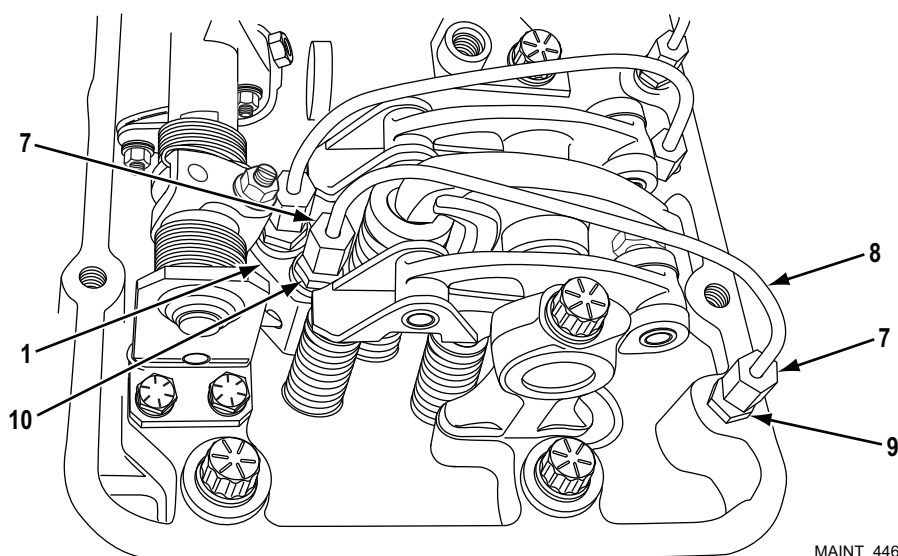


Figure 5. Fuel Supply Tube Removal.

4. Loosen two captive nuts (Figure 6, Item 11) on fuel (return) tube assembly (Figure 6, Item 12) from adapter fitting (Figure 6, Item 13) on fuel injector (Figure 6, Item 1) and fuel (return) nipple (Figure 6, Item 14) on cylinder head assembly. Remove fuel tube assembly (Figure 6, Item 12).

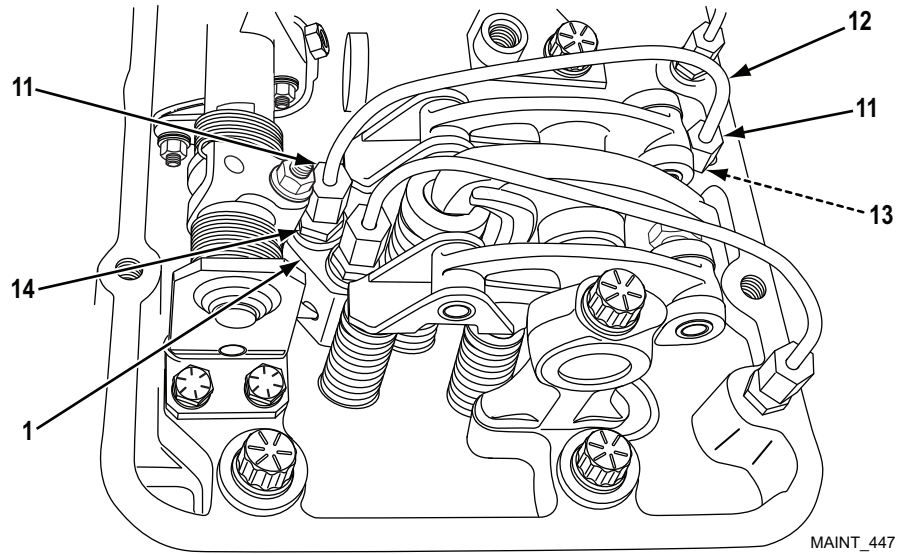
**REMOVAL - Continued**

Figure 6. Fuel Return Tube Removal.

**NOTE**

For engine models 5063-5299, 5063-5392, 5063-5393, and 5063-539L: To remove fuel injector for cylinder #1 on right cylinder head assembly, do Steps 5 through 9 and Steps 15 through 17.

5. Remove one machine bolt (Figure 7, Item 15) from front rocker arm shaft bracket (Figure 7, Item 17) and rocker arm shaft (Figure 7, Item 16).

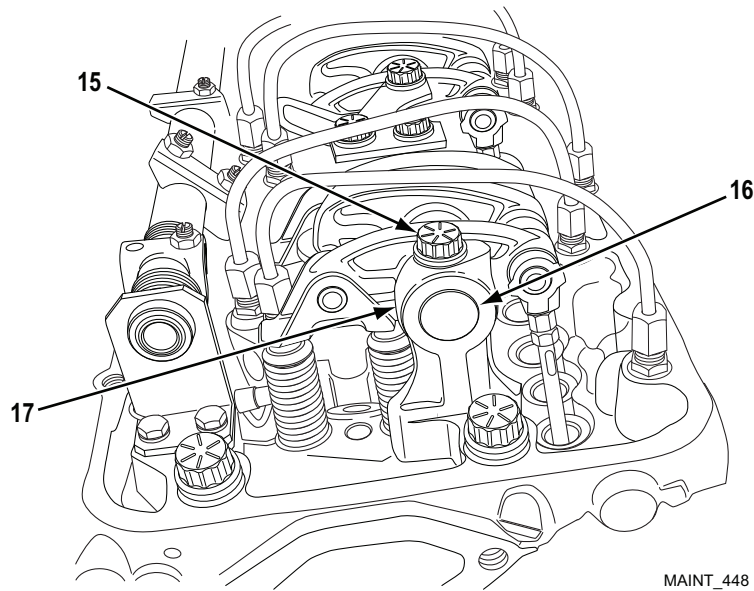


Figure 7. Front Rocker Arm Shaft Bracket.

**REMOVAL - Continued**

6. Remove one machine bolt (Figure 8, Item 19) from eye bracket (Figure 8, Item 20), throttle delay assembly (Figure 8, Item 18), and rocker arm shaft (Figure 8, Item 16).

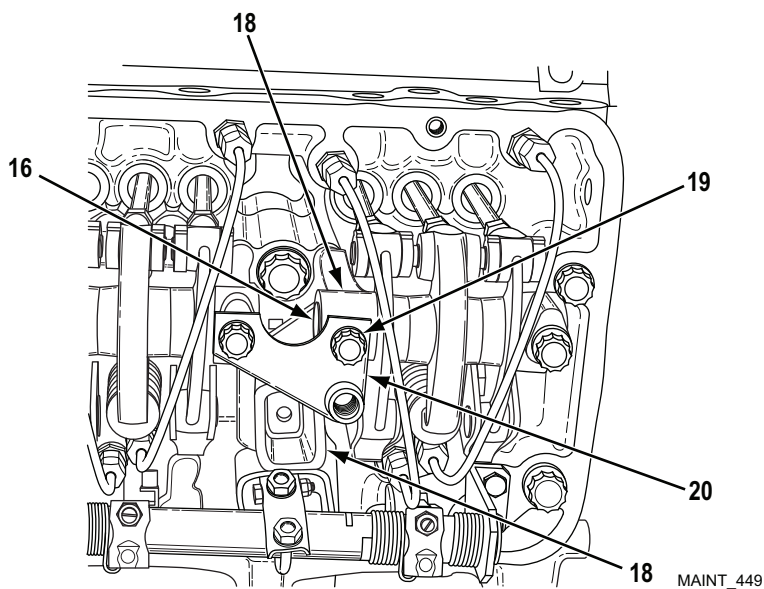


Figure 8. Rear Rocker Arm Shaft Machine Bolt Removal.

7. Remove one machine bolt (Figure 9, Item 21) and eye bracket (Figure 9, Item 20) from adjacent front rocker arm shaft bracket (Figure 9, Item 22) and throttle delay assembly (Figure 9, Item 18).

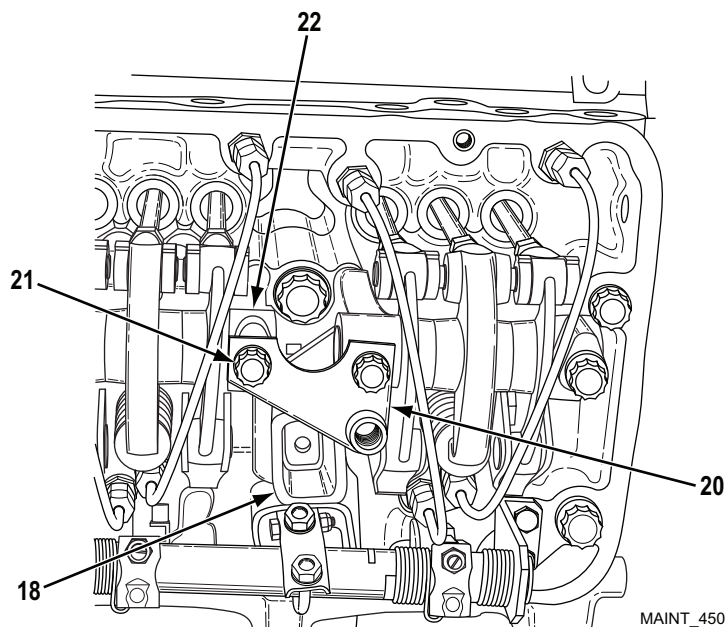


Figure 9. Machine Bolt Removal from Eye Bracket.

**REMOVAL - Continued**

8. Slide rocker arm shaft (Figure 10, Item 16) forward out of front rocker arm shaft bracket (Figure 10, Item 17) until clearing throttle delay assembly (Figure 10, Item 18). Move throttle delay assembly (Figure 10, Item 18) slightly rearward and away from rear exhaust valve rocker arm (Figure 10, Item 3) for clearance.
9. Lift front rocker arm shaft bracket (Figure 10, Item 17), rocker arm shaft (Figure 10, Item 16), two exhaust valve rocker arms (Figure 10, Item 2) and fuel injector rocker arm (Figure 10, Item 3), as a unit, away from cylinder head assembly, exhaust valve stems (Figure 10, Item 5) and fuel injector plunger follower (Figure 10, Item 4). Rotate unit over until three rocker arms (Figure 10, Items 2 and 3) rest upside-down.

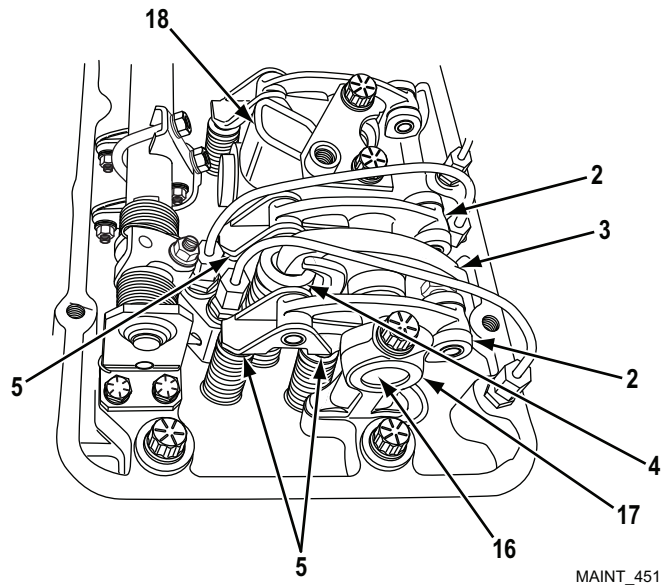


Figure 10. Rocker Arm Unit Lift.

**REMOVAL - Continued****NOTE**

For engine models 5063-5299, 5063-5392, 5063-5393, and 5063-539L: To remove fuel injectors for all cylinders, except #1 on right cylinder head, do Steps 10 through 17.

Mounting/use of eye brackets will vary from one cylinder location to another.

- (1) For cylinder #1 (left cylinder head assembly, only), an eye bracket will be mounted on the rear rocker arm shaft bracket.
- (2) For cylinder #2, an eye bracket will be mounted on both the front and rear rocker arm shaft brackets.
- (3) For cylinder #3, an eye bracket will be mounted on the front rocker arm shaft bracket.

Steps 10 through 14, which follow, pertain to the two (2) eye brackets mounted on the two rocker arm shaft brackets at cylinder #2. Adjust task step procedures as required, for removal/installation of single eye brackets at other cylinders.

10. Remove machine bolt (Figure 11, Item 24) from eye bracket (Figure 11, Item 23), adjacent rear rocker arm shaft bracket (Figure 11, Item 25), and threaded mounting hole in cylinder head assembly.

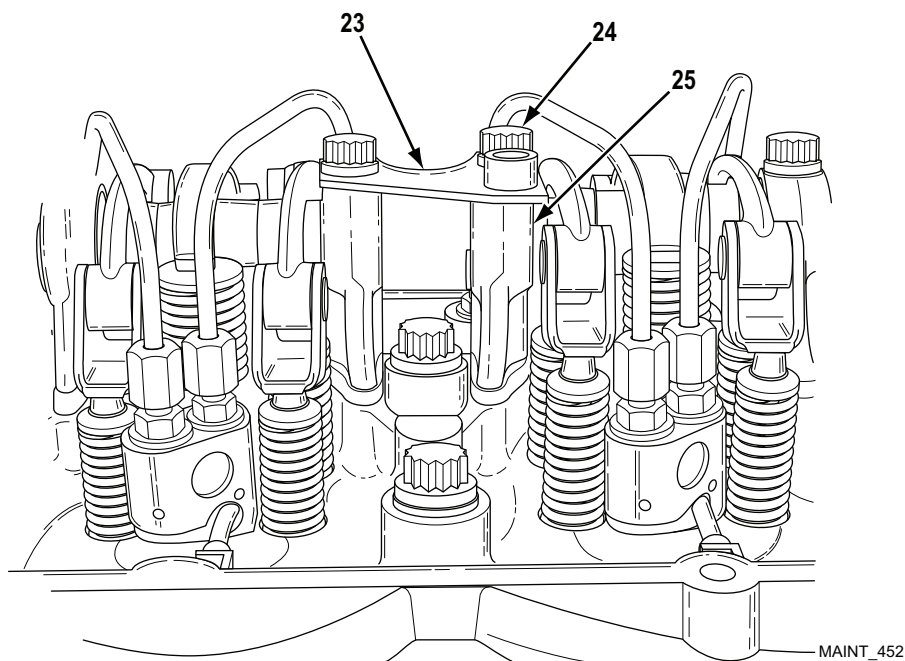


Figure 11. Adjacent Rear Shaft Bracket Machine Bolt Removal.

11. Loosen one machine bolt (Figure 12, Item 27) from eye bracket (Figure 12, Item 23), front rocker arm shaft bracket (Figure 12, Item 26), and rocker arm shaft (Figure 12, Item 28) until free of threaded mounting hole in cylinder head assembly.

REMOVAL - Continued

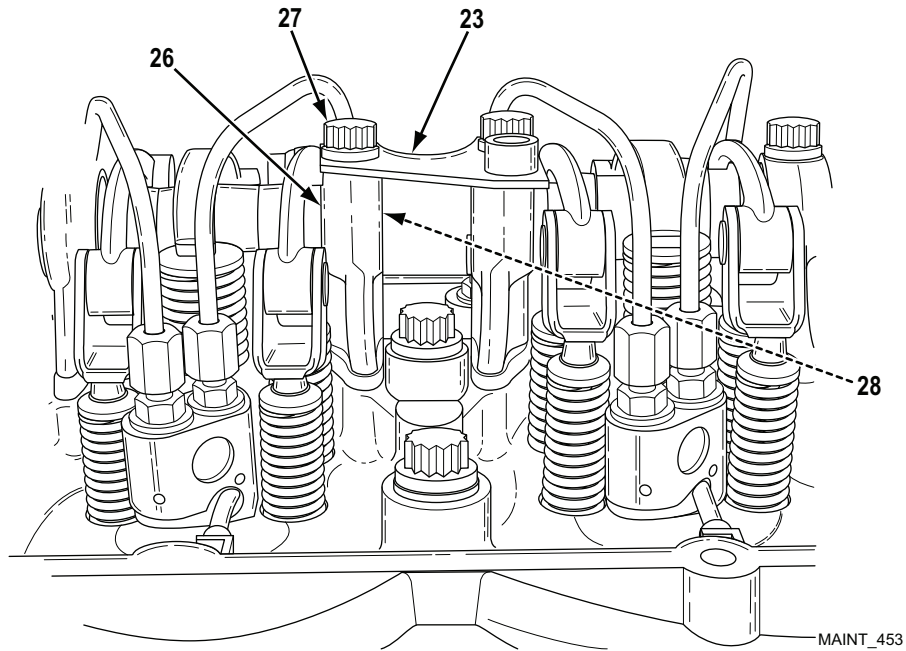


Figure 12. Loosen Front Rocker Arm Shaft Bracket.

12. Remove machine bolt (Figure 13, Item 29) from eye bracket (Figure 13, Item 30), adjacent front rocker arm shaft bracket (Figure 13, Item 31), and threaded mounting hole in cylinder head assembly.

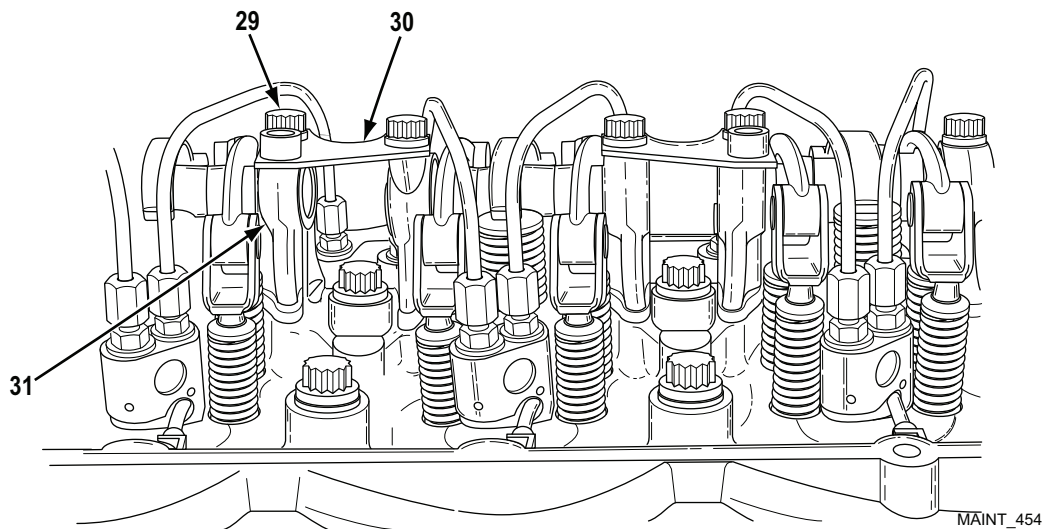


Figure 13. Adjacent Front Shaft Bracket Machine Bolt Removal.



**REMOVAL - Continued**

13. Loosen one machine bolt (Figure 14, Item 30) from eye bracket (Figure 14, Item 32), rear rocker arm shaft bracket (Figure 14, Item 33), and rocker arm shaft (Figure 14, Item 28) until free of threaded mounting hole in cylinder head assembly.

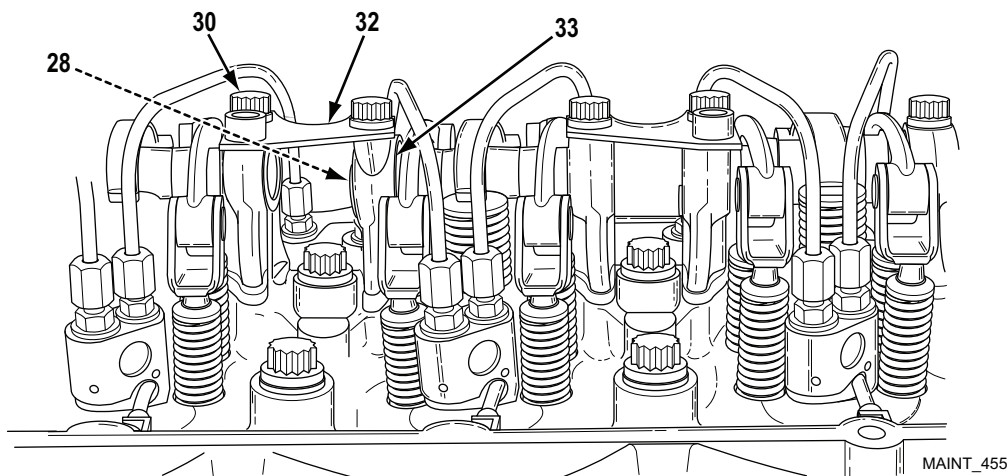


Figure 14. Loosen Rear Rocker Arm Shaft Bracket.

14. Lift two machine bolts (Figure 15, Items 27 and 33), front rocker arm shaft bracket (Figure 15, Item 26), rear rocker arm shaft bracket (Figure 15, Item 34), two eye brackets (Figure 15, Items 23 and 30), rocker arm shaft (Figure 15, Item 28), two exhaust valve rocker arms (Figure 15, Item 2) and fuel injector rocker arm (Figure 15, Item 3), as a unit, away from cylinder head assembly, exhaust valve stems (Figure 15, Item 5) and fuel injector plunger follower (Figure 15, Item 4). Rotate unit over until three rocker arms (Figure 15, Items 2 and 3) rest upside-down.

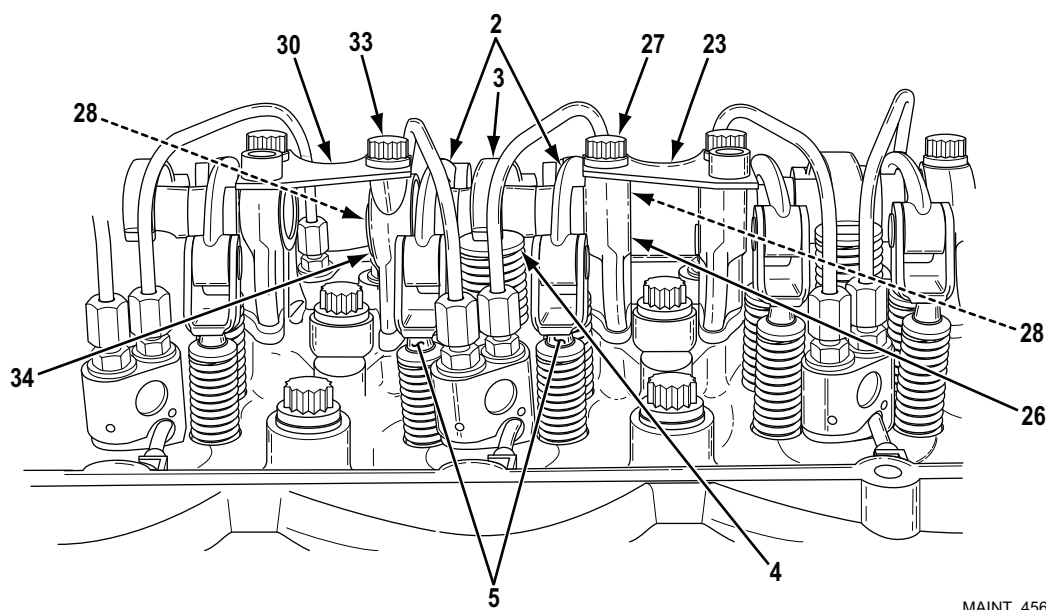


Figure 15. Cylinder #2 Rocker Arm Unit Lift.



**REMOVAL - Continued**

15. Remove hexagon head screw (Figure 16, Item 34), convex washer (Figure 16, Item 35), and fuel injector clamp (Figure 16, Item 36) from cylinder head assembly and fuel injector (Figure 16, Item 1). Discard convex washer (Figure 16, Item 35).

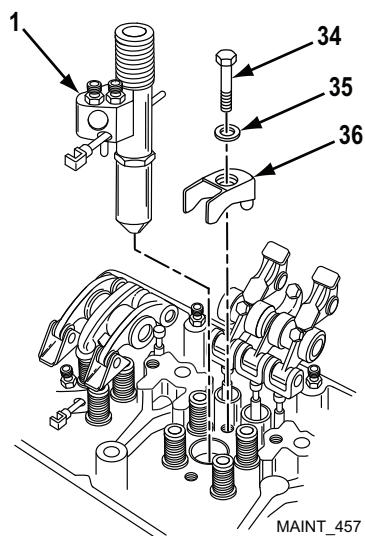


Figure 16. Fuel Injector Clamp Removal.

16. On injector control tube (Figure 17, Item 39), loosen control lever jam-nut and adjusting screw (Figure 17, Item 38) of injector control lever (Figure 17, Item 37). Slide end of control lever (Figure 17, Item 37) out of socket at end of fuel injector control rack (Figure 17, Item 40).

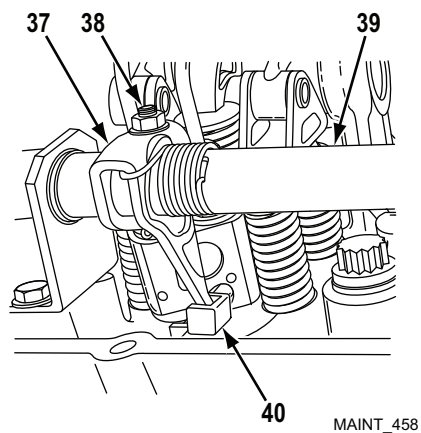


Figure 17. Fuel Injector Rack Disconnect.

**REMOVAL - Continued**

17. Remove fuel injector (Figure 18, Item 1) from fuel injector tube (Figure 18, Item 41) in cylinder head assembly.

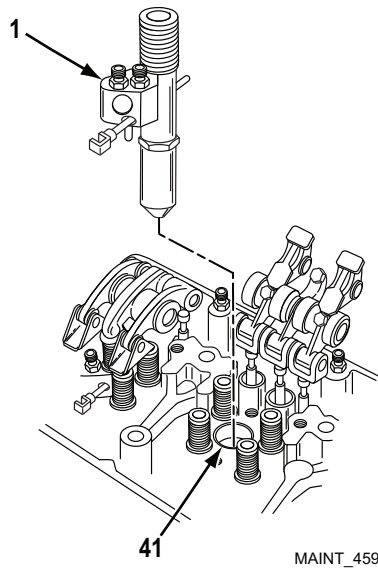


Figure 18. Fuel Injector Removal.

**END OF TASK****CLEANING****CAUTION**

When using the injector tube bevel reamer (J5286-9C) to remove carbon deposits from the fuel injector tube, exercise care to remove only carbon deposits. Using too much force or speed will cut through the thin wall of the fuel injector tube.

**NOTE**

Before installing a fuel injector in cylinder head assembly, remove carbon deposits from beveled seat of the injector tube. This will ensure correct alignment and fit of fuel injector nut and spray nozzle in the injector tube.

Pack the flutes of the reamer (J5286-9C) with grease to retain carbon removed from the injector tube. Rotate the reamer in a clockwise direction only, even when inserting and removing the tool from injector tube.

1. Place a couple drops of cutting oil around bevel seat (Figure 19, Item 43) of injector tube (Figure 19, Item 41).

**CLEANING - Continued**

2. Carefully lower reamer (Figure 19, Item 42) into injector tube (Figure 19, Item 41) until contacting bevel seat (Figure 19, Item 43).
3. Steadily turn reamer (Figure 19, Item 42) in a clockwise rotation without applying any downward force.
4. While maintaining rotation, remove reamer (Figure 19, Item 42) from injector tube (Figure 19, Item 41). Check reamer (Figure 19, Item 42) and injector tube (Figure 19, Item 41) for amount of carbon removed.
5. Remove carbon filled grease from reamer (Figure 19, Item 42) and re-apply clean grease. Repeat Steps 2 through 5 until carbon deposits are removed from bevel seat (Figure 19, Item 43) of injector tube (Figure 19, Item 41).
6. Clean injector tube (Figure 19, Item 41) with solvent and clean wiping rag. Dry with compressed air.

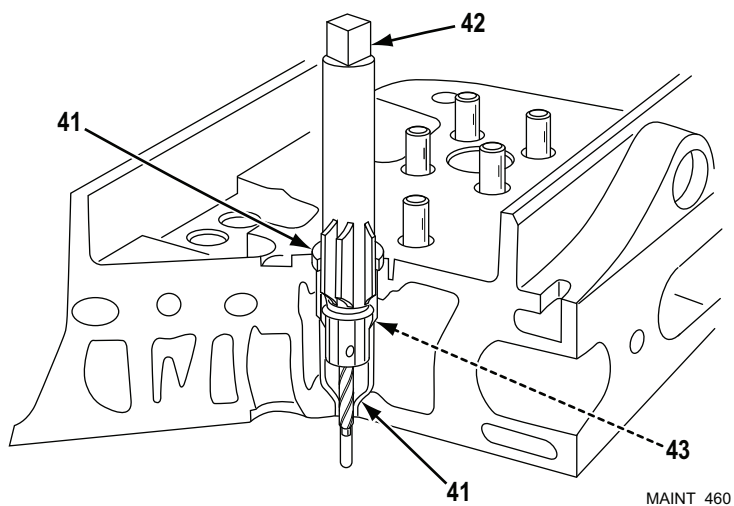


Figure 19. Cleaning Injector Tube.

**END OF TASK**

**INSTALLATION****CAUTION**

Make sure fuel injector clamp does not contact exhaust valve springs or fuel injector follower spring.

1. Align fuel injector (Figure 20, Item 1) with fuel injector tube (Figure 20, Item 41) in cylinder head assembly.
2. Align dowel pin (Figure 20, Item 45) at bottom of fuel injector holder (Figure 20, Item 44) with alignment hole in top of cylinder head assembly.
3. Insert fuel injector (Figure 20, Item 1) into fuel injector tube (Figure 20, Item 41). By hand, check fuel injector and dowel pin (Figure 20, Items 1 and 45) for correct alignment and snug fit.

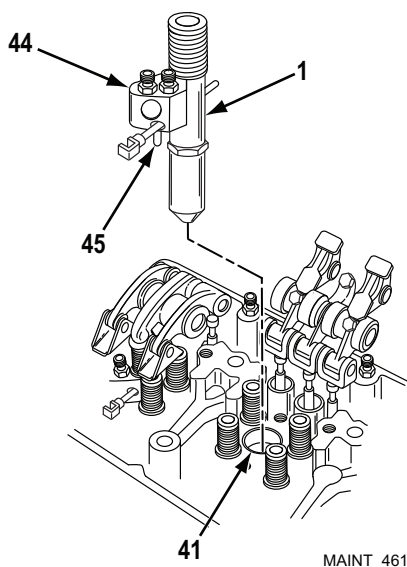


Figure 20. Insert Fuel Injector.

**NOTE**

Position new convex washer on injector clamp with hump-back curved side of convex washer saddled in recessed surface of clamp.

4. Align fuel injector clamp (Figure 21, Item 36) on fuel injector (Figure 21, Item 1) and threaded hole in cylinder head assembly. Install new convex washer (Figure 21, Item 35) and hexagon head screw (Figure 21, Item 34) in fuel injector clamp (Figure 21, Item 36) and threaded hole of cylinder head assembly. Torque hexagon head screw (Figure 21, Item 34) to 20–25 lb-ft (27–34 N·m).

## INSTALLATION - Continued

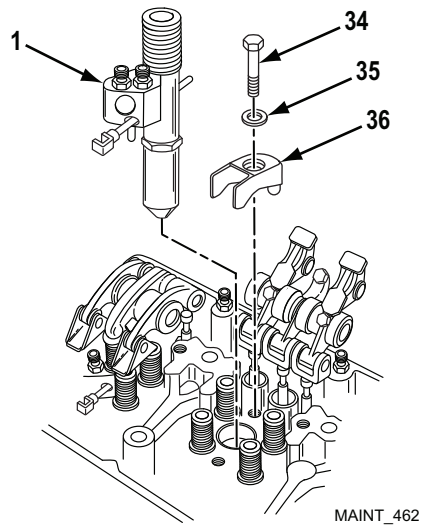


Figure 21. Install Fuel Injector Clamp.

- Slide end of injector control lever (Figure 22, Item 37) into socket at end of fuel injector control rack (Figure 22, Item 40). By hand, loosely tighten control lever adjusting screw (Figure 22, Item 38) on injector control tube (Figure 22, Item 39) just enough to keep ball-end of injector control lever (Figure 22, Item 37) snug in socket at end of fuel injector control rack (Figure 22, Item 40).

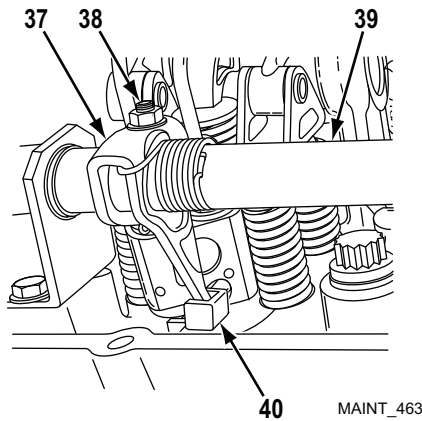


Figure 22. Connect Fuel Injector Rack.

## INSTALLATION - Continued

## NOTE

Throughout the installation steps, refer to placement references and information that was marked and tagged to parts during removal steps.

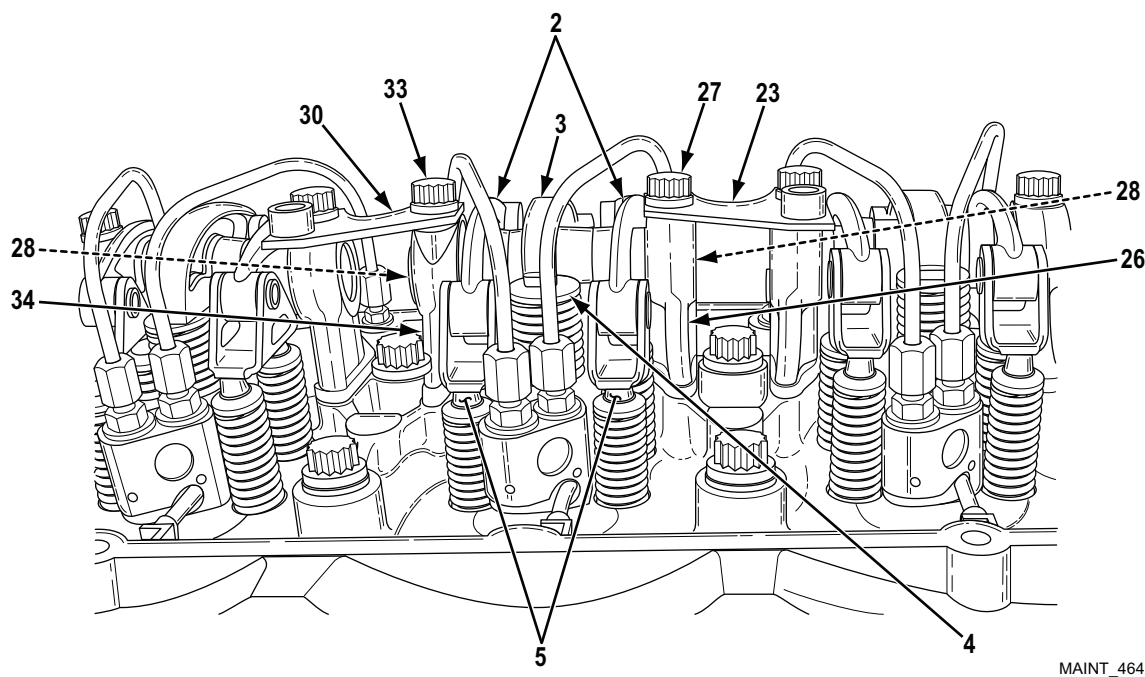
For engine models 5063-5299, 5063-5392, 5063-5393, and 5063-539L: To complete installation of fuel injectors for all cylinders, except #1 on right cylinder head assembly, do Steps 6 through 12 and 22 through 24.

Mounting/use of eye brackets will vary from one cylinder location to another.

- (1) For cylinder #1 (left cylinder head assembly, only), an eye bracket will be mounted on the rear rocker arm shaft bracket.
- (2) For cylinder #2, an eye bracket will be mounted on both the front and rear rocker arm shaft brackets.
- (3) For cylinder #3, an eye bracket will be mounted on the front rocker arm shaft bracket.

Steps 6 through 12, which follow, pertain to the two eye brackets mounted on the two rocker arm shaft brackets at cylinder #2. Adjust task step procedures as required, for installation of single eye brackets at other cylinders.

6. Raise two machine bolts (Figure 23, Items 27 and 33), front rocker arm shaft bracket (Figure 23, Item 26), rear rocker arm shaft bracket (Figure 23, Item 34), two eye brackets (Figure 23, Items 23 and 30), rocker arm shaft (Figure 23, Item 28), two exhaust valve rocker arms (Figure 23, Item 2), and fuel injector rocker arm (Figure 23, Item 3), as a unit, from upside-down position and carefully lower into mounting position on cylinder head assembly, exhaust valve stems (Figure 23, Item 5) and fuel injector plunger follower (Figure 23, Item 4) in the following manner:



MAINT\_464

Figure 23. Cylinder #2 Rocker Arm Unit Reposition.

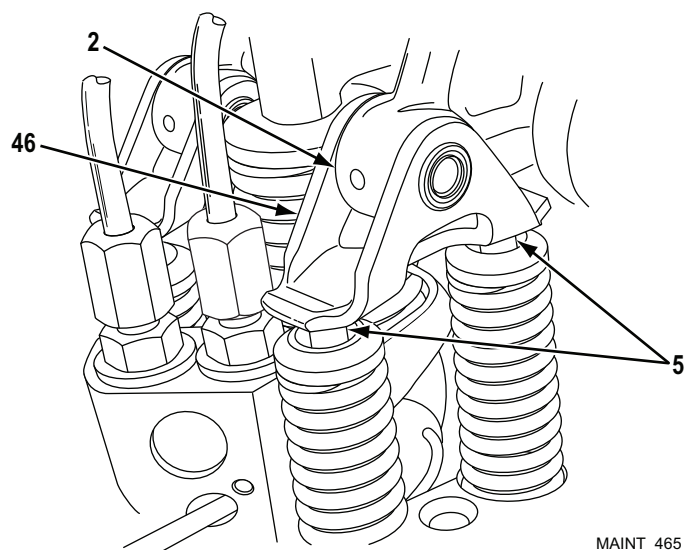
**INSTALLATION - Continued****CAUTION**

Exhaust valves can be damaged if rocker arms are not properly aligned with exhaust valve stems. Each exhaust valve rocker arm controls two exhaust valves. Attached to the end of each exhaust valve rocker arm is a hinged engine poppet bracket ("bridge"). Each end of a "bridge" aligns with the top of a companion/mated exhaust valve stem. When lowering a rocker arm and "bridge" onto a set of two exhaust valve stems, make sure each end of the "bridge" is centered and squarely placed on the top of each exhaust valve stem.

**NOTE**

One exhaust valve rocker with rocker arm bridge is shown.

7. Lower two exhaust valve rocker arms (Figure 24, Item 2) with rocker arm bridges (Figure 24, Item 46) carefully onto two sets of companion/mated exhaust valve stems (Figure 24, Item 5). Make sure both mating ends of rocker arm bridge (Figure 24, Item 46) are centered and squarely positioned on top of each exhaust valve stem (Figure 24, Item 5).



MAINT\_465

Figure 24. Rocker Arm Bridge Alignment at Cylinder #2.

**INSTALLATION - Continued**

8. Lower fuel injector rocker arm (Figure 25, Item 3) onto fuel injector plunger follower (Figure 25, Item 4).
9. Align bases of front rocker arm shaft bracket (Figure 25, Item 26) and rear rocker arm shaft bracket (Figure 25, Item 34) and two machine bolts (Figure 25, Items 27 and 33) with threaded mounting holes in engine cylinder head assembly. Loosely tighten two machine bolts (Figure 25, Items 27 and 33) finger tight.

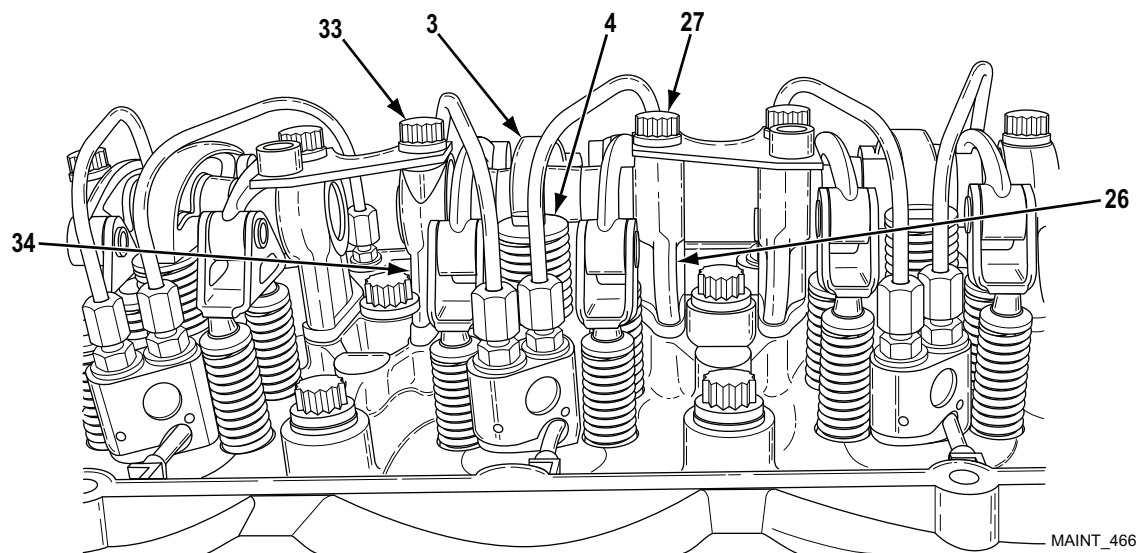


Figure 25. Cylinder #2 Rocker Arm Shaft Brackets Reposition.

10. Align loose end of eye bracket (Figure 26, Item 30) with adjacent front rocker arm shaft bracket (Figure 26, Item 31) and loosely install machine bolt (Figure 26, Item 29). Tighten machine bolt (Figure 26, Item 29) finger tight.

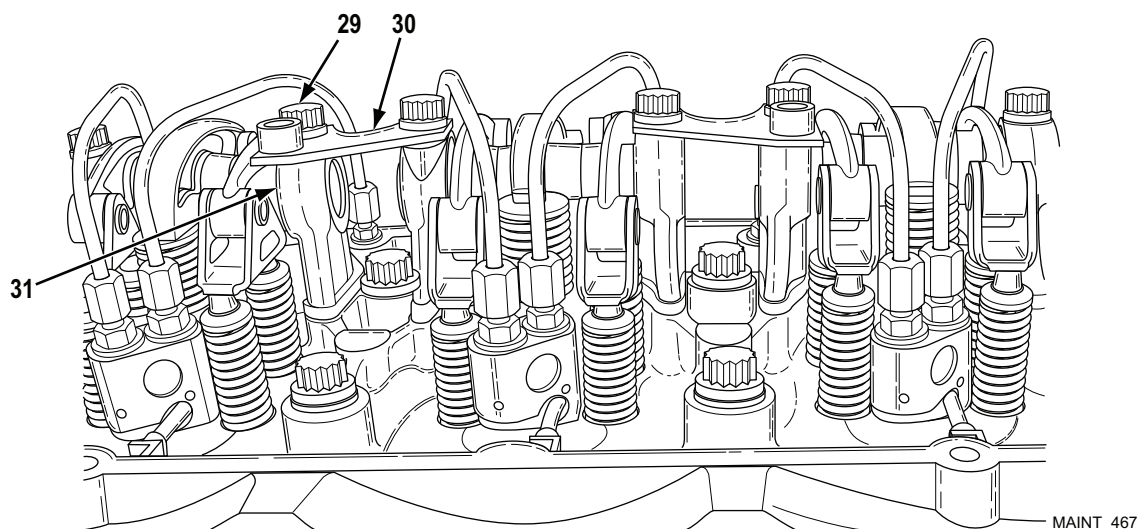


Figure 26. Adjacent Front Shaft Bracket Machine Bolt Installation.



**INSTALLATION - Continued**

11. Align loose end of eye bracket (Figure 27, Item 23) with adjacent rear rocker arm shaft bracket (Figure 27, Item 25) and loosely install machine bolt (Figure 27, Item 24). Tighten machine bolt (Figure 27, Item 24) finger tight.

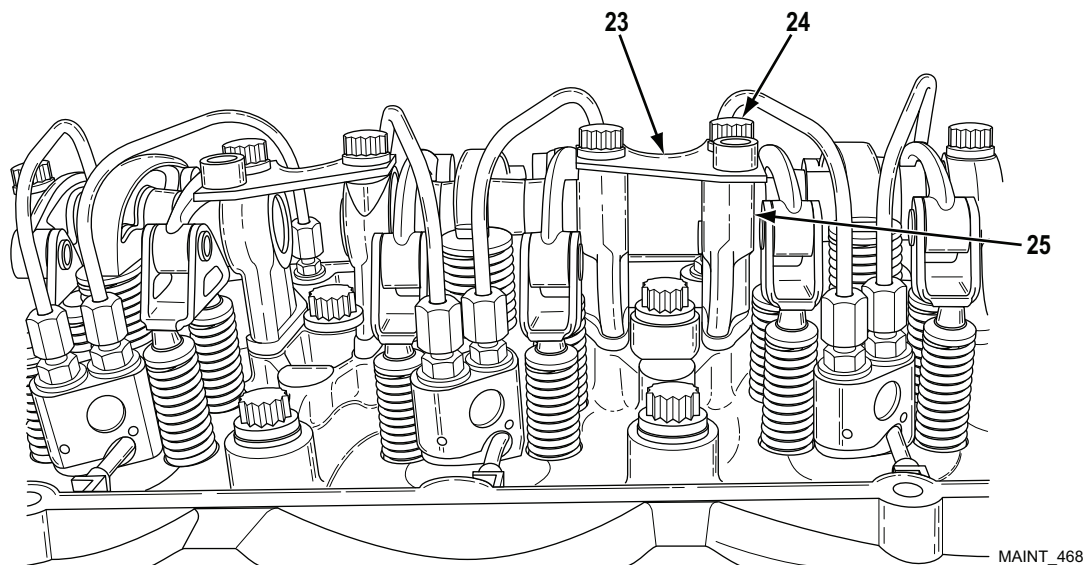


Figure 27. Adjacent Rear Shaft Bracket Machine Bolt Installation.

12. Torque four machine bolts (Figure 28, Items 24, 27, 29, and 32) to 50–55 lb-ft (68–75 N·m).

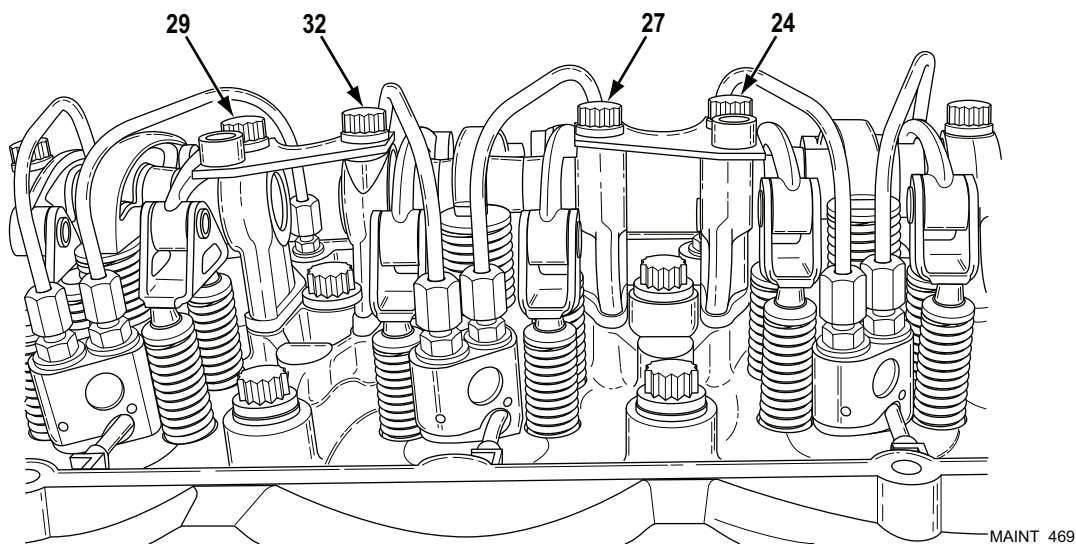


Figure 28. Torque Machine Bolts at Cylinder #2.

**INSTALLATION - Continued****NOTE**

For engine models 5063-5299, 5063-5392, 5063-5393, and 5063-539L: To complete installation of fuel injector for cylinder #1, do Steps 13 through 24.

13. Raise front rocker arm shaft bracket (Figure 29, Item 17), rocker arm shaft (Figure 29, Item 16), two exhaust valve rocker arms (Figure 29, Item 2), and fuel injector rocker arm (Figure 29, Item 3), as a unit, from upside-down position and carefully lower into mounting position on cylinder head assembly, exhaust valve stems (Figure 29, Item 5), and fuel injector plunger follower (Figure 29, Item 4) in the following manner:

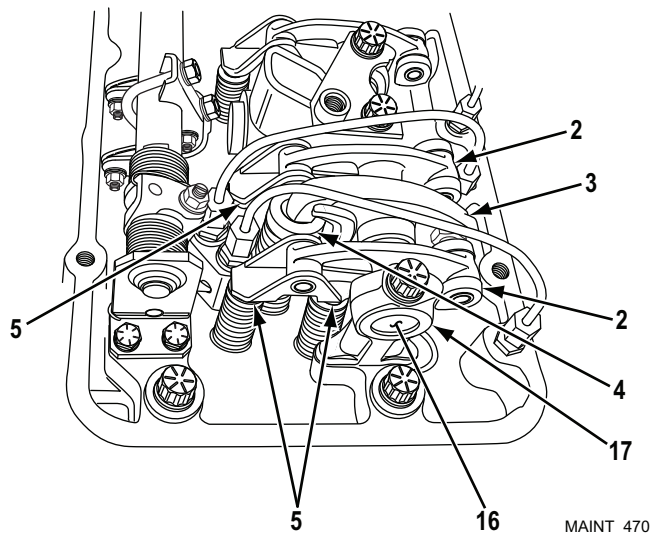


Figure 29. Rocker Arm Unit Reposition.

**INSTALLATION - Continued****CAUTION**

Exhaust valves can be damaged if rocker arms are not properly aligned with exhaust valve stems. Each exhaust valve rocker arm controls two exhaust valves. Attached to the end of each exhaust valve rocker arm is a hinged engine poppet bracket ("bridge"). Each end of a "bridge" aligns with the top of a companion/mated exhaust valve stem. When lowering a rocker arm and "bridge" onto a set of two exhaust valve stems, make sure each end of the "bridge" is centered and squarely placed on the top of each exhaust valve stem.

**NOTE**

One exhaust valve rocker arm with rocker arm bridge is shown.

14. Lower two exhaust valve rocker arms (Figure 30, Item 2) with rocker arm bridges (Figure 30, Item 46) carefully onto two sets of companion/mated exhaust valve stems (Figure 30, Item 5). Make sure both mating ends of rocker arm bridge (Figure 30, Item 46) are centered and squarely positioned on top of exhaust valve stems (Figure 30, Item 5).

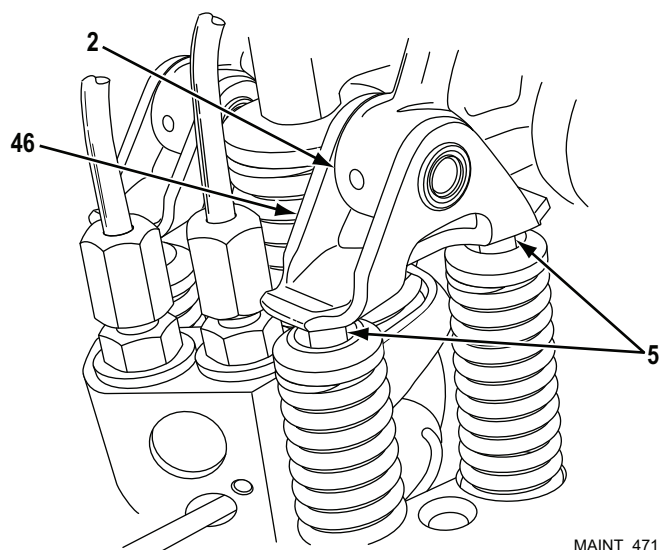


Figure 30. Rocker Arm Bridge Alignment.

**INSTALLATION - Continued**

15. Lower fuel injector rocker arm (Figure 31, Item 3) onto fuel injector plunger follower (Figure 31, Item 4).

**NOTE**

The rocker arm shaft has matched upper and lower through-shaft pathway bolt holes at each end of the shaft. The through-shaft pathway holes must be rotated until aligned with the corresponding vertical through-bolt holes in both the front rocker arm shaft bracket and throttle delay assembly. The mounting/machine bolts cannot be installed if this alignment is not achieved. Pre-align shaft pathway holes with bracket and delay assembly through-bolt holes before fully installing rocker arm shaft.

16. Position throttle delay assembly (Figure 31, Item 18) next to rear exhaust valve rocker arm (Figure 31, Item 2). Align bases of front rocker arm shaft bracket (Figure 31, Item 17) and throttle delay assembly (Figure 31, Item 18) with threaded mounting holes in engine cylinder head assembly.

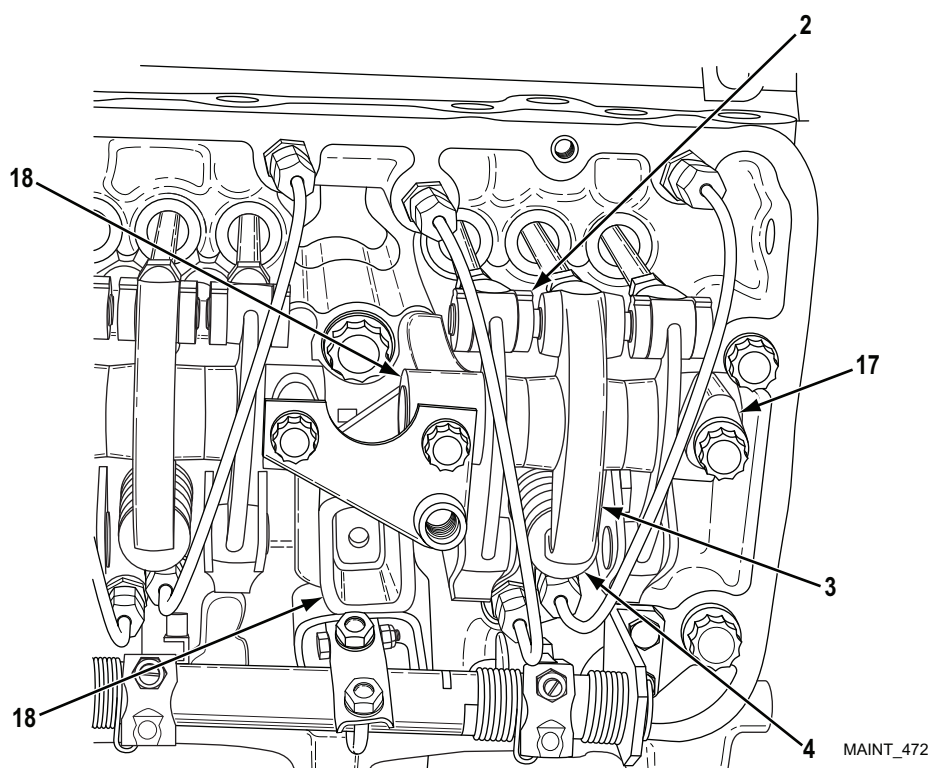


Figure 31. Throttle Delay Assembly Reposition.

**INSTALLATION - Continued**

17. Rotate rocker arm shaft (Figure 32, Item 16) until pathway bolt hole is compatible with through-bolt hole of front rocker arm shaft bracket (Figure 32, Item 17). Slide rocker arm shaft (Figure 32, Item 16) into position through front rocker arm shaft bracket (Figure 32, Item 17), two exhaust valve rocker arms (Figure 32, Item 2), fuel injector rocker arm (Figure 32, Item 3), and throttle delay assembly (Figure 32, Item 18).

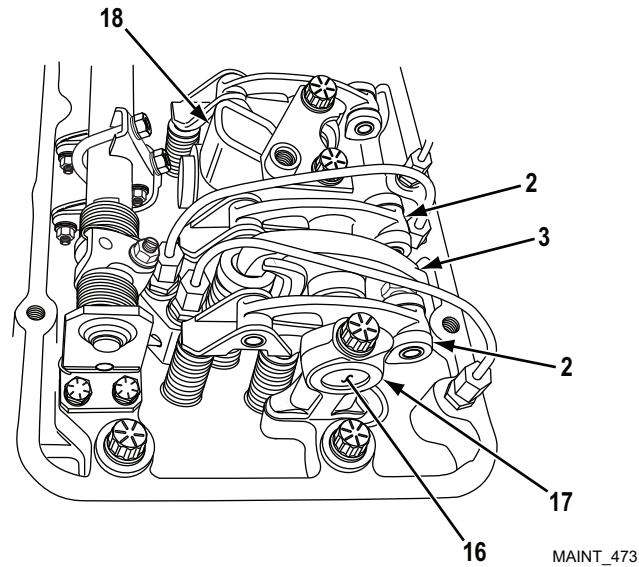


Figure 32. Position Rocker Arm Shaft.

**INSTALLATION - Continued**

- Align rear eye bracket (Figure 33, Item 20) on top of throttle delay assembly (Figure 33, Item 18). Insert machine bolt (Figure 33, Item 19) through eye bracket (Figure 33, Item 20), throttle delay assembly (Figure 33, Item 18), and rocker arm shaft (Figure 33, Item 16) into threaded hole of cylinder head assembly. Tighten machine bolt (Figure 33, Item 19) finger tight.

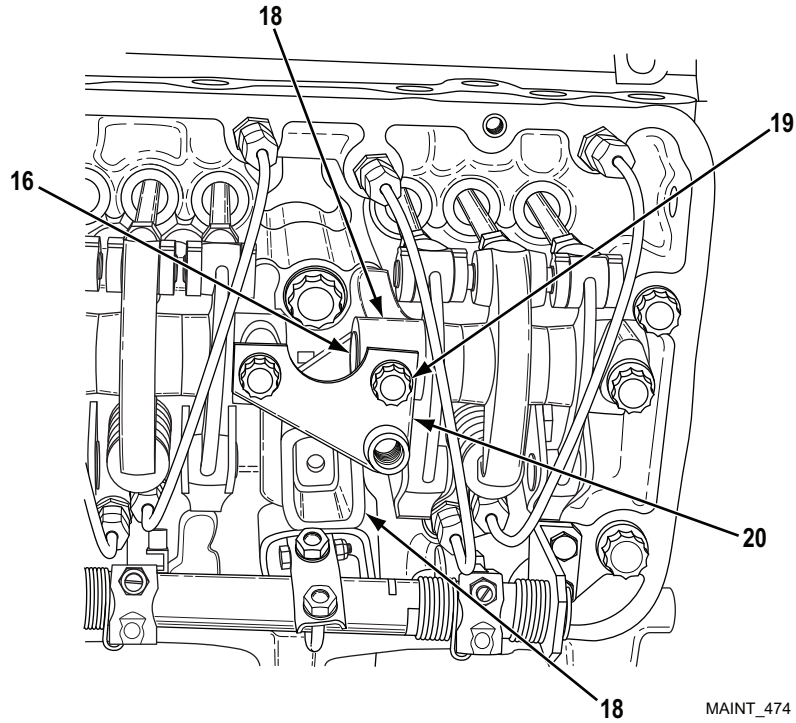


Figure 33. Rear Rocker Arm Shaft Bracket Machine Bolt Installation.

**INSTALLATION - Continued**

19. Insert machine bolt (Figure 34, Item 15) through front rocker arm shaft bracket (Figure 34, Item 17) and rocker arm shaft (Figure 34, Item 16) into threaded hole of cylinder head assembly. Tighten machine bolt (Figure 34, Item 15) finger tight.

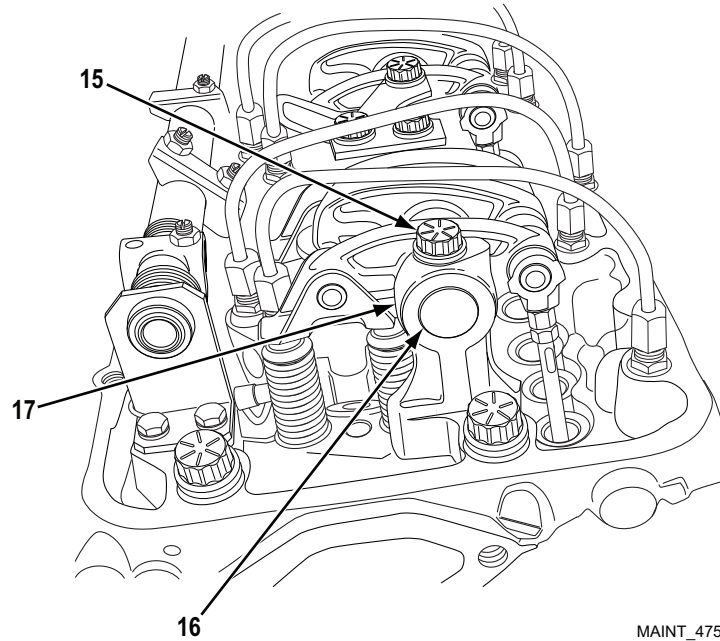


Figure 34. Front Rocker Arm Shaft Bracket Machine Bolt Installation.

**INSTALLATION - Continued**

20. Align loose end of eye bracket (Figure 35, Item 20) with adjacent front rocker arm shaft bracket (Figure 35, Item 22) and loosely install machine bolt (Figure 35, Item 21). Tighten machine bolt (Figure 35, Item 21) finger tight.

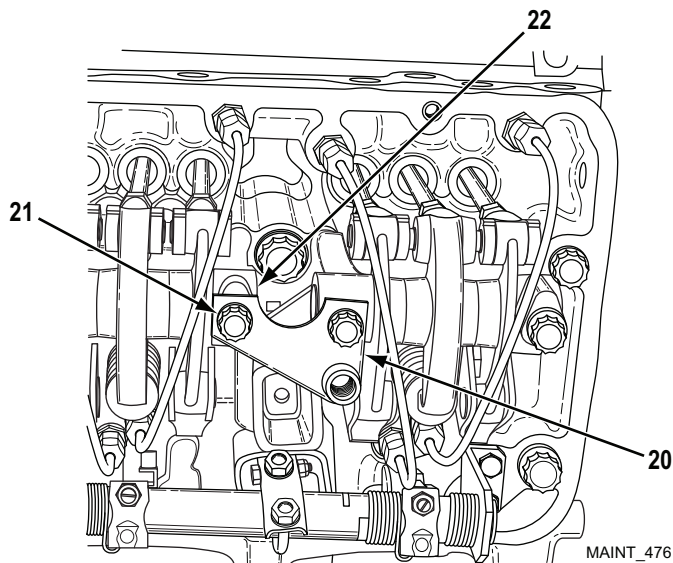


Figure 35. Machine Bolt and Eye Bracket Installation.

21. Torque three machine bolts (Figure 36, Items 15, 19, and 21) to 50–55 lb-ft (68–75 N·m).

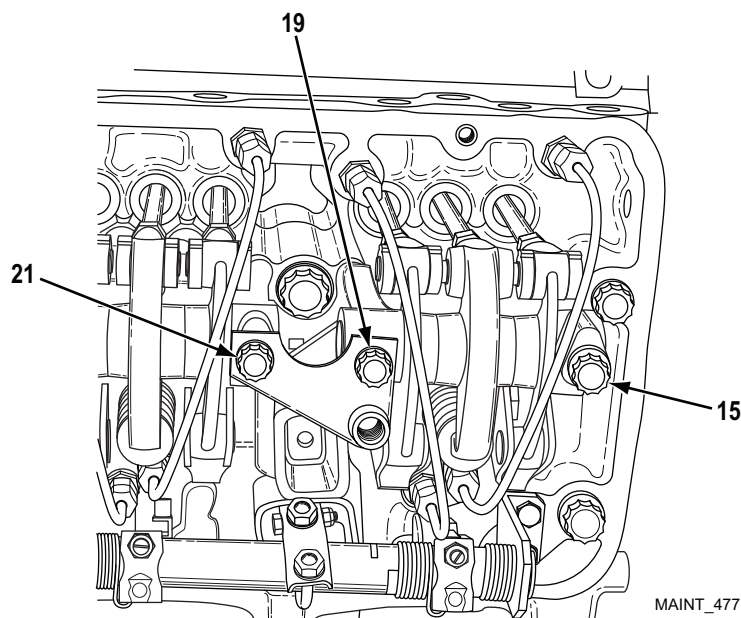


Figure 36. Torque Machine Bolts.



**INSTALLATION - Continued****CAUTION**

Fuel tube assemblies are pre-formed for exacting fit. Do not bend fuel tube assemblies during installation as this may cause the pre-formed radius-bend to crimp or buckle.

Do not over torque the captive nuts on fuel tube assemblies during installation. Excessive tightening will twist or fracture the flared-ends of the fuel tube and cause fuel leaks.

22. Align flared-ends of fuel (return) tube assembly (Figure 37, Item 12) with adapter fitting (Figure 37, Item 14) on fuel injector (Figure 37, Item 1) and fuel (return) nipple (Figure 37, Item 13) on cylinder head assembly. Slide two captive nuts (Figure 37, Item 11) over flared-ends of fuel (return) tube assembly (Figure 37, Item 12) and loosely thread onto adapter fitting (Figure 37, Item 14) and fuel (return) nipple (Figure 37, Item 13).

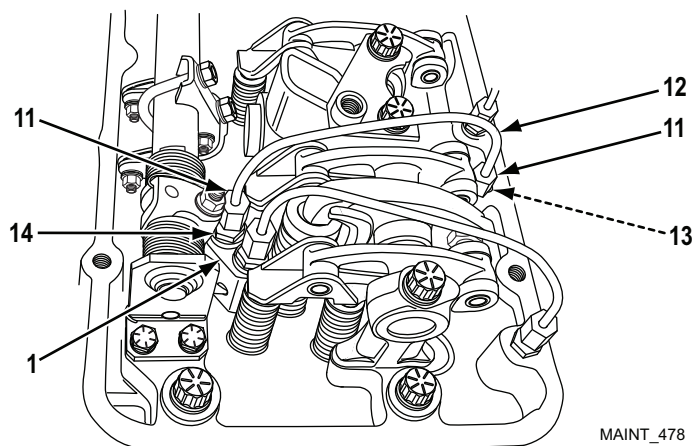


Figure 37. Fuel Return Tube Installation.

**INSTALLATION - Continued**

23. Align flared-ends of fuel (supply) tube assembly (Figure 38, Item 8) with adapter fitting (Figure 38, Item 10) on fuel injector (Figure 38, Item 1) and fuel (supply) nipple (Figure 38, Item 9) on cylinder head assembly. Slide two captive nuts (Figure 38, Item 7) over flared-ends of fuel (supply) tube assembly (Figure 38, Item 8) and loosely thread onto adapter fitting (Figure 38, Item 10) and fuel (supply) nipple (Figure 38, Item 9).

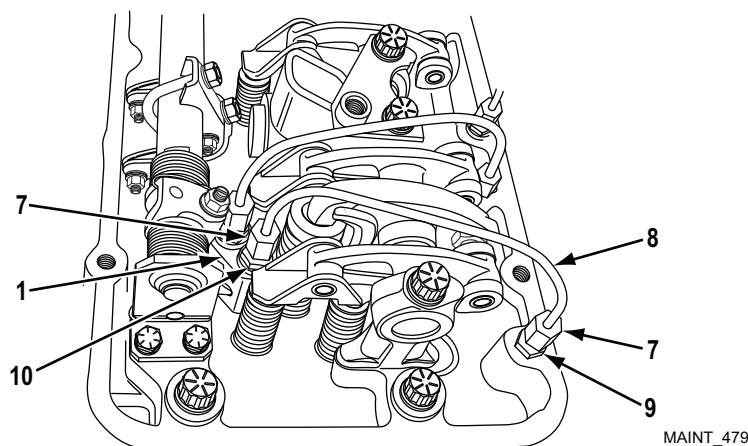


Figure 38. Fuel Supply Tube Installation.

24. At adapter fitting (Figure 39, Item 14), fuel (return) nipple (Figure 39, Item 13), adapter fitting (Figure 39, Item 10), and fuel (supply) nipple (Figure 39, Item 9), torque four captive nuts (Figure 39, Items 7 and 11) to 130–160 lb-in (14.7–18.1 N·m).

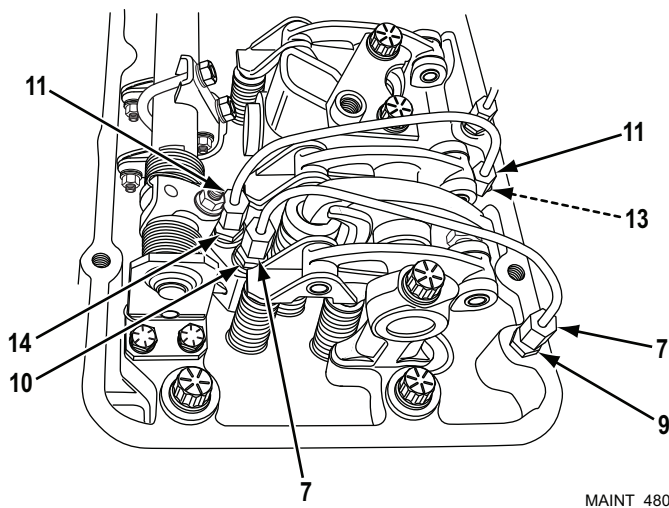


Figure 39. Torque Fuel Tubes Captive Nuts.

**END OF TASK**

**FOLLOW-ON TASK****CAUTION**

When rotating engine crankshaft in clockwise direction, manually hold the fuel shut-off control lever in the fuel shut-off/no fuel position and visually make sure all fuel injector racks are in the no fuel position. Manually rotating the engine crankshaft could create ignition and start the engine.

1. Adjust exhaust valves and fuel injector timing (WP 0078).
2. Adjust fuel injector racks and engine tune-up (WP 0078).
3. Install crankcase breather and rocker arm covers (WP 0052) and (WP 0053).
4. Powerpack removed from maintenance stand (TM 9-2350-277-13&P).
5. Powerpack installed in carrier (TM 9-2350-277-13&P).

**END OF TASK****END OF WORK PACKAGE**



---

**FIELD MAINTENANCE  
FUEL PUMP REPLACEMENT**

---

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

Tool Kit General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition**

Fuel lines removed (model 5063-5392)  
(WP 0050)  
Fuel lines removed  
(models 5063-5393 and 5063-539L)  
(WP 0051)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 91)

---

**REMOVAL**

1. Remove three bolts (Figure 1, Item 5), fuel pump (Figure 1, Item 4), and gasket (Figure 1, Item 3) from flywheel housing. Discard gasket.
2. Remove drive coupling fork (Figure 1, Item 2) from drive adapter (Figure 1, Item 1).

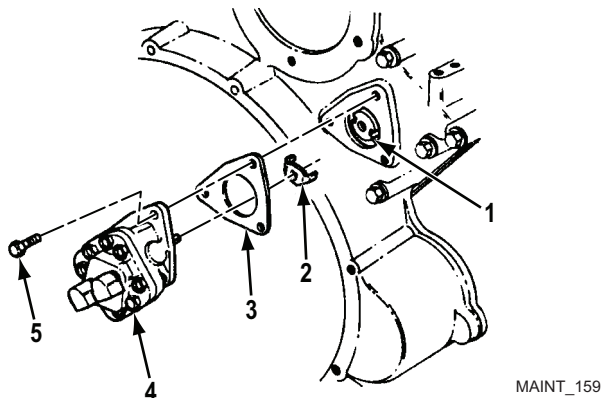


Figure 1. Fuel Pump Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install new gasket (Figure 1, Item 3) on fuel pump (Figure 1, Item 4).
2. Place drive coupling fork (Figure 1, Item 2) on square end of drive shaft.
3. Align drive coupling fork (Figure 1, Item 2) with slots in drive adapter (Figure 1, Item 1) and install fuel pump (Figure 1, Item 4) on flywheel housing with fuel inlet hole in down and inboard position.
4. Install three bolts (Figure 1, Item 5) fastening fuel pump (Figure 1, Item 4) to flywheel housing. Torque bolts to 13–17 lb-ft (18–23 N·m).

**END OF TASK****FOLLOW ON TASK**

1. Install fuel lines (models 5063-5393 and 5063-539L) (WP 0051).
2. Install fuel lines (model 5063-5392) (WP 0050).

**END OF TASK****END OF WORK PACKAGE**

---

**FIELD MAINTENANCE  
AIR INLET HOUSING REPLACEMENT  
(MODEL 5063-5299)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 71)

**Materials/Parts (cont.)**

Screen, Air Inlet (WP 0105, Table 1, Item 68)  
Washer, Lock  
Qty: (9) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Air box heater air line disconnected from air inlet  
elbow (WP 0042)  
Fuel line clip removed (WP 0044)

---

**REMOVAL**

1. Scribe lines between air inlet adapter (Figure 1, Item 1), air inlet housing (Figure 1, Item 11), and blower (Figure 1, Item 9) to assure assembly in same location.
2. Remove four screws (Figure 1, Item 2), four lockwashers (Figure 1, Item 3), four flat washers (Figure 1, Item 4), air inlet adapter (Figure 1, Item 1), and gasket (Figure 1, Item 13) from air inlet housing (Figure 1, Item 11). Discard lockwashers (Figure 1, Item 3) and gasket (Figure 1, Item 13).

**NOTE**

One air inlet housing to blower screw was removed during removal of fuel line clip.

One air inlet housing to blower screw is located inside inlet housing.

3. Remove short screw (Figure 1, Item 5), two long screws (Figure 1, Item 12), two mid-sized screws (Figure 1, Item 8), five lockwashers (Figure 1, Item 6), five flat washers (Figure 1, Item 7), air inlet housing (Figure 1, Item 11), and screen (Figure 1, Item 10) from blower (Figure 1, Item 9). Discard screen (Figure 1, Item 10) and lockwashers (Figure 1, Item 6).

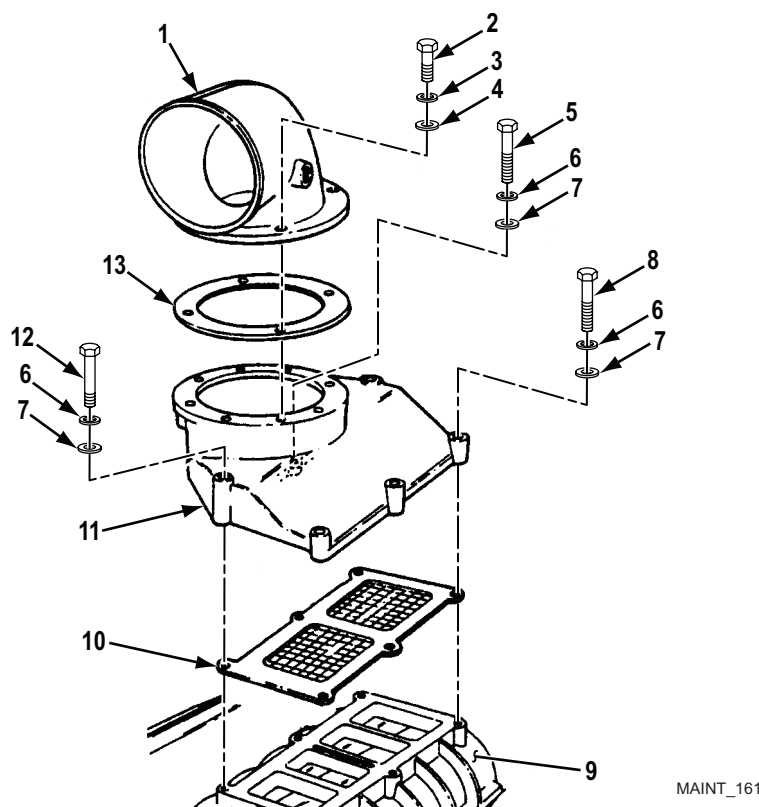
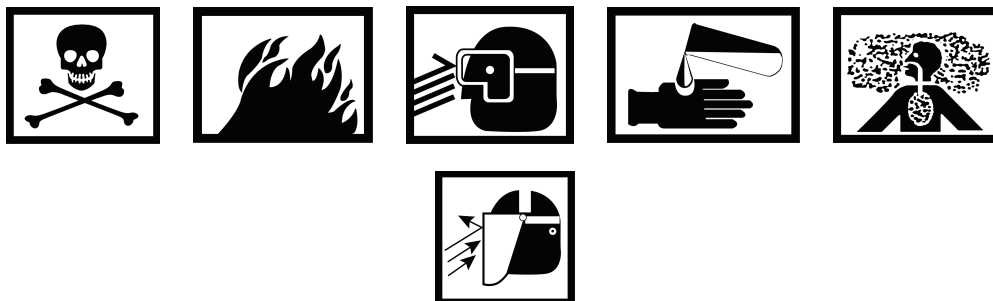


Figure 1. Air Inlet Housing Removal/Installation.

**END OF TASK**



**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean air inlet housing and adapter with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE and REJECTION CRITERIA**

Inspect parts for wear or damage.

**END OF TASK****INSTALLATION**

1. Place new air inlet screen (Figure 1, Item 10) on top of blower (Figure 1, Item 9) with wire side to blower.
2. Install air inlet housing (Figure 1, Item 11), five flat washers (Figure 1, Item 7), five new lockwashers (Figure 1, Item 6), short screw (Figure 1, Item 5), two long screws (Figure 1, Item 12), and two mid-sized screws (Figure 1, Item 8) on blower (Figure 1, Item 9) with inlet opening on left side of engine. Torque screws to 16–20 lb-ft(22–27 N·m).
3. Install new gasket (Figure 1, Item 13) and air inlet adapter (Figure 1, Item 1) on air inlet housing (Figure 1, Item 11) with adapter opening toward rear of engine. Align scribe marks on air inlet housing and adapter. Install four flat washers (Figure 1, Item 4), four new lockwashers (Figure 1, Item 3), and four screws (Figure 1, Item 2). Torque screws to 16–20 lb-ft (22–27 N·m).

**END OF TASK**

**FOLLOW ON TASK**

1. Install fuel line clip (WP 0044).
2. Connect air box heater air line to air inlet elbow (WP 0042).

**END OF TASK****END OF WORK PACKAGE**

---

**FIELD MAINTENANCE  
AIR INLET HOUSING REPLACEMENT  
(MODEL 5063-5392)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition (cont.)**

Fuel line clip removed (WP 0050)  
Angle bracket removed (WP 0043)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Screen, Air Inlet (WP 0105, Table 1, Item 140)  
Washer, Lock  
Qty: (9) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed (WP 0035)

---

**REMOVAL****NOTE**

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

1. Remove nine screws (Figure 1, Item 3), nine lockwashers (Figure 1, Item 4), angle bracket (Figure 1, Item 2), air inlet housing (Figure 1, Item 5), and screen (Figure 1, Item 7) from blower (Figure 1, Item 8). Discard screen and lockwashers.
2. If necessary, remove plug (Figure 1, Item 1) and plug (Figure 1, Item 6) from air inlet housing (Figure 1, Item 5).

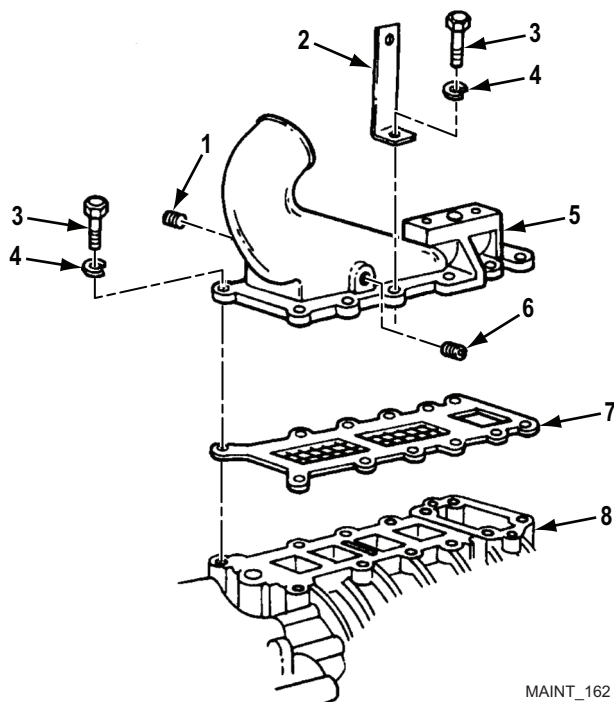
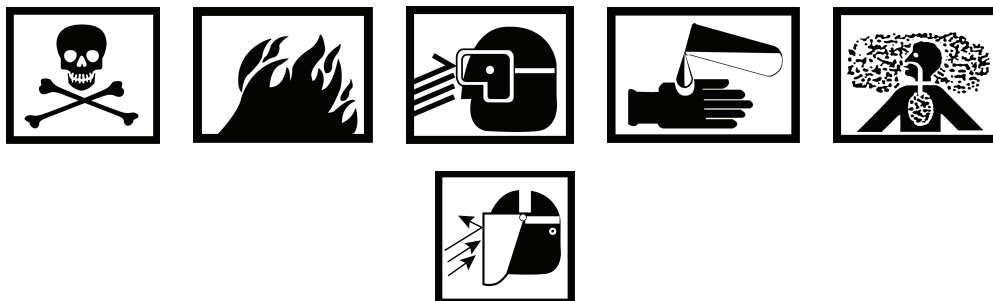


Figure 1. Air Inlet Housing Removal/Installation.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean air inlet housing with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE and REJECTION CRITERIA**

Inspect parts for wear or damage.

**END OF TASK****INSTALLATION****NOTE**

Angle bracket (Figure 1, Item 2) mounts on right side, third hole from rear of air inlet housing.

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

1. Install new screen (Figure 1, Item 7) (with wire side toward blower), angle bracket (Figure 1, Item 2), air inlet housing (Figure 1, Item 5), nine new lockwashers (Figure 1, Item 4), and nine screws (Figure 1, Item 3) on blower (Figure 1, Item 8). Torque screws to 16–20 lb-ft (22–27 N·m).
2. If removed, install plug (Figure 1, Item 1) and plug (Figure 1, Item 6) in air inlet housing (Figure 1, Item 5).

**END OF TASK**

**FOLLOW ON TASK**

1. Install angle bracket (WP 0043).
2. Install fuel line clip (WP 0050).
3. Install turbocharger (WP 0035).

**END OF TASK****END OF WORK PACKAGE**

---

**FIELD MAINTENANCE  
AIR INLET HOUSING REPLACEMENT  
(MODELS 5063-5393, 5063-539L)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition (cont.)**

Fuel line clip removed (WP 0051)  
Angle bracket removed (WP 0044)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Screen, Air Inlet (WP 0105, Table 1, Item 140)  
Washer, Lock  
Qty: (9) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed (WP 0036)

---

**REMOVAL****NOTE**

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

1. Remove four short screws (Figure 1, Item 6), two mid-sized screws (Figure 1, Item 1), three long screws (Figure 1, Item 2), nine lockwashers (Figure 1, Item 3), nine flat washers (Figure 1, Item 4), air inlet housing (Figure 1, Item 9), and screen (Figure 1, Item 7) from blower (Figure 1, Item 8). Discard lockwashers and screen.
2. Remove transducer (Figure 1, Item 5) from air inlet housing (Figure 1, Item 9).

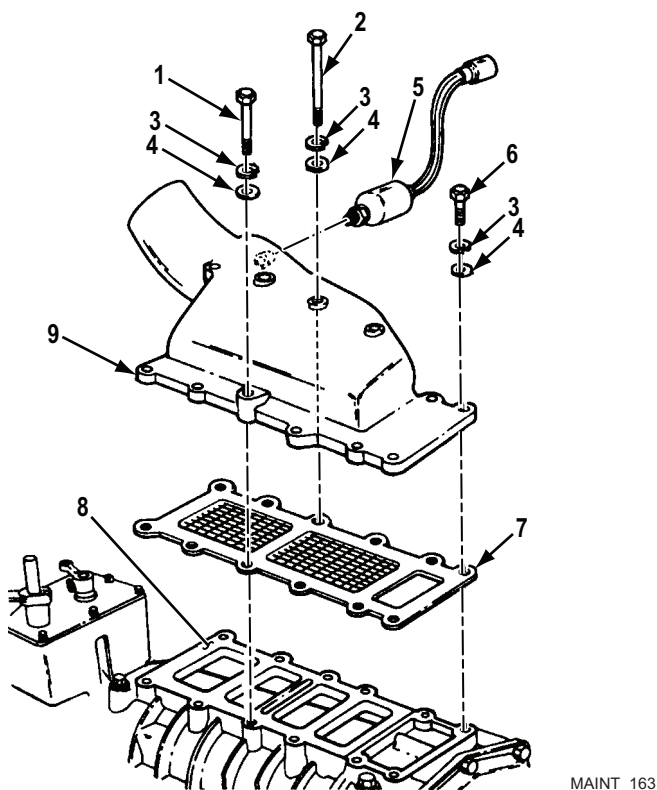
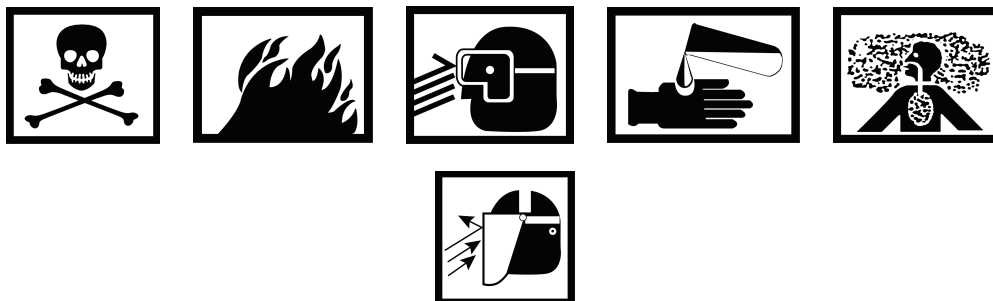


Figure 1. Air Inlet Housing Removal/Installation.

**END OF TASK**



**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean air inlet housing with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE and REJECTION CRITERIA**

Inspect transducer for damaged wires, connector, and threads.

**END OF TASK****INSTALLATION****NOTE**

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

1. Install new screen (Figure 1, Item 7), air inlet housing (Figure 1, Item 9), nine flat washers (Figure 1, Item 4), nine new lockwashers (Figure 1, Item 3), two mid-sized screws (Figure 1, Item 1), three long screws (Figure 1, Item 2), and four short screws (Figure 1, Item 6) on blower (Figure 1, Item 8). Torque screws to 16–20 lb-ft (22–27 N·m).
2. Install transducer (Figure 1, Item 5) in air inlet housing (Figure 1, Item 9).

**END OF TASK**

**FOLLOW ON TASK**

1. Install angle bracket (WP 0044).
2. Install fuel line clip (WP 0051).
3. Install turbocharger (WP 0036).

**END OF TASK****END OF WORK PACKAGE**

---

**FIELD MAINTENANCE  
TACHOMETER DRIVE REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Alignment Tool, Tachometer  
(WP 0104, Table 1, Item 9)

**Materials/Parts**

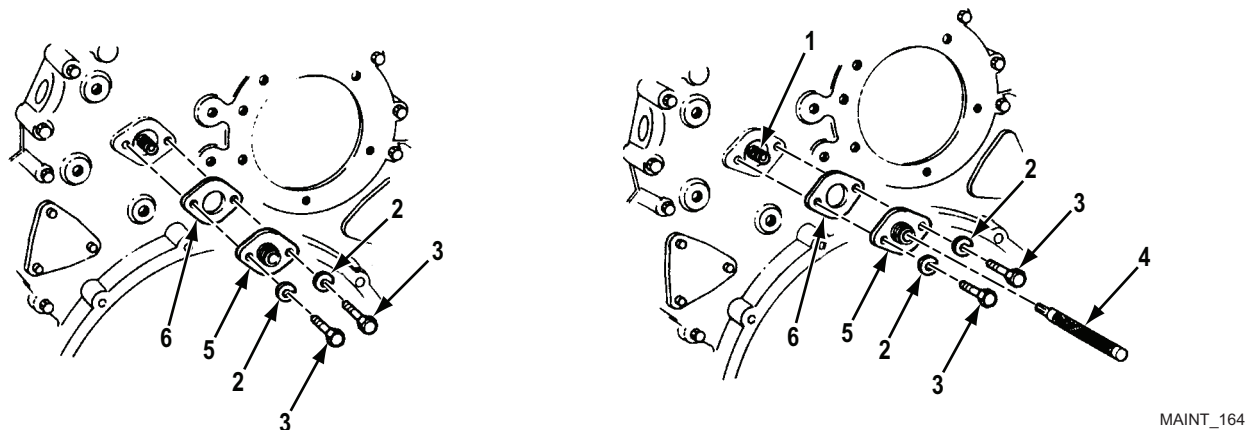
Gasket (WP 0105, Table 1, Item 81)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 178)

---

**REMOVAL****CAUTION**

Use care when removing tachometer adapter. Tachometer drive shaft is fragile and subject to breakage.

Remove two bolts (Figure 1, Item 3), two lockwashers (Figure 1, Item 2), tachometer adapter (Figure 1, Item 5), and gasket (Figure 1, Item 6) from flywheel housing. Discard lockwashers and gasket.



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Figure 1. Tachometer Drive Replacement Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install new gasket (Figure 1, Item 6), tachometer adapter (Figure 1, Item 5), two new lockwashers (Figure 1, Item 2), and two bolts (Figure 1, Item 3) on flywheel housing. Do not tighten bolts.
2. Insert tachometer alignment tool (Figure 1, Item 4) into tachometer adapter (Figure 1, Item 5) and over end of drive shaft (Figure 1, Item 1). Adjust adapter so there is no drive shaft binding on inside diameter of tachometer alignment tool when crankshaft is rotated one revolution.
3. Torque bolts (Figure 1, Item 3) to 13–17 lb-ft (18–23 N·m).
4. Remove tachometer alignment tool (Figure 1, Item 4) from tachometer adapter (Figure 1, Item 5).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**BLOWER DRIVE SUPPORT AND GOVERNOR WEIGHT ASSEMBLY REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Spacer, Governor Weight  
(WP 0104, Table 1, Item 98)  
Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Gasket (WP 0105, Table 1, Item 31)

**Materials/Parts (cont.)**

Gasket (WP 0105, Table 1, Item 66)  
Grease (WP 0103, Table 1, Item 18)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Plug, Cup (WP 0105, Table 1, Item 158)  
Sealing Compound (WP 0103, Table 1, Item 52)  
Washer, Flat Qty: (2) (WP 0105, Table 1, Item 96)

**Equipment Condition**

Right exhaust tube removed  
(models 5063-5393 and 5063-539L)  
(WP 0038)

---

**REMOVAL**

1. Remove four screws (Figure 1, Item 6), four flat washers (Figure 1, Item 5), blower drive cover (Figure 1, Item 7), and gasket (Figure 1, Item 8) from blower drive support assembly (Figure 1, Item 11). Discard gasket.
2. Remove retaining ring (Figure 1, Item 9) and pull blower drive shaft (Figure 1, Item 10) from blower drive support assembly (Figure 1, Item 11).
3. Remove two screws (Figure 1, Item 4) and two copper flat washers (Figure 1, Item 3) fastening blower drive support assembly (Figure 1, Item 11) to flywheel housing. Pull assembly until splined end of drive shaft (Figure 1, Item 12) is free from drive plate. Turn assembly slightly so serrated end of governor weight shaft will pass around governor operating fork (Figure 1, Item 2). Discard copper flat washers.
4. Remove gasket (Figure 1, Item 13) from flywheel housing (Figure 1, Item 1). Discard gasket.

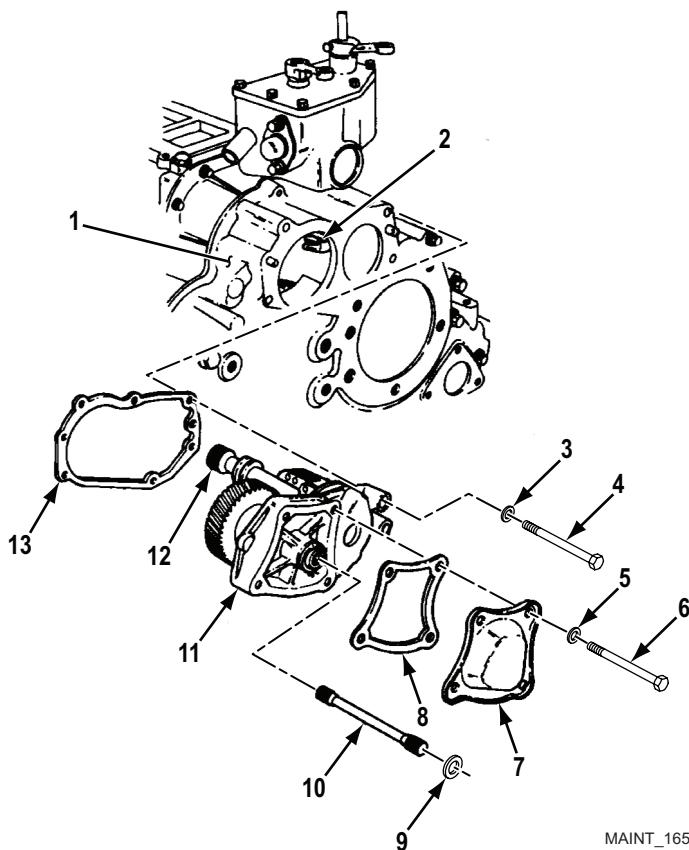
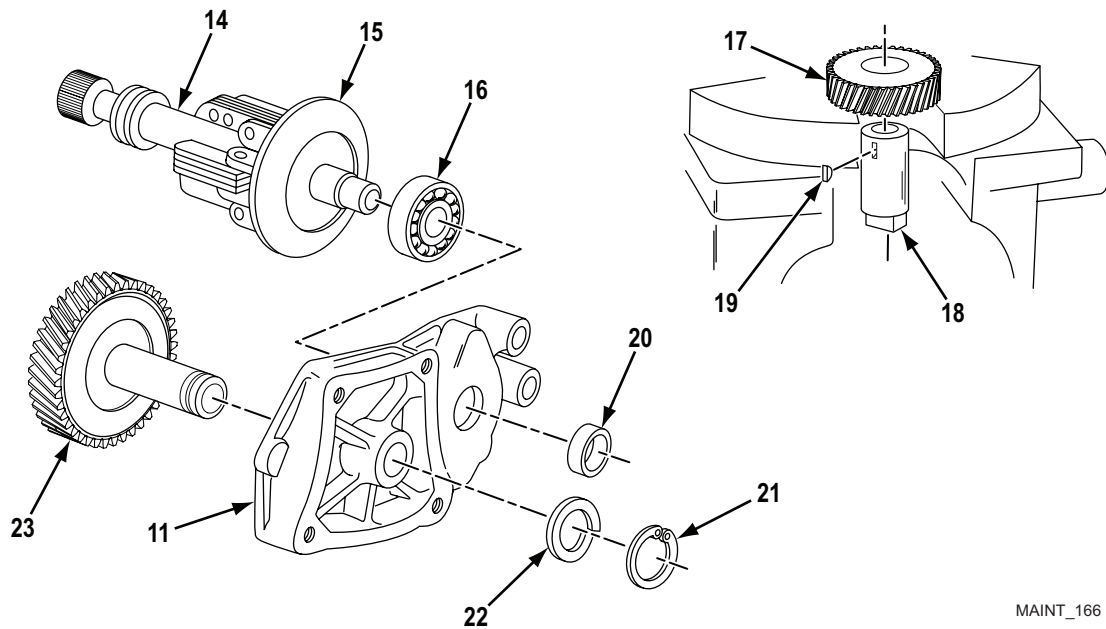


Figure 1. Blower Drive Support Removal.

**END OF TASK**

**DISASSEMBLY**

1. Blower drive support assembly procedures:
  - a. Remove governor weight shaft (Figure 2, Item 14) and carrier assembly (Figure 2, Item 15) from blower drive support assembly (Figure 2, Item 11) using pry bars if necessary.
  - b. Remove retaining ring (Figure 2, Item 21) and thrust washer (Figure 2, Item 22). Slide blower drive gear and shaft assembly (Figure 2, Item 23) from blower drive support assembly (Figure 2, Item 11).
  - c. Remove cup plug (Figure 2, Item 20) from blower drive support assembly (Figure 2, Item 11). Discard cup plug.
  - d. Tap governor weight shaft bearing (Figure 2, Item 16) from blower drive support assembly (Figure 2, Item 11). If bearing is a tight fit, place a spacer against bearing and press from drive support.
2. Blower drive gear and shaft assembly procedures:
  - a. Support blower drive gear and shaft assembly.
  - b. Place 1-1/8 inch diameter brass drift on end of shaft (Figure 2, Item 18) and press shaft out of gear (Figure 2, Item 17).
  - c. Remove key (Figure 2, Item 19) from shaft (Figure 2, Item 18).



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Figure 2. Blower Drive Support Disassembly.

**DISASSEMBLY - Continued**

3. Governor weight shaft and carrier assembly procedures:
  - a. Remove four retaining rings (Figure 3, Item 26) from four weight pins (Figure 3, Item 25).
  - b. Drive four weight pins (Figure 3, Item 25) out of carrier assembly (Figure 3, Item 15) by tapping on punch held against grooved end of pin. Remove two low speed weights (Figure 3, Item 24) and two high speed weights (Figure 3, Item 29).
  - c. Press shaft (Figure 3, Item 12) and governor riser assembly (Figure 3, Item 28) from carrier (Figure 3, Item 27).

**NOTE**

Do not remove bearing from riser since it is serviced only as an assembly.

- d. Slide governor riser assembly (Figure 3, Item 28) from shaft (Figure 3, Item 12).

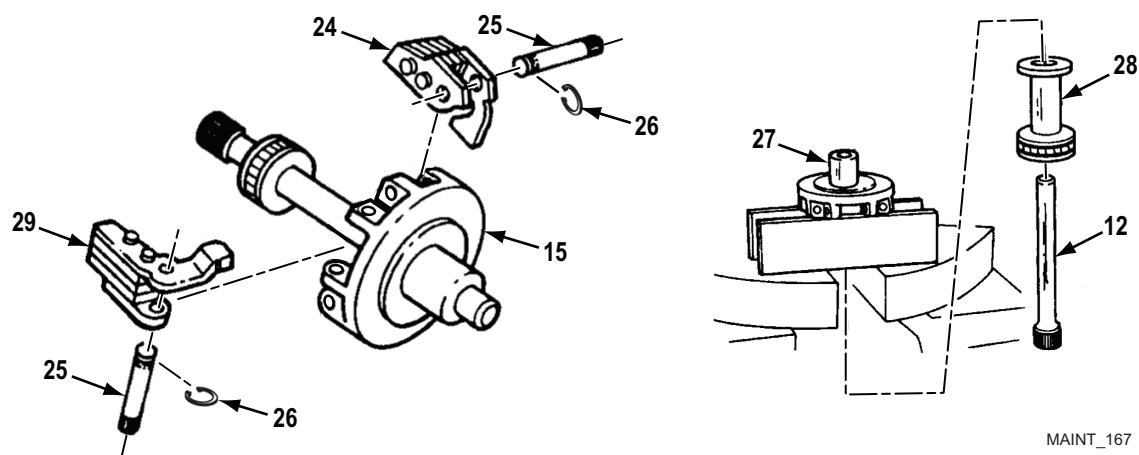
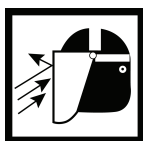


Figure 3. Governor Weight Shaft Disassembly.

**END OF TASK****CLEANING****WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash all parts in fuel oil and dry them with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE and REJECTION CRITERIA**

1. Inspect all bearings. Revolve ball bearing slowly by hand and observe rough or tight spots. Replace if this condition exists. Replace bearings if corroded or pitted.
2. Inspect gear teeth for evidence of scoring, pitting, burning, or wear.
3. Examine blower drive support thrust washer for scoring and wear. Thickness of new thrust washer is 0.093 to 0.103 inch (2.36 to 2.62 mm).
4. Inspect serrations on blower drive shaft and governor weight shaft. If excessive backlash is felt when shaft is inserted into mating part, install new shaft.
5. Inspect outside diameter of blower drive gear shaft and mating inside diameter of drive support for scoring and wear.
6. Examine weight carrier, weights, and pins. Replace worn parts.

**END OF TASK**

**ASSEMBLY**

1. Governor weight shaft and carrier assembly procedures:
  - a. Lubricate governor weight shaft (Figure 4, Item 12) with engine oil and slide governor riser assembly (Figure 4, Item 28) over shaft with bearing end toward serrated end of shaft. Pack bearing (Figure 4, Item 30) with grease.
  - b. Using governor weight spacer (Figure 4, Item 31), press weight shaft (Figure 4, Item 12) into carrier (Figure 4, Item 15). Spacer will properly position carrier on shaft.

**NOTE**

Governor high speed weights are identified by long cam arm and low speed weights are identified by short cam arm.

- c. Place two low speed weights (Figure 4, Item 24) on opposite sides of carrier assembly (Figure 4, Item 15). Drive grooved end of two weight pins (Figure 4, Item 25) through larger hole in carrier, through weight, and then through smaller hole in carrier. Drive knurled end of pin until groove is clear of carrier assembly.
- d. Install two retainer rings (Figure 4, Item 26) on two weight pins (Figure 4, Item 25).
- e. Install two high speed weights (Figure 4, Item 29) in same manner as installing low speed weights. Refer to Steps 1.c.–1.d..

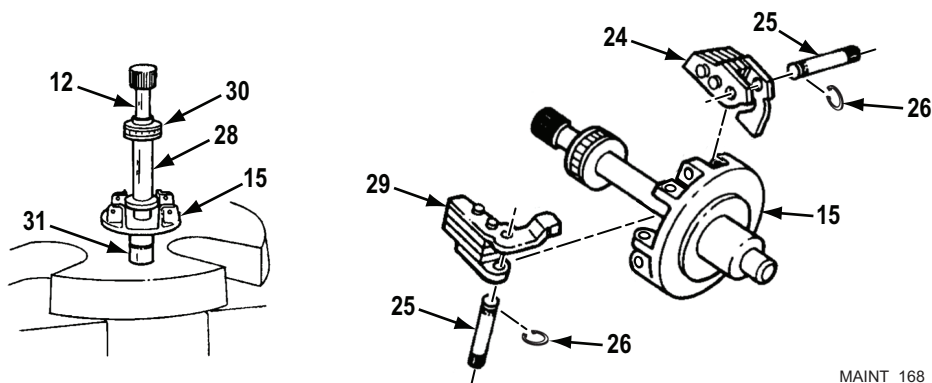


Figure 4. Governor Weight Shaft Assembly.

2. Blower drive support assembly procedures:
  - a. Lubricate drive gear shaft (Figure 5, Item 18) with engine oil and install in blower drive support assembly (Figure 5, Item 11).
  - b. Install thrust washer (Figure 5, Item 22) and retaining ring (Figure 5, Item 21) on end of blower drive gear shaft (Figure 5, Item 18).
  - c. Install key (Figure 5, Item 19) in shaft (Figure 5, Item 18).
  - d. Support blower drive support assembly (Figure 5, Item 11). Lubricate inside diameter of blower drive gear (Figure 5, Item 17) and start gear straight on shaft (Figure 5, Item 18), with keyway in gear aligned with key in shaft. Place governor weight spacer (Figure 5, Item 31) over gear and press gear on shaft until there is 0.004 to 0.012 inch (0.10 to 0.30 mm) clearance between gear and drive support.
  - e. Support blower drive support assembly (Figure 5, Item 11), with inner face up. Place governor weight shaft bearing (Figure 5, Item 16), numbered side up, on bore of drive support. Using a sleeve against outer race, press bearing against shoulder of blower drive support.

**ASSEMBLY - Continued**

- f. Place support under inner race of governor weight shaft bearing (Figure 5, Item 16). Start weight end of governor weight shaft (Figure 5, Item 12) into bearing. Press shaft until shoulder on shaft contacts inner race of bearing.
- g. Apply sealing compound to edge of new cup plug (Figure 5, Item 20). Press plug into blower drive support assembly (Figure 5, Item 11) until flush with support.
- h. Check clearance between fully extended governor weights (Figure 5, Items 24 and 29) and drive gear (Figure 5, Item 17). Clearance must be greater than 0.100 inch.

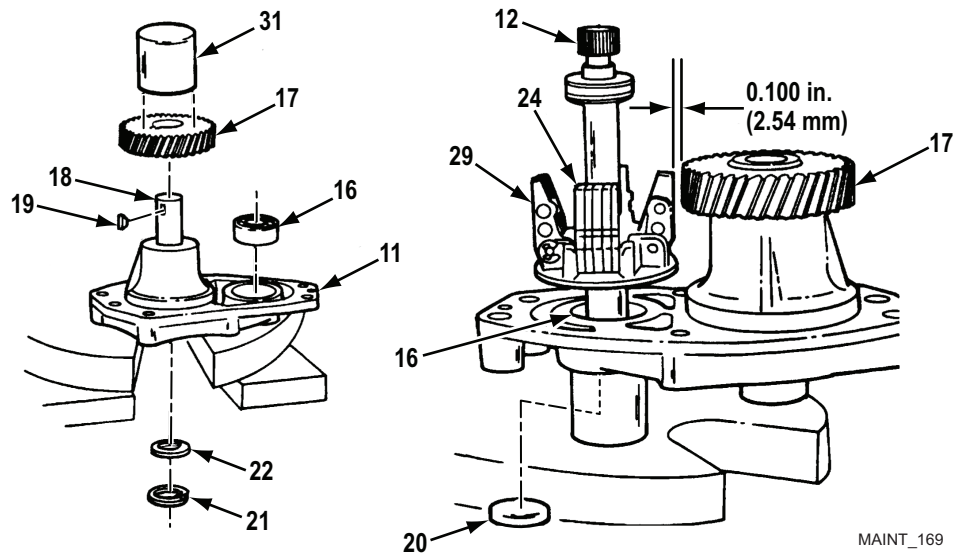


Figure 5. Blower Drive Support Assembly.

**END OF TASK**

**INSTALLATION****NOTE**

Ensure blower to cylinder block bolts are loose before installing blower drive support.

1. Install blower drive support assembly to engine as follows:
  - a. Using gasket adhesive, affix new gasket (Figure 6, Item 13) to blower drive support assembly (Figure 6, Item 11).
  - b. Place high speed governor weights (Figure 5, Item 29) in horizontal position to provide clearance. Position operating shaft fork (Figure 6, Item 2) away from blower for additional clearance.
  - c. Insert blower drive assembly (Figure 6, Item 11) in flywheel housing (Figure 6, Item 1) until drive gear (Figure 6, Item 17) enters housing. Turn drive assembly until serrated end of weight shaft (Figure 6, Item 12) passes around operating fork (Figure 6, Item 2) and fork is between serrated end of shaft and riser bearing (Figure 6, Item 30).
  - d. Push blower drive support assembly (Figure 6, Item 11) up against flywheel housing. Mesh serrated end of weight shaft (Figure 6, Item 12) with governor drive plate, and mesh blower drive gear (Figure 6, Item 17) with camshaft gear.
2. Install two new copper flat washers (Figure 6, Item 3) and two screws (Figure 6, Item 4) on small end of blower drive support assembly (Figure 6, Item 11) into flywheel housing. Torque bolts to 20–24 lb-ft (27–33 N·m).
3. Insert blower drive shaft (Figure 6, Item 10) into blower gear shaft (Figure 6, Item 18). If necessary, rotate camshaft until serrations on blower drive shaft align with serrations in blower drive cam and blower drive gear shaft.
4. Install retaining ring (Figure 6, Item 9) into blower drive gear shaft (Figure 6, Item 18).
5. Install new gasket (Figure 6, Item 8), cover (Figure 6, Item 7), four flat washers (Figure 6, Item 5), and four screws (Figure 6, Item 6) on blower drive support assembly (Figure 6, Item 11). Torque screws to 20–24 lb-ft (27–33 N·m).

## INSTALLATION - Continued

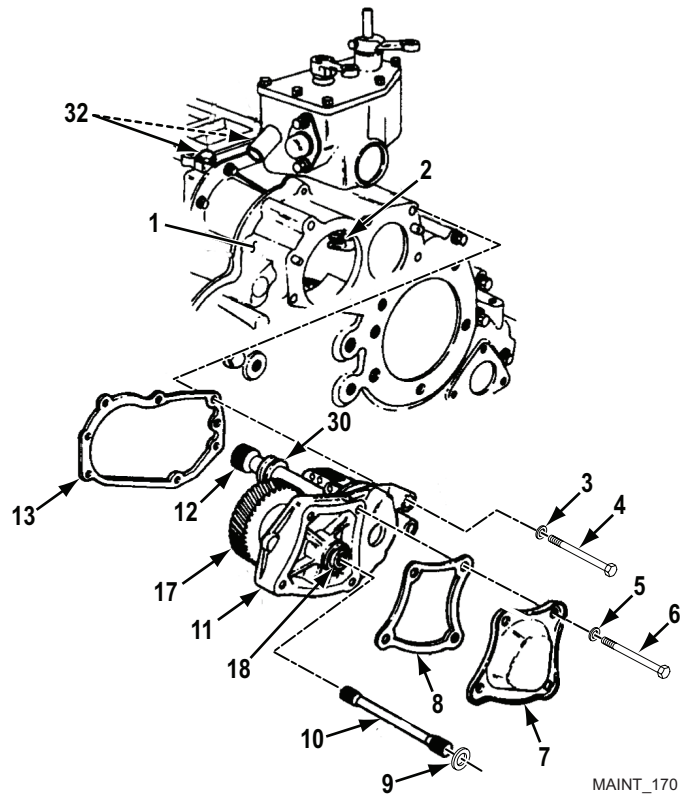


Figure 6. Blower Drive Support Installation.

**NOTE**

For model 5063-5299 support for air pump and ignition coil assembly is installed with the seven-inch front bolts (Figure 6, Item 32).

6. Torque blower to cylinder block bolts (Figure 6, Item 32) to 55–60 lb-ft (75–81 N·m).

**END OF TASK****FOLLOW ON TASK**

Install right exhaust tube (models 5063-5393 and 5063-539L) (WP 0038).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
GOVERNOR COVER AND THROTTLE CONTROL RODS REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Socket, Wrench, Face Spanner  
(WP 0104, Table 1, Item 96)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 65)  
Gasket (WP 0105, Table 1, Item 1)  
Nut, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 170)  
Pin, Cotter Qty: (2) (WP 0105, Table 1, Item 173)  
Washer, Flat  
Qty: (2) (WP 0105, Table 1, Item 117)

**References**

WP 0087  
WP 0100

**Equipment Condition**

Rocker arm covers removed  
(model 5063-5299) (WP 0052)  
Rocker arm covers removed  
(models 5063-5392, 5063-5393, and  
5063-539L) (WP 0053)

---

**REMOVAL**

1. Remove seven screw assemblies (Figure 1, Item 1), governor cover (Figure 1, Item 2), and gasket (Figure 1, Item 3) from governor housing (Figure 1, Item 4). Discard gasket.
2. Remove two bolts (Figure 1, Item 7), two copper flat washers (Figure 1, Item 8), cover (Figure 1, Item 9), and gasket (Figure 1, Item 10) from governor housing (Figure 1, Item 4). Discard gasket and copper flat washers.

**NOTE**

Keep spring pack assembly together as a unit and do not disassemble.

3. Using face spanner socket wrench, unscrew packing nut (Figure 1, Item 6) and remove spring pack assembly (Figure 1, Item 5) from side of governor housing (Figure 1, Item 4).

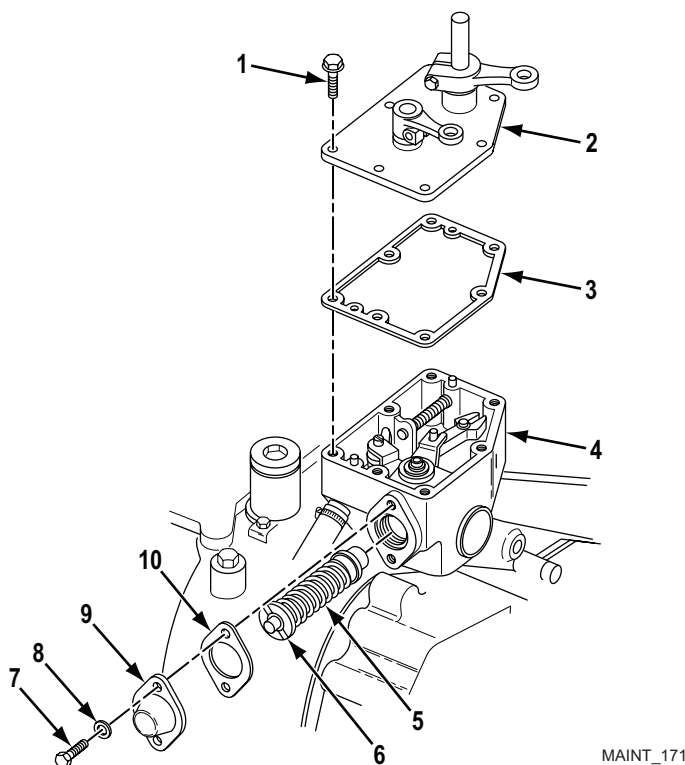


Figure 1. Governor Cover and Throttle Rod Removal.

**CAUTION**

Place clean rag over oil drain holes in cylinder head to prevent cotter pin from falling into engine.

4. On right cylinder head, remove cotter pin (Figure 2, Item 12) from pin (Figure 2, Item 14). Remove pin from lower connecting link (Figure 2, Item 15) on injector control tube lever (Figure 2, Item 13). Discard cotter pin.
5. Remove locknut (Figure 2, Item 16) and disconnect lower connecting link (Figure 2, Item 15) from upper connecting link (Figure 2, Item 17). Withdraw lower connecting link. Discard nut.
6. Remove shoulder pin (Figure 2, Item 11) and upper connecting link (Figure 2, Item 17) from inside governor housing (Figure 2, Item 4).



**REMOVAL - Continued**

7. Repeat Steps 4–6 for left cylinder head.

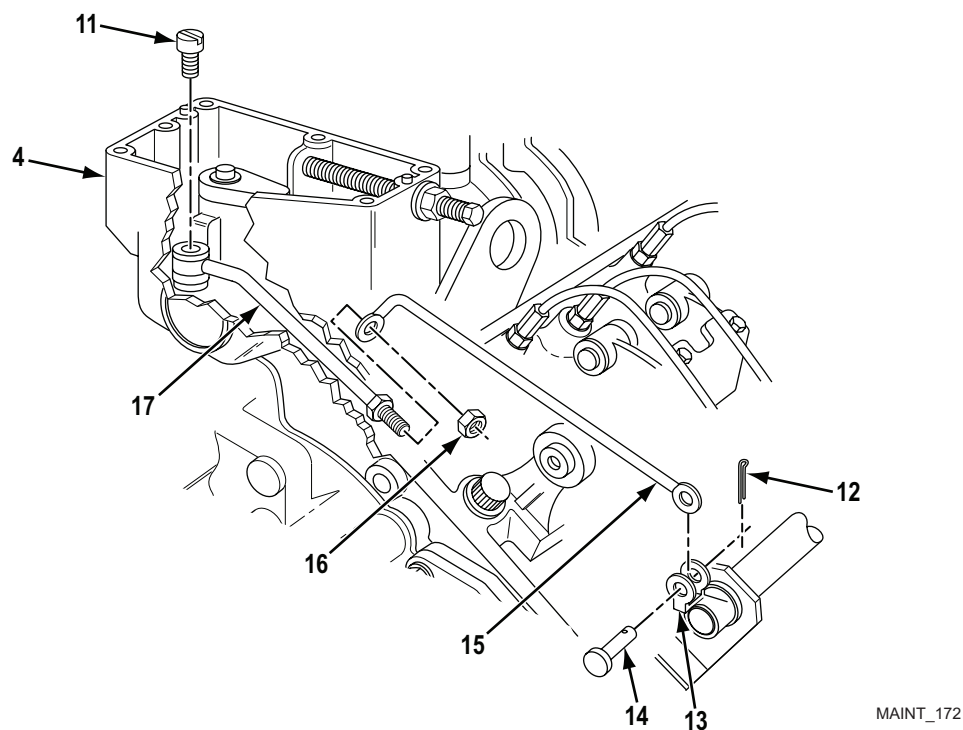


Figure 2. Lower Connecting Link Removal/Installation.

**END OF TASK****INSTALLATION**

1. On right cylinder, install right upper connecting link (Figure 2, Item 17) from inside governor housing (Figure 2, Item 4) and then install shoulder pin (Figure 2, Item 11). Tighten pin securely.
2. Connect lower connecting link (Figure 2, Item 15) to upper connecting link (Figure 2, Item 17) with new locknut (Figure 2, Item 16). Tighten nut securely.
3. Install pin (Figure 2, Item 14) through injector control tube lever (Figure 2, Item 13) and then through lower connecting link (Figure 2, Item 15) with cotter pin hole toward front. Install new cotter pin (Figure 2, Item 12) in hole of pin (Figure 2, Item 14).
4. Repeat Steps 1–3 for left cylinder head.

**INSTALLATION - Continued****NOTE**

If spring pack assembly comes apart during storage or removal, refer to (WP 0087) for assembly instructions.

5. Install spring pack assembly (Figure 3, Item 5) in side of governor housing (Figure 3, Item 4). Using face spanner socket wrench, tighten packing nut (Figure 3, Item 6).

**NOTE**

Torque bolts on cover (Figure 3, Item 9) during engine tune-up (WP 0100).

6. Install new gasket (Figure 3, Item 10), cover (Figure 3, Item 9), two new copper flat washers (Figure 3, Item 8), and two bolts (Figure 3, Item 7) on governor housing (Figure 3, Item 4).
7. Place new gasket (Figure 3, Item 3) and governor cover (Figure 3, Item 2) on top of governor housing (Figure 3, Item 4). Ensure control link lever (Figure 3, Item 23) engages pin (Figure 3, Item 21) on differential lever (Figure 3, Item 22); pin (Figure 3, Item 19) in speed control shaft enters slot in differential lever; and, pin (Figure 3, Item 20) in stop lever shaft (Figure 3, Item 18) engages between stop on underside of cover and against vertical extension of control link lever.
8. Install governor cover (Figure 3, Item 2) and seven screw assemblies (Figure 3, Item 1) on governor housing (Figure 3, Item 4). Tighten screws.

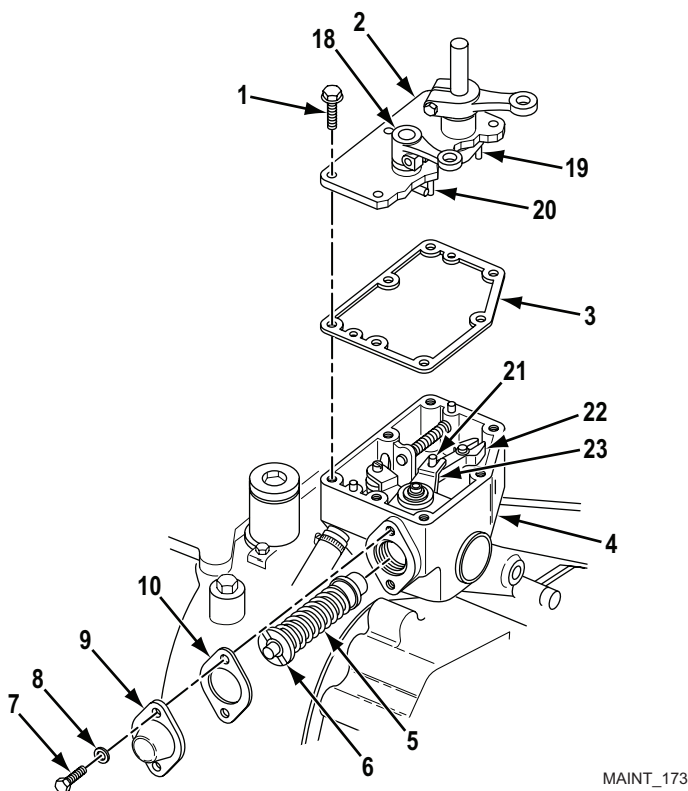


Figure 3. Governor Cover and Throttle Rod Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install rocker arm covers (models 5063-5392, 5063-5393, and 5063-539L) (WP 0053).
2. Install rocker arm covers (model 5063-5299) (WP 0052).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
GOVERNOR AND BLOWER ASSEMBLY REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Sling, Multiple Leg (Cable)  
(WP 0104, Table 1, Item 94)  
Guide Studs  
(WP 0081, Figure 4)  
Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)  
Gage Set, Depth, Micrometer  
(WP 0104, Table 1, Item 44)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Gasket (WP 0105, Table 1, Item 59)  
Gasket (WP 0105, Table 1, Item 67)  
Gasket Qty: (2) (WP 0105, Table 1, Item 126)  
Seal, Blower (WP 0105, Table 1, Item 72)  
Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 23)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)

**Equipment Condition**

Turbocharger removed (model 5063-5392)  
(WP 0035)

**Equipment Condition (cont.)**

Igniter and air pump bracket assembly removed  
(model 5063-5299) (WP 0042)  
Rocker arm covers removed (model 5063-5299)  
(WP 0052)  
Rocker arm covers removed (models 5063-5392,  
5063-5393, and 5063-539L) (WP 0053)  
Air inlet housing removed (model 5063-5299)  
(WP 0056)  
Air inlet housing removed (model 5063-5392)  
(WP 0057)  
Air inlet housing removed  
(model 5063-5393 and 5063-539L)  
(WP 0058)  
Blower drive support removed (WP 0060)  
Governor cover and throttle control rods removed  
(WP 0062)

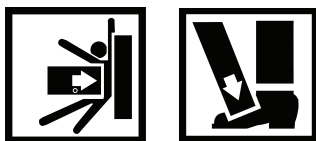
**REMOVAL**

1. Loosen two clamps (Figure 1, Item 2) on two left fuel rod hoses (Figure 1, Item 1) and slide two hoses onto left governor link housing (Figure 1, Item 3). Remove housing, hoses, and clamps from left side.
2. Loosen two clamps (Figure 1, Item 8) on right fuel rod hose (Figure 1, Item 7). Slide hose onto right fuel rod cover (Figure 1, Item 9).
3. Insert punch in flywheel housing hole (Figure 1, Item 11) and drive pin (Figure 1, Item 10) towards blower and clear of rear engine end plate (Figure 1, Item 12).

**NOTE**

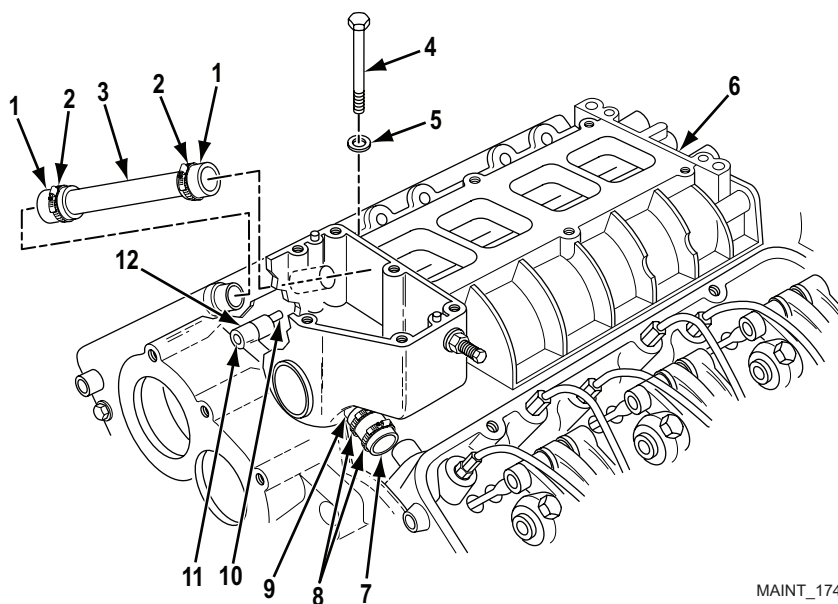
On model 5063-5299, two blower-to-block bolts and washers were removed during igniter and air pump assembly removal.

4. Remove four self-locking bolts (Figure 1, Item 4) and four hardened washers (Figure 1, Item 5) fastening blower and governor assembly (Figure 1, Item 6) to cylinder block.

**WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

5. Using two 3/8-16 eye bolts and multiple leg sling, lift blower and governor assembly (Figure 1, Item 6) from engine.

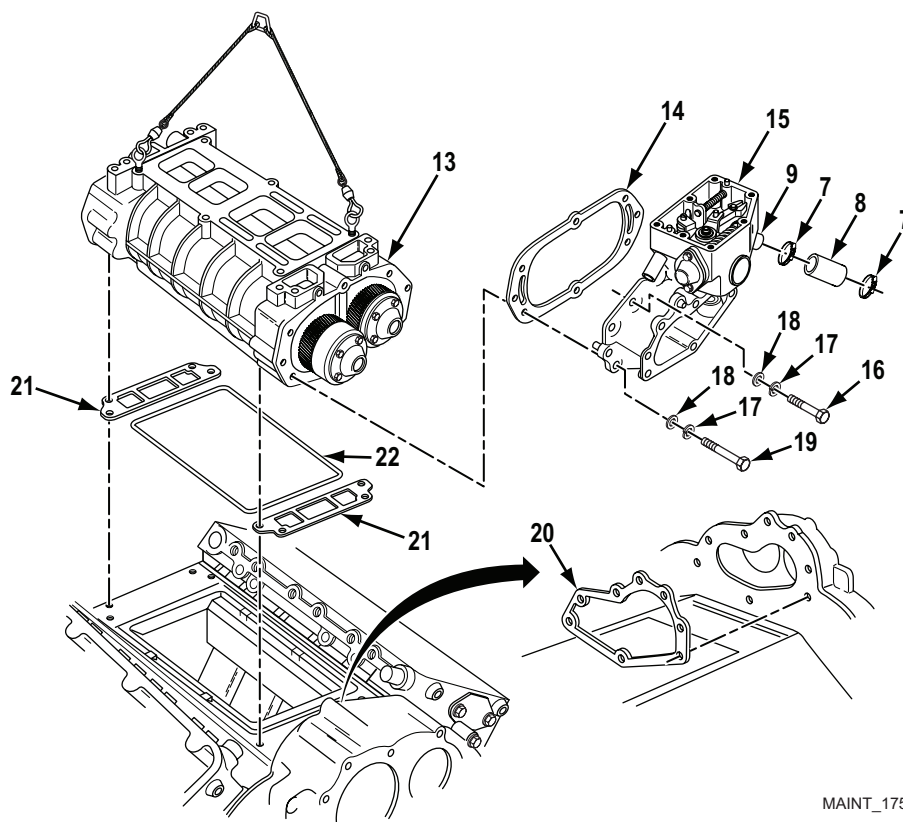


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Figure 1. Governor and Blower Mounting Hardware Removal.

**REMOVAL - Continued**

6. Remove seal (Figure 2, Item 22) and two gaskets (Figure 2, Item 21) from top of cylinder block. Discard seal and gaskets.
7. Remove gasket (Figure 2, Item 20) from rear of governor assembly (Figure 2, Item 15). Discard gasket.
8. For model 5063-5299, remove six screws (Figure 2, Item 19), six lockwashers (Figure 2, Item 17), six flat washers (Figure 2, Item 18), governor assembly (Figure 2, Item 15), and gasket (Figure 2, Item 14) from blower (Figure 2, Item 13) end plate. Discard gasket and lockwashers.
9. For models 5063-5392, 5063-5393, and 5063-539L, remove five screws (Figure 2, Item 19), short screw (Figure 2, Item 16), six lockwashers (Figure 2, Item 17), six flat washers (Figure 2, Item 18), governor assembly (Figure 2, Item 15), and gasket (Figure 2, Item 14) from blower (Figure 2, Item 13) end plate. Discard gasket and lockwashers.
10. Remove two clamps (Figure 2, Item 7) and hose (Figure 2, Item 8) from right fuel rod cover (Figure 2, Item 9).



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Figure 2. Governor and Blower Removal.

**END OF TASK**

## INSTALLATION

### NOTE

Remove four bolts and flat washers used to temporarily fasten rear end plate to blower housing.

Insert second screw in right side of governor housing before placing housing on blower.

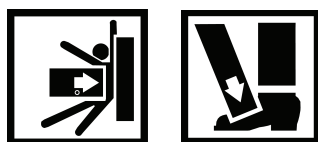
1. For model 5063-5299, install new gasket (Figure 3, Item 14), governor assembly (Figure 3, Item 15), six flat washers (Figure 3, Item 18), six new lockwashers (Figure 3, Item 17), and six screws (Figure 3, Item 19) on blower (Figure 3, Item 13) rear end plate. Torque screws to 20–24 lb-ft (27–33 N·m).
2. For models 5063-5392, 5063-5393, and 5063-539L, install new gasket (Figure 3, Item 14), governor assembly (Figure 3, Item 15), six flat washers (Figure 3, Item 18), six new lockwashers (Figure 3, Item 17), short screw (Figure 3, Item 16), and five screws (Figure 3, Item 19) on blower (Figure 3, Item 13) rear end plate. Torque screws to 20–24 lb-ft (27–33 N·m).

