

**TECHNICAL MANUAL
DIRECT SUPPORT AND
GENERAL SUPPORT
MAINTENANCE**

FOR

**ENGINE W/CONTAINER:
MODEL 5063-5299 (2815-00-124-5390)
(2815-01-295-7458)**

**ENGINE W/CONTAINER:
MODEL 5063-5392 (2815-01-246-0903)**

**ENGINE W/CONTAINER:
MODEL 5063-5393 (2815-01-248-7644)**

**ENGINE W/CONTAINER:
MODEL 5063-5395 (2815-01-031-6154)**

**ENGINE W/CONTAINER:
MODEL 5063-5398 (2815-00-909-5949)**

**ENGINE W/CONTAINER:
MODEL 5063-539F (2815-01-316-6617)**

**ENGINE W/CONTAINER:
MODEL 5063-539L (2815-01-412-2715)**

This manual supersedes TM 9-2815-205-34 dated March 1975, including all changes.

DISTRIBUTION STATEMENT: Approved for Public Release; Distribution is unlimited

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CHANGE
No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C. , 14 October 1995

**DIRECT SUPPORT AND
GENERAL SUPPORT MAINTENANCE FOR**

ENGINE W/CONTAINER

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MODEL 5063-539L (2815-01-412-2715)

1. TM 9-2815-205-34 is changed as follows:
2. Remove old pages and insert new pages as indicated below.
3. File this change sheet in front of the publication for reference purpose.

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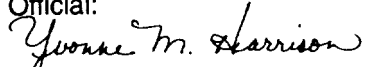
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DENNIS J. REIMER
General, United States Army
Chief of Staff

Official:



YVONNE M. HARRISON
Administrative Assistant to the
Secretary of the Army
00923

DISTRIBUTION:

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TM 9-2815-205-34.

SUMMARY OF WARNINGS

WARNING

Fuel spraying on hot components is an extreme fire hazard. Control leakage immediately to prevent fires and injury.

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

WARNING

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

WARNING

When inspecting a blower on a running engine, keep fingers, equipment and clothing away from moving parts of the blower. Run engine at low speeds only.

WARNING

Wear safety glasses and stand clear of air release ports when purging air from container. Make certain air pressure is fully vented before disassembly. Injury to eyes and inner ears can result from failure to properly vent container before disassembly.

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. Equipment may drop or shift and injury to personnel may result.

WARNING

Provide adequate support for heavy components to prevent injury to personnel from component falling during removal.

| WARNING |

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

| 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.

| WARNING |

Do not grasp or graze sharp edges of oil control rings with bare hands. Rings are extremely sharp and can cut personnel when mishandled.

WARNING

Wear safety glasses when working with a pressurized air system. Make certain air pressure is fully vented before disassembly. Sudden release of air pressure can throw liquid or debris resulting in serious personal injury. Injury to eyes and inner ears can result from failure to properly vent system before disassembly.

WARNING

Springs under compression may release airborne parts. Wear eye protection and use care when disassembling components. Injury to personnel may result.

WARNING

1,1,1 trichloroethane solution is toxic. Wear protective goggles and gloves and use in a well-ventilated area to avoid personal injury. Avoid breathing the fumes or direct contact with your skin. Use recommended safety equipment as required.

WARNING

Cooler cleaning solution is made from strong acids. 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 or injury may result.

WARNING

Fuel oil entering blood stream may cause serious infection. Always hold injector with tip away from skin.

WARNING

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

WARNING

Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.

WARNING

if turbocharger does not have built-in inlet shield, install protective turbocharger air inlet shield prior to doing maintenance with engine running and air inlet removed. Contact with rotating blades will cause injury to personnel.

WARNING

Mercury is a toxic material. Avoid contact with skin. Clean up any spilled mercury. Small amounts of mercury may be disposed of by wiping with aluminum foil.

WARNING

Exhaust gases contain carbon monoxide and can kill or poison you. Position exhaust piping to carry exhaust gases away from test area. Signs of exhaust gas poison are dizziness, headache, loss of muscle control, sleepiness, coma, or death.

TECHNICAL MANUAL
No. 9-2815-205-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 21 August 1992

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REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual by calling attention to errors and by recommending improvements and stating your reasons for the recommendations. Your letter or DA Form 2028 (Recommended Changes to Publications) should be mailed directly to: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-IM-MMAA, Warren, MI 48397-5000. A reply will be furnished to you.

You may also provide DA Form 2028/2028-2 information to TACOM via E-mail or datafax. Our fax number is DSN 786-6323. Our E-mail address is: amsta-mmaa@cc.tacom.army.mil

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HOW TO USE THIS MANUAL

Before starting a procedure, read HOW TO USE THIS MANUAL and Para 2-2, CLEANING AND GENERAL REPAIR INSTRUCTIONS.

WHAT IS IN THE MANUAL - FRONT TO BACK

SUMMARY OF WARNINGS AND FIRST AID lists the warnings and first aid information in this manual. These warnings contain additional information about things that could hurt or kill personnel.

TABLE OF CONTENTS lists the chapters, sections, and appendixes in this manual. It also lists the pages where chapters, sections, and appendixes can be found.

CHAPTER 1 covers general information and gives a quick review of major engine components and features.

CHAPTER 2 contains the following: Cleaning and general repair instructions, removing/installing the engine from/in the container, removing/installing exterior components, install/remove the engine on/from the maintenance stand, and unit component repair procedures.

CHAPTER 3 contains direct support and general support replacement and repair procedures. Direct support and general support procedures are in separate sections.

CHAPTER 4 explains preparation for testing, tune-up, testing, and preparation for storage of the engine after it has undergone repair.

APPENDIX A lists references, such as technical manuals and other publications, to be used by personnel.

APPENDIX B lists the tools used in the procedures, their part numbers, and the correct catalog or tool list where each tool may be found.

APPENDIX C lists expendable supplies and materials used to maintain or repair the engine.

APPENDIX D lists manufactured items that are used to support the procedures.

APPENDIX E gives the general torque limits required for standard fasteners on the engine.

APPENDIX F lists the mandatory replacement parts used to maintain or repair the engine.

APPENDIX G lists the engine repair specifications for repairing the engine.

GLOSSARY gives the meaning of unusual terms found in the procedures.

ALPHABETICAL INDEX lists the major engine parts that can be repaired or replaced at the DS or GS level. Each entry in the index includes the procedure paragraph number.

DA FORM 2028-2 is used to report an error found in this manual.

METRIC CONVERSION CHART converts U.S. measurements to their metric equivalents. Measurements in the procedures are given in both U.S. and metric units.

HOW TO USE YOUR MANUAL ON THE JOB

The best way to learn about this manual is to practice using it. Knowing how to use this manual will save time and effort.

Where do you start?

Entry to a repair procedure in this manual may come from observation, troubleshooting, or the Army Oil Analysis Program (AOAP). The problem will help to identify the item that needs repair or replacement.

How do you fix the problem?

1. Find the correct repair procedure in the manual. Pick a key word from the item to be repaired or replaced. Look up the word in the Alphabetical Index, which gives the paragraph number of the procedure.
2. Turn to the procedure and read it carefully before starting. Pay attention to warnings and cautions. Get the equipment, supplies, and any other personnel needed. Parts which will be destroyed or should not be reused are listed in the setup as Materials/Parts.
3. Start with step a. in the procedure and do each step in order. In some referenced Procedures, one or more steps may have been completed. If so, proceed to the next step. If a part fails inspection and requires replacement, refer to the Repair Parts and Special Tools List (RPSTL) TM 9-2815-205-34P.

HOW TO USE A MAINTENANCE PROCEDURE

The first page of a repair procedure lists everything needed to perform that procedure. The following paragraphs describe all the blocks of information found there.

APPLICABILITY. The data under this heading identifies those specific models to which the procedure applies.

TOOLS AND SPECIAL TOOLS. Individual tools from your mechanic's tool kit are not listed under this heading. If any tools from this kit are required, the tool kit itself is listed as the first item. Special tools, manufactured tools, and tools from any other source are listed with a reference to a specific item number and appendix letter. The referenced appendix provides the necessary information to find or make the tool. App B lists all special tools, tools from supply catalog sets, kits and outfits, and tools which must be acquired through the GSA catalog. App D lists the manufactured tools with complete fabricating instructions.

MATERIALS/PARTS. Any repair parts that are destroyed in disassembly, or not normally reused, are listed under this heading with reference to App F and specific item number. App F gives the detailed information necessary to requisition the parts if they are not on hand. This heading will appear only if new parts are always required for the procedure. Refer to the RPSTL (TM 9-2815-205-34P) for the NSN or part number and CAGE code.

EXPENDABLE/DURABLE SUPPLIES. Any expendable or consumable supplies needed to perform the procedure are listed under this heading with reference to App C and specific item number. App C gives the detailed information necessary to requisition the parts if they are not on hand. This heading will appear only if such supplies are required for the procedure.

PERSONNEL REQUIRED. The number of personnel required to perform the procedure are listed here. This heading only appears in procedures that require more than one person.

EQUIPMENT CONDITION. This heading describes the condition the equipment must be in before starting the procedure. The paragraph for each condition is listed followed by a description of the part removed, repaired, or adjusted.

HOW TO USE THIS MANUAL (Cont)

FEATURES OF WE NEW PROCEDURE FORMAT

WARNINGS. General warnings are placed both within the procedure right before the step where they apply and in the list of WARNINGS found behind the front cover of this TM. They call attention to things that could kill or injure personnel.

CAUTIONS. Cautions are found within the procedure immediately before the step to which they apply. They call attention to things or actions that could damage equipment.

NOTES. Notes are found within a procedure immediately before the appropriate step. They contain important facts or instructions to make the procedure easier or to modify the procedure for a similar model.

USE OF TOOLS AND PERSONNEL. Each procedure lists the tool kits and tools that are needed for the procedure. The procedure steps tell how and where to use common tools. However, the procedure steps do not tell which persons do which steps in the procedures needing more than one person. The mechanic responsible for the procedure should direct the rest of the personnel on what to do.

REFERENCES. References from one procedure to another within the TM are by paragraph number. References to other Technical Manuals are by the TM number only and the user needs to use the Alphabetical Index of that TM to find the information needed.

PROCEDURE ORGANIZATION. Most procedures in this TM fall into the category of removal/installation, replacement, repair, or adjustment. Replacement can contain removal, disassembly, inspection, assembly, and installation in the same procedure. Repair generally contains disassembly, inspection, and assembly in the same procedure.

HOW TO USE THE REPAIR PARTS AND SPECIAL TOOLS LIST (RPSTL) WITH THIS MANUAL

The RPSTL gives the National Stock Number (NSN) required to order parts which fail inspection in the repair procedures. To use the RPSTL to identify and order a part, do the following:

1. In this manual, turn to the page of the procedure where the part is installed.
2. Go to the RPSTL and find the same illustrated part. That part will have an item number assigned to it. Find the SMR code for the item.
3. If the SMR code does not authorize your level to repair the item, reassemble it and send it to the authorized level of maintenance.
4. If the SMR code does authorize your level to repair the item, look this figure and item number up in the figure and item number cross-reference index in the back of the RPSTL to find the JSN. If the item has no NSN, return to the illustration listing and order the item by the part number and CAGE code.

CHAPTER 1 INTRODUCTION

Section I. GENERAL INFORMATION

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1-1. SCOPE

- a. **Type of Manual:** Direct Support and General Support Maintenance.
- b. **Model Number and Equipment Name.** Detroit Diesel Corporation (formerly Detroit Diesel Allison) Series 6V53 diesel engine, models 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L.
- c. **Purpose of Equipment:** Powers the M113 and M551 family of vehicles (FOV).

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

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE. For general destruction procedures, refer to Procedures for Destruction of Tank-Automotive Equipment to Prevent Enemy Use listed in App A.

1-4. PREPARATION OF ENGINE FOR STORAGE OR SHIPMENT. Preparation for storage or shipment is provided in Para 4-10 and 4-11.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). If any M113 or M551 FOV diesel engine needs improvement, let us know. Send us an EIR. The user is the only one who can tell us how the-equipment might be improved. Let us know why you don't like the design: Put it on an SF 368 (Quality Deficiency Report), Mail it to us at: Commander, U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-MMAA, Warren, Michigan 48397-5000. We'll send a reply.

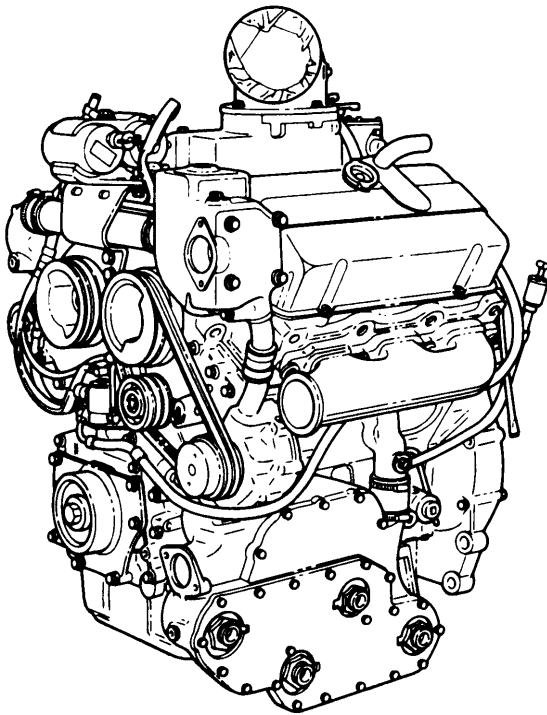
1-6. WARRANTY INFORMATION. The Series 6V53 diesel engine is warranted by Detroit Diesel Corporation for 12 months. Warranty starts on the date found on DD Form 250. Report all defects in material or workmanship to your supervisor who will take appropriate action.

Section II. EQUIPMENT DESCRIPTION

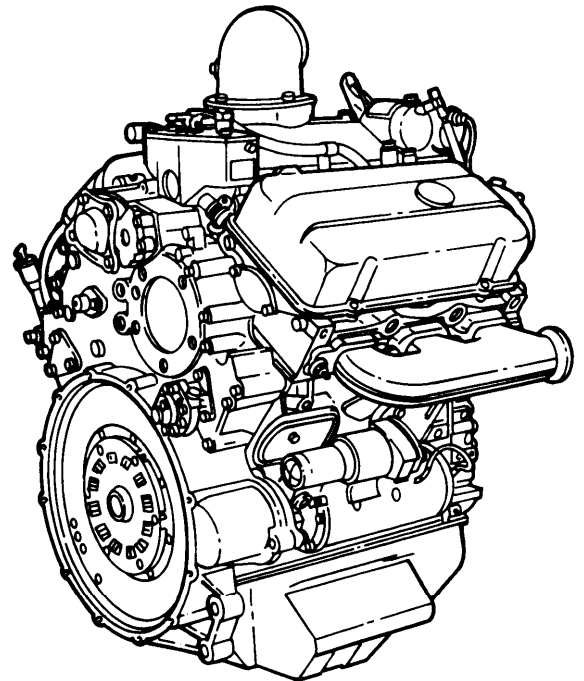
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Equipment Information

1-7. EQUIPMENT DESCRIPTION. All the engine models are two cycle, fuel injected, V-type, liquid cooled, six cylinder diesel engines with wet cylinder liners. The cylinders are numbered one, two, and three on the left and right starting from the front of the engine. The terms "right", "left", "front", and "rear" are defined as viewed from the rear or flywheel end of the engine.



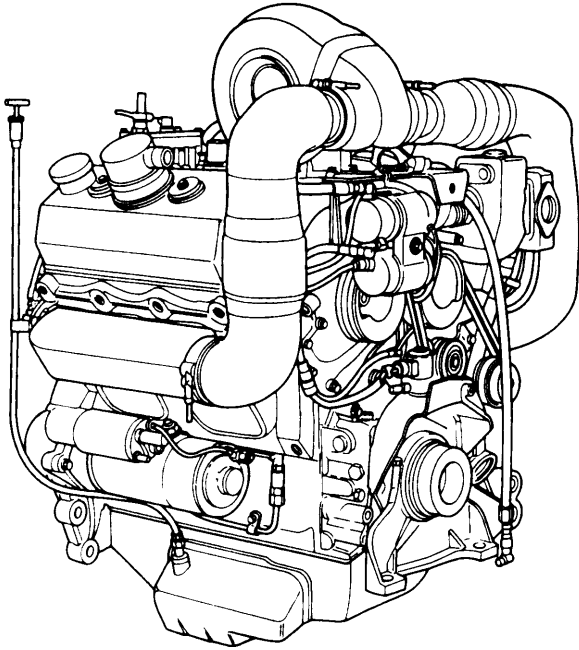
LEFT FRONT VIEW



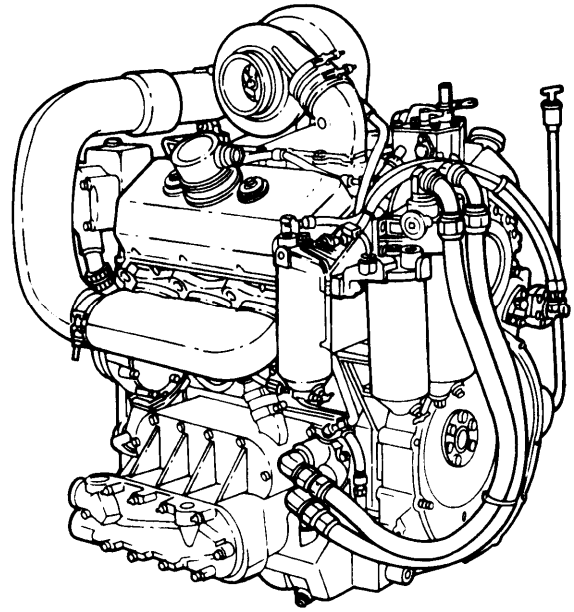
RIGHT REAR VIEW

MODEL 5063-5299

1-7. EQUIPMENT DESCRIPTION (Cont)

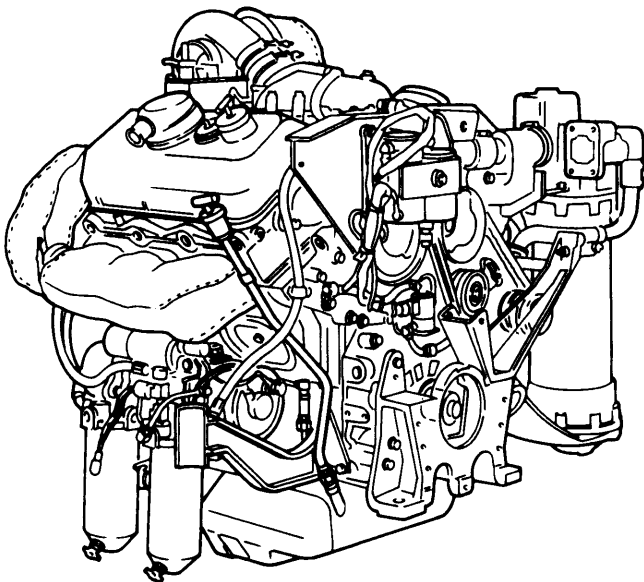


RIGHT FRONT VIEW

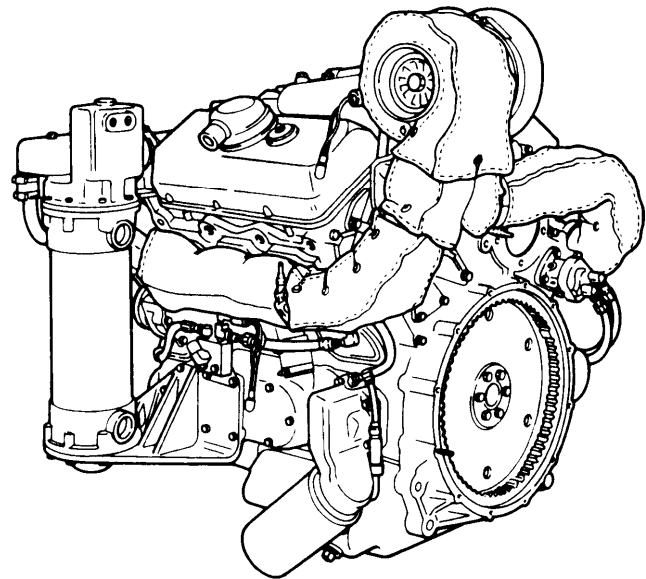


LEFT REAR VIEW

MODEL 5063-5392

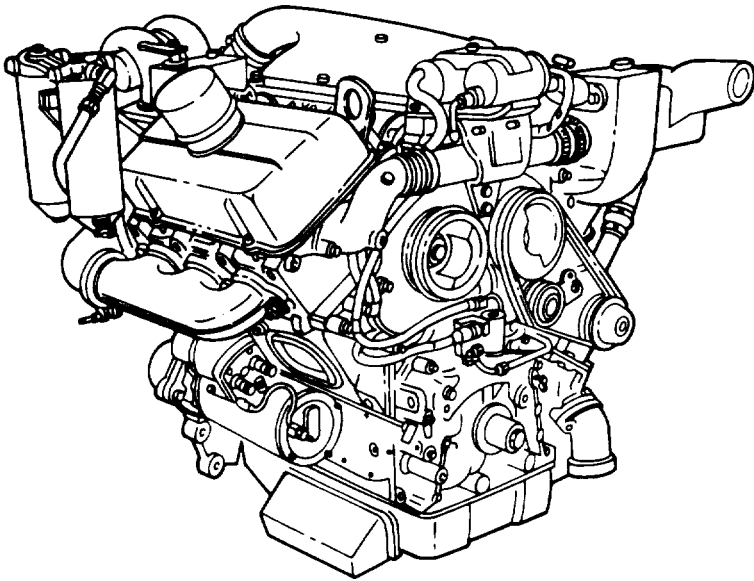


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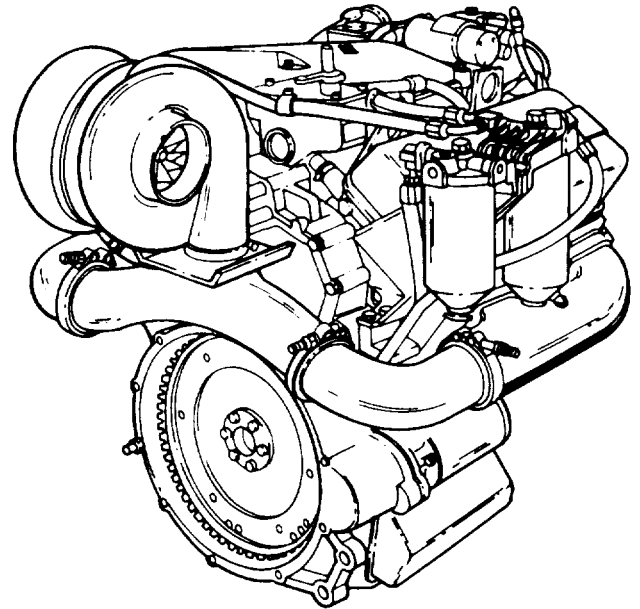


LEFT REAR VIEW

MODEL 5063-5393

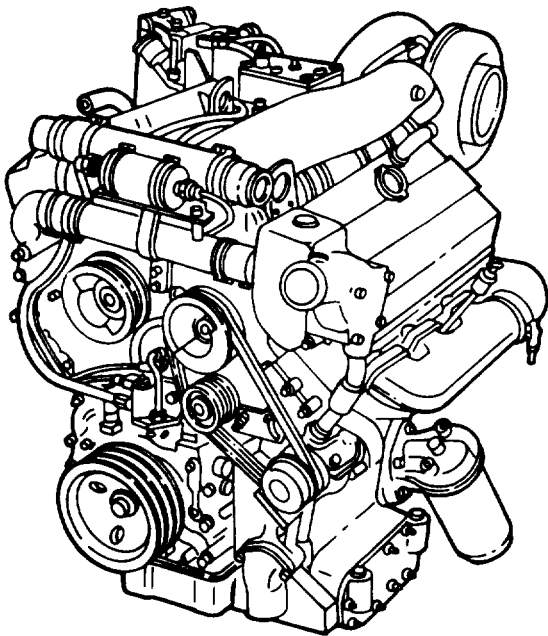


RIGHT FRONT VIEW

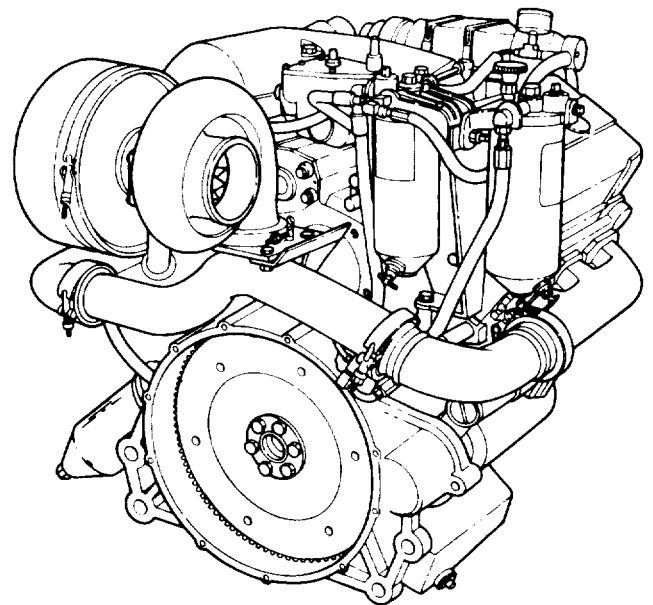


RIGHT REAR VIEW

MODEL 5063-5395



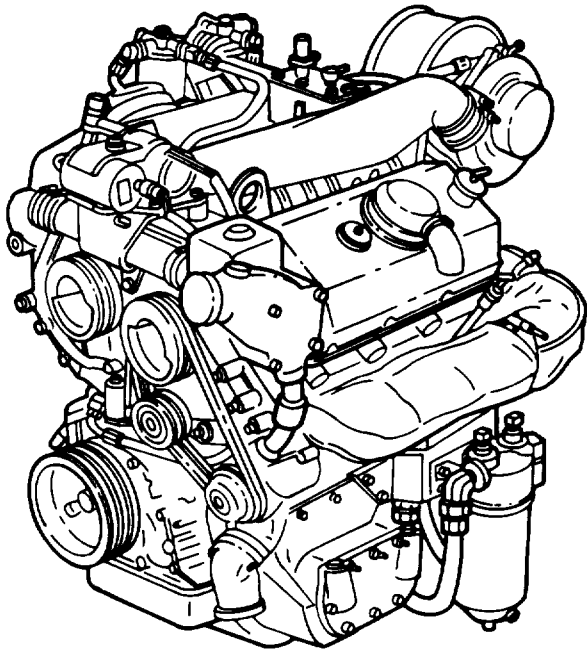
LEFT FRONT VIEW



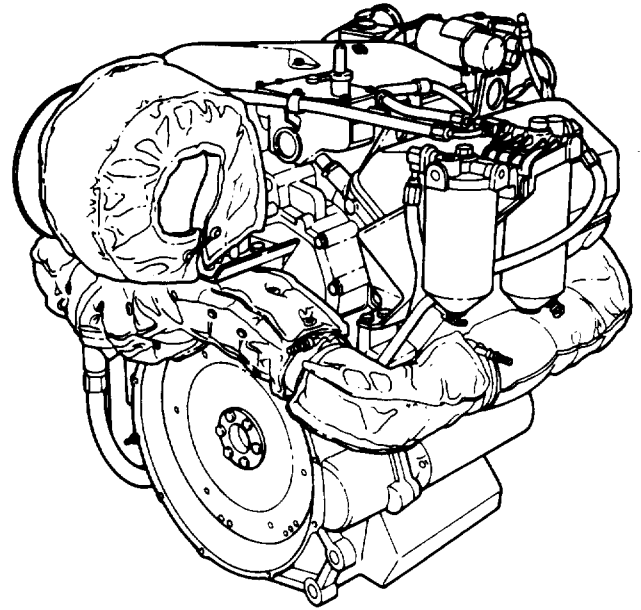
RIGHT REAR VIEW

MODEL 5063-5398

1-7. EQUIPMENT DESCRIPTION (Cont)

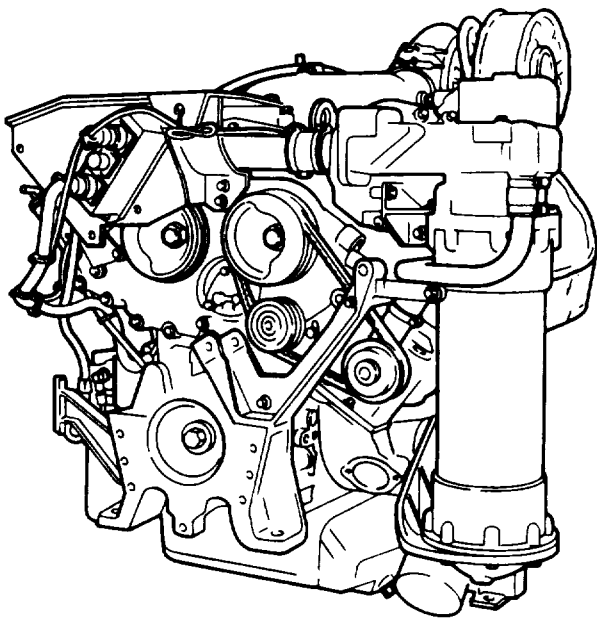


LEFT FRONT VIEW

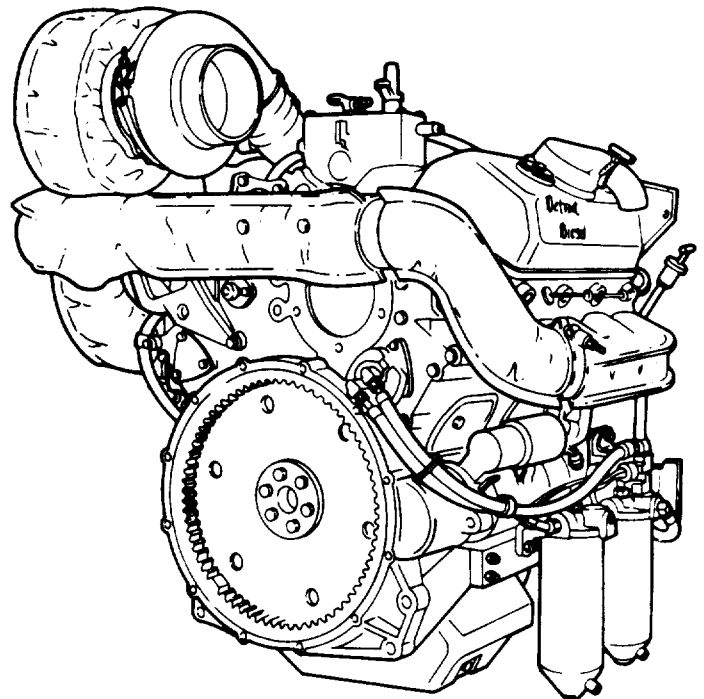


RIGHT REAR VIEW

MODEL 5063-539F



LEFT FRONT VIEW

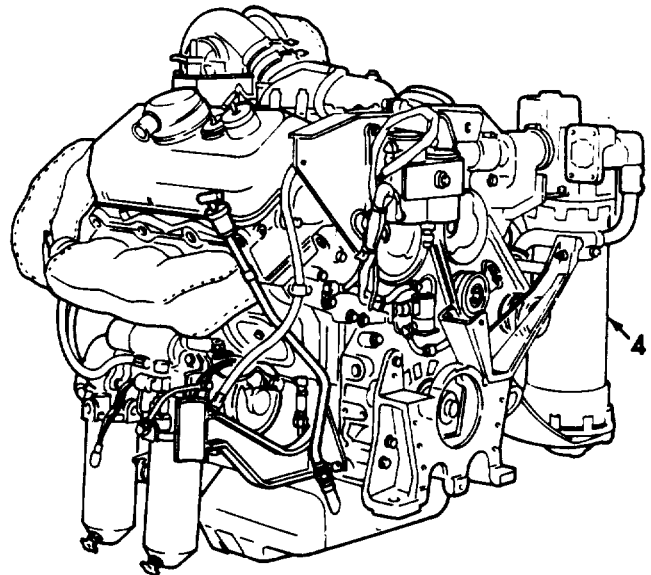
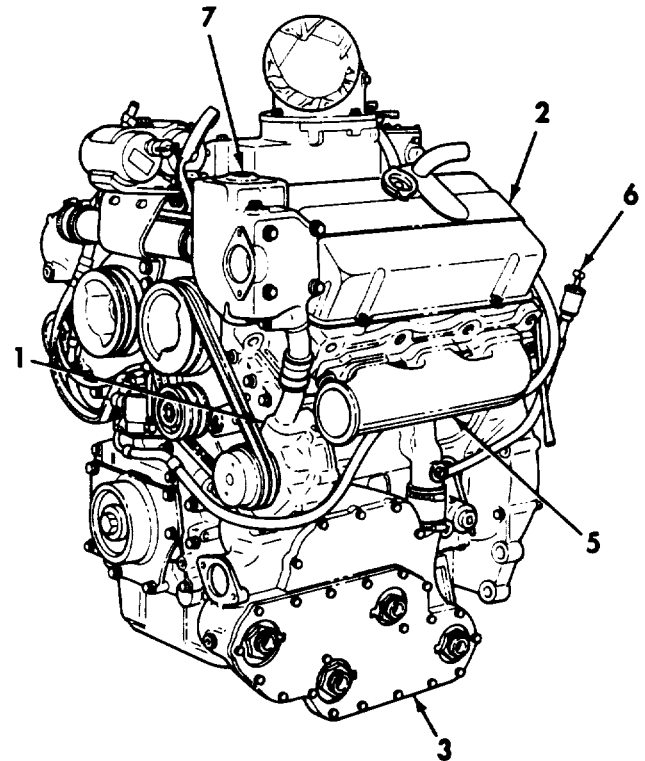


RIGHT REAR VIEW

MODEL 5063-539L

1-8. LOCATION AND DESCRIPTION OF COMPONENTS

- a. **Water Pump (1).** 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.
- b. **Valve Rocker Covers (2).** Encloses the valve and injector rocker arm mechanisms located on top of cylinder heads.
- c. **Engine Oil Cooler (3)** . 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.
- d. **Transmission Oil Cooler (4).** Models 5063-5393 and 5063-539L has a separate transmission oil cooler mounted on left side of engine block, H uses engine coolant to cool transmission oil.
- e. **Exhaust Manifolds (5).** Attached directly to cylinder heads, For all except model 5063-5299, they route exhaust gases through attached exhaust piping to the turbocharger.
- f. **Liquid Level Gage (Oil) Rod (6).** 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. On models 5063-5395, 5063-5398, and 5063-539F, it is mounted on the middle of the right cylinder head, It measures the liquid level in the oil pan.
- g. **Thermostat and Housing Assembly (7).** 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.



1-8. LOCATION AND DESCRIPTION OF COMPONENTS (Cont)

h. **Oil Filter (8).** 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.

i. **Governor (9).** 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.

j. **Oil Pan (10).** Mounted on the bottom of the cylinder block. It provides a reservoir for engine oil.

k. **Starter (11).** Mounted on right side of flywheel housing. It is an electric starter and engages the flywheel ring gear.

l. **Flywheel (12).** Mounted on the rear of the crankshaft. It is used to provide true alinement of transmission flex plate.

m. **Fuel Strainer (13).** 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. On models 5063-5395, 5063-5398, and 5063-539F, it is mounted near the right rear corner of the engine. It filters fuel to fuel pump.

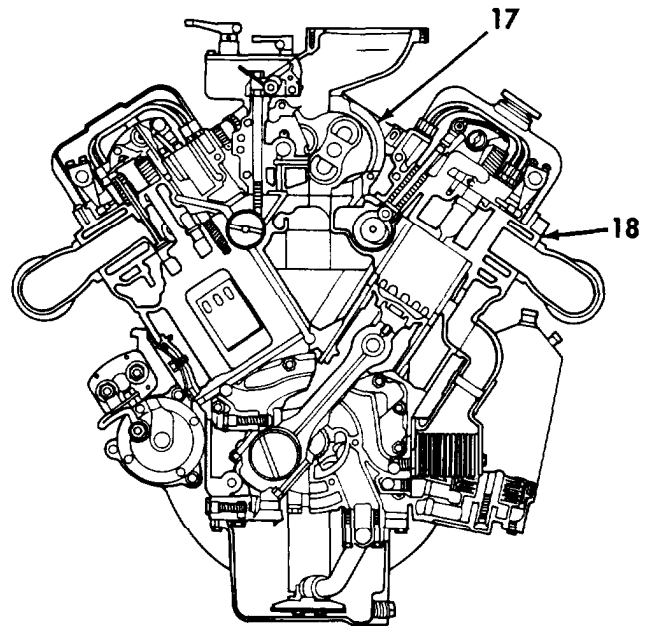
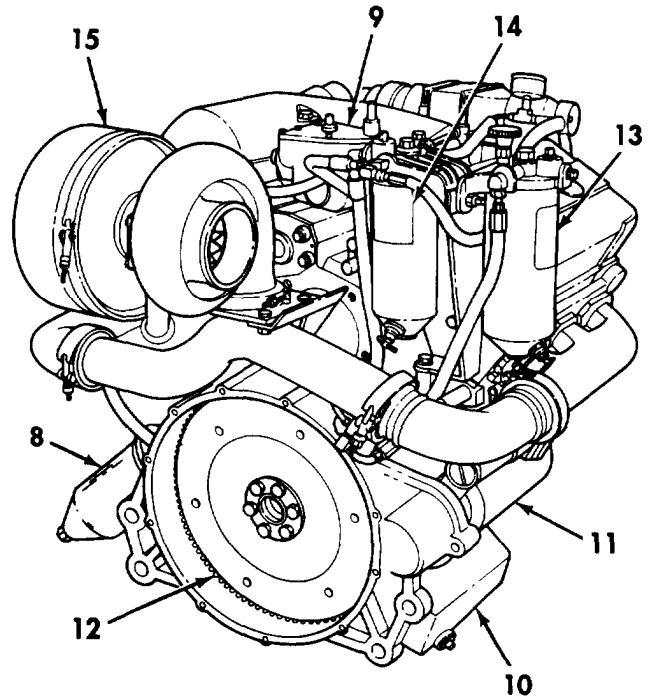
n. **Fuel Filter (14).** Mounted adjacent to the fuel strainer. It filters fuel to fuel inlet manifold.

o. **Turbocharger (15).** Mounted on the rear of the engine (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, 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.

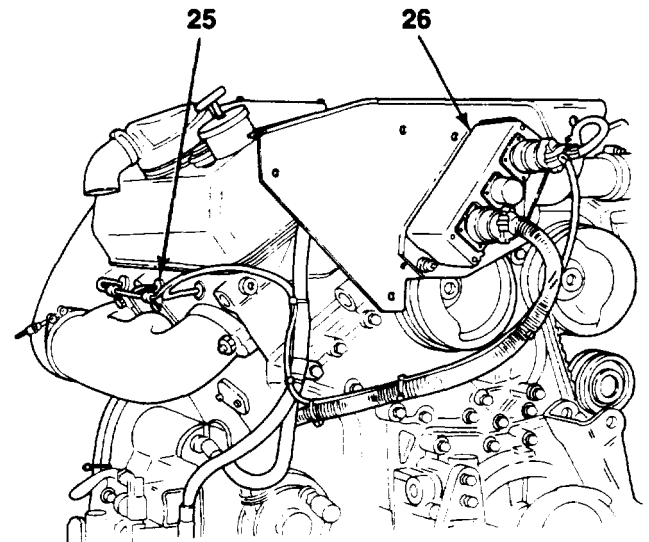
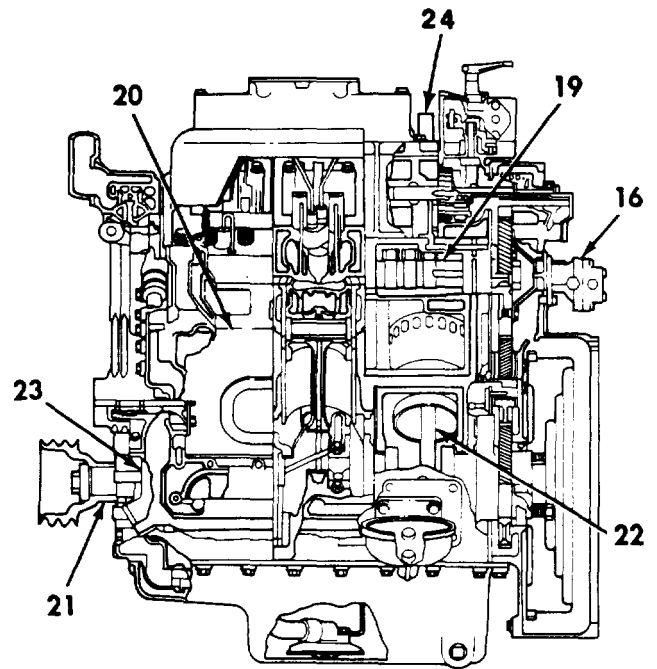
p. **Fuel Pump (16).** Attached to the flywheel housing and driven off the right side camshaft gear. It supplies low pressure fuel to fuel inlet manifolds in cylinder heads.

q. **Blower (17).** Mounted on top of the cylinder block. It supplies a constant volume of fresh air per revolution to the cylinders.

r. **Cylinder Heads (18).** Mounted on top of each cylinder bank. They contain fuel manifolds, exhaust valves, injectors, and injector and valve operating mechanisms.



- s. **Camshafts (19).** Located on top of each cylinder bank. They actuate injector and exhaust valve operating mechanisms.
- t. **Cylinder Block (20).** Being the main structural part. It provides rigidity and ensures alinement of all load bearing assemblies.
- u. **Crankshaft (21).** Attached to the bottom of the cylinder block. It transfers the engine load through the flywheel and supplies oil to piston assemblies.
- v. **Piston and Connecting Rod Assemblies (22).** Three assemblies are located in each bank. Pistons are cooled and lubricated by oil pressure fed up through drilled connecting rods.
- w. **Oil Pump (23).** Mounted inside the lower front engine cover. It pumps oil throughout the engine for lubrication and cooling.
- x. **Bypass Valve (24).** 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.
- y. **Glow Plugs (25).** They improve cold weather stability by heating the combustion chamber of each cylinder. The glow plugs screw into the cylinder head and protrude into the combustion chamber for model 5063-539L.
- z. **Glow Plug Controller (26).** 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.



1-9. DIFFERENCES BETWEEN MODELS

TABLE 1-1. COMPONENT DIFFERENCES BETWEEN MODELS

Component	Model 5063-5299	Model 5063-5392	Model 5063-5393	Model 5063-5395	Model 5063-5398	Model 5063-539F	Model 5063-539L
Cylinder Block	Cast Iron	Cast Iron	Cast Iron	Cast Iron	Aluminum	Cast Iron	Cast Iron
Turbocharger Mounting	-	On Blower	Rear	Rear	Rear	Rear	Rear
Piston and Con. Rod Assembly	Trunk	Crosshead	Crosshead	Trunk	Trunk	Crosshead	Crosshead
Throttle Delay	No	Yes	Yes	Yes	Yes	Yes	Yes
Engine Oil Cooler	18 Plate	18 Plate	18 Plate	18 Plate	18 Plate	16 Plate	18 Plate
Transmission Oil Cooler	10 Plate 14 Plate	18 Plate	Tubes in Shell	-	-	-	Tubes in Shell
Engine Front Mount	Trunnion	Trunnion and Bracket	Bracket	Trunnion	Trunnion	Trunnion	Bracket
Fuel Filter and Strainer Location	Remote	Left Rear	Left Side	Right Rear	Right Rear	Right Rear	Left Side
Crankshaft Front End	-	Hub	-	Pulley	Pulley	Pulley	-
Rocker Arm Covers	Stamped	Cast w/Breather	Cast w/Breather	Stamped w/Breather	Stamped	Cast w/Breather	Cast w/Breather
Oil Filter	Remote	Upper Left Rear	Lower Left Side	Lower Left Side	Lower Left Side	Lower Left Side	Lower Left Side
Air Box Heater	Yes	Yes	Yes	Yes	Yes	Yes	No
Glow plug and Controller	No	No	No	No	No	No	Yes

1-10. EQUIPMENT DATA

GENERAL SPECIFICATIONS

Type	Diesel, two-cycle
Manufacturer	Detroit Diesel Corporation*
Models	5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L
Number 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
Number of Main Bearings	4

ENGINE SPEED RATINGS

Maximum Governed Speed, Full-Load	2800 RPM
Idle Speed	600-700 RPM
Maximum No-Load Speed	2950-2990 RPM

ENGINE LUBRICATION SYSTEM

Total Capacity (with Filters)	40 qt (38 L)
Operating Pressure (at 2800 RPM)	50-70 PSI (345-483 kPa)
Minimum Operating Pressure	30 PSI (207 kPa)
Normal Operating Temperature	200-250° (93-121°C)
Oil Pump	Gear type

FUEL SYSTEM

Fuel Pump	Gear type
Supply Pressure (to Injectors)	50-70 PSI (345-483 kPa)

COOLING SYSTEM

Type	Liquid
Normal Operating Temperature	160-185°F (74-85°C)
Coolant Flow (at 2800 RPM)	143 GPM (541 L/min)

* Formerly Detroit Diesel Allison Division of GMC

1-10. EQUIPMENT DATA (Cont)

TABLE 1-2. ENGINE RATING DATA							
	Model 5063-5299	Model 5063-5392	Model 5063-5393	Model 5063-5395	Model 5063-5398	Model 5063-539F	Model 5063-539L
Maximum Brake Horsepower (at 2800 RPM)	210	275	275	300	300	300	275
Turbocharger		TV7303	TV7303	TV8104	T1900 TV8104	IV8104	TV7311
Injectors	N50	5C55	5C55	N70	N70	N70	5C55
Compression Ratio	21:1	18:1	18:1	17.5:1	17.5:1	18:1	18:1

TABLE 1-3. ENGINE PHYSICAL DATA							
	Model 5063-5299	Model 5063-5392	Model 5063-5393	Model 5063-5395	Model 5063-5398	Model 5063-539F	Model 5063-539L
Length - in. (cm)	32.0 (81.3)	39.0 (99.1)	39.0 (99.1)	44.5 (113.0)	44.5 (113.0)	44.5 (113.0)	39.0 (99.1)
Width - in. (cm)	35.0 (88.9)	36.5 (92.7)	40.0 (101.6)	36.6 (93.0)	36.6 (93.0)	36.6 (93.0)	40.0 (101.6)
Height - in. (cm)	44.4 (112.8)	41.5 (105.4)	42.8 (108.7)	38.5 (97.8)	38.5 (97.8)	38.5 (97.8)	42.8 (108.7)
Weight - lb. (Kg)	1335 (605.6)	1695 (768.8)	1745 (791.5)	1390 (630.5)	1134 (514.4)	1390 (630.5)	1745 (791.5)

Section III. PRINCIPLES OF OPERATION

Contents	Para	Page
Engine Systems	1-11 . . .	1-13
Operational Description	1-12 . . .	1-14

1-11. ENGINE SYSTEMS

a. General. The diesel engine is an internal combustion power unit where the heat energy of fuel is converted into work energy inside the cylinder. In a 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.

b. Fuel System. The fuel system consists of a fuel pump, strainer (prima 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.

c. 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.

d. 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.

e. 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 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.

1-11. ENGINE DESCRIPTION (Cont)

f. 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, 5063-5395, 5063-539F 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.

g. Electrical System.

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

(2) *Starter.* 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.

(3) *Air Box Heater.* 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.

(4) *Glow Plug Cold Start System.* 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,

h. 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.

i. 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.

1-12. OPERATIONAL DESCRIPTION

a. 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 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.

b. 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.

c. 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.

d. 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.

e. 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.

CHAPTER 2 GENERAL REPAIR AND ENGINE PREPARATION PROCEDURES

Section I. GENERAL INFORMATION

2-1. GENERAL. This chapter provides general maintenance practices of engine repair, removal and installation of engine accessories required to install the engine on maintenance stand, removal and installation of engine from container, installation and removal of engine onto the maintenance stand, and repair of Unit Support components removed in this chapter.

Section II. GENERAL MAINTENANCE PROCEDURES

2-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS

a. Cleaning:

- (1) General. 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 in paragraphs (2) thru (5) below. See TM 9-247 for additional information pertaining to cleaning.
 - (a) Clean all parts before inspection, after repair, and before assembly.
 - (b) Hands should be kept free of grease which can collect dust and dirt.
 - (c) After cleaning, all parts should be covered or wrapped in plastic to protect them from dust and dirt.
- (2) Castings.

WARNING

Dry cleaning solvent P-D-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 (36-50°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.

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

2-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS (Cont)

WARNING

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

(c) Use filtered compressed air to blow out and dry all tapped holes in castings.

(3) Oil Passages.

(a) Clean passages with wire or suitable probe to break up any sludge or gum deposits.

(b) Wash passages by flushing with dry cleaning solvent.

(c) Dry passages by blowing them out with compressed air.

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.

(4) Oil Seals, Cables, and Flexible Hoses. Clean oil seals, cables, and flexible hoses with soap, water, and a stiff brush.

(5) Ball Bearings.

(a) After removing surface oil and gum deposits, place bearings in hot oil (140°F) to loosen congealed oil and grease.

(b) Wipe bearing dry; do not use compressed air.

(c) After cleaning, coat bearings with a light film of oil and wrap in paper until parts are inspected and assembled.

(d) See TM 9-214 for information on care and maintenance of bearings.

b. Inspection.

(1) General. 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 standards found in App G 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.

(2) Castings.

(a) Inspect all ferrous and nonferrous castings for cracks using a magnifying glass and a strong light.

- (b) 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.
 - (c) Inspect machined surfaces of castings for nicks, burrs or raised metal.
 - (d) Mark damaged areas for repair with chalk or lumber crayon.
 - (e) Check all mating flanges on housings and supports for warpage with a straight edge or a surface plate.
 - (f) Check all mating flanges for discoloration which may indicate persistent leakage.
 - (g) inspect all pipe plug and cap screw tapped openings for damaged or stripped threads.
 - (h) Check all castings for conformance to applicable repair standards in App G.
- (3) Ball Bearings. See TM 9-214 for inspection of bearings. Check all bearings for conformance to applicable repair standards in App G.
- (4) Studs. Inspect all studs for stripped or damaged threads, bent or loose condition, and evidence of stretching.
- (5) Gears.
- (a) Inspect all gears for cracks using a magnifying glass and a strong light.
 - (b) Inspect all gear teeth for wear, sharp fins, burrs, and galled or pitted surfaces.
 - (c) Check all gears for conformance to applicable repair standards in App G.
- (6) Bushing and Bushing Type Bearings.
- (a) 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.
 - (b) Inspect bushing and bushing type bearings for wear, burrs, nicks, or out-of-round condition.
 - (c) Check for dirt in lubrication holes or grooves of bushings or bushing type bearings.
 - (d) Holes and grooves must be clean and free from damage to insure proper lubrication.
 - (e) Check all bushings and bushing type bearings for conformance to applicable repair standards in App G.
- (7) Oil Seals. Metal encased oil seals should not be replaced unless inspection indicates damage.
- (a) Inspect feather edge of oil seal for damage.
 - (b) Check seal for loss of softness and spring.
- (8) Core Hole Plugs.
- (a) Inspect core hole plugs for evidence of leakage.
 - (b) Replace plugs if leaking or damaged.

2-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS (Cont)

c. Repair

- (1) General. 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.

CAUTION

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

- (2) Castings.
 - (a) Replace all castings that are cracked or do not conform to tolerances specified in repair App G.

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (b) Repair minor damage to machined surfaces with a fine file, emery cloth, or crocus cloth dipped in cleaning solvent.
- (c) Replace all castings on which machined surfaces are burred or nicked to the point of impairing subsequent assembly or operation.
- (d) Repair minor warpage of a mounting 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.
- (e) 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.

- (f) Repair damaged pipe or cap screw threads in tapped holes with a thread tap.
- (3) Ball Bearings.
 - (a) Replace all galled, pitted, or damaged ball bearings and any that do not conform to tolerances specified in App G.

- (b) See TM 9-214 for maintenance of bearings.
- (4) Studs.
- (a) Replace all bent or loose studs or studs showing evidence of stretching.
 - (b) Repair minor thread damage with a thread chaser.
 - (c) Remove and replace studs as outlined in (d) and (e) below.
 - (d) Removal.
 - 1. Using stud extractor, back studs out slowly to avoid heating and possible seizure.
 - 2. When studs are broken off too short to use stud extractor, drill stud and extract with an easy out remover.
 - 3. Short studs may also be removed by welding a bar or nut to stud and removing with a wrench.
 - (e) Replacement.
 - 1. Only standard studs are supplied for replacement in steel or cast iron castings.
 - 2. Unless threads in casting are damaged beyond repair, use standard studs.
 - 3. If threaded openings are damaged and retapping will not clean up threads, drill and tap opening in casting and install a threaded insert.

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 (App C, Item (4), MIL-A-907) applied on the threads before the studs are installed in casting. Thread replacement stud into opening slowly to prevent overheating.

- (5) Gears.
- (a) Replace all gears that are cracked, worn, pitted, galled or do not conform to tolerances specified in App G.
 - (b) Remove sharp fins and burrs from gear teeth with crocus cloth dipped in cleaning solvent.
- (6) Bushing and Bushing Type Bearings. When bushings and bushing type bearings are damaged or worn beyond specified limits (App G), general associated parts must also be replaced. Reference to (a) and (b) below will be made in Chapter 4 for the particular part in which replacement of bushings and bushing type bearings is required.
- (a) Removal. Remove bushing and bushing type bearings by pressing out with a suitable arbor press or with special tools provided. (Refer to App B for listing of special tools and equipment).

2-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS (Cont)

(b) Installation.

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

(7) Oil Seals. Oil seals must be replaced during component repair.

(a) Removal. Press or pry damaged oil seal from casting or adapter. Use care not to damage bore in casting or adapter.

(b) Repair.

1. 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.
2. Remove slight nicks, burrs and scratches from bore in casting or adapter with crocus cloth dipped in cleaning solvent.

(c) Installation. Install new oil seal in bore of casting or adapter using proper oil seal installer tool.

d. Disassembly/Assembly Instructions.

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

(2) Precautionary Rules.

- (a) Cleanliness is essential in all component assembly operations.
- (b) Dirt and dust, even in minute quantities, are abrasive.
- (c) Parts must be cleaned as specified and kept clean.
- (d) Wrap or cover parts and components when assembly procedures are not immediately completed.
- (e) Coat all bearings and all contact surfaces with engine oil OE/HDO-15/40 (App C, Item 26) to insure lubrication of parts during initial engine starting.
- (f) Replace all gaskets and preformed packings removed in disassembly. Clean and remove all traces of gasket material from surfaces.
- (g) Store all fastening hardware (nuts, bolts, screws, lockwashers, and flat washers) in or with the related component to assist in reassembly.

**Section III. REMOVAL AND INSTALLATION OF EXTERNAL COMPONENTS
PRIOR TO INSTALLATION ON MAINTENANCE STAND**

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2-3. CONTAINER TOP REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

AH

TOOLS AND SPECIAL TOOLS

Tool set, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 1 Seal (App F, Item 166) (model 5063-5299)

MATERIALS/PARTS

- 1 Seal (App F, Item 165) (models 5063-5299, 5063-5392, 5063-5393, and 5063-539L)
- 1 Seal (App F, Item 164) (models 5063-5395, 5063-5398, and 5063-539F)

EXPENDABLE/DURABLE SUPPLIES

Desiccant (App C, Item 12)

PERSONNEL REQUIRED: 2

a. Removal

WARNING

Wear safety glasses and stand clear of air release ports when purging air from container. Make certain air pressure is fully vented before disassembly. Injury to eyes and inner ears can result from failure to properly vent container before disassembly.

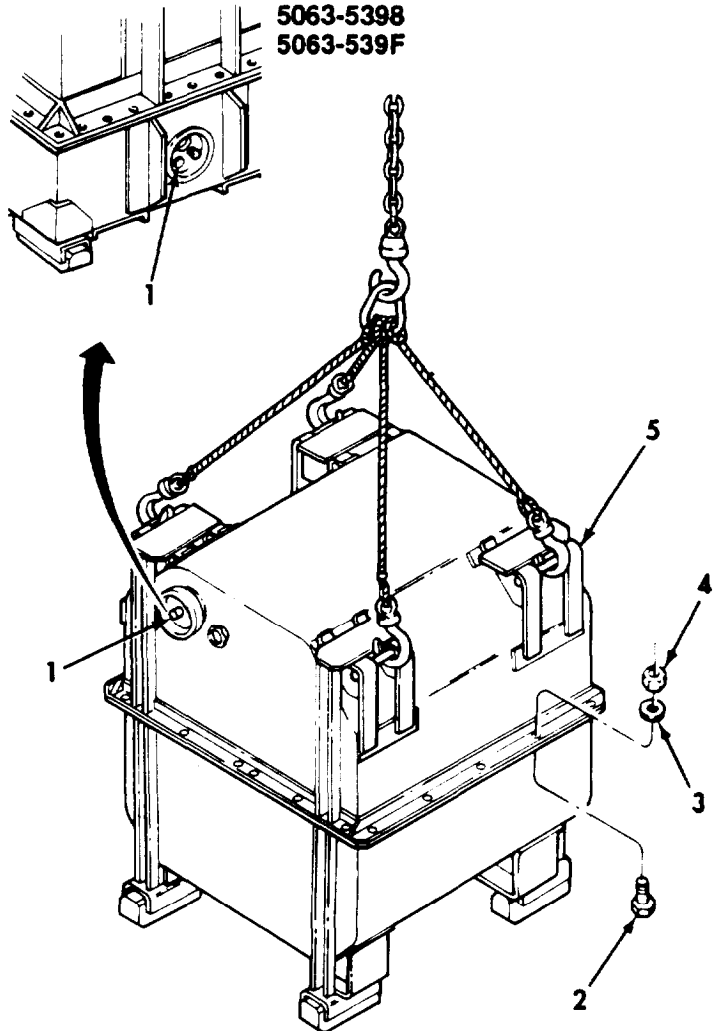
- (1) Press relief valve (1) to release pressure in shipping container.

NOTE

- Container (NSN 8145-00-138-7809) for model 5063-5299 uses twenty screws, no flat washers, and twenty nuts.
- Container (NSN 2815-01-232-9447) for models 5063-5299, 5063-5392, 5063-5393, and 5063-539L uses twenty-four screws, twenty-four flat washers, and twenty-four nuts.
- Container for models 5063-5395, 5063-5398, and 5063-539F, uses forty screws, forty flat washers, and forty nuts.

- (2) Remove screws (2), flat washers (3), and nuts (4) from shipping container,

**MODELS:
5063-5395
5063-5398
5063-539F**



WARNING

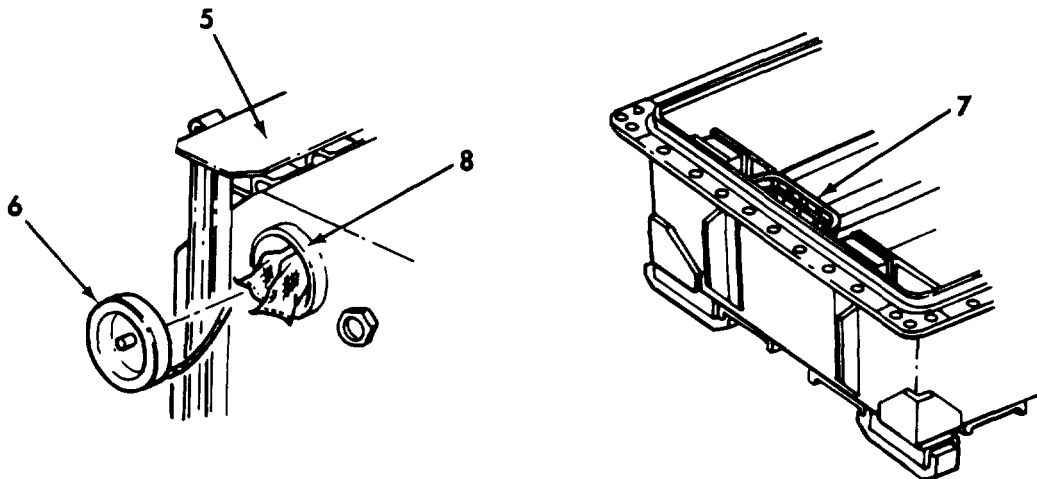
Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension. Equipment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

- (3) Using a sling, remove upper container half (5).

NOTE

Container for models 5063-5395, 5063-5398, and 5063-539F, has no access cover (6) and desiccant is stored in a wire basket (7) in bottom of container.

- (4) Open access cover (6) in upper container half (5) and remove desiccant bags. Discard desiccant.

**b. 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) for models 5063-5299, 5063-5392, 5063-5393 and 5063-539L requires 128 units of Class 1 desiccant.
- Container for models 5063-5395, 5063-5398, and 5063-539F, requires 128 units of Class 1 desiccant. It has no access cover. Store desiccant in a wire basket (7) in bottom of container.

- (1) Install Class 1 desiccant through access port (8) in upper container half (5) and screw access cover (6) onto port.

2-3. CONTAINER TOP REMOVAL/INSTALLATION (Cont)

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

WARNING

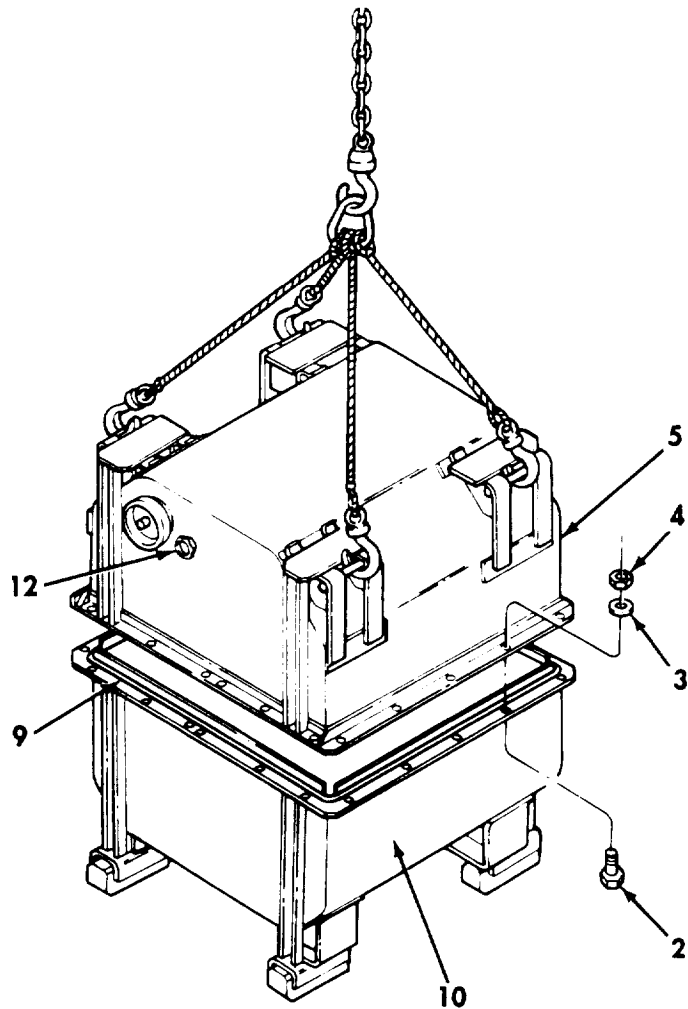
Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension. Equipment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

CAUTION

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 twenty screws, no flat washers, and twenty nuts, Torque screws to 54-59 lb-ft (76-83 N•m),
 - Container (NSN 2815-01-232-9447) for models 5063-5299, 5063-5392, 5063-5393, and 5063-539L uses twenty-four screws, twenty-four flat washers, and twenty-four nuts. Torque screws to 31-37 lb-ft (42-50 N•m).
 - Container for models 5063-5395, 5063-5398, and 5063-539F, uses forty screws, forty flat washers, and forty nuts. Torque screws to 60-70 lb-ft (84-95 N•m),
- (3) Using a sling, install upper container half (5), screws (2), flat washers (3), and nuts (4) on lower container half (10). Tighten screws progressively around perimeter of container. Torque screws to values noted above.

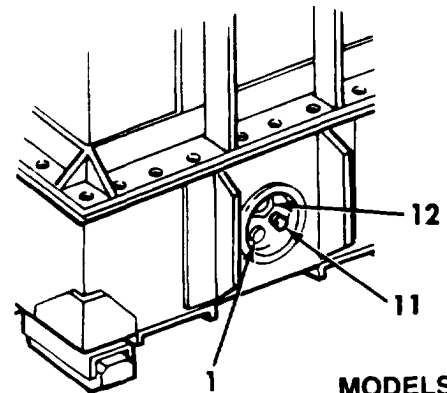
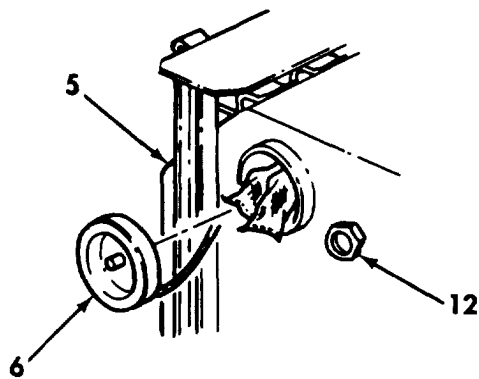


- (4) On container for models 5063-5395, 5063-5398, and 5063-539F, pressurize the container to 5 PSI (34 kPa) of dehydrated air using air intake valve (11).
- (5) Allow container to stand for a minimum of twelve hours. Then check humidity indicator (12) and verify that air pressure is maintained.

NOTE

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

- (6) If humidity indicator (12) is pink, remove container top, replace all desiccant bags, and replace container seal (9). Install container top and test container as indicated in steps (3) thru (5).



MODELS:
5063-5395
5063-5398
5063-539F

END OF TASK

2-4. TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODEL

5063-5393 5063-539L

MATERIALS/PARTS

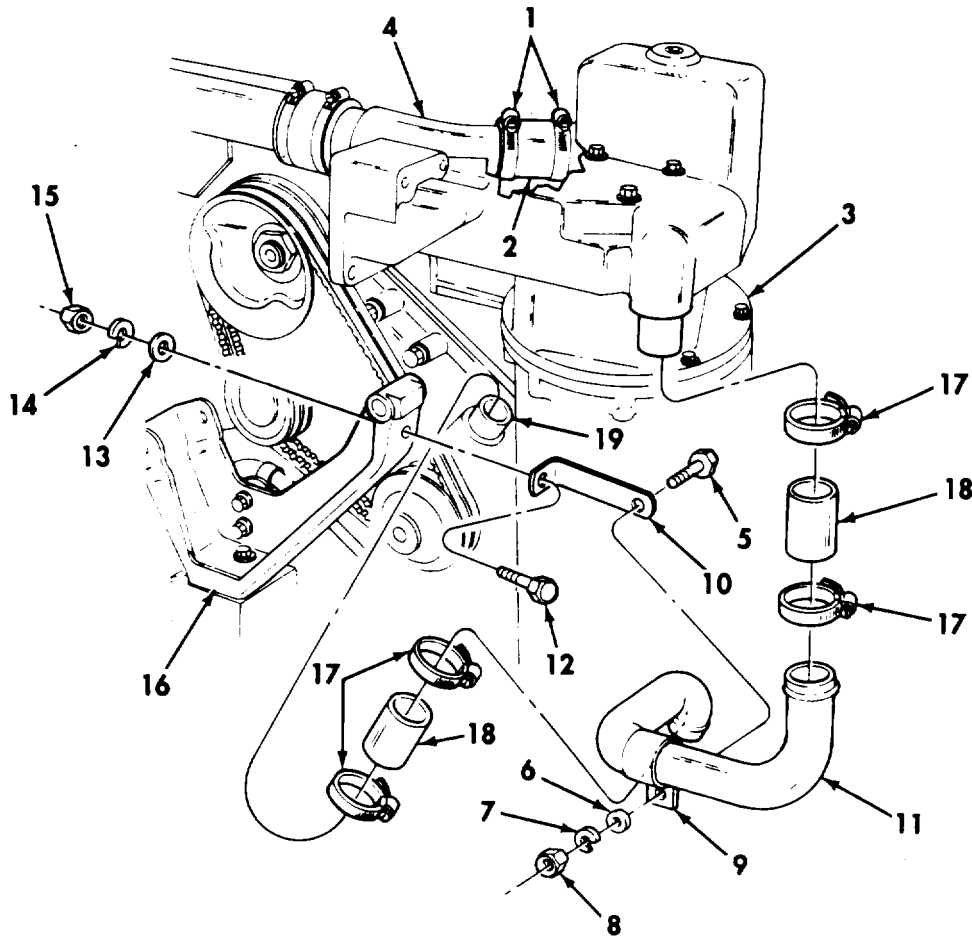
- 10 Lockwashers (App F, Item 98)
- 1 Lockwasher (App F, Item 99)
- 1 Lockwasher (App F, Item 100)
- 1 Gasket (App F, Item 87)

TOOLS AND SPECIAL TOOLS

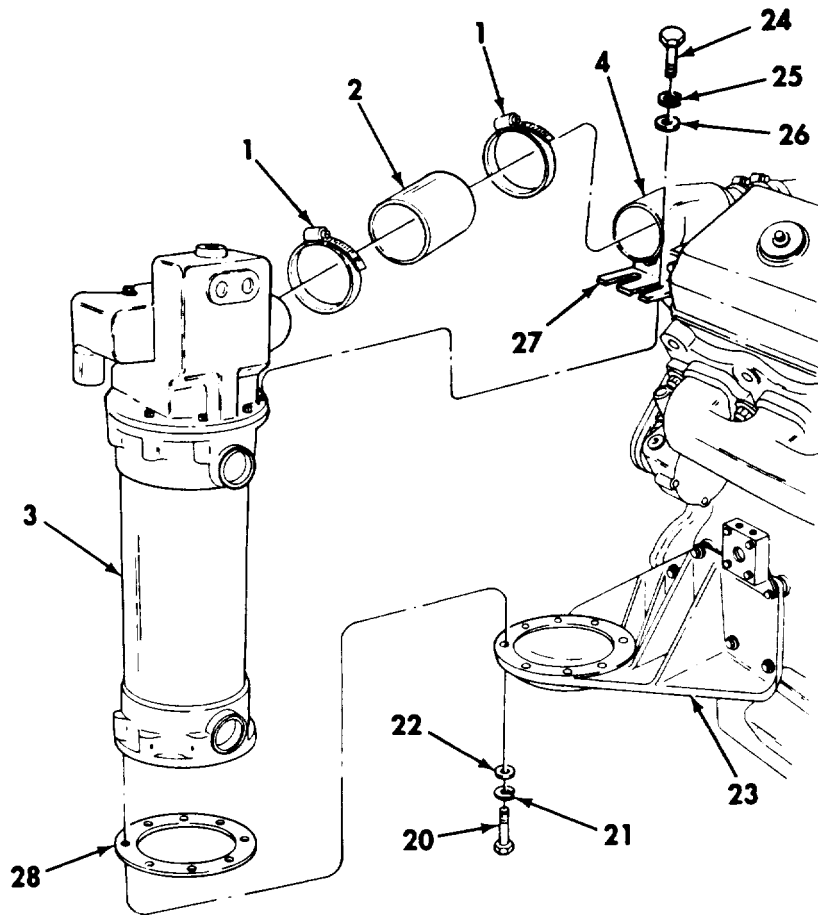
Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)

a. Removal

- (1) Loosen two hose clamps (1) on hose (2) between transmission oil cooler assembly (3) and water outlet housing (4).
- (2) Remove screw (5), flat washer (6), lockwasher (7), and nut (8) from clamp (9) and bracket (10) on tube (11). Discard lockwasher,
- (3) Remove bolt (12), bracket (10), flat washer (13), lockwasher (14), and nut (15) from fan support bracket (16). Discard lockwasher.



- (4) Loosen four hose clamps (17) on two hoses (18) on tube (11) between water pump (19) and transmission cooler top (3). Slide clamps and hoses onto tube and remove tube. Remove hoses and clamps from tube.



- (5) Remove eight screws (20), eight lockwashers (21), and eight flat washers (22) from bottom of transmission oil cooler bracket (23). Discard lockwashers.

WARNING

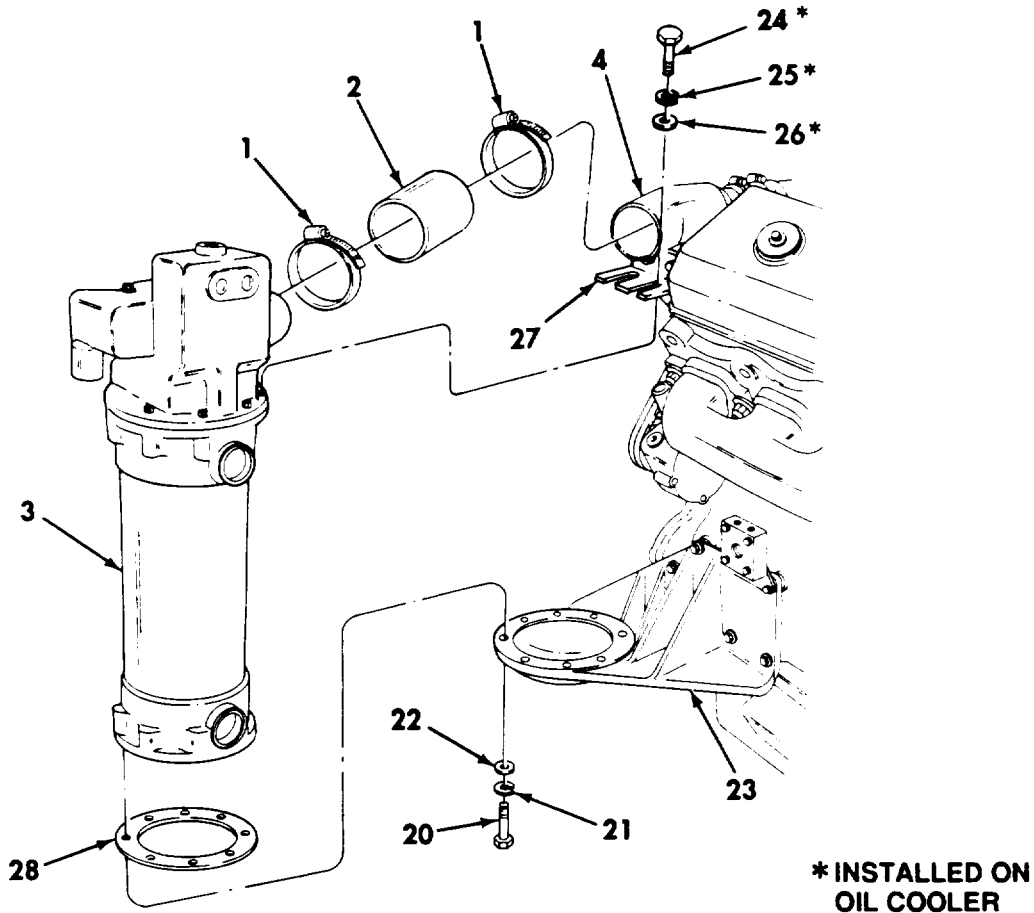
Transmission cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during removal.

- (6) Loosen two screws (24), two lockwashers (25), and two flat washers (26) securing bracket (27) to transmission oil cooler assembly (3). Remove transmission oil cooler assembly and gasket (28). Discard gasket.
- (7) Remove hose (2) and two clamps (1) from water outlet housing (4).

2-4. TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODELS 5063-5393, AND 5063-539L) (Cont)

b. Installation

- (1) Slide hose (2) and two clamps (1) onto water outlet housing (4).

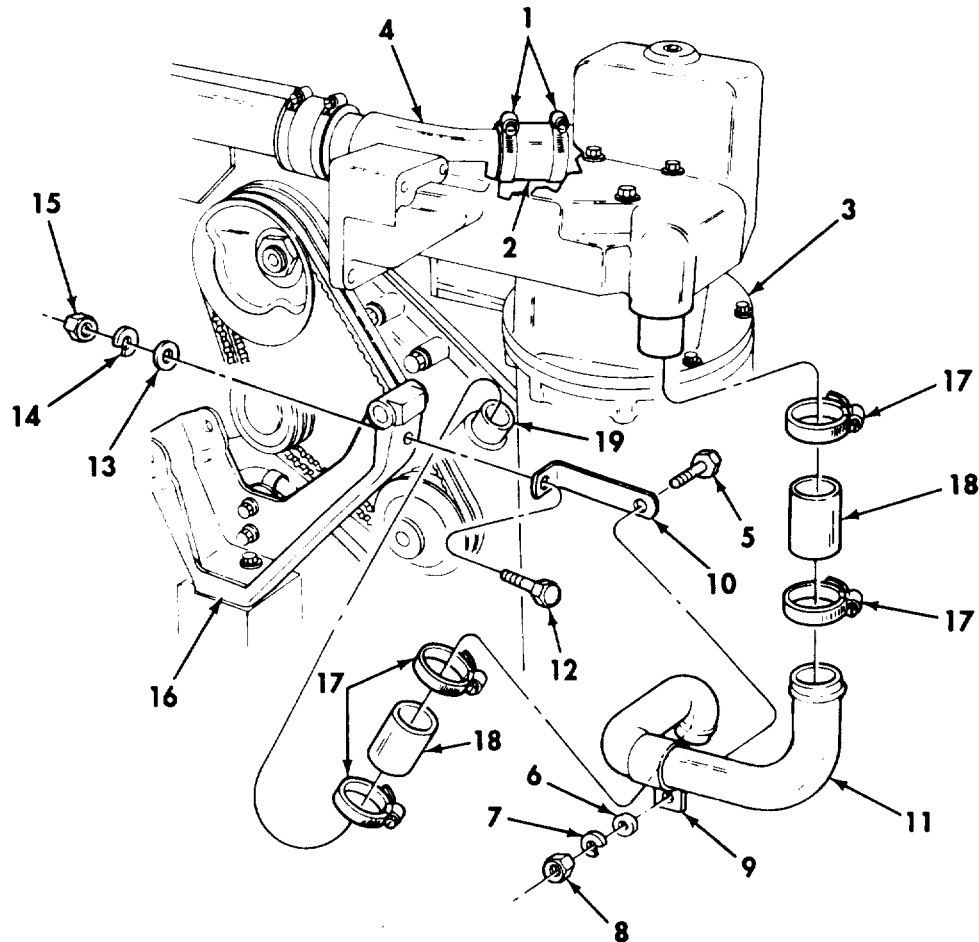


WARNING

Transmission cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during installation.

- (2) Place gasket (28) on transmission oil cooler bracket (23) and install transmission oil cooler assembly (3) on bracket with ports facing rear of engine,
- (3) Loosely install eight flat washers (22), eight lockwashers (21), and eight screws (20) securing bottom of transmission oil cooler assembly (3) to bracket (23).
- (4) Slide hose (2) and two clamps (1) over top of transmission oil cooler assembly (3) and tighten clamps.
- (5) Guide two flat washers (26), two lockwashers (25), and two screws (24) onto bracket (27).
- (6) Torque screws (20) and (24) to 13-17 lb-ft (18-23 N•m).

- (8) Slide two hoses (18) and four clamps (17) onto tube (11) and then over water pump (19) and transmission cooler (3) connections. Tighten clamps securely.



- (9) Install bracket (10), bolt (12), lockwasher (14), flat washer (13), and nut (15) to fan support bracket (16). Torque bolt to 30-35 lb-ft (41-47 N•m).
- (10) Install screw (5), clamp (9), flat washer (6), lockwasher (7), and nut (8) to bracket (10). Torque screw to 46-50 lb-ft (62-68 N•m).

END OF TASK

2-5. FUEL JUNCTION BLOCK AND LINES REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

MATERIALS/PARTS

2 Lockwashers (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

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

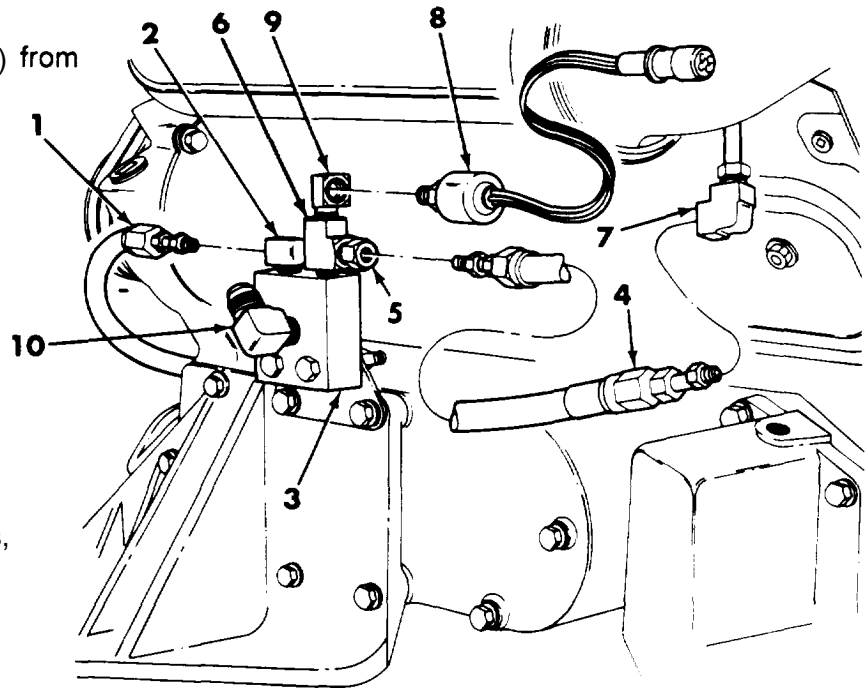
NOTE

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

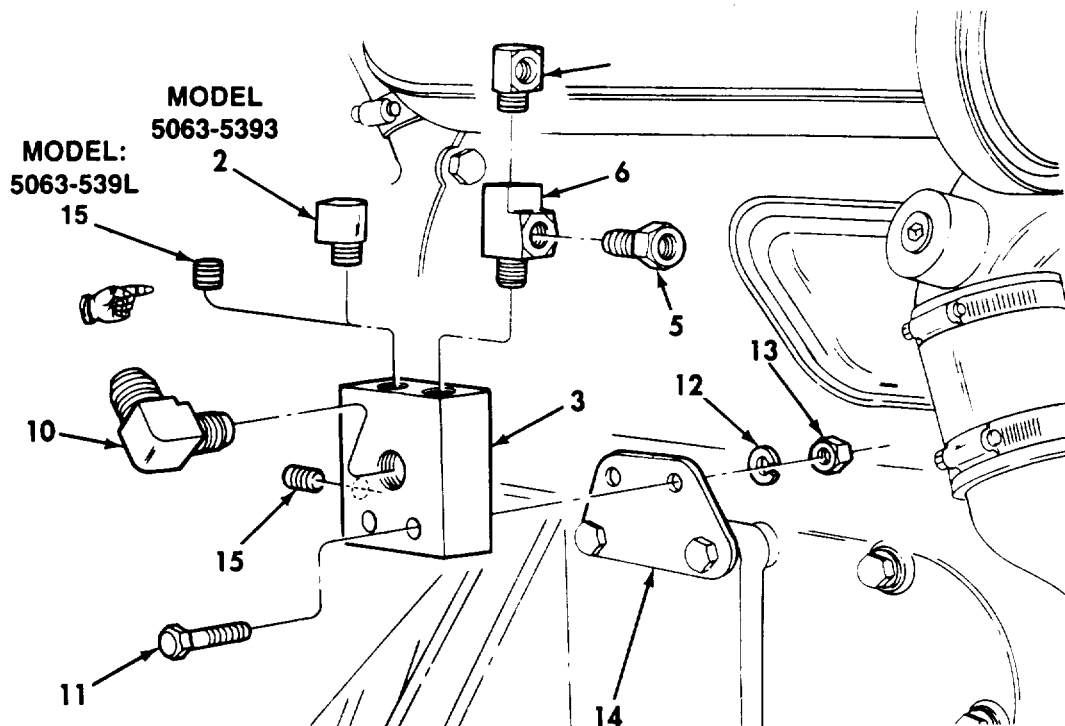
- (6) Remove elbows (2 and 10) and tee (6) from fuel junction block (3).
- (7) Remove two screws (11), two lockwashers (12), fuel junction block (3), and two nuts (13) from bracket (14). Discard lockwashers,

NOTE

Model 5063-539L has two plugs.



- (8) If necessary, remove plug (15) from fuel junction block (3).



b. Installation

- (1) Install two screws (11), fuel junction block (3), two lockwashers (12), and two nuts (13) on bracket (14). 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 (15) in fuel junction block (3).
- (3) Install tee fitting (6) in top of fuel junction block (3).

NOTE

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

- (4) On model 5063-5393, install elbow (2) in top of fuel junction block (3) and elbow (10) in side of junction block.
- (5) Install elbow (9) in top of tee fitting (6) and adaptor (5) in side of tee fitting.
- (6) Connect fuel hose (4) to adaptor (5) on fuel junction block (3) and to elbow (7). Tighten hose connection.
- (7) Install transducer (8) in elbow (9) on fuel junction block (3).
- (8) On model 5063-5393, connect fuel hose (1) to elbow (2) in fuel junction block (3). Tighten hose connection.

END OF TASK

2-6. COOLANT PUMP AND IDLER PULLEY ASSEMBLY REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation c. Adjustment

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Tension meter, dial indicator (App B, Item 98)
 Straight edge (App B, Item 96)
 Wrench, torque (App B, Item 116)

MATERIALS/PARTS

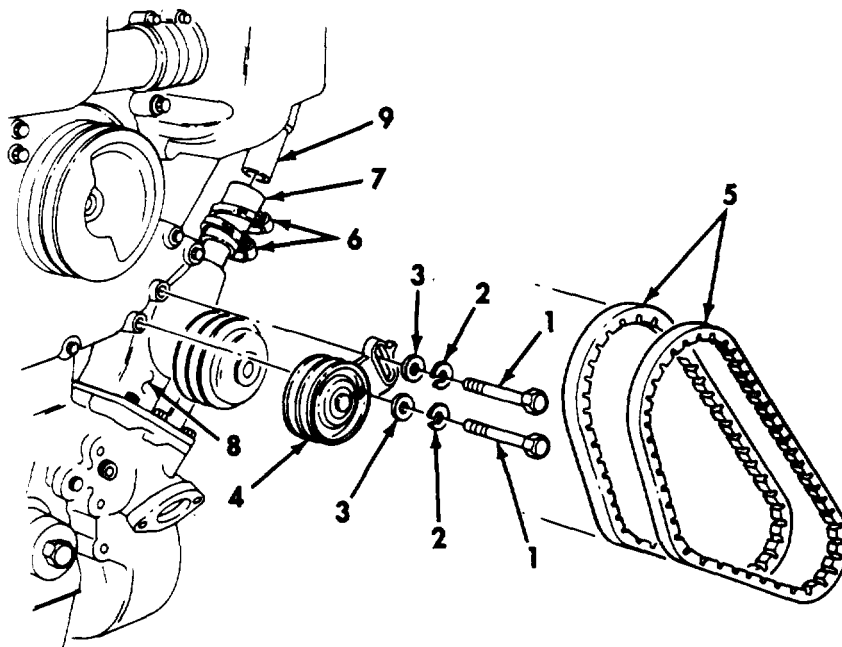
- 1 Gasket (App F, Item 59)
- 2 Lockwashers (App F, Item 99)
- 4 Lockwashers (App F, Item 98)

EQUIPMENT CONDITION

Para Description
 2-4 Water by-pass hose removed
 (models 5063-5393 and 5063-539L)

a. Removal

- (1) Remove two screws (1), two lockwashers (2), and two flat washers (3) securing idler pulley assembly (4) to engine. Discard lockwashers.
- (2) Remove idler pulley assembly (4) and two drive belts (5).



NOTE

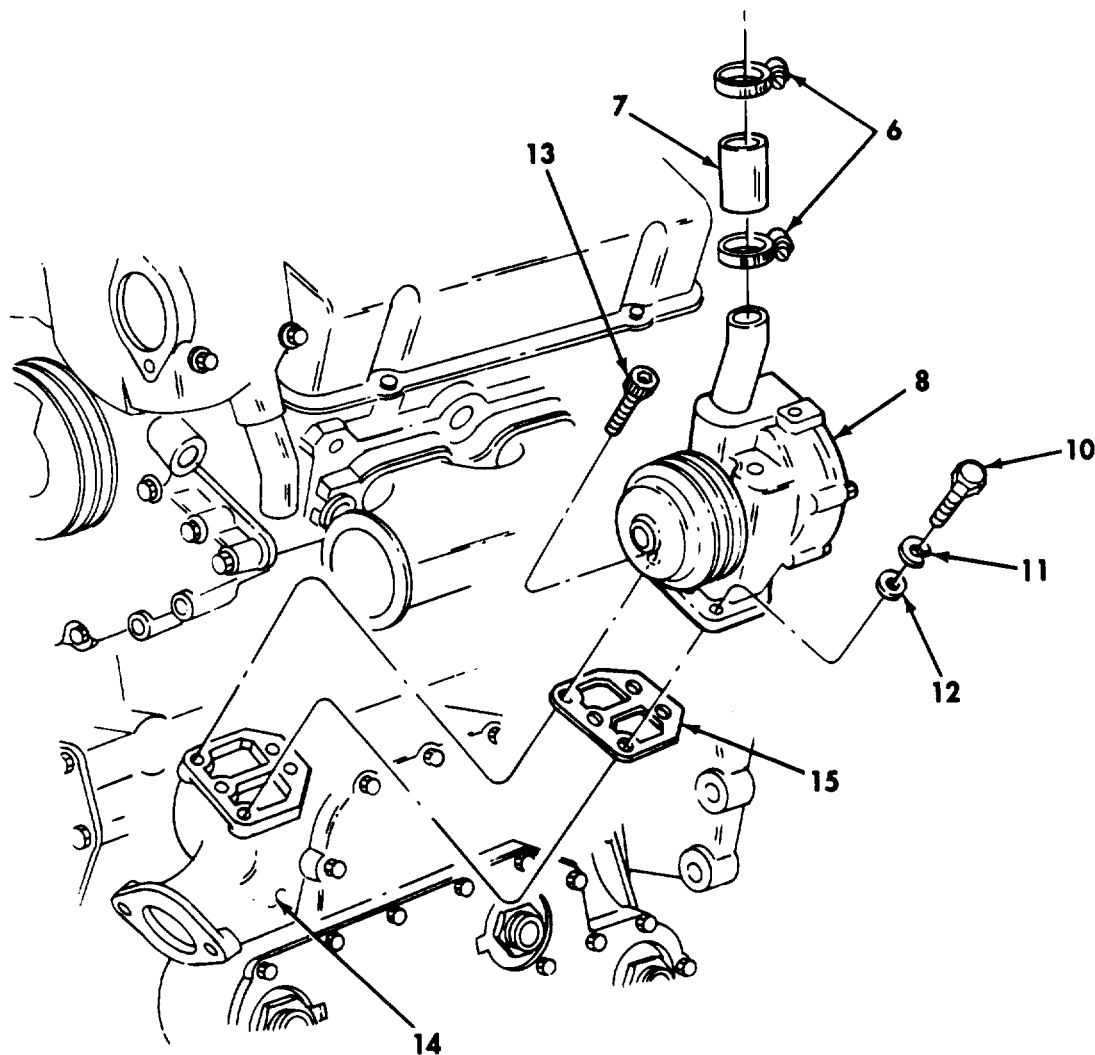
For models 5063-5393 and 5063-539L, water by-pass hose and two clamps were removed in Para 2-4.

- (3) Loosen two hose clamps (6) securing hose (7) to coolant pump (8) and water by-pass tube (9). Slide hose and clamps onto coolant pump.

NOTE

For models 5063-5393 and 5063-539L, 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 (refer to Para 2-5).

- (4) Remove four screws (10), four lockwashers (11), four flat washers (12), and socket head screw (13), securing coolant pump (8) to oil cooler (14). Discard lockwashers.



- (5) Remove coolant pump (8) and gasket (15). Discard gasket.

- (6) For all except models 5063-5393 and 5063-539L, remove hose (7) and two clamps (6) from coolant pump (8).

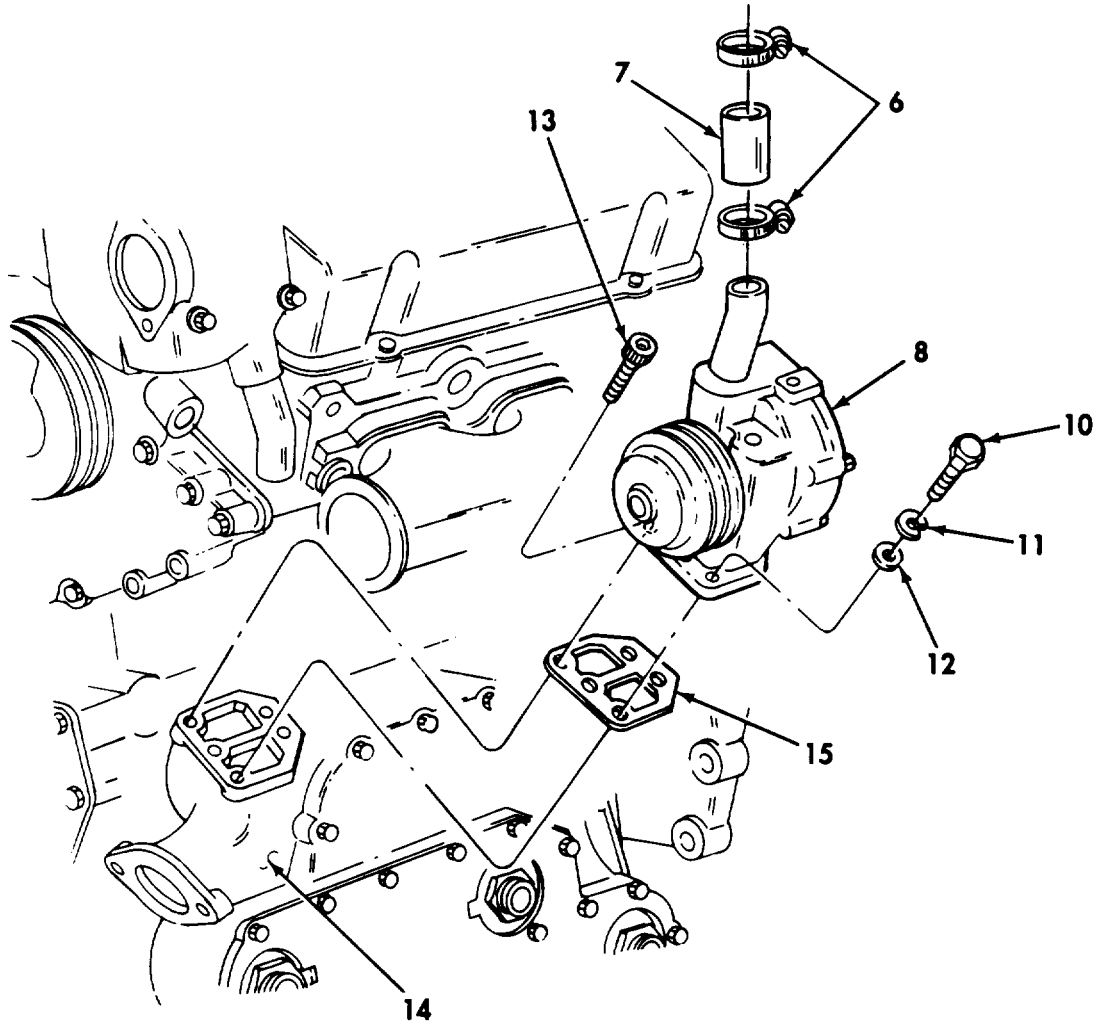
2-6. COOLANT PUMP AND IDLER PULLEY ASSEMBLY REMOVAL/INSTALLATION (Cont)

b. Installation

NOTE

For models 5063-5393 and 5063-539L, water by-pass hose and two clamps will be installed in Para 2-4.

- (1) Slide hose (7) and two clamps (6) onto coolant pump (8).
- (2) Position coolant pump gasket (15) to oil cooler (14).

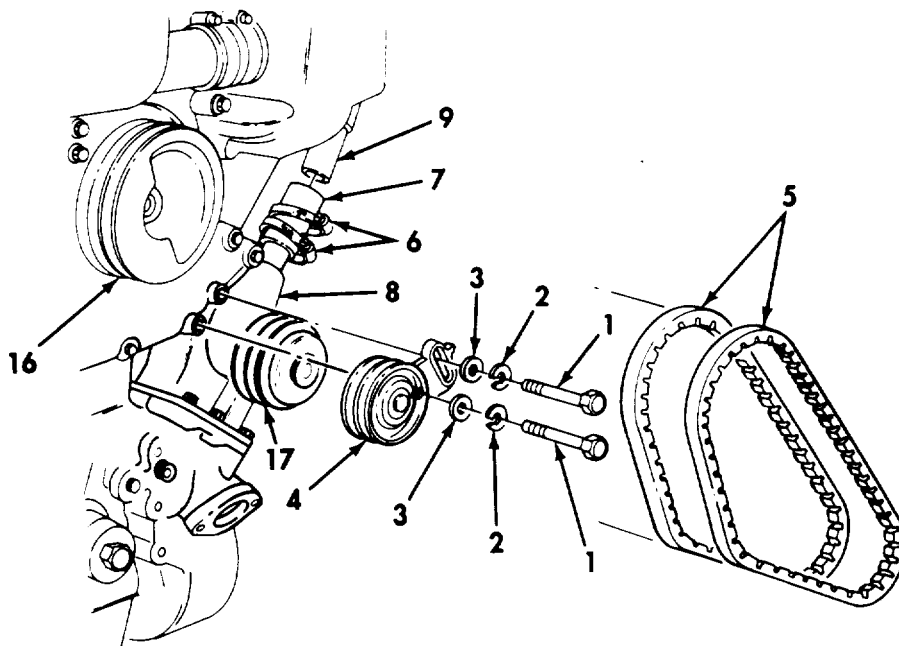


NOTE

For models 5063-5393 and 5063-539L, it will be necessary to install fuel line clamp under screw at front lower position when mounting coolant pump to oil cooler.

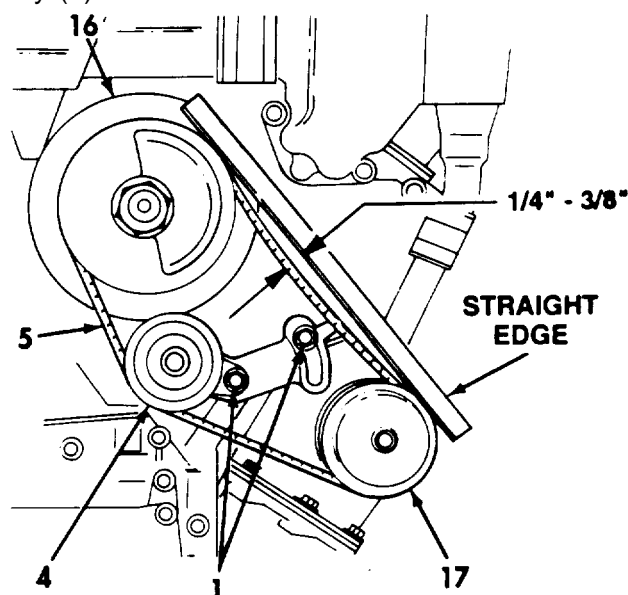
- (3) Install coolant pump (8), four flat washers (12), four lockwashers (11), four screws (10), and socket head screw (13) on oil cooler (14). Torque socket head screw and four screws to 13-17 lb-ft (18-23 N•m).

- (4) For all except models 5063-5393 and 5063-539L, slide hose (7) and two hose clamps (6) on coolant pump (8), onto water by-pass tube (9). Tighten clamps securely.
- (5) Install two drive belts (5) on left camshaft pulley (16) and coolant pump pulley (17).
- (6) Install idler pulley assembly (4), two flat washers (3), two lockwashers (2), and two screws (1)
- (7) If necessary, connect the fuel line, routed across the front of the coolant pump, to the fuel junction block (refer to Para 2-5).



c. Adjustment

- (1) Loosen two screws (1) on idler pulley assembly (4).
- (2) Pry upward on tang of idler pulley assembly (4) to get 1/4 to 3/8 inch deflection on drive belts (5) midway between pulleys (16 and 17) while applying a firm push with thumb. Tighten two screws (1).
- (3) Check for proper tension by using straight edge (18) to measure deflection across drive belts at pulleys (16 and 17). If tension meter is available, check for 40-50 lbs (173-217 N) tension. If necessary, readjust tension, and then torque two screws to 30-35 lb-ft (41-47 N•m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
 2-4 Install water by-pass hose (models 5063-5393 and 5063-539L)

2-7. OIL LEVEL GAGE ROD REMOVAL/INSTALLATION (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299

MATERIALS/PARTS

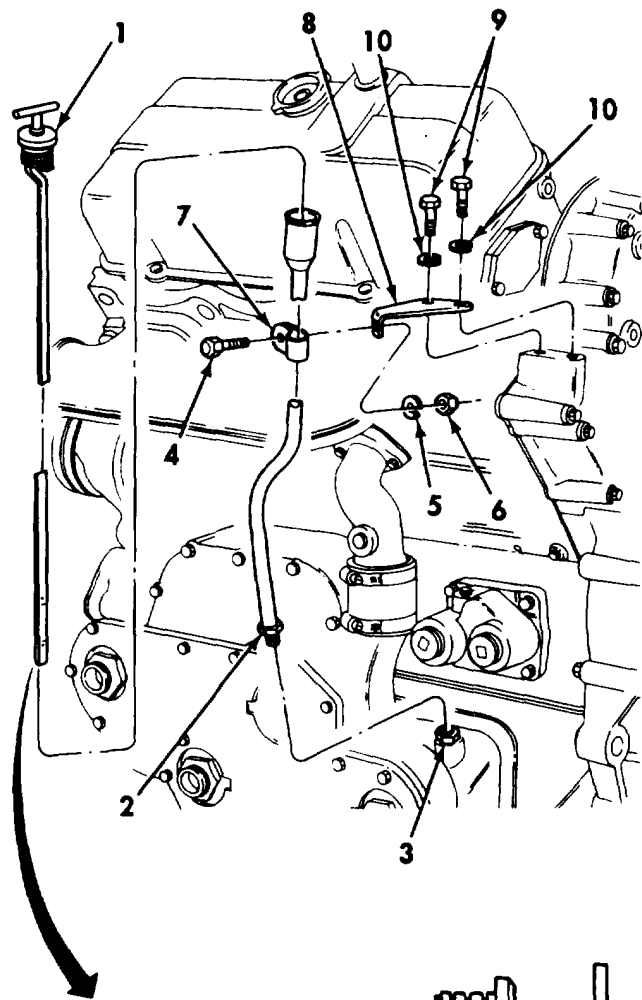
3 Lockwashers (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, item 107)
Torque wrench (App B, Item 116)

a. Removal

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



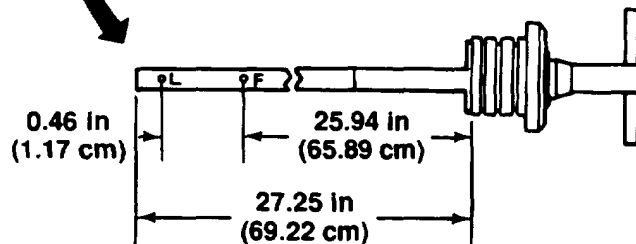
b. Installation

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

NOTE

Cut and mark new oil gage rod as shown.

- (5) Install oil gage rod (1) in tube assembly (2).



END OF TASK

2-8. OIL LEVEL GAGE ROD REMOVAL/INSTALLATION (MODEL 5063-5392)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392

MATERIALS/PARTS

1 Lockwasher (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

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

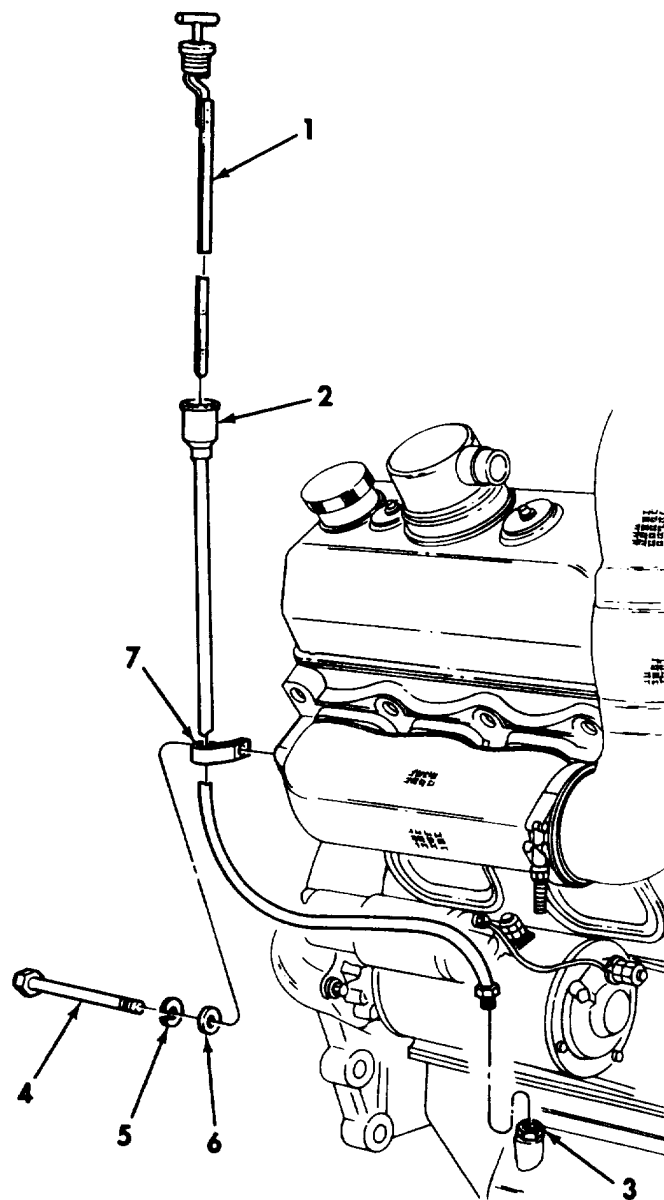
b. Installation

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

NOTE

Bolt (4) 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 (6), lockwasher (5), and bolt (4) through clip (7). Torque bolt to 30-35 lb-ft (41-47 N•m).
- (3) Tighten connection at adaptor (3) and tube assembly (2).
- (4) Install oil gage rod (1) in tube assembly (2).



END OF TASK

2-9. OIL LEVEL GAGE ROD REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

MATERIALS/PARTS

1 Nut, self-locking (App F, Item 106)

TOOLS AND SPECIAL TOOLS

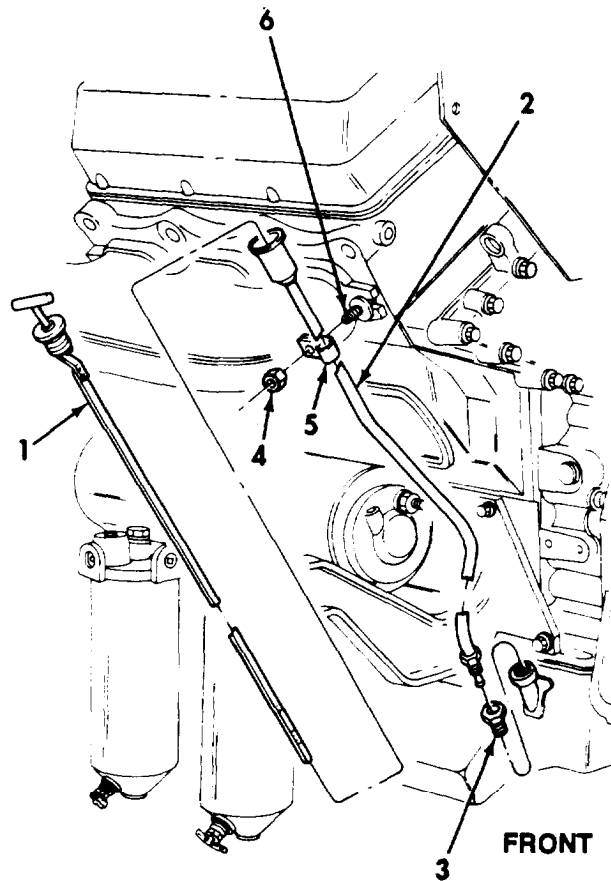
Tool kit, general mechanics (App B, Item 107)
Torque wrench (App B, Item 116)

a. Removal

- (1) Remove oil gage rod (1) from tube assembly (2).
- (2) Unscrew tube assembly (2) from adaptor (3) in front right side of oil pan,
- (3) Remove self-locking nut (4), clip (5), and tube assembly (2) from right front exhaust manifold stud (6). Replace nut on stud. If necessary, remove clip from tube assembly.
- (4) Remove adaptor (3) from oil pan.

b. Installation

- (1) Install adaptor (3) in right side of oil pan.
- (2) If removed, install clip (5) on tube assembly (2). Loosely install tube assembly in adaptor (3).
- (3) Remove self-locking nut (4) from right front exhaust manifold stud. Discard nut. Install clip (5), tube assembly (2), and nut. Securely tighten tube assembly to adaptor (3). Torque nut to 30-35 lb-ft (41-47 N•m).
- (4) Install oil gage rod (1) in tube assembly (2).



END OF TASK

2-10. OIL LEVEL GAGE ROD REMOVAL/INSTALLATION (MODELS 5063-5395, 5063-5396 AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

1 Lockwasher (App F, Item 99)

a. Removal

- (1) Remove oil gage rod (1) from tube assembly (2).
- (2) Unscrew tube assembly (2) from adaptor (3) in rear left side of oil pan.

NOTE

Loosen left exhaust manifold nuts (4) to remove tube assembly.

- (3) Remove screw (5), lockwasher (6), nut (7), clip (8), and tube assembly (2) from bracket (9) on left exhaust manifold. If necessary, remove clip from tube assembly. Discard lockwasher.

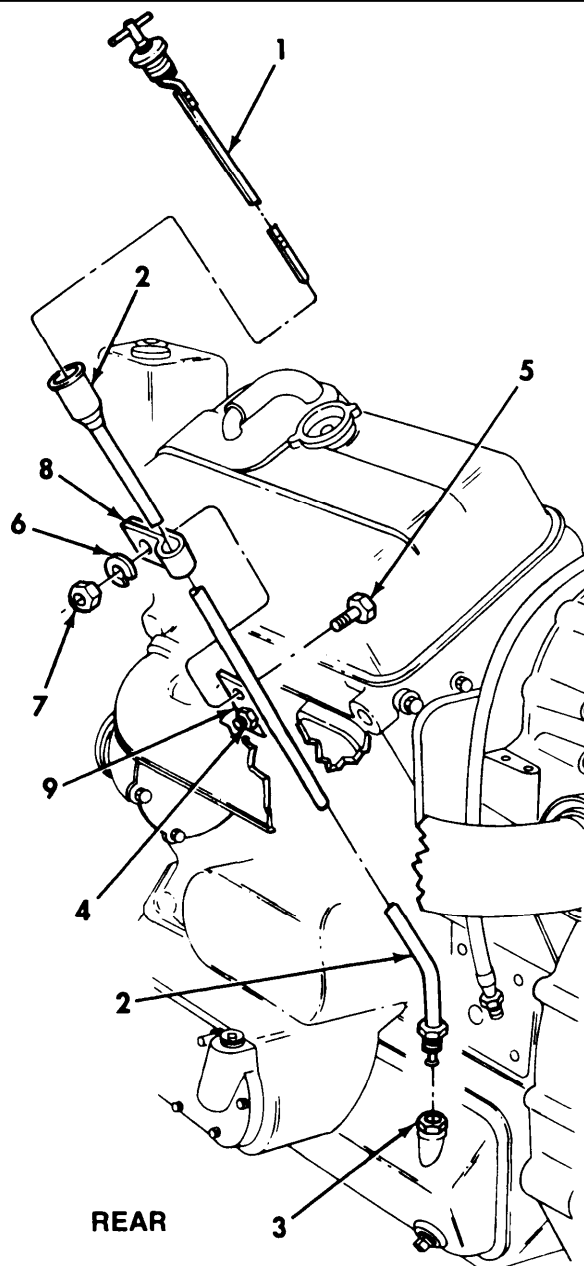
b. Installation

- (1) If removed, install clip (8) on tube assembly (2). Loosely install tube assembly in adaptor (3).

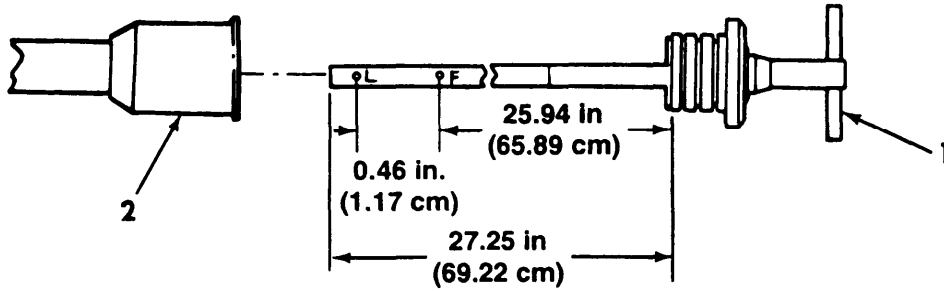
NOTE

Loosen left exhaust manifold nuts (4) to install tube assembly. Torque screw to 30-35 lb-ft (41-47 N·m).

- (2) Install screw (5), clip (8) (facing rearward), tube assembly (2), lockwasher (6), and nut (7) on bracket (9) at left exhaust manifold. Torque screw to 30-35 lb-ft (41-47 N·m).
- (3) Tighten tube assembly (2) in adaptor (3).



2-10. OIL LEVEL GAGE ROD REMOVAL/INSTALLATION (MODELS 5053-5395, 5063-5398 AND 5053-539F) (Cont)



NOTE

Cut and mark new oil gage rod as shown.

(4) Install oil gage rod (1) in tube assembly (2).

END OF TASK

2-11. OIL FILTER ADAPTOR REMOVAL/INSTALLATION (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUPMODELS

5063-5299

MATERIALS/PARTS

4	Lockwashers (App F, Item 99)
1	Gasket (App F, Item 60)

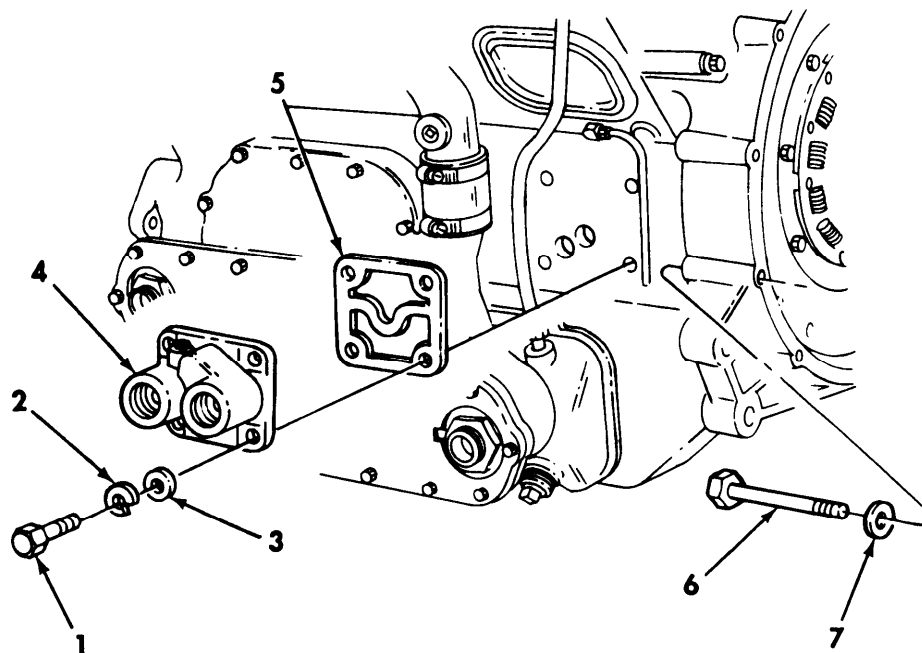
TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

Wrench, torque (App B, Item 116)

a. Removal

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

**b. Installation**

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

END OF TASK

2-12. OIL FILTER ASSEMBLY AND ADAPTOR REMOVAL/INSTALLATION (MODEL 5063-5392)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392

MATERIALS/PARTS

8 Lockwashers (App F, Item 99)
1 Gasket (App F, Item 32)

TOOLS AND SPECIAL TOOLS

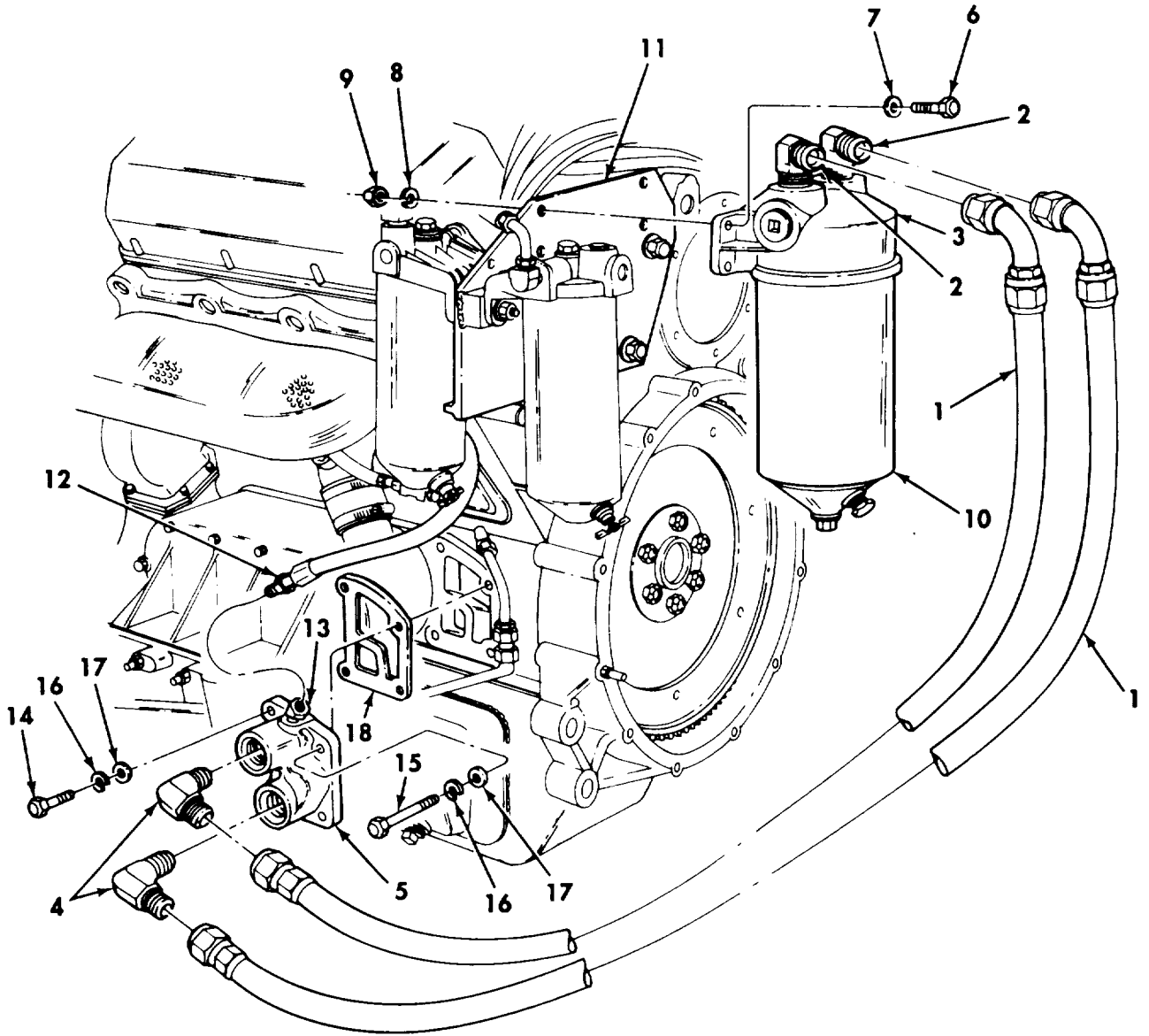
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

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

b. Installation

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



END OF TASK

2-13. OIL FILTER ASSEMBLY AND ADAPTOR REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

MATERIALS/PARTS

4 Lockwashers (App F, Item 99)
1 Gasket (App F, Item 32)

TOOLS AND SPECIAL TOOLS

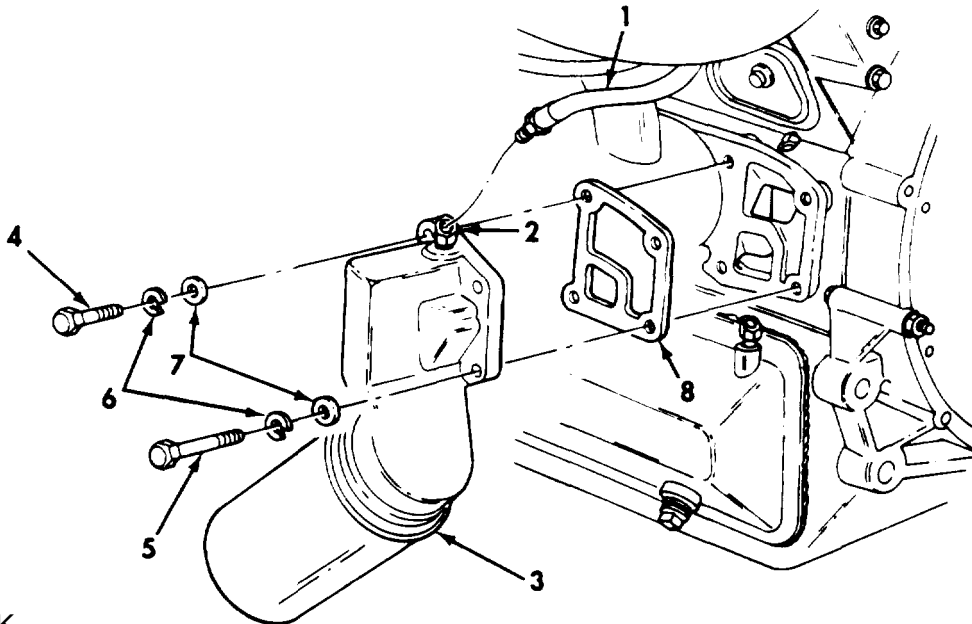
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

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

b. Installation

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



END OF TASK

2-14. OIL FILTER ASSEMBLY, ADAPTOR, AND MOUNTING BRACKETS REMOVAL/ INSTALLATION (MODELS 5063-5395 AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-539F

TOOLS AND SPECIAL TOOLS

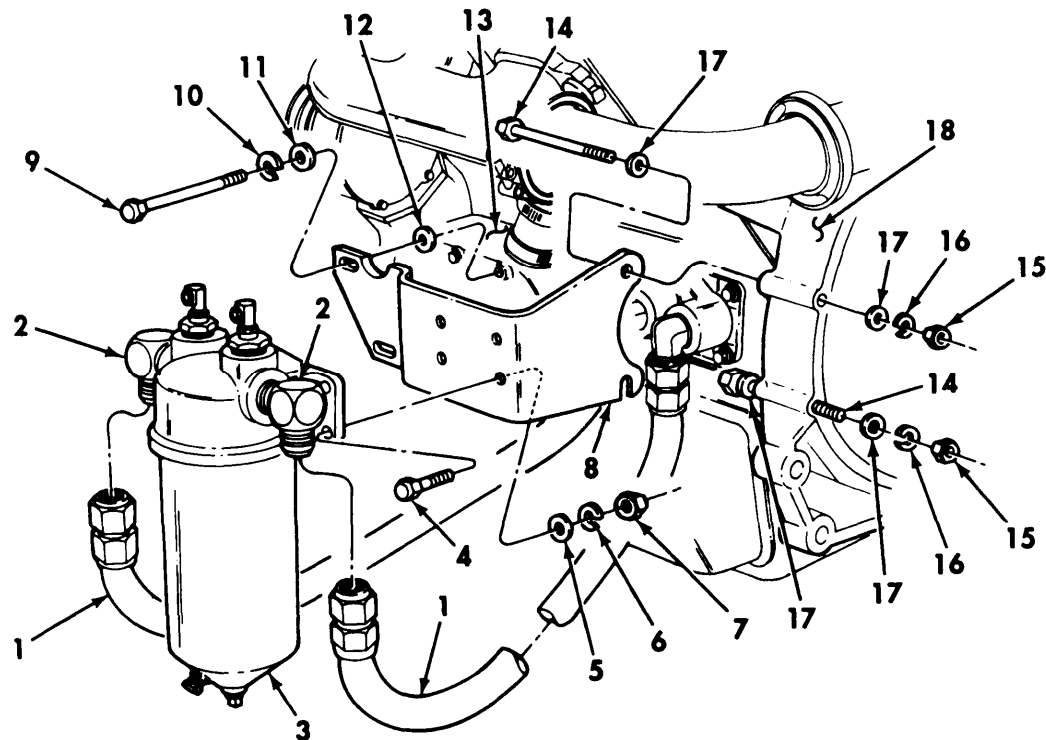
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

10	Lockwashers (App F, Item 99)
2	Lockwashers (App F, Item 98)
1	Gasket (App F, Item 60)

a. Removal

- (1) Disconnect two hose assemblies (1) at two elbows (2) on oil filter assembly (3).
- (2) Remove four screws (4), four flat washers (5), four lockwashers (6), four nuts (7), and oil filter assembly (3) from bracket (8). Discard lockwashers.
- (3) Remove two screws (9), two lockwashers (10), two flat washers (11), and two spacers (12) from bracket (8) at oil cooler (13). Discard lockwashers.



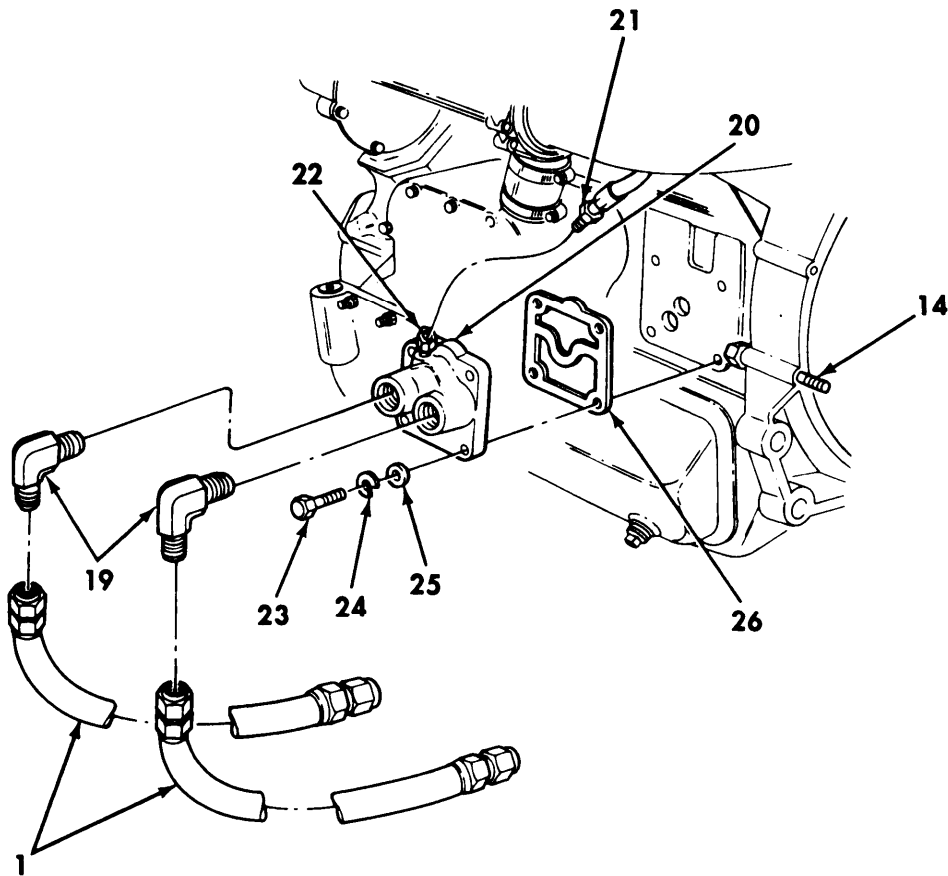
NOTE

Due to interference, leave lower screw (14) in place until oil filter adaptor is removed.

- (4) Remove two nuts (15), two lockwashers (16), four flat washers (17), screw (14), and bracket (8) from flywheel housing (18) and lower screw (14). Discard lockwashers.

2-14. OIL FILTER ASSEMBLY, ADAPTOR, AND MOUNTING BRACKETS REMOVAL/ INSTALLATION (MODELS 5063-5396 AND 5063-539F) (Cont)

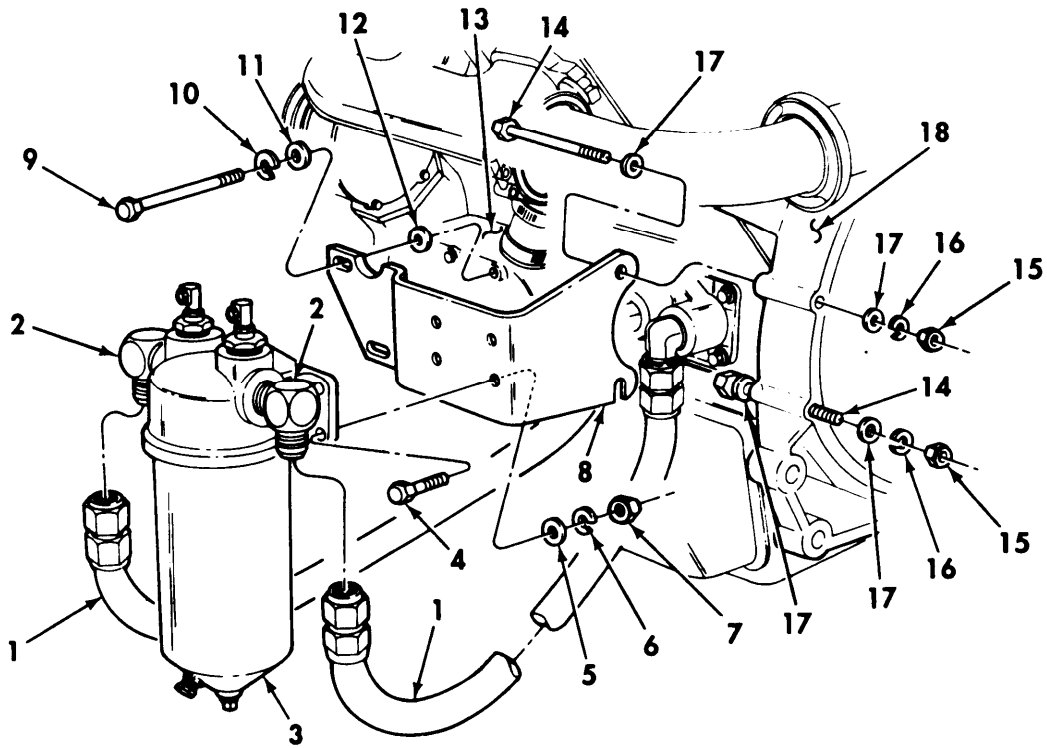
- (5) Remove two hose assemblies (1) from two elbows (19) on oil filter adaptor (20).
- (6) Disconnect turbocharger oil supply hose (21) from elbow (22) in oil filter adaptor (20).
- (7) If necessary, remove two elbows (19) from oil filter adaptor (20).
- (8) Remove four screws (23), four lockwashers (24), and four flat washers (25) from oil filter adaptor (20) at rear left side of cylinder block. Discard lockwashers.
- (9) Remove oil filter adaptor (20) and gasket (26) by tapping with a soft head hammer to break seal. Remove lower screw (14) and discard gasket.



b. Installation

- (1) Install screw (14) in flywheel housing prior to installation of oil filter adaptor due to interference.
- (2) Install gasket (26), oil filter adaptor (20), four flat washers (25), four lockwashers (24), and four screws (23) on rear left side of cylinder block. Torque screws to 30-35 lb-ft (41-47 N·m).
- (3) If removed, install two elbows (19) in oil filter adaptor (20). Tighten elbows securely with ends down.
- (4) Connect two hose assemblies (1) to two elbows (19) on oil filter adaptor (20). Tighten securely.
- (5) Connect oil supply hose (21) to elbow (22) in oil filter adaptor (20). Tighten securely.

- (6) Install upper screw (14), bracket (8), four flat washers (17), two lockwashers (16), and two nuts (15) on flywheel housing (18) and in-place screw (14). Loosely tighten screws.
- (7) Install two spacers (12), two flat washers (11), two lockwashers (10), and two small screws (9) in bracket (8) at oil cooler (13). Torque two small screws (9) to 13-17 lb-ft (18-23 N-m). Torque two large screws (14) to 35-39 lb-ft (47-53 N-m).



- (8) Install four screws (4), oil filter assembly (3), four flat washers (5), four lockwashers (6), and four nuts (7) on bracket (8). Torque screws to 30-35 lb-ft (41-47 N-m).
- (9) Connect two hose assemblies (1) to two elbows (2) in oil filter assembly (3). Tighten securely.

END OF TASK

2-16. ENGINE/TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

10 Lockwashers (App F, Item 98)
1 Gasket (App F, Item 41)

MATERIALS/PARTS (Cont)

1 Gasket (App F, Item 80)
1 Gasket (App F, Item 28)

EXPENDABLE/DURABLE SUPPLIES

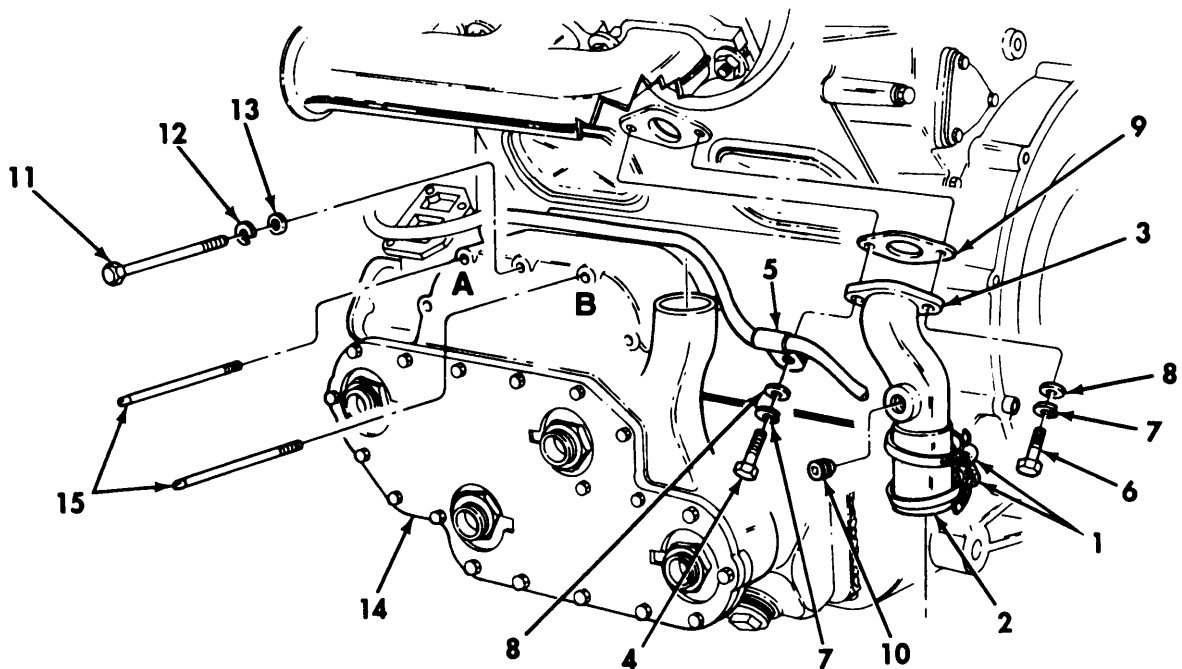
2 Studs (App C, Item 53)

EQUIPMENT CONDITION

Para Description
2-6 Coolant pump removed.

a. Removal

- (1) Loosen two hose clamps (1) on hose (2) over water outlet elbow (3).
- (2) Remove long bolt (4) through clip (5), short bolt (6), two lockwashers (7), two flat washers (8), water outlet elbow (3), hose (2), two hose clamps (1), and gasket (9) from cylinder block. Remove two hose clamps (1) and hose (2) from elbow (3). Discard gasket and lockwashers.
- (3) If necessary, remove pipe plug (10) from water outlet elbow (3).



- (4) Remove five bolts (11), five lockwashers (12), and five flat washers (13) from upper section of oil cooler assembly (14). Discard lockwashers.
- (5) Install two guide studs (15) in positions (A) and (B) through oil cooler assembly (14).

2-15. OIL FILTER ASSEMBLY AND ADAPTOR REMOVAL/INSTALLATION (MODEL 5063-5398)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5398

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)

MATERIALS/PARTS

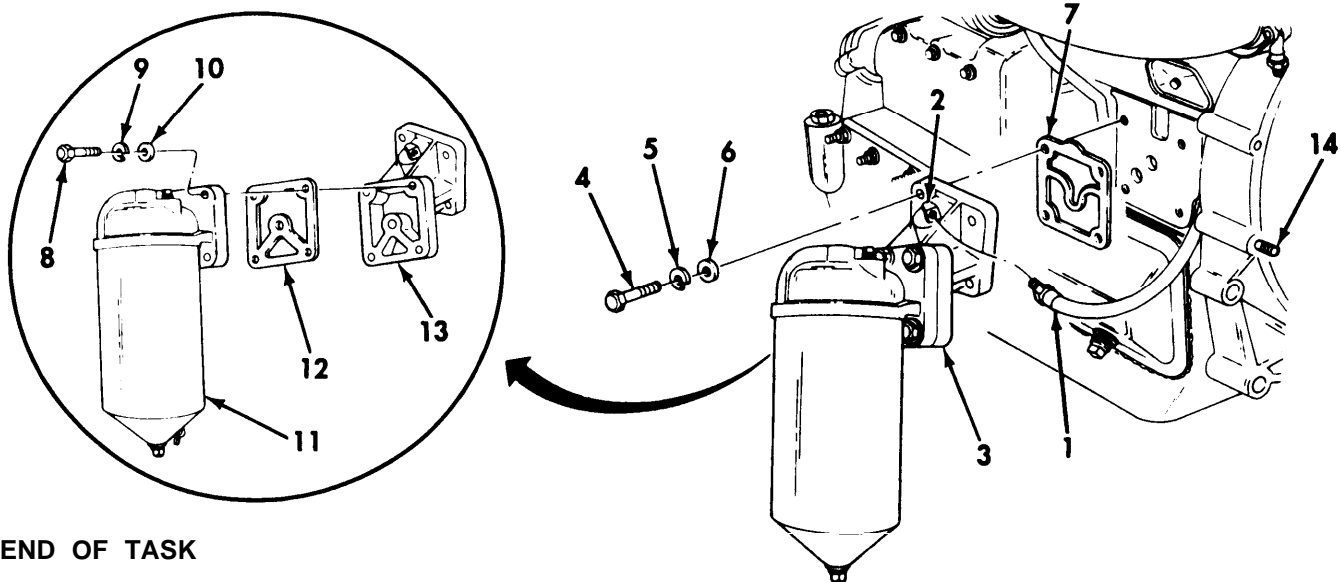
8 Lockwashers (App F, Item 99)
 1 Gasket (App F, Item 49)
 1 Gasket (App F, Item 56)

a. Removal

- (1) Disconnect turbocharger oil supply hose (1) at elbow (2) in oil filter and adaptor assembly (3).
- (2) Remove four screws (4), four lockwashers (5), four flat washers (6), oil filter and adaptor assembly (3), and gasket (7) from rear left cylinder block. Discard lockwashers and gasket.
- (3) Remove four screws (8), four lockwashers (9), four flat washers (10), oil filter assembly (11), and gasket (12) from adaptor (13). Discard gasket and lockwashers.
- (4) If engine is out of container, remove in-place screw (14) from flywheel housing.

b. Installation

- (1) If engine is out of container, install screw (14) in flywheel housing.
- (2) Install gasket (12), oil filter assembly (11), four flat washers (10), four lockwashers (9), and four screws (8) on adaptor (13). Torque screws to 30-35 lb-ft (41-47 N-m).
- (3) Install gasket (7), oil filter and adaptor assembly (3), four flat washers (6), four lockwashers (5), and four screws (4) on rear left cylinder block. Torque screws to 30-35 lb-ft (41-47 N-m).
- (4) Connect turbocharger oil supply hose (1) to elbow (2) in oil filter and adaptor assembly (3). Tighten hose connection securely.



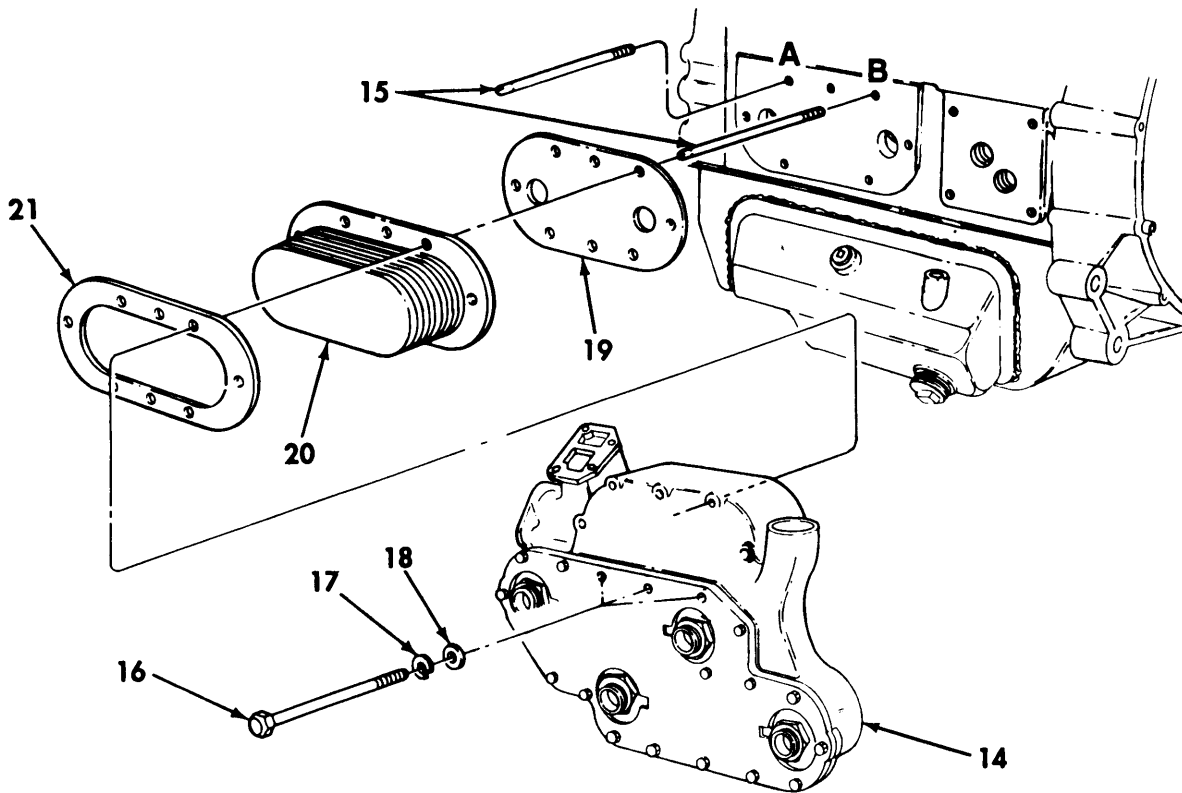
END OF TASK

2-16. ENGINE/TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODEL 5063-5299)
(Cont)

WARNING

Oil cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during removal.

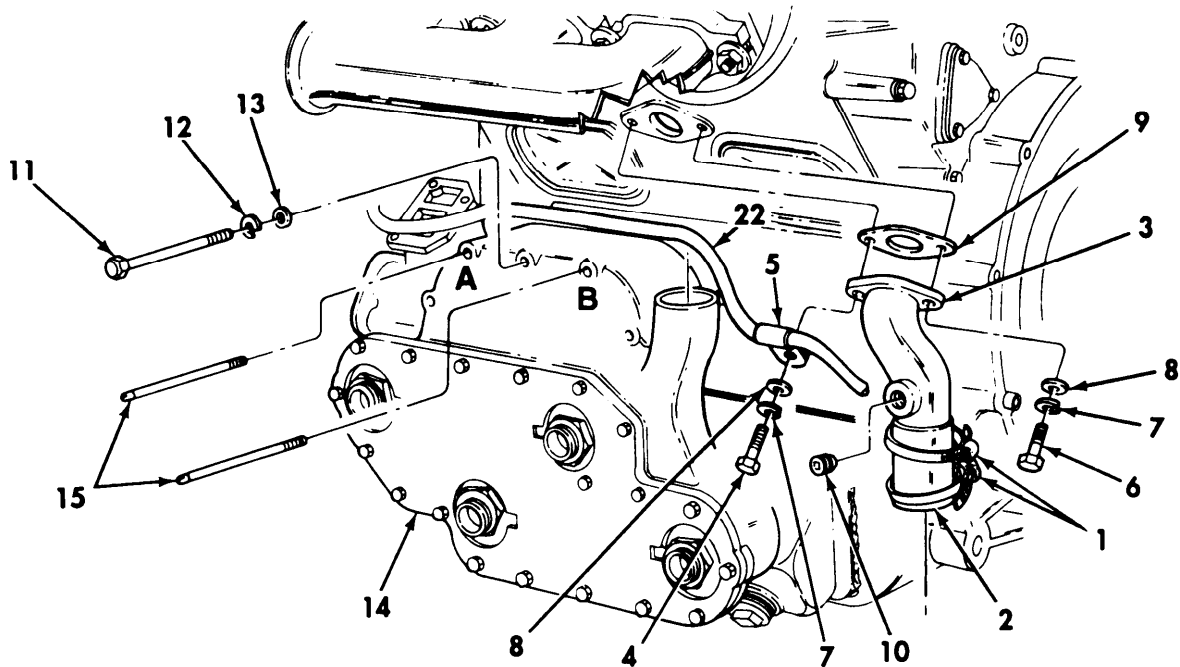
- (6) Remove three bolts (16), three lockwashers (17), three flat washers (18), oil cooler assembly (14), and gasket (19) from cylinder block. Discard gasket and lockwashers.
- (7) Remove oil cooler element (20) and gasket (21) from oil cooler assembly (14). Discard gasket.
- (8) Remove two guide studs (15) from cylinder block..



b. Installation

- (1) Install two guide studs (15) into cylinder block at positions (A) and (B).
- (2) Install gasket (19), oil cooler element (20), and gasket (21) on guide studs (15) with port marked "IN" toward front of engine and slide gaskets (19 and 21) and element (20) against cylinder block.
- (3) Position oil cooler assembly (14) on guide studs (15) and slide up against cylinder block.

- (4) Install three flat washers (18), three lockwashers (17), and three bolts (16) in oil cooler assembly (14). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (5) Remove two guide studs (15) and install five flat washers (13), five lockwashers (12), and five bolts (11) in oil cooler assembly (14). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (6) If removed, install pipe plug (10) in elbow (3).



- (7) Slide hose (2) and two clamps (1) onto oil cooler assembly (14).
- (8) Slide elbow (3) into hose (2) and install gasket (9), elbow (3), two flat washers (8), two lockwashers (7), long bolt (4) through clip (5) on hose (22), and short bolt (6) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N-m).
- (9) Adjust hose (2) and two clamps (1) between elbow (3) and oil cooler assembly (14) with clamp adjusting screws facing front of engine. Tighten clamps securely.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
2-6 Install coolant pump.

2-17. ENGINE/TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODEL 5063-5392)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

2 Lockwashers (App F, Item 99)
13 Lockwashers (App F, Item 98)

MATERIALS/PARTS (Cont)

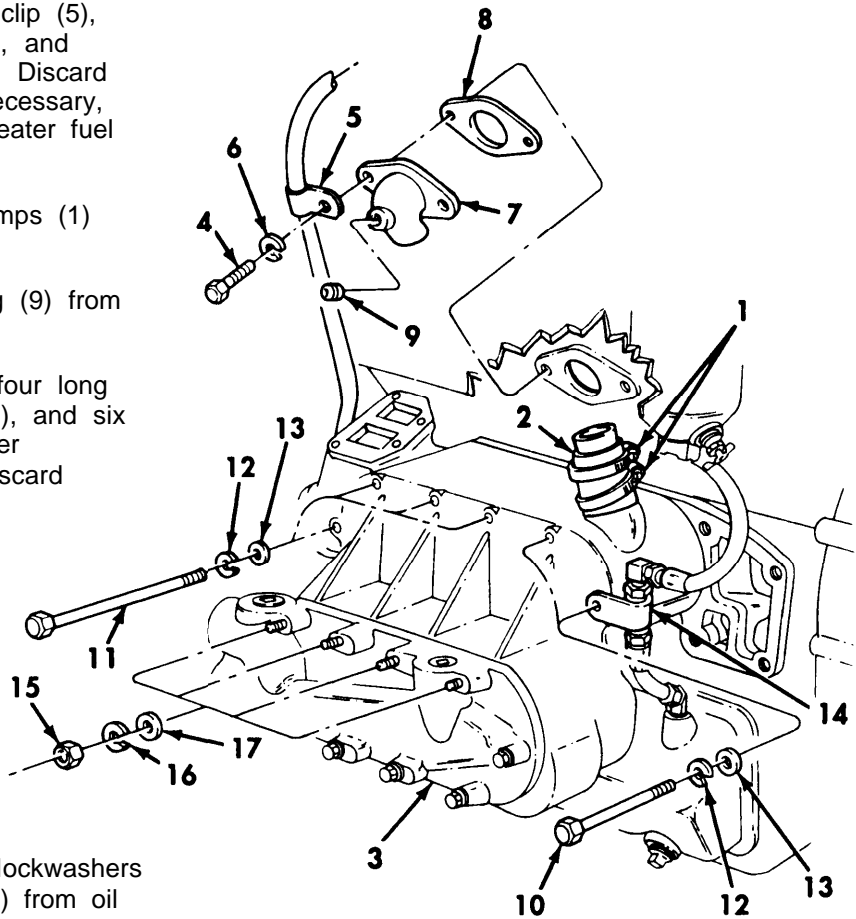
1 Gasket (App F, Item 41)
1 Gasket (App F, Item 34)
1 Gasket App F, Item 33)
1 Gasket App F, Item 31)

EQUIPMENT CONDITION

Para Description
2-6 Coolant pump removed.
2-12 Oil filter adaptor removed.

a. Removal

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

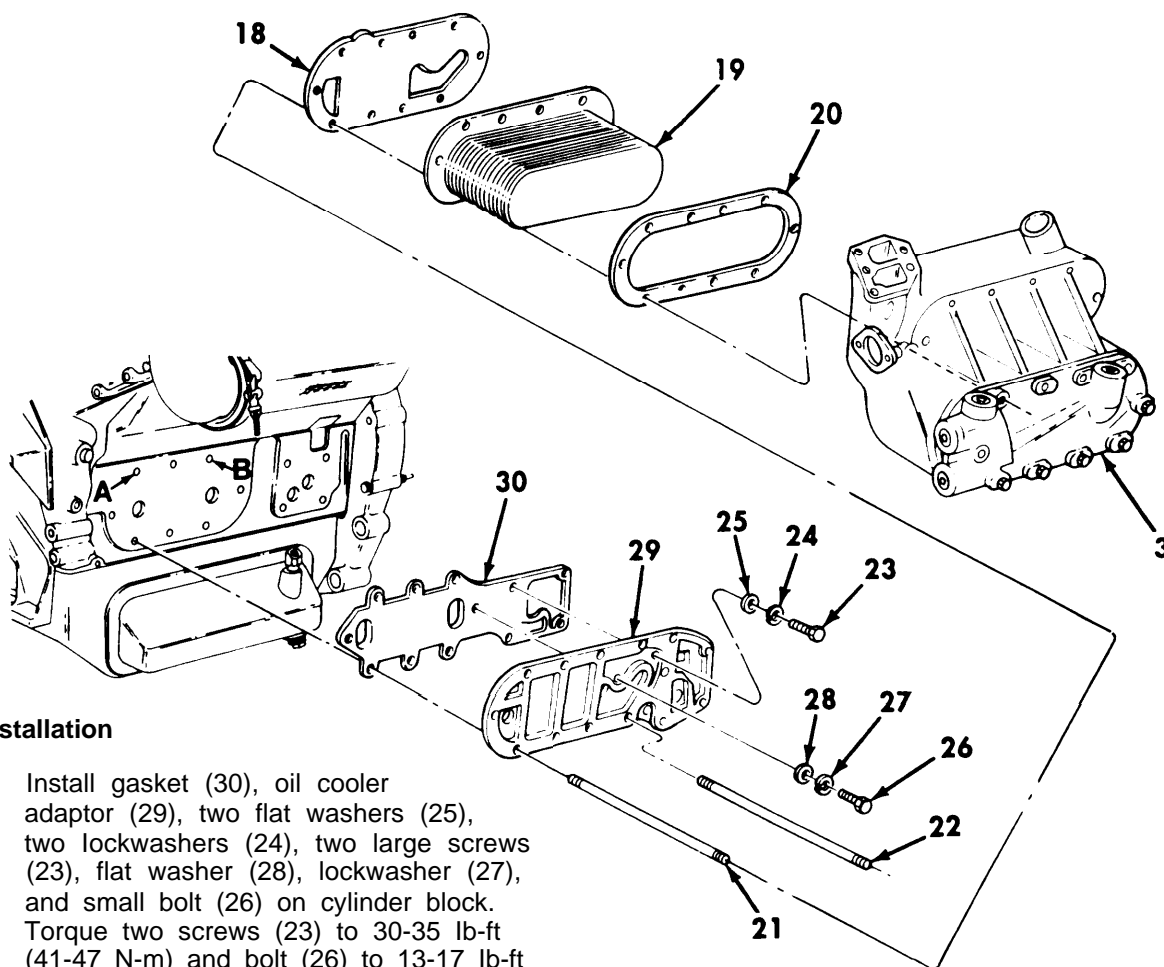


- (6) Remove four nuts (15), four lockwashers (16), and four flat washers (17) from oil cooler assembly (3). Discard lockwashers.

WARNING

Oil cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during removal.

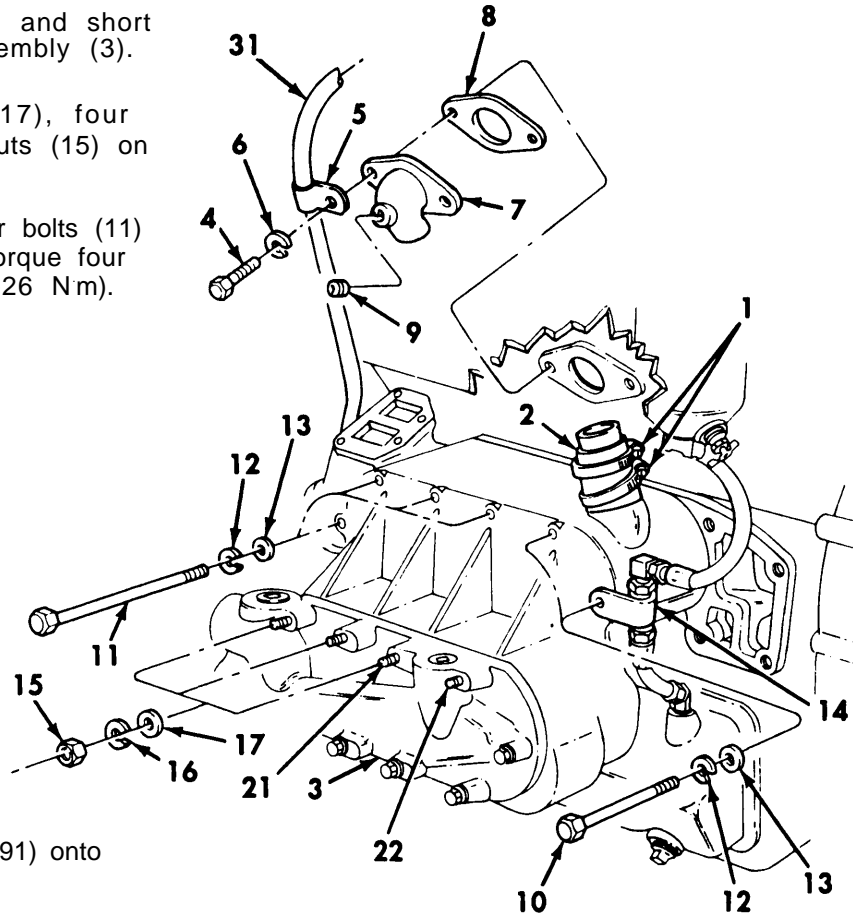
- (7) Remove oil cooler assembly (3) and gasket (18). Discard gasket.
- (8) Remove oil cooler element (19) and gasket (20) from oil cooler assembly (3). Discard gasket.
- (9) Remove three studs (21) and stud (22) from cylinder block.
- (10) Remove two large screws (23), two lockwashers (24), two flat washers (25), small bolt (26), lockwasher (27), flat washer (28), oil cooler adaptor (29), and gasket (30) from cylinder block. Discard gasket and lockwashers.

**b. Installation**

- (1) Install gasket (30), oil cooler adaptor (29), two flat washers (25), two lockwashers (24), two large screws (23), flat washer (28), lockwasher (27), and small bolt (26) on cylinder block. Torque two screws (23) to 30-35 lb-ft (41-47 N·m) and bolt (26) to 13-17 lb-ft (18-23 N·m).
- (2) Install two studs (21) in positions (A) and (B) to act as guides.
- (3) Position gasket (18), oil cooler element (19), and gasket (20) on two studs (21) with port marked "IN" toward front of engine and slide gaskets (18 and 20) and element (19) up against oil cooler adaptor (29).
- (4) Position oil cooler assembly (3) on two studs (21) and slide up against oil cooler adaptor (29).

**2-17. ENGINE/TRANSMISSION OIL COOLER REMOVAL/INSTALLATION (MODEL 5063-5392)
(Cont)**

- (5) Install four flat washers (13), four lockwashers (12), two short bolts (10) with lower rear bolt through clip (14), and two long bolts (11) in oil cooler assembly (3). Remove two guide studs (21) and install remaining two flat washers (13), two lockwashers (12), and two long bolts (11).
- (6) Install three long studs (21) and short stud (22) on oil cooler assembly (3).
- (7) Install four flat washers (17), four lockwashers (16), and four nuts (15) on studs (21 and 22).
- (8) Torque two bolts (10) and four bolts (11) to 13-17 lb-ft 918-23 Nm). Torque four nuts (15) to 15-19 lb-ft (20-26 Nm).



- (9) Slide hose (2) and two clamps (1) onto oil cooler assembly (3).
- (10) If removed, install pipe plug (9) in elbow (7). If removed, install clip (5) on air box heater fuel line (31).

NOTE

Front bolt (4) is installed through clip (5), on fuel line (31), into elbow (7).

- (11) Slide elbow (7) into hose (2) and install gasket (8), elbow (7), two lockwashers (6), and two bolts (4) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N-m).
- (12) Adjust hose (2) and two clamps (1) between elbow (7) and oil cooler assembly (3) with clamp adjusting screws facing front of engine. Tighten clamps securely.

END OF TASK

FOLLOW-ON MAINTENANCE

- Para Description
- 2-6 Install coolant pump.
- 2-12 Install oil filter adaptor.

2-18. ENGINE OIL COOLER REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 2 Lockwashers (App F, Item 99)
- 13 Lockwashers (App F, Item 98)
- 1 Gasket (App F, Item 34)
- 1 Gasket (App F, Item 33)
- 1 Gasket (App F, Item 31)
- 1 Gasket (App F, Item 41)

EXPENDABLE/DURABLE SUPPLIES

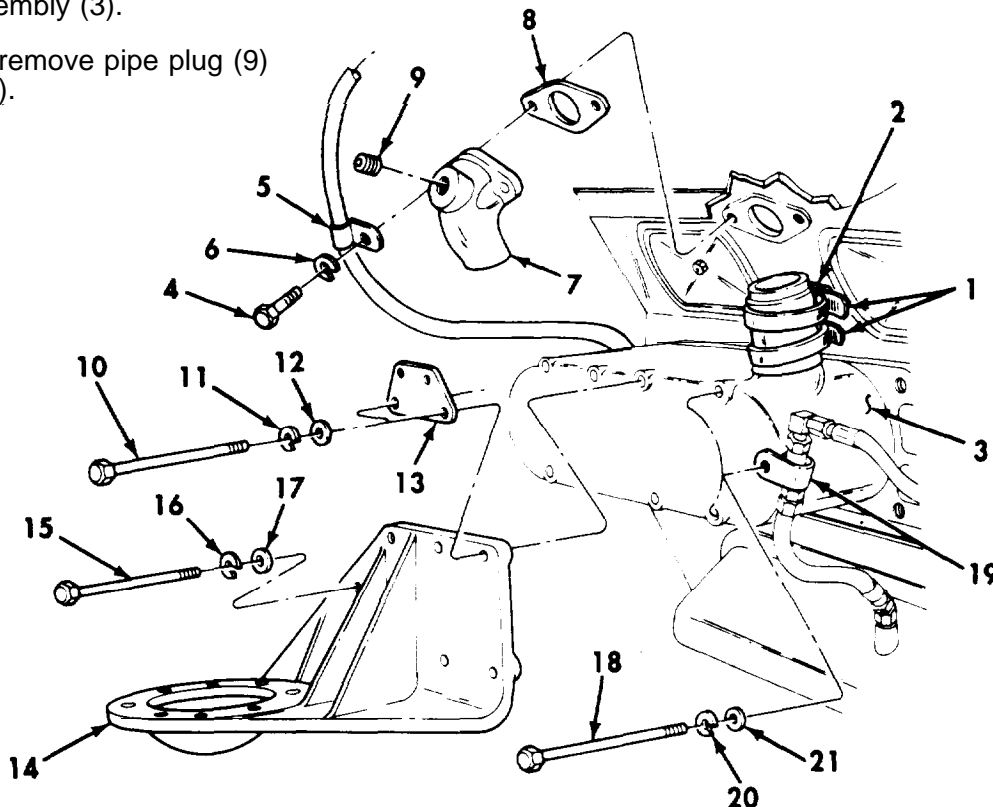
- 2 Studs (App C, Item 53)

EQUIPMENT CONDITION

- | Para | Description |
|------|--|
| 2-4 | Transmission oil cooler removed. |
| 2-6 | Coolant pump removed. |
| 2-5 | Fuel junction block removed. |
| 2-13 | Oil filter assembly and adaptor removed. |

a. Removal

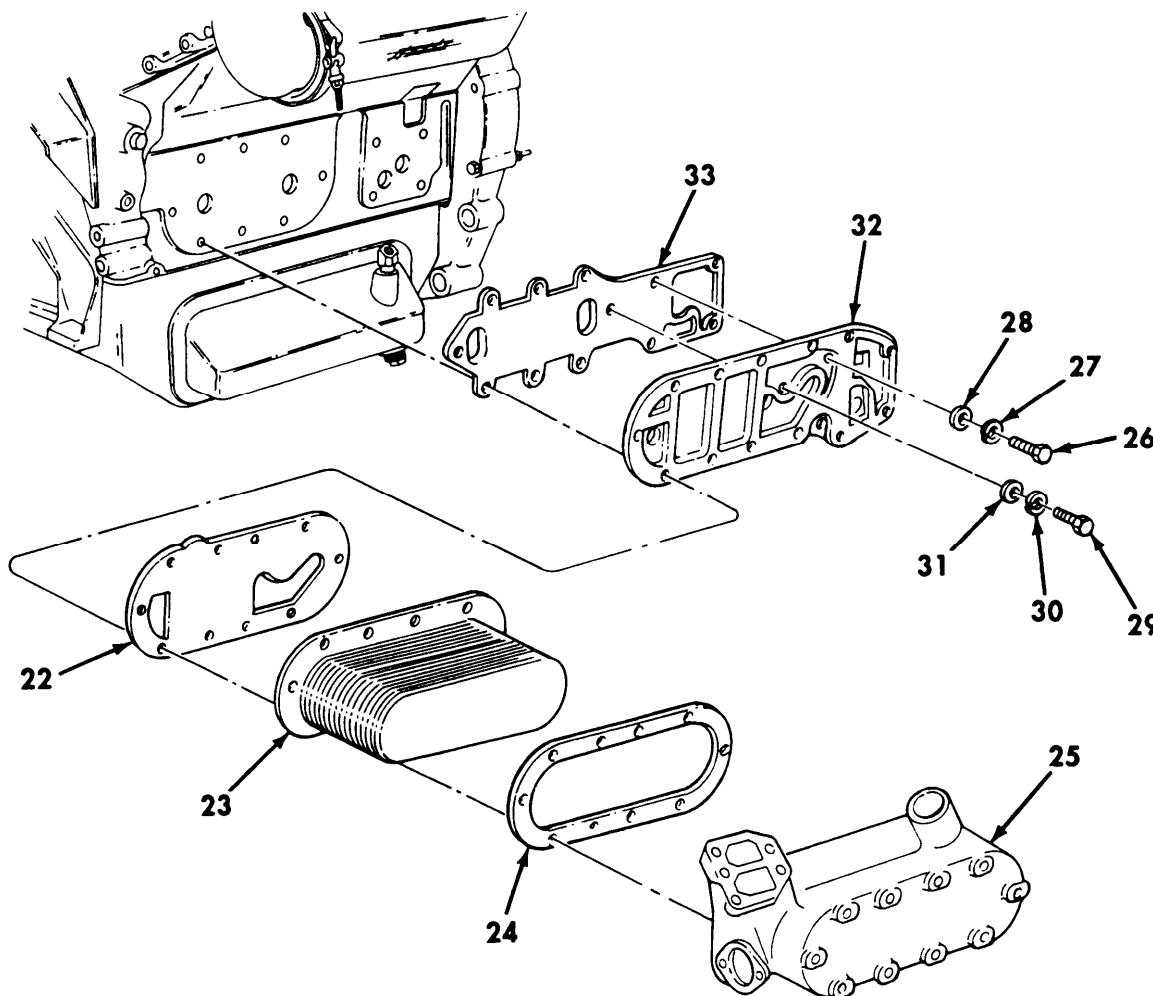
- (1) Loosen two hose clamps (1) and slide hose (2) down onto oil cooler assembly (3).
- (2) Remove two bolts (4) through clip (5), two lockwashers (6), elbow (7), and gasket (8) from cylinder block. Discard gasket and lockwashers.
- (3) Remove hose (2) and two clamps (1) from oil cooler assembly (3).
- (4) If necessary, remove pipe plug (9) from elbow (7).



- (5) Remove two bolts (10), two lockwashers (11), two flat washers (12), and bracket (13) from transmission oil cooler bracket (14). Discard lockwashers.
- (6) Remove five screws (15), five lockwashers (16), five flat washers (17), and transmission oil cooler bracket (14) from oil cooler assembly (3). Discard lockwashers.

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

- (7) Remove three bolts (18) through clip (19), three lockwashers (20), three flat washers (21), and oil cooler assembly (3) from cylinder block. Discard lockwashers.

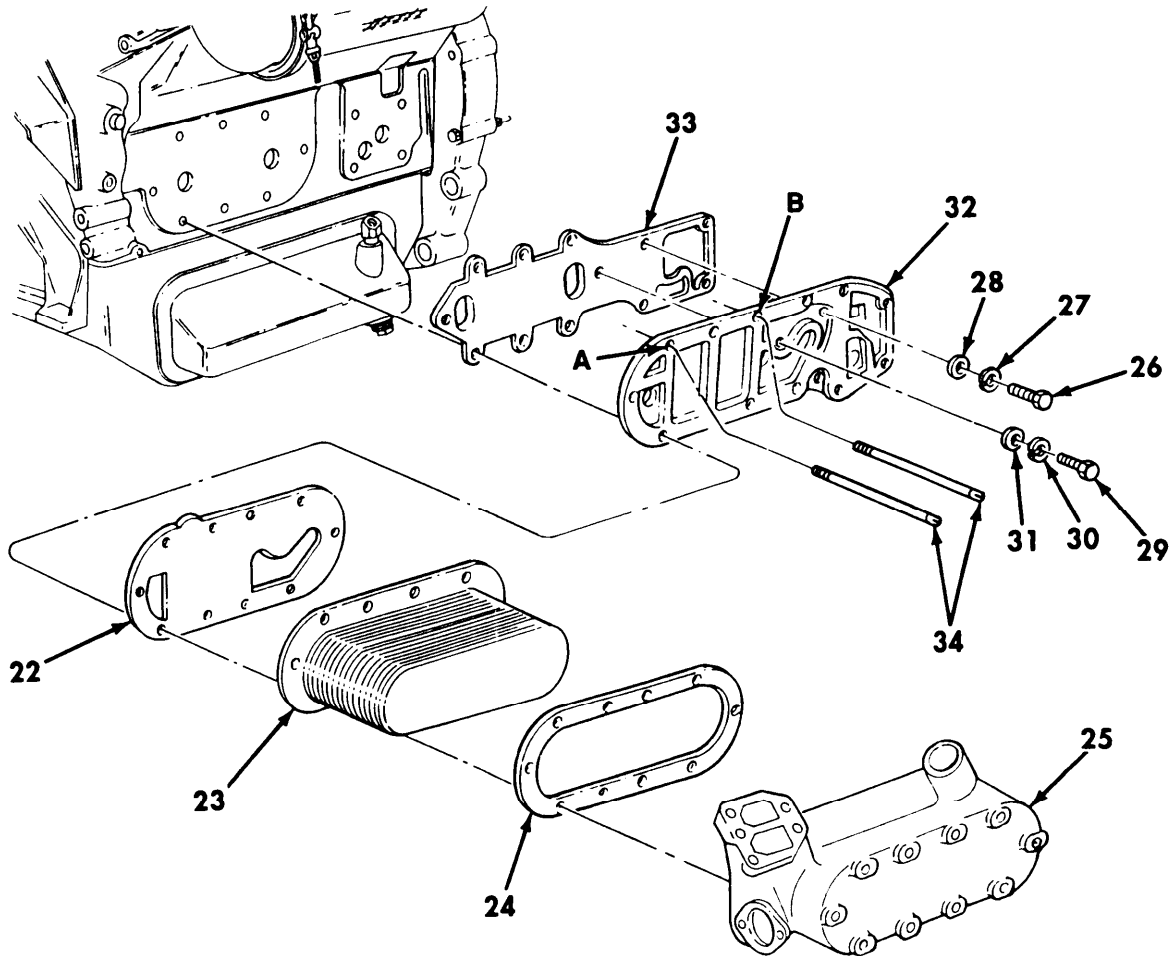


- (8) Remove gasket (22), oil cooler element (23), and gasket (24) from oil cooler housing (25). Discard gaskets.
- (9) Remove two large screws (26), two lockwashers (27), two flat washers (28), small bolt (29), lockwasher (30), flat washer (31), oil cooler adaptor (32), and gasket (33) from cylinder block. Discard gasket and lockwashers.

2-18. ENGINE OIL COOLER REMOVAL/INSTALLATION (MODEL 5063-5393) (Cont)

b. Installation

- (1) Install two guide studs (34) in positions (A) and (B).
- (2) Install gasket (33), oil cooler adaptor (32), two flat washers (28), two lockwashers (27), two large screws (26), flat washer (31), lockwasher (30), and small bolt (29) on cylinder block.



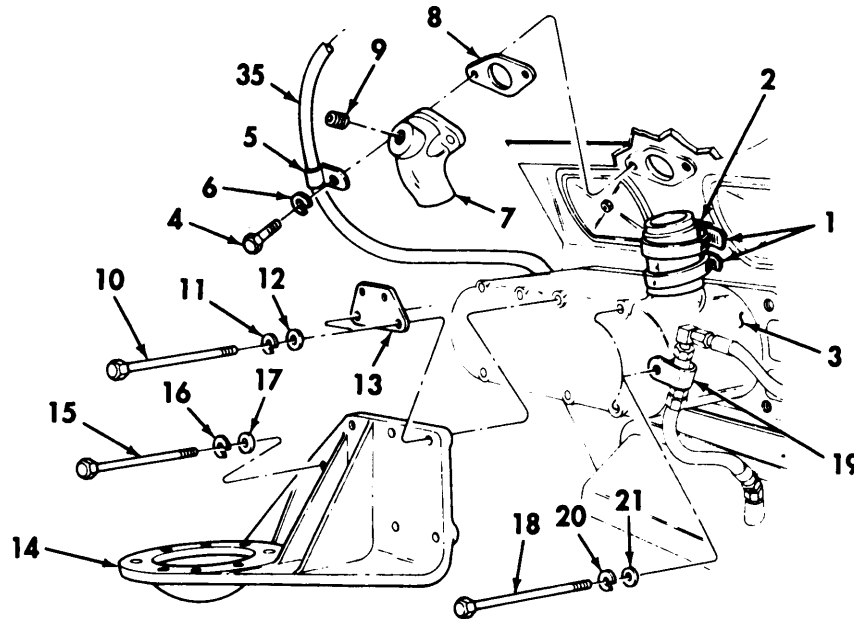
- (3) Install gasket (22), oil cooler element (23), and gasket (24) on guide studs (34) with port marked "IN" toward front of engine and slide gaskets (22 and 24) and element (23) up against cylinder block.

- (4) Place oil cooler housing (25) on studs (34) and slide up against cylinder block.

NOTE

Center bolt (18) is installed through clip (19) into oil cooler assembly (3).

- (5) Loosely install three flat washers (21), three lockwashers (20), and three bolts (18) on oil cooler assembly (3). Remove two guide studs (34).
- (6) Install transmission oil cooler bracket (14), five flat washers (17), five lockwashers (16), and five bolts (15) on oil cooler assembly (3).
- (7) Install bracket (13), two flat washers (12), two lockwashers (11), and two bolts (10) on transmission oil cooler bracket (14).



- (8) Torque two bolts (10), five bolts (15), and three bolts (18) to 13-17 lb-ft (18-23 N-m).
- (9) Slide hose (2) and two clamps (1) onto oil cooler assembly (3).
- (10) If removed, install pipe plug (9) in elbow (7).

NOTE

Front bolt (4) is installed through clip (5), on hose (35), into elbow (7).

- (11) Insert elbow (7) into hose (2) and install gasket (8), elbow (7), two lockwashers (6), and two bolts (4) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N-m).
- (12) Adjust hose (2) and two clamps (1) between elbow (7) and oil cooler assembly (3) with clamp adjusting screws facing front of engine. Tighten clamps securely.

END OF TASK**FOLLOW-ON MAINTENANCE**

Para Description

2-4 Install transmission oil cooler.

2-6 Install coolant pump.

2-5 Install fuel junction block.

2-13 Install oil filter assembly and adaptor.

2-19. ENGINE OIL COOLER REMOVAL/INSTALLATION (MODELS 5063-5395,5063-5398, AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 4 Lockwashers (App F, Item 99)
- 8 Lockwashers (App F, Item 98)
- 1 Gasket (App F, Item 66) (model 5063-5398)
- 1 Gasket (App F, Item 80) (models 5063-5395 and 5063-539F)

MATERIALS/PARTS (Cont)

- 1 Gasket (App F, Item 41) (models 5063-5395 and 5063-539F)
- 1 Seal ring (App F, Item 159) (model 5063-5398)
- 1 Gasket (App F, Item 48)
- 1 Gasket (App F, Item 28)

EQUIPMENT CONDITION

Para Description
 2-6 Coolant pump removed.
 2-14 Oil filter mounting bracket removed (models 5063-5395 and 5063-539F)

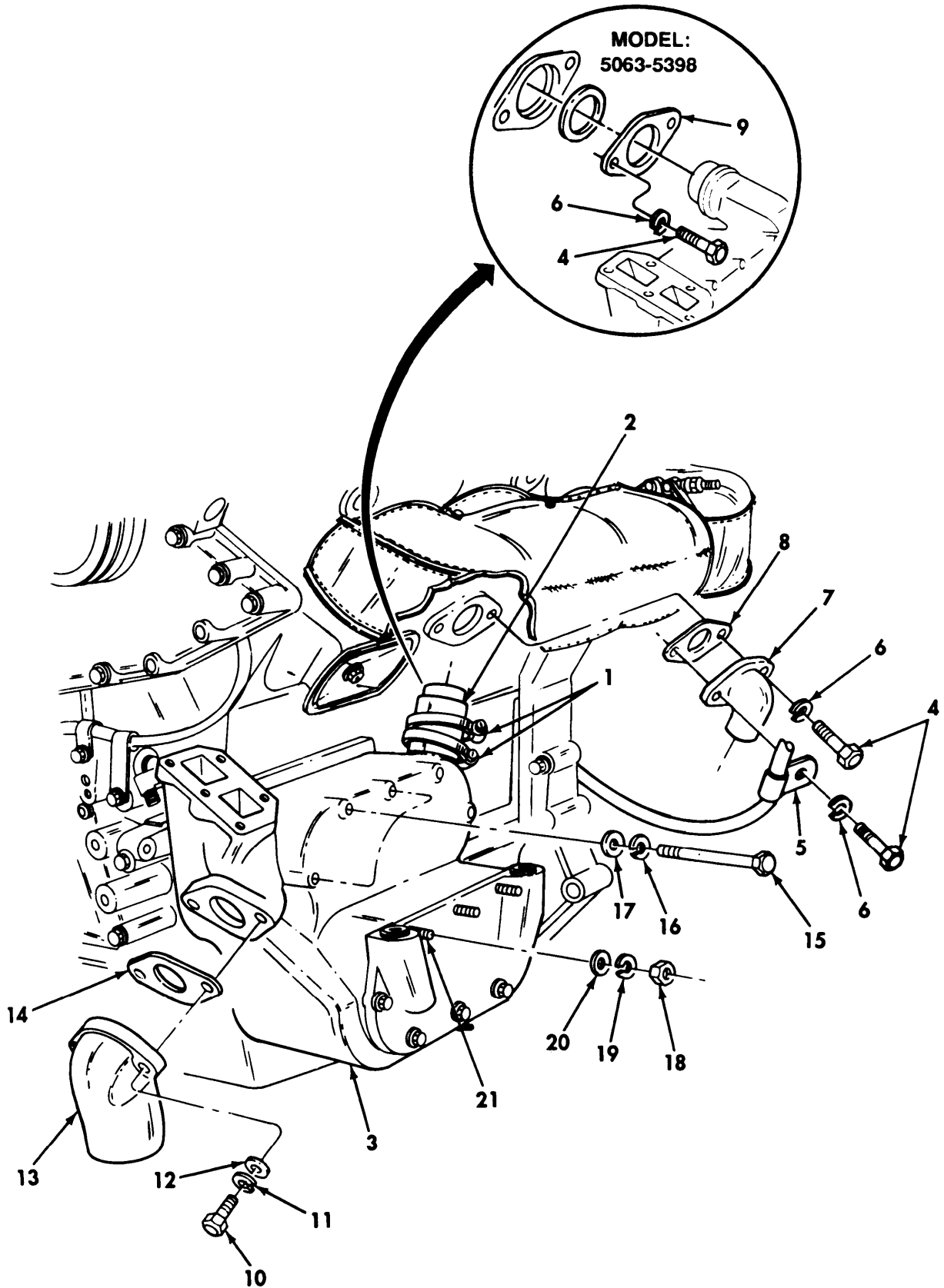
a. Removal

- (1) For models 5063-5395 and 5063-539F, loosen two clamps (1) and slide hose (2) down onto oil cooler housing (3).
- (2) For models 5063-5395 and 5063-539F, remove two bolts (4) securing clip (5), two lockwashers (6), elbow (7), and gasket (8) from cylinder block. Discard gasket and lockwashers.
- (3) For model 5063-5398, remove two bolts (4) securing clip (5) and two lockwashers (6) from flange (9) on cylinder block. Discard lockwashers.
- (4) Remove two bolts (10), two lockwashers (11), two flat washers (12), elbow (13), and gasket (14) from oil cooler housing (3). Discard gasket and lockwashers.
- (5) Remove three bolts (15), three lockwashers (16), and three flat washers (17) from oil cooler housing (3). Discard lockwashers.

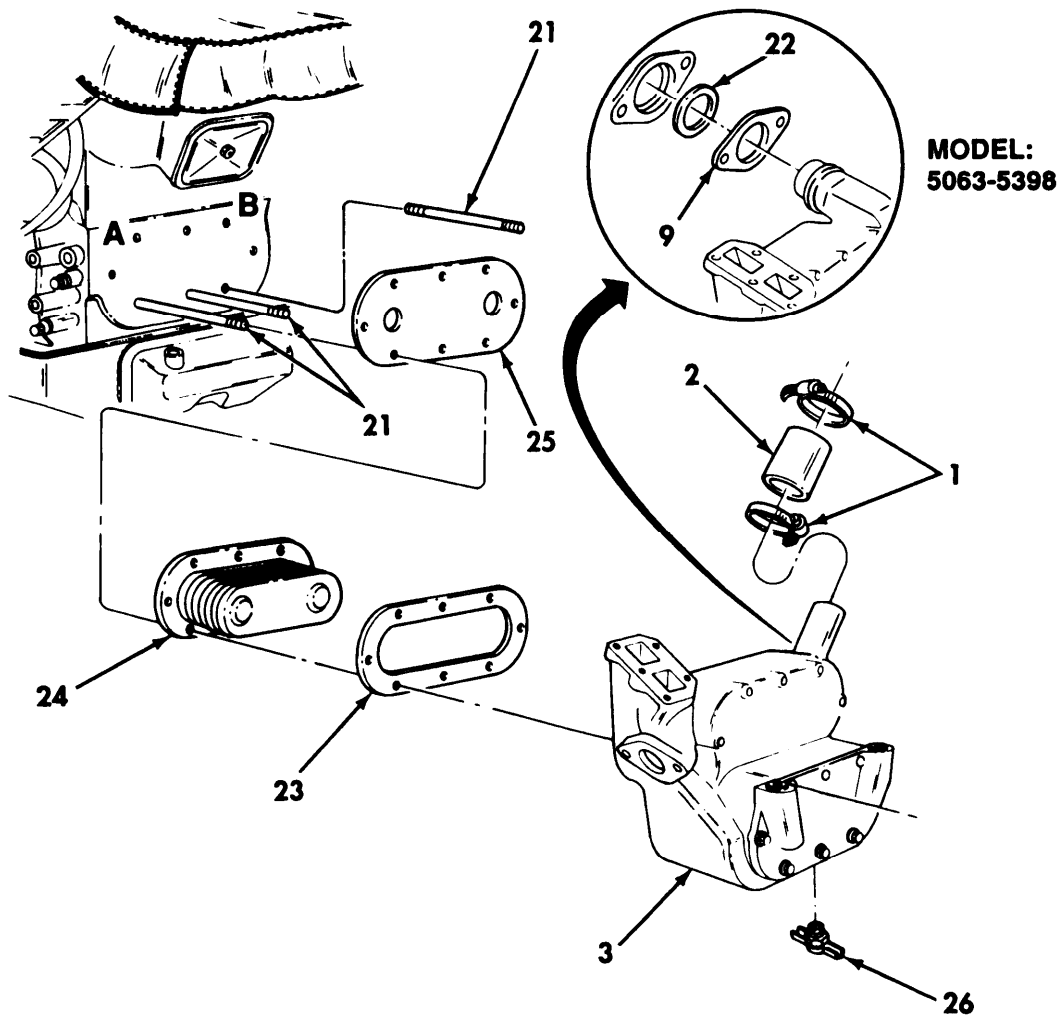


Oil cooler is heavy. Provide adequate support to prevent injury to personnel from cooler falling during removal.

- (6) Support oil cooler housing (3) and remove three nuts (18), three lockwashers (19), and three flat washers (20) from three studs (21) in oil cooler housing. Remove oil cooler assembly from cylinder block. Discard lockwashers.



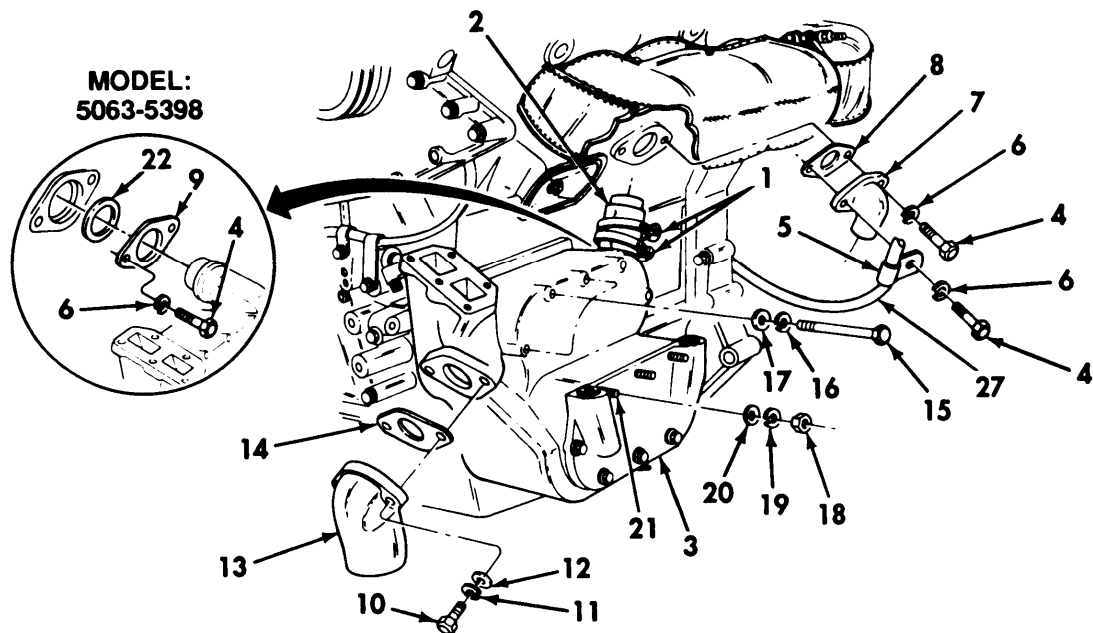
2-19. ENGINE OIL COOLER REMOVAL/INSTALLATION (MODELS 5063-5395, 5063-5398, AND 5063-539F) (Cont)



- (7) For models 5063-5395 and 5063-539F, remove two clamps (1) and hose (2) from oil cooler housing (3).
- (8) For model 5063-5398, remove flange (9) and seal ring (22). Discard seal ring.
- (9) Remove gasket (23), oil cooler element (24), and gasket (25) from oil cooler housing (3). Discard gaskets.
- (10) Remove three studs (21) from cylinder block.
- (11) If necessary, remove drain cock (26) from bottom of oil cooler housing (3).

b. Installation

- (1) If removed, install drain cock (26) in bottom of oil cooler housing (3).
- (2) Install two studs (21) in cylinder block at locations (A and B) to act as guides.
- (3) Place gasket (25), oil cooler element (24), and gasket (23) on studs (21) and slide gaskets (25 and 23) and element (24) up against cylinder block.



- (4) For models 5063-5395 and 5063-539F, slide hose (2) and two clamps (1) onto oil cooler housing (3).
- (5) For model 5063-5398, install flange (9) and seal ring (22) on oil cooler housing.
- (6) Place oil cooler housing (3) on studs (21) and slide up against cylinder block.
- (7) Install two flat washers (17), two lockwashers (16), and two bolts (15) on oil cooler housing (3). Remove two guide studs (21) from locations (A and B) and install remaining flat washer, lockwasher, and bolt in location (A). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (8) Install three studs (21), three flat washers (20), three lockwashers (19), and three nuts (18) in middle row of holes in oil cooler housing. Torque nuts to 15-19 lb-ft (20-26 N-m).

NOTE

Front bolt (4) is installed through clip (5) on hose (27) at elbow (7) for models 5063-5395 and 5063-529F or at flange (9) for model 5063-5398.

- (9) For models 5063-5395 and 5063-529F, insert elbow (7) in hose (2) and install gasket (8), elbow (7), two lockwashers (6), and two bolts (4) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N-m).
- (10) For model 5063-5398, install two lockwashers (6) and two bolts (4) in flange (9) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N-m).
- (11) For models 5063-5395 and 5063-539F, adjust hose (2) and two clamps (1) between elbow (7) and oil cooler housing (3) with clamp adjusting screws facing front. Tighten clamps securely.
- (12) Install gasket (14), elbow (13), two flat washers (12), two lockwashers (11), and two bolts (10) on oil cooler housing (3). Torque bolts to 30-35 lb-ft (41-47 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

2-6 Install coolant pump.

2-14 Install oil filter mounting bracket (models 5063-5395 and 5063-539 F).