### CAUTION

Excessive protrusion of blower housing with respect to end plate could cause distortion when torquing down blower resulting in rotor to housing contact.

3. Measure distance from bottom of rear end plate to bottom of blower housing. Protrusion of blower housing with respect to end plate must not be more than 0.001 inch (0.00254 mm) above to 0.004 inch (0.01016 mm) below end plate.
4. Using gasket adhesive, affix new gasket (Figure 3, Item 20) to cylinder block rear end plate (Figure 3, Item 12).
5. Place new seal (Figure 3, Item 22) in groove in top of cylinder block.
6. Using gasket adhesive, affix two new gaskets (Figure 3, Item 21) to top of cylinder block.
7. Install two guide studs (Figure 3, Item 23) in blower bolt holes in cylinder block.
8. Install two clamps (Figure 3, Item 7) and hose (Figure 3, Item 8) on right fuel rod cover (Figure 3, Item 9).

### WARNING

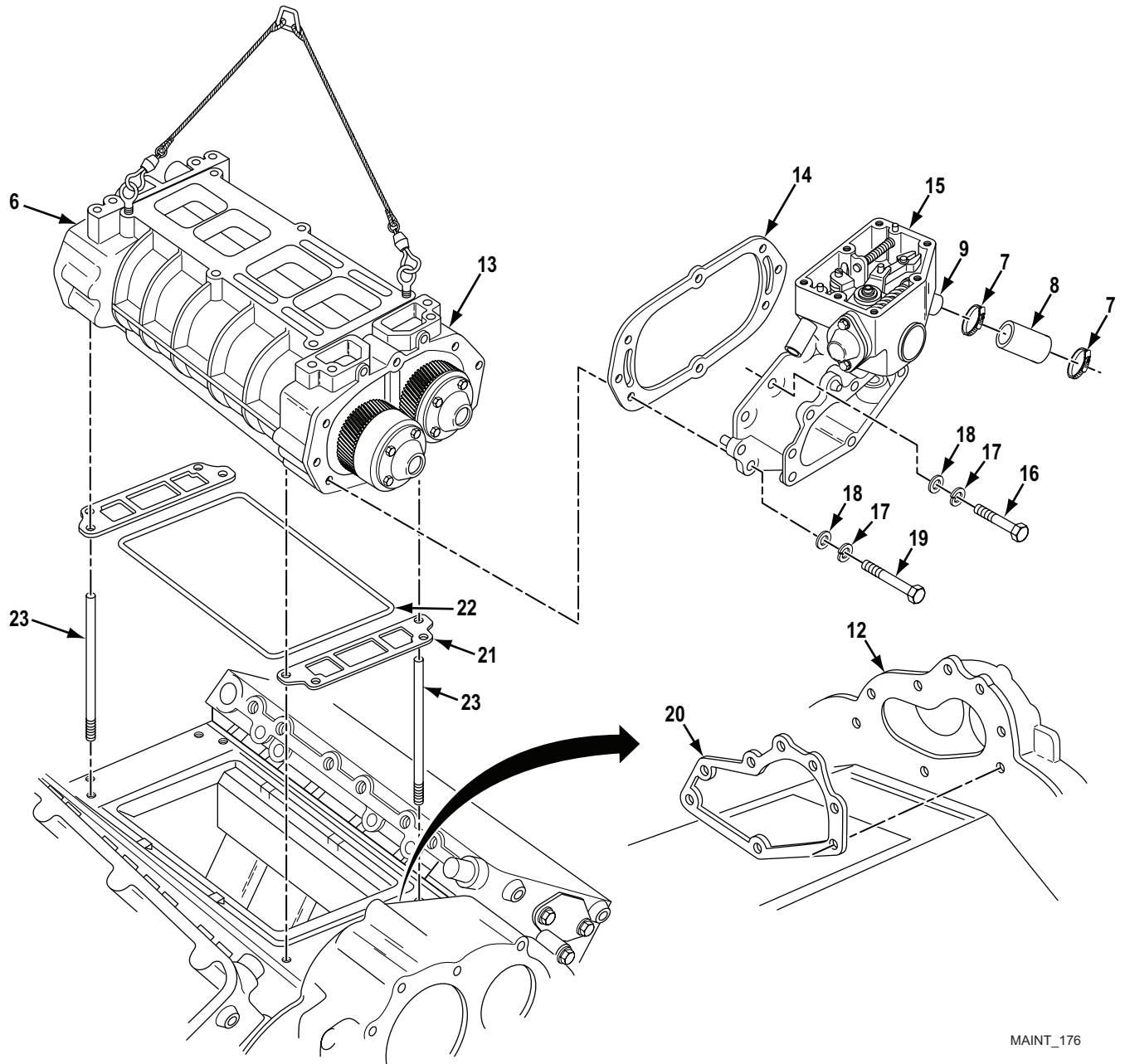


Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

9. Using two 3/8-16 eye bolts and multiple leg sling, lower blower and governor assembly (Figure 3, Item 6) over guide studs (Figure 3, Item 23). Push blower away from cylinder block rear end plate (Figure 3, Item 12) while lowering into position. Remove two guide studs.



INSTALLATION - Continued



MAINT\_176

Figure 3. Governor Installation.

**INSTALLATION - Continued****NOTE**

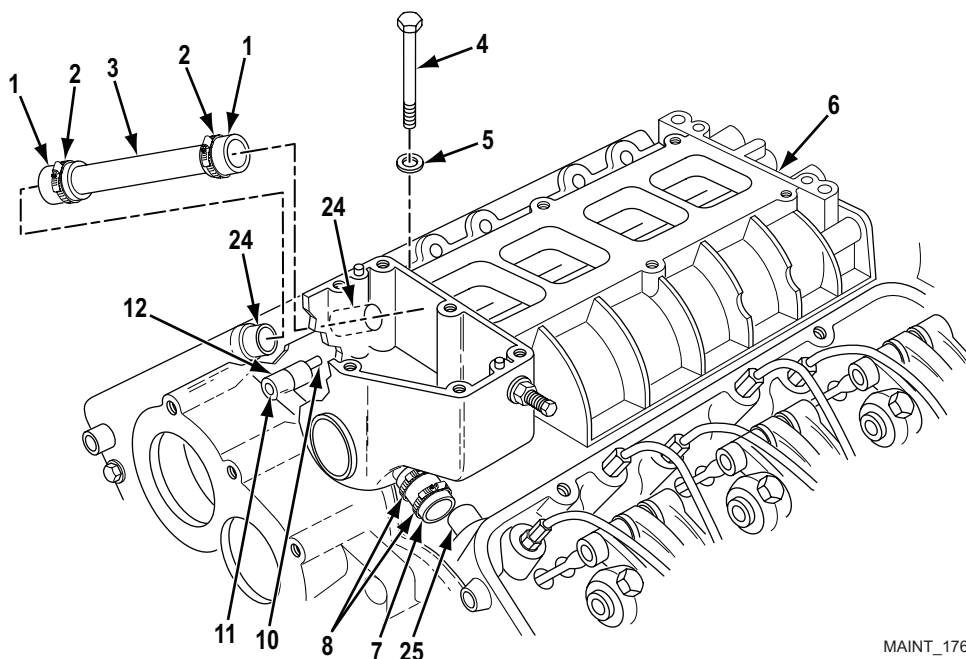
Model 5063-5299, uses two front blower-to-block bolts which are 5/16 inch longer. These bolts and washers are installed during the igniter and air pump assembly installation.

10. Apply water displacing compound, or equivalent, to four self-locking bolts (Figure 4, Item 4). Install four hardened washers (Figure 4, Item 5) and four self-locking bolts, fastening blower to cylinder block. Finger tighten bolts.
11. Drive dowel pin (Figure 4, Item 10) into cylinder block rear end plate (Figure 4, Item 12).

**NOTE**

Final torquing of bolts, attaching blower to block, is done following blower drive support installation (WP 0060).

12. Torque bolts (Figure 4, Item 4) to 10–15 lb-ft (14–20 N·m).
13. Slide two hoses (Figure 4, Item 1) and two clamps (Figure 4, Item 2) onto governor link housing (Figure 4, Item 3) and position between governor and left cylinder head sleeve (Figure 4, Item 24). Slide hoses and clamps onto governor housing and cylinder head sleeve and tighten clamps securely.
14. Slide hose (Figure 4, Item 7) and two clamps (Figure 4, Item 8) onto right cylinder head sleeve (Figure 4, Item 25). Tighten clamps.



MAINT\_176a

Figure 4. Blower Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install governor cover and throttle control rods (WP 0062).
2. Install blower drive support (WP 0060).
3. Install air inlet housing (model 5063-5393 and 5063-539L) (WP 0058).
4. Install air inlet housing (model 5063-5392) (WP 0057).
5. Install air inlet housing (model 5063-5299) (WP 0056).
6. Install rocker arm covers (models 5063-5392, 5063-5393, and 5063-539L) (WP 0053).
7. Install rocker arm covers (model 5063-5299) (WP 0052).
8. Install igniter and air pump bracket assembly (model 5063-5299) (WP 0042).
9. Install turbocharger (model 5063-5392) (WP 0035).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
OIL PAN REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 73)

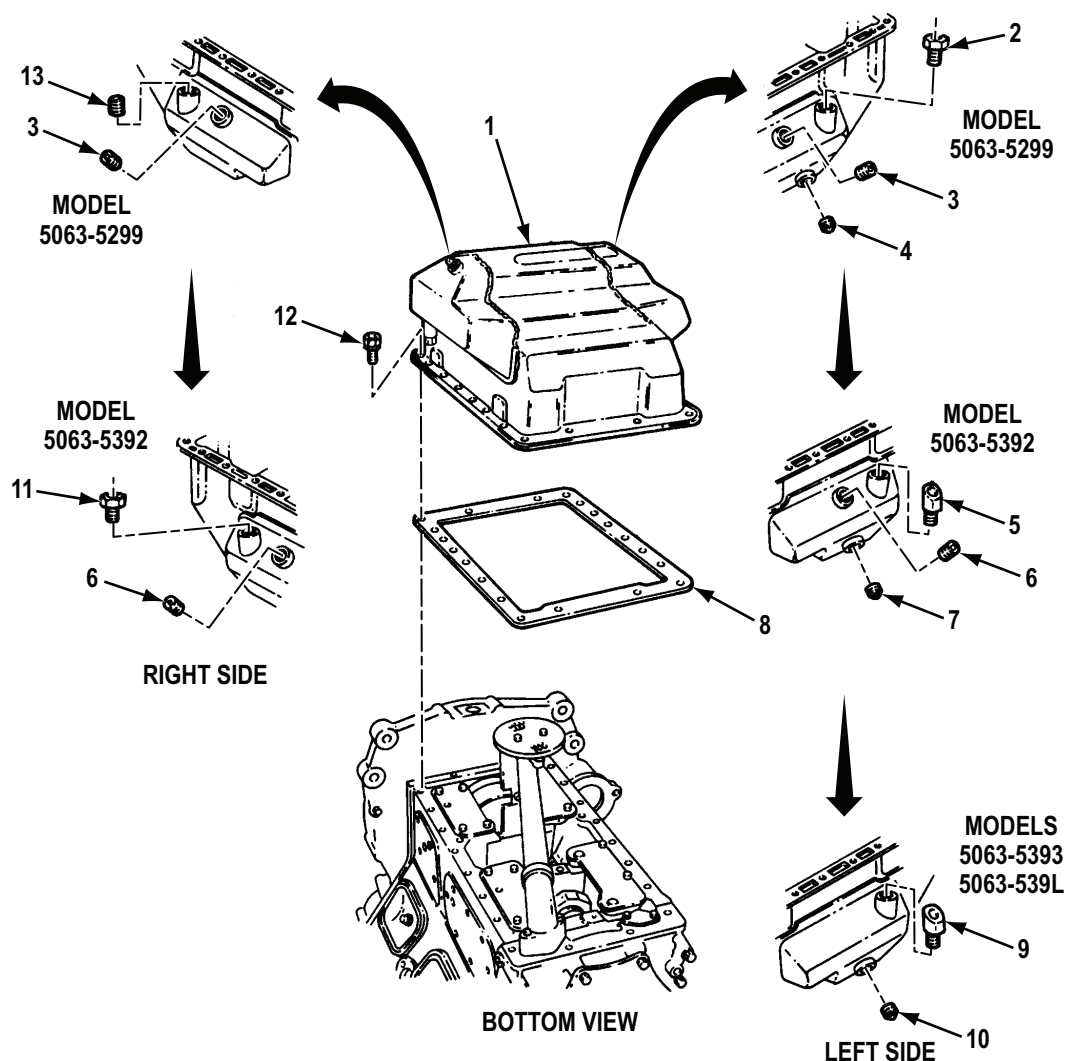
**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)

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**REMOVAL**

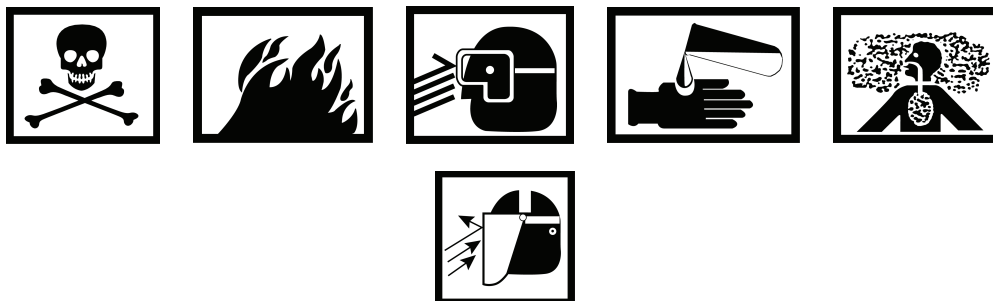
1. Remove 22 screw and washer assemblies (Figure 1, Item 12) from oil pan (Figure 1, Item 1).
2. Remove oil pan (Figure 1, Item 1) and gasket (Figure 1, Item 8). Discard gasket.
3. If necessary, remove following fittings from oil pan:
  - a. For model 5063-5299: adapter (Figure 1, Item 2), two plugs (Figure 1, Item 3), plug (Figure 1, Item 4), and plug (Figure 1, Item 13)
  - b. For model 5063-5392: adapter (Figure 1, Item 11), two plugs (Figure 1, Item 6), plug (Figure 1, Item 7), and elbow (Figure 1, Item 5)
  - c. For models 5063-5393 and 5063-539L: plug (Figure 1, Item 10) and elbow (Figure 1, Item 9)



MAINT\_177

Figure 1. Oil Pan Removal/Installation.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean oil pan with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect oil pan for holes, dents, cracks, and other damage, which may require replacement. Check for misaligned flanges or raised surfaces surrounding bolt holes.

**END OF TASK****INSTALLATION**

1. If removed, install following fittings in oil pan:
  - a. For model 5063-5299: adapter (Figure 1, Item 2), two plugs (Figure 1, Item 3), plug (Figure 1, Item 4), and plug (Figure 1, Item 13)
  - b. For model 5063-5392: adapter (Figure 1, Item 11), two plugs (Figure 1, Item 6), plug (Figure 1, Item 7), and elbow (Figure 1, Item 5)
  - c. For models 5063-5393 and 5063-539L: plug (Figure 1, Item 10) and elbow (Figure 1, Item 9)
2. Coat flange of oil pan (Figure 1, Item 1) with gasket adhesive.
3. Place new gasket (Figure 1, Item 8) on oil pan flange with contoured end towards front of engine.
4. Place oil pan (Figure 1, Item 1) on cylinder block with drain plug on left side. Install 22 screw and washer assemblies (Figure 1, Item 12). Torque screw assemblies to 10–20 lb-ft (14–27 N·m) starting with center screw on each side and working alternately toward each end of pan.

**END OF TASK****END OF WORK PACKAGE**





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**FIELD MAINTENANCE  
OIL PUMP INLET TUBE REPLACEMENT  
(MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Bolt, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 145)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 70)

**Materials/Parts (cont.)**

Nut, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 13)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (4) (WP 0105, Table 1, Item 23)

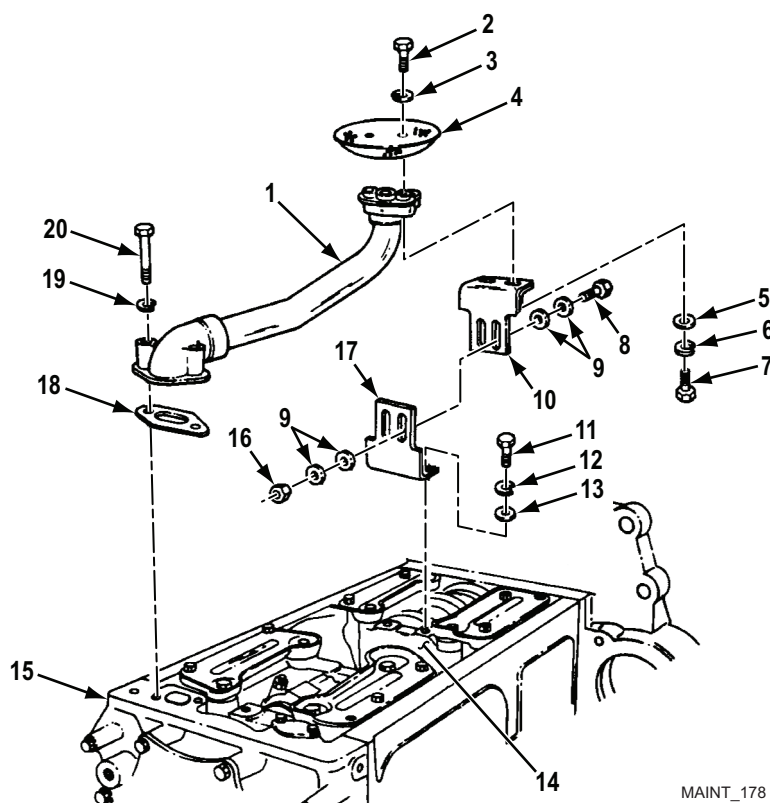
**Equipment Condition**

Oil pan removed (WP 0063)

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**REMOVAL**

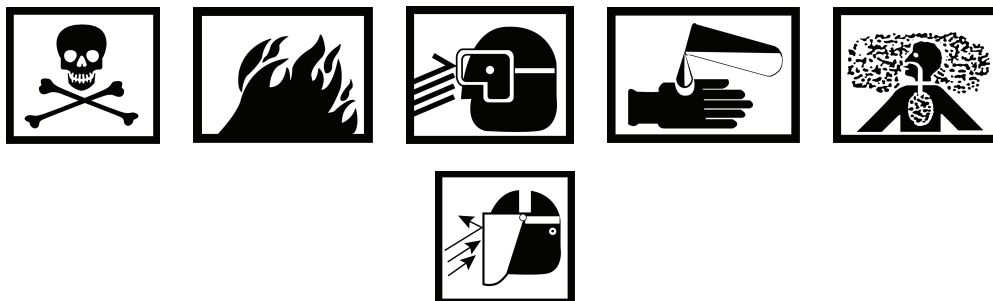
1. Remove two bolts (Figure 1, Item 20) and two lockwashers (Figure 1, Item 19) fastening oil pump inlet tube (Figure 1, Item 1) to bottom of lower front cover (Figure 1, Item 15). Discard lockwashers.
2. Remove two screws (Figure 1, Item 11), two lockwashers (Figure 1, Item 12), and two special washers (Figure 1, Item 13) fastening support bracket (Figure 1, Item 17) to main bearing cap (Figure 1, Item 14). Discard lockwashers.
3. Remove oil pump inlet tube (Figure 1, Item 1) and gasket (Figure 1, Item 18) from cylinder block.
4. Remove two self-locking bolts (Figure 1, Item 2), two flat washers (Figure 1, Item 3), and strainer (Figure 1, Item 4) from inlet tube (Figure 1, Item 1). Discard self-locking bolts.
5. Remove two screws (Figure 1, Item 7), two lockwashers (Figure 1, Item 6), two special washers (Figure 1, Item 5), and bracket (Figure 1, Item 10) from inlet tube (Figure 1, Item 1). Discard lockwashers.
6. Remove two locknuts (Figure 1, Item 16), eight flat washers (Figure 1, Item 9), two screws (Figure 1, Item 8), and bracket (Figure 1, Item 17) from bracket (Figure 1, Item 10). Discard locknuts.



MAINT\_178

Figure 1. Oil Inlet Tube Removal/Installation.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash components with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect tubes, brackets, and strainer for cracks or damage.

**END OF TASK****INSTALLATION**

1. Install bracket (Figure 1, Item 17), two screws (Figure 1, Item 8), eight flat washers (Figure 1, Item 9), and two new locknuts (Figure 1, Item 16) on bracket (Figure 1, Item 10). Loosely tighten screws.
2. Loosely install bracket (Figure 1, Item 10), two special washers (Figure 1, Item 5), two new lockwashers (Figure 1, Item 6), and two screws (Figure 1, Item 7) on oil pump inlet tube (Figure 1, Item 1).
3. Install strainer (Figure 1, Item 4), two flat washers (Figure 1, Item 3), and two new self-locking bolts (Figure 1, Item 2) on inlet tube (Figure 1, Item 1). Torque bolts to 13–17 lb-ft (18–23 N·m).
4. Install new gasket (Figure 1, Item 18), inlet tube (Figure 1, Item 1), two new lockwashers (Figure 1, Item 19), and two bolts (Figure 1, Item 20) on lower front cover (Figure 1, Item 15). Torque bolts to 13–17 lb-ft (18–23 N·m).
5. Install two special washers (Figure 1, Item 13), two new lockwashers (Figure 1, Item 12), and two screws (Figure 1, Item 11) in bracket (Figure 1, Item 17) at main bearing cap (Figure 1, Item 14). Torque screws to 30–35 lb-ft (41–47 N·m).
6. Torque two screws (Figure 1, Item 8) to 35–39 lb-ft (47–53 N·m) and two screws (Figure 1, Item 7) to 30–35 lb-ft (41–47 N·m), on brackets (Figure 1, Item 17 and 10).

**END OF TASK**

**FOLLOW ON TASK**

Install oil pan (WP 0063).

**END OF TASK**

**END OF WORK PACKAGE**

---

**FIELD MAINTENANCE**  
**OIL PUMP INLET TUBE REPLACEMENT**  
**(MODELS 5063-5392, 5063-5393, 5063-539L)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts (cont.)**

Washer, Lock  
Qty: (7) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 80)

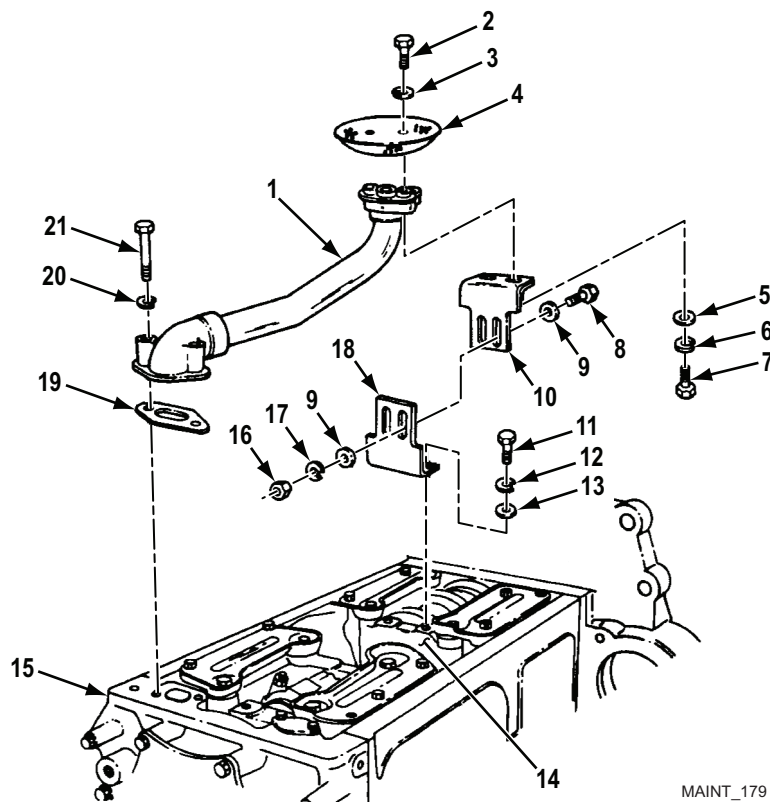
**Equipment Condition**

Oil pan removed (WP 0063)

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**REMOVAL**

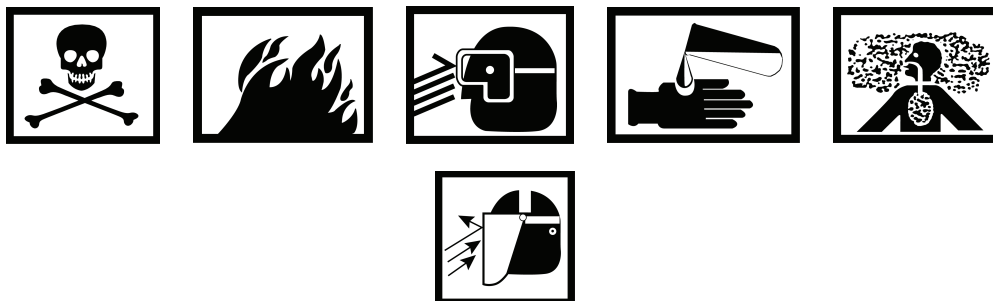
1. Remove two screws (Figure 1, Item 21) and two small lockwashers (Figure 1, Item 20) from inlet tube assembly (Figure 1, Item 1) at lower front cover (Figure 1, Item 15). Discard lockwashers.
2. Remove two screws (Figure 1, Item 11), two lockwashers (Figure 1, Item 12), and two flat washers (Figure 1, Item 13) from bracket (Figure 1, Item 18) at main bearing cap (Figure 1, Item 14). Discard lockwashers.
3. Remove inlet tube assembly (Figure 1, Item 1) and gasket (Figure 1, Item 19) from cylinder block.
4. Remove two bolts (Figure 1, Item 2), two lockwashers (Figure 1, Item 3), and strainer (Figure 1, Item 4) from inlet tube assembly (Figure 1, Item 1). Discard lockwashers.
5. Remove bolt (Figure 1, Item 7), lockwasher (Figure 1, Item 6), flat washer (Figure 1, Item 5), and bracket (Figure 1, Item 10) from inlet tube assembly (Figure 1, Item 1). Discard lockwasher.
6. Remove two nuts (Figure 1, Item 16), two lockwashers (Figure 1, Item 17), four flat washers (Figure 1, Item 9), two bolts (Figure 1, Item 8), and bracket (Figure 1, Item 18) from bracket (Figure 1, Item 10). Discard lockwashers.



MAINT\_179

Figure 1. Oil Inlet Tube Removal/Installation.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash components with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect tubes, brackets, and strainer for cracks or damage.

**END OF TASK****INSTALLATION**

1. Install bracket (Figure 1, Item 18), two bolts (Figure 1, Item 8), four flat washers (Figure 1, Item 9), two new lockwashers (Figure 1, Item 17), and two nuts (Figure 1, Item 16) on bracket (Figure 1, Item 10). Do not tighten nuts.
2. Loosely install bracket (Figure 1, Item 10), flat washer (Figure 1, Item 5), new lockwasher (Figure 1, Item 6) and bolt (Figure 1, Item 7) on inlet tube assembly (Figure 1, Item 1).
3. Install strainer (Figure 1, Item 4), two new lockwashers (Figure 1, Item 3), and two bolts (Figure 1, Item 2) on inlet tube assembly (Figure 1, Item 1). Torque bolts to 13–17 lb-ft (18–23 N·m).
4. Install new gasket (Figure 1, Item 19), inlet tube assembly (Figure 1, Item 1), two new lockwashers (Figure 1, Item 20), and two screws (Figure 1, Item 21) on lower front cover (Figure 1, Item 15). Loosely tighten screws.
5. Install two flat washers (Figure 1, Item 13), two new lockwashers (Figure 1, Item 12), and two screws (Figure 1, Item 11) in bracket (Figure 1, Item 18) at main bearing cap (Figure 1, Item 14). Torque screws (Figure 1, Item 11) to 30–35 lb-ft (41–47 N·m) and screws (Figure 1, Item 21) to 13–17 lb-ft (18–23 N·m).
6. Torque bolts (Figure 1, Item 8) to 15–19 lb-ft (20–26 N·m) and bolt (Figure 1, Item 7) to 13–17 lb-ft (18–23 N·m).

**END OF TASK**

**FOLLOW ON TASK**

Install oil pan (WP 0063).

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
CRANKSHAFT SPACER REPLACEMENT  
(MODELS 5063-5299, 5063-5393, 5063-539L)**

---

**INITIAL SETUP:**

**Tools and Special Tools**

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)

---

**REMOVAL****NOTE**

Secure flywheel or gear train to prevent crankshaft from turning during removal of crankshaft screw.

1. Remove screw (Figure 1, Item 1) and spacer ring (Figure 1, Item 2) from crankshaft.
2. Slide sleeve (Figure 1, Item 3) off crankshaft.

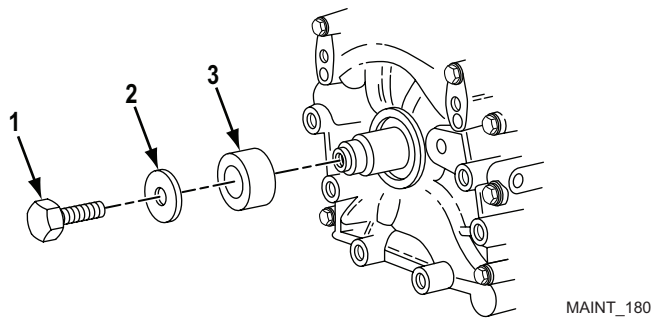


Figure 1. Camshaft Spacer Removal/Installation.

**END OF TASK****INSTALLATION****NOTE**

Secure flywheel or gear train to prevent crankshaft from turning during installation of crankshaft screw.

Install sleeve (Figure 1, Item 3), spacer ring (Figure 1, Item 2), and screw (Figure 1, Item 1) on crankshaft. Torque screw to 290–300 lb-ft (393–407 N·m).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
CRANKSHAFT PULLEY OR HUB REPLACEMENT  
(MODEL 5063-5392)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)  
Puller, Mechanical, Three-Leg  
(WP 0104, Table 1, Item 77)

**Tools and Special Tools (cont.)**

Installer, Crankshaft Pulley  
(WP 0104, Table 1, Item 62)

**Materials/Parts**

Oil, Engine (WP 0103, Table 1, Item 27)

---

**REMOVAL****NOTE**

Secure flywheel or gear train to prevent crankshaft from turning during removal of crankshaft screw.

1. Remove screw (Figure 1, Item 1) and spacer ring (Figure 1, Item 2) from crankshaft.
2. Install screw (Figure 1, Item 1) in crankshaft.

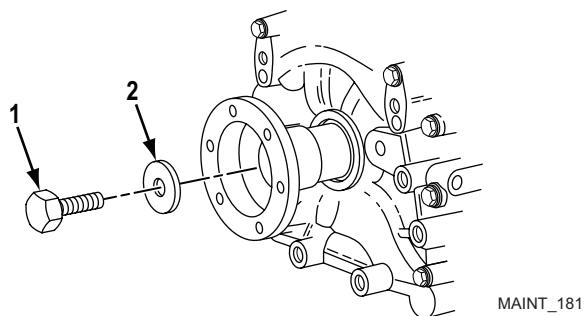


Figure 1. Crankshaft Hub Removal.

**NOTE**

Model 5063-5392 uses a hub (Figure 2, Item 4).

3. Using three-leg mechanical puller, remove outer cone (Figure 2, Item 5) and hub (Figure 2, Item 4) from crankshaft.
4. Remove inner cone (Figure 2, Item 3) from crankshaft.
5. Remove screw (Figure 2, Item 1) from crankshaft.

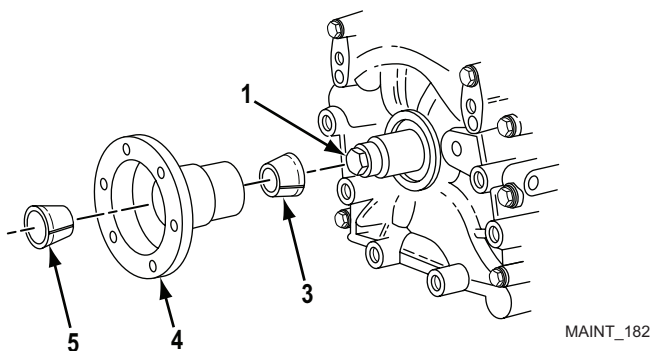


Figure 2. Crankshaft Hub Installation.

**END OF TASK**

**INSTALLATION**

1. Lubricate front of crankshaft with engine oil.
2. Install inner cone (Figure 3, Item 3) (with taper away from block) on crankshaft.

**NOTE**

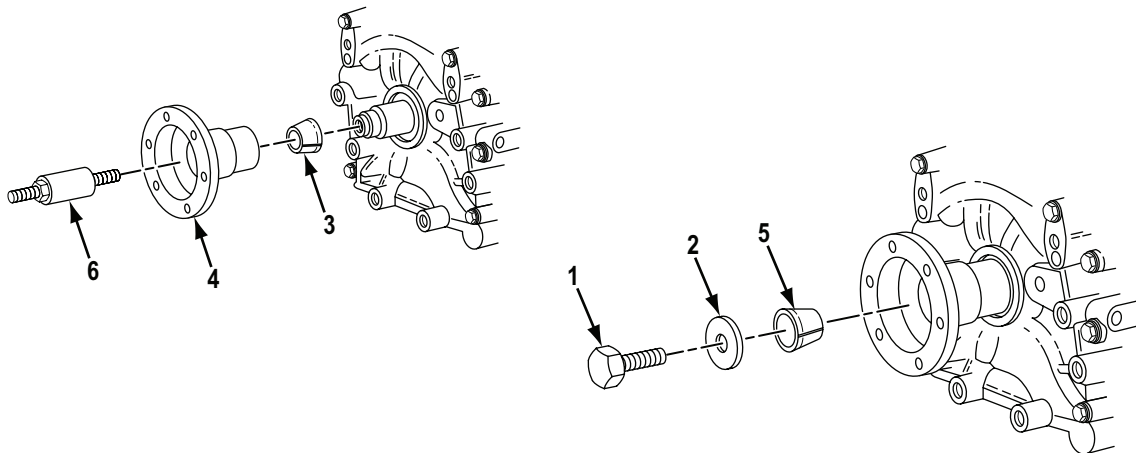
Model 5063-5392 uses a hub (Figure 3, Item 4).

3. Start hub (Figure 3, Item 4) straight on crankshaft.
4. Screw crankshaft pulley installer (Figure 3, Item 6) into crankshaft and force hub (Figure 3, Item 4) onto crankshaft. Remove crankshaft pulley installer.

**NOTE**

Secure flywheel or gear train to prevent crankshaft from turning during installation of crankshaft screw.

5. Install outer cone (Figure 3, Item 5) (with tapered end toward block), spacer ring (Figure 3, Item 2), and crankshaft screw (Figure 3, Item 1) on crankshaft. Torque screw to 290–300 lb-ft (393–407 N·m).



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Figure 3. Crankshaft Hub Installation.

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
ENGINE FRONT SUPPORT REPLACEMENT  
(MODEL 5063-5299)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 179)

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**REMOVAL**

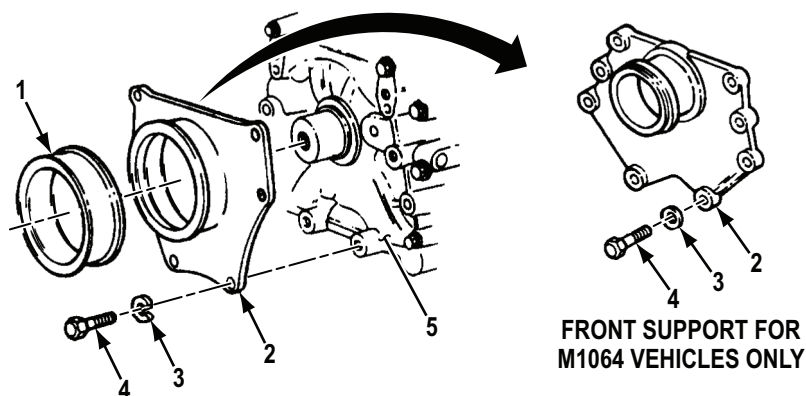
1. Slide preformed packing (Figure 1, Item 1) off of support (Figure 1, Item 2).

**NOTE**

All engines, except those used in M1064 vehicles, use six bolts with six lockwashers to retain a six-hole front support to lower cover.

Engines in M1064 vehicles use eight self-locking bolts with eight flat washers to retain an eight-hole front support to lower cover.

2. Remove bolts (Figure 1, Item 4), washers (Figure 1, Item 3), and support (Figure 1, Item 2) from lower front cover (Figure 1, Item 5). Discard lockwashers if used.



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Figure 1. Engine Front Support Removal/Installation.

**END OF TASK****INSTALLATION**

1. Install support (Figure 1, Item 2), bolts (Figure 1, Item 4), and washers (Figure 1, Item 3) against lower front cover (Figure 1, Item 5). Torque bolts to 46–50 lb-ft (62–68 N·m).
2. Slide preformed packing (Figure 1, Item 1) on support (Figure 1, Item 2).

**END OF TASK****END OF WORK PACKAGE**



---

**FIELD MAINTENANCE  
ENGINE FRONT SUPPORT REPLACEMENT  
(MODEL 5063-5392)**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Equipment Condition (cont.)**

Crankshaft hub removed (WP 0067)

**Materials/Parts**

Washer, Lock  
Qty: (8) (WP 0105, Table 1, Item 179)

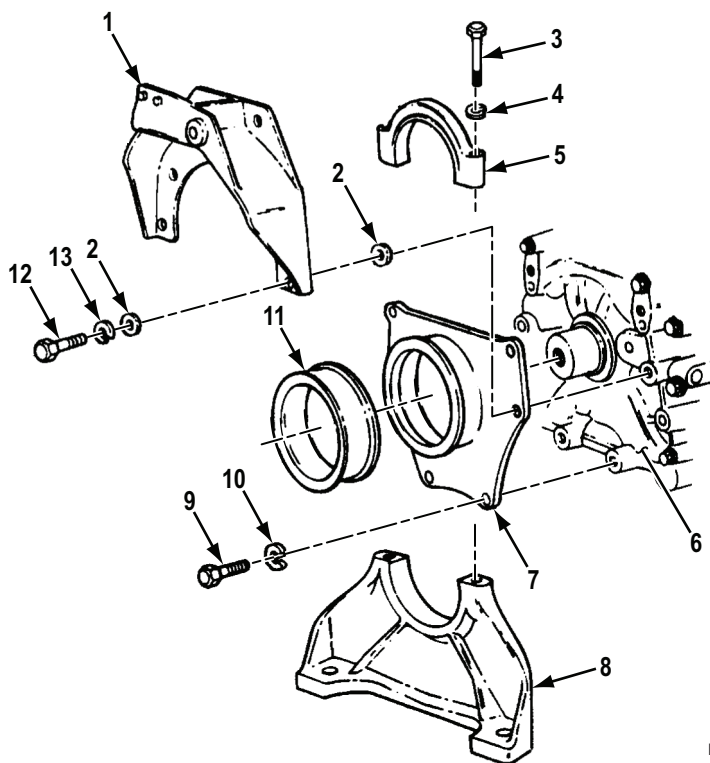
**Equipment Condition**

Solenoid valve and bracket removed (WP 0043)

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**REMOVAL**

1. Remove four screws (Figure 1, Item 12), four lockwashers (Figure 1, Item 13), eight flat washers (Figure 1, Item 2), and bracket (Figure 1, Item 1) from lower front cover (Figure 1, Item 6). Discard lockwashers.
2. Remove two screws (Figure 1, Item 3), two lockwashers (Figure 1, Item 4), and cap (Figure 1, Item 5) from engine support (Figure 1, Item 8). Remove support and discard lockwashers.
3. Slide preformed packing (Figure 1, Item 11) off of support (Figure 1, Item 7).
4. Remove two screws (Figure 1, Item 9), two lockwashers (Figure 1, Item 10), and front support (Figure 1, Item 7) from front cover (Figure 1, Item 6). Discard lockwashers.



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Figure 1. Engine Front Support Removal/Installation.

**END OF TASK**

**INSTALLATION****NOTE**

Four screws (Figure 1, Item 12) must be temporarily installed prior to torquing screws (Figure 1, Item 9) to ensure proper alignment of front support (Figure 1, Item 7).

1. Install front support (Figure 1, Item 7), four screws (Figure 1, Item 12), two screws (Figure 1, Item 9), and two new lockwashers (Figure 1, Item 10) on lower front cover (Figure 1, Item 6). Torque screws (Figure 1, Item 9) to 46–50 lb-ft (62–68 N·m). Remove four screws (Figure 1, Item 12).
2. Slide preformed packing (Figure 1, Item 11) on support (Figure 1, Item 7).
3. Install engine support (Figure 1, Item 8), two screws (Figure 1, Item 3), two new lockwashers (Figure 1, Item 4), and cap (Figure 1, Item 5) on preformed packing (Figure 1, Item 11) and front support (Figure 1, Item 7). Torque screws to 46–50 lb-ft (62–68 N·m).
4. Install bracket (Figure 1, Item 1), four screws (Figure 1, Item 12), four new lockwashers (Figure 1, Item 13), and eight flat washers (Figure 1, Item 2) on front support (Figure 1, Item 7). Torque screws to 46–50 lb-ft (62–68 N·m).

**END OF TASK****FOLLOW ON TASK**

1. Install crankshaft hub (WP 0067).
2. Install solenoid valve and bracket (WP 0043).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
FLYWHEEL ASSEMBLY REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Sling, Multiple Leg (Cable) (Model 5063-5299)  
(WP 0104, Table 1, Item 94)  
Guide Stud (WP 0081, Figure 3) (2)  
Soldering Torch Kit (Model 5063-5299)  
(WP 0104, Table 1, Item 97)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Gage, Flywheel Housing  
(WP 0104, Table 1, Item 34)

**Materials/Parts**

Bolt (Model 5063-5299)  
Qty: (8) (WP 0105, Table 1, Item 139)  
Bolts, Self-locking  
Qty: (6) (WP 0105, Table 1, Item 150)  
Cleaning Solvent (WP 0103, Table 1, Item 8)

**Materials/Parts (cont.)**

Compound, Heat Indicating  
(WP 0103, Table 1, Item 19)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)  
Wood Block  
Qty: (2) (WP 0103, Table 1, Item 71)

**Personnel Required**

Mechanic  
Helper (H)

**References**

WP 0088

**REMOVAL**

1. On model 5063-5299, remove eight bolts (Figure 1, Item 6) and clutch plate assembly (Figure 1, Item 5) from flywheel assembly (Figure 1, Item 2). Discard bolts.
2. Remove two self-locking bolts (Figure 1, Item 4) from flywheel assembly (Figure 1, Item 2) and crankshaft (Figure 1, Item 1). Thread two guide studs (Figure 1, Item 7) in locations where bolts were removed. Discard bolts.
3. Remove remaining four self-locking bolts (Figure 1, Item 4) and scuff plate (Figure 1, Item 3). Discard bolts.

**WARNING**

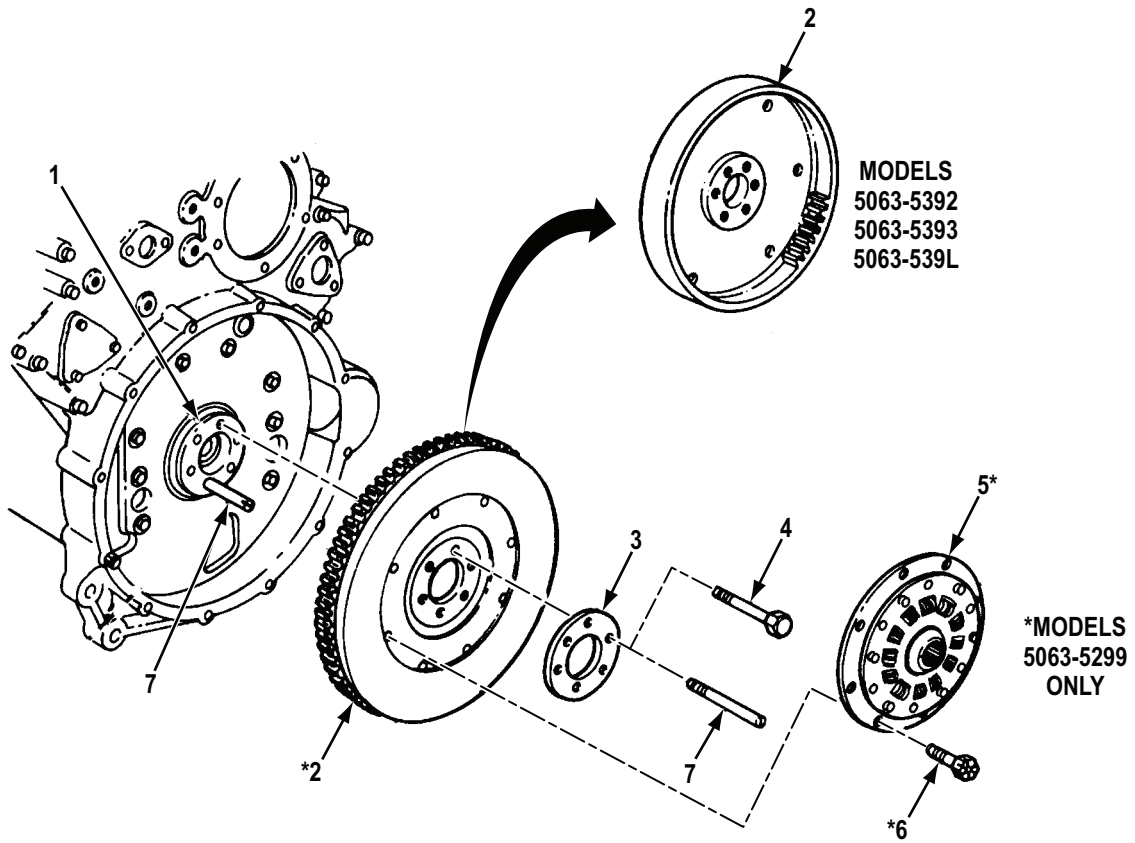
Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

**NOTE**

Flywheel on model 5063-5299 is heavy. Use two 3/8-16 eye bolts and multiple leg sling to lift flywheel.

4. Break flywheel assembly (Figure 1, Item 2) loose from crankshaft and slide off guide studs.
5. Remove two guide studs (Figure 1, Item 7) from crankshaft (Figure 1, Item 1).

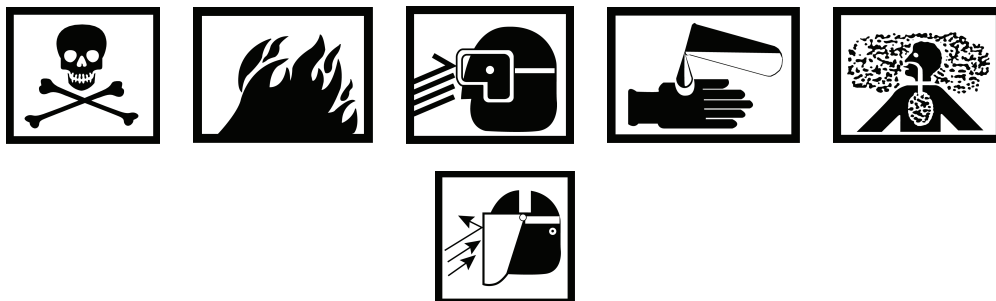
REMOVAL - Continued



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Figure 1. Flywheel Removal.

END OF TASK

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. For model 5063-5299, wash clutch plate assembly with cleaning solvent and dry with compressed air.
2. Clean flywheel assembly with cleaning solvent.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Check clutch plate assembly for broken or worn springs, cracked or worn plates, and worn hub splines.

**NOTE**

Although flywheels seldom require replacement, the flywheel ring gear may become worn due to normal usage or damaged by improper use of starting motor. If gear is worn or damaged, a replacement ring gear is required.

Ring tooth loss, chips, or wear must not exceed 25% of teeth in more than three places or two adjacent teeth.

2. Check flywheel assembly for cracks, worn teeth, or other damage. Replace ring gear if necessary.
3. Check end of crankshaft and flywheel mating surfaces for fretting or brinelling. If this condition is present, lightly stone surfaces.

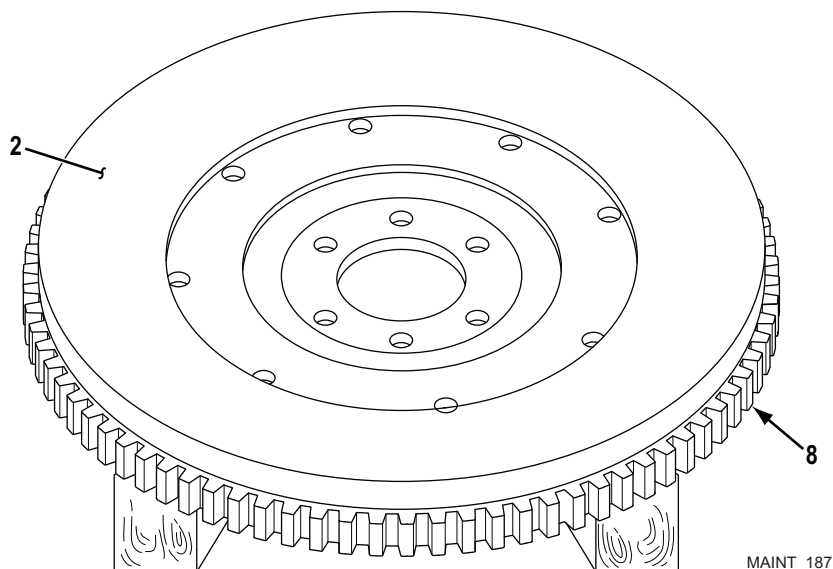
**END OF TASK**



**REPLACEMENT****WARNING**

Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

1. Remove ring gear (Figure 2, Item 8) from flywheel assembly as follows:
  - a. Place flywheel assembly (Figure 2, Item 2), crankshaft side down, on a solid flat surface or hardwood blocks which fit inside diameter of ring gear (Figure 2, Item 8).
  - b. Drive gear (Figure 2, Item 8) off flywheel assembly (Figure 2, Item 2) using a brass drift and hammer. Work around circumference of ring gear to avoid binding.



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Figure 2. Flywheel Inspection.

**REPLACEMENT - Continued**

2. Install ring gear (Figure 3, Item 8) on flywheel (Figure 3, Item 9) as follows:
  - a. Place flywheel (Figure 3, Item 9), crankshaft side up, on a solid flat surface.

**WARNING**

Hot metal components dissipate heat quickly. Wear heat-resistant gloves when handling heated parts. If you receive burns, immerse burn in cold water and seek medical aid. Failure to comply may result in injury to personnel.

**CAUTION**

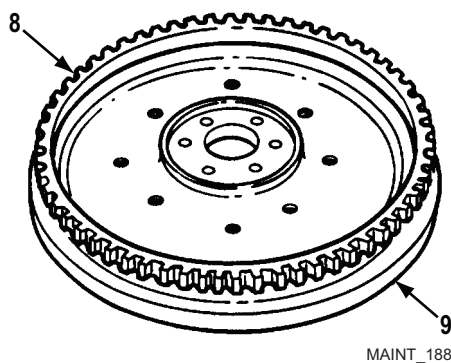
If a torch is used to heat ring gear, keep torch moving around circumference of gear to avoid hot spots. Do not heat over 400°F (204°C) under any circumstances. Excessive heat may destroy original heat treatment. Apply heat-indicating compound to work surface, which melts at a predetermined temperature, to determine heat range.

- b. Place ring gear (Figure 3, Item 8) on a metal surface and heat uniformly. Heat source can be a blow torch, acetylene torch, or oven.
- c. After ring gear is heated, place it in position on flywheel (Figure 3, Item 9).

**NOTE**

If ring gear cannot be tapped into place readily, repeat Steps 1–2.c. above.

- d. Tap ring gear (Figure 3, Item 8) into place against shoulder of flywheel (Figure 3, Item 9) using a brass drift and hammer. Work around circumference of flywheel to avoid binding.



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Figure 3. Flywheel Replacement.

**END OF TASK**

## INSTALLATION

1. Apply water displacing compound or equivalent to threads and to bolt head contact area (underside) of all flywheel-fastening bolts (Figure 4, Item 4). Fill threads completely with compound and remove excess.
2. Thread two guide studs (Figure 4, Item 7) into bolt holes of crankshaft (Figure 4, Item 1).

## WARNING



Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

## NOTE

Flywheel on model 5063-5299 is heavy. Use two 3/8-16 eye bolts and multiple leg sling to lift flywheel.

3. Guide flywheel assembly (Figure 4, Item 2) over guide studs (Figure 4, Item 7) and into bell of flywheel housing.
4. Install scuff plate (Figure 4, Item 3) and four self-locking bolts (Figure 4, Item 4). Snug bolts to hold plate and flywheel assembly in place against crankshaft.
5. Remove guide studs (Figure 4, Item 7) and install two remaining bolts (Figure 4, Item 4). Snug bolts.
6. Torque bolts (Figure 4, Item 4) to 48–52 lb-ft (65–71 N·m).
7. Turn bolts (Figure 4, Item 4) an additional 90–120 degrees to obtain required clamping force.

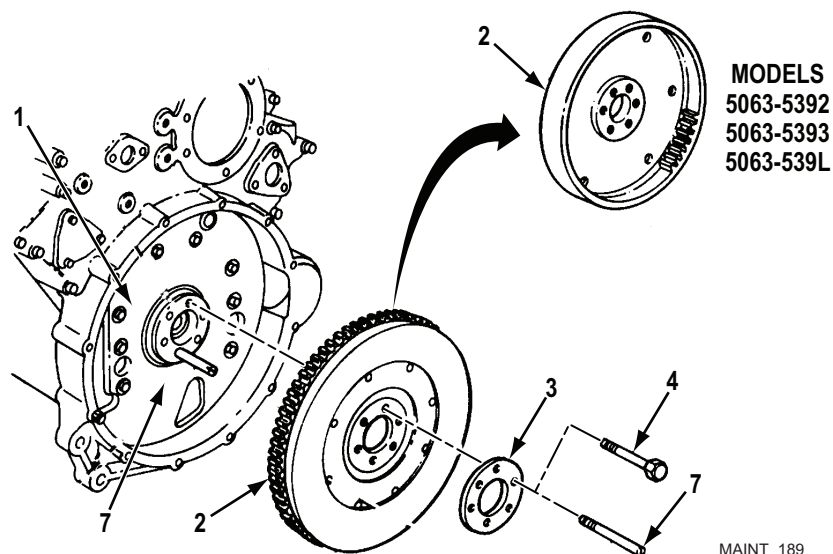


Figure 4. Flywheel Installation.

**INSTALLATION - Continued****NOTE**

On model 5063-5299, measure flywheel face runout before installing clutch plate assembly.

8. On model 5063-5299, install clutch plate assembly (Figure 5, Item 5) and eight new bolts (Figure 5, Item 6) to flywheel assembly (Figure 5, Item 2). Torque bolts to 30–35 lb-ft (41–47 N·m).

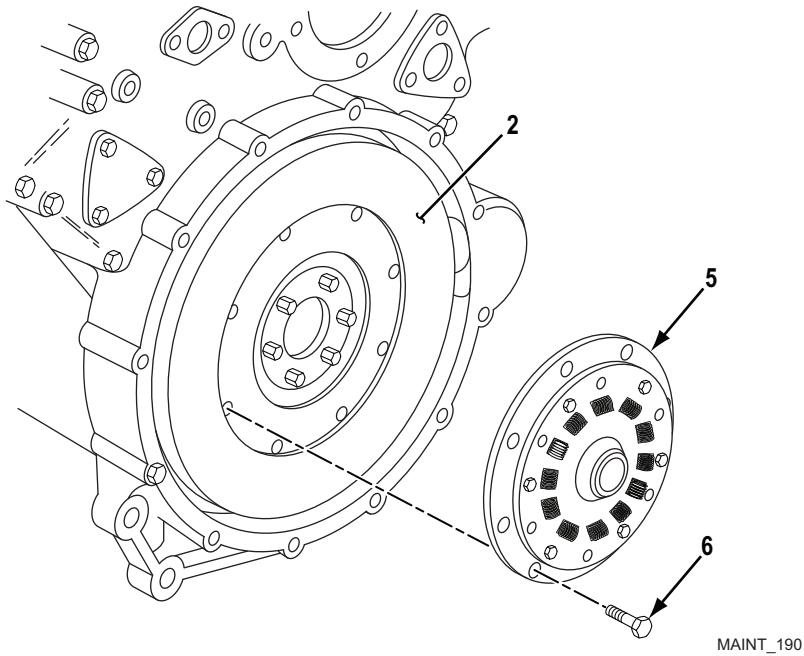


Figure 5. Flywheel Installation, (Model 5063-5299).

**END OF TASK**

**TESTING**

1. Measure flywheel face runout as follows:
  - a. Mount flywheel housing gage (Figure 6, Item 11) on flywheel housing (Figure 6, Item 10) with dial indicator needle against clutch contact face of flywheel (Figure 6, Item 2).
  - b. Pry flywheel assembly (Figure 6, Item 2) toward engine block (at six o'clock position) to ensure endplay is in one direction.
  - c. Adjust dial indicator on flywheel housing gage (Figure 6, Item 11) to read zero at 12 o'clock position.

**CAUTION**

When using hexagon head bolt at front of crankshaft to rotate crankshaft, always turn bolt clockwise. Serious engine damage may result if bolt becomes loose.

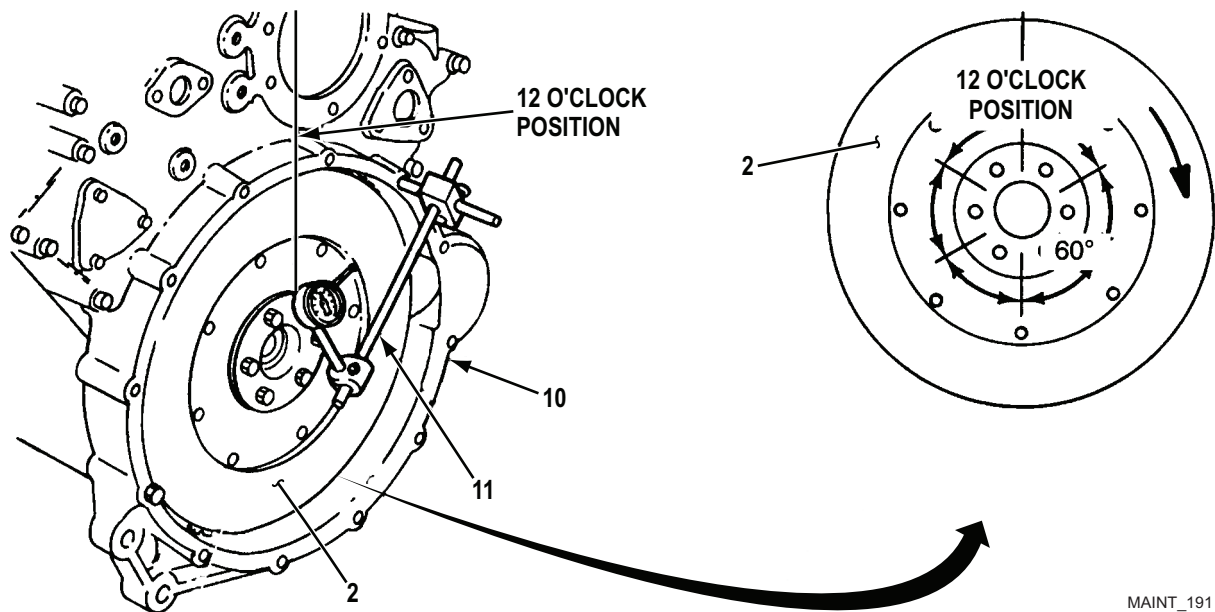
- d. Rotate crankshaft and record readings at 60 degree intervals (six readings). Pry flywheel assembly (Figure 6, Item 2) toward engine block before taking each reading.

**NOTE**

Runout is the maximum negative reading plus the maximum positive reading. For example, if maximum readings were 0.004 inch (0.102 mm) and -0.007 inch (-0.178 mm), then runout is 0.011 inch (0.280 mm).

Maximum allowable runout is 0.001 inch (0.025 mm) per inch (25.4 mm) of radius. Measure radius from center of flywheel assembly (Figure 6, Item 2) to dial indicator needle (clutch contact face). For example, if the radius is 12 inches (304.8 mm), then the runout should be less than 0.012 inch (0.305 mm).

- e. If flywheel face runout exceeds its maximum limit, remove flywheel assembly (Figure 6, Item 2) and check for dirt or foreign material between crankshaft and flywheel. Mount flywheel assembly. If readings are still out of limits, replace flywheel assembly.



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Figure 6. Flywheel Runout Check.

2. Measure flywheel housing bore concentricity and face runout as follows:
  - a. Mount dial indicator base (Figure 7, Item 14) to flywheel assembly (Figure 7, Item 2).
  - b. Install one dial indicator (Figure 7, Item 12) perpendicular to flywheel housing bell face and a second dial indicator (Figure 7, Item 13) against flywheel housing bell bore.
  - c. Pry flywheel assembly (Figure 7, Item 2) toward engine block (at six o'clock position) to ensure endplay is in one direction.
  - d. Adjust dial indicators to read zero at 12 o'clock position.

### CAUTION

When using hexagon head bolt at front of crankshaft to rotate crankshaft, always turn bolt clockwise. Serious engine damage may result if bolt becomes loose.

### NOTE

Total indicator reading is the maximum negative reading plus the maximum positive reading. For example, if maximum readings were 0.004 inch (0.102 mm) and -0.007 inch (-0.178 mm), then runout is 0.011 inch (0.280 mm).

Maximum total indicator reading must not exceed 0.013 inch (0.330 mm) for either bore concentricity or face runout.

- e. With assistant rotating front of crankshaft clockwise, record readings at 60 degree intervals (six readings each for bell bore and face). Pry flywheel assembly (Figure 7, Item 2) toward engine block before taking each reading.
- f. If bore concentricity or face runout exceeds its maximum limit, remove flywheel housing and check for foreign material on end plate, flywheel housing, and cylinder block mounting surfaces. Mount end plate and housing. If either reading is still out of limits, replace flywheel housing (WP 0088).

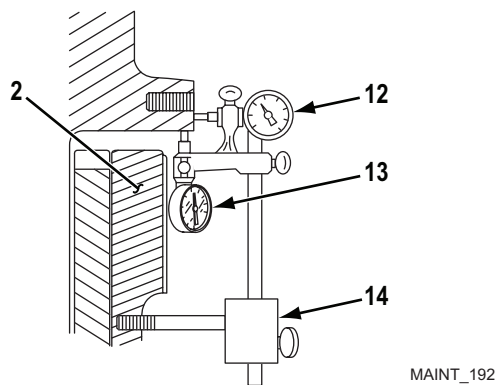


Figure 7. Flywheel Runout Dial Indicator Placement.

**END OF TASK**

**END OF WORK PACKAGE**

## FIELD MAINTENANCE

### REAR CRANKSHAFT OIL SEAL REPLACEMENT

#### INITIAL SETUP:

##### Tools and Special Tools

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)  
Insertor, Seal (Crankshaft Oil, Rear)  
(WP 0104, Table 1, Item 59)  
Handle, Driver (Seal Installer)  
(WP 0104, Table 1, Item 49)

##### Materials/Parts (cont.)

Screw, Sheet Metal  
Qty: (2) (WP 0103, Table 1, Item 50)  
Seal, Plain Encased  
(WP 0105, Table 1, Item 137)  
Washer, Flat Qty: (2) (WP 0103, Table 1, Item 68)

##### Personnel Required

Mechanic  
Helper (H)

##### Materials/Parts

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Crocus Cloth (WP 0103, Table 1, Item 10)  
Oil, Fuel (WP 0103, Table 1, Item 30)

##### Equipment Condition

Flywheel removed WP 0070

#### REMOVAL

1. Center punch two holes in casing of oil seal (Figure 1, Item 3) on opposite sides.
2. Install two sheet metal screws (Figure 1, Item 2) and two flat washers (Figure 1, Item 1).

#### CAUTION

Do not pry against crankshaft or gouging will result.

3. Pry against flat washers (Figure 1, Item 1) with pry bars to remove seal. Discard seal.

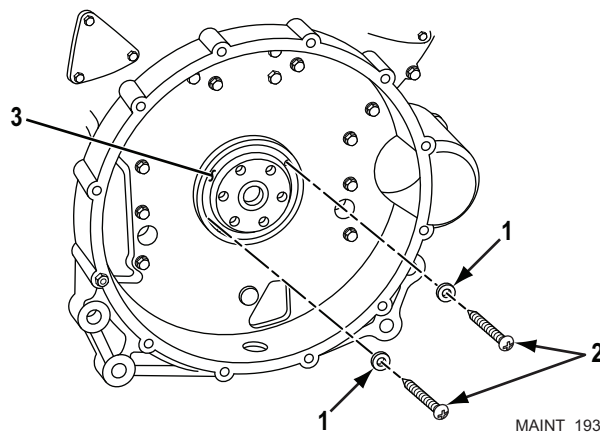
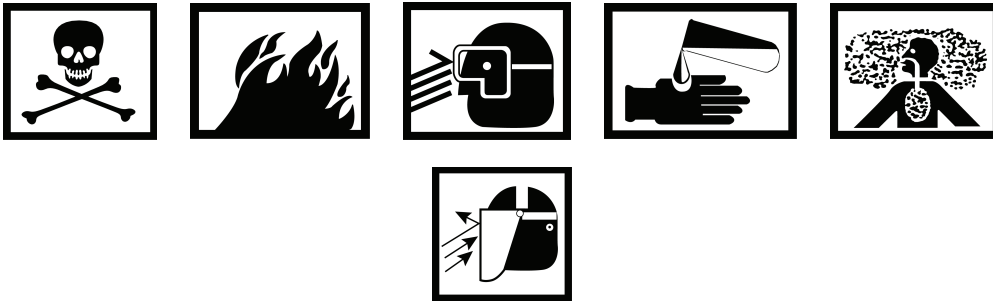


Figure 1. Rear Crankshaft Oil Seal Removal.

#### END OF TASK

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Clean flywheel housing seal bore.
2. Clean rear of crankshaft and flywheel housing seal bore with cleaning solvent and dry with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA****CAUTION**

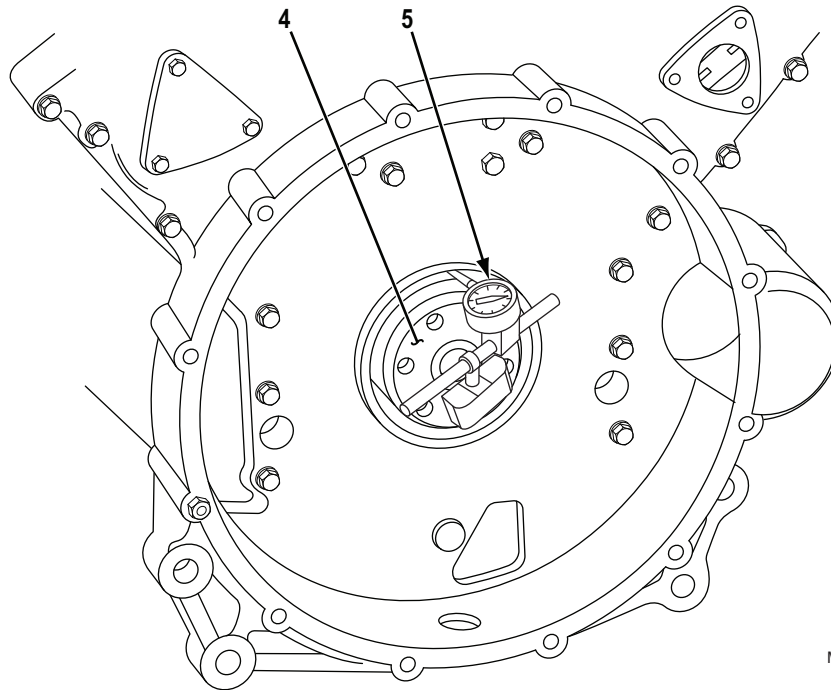
Do not polish parallel to crankshaft axis or ridges will result in sealing surface and cause oil leakage.

1. Inspect rear end of crankshaft (Figure 2, Item 4) for wear due to rubbing action of seal, dirt build up, or fretting by action of flywheel. Remove slight ridges from rear of crankshaft by working around circumference with crocus cloth wetted with fuel oil.

**CAUTION**

When using hexagon head bolt at front of crankshaft to rotate crankshaft, always turn bolt clockwise. Serious engine damage may result if bolt becomes loose.

2. Check runout of seal bore as follows:
  - a. Mount a dial indicator with magnetic base (Figure 2, Item 5) on rear of crankshaft (Figure 2, Item 4).
  - b. With an assistant rotating front of crankshaft clockwise, note runout reading. Maximum allowable runout of bore is 0.008 inch (0.20 mm).



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Figure 2. Rear Crankshaft Oil Seal Runout Check.

**END OF TASK**

**INSTALLATION****CAUTION**

Crankshaft surface must be clean and smooth to prevent damage to seal lip when a new seal is installed.

Do not scratch or nick sealing edge of oil seal or oil leakage past seal will result.

Do not lubricate new seal or crankshaft end prior to installation. Teflon-lip oil seals must be installed dry for proper sealing.

**NOTE**

Teflon-lip oil seal is packaged with plastic sleeve to protect seal lip during shipment and function as an installation tool.

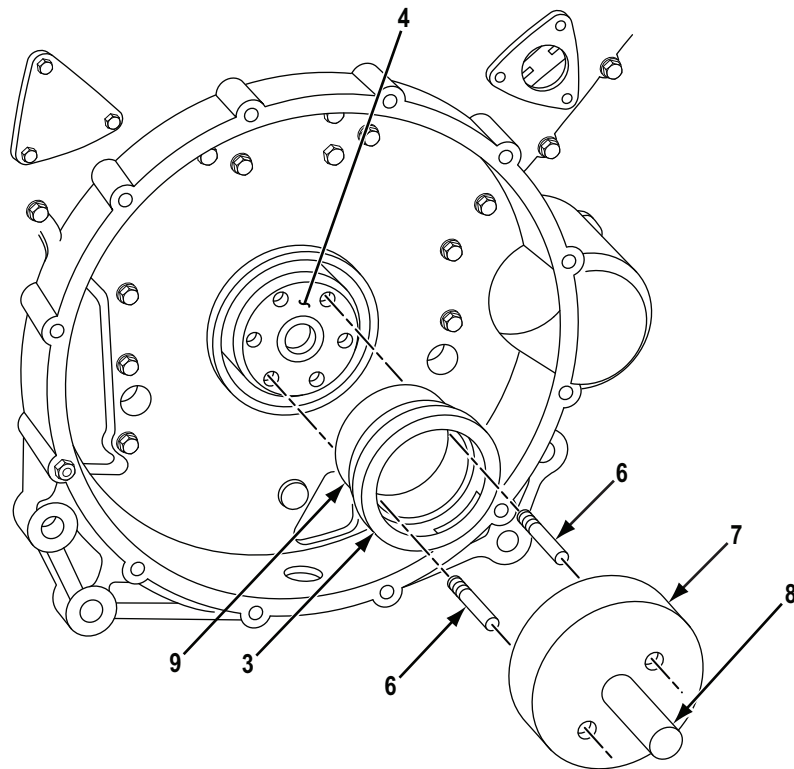
If oil seal is off plastic installation sleeve, push larger end of sleeve through seal in same direction seal lip is pointing.

1. Place installation sleeve (Figure 3, Item 9) and seal (Figure 3, Item 3) together on crankshaft (Figure 3, Item 4).
2. Slide seal (Figure 3, Item 3) off installation sleeve (Figure 3, Item 9) and onto crankshaft. Remove sleeve.
3. Install two guide studs (Figure 3, Item 6) in crankshaft.

**NOTE**

If ridge is present on crankshaft from previous oil seals, do not drive oil seal completely into flywheel housing. Drive oil seal only onto a smooth section of crankshaft. Do not drive oil seal more than 1/8 inch from original position.

4. Using seal inserter (Figure 3, Item 7) with driver handle (Figure 3, Item 8), drive seal until seal inserter contacts face of flywheel housing.
5. Remove seal inserter (Figure 3, Item 7), two guide studs (Figure 3, Item 6), and driver handle (Figure 3, Item 8).

**INSTALLATION - Continued**

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Figure 3. Rear Crankshaft Oil Seal Installation.

**END OF TASK****FOLLOW ON TASK**

Install flywheel (WP 0070).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE**  
**INJECTOR CONTROL TUBE AND THROTTLE DELAY REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Nut, Self-locking (WP 0105, Table 1, Item 170)  
Nut, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 29)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 177)

**References**

WP 0078

**Equipment Condition**

Rocker arm covers removed (model 5063-5299)  
(WP 0052)  
Rocker arm covers removed (models 5063-5392,  
5063-5393, and 5063-539L) (WP 0053)  
Throttle control rods disconnected (WP 0061)

**REMOVAL****NOTE**

Steps 1 and 4 apply to throttle delay assembly used on right side of all except model 5063-5299.

Place wiping rag over oil drain holes to prevent loss of parts.

1. Remove two nuts (Figure 1, Item 3), two lockwashers (Figure 1, Item 2), and U-bolt (Figure 1, Item 8) from throttle delay lever assembly (Figure 1, Item 9). Discard lockwashers.
2. Remove four screws (Figure 1, Item 7) fastening injector control tube brackets (Figure 1, Item 6) to cylinder head.
3. Disengage control rack levers (Figure 1, Item 11) from injector control racks (Figure 1, Item 1) and lift tube assembly (Figure 1, Item 10) from cylinder head.
4. Remove piston and link assembly (Figure 1, Item 5) from throttle delay bracket (Figure 1, Item 4).

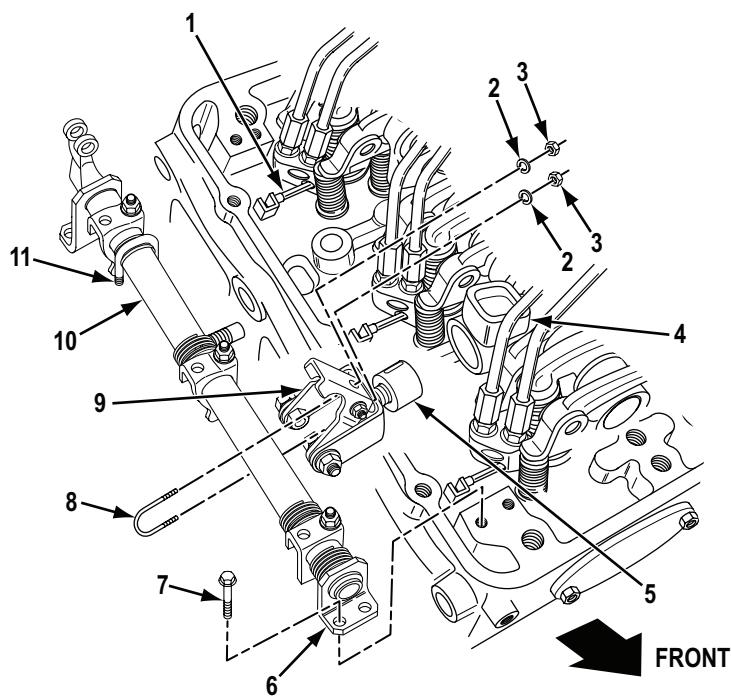


Figure 1. Injector Control Tube Removal.

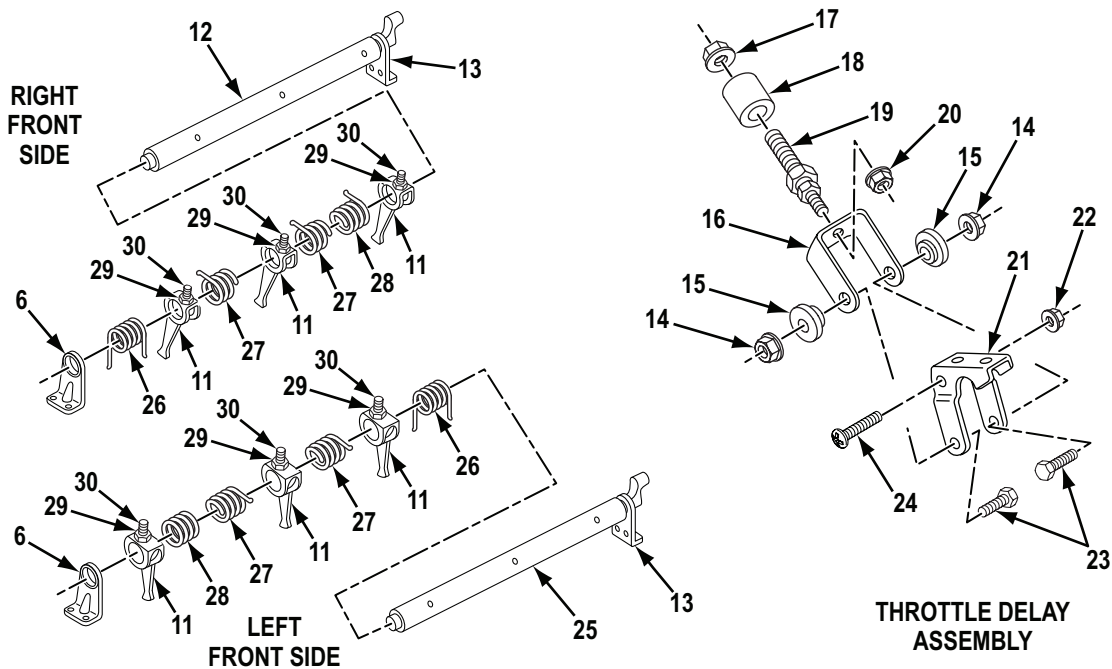
**END OF TASK****DISASSEMBLY****NOTE**

Note shape and location of the yield and return springs during disassembly.

1. Injector control tube assembly (left or right)
  - a. For left control tube assembly, remove bracket (Figure 2, Item 6) from front of tube.

**DISASSEMBLY - Continued**

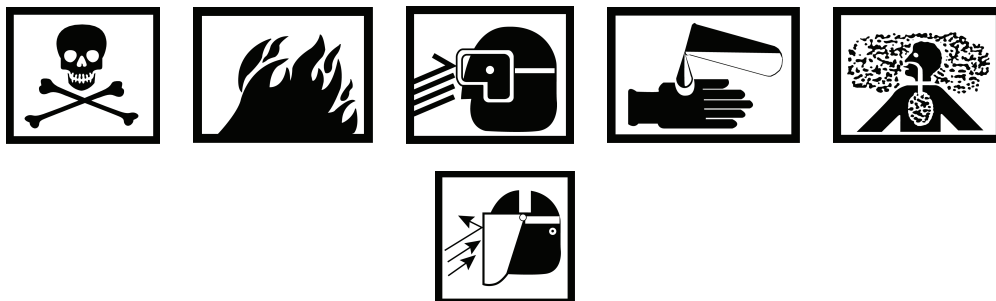
- b. Loosen locknut (Figure 2, Item 29) and adjusting screw (Figure 2, Item 30) from control lever (Figure 2, Item 11).
  - c. Disconnect yield spring (Figure 2, Items 27 or 28) from each control lever (Figure 2, Item 11). Roll yield springs out of slots and notches of control tube (Figure 2, Items 25 or 12).
  - d. Disconnect return spring (Figure 2, Item 26) from bracket (Figure 2, Item 13) and control lever (Figure 2, Item 11) at rear of left control tube (Figure 2, Item 25) or from bracket (Figure 2, Item 6) and control lever at front of right control tube (Figure 2, Item 12).
  - e. For right control tube assembly, remove bracket (Figure 2, Item 6) from front of tube.
  - f. Slide three control levers (Figure 2, Item 11), two yield springs (Figure 2, Item 27), yield spring (Figure 2, Item 28), and return spring (Figure 2, Item 26) off front of control tube (Figure 2, Items 25 and 12).
2. Throttle delay assembly
- a. Remove two locknuts (Figure 2, Item 14), two bushings (Figure 2, Item 15), two screws (Figure 2, Item 23), and link (Figure 2, Item 16) from bracket (Figure 2, Item 21). Discard nuts.
  - b. If necessary, remove locknut (Figure 2, Item 22) and machine screw (Figure 2, Item 24) from bracket (Figure 2, Item 21). Discard nut.
  - c. Remove locknut (Figure 2, Item 20) and link (Figure 2, Item 16) from joint (Figure 2, Item 19). Discard nut.
  - d. Remove locknut (Figure 2, Item 17) and joint (Figure 2, Item 19) from piston (Figure 2, Item 18). Discard nut.



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Figure 2. Injector Control Tube Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash components with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect components for excessive wear, cracks, or damage. Replace if necessary.
2. Inspect yield springs and return springs for wear and fractures.

**END OF TASK****ASSEMBLY**

1. Left injector control tube assembly
  - a. Install return spring (Figure 3, Item 26) on control tube (Figure 3, Item 25) and against rear bracket (Figure 3, Item 13).
  - b. Install two of right-hand helix springs (Figure 3, Item 27) and two control levers (Figure 3, Item 11) on control tube (Figure 3, Item 25) with control levers facing rear of control tube.
  - c. Install left-hand helix yield spring (Figure 3, Item 28) and control lever (Figure 3, Item 11) on control tube (Figure 3, Item 25) with control lever facing rear of control tube.
  - d. Connect curled end of two yield springs (Figure 3, Item 27) and yield spring (Figure 3, Item 28) to three rack control levers (Figure 3, Item 11) and roll yield springs into notch or slots in control tube (Figure 3, Item 25). Turn three adjusting screws (Figure 3, Item 30) with locknuts (Figure 3, Item 29) far enough into slots to position levers on control tube.
  - e. Connect curled end of control tube return spring (Figure 3, Item 26) to rack control lever (Figure 3, Item 11) and extended end of spring behind rear bracket (Figure 3, Item 13).
  - f. Install bracket (Figure 3, Item 6) to front of control tube (Figure 3, Item 25).



**ASSEMBLY - Continued**

2. Right injector control tube assembly
  - a. Install control lever (Figure 3, Item 11) and left-hand helix yield spring (Figure 3, Item 28) on control tube (Figure 3, Item 12) with control lever facing front of control tube.
  - b. Install two of right-hand helix yield springs (Figure 3, Item 27) and control levers (Figure 3, Item 11) on control tube (Figure 3, Item 12) with control lever facing front of control tube.
  - c. Connect curled end of two yield springs (Figure 3, Item 27) and yield spring (Figure 3, Item 28) to three rack control levers (Figure 3, Item 11) and roll yield springs into notch or slots in control tube (Figure 3, Item 12). Turn three adjusting screws (Figure 3, Item 30) with locknuts (Figure 3, Item 29) far enough into slots to position levers on control tube.
  - d. Install return spring (Figure 3, Item 26) and bracket (Figure 3, Item 6) at front of control tube (Figure 3, Item 12). Connect curled end of return spring to rack control lever and extended end of spring behind bracket.
3. Throttle delay assembly
  - a. Install joint (Figure 3, Item 19) and new locknut (Figure 3, Item 17) on piston (Figure 3, Item 18). Tighten nut.
  - b. Install link (Figure 3, Item 16) and new locknut (Figure 3, Item 20) on joint (Figure 3, Item 19). Tighten nut.
  - c. If removed, install screw (Figure 3, Item 24) and new locknut (Figure 3, Item 22) on bracket (Figure 3, Item 21). Tighten nut until width between legs is 1-7/16 inches (36.5 mm).
  - d. Install link (Figure 3, Item 16), two screws (Figure 3, Item 23), two bushings (Figure 3, Item 15), and two new locknuts (Figure 3, Item 14) on bracket (Figure 3, Item 21). Tighten nuts.

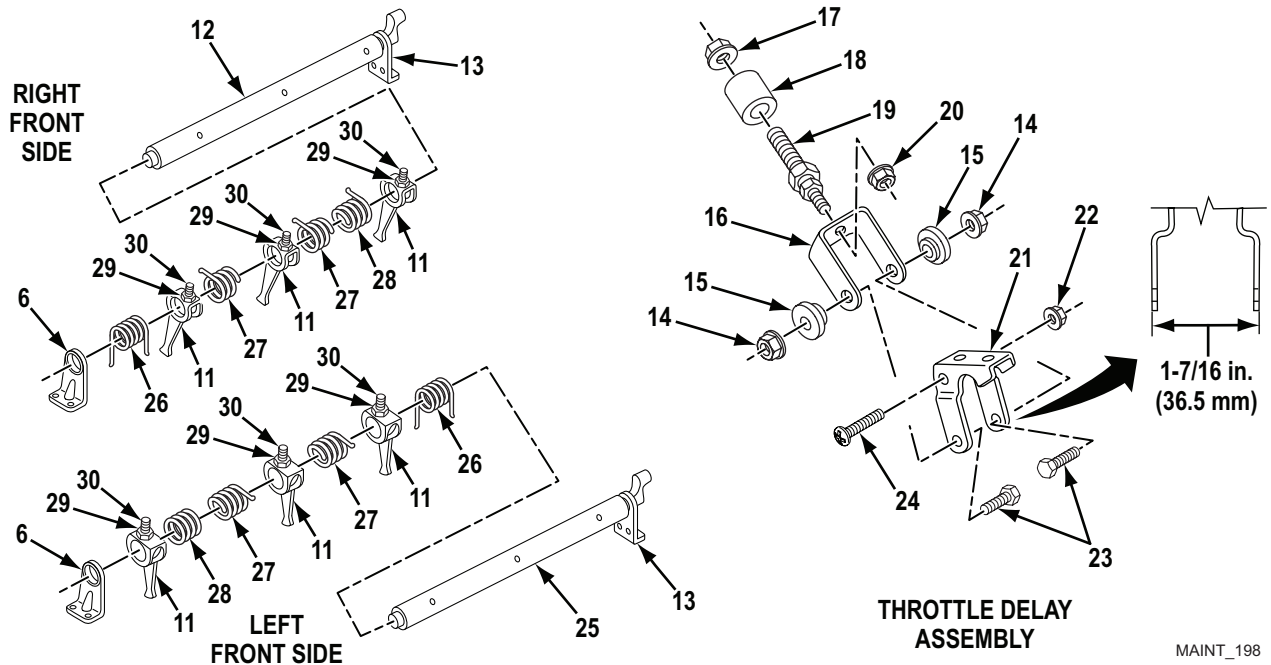


Figure 3. Injector Control Tube Assembly.

**END OF TASK**

## INSTALLATION

### NOTE

Steps 1 and 4 apply to throttle delay assembly used on right side of all except model 5063-5299.

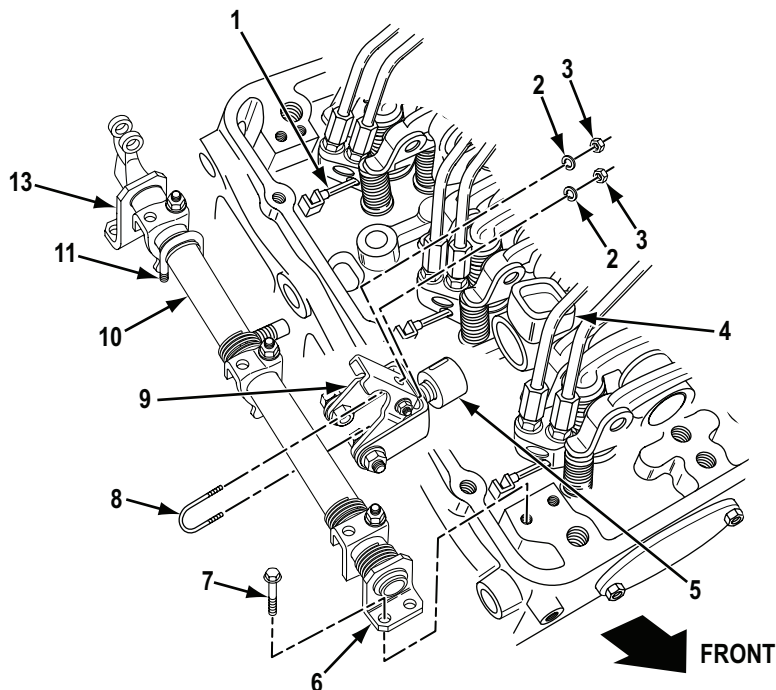
Legs on lever assembly (Figure 4, Item 9) must face downward and be inboard of control tube.

1. Slide throttle delay piston and linkage assembly (Figure 4, Item 5) in bore of housing (Figure 4, Item 4).
2. Place injector control tube assembly (Figure 4, Item 10) on cylinder head. Engage control levers (Figure 4, Item 11) with injector control racks (Figure 4, Item 1) and place end brackets (Figure 4, Items 6 and 13) over mounting holes in cylinder head.
3. Install four screws (Figure 4, Item 7) through end brackets into cylinder head. Torque screws to 120–144 lb-in(14–16 N·m).
4. Check control tube to ensure it moves freely in end brackets (Figure 4, Items 6 and 13). If necessary, tap control tube lightly to align bearing in brackets.

### NOTE

Final torque of nuts (Figure 4, Item 3) is done during throttle delay adjustment of tune-up (WP 0078).

5. Install U-bolt (Figure 4, Item 8) around bottom of control tube and through lever assembly (Figure 4, Item 9). Install two new lockwashers (Figure 4, Item 2) and two nuts (Figure 4, Item 3) on U-bolt. Tighten nuts snug.



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Figure 4. Injector Control Tube Installation.

END OF TASK

**FOLLOW ON TASK**

1. Connect throttle control rods (WP 0061).
2. Install rocker arm covers (models 5063-5392, 5063-5393, and 5063-539L) (WP 0053).
3. Install rocker arm covers (model 5063-5299) (WP 0052).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
CYLINDER HEAD ASSEMBLY REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Fixture, Lifting, Cylinder Head  
(WP 0104, Table 1, Item 29)  
Stud, Cylinder Head Guide  
(WP 0104, Table 1, Item 102)  
Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Gasket, Compression  
Qty: (6) (WP 0105, Table 1, Item 63)  
Seal Qty: (4) (WP 0105, Table 1, Item 44)  
Seal Qty: (8) (WP 0105, Table 1, Item 50)  
Seal Qty: (8) (WP 0105, Table 1, Item 62)  
Seal Strip Qty: (2) (WP 0105, Table 1, Item 51)  
Washer, Lock (WP 0105, Table 1, Item 23)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)  
Wood Block Qty: (2) (WP 0103, Table 1, Item 71)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Exhaust manifolds removed (WP 0039)

**Equipment Condition (cont.)**

Water outlet elbow and thermostat housing  
removed (models 5063-5299 and 5063-5392)  
(WP 0047)  
Water outlet elbow and thermostat housing  
removed (models 5063-5393 and 5063-539L)  
(WP 0048)  
Fuel lines removed (model 5063-5299)  
(WP 0049)  
Fuel lines removed (model 5063-5392)  
(WP 0050)  
Fuel lines removed  
(models 5063-5393 and 5063-539L)  
(WP 0051)  
Engine rocker arm covers removed  
(model 5063-5299) (WP 0052)  
Engine rocker arm covers removed  
(models 5063-5392, 5063-5393, and  
5063-539L) (WP 0053)  
Throttle control rods removed (WP 0061)  
Fuel rod hoses removed (WP 0062)  
Injector control tubes removed (WP 0072)

**REMOVAL**

1. Install cylinder head lifting fixture (Figure 1, Item 6), two 7/16 nuts (Figure 1, Item 4), and two 7/16 flat washers (Figure 1, Item 5) on exhaust manifold studs (Figure 1, Item 3) located at outboard side of cylinder head.
2. Attach a suitable lifting device to lifting fixture (Figure 1, Item 6) and apply a light tension.
3. Remove two cylinder head bolts (Figure 1, Item 1) from inboard corners of cylinder head and install two cylinder head guide studs (Figure 1, Item 2). Remove remaining six cylinder head bolts.

**WARNING**

Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

**CAUTION**

Place two-inch thick wooden blocks underneath ends of cylinder head before placing on bench to protect cam followers and fuel injector tips from damage.

4. Lift cylinder head assembly (Figure 1, Item 7) from cylinder block.

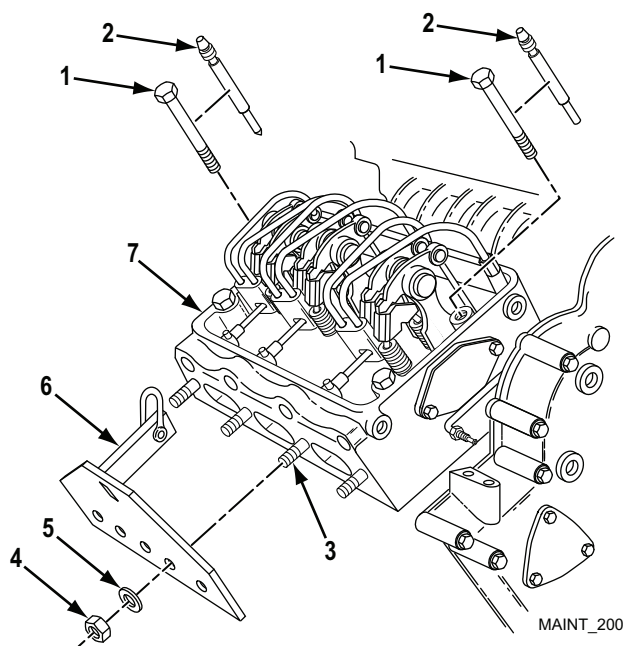


Figure 1. Cylinder Head Removal.

**REMOVAL - Continued**

5. Remove two cylinder head guide studs (Figure 2, Item 2) from cylinder block.
6. Remove three compression gaskets (Figure 2, Item 12), seal strip (Figure 2, Item 8), two seals (Figure 2, Item 9), four seals (Figure 2, Item 10), and four seals (Figure 2, Item 11) from cylinder side. Discard gaskets, seals, and seal strip.

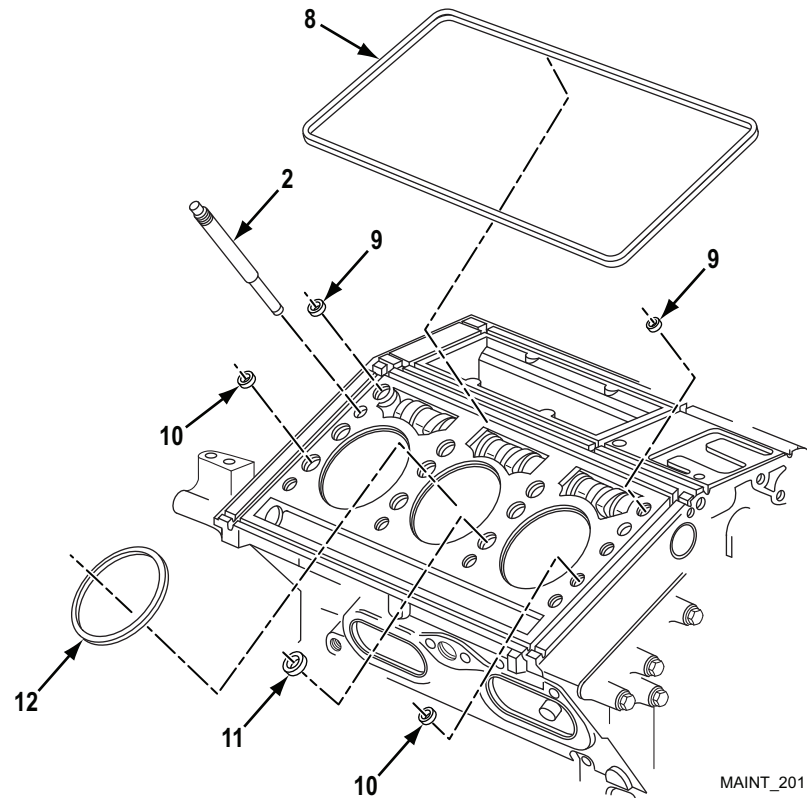


Figure 2. Cylinder Head Gasket Removal/Installation.

**REMOVAL - Continued**

7. Remove lifting fixture (Figure 3, Item 6), two nuts (Figure 3, Item 4), and two flat washers (Figure 3, Item 5) from cylinder head assembly (Figure 3, Item 7).
8. Repeat Steps 1–7 for opposite side.
9. On all except model 5063-5299: for left side, remove bolt (Figure 3, Item 15), lockwasher (Figure 3, Item 16), and clip (Figure 3, Item 17) from rear of cylinder head assembly (Figure 3, Item 7). If necessary, remove clip from fuel spill tube (Figure 3, Item 14). Discard lockwasher.
10. For left side, remove fuel spill tube (Figure 3, Item 14) from elbow (Figure 3, Item 13) at rear of cylinder head assembly (Figure 3, Item 7).

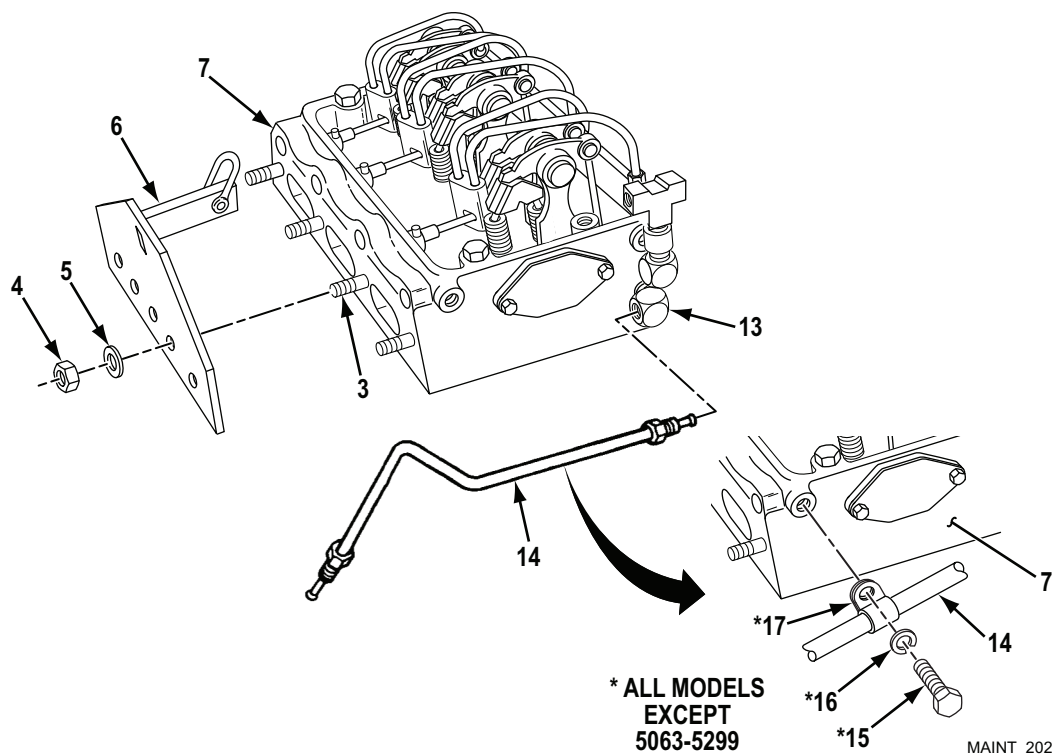


Figure 3. Cylinder Head Installation.

**END OF TASK****INSTALLATION**

1. Connect fuel spill tube (Figure 3, Item 14) to elbow (Figure 3, Item 13). Tighten tube connection.
2. On all except model 5063-5299 for left side: if removed, install clip (Figure 3, Item 17) on fuel spill tube (Figure 3, Item 14) and install bolt (Figure 3, Item 15), new lockwasher (Figure 3, Item 16), and clip on rear of cylinder head assembly (Figure 3, Item 7). Torque bolt to 23–26 lb-ft (31–35 N·m).
3. Install lifting fixture (Figure 3, Item 6), two flat washers (Figure 3, Item 5), and two nuts (Figure 3, Item 4) on exhaust manifold studs (Figure 3, Item 3) on outboard side of cylinder head.
4. Install three new compression gaskets (Figure 2, Item 12), new seal strip (Figure 2, Item 8), two new seals (Figure 2, Item 9), four new seals (Figure 2, Item 10), and four new seals (Figure 2, Item 11) on cylinder side.



**INSTALLATION - Continued**

5. Install two cylinder head guide studs (Figure 2, Item 2) in cylinder head bolt holes at inboard corner positions in cylinder block.

**WARNING**

Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

**CAUTION**

Ensure all gaskets, seals, sleeves, and seal strip are in place before installing cylinder head. A fold or twist of the seal strip can cause a leak.

6. Lift cylinder head above cylinder block and lower over cylinder head guide studs (Figure 1, Item 2). Lower head to 1/2 inch (12.7 mm) from surface of cylinder block. Check position of all gaskets, seals, sleeves, and seal strip and then lower head onto block.
7. Apply water displacing compound to cylinder head bolt threads and underside of bolt head. Install six bolts (Figure 1, Item 1) through cylinder head and thread into cylinder block until bolt heads contact cylinder head.
8. Remove two nuts (Figure 1, Item 4), two flat washers (Figure 1, Item 5), and lifting fixture (Figure 1, Item 6) from cylinder head.
9. Remove two cylinder head guide studs (Figure 1, Item 2) and install remaining bolts (Figure 1, Item 1). Torque all bolts to 15–20 lb-ft (20–27 N·m).

**INSTALLATION - Continued****NOTE**

Repeat tightening sequence at least once because first bolts tightened tend to lose significant clamping load during tightening of remaining bolts. Apply a steady pressure for two or three seconds at prescribed torque to allow bolts to turn while gaskets yield to their designed thickness.

10. Torque cylinder head bolts (Figure 1, Item 1) to 170–180 lb-ft (231–244 N·m) in 50 lb-ft (68 N·m) increments. Tighten bolts in alphabetical sequence shown (Figure 4).
11. Repeat Steps 3–10 for left side.

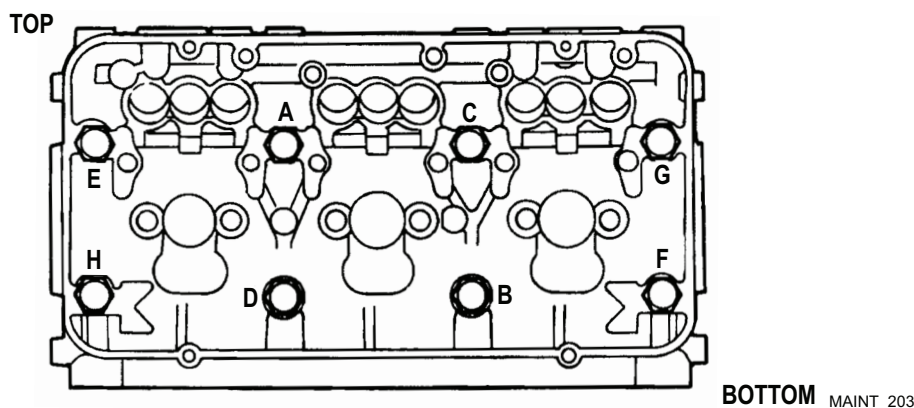


Figure 4. Cylinder Head Torque Sequence.

**END OF TASK****FOLLOW ON TASK**

1. Install injector control tubes (WP 0072).
2. Install fuel rod hoses (WP 0062).
3. Install throttle control rods (WP 0061).
4. Install engine rocker arm covers (models 5063-5392, 5063-5393, and 5063-539L) (WP 0053).
5. Install engine rocker arm covers (model 5063-5299) (WP 0052).
6. Install fuel lines (models 5063-5393 and 5063-539L) (WP 0051).
7. Install fuel lines (model 5063-5392) (WP 0050).
8. Install fuel lines (model 5063-5299) (WP 0049).
9. Install water outlet elbow and thermostat housing (models 5063-5393 and 5063-539L) (WP 0048).
10. Install water outlet elbow and thermostat housing (models 5063-5299 and 5063-5392) (WP 0047).
11. Install exhaust manifolds (WP 0039).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE**  
**AIR PUMP AND IGNITION COIL ASSEMBLY REPLACEMENT**  
**(MODELS 5063-5299, 5063-5392, 5063-5393)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Multimeter, Digital  
(WP 0104, Table 1, Item 70)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Test Lead  
(WP 0081, Figure 15)  
Gage, Tire Pressure  
(WP 0104, Table 1, Item 43)

**Equipment Condition (cont.)**

Air pump and ignition coil assembly removed  
(model 5063-5392) (WP 0043)  
Air pump and ignition coil assembly removed  
(model 5063-5393) (WP 0044)  
Air box heater assembly removed (WP 0046)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Vane Set (WP 0105, Table 1, Item 123)

**Equipment Condition**

Air pump and ignition coil assembly removed  
(model 5063-5299) (WP 0042)

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**DISASSEMBLY**

1. Remove bolt (Figure 1, Item 1), flat washer (Figure 1, Item 2), clamp bracket (Figure 1, Item 3), air pump (Figure 1, Item 7), ignition coil (Figure 1, Item 4), and two cushions (Figure 1, Item 5) from bracket (Figure 1, Item 6).
2. Remove check valve (Figure 1, Item 11), hose (Figure 1, Item 10), and adapter (Figure 1, Item 9) from elbow (Figure 1, Item 8) in air pump (Figure 1, Item 7).
3. If necessary, remove elbow (Figure 1, Item 15) and elbow (Figure 1, Item 8) from air pump (Figure 1, Item 7).
4. Remove three screws (Figure 1, Item 12) and cover (Figure 1, Item 13) from air pump (Figure 1, Item 7).
5. Remove three vanes (Figure 1, Item 14) from rotor of air pump (Figure 1, Item 7). Discard vanes.

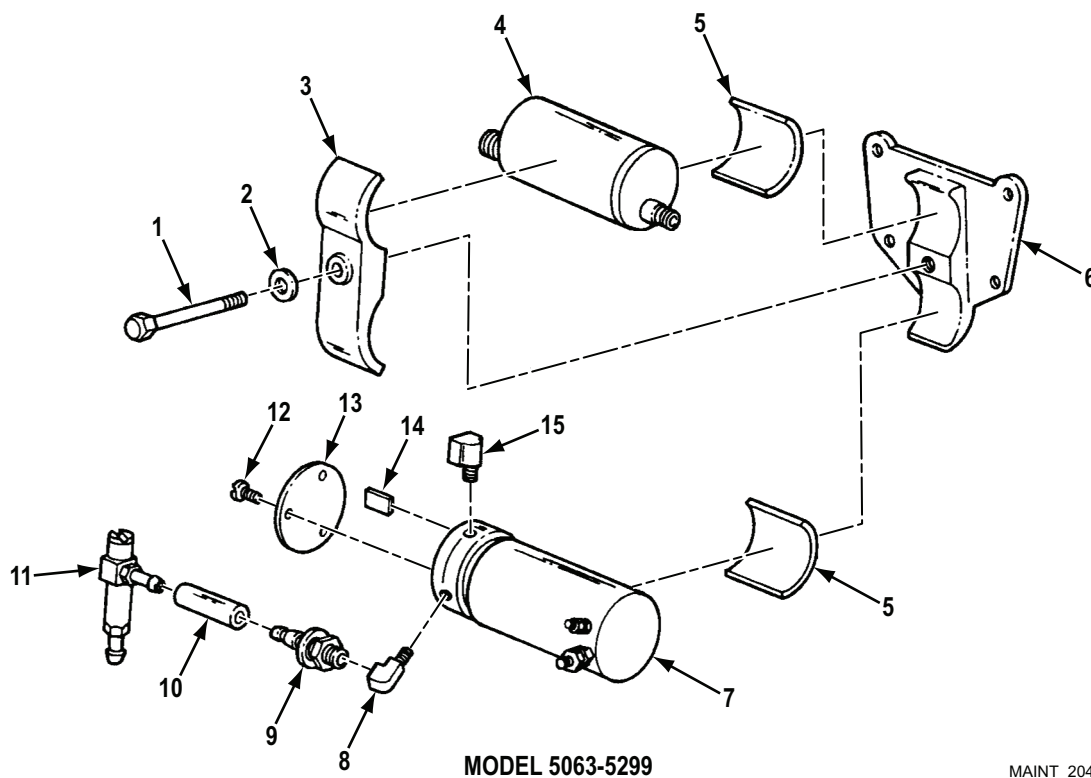
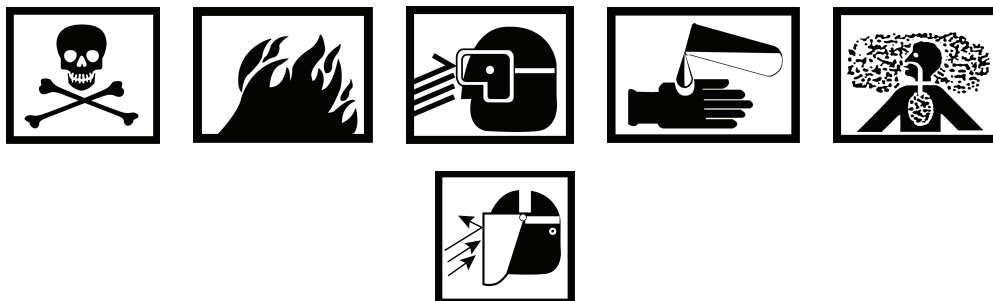


Figure 1. Air Pump and Ignition Coil Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Clean check valve, bracket, clamp, and outer surface of air pump with cleaning solvent and dry with compressed air.
2. Clean ignition coil and cushions with warm water and soap. Dry thoroughly.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect electrical terminals for damage and corrosion. Remove corrosion with a wire brush.
2. Inspect air hose for cuts, tears, kinks, and damage.
3. Inspect air pump rotor and body for excessive wear, corrosion, or other damage.

**END OF TASK**

**TESTING**

## 1. Air pump

**CAUTION**

Do not exceed 18 volts direct current on air pump. Excessive voltage will overspeed air pump and damage pump vanes.

**NOTE**

Install vanes, plate, and screws in air pump before testing.

Use fabricated test lead (Figure 2, Item 16) to reduce a 24 V dc power source to 18 V dc. Connect test lead in series with positive terminal of power source.

- a. Connect an 18 V dc power source to air pump (Figure 2, Item 7). Connect positive lead to terminal (Figure 2, Item 18) marked (+) and negative lead to unmarked terminal (Figure 2, Item 17).

**NOTE**

Use digital multimeter to measure amperage. Adapt pump outlet to fit a tire pressure gage or other suitable measuring device to measure air output pressure.

- b. Measure air pressure and amperage. Air pressure at outlet port elbow (Figure 2, Item 15) must be a minimum of 10 PSI at 18 V dc. Pump must draw a maximum of 25 amperes.
- c. Remove power source from terminals (Figure 2, Item 17 and 18).

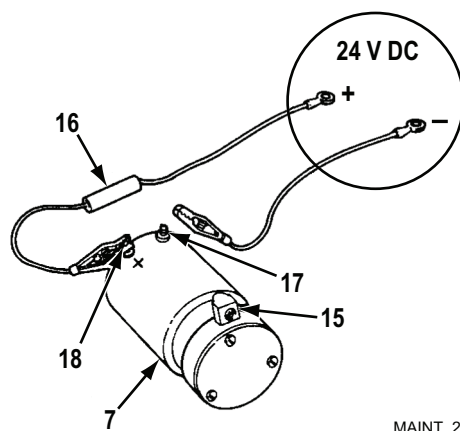


Figure 2. Air Pump Testing.

## 2. Ignition coil and igniter

**NOTE**

Ensure high tension wire used for testing is in good condition.

- a. Connect high tension lead (Figure 3, Item 23) to ignition coil (Figure 3, Item 4) and fuel igniter (Figure 3, Item 21).
- b. Connect air heater assembly (Figure 3, Item 22) and ignition coil (Figure 3, Item 4) to common ground (Figure 3, Item 19).

## TESTING - Continued

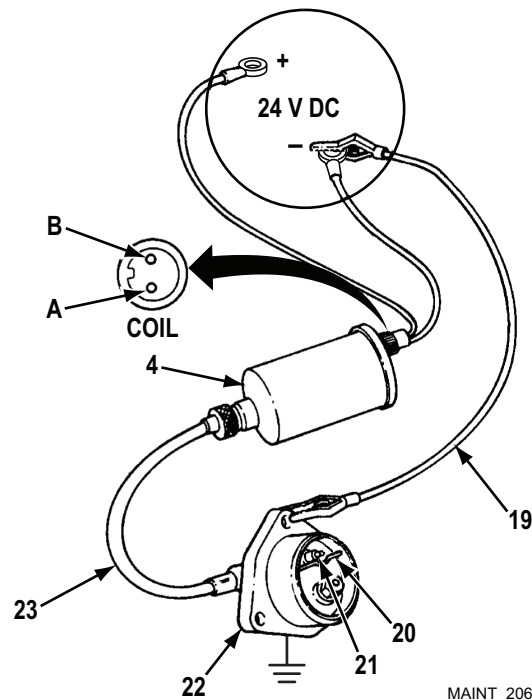
**WARNING**

High voltage is present. Do not touch ignition coil or air heater assembly while performing test. Failure to comply may result in injury to personnel.

**CAUTION**

Do not apply voltage to ignition coil unless coil is connected to air heater assembly. Ground coil and air heater assembly. Connect positive lead to pin (Figure 3, Item A) and negative lead to pin (Figure 3, Item B) or damage to coil will result.

- c. Connect a 24 V dc power source to power input side of ignition coil (Figure 3, Item 4). Observe electric arc between fuel igniter (Figure 3, Item 21) and wire (Figure 3, Item 20). A steady or intermittent (about 10 pulses a second) arc with a popping noise indicates a good coil and igniter.
- d. Disconnect power source and then disconnect leads from coil (Figure 3, Item 4). Remove high tension lead (Figure 3, Item 23) from coil and fuel igniter (Figure 3, Item 21).
- e. Disconnect air heater assembly (Figure 3, Item 22) and ignition coil (Figure 3, Item 4) from common ground (Figure 3, Item 19).



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Figure 3. Ignition Coil and Ignitor Testing.

**END OF TASK**

**ASSEMBLY**

1. Install new three vanes (Figure 4, Item 14) in rotor of air pump (Figure 4, Item 7).
2. Install cover (Figure 4, Item 13) and three screws (Figure 4, Item 12) on air pump (Figure 4, Item 7). Tighten screws.
3. If removed, install elbow (Figure 4, Item 15) in inlet port and elbow (Figure 4, Item 8) in outlet port of air pump (Figure 4, Item 7).
4. Install adapter (Figure 4, Item 9), hose (Figure 4, Item 10), and check valve (Figure 4, Item 11) on outlet elbow (Figure 4, Item 8).
5. Place two cushions (Figure 4, Item 5) on bracket (Figure 4, Item 6). Place ignition coil (Figure 4, Item 4) and air pump (Figure 4, Item 7) on cushions and bracket as shown for the appropriate model.

**NOTE**

Place clamp (Figure 4, Item 3) with cast part number above ignition coil (Figure 4, Item 4).

6. Install clamp bracket (Figure 4, Item 3), flat washer (Figure 4, Item 2), and bolt (Figure 4, Item 1) in bracket (Figure 4, Item 6) over coil (Figure 4, Item 4) and air pump (Figure 4, Item 7). Torque bolt to 60–96 lb-in (7–11 N·m).



ASSEMBLY - Continued

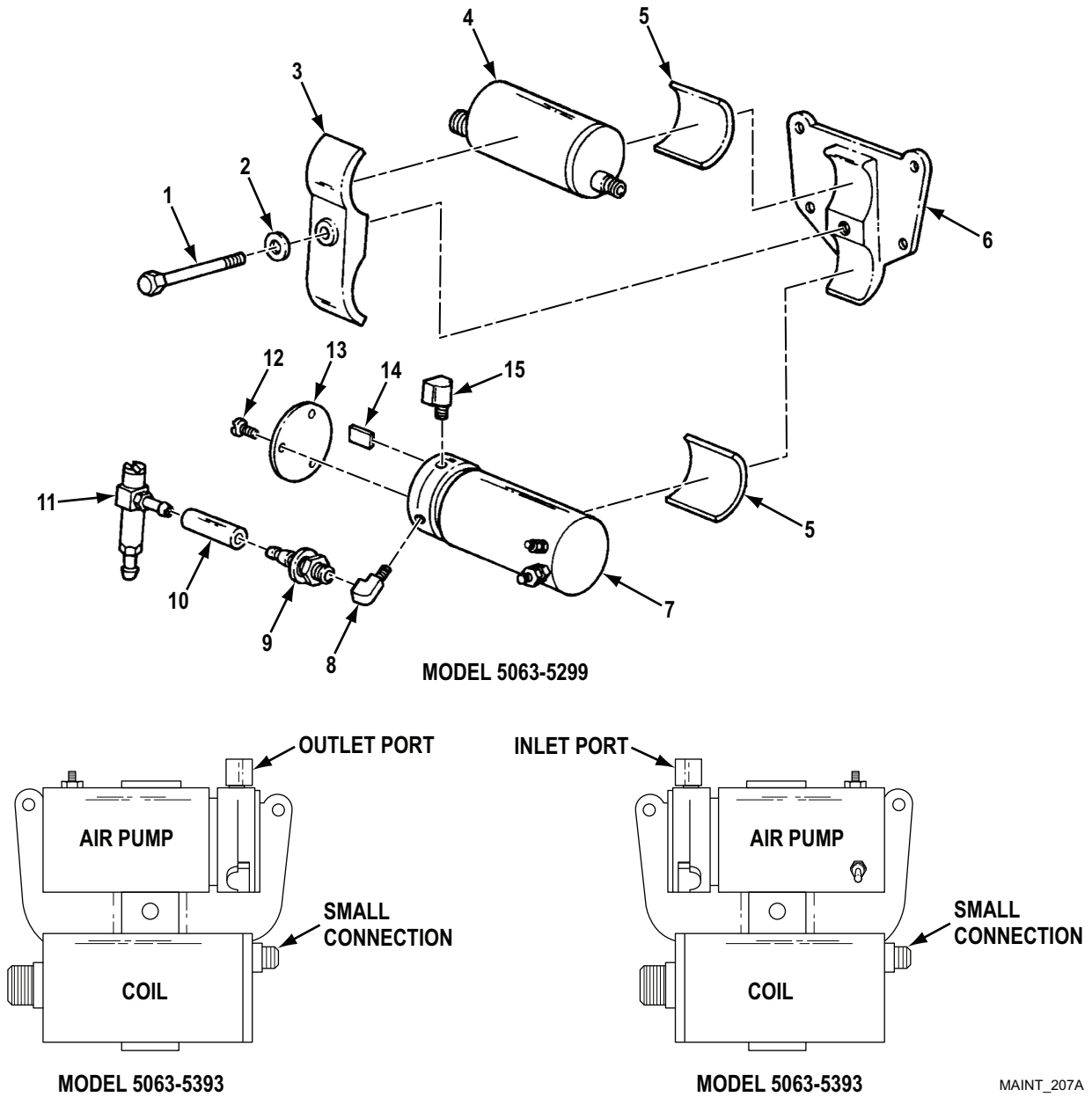


Figure 4. Air Pump and Ignition Coil Assembly.

END OF TASK

**FOLLOW ON TASK**

1. Install air box heater assembly (WP 0046).
2. Install air pump and ignition coil assembly (model 5063-5393) (WP 0044).
3. Install air pump and ignition coil assembly (model 5063-5392) (WP 0043).
4. Install air pump and ignition coil assembly (model 5063-5299) (WP 0042).

**END OF TASK****END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
OIL FILTER ADAPTOR REPAIR**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Tester, Spring  
(WP 0104, Table 1, Item 107)

**Equipment Condition (cont.)**

Oil filter adaptor removed (model 5063-5392)  
(WP 0018)  
Oil filter adaptor removed (models 5063-5393 and  
5063-539L) (WP 0019)

**Materials/Parts**

Oil, Fuel Diesel (WP 0103, Table 1, Item 30)

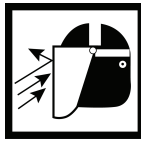
**Equipment Condition**

Oil filter adaptor removed (model 5063-5299)  
(WP 0017)

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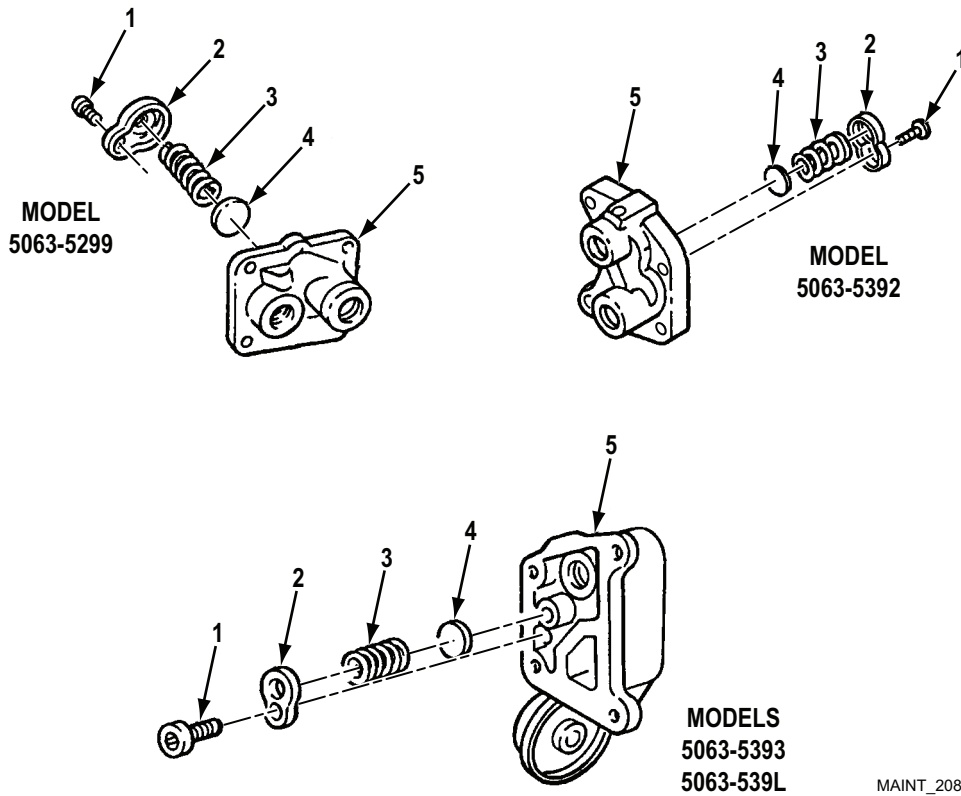
**DISASSEMBLY**

**WARNING**



Spring is under compression. Wear eye protection and use care when removing spring. Failure to comply may result in injury to personnel.

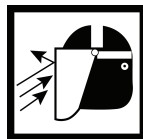
Remove screw (Figure 1, Item 1), retainer (Figure 1, Item 2), spring (Figure 1, Item 3), and bypass valve (Figure 1, Item 4) from adapter (Figure 1, Item 5).



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Figure 1. Oil Filter Adaptor Disassembly/Assembly.

**END OF TASK**

**CLEANING****WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean parts with fuel oil and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect all parts for damage and excessive wear and replace as necessary.
2. Using a spring tester, check bypass spring (Figure 1, Item 3) load. At 1.02 inches (25.09 mm), minimum compression load must be 13.5 pounds (6.12 Kg). Replace as necessary.

**END OF TASK****ASSEMBLY**

Install bypass valve (Figure 1, Item 4), spring (Figure 1, Item 3), retainer (Figure 1, Item 2), and screw (Figure 1, Item 1) in adapter (Figure 1, Item 5). Tighten screw securely.

**END OF TASK****FOLLOW ON TASK**

1. Install oil filter adaptor (models 5063-5393 and 5063-539L) (WP 0019).
2. Install oil filter adaptor (model 5063-5392) (WP 0018).
3. Install oil filter adaptor (model 5063-5299) (WP 0017).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
IDLER PULLEY ASSEMBLY REPAIR**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

**Equipment Condition**

Idler pulley assembly removed (WP 0013)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

---

**DISASSEMBLY****CAUTION**

Do not press bearing shaft (Figure 1, Item 2) from bearing assembly (Figure 1, Item 6).  
Pressing on end of bearing shaft will distort bearings and destroy bearing assembly.

1. Support pulley (Figure 1, Item 7). Place 1 inch (2.54 cm) diameter sleeve (Figure 1, Item 1) on outer race of bearing assembly (Figure 1, Item 6). Press bearing and bracket assembly (Figure 1, Item 3) from pulley.
2. Support bracket (Figure 1, Item 4). Using a short 1/2 inch (1.27 cm) diameter shaft (Figure 1, Item 5), apply pressure to bearing shaft (Figure 1, Item 2) and press bearing assembly (Figure 1, Item 6) from bracket.

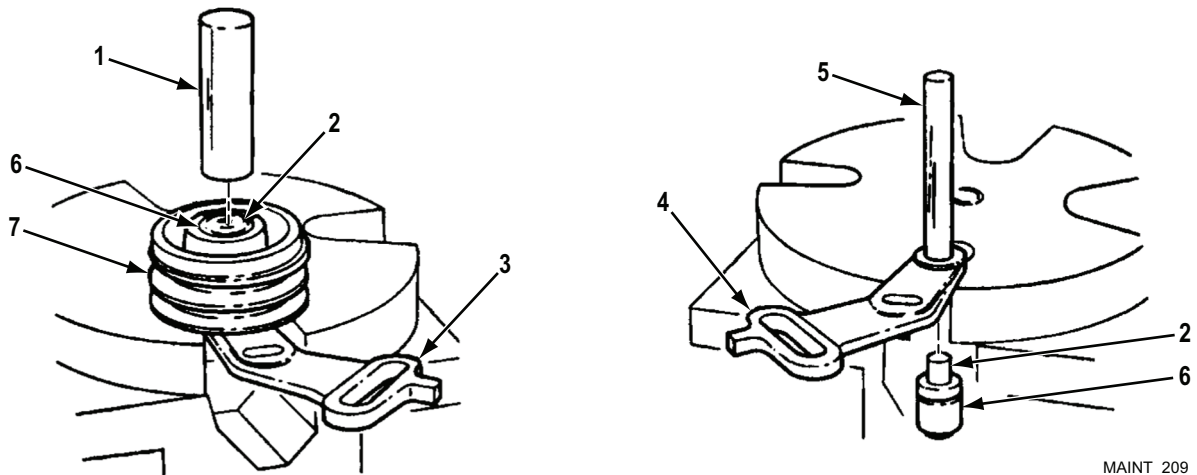
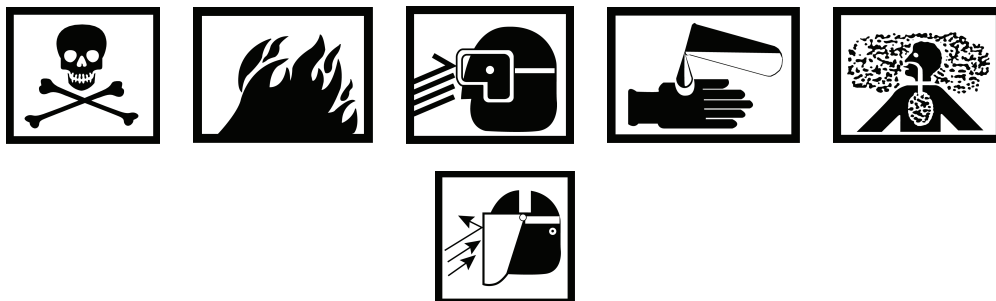


Figure 1. Idler Pulley Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Do not wash bearing assembly. Fuel oil or cleaning solvent will dissolve internal grease and destroy bearing assembly.

Wash pulley and bracket in cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect pulley and bracket for excessive wear or cracks.
2. Revolve shaft in bearing assembly by hand. If rough or tight spots are detected, replace bearing assembly.

**END OF TASK**



**ASSEMBLY****NOTE**

Bearing assembly (Figure 2, Item 6) will fit in pulley from either side; however, position bearing assembly on pulley as shown for proper installation.

1. Support pulley (Figure 2, Item 7) and press bearing assembly (Figure 2, Item 6) on pulley with shaft extended upward. Using 1-1/4 inch (3.17 cm) diameter sleeve (Figure 2, Item 8), press outer race of bearing until flush with inside surface of pulley.