2-20. FUEL FILTERS AND MOUNTING BRACKET REMOVAL/INSTALLATION (MODEL 5063-5392)

This task covers: a. Removal Installation

INITIAL SETUP

MODELS

5063-5392

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

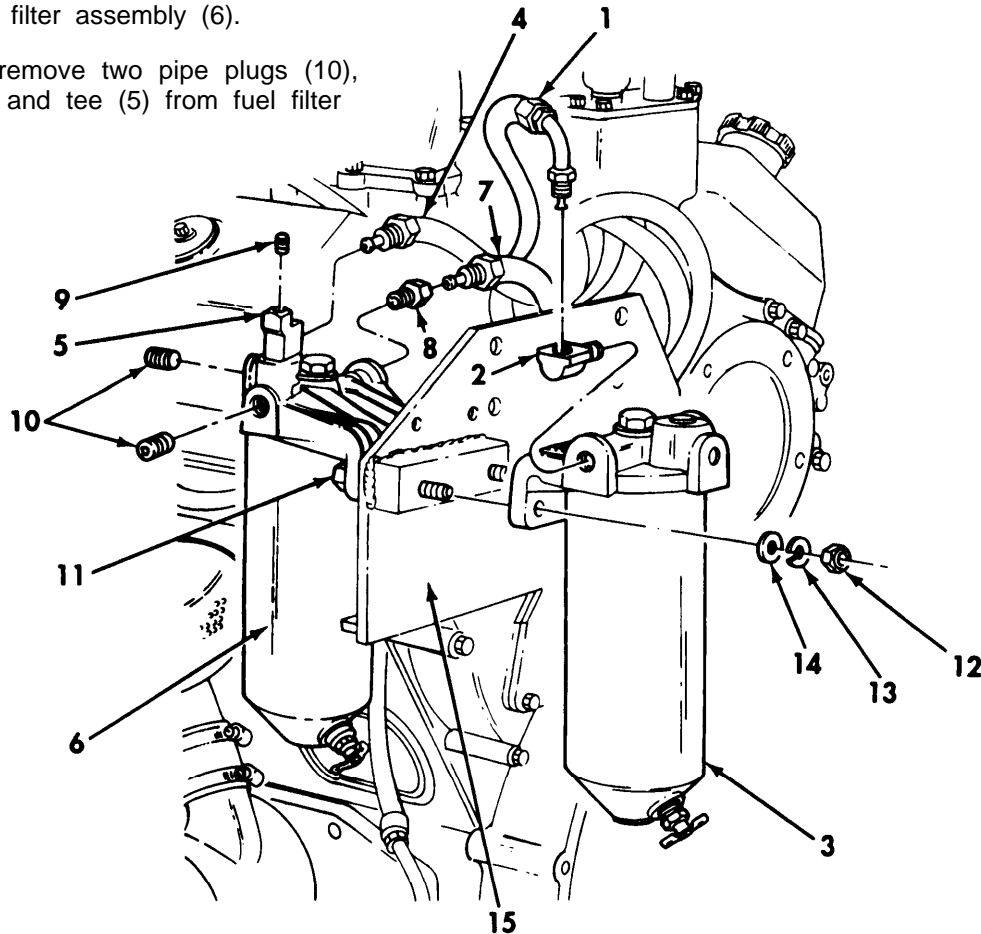
4 Lockwashers (App F, Item 99)
2 Lockwashers (App F, Item 101)

EQUIPMENT CONDITION

Para Description
2-12 Oil filter assembly removed

a. Removal

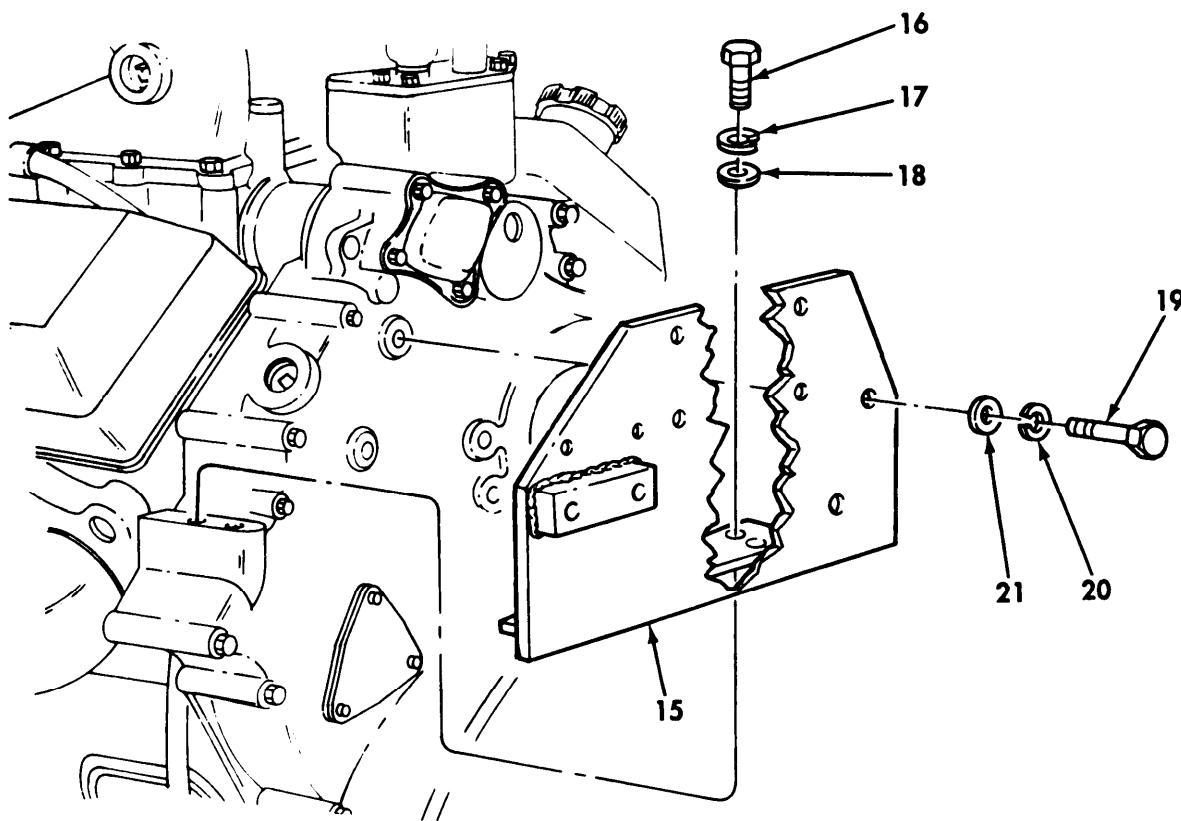
- (1) Disconnect hose assembly (1) from elbow (2) on fuel strainer assembly (3).
- (2) If necessary, remove elbow (2) from fuel strainer assembly (3).
- (3) Disconnect hose assembly (4) from tee (5) on fuel filter assembly (6).
- (4) Disconnect hose assembly (7) from connector (8) on fuel filter assembly (6).
- (5) If necessary, remove pipe plug (9) from tee (5) in fuel filter assembly (6).
- (6) If necessary, remove two pipe plugs (10), connector (8), and tee (5) from fuel filter assembly (6).



NOTE

If it is necessary to remove two screws (11) from upper section of fuel filter assembly, remove the lower canister due to interference (Para 2-37).

- (7) Remove two nuts (12), two lockwashers (13), and two flat washers (14) from two screws (11), fastening fuel filter assembly (6) and fuel strainer assembly (3) to filter mounting bracket (15). Remove fuel strainer and fuel filter assemblies. Discard lockwashers.

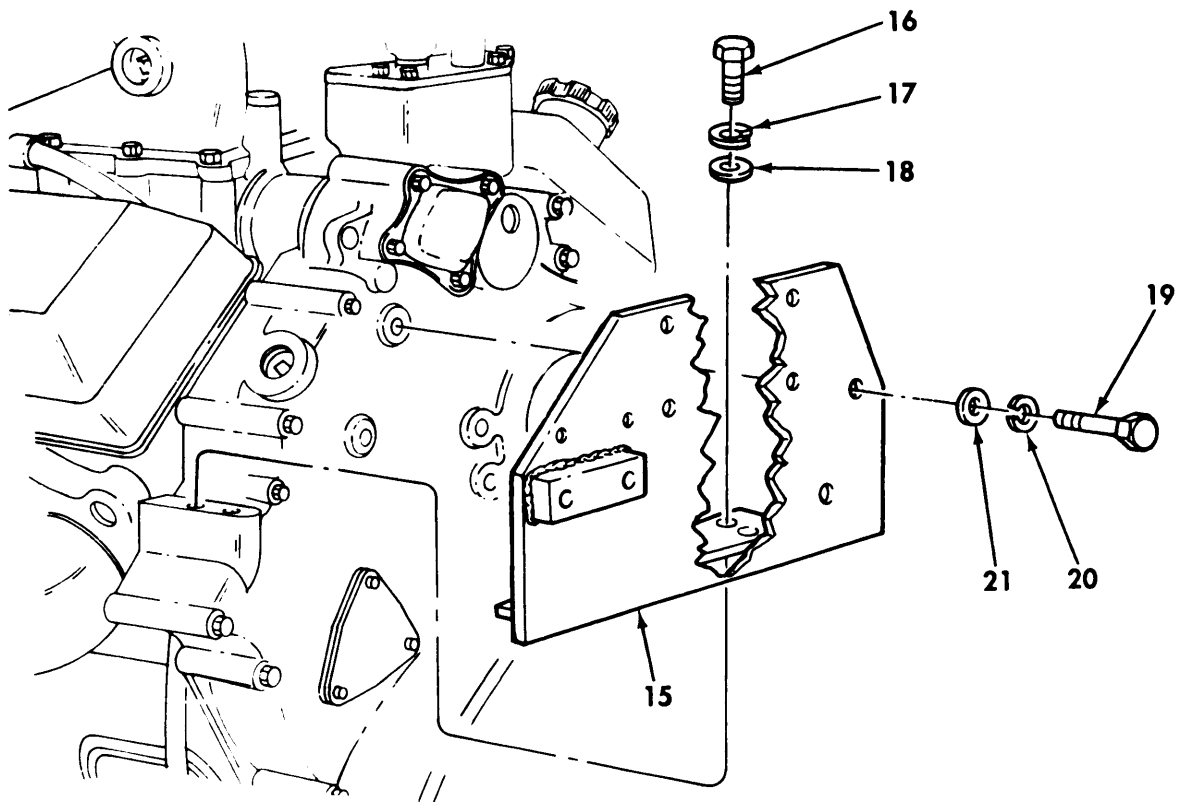


- (8) Remove two short screws (16), two lockwashers (17), two flat washers (18), two long screws (19), two lockwashers (20), two flat washers (21), and filter mounting bracket (15). Discard lockwashers.

**2-20. FUEL FILTERS AND MOUNTING BRACKET REMOVAL/INSTALLATION (MODEL 5063-5392)
(Cont)**

b. Installation

- (1) Install filter mounting bracket (15), two flat washers (21), two lockwashers (20), two long screws (19) (into side of flywheel housing), two flat washers (18), two lockwashers (17), and two short screws (16) (into top of flywheel housing). Torque screws (19) to 71-75 lb-ft (96-102 N·m) and screws 16 to 30-35 lb-ft (41-47 N·m).

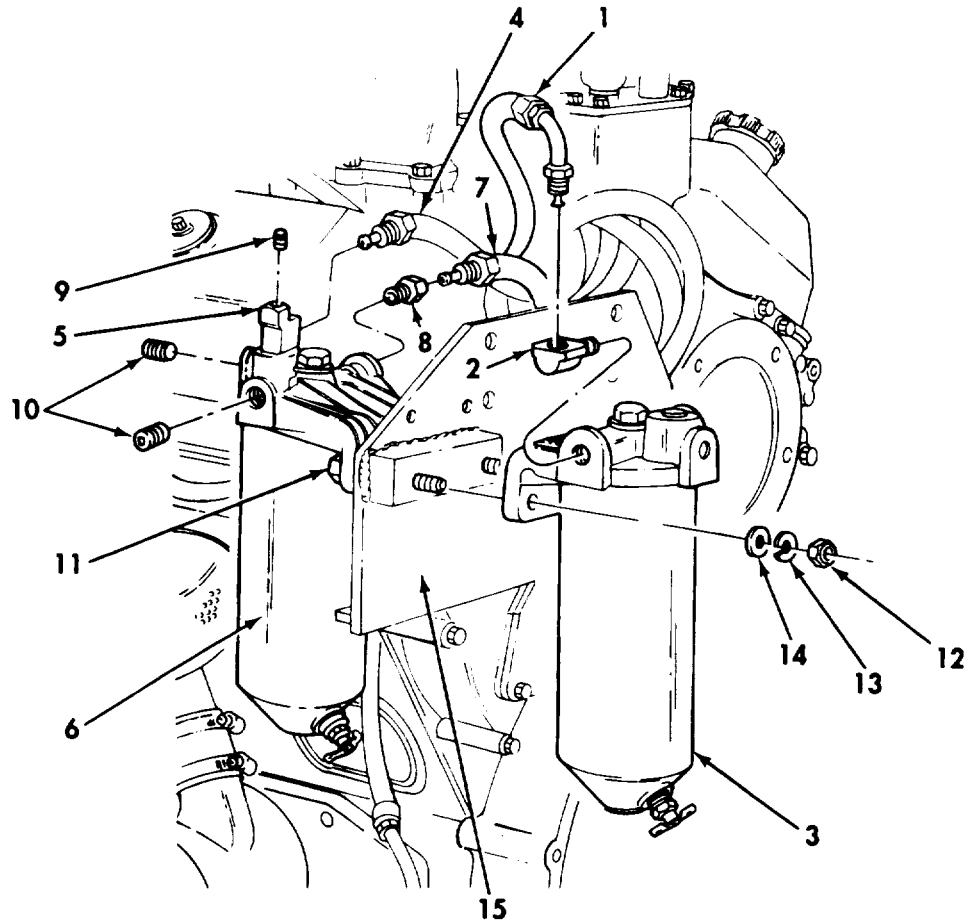


NOTE

If two screws (11) in upper section of fuel filter assembly have been removed, remove the lower canister to install screws due to interference (Para 2-37).

- (2) Install two screws (11), fuel filter assembly (6), fuel strainer assembly (3), two flat washers (14), two lockwashers (13), and two nuts (12) on filter mounting bracket (15). Torque nuts to 30-35 lb-ft (41-47 N·m).

- (3) If removed, install two pipe plugs (10), connector (8), and tee (5) on fuel filter assembly (6).
- (4) If removed, install pipe plug (9) in tee (5) on fuel filter assembly (6).
- (5) If removed, install elbow (2) in fuel strainer assembly (3).



- (6) Connect hose assembly (4) from fuel pump outlet to tee (5) on fuel filter assembly (6). Tighten hose connection.
- (7) Connect hose assembly (7) from left cylinder head to connector (8) on fuel filter assembly (6). Tighten hose connection.
- (8) Connect hose assembly (1) from fuel pump inlet to elbow (2) on fuel strainer assembly (3). Tighten hose connection.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
2-12 Install oil filter assembly

2-21. FUEL FILTERS AND MOUNTING BRACKETS REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

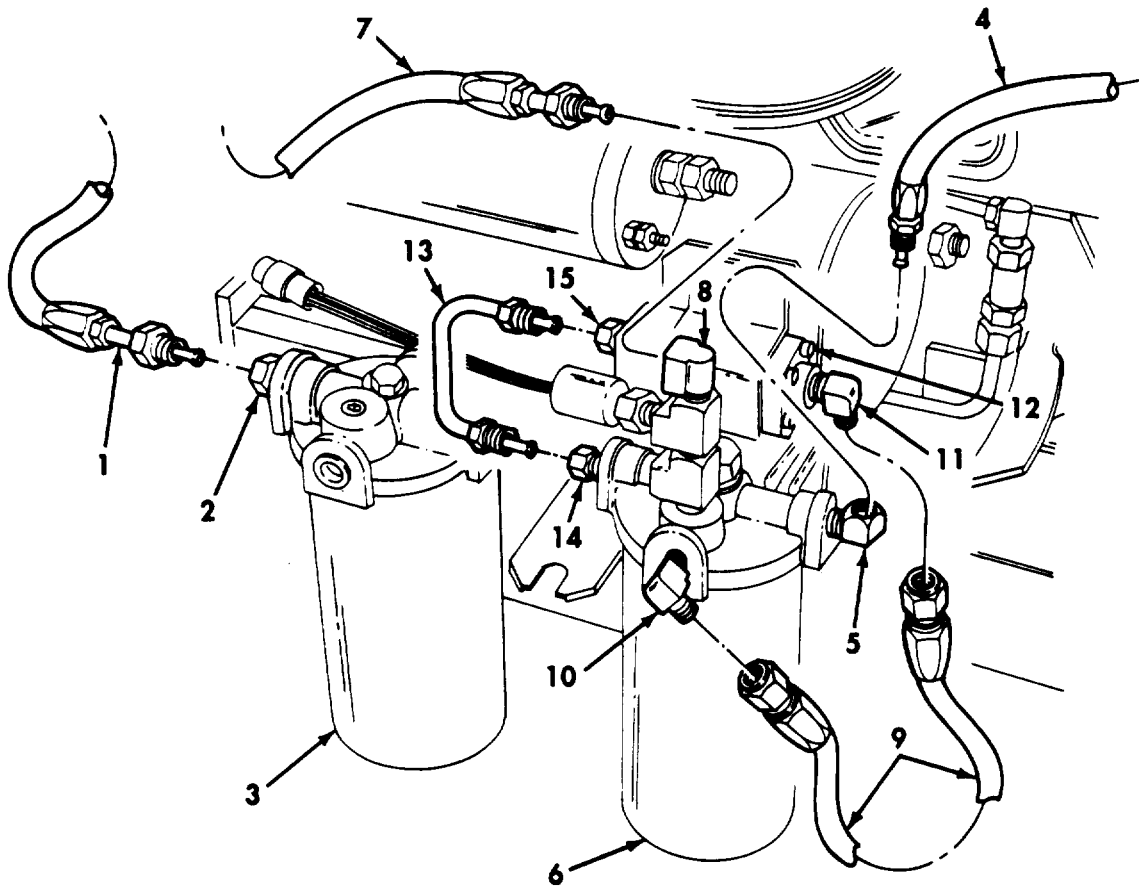
Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Wrench, torque (App B, Item 117)

MATERIALS/PARTS

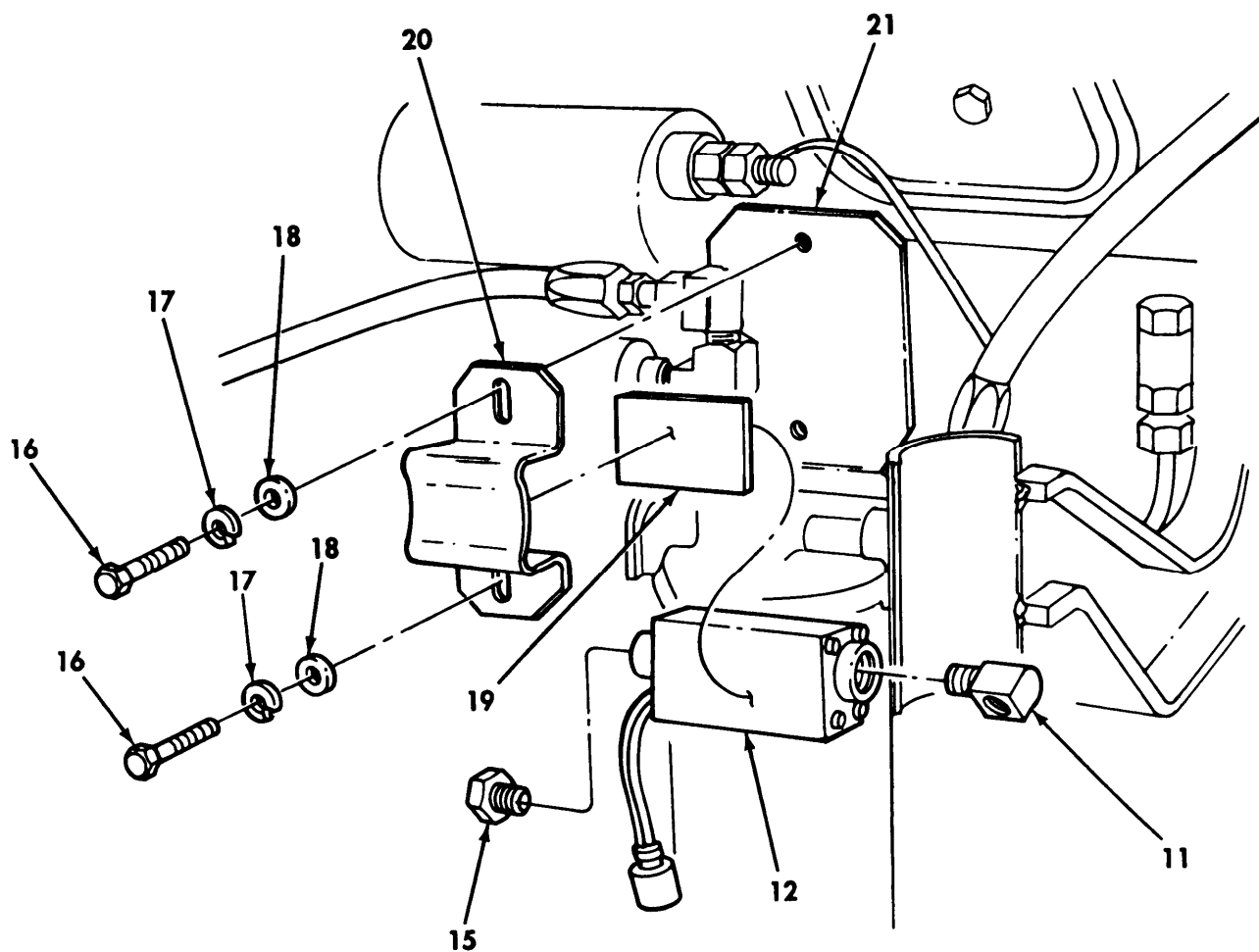
- 1 Lockwasher (App F, Item 99)
- 4 Lockwashers (App F, Item 98)
- 2 Lockwashers (App F, Item 103)
- 8 Nuts, self-locking (App F, Item 107)

a. Removal

- (1) Disconnect hose assembly (1) at connector (2) on fuel strainer assembly (3).
- (2) Disconnect hose assembly (4) at elbow (5) on fuel filter assembly (6).
- (3) Disconnect hose assembly (7) at elbow (8) on fuel filter assembly (6).



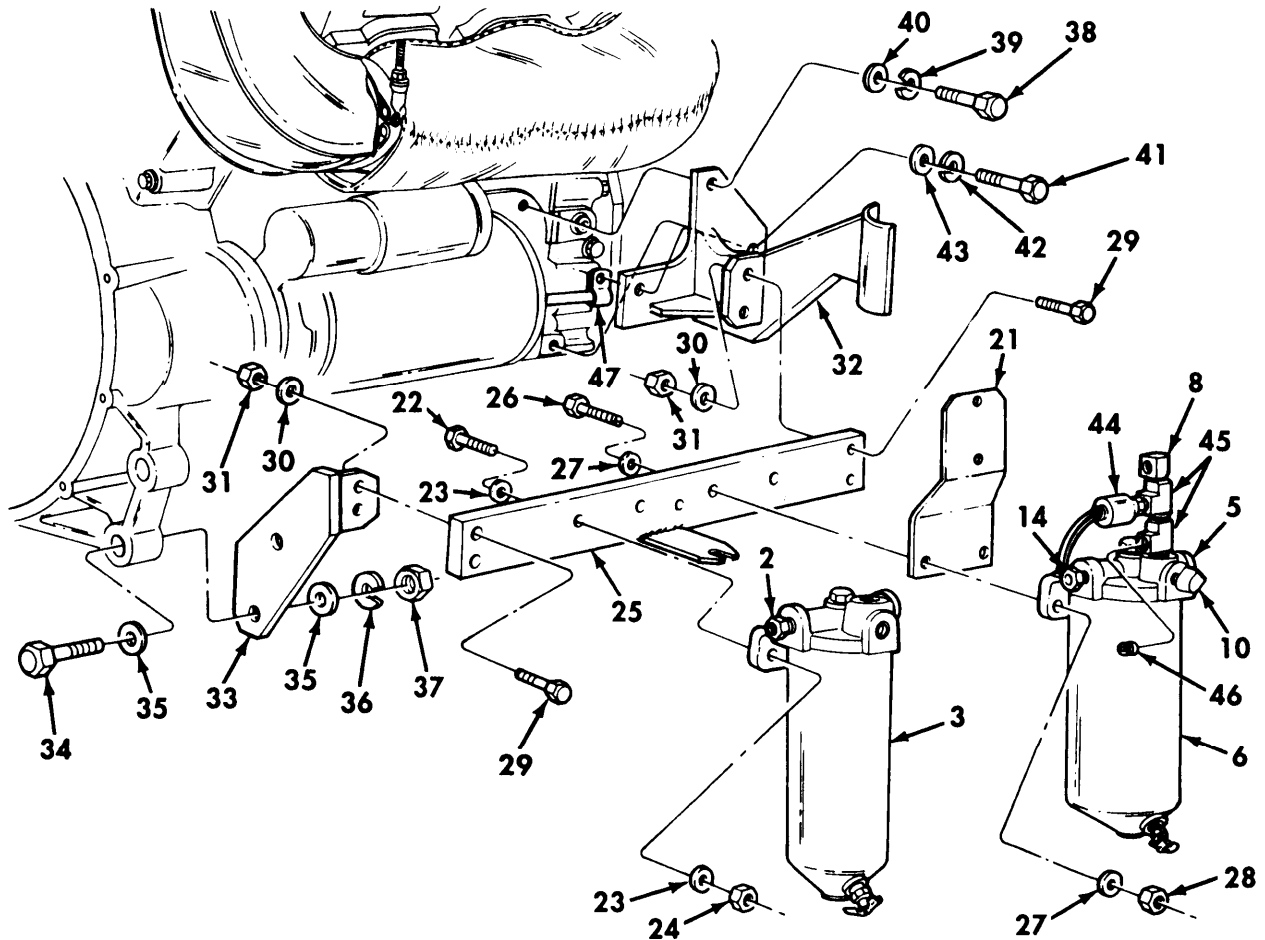
- (4) Disconnect hose assembly (9) at elbow (10) on fuel filter assembly (6) and at elbow (11) on pressure switch (12). Remove hose assembly.
- (5) Disconnect tube assembly (13) at connector (14) on fuel filter assembly (6) and at connector (15) on pressure switch (12). Remove tube assembly.



- (6) Remove two bolts (16), two lockwashers (17), two flat washers (18), pad (19), pressure switch (12), and pad bracket (20) from pressure switch bracket (21). Discard lockwashers.
- (7) If necessary, remove elbow (11) and connector (15) from pressure switch (12).

2-21. FUEL FILTERS AND MOUNTING BRACKETS REMOVAL/INSTALLATION (MODEL 5063-5393) (Cont)

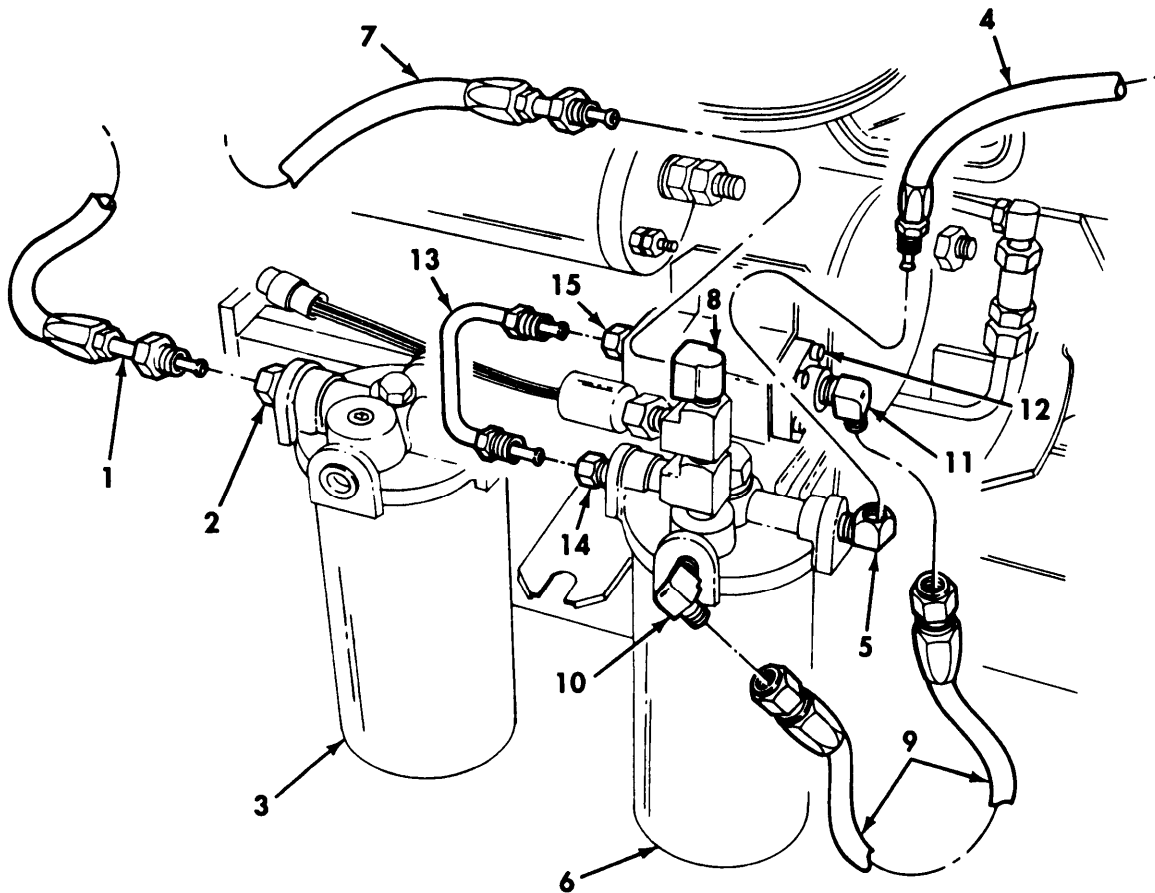
- (8) Remove two screws (22), four flat washers (23), two self-locking nuts (24), and fuel strainer assembly (3) from center mounting bracket (25). Discard self-locking nuts.
- (9) Remove two screws (26), four flat washers (27), two self-locking nuts (28), fuel filter assembly (6), and pressure switch bracket (21) from center mounting bracket (25). Discard self-locking nuts.
- (10) Remove four screws (29), four flat washers (30), four self-locking nuts (31), and center bracket (25) from end bracket (32) and end bracket (33). Discard self-locking nuts.



- (11) Remove two screws (34), four flat washers (35), two lockwashers (36), two nuts (37), and end bracket (33) from engine flywheel housing. Discard lockwashers.
- (12) Remove two small bolts (38), two lockwashers (39), two flat washers (40), large screw (41), lockwasher (42), flat washer (43), and end bracket (32) from side of cylinder block. Discard lockwashers.
- (13) If necessary, remove connector (2) from fuel strainer assembly (3).
- (14) If necessary, remove elbow (5), elbow (8), elbow (10), connector (14), transducer (44), two tees (45), and pipe plug (46) from fuel filter assembly (6).

2-21. FUEL FILTERS AND MOUNTING BRACKETS REMOVAL/INSTALLATION (MODEL 5063-5393) (Cont)

- (10) Connect tube assembly (13) to connector (14) on fuel filter assembly (6) and to connector (15) on pressure switch (12). Tighten tube connections.
- (11) Torque two bolts (16) to 13-17 lb-ft (18-23 N-m).
- (12) Connect hose assembly (9) to elbow (10) on fuel filter assembly (6) and to elbow (11) on pressure switch (12). Tighten hose connections.



- (13) Connect hose assembly (7) to elbow (8) on fuel filter assembly (6). Tighten hose connection.
- (14) Connect hose assembly (4) to elbow (5) on fuel filter assembly (6). Tighten hose connection.
- (15) Connect hose assembly (1) to connector (2) on fuel strainer assembly (3). Tighten hose connection.

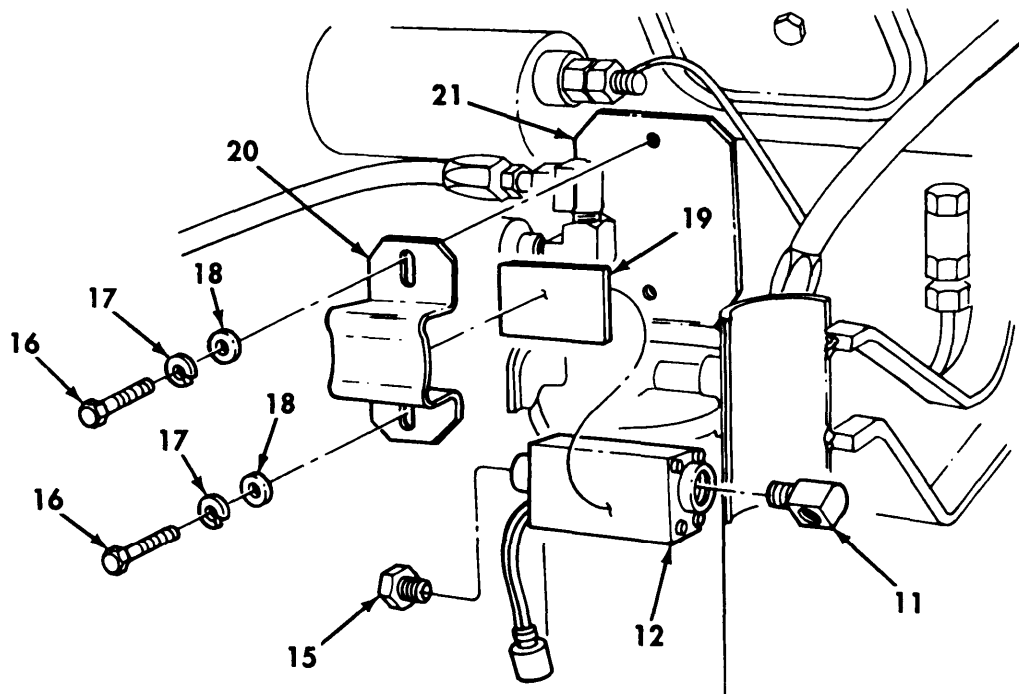
END OF TASK

b. Installation

NOTE

Install lower small bolt (38) through clip (47) on air box drain tube.

- (1) Install end bracket (32), two flat washers (40), two lockwashers (39), two small bolts (38), flat washer (43), lockwasher (42), and large screw (41) on side of cylinder block. Torque two bolts (38) to 13-17 lb-ft (18-23 N-m) and torque screw (41) to 30-35 lb-ft (41-47 N-m).
- (2) Install two screws (34), four flat washers (35), end bracket (33), two lockwashers (36), and two nuts (37) on engine flywheel housing. Torque screws to 240-250 lb-ft (326-340 N-m).
- (3) Install four screws (29), center mounting bracket (25), four flat washers (30), and four self-locking nuts (31) on end bracket (32) and end bracket (33). Torque screws to 30-35 lb-ft (41-47 N-m).
- (4) Install two screws (26), pressure switch bracket (21), fuel filter assembly (6), four flat washers (27), and two self-locking nuts (28) on center mounting bracket (25). Torque screws to 30-35 lb-ft (41-47 N-m).
- (5) Install two screws (22), fuel strainer assembly (3), four flat washers (23), and two self-locking nuts (24) on center mounting bracket (25). Torque screws to 30-35 lb-ft (41-47 N-m).
- (6) If removed, install elbow (5), elbow (10), connector (14), two tees (45), transducer (44), elbow (8), and pipe plug (46) on fuel filter assembly (6) as shown.
- (7) If removed, install connector (2) on fuel strainer assembly (3).



- (8) If removed, install elbow (11) and connector (15) in pressure switch (12).
- (9) Install pressure switch (12), pad (19), pad bracket (20), two flat washers (18), two lockwashers (17), and two bolts (16) on pressure switch bracket (21). Loosely tighten bolts.

2-22. FUEL FILTERS AND MOUNTING BRACKET REMOVAL/INSTALLATION (MODELS 5063-5395 and 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-539F

MATERIALS/PARTS

6 Lockwashers (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

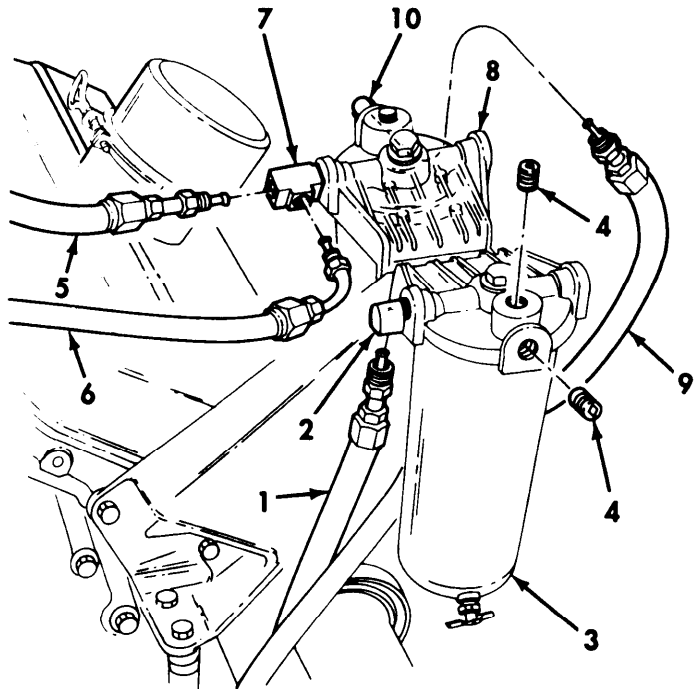
a. Removal

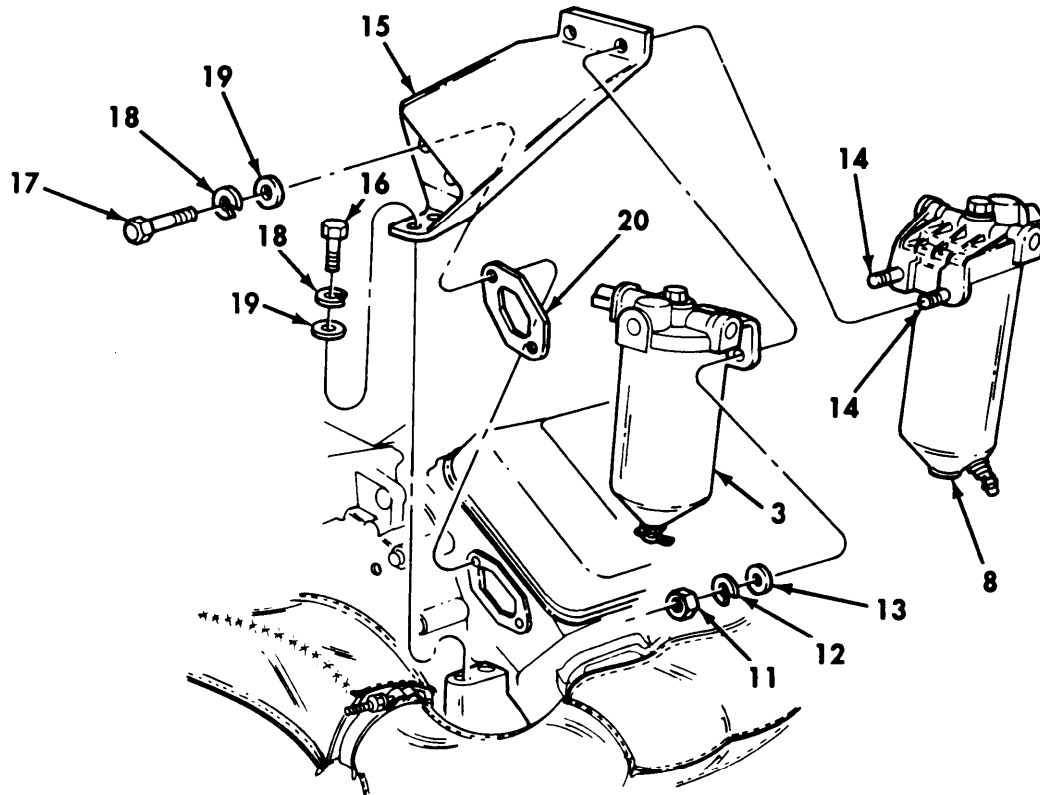
- (1) Disconnect hose assembly (1) at elbow (2) on fuel strainer assembly (3).
- (2) If necessary, remove elbow (2) and two pipe plugs (4) from fuel strainer assembly (3).
- (3) Disconnect hose assembly (5) and hose assembly (6) from tee (7) in fuel filter assembly (8).
- (4) Disconnect hose assembly (9) at elbow (10) on fuel filter assembly (8).
- (5) If necessary, remove tee (7) and elbow (10) from fuel filter assembly (8).

NOTE

To remove two bolts from upper section of fuel filter assembly, remove the lower canister due to interference (Para 2-37).

- (6) Remove two nuts (11), two lockwashers (12), two flat washers (13), two screws (14), fuel filter assembly (8), and fuel strainer assembly (3) from filter mounting bracket (15). Discard lockwashers.
- (7) Remove two short screws (16), two long screws (17), four lockwashers (18), four flat washers (19), filter mounting bracket (15), and gasket (20) from flywheel housing. Discard gasket and lockwashers.





b. Installation

- (1) Install gasket (20), filter mounting bracket (15), four flat washers (19), four lockwashers (18), two long screws (17) (into right cylinder head), and two short screws (16) (into flywheel housing). Torque screws to 30-35 lb-ft (41-47 N·m).

NOTE

To install two screws (14) in upper section of fuel filter assembly, remove the lower canister due to interference (Para 2-37).

- (2) Install two screws (14), fuel filter assembly (8), fuel strainer assembly (3), two flat washers (13), two lockwashers (12), and two nuts (11) on filter mounting bracket (15). Torque nuts to 30-35 lb-ft (41-47 N·m).
- (3) If removed, install tee (7) and elbow (10) in fuel filter assembly (8).
- (4) If removed, install elbow (2) and two pipe plugs (4) in fuel strainer assembly (3).
- (5) Connect hose assembly (9) to elbow (10) on fuel filter assembly (8). Tighten hose connection.
- (6) Connect hose assembly (5) and hose assembly (6) to tee (7) on fuel filter assembly (8). Tighten hose connections.
- (7) Connect hose assembly (1) to elbow (2) on fuel strainer assembly (3). Tighten hose connection.

END OF TASK

2-23. FUEL FILTERS AND MOUNTING BRACKET REMOVAL/INSTALLATION (MODEL 5063-5398)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5398

MATERIALS/PARTS

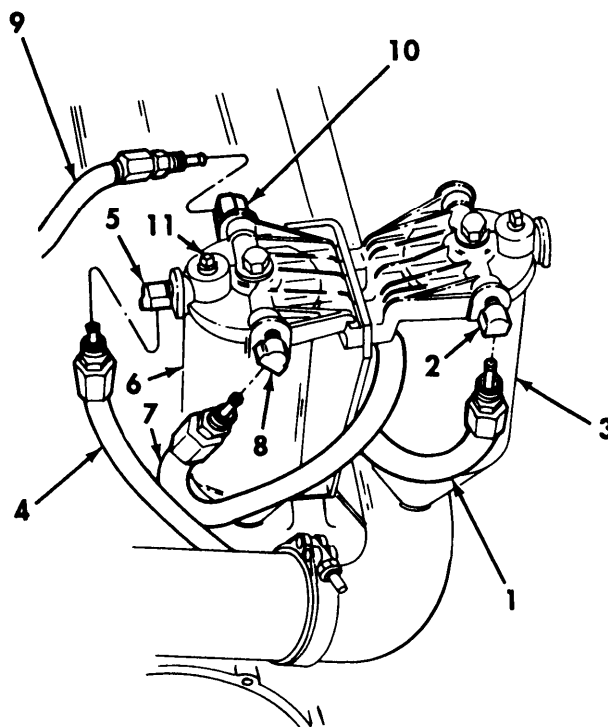
5 Lockwashers (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

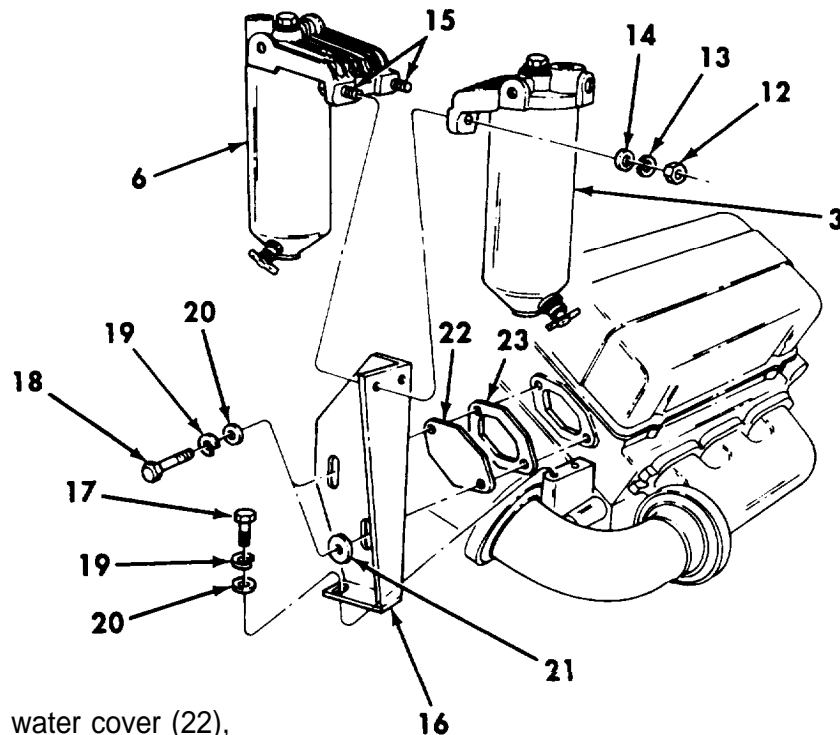
- (1) Disconnect hose assembly (1) from elbow (2) on fuel strainer assembly (3).
- (2) If necessary, remove elbow (2) from fuel strainer assembly (3).
- (3) Disconnect hose assembly (4) from elbow (5) in fuel filter assembly (6).
- (4) Disconnect hose assembly (7) from elbow (8) in fuel filter assembly (6).
- (5) Disconnect hose assembly (9) from elbow (10) in fuel filter assembly (6).
- (6) Remove pipe plug (11) and three elbows (5, 8, and 10) from fuel filter assembly (6).



NOTE

To remove two screws from upper section of fuel filter assembly, remove the lower canister (Para 2-37). Canister and filter head interfere with screws.

- (7) Remove two nuts (12), two lockwashers (13), two flat washers (14), two screws (15), fuel filter assembly (6), and fuel strainer assembly (3) from filter mounting bracket (16). Discard lockwashers.
- (8) Remove short screw (17), two long screws (18), three lockwashers (19), two flat washer (20), special washer (21), filter mounting bracket (16), water cover (22), and gasket (23) from rear of right cylinder head. Discard gasket and lockwashers.



b. Installation

- (1) Install gasket (23), water cover (22), filter mounting bracket (16), special washer (21), two flat washers (20), three lockwashers (19), two long screws (18) (into right cylinder head), and screw (17) into flywheel housing). Torque screws to 30-35 lb-ft (41-47 N•m).

NOTE

To install two screws (15) in upper section of fuel filter assembly, remove the lower canister due to interference (Para 2-37).

- (2) Install two screws (15), fuel filter assembly (6), fuel strainer assembly (3), two flat washers (14), two lockwashers (13), and two nuts (12) on filter mounting bracket (16). Torque nuts to 30-35 lb-ft (41-47 N•m).
- (3) Install pipe plug (11) and three elbows (5, 8, and 10) in fuel filter assembly (6).
- (4) Install elbow (2) in fuel strainer assembly (3).
- (5) Connect hose assembly (9) to outlet port elbow (10) in fuel filter assembly (6). Tighten hose connection.
- (6) Connect hose assembly (7) to outlet port elbow (8) in fuel filter assembly (6). Tighten hose connection.
- (7) Connect hose assembly (4) to inlet port elbow (5) in fuel filter assembly (6). Tighten hose connection.
- (8) Connect hose assembly (1) to outlet port elbow (2) in fuel strainer assembly (3). Tighten hose connection.

END OF TASK

2-24. TURBOCHARGER OIL SUPPLY LINE REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All except model 5063-5299

MATERIALS/PARTS

1 Lockwasher (App F, Item 99)

TOOLS AND SPECIAL TOOLS

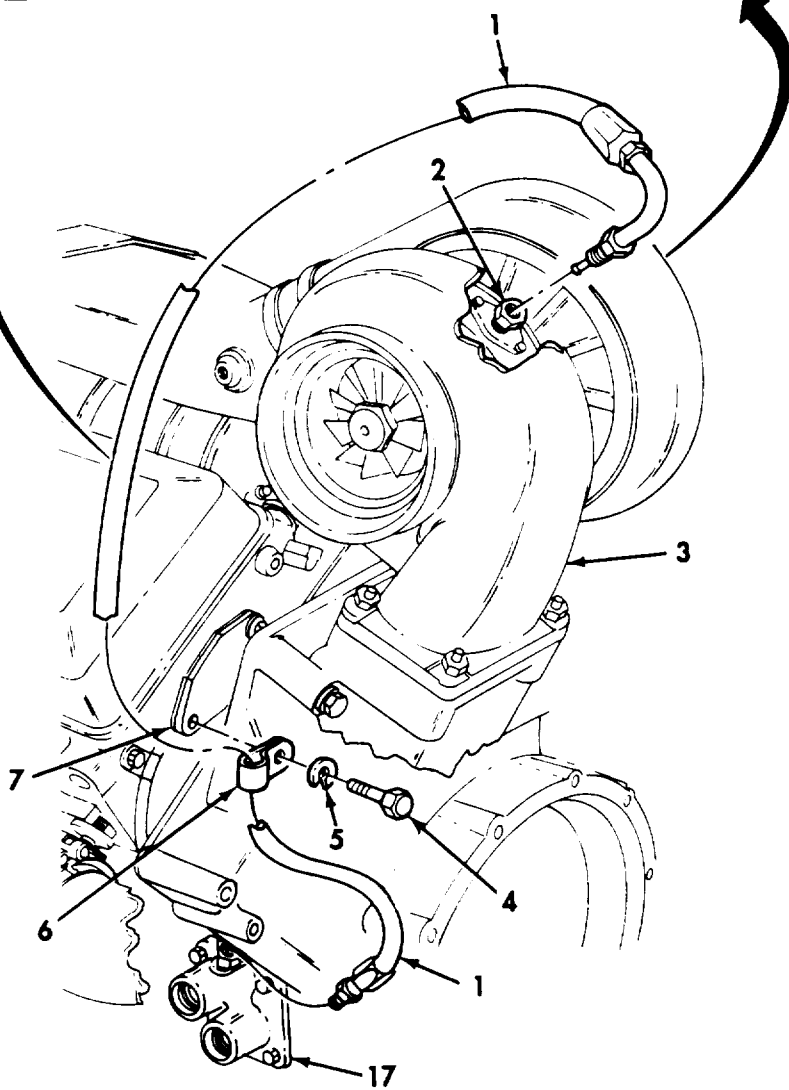
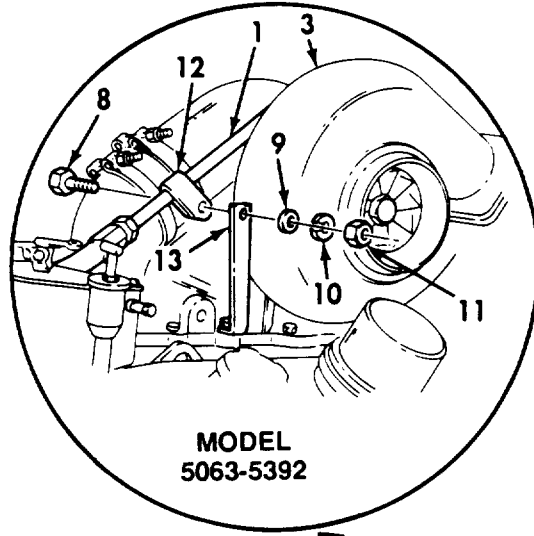
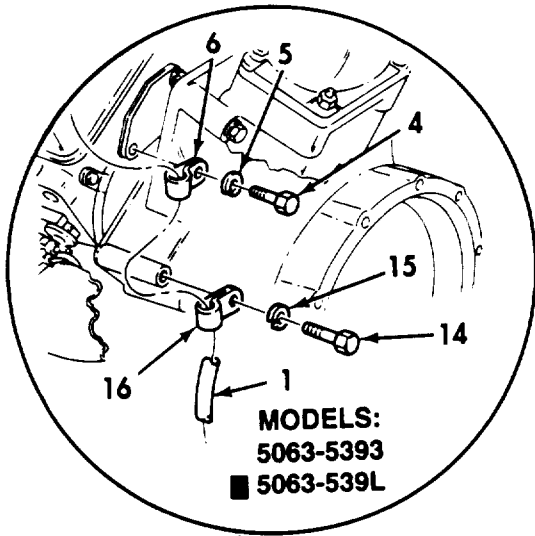
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

- (1) Disconnect hose assembly (1) from connector (2) in top of turbocharger (3).
- (2) Remove screw (4) and lockwasher (5) from clip (6) on hose assembly (1) at plate (7) on rear of left cylinder head. Discard lockwasher. If necessary, remove clip from hose assembly.
- (3) For model 5063-5392, remove screw (8), flat washer (9), lockwasher (10), and nut (11) from clip (12) on hose assembly (1) and from bracket (13) on air inlet housing. Discard lockwasher. If necessary, remove clip from hose assembly.
- (4) For models 5063-5393 and 5063-539L, remove screw (14) and lockwasher (15) from clip (16) on hose assembly (1) at left side of flywheel housing. Replace screw and lockwasher. If necessary, remove clip from hose assembly.
- (5) Disconnect hose assembly (1) from oil filter adaptor (17), Refer to Para 2-12 for model 5063-5392, Para 2-13 for models 5063-5393 and 5063-539L, Para 2-14 for model 5063-5395 and 5063-539F, and Para 2-15 for model 5063-5398,

b. Installation

- (1) Connect hose assembly (1) to connector (2) in top of turbocharger (3). Tighten securely.
- (2) Connect hose assembly (1) to oil filter adaptor (17). Refer to Para 2-12 for model 5063-5392, Para 2-13 for models 5063-5393 and 5063-539L, Para 2-14 for model 5063-5395 and 5063-539F, and Para 2-15 for model 5063-5398,
- (3) Remove screw (4) and lockwasher (5) from plate (7) at rear of left cylinder head and install screw and lockwasher in clip (6) and plate. Torque screw to 30-35 lb-ft (41-47 N•m).
- (4) For model 5063-5392: If removed, install clip (12) on hose assembly (1). Install screw (8), flat washer (9), lockwasher (10), and nut (11) in clip on hose assembly and in bracket (13) 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 (16) on hose assembly (1), Remove screw (14) and lockwasher (15) located at left side of flywheel housing. Install screw (in clip on hose assembly) and lockwasher on flywheel housing. Torque screw to 30-35 lb-ft (41-47 N•m).



END OF TASK

2-25. ELECTRIC STARTER REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 1 Gasket (App F, Item 57)
- 3 Lockwashers (App F, Item 102)

EQUIPMENT CONDITION

- Para Description
- 2-21 Fuel filters and mounting bracket removed (models 5063-5393 and 5063-539L)
- 3-12.1 Disconnect glow plug power harness (model 5063-539L)

a. Removal

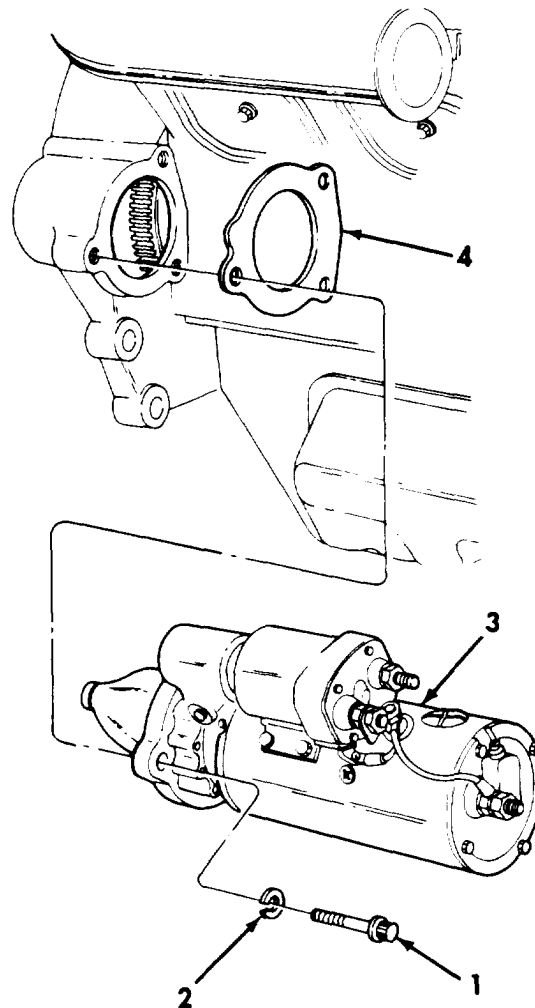
WARNING

Starter motor is heavy. Provide adequate support to electric starter to prevent injury to personnel during removal.

NOTE

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

Remove three bolts (1), three lockwashers (2), electric starter (3), and gasket (4) from flywheel housing. Discard gasket and lockwashers.



b. Installation

Install gasket (4), electric starter (3), three lockwashers (2), and three bolts (1) on flywheel housing, Torque bolts to 95-105 lb-ft (129-143 N•m).

END OF TASK

FOLLOW-ON MAINTENANCE

- Para Description
- 2-21 Install fuel filters and mounting bracket (models 5063-5393 and 5063-539L).
- 3-12.1 Connect glow plug power harness (model 5063-539L)

2-26. AIR BOX DRAINS REMOVAL/INSTALLATION (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUPMODELS

5063-5299

EQUIPMENT CONDITION

Para Description

2-25 Electric starter removed

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

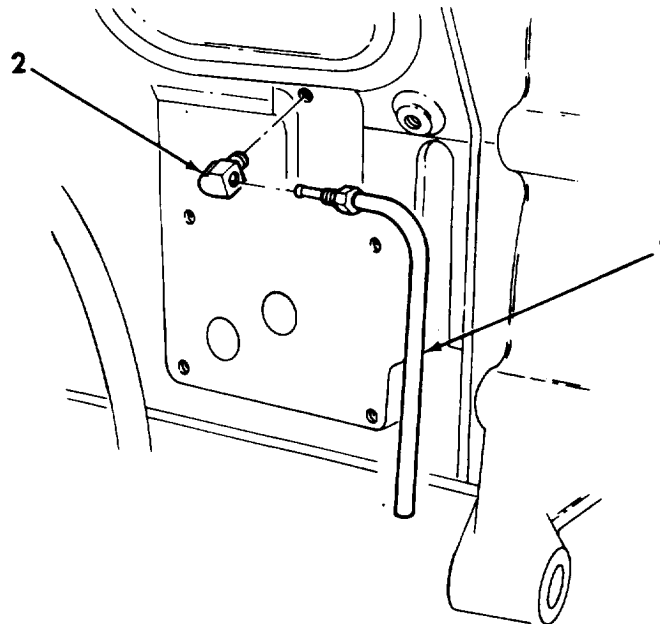
a. Removal**NOTE**

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

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

b. Installation

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

**END OF TASK**FOLLOW-ON MAINTENANCE

Para Description

2-25 Install electric starter.

2-27. AIR BOX DRAINS REMOVAL/INSTALLATION (MODELS 5063-5392,5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392 5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

3 Lockwashers (App F, Item 98)
2 Washers, copper (App F, Item 189)

EXPENDABLE/DURABLE SUPPLIES

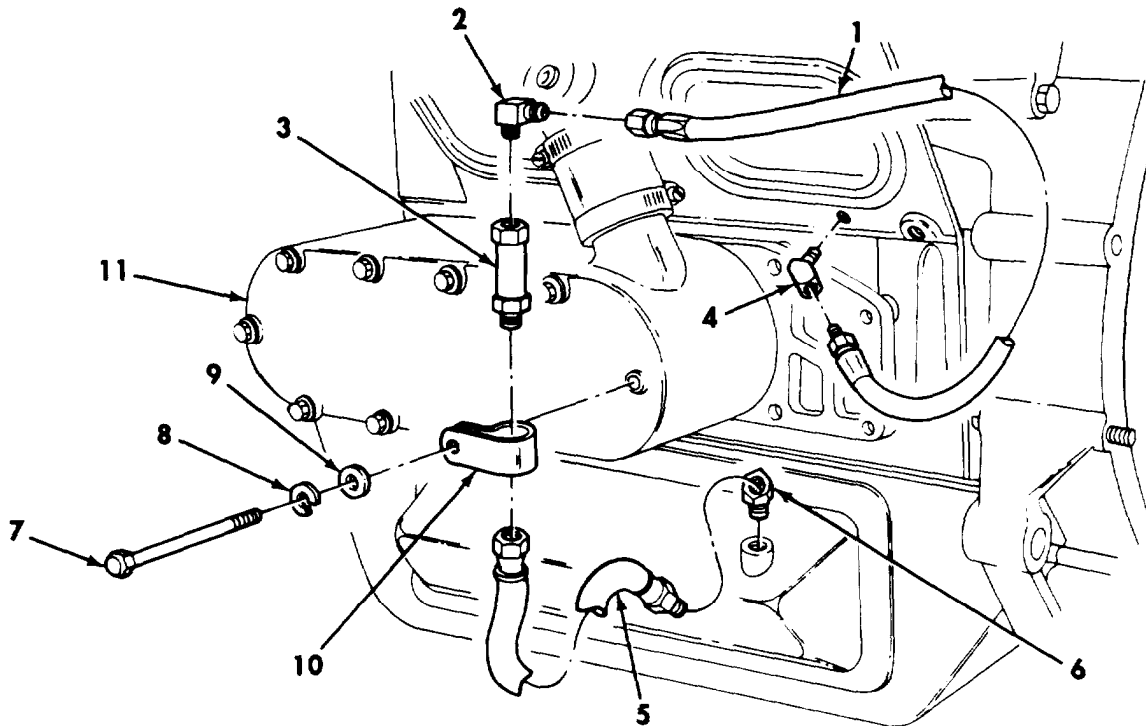
Sealing compound (App C, Item 45)

EQUIPMENT CONDITION

Para	Description
2-21	Fuel filters and mounting brackets removed (models 5063-5393 and 5063-539L).
2-25	Electric starter removed.

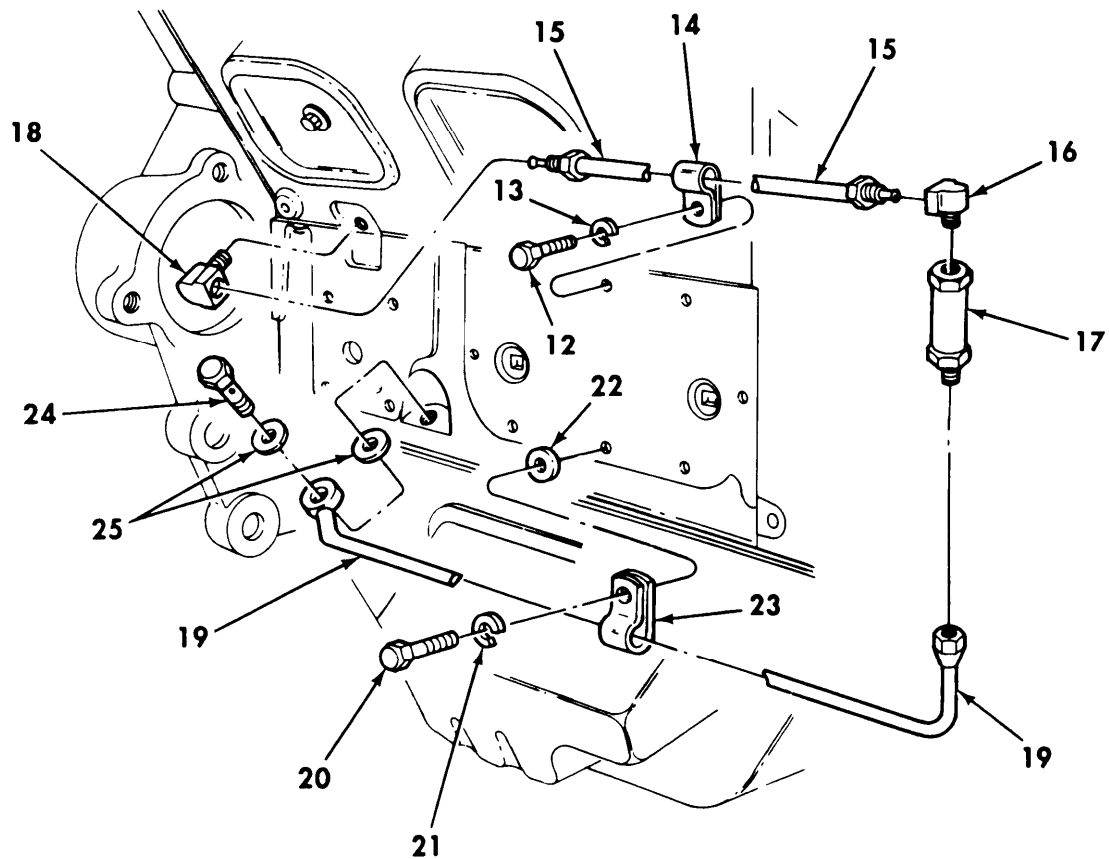
a. Removal

- (1) Remove upper hose assembly (1) from elbow (2), in check valve (3), and elbow (4) on rear left cylinder block.
- (2) Remove lower hose assembly (5) from check valve (3) and elbow (6) on rear left oil pan.



- (3) If oil cooler has not been removed, remove screw (7), lockwasher (8), and flat washer (9) from clip (10) on oil cooler (11). Discard lockwasher.
- (4) Remove elbow (2) from check valve (3), elbow (4) from left side of cylinder block, and elbow (6) from left side of oil pan. If necessary, remove clip (10) from check valve.

- (5) Remove bolt (12) and lockwasher (13) from clip (14) on upper tube assembly (15). Discard lockwasher.
- (6) Remove upper tube assembly (15) from elbow (16), in check valve (17), and elbow (18) in rear right cylinder block. If necessary, remove clip (14) from tube assembly.
- (7) Disconnect lower tube assembly (19) from check valve (17). Remove check valve.
- (8) Remove elbow (16) from check valve (17) and elbow (18) from cylinder block.

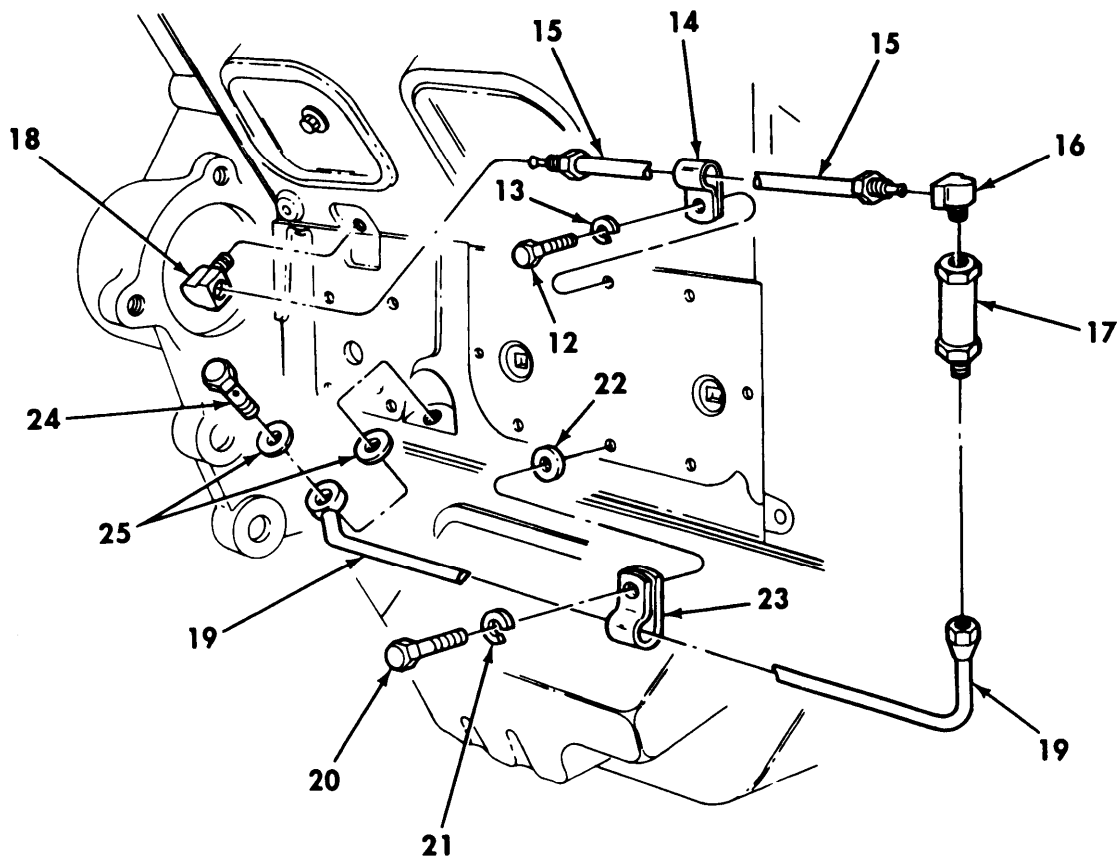


- (9) For model 5063-5392, remove bolt (20), lockwasher (21), and spacer (22) from clip (23) on lower tube assembly (19). Discard lockwasher.
- (10) Remove adaptor (24), two copper washers (25), and lower tube assembly (19) from cylinder block. If necessary, remove clip (23) from tube assembly. Discard flat washers.

2-27. AIR BOX DRAINS REMOVAL/INSTALLATION (MODELS 5063-5392 AND 5063-5393) (Cont)

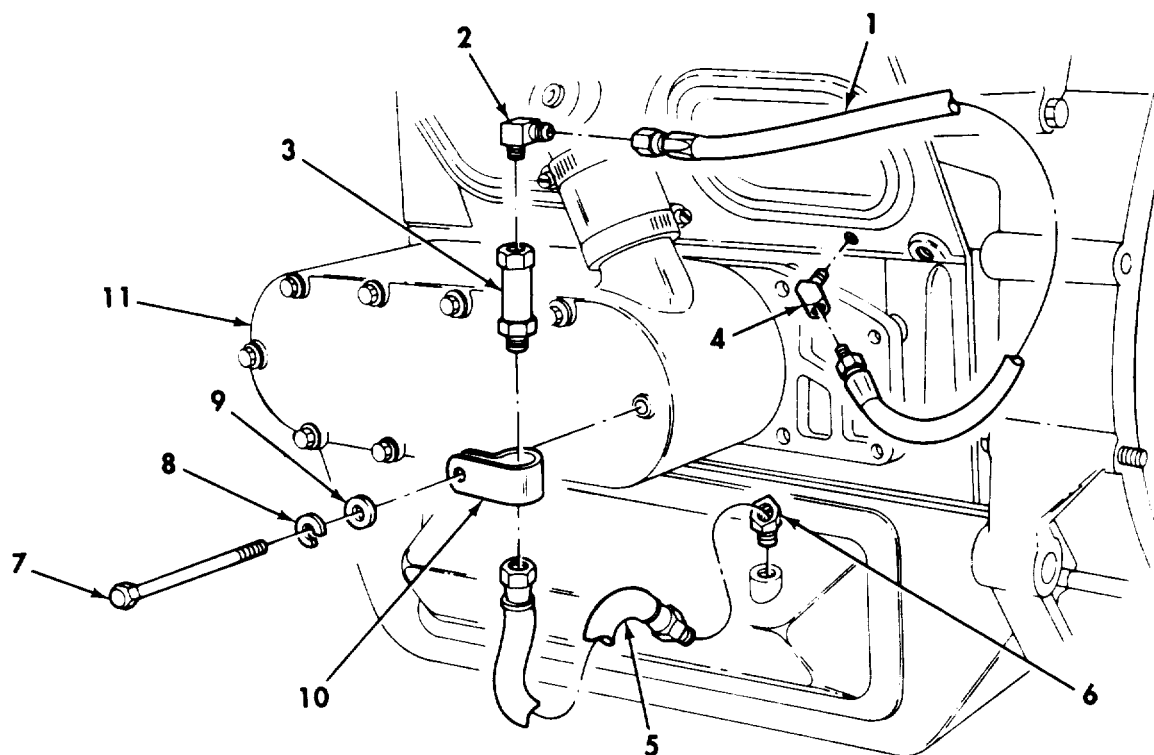
b. Installation

- (1) Loosely install lower tube assembly (19), adaptor (24), and two copper washers (25) on right side of cylinder block.
- (2) Coat threads on elbow (18) with a pipe sealing compound and install elbow into cylinder block with port facing toward front of engine.
- (3) Install elbow (16) in top of check valve (17) and tighten securely.
- (4) Loosely connect lower tube assembly (19) to bottom of check valve (17). If removed, install clip (23) on lower tube assembly.



- (5) Loosely install upper tube assembly (15) in elbow (18) and elbow (16) in check valve (17). If removed, install clip (14) on upper tube assembly.
- (6) Install lockwasher (13) and bolt (12) through clip (14) into cylinder block.
- (7) For model 5063-5392, install spacer (22), lockwasher (21), and bolt (20) through clip (23) into cylinder block.
- (8) Securely tighten tube assembly (15) and tube assembly (19). Torque adaptor (24) to 14-16 lb-ft (19-22 N-m). Torque bolt (12) and bolt (20) to 13-17 lb-ft (18-23 N-m).

- (9) Coat threads on elbow (4) with a pipe 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 (6) in oil pan and tighten securely with port facing outward from engine.
- (11) Install elbow (2) in top of check valve (3) and tighten securely. If removed, install clip (10) on check valve.
- (12) Connect upper hose assembly (1) to elbow (4) in cylinder block. Tighten securely.



- (13) Connect lower hose assembly (5) to elbow (6) in oil pan. Tighten securely.
- (14) If oil cooler is installed, install screw (7) through clip (10), lockwasher (8), and flat washer (9) in oil cooler. Torque screw to 13-17 lb-ft (18-23 N•m).
- (15) Connect hose assembly (1) to elbow (2), in check valve (3), and hose assembly (5) to bottom of check valve. Tighten securely.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

2-25 Install electric starter.

2-21 Install fuel filters and mounting brackets (models 5063-5393 and 5063-539L).

2-28. AIR BOX DRAINS REMOVAL/INSTALLATION (MODELS 5063-5395 AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-539F

MATERIALS/PARTS

1 Lockwashers (App F, Item 98)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

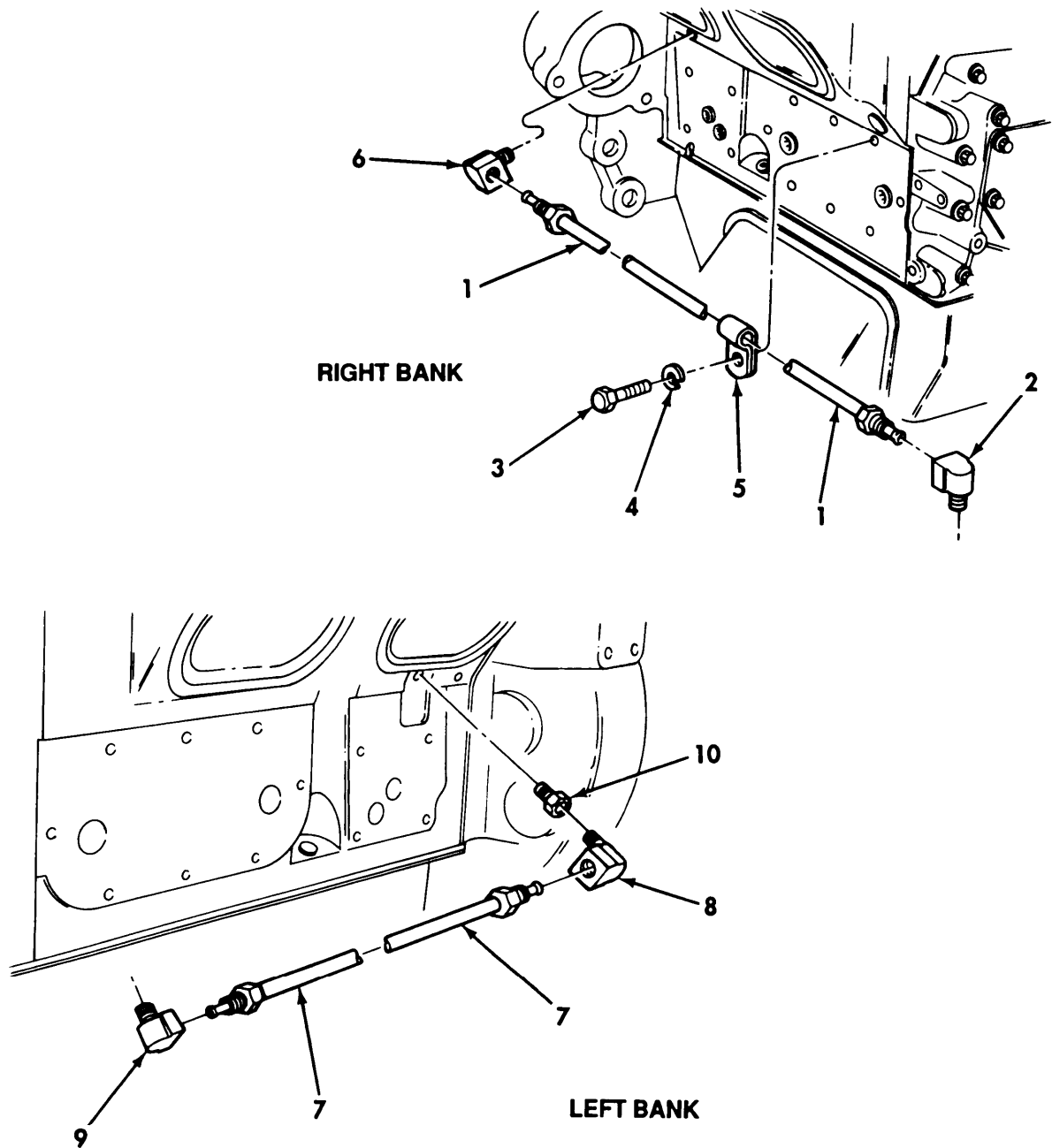
Para Description
2-25 Electric starter removed,

a. Removal

- (1) Disconnect right air box drain tube assembly (1) from elbow (2).
- (2) Remove bolt (3) and lockwasher (4) securing clip (5) on air box drain tube assembly (1) to right side of cylinder block. Discard lockwasher. If necessary, remove clip from tube assembly.
- (3) Remove air box drain tube assembly (1) from elbow (6) in right side of cylinder block.
- (4) Remove elbow (6) from right side of cylinder block.
- (5) Remove air box drain tube assembly (7) from elbow (8) in left side rear of cylinder block.
- (6) Disconnect air box drain tube assembly (7) from elbow (9).
- (7) Remove elbow (8) and pipe coupling (10) from left side of cylinder block.

b. Installation

- (1) Install pipe coupling (10) in left side of cylinder block. Install elbow (8) in coupling with port facing front of engine.
- (2) Connect air box drain tube assembly (7) to elbow (9).
- (3) Install air box drain tube assembly (7) in elbow (8) on left side of cylinder block. Tighten securely.
- (4) Install elbow (6) in right side of cylinder block with port facing front of engine.
- (5) Connect air box drain tube assembly (1) to elbow (2).
- (6) Install air box drain tube assembly (1) in elbow (6) on right side of cylinder block. Tighten securely.
- (7) If removed, install clip (5) on air box drain tube assembly (1). Install lockwasher (4) and bolt (3), through clip on air box drain tube assembly, into right side of cylinder block. Torque bolt to 13-17 lb-ft (18-23 N•m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
 2-25 Install electric starter.

2-29. AIR BOX DRAIN REMOVAL/INSTALLATION (MODEL 5063-5398)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

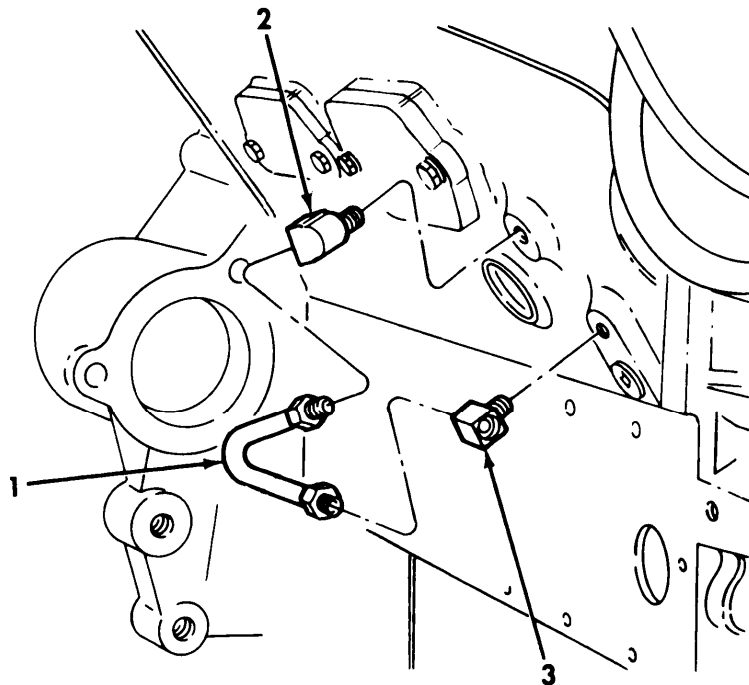
5063-5398

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

a. Removal

- (1) Disconnect air box drain tube assembly (1) from elbow (2) and tee (3) at front right side of cylinder block. Remove tube assembly.
- (2) Remove elbow (2) and tee (3) from front right side of cylinder block.



b. Installation

- (1) Install elbow (2) in right side of cylinder block with end facing toward rear and downward at a 45 degree angle.
- (2) Install tee (3) in right side of cylinder block with pipe-to-tube ports facing front and rear.
- (3) Install air box drain tube assembly (1) in elbow (2) and tee (3). Tighten securely.

END OF TASK

**Section IV. REMOVAL AND INSTALLATION FROM/TO CONTAINER
AND TO/FROM MAINTENANCE STAND**

Contents	Para	Page
Engine From/To Container (Model 5063-5299)	2-30..	2-76
Engine From/To Container (Models 5063-5299, 5063-5392, and 5063-5393)	2-31 . .	2-80
Engine From/To Container (Model 5063-5395, 5063-5398, and 5063-539F)	2-32 . .	2-84
Engine Removal/Installation to Maintenance Stand	2-33 . .	2-88

2-30. ENGINE FROM/TO CONTAINER (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299

TOOLS AND SPECIAL TOOLS

Tool set, general mechanics (App B, Item 107)

TOOLS AND SPECIAL TOOLS (Cont)

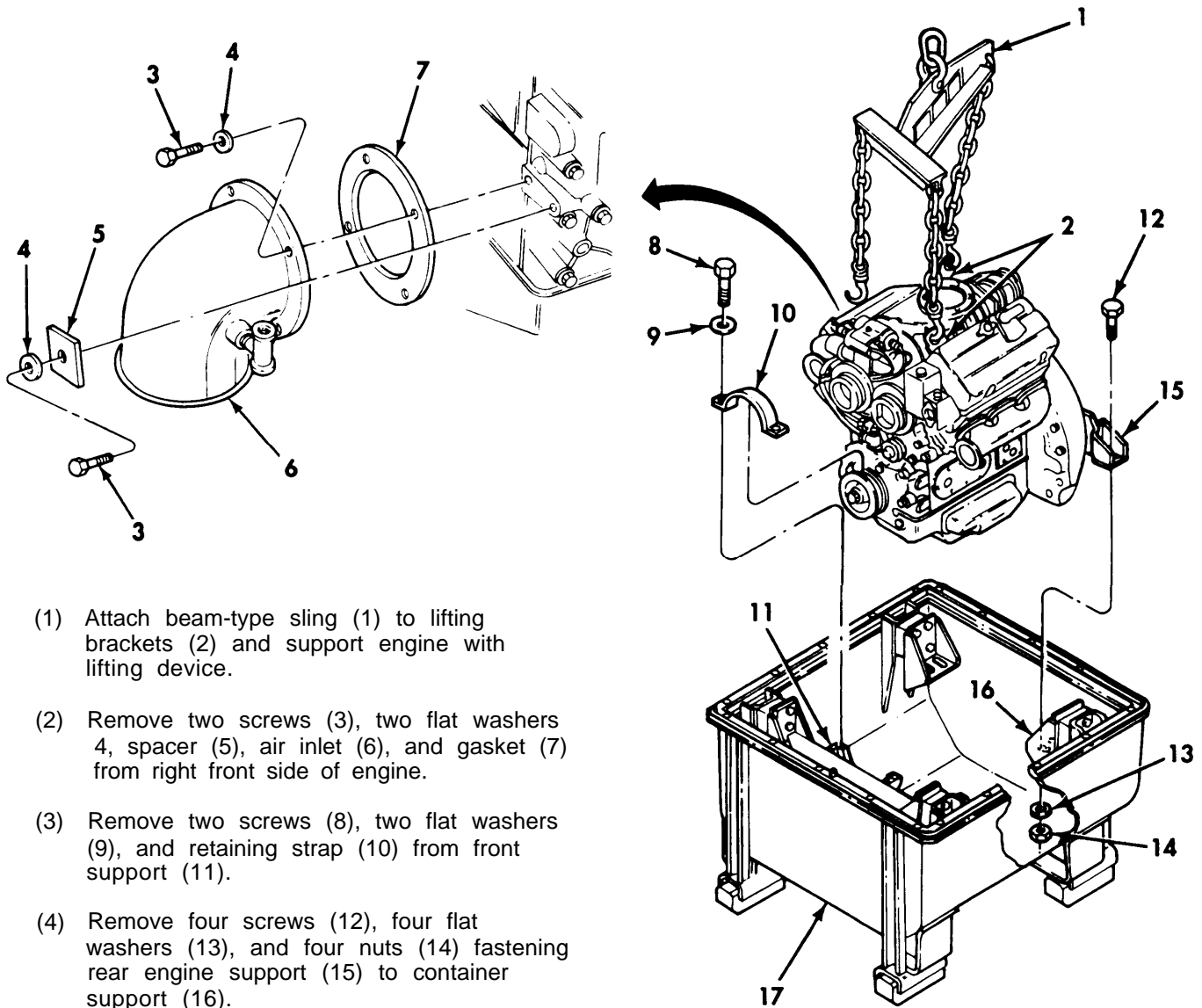
Sling, beam-type (App B, Item 92)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para Description
2-3 Container top removed.

PERSONNEL REQUIRED: 2

a. Removal



- (1) Attach beam-type sling (1) to lifting brackets (2) and support engine with lifting device.
- (2) Remove two screws (3), two flat washers (4), spacer (5), air inlet (6), and gasket (7) from right front side of engine.
- (3) Remove two screws (8), two flat washers (9), and retaining strap (10) from front support (11).
- (4) Remove four screws (12), four flat washers (13), and four nuts (14) fastening rear engine support (15) to container support (16).

WARNING

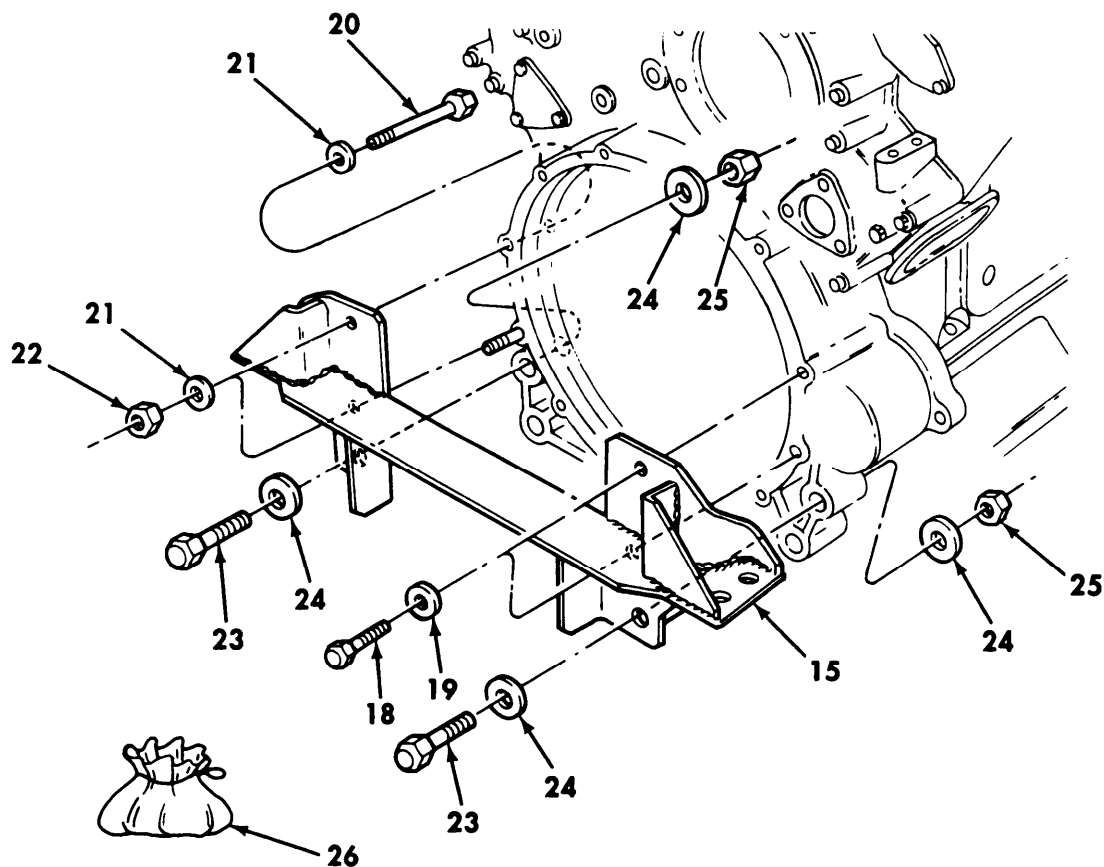
Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension. Equipment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

- (5) Remove engine from lower half of container (17).

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.

- (6) With engine supported by sling, remove two screws (18) and two flat washers (19) from right side of engine support (15). Remove two screws (20), four flat washers (21), and two nuts (22) from left side. Remove remaining two screws (23), four flat washers (24), two nuts (25), and engine support from engine. Place screws, washers, and nuts in mailbag (26) and store engine support and mailbag in lower half of container.

**CAUTION**

Always install top of container on bottom of container (Para 2-3) after the engine has been removed to avoid weather damage of container.

2-30. ENGINE FROM/TO CONTAINER (Model 5063-5299) (Cont)

b. Installation

WARNING

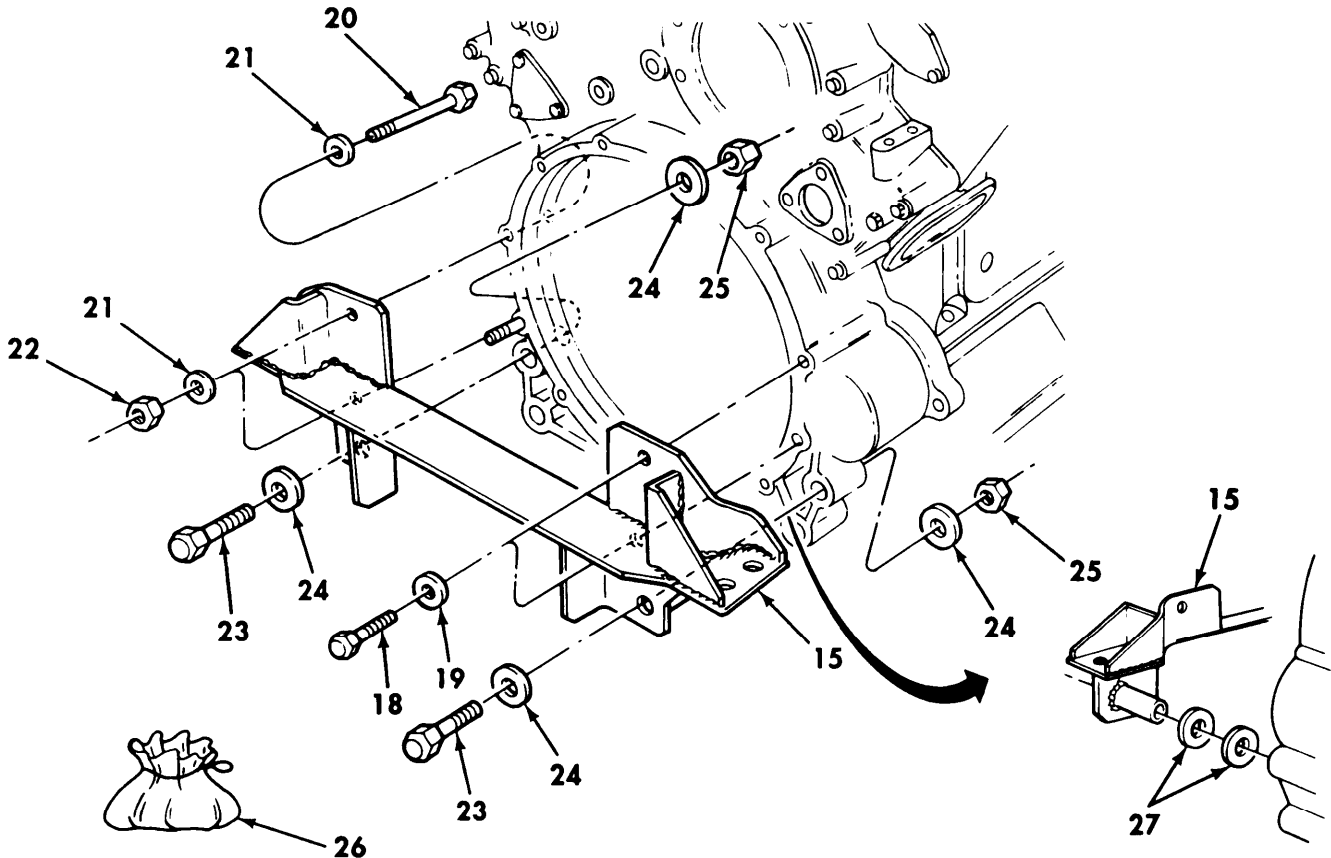
Never crawl under equipment when performing maintenance unless equipment is securely blocked. Keep clear of equipment when it is being raised or lowered. Do not allow heavy components to swing while suspended by lifting device. Exercise caution when working near a cable or a chain under tension. Equipment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

- (1) Attach a beam-type sling (1) to lifting brackets (2) and support engine with lifting device.
- (2) Remove mailbag (26) and engine support (15) from bottom of container. Remove screws, washers, and nuts from mailbag.

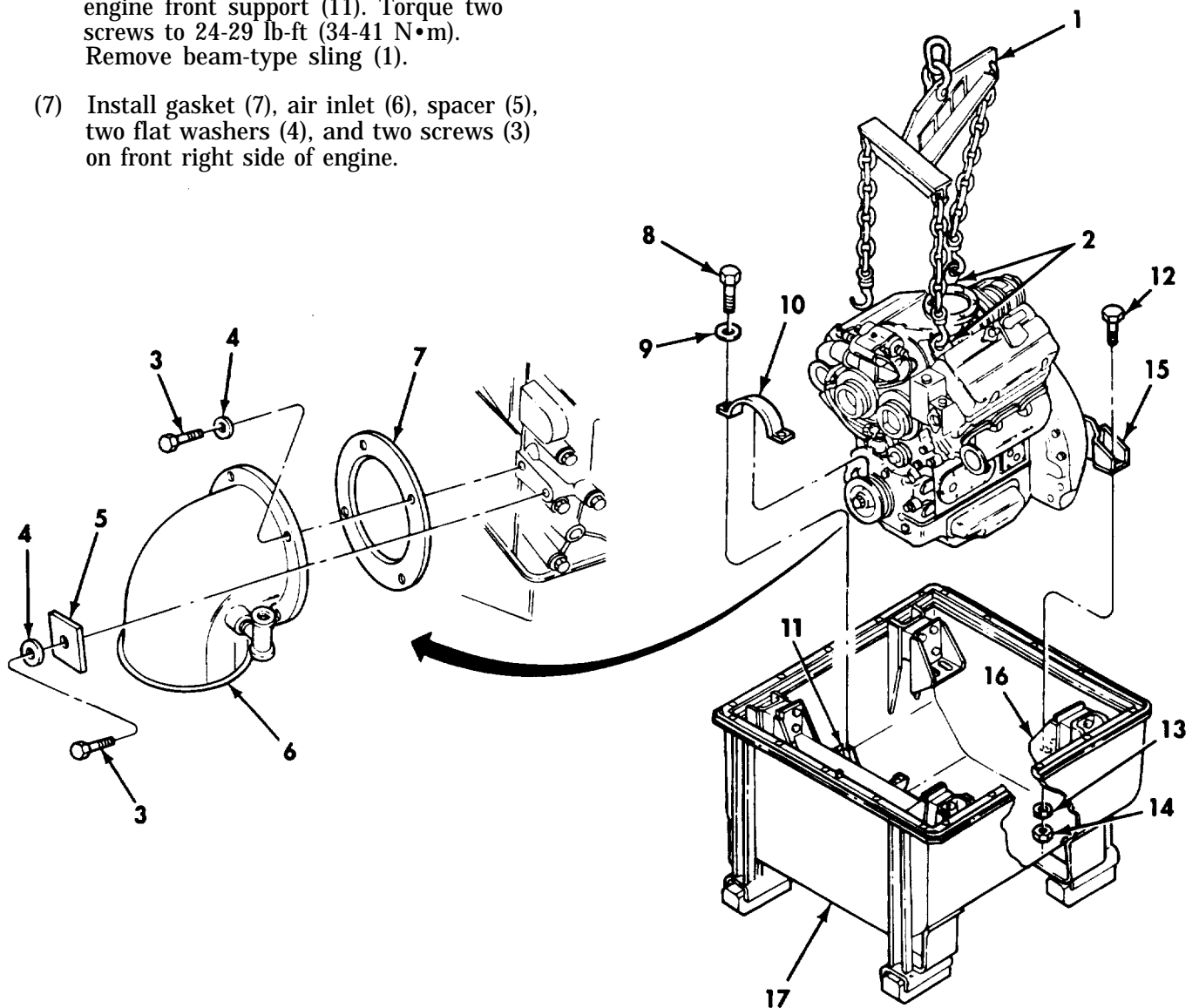
NOTE

Use two flat washers (27) between engine boss and engine support (15) 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 (23), four flat washers (24), engine support (15), and two nuts (25) to rear of engine. Install two screws (20), four flat washers (21) and two nuts (22) in support at left side rear of engine. Install two screws (18) and two flat washers (19) in support at right side rear of engine. Torque two screws (23) to 107-118 lb-ft (150-165 N-m). Torque two screws (18) and (20) to 22-24 lb-ft (31-34 N-m).



- (4) Install engine in lower half of container (17).
- (5) Install four screws (12), four flat washers (13), and four nuts (14) in rear support (15) to connect support (15) to two engine supports (16). Torque screws to 107-118 lb-ft (150-165 N•m).
- (6) Install retaining strap (10), two flat washers (9), and two screws (8) on engine front support (11). Torque two screws to 24-29 lb-ft (34-41 N•m). Remove beam-type sling (1).
- (7) Install gasket (7), air inlet (6), spacer (5), two flat washers (4), and two screws (3) on front right side of engine.



END OF TASK

2-31. ENGINE FROM/TO CONTAINER (MODELS 5063-5299,5063-5392, 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5392 5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool set, general mechanics (App B, Item 107)
Sling, beam-type (App B, Item 92)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

4 Lockwashers (App F, Item 101)

EQUIPMENT CONDITION

Para Description
2-3 Container top removed.

PERSONNEL REQUIRED: 2

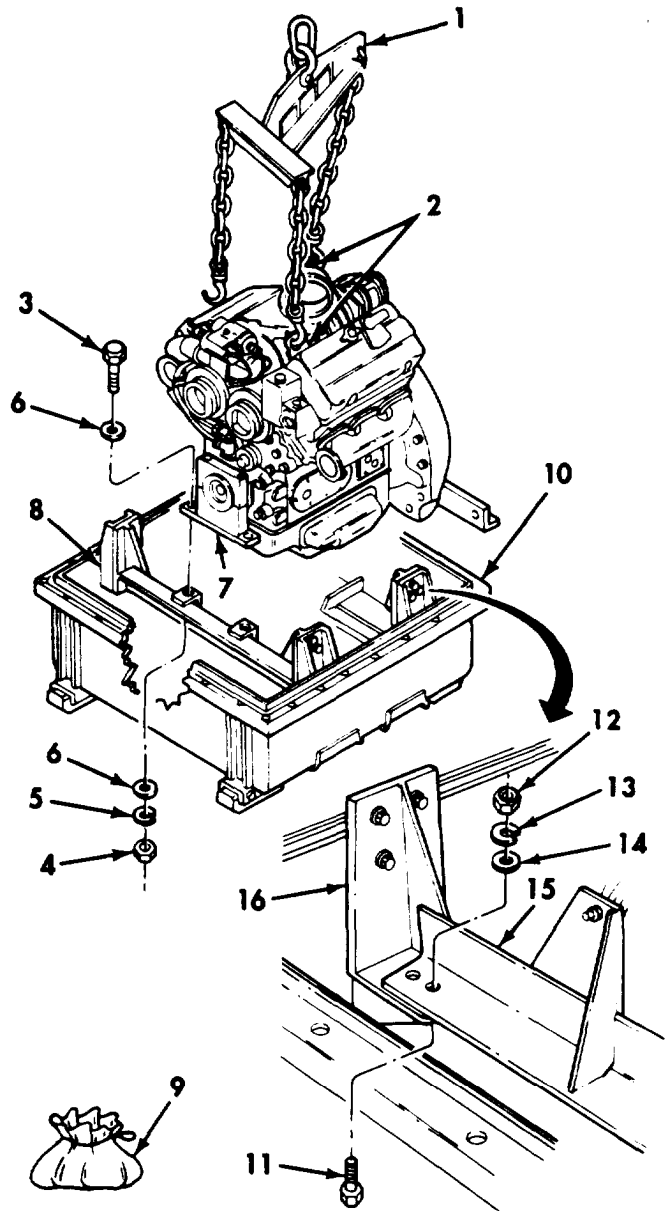
a. Removal

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

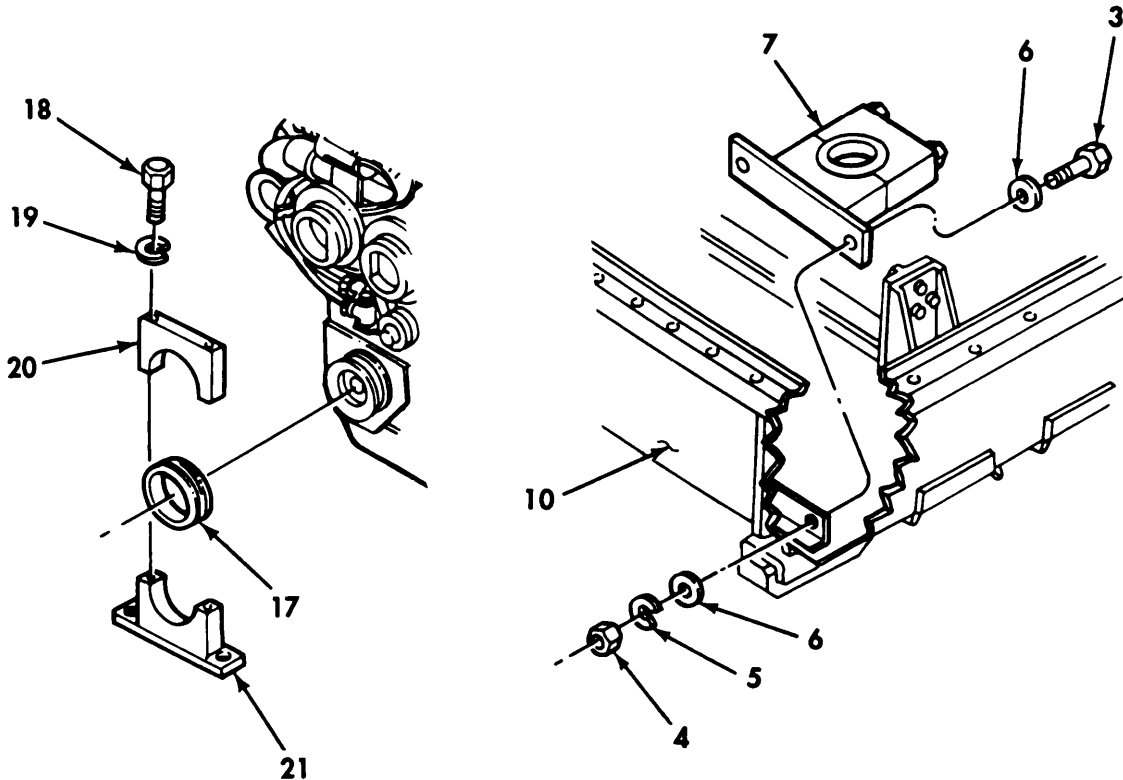
- (4) Remove engine from lower half of container (10).



NOTE

Do not discard preformed packing (17) 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.

- (5) For model 5063-5299, remove two screws (18), two lockwashers (19), upper shipping trunnion block (20), preformed packing (17), and lower shipping trunnion block (21) from front of engine.
- (6) For model 5063-5299, install two screws (18), two lockwashers (19), upper shipping trunnion block (20), and preformed packing (17) on lower shipping trunnion block (21). Tighten screws.
- (7) For model 5063-5299, install two screws (3), four flat washers (6), two lockwashers (5), two nuts (4) (located in mailbag), and shipping trunnion assembly (7) on lower half of container (10). Tighten screws.

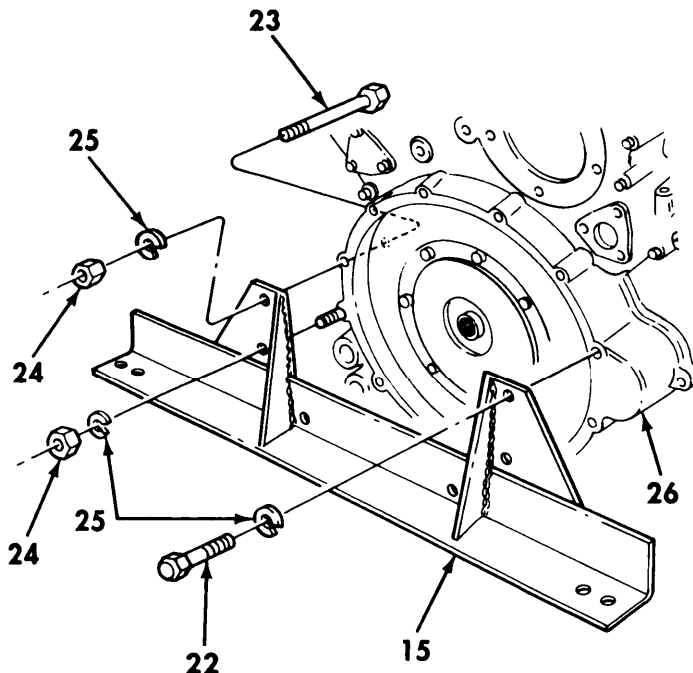


2-31. ENGINE FROM/TO CONTAINER (MODELS 5063-5299, 5063-5392, AND 5063-5393) (Cont)

NOTE

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

- (8) Remove four short screws (22), two long screws (23), two nuts (24), six lockwashers (25), and rear support (15) from engine flywheel housing (26). Store screws, washers, and nuts in mailbag (9). Store mailbag and rear support in lower half of container (10).



CAUTION

Always install top of container on bottom of container (Para 2-3) after the engine has been removed to avoid weather damage of container.

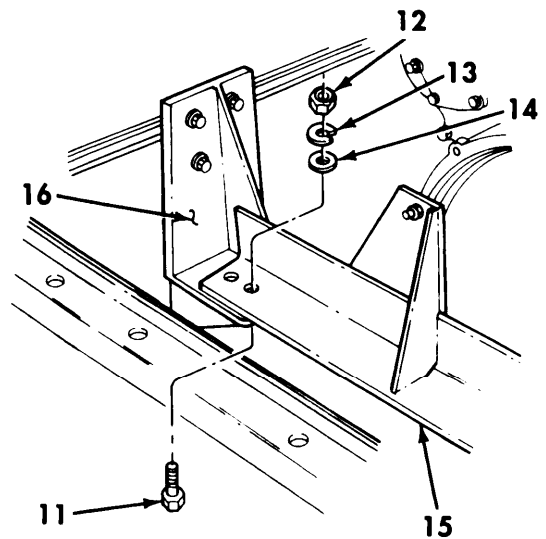
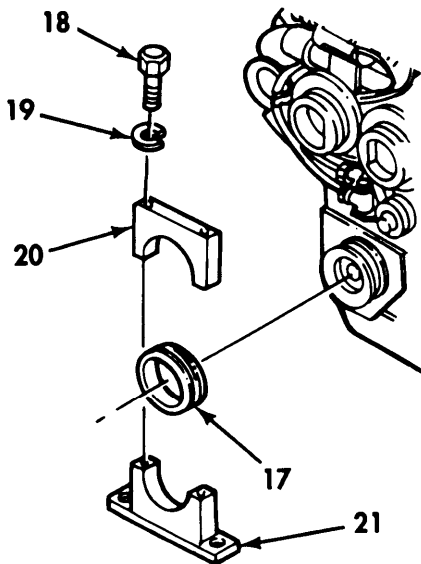
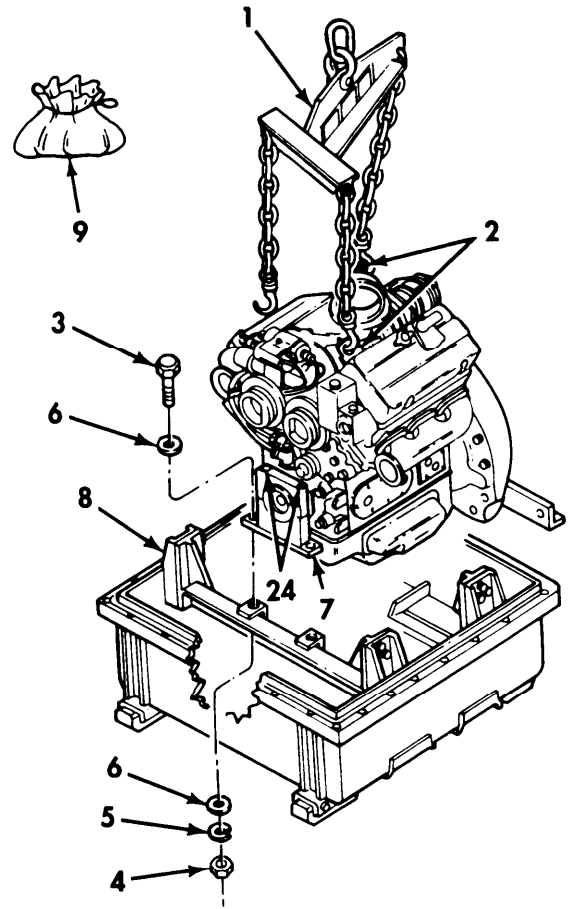
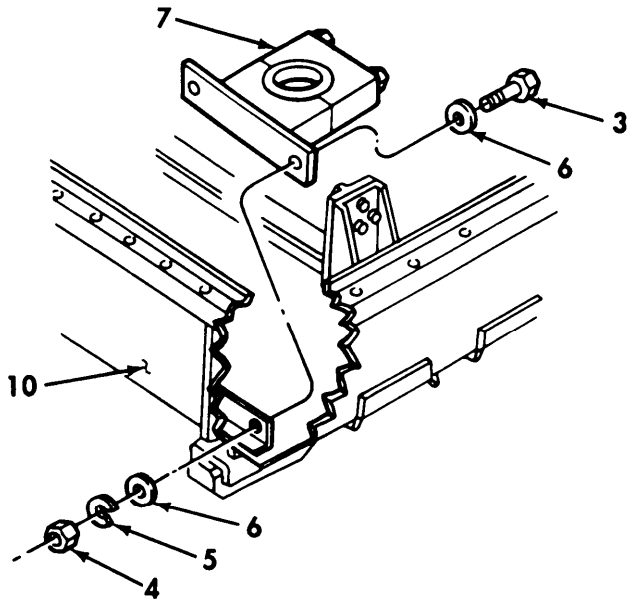
b. Installation

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. Equipment may drop or shift and injury to personnel may result.

- (1) Attach beam-type sling (1) to lifting brackets (2) and support engine with lifting device.
- (2) Install rear support (15), six lockwashers (25), four short screws (22), two long screws (23), and two nuts (24) on engine flywheel housing (26). Torque screws to 14-17 lb-ft (19-23 N-m). All screws, washers, and nuts are contained in mailbag (9).
- (3) For model 5063-5299, remove two screws (3), two lockwashers (5), four flat washers (6), and two nuts (4) from shipping trunnion assembly (7) in lower half of container. Store screws, washers, and nuts in mailbag (9).
- (4) For model 5063-5299, remove two screws (18), two lockwashers (19), and upper shipping trunnion block (20) from lower shipping trunnion block (21). Remove preformed packing (17) from lower shipping trunnion block and install on front of engine.
- (5) For model 5063-5299, install lower shipping trunnion block (21), upper shipping trunnion block (20), two screws (18), and two lockwashers (19) over preformed packing (17) on engine. Hand tighten screws.
- (6) Install engine in lower half of container (10).

- (7) Install two screws (3), two lockwashers (5), four flat washers (6), and two nuts (4) (from mailbag) into trunnion (7) and forward container support (8). Torque screws to 71-83 lb-ft (96-113 N.m).
- (8) Install four screws (11), four flat washers (14), four lockwashers (13), and four nuts (12), in rear support (15) and connect rear support to container mounting brackets (16). Torque screws to 31-37 lb-ft (42-50 N.m). Remove beam-type sling (1) from engine.
- (9) For model 5063-5299, torque two screws (18) in shipping trunnion (7) to 23-28 lb-ft (31-38 N.m).



END OF TASK

2-32. ENGINE FROM/TO CONTAINER (MODELS 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Preservation c. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool set, general mechanics (App B, Item 107)
Sling, beam-type (App B, Item 92)

TOOLS AND SPECIAL TOOLS (Cont)

Wrench, torque (App B, Item 116)
Wrench, torque (App B, Item 117)

EQUIPMENT CONDITION

Para Description
2-3 Container top removed.

PERSONNEL REQUIRED: 2

a. Removal

- (1) Attach beam-type sling (1) to engine lifting brackets (2) and support engine with lifting device.
- (2) Remove eight screws (3), eight flat washers (4), and eight self-locking nuts (5) connecting front mounting bracket (6) and two rear mounting brackets (7 and 8) to suspension frame (9).

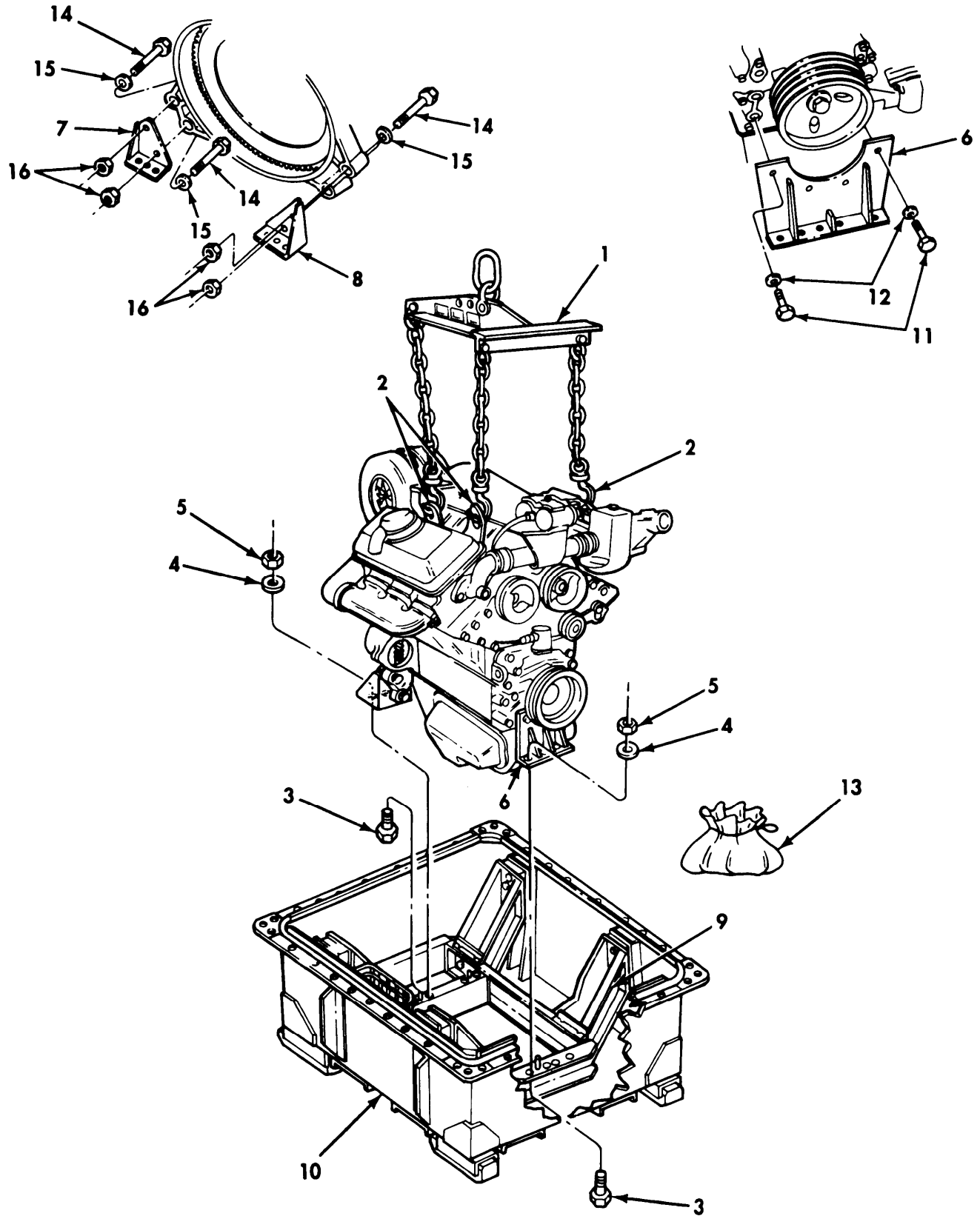
WARNING

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. Equipment may drop or shift and injury to personnel may result.

- (3) Remove engine from lower half of container (10).
- (4) Remove four screws (11), four flat washers (12), and engine mounting bracket (6) from front of engine. Store screws, washers, and nuts in mailbag (13) in lower half of container (10).
- (5) Remove four screws (14), four flat washers (15), left mounting bracket (7), right mounting bracket (8), and four self-locking nuts (16) from flywheel housing. Store screws, washers, and nuts in mailbag in lower half of container (10).

CAUTION

Always install upper section of the container on the bottom section and seal container (refer to Para 2-3) with bolts and nuts after the engine has been removed. This action is necessary to avoid weather damage to interior of container.



2-32. ENGINE FROM/TO CONTAINER (MODELS 5063-5395, 5063-5398, AND 5063-539F)

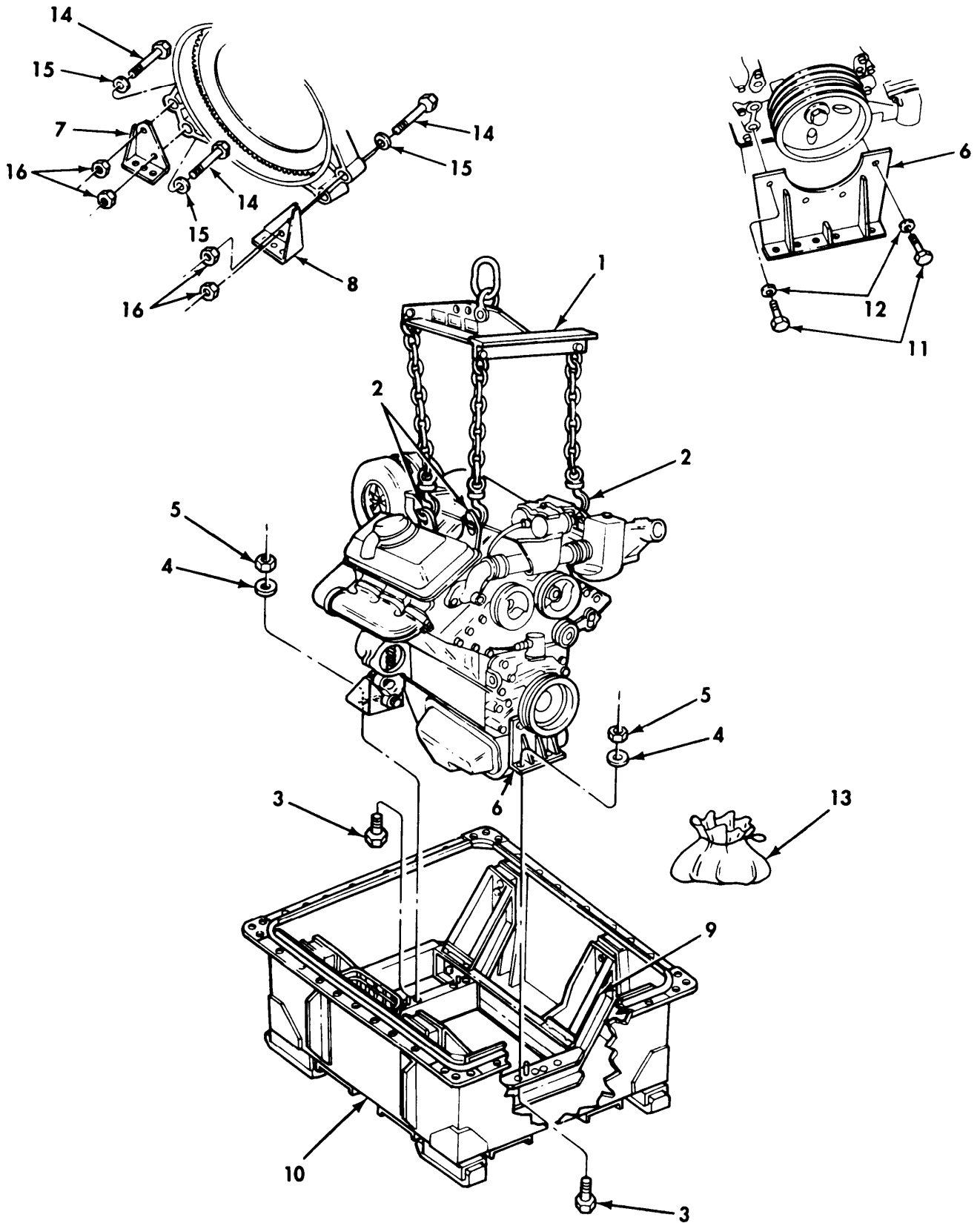
b. Installation

- (1) Install four screws (14), four flat washers (15), left mounting bracket (7), right mounting bracket (8), and four self-locking nuts (16) on flywheel housing. Torque screws to 40-250 lb-ft (325-339 N·m).
- (2) Install four screws (11), four flat washers (12), and engine mounting bracket (6) on front of engine. Torque screws to 46-50 lb-ft (62-68 N·m).

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. Equipment may drop or shift and injury to personnel may result.

- (3) Attach beam-type sling (1) to lifting brackets (2) and install engine in lower half of container (10) while aligning front mounting bracket (6) and two rear mounting brackets (7 and 8) to suspension frame (9).
- (4) Install eight screws (3), eight flat washers (4), and eight self-locking nuts (5) through front mounting bracket (6), two rear mounting brackets (7 and 8), and suspension frame (9). Torque screws to 35-39 lb-ft (47-53 N·m).



END OF TASK

2-33. ENGINE INSTALLATION/REMOVAL TO MAINTENANCE STAND

This task covers: a. Maintenance Stand Preparation b. Installation c. Removal

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Stand, maintenance (App B, Item 95)
 Sling, beam-type (App B, Item 92)
 Cradle (App B, Item 19)

TOOLS AND SPECIAL TOOLS (Cont)

Drain unit (App B, Item 21)
 Brackets, engine mounting (App B, Item 10)

MATERIALS/PARTS

8 Lockwashers (App F, Item 99)
 4 Lockwashers (App F, Item 100)

PERSONNEL REQUIRED: 2

a. Maintenance Stand Preparation

- (1) Assemble engine cradle (1) and maintenance stand (2) together using hole location number 5.
- (2) Install four engine mounting brackets (3), eight bolts (4), eight flat washers (5), and eight lockwashers (6) to engine block (two bolts per bracket). Leave brackets loose for adjustment.

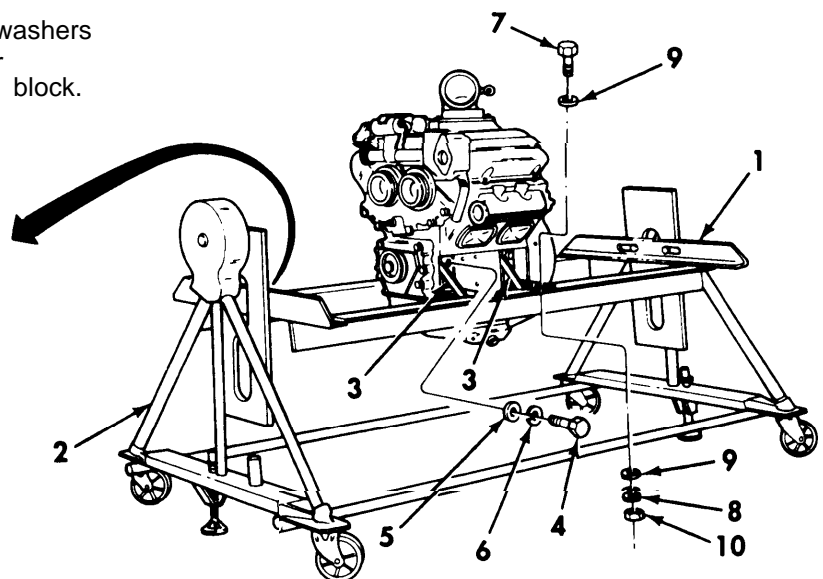
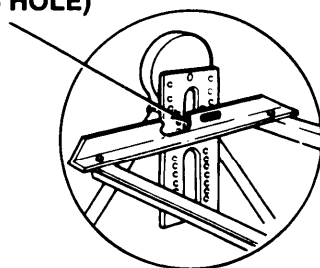
b. Installation

- (1) Attach a beam-type sling to engine lifting brackets and lift engine onto maintenance stand (2).
- (2) Install four bolts (7), four lockwashers (8), eight flat washers (9), and four nuts (10) in four mounting brackets (3) and side rails of cradle (1). Tighten stand and bracket bolts.

c. Removal

- (1) Attach beam-type lifting sling to engine lifting brackets with engine on maintenance stand (2).
- (2) Remove four bolts (7), four lockwashers (8), eight flat washers (9), and four nuts (10) connecting four mounting brackets (3) to side rails of cradle (1). Discard lockwashers.
- (3) Remove eight bolts (4), eight flat washers (5), eight lockwashers (6), and four mounting brackets (3) from engine block. Discard lockwashers.

POSITION OF CRADLE ASSEMBLY ON MAINTENANCE STAND MOUNTING BRACKET (NO. 5 HOLE)



END OF TASK

Section V. UNIT SUPPORT COMPONENT REPAIR

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Oil Filter Assembly Repair (Models 5063-5393 and 5063-539L)	2-36 . . .	2-94
Fuel Filter and Strainer Repair	2-37 . . .	2-96

2-34. CRANKCASE VENTILATION COLLECTOR REPAIR (MODEL 5063-5299)

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

5063-5299

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

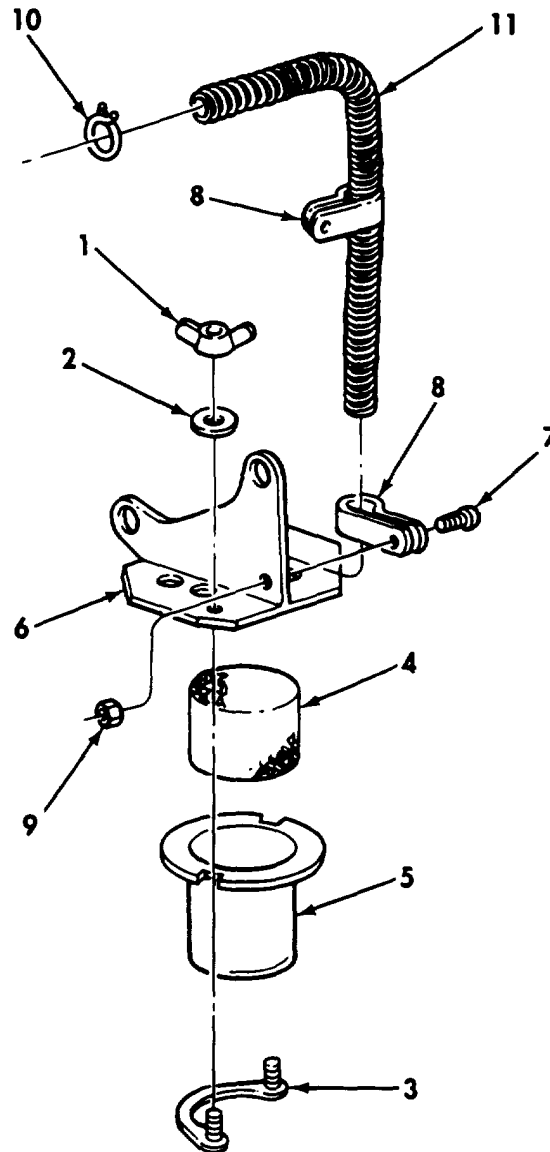
Tool kit, general mechanics (App B, Item 107)

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.

a. Disassembly

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



b. Cleaning/Inspection**WARNING**

- **Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.**
 - **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**
- (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.
 - (3) Check drain receptacle, retainer, and bracket for cracks or broken parts.

c. Assembly

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

END OF TASK

2-35. OIL FILTER ASSEMBLY REPAIR (ALL EXCEPT MODELS 5063-5393 AND 5063-539L)

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All except models 5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 1 Filter element (App F, Item 23)
- 1 Gasket App F, Item 78)
- 1 Gasket App F, Item 29)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

a. Disassembly

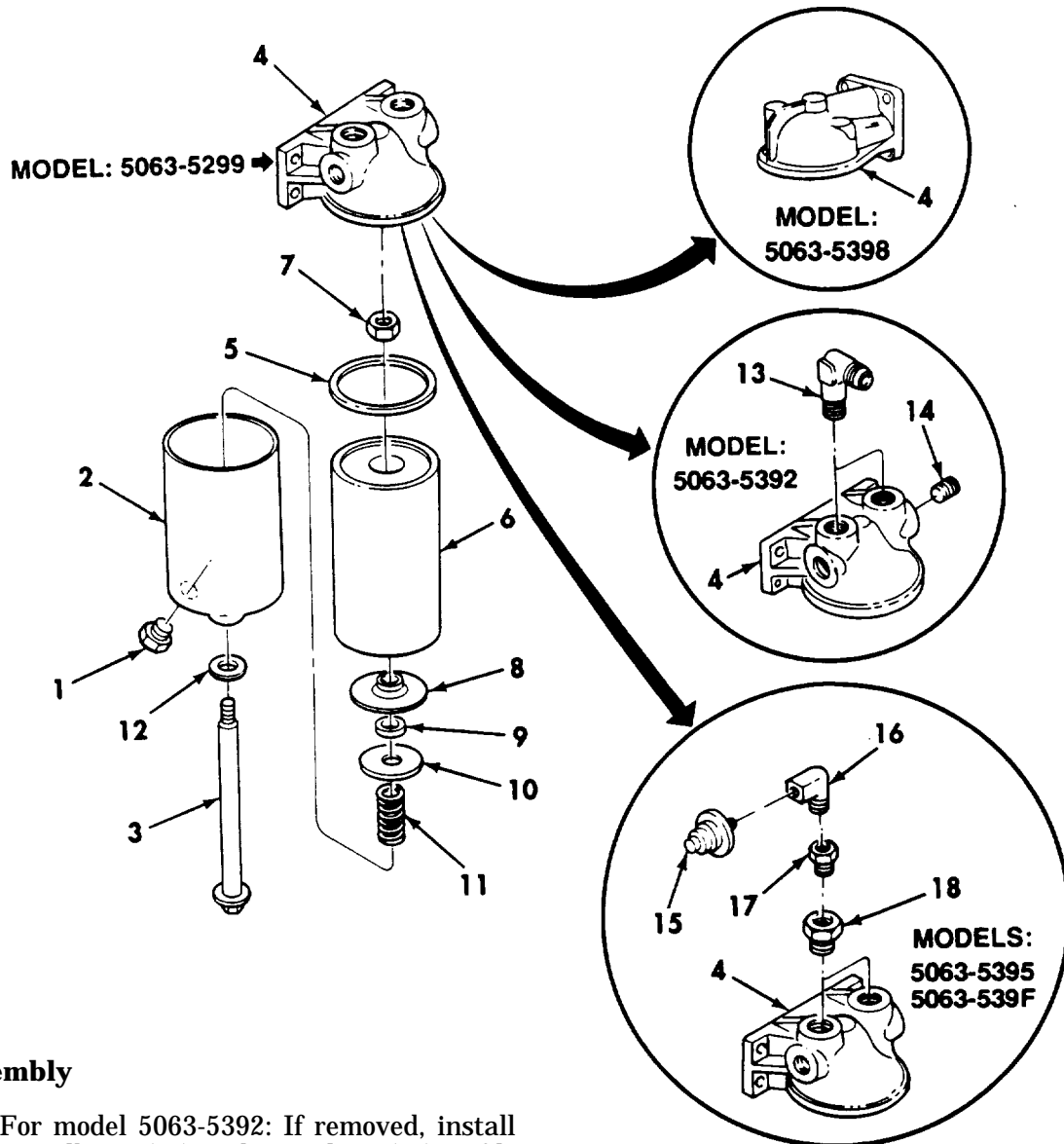
- (1) Remove drain plug (1) from bottom of oil filter cover (2).
- (2) Back out shoulder bolt (3) and separate filter head (4) from cover (2).
- (3) Remove gasket (5) from filter head (4). Discard gasket.
- (4) Remove oil filter element (6) from cover (2). Discard filter element,
- (5) Remove nut (7), retainer (8), preformed packing (9), spacer (10), and spring (11) from shoulder bolt (3) in cover (2).
- (6) Remove shoulder bolt (3) from cover (2) and gasket (12) from shoulder bolt. Discard gasket.
- (7) For model 5063-5392: If necessary, remove two elbows (13) and two plugs (14) from filter head (4).
- (8) For models 5063-5395 and 5063-539F: If necessary, remove two pressure switches (15), two elbows (16), two small bushings (17), and two large bushings (18) from filter head (4).

b. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.**
- **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**

- (1) Clean parts with dry cleaning solvent and dry with compressed air.
- (2) Inspect all parts for damage and excessive wear. Replace as necessary.



c. Assembly

- (1) For model 5063-5392: If removed, install two elbows (13) and two plugs (14) in filter head (4).
- (2) For models 5063-5395 and 5063-539F: If removed, install two large bushings (18), two small bushings (17), two elbows (16), and two pressure switches (15) in filter head (4).
- (3) Insert shoulder bolt (3) into gasket (12) and cover (2). Slide spring (11), spacer (10), preformed packing (9), and retainer (8) onto shoulder bolt and install nut (7).
- (4) Slide oil filter element (6) over shoulder bolt (3) in cover (2). Install gasket (5) in filter head (4).
- (5) Install cover (2) and shoulder bolt (3) on filter head (4). Torque bolt to 50-60 lb-ft (68-81 NŹm).
- (6) Install drain plug (1) in bottom of oil filter cover (2).

END OF TASK

■ **2-36. OIL FILTER ASSEMBLY REPAIR (MODELS 5063-5393 AND 5063-539L)**

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

■ 5063-5393 5063-539L

MATERIALS/PARTS

1 Element, spin-on, oil filter (App F, Item 22)

TOOLS AND SPECIAL TOOLS

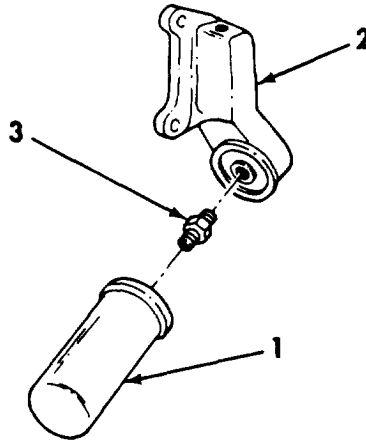
Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Wrench, oil filter (App B, Item 114)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
 Oil, engine (App C, Item 26)

a. Disassembly

- (1) Using an oil filter wrench, remove oil filter spin-on element (1) from adapter (2). Discard oil filter element.
- (2) If necessary, remove nipple (3) from adapter (2).



b. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.**
- **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**

- (1) Clean parts with dry cleaning solvent and dry with compressed air.
- (2) Inspect all parts for damage and excessive wear. Replace as necessary.

c. Assembly

- (1) If removed, install nipple (3) in adapter (2). Torque nipple to 70-80 lb-ft (95-108 N-m).
- (2) Lightly coat seal of oil filter spin-on element (1) 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 (1) on adapter nipple (3) and tighten by hand until seal contacts adapter (2). Then turn oil filter element an additional two-thirds revolution.

END OF TASK

2-37. FUEL FILTER AND STRAINER REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 1 Gaskets and filter element (primary)
(App F, Item 24)

MATERIALS/PARTS (Cont)

- 1 Filter element (secondary) (App F, Item 21)
- 1 Gasket (App F, Item 77)
- 1 Gasket (App F, Item 27)
- 1 Gasket (App F, Item 76)
- 1 Ring, retaining (App F, Item 146)

EXPENDABLE/DURABLE SUPPLIES

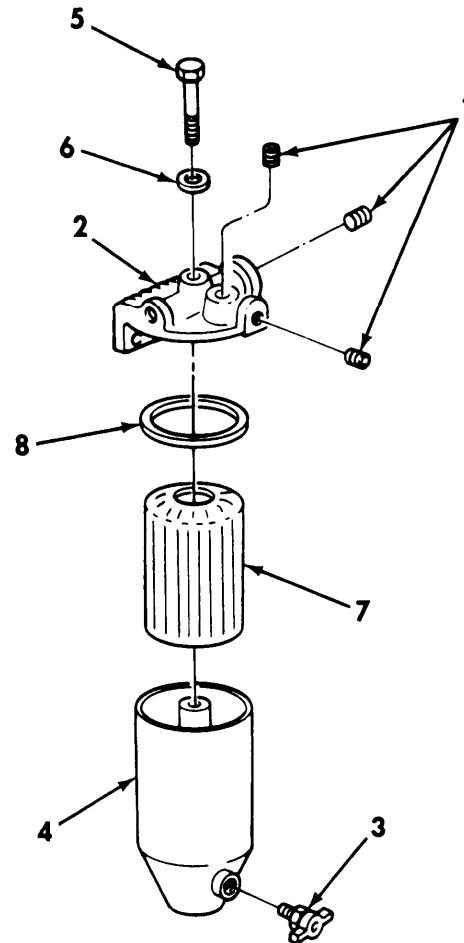
Oil, fuel (App C, Item 27)

a. Disassembly

- (1) Fuel primary filter assembly (strainer)
 - (a) If necessary, remove three plugs (1) from strainer head (2).
 - (b) Remove drain cock (3) from shell assembly (4).

NOTE

- Do not remove the element seat, spring, seal, and spring seat from the strainer shell assembly. Service these parts as an assembly.
- The filter element, small gasket, and large gasket are provisioned together.
- (c) Remove bolt (5), small gasket (6), filter element (7), large gasket (8), and shell assembly (4) from strainer head (2). Discard gaskets and filter element.



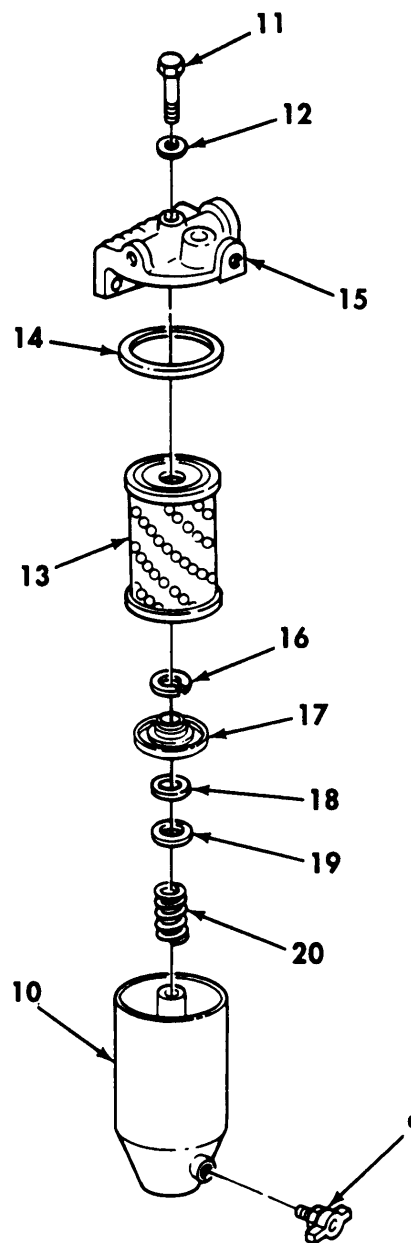
FUEL STRAINER

- (2) Fuel secondary filter assembly (filter)
 - (a) Remove drain cock (9) from filter body (10).
 - (b) Remove bolt (11), small gasket (12), filter body (10), filter element (13), and large gasket (14) from filter head (15). Discard filter element and gaskets.
 - (c) Remove retaining ring (16), seat (17), gasket (18), spring seat (19), and spring (20) from filter body (10). Discard gasket and retaining ring.

b. Cleaning/Inspection

WA`RNING

- **Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.**
- **Compressed air used for cleaning purpose will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**



**FUEL
FILTER**

- (1) Wash shell assembly and filter body thoroughly with dry cleaning solvent and dry with compressed air.
- (2) Examine gasket in shell assembly for cracks or hardening, replace if defective.

2-37. FUEL FILTER AND STRAINER REPAIR (Cont)

c. Assembly

NOTE

ŽA 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)

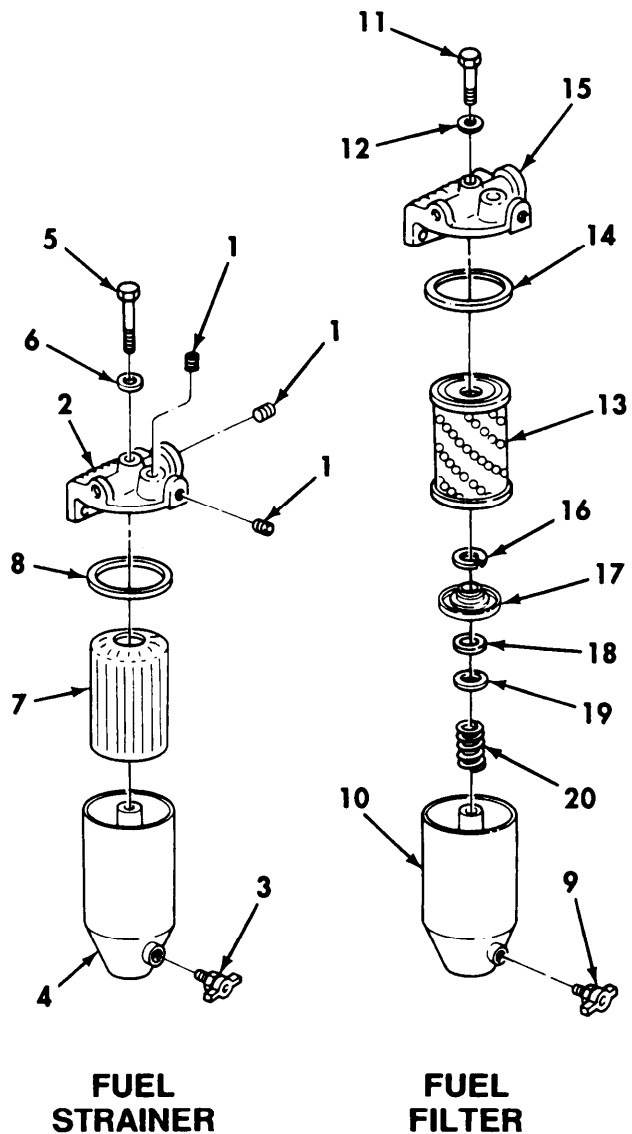
- Place filter element (7) over center stud in shell assembly (4) and push down until seated.
- Place large gasket (8) in recess of strainer head (2).
- Place filter element (7) and shell assembly (4) under strainer head (2) and install gasket (6) and bolt (5). Tighten bolt just enough to prevent fuel leakage.
- Install drain cock (3) in shell assembly (4).
- Install three plugs (1) in strainer head (2).

NOTE

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

(2) Fuel secondary filter assembly (filter)

- Install spring (20), spring seat (19), gasket (18), seat (17), and retaining ring (16) in filter body (10).
- Place filter element (13) over center stud in filter body (10) and push against seat (17).
- Place large gasket (14) in recess of filter head (15).
- Place filter element (13) and filter body (10) under filter head (15) and install small gasket (12) and bolt (11). Tighten bolt just enough to prevent fuel leakage.
- Install drain cock (9) in filter body (10).



END OF TASK

CHAPTER 3

REPAIR PROCEDURES FOR MAJOR COMPONENTS

Section I. GENERAL INFORMATION

3-1. GENERAL. This chapter provides the repair procedures performed on all engine models after the engine has been installed on the maintenance stand. The sequence of the repair procedures is done by the order the engine would be taken apart whenever possible. Component replacement typically consists of removal, disassembly, cleaning/inspection, repair, assembly, and installation of the component. Next, the engine block maintenance consists of disassembly, inspection, repair, and assembly of the block components. For major components, the repair is handled separately from removal and installation. Component repair usually consists of disassembly, cleaning/inspection, and assembly. When two or more models have identical or nearly identical components, those models will be covered in the same task. Direct Support and General Support procedures are separated by section.

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3-2. TURBOCHARGER REMOVAL/INSTALLATION (MODEL 5083-5392)

This task covers: a. Removal b. installation

INITIAL SETUP

MODELS

5063-5392

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Pliers, wire twister (App B, Item 76)
 Wrench, torque (App B, Item 118)

MATERIALS/PARTS

- 2 Lockwashers (App F, Item 100)
- 4 Nuts, self-locking (App F, Item 108)
- 1 Gasket (App F, Item 81)
- 1 Gasket (App F, Item 35)

EXPENDABLE/DURABLE SUPPLIES

Wire (App C, Item 57)
 Tape, masking (App C, Item 52)

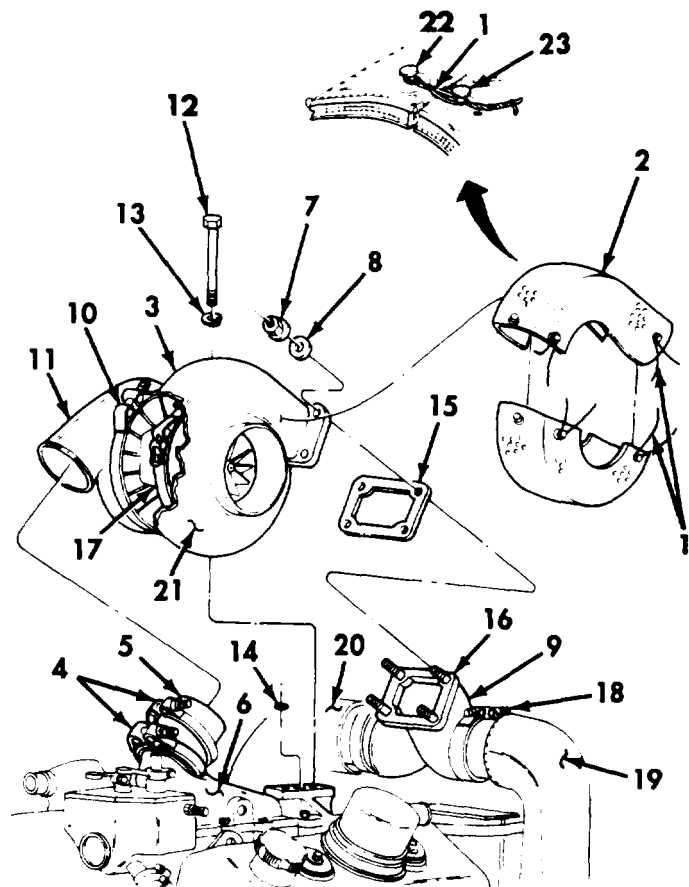
a. Removal

- (1) Cut wires (1) on insulator set (2). Remove insulator set from turbocharger (3). Discard wires.
- (2) Loosen two clamps (4) and hose (5) at turbocharger air outlet. Slide clamps and hose onto air inlet housing (6).
- (3) Remove four self-locking nuts (7), four special washers (8), and turbocharger (3) from exhaust tee (9). Discard self-locking nuts.
- (4) Loosen compressor housing coupling (10) and rotate outlet of compressor housing (11) 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 (12), two lockwashers (13), and turbocharger (3) from air inlet housing (6). Discard lockwashers.
- (6) Remove gasket (14) from air inlet housing (6) and gasket (15) from exhaust tee (9). Discard gaskets.
- (7) Remove two clamps (4 and hose (5) from air inlet housing (6).



b. Installation

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

END OF TASK

3-3. TURBOCHARGER REMOVAL/INSTALLATION (MODELS 5063-5393, 5063-5395, 5063-5398, 5063-539F, AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-5395 5063-5398 5063-539F
 5063-539L

MATERIALS/PARTS

1 Gasket (App F, Item 81)
 4 Self-locking nuts (App F, Item 108)

EXPENDABLE/DURABLE SUPPLIES

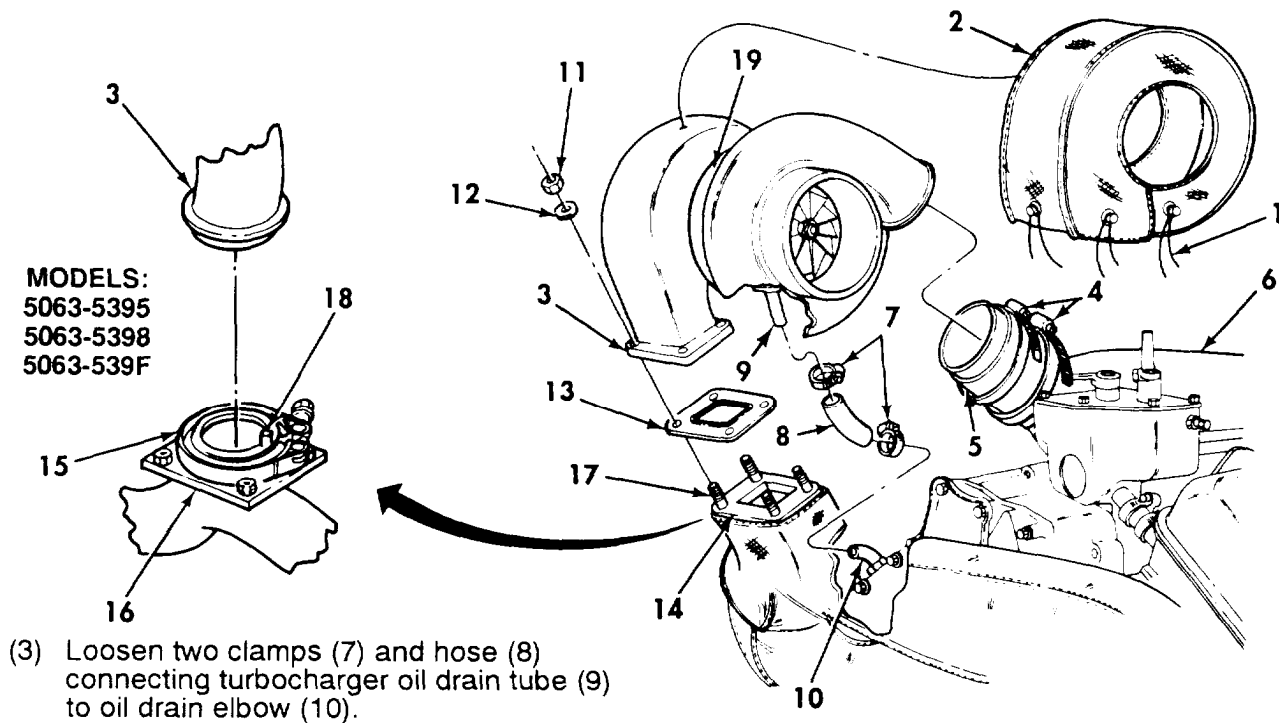
Wire (App C, Item 57)
 Tape, masking (App C, Item 52)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Pliers, wire twister (App B, Item 76)
 Wrench, torque (App B, Item 118)

a. Removal

- (1) On models 5063-5393, 5063-539F, and 5063-539L cut wires (1) on insulation blanket (2). Remove blanket from turbocharger (3) and discard wires.
- (2) Loosen two clamps (4) and hose (5) connecting turbocharger (3) to air inlet housing (6).



CAUTION

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

- (4) On models 5063-5393 and 5063-539L, remove four self-locking nuts (11), four special washers (12), turbocharger (3), and gasket (13) from exhaust tee (14). Discard nuts and gasket. ■
- (5) On all except models 5063-5393 and 5063-539L, loosen coupling (15) and lift turbocharger (3) from exhaust tee (16). ■
- (6) Remove two clamps (7) and hose (8) from elbow (10).
- (7) Remove two clamps (4) and hose (5) from air inlet housing (6).

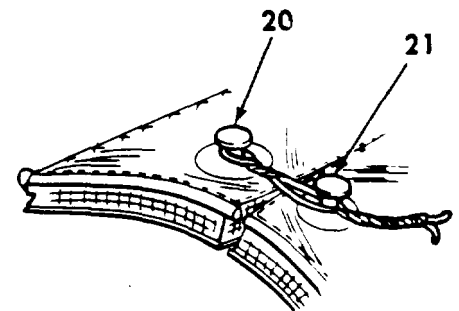
b. Installation

- (1) Slide two clamps (7) and hose (8) onto elbow (10).
- (2) Slide two clamps (4) and hose (5) onto air inlet housing (6).
- (3) On models 5063-5393 and 5063-539L, place gasket (13) and turbocharger (3) over four studs (17) in exhaust tee (14). Install four special washers (12) and four self-locking nuts (11) on studs. Torque nuts to 35-39 lb-ft (47-53 N•m). ■

NOTE

On model 5063-5398 using turbocharger 405681-1, spring pin (18) in flange of exhaust tee (16) must engage in hole in turbocharger exhaust inlet flange.

- (4) On all except models 5063-5393 and 5063-539L, install turbocharger (3) in coupling (15) on exhaust tee (16). Do not tighten coupling. ■
- (5) Loosen coupling (19) on compressor housing of turbocharger (3).
- (6) Adjust two clamps (4) and hose (5) between turbocharger (3) and air inlet housing (6). Tighten clamps.
- (7) Torque nut on compressor housing coupling (19) to 110-130 lb-in (12-15 N•m).
- (8) On all except models 5063-5393 and 5063-539L, tighten coupling (15). ■
- (9) Adjust two clamps (7) and hose (8) between oil drain tube (9) and elbow (10), Tighten clamps.
- (10) On models 5063-5393 and 5063-539F, install insulation blanket (2) on turbocharger (3) Fasten blanket together using wire (1) and wire-twister pliers as follows:
 - (a) Loop wire around first capstan (20) and apply two twists using wire-twister pliers.
 - (b) While holding insulation blanket in place by hand, place ends of wire on each side of adjacent capstan (21) and apply at least two more twists using wire-twister pliers.
 - (c) Trim wire 3/4 inch (20 mm) from second capstan.
 - (d) Repeat for remaining pairs of capstans on blanket.



END OF TASK

3-4. EXHAUST TUBES AND TEE REPLACEMENT (MODEL 5063-5392)

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

MODELS
5063-5392

EXPENDABLE/DURABLE SUPPLIES

Wire (App C, Item 57)

TOOLS AND SPECIAL TOOLS

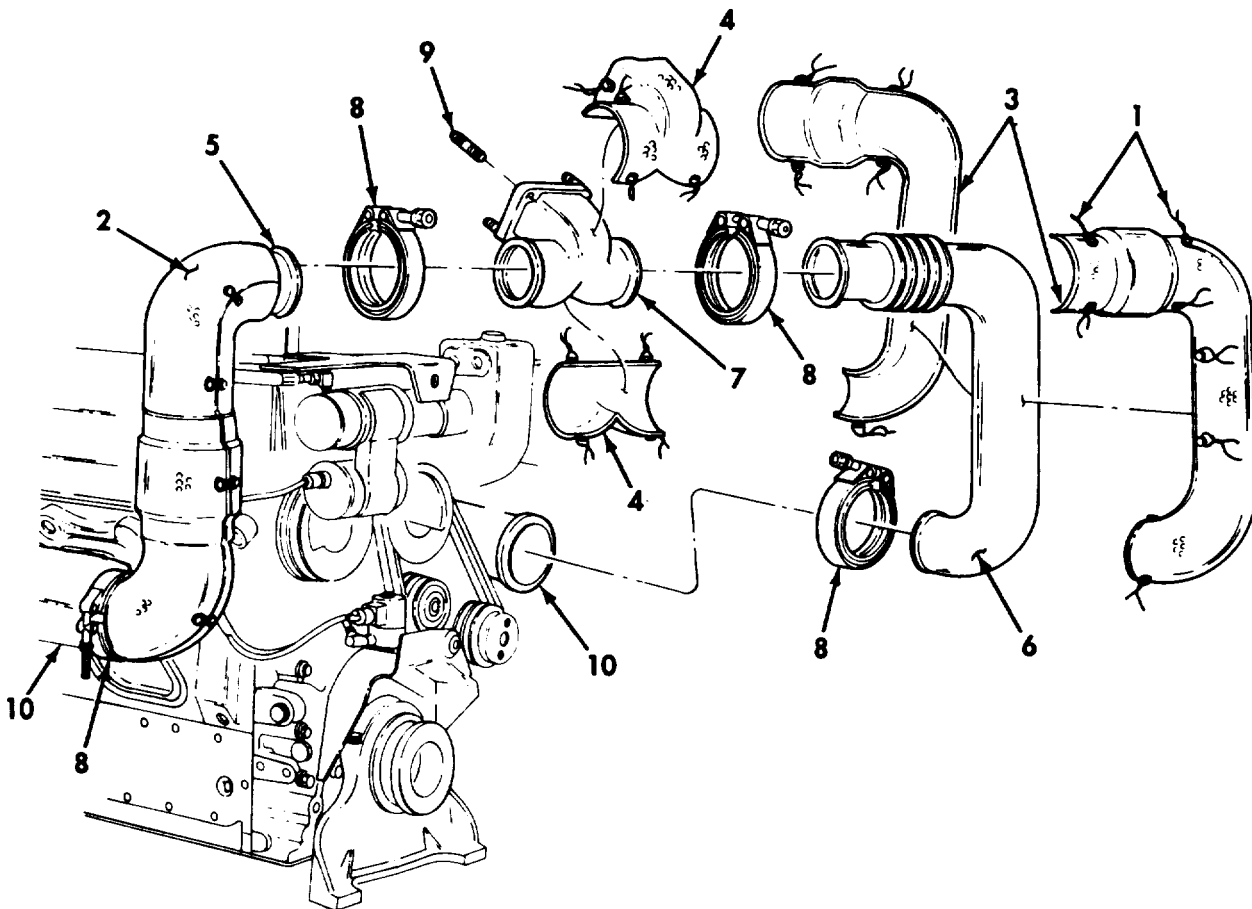
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Pliers, wire twister (App B, Item 76)

EQUIPMENT CONDITION

Para Description
3-2 Turbocharger removed

a. Removal

- (1) Cut wires (1) on insulator sets (2, 3, and 4). Remove insulator sets from exhaust tubes (5 and 6) and exhaust tee (7). Discard wires.



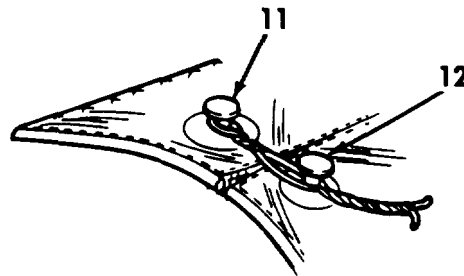
- (2) Loosen four couplings (8) on exhaust tubes (5 and 6). Slide couplings onto exhaust tubes and remove couplings, exhaust tubes, and exhaust tee.
- (3) If necessary, remove four studs (9) from exhaust tee (7).

b. Inspection

Check for cracks on exhaust tube flanges.

c. Installation

- (1) If removed, install four studs (9) in exhaust tee (7).
- (2) Install right exhaust tube (5), left exhaust tube (6), exhaust tee (7), and four couplings (8) on exhaust manifolds (10). Tighten couplings until springs are completely compressed.
- (3) Install insulator set (2) on exhaust tube (5), insulator set (3) on exhaust tube (6), and insulator set (4) on exhaust tee (7). Fasten insulator sets together using wire (1) and wire-twister pliers as follows:
 - (a) Loop wire around first capstand (11) and apply two twists using wire-twister pliers.



- (b) While holding insulator set in place by hand, place ends of wire on each side of adjacent capstand (12) and apply at least two more twists using wire-twister pliers.
- (c) Trim wire 3/4 inch (20 mm) from second capstand.
- (d) Repeat for remaining pairs of capstands on insulator sets.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-2 Install turbocharger.

3-5. TURBOCHARGER MOUNTING BRACKET AND EXHAUST TUBES REPLACEMENT (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Pliers, wire twister (App B, Item 76)

MATERIALS/PARTS

- 5 Lockwashers (App F, Item 99)
- 1 Lockwashers (App F, Hem 100)
- 2 Lockwashers (App F, Item 101)

EXPENDABLE/DURABLE SUPPLIES

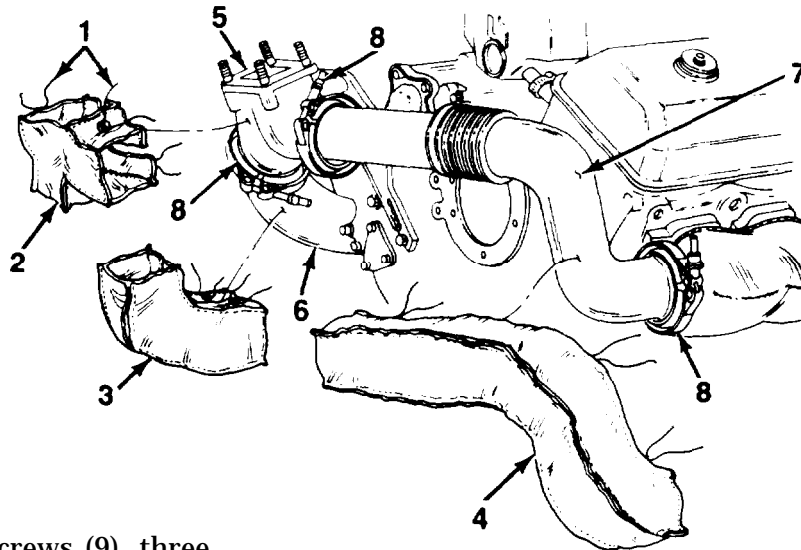
Wire (App C, Item 57)

EQUIPMENT CONDITION

Para Description
3-3 Turbocharger removed

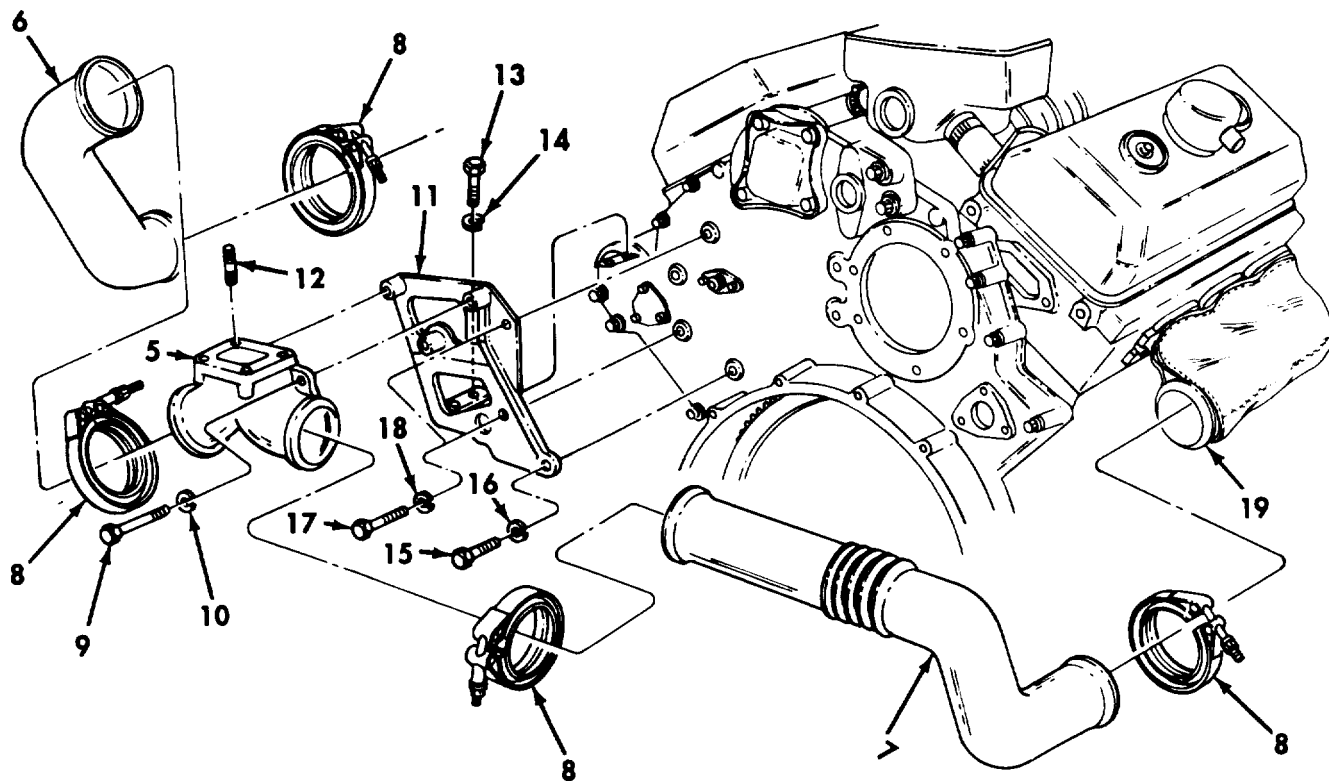
a. Removal

- (1) Cut wires (1) on insulation blankets (2, 3, and 4). Remove insulation blankets from exhaust tee (5), left exhaust tube (6), and right exhaust tube (7) and discard wires.
- (2) Loosen four couplings (8) on exhaust tubes (6 and 7). Loosen three screws (9) on exhaust tee (5). Slide couplings onto exhaust tubes and remove tubes and couplings.



- (3) Remove three screws (9), three lockwashers (10), and exhaust tee (5) from support bracket (11). Discard lockwashers.
- (4) If necessary, remove four studs (12) from exhaust tee (5).

- (5) Remove two screws (13), two lockwashers (14), screw (15), lockwasher (16), two screws (17), two lockwashers (18), and support bracket (11) from flywheel housing. Discard lockwashers.



b. Inspection

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

c. Installation

- (1) Install support bracket (11), two lockwashers (14), two small screws (13), lockwasher (16), screw (15), two lockwashers (18), and two large screws (17) on flywheel housing. Torque screws (13) to 30-35 lb-ft (41-47 NŹm), screw (15) to 46-50 lb-ft (62-68 NŹm), and screws (17) to 71-75 lb-ft (96-102 NŹm).
- (2) If removed, install four studs (12) in exhaust tee (5).
- (3) Loosely install exhaust tee (5), three lockwashers (10), and three screws (9) on support bracket (11). Do not tighten screws.
- (4) Install exhaust tube (6), exhaust tube (7), and four couplings (8) between exhaust manifolds (19) and exhaust tee (5).

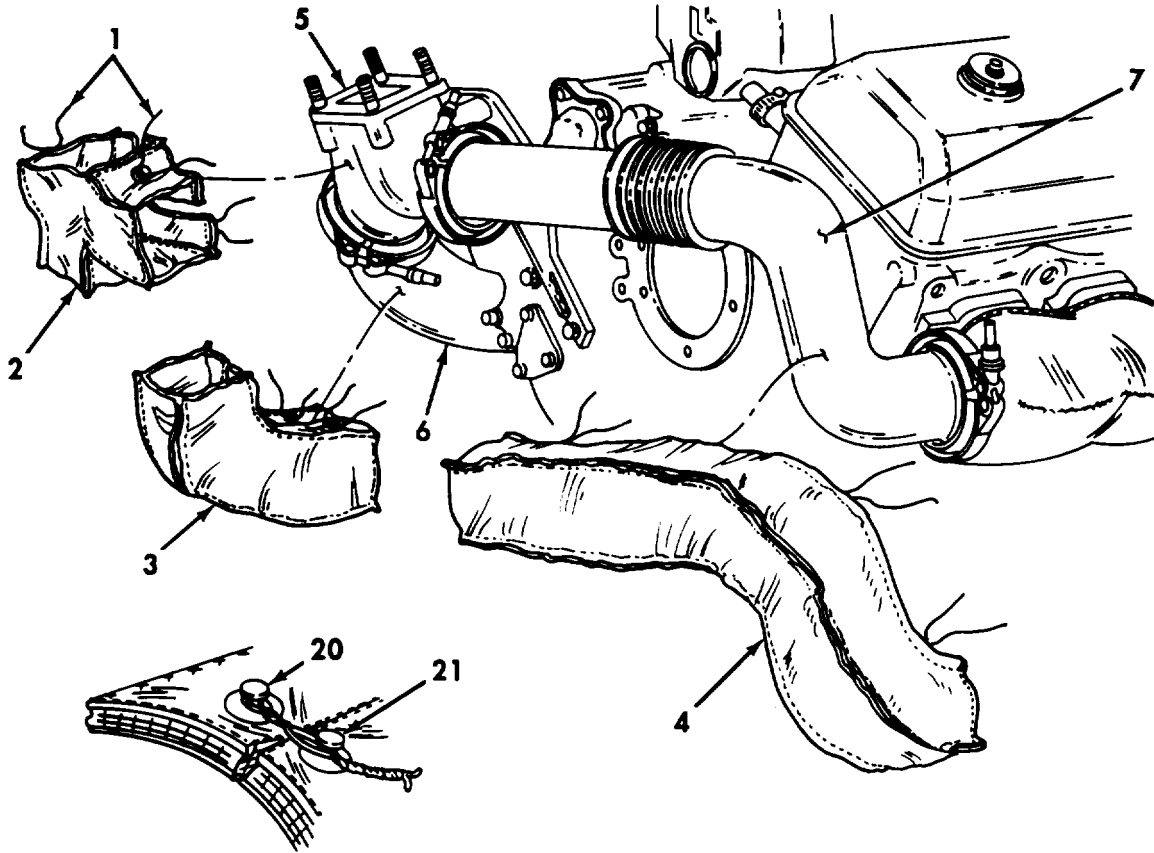
NOTE

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

- (5) Alternately tighten couplings (8) and screws (9). Torque screws to 30-35 lb-ft (41-47 NŹm). Tighten couplings until springs are completely compressed.

3-5. TURBOCHARGER MOUNTING BRACKET AND EXHAUST TUBES REPLACEMENT (MODELS 5063-5393 AND 5063-539L) (Cont)

- (6) Install insulation blanket (2) on exhaust tee (5), insulation blanket (3) on left exhaust tube (6), and insulation blanket (4) on right exhaust tube (7). Fasten blankets together using wire (1 and wire-twister pliers as follows:
- (a) Loop wire around first capstan (20) and apply two twists using wire-twister pliers.



- (b) While holding insulation blanket in place by hand, place ends of wire on each side of adjacent capstan (21) and apply at least two more twists using wire-twister pliers.
- (c) Trim wire 3/4 inch (20 mm) from second capstan (21).
- (d) Repeat for remaining pairs of capstans on all blankets.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-3 Install turbocharger.

3-6. TURBOCHARGER MOUNTING BRACKET AND EXHAUST TUBES REPLACEMENT (MODELS 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

EXPENDABLE/DURABLE SUPPLIES

Wire (App C, Item 57)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Pliers, wire twister (App B, Item 76)

EQUIPMENT CONDITION

Para Description
3-3 Turbocharger removed

MATERIALS/PARTS

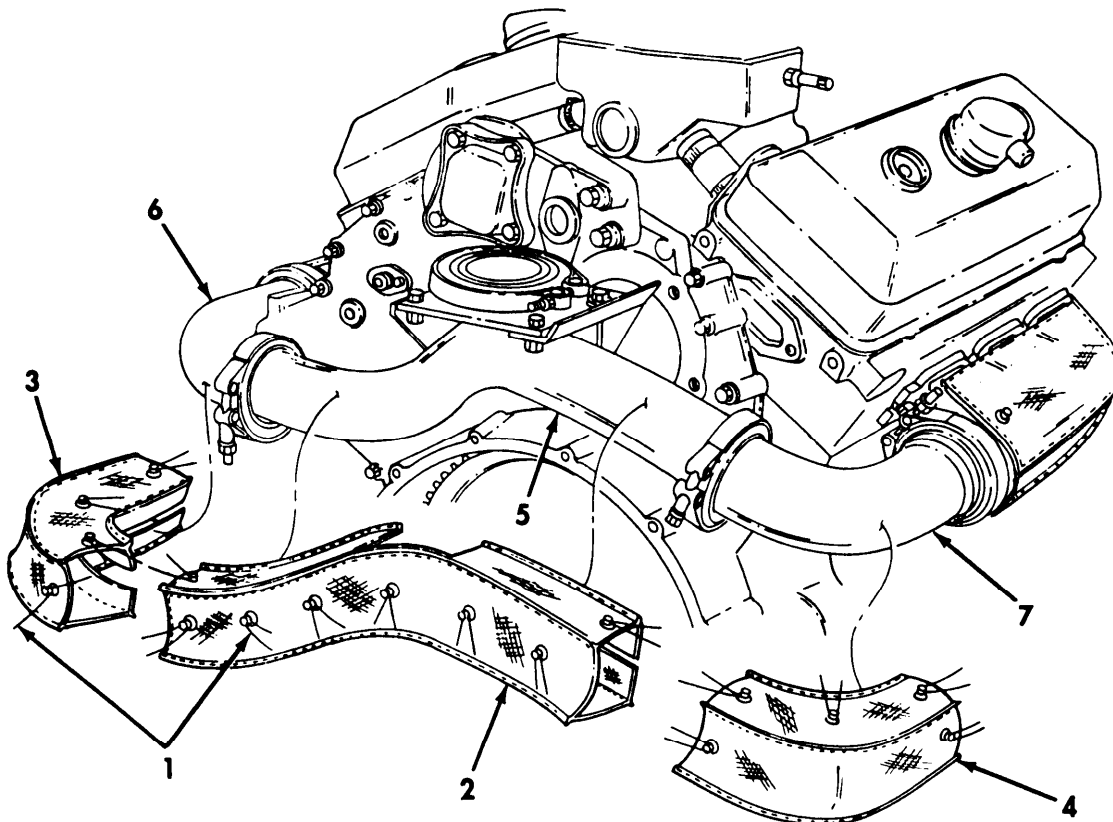
- 4 Lockwashers (App F, Item 99)
 - 4 Lockwashers (App F, Item 101)
-

a. Removal

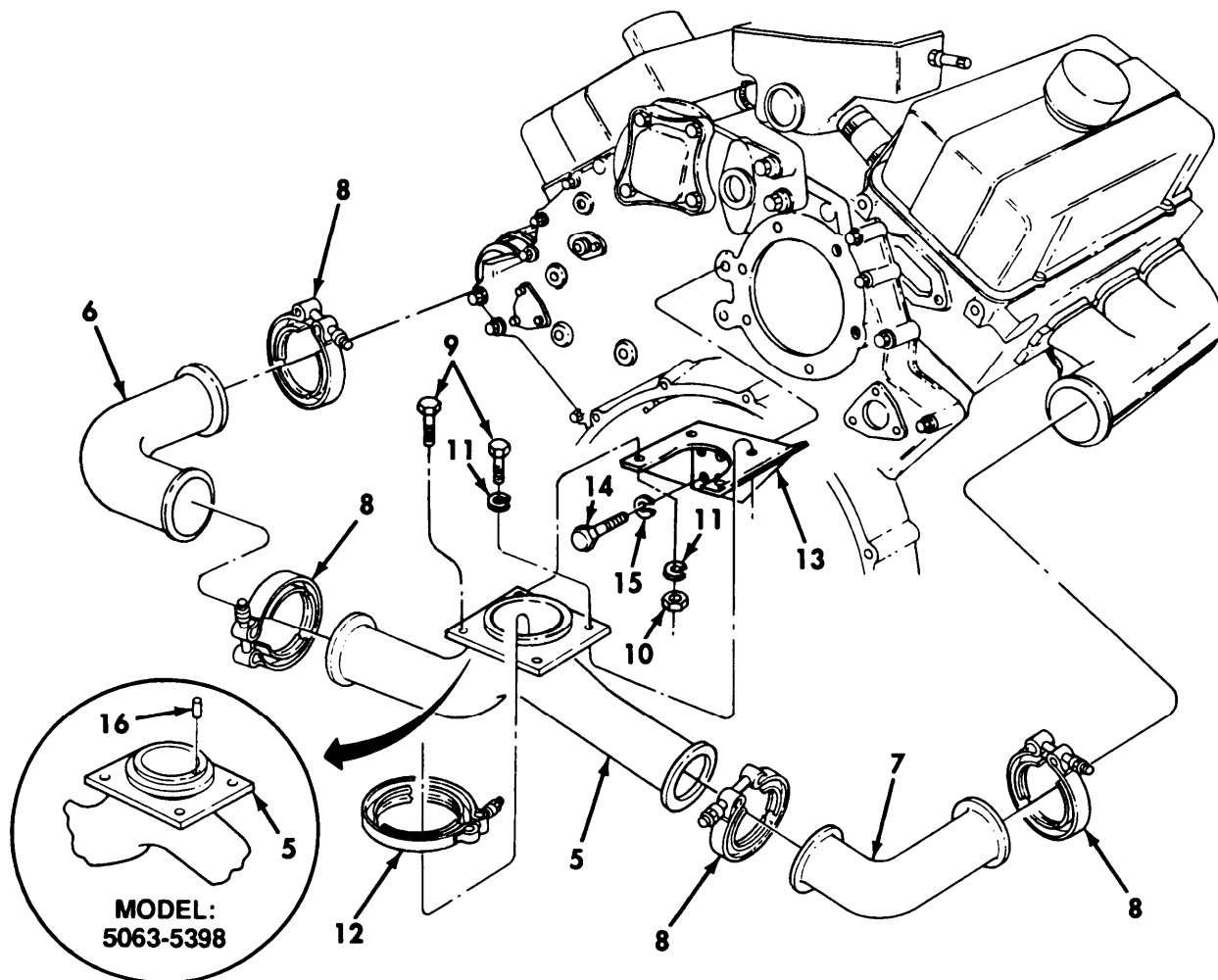
NOTE

Models 5063-5395 and 5063-5398 do not have insulation blankets on engine.

- (1) Cut wires (1) on insulation blankets (2, 3, and 4). Remove insulation blankets from exhaust tee (5), left exhaust tube (6), and right exhaust tube (7) and discard wires.



- (2) Loosen four couplings (8) on exhaust tubes (6 and 7). Slide couplings onto exhaust tubes. Loosen four screws (9) on exhaust tee (5). Remove exhaust tubes and couplings.
- (3) Remove two nuts (10), four lockwashers (11), four screws (9), coupling (12) and exhaust tee (5) from support bracket (13). Discard lockwashers.



- (4) Remove four screws (14), four lockwashers (15), and support bracket (13) from flywheel housing. Discard lockwashers.

NOTE

On model 5063-5398, using 405681-1 turbocharger, a spring pin (16) is pressed in exhaust tee (5).

- (5) If necessary, remove spring pin (16) from outlet flange on exhaust tee (5).

b. Inspection

Check for cracks on exhaust tube flanges, turbocharger support bracket, and exhaust tee mounting plate.

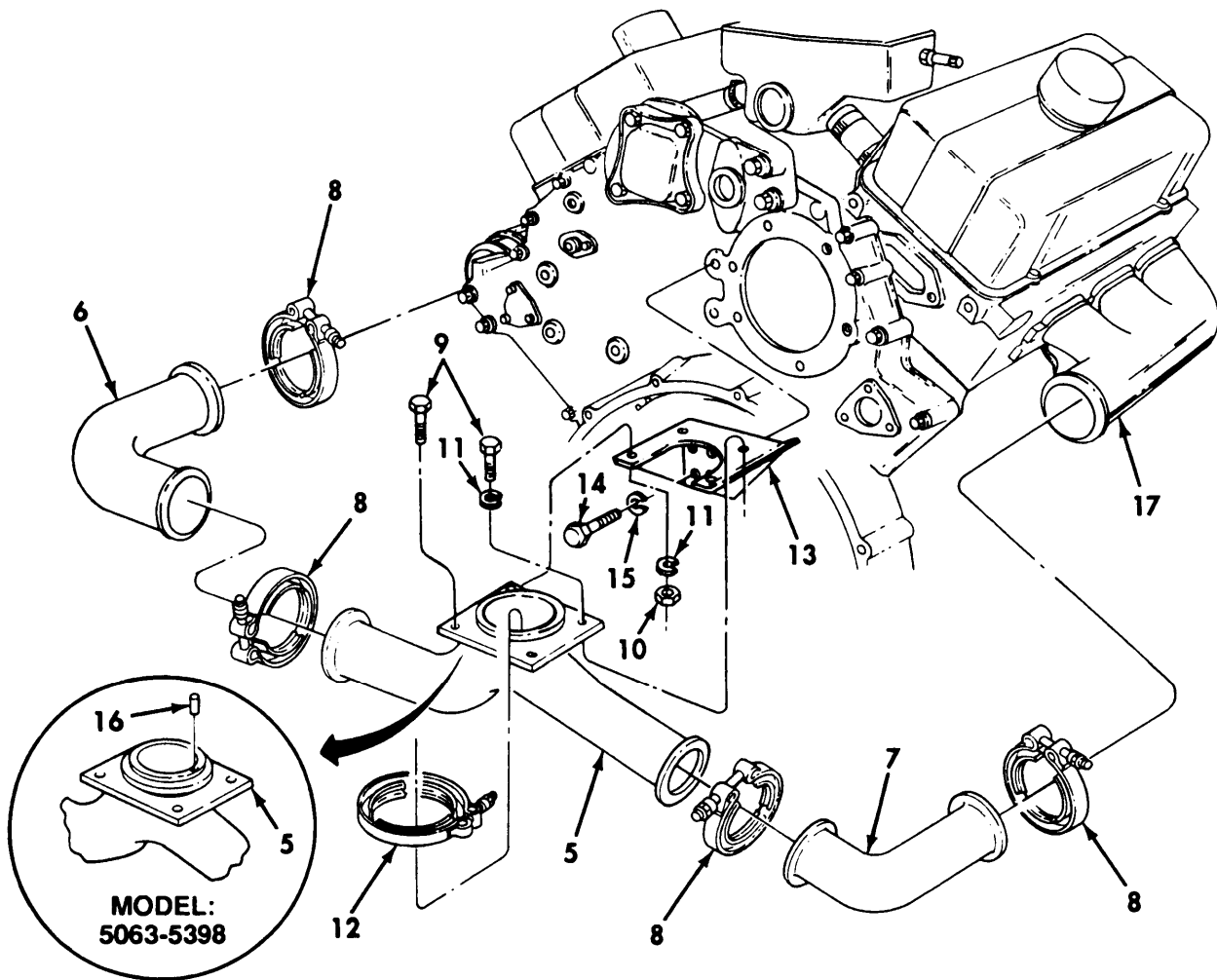
**3-6. TURBOCHARGER MOUNTING BRACKET AND EXHAUST TUBES REPLACEMENT
(MODELS 5063-5395, 5063-5398, AND 5063-539F) (Cont)**

c. Installation

NOTE

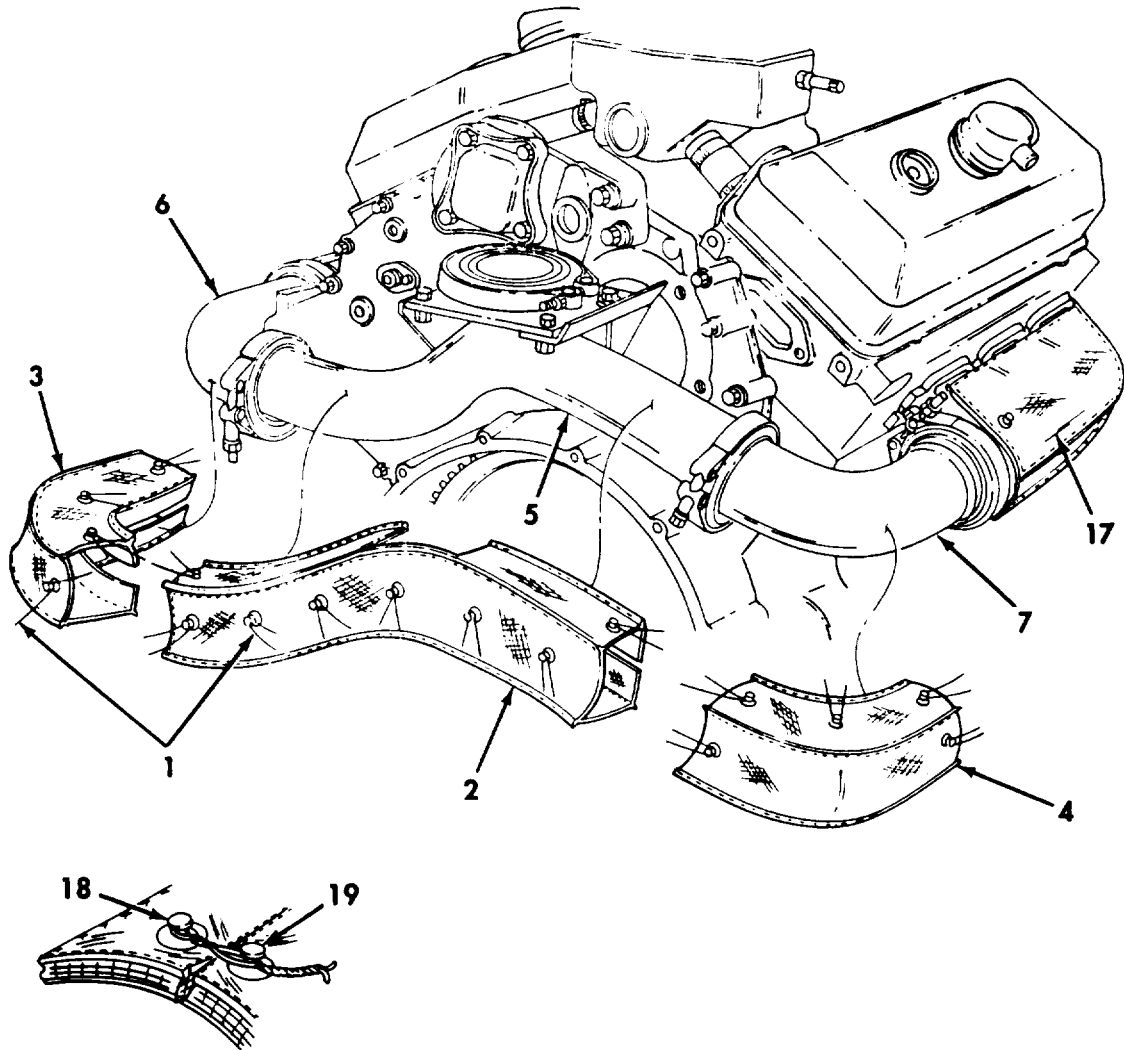
On model 5063-5398, using 405681-1 turbocharger, a spring pin (16) is pressed in exhaust tee (5).

- (1) If removed, install spring pin (16) in outlet flange on exhaust manifold tee (5).
- (2) Install support bracket (13), four lockwashers (15), and four screws (14) on flywheel housing.



- (3) Install exhaust tee (5), coupling (12), four screws (9), four lockwashers (11), and two nuts (10) on support bracket (13). Do not tighten screws.
- (4) Install exhaust tube (6), exhaust tube (7), and four couplings (8) on exhaust tee (5) and exhaust manifolds (17). Torque screws to 30-35 lb-ft (41-47 Nm). Tighten couplings until springs are completely compressed.

- (5) On model 5063-539F, install insulation blanket (2) on exhaust tee (5), insulation blanket (3) on left exhaust tube (6), and insulation blanket (4) on right exhaust tube (7). Fasten insulation blankets together using wire (1) and wire-twister pliers as follows:
- (a) Loop wire around first capstand (18) and apply two twists using wire-twister pliers.



- (b) While holding insulation blanket in place by hand, place ends of wire on each side of adjacent capstand (19) and apply at least two more twists using wire-twister pliers.
- (c) Trim wire 3/4 inch (20 mm) from second capstand (19).
- (d) Repeat for remaining pairs of capstands on all insulation blankets.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-3 Install turbocharger.

3-7. EXHAUST MANIFOLDS REPLACEMENT

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Wire (App C, Item 57)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Hem 116)
 Pliers, wire twister (App 6, Item 76)

EQUIPMENT CONDITION

Para Description
 3-4 Exhaust tube couplings removed (model 5063-5392)
 3-5 Exhaust tube couplings removed (models 5063-5393 and 5063-539L)
 3-6 Exhaust tube couplings removed (models 5063-5395, 5063-5395, and 5063-5395)
 3-12.1 Glow plug harness brackets removed (model 5063-539L)

MATERIALS/PARTS

2 Gaskets (App F, Item 39)
 8 Locknuts (App F, Item 106)

a. Removal

NOTE

- Models 5063-5392, 5063-5393, 5063-539F, 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 (1) connecting capstans on exhaust manifold insulation cover (2). Discard wires.
- (2) Remove exhaust manifold insulation cover (2) from exhaust manifold (3).

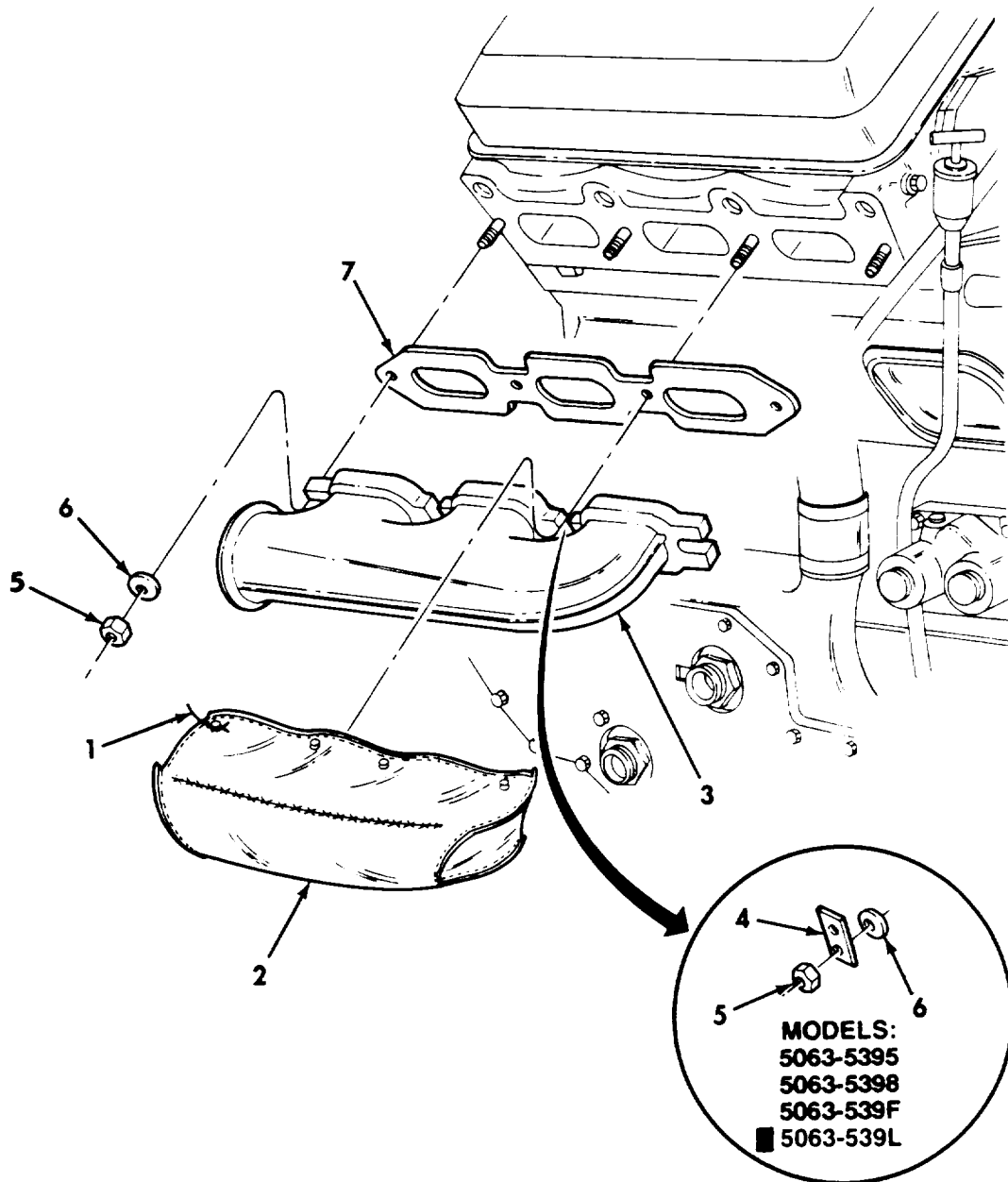
NOTE

- Only models 5063-5395, 5063-5398, and 5063-539F have a bracket (4) located between the second and third exhaust ports of the left bank.
- Model 5063-539L has two brackets (4) located between the first and fourth exhaust ports of the right and left banks.

- (3) Remove four locknuts (5), bracket (4), four spring washers (6), exhaust manifold (3), and gasket (7) from cylinder head. Discard locknuts and gasket,
- (3.1) For model 5063-539L, remove four locknuts (5), two brackets (4), four spring washers (6), exhaust manifold (3), and gasket (7) from cylinder head. Discard locknuts and gasket.
- (4) Repeat steps (1) thru (3.1) for opposite manifold.

b. Cleaning/Inspection

- (1) Remove loose scale, gasket material, and carbon from exhaust manifolds.
- (2) Check for cracks on exhaust manifolds at holding lug areas.



3-7. EXHAUST MANIFOLDS REPLACEMENT (Cont)

c. 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.
- For models 5063-5395, 5063-5398, and 5063-539F, install bracket (4) for oil level gage on stud located between second and third exhaust ports on left bank.
- Model 5063-539L has two brackets (4) located between the first and fourth exhaust ports of the right and left banks.

(1) Install gasket (7), exhaust manifold (3), bracket (4), one spring washer (6), and one nut (5) over studs (8) in cylinder head. Install remaining three spring washers (6) and three nuts (5) on studs.

(1.1) For model 5063-539L, install gasket (7), exhaust manifold (3), two brackets (4), four spring washers (6), and four locknuts (5) over studs (8) in cylinder head.

(2) Starting with the center stud and working alternately toward each end of manifold, torque nuts (5) to 30-35 lb-ft (41-47 N·m).

NOTE

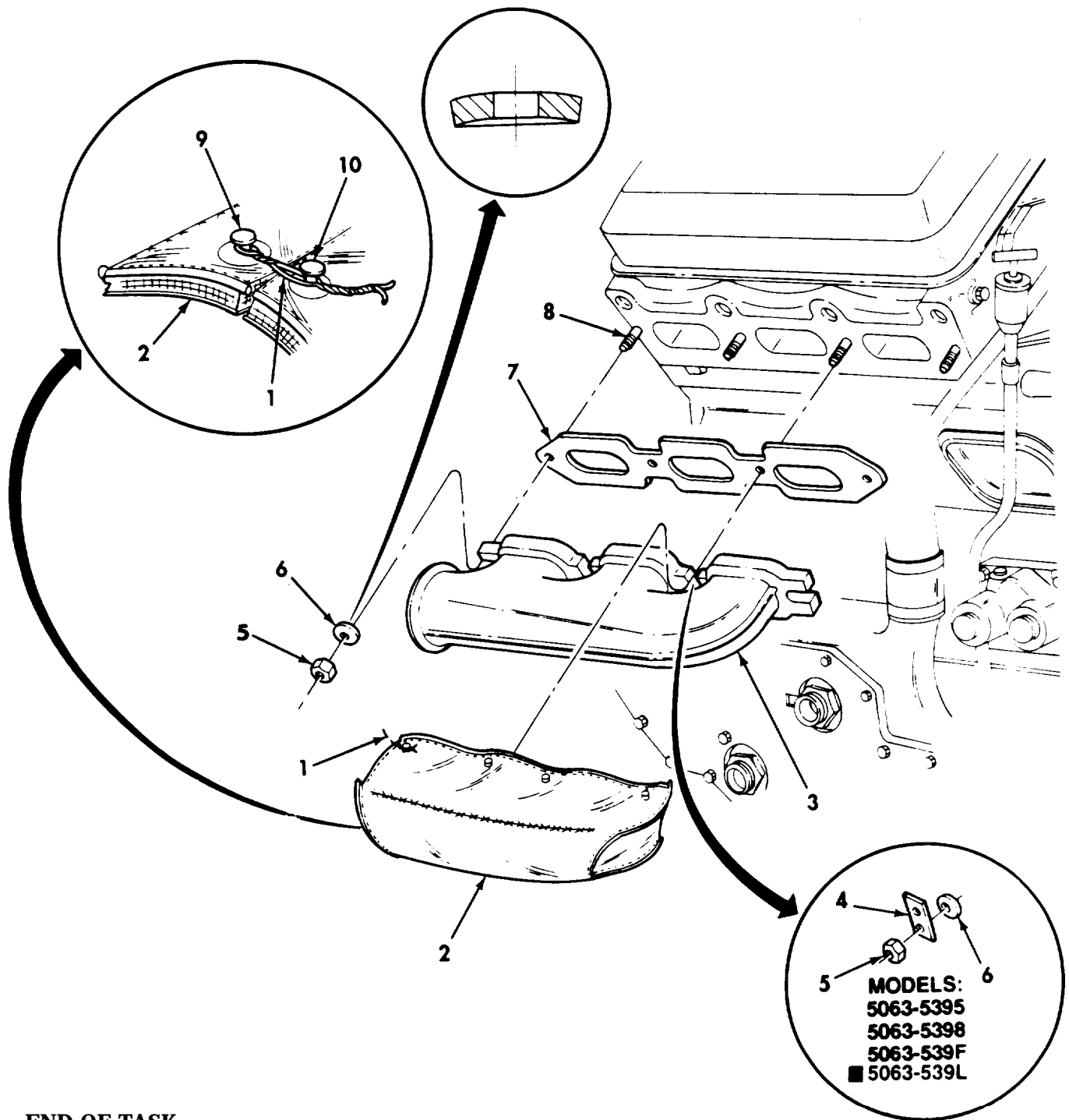
Models 5063-5392, 5063-5393, 5063-539F, and 5063-539L have insulating covers on exhaust manifolds.

(3) Place insulation cover (2) over exhaust manifold (3).

(4) Using wire (1) and wire-twister pliers, install insulation cover (2) as follows:

- (a) Loop wire around first capstan (9) and apply two twists using wire-twister pliers.
- (b) While holding insulation cover in place by hand, place ends of wire on each side of adjacent capstan (10) and apply at least two more twists using wire-twister pliers.
- (c) Trim wire 3/4 inch from second capstan (10).
- (d) Repeat for remaining pairs of capstans.

(5) Repeat steps (1) thru (4) for opposite manifold.



END OF TASK

FOLLOW-ON MAINTENANCE

- 3-4 Install exhaust tube couplings. (model 5063-5392)
- 3-5 Install exhaust tube couplings, (models 5063-5393 and 5063-539L)
- 3-6 Install exhaust tube couplings. (models 5063-5395, 5063-5395, and 5063-5395)
- 3-12.1 Install glow plug harness brackets. (model 5063-539L)

3-8. ENGINE LIFTER BRACKETS REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

MATERIALS/PARTS

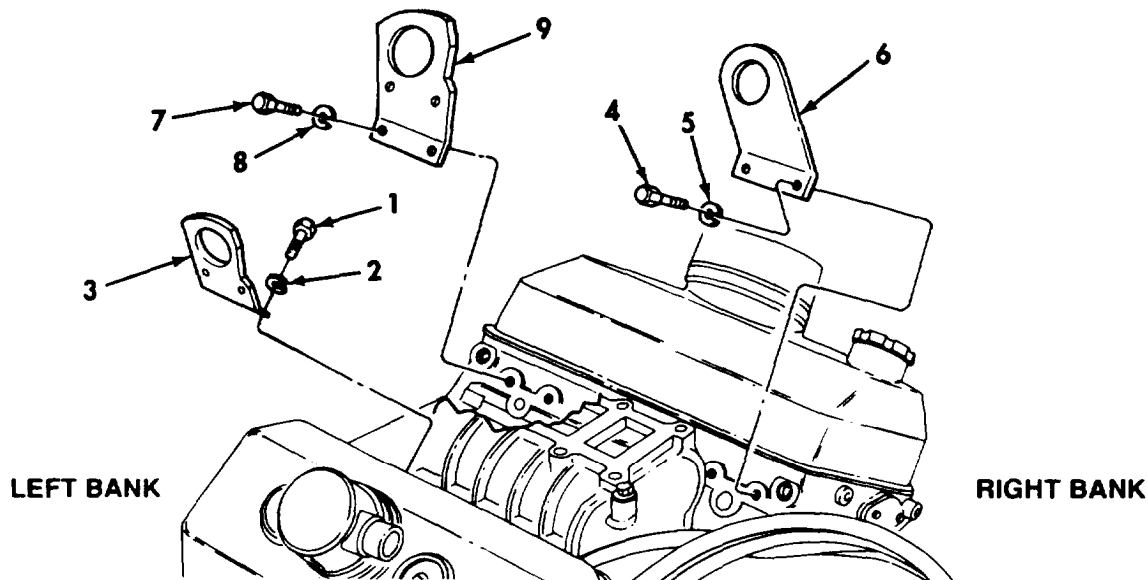
6 Lockwashers (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal

- (1) Remove two screws (1), two lockwashers (2), and lifting bracket (3) from front of left cylinder head. Discard lockwashers.
- (2) Remove two screws (4), two lockwashers (5), and lifting bracket (6) from rear of right cylinder head. Discard lockwashers.
- (3) For models 5063-5398, 5063-5395, and 5063-539F, remove two screws (7), two lockwashers (8), and lifting bracket (9) from front of right cylinder head. Discard lockwashers.



b. Installation

- (1) Install lifting bracket (3), two lockwashers (2), and two screws (1) on front of left cylinder head.
- (2) Install lifting bracket (6), two lockwashers (5), and two screws (4) to rear of right cylinder head.
- (3) For models 5063-5398, 5063-5395, and 5063-539F, install lifting bracket (9), two lockwashers (8), and two screws (7) on front of right cylinder head.
- (4) Torque all lifting bracket bolts to 30-35 lb-ft (41-47 N·m).

END OF TASK

3-9. ENGINE FRONT MOUNTING BRACKET REMOVAL/INSTALLATION (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal

b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

MATERIALS/PARTS

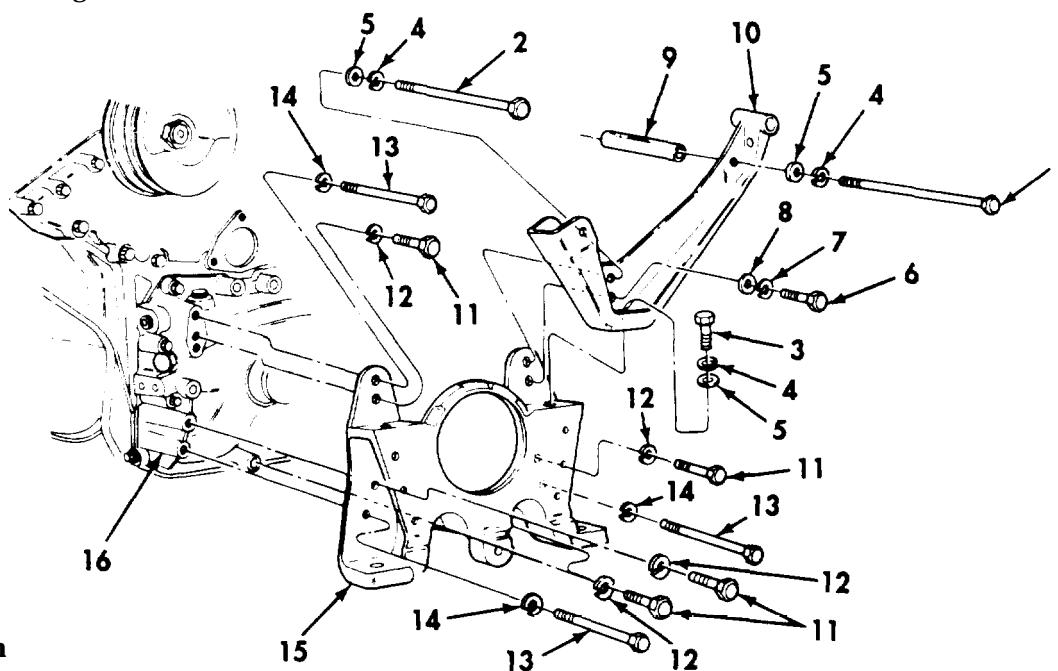
6 Lockwashers (App F, Item 99)
6 Lockwashers (App F, Item 100)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, item 116)

a. Removal

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



b. Installation

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

END OF TASK

3-10. AIR BOX HEATER HARDWARE REPLACEMENT (MODELS 5063-5299, 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Cleaning/Inspection c. Test d. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

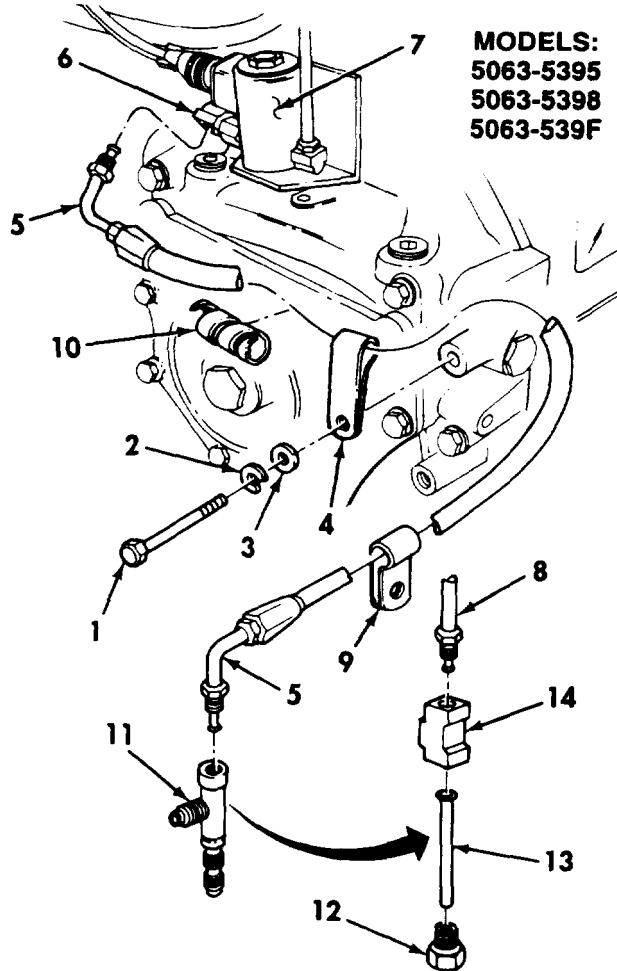
- 2 Lockwashers (App F, Item 96)
- 6 Lockwashers (App F, item 99)
- 1 Washer, copper (App F, Item 187)
- 2 Lockwashers (App F, Item 100)

EXPENDABLE/DURABLE SUPPLIES

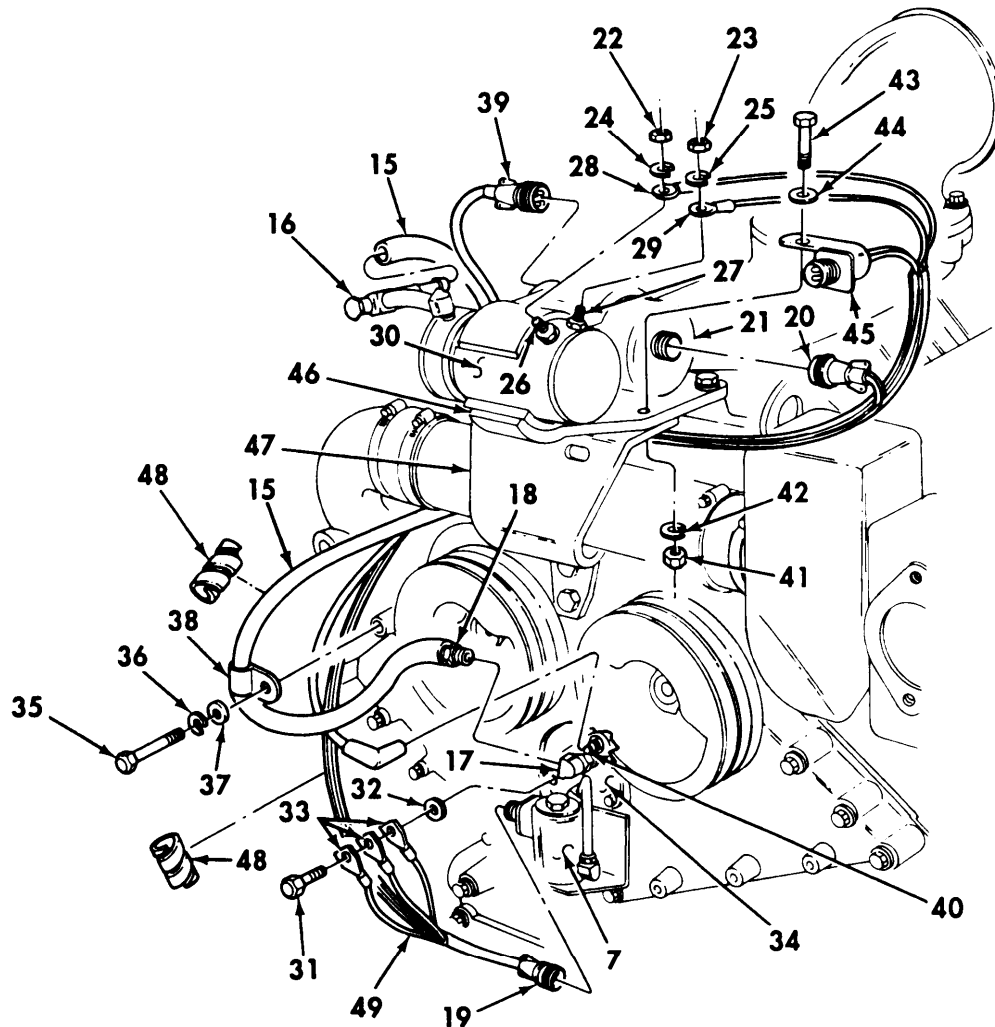
Cleaning solvent (App C, item 9)

a. Removal

- (1) Remove screw (1), lockwasher (2), and flat washer (3) securing hose clip (4) to lower front cover. Discard lockwasher.
- (2) Disconnect fuel inlet hose (5) from elbow (6) at fuel solenoid valve (7) and from fuel spill tube (8). Remove hose assembly from engine.
- (3) If necessary, remove clip (4), clip (9), and wire wrap (10) from hose assembly (5). For model 5063-5299, remove pipe tee (11) from hose assembly. For models 5063-5395, 5063-5398, and 5063-539F, remove nut (12), tube (13), and tee (14) from hose assembly.
- (4) Disconnect hose assembly (15) from check valve (16) and then from elbow (17) at air box heater body (34). If necessary, remove adapter (18) from hose.
- (5) Disconnect connector (19) from solenoid valve (7) and connector (20) from ignition coil (21).
- (6) Remove nut (22), nut (23), lockwasher 24, and lockwasher (25) from terminal (26) and terminal (27). Disconnect wiring harness lead (28) and lead (29) from air pump (30).
- (7) Remove bolt (31) and copper washer (32) connecting ground wires (33) to air box heater body (34) in upper front cover. Discard copper washer.



- (8) Remove screw (35), lockwasher (36), and flat washer (37) securing clip (38) to upper front cover. Discard lockwasher. If necessary, remove clip (38) from air hose (15).
- (9) Disconnect ignition coil cable (39) from ignition coil (21) and igniter (40).



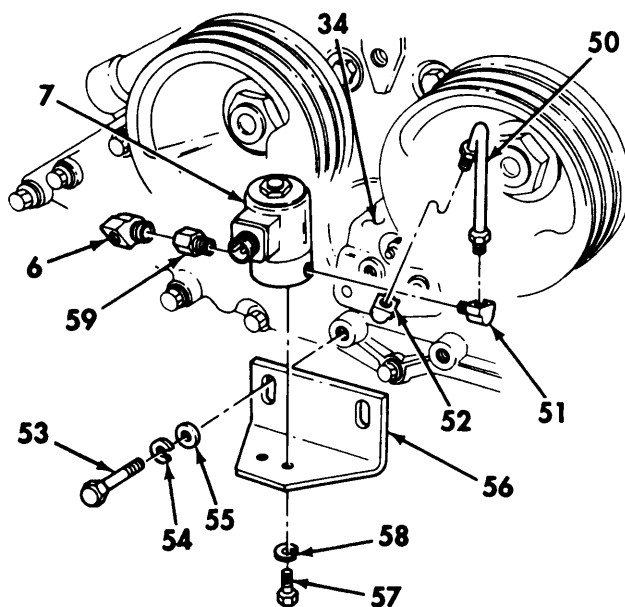
- (10) Remove nut (41), lockwasher (42), screw (43), and flat washer (44) securing clip (45), bracket assembly (46), and support (47). Discard lockwasher. If necessary, remove clip from harness plug.
- (11) Remove wire wrap (48) from harness assembly (49), ignition coil cable (39), and air hose (15). Remove air hose, ignition cable, and harness assembly from engine.

3-10. AIR BOX HEATER HARDWARE REPLACEMENT (MODELS 5063-5299, 5063-5395, 5063-5398, AND 5063-539F) (Cont)

- (12) Remove fuel line (50) from elbow (51) at solenoid valve (7) and from elbow (52) at air box heater body (34).

NOTE

For access to screws (53), loosen nut on top of solenoid (7) and rotate coil housing.



- (13) Remove two screws (53), two lockwashers (54), two flat washers (55) and solenoid bracket (56) from upper front cover. Discard lockwashers.
- (14) Remove two screws (57) and two lockwashers (58) from solenoid valve (7) and bracket assembly (56). Discard lockwashers.

- (15) If necessary, remove elbow (6), elbow (51), and adapter (59) from solenoid valve (7).

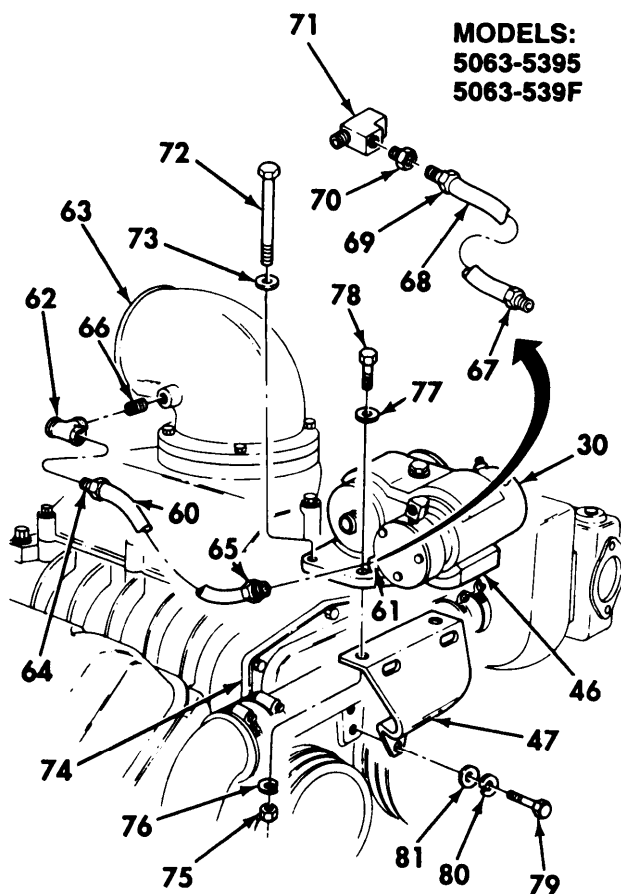
- (16) For model 5063-5299: disconnect hose assembly (60) from elbow (61) at air pump (30) and from tee (62) at air inlet elbow (63) and remove hose assembly. If necessary, remove adapter (64) and adapter (65) from hose. Remove tee and pipe nipple (66) from air inlet adapter.

- (17) For models 5063-5395 and 5063-539F: disconnect adapter (67) from elbow (61) at air pump (30) and remove hose assembly (68). If necessary, remove adapter (67), adapter (69), connector (70), and tee (71) from hose.

- (18) Remove two screws (72), two hardened washers (73), and bracket assembly (46) from top of blower (74).

- (19) Remove nut (75), lockwasher (76), flat washer (77), and screw (78) securing bracket assembly (46) and support (47). Discard lockwasher.

- (20) Remove two screws (79), two lockwashers (80), two flat washers (81), and support (47) from front of engine.



**MODELS:
5063-5395
5063-539F**

b. Cleaning/Inspection**WARNING**

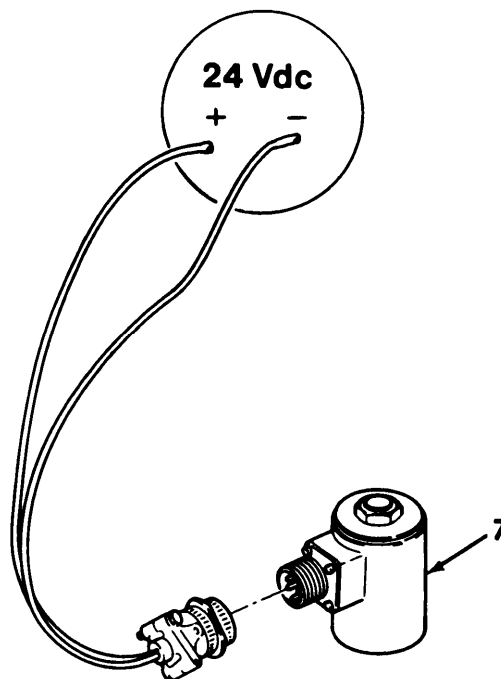
- Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while 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.

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

- (1) Clean fuel solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.
- (2) Inspect hoses for cuts, tears, kinks, or damage.
- (3) Inspect wiring harness for cuts, tears, burns, or damage.

c. Test

- (1) Apply a 24 V dc power source to solenoid valve (7) 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.
- (2) Disconnect power source from solenoid valve (7).



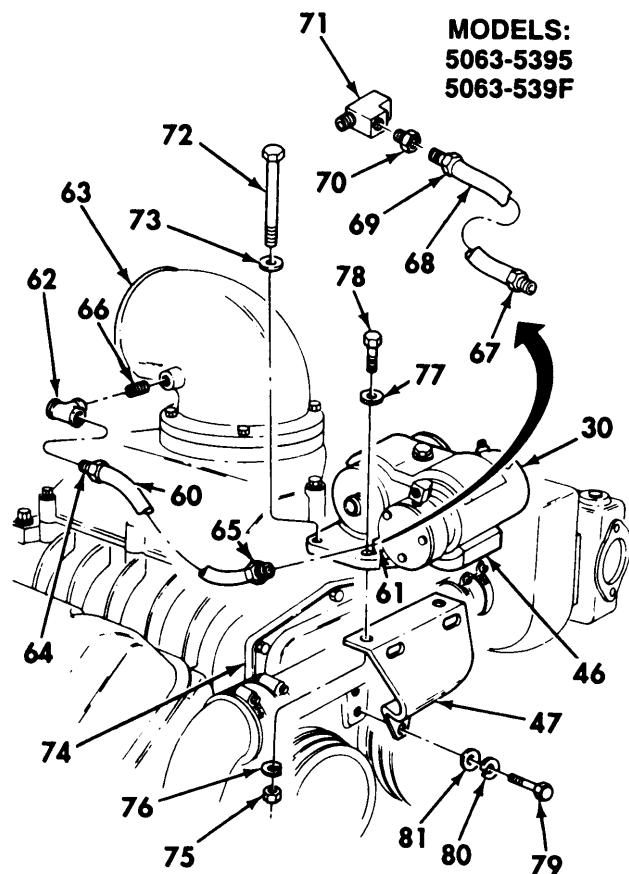
3-10. AIR BOX HEATER HARDWARE REPLACEMENT (MODELS 5063-5299, 5063-5395, 5063-5398, AND 5063-539F) (Cont)

d. Installation

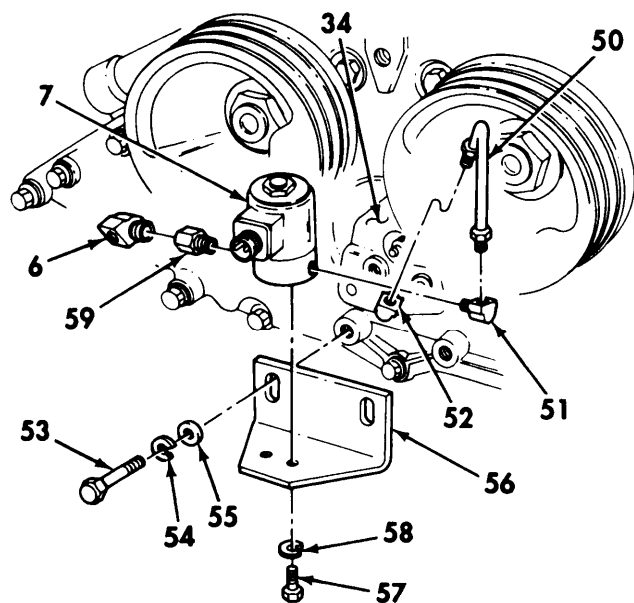
- (1) Loosely install support (47), two flat washers (81), two lockwashers (80), and two screws (79) on upper front cover.
- (2) Loosely install bracket assembly (46), screw (78), flat washer (77), lockwasher (76), and nut (75) on support (47).
- (3) Install two hardened washers (73) and two screws (72) on bracket assembly (46) into blower (74). Torque two screws (79) to 46-50 lb-ft (62-68 Nm), nut (75) to 30-35 lb-ft (41-47 N-m), and screws (72) to 55-60 lb-ft (75-81 Nm).
- (4) For model 5063-5299:
 - (a) If removed, install pipe nipple (66) and tee (62) in air inlet adapter (63). Install adapter (64) and adapter (65) into hose.
 - (b) Connect hose assembly (60) to elbow (61) on air pump (30) and then to tee (62) in air inlet elbow (63).
- (5) For models 5063-5395 and 5063-539F:
 - (a) If removed, install adapter (67), adapter (69), connector (70), and tee (71) into hose (68).
 - (b) Connect adapter (67) on hose assembly (68) to elbow (61) on air pump (30).
- (6) If removed, install elbow (51) (inlet port), adapter (59), and elbow (6) (outlet port) to solenoid valve (7).
- (7) Install solenoid valve (7), two lockwashers (58) and two screws (57) on bracket (56) with fuel inlet facing right bank. Tighten screws.

NOTE

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

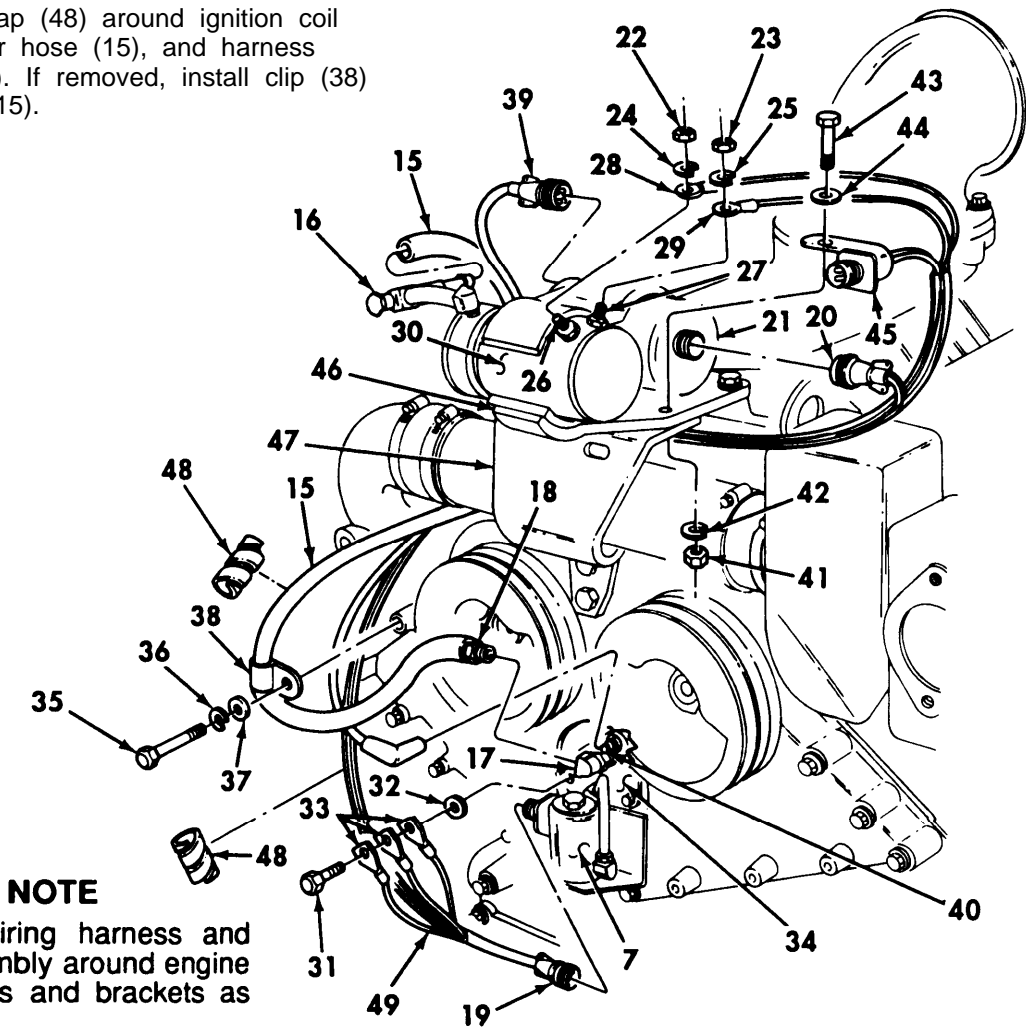


**MODELS:
5063-5395
5063-539F**



- (8) Install solenoid valve bracket (56), two flat washers (55), two lockwashers (54), and two screws (53) on upper front cover. Torque screws to 30-35 lb-ft (41-47 N-m).

- (9) Install fuel line (50) in elbow (51), at solenoid valve (7), and in elbow (52) on air box heater body (34). Tighten connections.
- (10) Wind wire wrap (48) around ignition coil cable (39), air hose (15), and harness assembly (49). If removed, install clip (38) on air hose (15).

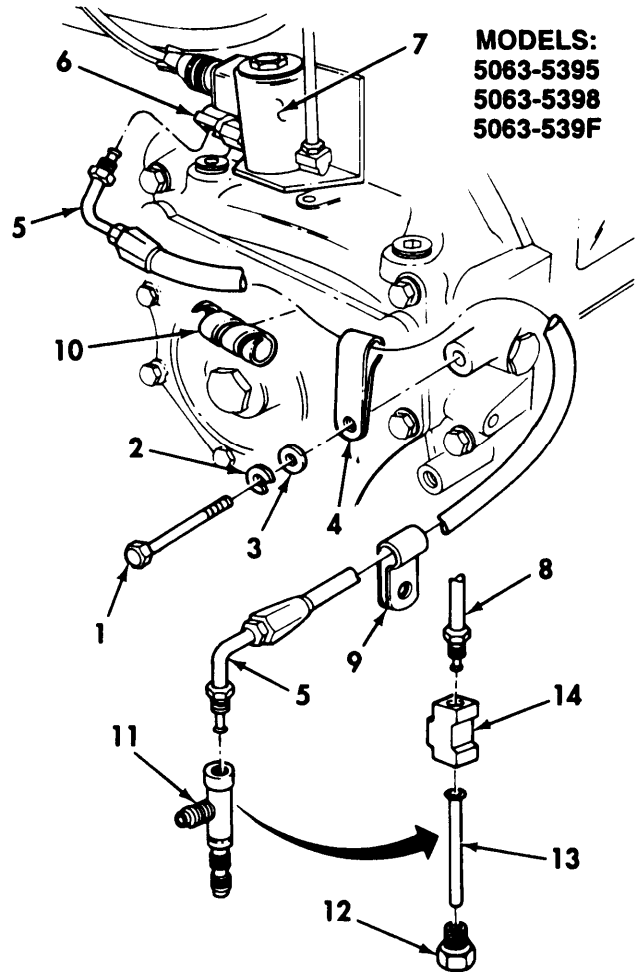
**NOTE**

Position wiring harness and hose assembly around engine components and brackets as shown.

- (11) If removed, install adapter (18) into hose assembly (15). Connect hose assembly to check valve (16) and adapter end to elbow (17) at air box heater body (34). Tighten connections.
- (12) Install connector (19) in solenoid (7) and connector (20) in ignition coil (21).
- (13) Install wiring harness lead (28), lockwasher (24), and nut (22) on terminal (26). Install lead (29), lockwasher (25), and nut (23) on terminal (29) on air pump (30). Tighten nuts securely.
- (14) Install ground wires (33), copper washer (32), and bolt (31) on air box heater body (34). Torque bolt to 13-17 lb-ft (18-23 N-m).
- (15) Install clip (38), on air hose (15), flat washer (37), lockwasher (36), and screw (35) on upper front cover. Torque screw to 30-35 lb-ft (41-47 Nm).
- (16) Connect boot end of ignition coil cable (39) to igniter (40) and connector end of ignition coil cable to ignition coil (21).
- (17) Install screw (43), flat washer (44), lockwasher (42), and nut (41) in bracket (46) and support (47). Torque nut to 30-35 lb-ft (41-47 Nm).

3-10. AIR BOX HEATER HARDWARE REPLACEMENT (MODELS 5063-5299, 5063-5395, 5063-5398, AND 5063-539F) (Cont)

- (18) If removed, install clip (4), clip (9), and wire wrap (10) on hose assembly (5). For model 5063-5299, install pipe tee (11) on hose assembly. For models 5063-5395, 5063-5398, and 5063-539F, install tee (14), tube (13), and nut (12) on hose assembly.
- (19) Install clip (4), flat washer (3), lockwasher (2) and screw (1) on lower front cover. Torque screw to 30-35 lb-ft (41-47 Nm).
- (20) Connect hose assembly (5) to elbow (6) in solenoid valve (7). Tighten connection.



END OF TASK

3-11. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5392)

This task covers: a. Removal b. Cleaning/Inspection c. Test d. Installation

INITIAL SETUP

MODELS

5063-5392

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

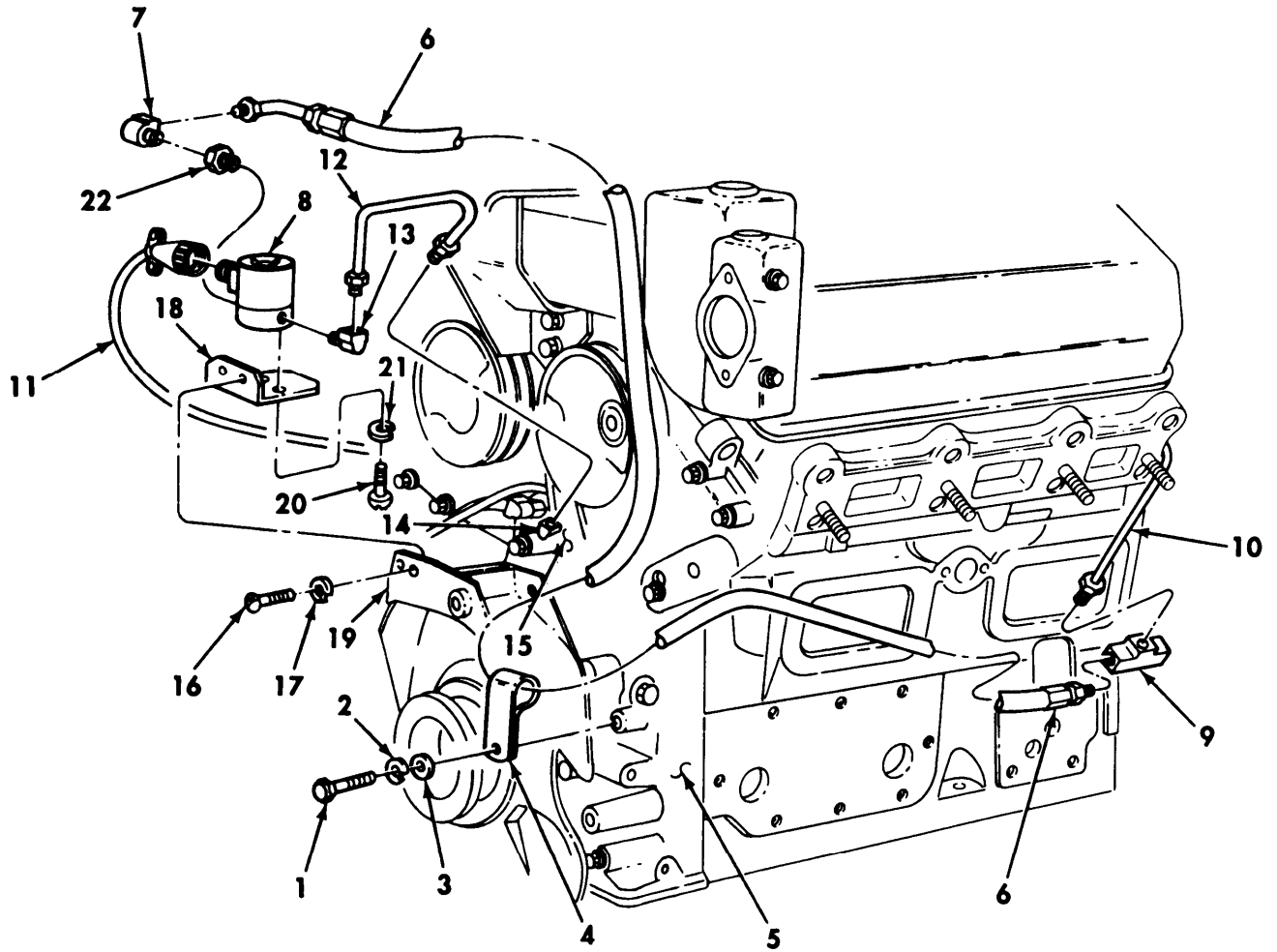
4 Lockwashers (App F, Item 96)
9 Lockwashers (App F, Item 99)
1 Washer, copper (App F, Item 187)
2 Lockwashers (App F, Item 100)
1 Lockwasher (App F, Item 97)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

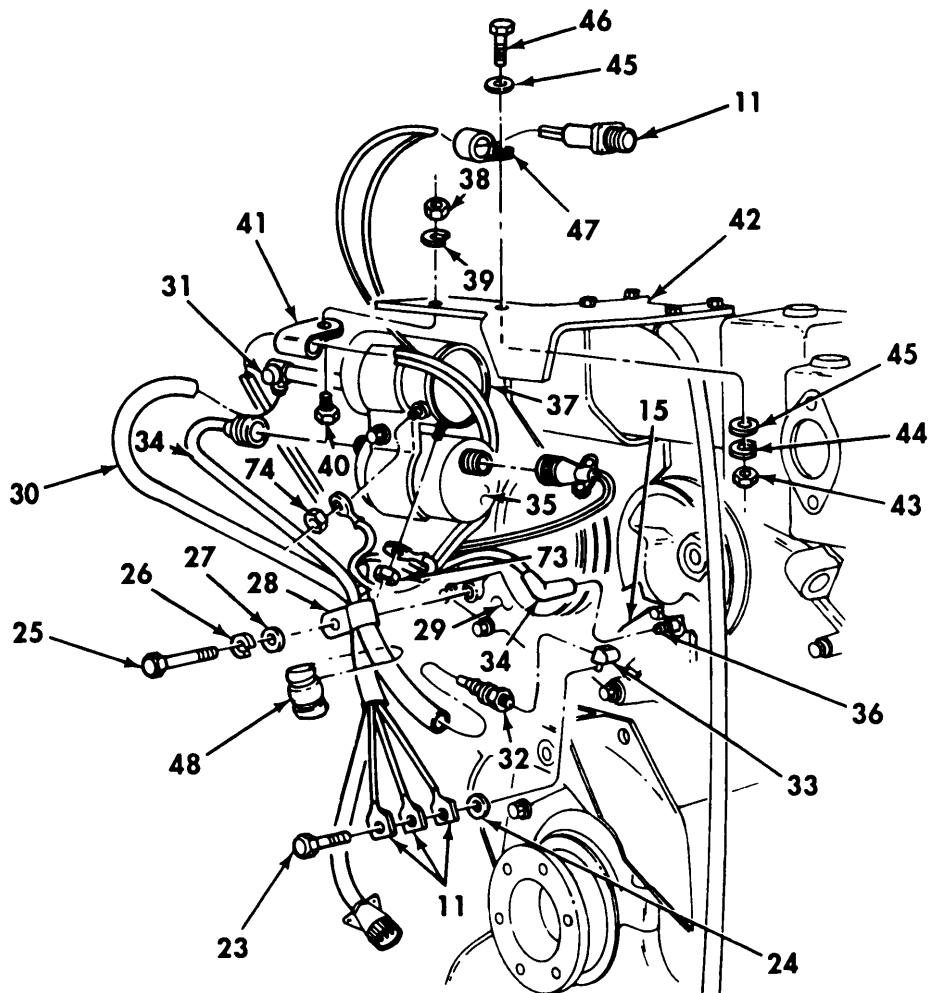
a. Removal

- (1) Remove screw (1), lockwasher (2), flat washer (3), and loop clamp (4) on lower front cover (5). Discard lockwasher.
- (2) Disconnect hose assembly (6) from elbow (7) in solenoid valve (8).
- (3) Disconnect hose assembly (6) from tee (9). Disconnect tee from fuel spill tube (10).
- (4) Disconnect harness assembly (11) from fuel solenoid valve (8).
- (5) Disconnect tube assembly (12) from elbow (13) in solenoid valve (8) and from elbow (14) in air box heater (15).
- (6) Remove two machine screws (16), two lockwashers (17), and mounting bracket (18) from engine bracket (19). Discard lockwashers.
- (7) Remove two machine screws (20), two lockwashers (21), and solenoid valve (8) from mounting bracket (18). Discard lockwashers.
- (8) If necessary, remove elbow (7), elbow (13), and adapter (22) from solenoid valve (8).



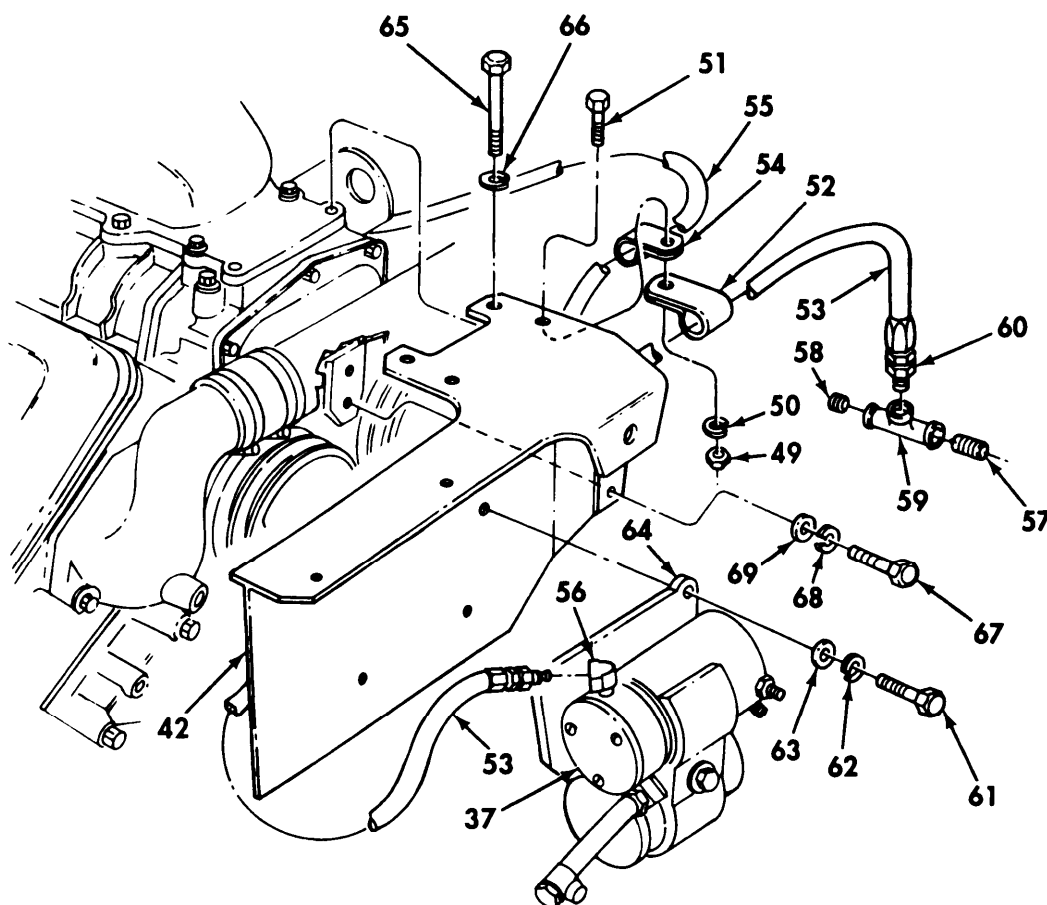
3-11. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5392) (Cont)

- (9) Remove bolt (23), copper washer (24), and grounding wires of harness assembly (11) form air box heater (15). Discard copper washer.
- (10) Remove screw (25), lockwasher (26), flat washer (27), and loop clamp (28) from front cover (29). Discard lockwasher.
- (11) Disconnect air hose (30) from check valve (31) and adapter (32) from elbow (33) in air box heater (15). If necessary, remove adapter from hose.
- (12) Disconnect ignition wire (34) from ignition coil (35) and spark igniter (36).
- (13) Remove two nuts (73 and 74) and disconnect two leads of harness assembly (11) from air pump (37).
- (14) Disconnect harness assembly (11) from ignition coil (35).
- (15) Remove nut (38), lockwasher (39), screw (40), and clip (41) from angle bracket (42). Discard lockwasher. If necessary, remove clip from harness assembly (11).



- (16) Remove nut (43), lockwasher (44), two flat washers (45), screw (46), and clip (47) from angle bracket (42). Discard lockwasher.
- (17) Remove clip (28) and wire wrqp (48) holding harness assembly (11), ignition wire (34), and air hose (30) together. Remove air hose, ignition cable, and harness assembly from engine.

- (18) Remove two nuts (49), two lockwashers (50), two screws (51), loop clamp (52) on air hose assembly (53), and two loop clamps (54) on fuel hose assembly (55) from angle bracket (42). Discard lockwashers.
- (19) Disconnect air hose assembly (53) from elbow (56) at air pump (37). Remove hose assembly from engine. If necessary, remove loop clamp (52), pipe nipple (57), pipe plug (58), pipe tee (59), and connector (60) from hose assembly.



- (20) Remove four screws (61), four lockwashers (62), four flat washers (63), and bracket assembly (64) from angle bracket (42). Discard lockwashers.
- (21) Remove two long screws (65) and two lockwashers (66) from top of angle bracket (42). Remove two short screws (67), two lockwashers (68), and two flat washers (69) from front of bracket. Remove bracket from engine. Discard lockwashers.

3-11. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5392) (Cont)

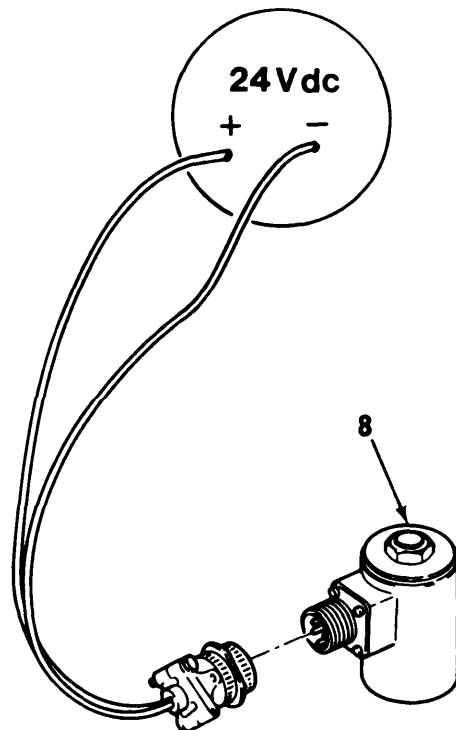
b. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (1) Clean solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.
 - (2) Inspect hoses for cuts, tears, kinks, or damage.
 - (3) inspect wiring harness for cuts, tears, burns, or damage.

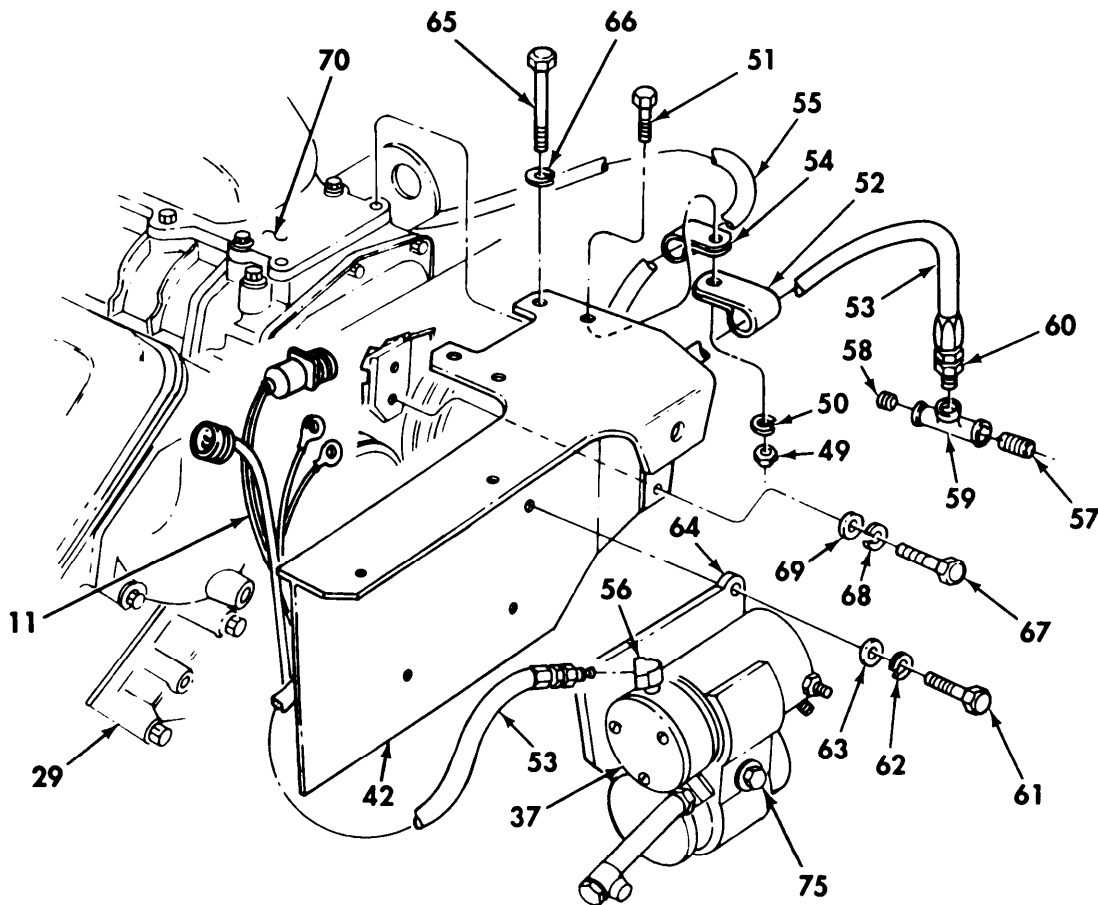
c. Test

- (1) Apply a 24 V dc power supply to the solenoid valve (8) 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.
- (2) Disconnect power supply from solenoid valve (8).



d. Installation

- (1) Lay harness assembly (11) in position on front of engine.
- (2) Place angle bracket (42) over front of air inlet housing (70) and against upper front cover (29). Install two lockwashers (66) and two long screws (65) in top of bracket and install two flat washers (69), two lockwashers (68), and two short screws (67) in front of bracket. Torque screws (65) to 16-20 lb-ft (22-27 Nm) and screws (67) to 46-50 lb-ft (62-68 Nm).

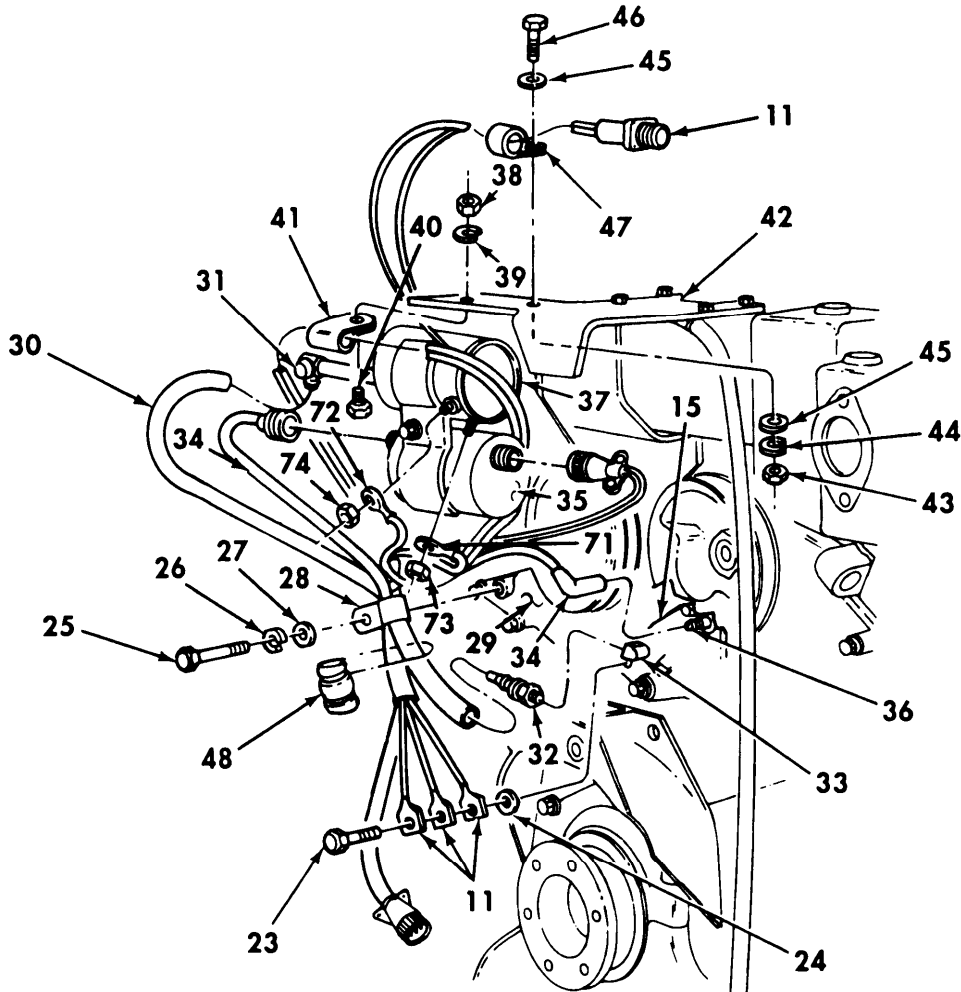
**NOTE**

To torque screws (61), it is necessary to loosen center bolt (75) on bracket assembly (64) and move air pump and ignition coil. Torque center bolt (75) to 60-96 lb-in (7-11 N-m).

- (3) Install bracket assembly (64), four flat washers (63), four lockwashers (62), and four screws (61) on angle bracket (42). Torque bolts to 30-35 lb-ft (41-47 Nm).
- (4) If removed, install loop clamp (52), connector (60), tee (59), pipe nipple (57), and pipe plug (58) on air inlet hose (53). connect hose to elbow (56) in air pump (37). Tighten connection.
- (5) Install two screws (51), two loop clamps (54) on top of bracket, loop clamp (52) on bottom of bracket, two lockwashers (50), and two nuts (49) on angle bracket (42). Torque screws to 30-35 lb-ft (41-47 Nm).

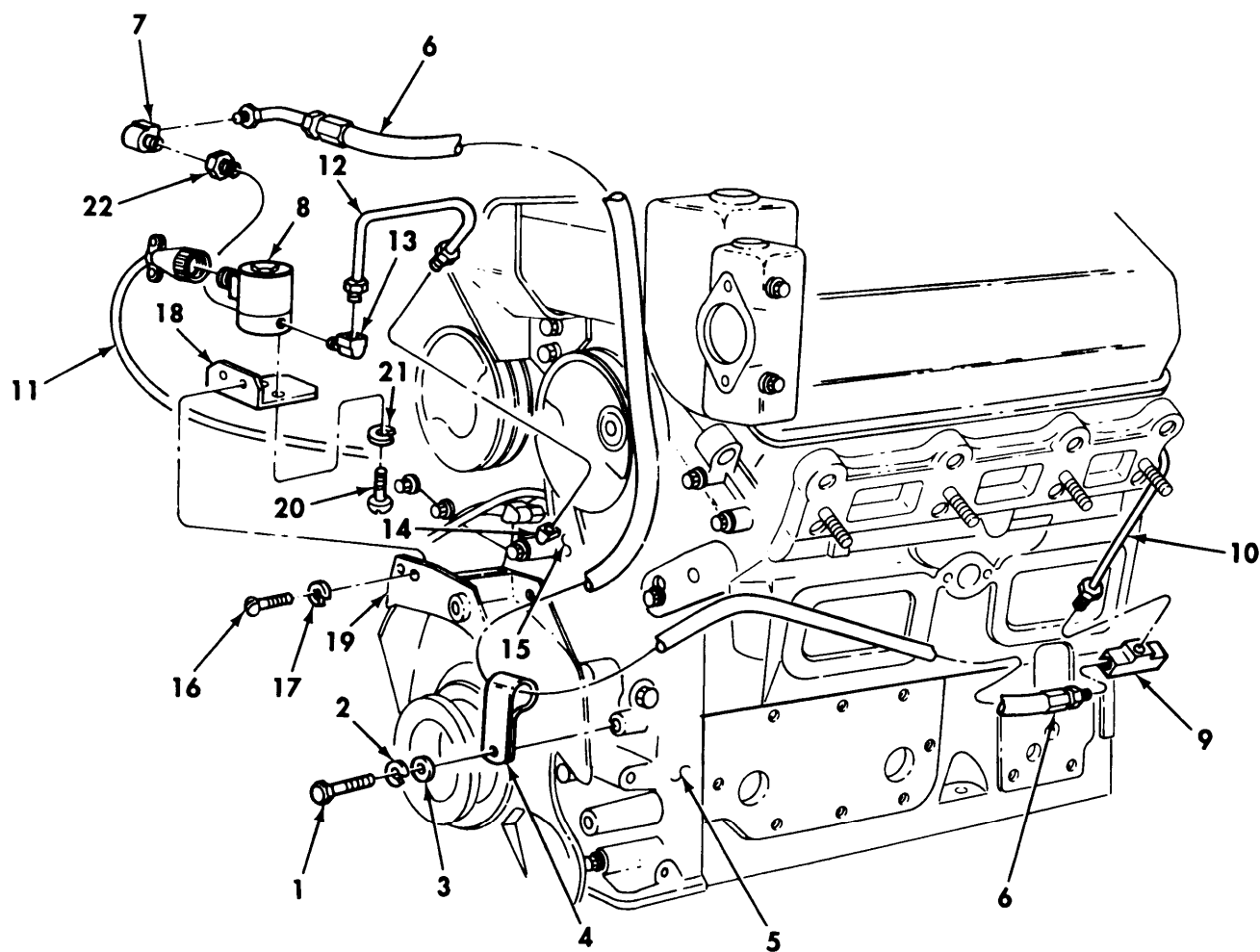
3-11. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5392) (Cont)

- (6) Install three round wires of harness assembly (11), copper washer (24), and bolt (23) in air box heater (15). Torque bolt to 13-17 lb-ft (18-23 Nm).
- (7) Connect ignition wire (34) to spark igniter (36) and ignition coil (35).
- (8) If removed, install adapter (32) in air hose (30). Connect hose to check valve (31) and adapter on hose to elbow (33) in air box heater (15).



- (9) Install terminal of harness assembly (11), clip (47), screw (46), two flat washers (45), lockwasher (44), and nut (43) to top of angle bracket (42). Torque nut to 30-35 lb-ft (41-47 Nm).
- (10) If removed, install clip (41) on harness assembly (11). Install screw (40), lockwasher (39), and nut (38) to bottom of angle bracket (42). Torque nut to 7-9 lb-ft (10-12 N-m).
- (11) Install wire wrap (48) and clip (28) around harness assembly (11), ignition wire (34), and air hose (30).
- (12) Install clip (28), flat washer (27), lockwasher (26), and screw (25) on upper front cover (29). Torque screw to 30-35 lb-ft (41-47 Nm).

- (13) If removed, install elbow (13) in outlet port and adapter (22) in inlet port of solenoid valve (8). Install elbow (7) in adapter.
- (14) Install solenoid valve (8), two lockwashers (21), and two machine screws (20) on mounting bracket (18) with fuel inlet facing right side of engine. Tighten screws.
- (15) Loosely install mounting bracket (18), two lockwashers (17), and two machine screws (16) on engine bracket (19).
- (16) Connect harness assembly (11) to solenoid valve (8) and ignition coil (35).
- (17) Install two harness assembly leads (71 and 72) and two nuts (73 and 74) on air pump (37)
- (18) Connect tube assembly (12) to elbow (13), in solenoid valve (8), and to elbow (14), in air box heater (15). Tighten connections and two machine screws (16).



- (19) Connect hose assembly (6) to elbow (7) in solenoid valve (8) and tee (9) to fuel spill tube (10). Tighten connections.
- (20) Install loop clamp (4), flat washer (3), lockwasher (2), and screw (1) in lower front cover (5). Torque screw to 30-35 lb-ft (41-47 N-m).

END OF TASK

3-12. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5393)

This task covers: a. Removal b. Cleaning/Inspection c. Test d. Installation

INITIAL SETUP

MODELS

5063-5393

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

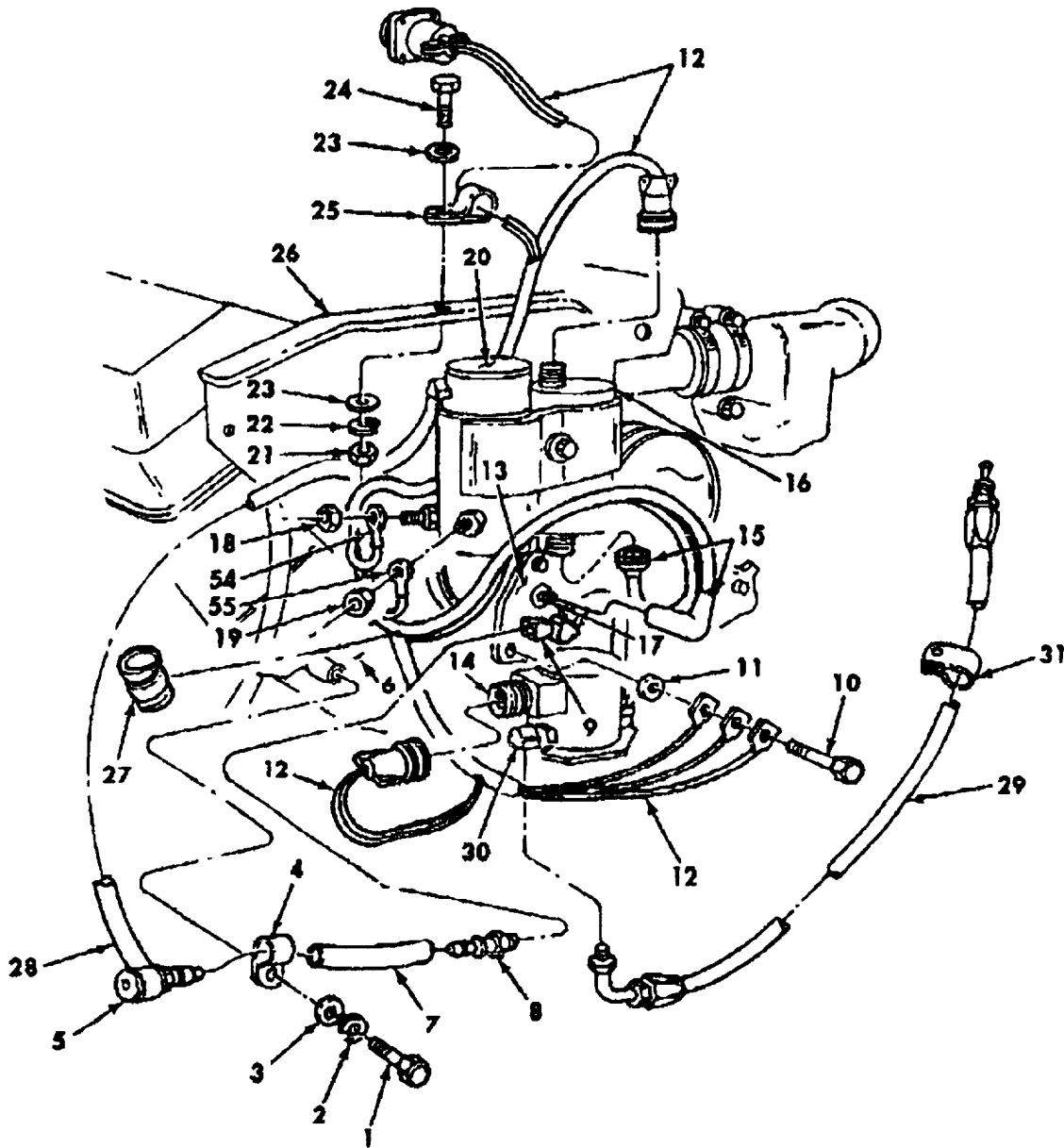
Para Description
3-9 Upper bracket on front support removed

MATERIALS/PARTS

2 Lockwashers (App F, Item 96)
10 Lockwashers (App F, Item 99)
1 Washer, copper (App F, Item 187)
2 Lockwashers (App F, Item 100)

a. Removal

- (1) Remove screw (1), lockwasher (2), flat washer (3), and loop clamp (4), on check valve (5), from upper front cover (6). Discard lockwasher.
- (2) Disconnect hose (7) from check valve (5) and adapter (8) from elbow (9). If necessary, remove adapter (8) from hose.
- (3) Remove bolt (10), copper washer (11), and ground wires of harness assembly (12) from air box heater (13). Discard copper washer.
- (4) Disconnect lead on harness assembly (12) from solenoid valve (14).
- (5) Disconnect ignition wire (15) from bottom of ignition coil (16) and spark igniter (17).
- (6) Remove nut (18) and nut (19) from air pump (20) and disconnect two leads of harness assembly (12).
- (7) Disconnect lead on harness assembly (12) from top of ignition coil (16).
- (8) Remove nut (21), lockwasher (22), two flat washers (23), screw (24), and clip (25) from mounting bracket (26). Discard lockwasher.
- (9) Remove wire wrap (27) from ignition wire (15), harness assembly (12), and hose (28).
- (10) Remove ignition wire (15) and harness assembly (12) from engine.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
 3-9 Install upper bracket on front support.

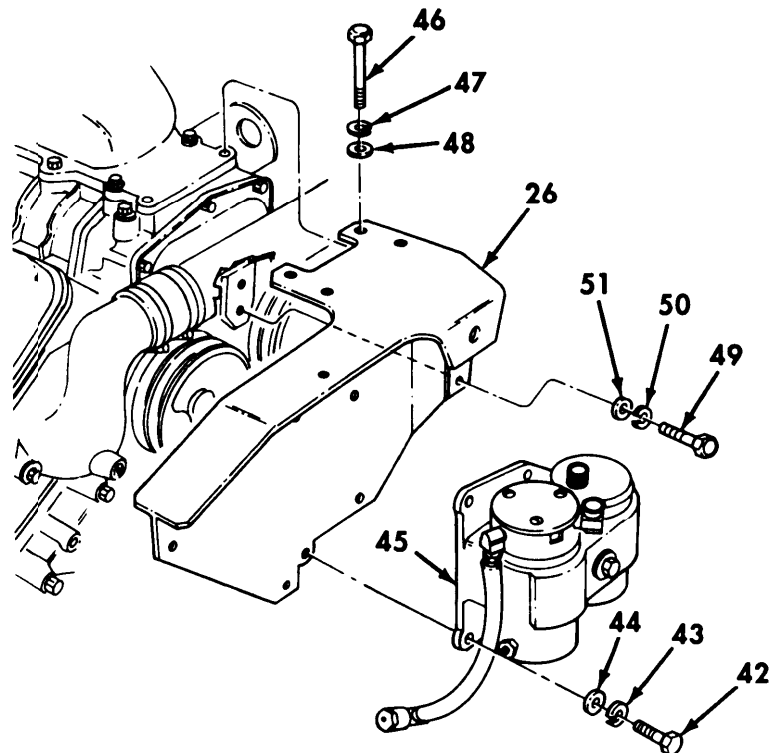
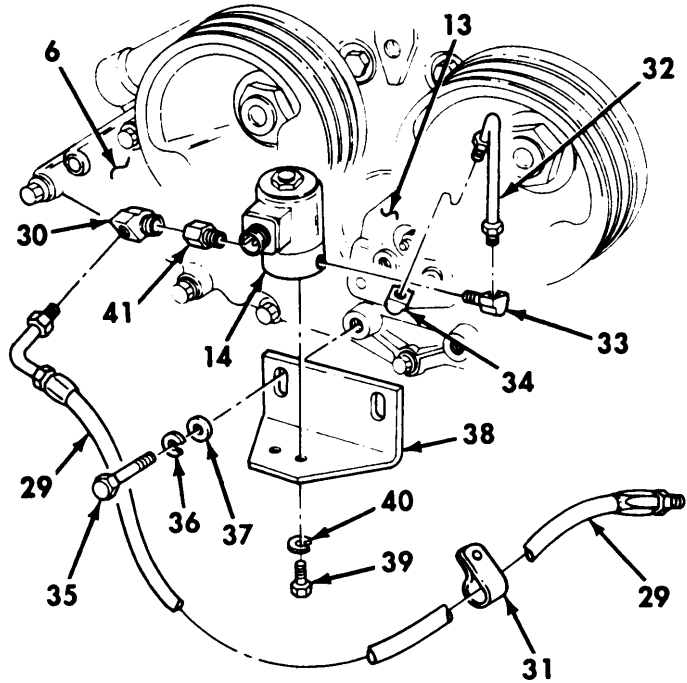
3-12. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5393) (Cont)

- (11) Disconnect hose assembly (29) from elbow (30) in solenoid valve (14). Remove hose assembly from engine. If necessary, remove loop clamp (31) from hose assembly.
- (12) Remove tube assembly (32) from elbow (33), in solenoid valve (14), and elbow (34) in air box heater (13).

NOTE

For access to screws (35), loosen nut on top of solenoid (14) and rotate coil housing.

- (13) Remove two screws (35), two lockwashers (36), two flat washers (37), and solenoid bracket (38) from front cover (6). Discard lockwashers.
- (14) Remove two machine screws (39), two lockwashers (40), and solenoid valve (14) from solenoid bracket (38). Discard lockwashers.
- (15) If necessary, remove elbow (30), elbow (33), and adapter (41) from solenoid valve (14).
- (16) Remove four screws (42), four lockwashers (43), four flat washers (44), and bracket assembly (45) from mounting bracket (26). Discard lockwashers.
- (17) Remove two long screws (46), two lockwashers (47), and two flat washers (48) from top of mounting bracket (26). Remove two short screws (49), two lockwashers (50), and two flat washers (51) from front of mounting bracket. Remove mounting bracket from engine. Discard lockwashers.



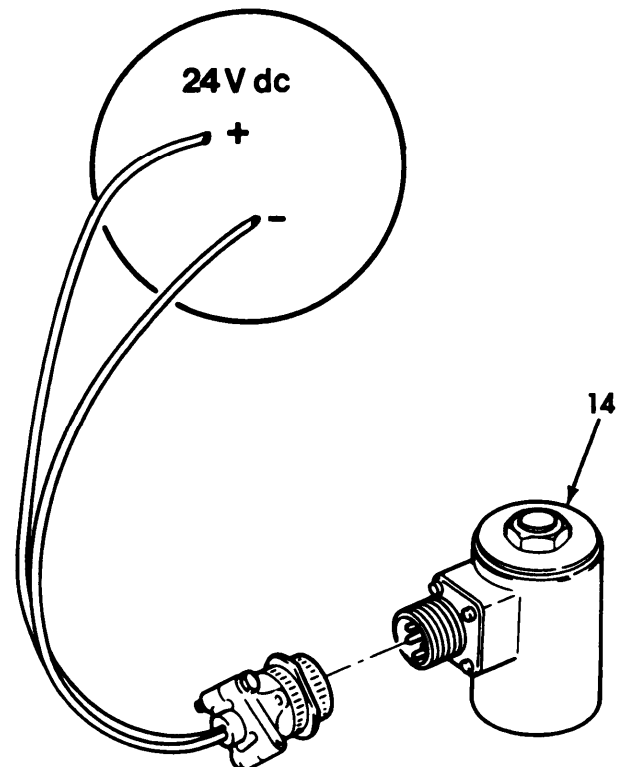
b. Cleaning/Inspection

WARNING

- Ž Dry cleaning solvent P-D-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 (38-50°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.
 - Ž Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (1) Clean fuel solenoid valve with rag moistened with cleaning solvent. Clean brackets with cleaning solvent. Dry components with compressed air.
 - (2) Inspect hoses for cuts, tears, kinks, or damage.
 - (3) Inspect wiring harness for cuts, tears, burns, or damage.

c. Test

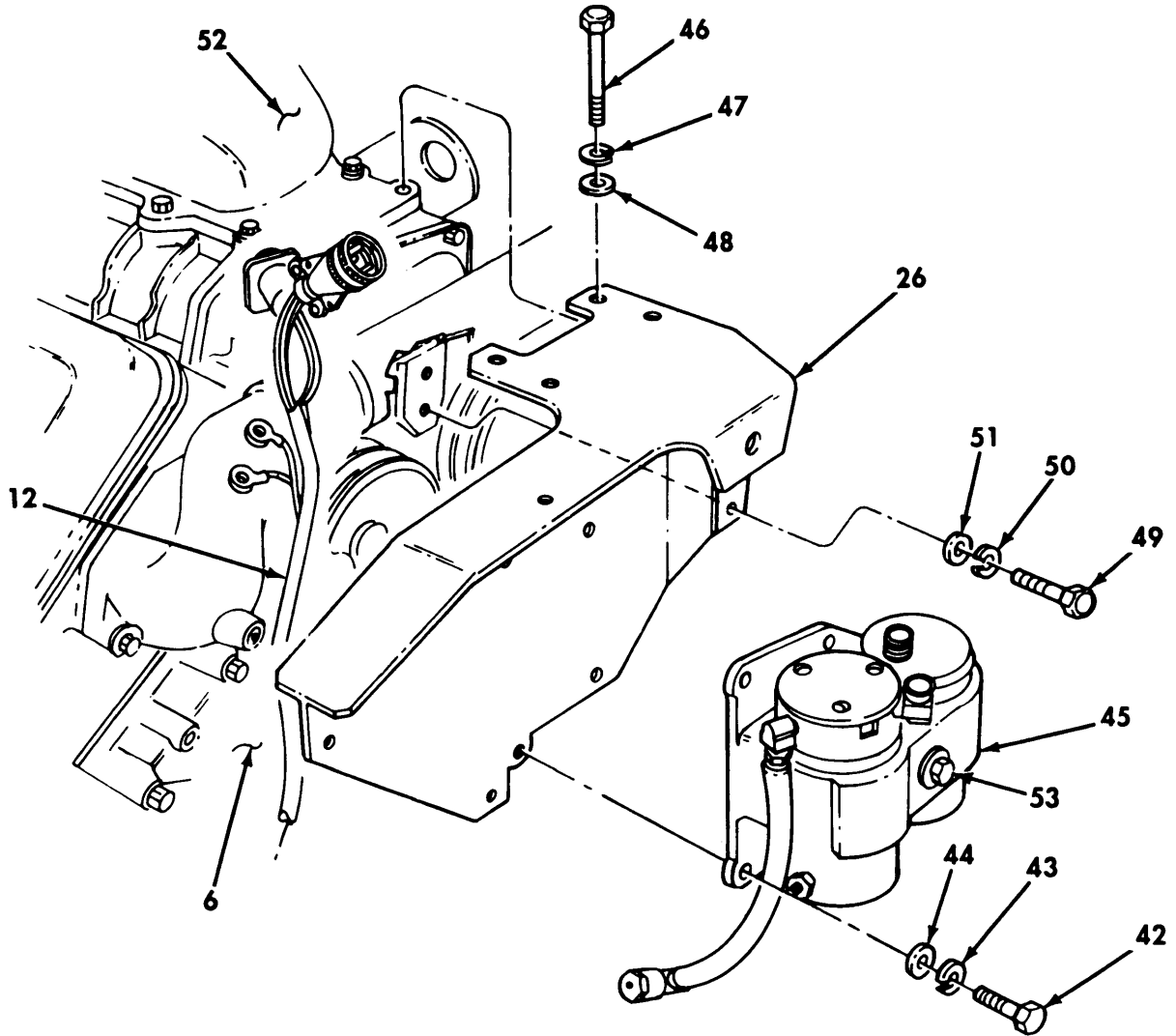
- (1) Apply a 24 V dc power supply to solenoid valve (14) several times and listen for valve to "click" to determine if valve functions. If there is no indication of valve movement, replace unit.
- (2) Disconnect power supply from solenoid valve (14).



3-12. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5393) (Cont)

d. Installation

- (1) Lay harness assembly (12) in position on front of engine.
- (2) Place mounting bracket (26) over front of air inlet housing (52) and against upper front cover (6). Install two flat washers (48), two lockwashers (47), and two long screws (46) into top of bracket and install two flat washers (51), two lockwashers (50), and two short screws (49) into front of bracket. Torque screws (46) to 16-20 lb-ft (22-27 Nm) and screws (49) to 46-50 lb-ft (62-68 N-m).

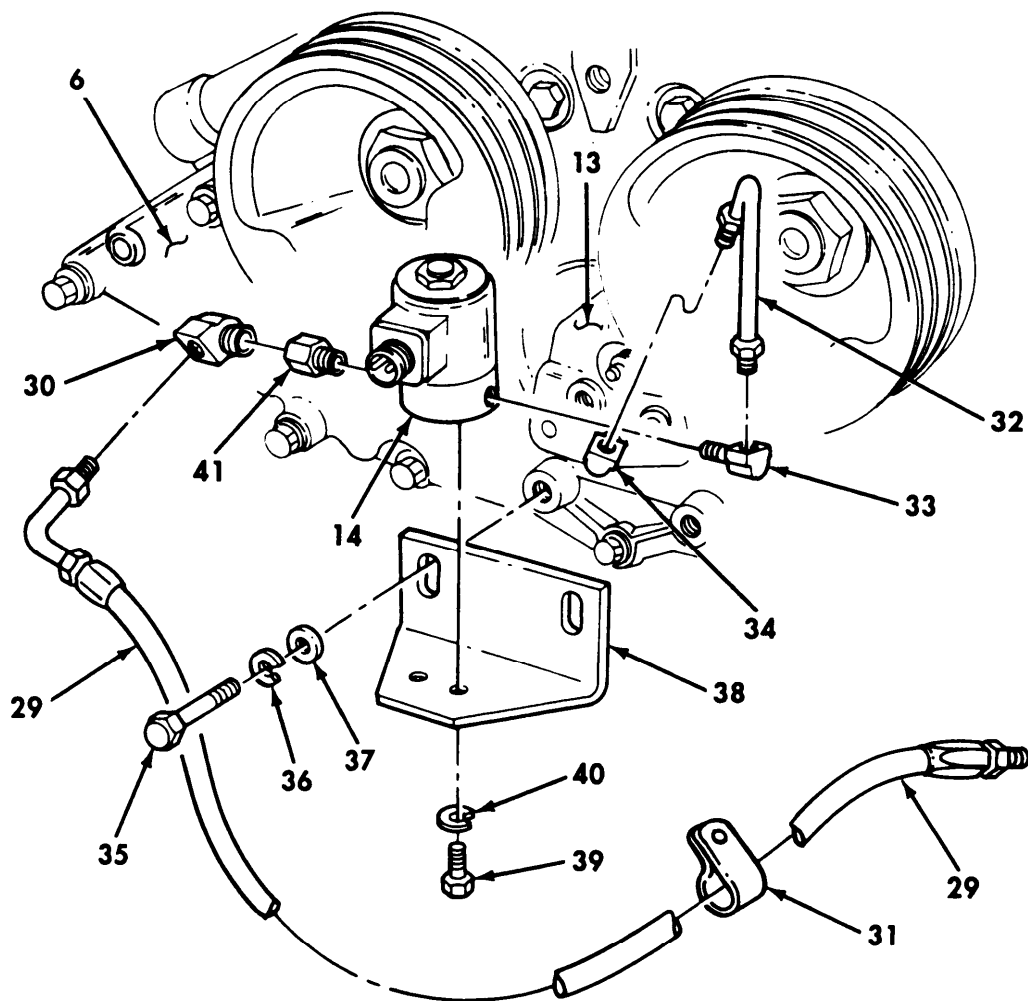


NOTE

To torque screws (42), it is necessary to loosen center bolt (53) on bracket assembly (45) and move air pump and ignition coil. Torque center bolt to 60-96 lb-in (7-11 Nm).

- (3) Install bracket assembly (45), four flat washers (44), four lockwashers (43), and four screws (42) on mounting bracket (26). Torque bolts to 30-35 lb-ft (41-47 Nm).

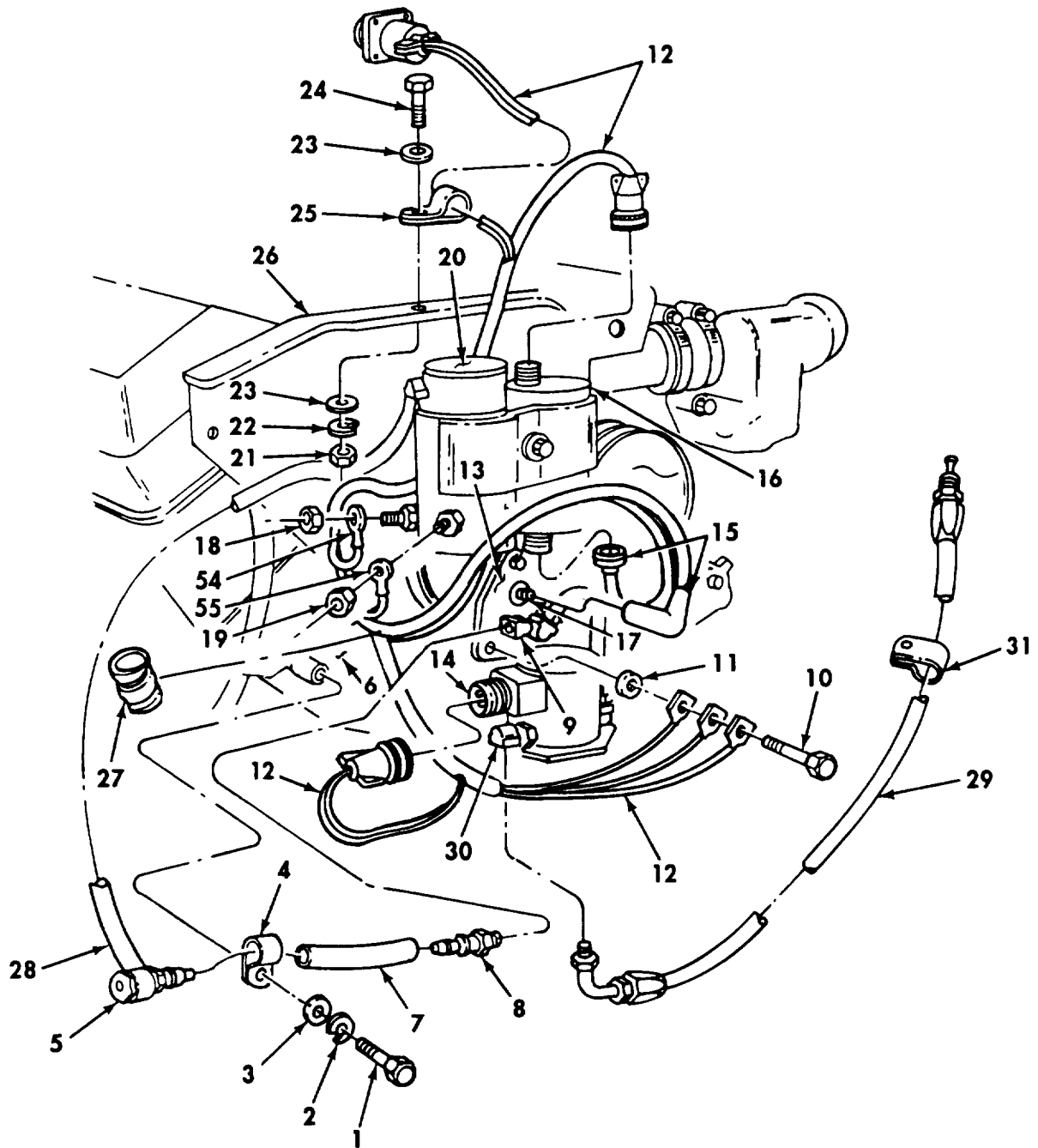
- (4) Install solenoid valve (14), two lockwashers (40), and two machine screws (39) on bracket (38) with inlet port facing right side of engine. Tighten screws.
- (5) If removed, install elbow (33) in outlet port and install adapter (41) and elbow (30) in inlet port of solenoid valve (14).



- (6) Loosely install solenoid bracket (38), two flat washers (37), two lockwashers (36), and two screws (35) on front cover.
- (7) Install tube assembly (32) in elbow (33), of solenoid valve (14), and in elbow (34) of air box heater (13). Tighten connections. Torque screws (35) to 30-35 lb-ft (41-47 N·m).
- (8) If removed, install loop clamp (31) on hose assembly (29).
- (9) Connect hose assembly (29) to elbow (30) in solenoid valve (14). Tighten connection.

3-12. AIR BOX HEATER HARDWARE REPLACEMENT (MODEL 5063-5393) (Cont)

- (10) Connect terminals of harness assembly (12) to solenoid valve (14) and top of ignition coil (16).
- (11) Install two harness assembly leads (54 and 55) and two nuts (18 and 19) on air pump (20).
- (12) Install three ground wires of harness assembly (12), copper washer (11), and bolt (10) in air box heater (13). Torque bolt to 13-17 lb-ft (18-23 Nm).
- (13) Install terminal of harness assembly (12), clip (25), screw (24), two flat washers (23), lockwasher (22), and nut (21) in top of bracket (26). Torque nut to 30-35 lb-ft (41-47 Nm).
- (14) Connect ignition wire (15) to spark igniter (17) and bottom of ignition coil (16).
- (15) If removed, install adapter (8) in hose (7).
- (16) Install check valve (5) in hose (7). Connect adapter (8) to elbow (9) in air box heater (13). Tighten adapter.
- (17) Place check valve (5) in loop clamp (4) and install loop clamp, flat washer (3), lockwasher (2), and screw (1) into rent cover (6). Torque screw to 30-35 lb-ft (41-47 Nm).
- (18) Install wire wrap (27) around ignition wire (15), hose (28), and harness assembly (12).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-9 Install upper bracket on front support.

3-12.1 GLOW PLUGS, CONTROLLER AND HARNESS REPLACEMENT (MODEL 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-539L

MATERIALS/PARTS

2 Lockwashers (App F, Item 98)

TOOLS AND SPECIAL TOOLS

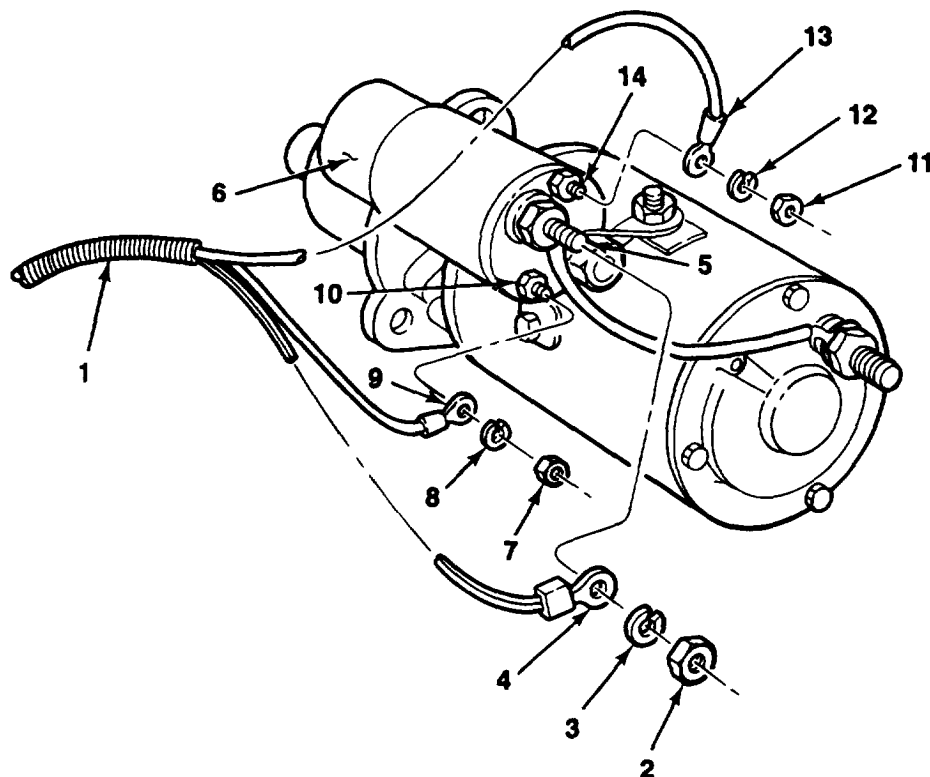
Tool kit, general mechanics (App B, Hem 107)

Wrench, torque (App B, Item 116)

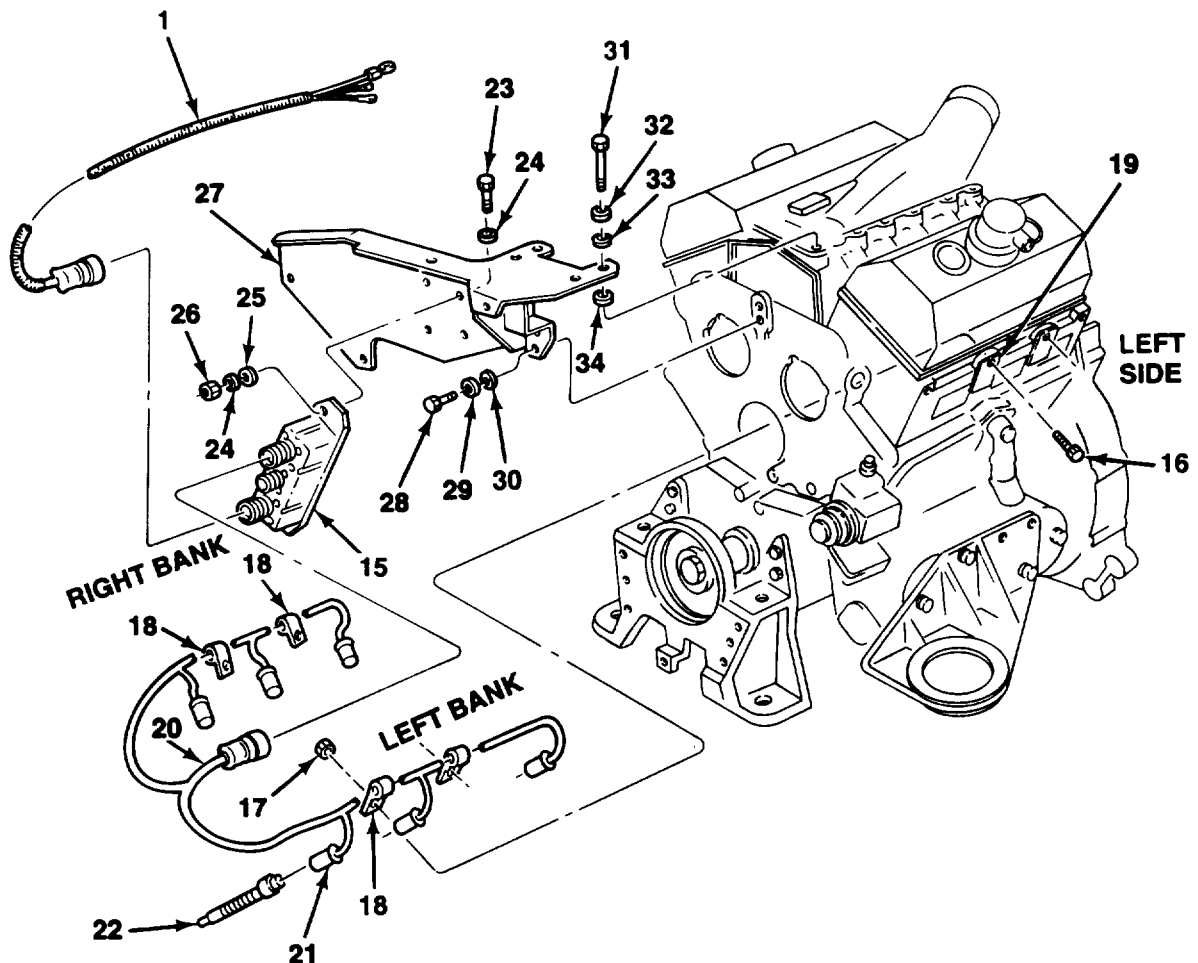
Wrench, torque (App B, Item 118)

a. Removal

- (1) Disconnect glow plug power harness (1) by removing nut (2) and lockwasher (3) securing red double lead power connection (4) at battery terminal (5) on solenoid (6). Remove lead and reinstall nut and lockwasher.
- (2) Remove nut (7) and lockwasher (8) securing orange switch lead connection (9) at switch terminal (10) on solenoid (6). Remove lead and reinstall nut and lockwasher.
- (3) Remove nut (11) and lockwasher (12) securing blue ground lead connection (13) to ground terminal (14) on solenoid (6). Remove lead and reinstall nut and lockwasher.



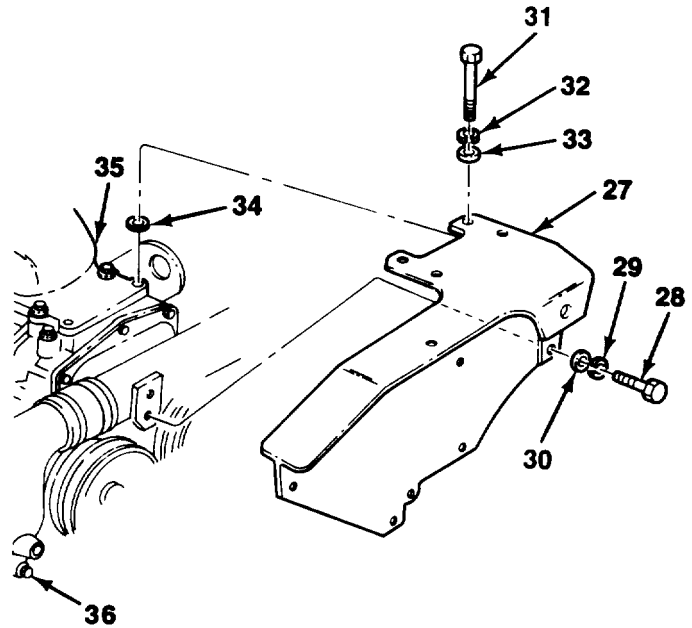
- (4) Disconnect and remove glow plug power harness (1) from left side of glow plug controller (15).
- (5) Remove two bolts (16) and two nut (17) securing two clips (18) to two brackets (19) on glow plug harness (20) to left cylinder head.
- (6) Disconnect three plug ends (21) of glow plug harness (20) at glow plugs (22) from left cylinder head.
- (7) Remove three glow plugs (22) from left cylinder head.
- (8) Repeat steps 5 through 7 above for the opposite side.
- (9) Disconnect and remove glow plug harness (20) from right side of glow plug controller (15).
- (10) If necessary, remove four clips (18) from glow plug harness (20).
- (11) Remove two bolts (23), two lockwashers (24) four flat washers (25), two nuts (26) and glow plug controller (15) from mounting bracket (27) on front of engine. Discard lockwashers.
- (12) Remove two short screws (28) two lockwashers (29), and two flat washers (30) from front of mounting bracket (27). Remove two long screws (31), two lockwashers (32), two flat washers (33), and two spacers (34) from top of mounting bracket. Remove mounting bracket from engine. Discard lockwashers.



**3-12.1 GLOW PLUGS, CONTROLLER AND HARNESS REPLACEMENT (MODEL 5063-539L)
(Cont)**

b. Installation

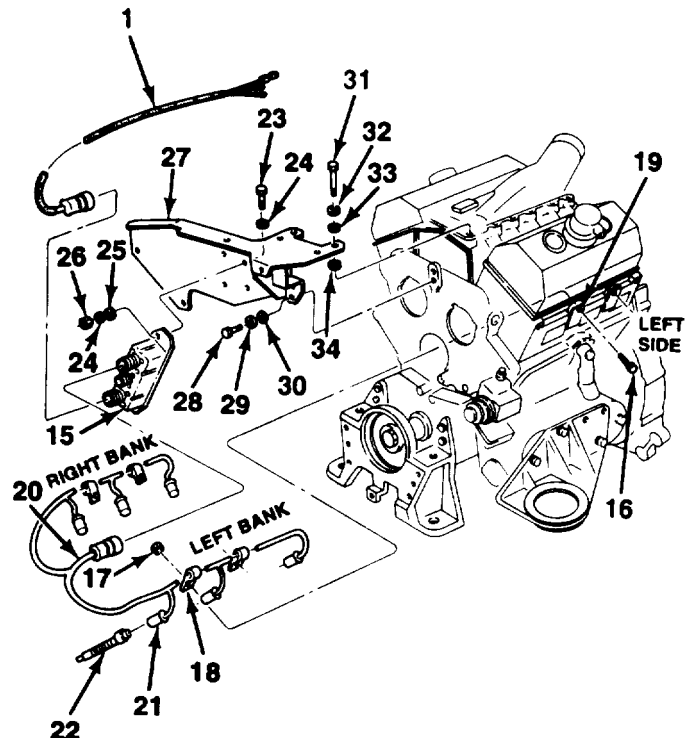
- (1) Place mounting bracket (27) over front of air inlet housing (35) and against upper front cover (36). Position two spacers (34) under mounting bracket and install two flat washers (33), two lockwashers (32), and two long screws (31) into top of bracket and install two flat washers (30), two lockwashers (29), and two short screws (28) into front of bracket. Torque screws (31) to 16-20 lb-ft (22-27 N•m) and screws (28) to 46-50 lb-ft (62-68 N•m).
- (2) Secure glow plug controller (15) to mounting bracket 27 with four flat washers (25), two lockwashers (32), and nuts (26) and two short screws (28). Torque screws to 13-17 lb-ft (18-23 N•m).
- (3) If removed, install two clips (18) on each side of glow plug harness (20).
- (4) Connect glow plug harness (20) to right side of glow plug controller (15). Tighten securely.
- (5) Install three glow plugs (22) in left cylinder head. Torque plugs to 132-156 lb-in (15-18 N•m).



CAUTION

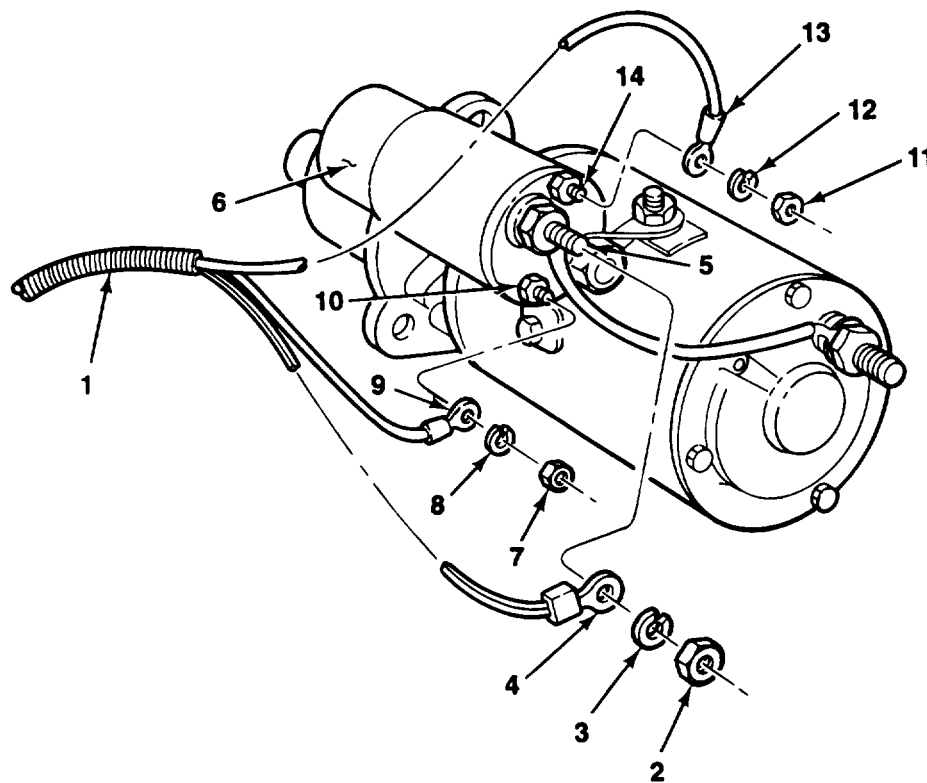
Glow plug harness leads are identified with location as to right or left bank. Correct installation of wires is necessary for proper diagnostics to aid in locating a failed glow plug.

- (6) Install three ends (21) of glow plug harness (20) to corresponding glow plug (22) locations in left cylinder head.
- (7) Secure glow plug harness (20) to two brackets (19) on left cylinder head with two bolts (16) and two nuts (17). Torque bolts to 30-35 lb-ft (41-47 N•m).
- (8) Repeat steps (4) through (7) above for opposite side.
- (9) Connect glow plug power harness (1) to left side of glow plug controller (15).



- (10) Connect glow plug power harness (1) to starter solenoid (6) by removing nut (11) and lockwasher(12) from ground terminal (14) on solenoid. Attach blue ground lead connection (13) and secure with nut and lockwasher. Tighten connection.
- (11) Remove nut (7) and lockwasher (8) from switch terminal (10) on solenoid (6). Attach orange switch lead connection (9) and secure with nut and lockwasher. Tighten connection.
- (12) Remove nut (2) and lockwasher (3) from battery terminal (5) on solenoid (6). Attach red double lead power connection (4) and secure with nut and lockwasher. Tighten connection,

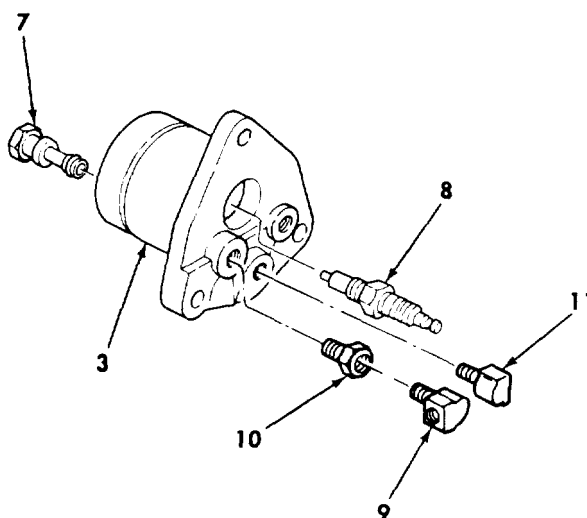
END OF TASK



- (1.1) For model 5063-539L, remove three flange head locking bolts (1) from air heater hole plug (3). Discard three locking bolts.
- (2) Remove air box heater (3), preformed packing (4), and gasket (5) from engine front cover (6). Discard preformed packing and gasket.
- (2.1) For model 5063-539L, remove air heater hole plug (3), preformed packing (4), and gasket (5) from engine front cover (6). Discard preformed packing and gasket.

b. Disassembly

- (1) Remove nozzle (7) from air box heater (3).
- (2) Remove igniter (8) from air box heater (3).
- (3) Remove elbow (9) and connector (10) from air inlet port of air box heater (3).
- (4) Remove elbow (11) from fuel inlet port of air box heater (3).



c. Cleaning/Inspection

WARNING

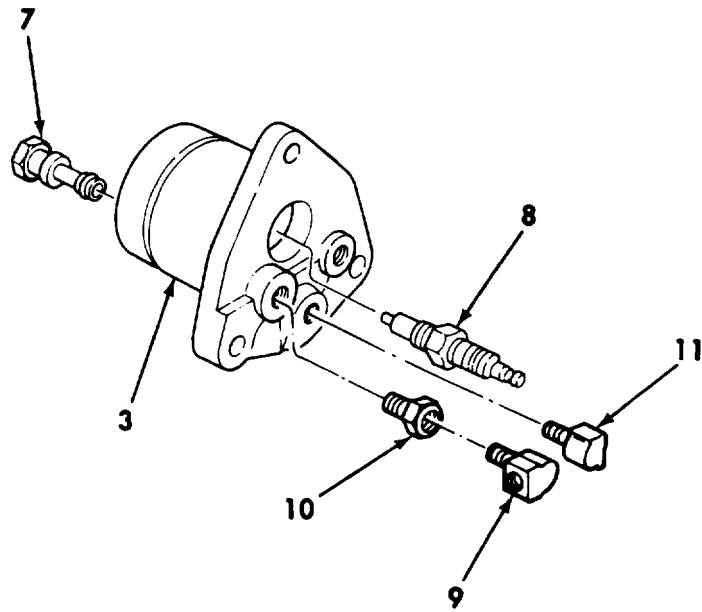
- Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Clean air box heater and fuel nozzle with cleaning solvent and dry with compressed air.
- (2) Inspect igniter, nozzle, and air box heater for cracks, pitting, or wear.

3-13. AIR BOX HEATER REPLACEMENT (Cont)

d. Assembly

- (1) Install nozzle (7) in air box heater (3). Tighten securely.
- (2) Install igniter (8) in air box heater (3). Tighten securely.
- (3) Install elbow (11) in fuel inlet port of air box heater (3).
- (4) Install connector (10) and elbow (9) in air inlet port of air box heater (3).

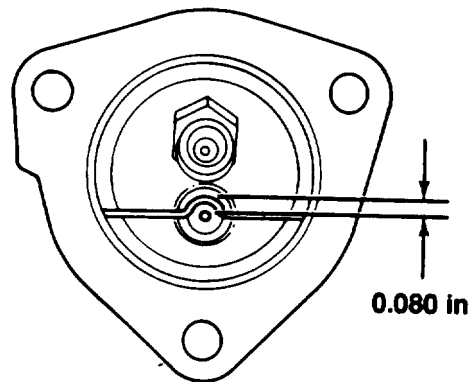


e. Test/Adjustment

NOTE

Test igniter and ignition coil simultaneously (Para 3-10, 3-11, and 3-12).

Using a thickness gage, adjust igniter-wire air gap to 0.080 inch.

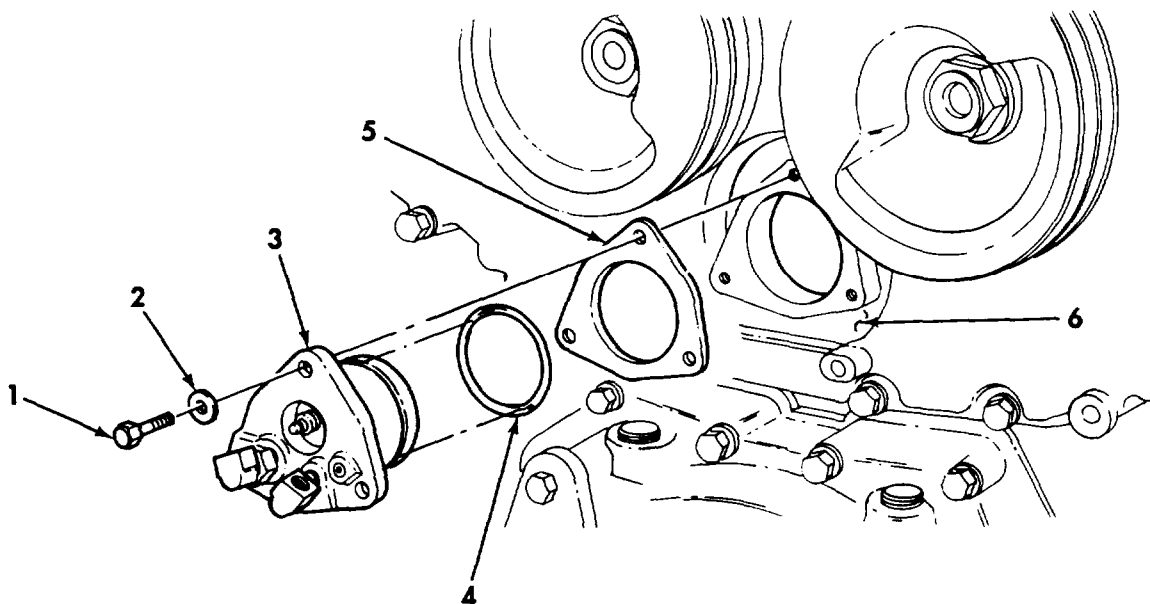


f. Installation

- (1) For all models except model 5063-539L, position gasket (5) and preformed packing (4) on air box heater (3). Lubricate packing with engine oil.

NOTE

- For all models except model 5063-539L, do not install the bolt, in lower left hole (when facing engine), and copper 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.
- (1.1) For model 5063-539L, position gasket (5) and preformed packing (4) on air box heater hole plug (3). Lubricate packing with engine oil.
- (2) For all models except model 5063-539L, install air box heater (3), two copper washers (2), and two bolts (1) in engine front cover (6) with fuel inlet port positioned at bottom. Torque bolts to 13-17 lb-ft (18-23 N·m).
- (2.1) For model 5063-539L, install air heater hole plug (3), and three flange head locking bolts (1) in engine front cover (6). Torque bolts to 13-17 lb-ft (18-23 N·m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-10 Connect fuel lines, air lines, solenoid, and electrical harness to air box heater (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F).
- 3-11 Connect fuel lines, air lines, solenoid, and electrical harness to air box heater (model 5063-5392).
- 3-12 Connect fuel lines, air lines, solenoid, and electrical harness to air box heater (model 5063-5393).

3-14. THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT (ALL EXCEPT MODEL 5063-5393)

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

MODELS

All except 5063-5393

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Installer, thermostat seal (App B, Item 68)
 Handle, seal installer (App B, Item 51)

EQUIPMENT CONDITION

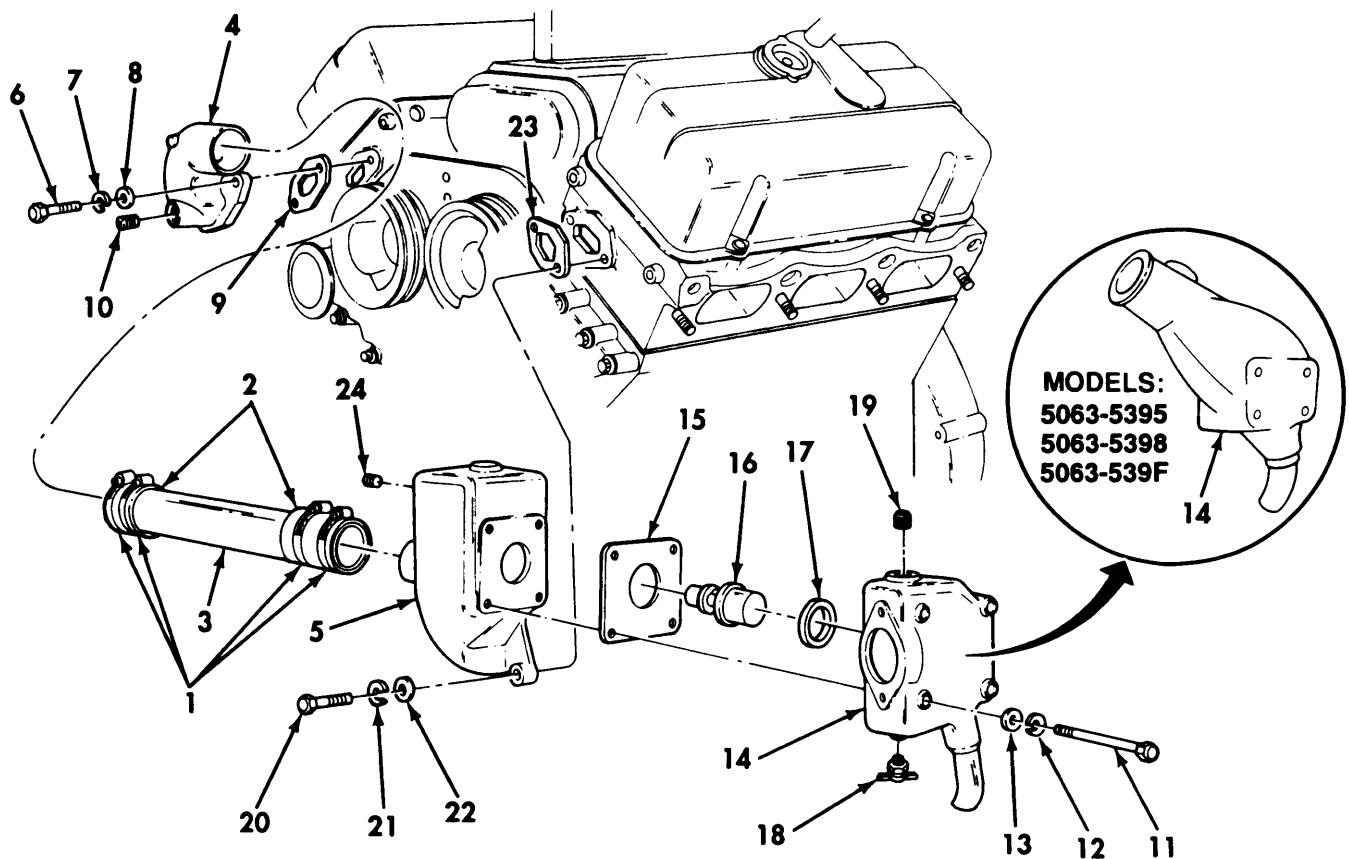
Para Description
 3-10 Air box heater bracket removed models
 5063-5299, 5063-5395, 5063-5398, and
 5063-539F)
 3-11 Air box heater bracket removed (model
 5063-5392)

MATERIALS/PARTS

- 1 Seal, plain encased (App F, Item 168)
 - 1 Gasket (App F, Item 42)
 - 2 Gaskets (App F, Item 40)
 - 8 Lockwashers (App F, Item 99)
-

a. Removal

- (1) Loosen four clamps (1) and two hoses (2) connecting crossover tube (3) to water outlet elbow (4) and water outlet elbow (5). Slide clamps and hoses onto crossover tube. Remove tube, clamps, and hoses.
- (2) Remove two screws (6), two lockwashers (7), two flat washers (8), right coolant outlet elbow (4), and gasket (9) from cylinder head. Discard lockwashers and gasket.
- (3) If necessary, remove plug (10) from right coolant outlet elbow (4).
- (4) Remove four screws (11), four lockwashers (12), four washers (13), thermostat housing cover (14), and gasket (15) from left coolant outlet elbow (5). Discard lockwashers and gasket.
- (5) Remove thermostat (16), thermostat seal (17), and drain cock (18) from thermostat housing cover (14). Discard seal.
- (6) For models 5063-5299 and 5063-5392: if necessary, remove plug (19) from top of thermostat housing cover (14).
- (7) Remove two screws (20), two lockwashers (21), two flat washers (22), left coolant outlet elbow (5), and gasket (23) from cylinder head. Discard lockwashers and gasket.
- (8) For models 5063-5299 and 5063-5392: if necessary, remove two plugs (24) from left coolant outlet elbow (5).



b. Inspection

WARNING

⚠ Dry cleaning solvent P-D-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 (38-50°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.

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

- (1) Clean plugs and metal parts in dry cleaning solvent and dry in compressed air. Clean drain cock with probe.
- (2) Inspect crossover tubes for cracks or damage.
- (3) Inspect hoses for cracks, wear, or damage.

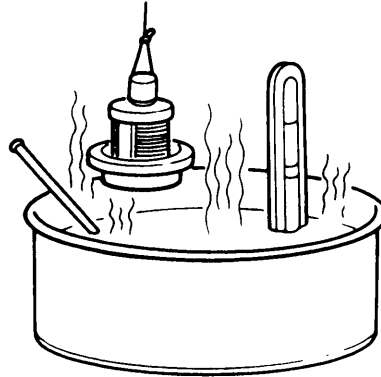
3-14. THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT (ALL EXCEPT MODEL 5063-5393) (Cont)

(4) Inspect thermostat as follows:

(a) Immerse thermostat in container of water. Do not allow it to touch bottom of container.

NOTE

- On models 5063-5299, 5063-5395, 5063-5398, and 5063-539F, 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 (80-83°C). Valve should be fully open at 197°F (92°C).



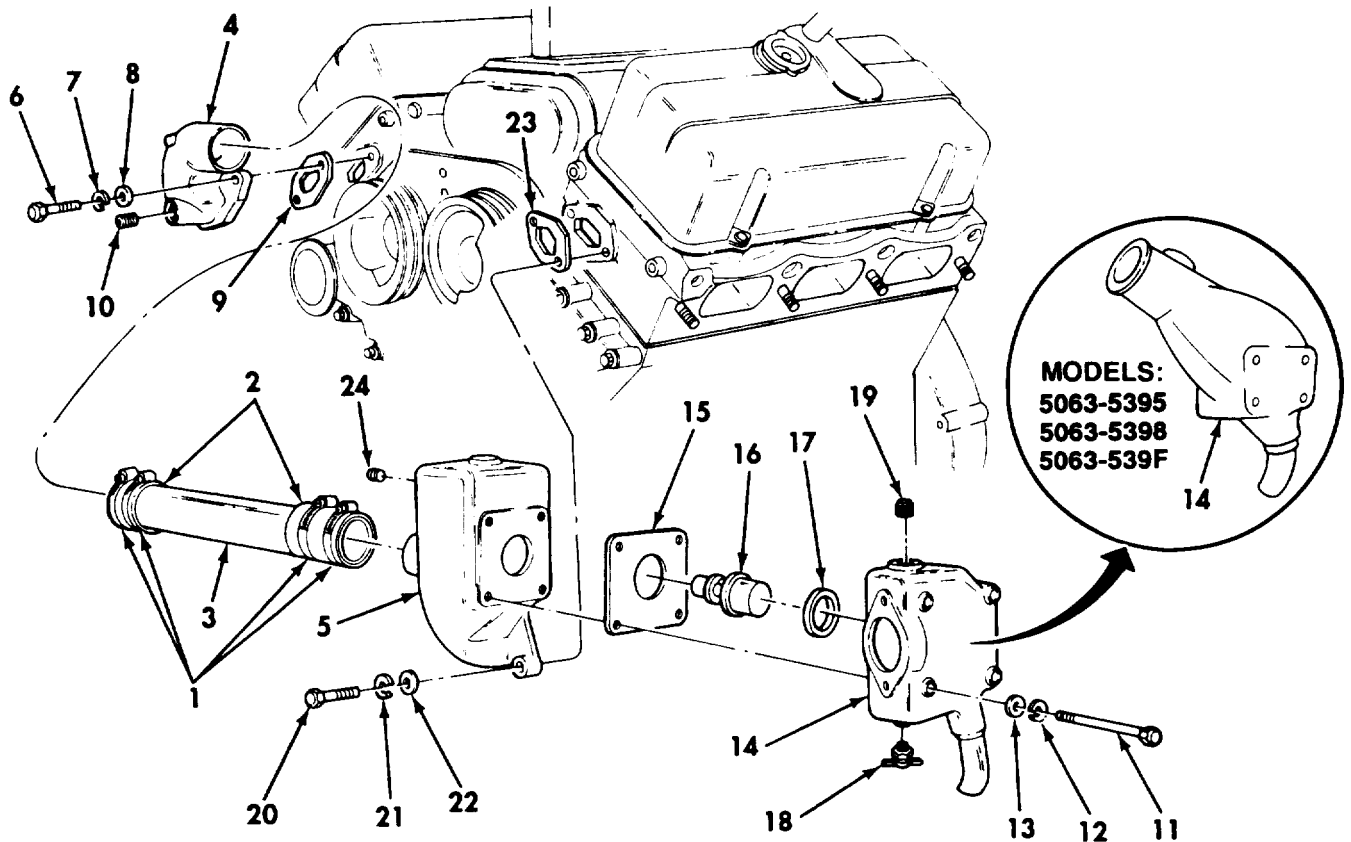
(b) Agitate water to maintain an even temperature throughout container. As water is heated, thermostat valve should begin to open. Allow at least 10 minutes for thermostat to react.

(c) Replace thermostat not meeting this requirement.

c. Installation

- (1) Install gasket (23), left coolant outlet elbow (5), two flat washers (22), two lockwashers (21), and two screws (20) 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 (24) in side of left coolant outlet elbow (5).
- (3) Using seal installer and handle, press seal (17) in thermostat housing cover (14). Position seal with lip facing toward inside of thermostat housing cover.
- (4) Install thermostat (16) into thermostat housing cover (14).
- (5) Install gasket (15), thermostat housing cover (14), four flat washers (13), four lockwashers (12), and four screws (11) on left coolant outlet elbow (5). Torque screws to 30-35 lb-ft (41-47 N-m).
- (6) For models 5063-5299 and 5063-5392: if removed, install plug (19) in top of thermostat housing cover (14).
- (7) Install drain cock (18) in bottom of thermostat housing cover (14).

- (8) Install gasket (9), right coolant outlet elbow (4), two flat washers (8), two lockwashers (7), and two screws (6) on front of cylinder head, Torque screws to 30-35 lb-ft (41-47 N•m).
- (9) If removed, install plug (10) in right coolant outlet elbow (4).



- (10) Install crossover tube (3), two hoses (2), and four clamps (1) between coolant outlet elbow (4) and coolant outlet elbow (5). Tighten hose clamps.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-10 Install air box heater bracket (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F).
- 3-11 Install air box heater bracket (model 5063-5392).

3-15. THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Inspection c. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Installer, thermostat seal (App B, Item 68)
 Handle, seal installer (App B, Item 51)

MATERIALS/PARTS

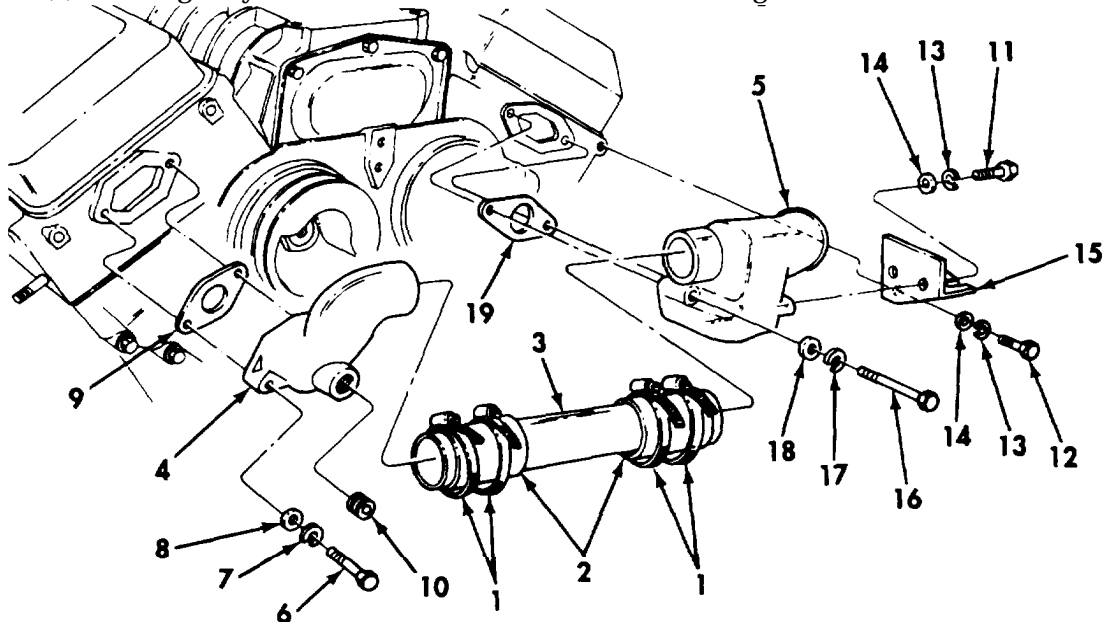
- 1 Seal (App F, Item 168)
- 1 Gasket (App F, Item 86)
- 2 Gaskets (App F, Item 40)
- 7 Lockwashers (App F, Item 99)
- 4 Lockwashers (App F, Item 98)

EQUIPMENT CONDITION

Para Description
 3-12 Air pump assembly bracket and angle bracket removed

a. Removal

- (1) Loosen four clamps (1) and two hoses (2) connecting crossover tube (3) to water outlet elbow (4) and to water outlet tee (5). Slide clamps and hoses onto crossover tube. Remove tube and slide clamps and hoses off tube.
- (2) Remove two screws (6), two lockwashers (7), two flat washers (8), water outlet elbow (4), and gasket (9) from right cylinder head. Discard lockwashers and gasket.



- (3) If necessary, remove plug (10) from water outlet elbow (4).
- (4) Remove two long screws (11), one short screw (12), three lockwashers (13), three flat washers (14), and bracket (15) from water outlet tee (5). Discard lockwashers.
- (5) Remove two screws (16), two lockwashers (17), two flat washers (18), water outlet tee (5), and gasket (19) from left cylinder head. Discard gasket and lockwashers.

NOTE

The transmission oil cooler assembly (20) and thermostat water outlet (21) were removed in Para 2-4 to allow mounting engine on maintenance stand.

- (6) Remove two short bolts (22), two long bolts (23), four lockwashers (24), four flat washers (25), thermostat water outlet (21), and gasket (26) from top of transmission oil cooler assembly (20). Discard gasket and lockwashers.
- (7) Remove thermostat (27) and seal (28) from thermostat water outlet (21). Discard seal. If necessary, remove plug (29) from cover.

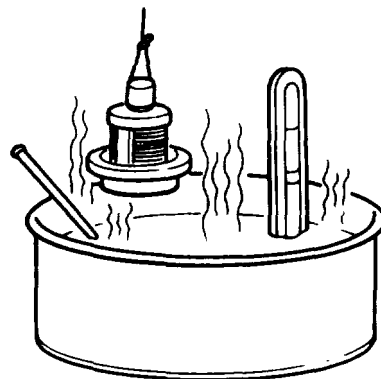
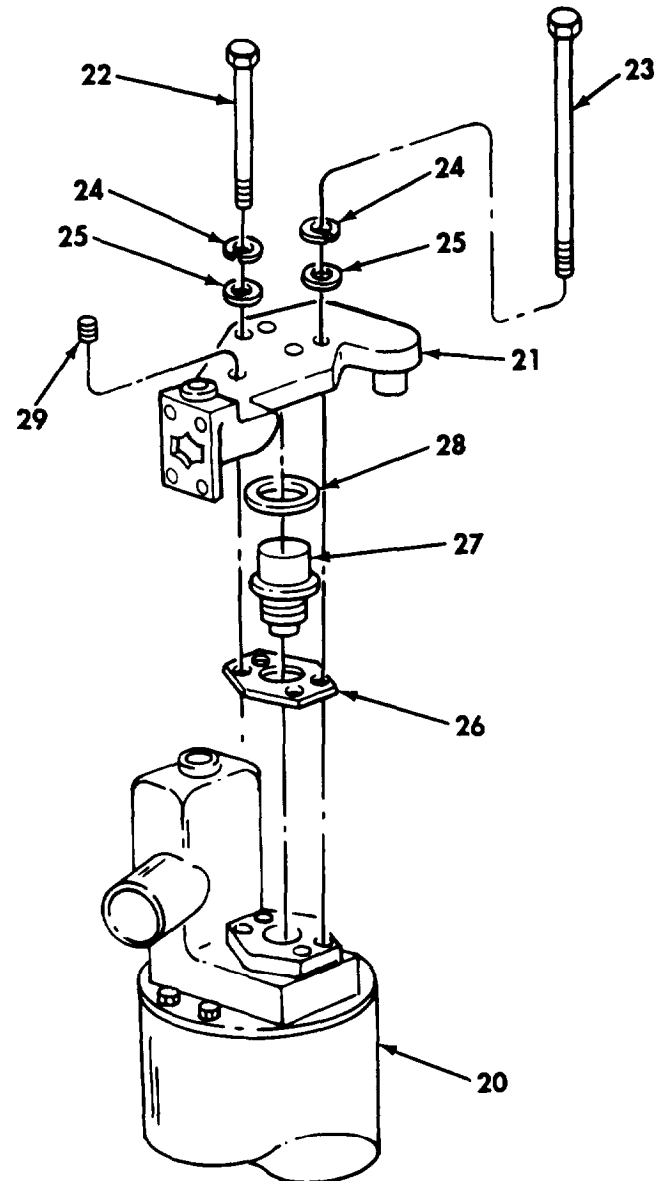
b. Inspection (thermostat)

- (1) Immerse thermostat in container 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 ten minutes for thermostat to react.

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.



3-15. THERMOSTAT HOUSING AND CROSSOVER TUBE REPLACEMENT (MODELS 5063-5393 AND 5063-539L) (Cont)

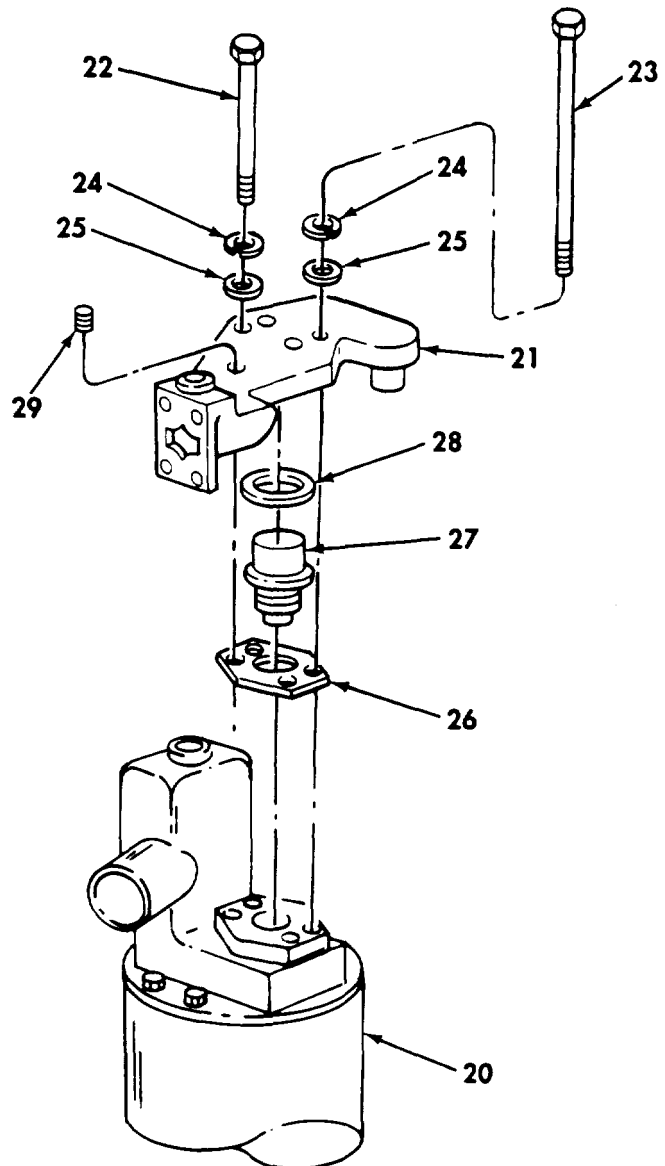
c. Installation

- (1) Using thermostat seal installer and seal installer handle, press seal (29) in thermostat water outlet (21). Position seal so lip will face away from thermostat.
- (2) Install thermostat (27) in thermostat water outlet (21). If removed, install plug (29) in outlet.

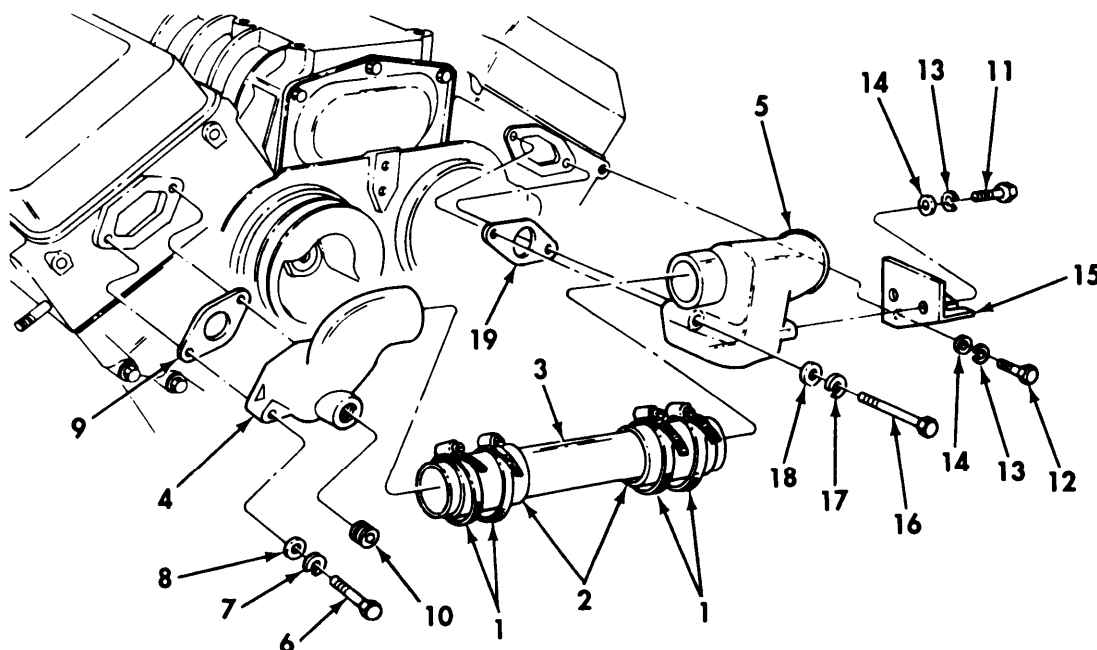
NOTE

The transmission oil cooler assembly (20) and thermostat water outlet (21) were removed in Para 2-4 to allow mounting engine on maintenance stand.

- (3) Install gasket (26), thermostat water outlet (21), four lockwashers (24), four flat washers (25), two short bolts (22), and two long bolts (23) on top of transmission oil cooler assembly (20). Torque bolts to 13-17 lb-ft (18-23 N \cdot m).



- (4) Install gasket (19), water outlet tee (5), two flat washers (18), two lockwashers (17), and two screws (16) on front of left cylinder head. Torque screws to 30-35 lb-ft (41-47 N-m).
- (5) Install bracket (15), three flat washers (14), three lockwashers (13), one short screw (12), and two long screws (11) on water outlet tee (5) and cylinder head. Torque screws to 30-35 lb-ft (41-47 Nm).
- (6) Install gasket (9), water outlet elbow (4), two lockwashers (7), two flat washers (8), and two screws (6) to front of right cylinder head. Torque screws to 30-35 lb-ft (41-47 N-m).



- (7) If removed, install plug (10) in water outlet elbow (4).
- (8) Slide two hoses (2) and four clamps (1) onto crossover tube (3). Install crossover tube between water outlet elbow (4) and water outlet tee (5). Slide two hoses and four clamps over connections and tighten clamps.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
 3-12 Install air pump assembly bracket and angle bracket.

3-16. FUEL LINES REPLACEMENT (MODEL 5063-5299)

This task covers: a. Removal b. installation

INITIAL SETUP

MODELS

5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

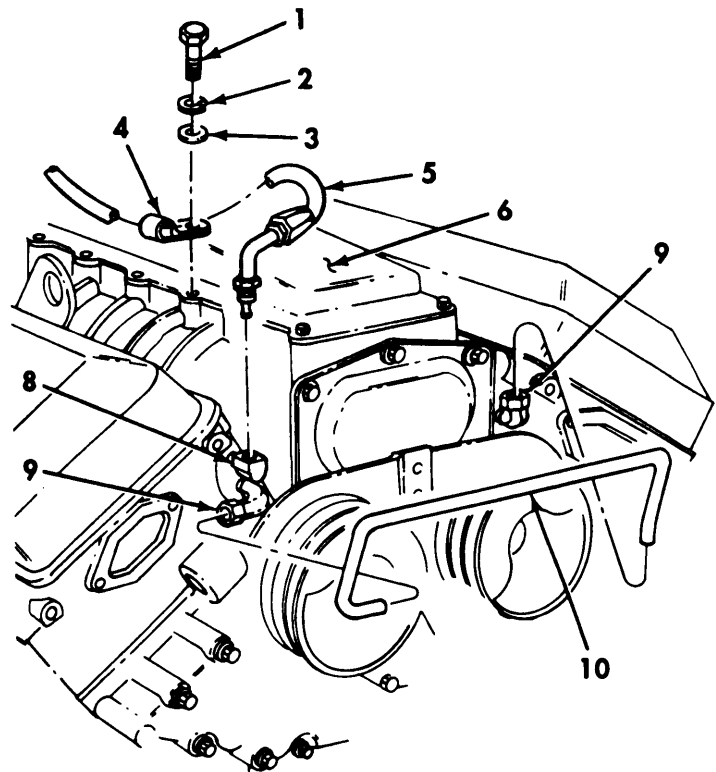
1 Lockwasher (App F, Item 99)

EQUIPMENT CONDITION

Para Description
3-10 Air pump support removed
3-14 Coolant crossover tube removed

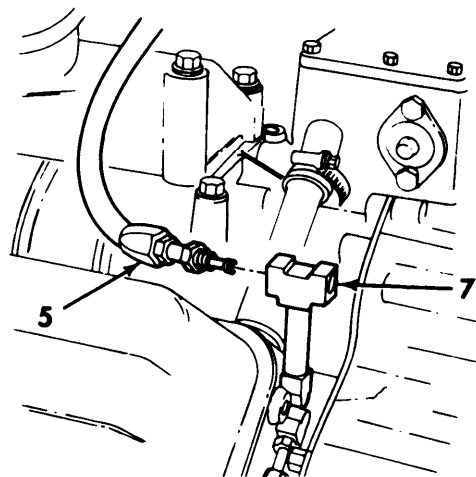
a. Removal

- (1) Remove screw (1), lockwasher (2), flat washer (3), and clip (4), on fuel relet hose assembly (5), from air inlet housing (6). Discard lockwasher. If necessary, remove clip from hose assembly.
- (2) Disconnect fuel inlet hose assembly (5) from tee (7) at rear of left cylinder head and from elbow (8) at front of right cylinder head. Remove hose assembly.
- (3) Loosen nuts on two elbows (9) at front of cylinder heads and remove fuel crossover tube (10).



b. Installation

- (1) Insert fuel crossover tube (10) into two elbows (9) at front of cylinder heads. Tighten nut on each elbow.
- (2) Connect fuel inlet hose assembly (5) to elbow (8) at front of right cylinder head and to tee (7) at rear of left cylinder head. Tighten hose connections.
- (3) If removed, install clip (4) on fuel inlet hose assembly (5).
- (4) Install clip (4), located on fuel inlet hose assembly (5), flat washer (3), lockwasher (2), and screw (1) on air inlet housing (6). Torque screw to 16-20 lb-ft (22-27 Nm).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-14 Install coolant crossover tube.
3-10 Install air pump support.

3-17. FUEL LINES REPLACEMENT (MODEL 5063-5392)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392

MATERIALS/PARTS

1 Lockwasher (App F, Item 99)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

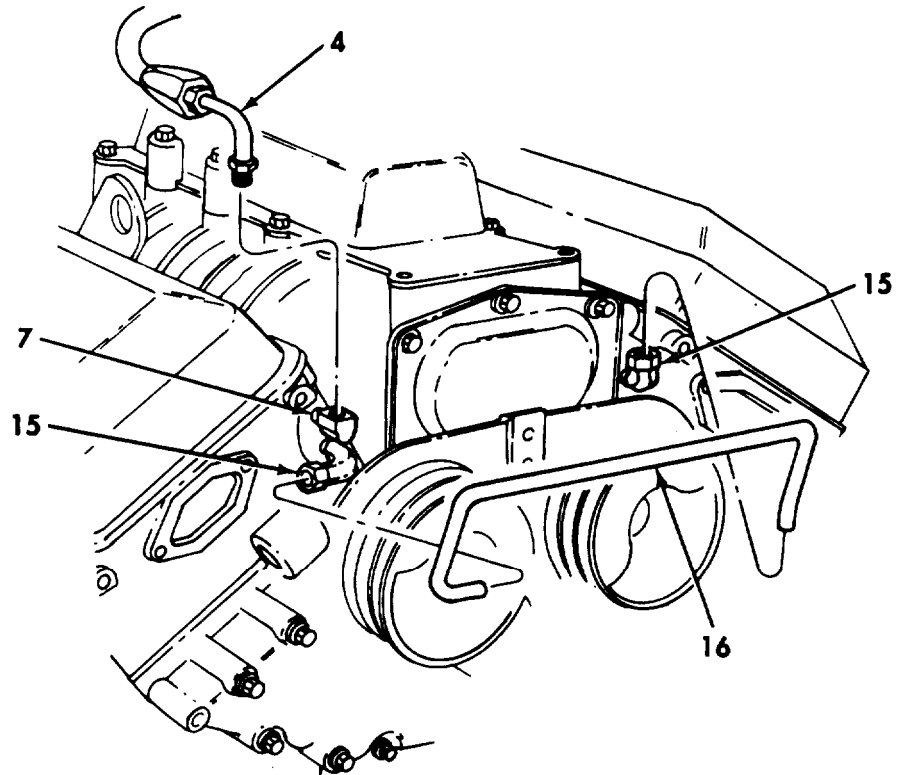
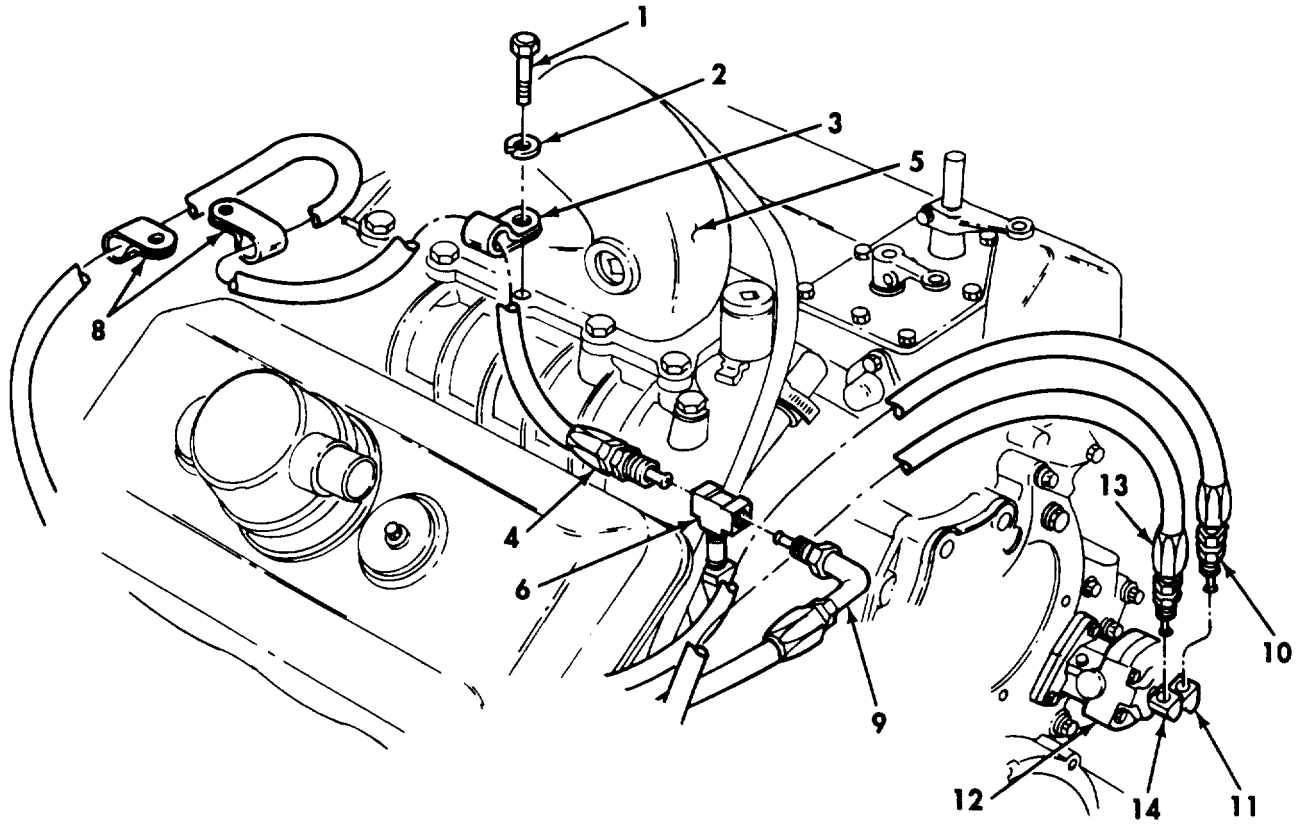
Para Description
3-11 Air pump assembly and support removed
3-14 Coolant crossover tube removed

a. Removal

- (1) Remove screw (1), lockwasher (2), and clip (3), on hose assembly (4), from air inlet housing (5). Discard lockwasher. If necessary, remove clip from hose assembly.
- (2) Disconnect hose assembly (4) from tee (6) at rear of left cylinder head and from elbow (7) at front of right cylinder head. Remove hose assembly. If necessary, remove two clips (8) from hose assembly.
- (3) Disconnect hose assembly (9) from tee (6) at rear of left cylinder head. Remove hose assembly.
- (4) Disconnect hose assembly (10) from elbow (11) in fuel pump (12). Remove hose assembly.
- (5) Disconnect hose assembly (13) from elbow (14) in fuel pump (12). Remove hose assembly.
- (6) Loosen nuts on two elbows (15) at front of cylinder heads and remove fuel crossover tube (16).

b. Installation

- (1) Insert fuel crossover tube (16) into two elbows (15) at front of cylinder heads. Tighten nut on each elbow.
- (2) Connect hose assembly (10) to outboard elbow (11) in fuel pump (12). Tighten hose connection.
- (3) Connect hose assembly (13) to inboard elbow (14) in fuel pump (12). Tighten hose connection.
- (4) Connect hose assembly (9) to tee (6) in fuel inlet at rear of left cylinder head. Tighten hose connection.
- (5) If removed, install two clips (8) on hose assembly (4). Connect hose assembly to tee (6) in fuel inlet at rear of left cylinder head and to elbow (7) at front of right cylinder head. Tighten hose connections.
- (6) If removed, install clip (3) on hose assembly (4).
- (7) Install clip (3), located on hose assembly (4), lockwasher (2), and screw (1) in air inlet housing (5). Torque screw to 16-20 lb-ft (22-27 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

- 3-11 Install air pump support.
- 3-14 Install coolant crossover

3-18. FUEL LINES REPLACEMENT (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

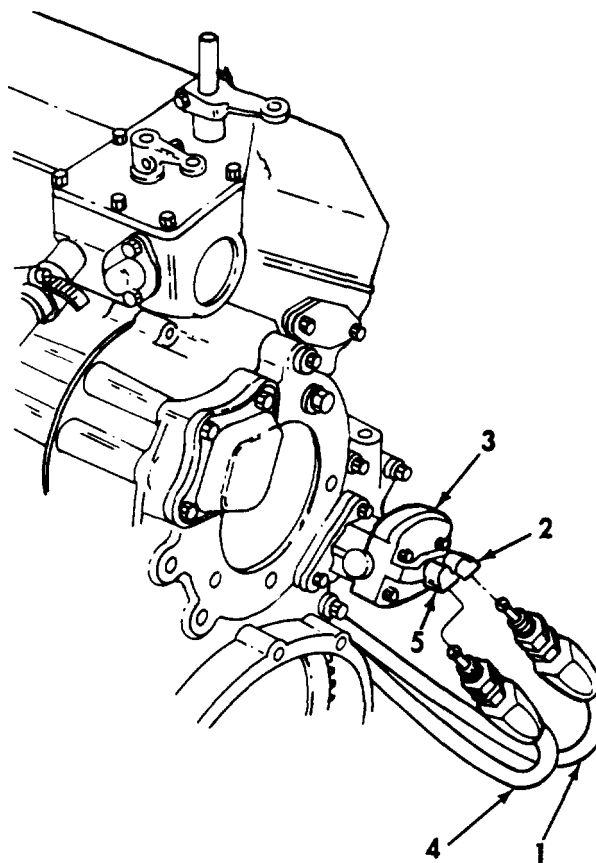
2 Lockwashers (App F, Item 99)

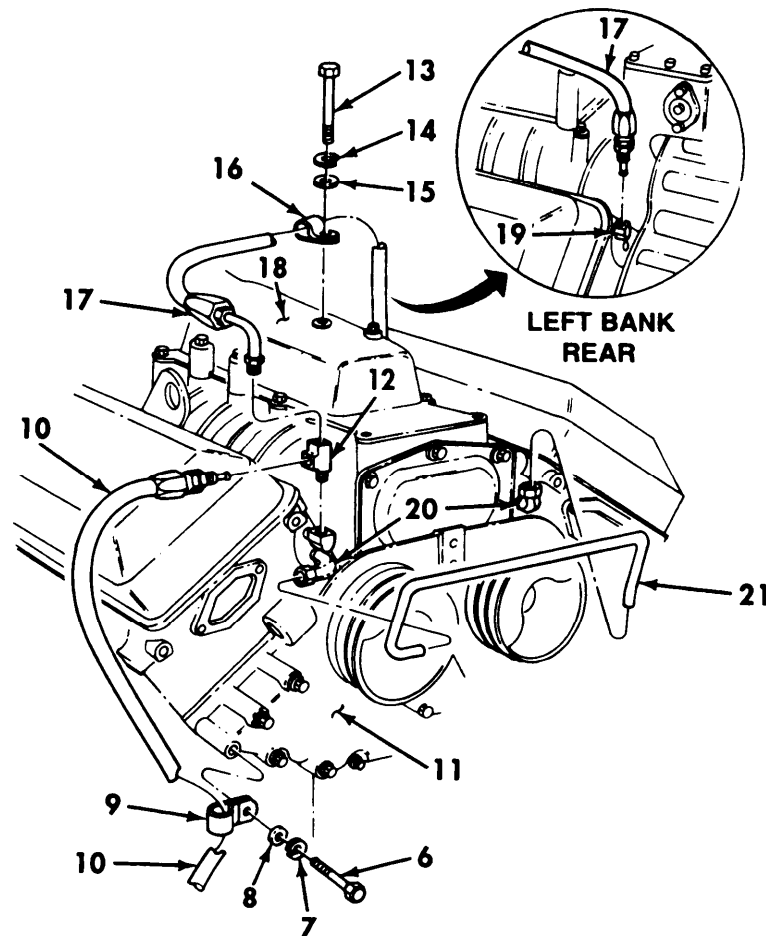
EQUIPMENT CONDITION

Para Description
3-12 Air pump assembly and angle bracket removed
3-15 Coolant crossover tube removed

a. Removal

- (1) Disconnect inlet hose assembly (1) from elbow (2) in fuel pump (3). Remove hose assembly.
- (2) Disconnect outlet hose assembly (4) from elbow (5) in fuel pump (3). Remove hose assembly,
- (3) Remove screw (6), lockwasher (7), flat washer (8), and clip (9), on hose assembly (10), from upper front cover (11). Discard lockwasher. If necessary, remove clip from hose assembly.
- (4) Disconnect hose assembly (10) from tee (12) in front of right cylinder head. Remove hose assembly.
- (5) Remove screw (13), lockwasher (14), flat washer (15), and clip (16), on hose assembly (17), from air inlet housing (18). Discard lockwashers. If necessary, remove clip from hose assembly.
- (6) Disconnect hose assembly (17) from tee (12) in front of right cylinder head, and from elbow (19) in rear of left cylinder head. Remove hose assembly.
- (7) Loosen nut on two elbows (20), at front of cylinder heads, and remove fuel crossover tube (21).





b. Installation

- (1) Insert fuel crossover tube (21) into two elbows (20) at front of cylinder heads. Tighten nut on each elbow.
- (2) If removed, install clip (16) on hose assembly (17). Connect hose assembly to tee (12) in front of right cylinder head and to elbow (19) at rear of left cylinder head. Tighten hose connections.
- (3) Connect hose assembly (17) to air inlet housing (18) with clip (16), screw (13), lockwasher (14), and flat washer (15). Torque screw to 16-20 lb-ft (22-27 N-m).
- (4) Connect hose assembly (10) to tee (12) in front of right cylinder head. Tighten hose connection.
- (5) If removed, install clip (9) on hose assembly (10). Install clip, screw (6), lockwasher (7), and flat washer (8) on upper front cover (11). Torque screw to 30-35 lb-ft (41-47 N-m).
- (6) Connect inlet hose assembly (1) to elbow (2) in fuel pump (3). Tighten hose connection.
- (7) Connect outlet hose assembly (4) to elbow (5) in fuel pump (3). Tighten hose connection.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-15 Install coolant crossover tube.

3-12 Install air pump assembly and support.

3-19. FUEL LINES REPLACEMENT (MODELS 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

1 Lockwasher (App F, Item 99)
1 Lockwasher (App F, Item 97)

EQUIPMENT CONDITION

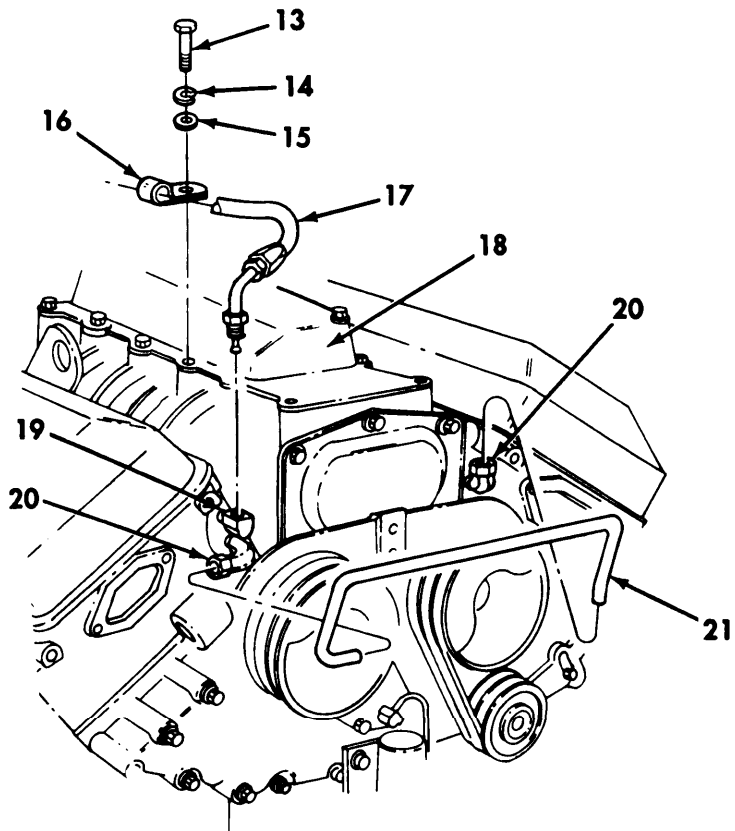
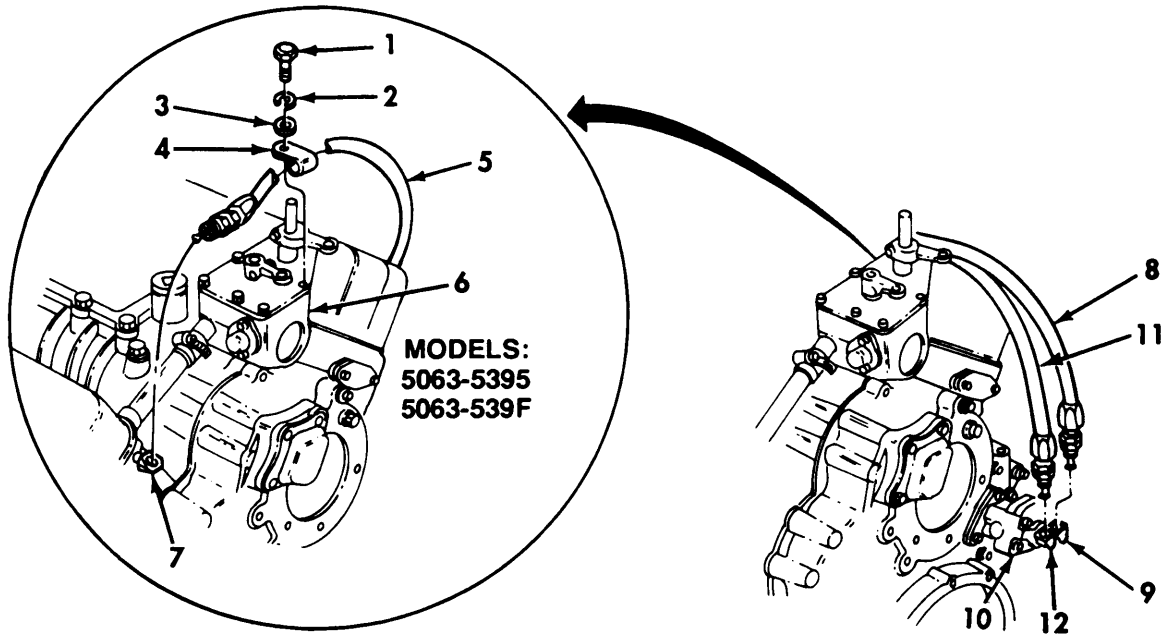
Para Description
3-10 Air pump support removed
3-14 Coolant crossover tube removed

a. Removal

- (1) For models 5063-5395 and 5063-539F, remove screw (1), lockwasher (2), flat washer (3), and clip (4), on hose assembly (5), at rear of governor cover (6). Discard lockwasher.
- (2) Disconnect hose assembly (5) from elbow (7) at rear of left cylinder head. Remove hose assembly. If necessary, remove clip (4) from hose assembly.
- (3) Disconnect hose assembly (8) from elbow (9) in fuel pump (10). Remove hose assembly.
- (4) Disconnect hose assembly (11) from elbow (12) in fuel pump (10). Remove hose assembly.
- (5) Remove screw (13), lockwasher (14), flat washer (15), and clip (16) on hose assembly (17) at air inlet housing (18). Discard lockwasher.
- (6) Disconnect hose assembly (17) from elbow (19) in front of right cylinder head. Remove hose assembly. If necessary, remove clip (16) from hose assembly.
- (7) Loosen nut on two elbows (20) at front of cylinder heads and remove fuel crossover tube (21).

b. Installation

- (1) Connect hose assembly (11) to elbow (12) in inlet of fuel pump (10). Tighten hose connection.
- (2) Connect hose assembly (8) to elbow (9) in outlet of fuel pump (10). Tighten hose connection.
- (3) Connect hose assembly (5) to elbow (7) in fuel inlet of left cylinder head. Tighten hose connection.
- (4) For models 5063-5395 and 5063-539F: if removed, install clip (4) on hose assembly (5). Install clip, flat washer (3), lockwasher (2), and screw (1) on rear of governor cover (6). Torque screw to 7-9 lb-ft (10-12 Nm).
- (5) Slide fuel crossover tube (21) into two elbows (20) at front of cylinder heads. Tighten nut on each elbow.
- (6) Connect right fuel inlet hose assembly (17) to elbow (19) in front of right cylinder head. Tighten hose connection.
- (7) If removed, install clip (16) on hose assembly (17). Install clip, flat washer (15), lockwasher (14), and screw (13) on air inlet housing (18). Torque screw to 16-20 lb-ft (22-27 N.m).



END OF TASK

FOLLOW-ON MAINTENANCE

- | Para | Description |
|------|---------------------------------|
| 3-14 | Install coolant crossover tube. |
| 3-10 | Install air pump support. |

3-20. ROCKER ARM COVERS REPLACEMENT (MODELS 5063-5299 AND 5063-5398)

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5398

MATERIALS/PARTS

2 Gaskets (App F, Item 71)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

a. 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 (1), rocker arm cover (2), and gasket (3) from cylinder head. Discard gasket.
- (2) If necessary, disconnect clip (4) and remove oil filler cap assembly (5) from rocker arm cover (2).

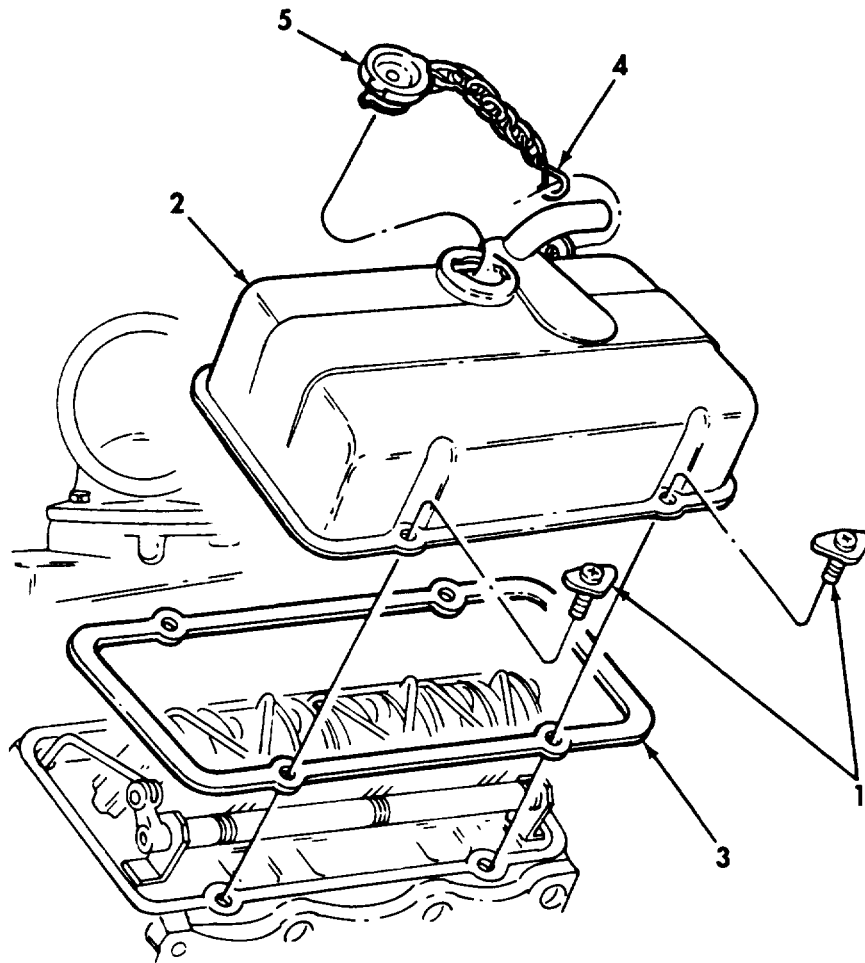
b. Cleaning/Inspection

WARNING

Ž Dry cleaning solvent P-D-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 (38-50°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.

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

- (1) Clean rocker arm covers with cleaning solvent and dry with compressed air.
- (2) Inspect covers for cracks, dents, or other damage.



c. Installation

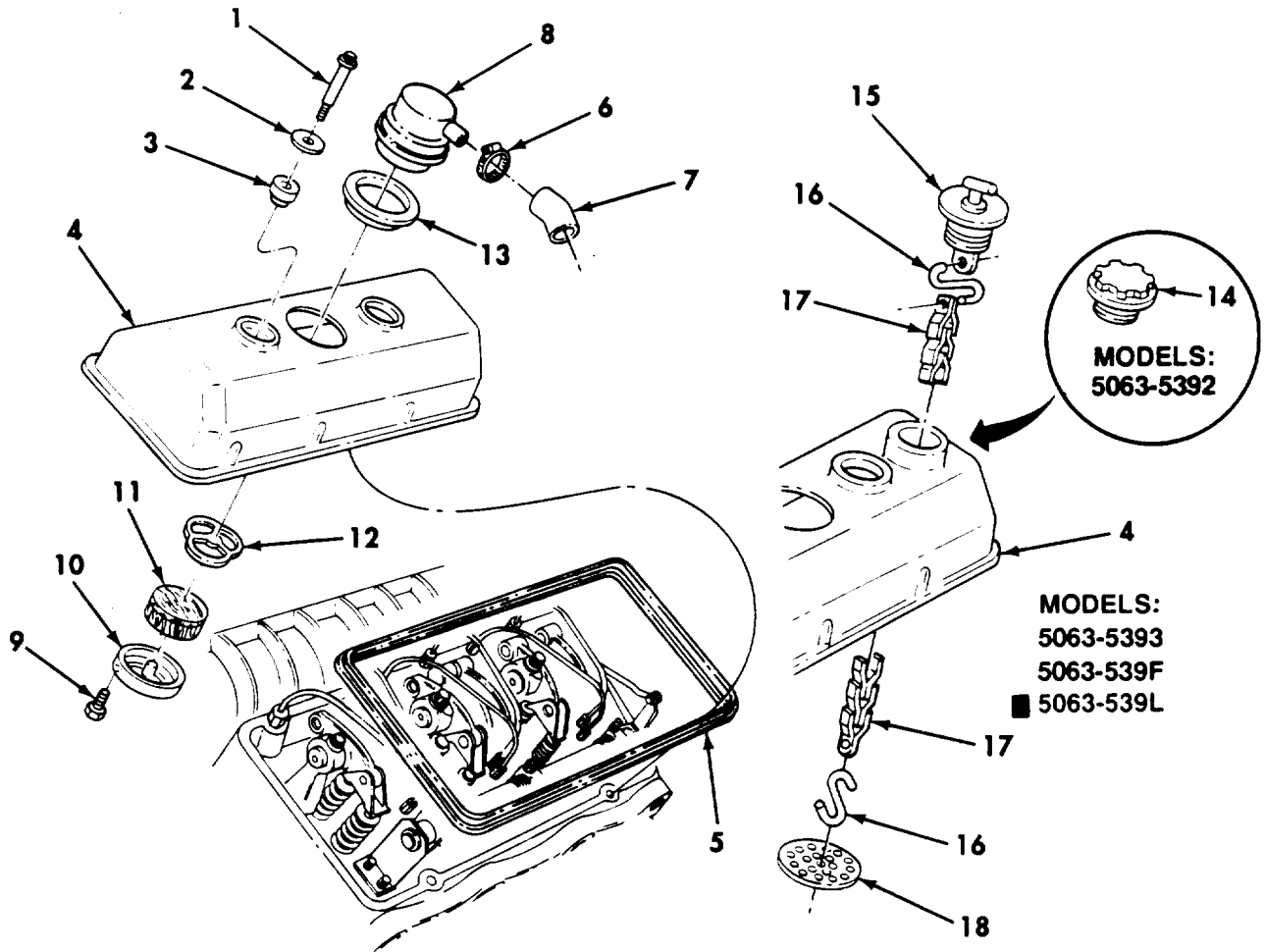
(1) If removed, install oil filler cap assembly (5) and clip (4) on rocker arm cover (2).

NOTE

- Breather tube outlet on rocker arm cover is always inboard.
- On model 5063-5299, rocker arm cover with oil filler hole mounts on left cylinder head.

(2) Install gasket (3), rocker arm cover (2), and four screw and clamp assemblies (1) on each cylinder head. Tighten screws.

END OF TASK



c. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-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 (38-50°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.**
- **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)-**

- (1) Clean rocker arm covers and breather housings with cleaning solvent and dry with compressed air. Inspect covers and housings for cracks or other damage.
- (2) Clean filtering disk with cleaning solvent and dry with compressed air.

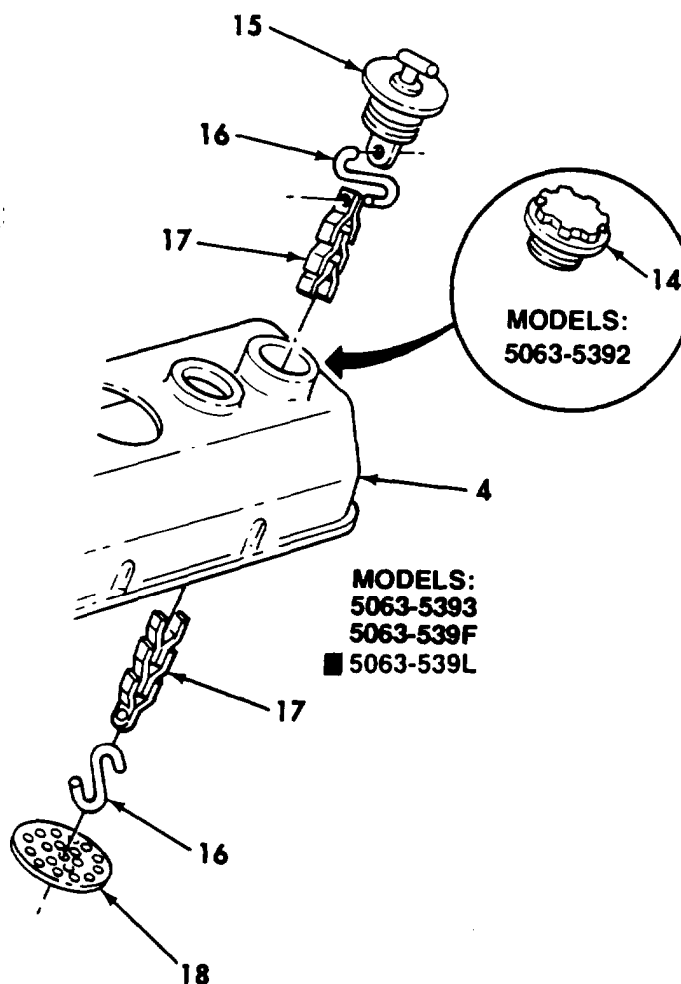
3-21. ROCKER ARM COVERS AND CRANKCASE BREATHERS REPLACEMENT (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

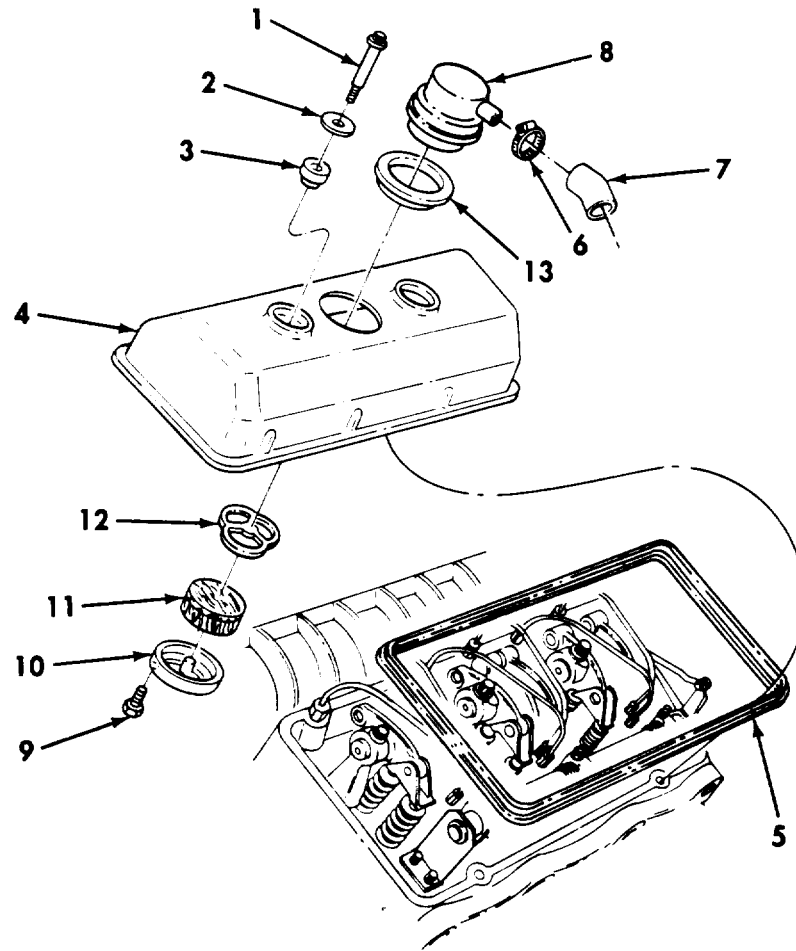
d. Assembly

- (1) On models 5063-5393, 5063-539F, and 5063-539L, install oil filler cap (15) as follows:
 - (a) If removed, press strainer element (18) into oil filler hole from bottom of rocker arm cover (4) until flush with bottom of bore. Stake strainer element in position.
 - (b) If removed, connect chain (17) to oil filler cap (15) and to strainer element (18) with two S-hooks (16). Crimp S-hooks shut.
- (2) On model 5063-5392, screw oil filler cap (14) into rocker arm cover (4) until cap clicks.

NOTE

- On models 5063-5393, 5063-539F, 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 (12) and filtering disk (11) in breather housing (8).
 - (4) Install seal (13), breather housing (8), retainer (10), and three screws (9) in rocker arm cover (4). Torque screws to 48-72 lb-in (6-8 N•m).





e. Installation

- (1) Install gasket (5) in groove at bottom of rocker arm cover (4). 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 model 5063-539F, oil filler cap is at front of left 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 (4), two resilient mounts (3), two flat washers (2), and two bolts (1) on cylinder head, Torque bolts to 96-156 lb-in (11-18 N•m).
 - (3) On models 5063-5393, 5063-539F, and 5063-539L, install hose (7) and clamp (6) on breather housing (8) with hose pointing downward. Tighten clamp.

END OF TASK

3-22. ROCKER ARM COVERS AND CRANKCASE BREATHERS REPLACEMENT (MODEL 5063-5395)

This task covers: a. Removal

b. Cleaning/Inspection

c. Installation

INITIAL SETUP

MODELS

5063-5395

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

MATERIALS/PARTS

- 2 Gaskets (App F, Item 71)
- 2 Gaskets (App F, Item 70)

EXPENDABLE/DURABLE SUPPLIES

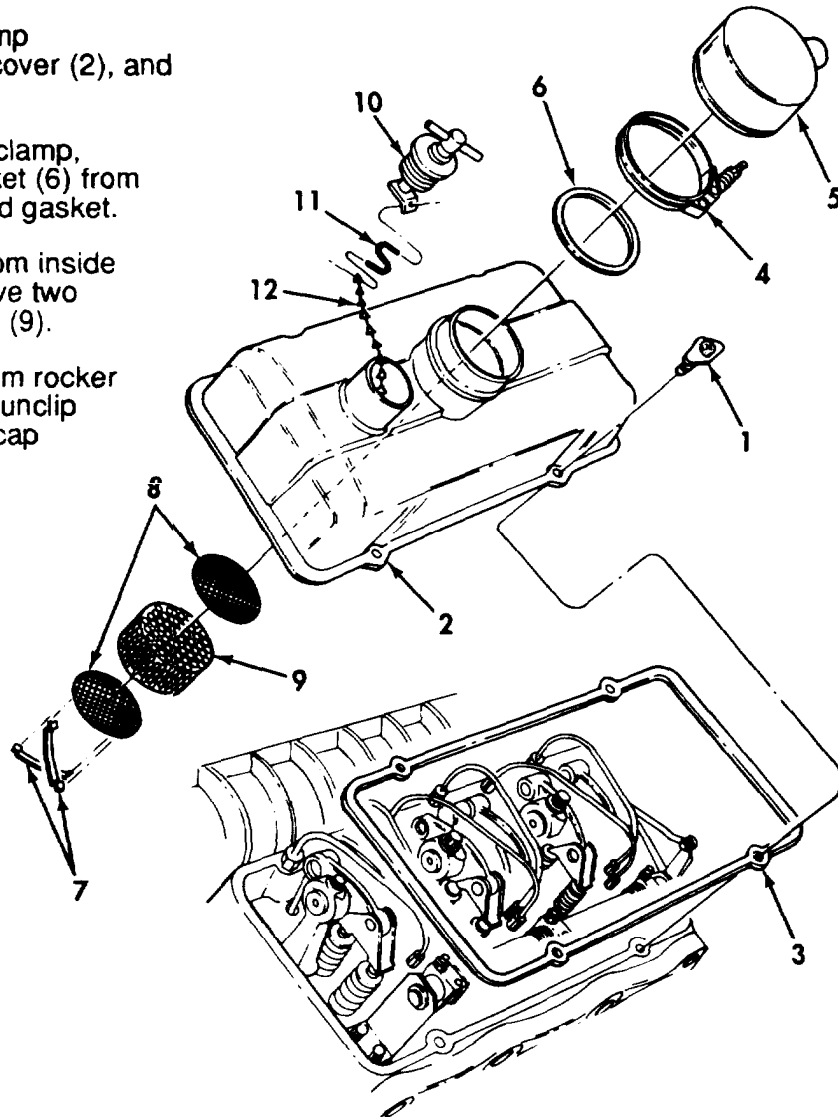
Cleaning solvent (App C, Item 9)

a. Removal

NOTE

Right and left rocker arm covers are identical except for oil filler hole. Use same procedure to remove both covers.

- (1) Remove four screw and clamp assemblies (1), rocker arm cover (2), and gasket (3). Discard gasket.
- (2) Loosen clamp (4). Remove clamp, breather cover (5), and gasket (6) from rocker arm cover (2). Discard gasket.
- (3) Remove two retainers (7) from inside rocker arm cover (2). Remove two screens (8) and filtering disk (9).
- (4) Remove oil filler cap (10) from rocker arm cover (2). If necessary, unclip hook (11) and remove filler cap from chain (12).



b. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (1) Clean rocker arm covers and oil filler cap with cleaning solvent and dry with compressed air. Inspect caps and covers for cracks, dents, or other damage.
 - (2) Clean filtering disk with cleaning solvent and dry with compressed air.

c. Installation

- (1) Install inner screen (8), filtering disk (9), and outer screen (8) in breather body of rocker arm cover (2) (from inside cover). Install two retainers (7) over screen into holes in breather body.

NOTE

Breather cover outlet points toward rear of engine.

- (2) Place gasket (6) and breather cover (5) on breather body of rocker arm cover (2). Install clamp (4) on breather cover and breather body. Tighten clamp.
- (3) If removed, install oil filler cap (10) on chain (12) with hook (11). Clip hook and install cap into oil filler hole. Tighten cap.

NOTE

- Right and left rocker arm covers are identical except for oil filler hole. Use same procedure to install both covers.
 - Oil filter hole is located at left front rocker cover.
- (4) Place gasket (3) and rocker arm cover (2) on cylinder head. Install four screw and clamp assemblies (1) into each rocker arm cover. Tighten screws securely.

END OF TASK

3-23. FUEL PUMP REPLACEMENT

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection
 d. Assembly e. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Wrench, torque (App B, Item 118)
- Tool set, fuel pump (App B, Item 109)
 - Installer, oil seal
 - Remover, oil seal
 - Adapter, oil seal
- Vise, machinist (App B, Item 111)
- Caps,vise jaw (App B, Item 13)

MATERIALS/PARTS

- 1 Gasket (App F, Item 72)
- 1 Gasket (App F, Item 73)
- 2 Seals, plain encased (App F, Item 170)

EXPENDABLE/DURABLE SUPPLIES

- Oil, fuel (App C, Item 27)
- Oil, engine (App C, Item 26)
- Sealing compound (App C, Item 44)
- Shortening compound (App C, Item 47)

EQUIPMENT CONDITION

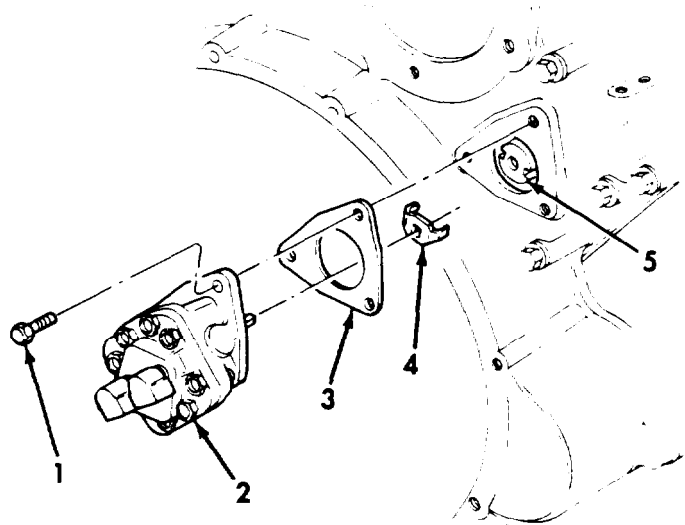
- | Para | Description |
|------|---|
| 3-17 | Fuel lines removed (model 5063-5392) |
| 3-18 | Fuel lines removed (models 5063-5393 and 5063-539L) |
| 3-19 | Fuel lines removed (models 5063-5395, 5063-5398, and 5063-539F) |

a. Removal

- (1) Remove three bolts (1), fuel pump (2), and gasket (3) from flywheel housing. Discard gasket.
- (2) Remove drive coupling fork (4) from drive adapter (5).

b. Disassembly

- (1) Place fuel pump (2) in a soft-jawed vise. Remove elbows (6 and 7) from pump.
- (2) Remove eight bolt and lockwasher assemblies (8) and pump body cover (9) from pump body (10).
- (3) Remove drive shaft assembly (11) from pump body (10).



NOTE

Driven gear is an assembly. Do not remove gear from shaft.

- (4) Remove driven gear assembly (12) from pump body (10).

CAUTION

Do not press square end of shaft through gear until locking ball is removed or locking ball will score shaft and damage oil seal contact surface.

- (5) If necessary, press drive gear (13) toward square end of drive shaft (14) past locking ball (15) and remove ball. Invert drive shaft and press drive gear off from round end of drive shaft. Remove drive gear.
- (6) Unscrew plug (16). Remove gasket (17), spring (18), straight pin (19), and relief valve (20) from pump body (10). Discard gasket.
- (7) Using oil seal remover, remove inner oil seal (21) and outer oil seal (22) from pump body (10). Discard seals.
- (8) If necessary, remove two pipe plugs (23) from pump body (10).
- (9) If necessary, remove two straight pins (24) from cover (9).

c. Cleaning/Inspection

- (1) Clean all parts with fuel oil.

WARNING

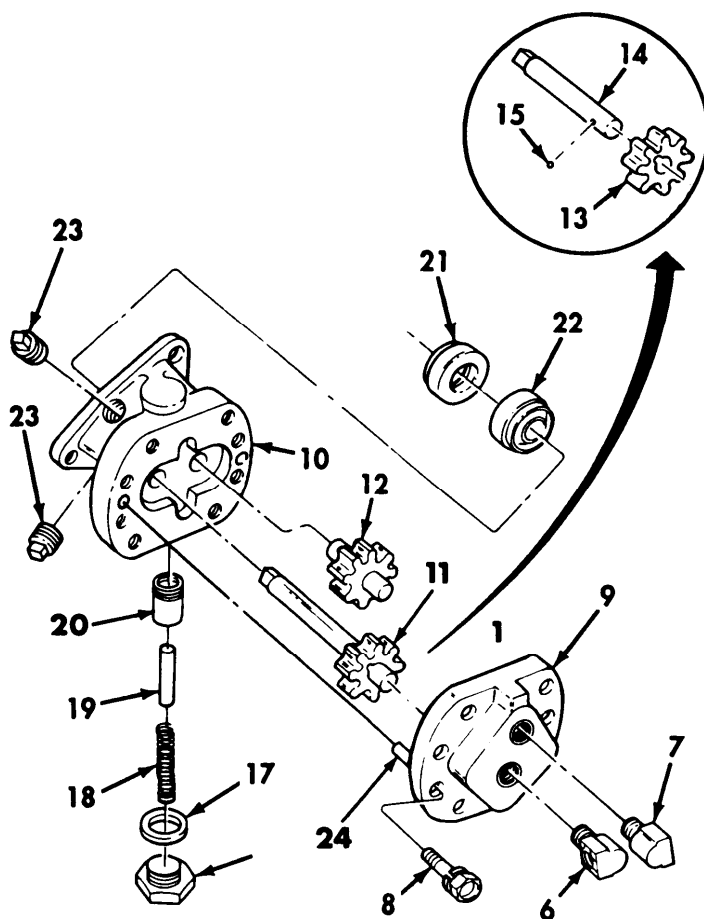
Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (2) Dry all parts with compressed air.
- (3) Inspect drive gear and drive shaft for scoring, burrs, or wear.
- (4) Inspect driven gear assembly for scoring, burrs, or wear.

NOTE

Any damage on pump body and cover sealing surfaces may result in fuel leaks.