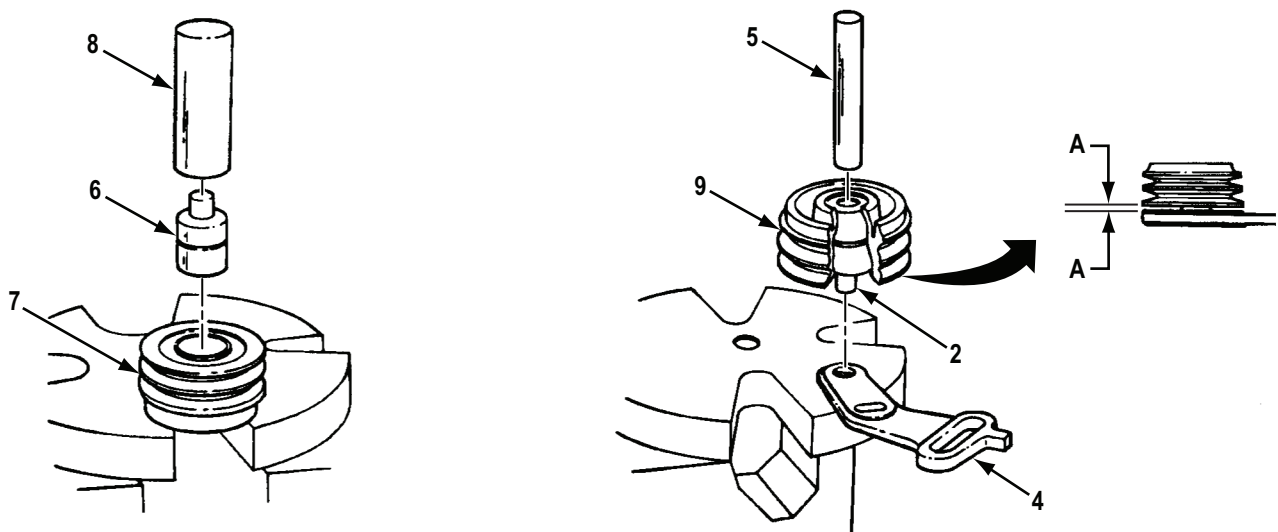
**CAUTION**

Do not press bearing shaft (Figure 2, Item 2) into bearing assembly (Figure 2, Item 6). Pressure on shaft will distort bearings and destroy bearing assembly.

**NOTE**

Pulley and bearing assembly will fit in bracket from either side; however, position pulley and bearing assembly on bracket as shown.

2. Support bracket (Figure 2, Item 4) and press bearing and pulley assembly (Figure 2, Item 9) into bracket using 1/2 inch (1.27 cm) diameter shaft (Figure 2, Item 5). Apply pressure to shaft (Figure 2, Item 2) only. Measure distance (Figure 2, Item A) between outer edge of pulley and bracket using thickness gage. Distance must be 0.160 inch (0.406 cm).



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Figure 2. Idler Pulley Assembly.

**END OF TASK****FOLLOW ON TASK**

Install idler pulley assembly (WP 0013).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
COOLANT PUMP REPAIR**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Puller Kit, Universal  
(WP 0104, Table 1, Item 73)  
Remover, Seal (Bearing and Bushing)  
(WP 0104, Table 1, Item 82)  
Calipers, Vernier (0–6.0 in.)  
(WP 0104, Table 1, Item 14)

**Materials/Parts (cont.)**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 56)  
Rag, Wiping (WP 0103, Table 1, Item 44)  
Seal, Coolant Pump  
(WP 0105, Table 1, Item 127)  
Sealing Compound (WP 0103, Table 1, Item 52)

**Equipment Condition**

Coolant pump removed (WP 0013)

**Materials/Parts**

Chamois Leather (WP 0103, Table 1, Item 7)

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**DISASSEMBLY**

1. Using puller, remove pulley (Figure 1, Item 12) from coolant pump shaft (Figure 1, Item 13).
2. Remove seven bolts (Figure 1, Item 3), cover (Figure 1, Item 4), and gasket (Figure 1, Item 5) from coolant pump assembly (Figure 1, Item 11). Discard gasket.
3. If necessary, remove large pipe plug (Figure 1, Item 1) and small pipe plug (Figure 1, Item 2) from coolant pump assembly (Figure 1, Item 11).

**CAUTION**

Do not press shaft into bearing assembly. Pressure on shaft will distort bearings and destroy bearing assembly.

4. Place bearing inserter (Figure 1, Item 7) on outer race of shaft and bearing assembly (Figure 1, Item 8). Press shaft and bearing assembly, seal (Figure 1, Item 9), and impeller (Figure 1, Item 10) from housing (Figure 1, Item 6).

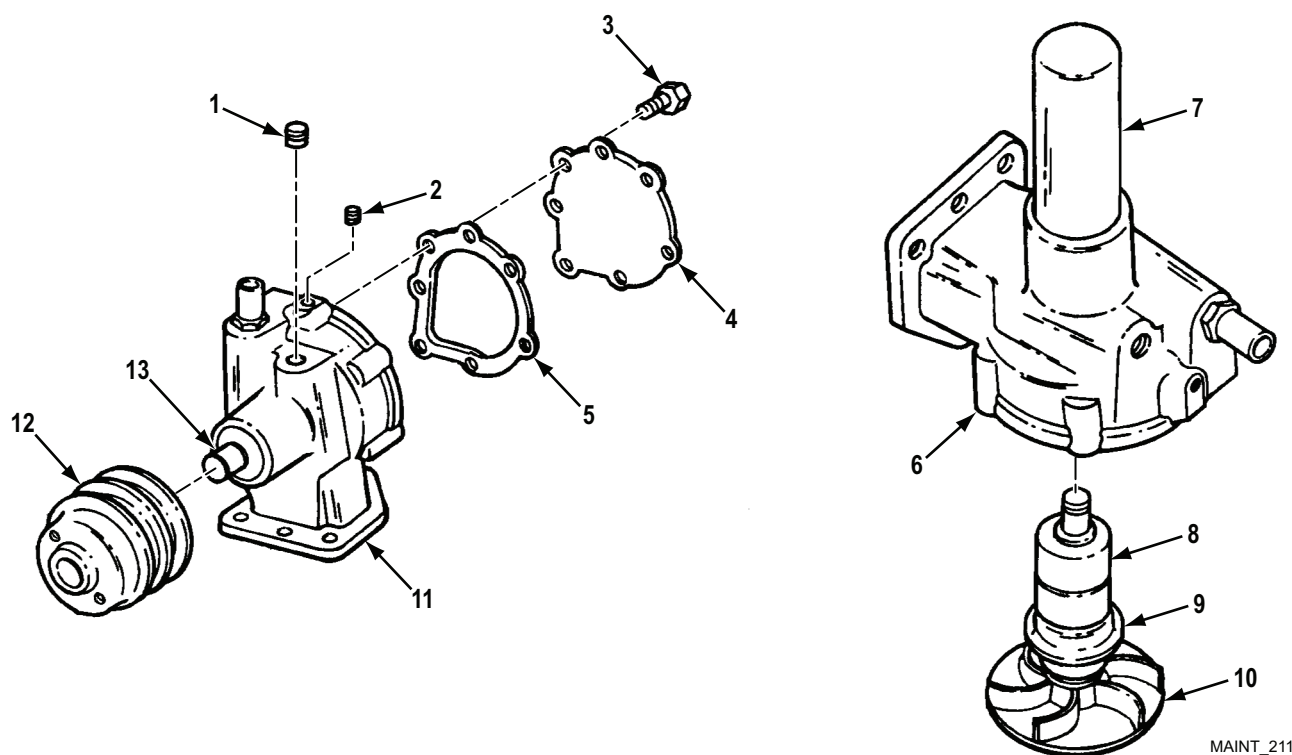


Figure 1. Coolant Pump Disassembly.

**DISASSEMBLY - Continued**

5. Support impeller (Figure 2, Item 10) on bed of arbor press. Place a short 1/2 inch (12.75 mm) diameter rod (Figure 2, Item 14) on shaft. Press shaft and bearing assembly (Figure 2, Item 8) out of impeller.
6. Remove seal (Figure 2, Item 9) from shaft and bearing assembly (Figure 2, Item 8). Discard seal.

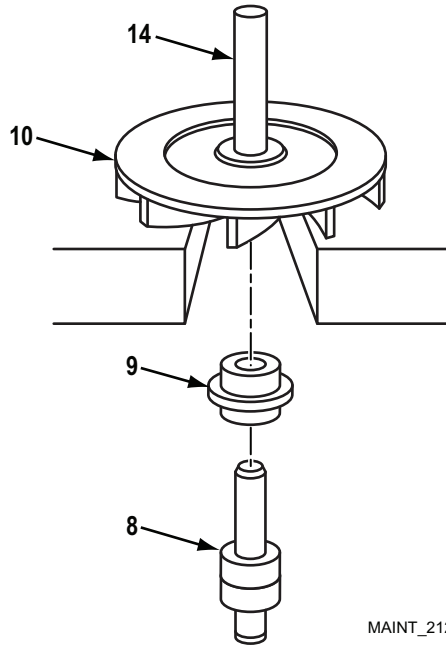
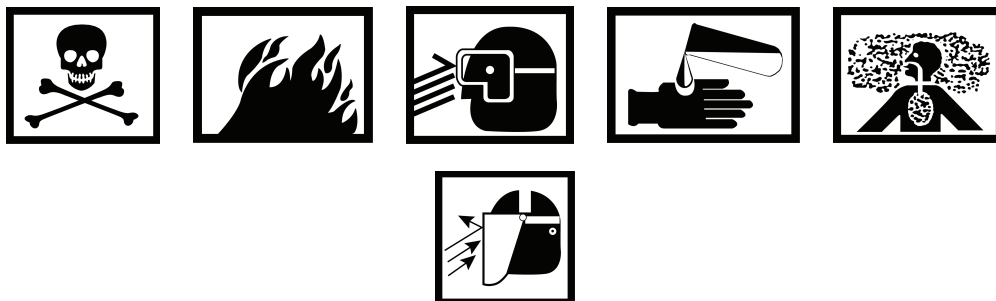


Figure 2. Coolant Pump Shaft Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Do not wash bearing assembly. Cleaning solvent will dissolve internal grease and destroy bearing assembly.

1. Wash all components, except bearing and shaft assembly, in cleaning solvent and dry with compressed air.
2. Wipe bearing and shaft assembly with clean wiping rag.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Discard bearing if it has a general feeling of roughness, is tight, or is damaged.
2. Inspect ceramic insert for cracks, scratches, and loss of bond to impeller (Figure 3, Item 10).

**END OF TASK****ASSEMBLY****CAUTION**

Do not press shaft into bearing assembly. Pressure on shaft will distort bearings and destroy bearing assembly.

1. Place bearing inserter (Figure 3, Item 7) against outer race of shaft and bearing assembly (Figure 3, Item 8) and press into pulley side of pump housing (Figure 3, Item 6) until outer race of bearing is flush with outer face of housing.
2. Apply a light coat of sealing compound to outside of new seal (Figure 3, Item 9). Support pump housing (Figure 3, Item 6) in press, pulley side down. Place a 1 1/2 inch inside diameter sleeve (Figure 3, Item 15) on outer flange of seal and press seal into housing until flange contacts housing. Wipe face of seal with chamois leather to remove dirt and metal particles.

## ASSEMBLY - Continued

**CAUTION**

Do not press top face of impeller beyond top face of pump housing. Pressing face of impeller further than top of housing will push impeller into water seal and destroy seal.

- Support pulley end of shaft and press impeller (Figure 3, Item 10) on shaft (Figure 3, Item 13) until impeller is flush with top face of pump housing (Figure 3, Item 6).

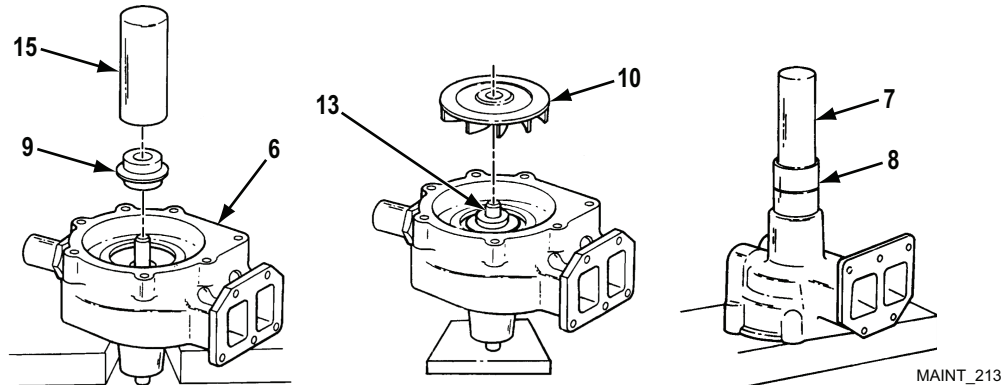


Figure 3. Coolant Pump Shaft Assembly.

- Support pulley (Figure 4, Item 12). Place a short 1/2 inch-diameter rod (Figure 4, Item 16) on impeller end of shaft and bearing assembly (Figure 4, Item 8). Press shaft into pulley until distance from front face of pulley to top face of pump housing is 5.60 in. (142.2 mm).
- Install new gasket (Figure 4, Item 5), cover (Figure 4, Item 4), and seven bolts (Figure 4, Item 3) on coolant pump assembly (Figure 4, Item 11). Torque bolts to 72–84 lb-in (8–9.5 N·m).
- If removed, install large pipe plug (Figure 4, Item 1) and small pipe plug (Figure 4, Item 2) in coolant pump assembly (Figure 4, Item 11).

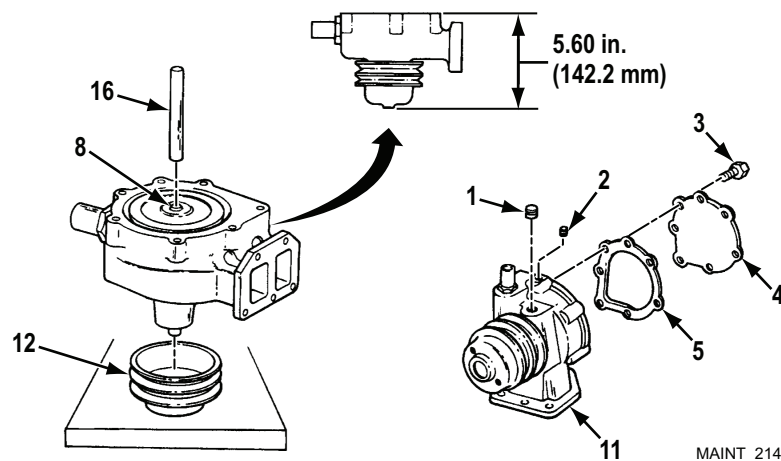


Figure 4. Coolant Pump Assembly.

**END OF TASK**

**FOLLOW ON TASK**

Install coolant pump (WP 0013).

**END OF TASK**

**END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
ENGINE TUNE-UP**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Gage, Injector Timing (model 5063-5299)  
(WP 0104, Table 1, Item 40)  
Gage, Injector Timing (models 5063-5392,  
5063-5393, and 5063-539L)  
(WP 0104, Table 1, Item 41)  
Gage, Injector Rack (Throttle, 0.454)  
(WP 0104, Table 1, Item 39)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 1)  
Washer, Flat  
Qty: (2) (WP 0105, Table 1, Item 117)

**Equipment Condition**

Rocker arm covers removed (model 5063-5299)  
(WP 0052)  
Rocker arm covers removed  
(models 5063-5392, 5063-5393, and  
5063-539L) (WP 0053)

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## ADJUSTMENT

### EXHAUST VALVE CLEARANCE

1. Place speed control lever (Figure 1, Item 2) in idle speed position and secure stop lever (Figure 1, Item 1) in stop position.

### CAUTION

Do not rotate crankshaft in counterclockwise direction using crankshaft bolt. Crankshaft bolt can loosen and serious engine damage may result if crankshaft bolt is not securely tightened to crankshaft.

2. Using crankshaft end bolt, rotate crankshaft clockwise until injector follower (Figure 1, Item 3) is fully depressed on cylinder to be adjusted.
3. Hold push rod (Figure 1, Item 8) in position and loosen push rod locknut (Figure 1, Item 7).

### NOTE

Normal ambient temperature (cold engine) is 100° F (38° C) or less.

4. Place 0.026 inch (0.660 mm) thickness gage (cold engine) between end of one exhaust valve stem (Figure 1, Item 5) and rocker arm bridge (Figure 1, Item 4).
5. Turn push rod (Figure 1, Item 8) in or out of clevis (Figure 1, Item 6) until a smooth pull is obtained on thickness gage.
6. Remove thickness gage. Hold push rod (Figure 1, Item 8) and tighten locknut (Figure 1, Item 7). Lightly tap rocker arm at bridge (Figure 1, Item 4) with wrench to release friction.

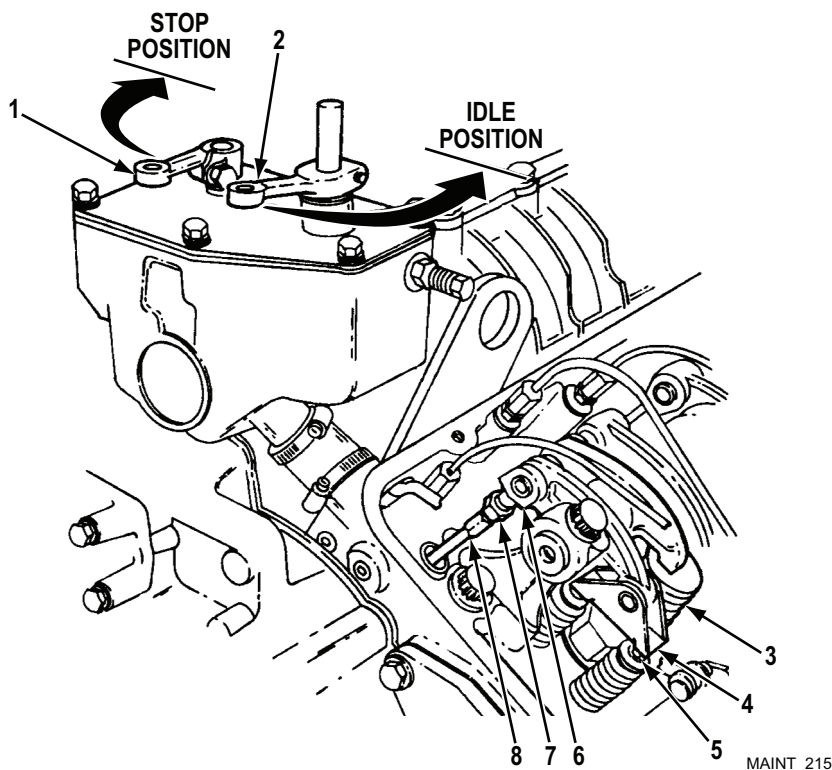


Figure 1. Adjust Valve Clearance.

**ADJUSTMENT****NOTE**

A 0.025 inch (0.635 mm) thickness gage (cold engine) must pass freely between end of one valve stem (Figure 1, Item 5) and rocker arm bridge (Figure 1, Item 4).

A 0.027 inch (0.686 mm) thickness gage (cold engine) must not pass through bridge clearance. Mark each rocker arm with a crayon or marker after adjustment.

7. Check valve bridge clearance with thickness gage. If clearance is not within limits, repeat procedures in Steps 3–6.
8. Adjust all exhaust valves following Steps 1–7.

**FUEL INJECTOR TIMING****CAUTION**

Do not rotate crankshaft in counterclockwise direction using crankshaft bolt. Crankshaft bolt can loosen and serious engine damage may result if crankshaft bolt is not securely tightened to crankshaft.

**NOTE**

Time all fuel injectors during one full revolution of crankshaft. Firing order: 1L, 3R, 3L, 2R, 2L, and 1R (Figure 2).

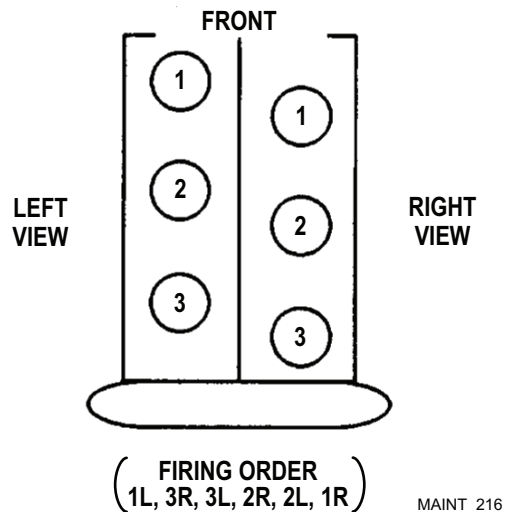


Figure 2. Firing Order (1L, 3R, 3L, 2R, 2L, 1R).

1. Using crankshaft end bolt, rotate crankshaft clockwise until exhaust valve stems (Figure 3, Item 5) are fully depressed on cylinder to be timed.
2. Hold fuel injector push rod (Figure 3, Item 8) and loosen push rod locknut (Figure 3, Item 7).

**ADJUSTMENT****NOTE**

Use 1.496 inch timing gage for models 50633-5392, 5063-5393 and 5063-539L.

Use 1.460 inch timing gage for models 5063-5299.

- Place small end of injector timing gage (Figure 3, Item 10) in hole (Figure 3, Item 11) at top of fuel injector body (Figure 3, Item 12). Place flat of injector timing gage on fuel injector follower (Figure 3, Item 3).

**NOTE**

Proper timing adjustment of fuel injector is achieved when rotating the injector timing gage wipes a drop of clean lubrication oil on injector follower to a thin even film behind flat of injector timing gage.

- Turn push rod (Figure 3, Item 8) to adjust injector follower (Figure 3, Item 3) height until flat of timing gage (Figure 3, Item 10) just passes over top of injector follower and wipes the oil clean.
- Hold injector push rod (Figure 3, Item 8) and tighten push rod locknut (Figure 3, Item 7). Lightly tap rocker arm (Figure 3, Item 9) with wrench to release friction.

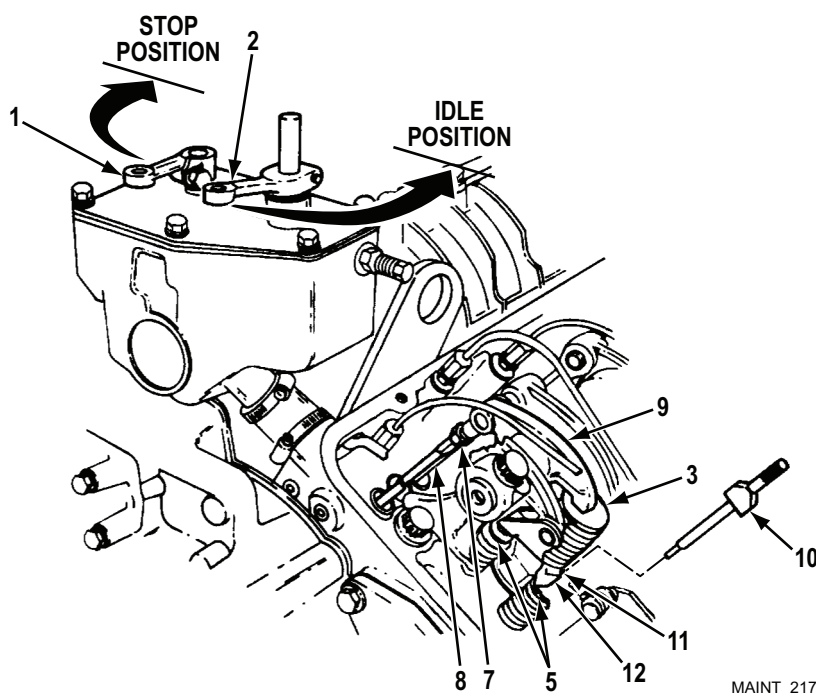


Figure 3. Injector Timing Adjustment.

**NOTE**

Mark each rocker arm with a crayon or marker after adjustment.

- Check injector timing again. If adjustment is required repeat Steps 3–5.
- Time remaining five fuel injectors as outlined in Steps 1–6.

**ADJUSTMENT****INJECTOR CONTROL TUBE**

1. On all except model 5063-5299, loosen two nuts (Figure 4, Item 13) on U-bolt (Figure 4, Item 15) on right injector control tube (Figure 4, Item 14). Injector control tube must move freely on U-bolt.

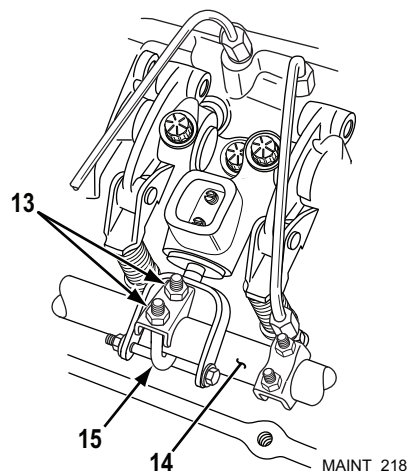


Figure 4. Injector Timing Adjustment.

2. Remove two bolts (Figure 5, Item 19), two copper flat washers (Figure 5, Item 18), idle speed adjustment screw cover (Figure 5, Item 17), and gasket (Figure 5, Item 16). Discard copper flat washers and gasket.

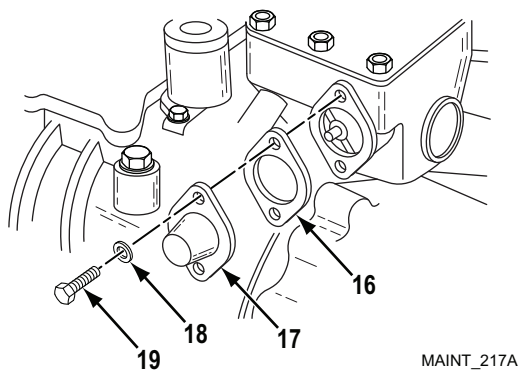


Figure 5. Idle Speed Adjustment Cover Removal.

## ADJUSTMENT

## NOTE

Letter "R" or "L" indicates injector location, right or left side, as viewed from rear of engine. Cylinder numbers start at front of each side.

Adjust No. 3L or 3R injector control lever first to establish a guide for adjusting remaining injector control levers.

Ensure idle speed adjusting screw is backed out or a false fuel injector rack setting will result.

Adjust injector control tubes with the same governor cover used on governor to ensure proper injector control tube adjustment.

3. Loosen idle speed locknut (Figure 6, Item 21). Hold locknut and turn idle speed adjusting screw (Figure 6, Item 22) until 1/2 inch of threads project from locknut.

## CAUTION

Cover oil drain hole in cylinder head with clean rag to prevent cotter pin and clevis pin from falling into engine.

4. Loosen six adjustment screw locknuts (Figure 6, Item 29) and back out six adjusting screws (Figure 6, Item 20). All six injector control levers (Figure 6, Item 28) should be loose on control tubes (Figure 6, Item 18).
5. Move linkage (Figure 6, Item 23) connecting governor to control tubes. Linkage must not bind.
6. Rotate clevis pins (Figure 6, Item 24) in right and left control tube levers (Figure 6, Item 25). Pins must rotate freely.
7. Check for slight movement of each control tube (Figure 6, Item 14) between its two brackets (Figure 6, Item 26) to ensure there is no binding.

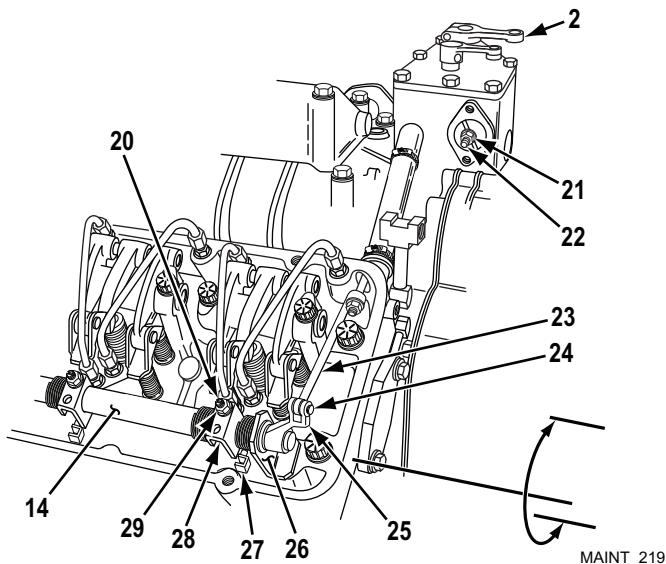


Figure 6. Injector Control Tube Adjustment.

**ADJUSTMENT**

8. Rotate each control tube lever (Figure 7, Item 25) to FULL FUEL position and then release lever. Control tubes must return to NO FUEL position.
9. Remove cotter pin (Figure 7, Item 30) and clevis pin (Figure 7, Item 24) from opposite control tube lever (Figure 7, Item 25). Discard cotter pin.
10. Move speed control lever (Figure 7, Item 2) to FULL FUEL position (clockwise direction) and hold with light finger pressure.

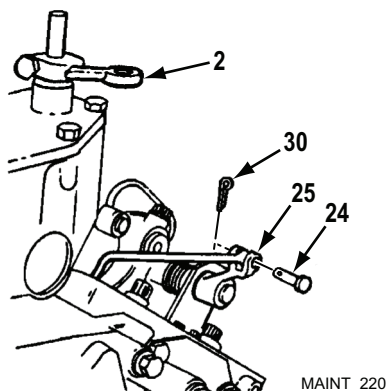


Figure 7. Speed Control to Injector Lever Adjustment.

**CAUTION**

Do not overtighten adjusting screws during installation or adjustment. Overtightening can result in damage to injector control tube. Recommended adjusting screw torque is 24–36 lb-in (3–4 N·m).

11. Turn adjusting screw (Figure 6, Item 20) on 3L or 3R injector control lever (Figure 6, Item 28) until slight movement is felt on speed control lever (Figure 6, Item 2), injector rack (Figure 6, Item 27) rolls up on injector control lever, or an increase in effort to turn screw is felt. Release speed control lever.

**NOTE**

Always secure adjusting screw to prevent turning when tightening locknut. Tightening locknut without securing adjusting screw can turn screw out of adjustment.

12. Hold adjusting screw and tighten locknut (Figure 6, Item 29).
13. Check left clevis pin (Figure 6, Item 24) for freeness. Pin must turn freely in control tube lever (Figure 6, Item 25) when 3L or 3R is in FULL FUEL position. If clevis pin does not rotate freely, adjust injector control lever again.
14. Check injector control rack lever adjustments as follows:
  - a. Hold speed control lever (Figure 6, Item 2) in FULL FUEL position.
  - b. Using a screw driver, lightly press downward on injector rack (Figure 6, Item 27) and slide screw driver off.
  - c. Injector rack (Figure 6, Item 27) should spring back upward.
15. If injector rack (Figure 6, Item 27) does not spring back, loosen adjusting screw locknut (Figure 6, Item 29) and tighten adjusting screw (Figure 6, Item 20) slightly. Tighten locknut. Check adjustment using Steps 13–14.

**ADJUSTMENT**

16. Move speed control lever (Figure 6, Item 2) to FULL FUEL position. If injector rack (Figure 6, Item 27) becomes tight before speed control lever reaches end of travel, setting is too tight. Loosen locknut (Figure 6, Item 29) and turn screw (Figure 6, Item 20) slightly counterclockwise. Tighten locknut. Check setting using Steps 13–14.
17. Connect opposite throttle control rod (Figure 6, Item 23) to control tube lever (Figure 6, Item 25) using clevis pin (Figure 7, Item 24) and cotter pin (Figure 7, Item 30).
18. Adjust opposite injector control lever (Figure 6, Item 28) per Steps 10–12.
19. Repeat check on 3L and 3R injector control levers (Figure 6, Item 28) per Steps 13–16. If 3L is loose, adjust 3R again. If 3R is loose, adjust 3R again.

**NOTE**

Once 3L and 3R injector control levers are adjusted, do not alter their settings. Make further adjustments only on remaining injector control rack levers.

20. Hold speed control lever (Figure 7, Item 2) in FULL FUEL position. Check clevis pins (Figure 7, Item 24) for drag on both right and left control tube lever (Figure 7, Item 25). Both pins should move freely.
21. With speed control lever still held lightly in FULL FUEL position, adjust 2L and 1L injector control rack levers (Figure 6, Item 28) per Steps 10–12. Check their adjustment per Steps 13–16. Do not readjust 3L.
22. With speed control lever still held lightly in FULL FUEL position, adjust 2R and 1R injector control rack levers (Figure 6, Item 28) per Steps 10–12. Check their adjustment per Steps 13–16. Do not readjust 3R.
23. Turn idle speed adjusting screw (Figure 6, Item 22) in until it projects 3/16 inch from locknut (Figure 6, Item 21) to permit starting of engine. Tighten locknut.
24. Install new gasket (Figure 8, Item 16), idle speed adjustment screw cover (Figure 8, Item 17), two new copper flat washers (Figure 8, Item 18), and two bolts (Figure 8, Item 19).

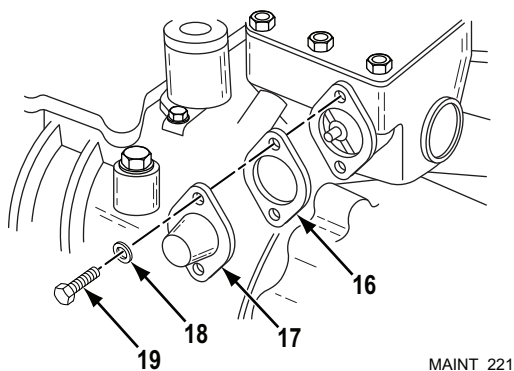


Figure 8. Idle Speed Adjustment Cover Installation.

**THROTTLE DELAY (FOR ALL EXCEPT MODEL 5063-5299)****NOTE**

Fill throttle delay reservoir with clean engine oil to lubricate mechanical components. Oil reservoir need not remain full during adjustment procedure.

1. Insert throttle delay timing gage (Figure 9, Item 31) on rack between injector body (Figure 9, Item 12) and clevis of injector rack (Figure 9, Item 27) on 2R injector.



**ADJUSTMENT**

2. Move injector control tube (Figure 9, Item 14) in direction of FULL FUEL.
3. Align throttle delay piston (Figure 9, Item 33) flush with edge of throttle delay cylinder (Figure 9, Item 32).

**CAUTION**

Do not overtighten two U-bolt nuts. Damage to injector control tube or U-bolt clamp could result.

4. Tighten two nuts (Figure 9, Item 13) on U-bolt (Figure 9, Item 15) snug.
5. Move injector rack from NO-FUEL to FULL FUEL position. There should be no binding during movement of injector control tube (Figure 9, Item 14). Torque nuts (Figure 9, Item 13) to 84–108 lb-in (9–12 N·m).

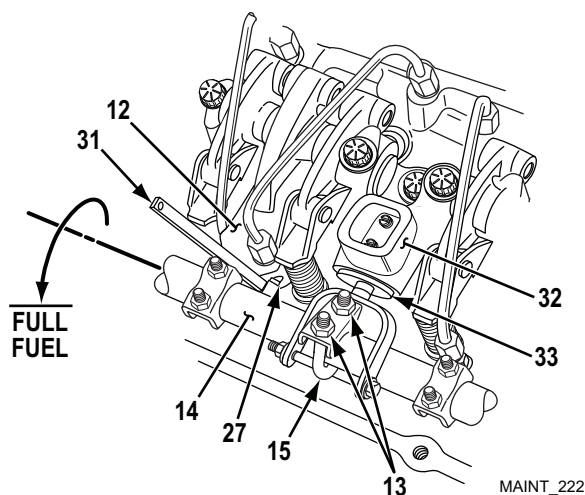


Figure 9. Throttle Delay Adjustment.

**END OF TASK****FOLLOW ON TASK**

1. Install rocker arm covers (models 5063-5392, 5063-5393, and 5063-539L) (WP 0053).
2. Install rocker arm covers (model 5063-5299) (WP 0052).

**END OF TASK****END OF WORK PACKAGE**



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**FIELD MAINTENANCE  
PREPARATION OF ENGINE**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Oil Filter (WP 0104, Table 1, Item 118)  
Sling, Beam-Type (WP 0104, Table 1, Item 93)

**Materials/Parts (cont.)**

Filter Element, Fluid (Model 5063-5393)  
(WP 0105, Table 1, Item 163)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Tape, Masking (WP 0103, Table 1, Item 64)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

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## PREPARATION FOR STORAGE OR SHIPMENT PROTECTION OF OVERHEAD ASSEMBLIES

1. On model 5063-5299, remove clamp (Figure 1, Item 3) and hose (Figure 1, Item 4) from left rocker arm cover (Figure 1, Item 1). Remove hose and clamp.
2. On model 5063-5299, remove four clamp and screw assemblies (Figure 1, Item 5) and rocker arm cover (Figure 1, Item 1) from each cylinder head.

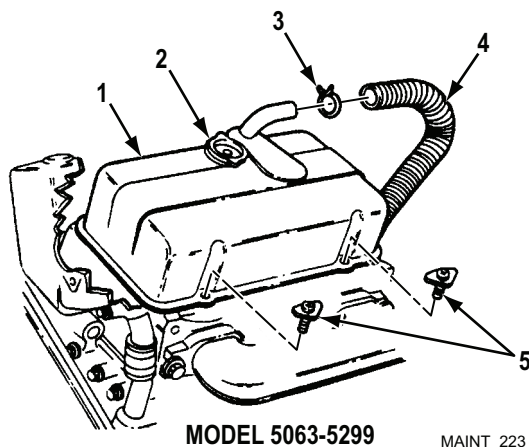


Figure 1. Rocker Arm Cover Removal (Model 5063-5299).

3. On models 5063-5392, 5063-5393, and 5063-539L, remove two bolts (Figure 2, Item 6), two flat washers (Figure 2, Item 7), two resilient mounts (Figure 2, Item 8), and rocker arm cover (Figure 2, Item 1) from each cylinder head.

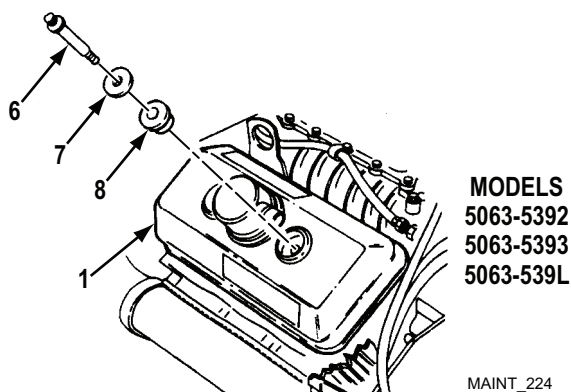


Figure 2. Rocker Arm Cover Removal (Model 5063-5392, 5063-5393, and 5063-539L).

**PREPARATION FOR STORAGE OR SHIPMENT****PROTECTION OF OVERHEAD ASSEMBLIES - Continued**

4. Slowly pour one-half gallon of engine oil over valves and valve train components of both cylinder heads.
5. On model 5063-5299 install rocker arm cover (Figure 1, Item 1) and four clamp and screw assemblies (Figure 1, Item 5) on cylinder head. Tighten clamp and screw assemblies.
6. On models 5063-5392, 5063-5393, and 5063-539L, install rocker arm cover (Figure 2, Item 1), two resilient mounts (Figure 2, Item 8), two flat washers (Figure 2, Item 7), and two bolts (Figure 2, Item 6) on each cylinder head.
7. On model 5063-5299, install hose (Figure 1, Item 4) and clamp (Figure 1, Item 3) on rocker arm cover (Figure 1, Item 1).

**END OF TASK****PROTECTION OF CRANKSHAFT**

1. Remove oil filler cap (Figure 1, Item 2).
2. When possible, fill the crankcase with oil to approximately 15 inches (38 cm) below the top of the oil gauge rod tube. (Used oil can be used for this purpose).
3. Manually turn engine over at least one complete revolution.
4. Remove oil pan drain plug and drain oil.
5. Install oil pan drain plug.
6. Install oil filler cap (Figure 1, Item 2).

**END OF TASK**

**DRAINING****WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

1. Lift engine using a beam-type sling (Figure 3, Item 9) attached to lifting brackets (Figure 3, Item 10). Use a hoist with a minimum lifting capacity of 1.5 tons (1.36 metric tons).

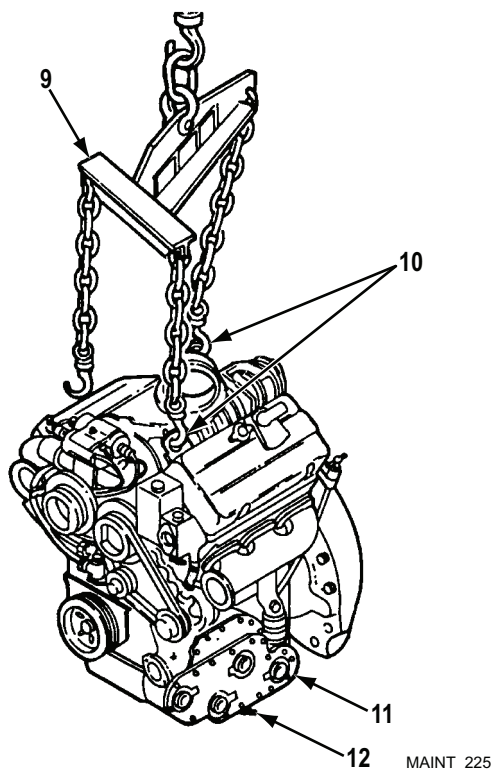


Figure 3. Sling and Engine Assembly.

**DRAINING - Continued****NOTE**

Refer to local procedures and plans for storage and disposal of drained fluids.

2. Open two drain cocks (Figure 4, Item 13) on right side of cylinder block and one on left side and drain engine coolant from cylinder block into a suitable container.

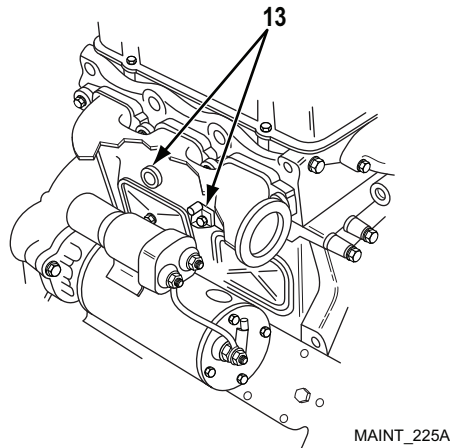


Figure 4. Drain Cocks Right Side of Engine.

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L have a plug instead of a drain cock.

3. Open drain cock (Figure 3, Item 12) in bottom of cooler (Figure 3, Item 11) and drain coolant from oil cooler.
4. For models 5063-5393 and 5063-539L only, remove plug (Figure 5, Item 14) in the bottom of transmission cooler (Figure 5, Item 15) and drain coolant from cooler.

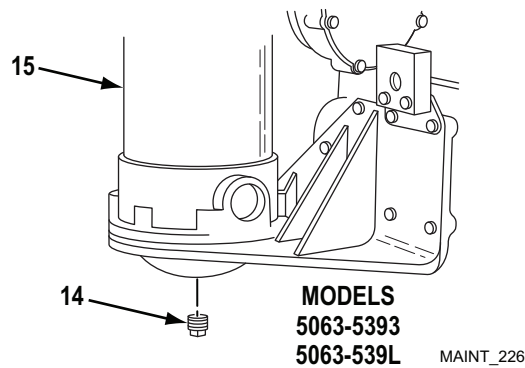


Figure 5. Transmission Oil Cooler Plug.

**DRAINING - Continued****NOTE**

Models 5063-5393 and 5063-539L, have no coolant drain at thermostat housing.

- Open drain cock (Figure 6, Item 16) and drain coolant from thermostat housing (Figure 6, Item 17).

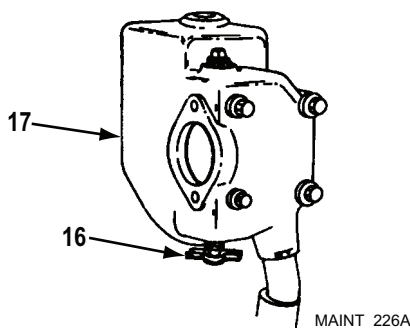


Figure 6. Thermostat Drain.

- After coolant is drained, close drain cocks (Figure 4, Item 13), (Figure 3, Item 12), and (Figure 6, Item 16). Install plugs in bottom of transmission cooler (Figure 5, Item 15) and engine cooler (Figure 3, Item 11).

**NOTE**

In model 5063-5299, oil filter is remote mounted in the vehicle.

- Remove plug (Figure 7, Item 19) in bottom of oil filter housing (Figure 7, Item 20) and drain oil into a separate container. Replace plug. For models 5063-5393 and 5063-539L, remove spin-on oil filter (Figure 7, Item 18) with oil filter wrench. Discard filter.

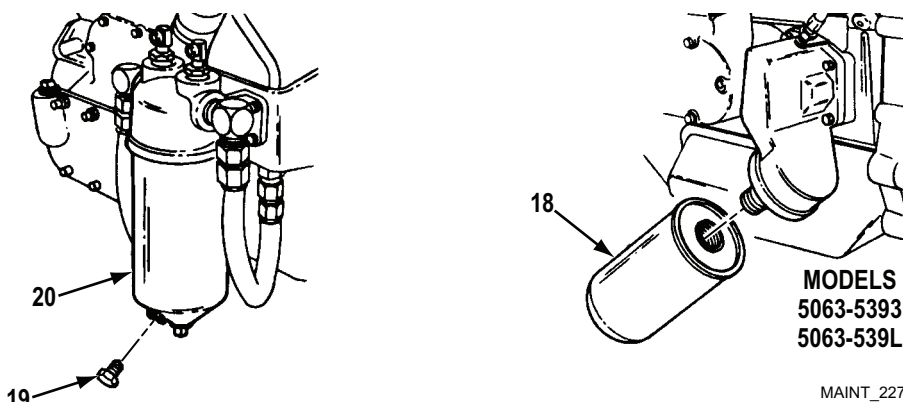


Figure 7. Oil Filter Draining.



**DRAINING - Continued**

- Remove plug (Figure 8, Item 21) from bottom of either left or right side of oil pan (Figure 8, Item 22) and drain oil. Replace drain plug.

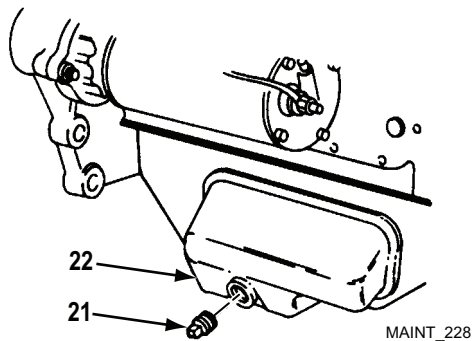


Figure 8. Engine Oil Pan Drain Plug.

**NOTE**

In model 5063-5299, fuel filters are remote mounted in the vehicle.

- Open drain cocks (Figure 9, Item 24) and drain fuel from fuel filters (Figure 9, Item 23) into a separate container.
- After fuel is drained, close drain cocks (Figure 9, Item 24).

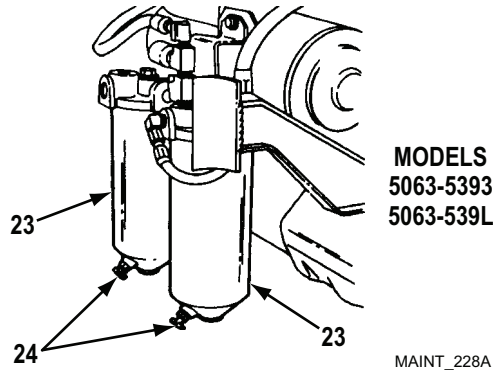


Figure 9. Fuel Filter Draining.

**DRAINING - Continued****WARNING**

Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension as equipment may drop or shift. Failure to comply may result in injury to personnel.

11. Lower engine and remove beam-type sling (Figure 10, Item 9).

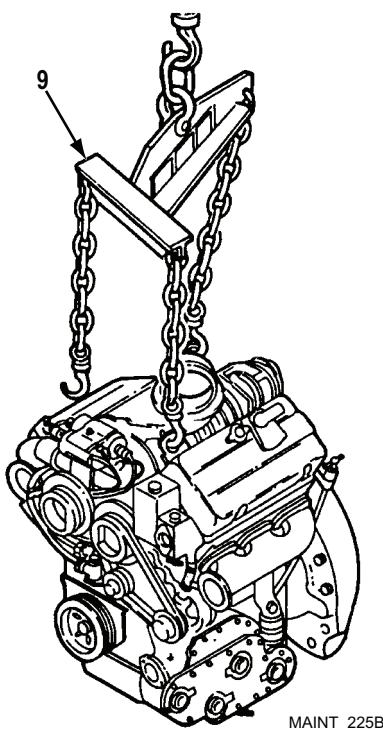


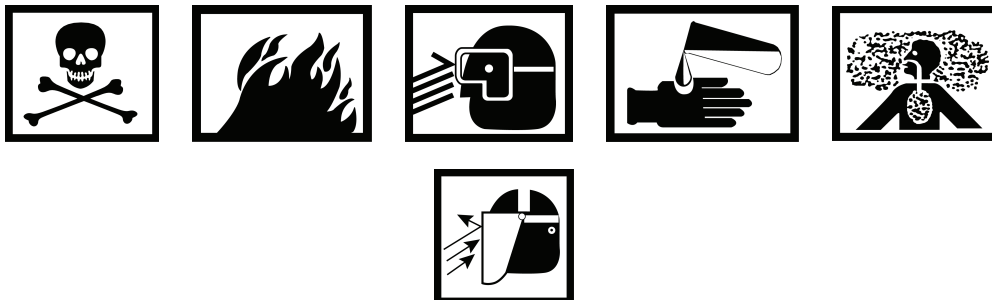
Figure 10. Sling and Engine Assembly.

**END OF TASK**

**CLEANING****CAUTION**

Foreign material in working parts of engine can damage engine. Use caution and keep dust and debris out of all engine openings.

1. Seal all openings on the engine and accessories with waterproof tape or suitable plugs.
2. Wash exterior of engine using water under pressure to remove dirt and mud.

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

3. Remove oil and grease from exterior of engine using a stiff brush and cleaning solvent. Blow dry with compressed air.

**END OF TASK****END OF WORK PACKAGE**



**FIELD MAINTENANCE  
ILLUSTRATED LIST OF MANUFACTURED ITEMS INTRODUCTION**

## INTRODUCTION

### Scope

This work package includes complete instructions for making items authorized to be manufactured or fabricated at the Field and Sustainment Maintenance Level.

### How to Use the Index of Manufactured Items

A part number index in alphanumeric order is provided for cross-referencing the part number of the item to be manufactured to the information which covers fabrication criteria.

### Explanation of the Illustrations of Manufactured Items

All instructions needed by maintenance personnel to manufacture the item are included on the illustrations. All bulk materials needed for manufacture of an item are listed by part number or specification number in a tabular list on the illustration.

**Table 1. Manufactured Items Index.**

ITEM NO.	PART NUMBER/ (CAGEC)	DESCRIPTION	DRAWING NUMBER	WP NO.
1		Pressure Testing Kit, Cylinder Head	11650232	
2		Governor Cover, Cut-Away	11650234	
3		Guide Stud	11650235	
4		Guide Stud	11650237	
5		Pressure Testing Kit, Oil Cooler Core	11650238	
6		Pressure Testing Kit, Oil Cooler	11650239	
7		Tube Assembly, Fuel, Fabricated	11650240	
8		Guide Pin, Starter	11650243	
9		Lifting Tool, Brush Spring	11650244	
10		Pressure Testing Kit, Cylinder Block	11650245	
11		Tester, Glow Plug Controller (Diagram A)	11650246	
12		Tester, Glow Plug Controller (Diagram B)	11650246	
13		Tester, Glow Plug Controller (Diagram C)	11650246	

*Table 1. Manufactured Items Index - Continued.*

ITEM NO.	PART NUMBER/ (CAGEC)	DESCRIPTION	DRAWING NUMBER	WP NO.
14		Tester, Glow Plug Controller (Diagram D)	11650246	
15		Test Lead	12384626	
16		Guide Stud	12384628	
17		Holding Fixture, Turbocharger	12384633	

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
ILLUSTRATED LIST OF MANUFACTURED ITEMS**

---

**INITIAL SETUP:**

Not Applicable

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**ITEM 1 - CYLINDER HEAD PRESSURE TESTING KIT**

1. Fabricate end plate from 3/8-inch thick steel plate, (Figure 1, Item A).
2. Fabricate gasket for end plate from 1/8-inch thick rubber material except with 0.5-inch diameter hole in center.
3. Quantity required: One each.
4. Additional items:

Two bolts (3/8-16 x 1) NSN 5305-00-269-3211

5. Fabricate blocking plates from 3/8-inch thick steel plate, (Figure 1, Item B).
6. Fabricate gaskets for blocking plates from 1/8-inch thick rubber material.
7. Quantity required: Four each.
8. Additional items:

Eight bolts (5/8-11 x 6) NSN 5305-00-724-6847

16 flat washers (5/8) NSN 5310-00-823-8803

Eight nuts (5/8-11) NSN 5310-00-012-5550

9. All dimensions are in inches.

**Table 1. Bulk Material**

ITEM NO.	NAME	QTY
1	Rubber gasket material 4.4 x 2 x 3/8 in.	1
2	Rubber gasket material 6.2 x 2 x 3/8 in.	4
3	Steel plate 4.4 x 2 x 3/8 in.	1
4	Steel plate 6.2 x 2 x 3/8 in.	4



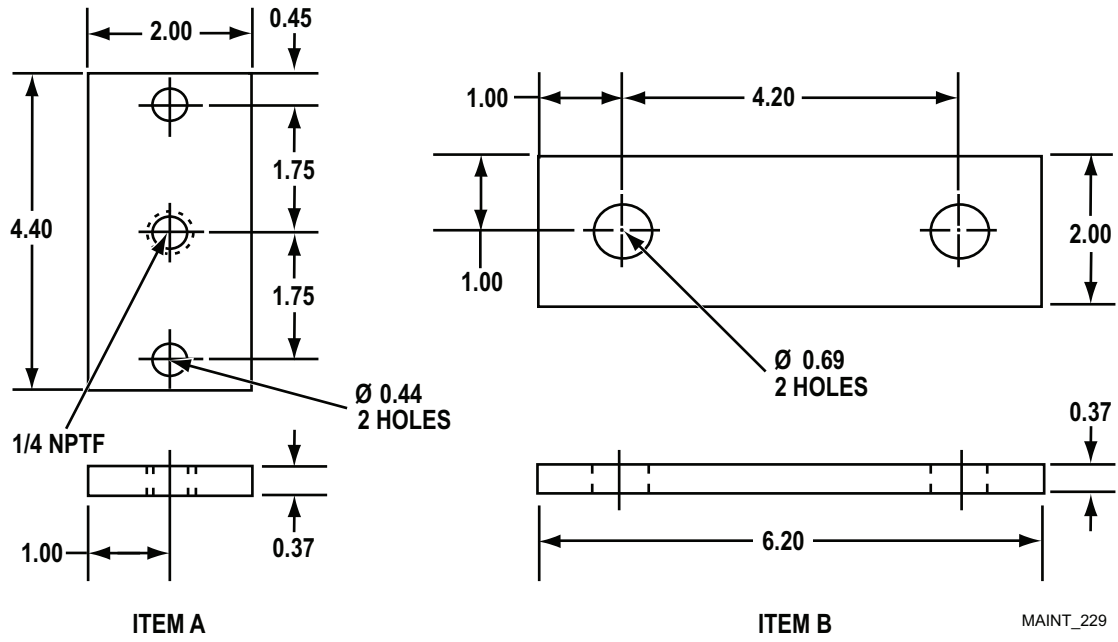


Figure 1. Item 1 - Cylinder Head Pressure Testing Kit (11650232).

**ITEM 2 - CUT-AWAY GOVERNOR COVER****Notes:**

1. Fabricate from NSN 2990-00-944-2053 governor cover by cutting out cross-hatched section.
2. Quantity required: One.
3. All dimensions are in inches.

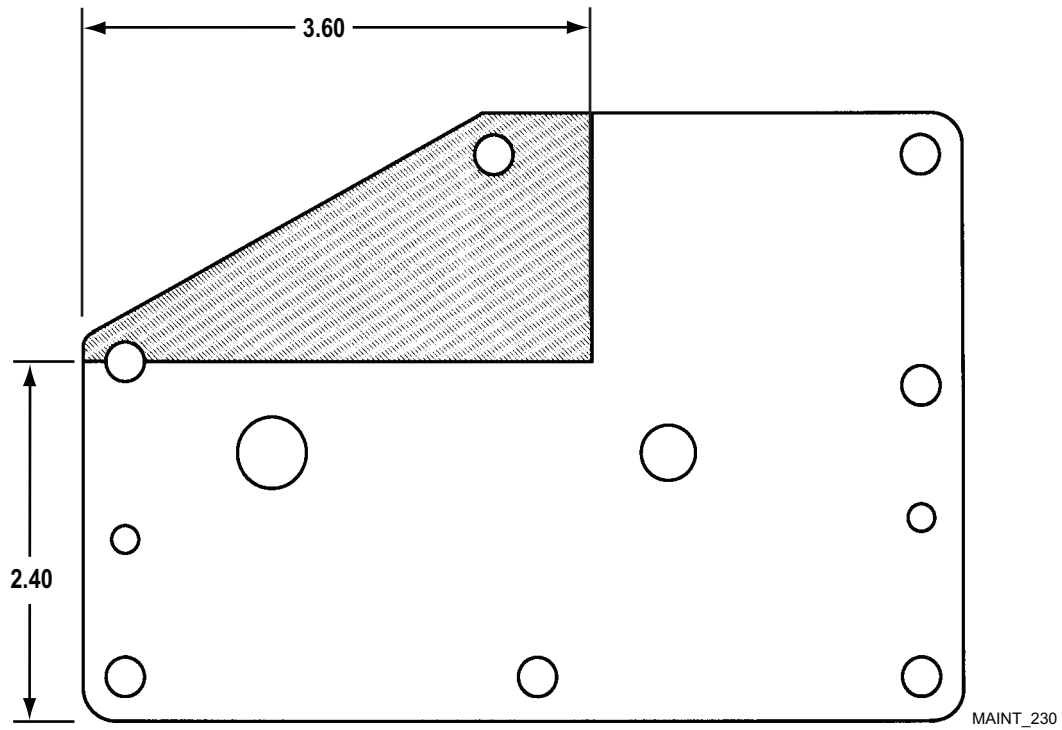


Figure 2. Item 2 - Cut-Away Governor Cover (11650234).

**ITEM 3 - GUIDE STUD**

**Notes:**

1. Fabricated from NSN 5305-00-719-5275 screw (1/2-20 x 5-1/2) by cutting off head of bolt. Saw or file a 0.06-inch screwdriver slot in unthreaded end.
2. Quantity required: Two.
3. All dimensions are in inches.

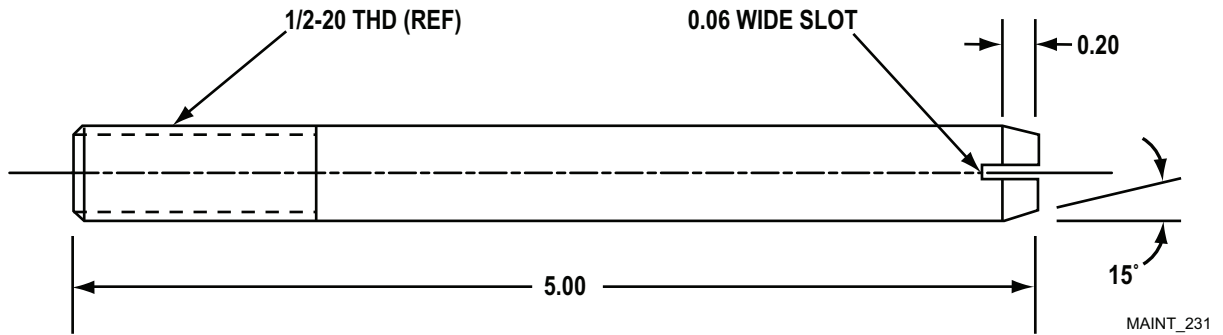


Figure 3. Item 3 - Guide Stud (11650235).

**ITEM 4 - GUIDE STUD**

**Notes:**

1. Fabricated from NSN 5305-00-930-3253 screw (3/8-16 x 7) by cutting off head of bolt. Saw or file a 1/16-inch screwdriver slot in unthreaded end.
2. Quantity required: Two.
3. All dimensions are in inches.

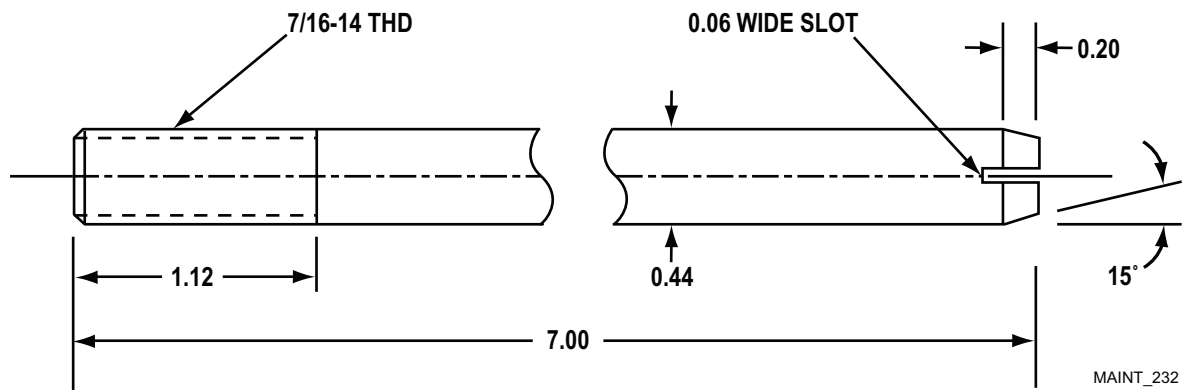


Figure 4. Item 4 - Guide Stud (11650237).

**ITEM 5 - OIL COOLER CORE PRESSURE TESTING KIT****Notes:**

1. Fabricate plate from 1/4-inch thick steel plate.
2. Fabricate gasket from 1/8-inch thick rubber material.
3. Quantity required: One each.
4. Additional items:

Eight screws 5/16-18 x 1 NSN 5305-00-226-4827

Eight flat washers 5/16 NSN 5310-00-081-4219

Eight nuts 5/16-18 NSN 5310-00-880-7744

5. All dimensions are in inches.

**Bulk Material**

Steel plate, 10.5 x 5 x 1/4 in. (1)

Rubber gasket material, 10.5 x 5 x 1/8 in. (1)

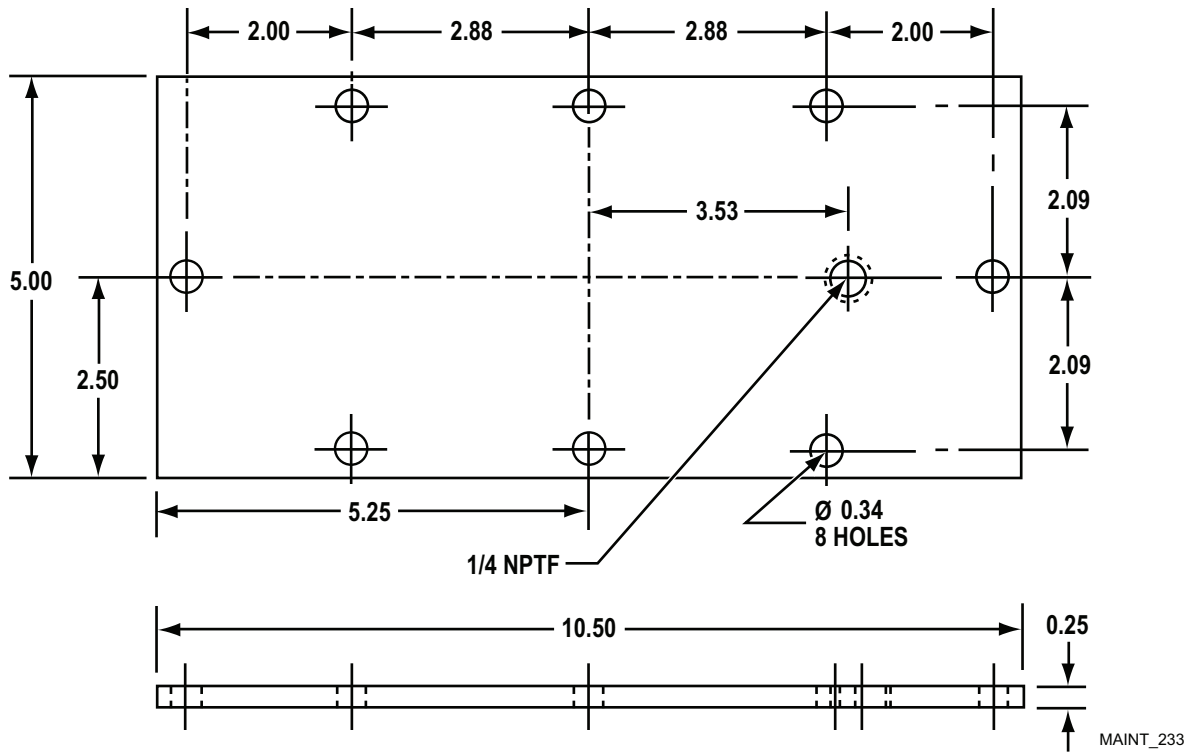


Figure 5. Item 5 - Oil Cooler Core Pressure Testing Kit (116502380).

**ITEM 6 - OIL COOLER PRESSURE TESTING KIT****Notes:**

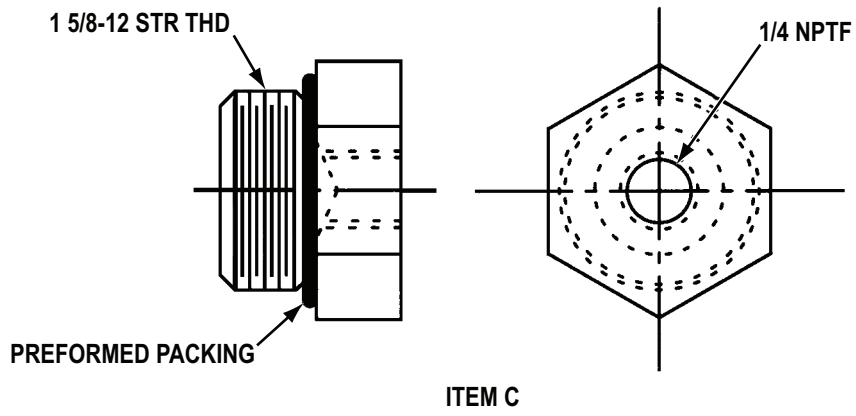
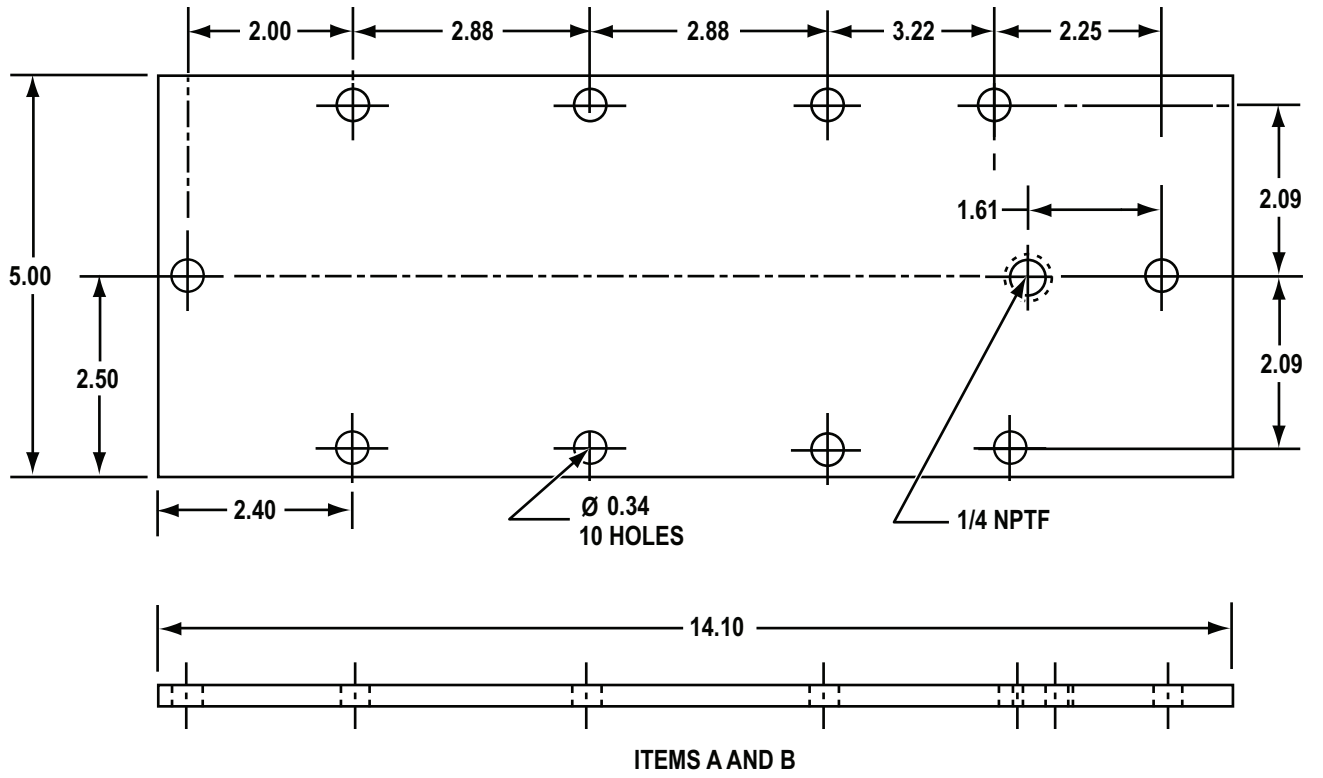
1. Item A, fabricate plate from 1/4-inch thick steel plate.
2. Item B, fabricate gasket from 1/8-inch thick rubber material.
3. Quantity required:
  - One, Item A
  - One, Item B
  - Two, Item C (model 5063-5393 only)
4. Additional items:

10 screws 5/16-18 x 1	NSN 5305-00-226-4827
10 flat washers 5/16	NSN 5310-00-081-4219
10 nuts 5/16-18	NSN 5310-00-880-7744
5. Item C, for model 5063-5393:

Two plugs, machine-threaded	NSN 5063-00-203-2616
Two packings, preformed	NSN 5330-00-816-3546
One plug with fabricated 1/4 NPT hole	
One plug without fabricated hole	
6. All dimensions are in inches.

**Bulk Material**

- Rubber gasket material, 14.1 x 5 x 1/8 in. (1)
- Steel plate, 14.1 x 5 x 1/4 in. (1)



MAINT\_234

Figure 6. Item 6 - Oil Cooler Pressure Testing Kit (11650239).

**FABRICATED FUEL TUBE ASSEMBLY****Notes:**

1. Fabricate from tube assembly, steel NSN 4710-00-792-8984.
2. Quantity required: One.
3. Bend as dimensioned.
4. All dimensions are in inches.

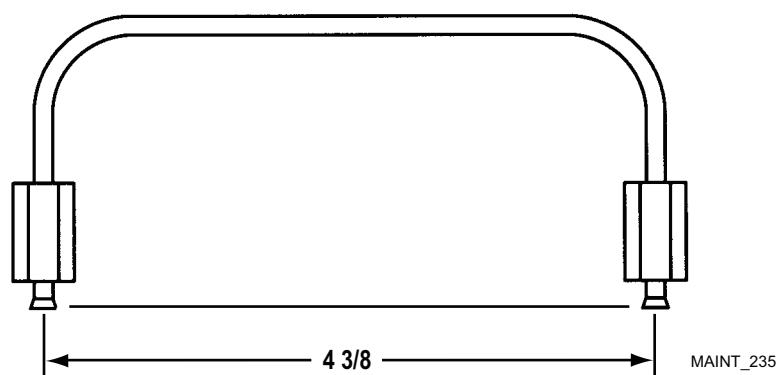


Figure 7. Item 7 - Fabricated Fuel Tube Assembly (11650240).

**ITEM 8 - STARTER GUIDE PIN****Notes:**

1. Fabricate from 0.125 inch welding rod or steel round stock.
2. File or round ends.
3. Quantity required: Four.
4. All dimensions are in inches.

Welding rod stock, 1/8 in. diameter (6 in.)

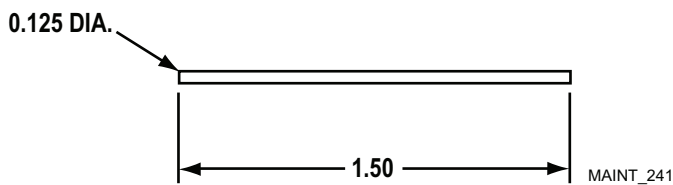


Figure 8. Item 8 - Starter Guide Pin (11650243).



**ITEM 9 - BRUSH SPRING LIFTING TOOL****Notes:**

1. Fabricate from 30-gage wire (0.080 inch diameter).
2. Bend as dimensioned.
3. All dimensions are in inches.

**Bulk Material**

Steel wire, 30-gage (7 in.)

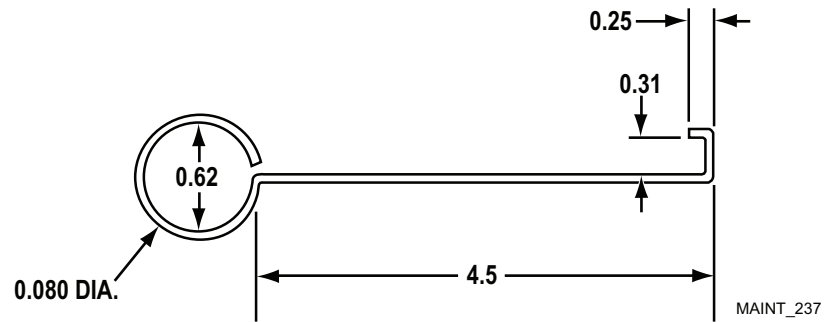


Figure 9. Item 9 - Brush Spring Lifting Tool (11650244).

**ITEM 10 - CYLINDER BLOCK PRESSURE TESTING KIT****Notes:**

1. Fabricate from 3/8-inch thick steel plate.
2. Quantity required: Two.
3. Additional items:

Six compression gaskets	NSN 5305-00-780-5243
12 preformed packings	NSN 5330-00-179-6227
Eight flat washers	NSN 5310-00-880-1263
Eight flat washers	NSN 5310-00-880-1264
Two gaskets	NSN 5330-00-613-9397
Two plates	NSN 2815-00-921-5355
One pipe plug (1/8 NPTF)	NSN 4730-00-371-5337
16 flat washers (5/8)	NSN 5310-00-823-8803
16 screws (5/8-11 x 2 1/4)	NSN 5305-00-724-7223
Four bolts (5/16-18 x 3/4)	NSN 5306-00-226-4825

4. All dimensions are in inches.

**Bulk Material**

Steel plate, 17.7 x 5.7 x 3/8 in. (2)

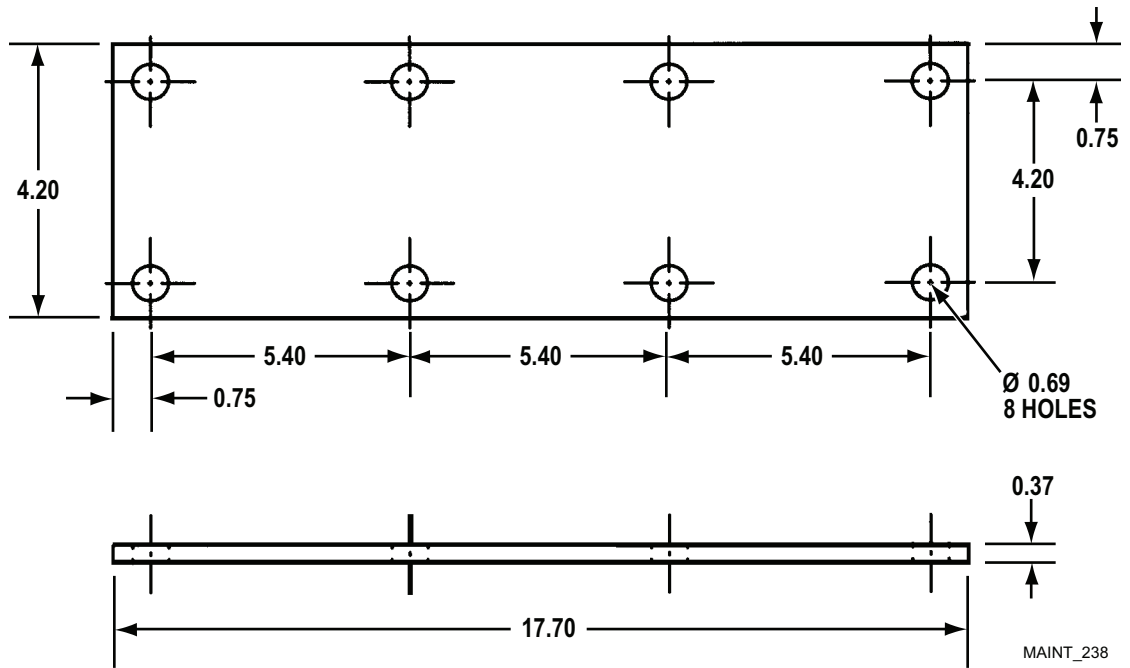


Figure 10. Item 10 - Cylinder Block Pressure Testing Kit (11650245).

**ITEM 11 - GLOW PLUG CONTROLLER TESTER****Notes:**

## 1. Additional items:

Connector, Plug, Electrical (P1)	5935-01-078-0962
Connector, Plug, Electrical (P2)	5935-00-755-3493
Connector, Plug, Electrical (P3)	5935-01-244-5761
Two Clamps, Cable	5935-01-190-6817
Two Clamps, Cable	5935-01-172-8574
Box, Aluminum, 8 x 6 x 2 in.	Local Purchase
Light, Indicator (Wait Lamp)	6210-01-128-2719
10 Lamps, 28 V dc	6210-00-245-7649
Nine Lights, Indicator	6210-00-745-7649
Diode, Light Emitting (LED), 5 V dc	5980-01-285-6688
10 Lens, Light	6220-01-423-0209
Two Switches, Toggle	5930-00-296-6318
Two Switches, Push	5930-01-204-4458
Voltage Regulator, 5 V dc	Local Purchase
Terminal Set, (+/-)	Local Purchase

2. Drill holes in aluminum box as shown in Diagram A.

3. Label holes as shown in Diagram B.

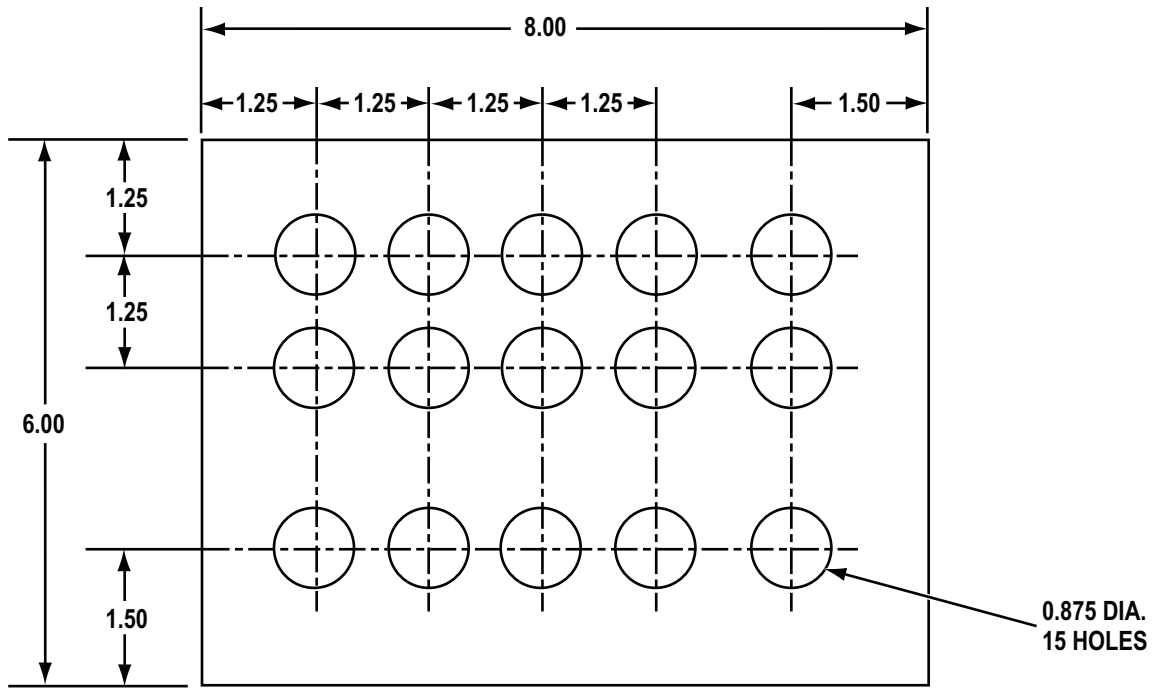
4. Install switches, indicator lights, and terminal in aluminum box as shown in Diagram C.

5. Cut 14-gage wire as required and connect components as shown schematic Diagram D.

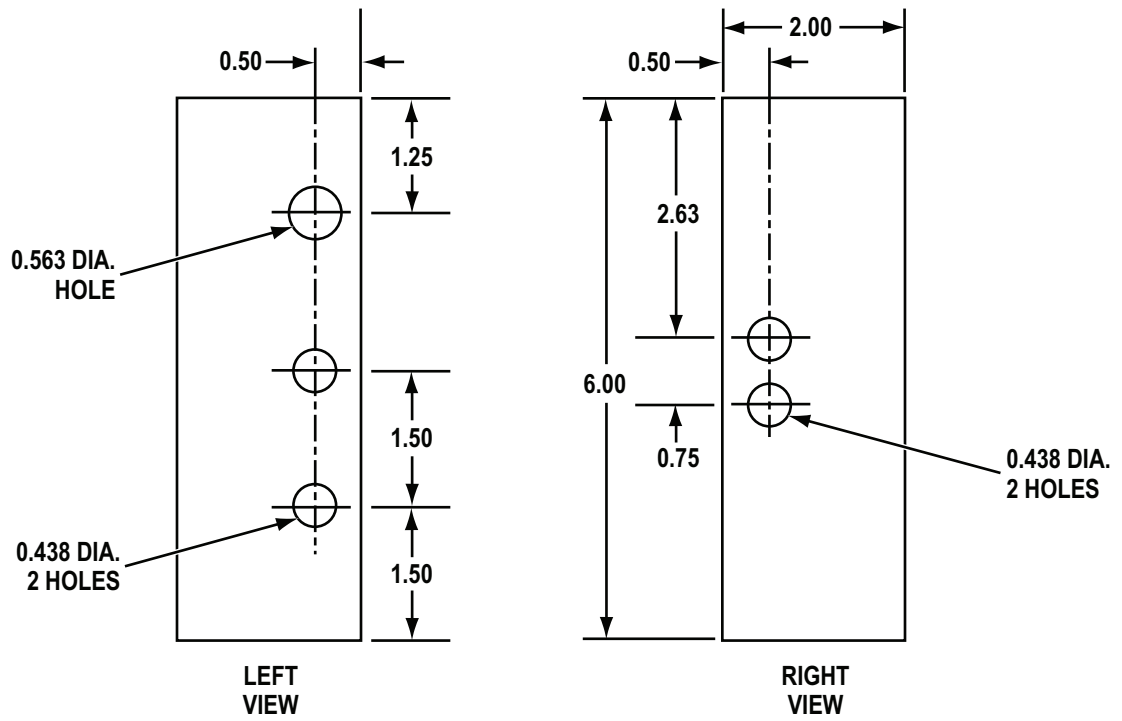
6. Install lamps and lenses in indicator lights. Secure loose components and aluminum box as needed.

**Bulk Material**

Insulated wire, 14-gage (720 in.)



TOP VIEW



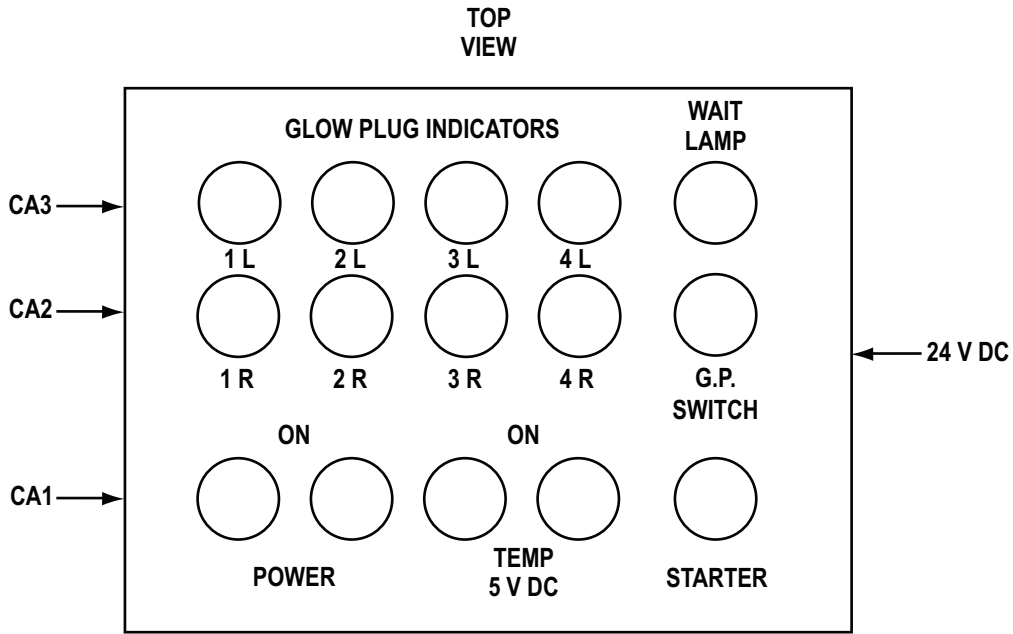
LEFT VIEW

RIGHT VIEW

DIAGRAM A

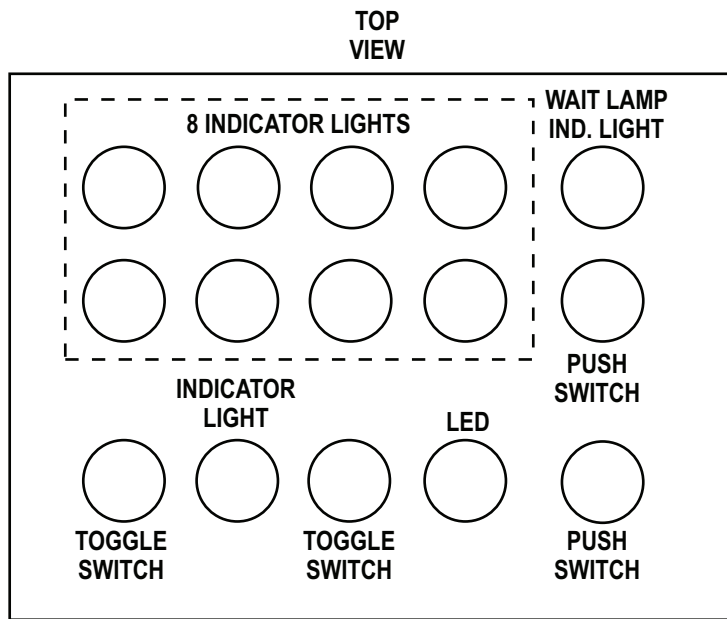
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Figure 11. Item 11 - Glow Plug Controller Tester - Diagram A (11650246).



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Figure 12. Item 12 - Glow Plug Controller Tester - Diagram B (11650246).



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Figure 13. Item 13 - Glow Plug Controller Tester - Diagram C (11650246).

GLOW PLUG CONTROLLER TESTER SCHEMATIC

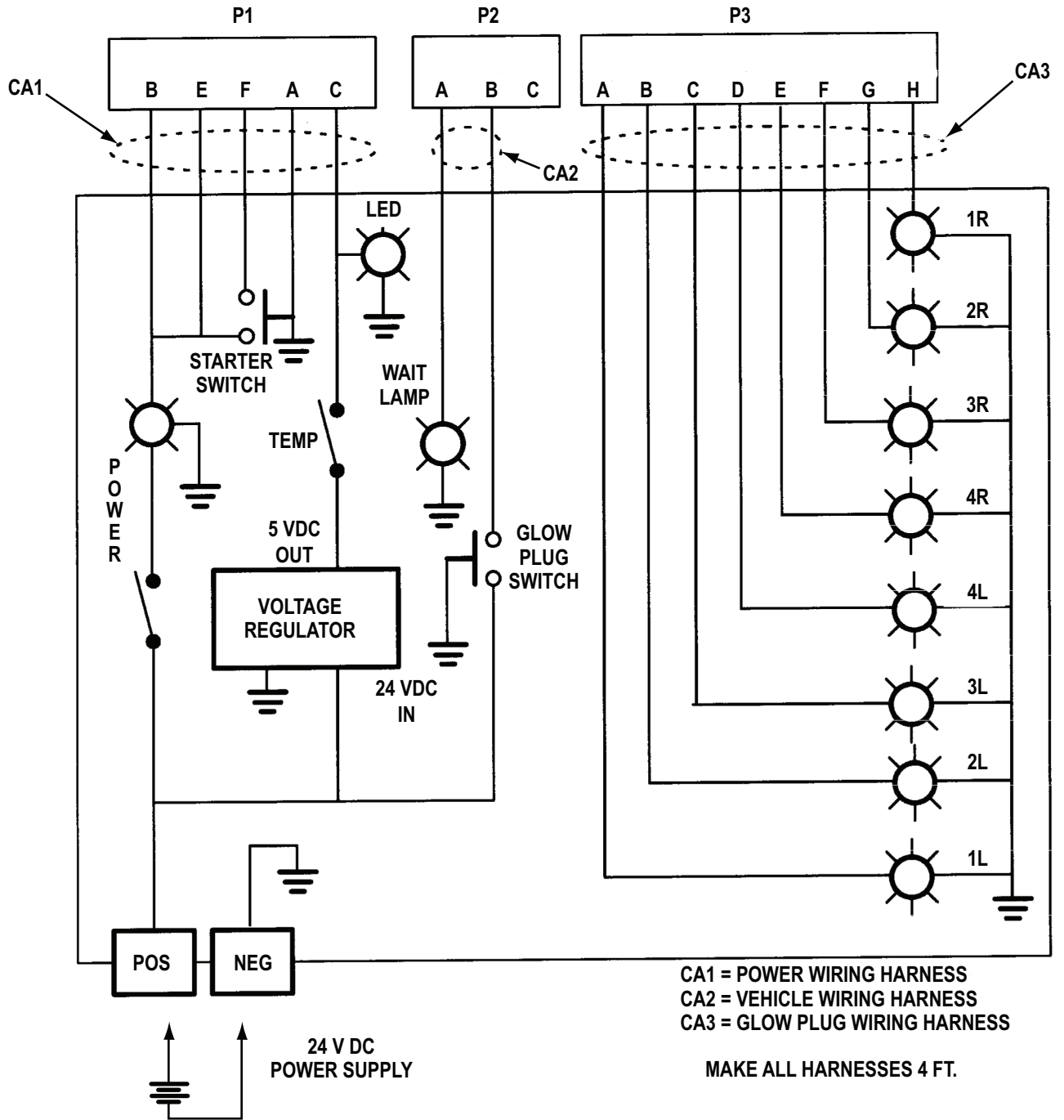


DIAGRAM D

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Figure 14. Item 14 - Glow Plug Controller Tester - Diagram D (11650246).

**ITEM 15 - TEST LEAD****Notes:**

1. Cut a piece of 12-gage wire 6 inches long.
2. Cut a piece of 12-gage wire 12 inches long.
3. Attach a test clip to one end of 6 and 12 inch long 12-gage wire.
4. Drill a hole through end of two No. 2K plugs in order to insert 12-gage wire through.
5. Drill a hole through end of two No. 2K plugs in order to insert 12-gage wire through.
6. Insert one lead through hole in plug and connect to 1-ohm, 50-watt resistor. Insert in rubber hose and attach other lead to resistor.

**Bulk Material**

Insulated wire, 12-gage (18 in.)

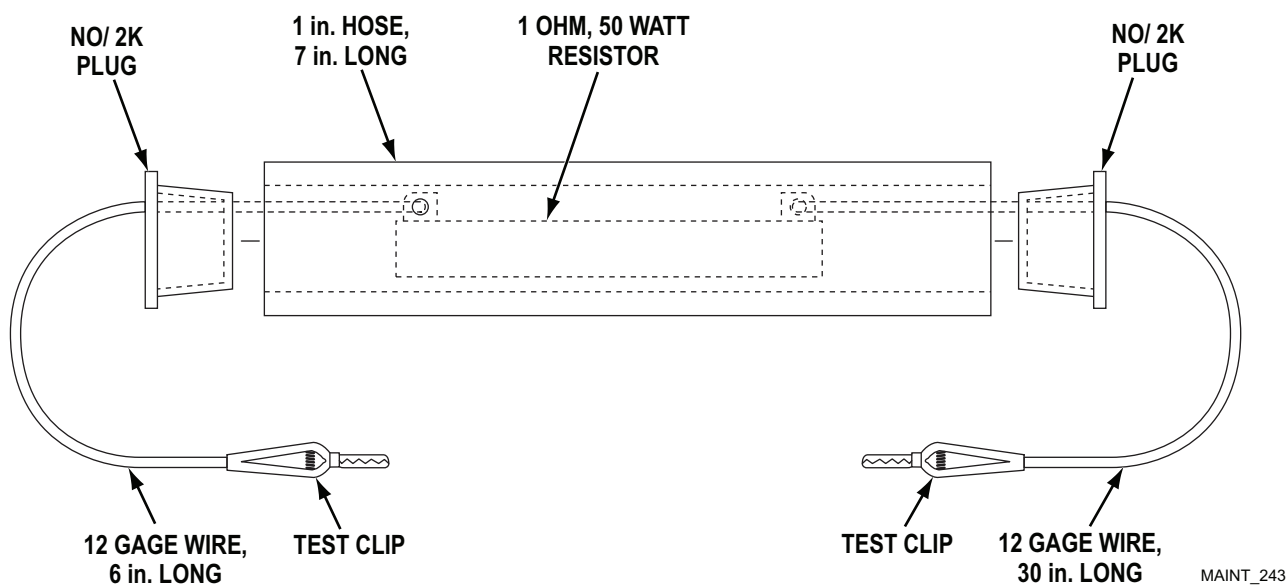


Figure 15. Item 15 - Test Lead (12384626).

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**ITEM 16 - GUIDE STUD****Notes:**

1. Fabricated from NSN 5305-00-964-0503 screw (3/8-16 x 5) by cutting off head of bolt. Saw or file a 1/16-inch screwdriver slot in unthreaded end.
2. Quantity required: Four for flywheel housing or two for lower front cover.
3. All dimensions are in inches.

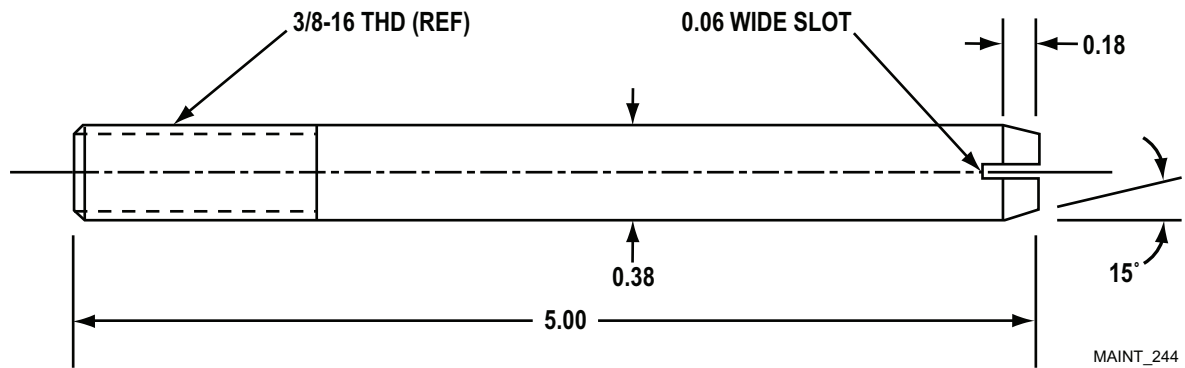


Figure 16. Item 16 - Guide Stud (12384628).

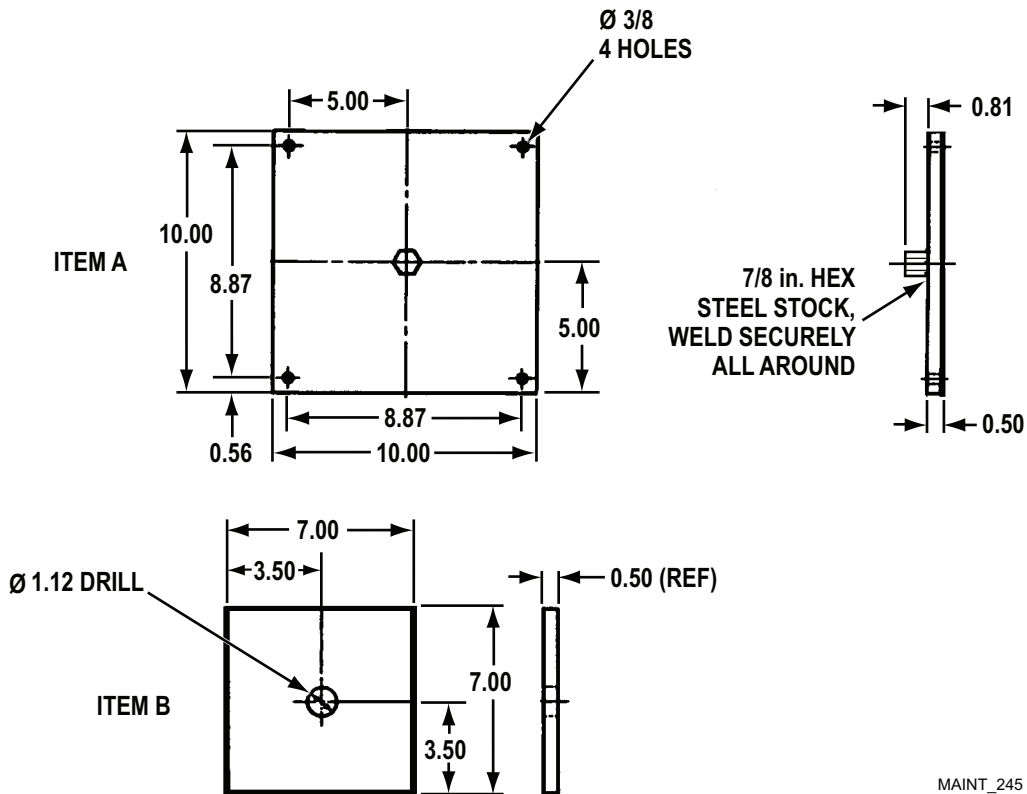
**ITEM 17 - TURBOCHARGER HOLDING FIXTURE**

**Notes:**

1. Fabricate from 1/2-inch thick steel plate, Item A.
2. Weld 7/8-inch hex steel stock 13/16 inch long to center of steel plate.
3. Quantity required: One.
4. Fabricate from 1/2-inch thick plywood, Item B.
5. Quantity required: One.
6. Plywood block is placed over steel plate.
7. All dimensions are in inches.

**Bulk Material**

Steel plate, 10 x 10 x 1/2 in. (1)  
 Plywood, 7 x 7 x 1/2 in. (1)



MAINT\_245

Figure 17. Item 17 - Turbocharger Holding Fixture (12384633).

**END OF WORK PACKAGE**

## FIELD MAINTENANCE TORQUE LIMITS

### Scope

This appendix provides the general torque limits for fasteners used on the 6V53/6V53T Diesel Engines. Special torque limits are indicated in the maintenance procedures for applicable components. These general torque limits cannot be applied to fasteners that retain rubber components. The rubber components will be damaged before the torque limit is reached.

This appendix lists the dry torque limits. Dry torque limits are used on fasteners that do not have lubricants applied to the threads. No wet torques are given because all wet torques are listed in the maintenance procedure. Refer to Table 1 for torques suitable for grade 5, 5.1, 7, and 8 fasteners. No grade 1 or 2 fasteners are used on the 6V53/6V53T Diesel Engine Series.

### How to Use the Torque Table

Measure the shaft diameter of the fastener and count the number of threads per inch. Under the heading thread size, look down the column until you find the diameter and threads per inch of the fastener. Next, look across that row and read the torque limit in lb-ft or N·m.

**Table 1. Torque Limits for Dry Fasteners.**

THREAD SIZE (INCHES- THREADS PER INCH)	TORQUE LIMIT (lb-ft)	TORQUE LIMIT (N·m)
1/4-20	7–9	10–12
1/4-28	8–10	11–14
5/16-18	13–17	18–23
5/16-24	15–19	20–26
3/8-16	30–35	41–47
3/8-24	35–39	47–53
7/16-14	46–50	62–68
7/16-20	57–61	77–83
1/2-13	71–75	96–102
1/2-20	83–93	113–126
9/16-12	90–100	122–136
9/16-18	107–117	146–159
5/8-11	137–147	186–200
5/8-18	168–178	228–242

## How to Use the Torque Table - Continued

*Table 1. Torque Limits for Dry Fasteners - Continued.*

THREAD SIZE (INCHES- THREADS PER INCH)	TORQUE LIMIT (lb-ft)	TORQUE LIMIT (N·m)
3/4-10	240–250	325–339
3/4-16	290–300	393–407
7/8-9	410–420	556–569
7/8-14	475–485	644–657
1-8	580–590	786–800
1-14	685–695	928–942

**END OF TASK****END OF WORK PACKAGE**

**CHAPTER 5**

**SUSTAINMENT MAINTENANCE LEVEL**  
**MAINTENANCE INSTRUCTIONS**  
**FOR**  
**6V53/6V53T DIESEL ENGINES**



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**SUSTAINMENT MAINTENANCE  
CYLINDER HEAD ASSEMBLY REPAIR**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)

Remover, Valve Seat Insert  
(WP 0104, Table 1, Item 84)

Insertor, Bearing and Bushing  
(Installer, Injector Tube - New Style)  
(WP 0104, Table 1, Item 56)

Tool Kit, Diesel Injector  
(WP 0104, Table 1, Item 111)

Compressor, Valve Spring Head Off Eng  
(WP 0104, Table 1, Item 20)

Remover, Valve Guide  
(WP 0104, Table 1, Item 83)

Tester, Spring (WP 0104, Table 1, Item 107)

Installing Tool, Valve (Seat)  
(WP 0104, Table 1, Item 67)

Pressure Testing Kit, Cylinder Head  
(WP 0081, Figure 1)

Installer, Valve Guide  
(WP 0104, Table 1, Item 64)

Adapter, Torque Wrench (Fuel Nut)  
(WP 0104, Table 1, Item 4)

Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)

Fixture, Cam Follower Holding  
(WP 0104, Table 1, Item 28)

Gage, Profile (WP 0104, Table 1, Item 111)

Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)

Grinding Kit, Valve Seat  
(WP 0104, Table 1, Item 48)

Adapter Kit, Valve Seat Grinder  
(WP 0104, Table 1, Item 7)

Gage Set, Telescoping  
(WP 0104, Table 1, Item 46)

Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)

Gage, Dial, Valve Seat  
(WP 0104, Table 1, Item 33)

Vise, Machinist, 4" Jaw  
(WP 0104, Table 1, Item 117)

Caps, Vise Jaw (WP 0104, Table 1, Item 16)

**Materials/Parts**

Cindol 3411 Quenching Oil, Metal  
(WP 0103, Table 1, Item 43)

Cleaning Solvent (WP 0103, Table 1, Item 8)

Crocus Cloth (WP 0103, Table 1, Item 10)

Gasket (WP 0105, Table 1, Item 49)

Injector Tube Kits  
Qty: (3) (WP 0105, Table 1, Item 136)

Oil, Cutting (WP 0103, Table 1, Item 26)

Oil, Engine (WP 0103, Table 1, Item 27)

Oil, Fuel (WP 0103, Table 1, Item 30)

Oil, Lubricating, Preservative  
(WP 0103, Table 1, Item 34)

Plug, Expansion  
Qty: (3) (WP 0105, Table 1, Item 86)

Plug, Expansion  
Qty: (3) (WP 0105, Table 1, Item 94)

Prussian Blue Paste (WP 0103, Table 1, Item 42)

Sealing Compound (WP 0103, Table 1, Item 52)

Tube Assembly, Fuel  
Qty: (6) (WP 0105, Table 1, Item 46)

Washer, Flat  
Qty: (6) (WP 0105, Table 1, Item 133)

Washer, Lock  
Qty: (6) (WP 0105, Table 1, Item 177)

Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

Wood Block Qty: (2) (WP 0103, Table 1, Item 71)

**References**

WP 0009  
WP 0080  
WP 0078

**Equipment Condition**

Engine lifter brackets removed (WP 0040)  
Cylinder head assembly removed (WP 0073)

**DISASSEMBLY****NOTE**

Cover each injector fuel port to keep out dirt immediately after removing fuel tube assemblies (Figure 1, Item 8).

1. Remove six fuel tube assemblies (Figure 1, Item 8) from fuel injectors (Figure 1, Item 7) and fuel nipples (Figure 1, Item 9). Discard tube assemblies.

**NOTE**

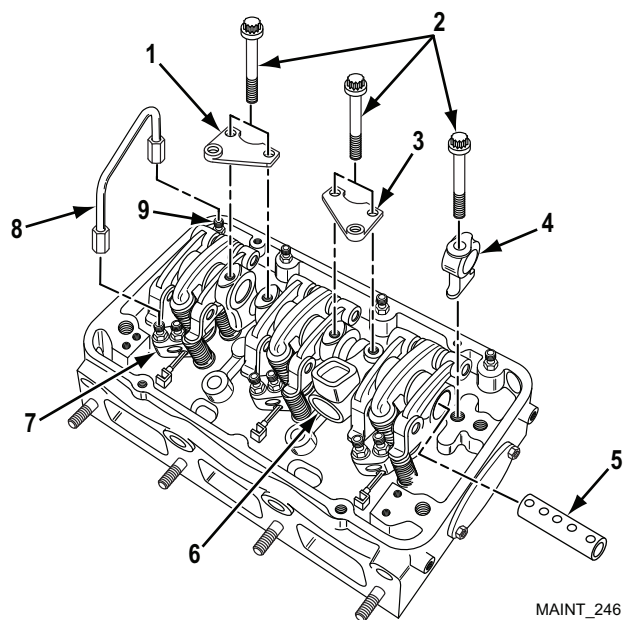
Tag rocker arms, shafts, brackets, valves, cam followers, and associated hardware for installation in original location.

2. Remove six bolts (Figure 1, Item 2) fastening rocker arm shafts (Figure 1, Item 5) and brackets (Figure 1, Item 4) to cylinder head. On models 5063-5392, 5063-5393, and 5063-539L, remove hold-down bracket (Figure 1, Item 1) and hold-down bracket (Figure 1, Item 3) from intermediate brackets.

**NOTE**

On all except model 5063-5299, one bracket (Figure 1, Item 4) on right cylinder head is also the throttle delay housing (Figure 1, Item 6).

3. Remove three rocker arm shafts (Figure 1, Item 5) and six brackets (Figure 1, Item 4) from cylinder head.



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Figure 1. Cylinder Head Disassembly.



**DISASSEMBLY - Continued**

4. For all except model 5063-5299: if necessary, remove check valve (Figure 2, Item 10), oil supply plug (Figure 2, Item 11), and strainer (Figure 2, Item 12) from throttle delay housing (Figure 2, Item 6).
5. Swing left rocker arm (Figure 2, Item 16), injector rocker arm (Figure 2, Item 17), and right rocker arm (Figure 2, Item 18) away from each injector. Remove injector clamp screw (Figure 2, Item 13), convex washer (Figure 2, Item 14), and clamp (Figure 2, Item 15) from each injector.
6. Remove three fuel injectors (Figure 2, Item 7) from cylinder head.
7. Loosen nine push rod nuts (Figure 2, Item 19) at upper end of push rods (Figure 2, Item 20) next to rocker arm clevis. Remove nine rocker arms (Figure 2, Items 16, 17, and 18) from push rods by unscrewing rocker arms.

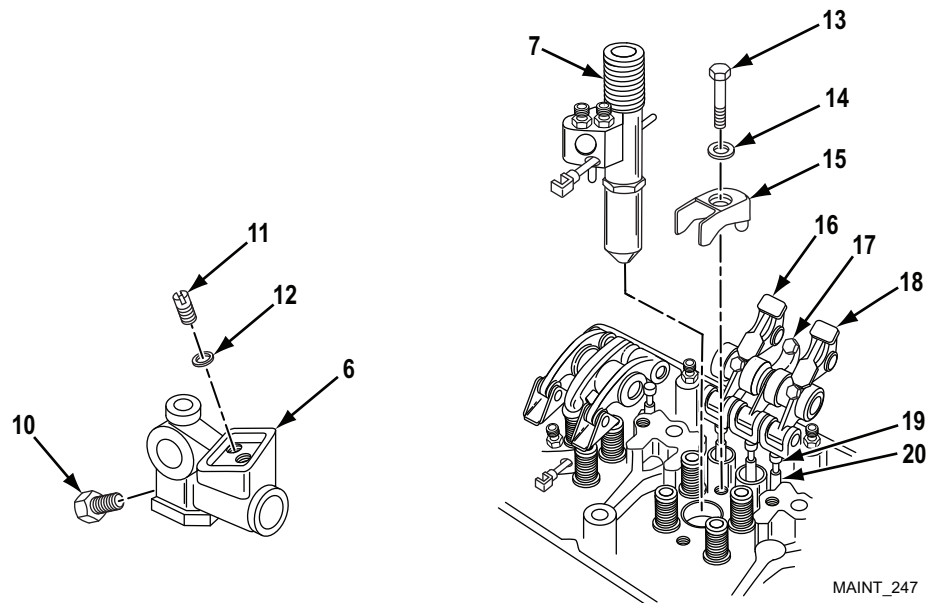


Figure 2. Cylinder Head Rocker Arm and Injector Removal.

**DISASSEMBLY - Continued**

8. Rest cylinder head on its side and remove six screws (Figure 3, Item 21), six lockwashers (Figure 3, Item 22), and three cam follower guides (Figure 3, Item 28). Discard lockwashers.
9. Remove nine cam follower spring retainers (Figure 3, Item 27) from bores in cylinder head.
10. Pull nine cam followers (Figure 3, Item 23) and nine push rod (Figure 3, Item 20) assemblies from bottom of cylinder head. Remove spring (Figure 3, Item 25), push rod nut (Figure 3, Item 19), upper spring seat (Figure 3, Item 26), and lower spring seat (Figure 3, Item 24) from nine push rods.

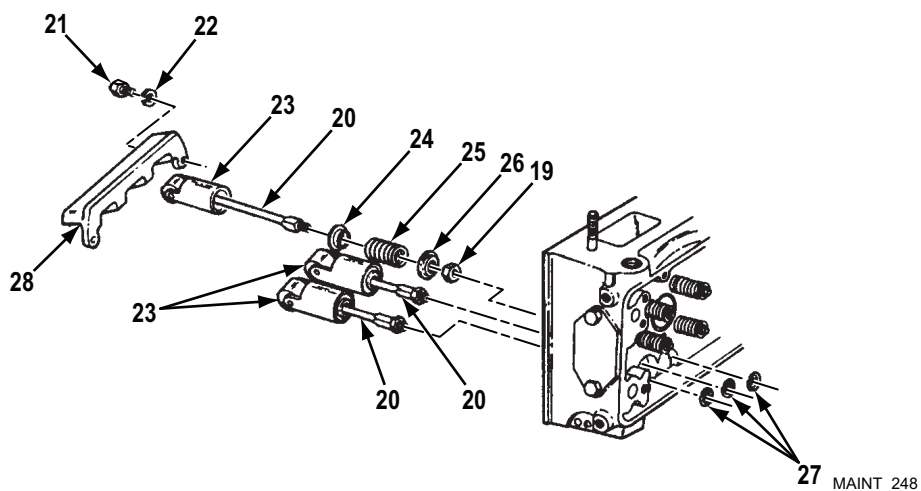


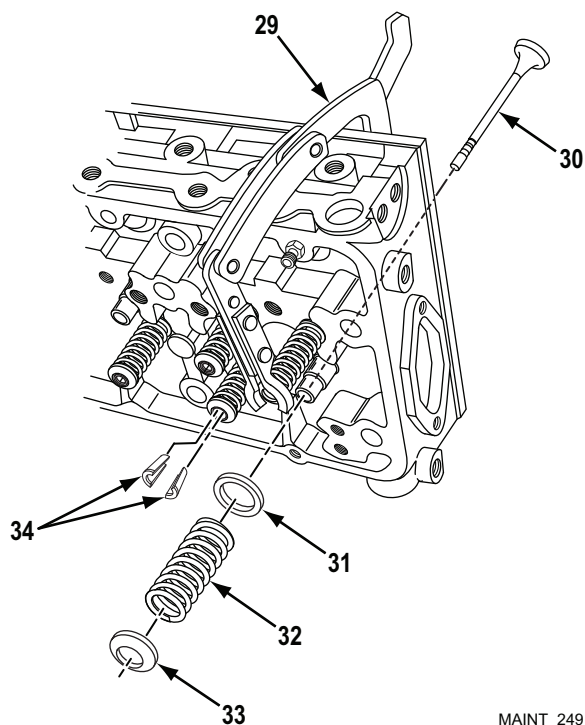
Figure 3. Cylinder Head Cam Follower Guides Removal.

**DISASSEMBLY - Continued****NOTE**

Tag each exhaust valve location. Install used valves in original location.

11. Remove twelve exhaust valves as follows:

- a. Position cylinder head on its side.
- b. Using valve spring compressor (Figure 4, Item 29), compress valve spring (Figure 4, Item 32). Remove two tapered valve locks (Figure 4, Item 34).
- c. Remove upper spring seat (Figure 4, Item 33), valve spring (Figure 4, Item 30), lower spring seat (Figure 4, Item 31), and exhaust valve (Figure 4, Item 30).



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Figure 4. Cylinder Exhaust Valve Removal.

**DISASSEMBLY - Continued**

12. Remove six fuel nipples (Figure 5, Item 9) and six copper flat washers (Figure 5, Item 35) from cylinder head. Discard copper flat washers.
13. If necessary, remove three expansion plugs (Figure 5, Item 37) from cylinder head, one from inboard side and two from outboard side. Discard plugs.
14. If necessary, remove sleeve (Figure 5, Item 40) from inboard side of cylinder head.

**CAUTION**

Inspect fuse plug. If fuse plug is melted, cylinder head assembly was overheated. Thoroughly inspect cylinder head assembly for cracks and other heat related damage.

**NOTE**

Pressure check cylinder head at this point as described in Test and Inspection.

15. Remove two screws (Figure 5, Item 41), two lockwashers (Figure 5, Item 42), cover (Figure 5, Item 43), and gasket (Figure 5, Item 44) from rear of cylinder head. Discard lockwashers and gasket.
16. If necessary, remove four studs (Figure 5, Item 48) from outboard side of cylinder head.
17. Remove fuse plug (Figure 5, Item 47) and adapter (Figure 5, Item 46) from outboard side of cylinder head.
18. Remove three expansion plugs (Figure 5, Item 45) from outboard side of cylinder head. Discard plugs.
19. Remove four pipe plugs (Figure 5, Item 38) from inboard side of cylinder head.
20. Remove pipe plug (Figure 5, Item 36) from each end of cylinder head.

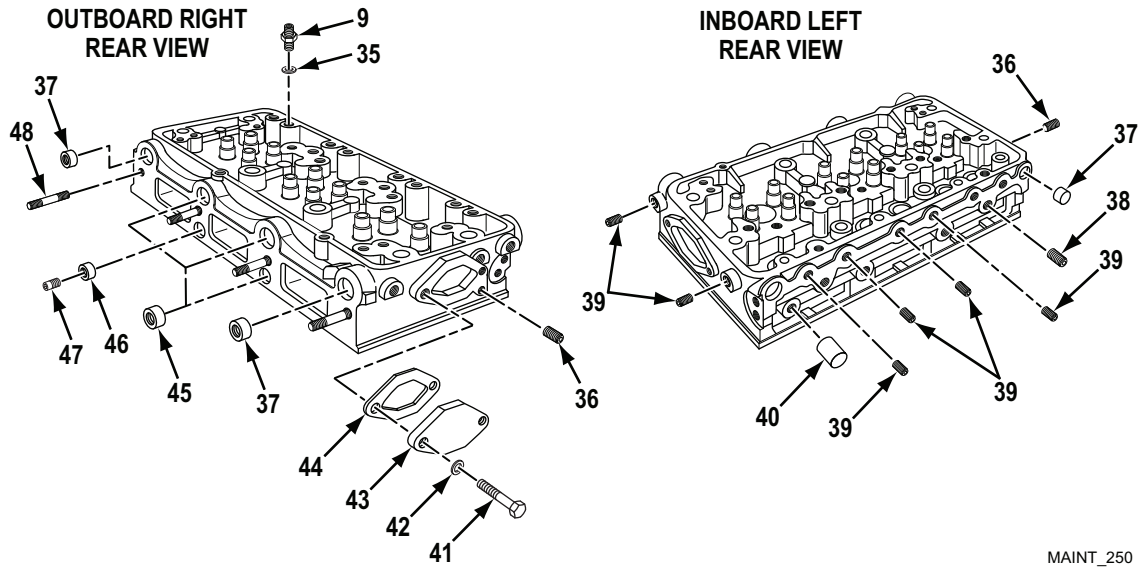
**NOTE**

Model 5063-5392 uses one threaded plug (Figure 5, Item 39) at rear of left cylinder head.

Models 5063-5393 and 5063-539L use one threaded plug (Figure 5, Item 39) at both ends of left cylinder head.

21. If necessary, remove six threaded plugs (Figure 5, Item 39), except where noted, from each end of head. Two plugs are located at each end and four plugs are located on inboard side of cylinder head.

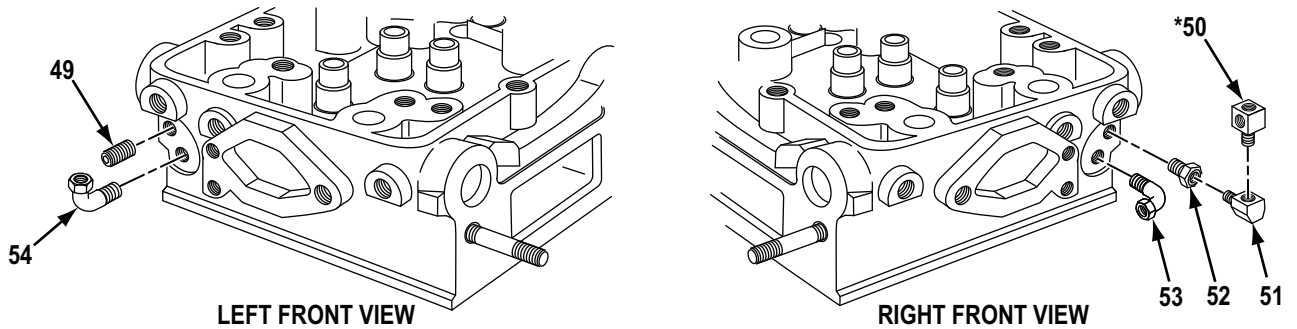
DISASSEMBLY - Continued



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Figure 5. Cylinder Head Freeze Plug Removal.

22. On models 5063-5393, and 5063-539L, remove tee (Figure 6, Item 50) from elbow (Figure 6, Item 51) at front of right cylinder head.
23. Remove elbow (Figure 6, Item 51), coupling (Figure 6, Item 52), and elbow (Figure 6, Item 53) from front of right cylinder head.
24. Remove pipe plug (Figure 6, Item 49) and elbow (Figure 6, Item 54) from front of left cylinder head.



\* MODELS 5063-5393 AND 5063-539L ONLY

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Figure 6. Cylinder Head Fuel Line Fitting Removal.

**DISASSEMBLY - Continued**

25. On models 5063-5299 and 5063-5392, remove tee (Figure 7, Item 55) and pipe nipple (Figure 7, Item 56) from elbow (Figure 7, Item 58) at rear of left cylinder head.
26. Remove elbow (Figure 7, Item 58) and elbow (Figure 7, Item 59) from rear of left cylinder head.
27. Remove two pipe plugs (Figure 7, Item 57) from rear of right cylinder head.

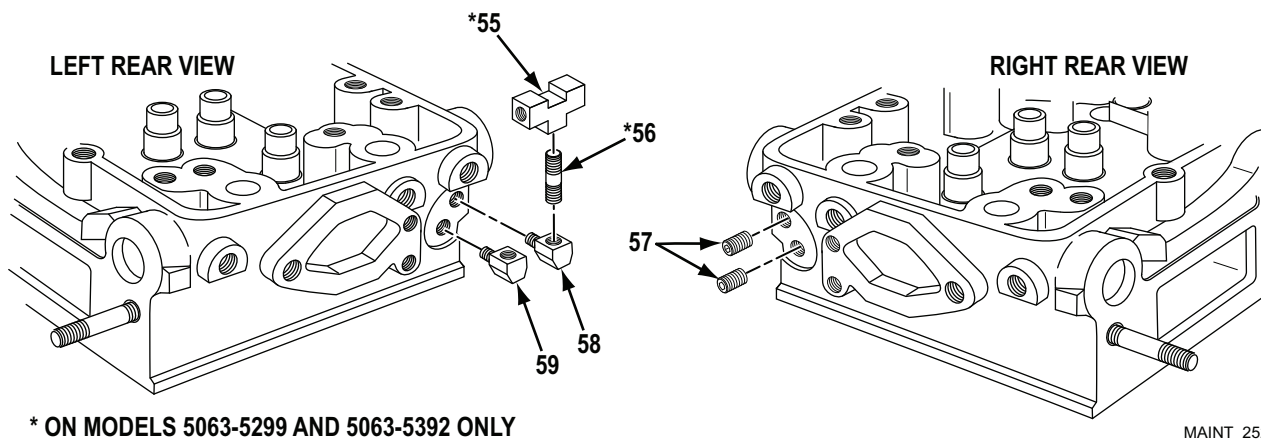
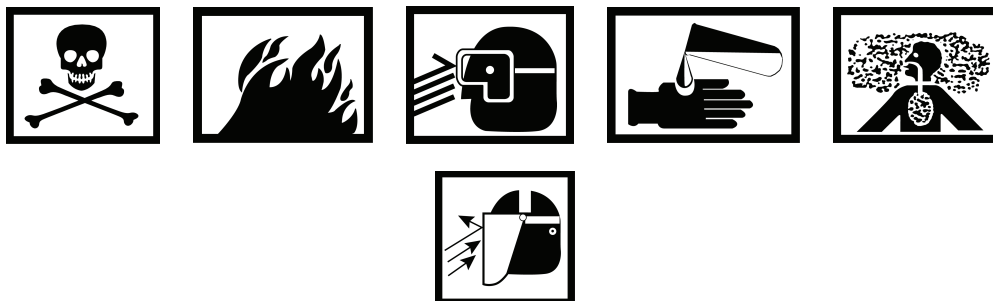


Figure 7. Cylinder Head Fuel Line Tee and Fittings Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Clean cylinder head and cylinder head components with cleaning solvent and dry with compressed air (WP 0009).
2. Clean galleries in cylinder head using probes and brushes.
3. If water passages are heavily coated with scale, remove injector tubes and water nozzles and thoroughly clean water jacket areas.

**END OF TASK**

## TEST AND INSPECTION

Pressure check cylinder head procedures are as follows:

- a. Ensure inside exhaust manifold studs (Figure 8, Item 48), adapter (Figure 8, Item 46), fuse plug (Figure 8, Item 47), three expansion plugs (Figure 8, Item 45), gasket (Figure 8, Item 44), cover (Figure 8, Item 43), and two bolts (Figure 8, Item 41) are in place to pressure check cylinder head.
- b. Install fabricated tapped end blocking plate (Figure 8, Item 64), gasket (Figure 8, Item 63), and two bolts (Figure 8, Item 41) over hole at end of cylinder head (WP 0080). Tighten bolts securely.
- c. Install four fabricated top blocking plates (Figure 8, Item 61), four gaskets (Figure 8, Item 62), eight bolts (Figure 8, Item 60), sixteen flat washers (Figure 8, Item 66), and eight nuts (Figure 8, Item 65) over eight water holes on fire deck (WP 0080). Tighten nuts securely.
- d. Install scrap or dummy injectors to properly seal injector tubes. Torque injector clamp screws to 20–25 lb-ft (27–34 N·m).
- e. Connect an air supply line with regulator to fabricated end plate (Figure 8, Item 64). Pressurize cylinder head water jacket to 40 PSI (276 kPa).
- f. Immerse cylinder head in a tank of water heated to 180–200°F (82–93°C) for twenty minutes to heat head. Observe water in tank for bubbles which indicate a leak or crack. Check for leaks at top and bottom of injector tubes, oil gallery, exhaust ports, fuel galleries, and at top and bottom of cylinder head.
- g. Relieve air pressure and remove cylinder head from water tank. Remove air supply line, regulator, end plate, scrap injectors, and blocking plates from cylinder head.

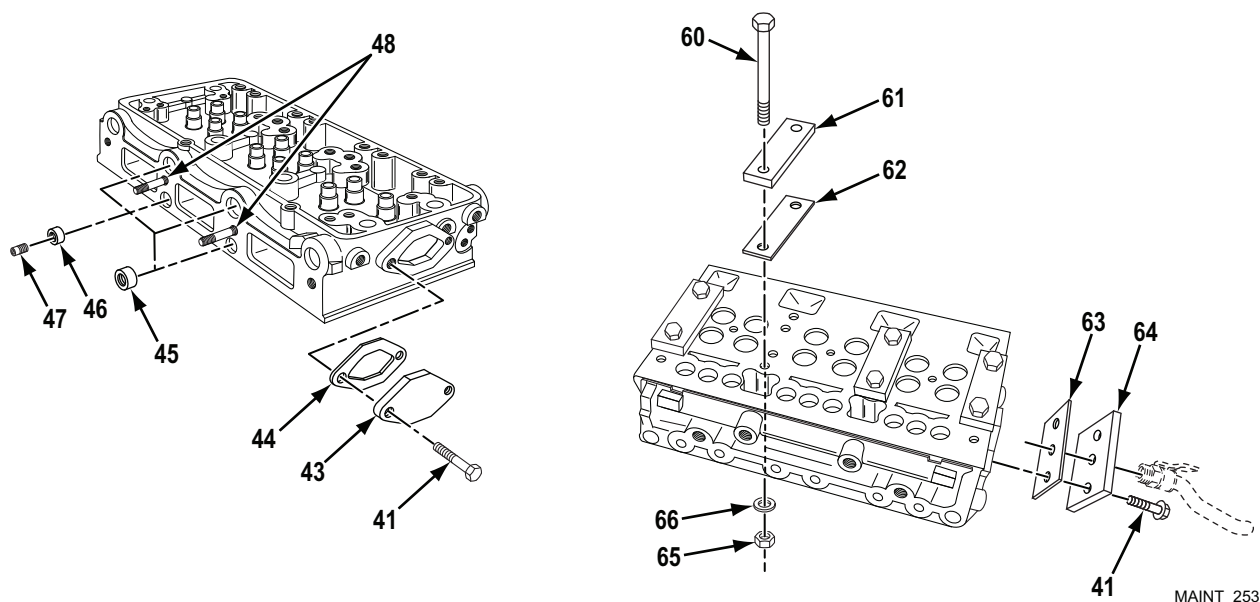


Figure 8. Cylinder Head Test and Inspection.

END OF TASK



**REPAIR OR REPLACEMENT**

1. Cylinder head inspection, repair and replacement procedures:
  - a. Check fire deck surface of cylinder head for flatness. Using a straight edge and thickness gages, check lengthwise (six places) (Figure 9, Items 1 through 6) and crosswise (four places) (Figure 9, Items A through D) for warpage. Maximum lengthwise warpage is 0.005 inch (0.125 mm) and maximum crosswise warpage is 0.004 inch (0.102 mm).
  - b. Inspect cam follower bores in cylinder head for scoring and wear. Clean light score marks with crocus cloth wet with fuel oil. Non-protruding longitudinal scoring of 0.003 inch (0.08 mm) deep and bore surface finish of 120 micro inch Arithmetic Average (AA) maximum is permissible. Check follower bore clearance with plug gage for diameter of 1.0626–1.0670 inches (26.990–27.102 mm). Replace head if worn beyond 1.0670 inches (27.102 mm).
2. Water nozzles inspection and repair procedures:
  - a. Check four water hole nozzles for looseness. If necessary, replace nozzle as follows:
  - b. Clean nozzle bore in cylinder head with 5/8 inch drill. Flare edge of hole slightly.
  - c. Remove any loose nozzle (Figure 9, Item 67) from cylinder head.
  - d. Place nozzle (Figure 9, Item 67) in bore with nozzle opening positioned as shown.
  - e. Press nozzle flush to 0.0312 inch (0.792 mm) below surface of cylinder head.
  - f. Nozzle must fit tight. If necessary, expand nozzle with wood dowel or other suitable tool to make a tight fit.