- (5) Inspect pump body and cover carefully for scratches, nicks, or burrs.
- (6) inspect relief valve for scoring or burrs.



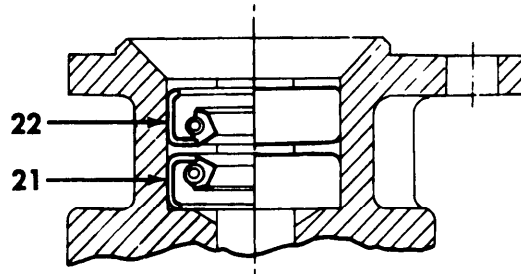
3-23. FUEL PUMP REPLACEMENT (Cont)

d. Assembly

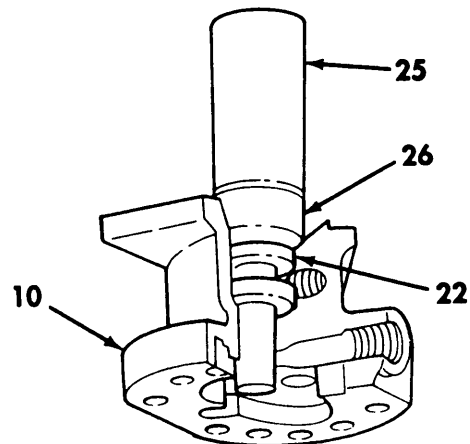
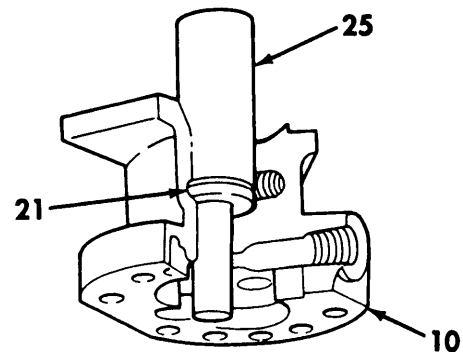
- (1) Lubricate oil seals (21 and 22) with a thin coat of shortening compound.

NOTE

Install new oil seals with seal lips facing each other as shown.



- (2) Support pump body (10) on wood blocks. Using oil seal installer (25), drive inner oil seal (21) into pump body until it bottoms out.
- (3) Using oil seal adapter (26) and installer (25), drive outer seal (22) into pump body (10) until shoulder on adapter contacts pump body.
- (4) Clamp pump body (10) in soft-jawed vise.
- (5) Lubricate outside diameter of relief valve (20) with clean engine oil. Insert valve into pump body (10) with hollow end facing out.
- (6) Install spring (18) and straight pin (19) into relief valve (20).
- (7) Install gasket (17) on plug (16) and screw into pump body (10). Torque plug to 18-22 lb-ft (24-30 N-m).
- (8) If removed, install two pipe plugs (23) in upper drain holes of pump body (10).
- (9) If removed, install two straight pins (24) into cover (9). Press pins into inner face of cover until they are flush with outer face.



NOTE

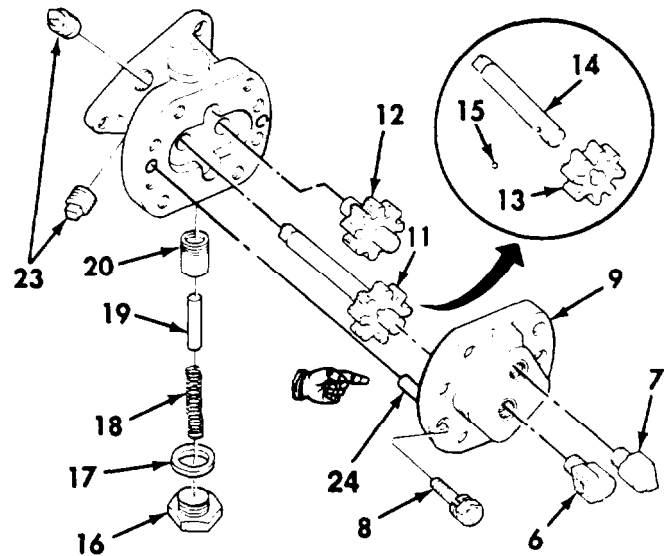
Install drive gear with slot facing round end of drive shaft.

- (10) If removed, install drive gear (13) on round end of drive shaft (14). Press drive gear beyond locking ball (15) detent on drive shaft.
- (11) Install locking ball (15) into drive shaft (14) detent. Invert drive shaft and press drive gear (13) until end of slot in gear contacts locking ball.

- (12) Lubricate drive shaft assembly (11) with clean engine oil. Insert square end of drive shaft through oil seals (21 and 22) in pump body (10).

NOTE

- If gear teeth of driven gear have a chamfered end, install chamfered end facing pump body.
- If driven gear has a slot, install gear with slot facing cover.



- (13) Install driven gear and shaft assembly (12) in pump body (10).

- (14) Lubricate gears and shafts with clean engine oil.

- (15) Apply a thin coat of sealing compound on cover (9) surface. Do not allow compound to enter gear chamber.

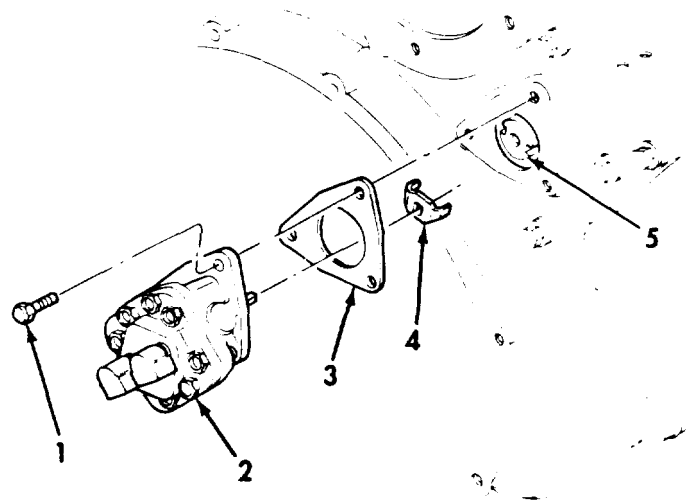
- (16) Align pump body (10) and cover (9). Install cover and eight bolt and lockwasher assemblies (8) on pump body. Tighten bolts alternately and evenly. Torque bolts to 84-108 lb-in (10-12 N•m).

- (17) Rotate drive shaft (14) by hand, Shaft should rotate freely. If not, gently tap corner of pump body (10) with hammer to free up.

- (18) Install elbow (6) and elbow (7) in cover (9).

e. Installation

- (1) Install gasket (3) on fuel pump (2).
- (2) Place drive coupling fork (4) on square end of drive shaft (14).
- (3) Align drive coupling fork (4) with slots in drive adapter (5) and install fuel pump (2) on flywheel housing with fuel inlet hole in down and inboard position.
- (4) Install three bolts (1) fastening fuel pump (2) to flywheel housing. Torque bolts to 13-17 lb-ft (18-23 N•m).



END OF TASK

FOLLOW-ON MAINTENANCE

- | Para | Description |
|------|--|
| 3-17 | Install fuel lines (model 5063-5392). |
| 3-18 | Install fuel lines (models 5063-5393 and 5063-539L). |
| 3-19 | Install fuel lines (models 5063-5395, 5063-5398, and 5063-539F). |

3-24. AIR INLET HOUSING REPLACEMENT (MODEL 5063-5299)

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

5063-5299

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para	Description
3-10	Air box heater air line disconnected from air inlet elbow
3-16	Fuel line clip removed

MATERIALS/PARTS

1 Screen, air inlet (App F, Item 149)
9 Lockwashers (App F, Item 99)
1 Gasket (App F, Item 55)

a. Removal

- (1) Scribe lines between air inlet adapter (1), air inlet housing (2), and blower (3) to assure assembly in same location.
- (2) Remove four screws (4), four lockwashers (5), four flat washers (6), air inlet adapter (1), and gasket (7) from air inlet housing (2). Discard lockwashers and gasket.

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.

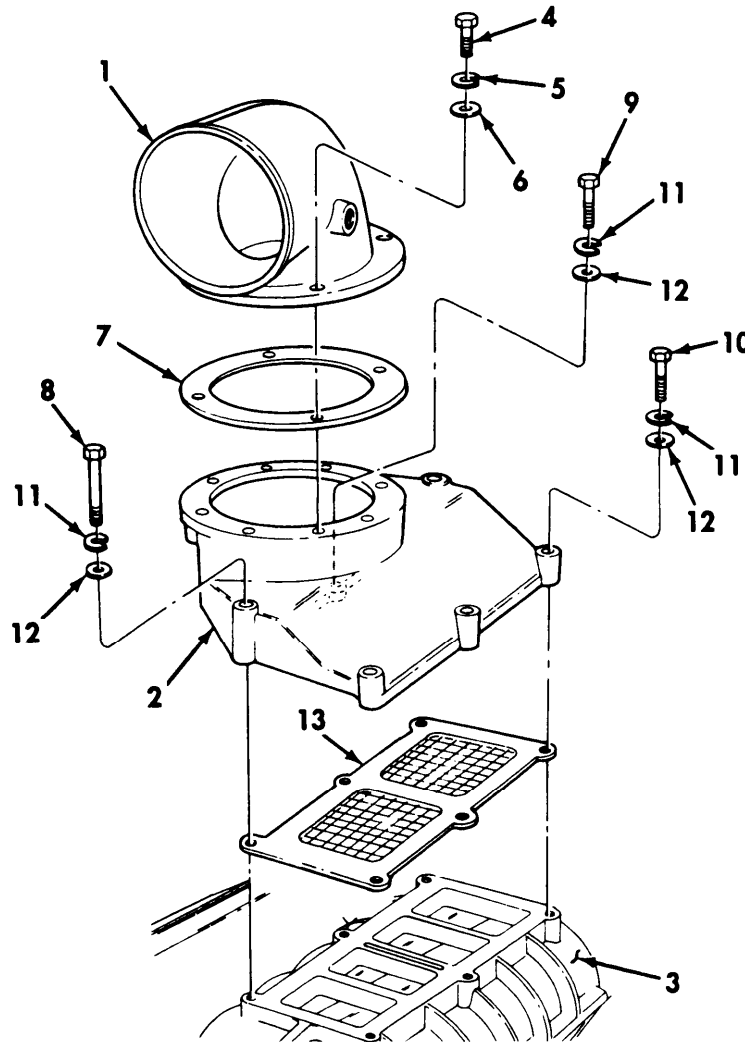
- (3) Remove two long screws (8), short screw (9), two mid-sized screws (10), five lockwashers (11), five flat washers (12), air inlet housing (2), and screen (13) from blower (3). Discard screen and lockwashers.

b. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Clean air inlet housing and adapter with cleaning solvent and dry with compressed air.
- (2) Inspect parts for wear or damage.



c. Installation

- (1) Place air inlet screen (13) on top of blower (3) with wire side to blower.
- (2) Install air inlet housing (2), five flat washers (12), five lockwashers (11), two long screws (8), short screw (9), and two mid-sized screws (10) on blower (3) with inlet opening on left side of engine. Torque bolts to 16-20 lb-ft (22-27 N-m).
- (3) Install gasket (7) and air inlet adapter (1) on air inlet housing (2) with adapter opening toward rear of engine. Align scribe marks on air inlet housing and adapter. Install four flat washers (6), four lockwashers (5), and four screws (4). Torque bolts to 16-20 lb-ft (22-27 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-16 Install fuel line clip.

3-10 Connect airbox heater air line to air inlet elbow.

3-25. AIR INLET HOUSING REPLACEMENT (MODEL 5063-5392)

This task covers: a. Removal b. Cleaning c. Installation

INITIAL SETUP

MODELS

5063-5392

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para Description
3-2 Turbocharger removed
3-17 Fuel line clip removed
3-11 Angle bracket removed

MATERIALS/PARTS

1 Screen, air inlet (App F, Item 150)
9 Lockwashers (App F, Item 99)

a. Removal

NOTE

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

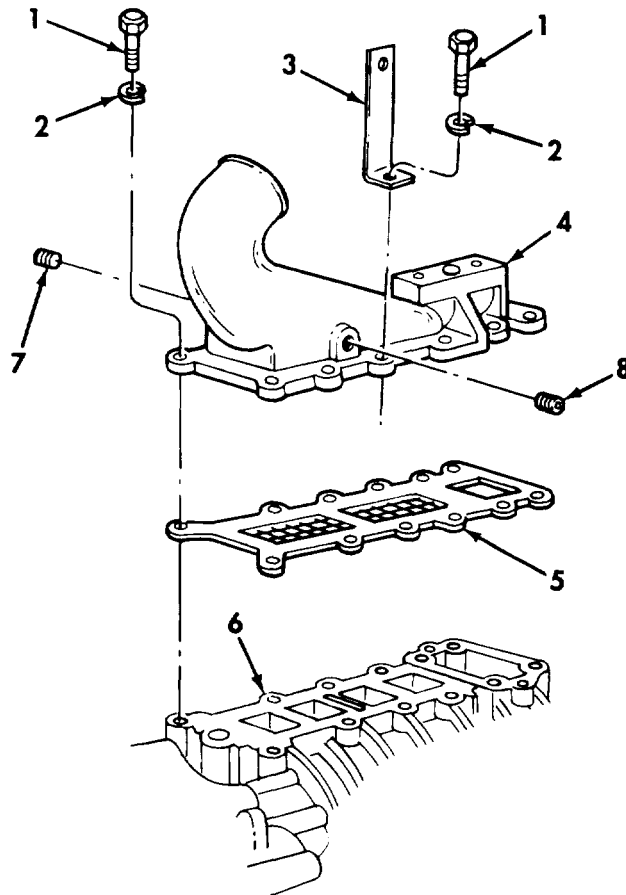
- (1) Remove nine screws (1), nine lockwashers (2), angle bracket (3), air inlet housing (4), and screen (5) from blower (6). Discard screen and lockwashers.
- (2) If necessary, remove plug (7) and plug (8) from air inlet housing (4).

b. Cleaning

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

Clean air inlet housing with cleaning solvent and dry with compressed air.



c. Installation

NOTE

- Angle bracket (3) mounts on right bank, 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 screen (5) (with wire side toward blower), angle bracket (3), air inlet housing (4), nine lockwashers (2), and nine screws (1) on blower (6). Torque screws to 16-20 lb-ft (22-27 N•m).

(2) If removed, install plug (7) and plug (8) in air inlet housing (4).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-11 Install angle bracket.

3-17 Install fuel line clip.

3-2 Install turbocharger.

3-26. AIR INLET HOUSING REPLACEMENT (MODELS 5063-5393 AND 5063-539L)

This task covers: a. Removal b. Cleaning c. Installation

INITIAL SETUP

MODELS

5063-5393 5063-539L

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para Description
3-3 Turbocharger removed
3-18 Fuel line clip removed
3-12 Mounting bracket removed

MATERIALS/PARTS

Screen, air inlet (App F, Item 150)
Lockwashers (App F, Item 99)

a. Removal

NOTE

Three air inlet housing to blower screws were removed during removal of fuel line clip and air pump bracket.

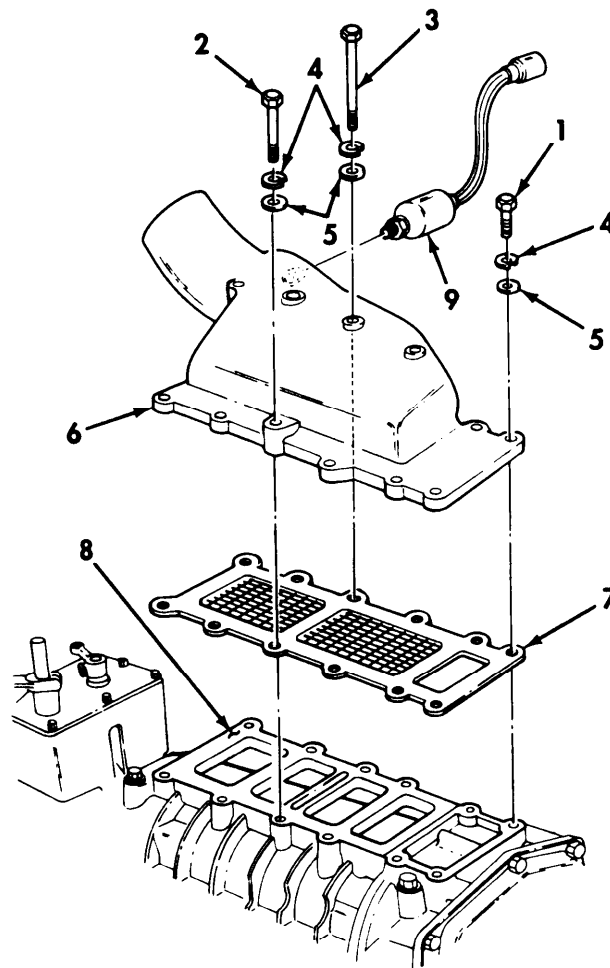
- (1) Remove four short screws (1), two mid-sized screws (2), three long screws (3), nine lockwashers (4), nine flat washers (5), air inlet housing (6), and screen (7) from blower (8). Discard lockwashers and screen.
- (2) Remove transducer (9) from air inlet housing (6).

b. Cleaning

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees C). If you become dizzy while using cleaning solvent, get fresh air immediately and see medical aid. If contact with eyes is made, wash with water and get medical aid immediately.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Clean air inlet housing with cleaning solvent and dry with compressed air.
- (2) Inspect transducer for damaged wires, connector, and threads.



c. Installation

NOTE

Three air inlet housing screws were removed during removal of fuel line clip and air pump bracket.

- (1) Install screen (7), air inlet housing (6), nine flat washers (5), nine lockwashers (4), two mid-sized screws (2), three long screws (3), and four short screws (1) on blower (8). Torque screws to 16-20 lb-ft (22-27 Nm).
- (2) Install transducer (9) in air inlet housing (6).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
 3-12 Install mounting bracket.
 3-18 Install fuel line clip.
 3-3 Install turbocharger.

3-27. AIR INLET HOUSING REPLACEMENT (MODELS 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Cleaning c. Installation

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para Description
3-3 Turbocharger removed
3-19 Fuel line clip removed

MATERIALS/PARTS

- 1 Screen, air inlet (App F, Item 149)
- 5 Lockwashers (App F, Item 99)

a. Removal

NOTE

Right middle air inlet housing screw was removed during removal of fuel line clip.

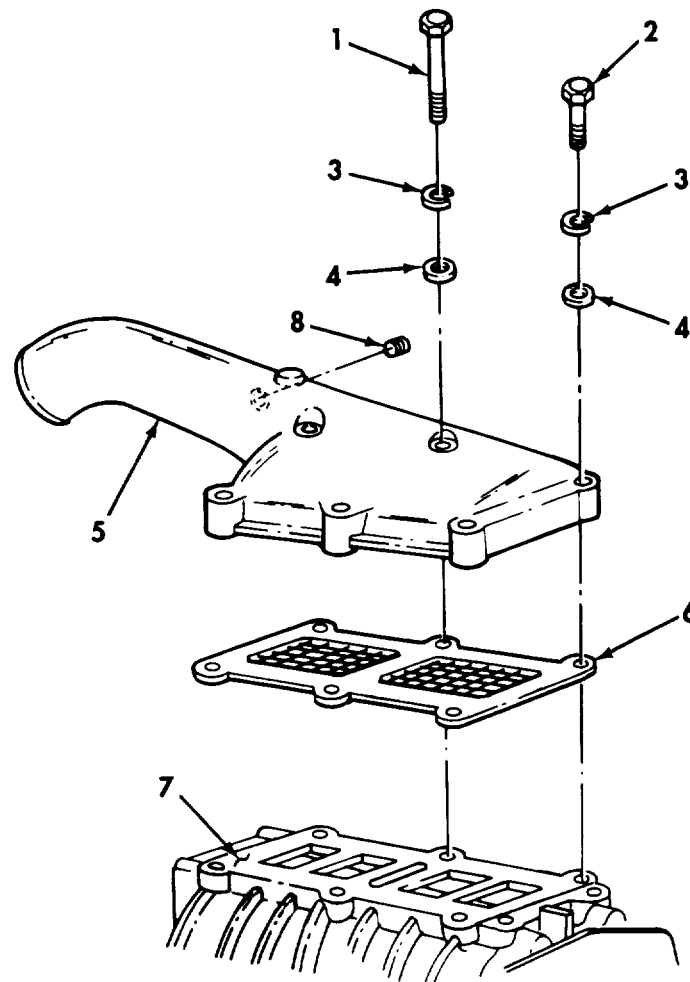
- (1) Remove two long screws (1), three short screws (2), five lockwashers (3), five flat washers (4), air inlet housing (5), and screen (6) from blower (7). Discard screen and lockwashers.
- (2) If necessary, remove plug (8) from air inlet housing (5).

b. Cleaning

WARNING

- Ž Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

Clean air inlet housing with fuel oil and dry with compressed air.



c. Installation

NOTE

Right middle air inlet housing screw was removed during removal of fuel line clip.

- (1) Install screen (6), air inlet housing (5), with air inlet toward rear of engine, five flat washers (4), five lockwashers (3), three short screws (2), and two long screws (1) on blower (7). Torque screws to 16-20 lb-ft (22-27 N•m).
- (2) If removed, install plug (8) in air inlet housing (5).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-19 Install fuel line clip.

3-3 Install turbocharger.

3-28. TACHOMETER DRIVE REPLACEMENT (MODELS 5063-5299, 5063-5392, 5063-5393, 5063-539F, AND 5063-539L)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5392 5063-5393 5063-539F
5063-539L

MATERIALS/PARTS

2 Lockwashers (App F, Item 98)
1 Gasket (App F, Item 68)

TOOLS AND SPECIAL TOOLS

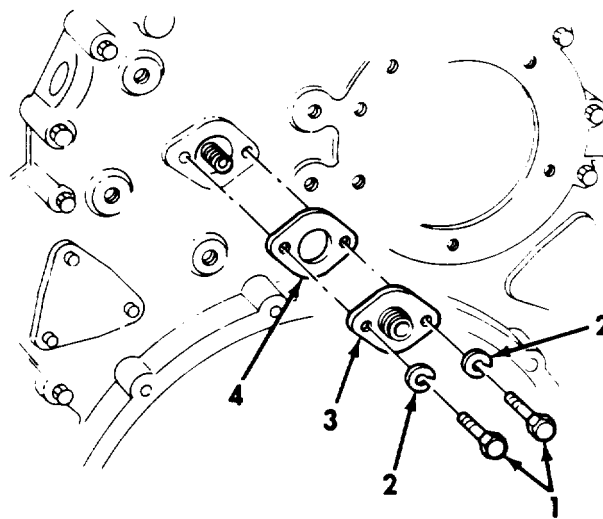
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Alignment tool, tachometer (App B, Item 7)

a. Removal

CAUTION

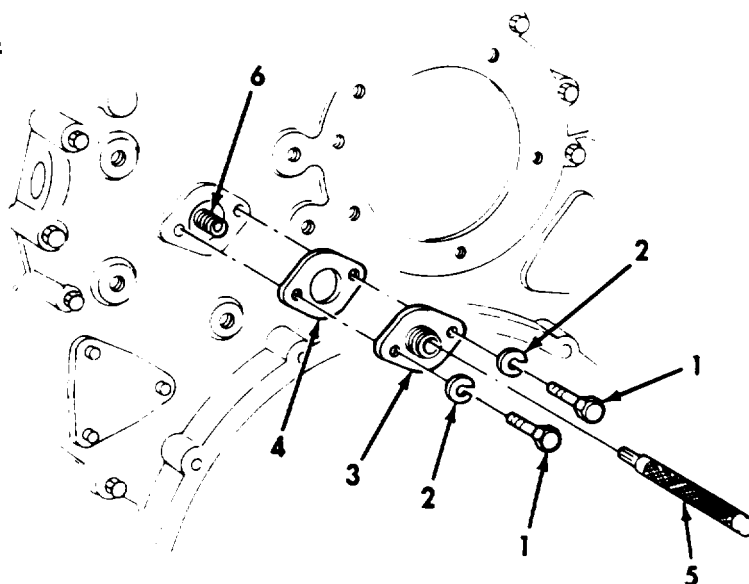
Use care when removing tachometer adapter. Tachometer drive shaft is fragile and subject to breakage.

Remove two bolts (1), two lockwashers (2), tachometer adapter (3), and gasket (4) from flywheel housing. Discard lockwashers and gasket.



b. Installation

- (1) Install gasket (4), tachometer adapter (3), two lockwashers (2), and two bolts (1) on flywheel housing. Do not tighten bolts.
- (2) Insert alignment tool (5) into tachometer adapter (3) and over end of drive shaft (6). Adjust adapter so there is no drive shaft binding on inside diameter of tool when crankshaft is rotated one revolution.
- (3) Torque bolts (1) to 13-17 lb-ft (18-23 N•m).
- (4) Remove alignment tool (5) from tachometer adapter (3).



END OF TASK

3-29. TACHOMETER DRIVE REPLACEMENT (MODELS 5063-5395 AND 5063-5398)

This task covers: a. Removal

b. Installation

INITIAL SETUP**MODELS**

5063-5395 5063-5398

MATERIALS/PARTS

2	Lockwashers (App F, Item 98)
1	Gasket (App F, Item 68)

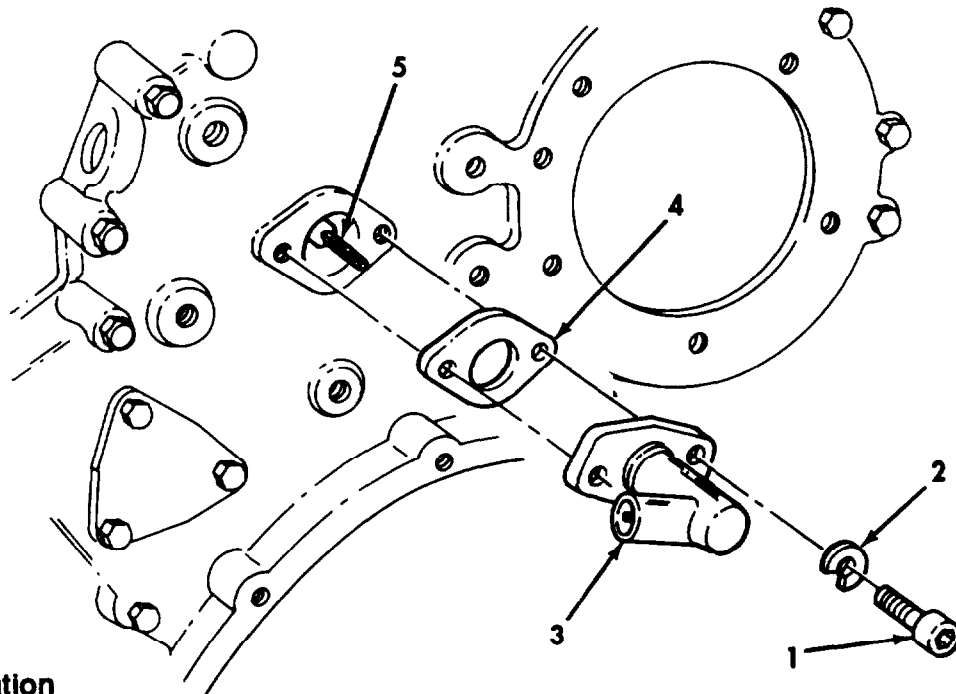
TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

a. Removal**CAUTION**

Use care when removing tachometer adapter. Tachometer drive shaft is fragile and subject to breakage.

Remove two screws (1), two lockwashers (2), tachometer generator (3), and gasket (4) from flywheel housing. Discard lockwashers and gasket.

**b. Installation**

- (1) Place gasket (4) on flywheel housing.
- (2) Guide square hole in tachometer generator (3) over drive shaft assembly (5) and install tachometer generator (3), two lockwashers (2), and two screws (1) on flywheel housing. Torque screws to 13-17 lb-ft (18-23 N•m).

END OF TASK

3-30. BLOWER DRIVE SUPPORT AND GOVERNOR WEIGHT ASSEMBLY REPLACEMENT

This task covers: a. Removal
d. Assembly b. Disassembly
e. Installation c. Cleaning/Inspection

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Spacer, governor weight (App B, Item 94)
Micrometer set (App B, Item 73)

MATERIALS/PARTS

- 1 Gasket (App F, Item 51)
- 2 Washers, copper (App F, Item 186)
- 1 Gasket (App F, Item 30)
- 1 Plug, cup (App F, Item 127)

EXPENDABLE/DURABLE SUPPLIES

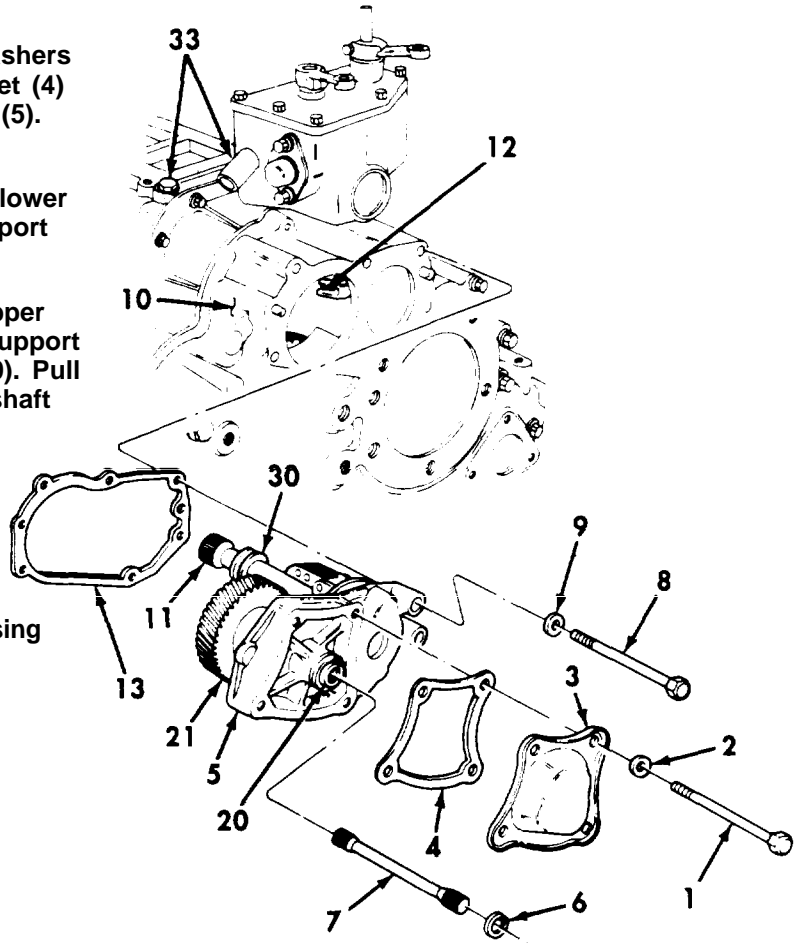
Oil, fuel (App C, Item 27)
Oil, engine (App C, Item 26)
Grease (App C, Item 18)
Sealing compound (App C, Item 44)
Adhesive, gasket (App C, Item 1)

EQUIPMENT CONDITION

Para Description
3-3 Turbocharger removed (models
5063-5395, 5063-5398, and 5063-539F)
3-5 Right exhaust tube removed (models
5063-5393 and 5063-539L)

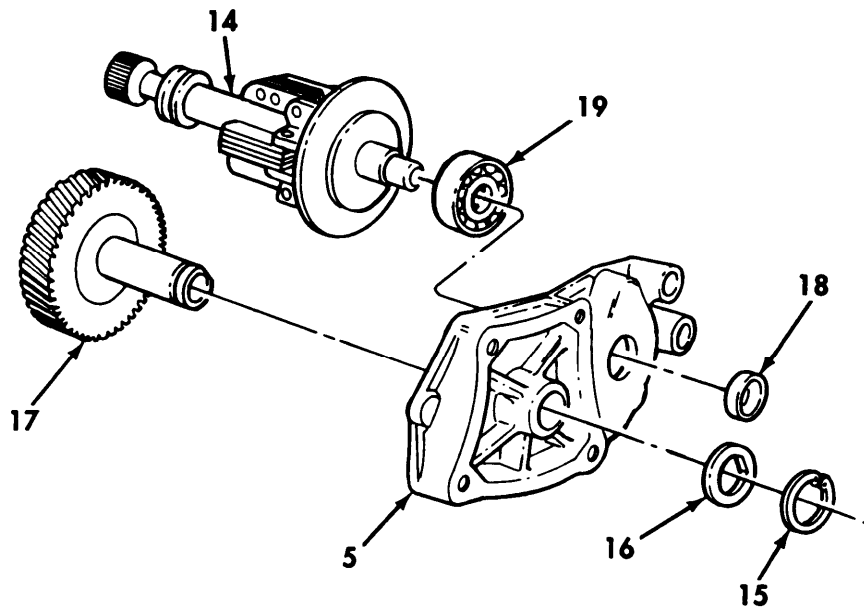
a. Removal

- (1) Remove four screws (1), four flat washers (2), blower drive cover (3), and gasket (4) from blower drive support assembly (5). Discard gasket.
- (2) Remove retaining ring (6) and pull blower drive shaft (7) from blower drive support assembly (5).
- (3) Remove two screws (8) and two copper washers (9) fastening blower drive support assembly (5) to flywheel housing (10). Pull assembly until splined end of drive shaft (11) is free from drive plate. Turn assembly slightly so serrated end of governors weight shaft will pass around governor operating fork (12). Discard copper washers.
- (4) Remove gasket (13) from flywheel housing (10). Discard gasket.

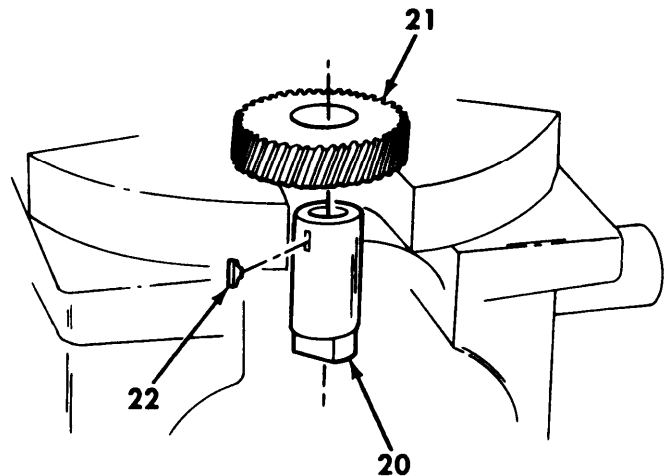


b. Disassembly**(1) Blower drive support assembly**

- (a) Remove governor weight shaft and carrier assembly (14) from blower drive support assembly (5) using pry bars if necessary.
- (b) Remove retaining ring (15) and thrust washer (16). Slide blower drive gear and shaft assembly (17) from blower drive support assembly (5).
- (c) Remove cup plug (18) from blower drive support assembly (5).
- (d) Tap governor weight shaft bearing (19) from blower drive support assembly (5). If bearing is a tight fit, place a spacer against bearing and press from drive support.

**(2) Blower drive gear and shaft assembly**

- (a) Support blower drive gear and shaft assembly.
- (b) Place 1-1/8 inch diameter brass drift on end of shaft (20) and press shaft out of gear (21).
- (c) Remove key (22) from shaft (20).



3-30. BLOWER DRIVE SUPPORT AND GOVERNOR WEIGHT ASSEMBLY REPLACEMENT (Cont)

(3) Governor weight shaft and carrier assembly

- (a) Remove four retaining rings (23) from four weight pins (24).
- (b) Drive four weight pins (24) out of carrier assembly (25) by tapping on punch held against grooved end of pin. Remove two low speed weights (26) and two high speed weights (27).
- (c) Press carrier (28) and governor riser assembly (29) from shaft (11).

NOTE

Do not remove bearing from riser since it is serviced only as an assembly.

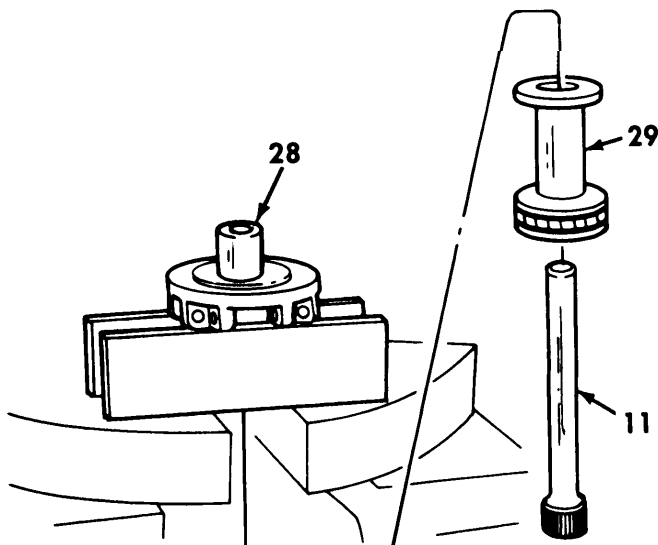
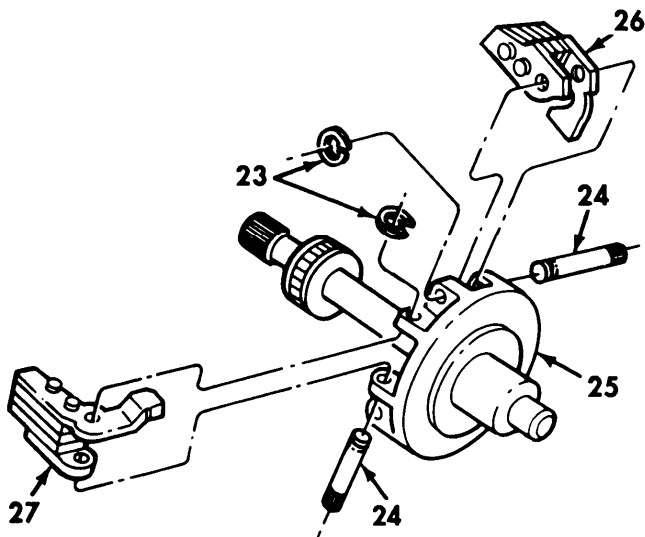
- (d) Slide governor riser assembly (29) from shaft (11).

c. Cleaning/Inspection

WARNING

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

- (1) Wash all parts in fuel oil and dry them with compressed air.
- (2) 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.
- (3) Inspect gear teeth for evidence of scoring, pitting, burning, or wear.
- (4) Examine blower drive support thrust washer for scoring and wear. Thickness of new thrust washer is 0.093-0.103 inch.
- (5) 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.
- (6) Inspect outside diameter of blower drive gear shaft and mating inside diameter of drive support for scoring and wear.
- (7) Examine weight carrier, weights, and pins. Replace worn parts.



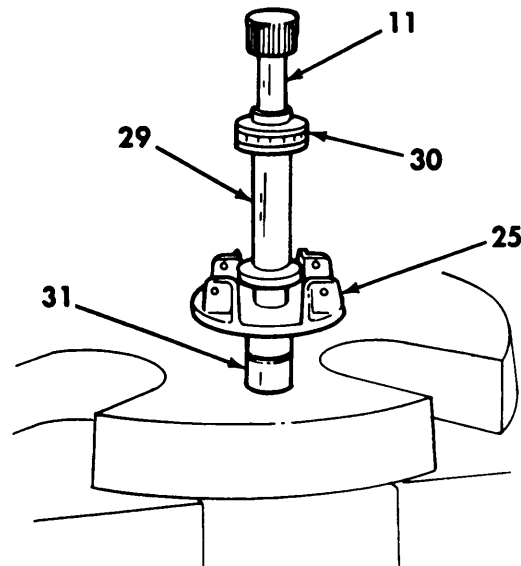
d. Assembly

(1) Governor weight shaft and carrier assembly

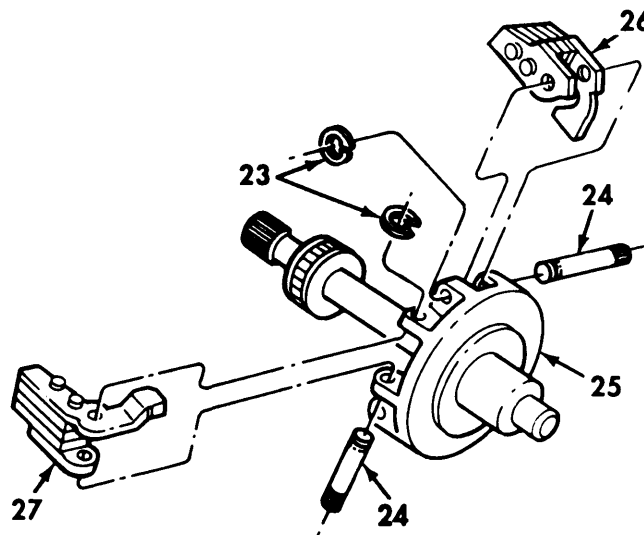
- (a) Lubricate governor weight shaft (11) with engine oil and slide governor riser assembly (29) over shaft with bearing end toward serrated end of shaft. Pack bearing (30) with grease.
- (b) Using governor weight spacer (31), press weight shaft (11) into carrier (25). Spacer will properly position carrier on shaft.

NOTE

Governor high speed weights are identified by long cam arm and low speed weights are identified by short cam arm.



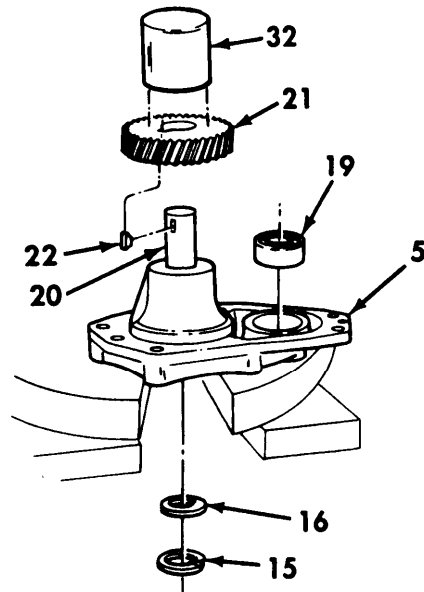
- (c) Place two low speed weights (26) on opposite sides of carrier assembly (25). Drive grooved end of two weight pins (24) through larger hole in carrier, through weight, and then through smaller hole in carrier. Drive knurled end of pin until groove is clear of carrier assembly.
- (d) Install two retainer rings (23) on two weight pins (24).
- (e) Install two high speed weights (27) in same manner as installing low speed weights (Steps (c) and (d)).



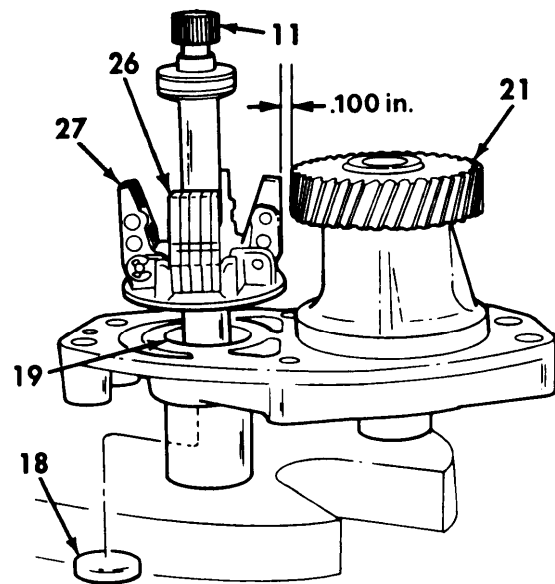
3-30. BLOWER DRIVE SUPPORT AND GOVERNOR WEIGHT ASSEMBLY REPLACEMENT (Cont)

(2) Blower drive support assembly

- (a) Lubricate drive gear shaft (20) with engine oil and install in blower drive support assembly (5).
- (b) Install thrust washer (16) and retaining ring (15) on end of blower drive gear shaft (20).
- (c) Install key (22) in shaft (20).
- (d) Support blower drive support assembly (5). Lubricate inside diameter of blower drive gear (21) and start gear straight on shaft (20), with keyway in gear aligned with key in shaft. Place governor weight spacer (32) over gear and press gear on shaft until there is 0.004 to 0.012 inch clearance between gear and drive support.



- (e) Support blower drive support assembly (5), with inner face up. Place governor weight shaft bearing (19), numbered side up, on bore of drive support. Using a sleeve against outer race, press bearing against shoulder of blower drive support.
- (f) Place support under inner race of governor weight shaft bearing (19). Start weight end of governor weight shaft (11) into bearing. Press shaft until shoulder on shaft contacts inner race of bearing.
- (g) Apply sealing compound to edge of cup plug (18). Press plug into blower drive support assembly (5) until flush with support.



- (h) Check clearance between fully extended governor weights (26 and 27) and drive gear (21). Clearance must be greater than 0.100 inch.

e. 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 gasket (13) to blower drive support assembly (5).

- (a) Using gasket adhesive, affix gasket (13) to blower drive support assembly (5).
 - (b) Place high speed governor weights (27) in horizontal position to provide clearance. Turn operating shaft fork (12) away from blower for additional clearance.
 - (c) Insert blower drive assembly (5) in flywheel housing (10) until drive gear (21) enters housing. Turn drive assembly until serrated end of weight shaft (11) passes around operating fork (12) and fork is between serrated end of shaft and riser bearing (30).
 - (d) Push blower drive support assembly (5) up against flywheel housing. Mesh serrated end of weight shaft (11) with governor drive plate, and mesh blower drive gear (21) with camshaft gear.
- (2) Install two copper washers (9) and two screws (8) on small end of blower drive support assembly (5) into flywheel housing. Torque bolts to 20-24 lb-ft (27-33 N•m).
 - (3) Insert blower drive shaft (7) into blower gear shaft (20). 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 (6) into blower drive gear shaft (20).
 - (5) Install gasket (4), cover (3), four flat washers (2), and four screws (1) on blower drive support assembly (5). Torque screws to 20-24 lb-ft (27-33 N•m).

NOTE

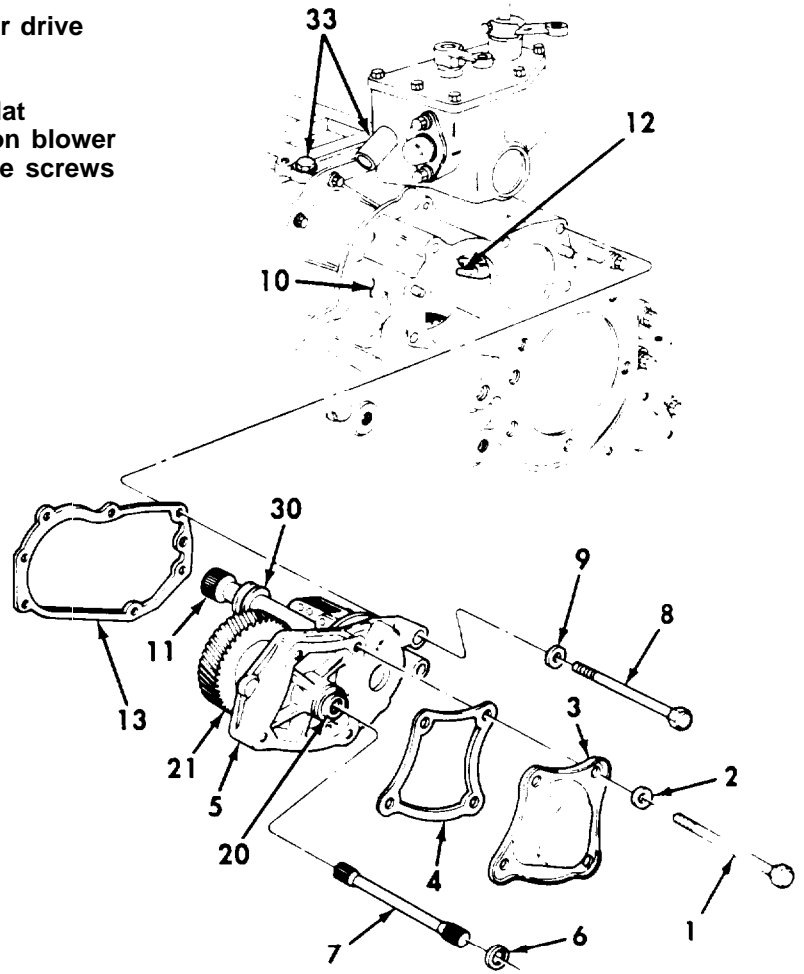
For models 5063-5299, 5063-5395, 5063-5398, and 5063-539F, support for air pump and ignition coil assembly is installed with the seven-inch front bolts (33).

- (6) Torque blower to cylinder block bolts (33) to 55-60 lb-ft (75-81 N•m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-5	Install right exhaust tube (models 5063-5393 and 5063-539L).
3-3	Install turbocharger (models 5063-5395, 5063-5398, and 5063-539F).



3-31. GOVERNOR COVER AND THROTTLE CONTROL RODS REMOVAL/INSTALLATION

This task covers: a. Removal

b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, retaining nut (App B, Item 115)

MATERIALS/PARTS

- 1 Gasket (App F, Item 50)
- 2 Washers, copper (App F, Item 185)
- 1 Gasket (App F, Item 79)
- 2 Pins, cotter (App F, Item 118)
- 2 Nuts, self-locking (App F, Item 105)

EQUIPMENT CONDITION

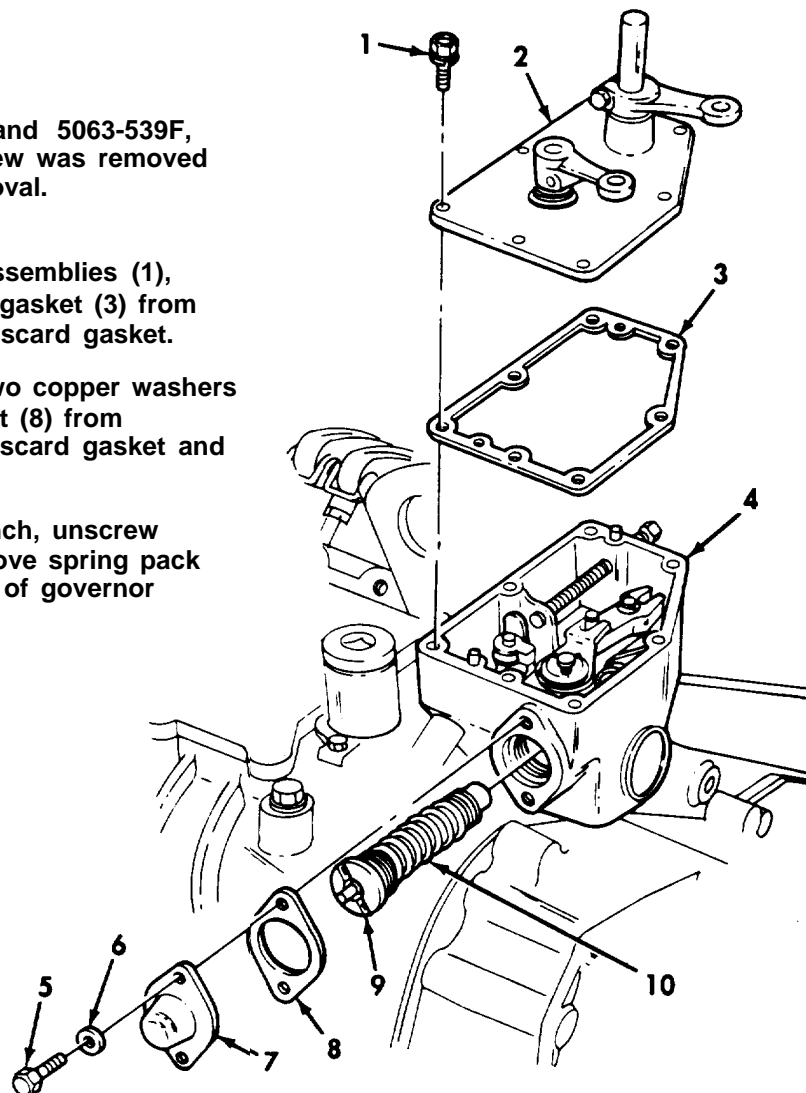
- | Para | Description |
|------|--|
| 3-19 | Fuel line clip removed (models 5063-5395 and 5063-539F) |
| 3-20 | Rocker arm covers removed (models 5063-5299 and 5063-5398) |
| 3-21 | Rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F and 5063-539L) |
| 3-22 | Rocker arm covers removed (model 5063-5395) |

a. Removal

NOTE

On models 5063-5395 and 5063-539F, one governor cover screw was removed during fuel line clip removal.

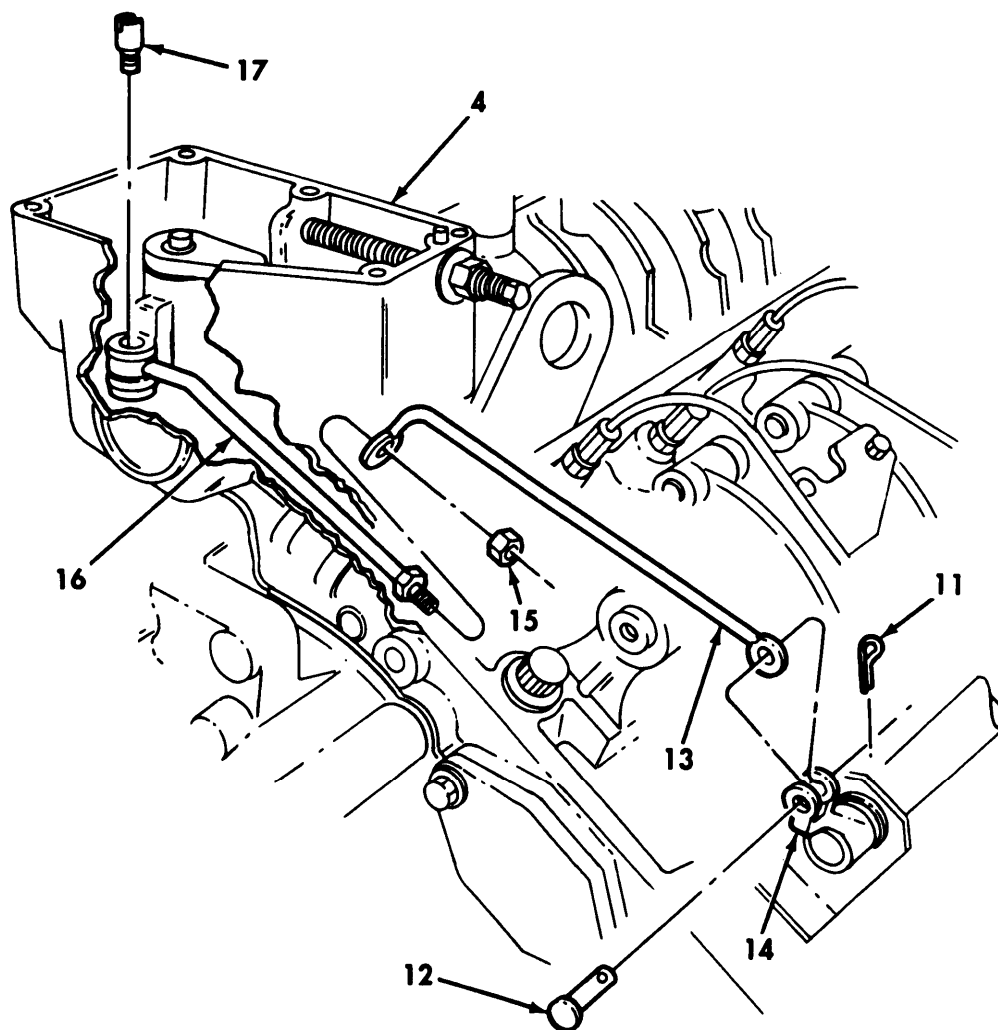
- (1) Remove seven screw assemblies (1), governor cover (2), and gasket (3) from governor housing (4). Discard gasket.
- (2) Remove two bolts (5), two copper washers (6), cover (7), and gasket (8) from governor housing (4). Discard gasket and copper washers.
- (3) Using retaining nut wrench, unscrew packing nut (9) and remove spring pack assembly (10) from side of governor housing (4).



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 (11) from pin (12). Remove pin from lower connecting link (13) on injector control tube lever (14). Discard cotter pin.

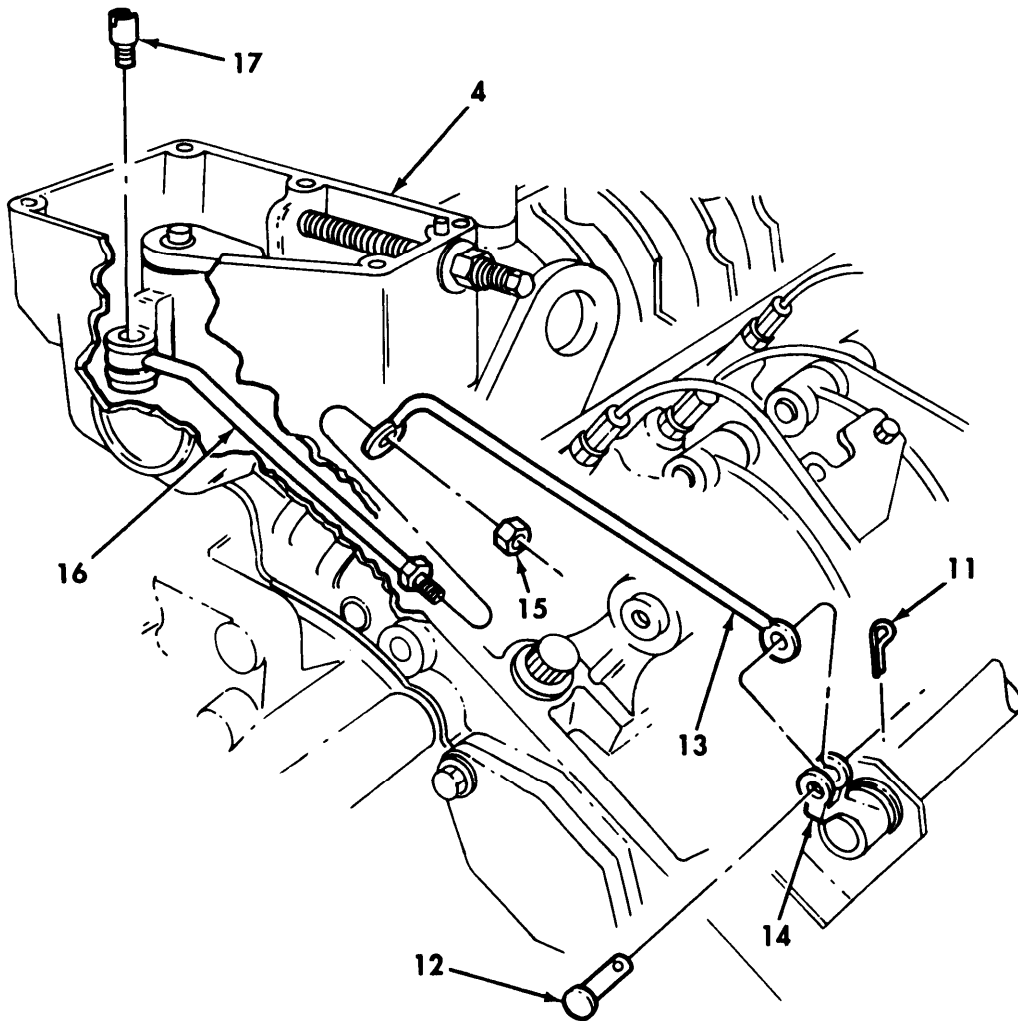


- (5) Remove self-locking nut (15) and disconnect lower connecting link (13) from upper connecting link (16). Withdraw lower connecting link. Discard nut.
- (6) Remove shoulder pin (17) and upper connecting link (16) from inside governor housing (4).
- (7) Repeat steps (4) thru (6) for left cylinder head.

3-31. GOVERNOR COVER AND THROTTLE CONTROL RODS REMOVAL/INSTALLATION (Cont)

b. Installation

- (1) On right cylinder, install right upper connecting link (16) from inside governor housing (4) and then install shoulder pin (17). Tighten pin securely.
- (2) Connect lower connecting link (13) to upper connecting link (16) with self-locking nut (15). Tighten nut securely.



- (3) Install pin (12) through injector control tube lever (14) and then through lower connecting link (13) with cotter pin hole toward front. Install cotter pin (11) in hole of pin (12).
- (4) Repeat steps (1) thru (3) for left cylinder head.

- (5) Install spring pack assembly (10) in side of governor housing (4). Using retaining nut wrench, tighten packing nut (9).

NOTE

Torque bolts on cover (7) during engine tune-up (Para 4-4).

- (6) Install gasket (8), cover (7), two copper washers (6), and two bolts (5) on governor housing (4).
- (7) Place gasket (3) and governor cover (2) on top of governor housing. Ensure: control link lever (18) engages pin (19) on differential lever (20); pin (21) in speed control shaft enters slot in differential lever; and, pin (22) in stop lever shaft (23) engages between stop on underside of cover and against vertical extension of control link lever.

NOTE

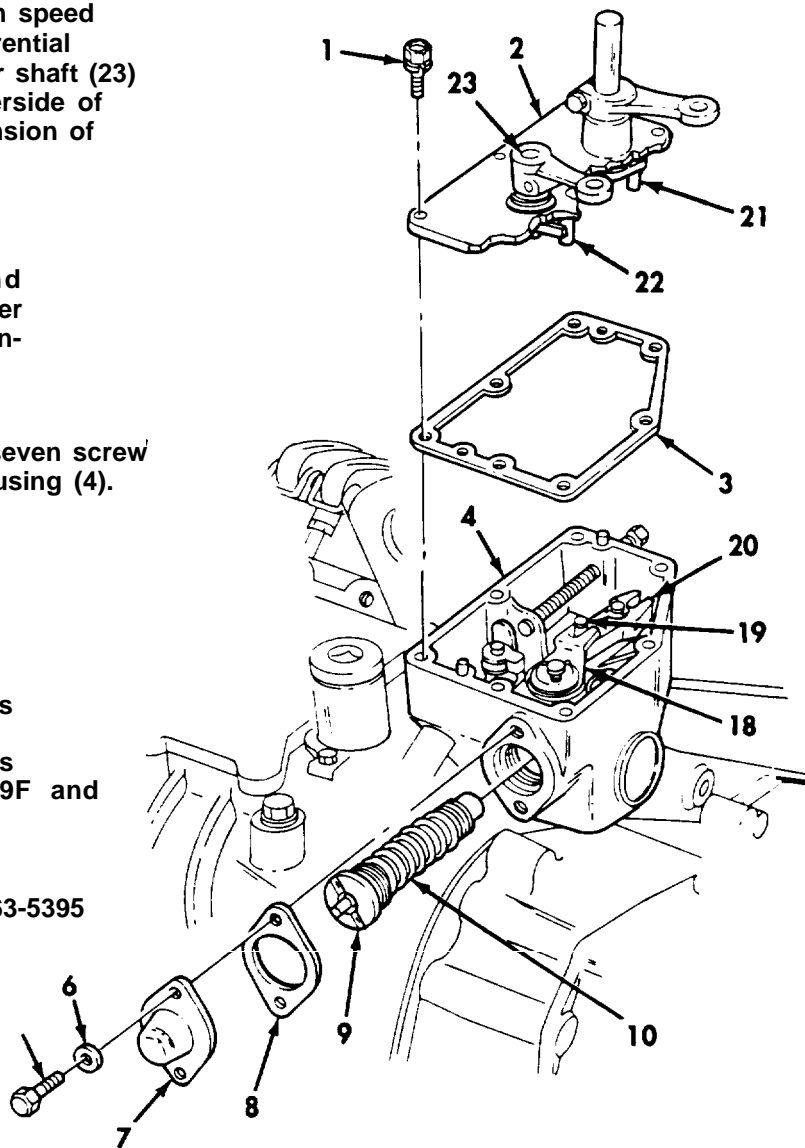
On models 5063-5395 and 5063-539F, one governor cover screw will be installed during installation of fuel line clip.

- (8) Install governor cover (2) and seven screw assemblies (1) on governor housing (4). Tighten screws.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-20	Install rocker arm covers (models 5063-5299 and 5063-5398).
3-21	Install rocker arm covers (models 5063-5392, 5063-5393, 5063-539F and 5063-539L).
3-22	Install rocker arm covers (model 5063-5395).
3-19	Install fuel line clip (models 5063-5395 and 5063-539F).



3-32. GOVERNOR AND BLOWER ASSEMBLY REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Sling, (App B, Item 93)
- Guide studs (App D, Item 11)
- Gage, depth (App B, Item 36)
- Gage set, depth, micrometer (App B, Item 31)

MATERIALS/PARTS

- 2 Gaskets (App F, Item 82)
- 1 Seal, blower App F, Item 163)
- 1 Gasket (App F Item 47)
- 1 Gasket (App F, Item 52)
- 6 Lockwashers (App F, Item 99)

EXPENDABLE/DURABLE SUPPLIES

- Adhesive (App C, Item 1)
- International compound no, 2 (App C, Item 21)

EQUIPMENT CONDITION

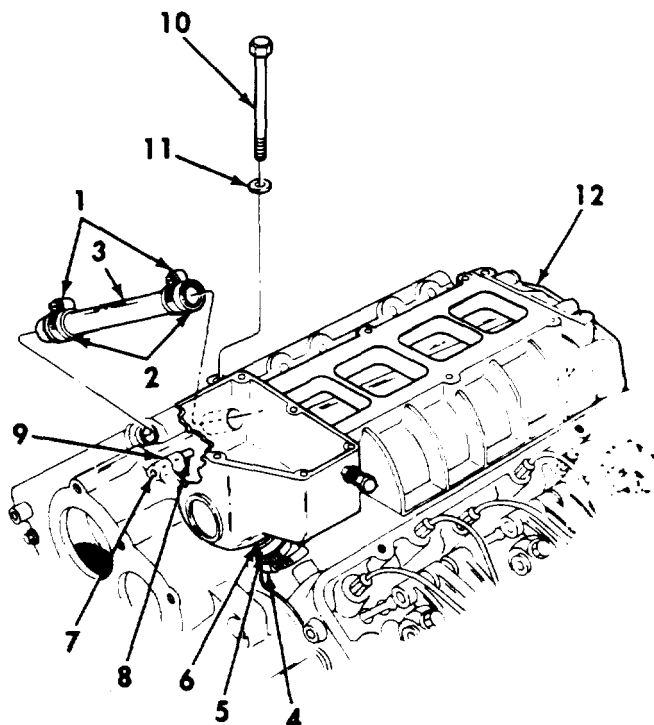
- | Para | Description |
|------|---|
| 3-2 | Turbocharger removed (model 5063-5392) |
| 3-19 | Fuel line clip removed (models 5063-5395 and 5063-539F) |
| 3-10 | Igniter and air pump bracket assembly removed (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F) |
| 3-20 | Rocker arm covers removed (models 5063-5299 and 5063-5398) |
| 3-21 | Rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F and 5063-539L) |
| 3-22 | Rocker arm covers removed (model 5063-5395) |
| 3-24 | Air inlet housing removed (model 5063-5299) |
| 3-25 | Air inlet housing removed (model 5063-5392) |
| 3-26 | Air inlet housing removed (model 5063-5393 and 5063-539L) |
| 3-27 | Air inlet housing removed (models 5063-5395, 5063-5398, and 5063-539F) |
| 3-30 | Blower drive support removed |
| 3-31 | Governor cover and throttle control rods removed |

a. Removal

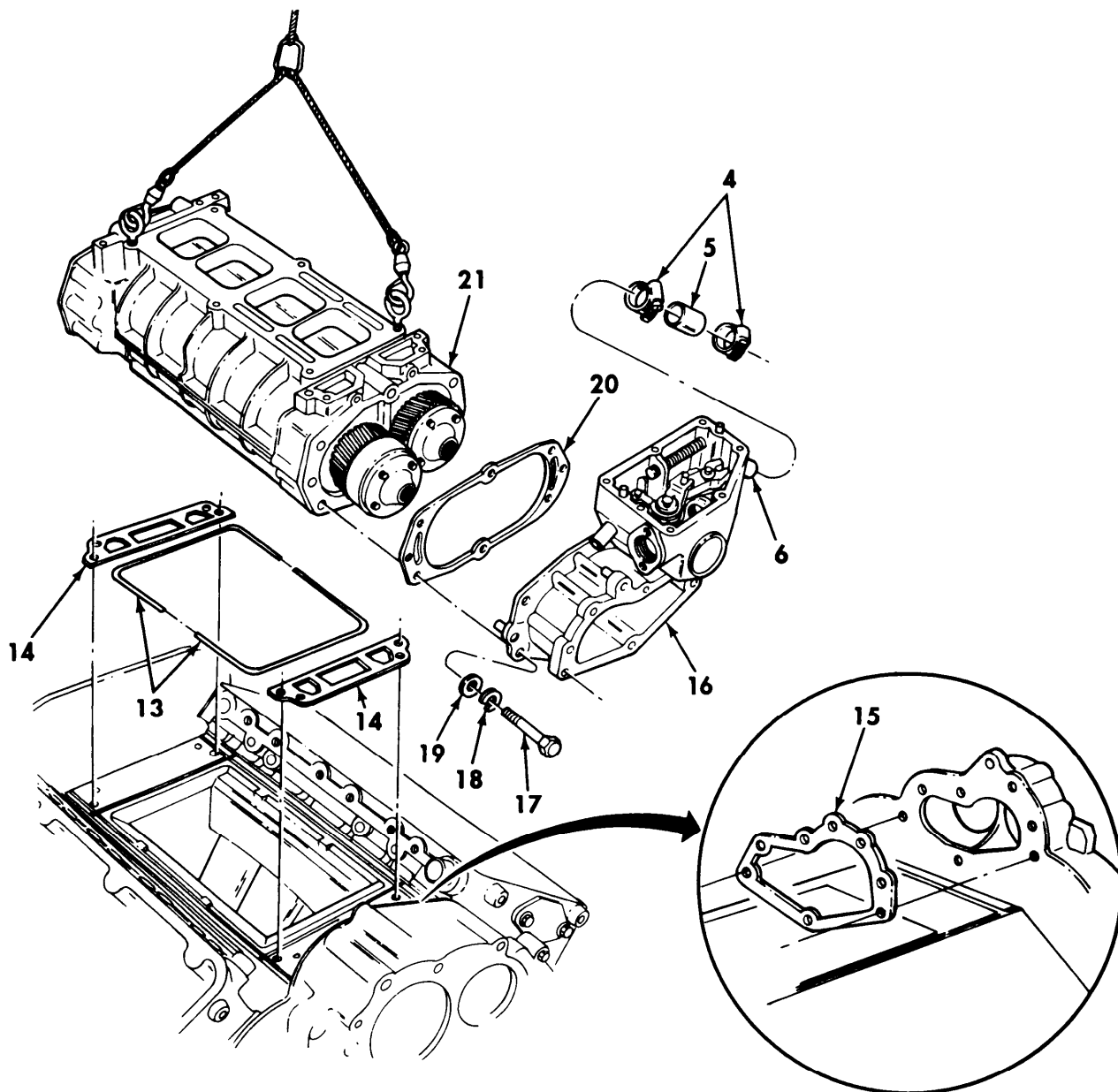
- (1) Loosen two clamps (1) on two left fuel rod hoses (2) and slide two hoses onto left governor link housing (3). Remove housing, hoses, and clamps from left bank.
- (2) Loosen two clamps (4) on right fuel rod hose (5). Slide hose onto right fuel rod cover (6).
- (3) Insert punch in flywheel housing hole (7) and drive pin (8) towards blower and clear of rear engine end plate (9).

NOTE

On models 5063-5299, 5063-5395, 5063-5398, and 5063-539F, two blower to block bolts and washers were removed during igniter and air pump assembly removal.



- (4) Remove four self-locking bolts (10) and four hardened washers (11) fastening blower and governor assembly (12) to cylinder block.
- (5) Using two 3/8-16 eye bolts and sling, lift blower and governor assembly (12) from engine.
- (6) Remove seal (13) and two gaskets (14) from top of cylinder block. Discard seal and gaskets.



- (7) Remove gasket (15) from rear of governor assembly (16). Discard gasket.
- (8) Remove six screws (17), six lockwashers (18), six flat washers (19), governor assembly (16), and gasket (20) from blower (21) end plate. Discard gasket and lockwashers.
- (9) Remove two clamps (4) and hose (5) from right fuel rod cover (6).

3-32. GOVERNOR AND BLOWER ASSEMBLY REMOVAL/INSTALLATION (Cont)

b. Installation

NOTE

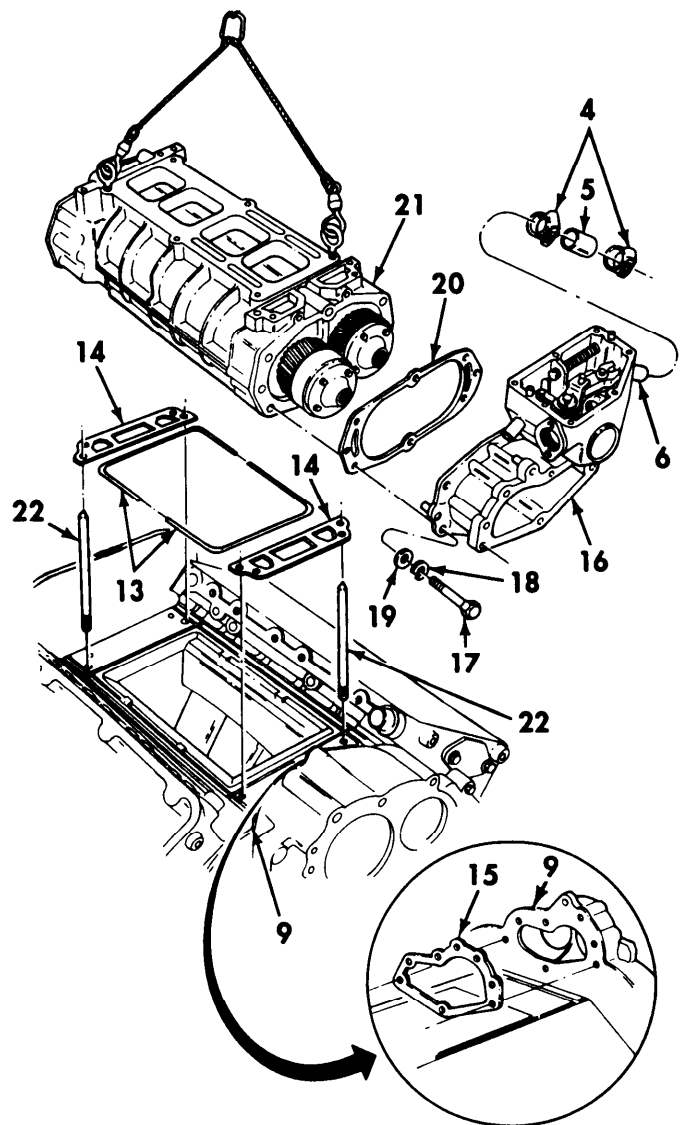
- Remove four bolts and flat washers used to temporarily fasten rear end plate to blower housing.
- Insert second screw in right side of governor housing before placing housing on blower.

- (1) Install gasket (20), governor assembly (16), six flat washers (19), six lockwashers (18) and six screws (17) on blower (21) 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.

- (2) 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 above to 0.004 inch below end plate.
- (3) Using gasket adhesive, affix gasket (15) to cylinder block rear end plate (9).
- (4) Place seal (13) in groove in top of cylinder block.
- (5) Using gasket adhesive, affix two gaskets (14) to top of cylinder block.
- (6) Install two guide studs (22) in blower bolt holes in cylinder block.
- (7) Install two clamps (4) and hose (5) on right fuel rod cover (6).
- (8) Using two 3/8-16 eye bolts and sling, lower blower and governor assembly (12) over guide studs (22). Push blower away from cylinder block rear end plate (9) while lowering into position. Remove two guide studs.



NOTE

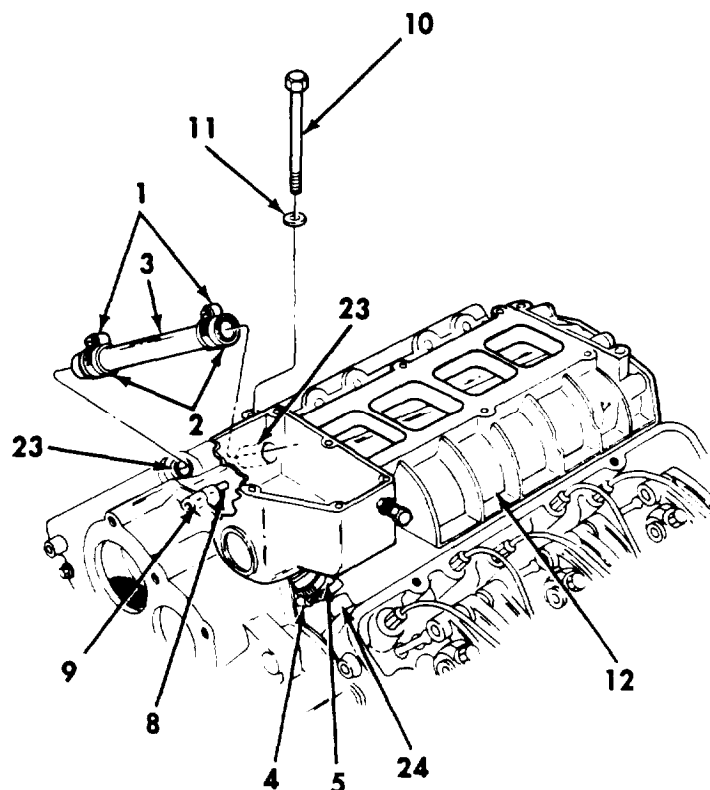
Models 5063-5299, 5063-5395, 5063-5398, and 5063-539F use two front blower to block bolts which are 5/16 inch longer. These bolts and washers are installed during the igniter and air pump assembly installation.

- (9) Apply International Compound No. 2, or equivalent, to four self-locking bolts (10). Install four hardened washers (11) and four self-locking bolts, fastening blower to cylinder block. Finger tighten bolts.
- (10) Drive dowel pin (8) into cylinder block rear end plate (9).

NOTE

Final torquing of bolts, attaching blower to block, is done following blower drive support installation (Para 3-30).

- (11) Torque bolts (10 to 10-15 lb-ft (14-20 N·m)).
- (12) Slide two hoses (2) and two clamps (1) onto governor link housing (3) and position between governor and left cylinder head sleeve (23). Slide hoses and clamps onto governor housing and cylinder head sleeve and tighten clamps securely.
- (13) Slide hose (5) and two clamps (4) onto right cylinder head sleeve (24). Tighten clamps.



END OF TASK

FOLLOW-ON MAINTENANCE

- | Para | Description |
|------|---|
| 3-31 | Install governor cover and throttle control rods. |
| 3-30 | Install blower drive support. |
| 3-24 | Install air inlet housing (model 5063-5299). |
| 3-25 | Install air inlet housing (model 5063-5392). |
| 3-26 | Install air inlet housing (models 5063-5393 and 5063-539L). |
| 3-27 | Install air inlet housing (models 5063-5395, 5063-5398 and 5063-539F). |
| 3-20 | Install rocker arm covers (models 5063-5299 and 5063-5398). |
| 3-21 | Install rocker arm covers (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L). |
| 3-22 | Install rocker arm covers (model 5063-5395). |
| 3-10 | Install igniter and air pump bracket assembly (models 5063-5299, 5063-5395, 5063-5398 and 5063-539F). |
| 3-19 | Install fuel line clip (models 5063-5395 and 5063-539F). |
| 3-2 | Install turbocharger (model 5063-5392). |

3-33. OIL PAN REPLACEMENT

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All

MATERIALS/PARTS

1 Gasket (App F, Item 43)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
Adhesive (App C, Item 1)

a. Removal

- (1) Remove twenty-two screw and washer assemblies (1) from oil pan (2).
- (2) Remove oil pan (2) and gasket (3). Discard gasket.
- (3) If necessary, remove following fittings from oil pan:
 - (a) For models 5063-5299,5063-5395, 5063-5398, and 5063-539F: adapter (4), two plugs (5), plug (6), and plug (7).
 - (b) For model 5063-5392: adapter (8), two plugs (9), plug (10), and elbow (11).
 - (c) For models 5063-5393 and 5063-539L: plug (12) and elbow (13).

b. Cleaning/Inspection

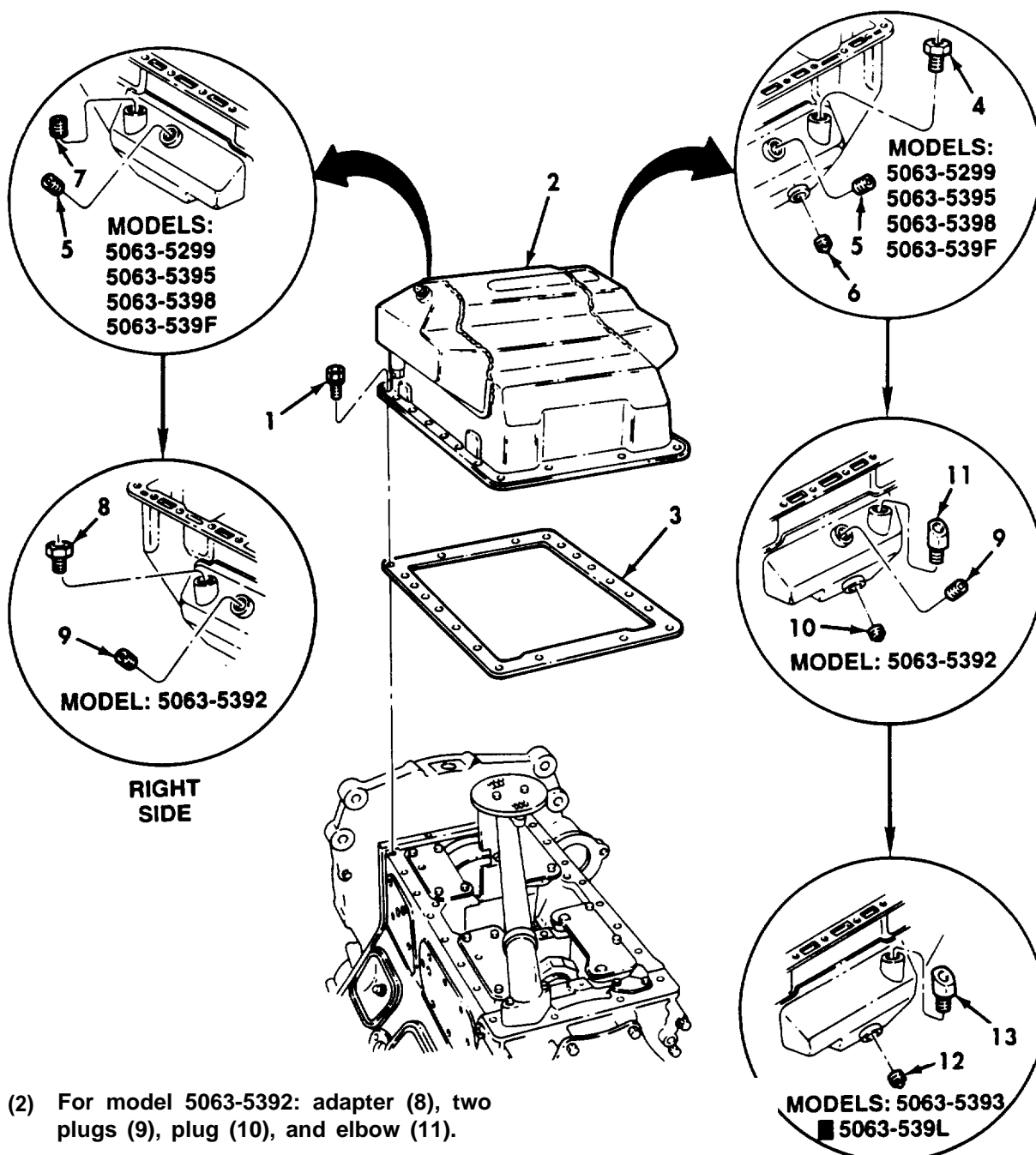
WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Clean oil pan with cleaning solvent and dry with compressed air.
- (2) Inspect oil pan for holes, dents, cracks, and other damage which may require replacement. Check for misaligned flanges or raised surfaces surrounding bolt holes.

c. Installation

- (1) If removed, install following fittings in oil pan:
 - (a) For models 5063-5299,5063-5395, 5063-5398, and 5063-539F: adapter (4), two plugs (5). plug (6), and plug (7).



- (2) For model 5063-5392: adapter (8), two plugs (9), plug (10), and elbow (11).
- (3) For models 5063-5393 and 5063-539L: plug (12) and elbow (13).
- (4) Coat flange of oil pan (2) with gasket adhesive.
- (5) Place gasket (3) on oil pan flange with contoured end towards front of engine.
- (6) Place oil pan (2) on cylinder block with drain plug on left side. Install twenty-two screw and washer assemblies (1). 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

3-34. OIL PUMP INLET TUBE REPLACEMENT (MODEL 5063-5299)

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 1 Gasket (App F, Item 54)
- 2 Lockwashers (App F, Item 98)
- 4 Lockwashers (App F, Item 99)

MATERIALS/PARTS (Cont)

- 2 Bolt, self-locking (App F, Item 192)
- 2 Nuts, self-locking (App F, Item 109)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

EQUIPMENT CONDITION

Para Description
3-33 Oil pan removed

a. Removal

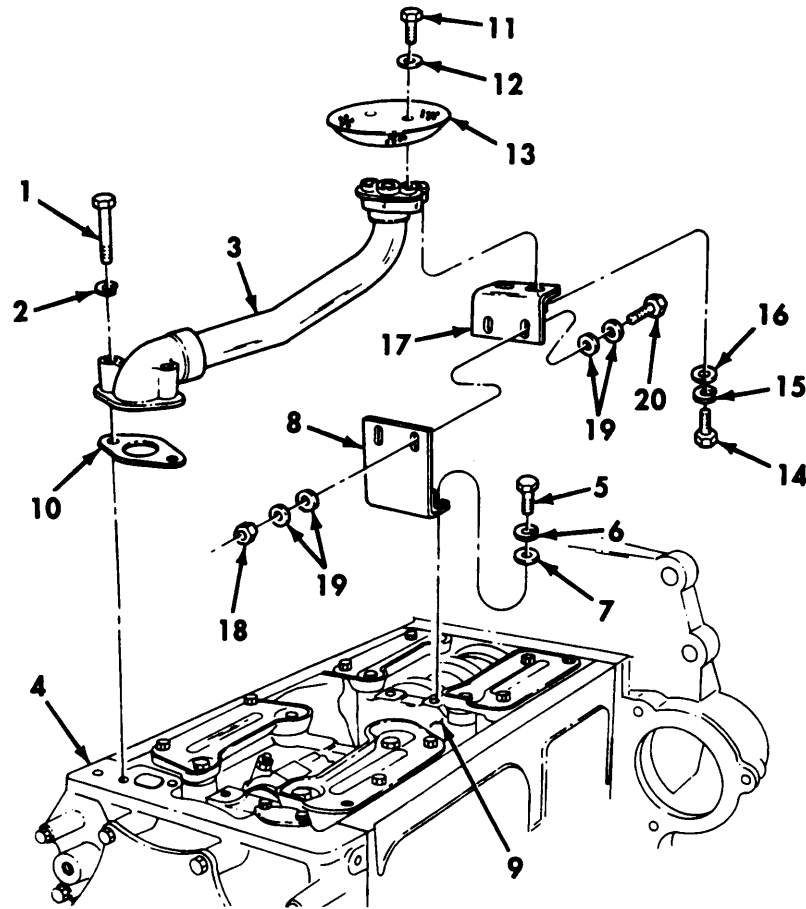
- (1) Remove two bolts (1) and two lockwashers (2) fastening oil pump inlet tube (3) to bottom of lower front cover (4). Discard lockwashers.
- (2) Remove two screw (5), two lockwashers (6), and two special washers (7) fastening support bracket (8) to main bearing cap (9). Discard lockwashers.
- (3) Remove oil pump inlet tube (3) and gasket (10) from cylinder block. Discard gasket.
- (4) Remove two self-locking bolts (11), two flat washers (12), and strainer (13) from inlet tube (3). Discard self-locking bolts.
- (5) Remove two screws (14), two lockwashers (15), two special washers (16), and bracket (17) from inlet tube (3). Discard lockwashers.
- (6) Remove two self-locking nuts (18), eight flat washers (19), two screws (20), and bracket (8) from bracket (17). Discard nuts.

b. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Wash components with cleaning solvent and dry with compressed air.
- (2) Inspect tubes, brackets, and strainer for cracks or damage.



c. Installation

- (1) Install bracket (8), two screws (20), eight flat washers (19), and two self-locking nuts (18) on bracket (17). Loosely tighten screws.
- (2) Loosely install bracket (17), two special washers (16), two lockwashers (15), and two screws (14) on oil pump inlet tube (3).
- (3) Install strainer (13), two flat washers (12), and two self-locking bolts (11) on inlet tube (3). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (4) Install gasket (10), inlet tube (3), two lockwashers (2), and two bolts (1) on lower front cover (4). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (5) Install two special washers (7), two lockwashers (6), and two screws (5) in bracket (8) at main bearing cap (9). Torque screws to 30-35 lb-ft (41-47 N-m).
- (6) Torque two screws (20) to 35-39 lb-ft (47-53 N-m) and two screws (14) to 30-35 lb-ft (41-47 N-m), on brackets (8 and 17).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-33 Install oil pan

3-35. OIL PUMP INLET TUBE REPLACEMENT (ALL EXCEPT MODEL 5063-5299)

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All except 5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

- 2 Gaskets (App F, Item 54)
- 1 Gasket (App F, Item 67)
- 2 Lockwashers (App F, Item 99)

MATERIALS/PARTS (CONT)

- 7 Lockwashers (App F, Item 98)
- 4 Lockwashers (App F, Item 95)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

EQUIPMENT CONDITION

Para Description
3-33 Oil pan removed

a. Removal

- (1) Remove two screws (1) and small lockwashers (2) from inlet tube assembly (3) at lower front cover (4). Discard lockwashers.
- (2) Remove two screws (5), two lockwashers (6), and two flat washers (7) from bracket (8) at main bearing cap (9). Discard lockwashers.
- (3) Remove inlet tube assembly (3) and gasket (10) from cylinder block. Discard gasket.
- (4) Remove two bolts (11), two lockwashers (12), and strainer (13) from inlet tube assembly (3). Discard lockwashers.
- (5) Remove bolt (14), lockwasher (15), flat washer (16), and bracket (17) from inlet tube assembly (3). Discard lockwasher.
- (6) Remove two nuts (18), two lockwashers (19), four flat washers (20), two bolts (21), and bracket (8) from bracket (17). Discard lockwashers.
- (7) On model 5063-5398, remove two lon bolts (22), two lockwashers (23), two short bolts (24), two special lockwashers (25), outlet tube assembly (26), and two gaskets (27). Discard lockwashers and gaskets;

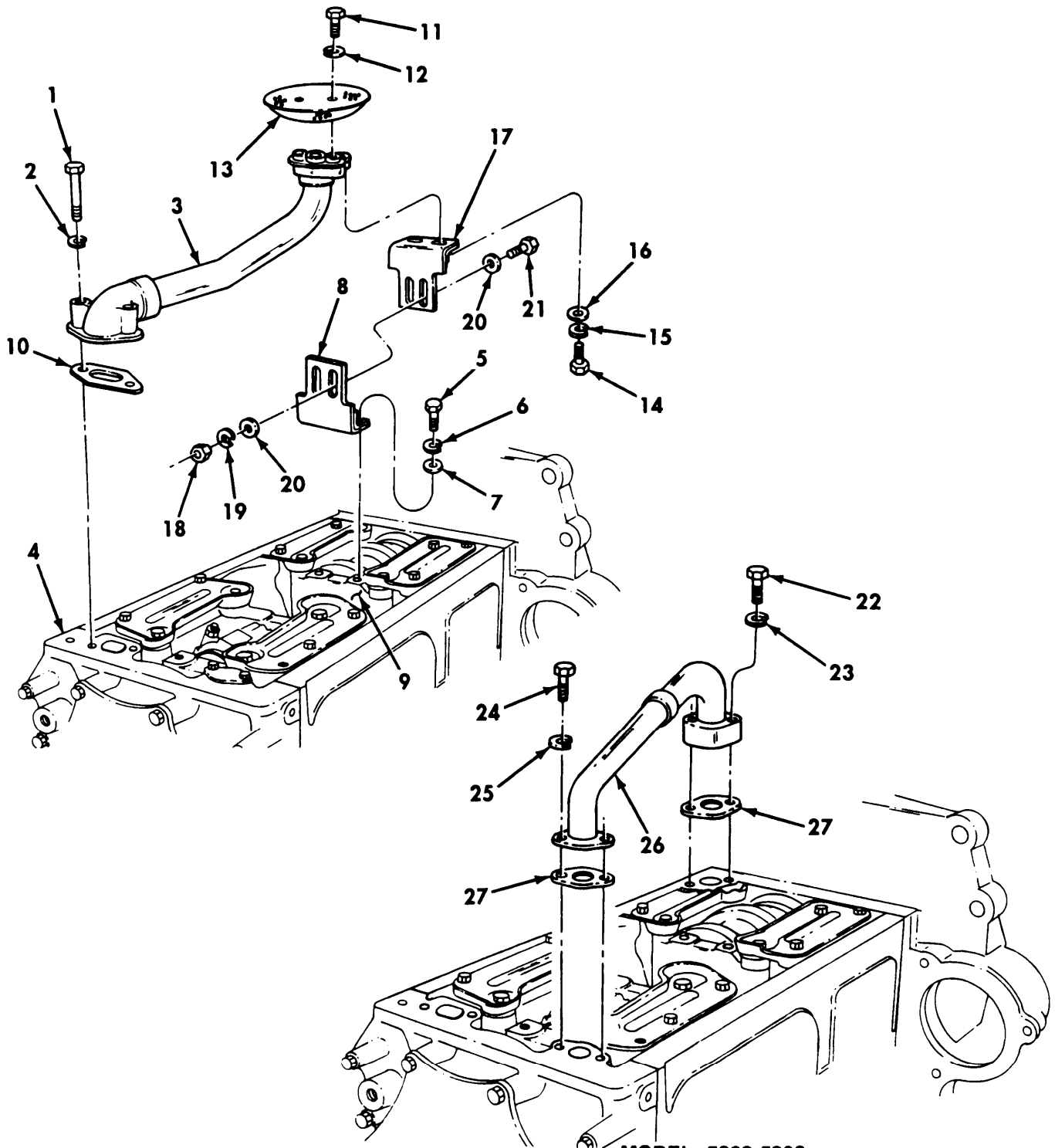
b. Cleaning/Inspection

WARNING

- Ž Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.

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

- (1) Wash components with cleaning solvent and dry with compressed air.
- (2) Inspect tubes, brackets, and strainer for cracks or damage.

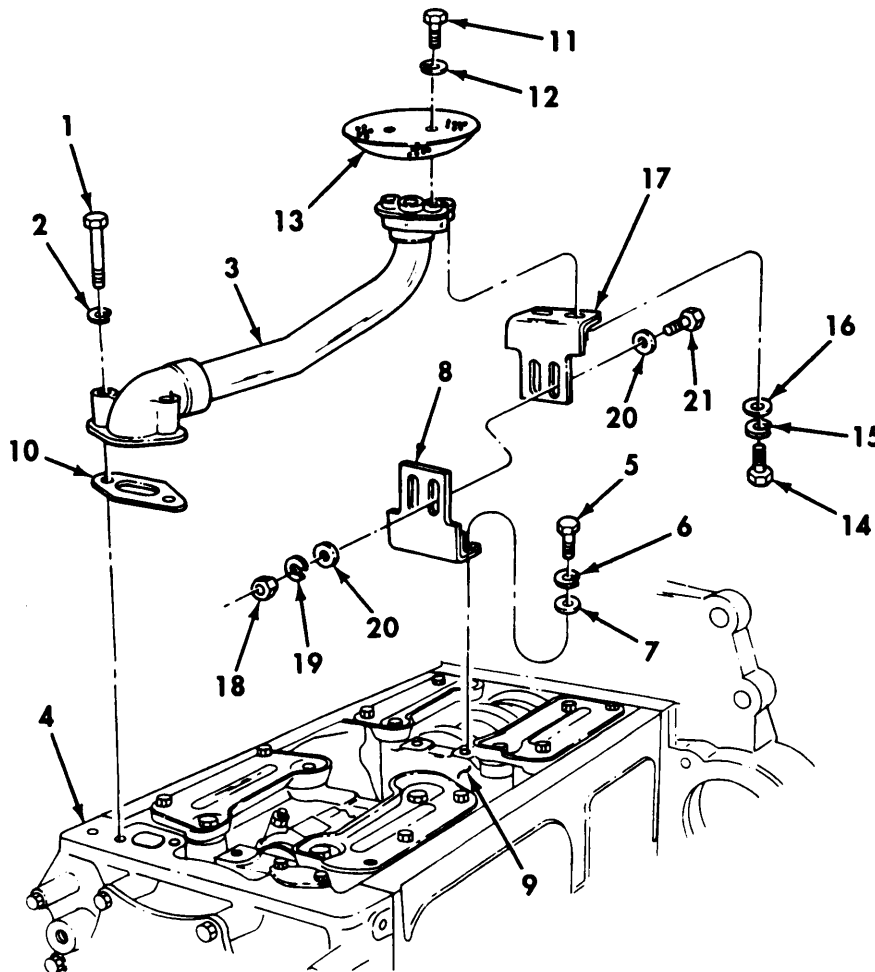


MODEL: 5063-5398

3-35. OIL PUMP INLET TUBE REPLACEMENT (ALL EXCEPT MODEL 5063-5299) (Cont)

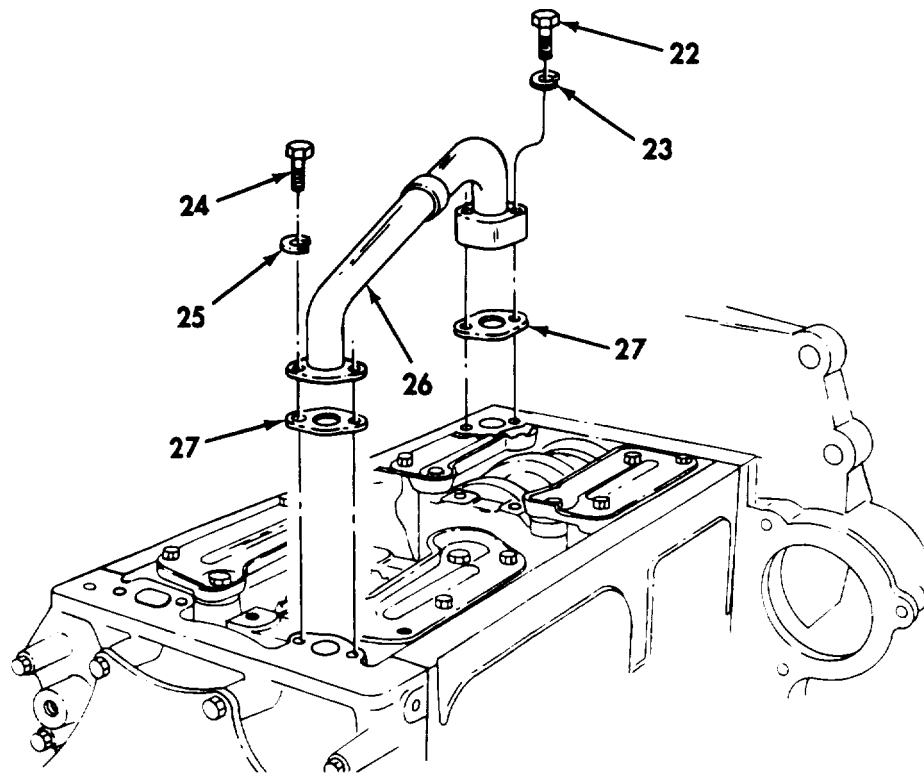
c. Installation

- (1) Install bracket (8), two bolts (21), four flat washers (20), two lockwashers (19), and two nuts (18) on bracket (17). Do not tighten nuts.
- (2) Loosely install bracket (17), flat washer (16), lockwasher (15) and bolt (14) on inlet tube assembly (3).
- (3) Install strainer (13), two lockwashers (12), and two bolts (11) on inlet tube assembly (3). Torque bolts to 13-17 lb-ft (18-23 Nm).



- (4) Install gasket (10), inlet tube assembly (3), two lockwashers (2), and two screws (1) on lower front cover (4). Loosely tighten screws.
- (5) Install two flat washers (7), two lockwashers (6), and two screws (5) in bracket (8) at main bearing cap (9). Torque screws (5) to 30-35 lb-ft (41-47 Nm) and screws (1) to 13-17 lb-ft (18-23 Nm).
- (6) Torque bolts (21) to 15-19 lb-ft (20-26 N-m) and bolt (14) to 13-17 lb-ft (18-23 Nm).

- (7) On model 5063-5398, install two gaskets (27), outlet tube assembly (26), two lockwashers (23), two long bolts (22), two special lockwashers (25), and two short bolts (24) on cylinder block. Torque bolts to 13-17 lb-ft (18-23 N•m)



MODEL: 5063-5398

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-33 Install oil pan.

3-36. Crankshaft SPACER REMOVAL/INSTALLATION (MODELS 5063-5299, 5063-5393 AND 5063-539L)

This task covers: a. Removal

b. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5393 5063-539L

TOOLS AND SPECIAL TOOLS

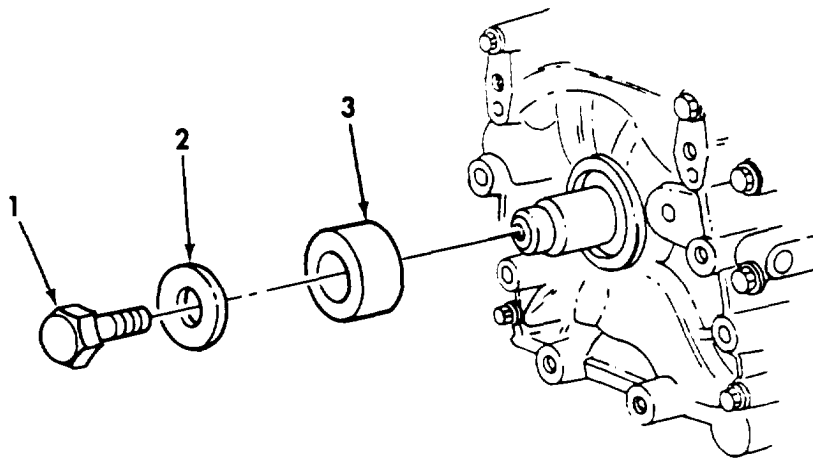
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 117)

a. Removal

NOTE

Secure flywheel or gear train to prevent crankshaft from turning during removal of crankshaft screw.

- (1) Remove screw (1) and spacer ring (2) from crankshaft.
- (2) Slide sleeve (3) off crankshaft.



b. Installation

NOTE

Secure flywheel or gear train to prevent crankshaft from turning during installation of crankshaft screw.

- (1) Install sleeve (3), spacer ring (2), and screw (1) on crankshaft. Torque screw to 290-300 lb-ft (393-407 N•m).

END OF TASK

3-37. CRANKSHAFT PULLEY OR HUB REMOVAL/INSTALLATION (MODELS 5063-5392, 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392 5063-5395 5063-5398 5063-539F

EXPENDABLE/DURABLE SUPPLIES

Oil, engine (App C, Item 26)

TOOLS AND SPECIAL TOOLS

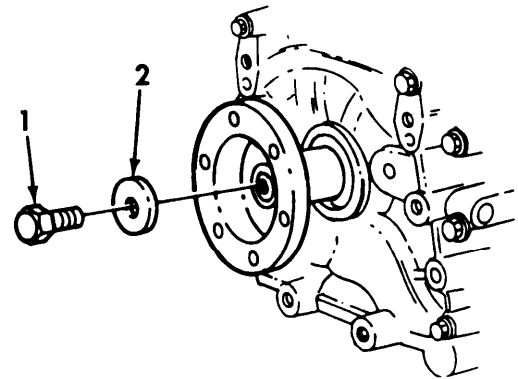
Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 117)
 Puller, mechanical three-leg (App B, Item 81)
 Installer, crankshaft pulley (App B, Item 61)

a. Removal

NOTE

Secure flywheel or gear train to prevent crankshaft from turning during removal of crankshaft screw.

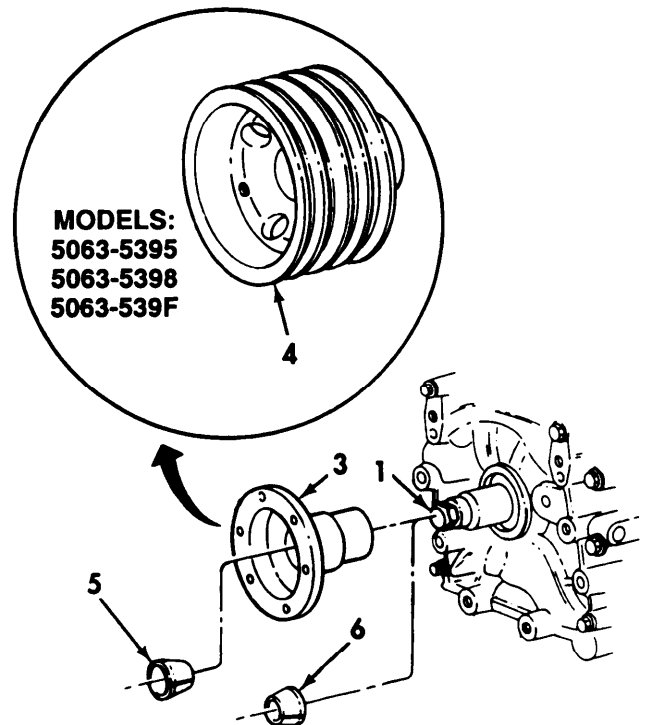
- (1) Remove screw (1) and spacer ring (2) from crankshaft.
- (2) Install screw (1) in crankshaft.



NOTE

Model 5063-5392 uses a hub (3) and models 5063-5395, 5063-5398, and 5063-539F use a pulley (4).

- (3) Using three-leg puller, remove outer cone (5) and hub (3) or pulley (4) from crankshaft.
- (4) Remove inner cone (6) from crankshaft.
- (5) Remove screw (1) from crankshaft.



3-37 CRANKSHAFT PULLEY OR HUB REMOVAL/INSTALLATION (MODELS 5063-5392, 5063-5395, 5063-5398, AND 5063-539F) (Cont)

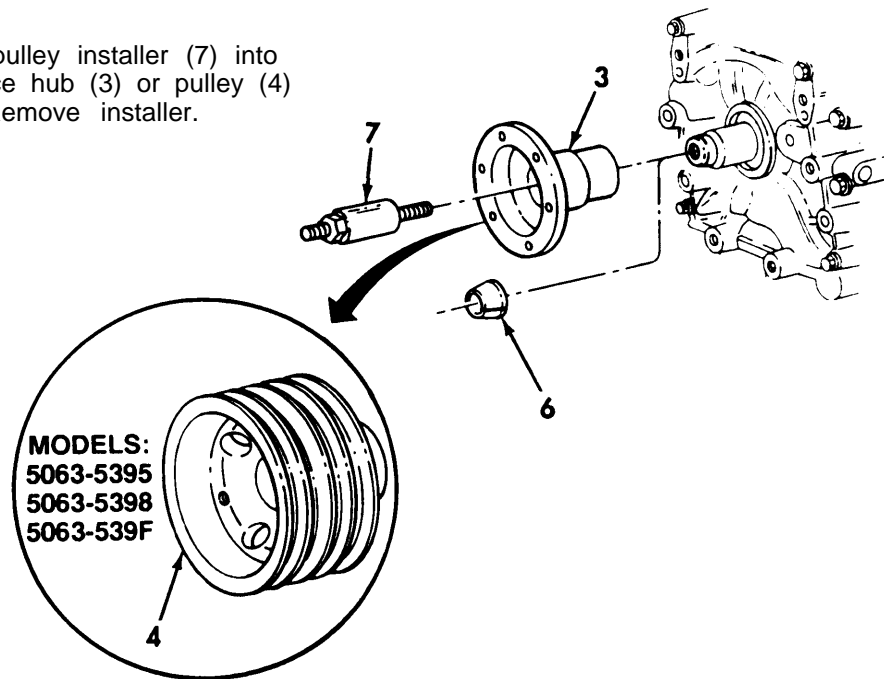
b. Installation

- (1) Lubricate front of crankshaft with engine oil.
- (2) Install inner cone (6) (with taper away from block) on crankshaft.

NOTE

Model 5063-5392 uses a hub (3) and models 5063-5395, 5063-5398, and 5063-539F use a pulley (4).

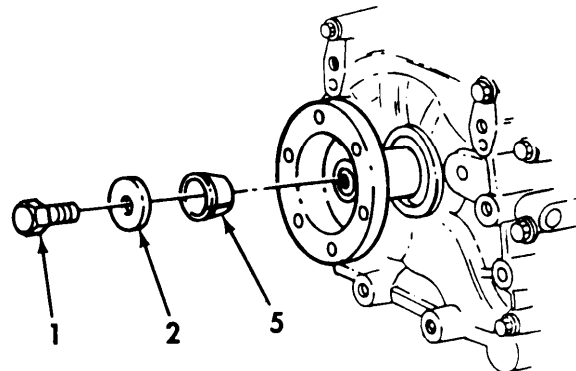
- (3) Start hub (3) or pulley (4) straight on crankshaft.
- (4) Screw crankshaft pulley installer (7) into crankshaft and force hub (3) or pulley (4) onto crankshaft. Remove installer.



NOTE

Secure flywheel or gear train to prevent crankshaft from turning during installation of crankshaft screw.

- (5) Install outer cone (5) (with tapered end toward block), spacer ring (2), and crankshaft screw (1) on crankshaft. Torque screw to 290-300 lb-ft (393-407 N·m).



END OF TASK

3-38. ENGINE FRONT SUPPORT REMOVAL/INSTALLATION (MODEL 5063-5299)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5299

MATERIALS/PARTS

6 Lockwashers (App F, Item 100)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

Wrench, torque (App B, Item 116)

a. Removal

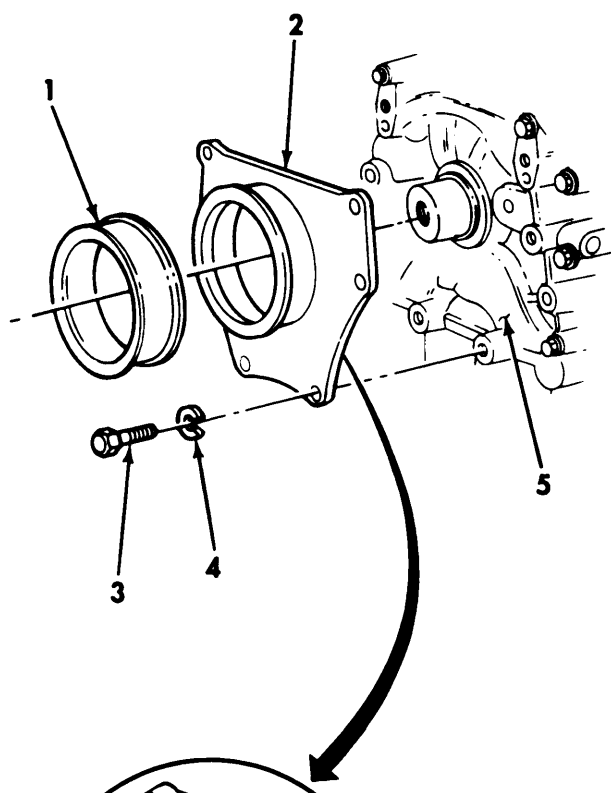
- (1) Slide preformed packing (1) off of support (2).

NOTE

- All engines except those used in the M106A1/M106A2 and M125A1/M125A2 vehicles use six bolts with six lockwashers to retain a six-hole front support to lower cover.

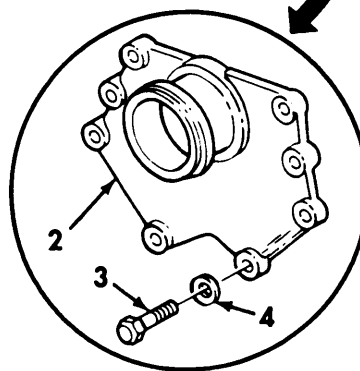
- Engines in the M106A1/M106A2 and M125A1/M125A2 vehicles use eight self-locking bolts with eight flat washers to retain an eight-hole front support to lower cover.

- (2) Remove bolts (3), washers (4), and support (2) from lower front cover (5). Discard lockwashers if used.



b. Installation

- (1) Install support (2), bolts (3), and washers (4) against lower front cover (5). Torque bolts to 46-50 lb-ft (62-68 Nm).
- (2) Slide preformed packing (1) on support (2).



**FRONT SUPPORT
FOR
M106A1/106A2
M125A1/M125A2
VEHICLES ONLY**

END OF TASK

3-39. ENGINE FRONT SUPPORT REMOVAL/INSTALLATION (MODEL 5063-5392)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

5063-5392

MATERIALS/PARTS

8 Lockwashers (App F, Item 100)

TOOLS AND SPECIAL TOOLS

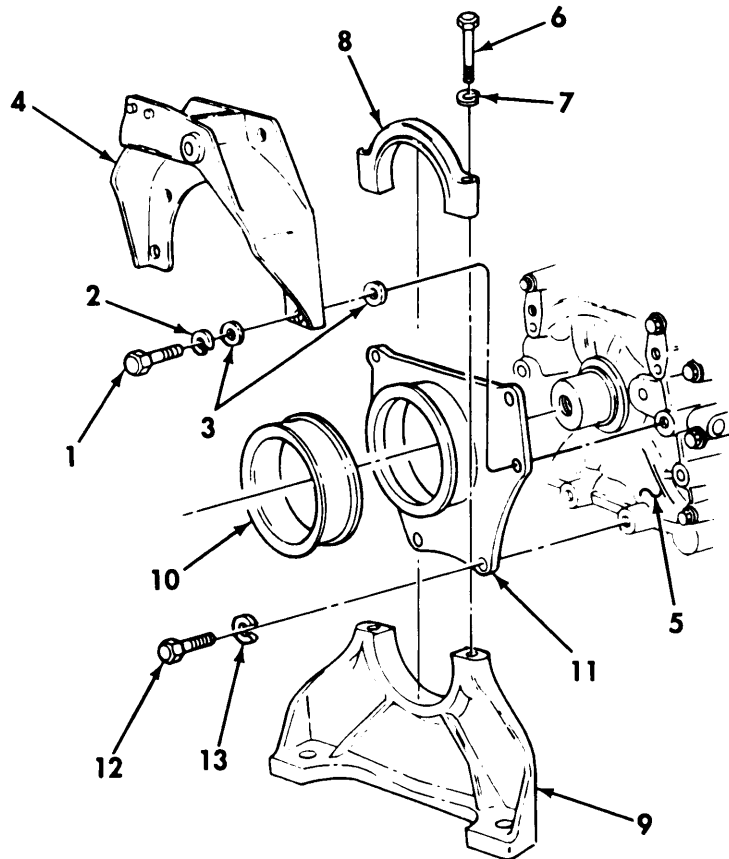
Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

EQUIPMENT CONDITION

Para Description
3-11 Solenoid valve and bracket removed
3-37 Crankshaft hub removed

a. Removal

- (1) Remove four screws (1), four lockwashers (2), eight flat washers (3), and bracket (4) from lower front cover (5). Discard lockwashers.
- (2) Remove two screws (6), two lockwashers (7), and cap (8) from engine support (9). Remove support and discard lockwashers.
- (3) Slide preformed packing (10) off of support (11).
- (4) Remove two screws (12), two lockwashers (13), and front support (11) from front cover (5). Discard lockwashers.



b. Installation**NOTE**

Four screws (1) must be temporarily installed prior to torquing screws (12) to ensure proper alignment of front support (11).

- (1) Install front support (11), four screws (1), two screws (12), and two lockwashers (13) on lower front cover (5) torque screws (12) to 46-50 lb-ft (62-68 N•m). Remove four screws (1).
- (2) Slide preformed packing (10) on support (11).
- (3) Install engine support (9), two screws (6), two lockwashers (7), and cap (8) on preformed packing (10) and front support (11). Torque screws to 46-50 lb-ft (62-68 N•m).
- (4) Install bracket (4), four screws (1), four lockwashers (2), and eight flat washers (3) on front support (11). Torque screws to 46-50 lb-ft (62-68 N•m).

END OF TASK**FOLLOW-ON MAINTENANCE****Para Description**

3-37 Install crankshaft hub.

3-11 Install solenoid valve and bracket.

3-40. FLYWHEEL ASSEMBLY REPLACEMENT

This task covers: a. Removal
d. Installation

b. Cleaning/Inspection
e. Test

c. Repair

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Guide studs (App D, Item 9)
Gage, flywheel housing (App B, Item 38)
Sling, (App B, Item 93 (model 5063-5299))

MATERIALS/PARTS

- 6 Bolts, self-locking (App F, Item 16)
- 8 Bolts (App F, Item 9) (model 5063-5299)

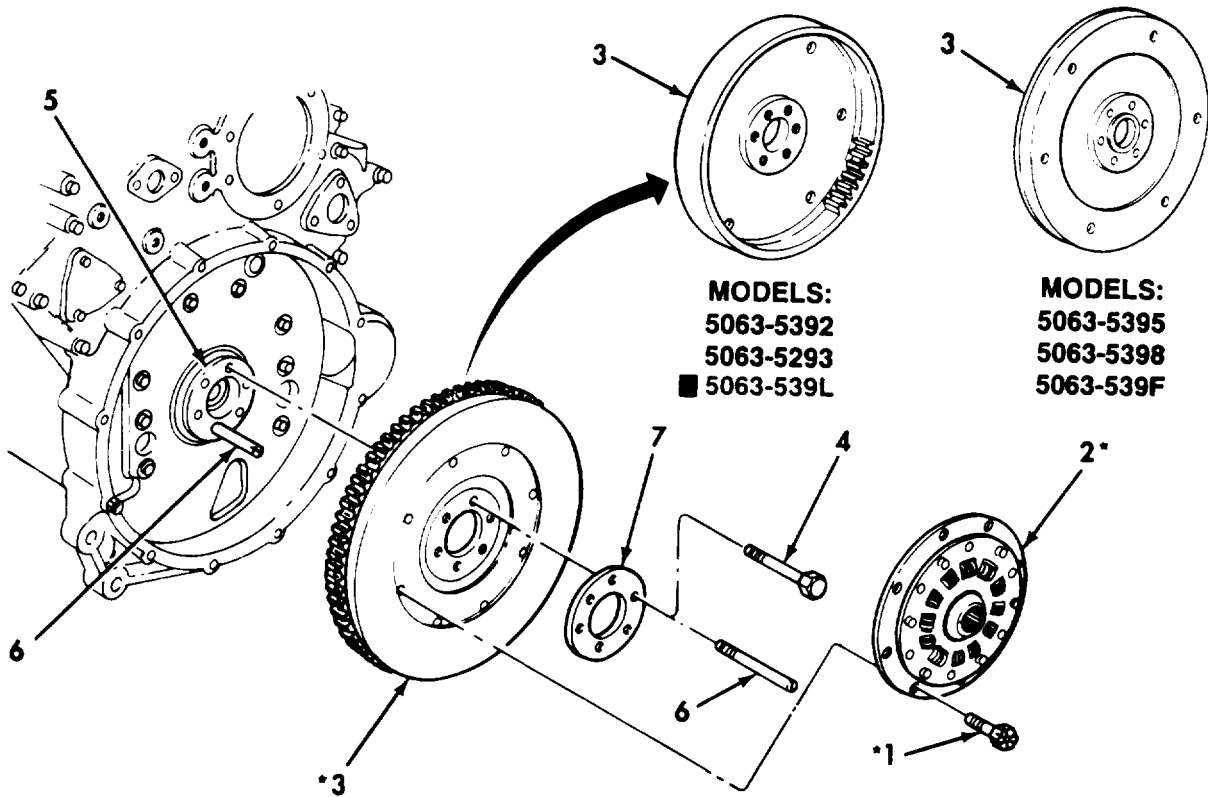
EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
Heat indicating crayon (App C, Item 19)
Wood blocks (App C, Item 58)
International compound No.2 (App C, Item 21)

PERSONNEL REQUIRED: 2

a. Removal

- (1) On model 5063-5299, remove eight bolts (1) and clutch plate assembly (2) from flywheel assembly (3). Discard bolts.
- (2) Remove two self-locking bolts (4) from flywheel assembly (3) and crankshaft (5). Thread two guide studs (6) in locations where bolts were removed. Discard bolts.
- (3) Remove remaining four self-locking bolts (4) and scuff plate (7). Discard bolts.



***MODEL 5063-5299 ONLY**

NOTE

Flywheel on model 5063-5299 is heavy. Use two 3/8-16 eye bolts and sling to lift flywheel.

- (4) Break flywheel assembly (3) loose from crankshaft and slide off guide studs.
- (5) Remove two guide studs (6) from crankshaft (5).

b. Cleaning/Inspection**WARNING**

Ž Dry cleaning solvent P-D-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 (38-50°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.

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

- (1) For model 5063-5299, wash clutch plate assembly with cleaning solvent and dry with compressed air.
- (2) Check clutch plate assembly for broken or worn springs, cracked or worn plates, and worn hub splines.
- (3) Clean flywheel assembly with cleaning solvent.

NOTE

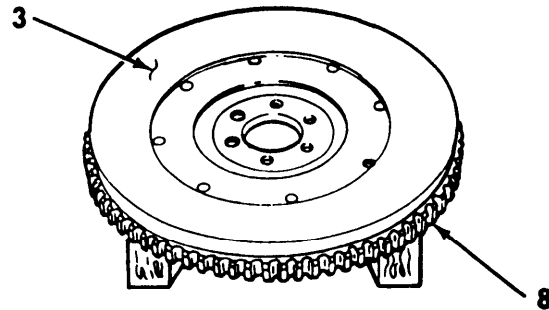
- Although flywheels seldom require replacement, the flywheel ring gear may become worn due to normal usage or damaged by improper use of starting motor. If gear is worn or damaged, a replacement ring gear is required.
 - Ring tooth loss, chips, or wear must not exceed 25 % of teeth in more than three places or two adjacent teeth.
- (4) Check flywheel assembly for cracks, worn teeth, or other damage. Replace ring gear if necessary.
 - (5) Check end of crankshaft and flywheel mating surfaces for fretting or brinelling. If this condition is present, lightly stone surfaces.

3-40. FLYWHEEL ASSEMBLY REPLACEMENT (Cont)

c. Repair

(1) Recovering ear(8) from flywheel assembly as follows:

- (a) Place flywheel assembly (3), crankshaft side down, on a solid flat surface or hardwood blocks which fit inside diameter of ring gear (8).
- (b) Drive gear (8) off flywheel assembly (3) using a brass drift and hammer. Work around circumference of ring gear to avoid binding.



(2) Install ring gear (8) on flywheel (9) as follows:

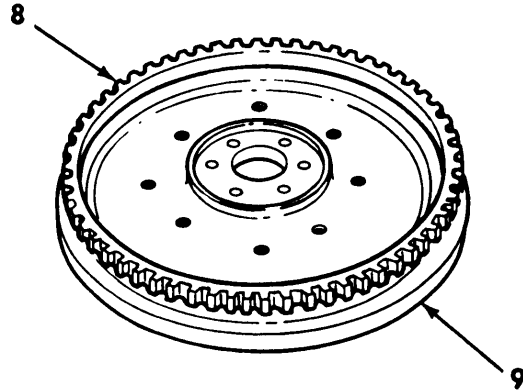
- (a) Place flywheel (9), crankshaft side up, on a solid flat surface.

WARNING

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

CAUTION

If a torch is used to heat ring gear, keep torch moving around circumference of ear 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 crayon to work surface, which melts at a predetermined temperature, to determine heat range.



- (b) Place ring gear (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 (9).

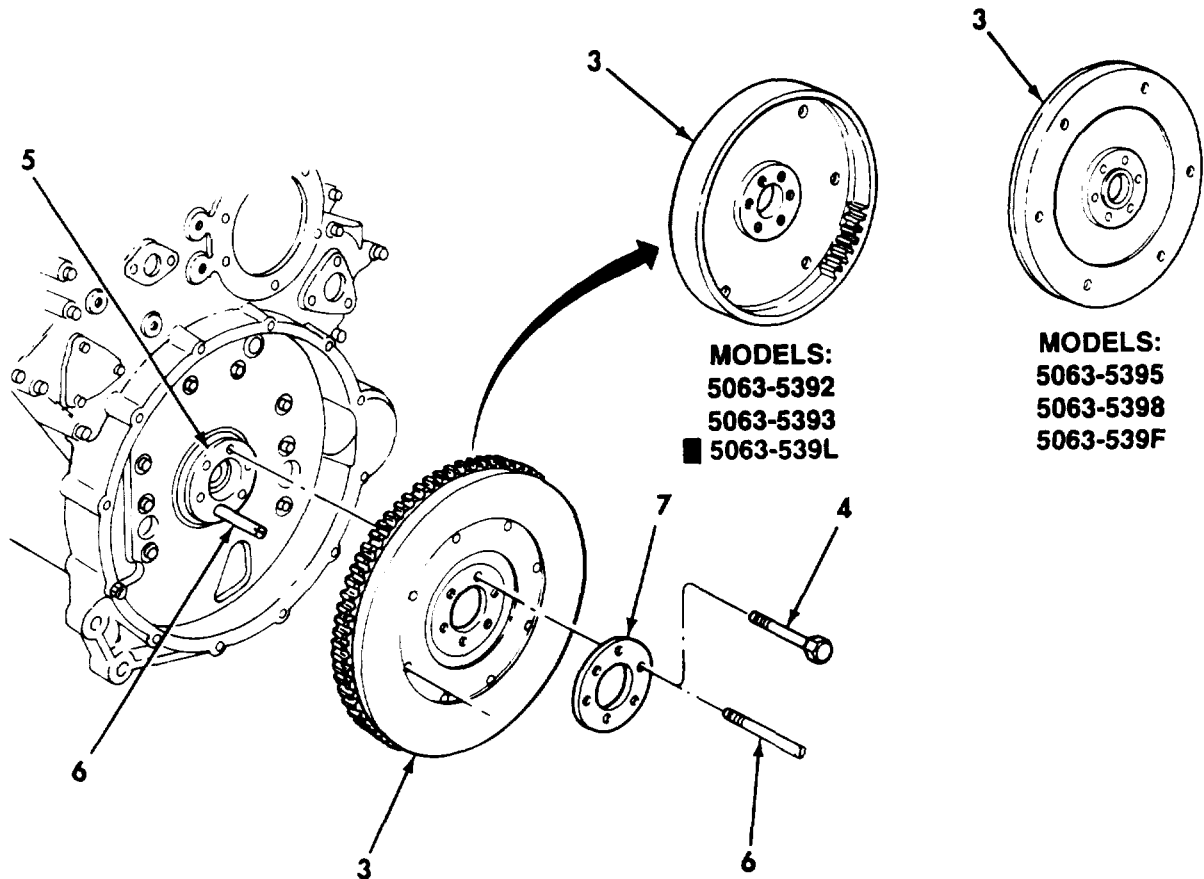
NOTE

If ring gear cannot be tapped into place readily, repeat steps (1) and (2) above.

- (d) Tap ring gear (8) into place against shoulder of flywheel (9) using a brass drift and hammer. Work around circumference of flywheel to avoid binding.

d. Installation

- (1) Apply International Compound No.2 or equivalent to threads and to bolt head contact area (underside) of all flywheel-fastening bolts (4). Fill threads completely with compound and remove excess.
- (2) Thread two guide studs (6) into crankshaft flywheel assembly (3) bolt holes.

**NOTE**

Flywheel on model 5063-5299 is heavy, Use two 3/8-16 eye bolts and sling to lift flywheel.

- (3) Guide flywheel assembly (3) over guide studs (6) and into bell of flywheel housing.
- (4) Install scuff plate (7) and four self-locking bolts (4). Snug bolts to hold plate and flywheel assembly in place against crankshaft.
- (5) Remove guide studs (6) and install two remaining bolts (4). Snug bolts.
- (6) Torque bolts (4) to 48-52 lb-ft (64-72 N•m).

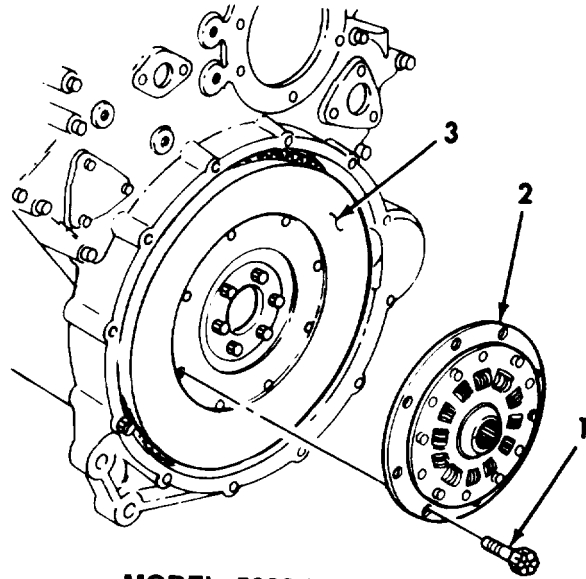
3-40. FLYWHEEL ASSEMBLY REPLACEMENT (Cmt)

- (7) Turn bolts an additional 90-120 degrees to obtain required clamping force.

NOTE

On model 5063-5299, measure flywheel face runout before installing clutch plate assembly.

- (8) On model 5063-5299, install clutch plate assembly (2) and eight bolts (1) to flywheel assembly (3). Torque bolts to 30-35 lb-ft (41-47 N·m).

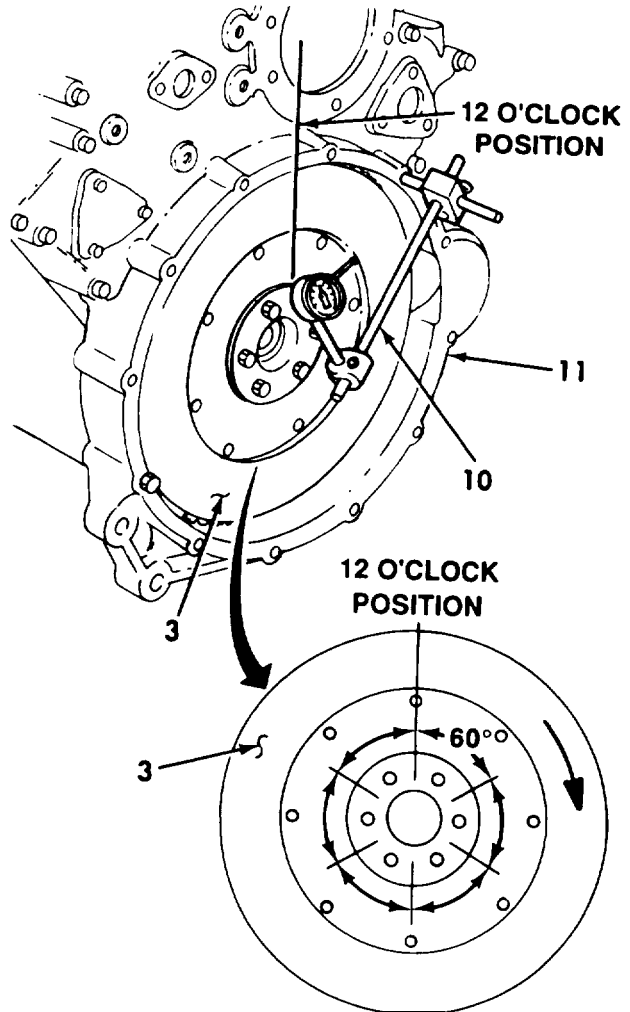


MODEL: 5063-5299 ONLY

e. Testing

- (1) Measure flywheel face runout as follows:

- (a) Mount flywheel housing gage (10) on flywheel housing (11) with dial indicator needle against clutch contact face of flywheel.
- (b) Pry flywheel assembly (3) toward engine block (at six o'clock position) to ensure endplay is in one direction.
- (c) Adjust dial indicator on gage (10) to read zero at twelve o'clock position.



CAUTION

When using hexagon head bolt at front of cranks aft to rotate crankshaft, always turn bolt clockwise. Serious engine damage may result if bolts becomes loose.

- (d) Rotate crankshaft and record readings at 60 degree intervals (six readings). Pry flywheel assembly (3) toward engine block before taking each reading.

NOTE

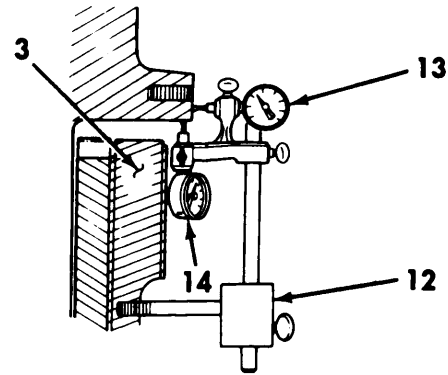
Ž Runout is the maximum negative reading plus the maximum positive reading. For example, if maximum readings were 0.004 and -0.007 inch, then runout is 0.01 inch.

Ž Maximum allowable runout is 0.001 inch per inch of radius. Measure radius from center of flywheel assembly (3) to dial indicator needle (clutch contact face). For example, if the radius is 12 inches, then the runout should be less than 0.012 inch.

- (e) If flywheel face runout exceeds its maximum limit, remove flywheel assembly (3) and check for dirt or foreign material between crankshaft and flywheel. Mount flywheel assembly. If readings are still out of limits, replace flywheel assembly.

(2) Measure flywheel housing bore concentricity and face runout as follows:

- (a) Mount dial indicator base (12) to flywheel assembly (3).
- (b) Install one dial indicator (13) perpendicular to flywheel housing bell face and a second dial indicator (14) against flywheel housing bell bore.
- (c) Pry flywheel assembly (3) toward engine block (at six o'clock position) to ensure endplay is in one direction.
- (d) Adjust dial indicators to read zero at twelve 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 and -0.007 inch, then runout is 0.011 inch.
 - Maximum total indicator reading must not exceed 0.013 inch 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 (3) 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 (see Para 3-44).

END OF TASK

3-41. REAR CRANKSHAFT OIL SEAL REPLACEMENT

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Indicator, dial, magnetic base (App B, Item 54)
 Installer, oil seal (with guide studs) (App B, Item 59)

Handle, oil seal installer (App B, Item 50)

MATERIALS/PARTS

- 1 Seal, plain encased (App F, Item 174)

EXPENDABLE/DURABLE SUPPLIES

- 2 Screws, sheet metal (App C, Item 40)
- 2 Washers, flat (App C, Item 56)
- Cleaning solvent (App C, Item 9)
- Crocus cloth (App C, Item 10)
- Oil, fuel (App C, Item 27)

EQUIPMENT CONDITION

Para Description
 3-40 Flywheel removed

PERSONNEL REQUIRED: 2

a. Removal

- (1) Center punch two holes in casing of oil seal (1) on opposite sides.
- (2) Install two sheet metal screws (2) and two flat washers (3).

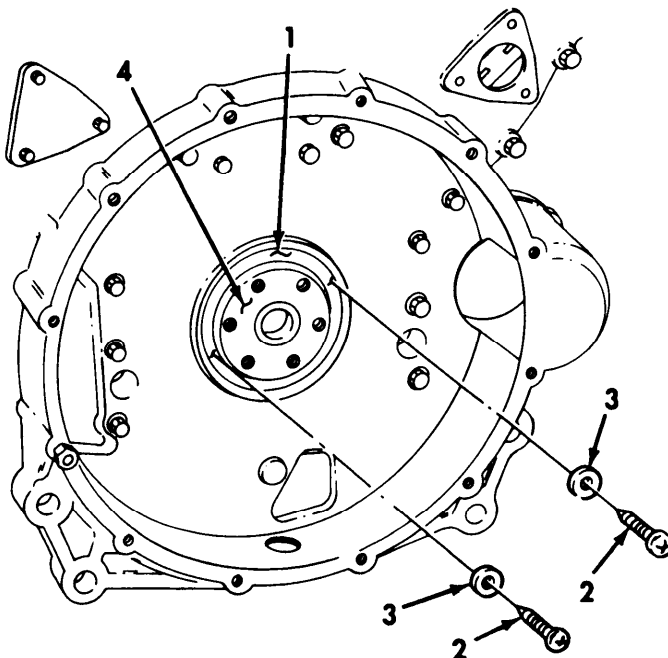
CAUTION

Do not pry against crankshaft or gouging will result.

- (3) Pry against flat washers (3) with pry bars to remove seal. Discard seal.

b. Cleaning/Inspection

- (1) Clean flywheel housing seal bore.



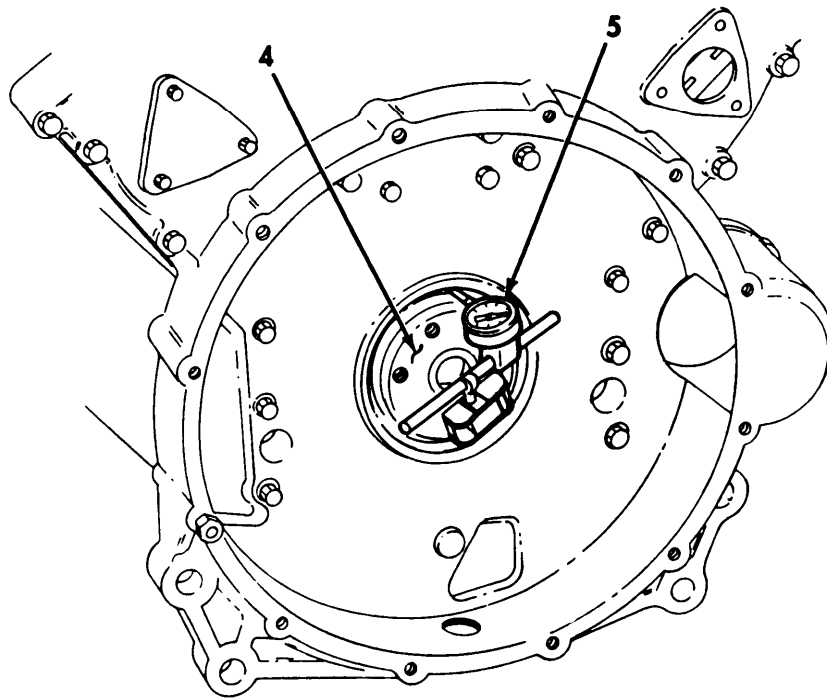
CAUTION

Do not polish parallel to crankshaft axis or ridges will result in sealing surface and cause oil leakage.

- (2) Inspect rear end of crankshaft (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.

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (3) Clean rear of crankshaft and flywheel housing seal bore with cleaning solvent and dry with compressed air.

**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.

- (4) Check runout of seal bore as follows:
- (a) Mount a magnetic base dial indicator (5) on rear of crankshaft (4).
 - (b) With an assistant rotating front of crankshaft clockwise, note runout reading. Maximum allowable runout of bore is 0.008 inch.

3-41. REAR CRANKSHAFT OIL SEAL REPLACEMENT (Cont)

c. 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

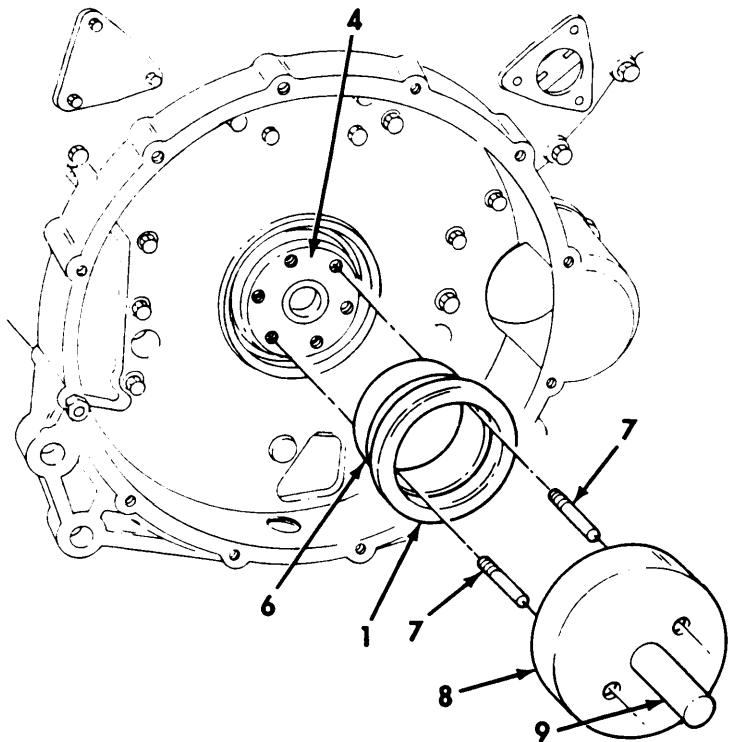
- Ž Teflon-lip oil seal is packaged with plastic sleeve to protect seal lip during shipment and function as an installation tool.
- Ž If oil seal is off plastic installation sleeve, push larger end of sleeve through seal in same direction seal lip is pointing.

- (1) Place installation sleeve (6) and seal (1) together on crankshaft (4).
- (2) Slide seal (1) off installation sleeve (6) and onto crankshaft. Remove sleeve.
- (3) Install two guide studs (7) 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 oil seal installer (8) with driver handle (9), drive seal until installer contacts face of flywheel housing.
- (5) Remove seal installer (8), two guide studs (7), and driver handle (9).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-40 Install flywheel.

3-42. INJECTOR CONTROL TUBE AND THROTTLE DELAY REPLACEMENT

This task covers: a. Removal
 d. Assembly b. Disassembly c. Cleaning/Inspection
 e. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 118)

MATERIALS/PARTS

- 2 Lockwashers (App F, Item 97)
- 4 Nuts, self-locking (App F, Item 111)
- 1 Nut, self-locking (App F, Item 105)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)

EQUIPMENT CONDITION

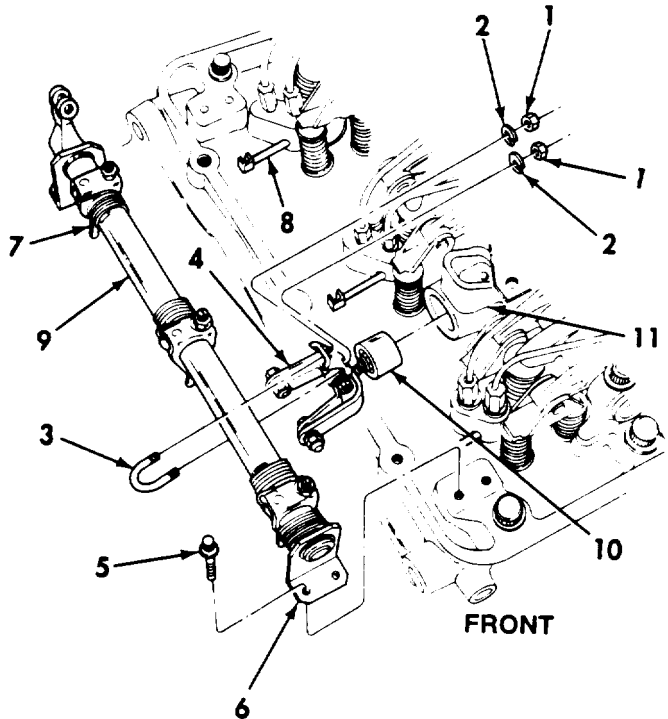
Para	Description
3-20	Rocker arm covers removed (models 5063-5299 and 5063-5398)
3-21	Rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F and 5063-539L)
3-22	Rocker arm covers removed (model 5063-5395)
3-31	Throttle control rods disconnected

a. Removal

NOTE

- Steps (1) and (4) apply to throttle delay assembly used on right bank of all except model 5063-5299.
- Place wiping rag over oil drain holes to prevent loss of parts.

- (1) Remove two nuts (1), two lockwashers (2), and U-bolt (3) from throttle delay lever assembly (4). Discard lockwashers.
- (2) Remove four screws (5) fastening injector control tube brackets (6) to cylinder head.
- (3) Disengage control rack levers (7) from injector control racks (8) and lift tube assembly (9) from cylinder head.
- (4) Remove piston and link assembly (10) from throttle delay bracket (11).



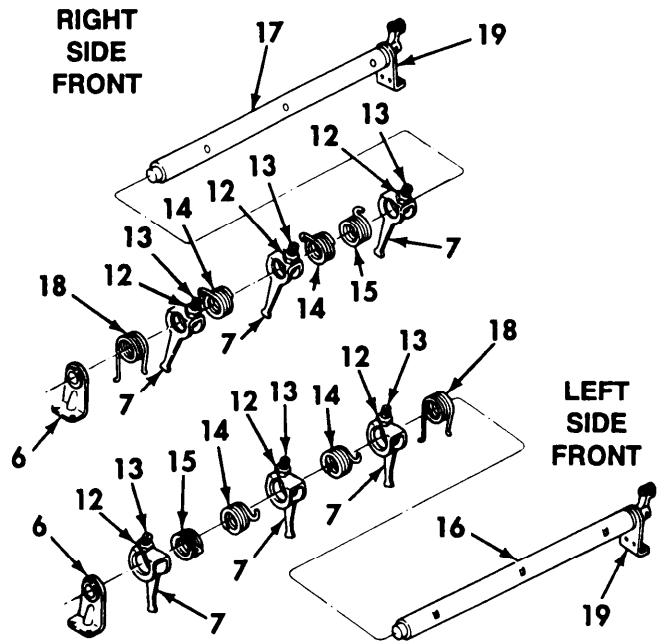
b. Disassembly

NOTE

Note shape and location of the yield and return springs during disassembly.

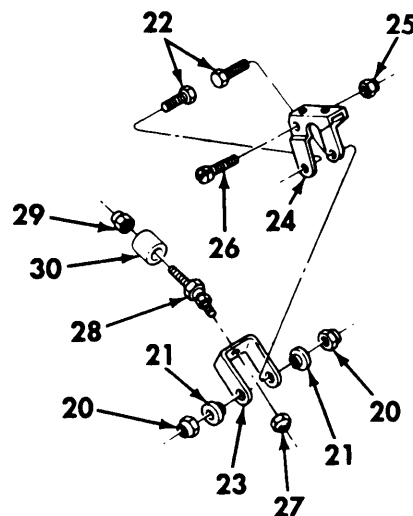
- (1) Injector control tube assembly (left or right)
 - (a) For left control tube assembly, remove bracket (6) from front of tube.

- (b) Loosen locknut (12) and adjusting screw (13) from control lever (7).
- (c) Disconnect yields ring (14 or 15) from each control lever (7). Roll yield springs out of slots and notches of control tube (16 or 17).
- (d) Disconnect return spring (18) from bracket (19) and control lever (7) at rear of left control tube (16) or from bracket (6) and control lever at front of right control tube (17).
- (e) For right control tube assembly, remove bracket (6) from front of tube.
- (f) Slide three control levers (7), two yield springs (14), yield spring (15), and return spring (18) off front of control tube (16 and 17).



(2) Throttle delay assembly

- (a) Remove two self-locking nuts (20), two bushings (21), two screws (22), and link (23) from bracket (24). Discard nuts.
- (b) If necessary, remove self-locking nut (25) and machine screw (26) from bracket (24). Discard nut.
- (c) Remove self-locking nut (27) and link (23) from joint (28). Discard nut.
- (d) Remove self-locking nut (29) and joint (28) from piston (30). Discard nut.



c. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Ž Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Wash components with cleaning solvent and dry with compressed air.

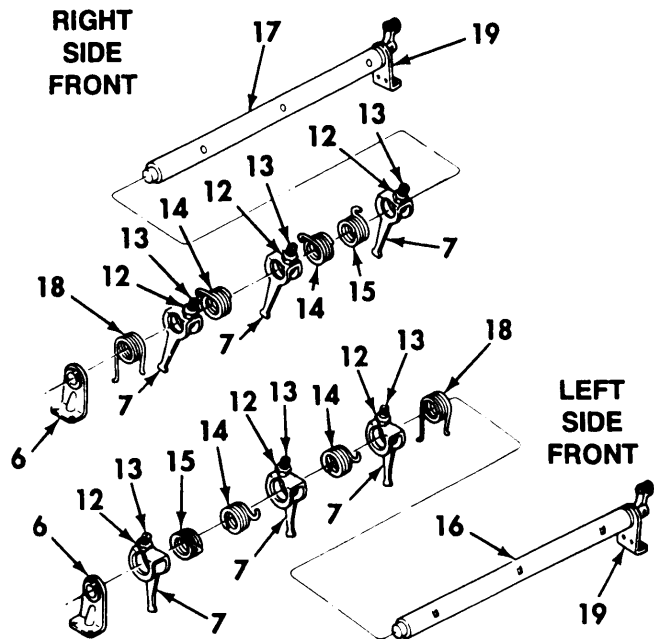
3-42. INJECTOR CONTROL TUBE AND THROTTLE DELAY REPLACEMENT (Cont)

- (2) Inspect components for excessive wear, cracks, or damage. Replace if necessary.
- (3) Inspect yield springs and return springs for wear and fractures.

d. Assembly

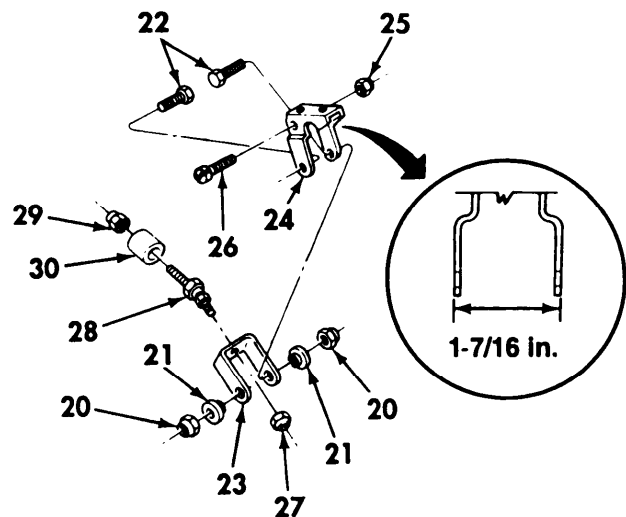
(1) Left injector control tube assembly

- (a) Install return spring (18) on control tube (16) and against rear bracket (19).
- (b) Install two of right-hand helix springs (14) and two control levers (7) on control tube (16) with control levers facing rear of control tube.
- (c) Install left-hand helix yield spring (15) and control lever (7) on control tube (16) with control lever facing rear of control tube.
- (d) Connect curled end of two yield springs (14) and yield spring (15) to three rack control levers (7) and roll yield springs into notch or slots in control tube (16). Turn three adjusting screws (13) with locknuts (12) far enough into slots to position levers on control tube.
- (e) Connect curled end of control tube return spring (18) to rack control lever (7) and extended end of spring behind rear bracket (19).
- (f) Install bracket (6) to front of control tube (16).



(2) Right injector control tube assembly

- (a) Install control lever (7) and left-hand helix yield spring (15) on control tube (17) with control lever facing front of control tube.
- (b) Install two of right-hand helix yield springs (14) and control levers (7) on control tube (17) with control lever facing front of control tube.
- (c) Connect curled end of two yield springs (14) and yield spring (15) to three rack control levers (7) and roll yield springs into notch or slots in control tube (17). Turn three adjusting screws (13) with locknuts (12) far enough into slots to position levers on control tube.



- (d) Install return spring (18) and bracket (6) at front of control tube (17). Connect curled end of return spring to rack control lever and extended end of spring behind bracket.

(3) Throttle delay assembly

- (a) Install joint (28) and self-locking nut (29) on piston (30). Tighten nut.
- (b) Install link (23) and self-locking nut (27) on joint (28). Tighten nut.
- (c) If removed, install screw (26) and self-locking nut (25) on bracket (24). Tighten nut until width between legs is 1 7/16 inches.
- (d) Install link (23), two screws (22), two bushings (21), and two self-locking nuts (20) on bracket (24). Tighten nuts.

e. Installation

NOTE

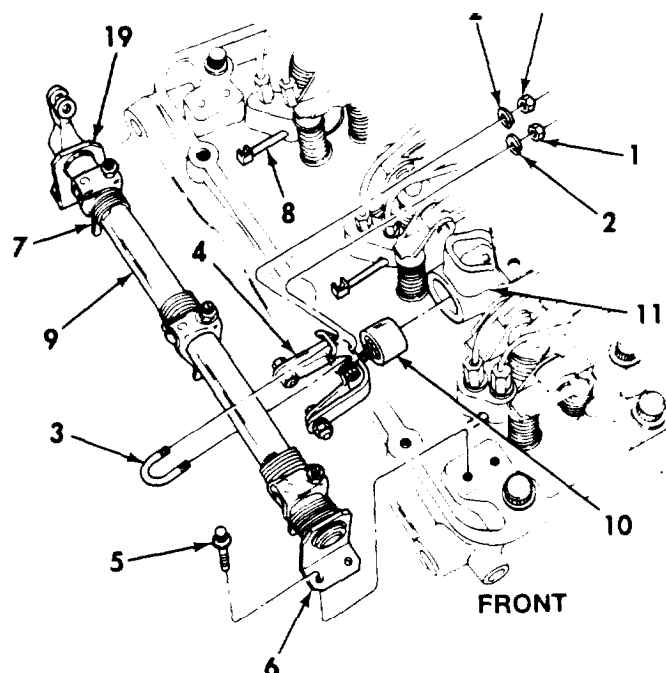
- Steps (1) and (4) apply to throttle delay assembly used on right bank of all except model 5063-5299.
- Legs on lever assembly (4) must face downward and be inboard of control tube.

- (1) Slide throttle delay piston and linkage assembly (10) in bore of housing (11).
- (2) Place injector control tube assembly (9) on cylinder head. Engage control levers (7) with injector control racks (8) and place end brackets (6 and 19) over mounting holes in cylinder head. Install four screws (5) through end brackets into cylinder head. Torque screws to 120-144 lb-in (14-16 N•m).
- (3) Check control tube to ensure it moves freely in end brackets (6 and 19). If necessary, tap control tube lightly to align bearing in brackets.

NOTE

Final torque of nuts (1) is done during throttle delay adjustment of tune-up (para 4-4).

- (4) Install U-bolt (3) around bottom of control tube and through lever assembly (4). Install two lockwashers (2) and two nuts (1) on U-bolt. Tighten nuts snug.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-31 Connect throttle control rods.

3-20 Install rocker arm covers (models 5063-5299 and 5063-5398)

3-21 Install rocker arm covers (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L)

3-22 Install rocker arm covers model 5063-5395).

3-43. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Fixture, cylinder head lifting (App B, Item 27)
 Studs, cylinder head guide (App B, Item 97)

MATERIALS/PARTS

- 6 Gaskets, compression (App F, Item 89)
- 2 Seal strips (App F, item 161)
- 4 Seals (App F, Item 154)
- 8 Seals (App F, Item 155) *
- 8 Seals (App F, Item 156) *
- 8 Seals (App F, Item 158) **
- 8 Seals (App F, Item 157) **
- 8 Sleeves (App F, Item 178)**
- 8 Sleeves (App F, Item 179)**
- 1 Lockwasher (App F, Item 99)

All except model 5063-5398
 Model 5063-5398

EXPENDABLE/DURABLE SUPPLIES

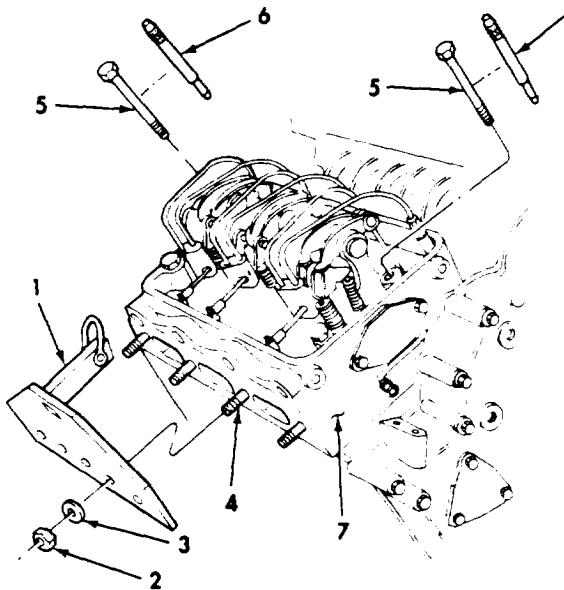
International Compound No. 2 (App C, Item 21)
 Wood blocks (App C, Item 58)
 Adhesive, gasket (App C, Item 1

EQUIPMENT CONDITION

- | Para | Description |
|------|---|
| 3-7 | Exhaust manifolds removed |
| 3-14 | Water outlet elbow and thermostat housing removed (all except models 5063-5393 and 5063-539L) |
| 3-15 | Water outlet elbow and thermostat housing removed (models 5063-5393 and 5063-539L) |
| 3-16 | Fuel lines removed (model 5063-5299) |
| 3-17 | Fuel lines removed (model 5063-5392) |
| 3-18 | Fuel lines removed (models 5063-5393 and 5063-539L) |
| 3-19 | Fuel lines removed (models 5063-5395, 5063-5398, and 5063-539F) |
| 3-20 | Engine rocker arm covers removed (models 5063-5299 and 5063-5398) |
| 3-21 | Engine rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L) |
| 3-22 | Engine rocker arm covers removed (model 5063-5395) |
| 3-31 | Throttle control rods removed |
| 3-32 | Fuel rod hoses removed |
| 3-42 | Injector control tubes removed |

a. Removal

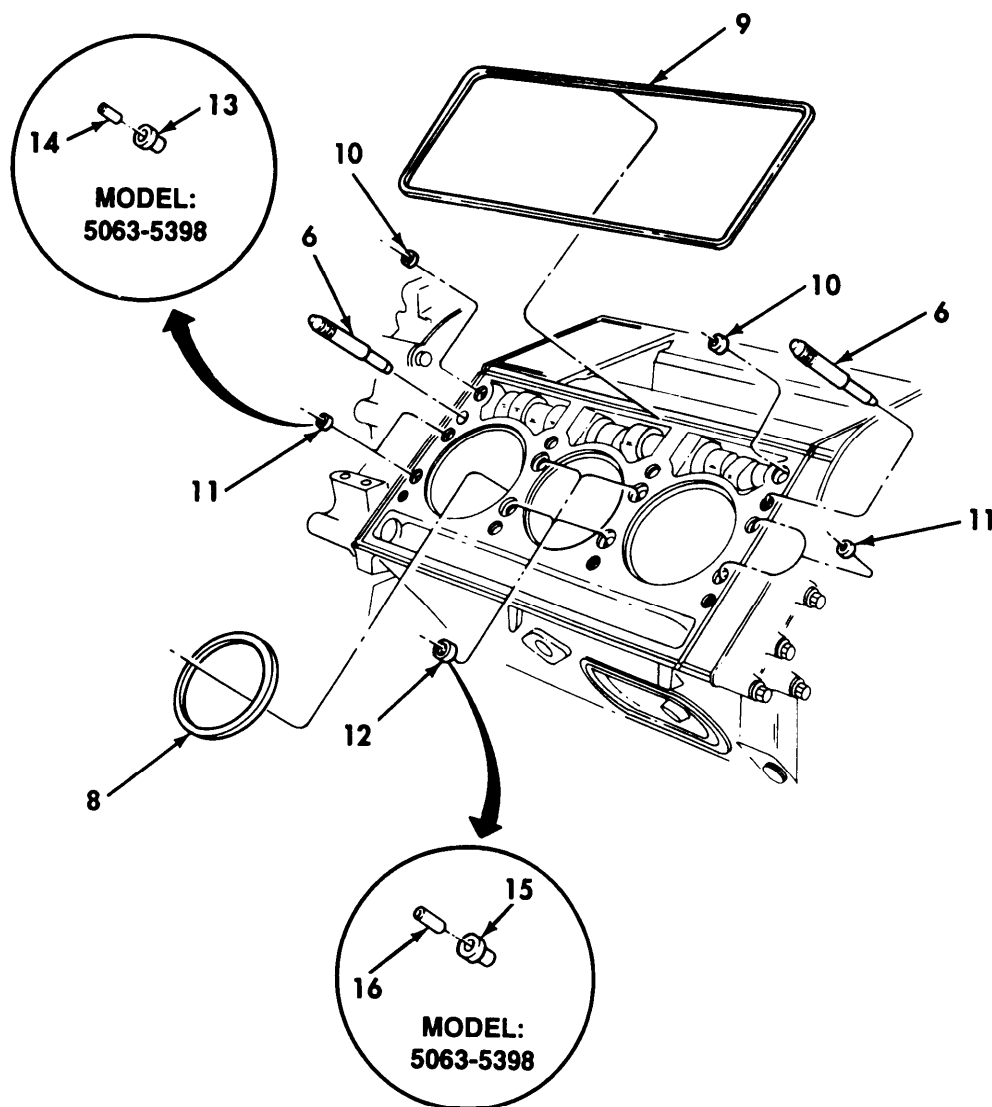
- (1) Install cylinder head lifting fixture (1), two 7/16 nuts (2), and two 7/16 flat washers (3) on exhaust manifold studs (4) located at outboard side of cylinder head.
- (2) Attach a suitable lifting device to lifting fixture (1) and apply a light tension.
- (3) Remove two cylinder head bolts (5) from inboard corners of cylinder head and install two guide studs (6). Remove remaining six cylinder head bolts.



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.

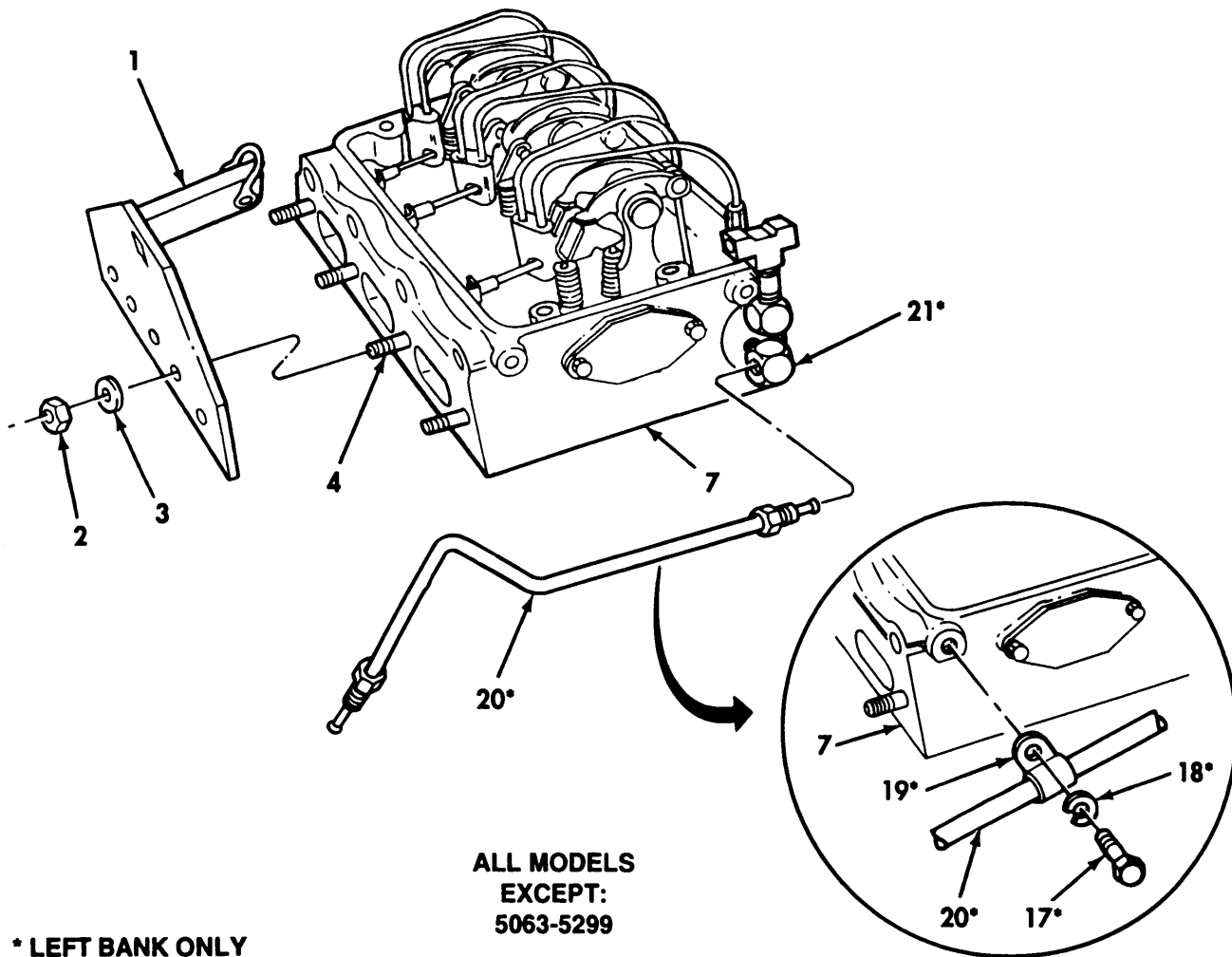
- (4) Lift cylinder head assembly (7) from cylinder block.
- (5) Remove two guide studs (6) from cylinder block.



- (6) For all except model 5063-5398, remove three compression gaskets (8), seal strip (9), two seals (10), four seals (11), and four seals (12) from cylinder bank. Discard gaskets, seals, and seal strip.
- (7) For model 5063-5398, remove three compression gaskets (8), seal strip (9), two seals (10), four seals (13), four sleeves (14), four seals (15), and four sleeves (16) from cylinder bank. Discard gaskets, seals, sleeves, and seal strip.

3-43. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION (Cont)

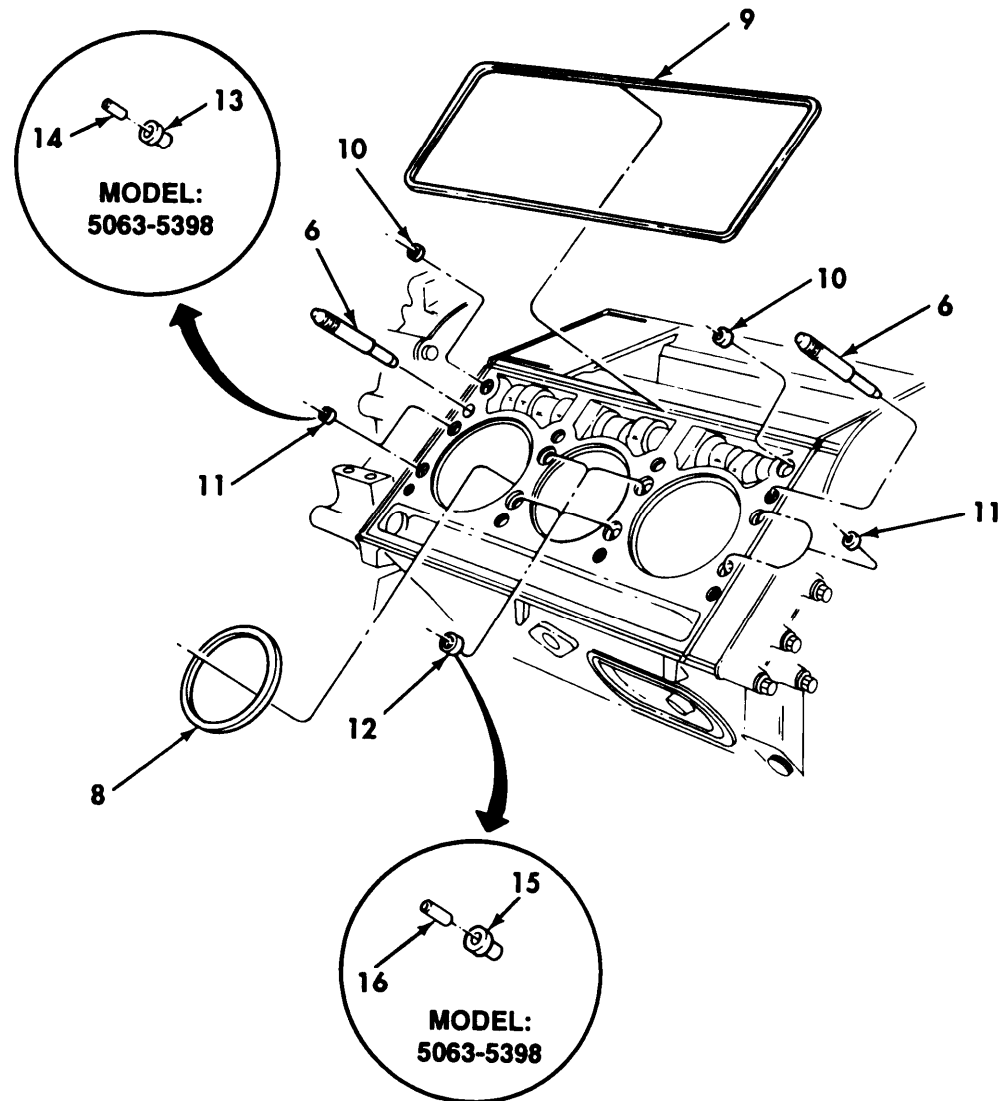
- (8) Remove lifting fixture (1), two nuts (2), and two flat washers (3) from cylinder head assembly.
- (9) Repeat steps (1) thru (8) for opposite bank.
- (10) On all except model 5063-5299: for left bank, remove bolt (17), lockwasher (18), and clip (19) from rear of cylinder head assembly. If necessary, remove clip from fuel spill tube (20). Discard lockwasher.
- (11) For left bank, remove fuel spill tube (20) from elbow (21) at rear of cylinder head assembly.



b. Installation

- (1) Connect fuel spill tube (20) to elbow (21). Tighten tube connection.
- (2) On all except model 5063-5299 for left bank: if removed, install clip (19) on fuel spill tube (20) and install bolt (17), lockwasher (18), and clip on rear of cylinder head assembly. Torque bolt to 23-26 lb-ft (31-35 Nm).
- (3) Install lifting fixture (1), two flat washers (3), and two nuts (2) on exhaust manifold studs (4) on outboard side of cylinder head.

- (4) For all except model 5063-5398, install three compression gaskets (8), seal strip (9), two seals (10), four seals (11), and four seals (12) on cylinder bank.



- (5) For model 5063-5398, install three compression gaskets (8), seal strip (9), two seals (10), four seals (13), four sleeves (14), four seals (15), and four sleeves (16) on cylinder bank.

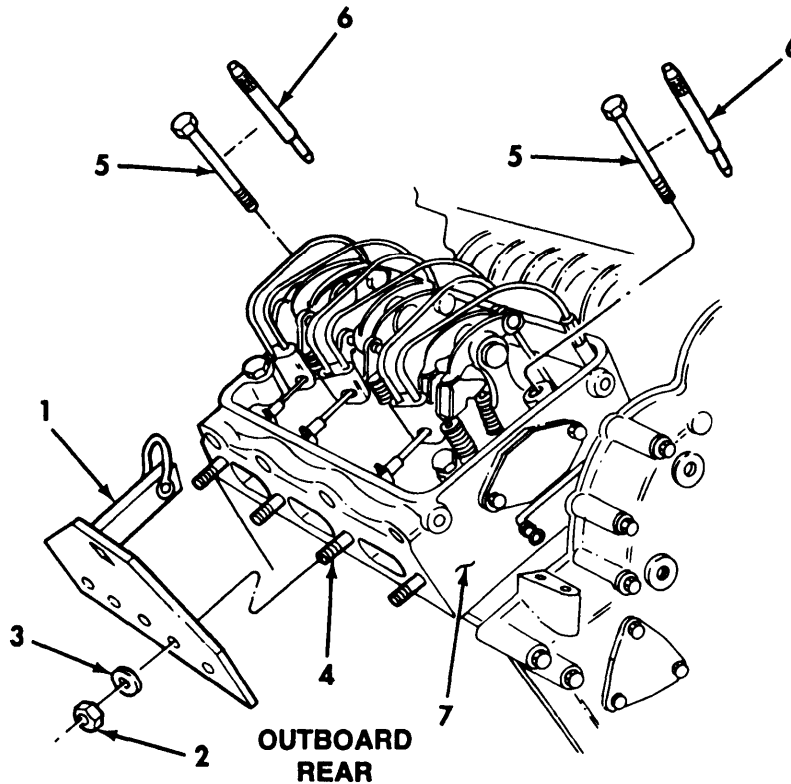
- (6) Install two guide studs (6) in cylinder head bolt holes at inboard corner positions in cylinder block.

3-43. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION (Cont)

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.

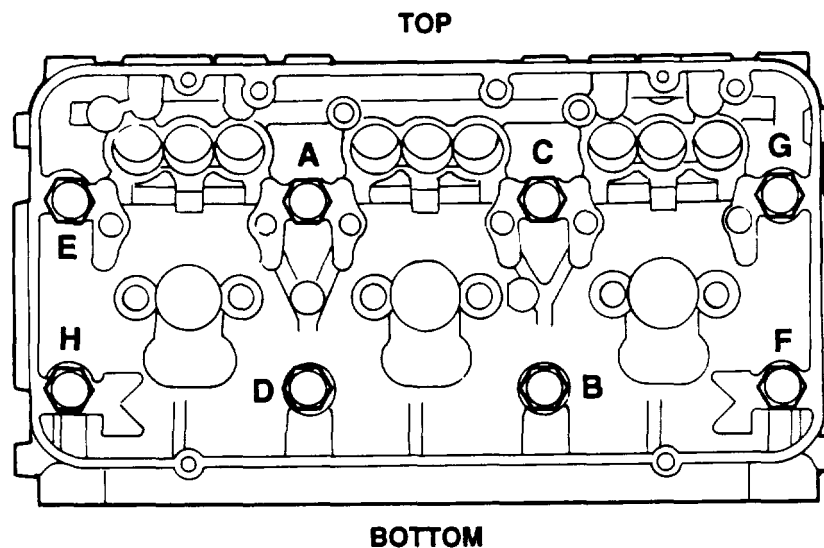
- (7) Lift cylinder head above cylinder block and lower over guide studs (6). Lower head to 1/2 inch from surface of cylinder block. Check position of all gaskets, seals, sleeves, and seal strip and then lower head onto block.



NOTE

- Model 5063-5398 uses two lengths of cylinder head bolts for the right cylinder head, three 7-3/8 inch bolts and five 6-1/2 inch bolts. Longer bolts go in ends of cylinder heads except at rear outboard position.
 - Model 5063-5398 uses two lengths of cylinder head bolts for the left cylinder head, four 7-3/8 inch bolts and four 6-1/2 inch bolts. Longer bolts go in ends of cylinder heads.
- (8) Apply International Compound No. 2 to cylinder head bolt threads and underside of bolt head. Install six bolts (5) through cylinder head and thread into cylinder block until bolt heads contact cylinder head.

- (9) Remove two nuts (2), two flat washers (3), and lifting fixture (1) from cylinder head.
- (10) Remove two guide studs (6) and install remaining bolts (5). Torque all bolts to 15-20 lb-ft (20-27 Nžm).



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.

- (11) Torque cylinder head bolts (5) to 170-180 lb-ft (231-244 Nžm) in 50 lb-ft (68 N•m) increments. Tighten bolts in alphabetical sequence shown.
- (12) Repeat steps (3) thru (11) for left bank.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-42 Install injector control tubes.
- 3-32 Install fuel rod hoses
- 3-31 Install throttle control rods.
- 3-20 Install engine rocker arm covers (models 5063-5299 and 5063-5398).
- 3-21 Install engine rocker arm covers (models 5063-5392, 5063-5393, 5063-539F, and 5063 -539 L).
- 3-22 Install engine rocker arm covers (model 5063-5395).
- 3-16 Install fuel lines (model 5063-5299).
- 3-17 Install fuel lines (model 5063-5392).
- 3-18 Install fuel lines (models 5063-5393 and 5063-539L).
- 3-19 Install fuel lines (models 5063-5395, 5063-5398, and 5063-539F).
- 3-14 Install water outlet elbow and thermostat housing (all except models 5063-5393 and 5063-539L).
- 3-15 Install water outlet elbow and thermostat housing (models 5063-5393 and 5063-539L).
- 3-7 Install exhaust manifolds.

Section III. GENERAL SUPPORT ENGINE MAINTENANCE

Contents	Para	Page
Flywheel Housing Replacement	3-44	3-140
Lower Front Cover, Oil Pump, and Oil Pressure Regulator Replacement	3-45	3-148
Upper Front Cover Replacement	3-46	3-156
Fuel Pump and Hydraulic Pump Drive Assemblies Replacement	3-47	3-162
Camshafts, Camshaft Gears, and Idler Gear Replacement	3-48	3-164
End Plate Replacement	3-49	3-174

344. FLYWHEEL HOUSING REPLACEMENT

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Hem 107)
 Wrench, torque (App B, Item 116)
 Sling (App B, Item 93)
 Guide studs (App D, Item 2)
 Expander, oil seal (App B, Item 25)

MATERIALS/PARTS

- 1 Gasket (App F, Item 75)
- 1 Gasket (App F, Item 69)
- 1 Gasket (App F, Item 72)
- 3 Lockwashers (App F, Item 98)
- 20 Lockwashers (App F, Item 99)
- 2 Bolts, self-locking (App F, Item 15)
- 4 Bolts, self-locking (App F, Item 20)
(all except model 5063-5398)
- 4 Bolts, self-locking (App F, Item 14)
(model 5063-5398)

EQUIPMENT CONDITION

- | Para | Description |
|------|---|
| 3-3 | Turbocharger removed (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L) |
| 3-5 | Mounting bracket and exhaust tubes removed (models 5063-5393 and 5063-539L) |
| 3-6 | Mounting bracket and exhaust tubes removed (models 5063-5395, 5063-5398, 5063-539F) |
| 3-23 | Fuel pump removed |
| 3-28 | Tachometer drive adapter removed (models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L) |
| 3-29 | Tachometer drive adapter removed (models 5063-5395 and 5063-5398) |
| 3-30 | Blower drive supped removed |
| 3-33 | Oil pan removed |
| 3-40 | Flywheel removed |

EXPENDABLE/DURABLE SUPPLIES

Oil, engine (App C, Item 26)
 Grease (App C, Item 18)
 Cleaning solvent (App C, Item 9)
 Adhesive, gasket (App C, Item 1)

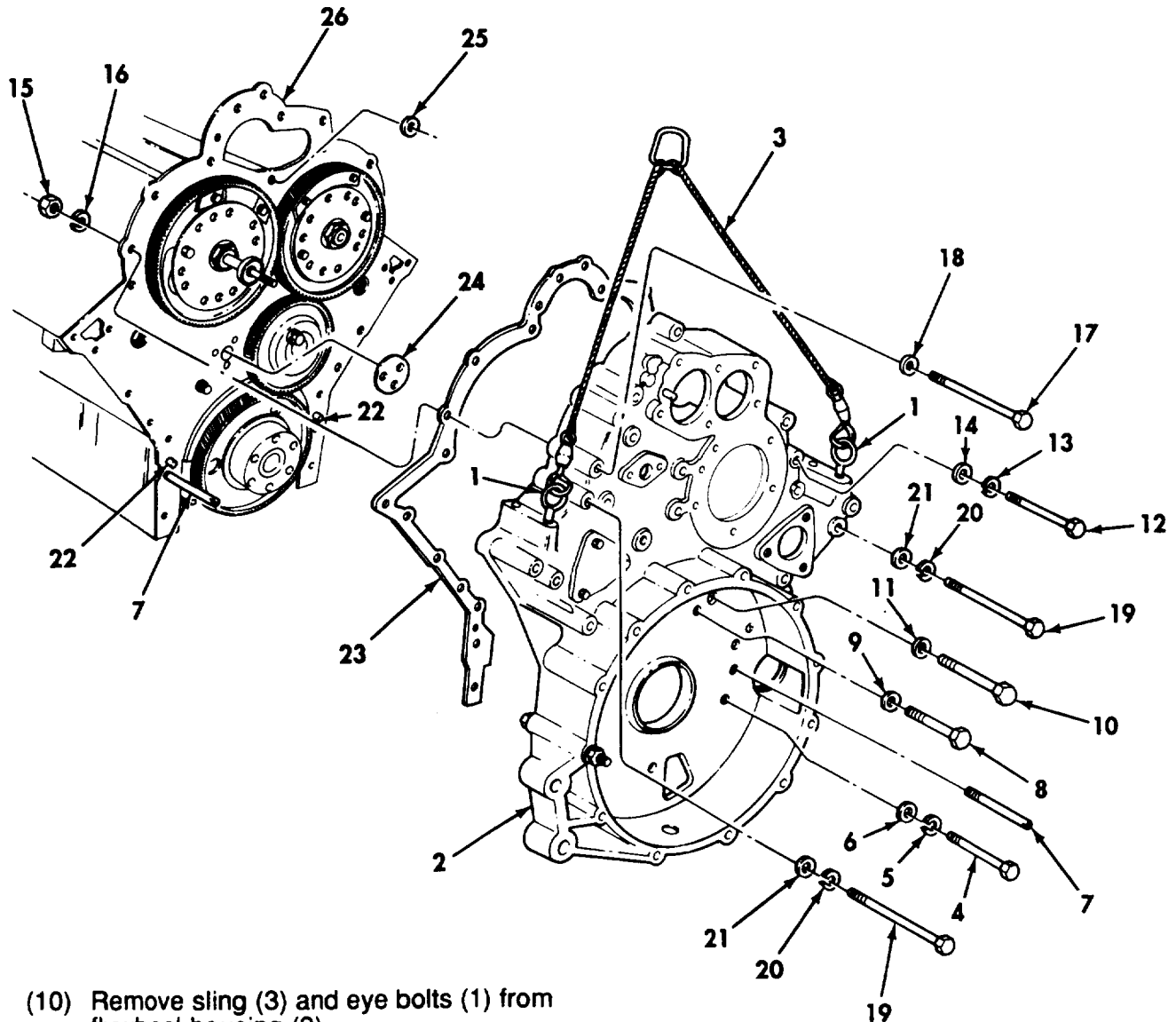
a. Removal

- (1) Thread two 3/8-16 eye bolts (1) into tapped holes located in pads at sides of flywheel housing (2). Attach sling (3) to eye bolts.
- (2) Remove eight screws (4), eight lockwashers (5), and eight flat washers (6) from area inside bell of flywheel housing (2). Discard lockwashers.
- (3) Thread two studs (7) into cylinder block inside bell area of flywheel housing (2).
- (4) Remove two large self-locking bolts (8), two flat washers (9), four small self-locking bolts (10), and four flat washers (11) from area inside bell of flywheel housing (2). Discard bolts.
- (5) Remove two screws (12), two lockwashers (13), and two flat washers (14) from upper right side of flywheel housing (2). Discard lockwashers.
- (6) Remove two nuts (15), two lockwashers (16), two screws (17), and two flat washers (18) from upper left side of flywheel housing (2). Discard lockwashers.

NOTE

On model 5063-5398, one of the eight screws (19) is shorter.

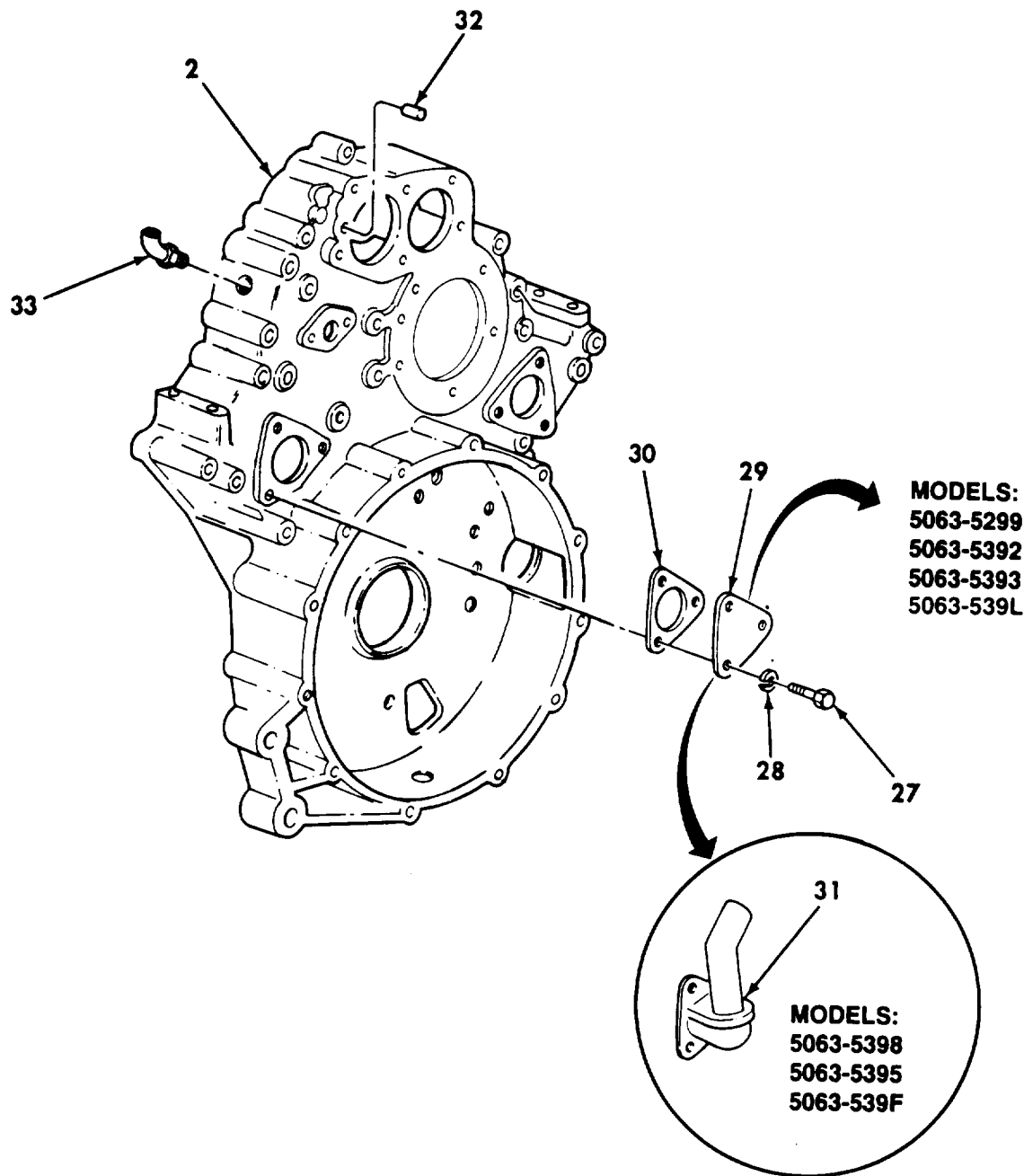
- (7) Remove eight screws (19), eight lockwashers (20), and eight flat washers (21) from sides of flywheel housing (2). Discard lockwashers.
- (8) Strike front face of flywheel housing (2) alternately on each side with a soft head hammer. Loosen housing and work off dowel pins (22).
- (9) Guide flywheel housing (2) off studs (7) and remove from engine using sling (3).



- (10) Remove sling (3) and eye bolts (1) from flywheel housing (2).
- (11) Remove studs (7) from cylinder block.
- (12) Remove flywheel housing gasket (23), shim (24), and gasket (25) from end plate (26). Discard gaskets.

3-44. FLYWHEEL HOUSING REPLACEMENT (Cont)

- (13) On models 5063-5299, 5063-5392, 5063-5393, and 5063 -539L, remove three bolts (27), three lockwashers (28), cover (29), and gasket (30) from left side of flywheel housing (2). Discard gasket and lockwashers.
- (14) On models 5063-5395, 5063-5398, and 5063-539F, remove three bolts (27), three lockwashers (28), drain adapter (31), and gasket (30) from left side of flywheel housing (2). Discard gasket and lockwashers.



(15) If required, remove dowel (32) from upper part of flywheel housing (2).

(16) On models 5063-5393 and 5063-539L, remove elbow (33) from left side of flywheel housing (2).

b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

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

(1) Clean flywheel housing with cleaning solvent and dry with compressed air.

(2) Inspect flywheel housing for cracks or damage.

c. Installation

(1) On models 5063-5393 and 5063-539L, install elbow (33) in left side of flywheel housing (2). ■

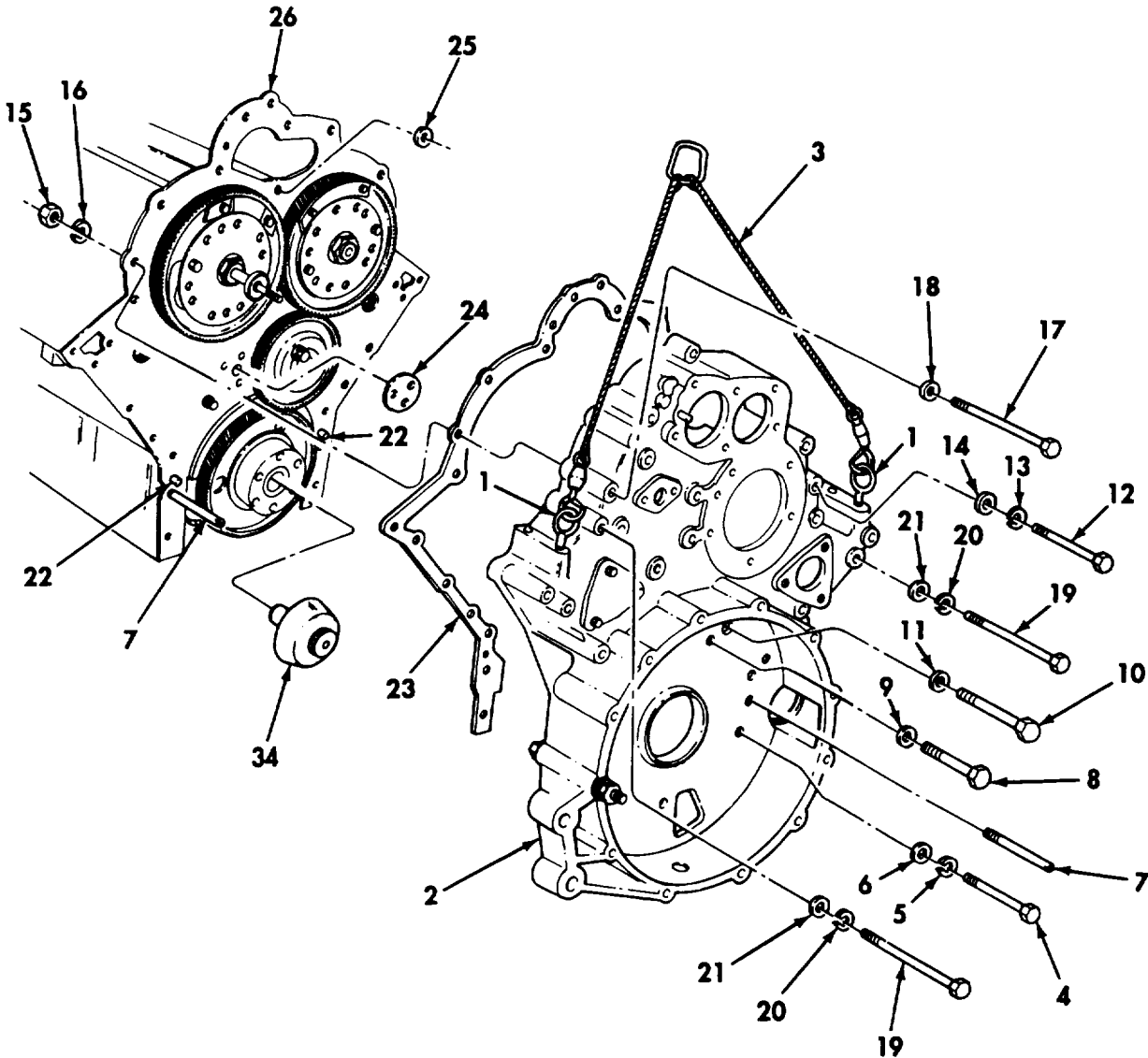
(2) If removed, install dowel (32) in upper part of flywheel housing (2).

(3) On models 5063-5299, 5063-5392, 5063-5393, and 5063-539L, install gasket (30), cover (29), three lockwashers (28), and three bolts (27) on left side of flywheel housing (2). Torque bolts to 13-17 lb-ft (18-23 N•m). ■

(4) On models 5063-5395, 5063-5398, and 5063-539F, install gasket (30), drain adapter (31), three lockwashers (28), and three bolts (27) on left side of flywheel housing (2). Torque bolts to 13-17 lb-ft (18-23 N•m).

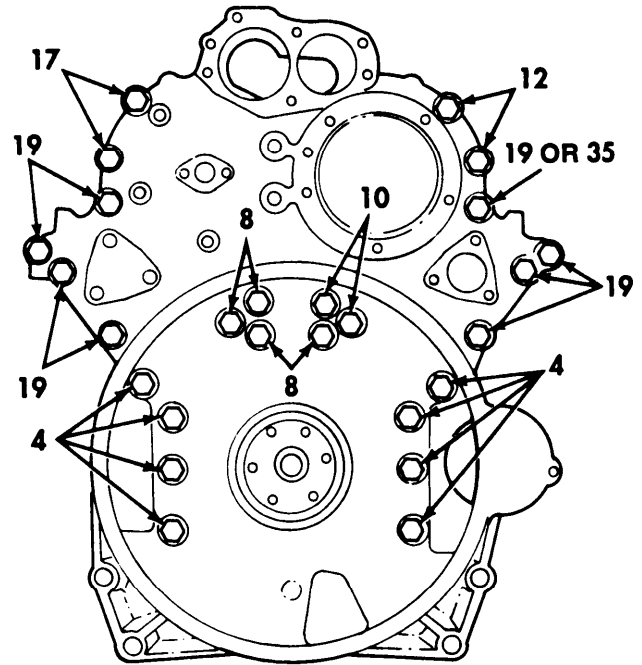
3-44. FLYWHEEL HOUSING REPLACEMENT (Cont)

- (5) Affix flywheel housing gasket (23) and gasket (25) to end plate (26) using gasket adhesive. Install shim (24) to end plate using grease to hold it in position.
- (6) Lubricate teeth on gear train with clean engine oil.
- (7) Thread two studs (7) into rear of cylinder block.
- (8) Thread two 3/8-16 eye bolts (1) into tapped holes located in pads at sides of flywheel housing (2). Attach sling (3) to eye bolts.



- (9) Install oil seal expander (34) on end of crankshaft.
- (10) Position flywheel housing (2) over two studs (7) and end of crankshaft. Push housing over dowel pins (22) and against end plate (26).

TABLE 3-1. FLYWHEEL HOUSING BOLT SIZE		
Item No.	All Except Model 5063-5398	Model 5063-5398
4	3/8-16 X 2 1/2	3/8-16 X 2 3/4
8	5/16-18 X 2 1/2	5/16-18 X 2 1/2
10	3/8-16 X 2 1/2	3/8-16 X 2 3/4
12	3/8-24 X 3 1/4	3/8-24 X 3 1/4
17	3/8-24 X 3 1/2	3/8-24 X 3 1/2
19	3/8-16 X 3 3/4	3/8-16 X 4
35	—	3/8-16 X 3 7/8



BOLT LOCATION CHART

NOTE

Ž Install all flywheel housing fastening screws and bolts finger tight. Bolt and screw sizes for each location are shown in Table 3-1.

- Ensure shim (24) is in position before installing any flywheel bolts or screws.

- (11) Install six flat washers (6), six lockwashers (5), and six screws (4) into bell area of flywheel housing (2).
- (12) Remove two studs (7) and install two flat washers (6), two lockwashers (5), and two screws (4).
- (13) Remove oil seal expander (34), sling (3), and two eye bolts (1).
- (14) Install two flat washers (9), two large self-locking bolts (8), four flat washers (11), and four small self-locking bolts (10) into bell area of flywheel housing (2).
- (15) Install two flat washers (14), two lockwashers (13), and two screws (12) to upper right side of flywheel housing (2).
- (16) Install two flat washers (18), two lockwashers (16), two screws (17), and two nuts (15) to upper left side of flywheel housing (2).

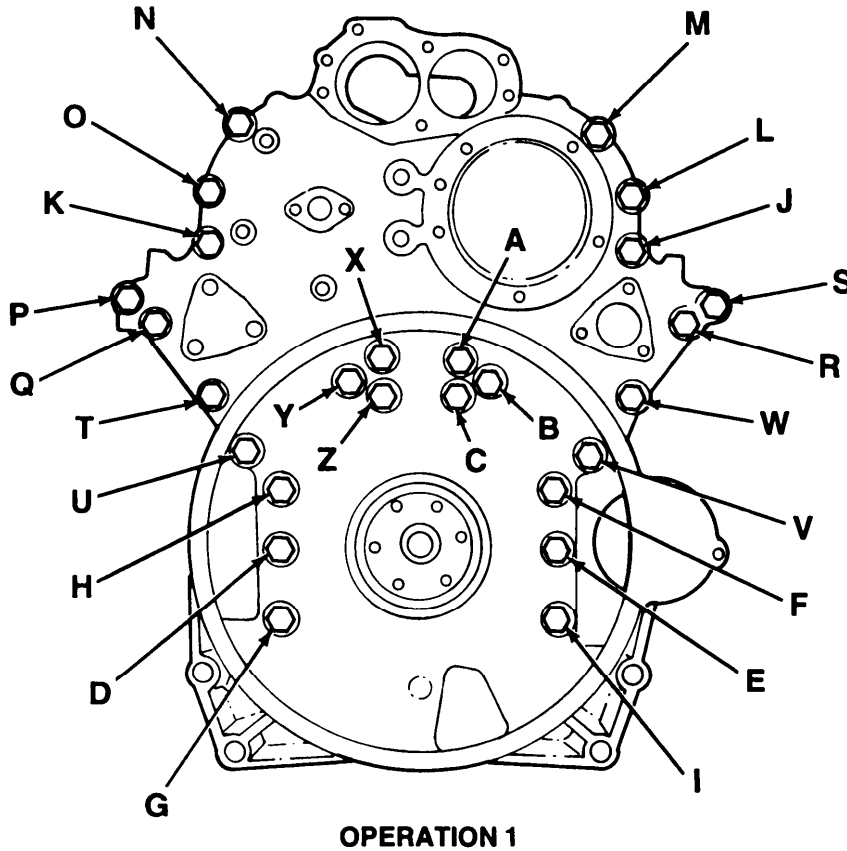
NOTE

Model 5063-5398 uses seven long screws (19) and one short screw (35) where shown.

- (17) Install eight lockwashers (20), eight flat washers (21), and eight screws (19) in sides of flywheel housing (2).

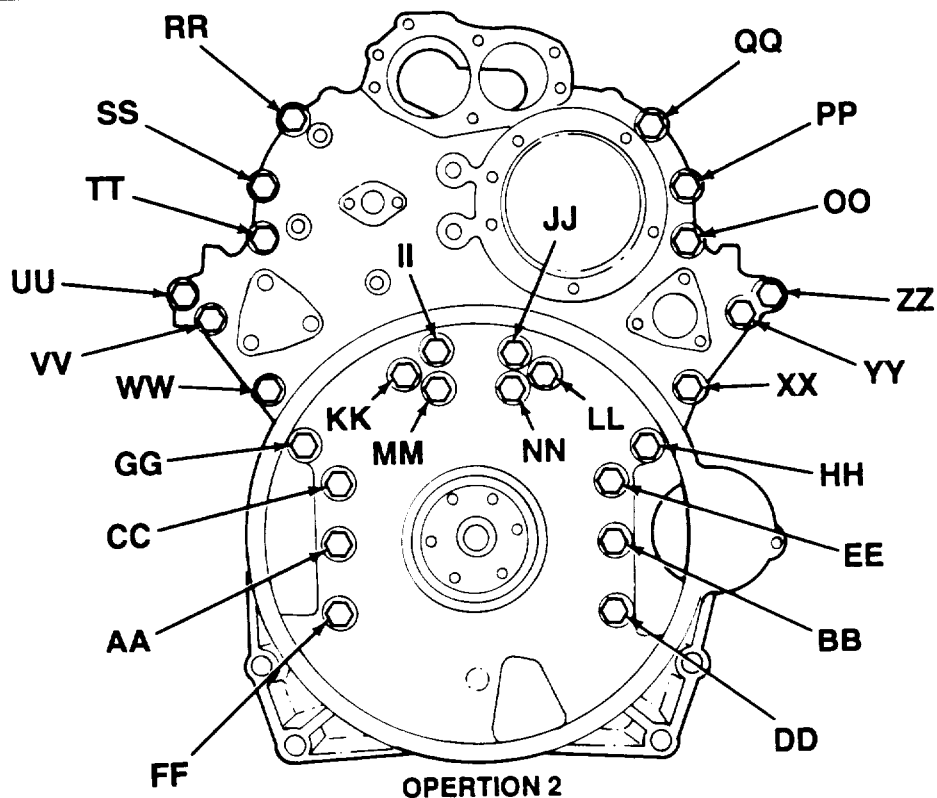
3-44. FLYWHEEL HOUSING REPLACEMENT (Cont)

- (18) Tighten twenty-six flywheel housing screws and bolts snug in alphabetical order shown under OPERATION 1.



- (19) Torque twenty-six flywheel housing screws and bolts in alphabetical order shown under OPERATION 2 to values given in Table 3-2 .

TABLE 3-2 . FLYWHEEL HOUSING BOLT TORQUES BY LOCATION	
OPERATION 2 Bolt Location	Torque
AA thru HH and OO thru ZZ	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)



END OF TASK

FOLLOW-ON MAINTENANCE

- | | |
|------|--|
| Para | Description |
| 3-40 | Install flywheel. |
| 3-33 | Install oil pan. |
| 3-30 | Install blower drive support. |
| 3-28 | Install tachometer drive adapter (models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L). |
| 3-29 | Install tachometer drive adapter (models 5063-5395 and 5063-5398). |
| 3-23 | Install fuel pump. |
| 3-5 | Install mounting bracket and exhaust tubes (models 5063-5393 and 5063-539L). |
| 3-6 | Install mounting bracket and exhaust tubes (models 5063-5395, 5063-5398, 5063-539F). |
| 3-3 | Install turbocharger (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L). |

3-45. LOWER FRONT COVER, OIL PUMP, AND OIL PRESSURE REGULATOR REPLACEMENT

This task covers: a. Removal b. Disassembly c. Cleaning/Inspection
 d. Measurements e. Assembly f. Installation

INITIAL SETUP**MODELS**

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Installer, oil seal (App B, Item 58)
Oil seal expander (App B, Item 24)
Gage set, depth micrometer (App 6, Item 31)
Guide studs (App D, Item 2)

MATERIALS/PARTS

1 Gasket (App F, Item 45)
2 Washers, copper (App F, Item 184)
1 Gasket (App F Item 54)
2 Screws, drive (App F, Item 153)
12 Lockwashers (App F, Item 99)
8 Lockwashers (App F, Item 98)
1 Plug, cup (App F, Item 126)
1 Seal, plain encased (App F, Item 171)
(model 5063-5299)
1 Seal, plain encased (App F, Item 172)
(all except model 5063-5299)
1 Bearing, sleeve (App F, Item 4)

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, item 27)
Sealing compound (App C, Item 44)
Grease (App C, Item 18)
Oil, engine (App C, Item 26)

EXPENDABLE/DURABLE SUPPLIES (Cont)

Stone, sharpening (App C, Item 50)
Stone, sharpening x-fine (App C, Item 51)
Crocus cloth (App C, Item 10)
Adhesive, retaining (App C, Item 2)
Adhesive, gasket (App C, Item 1)
2 Screws, sheet metal (App C, Item 40)
2 Washers, flat (App C, Item 56)

EQUIPMENT CONDITION

<u>Para</u>	<u>Description</u>
3-9	Engine front mounting bracket removed (models 5063-5393 and 5063-539L)
3-10	Fuel line clip and solenoid valve bracket removed (all except model 5063-5392)
3-11	Fuel line clip and solenoid valve bracket removed (model 5063-5392)
3-33	Oil pan removed
3-34	Oil pump inlet and outlet tubes removed model 5063-5299)
3-35	Oil pump inlet and outlet tubes removed (all except model 5063-5299)
3-36	Crankshaft spacer removed (models 5063-5299, 5063-5393, and 5063-539L)
3-37	Crankshaft hub or pulley removed (models 5063-5392, 5063-5395, 5063-5398 and 5063-539F)
3-38	Engine front support removed (model 5063-5299)
3-39	Engine front support removed (model 5063-5392)

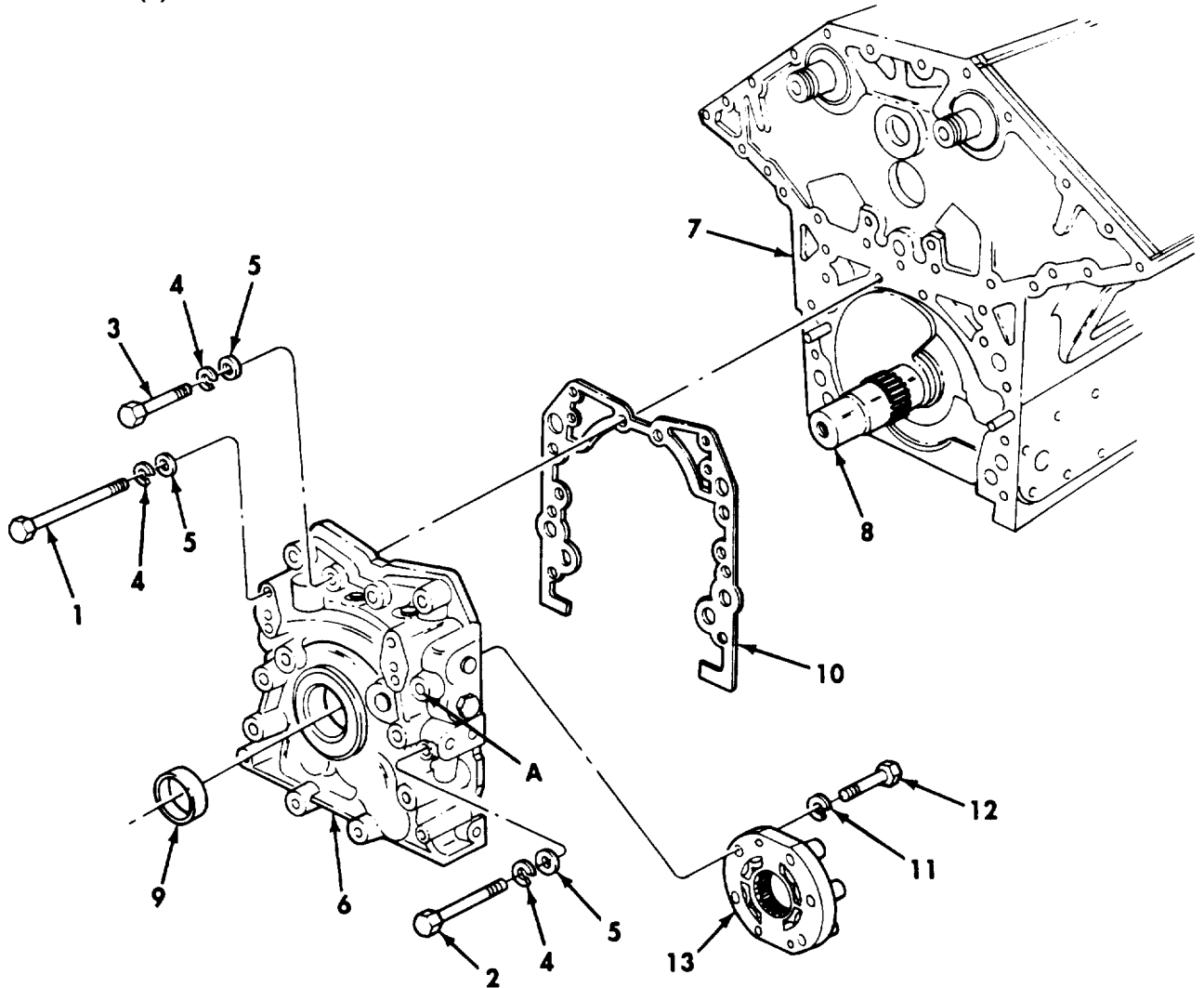
a. Removal**NOTE**

- On model 5063-5393, four screws (1) were removed with front support.
 - On all except model 5063-5393, one screw (2) was removed at location (A) with a fuel line clip.
- (1) Remove four long screws (1), four mid-sized screws (2), four short screws (3), twelve lockwashers (4), and twelve flat washers (5) fastening front cover (6) to cylinder block (7). Discard lockwashers.
 - (2) Strike front cover (6) on sides with soft head hammer to free it. Pull cover straight off crankshaft (8). Remove spacer ring (9) from cover.
 - (3) Remove and discard cover gasket (10).

NOTE

Models 5063-5392, 5063-5393, 5063-539F, and 5063-539L, do not use lockwashers (11).

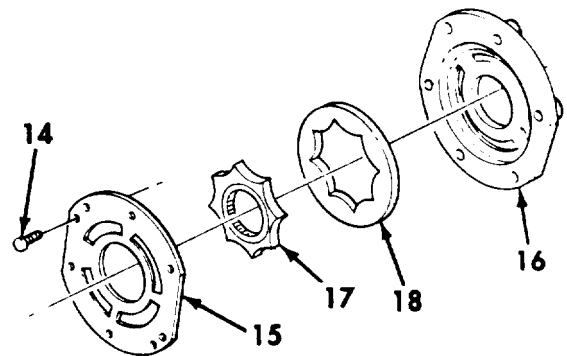
- (4) Remove six self-locking bolts (12), six lockwashers (11), and oil pump assembly (13) from front cover (6). Discard lockwashers.



b. Disassembly

- (1) Oil pump assembly:

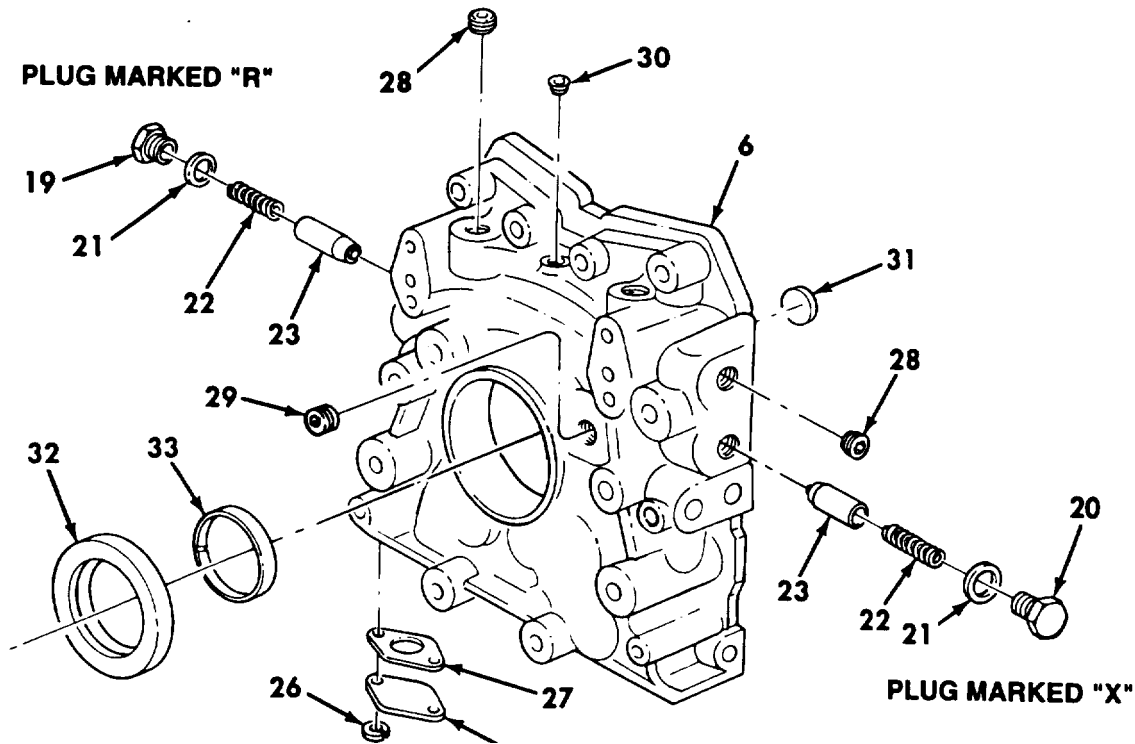
- (a) Using small punch, drive out two drive screws (14) and remove cover plate (15) from pump housing (16). Discard screws.
- (b) Remove inner rotor (17) and outer rotor (18) from pump housing (16).



3-45. LOWER FRONT COVER, OIL PUMP, AND OIL PRESSURE REGULATOR REPLACEMENT
(Cont)

(2) Front cover assembly:

- (a) Remove plug (19), plug (20), two copper washers (21), two springs (22), and two sleeves (23) from sides of front cover (6). Discard copper washers.



NOTE

Models 5063-5299 and 5063-5398 do not use cover plate (24) or fastening hardware.

- (b) Remove two screws (25), two lockwashers (26), cover plate (24), and gasket (27) from bottom of front cover (6). Discard gasket and lockwashers.
- (c) For model 5063-5299: if necessary, remove two plugs (28) and plug (29) from front cover (6).
- (d) For all except model 5063-5299: if necessary, remove four plugs (28), plug (29), plug (30), and cup plug (31) from front cover (6). Discard cup plug.
- (e) Drill two holes in opposite sides of casing of oil seal (32). 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 (33).

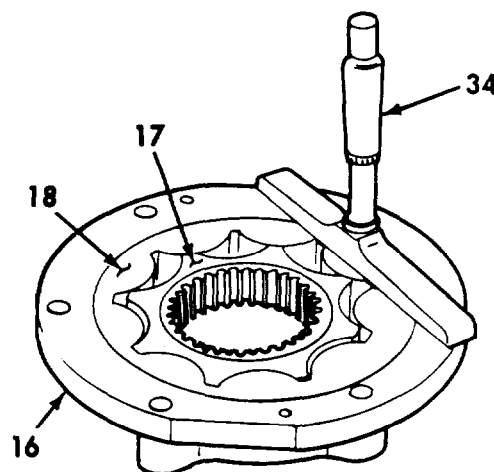
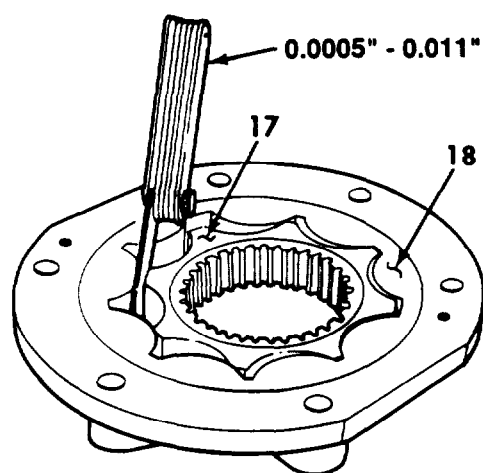
- (f) Press or drive sleeve bearing (33) from bore in front cover (6). Discard bearing.

c. Cleaning/Inspection

WARNING

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

- (1) Wash all parts in fuel oil and dry with compressed air.
- (2) 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.
- (3) Inspect splines of inner oil pump rotor for excessive wear.
- (4) 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.
- (5) Inspect valve springs for pitting and fractured coils.
- (6) Inspect lower front cover for cracks at oil seal bore and valve bores.
- (7) 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.



d. Measurements

NOTE

Models 5063-5299, 5063-5395, and 5063-5398 have a gear rotor thickness of 1 inch. Models 5063-5392, 5063-5393, 5063-539F, and 5063-539L have a gear rotor thickness of 1 1/4 inch.

- (1) Using depth gage (34), measure clearance from face of pump housing (16) to face of inner rotor (17) and to outer rotor (18). Clearance should be 0.001 to 0.0035 inch.
- (2) Measure clearance between inner rotor (17) and outer rotor (18) at each lobe. Clearance should be 0.0005 to 0.011 inch.

3-45. LOWER FRONT COVER, OIL PUMP, AND OIL PRESSURE REGULATOR REPLACEMENT
(Cont)

e. Assembly

(1) Front cover assembly

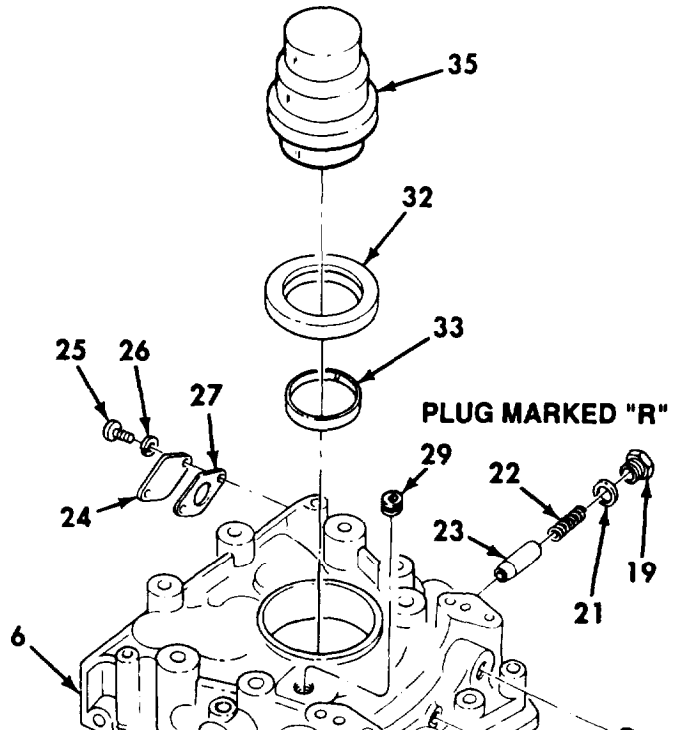
NOTE

Model 5063-5299 does not use sleeve bearing (33).

- (a) Coat bore of front cover (6) with retaining adhesive and position sleeve bearing (33) in cover with split line at bottom. Press bearing into cover until flush to 0.015 inch below outer face.

NOTE

If oil seal is not precoated, apply sealing compound to outside diameter of metal casing.



- (b) Position oil seal (32) in front cover (6) with seal lip pointed toward inner face of cover.
- (c) Using oil seal installer (35), press oil seal (32) into front cover (6) until flush with outside face.
- (d) For all except model 5063-5299: if removed, install four plugs (28), plug (29), plug (30), and cup plug (31) into front cover (6).
- (e) For model 5063-5299: if removed, install two plugs (28) and plug (29) into front cover (6).

NOTE

Models 5063-5299 and 5063-5398 do not use cover plate (24) or fastening hardware.

- (f) Install gasket (27), cover plate (24), two lockwashers (26), and two screws (25) to bottom of front cover (6). Torque screws to 13-17 lb-ft (18-23 N•m).

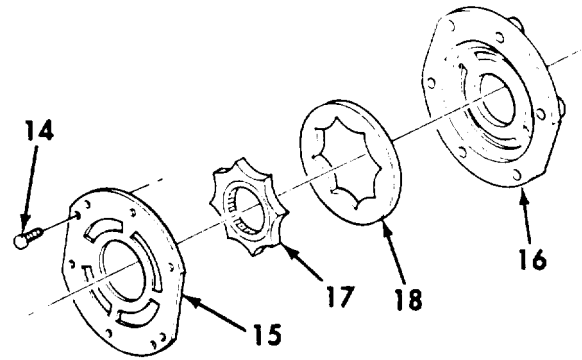
NOTE

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 (23), two springs (22), two copper washers (21), plug (19), and plug (20) in sides of front cover (6). Torque plugs to 30-40 lb-ft (41-54 N•m).

(2) Oil pump assembly:

- (a) Lubricate oil pump outer rotor (18) and inner rotor (17) with engine oil and place in pump housing (16).
- (b) Place cover plate (15) on pump housing (16). Align bolt holes and drive screw holes with holes in pump housing.
- (c) Install cover plate (15) and two drive screws (14) on pump housing (16).



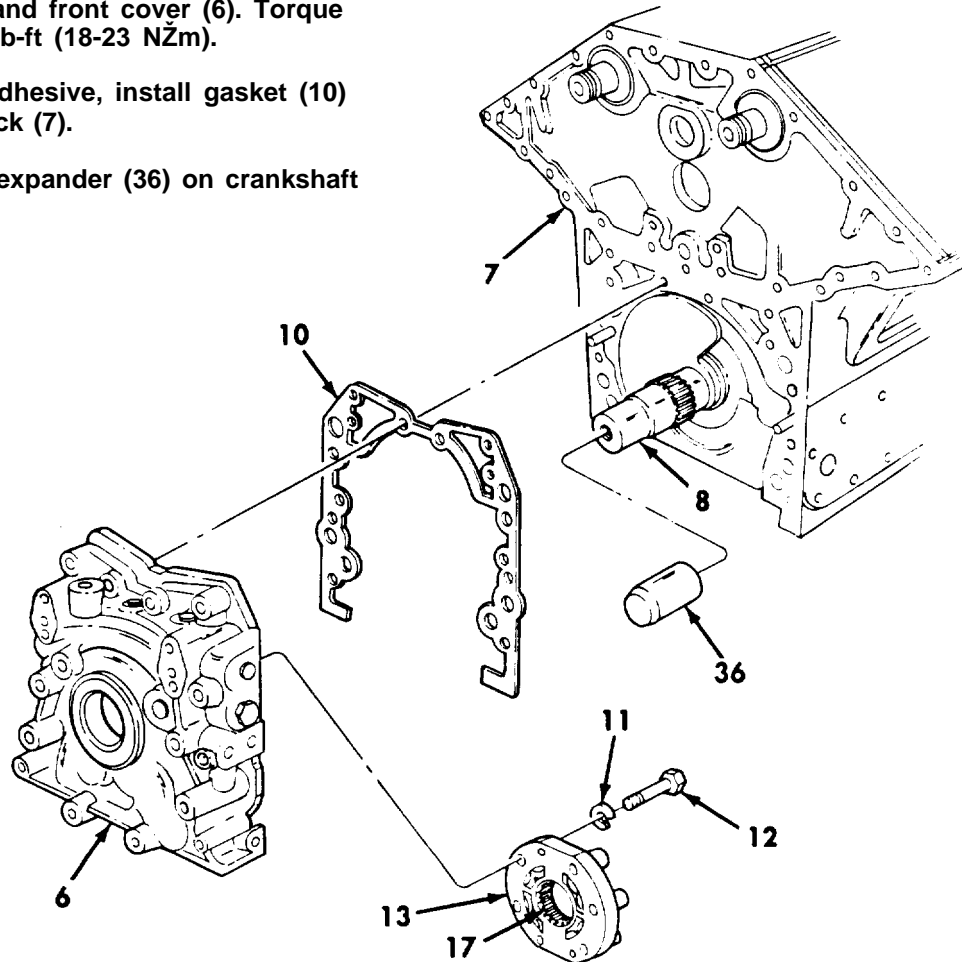
f. Installation

- (1) Place oil pump assembly (13) in rear of front cover (6) with markings "UP R.H." at top of front cover.

NOTE

Models 5063-5392, 5063-5393, 5063-539F, and 5063-539L do not use lockwashers (11).

- (2) Install six lockwashers (11) and six self-locking bolts (12) in oil pump assembly (13) and front cover (6). Torque bolts to 13-17 lb-ft (18-23 NŹm).
- (3) Using gasket adhesive, install gasket (10) on cylinder block (7).
- (4) Install oil seal expander (36) on crankshaft (8).

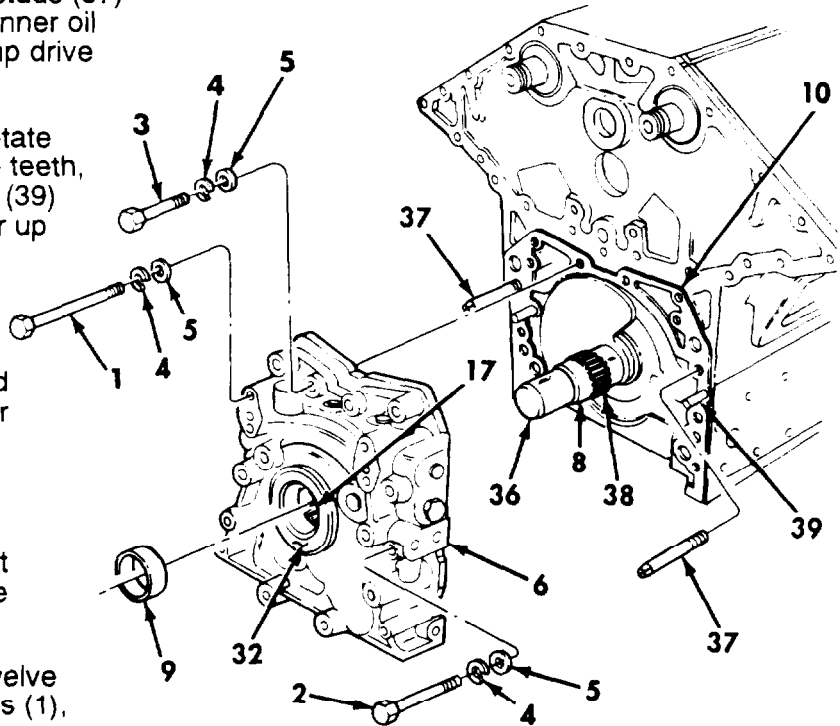


3-45. LOWER FRONT COVER, OIL PUMP. AND OIL PRESSURE REGULATOR REPLACEMENT (Cont)

- (5) Thread two guide studs (37) into diametrically opposite bolt holes in cylinder block.
- (6) Apply light coat of grease to lip of oil seal (32).
- (7) Slide front cover (6) over guide studs (37) and oil seal expander (36) until inner oil pump rotor (17) contacts oil pump drive gear (38) on crankshaft (8).
- (8) Remove guide studs (37) and rotate front cover (6) slightly to engage teeth, then align cover with dowel pins (39) on cylinder block and slide cover up against gasket (10).

NOTE

- On models 5063-5393 and 5063-539L, do not install four screws (1) because of front support installation.
- On all except model 5063-5393, do not install screw (2) at location (A) because of fuel line clip installation.



- (9) Install twelve flat washers (5), twelve lockwashers (4), four long screws (1), four mid-sized screws (2), and four short screws (3) on front cover (6).
- (10) Remove oil seal expander (36).

Install spacer ring (9) on crankshaft (8) with bevel toward cylinder block and push spacer ring into oil seal (32).

Torque front cover screws (1, 2, and 3) to 30-35 lb-ft (41-47 NŹm).

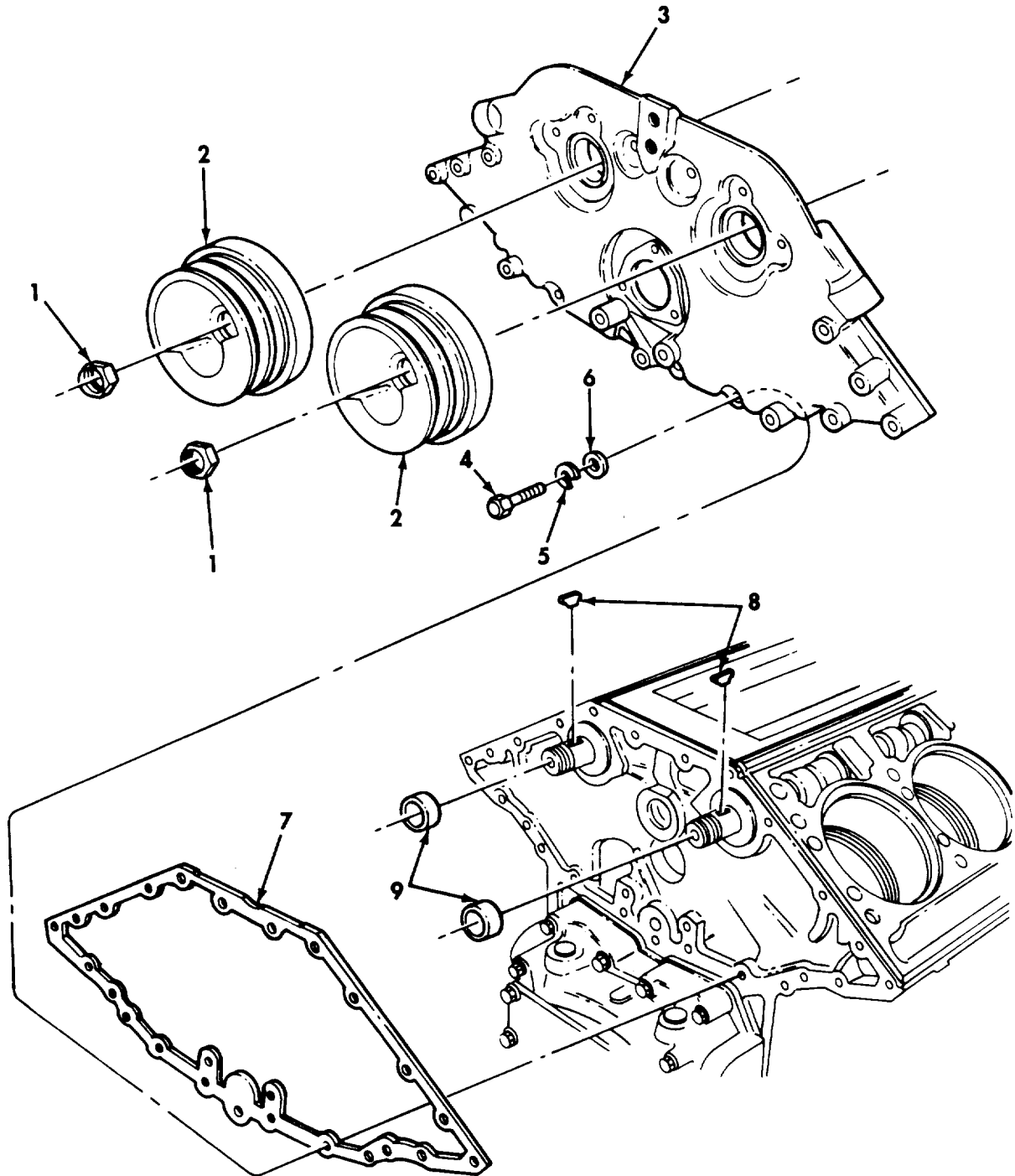
END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-38 Install engine front support (model 5063-5299).
- 3-39 Install engine front support (model 5063-5392),
- 3-36 Install crankshaft spacer (models 5063-5299, 5063-5393 and 5063-539L).
- 3-37 Install crankshaft hub or pulley (models 5063-5392, 5063-5395, 5063-5398 and 5063-539F)
- 3-34 Install oil pump inlet and outlet tubes (model 5063-5299).
- 3-35 Install oil pump inlet and outlet tubes (all except model 5063-5299).
- 3-33 Install oil pan.
- 3-11 Install fuel line clip and solenoid valve bracket (model 5063-5392)
- 3-10 Install fuel line clip and solenoid valve bracket (all except model 5063-5392).
- 3-9 Install engine front mounting bracket (models 5063-5393 and 5063-539L).

- (3) Remove all bolts (4), lockwashers (5), and flat washers (6) fastening upper front cover (3) to cylinder block. Discard lockwashers.
- (4) Using soft head hammer, tap front cover (3) away from cylinder block. Remove front cover and gasket (7). Discard gasket.
- (5) Remove two Woodruff keys (8) and two oil seal spacers (9) from camshafts.



3-46. UPPER FRONT COVER REPLACEMENT (Cont)

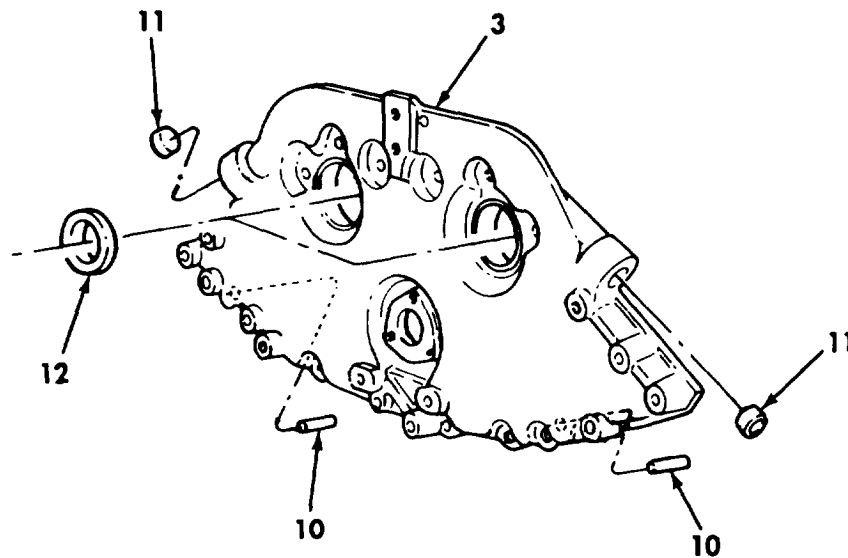
b. Disassembly

- (1) If required, remove two dowel pins (10) and two cup plugs (11) from front cover (3). Discard plugs and pins.

NOTE

To remove oil seal (12) with upper front cover (3) 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 (3) on wooden blocks. Drive out two oil seals (12). Discard seals.



c. Cleaning/Inspection

WARNING

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (1) Clean front cover with cleaning solvent and dry with compressed air.
- (2) Inspect seals and seal spacers for wear or damage.

- (3) 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 30° arc and the pulley is installed on the right camshaft.

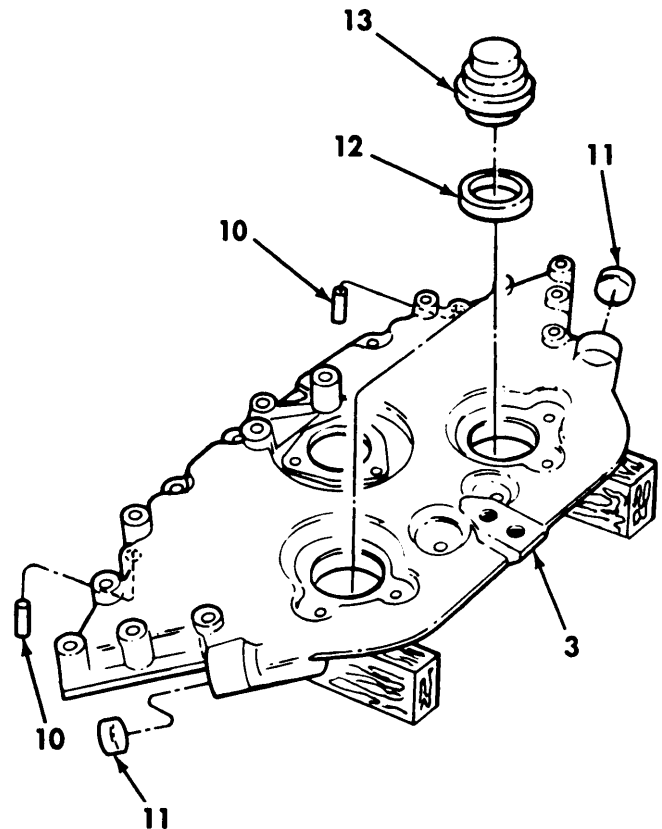
d. Assembly

- (1) Install oil seals in following manner:

NOTE

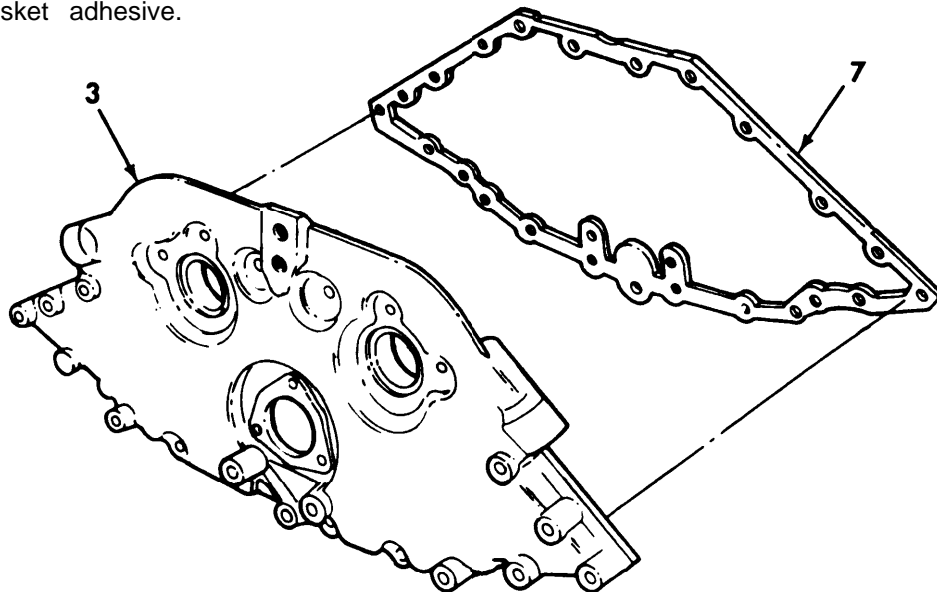
If outside diameter of oil seal (12) is not precoated, coat seal bore in front cover (3) with sealing compound.

- (a) Place inner face of front cover (3) on wooden blocks.
 - (b) Place oil seal (12) on cover (3) with lip of seal pointing toward inner face of cover. Using seal installer (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 cup plugs (11) and press into front cover (3) until flush with face of bore.
 - (3) If removed, press two dowel pins (10) into front cover (3) until pins protrude 3/8 inch.



e. Installation

- (1) Install gasket (7) to upper front cover (3) with gasket adhesive.

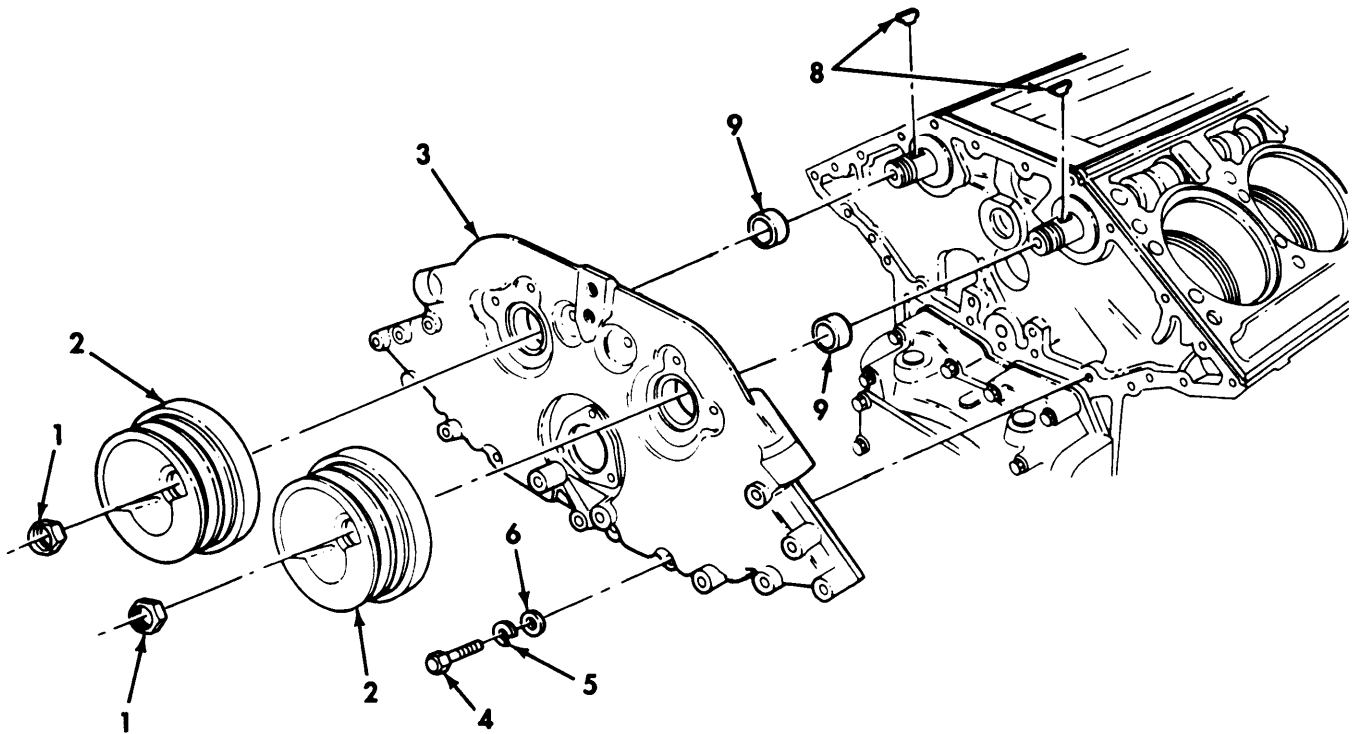


3-46. UPPER FRONT COVER REPLACEMENT (Cont)

NOTE

- Several front cover fastening bolts are installed with installation of clips, water pump idler pulley assembly, solenoid bracket, and fan support bracket (refer to para 3-10, 3-11, 3-12, 3-13, and 3-39).
- See Table 3-3 for bolt sizes and locations.

- (2) Install upper front cover (3), flatwashers (6), lockwashers (5), and bolts (4) on cylinder block. Torque bolts to 30-35 lb-ft (41-47 Nm).
- (3) Apply grease to outside diameter of two seal spacers (9) and slide in position on camshafts.
- (4) Install two Woodruff keys (8) in slot at end of camshafts.



- (5) Align keyway in pulley with Woodruff key (8). Slide two pulleys (2) on ends of camshafts.

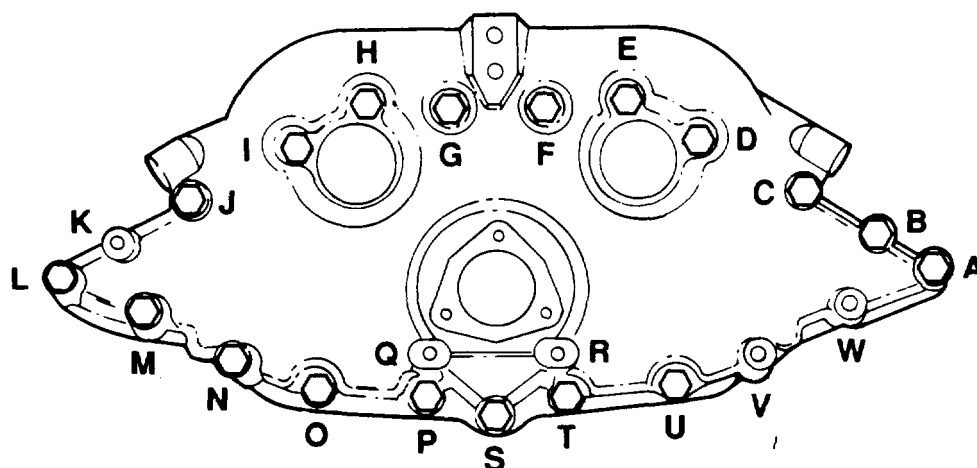
NOTE

- To tighten and torque camshaft nuts with flywheel housing on engine, secure flywheel or crankshaft to prevent camshaft gears from turning.
- Ž To tighten and torque camshaft nuts with flywheel housing removed, wedge a rag between camshaft gears.

- (6) Install two nuts (1) on camshafts and torque to 300-325 lb-ft (407-441 N-m).

TABLE 3-3. UPPER FRONT COVER BOLT SIZE AND LOCATION

Hole	Models 5063-5299 5063-5395 5063-539F	Model 5063-5392	Model 5063-5393 ■ 5063-539L	Model 5063-5398
A & M	3/8-16 X 2 1/4	3/8-16 X 2 1/4	—	3/8-16 X 2 1/2
B & J	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/2
C	3/8-16 X 2 1/4	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	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	3/8- 16 X 1 3/4
K	—	3/8-16 X 2 1/4	3/8-16 X 2 1/4	—
L	3/8-16 X 2 1/4	—	—	3/8-16 X 2 1/2
N	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/4	3/8-16 X 2 1/2
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	—	—	—	—



END OF TASK

FOLLOW-ON MAINTENANCE

- | | |
|-------------|--|
| Para | Description |
| 3-39 | Install fan support bracket (model 5063-5392). |
| 3-13 | Install air box heater. |
| 3-10 | Install air box heater hardware (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F). |
| 3-11 | Install air box heater hardware (model 5063-5392). |
| 3-12 | Install air box heater hardware (model 5063-5393). |
| 3-12.1 | install glow plug controller, bracket and harnesses (model 5063-539L) |

3-47. FUEL PUMP AND HYDRAULIC PUMP DRIVE ASSEMBLIES REPLACEMENT

This task covers: a. Removal b. Cleaning/Inspection c. Installation

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)
Oil, engine (App C, Item 26)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Dial indicator, magnetic base (App B, Item 54)

EQUIPMENT CONDITION

Para Description
3-44 Flywheel housing removed

MATERIALS/PARTS

- 2 Bolts, self-locking (App F, Item 193)
- 1 Bolt, self-locking (App F, Item 194)

NOTE

All models have a fuel pump drive assembly on the right bank. Only model 5063-5393 has a hydraulic pump drive assembly on the left bank. Repeat the same procedures on the left bank for the hydraulic pump drive assembly replacement.

a. Removal

- (1) Remove two self-locking bolts (1) and adapter (2) from drive gear (3). Discard self-locking bolts.
- (2) Remove self-locking bolt (4), flat washer (5), two thrust washers (6), gear (3), and hub (7) from end plate. Discard self-locking bolt.

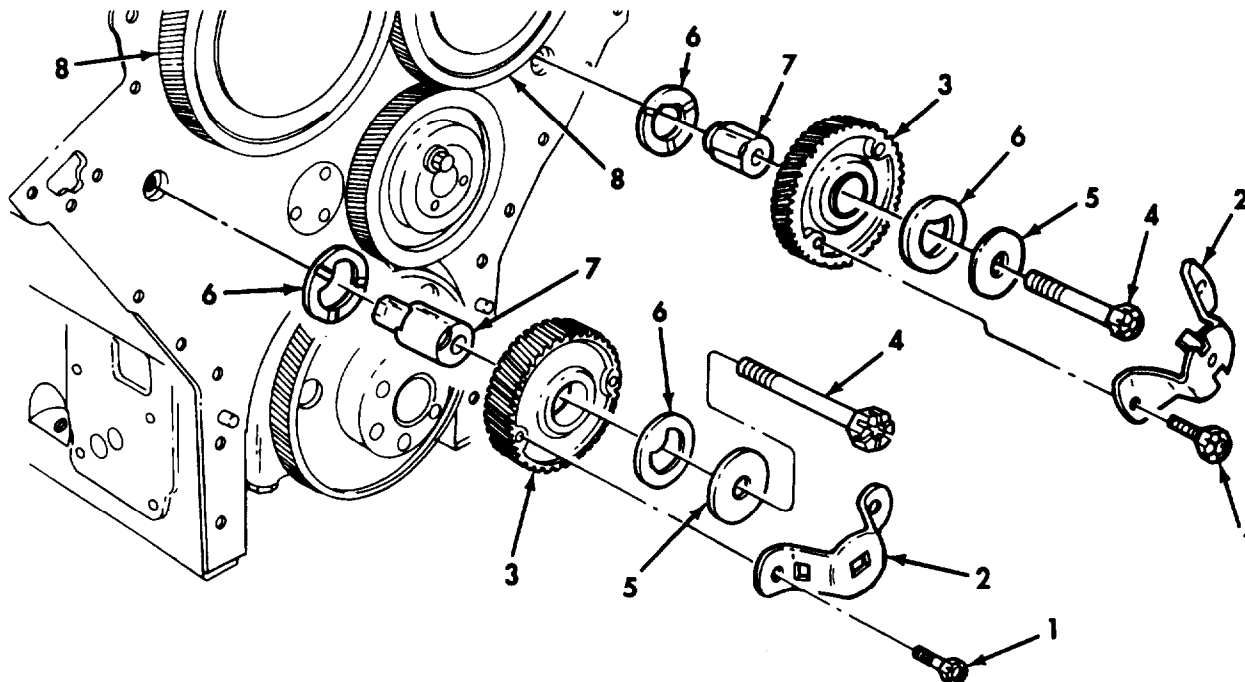
b. Cleaning/inspection

WARNING

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

- (1) Wash gear, hub, and flat washers in fuel oil and dry with compressed air.
- (2) Inspect thrust washers, hub, and drive gear bearing for wear and scoring.
- (3) Examine gear teeth for wear, scoring, and pitting.
- (4) Measure gear bearing, hub, and thrust washers for repair standards (Table 3-4).

TABLE 3-4. 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. (0.178 mm)
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)	-



c. Installation

- (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 (6) on small diameter of hub (7). Slide drive gear (3) and outer thrust washer (6) over larger diameter of hub.
- (3) Install small diameter of hub (7) 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 (8).
- (4) Install flat washer (5) and self-locking bolt (4) on hub (7) 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 (6) and gear (3). Clearance should be 0.005 to 0.018 inch with new parts and a maximum of 0.022 inch with used parts.
- (6) Using magnetic base dial indicator, measure backlash between drive gear (3) and mating camshaft gear (8). Backlash should be 0.003 to 0.005 inch with new gears and a maximum of 0.007 inch with used gears.
- (7) Install adapter (2) and two self-locking bolts (1) on drive gear (3). Torque bolts to 7-9 lb-ft (10-12 N·M)

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-44 Install flywheel housing.

3-48. CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT

This task covers: a. Removal b. Disassembly c. Cleaning d. Inspection
 e. Assembly f. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Wrench, torque (App B, Item 117)
- Remover, tachometer drive (App B, Item 84)
 (models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L)
- Remover, tachometer drive (App B, Item 89)
 (models 5063-5395 and 5063-5398)
- Puller set, slide hammer (App B, Item 77)
- Puller, camshaft gear (App B, Item 78)
- Drill set, twist (App B, Item 22)
- Drill, electric (App B, Item 23)
- Threading set, screw (App B, Item 104)
- Indicator, dial, magnetic base (App B, Item 54)
- V-block (App B, Item 112)
- Micrometer set (App B, Item 73)
- Gage set, telescoping (App B, Item 33)
- Gage set, depth, micrometer (App B, Item 31)
- Straight edge (App B, Item 96)
- Vise, machinist (App B, Item 111)
- Caps, vise jaw (App B, Item 13)

MATERIALS/PARTS

- 4 Plugs (App F, Item 121)
- 4 Lockwashers (App F, Item 99)
- 4 Bolts, self-locking (App F, Item 17)

EXPENDABLE/DURABLE SUPPLIES

- Cleaning solvent (App C, Item 9)
- Oil, fuel (App C, Item 27)
- Engine oil (App C, Item 26)
- Grease (App C Item 18)
- Stone, sharpening X-fine (App C, Item 51)
- Sealing compound (App C, Item 44)
- Sealing compound, MIL-R-46082 (App C, Item 46)
- 2 Screws (App C, Item 37)
- 1 Screw (App C, Item 39)
- 2 Wood blocks (App C, Item 58)

EQUIPMENT CONDITION

- | Para | Description |
|------|---|
| 3-10 | Air box heater hardware removed (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F) |
| 3-11 | Air box heater hardware removed (model 5063-5392) |
| 3-12 | Air box heater hardware removed (model 5063-5393) |
| 3-13 | Air box heater removed |
| 3-39 | Fan support bracket removed (model 5063-5392) |
| 3-40 | Flywheel assembly removed |
| 3-44 | Flywheel housing removed |
| 3-43 | Cylinder heads removed |
| 3-46 | Upper front cover removed |
| 3-47 | Fuel pump and hydraulic pump drive assemblies removed |

a. Removal

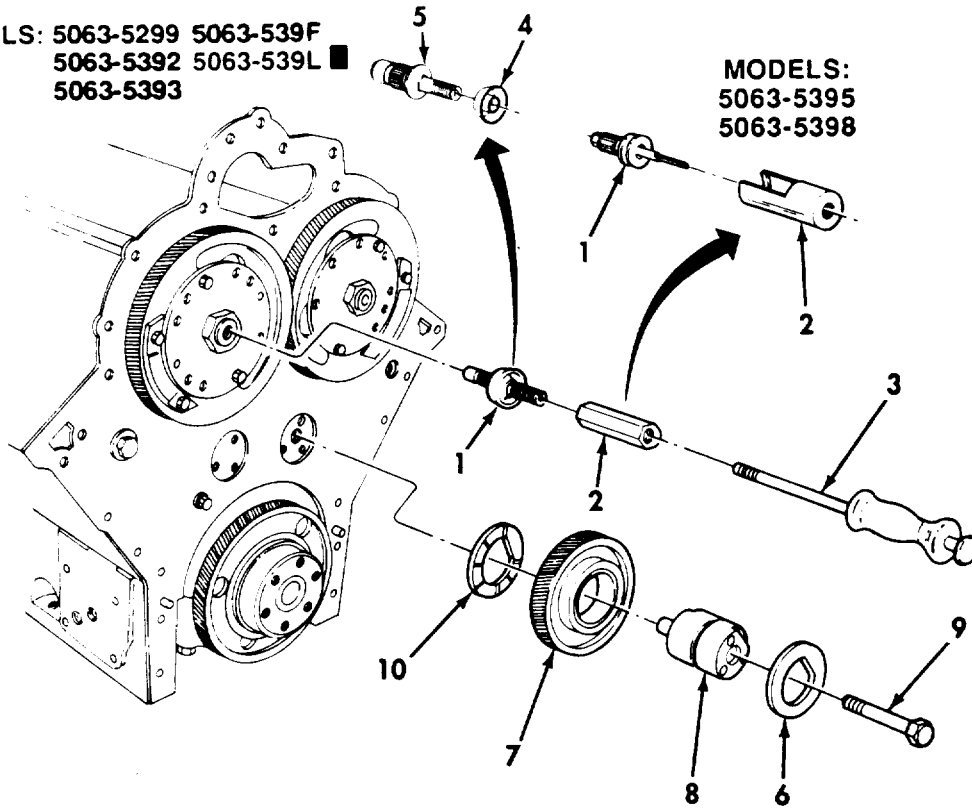
NOTE

- Use tachometer drive remover (App B, Item 84) for models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L.
- Use tachometer drive remover (App B, Item 89) for models 5063-5395 and 5063-5398.

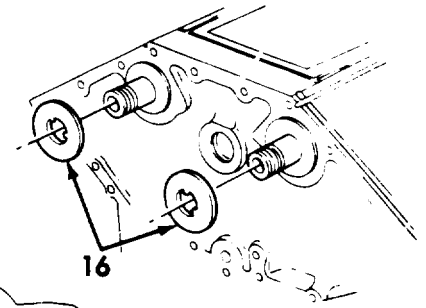
- (1) Remove tachometer drive assembly (1) from left camshaft with adapter (2) and slide hammer puller set (3).
- (2) For models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L: if necessary, remove tachometer dirt deflector (4) from tachometer drive shaft (5).
- (3) Remove outer idler gear thrust washer (6) and idler gear assembly (7) from hub (8).

MODELS: 5063-5299 5063-539F
5063-5392 5063-539L ■
5063-5393

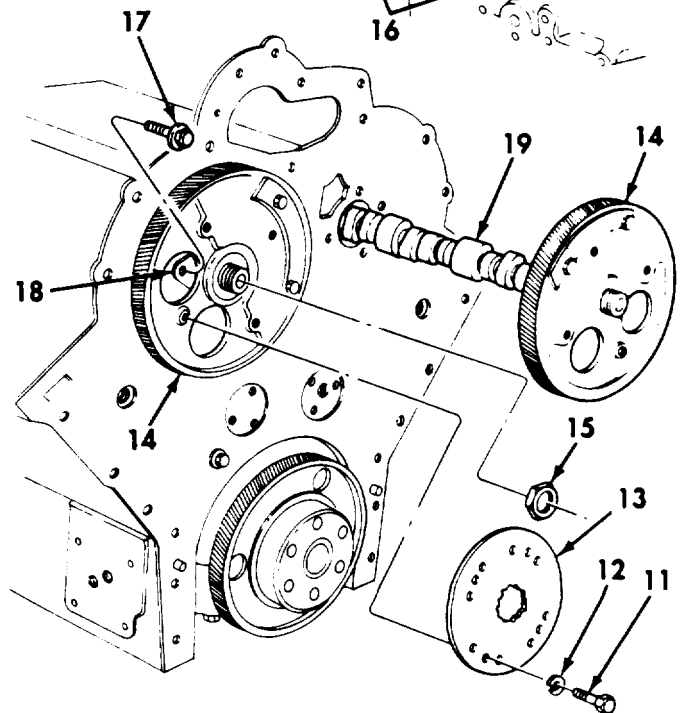
MODELS:
5063-5395
5063-5398



MODEL:
5063-5398



- (4) Remove screw (9), hub (8), and inner idler gear thrust washer (10).
- (5) Remove four screws (11), four lockwashers (12), and two retaining plates (13) from camshaft gears (14). Discard lockwashers.
- (6) Wedge a rag between two camshaft gears (14). Remove two nuts (15).
- (7) Remove rag from camshaft gears (14).
- (8) On model 5063-5398, remove dirt deflector (16) from front of each camshaft.
- (9) Remove four self-locking bolts (17) fastening two spacer plates (18) to cylinder block. Insert socket wrench through opening in web of camshaft gear (14) to gain access to bolts. Discard self-locking bolts.
- (10) Remove camshaft and gear assemblies (19) from rear of cylinder block.

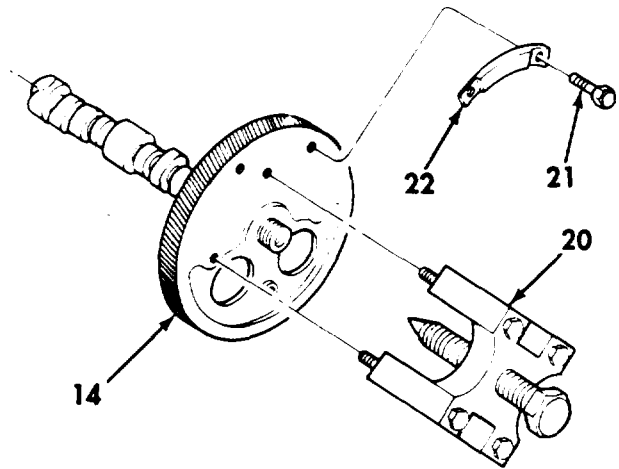


3-48. CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT (Cont)

b. Disassembly

NOTE

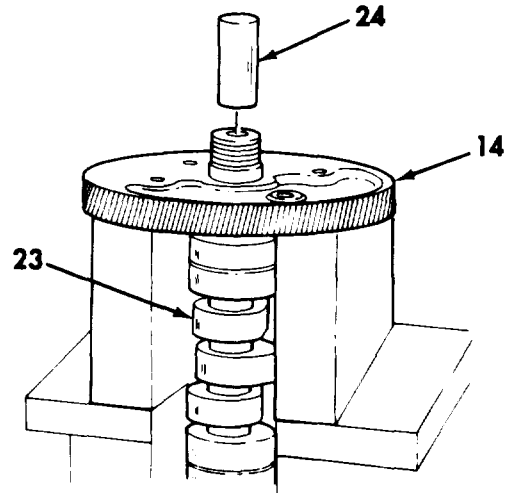
- Tag camshafts and gears prior to disassembling.
- Use same procedure for right and left camshafts.
- When press is not available, use camshaft gear puller (20) to remove camshaft gears.



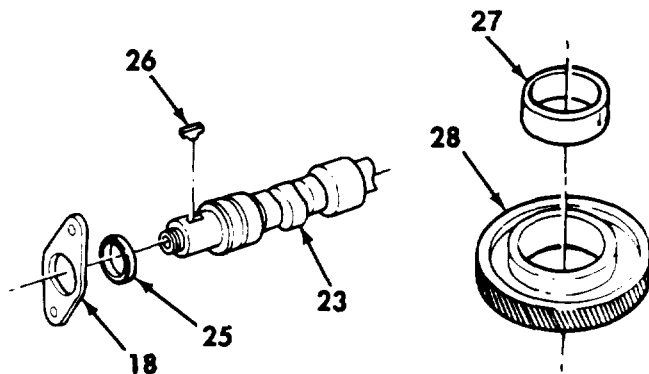
- (1) On models 5063-5392, 5063-5393, 5063-539F, and 5063-539L, remove two bolts (21) and balance weight (22) from camshaft gear (14).
- (2) Remove camshaft gears in the following manner:
 - (a) Support camshaft (23) and camshaft gear (14) under gear.

NOTE

Place wooden block under lower end of camshaft to prevent thread damage when camshaft is pressed from camshaft gear.



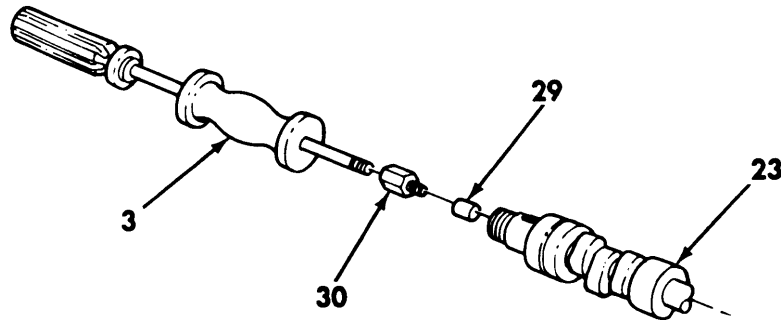
- (b) Place a short 3/4 inch diameter brass rod (24) on camshaft (23). Press camshaft out of camshaft gear (14).
- (c) Remove spacer plate (18), spacer sleeve (25), and Woodruff key (26) from camshaft (23).
- (3) If necessary, press bearing (27) from idler gear (28). Discard bearing.
- (4) Remove two camshaft end plugs (29) from camshaft (23) 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 soft-jawed vise.
- (b) Make indentation in center of end plug with 31/64-inch drill.
- (c) Punch a deep hole with a center punch to break through hardened surface of plug.
- (d) Drill a hole straight through center of plug with a 1/4-inch drill.



- (e) Use 1/4-inch drilled hole as a guide and redrill plug with 5/16-inch drill.
- (f) Tap hole with a 3/8-16 inch tap.
- (g) Thread 3/8-16-inch adapter (30) into plug. Fasten slide hammer puller set (3) to adapter. Remove and discard plug.

NOTE

If suitable rod is not available, remove remaining plug by repeating steps (a) thru (g).

- (h) Insert a long 3/8-inch steel rod into camshaft. Drive out remaining plug. Discard plug.

c. Cleaning

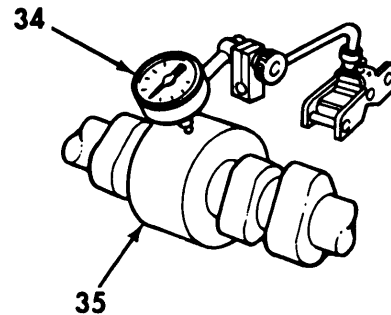
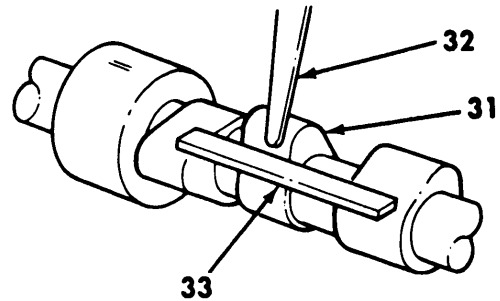
WARNING

- Dry cleaning solvent P-D-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 Degrees F (36-50 Degrees 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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (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.

3-48. CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT (Cont)

d. Inspection

- (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 (31) with thickness gages (32) and straight edge (33).
 - (b) Replace camshaft if flats are worn more than 0.003 inch.
- (3) Using dial indicator (34), measure runout of intermediate camshaft journals (35) with end journals mounted on V-blocks. Replace camshaft if runout exceeds 0.002 inch.
- (4) Examine faces of thrust washers for scoring and wear. New thrust washers are 0.208 to 0.210 inch 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 undersize on inside diameter.
 - If camshaft bearings require replacement, see Cylinder Block Maintenance (Para 3-54 or 3-55).
- (6) Using micrometer and telescoping gages, measure outside diameter of camshaft journals and inside diameter of camshaft bearings. Clearance between journals and bearings should be 0.0035-0.007 inch with new parts and a maximum of 0.008 inch 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.

e. Assembly

NOTE

Use same procedure for left and right camshaft.

- (1) Coat plugs (29) with sealing compound and press into ends of camshaft (23) to a depth of 1.940 inches.

CAUTION

Camshafts improperly installed may cause severe engine damage.

NOTE

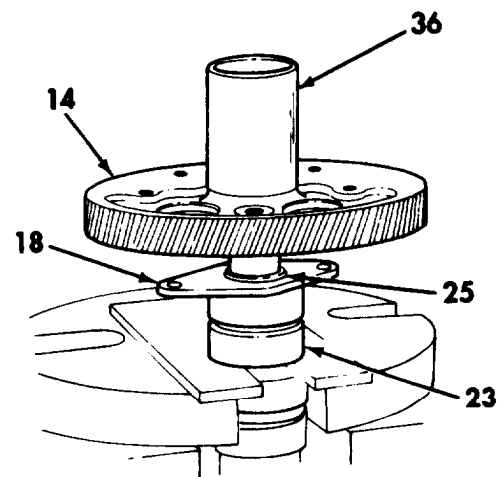
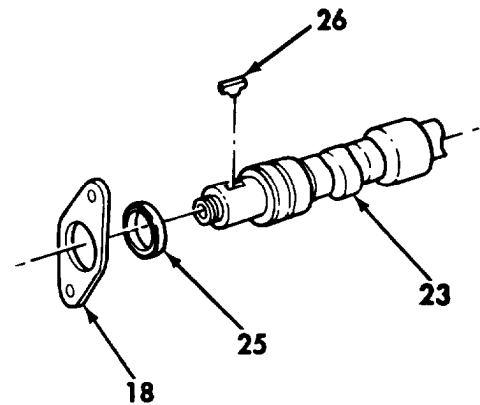
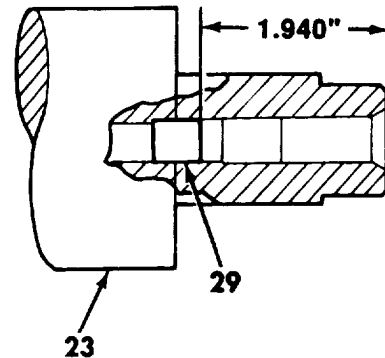
Camshafts are stamped at ends for location. Camshaft marked "RH-R BANK" goes in right bank, and camshaft marked "RH-L BANK" goes in left bank. Install camshafts with markings at rear of engine.

- (2) Install spacer sleeve (25) and Woodruff key (26) to rear of camshaft (23).
- (3) Lubricate spacer plate (18) with engine oil and place over spacer sleeve (25).

NOTE

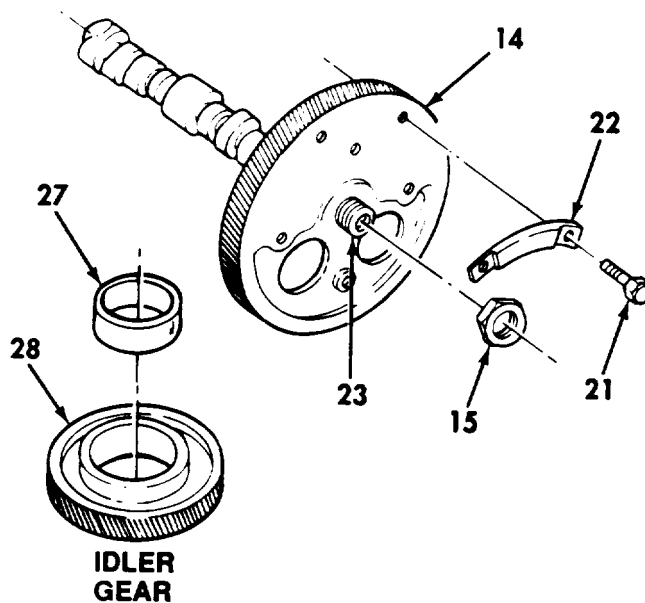
Camshaft gear with timing marks of two circles and two triangles goes on right camshaft.

- (4) Align keyway in camshaft gear (14) with Woodruff key in camshaft. Place camshaft gear on camshaft (23).
- (5) Support camshaft (23) and place 1 1/2-inch sleeve (36) on top of camshaft gear (14). Press camshaft gear tight against spacer sleeve (25).
- (6) Measure clearance between spacer plate (18) and camshaft (23). Clearance should be 0.008-0.015 inch with new parts and a maximum of 0.021 inch with used parts.



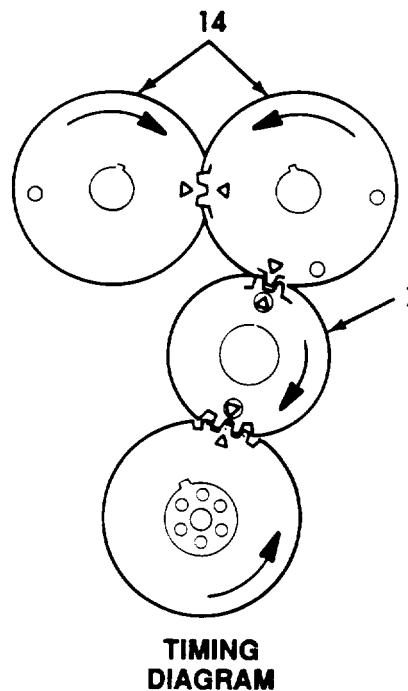
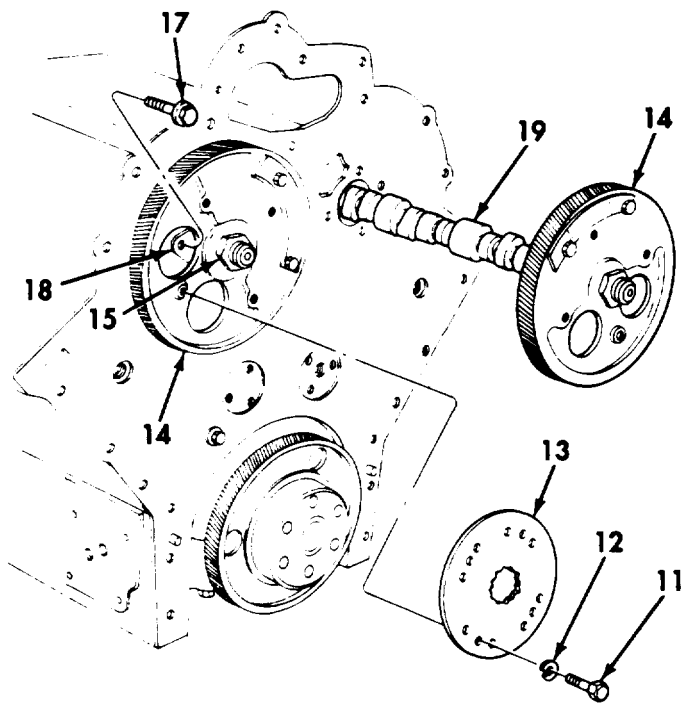
3-48. CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT (Cont)

- (7) Thread nut (15) on rear of camshaft (23) and hand tighten.
- (8) On models 5063-5392, 5063-5393, 5063-539F, and 5063-539L, install balance weight (22) and two bolts (21) on outer face of gear (14). Torque bolts to 30-35 lb-ft (41-47 N-m).
- (9) If removed, press bearing (27) into idler gear (28) until flush with both faces of gear.

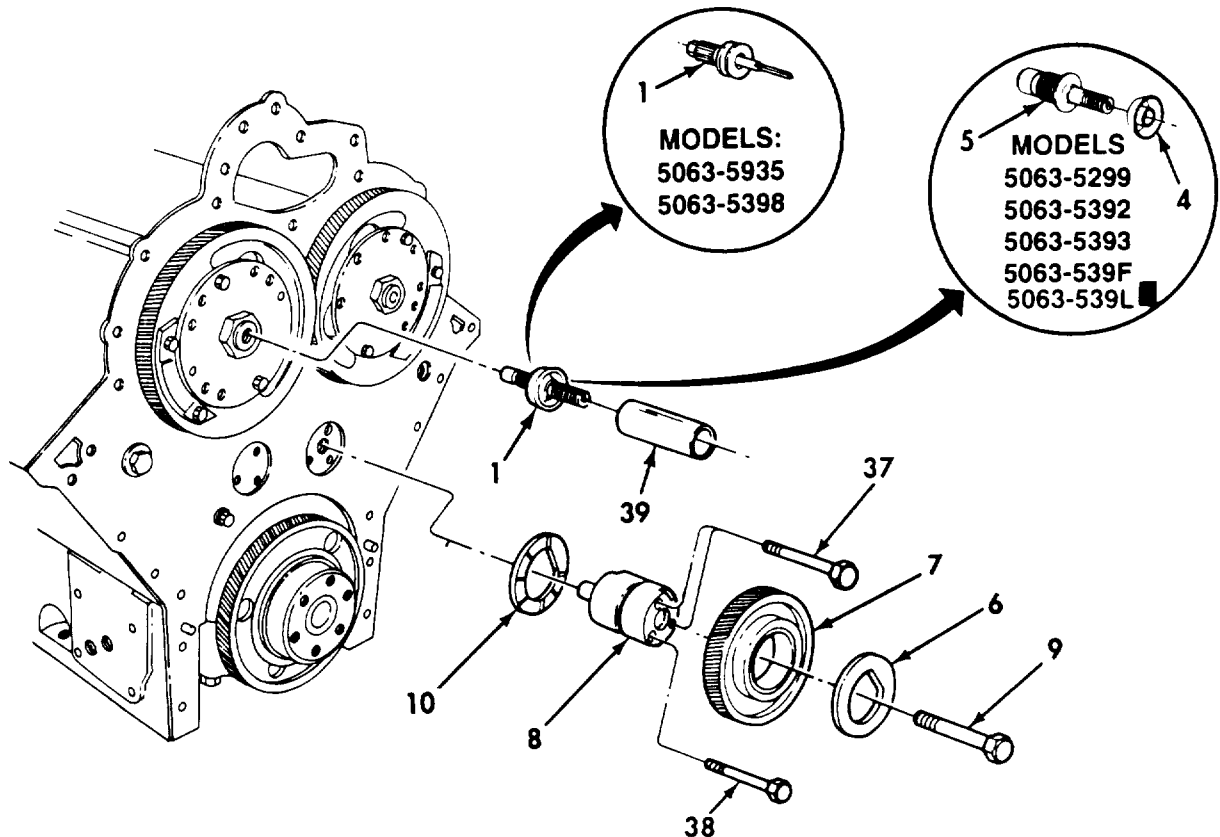


f. Installation

- (1) Lubricate camshaft bearings and journals with engine oil and slide camshaft and gear assemblies (19) into cylinder block.
- (2) Align timing marks (triangles) on camshaft gears (14) as shown in timing diagram.
- (3) Install four self-locking bolts (17) through two spacer plates (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 (15) to 300-325 lb-ft (407-441 N-m).
- (5) Install retainer plate (13), two lockwashers (12), and two screws (11) on each camshaft gear (14). Torque screws to 35-39 lb-ft (47-53 N-m).
- (6) Remove rag from between camshaft gears.



- (7) Place inner idler gear thrust washer (10) on front of gear hub (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 (8) into counterbore of cylinder block.
- (9) Thread two large pilot screws (37) and small pilot screw (38) through gear hub (8) and into cylinder block.



- (10) Install screw (9) in center hole in gear hub (8). Torque bolt to 40-45 lb-ft (54-61 N-m) Remove two large pilot screws (37) and small pilot screw (38) from gear hub.
- (11) Lubricate gear hub (8), idler gear bearing (27), and inner thrust washer (10) with engine oil
- (12) Slide idler gear assembly (7) over gear hub (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 (6). Place thrust washer over gear hub (8) with grooved face toward idler gear and flat in thrust washer over flat of gear hub.

NOTE

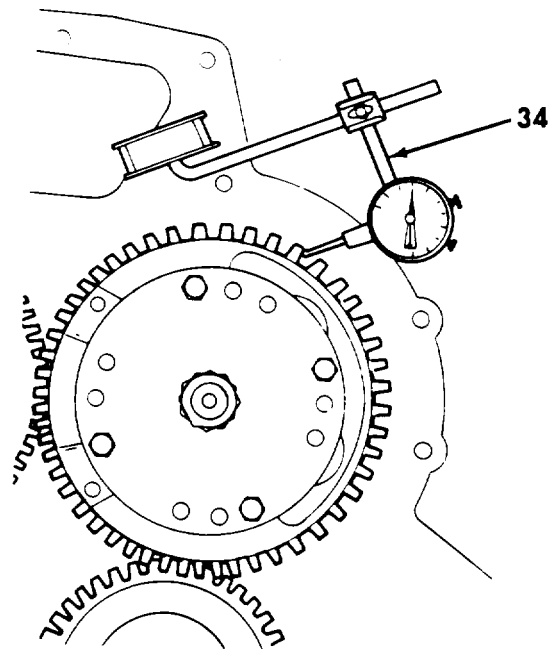
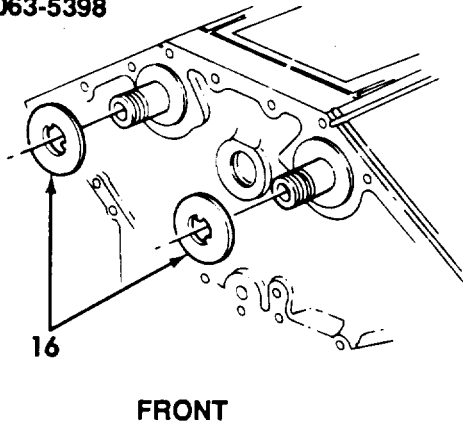
Fit between dirt deflector and tachometer drive shaft must be sufficiently snug to require some degree of force to move dirt deflector. If necessary, use sealing compound, MIL-R-46082, between parts to correct fit.

- (14) For models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L: if removed, Install tachometer dirt deflector (4) on tachometer drive shaft (5).
- (15) Using a sleeve (39), tap tachometer drive assembly (1) into rear of left camshaft.

3-48. CAMSHAFTS, CAMSHAFT GEARS, AND IDLER GEAR REPLACEMENT (Cont)

- (16) On model 5063-5398, install dirt deflector (16) to front of each camshaft.
- (17) Using a magnetic base dial indicator (34), measure backlash between mating gears. Backlash should be 0.0005 to 0.005 inch with new gears and a maximum of 0.007 inch with used gears.

**MODEL:
5063-5398**



END OF TASK

FOLLOW-ON MAINTENANCE

- 3-47 Install fuel pump and hydraulic pump drive assemblies.
- 3-46 Install upper front cover.
- 3-43 Install cylinder heads.
- 3-40 Install flywheel assembly.
- 3-44 Install flywheel housing.
- 3-39 Install fan support bracket (model 5063-5392).
- 3-10 Install air box heater hardware (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F).
- 3-11 Install air box heater hardware (model 5063-5392).
- 3-12 Install air box heater hardware (models 5063-5393 and 5063-539L).
- 3-13 Install air box heater.

3-49. END PLATE REPLACEMENT

This task covers: a. Removal
 e. Installation

b. Disassembly

c. Cleaning

d. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)

MATERIALS/PARTS

1 Gasket (App F, Item 61)
10 Lockwashers (App F, Item 99)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
Adhesive, gasket (App C, Item 1)

EQUIPMENT CONDITION

Para Description

3-3 Turbocharger removed (models
5063-5393, 5063-5395, 5063-5398,
5063-539F, and 5063-539L)

3-5 Turbocharger mounting bracket and
exhaust tubes removed (models
5063-5093 and 5063-539L)

3-6 Turbocharger mounting bracket and
exhaust tubes removed (models
5063-5395, 5063-5398, and 5063-539F)

3-23 Fuel pump removed

3-28 Tachometer drive removed (models
5063-5299, 5063-5392, 5063-5393,
5063-539F, and 5063-539L)

3-29 Tachometer drive removed (models
5063-5395 and 5063-5398)

3-33 Oil pan removed

3-40 Flywheel assembly removed

3-44 Flywheel housing removed

3-47 Fuel pump and hydraulic pump drive
assemblies removed

3-48 Camshafts, camshaft gears, and idler
gear removed

a. Removal

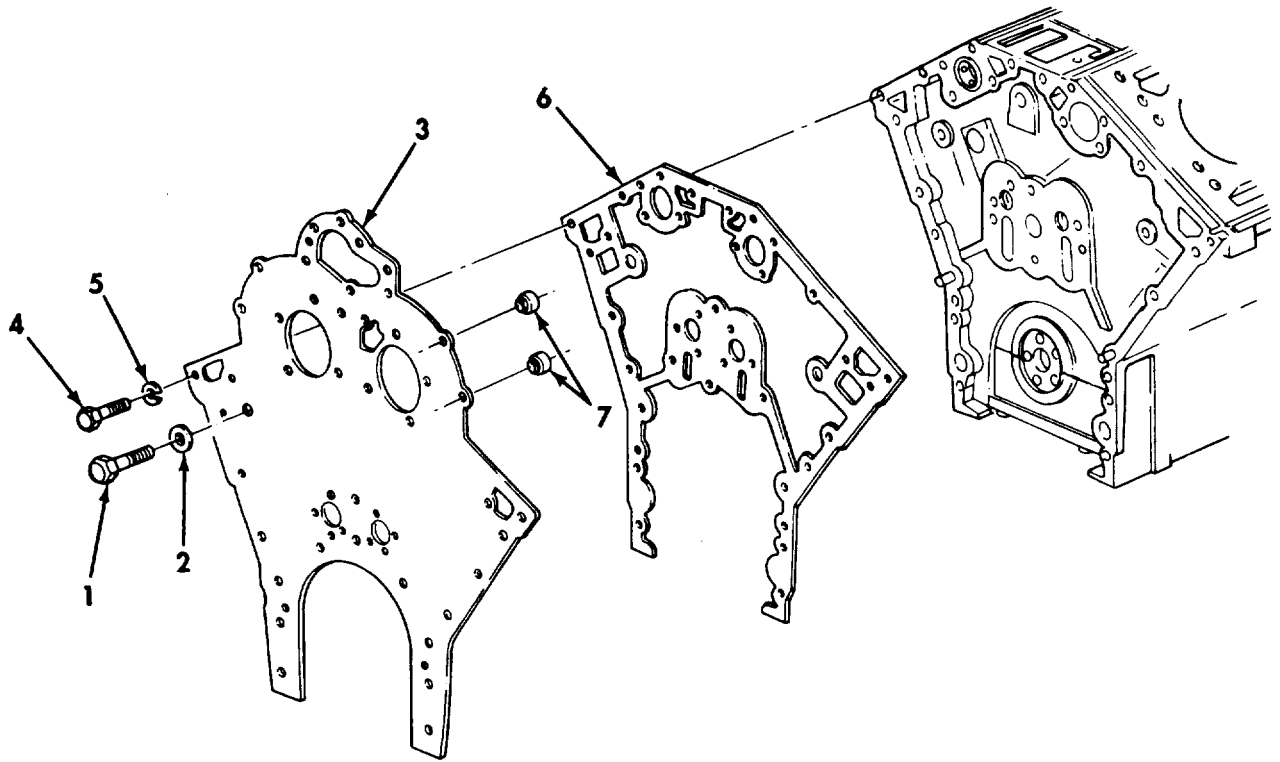
- (1) For all except model 5063-5393, remove screw (1) and special washer (2) from left side of end plate (3).
- (2) Remove ten screws (4), ten lockwashers (5), end plate (3), and gasket (6) from cylinder block. Discard gasket and lockwashers.

b. Disassembly

CAUTION

When removing inserts, support end plate on flat surface to prevent warping or bending.

If necessary, press out inserts (7) from rear of end plate (3).



c. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (1) Remove all gasket material from end plate and wash plate with cleaning solvent.
- (2) Check plate for nicks, dents, scratches, score marks, and warpage.
- (3) Inspect screw inserts for cracks and damaged threads.

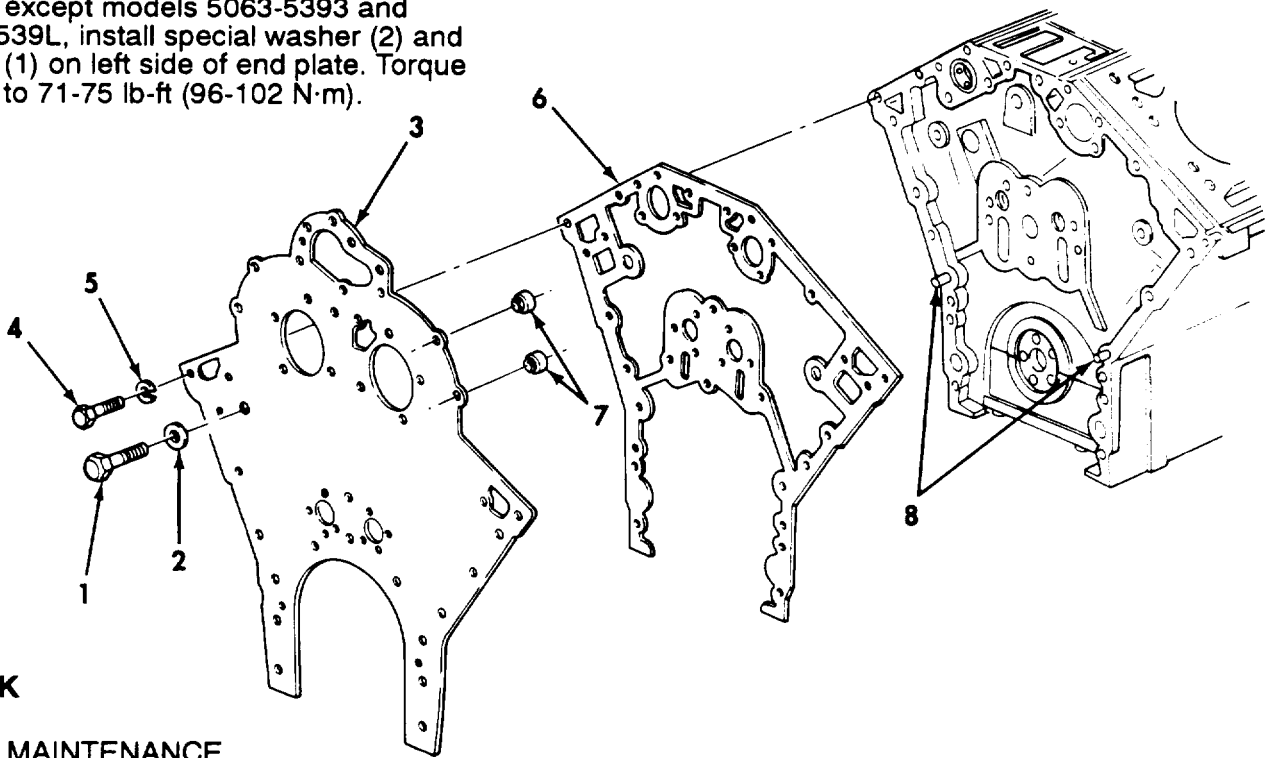
3-49. END PLATE REPLACEMENT (Cont)

d. Assembly

If screw inserts (7) were removed, support end plate (3) on flat surface and press screw inserts into plate from front until insert seats on end plate.

e. Installation

- (1) Install gasket (6) on rear of cylinder block using gasket adhesive.
- (2) Apply a coat of gasket adhesive to outer surface of gasket (6).
- (3) Align holes in end plate (3) with dowels (8) in cylinder block. Push end plate against cylinder block.
- (4) Install ten lockwashers (5) and ten screws (4). Torque screws to 30-35 lb-ft (41-47 N-m).
- (5) On all except models 5063-5393 and 5063-539L, install special washer (2) and screw (1) on left side of end plate. Torque screw to 71-75 lb-ft (96-102 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-48 Install camshafts, camshaft gears, and idler gear.
- 3-47 Install fuel pump and hydraulic pump drive assemblies.
- 3-44 Install flywheel housing.
- 3-40 Install flywheel assembly.
- 3-33 Install oil pan.
- 3-28 Install tachometer drive (models 5063-5299, 5063-5392, 5063-5393, 5063-539F, and 5063-539L).
- 3-29 Install tachometer drive (models 5063-5395 and 5063-5398).
- 3-23 Install fuel pump.
- 3-5 Install turbocharger mounting bracket and exhaust tubes (models 5063-5393 and 5063-539L).
- 3-6 Install turbocharger mounting bracket and exhaust tubes (models 5063-5395, 5063-5398, and 5063-539F).
- 3-3 Install turbocharger (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L).

Section IV. GENERAL SUPPORT ENGINE DISASSEMBLY/ASSEMBLY

Contents	Para	Page
Piston and Connecting Rod Maintenance - Trunk (Models 5063-5299, 5063-5395, and 5063-5398).....	3-50...	3-178
Piston and Connecting Rod Maintenance -Cross-head Piston (Models 5063-5392, 5063-5393, 5063-539F and 5063-539L)	3-51. . .	3-196 ■
Cylinder Liner Maintenance	3-52...	3-214
Crankshaft Maintenance	3-53...	3-220
Cylinder Block Maintenance (All Except Model 5063-5398)	3-54. . .	3-230
Cylinder Block Maintenance (Model 5063-5398).	3-55. . .	3-242

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5396)

This task covers: a. Removal b. Disassembly c. Cleaning d. Inspection
 e. Fitting Piston f. Fitting Piston Rings g. Assembly h. Installation

INITIAL SETUP

MODELS

5063-5299 5063-5395 5063-5398

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Clamps, hold-down (App B, Item 14)
- Reamer, cylinder ridge (App B, Item 82)
- Cleaner, piston ring groove (App B, Item 15)
- Die set, metal stamping, hand (App B, Item 20)
- Pliers, piston ring (App B, Item 75)
- Installer, piston pin retainer (App B, Item 67)
- Leak detector, piston pin retainer (App B, Item 71)
- Compressor, piston ring (App B, Item 16)
- Gage set, piston-liner thickness (App B, Item 32)
 - Spring scale
 - Gage set, thickness
- Micrometer 0-1 inch (App B, Item 73)
 - Micrometer 0-1 inch
 - Micrometer 3-4 inch
 - Micrometer 1-2 inch
- Ball attachment, micrometer (App B, Item 8)
- Vise, machinist (App B, Item 111)
- Caps, vise jaw (App B, Item 13)

MATERIALS/PARTS

- 1 Ring, piston (App F, item 139) *
- 1 Ring, piston (App F, Item 141) **
- 3 Rings, piston (App F, Item 140)

MATERIALS/PARTS (Cont)

- 1 Ring set, oil (App F, Item 137)*
- 1 Ring set, oil (App F, Item 136) **
- 2 Retainers, piston pin (App F, Item 134)
- 2 Packings, preformed (App F, Item 116)

- * Model 5063-5299
- ** Models 5063-5395 and 5063-5398

EXPENDABLE/DURABLE SUPPLIES

- Carbon removing compound (App C, Item 5)
- Cleaning solvent (App C, Item 9)
- Plastic gage, green (App C, Item 16)
- Plastic gage, red (App C, Item 17)
- Stone, sharpening X-fine (App C, Item 51)
- Oil, engine (App C, Item 26)
- Wood block (App C, Item 58)
- Crocus cloth (App C, Item 10)
- Oil, fuel (App C, Item 27)
- Shortening compound (App C, Item 47)
- Antifreeze (App C, Item 3)

EQUIPMENT CONDITION

Para	Description
3-33	011 pan removed
3-34	Oil pump inlet tubes removed (model 5063-5299)
3-35	Oil pump inlet tubes removed (models 5063-5395 and 5063-5398)
3-43	Cylinder head removed

a. Removal

- (1) Install a hold-down clamp (1) on each cylinder to anchor liners (2) during crankshaft rotation.
- (2) Rotate crankshaft (3) until connecting rod journal (4) being worked on is at bottom of its travel.
- (3) Remove hold-down clamp (1) 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 (2).

- (5) Remove two nuts (5), cap (6), and lower bearing shell (7) from piston and connecting rod assembly (8).

NOTE

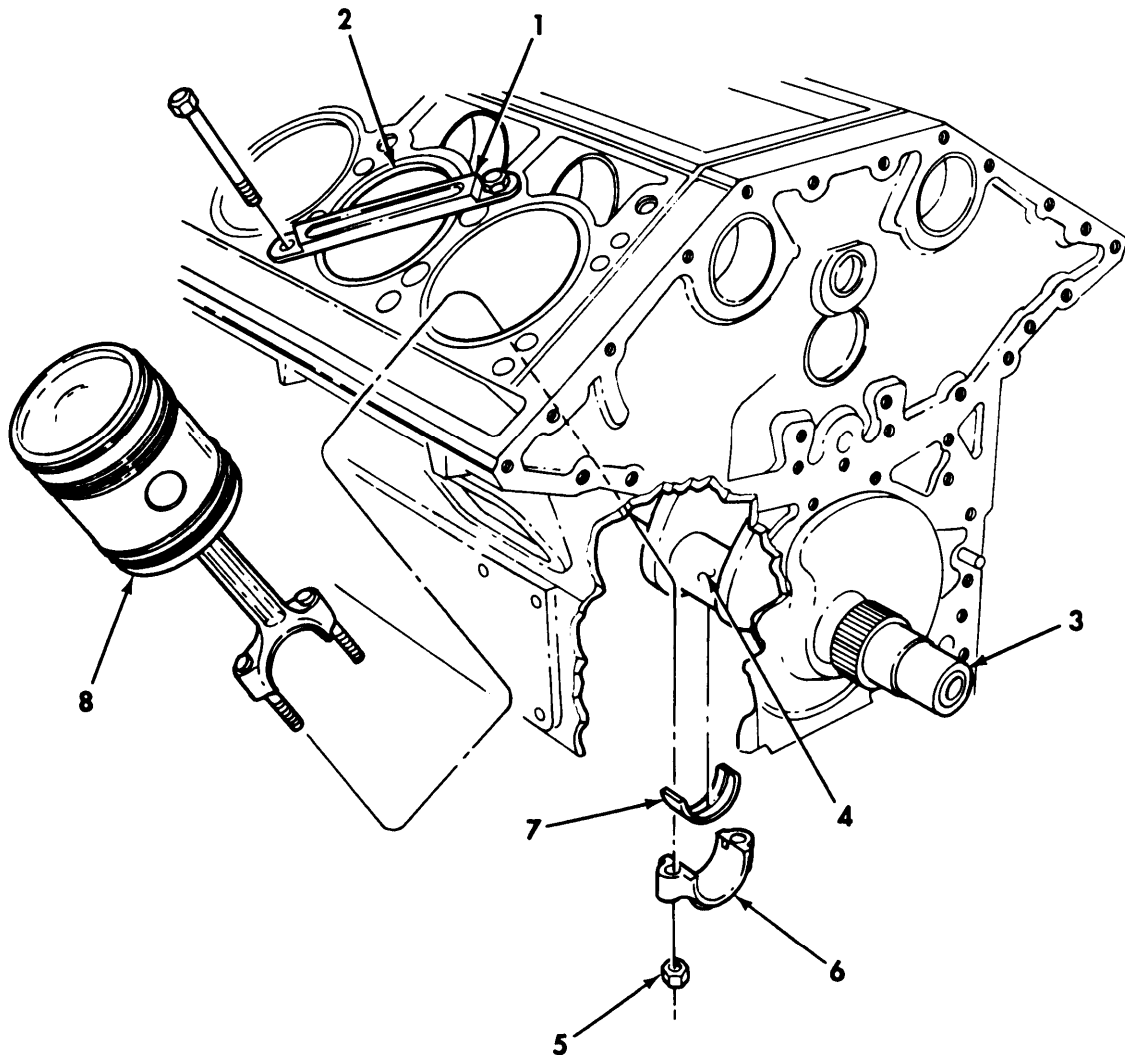
Tag piston assembly and liner with cylinder number for matching during reassembly.

- (6) Push piston and connecting rod assembly (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 (6), lower bearing shell (7), and two nuts (5) on piston and connecting rod assembly (8).
- (8) Repeat steps (2) thru (7) for remaining piston and connecting rod assemblies (8).



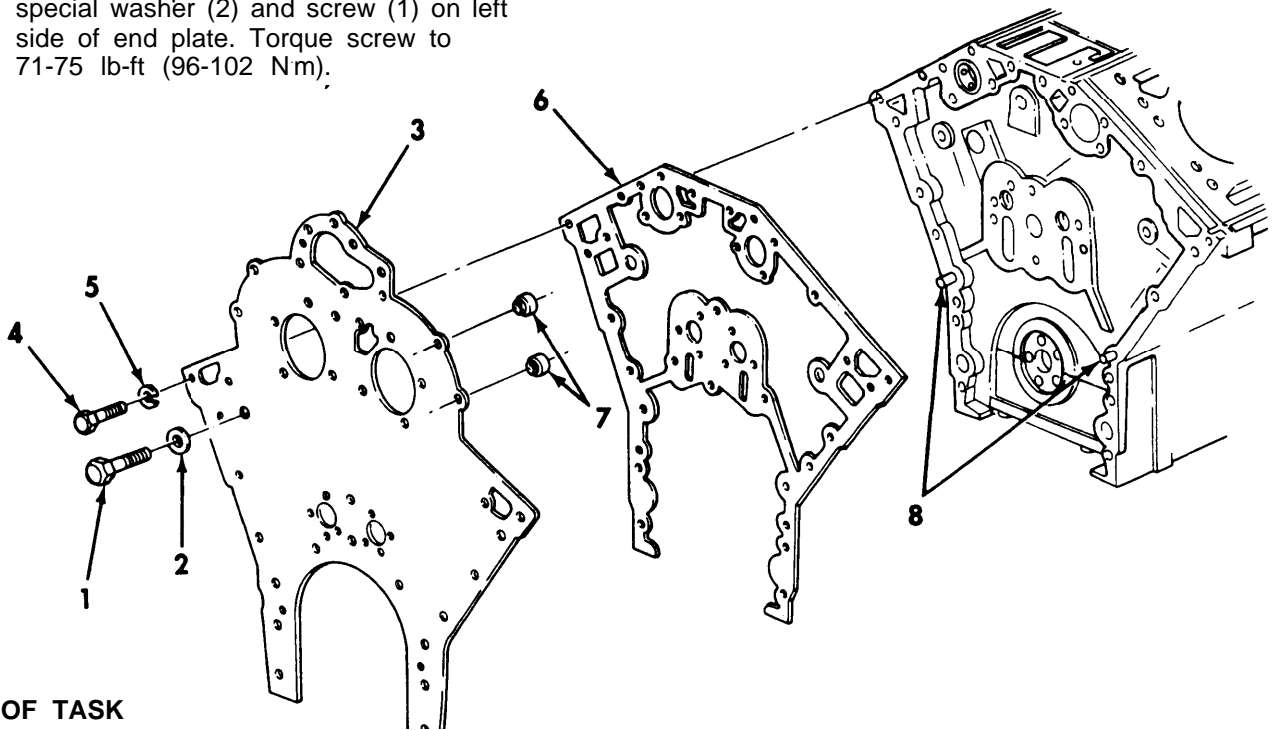
3-49. END PLATE REPLACEMENT (Cont)

d. Assembly

If screw inserts (7) were removed, support end plate (3) on flat surface and press screw inserts into plate from front until insert seats on end plate.

e. Installation

- (1) Install gasket (6) on rear of cylinder block using gasket adhesive.
- (2) Apply a coat of gasket adhesive to outer surface of gasket (6).
- (3) Align holes in end plate (3) with dowels (8) in cylinder block. Push end plate against cylinder block.
- (4) Install ten lockwashers (5) and ten screws (4). Torque screws to 30-35 lb-ft (41-47 Nm).
- (5) On all except model 5063-5393, install special washer (2) and screw (1) on left side of end plate. Torque screw to 71-75 lb-ft (96-102 Nm).



END OF TASK

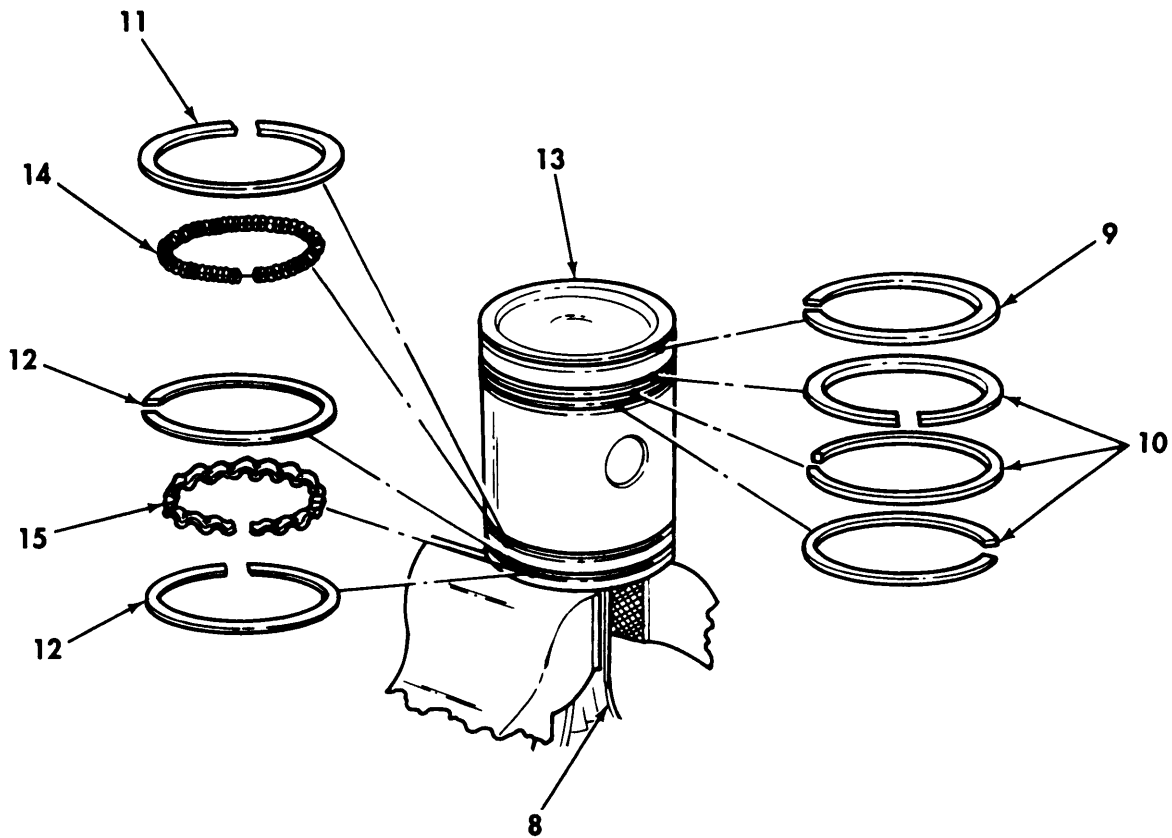
FOLLOW-ON MAINTENANCE

- | Para | Description |
|------|---|
| 3-48 | Install camshafts, camshaft gears, and idler gear. |
| 3-47 | Install fuel pump and hydraulic pump drive assemblies. |
| 3-44 | Install flywheel housing. |
| 3-40 | Install flywheel assembly. |
| 3-33 | Install oil pan. |
| 3-28 | Install tachometer drive (models 5063-5299, 5063-5392, 5063-5393, and 5063-539F). |
| 3-29 | Install tachometer drive (models 5063-5395 and 5063-5398). |
| 3-23 | Install fuel pump. |
| 3-5 | Install turbocharger mounting bracket and exhaust tubes (model 5063-5393). |
| 3-6 | Install turbocharger mounting bracket and exhaust tubes (models 5063-5395, 5063-5398, and 5063-539F). |
| 3-3 | Install turbocharger (models 5063-5393, 5063-5395, 5063-5398, and 5063-539F). |

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

b. Disassembly

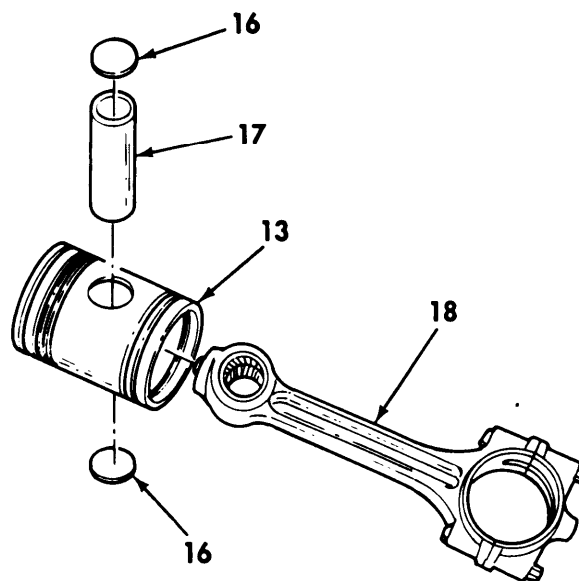
- (1) Secure piston and connecting rod assembly (8) in a soft-jawed vise. Remove fire ring (9), three compression rings (10), upper oil ring (11), and two lower oil rings (12) from piston (13) using piston ring pliers. Remove spiral oil ring expander (14) and wavy oil ring expander (15) from lower grooves in piston. Discard rings and expanders.
- (2) Remove piston and connecting rod assembly (8) from soft-jawed vise and lay horizontally on flat surface.



CAUTION

Use care not to damage piston or bushings during removal of piston pin retainers.

- (3) Punch a hole through center of one piston pin retainer (16) and pry retainer from piston (13). Discard retainer.
- (4) Remove piston pin (17) and connecting rod assembly (18) from piston (13).
- (5) Drive remaining piston pin retainer (16) out from inside. Discard retainer.



CAUTION

Do not remove bushings in piston or connecting rod. These parts are not serviced.

- (6) Repeat steps (1) thru (5) for remaining piston and connecting rod assemblies (8).

c. Cleaning

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- 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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

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.

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

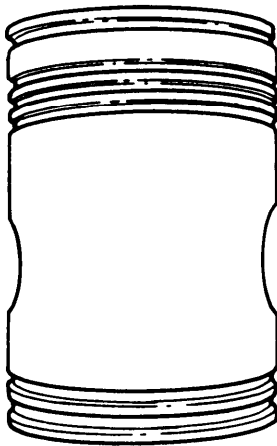
d. Inspection

NOTE

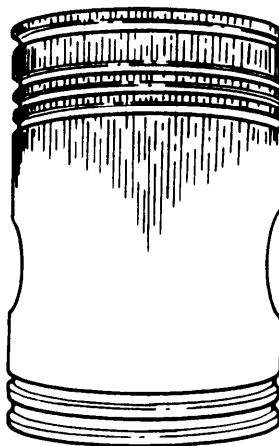
Trunk piston can come in two configurations as shown. The new configuration has eight or sixteen oil drain holes and J-relief. The old configuration has eight oil drain holes and no J-relief. Either configuration is acceptable and matching throughout an engine is not required.

(1) Piston

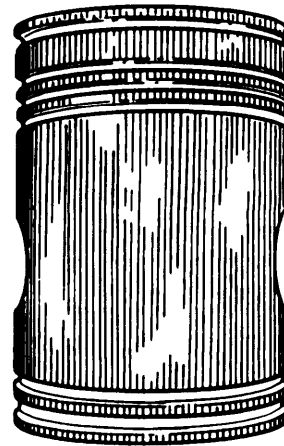
- (a) Check cylinder liner and block bore for excessive out of round, taper, or high spots which could cause failure of piston (see Para 3-52).



PISTON SUITABLE FOR
INSTALLATION AS IS.



PISTON SLIGHTLY SCORED. USE ONLY
AFTER REMOVING SCORE MARKS
BY POLISHING WITH CROCUS
CLOTH OR HARD INDIA STONE.

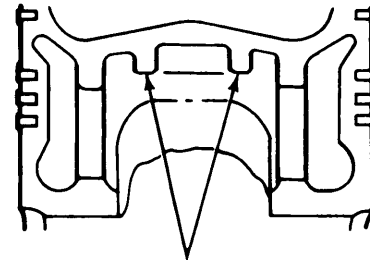


PISTON BADLY SCORED -
UNFIT FOR USE.

NOTE

Overheating or burned spots on piston may indicate an obstruction in connecting rod oil passage.

- (b) 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.



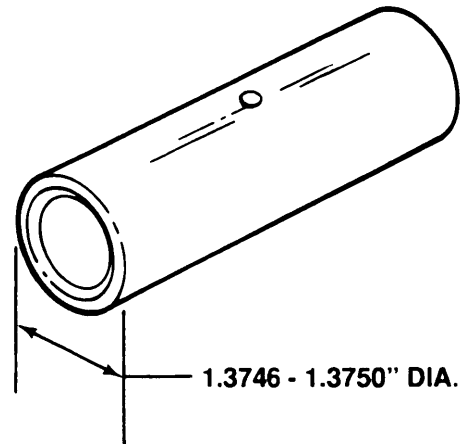
**INTERNAL
STRUTS**

(2) Piston Pin

CAUTION

Do not polish or refinish piston pin. Hand polishing or refinishing will destroy precision finish and result in rapid bushing wear.

- (a) Inspect piston pin for signs of fretting. Discard piston pin if fretting is present.
- (b) Measure piston pin diameter. Diameter of new piston pin is 1.3746 to 1.3750 inches.



(3) Connecting Rod

- (a) Check connecting rod 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.
- (b) Check for cracks using the magnetic particle inspection method (reference MIL-C-1949).

NOTE

Overheated bushings may become loose and creep together, thus blocking off supply of lubricating oil to piston pin and spray nozzle.

- (c) Check connecting rod bushings for indications of scoring, overheating, or other damage.

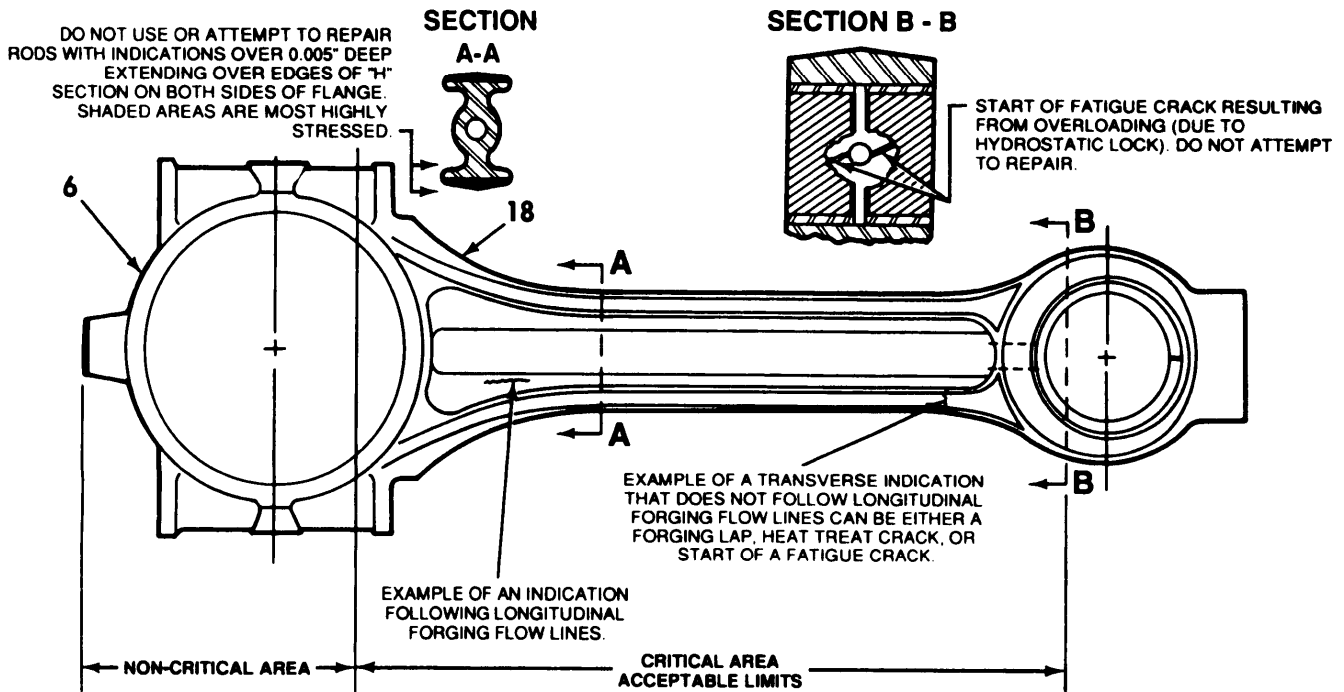
WARNING

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

- (d) 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.
- (e) Inspect connecting rod bearing bores for burrs or foreign particles, Clean up minor burrs with crocus cloth using circular motion.

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

(f) When installing a new connecting rod assembly, stamp cylinder number on connecting rod (18) and cap (6) using metal stamping die set.

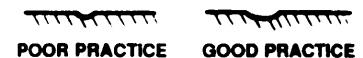


INDICATIONS IN NONCRITICAL AREAS ARE ACCEPTABLE UNLESS THEY CAN BE OBSERVED AS OBVIOUS CRACKS WITHOUT MAGNETIC INSPECTION.

LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE USUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 0.03" DEEP DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

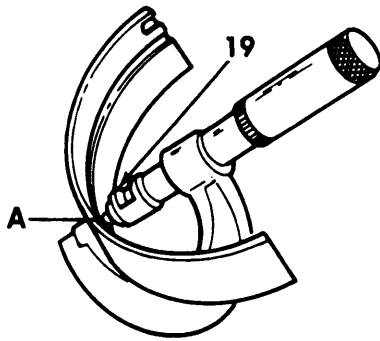
TRANSVERSE INDICATIONS (ACROSS FLOW LINES) HAVING A MAXIMUM LENGTH OF 0.5" WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 0.016" ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL. AN EXCEPTION TO THIS CASE IS A ROD HAVING AN INDICATION WHICH EXTENDS OVER THE EDGE OF "H" SECTION AND IS PRESENT ON BOTH SIDES OF THE FLANGE. IN THIS CASE, MAXIMUM ALLOWABLE DEPTH IS 0.005" (SEE SECTION A-A).

GRINDING NOTES: CARE SHOULD BE TAKEN IN GRINDING OUT INDICATIONS TO ASSURE PROPER BLENDING OF GROUND AREA INTO UNGROUND SURFACE SO AS TO FORM A SMOOTH CONTOUR.



(4) Connecting Rod Bearings

- (a) Inspect bearing shells for scoring, pitting, flaking, etching, and dirt grooving. If defective, discard bearing shells.
- (b) 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 3-5, replace both bearing shells (upper and lower).

TABLE 3-5. 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.

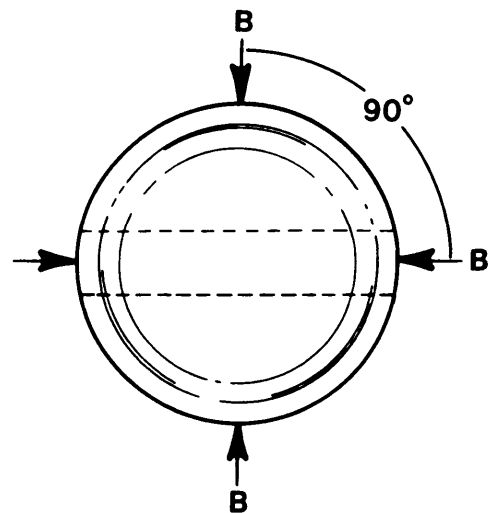
- (c) Using a micrometer and ball attachment (19), measure thickness of lower and upper connecting rod bearing shells at point (A), 90 degrees from parting line.

e. Fitting Piston

NOTE

Fit new or used piston to corresponding cylinder liner and retain as matched set for assembly in engine.

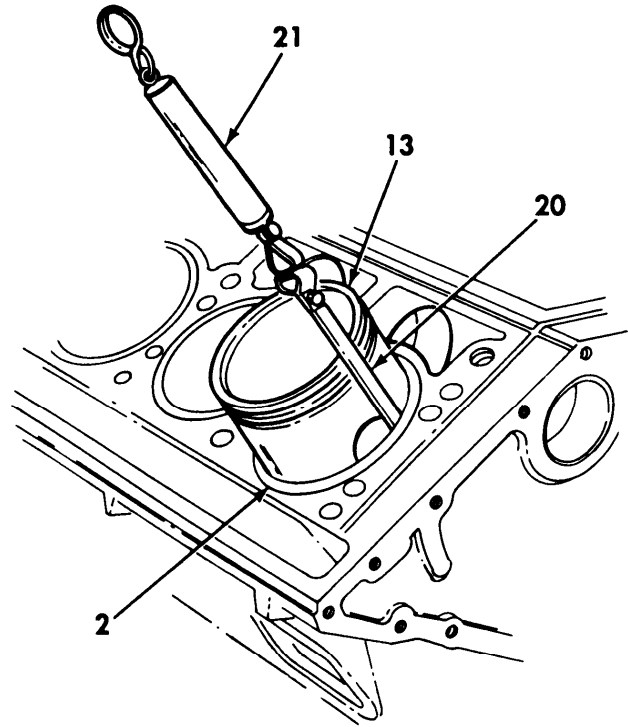
- (1) Using a micrometer, measure piston skirt outside diameter (B) parallel to and perpendicular with piston pin bore at room temperature, 70°F (21°C). Skirt diameter for model 5063-5299 is 3.8699 to 3.8721 inches. Skirt diameter for models 5063-5395 and 5063-5398 is 3.8679 to 3.8701 inches. Taper and out-of-round must not exceed 0.0005 inch.



3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

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 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.



- (2) With cylinder liner (2) in cylinder block, hold piston (13) upside down in liner and measure clearance in four places, 90 degrees apart, using a thickness gage (20) attached to a spring scale (21). Clearance for model 5063-5299 must be 0.0027 to 0.0068 inch for new parts and to 0.010 inch for used parts. Clearance for models 5063-5395 and 5063-5398 must be 0.0047 to 0.0088 inch for new parts and to 0.012 inch for used parts.

- (3) 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.

f. Fitting Piston Rings

- (1) Insert piston ring inside cylinder liner in normal area of ring travel. Using the piston, push ring down parallel with top of liner (2). Measure ring gap with thickness gage. Refer to Table 3-6 for ring gap specifications. Repeat procedure for balance of compression and oil rings.

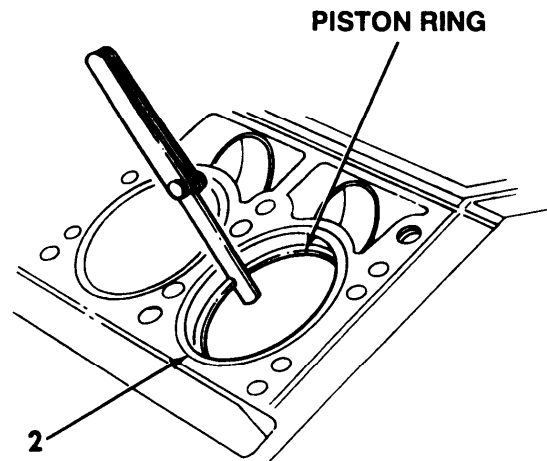


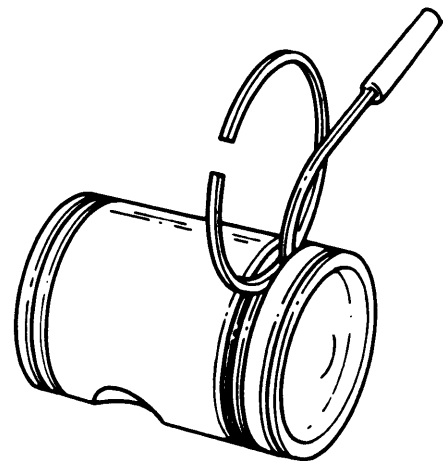
TABLE 3-6. PISTON RING SPECIFICATIONS

	MINIMUM	MAXIMUM
RING GAP		
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)
CLEARANCE (RING TO GROOVE)		
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)
Third and Fourth Grooves Models 5063-5395 and 5063-5398	0.0050 in. (0.127 mm)	0.0080 in. (0.203 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.

- (2) 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.
- (3) Using thickness gage, measure ring side clearance. Refer to Table 3-6 for ring side clearance specifications.



3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

g. Assembly

(1) Connecting Rod Assembly to Piston

- (a) Apply clean engine oil to piston pin, piston pin bushings, and connecting rod bushings.

CAUTION

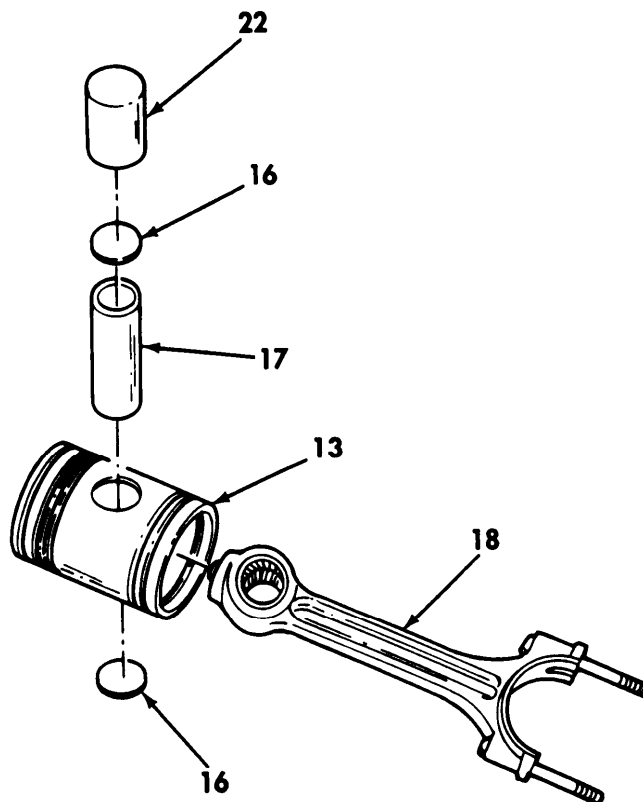
Do not drive piston pin retainer in too far. Retainer may move piston bushing inward and result in reduced piston pin end clearance.

- (b) Insert one piston pin retainer (16) in position. Then place crowned end of installer (22) against retainer and strike installer just hard enough to deflect retainer and seat it evenly in piston (13).

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 maximum are allowed.

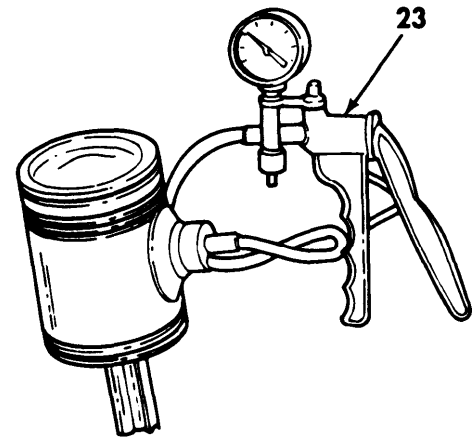
- (c) Place upper end of connecting rod assembly (18) between piston pin bosses and in line with piston pin holes. Then slide piston pin (17) in place.
- (d) Repeat step (b) for second piston pin retainer (16).
- (e) Check for piston pin end clearance by cocking connecting rod and shifting pin in bushings.



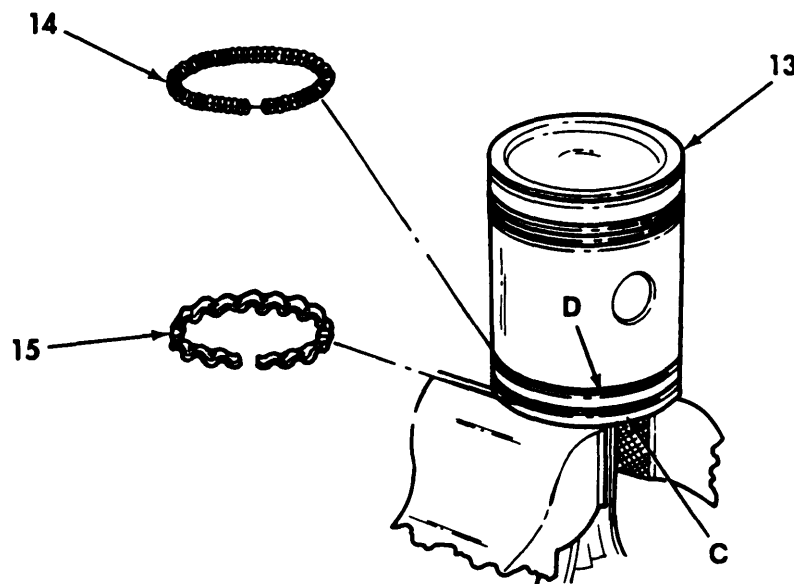
NOTE

Clean piston surface around piston pin retainer before measuring retainer leakage.

- (f) Check each piston pin retainer for proper sealing with leak detector (23). Place suction cup over retainer and hand operate lever to pull a vacuum of 10.0 inches of mercury on gage. A drop of more than 5.0 inches of mercury in gage reading over 10 seconds indicates air leakage at retainer.

**(2) Installation - Piston Rings**

- (a) Lubricate 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 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 wavy ring expander (15) in oil control ring groove (C) in piston (13).

(c) Install spiral ring expander (14) in oil control ring groove (D) in piston (13).

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

WARNING

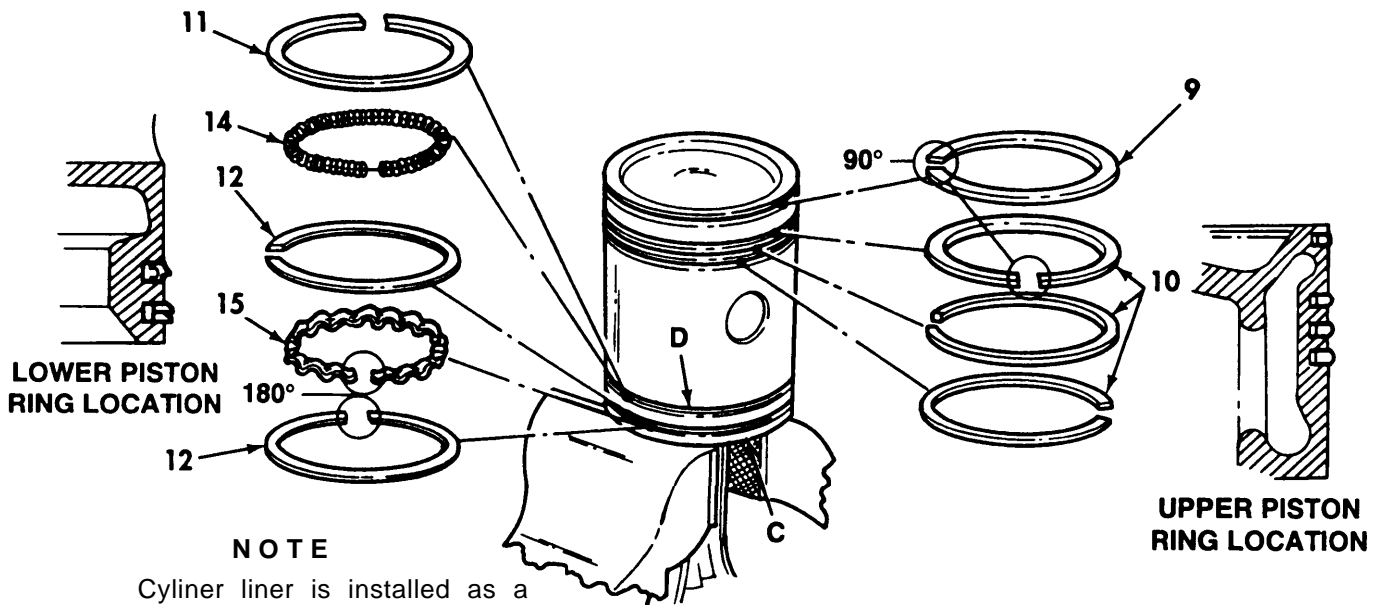
Do not grasp or graze sharp edges of oil control rings with bare hands. Rings are extremely sharp and can cut personnel when mishandled.

CAUTION

Do not spread rings more than necessary to slip over piston. Ring breakage and overstressing 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 lower oil control ring (12) in lower groove with gap 180 degrees from gap in expander (15) 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 pliers, position upper oil control ring (11) over groove D. Position gap in oil ring 180 degrees from gap in expander (14). Press ring against gap side of expander to prevent ends of expander from overlapping. Align ring with groove and release tension on pliers.
- (f) Starting with bottom compression ring, install three compression rings (10) and fire ring (9) using piston ring pliers. Install fire ring with side marked "TOP" or side with dark color dot toward top of piston (13).
- (g) Stagger compression and fire ring gaps around piston a minimum of 90 degrees from each other.



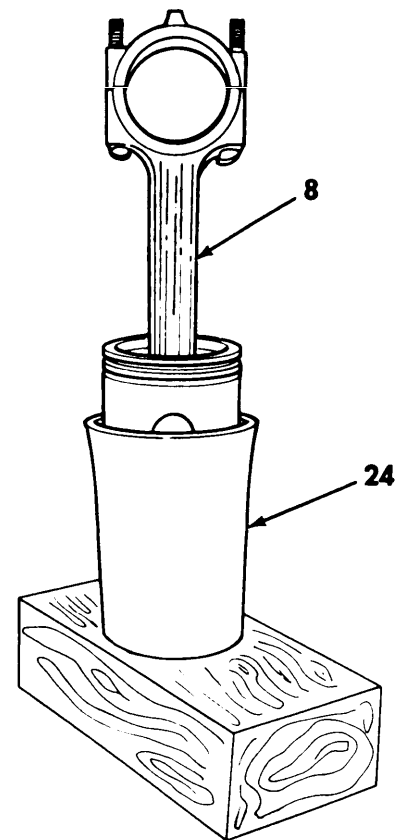
(3) Piston and Connecting Rod Assembly into Cylinder Liner

- (a) Apply clean engine oil to piston, rings, and residue surface of piston ring compressor.

CAUTION

Inspect ring compressor for nicks or burrs, especially at inside diameter of small end. Nicks or burrs on inside diameter of compressor will result in damage to piston rings.

- (b) Place piston ring compressor (24) on a wood block with larger end of 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 (8) straight into ring compressor (24). Then push piston down until it contacts wood block.

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

- (d) Place cylinder liner (2) with flange end down on wood block.

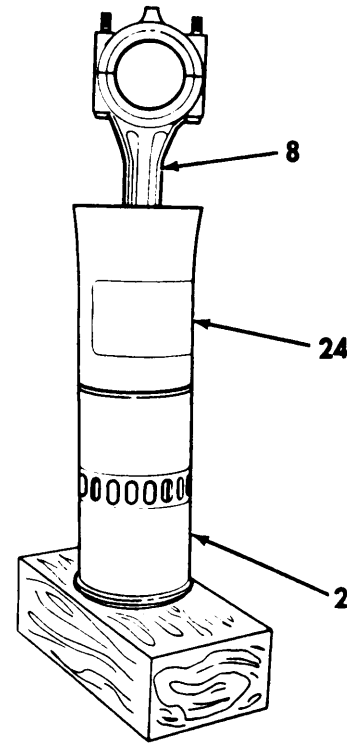
NOTE

Numbers on side of connecting rod and cap identify the cylinder location where they were originally used.

- (e) Place ring compressor (24) and piston and connecting rod assembly (8) on liner (2) with numbers on side of connecting rod and cap aligned with matchmark on liner (Para 3-52).

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 (8) down into liner until piston is free of ring compressor (24).
 - (g) Remove connecting rod cap and then remove ring compressor from piston, connecting rod, and liner assembly. Push piston down until compression rings pass cylinder liner ports.
- (4) Repeat steps (1) thru (3) for remaining piston and connecting rod assemblies.

h. Installation - Cylinder Kit Assembly

CAUTION

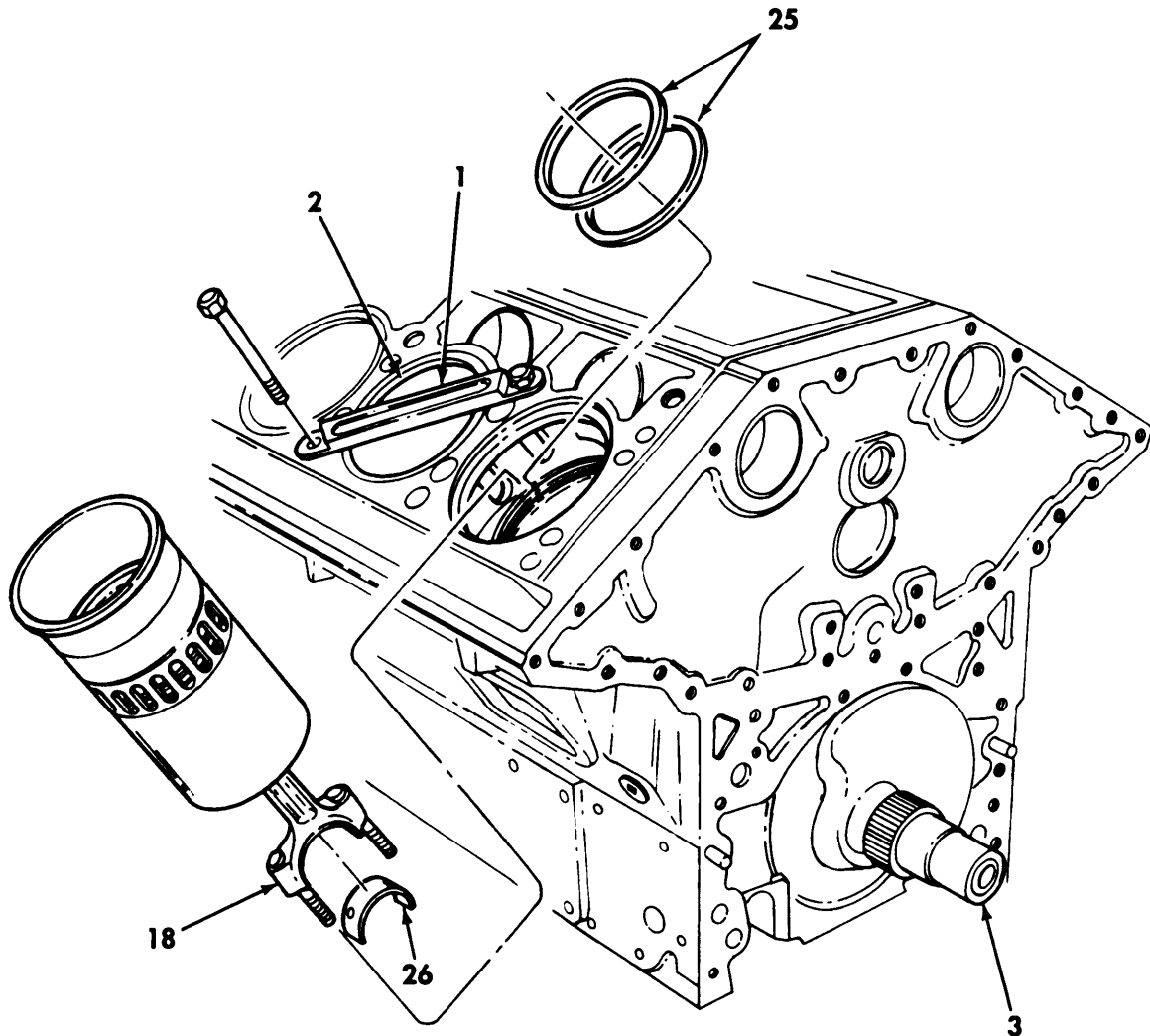
Cylinder block bore grooves must be clean. Debris in grooves will cause coolant leakage into engine oil and engine damage can result.

NOTE

If any pistons and liners are already in engine, use hold-down clamps (1) to retain liners (2) in place when rotating crankshaft.

- (1) Install two preformed packings (25) in cylinder block bore grooves.

- (2) Apply shortening compound or antifreeze to inner surface of preformed packings (25).
- (3) Rotate crankshaft (3) until connecting rod journal of cylinder is at bottom of its travel. Wipe journal clean and lubricate with clean engine oil.



NOTE

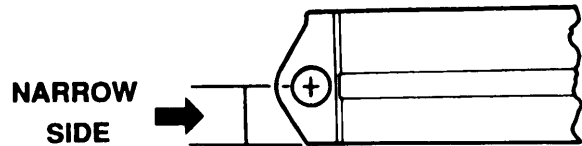
Tang on bearing shell must fit in indentation on connecting rod.

- (4) Install upper bearing shell (26) (without continuous oil groove) in connecting rod (18). Lubricate bearing shell with clean engine oil.

3-50. PISTON AND CONNECTING ROD MAINTENANCE - TRUNK (MODELS 5063-5299, 5063-5395, AND 5063-5398) (Cont)

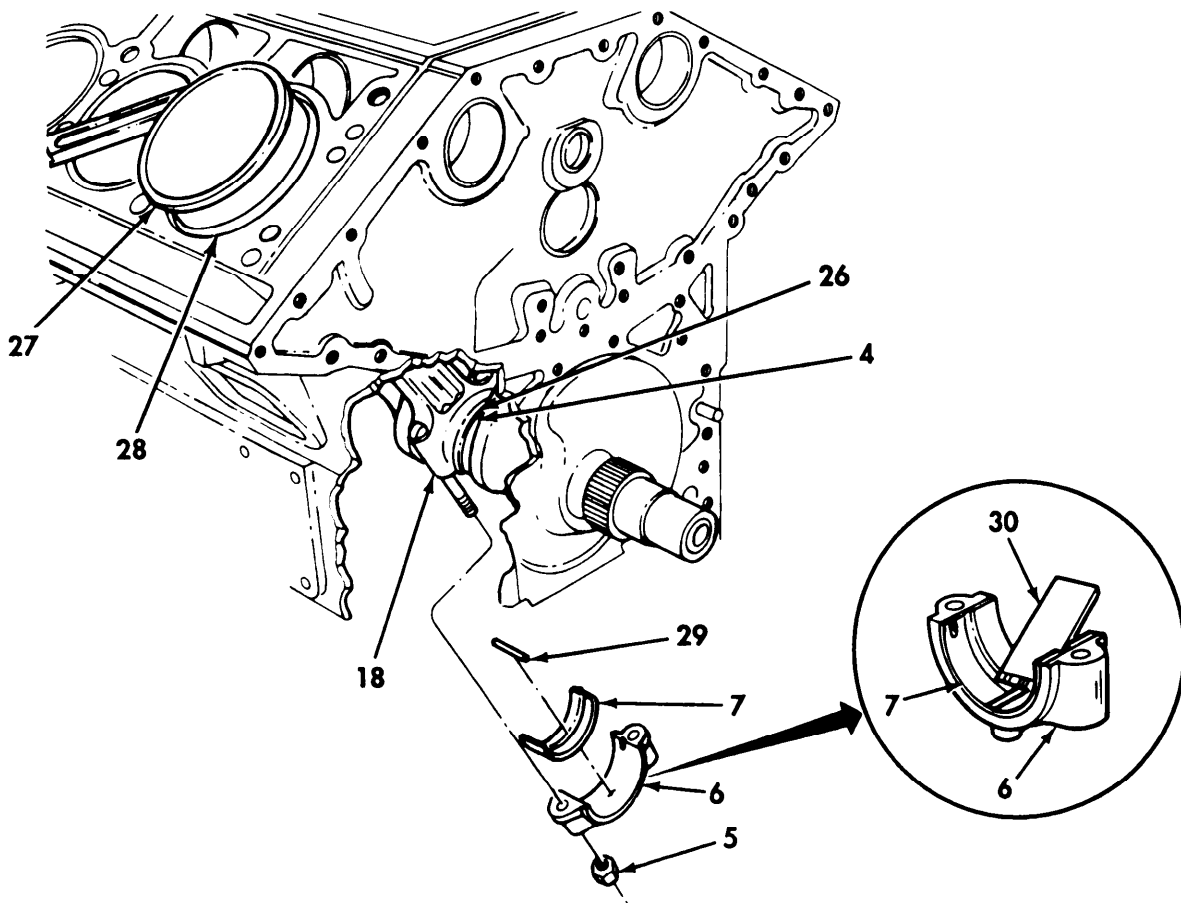
CAUTION

- 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 (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 (18) through block bore. Then slide piston, connecting rod, and liner assembly straight into block bore until liner flange rests against block counterbore (28).



- (6) Push piston into liner until upper bearing shell (26) seats firmly on crankshaft journal (4).

NOTE

Tang on bearing shell must fit in indentation in connecting rod cap.

- (7) Place lower bearing shell (7) (with continuous oil groove) in connecting rod cap (6).

CAUTION

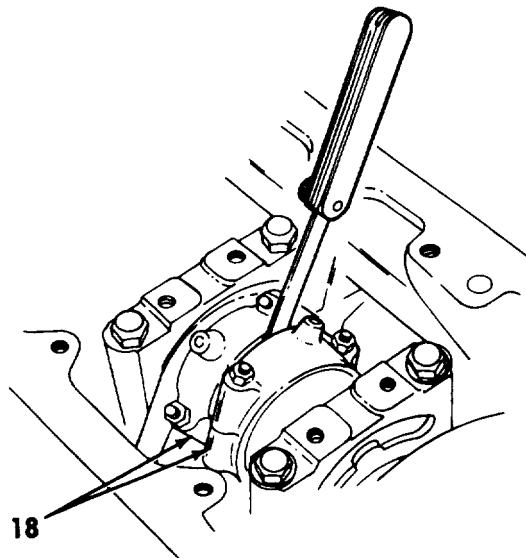
Connecting rod bolt must not turn in connecting rod when tightening nut.

- (8) To check bearing to crankshaft journal clearance, place strip of plastic gage (29) between crankshaft journal (4) and connecting rod cap (6). Torque connecting rod nuts (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 (30). Maximum clearance for used parts is 0.0060 inch.
- (9) Lubricate bearing with clean engine oil and install bearing cap (6) and lower bearing shell (7) on connecting rod (18) with identification numbers on cap and rod adjacent to each other. Install two connecting rod bolt nuts (5) and torque to 40-45 lb-ft (54-61 N-m).

NOTE

If necessary, pry connecting rods apart before measuring side clearance.

- (10) Using thickness gage, measure side clearance between each pair of connecting rods (18). Clearance limits are 0.008 to 0.016 inch.
- (11) Repeat steps (1) thru (10) to install additional liners, pistons, and rod assemblies. Use hold-down clamps (1) to hold installed liners in place.
- (12) Remove all liner hold-down clamps (1).

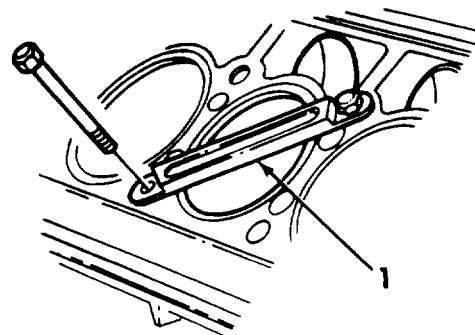


END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-33 Install oil pan.
- 3-34 Install oil pump inlet tubes (model 5063-5299).
- 3-35 Install oil pump inlet tubes (models 5063-5395 and 5063-5398).
- 3-43 Install cylinder head.



3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L)

This task covers: a. Removal b. Disassembly c. Cleaning d. Inspection
 e. Fitting Piston f. Fitting Piston Rings g. Assembly h. Installation

INITIAL SETUP

MODELS

5063-5392 5063-5393 5063-539F

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Pliers, piston ring (App B, Item 75)
- Reamer, cylinder ridge (App B, Item 82)
- Cleaner, piston ring groove (App B, Item 15)
- Die set, metal stamping, hand (App B, Item 20)
- Ball attachment, micrometer (App B, Item 8)
- Installer, piston pin retainer (App B, Item 66)
- Leak detector, piston pin retainer (App B, Item 71)
- Compressor, piston ring (App B, Item 16)
- Clamps, hold-down (App B, Item 14)
- Gage set, piston-liner thickness (App B, Item 32)
- Spring scale
- Gage set, thickness
- Micrometer 0-1 inch App B, Item 73)
- Micrometer 0-1 inch
- Micrometer 3-4 inch
- Micrometer 1-2 inch
- Vise, machinist (App B, Item 111)
- Caps, vise jaw (App B, Item 13)

MATERIALS/PARTS

- 1 Ring, piston (App F, Item 143)
- 1 Rings, piston (App F, Item 142)
- 1 Ring set, oil (App F, Item 138)
- 2 Retainers, piston pin (App F, Item 135)
- 2 Packings, preformed (App F, Item 116)
- 2 Bolts (App F, Item 10)
- 2 Spacer (App F, Item 181)
- 1 Seal, ring (App F, Item 175)

EXPENDABLE/DURABLE SUPPLIES

- Carbon removing compound (App C, Item 5)
- Cleaning solvent (App C, Item 9)
- Plastic gage, green (App C, Item 16)
- Plastic gage, red (AppC, Item 17) ‘
- Stone, sharpening (App C, Item 51)
- Oil, engine (App C, Item 26)
- Wood block (App C, Item 58)
- Crocus cloth (App C, Item 10)
- Oil, fuel (App C, Item 27)
- Shortening compound (App C, Item 47)
- Antifreeze (App C, Item 3)

EQUIPMENT CONDITION

- Para Description
- 3-33 Oil pan removed
- 3-35 Oil pump inlet tubes removed
- 3-43 Cylinder head removed

a. Removal

- (1) Install hold-down clamps (1) to each cylinder to anchor liners (2) during crankshaft rotation.
- (2) Rotate crankshaft (3) until connecting rod journal (4) is at bottom of its travel.
- (3) Remove hold-down clamp (1) 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.

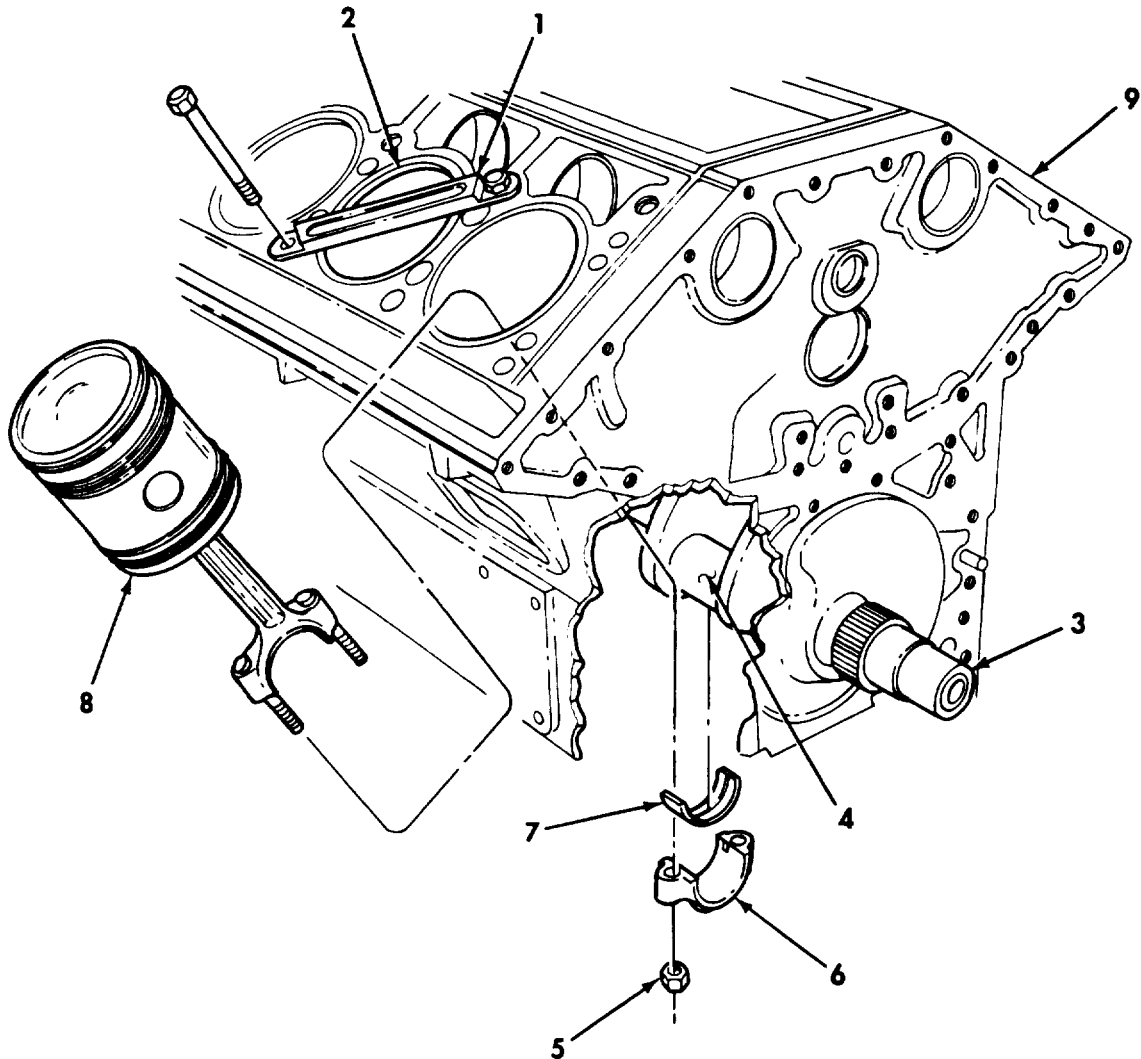
- (4) Using a cylinder ridge reamer, remove carbon deposits from upper inner surfaces of cylinder liner (2).

- (5) Remove two nuts (5), cap (6), and lower bearing shell (7) from piston and connecting rod assembly (8).

NOTE

Tag piston assembly with cylinder number for matching during reassembly.

- (6) Push piston and connecting rod assembly (8) out through top of cylinder block (9).



NOTE

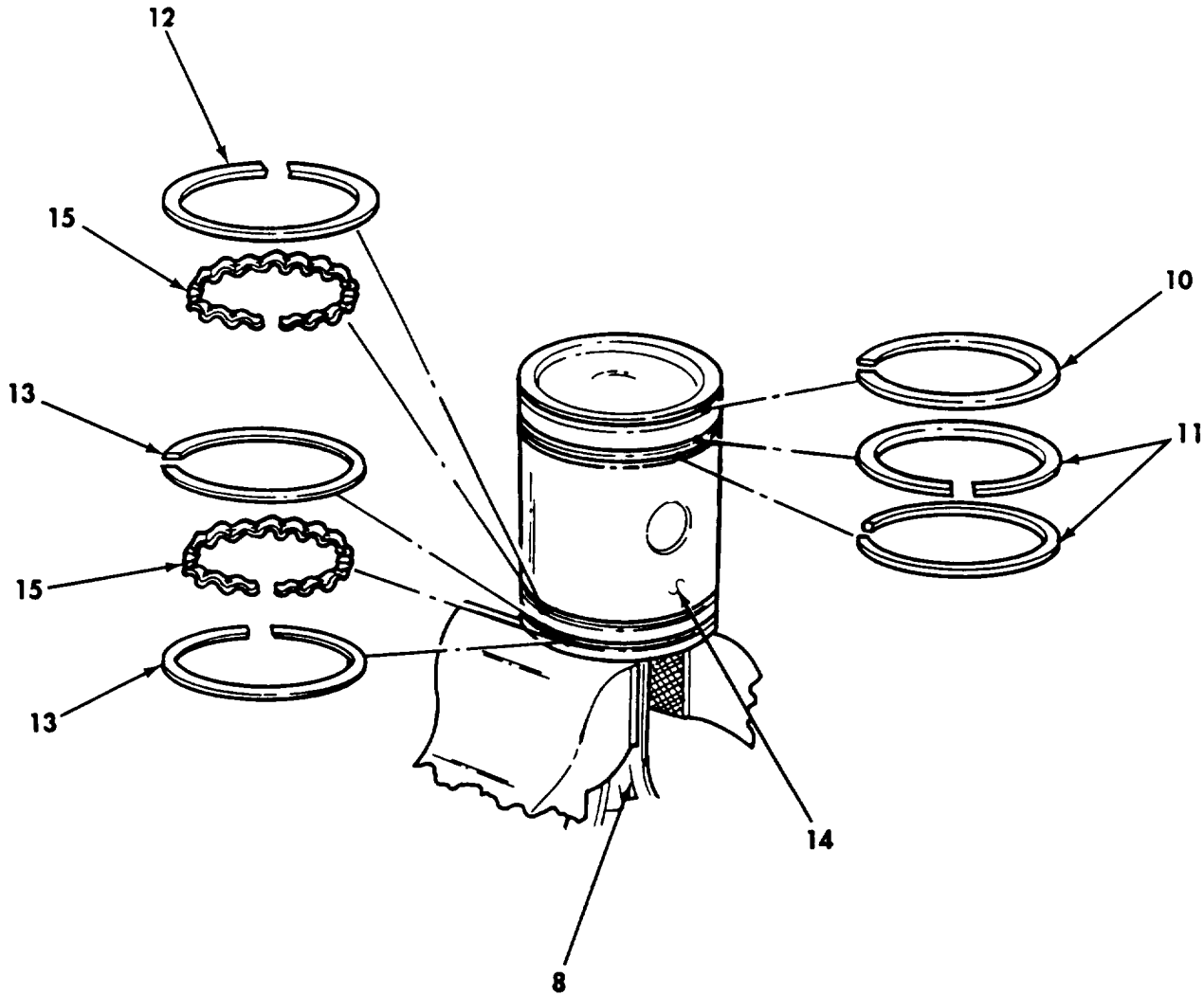
Always assemble cap with stamped number on same side as stamped on lower part of connecting rod to ensure cap is not rotated 180 degrees.

- (7) Assemble bearing cap (6), lower bearing shell (7), and two nuts (5) on piston and connecting rod assembly (8).
- (8) Repeat steps (2) thru (7) for remaining piston and connecting rod assemblies (8).

3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

b. Disassembly

- (1) Secure piston and connecting rod assembly (8) in a soft-jawed vise. Using ring pliers, remove fire ring (10), two compression rings (11), thick oil control ring (12), and two thin oil control rings (13) from piston assembly (14). Remove two oil ring expanders (15) from lower grooves in piston. Discard rings and expanders.



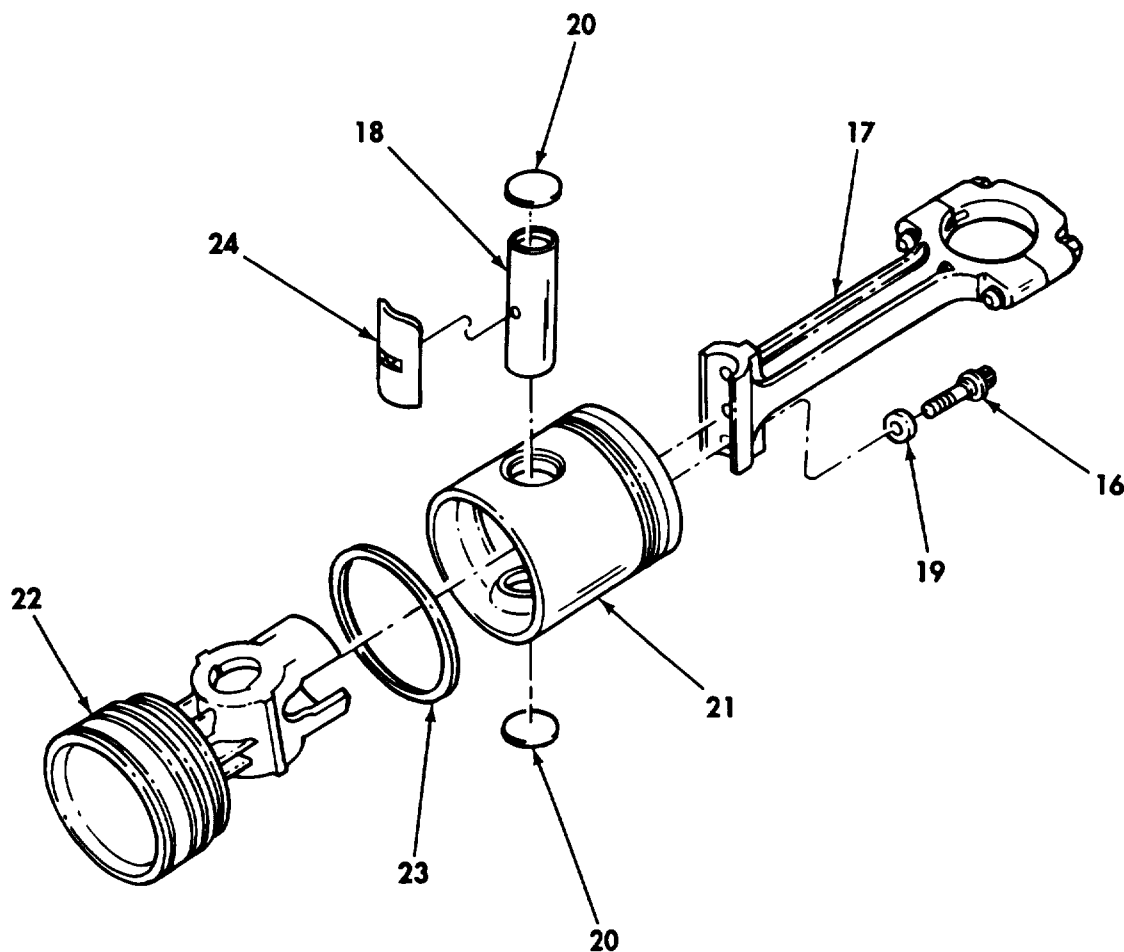
- (2) Secure piston and connecting rod assembly (8) upside down in a soft-jawed vise. Loosen two bolts (16) from connecting rod (17) and piston pin (18). Remove assembly from vise. Remove two bolts, two spacers (19), and connecting rod. Discard bolts and spacers.

- (3) Lay piston assembly (14) horizontally on flat surface.

CAUTION

Use care not to damage piston pin while removing piston pin retainers.

- (4) Punch a hole through center of one piston pin retainer (20) with a narrow chisel or punch and pry retainer from piston. Remove opposite retainer in same manner. Discard retainers.
- (5) Remove piston pin (18) from piston assembly.



- (6) Separate piston skirt (21) from piston dome (22).
- (7) Remove ring seal (23) from piston dome (22). Discard ring seal.
- (8) Remove piston pin bushing (24) from piston dome (22).
- (9) Repeat steps (1) thru (8) for remaining piston and connecting rod assemblies (8).

3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

c. Cleaning

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
 - 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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (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

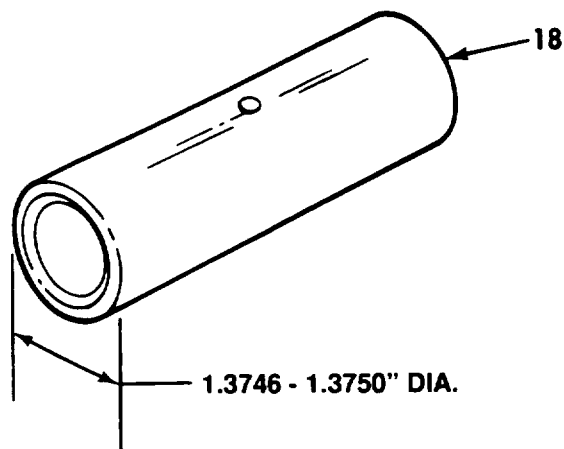
Do not use crocus cloth on bushing side of pin. Bushing side requires a polished finish.

- (4) Use crocus cloth wet with fuel oil to remove any trace of fretting or corrosion on pin-contacting surface of connecting rod.

d. Inspection**(1) Dome and Skirt****NOTE**

Overheating or burned spots on piston skirt or dome may indicate an obstruction in connecting rod oil passage.

- (a) 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.
- (b) Check cylinder liner and block bore for excessive out of round, taper, or high spots which could cause failure of piston (see Para 3-52).

**(2) Piston Pin****CAUTION**

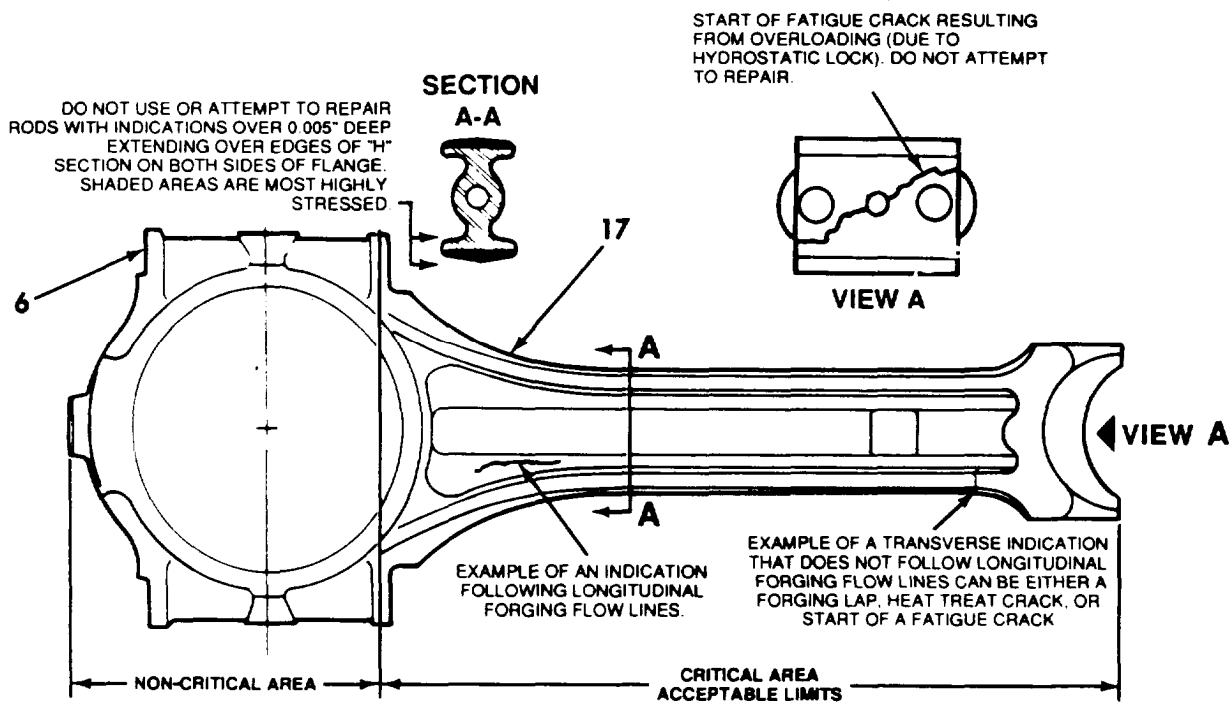
Do not polish or refinish piston pin. Hand polishing or refinishing will destroy precision finish and result in rapid bushing wear.

- (a) Inspect piston pin (18) for signs of fretting.
- (b) New piston pin has diameter of 1.3746 to 1.3750 inches. Replace piston pin if worn to diameter of 1.3730 inches or less.

3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

(3) Connecting Rod

- (a) 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.
- (b) Check for cracks by magnetic particle inspection method (reference MIL-C-1949).
- (c) Inspect connecting rod bearing bores for burrs or foreign particles. Clean up minor burrs with crocus cloth using circular motion.
- (d) If new connecting rod is required, stamp cylinder number on connecting rod (17) and cap (6) using metal stamping die set.



INDICATIONS IN NONCRITICAL AREAS ARE ACCEPTABLE UNLESS THEY CAN BE OBSERVED AS OBVIOUS CRACKS WITHOUT MAGNETIC INSPECTION.

LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE USUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 0.03" DEEP DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

GRINDING NOTES:
 CARE SHOULD BE TAKEN IN GRINDING OUT INDICATIONS TO ASSURE PROPER BLENDING OF GROUND AREA INTO UNGROUND SURFACE SO AS TO FORM A SMOOTH CONTOUR.

TRANSVERSE INDICATIONS (ACROSS FLOW LINES) HAVING A MAXIMUM LENGTH OF 0.5" WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 0.016" ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL. AN EXCEPTION TO THIS CASE IS A ROD HAVING AN INDICATION WHICH EXTENDS OVER THE EDGE OF "H" SECTION AND IS PRESENT ON BOTH SIDES OF THE FLANGE. IN THIS CASE, MAXIMUM ALLOWABLE DEPTH IS 0.005" (SEE SECTION A-A).



(4) Connecting Rod Bearings

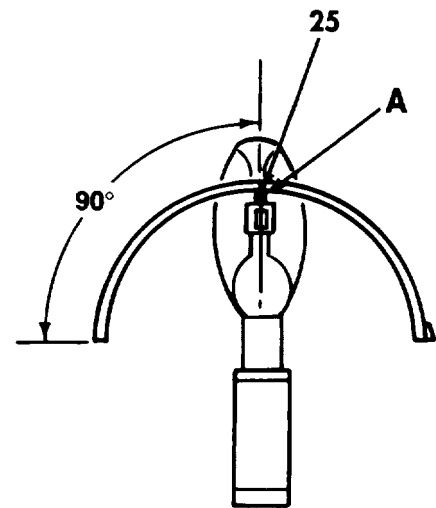
- (a) Inspect bearing shells for scoring, pitting, flaking, etching, and dirt grooving. If defective, discard bearing shells.
- (b) Discard bearing shells with bright spots on backs indicating movement in bearing caps or supports.

NOTE

If one bearing shell is less than minimum thickness shown in Table 3-7, replace both bearing shells (upper and lower).

- (c) Using a micrometer and ball attachment (25), measure thickness of lower and upper bearing shells at point (A), 90 degrees from parting line.

TABLE 3-7. 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)



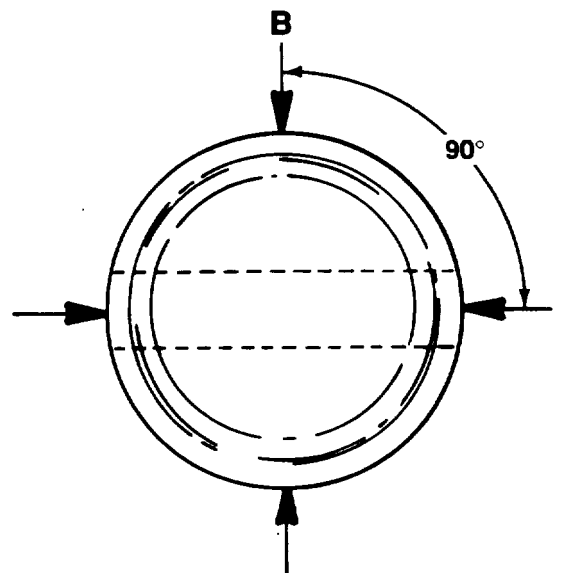
*Thickness 90 degrees from parting line of bearing.

e. Fitting Piston

NOTE

Fit new or used piston skirt to corresponding cylinder liner and retain as a matched set for assembly in engine.

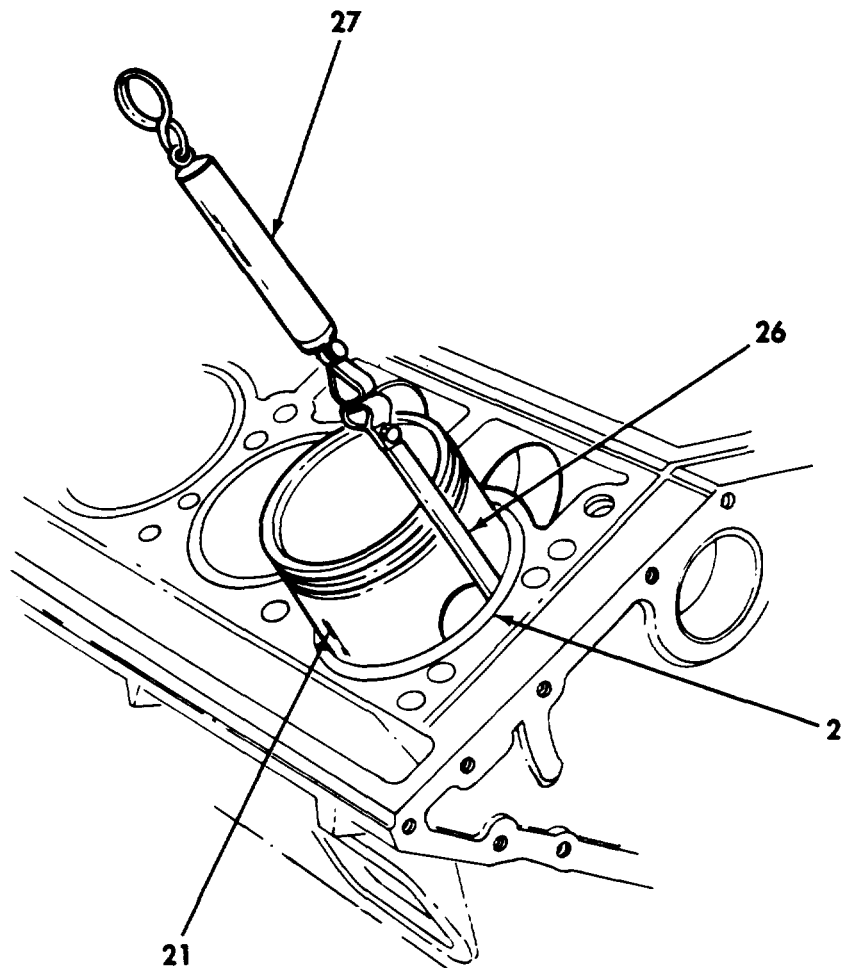
- (1) Using micrometer, measure piston skirt outside diameter (B) parallel and perpendicular to piston pin bore at room temperature (70°F – 21°C). Diameter must be 3.8695 to 3.8717 inches.



3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

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.
- (2) With cylinder liner (2) installed in cylinder block, hold piston skirt (21) upside down in liner and check clearance in four places, 90 degrees apart, using a thickness gage (26) attached to spring scale (27). Clearance must be 0.0035 to 0.0072 inch with new parts and a maximum of 0.012 inch for used parts.
 - (3) 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.



f. Fitting Piston Rings

- (1) Insert top piston ring inside cylinder liner
- (2) in normal area of ring travel. Using piston skirt, push ring down parallel with top of liner. Measure ring gap with thickness gage set. Refer to Table 3-8 for specifications. Repeat procedure for balance of compression and oil rings.

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.

- (2) 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.

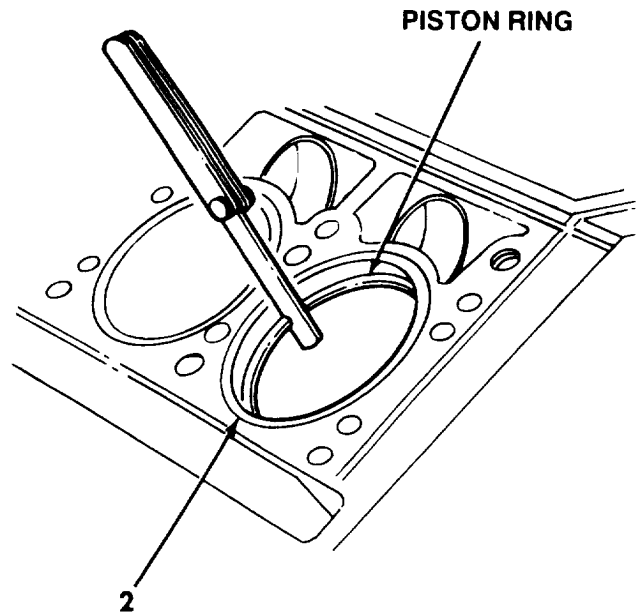
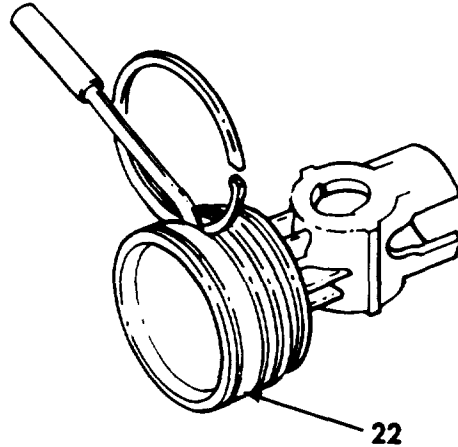


TABLE 3-8. PISTON RING SPECIFICATIONS

	MINIMUM	MAXIMUM
RING GAP		
Fire Ring	0.0230 in. (0.584 mm)	0.0380 in. (0.965 mm)
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)
CLEARANCE (RING TO GROOVE)		
Top Groove	0.0030 in. (0.076 mm)	0.0066 in. (0.168 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)

3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

- (3) Using thickness gage set, measure side clearance of ring in piston dome (22). Refer to Table 3-8 or ring side clearance specifications.



g. Assembly

(1) Piston and Rod Assembly

- (a) Install pin bushing (24) in piston dome (22). Bushing must slide into piston dome without force.

NOTE

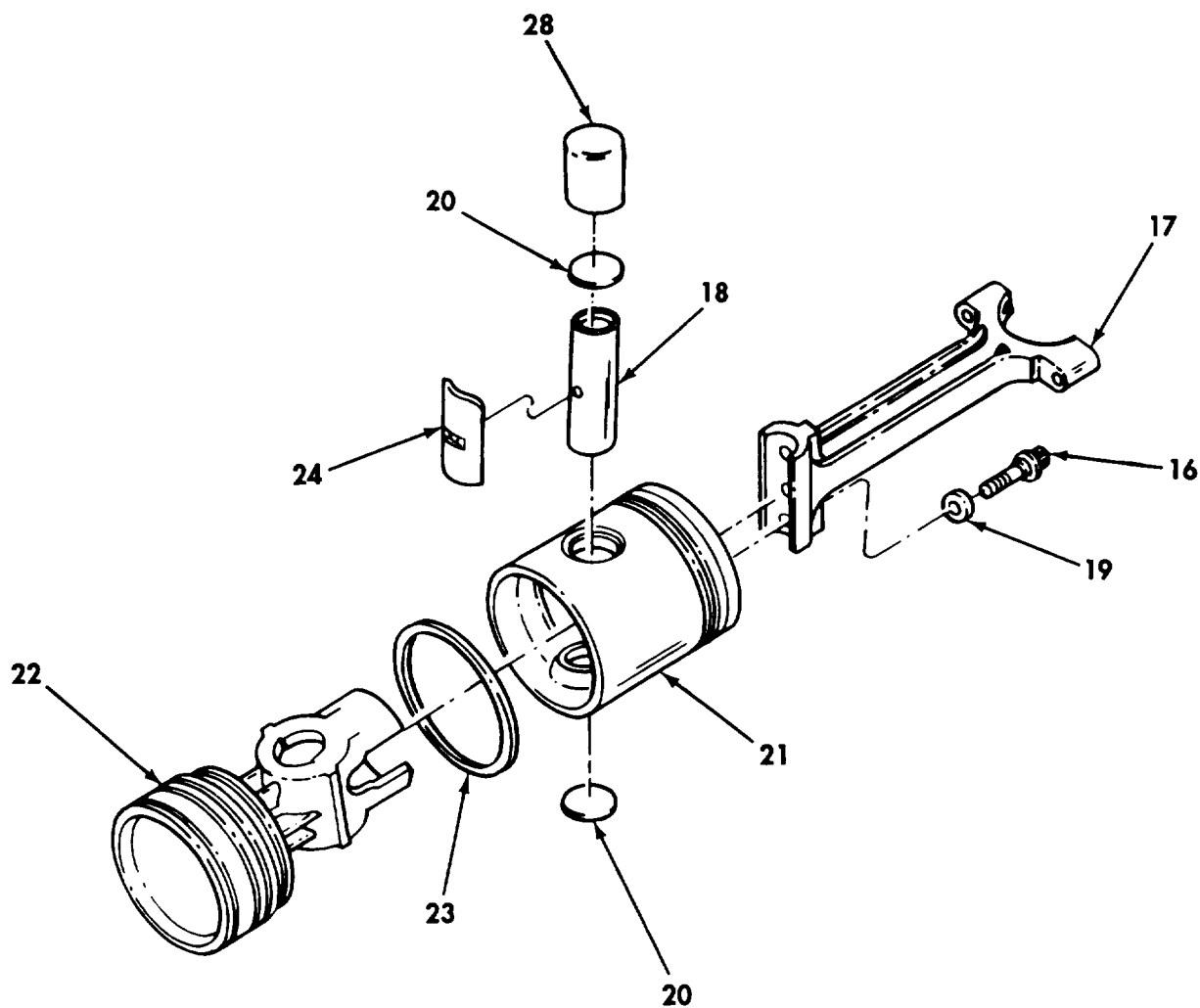
Soak ring seal in engine oil for 15 minutes prior to installation on dome.

- (b) Lubricate ring seal (23) with engine oil and install in groove on piston dome (22).
- (c) Align piston pin holes in skirt (21) and dome (22), then push skirt into position on dome.
- (d) Apply clean engine oil to piston pin (18) and piston pin bushing (24) and install piston pin.
- (e) Install spacers (19) on piston pin bolts (16). Apply small amount of International Compound No. 2, or equivalent, to bolt threads and bolt head contact surfaces.
- (f) Install connecting rod (17), two spacers (19), and two bolts (16) on piston pin (18). Tighten bolts finger tight.
- (g) Clamp connecting rod (17) in soft-jawed vise and torque piston pin bolts (16) to 30-35 lb-ft (41-47 N-m). Do not exceed this torque.

CAUTION

Ensure piston pin retainers do not buckle during installation and seat completely in counterbore with spacing even around retainer to seal properly.

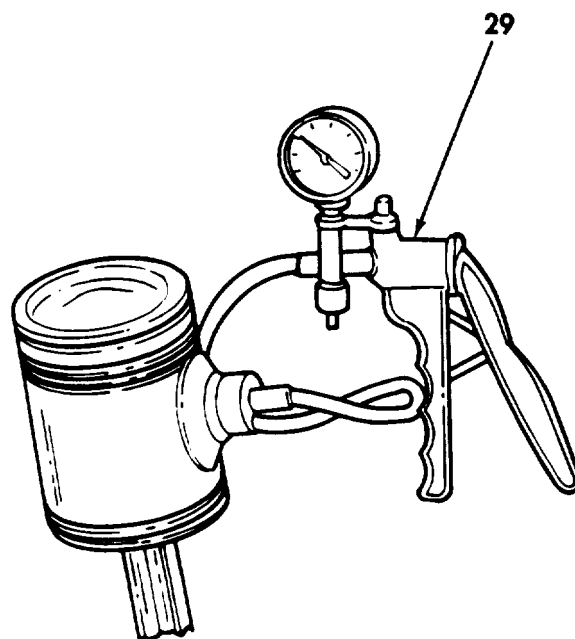
- (h) Insert first piston in retainer (20) in position. Place crowned end of piston pin installer (28) against retainer. Strike tool just hard enough to deflect retainer and to seat it evenly in skirt (21). Install second retainer in same manner.



NOTE

Clean piston surface around piston pin retainer before checking retainer for leakage.

- (i) Check each retainer for proper sealing with leak detector (29). Place suction cup over retainer and hand operate lever to pull a vacuum of 10.0 inches of mercury on gage. A drop of more than 5.0 inches of mercury over 10 seconds indicates air leakage at retainer.



3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

(2) Installation - Piston Rings

- (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 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 (15) in oil control ring grooves in piston skirt (21) with legs of free ends pointing toward bottom of piston.

WARNING

Do not grasp or graze sharp edges of oil control rings with bare hands. Rings are extremely sharp and can cut personnel when mishandled.

CAUTION

Do not spread rings any more than necessary to slip them over piston. Ring breakage and overstressing will result.