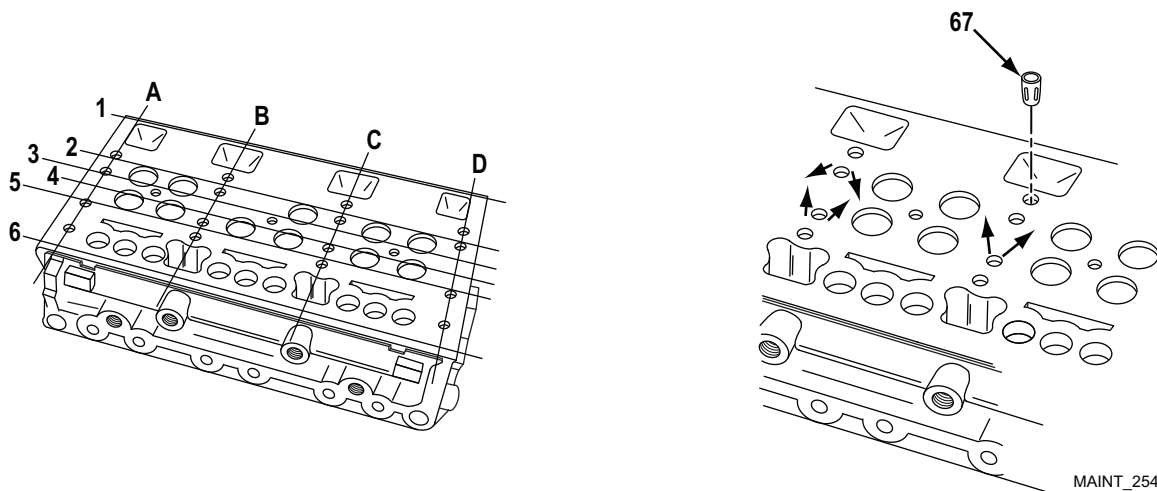


Figure 9. Cylinder Head Flatness and Water Nozzle Check.

**REPAIR OR REPLACEMENT - Continued**

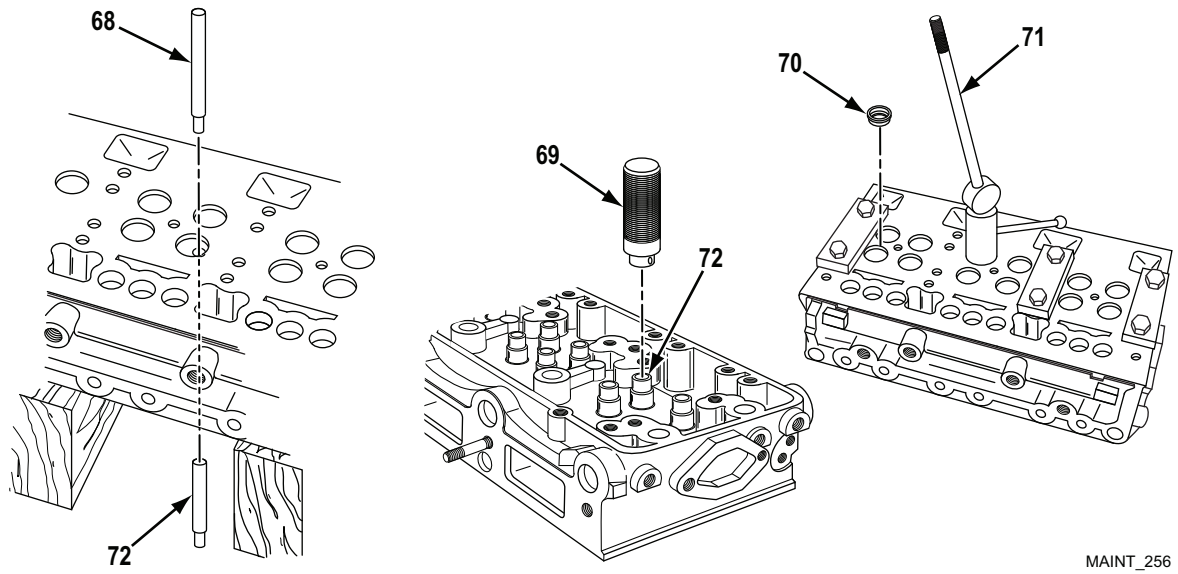
3. Exhaust valve guides inspection and replacement procedures:
  - a. Inspect valve guides (Figure 10, Item 72) for fractures, chipping, scoring, or excessive wear. Measure inside diameter of valve guide and diameter of valve stem to determine clearance between guide and valve stem. If clearance exceeds 0.005 inch (0.125 mm), replace valve guide.
  - b. Replace valve guide as follows:
  - c. Support cylinder head, bottom side up, on three inch thick wood blocks.
  - d. Using valve guide remover (Figure 10, Item 68), drive valve guide (Figure 10, Item 72) out of cylinder head.
  - e. Place cylinder head right side up in press.
  - f. Place valve guide (Figure 10, Item 72) squarely in bore. Using valve guide installer (Figure 10, Item 69), press guide until tool contacts cylinder head.
4. Valve seats inspection and replacement procedures:
  - a. Inspect valve seats (Figure 10, Item 70) for excessive wear, pitting, cracking, or improper seat angle.
  - b. Replace as follows:
    - (1) Place cylinder head on wood blocks with fire deck side up.
    - (2) Using valve seat installing tool (Figure 10, Item 71), remove valve seat (Figure 10, Item 70).
    - (3) Clean valve seat counter bore in cylinder head and inspect for concentricity, flatness, and cracks.

**NOTE**

Valve seat counterbore has a diameter of 1.159–1.160 inches (29.44–29.46 mm) and a depth of 0.294–0.306 inch (7.47–7.77 mm). Counterbores must be concentric with valve guides within 0.003 inch (0.08 mm) total indicator reading.

- (4) Immerse cylinder head in water heated to 180–200°F (82–93°C) for 30 minutes or cool insert with liquid nitrogen.

REPAIR OR REPLACEMENT - Continued



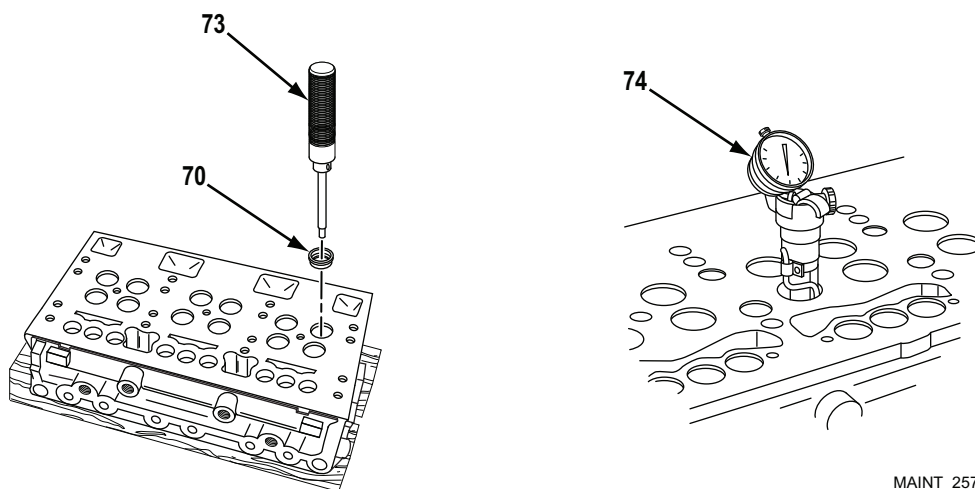
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Figure 10. Cylinder Exhaust Valve Guide and Seats Inspect and Repair.

**REPAIR OR REPLACEMENT - Continued****NOTE**

Install valve seat in cylinder head while head is still hot and valve seat is at room temperature or when valve seat is chilled with liquid nitrogen and cylinder head is at room temperature.

- (5) Place cylinder head on bench with fire deck up. Place valve seat (Figure 11, Item 70) in counterbore with tapered face up.
- (6) Using valve seat installing tool (Figure 11, Item 73), drive valve seat in place until it seats solidly in cylinder head.
- (7) Check valve seats for concentricity in relation to valve guides using valve seat dial gage (Figure 11, Item 74).



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Figure 11. Cylinder Valve Seat Installation and Valve Seal Centricity Check.

**REPAIR OR REPLACEMENT - Continued****NOTE**

Exhaust valve seats are prefinished. Check for concentricity after installation. Grind valve seats only if runout exceeds 0.002 inch (0.05 mm).

5. Valve seat grinding procedures are as follows:

Using valve seat grinder and valve seat grinder adapter kit, grind valve seats as follows:

**CAUTION**

Do not permit grinding wheel to contact cylinder head when grinding valve seat. If valve seat is ground until grinding wheel contacts cylinder head, then install new valve seat.

- (1) Apply 31 degree grinding wheel on valve seat.
- (2) Grind throat of valve seat using 60 degree grinding wheel (Figure 12).

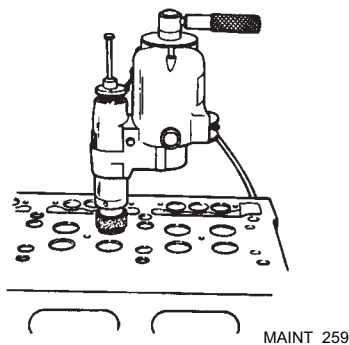


Figure 12. Cylinder Head Valve Seat Grinding.

**REPAIR OR REPLACEMENT - Continued**

- (3) Grind top surface of valve seat with 15 degree grinding wheel to narrow seat width to dimensions shown. Adjust the 31 degree face (Figure 13, Item 76) relative to center of valve face (Figure 13, Item 75) using 15 and 60 degree grinding wheels.

**NOTE**

Grinding will reduce thickness of valve seat and cause valve to recede into cylinder head. Replace valve seat if valve recedes beyond limits.

- (4) After grinding is completed, clean valve seat thoroughly. Measure concentricity of valve seat in relation to valve guide. If runout exceeds 0.002 inch (0.05 mm), check for bent or worn valve guide before regrinding valve seat.

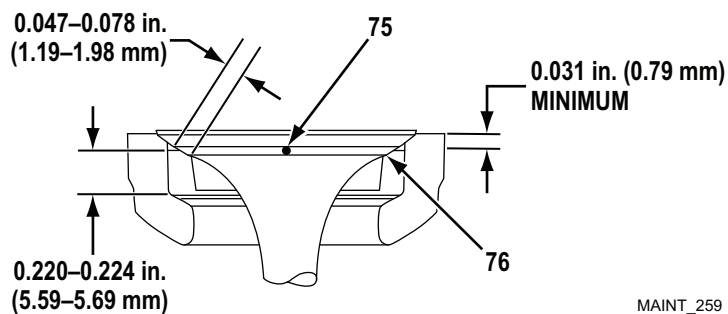


Figure 13. Cylinder Head Valve Seat Centricity Measurement.

**REPAIR OR REPLACEMENT - Continued**

- (5) Apply a light coat of Prussian blue paste to valve seat.
  - (6) Lower stem of valve in valve guide and bounce valve on seat. Do not rotate valve.
  - (7) Remove valve and observe area of contact on valve face. Most desirable area of contact is at center of valve face.
6. Exhaust valves and springs inspection and replacement procedures:
- a. Valve stems must be free from scratches or scuff marks. Valve faces must be free of ridges, cracks, or pitting.
  - b. Replace valves if warped, excessively worn, or pitted.
  - c. Using spring tester (Figure 14, Item 77), measure load required to compress valve spring (Figure 14, Item 32) to 1.93 inches (4.90 cm). Replace valve spring if load is less than 25 lbs (11.3 kg).

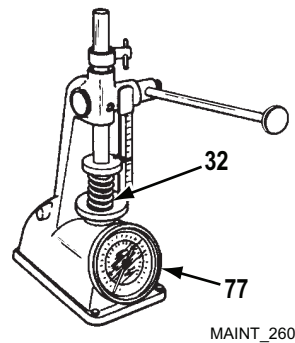


Figure 14. Cylinder Head Valve Spring Load Test.

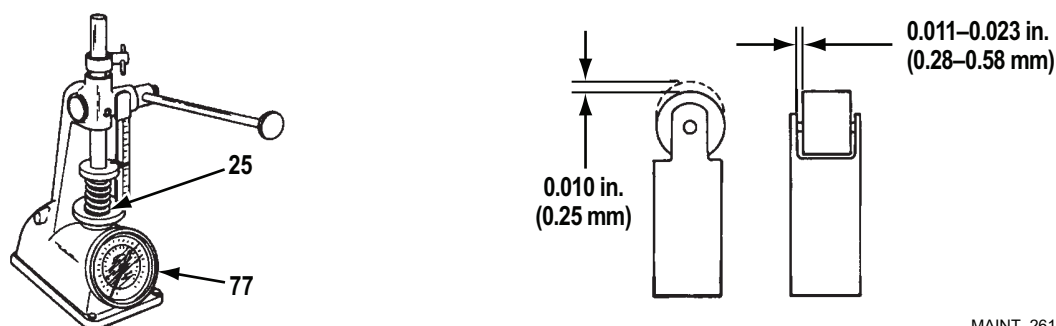
## REPAIR OR REPLACEMENT - Continued

## CAUTION

The difference in load of a pair of valve springs under one bracket must not exceed 6 pounds or exhaust valve bracket will be unbalanced.

Replace both springs under an exhaust valve bracket together. Mating a new spring with a used spring can cause unbalanced valve operation.

7. Cam followers and cam follower springs inspection and replacement procedures:
  - a. Examine cam follower springs (Figure 15, Item 25) for wear or damage. Using spring tester (Figure 15, Item 77), check spring load. Replace spring if a load less than 250 lbs compresses spring to 2.14 inches (5.44 cm).



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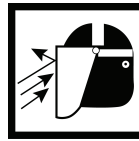
Figure 15. Cylinder Head Cam Spring Follower Load Test.

## CAUTION

Do not use fuel oil to clean cam followers. Lubricating oil will be washed away and cause scoring of cam roller bushing at startup.

- b. Wash cam followers with engine oil and wipe dry. Examine rollers for pitting, scoring, and flat spots. Rollers (Figure 16, Item 78) must turn freely on their pins (Figure 16, Item 79).
- c. Using a dial indicator and holding fixture, measure total diametric clearance on roller. Install cam follower assembly in a vise or other holding device and place dial indicator needle against outside diameter of roller. To obtain total clearance, move roller in crosswise direction. Maximum clearance is 0.010 inch (0.03 mm).
- d. Using thickness gages, measure side clearance on cam follower. Insert gage between end of roller and leg of cam follower body. Side clearance must be 0.011–0.023 inch (0.28–0.58 mm).
- e. If necessary, install new roller and pin as follows:
  - (1) Clamp holding fixture (Figure 16, Item 80) in a vise and place cam follower in groove at top of fixture with pin resting on top of small plunger.



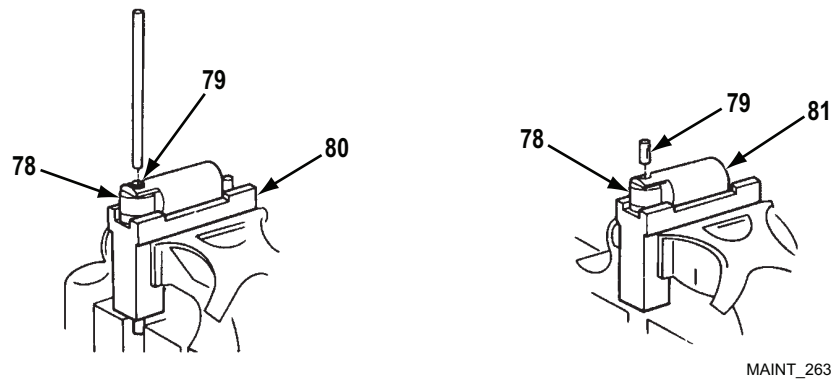
**REPAIR OR REPLACEMENT - Continued****WARNING**

Restrain cam follower body and roller during removal from holding fixture. Follower pin is seated on top of spring loaded plunger in holding fixture and a sudden release could eject cam follower. Failure to comply may result in injury to personnel.

**CAUTION**

Any pin hole burrs on cam follower surfaces must be removed prior to installing roller and pin to prevent scoring of roller bushing and pin.

- (2) Drive pin (Figure 16, Item 79) from roller (Figure 16, Item 78) follower body (Figure 16, Item 81) with a drift.
- (3) Place follower body (Figure 16, Item 81) in groove of holding fixture with small plunger extending through roller pin hole in one leg of follower body.
- (4) Coat pin (Figure 16, Item 79) and roller (Figure 16, Item 78) with engine oil.
- (5) Place roller (Figure 16, Item 78) in cam follower body (Figure 16, Item 81). Plunger will extend into roller bushing and ensure accurate alignment of bushing with roller pin holes in follower body.
- (6) Start pin (Figure 16, Item 79) squarely into follower body (Figure 16, Item 81) and drive into position until pin is centered in legs of follower.
- (7) Check side clearance between roller (Figure 16, Item 78) and follower body (Figure 16, Item 81). Clearance must be 0.011–0.023 inch (0.28–0.58 mm).



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Figure 16. Cam Follower Roller Replacement.

**REPAIR OR REPLACEMENT - Continued**

## 8. Rocker arms and shafts inspection procedures:

Inspect rocker arm shafts and bushings for wear. Maximum shaft to bushing clearance is 0.004 inch (0.10 mm).

## 9. Injector tube leak test and replacement procedures:

Replace injector tubes if found leaking during pressure test as follows:

- (1) Place bearing and bushing inserter (Figure 17, Item 85) in injector tube (Figure 17, Item 84).
- (2) Insert pilot (Figure 17, Item 82) in small hole in injector tube (Figure 17, Item 84) and thread pilot in threaded hole of bearing and bushing inserter (Figure 17, Item 85).
- (3) Tap pilot (Figure 17, Item 82) to drive out injector tube (Figure 17, Item 84). Lift injector tube, pilot, preformed packing (Figure 17, Item 83), and bearing and bushing inserter (Figure 17, Item 85) from cylinder head. Discard injector tube and preformed packing.
- (4) Thoroughly clean injector tube hole in cylinder head to remove dirt, burrs, or foreign material that may prevent tube from seating properly.
- (5) Lubricate injector tube preformed packing (Figure 17, Item 83) with engine oil and place in counterbore of cylinder head.

**NOTE**

There are two types of injector tube installers, a fixed tool (Figure 17, Item 85) for the superseded tube and an adjustable tool (Figure 17, Item 87) for the current tube. The current tube has "606" stamped on top flange. Either injector tube is acceptable if used with the proper installer.

For proper installation of current injector tube, adjustable injector tube installer must contact bottom of injector tube before it touches flange at top. Clearance at top, between flange and tool, must be 0.001–0.010 inch (0.03–0.25 mm).

- (6) Place bearing and bushing inserter (Figure 17, Items 85 or 87) in injector tube (Figure 17, Item 84). Insert pilot (Figure 17, Item 82) through small hole in injector tube and thread into tapped hole at end of installer.
- (7) Slip injector tube (Figure 17, Item 84), bearing and bushing inserter (Figure 17, Item 85 or 87), and pilot (Figure 17, Item 82), into injector bore and drive into place.
- (8) Turn cylinder head fire deck up and remove installer pilot. Thread flaring die installer (Figure 17, Item 86) into tapped hole of bearing and bushing inserter (Figure 17, Item 85 or 87).
- (9) Apply 30 lb-ft (41 N·m) torque to flaring die installer (Figure 17, Item 86).
- (10) Remove flaring die installer (Figure 17, Item 86) and bearing and bushing inserter (Figure 17, Item 85 or 87) from injector tube.

## REPAIR OR REPLACEMENT - Continued

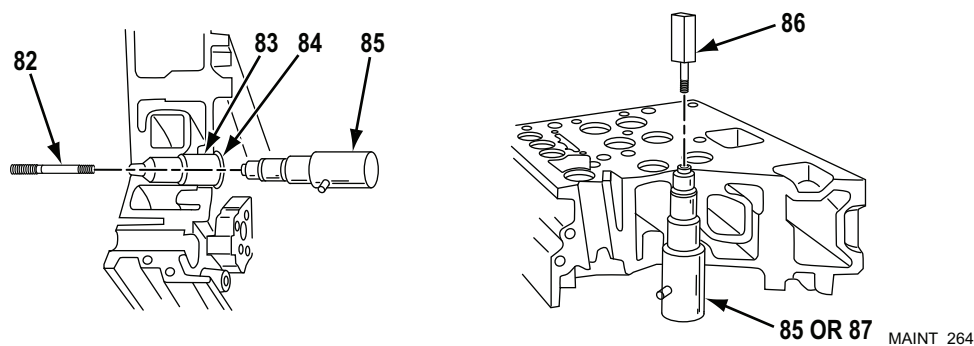


Figure 17. Injector Tube Pilot Installation.

**NOTE**

Reamers do not contact large inside diameter of current injector tube marked "606". Ream only at small inside diameter and injector nut seat.

- (11) Clean injector tube (Figure 18, Item 84) and place cylinder head with fire deck facing down. Apply a few drops of cutting oil on reamer flutes and carefully position finishing reamer (Figure 18, Item 88) in injector tube.

**CAUTION**

Turn reamers only in clockwise direction, both when inserting and removing reamers. Movement in opposite direction will dull cutting edges on flutes.

- (12) Turn finishing reamer (Figure 18, Item 88) clockwise (withdraw reamer frequently to remove chips) until lower shoulder contacts injector tube (Figure 18, Item 84). Clean out all chips.
- (13) Turn cylinder head to fire deck up position. Insert pilot of tube tip refinisher (Figure 18, Item 89) into small hole of injector tube (Figure 18, Item 84).
- (14) Apply a few drops of cutting oil on tube tip refinisher (Figure 18, Item 89). Using a socket and revolving grip socket wrench handle, remove excess stock so lower end of injector tube (Figure 18, Item 84) is from flush to 0.005 inch (0.13 mm) below finished surface of cylinder head.

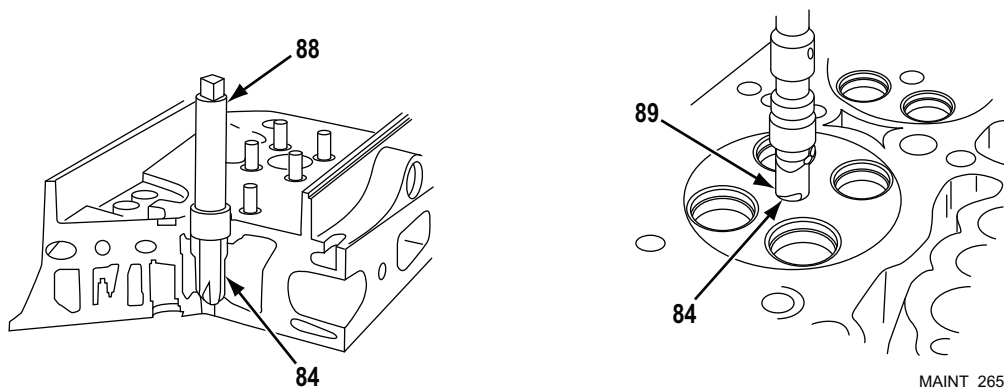


Figure 18. Injector Tube Reaming.

**REPAIR OR REPLACEMENT - Continued**

- (15) Install cylinder depth gage (Figure 19, Item 90) in injector tube. Using profile gage (Figure 19, Item 91), pre-measure distance from fire deck to gage (final reading will have to be within +/- 0.014 inch (0.36 mm) of fire deck).
- (16) Wash interior of injector tube (Figure 19, Item 84) to prepare for second reaming operation.
- (17) Apply a few drops of cutting oil on bevel seat of injector tube (Figure 19, Item 84). Lower bevel reamer (Figure 19, Item 92) carefully into injector tube until it contacts bevel seat.
- (18) For trial cut, turn bevel reamer (Figure 19, Item 92) steadily without applying any downward force. Remove reamer, clean out chips, and observe what portion of injector nut seat was cut.
- (19) Proceed with reaming and withdraw bevel reamer occasionally to observe progress.
- (20) Continue reaming until shoulder of spray tip is within +/- 0.014 inch (0.36 mm) of fire deck. Use gages (Figure 19, Items 91 and 90) to measure distance.
- (21) Wash interior of injector tube (Figure 19, Item 84).

## 10. Throttle delay housing assembly inspection procedures:

Inspect throttle delay check valve for leakage. Fill throttle delay cylinder with fuel oil and watch check valve for leakage while slowly moving piston into housing. If more than a drop of leakage occurs, replace check valve.

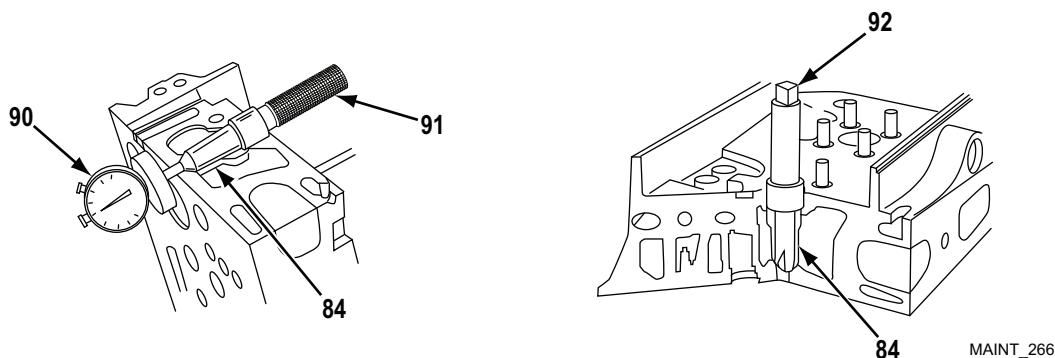


Figure 19. Fuel Injector Depth Gage Check and Injector Tube Reaming.

**END OF TASK****ASSEMBLY****NOTE**

Coat plugs and fittings with sealing compound before installing.

Drive expansion plugs flush to 0.0625 inch (1.588 mm) below surface of cylinder head.

1. If removed, install three new expansion plugs (Figure 20, Item 37) in sides of cylinder head, one plug on inboard side and two plugs on outboard side.
2. If removed, install sleeve (Figure 20, Item 40) on inboard side of cylinder head at rear. Coat sleeve with sealing compound and drive into bore until it protrudes 3/8 inch.

**ASSEMBLY - Continued**

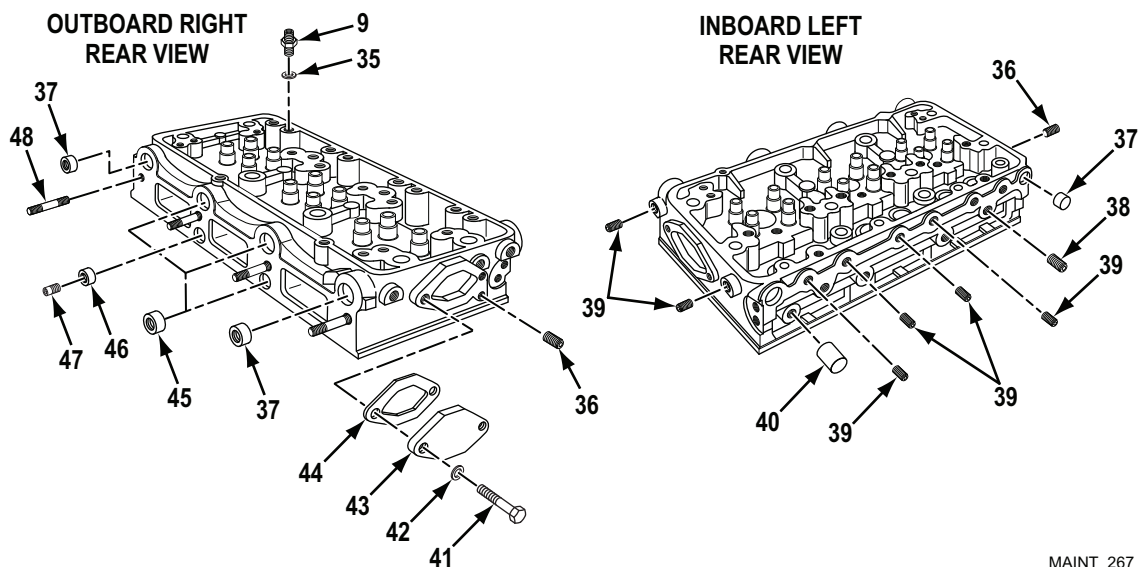
3. Install adapter (Figure 20, Item 46) into bore at outboard side of cylinder head; lower front hole on left head and lower rear hole on right head. Apply sealing compound to adapter and drive flush to 0.03 inch (0.76 mm) below surface.
4. Install fuse plug (Figure 20, Item 47) into adapter (Figure 20, Item 46).
5. Install three new expansion plugs (Figure 20, Item 45) at outboard side of cylinder head.
6. Install four pipe plugs (Figure 20, Item 38) in fuel galleries on inboard side of cylinder head.
7. Install pipe plug (Figure 20, Item 36) in oil gallery at each end of cylinder head.

**NOTE**

Model 5063-5392 uses one threaded plug (Figure 20, Item 39) at rear of left cylinder head.

Models 5063-5393 and 5063-539L uses one threaded plug (Figure 20, Item 39) at both ends of left cylinder head.

8. If removed, install six threaded plugs (Figure 20, Item 39), except where noted, in cylinder head. One plug located at each end and four plugs located in inboard side of cylinder head.
9. If any exhaust manifold stud (Figure 20, Item 48) was removed, apply sealing compound to threads of stud and install in outboard side of cylinder head. Torque stud to 25–40 lb-ft (34–54 N·m). Stud must protrude 1-7/16 – 1-1/2 inches (3.5–3.8 cm) from face of cylinder head.
10. Install six fuel nipples (Figure 20, Item 9) and six new copper flat washers (Figure 20, Item 35) to fuel galleries at top of cylinder head. Torque connectors to 20–28 lb-ft (27–38 N·m).
11. Install new gasket (Figure 20, Item 44), cover (Figure 20, Item 43), two new lockwashers (Figure 20, Item 42), and two bolts (Figure 20, Item 41) on rear of cylinder head.

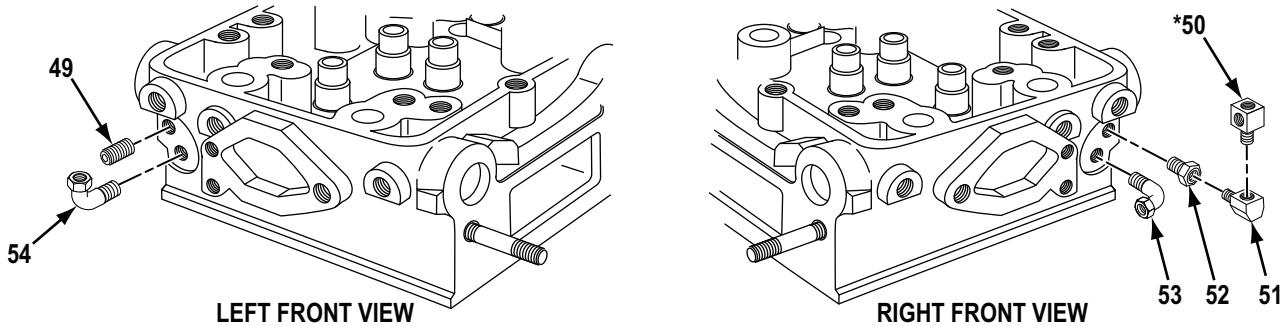


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Figure 20. Cylinder Head Freeze Plug Assembly.

**ASSEMBLY - Continued**

12. Install elbow (Figure 21, Item 53) to front of right cylinder head. Position elbow pointing outboard.
13. Install coupling (Figure 21, Item 52) and elbow (Figure 21, Item 51) to front of right cylinder head. Position elbow pointing in a ten o'clock position.
14. On models 5063-5393 and 5063-539L, install tee (Figure 21, Item 50) to elbow (Figure 21, Item 51) at front of right cylinder head.
15. Install pipe plug (Figure 21, Item 49) and elbow (Figure 21, Item 54) in front of left cylinder head. Position elbow pointing upward.

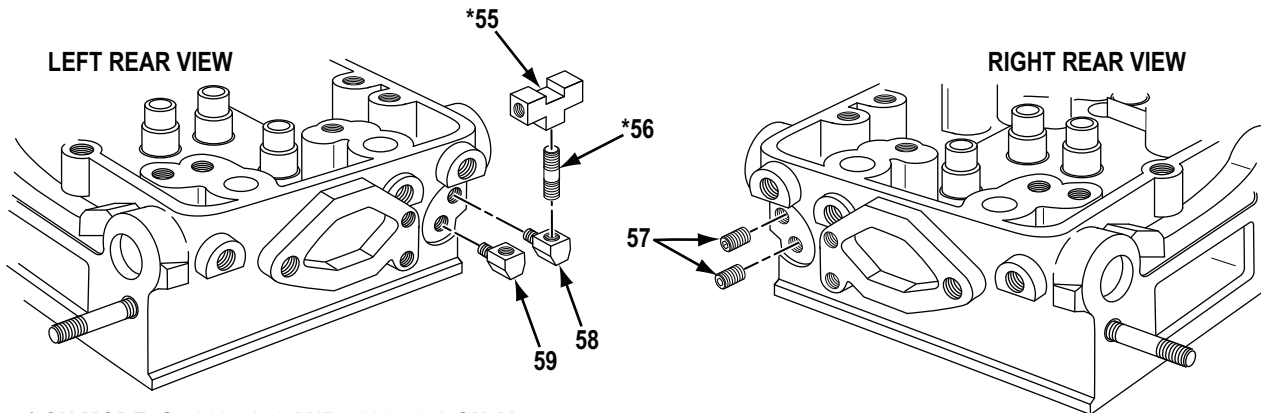


**\* MODELS 5063-5393 AND 5063-539L ONLY**

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Figure 21. Cylinder Head Fuel Line Fitting Assembly.

16. Install elbows (Figure 22, Items 58 and 59) facing upward in rear of left cylinder head.
17. On models 5063-5299 and 5063-5392, install pipe nipple (Figure 22, Item 56) and tee (Figure 22, Item 55) to elbow (Figure 22, Item 58) in rear of left cylinder head.
18. Install two pipe plugs (Figure 22, Item 57) to rear of right cylinder head.



**\* ON MODELS 5063-5299 AND 5063-5392 ONLY**

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Figure 22. Cylinder Head Fuel Line Tee and Fittings Installation.

**ASSEMBLY - Continued**

19. Install twelve exhaust valves as follows:

- a. Place cylinder head on its side. Lubricate valve stems with preservative lubricating oil and slide valves (Figure 23, Item 30) all the way into guides (Figure 23, Item 68).

**NOTE**

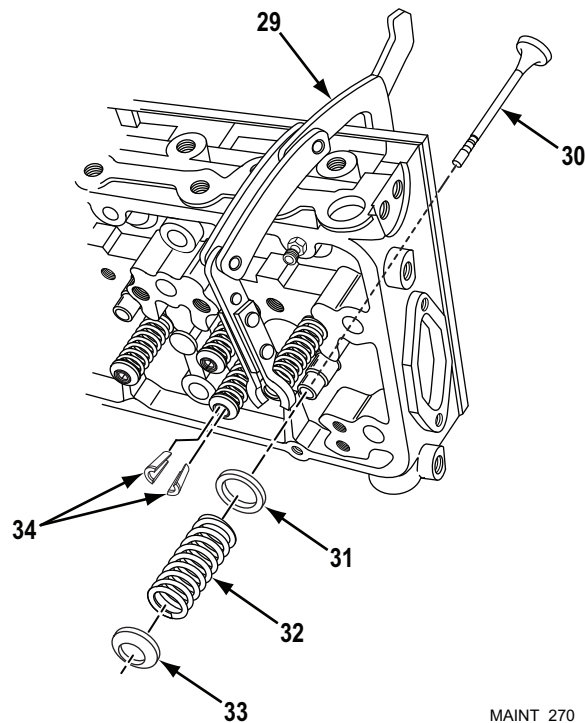
Install used valves only in their original location.

- b. Install lower spring seat (Figure 23, Item 31), valve spring (Figure 23, Item 32), and upper spring seat (Figure 23, Item 33) over valve stem.

**CAUTION**

Avoid scoring valve stem with spring seats when compressing spring.

- c. Using valve spring compressor (Figure 23, Item 29), compress valve spring (Figure 23, Item 32) and install two tapered valve locks (Figure 23, Item 34).
- d. Release pressure on valve spring compressor (Figure 23, Item 29) and remove it.
- e. Repeat Steps 19.a. – 19.d. for remaining valves.
- f. Support cylinder head on wood blocks at both ends (fire deck down). Give stem end of valves a sharp tap with soft head hammer to seat valve locks (Figure 23, Item 34).



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Figure 23. Cylinder Head Exhaust Valve Installation.

**ASSEMBLY - Continued****NOTE**

The limits for exhaust valve protrusion with respect to cylinder head is shown (Figure 24).

- g. With bottom of cylinder head facing up, measure exhaust valve protrusion beyond fire deck using cylinder depth gage (Figure 24, Item 93). If out of limits, regrind or replace insert and exhaust valve.

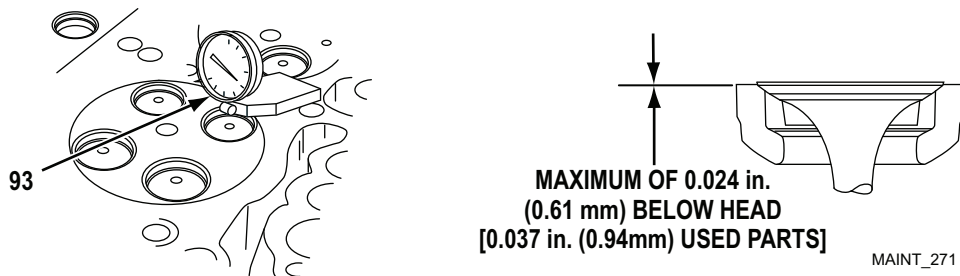


Figure 24. Cylinder Head Exhaust Valve Depth Check.

**NOTE**

Before installing cam followers, immerse in Cindol 1411 metal quenching oil heated to 100–125°F (38–52°C) for one hour for initial lubrication of cam roller pins and bushings. Rotate cam rollers during soaking period to purge air from bushing and roller area.

Install used cam followers and push rods in original locations.

20. Assemble lower spring seat (Figure 25, Item 24), spring (Figure 25, Item 25), upper spring seat (Figure 25, Item 26), and push rod nut (Figure 25, Item 19) on nine push rods (Figure 25, Item 20).
21. Install nine spring retainers (Figure 25, Item 27) in bores from top of cylinder head.
22. Slide nine push rod (Figure 25, Item 20) assemblies in cylinder head from bottom.

**NOTE**

Install cam followers with oil hole away from exhaust valves.

23. Slide nine cam followers (Figure 25, Item 23) in cylinder head from bottom.

**CAUTION**

Cam follower must not be cocked in bore. With cam follower guide installed, bottom of cam follower body must be flush with fire deck.

24. Install three cam follower guides (Figure 25, Item 28), six new lockwashers (Figure 25, Item 22), and six screws (Figure 25, Item 21) on cylinder head. Torque screws to 144–180 lb-in (16–20 N·m).



ASSEMBLY - Continued

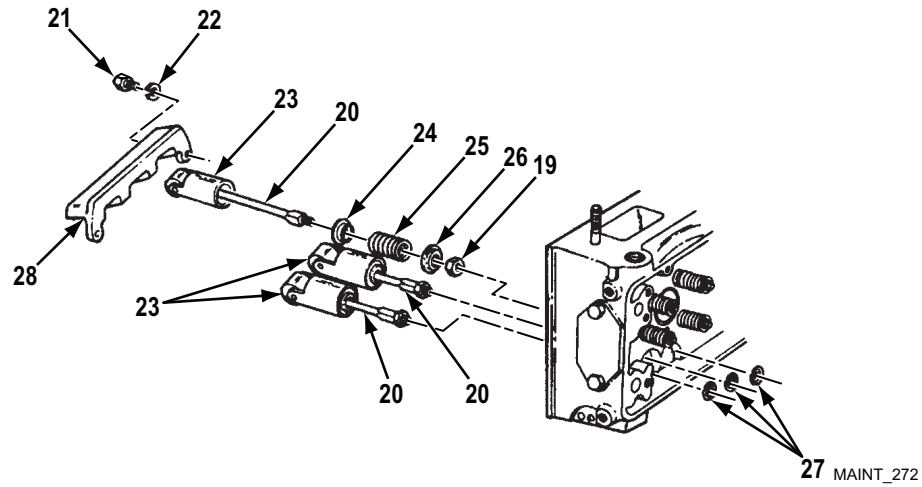


Figure 25. Cylinder Head Cam Follower Installation.

25. Measure clearance between cam follower guide (Figure 26, Item 28) and cam follower legs using thickness gages. Clearance must be at least 0.005 inch (0.13 mm).
26. If clearance is too small, slightly loosen screws (Figure 26, Item 21) and tap corners of guide (Figure 26, Item 28) with brass drift. Torque screws again after proper adjustment.

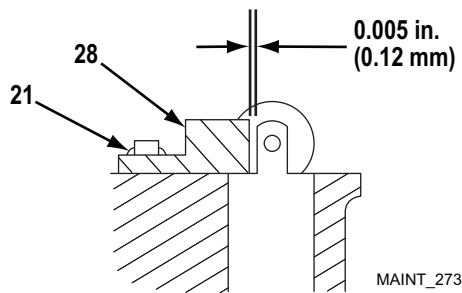


Figure 26. Cylinder Head Cam Follower Guide Clearance Check.

**ASSEMBLY - Continued****NOTE**

If a new rocker arm is installed, also install a new push rod.

Push rod nut adjustment is performed during Engine Adjustment (WP 0078).

27. Thread each rocker arm (Figure 27, Item 16, 17, and 18) on its push rod (Figure 27, Item 20) assembly until end of push rod is flush with inner side of clevis yoke (Figure 27, Item 94).

**CAUTION**

Injector hold-down clamp must not contact exhaust valve spring or injector follower spring.

28. Install three fuel injectors (Figure 27, Item 7), three clamps (Figure 27, Item 15), three convex washers (Figure 27, Item 14), and three screws (Figure 27, Item 13) in cylinder head. Install convex washers with curved side toward injector clamp. Align dowel pin in injector with hole in cylinder head. Torque screws to 20–25 lb-ft (27–34 N·m).
29. For all except model 5063-5299: if necessary, install check valve (Figure 27, Item 10), strainer (Figure 27, Item 12), and oil supply plug (Figure 27, Item 11) into throttle delay housing (Figure 27, Item 6).

**NOTE**

Collar for right and left rocker arm shaft is longer on side facing injector rocker arm. Injector rocker arm has no valve bracket.

On all except model 5063-5299 for No. 1 cylinder of right cylinder head, replace rear bracket on rocker arm shaft with throttle delay housing (Figure 27, Item 6).

30. Apply engine oil to each rocker arm shaft (Figure 28, Item 5) and slide shaft through left rocker arm (Figure 27, Item 16), injector rocker arm (Figure 27, Item 17), and right rocker arm (Figure 27, Item 18). Place a bracket (Figure 28, Item 4) on each shaft end with finished face of bracket toward rocker arm.

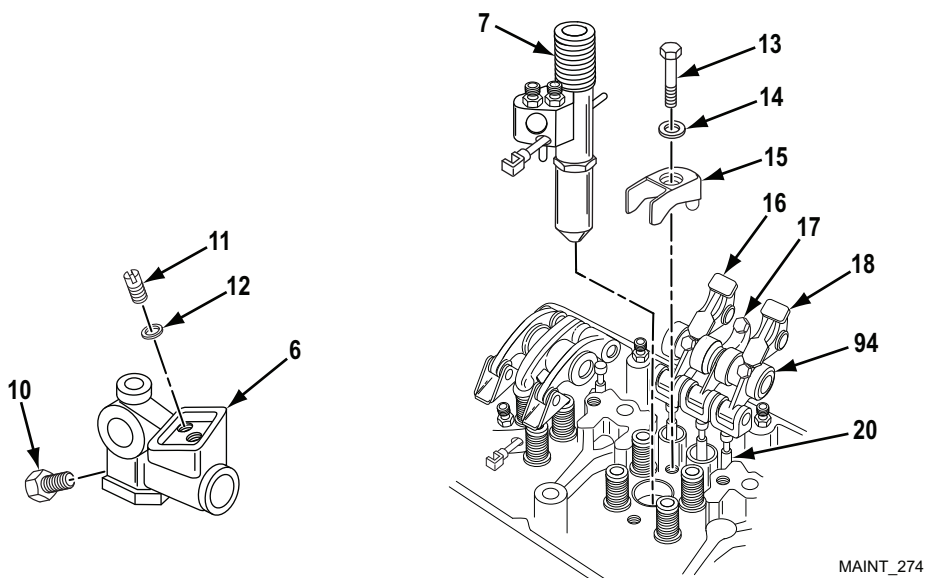


Figure 27. Cylinder Head Rocker Arm and Injector Installation.

**ASSEMBLY - Continued****CAUTION**

Exhaust valve bracket must rest squarely on ends of exhaust valves when tightening rocker arm bracket bolts. Cocking exhaust valve bracket against valve stem will damage exhaust valves.

31. On model 5063-5299, insert six bolts (Figure 28, Item 2) through six brackets (Figure 28, Item 4) and three shafts (Figure 28, Item 5). Swing rocker arms, shafts, and brackets into position and thread bolts into cylinder head. Torque bolts to 50–55 lb-ft (68–75 N·m).
32. On models 5063-5392, 5063-5393, and 5063-539L, insert six bolts (Figure 28, Item 2) through hold-down bracket (Figure 28, Item 1), hold-down bracket (Figure 28, Item 3), six brackets (Figure 28, Item 4), and three shafts (Figure 28, Item 5) with hold-down brackets positioned as shown. Swing rocker arms, shafts, and brackets into position and thread bolts into cylinder head. Torque bolts to 50–55 lb-ft (68–75 N·m).

**CAUTION**

Do not bend fuel tube assemblies and do not exceed specified torque on fuel tube nuts. Excessive tightening will twist or fracture flared end of fuel tube and result in leaks.

33. Remove covering from fuel injectors (Figure 28, Item 7) and install six fuel tube assemblies (Figure 28, Item 8) on fuel injectors and fuel nipples (Figure 28, Item 9). Using torque wrench adapter (Figure 28, Item 95), torque fuel tube nuts to 130–160 lb-in (14.7–18.1 N·m).

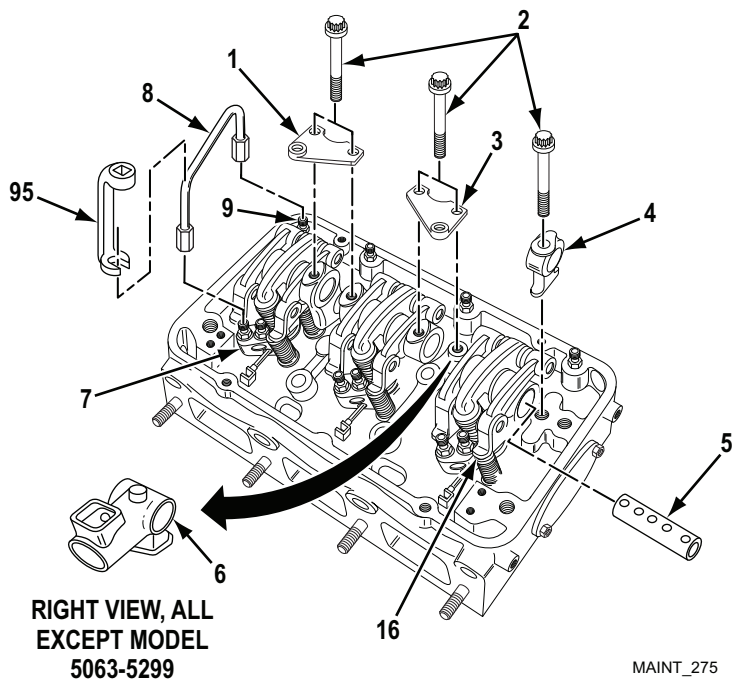


Figure 28. Cylinder Head Assembly.

**END OF TASK**

**FOLLOW ON TASK**

1. Install cylinder head assembly (WP 0073).
2. Install engine lifter brackets (WP 0040).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
FUEL INJECTOR ASSEMBLY REPAIR**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Injector Vise (Fixture, Inject. Holding)  
(WP 0104, Table 1, Item 55)  
Tool Kit, Diesel Injector  
(WP 0104, Table 1, Item 112)  
Reamer, Hand, Injection Body  
(WP 0104, Table 1, Item 80)  
Tester, Spring (WP 0104, Table 1, Item 107)  
Gage, Lift (Needle Valve Height)  
(WP 0104, Table 1, Item 42)  
Block Set, Lapping (WP 0104, Table 1, Item 11)  
Gage, Injector (Tip and Concentricity)  
(WP 0104, Table 1, Item 36)  
Brush, Wire, Rotary Wheel (Brass)  
(WP 0104, Table 1, Item 13)  
Test Fixture, Diesel Fuel Injector  
(WP 0104, Table 1, Item 104)  
Tester, Diesel Fuel Injector Nozzle  
(WP 0104, Table 1, Item 106)  
Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)

**Materials/Parts (cont.)**

Filter Element (WP 0105, Table 1, Item 110)  
Lapping Compound (WP 0103, Table 1, Item 23)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Packing, Preformed  
(WP 0105, Table 1, Item 111)  
Spacer, Ring  
Qty: (2) (WP 0105, Table 1, Item 109)  
Wood Block (WP 0103, Table 1, Item 71)

**Equipment Condition**

Injectors removed (WP 0083)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

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**NOTE**

Injectors which were removed from engine should be tested (refer to Testing, Steps 1–6) prior to any disassembly to avoid unnecessary repair.

**DISASSEMBLY**

1. Using rotary wheel wire brush, remove carbon from injector nut (Figure 1, Item 6) and spray tip (Figure 1, Item 5).
2. Place injector upright in injector holding fixture (Figure 1, Item 4).
3. Remove two fuel line connectors (Figure 1, Item 10), two ring spacers (Figure 1, Item 9), and filter element (Figure 1, Item 8). Discard filter and ring spacers.
4. Rotate follower spring (Figure 1, Item 7) until end is clear of stop pin (Figure 1, Item 3). Press down on follower (Figure 1, Item 1) and compress spring. Then raise spring above pin with screwdriver and remove pin. Gradually release pressure on follower and spring.
5. Remove follower (Figure 1, Item 1), follower spring (Figure 1, Item 7), and plunger (Figure 1, Item 2) from injector.

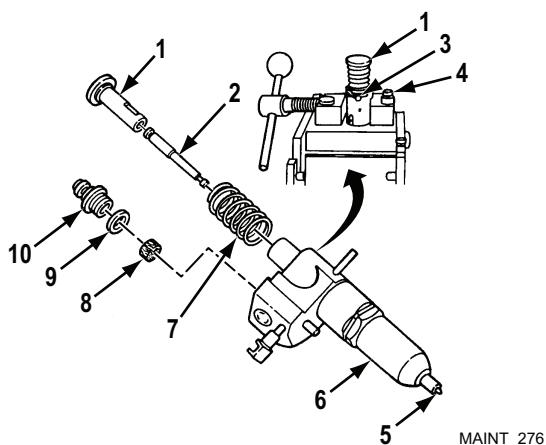


Figure 1. Fuel Injector Disassembly.

6. Invert injector on fixture. Using injector fuel line open end box wrench (Figure 2, Item 11), loosen injector nut (Figure 2, Item 6) from injector.
7. Lift injector nut (Figure 2, Item 6) straight up.

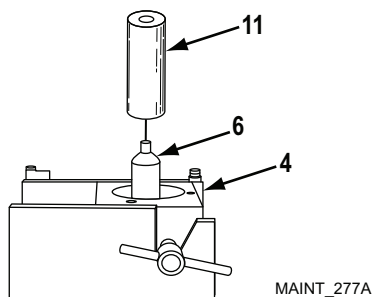


Figure 2. Injector Nut Removal.

## DISASSEMBLY - Continued

## NOTE

When injector has been in service for an extended period, spray tip assembly may not be easily pushed from nut. In this case, support nut on a wood block and drive tip out with spray tip driver (Figure 3, Item 25).

Do not dislodge spray tip and valve parts during injector nut removal.

8. Remove spray tip (Figure 3, Item 5), needle valve (Figure 3, Item 12), spring cage (Figure 3, Item 13), spring seat (Figure 3, Item 14), valve spring (Figure 3, Item 15), check valve cage (Figure 3, Item 16), and check valve (Figure 3, Item 17).
9. Remove spill deflector (Figure 3, Item 18).
10. Lift bushing (Figure 3, Item 19) straight out of injector body (Figure 3, Item 23).
11. Remove injector body (Figure 3, Item 23) from holding fixture (Figure 2, Item 4). Turn body upside down and catch gear retainer (Figure 3, Item 20) and gear (Figure 3, Item 21) in hand as they fall from body.
12. Remove injector control rack (Figure 3, Item 24) from body (Figure 3, Item 23).
13. Remove preformed packing (Figure 3, Item 22) from body. Discard preformed packing.

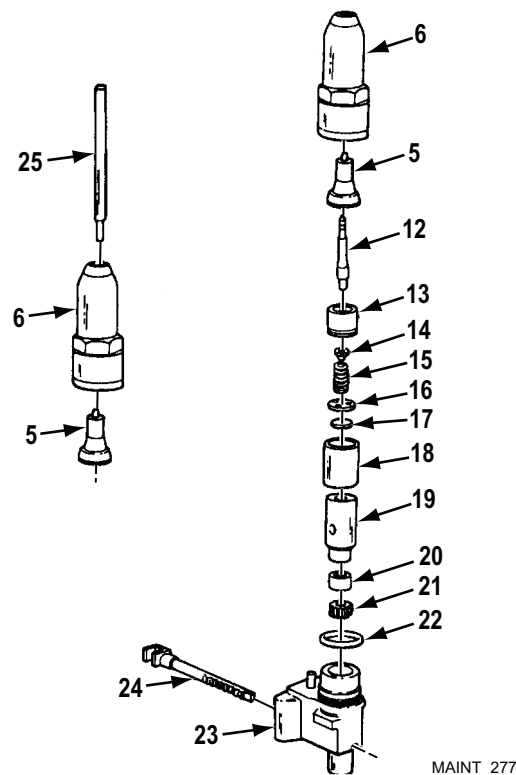
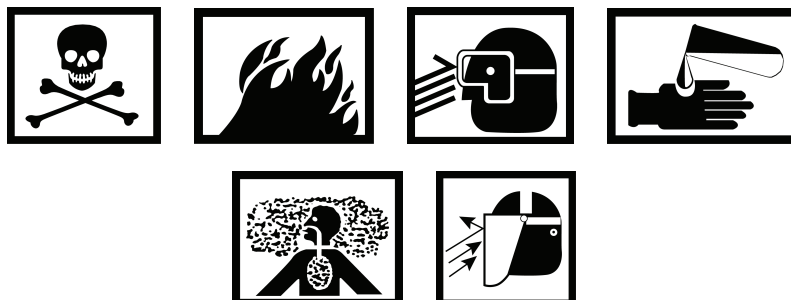


Figure 3. Fuel Injector Exploded View.

END OF TASK

**CLEANING**

1. Injector spray tip cleaning procedures:

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

- a. Soak spray tip in cleaning solvent to loosen carbon.

**CAUTION**

Do not contact needle valve seat with carbon remover during spray tip insertion or valve seat could be damaged.

- b. Clean needle valve orifice of spray tip (Figure 4, Item 5) with carbon remover (Figure 4, Item 26).
- c. Clean spray tip (Figure 4, Item 5) orifices with pin vise (Figure 4, Item 28) and cleaning wire (Figure 4, Item 27).

**CAUTION**

Do not buff spray tip area excessively. Do not use a steel rotary wire brush or spray tip holes may be distorted.

- d. Clean exterior of spray tip with brass wire brush.

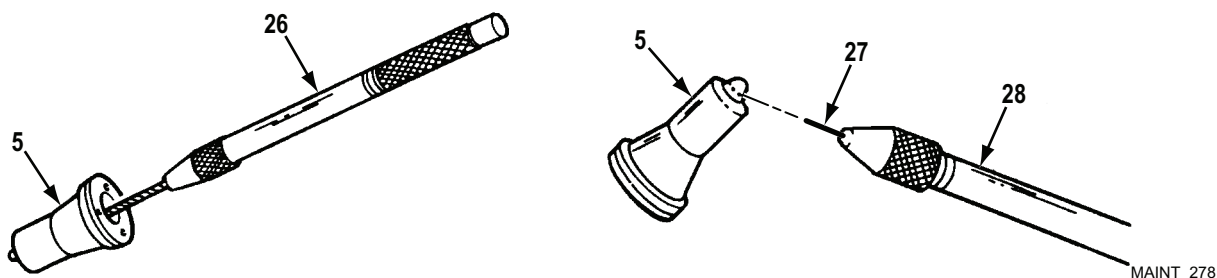


Figure 4. Injector Spray Tip Cleaning.



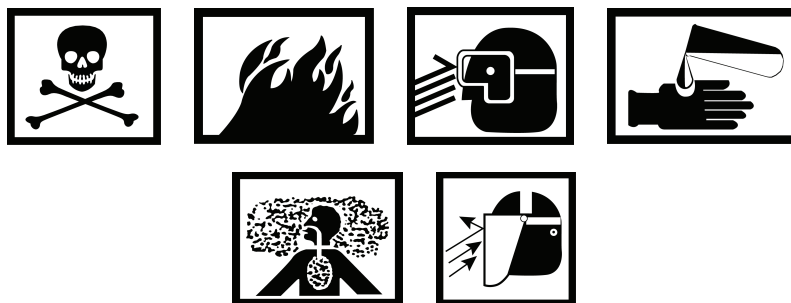
**CLEANING - Continued**

2. Injector body cleaning procedures:
  - a. Clean and brush all passages in injector body (Figure 5, Item 23) using injector brush and rack hole brush.
  - b. Ream injector body ring using injection body hand reamer (Figure 5, Item 29). Insert injection body hand reamer in body and turn in clockwise direction a few turns. Then remove injection body hand reamer and check face of ring for injection body hand reamer contact. Repeat operation until injection body hand reamer makes contact with entire face of ring. Clean opposite side of ring in same manner.
3. Injector nut cleaning procedures:
  - a. Turn injection body hand reamer (Figure 5, Item 30) clockwise to remove carbon deposits from lower end of injector nut (Figure 5, Item 6).

**CAUTION**

Completely remove all carbon deposits. Carbon deposits on spray tip seating surfaces of injector nut cause poor seating and result in fuel leakage around spray tip.

- b. Turn injection body hand reamer (Figure 5, Item 31) clockwise to remove carbon deposits from bottom of injector nut (Figure 5, Item 6) to produce a clean uniform seat for spray tip.

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

- c. Wash injector nut (Figure 5, Item 6) in clean solvent and blow dry.
- d. If necessary, repeat Steps 3.a.–3.c. until all carbon is removed.

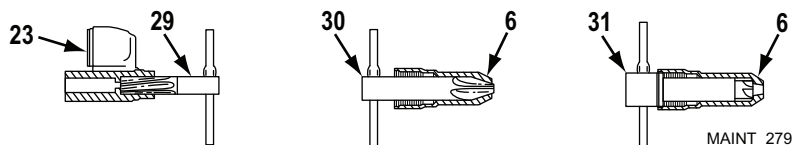
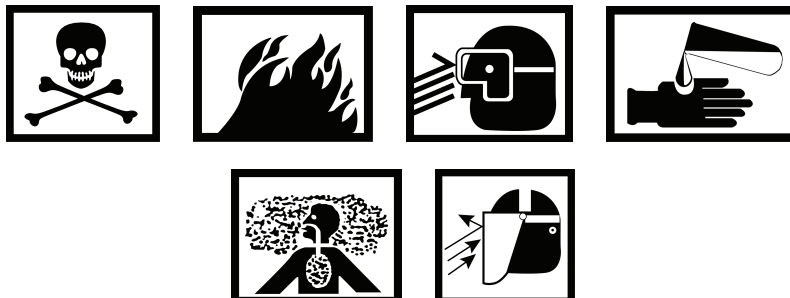


Figure 5. Injector Body Cleaning.

**CLEANING - Continued**

4. Injector plunger and bushing:

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Ensure high pressure bleed hole in side of bushing is not plugged. If hole is plugged, fuel oil will leak into engine and cause oil dilution.

**NOTE**

Keep plunger and bushing together as a matched set. Keep parts of each injector assembly together.

Wash plunger and bushing with cleaning solvent and dry with compressed air.

**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Follow inspection and measuring procedures:
  - a. Measure distance between top of follower (Figure 6, Item 1) and slot. Dimension must be 1.645 to 1.649 inches (41.78 to 41.88 mm).

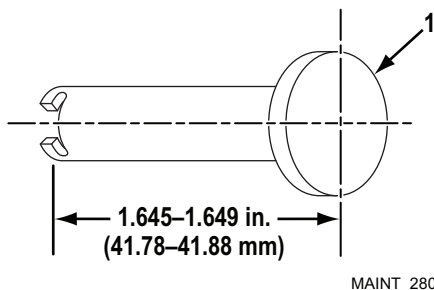


Figure 6. Follower Inspection.

- b. Inspect stop pin groove in side of follower for smoothness and damage. Discard follower if there is more than 0.002 inch (0.051 mm) wear on top or there is other visual damage or wear.
2. Follower spring inspection procedures:
  - a. Examine outside diameter of follower spring coils for wear caused by rocker arms contacting coils. Replace if worn.
  - b. Inspect follower springs for damage from rust, pitting, nicks, or notches in coils, broken coils, broken coil ends, and notches under coil ends. Replace if damaged.
  - c. Check spring tension with spring tester. Replace spring when a load of less than 78 lbs (35.4 kg) will compress it to 1.028 inches (26.11 mm).
3. Injector body inspection procedures:
 

Inspect injector body threads, bushing seating surface, and fuel connector ring spacer sealing surfaces for damage. Inspect rack hole, body preformed packing sealing surface, clamp radius, and dowel pin. Replace if necessary.
4. Fuel connectors inspection procedures:
 

Check condition of jumper line sealing surfaces, copper ring spacer sealing surfaces, and fuel connector threads. Replace if necessary.
5. Control rack inspection procedures:
  - a. Check injector control rack for straightness, rack teeth for damage, and notch in clevis for wear. Check rack for nicks, burrs, or rust.
  - b. Notch in clevis should be 0.3125 to 0.3145 inch (7.938 to 7.988 mm).
6. Gear and gear retainer inspection procedures:
 

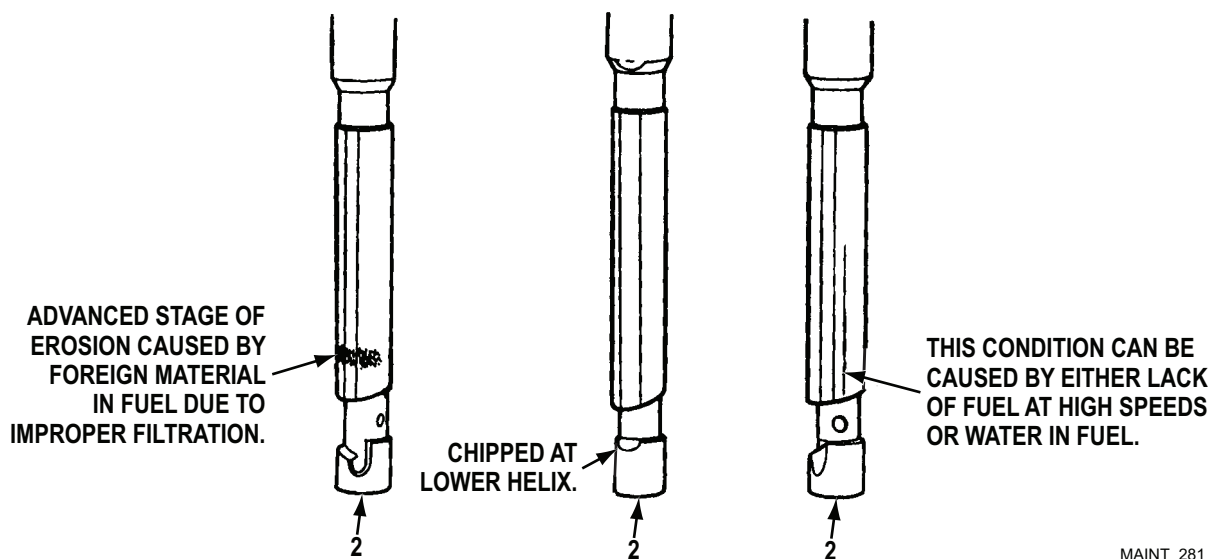
Inspect gear and gear retainer for nicks, burrs, or rust. Check gear teeth for wear.
7. Bushing inspection procedures:
 

Check bushing lapped sealing surface for scratches and bushing internal diameter for scoring. Check condition of dowel pin. Check for corrosion and varnish. Replace if necessary.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

## 8. Plunger inspection procedures:

Check plunger (Figure 7, Item 2) for erosion, corrosion or varnish, scoring, scratching or wear, and chips along edge of helix.



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Figure 7. Injector Plunger Check.

## 9. Check valve and check valve cage inspection procedures:

- a. Inspect for cracks and scratches on lapped surfaces. Also inspect for corrosion, varnish, and wear.
- b. Measure thickness of check valve and check valve cage. Minimum cage thickness is 0.163 inch (4.14 mm) and minimum check valve thickness is 0.022 inch (0.56 mm). Replace if necessary.

## 10. Valve spring inspection procedures:

Check spring for wear on coil ends, broken coil ends, and notches under coil ends. Check for corrosion, nicks, and cavitation erosion on inside at approximately 1-1/2 coils from end. Replace if necessary.

## 11. Spring seat inspection procedures:

Check surfaces for wear as shown by visible chamfer. Replace if necessary.

## 12. Spring cage inspection procedures:

- a. Inspect for cracks, corrosion or varnish, and scratches on lapped sealing surfaces. Inspect spring seat surface and needle valve seating surface for wear.
- b. Measure thickness of spring cage. Minimum thickness is 0.602 inch (15.29 mm). Replace if necessary.

## 13. Spray tip:

- a. Check for cracks, enlarged spray holes, corrosion on outside diameter taper, and oxide scale on spray hole end. Check nut to tip sealing surface and lapped sealing surface for scratches. Do not use spray tip if there are scale, cracks, or enlarged spray holes.
- b. Measure thickness of spray tip (Figure 8, Item 5) shoulder. Minimum thickness is 0.199 inch (5.05 mm).

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

## 14. Needle valve:

Check spray tip needle valve for erosion at seat shoulder, scratches, and overheating.

## 15. Needle valve lift.

Using lift gage (Figure 8, Item 32), measure needle valve lift as follows:

- (1) Install needle valve (Figure 8, Item 12) in spray tip (Figure 8, Item 5).
- (2) Press plunger of needle valve height gage against a flat surface and zero indicator dial.
- (3) Place spray tip (Figure 8, Item 5) and needle valve (Figure 8, Item 12) tight against bottom of gage with quill of needle valve in hole in plunger.
- (4) While holding spray tip and needle valve assembly tight against gage (Figure 8, Item 32), read needle valve lift on indicator. Lift must be 0.008 to 0.018 inch (0.203 to 0.457 mm). If needle valve lift exceeds 0.018 inch (0.457 mm), replace tip assembly. If lift is less than 0.008 inch (0.203 mm), inspect assembly for foreign material between needle valve and tip seat.

## 16. Injector nut inspection procedures:

Check injector nut for damaged threads, condition of preformed packing seating area, and condition of spray tip seating area. Check spray tip hole for corrosion.

## 17. Spill deflector inspection procedures:

Inspect ends of deflector for sharp edges or burrs.

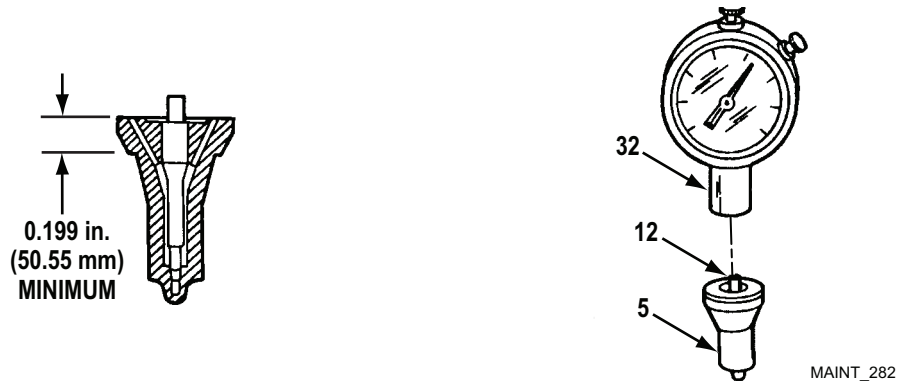


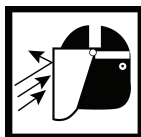
Figure 8. Needle Valve Lift Measuring.

**END OF TASK**

**REPAIR OR REPLACEMENT****NOTE**

Check valve only requires one lapped side. Turn over to utilize unused side.

New parts do not require lapping prior to use. Following list of used parts may require lapping: check valve cage (Figure 9, Item 16), bushing (Figure 9, Item 19), valve spring cage (Figure 9, Item 13), and spray tip (Figure 9, Item 5). Lap components using following procedure:

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

- a. Clean lapping block set (Figure 9, Item 33) with compressed air. Do not use cloth or other material for this purpose.
- b. Spread 600 grit dry lapping compound on lapping block (Figure 9, Item 33).

**CAUTION**

Do not press on part. Apply only enough pressure to keep part flat on block. Keep part flat on block at all times.

- c. Place part flat on lapping block (Figure 9, Item 33). Using a figure-eight motion, move part back and forth across block.
- d. After five passes, draw part across clean piece of tissue placed on flat surface and clean lapping compound from it.
- e. Inspect part and continue lapping if necessary. Do not lap excessively.

**REPAIR OR REPLACEMENT - Continued****WARNING**

Dry cleaning solvent MIL-PRF-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100–138°F (38–59°C). If you become dizzy while using cleaning solvent, get fresh air immediately and seek medical aid. If contact with eyes is made, wash with water and get medical aid immediately. Failure to comply may result in injury, illness, or death to personnel.

**NOTE**

When using MIL-PRF-680 solvents, ensure MIL-PRF-680 solvent container is sealed. Store, handle and dispose unused and spent solvents in accordance with local procedures and plans.

- f. When part is flat, wash in cleaning solvent and dry with compressed air.
- g. Place part on second block (Figure 9, Item 33). Apply 600 grit lapping compound to block and repeat Steps 1.c.–1.f.
- h. Place part on third block (Figure 9, Item 33). Do not apply lapping compound to this block and repeat Steps 1.c.–1.f.

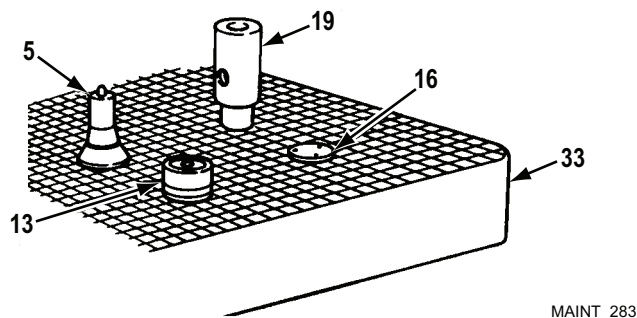


Figure 9. Parts Placement on Lapping Block.

**END OF TASK**

**ASSEMBLY**

1. Install injector body (Figure 10, Item 23) in holding fixture (Figure 10, Item 4) with top up.
2. Install new filter element (Figure 10, Item 8) in inlet port (Figure 10, Item 34) of body (located above injector rack) with dimple end down and slotted end up. No filter is used in outlet port.
3. Install two new ring spacers (Figure 10, Item 9) and two fuel connectors (Figure 10, Item 10) in injector body. Torque connectors to 65–75 lb-ft (88–102 N·m) (blued components) or 54–70 lb-ft (74–95 N·m) (mixed or steel gray components).
4. Support injector body assembly (Figure 10, Item 23), bottom end up, in holding fixture (Figure 10, Item 4).

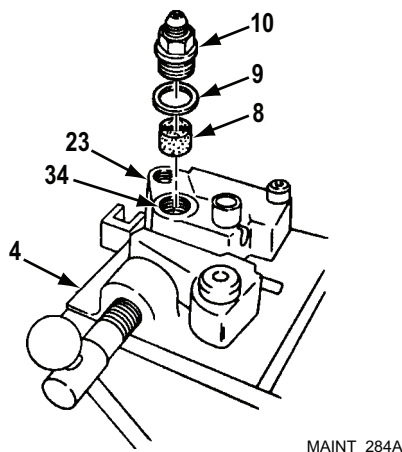


Figure 10. Injector Body Assembly.

5. Install new preformed packing (Figure 11, Item 22) on shoulder of injector body (Figure 11, Item 23).
6. Slide injector control rack (Figure 11, Item 24) into injector body.
7. Look into injector body bore and move control rack (Figure 11, Item 24) until you see two drill marks on rack. Hold rack in this position.
8. Place gear (Figure 11, Item 21) in injector body so that marked tooth on gear is engaged between two marked teeth on control rack (Figure 11, Item 24) as shown.
9. Place gear retainer (Figure 11, Item 20) on gear (Figure 11, Item 21).
10. Align locating pin in bushing (Figure 11, Item 19) with slot in injector body (Figure 11, Item 23) and slide into place.
11. Install spill deflector (Figure 11, Item 18) over barrel of bushing (Figure 11, Item 19).

**NOTE**

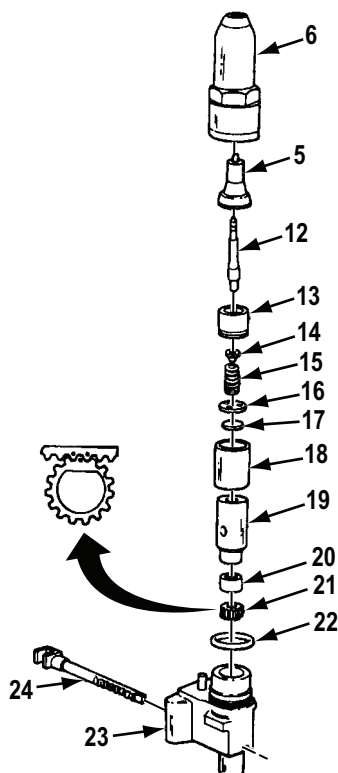
Perform needle valve opening pressure test (Testing, Step 5) at this time before completing assembly.

12. Place check valve (Figure 11, Item 17) centrally on top of bushing (Figure 11, Item 19).
13. Place check valve cage (Figure 11, Item 16), flat side up, and check valve (Figure 11, Item 17) on bushing (Figure 11, Item 19) with check valve in recess of check valve cage.
14. Insert spring seat (Figure 11, Item 14) in valve spring (Figure 11, Item 15) and install on check valve cage (Figure 11, Item 16) with seat up.



**ASSEMBLY - Continued**

15. Place spring cage (Figure 11, Item 13) over spring seat (Figure 11, Item 14) and spring (Figure 11, Item 15).
16. Insert needle valve (Figure 11, Item 12) into spray tip (Figure 11, Item 5) with tapered end down. Place spray tip and valve assembly on top of spring cage (Figure 11, Item 13) with quill end of needle valve in hole in spring cage.
17. Lubricate threads on injector nut (Figure 11, Item 6) with engine oil and carefully thread nut on injector body. Tighten nut as tight as possible by hand.

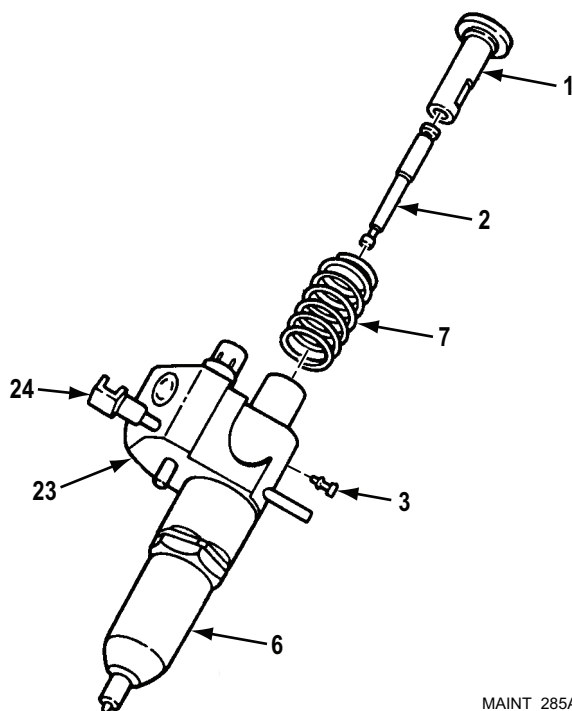


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Figure 11. Fuel Injector Exploded View.

**ASSEMBLY - Continued**

18. Turn injector over and push rack (Figure 12, Item 24) all the way in.
19. Place follower spring (Figure 12, Item 7) on injector body (Figure 12, Item 23).
20. Slide head of plunger (Figure 12, Item 2) into follower (Figure 12, Item 1).
21. Insert free end of plunger (Figure 12, Item 2) in injector body (Figure 12, Item 23).
22. Press down follower (Figure 12, Item 1) and slide rack (Figure 12, Item 24) in and out until plunger (Figure 12, Item 2) falls in place with flat of plunger against flat in gear.
23. Align slot in follower (Figure 12, Item 1) with stop pin hole in injector body (Figure 12, Item 23).
24. Place stop pin (Figure 12, Item 3) in slot on injector body (Figure 12, Item 23). Rotate spring (Figure 12, Item 7) so flat on end of coil is clear of stop pin. Then push stop pin in place while pressing down on follower (Figure 12, Item 1). Once in place, rotate spring so flat on end of coil is positioned over stop pin.



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Figure 12. Fuel Injector Assembly.

**ASSEMBLY - Continued****CAUTION**

Do not exceed specified torque. Otherwise, over-torquing will stretch injector nut and result in improper sealing of lapped surfaces in injector.

**NOTE**

After assembling fuel injector, always check area between nut and body. If preformed packing is still visible after nut is torqued, try another nut and preformed packing.

25. Using injector fuel line open end box wrench (Figure 13, Item 11), torque injector nut (Figure 13, Item 6) to 75–85 lb-ft (102–115 N·m) for blued components, 45–55 lb-ft (61–75 N·m) for steel gray components, or 60–70 lb-ft (81–95 N·m) for mixed components.

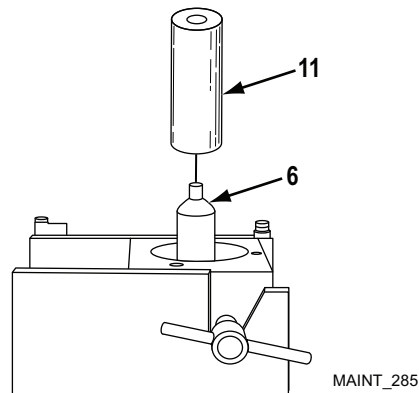


Figure 13. Fuel Injector Nut Assembly.

**END OF TASK**

**TESTING**

1. Injector control rack freeness procedures:
  - a. Place injector in injector tip and concentricity gage (Figure 14, Item 37).
  - b. Hold rack (Figure 14, Item 24) in NO FUEL position (rack extended all the way out).
  - c. Using handle (Figure 14, Item 35), depress follower to bottom of its stroke.
  - d. Slowly release pressure on handle (Figure 14, Item 35) while moving rack (Figure 14, Item 24) in and out until follower reaches top of its travel. Injector passes test if rack falls freely when fully extended and released.
  - e. If rack binds, loosen injector nut, turn tip, and then retighten nut. Loosen and tighten nut several times if necessary. If rack still binds, change injector nut. Finally, if rack binds, disassemble injector to eliminate cause of misaligned parts or to remove dirt.
2. Spray tip concentricity procedures:
  - a. Place injector in injector tip and concentricity gage (Figure 14, Item 37).
  - b. Adjust dial indicator (Figure 14, Item 36) to zero.
  - c. Rotate injector 360 degrees and note total runout as indicated on dial.
  - d. If total runout exceeds 0.008 inch (0.203 mm), remove injector from gage. Loosen injector nut, center spray tip, and torque nut. Check spray tip concentricity again. If, after several attempts, spray tip cannot be positioned satisfactorily, replace injector nut.

## TESTING - Continued

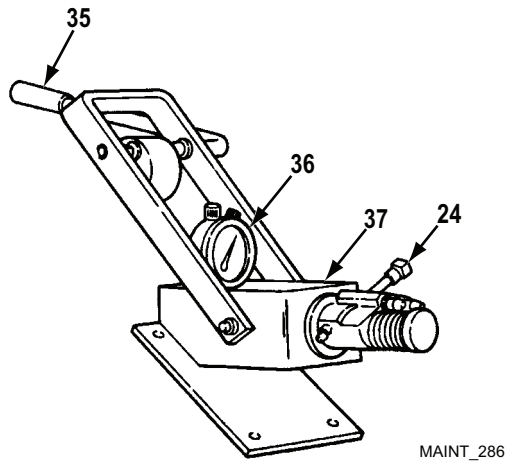


Figure 14. Fuel Injector Testing (Concentricity Gage).

**TESTING - Continued**

3. High pressure leak test procedures:

**WARNING**

Always hold injector so that fuel spray cannot penetrate skin. Fuel oil which enters blood stream may cause serious infection. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

- a. Thoroughly dry injector with compressed air.
  - b. Place injector in diesel fuel injector test fixture (Figure 15, Item 39).
  - c. Check fuel connections for leaks. If leaks have occurred, tighten connections, dry injector, and check again.
  - d. With injector rack in FULL FUEL position (fully depressed) and popping handle (Figure 15, Item 38) locked in downward position, operate pump handle (Figure 15, Item 40) to build up and maintain pressure.
  - e. Pump up injector tester and maintain pressure of 1600 to 2000 psi (11031 to 13789 kPa). Inspect for leaks at fuel connector ring spacers, injector body plugs, and injector nut preformed packing.
4. Spray pattern check procedures:
- a. Place injector in diesel fuel injector test fixture (Figure 15, Item 39).
  - b. Place injector rack in FULL FUEL position (fully depressed).

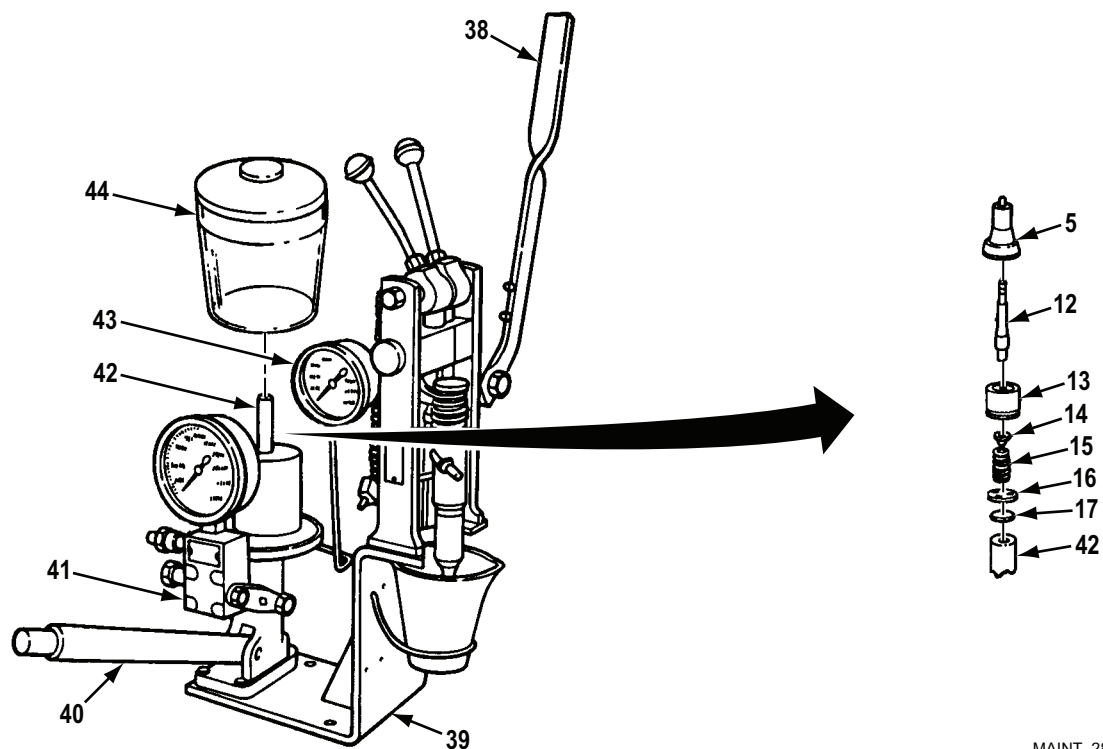
**WARNING**

Do not operate diesel fuel injector nozzle tester without shield. Fuel spray can penetrate skin. Fuel oil entering blood stream may cause serious infection. Failure to comply may result in injury, illness, or death to personnel.

- c. Place shield (Figure 15, Item 44) on diesel fuel injector nozzle tester (Figure 15, Item 41). Operate pump handle (Figure 15, Item 40) to build up slight pressure (10 psi (69 kPa) minimum) in system.
- d. Pop fuel injector several times with popping handle (Figure 15, Item 38). Observe spray pattern emitted from fuel injector spray tip. If spray tip pattern is not uniform, spray tip orifice is dirty or damaged.
- e. Pop fuel injector several times with popping handle (Figure 15, Item 38) until no pressure is observed on test gage (Figure 15, Item 43) to avoid fuel spray when injector is removed from diesel fuel injector test fixture.

**TESTING - Continued**

5. Needle valve opening pressure check procedures:
  - a. Operate pump handle (Figure 15, Item 40) on diesel fuel injector nozzle tester (Figure 15, Item 41) until a clear flow of test oil comes out of mounting pedestal (Figure 15, Item 42).
  - b. Place check valve (Figure 15, Item 17) centrally on pedestal (Figure 15, Item 42).
  - c. Place check valve cage (Figure 15, Item 16), flat side up, and check valve (Figure 15, Item 17) on pedestal (Figure 15, Item 42) with check valve in recess of check valve cage.
  - d. Insert spring seat (Figure 15, Item 14) in valve spring (Figure 15, Item 15) and install on check valve cage (Figure 15, Item 16) with seat up.
  - e. Place spring cage (Figure 15, Item 13) over spring seat (Figure 15, Item 14) and spring (Figure 15, Item 15).
  - f. Insert needle valve (Figure 15, Item 12) into spray tip (Figure 15, Item 5) with tapered end down. Place assembly on spring cage (Figure 15, Item 13) with quill end of needle valve in hole in spring cage.



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Figure 15. Fuel Injector Testing (Test Fixture).

**TESTING - Continued**

- g. Lubricate threads on injector nut (Figure 16, Item 6) with engine oil and carefully thread nut on pedestal (Figure 13, Item 42). Tighten nut as tight as possible by hand.
- h. Using injector fuel line open end wrench (Figure 13, Item 11), torque injector nut (Figure 16, Item 6) to 75–85 lb-ft (102–115 N·m) for blued components, 45–55 lb-ft (61–75 N·m) for steel gray components, or 60–70 lb-ft (81–95 N·m) for mixed components.

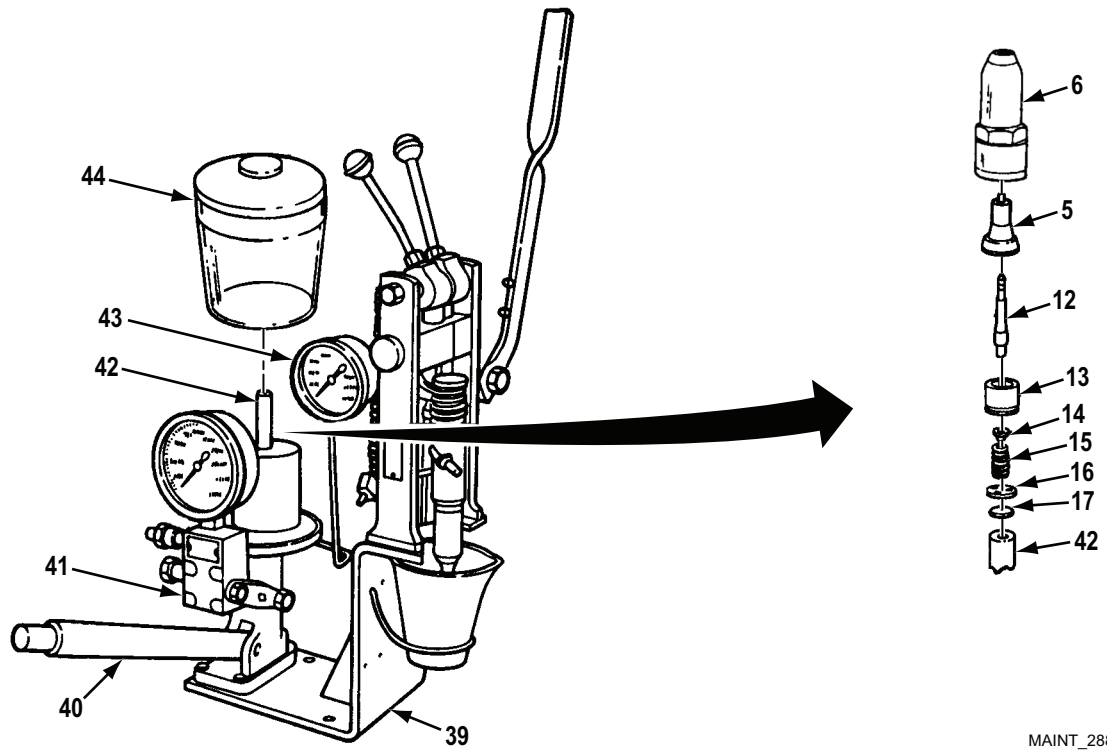
**WARNING**

Do not operate diesel fuel injector nozzle tester without shield. Fuel spray can penetrate skin. Fuel oil entering blood stream may cause serious infection. Failure to comply may result in injury, illness, or death to personnel.

- i. Place shield (Figure 16, Item 44) on diesel fuel injector nozzle tester (Figure 16, Item 41). Operate pump handle (Figure 16, Item 40) with smooth even strokes and record fuel injector needle valve opening pressure (pop pressure). Needle valve opens when fuel sprays from tip. Pop needle valve several times to purge air from system. Record test gage (Figure 16, Item 43) opening pressure. Final needle valve opening pressure must be 2600–3200 psi (17926–22063 kPa) for new injector and 2300–3300 psi (15857–22752 kPa) for used injector.
- j. Remove injector nut (Figure 16, Item 6), spray tip (Figure 16, Item 5), needle valve (Figure 16, Item 12), spring (Figure 16, Item 15), spring seat (Figure 16, Item 14), spring cage (Figure 16, Item 13), check valve cage (Figure 16, Item 16), and check valve (Figure 16, Item 17) from mounting pedestal (Figure 16, Item 42).



TESTING - Continued



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Figure 16. Fuel Injector Testing.

**TESTING - Continued****NOTE**

After needle valve opening pressure test is complete, continue injector assembly.

6. Injector holding pressure check procedures:
  - a. Place fuel injector in diesel fuel injector test fixture (Figure 17, Item 39).
  - b. Operate pump handle (Figure 17, Item 40) until test gage (Figure 17, Item 45) pressure reaches 2200 psi (15168 kPa).
  - c. Close fuel shut off valve. Start timing when pressure reaches 2000 psi (13789 kPa) and stop at 1500 psi (10342 kPa). Minimum time is 5 seconds.
  - d. If pressure drops in less than 5 seconds, check for leaks around spray tip, preformed packing, and fuel connectors.
  - e. Pop fuel injector several times with popping handle (Figure 17, Item 38) until test gage (Figure 17, Item 45) shows no pressure to avoid fuel spray when removing injector from diesel fuel injector test fixture (Figure 17, Item 39).
7. Cover injector ports to prevent dirt from entering injector.

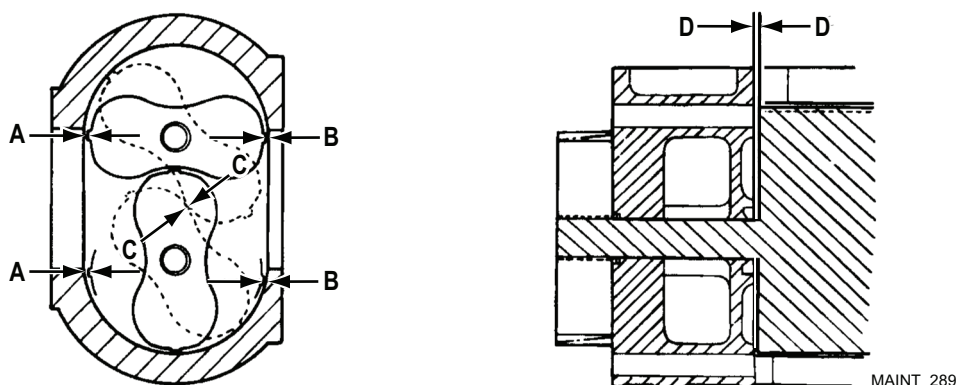


Figure 17. Fuel Injector Pressure Test.

**END OF TASK****FOLLOW ON TASK**

Install injectors (WP 0083).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
BLOWER REPAIR**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Wrench, Torque, 0–300 Lb-In  
(WP 0104, Table 1, Item 121)  
Tool Kit, Blower and Governor  
(WP 0104, Table 1, Item 110)  
Puller Set  
Installer, Blower Seal  
Installer, Oversize Sleeve  
Gage Set, Thickness, Stacked  
Indicator, Dial (WP 0104, Table 1, Item 53)  
Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)

**Materials/Parts**

Bolt, Self-locking (WP 0105, Table 1, Item 183)  
Bolt, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 147)  
Bolt, Self-locking  
Qty: (3) (WP 0105, Table 1, Item 148)  
Bolt, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 151)  
Bolt, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 152)  
Cleaning Solvent (WP 0103, Table 1, Item 8)

**Materials/Parts (cont.)**

Emery Cloth (WP 0103, Table 1, Item 13)  
Gasket (WP 0105, Table 1, Item 58)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Rag, Wiping (WP 0103, Table 1, Item 44)  
Screw Qty: (8) (WP 0103, Table 1, Item 47)  
Screw  
(models 5063-5392, 5063-5393, 5063-539L)  
Qty: (4) (WP 0103, Table 1, Item 48)  
Sealing Compound (WP 0103, Table 1, Item 51)  
Seal, Plain Encased, Standard  
Qty: (4) (WP 0105, Table 1, Item 87)  
Seal, Plain Encased, Oversize  
Qty: (4) (WP 0105, Table 1, Item 107)  
Sleeve, Blower Seal, Oversize  
Qty: (4) (WP 0105, Table 1, Item 108)  
Stone, Sharpening, X-Fine  
(WP 0103, Table 1, Item 62)  
Washer, Flat Qty: (8) (WP 0103, Table 1, Item 67)  
Washer, Flat Qty: (2) (WP 0103, Table 1, Item 68)  
Washer, Lock  
(models 5063-5392, 5063-5393, 5063-539L)  
Qty: (2) (WP 0105, Table 1, Item 177)

**Equipment Condition**

Governor and blower assembly removed  
(WP 0062)

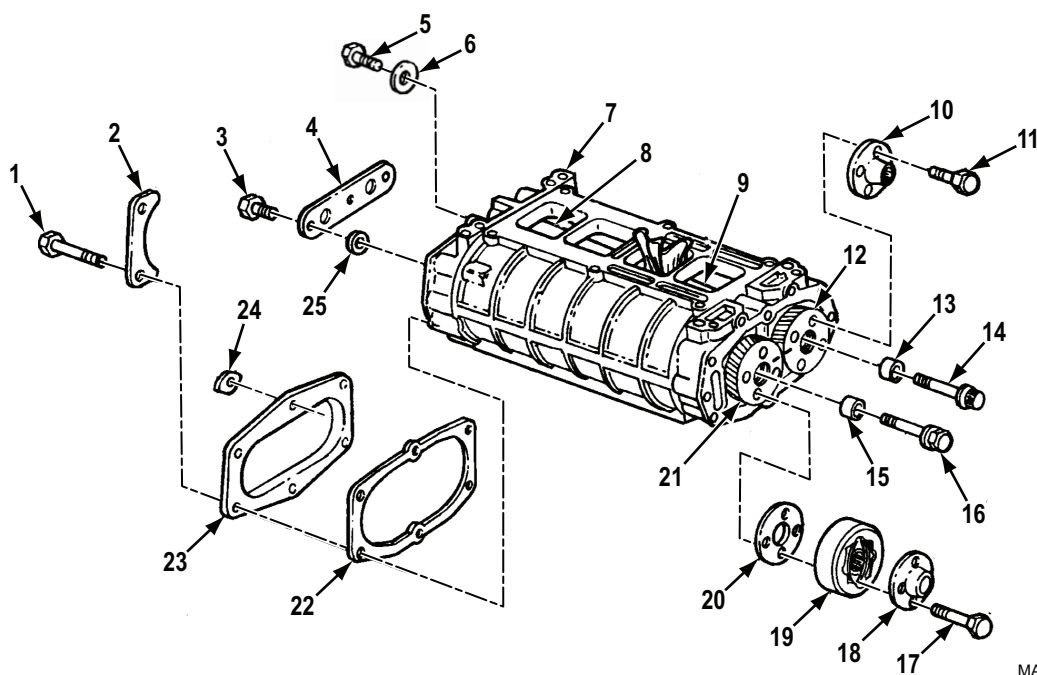
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## DISASSEMBLY

## NOTE

Match mark blower housing at front and rear end plates before disassembly.

1. Remove six screws (Figure 1, Item 1), two plates (Figure 1, Item 2), two spacers (Figure 1, Item 24), end plate cover (Figure 1, Item 23), and gasket (Figure 1, Item 22) from front end plate (Figure 1, Item 7). Discard gasket.
2. Wedge a clean folded rag between rotors (Figure 1, Items 9 and 8) to prevent turning.
3. Remove four self-locking bolts (Figure 1, Item 11) and drive coupling (Figure 1, Item 10) from gear (Figure 1, Item 12). Discard bolts.
4. Remove four self-locking bolts (Figure 1, Item 17), retainer (Figure 1, Item 18), coupling (Figure 1, Item 19), and spacer (Figure 1, Item 20) from gear (Figure 1, Item 21). Discard bolts.
5. Remove three self-locking bolts (Figure 1, Item 3), thrust plate (Figure 1, Item 4), and three spacers (Figure 1, Item 25) from front end plate (Figure 1, Item 7). Discard bolts.
6. Remove two self-locking bolts (Figure 1, Item 5) and two thrust washers (Figure 1, Item 6) from front of blower. Discard bolts.
7. Mark gear (Figure 1, Item 12) and gear (Figure 1, Item 21) for reassembly.
8. Remove twelve-point bolt (Figure 1, Item 14) and blower drive pilot (Figure 1, Item 13) from gear (Figure 1, Item 12). Discard bolt.
9. Remove self-locking bolt (Figure 1, Item 16) and blower drive pilot (Figure 1, Item 15) from gear (Figure 1, Item 21). Discard bolt.



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Figure 1. Blower Disassembly.

**DISASSEMBLY - Continued**

- Using two gear pullers, remove right gear (Figure 2, Item 12) and left gear (Figure 2, Item 21) simultaneously.

**NOTE**

Attach shims to matching gear for identical replacement of size and number of shims during reassembly.

- Remove two flat washers (Figure 2, Item 27) and shims (Figure 2, Item 26) from rotors (Figure 2, Items 9 and 8). Place components with respective gears to ensure correct assembly. Remove rag from rotors.

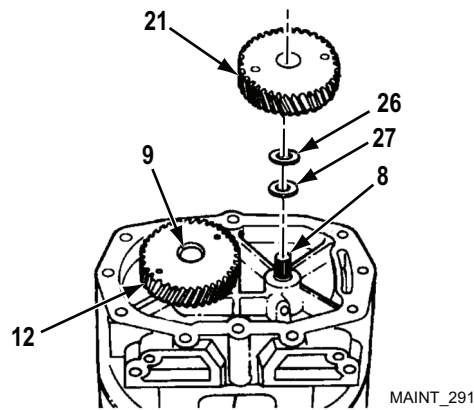


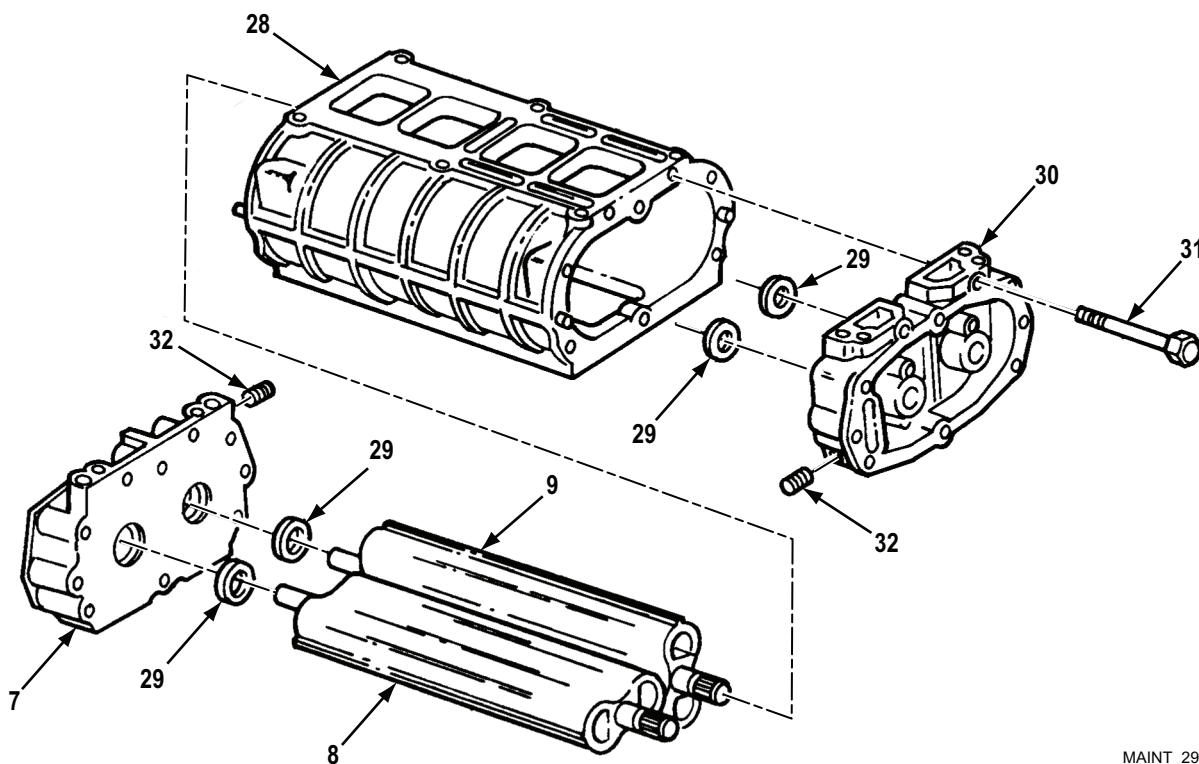
Figure 2. Blower Left and Right Gear Disassembly.

## DISASSEMBLY - Continued

## CAUTION

Handle blower end plates, rotors, and blower housing with care during disassembly to ensure no damage to mating surfaces.

12. Tap front end plate (Figure 3, Item 7) off of dowel pins and away from blower housing (Figure 3, Item 28) with a soft head hammer. Remove end plate.
13. Withdraw right rotor (Figure 3, Item 9) and left rotor (Figure 3, Item 8) from front of blower housing (Figure 3, Item 28).
14. On models 5063-5392, 5063-5393, and 5063-539L, remove two screws (Figure 3, Item 31) retaining rear end plate (Figure 3, Item 30) to blower housing (Figure 3, Item 28).
15. Tap rear end plate (Figure 3, Item 30) off of dowel pins and away from blower housing (Figure 3, Item 28) with a soft head hammer. Remove end plate.
16. Remove two seals (Figure 3, Item 29) from each end plate (Figure 3, Items 7 and 30). Discard seals.
17. If necessary, remove pipe plugs (Figure 3, Item 32) from both front and rear end plates (Figure 3, Items 7 and 30).



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Figure 3. Blower Rotor Removal.

**DISASSEMBLY - Continued**

18. If necessary, remove oversize seal sleeve (Figure 4, Item 33) from each end of each blower rotors (Figure 4, Items 9 and 8) using a cold chisel to split the sleeve. Discard sleeves.

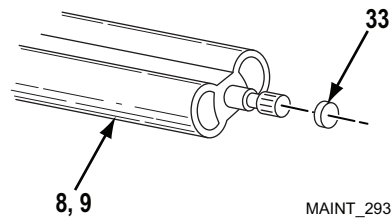


Figure 4. Blower Rotor Disassembly.

19. For models 5063-5392, 5063-5393, and 5063-539L, remove bypass valve as follows:
- Remove two screws (Figure 5, Item 34), two lockwashers (Figure 5, Item 40), and two clamps (Figure 5, Item 36) fastening bypass valve (Figure 5, Item 35) to end plate (Figure 5, Item 30). Discard lockwashers.
  - Remove two clamps (Figure 5, Item 37) and hose (Figure 5, Item 38) from bypass valve (Figure 5, Item 35) and tube (Figure 5, Item 39).
  - Remove bypass valve (Figure 5, Item 35) from end plate (Figure 5, Item 30).
  - Remove preformed packing (Figure 5, Item 41) from bypass valve (Figure 5, Item 35). Discard packing.
  - If necessary, remove tube (Figure 5, Item 39) from blower end plate (Figure 5, Item 30).

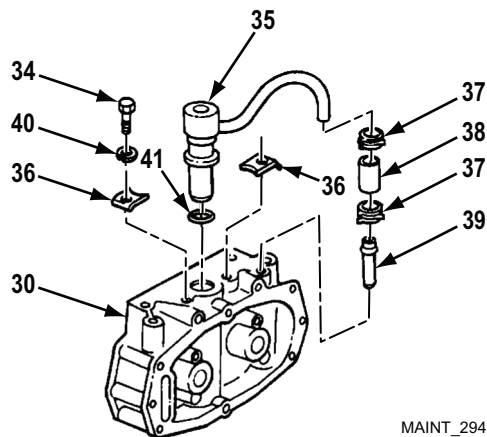
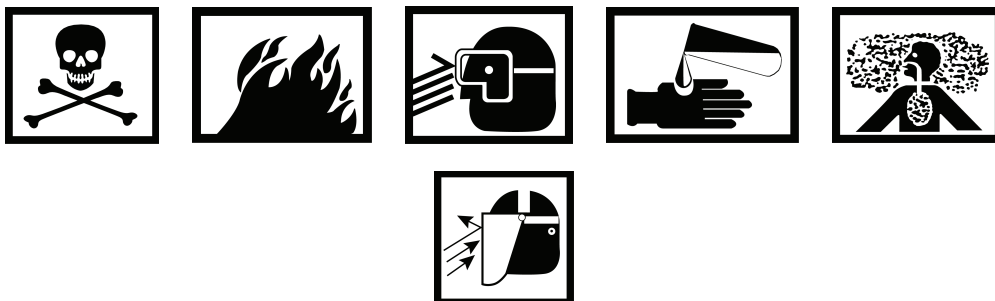


Figure 5. Blower End Plate Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash rotors and blower housing with cleaning solvent and remaining parts with fuel oil. Dry with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect inside finished face of each end plate and finished ends of blower housing for smoothness and flatness. If finished face is slightly scored or burred, clean up with emery cloth.
2. Inspect surfaces of rotors and blower housing for burrs, scoring, and scratches. Use X-fine sharpening stone to clean up surfaces.
3. Inspect splines on rotor shafts, gears, and drive couplings for wear, burrs, or peening.
4. Examine teeth on gears for wear or damage.
5. Check oil seal contact surfaces for wear, nicks, or scoring.
6. Examine blower drive coupling components for cracks and broken parts.
7. Examine thrust plate and thrust washers for wear.
8. Check bearing surfaces of rotor shafts for scoring and wear.
9. For models 5063-5392, 5063-5393, and 5063-539L, inspect bypass valve. Push in plunger on bypass valve. If plunger sticks or does not return, replace valve.

**END OF TASK**

**ASSEMBLY****NOTE**

If rotor shafts have grooves from seal, install an oversize sleeve on the shaft. If an oversize seal is installed, also install an oversize sleeve.

1. Install oversize sleeve on blower rotor shaft as follows:
  - a. Position left rotor (Figure 6, Item 8) on wood blocks and install oversize sleeve (Figure 6, Item 33) over blower rotor shaft (Figure 6, Item 46). Using blower sleeve installer (Figure 6, Item 42), press sleeve until shoulder of installer contacts shaft. Repeat for opposite end rotor shaft.
  - b. Repeat Step 1.a. for right blower rotor.

**CAUTION**

New standard size seals are Teflon coated and must be installed dry to ensure proper sealing. Oversized seals are not Teflon coated and must be lubricated prior to installing to ensure proper sealing.

**NOTE**

Identify rear end plate (Figure 6, Item 30) by governor lubrication oil hole (Figure 6, Item A) drilled in outer face of plate. Install blower seals (Figure 6, Item 29) with lips dry.

2. Install two new standard or oversize seals in each end plate as follows:
  - a. Place front end plate (Figure 6, Item 7), seal counterbores up, on press.
  - b. Lubricate outer diameter of seal (Figure 6, Item 29) with engine oil.
  - c. Place seal (Figure 6, Item 29), lip facing down with part number on seal facing out, in counterbore. Using blower seal installer (Figure 6, Item 45), press seal until shoulder of installer contacts end plate.
  - d. Repeat Steps 2.b. – 2.c. for second seal (Figure 6, Item 29).
  - e. Repeat Steps 2.a. – 2.d. for rear end plate (Figure 6, Item 30).

**CAUTION**

Sealant is required when assembling blower end plates to blower housing. Failure to apply sealant may result in air leakage between blower housing and end plates, which may affect engine performance.

**NOTE**

Blower end plate and blower housing mating surfaces must be thoroughly clean and free of any grease, oil film, or cleaner residue. Clean the surfaces with cleaning solvent.

3. Apply a thin, even coating of Teflon-based sealing compound from sealant kit over the entire end surfaces of both ends of the blower housing. Wipe off any excess sealant from housing bore. Allow sealant to dry to touch before assembling housing to end plates.
4. Place front end plate (Figure 6, Item 7), inner face up, on two wooden blocks. Install right rotor (Figure 6, Item 9) and left rotor (Figure 6, Item 8), splined shaft ends up, in end plate.

**NOTE**

Install blower housing in same orientation as match marked during removal for better rotor to housing clearances.

5. Install blower housing (Figure 6, Item 28) over rotors (Figure 6, Items 8 and 9).

**ASSEMBLY - Continued**

- Place rear end plate (Figure 6, Item 30) over rotor shafts. Temporarily install eight flat washers (Figure 6, Item 44) and eight screws (Figure 6, Item 43) on front end plate (Figure 6, Item 7) and rear end plate (Figure 6, Item 30) at blower housing (Figure 6, Item 28). Tighten screws until snug.

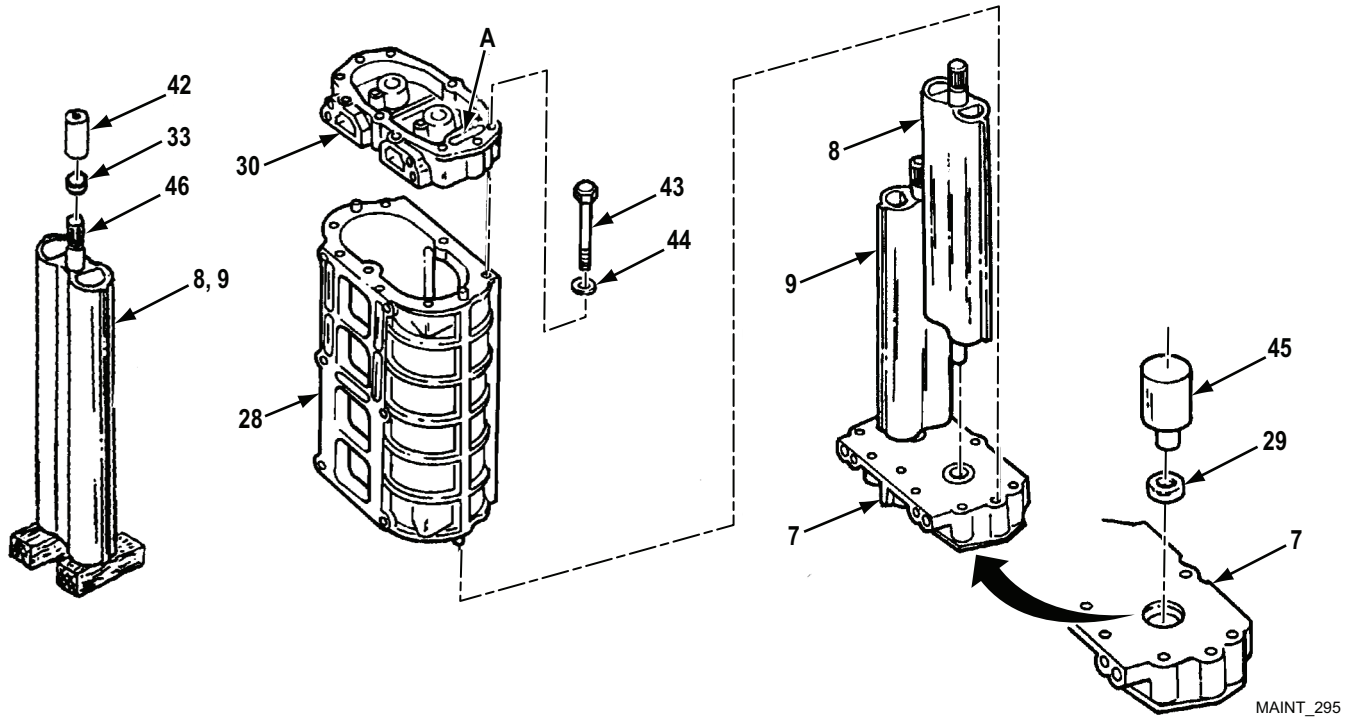


Figure 6. Blower Rotor Assembly.

**ASSEMBLY - Continued****NOTE**

Install shims (Figure 7, Item 26) in same gear from which they were removed.

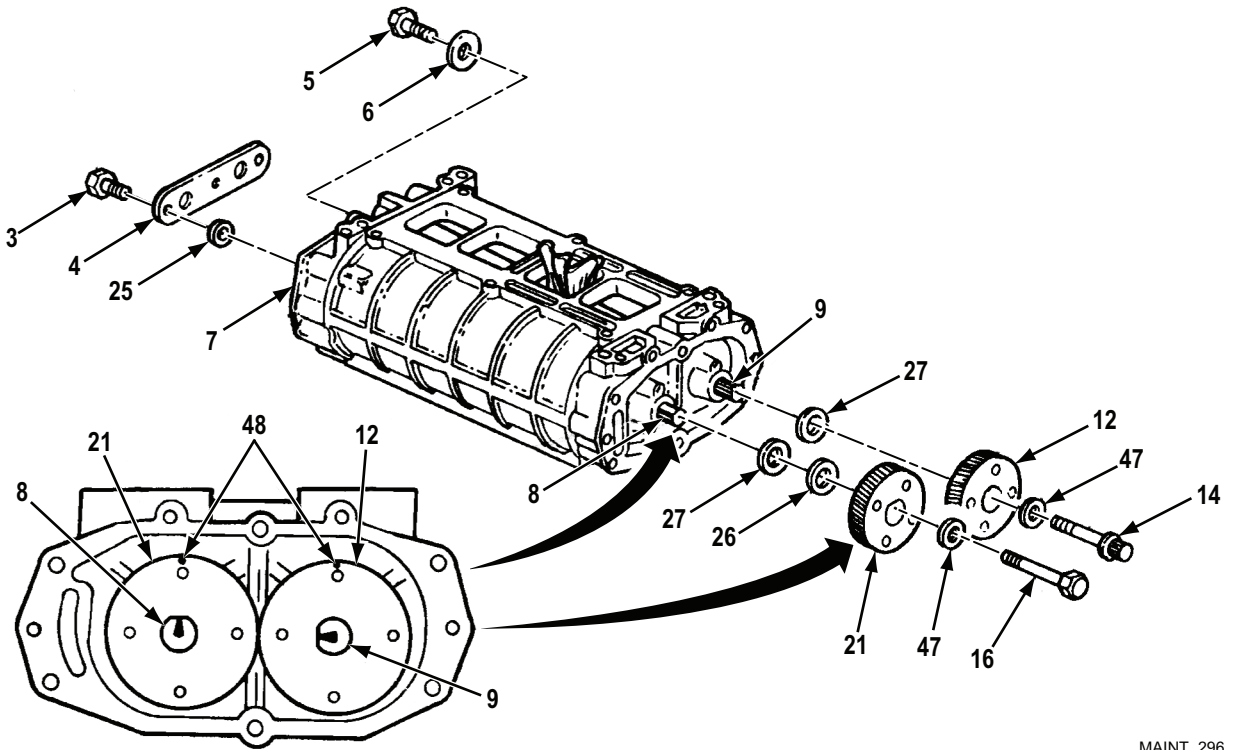
7. Install two new flat washers (Figure 7, Item 27) and shims (Figure 7, Item 26) in counterbore in inside face of gear (Figure 7, Item 12) and gear (Figure 7, Item 21).

**NOTE**

Replace blower gears as a matched set.

8. Place flat in spline in left rotor (Figure 7, Item 8) facing top of blower and flat in spline in right rotor (Figure 7, Item 9) facing left side of blower (forming the rotors into a "T" shape) as shown. Then place right gear (Figure 7, Item 12) on rotor (Figure 7, Item 9) and left gear (Figure 7, Item 21) on rotor (Figure 7, Item 8) with flats in splines on gears in alignment with flats in splines on rotor shafts.
9. Tap gears (Figure 7, Items 12 and 21) lightly with a soft head hammer to seat them on shafts. Rotate gears until timing marks (Figure 7, Item 48) on face of gears match. Reposition gears if marks do not match.
10. Wedge a clean folded rag between blower rotors (Figure 7, Items 8 and 9).
11. Install new twelve-point bolt (Figure 7, Item 14), new bolt (Figure 7, Item 16), and two 5/16-inch flat washers (Figure 7, Item 47) in gears (Figure 7, Items 12 and 21). Turn bolts simultaneously and force gears on rotor shafts until tight against shoulders of rotor.
12. Remove bolt (Figure 7, Item 14), bolt (Figure 7, Item 16), and two flat washers (Figure 7, Item 47).
13. Install two thrust washers (Figure 7, Item 6) and two new self-locking bolts (Figure 7, Item 5) to front of blower rotors. Torque bolts to 54–59 lb-ft (73–80 N·m).
14. Install three spacers (Figure 7, Item 25), thrust plate (Figure 7, Item 4), and three new self-locking bolts (Figure 7, Item 3) on front end plate (Figure 7, Item 7). Torque bolts to 84–108 lb-in (10–12 N·m).
15. Using thickness gage set, check clearance between thrust plate (Figure 7, Item 4) and thrust washers (Figure 7, Item 6). Clearance must be 0.0025 to 0.0050 inch (0.0635 to 0.127 mm).

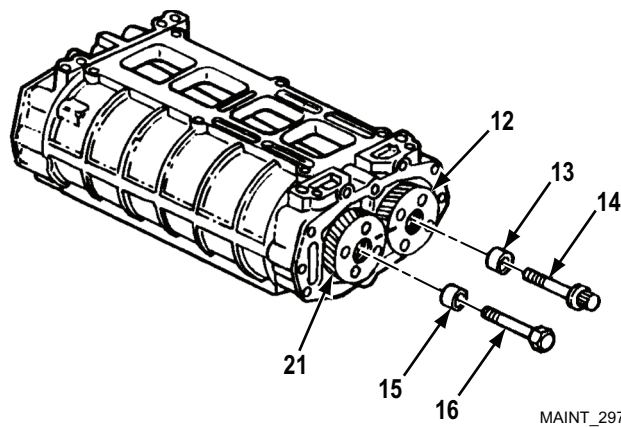
ASSEMBLY - Continued



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Figure 7. Blower Left and Right Gear Assembly.

16. Install twelve-point bolt (Figure 8, Item 14) and right blower drive pilot (Figure 8, Item 13) in counterbore of right gear (Figure 8, Item 12). Install new self-locking bolt (Figure 8, Item 16) and left blower drive pilot (Figure 8, Item 15) in counterbore of left gear (Figure 8, Item 21). Torque bolts to 25–30 lb-ft (34–41 N·m).
17. Remove rag from rotors. Check backlash between gears (Figure 8, Items 12 and 21) using dial indicator. Backlash must be 0.0005 to 0.0025 inch (0.0127 to 0.0635 mm) with new gears and a maximum of 0.0035 inch (0.0889 mm) with used gears.



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Figure 8. Blower Left and Right Gear Backlash Adjustment.

## ASSEMBLY - Continued

## NOTE

Add or remove shims between gear and rotor spacer until blower clearances meet specifications.

18. Using stacked thickness gages, obtain blower clearances as follows:

- a. Measure clearance between rotor lobes and blower housing at (Figure 9, Item A) and (Figure 9, Item B). Take measurements across entire length of each rotor lobe. Clearance (Figure 9, Item B) must be 0.004 inch (0.102 mm) minimum and clearance (Figure 9, Item A) must be 0.010 inch (0.254 mm) minimum.
- b. Rotate gears until rotor lobes are at their closest position. Measure clearance (Figure 9, Item C) between rotor lobes across entire length. Clearance must be 0.009 inch (0.229 mm) minimum.
- c. Measure clearance (Figure 9, Item D) between end of rotors and blower end plates. Push rotor toward end plate being measured and hold at this position while obtaining measurement. For model 5063-5299, clearance must be 0.008 inch (0.20 mm) minimum at front end plate and 0.010 inch (0.254 mm) minimum at rear end plate. For models 5063-5292, 5063-5293, and 5063-529L, clearance must be 0.010 inch (0.254 mm) minimum at front end plate and 0.012 inch (0.305 mm) minimum at rear end plate.

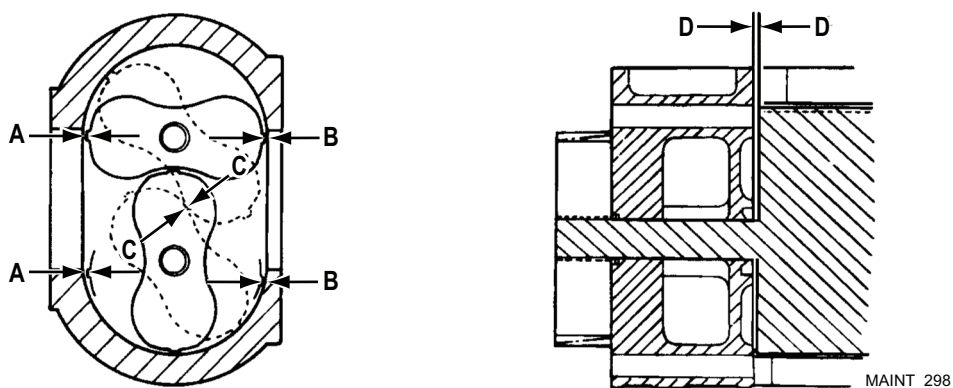


Figure 9. Blower Rotor Lobe Clearance.

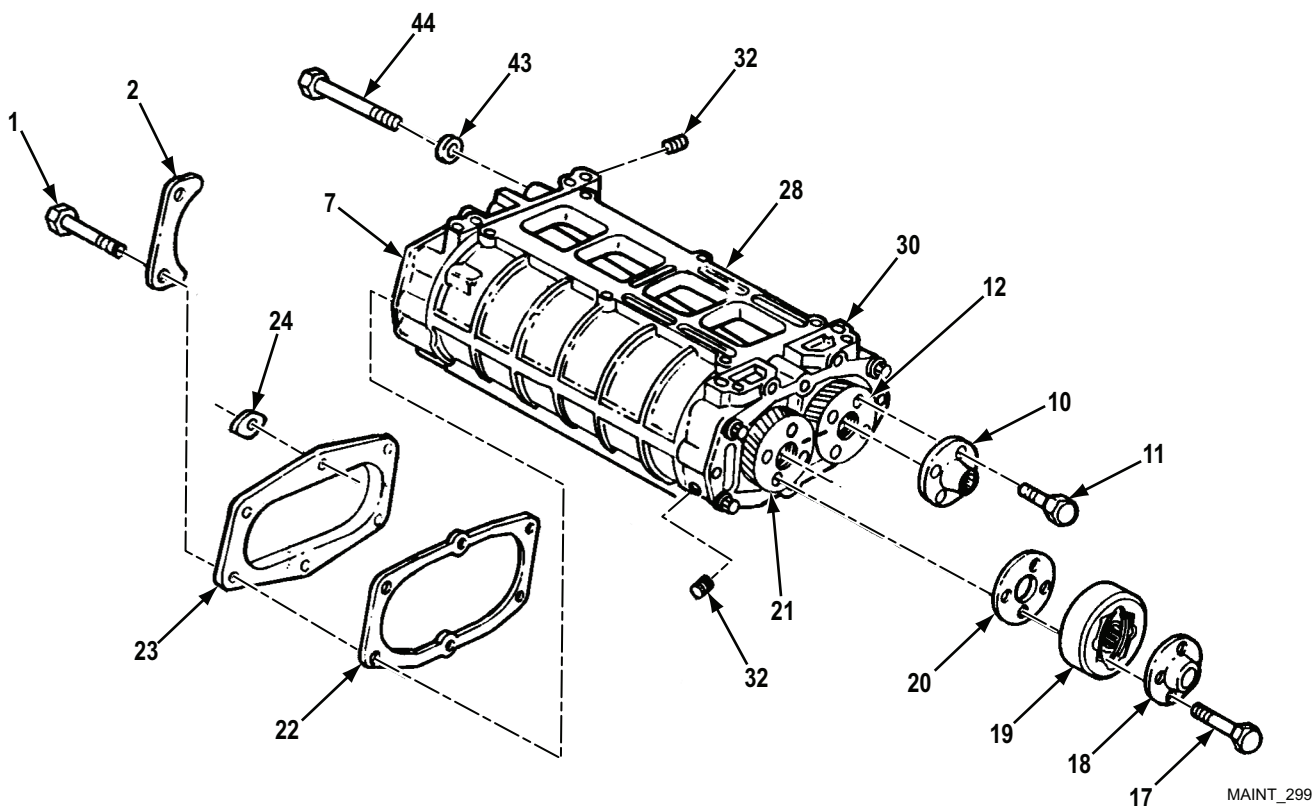
**ASSEMBLY - Continued**

19. Remove four bolts (Figure 10, Item 44) and four flat washers (Figure 10, Item 43) used to temporarily fasten front end plate to blower housing. Install new gasket (Figure 10, Item 22), cover (Figure 10, Item 23), two spacers (Figure 10, Item 24), two plates (Figure 10, Item 2), and six screws (Figure 10, Item 1) on front of blower. Torque bolts to 20–25 lb-ft (27–34 N·m).

**CAUTION**

Excessive protrusion of blower housing with respect to end plate will cause distortion of housing when blower hold-down bolts are tightened and result in rotor to housing contact.

20. Using depth gage, check relationship of front and rear blower end plates (Figure 10, Items 7 and 30) to bottom of blower housing (Figure 10, Item 28). Protrusion of blower housing with respect to end plate must not be more than 0.001 inch (0.025 mm) above or 0.004 inch (0.102 mm) below end plate.
21. Install spacer (Figure 10, Item 20), coupling (Figure 10, Item 19), retainer (Figure 10, Item 18), and four new self-locking bolts (Figure 10, Item 17) on gear (Figure 10, Item 21). Torque bolts to 14–18 lb-ft (19–24 N·m).
22. Install drive coupling (Figure 10, Item 10) and four new self-locking bolts (Figure 10, Item 11) on gear (Figure 10, Item 12). Torque bolts to 8–10 lb-ft (11–14 N·m).
23. If removed, install pipe plug (Figure 10, Item 32) into side of each end plate (Figure 10, Items 7 and 30).



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Figure 10. Blower Assembly.

**ASSEMBLY - Continued**

24. On models 5063-5392, 5063-5393, and 5063-539L, install bypass valve as follows:
- If removed, tap tube (Figure 11, Item 39) into top of rear end plate (Figure 11, Item 30) until it bottoms out.
  - Install preformed packing (Figure 11, Item 41) on bypass valve (Figure 11, Item 35). Install valve in rear end plate (Figure 11, Item 30).
  - Install hose (Figure 11, Item 38) and two clamps (Figure 11, Item 37) on bypass valve (Figure 11, Item 35) and tube (Figure 11, Item 39).
  - Install two clamps (Figure 11, Item 36) against bypass valve (Figure 11, Item 35), two lockwashers (Figure 11, Item 40), and two screws (Figure 11, Item 34) on rear end plate (Figure 11, Item 30). Torque screws to 7–9 lb-ft (10–12 N·m).
  - On models 5063-5392, 5063-5393, and 5063-539L, install two screws (Figure 11, Item 31) on rear end plate (Figure 11, Item 30) into blower housing (Figure 11, Item 28). Torque screws to 13–17 lb-ft (18–23 N·m).