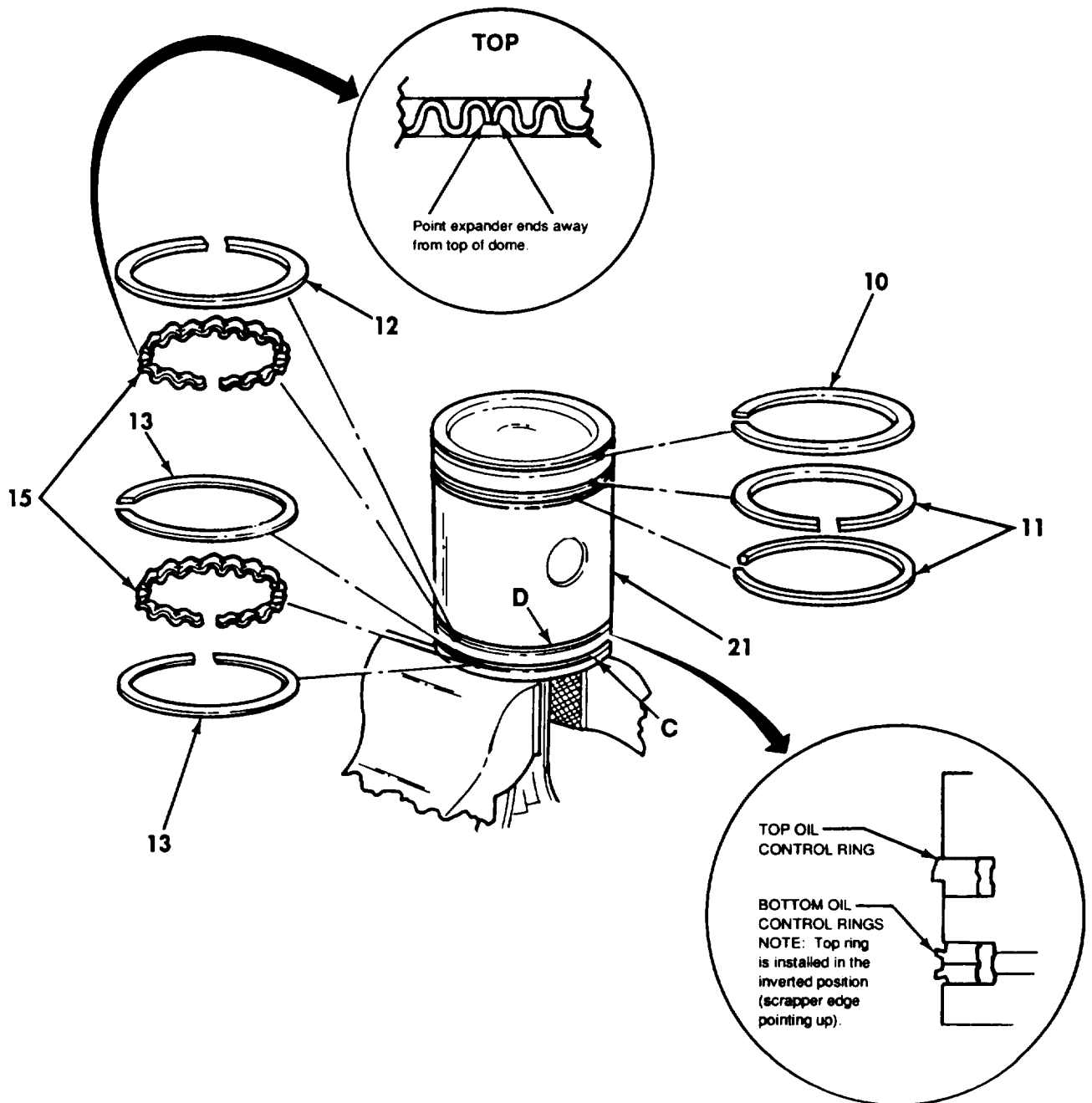
NOTE

- 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 (13), scraper edge down, in groove C (lower groove) with gap in ring 180 degrees from gap in expander (15). Then install upper ring (13), scraper edge up, in groove C with gap 180 degrees from gap in lower ring.
- (d) Using ring pliers, install thick oil control ring (12) in groove D (upper groove). Position gap in ring 180 degrees from gap in expander (15). Press ring against gap side of expander to prevent ends of expander from overlapping. Align ring with groove and release tension on pliers.

NOTE

Install fire ring (10) with dark side (with prestress mark) toward top of dome.

- (e) Using piston ring pliers and starting from bottom, first install two compression rings (11) and then install fire ring (10).
- (f) Stagger ring gaps around piston a minimum of 90 degrees from each other.



3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

(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 ring compressor for nicks or burrs, especially at inside diameter of straight end. Nicks or burrs on inside diameter of compressor will result in damage to piston rings.

- (b) Place piston ring compressor (30) on wood block, with larger end of ring compressor facing up.

CAUTION

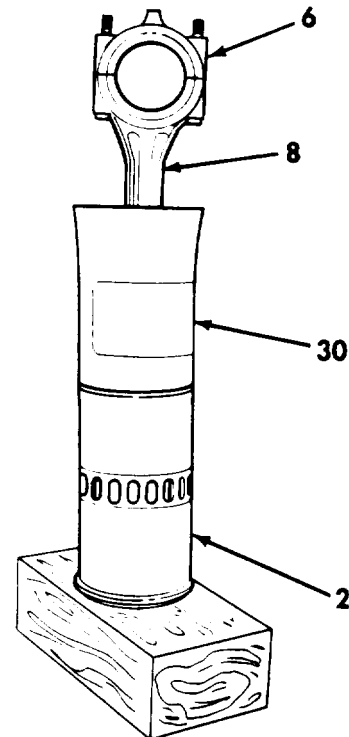
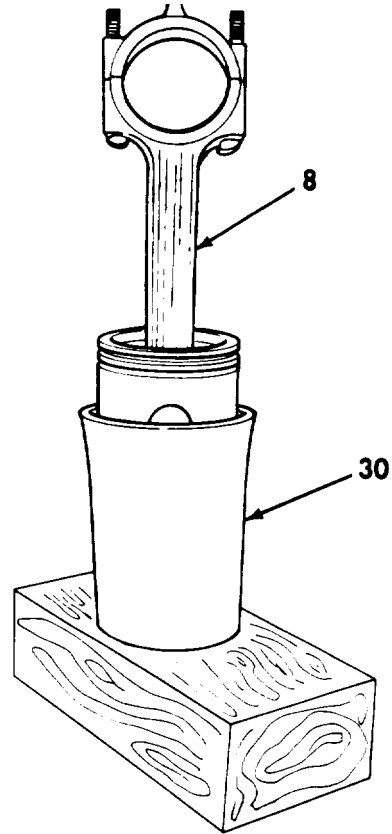
Piston ring gaps must be 90 degrees apart on piston for proper compression. Ends of oil control ring "expanders must not overlap or breakage will result.

- (c) Start top of piston and connecting rod assembly (8) straight into ring compressor (30). Then push piston down until it contacts wood block.
- (d) Place liner (2) 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 ring compressor (30) and piston and connecting rod assembly (8) on liner (2) with numbers on side of connecting rod and cap aligned with matchmark on liner.



CAUTION

Do not force piston into liner. Expanders apply considerably force on oil rings; therefore, exercise care during loading operation to prevent ring breakage.

- (f) Push piston and connecting rod assembly (8) down into liner (2) until piston is free of ring compressor (30).
- (g) Remove connecting rod cap (6) and then remove ring compressor (30) from piston and connecting rod assembly (8). Push piston down until compression rings pass cylinder liner ports.
- (h) Repeat steps (a) thru (g) for remaining pistons and liners.

h. Installation - Cylinder Kit Assembly**CAUTION**

Cylinder block bore grooves must be clean. Debris in grooves will cause coolant leakage into engine oil and engine damage can result.

NOTE

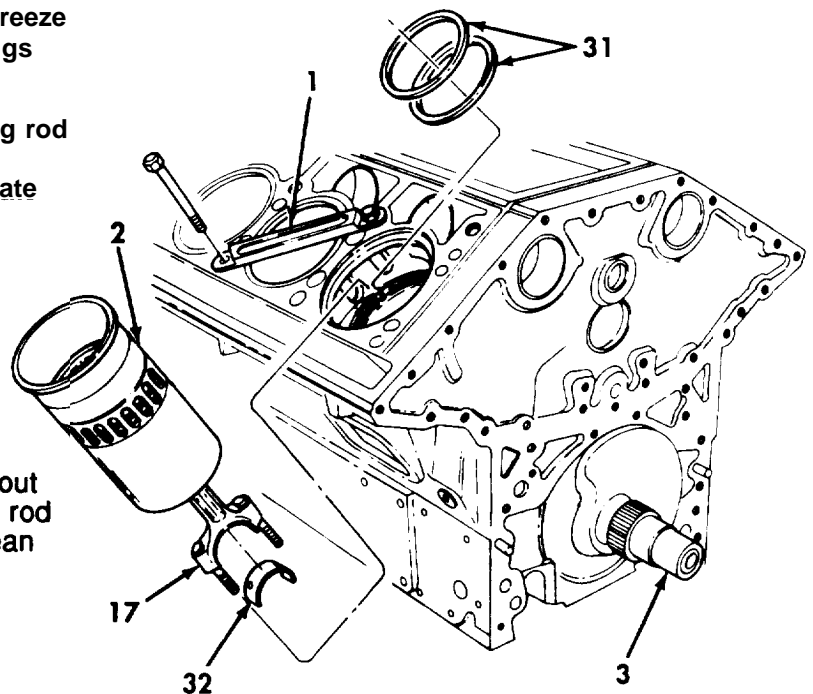
If any pistons and liners are already in engine, use hold-down clamps (1) to retain liners (2) in place when crankshaft is rotated.

- (1) Install two preformed packings (31) in cylinder block bore grooves.
- (2) Apply shortening compound or antifreeze to inner surface of preformed packings (31).
- (3) Rotate crankshaft (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 (32) (without continuous oil groove) in connecting rod (17). Lubricate bearing shell with clean engine oil.

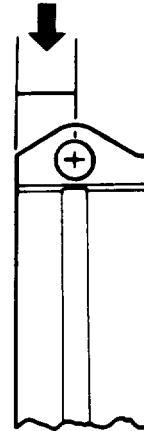


3-51. PISTON AND CONNECTING ROD MAINTENANCE - CROSS-HEAD (MODELS 5063-5392, 5063-5393, 5063-539F, AND 5063-539L) (Cont)

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.

NARROW SIDE



- (5) Position piston, rod, and liner assembly (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 (17) through block bore. Then slide piston, connecting rod, and liner assembly straight into block bore until liner flange rests against block counterbore (34).
- (6) Push piston into liner until upper bearing shell (32) is firmly seated on crankshaft journal (4).

NOTE

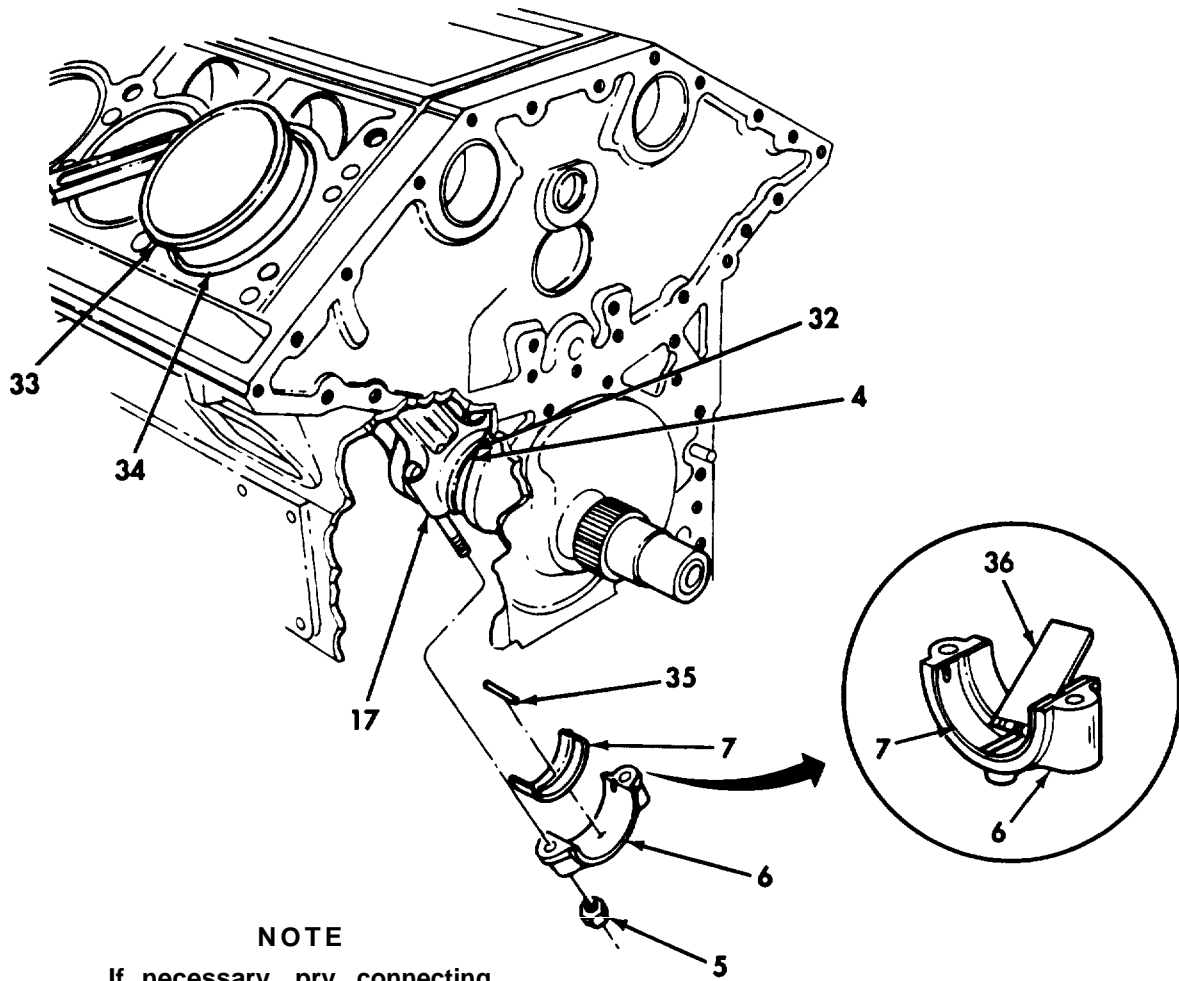
Tang on bearing shell must fit in indentation in connecting rod cap.

- (7) Place lower bearing shell (7) (with continuous oil groove) in connecting rod cap (6).

NOTE

Connecting rod bolt must not turn in connecting rod when torquing nut.

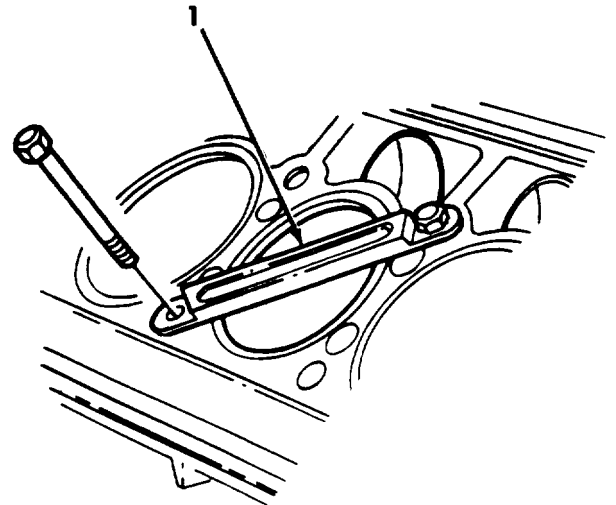
- (8) To check bearing to crankshaft journal clearance, place a plastic gage strip (35) between crankshaft journal (4) and connecting rod cap (6). Tighten connecting rod nuts (5) to 40-45 lb-ft (54-61 N·m.). Remove connecting rod nuts and cap, and measure width of plastic gage with measuring strip (36). Maximum clearance with used parts is 0.006 inch.
- (9) Lubricate lower bearing shell (7) with clean engine oil and install bearing cap (6) and bearing shell on connecting rod (17) with identification numbers on cap and rod adjacent to each other. Torque connecting rod bolt nuts (5) to 40-45 lb-ft (54-61 N·m).



NOTE

If necessary, pry connecting rods apart before measuring side clearance.

- (10) Using thickness gage set, measure side clearance between each pair of connecting rods. Clearance must be 0.008 to 0.016 inch.
- (11) Repeat steps (1) thru (10) to install additional liners, pistons, and rod assemblies. Use hold-down clamps (1) to hold each liner in place.
- (12) Remove all liner hold-down clamps (1).



END OF TASK

FOLLOW-ON MAINTENANCE

- | Para | Description |
|------|-------------------------------|
| 3-43 | Install cylinder head. |
| 3-35 | Install oil pump inlet tubes. |
| 3-33 | Install oil pan. |

3-52. CYLINDER LINER MAINTENANCE

This task covers: a. Removal b. Cleaning c. Inspection d. Measurements
 e. Honing f. Fitting Cylinder Liner in Block Bore g. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Gage, depth (App B, Item 36)
- Remover, cylinder liner (App B, Item 86)
- Hone, cylinder (App B, Item 52)
- Gage, cylinder bore (App B, Item 35)
- Die set, metal stamping, hand (App B, Item 20)
- Micrometer set (App B, Item 73)
 - Micrometer 4-5 inch
- Clamp, hold-down (App B, Item 14)

MATERIALS/PARTS

- 2 Packings, preformed (App F, Item 116)

EXPENDABLE/DURABLE SUPPLIES

- Cleaning solvent (App C, Item 9)
- Stone, sharpening (App C, Item 50)

EQUIPMENT CONDITION

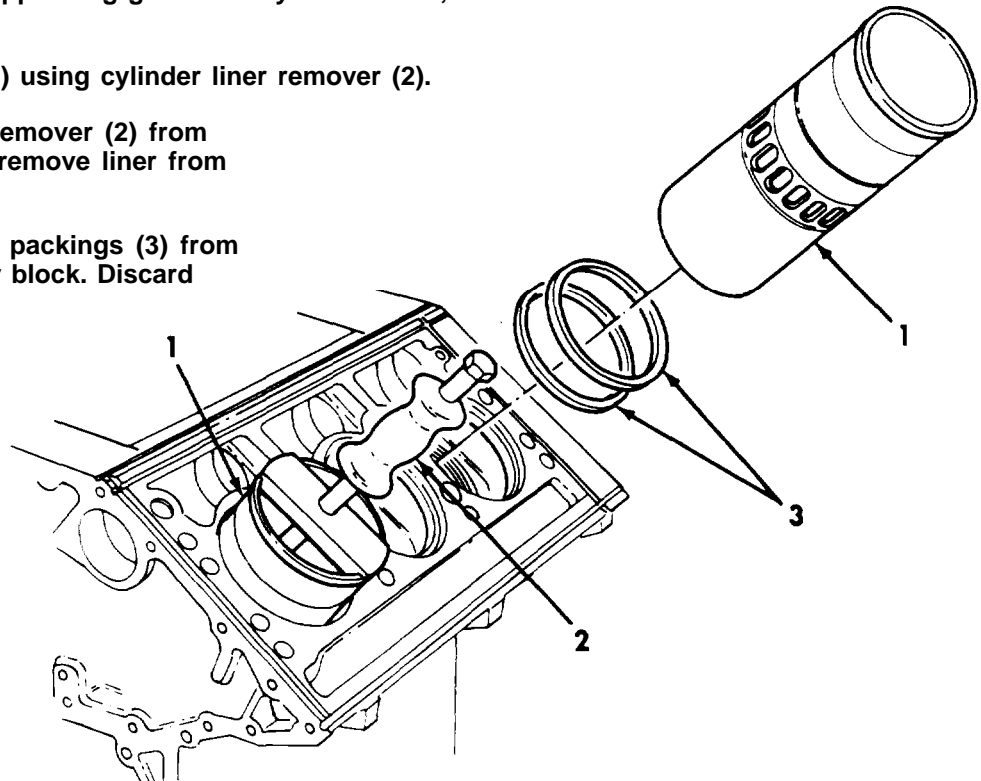
- | Para | Description |
|------|--|
| 3-33 | Oil pan removed |
| 3-34 | Oil pump inlet tubes removed (model 5063-5299) |
| 3-35 | Oil pump inlet tubes removed (all except model 5063-5299) |
| 3-43 | Cylinder head removed |
| 3-50 | Piston and rod assembly removed (models 5063-5299, 5063-5395, and 5063-5398). |
| 3-51 | Piston and rod assembly removed (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L). |

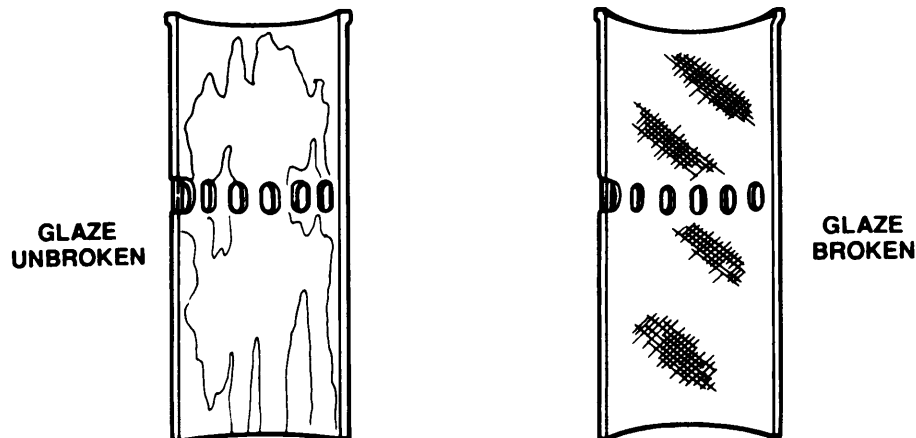
a. Removal

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 (1) using cylinder liner remover (2).
- (2) Remove cylinder liner remover (2) from cylinder liner (1). Then remove liner from cylinder block.
- (3) Remove two preformed packings (3) from ring grooves in cylinder block. Discard preformed packings.



b. Cleaning**WARNING**

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

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.

c. Inspection

- (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

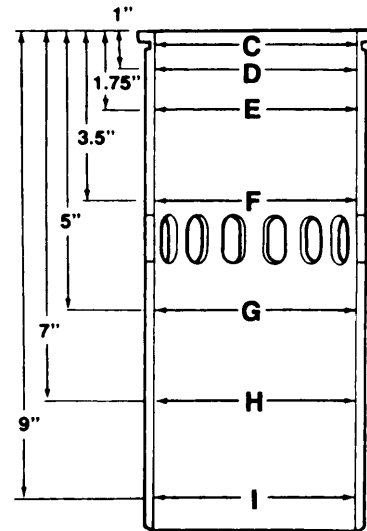
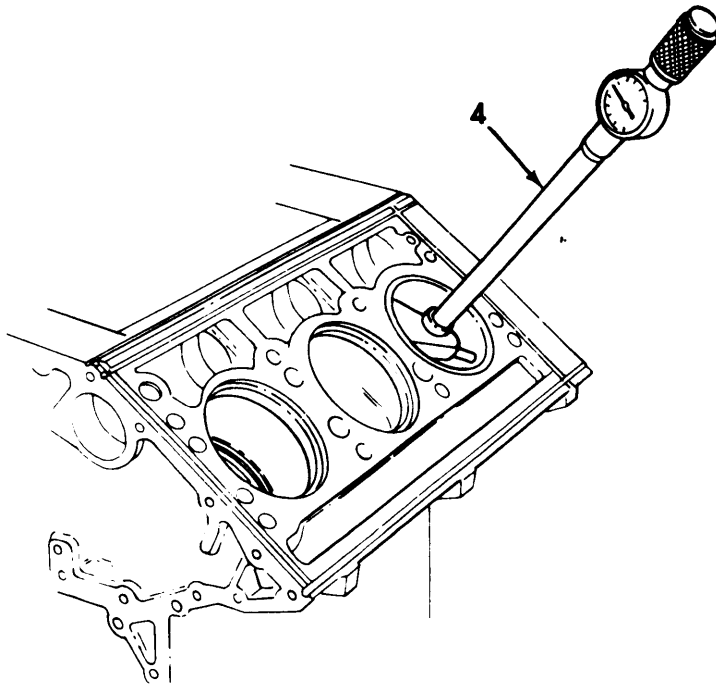
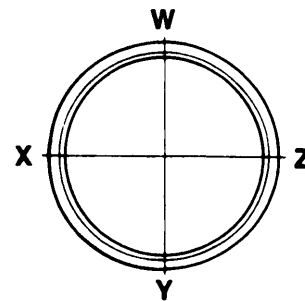
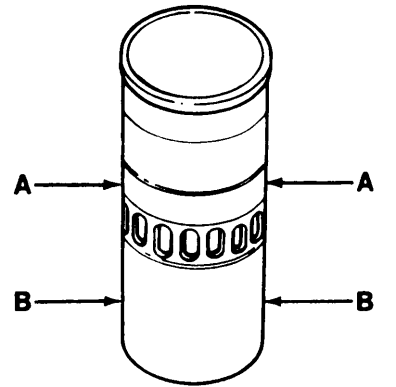
Excessive liner to block clearance or block bore distortion will reduce heat transfer from liner to block.

- (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.

3-52. CYLINDER LINER MAINTENANCE (Cont)

d. Measurements

- (1) Measure outside diameter of liner at (A and B). Diameter (A) must be 4.485 to 4.486 inches, diameter (B) must be 4.355 to 4.356 inches.
- (2) Install liner in proper bore of cylinder block. Using cylinder bore age (4), measure cylinder liner inside diameter at fourteen places (C thru I) on (XZ) and (WY) axes as shown.
- (3) Check liner inside diameter for taper and out-of-round. Taper must not exceed 0.002 inch on used liner and 0.001 inch on new liner. Out-of-round must not exceed 0.003 inch on used liner and 0.002 inch on new liner.



- Liners, standard and oversized, have an inside diameter of 3.8752 to 3.8767 inches. Liners are available in 0.010 and 0.020 inch oversized on outside diameter.
- Special liner to block preformed packings are required when using 0.020 inch 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.

e. Honing

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

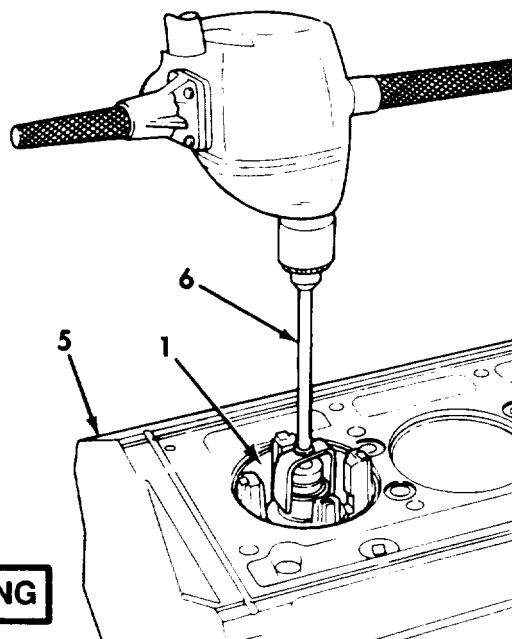
- Hone used cylinder liners to break glaze resulting from extended operation and remove ridge formed at top of piston ring travel. If glaze is not removed, time required to seat new piston rings will be lengthened.
- A scrap cylinder block makes an excellent honing fixture.

- (1) Place liner (1) in honing fixture (5).

CAUTION

If liner is honed in block, completely dismantle engine to ensure all abrasive material is cleaned out (Paragraphs 3-50 thru 3-55).

- (2) Work cylinder hone (6), equipped with 120 grit stones, up and down full length of liner few times between 300 to 400 RPM to produce a crisscross pattern of hone marks on 45 degree axis.

**WARNING**

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

NOTE

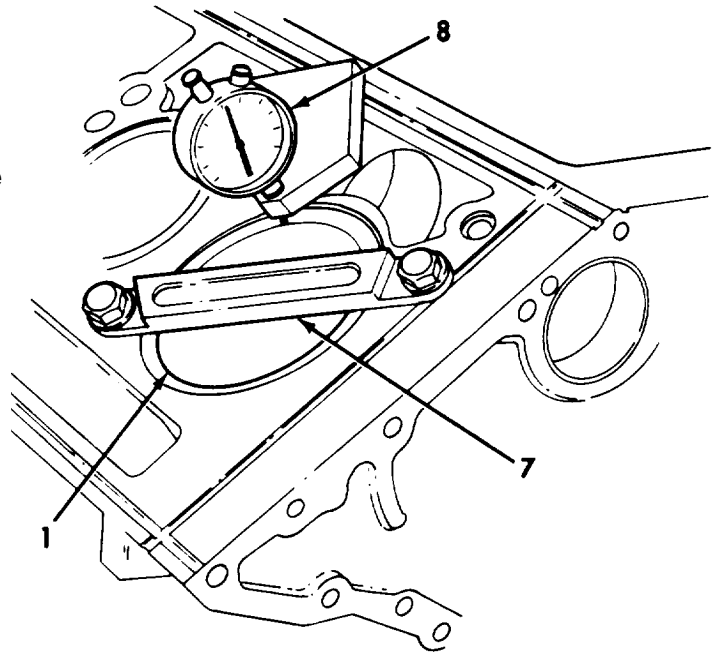
After honing, liner must conform to same limits on taper and out-of-round as a new liner and piston to liner clearance must be within specified limits.

- (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.

3-52. CYLINDER LINER MAINTENANCE (Cont)

f. Fitting Cylinder Liner In Block Bore

- (1) Wipe inside and outside of liner clean, Clean block bore and counterbore thoroughly.
- (2) Slide cylinder liner (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 hold-down clamp (7).



NOTE

Maximum liner height difference of 0.002 inch 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 gage (8). Liner flange must be 0.0465 to 0.050 inch 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 hold-down clamp (7) and cylinder liner (1).

g. Installation

NOTE

Cylinder liner is installed as a complete assembly including piston, connecting rod, and cylinder liner. See Para 3-50 or 3-51 for installation instructions.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

- 3-50 Install piston and rod assembly (models 5063-5299, 5063-5395, and 5063-5398),
- 3-51 Install piston and rod assembly (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L).
- 3-43 Install cylinder head.
- 3-34 Install oil pump inlet tubes (model 5063-5299),
- 3-35 Install oil pump inlet tubes (all except model 5063-5299).
- 3-33 Install oil pan.

3-53. CRANKSHAFT MAINTENANCE

This task covers: a. Removal b. Disassembly c. Cleaning d. Inspection
 e. Measurements f. Repair g. Assembly h. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Indicator, dial, magnetic base (App B, Item 54)
- Micrometer set(App B, Item 73)
 - Micrometer 0-1 inch
 - Micrometer 2-3 inch
 - Micrometer 3-4 inch
- Three-leg puller (App B, Item 81)
- Gage, bore (App B, Item 35)
- Sling (App B, Item 93)
- Die set, metal stamping, hand (App B, Item 20)
- Ball attachment, micrometer (App B, Item 8)
- Gage set, telescoping (App B, Item 33)
- Installer, crankshaft gear (App B, Item 57)
- Installer crankshaft plug (App B, Item 60)
- Installer, oil pump ear (App B, Item 65)
- Installer, crankshaft pulley (App B, Item 61)
- Adapter, slip torque (App B, Item 4)
- Puller, mechanical (App B, Item 80)

MATERIALS/PARTS

8 Screws, self-locking (App F, Item 152)

EXPENDABLE/DURABLE SUPPLIES

- Oil, engine (App C, Item 26)
- Plastic gage (App C, Item 16)
- Crocus cloth (App C, Item 10)
- Emery cloth (App C, Item 13)
- Oil, fuel (App C, Item 27)
- International Compound No, 2 (App C, Item 21)
- Cleaning solvent (App C, Item 9)
- Stone, sharpening X-fine (App C, Item 51)
- Washers, flat (App C, Item '55)
- 3 Nuts (App C, Item 24)

EQUIPMENT CONDITION

- | | |
|------|---|
| Para | Description |
| 3-50 | Cylinder kits removed (models 5063-5299, 5063-5395, and 5063-5395) |
| 3-51 | Cylinder kits removed (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L) |

a. Removal

- (1) For all except model 5063-5398, remove eight small self-locking screws (1), eight hardened washers (2), eight large bolts (3), eight hardened washers (4), and four stabilizer plates (5) from bottom of cylinder block. Discard self-locking screws.
- (2) For model 5063-5398, remove sixteen bolts (6), sixteen washers (7), four supports (8), and eight spacers (9) from bottom of cylinder block.

CAUTION

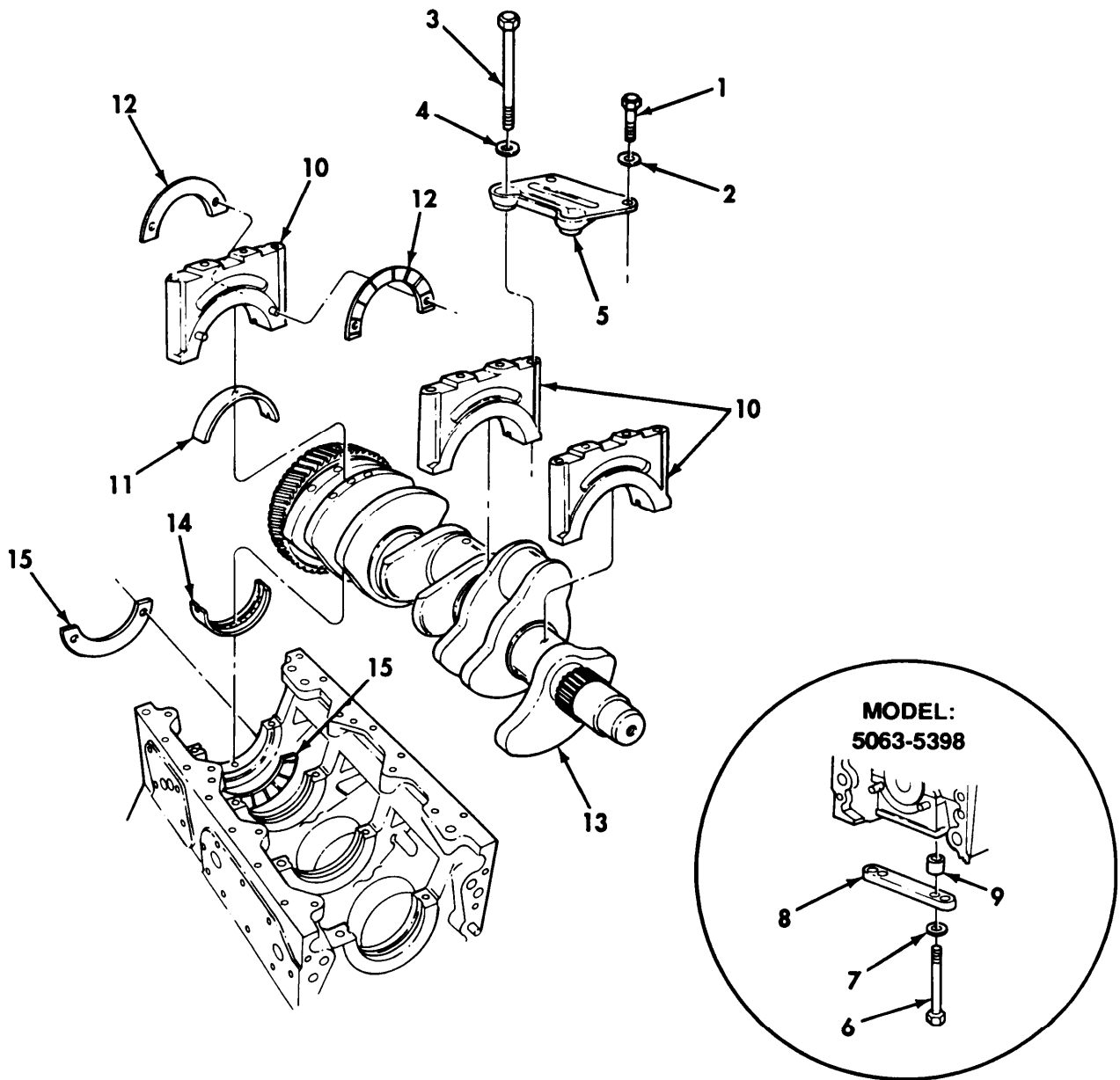
Keep main bearing caps and main bearing shells in their original position. Main bearing caps are numbered 1, 2, 3, and 4. Upper bearing shell has an oil hole and groove for lubrication, and lower bearing shell is smooth with no groove or oil hole.

- (3) Remove four main bearing caps (10) from cylinder block. Remove four lower bearing shells (11) and two lower thrust washers (12) (rear cap only) from caps and mark with corresponding bearing number.

WARNING

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

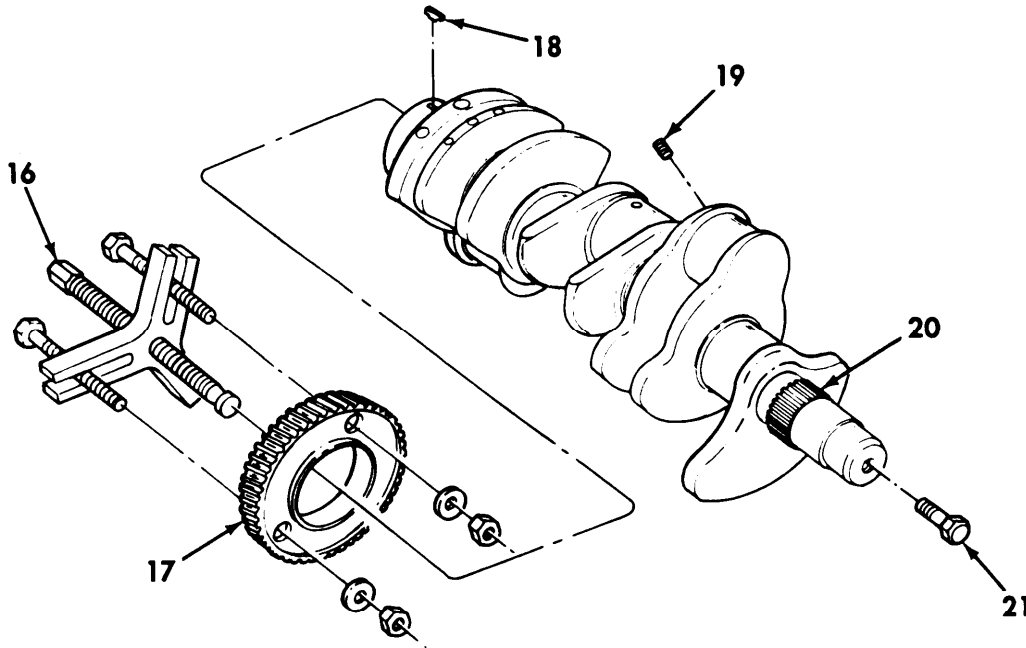
- (4) Remove crankshaft (13) from cylinder block.
- (5) Remove four upper bearing shells (14) and two upper thrust washers (15) from block and mark with corresponding bearing number.



3-53. CRANKSHAFT MAINTENANCE (Cont)

b. Disassembly

- (1) Install three-leg puller (16) on rear crankshaft gear (17) 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 (18) from rear of crankshaft.
- (3) Remove three pipe plugs (19) from crankshaft.
- (4) If necessary, remove oil pump drive gear (20) from front of crankshaft using gear puller. Thread screw (21) in crankshaft for puller screw to seat.



c. Cleaning

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

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.

d. Inspection

- (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 inch.

NOTE

Replace crankshaft if journal ridges are greater than 0.001 inch 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 inch, 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 MIL-C-1949).
 - 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.

3-53. CRANKSHAFT MAINTENANCE (Cont)

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.

e. Measurements

- (1) Using micrometer and ball attachment (22), measure thickness of bearing shells (11 and 14) at point (C), 90 degrees from parting line. Replace if minimum thickness is less than 0.1230 inch. A standard bearing is 0.1240 to 0.1245 inch thick. Refer to Table 3-9 for thickness of bearings.

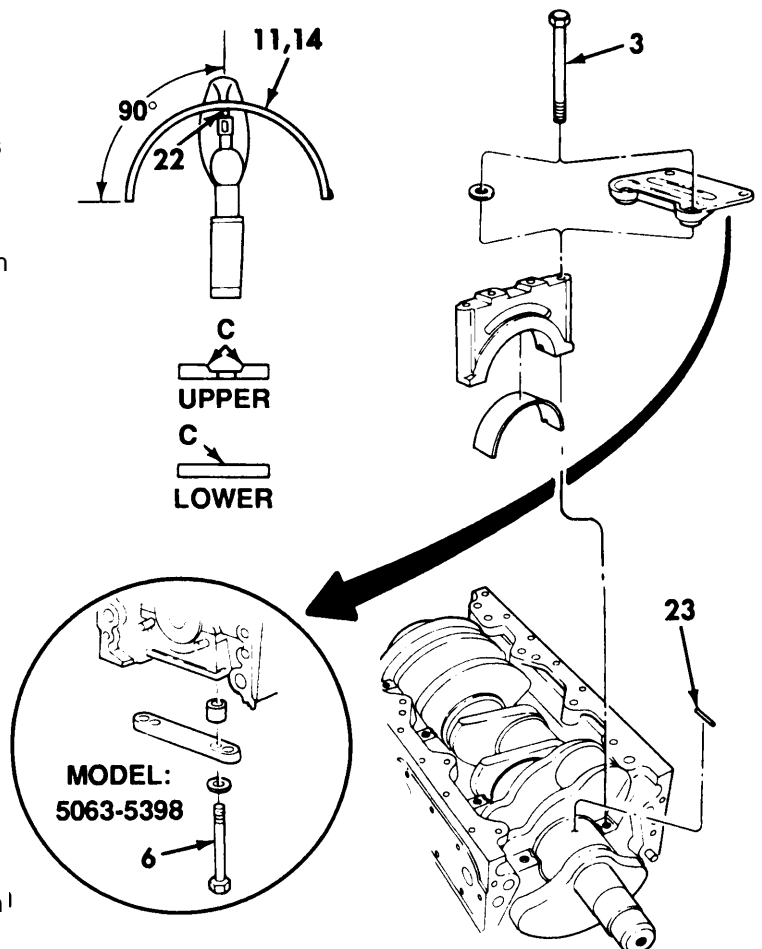
NOTE

If clearance between any crankshaft journal and its bearing shells exceeds 0.0060 inch, replace all bearing shells. Clearance for new parts is 0.0010 to 0.0040 inch.

- (2) Check main bearings to crankshaft journals clearance using step (a) or (b):
 - (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 inch larger in diameter at parting line than 90 degrees from parting line.

TABLE 3-9. CRANKSHAFT BEARING SHELL THICKNESS		
BEARING SIZE	NEW BEARING THICKNESS *	MINIMUM USED THICKNESS *
Standard	0.1240-0.1245 in. (3.167-3.180 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	0.1290-0.1295 in. (3.277-3.289 mm)	0.1280 in. (3.251 mm)
0.020 in. Undersized	0.1340-0.1345 in. (3.404-3.416 mm)	0.1330 in. (3.378 mm)
0.030 in. Undersized	0.1390-0.1395 in. (3.531-3.543 mm)	0.1380 in. (3.505 mm)

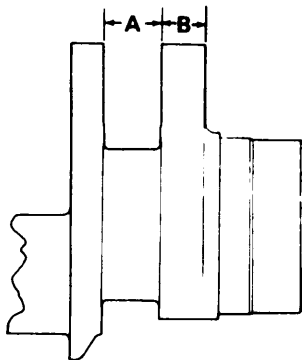
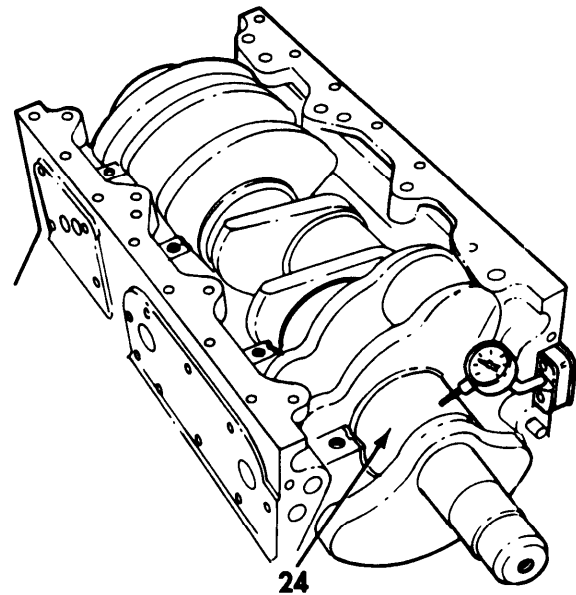
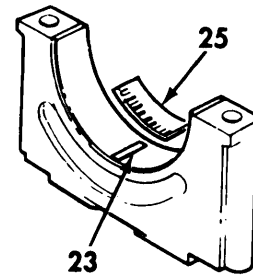
*Thickness 90 degrees from parting line of bearing.



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 (23) on crankshaft journal (24). Install main bearing cap assembly, stabilizers or washers, and bolts. Torque main bearing bolts (3) to 120-130 lb-ft (163-177 N-m) or main bearing bolts (6) to 53-57 lb-ft (72-77 N.m). Remove main bearing bolts, stabilizers or washers, and cap assembly. Measure width of plastic gage with measuring strip (25).



- (3) Measure intermediate main bearing journal runout with dial indicator. 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 runout on adjacent journals are in opposite directions, sum must not exceed 0.003 inch total. When high spots of runout on adjacent journals are in same direction, difference must not exceed 0.003 inch. When high spots of runout on adjacent journals are at right angles, sum must not exceed 0.004 inch or 0.002 inch on each journal.

NOTE

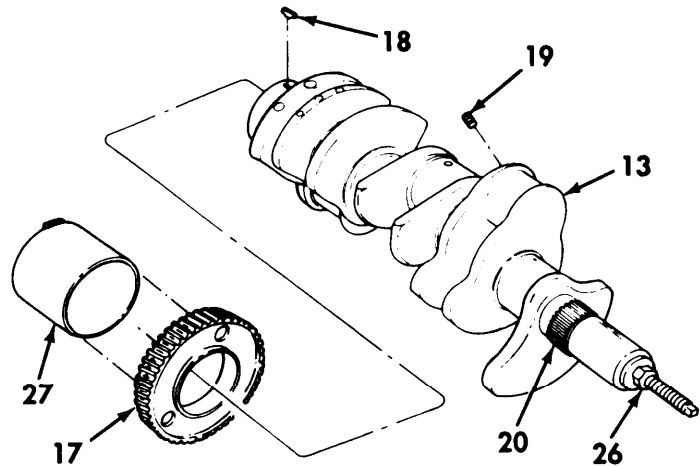
Maximum clearance between connecting rod journal and bearing shell is 0.0041 inch (with new shells). Maximum clearance between main bearing journal and bearing shell is 0.0040 inch (with new shells). Main bearing journal taper or out-of-round must not exceed 0.003 inch. Replace crankshaft if measurements 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 inch.
- (5) Measure crankshaft thrust surfaces at points (A) and (B). Dimension (A) must be 1.299 to 1.301 inches and dimension (B) must be 1.34 inches.

3-53. CRANKSHAFT MAINTENANCE (Cont)

f. Assembly

- (1) Using crankshaft plug installer, install three pipe plugs (19) into crankshaft (13). Torque plugs to 10-12 lb-ft (14-16 Nm).
- (2) If removed, install oil pump drive gear (20) 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 installer (26) must contact the end of crankshaft to correctly position the drive gear.

- (c) Place oil pump drive gear installer (26) over crankshaft and against drive gear (20). Force gear on crankshaft until bore in installation tool contacts end of crankshaft.
- (d) Using slip torque adapter, check press fit of drive gear to crankshaft. Drive gear should not slip on crankshaft with a torque of 100 lb-ft (136 Nm).

NOTE

Do not exceed torque of 100 lb-ft (136 N-m) on slip torque adapter. If gear slips on crankshaft, install new drive gear.

- (3) Install Woodruff key (18) in keyway of crankshaft. Start crankshaft gear (17) on crankshaft with timing marks on rim of gear facing out and keyway in gear in alignment with Woodruff key.
- (4) Place crankshaft gear installer (27) against rear face of gear (17). Drive gear tight against shoulder on crankshaft.

g. 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 (14) 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 men to remove crankshaft. Crankshaft is heavy and awkward to handle. Serious injury can result if crankshaft is dropped.

CAUTION

Do not damage journals or main bearing shells when lowering crankshaft into position. Damage will result in short component life.

- (3) Place crankshaft (13) in upper bearing shells in cylinder block.
- (4) Install upper crankshaft thrust washers (15) on each side of rear main bearing support with grooved side of thrust washers toward crankshaft thrust surfaces.

NOTE

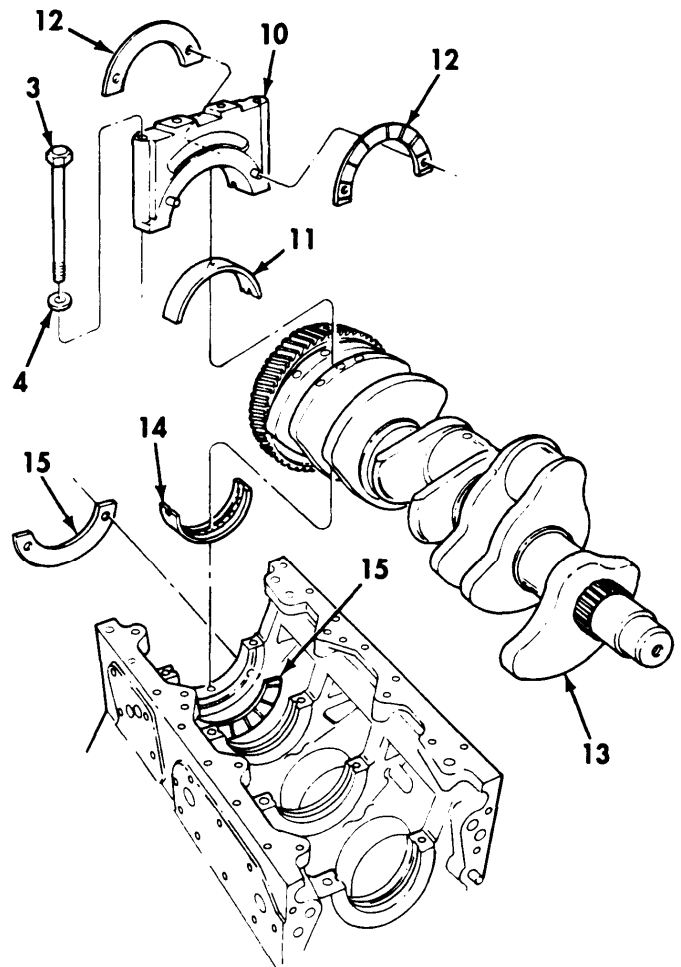
- Install bearings in same bearing caps from which removed.

ŽAll crankshaft bearing shells have a tang for proper alignment. Upper bearing shells have oil holes for lubrication.

- (5) Install lower main bearing shells (11) in bearing caps (10). Install two lower thrust washers (12) 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.

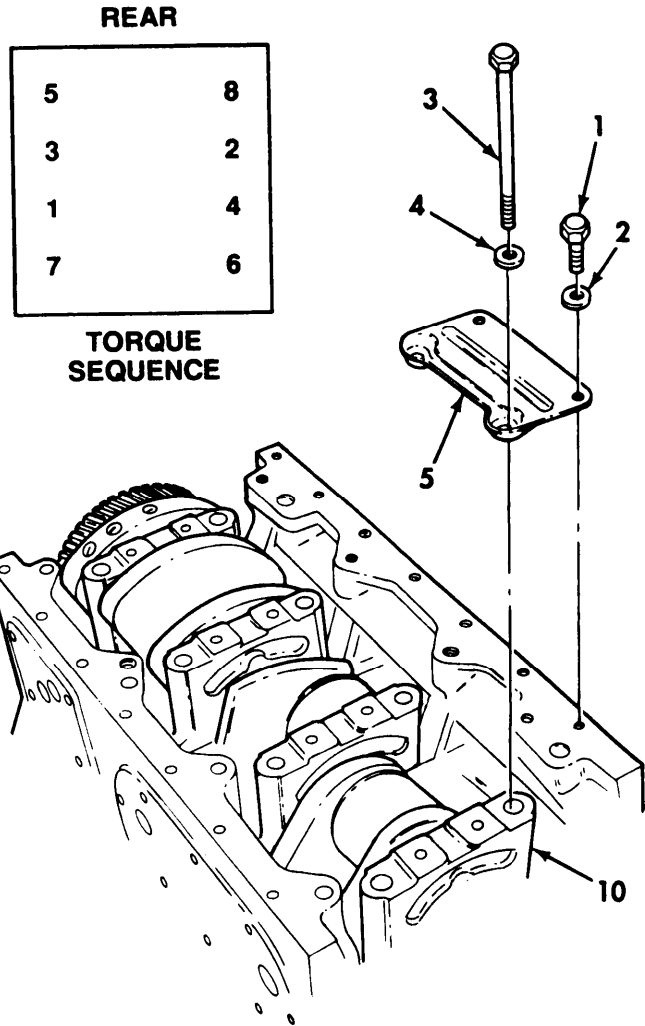


- (6) Install four main bearing caps (10) along with lower bearing shells (11) and two lower thrust washers (12). Lubricate bearings and thrust washers with engine oil prior to installation.
- (7) Apply a small quantity of International Compound No. 2 or equivalent to main bearing bolt threads (3 or 6) and bolt head contact area.

3-53. CRANKSHAFT MAINTENANCE (Cont)

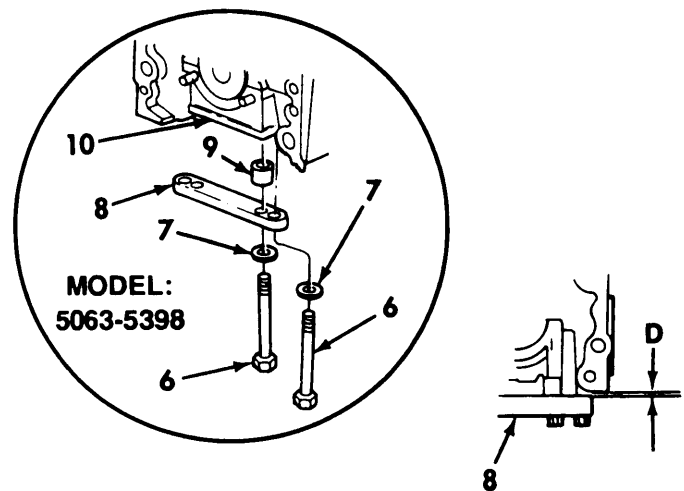
(8) For all except model 5063-5398:

- (a) Install four stabilizer plates (5), eight hardened washers (4), eight large bolts (3), eight hardened washers (2), and eight small self-locking screws (1) in cylinder block. Tighten bolts until snug.
- (b) Strike main bearing caps (10) sharply with a soft head hammer to seat caps.
- (c) Torque all main bearing bolts (3) (except rear main bearing bolts) to 120-130 lb-ft (163-177 N-m) in sequence shown. Torque rear main bearing bolts to 40-50 lb-ft (54-68 N-m).
- (d) 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 (3) to 120-130 lb-ft (163-177 N-m) again.
- (e) Torque eight stabilizer plate screws (1) to 46-50 lb-ft (62-68 N-m).



(9) For model 5063-5398:

- (a) Place eight spacers (9) and four supports (8) on main bearing caps (10). Install eight washers (7) and eight bolts (6) in inboard holes of support and through spacers and main bearing cap. Tighten bolts until snug.
- (b) Strike main bearing caps (10) sharply with a soft head hammer to seat them properly.
- (c) Torque eight main bearing bolts (6) to 53-57 lb-ft (72-77 N-m) in sequence shown.
- (d) Measure gap (D) between support (8) and bottom of cylinder block at both ends of support. Gap must be 0.006 to 0.023 inch. If gap is not within limits, remove and turn support over or switch spacers (9) and measure gap again.



NOTE

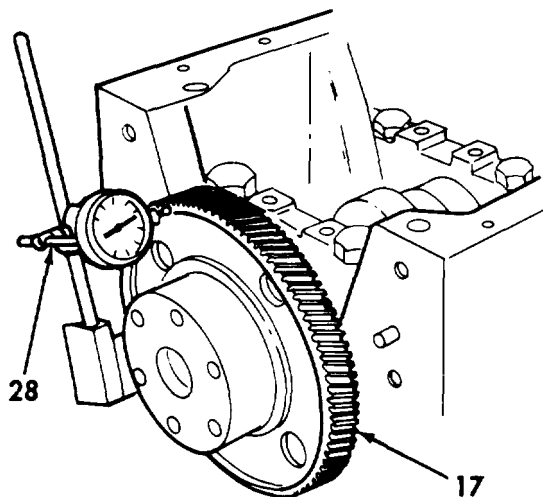
After proper gaps have been obtained, do not tighten inboard main bearing bolts again.

- (e) Install eight main bearing bolts (6) with hardened washers (7) through outboard holes in support (8) and into threaded holes in cylinder block. Torque bolts uniformly to 91-99 lb-ft (124-134 N-m) starting with center caps-and working alternately towards both ends of block.

NOTE

If bearings are installed properly, crankshaft will turn freely with all of bearing cap bolts drawn to specified torque.

- (10) Rotate crankshaft one full turn to ensure freedom of movement.
- (11) Measure Crankshaft End Play
- (a) Mount dial indicator (28) on rear of cylinder block with indicator point resting on rear face of crankshaft gear (17).
- (b) Using large screwdriver between main bearing cap and crankshaft counterweight, push crankshaft toward dial indicator. With constant pressure on screwdriver, set dial indicator to zero.

**NOTE**

- If correct crankshaft endplay cannot be obtained with standard size thrust washers, use 0.005 or 0.010 inch 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 to 0.016 inch with new parts and maximum of 0.018 inch with used parts.

END OF TASK**FOLLOW-ON MAINTENANCE****Para Description**

3-50 Install cylinder kits (models 5063-5299, 5063-5398, and 5063-5395)

3-51 Install cylinder kits (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L)

3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5063-5398)

This task covers: a. Disassembly b. Cleaning c. Inspection d. Assembly
 e. Pressure test

INITIAL SETUP

MODELS

All except 5063-5398

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Gage, cylinder bore (App B, Item 35)
 Die set, metal stamping, hand (App B, Item 20)
 Remover kit, camshaft bearing (App B, Item 85)
 Straight edge (App B, Item 96)
 Gage, depth (App B, Item 36)
 Pressure testing kit, cylinder block (App D, Item 7)

MATERIALS/PARTS

- 4 Gaskets (App F, Item 36)
- 3 Gasket (App F, Item 41)
- 2 Lockwashers (App F, Item 98)
- 1 Plug (App F, Item 120)
- 2 Cup plugs (App F, Item 123)
- 1 Plug, expansion (App F, Item 131)
- 4 Gaskets, copper (App F, Item 26)
- 1 Bearing set (App F, Item 2)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
 International Compound No. 2 (App C, Item 21)
 Sealing compound (App C, Item 44)
 Oil, engine (App C, Item 26)
 Shortening compound (App C, Item 47)
 Antifreeze (App C, Item 3)
 Adhesive, gasket (App C, Hem 1)
 Corrosion preventative (App C, Item 11)

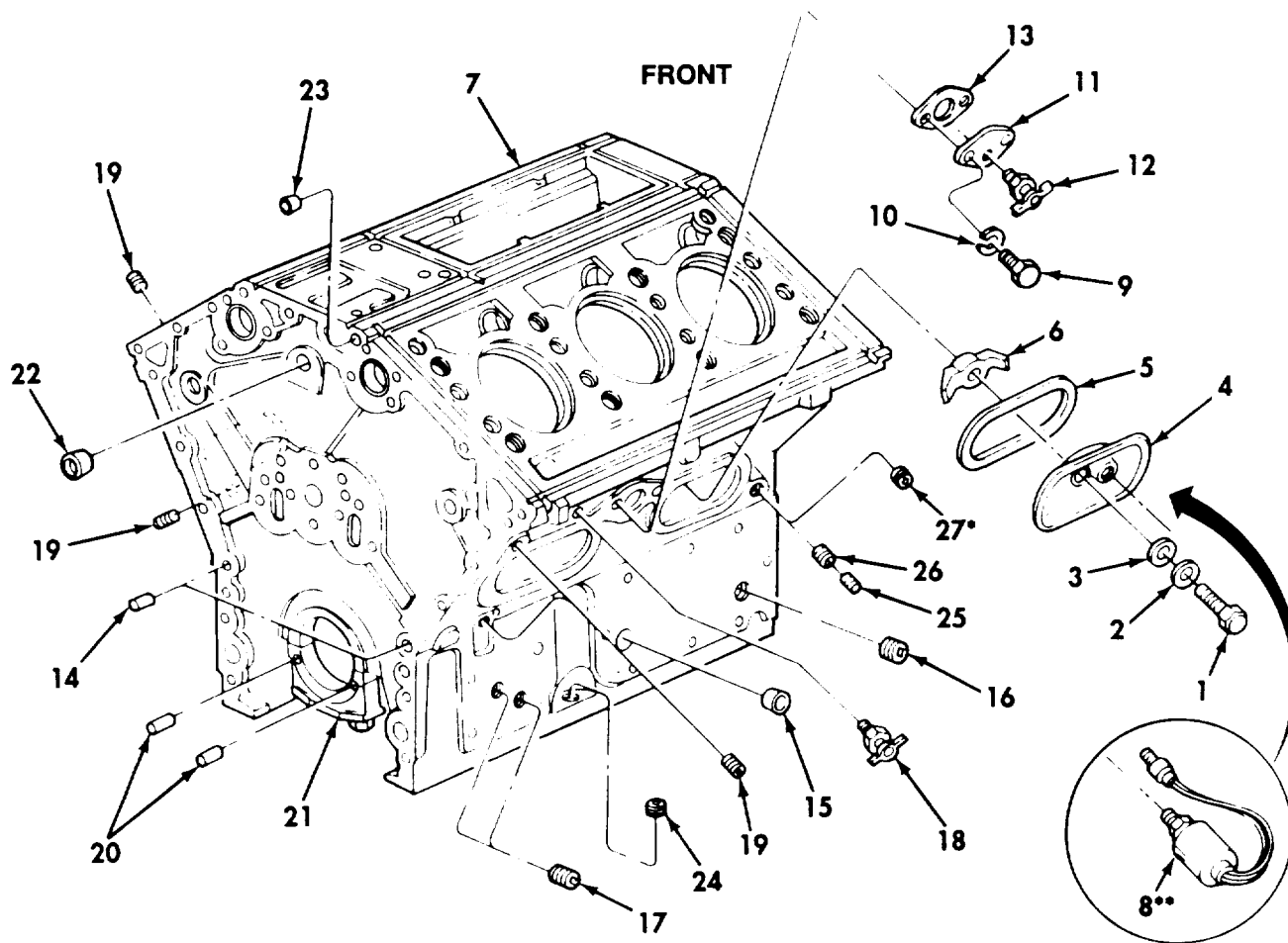
EQUIPMENT CONDITION

Para Description
 3-50 Cylinder kits removed (models 5063-5299 and 5063-5395)
 3-51 Cylinder kits removed (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L)
 3-52 Cylinder liners removed
 3-53 Crankshaft removed

a. Disassembly

- (1) Remove four screws (1), four flat washers (2), four copper gaskets (3), four airbox covers (4), four gaskets (5), and four clamps (6) from cylinder block (7). Discard gaskets.
- (2) On model 5063-5393, remove transducer assembly (8) from right front airbox cover (4).
- (3) Remove two bolts (9), two lockwashers (10), cover plate (11), draincock (12), and gasket (13) from right side of cylinder block. Discard gasket and lockwashers.
- (4) If necessary, remove four dowel pins (14) from ends of cylinder block.
- (5) Remove cup plug (15), pipe plug (16), and two pipe plugs (17) from right side of cylinder block. Discard cup plug.
- (6) Remove two draincocks (18) from sides of cylinder block.
- (7) Remove four pipe plugs (19); one from left side of block, two from right side of block, and one from top of left cylinder bank.
- (8) If necessary, remove four pins (20) from rear main bearing cap (21).
- (9) Remove two cup plugs (22) from main oil gallery at ends of cylinder block. Discard cup plugs.
- (10) Remove cup plug (23) from rear of cylinder block at upper right side. Discard plug.

- (11) On models 5063-5299, 5063-5395, and 5063-539F, remove two pipe plugs (24) from dipstick holes on each side of cylinder block.
- (12) On models 5063-5392, 5063-5393, and 5063-539L, remove pipe plug (24) from dipstick hole at left side of cylinder block.

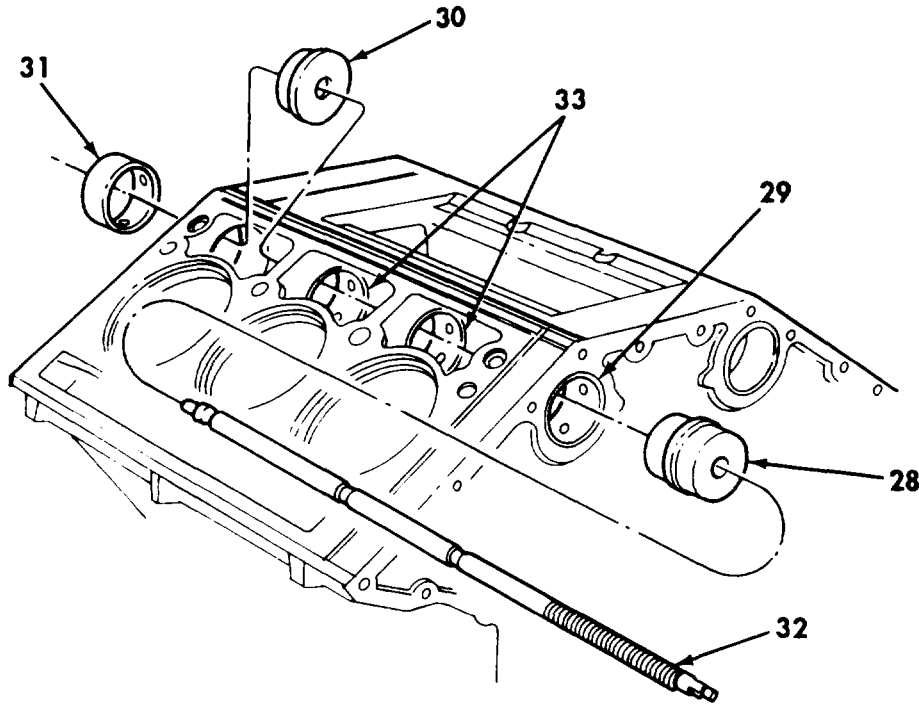


*MODEL 5063-5392
 **MODEL 5063-5393

- (13) On models 5063-5299, 5063-5395, 5063-5393, 5063-539F, and 5063-539L, remove pipe plug (25) and bushing (26) from oil gallery at right side of cylinder block.
- (14) On model 5063-5392, remove pipe plug (27) from oil gallery at right side of cylinder block.

3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5063-5398) (Cont)

(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 and install undersize bearings, reduce outside diameter of pilot, installers, and remover by 0.020 inch.

- (a) Insert small diameter end of pilot (28) in end bearing (29).
- (b) Insert small diameter end of remover (30) in end bearing (31).
- (c) Insert unthreaded end of shaft (32) into pilot (28) and through intermediate bearings (33). Push end of shaft into remover (30) until shaft snaps into place.
- (d) Drive end bearing (31) out of cylinder block.
- (e) Repeat steps (a) thru (d) for two intermediate bearings (33).
- (f) Insert large diameter end of pilot (28) in camshaft end bore with bearing removed. Repeat steps (b) thru (d) to remove end bearing (29).
- (g) Repeat steps (a) thru (f) for opposite cylinder bank.
- (h) Discard all bearings.

b. Cleaning

NOTE

Remove all plugs from cylinder block except flush mounted dowel pins.

- (1) Scrape all gasket material from cylinder block.

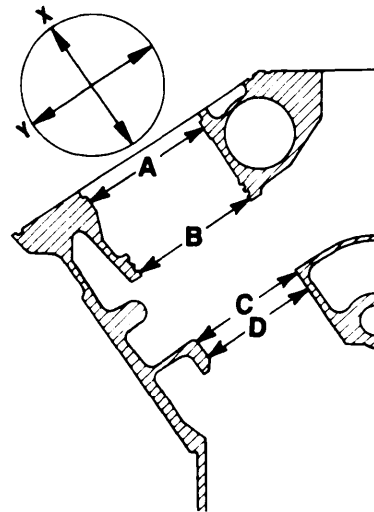
WARNING

- **Dry cleaning solvent P-D-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 (38-50°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.**
- **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**

- (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 blow out with compressed air.
- (4) Dry cylinder block with compressed air.

c. Inspection

- (1) Inspect seal ring grooves in cylinder bores for evidence of pitting and erosion.

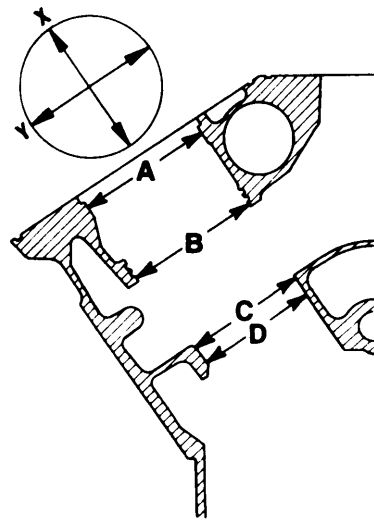
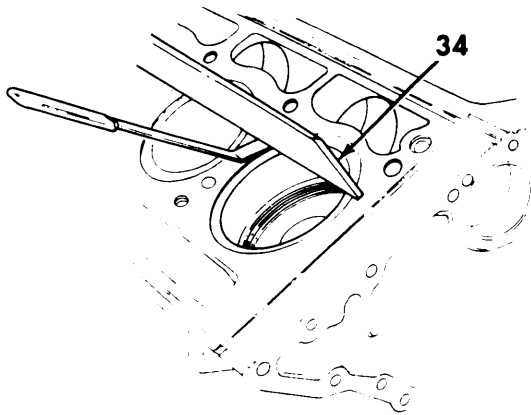
**NOTE**

- Use standard size cylinder liner if diameter (A) is less than 4.5235 inches, diameter (B) is less than 4.4900 inches, and diameters (C) and (D) are less than 4.3595 inches.
 - See Table 3-10 for cylinder bore diameters requiring oversize cylinder liners.
 - When oversize liner is used, stamp amount of oversize on top of cylinder bore adjacent to liner counterbore using metal stamping die set.
- (2) 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.
 - (3) Check cylinder bore taper and out of round. Neither may exceed 0.0015 inch.

3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5053-5398) (Cont)

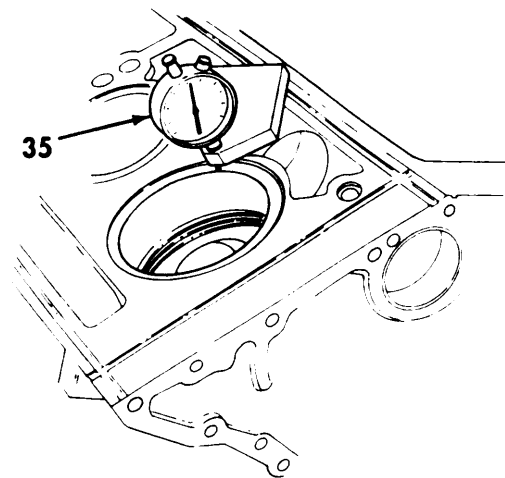
TABLE 3-10. OVERSIZE CYLINDER LINER SIZE REQUIREMENTS			
Liner Oversize	(A) Diameter Limits	(B) Diameter Limits	(C) and (D) Diameter Limits
0.010 in. (0.254 mm)	4.5295/4.5315 in. (115.05/115.10 mm)	4.4965/4.4980 in. (114.21/114.25 mm)	4.53665/4.36755 in. (110.91/110.93 mm)
0.020 in. (0.508 mm)	4.5395/4.5415 in. (115.30/115.35 mm)	4.5065/4.5080 in. (114.46/114.50 mm)	4.3765/4.3775 in. (111.16/111.19 mm)

(4) Check cylinder head contact area for flatness with straight edge (34) and thickness gage set. Measurements must not vary more than 0.003 inch crosswise and 0.006 inch lengthwise.



NOTE

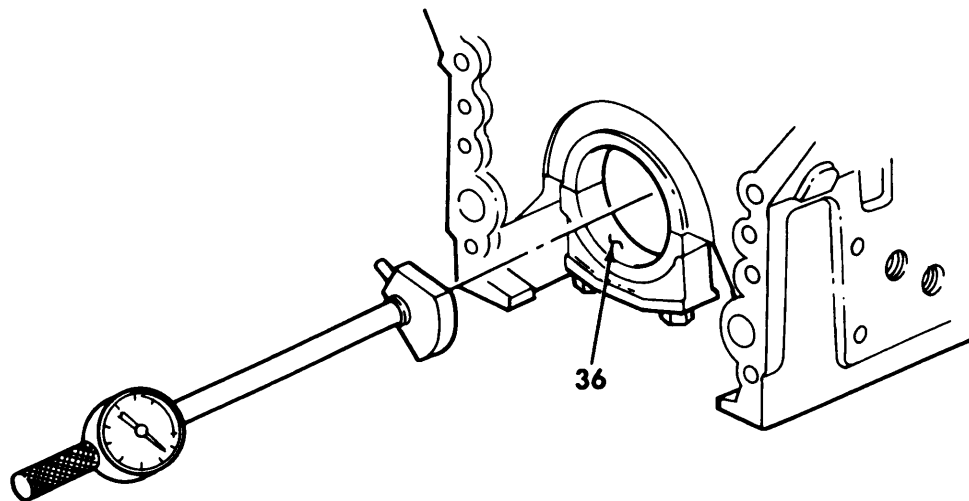
Counterbore depth must be 0.300 to 0.302 inch and not vary more than 0.0015 inch throughout circumference. Counterbore surfaces must be smooth and square with cylinder bore. There must not be over 0.001 inch difference between any two adjacent cylinder counterbores when measured lengthwise along cylinder center line of cylinder block. If difference is over 0.001 inch, do not reuse block.



(5) Using depth gage (35), measure cylinder liner counterbore depth.

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 (reference Para 3-53).
- (6) Using bore gage, measure diameters of main bearing bores (36) with bearing caps in original position. Diameter of main bearing bore is 3.751 to 3.752 inches. If bores do not meet these limits, replace cylinder block.



- (7) Measure diameter of camshaft bearing bores. End bearing bores must be 2.3750 to 2.3760 inches for standard bearings and 2.3850 to 2.3860 inches for oversized bearings. Intermediate bearing bores must be 2.3650 to 2.3660 inches for standard bearings and 2.3750 to 2.3760 inches for oversized bearings.
- (8) 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.
- (9) 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.

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.

3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5063-5398) (Cont)

d. Assembly

NOTE

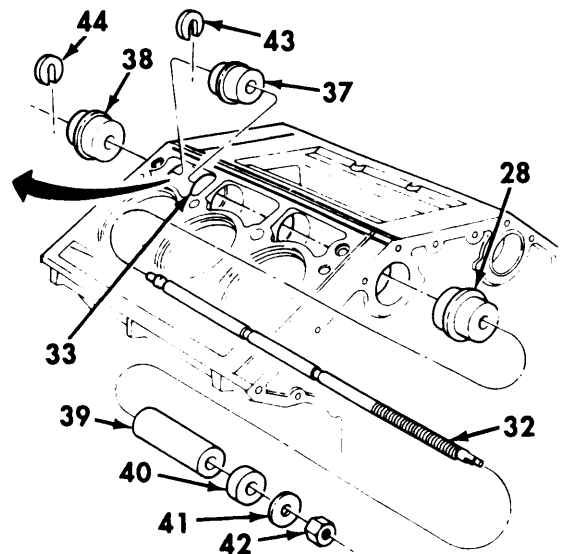
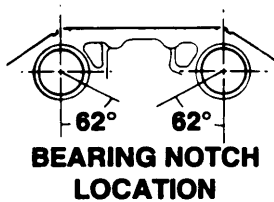
- Install camshaft intermediate bearings prior to installing camshaft end bearings and press into cylinder block from outboard end of bore.
- Notch in front end and front intermediate bearings is toward front of engine. Notch in rear end and rear intermediate bearings is toward rear of engine.
- Camshaft replacement bearings are available with either standard or oversized outside diameter and standard or undersized inside diameters (see Table 3-11).
- Camshaft bearing remover and installer set is designed for use with standard size bearings. To remove and install undersize bearings, reduce outside diameter of pilot, installers, and remover by 0.020 inch.

- (1) Install four intermediate camshaft bearings (33) as follows:
- Insert large diameter of pilot (28) in camshaft end bearing bore in block.
 - Insert intermediate bearing (33) into outboard end of camshaft bore. Ensure notch is positioned properly in bore as shown.
 - Start unthreaded end of shaft (32) in pilot (28) and push shaft through entire length of cylinder block bores.
 - Slide installer (37) on shaft (32) until locating pin engages notch in bearing (33).

Bearing Position	Color Code		Outside Diameter	Inside Diameter
	Current	Former		
End	Brown	Black	Standard	Standard, 0.010, & 0.020 Undersize
	Brown	Yellow	Oversize	
Inter-mediate	Orange	Red	Standard	Standard, 0.010, & 0.020 Undersize
	Orange	Blue	0.010 Oversize	

NOTE

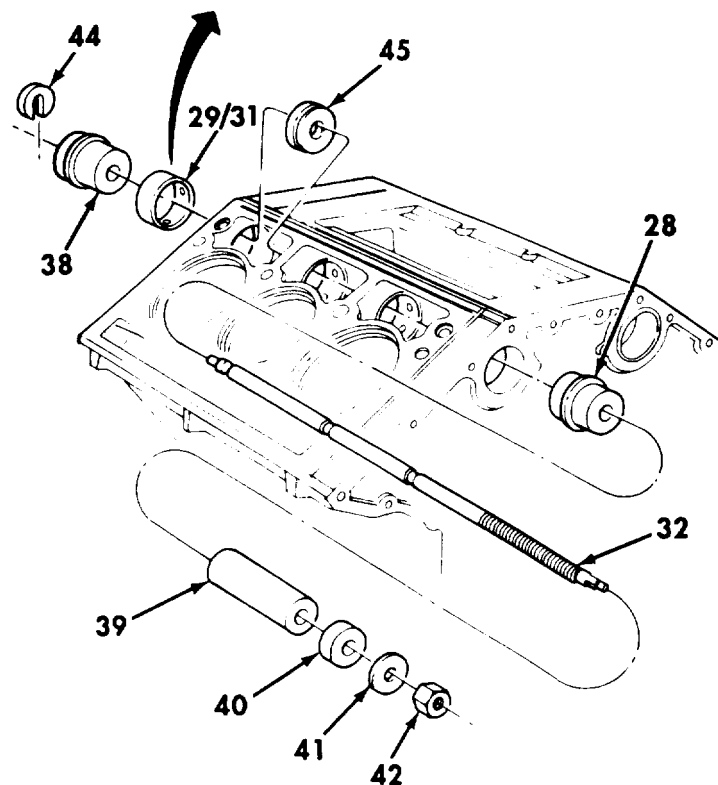
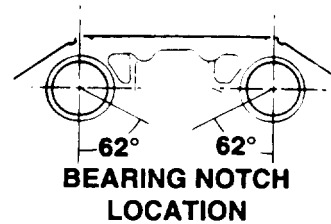
Use J-7593-15 installer when installing right front or left rear intermediate bearing. Use J-7593-3 installer when installing left front or right rear intermediate bearing.



- Slide installer (38) on end of shaft (32) with large diameter inserted into end of block bore.
- Place spacer (39), thrust bearing (40), flat washer (41), and hex nut (42) over threaded end of shaft (32).
- Align shaft (32) and install C-washer (43) in groove in shaft adjacent to installer (37).

- (h) Place C-washer (44) in groove near end of shaft (32).
 - (i) To draw bearing (33) into position, turn hex nut (42) until C-washer (44) butts up against installer (38).
 - (j) Remove bearing installer (38) assembly from cylinder block.
 - (k) Repeat steps (a) thru (j) for remaining intermediate bearings (33).
- (2) Install four camshaft end bearings (29 and 31) as follows:

- (a) Insert pilot (28) 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 (45) in end bore at opposite end of block.
- (c) Start unthreaded end of shaft (32) into pilot (28) and push through block and support (45).
- (d) Place end bearing (29 or 31) on installer (38) and align notch in bearing with pin on installer. Slide bearing and installer on shaft (32). Ensure notch in bearing is positioned properly in bore as shown.
- (e) Place C-washer (44) in groove near end of shaft (32). Pull shaft back until C-washer butts against installer (38).
- (f) Place spacer (39) (if required), thrust washer (40), flat washer (41), and hex nut (42) over threaded end of shaft (32).
- (g) To draw bearing (29 or 31) into position, turn hex nut (42) until shoulder on installer (38) butts up against block bore.
- (h) Remove bearing installer (38) assembly from cylinder block.
- (i) Repeat steps (a) thru (h) for remaining end bearings.

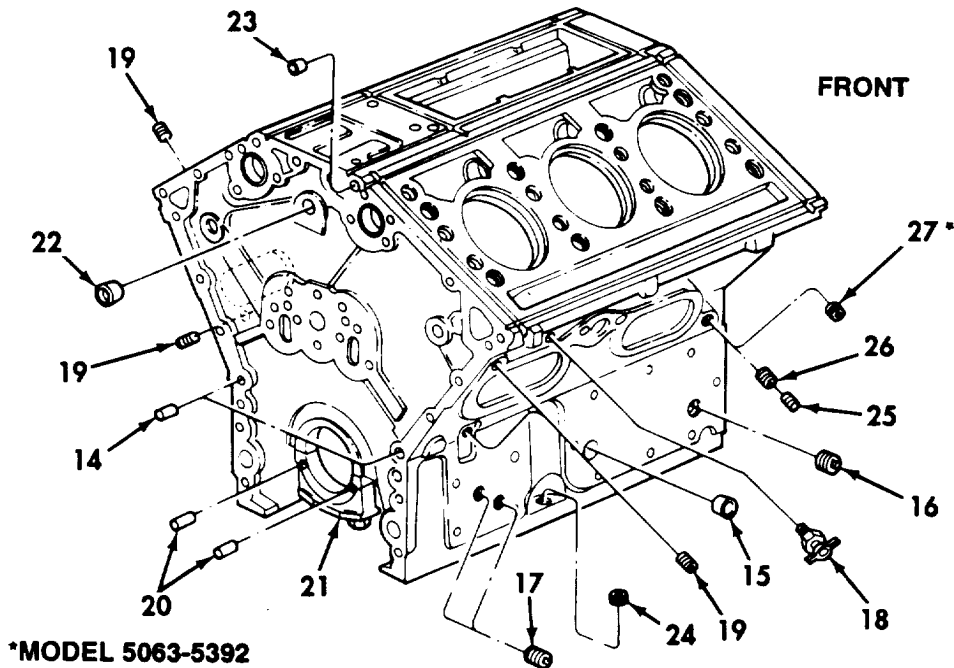


3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5063-5398) (Cont)

NOTE

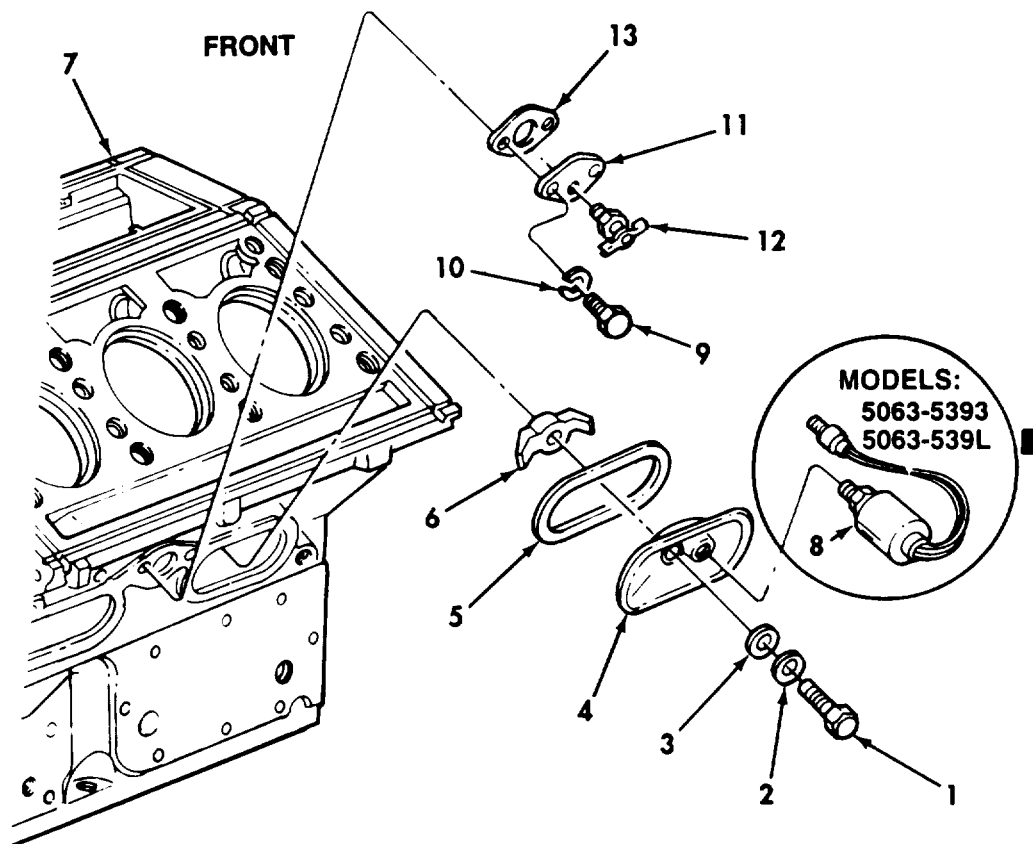
Apply sealing compound to all uncoated plugs and fittings.

- (3) On model 5063-5392, install pipe plug (27) in oil gallery hole at right side of cylinder block.
- (4) On models 5063-5299, 5063-5395, 5063-5393, 5063-539F, and 5063-539L, install bushing (26) and pipe plug (25) in oil gallery hole at right side of cylinder block.
- (5) On models 5063-5392, 5063-5393, and 5063-539L, install pipe plug (24) in dipstick hole at left side of cylinder block.
- (6) On models 5063-5299, 5063-5395, and 5063-539F, install two pipe plugs (24) in dipstick holes on each side of cylinder block.
- (7) Install cup plug (23) in rear of cylinder block at upper right side. Cup plug must be flush to 0.030 inch below surface.



- (8) Install two cup plugs (22) in main oil gallery at ends of cylinder block. Cup plugs must be flush to 0.030 inch below surface of block.
- (9) If removed, press four pins (20) into rear main bearing cap (21). Pins must protrude 0.107 to 0.117 inch.
- (10) Install four pipe plugs (19); one in left side of block, two in right side of block, and one in top of left cylinder bank.
- (11) Install two draincocks (18) in sides of cylinder block,
- (12) Install cup plug (15), pipe plug (16), and two pipe plugs (17) in right side of cylinder block. Cup plug must be flush to 0.030 inch below surface of block,
- (13) Install four dowel pins (14) into ends of cylinder block. Pins must protrude 11/16 inch.

- (14) Install gasket (13), cover plate (11), two lockwashers (10), and two bolts (9) on right side of block, Torque bolts to 13-17 lb-ft (18-23 N-m).
- (15) Install draincock (12) in cover plate (11).



NOTE

On models 5063-5393, and 5063-539L, airbox cover with threaded hole must be at right side front position and hole toward the front.

- (16) Install clamp (6), copper gasket (3), flat washer (2), and screw (1) on airbox cover (4) Install gasket (5) on airbox cover using gasket adhesive. Turn clamp until positioned between tangs on back of airbox cover. Insert four airbox 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 (8) in right front airbox cover (4).

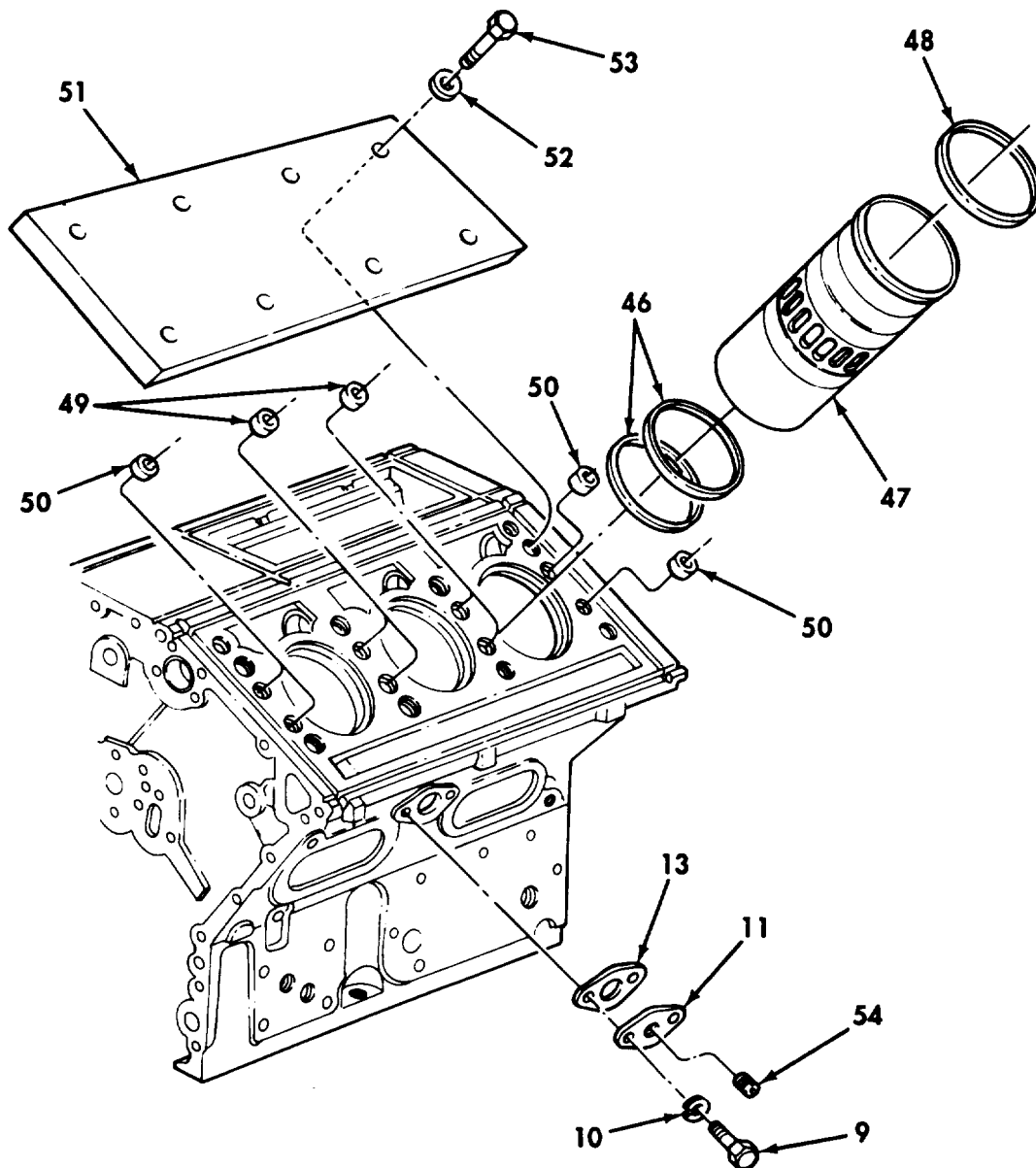
3-54. CYLINDER BLOCK MAINTENANCE (ALL EXCEPT MODEL 5053-5398) (Cont)

e. Pressure test

NOTE

Ensure all water hole plugs are in cylinder block before pressure testing.

- (1) Install two preformed packings (46) in grooves at each cylinder bore position.
- (2) Apply shortening compound or antifreeze to inner surface of preformed packings (46).
- (3) Slide cylinder liners (47) into block, being careful not to roll or damage preformed packings (46).



- (4) Install three compression gaskets (48), four large seal rings (49), and four small seal rings (50) on top surface of each cylinder bank.
- (5) Install fabricated blocking plate (51), eight flat washers (52), and eight bolts (53) on top of each cylinder bank. Tighten bolts securely.
- (6) Install gasket (13), water hole cover (11), two lockwashers (10), and two bolts (9) on each side of cylinder block. Plug hole in one of the covers with 1/8 inch NPTF pipe plug (54).
- (7) Connect air line with regulator to hole in other water hole cover (11).
- (8) Immerse cylinder block in water heated to 180-200°F (82-93°C) for twenty minutes.

WARNING

Wear safety glasses when working with pressurized air system. Make certain air pressure is fully vented before disassembly. Sudden release of air pressure can throw debris resulting in serious personal injury. Injury to eyes and inner ears can result from failure to properly vent block before disassembly.

- (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. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (11) Blow out 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 MAINTENANCE

Para Description

3-53 Install crankshaft

3-50 Install cylinder kits (models 5063-5299 and 5063-5395)

3-51 Install cylinder kits (models 5063-5392, 5063-5393, 5063-539F, and 5063-539L)

3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5398)

This task covers: a. Disassembly b. Cleaning c. Inspection d. Assembly
 e. Pressure test

INITIAL SETUP

MODELS

5063-5398

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Gage, cylinder bore (App B, Item 35)
 Die set, metal stamping, hand (App B, Item 20)
 Remover kit, camshaft bearing (App B, Item 85)
 Straight edge (App B, Item 96)
 Gage, depth (App B, Item 36)
 Pressure testing kit, cylinder block (App D, Item 7)

MATERIALS/PARTS

4 Gaskets (App F, Item 83)
 3 Gasket (App F, Item 58)
 10 Lockwashers App F, Item 98)
 1 Gasket (App F, Item 54)
 2 Plugs, expansion (App F, Item 129)
 2 Plugs, cup App F, Item 125)
 2 Plugs, cup App F, Item 124)
 8 Plugs, cup (App F, Item 123)
 1 Plug, expansion (App F, Item 131)
 1 Bearing set (App F, Item 2)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
 International Compound No. 2 (App C, Item 21)
 Sealing compound (App C, item 44)
 Oil, engine (App C, Item 26)
 Shortening compound (App C, Item 47)
 Adhesive, gasket (App C, Item 1)
 Corrosion preventative (App C, Item 11)

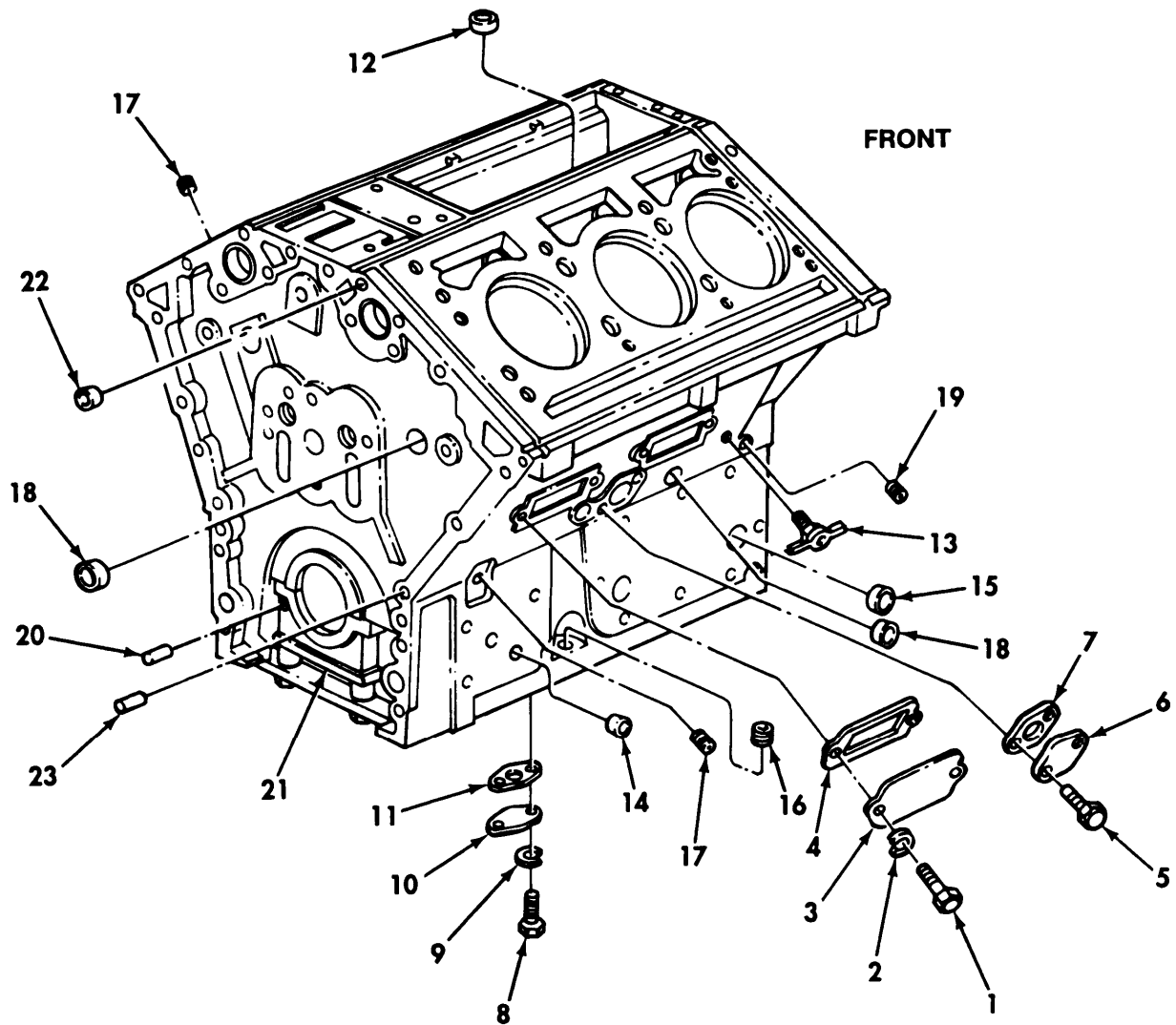
EQUIPMENT CONDITION

Para	Description
3-50	Cylinder kits removed
3-52	Cylinder liners removed
3-53	Crankshaft removed

a. Disassembly

- (1) Remove eight bolts (1), eight lockwashers (2), four airbox covers (3), and four gaskets (4) from cylinder block. Discard gaskets and lockwashers.
- (2) Remove two self-locking bolts (5), cover (6), and gasket (7) from right side of cylinder block. Discard gasket.
- (3) Remove two bolts (8), two lockwashers (9), plate (10), and gasket (11) from bottom of cylinder block. Discard gasket and lockwashers.
- (4) Remove two expansion plugs (12) from floor of airbox. Discard plugs.
- (5) Remove two draincocks (13) from sides of cylinder block.
- (6) Remove two cup plugs (14) and two cup plugs (15) from right side of cylinder block. Discard plugs.
- (7) Remove two pipe plugs (16) from holes at sides of cylinder block.
- (8) Remove ten pipe plugs (17); three from left side, three from right side, two from top of left cylinder bank, one from top of right cylinder bank, and one from top of cylinder block.

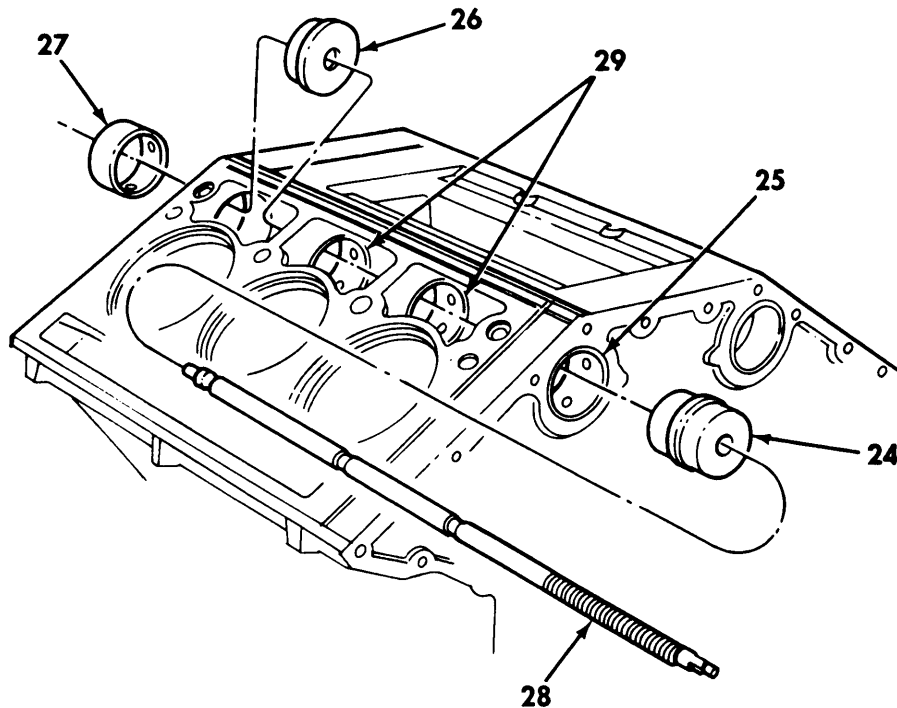
- (9) Remove eight cup plugs (18), two from each side and two from each end of cylinder block. Discard plugs.
- (10) Remove pipe plug (19) from right side of cylinder block.
- (11) If necessary, remove four pins (20) from rear main bearing cap (21).



- (12) Remove expansion plug (22) from rear of cylinder block near right camshaft bore. Discard plug.
- (13) If necessary, remove two dowel pins (23) from rear of cylinder block.

3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5398) (Cont)

(14) Remove eight camshaft bearings from cylinder block as outlined below:



NOTE

Camshaft bearing remover and installer set is designed for use with standard size bearings. To remove and install undersize bearings, reduce outside diameter of pilot, installers, and remover by 0.020 inch.

- (a) Insert small diameter end of pilot (24) in end bearing (25).
- (b) Insert small diameter end of remover (26) in end bearing (27).
- (c) Insert unthreaded end of shaft (28) into pilot (24) and through intermediate bearings (29). Push end of shaft into remover (26) until shaft snaps into place.
- (d) Drive end bearing (27) out of cylinder block.
- (e) Repeat steps (a) thru (d) for two intermediate bearings (29).
- (f) Insert large diameter end of pilot (24) in camshaft bore with bearing removed. Repeat steps (b) thru (d) to remove end bearing (25).
- (g) Repeat steps (a) thru (f) for opposite cylinder bank.
- (h) Discard all bearings.

b. Cleaning

NOTE

Remove all plugs from cylinder block except flush mounted dowel pins.

- (1) Scrape all gasket material from cylinder block.

WARNING

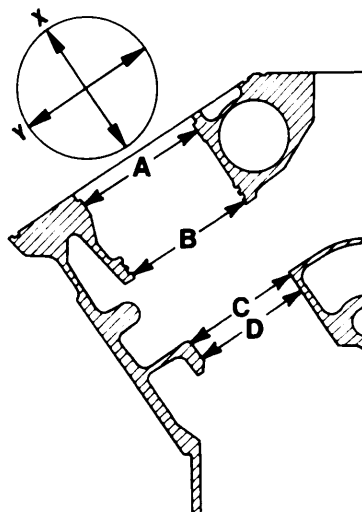
- Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while 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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (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 blow out with compressed air.
 - (4) Dry cylinder block with compressed air.

c. Inspection

- (1) Inspect seal ring grooves in cylinder bores for evidence of pitting and erosion.

NOTE

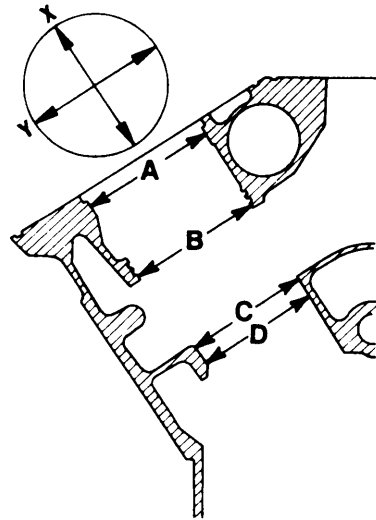
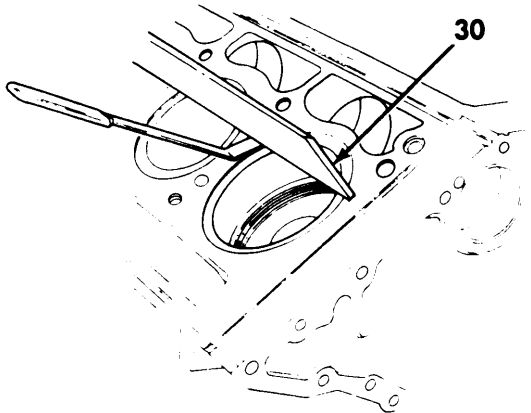
- Use standard size cylinder liner if diameter at position (A) is less than 4.5245 inches, diameter at position (B) is less than 4.4960 inches, and diameters at positions (C) and (D) are less than 4.3605 inches.
 - See Table 3-12 for cylinder bore diameters required for oversize cylinder liners.
 - When oversize liner is used, stamp amount of oversize on top of cylinder bore adjacent to liner counterbore using metal stamping die set.
- (2) 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.
 - (3) Check cylinder bore taper and out of round. Neither may exceed 0.0015 inch.



3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5398) (Cont)

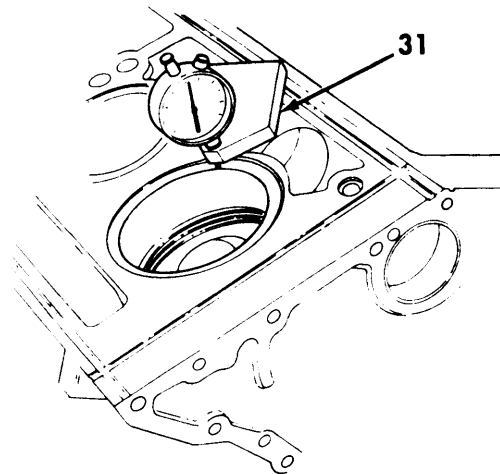
TABLE 3-12. OVERSIZE CYLINDER LINER SIZE REQUIREMENTS			
Liner Oversize	(A) Diameter Limits	(B) Diameter Limits	(C) and (D) Diameter Limits
0.010 in. (0.254 mm)	4.5295/4.5315 in. (115.05/115.10 mm)	4.4965/4.4980 in. (114.21/114.25 mm)	4.53665/4.36755 in. (110.91/110.93 mm)
0.020 in. (0.508 mm)	4.5395/4.5415 in. (115.30/115.35 mm)	4.5065/4.5080 in. (114.46/114.50 mm)	4.3765/4.3775 in. (111.16/111.19 mm)

(4) Check cylinder head contact area for flatness with straight edge (30) and thickness gage set. Crosswise and lengthwise warpage measurements must not exceed 0.018 inch.



NOTE

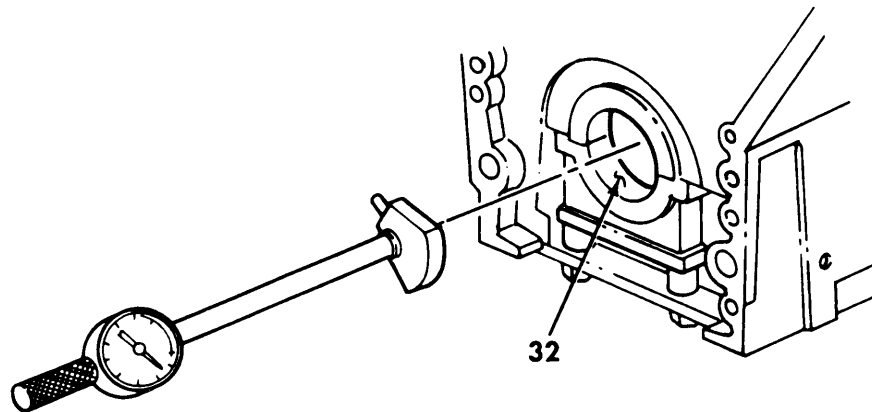
Counterbore depth must be 0.300 to 0.302 inch and not vary more than 0.0015 inch throughout circumference. Counterbore surfaces must be smooth and square with cylinder bore. There must not be over 0.001 inch difference between any two adjacent cylinder counterbores when measured lengthwise along cylinder center line of cylinder block. If difference is over 0.001 inch, do not reuse block.



(5) Using depth gage (31), measure cylinder liner counterbore depth.

NOTE

- Install main bearing bolts, bearing caps, stabilizers, and hardened washers (reference Para 3-53).
 - 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 front oil pan rail.
- (6) Using bore gage, measure diameters of main bearing bore (32) with bearing caps in original position. Main bearing bore diameter is 3.751 to 3.752 inches. If bores do not meet these limits, replace cylinder block.



- (7) Measure diameter of camshaft bearing bores. End bearing bores must be 2.3750 to 2.3760 inches. Intermediate bearing bores must be 2.3650 to 2.3660 inches.
- (8) 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.
- (9) 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.

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.

3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5398) (Cont)

d. Assembly

NOTE

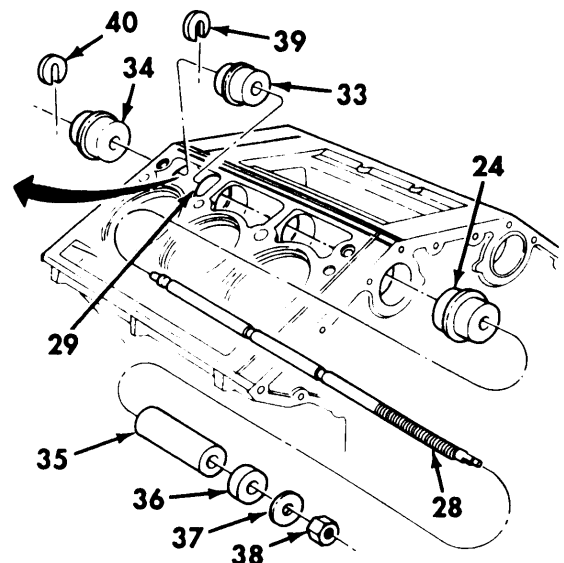
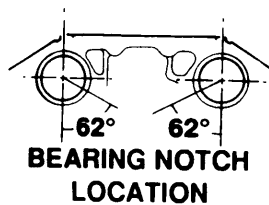
- Camshaft intermediate bearings must be installed prior to installing camshaft end bearings and are pressed into cylinder block from outboard end of bore.
- Notch in front end bearing and front intermediate bearing is toward front of engine. Notch in rear end bearing and rear intermediate bearing is toward rear of engine.
- Camshaft replacement bearings are available with either standard or oversized outside diameter and standard or undersized inside diameters as shown in Table 3-13.
- Camshaft bearing remover and installer set is designed for use with standard size bearings. Set can be used to remove and install undersize bearings if outside diameter of pilot, installers, and remover is reduced by 0.020 inch.

- (1) Install four intermediate camshaft bearings (29) as follows:
- Insert large diameter of pilot (24) in camshaft end bearing bore in block.
 - Insert intermediate bearing (29) into outboard end of camshaft bore. Ensure notch is positioned properly in bore as shown.
 - Start unthreaded end of shaft (28) in pilot (24) and push shaft through entire length of cylinder block bores.
 - Slide installer (33) on shaft (28) until locating pin engages notch in bearing (29).

Bearing Position	Color Code		Outside Diameter	Inside Diameter
	Current	Former		
End	Brown	Black	Standard 0.010	Standard, 0.010, & 0.020 Undersize
	Brown	Yellow	Oversize	Standard
Inter- mediate	Orange	Red	Standard	Standard, 0.010, & 0.020 Undersize
	Orange	Blue	0.010 Oversize	Standard

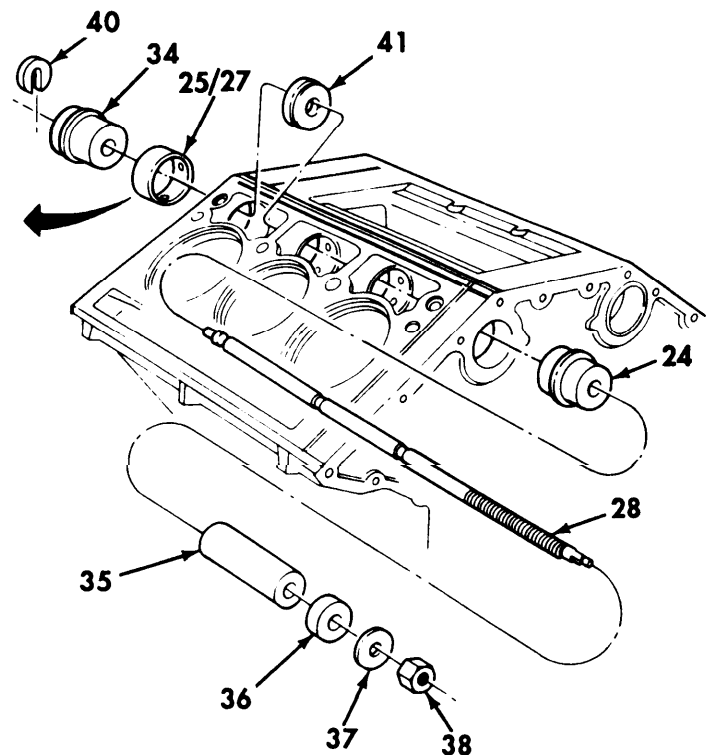
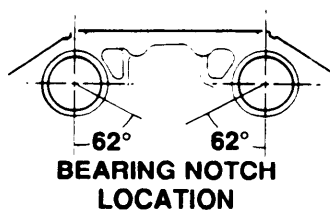
NOTE

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.



- Slide installer (34) on end of shaft (28) with large diameter inserted into end of block bore.
- Place spacer (35), thrust washer (36), plain washer (37), and hex nut (38) over threaded end of shaft (28).

- (g) Align shaft (28) and install C-washer (39) in groove in shaft adjacent to installer (33).
 - (h) Place C-washer (40) in groove near end of shaft (28).
 - (i) To draw bearing (29) into position, turn hex nut (38) until C-washer (40) butts up against installer (34).
 - (j) Remove bearing installer (34) assembly from cylinder block.
 - (k) Repeat steps (a) thru (j) for remaining intermediate bearings (29).
- (2) Install four camshaft end bearings (25 and 27) as follows:
- (a) Insert pilot (24) 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 (41) in end bore at opposite end of block.
 - (c) Start unthreaded end of shaft (28) into pilot (24) and push through block and support (41).
 - (d) Place end bearing (25 or 27) on installer (34) and align notch in bearing with pin on installer. Slide bearing and installer on shaft (28). Ensure notch in bearing is positioned properly in bore as shown.
 - (e) Place C-washer (40) in groove near end of shaft (28). Pull shaft back until C-washer butts against installer (34).
 - (f) Place spacer (35) (if required), thrust washer (36), plain washer (37), and hex nut (38) over threaded end of shaft (28).



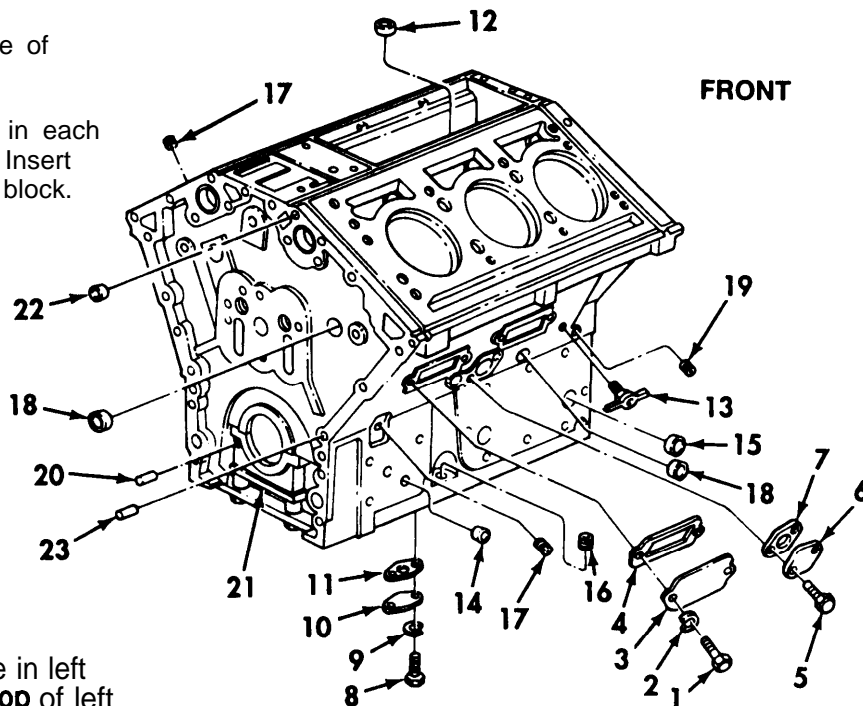
- (g) To draw bearing (25 or 27) into position, turn hex nut 38) until shoulder on installer (34) butts against block bore.
- (h) Remove bearing installer (34) assembly from cylinder block.
- (i) Repeat steps (a) thru (h) for remaining end bearings.

3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5396) (Cont)

NOTE

Apply sealing compound to all plugs and fittings unless precoated.

- (3) Install two pins (23) in rear of cylinder block. Pins must protrude 11/16 inch.
- (4) Install expansion plug (22) in rear of cylinder block near right camshaft bore. Insert plug flush to 0.030 inch below surface.
- (5) Press four pins (20) into rear main bearing cap (21). Pins must protrude 0.107 to 0.117 inch.
- (6) Install pipe plug (19) in right side of cylinder block.
- (7) Install eight cup plugs (18), two in each side and end of cylinder block. Insert plugs flush to below surface of block.



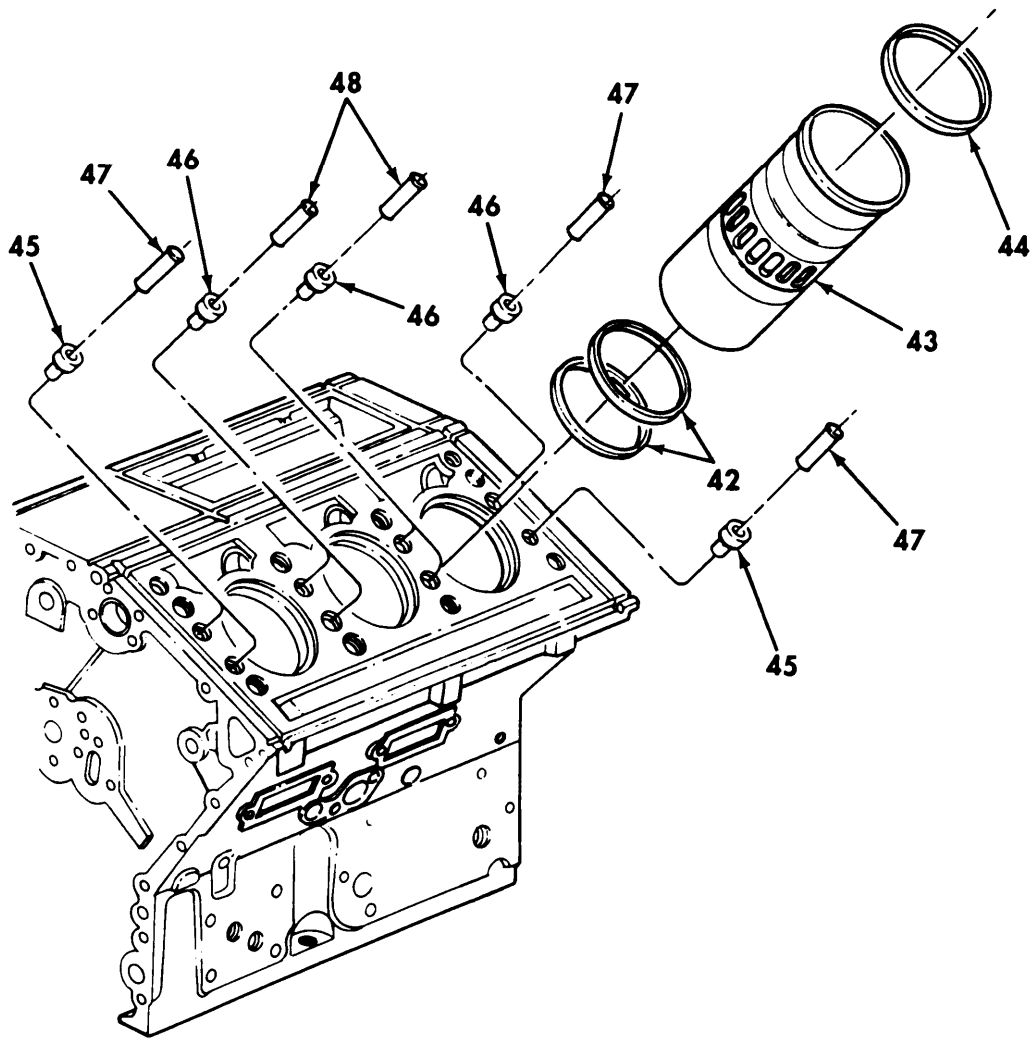
- (8) Install ten pipe plugs (17); three in left side, three in right side, two in top of left cylinder bank, one in top of right cylinder bank, and one in top of cylinder block.
- (9) Install two pipe plugs (16) in holes at sides of cylinder block.
- (10) Install two cup plugs (14) and two cup plugs (15) in right side of cylinder block. Drive plugs flush with surface.
- (11) Install two draincocks (13) in sides of cylinder block.
- (12) Install two expansion plugs (12) in bottom of airbox. Drive plugs 0.090 inch below surface.
- (13) Install gasket (11), plate (10), two lockwashers (9), and two bolts (8) to bottom of cylinder block. Torque bolts to 13-17 lb-ft (8-23 N·m).
- (14) Install gasket (7), cover (6), and two self-locking bolts (5) to right side of cylinder block. Torque bolts to 13-17 lb-ft (18-23 N·m).
- (15) Install four gaskets (4), four airbox covers (3), eight lockwashers (2), and eight bolts (1) on sides of cylinder block. Torque bolts to 13-17 lb-ft (18-23 N·m).

e. Pressure test

NOTE

Ensure all water hole plugs are in cylinder block before pressure testing.

- (1) Install two preformed packings (42) in grooves at each cylinder bore position.
- (2) Apply shortening compound or antifreeze to inner surface of preformed packings (42).



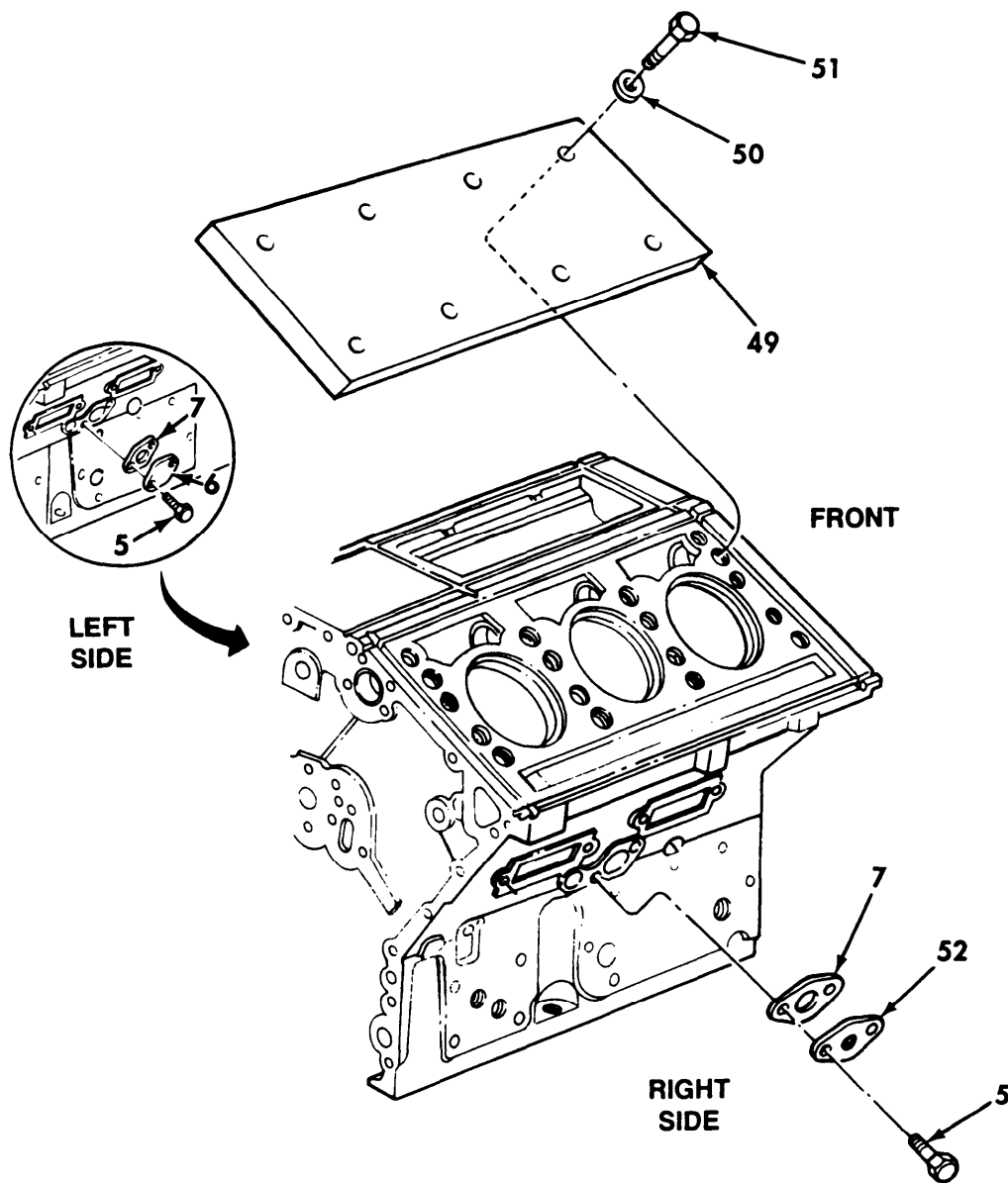
- (3) (3) Slide cylinder liners (43) into block, being careful not to roll or damage preformed packings (42).
- (4) Install three compression gaskets (44), four small seals (45), four large seals (46), four small sleeves (47), and four large sleeves (48) on top surface of each cylinder bank.

3-55. CYLINDER BLOCK MAINTENANCE (MODEL 5063-5398) (Cont)

NOTE

Install seven 5/8-11 x 3 1/2 inches long and nine 5/8-11 x 2 1/2 inches long bolts for two blocking plates (49). Insert longer bolts at front and rear of each cylinder bank except at right rear outboard position.

- (5) Install large fabricated blocking plate (49), eight washers (50), and eight bolts (51) on top of each cylinder bank.
- (6) Install small fabricated blocking plate (52) on right side, water hole cover (6) on left side, two gaskets (7), and four self-locking bolts (5) on cylinder block.



- (7) Immerse cylinder block in a tank of water heated to 180-200°F (82-93°C) for twenty minutes.

WARNING

Wear safety glasses when working on air system components. Make certain air pressure is fully vented before disassembly. Sudden release of air pressure can throw debris resulting in serious personal injury. Injury to eyes and inner ears can result from failure to properly vent block before disassembly.

- (8) 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.
- (9) After completing pressure test, release air pressure and remove block from water tank. Remove plates, seals, liners, sleeves, and gaskets from cylinder block.

WARNING

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

- (10) Blow out all passages in block with compressed air.
- (11) Dry cylinder liners with compressed air and coat them with lubricating oil to prevent from rusting.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-53 Install crankshaft.

3-50 Install cylinder kits.

Section V. DIRECT SUPPORT COMPONENT REPAIR

Contents	Para	Page
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3-56. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODEL 5063-5299)

This task covers: a. Disassembly b. Cleaning c. Pressure check d. Assembly

INITIAL SETUP

MODELS

5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Pressure testing kit, oil cooler (App D, Item 12)

MATERIALS/PARTS

4 Gaskets (App F, Item 65)
 4 Washers, key (App F, Item 191)
 1 Gasket (App F, Item 64)
 17 Lockwashers (App F, Item 98)

EXPENDABLE/DURABLE SUPPLIES

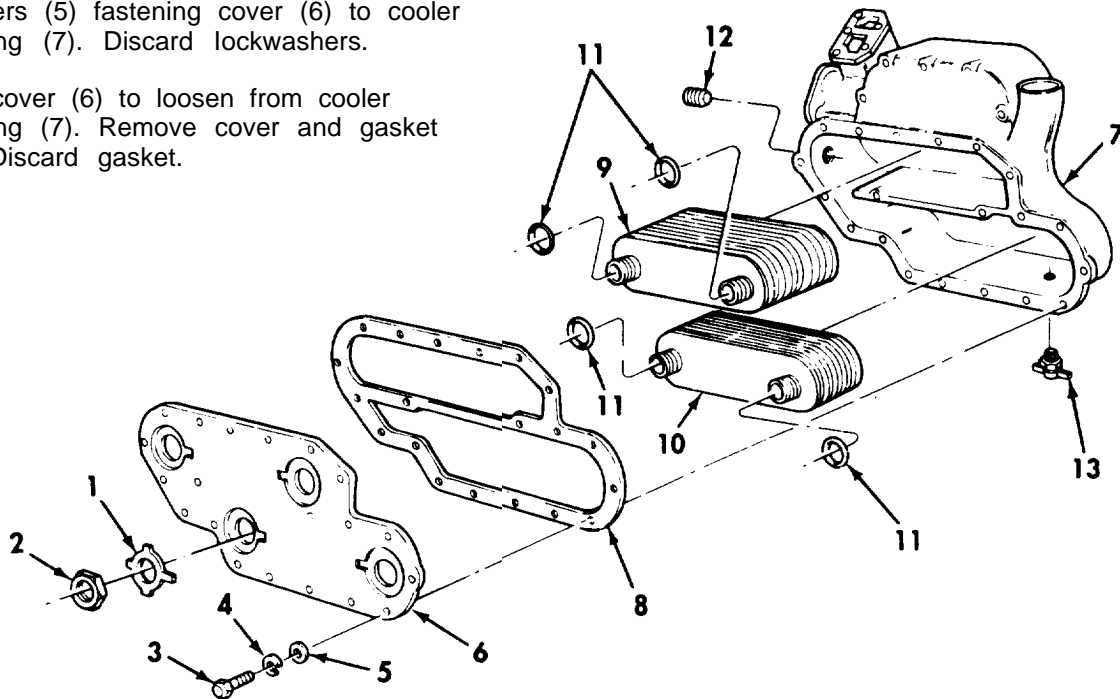
Oil, engine (App C, Item 26)
 Cleaning solvent (App C, Item 9)
 Trichloroethane, 1, 1, 1 (App C, Item 54)
 Oxalic acid (App C, Item 30)
 Hydrochloric acid (App C, Item 20)
 1 Reducer, pipe (App C, Item 34)
 1 Plug, pipe (App C, Item 31)

EQUIPMENT CONDITION

2-16 Engine/transmission oil cooler removed

a. Disassembly

- (1) Bend tabs on four key washers (1) away from sides of nuts (2). Remove four nuts and four key washers. Discard key washers.
- (2) Remove seventeen bolts (3), seventeen lockwashers (4), and seventeen flat washers (5) fastening cover (6) to cooler housing (7). Discard lockwashers.
- (3) Tap cover (6) to loosen from cooler housing (7). Remove cover and gasket (8). 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 (9) and differential oil cooler (10) from cooler housing (7).
- (5) Remove four gaskets (11) from oil cooler (9) and oil cooler (10). Discard gaskets.
- (6) If necessary, remove pipe plug (12) and draincock (13) from cooler housing (7).

b. Cleaning**NOTE**

- Engine oil cooler was removed from engine during oil cooler assembly removal (Para 2-16).
 - Do not clean cooler if engine or transmission has had metal particles enter oil system. Instead, replace oil cooler.
- (1) Oil cooler - oil side

WARNING

1, 1, 1 trichloroethane solution is toxic. Wear protective goggles and gloves and use in a well-ventilated area to avoid personal injury. Avoid breathing the fumes or direct contact with your skin. Use recommended safety equipment as required.

- (a) Pump 1, 1, 1 trichloroethane solution through oil cooler to remove carbon and sludge.

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

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

3-56. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODEL 5063-5299) (Cont)

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (2) Clean oil cooler housing and cover with cleaning solvent and dry with compressed air.
- (3) Oil cooler – water side

WARNING

Cooler cleaning solution is made from two strong acids. 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 or injury may result.

- (a) Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound of oxalic acid for each 2.5 gallons of solution.
- (b) Immerse oil coolers in solution.
- (c) Watch cleaning process carefully. Remove oil coolers from solution when bubbling stops (usually 30 to 60 seconds).
- (d) Flush oil coolers in clean hot water.
- (e) After cleaning oil coolers, dip in light oil.

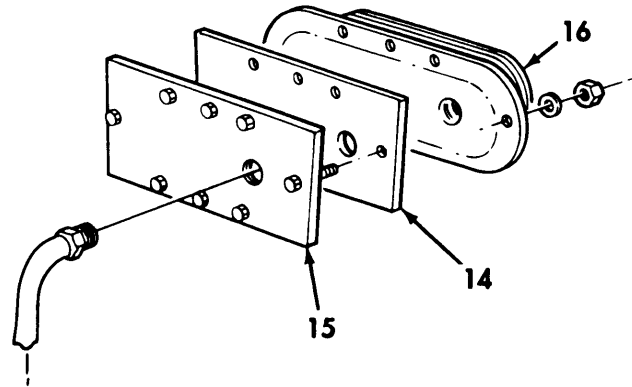
c. Pressure check

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.

- (1) Engine oil cooler
- (a) Install rubber gasket (14), fabricated blocking plate (15), eight 5/16-inch diameter bolts, flat washers, and nuts on flanged side of engine oil cooler (16).

- (b) Connect air line to blocking plate (15) and apply pressure of 75 PSI (517 kPa) to oil cooler.
- (c) 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.
- (d) Release air pressure on oil cooler assembly. Remove plate, gasket, and hose from oil cooler.



WARNING

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

- (e) Dry oil cooler with compressed air.
- (2) Transmission and differential oil coolers

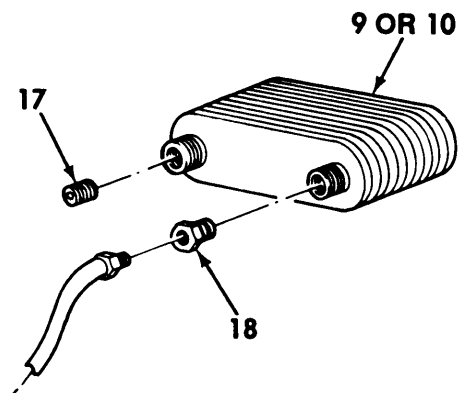
- (a) Plug one hole in transmission oil cooler (9) with 3/4-14 NPT pipe plug (17). Install 3/4-1/4 inch reducer bushing (18) in other hole of oil cooler.
- (b) Connect air line to inlet hole in oil cooler. Pressurize oil cooler to 75 PSI (517 kPa).

- (c) Submerge oil cooler in a container of water heated to 180°F (82°C). Air bubbles in the water indicate a leak. Replace any oil cooler with a leak.

- (d) Release pressure on oil cooler assembly. Remove plug, reducer bushing, and air hose from oil cooler.

- (e) Dry oil cooler with compressed air.

- (f) Repeat steps (a) thru (e) for differential oil cooler (10).



3-56. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODEL 5063-5299) (Cont)

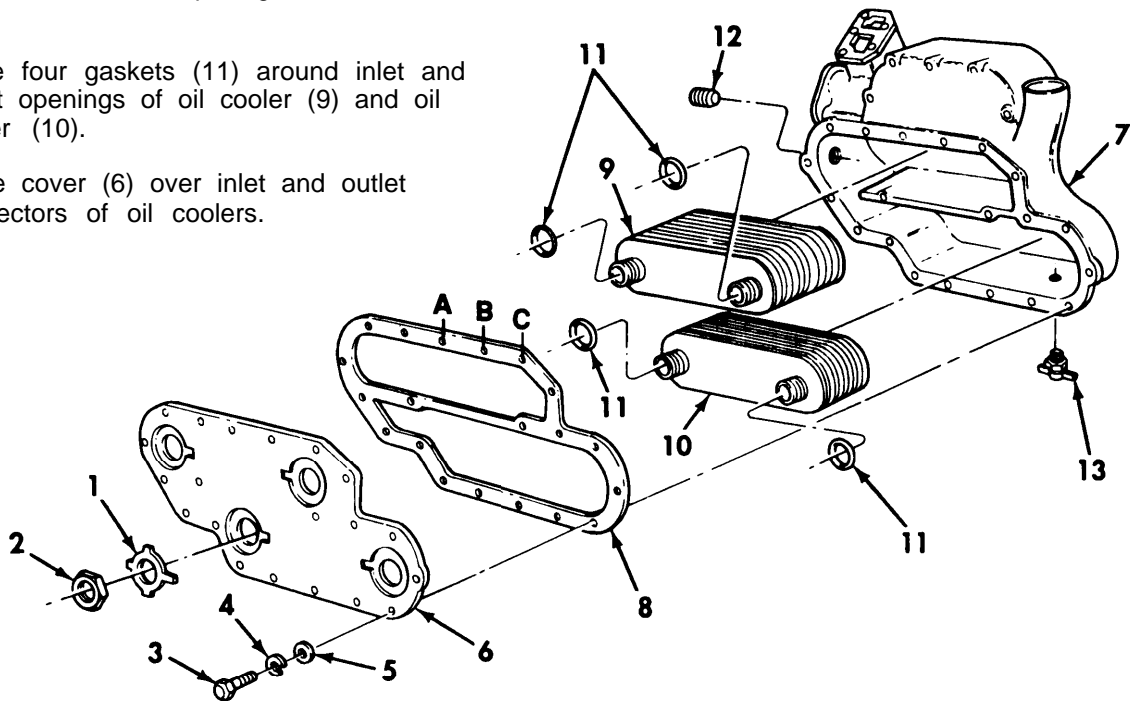
d. Assembly

- (1) If removed, install pipe plug (12) in side of oil cooler housing (7) and draincock (13) in bottom of cooler housing.
- (2) Place gasket (8) on oil cooler housing (7).

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 gaskets (11) around inlet and outlet openings of oil cooler (9) and oil cooler (10).
- (4) Place cover (6) over inlet and outlet connectors of oil coolers.



- (5) Install four key washers (1) and four nuts (2) on inlet and outlet connectors of oil coolers. Do not tighten nuts.
- (6) Place assembly of cover (6), oil cooler (9), and oil cooler (10) in oil cooler housing (7).

NOTE

Do not install bolts in locations (A), (B), and (C).

- (7) Install cover (6), seventeen flat washers (5), seventeen lockwashers (4), and seventeen bolts (3) on oil cooler housing (7). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (8) Torque nuts (2) to 50-60 lb-ft (68-82 N-m). Bend short tangs on key washers (1) against nuts.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
2-16 Install engine/transmission oil cooler.

3-57. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODEL 5063-5392)

This task covers: a. Disassembly b. Cleaning c. Pressure check d. Assembly

INITIAL SETUP

MODELS

5063-5392

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Pressure testing kit, oil cooler (App D, Item 13)

MATERIALS/PARTS

- 1 Gasket (App F, Item 37)
- 1 Gasket (App F, Item 34)
- 6 Lockwashers (App F, Item 98)

EXPENDABLE/DURABLE SUPPLIES

Oil, engine (App C, Item 26)
Cleaning solvent (App C, Item 9)
Trichloroethane, 1, 1, 1 (App C, Item 54)
Oxalic acid (App C, Item 30)
Hydrochloric acid (App C, Item 20)

EQUIPMENT CONDITION

2-17 Engine oil cooler assembly and studs removed

a. Disassembly

- (1) Remove six bolts (1), six lockwashers (2), six flat washers (3), and cover (4) from oil cooler housing (5). 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.

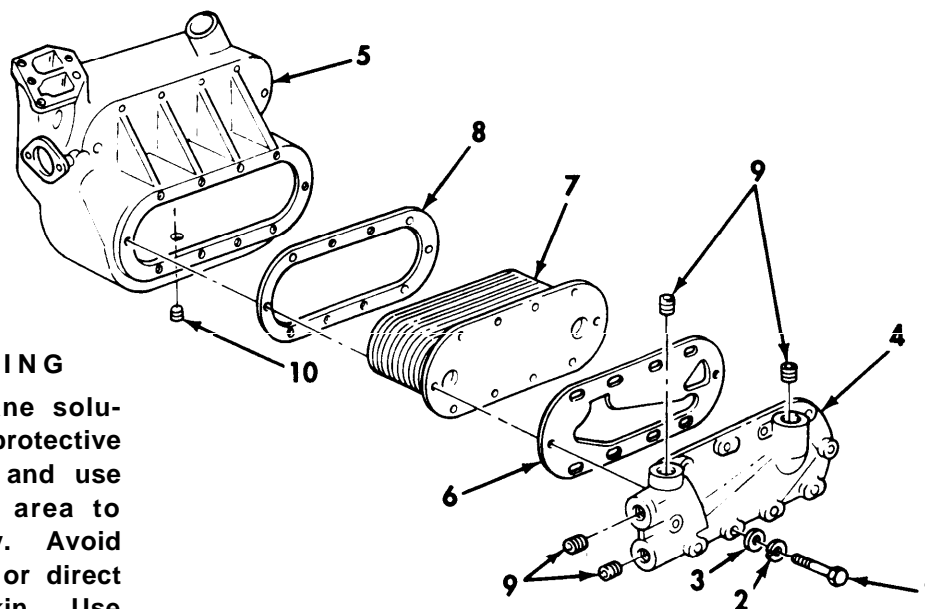
- (2) Remove gasket (6), transmission oil cooler (7), and gasket (8) from oil cooler housing (5). Discard gaskets.
- (3) If necessary, remove four pipe plugs (9) from cover (4).
- (4) If necessary, remove pipe plug (10) from bottom of oil cooler housing (5).

b. Cleaning

NOTE

- Engine oil cooler was removed when oil cooler assembly was removed from engine (Para 2-17).
- 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

**WARNING**

1, 1, 1 trichloroethane solution is toxic. Wear protective goggles and gloves and use in a well-ventilated area to avoid personal injury. Avoid breathing the fumes or direct contact with your skin. Use recommended safety equipment as required.

- (a) Pump 1, 1, 1 trichloroethane solution through oil cooler to remove carbon and sludge.

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (b) If oil passages are badly clogged, pump cleaning solvent through oil cooler and flush thoroughly with clean, hot water.
- (2) Oil coolers - water side

WARNING

Cooler cleaning solution is made from two strong acids. 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 or injury may result.

- (a) Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound of oxalic acid for each 2.5 gallons of solution.

3-57. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODEL 5063-5392) (Cont)

- (b) Immerse oil coolers in solution.
- (c) Watch cleaning process carefully. Remove oil coolers from solution when bubbling stops (usually 30 to 60 seconds).
- (d) Flush oil coolers in clean hot water.
- (e) After cleaning oil cooler, dip in light oil.

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

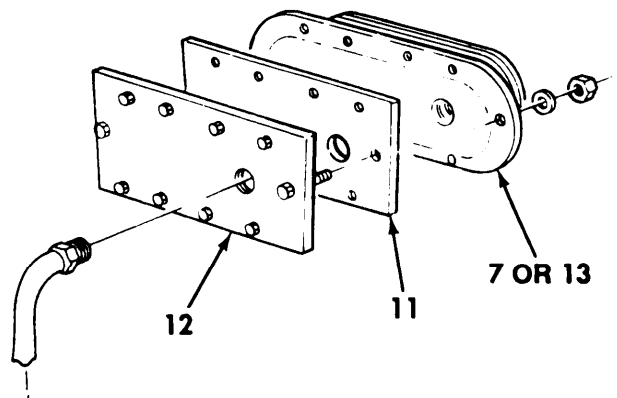
(3) Clean oil cooler housing and cover with cleaning solvent and dry with compressed air.

c. Pressure check

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.

- (1) Install rubber gasket (11), fabricated blocking plate (12), ten 5/16 inch-diameter screws, flat washers, and nuts on transmission oil cooler (7) or engine oil cooler (13).
- (2) Connect air line to blocking plate (12) 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 cooler assembly. Remove blocking plate, rubber gasket, and hose from oil cooler.



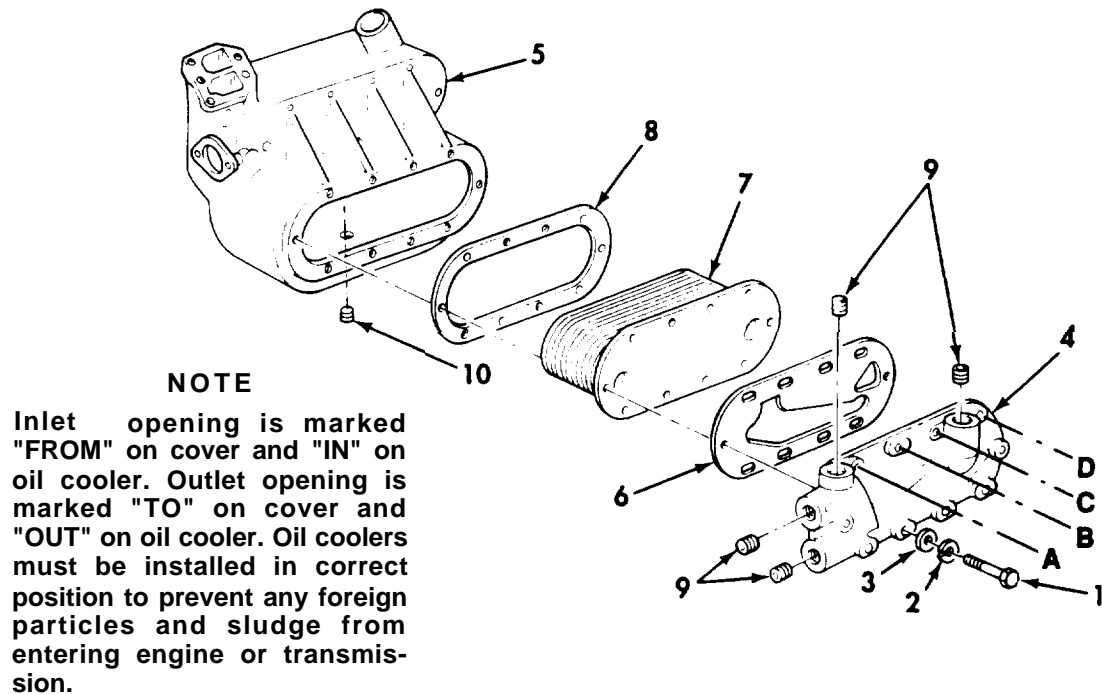
WARNING

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

(5) Dry oil cooler with compressed air.

d. Assembly

- (1) If removed, install pipe plug (10) in bottom of oil cooler housing (5).
- (2) Place gasket (8) on oil cooler housing (5).



- (3) Carefully place oil cooler (7) inside oil cooler housing (5).

NOTE

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

- (4) Install gasket (6), cover (4), six fiat washers (3), six lockwashers (2), and six bolts (1) on oil cooler (7) and oil cooler housing (5). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (5) if removed, install four pipe plugs (9) in cover (4).

END OF TASK**FOLLOW-ON MAINTENANCE**

Para Description
2-17 Install engine/transmission oil cooler assembly.

3-58. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODELS 5063-5393, AND 5063 -539L)

This task covers: a. Disassembly b. Cleaning c. Pressure check d. Assembly

INITIAL SETUP

MODELS

5063-5393

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Pressure testing kit, engine oil cooler (App D, Item 13)

MATERIALS/PARTS

- 1 Gasket (App F, Item 85)
- 6 LockWashers (App F, Item 98)

EXPENDABLE/DURABLE SUPPLIES

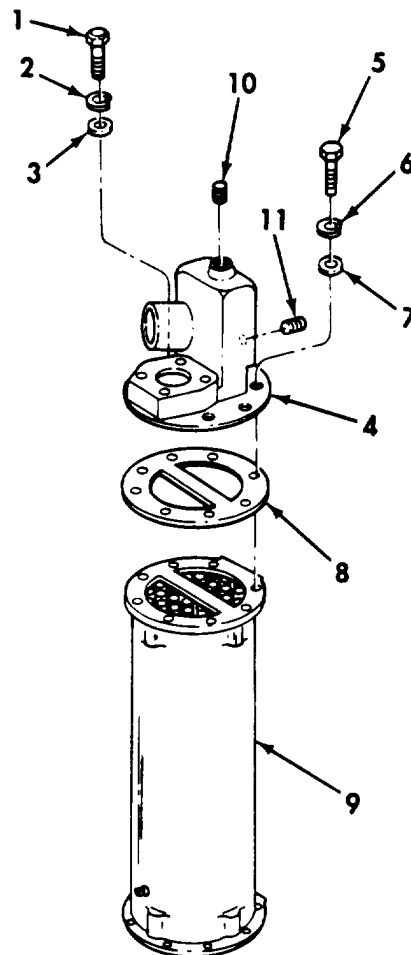
Oil, engine (App C, Item 26)
 Cleaning solvent (App C, Item 9)
 Trichloroethane, 1, 1, 1 (App C, Item 54)
 Oxalic acid (App C, Item 30)
 Hydrochloric acid (App C, Item 20)
 Cleaning solution kit (App C, Item 8)

EQUIPMENT CONDITION

2-4 Transmission oil cooler removed
 2-18 Engine oil cooler removed

a. Disassembly

- (1) Transmission oil cooler
 - (a) Remove two long bolts (1), two lockwashers (2), and two flat washers (3) from water outlet housing (4). Discard lockwashers.
 - (b) Remove four short bolts (5), four lockwashers (6), four flat washers (7), water outlet housing (4), and gasket (8) from top of oil cooler (9). Discard gasket and lockwashers.
 - (c) If necessary, remove pipe plug (10) and two pipe plugs (11) from water outlet housing (4).

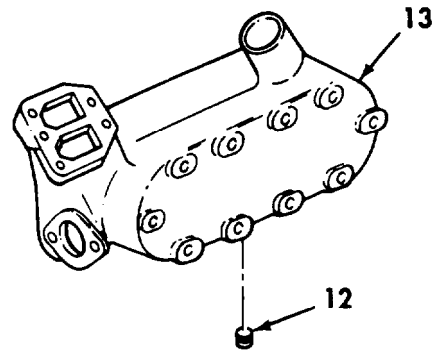


(2) Engine oil cooler

If necessary, remove pipe plug (12) from bottom of engine oil cooler housing (13).

b. Cleaning**NOTE**

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



(1) Engine oil cooler - oil side

WARNING

1, 1, 1 trichloroethane solution is toxic. Wear protective goggles and gloves and use in a well-ventilated area to avoid personal injury. Avoid breathing the fumes or direct contact with your skin. Use recommended safety equipment as required.

- (a) Pump 1, 1, 1 trichloroethane through oil cooler (14) to remove sludge (ref. page 3-269).

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (b) If oil passages are badly clogged, circulate cleaning solvent through oil cooler and flush thoroughly with clean, hot water.

(2) Engine oil cooler - water side

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 or injury may result.

- (a) Mix a solution composed of one-fifth hydrochloric acid and four-fifths water. Add 0.5 pound of oxalic acid for each 2.5 gallons of solution.

■ **3-58. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODELS 5063-5393, AND 5063-539L)**
(Cont)

- (b) Immerse oil cooler in solution.
 - (c) Watch cleaning process carefully. Remove oil cooler from solution when bubbling stops (usually takes 30 to 60 seconds).
 - (d) Flush oil cooler in clean hot water.
 - (e) After cleaning oil cooler, dip in light oil.
- (3) Transmission oil cooler - water side

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 or injury may result.

CAUTION

Coolant system cleaning solution is an acid. Neutralize solution residue or it may corrode tubes in oil cooler.

- (a) Circulate cleaning solution through tubes.
 - (b) Run a bore brush through tubes in oil cooler.
 - (c) Rinse tubes with clean, hot water.
- (4) Transmission oil cooler - oil side

- (a) Position oil cooler in a vertical position. Ensure oil cooler is adequately supported for cleaning operation.

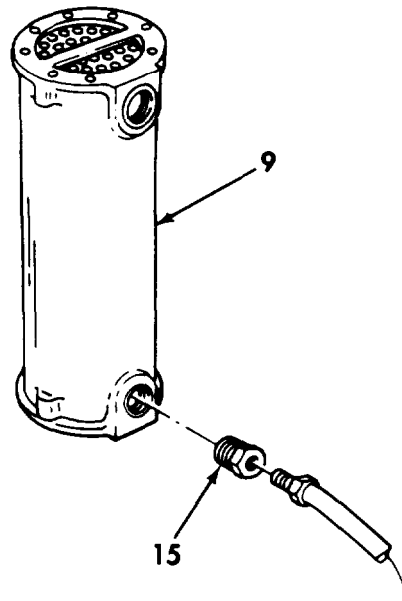
CAUTION

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

NOTE

Minimum seepage past the reducer bushing is acceptable during cleaning procedure.

- (b) Install fabricated reducer bushing (15) from transmission oil cooler pressure test kit in bottom port of oil cooler (9).
- (c) Connect air line to fabricated reducer bushing (15).



WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (d) With air pressure off, pour 2.5 quarts (2.5 liters) of cleaning solvent into upper port of oil cooler.
- (e) Slowly apply 20 PSI of air pressure and allow air to enter oil cooler for 10 minutes.
- (f) Shut off air supply. Remove air line and carefully drain cleaning solvent.
- (g) Move fabricated reducer bushing (15) and air line to upper port in oil cooler.
- (h) Apply air pressure of 20 PSI to upper port until remaining solvent is forced out of lower port.
- (i) Invert transmission oil cooler and repeat steps (d) thru (h) until cleaning solvent comes out clear in each direction.

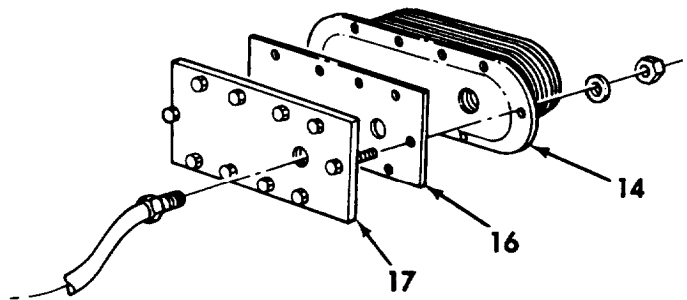
WARNING

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

- (5) Remove reducer bushing (15) and clean engine oil cooler housing with cleaning solvent and dry with compressed air.

c. Pressure check**WARNING**

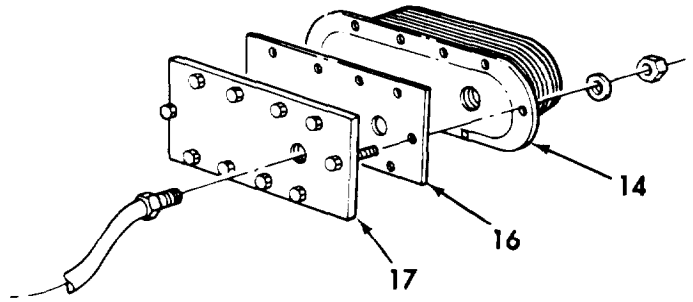
Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler when making this pressure test.



- (1) Engine oil cooler
 - (a) Using engine pressure testing kit, place rubber gasket (16), fabricated blocking plate (17), ten bolts, ten flat washers, and ten nuts over flanged side of oil cooler (14) with threaded hole at inlet opening in oil cooler.
 - (b) Connect air line to steel plate (17) and apply pressure of 75 PSI (517 kPa) to oil cooler.

3-58. ENGINE/TRANSMISSION OIL COOLER REPAIR (MODELS 5063-5393, AND 5063-539L)

- (c) 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.
- (d) Release air pressure on cooler assembly. Remove steel plate (17), rubber gasket (16), and hose from oil cooler (14).



WARNING

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

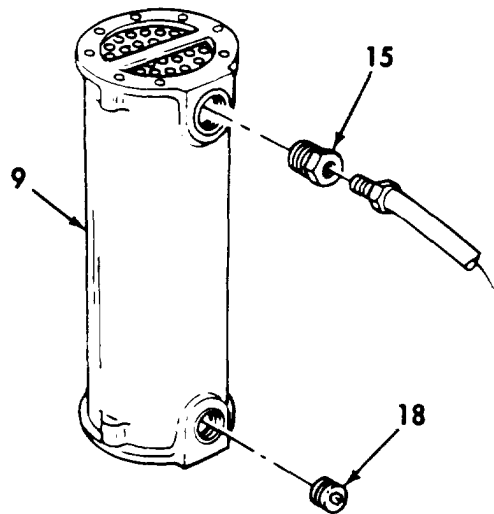
- (e) Dry oil cooler with compressed air.

(2) Transmission oil cooler

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.

- (a) Install fabricated machine thread plug (15) in one port and standard machine thread plug (18) in other port of oil cooler (9).
- (b) Connect air line to fabricated machine thread plug (15) and pressurize oil cooler to 75 PSI (517 kPa).
- (c) Submerge transmission oil cooler 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.
- (d) Release air pressure and remove plug, air line, and reducer bushing.



WARNING

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

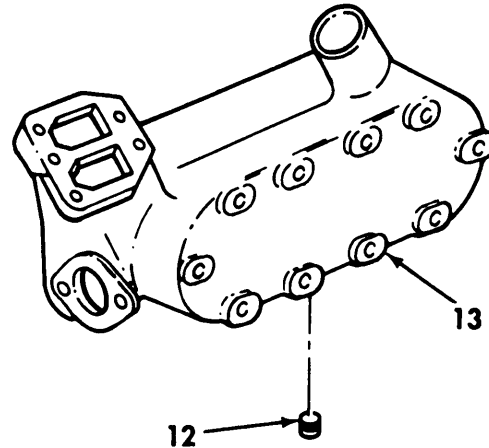
(e) Dry oil cooler with compressed air.

d. Assembly

(1) Engine oil cooler

If removed, install pipe plug (12) in bottom of oil cooler housing (13).

(2) Transmission oil cooler



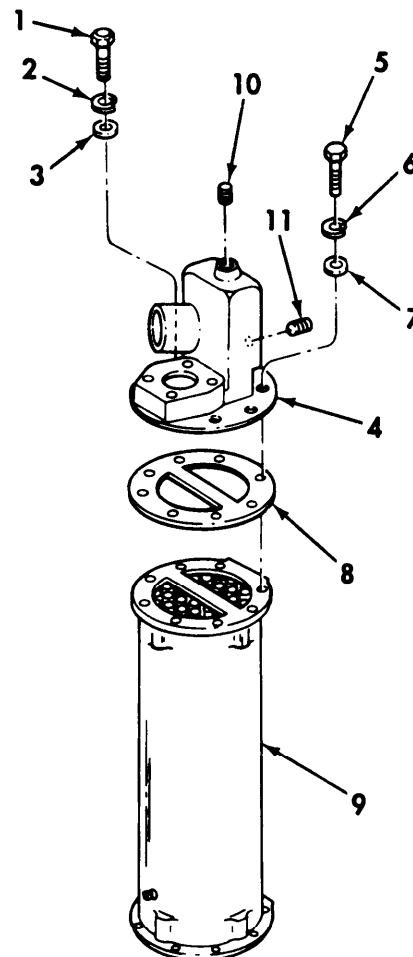
NOTE

- Water outlet housing is installed on oil cooler end opposite oil drain plug with housing reservoir directly above oil inlet port.
- Two long bolts (1) are installed in holes 90 degrees counter-clockwise from oil inlet port.

(a) Install gasket (8), water outlet housing (4), two long bolts (1), two lockwashers (2), and two flat washers (3) in oil cooler (9). Do not tighten bolts.

(b) Install four short bolts (5), four lockwashers (6), and four flat washers (7), in transmission oil cooler. Torque bolts (5) to 13-17 lb-ft (18-23 N-m).

(c) If removed, install pipe plug (10) and two pipe plugs (11) in water outlet housing (4).



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
2-4	Install transmission oil cooler.
2-18	Install engine oil cooler.

3-59. ENGINE OIL COOLER REPAIR (MODELS 5063-5395, 5063-5398, AND 5063-539F)

This task covers: a. Disassembly b. Cleaning c. Pressure check d. Assembly

INITIAL SETUP

MODELS

5063-5395 5063-5398 5063-539F

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Pressure testing kit, oil cooler (App D, Item 12)

MATERIALS/PARTS

- 1 Gasket (App F, Item 28)
- 5 Lockwashers (App F, Item 98)

EXPENDABLE/DURABLE SUPPLIES

Oil, engine (App C, Item 26)
Cleaning solvent (App C, Item 9)
Trichloroethane, 1, 1, 1 (App C, Item 54)
Oxalic acid (App C, Item 30)
Hydrochloric acid (App C, Item 20)

EQUIPMENT CONDITION

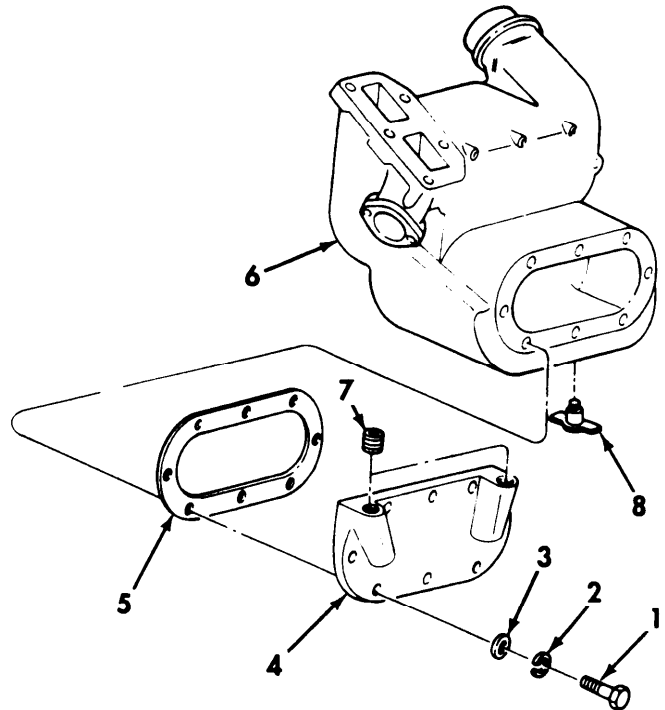
2-19 Engine oil cooler and studs removed

a. Disassembly

NOTE

The lower compartment oil cooler, formerly used for the transmission, is no longer required or installed. To install cover without this oil cooler, use 1/4 inch shorter bolts and studs.

- (1) Remove five bolts (1), five lockwashers (2), five flat washers (3), cover (4), and gasket (5) from oil cooler housing (6). Discard gasket and lockwashers.
- (2) If necessary remove two pipe plugs (7) from cover (4).
- (3) If necessary, remove draincock (8) from bottom of oil cooler housing (6).



b. Cleaning**NOTE**

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

- (1) Oil cooler - oil side

WARNING

1, 1, 1 trichloroethane solution is toxic. Wear protective goggles and gloves and use in a well-ventilated area to avoid personal injury. Avoid breathing the fumes or direct contact with your skin. Use recommended safety equipment as required.

- (a) Pump 1, 1, 1 trichloroethane through oil cooler to remove carbon and sludge.

WARNING

Dry cleaning solvent P-D-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 (38-50°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.

- (b) If oil passages are badly clogged, circulate cleaning solvent through oil cooler and flush thoroughly with clean, hot water.
- (2) Oil cooler – water side
- (a) Immerse oil cooler in following solution: add one-half pound of oxalic acid to each two and one-half gallons of solution composed of one-third Hydrochloric acid and two-thirds water.
- (b) Watch cleaning recess carefully. Remove oil cooler from solution when bubbling stops (usually takes 30 to 60 seconds).
- (c) Flush oil cooler in clean hot water, let dry, and dip in light oil..

WARNING

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

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

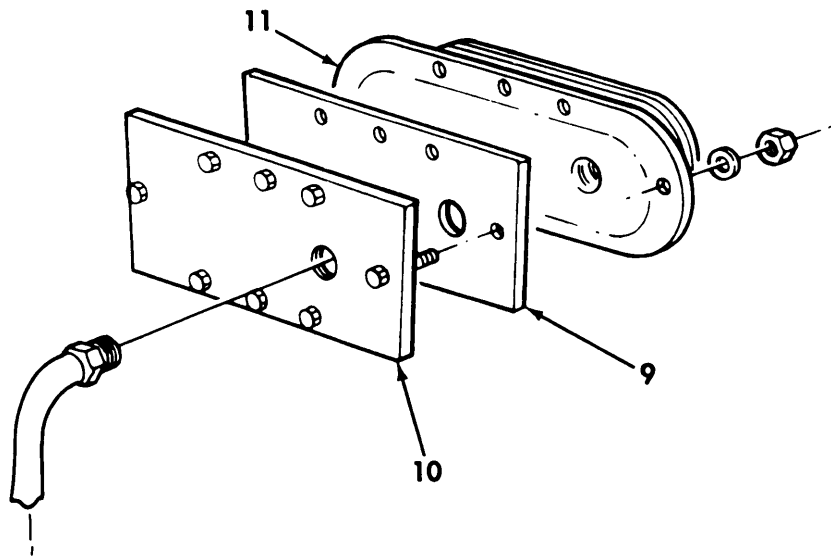
3-59. ENGINE OIL COOLER REPAIR (MODELS 5063-5395, 5063-5396, AND 5063-539F) (Cont)

c. Pressure check

WARNING

Protect personnel against any stream of pressurized water from a leak or rupture of a fitting, hose, or oil cooler when making this pressure test.

- (1) Install a rubber gasket (9), fabricated blocking plate (10), eight 5/16 inch-diameter bolts, flat washers, and nuts on flanged side of oil cooler (11) with air line connection at inlet opening in oil cooler.
- (2) Connect air line to steel plate (10) 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 the water indicate leaks. Replace oil cooler if it leaks.
- (4) Release air pressure on cooler assembly. Remove plate, gasket, and hose from oil cooler.



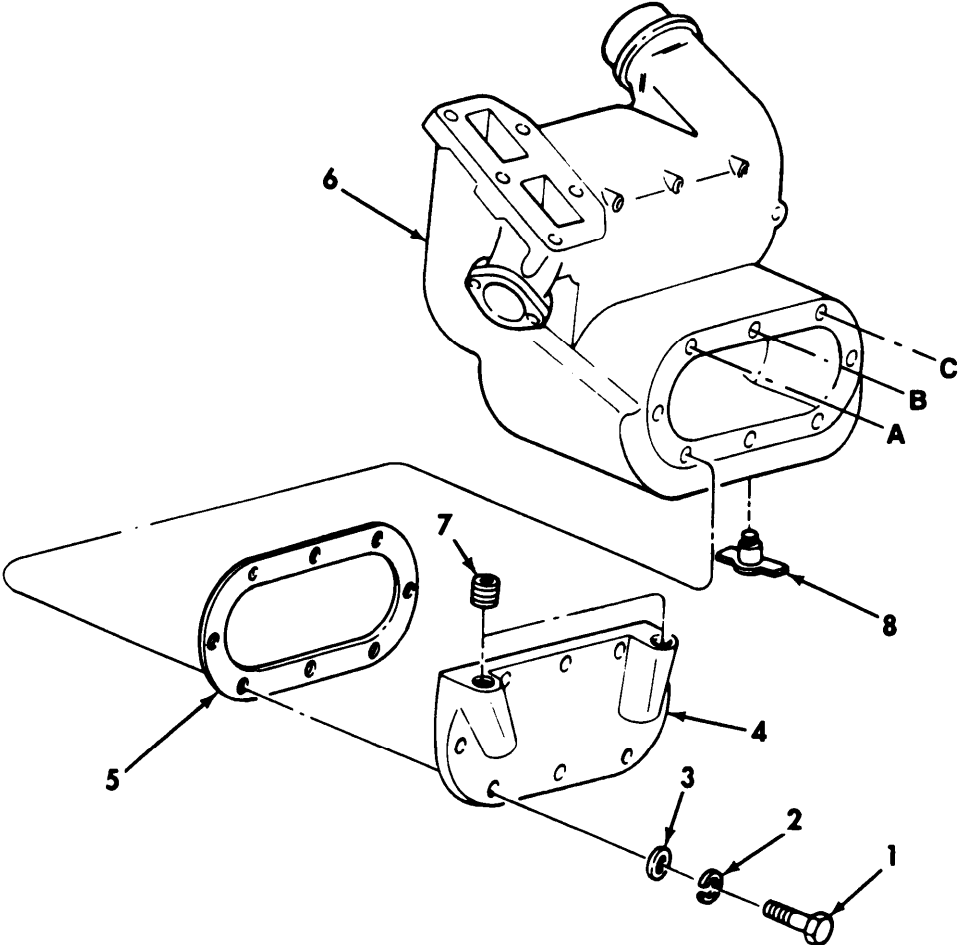
WARNING

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

- (5) Dry oil cooler with compressed air.

d. Assembly

(1) If removed, install draincock (8) in bottom of oil cooler housing (6).



NOTE

- The lower compartment oil cooler, formerly used for the transmission, is no longer required to be installed. To install cover without this oil cooler, use 1/4 inch shorter bolts and studs.
 - Do not install bolts in locations (A), (B), and (C).
- (2) Install gasket (5), cover (4), five flat washers (3), five lockwashers (2), and five bolts (1) on oil cooler housing (6). Torque bolts to 13-17 lb-ft (18-23 N-m).
- (3) If removed, install two pipe plugs (7) in cover (4).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
2-19 Install engine oil cooler.

3-60. OIL FILTER ADAPTOR REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Tester, spring (App B, Item 103)

a. Disassembly

WARNING

Spring is under compression. Wear eye protection and use care when removing spring. Injury to personnel may result from possible airborne parts.

Remove screw (1), retainer (2), spring (3), and bypass valve (4) from adapter (5).

b. Cleaning/Inspection

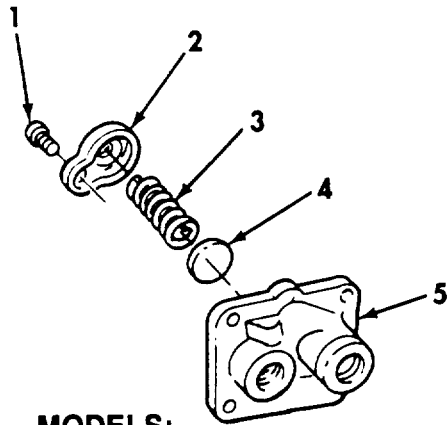
WARNING

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

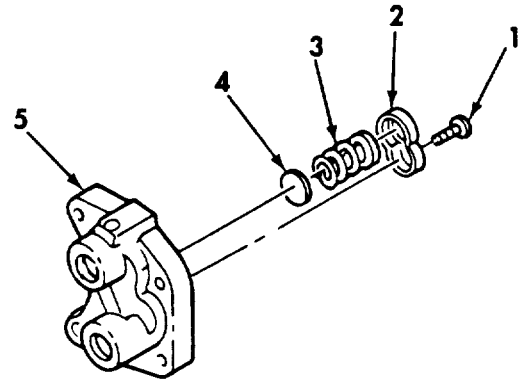
- (1) Clean parts with fuel oil and dry with compressed air.
- (2) Inspect all parts for damage and excessive wear and replace as necessary.
- (3) Using a spring tester, check bypass spring (3) load. At 1.02 inches, minimum compression load must be 13.5 pounds. Replace as necessary.

c. Assembly

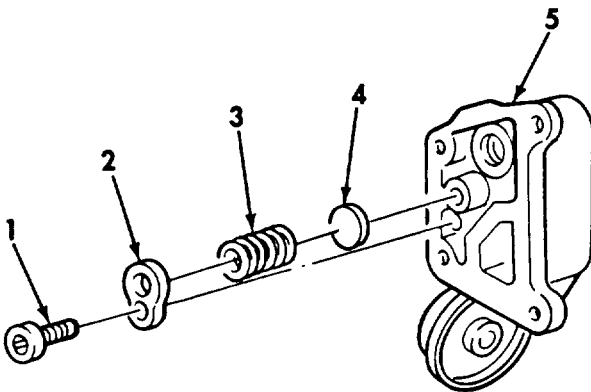
Install bypass valve (4), spring (3), retainer (2), and screw (1) in adapter (5). Tighten screw securely.



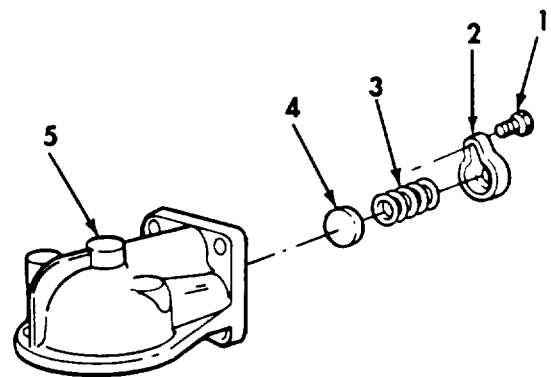
MODELS:
5063-5299
5063-5395
5063-539F



MODEL:
5063-5392

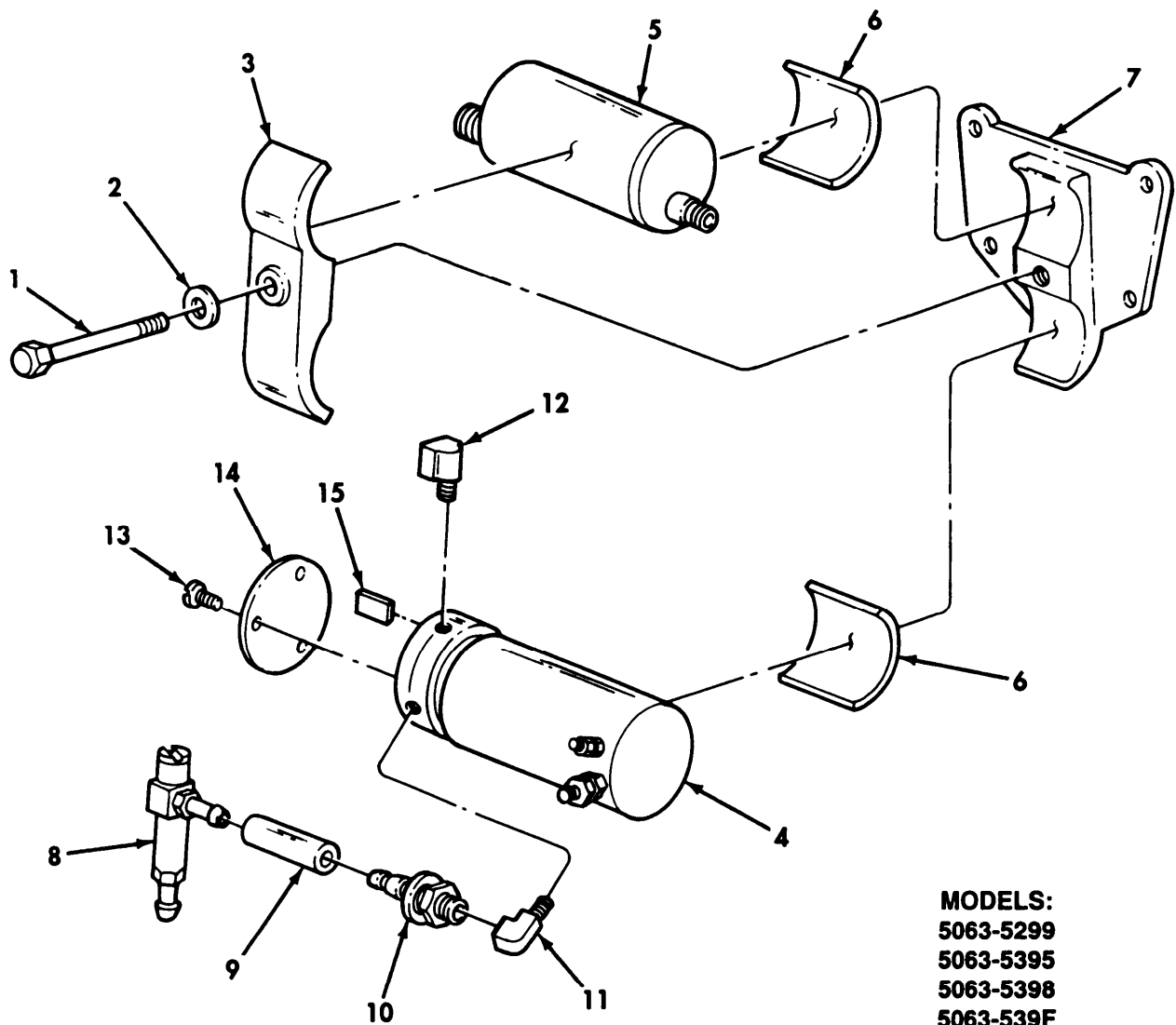


MODELS:
5063-5393
5063-539L



MODEL:
5063-5398

END OF TASK



MODELS:
5063-5299
5063-5395
5063-5398
5063-539F

- (1) Clean check valve, bracket, clamp, and outer surface of air pump with cleaning solvent and dry with compressed air.
- (2) Inspect electrical terminals for damage and corrosion. Remove corrosion with a wire brush.
- (3) Inspect air hose for cuts, tears, kinks, and damage.
- (4) Inspect air pump rotor and body for excessive wear, corrosion, or other damage.
- (5) Clean ignition coil and cushions with warm water and soap. Dry thoroughly.

3-61. AIR PUMP AND IGNITION COIL ASSEMBLY REPAIR (Cont)

c. Test

- (1) Air pump

CAUTION

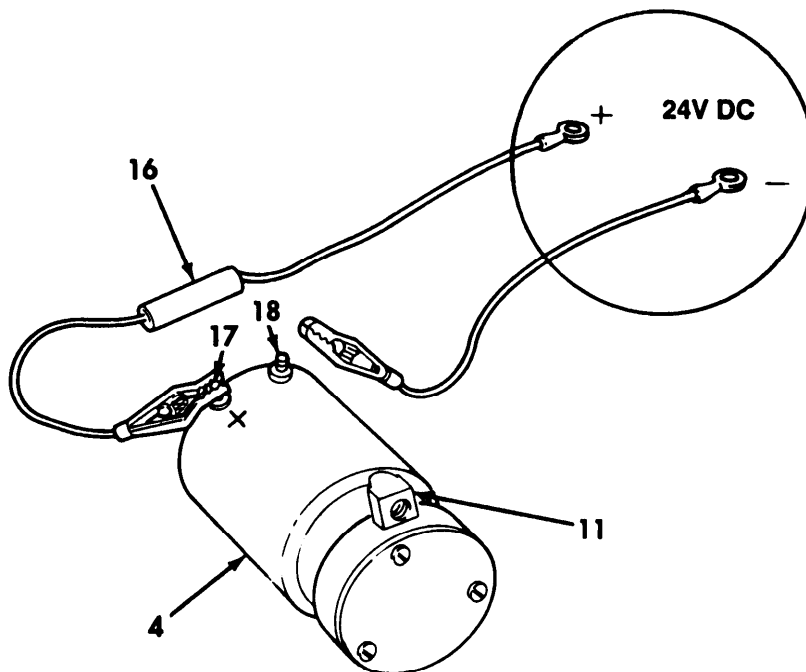
Do not exceed 18 volts direct current on air pump. Excessive voltage will overspeed air pump and damage pump vanes.

NOTE

- Install vanes, plate, and screws in air pump before testing.
 - Use fabricated test lead (16) to reduce a 24 Vdc power source to 18 Vdc. Connect lead in series with positive terminal of power source.
- (a) Connect an 18 V dc power source to air pump (4). Connect positive lead to terminal (17) marked (+) and negative lead to unmarked terminal (18).

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 (11) 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 (17 and 18).



(2) Ignition coil and igniter

NOTE

Ensure high tension wire used for testing is in good condition.

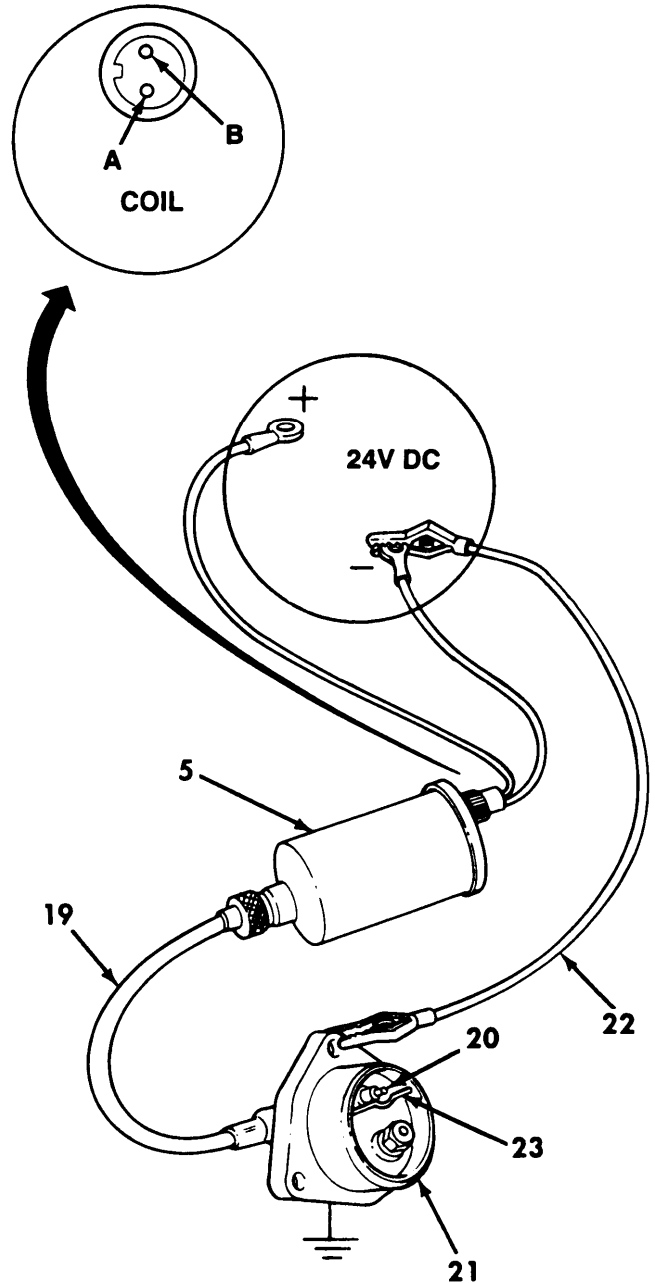
- (a) Connect high tension lead (19) to ignition coil (5) and fuel igniter (20).
- (b) Connect air heater assembly (21) and ignition coil (5) to common ground (22).

WARNING

Do not touch ignition coil or air heater assembly while performing test. High voltage is present and personal injury may result.

CAUTION

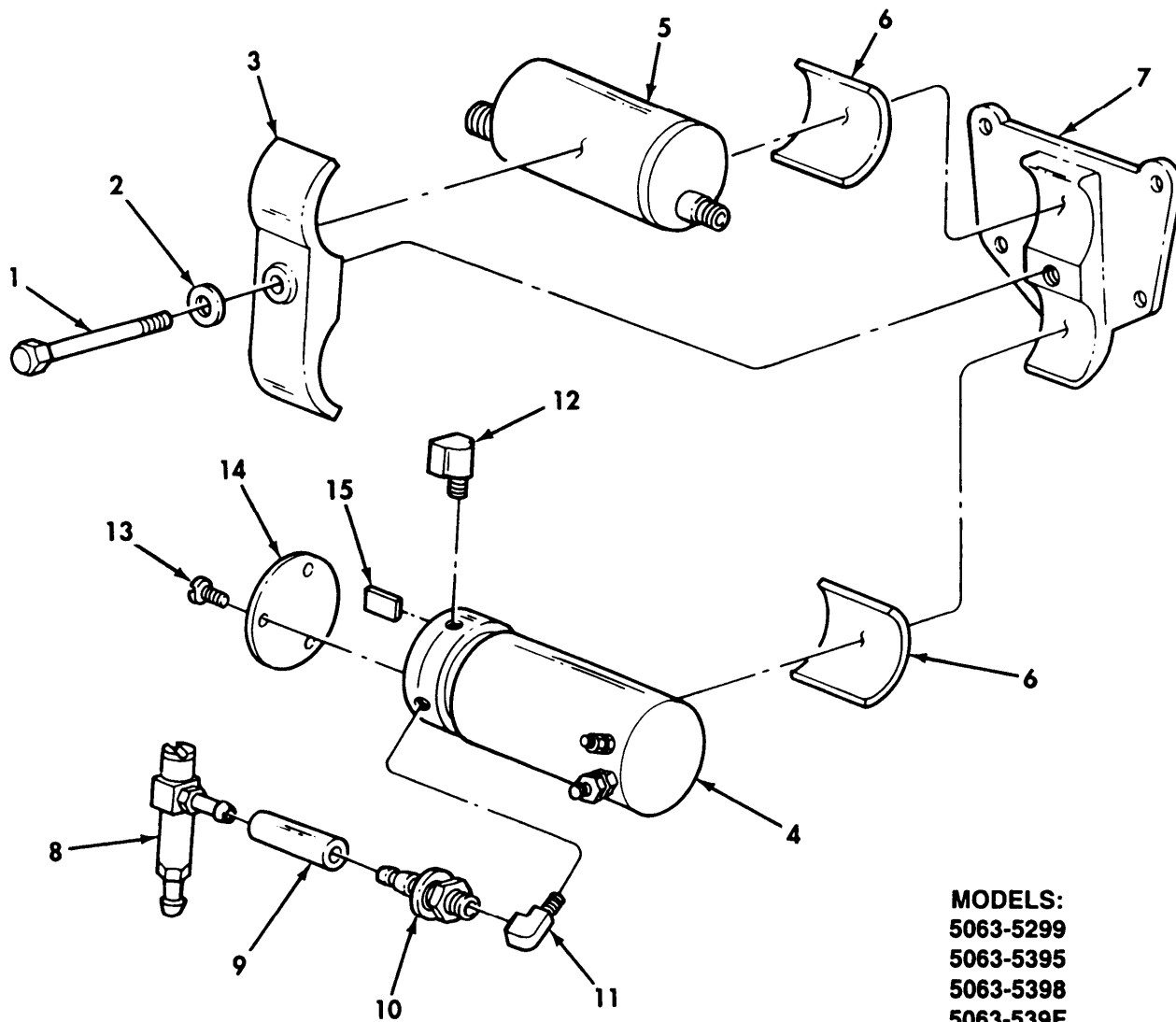
- Do not apply voltage to ignition coil unless coil is connected to air heater assembly. Ground coil and air heater assembly.
 - Connect positive lead to pin (A) and negative lead to pin (B) or damage to coil will result.
- (c) Connect a 24 V dc power source to power input side of ignition coil (5). Observe electric arc between fuel igniter (20) and wire (23). A steady or intermittent (about ten pulses a second) arc with a popping noise indicates a good coil and igniter.
 - (d) Disconnect power source and then disconnect leads from coil (5). Remove high tension lead (19) from coil and fuel igniter (20).
 - (e) Disconnect air heater assembly (21) and ignition coil (5) from common ground (22).



3-61. AIR PUMP AND IGNITION COIL ASSEMBLY REPAIR (Cont)

d. Assembly

- (1) Install three vanes (15) in rotor of air pump (4).
- (2) Install cover (14) and three screws (13) on air pump (4). Tighten screws.
- (3) If removed, install elbow (12) in inlet port and elbow (11) in outlet port of air pump (4).

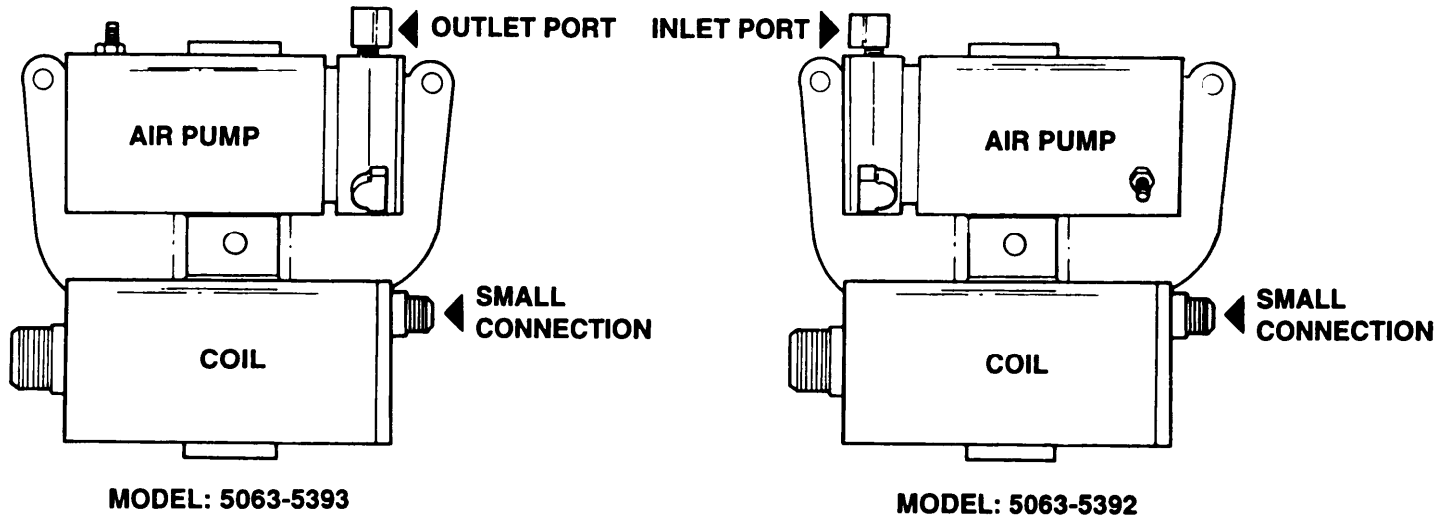


- (4) Install adapter (10), hose (9), and check valve (8) on outlet elbow (11).
- (5) Place two cushions (6) on bracket (7). Place ignition coil (5) and air pump (4) on cushions and bracket as shown for the appropriate model.

NOTE

Place clamp (3) with cast part number above ignition coil (5).

- (6) Install clamp bracket (3), flat washer (2), and bolt (1) in bracket (7) over coil (5) and air pump (4). Torque bolt to 60-96 lb-in (7-11 N-m).

**END OF TASK****FOLLOW-ON MAINTENANCE**

Para Description

3-13 Install air heater assembly.

3-10 Install air pump/ignition Coil assembly (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F).

3-11 Install air pump/ignition coil assembly (model 5063-5392).

3-12 Install air pump/ignition coil assembly (model 5063-5393).

3-62. IDLER PULLEY ASSEMBLY REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)

TOOLS AND SPECIAL TOOLS

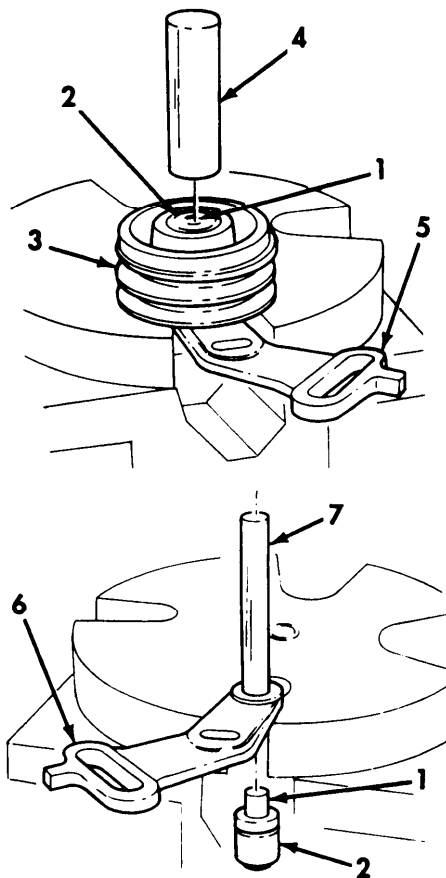
Tool kit, general mechanics (App B, Item 107)

a. Disassembly

CAUTION

Do not press bearing shaft (1) from bearing assembly (2). Pressing on end of bearing shaft will distort bearings and destroy bearing assembly.