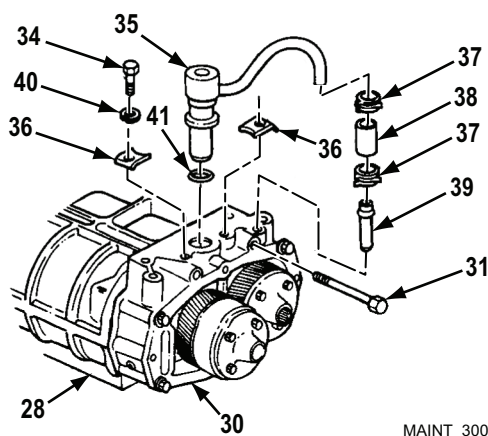


Figure 11. Blower End Plate Assembly.

**END OF TASK**

**FOLLOW ON TASK**

Install governor and blower assembly (WP 0062).

**END OF TASK**

**END OF WORK PACKAGE**



**SUSTAINMENT MAINTENANCE  
TURBOCHARGER REPAIR  
(MODELS 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Adapter, Dial Indicator  
(WP 0104, Table 1, Item 2)  
Fixture Set, Turbocharger Holding  
(WP 0104, Table 1, Item 30)  
Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)

**Materials/Parts**

Antiseize Compound (WP 0103, Table 1, Item 4)  
Bearing Kit Qty: (2) (WP 0105, Table 1, Item 89)  
Bearing, Washer, Thrust  
(models 5063-5392, 5063-5393, 5063-539L)  
(WP 0105, Table 1, Item 28)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Crocus Cloth (WP 0103, Table 1, Item 10)  
Gasket (WP 0105, Table 1, Item 99)  
Nut, Self-locking  
(models 5063-5392, 5063-5393, 5063-539L)  
(WP 0105, Table 1, Item 27)  
Oil, Engine (WP 0103, Table 1, Item 27)

**Materials/Parts (cont.)**

Ring, Retaining (WP 0105, Table 1, Item 88)  
Ring, Retaining  
Qty: (3) (WP 0105, Table 1, Item 103)  
Ring, Seal (WP 0105, Table 1, Item 105)  
Seal Ring, Metal  
Qty: (2) (WP 0105, Table 1, Item 101)  
Silicone Carbide Cloth  
(WP 0103, Table 1, Item 59)  
Silicone Lubricant (WP 0103, Table 1, Item 60)  
Washer, Flat  
(models 5063-5392, 5063-5393, 5063-539L)  
Qty: (2) (WP 0105, Table 1, Item 106)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed (model 5063-5392)  
(WP 0035)  
Turbocharger removed  
(models 5063-5393, 5063-539L) (WP 0036)

**DISASSEMBLY**

1. Match mark compressor housing (Figure 1, Item 1), center housing (Figure 1, Item 2), and turbine housing (Figure 1, Item 3) for reassembly.

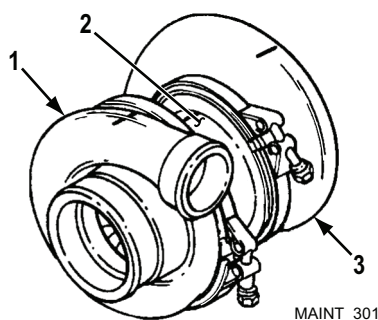
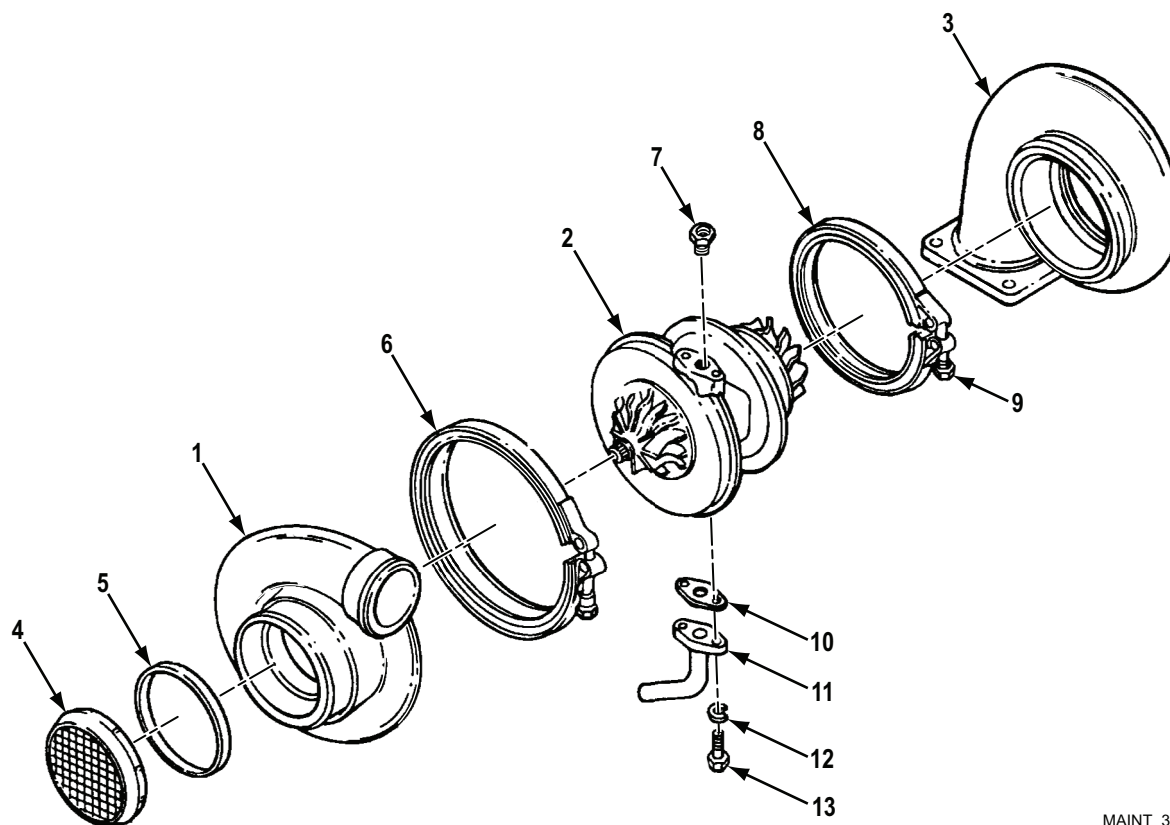


Figure 1. Turbo Match Marking.

**DISASSEMBLY - Continued****CAUTION**

Exercise care when removing compressor housing and turbine housing to prevent damage to compressor and turbine wheels.

2. Remove V-band coupling (Figure 2, Item 6) and compressor housing (Figure 2, Item 1) from center housing (Figure 2, Item 2).
3. If necessary for models 5063-5392, 5063-5393, and 5063-539L, remove inlet screen (Figure 2, Item 4) and seal (Figure 2, Item 5) from compressor housing (Figure 2, Item 1).
4. On models 5063-5393 and 5063-539L, remove two screws (Figure 2, Item 13), two lockwashers (Figure 2, Item 12), drain tube (Figure 2, Item 11), and gasket (Figure 2, Item 10) from center housing (Figure 2, Item 2). Discard lockwashers and gasket.
5. Remove connector (Figure 2, Item 7) from top of center housing (Figure 2, Item 2).
6. Remove locknut (Figure 2, Item 9), V-band coupling (Figure 2, Item 8), and turbine housing (Figure 2, Item 3) from center housing (Figure 2, Item 2).



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Figure 2. Turbo Disassembly.

**DISASSEMBLY - Continued****CAUTION**

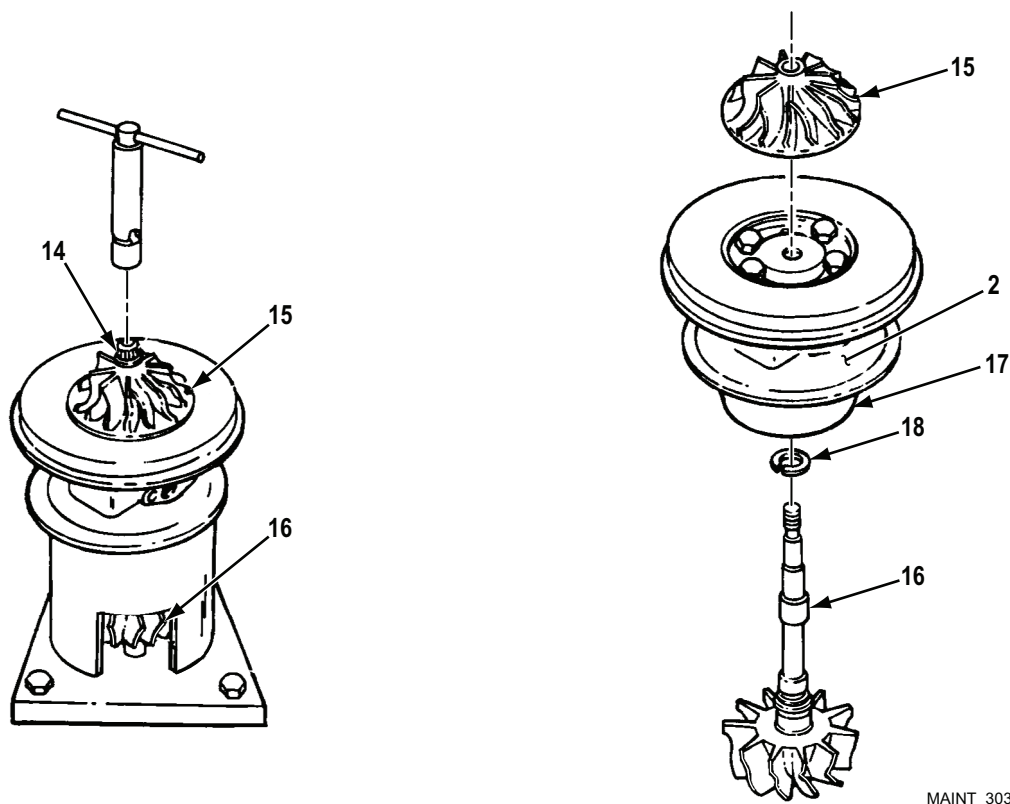
Remove compressor wheel nut from shaft with a double universal socket and tee handle to prevent bending turbine wheel shaft.

7. Place turbine wheel assembly (Figure 3, Item 16) in turbocharger holding fixture. Remove locknut (Figure 3, Item 14) from shaft. Discard locknut.
8. Remove compressor wheel (Figure 3, Item 15) from turbine wheel assembly (Figure 3, Item 16).

**CAUTION**

Catch wheel shroud before it falls from press. Wheel shroud (Figure 3, Item 17) will fall free when turbine wheel assembly is removed.

9. Remove turbine wheel assembly (Figure 3, Item 16) and wheel shroud (Figure 3, Item 17) from center housing (Figure 3, Item 2).
10. Remove retaining ring (Figure 3, Item 18) from turbine wheel assembly (Figure 3, Item 16). Discard retaining ring.

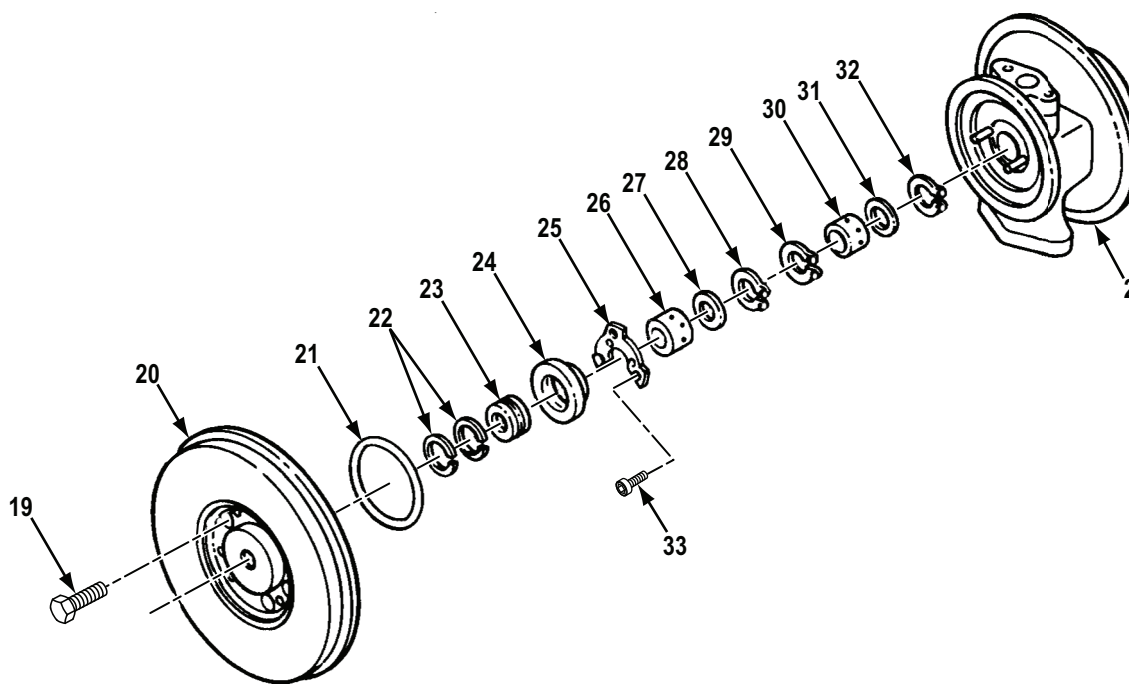


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Figure 3. Turbo Turbine Disassembly.

**DISASSEMBLY - Continued**

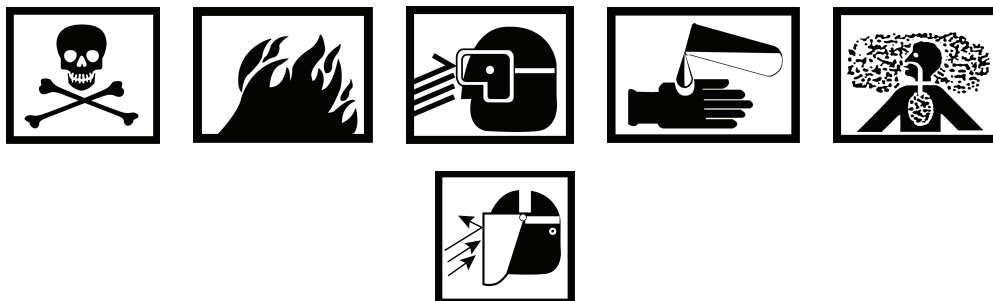
11. On models 5063-5392, 5063-5393, and 5063-539L, remove four screws (Figure 4, Item 19) fastening backplate (Figure 4, Item 20) to center housing (Figure 4, Item 2).
12. Tap backplate (Figure 4, Item 20) lightly and remove from center housing (Figure 4, Item 2).
13. Remove seal ring (Figure 4, Item 21) from groove in center housing (Figure 4, Item 2). Discard seal ring.
14. On models 5063-5392, 5063-5393, and 5063-539L, remove three socket head screws (Figure 4, Item 33) and thrust washer (Figure 4, Item 25) from center housing (Figure 4, Item 2). Discard thrust washer and screws.
15. Remove thrust spacer (Figure 4, Item 23) with metal seal rings (Figure 4, Item 22), and thrust collar (Figure 4, Item 24) from backplate (Figure 4, Item 20). Remove two seal rings from spacer. Discard seal rings.
16. Remove bearing (Figure 4, Item 26), flat washer (Figure 4, Item 27), and retaining ring (Figure 4, Item 28) from center housing (Figure 4, Item 2). Discard bearing, flat washer, and retaining ring.
17. Remove outer retaining ring (Figure 4, Item 29), bearing (Figure 4, Item 30), and flat washer (Figure 4, Item 31) from compressor end of center housing (Figure 4, Item 2), then remove inner retaining ring (Figure 4, Item 32). Discard retaining rings, flat washer, and bearing.



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Figure 4. Turbo Center Housing Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Do not use a caustic solution to clean turbocharger. Do not use wire brush or steel blade scraper to clean parts. Such cleaning will damage finished surfaces of turbocharger.

**NOTE**

Before cleaning, inspect parts for signs of burning, rubbing, or other damage which might not be evident after cleaning.

Ensure compressor and turbine wheel blades are thoroughly clean. Deposits left on blades will affect balance of rotating assembly.

1. Soak all parts in cleaning solvent for 25 minutes.
2. After soaking, use a stiff bristle brush to remove all dirt particles.
3. Using compressed air, dry all parts thoroughly.
4. Clean all internal cavities and oil passages in center housing thoroughly with compressed air.
5. Clean oil passage in center housing thrust plate with compressed air.

**CAUTION**

When polishing surfaces, use silicone carbide abrasive cloth for aluminum parts and crocus cloth for steel parts.

6. Minor surface damage of non-bearing surfaces may be burnished or polished away.

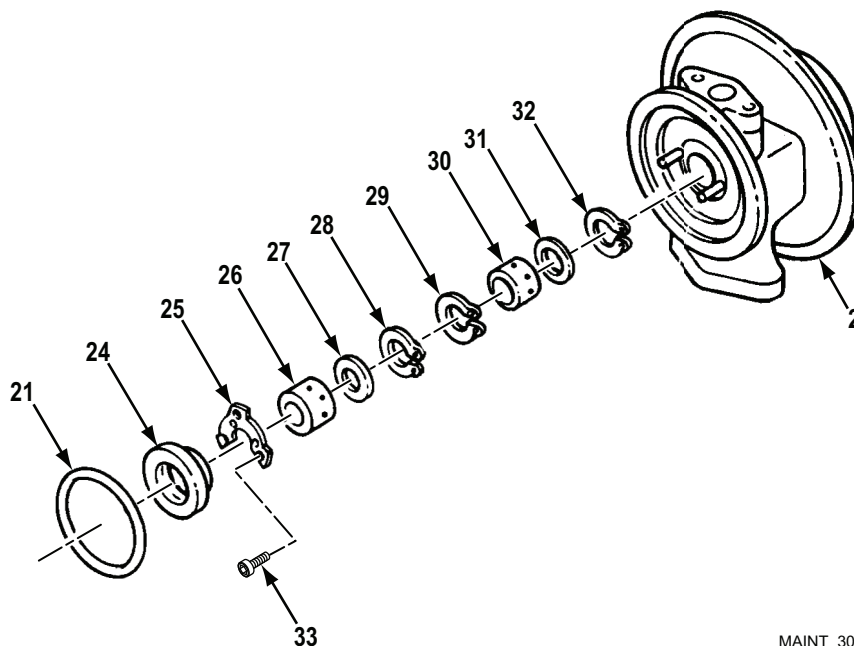
**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect all parts for signs of damage, corrosion, or deterioration. Check for nicked, crossed, or stripped threads.
2. Check turbine wheel for nicks, rubbing, and wear.
3. Inspect shaft for signs of scoring, scratches, or bearing seizure.
4. Check compressor wheel for signs of rubbing or blade damage. Check to see wheel bore is not galled.
5. Inspect seal parts for signs of rubbing or scoring of running faces.
6. Inspect backplate for wear or damaged bore.
7. Inspect center housing for contact with rotating parts.

**END OF TASK****ASSEMBLY**

1. Lubricate new bearing (Figure 5, Item 26) and new bearing (Figure 5, Item 30) with engine oil.
2. Install new inner retaining ring (Figure 5, Item 32), new flat washer (Figure 5, Item 31), new bearing (Figure 5, Item 30), and new outer retaining ring (Figure 5, Item 29) in compressor end of center housing (Figure 5, Item 2).
3. Install new retaining ring (Figure 5, Item 28), new flat washer (Figure 5, Item 27), and bearing (Figure 5, Item 26) in compressor end of center housing (Figure 5, Item 2).
4. On models 5063-5392, 5063-5393, and 5063-539L, insert thrust collar (Figure 5, Item 24) into new thrust washer (Figure 5, Item 25) and install thrust collar, thrust washer, and three new socket head screws (Figure 5, Item 33) in center housing (Figure 5, Item 2). Torque screws to 30–35 lb-in. (3.4–3.9 N·m).
5. Install new seal ring (Figure 5, Item 21) in groove at compressor end of center housing (Figure 5, Item 2).



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Figure 5. Turbo Center Housing Assembly.

**ASSEMBLY - Continued****CAUTION**

Do not cock or force metal seal rings (Figure 6, Item 22) in grooves. Ring is brittle and will snap easily.

6. Install two new metal seal rings (Figure 6, Item 22) on thrust spacer (Figure 6, Item 23). Lubricate seal rings with engine oil and gently insert thrust spacer assembly into backplate (Figure 6, Item 20).
7. On models 5063–5392, 5063-5393, and 5063-539L, install backplate (Figure 6, Item 20) and four screws (Figure 6, Item 19) on center housing. Torque bolts to 90–110 lb-in. (10.2–12.5 N·m).

**CAUTION**

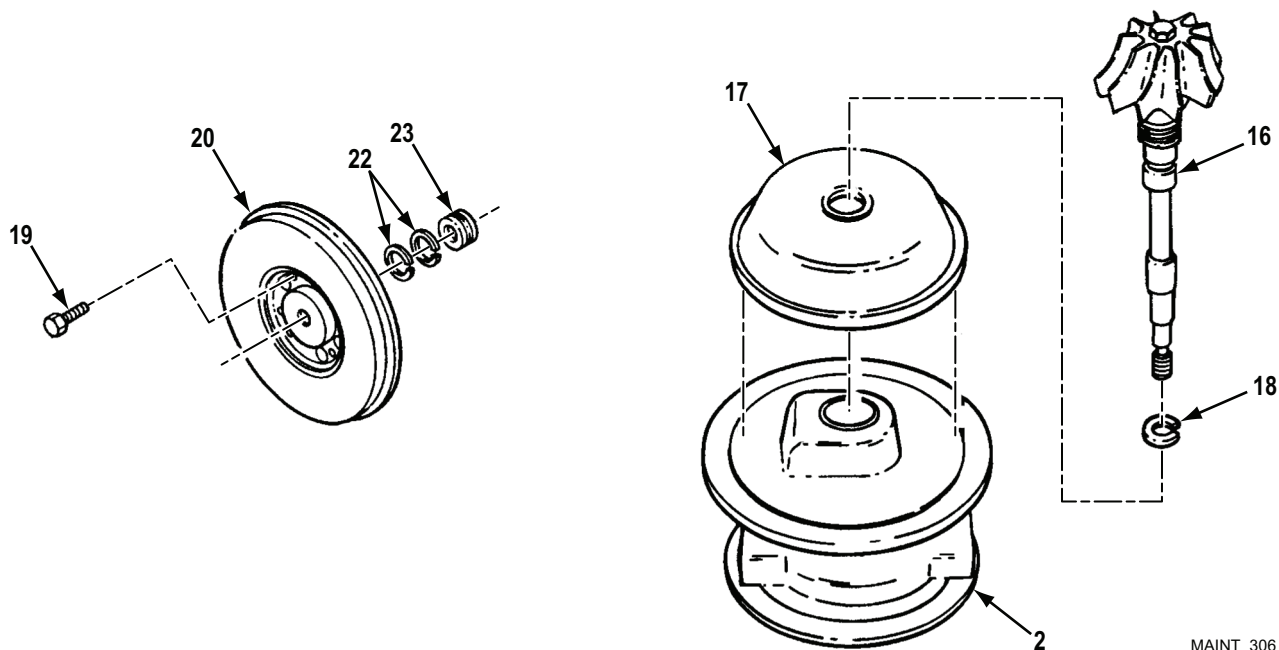
Do not cock or force retaining ring (Figure 6, Item 18) in groove. Ring is brittle and will snap easily.

8. Fill piston ring groove with high vacuum silicone lubricant and install new retaining ring (Figure 6, Item 18) on turbine wheel assembly (Figure 6, Item 16).

**CAUTION**

Do not scuff or scratch bearings when installing shaft or bearing will seize during operation.

9. Lubricate turbine wheel assembly (Figure 6, Item 16) with engine oil. Position wheel shroud (Figure 6, Item 17) against center housing (Figure 6, Item 2). Insert turbine wheel assembly through wheel shroud and into center housing.



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Figure 6. Turbo Center Turbine Shaft Assembly.

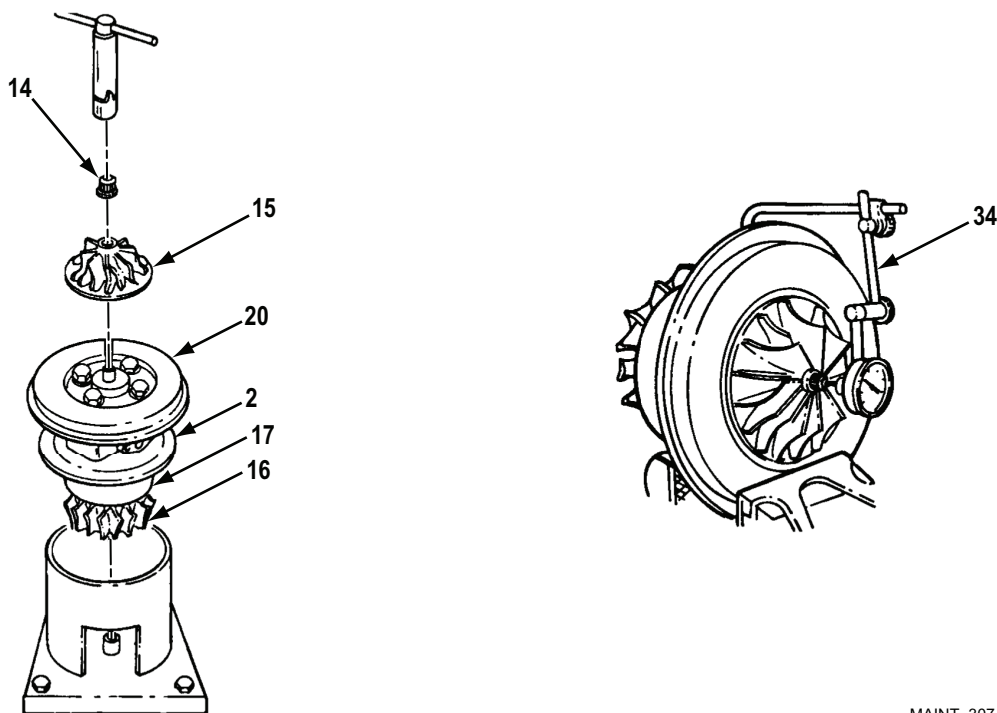
**ASSEMBLY - Continued**

10. Place turbine wheel assembly (Figure 7, Item 16), wheel shroud (Figure 7, Item 17), center housing (Figure 7, Item 2), and backplate (Figure 7, Item 20) upright in turbocharger holding fixture.
11. With compressor wheel (Figure 7, Item 15) at room temperature, position it over shaft of turbine wheel assembly (Figure 7, Item 16).

**CAUTION**

Turn compressor wheel nut with a double universal socket to prevent bending turbine wheel shaft.

12. Lubricate threads of turbine wheel assembly (Figure 7, Item 16) and wheel face on compressor wheel (Figure 7, Item 15) with engine oil. Install new locknut (Figure 7, Item 14). Torque nut to 125–150 lb-in. (14–17 N·m) to seat compressor wheel against thrust spacer.
13. Loosen locknut (Figure 7, Item 14) and inspect nut face and front face of compressor wheel to ensure they are smooth and clean.
14. Torque locknut (Figure 7, Item 14) to 35–55 lb-in. (4–6 N·m).
15. Turn locknut (Figure 7, Item 14) an additional 120–130 degrees.
16. Check bearing axial end play as follows:
  - a. Clamp center housing assembly in soft-jawed vise.
  - b. Fasten magnetic base dial indicator (Figure 7, Item 34) to center housing with indicator tip resting on end of rotating shaft on compressor side.
  - c. Move shaft axially back and forth by hand. Total indicator reading should be between 0.003 and 0.010 inch (0.07 to 0.25 mm). Replace shaft assembly if readings are not in limits.



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Figure 7. Turbo Turbine Assembly.



**ASSEMBLY - Continued**

17. Check shaft radial movement as follows:
  - a. Bolt dial indicator adapter (Figure 8, Item 36) to oil drain tube mounting pad.
  - b. Mount magnetic base dial indicator (Figure 8, Item 34) on dial indicator adapter (Figure 8, Item 36).
  - c. Place dial indicator tip against indicator adapter rod (Figure 8, Item 35).

**NOTE**

Ensure adapter rod (Figure 8, Item 35) does not contact sides of center housing or readings are invalid.

- d. Grasp ends of rotating assembly and apply equal pressure at each end, moving rotating shaft toward and away from dial indicator. Crosswise movement must be between 0.003 and 0.007 inch (0.07 to 0.17 mm).

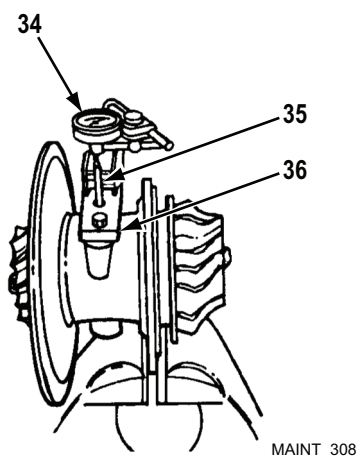


Figure 8. Turbo Radial Movement Check.

**ASSEMBLY - Continued**

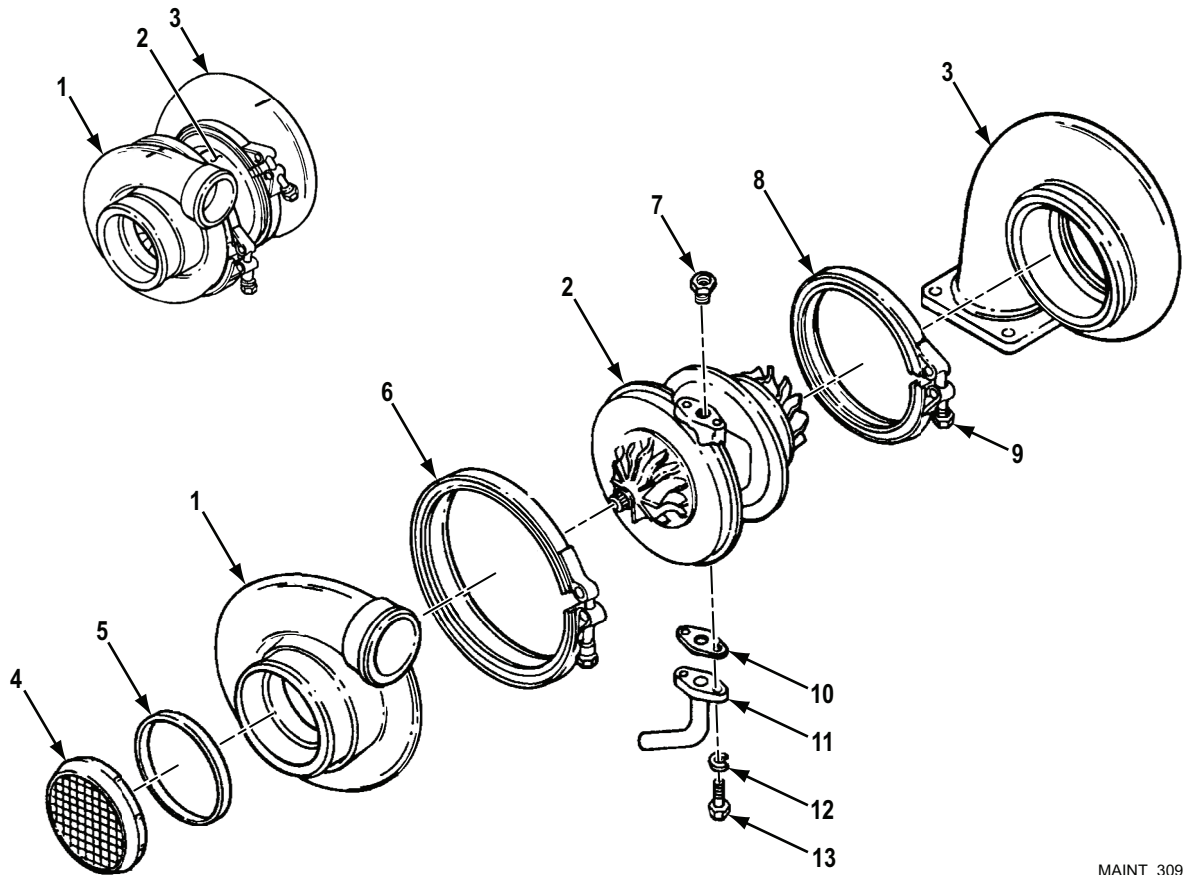
18. Install turbine housing (Figure 9, Item 3) on center housing (Figure 9, Item 2) and align match marks.
19. Install turbine V-band coupling (Figure 9, Item 8) and locknut (Figure 9, Item 9). Use following procedure to tighten clamp:
  - a. Install V-band coupling (Figure 9, Item 8) on turbine housing (Figure 9, Item 3) and center housing (Figure 9, Item 2) so that T-bolt end does not interfere with turbine housing.
  - b. Lubricate threads on T-bolt with anti-seize compound.

**CAUTION**

Do not tighten V-band coupling (Figure 9, Item 8) if turbine housing is misaligned. Forcing turbine housing into alignment by tightening coupling can damage components.

- c. Torque locknut (Figure 9, Item 9) to 152–168 lb-in. (17–19 N·m).
  - d. Slowly loosen locknut (Figure 9, Item 9) on V-band coupling (Figure 9, Item 8) to approximately 50 lb-in. (6 N·m), then re-torque locknut to 152–168 lb-in. (17–19 N·m).
20. Align match marks on compressor housing (Figure 9, Item 1) and center housing (Figure 9, Item 2). Install compressor housing and V-band coupling (Figure 9, Item 6) on center housing. Lubricate threads on T-bolt with engine oil and torque locknut to 110–130 lb-in. (12–15 N·m).
21. Install connector (Figure 9, Item 7) to top of center housing (Figure 9, Item 2).
22. On models 5063-5393 and 5063-539L, install new gasket (Figure 9, Item 10), drain tube (Figure 9, Item 11), two new lockwashers (Figure 9, Item 12), and two screws (Figure 9, Item 13) to bottom of center housing (Figure 9, Item 2). Torque screws to 30–35 lb-ft (41–47 N·m).
23. If removed for models 5063-5392, 5063-5393, and 5063-539L, install inlet screen (Figure 9, Item 4) and seal (Figure 9, Item 5) on compressor housing (Figure 9, Item 1).

## ASSEMBLY - Continued



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Figure 9. Turbo Assembly.

## END OF TASK

## FOLLOW ON TASK

1. Install turbocharger (models 5063-5393 and 5063-539L) (WP 0036).
2. Install turbocharger (model 5063-5392) (WP 0035).

## END OF TASK

## END OF WORK PACKAGE



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**SUSTAINMENT MAINTENANCE  
GOVERNOR REPAIR**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Remover, Bearing and Bushing (Gov)  
(WP 0104, Table 1, Item 81)  
Remover and Installer (Gov Cvr Brng)  
(WP 0104, Table 1, Item 85)  
Installer, Governor Cover Bearing  
(WP 0104, Table 1, Item 63)  
Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)

**Materials/Parts**

Grease (WP 0103, Table 1, Item 18)

**Materials/Parts (cont.)**

Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Packing, Preformed  
(WP 0105, Table 1, Item 174)  
Plug, Expansion (WP 0105, Table 1, Item 4)  
Plug, Pipe (WP 0105, Table 1, Item 157)  
Seal, Special (WP 0105, Table 1, Item 30)  
Sealing Compound (WP 0103, Table 1, Item 52)  
Wood Block Qty: (2) (WP 0103, Table 1, Item 71)

**Equipment Condition**

Governor cover and spring pack removed  
(WP 0061)  
Governor removed from blower assembly  
(WP 0062)

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**DISASSEMBLY**

**NOTE**

Before disassembly of governor, clean entire unit and inspect for worn or damaged parts. Repair damaged parts without disassembly of governor wherever possible.

1. Governor cover removal procedures:
  - a. Loosen screw (Figure 1, Item 2) and remove remote control lever (Figure 1, Item 3).
  - b. Remove flat washer (Figure 1, Item 4) from throttle shaft (Figure 1, Item 13).
  - c. Remove retaining ring (Figure 1, Item 5), flat washer (Figure 1, Item 6), and shouldered washer (Figure 1, Item 7) and withdraw throttle shaft (Figure 1, Item 13) from bottom of cover (Figure 1, Item 9).
  - d. Remove preformed packing (Figure 1, Item 8) from cover (Figure 1, Item 9). Discard packing.
  - e. Loosen screw (Figure 1, Item 20) and remove stop lever (Figure 1, Item 1).
  - f. Remove retaining ring (Figure 1, Item 19), flat washer (Figure 1, Item 18), and shouldered washer (Figure 1, Item 17). Withdraw stop lever shaft (Figure 1, Item 15) from bottom of cover (Figure 1, Item 9).
  - g. If necessary, remove pin (Figure 1, Item 14) from stop lever shaft (Figure 1, Item 15).
  - h. Remove special seal (Figure 1, Item 16) from cover (Figure 1, Item 9). Discard seal.
  - i. If necessary, remove two tapered pins (Figure 1, Item 12) from bottom of cover (Figure 1, Item 9).
  - j. If two bushings (Figure 1, Item 11) require replacement, support governor cover (Figure 1, Item 9) on two wooden blocks in press and press two bushings from cover using bearing and bushing remover (Figure 1, Item 10).

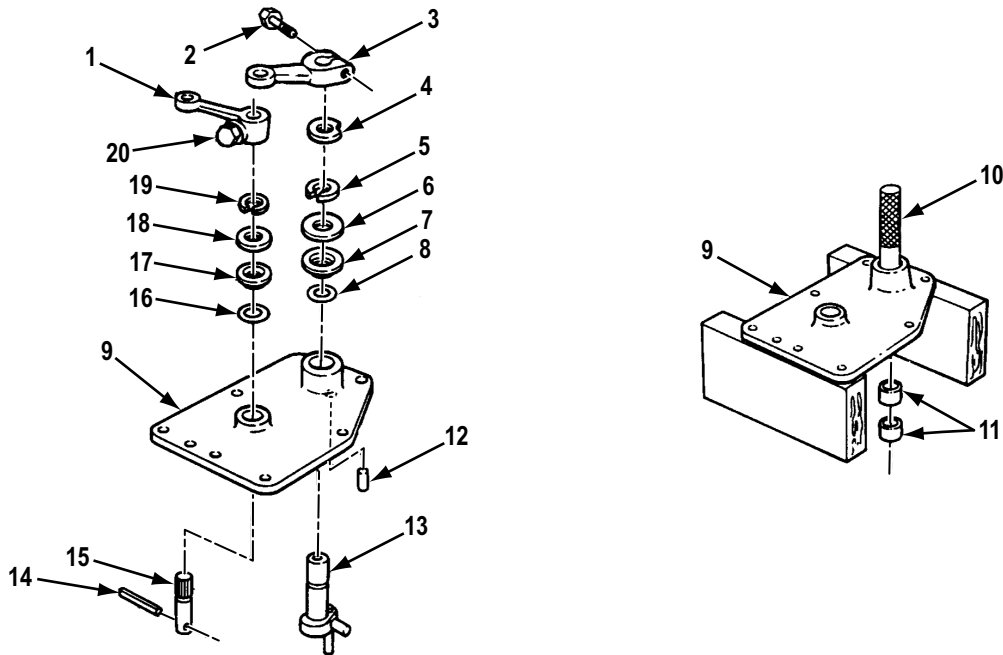


Figure 1. Governor Cover Removal.

**DISASSEMBLY - Continued**

2. Governor spring pack removal procedures:
  - a. Remove retainer (Figure 2, Item 24), spring (Figure 2, Item 25), and spring seat (Figure 2, Item 23) from plunger (Figure 2, Item 21).
  - b. Remove nut (Figure 2, Item 29) from screw (Figure 2, Item 30).

**NOTE**

Retain original shims and special washers for assembly.

- c. Remove screw (Figure 2, Item 30), packing nut (Figure 2, Item 31), spring (Figure 2, Item 28), shims (Figure 2, Item 27), special washers (Figure 2, Item 26), and pin (Figure 2, Item 22) from plunger (Figure 2, Item 21).

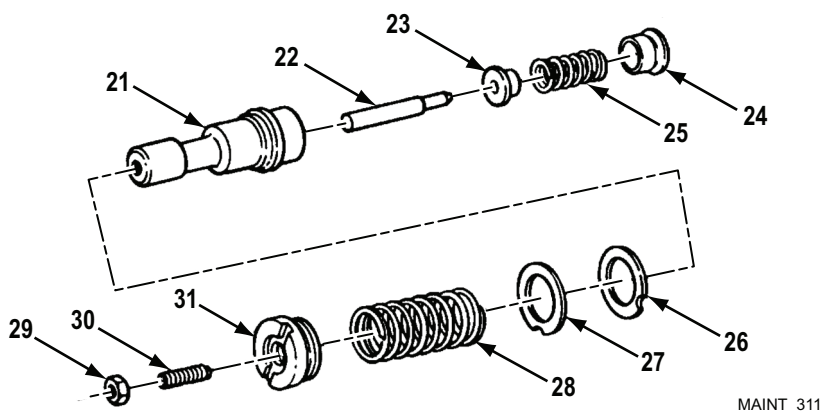
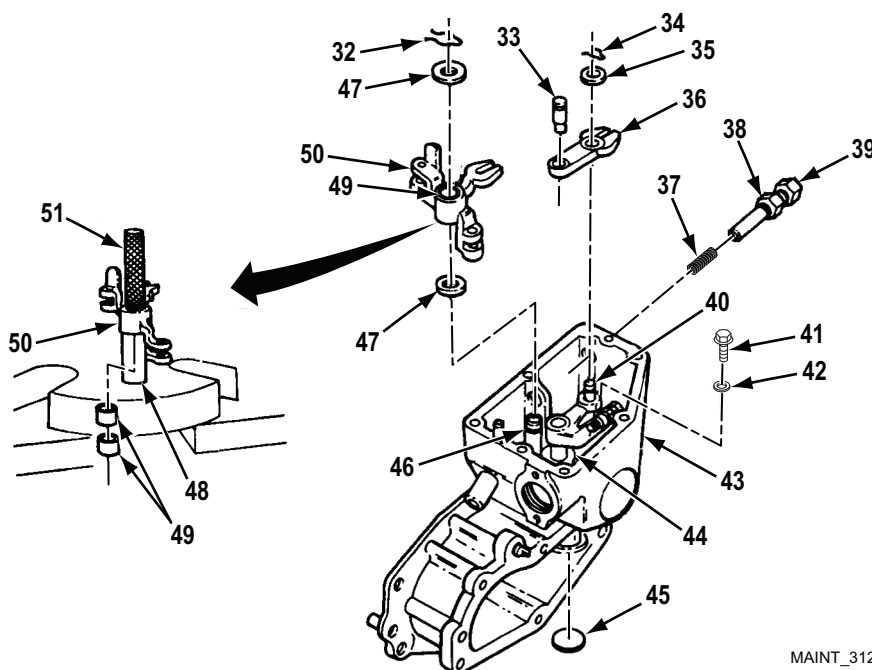


Figure 2. Governor Spring Pack Removal.

**DISASSEMBLY - Continued**

3. Governor housing assembly removal procedures:
  - a. Loosen nut (Figure 3, Item 38) and remove buffer screw (Figure 3, Item 39) and spring (Figure 3, Item 37) from side of governor housing (Figure 3, Item 43).
  - b. Remove retaining clip (Figure 3, Item 32), two flat washers (Figure 3, Item 47), and roller bearing (Figure 3, Item 48) and control link lever (Figure 3, Item 49) assembly from grooved pin (Figure 3, Item 46).
  - c. If two roller bearings (Figure 3, Item 49) require replacement, support control link lever (Figure 3, Item 50) assembly on a sleeve (Figure 3, Item 48) in press. Press two bearings out of lever assembly using bearing and bushing remover (Figure 3, Item 51).
  - d. Remove retaining clip (Figure 3, Item 34) and flat washer (Figure 3, Item 35) from pin (Figure 3, Item 40). Remove differential lever (Figure 3, Item 36) assembly.
  - e. If necessary, press pin (Figure 3, Item 33) from differential lever (Figure 3, Item 36).
  - f. Remove expansion plug (Figure 3, Item 45) from bottom of governor housing (Figure 3, Item 43). Discard expansion plug.
  - g. Remove special screw (Figure 3, Item 41) and flat washer (Figure 3, Item 42) fastening governor bearing (Figure 3, Item 44) in governor housing (Figure 3, Item 43).



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Figure 3. Governor Housing Disassembly.

- h. Place governor housing (Figure 4, Item 43), top down, on wooden blocks in press. Using a short 3/8 inch (9.5 mm) diameter rod (Figure 4, Item 52), press operating shaft (Figure 4, Item 53) free of bearing (Figure 4, Item 54).
- i. Insert 9/16 inch open end wrench (Figure 4, Item 70) between shifter fork (Figure 4, Item 65) and governor housing (Figure 4, Item 43). Using a 3/8 inch (9.5 mm) diameter rod (Figure 4, Item 52), press operating shaft (Figure 4, Item 53) out of shifter fork.



**DISASSEMBLY - Continued**

- j. Remove operating shaft (Figure 4, Item 53), bearing (Figure 4, Item 44), operating shaft lever assembly (Figure 4, Item 61), and shifter fork (Figure 4, Item 65) from governor housing (Figure 4, Item 43).
- k. Press operating shaft (Figure 4, Item 54) from operating shaft lever assembly (Figure 4, Item 61) and bearing (Figure 4, Item 44).
- l. If necessary, press pin (Figure 4, Item 40) from operating shaft lever (Figure 4, Item 55).
- m. On model 5063-5299, remove nut (Figure 4, Item 56) and screw (Figure 4, Item 57) from operating shaft lever (Figure 4, Item 55).
- n. On all except model 5063-5299, remove bolt (Figure 4, Item 58), special nut (Figure 4, Item 60), and nut (Figure 4, Item 59) from operating shaft lever (Figure 4, Item 55).
- o. Press ball bearing (Figure 4, Item 53) from governor housing (Figure 4, Item 43).
- p. If necessary, remove plug (Figure 4, Item 64) from side of governor housing (Figure 4, Item 43). Discard plug.
- q. If necessary, remove two pins (Figure 4, Item 69) from top of governor housing (Figure 4, Item 43).
- r. If necessary, remove two adapters (Figure 4, Item 68) from sides of governor housing (Figure 4, Item 43).
- s. If necessary, remove two pins (Figure 4, Item 67) from front and pin (Figure 4, Item 66) from rear of governor housing (Figure 4, Item 43).
- t. If necessary, remove two drive screws (Figure 4, Item 62) and plate (Figure 4, Item 63) from side of governor housing (Figure 4, Item 43).
- u. If necessary, remove pin (Figure 4, Item 46) from inside governor housing (Figure 4, Item 43).

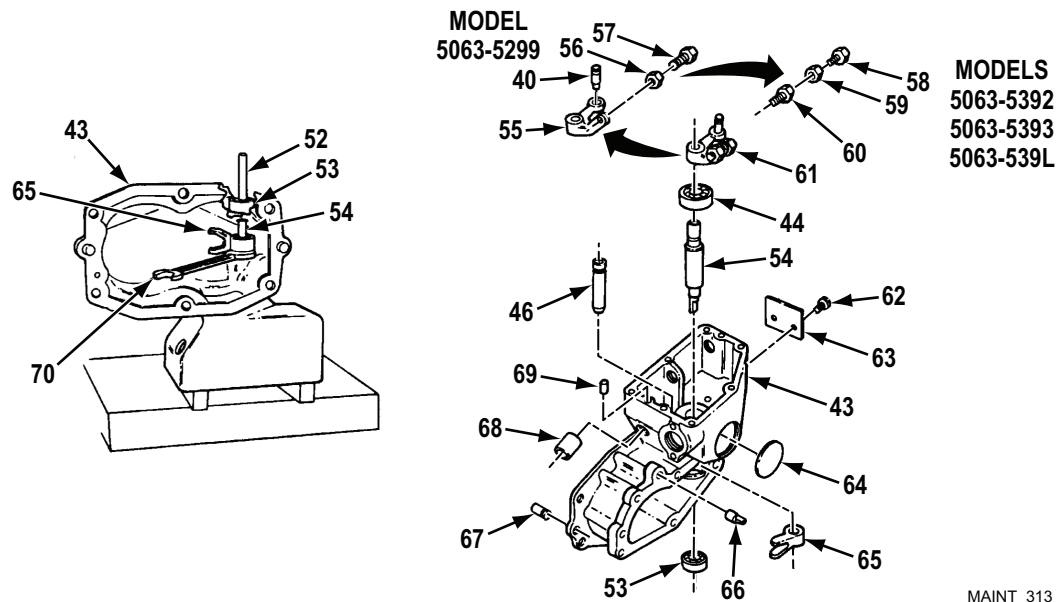
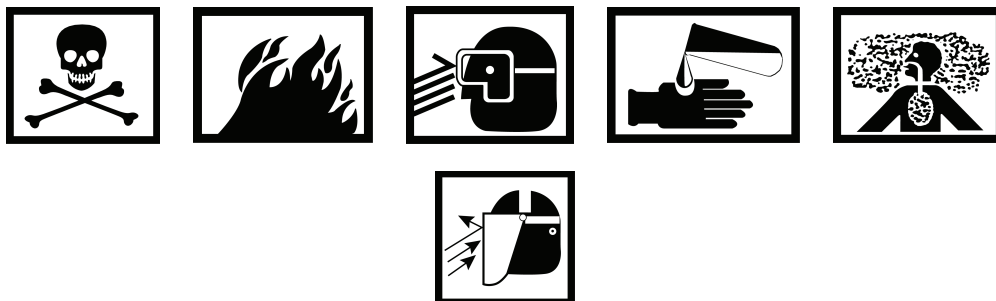


Figure 4. Governor Housing Assembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean all parts with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect bearings for corrosion or pitting. Revolve bearings by hand and check for rough or tight spots.
2. Inspect needle bearings in control link lever assembly and mating lever pin for wear.
3. Inspect governor springs, spring seat, spring cap, plunger, spring retainer, adjusting screws, and other parts of governor for wear.
4. Inspect governor housing for cracks, warpage, and damaged threads.

**END OF TASK**

**ASSEMBLY**

1. Governor cover procedures:
  - a. If removed, press two pins (Figure 6, Item 12) in bottom of cover (Figure 6, Item 9) until flush to 0.005 inch (0.127 mm) below machined surface.
  - b. If bushings (Figure 5, Item 11) were removed, place governor cover (Figure 5, Item 9), inner face down, in press. Start bushing straight into bore, numbered side up. Place bearing installer (Figure 5, Item 71) in bushing and press until shoulder of installer contacts cover. Invert cover and install second bushing (Figure 5, Item 11) in same manner.

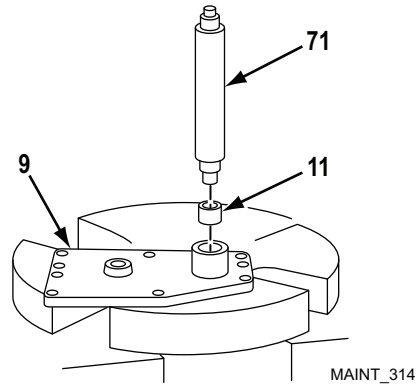


Figure 5. Governor Cover Bushing Replacement.

**ASSEMBLY - Continued**

- c. Lubricate throttle shaft (Figure 6, Item 13) with engine oil and slide into bushings from bottom of cover with lever pin (Figure 6, Item 12) in slot on underside of cover.
- d. Install new preformed packing (Figure 6, Item 8), shouldered washer (Figure 6, Item 7), flat washer (Figure 6, Item 6), and retaining ring (Figure 6, Item 5) over throttle shaft (Figure 6, Item 13).
- e. Install pin (Figure 6, Item 14) into stop lever shaft (Figure 6, Item 15). Press pin into shaft, from side with flat spots, until flared end of pin protrudes 1/4 inch (6.35 mm).
- f. Lubricate stop lever shaft (Figure 6, Item 15) with engine oil and slide into cover (Figure 6, Item 9) from bottom side.
- g. Install new special seal (Figure 6, Item 16), shouldered washer (Figure 6, Item 17), flat washer (Figure 6, Item 18), and retainer ring (Figure 6, Item 19) on stop lever shaft (Figure 6, Item 15).
- h. Install flat washer (Figure 6, Item 4) on throttle shaft (Figure 6, Item 13).
- i. Install stop lever (Figure 6, Item 1) on shaft (Figure 6, Item 15). Torque screw (Figure 6, Item 20) to 84–106 lb-in (10–12 N·m).
- j. Install remote control lever (Figure 6, Item 3) on shaft (Figure 6, Item 13). Remote control lever must contact flat washer (Figure 6, Item 4). Torque screw (Figure 6, Item 2) to 84–106 lb-in (10–12 N·m).

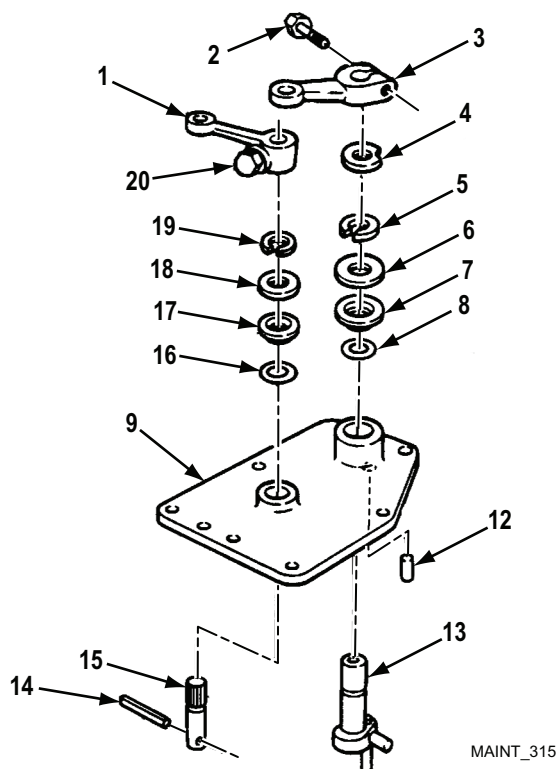


Figure 6. Governor Cover Assembly.

**ASSEMBLY - Continued**

2. Governor spring pack procedures:
  - a. Thread screw (Figure 7, Item 30) into plunger (Figure 7, Item 21).

**NOTE**

Install original shims and special washers if available. If original shims and special washers are not available, install five shims and five special washers.

- b. Install shims (Figure 7, Item 27), special washers (Figure 7, Item 26), and spring (Figure 7, Item 28) on plunger (Figure 7, Item 21) with thin special washers first.
- c. Lubricate spring (Figure 7, Item 28) and plunger (Figure 7, Item 21) with engine oil.
- d. Place packing nut (Figure 7, Item 31) over plunger (Figure 7, Item 21) and thread nut (Figure 7, Item 29) on screw (Figure 7, Item 30) until 1/4 inch (6.35 mm) of screw extends beyond nut.
- e. Lubricate pin (Figure 7, Item 22), spring seat (Figure 7, Item 23), spring (Figure 7, Item 25), and retainer (Figure 7, Item 24) with engine oil and install into end of plunger (Figure 7, Item 21) as shown.

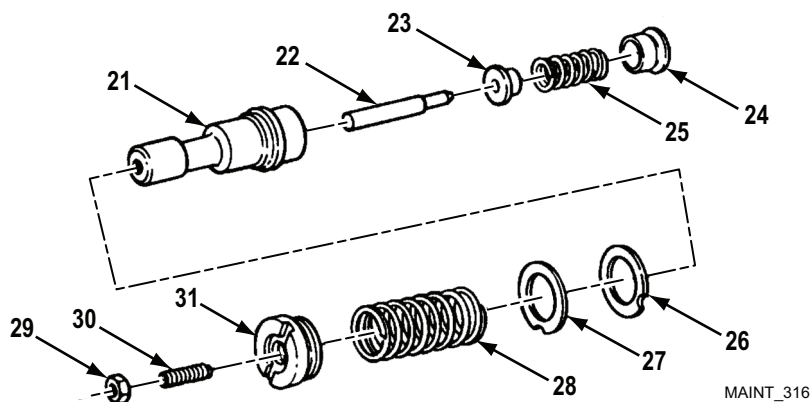


Figure 7. Governor Spring Pack Installation.

**ASSEMBLY - Continued**

3. Governor housing assembly procedures:
  - a. If removed, press two pins (Figure 8, Item 69) into top of governor housing (Figure 8, Item 43) until pins bottom out.
  - b. If removed, apply sealing compound to two adapters (Figure 8, Item 68) and tap into place until they extend 1-7/16 inches (36.51 mm) beyond governor housing (Figure 8, Item 43).
  - c. If removed, press pin (Figure 8, Item 66) into rear of governor housing (Figure 8, Item 43) until it extends 3/8 inch (9.5 mm) beyond housing.
  - d. If removed, press two pins (Figure 8, Item 67) into front of governor housing (Figure 8, Item 43) until they extend 7/16 inch (36.51 mm) beyond housing.
  - e. If removed, install plate (Figure 8, Item 63) and two drive screws (Figure 8, Item 62) on governor housing (Figure 8, Item 43).
  - f. If removed, press pin (Figure 8, Item 46) into governor housing (Figure 8, Item 43). Pin must extend 1.055–1.060 inches (26.80–26.92 mm) above housing for model 5063-5299 and 1.497–1.504 inches (38.02–38.20 mm) above housing on all except model 5063-5299. Measure pin using depth gage.
  - g. Support lower end of operating shaft (Figure 8, Item 54) in press. Start bearing (Figure 8, Item 44) on shaft, numbered side up, and press bearing against shoulder on shaft using a sleeve positioned against inner race of bearing.
  - h. If removed, press pin (Figure 8, Item 40) in operating lever (Figure 8, Item 55) until it bottoms out on shoulder.
  - i. On model 5063-5299, install nut (Figure 8, Item 56) and screw (Figure 8, Item 57) in operating shaft lever (Figure 8, Item 55).
  - j. On all except model 5063-5299, install bolt (Figure 8, Item 58), special nut (Figure 8, Item 60), and nut (Figure 8, Item 59) in operating shaft lever (Figure 8, Item 55).
  - k. Start operating shaft lever assembly (Figure 8, Item 61) on operating shaft (Figure 8, Item 54) with flat on shaft in flat in lever bore and pin (Figure 8, Item 40) up. Using a sleeve, press lever tight against inner race of bearing (Figure 8, Item 44).
  - l. Insert lever, bearing, and shaft assembly (Figure 8, Item 72) through bore inside governor housing (Figure 8, Item 43). Place shifter fork (Figure 8, Item 65) on lower end of shaft with finished cam surfaces facing rear of governor housing.

ASSEMBLY - Continued

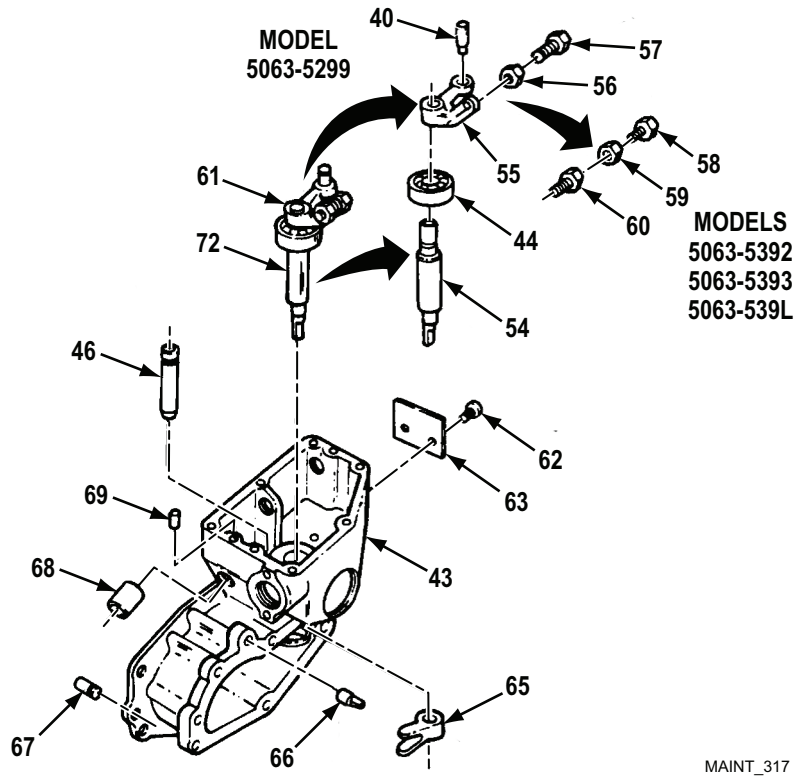
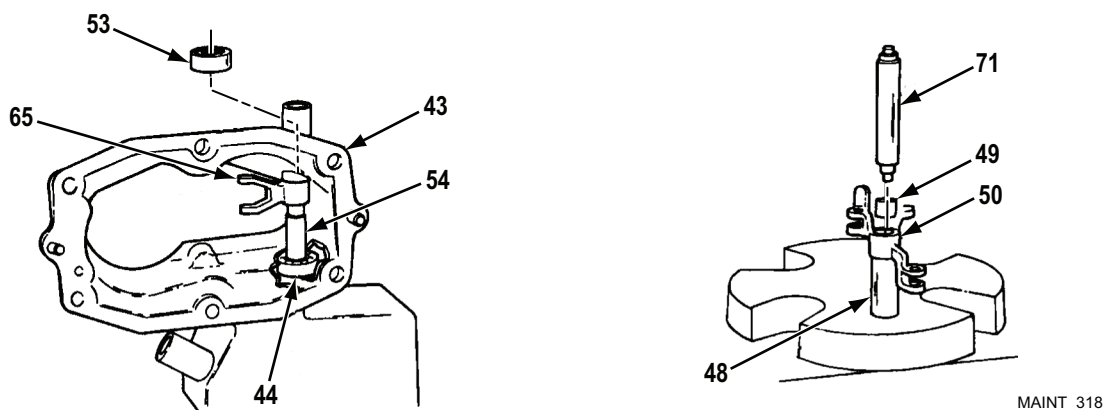


Figure 8. Governor Housing Assembly.

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**ASSEMBLY - Continued**

- m. Support governor housing (Figure 9, Item 43) in press with upper end of shaft (Figure 9, Item 54) against bed of press. Align flat on shaft with flat in bore of shifter fork (Figure 9, Item 65). Place sleeve over shaft and against fork. Press fork tight against shoulder on shaft.
- n. Place bearing (Figure 9, Item 53), shield side toward the shifter fork (Figure 9, Item 65), on lower end of shaft (Figure 9, Item 54). With upper end of shaft supported, press bearing against shoulder in bore of governor housing (Figure 9, Item 43) using sleeve against inner race of bearing.
- o. Lubricate bearing (Figure 9, Item 44) and bearing (Figure 9, Item 53) with engine oil.
- p. Support control link lever (Figure 9, Item 50) on sleeve (Figure 9, Item 48). Place roller bearing (Figure 9, Item 49), numbered side up, on lever and press flush using governor cover bearing installer (Figure 9, Item 71). Invert lever and install second roller bearing in same manner.



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**ASSEMBLY - Continued**

- q. Apply sealing compound around edge of new expansion plug (Figure 10, Item 45) and tap in place in governor housing (Figure 10, Item 43).
- r. If removed, apply sealing compound around edge of new plug (Figure 10, Item 64) and tap in place in governor housing (Figure 10, Item 43).
- s. Install flat washer (Figure 10, Item 42) and special screw (Figure 10, Item 41) against governor bearing (Figure 10, Item 44).
- t. If removed, press pin (Figure 10, Item 33) in differential lever (Figure 10, Item 36) until pin bottoms out on shoulder.
- u. Install differential lever (Figure 10, Item 36) assembly over pin (Figure 10, Item 40). Install flat washer (Figure 10, Item 35) and retaining clip (Figure 10, Item 34) against assembly.
- v. Place first flat washer (Figure 10, Item 47) over grooved pin (Figure 10, Item 46). Pack roller bearings (Figure 10, Item 49) with grease and install roller bearing and control link lever (Figure 10, Item 50) assembly, tapered end of link pin holes down, over grooved pin. Place second flat washer (Figure 10, Item 47) over grooved pin and install retaining clip (Figure 10, Item 32).
- w. Thread nut (Figure 10, Item 38) on buffer screw (Figure 10, Item 39). Place spring (Figure 10, Item 37) in buffer screw and thread screw in side of governor housing (Figure 10, Item 43) until it extends 9/16–5/8 inch (14.28–15.87 mm) beyond housing.

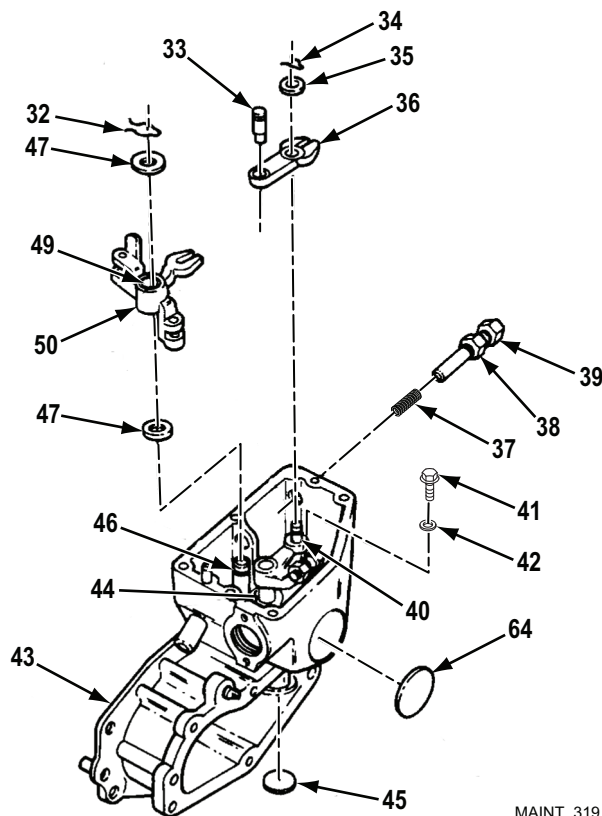


Figure 10. Governor Housing Installation.

**END OF TASK**

**FOLLOW ON TASK**

1. Install governor to blower assembly (WP 0062).
2. Install spring pack and governor cover (WP 0061).

**END OF TASK**

**END OF WORK PACKAGE**

---

**SUSTAINMENT MAINTENANCE  
FLYWHEEL HOUSING REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Sling, Multiple Leg (Cable)  
(WP 0104, Table 1, Item 94)  
Guide, Stud  
(WP 0081, Figure 16)  
Expander, Oil Seal, Rear  
(WP 0104, Table 1, Item 26)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Bolt, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 120)  
Bolt, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 154)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 83)  
Gasket (WP 0105, Table 1, Item 91)

**Materials/Parts (cont.)**

Gasket (WP 0105, Table 1, Item 100)  
Grease (WP 0103, Table 1, Item 18)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Washer, Lock  
Qty: (3) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (20) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed  
(models 5063-5393 and 5063-539L)  
(WP 0036)  
Mounting bracket and exhaust tubes removed  
(models 5063-5393 and 5063-539L)  
(WP 0038)  
Fuel pump removed (WP 0055)  
Tachometer drive adapter removed (WP 0059)  
Blower drive support removed (WP 0060)  
Oil pan removed (WP 0063)  
Flywheel removed (WP 0070)

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**REMOVAL**

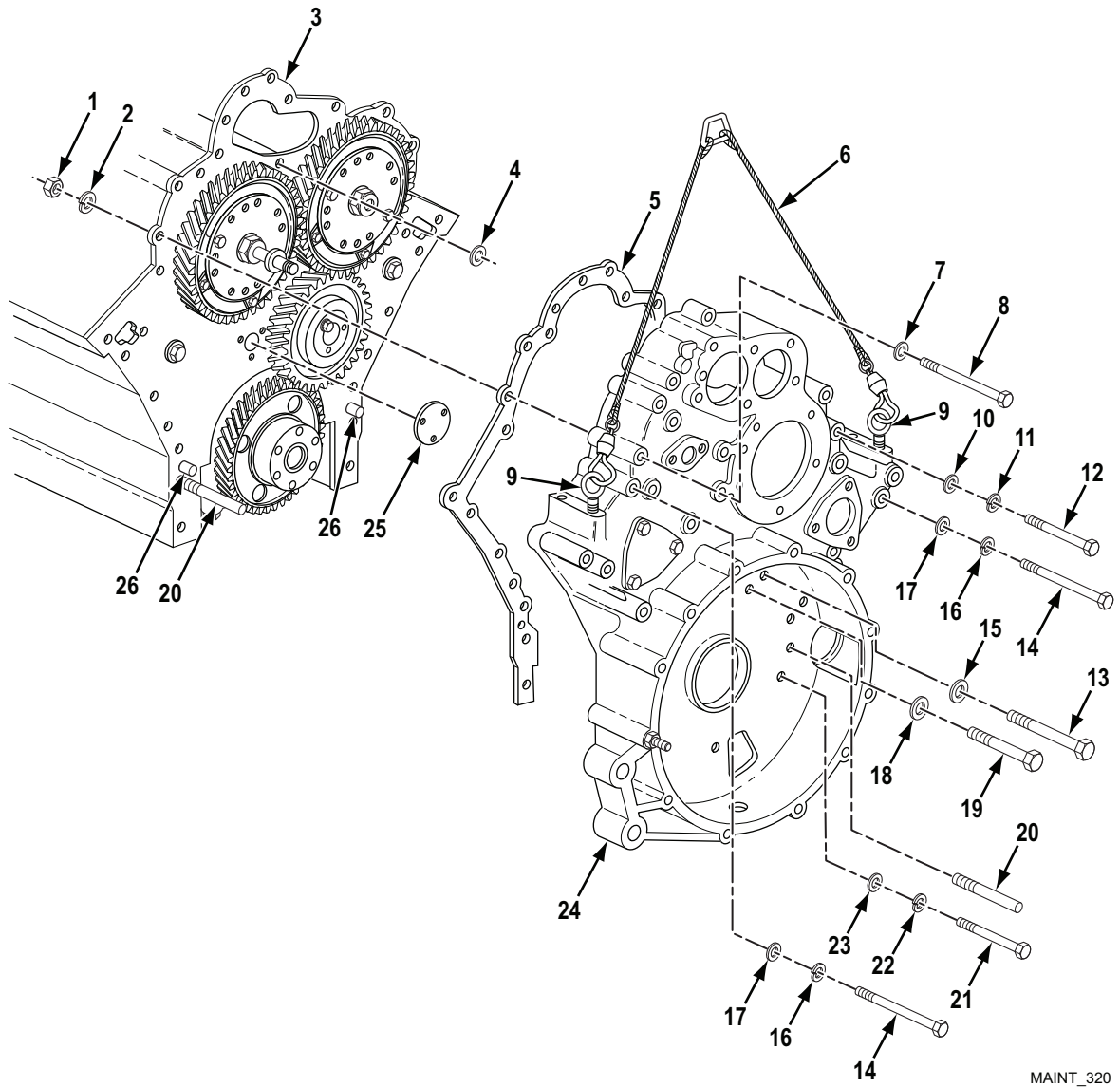
1. Thread two 3/8-16 eye bolts (Figure 1, Item 9) into tapped holes located in pads at sides of flywheel housing (Figure 1, Item 24). Attach sling (Figure 1, Item 6) to eye bolts.
2. Remove eight screws (Figure 1, Item 21), eight lockwashers (Figure 1, Item 22), and eight flat washers (Figure 1, Item 23) from area inside bell of flywheel housing (Figure 1, Item 24). Discard lockwashers.
3. Thread two studs (Figure 1, Item 20) into cylinder block inside bell area of flywheel housing (Figure 1, Item 24).
4. Remove two small self-locking bolts (Figure 1, Item 19), two flat washers (Figure 1, Item 18), four large self-locking bolts (Figure 1, Item 13), and four flat washers (Figure 1, Item 15) from area inside bell of flywheel housing (Figure 1, Item 24). Discard bolts.
5. Remove two screws (Figure 1, Item 12), two lockwashers (Figure 1, Item 11), and two flat washers (Figure 1, Item 10) from upper right side of flywheel housing (Figure 1, Item 24). Discard lockwashers.
6. Remove two nuts (Figure 1, Item 1), two lockwashers (Figure 1, Item 2), two screws (Figure 1, Item 8), and two flat washers (Figure 1, Item 7) from upper left side of flywheel housing (Figure 1, Item 24). Discard lockwashers.
7. Remove eight screws (Figure 1, Item 14), eight lockwashers (Figure 1, Item 16), and eight flat washers (Figure 1, Item 17) from sides of flywheel housing (Figure 1, Item 24). Discard lockwashers.

**WARNING**

Components of this engine are heavy and awkward to handle. Use correct lifting procedures, indicated lifting devices, and/or assistance from other personnel. Failure to comply may result in injury to personnel.

8. Strike front face of flywheel housing (Figure 1, Item 24) alternately on each side with a soft head hammer. Loosen housing and work off dowel pins (Figure 1, Item 26).
9. Guide flywheel housing (Figure 1, Item 24) off studs (Figure 1, Item 20) and remove from engine using sling (Figure 1, Item 6).
10. Remove sling (Figure 1, Item 6) and eye bolts (Figure 1, Item 9) from flywheel housing (Figure 1, Item 24).
11. Remove studs (Figure 1, Item 20) from cylinder block.
12. Remove flywheel housing gasket (Figure 1, Item 5), shim (Figure 1, Item 25), and gasket (Figure 1, Item 4) from end plate (Figure 1, Item 3). Discard gaskets.

REMOVAL - Continued



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Figure 1. Flywheel Housing Removal.

**REMOVAL - Continued**

13. Remove three bolts (Figure 2, Item 28), three lockwashers (Figure 2, Item 29), cover (Figure 2, Item 30), and gasket (Figure 2, Item 31) from left side of flywheel housing (Figure 2, Item 24). Discard gasket and lockwashers.
14. If required, remove dowel (Figure 2, Item 27) from upper part of flywheel housing (Figure 2, Item 24).
15. On models 5063-5393 and 5063-539L, remove elbow (Figure 2, Item 32) from left side of flywheel housing (Figure 2, Item 24).

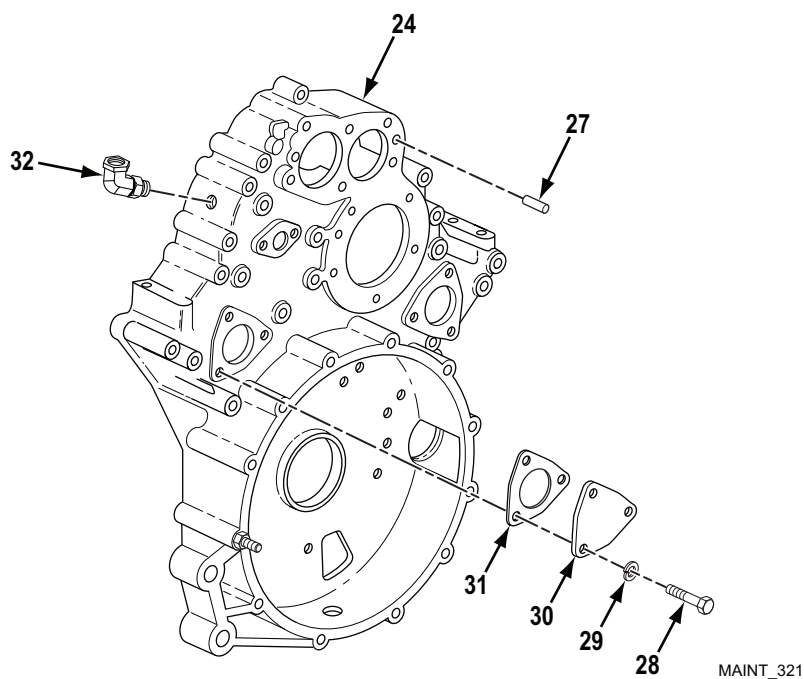
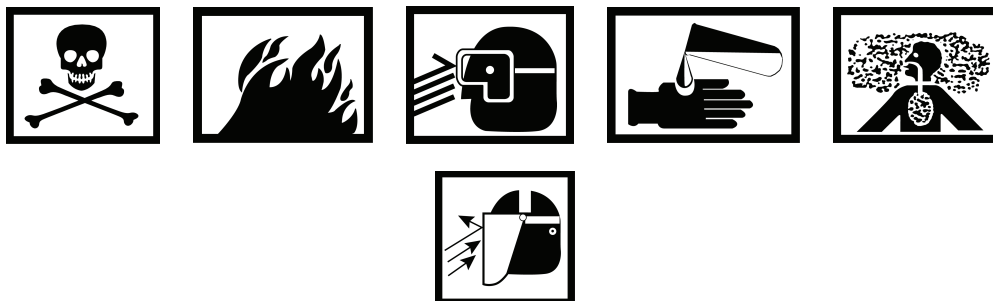


Figure 2. Flywheel Housing Disassembly/Assembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean flywheel housing with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

Inspect flywheel housing for cracks or damage.

**END OF TASK****INSTALLATION**

1. On models 5063-5393 and 5063-539L, install elbow (Figure 2, Item 32) in left side of flywheel housing (Figure 2, Item 24).
2. If removed, install dowel (Figure 2, Item 27) in upper part of flywheel housing (Figure 2, Item 24).
3. Install new gasket (Figure 2, Item 31), cover (Figure 2, Item 30), three new lockwashers (Figure 2, Item 29), and three bolts (Figure 2, Item 28) on left side of flywheel housing (Figure 2, Item 24). Torque bolts to 13–17 lb-ft (18–23 N·m).

**INSTALLATION - Continued**

4. Affix new flywheel housing gasket (Figure 3, Item 5) and new gasket (Figure 3, Item 4) to end plate (Figure 3, Item 3) using gasket adhesive. Install shim (Figure 3, Item 25) to end plate using grease to hold it in position.
5. Lubricate teeth on gear train with clean engine oil.
6. Thread two studs (Figure 3, Item 20) into rear of cylinder block.
7. Thread two 3/8-16 eye bolts (Figure 3, Item 9) into tapped holes located in pads at sides of flywheel housing (Figure 3, Item 24). Attach sling (Figure 3, Item 6) to eye bolts.
8. Install oil seal expander (Figure 3, Item 33) on end of crankshaft.
9. Position flywheel housing (Figure 3, Item 24) over two studs (Figure 3, Item 20) and end of crankshaft. Push housing over dowel pins (Figure 3, Item 26) and against end plate (Figure 3, Item 3).

**NOTE**

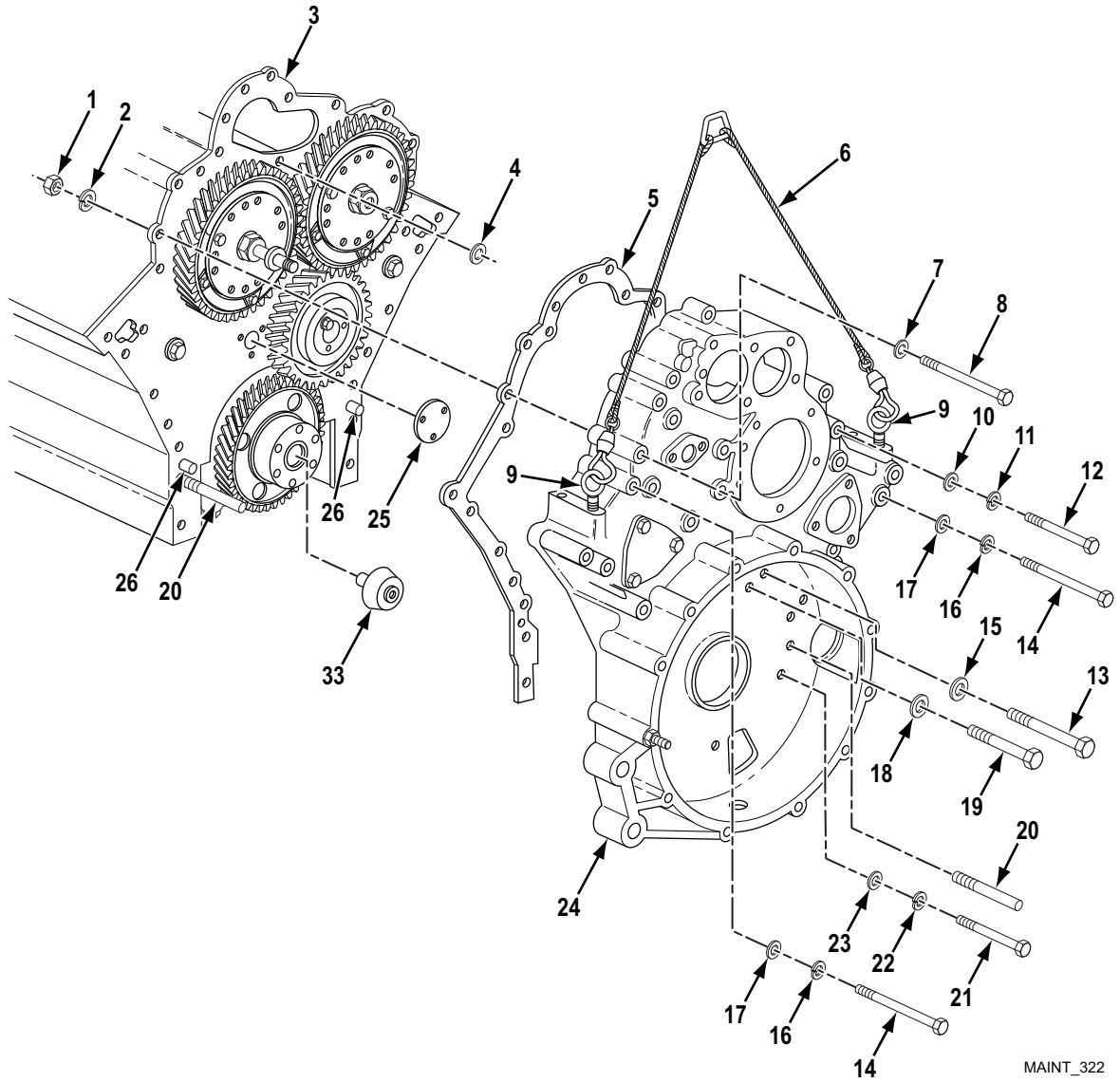
Install all flywheel housing fastening screws and bolts finger tight. Bolt and screw sizes for each location are shown in Table 1 and Figure 4.

Ensure shim (Figure 3, Item 25) is in position before installing any flywheel bolts or screws.

10. Install six flat washers (Figure 3, Item 23), six new lockwashers (Figure 3, Item 22), and six screws (Figure 3, Item 21) into bell area of flywheel housing (Figure 3, Item 24).
11. Remove two studs (Figure 3, Item 20) and install two flat washers (Figure 3, Item 23), two new lockwashers (Figure 3, Item 22), and two screws (Figure 3, Item 21).
12. Remove oil seal expander (Figure 3, Item 33), sling (Figure 3, Item 6), and two eye bolts (Figure 3, Item 9).
13. Trim ends of gasket (Figure 3, Item 5) level with cylinder block.
14. Install two flat washers (Figure 3, Item 18), two small new self-locking bolts (Figure 3, Item 19), four flat washers (Figure 3, Item 15), and four large new self-locking bolts (Figure 3, Item 13) into bell area of flywheel housing (Figure 3, Item 24).
15. Install two flat washers (Figure 3, Item 10), two new lockwashers (Figure 3, Item 11), and two screws (Figure 3, Item 12) to upper right side of flywheel housing (Figure 3, Item 24).
16. Install two flat washers (Figure 3, Item 7), two new lockwashers (Figure 3, Item 2), two screws (Figure 3, Item 8), and two nuts (Figure 3, Item 1) to upper left side of flywheel housing (Figure 3, Item 24).
17. Install eight new lockwashers (Figure 3, Item 16), eight flat washers (Figure 3, Item 17), and eight screws (Figure 3, Item 14) in sides of flywheel housing (Figure 3, Item 24).



INSTALLATION - Continued



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Figure 3. Flywheel Housing Installation.

INSTALLATION - Continued

Table 1. Flywheel Housing Bolt Sizes.

NUMBER	BOLT SIZE
8	3/8-24 X 3-1/2
12	3/8-24 X 3-1/4
13	3/8-16 X 2-1/2
14	3/8-16 X 3-3/4
19	5/16-18 X 2-1/2
21	3/8-16 X 2-1/2

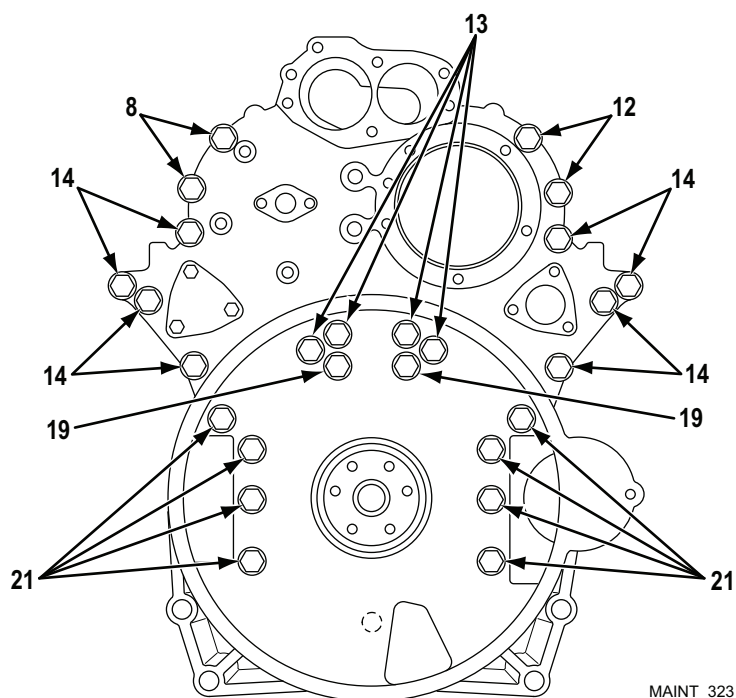


Figure 4. Flywheel Housing Bolt Requirements.

**NOTE**

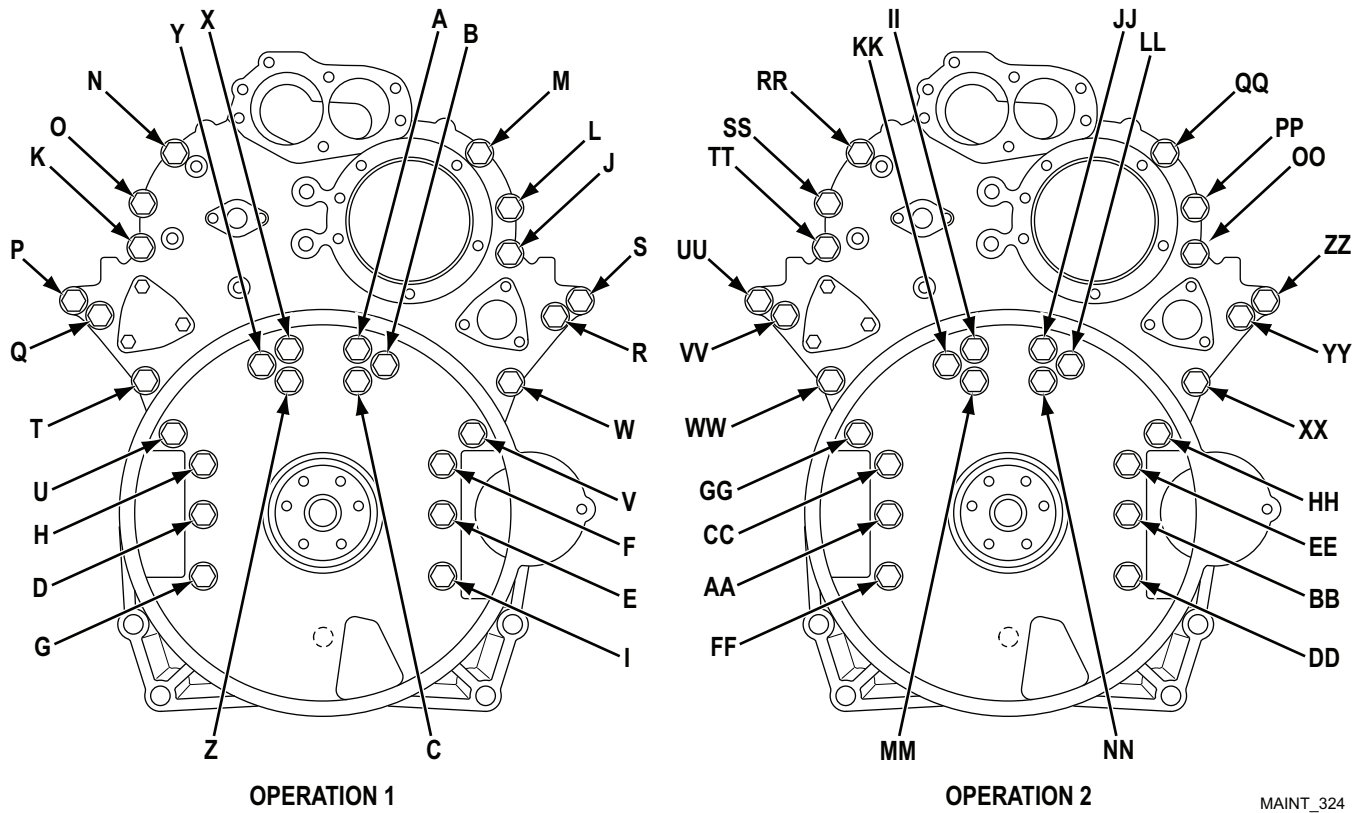
Always tighten flywheel housing screws and bolts in alphabetical order shown to ensure proper compression of flywheel gasket.

- 18. Tighten 26 flywheel housing screws and bolts snug in alphabetical order shown under OPERATION 1 (Figure 5).
- 19. Torque 26 flywheel housing screws and bolts in alphabetical order shown under OPERATION 2 (Figure 5) to values given in Table 2.

INSTALLATION - Continued

Table 2. Flywheel Housing Bolt Torques By Location.

OPERATION 2 BOLT LOCATION	TORQUE
AA thru HH	25–30 lb-ft (34–41 N·m)
II thru LL	40–45 lb-ft (54–61 N·m)
MM and NN	19–23 lb-ft (26–41 N·m)
OO thru ZZ	25–30 lb-ft (34–41 N·m)



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Figure 5. Flywheel Housing Torque Procedures.

END OF TASK

**FOLLOW ON TASK**

1. Install flywheel (WP 0070).
2. Install oil pan (WP 0063).
3. Install blower drive support (WP 0060).
4. Install tachometer drive adapter (WP 0059).
5. Install fuel pump (WP 0055).
6. Install mounting bracket and exhaust tubes (models 5063-5393 and 5063-539L) (WP 0038).
7. Install turbocharger (models 5063-5393 and 5063-539L) (WP 0036).

**END OF TASK****END OF WORK PACKAGE**

---

**SUSTAINMENT MAINTENANCE**  
**LOWER FRONT COVER, OIL PUMP, AND OIL PRESSURE REGULATOR REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Insertor, Seal (Crankshaft Oil, Front)  
(WP 0104, Table 1, Item 58)  
Gage Set, Depth, Micrometer  
(WP 0104, Table 1, Item 44)  
Guide Stud  
(WP 0081, Figure 3)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Adhesive, Retaining (WP 0103, Table 1, Item 2)  
Bearing, Sleeve (WP 0105, Table 1, Item 82)  
Crocus Cloth (WP 0103, Table 1, Item 10)  
Gasket (WP 0105, Table 1, Item 57)  
Gasket (WP 0105, Table 1, Item 70)  
Grease (WP 0103, Table 1, Item 18)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Plug (WP 0105, Table 1, Item 85)  
Sealing Compound (WP 0103, Table 1, Item 52)  
Seal, Plain Encased (Model 5063-5299)  
(WP 0105, Table 1, Item 48)  
Seal, Plain Encased (All Except Model 5063-5299)  
(WP 0105, Table 1, Item 84)  
Screw, Drive  
Qty: (2) (WP 0105, Table 1, Item 172)  
Screw, Self-Tapping  
Qty: (2) (WP 0103, Table 1, Item 50)  
Stone, Sharpening (WP 0103, Table 1, Item 61)

**Materials/Parts (cont.)**

Stone, Sharpening X-Fine  
(WP 0103, Table 1, Item 62)  
Washer, Flat  
Qty: (2) (WP 0105, Table 1, Item 115)  
Washer, Flat Qty: (2) (WP 0103, Table 1, Item 68)  
Washer, Lock  
Qty: (8) (WP 0105, Table 1, Item 178)  
Washer, Lock  
Qty: (12) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Engine front mounting bracket removed  
(models 5063-5393, 5063-539L) (WP 0041)  
Fuel line clip and solenoid valve bracket removed  
(models 5063-5299) (WP 0042)  
Fuel line clip and solenoid valve bracket removed  
(model 5063-5392) (WP 0043)  
Oil pan removed (WP 0063)  
Oil pump inlet and outlet tubes removed  
(model 5063-5299) (WP 0064)  
Oil pump inlet and outlet tubes removed  
(all except model 5063-5299) (WP 0065)  
Crankshaft spacer removed  
(models 5063-5299, 5063-5393, 5063-539L)  
(WP 0066)  
Crankshaft hub or pulley removed  
(models 5063-5392) (WP 0067)  
Engine front support removed (model 5063-5299)  
(WP 0068)  
Engine front support removed (model 5063-5392)  
(WP 0069)

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**REMOVAL****NOTE**

On models 5063-5393 and 5063-539L, four screws (Figure 1, Item 13) were removed with front support.

On all except models 5063-5393 and 5063-539L, one screw (Figure 1, Item 11) was removed at location (Figure 1, Item A) with a fuel line clip.

1. Remove four long screws (Figure 1, Item 13), four mid-sized screws (Figure 1, Item 11), four short screws (Figure 1, Item 1), 12 lockwashers (Figure 1, Item 2), and 12 flat washers (Figure 1, Item 3) fastening front cover (Figure 1, Item 10) to cylinder block (Figure 1, Item 5). Discard lockwashers.
2. Strike front cover (Figure 1, Item 10) on sides with soft head hammer to free it. Pull cover straight off crankshaft (Figure 1, Item 6). Remove spacer ring (Figure 1, Item 12) from cover.
3. Remove and discard cover gasket (Figure 1, Item 4).

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L do not use lockwashers (Figure 1, Item 8).

4. Remove six self-locking bolts (Figure 1, Item 7), six lockwashers (Figure 1, Item 8), and oil pump assembly (Figure 1, Item 9) from front cover (Figure 1, Item 10). Discard lockwashers.

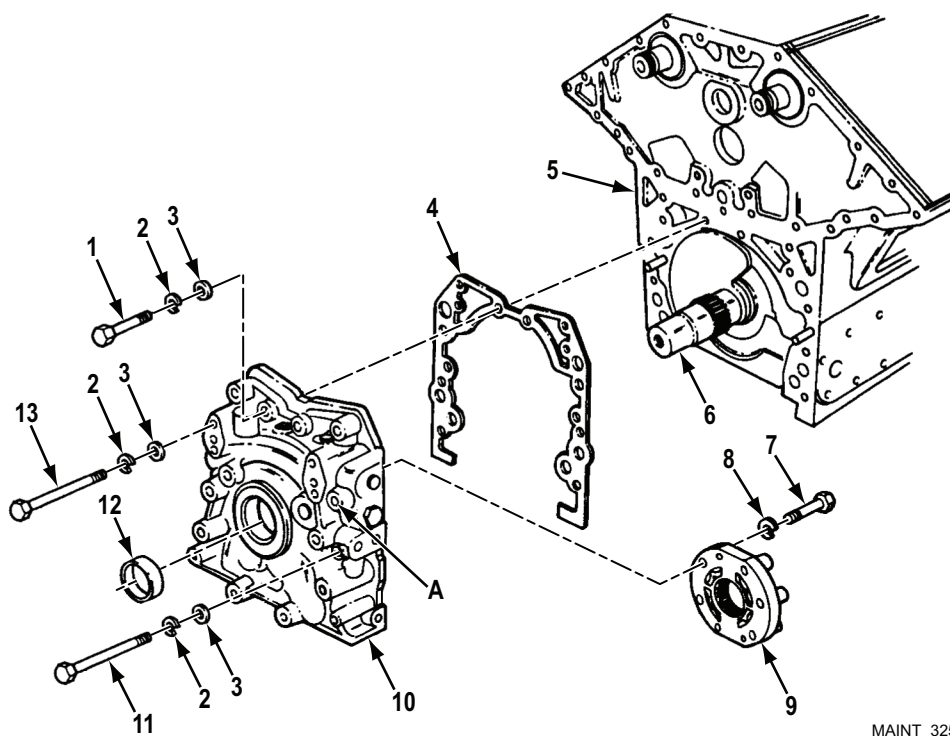


Figure 1. Front Cover Removal.

**END OF TASK**

**DISASSEMBLY**

1. Oil pump assembly:
  - a. Using small punch, drive out two drive screws (Figure 2, Item 14) and remove cover plate (Figure 2, Item 15) from pump housing (Figure 2, Item 18). Discard screws.
  - b. Remove inner rotor (Figure 2, Item 16) and outer rotor (Figure 2, Item 17) from pump housing (Figure 2, Item 18).

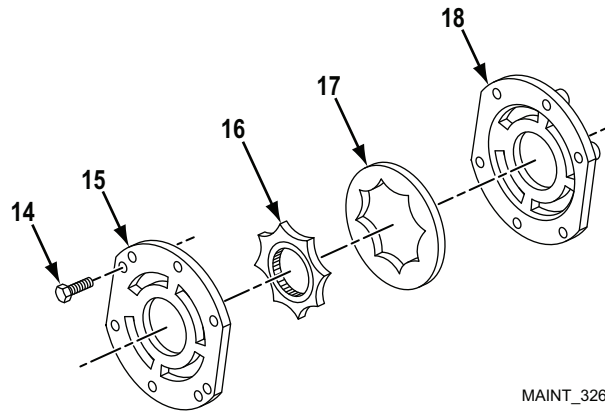


Figure 2. Oil Pump Disassembly.

**DISASSEMBLY - Continued**

## 2. Front cover assembly removal procedures:

- a. Remove plug (Figure 3, Item 33), plug (Figure 3, Item 24), two copper flat washers (Figure 3, Item 23), two springs (Figure 3, Item 22), and two sleeves (Figure 3, Item 25) from sides of front cover (Figure 3, Item 10). Discard copper flat washers.

**NOTE**

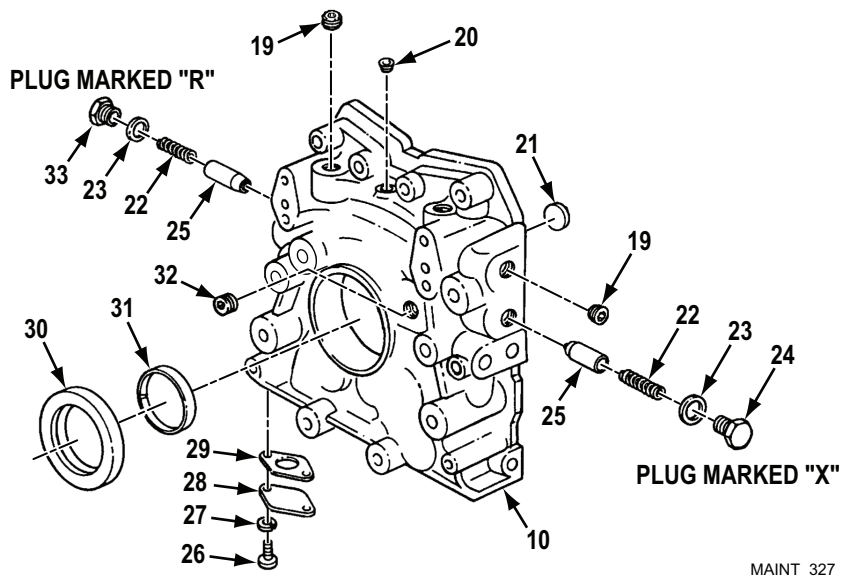
Model 5063-5299 does not use cover plate (Figure 3, Item 28) or fastening hardware.

- b. Remove two screws (Figure 3, Item 26), two lockwashers (Figure 3, Item 27), cover plate (Figure 3, Item 28), and gasket (Figure 3, Item 29) from bottom of front cover (Figure 3, Item 10). Discard gasket and lockwashers.
- c. For model 5063-5299: if necessary, remove two plugs (Figure 3, Item 19) and plug (Figure 3, Item 32) from front cover (Figure 3, Item 10).
- d. For all except model 5063-5299: if necessary, remove four plugs (Figure 3, Item 19), plug (Figure 3, Item 32), plug (Figure 3, Item 20), and cup plug (Figure 3, Item 21) from front cover (Figure 3, Item 10). Discard cup plug.
- e. Drill two holes in opposite sides of casing of oil seal (Figure 3, Item 30). Thread metal screws with flat washers into casing. Pry against flat washers and remove oil seal. Discard seal.

**NOTE**

Model 5063-5299 does not use sleeve bearing (Figure 3, Item 31).

- f. Press or drive sleeve bearing (Figure 3, Item 31) from bore in front cover (Figure 3, Item 10). Discard bearing.

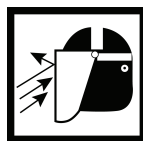


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Figure 3. Front Cover Disassembly.

**END OF TASK**



**CLEANING****WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash all parts in fuel oil and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect lobes and faces of oil pump rotors for scratches or burrs, and surfaces of pump housing and cover for scoring. Remove scratches or score marks with sharpening stone.
2. Inspect splines of inner oil pump rotor for excessive wear.
3. Inspect regulator valve and by-pass valve for wear or damage. Valve must move freely in bore. If valve is scored, clean up with crocus cloth.
4. Inspect valve springs for pitting and fractured coils.
5. Inspect lower front cover for cracks at oil seal bore and valve bores.
6. Inspect plug threads. Threads are acceptable, provided there is no damage that would allow leakage and no blockage of internal passages with plug installed in hole.

**NOTE**

Models 5063-5299 has a gear rotor thickness of 1 inch (25.4 mm). Models 5063-5392, 5063-5393, and 5063-539L have a gear rotor thickness of 1-1/4 inch (31.75 mm).

7. Using micrometer depth gage set (Figure 4, Item 34), measure clearance from face of pump housing (Figure 4, Item 18) to face of inner rotor (Figure 4, Item 16) and to outer rotor (Figure 4, Item 17). Clearance should be 0.001–0.0035 inch (0.03–0.09 mm).
8. Measure clearance between inner rotor (Figure 4, Item 16) and outer rotor (Figure 4, Item 17) at each lobe. Clearance should be 0.0005–0.011 inch (0.013–0.28 mm).

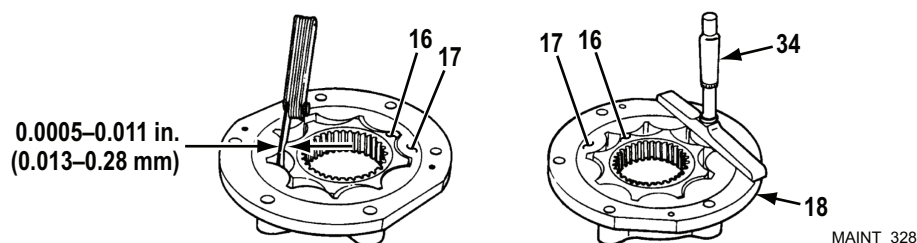


Figure 4. Oil Pump Inspection.

**END OF TASK**

**ASSEMBLY**

1. Front cover assembly:

**NOTE**

Model 5063-5299 does not use sleeve bearing (Figure 5, Item 31).

- a. Coat bore of front cover (Figure 5, Item 10) with retaining adhesive and position new sleeve bearing (Figure 5, Item 31) in cover with split line at bottom. Press bearing into cover until flush to 0.015 inch (0.381 mm) below outer face.

**NOTE**

If oil seal is not precoated, apply sealing compound to outside diameter of metal casing.

- b. Position new oil seal (Figure 5, Item 30) in front cover (Figure 5, Item 10) with seal lip pointed toward inner face of cover.
- c. Using oil seal installer (Figure 5, Item 35), press new oil seal (Figure 5, Item 30) into front cover (Figure 5, Item 10) until flush with outside face.
- d. For all except model 5063-5299: if removed, install four plugs (Figure 5, Item 19), plug (Figure 5, Item 32), plug (Figure 5, Item 20), and new cup plug (Figure 5, Item 21) into front cover (Figure 5, Item 10).
- e. For model 5063-5299: if removed, install two plugs (Figure 5, Item 19) and plug (Figure 5, Item 32) into front cover (Figure 5, Item 10).

**NOTE**

Model 5063-5299 does not use cover plate (Figure 5, Item 28) or fastening hardware.

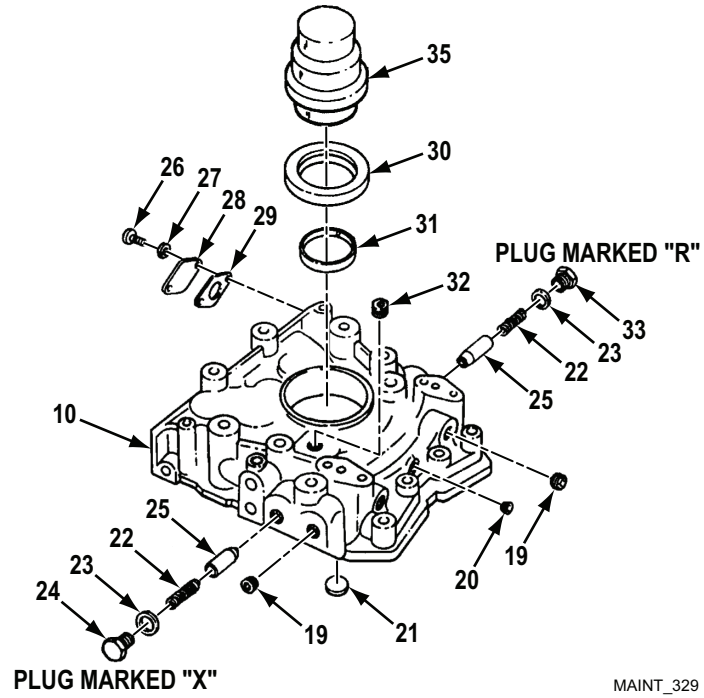
- f. Install new gasket (Figure 5, Item 29), cover plate (Figure 5, Item 28), two new lockwashers (Figure 5, Item 27), and two screws (Figure 5, Item 26) to bottom of front cover (Figure 5, Item 10). Torque screws to 13–17 lb-ft (18–23 N·m).

**NOTE**

Install plug marked "R" on left side of front cover and plug marked "X" on right side of front cover (as viewed from the front).

- g. Install two sleeves (Figure 5, Item 25), two springs (Figure 5, Item 22), two new copper flat washers (Figure 5, Item 23), plug (Figure 5, Item 33), and plug (Figure 5, Item 24) in sides of front cover (Figure 5, Item 10). Torque plugs to 30–40 lb-ft (41–54 N·m).

ASSEMBLY - Continued

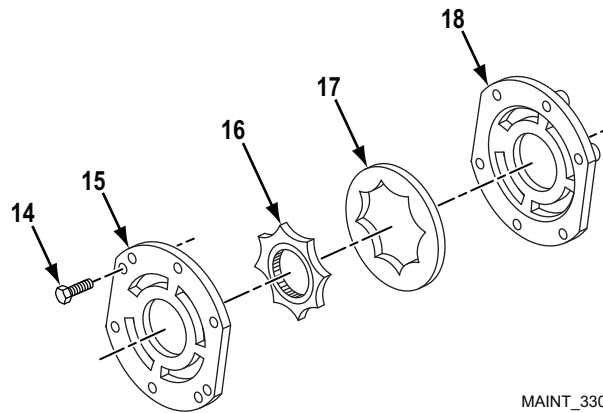


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Figure 5. Front Cover Assembly.

**ASSEMBLY - Continued**

2. Oil pump assembly:
  - a. Lubricate oil pump outer rotor (Figure 6, Item 17) and inner rotor (Figure 6, Item 16) with engine oil and place in pump housing (Figure 6, Item 18).
  - b. Place cover plate (Figure 6, Item 15) on pump housing (Figure 6, Item 18). Align bolt holes and drive screw holes with holes in pump housing.
  - c. Install cover plate (Figure 6, Item 15) and two new drive screws (Figure 6, Item 14) on pump housing (Figure 6, Item 18).



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Figure 6. Oil Pump Assembly.

**END OF TASK**

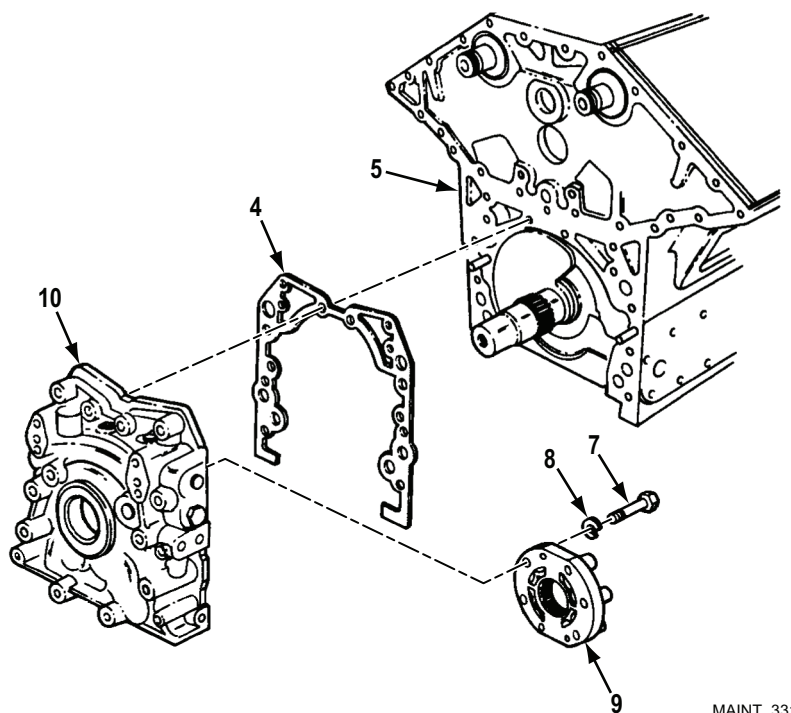
**INSTALLATION**

1. Place oil pump assembly (Figure 7, Item 9) in rear of front cover (Figure 7, Item 10) with markings "UP R.H." at top of front cover.

**NOTE**

Models 5063-5392, 5063-5393, and 5063-539L do not use lockwashers (Figure 7, Item 8).

2. Install six new lockwashers (Figure 7, Item 8) and six self-locking bolts (Figure 7, Item 7) in oil pump assembly (Figure 7, Item 9) and front cover (Figure 7, Item 10). Torque bolts to 13–17 lb-ft (18–23 N·m).
3. Using gasket adhesive, install new gasket (Figure 7, Item 4) on cylinder block (Figure 7, Item 5).



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Figure 7. Front Cover Oil Pump Installation.

4. Thread two guide studs (Figure 7, Item 36) into diametrically opposite bolt holes in cylinder block.
5. Apply light coat of grease to lip of oil seal (Figure 7, Item 30).
6. Slide front cover (Figure 7, Item 10) over guide studs (Figure 7, Item 36) until inner oil pump rotor (Figure 7, Item 16) contacts oil pump drive gear (Figure 7, Item 38) on crankshaft (Figure 7, Item 6).

**INSTALLATION - Continued**

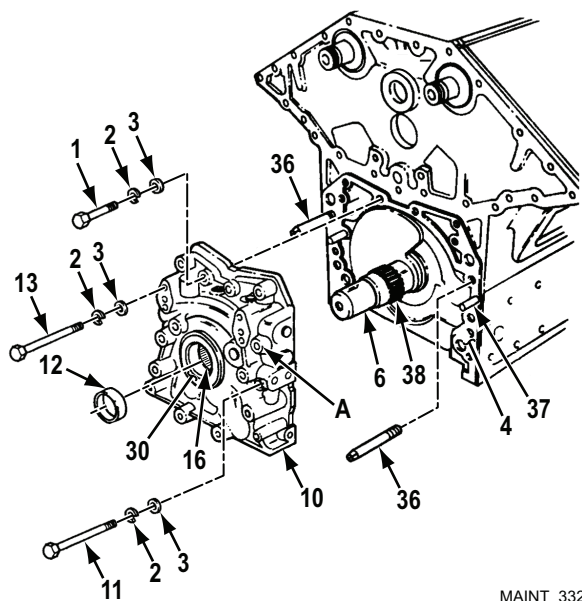
7. Remove guide studs (Figure 8, Item 36) and rotate front cover (Figure 8, Item 10) slightly to engage teeth, then align cover with dowel pins (Figure 8, Item 37) on cylinder block and slide cover up against gasket (Figure 8, Item 4).

**NOTE**

On models 5063-5393 and 5063-539L, do not install four screws (Figure 8, Item 13) because of front support installation.

On 5063-5299, 5063-5393, do not install screw (Figure 8, Item 11) at location (Figure 8, Item A) because of fuel line clip installation.

8. Install 12 flat washers (Figure 8, Item 3), 12 new lockwashers (Figure 8, Item 2), four long screws (Figure 8, Item 13), four mid-sized screws (Figure 8, Item 11), and four short screws (Figure 8, Item 1) on front cover (Figure 8, Item 10).
9. Install spacer ring (Figure 8, Item 12) on crankshaft (Figure 8, Item 6) with bevel toward cylinder block and push spacer ring into oil seal (Figure 8, Item 30).
10. Torque front cover screws (Figure 8, Item 13, 11, and 1) to 30–35 lb-ft (41–47 N·m).
11. Trim excess material from gasket (Figure 8, Item 4) level to cylinder block.



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Figure 8. Front Cover Installation.

**END OF TASK****FOLLOW ON TASK**

1. Install engine front support (model 5063-5392) (WP 0069).
2. Install engine front support (model 5063-5299) (WP 0068).
3. Install crankshaft hub or pulley (models 5063-5392) (WP 0067).

**FOLLOW ON TASK - Continued**

4. Install crankshaft spacer (models 5063-5299, 5063-5393, and 5063-539L) (WP 0066).
5. Install oil pump inlet and outlet tubes (all except model 5063-5299) (WP 0065).
6. Install oil pump inlet and outlet tubes (model 5063-5299) (WP 0064).
7. Install oil pan (WP 0063).
8. Install fuel line clip and solenoid valve bracket (model 5063-5392) (WP 0043).
9. Install fuel line clip and solenoid valve bracket (model 5063-5299) (WP 0042).
10. Install engine front mounting bracket (models 5063-5393 and 5063-539L) (WP 0041).

**END OF TASK****END OF WORK PACKAGE**





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**SUSTAINMENT MAINTENANCE  
UPPER FRONT COVER REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)  
Insertor, Seal (Front Cover)  
(WP 0104, Table 1, Item 60)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 69)  
Grease (WP 0103, Table 1, Item 18)  
Pin, Dowel Qty: (2) (WP 0105, Table 1, Item 97)  
Plug, Expansion  
Qty: (2) (WP 0105, Table 1, Item 92)  
Seal, Plain Encased  
Qty: (2) (WP 0105, Table 1, Item 38)  
Sealing Compound (WP 0103, Table 1, Item 52)

**Materials/Parts (cont.)**

Washer, Lock  
Qty: (23) (WP 0105, Table 1, Item 23)  
Wood Block (WP 0103, Table 1, Item 71)

**Equipment Condition**

Air box heater hardware removed  
(model 5063-5299) (WP 0042)  
Air box heater hardware removed  
(model 5063-5392) (WP 0043)  
Air box heater hardware removed  
(model 5063-5393) (WP 0044)  
Glow plug controller, bracket, and harnesses  
removed (model 5063-539L) (WP 0045)  
Air box heater removed (WP 0046)  
Fan support bracket removed (model 5063-5392)  
(WP 0069)

**REMOVAL****NOTE**

To remove camshaft nuts with flywheel housing on engine, secure flywheel or crankshaft to prevent camshaft gears from turning.

To remove camshaft nuts with flywheel housing removed, wedge a rag between camshaft gears.

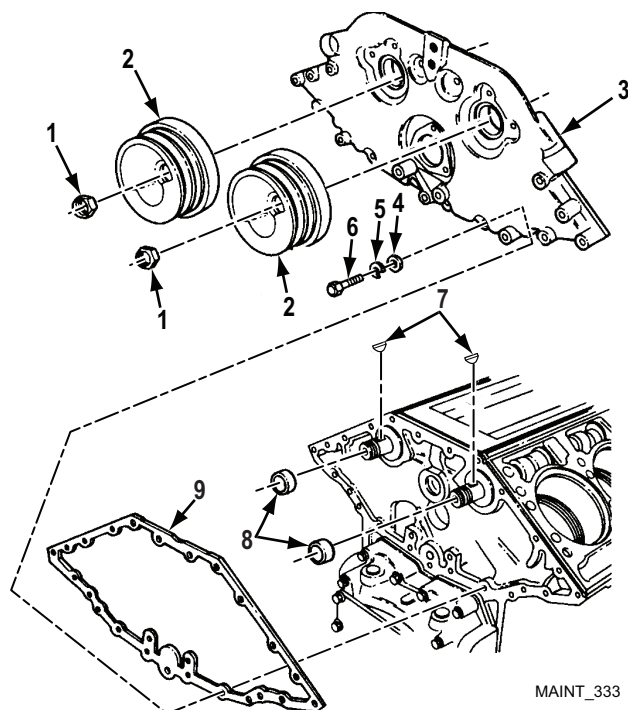
1. Remove two nuts (Figure 1, Item 1) from front end of camshafts using 100–500 lb-ft torque wrench.
2. Using two pry bars between pulley (Figure 1, Item 2) and front cover (Figure 1, Item 3), pry two pulleys off shafts.

**NOTE**

Several front cover fastening bolts were removed during removal of clips, water pump idler pulley assembly, solenoid bracket, and fan support bracket.

Quantity and length of bolts vary with engine model. Size and location of bolts for each model is noted in Table 1 for installation.

3. Remove all bolts (Figure 1, Item 6), lockwashers (Figure 1, Item 5), and flat washers (Figure 1, Item 4) fastening upper front cover (Figure 1, Item 3) to cylinder block. Discard lockwashers.
4. Using soft head hammer, tap front cover (Figure 1, Item 3) away from cylinder block. Remove front cover and gasket (Figure 1, Item 9). Discard gasket.
5. Remove two Woodruff keys (Figure 1, Item 7) and two oil seal spacers (Figure 1, Item 8) from camshafts.



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Figure 1. Upper Front Cover Removal.

**END OF TASK**

**DISASSEMBLY**

1. If required, remove two dowel pins (Figure 2, Item 11) and two expansion plugs (Figure 2, Item 10) from front cover (Figure 2, Item 3). Discard plugs and pins.

**NOTE**

To remove oil seal with upper front cover installed, drill two holes in opposite sides of casing of oil seal. Thread sheet metal screws with flat washers into casing, and pry against flat washers until seals are removed.

2. Place inner face of front cover (Figure 2, Item 3) on wood blocks. Drive out two oil seals (Figure 2, Item 12). Discard seals.

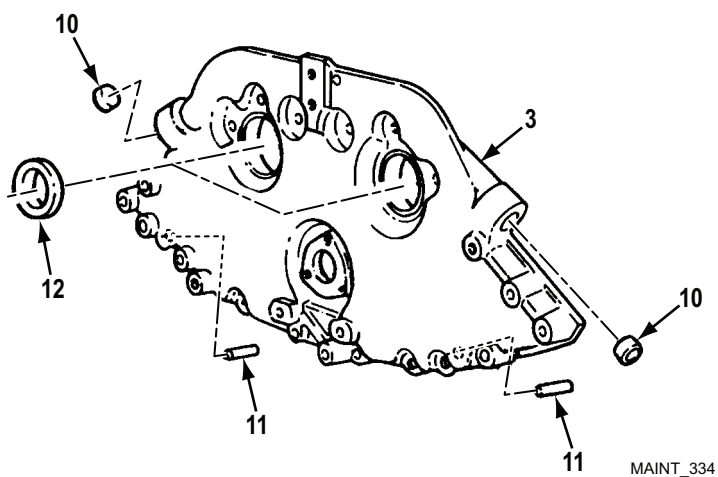
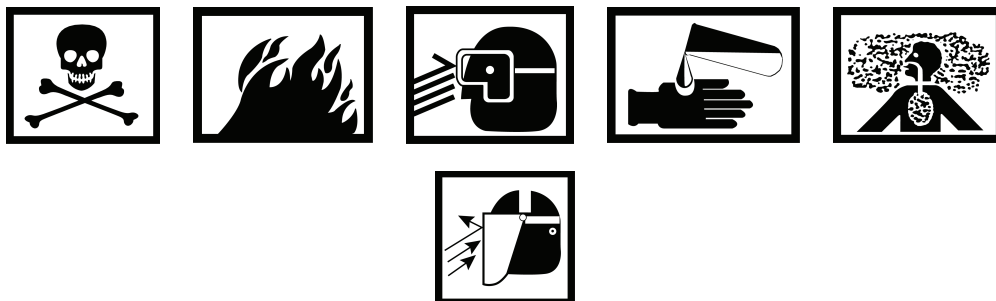


Figure 2. Upper Front Cover Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean front cover with cleaning solvent and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect seals and seal spacers for wear or damage.
2. Inspect pulleys for evidence of cracks, chips, or broken areas. A crack, chip, or broken area on the belt grooves is acceptable provided the damage does not exceed 305 arc and the pulley is installed on the right camshaft.

**END OF TASK****ASSEMBLY**

1. Install new oil seals in following manner:

**NOTE**

If outside diameter of oil seal is not precoated, coat seal bore in front cover with sealing compound.

- a. Place inner face of front cover (Figure 3, Item 3) on wooden blocks.
  - b. Place new oil seal (Figure 3, Item 12) on cover (Figure 3, Item 3) with lip of seal pointing toward inner face of cover. Using seal inserter (Figure 3, Item 13), press seal into cover until flush with bottom of counterbore.
  - c. If necessary, remove excess sealing compound from cover and seal.
2. If removed, apply sealing compound to two new expansion plugs (Figure 3, Item 10) and press into front cover (Figure 3, Item 3) until flush with face of bore.

**ASSEMBLY - Continued**

3. If removed, press two new dowel pins (Figure 3, Item 11) into front cover (Figure 3, Item 3) until pins protrude 3/8 inch (9.53 mm).

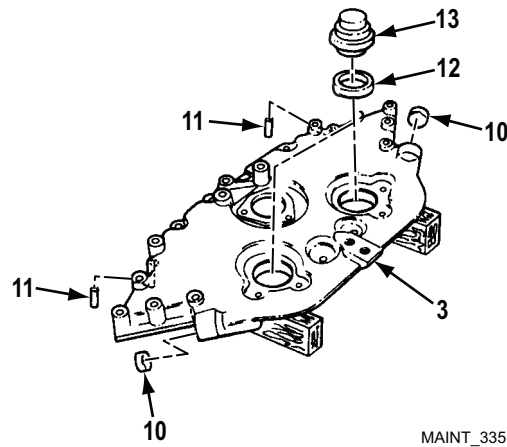


Figure 3. Upper Front Cover Assembly.

**END OF TASK****INSTALLATION**

1. Install new gasket (Figure 4, Item 9) to upper front cover (Figure 4, Item 3) with new gasket adhesive.

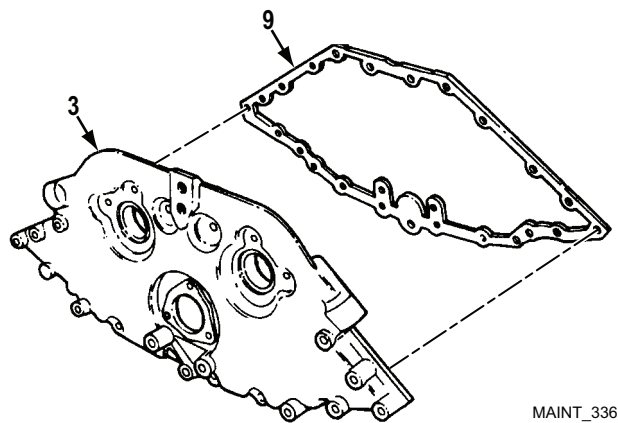


Figure 4. Upper Front Cover Installation.

**INSTALLATION - Continued****NOTE**

Several front cover fastening bolts are installed with installation of clips, water pump idler pulley assembly, solenoid bracket, and fan support bracket (WP 0042) , (WP 0043) , (WP 0044) , (WP 0046) , and (WP 0069). See Table 1 for bolt sizes and locations.

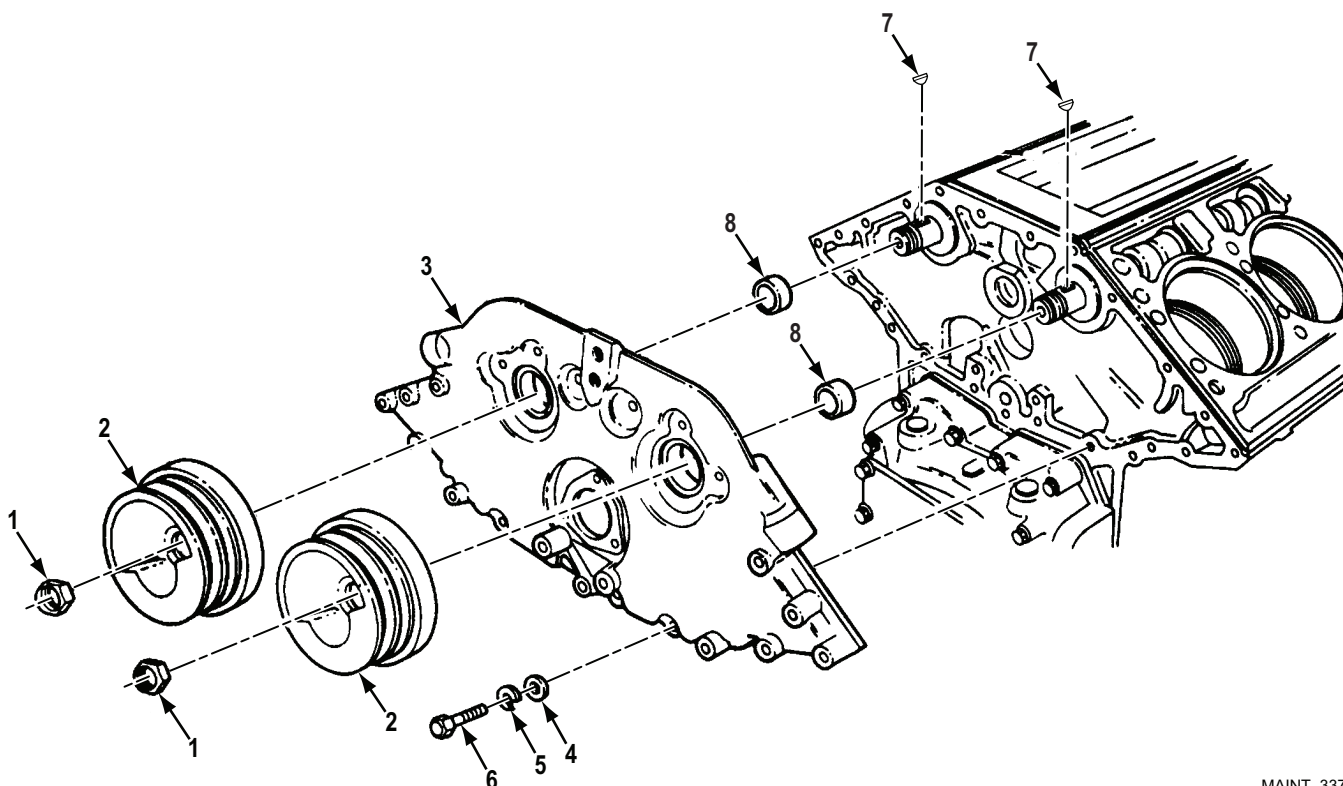
2. Install upper front cover (Figure 5, Item 3), flat washers (Figure 5, Item 4), new lockwashers (Figure 5, Item 5), and bolts (Figure 5, Item 6) on cylinder block. Torque bolts to 30–35 lb-ft (41–47 N·m).
3. Apply grease to outside diameter of two seal spacers (Figure 5, Item 8) and slide in position on camshafts.
4. Install two Woodruff keys (Figure 5, Item 7) in slot at end of camshafts.
5. Align keyway in pulley with Woodruff key (Figure 5, Item 7). Slide two pulleys (Figure 5, Item 2) on ends of camshafts.

**NOTE**

To tighten and torque camshaft nuts with flywheel housing on engine, secure flywheel or crankshaft to prevent camshaft gears from turning.

To tighten and torque camshaft nuts with flywheel housing removed, wedge a rag between camshaft gears.

6. Install two nuts (Figure 5, Item 1) on camshafts and torque to 300–325 lb-ft (407–441 N·m).



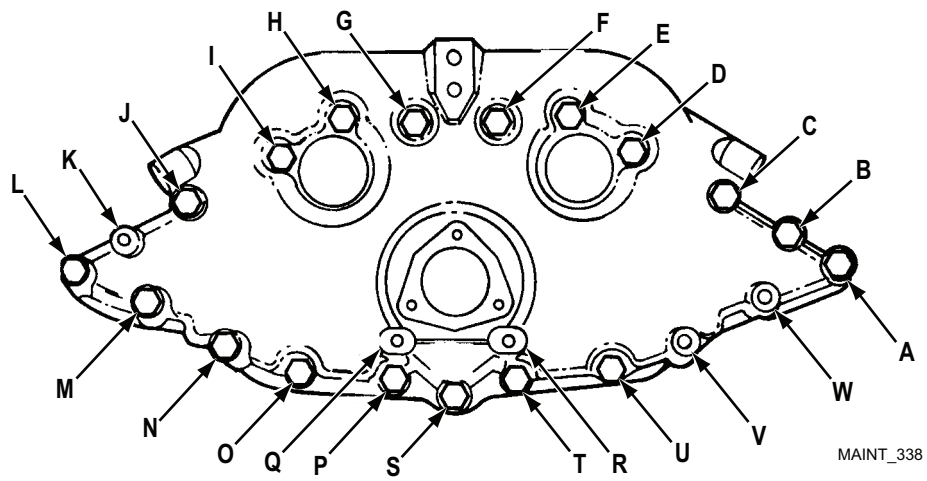
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Figure 5. Upper Cam Shaft Pulley Installation.

INSTALLATION - Continued

Table 1. Upper Front Cover Bolt Size and Location.

HOLE	MODEL 5036-5299	MODEL 5063-5392	MODELS 5063-5393 and 5063-539L
A,M	3/8-16 X 2 1/4	3/8-16 X 2 1/4	—
B,J	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/4
C	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/4
D,E,H,I,U	3/8-16 X 1 5/8	3/8-16 X 1 5/8	3/8-16 X 1 5/8
F,G,O,P,T	3/8-16 X 1 5/8	3/8-16 X 1 5/8	3/8-16 X 1 5/8
K	—	3/8-16 X 2 1/4	3/8-16 X 2 1/4
L	3/8-16 X 2 1/4	—	—
N	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/4
Q,R	—	3/8-16 X 2 1/4	—
S	3/8-16 X 1 5/8	3/8-16 X 1 5/8	3/8-16 X 1 5/8
V,W	—	—	—



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Figure 6. Upper Front Cover Bolt Sizes.

END OF TASK

**FOLLOW ON TASK**

1. Install fan support bracket (model 5063-5392) (WP 0069).
2. Install air box heater (WP 0046).
3. Install glow plug controller, bracket, and harnesses (model 5063-539L) (WP 0045).
4. Install air box heater hardware (model 5063-5393) (WP 0044).
5. Install air box heater hardware (model 5063-5392) (WP 0043).
6. Install air box heater hardware (model 5063-5299) (WP 0042).

**END OF TASK****END OF WORK PACKAGE**



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**SUSTAINMENT MAINTENANCE  
FUEL PUMP AND HYDRAULIC PUMP DRIVE ASSEMBLIES REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)

**Materials/Parts (cont.)**

Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)

**Equipment Condition**

Flywheel housing removed (WP 0088)

**Materials/Parts**

Bolt, Self-locking  
Qty: (2) (WP 0105, Table 1, Item 149)  
Bolt, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 121)

---

**REMOVAL****NOTE**

All models have a fuel pump drive assembly on the right side. Only models 5063-5393 and 5063-539L have a hydraulic pump drive assembly on the left side. Repeat the same procedures on the left side for the hydraulic pump drive assembly replacement.

1. Remove two self-locking bolts (Figure 1, Item 8) and adapter (Figure 1, Item 7) from drive gear (Figure 1, Item 4). Discard self-locking bolts.
2. Remove self-locking bolt (Figure 1, Item 6), flat washer (Figure 1, Item 5), two thrust washers (Figure 1, Item 2), gear (Figure 1, Item 4), and hub (Figure 1, Item 3) from end plate. Discard self-locking bolt.

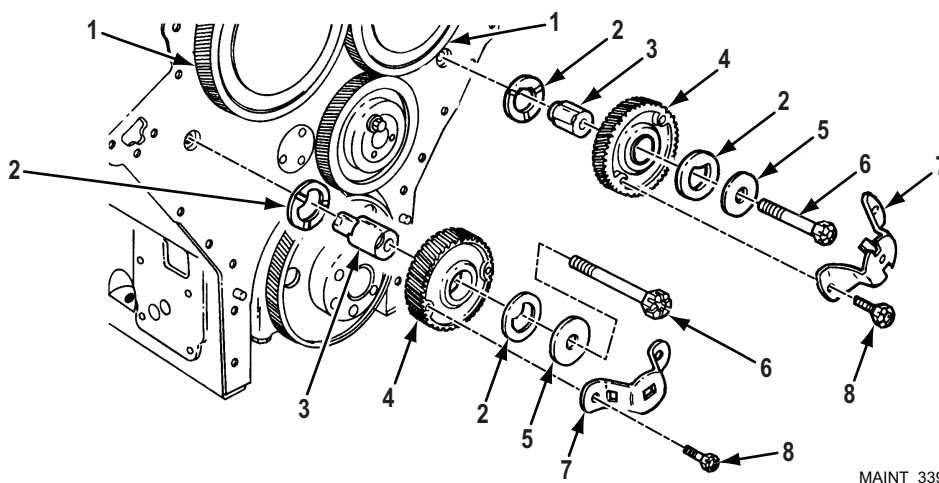
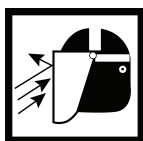


Figure 1. Fuel Pump Drive Removal/Installation.

**END OF TASK****CLEANING****WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Wash gear, hub, and flat washers in fuel oil and dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect thrust washers, hub, and drive gear bearing for wear and scoring.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

2. Examine gear teeth for wear, scoring, and pitting.
3. Measure gear bearing, hub, and thrust washers for repair standards (Table 1).

**END OF TASK****INSTALLATION****Table 1. Repair Standards for Drive Gear Assemblies.**

POINT OF MEASUREMENT	SIZE OF NEW PARTS	WEAR LIMIT
ID of Gear Bearing	1.1205–1.1220 in. (28.461–28.499 mm)	1.1230 in. (28.524 mm)
OD of Hub	1.1205–1.1220 in. (28.461–28.499 mm)	1.1200 in. (28.448 mm)
Bearing to Hub Clearance	0.0015–0.0030 in. (0.038–0.076 mm)	0.0070 in. (0.178mm)
Thrust Washer Thickness	0.1580–0.1600 in. (4.013–4.064 mm)	0.156 in. (3.962 mm)
Gear End Play	0.0040–0.0140 in. (0.102–0.356 mm)	—

1. Lubricate drive gear bearing, thrust washers, and hub with engine oil.

**NOTE**

Oil grooves on thrust washers must face toward gear.

2. Place inner thrust washer (Figure 1, Item 2) on small diameter of hub (Figure 1, Item 3). Slide drive gear (Figure 1, Item 4) and outer thrust washer (Figure 1, Item 2) over larger diameter of hub.
3. Install small diameter of hub (Figure 1, Item 3) in counterbore in end plate with flat on outside diameter of hub engaging flat in hole. Mesh teeth on drive gear with teeth on camshaft gear (Figure 1, Item 1).
4. Install flat washer (Figure 1, Item 5) and new self-locking bolt (Figure 1, Item 6) on hub (Figure 1, Item 3) and into cylinder block. Torque bolt to 71–75 lb-ft (96–102 N·m).
5. Using thickness gage, measure clearance between outer thrust washer (Figure 1, Item 2) and gear (Figure 1, Item 4). Clearance should be 0.005 to 0.018 inch (0.127 mm to 0.457 mm) with new parts and a maximum of 0.022 inch (0.559 mm) with used parts.
6. Using dial indicator with magnetic base, measure backlash between drive gear (Figure 1, Item 4) and mating camshaft gear (Figure 1, Item 1). Backlash should be 0.003 to 0.005 inch (0.076 mm to 0.127 mm) with new gears and a maximum of 0.007 inch (0.178 mm) with used gears.
7. Install adapter (Figure 1, Item 7) and two new self-locking bolts (Figure 1, Item 8) on drive gear (Figure 1, Item 4). Torque bolts to 7–9 lb-ft (10–12 N·m).

**END OF TASK**

**FOLLOW ON TASK**

Install flywheel housing (WP 0088).

**END OF TASK**

**END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

Wrench, Torque, 100–500 Lb-Ft  
(WP 0104, Table 1, Item 122)

Adapter, Tachometer Drive (Remover)  
(WP 0104, Table 1, Item 3)

Slide Hammer Set (Puller)  
(WP 0104, Table 1, Item 91)

Puller, Mechanical (Camshaft Gear)  
(WP 0104, Table 1, Item 74)

Drill Set, Twist  
(WP 0104, Table 1, Item 25)

Drill, Electric, Portable  
(WP 0104, Table 1, Item 24)

Threading Set, Screw  
(WP 0104, Table 1, Item 109)

Adapter, 3/8"-16 UNC  
(WP 0104, Table 1, Item 6)

Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)

V-Block  
(WP 0104, Table 1, Item 116)

Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)

Gage Set, Telescoping  
(WP 0104, Table 1, Item 46)

Gage Set, Depth, Micrometer  
(WP 0104, Table 1, Item 44)

Straight Edge  
(WP 0104, Table 1, Item 101)

Vise, Machinist, 4" Jaw  
(WP 0104, Table 1, Item 117)

Caps, Vise Jaw  
(WP 0104, Table 1, Item 16)

**Materials/Parts**

Bolt, Self-locking  
Qty: (4) (WP 0105, Table 1, Item 146)

Cleaning Solvent (WP 0103, Table 1, Item 8)

**Materials/Parts (cont.)**

Grease (WP 0103, Table 1, Item 18)

Oil, Engine (WP 0103, Table 1, Item 27)

Oil, Fuel (WP 0103, Table 1, Item 30)

Pin, Straight, Headless  
Qty: (4) (WP 0105, Table 1, Item 93)

Rag, Wiping (WP 0103, Table 1, Item 44)

Sealing Compound (WP 0103, Table 1, Item 52)

Sealing Compound, ASTM D5363  
(WP 0103, Table 1, Item 57)

Screw  
Qty: (2) (WP 0103, Table 1, Item 48)

Screw (WP 0103, Table 1, Item 49)

Stone, Sharpening X-Fine  
(WP 0103, Table 1, Item 62)

Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 23)

Wood Block  
Qty: (2) (WP 0103, Table 1, Item 71)

**References**

WP 0098

**Equipment Condition**

Air box heater hardware removed  
(models 5063-5299) (WP 0042)

Air box heater hardware removed  
(model 5063-5392) (WP 0043)

Air box heater hardware removed  
(model 5063-5393) (WP 0044)

Air box heater removed (WP 0045)

Fan support bracket removed  
(model 5063-5392) (WP 0069)

Flywheel assembly removed (WP 0070)

Flywheel housing removed (WP 0088)

Cylinder heads removed (WP 0073)

Upper front cover removed (WP 0090)

Fuel pump and hydraulic pump drive assemblies  
removed (WP 0091)

## REMOVAL

## NOTE

Use tachometer drive remover adapter (WP 0104, Table 1, Item 3).

1. Remove tachometer drive assembly (Figure 1, Item 3) from left camshaft with 3/8"-16 UNC adapter (Figure 1, Item 4) and slide hammer set (Figure 1, Item 5).
2. If necessary, remove tachometer dirt deflector (Figure 1, Item 2) from tachometer drive shaft (Figure 1, Item 1).
3. Remove outer idler gear thrust washer (Figure 1, Item 7) and idler gear assembly (Figure 1, Item 9) from hub (Figure 1, Item 8).
4. Remove screw (Figure 1, Item 6), hub (Figure 1, Item 8), and inner idler gear thrust washer (Figure 1, Item 10).

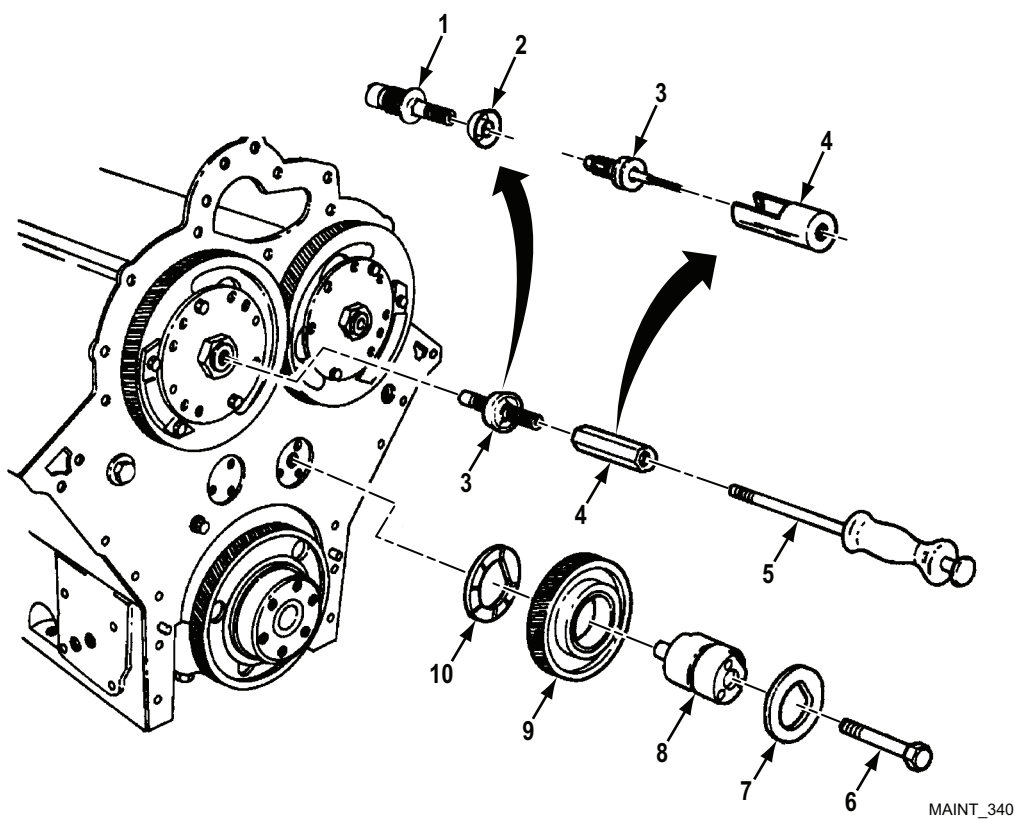


Figure 1. Cam and Idler Gear Hardware Removal.

**REMOVAL - Continued**

5. Remove two screws (Figure 2, Item 15), two lockwashers (Figure 2, Item 16), and retaining plate (Figure 2, Item 17) from each camshaft gear (Figure 2, Item 13). Discard lockwashers.
6. Wedge a rag between two camshaft gears (Figure 2, Item 13). Remove two nuts (Figure 2, Item 14).
7. Remove rag from camshaft gears (Figure 2, Item 13).
8. Remove four self-locking bolts (Figure 2, Item 11) fastening two spacer plates (Figure 2, Item 18) to cylinder block. Insert socket wrench through opening in web of camshaft gear (Figure 2, Item 13) to gain access to bolts. Discard self-locking bolts.
9. Remove camshaft and gear assemblies (Figure 2, Item 12) from rear of cylinder block.

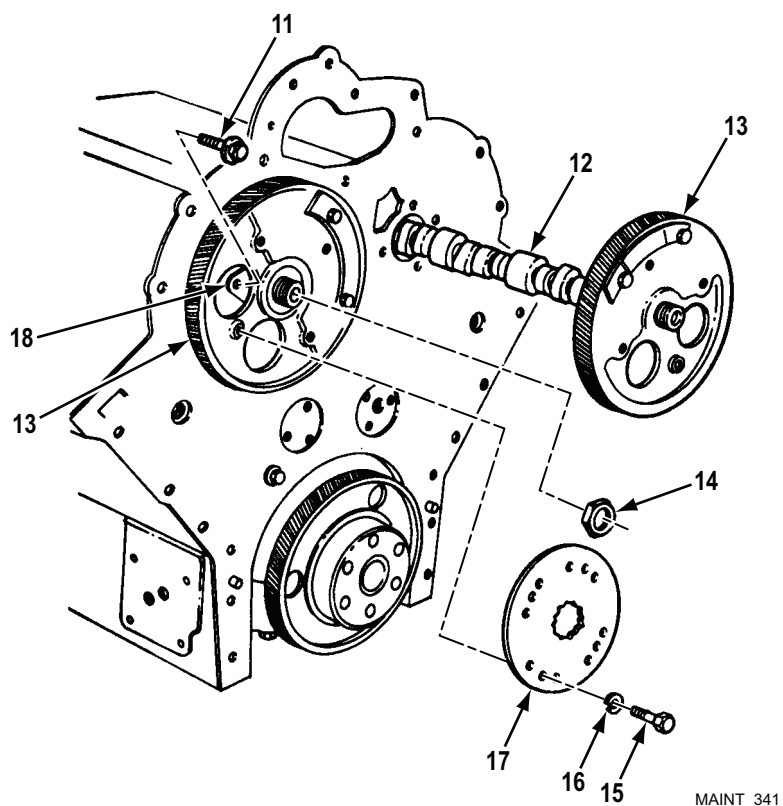


Figure 2. Cam and Idler Gear Removal.

**END OF TASK**

## DISASSEMBLY

## NOTE

Tag camshafts and gears prior to disassembling. Use same procedure for right and left camshafts. When press is not available, use mechanical puller (Figure 3, Item 21) to remove camshaft gears.

1. On models 5063-5392, 5063-5393, and 5063-539L, remove two bolts (Figure 3, Item 20) and balance weight (Figure 3, Item 19) from camshaft gear (Figure 3, Item 13).

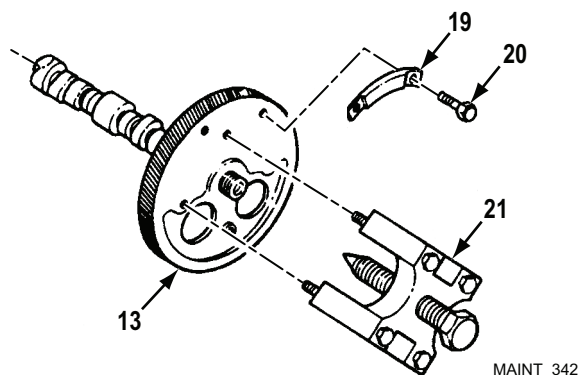


Figure 3. Cam Gear Disassembly.

2. Remove camshaft gears in the following manner:
  - a. Support camshaft (Figure 4, Item 26) and camshaft gear (Figure 4, Item 13) under gear.

## NOTE

Place wooden block under lower end of camshaft to prevent thread damage when camshaft is pressed from camshaft gear.

- b. Place a short 3/4 inch (19.05 mm) diameter brass rod (Figure 4, Item 22) on camshaft (Figure 4, Item 26). Press camshaft out of camshaft gear (Figure 4, Item 13).
  - c. Remove spacer plate (Figure 4, Item 18), spacer sleeve (Figure 4, Item 27), and Woodruff key (Figure 4, Item 23) from camshaft (Figure 4, Item 26).
3. If necessary, press bearing (Figure 4, Item 24) from idler gear (Figure 4, Item 25). Discard bearing.

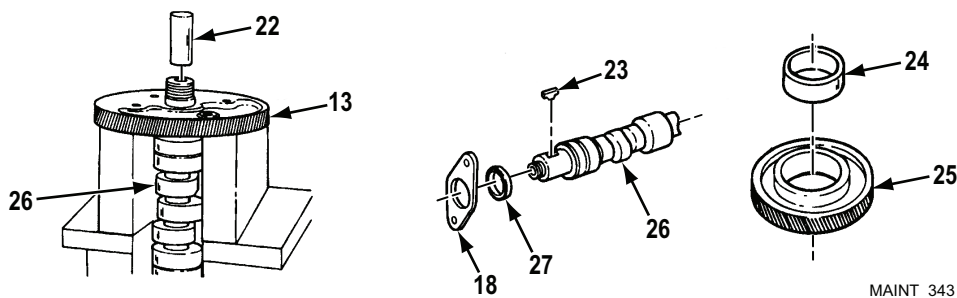


Figure 4. Camshaft and Cam Gear Disassembly.



**DISASSEMBLY - Continued**

4. Remove two camshaft headless straight pins (Figure 5, Item 29) from camshaft (Figure 5, Item 26) in the following manner:

**CAUTION**

Use care when handling cam lobes or journals of shaft. Lobe and journal surfaces are precision machined and must not be damaged.

- a. Clamp camshaft in a machinist vise with vise jaw caps.
- b. Make indentation in center of headless straight pin with twist drill set.
- c. Punch a deep hole with a center punch to break through hardened surface of headless straight pin.
- d. Drill a 1/4 inch (6.35 mm) hole straight through center of headless straight pin with a portable electric drill.
- e. Use 1/4 inch (6.35 mm) drilled hole as a guide and re-drill headless straight pin with twist drill set.
- f. Tap a hole with a 3/8"-16 tap.
- g. Thread 3/8"-16 UNC adapter (Figure 5, Item 28) into headless straight pin. Fasten slide hammer set mechanical puller (Figure 5, Item 5) to adapter. Remove and discard headless straight pin.

**NOTE**

If suitable rod is not available, remove remaining headless straight pin by repeating Steps 4.a.-4.g.

- h. Insert a long 3/8 inch (9.53 mm) steel rod into camshaft. Drive out remaining headless straight pin. Discard headless straight pin.

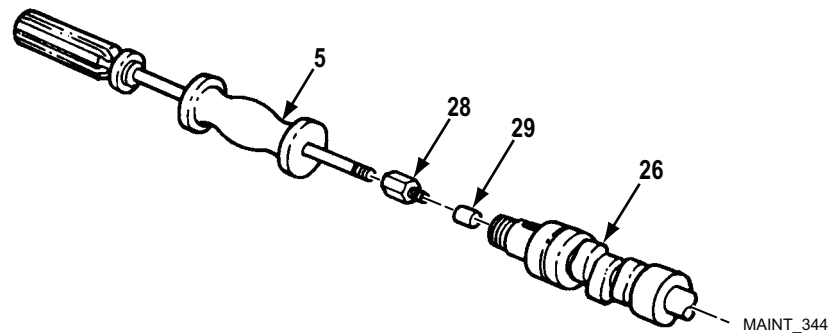
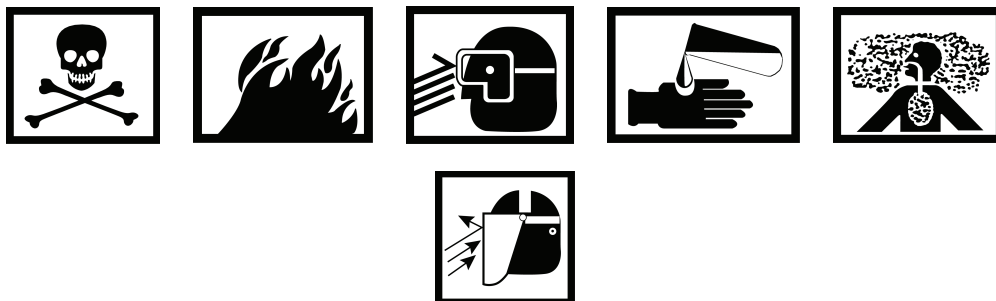


Figure 5. Camshaft Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Soak camshafts in cleaning solvent. Run brush through oil gallery to remove sludge or foreign material. Clean exterior of camshaft. Blow out oil gallery and oil holes with compressed air.
2. Clean gears, thrust washers, gear hub, and related parts with fuel oil. Dry with compressed air.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Check camshaft keyways and threads for damage.
2. Inspect camshaft journals and lobes for wear and scoring. Check wear of camshaft lobes as follows:
  - a. Measure flat on cam lobes (Figure 6, Item 31) with thickness gages (Figure 6, Item 30) and straight edge (Figure 6, Item 32).

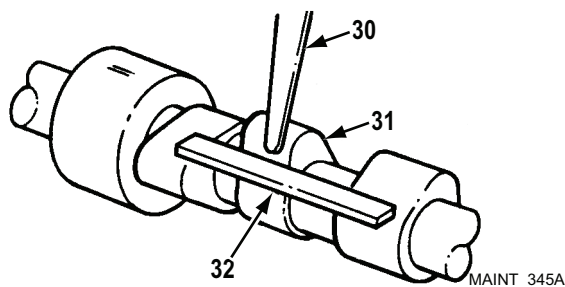


Figure 6. Camshaft Lobe Wear.

- b. Replace camshaft if flats are worn more than 0.003 inch (0.076 mm).

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

3. Using dial indicator with magnetic base (Figure 7, Item 33), measure runout of intermediate camshaft journals (Figure 7, Item 34) with end journals mounted on V-blocks. Replace camshaft if runout exceeds 0.002 inch (0.050 mm).
4. Examine faces of thrust washers for scoring and wear. New thrust washers are 0.208 to 0.210 inch (5.283-5.334 mm) thick.
5. Examine surfaces which thrust washers contact. Smooth scratched or scored surfaces with oil stone.

**NOTE**

Camshaft bearings are available in 0.010 and 0.020 inch (0.254 and 0.508 mm) undersize on inside diameter.

If camshaft bearings require replacement, see Cylinder Block Maintenance (WP 0098).

6. Using micrometer depth gage set and telescoping gage set, measure outside diameter of camshaft journals and inside diameter of camshaft bearings. Clearance between journals and bearings should be 0.0035–0.007 inch (0.089-0.177 mm) with new parts and a maximum of 0.008 inch (0.203 mm) with used parts.
7. Examine teeth on gears for scoring, pitting, and wear.
8. Inspect idler gear bearing for scoring, pitting, and wear.
9. Examine gear hub and thrust washers for scoring and wear.
10. Inspect tachometer drive shaft for distortion or other damage. If damage, discard.

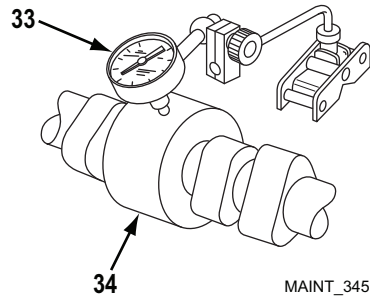


Figure 7. Camshaft Journal Runout.

**END OF TASK**

**ASSEMBLY****NOTE**

Use same procedure for left and right camshaft.

1. Coat new headless straight pins (Figure 8, Item 29) with sealing compound and press into ends of camshaft (Figure 8, Item 26) to a depth of 1.940 inches (49.28 mm).

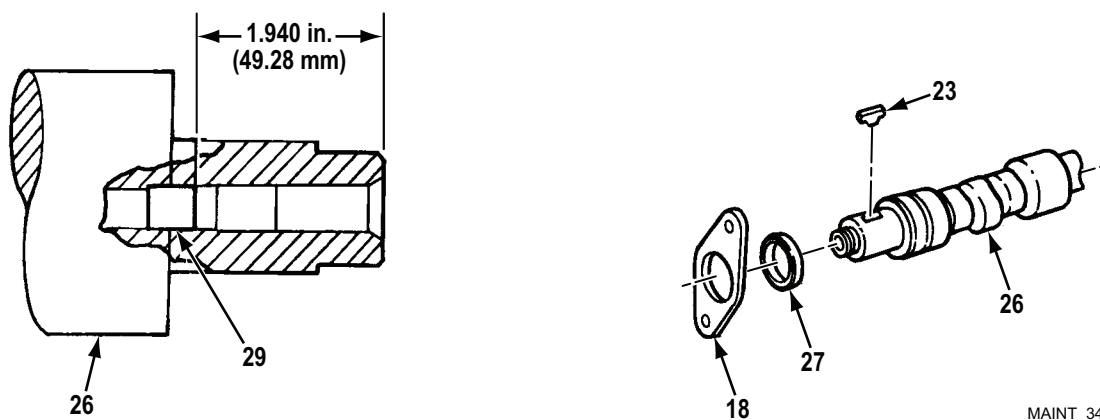
**CAUTION**

Camshafts improperly installed may cause severe engine damage.

**NOTE**

Camshafts are stamped at ends for location. Camshaft marked "RH-R BANK" goes in right side, and camshaft marked "RH-L BANK" goes in left side. Install camshafts with markings at rear of engine.

2. Install spacer sleeve (Figure 8, Item 27) and Woodruff key (Figure 8, Item 23) to rear of camshaft (Figure 8, Item 26).
3. Lubricate spacer plate (Figure 8, Item 18) with engine oil and place over spacer sleeve (Figure 8, Item 27).



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Figure 8. Camshaft Assembly.

**ASSEMBLY - Continued****NOTE**

Camshaft gear with timing marks of two circles and two triangles goes on right camshaft.

4. Align keyway in camshaft gear (Figure 9, Item 13) with Woodruff key in camshaft. Place camshaft gear on camshaft (Figure 9, Item 26).
5. Support camshaft (Figure 9, Item 26) and place 1-1/2 inch (38.10 mm) sleeve (Figure 9, Item 35) on top of camshaft gear (Figure 9, Item 13). Press camshaft gear tight against spacer sleeve (Figure 9, Item 27).
6. Measure clearance between spacer plate (Figure 9, Item 18) and camshaft (Figure 9, Item 26). Clearance should be 0.008–0.015 inch (0.203–0.381 mm ) with new parts and a maximum of 0.021 inch (0.533 mm) with used parts.

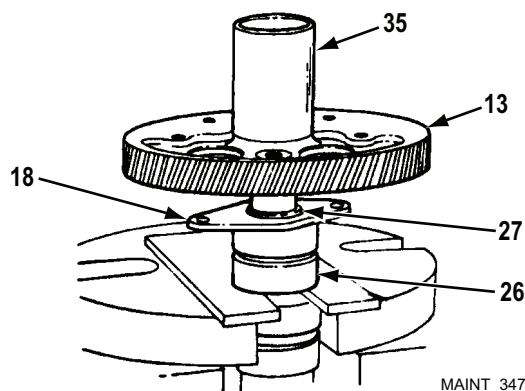


Figure 9. Camshaft and Cam Gear Assembly.

**ASSEMBLY - Continued**

7. Thread nut (Figure 10, Item 14) on rear of camshaft (Figure 10, Item 26) and hand tighten.
8. On models 5063-5392, 5063-5393 and 5063-539L, install balance weight (Figure 10, Item 19) and two bolts (Figure 10, Item 20) on outer face of gear (Figure 10, Item 13).
9. If removed, press new bearing (Figure 10, Item 24) into idler gear (Figure 10, Item 25) until flush with both faces of gear.

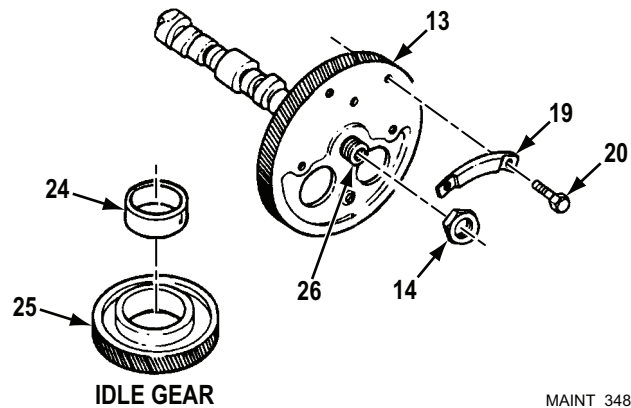


Figure 10. Cam Gear Assembly.

**END OF TASK**

**INSTALLATION**

1. Lubricate camshaft bearings and journals with engine oil and slide camshaft and gear assemblies (Figure 11, Item 12) into cylinder block.
2. Align timing marks (triangles) on camshaft gears (Figure 11, Item 13) as shown in timing diagram.
3. Install four new self-locking bolts (Figure 11, Item 11) through two spacer plates (Figure 11, Item 18) and into cylinder block. Rotate camshaft gears to gain access to bolt holes. Torque bolts to 30–35 lb-ft (41–47 N·m).
4. Place a rag between teeth of two camshaft gears. Torque camshaft nuts (Figure 11, Item 14) to 300–325 lb-ft (407–441 N·m).
5. Install retainer plate (Figure 11, Item 17), two new lockwashers (Figure 11, Item 16), and two screws (Figure 11, Item 15) on each camshaft gear (Figure 11, Item 13). Torque screws to 35–39 lb-ft (47–53 N·m).

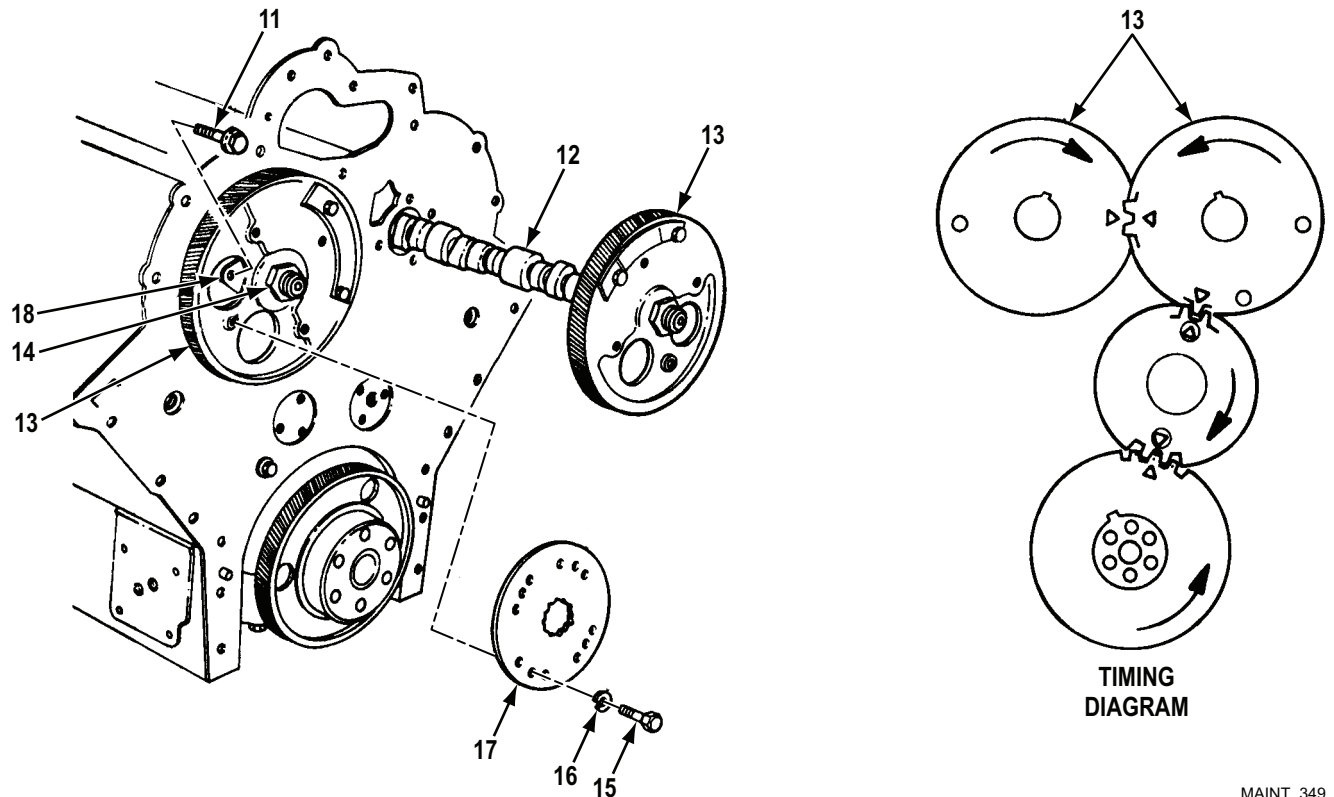


Figure 11. Cam and Idler Gear Installation.

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**INSTALLATION - Continued**

6. Remove rag from between camshaft gears.
7. Place inner idler gear thrust washer (Figure 12, Item 10) on front of gear hub (Figure 12, Item 8) with oil grooves in thrust washer facing idler gear and with flat in thrust washer over flat on gear hub.
8. Insert small end of gear hub (Figure 12, Item 8) into counterbore of cylinder block.
9. Thread two large pilot screws (Figure 12, Item 37) and small pilot screw (Figure 12, Item 38) through gear hub (Figure 12, Item 8) and into cylinder block.
10. Install screw (Figure 12, Item 6) in center hole in gear hub (Figure 12, Item 8). Torque bolt to 40–45 lb-ft (54–61 N·m). Remove two large pilot screws (Figure 12, Item 37) and small pilot screw (Figure 12, Item 38) from gear hub.
11. Lubricate gear hub (Figure 12, Item 8), idler gear bearing (Figure 12, Item 24), and inner thrust washer (Figure 12, Item 10) with engine oil.
12. Slide idler gear assembly (Figure 12, Item 9) over gear hub (Figure 12, Item 8). Align triangles inside circles on idler gear with triangles on camshaft gear and on crankshaft gear as shown in timing diagram.
13. Lightly apply grease to grooved face of thrust washer (Figure 12, Item 7). Place thrust washer over gear hub (Figure 12, Item 8) with grooved face toward idler gear and flat in thrust washer over flat of gear hub.

**NOTE**

Fit between dirt deflector and tachometer drive shaft must be sufficiently snug to require some degree of force to move dirt deflector. If necessary, use sealing compound, ASTM D5363, between parts to correct fit.

14. If removed, install tachometer dirt deflector (Figure 12, Item 2) on tachometer drive shaft (Figure 12, Item 1).
15. Using a sleeve (Figure 12, Item 36), tap tachometer drive assembly (Figure 12, Item 3) into rear of left camshaft.

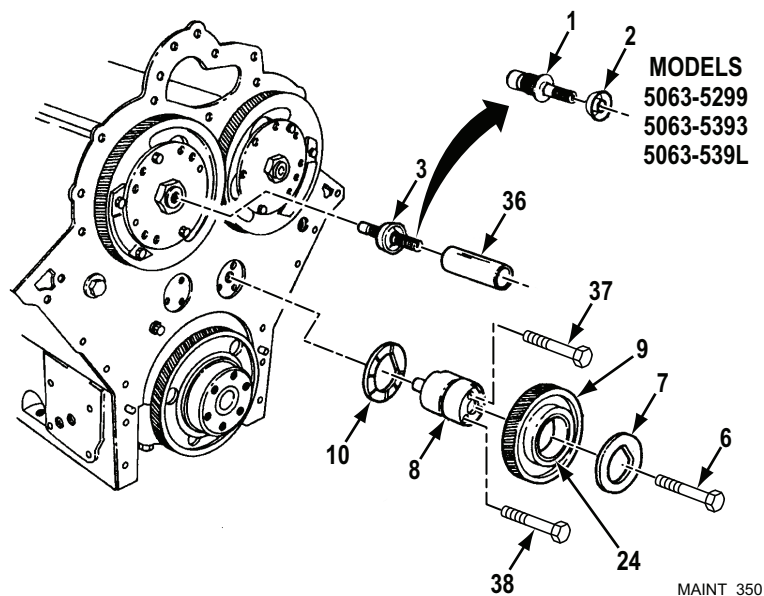


Figure 12. Cam and Idler Gear Hardware Installation.



**INSTALLATION - Continued**

- Using a dial indicator with magnetic base (Figure 13, Item 33), measure backlash between mating gears. Backlash should be 0.0005–0.005 inch (0.013–0.127 mm) with new gears and a maximum of 0.007 inch (0.177 mm) with used gears.

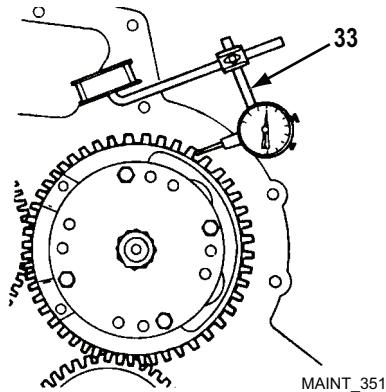


Figure 13. Gear Backlash Check.

**END OF TASK****FOLLOW ON TASK**

- Install fuel pump and hydraulic pump drive assemblies (WP 0091).
- Install upper front cover (WP 0090).
- Install cylinder heads (WP 0073).
- Install flywheel housing (WP 0088).
- Install flywheel assembly (WP 0070).
- Install fan support bracket (model 5063-5392) (WP 0069).
- Install air box heater (WP 0045).
- Install air box heater hardware (model 5063-5393) (WP 0044).
- Install air box heater hardware (model 5063-5392) (WP 0043).
- Install air box heater hardware (models 5063-5299) (WP 0042).

**END OF TASK****END OF WORK PACKAGE**



---

**SUSTAINMENT MAINTENANCE  
END PLATE REPLACEMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Gasket (WP 0105, Table 1, Item 76)  
Washer, Lock  
Qty: (10) (WP 0105, Table 1, Item 23)

**Equipment Condition**

Turbocharger removed  
(models 5063-5393 and 5063-539L)  
(WP 0036)  
Turbocharger mounting bracket and exhaust  
tubes removed  
(models 5063-5093 and 5063-539L)  
(WP 0038)  
Fuel pump removed (WP 0055)

**Equipment Condition (cont.)**

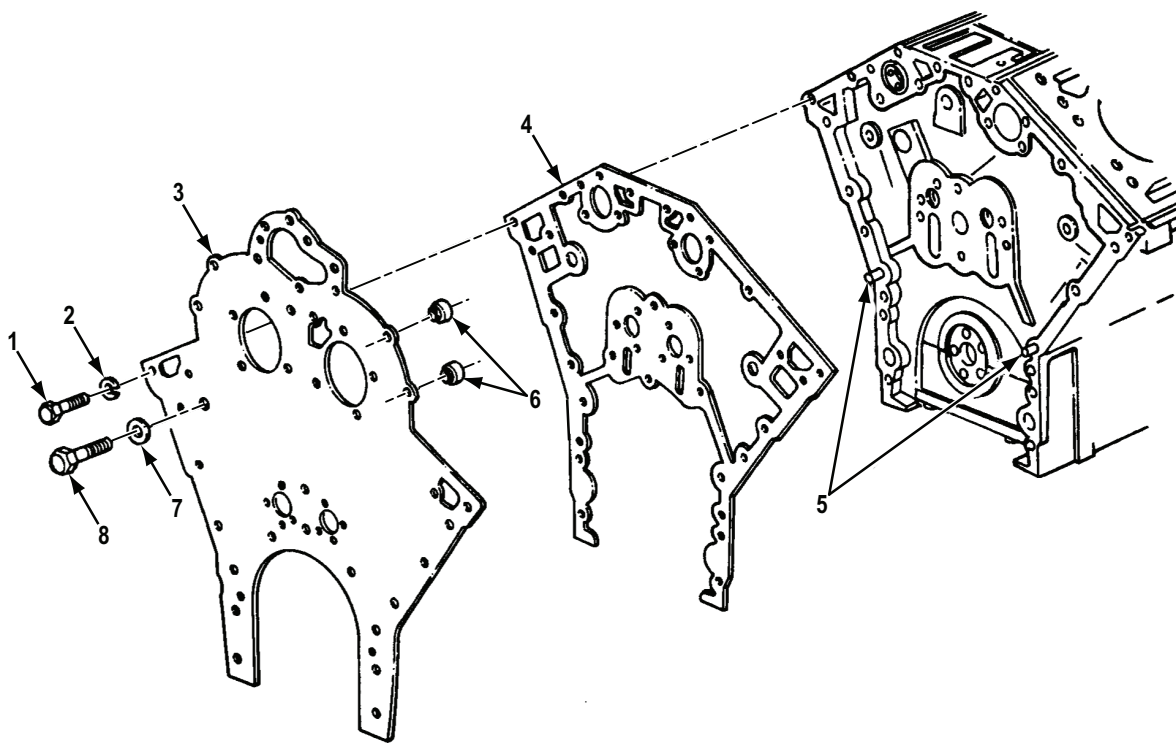
Tachometer drive removed (WP 0059)  
Oil pan removed (WP 0063)  
Flywheel assembly removed (WP 0070)  
Flywheel housing removed (WP 0088)  
Cylinder heads removed (WP 0073)  
Upper front cover removed (WP 0090)  
Fuel pump and hydraulic pump drive assemblies  
removed (WP 0091)  
Camshafts, camshaft gears, and idler gear  
removed (WP 0092)

**REMOVAL**

1. For all, except model 5063-5393, remove screw (Figure 1, Item 8) and special washer (Figure 1, Item 7) from left side of end plate (Figure 1, Item 3).
2. Remove 10 screws (Figure 1, Item 1), 10 lockwashers (Figure 1, Item 2), end plate (Figure 1, Item 3), and gasket (Figure 1, Item 4) from cylinder block. Discard gasket and lockwashers.

**END OF TASK****DISASSEMBLY****CAUTION**

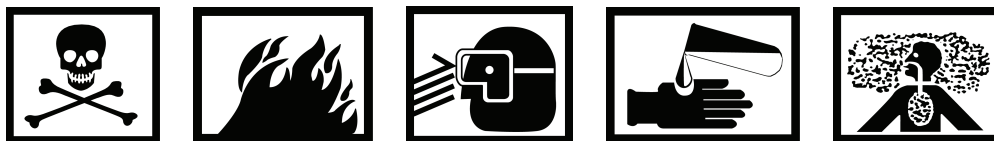
When removing inserts, support end plate on flat surface to prevent warping or bending.  
If necessary, press out inserts (Figure 1, Item 6) from rear of end plate (Figure 1, Item 3).



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Figure 1. End Plate Removal/Installation.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Remove all gasket material from end plate and wash plate with cleaning solvent.

**END OF TASK****INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Check plate for nicks, dents, scratches, score marks, and warpage.
2. Inspect screw inserts for cracks and damaged threads.

**END OF TASK****ASSEMBLY**

If screw inserts (Figure 1, Item 6) were removed, support end plate (Figure 1, Item 3) on flat surface and press screw inserts into plate from front until insert seats on end plate.

**END OF TASK****INSTALLATION**

1. Install new gasket (Figure 1, Item 4) on rear of cylinder block using gasket adhesive.
2. Apply a coat of gasket adhesive to outer surface of gasket (Figure 1, Item 4).
3. Align holes in end plate (Figure 1, Item 3) with dowels (Figure 1, Item 5) in cylinder block. Push end plate against cylinder block.
4. Install 10 new lockwashers (Figure 1, Item 2) and 10 screws (Figure 1, Item 1). Torque screws to 30–35 lb-ft (41–47 N·m).
5. On all, except models 5063-5393 and 5063-539L, install special washer (Figure 1, Item 7) and screw (Figure 1, Item 8) on left side of end plate. Torque screw to 71–75 lb-ft (96–102 N·m).

**END OF TASK**

**FOLLOW ON TASK**

1. Install camshafts, camshaft gears, and idler gear (WP 0092).
2. Install fuel pump and hydraulic pump drive assemblies (WP 0091).
3. Install upper front cover (WP 0090).
4. Install cylinder heads (WP 0073).
5. Install flywheel housing (WP 0088).
6. Install flywheel assembly (WP 0070).
7. Install oil pan (WP 0063).
8. Install tachometer drive (WP 0059).
9. Install fuel pump (WP 0055).
10. Install turbocharger mounting bracket and exhaust tubes (models 5063-5093 and 5063-539L) (WP 0038).
11. Install turbocharger (models 5063-5393 and 5063-539L) (WP 0036).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
PISTON AND CONNECTING ROD REPLACEMENT  
(MODEL 5063-5299)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)

Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

Clamp, Hold-Down, Cylinder Liner  
(WP 0104, Table 1, Item 17)

Reamer, Cylinder Ridge  
(WP 0104, Table 1, Item 78)

Cleaner, Piston Ring Groove  
(WP 0104, Table 1, Item 18)

Die Set, Metal Stamping, Hand  
(WP 0104, Table 1, Item 22)

Remover and Replace (Piston Ring)  
(WP 0104, Table 1, Item 86)

Replacer, Piston Pin (Retainer)  
(WP 0104, Table 1, Item 87)

Tester, Vacuum Gage  
(Leak Detector, Piston Pin Retainer)  
(WP 0104, Table 1, Item 108)

Compressor, Piston Ring  
(WP 0104, Table 1, Item 19)

Gage Set, Piston-Liner Thickness  
(WP 0104, Table 1, Item 45)

Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)

Ball Attachment, Micrometer  
(WP 0104, Table 1, Item 10)

Vise, Machinist, 4" Jaw  
(WP 0104, Table 1, Item 117)

Caps, Vise Jaw  
(WP 0104, Table 1, Item 16)

**Materials/Parts**

Antifreeze (WP 0103, Table 1, Item 3)

**Materials/Parts (cont.)**

Carbon Removing Compound  
(WP 0103, Table 1, Item 6)

Cleaning Solvent (WP 0103, Table 1, Item 8)

Crocus Cloth (WP 0103, Table 1, Item 10)

Gage, Plastic, Green (WP 0103, Table 1, Item 15)

Gage, Plastic, Red (WP 0103, Table 1, Item 16)

Oil, Engine (WP 0103, Table 1, Item 27)

Oil, Fuel (WP 0103, Table 1, Item 30)

Packing, Preformed  
Qty: (2) (WP 0105, Table 1, Item 64)

Retainer, Piston Pin  
Qty: (2) (WP 0105, Table 1, Item 40)

Ring, Piston  
Qty: (3) (WP 0105, Table 1, Item 45)

Ring, Piston (WP 0105, Table 1, Item 125)

Ring Set, Oil (model 5063-5299)  
(WP 0105, Table 1, Item 104)

Shortening Compound  
(WP 0103, Table 1, Item 58)

Stone, Sharpening X-Fine  
(WP 0103, Table 1, Item 62)

Wood Block (WP 0103, Table 1, Item 71)

**References**

WP 0097  
ASTM E1444

**Equipment Condition**

Oil pan removed (WP 0063)

Oil pump inlet tubes removed (model 5063-5299)  
(WP 0064)

Cylinder head removed (WP 0073)

---

**REMOVAL**

1. Install a cylinder liner hold-down clamp (Figure 1, Item 2) on each cylinder to anchor cylinder liners (Figure 1, Item 1) during crankshaft rotation.
2. Rotate crankshaft (Figure 1, Item 3) until connecting rod journal (Figure 1, Item 4) being worked on is at bottom of its travel.
3. Remove cylinder liner hold-down clamp (Figure 1, Item 2) from cylinder being worked on.

**CAUTION**

Remove all carbon deposits at top of liner before removing piston from cylinder liner.  
Piston ring breakage can occur when carbon deposits are present.

4. Using cylinder ridge reamer, remove carbon deposits from upper surface of cylinder liner (Figure 1, Item 1).
5. Remove two nuts (Figure 1, Item 5), cap (Figure 1, Item 6), and lower bearing shell (Figure 1, Item 7) from piston and connecting rod assembly (Figure 1, Item 8).

**NOTE**

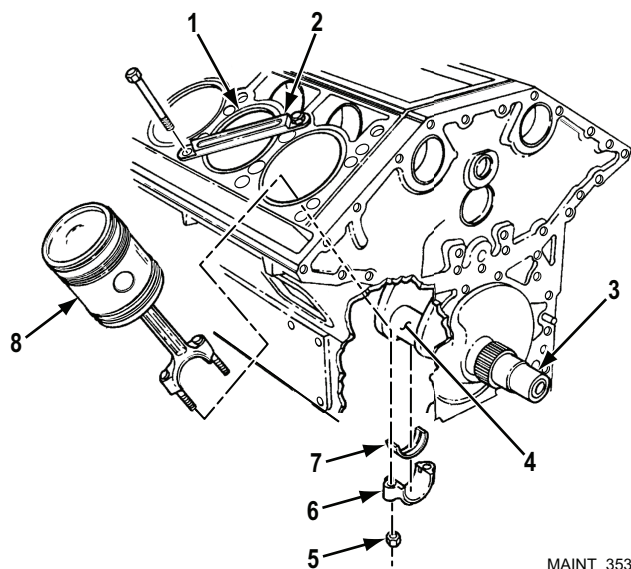
Tag piston assembly and liner with cylinder number for matching during reassembly.

6. Push piston and connecting rod assembly (Figure 1, Item 8) out through top of cylinder block.

**NOTE**

Always assemble cap with stamped number on same side as stamped on lower part of connecting rod to ensure cap is not rotated 180 degrees.

7. Assemble bearing cap (Figure 1, Item 6), lower bearing shell (Figure 1, Item 7), and two nuts (Figure 1, Item 5) on piston and connecting rod assembly (Figure 1, Item 8).
8. Repeat Steps 2–7 for remaining piston and connecting rod assemblies (Figure 1, Item 8).



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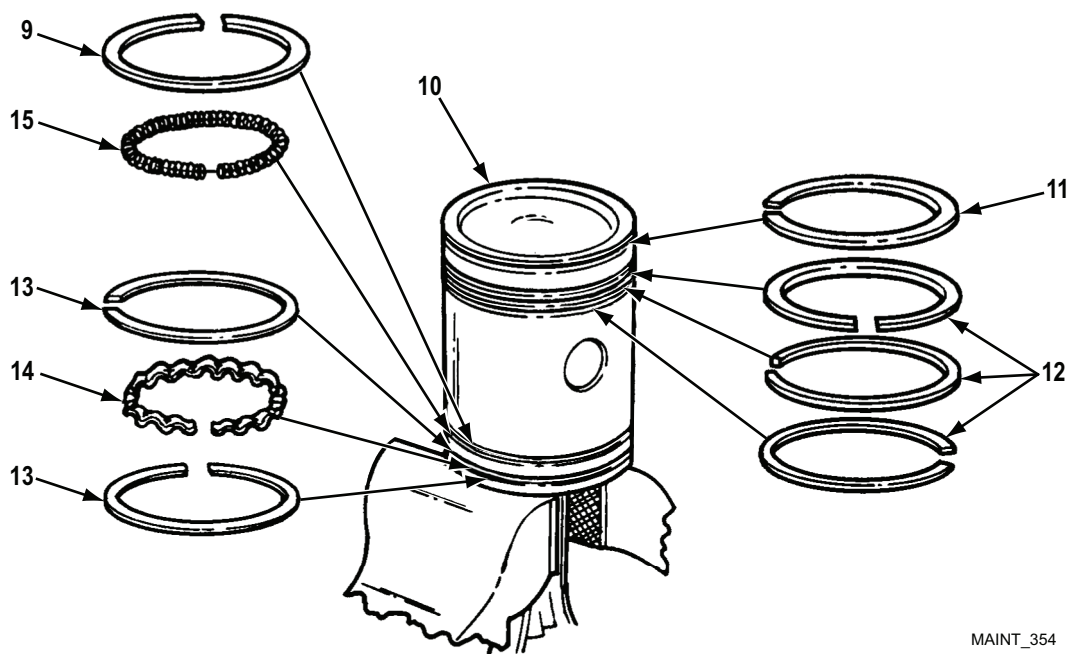
Figure 1. Piston and Connecting Rod Removal.

**END OF TASK**



**DISASSEMBLY**

1. Secure piston and connecting rod assembly (Figure 1, Item 8) in a machinist vise with vise jaw caps. Remove fire ring (Figure 2, Item 11), three compression rings (Figure 2, Item 12), upper oil ring (Figure 2, Item 9), and two lower oil rings (Figure 2, Item 13) from piston (Figure 2, Item 10) using piston ring tool. Remove spiral oil ring expander (Figure 2, Item 15) and wavy oil ring expander (Figure 2, Item 14) from lower grooves in piston. Discard rings and expanders.
2. Remove piston and connecting rod assembly (Figure 1, Item 8) from machinist vise and lay horizontally on flat surface.



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Figure 2. Piston Ring Disassembly.

**DISASSEMBLY - Continued****CAUTION**

Use care not to damage piston or bushings during removal of piston pin replacers.

3. Punch a hole through center of one piston pin replacer (Figure 3, Item 16) and pry piston pin replacer from piston (Figure 3, Item 10). Discard replacer.
4. Remove piston pin (Figure 3, Item 17) and connecting rod assembly (Figure 3, Item 18) from piston (Figure 3, Item 10).
5. Drive remaining piston pin replacer (Figure 3, Item 16) out from inside. Discard replacer.

**CAUTION**

Do not remove bushings in piston or connecting rod. These parts are not serviced.

6. Repeat Steps 1–5 for remaining piston and connecting rod assemblies (Figure 1, Item 8).

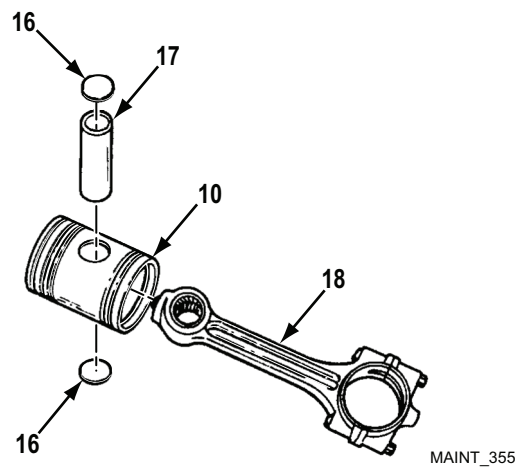
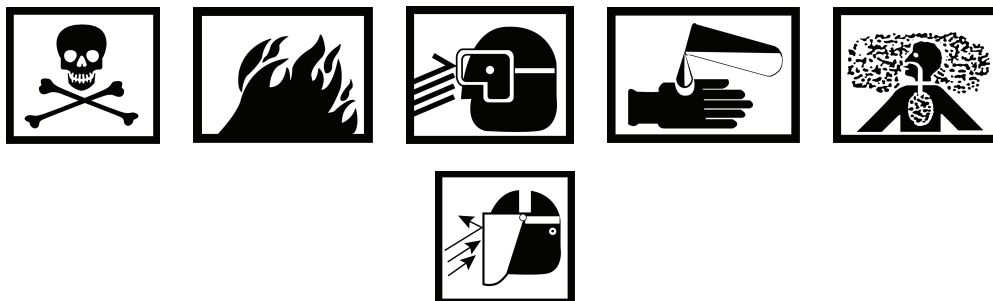


Figure 3. Piston and Connecting Rod Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Do not use wire brush on lower section of piston with tin plating. Wire brush will remove tin plating and damage piston. Wire brush only upper section with four top grooves to remove any hard carbon.

1. Clean piston components with cleaning solvent and dry with compressed air. If cleaning solvent does not remove carbon deposits, use carbon removing compound, which will not harm bushings or tin plating on piston.
2. Clean ring grooves with piston ring groove cleaner or broken compression ring ground to a beveled edge.
3. Clean inside surfaces of piston and oil drain holes in lower part of piston. Do not enlarge holes during cleaning.

**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA****NOTE**

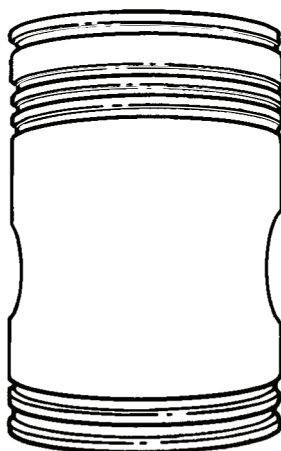
Trunk piston can come in two configurations as shown. The new configuration has eight or sixteen oil drain holes and J-relief. The old configuration has eight oil drain holes and no J-relief. Either configuration is acceptable and matching throughout an engine is not required.

1. For piston, check cylinder liner and block bore for excessive out of round, taper, or high spots, which could cause failure of piston (WP 0097).

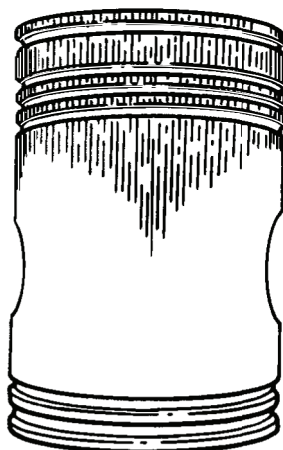
**NOTE**

Overheating or burned spots on piston may indicate an obstruction in connecting rod oil passage.

2. Examine piston for score marks, cracks, damaged ring grooves, loss of tin plating, or indications of overheating. Using a crocus cloth, remove light score marks from piston. Replace any piston severely scored or overheated. Discard piston if cracks are found across internal struts.



**PISTON SUITABLE FOR  
INSTALLATION.**



**PISTON SLIGHTLY SCORED.  
USE ONLY AFTER REMOVING  
SCORE MARKS BY POLISHING  
WITH CROCUS CLOTH OR  
HARD INDIA STONE.**



**PISTON BADLY SCORED-  
UNFIT FOR USE.**

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Figure 4. Piston Inspection.

**CAUTION**

Do not polish or refinish piston pin. Hand polishing or refinishing will destroy precision finish and result in rapid bushing wear.

3. For piston pin, inspect for signs of fretting. Discard piston pin if fretting is present.
4. Measure piston pin diameter. Diameter of new piston pin is 1.3746–1.3750 inches (34.915–34.925 mm).

## INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued

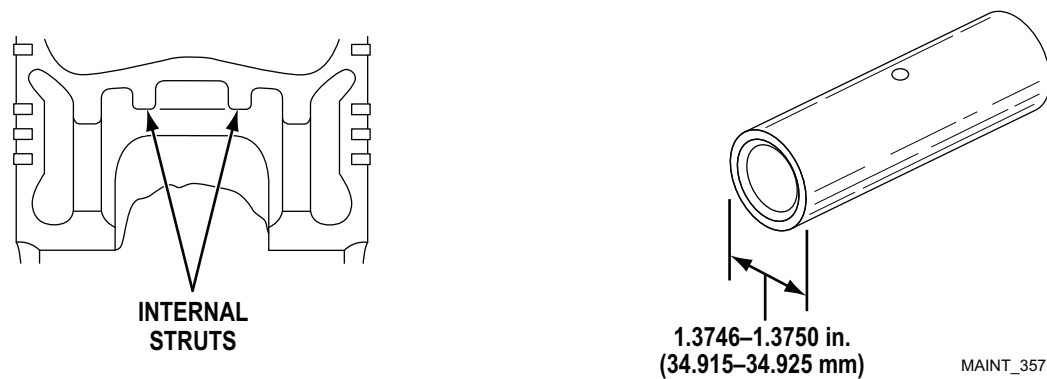


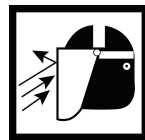
Figure 5. Piston Pin Inspection.

5. For connecting rod, check for visual damage. Discard if rod is bent, had previous bearing failure, was overheated (blued) at top or bottom end, or is fretted at split line between rod and cap.
6. Check for cracks using the magnetic particle inspection method (reference ASTM E1444).

**NOTE**

Overheated bushings may become loose and creep together, thus blocking off supply of lubricating oil to piston pin and spray nozzle.

7. Check connecting rod bushings for indications of scoring, overheating, or other damage.

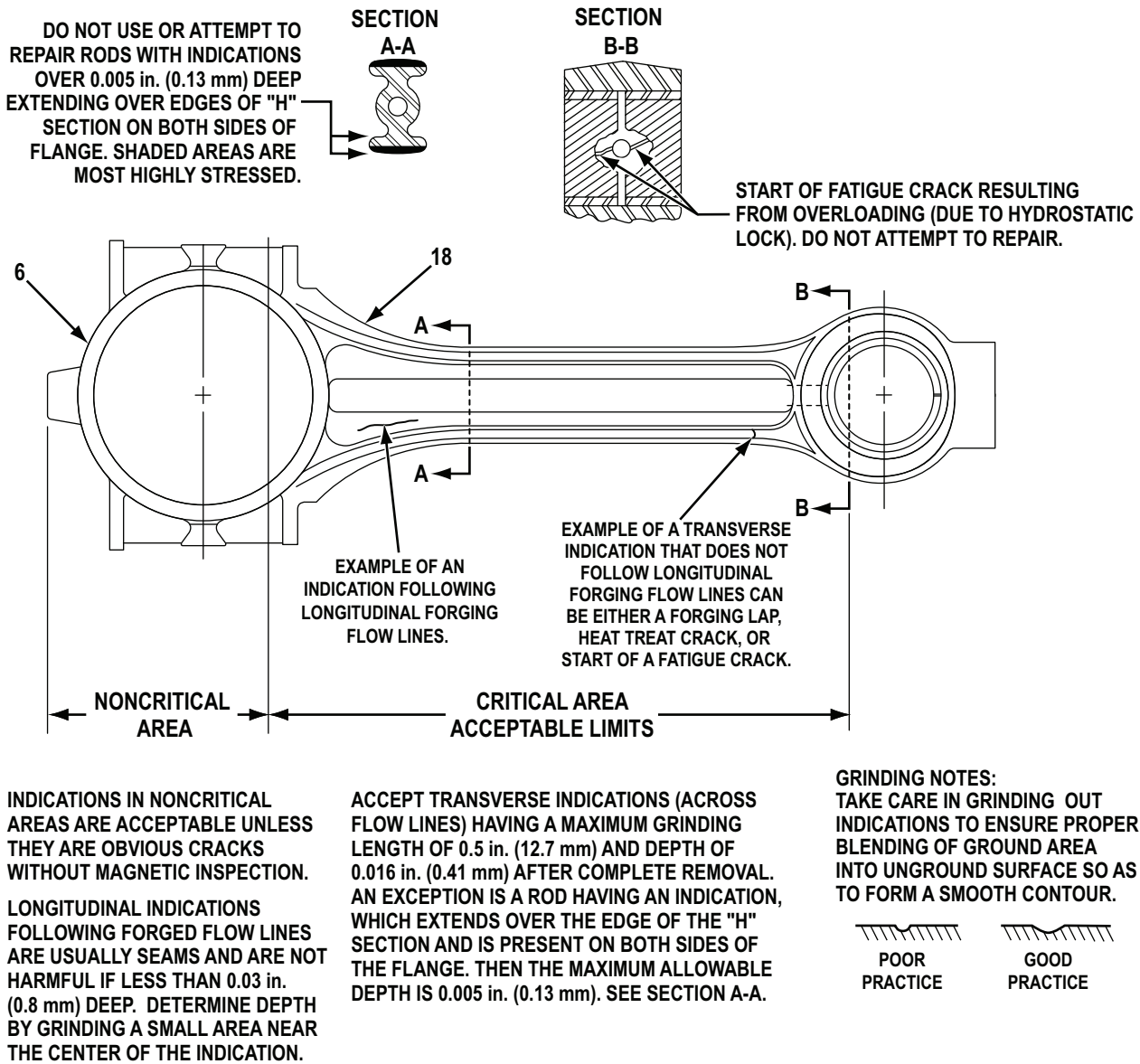
**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

8. Check spray nozzle at upper end of connecting rod for plugged holes. Blow compressed air through drilled oil passage in rod to ensure spray nozzle holes are open.
9. Inspect connecting rod bearing bores for burrs or foreign particles. Clean up minor burrs with crocus cloth using circular motion.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

10. When installing a new connecting rod assembly, stamp cylinder number on connecting rod (Figure 6, Item 18) and cap (Figure 6, Item 6) using metal stamping die set.



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Figure 6. Connecting Rod Inspection.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

11. Inspect bearing shells for scoring, pitting, flaking, etching, and dirt grooving. If defective, discard bearing shells.
12. Discard bearing shells with bright spots on backs indicating movement in bearing caps or supports.

**NOTE**

If one bearing shell is less than minimum thickness shown in Table 1, replace both bearing shells (upper and lower).

13. Using a micrometer ball attachment (Figure 7, Item 19), measure thickness of lower and upper connecting rod bearing shells at point (Figure 7, Item A), 90 degrees from parting line.

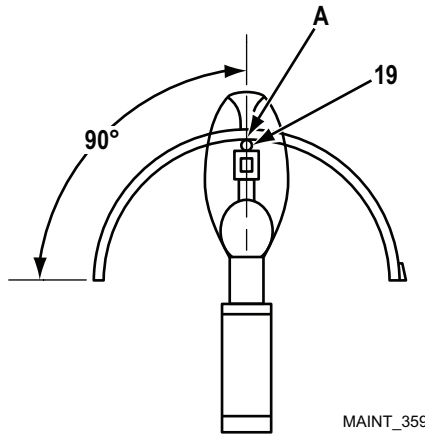


Figure 7. Connecting Rod Bearing Inspection.

**Table 1. Connecting Rod Bearing Shell Thickness.**

BEARING SIZE	NEW BEARING THICKNESS *	MINIMUM USED THICKNESS *
Standard	0.1247–0.1252 in. (3.167–3.180 mm)	0.1230 in. (3.124 mm)
0.002 in. Undersized	0.1257–0.1262 in. (3.193–3.205 mm)	0.1240 in. (3.150 mm)
0.010 in. Undersized	0.1297–0.1302 in. (3.294–3.307 mm)	0.1280 in. (3.251 mm)
0.020 in. Undersized	0.1347–0.1352 in. (3.421–3.434 mm)	0.1330 in. (3.378 mm)
0.030 in. Undersized	0.1397–0.1402 in. (3.548–3.561 mm)	0.1380 in. (3.505 mm)
* Thickness 90 degrees from parting line of bearing.		

## INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued

**NOTE**

Fit new or used piston to corresponding cylinder liner and retain as matched set for assembly in engine.

14. For fitting piston, using a micrometer set, measure piston skirt outside diameter (Figure 8, Item B) parallel to and perpendicular with piston pin bore at room temperature, 70° F (21° C). Skirt diameter for model 5063-5299 is 3.8699–3.8721 inches (98.3–98.35 mm).

**NOTE**

Thickness gages must be perfectly flat and free of nicks and bends.

Select a thickness gage thickness requiring six pounds pull to move. Piston to liner clearance is 0.001 inch (0.025 mm) greater than thickness of thickness gage used. For example, a 0.004 inch (0.102 mm) thickness gage indicates 0.005 inch (0.127 mm) clearance when withdrawn with a six pound pull.

15. With cylinder liner (Figure 8, Item 1) in cylinder block, hold piston (Figure 8, Item 10) upside down in liner and measure clearance in four places, 90 degrees apart, using a thickness gage (Figure 8, Item 21) attached to a spring scale (Figure 8, Item 20). Clearance for model 5063-5299 must be 0.0027–0.0068 inch (0.069–0.173 mm) for new parts and to 0.010 inch (0.25 mm) for used parts.

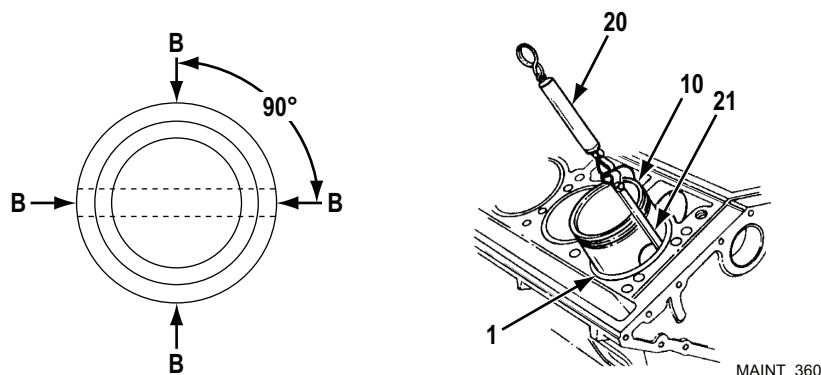


Figure 8. Piston Fitting.

16. If binding occurs between piston and liner, remove piston and examine piston and liner for burrs. Remove burrs on piston with an X-fine sharpening stone. Remove burrs in liner with fine flat hone and recheck clearance.
17. For fitting piston rings, insert piston ring inside cylinder liner in normal area of ring travel. Using the piston, push ring down parallel with top of liner (Figure 9, Item 1). Measure ring gap with thickness gage. Repeat procedure for balance of compression and oil rings.



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

**Table 2. Piston Ring Specifications.**

	<b>MINIMUM</b>	<b>MAXIMUM</b>
<b>RING GAP</b>		
Compression Rings	0.0200 in. (0.508 mm)	0.0460 in. (1.168 mm)
Oil Control Rings	0.0100 in. (0.254 mm)	0.0250 in. (0.635 mm)
<b>CLEARANCE (RING TO GROOVE)</b>		
Top Groove	0.0030 in. (0.076 mm)	0.0060 in. (0.152 mm)
Second Groove	0.0070 in. (0.178 mm)	0.0100 in. (0.254 mm)
Third and Fourth Grooves Model 5063-5299	0.0045 in. (0.114 mm)	0.0070 in. (0.178 mm)
Oil Control Ring Grooves	0.0015 in. (0.038 mm)	0.0055 in. (0.140 mm)

**CAUTION**

File or stone both ends of fire and compression rings from outer surface to inner surface to prevent chipping or peeling of chrome plating on rings.

18. File ends of fire or compression ring if ring gap is too small. Ends of ring must remain square and chamfer on outer edge must be approximately 0.015 inch (0.381 mm).
19. Using thickness gage, measure ring side clearance. Refer to Table 2 for ring side clearance specifications.

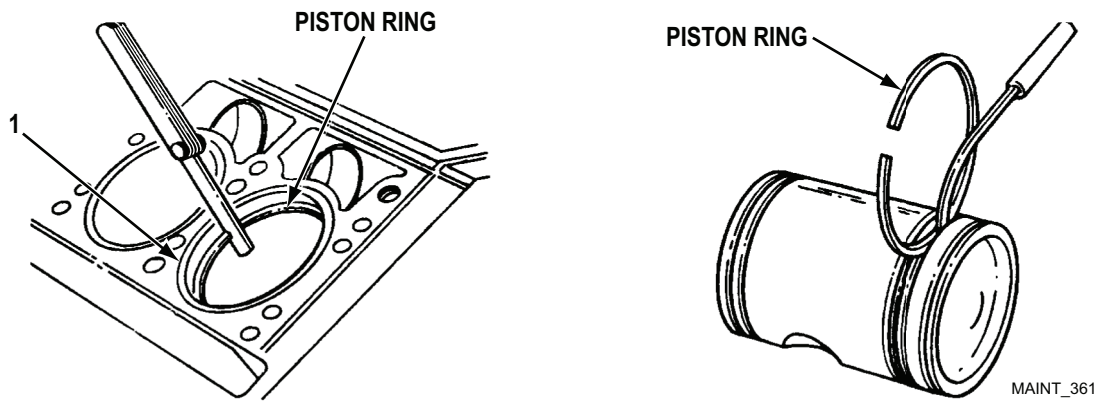


Figure 9. Fitting Piston Rings.

**END OF TASK**

**ASSEMBLY**

## 1. Connecting Rod Assembly to Piston Procedures:

- a. Apply clean engine oil to piston pin, piston pin bushings, and connecting rod bushings.

**CAUTION**

Do not drive piston pin replacer in too far. Replacer may move piston bushing inward and result in reduced piston pin end clearance.

- b. Insert one new piston pin replacer (Figure 10, Item 16) in position. Then place crowned end of installer (Figure 10, Item 22) against replacer and strike installer just hard enough to deflect replacer and seat it evenly in piston (Figure 10, Item 10).

**NOTE**

Since loading on piston pin is downward, it must have free movement to ensure perfect alignment and uniform wear. Therefore, piston pin has a full floating fit in connecting rod and piston bushings. Large clearances of 0.010 inch (0.25 mm) maximum are allowed.

- c. Place upper end of connecting rod assembly (Figure 10, Item 18) between piston pin bosses and in line with piston pin holes. Then slide piston pin (Figure 10, Item 17) in place.
- d. Repeat Step 1.b. for second new piston pin replacer (Figure 10, Item 16).

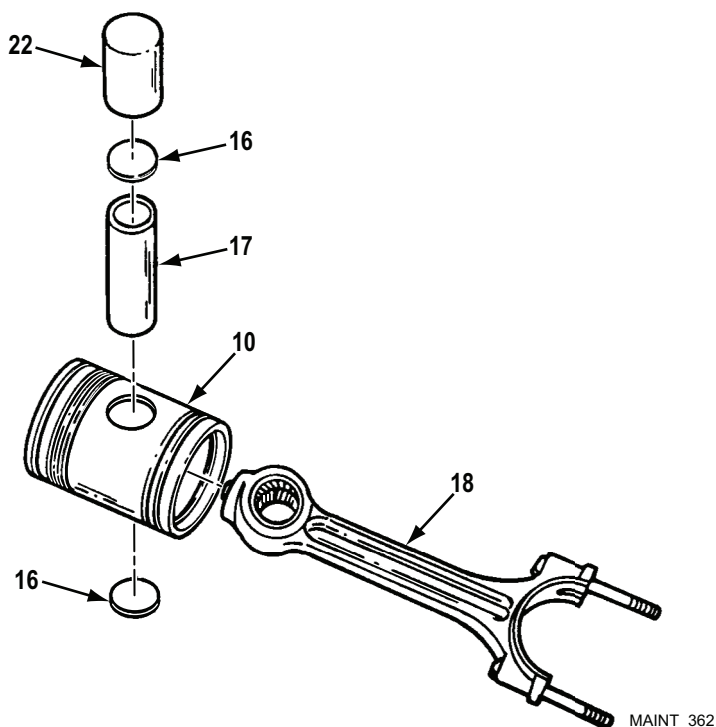


Figure 10. Piston and Connecting Rod Assembly.

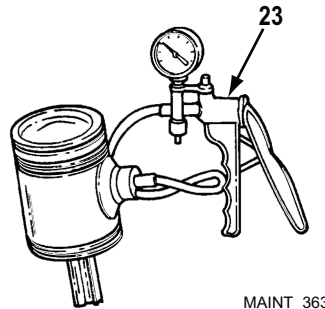
**ASSEMBLY - Continued**

- e. Check for piston pin end clearance by cocking connecting rod and shifting pin in bushings.

**NOTE**

Clean piston surface around piston pin replacer before measuring replacer leakage.

- f. Check each piston pin replacer for proper sealing with vacuum gage tester (Figure 11, Item 23). Place suction cup over replacer and hand operate lever to pull a vacuum of 10.0 inches (254 mm) of mercury on gage. A drop of more than 5.0 inches (127 mm) of mercury in gage reading over 10 seconds indicates air leakage at replacer.



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Figure 11. Piston Replacer Sealing Check.

**ASSEMBLY - Continued**

## 2. Installation – Piston Rings Procedures:

- a. Lubricate new piston rings and piston with engine oil before installing rings.

**CAUTION**

Do not overlap ends of oil control ring expanders. An overlapped expander will cause oil control ring to protrude beyond allowable limits and result in breakage when inserting piston in piston ring compressor.

Do not cut or grind ends of expanders to prevent overlapping. Cutting or grinding ends will decrease expanding force on oil control rings and result in high lubricating oil consumption.

- b. Install new wavy ring expander (Figure 12, Item 14) in oil control ring groove (Figure 12, Item C) in piston (Figure 12, Item 10).
- c. Install new spiral ring expander (Figure 12, Item 15) in oil control ring groove (Figure 12, Item D) in piston (Figure 12, Item 10).

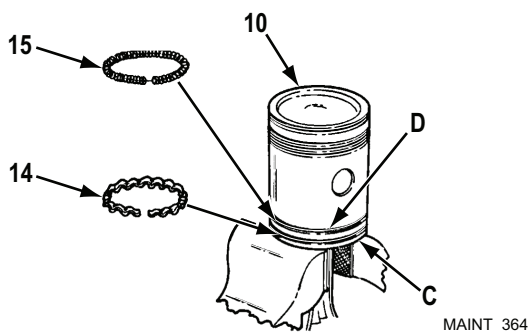


Figure 12. Piston Ring Installation.

**ASSEMBLY - Continued**

**WARNING**



Rings are extremely sharp. Do not grasp or graze sharp edges of oil control rings with bare hands. Failure to comply may result in injury to personnel.

**CAUTION**

Do not spread rings more than necessary to slip over piston. Ring breakage and oversteering will result.

**NOTE**

Upper oil control ring groove requires one thick ring and lower groove requires two thin rings.

Install upper and lower oil control rings in lower groove by hand.

Scraper edges of all oil control rings must face downward (toward bottom of piston) for proper oil control.

- d. Install new lower oil control ring (Figure 13, Item 13) in lower groove with gap 180 degrees from gap in expander (Figure 13, Item 14) in groove C and then install upper oil control ring in lower groove with gap 45 degrees from gap in other ring.
- e. Using piston ring tool, position new upper oil control ring (Figure 13, Item 9) over groove (Figure 13, Item D). Position gap in oil ring 180 degrees from gap in expander (Figure 13, Item 15). Press ring against gap side of expander to prevent ends of expander from overlapping. Align ring with groove and release tension on remover and replace.
- f. Starting with bottom compression ring, install three new compression rings (Figure 13, Item 12) and new fire ring (Figure 13, Item 11) using piston ring tool. Install fire ring with side marked "TOP" or side with dark color dot toward top of piston (Figure 13, Item 10).

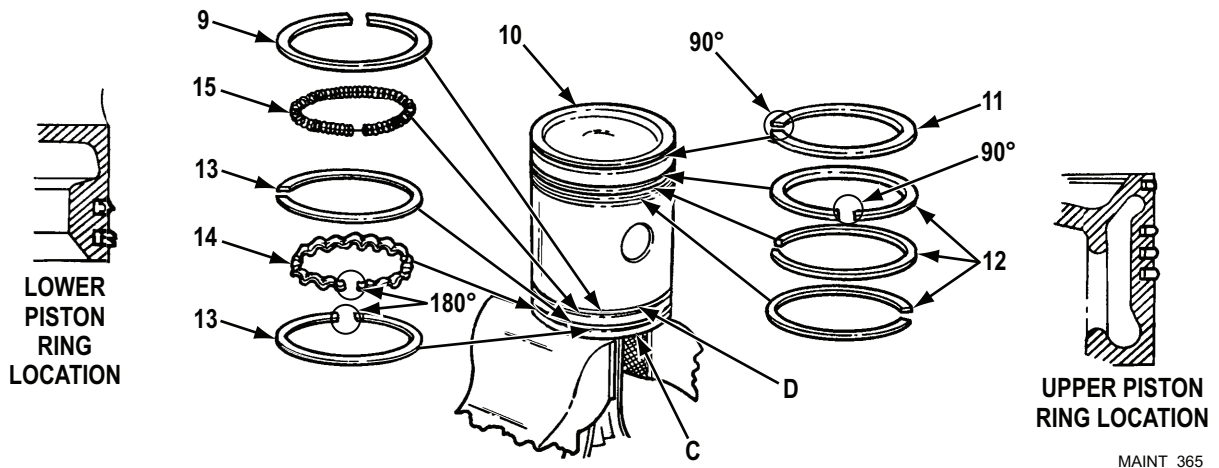


Figure 13. Piston Ring Placement.

**ASSEMBLY - Continued**

- g. Stagger compression and fire ring gaps around piston a minimum of 90 degrees from each other.

**NOTE**

Cylinder liner is installed as a complete assembly, including piston, connecting rod, and cylinder liner. See (WP 0097) for removal instructions.

**3. Piston and Connecting Rod Assembly into Cylinder Liner.**

- a. Apply clean engine oil to piston, rings, and inside surface of piston ring compressor.

**CAUTION**

Inspect piston ring compressor for nicks or burrs, especially at inside diameter of small end. Nicks or burrs on inside diameter of piston ring compressor will result in damage to piston rings.

- b. Place piston ring compressor (Figure 14, Item 24) on a wood block with larger end of piston ring compressor facing up.

**CAUTION**

Piston ring gaps must remain 90 degrees apart on piston for proper compression. Ends of oil control ring expanders must not overlap or ring breakage will result.

- c. Start top of piston and connecting rod assembly (Figure 14, Item 8) straight into piston ring compressor (Figure 14, Item 24). Then push piston down until it contacts wood block.
- d. Place cylinder liner (Figure 14, Item 1) with flange end down on wood block.

**NOTE**

Numbers on side of connecting rod and cap identify the cylinder location where they were originally used.

- e. Place piston ring compressor (Figure 14, Item 24) and piston and connecting rod assembly (Figure 14, Item 8) on liner (Figure 14, Item 1) with numbers on side of connecting rod and cap aligned with matchmark on liner (WP 0097).

**ASSEMBLY - Continued****CAUTION**

Do not force piston into liner. Expanders apply considerable force on oil rings; therefore, exercise care during loading operation to prevent ring breakage.

- f. Push piston and connecting rod assembly (Figure 14, Item 8) down into liner until piston is free of piston ring compressor (Figure 14, Item 24).
  - g. Remove connecting rod cap and then remove piston ring compressor from piston, connecting rod, and liner assembly. Push piston down until compression rings pass cylinder liner ports.
4. Repeat Steps 1–3 for remaining piston and connecting rod assemblies.

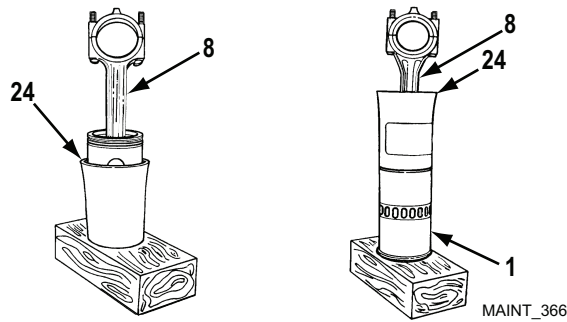


Figure 14. Piston and Connecting Rod into Cylinder Liner.

**END OF TASK**

**INSTALLATION****CAUTION**

Cylinder block bore grooves must be clean. Debris in grooves will cause coolant leakage into engine oil and engine damage can result.

**NOTE**

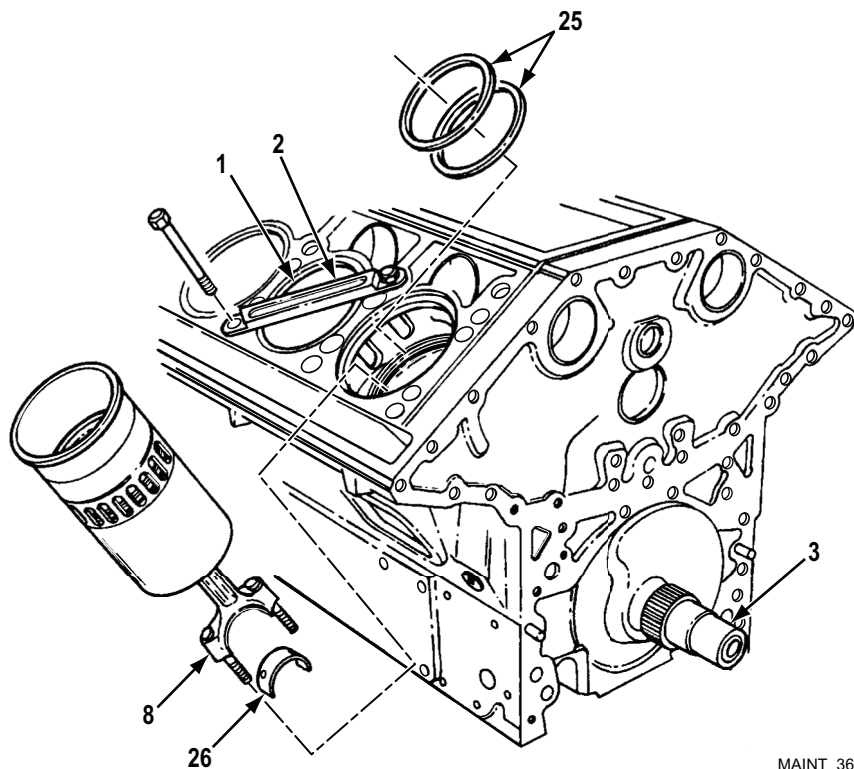
If any pistons and liners are already in engine, use cylinder liner hold-down clamp (Figure 15, Item 2) to retain liners (Figure 15, Item 1) in place when rotating crankshaft.

1. Install two new preformed packings (Figure 15, Item 25) in cylinder block bore grooves.
2. Apply shortening compound or antifreeze to inner surface of new preformed packings (Figure 15, Item 25).
3. Rotate crankshaft (Figure 15, Item 3) until connecting rod journal of cylinder is at bottom of its travel. Wipe journal clean and lubricate with clean engine oil.

**NOTE**

Tang on bearing shell must fit in indentation on connecting rod.

4. Install upper bearing shell (Figure 15, Item 26) (without continuous oil groove) in connecting rod (Figure 15, Item 8). Lubricate bearing shell with clean engine oil.



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Figure 15. Piston Liner Installation.



**INSTALLATION - Continued****CAUTION**

Distance from vertical center line of connecting rod bolts to edges of rod are not equal. When installing piston and connecting rod assembly, ensure narrow side of two adjoining connecting rods are together to avoid cocking of rod.

Do not damage or dislocate bearing shell when guiding end of connecting rod assembly through block bore.

Do not damage preformed packings when sliding piston, connecting rod, and liner assembly into block bore.

5. Place piston, connecting rod, and liner assembly (Figure 17, Item 27) in line with cylinder block bore. Align identification number and letter on rod with outer edge of cylinder block and matchmarks on liner. Guide connecting rod assembly (Figure 17, Item 18) through block bore. Then slide piston, connecting rod, and liner assembly straight into block bore until liner flange rests against block counterbore (Figure 17, Item 28).

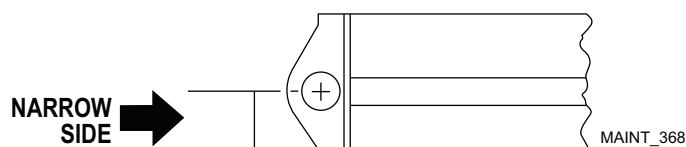


Figure 16. Piston Adjoining Connecting Rods Installation.

**INSTALLATION - Continued**

6. Push piston into liner until upper bearing shell (Figure 17, Item 26) seats firmly on crankshaft journal (Figure 17, Item 4).

**NOTE**

Tang on bearing shell must fit in indentation in connecting rod cap.

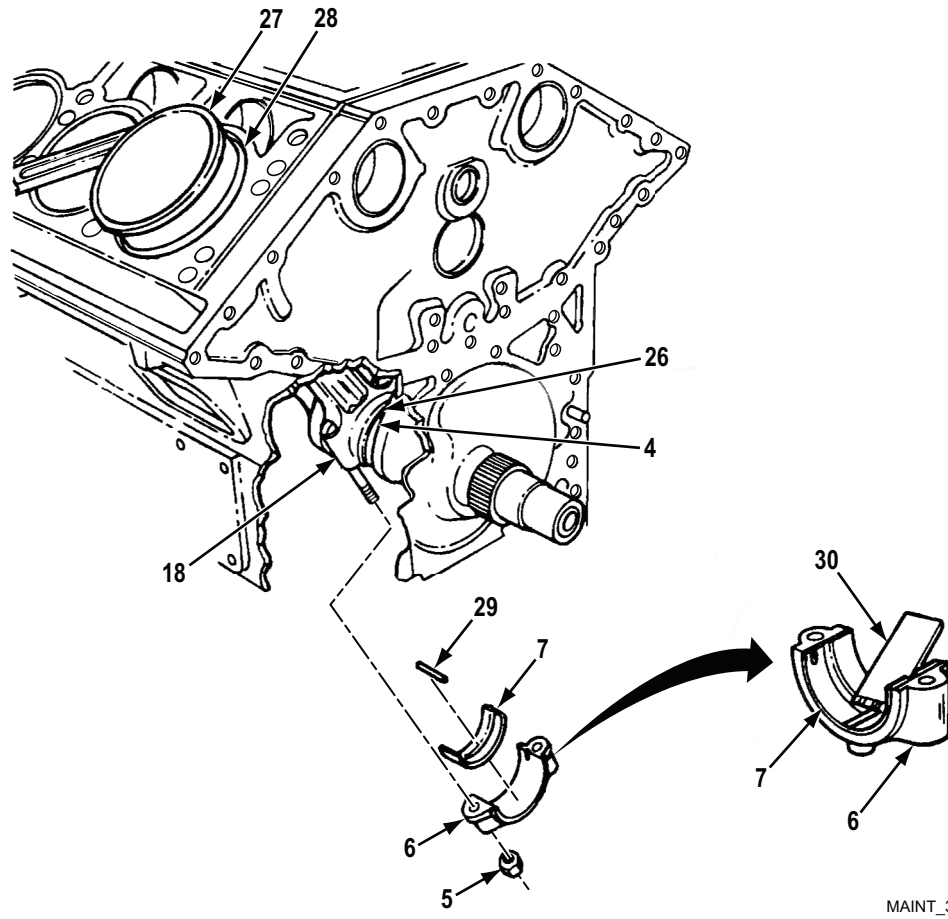
7. Place lower bearing shell (Figure 17, Item 7) (with continuous oil groove) in connecting rod cap (Figure 17, Item 6).

**CAUTION**

Connecting rod bolt must not turn in connecting rod when tightening nut.

8. To check bearing to crankshaft journal clearance, place strip of plastic gage (Figure 17, Item 29) between crankshaft journal (Figure 17, Item 4) and connecting rod cap (Figure 17, Item 6). Torque connecting rod nuts (Figure 17, Item 5) to 40–45 lb-ft (54–61 N·m). Remove connecting rod nuts and cap, and measure width of strip with strip measuring gage (Figure 17, Item 30). Maximum clearance for used parts is 0.0060 inch (0.152 mm).
9. Lubricate bearing with clean engine oil and install bearing cap (Figure 17, Item 6) and lower bearing shell (Figure 17, Item 7) on connecting rod (Figure 17, Item 18) with identification numbers on cap and rod adjacent to each other. Install two connecting rod bolt nuts (Figure 17, Item 5) and torque to 40–45 lb-ft (54–61 N·m).

INSTALLATION - Continued



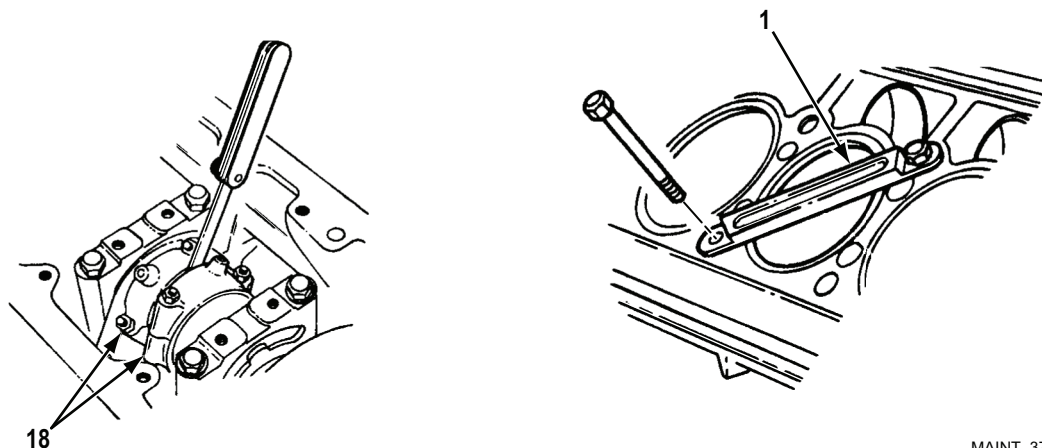
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Figure 17. Piston Connecting Rod Installation.

**INSTALLATION - Continued****NOTE**

If necessary, pry connecting rods apart before measuring side clearance.

10. Using thickness gage, measure side clearance between each pair of connecting rods (Figure 18, Item 18). Clearance limits are 0.008–0.016 inch (0.20–0.41 mm).
11. Repeat Steps 1–10 to install additional liners, pistons, and rod assemblies. Use cylinder liner hold-down clamp (Figure 18, Item 1) to hold installed liners in place.
12. Remove all cylinder liner hold-down clamps (Figure 18, Item 1).



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Figure 18. Piston Cylinder Liner Hold-Down Clamp.

**END OF TASK****FOLLOW ON TASK**

1. Install cylinder head (WP 0073).
2. Install oil pump inlet tubes (model 5063-5299) (WP 0064).
3. Install oil pan (WP 0063).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
PISTON AND CONNECTING ROD REPLACEMENT  
(MODELS 5063-5392, 5063-5393, 5063-539L)**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Remover and Replace, (Piston Ring)  
(WP 0104, Table 1, Item 86)  
Reamer, Cylinder Ridge  
(WP 0104, Table 1, Item 78)  
Cleaner, Piston Ring Groove  
(WP 0104, Table 1, Item 18)  
Die Set, Metal Stamping, Hand  
(WP 0104, Table 1, Item 22)  
Ball Attachment, Micrometer  
(WP 0104, Table 1, Item 10)  
Inserter, Piston (Pin Retainer)  
(WP 0104, Table 1, Item 57)  
Tester, Vacuum Gage  
(Leak Detector, Piston Pin Retainer)  
(WP 0104, Table 1, Item 108)  
Compressor, Piston Ring  
(WP 0104, Table 1, Item 19)  
Clamp, Hold-Down, Cylinder Liner  
(WP 0104, Table 1, Item 17)  
Gage Set, Piston-Liner Thickness  
(WP 0104, Table 1, Item 45)  
Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)  
Vise, Machinist, 4" Jaw  
(WP 0104, Table 1, Item 117)  
Caps, Vise Jaw (WP 0104, Table 1, Item 16)

**Materials/Parts**

Antifreeze (WP 0103, Table 1, Item 3)  
Bolt, Machine  
Qty: (2) (WP 0105, Table 1, Item 131)  
Carbon Removing Compound  
(WP 0103, Table 1, Item 6)  
Cleaning Solvent (WP 0103, Table 1, Item 8)

**Materials/Parts (cont.)**

Crocus Cloth (WP 0103, Table 1, Item 10)  
Gage, Plastic, Green (WP 0103, Table 1, Item 15)  
Gage, Plastic, Red (WP 0103, Table 1, Item 16)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Packing, Preformed  
Qty: (2) (WP 0105, Table 1, Item 64)  
Retainer, Piston Pin  
Qty: (2) (WP 0105, Table 1, Item 128)  
Ring, Piston  
Qty: (2) (WP 0105, Table 1, Item 134)  
Ring, Piston (WP 0105, Table 1, Item 135)  
Ring Set, Oil  
Qty: (2) (WP 0105, Table 1, Item 138)  
Seal, Ring (WP 0105, Table 1, Item 130)  
Shortening Compound  
(WP 0103, Table 1, Item 58)  
Spacer Sleeve  
Qty: (2) (WP 0105, Table 1, Item 129)  
Stone, Sharpening X-Fine  
(WP 0103, Table 1, Item 62)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)  
Wood Block (WP 0103, Table 1, Item 71)

**References**

WP 0097  
ASTM E1444

**Equipment Condition**

Oil pan removed (WP 0063)  
Oil pump inlet tubes removed (WP 0065)  
Cylinder head removed (WP 0073)

---

**REMOVAL**

1. Install cylinder liner hold-down clamp (Figure 1, Item 2) to each cylinder to anchor liners (Figure 1, Item 1) during crankshaft rotation.
2. Rotate crankshaft (Figure 1, Item 4) until connecting rod journal (Figure 1, Item 5) is at bottom of its travel.
3. Remove cylinder liner hold-down clamp (Figure 1, Item 2) from cylinder being worked on.

**CAUTION**

Remove all carbon deposits at top of liner before removing piston from cylinder liner.  
Piston ring breakage can occur when carbon deposits are present.

4. Using a cylinder ridge reamer, remove carbon deposits from upper inner surfaces of cylinder liner (Figure 1, Item 1).
5. Remove two nuts (Figure 1, Item 6), cap (Figure 1, Item 7), and lower bearing shell (Figure 1, Item 8) from piston and connecting rod assembly (Figure 1, Item 9).

**NOTE**

Tag piston assembly with cylinder number for matching during reassembly.

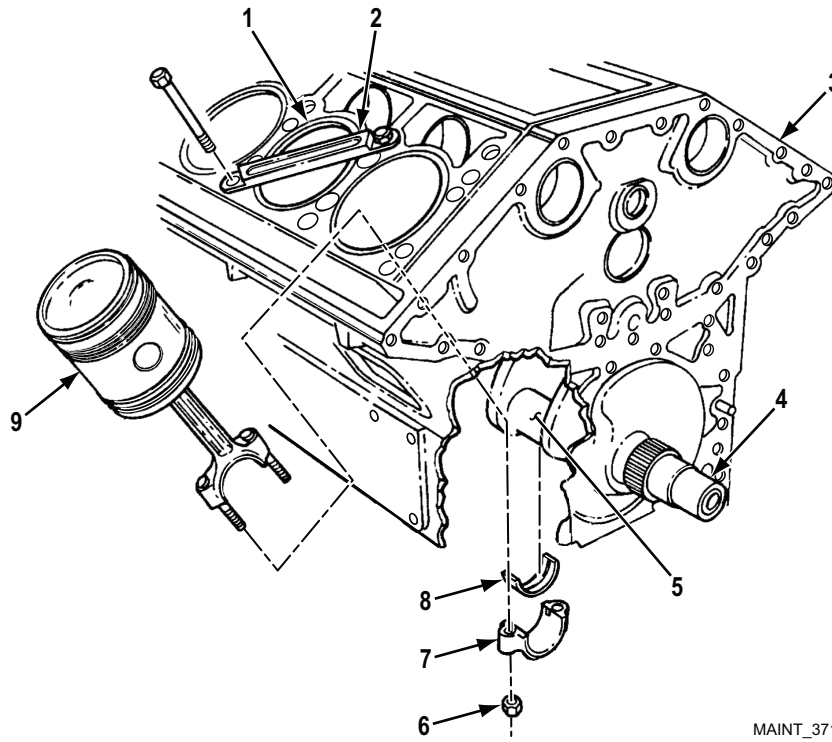
6. Push piston and connecting rod assembly (Figure 1, Item 9) out through top of cylinder block (Figure 1, Item 3).

**NOTE**

Always assemble cap with stamped number on same side as stamped on lower part of connecting rod to ensure cap is not rotated 180 degrees.

7. Assemble bearing cap (Figure 1, Item 7), lower bearing shell (Figure 1, Item 8), and two nuts (Figure 1, Item 6) on piston and connecting rod assembly (Figure 1, Item 9).
8. Repeat Steps 2–7 for remaining piston and connecting rod assemblies (Figure 1, Item 9).

REMOVAL - Continued



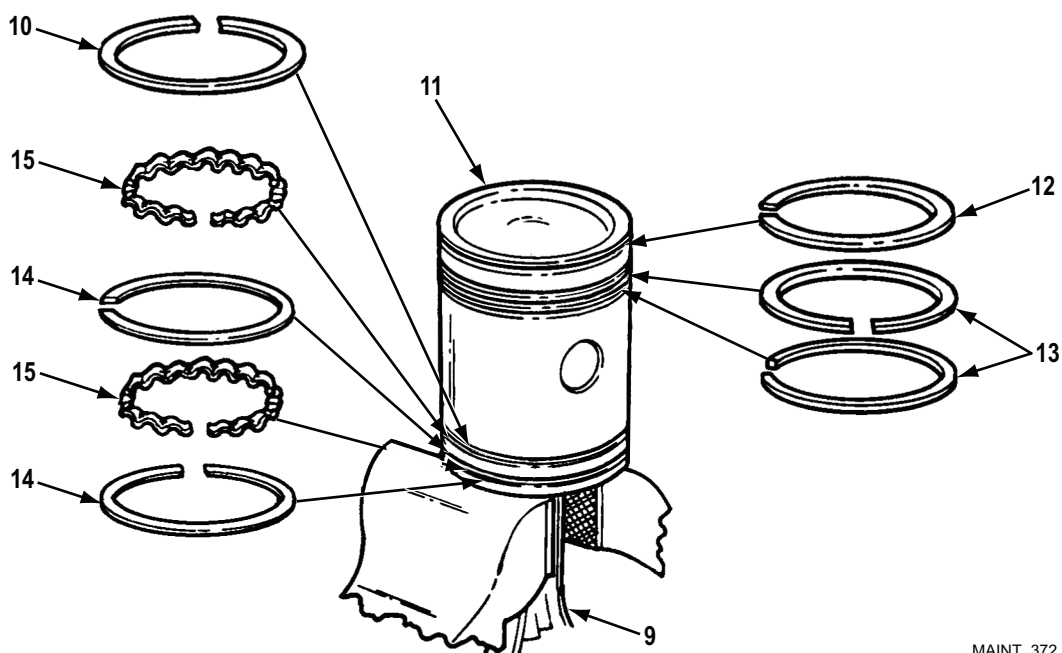
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Figure 1. Piston and Connecting Rod Removal.

END OF TASK

**DISASSEMBLY**

1. Secure piston and connecting rod assembly (Figure 2, Item 9) in a machinist vise with vise jaw caps.
2. Using piston ring tool, remove fire ring (Figure 2, Item 12), two compression rings (Figure 2, Item 13), thick oil control ring (Figure 2, Item 10), and two thin oil control rings (Figure 2, Item 14) from piston assembly (Figure 2, Item 11). Discard rings.
3. Remove two oil ring expanders (Figure 2, Item 15) from lower grooves in piston. Discard expanders.
4. Secure piston and connecting rod assembly (Figure 2, Item 8) upside down in a machinist vise with vise jaw caps.
5. Loosen two bolts (Figure 3, Item 23) from connecting rod (Figure 3, Item 22) and piston pin (Figure 3, Item 20). Remove assembly from machinist vise.
6. Remove two bolts, two spacers (Figure 3, Item 24), and connecting rod. Discard bolts and spacers.
7. Lay piston assembly (Figure 2, Item 11) horizontally on flat surface.



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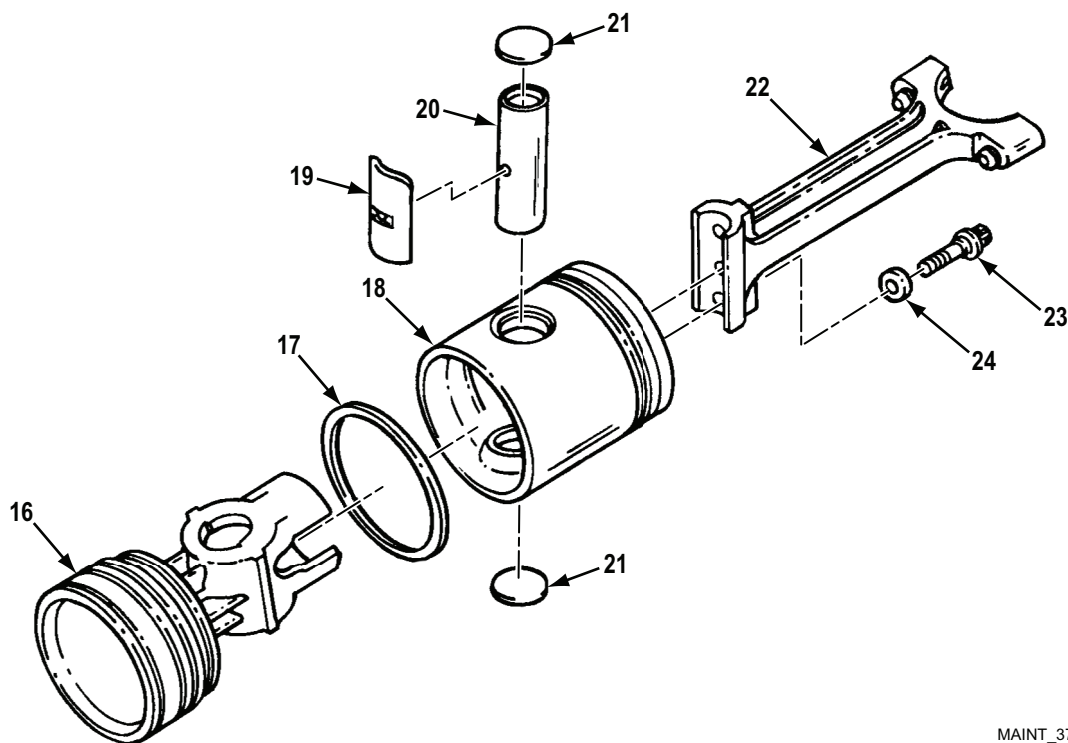
Figure 2. Piston Ring Disassembly.



**DISASSEMBLY - Continued****CAUTION**

Use care not to damage piston pin while removing vacuum gage testers.

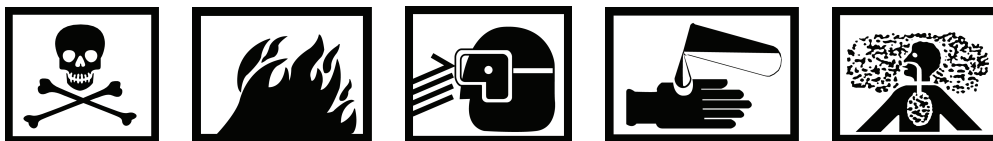
8. Punch a hole through center of one vacuum gage tester (Figure 3, Item 21) with a narrow chisel or punch and pry retainer from piston. Remove opposite retainer in same manner. Discard retainers.
9. Remove piston pin (Figure 3, Item 20) from piston assembly.
10. Separate piston skirt (Figure 3, Item 18) from piston dome (Figure 3, Item 16).
11. Remove ring seal (Figure 3, Item 17) from piston dome (Figure 3, Item 16). Discard ring seal.
12. Remove piston pin bushing (Figure 3, Item 19) from piston dome (Figure 3, Item 16).
13. Repeat Steps 1–8 for remaining piston and connecting rod assemblies (Figure 3, Item 9).



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Figure 3. Piston and Connecting Rod Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon removing compound. Provide adequate ventilation. Avoid inhaling fumes and contact with skin. If compound is splashed on skin, flush with water and wash with alcohol. Alcohol containing 2 or 3 percent camphor is preferable. If contact with eyes is made, flush eyes with water and get medical aid immediately. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

1. Clean piston components with cleaning solvent and dry with compressed air. If cleaning solvent does not remove carbon deposits, use carbon-removing compound which will not harm bushings or tin plate on piston skirt.
2. Clean ring grooves in dome with suitable tool or piece of an old compression ring ground to bevel edge.

**CAUTION**

Do not wire brush or glass bead piston skirt. Skirt is tin plated and wire brushing and glass beading will remove plating.

3. Clean inside surfaces of piston dome and skirt. Clean oil drain holes in lower half of piston skirt. Do not enlarge holes while cleaning them.

**CAUTION**

Do not use crocus cloth on bushing side of pin. Bushing side requires a polished finish.

4. Use crocus cloth wet with fuel oil to remove any trace of fretting or corrosion on pin-contacting surface of connecting rod.

**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA****NOTE**

Overheating or burned spots on piston skirt or dome may indicate an obstruction in connecting rod oil passage.

1. Examine piston skirt and dome for score marks, cracks, damaged ring groove lands, or indications of overheating. Using a crocus cloth, remove light score marks. Replace piston skirt or dome severely scored or overheated.
2. Check cylinder liner and block bore for excessive out of round, taper, or high spots which could cause failure of piston (WP 0097).

**CAUTION**

Do not polish or refinish piston pin. Hand polishing or refinishing will destroy precision finish and result in rapid bushing wear.

3. Inspect piston pin (Figure 4, Item 20) for signs of fretting.
4. New piston pin has diameter of 1.3746–1.3750 inches (34.915–34.925 mm). Replace piston pin if worn to diameter of 1.3730 inches (34.874 mm) or less.

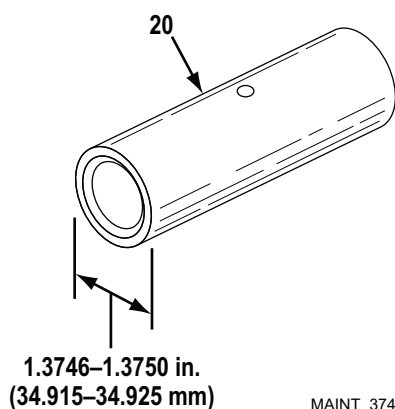


Figure 4. Piston Pin Inspection.

5. Check connecting rod for visual damage. Discard rod if bent, had previous bearing failure, was overheated (blued) at top or bottom end, is fretted at split line between rod and cap, or has excessive pound in of bolt head or nut.
6. Check for cracks by magnetic particle inspection method (reference ASTM E1444).
7. Inspect connecting rod bearing bores for burrs or foreign particles. Clean up minor burrs with crocus cloth using circular motion.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

- If new connecting rod is required, stamp cylinder number on connecting rod (Figure 5, Item 22) and cap (Figure 5, Item 7) using metal stamping die set.

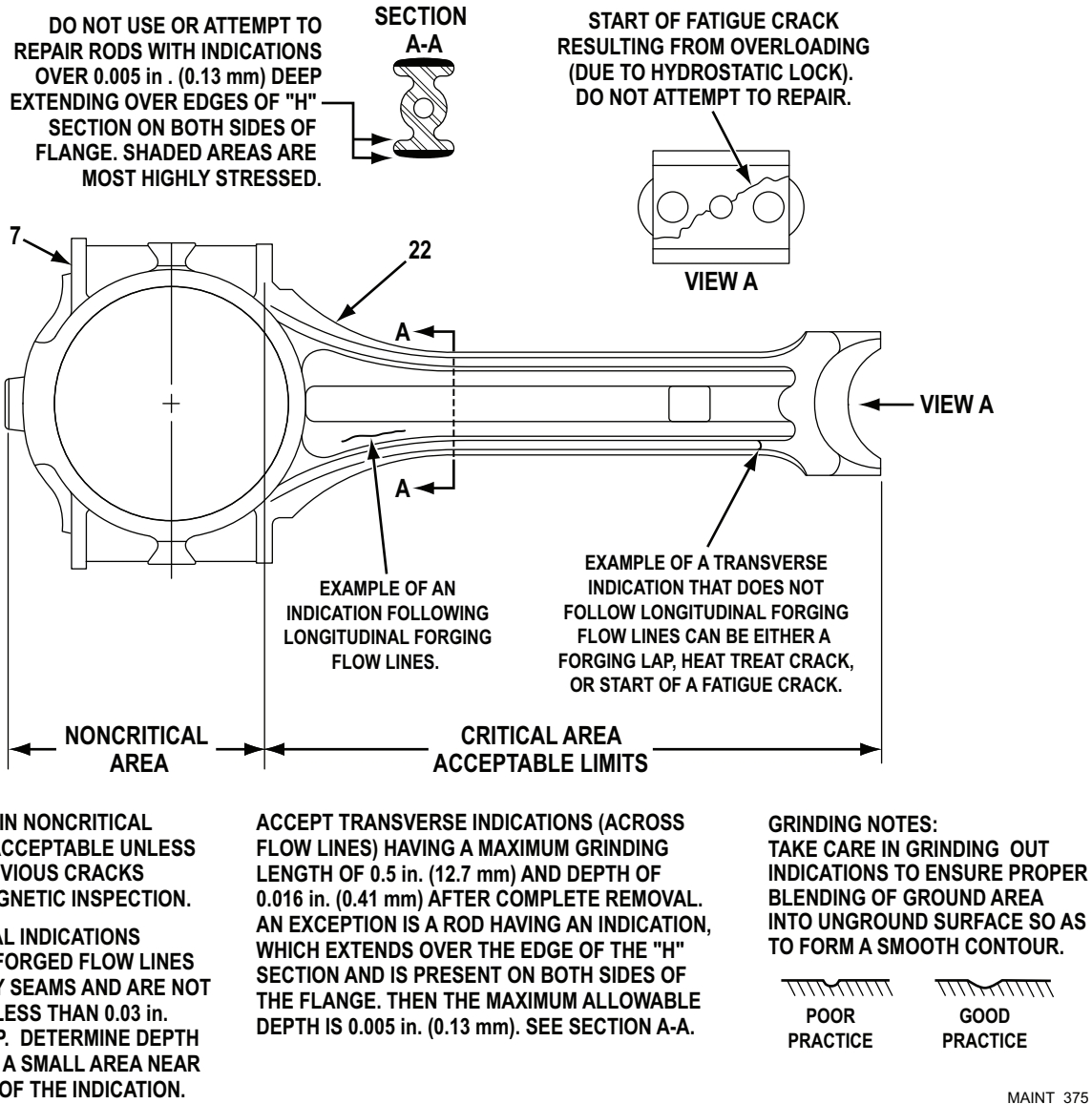


Figure 5. Connecting Rod Inspection Procedures.

- Inspect bearing shells for scoring, pitting, flaking, etching, and dirt grooving. If defective, discard bearing shells.
- Discard bearing shells with bright spots on backs indicating movement in bearing caps or supports.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

**NOTE**

If one bearing shell is less than minimum thickness shown in Table 1, replace both bearing shells (upper and lower).

11. Using a micrometer ball attachment (Figure 6, Item 25), measure thickness of lower and upper bearing shells at point (Figure 6, Item A), 90 degrees from parting line.

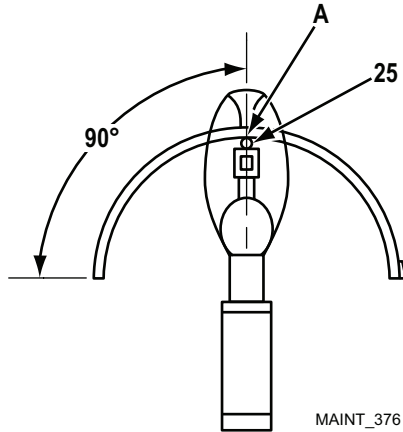


Figure 6. Connecting Rod Bearing Thickness.

**Table 1. Connecting Rod Bearing Shell Thickness.**

BEARING SIZE	NEW BEARING THICKNESS *	MINIMUM USED THICKNESS *
Standard	0.1247–0.1252 in. (3.167–3.180 mm)	0.1230 in. (3.124mm)
0.002 in. Undersized	0.1257–0.1262 in. (3.193–3.205 mm)	0.1240 in. (3.150mm)
0.010 in. Undersized	0.1297–0.1302 in. (3.294–3.307 mm)	0.1280 in. (3.251mm)
0.020 in. Undersized	0.1347–0.1352 in. (3.421–3.434 mm)	0.1330 in. (3.378mm)
0.030 in. Undersized	0.1397–0.1402 in. (3.548–3.561 mm)	0.1380 in. (3.505mm)
* Thickness 90 degrees from parting line of bearing.		

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

**NOTE**

Fit new or used piston skirt to corresponding cylinder liner and retain as a matched set for assembly in engine.

- 12. Using micrometer set, measure piston skirt outside diameter (Figure 7, Item B) parallel and perpendicular to piston pin bore at room temperature 70°F (21°C). Diameter must be 3.8695–3.8717 inches (98.285–98.341 mm).

**NOTE**

Thickness gage must be perfectly flat and free of nicks and bends.

Select thickness gage thickness requiring six pounds pull to move. Piston to liner clearance will be 0.001 inch greater than thickness of thickness gage used. For example, a 0.004 inch thickness gage indicates 0.005 inch clearance when withdrawn with a six pound pull.

- 13. With cylinder liner (Figure 7, Item 1) installed in cylinder block, hold piston skirt (Figure 7, Item 18) upside down in liner and check clearance in four places, 90 degrees apart, using a thickness gage (Figure 7, Item 27) attached to spring scale (Figure 7, Item 26). Clearance must be 0.0035–0.0072 inch (0.089–0.183 mm) with new parts and a maximum of 0.012 inch (0.30 mm) for used parts.
- 14. If binding occurs between piston and liner, remove piston and examine piston and liner for burrs. Remove burrs on skirt with X-fine sharpening stone. Remove burrs in liner with fine flat hone and recheck clearance.

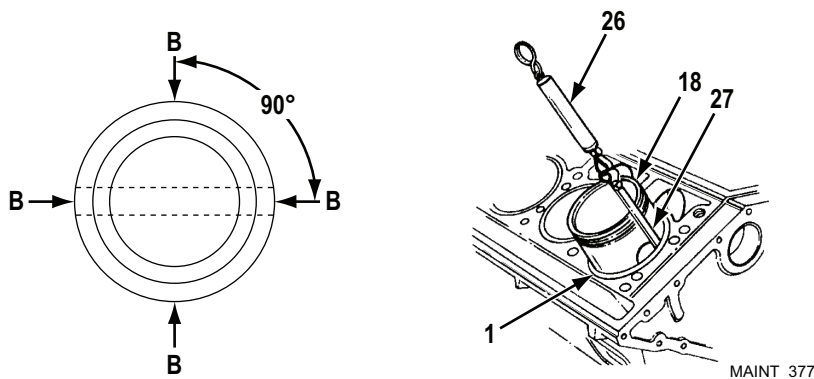


Figure 7. Fitting Piston.

- 15. Insert top piston ring inside cylinder liner (Figure 8, Item 1) in normal area of ring travel. Using piston skirt, push ring down parallel with top of liner. Measure ring gap with piston-liner thickness gage set. Refer to Table 2 for specifications. Repeat procedure for balance of compression and oil rings.

**Table 2. Piston Ring Specifications.**

	<b>MINIMUM</b>	<b>MAXIMUM</b>
<b>RING GAP</b>		
Fire Ring	0.0230 in. (0.584 mm)	0.0380 in. (0.965 mm)

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

**Table 2. Piston Ring Specifications - Continued.**

	<b>MINIMUM</b>	<b>MAXIMUM</b>
Two Compression Rings	0.0200 in. (0.508 mm)	0.0300 in. (0.762 mm)
Upper Oil Control Ring	0.0070 in. (0.178 mm)	0.0170 in. (0.432 mm)
Two Lower Oil Control Rings	0.0100 in. (0.254 mm)	0.0250 in. (0.635 mm)
<b>CLEARANCE (RING TO GROOVE)</b>		
Top Groove	0.0030 in. (0.076 mm)	0.0060 in. (0.152 mm)
Second Groove	0.0070 in. (0.178 mm)	0.0100 in. (0.254 mm)
Third Groove	0.0050 in. (0.127 mm)	0.0080 in. (0.203 mm)
Upper Oil Control Ring Groove	0.0005 in. (0.013 mm)	0.0040 in. (0.102 mm)
Lower Oil Control Ring Groove	0.0015 in. (0.038 mm)	0.0055 in. (0.140 mm)

**CAUTION**

File or stone both ends of fire and compression rings from outer surface to inner surface to prevent chipping or peeling of chrome plating on ring.

16. File ends of compression ring if ring gap is too small. Ends of ring must remain square and chamfer on outer edge must be approximately 0.015 inch (0.038 mm).
17. Using piston-liner thickness gage set, measure side clearance of ring in piston dome (Figure 8, Item 16). Refer to Table 2 for ring side clearance specifications.

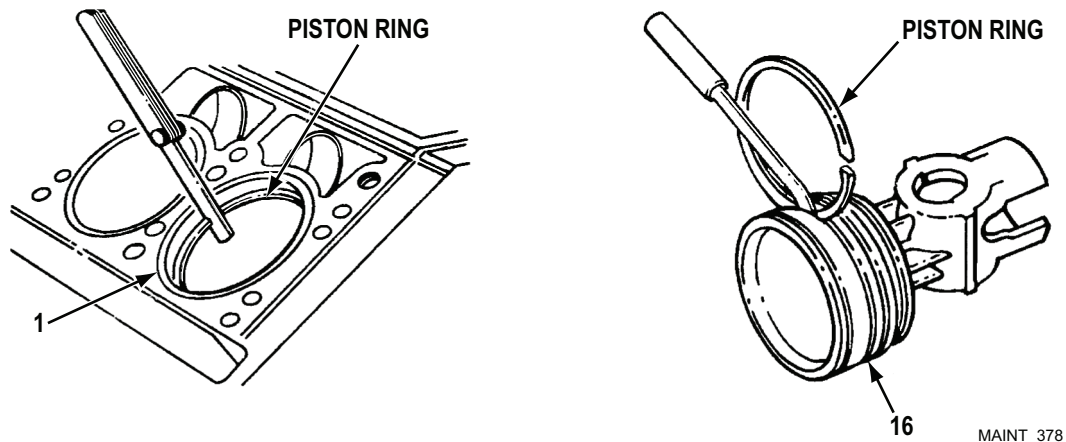


Figure 8. Fitting Piston Rings.

**END OF TASK**

**ASSEMBLY**

1. Piston and rod assembly procedures:
  - a. Install pin bushing (Figure 9, Item 19) in piston dome (Figure 9, Item 16). Bushing must slide into piston dome without force.

**NOTE**

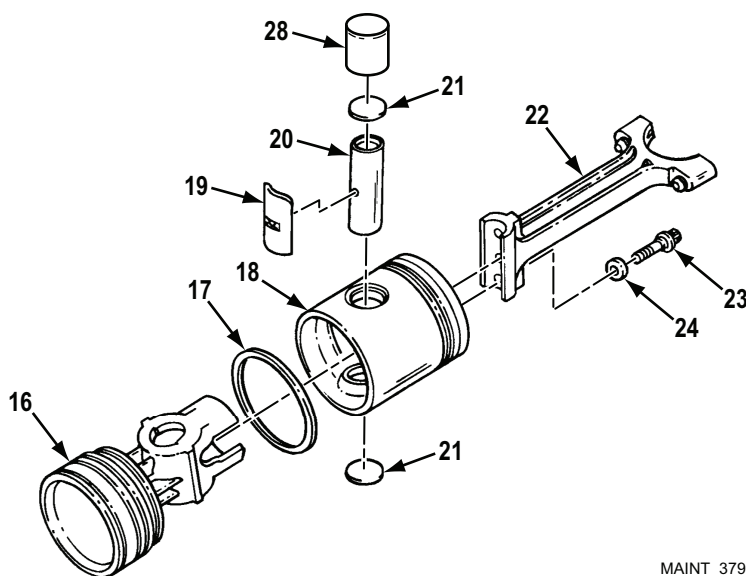
Soak ring seal in engine oil for 15 minutes prior to installation on dome.

- b. Lubricate ring seal (Figure 9, Item 17) with engine oil and install in groove on piston dome (Figure 9, Item 16).
- c. Align piston pin holes in skirt (Figure 9, Item 18) and dome (Figure 9, Item 16), then push skirt into position on dome.
- d. Apply clean engine oil to piston pin (Figure 9, Item 20) and piston pin bushing (Figure 9, Item 19) and install piston pin.
- e. Install spacers (Figure 9, Item 24) on piston pin bolts (Figure 9, Item 23). Apply small amount of Water Displacing Compound, or equivalent, to bolt threads and bolt head contact surfaces.
- f. Install connecting rod (Figure 9, Item 22), two spacers (Figure 9, Item 24), and two bolts (Figure 9, Item 23) on piston pin (Figure 9, Item 20). Tighten bolts finger tight.
- g. Clamp connecting rod (Figure 9, Item 22) in machinist vise with vise jaw caps and torque piston pin bolts (Figure 9, Item 23) to 30–35 lb-ft (41–47 N·m). Do not exceed this torque.

**CAUTION**

Ensure vacuum gage testers do not buckle during installation and seat completely in counterbore with spacing even around retainer to seal properly.

- h. Insert first vacuum gage tester (Figure 9, Item 21) in position. Place crowned end of piston pin installer (Figure 9, Item 28) against retainer. Strike tool just hard enough to deflect retainer and to seat it evenly in skirt (Figure 9, Item 18). Install second retainer in same manner.



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Figure 9. Piston and Connecting Rod Assembly.



**ASSEMBLY - Continued****NOTE**

Clean piston surface around vacuum gage tester before checking retainer for leakage.

- i. Check each retainer for proper sealing with vacuum gage tester (Figure 10, Item 29). Place suction cup over retainer and hand operate lever to pull a vacuum of 10.0 inches of mercury (34 kPa) on gage. A drop of more than 5.0 inches of mercury (17 kPa) over 10 seconds indicates air leakage at retainer.

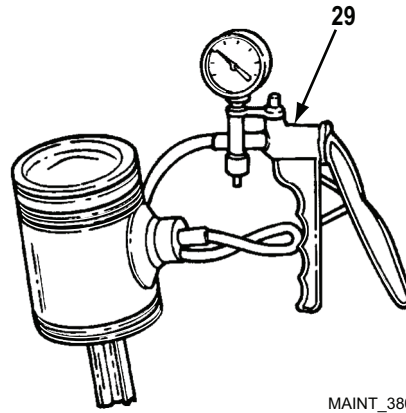


Figure 10. Piston Retainer Seal Check.

**ASSEMBLY - Continued**

## 2. Installation - Piston Rings Procedures:

- a. Lubricate piston rings and piston with engine oil before installing rings.

**CAUTION**

Do not allow ends of oil ring expanders to overlap. An overlapped expander will cause oil ring to protrude beyond allowable limits and result in breakage when piston is inserted in piston ring compressor during installation in cylinder liner.

Do not cut or grind ends of expanders to prevent overlapping. Cutting or grinding ends will decrease expanding force on oil control rings and result in high lubricating oil consumption.

- b. Install two oil ring expanders (Figure 11, Item 15) in oil control ring grooves in piston skirt (Figure 11, Item 18) with legs of free ends pointing toward bottom of piston.