- (1) Support pulley (3). Place 1 inch-diameter sleeve (4) on outer race of bearing assembly (2). Press bearing and bracket assembly (5) from pulley.
- (2) Support bracket (6). Using a short 1/2 inch-diameter shaft (7), apply pressure to bearing shaft (1) and press bearing assembly (2) from bracket.



b. Cleaning/inspection

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for Cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

CAUTION

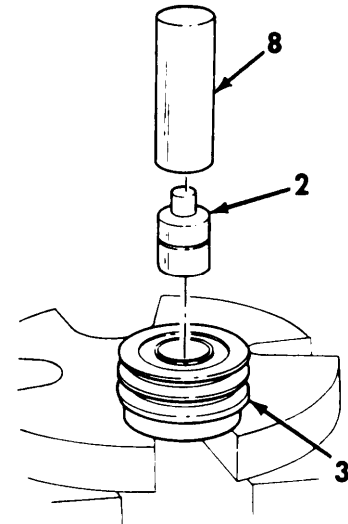
Do not wash bearing assembly. Fuel oil or cleaning solvent will dissolve internal grease and destroy bearing assembly.

- (1) Wash pulley and bracket in cleaning solvent and dry with compressed air.
- (2) Inspect pulley and bracket for excessive wear or cracks.
- (3) Revolve shaft in bearing assembly by hand. If rough or tight spots are detected, replace bearing assembly.

c. Assembly**NOTE**

Bearing assembly (2) will fit in pulley from either side; however, position bearing assembly on pulley as shown for proper installation.

- (1) Support pulley (3) and press bearing assembly (2) on pulley with shaft extended upward. Using 1 1/4 inch-diameter sleeve (8), press outer race of bearing until flush with inside surface of pulley.

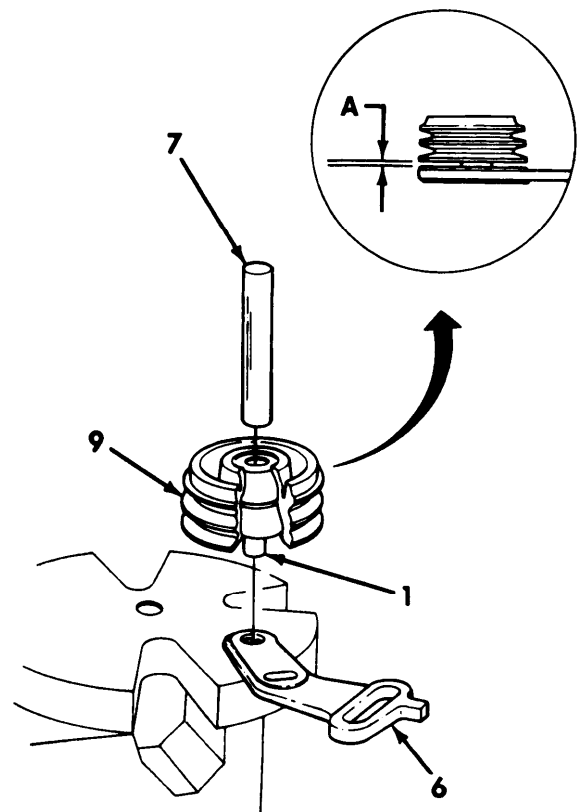
**CAUTION**

Do not press bearing shaft (1) into bearing assembly (2). 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 (6) and press bearing and pulley assembly (9) into bracket using 1/2 inch-diameter shaft (7). Apply pressure to shaft (1) only. Measure distance (A) between outer edge of pulley and bracket using thickness gage. Distance must be 0.160 inch (0.406 cm).

**END OF TASK**

3-63. COOLANT PUMP REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 118)
 Puller, combination leg (App B, Item 79)
 Inserter, bearing and bushing (App B, Item 56)
 Caliper, vernier (App B, Item 12)

MATERIALS/PARTS

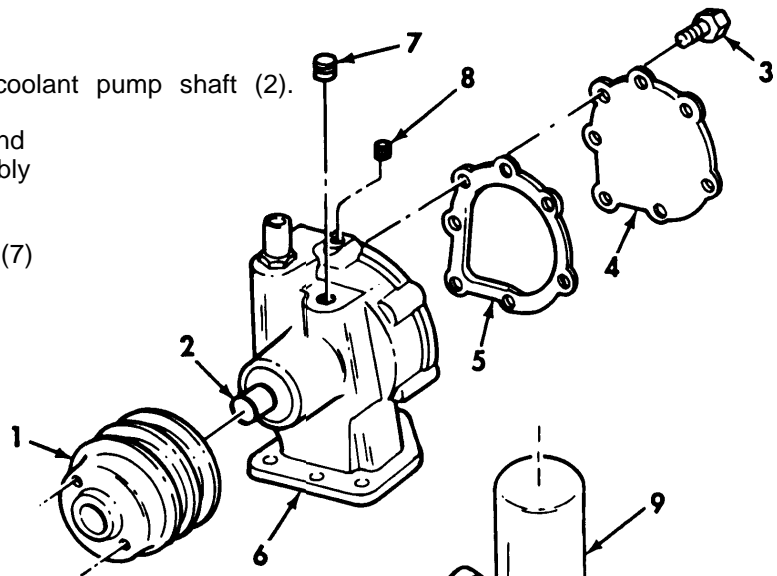
- 1 Gasket (App F, Item 44)
- 1 Seal, coolant pump (App F, Item 177)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 9)
 Sealing compound (App C, Item 44)
 Chamois leather, sheepskin (App C, Item 6)
 Rag, wiping (App C, Item 33)

a. Disassembly

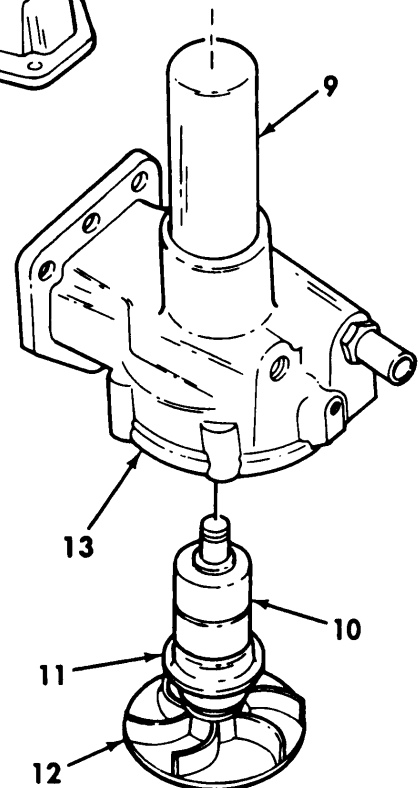
- (1) Using puller, remove pulley (1) from coolant pump shaft (2).
- (2) Remove seven bolts (3), cover (4), and gasket (5) from coolant pump assembly (6). Discard gasket.
- (3) If necessary, remove large pipe plug (7) and small pipe plug (8) from coolant pump assembly (6).



CAUTION

Do not press shaft into bearing assembly. Pressure on shaft will distort bearings and destroy bearing assembly.

- (4) Place bearing inserter (9) on outer race of shaft and bearing assembly (10). Press shaft and bearing assembly, seal (11), and impeller (12) from housing (13).
- (5) Support impeller (12) on bed of arbor press. Place a short 1/2 inch-diameter rod (14) on shaft. Press shaft and bearing assembly (10) out of impeller.
- (6) Remove seal (11) from shaft and bearing assembly (10). Discard seal.



b. Cleaning/inspection

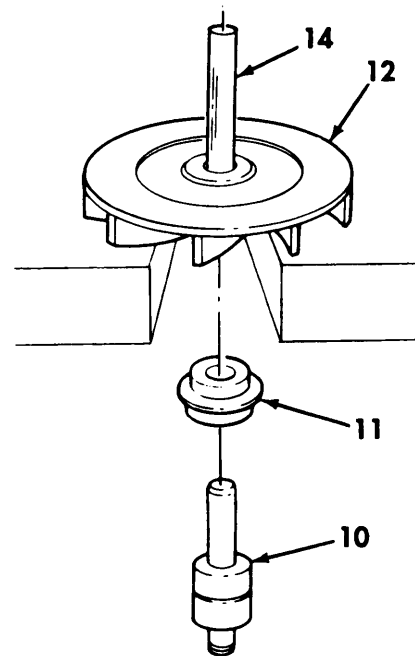
WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

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.
- (3) Discard bearing if it has a general feeling of roughness, is tight, or is damaged.
- (4) Inspect ceramic insert for cracks, scratches, and loss of bond to impeller (12).

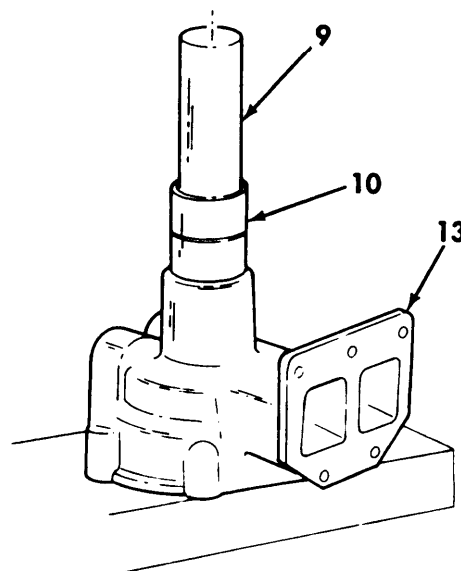


c. Assembly

CAUTION

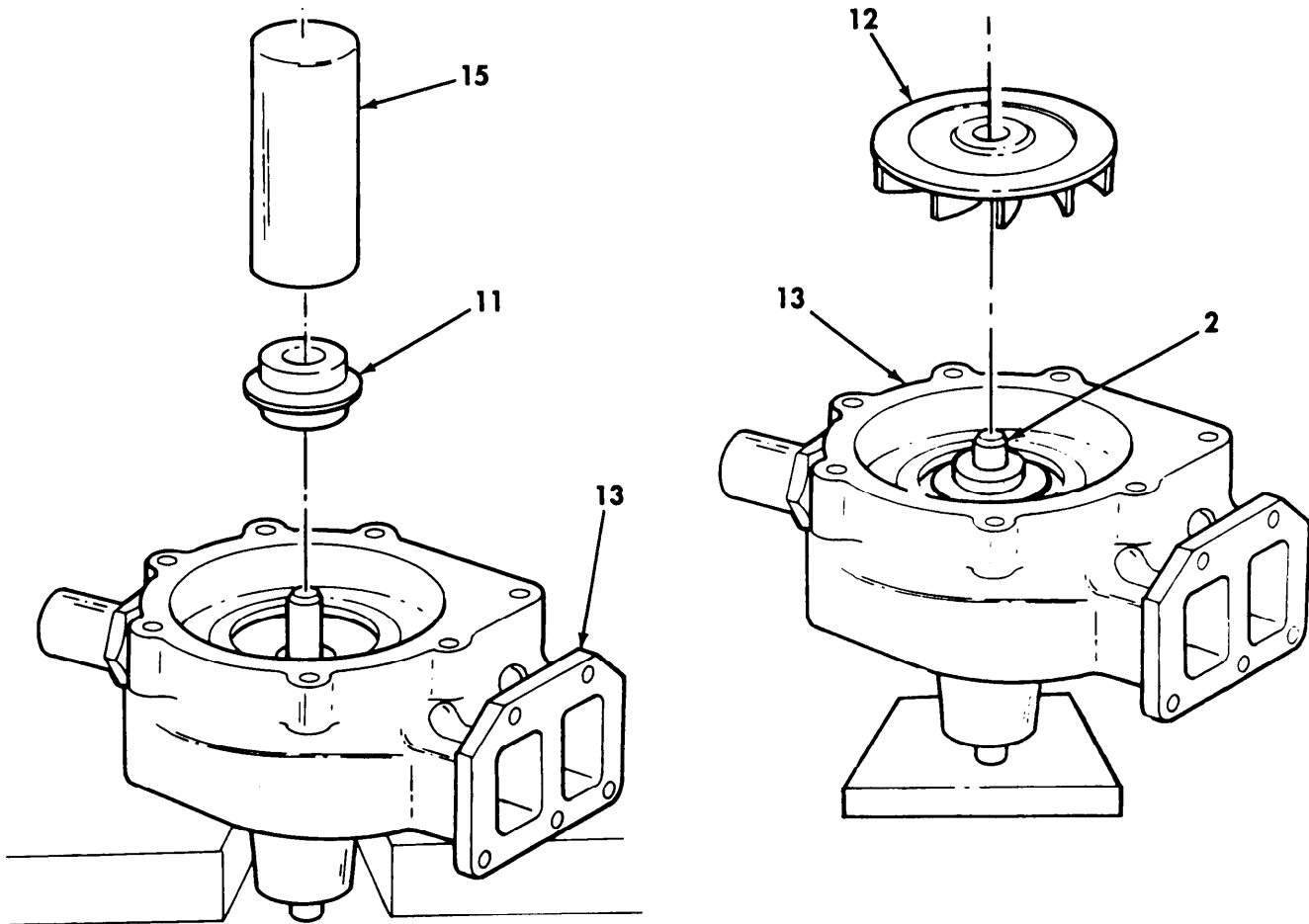
Do not press shaft into bearing assembly. Pressure on shaft will distort bearings and destroy bearing assembly.

- (1) Place bearing inserter (9) against outer race of shaft and bearing assembly (10) and press into pulley side of pump housing (13) until outer race of bearing is flush with outer face of housing.



3-63. COOLANT PUMP REPAIR

- (2) Apply a light coat of sealing compound to outside of seal (11). Support pump housing (13) in press, pulley side down. Place a 1 1/2 inch inside diameter sleeve (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.

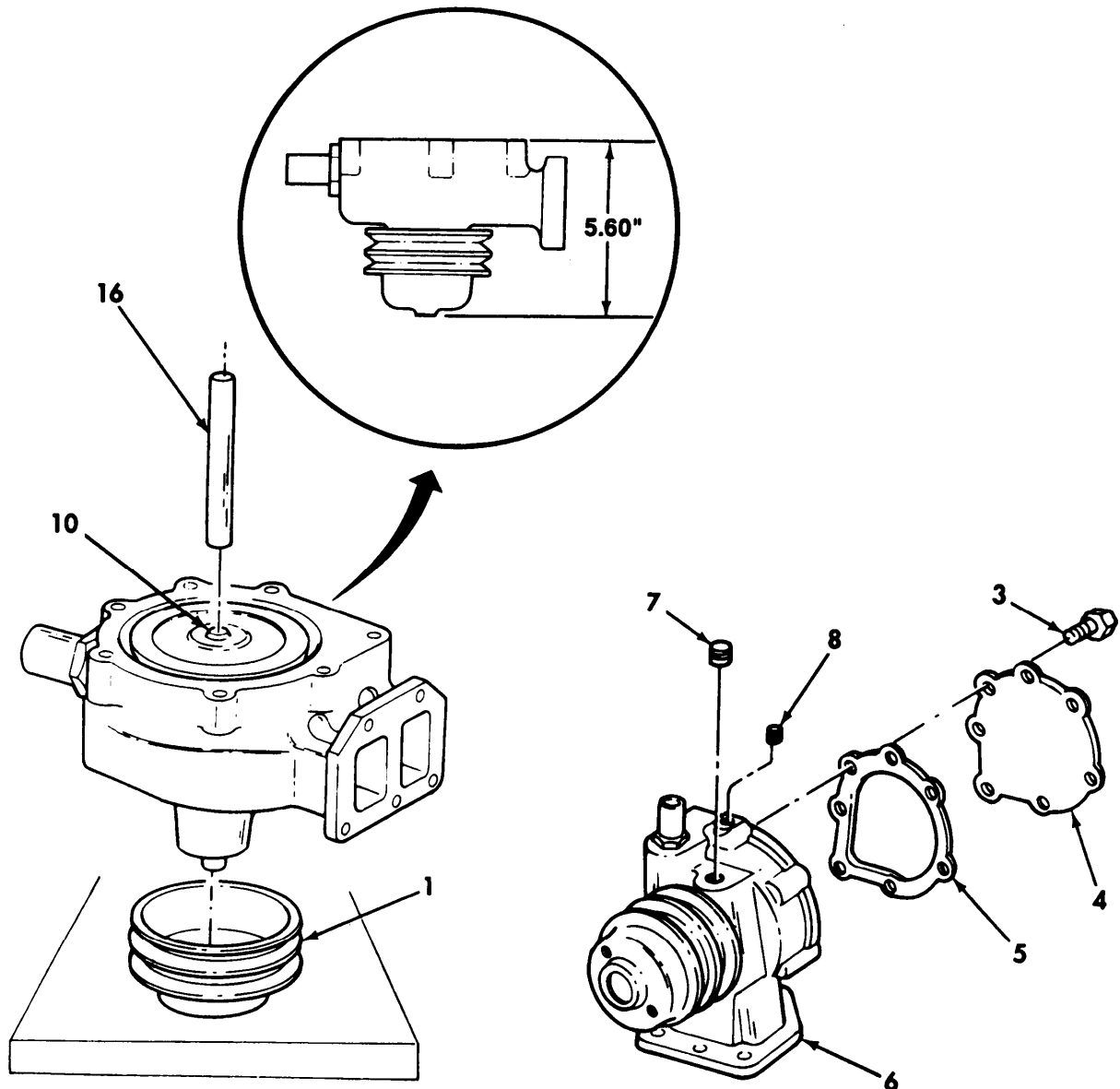


CAUTION

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.

- (3) Support pulley end of shaft and press impeller (12) on shaft (2) until impeller is flush with top face of pump housing (13).

- (4) Support pulley (1). Place a short 1/2 inch-diameter rod (16) on impeller end of shaft and bearing assembly (10). Press shaft into pulley until distance from front face of pulley to top face of pump housing is 5.60 inches.



- (5) Install gasket (5), cover (4), and seven bolts (3) on coolant pump assembly (6). Torque bolts to 72-84 lb-in (8-9.5 N-m).

- (6) If removed, install large pipe plug (7) and small pipe plug (8) in coolant pump assembly (6).

END OF TASK

Section VI. GENERAL SUPPORT COMPONENT REPAIR

Contents	Para	Page
Cylinder Head Assembly Repair	3-64	.. 3-292
Fuel Injector Assembly Repair	3-65	.. 3-314
Blower Repair	3-66	.. 3-328
Turbocharger Repair (All Except Model 5063-5299).	3-67	.. 3-338
Governor Repair	3-68	.. 3-348

3-64. CYLINDER HEAD ASSEMBLY REPAIR

This task covers: a. Disassemble b. Cleaning c. Pressure check
d. Inspection/Repair e. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Wrench, torque (App B, Item 116)
Wrench, torque (App B, Item 118)
Tool kit, valve seat (App B, Item 108)
Installer, injector tube, adjustable (App B, Item 64)
Injector tube reconditioning set (App B, Item 55)
 Installer, injector tube, fixed
 Reamer, bevel
 Reamer, finishing
 Installer, flaring, die
 Installer, pilot
 Refinisher, tube, tip
Compressor, valve spring (App B, Item 17)
Remover, valve guide (App B, Item 90)
Tester, spring (App B, Item 103)
Installer, valve seat (App B, Item 70)
Pressure testing kit, cylinder head (App D, Item 6)
Gage, injector depth (App B, Item 36)
Installer, valve guide (App B, Item 69)
Wrench, fuel nut (App B, Item 113)
Micrometer set (App B, Item 73)
 Micrometer, 0-1 inch
 Micrometer, 1-2 inch
Fixture, cam follower holding (App B, Item 26)
Gage, injector protrusion (App B, Item 40)
Indicator, dial, magnetic base (App B, Item 54)
Grinding kit, valve seat (App B, Item 49)
 Grinder, valve seat
Adapter kit, valve seat grinder (App B, Item 1)
Gage set, telescoping (App B, Item 33)

TOOLS AND SPECIAL TOOLS (Cont)

Gage, depth (App B, Item 36)
Gage, dial, valve seat (App B, item 37)
Vise, machinist (App B, Item 111)
Caps, vise jaw (App B, Item 13)

MATERIALS/PARTS

6 Tube assemblies, fuel (App F, Item 182)
3 Injector tube kits (App F, Item 90)
6 Washers, copper (App F, Item 188)
3 Plugs, expansion (App F, Item 133)
3 Plugs, expansion (App F, Item 130)
1 Gasket (App F, Item 40)
2 Lockwashers (App F, Item 99)
6 Lockwashers (App F, Item 97)

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)
Cleaning solvent (App C, Item 9)
Crocus cloth (App C, Item 10)
Oil, cindol 1705 (App C, Item 7)
Oil, engine oil (App C, Item 26)
Oil, lubricating, preservative E.P. type (App C, Item 28)
Oil, cutting oil (App C, Item 25)
Sealing compound (App C, Item 44)
Prussian blue paste (App C, Item 32)
Wood block (App C, Item 58)

EQUIPMENT CONDITION

Para Description
3-8 Engine lifter brackets removed
3-43 Cylinder head assembly removed

a. Disassembly

NOTE

Cover each injector fuel port to keep out dirt immediately after removing fuel tube assemblies (1).

- (1) Remove six fuel tube assemblies (1) from fuel injectors (2) and fuel nipples (3). Discard tube assemblies.

NOTE

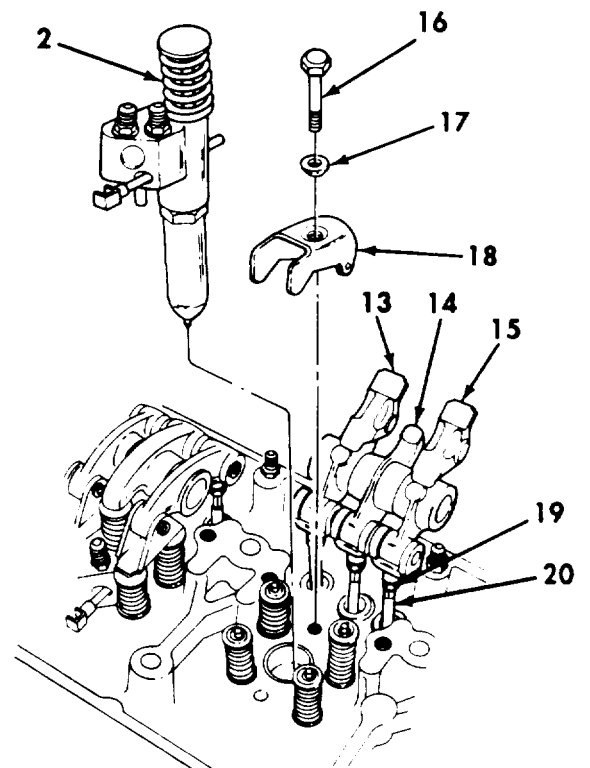
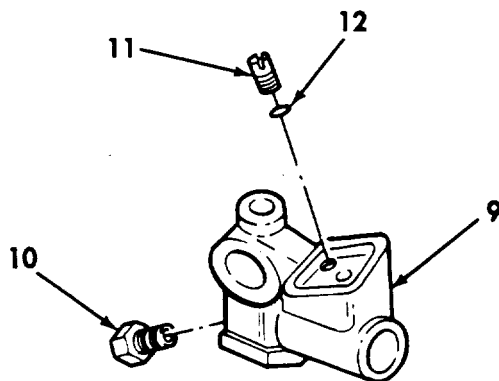
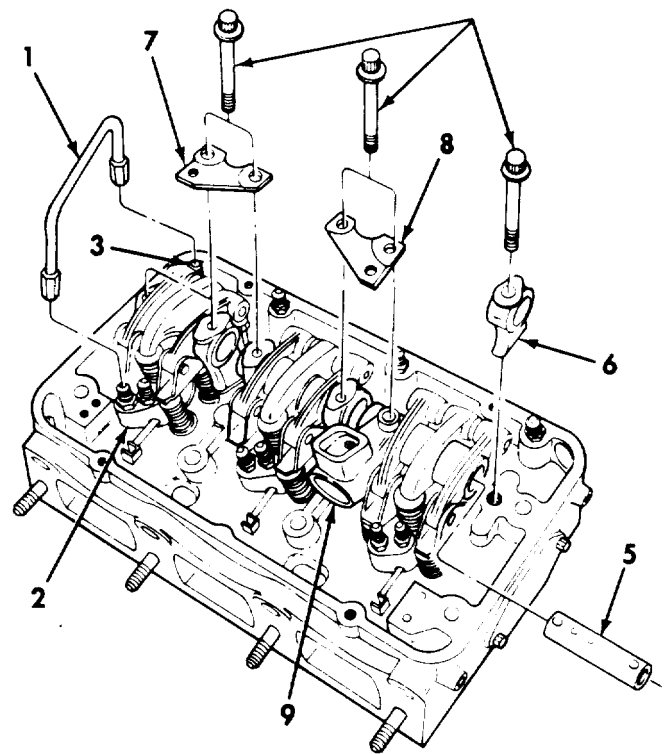
Tag rocker arms, shafts, brackets, valves, cam followers, and associated hardware for installation in original location.

- (2) Remove six bolts (4) fastening rocker arm shafts (5) and brackets (6) to cylinder head. On models 5063-5392, 5063-5393, 5063-539F, and 5063-539L, remove hold-down bracket (7) and hold-down bracket (8) from intermediate brackets (6).

NOTE

On all except model 5063-5299, one bracket (6) on right cylinder head is also the throttle delay housing (9).

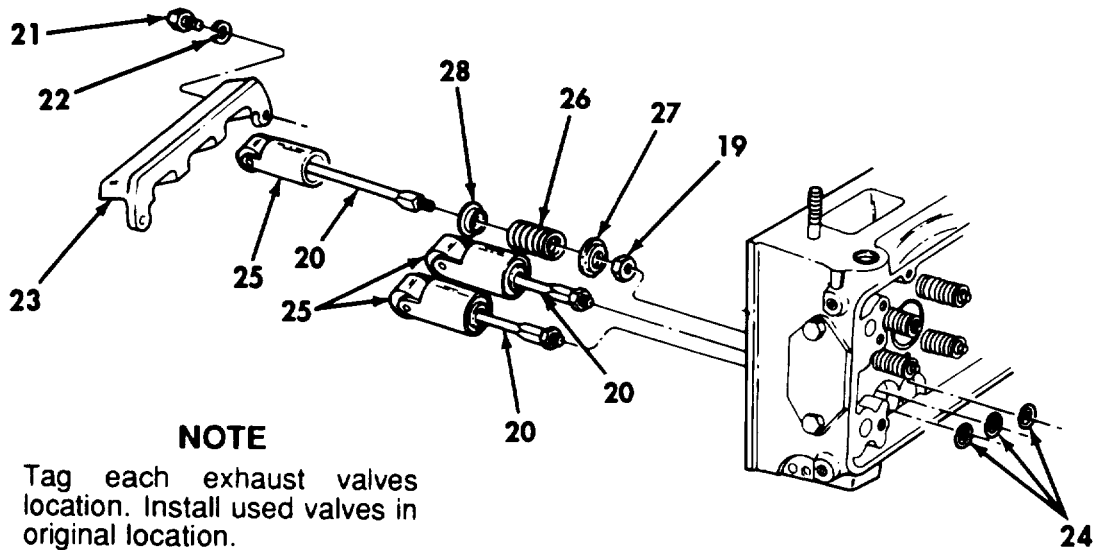
- (3) Remove three rocker arm shafts (5) and six brackets (6) from cylinder head.
- (4) For all except model 5063-5299: if necessary, remove check valve (10), oil supply plug (11), and strainer (12) from throttle delay housing (9).
- (5) Swing left rocker arm (13), injector rocker arm (14), and right rocker arm (15) away from each injector. Remove injector clamp screw (16), convex washer (17), and clamp (18) from each injector.



- (6) Remove three fuel injectors (2) from cylinder head.
- (7) Loosen nine locknuts (19) at upper end of push rods (20) next to rocker arm clevis. Remove nine rocker arms (13, 14, and 15) from push rods by unscrewing rocker arms.

3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

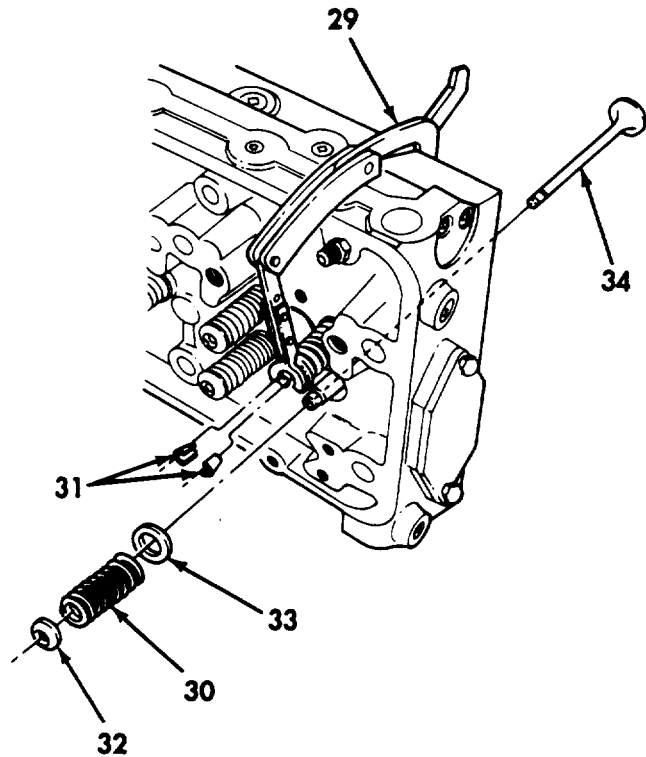
- (8) Rest cylinder head on its side and remove six screws (21), six lockwashers (22), and three cam follower guides (23). Discard lockwashers.
- (9) Remove nine cam follower spring retainers (24) from bores in cylinder head.
- (10) Pull nine cam followers (25) and nine push rod (20) assemblies from bottom of cylinder head. Remove spring (26), push rod nut (27), upper spring seat (28), and lower spring seat (28) from nine push rods.



NOTE

Tag each exhaust valves 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 (29), compress valve spring (30). Remove two tapered valve locks (31).
 - (c) Remove upper spring seat (32), valve spring (30), lower spring seat (33), and exhaust valve (34).
- (12) Remove six fuel nipples (3) and six copper washers (35) from cylinder head. Discard copper washers.
- (13) If necessary, remove three expansion plugs (36) from cylinder head, one from inboard side and two from outboard side. Discard plugs.
- (14) If necessary, remove sleeve (37) from inboard side of cylinder head.



CAUTION

Inspect fuse plug (38). If fuse plug is melted, cylinder head assembly was overheated. Thoroughly inspect cylinder head assembly for cracks and other heat related damage.

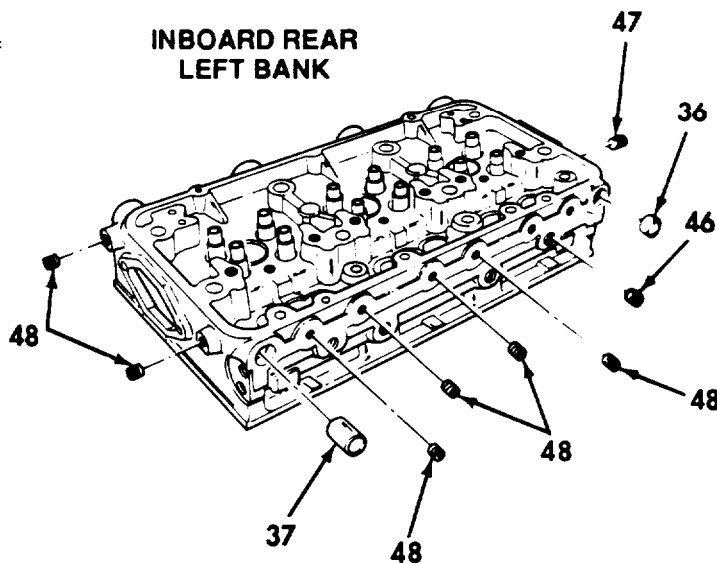
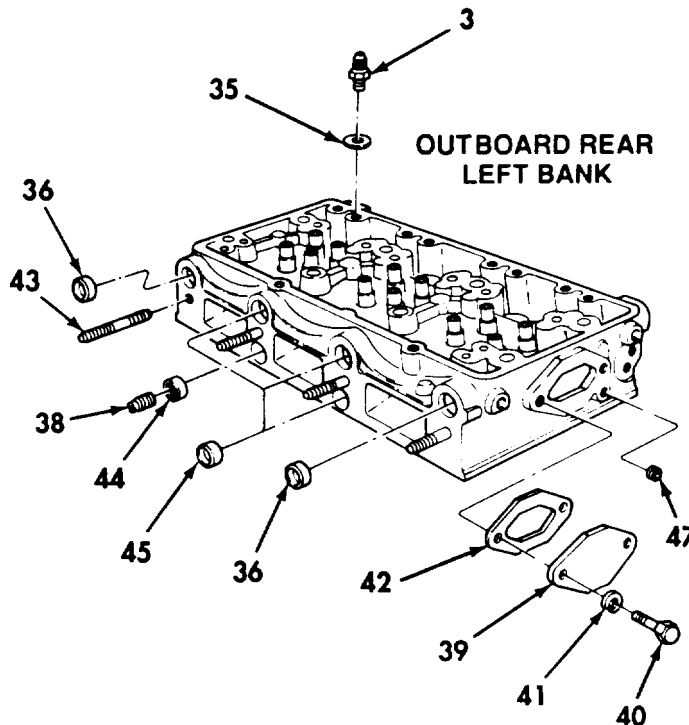
NOTE

- Pressure check cylinder head at this point as described in step c.
- Models 5063-5395, 5063-5398, and 5063-539F do not use cover (39) and fastening hardware on rear of right cylinder head assembly.

- (15) Remove two screws (40), two lockwashers (41), cover (39), and gasket (42) from rear of cylinder head. Discard lockwashers and gasket.
- (16) If necessary, remove four studs (43) from outboard side of cylinder head.
- (17) Remove fuse plug (38) and adapter (44) from outboard side of cylinder head.
- (18) Remove three expansion plugs (45) from outboard side of cylinder head, Discard plugs.
- (19) Remove four pipe plugs (46) from inboard side of cylinder head.
- (20) Remove pipe plug (47) from each end of cylinder head.

NOTE

- Models 5063-5395, 5063-5398, 5063-5392, and 5063-539F use one threaded plug (48) at rear of left cylinder head.
- Models 5063-5393, and 5063-539L uses one threaded plug (48) at both ends of left cylinder head.
- Models 5063-5395, 5063-5398, and 5063-539F, use two threaded plugs (48) at inboard side of right cylinder head.



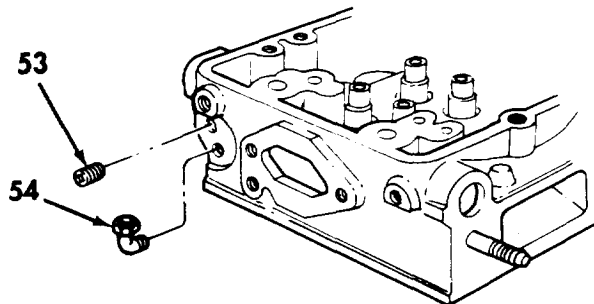
- (21) If necessary, remove six threaded plugs (48), except where noted, from each end of head. Two plugs are located at each end and four plugs are located on inboard side of cylinder head.

3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

(22) On models 5063-5393, and 5063-539L, remove tee (49) from elbow (50) at front of right cylinder head.

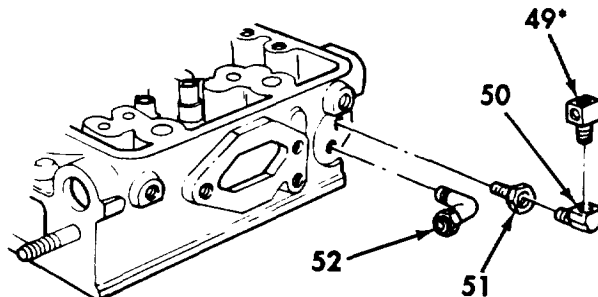
(23) Remove elbow (50), coupling (51), and elbow (52) from front of right cylinder head.

(24) Remove pipe plug (53) and elbow (54) from front of left cylinder head.



LEFT BANK FRONT

* MODELS: 5063-5393 AND 5063-539L ONLY



RIGHT BANK FRONT

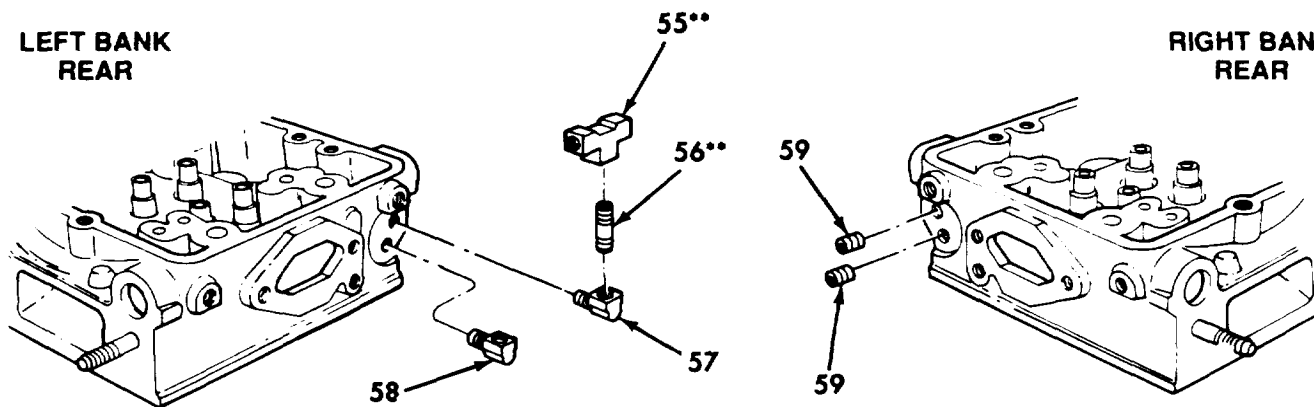
(25) On models 5063-5299 and 5063-5392, remove tee (55) and pipe nipple (56) from elbow (57) at rear of left cylinder head.

(26) Remove elbow (57) and elbow (58) from rear of left cylinder head.

(27) Remove two pipe plugs (59) from rear of right cylinder head.

LEFT BANK REAR

RIGHT BANK REAR



**MODELS: 5063-5299 AND 5063-5392

b. Cleaning

- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.

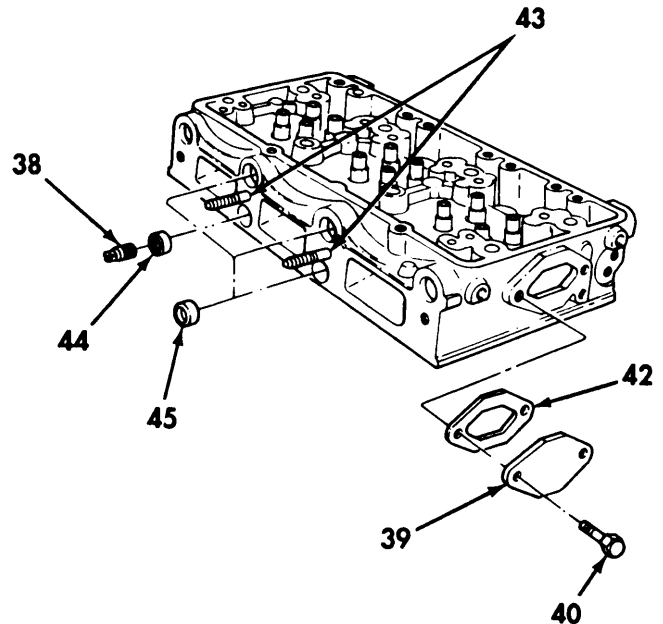
- **Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)**

- (1) Clean cylinder head and cylinder head components with cleaning solvent and dry with compressed air (refer to Para 2-2).
- (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.

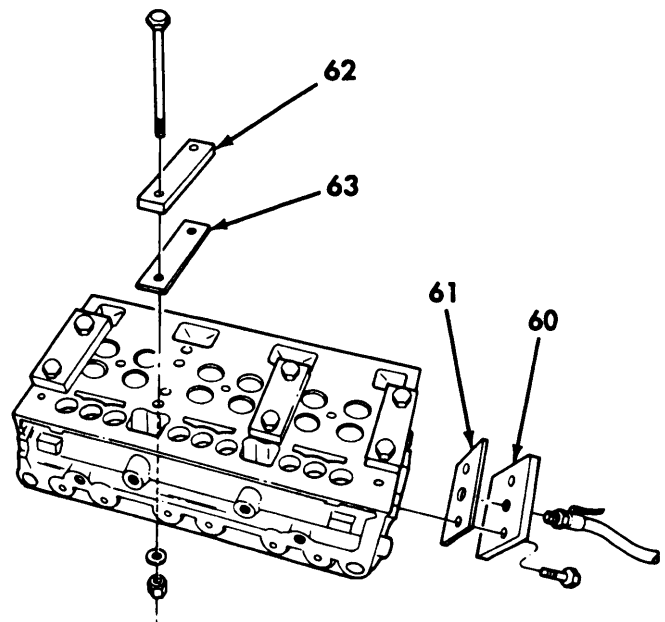
c. Pressure Check Cylinder Head

NOTE

Two inside exhaust manifold studs (43), adapter (44), fuse plug (38), three expansion plugs (45), gasket (42), cover (39), and two bolts (40) must be in place to pressure check cylinder head.



- (1) Install fabricated tapped blocking plate (60), gasket (61), and two screws over hole at end of cylinder head. Tighten bolts securely.
- (2) Install four fabricated blocking plates (62), four gaskets (63), eight bolts, sixteen flat washers, and eight nuts over eight water holes on fire deck, Tighten nuts securely.
- (3) Install scrap or dummy injectors to properly seal injector tubes. Torque injector clamp screws to 20-25 lb-ft (27-34 N-m).
- (4) Connect an air supply line with regulator to fabricated end plate (60). Pressurize cylinder head water jacket to 40 PSI (276 kPa).



- (5) 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.
- (6) 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.

3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

d. Inspection/Repair

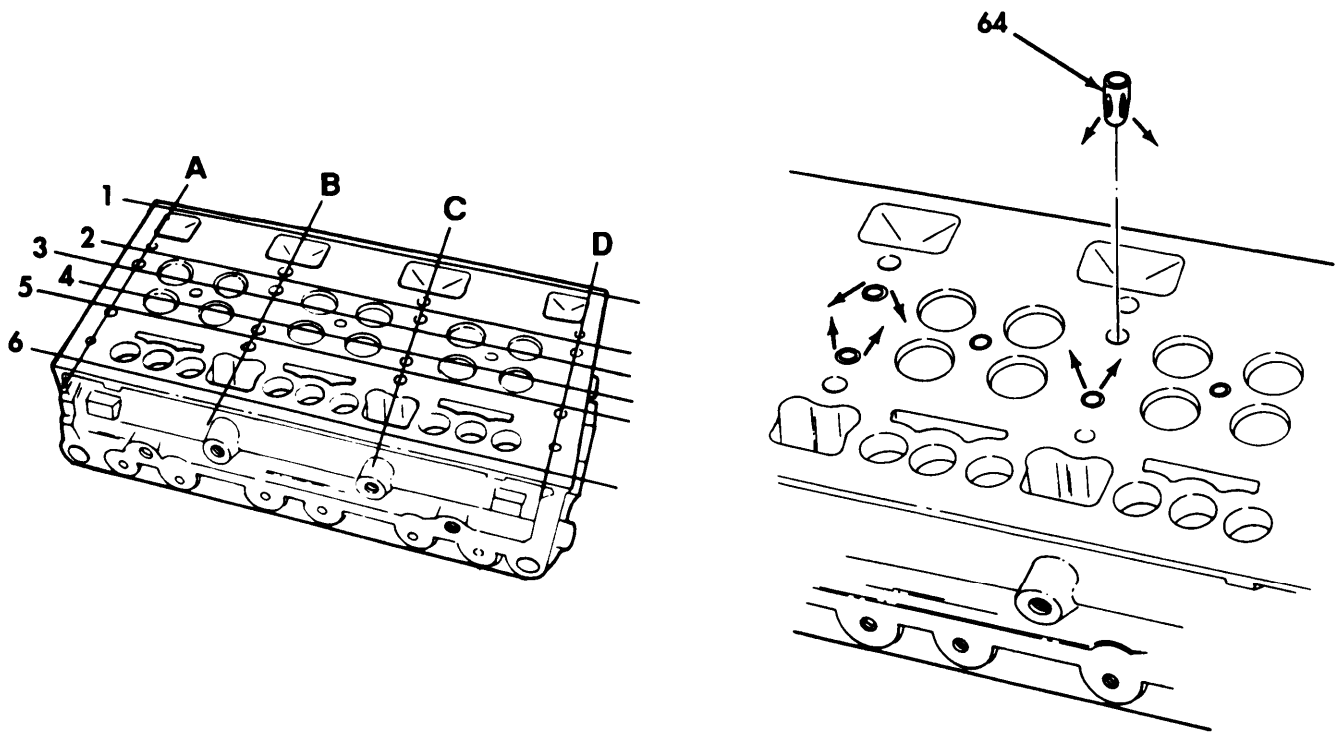
(1) Cylinder head

- (a) Check fire deck surface of cylinder head for flatness. Using a straight edge and thickness gages, check lengthwise (six places) and crosswise (four places) 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. Nonprotruding longitudinal scoring of 0.003 inch (0.08 mm) deep and bore surface finish of 120 μ inch 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

Check four water hole nozzles for looseness. If necessary, replace nozzle as follows:

- (a) Clean nozzle bore in cylinder head with 5/8 inch drill. Flare edge of hole slightly.

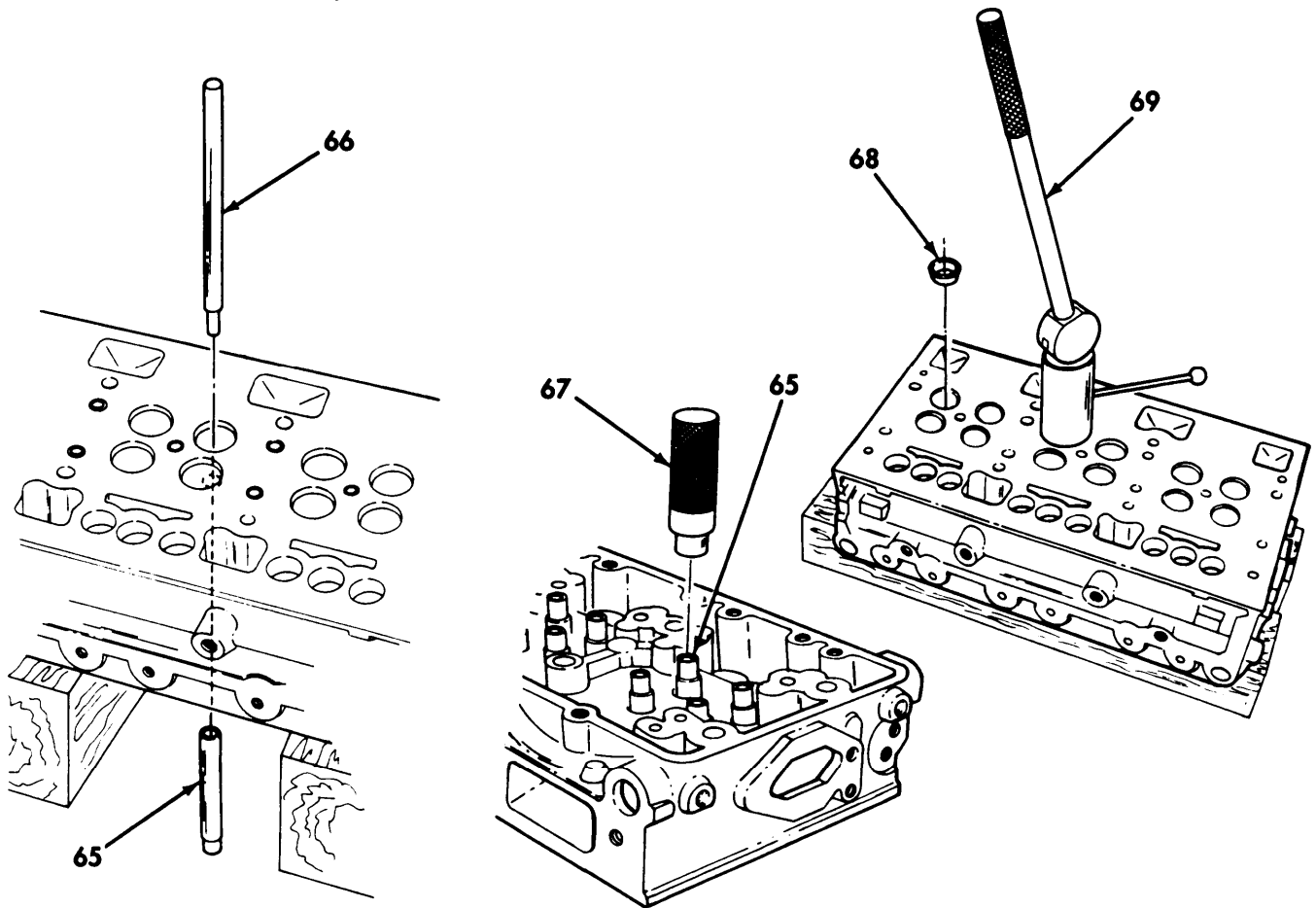


- (b) Remove any loose nozzle (64) from cylinder head.
- (c) Place nozzle (64) in bore with nozzle opening positioned as shown.
- (d) Press nozzle flush to 0.0312 inch (0.792 mm) below surface of cylinder head.
- (e) Nozzle must fit tight. If necessary, expand nozzle with wood dowel or other suitable tool to make a tight fit.

(3) Exhaust valve guides

Inspect valve guides (65) 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. Replace valve guide as follows:

- (a) Support cylinder head, bottom side up, on three inch thick wood blocks.
- (b) Using valve guide remover (66), drive valve guide (65) out of cylinder head.
- (c) Place cylinder head right side up in press.
- (d) Place valve guide (65) squarely in bore. Using valve guide installer (67), press guide until tool contacts cylinder head.



(4) Valve seats

Inspect valve seats (68) for excessive wear, pitting, cracking, or improper seat angle. Replace as follows:

- (a) Place cylinder head on wood blocks with fire deck side up.
- (b) Using valve seat tool kit (69), remove valve seat (68).
- (c) Clean valve seat counterbore in cylinder head and inspect for concentricity, flatness, and cracks.

3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

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.

- (d) Immerse cylinder head in water heated to 180-200°F (82-93°C) for 30 minutes or cool insert with liquid nitrogen.

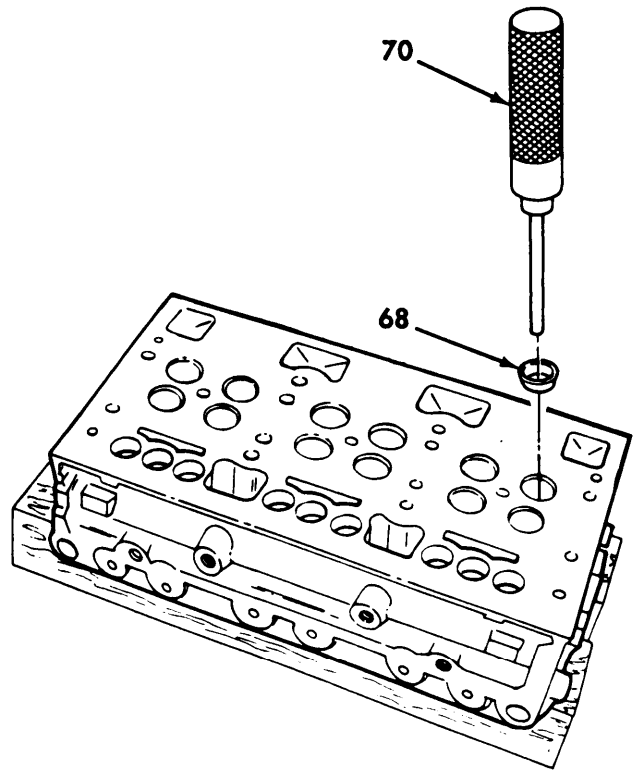
NOTE

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.

- (e) Place cylinder head on bench with fire deck up. Place valve seat (68) in counterbore with tapered face up.
- (f) Using valve seat installer (70), drive valve seat in place until it seats solidly in cylinder head.
- (g) Check valve seats for concentricity in relation to valve guides using valve seat dial gage (71).

NOTE

Exhaust valve seats are prefinished. Check for concentricity after installation. Grind valve seats only if runout exceeds 0.002 inch (0.05 mm).

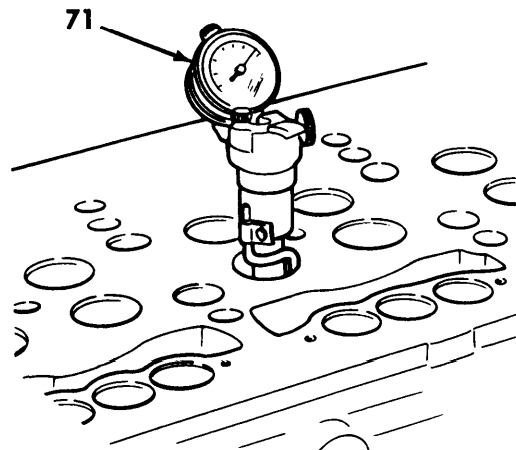


(5) Valve seat grinding

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.

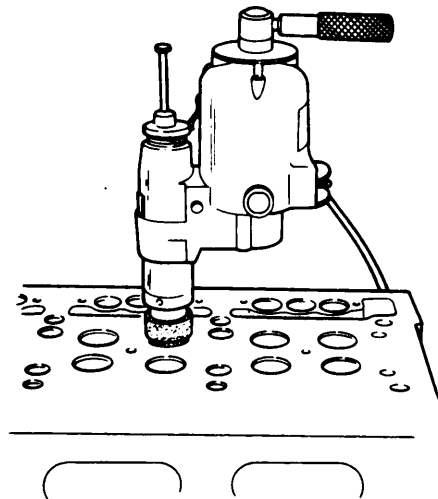


- (a) Apply 31 degree grinding wheel on valve seat.

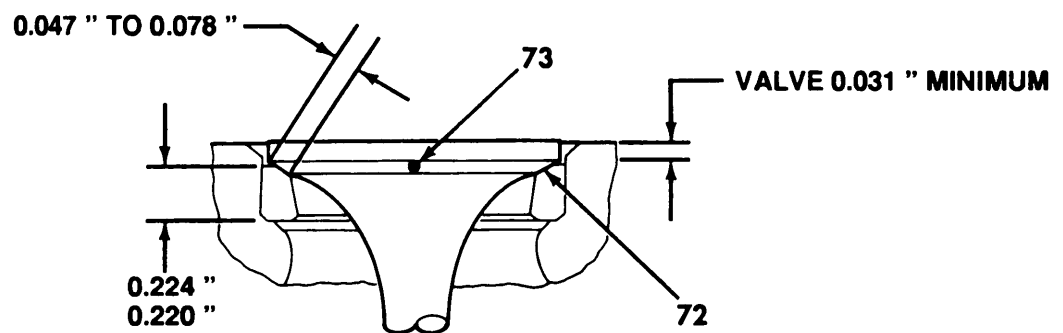
- (b) Grind throat of valve seat using 60 degree grinding wheel.
- (c) Grind top surface of valve seat with 15 degree grinding wheel to narrow seat width to dimensions shown. Adjust the 31 degree face (72) relative to center of valve face (73) using 15 and 60 degree grinding wheels.

NOTE

Grinding will reduce thickness of valve seat and cause valve to recede into cylinder head. Replace valve seat if valve recedes beyond limits.



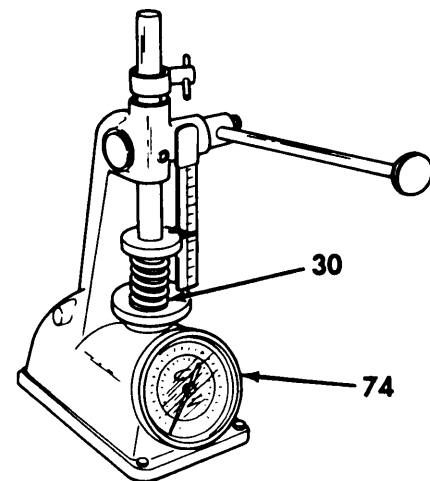
- (d) After grinding is completed, clean valve seat thoroughly. Measure concentricity of valve seat in relation to valve guide. If runout exceeds 0.002 inch (0.05 mm), check for bent or worn valve guide before-regrinding valve seat.



- (e) Apply a light coat of Prussian blue paste to valve seat.
- (f) Lower stem of valve in valve guide and bounce valve on seat. Do not rotate valve.
- (g) 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

- (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 (74), measure load required to compress valve spring (30) to 1.93 inches (4.90 cm). Replace valve spring if load is less than 25 lbs.



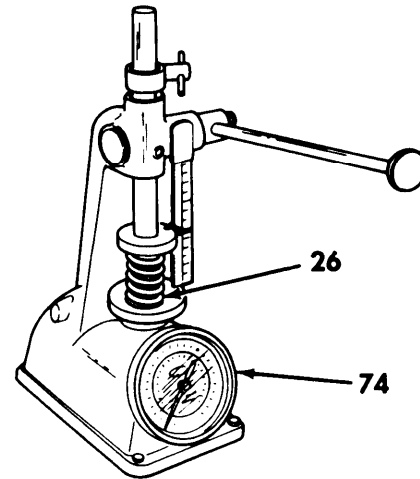
3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

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.

- (a) Examine cam follower springs (26) for wear or damage. Using spring tester (74), check spring load. Replace spring if a load less than 250 lbs compresses spring to 2.14 inches (5.44 cm).

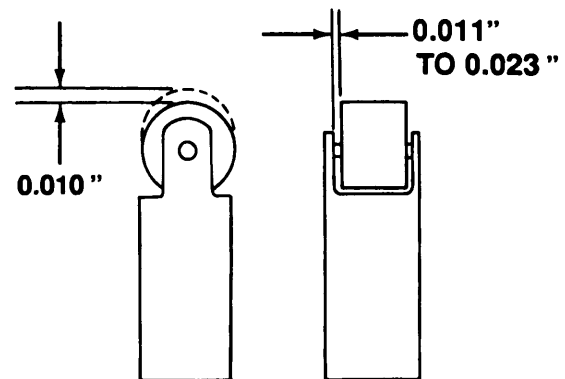


CAUTION

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 (75) must turn freely on their pins (76).

- (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 (77) in a vise and place cam follower in groove at top of fixture with pin resting on top of small plunger.

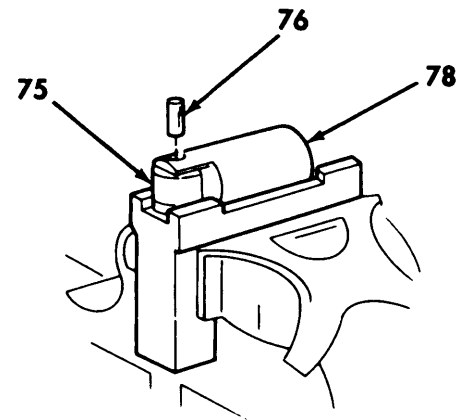
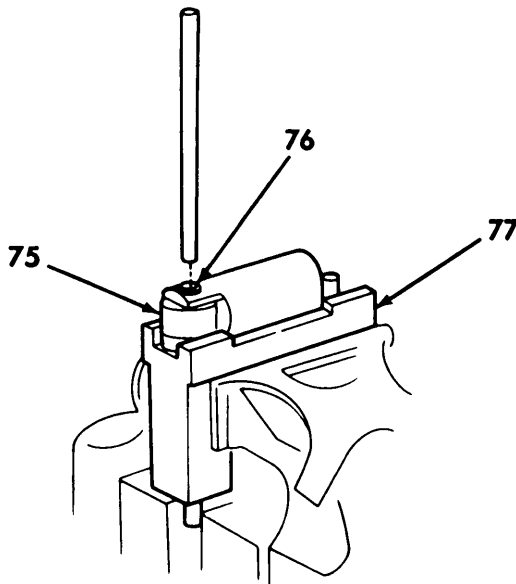
WARNING

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 and cause 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 (76) from roller (75) follower body (78) with a drift.
3. Place follower body (78) in groove of holding fixture with small plunger extending through roller pin hole in one leg of follower body.



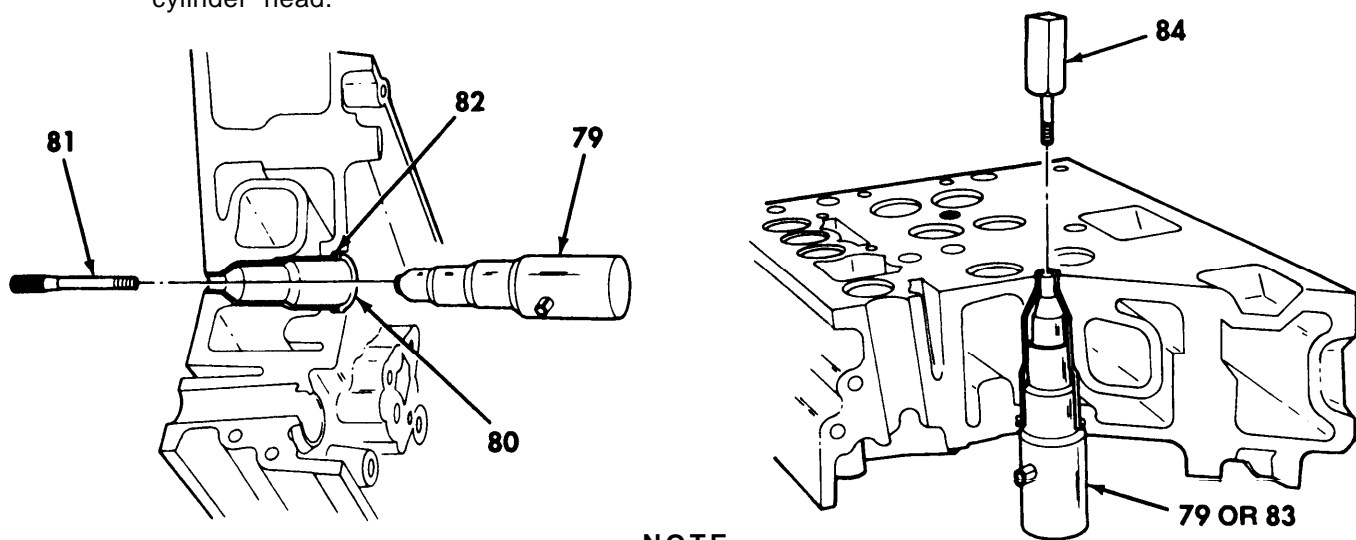
4. Coat pin (76) and roller (75) with engine oil.
 5. Place roller (75) in cam follower body (78). Plunger will extend into roller bushing and ensure accurate alignment of bushing with roller pin holes in follower body.
 6. Start pin (76) squarely into follower body (78) and drive into position until pin is centered in legs of follower.
 7. Check side clearance between roller (75) and follower body (78). Clearance must be 0.011-0.023 inch (0.28-0.58 mm).
- (8) Rocker arms and shafts
- Inspect rocker arm shafts and bushings for wear. Maximum shaft to bushing clearance is 0.004 inch (0.10 mm).

3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

(9) Injector tube

Replace injector tubes if found leaking during pressure test as follows:

- (a) Place injector tube installer (79) in injector tube (80).
- (b) Insert pilot (81) in small hole in injector tube (80) and thread pilot in threaded hole of installer (79).
- (c) Tap pilot (81) to drive out injector tube (80). Lift injector tube, pilot, preformed packing (82), and installer (79) from cylinder head. Discard injector tube and preformed packing.
- (d) Thoroughly clean injector tube hole in cylinder head to remove dirt, burrs, or foreign material that may prevent tube from seating properly.
- (e) Lubricate injector tube preformed packing (82) with engine oil and place in counterbore of cylinder head.



NOTE

- There are two types of injector tube installers, a fixed tool (79) for the superseded tube and an adjustable tool (83) 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).
- (f) Place installer (79 or 83) in injector tube (80). Insert pilot (81) through small hole in injector tube and thread into tapped hole at end of installer.
 - (g) Slip injector tube (80), installer (79 or 83), and pilot (81), into injector bore and drive into place.
 - (h) Turn cylinder head fire deck up and remove installer pilot. Thread flaring die installer (84) into tapped hole of installer (79 or 83).
 - (i) Apply 30 lb-ft (41 N-m) torque to flaring die installer (84).
 - (j) Remove flaring die installer (84) and injector tube installer (79 or 83) from injector tube.

NOTE

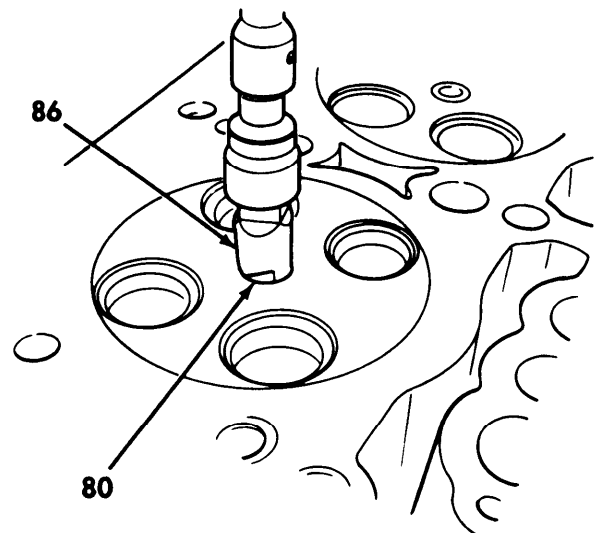
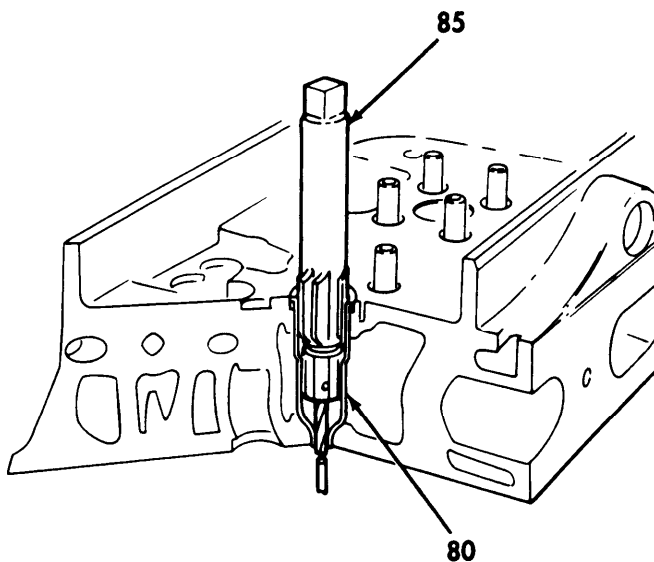
Reamers do not contact large inside diameter of current injector tube marked "606".
Ream only at small inside diameter and injector nut seat.

- (k) Clean injector tube (80) and place cylinder head with fire deck facing down. Apply a few drops of cutting oil on reamer flutes and carefully position finishing reamer (85) in injector tube.

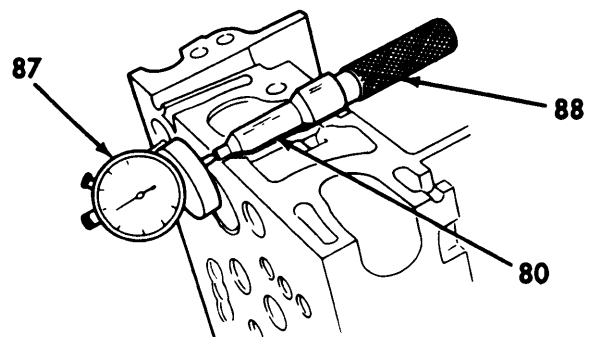
CAUTION

Turn reamers only in clockwise direction, both when inserting and removing reamers.
Movement in opposite direction will dull cutting edges on flutes.

- (l) Turn finishing reamer (85) clockwise (withdraw reamer frequently to remove chips) until lower shoulder contacts injector tube (80). Clean out all chips.

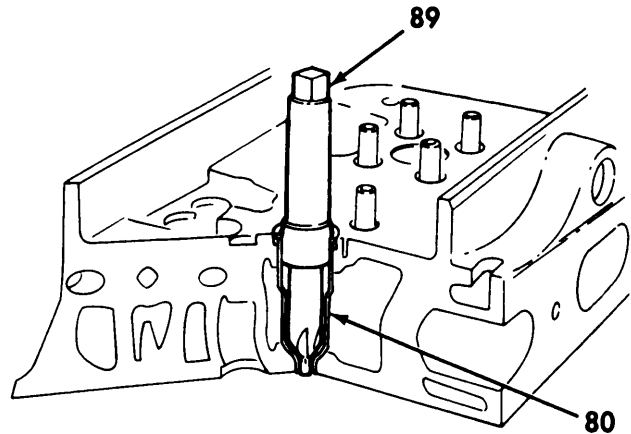


- (m) Turn cylinder head to fire deck up position. Insert pilot of tube tip refinisher (86) into small hole of injector tube (80).
- (n) Apply a few drops of cutting oil on tube tip refinisher (86). Using a socket and revolving grip socket wrench handle, remove excess stock so lower end of injector tube (80) is from flush to 0.005 inch (0.13 mm) below finished surface of cylinder head.
- (o) Install injector depth gage (87) in injector tube. Using injector protrusion gage (88), premeasure distance from fire deck to gage (final reading will have to be within +/- 0.014 inch (0.36 mm) of fire deck).
- (p) Wash interior of injector tube (80) to prepare for second reaming operation.



3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

- (q) Apply a few drops of cutting oil on bevel seat of injector tube (80). Lower bevel reamer (89) carefully into injector tube until it contacts bevel seat.
- (r) For trial cut, turn bevel reamer (89) steadily without applying any downward force. Remove reamer, clean out chips, and observe what portion of injector nut seat was cut.
- (s) Proceed with reaming and withdraw bevel reamer occasionally to observe progress.
- (t) Continue reaming until shoulder of spray tip is within ± 0.014 inch (0.36 mm) of fire deck. Use gages (88 and 87) to measure distance.
- (u) Wash interior of injector tube (80).



(10) Throttle delay housing assembly

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.

e. 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 expansion plugs (36) in sides of cylinder head, one plug on inboard side and two plugs on outboard side.
 - (2) If removed, install sleeve (37) on inboard side of cylinder head at rear. Coat sleeve with sealing compound and drive into bore until it protrudes 3/8 inch.
 - (3) Install adapter (44) 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 (38) into adapter (44).
 - (5) Install three expansion plugs (45) at outboard side of cylinder head.
 - (6) Install four pipe plugs (46) in fuel galleries on inboard side of cylinder head.
 - (7) Install pipe plug (47) in oil gallery at each end of cylinder head.

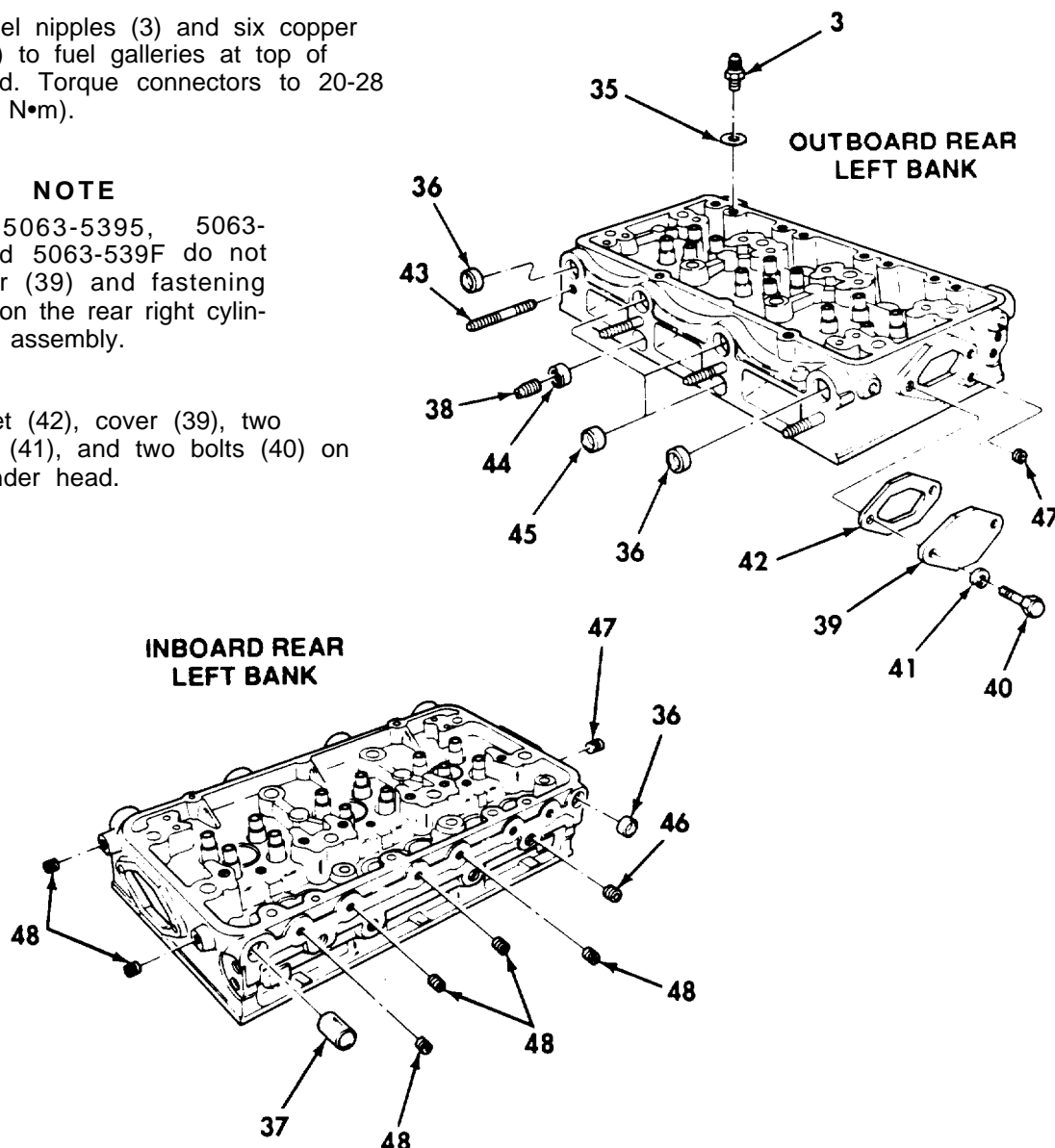
NOTE

- Models 5063-5395, 5063-5398, 5063-5392, and 5063-539F use one threaded plug (48) at rear of left cylinder head.
 - Models 5063-5393 and 5063-539L uses one threaded plug (48) at both ends of left cylinder head.
 - Models 5063-5395, 5063-5398, and 5063-539F use two threaded plugs (48) at inboard side of right cylinder head.
- (8) If removed, install six threaded plugs (48), 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 (43) 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 (3) and six copper washers (35) to fuel galleries at top of cylinder head. Torque connectors to 20-28 lb-ft (27-38 N·m).

NOTE

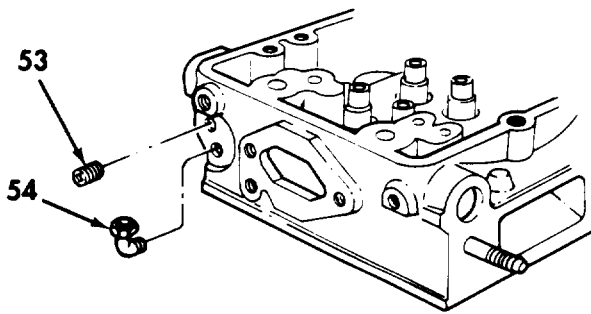
Models 5063-5395, 5063-5398, and 5063-539F do not use cover (39) and fastening hardware on the rear right cylinder head assembly.

- (11) Install gasket (42), cover (39), two lockwashers (41), and two bolts (40) on rear of cylinder head.

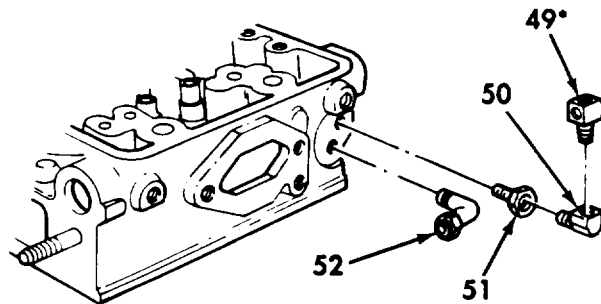


3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

- (12) Install elbow (52) to front of right cylinder head. Position elbow pointing outboard.
- (13) Install coupling (51) and elbow (50) 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 (49) to elbow (50) at front of right cylinder head.
- (15) Install pipe plug (53) and elbow (54) in front of left cylinder head. Position elbow pointing upward.



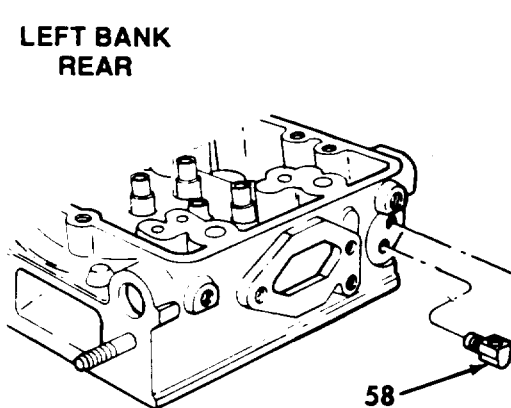
LEFT BANK FRONT



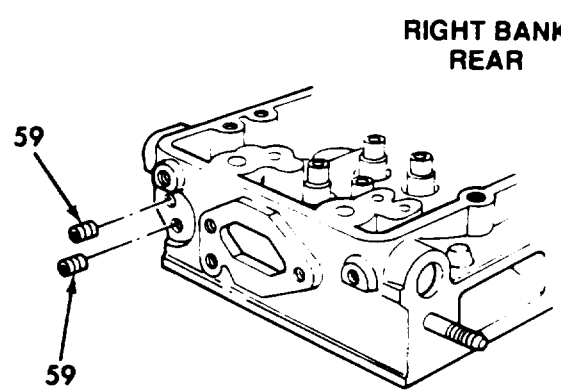
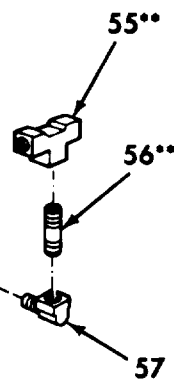
RIGHT BANK FRONT

*** MODELS: 5063-5393 AND 5063-539L ONLY**

- (16) Install elbow (57) facing upward and elbow (58) facing outboard in rear of left cylinder head.
- (17) On models 5063-5299 and 5063-5392, install pipe nipple (56) and tee (55) to elbow (57) in rear of left cylinder head.
- (18) Install two pipe plugs (59) to rear of right cylinder head.



LEFT BANK REAR



RIGHT BANK REAR

****MODELS: 5063-5299 AND 5063-5392**

(19) Install twelve exhaust valves as follows:

- (a) Place cylinder head on its side. Lubricate valve stems with preservative lubricating oil and slide valves (34) all the way into guides (65).

NOTE

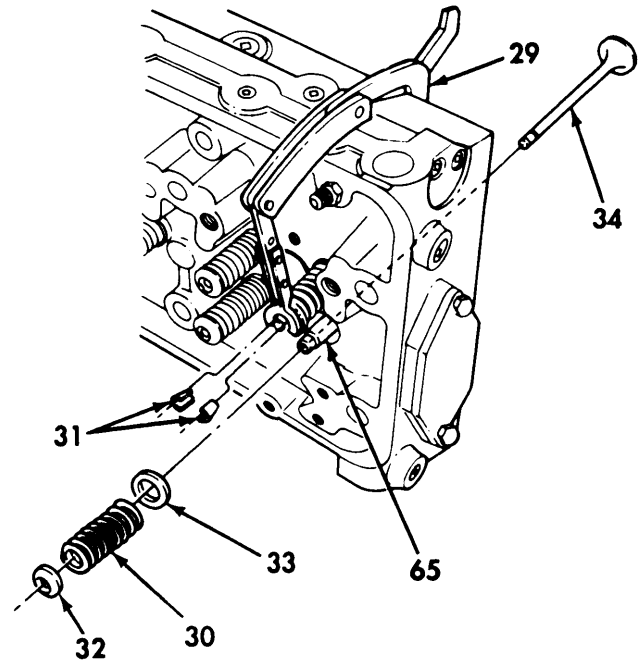
Install used valves only in their original location.

- (b) Install lower spring seat (33), valve spring (30), and upper spring seat (32) over valve stem.

CAUTION

Avoid scoring valve stem with spring seats when compressing spring.

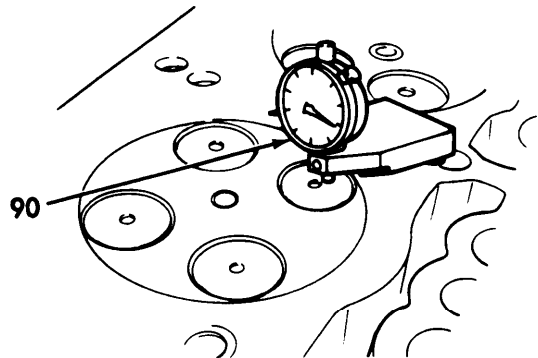
- (c) Using valve spring compressor (29), compress valve spring (30) and install two tapered valve locks (31).
- (d) Release pressure on spring compressor (29) and remove it.
- (e) Repeat steps (a) thru (d) for remaining valves.



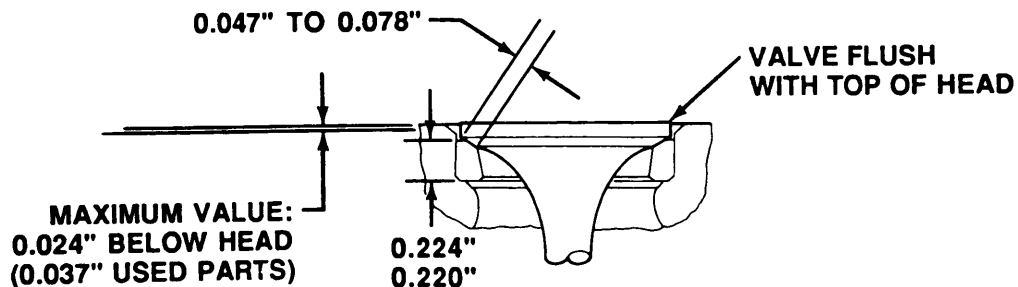
- (f) Support cylinder head on wood blocks at both ends (fire deck down). Give stem end of valves a sharp tap with soft head hammer to seat valve locks (31).

NOTE

The limits for exhaust valve protrusion with respect to cylinder head is shown.



- (g) With bottom of cylinder head facing up, measure exhaust valve protrusion beyond fire deck using depth gage (90). If out of limits, regrind or replace insert and exhaust valve.

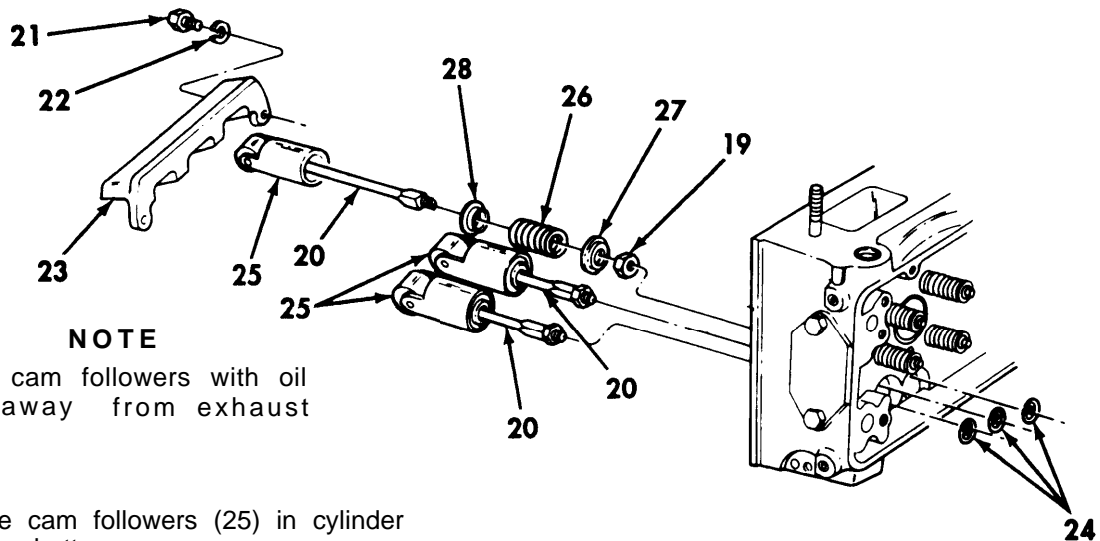


3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cont)

NOTE

- Before installing cam followers, immerse in Cindol 1705 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 (28), spring (26), upper spring seat (27), and push rod nut (19) on nine push rods (20).
- (21) Install nine spring retainers (24) in bores from top of cylinder head.
- (22) Slide nine push rod (20) assemblies in cylinder head from bottom.



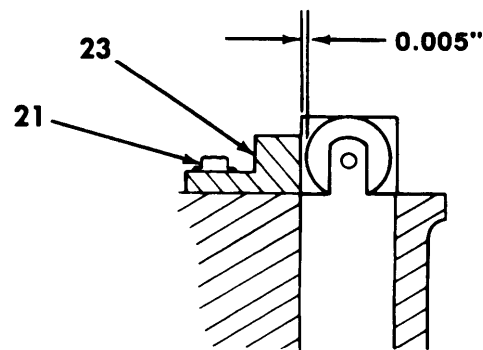
NOTE

Install cam followers with oil hole away from exhaust valves.

- (23) Slide nine cam followers (25) 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 (23), six lockwashers (22), and six screws (21) on cylinder head. Torque screws to 144-180 lb-in (16-20 N-m).
- (25) Measure clearance between cam follower guide (23) 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 (21) and tap corners of guide (23) with brass drift. Torque screws again after proper adjustment.

NOTE

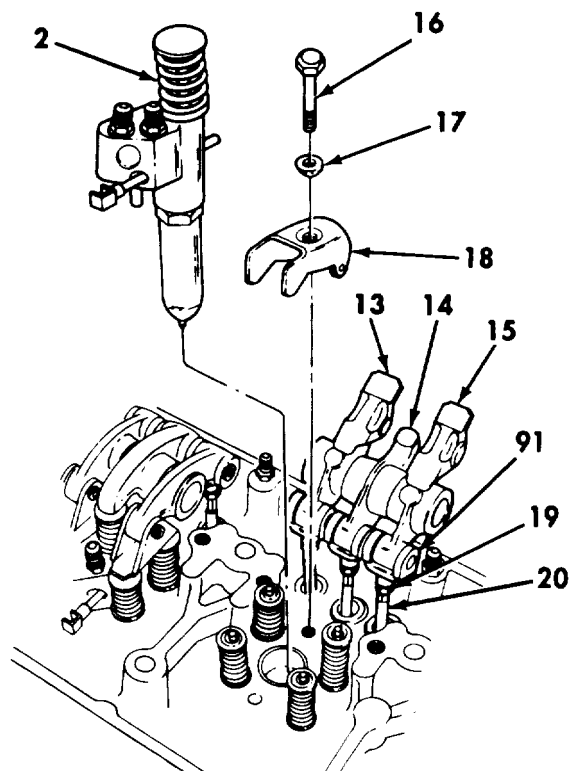
- If a new rocker arm is installed, also install a new push rod.
- Push rod nut adjustment is performed during engine tune-up (para 4-4).

- (27) Thread each rocker arm (13, 14, and 15) on its push rod (20) assembly until end of push rod is flush with inner side of clevis yoke (91).

CAUTION

Injector hold-down clamp must not contact exhaust valve spring or injector follower spring.

- (28) Install three fuel injectors (2), three clamps (18), three convex washers (17), and three screws (16) 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 (10), strainer (12), and oil supply plug (11) into throttle delay housing (9).

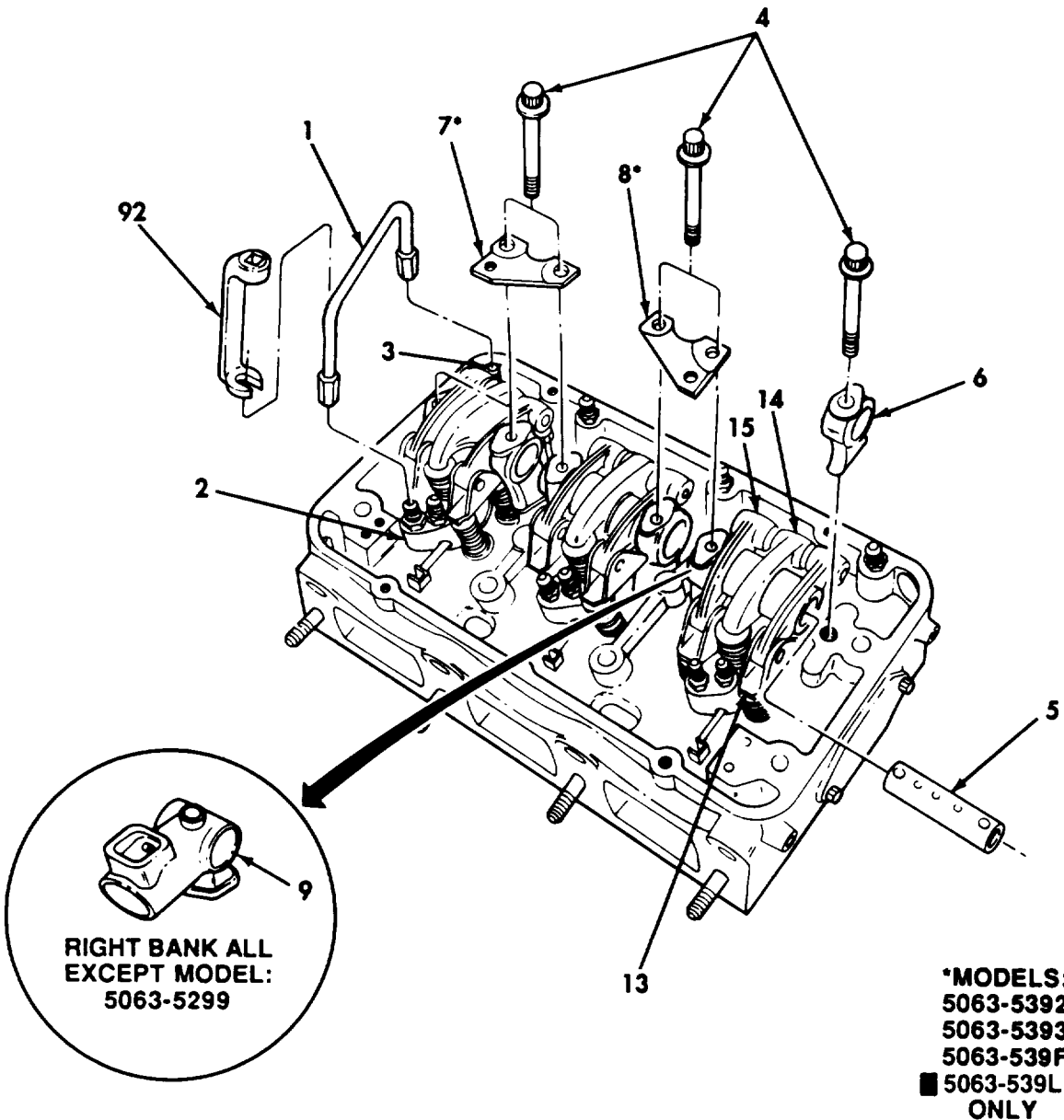


3-64. CYLINDER HEAD ASSEMBLY REPAIR (Cent)

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 (9).

(30) Apply engine oil to each rocker arm shaft (5) and slide shaft through left rocker arm (13), injector rocker arm (14), and right rocker arm (15). Place a bracket (6) on each shaft end with finished face of bracket toward rocker arm.



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 models 5063-5299, 5063-5395, and 5063-5398, insert six bolts (4) through six brackets (6) and three shafts (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, 5063-539F, and 5063-539L, insert six bolts (4) through hold-down bracket (7), hold-down bracket (8), six brackets (6), and three shafts (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 (2) and install six fuel tube assemblies (1) on fuel injectors and fuel nipples (3). Using fuel nut wrench (92), torque fuel tube nuts to 130-160 lb-in (14.7-18.1 N·m).

END OF TASK**FOLLOW-ON MAINTENANCE**

Para Description

3-43 Install cylinder head assembly.

3-8 Install engine lifter brackets.

3-65. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

(4) Injector plunger and bushing

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Dry cleaning solvent P-D-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 Degrees F (38-50 Degrees 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.

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

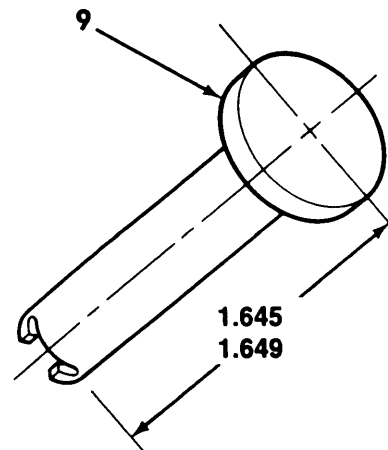
Keep plunger and bushing together as a matched set. Keep parts of each injector assembly together.

Wash plunger and bushing with cleaning solvent and dry with compressed air.

c. Inspection/Measurements

(1) Follower

- Measure distance between top of follower (9) and slot. Dimension must be 1.645 to 1.649 inches.
- Inspect stop pin groove in side of follower for smoothness and damage. Discard follower if there is more than 0.002 inch wear on top or there is other visual damage or wear.



(2) Follower spring

- Examine outside diameter of follower spring coils for wear caused by rocker arms contacting coils. Replace if worn.
- 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.
- Check spring tension with spring tester. Replace spring when a load of less than 78 lbs will compress it to 1.028 inches.

(3) Injector body

Inspect injector body threads, bushing seating surface, and fuel connector ring spacer sealing surfaces or damage. Inspect rack hoe, body preformed packing sealing surface, clamp radius, and dowel pin. Replace if necessary.

(4) Fuel connectors

Check condition of jumper line sealing surfaces, copper ring spacer sealing surfaces, and fuel connector threads. Replace if necessary.

(5) Control rack

(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.

(6) Gear and gear retainer

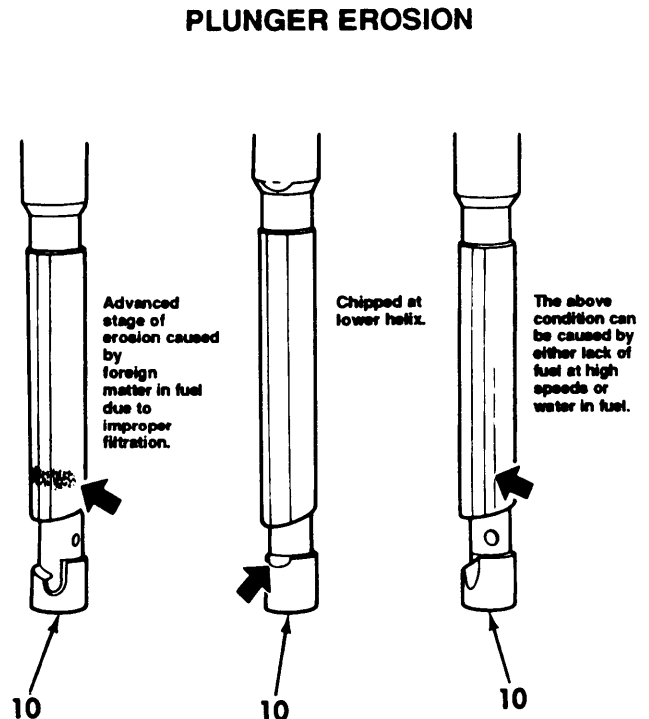
Inspect gear and gear retainer for nicks, burrs, or rust. Check gear teeth for wear.

(7) Bushing

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.

(8) Plunger

Check plunger (10) for erosion, corrosion or varnish, scoring, scratching or wear, and chips along edge of helix.



(9) Check valve and check valve cage

(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 and minimum check valve thickness is 0.022 inch. Replace if necessary.

(10) Valve spring

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

Check surfaces for wear as shown by visible chamfer. Replace if necessary.

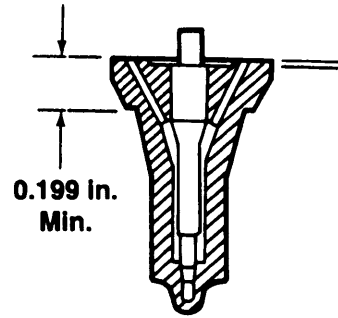
3-65. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

(12) Spring cage

- (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. 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 (2) shoulder. Minimum thickness is 0.199 inch.

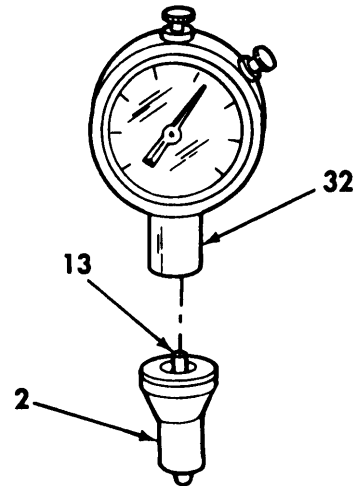
(14) Needle valve

Check spray tip needle valve for erosion at seat shoulder, scratches, and overheating.

(15) Needle valve lift

Using needle valve height gage (32), measure needle valve lift as follows:

- (a) Install needle valve (13) in spray tip (2).
- (b) Press plunger of needle valve height gage against a flat surface and zero indicator dial.
- (c) Place spray tip (2) and needle valve (13) tight against bottom of gage with quill of needle valve in hole in plunger.
- (d) While holding spray tip and needle valve assembly tight against gage (32), read needle valve lift on indicator. Lift must be 0.008 to 0.018 inch. If needle valve lift exceeds 0.018 inch, replace tip assembly. If lift is less than 0.008 inch, inspect assembly for foreign material between needle valve and tip seat.



(16) Injector nut

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

Inspect ends of deflector for sharp edges or burrs.

d. Lapping**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 (17), bushing (20), valve spring cage (14), and spray tip (2). Lap components using following procedure:

WARNING

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

- (1) Clean lapping block set (33) with compressed air. Do not use cloth or other material for this purpose.
- (2) Spread 600 grit dry lapping compound on lapping block (33).

CAUTION

Ensure no lapping compound is accidentally placed on the lapped surfaces located higher up in the spray tip. The slightest lapping action on these surfaces can alter the near perfect fit between the needle valve and tip.

- (3) Place part flat on lapping block (33). Using a figure-eight motion, move part back and forth across block. Do not press on part. Apply only enough pressure to keep part flat on block. Keep part flat on block at all times.
- (4) After five passes, draw part across clean piece of tissue placed on flat surface and clean lapping compound from it.
- (5) Inspect part and continue lapping if necessary. Do not lap excessively.

WARNING

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- (6) When part is flat, wash in cleaning solvent and dry with compressed air.
- (7) Place part on second block (33). Apply 600 grit lapping compound to block and repeat steps (3) and (6).
- (8) Place part on third block (33). Do not apply lapping compound to this block and repeat steps (3) and (6).

3-65. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

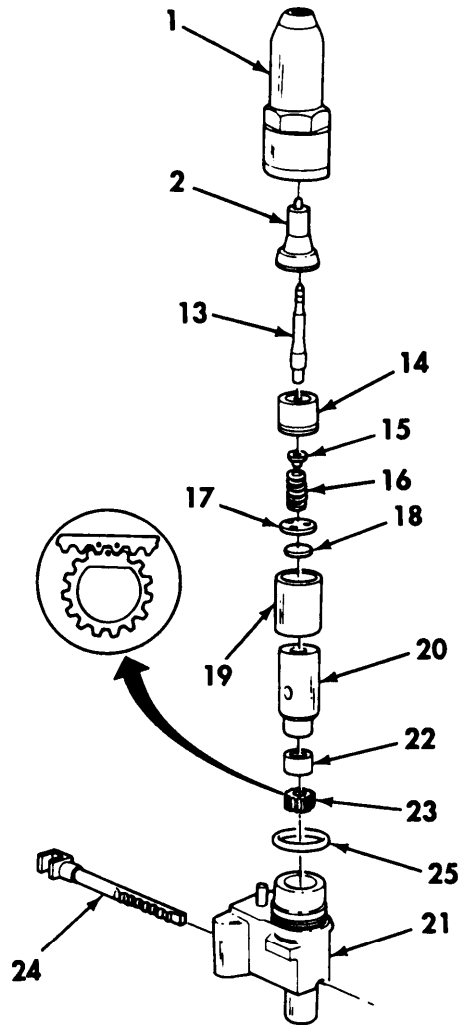
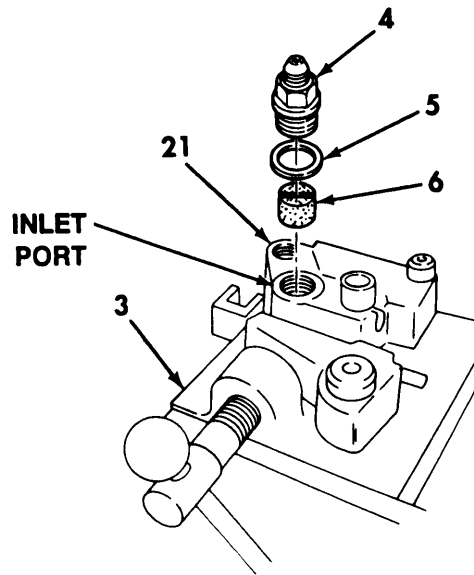
e. Assembly

- (1) Install injector body (21) in holding fixture (3) with top up.
- (2) Install filter element (6) in inlet port of body (located above injector rack) with dimple end down and slotted end up. No filter is used in outlet port.
- (3) Install two ring spacers (5) and two fuel connectors (4) 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 (21), bottom end up, in holding fixture (3).
- (5) Install preformed packing (25) on shoulder of injector body (21).
- (6) Slide injector control rack (24) into injector body.
- (7) Look into injector body bore and move control rack (24) until you see two drill marks on rack. Hold rack in this position.
- (8) Place gear (23) in injector body so that marked tooth on ear is engaged between two marked teeth on control rack (24) as shown.
- (9) Place gear retainer (22) on gear (23).
- (10) Align locating pin in bushing (20) with slot in injector body (21) and slide into place.
- (11) Install spill deflector (19) over barrel of bushing (20).

NOTE

Perform needle valve opening pressure test [step f.(5)] at this time before completing assembly.

- (12) Place check valve (18) centrally on top of bushing (20).
- (13) Place check valve cage (17), flat side up, and check valve (18) on bushing (20) with check valve in recess of check valve cage.

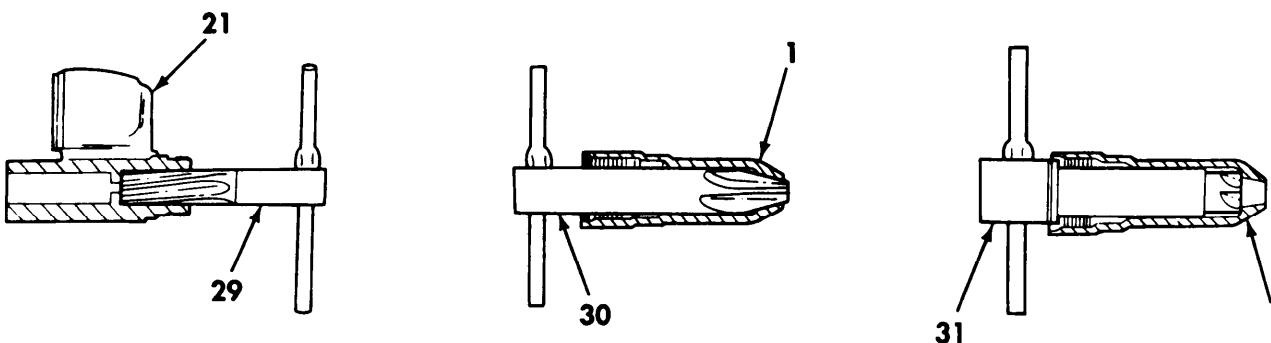


(2) Injector body

- (a) Clean and brush all passages in injector body (21) using injector brush and rack hole brush.
- (b) Ream injector body ring using reamer (29). Insert reamer in body and turn in clockwise direction a few turns. Then remove reamer and check face of ring for reamer contact. Repeat operation until reamer makes contact with entire face of ring. Clean opposite side of ring in same manner.

(3) Injector nut

- (a) Turn injector nut reamer (30) clockwise to remove carbon deposits from lower end of injector nut (1).

**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 tip hole injector nut reamer (31) clockwise to remove carbon deposits from bottom of injector nut (1) to produce a clean uniform seat for spray tip.

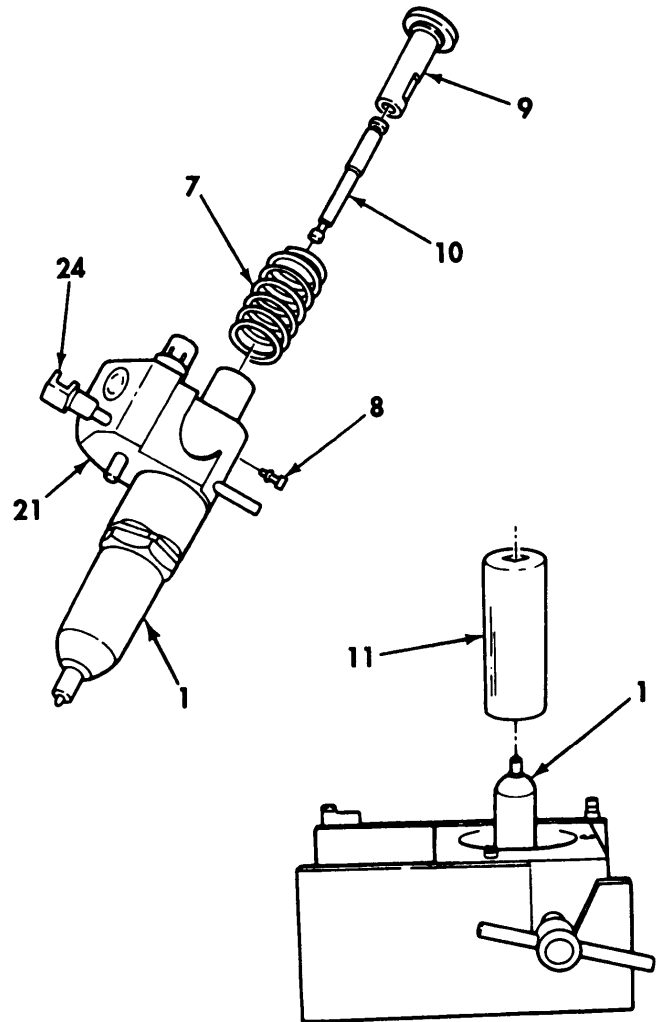
WARNING

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

(c) Wash injector nut (1) in clean solvent and blow dry.

(d) If necessary, repeat steps (a) thru (c) until all carbon is removed.

- (14) Insert spring seat (15) in valve spring (16) and install on check valve cage (17) with seat up.
- (15) Place spring cage (14) over spring seat (15) and spring (16).
- (16) Insert needle valve (13) into spray tip (2) with tapered end down. Place spray tip and valve assembly on top of spring cage (14) with quill end of needle valve in hole in spring cage.
- (17) Lubricate threads on injector nut (1) with engine oil and carefully thread nut on injector body. Tighten nut as tight as possible by hand.
- (18) Turn injector over and push rack (24) all the way in.
- (19) Place follower spring (7) on injector body (21).
- (20) Slide head of plunger (10) into follower (9).
- (21) Insert free end of plunger (10) in injector body (21).
- (22) Press down follower (9) and slide rack (24) in and out until plunger (10) falls in place with flat of plunger against flat in gear (23).
- (23) Align slot in follower (9) with stop pin hole in injector body (21).
- (24) Place stop pin (8) in slot on injector body (21). Rotate spring (7) so flat on end of coil is clear of stop pin. Then push stop pin in place while pressing down on follower (9). Once in place, rotate spring so flat on end of coil is positioned over stop pin.



CAUTION

Do not exceed specified torque. Otherwise, overtightening 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.

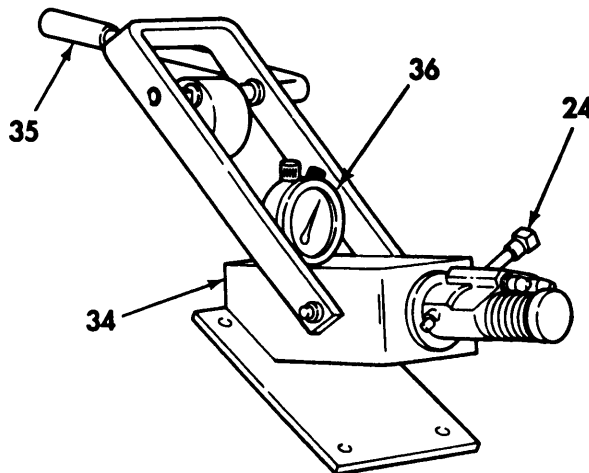
- (25) Using injector wrench (11), torque injector nut (1) to 75-85 lb-ft (102-115 N-m) for blued components, 45-55 lb-ft (61-75 N-m) for steel gray components, or 60-70 lb-ft (81-95 N-m) for mixed components.

3-65. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

f. Testing

(1) Injector control rack freeness

- (a) Place injector in injector tip and concentricity gage (34).
- (b) Hold rack (24) in NO FUEL position (rack extended all the way out).
- (c) Using handle (35), depress follower to bottom of its stroke.
- (d) Slowly release pressure on handle (35) while moving rack (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

- (a) Place injector in injector tip and concentricity gage (34).
- (b) Adjust dial indicator (36) to zero.
- (c) Rotate injector 360 degrees and note total runout as indicated on dial.
- (d) If total runout exceeds 0.008 inch, 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.

(3) High pressure leak test

WARNING

- Always hold injector so that fuel spray cannot penetrate skin. Fuel oil which enters blood stream may cause serious infection.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

- (a) Thoroughly dry injector with compressed air.
- (b) Place injector in diesel fuel tester (37).

- (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 (38) locked in downward position, operate pump handle (39) to build up and maintain pressure.
- (e) Pump up injector tester and maintain pressure of 1600 to 2000 PSI. Inspect for leaks at fuel connector ring spacers, injector body plugs, and injector nut preformed packing.

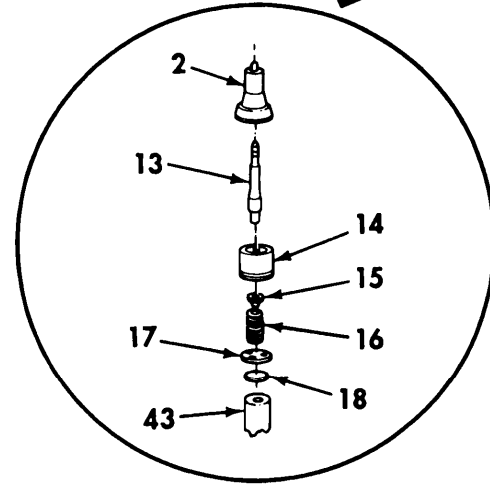
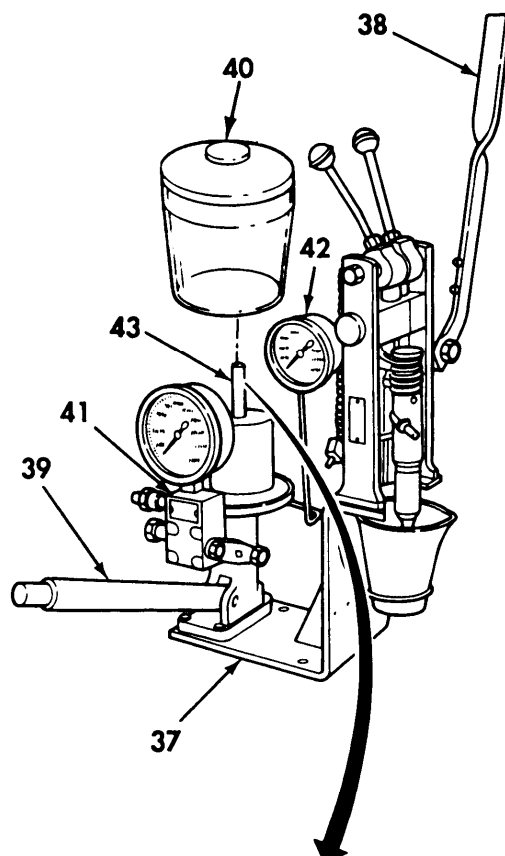
(4) Spray pattern

- (a) Place injector in diesel fuel tester (37).
- (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.

- (c) Place shield (40) on diesel fuel injector nozzle tester (41). Operate pump handle (39) to build up slight pressure (10 PSI minimum) in system.
- (d) Pop fuel injector several times with popping handle (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 (38) until no pressure is observed on test gage (42) to avoid fuel spray when injector is removed from diesel fuel tester.

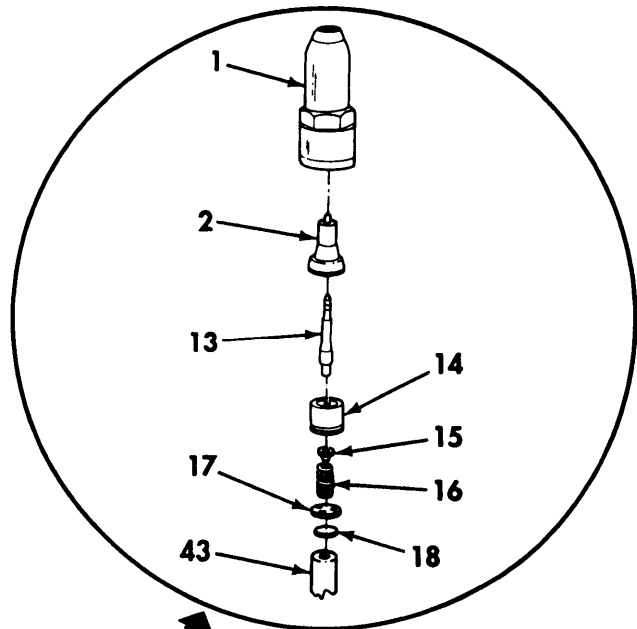


(5) Needle valve opening pressure

- (a) Operate pump handle (39) on diesel fuel injector nozzle tester (41) until a clear flow of test oil comes out of mounting pedestal (43).
- (b) Place check valve (18) centrally on pedestal (43).
- (c) Place check valve cage (17), flat side up, and check valve (18) on pedestal (43) with check valve in recess of check valve cage.
- (d) Insert spring seat (15) in valve spring (16) and install on check valve cage (17) with seat up.

3-65. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

- (e) Place spring cage (14) over spring seat (15) and spring (16).
- (f) Insert needle valve (13) into spray tip (2) with tapered end down. Place assembly on spring cage (14) with quill end of needle valve in hole in spring cage.
- (g) Lubricate threads on injector nut (1) with engine oil and carefully thread nut on pedestal (43). Tighten nut as tight as possible by hand.
- (h) Using injector wrench (11), torque injector nut (1) 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.



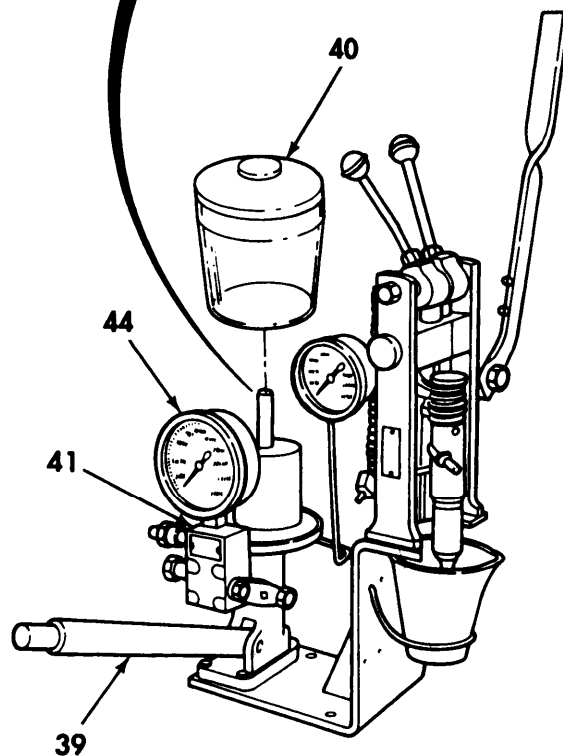
WARNING

Do not operate diesel fuel injector nozzle tester without shield. Fuel spray can penetrate skin. Fuel oil entering blood stream may cause serious infection.

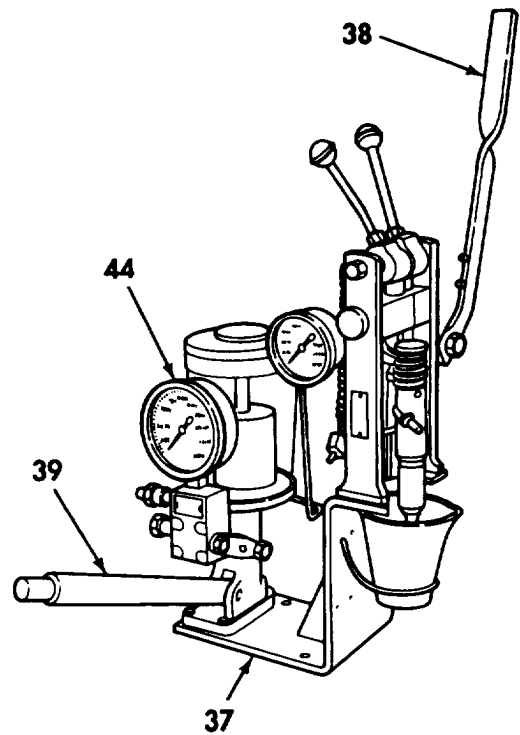
- (i) Place shield (40) on diesel fuel injector nozzle tester (41). Operate pump handle (39) with smooth even strokes and record fuel injector needle valve opening pressure (pop pressure). Needle valve opens when fuel sprays from tip. Pop needle valve several times to purge air from system. Record test gage (44) opening pressure. Final needle valve opening pressure must be 2600-3200 PSI for new injector and 2300-3300 PSI for used injector.
- (j) Remove injector nut (1), spray tip (2), needle valve (13), spring (16), spring seat (15), spring cage (14), check valve cage (17), and check valve (18) from mounting pedestal (43).

NOTE

After needle valve opening pressure test is complete, continue injector assembly.



- (6) Injector holding pressure
- (a) Place fuel injector in diesel fuel tester (37).
 - (b) Operate pump handle (39) until test gage (44) pressure reaches 2200 PSI.
 - (c) Close fuel shut off valve. Start timing when pressure reaches 2000 PSI and stop at 1500 PSI. 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 (38) until test gage (44) shows no pressure to avoid fuel spray when removing injector from diesel fuel tester.
- (7) Cover injector ports to prevent dirt from entering injector.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-64 Install injectors.

3-66. BLOWER REPAIR

This task covers: a. Disassembly b. Cleaning c. Inspection d. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

- Tool kit, general mechanics (App B, Item 107)
- Wrench, torque (App B, Item 116)
- Wrench, torque (App B, Item 118)
- Tool kit, blower (App B, Item 105)
- Puller set
- Installer, blower seal
- Gage set, thickness, stacked (App B, Item 34)
- Indicator, dial (App B, Item 53)
- Gage, depth (App B, Item 36)

MATERIALS/PARTS

- 1 Gasket (App F, Item 46)
- 4 Seals, plain encased (App F, Item 173)
- 2 Lockwashers (App F, Item 97) *
- 1 Packing, preformed (App F, Item 114) *
- 4 Bolts, self-locking (App F, Item 18)
- 4 Bolts, self-locking (App F, Item 19)
- 3 Bolts, self-locking (App F, Item 13)
- 2 Bolts, self-locking (App F, Item 12)
- 1 Bolt, self-locking (App F, Item 11)

EXPENDABLE/DURABLE SUPPLIES

- Cleaning solvent (App C, Item 9)
- Oil, fuel (App C, Item 27)
- Emery cloth (App C, Item 13)
- Stone, sharpening, X-fine (App C, Item 51)
- Oil, engine (App C, Item 26)
- Rag, wiping (App C, Item 33)
- 2 Flat washers (App C, Item 56)
- 8 Flat washers App C, Item 55)
- 8 Screws (App C, Item 36)
- 4 Screws (App C, Item 37) *

* Models 5063-5392, 5063-5393, and 5063-539L

EQUIPMENT CONDITION

Para Description
3-32 Governor and blower assembly removed

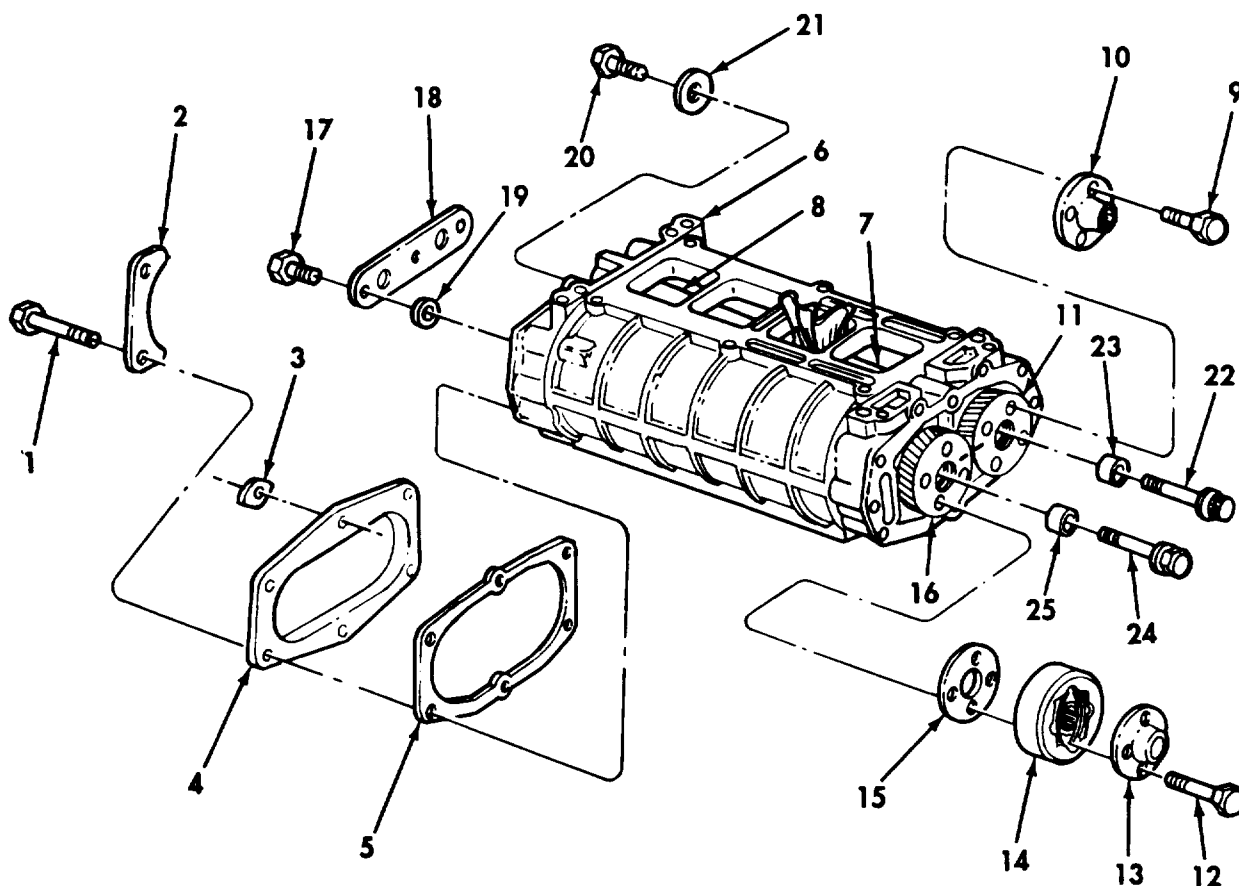
a. Disassembly

NOTE

Match mark blower housing at front and rear end plates before disassembly.

- (1) Remove six screws (1), two plates (2), two spacers (3), end plate cover (4), and gasket (5) from front end plate (6). Discard gasket.
- (2) Wedge a clean folded rag between rotors (7 and 8) to prevent turning.
- (3) Remove four self-locking bolts (9) and drive coupling (10) from gear (11). Discard bolts.
- (4) Remove four self-locking bolts (12), retainer (13), coupling (14), and spacer (15) from gear (16). Discard bolts.
- (5) Remove three self-locking bolts (17), thrust plate (18), and three spacers (19) from front end plate (6). Discard bolts.
- (6) Remove two self-locking bolts (20) and two thrust washers (21) from front of blower, Discard bolts.
- (7) Mark gear (11) and gear (16) for reassembly.
- (8) Remove twelve-point bolt (22) and blower drive pilot (23) from gear (11).

- (8) Remove twelve-point bolt (22) and blower drive pilot (23) from gear (11).
- (9) Remove self-locking bolt (24) and blower drive pilot (25) from gear (16). Discard bolt.

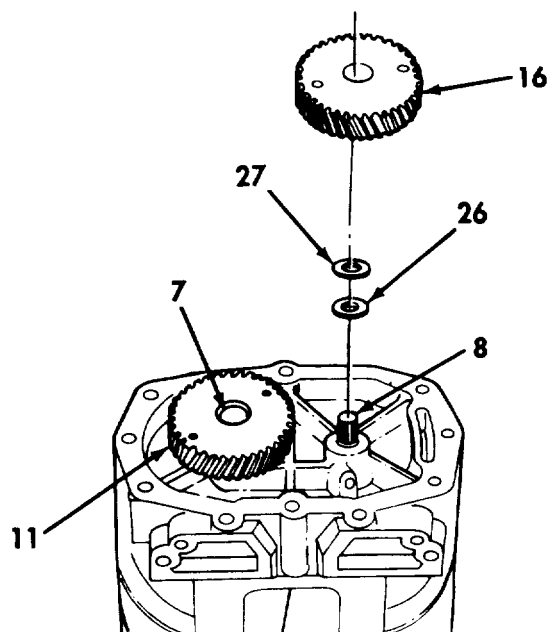


- (10) Using two gear pullers, remove right gear (11) and left gear (16) simultaneously.

NOTE

Attach shims to matching gear for identical replacement of size and number of shims during reassembly.

- (11) Remove two special washers (26) and shims (27) from rotors (7 and 8). Place components with respective gears to ensure correct assembly. Remove rag from rotors.

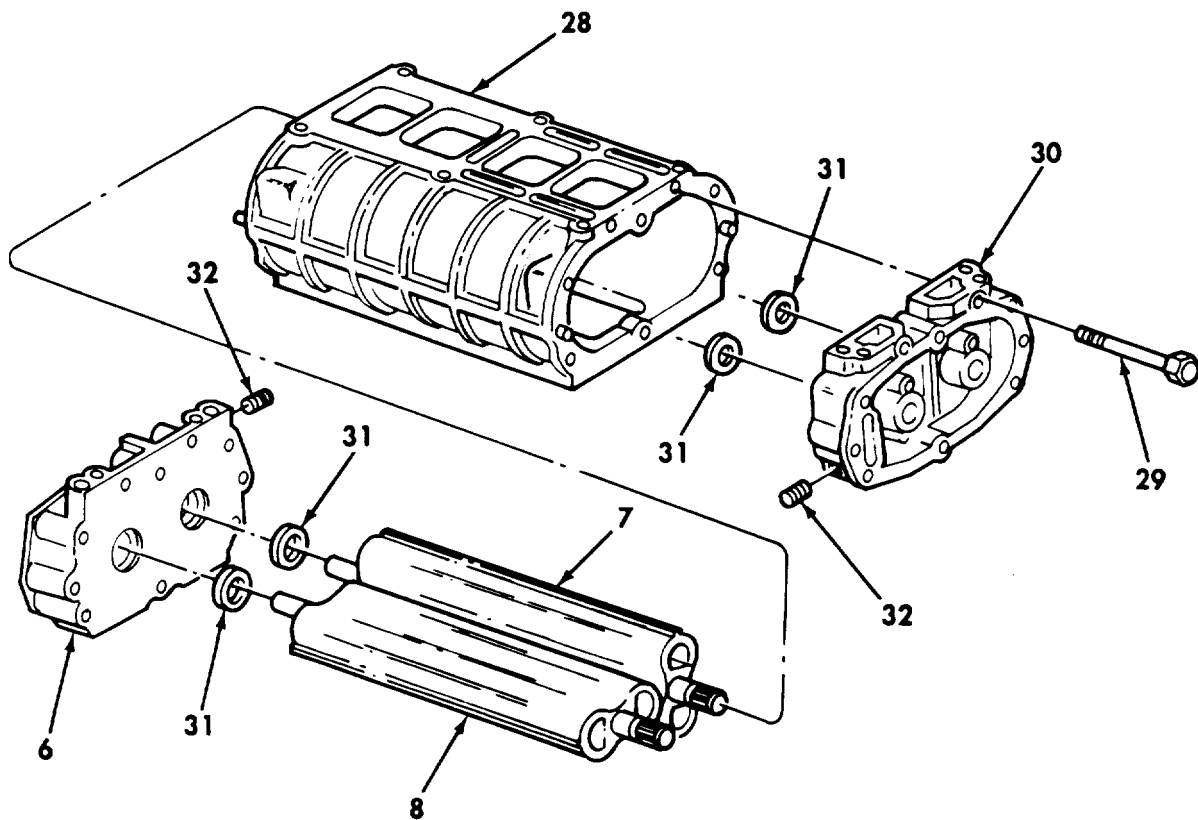


3-66. BLOWER REPAIR (Cont)

CAUTION

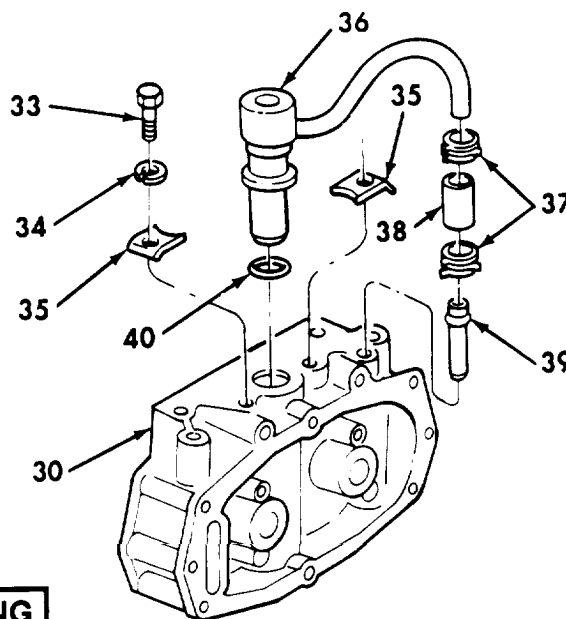
Handle blower end plates, rotors, and blower housing with care during disassembly to ensure no damage to mating surfaces,

- (12) Tap front end plate (6) off of dowel pins and away from blower housing (28) with a soft head hammer. Remove end plate.
- (13) Withdraw right rotor (7) and left rotor (8) from front of blower housing (28).
- (14) On models 5063-5392, 5063-5393, and 5063 -539L, remove two screws (29) retaining rear end plate (30) to blower housing (28).



- (15) Tap rear end plate (30) off of dowel pins and away from blower housing (28) with a soft head hammer. Remove end plate.
- (16) Remove two seals (31) from each end plate (6 and 30). Discard seals.
- (17) If necessary, remove pipe plugs (32) from both front and rear end plates (6 and 30).
- (18) For models 5063-5392, 5063-5393, and 5063 -539L, remove bypass valve as follows:

- (a) Remove two screws (33), two lockwashers (34), and two clamps (35) fastening bypass valve (36) to end plate (30). Discard lockwashers.
- (b) Remove two clamps (37) and hose (38) from bypass valve (36) and tube (39).
- (c) Remove bypass valve (36) from end plate (30).
- (d) Remove preformed packing (40) from bypass valve (36). Discard packing.
- (e) If necessary, remove tube (39) from blower end plate (30).



b. Cleaning

WARNING

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

Wash rotors and blower housing with cleaning solvent and remaining pads with fuel oil. Dry with compressed air.

c. Inspection

- (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.

3-66. BLOWER REPAIR (Cont)

d. Assembly

NOTE

- Identify rear end plate (30) by governor lubrication oil hole (A) drilled in outer face of plate.
- Install blower seals (31) with lips dry.

(1) Install seals in end plates as follows:

- (a) Place front end plate (6), seal counterbores up, on press.
- (b) Lubricate outer diameter of seal (31) with engine oil.
- (c) Place seal (31), lip facing down, in counterbore. Using blower seal installer (41), press seal until shoulder of installer contacts end plate.
- (d) Repeat steps (b) and (c) for second seal (31).
- (e) Repeat steps (a) thru (d) for rear end plate (30).

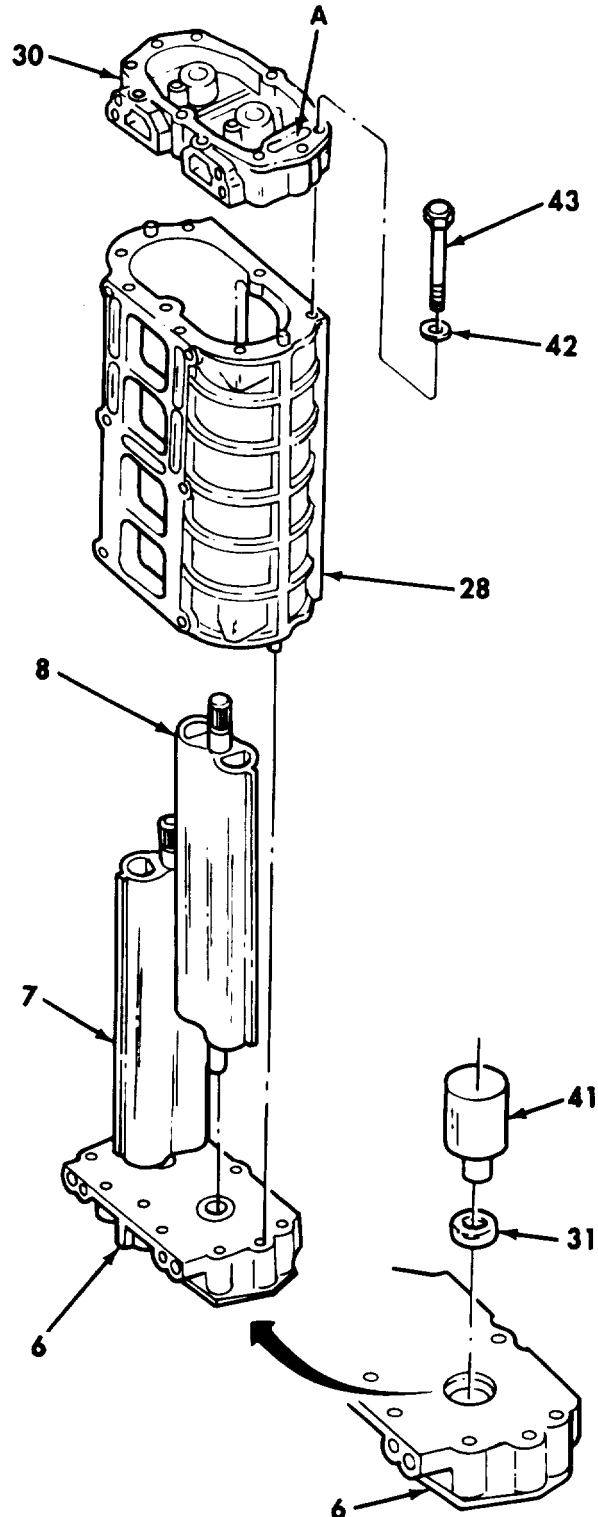
(2) Place front end late (6), inner face up, on two wooden blocks. Install right rotor (7) and left rotor (8), splined shaft ends up, in end plate.

NOTE

Install blower housing in same orientation as match marked during removal for better rotor to housing clearances.

(3) Install blower housing (28) over rotors (7 and 8).

(4) Place rear end plate (30) over rotor shafts. Temporarily install eight flat washers (42) and eight screws (43) on front end plate (6) and rear end plate (30) at blower housing (28). Tighten screws until snug.



NOTE

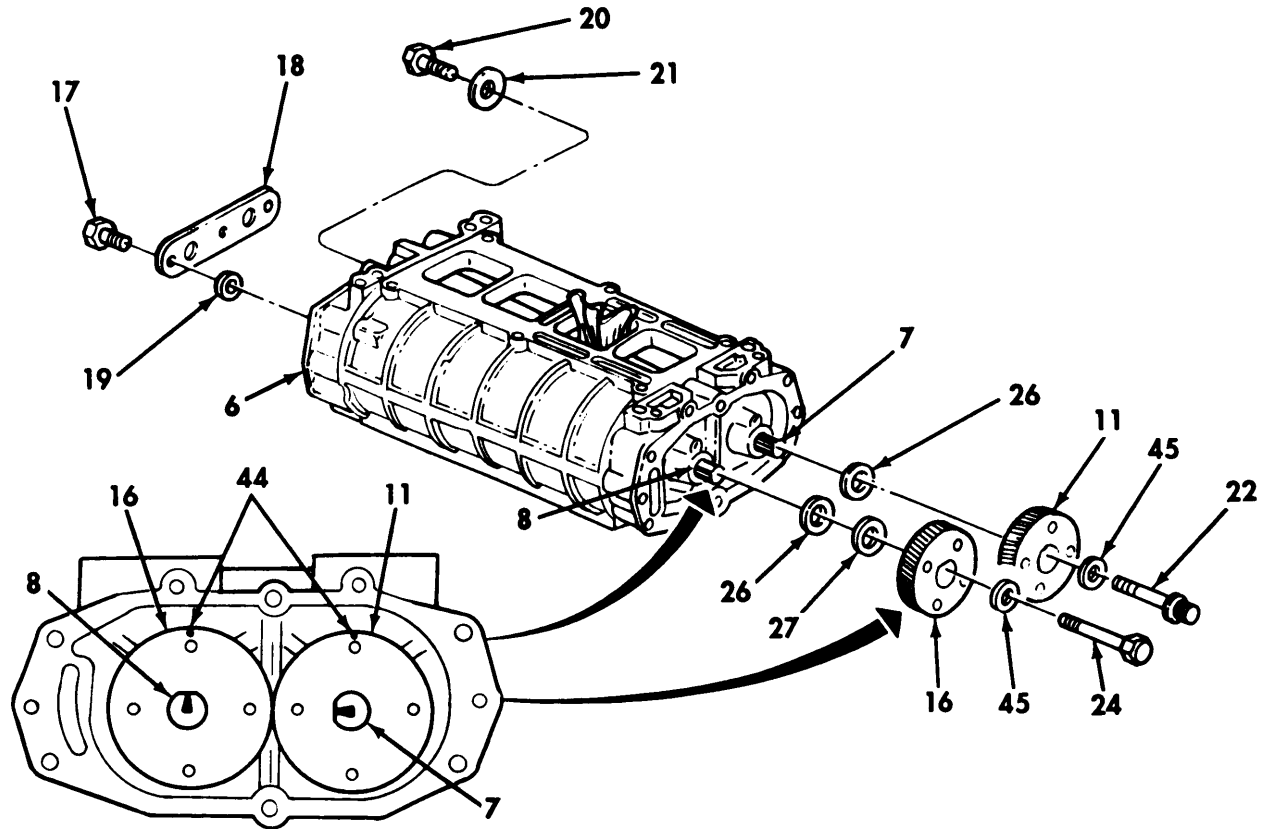
Install shims (27) in same gear from which they were removed.

- (5) Install special washers (26) and shims (27) in counterbore in inside face of gear (11) and gear (16).

NOTE

Replace blower gears as a matched set.

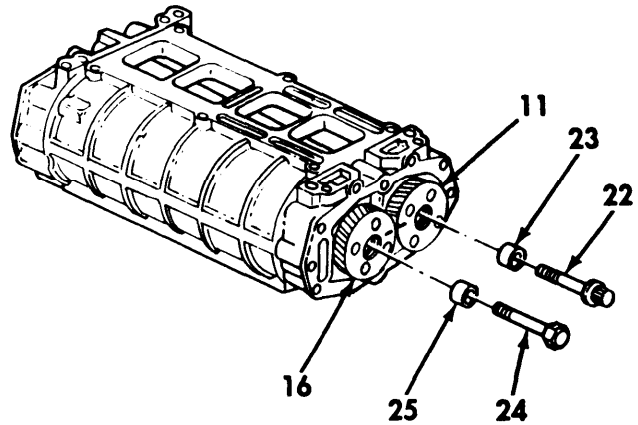
- (6) Place flat in spline in left rotor (8) facing top of blower and flat ins line in right rotor (7) facing left side of blower (forming the rotors into a "T" shape) as shown. Then place right gear (11) on rotor (7) and left gear (16) on rotor (8) with flats in splines on gears in alignment with flats in splines on rotor shafts.
- (7) Tap gears (11 and 16) lightly with a soft head hammer to seat them on shafts. Rotate gears until timing marks (44) on face of gears match. Reposition gears if marks do not match.
- (8) Wedge a clean folded rag between blower rotors (7 and 8).



- (9) Install twelve-point bolt (22), bolt (24), and two 5/16-inch flat washers (45) in gears (11 and 16). Turn bolts simultaneously and force gears on rotor shafts until tight against shoulders of rotor.
- (10) Remove bolt (22), bolt (24), and two flat washers (45).
- (11) Install two thrust washers (21) and two self-locking bolts (20) to front of blower rotors. Torque bolts to 54-59 lb-ft (73-80 N-m).
- (12) Install three spacers (19), thrust plate (18), and three self-locking bolts (17) on front end plate (6). Torque bolts to 84-108 lb-in (10-12 N-m).
- (13) Using thickness gage set, check clearance between thrust plate (18) and thrust washers (21). Clearance must be 0.0025 to 0.0050 inch.

3-66. BLOWER REPAIR (Cont)

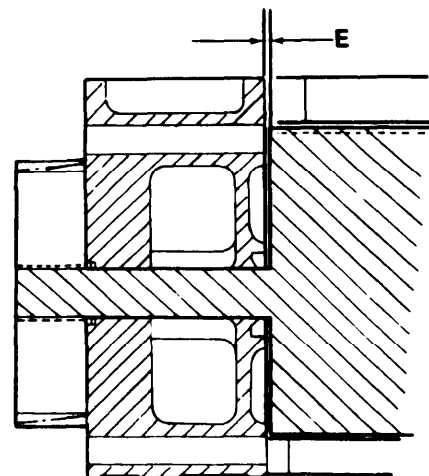
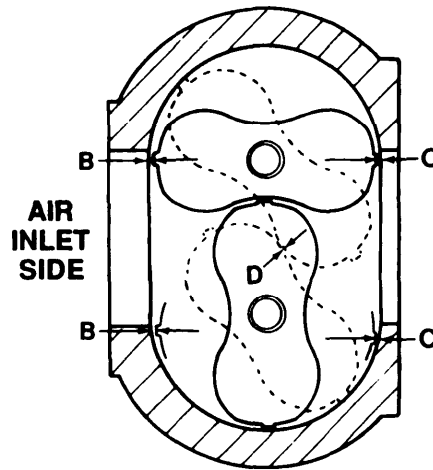
- (14) Install twelve-point bolt (22) and right blower drive pilot (23) in counterbore of right gear (11). Install self-locking bolt (24) and left blower drive pilot (25) in counterbore of left ear (16). Torque bolts to 25-30 lb-ft (34-41 N-m).
- (15) Remove rag from rotors. Check backlash between gears (11 and 16) using dial indicator. Backlash must be 0.0005 to 0.0025 inch with new gears and a maximum of 0.0035 inch with used gears.



NOTE

Add or remove shims between gear and rotor spacer until blower clearances meet specifications.

- (16) Using stacked thickness gages, obtain blower clearances as follows:
 - (a) Measure clearance between rotor lobes and blower housing at (B) and (C). Take measurements across entire length of each rotor lobe. Clearance (C) must be 0.004 inch minimum and clearance (B) must be 0.010 inch minimum.
 - (b) Rotate gears until rotor lobes are at their closest position. Measure clearance (D) between rotor lobes across entire length. Clearance must be 0.009 inch minimum.
 - (c) Measure clearance (E) 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 minimum at front end plate and 0.010 inch minimum at rear end plate. For all except model 5063-5299, clearance must be 0.010 inch minimum at front end plate and 0.012 inch minimum at rear end plate.

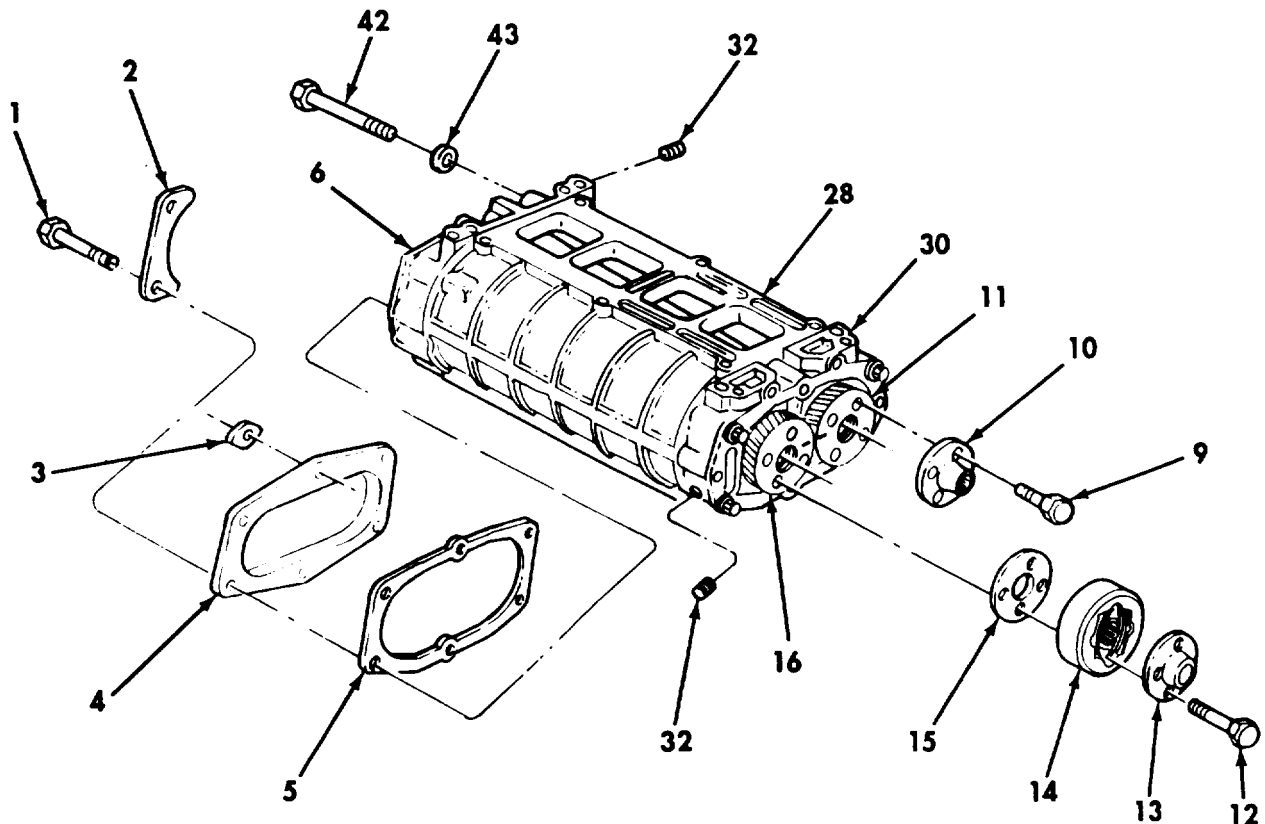


- (17) Remove four bolts (42) and four flat washers (43) used to temporarily fasten front end plate to blower housing. Install gasket (5), cover (4), two spacers (3), two plates (2), and six screws (1) on front of blower. Torque bolts to 20-25 lb-ft (27-34 N·m).

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.

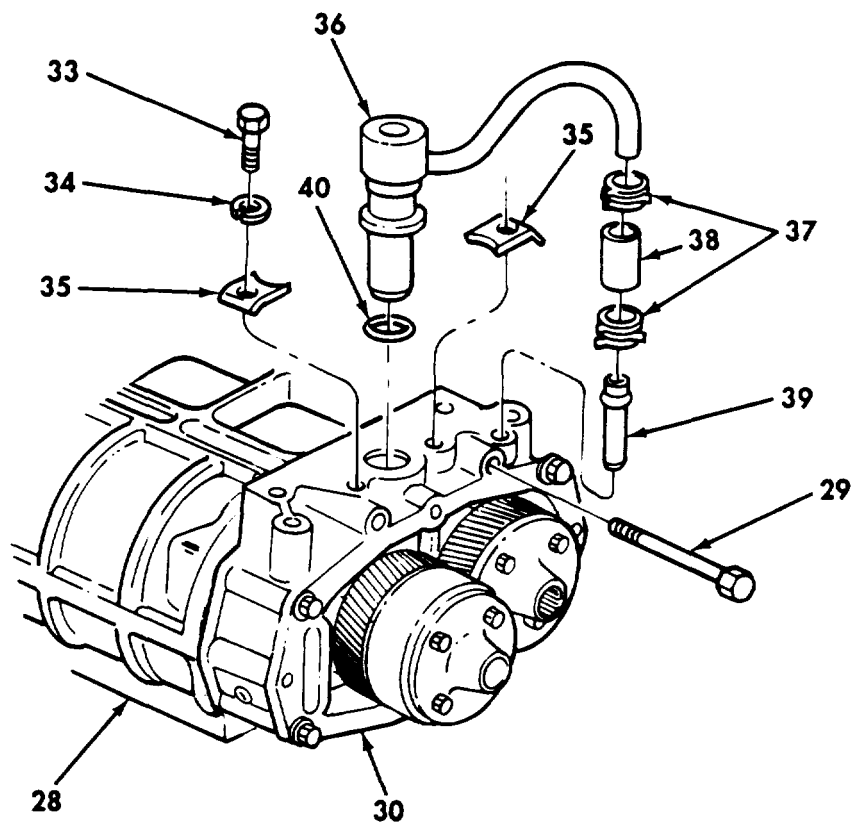
- (18) Using depth gage, check relationship of front and rear blower end plates (6 and 30) to bottom of blower housing (28). Protrusion of blower housing with respect to end plate must not be more than 0.001 inch above or 0.004 inch below end plate.



- (19) Installs spacer (15), coupling (14), retainer (13), and four self-locking bolts (12) on gear (16). Torque bolts to 14-18 lb-ft (19-24 N·m).
- (20) Install drive coupling (10) and four self-locking bolts (9) on gear (11). Torque bolts to 8-10 lb-ft (11-14 N·m).
- (21) If removed, install pipe plug (32) into side of each end plate (30 and 6).

3-66. BLOWER REPAIR (Cont)

- (22) On models 5063-5392, 5063-5393, and 5063-539L, install bypass valve as follows:
 - (a) If removed, tap tube (39) into top of rear end plate (30) until it bottoms out.
 - (b) Install preformed packing (40) on bypass valve (36). Install valve in rear end plate (30).
 - (c) Install hose (38) and two clamps (37) on bypass valve (36) and tube (39).
 - (d) Install two clamps (35) [against bypass valve (36)], two lockwashers (34), and two screws (33) on rear end plate (30). Torque screws to 7-9 lb-ft (10-12 N·m).



- (e) On models 5063-5392, 5063-5393, and 5063-539L, install two screws (29) on rear end plate (30) into blower housing (28). Torque screws to 13-17 lb-ft (18-23 N·m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-32 Install governor and blower assembly.

3-67. TURBOCHARGER REPAIR (ALL EXCEPT MODEL 5063-5299)

This task covers: a. Disassembly b. Cleaning c. Inspection d. Assembly

INITIAL SETUP

MODELS

All except 5063-5299

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Adapter, dial indicator (App B, item 3)
 Fixture, turbocharger holding (App B, Item 30)
 Indicator, dial, magnetic base (App B, Item 54)
 Fixture, turbocharger holding (App D, Item 4) *

MATERIALS/PARTS

- 4 Locking plates (App F, Item 93) *
- 1 Gasket (App F, Item 63)
- 4 Lockwashers (App F, Item 98)
- 1 Gasket (App F, Item 62) *
- 4 Locking plates (App F, Item 92) **
- 1 Nut, self-locking (App F, Item 110) **
- 1 Nut, self-locking (App F, Item 112) ***
- 1 Nut, self-locking (App F, Item 104) *
- 1 Ring, seal (App F, Item 148)
- 1 Gasket (App F, Item 74)
- 2 Lockwashers (App F, Item 99)
- 2 Seal rings, metal (App F, Item 162)
- 3 Screws (App F, Item 151)
- 1 Bearing, washer, thrust (App F, Item 7)
- 2 Bearings (App F, Item 3)
- 2 Washers, flat (App F, Item 190)
- 3 Rings, retaining (App F, Item 145)

MATERIALS/PARTS (Cont)

- 1 Ring, retaining (App F, Item 144)
- 1 Bearing, washer, thrust (App F, Item 8)
- 1 Bearing kit (App F, Item 1) *
- 4 Locking plates (App F, Item 91) *
- 2 Seal rings, metal (App F, Item 160) *
- 1 Bearing, washer, thrust (App F, Item 5) *
- 1 Ring, seal (App F, Item 147) *

* (For 405681-1 turbocharger)

** (Models 5063-5392, 5063-5393, and 5063-539L)

*** (Models 5063-5395, 5063-5398, and 5063-539F)

EXPENDABLE/DURABLE SUPPLIES

Oil, engine (App C, Item 26)
 Cleaning solvent (App C, Item 9)
 Crocus cloth (App C, Item 10)
 Silicon carbide cloth (App C, Item 48)
 Antiseize compound (App C, Item 4)
 Silicone lubricant (App C, Item 49)

EQUIPMENT CONDITION

Para Description
 3-2 Turbocharger removed (model 5063-5392)
 3-3 Turbocharger removed (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L)

a. Disassembly

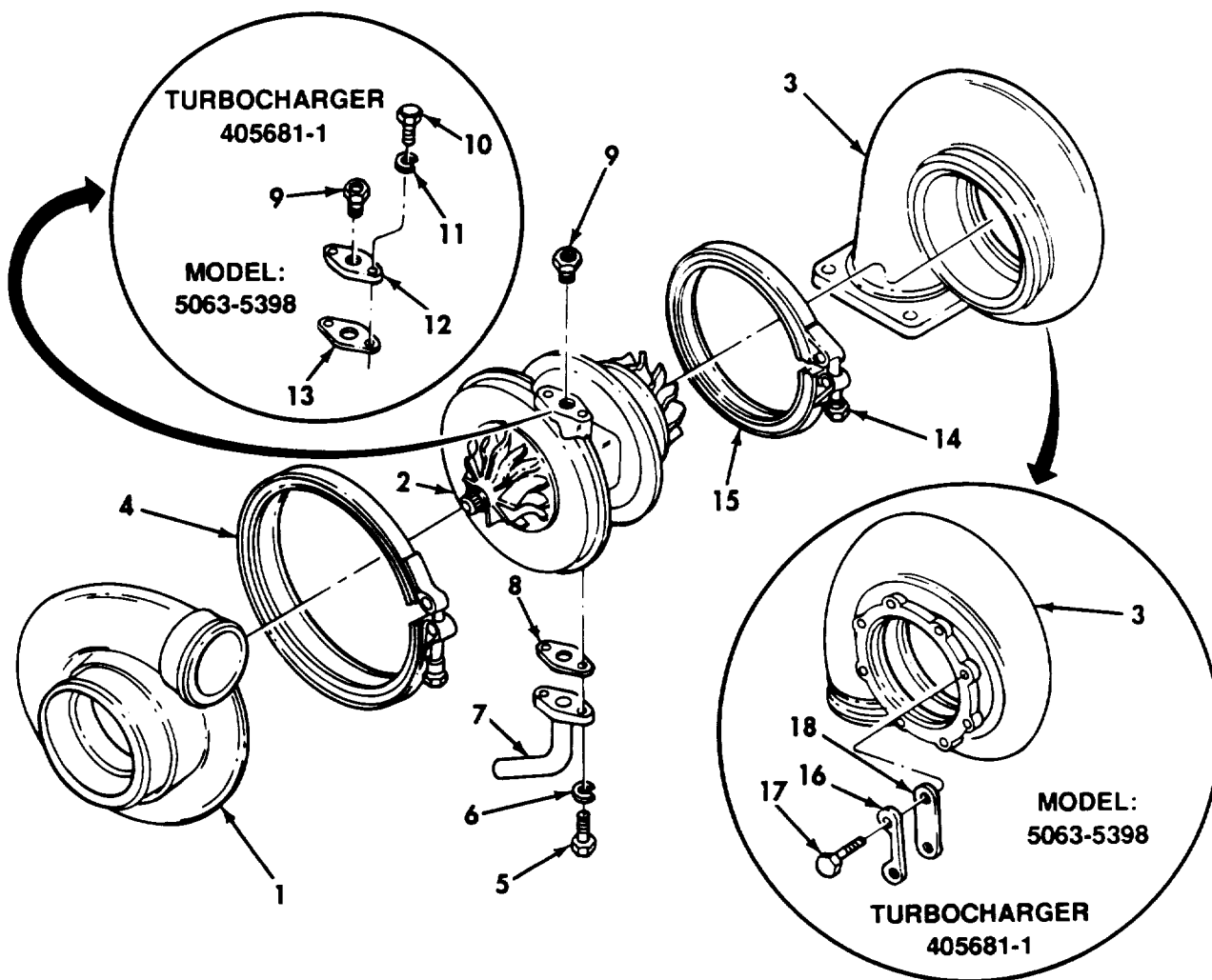
- (1) Match mark compressor housing (1), center housing (2), and turbine housing (3) for reassembly.

CAUTION

Exercise care when removing compressor housing and turbine housing to prevent damage to compressor and turbine wheels.

- (2) Remove V-band coupling (4) and compressor housing (1) from center housing (2).

- (3) On models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L, remove two screws (5), two lockwashers (6), drain tube (7), and gasket (8) from center housing (2). Discard lockwashers and gasket.
- (4) Remove connector (9) from top of center housing (2).
- (5) On model 5063-5398 using 405681-1 turbocharger, remove two bolts (10), two lockwashers (11), cover (12), and gasket (13) from top of center housing (2). Discard gasket and lockwashers.



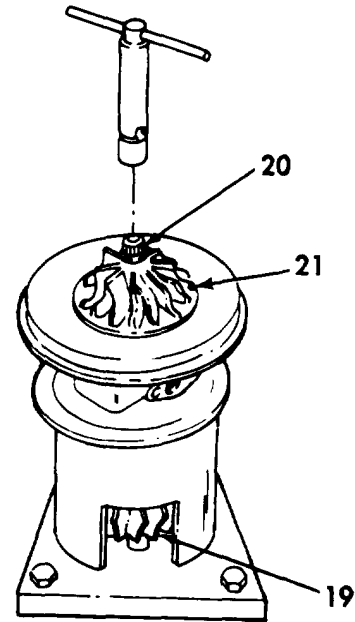
- (6) On all except model 5063-5398 using 405681-1 turbocharger, remove locknut (14), V-band coupling (15), and turbine housing (3) from center housing (2).
- (7) On model 5063-5398 using 405681-1 turbocharger, bend down ends of four locking plates (16) and remove eight bolts (17), four locking plates, and four clamps (18) from turbine housing (3). Remove turbine housing from center housing (2), Discard locking plates.

3-67. TURBOCHARGER REPAIR (ALL EXCEPT MODEL 5063-5299) (Cont)

CAUTION

Remove compressor wheel nut from shaft with a double universal socket and tee handle to prevent bending turbine wheel shaft.

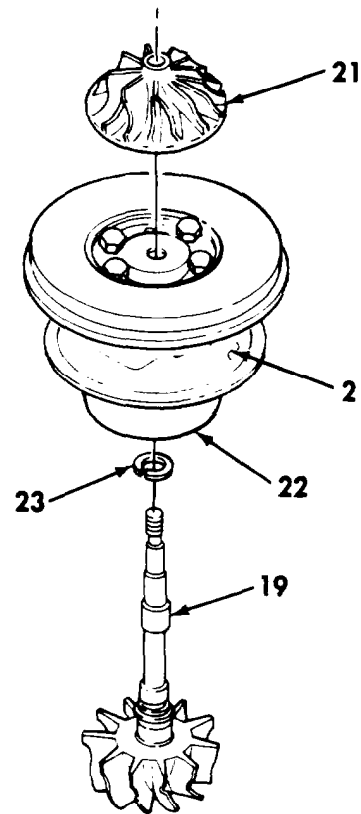
- (8) Place turbine wheel assembly (19) in turbocharger holding fixture. Remove self-locking nut (20) from shaft. Discard self-locking nut.
- (9) Remove compressor wheel (21) from turbine wheel assembly (19). For models 5063-5395, 5063-5398, and 5063-539F, use press for removal.



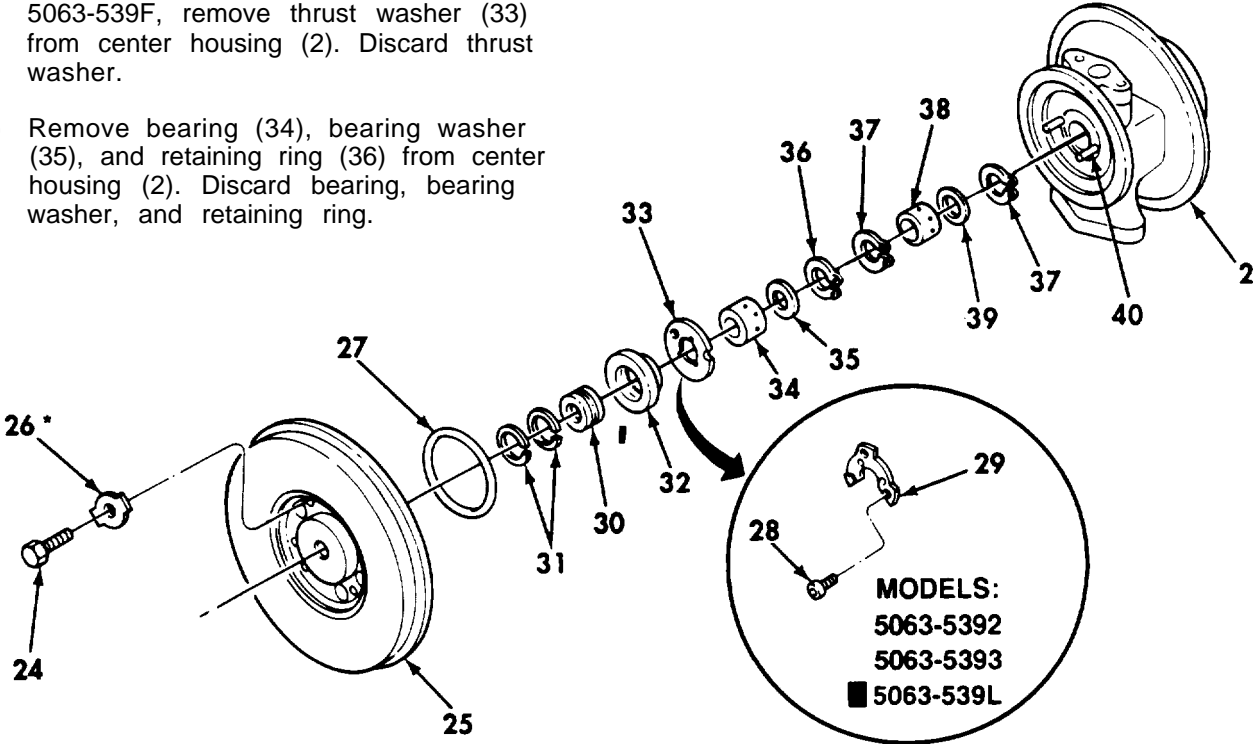
CAUTION

Catch wheel shroud before it falls from press. Wheel shroud (22) will fall free when turbine wheel assembly is removed.

- (10) Remove turbine wheel assembly (19) and wheel shroud (22) from center housing (2).
- (11) On all except model 5063-5398 using 405681-1 turbocharger, remove retaining ring (23) from turbine wheel assembly (19). Discard retaining ring.
- (12) On models 5063-5392, 5063-5393, and 5063-539L, remove four screws (24) fastening backplate (25) to center housing (2).
- (13) On models 5063-5395, 5063-5398, and 5063-539F, bend down tabs of four lock plates (26). Remove four screws (24) and lock plates fastening backplate (25) to center housing (2). Discard lock plates.
- (14) Tap backplate (25) lightly and remove from center housing (2).
- (15) Remove seal ring (27) from groove in center housing (2). Discard seal ring.



- (16) On models 5063-5392, 5063-5393, and 5063-539L, remove three socket head screws (28) and thrust washer (29) from center housing (2). Discard thrust washer and screws.
- (17) Remove thrust spacer (30) with metal seal rings (31), and thrust collar (32) from backplate (25). Remove two seal rings (31) from spacer (30). Discard seal rings.
- (18) On models 5063-5395, 5063-5398, and 5063-539F, remove thrust washer (33) from center housing (2). Discard thrust washer.
- (19) Remove bearing (34), bearing washer (35), and retaining ring (36) from center housing (2). Discard bearing, bearing washer, and retaining ring.



- (20) Remove outer retaining ring (37), bearing (38), and bearing washer (39) from compressor end of center housing (2), then remove inner retaining ring (37). Discard retaining rings, bearing washer, and bearing.

• NOT USED ON MODELS: 5063-5392, 5063-5393 AND 5063-539L

3-67. TURBOCHARGER REPAIR (ALL EXCEPT MODEL 5063-5299) (Cont)

b. Cleaning

WARNING

- Dry cleaning solvent P-D-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 (36-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

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. After soaking, use a stiff bristle brush to remove all dirt particles. Using compressed air, dry all parts thoroughly.
 - (2) Clean all internal cavities and oil passages in center housing thoroughly with compressed air.
 - (3) 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.

- (4) Minor surface damage of nonbearing surfaces maybe burnished or polished away.

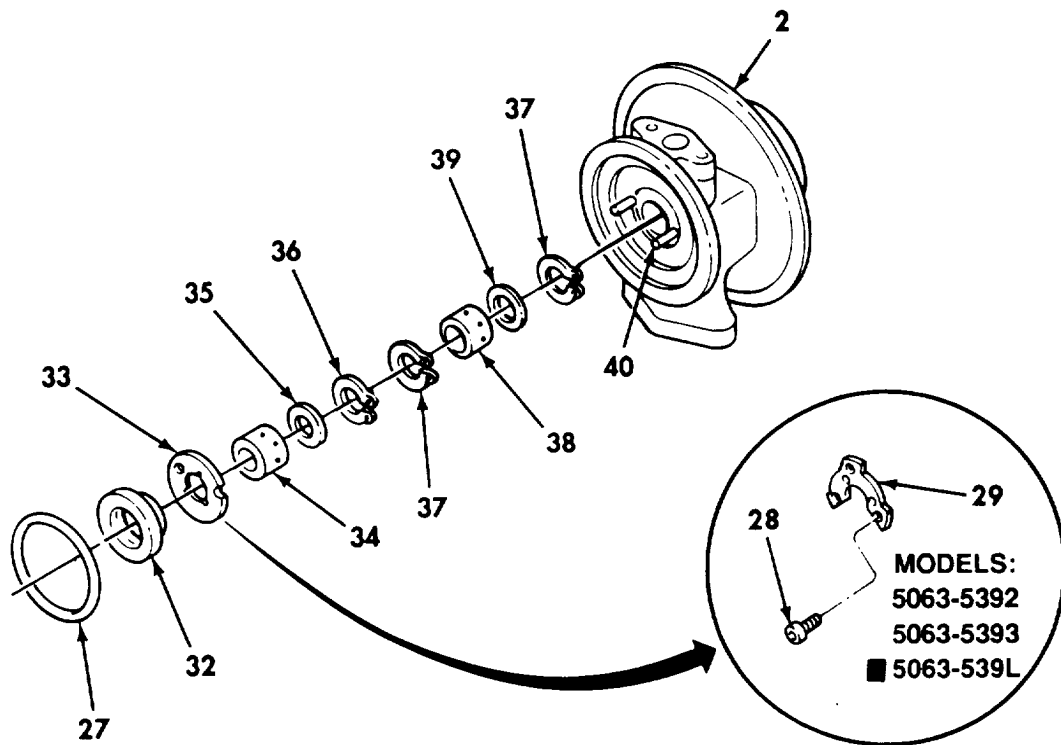
c. Inspection

- (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.

d. Assembly

- (1) Lubricate bearing (34) and bearing (38) with engine oil.
- (2) Install inner retaining ring (37), bearing washer (39), bearing (38), and outer retaining ring (37) in compressor end of center housing (2).



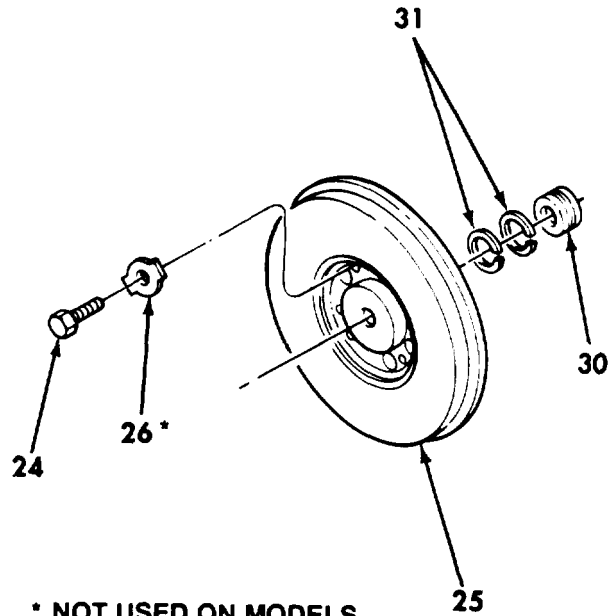
- (3) Install retaining ring (36), bearing washer (35), and bearing (34) in compressor end of center housing (2).
- (4) On models 5063-5395, 5063-5398, and 5063-539F, install thrust washer (33) with hole and cutout in thrust washer in alignment with pins (40). Install thrust washer with smooth side against center housing (2).
- (5) On models 5063-5392, 5063-5393, and 5063-539L, insert thrust collar (32) into thrust washer (29) and install thrust collar, thrust washer, and three socket head screws (28) in center housing (2). Torque screws to 30-35 lb-in (3.4-3.9 N-m).
- (6) On models 5063-5395, 5063-5398, and 5063-539F, lubricate thrust collar (32) and thrust washer (33) with engine oil. Install thrust collar snugly against thrust washer.
- (7) Install seal ring (27) in groove at compressor end of center housing (2).

3-67. TURBOCHARGER REPAIR (ALL EXCEPT MODEL 5063-5299) (Cont)

CAUTION

Do not cock or force metal seal rings (31) in grooves. Ring is brittle and will snap easily.

- (8) Install two metal seal rings (31) on thrust spacer (30), Lubricate seal rings with engine oil and gently insert thrust spacer assembly into backplate (25).
- (9) On models 5063-5392, 5063-5393, and 5063-539L, install backplate (25) and four screws (24) on center housing. Torque bolts to 90-110 lb-in (10.2-12.5 N-m).
- (10) On models 5063-5395, 5063-5398, and 5063-539F, align oil feed hole in center housing (2) and backplate assembly (25). Install backplate, four screws (24), and four locking plates (26) on center housing. Torque bolts to 90-110 lb-in (10.2-12.5 N-m). Bend locking plate tabs up against side of screw head.



* NOT USED ON MODELS
5063-5392, 5063-5393 AND 5063-539L

CAUTION

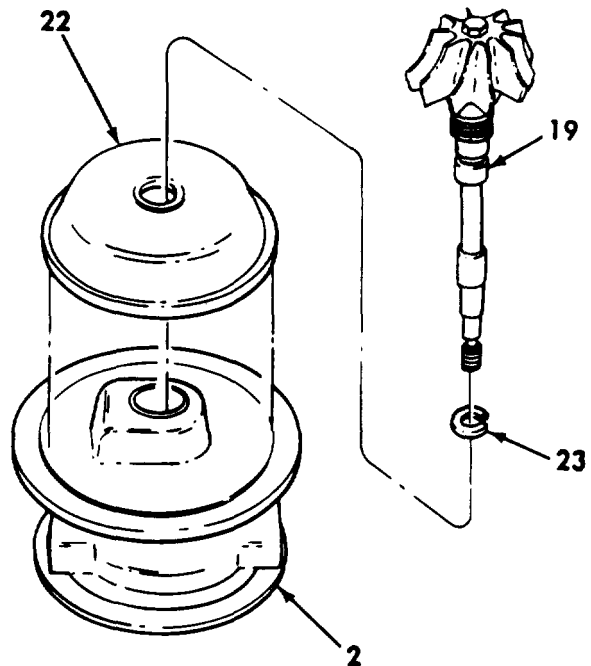
Do not cock or force retaining ring (23) in groove, Ring is brittle and will snap easily.

- (11) On all except model 5063-5398 using 405681-1 turbocharger, fill piston ring groove with high vacuum silicone lubricant and install retaining ring (23) on turbine wheel assembly (19).

CAUTION

Do not scuff or scratch bearings when installing shaft or bearing will seize during operation.

- (12) Lubricate turbine wheel assembly (19) with engine oil, Position wheel shroud (22) against center housing (2). Insert turbine wheel assembly through wheel shroud and into center housing.

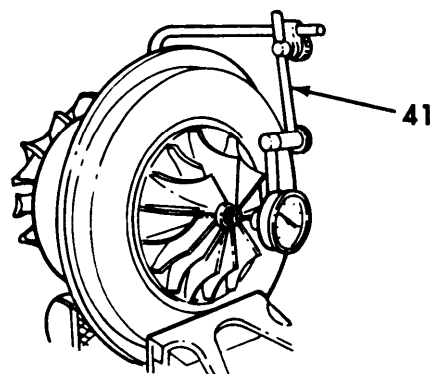
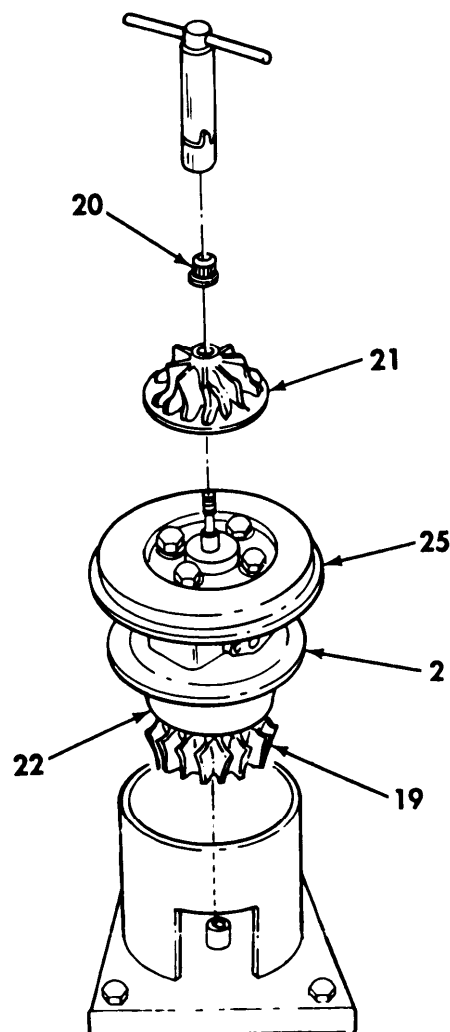


- (13) Place turbine wheel assembly (19), wheel shroud (22), center housing (2), and backplate (25) upright in turbocharger holding fixture.
- (14) With compressor wheel (21) at room temperature, position it over shaft of turbine wheel assembly (19).

Turn compressor wheel nut with a double universal socket to prevent bending turbine wheel shaft.

- (15) Lubricate threads of turbine wheel assembly (19) and wheel face on compressor wheel (21) with engine oil. Install self-locking nut (20). Torque nut to 125-150 lb-in (14-17 Nm) to seat compressor wheel against thrust spacer.
- (16) Loosen self-locking nut (20) and inspect nut face and front face of compressor wheel to ensure they are smooth and clean.
- (17) Torque self-locking nut (20) to 35-55 lb-in (4-6 Nm).
- (18) Turn self-locking nut (20) an additional 120-130 degrees.
- (19) Check bearing axial end play as follows:

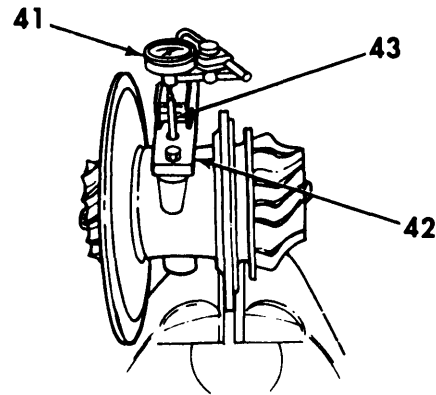
- (a) Clamp center housing assembly in soft-jawed vise.
- (b) Fasten magnetic base dial indicator (41) to center housing with indicator tip resting on end of rotating shaft on compressor side.
- (c) Move shaft axially back and forth by hand. Total indicator reading should be between 0.003 and 0.010 inch. Replace shaft assembly if readings are not in limits.



3-67. TURBOCHARGER REPAIR (ALL EXCEPT MODEL 5063-5299) (Cont)

(20) Check shaft radial movement as follows:

- (a) Bolt dial indicator adapter (42) to oil drain tube mounting pad.
- (b) Mount magnetic base dial indicator (41) on dial indicator adapter (42).
- (c) Place dial indicator tip against indicator adapter rod (43).



NOTE

Ensure adapter rod (43) 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.

(21) Install turbine housing (3) on center housing (2) and align match marks.

(22) On all except model 5063-5398 using 405681-1 turbocharger, install turbine V-band coupling (15) and locknut (14). Use following procedure to tighten clamp:

- (a) Install V-band coupling (15) on turbine housing (3) and center housing (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 (15) if turbine housing is misaligned. Forcing turbine housing into alignment by tightening coupling can damage components.

(c) Torque locknut (14) to 152-168 lb-in (17-19 Nm).

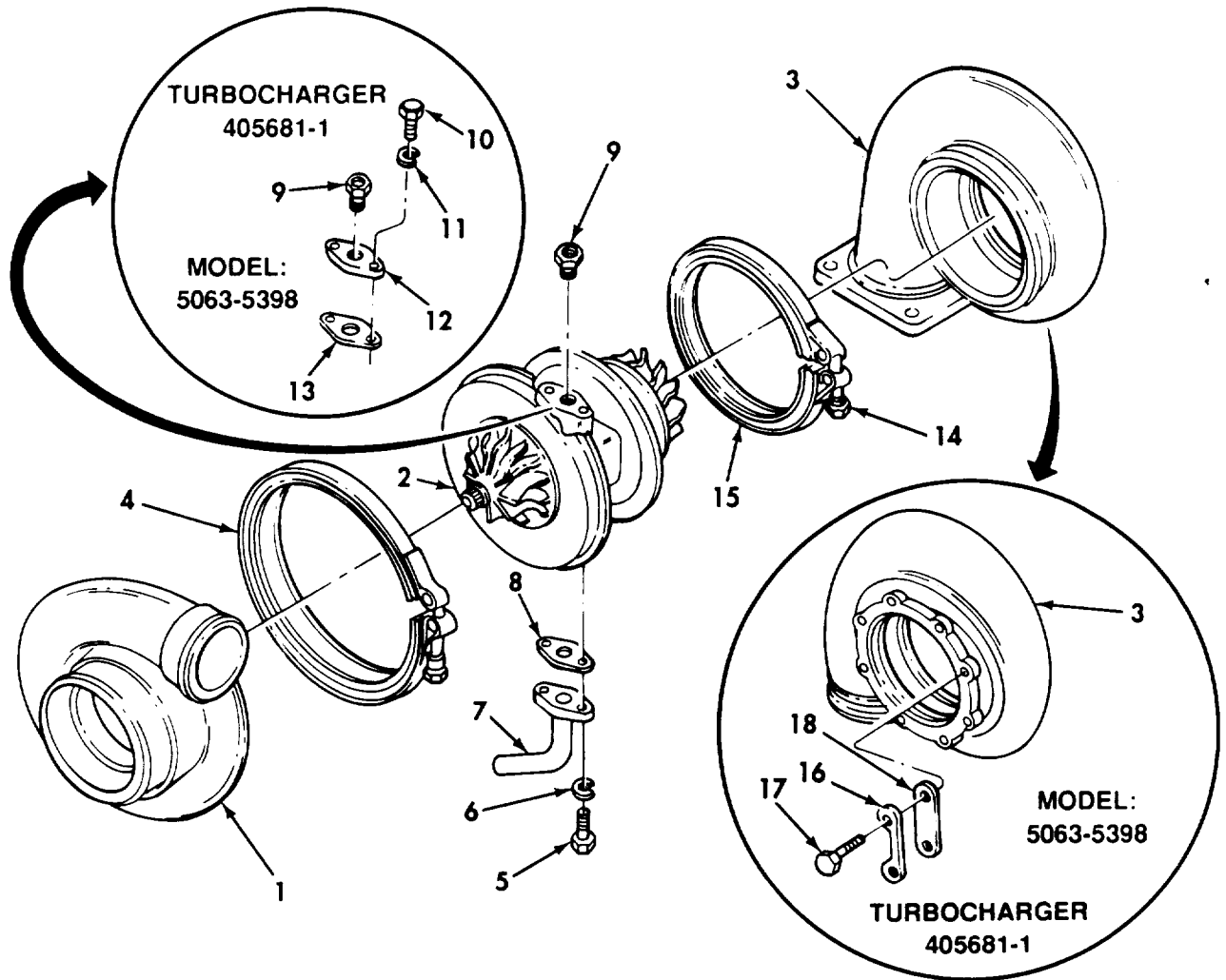
(d) Slowly loosen locknut (14) on V-band coupling (15) to approximately 50 lb-in (6 Nm), then retorque locknut to 152-8 lb-in (17-19 Nm).

(23) On model 5063-5398 using 405681-1 turbocharger, install four clamps (18), four locking plates (16), and eight bolts (17). Torque bolts to 100 to 130 lb-in (11-15 Nm). Bend locking plate tabs over side of bolt heads.

(24) Align match marks on compressor housing (1) and center housing (2). Install compressor housing and V-band coupling (4) on center housing. Lubricate threads on T-bolt with engine oil and torque locknut to 110 -130 lb-in (12-15 Nm).

(25) On model 5063-5398 using 405681-1 turbocharger, install gasket (13), plate (12), two lockwashers (11), and two bolts (10) to top of center housing (2). Torque bolts to 13-17 lb-ft (18-23 Nm).

(26) Install connector (9) to top of center housing (2).



- (27) On models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L, install gasket (8), drain tube (7), two lockwashers (6), and two screws (5) to bottom of center housing (2). Torque screws to 30-35 lb-ft (41-47 N·m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-2 Install turbocharger (model 5063-5392),

3-3 Install turbocharger (models 5063-5393, 5063-5395, 5063-5398, 5063-539F, and 5063-539L).

3-68. GOVERNOR REPAIR

This task covers: a. Disassembly b. Cleaning/Inspection c. Assembly

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Wrench, torque (App B, Item 116)
 Remover, bushing (App B, Item 88)
 Remover, bearing (App B, Item 87)
 Installer, bearing (App B, Item 63)
 Gage, depth (App B, Item 36)

MATERIALS/PARTS

- 1 Plug (App F, Item 122)
- 1 Plug, expansion (App F, Item 128)
- 1 Seal, special (App F, Item 176)
- 1 Packing, preformed (App F, Item 113)

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)
 Sealing compound (App C, Item 44)
 Grease (App C, Item 18)
 Oil, engine (App C, Item 26)
 Wood block (App C, Item 58)

EQUIPMENT CONDITION

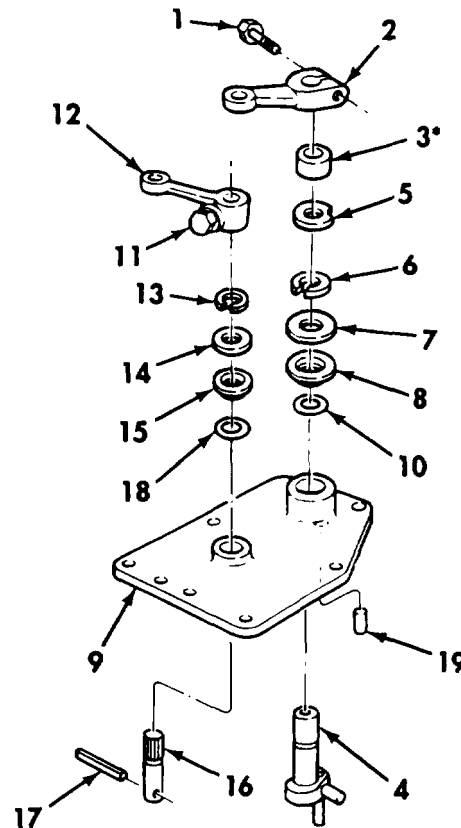
Para Description
 3-31 Governor cover and spring pack removed
 3-32 Governor removed from blower assembly

a. Disassembly

NOTE

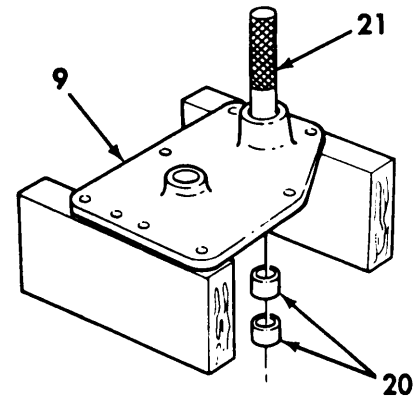
Before disassembly of governor, clean entire unit and inspect for worn or damaged parts. Repair damaged parts without disassembly of governor wherever possible.

- (1) Governor cover
 - (a) Loosen screw (1) and remove remote control lever (2).
 - (b) On model 5063-5398, remove spacer (3) from throttle shaft (4).
 - (c) Remove flat washer (5) from throttle shaft (4).
 - (d) Remove retaining ring (6), flat washer (7), and shouldered washer (8) and withdraw throttle shaft (4) from bottom of cover (9).
 - (e) Remove preformed packing (10) from cover (9). Discard packing.
 - (f) Loosen screw (11) and remove stop lever (12).



***MODEL 5063-5398 ONLY**

- (g) Remove retaining ring (13), flat washer (14), an shouldered washer 15. Withdraw stop lever shaft (16) from bottom of cover (9).
- (h) If necessary, remove pin (17) from stop lever shaft (16).
- (i) Remove special seal (18) from cover (9). Discard seal.
- (j) If necessary, remove two tapered pins (19) from bottom of cover (9).
- (k) If two bushings (20) require replacement, support governor cover (9) on two wooden blocks in press and press two bushings from cover using bushing remover (21).



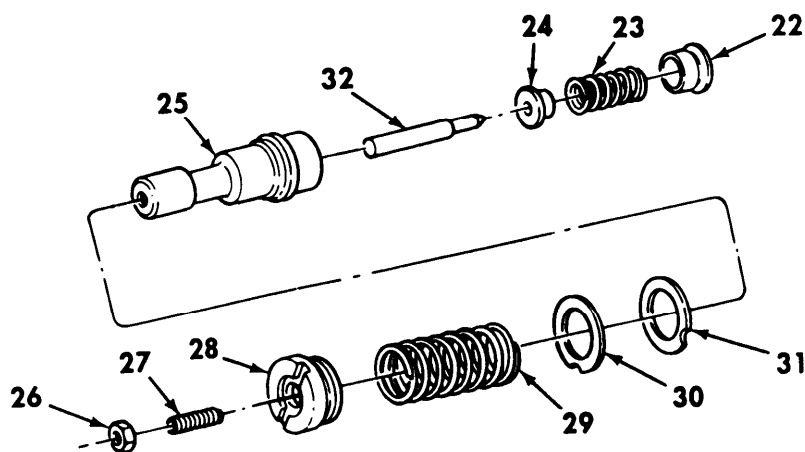
(2) Governor spring pack

- (a) Remove retainer (22), spring (23), and spring seat (24) from plunger (25).
- (b) Remove nut (26) from screw (27).

NOTE

Retain original shims and special washers for assembly.