**WARNING**

Rings are extremely sharp. Do not grasp or graze sharp edges of oil control rings with bare hands. Failure to comply may result in injury to personnel.

**CAUTION**

Do not spread rings anymore than necessary to slip them over piston. Ring breakage and overstressing will result.

**NOTE**

Install oil control rings in lower groove by hand.

Upper oil control ring groove requires one thick ring and lower groove requires two thin rings.

Install upper oil control ring in lower groove with scraper edge facing up. Install lower oil control ring with scraper edge facing down.

- c. Install lower thin oil control ring (Figure 11, Item 14), scraper edge down, in groove C (Figure 11, Item C) (lower groove) with gap in ring 180 degrees from gap in expander (Figure 11, Item 15). Then install upper ring (Figure 11, Item 14), scraper edge up, in groove C (Figure 11, Item C) with gap 180 degrees from gap in lower ring.

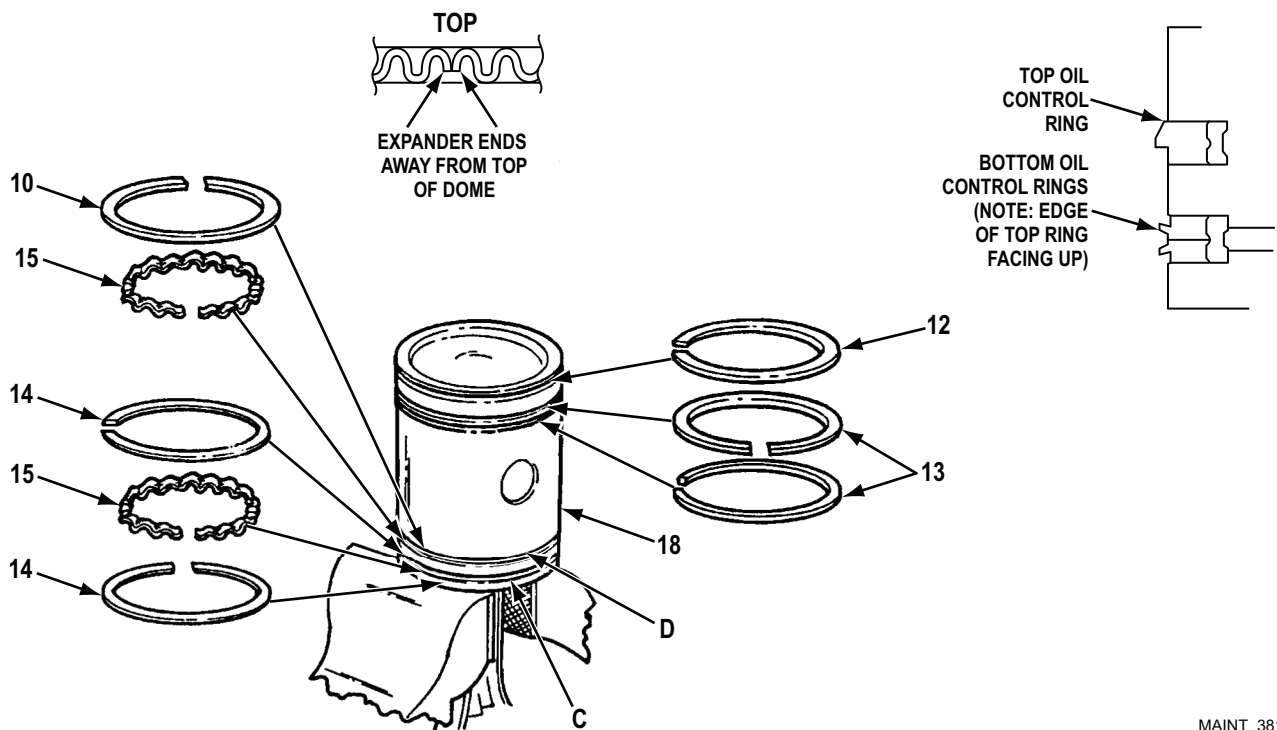
**ASSEMBLY - Continued**

- d. Using piston ring tool, install thick oil control ring (Figure 11, Item 10) in groove D (Figure 11, Item D) (upper groove). Position gap in ring 180 degrees from gap in expander (Figure 11, Item 15). Press ring against gap side of expander to prevent ends of expander from overlapping. Align ring with groove and release tension on remover and replace.

**NOTE**

Install fire ring (Figure 11, Item 12) with dark side (with prestress mark) toward top of dome.

- e. Using piston ring tool and starting from bottom, first install two compression rings (Figure 11, Item 13) and then install fire ring (Figure 11, Item 12).
- f. Stagger ring gaps around piston a minimum of 90 degrees from each other.



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Figure 11. Piston Ring Placement.

**ASSEMBLY - Continued**

3. Piston and Connecting Rod Assembly to Cylinder Liner.
  - a. Apply clean engine oil to piston, rings, and inside surface of piston ring compressor.

**CAUTION**

Inspect piston ring compressor for nicks or burrs, especially at inside diameter of straight end. Nicks or burrs on inside diameter of piston ring compressor will result in damage to piston rings.

- b. Place piston ring compressor (Figure 12, Item 30) on wood block, with larger end of piston ring compressor facing up.

**CAUTION**

Piston ring gaps must be 90 degrees apart on piston for proper compression. Ends of oil control ring expanders must not overlap or breakage will result.

- c. Start top of piston and connecting rod assembly (Figure 12, Item 8) straight into piston ring compressor (Figure 12, Item 30). Then push piston down until it contacts wood block.
  - d. Place liner (Figure 12, Item 1) with flange end down on wood block.

**NOTE**

Numbers on side of connecting rod and cap identify rod with cap and indicate particular cylinder in which they are used.

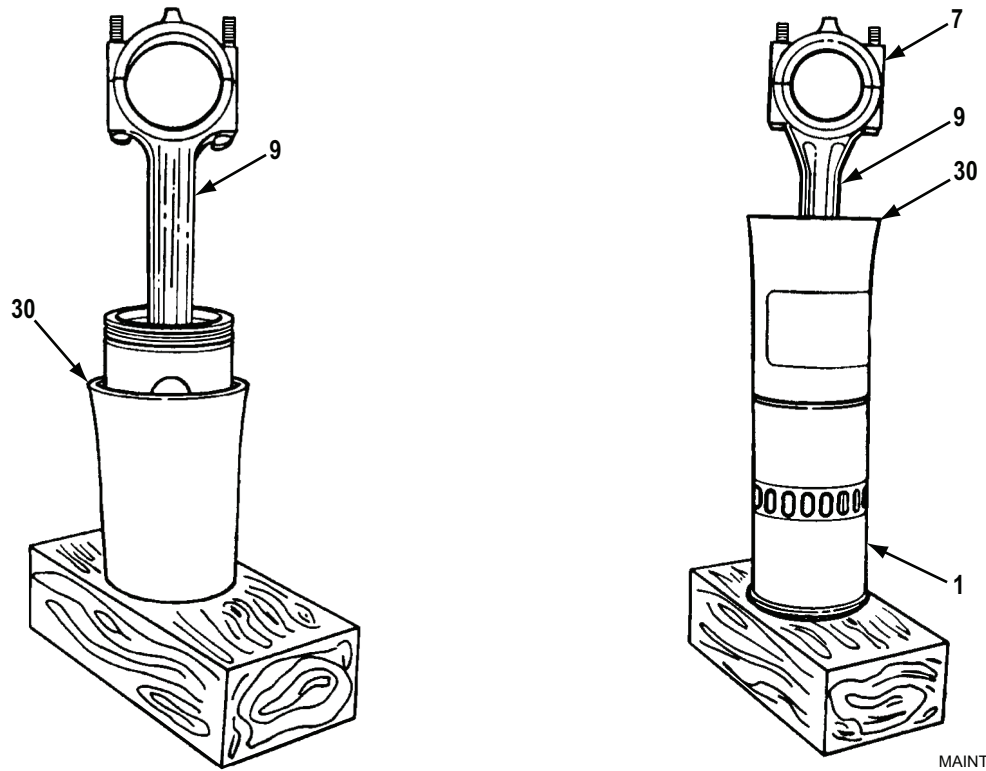
- e. Place piston ring compressor (Figure 12, Item 30) and piston and connecting rod assembly (Figure 12, Item 9) on liner (Figure 12, Item 1) with numbers on side of connecting rod and cap aligned with matchmark on liner.

**CAUTION**

Do not force piston into liner. Expanders apply considerable force on oil rings; therefore, exercise care during loading operation to prevent ring breakage.

- f. Push piston and connecting rod assembly (Figure 12, Item 9) down into liner (Figure 12, Item 1) until piston is free of piston ring compressor (Figure 12, Item 30).
  - g. Remove connecting rod cap (Figure 12, Item 7) and then remove piston ring compressor (Figure 12, Item 30) from piston and connecting rod assembly (Figure 12, Item 9). Push piston down until compression rings pass cylinder liner ports.
  - h. Repeat Steps 3.a. – 3.g. for remaining pistons and liners.

ASSEMBLY - Continued



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Figure 12. Piston and Connecting Rod Into Cylinder Liner.

END OF TASK

**INSTALLATION****CAUTION**

Cylinder block bore grooves must be clean. Debris in grooves will cause coolant leakage into engine oil and engine damage can result.

**NOTE**

If any pistons and liners are already in engine, use cylinder liner hold-down clamp (Figure 13, Item 2) to retain liners (Figure 13, Item 1) in place when crankshaft is rotated.

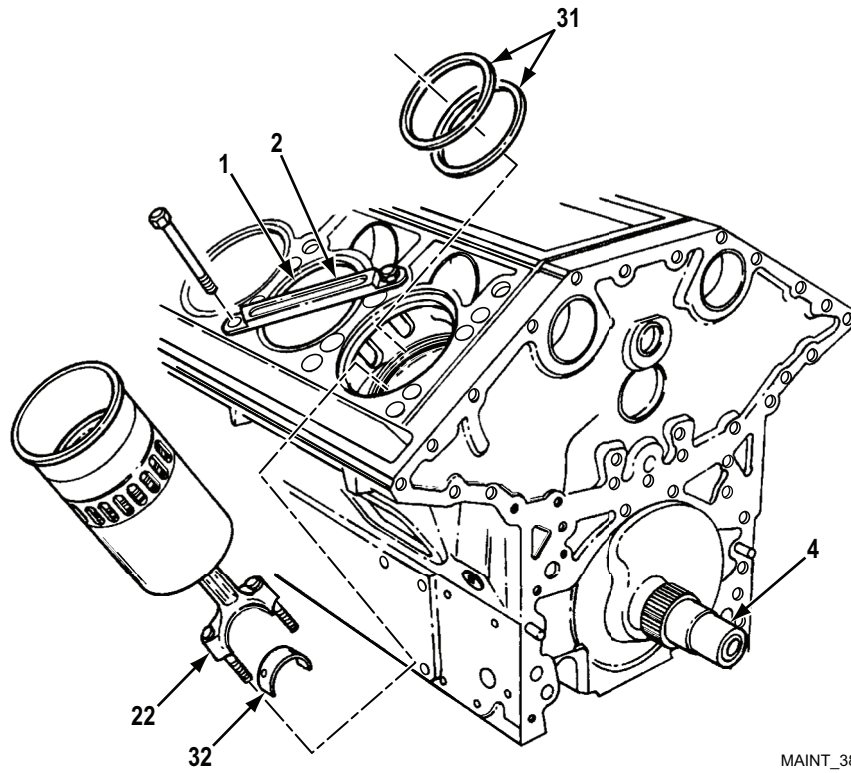
1. Install two preformed packings (Figure 13, Item 31) in cylinder block bore grooves.
2. Apply shortening compound or antifreeze to inner surface of preformed packings (Figure 13, Item 31).
3. Rotate crankshaft (Figure 13, Item 4) until connecting rod journal of cylinder is at bottom of its travel. Wipe journal clean and lubricate with clean engine oil.

**NOTE**

Tang on bearing shell must fit in indentation on connecting rod.

4. Install upper bearing shell (Figure 13, Item 32) (without continuous oil groove) in connecting rod (Figure 13, Item 22). Lubricate bearing shell with clean engine oil.

INSTALLATION - Continued



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Figure 13. Piston Liner Installation.

**INSTALLATION - Continued****CAUTION**

Distance from vertical center line of connecting rod bolts to edges of rod are not equal. When installing piston and connecting rod assembly, ensure narrow side of two adjoining connecting rods are together to avoid cocking of rod (Figure 14).

Do not damage or dislocate bearing shell when guiding end of connecting rod assembly through block bore.

Do not damage preformed packings when sliding piston, connecting rod, and liner assembly into block bore.

5. Position piston, rod, and liner assembly (Figure 15, Item 33) in line with cylinder block bore. Align identification number and letter on rod face with outer edge of cylinder block and matchmarks on liner. Guide end of connecting rod (Figure 15, Item 22) through block bore. Then slide piston, connecting rod, and liner assembly straight into block bore until liner flange rests against block counterbore (Figure 15, Item 37).

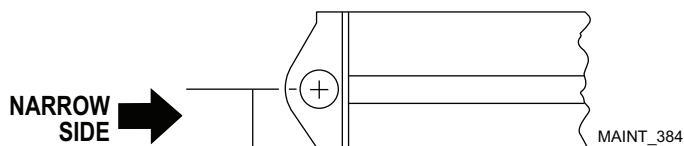


Figure 14. Connecting Rod Bolt Location.

6. Push piston into liner until upper bearing shell (Figure 15, Item 34) is firmly seated on crankshaft journal (Figure 15, Item 5).

**NOTE**

Tang on bearing shell must fit in indentation in connecting rod cap.

7. Place lower bearing shell (Figure 15, Item 8) (with continuous oil groove) in connecting rod cap (Figure 15, Item 7).



**INSTALLATION - Continued****NOTE**

Connecting rod bolt must not turn in connecting rod when torquing nut.

8. To check bearing to crankshaft journal clearance, place a plastic gage strip (Figure 15, Item 35) between crankshaft journal (Figure 15, Item 5) and connecting rod cap (Figure 15, Item 7). Tighten connecting rod nuts (Figure 15, Item 6) to 40–45 lb-ft (54–61 N·m). Remove connecting rod nuts and cap, and measure width of plastic gage with measuring strip (Figure 15, Item 36). Maximum clearance with used parts is 0.006 inch (0.152 mm).
9. Lubricate lower bearing shell (Figure 15, Item 8) with clean engine oil and install bearing cap (Figure 15, Item 7) and bearing shell on connecting rod (Figure 15, Item 22) with identification numbers on cap and rod adjacent to each other. Torque connecting rod bolt nuts (Figure 15, Item 6) to 40–45 lb-ft (54–61 N·m).

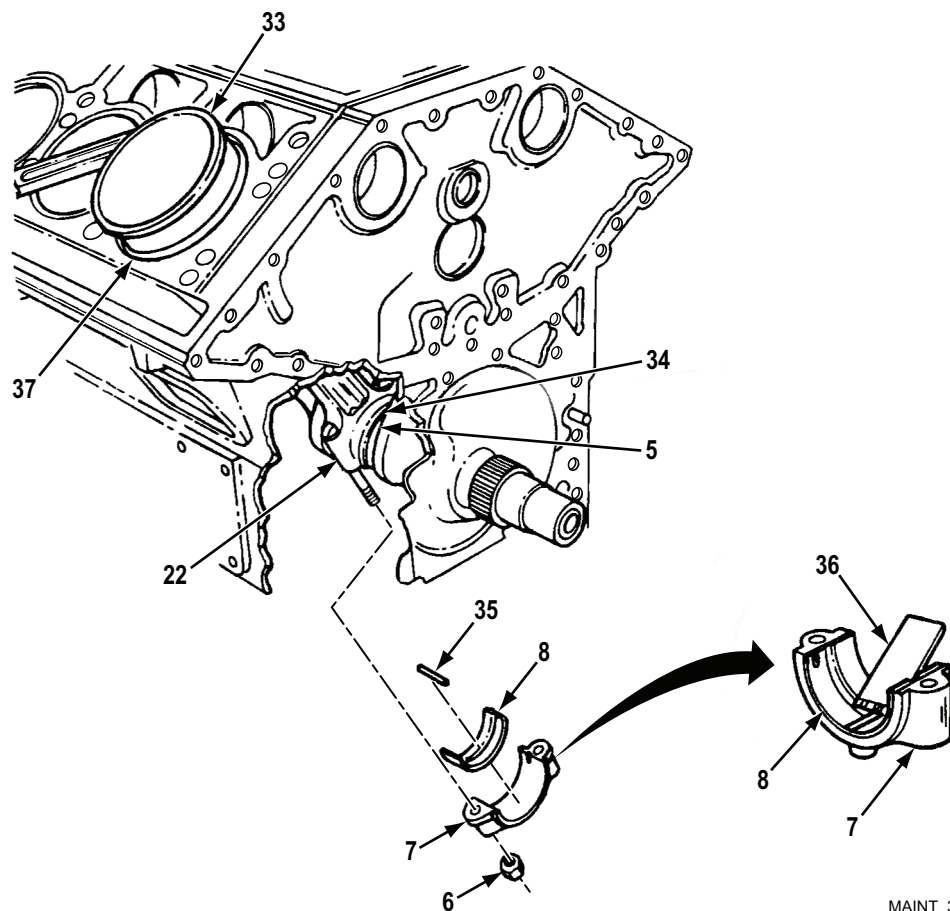
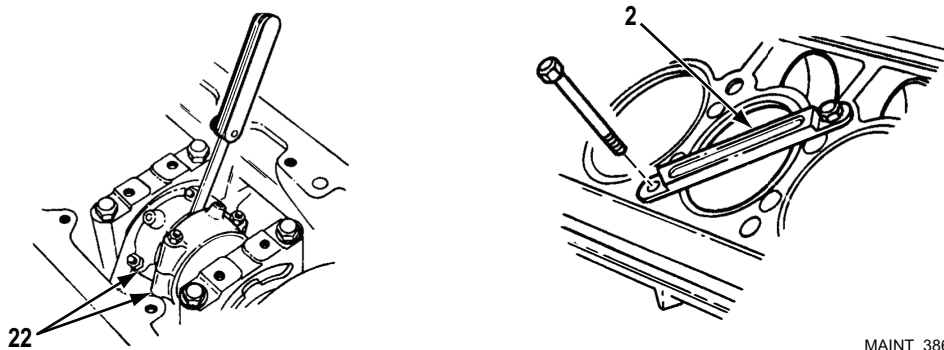


Figure 15. Piston Connecting Rod Installation.

**INSTALLATION - Continued****NOTE**

If necessary, pry connecting rods apart before measuring side clearance.

10. Using piston-liner thickness gage set, measure side clearance between each pair of connecting rods (Figure 16, Item 22). Clearance must be 0.008–0.016 inch (0.20–0.41 mm).
11. Repeat Steps 1–10 to install additional liners, pistons, and rod assemblies. Use cylinder liner hold-down clamps (Figure 16, Item 2) to hold each liner in place.
12. Remove all liner cylinder liner hold-down clamps (Figure 16, Item 2).



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Figure 16. Connecting Rod Side Clearance and Piston Cylinder Liner Hold-Down Clamp.

**END OF TASK****FOLLOW ON TASK**

1. Install cylinder head (WP 0073).
2. Install oil pump inlet tubes (WP 0065).
3. Install oil pan (WP 0063).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
CYLINDER LINER REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)  
Puller, Mechanical, Cylinder Liner  
(WP 0104, Table 1, Item 76)  
Hone, Cylinder (WP 0104, Table 1, Item 52)  
Gage, Cylinder Bore (WP 0104, Table 1, Item 31)  
Die Set, Metal Stamping, Hand  
(WP 0104, Table 1, Item 22)  
Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)  
Clamp, Hold-Down, Cylinder Liner  
(WP 0104, Table 1, Item 17)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)  
Stone, Sharpening (WP 0103, Table 1, Item 61)  
Packing, Preformed  
Qty: (2) (WP 0105, Table 1, Item 64)

**References**

WP 0099

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**References (cont.)**

WP 0094  
WP 0095

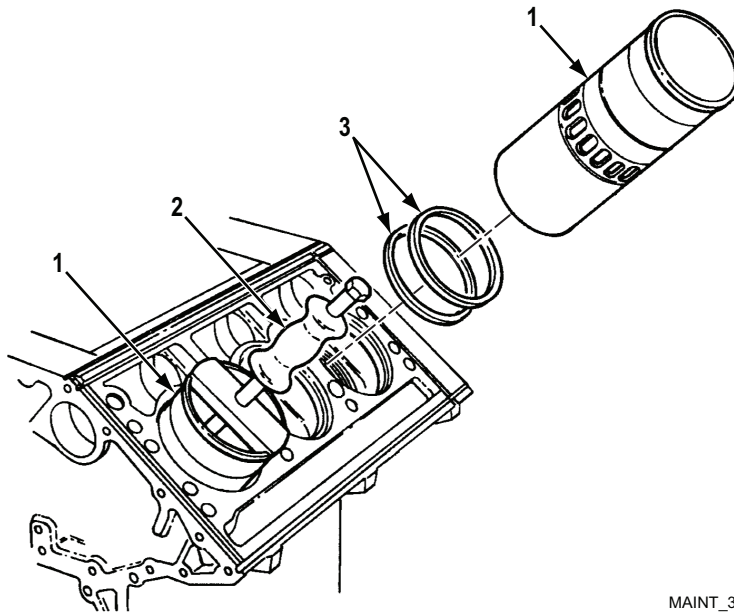
**Equipment Condition**

Oil pan removed (WP 0063)  
Oil pump inlet tubes removed (model 5063-5299)  
(WP 0064)  
Oil pump inlet tubes removed  
(all except model 5063-5299) (WP 0087)  
Cylinder head removed (WP 0098)  
Piston and rod assembly removed  
(model 5063-5299) (WP 0021)  
Piston and rod assembly removed  
(models 5063-5392, 5063-5393, and  
5063-539L) (WP 0016)

**REMOVAL****CAUTION**

Do not insert bar in liner ports and rotate crankshaft to push out liner. Bar can damage piston and collapse upper ring groove of cylinder block.

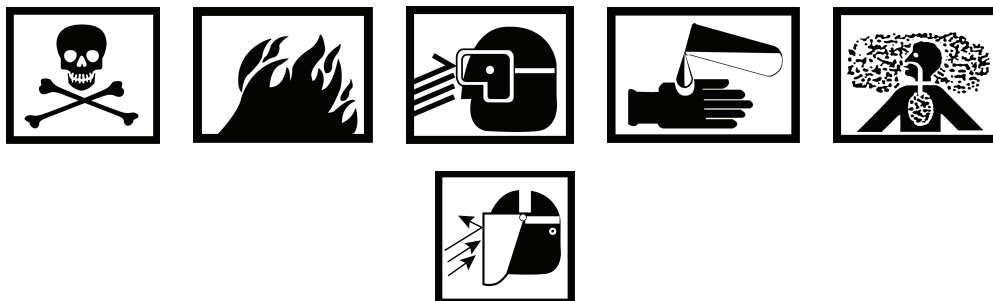
1. Loosen cylinder liner (Figure 1, Item 1) using cylinder liner remover (Figure 1, Item 2).
2. Remove cylinder liner remover (Figure 1, Item 2) from cylinder liner (Figure 1, Item 1). Then remove liner from cylinder block.
3. Remove two preformed packings (Figure 1, Item 3) from ring grooves in cylinder block. Discard preformed packings.



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Figure 1. Cylinder Liner Removal.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**CAUTION**

Always store liners in an upright position until ready for use. Liners left on their side can become distorted.

Clean cylinder liner with cleaning solvent and dry with compressed air.

**END OF TASK**

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - CYLINDER LINER**

1. Check outside of liner for cracks, scoring, and flange irregularities. Discard cracked or excessively scored liners. Clean up lightly scored liners using cylinder hone.

**NOTE**

Excessive liner to block clearance or block bore distortion will reduce heat transfer from liner to block.

2. Examine outside surface for fretting. Remove metal particles from outer surface with sharpening stone.
3. Liner flange must be smooth and flat on top and bottom surfaces. Replace if cracked at flange.
4. Check inside diameter of liner for glazing, cracking, scoring, and unusual wear. Replace cracked, scuffed, or scored liners.

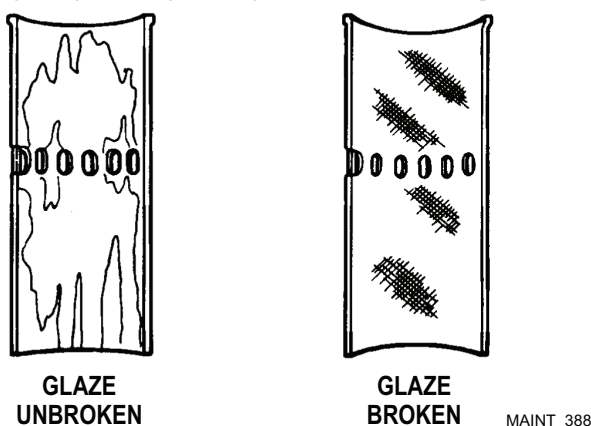


Figure 2. Cylinder Liner Inspection.

**END OF TASK**

**MEASUREMENTS - CYLINDER LINER**

1. Measure outside diameter of liner at (Figure 3, Items A and B). Diameter (Figure 3, Item A) must be 4.485–4.486 in. (113.92–113.94 mm), diameter (Figure 3, Item B) must be 4.355–4.356 in. (110.62–110.64 mm).

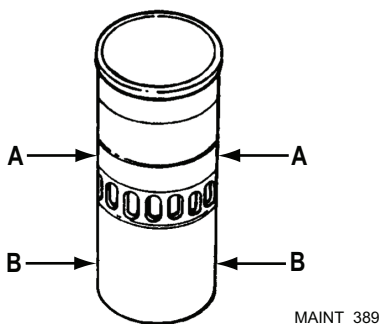


Figure 3. Cylinder Liner Measurements.

**MEASUREMENTS - CYLINDER LINER - Continued**

2. Install liner in proper bore of cylinder block. Using cylinder bore gage (Figure 4, Item 4), measure cylinder liner inside diameter at 14 places (Figure 4, Items C thru I) on (XZ) and (WY) axes. Refer to Table 1 for location of measurement.

**Table 1. Location of Cylinder Liner Inside Diameter Measurement.**

MEASUREMENT	DISTANCE FROM TOP EDGE
C	0.0 in. (0.0 mm)
D	1.0 in. (25.4 mm)
E	1.75 in. (44.5 mm)
F	3.5 in. (88.9 mm)
G	5.0 in. (127.0 mm)
H	7.0 in. (177.8 mm)
I	9.0 in. (228.6 mm)

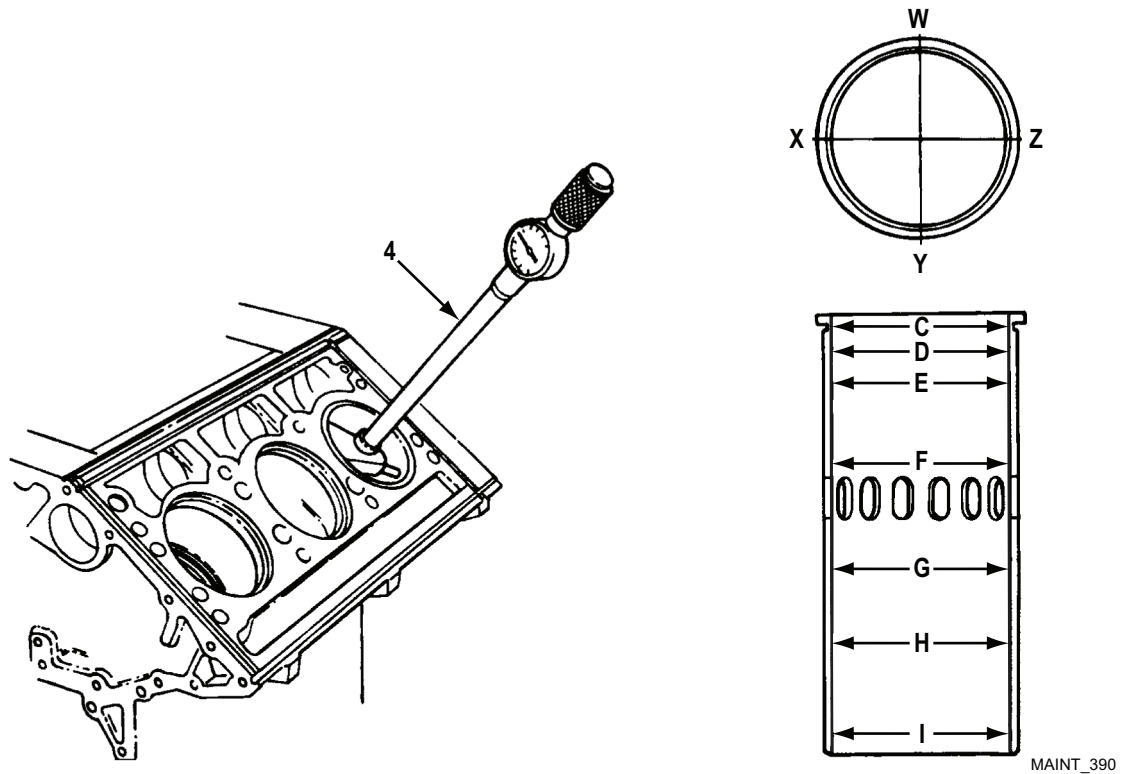


Figure 4. Cylinder Bore Gage.

**MEASUREMENTS - CYLINDER LINER - Continued**

3. Check liner inside diameter for taper and out-of-round. Taper must not exceed 0.002 in. (0.05 mm) on used liner and 0.001 in. (0.03 mm) on new liner. Out-of-round must not exceed 0.003 in. (0.08 mm) on used liner and 0.002 in. (0.05 mm) on new liner.

**NOTE**

Liners, standard and oversized, have an inside diameter of 3.8752–3.8767 in. (98.430–98.468 mm). Liners are available in 0.010 and 0.020 in. (0.254 and 0.508 mm) on outside diameter.

Special liner to block preformed packings are required when using 0.020 in. (0.508 mm) oversize liner.

When an oversize liner is installed, stamp amount of oversize on top of cylinder block bore adjacent to liner counterbore using metal stamping die set.

4. Remove liner from cylinder block.

**END OF TASK****FITTING CYLINDER LINER IN BLOCK BORE****NOTE**

If the cylinder liner is used with an unbroken glaze, hone liner before fitting liner to block bore (see Repair).

1. Wipe inside and outside of liner clean. Clean block bore and counterbore thoroughly.
2. Slide cylinder liner (Figure 5, Item 1) into cylinder block bore until liner flange rests on bottom of counterbore in block. Do not drop or slam liner flange against bottom of counterbore in block.
3. Tap liner lightly with soft head hammer to ensure liner flange seats on bottom of counterbore.
4. Install cylinder liner hold-down clamp (Figure 5, Item 6).

**NOTE**

Maximum liner height difference of 0.002 in. (0.05 mm) between any two adjacent liners is allowed as measured lengthwise along center line between adjacent cylinders.

5. Measure distance from top of liner flange to top of block with depth cylinder gage (Figure 5, Item 5). Liner flange must be 0.0465–0.050 in. (1.181–1.270 mm) below top of block.
6. If above liner depth limits are not met, use a new liner or install liner in another bore.
7. Matchmark liner and cylinder block on outboard side so liner is reinstalled in same position and same cylinder bore as measured.
8. Remove cylinder liner hold-down clamp (Figure 5, Item 6) and cylinder liner (Figure 5, Item 1).



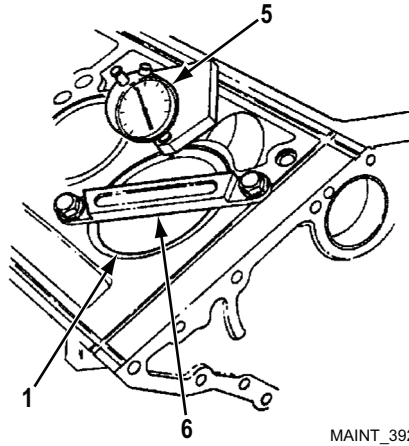
**FITTING CYLINDER LINER IN BLOCK BORE - Continued**

Figure 5. Cylinder Hold Down.

**END OF TASK**

**REPAIR OR REPLACEMENT****CAUTION**

Do not modify inside surface finish of new liner. Liner is properly finished at factory so changes will adversely affect piston ring seating.

**NOTE**

Hone used cylinder liners to break glaze resulting from extended operation and remove ridge formed at top of piston ring travel. If glaze is not removed, time required to seat new piston rings will be lengthened.

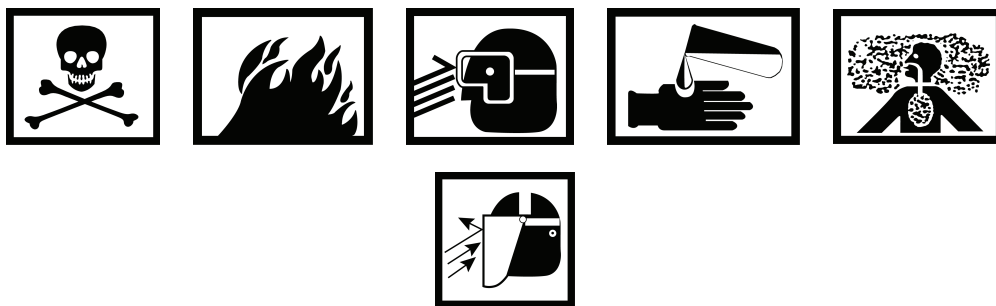
A scrap cylinder block makes an excellent honing fixture.

1. Place liner (Figure 6, Item 1) in honing fixture (Figure 6, Item 8).

**CAUTION**

If liner is honed in block, completely dismantle engine to ensure all abrasive material is cleaned out, refer to (WP 0099).

2. Work cylinder hone (Figure 6, Item 7), equipped with 120 grit stones, up and down full length of liner a few times between 300–400 rpm to produce a crisscross pattern of hone marks on 45 degree axis.

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

**NOTE**

After honing, liner must conform to same limits on taper and out-of-round as a new liner and piston to liner clearance must be within specified limits.

3. Remove liner from fixture and clean with cleaning solvent. Dry with compressed air and check surface for burrs and finish. Surface finish must be maintained between 32–55 RMS.

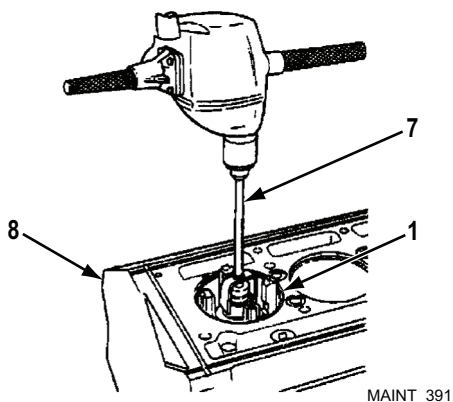
**REPAIR OR REPLACEMENT - Continued**

Figure 6. Cylinder Honing.

**END OF TASK****INSTALLATION**

Install cylinder liner as a complete assembly, including piston, connecting rod, and cylinder liner. See (WP 0094) or (WP 0095) installation instructions.

**END OF TASK****FOLLOW ON TASK**

1. Install piston and rod assembly (models 5063-5392, 5063-5393, and 5063-539L) (WP 0016).
2. Install piston and rod assembly (model 5063-5299) (WP 0021).
3. Install cylinder head (WP 0098).
4. Install oil pump inlet tubes (all except model 5063-5299) (WP 0087).
5. Install oil pump inlet tubes (model 5063-5299) (WP 0064).
6. Install oil pan pan (WP 0063).

**END OF TASK****END OF WORK PACKAGE**



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**SUSTAINMENT MAINTENANCE  
CRANKSHAFT REPLACEMENT**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Indicator, Dial (w/Magnetic Base)  
(WP 0104, Table 1, Item 54)  
Micrometer Set (Caliper Set, O/Side)  
(WP 0104, Table 1, Item 69)  
Puller, Mechanical, Three-Leg  
(WP 0104, Table 1, Item 77)  
Gage, Cylinder Bore  
(WP 0104, Table 1, Item 31)  
Sling, Multiple Leg (Cable)  
(WP 0104, Table 1, Item 94)  
Die Set, Metal Stamping, Hand  
(WP 0104, Table 1, Item 22)  
Ball Attachment, Micrometer  
(WP 0104, Table 1, Item 10)  
Gage Set, Telescoping  
(WP 0104, Table 1, Item 46)  
Installing Tool (Crankshaft Gear)  
(WP 0104, Table 1, Item 65)  
Screwdr Attchmt, Sckt Wrench  
(Installer, Crankshaft Plug)  
(WP 0104, Table 1, Item 88)  
Installing Tool, Drive (Oil Pump Gear)  
(WP 0104, Table 1, Item 66)  
Installer, Crankshaft Pulley  
(WP 0104, Table 1, Item 62)  
Adapter, Torque Wrench (Slip)  
(WP 0104, Table 1, Item 5)  
Puller, Mechanical (Slide-Hammer)  
(WP 0104, Table 1, Item 75)

**Materials/Parts (cont.)**

Crocus Cloth (WP 0103, Table 1, Item 10)  
Emery Cloth (WP 0103, Table 1, Item 13)  
Gage, Plastic Green (WP 0103, Table 1, Item 15)  
Nut Qty: (3) (WP 0103, Table 1, Item 25)  
Oil, Engine SAE 15/40  
(WP 0103, Table 1, Item 27)  
Oil, Fuel Diesel DF-2 Regular  
(WP 0103, Table 1, Item 30)  
Screw Qty: (8) (WP 0105, Table 1, Item 155)  
Stone, Sharpening X-Fine  
(WP 0103, Table 1, Item 62)  
Washer, Flat Qty: (3) (WP 0103, Table 1, Item 67)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)

**References**

ASTM E1444

**Equipment Condition**

Cylinder kits removed (model 5063-5299)  
(WP 0094)  
Cylinder kits removed (models 5063-5392,  
5063-5393, and 5063-539L) (WP 0095)

**Materials/Parts**

Cleaning Solvent (WP 0103, Table 1, Item 8)

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**REMOVAL**

1. Remove eight small self-locking screws (Figure 1, Item 5), eight hardened washers (Figure 1, Item 6), eight large bolts (Figure 1, Item 4), eight hardened washers (Figure 1, Item 3), and four stabilizer plates (Figure 1, Item 7) from bottom of cylinder block. Discard self-locking screws.

**CAUTION**

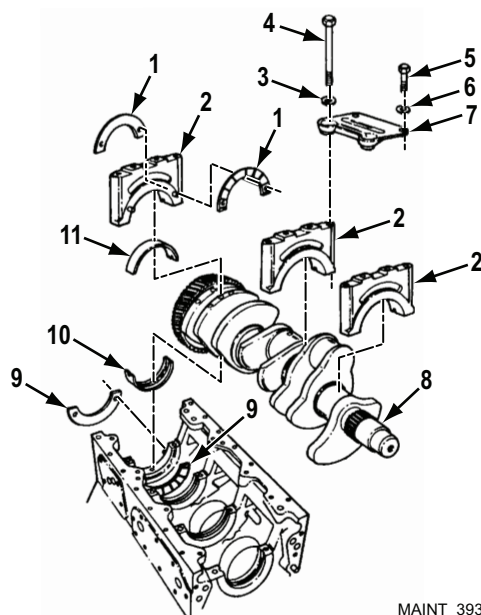
Keep main bearing caps and main bearing shells in their original position. Main bearing caps are numbered 1, 2, 3, and 4. Upper bearing shell has an oil hole and groove for lubrication, and lower bearing shell is smooth with no groove or oil hole.

2. Remove four main bearing caps (Figure 1, Item 2) from cylinder block. Remove four lower bearing shells (Figure 1, Item 11) and two lower thrust washers (Figure 1, Item 1) (rear cap only) from caps and mark with corresponding bearing number.

**WARNING**

If hoist and sling are not available, use two or more personnel to remove crankshaft. Crankshaft is heavy and awkward to handle. Serious injury can result if crankshaft is dropped. Failure to comply may result in injury to personnel.

3. Remove crankshaft (Figure 1, Item 8) from cylinder block.
4. Remove four upper bearing shells (Figure 1, Item 10) and two upper thrust washers (Figure 1, Item 9) from block and mark with corresponding bearing number.



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Figure 1. Crankshaft Removal.

**END OF TASK**

**DISASSEMBLY**

1. Install three-leg mechanical puller (Figure 2, Item 17) on rear crankshaft gear (Figure 2, Item 16) using three bolts (3/8-16), three flat washers (7/16), and three nuts (3/8-16) through holes in gear. Remove gear from crankshaft. Remove puller from gear.
2. Remove Woodruff key (Figure 2, Item 12) from rear of crankshaft.
3. Remove three pipe plugs (Figure 2, Item 13) from crankshaft.
4. If necessary, remove oil pump drive gear (Figure 2, Item 14) from front of crankshaft using gear puller. Thread screw (Figure 2, Item 15) in crankshaft for puller screw to seat.

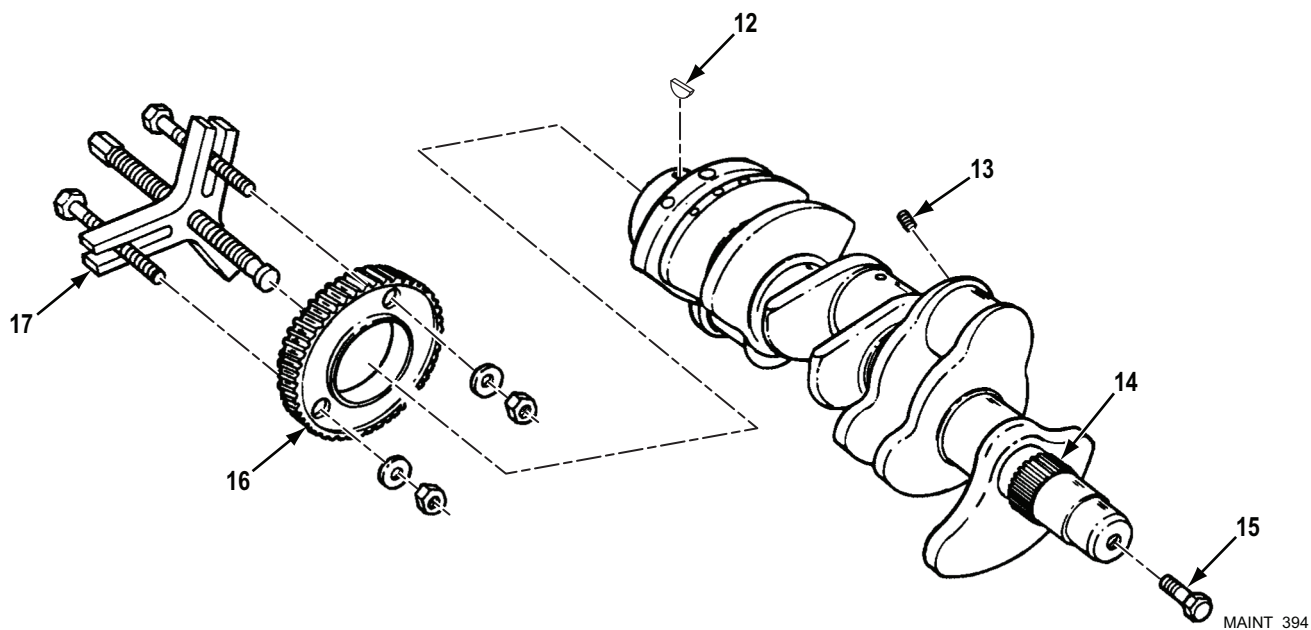
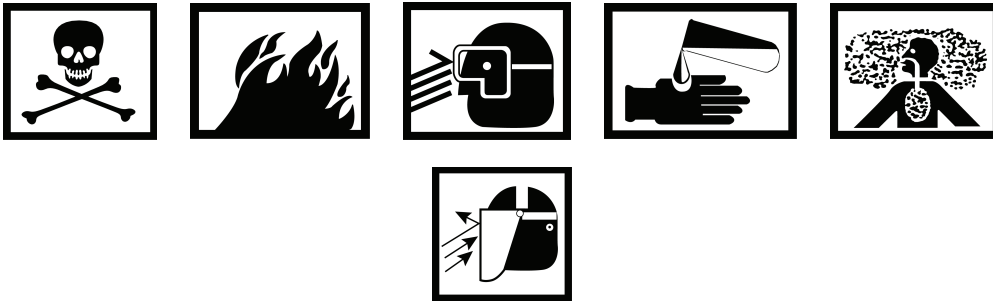


Figure 2. Crankshaft Disassembly.

**END OF TASK**

**CLEANING****WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

Clean all crankshaft oil passages thoroughly with cleaning solvent and blow out with compressed air. Clean crankshaft, crankshaft gear, and oil pump drive gear with cleaning solvent. Dry all parts with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA****Inspection of Crankshaft**

1. Inspect gear teeth for evidence of scoring, pitting, and wear. If severely damaged or worn, replace gear.
2. Inspect crankshaft keyways for evidence of cracks or wear. Replace crankshaft if required.

**CAUTION**

Replace crankshaft when signs of excessive overheating appear since heat treatment has probably been destroyed.

Remove ridges on crankshaft journals. If ridges are not removed, localized high unit pressures are placed on new bearing shells and short bearing life can result.

3. Inspect crankshaft journals for ridges and grooves. Remove ridges exceeding 0.0002 in. (0.005 mm).

**NOTE**

Replace crankshaft if journal ridges are greater than 0.001 in. (0.03 mm) in depth.

4. Remove crankshaft journal ridges by working crocus cloth, wet with fuel oil, around circumference of journals. If ridges are greater than 0.0005 in. (0.013 mm), first use 120 grit Emery cloth to clean up ridges, 240 grit Emery cloth for finishing and wet crocus cloth for polishing.
5. Inspect rear crankshaft at oil seal contact surface for evidence of rough or grooved condition. Clean up slight ridges on crankshaft oil seal contact surface with crocus cloth. If crankshaft cannot be cleaned up satisfactorily, reposition oil seal in flywheel housing.
6. Check crankshaft thrust surfaces for excessive wear or grooving. If only slightly worn, dress surfaces with an X-fine sharpening stone.

**NOTE**

To detect minute cracks use magnetic particle inspection method (reference ASTM E1444).

Crankshaft failures are rare and when one cracks or breaks completely, make a thorough inspection for contributory factors.

7. Inspect crankshaft for fatigue cracks which start at an oil hole and follow journal surface at an angle of 45 degrees to axis. Reject crankshaft with cracks.
8. Inspect main bearing shells for bright spots on backs indicating movement in bearing caps or supports. Discard shells if this condition is present.

**CAUTION**

Install upper and lower bearing shells as a set. Do not replace one main bearing shell alone. Always install all new bearing shells with new crankshaft.

**NOTE**

Lower bearing shells, which carry the load, will normally show signs of distress before upper bearing shells.

9. Discard main bearings with signs of scoring, pitting, flaking, etching, overheating, or loss of overlay.

**END OF TASK**

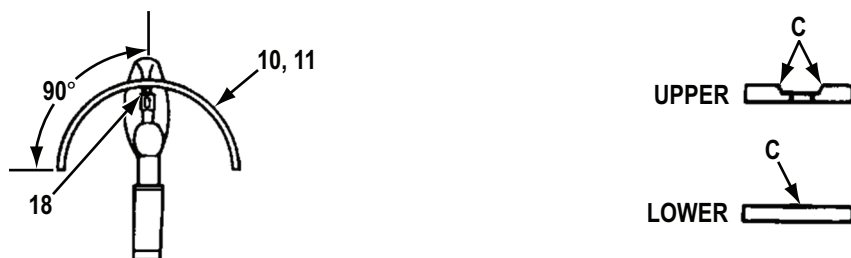
**MEASUREMENTS**

- Using micrometer ball attachment (Figure 3, Item 18), measure thickness of bearing shells (Figure 3, Items 10 and 11) at point (C), 90 degrees from parting line. Replace if minimum thickness is less than 0.1230 in. (3.124 mm). A standard bearing is 0.1240–0.1245 in. (3.150–3.162 mm) thick, refer to Table 1 for thickness of bearings.

**Table 1. Crankshaft Bearing Shell Thickness.**

BEARING SIZE	NEW BEARING THICKNESS *	MINIMUM USED THICKNESS *
Standard	0.1240–0.1255 in. (3.150–3.162 mm)	0.1230 in. (3.124 mm)
0.002 in. Undersized	0.1250–0.1255 in. (3.175–3.188 mm)	0.1240 in. (3.150 mm)
0.010 in. Undersized	0.1290–0.1305 in. (3.277–3.289 mm)	0.1280 in. (3.251 mm)
0.020 in. Undersized	0.1340–0.1345 in. (3.421–3.434 mm)	0.1330 in. (3.378 mm)
0.030 in. Undersized	0.1390–0.1395 in. (3.548– 3.561 mm)	0.1380 in. (3.505 mm)

\* Thickness 90 degrees from parting line of bearing.



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Figure 3. Thickness of Bearings.

**MEASUREMENTS - Continued****NOTE**

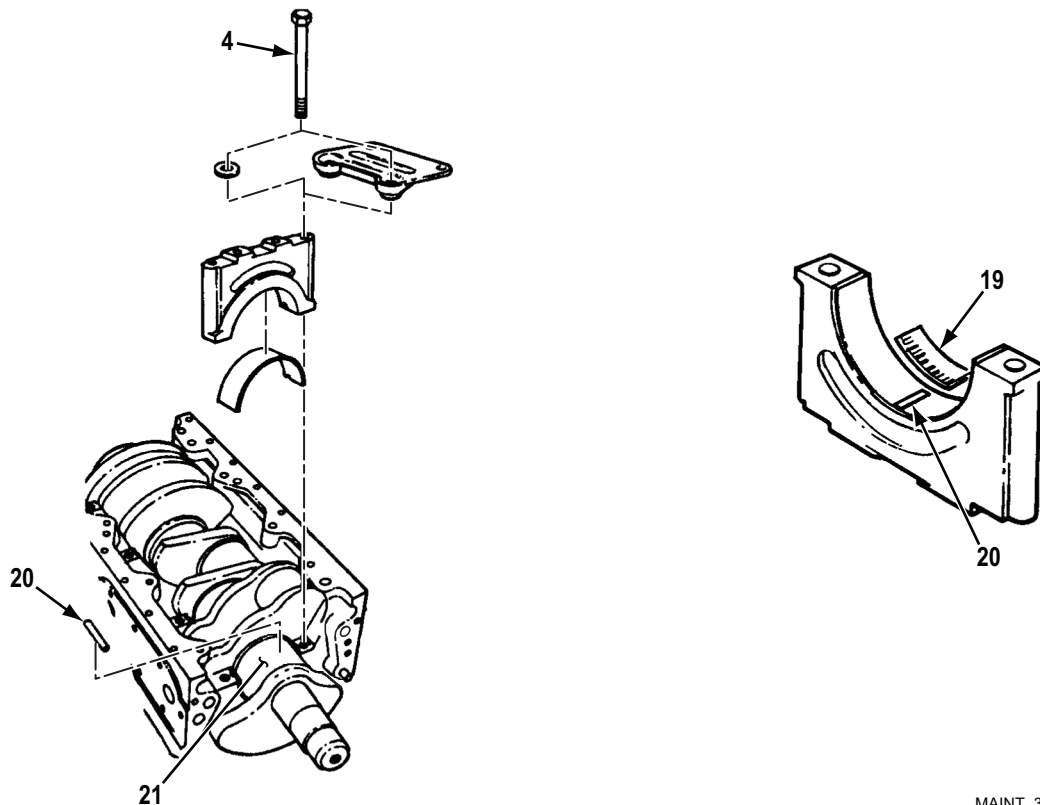
If clearance between any crankshaft journal and its bearing shells exceeds 0.0060 in. (0.152 mm), replace all bearing shells. Clearance for new parts is 0.0010–0.0040 in. (0.025–0.102 mm).

2. Check main bearings to crankshaft journals clearance as follows:
  - a. With crankshaft removed, measure outside diameter of crankshaft main bearing journals and inside diameter of main bearing shells in place with required torque. When installed, bearing shells are 0.001 in. (0.03 mm) larger in diameter at parting line than 90 degrees from parting line.

**CAUTION**

Use washers, spacers, stabilizers, or supports under main bearing bolts to prevent bolts from bottoming out in cylinder block holes.

- b. With main bearings and crankshaft in position, place plastic gage strip (Figure 4, Item 20) on crankshaft journal (Figure 4, Item 21). Install main bearing cap assembly, stabilizers or washers and bolts. Torque main bearing bolts (Figure 4, Item 4) to 120–130 lb-ft (163–177 N·m). Remove main bearing bolts, stabilizers or washers, and cap assembly. Measure width of plastic gage with measuring strip (Figure 4, Item 19).



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Figure 4. Crankshaft Journal Gage.

**MEASUREMENTS - Continued**

3. Measure intermediate main bearing journal runout with dial indicator with magnetic base. Support crankshaft at front and rear journals on inverted engine block with only front and rear upper bearing shells in place. When high spots of run out on adjacent journals are in opposite directions, sum must not exceed 0.003 in. (0.08 mm) total. When high spots of run out on adjacent journals are in same direction, difference must not exceed 0.003 in. (0.08 mm). When high spots of runout on adjacent journals are at right angles, sum must not exceed 0.004 in. (0.10 mm) or each journal must not exceed 0.002 in. (0.05 mm).

**NOTE**

Maximum clearance between connecting rod journal and bearing shell is 0.0041 in. (0.104 mm) (with new shells). Maximum clearance between main bearing journal and bearing shell is 0.0040 in. (0.102 mm) (with new shells). Main bearing journal taper or out-of-round must not exceed 0.003 in. (0.08 mm). Replace crankshaft if measurements exceed limits.

4. Measure all main and connecting rod bearing journals. Measure journals at several places on circumference so that taper (calculated from two end outside diameter measurements of journal), out-of-round, and bearing clearances can be determined. Measurements must be accurate to nearest 0.0002 in. (0.005 mm).
5. Measure crankshaft thrust surfaces at points (Figure 5, A) and (Figure 5, B), Dimension (Figure 5, A) must be 1.299–1.301 in. (32.99–33.05 mm) and dimension (Figure 5, B) must be 1.34 in. (34.0 mm).

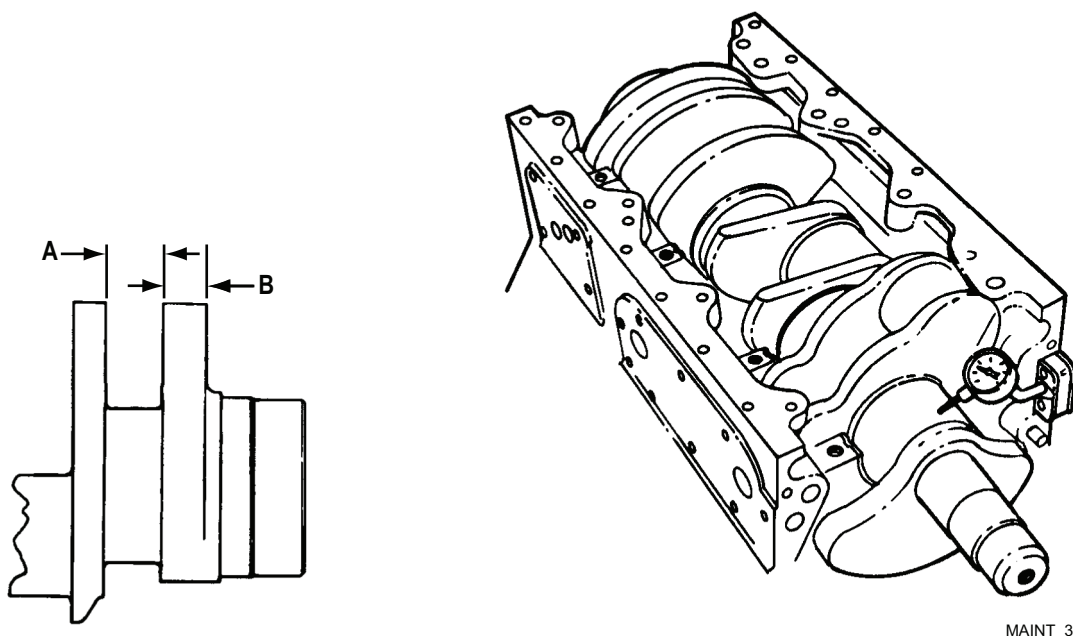


Figure 5. Crankshaft Main Bearing Journal Runout Check.

**END OF TASK**

**ASSEMBLY**

1. Using crankshaft pulley installer, install three pipe plugs (Figure 6, Item 13) into crankshaft (Figure 6, Item 8), Torque plugs to 10–12 lb-ft (14–16 N·m).
2. If removed, install oil pump drive gear (Figure 6, Item 14) as follows:
  - a. Lubricate inside diameter of oil pump drive gear with engine oil.
  - b. Start gear on crankshaft with chamfered edge of gear toward crankshaft journals.

**NOTE**

The end of bore in crankshaft pulley installer (Figure 6, Item 23) must contact the end of crankshaft to correctly position the drive gear.

- c. Place oil pump drive gear installer (Figure 6, Item 23) over crankshaft and against drive gear (Figure 6, Item 14), Force gear on crankshaft until bore in installation tool contacts end of crankshaft.
- d. Using torque wrench adapter, check press fit of drive gear to crankshaft. Drive gear should not slip on crankshaft with a torque of 100 lb-ft (136 N·m).

**NOTE**

Do not exceed torque of 100 lb-ft (136 N·m) on torque wrench adapter. If gear slips on crankshaft, install new drive gear.

3. Install Woodruff key (Figure 6, Item 12) in keyway of crankshaft. Start crankshaft gear (Figure 6, Item 16) on crankshaft with timing marks on rim of gear facing out and keyway in gear in alignment with Woodruff key.
4. Place installing tool (Figure 6, Item 22) against rear face of gear (Figure 6, Item 16). Drive gear tight against shoulder on crankshaft.

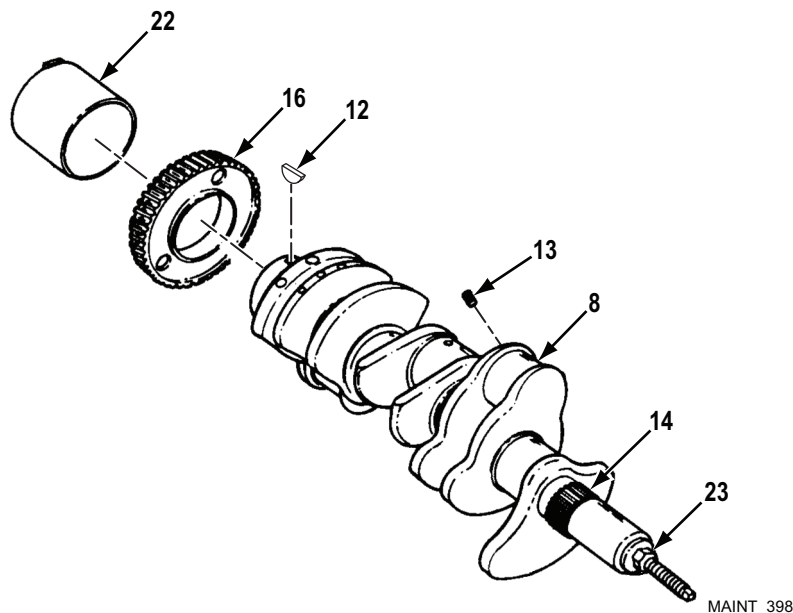


Figure 6. Crankshaft Assembly.

**END OF TASK**

## INSTALLATION

### CAUTION

When a new or reground crankshaft is installed, all new main and connecting rod bearing shells and thrust washers must be installed.

1. Install upper main bearing shells (Figure 7, Item 10) in block. If bearings are being reused, install them in same locations from which they were removed.
2. Apply clean engine oil to upper bearing shells and completely around crankshaft main bearing journals.

### WARNING



If hoist and sling are not available, use two or more personnel to remove crankshaft. Crankshaft is heavy and awkward to handle. Serious injury can result if crankshaft is dropped. Failure to comply may result in injury to personnel.

### CAUTION

Do not damage journals or main bearing shells when lowering crankshaft into position. Damage will result in short component life.

3. Place crankshaft (Figure 7, Item 8) in upper bearing shells in cylinder block.
4. Install upper crankshaft thrust washers (Figure 7, Item 9) on each side of rear main bearing support with grooved side of thrust washers toward crankshaft thrust surfaces.

### NOTE

Install bearings in same bearing caps from which removed.

All crankshaft bearing shells have a tang for proper alignment. Upper bearing shells have oil holes for lubrication.

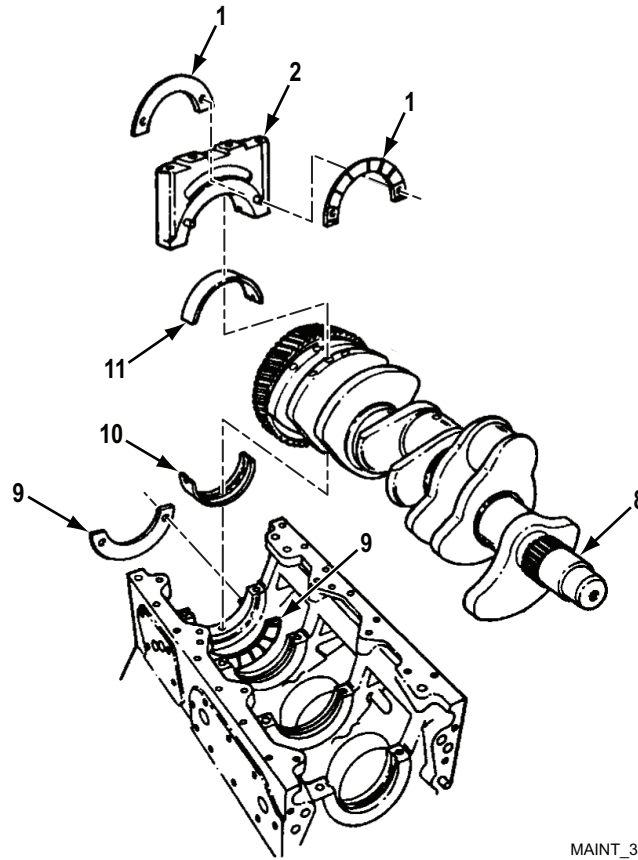
5. Install lower main bearing shells (Figure 7, Item 11) in bearing caps (Figure 7, Item 2). Install two lower thrust washers (Figure 7, Item 1) on rear main bearing cap with thrust washers over dowel pins in sides of main bearing cap and grooved side of washer facing crankshaft thrust surface.

### NOTE

Main bearing caps are bored in position and stamped 1, 2, 3, and 4. Install caps with identification stamp on right side of engine.

6. Install four main bearing caps (Figure 7, Item 2) along with lower bearing shells (Figure 7, Item 11) and two lower thrust washers (Figure 7, Item 1). Lubricate bearings and thrust washers with engine oil prior to installation.

INSTALLATION - Continued



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Figure 7. Crankshaft Installation.

**INSTALLATION - Continued**

7. Apply a small quantity of water displacing compound or equivalent to main bearing bolt threads (Figure 8, Item 4) and bolt head contact area.
8. Install four stabilizer plates (Figure 8, Item 7), eight hardened washers (Figure 8, Item 3), eight large bolts (Figure 8, Item 4), eight hardened washers (Figure 8, Item 6), and eight new small self-locking screws (Figure 8, Item 5) in cylinder block. Tighten bolts until snug.
9. Strike main bearing caps (Figure 8, Item 2) sharply with a softhead hammer to seat caps.
10. Torque all main bearing bolts (Figure 8, Item 4) (except rear main bearing bolts) to 120–130 lb-ft (163–177 N·m) in sequence shown (Figure 9). Torque rear main bearing bolts to 40–50 lb-ft (54–68 N·m).
11. Strike both ends of crankshaft two or three sharp blows with a soft head hammer to ensure proper positioning of rear main bearing cap in block saddle. Torque all main bearing bolts (Figure 8, Item 4) to 120–130 lb-ft (163–177 N·m) again.

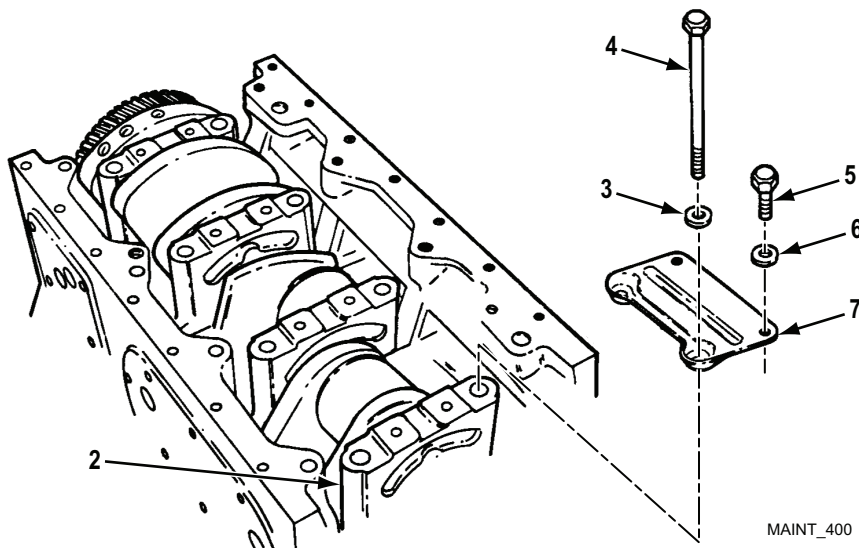


Figure 8. Crankshaft Installation.

12. Torque eight stabilizer plate screws (Figure 8, Item 5) to 46–50 lb-ft (62–68 N·m).

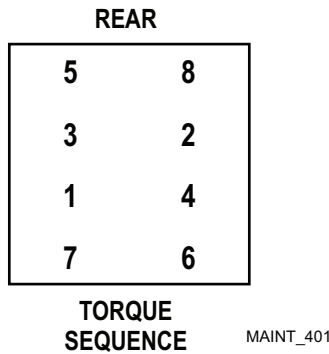


Figure 9. Torque Sequence.



**INSTALLATION - Continued****NOTE**

If bearings are installed properly, crankshaft will turn freely with all of bearing cap bolts drawn to specified torque.

13. Rotate crankshaft one full turn to ensure freedom of movement.
14. Check crankshaft end play as follows:
  - a. Mount dial indicator with magnetic base (Figure 10, Item 24) on rear of cylinder block with indicator point resting on rear face of crankshaft gear (Figure 10, Item 16).
  - b. Using large screwdriver between main bearing cap and crankshaft counterweight, push crankshaft toward dial indicator with magnetic base. With constant pressure on screwdriver, set dial indicator with magnetic base to zero.

**NOTE**

If correct crankshaft endplay cannot be obtained with standard size thrust washers, use 0.005 or 0.010 in. oversize washers.

Insufficient end play can result from a misaligned rear main bearing or a burr or dirt on inner face of one or more thrust washers.

- c. Force crankshaft in opposite direction and note amount of end play on dial. End play must be 0.004–0.016 in. (0.10–0.41 mm) with new parts and maximum of 0.018 in. (0.46 mm) with used parts.

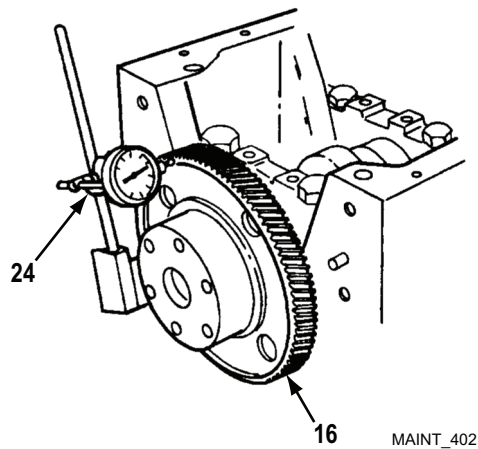


Figure 10. Crankshaft End Play.

**END OF TASK**

**FOLLOW ON TASK**

1. Install cylinder kits (models 5063-5392, 5063-5393, and 5063-539L) (WP 0095).
2. Install cylinder kits (model 5063-5299) (WP 0094).

**END OF TASK****END OF WORK PACKAGE**

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**SUSTAINMENT MAINTENANCE  
CYLINDER BLOCK REPAIR**

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Gage, Cylinder Bore (WP 0104, Table 1, Item 31)  
Die Set, Metal Stamping, Hand  
(WP 0104, Table 1, Item 22)  
Tool Kit, Internal Combustion Engine  
(WP 0104, Table 1, Item 114)  
Straight Edge (WP 0104, Table 1, Item 101)  
Gage, Cylinder, Depth  
(WP 0104, Table 1, Item 32)  
Pressure Testing Kit, Cylinder Block  
(WP 0081, Figure 10)

**Materials/Parts**

Adhesive, Gasket (WP 0103, Table 1, Item 1)  
Antifreeze (WP 0103, Table 1, Item 3)  
Bearing Set (WP 0105, Table 1, Item 102)  
Cleaning Solvent (WP 0103, Table 1, Item 8)  
Corrosion Preventative  
(WP 0103, Table 1, Item 11)  
Gasket Qty: (4) (WP 0105, Table 1, Item 184)  
Gasket Qty: (4) (WP 0105, Table 1, Item 161)

**Materials/Parts (cont.)**

Gasket Qty: (3) (WP 0105, Table 1, Item 52)  
Packing, Preformed (WP 0105, Table 1, Item 64)  
Plug (WP 0105, Table 1, Item 54)  
Plug, Expansion  
Qty: (2) (WP 0105, Table 1, Item 41)  
Plug, Expansion (WP 0105, Table 1, Item 90)  
Oil, Engine SAE 15/40  
(WP 0103, Table 1, Item 27)  
Sealing Compound (WP 0103, Table 1, Item 52)  
Shortening Compound  
(WP 0103, Table 1, Item 58)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 178)  
Water Displacing Compound  
(WP 0103, Table 1, Item 69)

**Equipment Condition**

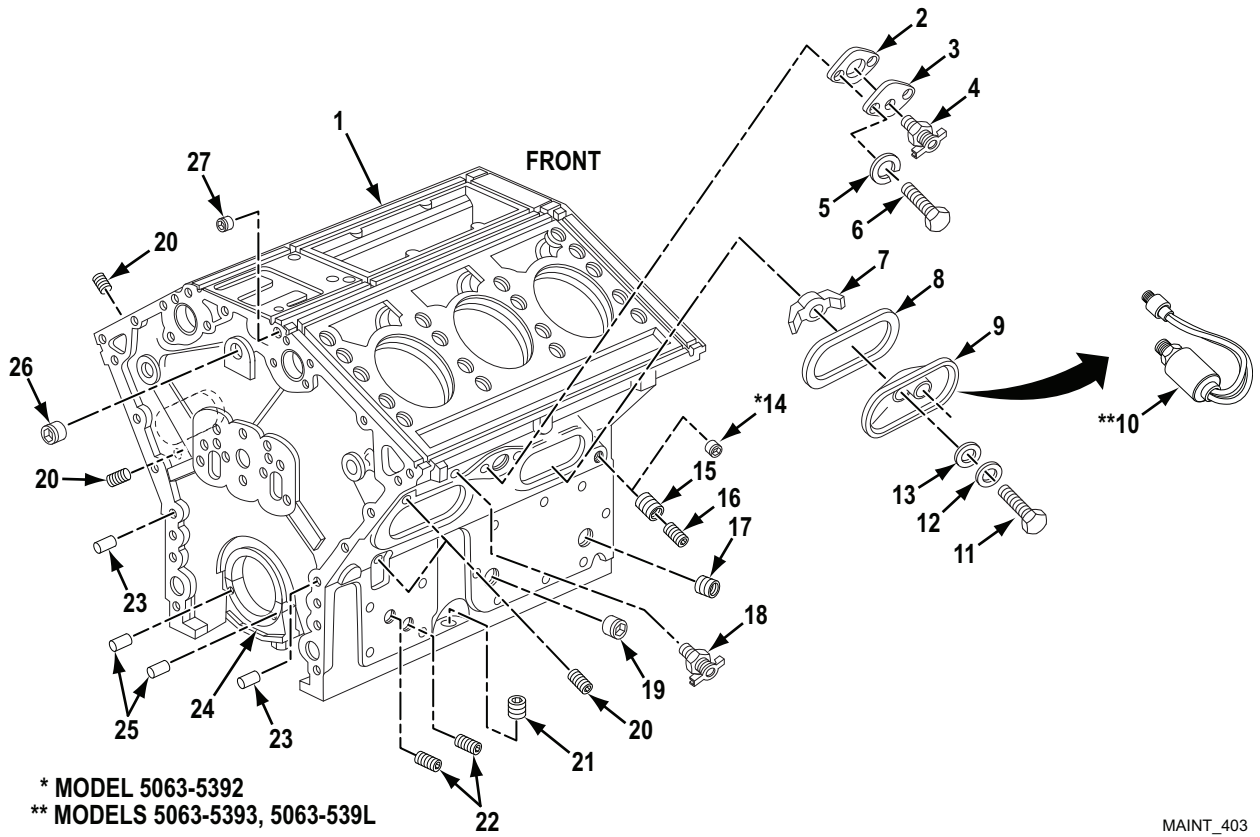
Cylinder kits removed (model 5063-5299)  
(WP 0094)  
Cylinder kits removed (models 5063-5392,  
5063-5393, and 5063-539L) (WP 0095)  
Cylinder liners removed (WP 0096)  
Crankshaft removed (WP 0097)

---

**DISASSEMBLY**

1. Remove four screws (Figure 1, Item 11) , four flat washers (Figure 1, Item 12), four copper gaskets (Figure 1, Item 13), four air box covers (Figure 1, Item 9), four gaskets (Figure 1, Item 8), and four clamps (Figure 1, Item 7) from cylinder block (Figure 1, Item 1). Discard gaskets.
2. On models 5063-5393 and 5063-539L, remove transducer assembly (Figure 1, Item 10) from right front air box cover (Figure 1, Item 9).
3. Remove two bolts (Figure 1, Item 6), two lockwashers (Figure 1, Item 5), cover plate (Figure 1, Item 3), draincock (Figure 1, Item 4), and gasket (Figure 1, Item 2) from right side of cylinder block.
4. If necessary, remove four dowel pins (Figure 1, Item 23) from ends of cylinder block.
5. Remove plug (Figure 1, Item 19), pipe plug (Figure 1, Item 17), and two pipe plugs (Figure 1, Item 22) from right side of cylinder block. Discard plug (Figure 1, Item 19).
6. Remove two draincocks (Figure 1, Item 18) from sides of cylinder block.
7. Remove four pipe plugs (Figure 1, Item 20): one from left side of block, two from right side of block, and one from top of left cylinder side.
8. If necessary, remove four pins (Figure 1, Item 25) from rear main bearing cap (Figure 1, Item 24).
9. Remove two expansion plugs (Figure 1, Item 26) from main oil gallery at ends of cylinder block (Figure 1, Item 1). Discard expansion plugs.
10. Remove expansion plug (Figure 1, Item 27) from rear of cylinder block (Figure 1, Item 1) at upper right side. Discard expansion plug (Figure 1, Item 27).
11. On model 5063-5299, remove two pipe plugs (Figure 1, Item 21) from dipstick holes on each side of cylinder block (Figure 1, Item 1).
12. On models 5063-5392, 5063-5393, and 5063-539L, remove pipe plug (Figure 1, Item 21) from dipstick hole at left side of cylinder block.
13. Remove pipe plug (Figure 1, Item 16) and bushing (Figure 1, Item 15) from oil gallery at right side of cylinder block.
14. On model 5063-5392, remove pipe plug (Figure 1, Item 14) from oil gallery at right side of cylinder block.

DISASSEMBLY - Continued



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Figure 1. Cylinder Block Disassembly.

**DISASSEMBLY - Continued**

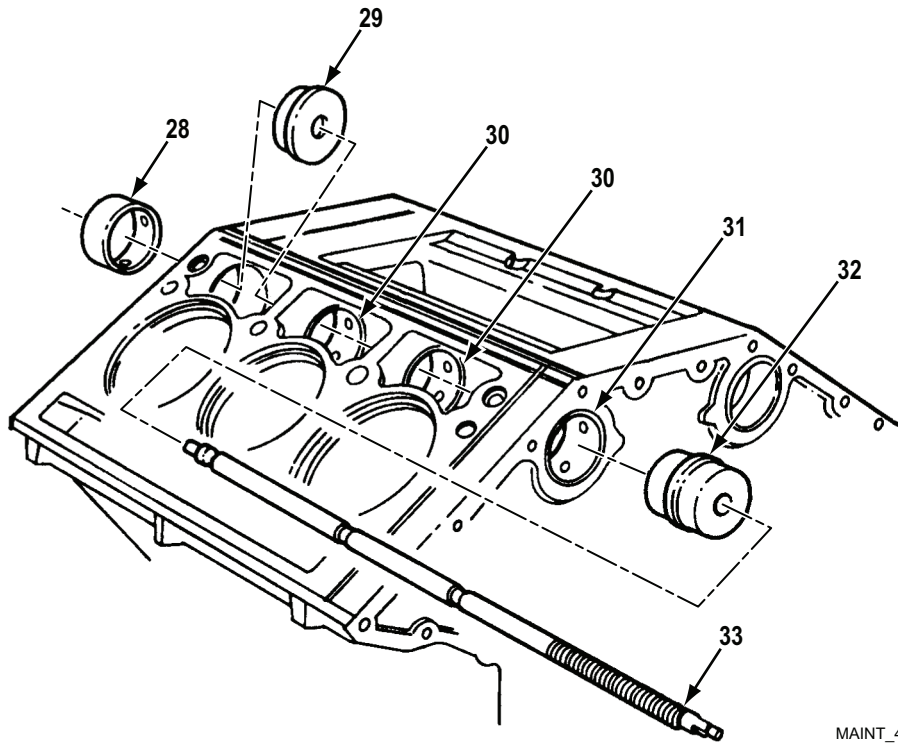
15. Remove eight camshaft bearings from cylinder block as follows:

**NOTE**

Camshaft bearing remover and installer set is designed for use with standard size bearings. To remove undersized bearings, reduce outside diameter of pilot, installers, and remover by 0.020 in. (0.51 mm).

- a. Insert small diameter end of pilot (Figure 2, Item 32) in end bearing (Figure 2, Item 31).
- b. Insert small diameter end of remover (Figure 2, Item 29) in end bearing (Figure 2, Item 28).
- c. Insert unthreaded end of shaft (Figure 2, Item 33) into pilot (Figure 2, Item 32) and through intermediate bearings (Figure 2, Item 30). Push end of shaft into remover (Figure 2, Item 29) until shaft snaps into place.
- d. Drive end bearing (Figure 2, Item 28) out of cylinder block.
- e. Repeat Steps 15.a.–15.d. for two intermediate bearings (Figure 2, Item 30).
- f. Insert large diameter end of pilot (Figure 2, Item 32) in camshaft end bore with bearing removed. Repeat Steps 15.b.–15.d. to remove end bearing (Figure 2, Item 31).
- g. Repeat Steps 15.a.–15.e. for opposite cylinder side.
- h. Discard all bearings.

DISASSEMBLY - Continued



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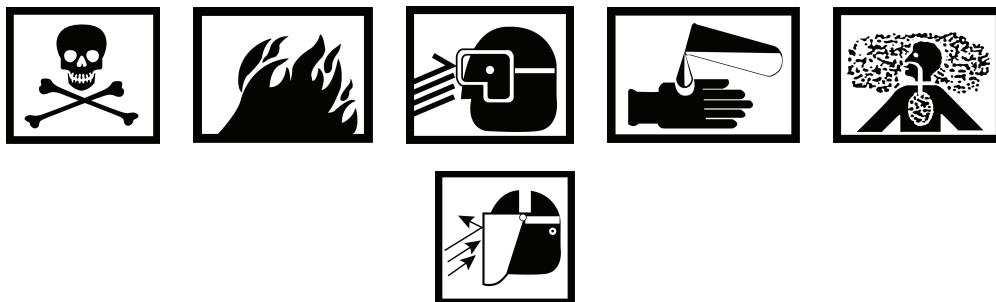
Figure 2. Cylinder Block Bearing Disassembly.

END OF TASK

**CLEANING****NOTE**

Remove all plugs from cylinder block except flush mounted dowel pins.

1. Scrape all gasket material from cylinder block.

**WARNING**

Cleaning solvent is TOXIC and flammable. Wear protective goggles and gloves; use only in a well-ventilated area; avoid contact with skin, eyes, and clothes; and do not breathe vapors. Keep away from heat or flame. Never smoke when using cleaning solvent. Failure to comply may result in injury, illness, or death to personnel.

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

2. Clean inner and outer surfaces of cylinder block with cleaning solvent.
3. Clean water, air, and oil passages with bore brush. Flush passages with cleaning solvent and blowout with compressed air.
4. Dry cylinder block with compressed air.

**END OF TASK**



**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA**

1. Inspect seal ring grooves in cylinder bores for evidence of pitting and erosion.

**NOTE**

Use standard size cylinder liner if diameter (A) is less than 4.5235 in. (114.897 mm), diameter (B) is less than 4.4900 in. (114.046 mm), and diameters (C) and (D) are less than 4.3595 in. (110.731 mm).

See Table 1 for cylinder bore diameters requiring oversize cylinder liners.

2. When oversize liner is used, stamp amount of oversize on top of cylinder bore adjacent to liner counter bore using metal stamping die set.

**Table 1. Oversize Cylinder Liner Size Requirements.**

LINER OVERSIZE	(A) DIAMETER LIMITS	(B) DIAMETER LIMITS	(C) AND (D) DIAMETER LIMITS
0.010 in. (0.25 mm)	4.5295/4.5315 in. (115.05/115.10 mm)	4.4965/4.4980 in. (114.21/114.25 mm)	4.53665/4.36755 in. (115.23/110.94 mm)
0.020 in. (0.51 mm)	4.5395/4.5415 in. (115.30/115.35 mm)	4.5065/4.5080 in. (114.47/114.50 mm)	4.3765/4.3775 in. (111.16/111.19 mm)

3. Measure entire bore of each cylinder with cylinder bore gage. Take measurements at positions (A), (B), (C), and (D) in bore on axis 90 degrees apart as shown (Figure 3).

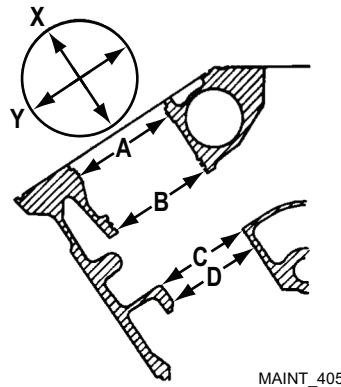


Figure 3. Cylinder Bore Measurement.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued**

4. Check cylinder bore taper and out of round. Neither may exceed 0.0015 in. (0.038 mm).
5. Check cylinder head contact area for flatness with straight edge (Figure 4, Item 34) and thickness gage set. Measurements must not vary more than 0.003 in. (0.08 mm) crosswise and 0.006 in. (0.15 mm) lengthwise.

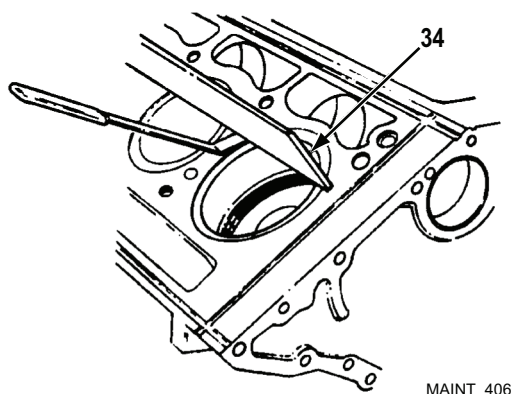


Figure 4. Cylinder Head Contact Flatness.

**NOTE**

Counter bore depth must be 0.300–0.302 in. (7.62–7.67 mm) and not vary more than 0.0015 in. (0.038 mm) throughout circumference. Counter bore surfaces must be smooth and square with cylinder bore. There must not be over 0.001 in. (0.03 mm) difference between any two adjacent cylinder counter bores when measured lengthwise along cylinder center line of cylinder block. If difference is over 0.001 in. (0.03 mm), do not reuse block.

6. Using depth cylinder gage (Figure 5, Item 35), measure cylinder liner counter bore depth.

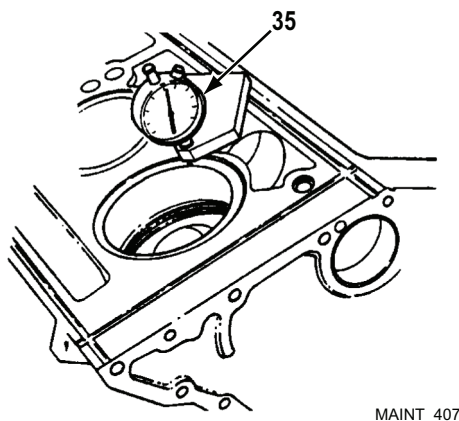


Figure 5. Cylinder Liner Counter Bore Depth.

**INSPECTION-ACCEPTANCE AND REJECTION CRITERIA - Continued****NOTE**

Main bearing caps are numbered to correspond with their respective positions in cylinder block. No. 1 bearing cap is located at front of block and stamped on bottom of front oil pan rail.

Install main bearing bolts, bearing caps, stabilizers, and hardened washers (WP 0097).

- Using cylinder bore gage, measure diameters of main bearing bores (Figure 6, Item 36) with bearing caps in original position. Diameter of main bearing bore is 3.751–3.752 in. (95.28–95.30 mm). If bores do not meet these limits, replace cylinder block.

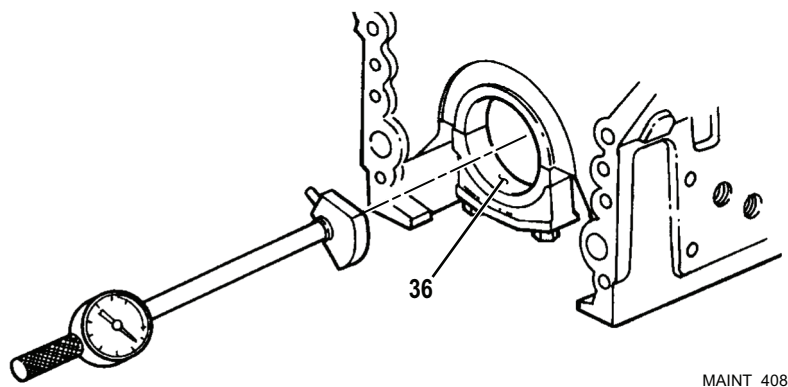


Figure 6. Main Bearing Bore Depth.

- Measure diameter of camshaft bearing bores. End bearing bores must be 2.3750–2.3760 in. (60.325–60.350 mm) for standard bearings and 2.3850–2.3860 in. (60.579–60.044 mm) for oversized bearings. Intermediate bearing bores must be 2.3650–2.3660 in. (60.071–60.096 mm) for standard bearings and 2.3750–2.3760 in. (60.325–60.350 mm) for oversized bearings.
- Check remaining cylinder block surfaces and threaded holes for damage. Check all mating surfaces or mounting pads for flatness, nicks, and burrs. Clean up damaged threads in tapped holes with a tap or install helical thread inserts if necessary.
- Check for cracking in area between center water transfer holes and cylinder head to block bolt holes (cam and exhaust sides). If cracks are found, replace cylinder block.

**END OF TASK**

**ASSEMBLY****CAUTION**

If cylinder block is not to be used immediately, spray machined surfaces with engine oil. If cylinder block is to be stored for an extended period of time, spray or dip block with corrosion preventative. Castings free of oil will rust when exposed to atmosphere.

**NOTE**

Install camshaft intermediate bearings prior to installing camshaft end bearings and press into cylinder block from outboard end of bore.

Notch in front end and front intermediate bearings is toward front of engine. Notch in rear end and rear intermediate bearings is toward rear of engine.

Camshaft replacement bearings are available with either standard or oversized outside diameter and standard or undersized inside diameters (see Table 2).

Camshaft bearing remover and installer set is designed for use with standard size bearings. To install undersized bearings, reduce outside diameter of pilot, installers, and remover by 0.020 in. (0.51 mm).

**Table 2. Camshaft Bearing Color Code.**

<b>BEARING POSITION</b>	<b>OUTSIDE DIAMETER</b>	<b>INSIDE DIAMETER</b>	<b>CURRENT COLOR</b>	<b>FORMER COLOR</b>
End	Standard	0.010 in. (0.25 mm) Undersize	Brown	Black
	0.010 inch (0.25 mm) Oversize	Standard	Brown	Yellow
Intermediate	Standard	0.010 inch (0.25 mm) Undersize	Orange	Red
	0.010 inch (0.25 mm) Oversize	Standard	Orange	Blue

1. Install four intermediate camshaft bearings (Figure 7, Item 30) as follows:
  - a. Insert large diameter of pilot (Figure 7, Item 32) in camshaft end bearing bore in block.
  - b. Insert intermediate bearing (Figure 7, Item 30) into outboard end of camshaft bore. Ensure notch is positioned properly in bore as shown.
  - c. Start unthreaded end of shaft (Figure 7, Item 33) in pilot (Figure 7, Item 32) and push shaft through entire length of cylinder block bores.
  - d. Slide installer (Figure 7, Item 40) on shaft (Figure 7, Item 33) until locating pin engages notch in bearing (Figure 7, Item 30).

## ASSEMBLY - Continued

## NOTE

Use J-7593-15 installer when installing right front or left rear intermediate bearing. Use J-7593-3 installer when installing left front or right rear intermediate bearing.

- e. Slide installer (Figure 7, Item 38) on end of shaft (Figure 7, Item 33) with large diameter inserted into end of block bore.
- f. Place spacer (Figure 7, Item 44), thrust bearing (Figure 7, Item 43), flat washer (Figure 7, Item 42), and hex nut (Figure 7, Item 41) over threaded end of shaft (Figure 7, Item 33).
- g. Align shaft (Figure 7, Item 33) and install C-washer (Figure 7, Item 39) in groove in shaft adjacent to installer (Figure 7, Item 40).
- h. Place C-washer (Figure 7, Item 37) in groove near end of shaft (Figure 7, Item 33).
- i. To draw bearing (Figure 7, Item 30) into position, turn hex nut (Figure 7, Item 41) until C-washer (Figure 7, Item 37) butts up against installer (Figure 7, Item 38).
- j. Remove bearing installer (Figure 7, Item 38) assembly from cylinder block.
- k. Repeat Steps 1.a.–1.i. for remaining intermediate bearings (Figure 7, Item 30).

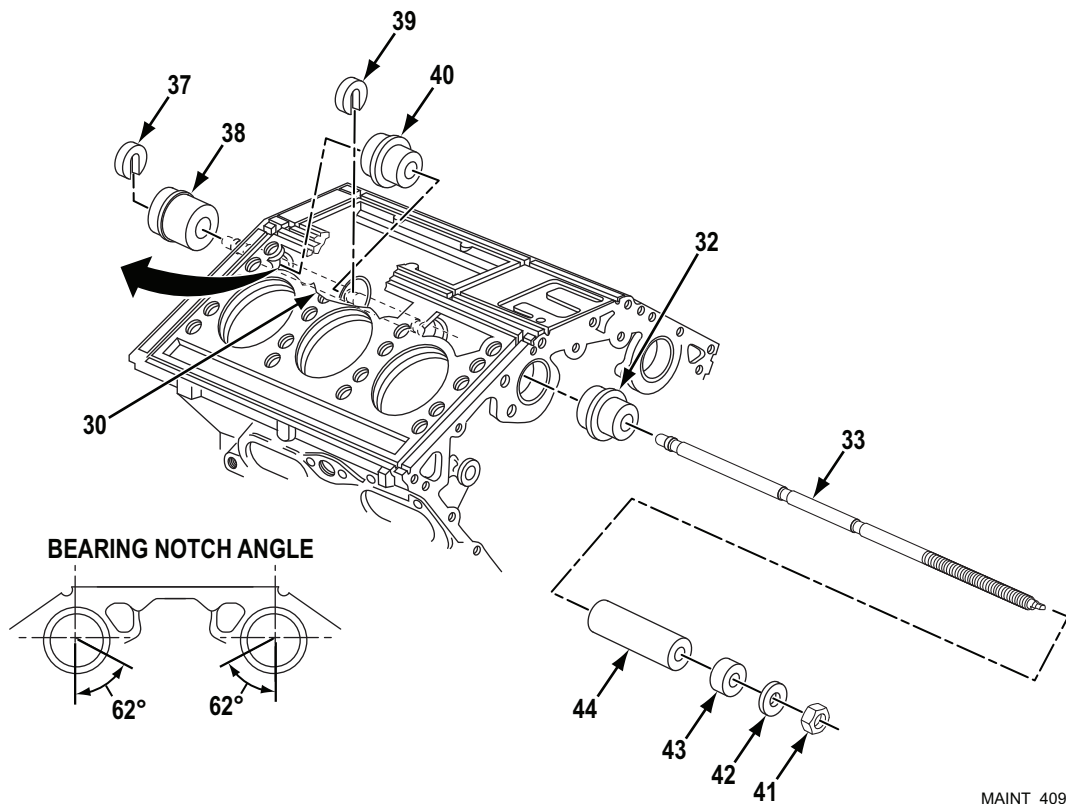


Figure 7. Cylinder Block Assembly.

**ASSEMBLY - Continued**

2. Install four camshaft end bearings (Figure 8, Items 31 and 28) as follows:
  - a. Insert pilot (Figure 8, Item 32) in bore of cylinder block. Use small diameter of pilot if bearing has been installed. Use large diameter if there is no bearing in block.
  - b. Insert support (Figure 8, Item 45) in end bore at opposite end of block.
  - c. Start unthreaded end of shaft (Figure 8, Item 33) into pilot (Figure 8, Item 32) and push through block and support (Figure 8, Item 45).
  - d. Place end bearing (Figure 8, Items 31 or 28) on installer (Figure 8, Item 38) and align notch in bearing with pin on installer. Slide bearing and installer on shaft (Figure 8, Item 33). Ensure notch in bearing is positioned properly in bore as shown.
  - e. Place C-washer (Figure 8, Item 37) in groove near end of shaft (Figure 8, Item 33). Pull shaft back until C-washer butts against installer (Figure 8, Item 38).
  - f. Place spacer (Figure 8, Item 44) (if required), thrust washer (Figure 8, Item 43), flat washer (Figure 8, Item 42), and hex nut (Figure 8, Item 41) over threaded end of shaft (Figure 8, Item 33).
  - g. To draw bearing (Figure 8, Items 31 or 28) into position, turn hex nut (Figure 8, Item 41) until shoulder on installer (Figure 8, Item 38) butts up against block bore.
  - h. Remove bearing installer (Figure 8, Item 38) assembly from cylinder block.
  - i. Repeat Steps 2.a.–2.h. for remaining end bearings.

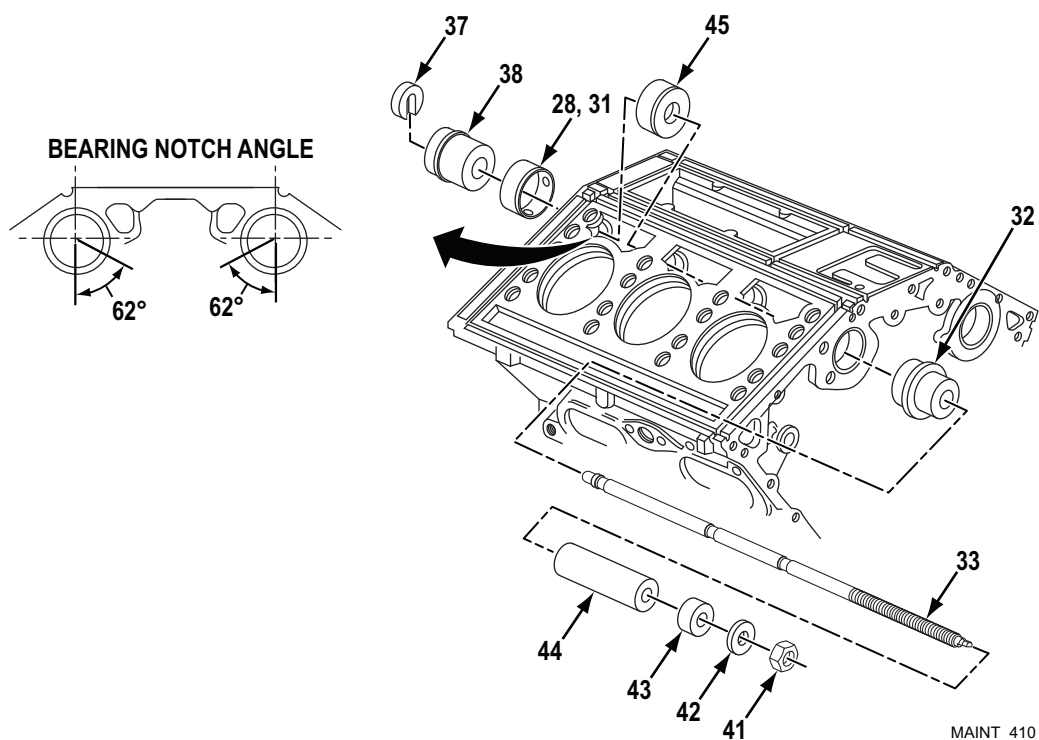


Figure 8. Cylinder Block Bearing Assembly.

**ASSEMBLY - Continued****NOTE**

Apply sealing compound to all uncoated plugs and fittings.

3. On model 5063-5392, install pipe plug (Figure 9, Item 14) in oil gallery hole at right side of cylinder block.
4. On models 5063-5299, 5063-5393, and 5063-539L, install bushing (Figure 9, Item 15) and pipe plug (Figure 9, Item 16) in oil gallery hole at right side of cylinder block.
5. On models 5063-5392, 5063-5393, and 5063-539L, install pipe plug (Figure 9, Item 21) in dipstick hole at left side of cylinder block.
6. On model 5063-5299, install two pipe plugs (Figure 9, Item 21) in dipstick holes on each side of cylinder block.
7. Install new expansion plug (Figure 9, Item 27) in rear of cylinder block at upper right side. Expansion plug must be flush to 0.030 in. (0.76 mm) below surface.
8. Install two new expansion plugs (Figure 9, Item 26) in main oil gallery at ends of cylinder block. Expansion plugs must be flush to 0.030 in. (0.76 mm) below surface of block.
9. If removed, press four pins (Figure 9, Item 25) into rear main bearing cap (Figure 9, Item 24). Pins must protrude 0.107–0.117 in. (2.72–2.97 mm).
10. Install four pipe plugs (Figure 9, Item 20): one in left side of block, two in right side of block, and one in top of left cylinder side.
11. Install two draincocks (Figure 9, Item 18) in sides of cylinder block.
12. Install new plug (Figure 9, Item 19), pipe plug (Figure 9, Item 17), and two pipe plugs (Figure 9, Item 22) in right side of cylinder block. Plug must be flush to 0.030 in. (0.76 mm) below surface of block.
13. Install four dowel pins (Figure 9, Item 23) into ends of cylinder block. Pins must protrude 11/16 inch (17.46 mm).

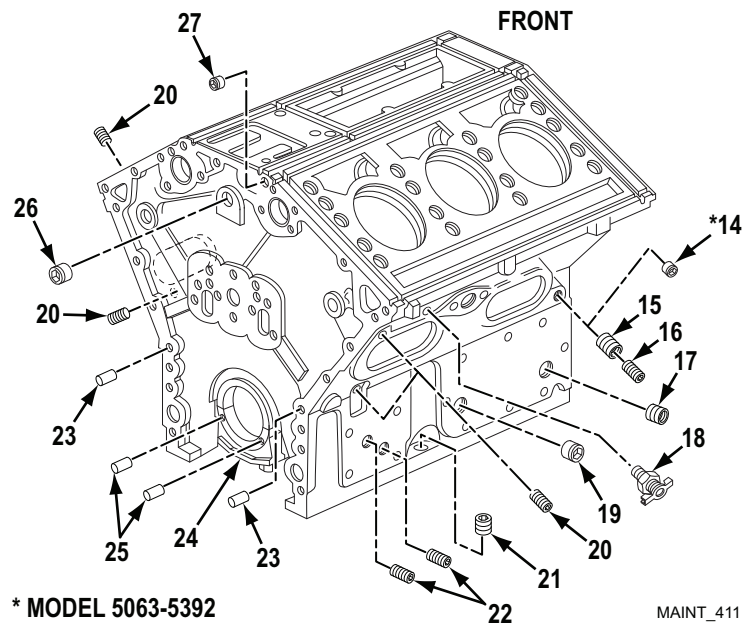


Figure 9. Cylinder Block Assembly.

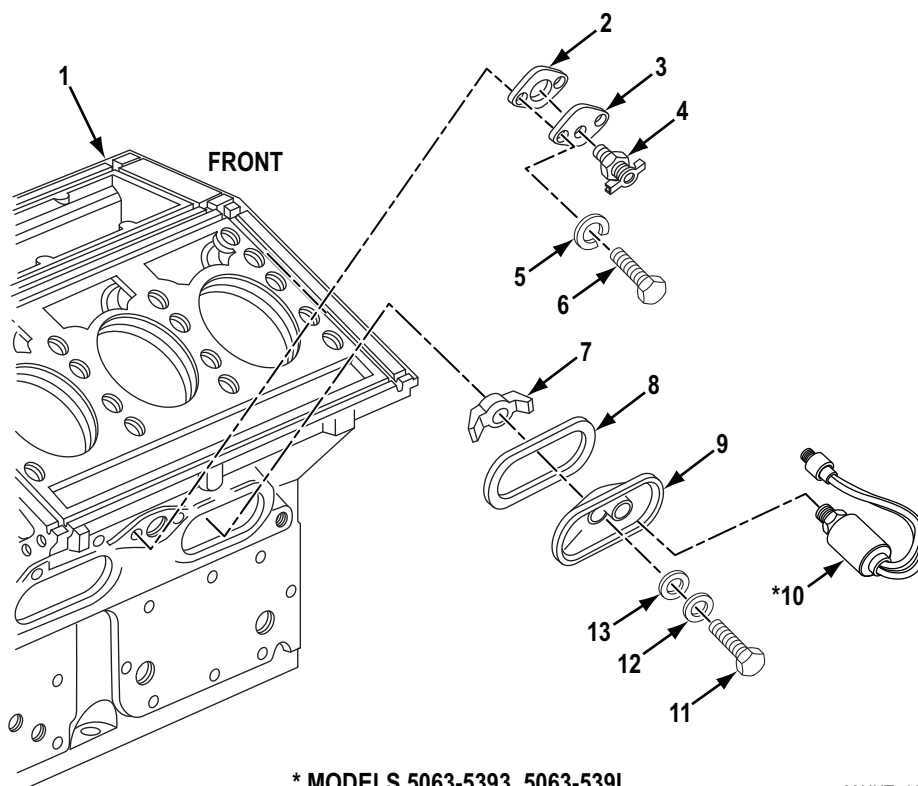
**ASSEMBLY - Continued**

14. Install new gasket (Figure 10, Item 2), cover plate (Figure 10, Item 3), two lockwashers (Figure 10, Item 5), and two bolts (Figure 10, Item 6) on right side of block. Torque bolts to 13–17 lb-ft (18–23 N·m).
15. Install draincock (Figure 10, Item 4) in cover plate (Figure 10, Item 3).

**NOTE**

On models 5063-5393 and 5063-539L, air box cover with threaded hole must be at right side front position and hole toward the front.

16. Install clamp (Figure 10, Item 7), copper gasket (Figure 10, Item 13), flat washer (Figure 10, Item 12), and screw (Figure 10, Item 11) on air box cover (Figure 10, Item 9). Install gasket (Figure 10, Item 8) on air box cover using gasket adhesive. Turn clamp until positioned between tangs on back of air box cover. Insert four air box cover assemblies into cylinder block, place clamp against inner cylinder block wall, and tighten screws to 12–15 lb-ft (16–20 N·m).
17. On models 5063-5393 and 5063-539L, install transducer assembly (Figure 10, Item 10) in right front air box cover (Figure 10, Item 9).



\* MODELS 5063-5393, 5063-539L

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Figure 10. Cylinder Block Air Box Cover Installation.

**END OF TASK**



## TEST AND INSPECTION

## NOTE

Ensure all water hole plugs are in cylinder block before pressure testing.

1. Install two preformed packings (Figure 11, Item 51) in grooves at each cylinder bore position.
2. Apply shortening compound or antifreeze to inner surface of preformed packings (Figure 11, Item 51).
3. Slide cylinder liners (Figure 11, Item 50) into block, being careful not to roll or damage preformed packings (Figure 11, Item 51).
4. Install three compression gaskets (Figure 11, Item 49), four large seal rings (Figure 11, Item 54), and four small seal rings (Figure 11, Item 52) on top surface of each cylinder side.
5. Install fabricated blocking plate (Figure 11, Item 46), eight flat washers (Figure 11, Item 47), and eight bolts (Figure 11, Item 48) on top of each cylinder side. Tighten bolts securely.
6. Install gasket (Figure 11, Item 2), water hole cover (Figure 11, Item 3), two lockwashers (Figure 11, Item 5), and two bolts (Figure 11, Item 6) on each side of cylinder block. Plug hole in one of the covers with 1/8 inch NPTF pipe plug (Figure 11, Item 53).
7. Connect air line with regulator to hole in other water hole cover (Figure 11, Item 3).

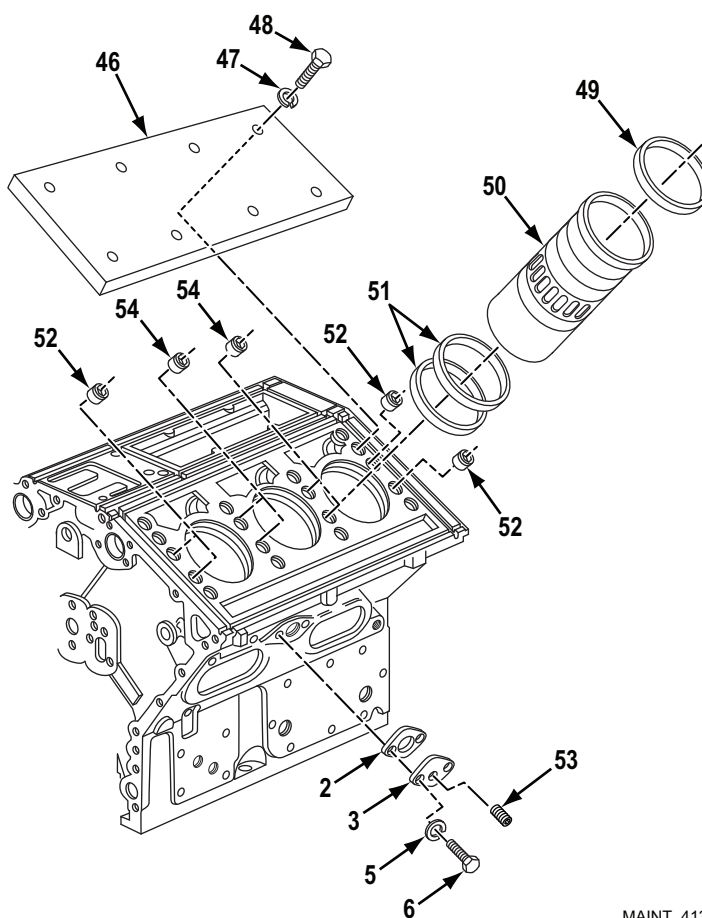
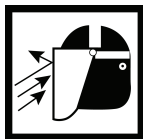


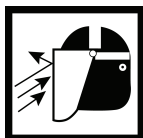
Figure 11. Cylinder Liner Installation.

8. Immerse cylinder block in water heated to 180–200°F (82–93°C) for 20 minutes.

**WARNING**

Wear eye protection when working with pressurized air system. Make certain air pressure is fully vented before disassembly. Sudden release of air pressure can throw debris. Failure to comply may result in injury to personnel.

9. Apply 40 psi (276 kPa) air pressure to water jacket and observe water in tank for bubbles which indicates a crack or leak in block. Replace block if cracked.
10. After completing pressure test, release air pressure and remove block from water tank. Remove plates, seals, liners, and gaskets from cylinder block.

**WARNING**

Compressed air used for cleaning purposes will not exceed 30 PSI (207 kPa). Use only with protective equipment (goggles, face shield, gloves, etc.). Failure to comply may result in injury to personnel.

11. Blowout all passages in block with compressed air.
12. Dry cylinder liners with compressed air and coat with lubricating oil to prevent rust from forming.

**END OF TASK****FOLLOW ON TASK**

1. Install crankshaft (WP 0097).
2. Install cylinder liners (WP 0097).
3. Install cylinder kits (models 5063-5392, 5063-5393, and 5063-539L) (WP 0095).
4. Install cylinder kits (model 5063-5299) (WP 0094).

**END OF TASK****END OF WORK PACKAGE**

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## SUSTAINMENT MAINTENANCE ENGINE PREPARATION FOR RUNNING

---

### INITIAL SETUP:

#### Tools and Special Tools

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Shield, Turbocharger, Protective  
(WP 0104, Table 1, Item 89)

#### References (cont.)

WP 0052  
WP 0053  
WP 0054

#### Materials/Parts

Antifreeze (WP 0103, Table 1, Item 3)  
Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)

#### References

TB 9-2350-368-25

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### CAUTION

Run engine in clean area when air intake ducting is removed. Dirt, dust, and particles in unfiltered air can enter engine and damage parts or cause mechanical failure.

### INSTALLATION

1. Install engine on dynamometer or powerplant test stand. Refer to TB 9-2350-368-25.

### WARNING



A protective shield must be installed on turbocharger inlet prior to running engine without built-in inlet screen or air cleaners. The turbocharger creates a strong suction at high engine speeds and can pull hands or clothing into spinning blades. Failure to comply may result in injury to personnel.

### NOTE

Do not overfill any fluid reservoir/tank. If a fluid starts to flow out of reservoir/tank, stop immediately to avoid spillage. Immediately clean up spilled fluid before proceeding with any task.

2. Connect source of fuel supply and fuel return to engine. Fill fuel filters with clean grade DF-2 fuel oil.
3. Connect same type of air cleaners used for engine when in vehicle.

**INSTALLATION - Continued****NOTE**

Locate air intake so that engine inducts cool fresh air.

Do not overfill any fluid reservoir/tank. If a fluid starts to flow out of reservoir/tank, stop immediately to avoid spillage. Immediately clean up spilled fluid before proceeding with any task.

4. Connect engine cooling system to heat exchanger or radiator similar to vehicle type used to cool engine. Fill cooling system with antifreeze, refer to applicable vehicle lubrication order.
5. Provide an external source of 24 V dc electrical power for starting engine.
6. Install oil pressure gage in oil gallery (Figure 1, Item 1).

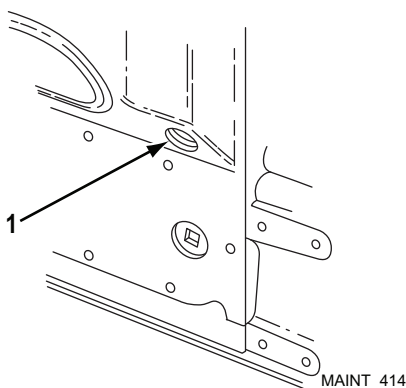


Figure 1. Oil Pressure Gage Location.

7. Install water temperature gage in thermostat housing.

**WARNING**

Position exhaust piping to carry toxic carbon monoxide exhaust gases away from test area. Failure to comply may result in injury, illness, or death to personnel.

8. Connect tubing to exhaust outlet of turbocharger, or exhaust manifolds, to conduct exhaust gases from engine.
9. Connect throttle control linkage to throttle control levers on governor.

**END OF TASK****ASSEMBLY AND PREPARATION FOR USE****NOTE**

Prime or purge engine fuel system after any major repair or overhaul.

1. Block or disconnect line from fuel pump.

**ASSEMBLY AND PREPARATION FOR USE - Continued**

2. Apply fuel under pressure, 60–80 PSI (413–552 kPa), to inlet on secondary filter with external fuel source. Allow fuel to flow freely from fuel return line until a steady stream without air bubbles is observed.

**END OF TASK****LUBRICATION****Prelubrication of Oil Gallery with Pressure Lubricator****CAUTION**

Prelubricate any stored or repaired engine prior to start-up. Oil gallery and associated components will have insufficient oil during the time lag following start-up. Bearing damage from lack of lubrication could result.

1. Remove plug from engine main oil gallery and connect lubricator hose.
2. Remove rocker arm covers, refer to (WP 0052) , (WP 0053) , and (WP 0054).
3. Using a positive displacement pump set at 25–35 PSI (172–242 kPa), pump in lubricating oil until oil flows from rocker arms.
4. Disconnect lubricator hose and install oil gallery plug.
5. Install rocker arm covers, refer to (WP 0052) , (WP 0053) , and (WP 0054).
6. Check and fill crankcase to proper level, refer to applicable vehicle lubrication order.

**Prelubrication of Oil Gallery without Pressure Lubricator**

1. Remove rocker arm covers, refer to (WP 0052) , (WP 0053) , and (WP 0054).
2. Pour lubricating oil on rocker arm assemblies.
3. Install rocker arm covers, refer to (WP 0052) , (WP 0053) , and (WP 0054).
4. Check and fill crankcase to proper level, refer to applicable vehicle lubrication order.

**Prelubrication of Turbocharger**

1. Disconnect oil supply line at turbocharger bearing (center) housing.
2. Fill bearing housing cavity with oil while rotating assembly by hand to coat internal bearing surfaces with oil.
3. Connect turbocharger oil supply line.

**END OF TASK****ASSEMBLY AND PREPARATION FOR USE****CAUTION**

Do not energize starter for more than 30 seconds at one time. Allow starter motor to cool for two to three minutes between operations to prevent overheating and damage.

1. Crank engine with governor in NO FUEL position until an oil pressure reading registers on gage.
2. Start and run engine at idle. Oil pressure gage should read 10 PSI (69 kPa) for adequate lubrication.

**END OF WORK PACKAGE**



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**SUSTAINMENT MAINTENANCE  
ENGINE ADJUSTMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Gage, Injector Rack (Starting, 0.345)  
(WP 0104, Table 1, Item 37)  
Gage, Injector Rack (Starting, 0.395)  
(WP 0104, Table 1, Item 38)  
Governor Cover, Cut-away  
(WP 0081, Figure 2)  
Socket, Wrench, Face Spanner  
(WP 0104, Table 1, Item 96)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)

**Materials/Parts**

Gasket (WP 0105, Table 1, Item 1)  
Washer, Flat  
Qty: (2) (WP 0105, Table 1, Item 117)

**Personnel Required**

Mechanic  
Helper (H)

**Equipment Condition**

Engine prepared for start-up (WP 0099)  
Engine tuned up (WP 0078)

---

**ADJUST****Governor Gap****NOTE**

Before proceeding with governor adjustments, disconnect linkage from stop lever and speed control lever.

1. On all except model 5063-5299, loosen two nuts (Figure 1, Item 1) on throttle delay U-bolt (Figure 1, Item 3) on right injector control tube (Figure 1, Item 2). Injector control tube must move freely in U-bolt.

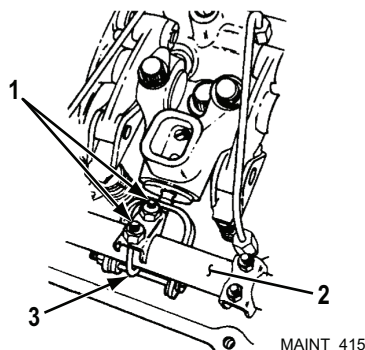


Figure 1. Fuel Injector Control Tube.

**WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

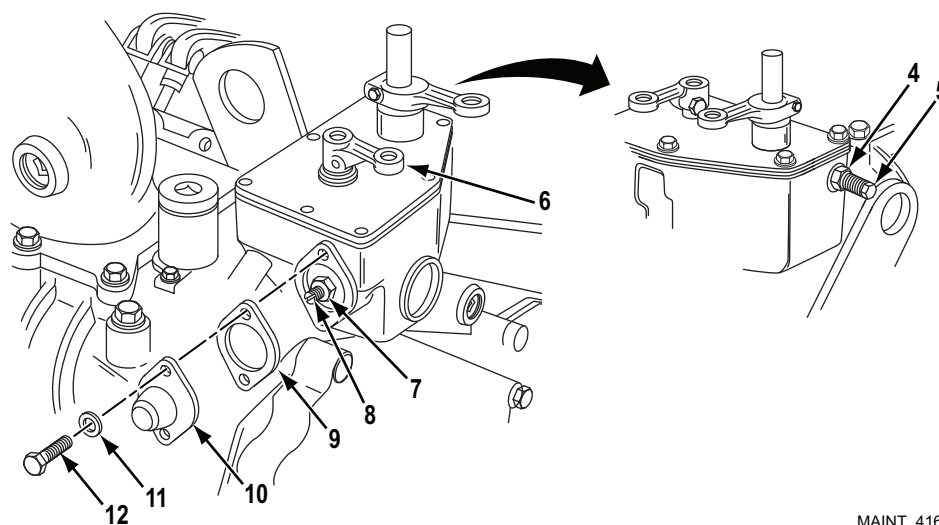
2. Start and operate engine to attain coolant outlet temperature of 160–185°F (71–85°C).
3. Stop engine and remove two bolts (Figure 2, Item 12), two copper flat washers (Figure 2, Item 11), spring pack cover (Figure 2, Item 10), and gasket (Figure 2, Item 9) from side of governor. Discard gasket and flat washers.

**NOTE**

Do not back the buffer screw out beyond limits given or the control link lever may disengage the differential lever.

4. Loosen locknut (Figure 2, Item 4) and back out buffer screw (Figure 2, Item 5) until it extends 5/8 in. (16 mm) from locknut.
5. Start engine. Hold idle speed screw (Figure 2, Item 8) and loosen idle speed locknut (Figure 2, Item 7). Adjust idle speed screw to obtain idle of 500–600 rpm. Hold idle speed screw and tighten idle speed locknut.
6. Stop engine using engine stop lever (Figure 2, Item 6).



**ADJUST**

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Figure 2. Governor Assembly.

7. Remove seven screw assemblies (Figure 3, Item 13), cut-away governor cover (Figure 3, Item 21), and gasket (Figure 3, Item 20) from top of governor.
8. On models 5063-5392, 5063-5393, and 5063-539L loosen locknut (Figure 3, Item 16) and screw starting aid screw (Figure 3, Item 15) into gap adjusting screw (Figure 3, Item 17).

**CAUTION**

When manually overriding governor, watch engine controls closely and do not allow engine to overspeed. Extended engine operation above speed limits can damage engine.

9. Start and run engine between 1100–1300 rpm by manual operation of differential lever (Figure 3, Item 14).
10. Check gap between low-speed spring cap (Figure 3, Item 18) and high-speed spring plunger (Figure 3, Item 19) with an injector rack gage. Gap should be 0.002–0.004 in. (0.05–0.10 mm). If necessary, set gap again with adjusting screw (Figure 3, Item 17).
11. On model 5063-5299, hold gap adjusting screw (Figure 3, Item 17) and tighten locknut (Figure 3, Item 16).
12. Check gap with engine running between 1100–1300 rpm, adjust gap if necessary.
13. Stop engine by moving differential lever (Figure 3, Item 14) to NO FUEL position.

**CAUTION**

Ensure governor stop lever moves injector racks freely to NO FUEL position before installing cut-away governor cover. Any binding of stop lever and injector racks could result in failure to stop a run-away engine. Extended engine operation above speed limits can damage engine.

**NOTE**

On models 5063-5392, 5063-5393, and 5063-539L, install cut-away governor cover after starting aid screw adjustment.

14. On model 5063-5299, install cut-away governor cover (Figure 3, Item 21), gasket (Figure 3, Item 20), and seven screw assemblies (Figure 3, Item 13) to governor. Tighten screws securely.

## ADJUST

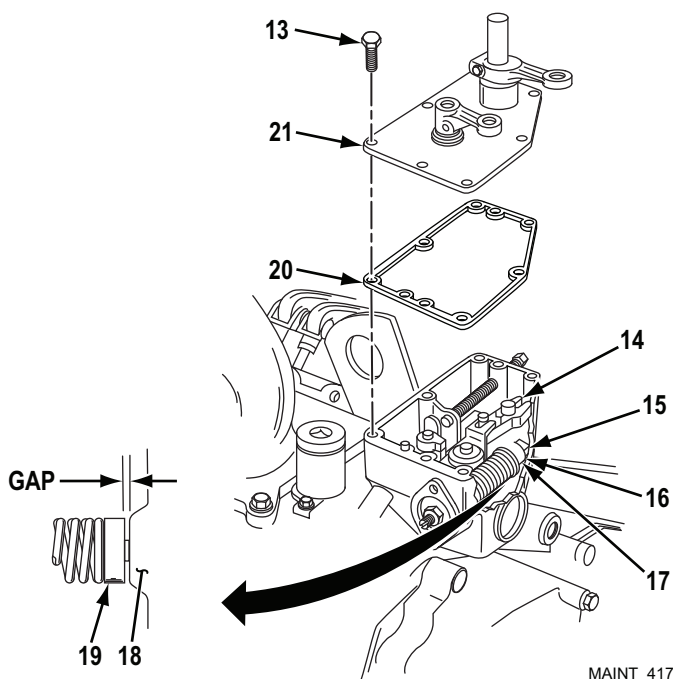


Figure 3. Governor Cover Assembly.

## Starting Aid Screw

**NOTE**

Perform starting aid screw adjustment with engine shutdown.

1. Install fabricated cut-away governor cover (Figure 4, Item 26) on governor housing.
2. Position stop lever (Figure 4, Item 6) in RUN position and speed control lever (Figure 4, Item 22) in IDLE position.
3. Hold starting aid screw (Figure 4, Item 15) and loosen locknut (Figure 4, Item 16).

**NOTE**

Backing out starting aid screw will increase clearance between injector rack clevis and injector body. Turning in starting aid screw will reduce clearance.

For models 5063-5392, 5063-5393, and 5063-539L, use 0.345-inch injector rack gage.

4. Insert injector rack gage (Figure 4, Item 24) in a vertical position on 3R injector rack (Figure 4, Item 25) between clevis and injector body (Figure 4, Item 23). Prevent gap adjusting screw (Figure 4, Item 17) from turning and adjust starting aid screw (Figure 4, Item 15) until clearance is enough to release gage.
5. Hold starting aid screw (Figure 4, Item 15) and tighten locknut (Figure 4, Item 16). Remove gage (Figure 4, Item 24).
6. Check clearance between injector body (Figure 4, Item 23) and clevis of injector rack (Figure 4, Item 25) as follows:
  - a. Position stop lever (Figure 4, Item 6) in RUN position.

**ADJUST**

- b. Move engine speed control lever (Figure 4, Item 22) from IDLE speed to FULL FUEL position.
- c. Return speed control lever (Figure 4, Item 22) to IDLE position.
- d. Insert injector rack gage (Figure 4, Item 24) in a vertical position on 3R injector rack (Figure 4, Item 25) between clevis and injector body (Figure 4, Item 23) and recheck clearance of injector rack clevis to injector body. If necessary, adjust starting aid screw (Figure 4, Item 15) again using Steps 1–5.

**NOTE**

If governor gap is changed, adjust injector control racks again.

7. Start engine and check running governor gap, Engine Tune-Up (WP 0078), Adjustment. If necessary, set governor gap again. Running governor gap should be 0.0015 in. (0.038 mm). Stop engine.

**CAUTION**

Ensure injector racks move into NO FUEL position with governor stop lever before starting engine. Extended engine operation above speed limits can damage engine.

8. Remove cut-away governor cover (Figure 4, Item 26) from governor and install original cut-away governor cover on engine.

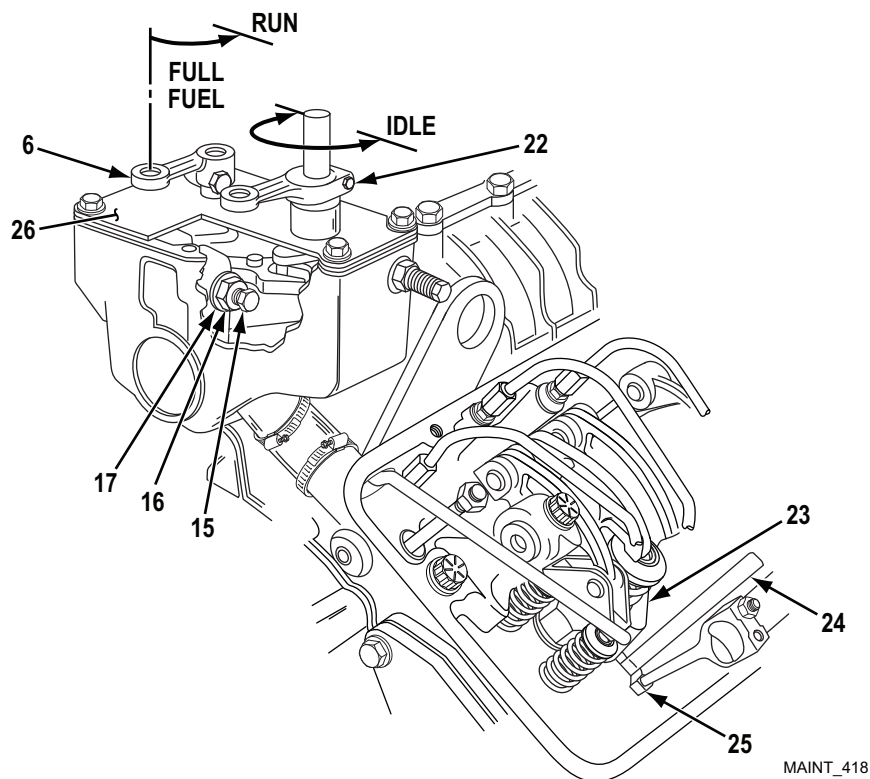


Figure 4. Starter Aid Screw Location.

**Maximum No-Load Speed**

**ADJUST****WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

**NOTE**

To adjust engine, start with five 0.010-inch shims and five 0.078-inch shims in governor spring pack. Buffer screw must project 5/8 in. (16 mm) beyond locknut or interference will result during no-load speed adjustment.

1. Start engine and operate until coolant outlet temperature is 160–185°F (71–85°C).
2. Remove load from engine and place speed control lever (Figure 5, Item 22) in FULL FUEL position. Note engine speed. Maximum speed should be approximately 2965 rpm.
3. Stop engine and, if necessary, adjust no-load speed as follows:

**CAUTION**

Do not jar high speed spring and plunger assembly (Figure 5, Item 32) during removal or low speed spring and cap may drop into governor.

- a. Loosen idle speed screw (Figure 5, Item 8) and unscrew retainer nut (Figure 5, Item 28) from side of governor housing (Figure 5, Item 27) using retaining nut wrench (Figure 5, Item 33). Remove high speed spring and plunger assembly (Figure 5, Item 32).

**NOTE**

Removing shims will decrease engine speed and adding shims will increase engine speed. Each 0.010-inch shim will change engine speed approximately 10 rpm.

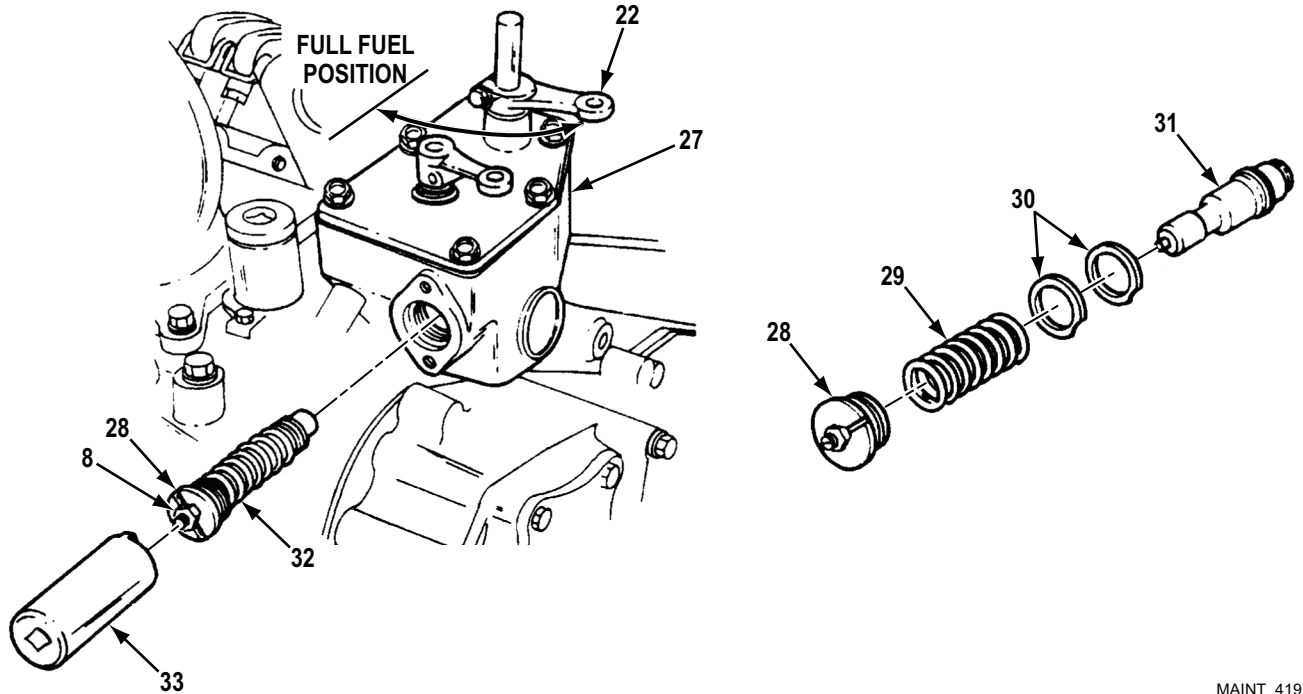
- b. Remove high speed spring (Figure 5, Item 29) from plunger (Figure 5, Item 31) and add or remove shims (Figure 5, Item 30) as required to attain desired engine no-load speed.
  - c. Place high speed spring (Figure 5, Item 29) on plunger (Figure 5, Item 31) and install assembly (Figure 5, Item 32) in governor housing (Figure 5, Item 27). Thread retainer nut (Figure 5, Item 28) into governor housing and tighten using retaining nut wrench (Figure 5, Item 33).
4. Start engine and check maximum no-load speed. Repeat Steps 1–3 as necessary to attain desired no-load speed of 2965 rpm.

**Idle Speed****WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

**ADJUST**

1. Start engine and operate until coolant outlet temperature of 160–185°F (71.1–85.0°C) is attained.
2. Place speed control lever (Figure 5, Item 22) in IDLE position.



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Figure 5. Maximum No-Load Speed Adjustment Locations.

**NOTE**

Model 5063-5299 requires an idle speed setting of 650–700 rpm. Models 5063-5392, 5063-5393 and 5063-539L are set at 600–650 rpm.

3. Hold idle speed screw (Figure 6, Item 8) and loosen idle speed locknut (Figure 6, Item 7). Adjust engine idle speed screw to obtain 15 rpm below recommended idle speed. Prevent idle speed screw from turning and tighten idle speed locknut.
4. Stop engine.

**Buffer Screw****WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

1. Start engine and operate until coolant outlet temperature is 165–185°F (71.1–85.0°C).

**ADJUST**

2. Place speed control lever (Figure 6, Item 22) in FULL FUEL position and record maximum no-load speed.

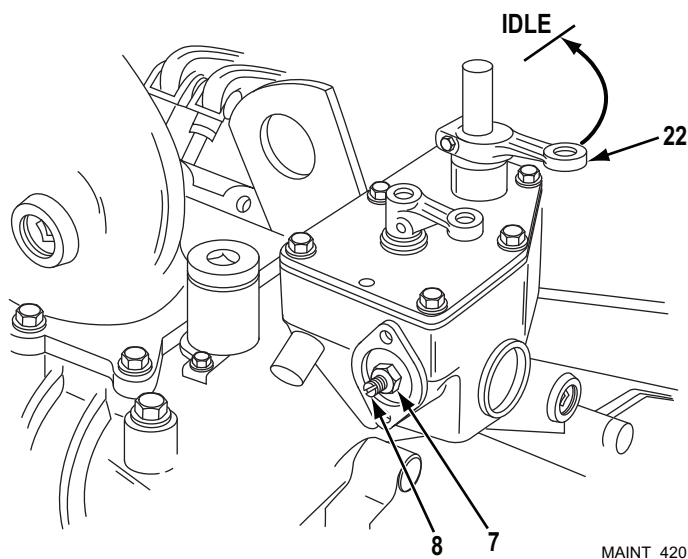


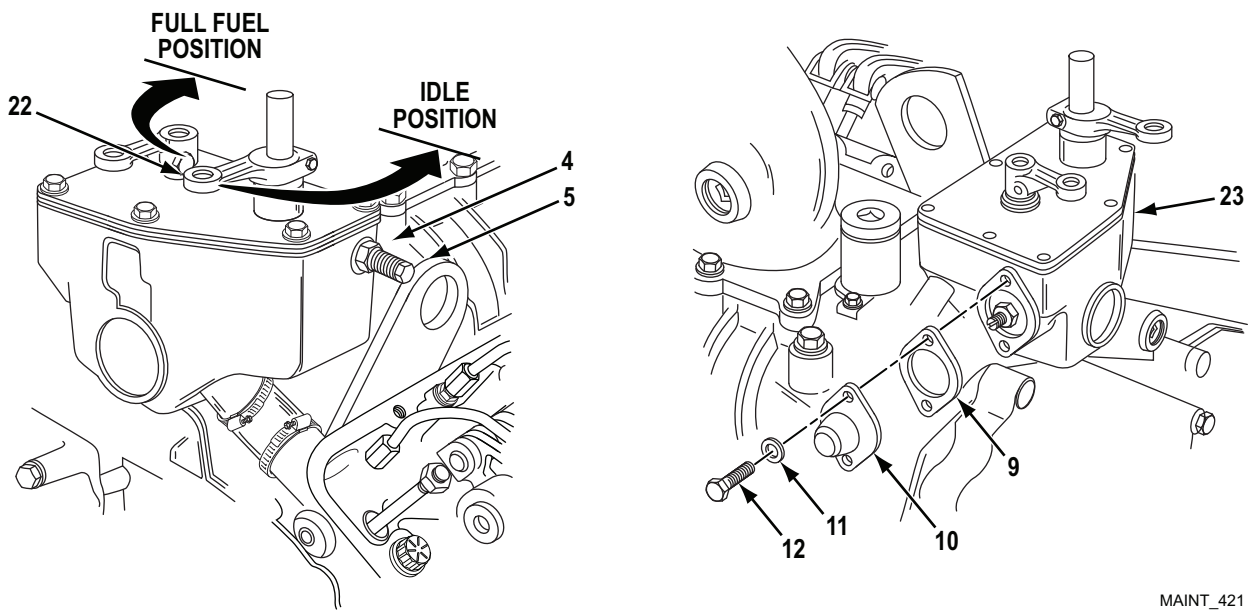
Figure 6. Idle Speed Adjustment Locations.

**NOTE**

Do not increase engine idle speed more than 15 rpm with buffer screw.

3. Place speed control lever (Figure 7, Item 22) in IDLE position.
4. Hold locknut (Figure 7, Item 4) and turn buffer screw (Figure 7, Item 5) until it contacts differential lever as lightly as possible and eliminates engine roll.
5. Move speed control lever (Figure 7, Item 22) to FULL FUEL position. If maximum no-load speed has increased more than 25 rpm, hold buffer screw locknut (Figure 7, Item 4) and back out buffer screw (Figure 7, Item 5) until no-load speed increase is less than 15 rpm.
6. Hold buffer screw (Figure 7, Item 5) and tighten locknut (Figure 7, Item 4).
7. Stop engine.
8. Install new gasket (Figure 7, Item 9), spring pack cover (Figure 7, Item 10), two new copper flat washers (Figure 7, Item 11), and two bolts (Figure 7, Item 12) on governor housing (Figure 7, Item 23). Torque bolts to 10–13 lb-ft (14–18 N·m).

**ADJUST**



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Figure 7. Buffer Screw Adjustment Locations.

**END OF TASK**

**END OF WORK PACKAGE**





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**SUSTAINMENT MAINTENANCE  
ENGINE TESTING AND PREPARATION FOR STORAGE OR SHIPMENT**

---

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

Tool Kit, General Mechanic's  
(WP 0104, Table 1, Item 113)  
Adapter, Cylinder Compression  
(WP 0104, Table 1, Item 1)  
Tester, Cylinder Compression  
(WP 0104, Table 1, Item 105)  
Adapter, Torque Wrench (Fuel Nut)  
(WP 0104, Table 1, Item 4)  
Gage, Fuel Pressure (WP 0104, Table 1, Item 35)  
Wrench, Torque, Dial, 0–175 Lb-Ft  
(WP 0104, Table 1, Item 120)  
Manometer, U-Tube (WP 0104, Table 1, Item 68)  
Tubing, Nonmetallic  
(WP 0104, Table 1, Item 115)  
Coupling Half (C/O Air Hose Assy)  
(WP 0104, Table 1, Item 21)  
Tube Assembly, Fuel (WP 0081, Figure 7)

**Materials/Parts**

Food Coloring (WP 0103, Table 1, Item 14)  
Mercury (WP 0103, Table 1, Item 24)

**Materials/Parts (cont.)**

Oil, Engine (WP 0103, Table 1, Item 27)  
Oil, Fuel (WP 0103, Table 1, Item 30)  
Oil, Preservative (WP 0103, Table 1, Item 37)  
Washer, Lock  
Qty: (2) (WP 0105, Table 1, Item 177)

**References**

WP 0052  
WP 0053  
WP 0072  
WP 0014  
WP 0015  
WP 0016  
WP 0100  
WP 0073  
WP 0078

**Equipment Condition**

Engine prepared for start-up (WP 0099)

## TESTING

## Cylinder Compression

## WARNING



Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

1. Start engine and operate at one-half rated load until coolant outlet temperature is 165–185°F (71.1–85.0°C). Stop engine and remove rocker arm cover (WP 0052) or (WP 0053).
2. Move speed control lever (Figure 1, Item 5) to NO FUEL position.
3. Loosen four fabricated fuel tube assembly nuts (Figure 1, Item 2) and remove two fuel tubes (Figure 1, Item 1) from one cylinder position.
4. Rotate appropriate cylinder to bottom dead center.
5. On 1R cylinder, for all except model 5063-5299, remove two nuts (Figure 2, Item 8), two lockwashers (Figure 2, Item 7), and U-bolt (Figure 2, Item 11) from throttle delay lever assembly (Figure 2, Item 6). Discard lockwashers.
6. Remove two rocker shaft bracket bolts (Figure 1, Item 3).
7. On models 5063-5392, 5063-5393, and 5063-539L, remove hold-down bracket (Figure 2, Item 10) and rocker shaft bracket bolt (Figure 2, Item 3) of any adjacent cylinder.
8. Swing rocker arms (Figure 1, Item 4) away from injector and valves.

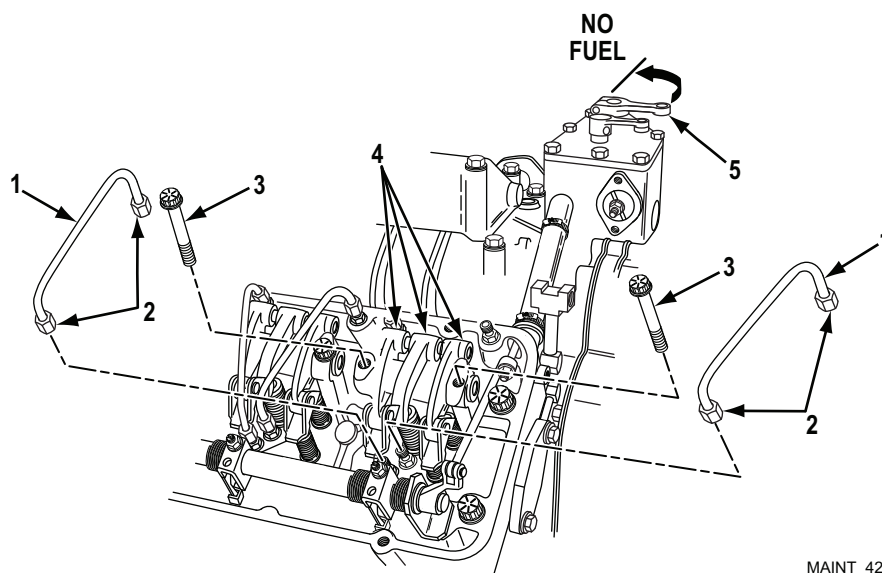


Figure 1. Fuel Tube Removal.

9. On 1R cylinder, for all except model 5063-5299, remove throttle delay lever assembly (Figure 2, Item 6) from throttle delay bracket (Figure 2, Item 9) (WP 0072).

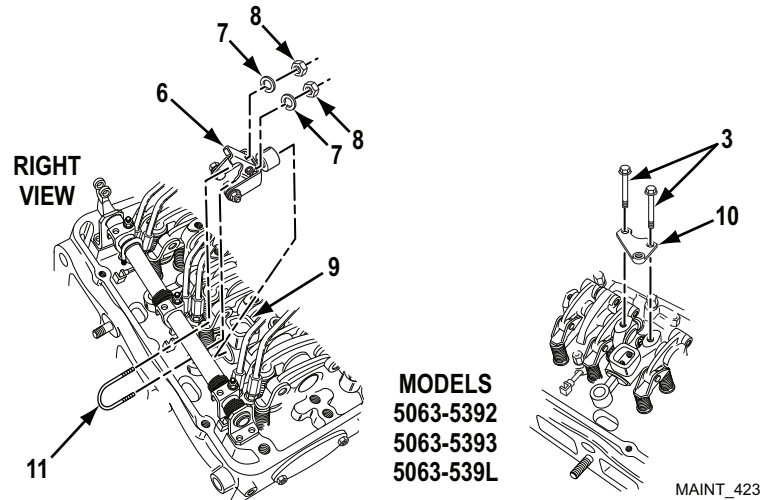


Figure 2. Remove Throttle Delay Lever and Rocker Shaft Bracket.

10. Loosen locknut (Figure 3, Item 17) and back out adjusting screw (Figure 3, Item 19) on control tube lever (Figure 3, Item 18). Slide injector control lever on injector control tube (Figure 3, Item 20) away from injector control rack (Figure 3, Item 22).
11. Remove bolt (Figure 3, Item 14), convex washer (Figure 3, Item 15), clamp (Figure 3, Item 16), and injector (Figure 3, Item 13) in cylinder head.

### CAUTION

Injector clamp must not interfere with follower spring or exhaust valve springs when installed. Damage could occur to engine valve or injector clamp.

12. Install cylinder compression adapter (Figure 3, Item 21), clamp (Figure 3, Item 16), convex washer (Figure 3, Item 15), and bolt (Figure 3, Item 14) in injector tube. Torque bolt to 20–25 lb-ft (27–34 N·m). Connect cylinder compression tester (Figure 3, Item 12) to adapter.

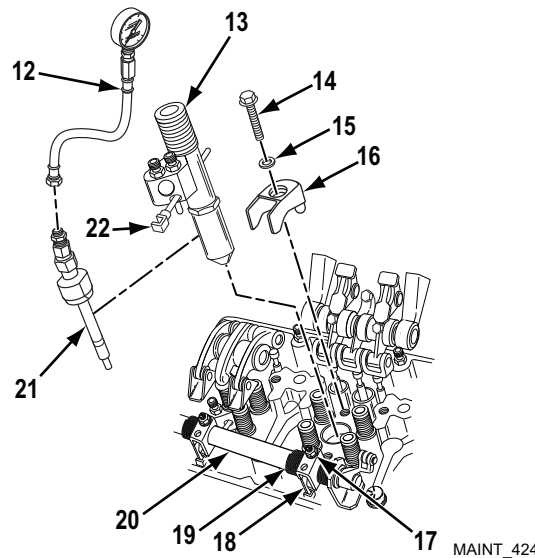


Figure 3. Remove Injector and Install Cylinder Compression Tester.

**CAUTION**

Exhaust valve bridges must rest on ends of exhaust valves when tightening rocker arm shaft bolts or damage to exhaust valves will result.

13. Position rocker arms (Figure 4, Item 4) over cylinder compression adapter (Figure 4, Item 21) and exhaust valves. Install two rocker arm shaft bolts (Figure 4, Item 3) and torque to 50–55 lb-ft (68–75 N·m).

**NOTE**

Do not crank engine using starter motor to obtain compression pressure. Engine must be running to obtain accurate reading.

Variation in compression pressures between cylinders must not exceed 25 psi (172 kPa) at 600 rpm.

Use spare fabricated fuel tube assembly to fabricate a jumper connection between fuel inlet and fuel return manifold connectors. Do not install fuel tubes on engine after bending for fabrication.

14. Install spare fabricated fuel tube assembly (Figure 4, Item 23) between inlet manifold (Figure 4, Item 25) and return manifold (Figure 4, Item 24).

**WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

15. Start engine and run at 600 rpm. Record pressure shown on fuel pressure gage.
16. Stop engine. Move speed control lever (Figure 1, Item 5) to NO FUEL position.
17. Cylinder compression pressure of any one cylinder, measured in Step 15 above, must not be less than minimum pressures, see Table 1.

**Table 1. Minimum Compression Pressure at 600 RPM.**

ALTITUDE FEET (METERS)	MODEL 5063–5299 PSI (kPa)	ALL EXCEPT MODEL 5063-5299 PSI (kPa)
500 (152)	540 (3721)	430 (2963)
2500 (762)	500 (3445)	400 (2756)
5000 (1524)	465 (3204)	370 (2549)
7500 (2286)	430 (2963)	340 (2343)
10000 (3048)	395 (2722)	315 (2170)

18. Remove spare fabricated fuel tube assembly (Figure 4, Item 23). Remove two rocker arm shaft bolts (Figure 4, Item 3) and swing rocker arms (Figure 4, Item 4) away from cylinder compression adapter (Figure 4, Item 21) and valves.

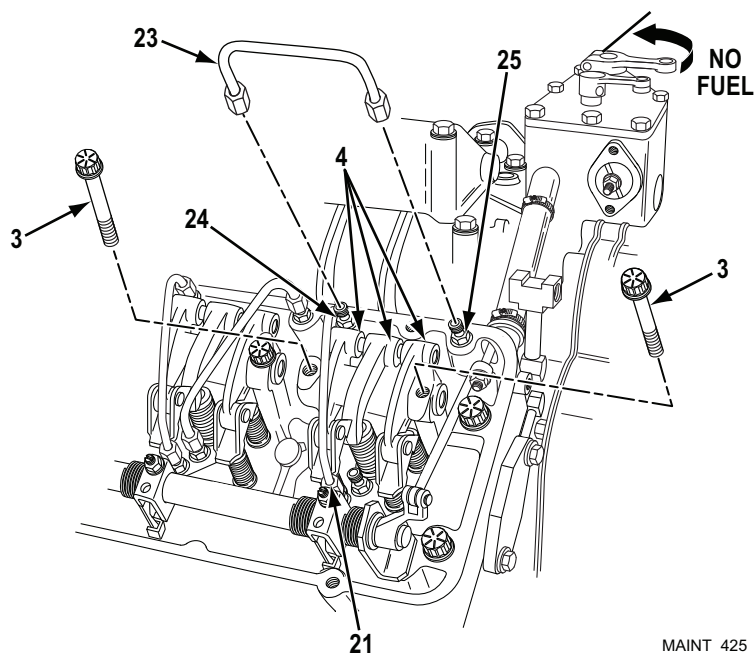


Figure 4. Spare Fuel Tube Installation.

19. Remove bolt (Figure 5, Item 14), convex washer (Figure 5, Item 15), clamp (Figure 5, Item 16), cylinder compression tester (Figure 5, Item 12), and cylinder compression adapter (Figure 5, Item 21) from cylinder head.
20. Align dowel (Figure 5, Item 26), on injector (Figure 5, Item 13), with locating hole in cylinder head. Install injector in injector tube.
21. Install clamp (Figure 5, Item 16), convex washer (Figure 5, Item 15), and bolt (Figure 5, Item 14) with convex side of washer facing clamp. Torque bolt to 20–25 lb-ft (27–34 N·m).

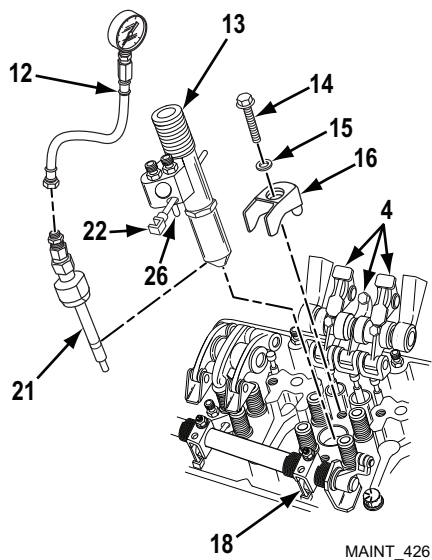


Figure 5. Remove Cylinder Tester and Install Injector.

22. On 1R cylinder, for all except model 5063-5299, install throttle delay lever assembly (Figure 6, Item 8) in throttle delay bracket (Figure 6, Item 9).
23. Swing rocker arms (Figure 5, Item 4) on top of injector and valves.
24. On models 5063-5392, 5063-5393, and 5063-539L, install hold-down bracket (Figure 6, Item 10) and rocker shaft bracket bolt (Figure 6, Item 3) of any adjacent cylinder.
25. Install two rocker arm shaft bolts (Figure 6, Item 3). Torque bolts to 50–55 lb-ft (68–75 N·m).
26. On models 5063-5392, 5063-5393, and 5063-539L, torque adjacent rocker arm shaft bolts (Figure 7, Item 3) to 50–55 lb-ft (68–75 N·m).
27. Slide control tube lever (Figure 5, Item 18) into injector rack (Figure 5, Item 22).
28. On 1R cylinder, for all except model 5063-5299, install U-bolt (Figure 6, Item 11), two new lockwashers (Figure 6, Item 7), and two nuts (Figure 6, Item 8) in throttle delay lever assembly (Figure 6, Item 6).

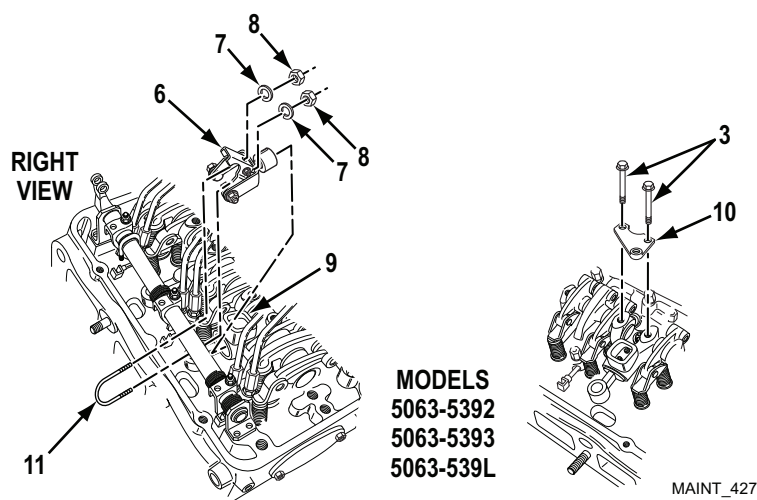
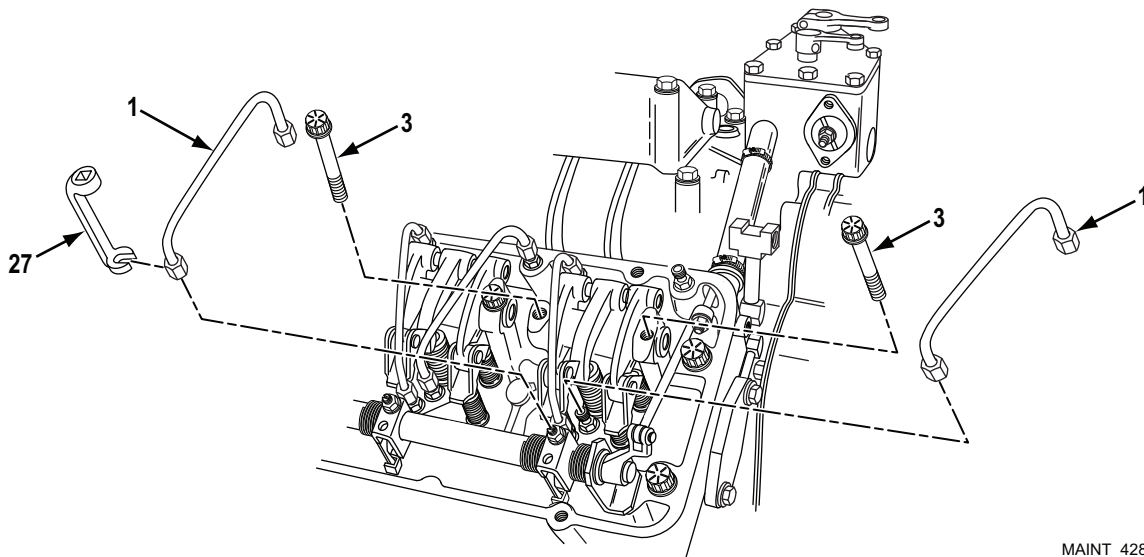


Figure 6. Install Throttle Delay Lever and Rocker Shaft Bracket.

**CAUTION**

Do not bend fabricated fuel tube assemblies and do not exceed specified torque on fuel tube nuts. Excessive tightening will twist or fracture flared end of fabricated fuel tube assembly and result in leaks.

29. Install two fuel tubes (Figure 7, Item 1). Using fuel nut wrench (Figure 7, Item 27), torque four fabricated fuel tube assembly nuts to 130–160 lb-in. (14.7–18.1 N·m).
30. Repeat Steps 1–29 on remaining cylinders.



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Figure 7. Fuel Tube Installation.

## Fuel Flow

### NOTE

If necessary, adapt a fuel line to the fuel return to reach container.

On model 5063-5393 the fuel return fitting is machined into a fuel junction block which is mounted on the engine oil cooler.

1. Connect a fuel return line (Figure 8, Item 29) to the fuel return fitting (Figure 8, Item 28) on engine.
2. Hold open end of fuel return line (Figure 8, Item 29) in a measured container.

### WARNING



Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

3. Start engine and run at 2200 rpm NO-LOAD. Using a stop watch, measure fuel flow from fuel return line (Figure 8, Item 29) for one minute. Minimum fuel return rate is 2/3 Gallons Per Minute (GPM).
4. Stop engine and remove fuel line (Figure 8, Item 29). Connect fuel return.

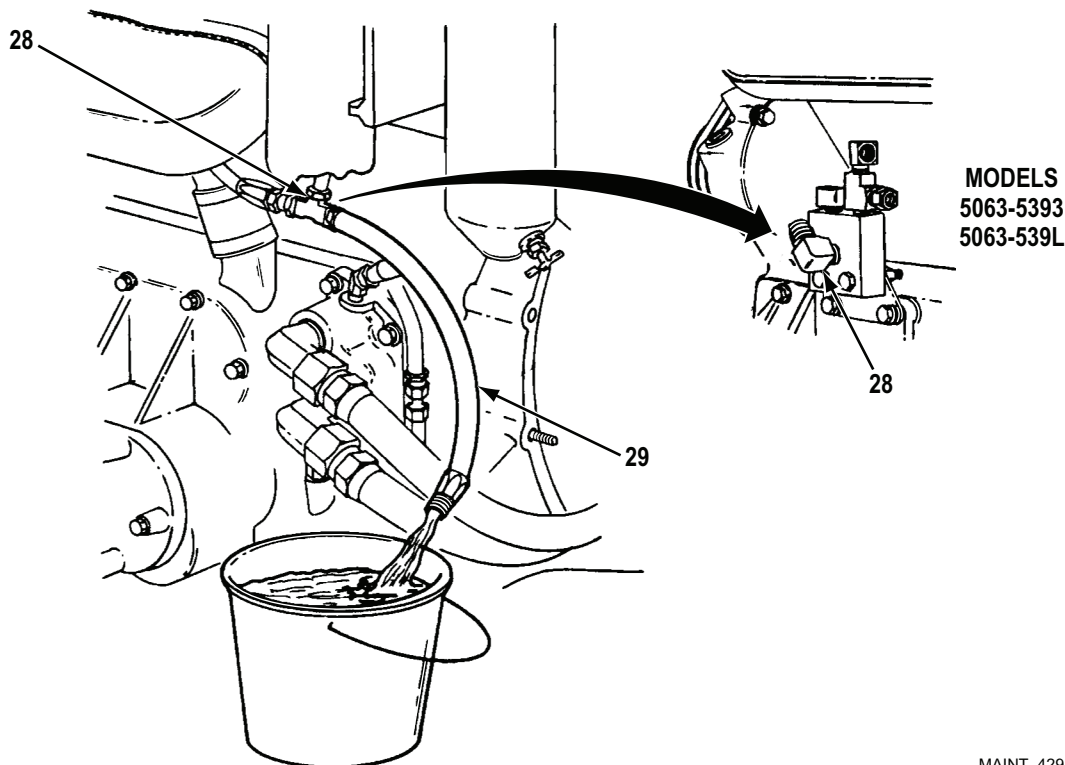


Figure 8. Fuel Flow Check.

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## Fuel Pressure

1. Remove fuel inlet tube assembly (Figure 9, Item 30) from injector (Figure 9, Item 33) and fuel inlet manifold (Figure 9, Item 32).
2. Connect fuel pressure gage (Figure 9, Item 31) to injector (Figure 9, Item 33) and fuel manifold (Figure 9, Item 32).

### WARNING



Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

3. Start engine and operate at 2500 rpm. Note reading on fuel pressure gage (Figure 9, Item 31). Fuel pressure must be 45–70 psi (310–483 kPa) at 2500 rpm.

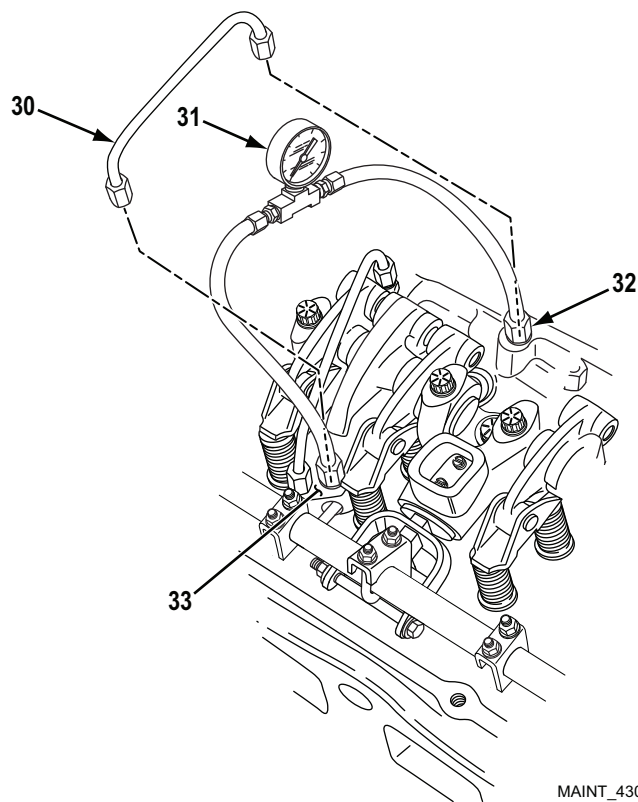


Figure 9. Remove Fuel Inlet Tube and Install Fuel Pressure Gage.

- Stop engine by moving governor stop lever (Figure 10, Item 34) to NO FUEL position.

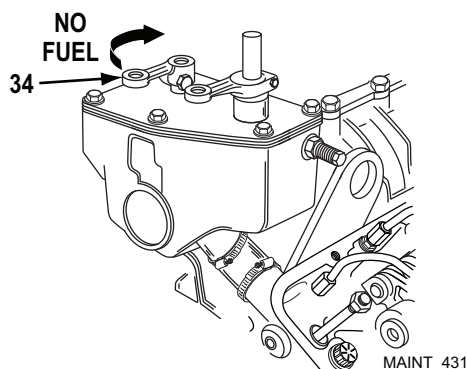


Figure 10. Governor Stop Lever.

- Remove fuel pressure gage (Figure 9, Item 31) from connection at injector (Figure 9, Item 33) and fuel inlet manifold (Figure 9, Item 32).

### CAUTION

Do not bend fabricated fuel tube assemblies and do not exceed specified torque on fuel tube nuts. Excessive tightening will twist or fracture flared end of fabricated fuel tube assembly and result in leaks.

- Install fuel inlet tube assembly (Figure 9, Item 30) on injector (Figure 9, Item 33) and fuel inlet manifold (Figure 9, Item 32). Using fuel nut wrench, torque fuel tube nuts to 130–160 lb-in (14.7–18.1 N·m).

### Crankcase Pressure

- Remove one tube connector (Figure 11, Item 36) from u-tube manometer (Figure 11, Item 40) by rotating counterclockwise.
- Turn other tube connector (Figure 11, Item 35) clockwise until fully engaged and then back out one full turn.
- Add five drops of food coloring to one pint of distilled water and mix.
- Add colored solution (Figure 11, Item 39) to u-tube manometer (Figure 11, Item 40) until liquid level is opposite zero mark on scale with u-tube manometer vertical.

### NOTE

Eliminate air bubbles in u-tube manometer by tilting and gently tapping.

- Install tube connector (Figure 11, Item 36) until fully engaged and then back out one full turn.

### NOTE

Torque wrench adapter must not extend into oil in oil pan.

- Remove oil level gage, oil level gage tube, and adapter from oil pan (WP 0014), (WP 0015), or (WP 0016). Install coupling half (Figure 11, Item 37) in oil pan.
- Connect nonmetallic tubing (Figure 11, Item 38) to coupling half (Figure 11, Item 37) and tube connector (Figure 11, Item 36). Mount u-tube manometer in vertical position. Close manometer u-tube connector connected to nonmetallic tubing.

**WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

**CAUTION**

If crankcase pressure is excessively high, this pressure may exceed the capacity of u-tube manometer. To prevent blowing liquid out of u-tube manometer, discontinue test if liquid level approaches limits of u-tube manometer scale by closing u-tube manometer connector.

8. Start engine and operate at 2500 rpm, FULL LOAD. Slowly open u-tube manometer connector (Figure 11, Item 36), connected to nonmetallic tubing (Figure 11, Item 38), while carefully observing liquid level in u-tube manometer.

**NOTE**

A u-tube manometer measurement is the sum of the displacements from zero of the two columns of liquid. The value expressed is in inches of water.

For model 5063-5299, crankcase pressure must not exceed 0.9 inch of water at 2500 rpm, FULL LOAD.

For all except model 5063-5299, crankcase pressure must not exceed 3.3 inches of water at 2800 rpm, FULL LOAD.

9. When u-tube manometer connector (Figure 11, Item 36) has been opened one full turn, read crankcase pressure on u-tube manometer scale.
10. Stop engine by moving governor stop lever (Figure 10, Item 34) to NO FUEL position.
11. Disconnect hose (Figure 11, Item 38) and remove coupling half (Figure 11, Item 37).
12. Install torque wrench adapter, oil level gage tube, and oil level gage to oil pan (WP 0014) , (WP 0015), or (WP 0016).

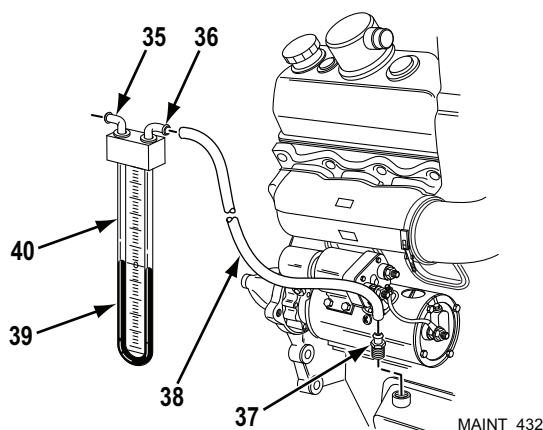


Figure 11. Crankcase Pressure Check.

## Air Box Pressure

**WARNING**

Mercury is a toxic material. Avoid contact with skin. Clean up any spilled mercury. Dispose of small amounts of mercury by wiping with aluminum foil. Failure to comply may result in injury, illness, or death to personnel.

1. Remove one tube connector (Figure 12, Item 41) from u-tube manometer (Figure 12, Item 46) by rotating counterclockwise.
2. Turn remaining tube connector (Figure 12, Item 42) clockwise until fully engaged and then back out one full turn.
3. Add mercury to u-tube manometer (Figure 12, Item 46) until mercury level (Figure 12, Item 45) is opposite zero mark on scale with u-tube manometer vertical.
4. Install tube connector (Figure 12, Item 41) until fully engaged and then back out one full turn.
5. On models 5063-5392, 5063-5393, and 5063-539L, disconnect air box drain tube (Figure 12, Item 44) from elbow (Figure 12, Item 43) in cylinder block. Plug air box drain tube routed to engine crankcase.

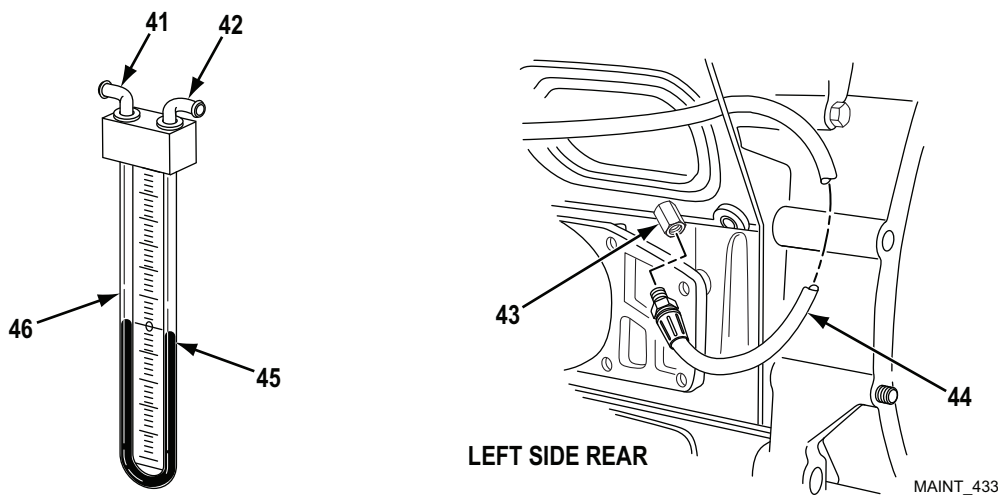
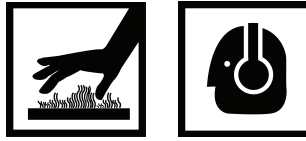


Figure 12. Air Box Pressure Check.

**NOTE**

On models 5063-5392, 5063-5393, and 5063-539L ensure air box drain tube and elbow are not plugged with sludge or debris.

6. Connect nonmetallic tubing (Figure 13, Item 48) to air box drain tube (Figure 13, Item 47) and to tube connector (Figure 13, Item 41). Close tube connector connected to nonmetallic tubing.
7. Mount u-tube manometer (Figure 13, Item 46) in a vertical position and adjust scale until zero mark is opposite mercury level.

**WARNING**

Avoid contact with hot manifolds, pulleys, and other moving parts. Wear proper ear protection when running engine. Failure to comply may result in injury to personnel.

8. Start engine and operate at 2800 rpm, FULL LOAD. Slowly open tube connector (Figure 13, Item 41) and read air box pressure on u-tube manometer scale.

**NOTE**

A u-tube manometer measurement is the sum of the displacements from zero of the two columns of mercury. This value is expressed as inches of mercury.

For model 5063-5299, air box pressure must be at least 6.1 inches of mercury at 2800 rpm, FULL LOAD with zero exhaust back pressure.

For all except model 5063-5299, air box pressure must be at least 39.0 inches of mercury at 2800 rpm, FULL LOAD with zero exhaust back pressure.

9. Stop engine by moving governor stop lever (Figure 10, Item 34) to NO FUEL position.
10. Disconnect nonmetallic tubing (Figure 13, Item 48) from air box drain tube, or fitting, and u-tube manometer (Figure 13, Item 46).

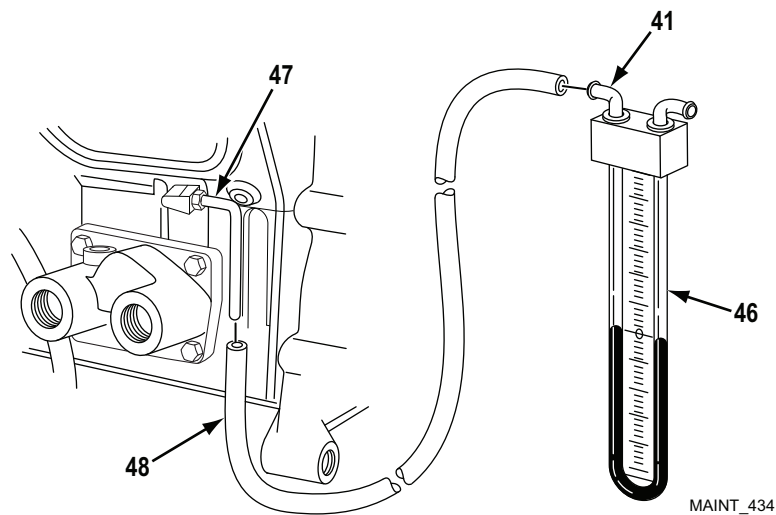


Figure 13. Air Box Pressure Check.

11. On models 5063-5392, 5063-5393, and 5063-539L, connect air box drain tube (Figure 14, Item 44) to elbow (Figure 14, Item 43).

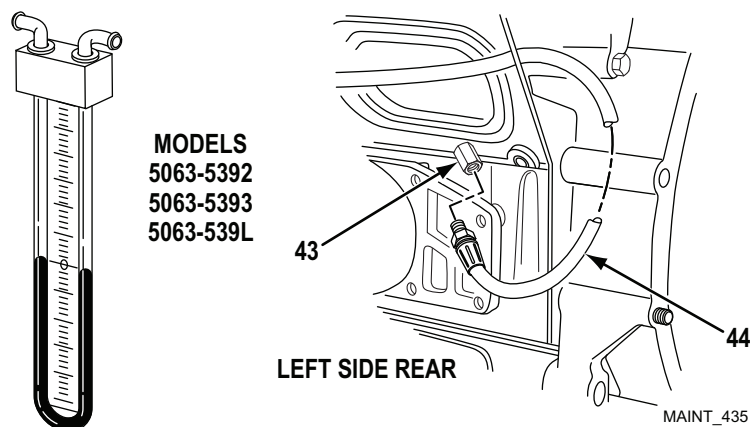


Figure 14. Air Box Drain Tube Assembly.

## Run-in Procedure

### CAUTION

Observe engine operation closely at all times. Operator must detect malfunctions which may develop early. Correct minor problems immediately so that major problems will not develop and cause engine damage.

### NOTE

During Period 1, remove rocker arm covers, inspect for fuel oil and coolant leaks in the rocker arm compartment, and install rocker arm covers (WP 0052), (WP 0053), or (WP 0054).

After completion of Period 2, adjust governor gap (WP 0100).

After completion of Period 5, adjust idle speed, no-load speed, and buffer screw (WP 0100).

1. Using appropriate run-in schedule (see Table 2), start and run engine. Record the following data for each run-in period.

**Table 2. Run-in Schedule.**

PERIOD	TIME: MINUTES	ENGINE SPEED: RPM	LOAD (BHP), MODEL 5063-5299	LOAD (BHP), MODELS 5063-5392, 5063-5393, 5063-539L
1	5	Idle	0	0
2	30	2800	N/A	N/A
3	10	1800	30	30
4	10	1500	N/A	N/A
5	30	2200	130	120
6	30	2500	N/A	180
7	30	2800	171	200
8	10	2800	Full Power	Full Power
9	5	Idle (Cooling Off)	0	0

- a. Oil sump temperature
- b. Oil gallery pressure
- c. Crankcase pressure
- d. Air intake manifold vacuum
- e. Engine air intake temperature
- f. Air box pressure
- g. Engine speed
- h. Brake horsepower
- i. Period duration

**NOTE**

Record the following data to correct brake horsepower during full power check (Period 8, Table 2).

- j. Barometric pressure
  - k. Ambient air wet bulb temperature
  - l. Ambient air dry bulb temperature
2. Tighten cylinder head bolts (WP 0073) and adjust exhaust valve clearance (WP 0078) after run-in.

**Horsepower Correction and Acceptance**

1. See Table 3 for listing of required terms.

**Table 3. List of Required Terms.**

Symbol	Name	Units
BAROo	Observed Barometric Pressure	inches Hg
BAROd	Dry Barometric Pressure	inches Hg
T	Engine Air Intake Temperature	°F
Tdb	Dry Bulb Temperature	°F
Twb	Wet Bulb Temperature	°F
VP	Water Vapor Pressure	inches Hg
CFa	Air Correction Factor	HP
CFsg	Fuel Specific Gravity Correction Factor	HP
CFft	Fuel Temperature Correction Factor	HP
BHPo	Brake Horsepower Observed	HP
BHPc	Brake Horsepower Corrected	HP

2. Dry Barometric Pressure
  - a. Record observed local barometric pressure (BAROo).
  - b. Measure wet-bulb and dry-bulb temperatures (Twb and Tdb).
  - c. See Table 4 for water vapor pressure (VP) at observed wet-bulb and dry-bulb temperatures.

**Table 4. Water Vapor Pressure (VP) in Inches HG from Wet Bulb and Dry Bulb Temperatures.**

Wet Bulb Temperature	Dry Bulb Temperature								
	50°F	55°F	60°F	65°F	70°F	75°F	80°F	85°F	90°F
55°F	0.31	0.43							
60°F	0.25	0.38	0.52						
65°F	0.27	0.33	0.47	0.62					
70°F	0.15	0.27	0.41	0.57	0.74				
75°F	0.09	0.22	0.36	0.51	0.68	0.87			



**Table 4. Water Vapor Pressure (VP) in Inches HG from Wet Bulb and Dry Bulb Temperatures - Continued.**

Wet Bulb Temperature	Dry Bulb Temperature								
80°F	0.04	0.17	0.30	0.46	0.63	0.82	1.03		
85°F	0.00	0.12	0.25	0.41	0.57	0.76	0.97	1.21	
90°F	0.00	0.07	0.20	0.35	0.52	0.71	0.92	1.15	1.42
95°F	0.00	0.01	0.14	0.30	0.46	0.65	0.86	1.10	1.36
100°F		0.00	0.09	0.24	0.41	0.60	0.81	1.05	1.31
105°F		0.00	0.04	0.19	0.36	0.54	0.75	0.99	1.25
110°F			0.00	0.13	0.30	0.49	0.70	0.94	1.20
115°F			0.00	0.09	0.25	0.44	0.65	0.88	1.20
120°F			0.00	0.03	0.20	0.39	0.60	0.83	1.10
125°F				0.00	0.13	0.33	0.54	0.78	1.04

- d. Dry barometric pressure is  
 $BAROd = BAROo - VP$
- 3. Air Correction Factor (CFa).
  - a. Measure air inlet temperature (T) at air cleaner during test.
  - b. See Table 5 or Table 6 of appropriate model for air correction factor (CFa) using air inlet temperature (T) and dry barometric pressure (BAROd).

**Table 5. Air Correction Factor (CFa) in BHP for Model 5063-5299.**

Wet Bulb Temperature (°F)	Dry Bulb Temperature (°F)								
	50	55	60	65	70	75	80	85	90
60	8	6	4	3	1	0	0	-1	-2
65	8	6	4	3	1	1	0	-1	-2
70	8	6	5	3	2	1	0	-1	-1
75	9	7	5	3	2	1	0	0	-1
80	9	7	5	4	2	1	1	0	-1
85	9	7	6	4	2	2	1	0	0
90	9	8	6	4	3	2	1	0	0

**Table 5. Air Correction Factor (CFa) in BHP for Model 5063-5299 - Continued.**

Wet Bulb Temperature (°F)	Dry Bulb Temperature (°F)								
95	10	8	6	5	3	2	1	1	0
100	10	8	6	5	3	2	2	1	0
105	10	8	7	5	3	3	2	1	1
110	10	9	7	5	4	3	2	2	1
115	11	9	7	6	4	3	3	2	1
120	11	9	7	6	4	4	3	2	1
125	11	9	8	6	5	4	3	2	2

**Table 6. Air Correction Factor (CFa) in BHP for Model 5063-5392, 5063-5393, and 5063-539L.**

Wet Bulb Temperature (°F)	Dry Bulb Temperature (°F)								
	50°F	55°F	60°F	65°F	70°F	75°F	80°F	85°F	90°F
60	6	4	3	1	0	-1	-2	-2	-3
65	6	5	3	2	0	0	-1	-2	-2
70	7	5	4	2	1	0	0	-1	-2
75	8	6	5	3	2	1	0	0	-1
80	8	7	5	4	2	2	1	0	0
85	9	7	6	4	3	2	2	1	0
90	10	8	6	5	3	3	2	1	1
95	10	9	7	6	4	3	3	2	1
100	11	9	8	6	5	4	3	3	2
105	11	10	8	7	5	5	4	3	3
110	12	10	9	7	5	5	4	3	3
115	13	11	9	8	6	6	5	4	4
120	13	12	10	8	7	6	6	5	4
125	14	12	11	9	8	7	6	6	5

4. Fuel specific gravity correction factor (CFsg).
  - a. Measure fuel specific gravity and correct to 60°F (15.6°C).
  - b. Refer to following chart for fuel specific gravity correction factor (CFsg).

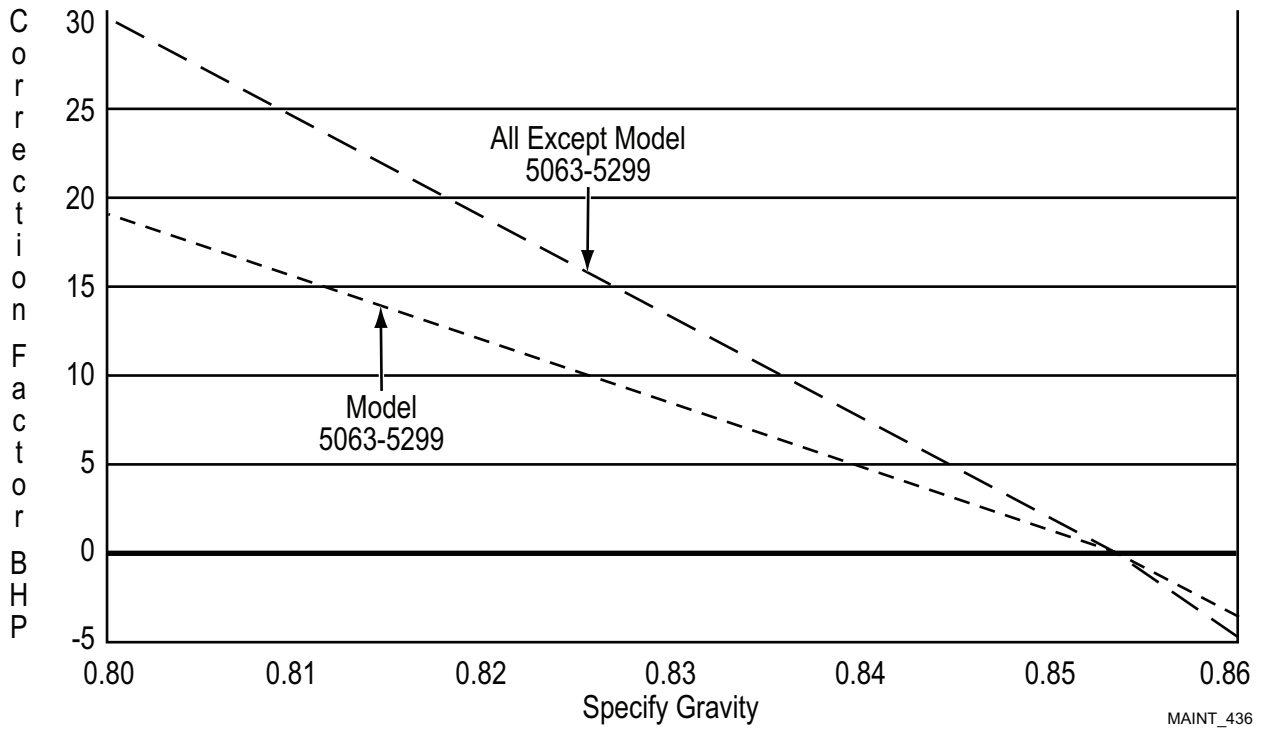
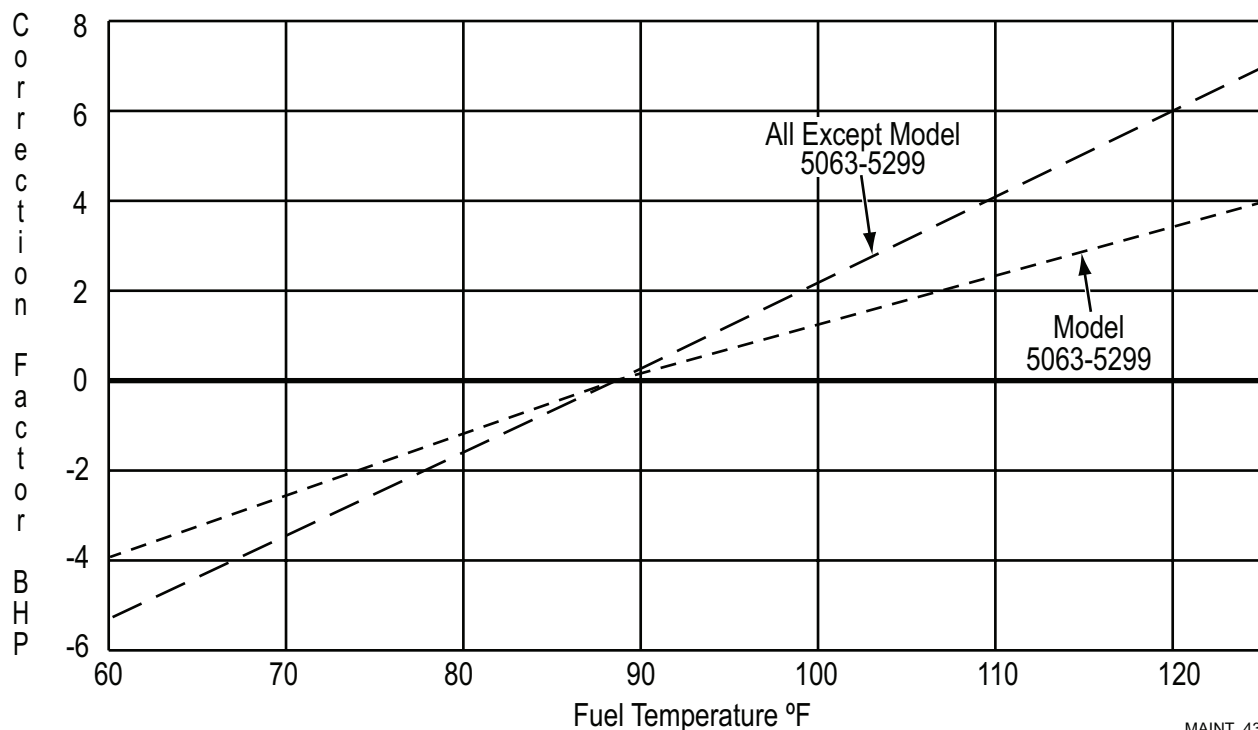


Figure 15. Fuel Specific Gravity Correction Factor (CFsg) in BHP.

5. Fuel temperature correction factor (CFft).
  - a. Measure fuel temperature at fuel filter outlet.
  - b. Refer to following chart for fuel temperature correction factor (CFft).



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Figure 16. Fuel Temperature Correction Factor (CFft) in BHP.

6. Corrected brake horsepower (BHPc) is:  $BHPc = BHPo + CFa + CFsg + CFft$
7. Minimum acceptable corrected brake horsepower are as follows:  
 Model 5063-5299 204 BHP  
 Models 5063-5392, 5063-5393, and 5063-539L 261 BHP

**END OF TASK**

**PREPARATION FOR STORAGE OR SHIPMENT**

**Fuel System**

1. Equip an auxiliary fuel container (Figure 17, Item 50) with a fuel line and fill container with a sufficient amount of preservation oil.
2. Locate the auxiliary fuel container (Figure 17, Item 50) to provide adequate pressure for proper supply of preservation oil to the fuel system.
3. Disconnect fuel line (Figure 17, Item 52) at inlet of fuel pump (Figure 17, Item 53) and connect auxiliary fuel line (Figure 17, Item 51).
4. Disconnect the engine fuel return at the quick disconnect coupling (Figure 17, Item 55). Connect a transparent plastic line (Figure 17, Item 54) at this point and insert opposite end into a suitable container to collect return fuel. Discard diluted preservation oil.

**PREPARATION FOR STORAGE OR SHIPMENT - Continued**

5. Open fuel valve of the auxiliary container. Start and run engine no faster than 1200 rpm until undiluted preservation oil is flowing from the fuel return line. Stop engine.

**COMBUSTION CHAMBER AND VALVES**

1. Open fuel valve from the auxiliary fuel container (Figure 17, Item 50).

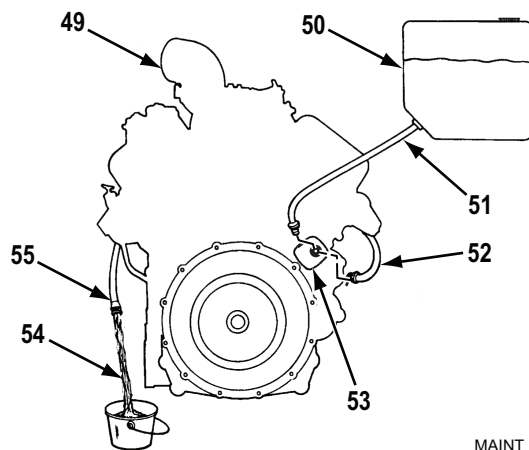
**CAUTION**

Total cranking time is not to exceed one minute. No cranking interval is to exceed 30 seconds. Further cranking will damage electric starter or solenoid.

**NOTE**

A metal clipboard over air inlet makes a sturdy cover to prevent engine from starting.

2. Cover air inlet (Figure 17, Item 49) tightly so engine cannot get air to start. Place throttle controls in FULL FUEL position and crank electric starter for 15 seconds. Stop cranking for 2 minutes and repeat cranking for another 15 seconds.
3. Close fuel valve from the auxiliary fuel container (Figure 17, Item 50), uncover air inlet (Figure 17, Item 49), and discard diluted preservation oil.
4. Disconnect auxiliary fuel line (Figure 17, Item 51) at inlet of fuel pump (Figure 17, Item 53) and connect engine fuel line (Figure 17, Item 52).
5. Disconnect the transparent plastic line (Figure 17, Item 54) at the quick disconnect coupling (Figure 17, Item 55).



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Figure 17. Preparation for Storage and Shipment/Combustion Chamber and Valves.

**END OF TASK****END OF WORK PACKAGE**



**CHAPTER 6**

**FIELD AND SUSTAINMENT MAINTENANCE LEVEL**  
**SUPPORTING INFORMATION**  
**FOR**  
**6V53/6V53T DIESEL ENGINES**





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**FIELD MAINTENANCE  
REFERENCES**

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**Scope**

This work package lists all forms, pamphlets, technical bulletins, technical manuals, and miscellaneous publications referenced in this manual.

**COMMON TABLE OF ALLOWANCE**

CTA 8-100	Army Medical Department Expendable/Durable Items
CTA 50-909	Field and Garrison Furnishings and Equipment
CTA 50-970	Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items)

**FIELD MANUALS**

FM 4-25.11	First Aid
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**FORMS**

DA Form 2028	Recommended Changes to Publications and Blank Forms
SF 368	Product Quality Deficiency Report
STA Form 1692	Engineering Change Proposal (Short Form)
STA Form 1695	Engineering Change Proposal (Short Form)

**PAMPHLETS**

DA PAM 750-8	The Army Maintenance Management System (TAMMS) Users Manual
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**SPECIFICATIONS**

MIL-PRF-907	Antiseize Thread Compound, High Temperature
ASTM E1444	Magnetic Particle Inspection

**TECHNICAL BULLETINS**

TB 9-2350-368-25	Fabrication and Operation of Powerplant Test Stand
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**TECHNICAL MANUALS**

TM 9-214	Inspection, Care, and Maintenance of Anti-friction Bearings
TM 9-237	Operator's Manual for Welding Theory and Application
TM 9-247	Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance
TM 9-2350-277-13&P	Field Maintenance Manual and Repair Parts and Special Tools List for Carrier, Personnel, Full-Track, Armored M113A3
TM 9-2815-205-24P	Field and Sustainment Maintenance Manual Repair Parts and Special Tools List for 6V53/6V53T Engines, Diesel with Containers
TM 750-244-6	Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use

**END OF WORK PACKAGE**

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**FIELD MAINTENANCE  
EXPENDABLE AND DURABLE ITEMS LIST**

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## **INTRODUCTION**

### **Scope**

This work package lists expendable and durable items that you will need to operate and maintain the 6V53/6V53T Diesel Engines. This list is for information only and is not authority to requisition the listed items. These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V Repair Parts, and Heraldic Items), CTA 50-909, Field and Garrison Furnishings and Equipment or CTA 8-100, Army Medical Department Expendable/Durable Items.

### **Explanation of Columns in the Expendable/Durable Items List**

Column (1) Item No. This number is assigned to the entry in the list and is referenced in the narrative instructions to identify the item (e.g., Use brake fluid (WP 0098, Item 5)).

Column (2) Level. This entry identifies the lowest level of maintenance that requires the listed item (F = Maintainer or ASB).

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, Part Number/(CAGEC). This column provides the other information you need to identify the item. The last line below the description is the part number and the Commercial and Government Entity Code (CAGEC) (in parentheses).

Column (5) U/I. Unit of Issue (U/I) code shows the physical measurement or count of an item, such as gallon, dozen, gross, etc.

Table 1. Expendable and Durable Items List.

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER (NSN)	(4) ITEM NAME, DESCRIPTION, PART NUMBER/ (CAGEC)	(5) U/I
1	F	8040-00-941-9984	ADHESIVE, GASKET 917252C1 (66195)	CA
2	F	8040-01-129-7171	ADHESIVE, RETAINING 620 (05920)	BT
3	F	6850-01-441-3223	ANTIFREEZE A-A-52624 (58536)	GAL
4	F	8030-00-597-5367	ANTISEIZE COMPOUND MIL-PRF-907 51008 (73165)	CN
5	F	5340-00-450-5718	CAP SET KIT 10935405 (19207)	EA
6	F	6850-00-162-9964	CARBON REMOVING COMPOUND MIL-S-12382 (ORD) TYPE 1 MILS12382TYPE1 (81349)	GAL
7	F	8330-01-010-9402	CHAMOIS LEATHER, SHEEPSKIN 166684 (35643)	EA
8	F	6850-00-664-5685	CLEANING SOLVENT 1-QT CAN A-A-59601 (58536)	QT
9	F	6850-00-281-1985	CLEANING SOLVENT 1-GAL CAN A-A-59601 (58536)	GAL
10	F	5350-00-221-0872	CROCUS CLOTH P-C-458 051144-02435 (76381)	EA
11	F	8030-00-231-2353	CORROSION PREVENTATIVE MIL-C-11796 42450PC7 (10001)	CN
12	F	6850-00-264-6572	DESICCANT 8790670-1 (19203)	PK
13	F	5350-01-582-4595	EMERY CLOTH	
14	F	8950-00-823-7664	FOOD COLORING MIL-F-35093 (81349)	BT
15	F	5210-00-640-6177	GAGE, PLASTIC, GREEN (0.001 THRU 0.003 IN. GAP), BOX OF 12 PG-1 (77220)	BX
16	F	5210-00-640-6178	GAGE, PLASTIC, RED (0.002 THRU 0.005 IN. GAP), BOX OF 12 PR-1 (77220)	BX
17	F		GREASE, GAA	
18	F	9150-01-326-5424	GREASE MOLYBDENUM DISULFIDE ROYCO 64 (07950)	CA
19	F	6685-00-275-9000	COMPOUND, TEMPERATURE INDICATING TEMPILSTIK350DEGF (82682)	EA
20	F	6810-00-753-4786	HYDROCHLORIC ACID 16-OZ BOTTLE	PT

Table 1. Expendable and Durable Items List - Continued.

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER (NSN)	(4) ITEM NAME, DESCRIPTION, PART NUMBER/ (CAGEC)	(5) U/I
21	F	6810-00-237-2955	O-C-265 (81349) HYDROCHLORIC ACID 90-OZ BOTTLE O-C-265 (81348)	BT
22	F	5970-01-469-7652	INSULATING VARNISH, ELECTRICAL (09225)	GL
23	F	5350-01-157-6916	LAPPING COMPOUND J3179-5 (33287)	EA
24	F	6810-00-281-7453	MERCURY A-A-59282 (81349)	BT
25	F	5310-00-732-0558	NUT 3/8-16 123221 (72582)	EA
26	F	9150-00-076-1567	OIL, CUTTING KUTWELL40 (29700)	GAL
27	F	9150-01-152-4117	OIL, ENGINE SAE 15/40 MIL-L-2104, 1-QT CAN MIL-PRF-2104 (81349)	QT
28	F	4150-01-421-1424	OIL, ENGINE SAE 15/40 MIL-L-2104, 5-GAL DRUM MIL-PRF-2104 (81349)	GAL
29	F	9150-01-421-1432	OIL, ENGINE SAE 15/40 MIL-L-2104, 55-GAL DRUM MIL-PRF-2104 (81349)	GAL
30	F	9140-00-286-5294	OIL, FUEL DIESEL DF-2 REGULAR BULK AA52557 (58536)	GAL
31	F	9140-00-286-5295	OIL, FUEL DIESEL DF-2 REGULAR 5-GAL CAN AA52557 (58536)	GAL
32	F	9140-00-286-5296	OIL, FUEL DIESEL DF-2 REGULAR 55-GAL DRUM, 16 GAGE AA52557 (58536)	GAL
33	F	9140-00-286-5297	OIL, FUEL DIESEL DF-2 REGULAR 55-GAL DRUM, 18 GAGE AA52557 (58536)	GAL
34	F	9150-00-111-0201	OIL, LUBRICATING, PRESERVATIVE 1-PT CAN MIL-L-21260 (81349)	PT
35	F	9150-00-153-0207	OIL, LUBRICATING, PRESERVATIVE 1-QT CAN MIL-L-21260 (81349)	QT
36	F	9150-00-111-0208	OIL, LUBRICATING, PRESERVATIVE 5-GAL DRUM MIL-L-21260 (81349)	GAL
37	F	8030-00-062-5866	OIL, PRESERVATION 1-GAL MIL-PRF-16173 (81349)	GAL
38	F	8030-00-244-1293	OIL, PRESERVATION 5-GAL MIL-PRF-16173 (81349)	GAL
39	F	8030-00-244-1294	OIL, PRESERVATION 55-GAL MIL-PRF-16173 (81349)	GAL

Table 1. Expendable and Durable Items List - Continued.

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER (NSN)	(4) ITEM NAME, DESCRIPTION, PART NUMBER/ (CAGEC)	(5) U/I
40	F	6810-00-132-4020	OXALIC ACID 4-OZ BOTTLE O-C-265 (81348)	BT
41	F	4730-01-161-1255	PLUG, PIPE 3/4 NPT AA59616ACADBUE (58536)	EA
42	F	8010-00-652-3626	PRUSSIAN BLUE PASTE MILP30501 (81349)	OZ
43	F	3911-01-086-4166	QUENCHING OIL, METAL CINDOL 3411 (73277)	GAL
44	F	7920-00-205-1711	RAG, WIPING 7920-00-205-1711 (64067)	LB
45	F	4730-01-076-7697	REDUCER, PIPE 3/4-1/4 NPT 189060 (24617)	EA
46	F	5350-01-161-9044	SANDPAPER	SH
47	F	5305-00-638-8920	SCREW 3/8-16 X 2-1/4 IN. B1821BH038C225N (80204)	EA
48	F	5305-00-846-5703	SCREW 3/8-16 X 3 IN. B1821BH038C300N (80204)	EA
49	F	5305-00-226-4835	SCREW 5/16-18X 2-1/2 IN. B1821BH031C250N (80204)	EA
50	F	5305-00-883-0625	SCREW, SELF-TAPPING MS24617-36 (96906)	EA
51	F	8030-01-158-6070	SEALING COMPOUND ASTM D5363 (81346)	BT
52	F	8030-00-181-7603	SEALING COMPOUND 50-CC 63531 (05972)	BT
53	F	8030-00-181-7529	SEALING COMPOUND 250-CC 64041 (05972)	BT
54	F	8030-00-252-3391	SEALING, COMPOUND 1756371 (80064)	TU
55	F	8030-01-104-5392	SEALING, COMPOUND 24221 (05972)	BT
56	F	8030-01-166-0675	SEALING COMPOUND 56747 (05972)	TU
57	F	8030-00-180-6150	SEALING COMPOUND ASTM D5363 60921 (05972)	BX
58	F	8945-01-277-6727	SHORTENING COMPOUND 6 LB CRISCO, 6 LB. (5E828)	CN
59	F	5350-00-224-7203	PAPER, ABRASIVE P-P-121 ANSI B74.18 (80204)	EA
60	F	6850-01-265-3115	SILICONE LUBRICANT	CN

**Table 1. Expendable and Durable Items List - Continued.**

(1) ITEM NO.	(2) LEVEL	(3) NATIONAL STOCK NUMBER (NSN)	(4) ITEM NAME, DESCRIPTION, PART NUMBER/ (CAGEC)	(5) U/I
61	F	5345-00-198-8050	CRC03030 (10136) STONE, SHARPENING ANSI-B74.12 (80204)	EA
62	F	5345-00-584-4607	STONE, SHARPENING X-FINE A6F0 (70752)	EA
63	F	2930-00-945-7430	STUD, OIL COOLER 5/16-18-24 X 9.6 IN. 5133960 (72582)	EA
64	F	7510-00-290-2027	TAPE, MASKING ASTM D-6123 (81346)	RO
65	F	6850-01-397-2306	TECH SOLV 340	CN
66	F	5310-00-276-3015	WASHER, CONVEX 5150250 (72582)	EA
67	F	5310-00-080-6004	WASHER, FLAT 3/8 IN. MS27183-14 (96906)	EA
68	F	5310-00-081-4219	WASHER, FLAT 5/16 IN. MS27183-12 (96906)	EA
69	F	6850-01-355-3387	WATER DISPLACING COMPOUND AV30 (0L040)	CN
70	F	9525-00-618-0257	WIRE MS20995NC20 (80205)	RL
71	F	5510-00-351-3511	BLOCK, FILLER, WOOD SCB28799 (80063)	LF

**END OF WORK PACKAGE**





## FIELD MAINTENANCE TOOL IDENTIFICATION LIST

### INTRODUCTION

#### Scope

This work package lists all common tools and supplements and special tools/fixtures needed to maintain the 6V53/6V53T Diesel Engines.

Most PM-SKOT products have lifetime warranties and replacement capabilities and are supported world-wide through PM-SKOT. The PM-SKOT implemented a Web-based tool replacement and warranty program in May 2005 for tools authorized in SKO. User may access the online program by first accessing the PM-SKOT Web site at <https://pmskot.army.mil> and clicking on the Tool Replacement/Warranty banner.

#### Explanation of Columns in the Tool Identification List

Column (1) - Item Number. This number is assigned to the entry in the list and is referenced in the initial setup to identify the item (e.g., Extractor (WP 0090, item 32)).

Column (2) - Item Name. This column lists the item by noun nomenclature and other descriptive features (e.g., Gage, belt tension).

Column (3) - National Stock Number (NSN). This is the National Stock Number (NSN) assigned to the item; use it to requisition the item.

Column (4) - Part Number/(CAGEC). Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or Government activity) which controls the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items. The manufacturer's Commercial and Government Entity Code (CAGEC) is also included.

Column (5) - Reference. This column identifies the authorizing supply catalog or RPSTL for items listed in this work package. (Not required for DMWRs/NMWRs).

**Table 1. Tool Identification List.**

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
1	Adapter, Cylinder Compression	4910-01-240-3101	J7915-3C	TM 9-2815-205-24P
2	Adapter, Dial Indicator	4910-00-907-0713	J21224 (33287)	TM 9-2815-205-24P
3	Adapter, Tachometer Drive (Remover)	5120-00-127-7831	J-5901-3 (33287)	TM 9-2815-205-24P
4	Adapter, Torque Wrench (Fuel Nut)	5120-01-147-7923	10881875 (19207)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
5	Adapter, Torque Wrench (Slip)	5120-01-169-5300	J23126 (10513891) (33287)	TM 9-2815-205-24P
6	Adapter, 3/8"-16 UNC	5120-01-130-8865	J-6471-2 (33287)	TM 9-2815-205-24P
7	Adapter Kit, Valve Seat Grinder	4910-00-254-5018	J7792-01 (33287)	TM 9-2815-205-24P
8	Alignment Stud, Flywheel Housing	5120-00-872-6015	J7540 (33287)	TM 9-2815-205-24P
9	Alignment Tool, Tachometer	5180-01-025-8062	J23068 (33287)	TM 9-2815-205-24P
10	Ball Attachment, Micrometer	5210-00-494-1738	J4757 (33287)	TM 9-2815-205-24P
11	Block Set, Lapping	3460-00-937-5521	J22090-A (33287)	TM 9-2815-205-24P
12	Bracket, Engine Mounting	2520-01-006-4589	11678105 (19207)	TM 9-2815-205-24P
13	Brush, Wire, Rotary Wheel (Brass)	5130-00-937-7281	J7944 (33287)	TM 9-2815-205-24P
14	Calipers, Vernier (0-6.0 in.)	-	KTC S0999 (00NS2)	CL 4910-95-A82
15	Cap Set, Protective, Dust and Moisture	5340-00-450-5718	10935405 (19207)	TM 9-2815-205-24P
16	Caps, Vise Jaw	-	KTC S0153 (00NS2)	CL 4910-95-A81
17	Clamp, Hold-Down, Cylinder Liner	5120-00-999-8618	J21793-B (-01) (33287)	TM 9-2815-205-24P
18	Cleaner, Piston Ring Groove	5120-00-799-3398	J-3936-03 (-01) (33287)	TM 9-2815-205-24P
19	Compressor, Piston Ring	5120-01-406-4702	J6883-B (33287)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
20	Compressor, Valve Spring Head Off Eng	5120-00-254-5049	J8062 (33287)	TM 9-2815-205-24P
21	Coupling Half (C/O Air Hose Assy)	-	SJ60101770E XT (55719)	CL 4940-95-E42
22	Die Set, Metal Stamping, Hand	-	KTC S1000 and KTC S1001 (00NS2)	CL 4910-95-A82
23	Drain Unit, Waste Oil	4930-00-545-8639	8708359 (19207)	TM 9-2815-205-24P
24	Drill, Electric, Portable	-	D21002 (00NS2)	CL 4910-95-A64
25	Drill Set, Twist	-	KTC S0194 and S0195 (00NS2)	CL 4910-95-A81
26	Expander, Oil Seal, Rear	5120-00-918-0587	J9769 (33287)	TM 9-2815-205-24P
27	Extension, 3/4" Dr., 4.5" Long	-	KTC S0376 (00NS2)	CL 4910-95-A81
28	Fixture, Cam Follower Holding	4910-00-705-9278	J-33421-A (33287)	TM 9-2815-205-24P
29	Fixture, Lifting, Cylinder Head	4910-00-456-7620	J22062-A (33287)	TM 9-2815-205-24P
30	Fixture Set, Turbocharger Holding	4910-01-170-4914	J29086 (33287)	TM 9-2815-205-24P
31	Gage, Cylinder Bore	-	452B-9 (00NS2)	CL 4910-95-A64
32	Gage, Cylinder, Depth	5210-00-023-4798	J-22273-A (33287)	TM 9-2815-205-24P
33	Gage, Dial, Valve Seat	4910-00-779-7103	9320 (00256)	TM 9-2815-205-24P
34	Gage, Flywheel Housing	5210-00-937-7284	J-9737-D (33287)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
35	Gage, Fuel Pressure	6685-00-525-8109	J8151 (33287)	TM 9-2815-205-24P
36	Gage, Injector (Tip and Concentricity)	5210-00-990-3327	2BF852 (45152)	TM 9-2815-205-24P
37	Gage, Injector Rack (Starting, 0.345)	5210-01-091-8354	J-24889 (33287)	TM 9-2815-205-24P
38	Gage, Injector Rack (Starting, 0.395)	5210-01-373-9397	J-28479 (33287)	TM 9-2815-205-24P
39	Gage, Injector Rack (Throttle, 0.454)	5120-00-538-8465	J23190 (33287)	TM 9-2815-205-24P
40	Gage, Injector Timing	5210-00-387-9581	J-1853 (33287)	TM 9-2815-205-24P
41	Gage, Injector Timing	5210-01-242-4091	J9595 (33287)	TM 9-2815-205-24P
42	Gage, Lift (Needle Valve Height)	5210-00-937-7285	J9462-02 (33287)	TM 9-2815-205-24P
43	Gage, Tire Pressure	-	976 (55719)	CL 4940-95-E42
44	Gage Set, Depth, Micrometer	5120-00-619-4045	52-225-015 (1E258)	TM 9-2815-205-24P
45	Gage Set, Piston-Liner Thickness	5210-00-116-1631	J-05438-A (33287)	TM 9-2815-205-24P
46	Gage Set, Telescoping	-	S98-6 (00NS2)	CL 4910-95-A64
47	Gage Set, Thickness	5210-01-245-9564	J1698-02 (33287)	TM 9-2815-205-24P
48	Grinding Kit, Valve Seat	-	035-0001-56 (00NS2)	CL 4910-95-A64
49	Handle, Driver (Seal Installer)	5120-00-808-5082	J-3154-1A (33287)	TM 9-2815-205-24P
50	Handle, Driver (Seal Installer)	5120-00-977-5578	J7079-2 (33287)	TM 9-2815-205-24P

**Table 1. Tool Identification List - Continued.**

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
51	Handle, Ratchet, 3/4" Dr., 4.5" Long	-	KTC S0374 (00NS2)	CL 4910-95-A81
52	Hone, Cylinder	-	2833 (00NS2)	CL 4910-95-A64
53	Indicator, Dial	-	60100C (00NS2)	CL 4910-95-A64
54	Indicator, Dial (w/Magnetic Base)	5210-00-402-9619	J7872 (33287)	CL 4940-95-E42 TM 9-2815-205-24P
55	Injector Vise (Fixture, Inject. Holding)	5220-01-061-4248	J22396-1 (33287)	TM 9-2815-205-24P
56	Insertor, Bearing and Bushing (Installer, Injector Tube - New Style)	5120-01-248-7737	J5286-20 (33287)	TM 9-2815-205-24P
57	Insertor, Piston (Pin Retainer)	5120-01-242-4092	J35572 (33287)	TM 9-2815-205-24P
58	Insertor, Seal (Crankshaft Oil, Front)	5120-00-936-4377	J9783 (33287)	TM 9-2815-205-24P
59	Insertor, Seal (Crankshaft Oil, Rear)	5120-00-169-5806	J9479 (33287)	TM 9-2815-205-24P
60	Insertor, Seal (Front Cover)	5120-00-937-6143	J-9790 (33287)	TM 9-2815-205-24P
61	Insertor, Seal (Thermostat Seal)	5120-00-116-3652	J-22091 (33287)	TM 9-2815-205-24P
62	Installer, Crankshaft Pulley	4910-00-779-6392	J7773 (33287)	TM 9-2815-205-24P
63	Installer, Governor Cover Bearing	4910-00-779-6078	J21068 (33287)	TM 9-2815-205-24P
64	Installer, Valve Guide	5120-01-166-5167	J24519 (33287)	TM 9-2815-205-24P
65	Installing Tool (Crankshaft Gear)	4910-00-736-1371	J7557 (33287)	TM 9-2815-205-24P
66	Installing Tool, Drive (Oil Pump Gear)	4910-00-169-5805	J-8968-A (33287)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
67	Installing Tool, Valve (Seat)	4910-00-603-8925	J7790 (33287)	TM 9-2815-205-24P
68	Manometer, U-Tube	6685-00-857-4895	1211-60 (85274)	TM 9-2815-205-24P
69	Micrometer Set (Caliper Set, O/Side)	-	599-182-926- 1 (00NS2)	CL 4910-95-A64
70	Multimeter, Digital	-	KTC S0252 (00NS2)	CL 4910-95-A81
71	Pail, Utility	7240-00-160-0455	A-A-1273 TY2 (80244)	TM 9-2815-205-24P
72	Pliers, Wire Twister	5120-01-112-5031	GA311B (55719)	TM 9-2815-205-24P
73	Puller Kit, Universal (Comb Leg)	5180-00-999-4053	J-24420-C (33287)	TM 9-2815-205-24P
74	Puller, Mechanical (Camshaft Gear)	5120-00-219-8397	J-1902-01 (33287)	TM 9-2815-205-24P
75	Puller, Mechanical (Slide-Hammer)	5120-00-293-1429	PD5120-00-2 93-1429 (80244)	TM 9-2815-205-24P
76	Puller, Mechanical, Cylinder Liner	5120-00-937-6140	J22490 (33287)	TM 9-2815-205-24P
77	Puller, Mechanical, Three-Leg	5120-00-740-3345	J-04871-A (33287)	TM 9-2815-205-24P
78	Reamer, Cylinder Ridge	-	36500 (00NS2)	CL 4910-95-A64
79	Reamer, Hand (2nd Operation)	5110-00-294-4606	J5286-9C (33287)	TM 9-2815-205-24P
80	Reamer, Hand, Injection Body	5140-00-937-7628	J-21089 (33287)	TM 9-2815-205-24P
81	Remover, Bearing and Bushing (Gov)	5120-00-808-5078	J- 21967-01 (33287)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
82	Remover, Seal (Bearing and Bushing)	5120-00-363-7572	J-1930 (33287)	TM 9-2815-205-24P
83	Remover, Valve Guide	4910-00-591-6632	J-7775-A (33287)	TM 9-2815-205-24P
84	Remover, Valve Seat Insert	5180-00-591-6631	J-23479-453 (33287)	TM 9-2815-205-24P
85	Remover and Installer (Gov Cvr Brng)	4910-00-779-7315	J8985 (33287)	TM 9-2815-205-24P
86	Remover and Replacer (Piston Ring)	5120-00-494-1846	J-8128 (33287)	TM 9-2815-205-24P
87	Replacer, Piston Pin (Retainer)	5120-00-733-8874	10881874 (19207)	TM 9-2815-205-24P
88	Screwdr Attchmt, Sckt Wrench (Installer, Crankshaft Plug)	5120-01-297-2374	J-34650 (33287)	TM 9-2815-205-24P
89	Shield, Turbocharger, Protective	4910-01-127-7959	J26554-A (33287)	TM 9-2815-205-24P
90	Slide Hammer Set	5120-00-910-7868	J-2619-01 (33287)	TM 9-2815-205-24P
91	Slide Hammer Set (Puller)	5120-00-937-7266	J-6471-02 (33287)	TM 9-2815-205-24P
92	Sling (2-Point, Adjustable Chain)	-	KTC S1050 and KTC S1051 (00NS2)	CL 4910-95-A82
93	Sling, Beam-Type	4910-00-646-6893	10942647 (19207)	TM 9-2815-205-24P
94	Sling, Multiple Leg (Cable)	3940-00-977-7398	10930560 (19207)	TM 9-2815-205-24P
95	Socket, Socket Wrench, 3/4" Dr., 1-1/6"	-	KTC S0384 (00NS2)	CL 4910-95-A81
96	Socket, Wrench, Face Spanner	5120-00-808-5230	J-5895 (33287)	TM 9-2815-205-24P

Table 1. Tool Identification List - Continued.

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
97	Soldering Torch Kit	-	UL 125 (55719)	CL 4940-95-E42
98	Spacer, Governor Weight	4910-00-779-7308	J8984 (33287)	TM 9-2815-205-24P
99	Stand, Maintenance	4910-00-795-0189	7950189 (23569)	TM 9-2815-205-24P
100	Stand, Sub-Assy., Maint. Aug. (Cradle)	4910-00-795-0198	7950198 (19207)	TM 9-2815-205-24P
101	Straight Edge	-	386-36 (00NS2)	CL 4910-95-A64
102	Stud, Cylinder Head Guide	4910-00-591-6634	J9665 (33287)	TM 9-2815-205-24P
103	Tensionmeter, Dial Indicator	6635-01-093-3710	J23600-B (33287)	TM 9-2815-205-24P
104	Test Fixture, Diesel Engine	4910-00-355-6248	65-0251 (92372)	TM 9-2815-205-24P
105	Tester, Cylinder Compression	4910-00-870-6283	10899180 (19207)	TM 9-2815-205-24P
106	Tester, Diesel Fuel Injector Nozzle	4910-00-255-8641	7551255 (19204)	TM 9-2815-205-24P
107	Tester, Spring	4940-01-138-8259	J-22738-02 (33287)	TM 9-2815-205-24P
108	Tester, Vacuum Gage (Leak Detector, Piston Pin Retainer)	6685-01-061-4253	J23987-B (33287)	TM 9-2815-205-24P
109	Threading Set, Screw	-	KTC S0186 and KTC S0185 (00NS2)	CL 4910-95-A81
110	Tool Kit, Blower and Governor	5180-01-035-1314	J-23679-A (33287)	TM 9-2815-205-24P
111	Tool Kit, Diesel Injector	5180-00-596-8541	J-22525-B (33287)	TM 9-2815-205-24P



**Table 1. Tool Identification List - Continued.**

(1) ITEM NO.	(2) ITEM NAME	(3) NATIONAL STOCK NUMBER (NSN)	(4) PART NUMBER /(CAGEC)	(5) REFERENCE
112	Tool Kit, Diesel Injector	5180-01-038-0251	J23435-C (33287)	TM 9-2815-205-24P
113	Tool Kit, General Mechanic's (GMTK)	5180-01-548-7634	PD484 (19200)	CL 5180-95-B48
114	Tool Kit, Internal Combustion Engine	5180-01-167-8073	J-7593-03 (33287)	TM 9-2815-205-24P
115	Tubing, Nonmetallic	4720-00-271-9839	564-0077-011 (94756)	TM 9-2815-205-24P
116	V-Block	-	VB-334-17 (00NS2)	CL 4910-95-A64
117	Vise, Machinist, 4" Jaw	-	KTC S0725 (00NS2)	CL 4910-95-A81
118	Wrench, Oil Filter	5120-01-197-6720	YA342C (55719)	TM 9-2815-205-24P
119	Wrench, O/End Box, Injector Fuel Line	5120-00-740-3347	10949344 (19207)	TM 9-2815-205-24P
120	Wrench, Torque, Dial, 0-175 Lb-Ft	5120-00-640-6364	B107.14 (05047)	TM 9-2815-205-24P
121	Wrench, Torque, 0-300 Lb-In	-	KTC S0987 (00NS2)	CL 4910-95-A81
122	Wrench, Torque, 100-500 Lb-Ft	5120-01-396-6072	B107.14 (05047)	TM 9-2815-205-24P

**END OF WORK PACKAGE**



**FIELD MAINTENANCE  
MANDATORY REPLACEMENT PARTS LIST**

**Scope**

This work package includes a list of all mandatory replacement parts referenced in the task initial setups and procedures for repair of the 6V53/6V53T Diesel Engines and is included for that purpose only. These are items that must be replaced during maintenance whether they have failed or not.

**Explanation of Columns of the Index of Manufactured Item**

Item Number – This number is assigned to the entry in the listing and is referenced in the Initial Setup to identify the item (e.g., Pin, cotter (WP 0119, Item 120)).

Part Number – This column indicates the primary number used by the manufacturer (individual, company, firm, corporation, or government activity) which controls the design and characteristics of the item by means of engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items. The part number will be followed by the Contractor and Government Entity Code (CAGE) in parentheses only when the CAGE is required to requisition the part.

**NOTE**

When using the National Stock Number (NSN) to requisition a part, the part you get may have a different part number from the number ordered, but go ahead and use or furnish it as the supply part.

National Stock Number – This column is the National Stock Number (NSN) assigned to the item; use it to requisition the item.

Nomenclature – This column identifies the name or description of the parts which appear in the Initial Setup of the procedure under the heading "Materials/Parts."

Quantity – This column gives the Quantity (QTY) required for the total engine repair or rebuild. The quantity required for each task is given in the initial setup prior to the item number when the quantity is greater than one.

**Table 1. Mandatory Replacement Parts List.**

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
1	08922593 (72582)	5330-01-392-3354	GASKET	3
2	10499638	5305-01-294-2234	SCREW, ASSEMBLED WASHER	
3	10955138	5330-00-945-3351	SEAL, NONMETALLIC	
4	116337	5340-00-089-8037	PLUG, EXPANSION	1
5	11650220 (19207)	5330-01-241-2797	SEAL, NONMETALLIC	1
6	11678205	5330-01-052-7673	SEAL, NONMETALLIC	1
7	1595620 (72582)	5330-01-383-3753	GASKET	1

Table 1. Mandatory Replacement Parts List - Continued.

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
8	1851960	5331-01-113-9678	O-RING	
9	1894635	3120-00-828-6852	BUSHING, SLEEVE	
10	1894642	5331-01-053-7021	O-RING	
11	1894643	5331-01-053-2907	O-RING	
12	1916272	5331-00-599-2321	O-RING	
13	192481	5310-01-058-3353	NUT, SELF-LOCKING	2
14	1964857	5330-00-914-0703	GASKET	
15	1985304	5331-01-246-0624	O-RING	
16	1985320	5331-01-245-8777	O-RING	
17	1988096	3120-01-266-6465	BUSHING, SLEEVE	
18	1988340	5970-01-267-0175	INSULATOR, BUSHING	
19	1988776	5975-01-294-8966	BOOT	
20	2104099525 (24975)	5305-01-312-4837	SCREW	
21	23501591	5330-01-299-3160	GASKET	3
22	23509198 (72582)	5330-01-241-5104	GASKET	
23	23MS35338-46 (80045)	5310-00-637-9541	WASHER, LOCK	175
24	2434	5310-00-775-5139	WASHER, LOCK	2
25	3249	5310-00-274-4546	WASHER	
26	3S9643 (11083)	5330-00-246-6380	SEAL, PLAIN ENCASED	1
27	400627-0620 (08179)	5306-01-238-6378	BOLT, MACHINE	1
28	443686-1	3120-01-355-8844	BEARING, WASHER, THRUST	1
29	454749	5310-00-164-1790	NUT, SELF-LOCKING	4
30	5101691	5330-01-105-6889	SEAL, SPECIAL	1
31	5103474	5330-01-143-2300	GASKET	1
32	5103646	5330-01-088-2740	SEAL, PLAIN	2
33	5104846	5330-01-157-3771	GASKET	1

**Table 1. Mandatory Replacement Parts List - Continued.**

ITEM NO.	PART NUMBER (CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
34	5104866	5330-01-157-3770	GASKET	1
35	5104868	5330-01-157-3772	GASKET	1
36	5104881	5330-01-157-3773	GASKET	2
37	5104978	5330-01-163-8179	GASKET	1
38	5106223	5330-01-083-3980	SEAL, PLAIN ENCASED	2
39	5107223	5330-01-083-3063	SEAL, PLAIN ENCASED	
40	5108131	2815-01-075-7813	RETAINER, PISTON PIN	2
41	5109157	5340-00-919-2876	PLUG, EXPANSION	2
42	5109496	5330-00-689-8265	GASKET	2
43	5109517	5331-00-403-0024	PACKING, PREFORMED	1
44	5116122	5310-00-774-9545	SEAL	4
45	5116184	2815-00-883-5593	RING, PISTON	3
46	5116204	4710-00-792-8984	TUBE ASSEMBLY, FUEL	6
47	5116205	5330-00-780-5221	GASKET	2
48	5116224	5330-00-792-9841	SEAL, PLAIN ENCASED	1
49	5116242	5330-00-055-1584	GASKET	3
50	5116290	5310-00-880-1264	SEAL	8
51	5116292	5330-00-921-5344	SEAL STRIP	2
52	5116357	5330-00-613-9397	GASKET	4
53	5117786	5330-00-781-7117	GASKET	1
54	5119218	2815-00-921-5348	PLUG	1
55	5119266	5330-00-999-7210	GASKET	
56	5119282 NON- ASBESTOS (72582)	5330-01-347-8155	GASKET	1
57	5119368	5330-00-780-5242	GASKET	1
58	5119433 NON- ASBESTOS (72582)	5330-01-347-8154	GASKET	1
59	5119438	5330-00-780-5231	GASKET	1

**Table 1. Mandatory Replacement Parts List - Continued.**

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
60	5119457 (72582)	5330-00-792-9026	GASKET	2
61	5120540	5330-00-953-2014	GASKET	1
62	5121207 (72582)	5330-00-880-1263	SEAL	8
63	5121254	5330-00-780-5243	GASKET, COMPRESSION	6
64	5121256	5330-00-179-6227	PACKING, PREFORMED	5
65	5121342 (72582)	5330-00-780-5232	GASKET	1
66	5121344	5330-00-074-1925	GASKET	1
67	5121345	5330-00-780-5233	GASKET	1
68	5122610	2990-00-866-9378	SCREEN, AIR INLET	1
69	5124055 (72582)	5330-00-074-1931	GASKET	1
70	5126473	5330-00-682-7195	GASKET	2
71	5127247	5330-00-682-7197	GASKET	1
72	5127963	2990-00-780-5236	SEAL, BLOWER	1
73	5130995	5330-00-980-1546	GASKET	2
74	5133107	5330-00-235-4885	GASKET	1
75	5133263	5330-00-074-1923	GASKET	1
76	5133397	5330-00-789-4846	GASKET	1
77	5133537	5330-00-789-4871	GASKET	1
78	5133539	5310-00-789-4870	WASHER, KEY	4
79	5133619	5330-00-789-4867	GASKET	4
80	5135877	5330-00-944-7073	GASKET	1
81	5135935	5330-00-466-0467	GASKET	1
82	5136097	3120-00-930-3265	BEARING, SLEEVE	1
83	5137470	5330-00-944-4148	GASKET	1
84	5138796	5330-00-944-7065	SEAL, PLAIN ENCASED	1
85	5139988	5342-01-144-1937	PLUG	1

**Table 1. Mandatory Replacement Parts List - Continued.**

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
86	5139997	5340-00-202-0765	PLUG, EXPANSION	3
87	5142266	5330-00-079-8421	SEAL, PLAIN ENCASED	4
88	5149154	5325-01-015-5414	RING, RETAINING	1
89	5149460	3120-01-086-8270	BEARING KIT	2
90	5150130	5340-00-237-8324	PLUG, EXPANSION	1
91	5150193	5330-00-212-6290	GASKET	2
92	5150829	5340-00-921-5379	PLUG, EXPANSION	2
93	5151277	5315-00-276-4818	PIN, STRAIGHT, HEADLESS	4
94	5151449	5340-00-921-5380	PLUG, EXPANSION	3
95	5151921	5310-00-532-8136	WASHER, FLAT	2
96	5152148 (72582)	5310-00-264-1939	WASHER, FLAT	2
97	5157933 (72582)	5315-00-238-0838	PIN, DOWEL	2
98	5161003	5330-00-599-5577	GASKET	
99	5170468	5330-00-725-2388	GASKET	1
100	5175882	5330-01-109-6608	GASKET	1
101	5197583 (72582)	5330-00-930-3254	SEAL RING, METAL	2
102	5197944 (72582)	3120-00-089-3536	BEARING SET, SLEEVE	1
103	5198049	5325-00-930-3257	RING, RETAINING	3
104	5198092	2815-00-112-4606	RING SET, OIL	1
105	5198936 (72582)	5365-01-016-0443	RING, SEAL	1
106	5198988	5310-00-153-2717	WASHER, FLAT	2
107	5199366 (73342)	5330-01-359-0149	SEAL, PLAIN ENCASED	4
108	5199368	2815-01-051-7917	SLEEVE, BLOWER SEAL, OVERSIZE	4
109	5226186	5365-00-255-0296	SPACER, RING	2
110	5228587	2910-00-374-4929	FILTER ELEMENT, FLUID	1

**Table 1. Mandatory Replacement Parts List - Continued.**

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
111	5229167	5330-00-364-3434	PACKING, PREFORMED	1
112	5574120 (70040)	5365-00-543-3615	RING, RETAINING	2
113	5574126 (70040)	5330-00-612-3123	GASKET	1
114	5574161	5330-00-846-9841	GASKET	1
115	60598	5310-00-663-7617	WASHER, FLAT	2
116	6437298	5330-00-833-0870	GASKET SET	1
117	7375429 (19207)	5310-00-737-5429	WASHER, FLAT	9
118	74980	5331-00-838-6729	O-RING	
119	78420	5970-01-118-6746	WASHER, INSULATOR	
120	8350641 (19207)	5306-00-543-5696	BOLT, SELF-LOCKING	2
121	8675776 (19207)	5306-00-846-3246	BOLT, SELF-LOCKING	4
122	8920631	5306-01-169-5526	BOLT, MACHINE	3
123	8921167	2540-01-105-3037	VANE SET	1
124	8923223	5330-01-196-2504	GASKET	1
125	8923328 (72582)	2815-01-187-4704	RING, PISTON	1
126	8923566	5330-01-242-2697	GASKET	2
127	8924297 (72582)	5330-00-866-9403	SEAL, WATER PUMP	1
128	8924731	5340-01-224-1560	DISK, SOLID, PLAIN	2
129	8924732	5365-01-223-7179	SPACER, SLEEVE	2
130	8924733	5330-01-224-1474	SEAL, RING	1
131	8924734	5306-01-254-6351	BOLT, MACHINE	2
132	8925273	5330-01-242-0467	GASKET	2
133	8925644	5310-01-239-5071	WASHER, FLAT	6
134	8925779	2815-01-220-6659	RING, PISTON	2
135	8925780	2815-01-220-9169	RING, PISTON	1



**Table 1. Mandatory Replacement Parts List - Continued.**

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
	(72582)			
136	8925981 (72582)	2910-00-004-3443	INJECTOR TUBE KIT	3
137	8926902	5330-01-176-7872	SEAL, PLAIN ENCASED	1
138	8927224	2815-01-230-0207	RING SET, OIL	2
139	8927580 (72582)	5306-01-193-9291	BOLT	8
140	8927733 (72582)	2540-01-238-8792	SCREEN, AIR INLET	1
141	8928716	5330-01-248-9559	GASKET	1
142	8928720	5330-01-254-1389	GASKET	1
143	8928812	5330-01-252-0201	GASKET	1
144	8929529 (72582)	5330-01-037-4129	GASKET	1
145	9409010	5306-00-940-9010	BOLT, SELF-LOCKING	2
146	9409029	5306-01-421-9946	BOLT, SELF-LOCKING	4
147	9409034	5305-00-940-9034	SCREW, CAP, HEXAGON HEAD	2
148	9409062	5306-00-940-9062	BOLT, SELF-LOCKING	3
149	9409073	5306-00-822-3685	BOLT, SELF-LOCKING	2
150	9409129	5306-00-057-8494	BOLT, SELF-LOCKING	6
151	9409219	5306-00-781-7777	BOLT, SELF-LOCKING	4
152	9409221	5306-00-780-8109	BOLT, SELF-LOCKING	4
153	9412305	5310-00-965-6000	NUT, SELF-LOCKING	
154	9414215	5306-00-053-8378	BOLT, SELF-LOCKING	4
155	9414523	5305-00-921-5364	SCREW	8
156	9416374	5325-01-139-9845	RING, RETAINING	
157	9417025	4730-00-921-5736	PLUG, PIPE	1
158	9421753	5342-01-157-8867	PLUG, CUP	1
159	95780 (24975)	3120-01-306-9870	BUSHING, INSULATOR	
160	97799	5330-01-079-6372	SEAL, PLAIN ENCASED	

Table 1. Mandatory Replacement Parts List - Continued.

ITEM NO.	PART NUMBER /(CAGEC)	NATIONAL STOCK NUMBER (NSN)	NOMENCLATURE	QTY
161	B5107441 (72582)	5330-01-118-5600	GASKET	4
162	F-F-351 / 7-3 (81348)	2940-00-580-6283	FILTER ELEMENT, FLUID	1
163	FL804FP	2940-01-197-7106	FILTER ELEMENT, FLUID	2
164	GPW9184 (57526)	5330-00-551-0433	GASKET	1
165	M148095770 (24975)	5970-01-308-0374	WASHER, INSULATOR	
166	M148096032 (24975)	5999-01-329-0309	INSULATOR	
167	M45913/1-6CG5C (81349)	5310-00-087-4652	NUT, SELF-LOCKING	8
168	M45913/2-6FG5C (81349)	5310-00-959-1488	NUT, SELF-LOCKING	4
169	MIL-F-20627TY11CL2 (81349)	2910-00-287-1912	FILTER ELEMENT, FLUID	1
170	MS17829-4F	5310-00-483-8791	NUT, SELF-LOCKING	3
171	MS21045-7	5310-00-274-9364	NUT, SELF-LOCKING	9
172	MS21318-29	5305-00-253-5620	SCREW, DRIVE	2
173	MS24665-132 (80205)	5315-00-839-2325	PIN, COTTER	2
174	MS28775-112	5331-00-599-2934	PACKING, PREFORMED	1
175	MS35338-42	5310-00-045-3299	WASHER, LOCK	1
176	MS35338-43	5310-00-045-3296	WASHER, LOCK	5
177	MS35338-44 (80205)	5310-00-582-5965	WASHER, LOCK	13
178	MS35338-45 (80205)	5310-00-407-9566	WASHER, LOCK	80
179	MS35338-47	5310-00-209-0965	WASHER, LOCK	28
180	MS35338-48 (80205)	5310-00-584-5272	WASHER, LOCK	10
181	MS35338-50	5310-00-820-6653	WASHER, LOCK	2
182	MS35338-51	5310-00-584-7888	WASHER, LOCK	2

**Table 1. Mandatory Replacement Parts List - Continued.**

<b>ITEM NO.</b>	<b>PART NUMBER /(CAGEC)</b>	<b>NATIONAL STOCK NUMBER (NSN)</b>	<b>NOMENCLATURE</b>	<b>QTY</b>
183	MS35764-1277	5306-01-020-6895	BOLT, SELF-LOCKING	1
184	MS35769-7 (81343)	5330-01-346-3821	GASKET	4
185	N0674 2-012 (2697)	5331-00-579-6495	PACKING, PREFORMED	
186	T552	2940-00-745-7730	FILTER ELEMENT, FLUID	1
187	Z053074981 (24975)	5331-00-633-6827	PACKING, PREFORMED	
188	Z082078421 (24975)	5970-01-118-6753	BUSHING, INSULATOR	
189	Z112007092 (24975)	5305-00-335-4067	SCREW	

**END OF WORK PACKAGE**



**FIELD MAINTENANCE  
ENGINE REPAIR SPECIFICATIONS**

## INTRODUCTION

### Scope

This appendix lists the repair specifications for the 6V53/6V53T Diesel Engines. Refer to Table 1.

### Explanation of Columns for the Repair Specifications List

Column 1 - Point of Measurement - This column lists the area of the engine (e.g., CYLINDER BLOCK), then lists the specific component (e.g., Main Bearing Bore), and finally describes the critical dimension (e.g., Inside diameter).

Column 2 - New Minimum - This column lists the minimum acceptable dimension of the new part. All dimensions are in inches unless stated differently.

Column 3 - New Maximum - This column lists the maximum acceptable dimension of the new part. All dimensions are in inches unless stated differently.

Column 4 - Wear Limit - This column lists the maximum acceptable deviation for the used part. All dimensions are in inches unless stated differently. An asterisk (\*) in this column indicates the part must keep the same minimum and maximum limit as the new part.

**Table 1. Repair Specifications List.**

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM INCHES (MM)	(3) NEW MAXIMUM INCHES (MM)	(4) WEAR LIMIT INCHES (MM)
<b>CYLINDER BLOCK</b>			
Diameter (top)	4.5195 (114.80)	4.5215 (114.85)	4.5235 (114.90)
Diameter (center)	4.4865 (113.96)	4.488 (114.00)	4.4900 (114.05)
Diameter (bottom)	4.3565 (110.66)	4.3575 (110.68)	4.3595 (110.73)
Out-of-round	0.0015 (0.04)	0.0020 (0.05)	*
Taper		0.0015 (0.04)	0.0020 (0.05)
<b>Cylinder Liner Counterbore</b>			
Diameter	4.8200 (122.43)	4.8350 (122.81)	*
Depth	0.3000 (7.62)	0.3020 (7.67)	*
<b>Main Bearing Bore</b>			
Inside diameter (vertical axis)	3.7510 (95.28)	3.7520 (95.30)	*

**Table 1. Repair Specifications List - Continued.**

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM INCHES (MM)	(3) NEW MAXMUM INCHES (MM)	(4) WEAR LIMIT INCHES (MM)
<b>Camshaft Bore (Oversize Bearing)</b>			
End	2.3850 (60.58)	2.3860 (60.60)	*
Intermediate	2.3750 (60.32)	2.3760 (60.35)	*
<b>Top Surface of Block</b>			
Flatness (transverse)		0.0030 (0.08)	*
Flatness (longitudinal)		0.0060 (0.15)	*
<b>Depth of Counterbores (Top Surface)</b>			
Cylinder head seal strip groove	0.0970 (2.46)	0.1070 (2.72)	*
Water holes (intermediate)	0.1090 (2.77)	0.1150 (2.92)	*
Water holes (end)	0.0920 (2.34)	0.0980 (2.49)	*
Oil holes	0.0920 (2.34)	0.0980 (2.49)	*
<b>CYLINDER LINERS</b>			
Outside diameter (upper seal ring surface)	4.4850 (113.92)	4.4860 (113.94)	*
Outside diameter (lower seal ring surface)	4.3550 (110.62)	4.3560 (110.64)	*
Inside diameter	3.8752 (98.43)	3.8767 (98.47)	*
Out-of-round (inside diameter)	0.0020 (0.05)	0.0030 (0.08)	*
Taper (inside diameter)	0.0010 (0.03)	0.0020 (0.05)	*
Depth of flange below block	0.0465 (1.18)	0.0500 (1.27)	0.0500 (1.27)
Variation in depth between adjacent liners	0.0020 (0.05)	0.0020 (0.05)	*
<b>PISTON ASSEMBLY (TRUNK TYPE)</b>			
Piston			

**Table 1. Repair Specifications List - Continued.**

<b>(1) POINT OF MEASUREMENT</b>	<b>(2) NEW MINIMUM INCHES (MM)</b>	<b>(3) NEW MAXMUM INCHES (MM)</b>	<b>(4) WEAR LIMIT INCHES (MM)</b>
Diameter (at skirt–turbocharged)	3.8699 (98.30)	3.8721 (98.35)	*
Diameter (at skirt–nonturbocharged)	3.8679 (98.24)	3.8701 (98.30)	*
Clearance (skirt to liner–turbocharged)	0.0027 (0.07)	0.0068 (0.17)	0.0100 (0.25)
Clearance (skirt to liner–nonturbocharged)	0.0047 (0.12)	0.0088 (0.22)	0.0120 (0.30)
Out–of–round and taper		0.0005 (0.01)	*
Inside diameter (pin bushing)	1.3775 (34.99)	1.3780 (35.00)	*
<b>Compression Rings</b>			
Gap	0.0200 (0.51)	0.0460 (1.17)	0.0600 (1.52)
<b>Clearance (Ring to Groove)</b>			
No. 1	0.0030 (0.08)	0.0060 (0.15)	0.0120 (0.30)
No. 2	0.0070 (0.18)	0.0100 (0.25)	0.0140 (0.36)
No. 3 and 4 (turbocharged)	0.0050 (0.13)	0.0080 (0.20)	0.0130 (0.33)
No. 3 and 4 (nonturbocharged)	0.0045 (0.11)	0.0070 (0.18)	0.0120 (0.30)
<b>Oil Control Rings</b>			
Gap	0.0100 (0.25)	0.0250 (0.64)	0.0440 (1.12)
Clearance (ring to groove)	0.0015 (0.04)	0.0055 (0.14)	0.0080 (0.20)
<b>Piston Pin</b>			
Diameter	1.3746 (34.91)	1.3750 (34.92)	
Clearance (pin to piston bushing)	0.0025 (0.06)	0.0034 (0.09)	0.0100 (0.25)
Clearance (pin to connecting rod bushing)	0.0010 (0.03)	0.0019 (0.05)	0.0100 (0.25)

Table 1. Repair Specifications List - Continued.

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM INCHES (MM)	(3) NEW MAXMUM INCHES (MM)	(4) WEAR LIMIT INCHES (MM)
<b>PISTON ASSEMBLY (CROSS-HEAD TYPE)</b>			
Piston Crown			
Saddle to crown distance	2.8325 (71.95)	2.8395 (72.12)	*
Diameter			
Top	3.8486 (97.75)	3.8516 (97.83)	*
Below both compression rings	3.8636 (98.14)	3.8666 (98.21)	*
Above/below seal ring groove	3.8666 (98.21)	3.8676 (98.24)	*
Above/below bearing saddle	2.8350 (72.01)	2.8380 (72.09)	*
Compression Rings			
Gap (top ring)	0.0230 (0.58)	0.0380 (0.97)	0.0600 (1.52)
Gap (No.2 and 3)	0.0200 (0.51)	0.0300 (0.76)	0.0600 (1.52)
Clearance (ring to groove)			
Top ring	0.0030 (0.08)	0.0066 (0.17)	0.0086 (0.22)
No. 2	0.0070 (0.18)	0.0100 (0.25)	0.0140 (0.36)
No. 3	0.0050 (0.13)	0.0080 (0.20)	0.0130 (0.33)
Oil Control Rings			
Gap (two rings-lower groove)	0.0100 (0.25)	0.0250 (0.64)	0.0440 (1.12)
Gap (one ring-upper groove)	0.0070 (0.18)	0.0170 (0.43)	0.0370 (0.94)
Clearance (two rings-lower groove)	0.0015 (0.04)	0.0055 (0.14)	0.0080 (0.20)
Clearance (one ring-upper groove)	0.0005 (0.01)	0.0040 (0.10)	0.0065 (0.17)
Piston Skirt			



**Table 1. Repair Specifications List - Continued.**

<b>(1) POINT OF MEASUREMENT</b>	<b>(2) NEW MINIMUM INCHES (MM)</b>	<b>(3) NEW MAXIMUM INCHES (MM)</b>	<b>(4) WEAR LIMIT INCHES (MM)</b>
Diameter	3.8695 (98.29)	3.8717 (98.34)	*
Clearance (skirt to liner)	0.0035 (0.09)	0.0072 (0.18)	0.0110 (0.28)
Seal ring bore	3.7000 (93.98)	3.7040 (94.08)	3.7060 (94.13)
Piston pin bore	1.3775 (34.99)	1.3785 (35.01)	1.3790 (35.03)
<b>Piston Pin</b>			
Length	3.2250 (81.91)	3.2450 (82.42)	*
Diameter	1.3746 (34.91)	1.3750 (34.92)	1.3730 (34.87)
<b>Piston Pin Bushing</b>			
Thickness	0.0870 (2.21)	0.0880 (2.24)	0.0860 (2.18)
Clearance (bushing to groove)	0.0005 (0.01)	0.0105 (0.27)	0.0120 (0.30)
<b>CONNECTING RODS</b>			
<b>Length</b>			
Center bore to center bore—trunk	8.7990 (223.49)	8.8010 (223.55)	*
Center bore to center of pin—crosshead	8.7990 (223.49)	8.8010 (223.55)	*
Side Clearance	0.0080 (0.20)	0.0160 (0.41)	*
<b>CRANKSHAFT</b>			
<b>Journal Diameter</b>			
Main bearing	3.4990 (88.87)	3.5000 (88.90)	*
Connecting rod bearing	2.7490 (69.82)	2.7500 (69.85)	*
Journal out-of-round	0.00025 (0.01)	0.0030 (0.08)	*
Journal taper	0.0005 (0.01)	0.0030 (0.08)	*
Runout (intermediate journals)			0.0020 (0.05)
Thrust washer thickness	0.1190 (3.02)	0.1220 (3.10)	*

Table 1. Repair Specifications List - Continued.

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM INCHES (MM)	(3) NEW MAXMUM INCHES (MM)	(4) WEAR LIMIT INCHES (MM)
End play	0.0040 (0.10)	0.0160 (0.41)	0.0180 (0.46)
<b>CONNECTING ROD BEARINGS</b>			
Inside diameter (vertical axis)	2.7511 (69.88)	2.7531 (69.93)	*
Bearing to journal clearance	0.0011 (0.03)	0.0041 (0.10)	0.0060 (0.15)
Bearing thickness (905 part line)	0.1247 (3.17)	0.1252 (3.18)	0.1230 (3.12)
<b>MAIN BEARINGS</b>			
Inside diameter (vertical axis)	3.5030 (88.98)	3.5040 (89.00)	*
Bearing to journal clearance	0.0010 (0.03)	0.0040 (0.10)	0.0060 (0.15)
Bearing thickness (905 part line)	0.1240 (3.15)	0.1245 (3.16)	0.1230 (3.12)
<b>CAMSHAFTS</b>			
Diameter (bearing journals)	2.1815 (55.41)	2.1825 (55.44)	*
Runout (intermediate journals)		0.0020 (0.05)	*
End thrust	0.0030 (0.08)	0.0150 (0.38)	0.0190 (0.48)
Thrust washer thickness	0.2080 (5.28)	0.2100 (5.33)	*
<b>CAMSHAFT BEARINGS</b>			
Inside diameter	2.1870 (55.55)	2.1880 (55.58)	*
Clearance (bearing to shaft)	0.0035 (0.09)	0.0070 (0.18)	0.0080 (0.20)
<b>CAMSHAFT GEARS</b>			
Backlash	0.0005 (0.01)	0.0050 (0.13)	0.0070 (0.18)
<b>IDLER GEAR</b>			

**Table 1. Repair Specifications List - Continued.**

<b>(1) POINT OF MEASUREMENT</b>	<b>(2) NEW MINIMUM INCHES (MM)</b>	<b>(3) NEW MAXMUM INCHES (MM)</b>	<b>(4) WEAR LIMIT INCHES (MM)</b>
Backlash	0.0005 (0.01)	0.0050 (0.13)	0.0070 (0.18)
Inside diameter (bearing)	2.1860 (55.52)	2.1870 (55.55)	*
Clearance (bearing to hub)	0.0025 (0.06)	0.0045 (0.11)	0.0070 (0.18)
Endplay	0.0060 (0.15)	0.0130 (0.33)	0.0170 (0.43)
Hub outside diameter	2.1825 (55.44)	2.1835 (55.46)	*
Thrust washer thickness	0.1180 (3.00)	0.1200 (3.05)	*
<b>CRANKSHAFT TIMING GEAR</b>			
Backlash	0.0005 (0.01)	0.0050 (0.13)	0.0070 (0.18)
Inside diameter	4.0575 (103.06)	4.0585 (103.09)	*
Outside diameter (crankshaft)	4.0600 (103.12)	4.0610 (103.15)	*
<b>BLOWER DRIVE GEAR</b>			
Backlash	0.0030 (0.08)	0.0050 (0.13)	0.0070 (0.18)
Thrust washer thickness	0.0930 (2.36)	0.1030 (2.62)	*
Endplay (blower drive gear shaft)	0.0040 (0.10)	0.0120 (0.30)	*
<b>FUEL PUMP DRIVE GEAR</b>			
Backlash	0.0030 (0.08)	0.0050 (0.13)	0.0070 (0.18)
Bearing (inside diameter)	1.1220 (28.50)	1.1230 (28.52)	*
Clearance (bearing to hub)	0.0020 (0.05)	0.0035 (0.09)	*
Endplay	0.0050 (0.13)	0.0180 (0.46)	0.0220 (0.56)
Hub (outside diameter)	1.1200 (28.45)	1.1205 (28.46)	*
Thrust washer thickness	0.1580 (4.01)	0.1600 (4.06)	*
<b>CYLINDER HEAD</b>			
Cam follower bore	1.0626 (26.99)	1.0636 (27.02)	*

Table 1. Repair Specifications List - Continued.

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM INCHES (MM)	(3) NEW MAXMUM INCHES (MM)	(4) WEAR LIMIT INCHES (MM)
Valve insert counterbore (diameter)	1.1590 (29.44)	1.1600 (29.46)	*
<b>EXHAUST VALVE INSERTS</b>			
Outside diameter	1.1605 (29.48)	1.1615 (29.50)	*
Seat width	0.0468 (1.19)	0.0781 (1.98)	0.0781 (1.98)
Valve seat runout	0.0020 (0.05)	0.0020 (0.05)	*
<b>EXHAUST VALVES</b>			
Stem diameter	0.2480 (6.30)	0.2488 (6.32)	*
Valve head to cylinder head distance		0.0240 (0.61)	0.0390 (0.99)
	flush	recess	recess
<b>EXHAUST VALVE SPRINGS</b>			
Load at 1.93 inches (length)	25 lb (11.34 kg)		
<b>VALVE GUIDES</b>			
Distance below top of head	0.1500 (3.81)	0.1800 (4.57)	*
Inside diameter	0.2505 (6.36)	0.2515 (6.39)	*
Clearance (valve stem to guide)	0.0017 (0.04)	0.0035 (0.09)	0.0050 (0.13)
<b>ROCKER ARMS AND SHAFTS</b>			
Diameter (rocker shaft)	0.8735 (22.19)	0.8740 (22.20)	*
Diameter (injector rocker arm)	0.8750 (22.22)	0.8760 (22.25)	*
Diameter (valve rocker arm)	0.8753 (22.23)	0.8763 (22.26)	*
Clearance (shaft to injector rocker arm bushing)	0.0010 (0.03)	0.0025 (0.06)	0.0040 (0.10)

**Table 1. Repair Specifications List - Continued.**

<b>(1) POINT OF MEASUREMENT</b>	<b>(2) NEW MINIMUM INCHES (MM)</b>	<b>(3) NEW MAXMUM INCHES (MM)</b>	<b>(4) WEAR LIMIT INCHES (MM)</b>
Clearance (shaft to valve rocker arm bore)	0.0013 (0.03)	0.0028 (0.07)	0.0040 (0.10)
<b>CAM FOLLOWERS</b>			
Diameter (follower body)	1.0600 (26.92)	1.0610 (26.95)	*
Diameter (roller pin hole)	0.4362 (11.08)	0.4372 (11.10)	*
Diameter (roller pin)	0.4374 (11.11)	0.4377 (11.12)	*
Outside diameter (roller)	0.9077 (23.06)	0.9082 (23.07)	*
Inside diameter (roller bushing)	0.4390 (11.15)	0.4395 (11.16)	*
Clearance (follower body to head)	0.0016 (0.04)	0.0036 (0.09)	0.0060 (0.15)
Roller and Pins			
Clearance (pin to bushing)	0.0013 (0.03)	0.0021 (0.05)	horiz 0.010 (0.03)
Side clearance (roller to follower)	0.0150 (0.38)	0.0230 (0.58)	0.0230 (0.58)
Clearance (cam follower guide to cam follower legs)	0.0050 (0.13)		
<b>CAM FOLLOWER SPRINGS</b>			
Load at 2.1406 inches (length)	250 lb (113.39 kg)		
<b>BLOWER</b>			
Backlash (rotor gears)	0.0005 (0.01)	0.0025 (0.06)	0.0035 (0.09)
Backlash (between blower drive gear and camshaft gear)	0.0030 (0.08)	0.0070 (0.18)	*
Oil seal depth (below end plate surface)	0.0020 (0.05)	0.0080 (0.20)	*
Clearances			

**Table 1. Repair Specifications List - Continued.**

<b>(1) POINT OF MEASUREMENT</b>	<b>(2) NEW MINIMUM INCHES (MM)</b>	<b>(3) NEW MAXMUM INCHES (MM)</b>	<b>(4) WEAR LIMIT INCHES (MM)</b>
Thrust plate to thrust washers	0.0025 (0.06)	0.0050 (0.13)	*
Rotor to air outlet side of housing		0.0040 (0.10)	*
Rotor to air inlet side of housing		0.0100 (0.25)	*
Rotor to front end plate (turbocharged)		0.0100 (0.25)	*
Rotor to front end plate (nonturbocharged)		0.0080 (0.20)	*
Rotor to rear end plate (turbocharged)		0.0120 (0.30)	*
Rotor to rear end plate (nonturbocharged)		0.0100 (0.25)	*
Rotor to rotor (turbocharged)		0.0130 (0.33)	*
Rotor to rotor (nonturbocharged)		0.0090 (0.23)	*
<b>OIL PUMP</b>			
Lobe clearance (inner and outer rotors)	0.0005 (0.01)	0.0110 (0.28)	*
Clearance (pump body to side of inner and outer rotor)	0.0010 (0.03)	0.0035 (0.09)	*
<b>FUEL INJECTOR</b>			
Follower spring load at 1.028 inches (26.11 mm) (length)	70 lb (31.75 kg)		*
Valve spring load at 0.4358 inches (11.07 mm) (length)	41 lb (18.60 kg)		*

**END OF WORK PACKAGE**

## GLOSSARY

### WORDS AND TERMS

<u>Term</u>	<u>Definition</u>
Axial	Situated around, in the direction of, on, or along an axis.
Base Metal	Original machined or cast metal form or shape. Parent metal
Blend Repair	A repair where defects are eliminated by smoothing out discrepancies.
Brinelling	A hardening of metal from excessive loading or pounding.
Burr	Local rise of material forming a protruding sharp point or high spot.
Chipping	Loss of material over larger area than that of nicks.
Circumferential	On the circumference
Continuity	Electrical resistance of 1 ohm or less
Corrosion	Chemical reaction between surfaces of material and environment to which it is subjected. Generally appears as rust on steel or as a light-colored, powdery coating on aluminum or magnesium. Advanced forms of corrosion will result in pitting.
Crosshead Piston	A two part piston consisting of a free-floating dome and skirt linked by a transverse pin.
Counterbore	A sunken machined surface around a machined hole usually for seal rings or packings.
Crack	Surface or material break caused by stress which results in partial or complete separation of material.
Deburr	To remove a burr from a machined surface.
Deformation	Loss of original shape, either local or over an area. Includes bends, twists, warps, bulges, dents, kinks, flattening, or crushing.
Elongation	Stretching or lengthening of original dimensions; usually applies to bolt holes.
Erosion	The wearing away by environment elements or by chemical reactions.
Excessive Wear	Obvious wear beyond expectations. Determined by inspector's experience. Term is applicable to parts visually inspected.
Fretting	Erosion from rubbing or wear
Gouge	A groove in or breakdown of metal surface from foreign contact under heavy pressure. Usually, loss of material rather than displacement.
Groove	A long, narrow channel or depression

## GLOSSARY - Continued

<u>Term</u>	<u>Definition</u>
Leakage	Evidence of a fluid beyond its container
Meniscus	The lowest point of a fluid in a narrow container
Multimeter	A general purpose electrical meter used to measure amperage, voltage, and resistance.
Nick	A small groove or notch. Usually, displacement of material rather than loss.
Overheating	A condition indicated by discoloration of parts which usually results in a loss of hardness. Usually caused by a lack of lubrication, malfunction of parts, or excessive wear.
Parent Metal	Original machined or cast metal form or shape/Base metal
Peen	To deform metal caused by pounding with a hard object.
Pitting	A material surface cavity, usually with defined rough edges. Usually caused by rust and corrosion.
Radial	Going from the center outward or from the circumference inward along a radius. A circular direction at a specific radius.
Repair	A process of fixing something that is damaged or worn or does not operate or function properly.
Rub	Evidence of friction caused by contact of two items.
Runout	The different surface level of a machined surface when a part is turned axially.
Scoring	Deep tears or breaks in material surfaces from foreign contact under pressure. May show temperature effect from high friction.
Scratch	A slight tear or break in material surface from momentary foreign contact.
Spline	A keyway between two mating parts. Usually used with multiple keyways.
Teflon	Synthetic fluorine-containing resins (polytetrafluoroethylene) used for molding articles and for coatings to prevent sticking.
Uneven Wear	Excessive wear in local areas. Includes hollows, shiny spots, uneven polish, and abrasions of parts subject to fluid, air, or gas flow.
Wear	Loss of material from contacting surfaces. Normal wear is the slow loss of material from contacting surfaces. Wear usually has a polished finish and leaves a pronounced pattern.



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Troubleshooting Procedures Introduction (Sustainment).....	WP 0006-1
Turbocharger Mounting Bracket and Exhaust Tubes Replacement (MODELS 5063-5393, 5063-539L).....	WP 0038-1
Turbocharger Oil Supply Line Replacement (Models 5063-5392, 5063-5393, 5063-539L).....	WP 0025-1
Turbocharger Repair (Models 5063-5392, 5063-5393, 5063-539L).....	WP 0086-1
Turbocharger Replacement (Model 5063-5392).....	WP 0035-1
Turbocharger Replacement (Models 5063-5393, 5063-539L).....	WP 0036-1

## U

## INDEX - Continued

**Subject**

**WP Sequence No.-Page No.**

Upper Front Cover Replacement..... WP 0090-1



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<b>TO</b> (Forward to proponent of publication or form) (Include ZIP Code) U.S. Army TACOM Life Cycle Management Command ATTN: AMSTA-LCL-MPP/TECH PUBS 6501 E. 11 Mile Road, Warren, MI 48397-5000						<b>FROM</b> (Activity and location) (Include ZIP Code) <i>Your mailing address</i>	
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PUBLICATION/FORM NUMBER TM 9-2815-205-24				DATE 25 February 2013		TITLE: FIELD AND SUSTAINMENT MAINTANANCE REPAIR PARTS AND SPECIAL TOOLS LIST FOR 6V53/6V53T	
ITEM	PAGE	PARA- GRAPH	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)	
	0007-3					Figure 2, Item 9 should show a lockwasher. Currently shows a flat washer.	
	0018-2					Cleaning and inspection, Step 6, reference to governor support pin (14) is wrong reference. Reference should be change to (12).	
<h1>SAMPLE</h1>							
TYPED NAME, GRADE OR TITLE  <i>Your Name</i>					TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION  <i>Your Phone Number</i>		SIGNATURE  <i>Your Signature</i>

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**PART II – REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS**

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**PART III – REMARKS** (Any general remarks, or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)

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By Order of the Secretary of the Army:

Official:



JOYCE E. MORROW  
*Administrative Assistant to the  
Secretary of the Army*

1301602

RAYMOND T. ODIERNO  
*General, United States Army  
Chief of Staff*

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 371406 requirements for TM 9-2815-205-24.



# THE METRIC SYSTEM AND EQUIVALENTS

## Linear Measure

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches  
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches  
 1 Kilometer = 1000 Meters = 0.621 Miles

## Weights

1 Gram = 0.001 Kilograms = 1000 Milligrams = 0.035 Ounces  
 1 Kilogram = 1000 Grams = 2.2 Pounds  
 1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

## Liquid Measure

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces  
 1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

## Square Measure

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches  
 1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet  
 1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

## Cubic Measure

1 Cu timeter = 1,000 Cu Millimeters = 0.06 Cu Inches  
 1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

## Temperature

$5/9 (F - 32) = C$   
 212 Fahrenheit is equivalent to 100 Celsius  
 90 Fahrenheit is equivalent to 32.2 Celsius  
 32 Fahrenheit is equivalent to 0 Celsius  
 $9/5 C + 32 = F$

## APPROXIMATE CONVERSION FACTORS

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Inches.....	Centimeters .....	2.540
Feet.....	Meters .....	0.305
Yards.....	Meters .....	0.914
Miles.....	Kilometers.....	1.609
Square Inches.....	Square Centimeters.....	6.451
Square Feet.....	Square Meters.....	0.093
Square Yards.....	Square Meters.....	0.836
Square Miles.....	Square Kilometers.....	2.590
Acres.....	Square Hectometers.....	0.405
Cubic Feet.....	Cubic Meters.....	0.028
Cubic Yards.....	Cubic Meters.....	0.765
Fluid Ounces.....	Milliliters.....	29.573
Pints.....	Liters.....	0.473
Quarts.....	Liters.....	0.946
Gallons.....	Liters.....	3.785
Ounces.....	Grams.....	28.349
Pounds.....	Kilograms.....	0.454
Short Tons.....	Metric Tons.....	0.907
Pound-Feet.....	Newton-Meters.....	1.356
Pounds/Sq Inch.....	Kilopascals.....	6.895
Miles per Gallon.....	Kilometers per Liter.....	0.425
Miles per Hour.....	Kilometers per Hour.....	1.609

<u>TO CHANGE</u>	<u>TO</u>	<u>MULTIPLY BY</u>
Centimeters.....	Inches.....	0.394
Meters.....	Feet.....	3.280
Meters.....	Yards.....	1.094
Kilometers.....	Miles.....	0.621
Sq Centimeters.....	Square Inches.....	0.155
Square Meters.....	Square Feet.....	10.764
Square Meters.....	Square Yards.....	1.196
Square Kilometers.....	Square Miles.....	0.386
Square Hectometers.....	Acres.....	2.471
Cubic Meters.....	Cubic Feet.....	35.315
Cubic Meters.....	Cubic Yards.....	1.308
Milliliters.....	Fluid Ounces.....	0.034
Liters.....	Pints.....	2.113
Liters.....	Quarts.....	1.057
Liters.....	Gallons.....	0.264
Grams.....	Ounces.....	0.035
Kilograms.....	Pounds.....	2.205
Metric Tons.....	Short Tons.....	1.102
Newton-Meters.....	Pound-Feet.....	0.738
Kilopascals.....	Pounds per Sq Inch.....	0.145
Km per Liter.....	Miles per Gallon.....	2.354
Km per Hour.....	Miles per Hour.....	0.621