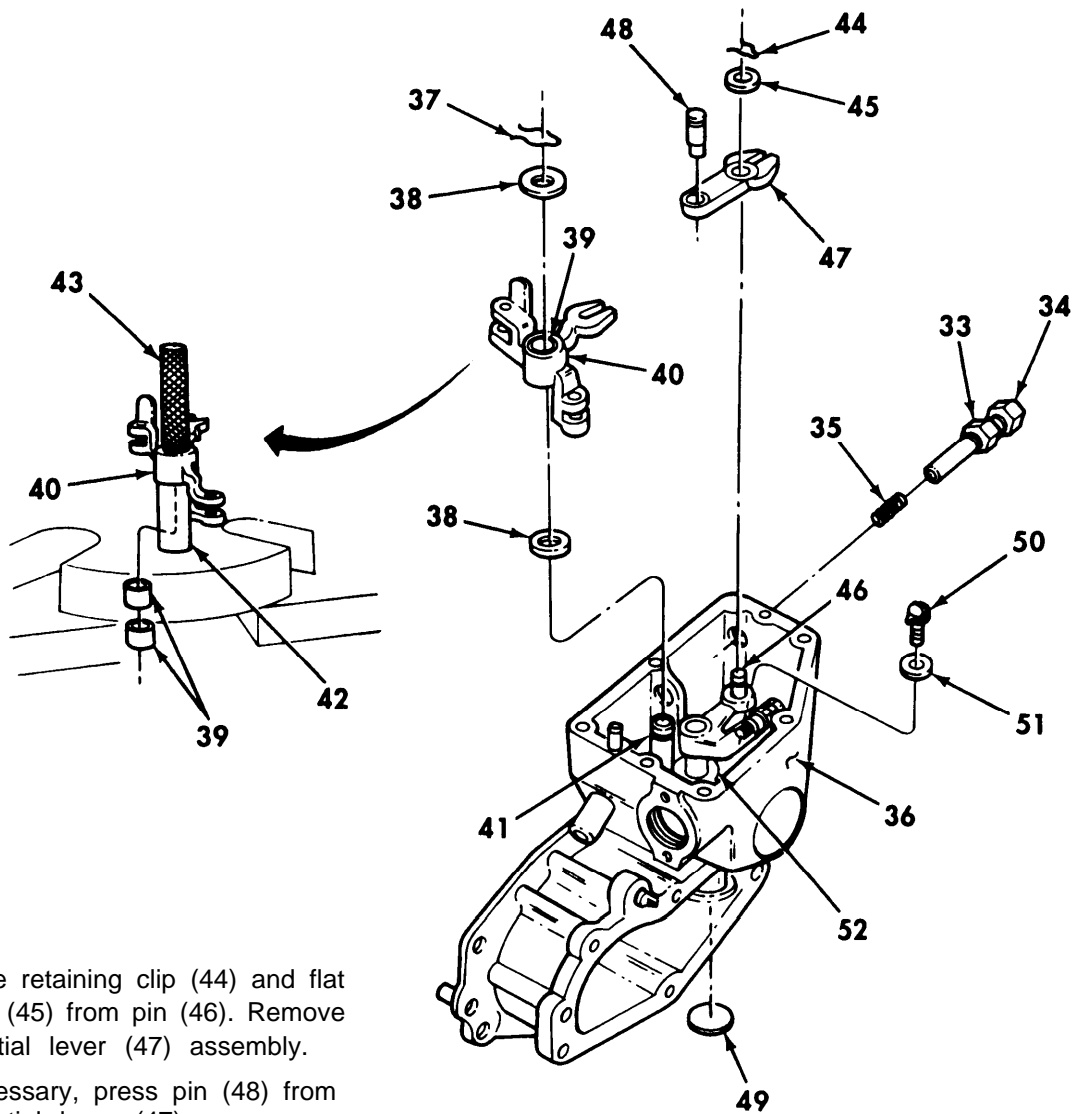
- (c) Remove screw (27), packing nut (28), spring (29), shims (30), special washers (31), and pin (32) from plunger (25).



3-60. GOVERNOR REPAIR (Cont)

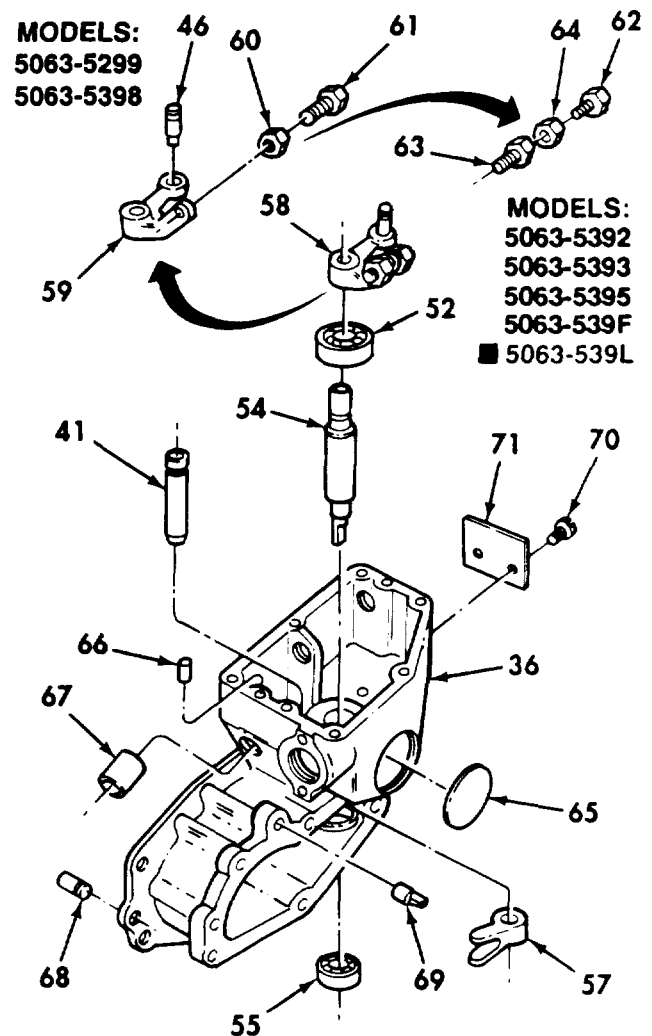
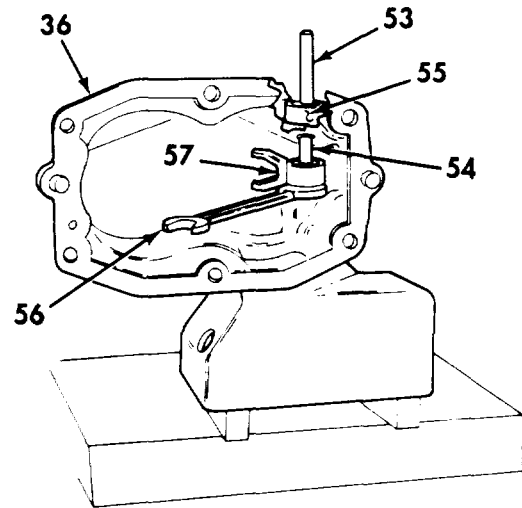
(3) Governor housing assembly

- (a) Loosen nut (33) and remove buffer screw (34) and spring (35) from side of governor housing (36).
- (b) Remove retaining clip (37), two flat washers (38), and roller bearing (39) and control link lever (40) assembly from grooved pin (41).
- (c) If two roller bearings (39) require replacement, support control link lever (40) assembly on a sleeve (42) in press. Press two bearings out of lever assembly using bearing remover (43).



- (d) Remove retaining clip (44) and flat washer (45) from pin (46). Remove differential lever (47) assembly.
- (e) If necessary, press pin (48) from differential lever (47).
- (f) Remove expansion plug (49) from bottom of governor housing (36). Discard expansion plug.
- (g) Remove special screw (50) and flat washer (51) fastening governor bearing (52) in governor housing (36).

- (h) Place governor housing (36), top down, on wooden blocks in press. Using a short 3/8 inch-diameter rod (53), press operating shaft (54) free of bearing (55).
- (i) Insert 9/16 inch open end wrench (56) between shifter fork (57) and governor housing (36). Using a 3/8 inch-diameter rod (53), press operating shaft (54) out of shifter fork.
- (j) Remove operating shaft (54), bearing (52), operating shaft lever assembly (58), and shifter fork (57) from governor housing (36).
- (k) Press operating shaft (54) from operating shaft lever assembly (58) and bearing (52).
- (l) If necessary, press pin (46) from operating shaft lever (59).
- (m) On models 5063-5299 and 5063-5398, remove nut (60) and screw (61) from operating shaft lever (59).
- (n) On models 5063-5395, 5063-5392, 5063-5393, 5063-539F, and 5063-539L, remove bolt (62), special nut (63), and nut (64) from operating shaft lever (59).
- (o) Press ball bearing (55) from governor housing (36).
- (p) If necessary, remove plug (65) from side of governor housing (36). Discard plug.
- (q) If necessary, remove two pins (66) from top of governor housing (36).
- (r) If necessary, remove two adapters (67) from sides of governor housing (36).
- (s) If necessary, remove two pins (68) from front and pin (69) from rear of governor housing (36).
- (t) If necessary, remove two drive screws (70) and plate (71) from side of governor housing (36).
- (u) If necessary, remove pin (41) from inside governor housing (36).



3-68. GOVERNOR REPAIR (Cont)

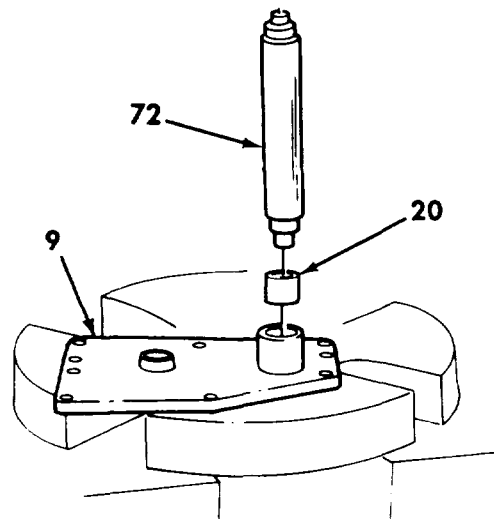
b. Cleaning/Inspection

WARNING

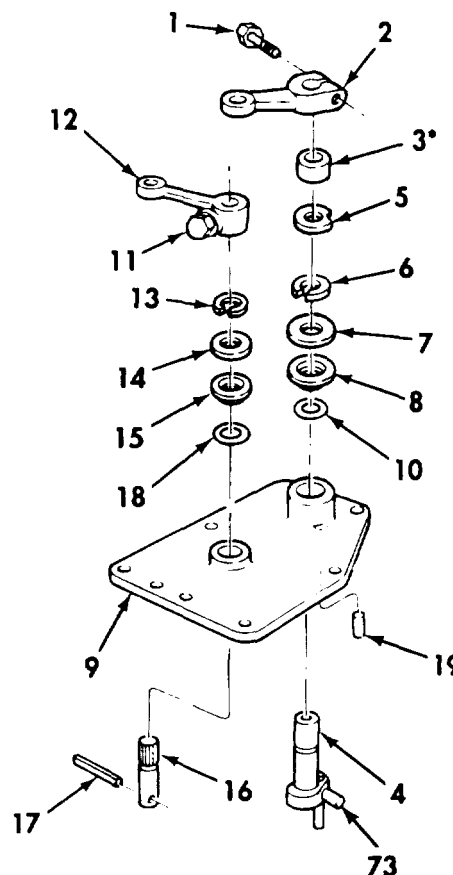
- Drycleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Do not breathe vapors. Do not use near open flame or excessive heat. The flash point is 100-138°F (38-50°C). If you become dizzy while 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.
 - Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)
- (1) Clean all parts with cleaning solvent and dry with compressed air.
 - (2) Inspect bearings for corrosion or pitting. Revolve bearings by hand and check for rough or tight spots.
 - (3) Inspect needle bearings in control link lever assembly and mating lever pin for wear.
 - (4) Inspect governor springs, spring seat, spring cap, plunger, spring retainer, adjusting screws, and other parts of governor for wear.
 - (5) Inspect governor housing for cracks, warpage, and damaged threads.

c. Assembly

- (1) Governor cover
 - (a) If removed, press two pins (19) in bottom of cover (9) until flush to 0.005 inch below machined surface.
 - (b) If bushings (20) were removed, place governor cover (9), inner face down, in press. Start bushing straight into bore, numbered side up. Place bearing installer (72) in bushing and press until shoulder of installer contacts cover. Invert cover and install second bushing (20) in same manner.
 - (c) Lubricate throttle shaft (4) with engine oil and slide into bushings from bottom of cover with lever pin (73) in slot on underside of cover.
 - (d) Install preformed packing (10), shouldered washer (8), fiat washer (7), and retaining ring (6) over throttle shaft (4).
 - (e) Install pin (17) into stop lever shaft (16). Press pin into shaft, from side with fiat spots, until flared end of pin protrudes 1/4 inch.



- (f) Lubricate stop lever shaft (16) with engine oil and slide into cover (9) from bottom side.
- (g) Install special seal (18), shouldered washer (15), flat washer (14), and retainer ring (13) on stop lever shaft (16).
- (h) Install flat washer (5) on throttle shaft (4).
- (i) On model 5063-5398, install spacer (3) on throttle shaft (4).
- (j) Install stop lever (12) on shaft (16). Torque screw (11) to 84-106 lb-in (10-12 N·m).
- (k) Install remote control lever (2) on shaft (4). Remote control lever must contact flat washer (5) or spacer (3). Torque screw (1) to 84-106 lb-in (10-12 N·m).



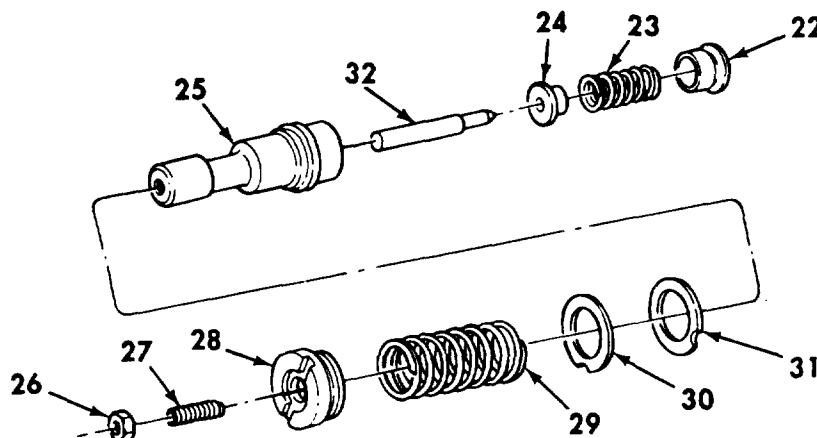
***MODEL 5063-5398 ONLY**

- (2) Governor spring pack
 - (a) Thread screw (27) into plunger (25).

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.

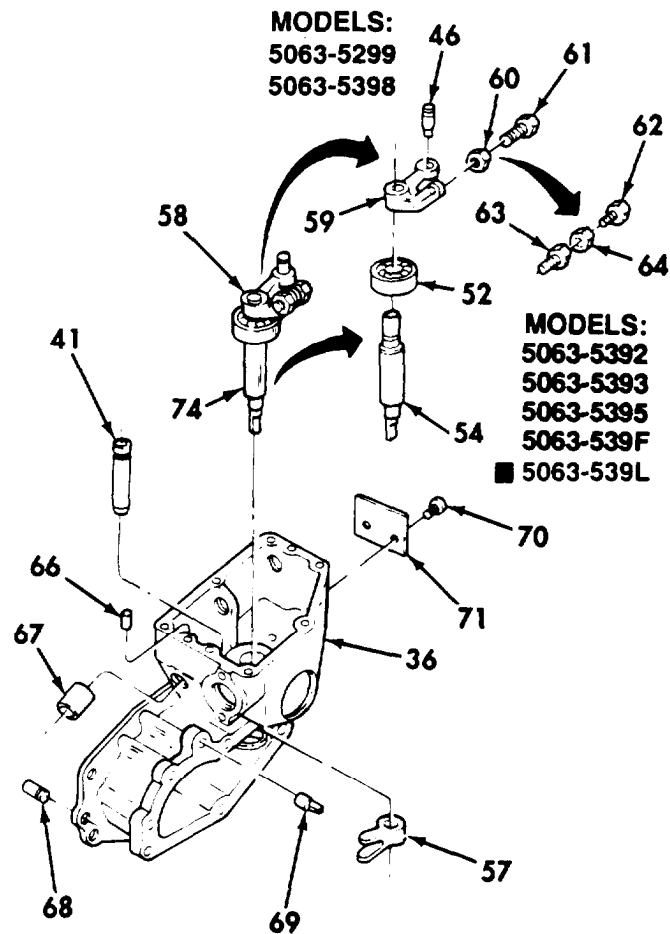
- (b) Install shims (30), special washers (31), and spring (29) on plunger (25) with thin special washers first.
- (c) Lubricate spring (29) and plunger (25) with engine oil.
- (d) Place packing nut (28) over plunger (25) and thread nut (26) on screw (27) until 1/4 inch of screw extends beyond nut.
- (e) Lubricate pin (32), spring seat (24), spring (23), and retainer (22) with engine oil and install into end of plunger (25) as shown.



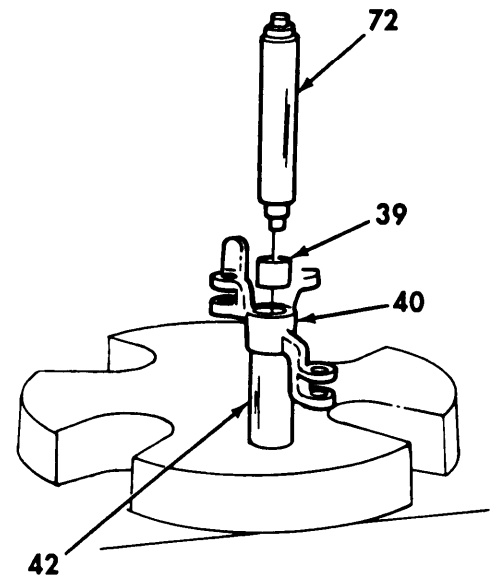
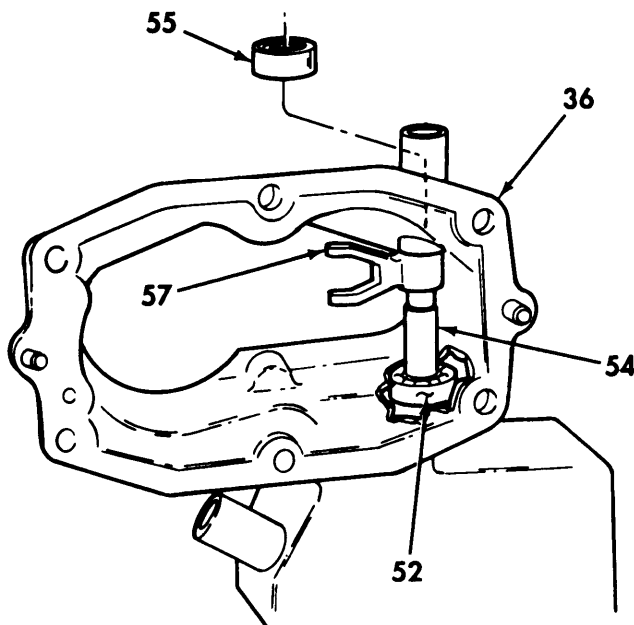
3-68. GOVERNOR REPAIR (Cont)

(3) Governor housing assembly

- (a) If removed, press two pins (66) into top of governor housing (36) until pins bottom out.
- (b) If removed, apply sealing compound to two adapters (67) and tap into place until they extend 1 7/16 inches beyond governor housing (36).
- (c) If removed, press pin (69) into rear of governor housing (36) until it extends 3/8 inch beyond housing.
- (d) If removed, press two pins (68) into front of governor housing (36) until they extend 7/16 inch beyond housing.
- (e) If removed, install plate (71) and two drive screws (70) on governor housing (36).
- (f) If removed, press pin (41) into governor housing (36). Pin must extend 1.055-1.060 inches above housing for model 5063-5299 and 1.497-1.504 inches above housing on all except model 5063-5299. Measure pin using depth gage.
- (g) Support lower end of operating shaft (54) in press. Start bearing (52) 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 (46) in operating lever (59) until it bottoms out on shoulder.
- (i) On models 5063-5299 and 5063-5398, install nut (60) and screw (61) in operating shaft lever (59).
- (j) On models 5063-5395, 5063-5392, 5063-5393, 5063-539F, and 5063-539L, install bolt (62), special nut (63), and nut (64) in operating shaft lever (59).
- (k) Start operating shaft lever assembly (58) on operating shaft (54) with flat on shaft in flat in lever bore and pin (46) up. Using a sleeve, press lever tight against inner race of bearing (52).
- (l) Insert lever, bearing, and shaft assembly (74) through bore inside governor housing (36). Place shifter fork (57) on lower end of shaft with finished cam surfaces facing rear of governor housing.



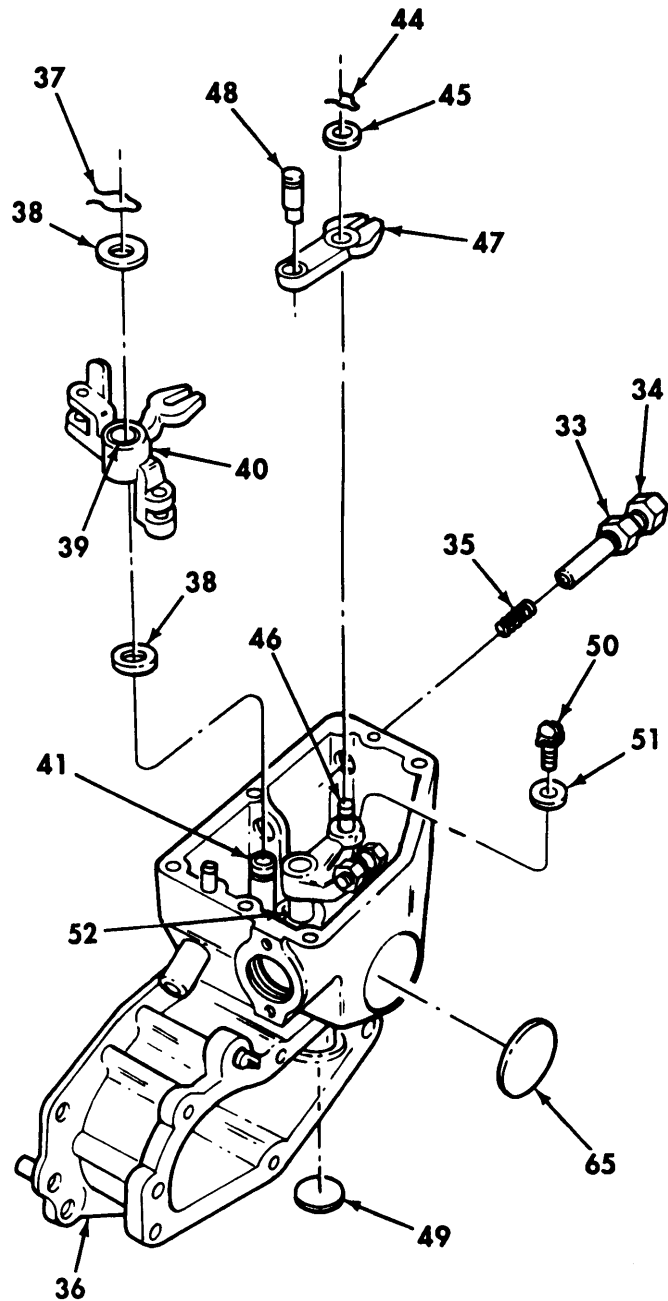
- (m) Support governor housing (36) in press with upper end of shaft (54) against bed of press. Align flat on shaft with flat in bore of shifter fork (57). Place sleeve over shaft and against fork. Press fork tight against shoulder on shaft.
- (n) Place bearing (55), shield side toward the shifter fork (57), on lower end of shaft (54). With upper end of shaft supported, press bearing against shoulder in bore of governor housing (36) using sleeve against inner race of bearing.
- (o) Lubricate bearing (52) and bearing (55) with engine oil.



- (p) Support control link lever (40) on sleeve (42). Place roller bearing (39), numbered side up, on lever and press flush using bearing installer (72). Invert lever and install second roller bearing in same manner.

3-68. GOVERNOR REPAIR (Cont)

- (q) Apply sealing compound around edge of expansion plug (49) and tap in place in governor housing (36).
- (r) If removed, apply sealing compound around edge of plug (65) and tap in place in governor housing (36).
- (s) Install flat washer (51) and special screw (50) against governor bearing (52).
- (t) If removed, press pin (48) in differential lever (47) until pin bottoms out on shoulder.
- (u) Install differential lever (47) assembly over pin (46). Install flat washer (45) and retaining clip (44) against assembly.
- (v) Place first flat washer (38 over grooved pin (41). Pack roller bearings (39) with grease and install roller bearing and control link lever (40) assembly, tapered end of link pin holes down, over grooved pin. Place second flat washer (38) over grooved pin and install retaining clip (37).
- (w) Thread nut (33) on buffer screw (34). Place spring (35) in buffer screw and thread screw in side of governor housing (36) until it extends 9/16-5/8 inch beyond housing.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-32 Install governor to blower assembly.

3-31 Install governor cover and spring pack.

CHAPTER 4

TESTING AND INSPECTION PROCEDURES

Section I. GENERAL INFORMATION

4-1. GENERAL. This chapter provides the necessary instructions for engine preparation, adjustments, tests, run-in, and engine preservation required following any major repair.

Whenever work is done which allows air in the fuel system, purge the fuel system to help start the engine.

After an engine is overhauled or in storage, prelubricate the turbocharger and rocker arm mechanisms to ensure adequate lubrication at start-up.

Whenever a major repair involves the governor, blower, cylinder head, or fuel injector controls, adjust the fuel control system prior to issue.

Prior to release for issue to user, test the engine condition and performance characteristics.

Whenever a major repair involves the installation of piston rings, pistons, cylinder liners, or bearings, run in the engine.

Prior to installing engine in container, fill the fuel injectors with preservation oil and drain fuel oil filters, lubrication oil filter, oil pan, cylinder block, thermostat housing, and oil coolers.

Section II. ENGINE PREPARATION

4-2. PREPARATION OF ENGINE FOR START-UP

This task covers:

a. Installing Engine on Dynamometer	b. Priming Fuel System
c. Prelubrication of Oil Gallery (with Pressure Lubricator)	
d. Prelubrication of Oil Gallery (without Pressure Lubricator)	
e. Prelubrication of Turbocharger	f. Initial Start-up

INITIAL SETUP

MODELS

All

EXPENDABLE / DURABLE SUPPLIES

Oil, fuel (App C, Item 27)
Oil, engine (App C, Item 26)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

WARNING

When running engine without air cleaners and turbocharger does not have built-in inlet shield, install protective turbocharger air inlet shield prior to doing maintenance. Contact with rotating blades will cause injury to personnel.

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.

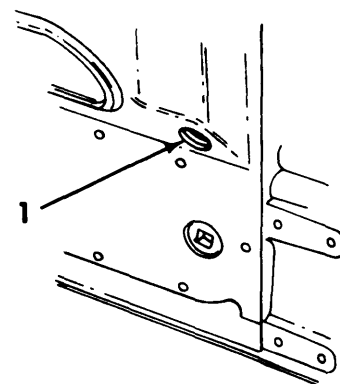
a. Installing Engine on Dynamometer

- (1) Install engine on dynamometer.
- (2) Connect source of fuel supply and fuel return to engine. Fill fuel filters with clean grade DF2 fuel oil.
- (3) Connect same type of air cleaners used for engine when in vehicle.

NOTE

Locate air intake so that engine inducts cool fresh air.

- (4) Connect engine cooling system to heat exchanger or radiator similar to vehicle type used to cool engine. Fill cooling system with coolant (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 (1).



**RIGHT BANK
FRONT**

4-2. PREPARATION OF ENGINE FOR START-UP (Cont)

- (7) Install water temperature gage in thermostat housing.

WARNING

Position exhaust piping to carry toxic carbon monoxide exhaust gases away from test area.

- (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.

b. Priming Fuel System

NOTE

Prime and/or purge engine fuel system after any major repair or overhaul.

- (1) Block or disconnect line from fuel pump.
- (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.

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.

c. Prelubrication of Oil Gallery (With Pressure Lubricator)

- (1) Remove plug from engine main oil gallery and connect lubricator hose.
- (2) Remove rocker arm covers (Refer to Para 3-20, 3-21, and 3-22).
- (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 Para 3-20, 3-21, and 3-22).
- (6) Check and fill crankcase to proper level (Refer to applicable vehicle lubrication order).

d. Prelubrication of Oil Gallery (Without Pressure Lubricator)

- (1) Remove rocker arm covers (Refer to Para 3-20,3-21, and 3-22).
- (2) Pour lubricating oil on rocker arm assemblies.

- (3) Install rocker arm covers (Refer to Para 3-20,3-21, and 3-22).
- (4) Check and fill crankcase to proper level (Refer to applicable vehicle lubrication order).

e. 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.

f. Initial Start-up

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 TASK

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Section III. ENGINE ADJUSTMENT.

Contents	Para	Page
Intervals And Adjustment Sequence	4-3.	4-7
Engine Tune-up	4-4.	4-8

4-3. INTERVALS AND ADJUSTMENT SEQUENCE

a. Intervals. Following any engine repair, perform the adjustments specified in Para 4-3.b.

b. Adjustment Sequence. Normally, when performing adjustments on an engine in service, check various settings for possible changes from previous adjustments. However, if the cylinder head, governor, or fuel injectors have been removed or replaced, also check specific preliminary adjustments before starting engine. The preliminary adjustments consist of the first four steps in the following sequence. The remaining items complete the list of engine adjustments to be performed.

- (1) Exhaust Valve Clearance (Cold Engine or Hot Engine)
- (2) Fuel Injector Timing Adjustment
- (3) Governor Gap Adjustment
- (4) Fuel Injector Control Tube Adjustment
- (5) Throttle Delay Adjustment
- (6) Starting Aid Screw Adjustment (internal Starting Aid Screw)
- (7) Maximum No-Load Speed Adjustment
- (8) Idle Speed Adjustment
- (9) Buffer Screw Adjustment

4-4. ENGINE TUNE-UP

This task covers:

a. Exhaust Valve Clearance Adjustment (Hot or Cold Engine)	
b. Fuel Injector Timing Adjustment	c. Governor Gap Adjustment
d. Injector Control Tube Adjustment	e. Throttle Delay Adjustment
f. Starting Aid Screw Adjustment	
g. Maximum No-Load Speed Adjustment	h. Idle Speed Adjustment
i. Buffer Screw Adjustment	

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Gage, injector timing (App B, Item 41) (models 5063-5299, 5063-5395, 5063-5398, and 5063-539F)
 Gage, injector timing (App B, Item 42) (models 5063-5392, 5063-5393 and 5063-539L)
 Shield, turbocharger inlet App B, Item 91)
 Gage, throttle delay (App B, Item 48)
 Gage, starting aid screw 0.345 (App B, Item 45) (models 5063-5392, 5063-5393 and 5063-539L)
 Gage, starting aid screw 0.395 (App B, Item 46) (models 5063-5395, 5063-5398, and 5063-539F)

TOOLS AND SPECIAL TOOLS (Cont)

Governor cover, cut-away (App D, Item 8)
 Wrench, retaining nut (App B, Item 115)

EQUIPMENT CONDITION

Para	Description
4-2	Prepare engine for start-up
3-20	Rocker arm covers removed (models 5063-5299 and 5063-5398)
3-21	Rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F and 5063-539L)
3-22	Rocker arm covers removed (model 5063-5395)

PERSONNEL REQUIRED: 2

a. Exhaust Valve Clearance Adjustment (Hot or Cold Engine)

(1) Place speed control lever (1) in idle speed position and secure stop lever (2) 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.

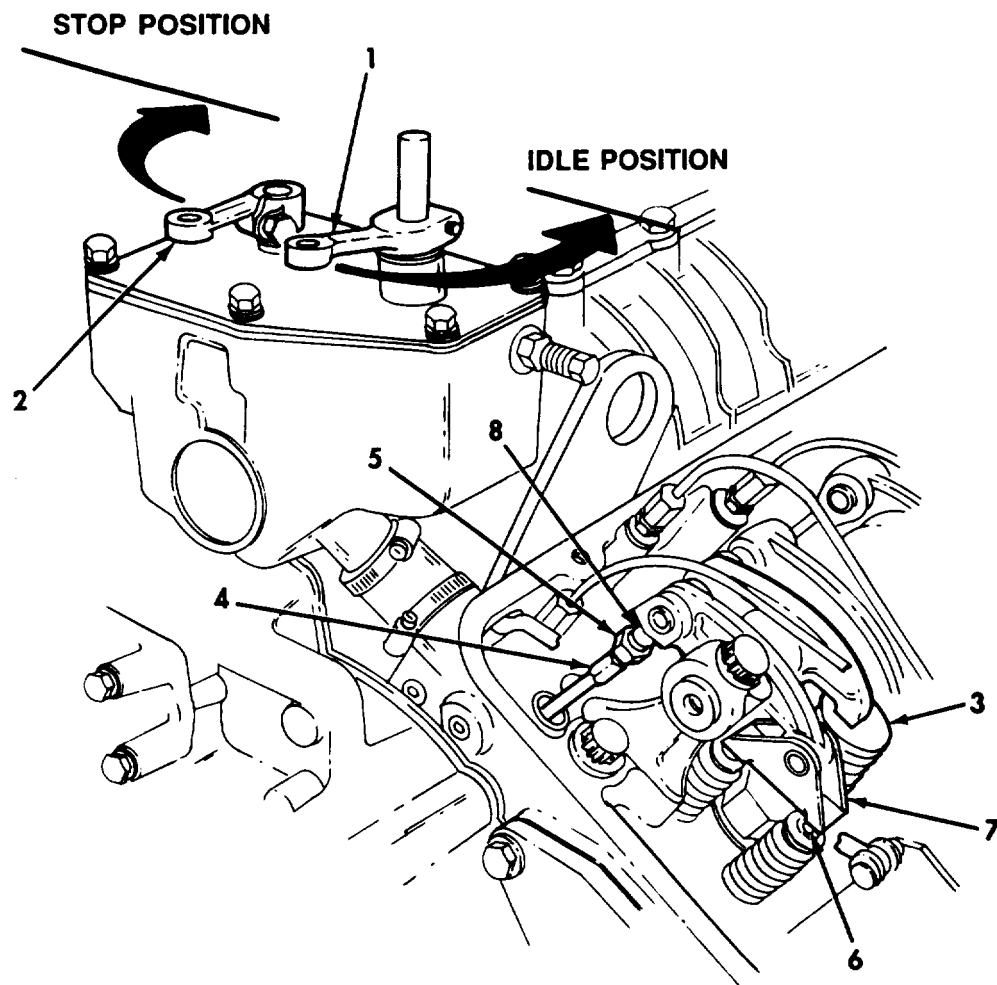
- (2) Using crankshaft end bolt, rotate crankshaft clockwise until injector follower (3) is fully depressed on cylinder to be adjusted.
- (3) Hold push rod (4) in position and loosen push rod locknut (5).

NOTE

- Normal engine coolant operating temperature (hot engine) is 160-185°F (71.1-85. 0°C).
- Normal ambient temperature (cold engine) is 100°F (38°C) or less.

(4) Place 0.026 inch (0.660 mm) thickness gage (cold engine) or 0.024 inch (0.610 mm) thickness gage (hot engine) between end of one exhaust valve stem (6) and rocker arm bridge (7).

- (5) Turn push rod (4) in or out of clevis (8) until a smooth pull is obtained on thickness gage.
- (6) Remove thickness gage. Hold push rod (4) and tighten lock nut (5). Lightly tap rocker arm at bridge (7) with wrench to release friction.



NOTE

- A 0.025 inch (0.635 mm) thickness gage (cold engine) or a 0.023 inch (0.584 mm) thickness gage (hot engine) must pass freely between end of one valve stem (6) and rocker arm bridge (7).
 - A 0.027 inch (0.686 mm) thickness gage (cold engine) or a 0.025 inch (0.635 mm) thickness gage (hot 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) thru (6).
 - (8) Adjust all exhaust valves following steps (1) thru (7).

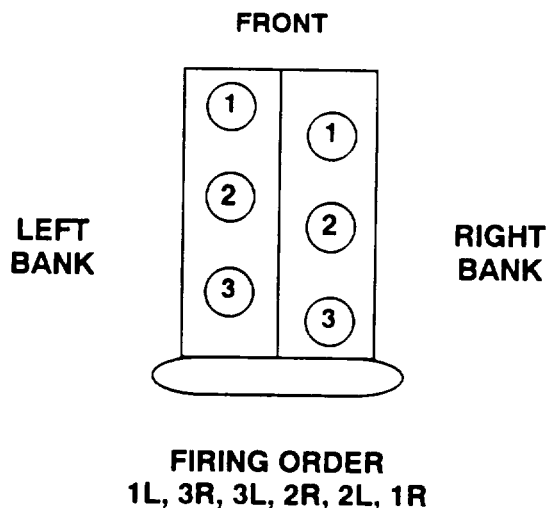
4-4. ENGINE TUNE-UP (Cont)

b. Fuel Injector Timing Adjustment

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.

- (1) Using crankshaft end bolt, rotate crankshaft clockwise until exhaust valve stems (6) are fully depressed on cylinder to be timed.



NOTE

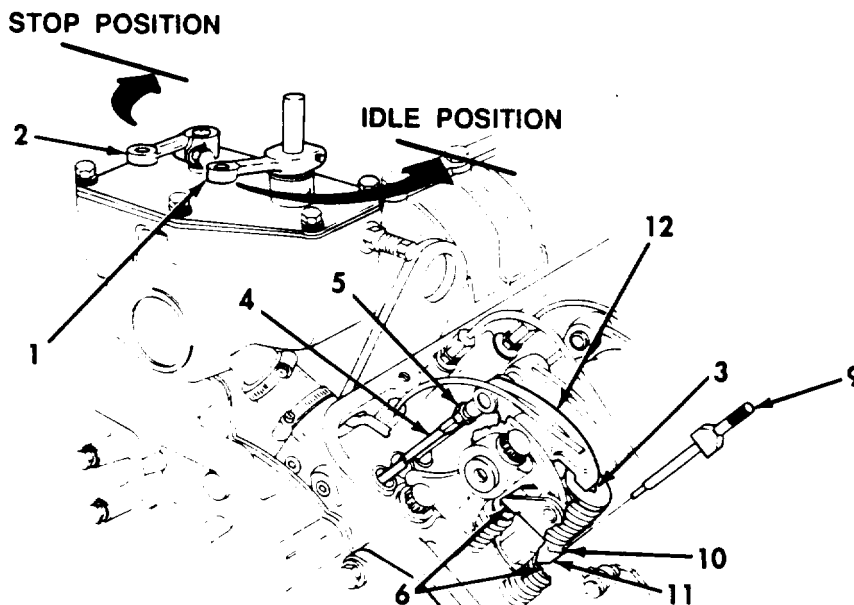
Time all fuel injectors during one full revolution of crankshaft. Firing order: 1L, 3R, 3L, 2R, 2L, and 1R.

- (2) Hold fuel injector push rod (4) and loosen push rod locknut (5).

NOTE

- Use 1.496 inch timing gage for models 5063-5392, 5063-5393 and 5063-539L.
- Use 1.460 inch timing gage for models 5063-5299, 5063-5395, 5063-5398, and 5063-539F.

- (3) Place small end of injector timing gage (9) in hole (10) at top of fuel injector body (11). Place flat of timing gage on fuel injector follower (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 gage.

- (4) Turn push rod (4) to adjust injector follower (3) height until flat of timing gage (9) just passes over top of injector follower and wipes the oil clean.
- (5) Hold injector push rod (4) and tighten push rod locknut (5). Lightly tap rocker arm (12) with wrench to release friction.

NOTE

Mark each rocker arm with a crayon or marker after adjustment.

- (6) Check injector timing again. If adjustment is required repeat steps (2) thru (5).
- (7) Time remaining five fuel injectors as outlined in steps (1) thru (6).

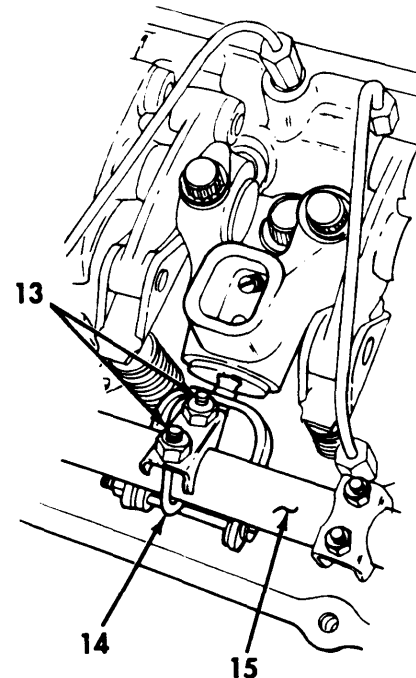
c. Governor Gap Adjustment**NOTE**

Before proceeding with governor adjustments, disconnect linkage from stop lever (1) and speed control lever (2).

- (1) On all except model 5063-5299, loosen two nuts (13) on throttle delay U-bolt (14) on right injector control tube (15). Injector control tube must move freely in U-bolt.

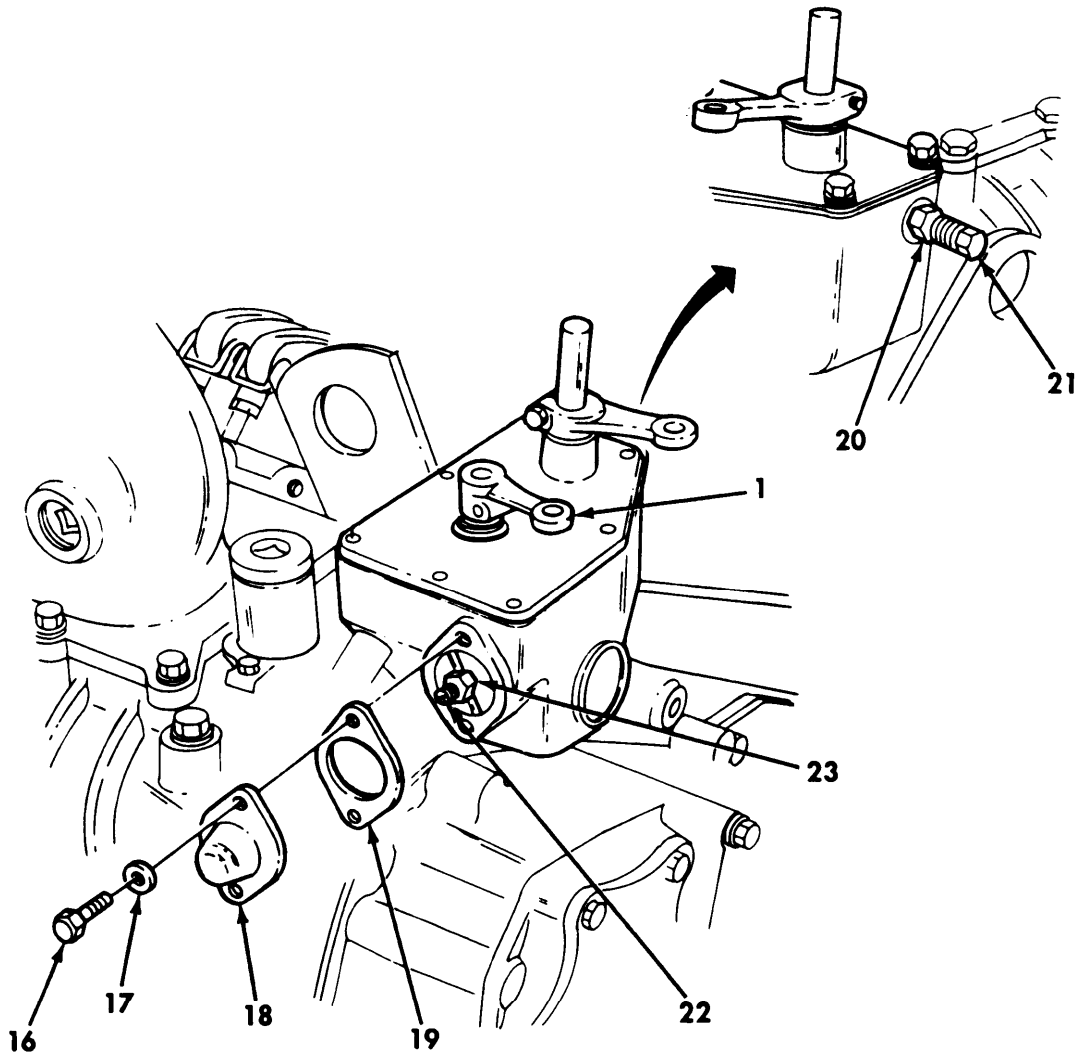
WARNING

- Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.
- Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.



4-4. ENGINE TUNE-UP (Cont)

- (2) Start and operate engine to attain coolant outlet temperature of 160-185°F (71-85°C).
- (3) Stop engine and remove two bolts (16), two washers (17), spring pack cover (18), and gasket (19) from side of governor. Discard gasket.



NOTE

Do not back the buffer screw out beyond limits given or the control link lever may disengage the differential lever.

- (4) Loosen locknut (20) and back out buffer screw (21) until it extends 5/8 inch from locknut.
- (5) Start engine. Hold idle speed screw (22) and loosen idle speed locknut (23). Adjust idle speed screw to obtain idle of 500-600 RpN1. Hold idle speed screw and tighten idle speed locknut.
- (6) Stop engine using engine stop lever (1).

NOTE

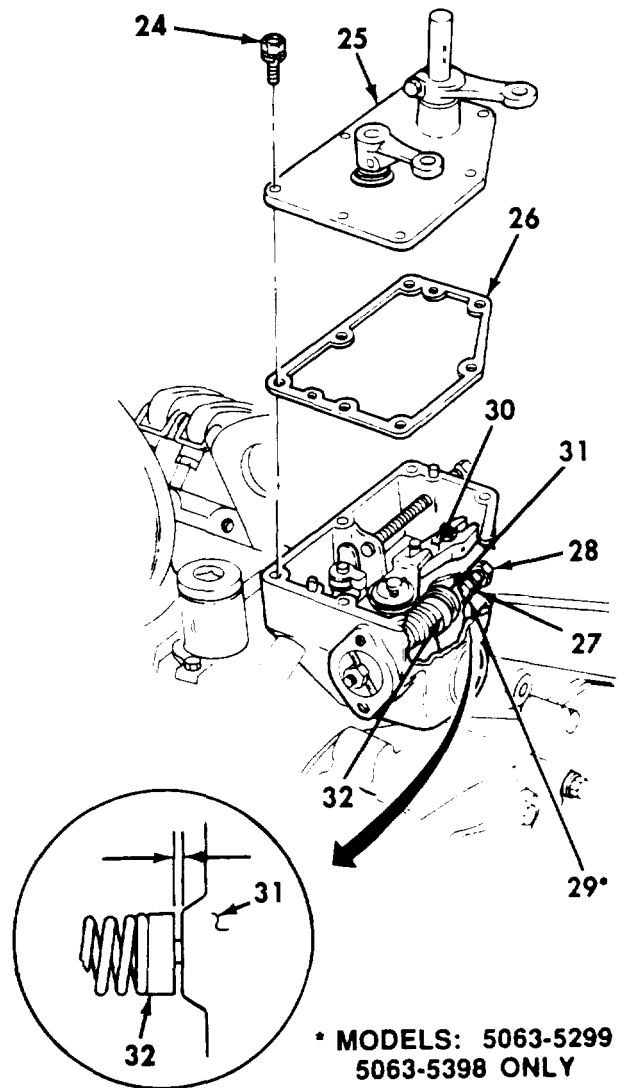
- On models 5063-5395 and 5063-539F, install fuel line clip on top of governor cover.
- Replace governor cover gasket only if damaged during removal.

- (7) Remove seven screw assemblies (24), governor cover assembly (25), and gasket (26) from top of governor.
- (8) On models 5063-5392, 5063-5393, 5063-5395, 5063-539F and 5063-539L loosen locknut (27) and screw starting aid screw (28) into gap adjusting screw (29).

CAUTION

When manual 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 (30).
- (10) Check gap between low-speed spring cap (31) and high-speed spring plunger (32) with a thickness gage. Gap should be 0.002-0.004 inch. If necessary, set gap again with adjusting screw (29).
- (11) On models 5063-5299 and 5063-5398, hold gap adjusting screw (29) and tighten locknut (27).
- (12) Check gap with engine running between 1100-1300 RPM, adjust gap if necessary.
- (13) Stop engine by moving differential lever (30) to NO FUEL position.

**CAUTION**

Ensure governor stop lever moves injector racks freely to NO FUEL position before installing 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, 5063-5395, 5063-539F and 5063-539L, install governor cover after starting aid screw adjustment.

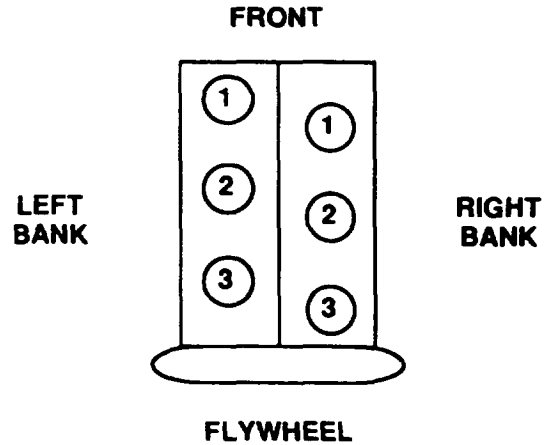
- (14) On models 5063-5299 and 5063-5398, install governor cover (25), gasket (26), and seven screw assemblies (24) to governor. Tighten screws securely.

4-4. ENGINE TUNE-UP (Cont)

d. Injector Control Tube Adjustment

NOTE

- Letter "R" or "L" indicates injector location, right or left bank, as viewed from rear of engine. Cylinder numbers start at front of each bank.
- 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.

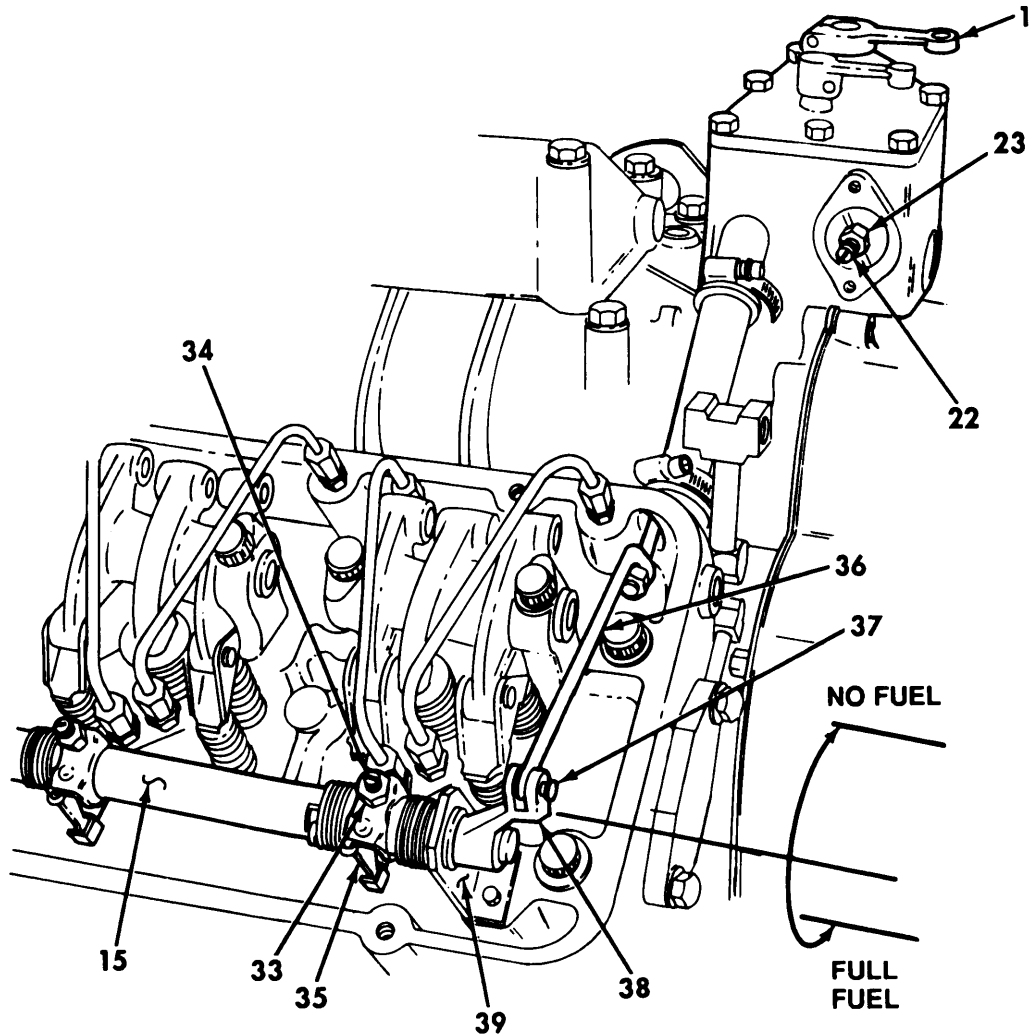


- (1) Loosen idle speed locknut (23). Hold locknut and turn idle speed adjusting screw (22) until 1/2 inch of threads project from locknut.

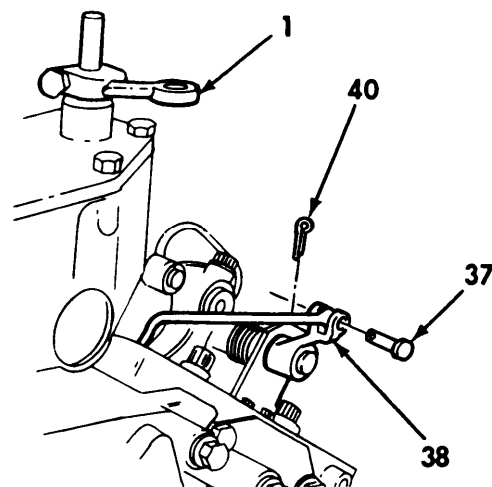
CAUTION

Cover oil drain hole in cylinder head with clean rag to prevent cotter pin and clevis pin from falling into engine.

- (2) Loosen six adjustment screw locknuts (33) and back out six adjusting screws (34). All six injector control levers (35) should be loose on control tubes (15).
- (3) Move linkage (36) connecting governor to control tubes. Linkage must not bind.



- (4) Rotate clevis pins (37) in right and left control tube levers (38). Pins must rotate freely.
- (5) Check for slight movement of each control tube (15) between its two brackets (39) to ensure there is no binding.
- (6) Rotate each control tube lever (38) to FULL FUEL position and then release lever. Control tubes must return to NO FUEL position.
- (7) Remove cotter pin (40) and clevis pin (37) from opposite control tube lever (38). Discard cotter pin.
- (8) Move speed control lever (1) to FULL FUEL position (clockwise direction) and hold with light finger pressure.



44. ENGINE TUNE-UP (Cont)

CAUTION

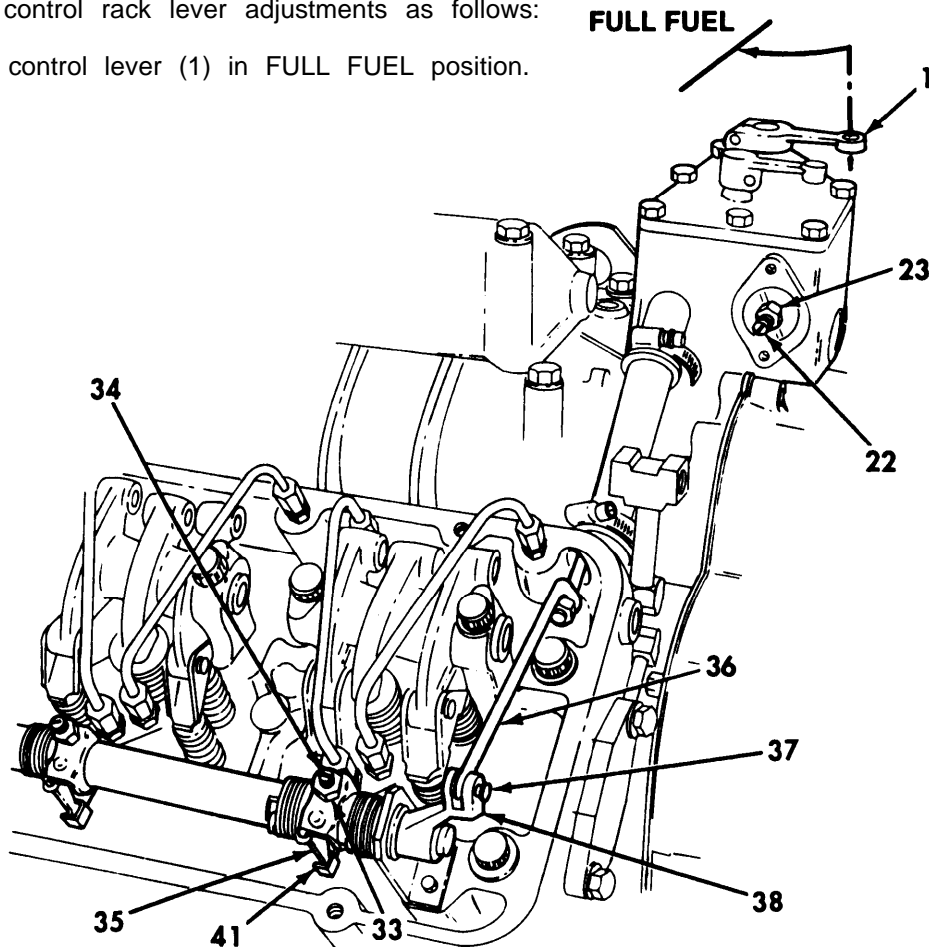
Do not overtighten adjusting screws during installation or adjustment. Overtightening can result in damage to injector control tube. Recommended adjusting screw torque is 24-36 lb-in (3-4 Nm).

- (9) Turn adjusting screw (34) on 3L or 3R injector control lever (35) until slight movement is felt on speed control lever (1), injector rack (41) 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.

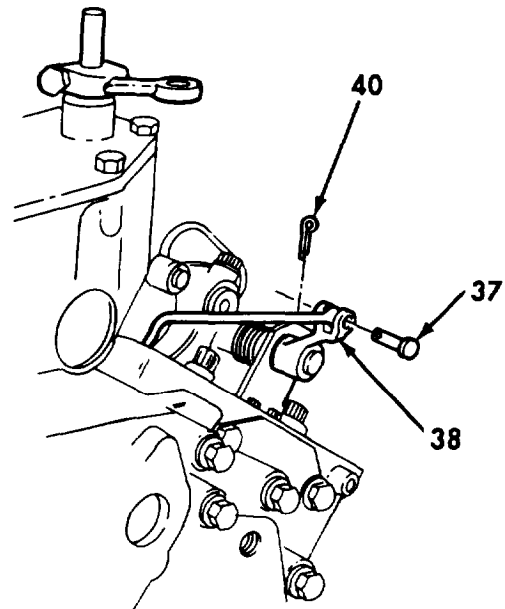
- (10) Tighten adjusting screw (34) an additional 1/8 turn. Hold adjusting screw and tighten locknut (33).
- (11) Check left clevis pin (37) for freeness. Pin must turn freely in control tube lever (38) when 3L or 3R is in FULL FUEL position. If clevis pin does not rotate freely, adjust injector control lever again.
- (12) Check injector control rack lever adjustments as follows:
 - (a) Hold speed control lever (1) in FULL FUEL position.



- (b) Using a screw driver, lightly press downward on injector rack (41) and slide screw driver off.
- (c) Injector rack (41) should spring back upward.
- (13) If injector rack (41) does not spring back, loosen adjusting screw lock nut (33) and tighten adjusting screw (34) slightly. Tighten locknut. Check adjustment using steps (11) and (12).
- (14) Move speed control lever (1) to FULL FUEL position. If injector rack (41) becomes tight before speed control lever reaches end of travel, setting is too tight. Loosen locknut (33) and turn screw (34) slightly counterclockwise. Tighten locknut. Check setting using steps (11) and (12).
- (15) Connect opposite throttle control rod (36) to control tube lever (38) using clevis pin (37) and cotter pin (40).
- (16) Adjust opposite injector control lever (35) per steps (8) thru (10).
- (17) Repeat check on 3L and 3R injector control levers (35) per steps (11) thru (14). 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.



- (18) Hold speed control lever (1) in FULL FUEL position. Check clevis pins (37) for drag on both right and left control tube lever (38). Both pins should move freely.
- (19) With speed control lever still held lightly in FULL FUEL position, adjust 2L and 1L injector control rack levers (35) per steps (8) thru (10). Check their adjustment per steps (11) thru (14). Do not readjust 3L.
- (20) With speed control lever still held lightly in FULL FUEL position, adjust 2R and 1R injector control rack levers (35) per steps (8) thru (10). Check their adjustment per steps (11) thru (14). Do not readjust 3R.
- (21) Turn idle speed adjusting screw (22) in until it projects 3/16 inch from locknut (23) to permit starting of engine. Tighten locknut.

4-4. ENGINE TUNE-UP (Cont)

e. Throttle Delay Adjustment (For All Except Model 5063-5299)

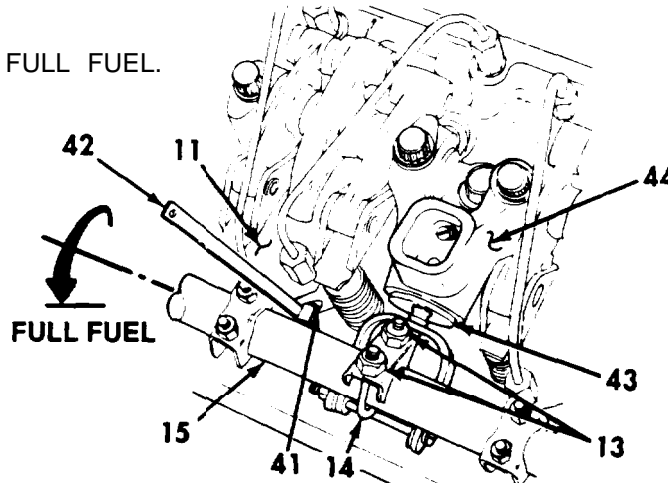
NOTE

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 (42) on rack between injector body (11) and clevis of injector rack (41) on 2R injector.
- (2) Move injector control tube (15) in direction of FULL FUEL.
- (3) Align throttle delay piston (43) flush with edge of throttle delay cylinder (44).

CAUTION

Do not overtighten two U-bolt nuts. Damage to injector control tube or U-bolt clamp could result.



- (4) Tighten two nuts (13) on U-bolt (14) snug.
- (5) Move injector rack from NO-FUEL to FULL FUEL position. There should be no binding during movement of injector control tube (15). Torque nuts (13) to 84-108 lb-in (9-12 N-m).

f. Starting Aid Screw Adjustment

NOTE

Perform starting aid screw adjustment with engine shutdown.

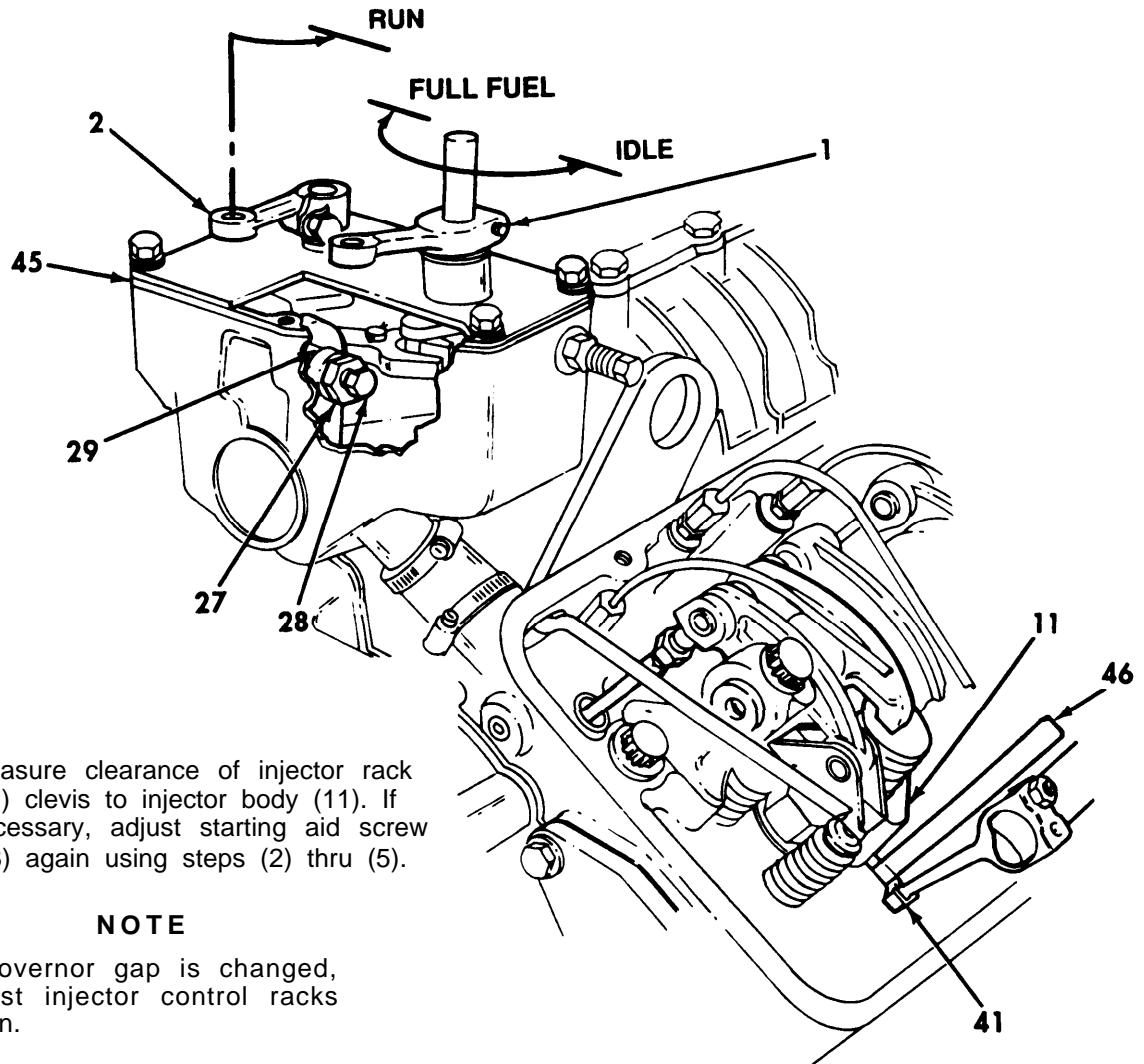
- (1) Install fabricated cutaway governor cover assembly (45) on governor housing,
- (2) Position shutdown lever (2) in RUN position and throttle lever (1) in IDLE position.
- (3) Hold starting aid screw (28) and loosen locknut (27).

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 starting aid screw gage.
- For models 5063-5395, 5063-5398, and 5063-539F, use 0.395-inch starting aid screw gage.

- (4) Insert starting aid screw gage (46) on 3R injector rack (41) between clevis and injector body (11). Prevent gap adjusting screw (29) from turning and adjust starting aid screw (28) to required setting. Move gage back and forth along injector rack until a clearance of 0.016 inch is noted. Remove gage.

- (5) Hold starting aid screw (28) and tighten locknut (27).
- (6) Check clearance between injector body (11) and clevis of injector rack (41) as follows:
 - (a) Position stop lever (2) in RUN position.
 - (b) Move engine speed control lever (1) from IDLE speed to FULL FUEL position.
 - (c) Return speed control lever (1) to IDLE position.



- (d) Measure clearance of injector rack (41) clevis to injector body (11). If necessary, adjust starting aid screw (28) again using steps (2) thru (5).

NOTE

If governor gap is changed, adjust injector control racks again.

- (7) Start engine and check running governor gap (ref. Para 4-4.c.). If necessary, set governor gap again. Running governor gap should be 0.0015 inch. 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 cutaway governor cover assembly (45) from governor and install original governor cover assembly on engine.

4-4. ENGINE TUNE-UP (Cont)

g. Maximum No-Load Speed Adjustment

WARNING

- **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**
- **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**

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 inch beyond locknut or interference will result during no-load speed adjustment.
- (1) Start engine and operate until coolant outlet temperature is 160- 185°F (71.1-85.0°C).
 - (2) Remove load from engine and place speed control lever (1) 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 (47) during removal or low speed spring and cap may drop into governor.

- (a) Loosen idle speed screw (22) and unscrew retainer nut (48) from side of governor housing (49) using retaining nut wrench (50). Remove high speed spring and plunger assembly (47).

NOTE

Removing shims will decrease engine speed and adding shims will increase engine speed. Each 0.010 inch in shim will change engine speed approximately 10 RPM.

- (b) Remove high speed spring (51) from plunger (52) and add or remove shims (53) as required to attain desired engine no-load speed.

- (c) Place high speed spring (51) on plunger (52) and install assembly (47) in governor housing (49). Thread retainer nut (48) into governor housing and tighten using retaining nut wrench (50).
- (4) Start engine and check maximum no-load speed. Repeat steps (1) thru (3) as necessary to attain desired no-load speed of 2965 RPM.

h. Idle Speed Adjustment

WARNING

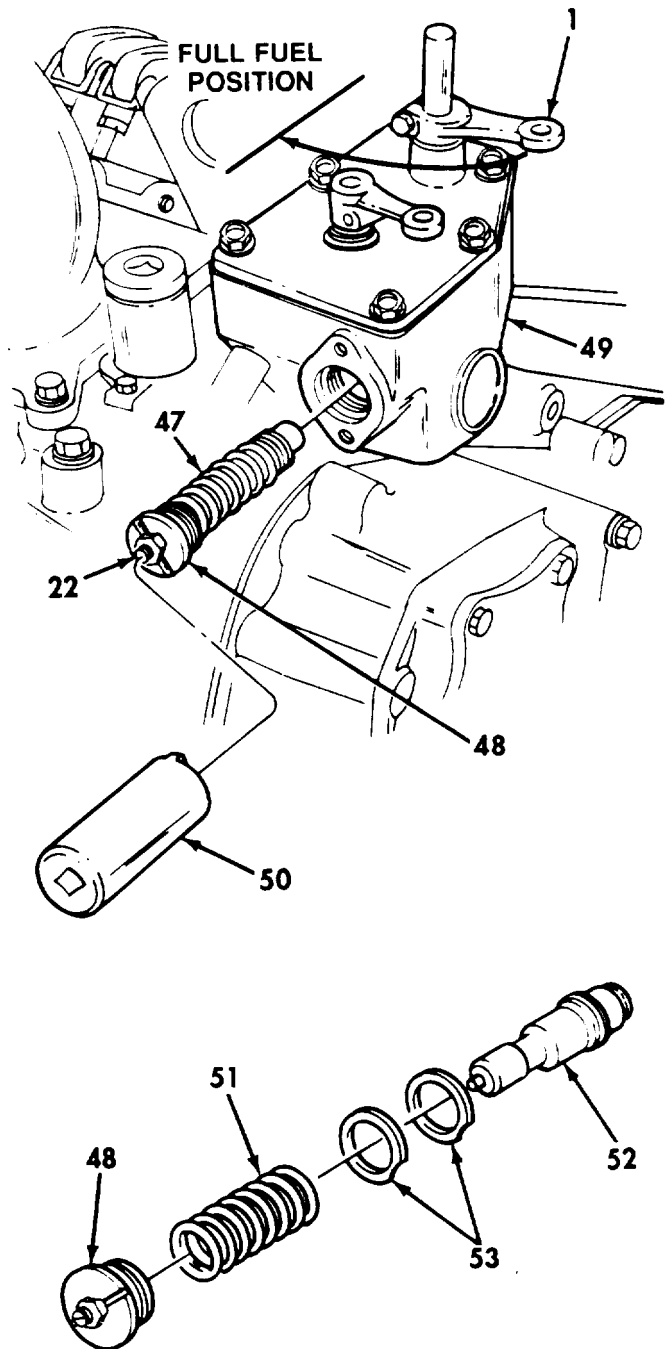
- **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**
- **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**

- (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 (1) in IDLE position.

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 and models 5063-5395, 5063-5398, and 5063-539F at 625-675 RPM.

- (3) Hold idle speed screw (22) and loosen idle speed locknut (23), 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.



4-4. ENGINE TUNE-UP (Cont)

i. Buffer Screw Adjustment

WARNING

- Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.
- Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.

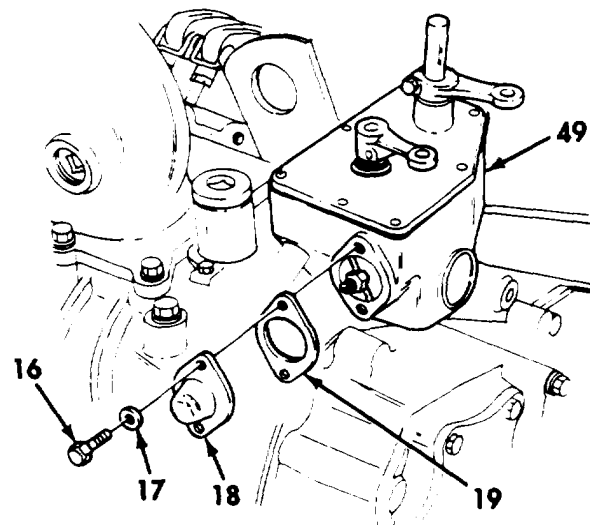
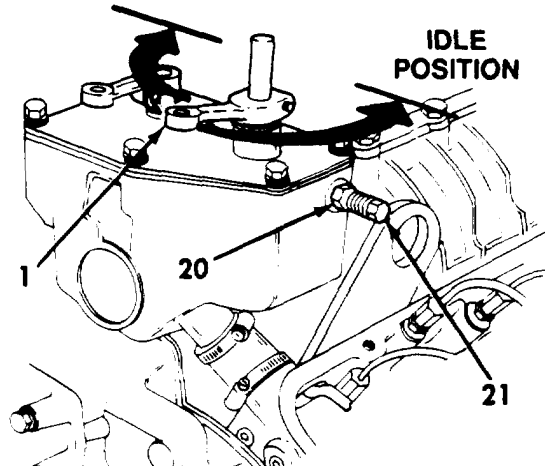
- (1) Start engine and operate until coolant outlet temperature is 165-185°F (71.1-85.0°C).
- (2) Place speed control lever (1) in FULL FUEL position and record maximum no-load speed.

NOTE

Do not increase engine idle speed more than 15 RPM with buffer screw.

- (3) Place speed control lever (1) in IDLE position.
- (4) Hold locknut (20) and turn buffer screw (21) until it contacts differential lever as lightly as possible and eliminates engine roll.
- (5) Move speed control lever (1) to FULL FUEL position. If maximum no-load speed has increased more than 25 RPM, hold buffer screw locknut (20) and back out buffer screw (21) until no-load speed increase is less than 15 RPM,
- (6) Hold buffer screw (21) and tighten locknut (20).
- (7) Stop engine.
- (8) Install gasket (19), spring pack cover (18), two copper washers (17), and two bolts (16) on governor housing (49). Torque bolts to 10-13 lb-ft (14-18 N·m).

FULL FUEL POSITION



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-20	Install rocker arm covers (models 5063-5299 and 5063-5398).
3-21	Install rocker arm covers (models 5063-5392, 5063-5393, 5063-539F and 5063-539 L),
3-22	Install rocker arm covers (model 5063-5395).

Section IV. ENGINE TESTING

Contents	Para	Page
Cylinder Compression Test	4-5...	4-24
Fuel Flow Test	4-6...	4-30
Fuel Pressure Test	4-7...	4-32
Crankcase Pressure Test	4-8...	4-34
Air Box Pressure Test	4-9.	4-36

4-5. CYLINDER COMPRESSION TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

1 Tube assembly, fuel (App D, Item 14)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
 Adapter, cylinder compression (App B, Item 2)
 Tester, cylinder compression (App B, Item 100)
 Wrench, fuel nut (App B, Item 113)

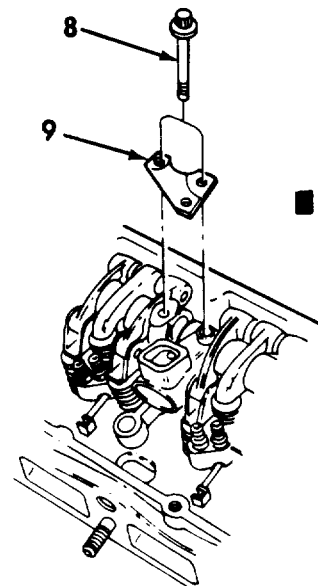
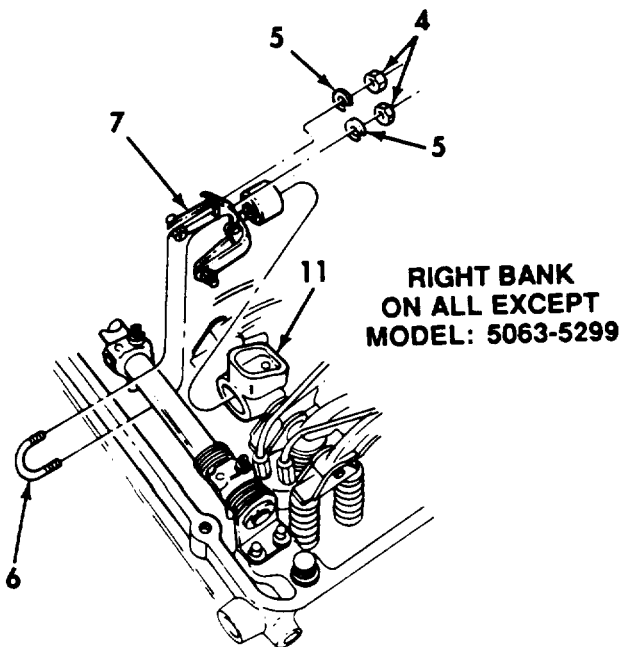
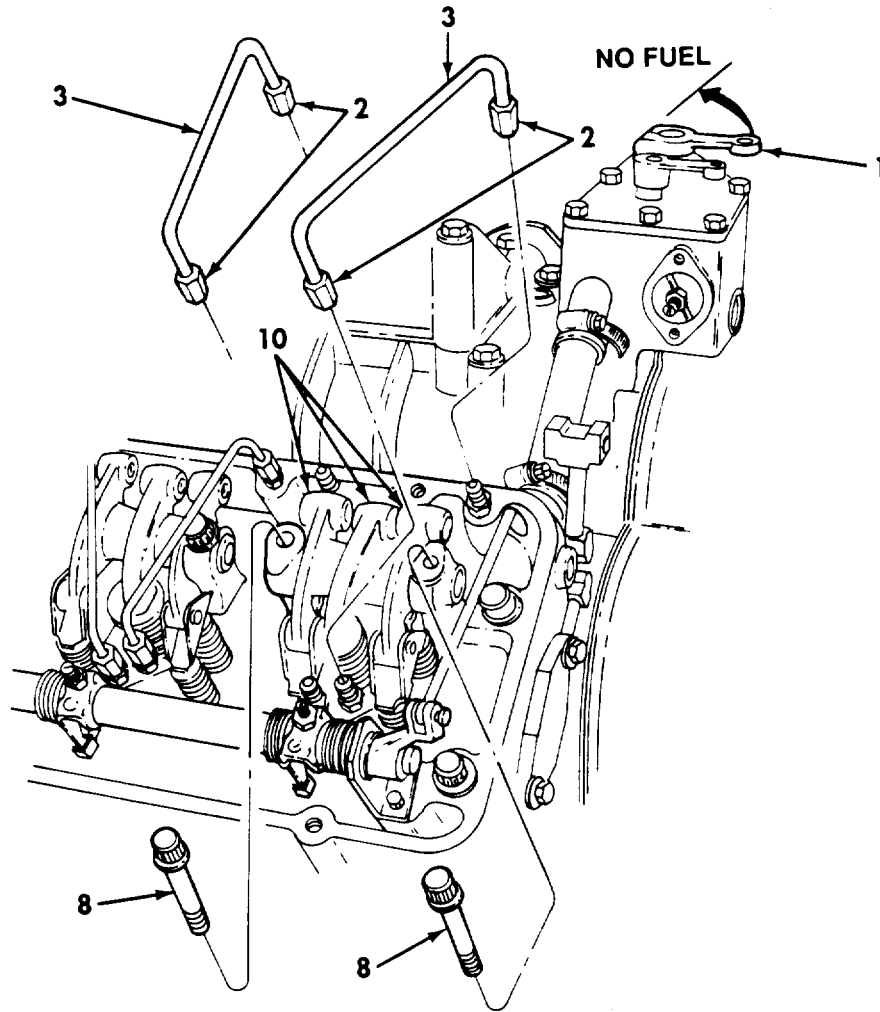
EQUIPMENT CONDITION

Para Description
 4-2 Prepare engine for start-up

Testing

WARNING

- **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**
 - **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**
- a. 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 (refer to Para 3-20,3-21, or 3-22),
 - b. Move speed control lever (1) to NO FUEL position.
 - c. Loosen four fuel tube nuts (2) and remove two fuel tubes (3) from one cylinder position.
 - d. Rotate appropriate cylinder to bottom dead center.
 - e. On 1 R cylinder, for all except model 5063-5299, remove two nuts (4), two lockwashers (5), and U-bolt (6) from throttle delay lever assembly (7). Discard lockwashers.
 - f. Remove two rocker shaft bracket bolts (8).
 - g. On models 5063-5392, 5063-5393, 5063-539F and 5063-539L, remove hold-down bracket (9) and rocker shaft bracket bolt (8) of any adjacent cylinder.
 - h. Swing rocker arms (10) away from injector and valves.
 - i. On 1R cylinder, for all except model 5063-5299, remove throttle delay lever assembly (7) from throttle delay bracket (11) (ref. Para 3-42).



**MODELS:
5063-5392
5063-5393
5063-539F
■ 5063-539L**

4-5. CYLINDER COMPRESSION TEST (Cont)

- j. Loosen locknut (12) and back out adjusting screw (13) on control tube lever (14). Slide injector control lever on injector control tube (15) away from injector control rack (16).
- k. Remove bolt (17), convex washer (18), clamp (19), and injector (20) in cylinder head.

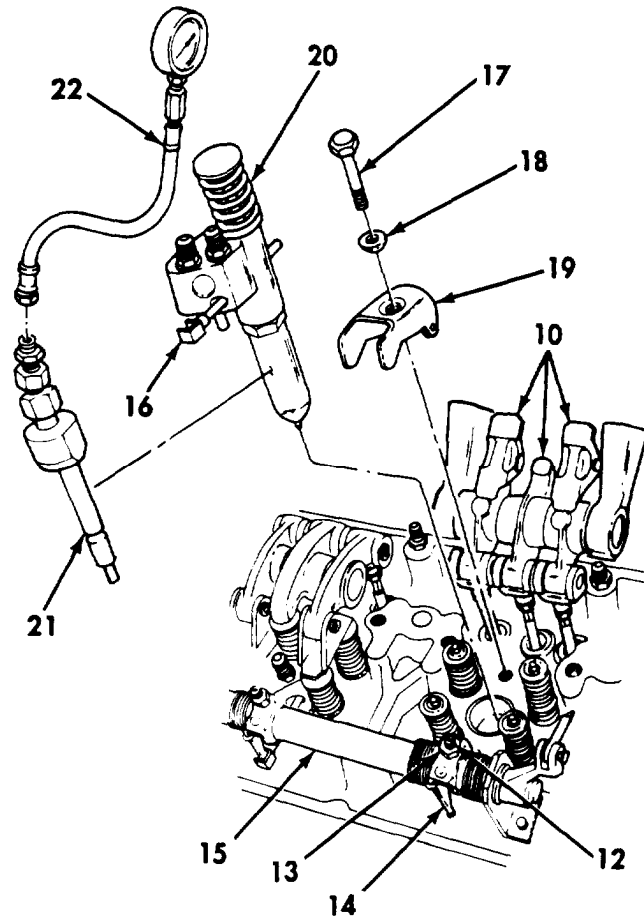
CAUTION

Injector clamp must not interfere with follower spring or exhaust valve springs when installed. Damage could occur to engine valve or injector clamp.

- l. Install cylinder adapter (21), clamp (19), convex washer (18), and bolt (17) in injector tube. Torque bolt to 20-25 lb-ft (27-34 N-m). Connect cylinder tester (22) to adapter.

CAUTION

Exhaust valve bridges must rest on ends of exhaust valves when tightening rocker arm shaft bolts or damage to exhaust valves will result.



- m. Position rocker arms (10) over pressure gage and adapter (21), and exhaust valves. Install two rocker arm shaft bolts (8) 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 fuel tube to fabricate a jumper connection between fuel inlet and fuel return manifold connectors. Do not install fuel tubes on engine after bending for fabrication.

- n. Install spare fuel tube (23) between inlet manifold (24) and return manifold (25).

WARNING

- Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.
- Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.

- Start engine and run at 600 RPM. Record pressure shown on cylinder tester gage.
- Stop engine. Move speed control lever (1) to NO FUEL position.
- Cylinder compression pressure of any one cylinder, measured in steps a. thru p. above, must not be less than minimum pressures shown in Table 4-1.
- Remove spare fuel tube (23). Remove two rocker arm shaft bolts (8) and swing rocker arms (10) away from pressure gage adapter (21) and valves.

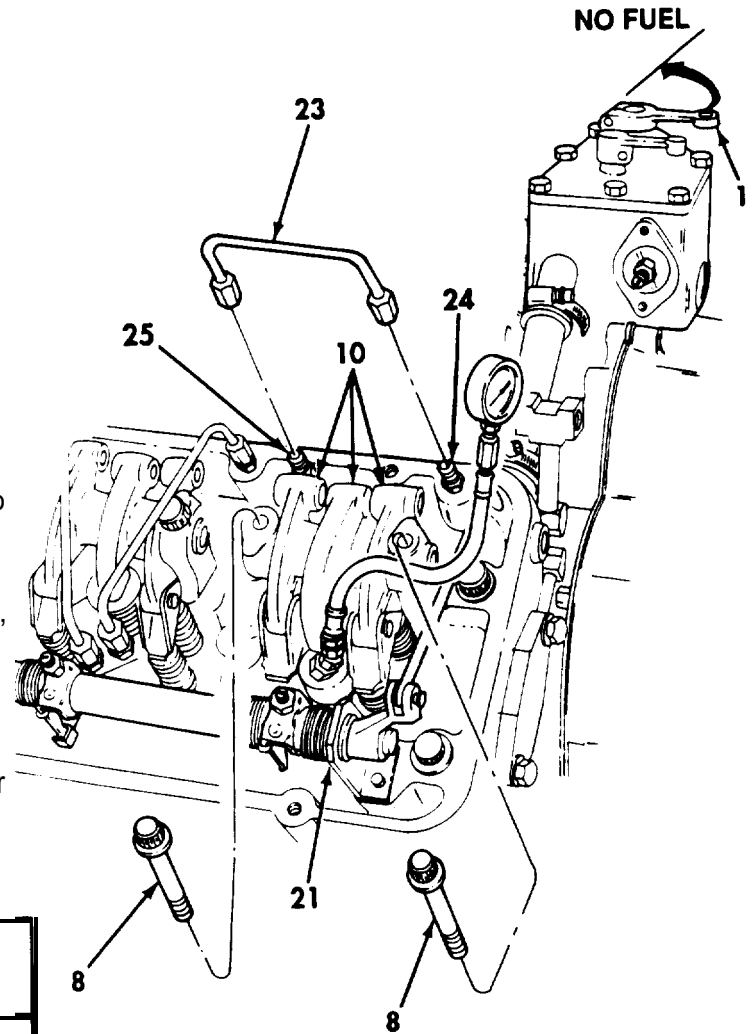
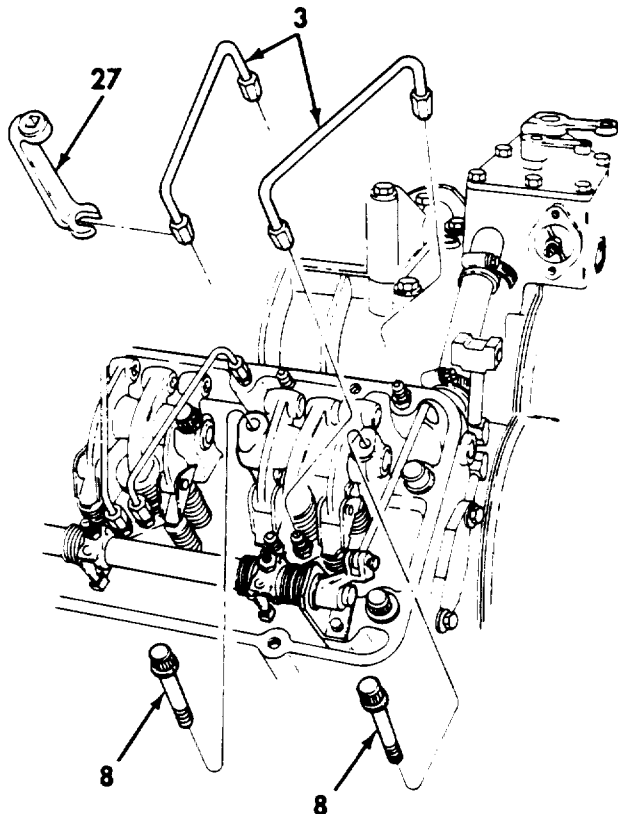
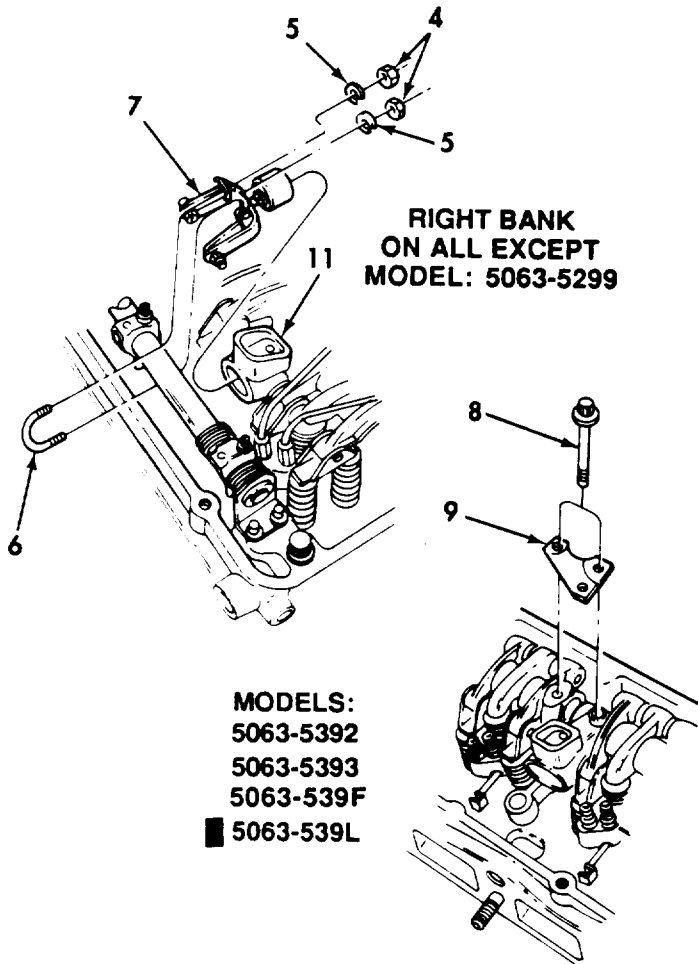
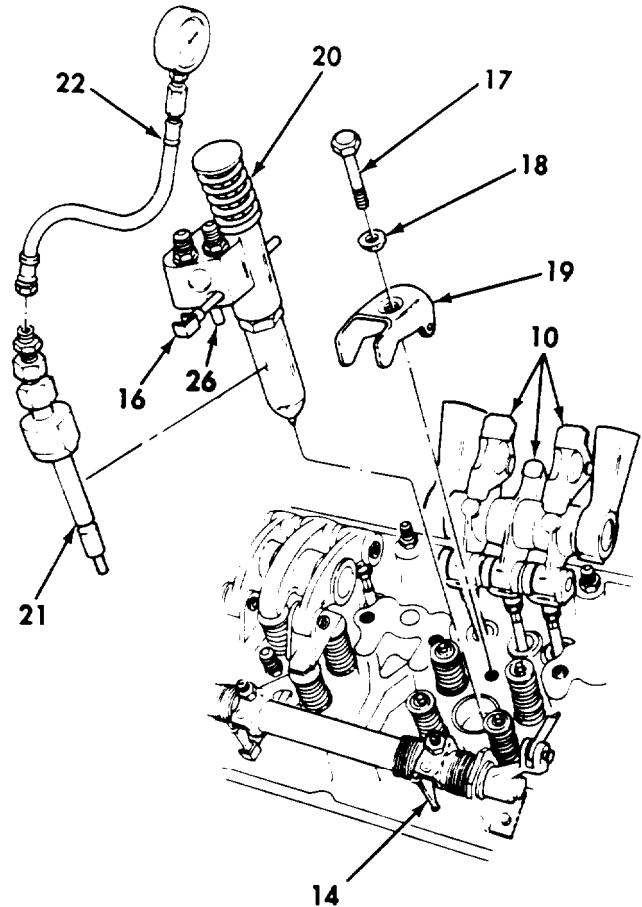


TABLE 4-1. MINIMUM COMPRESSION PRESSURE AT 600 RPM		
Model 5063-5299	All Except Model 5063-529.9	Altitude
PSI (kPa)	PSI (kPa)	Feet (meters)
(3721)	(2963)	500 (152)
500 (3445)	400 (2756)	2500 (762)
465 (3204)	370 (2549)	5000 (1524)
430 (2963)	340 (2343)	7500 (2286)
395 (2722)	315 (2170)	10000 (3048)

4-5. CYLINDER COMPRESSION TEST (Cont)

- s. Remove bolt (17), convex washer (18), clamp (19), cylinder tester (22), and cylinder adapter (21) from cylinder head.
- t. Align dowel (26), on injector (20), with locating hole in cylinder head. Install injector in injector tube.
- u. Install clamp (19), convex washer (18), and bolt (17) with convex side of washer facing clamp. Torque bolt to 20-25 lb-ft (27-34 N-m).
- v. On 1R cylinder, for all except model 5063-5299, install throttle delay lever assembly (7) in throttle delay bracket (11).
- w. Swing rocker arms (10) on top of injector and valves.
- x. On models 5063-5392, 5063-5393, 5063-539F and 5063-539L, install hold-down bracket (9) and rocker shaft bracket bolt (8) of any adjacent cylinder.



- y. Install two rocker arm shaft bolts (8). Torque bolts to 50-55 lb-ft (68-75 N-m).
- z. On models 5063-5392, 5063-5393, 5063-539F and 5063-539L, torque adjacent rocker arm shaft bolts (8) to 50-55 lb-ft (68-75 N-m).
- aa. Slide control tube lever (14) into injector rack (16).
- ab. On 1 R cylinder, for all except model 5063-5299, install U-bolt (6), two lockwashers (5), and two nuts (4) in throttle delay lever assembly (7).

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.

- ac. Install two fuel tubes (3). Using fuel nut wrench (27), torque four fuel tube nuts to 130-160 lb-in (14.7-18.1 N·m).
- ad. Repeat steps a. thru ac. on remaining cylinders.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

4-4.d Adjust injector control tubes.

4-4.e Adjust throttle delay,

3-20 Install rocker arm covers (models 5063-5299 and 5063-5398).

3-21 Install rocker arm covers (models 5063-5392, 5063-5393, 5063-539F and 5063-539 L).

3-22 Install rocker arm covers (models 5063-5395).

4-6. FUEL FLOW TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

Para Description
4-2 Prepare engine for start-up

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

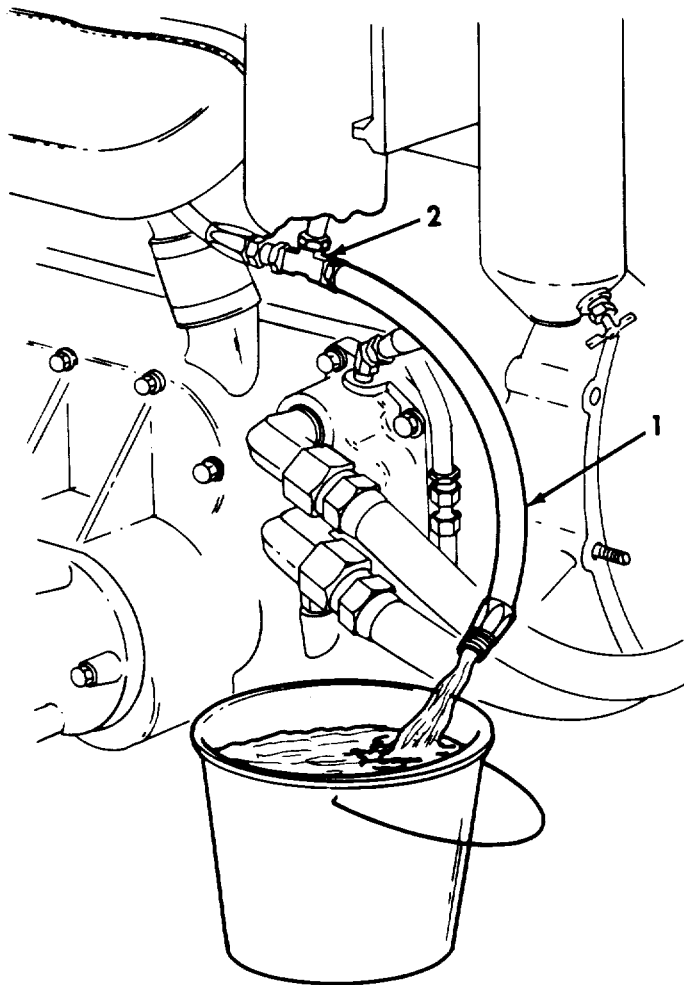
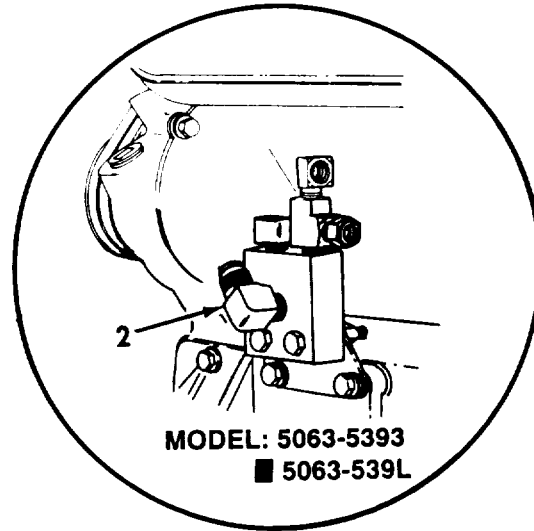
Testing

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.
- a. Connect a fuel return line (1) to the fuel return fitting (2) on engine.
 - b. Hold open end of fuel return line (1) in a measured container.

WARNING

- **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**
 - **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**
- c. Start engine and run at 2200 RPM NO-LOAD. Using a stop watch, measure fuel flow from fuel return line (1) for one minute. Minimum fuel return rate is 2/3 GPM.
 - d. Stop engine and remove fuel line (1). Connect fuel return.



END OF TASK

4-7. FUEL PRESSURE TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Gage, fuel pressure (App B, Item 39)
Wrench, fuel nut (App B, Item 113)
Torque wrench (App B, Item 118)

EQUIPMENT CONDITION

Para Description

4-2 Prepare engine for start-up

3-20 Rocker arm covers removed (models 5063-5299 and 5063-5398)

3-21 Rocker arm covers removed (models 5063-5392, 5063-5393, 5063-539F and 5063-539L)

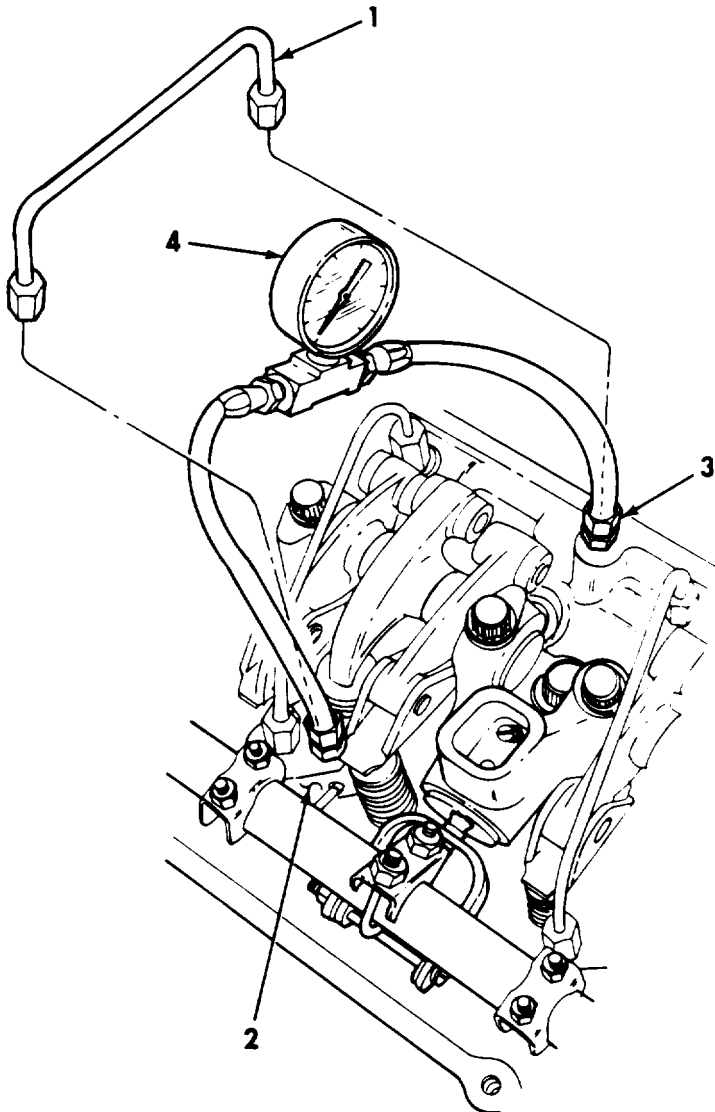
3-22 Rocker arm covers removed (model 5063-5395)

Testing

- a. Remove fuel inlet tube assembly (1) from injector (2) and fuel inlet manifold (3).
- b. Connect pressure gage (4) to injector (2) and fuel manifold (3).

Ž **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**

- **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**



- c. Start engine and operate at 2500 RPM. Note reading on fuel pressure gage (4). Fuel pressure must be 45-70 PSI (310-483 kPa) at 2500 RPM.
- d. Stop engine by moving governor stop lever (5) to NO FUEL position.
- e. Remove fuel pressure gage (4) from connection at injector (2) and fuel inlet manifold (3).

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.

- f. Install fuel inlet tube assembly (1) on injector (2) and fuel inlet manifold (3). Using fuel nut wrench, torque fuel tube nuts to 130-160 lb-in (14.7-18.1 N·m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

3-20 Install rocker arm covers (models 5063-5299 and 5063-5398).

3-21 Install rocker arm covers models 5063-5392, 5063-5393, 5063-539F and 5063-539L)

3-22 Install rocker arm covers (model 5063-5395).

4-8. CRANKCASE PRESSURE TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Food coloring (App C, Item 14)

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)
Manometer (App B, Item 72)
Tubing nonmetallic (App B, Item 110)
Coupling half (App B, Item 18)

EQUIPMENT CONDITION

Para Description
4-2 Prepare engine for start-up

Testing

- a. Remove one tube connector (1) from manometer (2) by rotating counterclockwise.
- b. Turn other tube connector (3) clockwise until fully engaged and then back out one full turn.
- c. Add five drops of food coloring to one pint of distilled water and mix.
- d. Add colored solution (4) to manometer (2) until liquid level is opposite zero mark on scale with manometer vertical.

NOTE

Eliminate air bubbles in manometer by tilting and gently tapping.

- e. Install tube connector (1) until fully engaged and then back out one full turn.

NOTE

Adapter must not extend into oil in oil pan.

- f. Remove oil level gage, oil level gage tube, and adapter from oil pan (refer to Para 2-7, 2-8, 2-9, or 2-10). Install coupling half (5) in oil pan.
- g. Connect nonmetallic tubing (6) to coupling half (5) and tube connector (1). Mount manometer in vertical position. Close manometer tube connector connected to nonmetallic tubing.

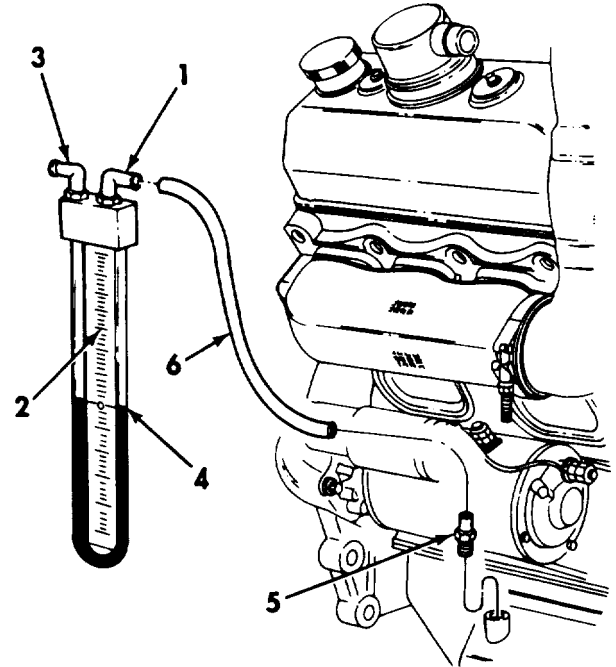
WARNING

- **Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.**
- **Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.**

CAUTION

If crankcase pressure is excessively high, this pressure may exceed the capacity of manometer. To prevent blowing liquid out of manometer, discontinue test if liquid level approaches limits of manometer scale by closing manometer tube connector.

- h. Start engine and operate at 2500 RPM, FULL LOAD. Slowly open manometer tube connector (1), connected to nonmetallic tubing (6), while carefully observing liquid level in manometer tube.



NOTE

- . A 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 3.0 inches of water at 2500 RPM, FULL LOAD.
- i. When manometer tube connector (1) has been opened one full turn, read crankcase pressure on manometer scale.
- j. Stop engine by moving governor stop lever to NO FUEL position.
- k. Disconnect hose (6) and remove coupling half (5).
- l.

4-9. AIR BOX PRESSURE TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics App B, Item 107)
 Manometer (App B, Item 72)
 Tubing, nonmetallic (App B, Item 110)

EXPENDABLE/DURABLE SUPPLIES

Mercury (App C, Item 23)

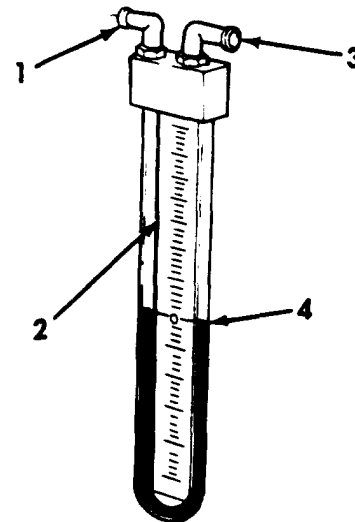
EQUIPMENT CONDITION

Para Description
 4-2 Prepare engine for start-up

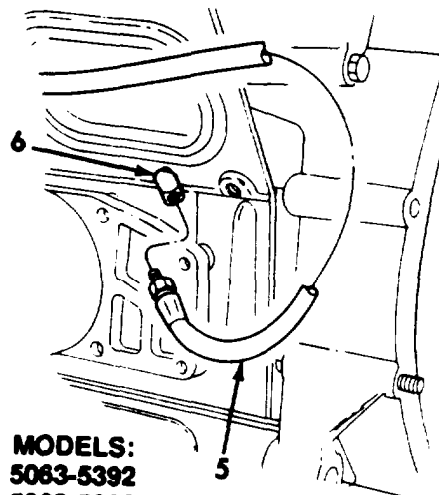
Testing

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.



- Remove one tube connector (1) from manometer (2) by rotating counterclockwise.
- Turn remaining tube connector (3) clockwise until fully engaged and then back out one full turn.
- Add mercury to manometer (2) until mercury level (4) is opposite zero mark on scale with manometer vertical.
- Install tube connector (1) until fully engaged and then back out one full turn.
- On models 5063-5392, 5063-5393 and 5063-539L, disconnect air box drain tube (5) from elbow (6) in cylinder block. Plug air box drain tube routed to engine crankcase.



MODELS:
 5063-5392
 5063-5393
 ■ 5063-539L

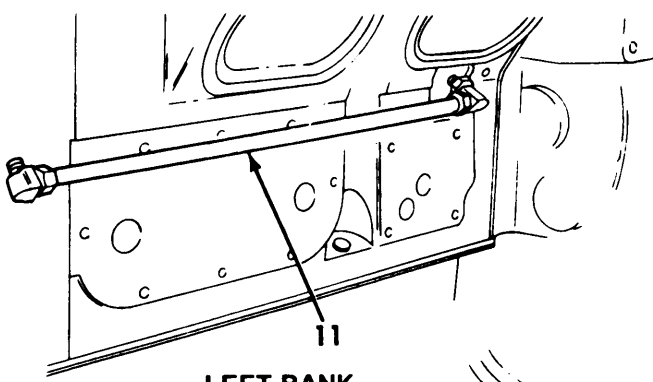
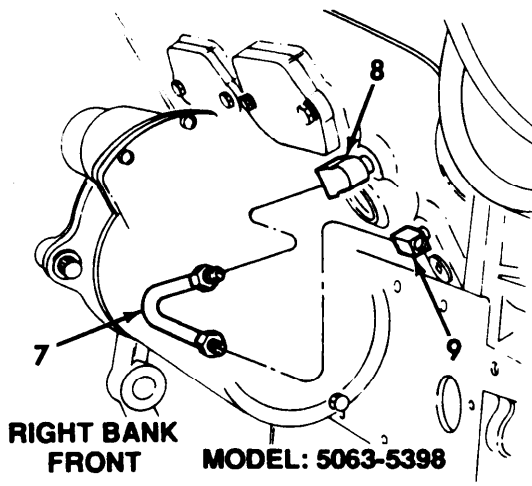
LEFT BANK REAR

- f. On model 5063-5398, remove air box drain tube (7) from elbows (8 and 9) in right side of cylinder block. Plug lower elbow (9) routed to engine crankcase.

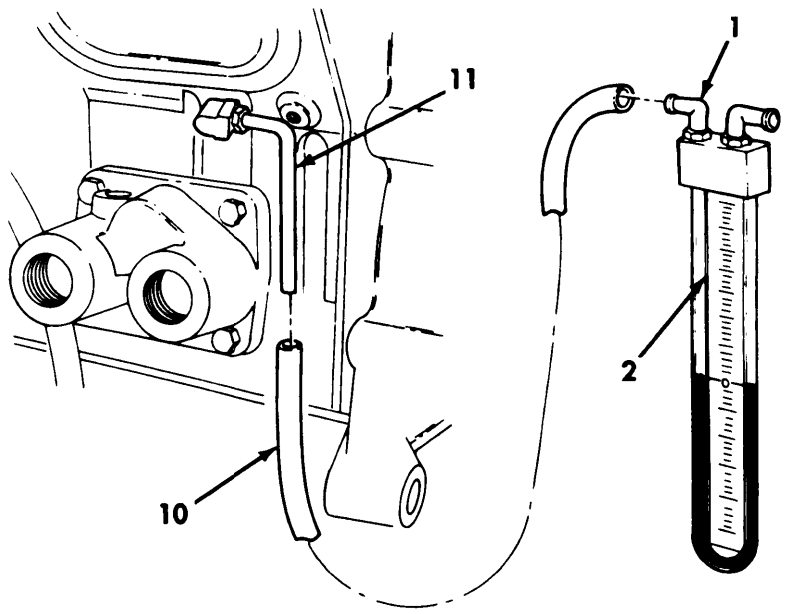
NOTE

Ensure air box drain tube and elbow are not plugged with sludge or debris.

- g. Connect nonmetallic tubing (10) to air box drain tube (11), elbow (6), or elbow (8) and to tube connector (1). Close tube connector connected to nonmetallic tubing.
- h. Mount manometer (2) in a vertical position and adjust scale until zero mark is opposite mercury level.



LEFT BANK FRONT



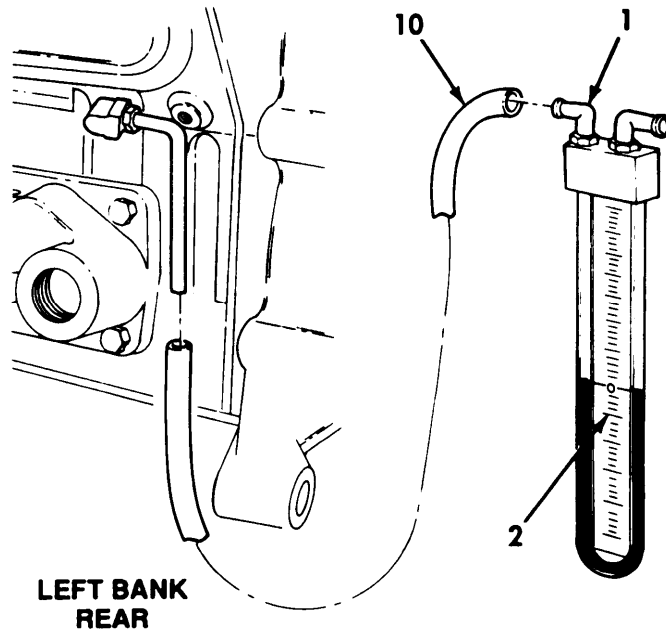
4-9. AIR BOX PRESSURE TEST (Cont)

WARNING

- Avoid contact with hot manifolds, pulleys, and other moving parts to avoid personal injury.
 - Wear proper ear protection when running engine. Noise volume of engine can cause hearing loss or injury.
- i. Start engine and operate at 2800 RPM, FULL LOAD. Slowly open tube connector (1) and read air box pressure on manometer scale.

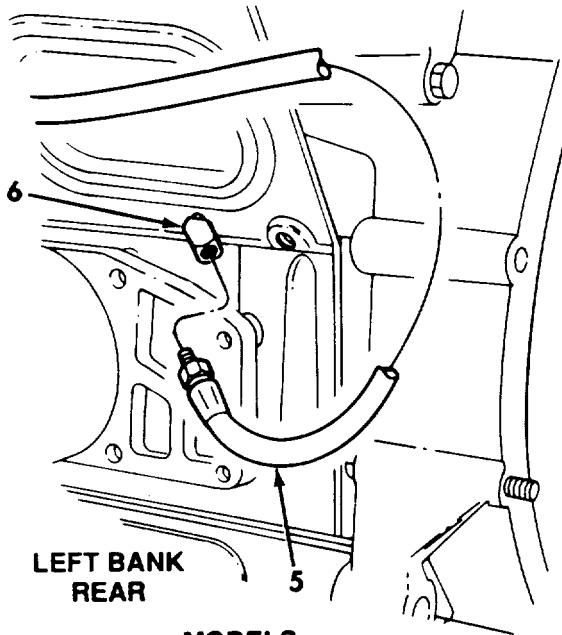
NOTE

- A 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.



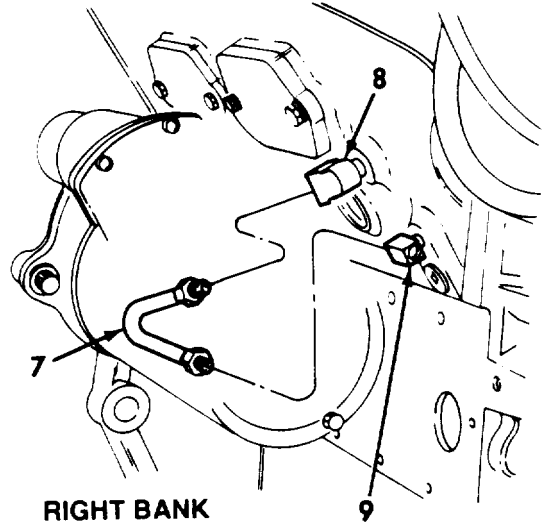
- L Stop engine by moving governor stop lever to NO FULL position.
- k. Disconnect nonmetallic tubing (10) from air box drain tube, or fitting, and manometer (2).

- l. On models 5063-5392, 5063-5393 and 5063-539L, connect air box drain tube (5) to elbow (6).
- m. On model 5063-5398, install air box drain tube (7) to elbows (8 and 9) in cylinder block.



**LEFT BANK
REAR**

**MODELS:
5063-5392
5063-5393
■ 5063-539L**



**RIGHT BANK
FRONT**

MODEL: 5063-5398

END OF TASK

Section V. ENGINE RUN-IN AND PREPARATION FOR STORAGE

Contents	Para	Page
Engine Run-in and Internal Components Preservation	4-10 . .	4-42
Preparation of Engine for Storage	4-11 . .	4-52

4-10. ENGINE RUN-IN AND INTERNAL COMPONENTS PRESERVATION

This task covers: a. Run-In Procedure b. Horsepower Correction and Acceptance Test
c. Preservation of Internal Components

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool kit, general mechanics (App B, Item 107)

EXPENDABLE/DURABLE SUPPLIES

Oil, fuel (App C, Item 27)
Oil, engine (App C, Item 26)
Oil, preservative (App C, Item 29)

EQUIPMENT CONDITION

Para Description
4-2 Engine prepared for start-up

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.

a. Run-In Procedure.

NOTE

- During Period 1, Table 4-2; remove rocker arm covers, inspect for fuel oil and coolant leaks in the rocker arm compartment, and install rocker arm covers (Refer to Para 3-20, 3-21, or 3-22).
- Ž After completion of Period 2, Table 4-2; adjust governor gap (Refer to Para 4-4).
- Ž After completion of Period 5, Table 4-2; adjust idle speed, no-load speed, and buffer screw (Refer to Para 4-4).

- (1) Using appropriate run-in schedule (Table 4-2), start and run engine. Record the following data for each run-in period.
 - (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 4-2).

- (j) Barometric pressure
- (k) Ambient air wet bulb temperature.
- (l) Ambient air dry bulb temperature.

Table 4-2, Run-In Schedule					
Period Number	Time (Minutes)	Engine Speed (RPM)	Load (Brake Horsepower)		
			Model 5063-5299	Models 5063-5392 5063-5393 5063-539F 5063-539L	Models 5063-5395 5063-5398
1	5	IDLE	0	0	0
2	30	2800	N/A	N/A	0
3	10	1800	30	30	N/A
4	10	1500	N/A	N/A	30
5	30	2200	130	120	130
6	30	2500	N/A	180	200
7	30	2800	171	200	225
8	10	2800	Full Power	Full Power	Full Power
9	5	IDLE (Cooling Off)	0	0	0

N/A = Not Applicable

- (2) Tighten cylinder head bolts (Refer to Para 3-43) and adjust exhaust valve clearance (Refer to Para 4-4) after run-in.

4-10. RUN-IN OF ENGINE (Cont)

b. Horsepower Correction and Acceptance Test.

(1) See Table 4-3 for listing of required terms.

Table 4-3. List of Required Terms		
Symbol	Name	Units
BARO_o	Observed Barometric Pressure	inches Hg
BARO_d	Dry Barometric Pressure	inches Hg
T	Engine Air Intake Temperature	°F
T_{db}	Dry Bulb Temperature	°F
T_{wb}	Wet Bulb Temperature	°F
VP	Water Vapor Pressure	inches Hg
CF_a	Air Correction Factor	HP
CF_{sg}	Fuel Specific Gravity Correction Factor	HP
CF_{ft}	Fuel Temperature Correction Factor	HP
BHP_o	Brake Horsepower Observed	HP
BHP_c	Brake Horsepower Corrected	HP

(2) Dry Barometric Pressure.

- (a) Measure wet-bulb and dry-bulb temperatures (**T_{wb}** and **T_{db}**).
- (b) Record observed local barometric pressure (**BARO_o**).
- (c) Refer to Table 4-4 for water vapor pressure (**VP**) at observed wet-bulb and dry-bulb temperatures.
- (d) Dry barometric pressure is:

$$\mathbf{BARO_d = BARO_o - VP}$$

		Table 4-4. Water Vapor Pressure (inches HG)								
		Wet Bulb Temperature – Twb – °F								
		50	55	60	65	70	75	80	85	90
D	55	0.31	0.43							
r	60	0.25	0.38	0.52						
γ	65	0.27	0.33	0.47	0.62					
	70	0.15	0.27	0.41	0.57	0.74				
B	75	0.09	0.22	0.36	0.51	0.68	0.87			
u	80	0.04	0.17	0.30	0.46	0.63	0.82	1.03		
l	85	0.00	0.12	0.25	0.41	0.57	0.76	0.97	1.21	
b	90	0.00	0.07	0.20	0.35	0.52	0.71	0.92	1.15	1.42
	95	0.00	0.01	0.14	0.30	0.46	0.65	0.86	1.10	1.36
	100		0.00	0.09	0.24	0.41	0.60	0.81	1.05	1.31
Tdb	105		0.00	0.04	0.19	0.36	0.54	0.75	0.99	1.25
	110			0.00	0.13	0.30	0.49	0.70	0.94	1.20
	115			0.00	0.09	0.25	0.44	0.65	0.88	1.15
°F	120			0.00	0.03	0.20	0.39	0.60	0.83	1.10
	125				0.00	0.13	0.33	0.54	0.78	1.04

4-10. RUN-IN OF ENGINE (Cont)

(3) Air Correction Factor (CFa).

(a) Measure air inlet temperature (T) at air cleaner during test.

(b) Refer to Table 4-5, 4-6, or 4-7 of appropriate model for air correction factor (CFa) using air inlet temperature (T) and dry barometric pressure (BAROd).

Table 4-5. Air Correction Factor (CFa) in BHP Model 5063-5299										
		Dry Barometric Pressure - (BAROd) – inches Hg								
		24.00	25.00	26.00	27.00	28.00	28.50	29.00	29.50	30.00
T	60	8	6	4	3	1	0	0	-1	-2
e	65	8	6	4	3	1	1	0	-1	-2
m	70	8	6	5	3	2	1	0	-1	-1
p	75	9	7	5	3	2	1	0	0	-1
e	80	9	7	5	4	2	1	1	0	-1
r	85	9	7	6	4	2	2	1	0	0
a	90	9	8	6	4	3	2	1	0	0
t	95	10	8	6	5	3	2	1	1	0
u	100	10	8	6	5	3	2	2	1	0
r	105	10	8	7	5	3	3	2	1	1
e	110	10	9	7	5	4	3	2	2	1
	115	11	9	7	6	4	3	3	2	1
T	120	11	9	7	6	4	4	3	2	1
	125	11	9	8	6	5	4	3	2	2
°F										

Table 4-6, Air Correction Factor (CF _a) in BHP Models 5063-5392, 5063-5393 and 5063-539L										
		Dry Barometric Pressure - (BARO _d) - inches Hg								
		24.00	25.00	26.00	27.00	28.00	26.50	29.00	29.50	30.00
T	60	6	4	3	1	0	-1	-2	-2	-3
e	65	6	5	3	2	0	0	-1	-2	-2
m	70	7	5	4	2	1	0	0	-1	-2
p	75	8	6	5	3	2	1	0	0	-1
e	80	8	7	5	4	2	2	1	0	0
r	85	9	7	6	4	3	2	2	1	0
a	90	10	8	6	5	3	3	2	1	1
t	95	10	9	7	6	4	3	3	2	1
u	100	11	9	8	6	5	4	3	3	2
r	105	11	10	8	7	5	5	4	3	3
e	110	12	10	9	7	6	5	5	4	3
	115	13	11	9	8	6	6	5	4	4
T	120	13	12	10	8	7	6	6	5	4
	125	14	12	11	9	8	7	6	6	5
°F										

Table 4-7, Air Correction Factor (CF _a) in BHP Models 5063-5395, 5063-5398, and 5063-539F										
		Dry Barometric Pressure - (BARO _d) - inches Hg								
		24.00	25.00	26.00	27.00	28.00	28.50	29.00	29.50	30.00
T	60	6	5	3	1	0	-1	-2	-2	-3
e	65	7	5	4	2	0	0	-1	-2	-2
m	70	8	6	4	3	1	0	0	-1	-2
p	75	8	7	5	3	2	1	0	0	-1
e	80	9	8	6	4	3	2	1	0	0
r	85	10	9	7	5	4	3	2	2	1
a	90	11	9	8	6	4	3	3	2	2
t	95	11	9	8	6	4	3	3	2	2
u	100	12	10	8	7	5	4	4	3	2
r	105	12	11	9	7	6	5	4	4	3
e	110	13	11	10	8	6	5	5	4	3
	115	14	12	10	9	7	6	6	5	4
T	120	14	13	11	9	8	6	6	5	5
	125	15	13	12	10	8	7	7	6	5
°F										

4-10. RUN-IN OF ENGINE (Cont)

(4) Fuel specific gravity correction factor (CF_{sg}).

(a) Measure fuel specific gravity and correct to 60 °F (15.6°C).

(b) Refer to Figure 4-1 for fuel specific gravity correction factor (CF_{sg}).

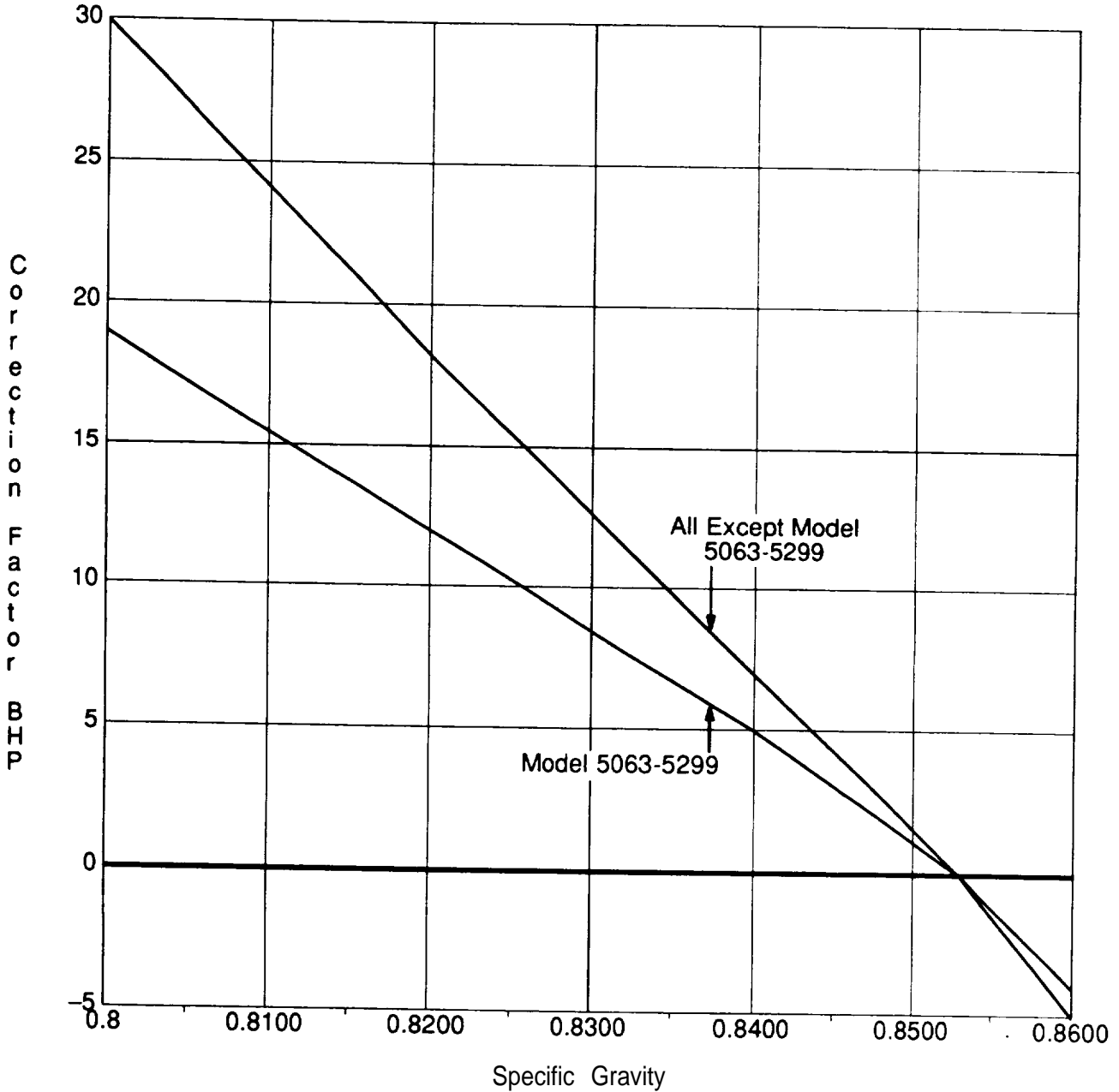


Figure 4-1. Fuel Specific Gravity Correction Factor (CF_{sg}) in BHP

(5) Fuel temperature correction factor (CF_{ft}).

(a) Measure fuel temperature at fuel filter outlet,

(b) Refer to Figure 4-2 for fuel temperature correction factor (CF_{ft}).

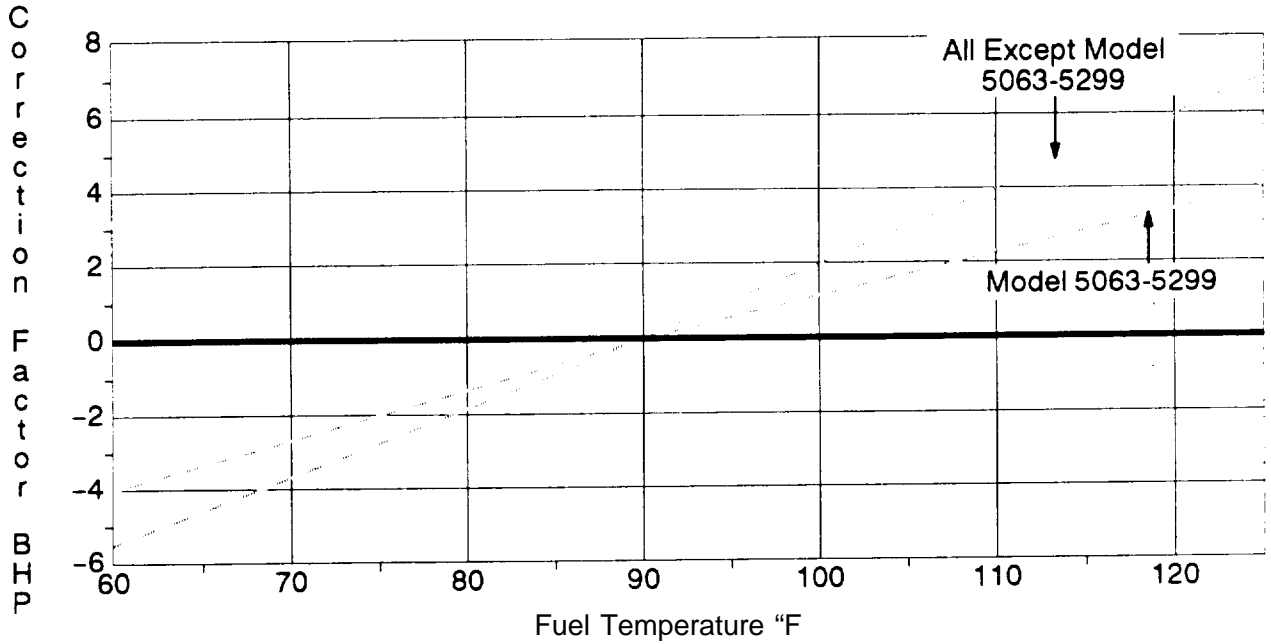


Figure 4-2. Fuel Temperature Correction Factor (CF_{ft}) in BHP

(6) Corrected brake horsepower (BHP_c).

$$BHP_c = BHP_o + CF_a + CF_{sg} + CF_{ft}$$

(7) Minimum acceptable corrected brake horsepowers are as follows:

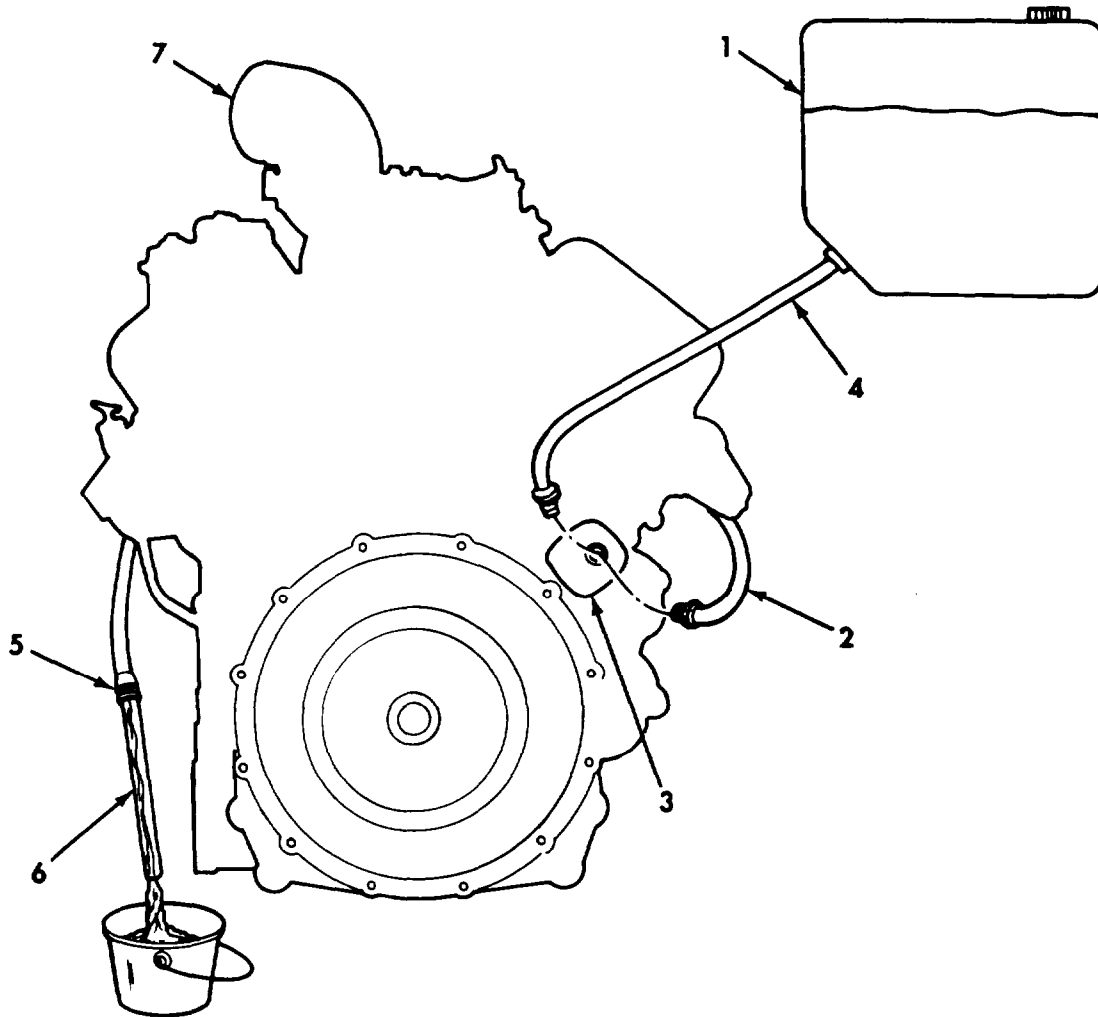
- Model 5063-5299 204 BHP
- Models 5063-5392, 5063-5393 and 5063-539L 261 BHP
- Models 5063-5395, 5063-5398, and 5063-539F 285 BHP

4-10. RUN-IN OF ENGINE (Cont)

c. Preservation of Internal Components

(1) Preservation of fuel system.

- (a) Equip an auxiliary fuel container (1) with a fuel line and fill container with a sufficient amount of preservation oil.
- (b) Locate the auxiliary fuel container (1) to provide adequate pressure for proper supply of preservation oil to the fuel system.



- (c) Disconnect fuel line (2) at inlet of fuel pump (3) and connect auxiliary fuel line (4).
- (d) Disconnect the engine fuel return at the quick disconnect coupling (5). Connect a transparent plastic line (6) at this point and insert opposite end into a suitable container to collect return fuel. Discard diluted preservation oil.
- (e) 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.

- (2) Preservation of combustion chamber and valves.
- (a) Open fuel valve from the auxiliary fuel container (1).

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.

- (b) Cover air inlet (7) 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.
- (c) Close fuel valve from the auxiliary fuel container (1), uncover air inlet (7), and discard diluted preservation oil.
- (d) Disconnect auxiliary fuel line (4) at inlet of fuel pump (3) and connect engine fuel line (2).
- (e) Disconnect the transparent plastic line (6) at the quick disconnect coupling (5).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

4-11 Prepare engine for storage.

4-11. PREPARATION OF ENGINE FOR STORAGE

This task covers: a. Protection of Overhead Assemblies
c. Draining Engine

b. Protection of Crankshaft
d. Cleaning Engine

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

Tool set, general mechanics (App B, Item 107)
Wrench, oil filter (App B, Item 114)
Sling, beam-type (App B, Item 92)

MATERIALS/PARTS

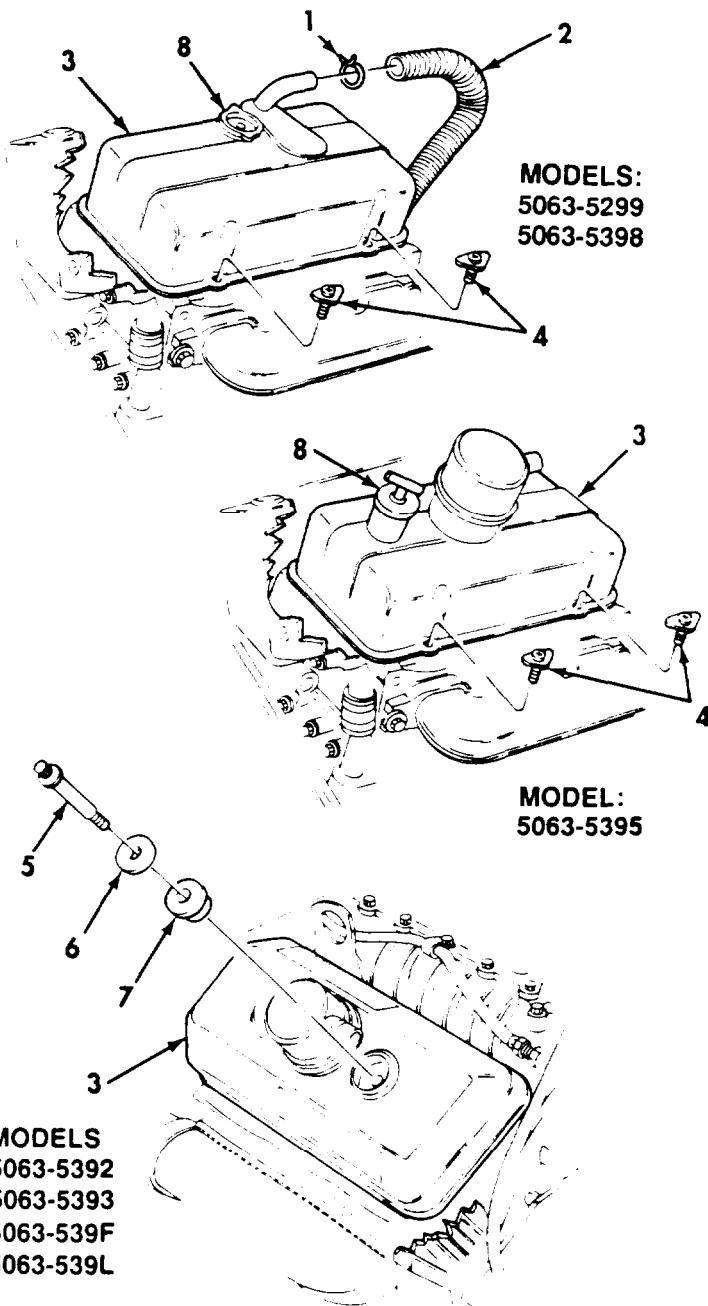
- 1 Filter element, fluid (App F, Item 22)
(model 5063-5393)

EXPENDABLE/DURABLE SUPPLIES

Masking tape (App C, Item 52)
Cleaning solvent (App CI Item 9)

a. Protection of Overhead Assemblies

- (1) On model 5063-5299, remove clamp (1) and hose (2) from left rocker arm cover (3). Remove hose and clamp.
- (2) On models 5063-5299, 5063-5395, and 5063-5398, remove four clamp and screw assemblies (4) and rocker arm cover (3) from each cylinder head.
- (3) On models 5063-5392, 5063-5393, 5063-539F and 5063-539L, remove two bolts (5), two flat washers (6), two resilient mounts (7), and rocker arm cover (3) from each cylinder head.
- (4) Slowly pour one-half gallon of engine oil over valves and valve train components of both cylinder heads.
- (5) On models 5063-5299, 5063-5395, and 5063-5398, install rocker arm cover (3) and four clamp and screw assemblies (4) on cylinder head. Tighten clamp and screw assemblies.
- (6) On models 5063-5392, 5063-5393, 5063-539F and 5063-539L, install rocker arm cover (3), two resilient mounts (7), two flat washers (6), and two bolts (5) on each cylinder head.
- (7) On model 5063-5299, install hose (2) and clamp (1) on rocker arm cover (3).



b. Protection of Crankshaft

- (1) Remove oil filler cap (8).

- (2) When possible, fill the crankcase with oil to a proximately 15 inches (38 cm) below the top of the oil gage 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 (8).

c. 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. Equipment may drop or shift and injury to personnel may result.

- (1) Lift engine using a beam-type sling (9) attached to lifting brackets (10). Use a hoist with a minimum lifting capacity of 1.5 tons (1.36 metric tons).

NOTE

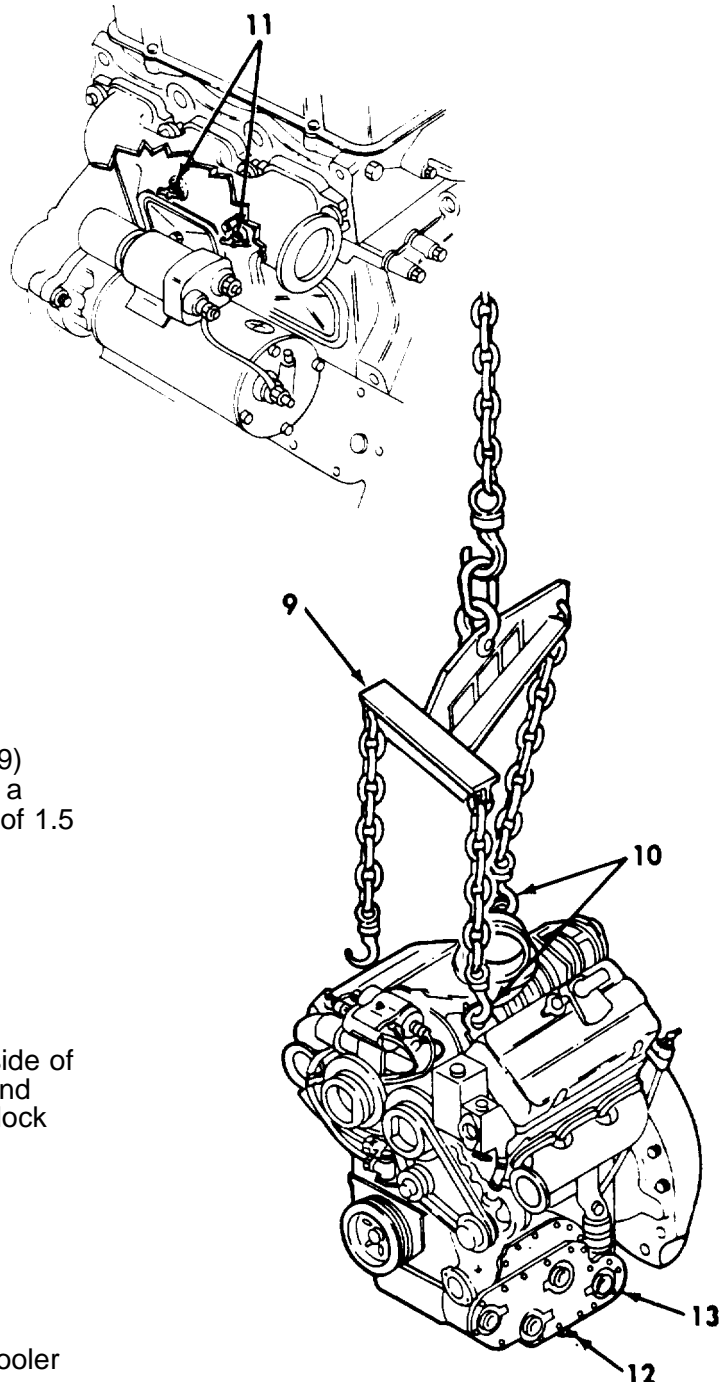
Model 5063-5398 has only two drain cocks, one on each side of engine.

- (2) Open two drain cocks (11) on right side of cylinder block and one on left side and drain engine coolant from cylinder block into a suitable container.

NOTE

Models 5063-5392, 5063-5393, and 5063-539L have a plug instead of a drain cock.

- (3) Open drain cock (12) in bottom of cooler (13) and drain coolant from oil cooler.



4-11. PREPARATION OF ENGINE FOR STORAGE (Cont)

- (4) For models 5063-5393 and 5063-539L only, remove plu (14) in the bottom of transmission cooler (15) and drain coolant from cooler.

NOTE

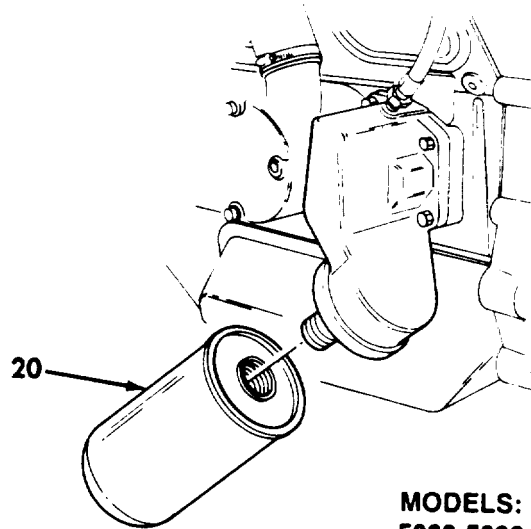
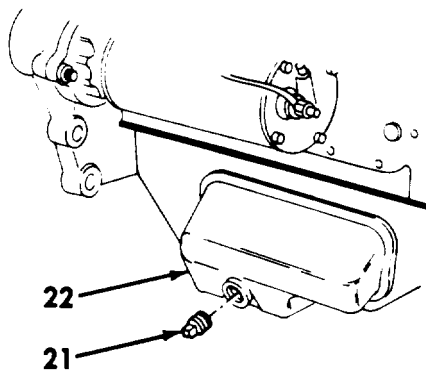
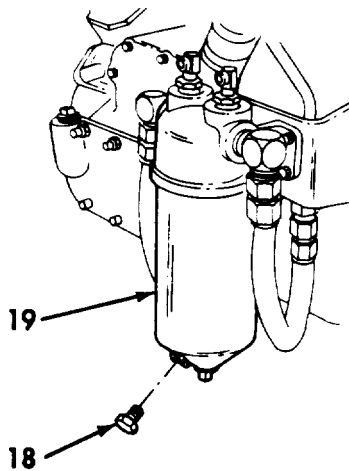
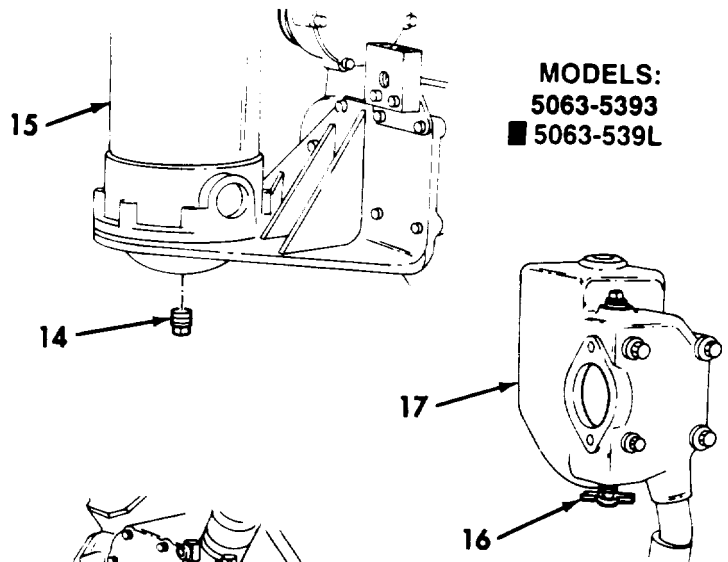
Models 5063-5393 and 5063-539L have no coolant drain at thermostat housing.

- (5) Open drain cock (16) and drain coolant from thermostat housing (17).
- (6) After coolant is drained, close drain cocks (11), (12), and (16). Install plugs in bottom of transmission cooler (15) and engine cooler (13).

NOTE

In model 5063-5299, oil filter is remote mounted in the vehicle.

- (7) Remove plug (18) in bottom of oil filter housing (19) and drain oil into a separate container. Replace plug. For models 5063-5393 and 5063-539L, remove spin-on oil filter (20) with oil filter wrench. Discard filter.



MODELS:
5063-5393
■ 5063-539L

- (8) Remove plug (21) from bottom of either left or right side of oil pan (22) and drain oil. Replace drain plug.

NOTE

In model 5063-5299, fuel filters are remote mounted in the vehicle.

- (9) Open drain cocks (23) and drain fuel from fuel filters (24) into a separate container.
- (10) After fuel is drained, close drain cocks (23).

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. Equipment may drop or shift and injury to personnel may result.

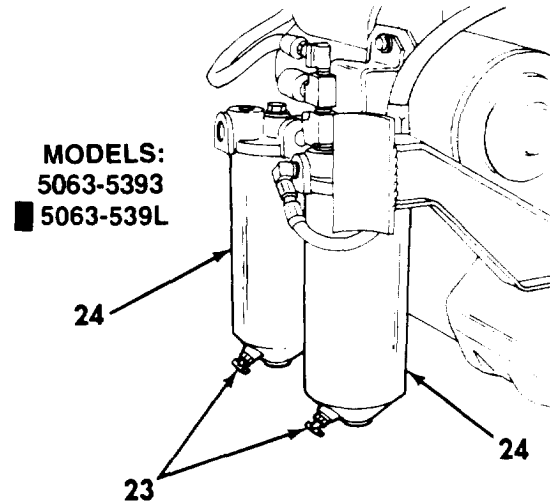
- (11) Lower engine and remove beam-type sling (9).

d. 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.



4-11. PREPARATION OF ENGINE PRIOR TO REMOVAL OF ENGINE ACCESSORIES AND INSTALLATION ON MAINTENANCE STAND (Cont)

- Dry cleaning solvent P-D-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 (38-50°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.
- Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.)

(3) Remove oil and grease from exterior of engine using a stiff brush and cleaning solvent. Blow dry with compressed air.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description

2-30 Install engine in container (model 5063-5299).

2-31 Install engine in container (models 5063-5299, 5063-5392, 5063-5393 and 5063-539L).

2-32 Install engine in container (models 5063-5395, 5063-5398, and 5063-539F).

APPENDIX A REFERENCES

A-1 SCOPE

This appendix lists all forms, field manuals, technical manuals, and other publications referenced in this manual. It also lists publications that should be consulted for additional information about engine operation.

A-2. PUBLICATION INDEXES

The following indexes should be consulted for latest changes or revisions to references given in this appendix and for new publications or instructions relating to material covered in this manual.

Consolidated Index of Army Publications and Blank Forms DA PAM 25-30
 The Army Maintenance Management System (TAMMS) DA PAM 738-750

A-3. MAINTENANCE FORMS AND RECORDS

Recommended Changes to DA Publications DA Form 2028
 Recommended Changes to Equipment Technical Manuals DA Form 2028-2
 Quality Deficiency Report SF 368

A-4. REGULATIONS

Accident Reporting and Records.. AR-385-40

A-5. LUBRICATION

Lubrication Order for Carrier, Guided Missile Equipment, Self-propelled, M730A2 . . . LO 9-1450-300-12
 Lubrication Order for Carrier, Guided Missile Equipment, M667 LO 9-1450-485-12
 Lubrication Order for Carrier, Guided Missile Equipment, M730/M730A1 LO 9-1450-585-12
 Lubrication Order for Carrier, Personnel, Full-tracked, Armored, M113A1,
 Carrier, Command Post, Light, Tracked, M577A1,
 Carrier, Mortar, 107mm, Self-propelled, M106A1,
 Carrier, Mortar, 81 mm, Self-propelled, M125A1, and
 Chassis, Gun, Anti-aircraft Artillery, 20mm, Self-propelled, M741 LO 9-2300-257-12
 Lubrication Order for Armored, Reconnaissance/Airborne Assault Vehicle,
 Full-tracked, 152mm, M551A1/M551NTC. L09-2350-230-12
 Lubrication Order for Carrier, Cargo, Full-tracked, M548/M548AI and
 M1015/M1015A1 L09-2350-247-12
 Lubrication Order for Carrier, Tow Missile, Anti-tank Improved, M901A1 LO 9-2350-259-12
 Lubrication Order for Carrier, Personnel, Full-tracked, Armored, M113A2,
 Carrier, Command Post, Light, Tracked, M577A2,
 Carrier, Mortar, 107mm, Self-propelled, M106A2,
 Carrier, Smoke Generator, Full-tracked, M1059,
 Carrier, Mortar, 81mm, Self-propelled, M125A2, and
 Chassis, Gun, Anti-aircraft Artillery, 20mm, Self-propelled, M741A1 LO 9-2350-261-12

A-5. LUBRICATION (Cont)

Lubrication Order for Vehicle, Fire support Team, M981 LO 9-2350-266-12
Lubrication Order for Carrier, Personnel, Full-tracked, Armored, M113A3 LO 9-2350-277-12

A-6. FIELD MANUALS

Operation and Maintenance of Ordnance Material in Cold Weather FM 9-207
First Aid for Soldiers FM 21-11
Basic Cold Weather Manual FM 31-70
Desert Operations (How to Fight) FM 90-3

A-7. TECHNICAL MANUALS

inspection, Care, and Maintenance of Antifriction Bearings TM 9-214
Welding: Theory and Application.. TM 9-237
Use and Care of Hand Tools and Measuring Tools TM 9-243
Materials Used for Cleaning, Preserving, Abrading, and Cementing Ordnance Materiel
and Related Parts TM 9-247
Data Sheets for Ordnance Type Materiel TM 9-500
Technical Manuals for Carrier, Guided Missile Equipment, Self-propelled,
M130A2 TM 9-1450-300-Series
Technical Manuals for Carrier, Guided Missile Equipment, M667 , TM9-1450-485-Series
Technical Manuals for Carrier, Guided Missile Equipment, M730/M730A1 TM 9-1450-585-Series
Technical Manuals for
Carrier, Personnel, Full-tracked, Armored, M113A1,
Carrier, Command Post, Light, Tracked, M577A1,
Carrier, Mortar, 107mm, Self-propelled, M106A1,
Carrier, Mortar, 81mm, Self-propelled, MI 25A1, and
Chassis, Gun, Anti-aircraft Artillery, 20mm, Self-propelled, M741 TM 9-2300-257-Series
Technical Manuals for Armored, Reconnaissance/Airborne Assault Vehicle,
Full-tracked, 152mm, M551A1/M551 NTC TM 9-2350-230-Series
Technical Manuals for Carrier, Cargo, Full-tracked, M548/M548AI and
M1015/M1015A1 TM 9-2350-247-Series
Technical Manuals for Carrier, Tow Missile, Anti-tank Improved, M901 AI TM 9-2350-259-Series
Technical Manuals for
Carrier, Personnel, Full-tracked, Armored, M113A2,
Carrier, Command Post, Light, Tracked, M577A2,
Carrier, Mortar, 107mm, Self-propelled, M106A2,
Carrier, Smoke Generator, Full-tracked, M1059,
Carrier, Mortar, 81mm, Self-propelled, M125A2, and
Chassis, Gun, Anti-aircraft Artillery, 20mm, Self-propelled, M741A1 TM 9-2350-261-Series
Technical Manuals for Vehicle, Fire Support Team, M981 TM 9-2350-266-Series
Technical Manuals for Carrier, Personnel, Full-tracked, Armored, M113A3 TM 9-2350-277-Series

Direct Support and General Support Maintenance

Repair Parts and Special Tools List for

- Engine w/Container: Model 5063-5299 (NSN 2815-00-124-5390) and (NSN 2815-01-295-7458),
- Engine w/Container: Model 5063-5392 (NSN 2815-01-246-0903),
- Engine w/Container: Model 5063-5393 (NSN 2815-01-248-7644),
- Engine w/Container: Model 5063-5395 (NSN 2815-01-031-6154),
- Engine w/Container: Model 5063-5398 (NSN 2815-00-909-5949), and
- Engine w/Container: Model 5063-539F (NSN 2815-01-316-617) TM 9-2815-205-34P

- Principles of Automotive Vehicles TM 9-8000
- Preservation, Packaging, and Packing of Military Supplies and Equipment TM 38-230-1
- Preservation, Packaging, and Packing of Military Supplies and Equipment TM 38-230-2
- Procedures for Destruction of Tank — Automotive Equipment to Prevent
Enemy Use TM 750-244-750

A-8. TECHNICAL BULLETINS

- Depot Reconditioning of Type I and Type II Reusable Metal Containers TB 9-289
- Ordnance Engines: Run-In and Test Procedures TB 9-2800-200-50
- DA Technical Bulletin Warranty Program
 - Direct Support and General Support Maintenance TB 9-2815-205-34
 - Army Oil Analysis Program TB43-0210
 - Maintenance in the Desert TB 43-0239

A-9. MILITARY SPECIFICATIONS

- Clean Process MIL-P-116
- Military Standard Marking for Shipment and Storage MIL-STD-129
- Magnetic Particle Inspection MIL-STD-1949

A-10. SUPPLY CATALOGS

- Shop Equipment Automotive Maintenance and Repair:
 - Field Maintenance, Supplemental No. 1, Less Power
(NSN 4910-00-754-0706) and
 - Shop Equipment Automotive Maintenance and Repair:
 - Field Maintenance, Supplemental No. 1,
Map Only (NSN 4910 -00-919 -0078).... . SC4910-95-A62
 - Shop Equipment Automotive Maintenance and Repair:
 - Field Maintenance, Supplemental No. 2, Less Power
(NSN 4910-00-754-0707) and
 - Shop Equipment Automotive Maintenance and Repair:
 - Field Maintenance, Supplemental No. 2,
Map Only (NSN 4910 -00-919 -0093).... . SC4910-95-A63
 - Shop Equipment General Purpose Repair:
 - Semitrailer Mounted (NSN 4940-00-287-4895) SC 4940-95 -CL-B02

A-10. SUPPLY CATALOGS (Cont)

Shop Equipment, Fuel and Electrical System Engine:

Field Maintenance, Less Power (NSN 4940-00-754-0714) and

Shop Equipment, Fuel and Electrical System Engine:

Field Maintenance, Map only (NSN 4940-00-919-0083) SC 4940-95-CL-B20

Tool Kit, General Mechanic's (NSN 5180-00-699-5273) SC 5180-90-CL-N05

APPENDIX B

TOOLS AND TEST EQUIPMENT SPECIAL TOOLS, AND COMMON TOOL SETS

Section L INTRODUCTION

B-1 SCOPE

This appendix lists all common tool sets and supplemental sets and special tools/fixtures needed to maintain the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L engines.

B-2 EXPLANATION OF COLUMNS

- a. Column 1 — Item Number. This number is assigned to the entry in the listing and is referenced in the Initial Setup to identify the item (e.g., "Cradle (App B, Item 19)").
- b. Column 2 — Description. This column lists the item by noun nomenclature and other descriptive features (e.g., "Puller, mechanical").
- c. Column 3 — Part Number. Indicates the primary number used by the manufacturer (individual, company, firm, corporation, or government activity) design and characteristics of the item by means of engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.
- d. Column 4 — National Stock Number. This column is the National Stock Number (NSN) assigned to the item; use it to requisition the item.
- e. Column 5 — **Reference.** This column identifies the authorizing Supply Catalog (SC) or Repair Parts and Special Tools List (RPSTL) for the items listed in this appendix.

Section II. COMMON TOOLS. SUPPLEMENTS. SPECIAL TOOLS AND FIXTURES LIST

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>	<u>(5)</u> <u>REFERENCE</u>
1	ADAPTER KIT, VALVE SEAT GRINDER	J7792-01		TM 9-2815-205-34P
2	ADAPTER, CYLINDER COMPRESSION	10934456	4910-00-019-5241	TM 9-28 15-205-34P
3	ADAPTER, DIAL INDICATOR	J21224	4910-00-907-0713	TM 9-2815-205-34P
4	ADAPTER, SLIP TORQUE	J23126	5120-01-169-5300	TM 9-2815-205-34P
5	ADAPTER, 3/8-1 6		5120-00-316-9170	SC 4940-95-CL-B02
6	ALIGNING STUDS, FLYWHEEL HOUSING	J7540	5120-00-872-6015	TM 9-2815-205-34P
7	ALIGNMENT TOOL, TACHOMETER	J23068	5180-01-025-8062	TM 9-2815-205-34P
8	BALL ATTACHMENT, MICROMETER	J4757	5210-00-494-1738	TM 9-2815-205-34P
9	BLOCK SET, LAPPING	J22090-A	3460-00-937-5521	TM 9-2815-205-34P
10	BRACKETS, ENGINE MOUNTING	11678105	2520-01-006-4589	TM 9-2815-205-34P
11	BRUSH, WIRE, BRASS	J7944	5130-00-937-7281	TM 9-2815-205-34P
12	CALIPERS, VERNIER (0-6.0 IN.)		5210-00-277-7549	SC 4940-95-CL-B02
13	CAPS, VISE JAW		5120-00-293-1439	SC 4940-95-CL-B20
14	CLAMP, CYLINDER LINER HOLD-DOWN	J21793-B	5120-00-999-8618	TM 9-2815-205-34P
15	CLEANER, PISTON RING GROOVE		5120-00-799-3398	SC 4940-95-CL-B02
16	COMPRESSOR, PISTON RING	J6883-01	5120-00-901-8651	TM 9-2815-205-34P
17	COMPRESSOR, VALVE SPRING HEAD OFF ENG	J8062	5120-00-254-5049	TM 9-2815-205-34P
18	COUPLING HALF		4730-00-176-4292	SC 4940-95-CL-B02
19	CRADLE	7950198	4910-00-795-0198	TM 9-2815-205-34P
20	DIE SET, METAL STAMPING, HAND		5120-00-293-1905	SC 4940-95-CL-B02
21	DRAIN UNIT	8708359	4930-00-545-8639	TM 9-2815-205-34P
22	DRILL SET, TWIST		5133-00-293-0983	SC 4940-95-CL-B02
23	DRILL, ELECTRIC, PORTABLE		5130-00-889-8996	SC 4940-95-CL-B02
24	EXPANDER, OIL SEAL, FRONT	J7454	4910-00-591-6640	TM 9-2815-205-34P
25	EXPANDER, OIL SEAL, REAR	J9769	5120-00-918-0587	TM 9-2815-205-34P
26	FIXTURE, CAM FOLLOWER HOLDING	10881910	2815-00-705-9278	TM 9-2815-205-34P
27	FIXTURE, CYLINDER HEAD LIFTING	J22062-01	4910-00-456-7620	TM 9-2815-205-34P
28	FIXTURE, INJECTOR HOLDING	J22396-1	5220-01-061-4248	TM 9-2815-205-34P
29	FIXTURE, INJECTOR TEST	65-928B	4910-00-355-6248	TM 9-2815-205-34P
30	FIXTURE, TURBOCHARGER HOLDING	J29086	4910-01-170-4914	TM 9-2815-205-34P
31	GAGE SET, DEPTH, MICROMETER		5210-00-619-4045	SC 4940-95-CL-B02
32	GAGE SET, PISTON-LINER THICKNESS	J5438-01	5210-00-116-1631	TM 9-2815-205-34P
33	GAGE SET, TELESCOPING		5210-00-473-9350	SC 4940-95-CL-B02
34	GAGE SET, THICKNESS	J1698-02	5210-01-245-9564	TM 9-2815-205-34P
35	GAGE, CYLINDER BORE		5210-00-494-1774	SC 4910-95-A63
36	GAGE, DEPTH	J22273-01	5210-00-023-4798	TM 9-2815-205-34P
37	GAGE, DIAL, VALVE SEAT	9320	4910-00-779-7103	TM 9-2815-205-34P
38	GAGE, FLYWHEEL HOUSING	J9737-C	5210-00-937-7284	TM 9-2815-205-34P
39	GAGE, FUEL PRESSURE	J8151	6620-00-671-4509	TM 9-2815-205-34P
40	GAGE, INJECTOR PROTRUSION	J25521	5220-01-167-4281	TM 9-2815-205-34P
41	GAGE, INJECTOR TIMING	J1853	5220-00-387-9581	TM 9-2815-205-34P
42	GAGE, INJECTOR TIMING	J9595	2930-01-242-4091	TM 9-2815-205-34P
43	GAGE, INJECTOR TIP & CONCENTRICITY	J29584	5210-00-990-3327	TM 9-2815-205-34P

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>	<u>(5)</u> <u>REFERENCE</u>
44	GAGE, NEEDLE VALVE HEIGHT	J9462-02	5210-00-937-7285	TM 9-2815-205-34P
45	GAGE, STARTING AID SCREW 0.345	J24889	5210-01-091-8354	TM 9-2815-205-34P
46	GAGE, STARTING AID SCREW 0.395	J28479		TM 9-2815-205-34P
47	GAGE, TIRE PRESSURE		5210-00-517-8097	SC 4940-95-CL-B02
48	GAGE, THROTTLE DELAY 0.454	J23190	5120-00-538-8465	TM 9-2815-205-34P
49	GRINDING KIT, VALVE SEAT		4910-00-473-6437	SC 4910-95-A63
50	HANDLE, SEAL INSTALLER	J3154-1	5120-00-808-5082	TM 9-2815-205-34P
51	HANDLE, SEAL INSTALLER	J7079-2	5120-00-977-5578	TM 9-2815-205-34P
52	HONE, CYLINDER		5130-00-991-0699	SC 4910-95-A63
53	INDICATOR, DIAL		5210-00-277-8840	SC 4940-95-CL-B02
54	INDICATOR, DIAL, MAGNETIC BASE	J7872	5210-00-402-9619	TM 9-2815-205-34P
55	INJECTOR TUBE RECONDITIONING SET		2910-00-146-9619	SC 4940-95-CL-B02
56	INSERTER, BEARING AND BUSHING	J1930	5120-00-363-7572	TM 9-2815-205-34P
57	INSTALLER, CRANKSHAFT GEAR	J7557	4910-00-736-1371	TM 9-2815-205-34P
58	INSTALLER, CRANKSHAFT OIL SEAL, FRONT	J9783	5120-00-936-4377	TM 9-2815-205-34P
59	INSTALLER, CRANKSHAFT OIL SEAL, REAR	J9479	5120-00-169-5806	TM 9-2815-205-34P
60	INSTALLER, CRANKSHAFT PLUG	J34650	5120-01-297-2374	TM 9-2815-205-34P
61	INSTALLER, CRANKSHAFT PULLEY	J7773	4910-00-779-6392	TM 9-2815-205-34P
62	INSTALLER, FRONT COVER SEAL	J9790	5120-00-937-6143	TM 9-2815-205-34P
63	INSTALLER, GOVERNOR COVER BEARING	J21068	4910-00-779-6078	TM 9-2815-205-34P
64	INSTALLER, INJECTOR TUBE-NEW STYLE	J5286-20	5120-01-248-7737	TM 9-2815-205-34P
65	INSTALLER, OIL PUMP GEAR	J8968-01	4910-00-169-5805	TM 9-2815-205-34P
66	INSTALLER, PISTON PIN RETAINER	J35572	5120-01-242-4092	TM 9-2815-205-34P
67	INSTALLER, PISTON PIN RETAINER	10881874	5120-00-733-8874	TM 9-2815-205-34P
68	INSTALLER, THERMOSTAT SEAL	J22091	5120-00-116-3652	TM 9-2815-205-34P
69	INSTALLER, VALVE GUIDE	J24519	5120-01-166-5167	TM 9-2815-205-34P
70	INSTALLER, VALVE SEAT	J7790	4910-00-603-8925	TM 9-2815-205-34P
71	LEAK DETECTOR, PISTON PIN RETAINER	J23987-01	5210-01-061-4253	TM 9-2815-205-34P
72	MANOMETER	J21478-1	6685-00-857-4895	TM 9-2815-205-34P
73	MICROMETER SET		5210-00-554-7134	SC 4910-95-A63
74	MULTIMETER, DIGITAL		6625-01-139-2512	SC 4940 -95-CL-B20
75	PLIERS, PISTON RING	J8128	5120-00-494-1846	TM 9-2815-205-34P
76	PLIERS, WIRE TWISTER	GA311-c	5120-01-112-5031	TM 9-2815-205-34P
77	PULLER SET, SLIDE HAMMER	J6471-02	5120-00-937-7266	TM 9-2815-205-34P
78	PULLER, CAMSHAFT GEAR	J1902-01	5120-00-219-8397	TM 9-2815-205-34P
79	PULLER, COMBINATION LEG	J24420-A	5180-00-999-4053	TM 9-2815-205-34P
80	PULLER, MECHANICAL		5120-00-293-1429	SC 4940-95 -CL-B02
81	PULLER, MECHANICAL THREE-LEG	J4871	5120-00-740-3345	TM 9-2815-205-34P
82	REAMER, CYLINDER RIDGE		5110-00-237-8598	SC 4940 -95-CL-B02
83	REAMER, INJECTOR BODY	J21089	5110-00-937-7628	TM 9-2815-205-34P
84	REMOVER ADAPTER, TACHOMETER DRIVE	J5901-3	5120-00-127-7831	TM 9-2815-205-34P
85	REMOVER KIT, CAMSHAFT BEARING	J7593-03	5180-01-167-8073	TM 9-2815-205-34P
86	REMOVER, CYLINDER LINER	J22490	5120-00-937-6140	TM 9-2815-205-34P
87	REMOVER, GOVERNOR COVER BEARING	J8985	4910-00"779-7315	TM 9-2815-205-34P
88	REMOVER, GOVERNOR COVER BUSHING	J21967-01	5120-01-145-4490	TM 9-2815-205-34P
89	REMOVER, TACHOMETER DRIVE	J24730	5120-01-048-3117	TM 9-2815-205-34P

COMMON TOOLS, SUPPLEMENTS, SPECIAL TOOLS AND FIXTURES LIST (Cont)

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>	<u>(5)</u> <u>REFERENCE</u>
90	REMOVER, VALVE GUIDE	J7775	4910-00-591-6632	TM 9-2815-205-34P
91	SHIELD, TURBOCHARGER INLET	J26554-A	4910-01-127-7959	TM 9-2815-205-34P
92	SLING, BEAM-TYPE	10942647	4910-00-646-6893	TM 9-2815-205-34P
93	SLING	10930560	3940-00-977-7398	TM 9-2815-205-34P
94	SPACER, GOVERNOR WEIGHT	J8984	4910-00-779-7308	TM 9-2815-205-34P
95	STAND, MAINTENANCE	7950189	4910-00-795-0189	TM 9-2815-205-34P
96	STRAIGHTEDGE		6675-00-224-8807	SC 4910-95-A63
97	STUDS, CYLINDER HEADGUIDE	J9665	4910-00-591-6634	TM 9-2815-205-34P
98	TENSIONMETER, DIAL INDICATOR	J23600-B	6635-01-093-3710	TM 9-2815-205-34P
99	TEST FIXTURE, DIESEL		4910-00-255-8641	SC 4940-95-CL-B02
100	TESTER, CYLINDER COMPRESSION	10899180	4910-00-870-6283	TM 9-2815-205-34P
101	TESTER, DIESEL FUEL		4910-00-355-6248	SC 4940-95-CL-B02
102	TESTER, DIESEL FUEL INJECTOR NOZZLE		4910-00-255-8641	SC 4940-95-CL-B20
103	TESTER, SPRING	J22738-02	4940-01-138-8259	TM 9-2815-205-34P
104	THREADING SET, SCREW		5180-00-317-8263	SC 4940-95-CL-B02
105	TOOL KIT, BLOWER	J23679-A	5180-01-035-1314	TM 9-2815-205-34P
106	TOOL KIT, DIESEL INJECTOR	J23435-C	5180-01-038-0251	TM 9-2815-205-34P
107	TOOL KIT, GENERAL MECHANICS		5180-00-699-5273	SC 5180-90-CL-N05
108	TOOL KIT, VALVE SEAT	J23479-453	5180-00-591-6631	TM 9-2815-205-34P
109	TOOL SET, FUEL PUMP	J1508-D	5180-00-219-8407	TM 9-2815-205-34P
110	TUBING, NONMETALLIC	564-0077-0114	720-00-271-9839	TM 9-2815-205-34P
111	WISE, MACHINIST		5120-00-293-1439	SC 4940-95-CL-B20
112	V-BLOCK		3460-00-725-5076	SC 4910-95-A63
113	WRENCH, FUEL NUT	10881875	5120-01-147-7923	TM 9-2815-205-34P
114	WRENCH, OIL FILTER	YA342A	5120-01-197-6720	TM 9-2815-205-34P
115	WRENCH, RETAINING NUT	J5895	5120-00-808-5230	TM 9-2815-205-34P
116	WRENCH, TORQUE 10-175 LB-FT		5120-00-640-6364	SC 4940-95-CL-B02
117	WRENCH, TORQUE 100-500 LB-FT	9033917	5120-00-542-5577	SC 4940-95-CL-B02
118	WRENCH, TORQUE 0-300 LB-IN	S30013-8	5120-00-958-6906	SC 4940-95-CL-B02

APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1 SCOPE

This appendix lists expendable supplies and materials needed to maintain the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L engines. These items are authorized by CTA 50-970. This appendix includes expendable items (except Medical, Class V, Repair Parts, and Heraldic items) and consumable materials.

C-2 EXPLANATION OF COLUMNS

- a. **Column 1 — 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., "Antiseize compound (App C, Item 4)").
- b. **Column 2 — Description.** This column lists the federal item name and a description to identify the item,
- c. **Column 3 — National Stock Number.** This column is the National Stock Number (NSN) assigned to the item; use it to requisition the item.
- d. **Column 4 — Unit of Measure (U/M).** This column indicates the measure used in performing the actual maintenance function. This measure is expressed by an alphabetical abbreviation (e.g, EA, IN, PR). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy the requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>	<u>(4)</u> <u>U/M</u>
1	ADHESIVE, GASKET	8040-00-941-9984	CA
2	ADHESIVE, RETAINING	8040-01-129-7171	BT
3	ANTIFREEZE	6850-00-181-7940	GAL
4	ANTISEIZE COMPOUND (MIL-A-907)	8030-00-597-5367	CN
5	CARBON REMOVING COMPOUND MIL-S-12382 (ORD) TYPE 1	6850-00-281-3044	GAL
6	CHAMOIS LEATHER, SHEEPSKIN	8330-01-010-9402	EA
7	CINDOL P/N 1705 (73277)		GAL
8	CLEANING SOLUTION, KIT	6850-00-598-7328	
9	CLEANING SOLVENT, P-D-680 1-QT CAN 1-GAL CAN	6850-00-664-5685 6850-00-281-1985	QT GAL
10	CROCUS CLOTH, P-C-458	5350-00-221-0872	EA
11	CORROSION PREVENTATIVE (MIL-C-11796)	8030-00-231-2353	CN
12	DESICCANT	6850-00-264-6572	PK
13	EMERY CLOTH		
14	FOOD COLORING	8950-00-823-7664	BT
15	FUEL LINE	4710-00-020-2734	EA
16	GAGE, PLASTIC, GREEN (0.001 THRU 0.003 IN. GAP) BOX OF 12	5210-00-640-6177	BX
17	GAGE, PLASTIC, RED (0.002 THRU 0.005 IN. GAP) BOX OF 12	5210-00-640-6178	BX
18	GREASE, MOLYBDENUM DISULFIDE	9150-01-091-9336	CN
19	HEAT INDICATING CRAYON		
20	HYDROCHLORIC ACID 16-OZ BOTTLE 90-OZ BOTTLE	6810-00-753-4786 6810-00-237-2955	PT BT
21	INTERNATIONAL COMPOUND NO. 2 P/N 5198563 (72582)		CN
22	LAPPING COMPOUND, P/N J3179-5 (33287)	5350-01-157-6916	EA
23	MERCURY	6810-00-281-7453	BT
24	NUT 3/8-16	5310-00-732-0558	EA
25	OIL, CUTTING	9150-00-076-1567	GAL
26	OIL, ENGINE SAE 15/40 (MIL-L-2104) 1-QT CAN 5-GAL DRUM 55-GAL DRUM	9150-01-152-4117 9150-01-152-4118 9150-01-152-4119	QT GAL GAL
27	OIL, FUEL DIESEL DF-2 REGULAR BULK 5-GAL CAN 55-GAL DRUM, 16 GAGE 55-GAL DRUM, 18 GAGE	9140-00-286-5294 9140-00-286-5295 9140-00-286-5296 9140-00-286-5297	GAL GAL GAL GAL

(1) ITEM NUMBER	(2) DESCRIPTION	(3) NATIONAL STOCK NUMBER	(4) U/M
28	OIL.LUBRICATING, PRESERVATIVE (MIL-L-21260)		
	1-QT CAN	9150-00-111-0201	PT
	5-GAL DRUM	9150-00-153-0207	QT
		9150-00-111-0208	GAL
29	OIL,PRESERVATION (MIL-C-1617 3)		
	5- GAL	8030-00-062-5866	GAL
	55-GAL	8030-00-244-1293	GAL
		8030-00-244-1294	GAL
30	OXALIC ACID		
	4-OZ BOTTLE	6810-00-132-4020	BT
	1-LB BOTTLE	6810-00-246-3947	LB
31	PLUG, PIPE 3/4 NPT	4730-01-161-1255	EA
32	PRUSSIAN BLUE PASTE	8010-00-652-3626	Oz
33	RAG, WIPING	7920-00-205-1711	LB
34	REDUCER, PIPE 3/4-1/4 NPT	4730-01-076-7697	EA
35	SCREW 3/8-16 X 2 1/2 IN.	5305-00-543-2866	EA
36	SCREW 3/8-16 X 2 1/4 IN.	5305-00-638-8920	EA
37	SCREW 3/8-16 X 3 IN.	5305-00-846-5703	EA
38	SCREW 3/8-16 X 3 1/2 IN.	5305-00-781-8927	EA
39	SCREW 5/16-18 X 2 1/2 IN.	5305-00-226-4835	EA
40	SCREW, SELF-TAPPING	5305-00-883-0625	EA
41	SEAL, CONTAINER	5330-01-142-4882	EA
42	SEAL, CONTAINER	5330-01-288-4550	EA
43	SEAL, CONTAINER	5330-01-288-9435	EA
44	SEALING- COMPOUND		
	250-CC	8030-00-181-7603	BT
		8030-00-181-7529	BT
45	SEALING COMPOUND, 567-47	8030-01-166-0675	TU
46	SEALING COMPOUND, MIL-R-46082	8030-00-180-6150	BX
47	SHORTENING COMPOUND	8945-01-277-6727	CN
48	SILICONE CARBIDE CLOTH, P-P-121	5350-00-224-7203	EA
49	SILICONE LUBRICANT	6850-01-139-4040	CN
50	STONE, SHARPENING	5345-00-198-8050	EA
51	STONE, SHARPENING X-FINE	5345-00-584-4607	EA
52	TAPE, MASKING	7510-00-290-2027	RO
53	STUD 5/16-18-24 X 9.60 IN.	2930-00-945-7430	EA
54	TRICLOROETHANE 1, 1, 1: 5-GAL PAIL		
		6810-00-664-0388	CN
55	WASHER, FLAT 3/8 IN.	5310-00-080-6004	EA
56	WASHER, FLAT 5/16 IN.	5310-00-081-4219	EA
57	WIRE	9525-00-618-0257	RL
58	WOOD BLOCK, 2 X 4 IN.		

APPENDIX D

ILLUSTRATED LIST OF MANUFACTURED ITEMS

Section 1. INTRODUCTION

D-1 SCOPE

This appendix includes complete instructions and materials for making items authorized to be manufactured or fabricated at direct and general support maintenance for the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L engines. All bulk materials needed for manufacture of an item are listed by part number or specification number in a tabular list on the illustration.

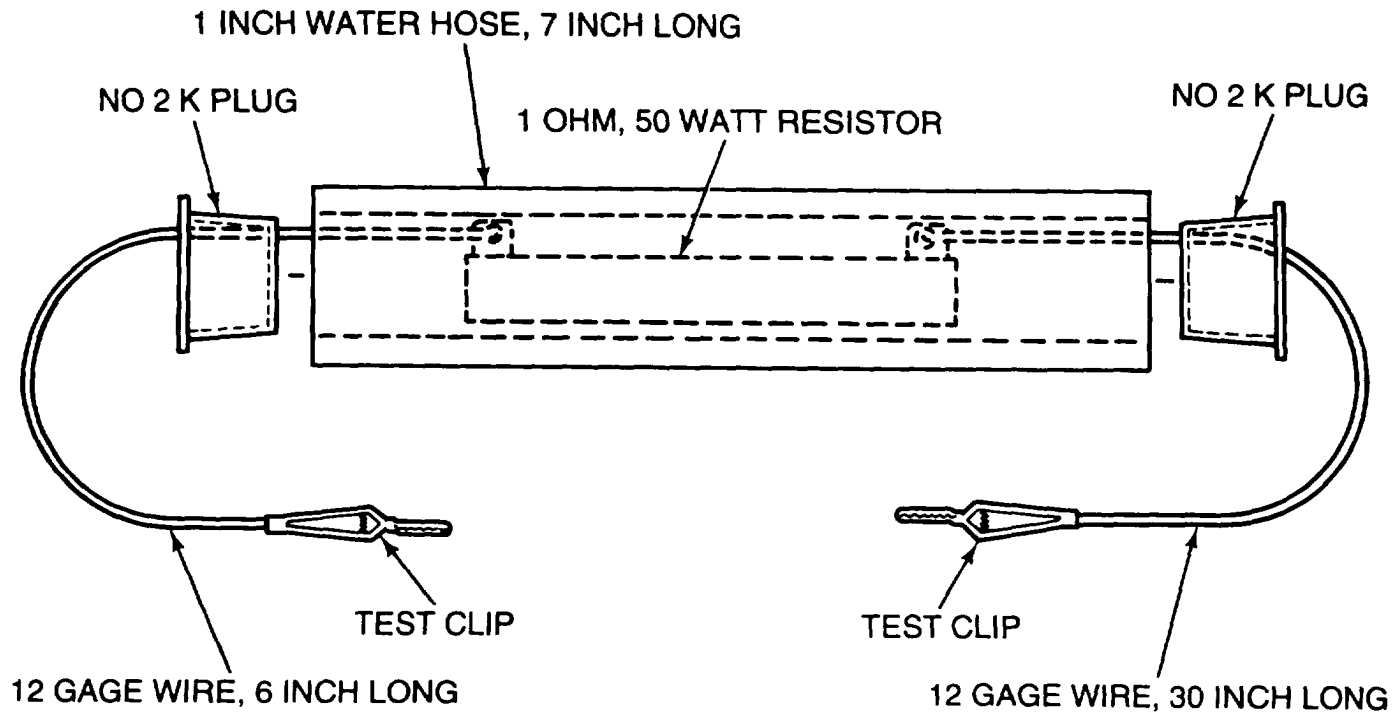
D-2 EXPLANATION OF COLUMNS

- a. Column 1 — Item Number.** This number is assigned to the entry in the listing and is referenced in the Initial Setup to identify the item (e.g., "Test Lead (App D, Item 1)").
- b. Column 2 — Part Number.** This column lists part numbers index in alphanumeric order for cross-referencing the part number of the item to be manufactured to the figure which covers fabrication criteria.
- c. Column 3 — National Stock Number.** This column is the National Stock Number (NSN) assigned to the item; use it to requisition the item.
- d. Column 4 — Description.** This column lists the federal item name and a description to identify the item.
- e. Column 5 — Figure Number.** This column lists the figure number assigned to the item to be manufactured.

Section II. MANUFACTURED ITEMS PART NUMBER INDEX

(1) ITEM NO.	(2) PART NO.	(3) NATIONAL STOCK NO.	(4) DESCRIPTION	(5) FIGURE NO.
1	12384626		TEST LEAD	D - 1
2	12384628		GUIDE STUD	D - 2
3	12384630		ADAPTOR	D - 3
4	12384633		TURBOCHARGER HOLDING FIXTURE	D - 4
5	12384637		SLEEVE	D - 5
6	11650232		PRESSURE TESTING KIT, CYLINDER HEAD	D- 6
7	11650233		PRESSURE TESTING KIT, CYLINDER BLOCK	D- 7
8	11650234		GOVERNOR COVER, CUT-AWAY	D- 8
9	11650235		GUIDE STUD	D - 9
10	11650236		GUIDE STUD	D-10
11	11650237		GUIDE STUD	D-11
12	11650238		PRESSURE TESTING KIT, OIL COOLER CORE	D-12
13	11650239		PRESSURE TESTING KIT, OIL COOLER CORE	D-13
14	11650240		TUBE ASSEMBLY, FUEL, FABRICATED	D-14

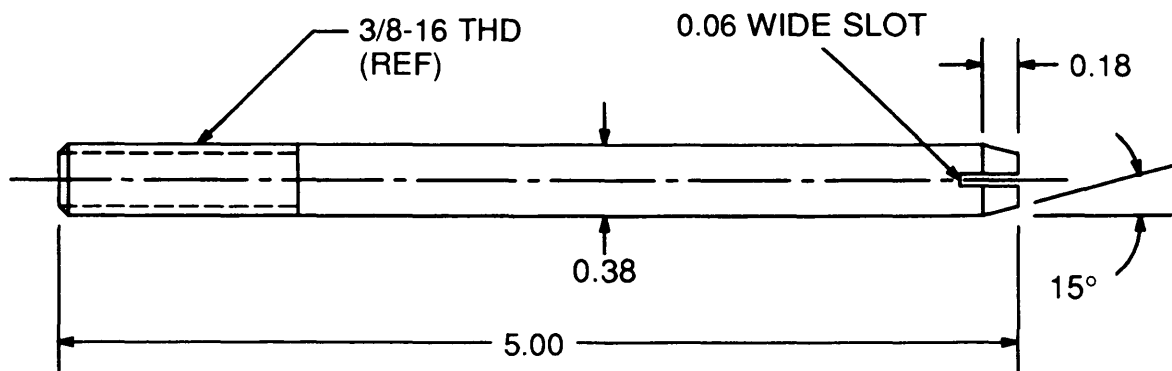
Section III. ILLUSTRATIONS OF MANUFACTURED ITEMS



NOTES: To reduce 24 V dc to 18 V dc.

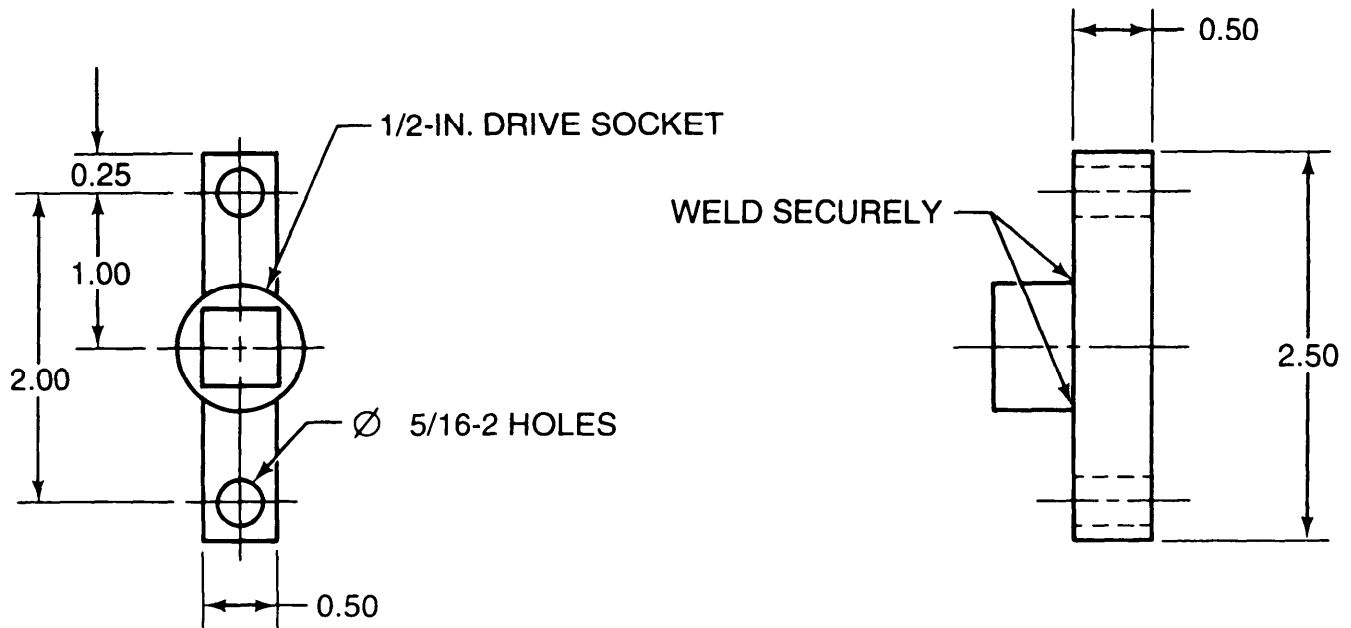
1. Cut a piece of 12-gage wire 6 inches long.
2. Cut a piece of 12-gage wire 12 inches long.
3. Cut a piece of 1-inch diameter rubber hose 7 inches long.
4. Attach a test clip to one end of 6 and 12 inch long 12 gage wire.
5. Drill a hole through end of two no. 2K plugs in order to insert 12-gage wire through.
6. Insert one lead through hole in plug and connect to 50-watt resistor. Insert in rubber hose and attach other lead to resistor.

FIGURE D-1 . TEST LEAD (P/N 12384626)

**NOTES:**

1. Fabricated from NSN 5305-00-269-3228 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.

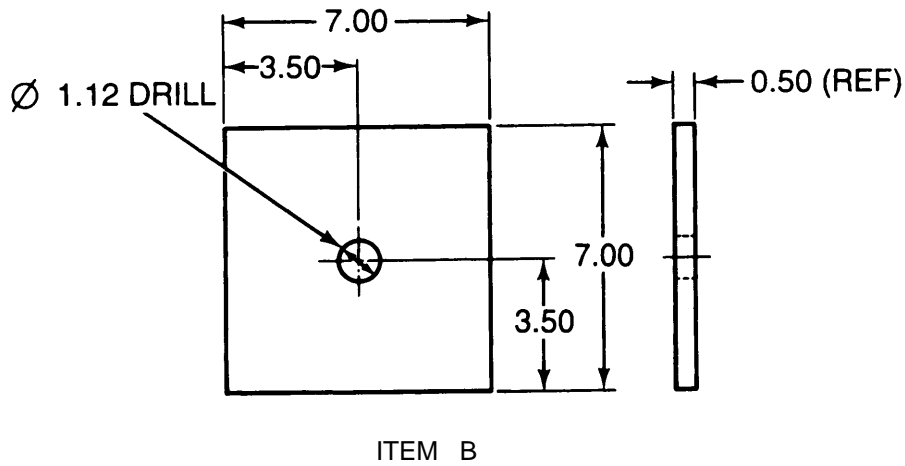
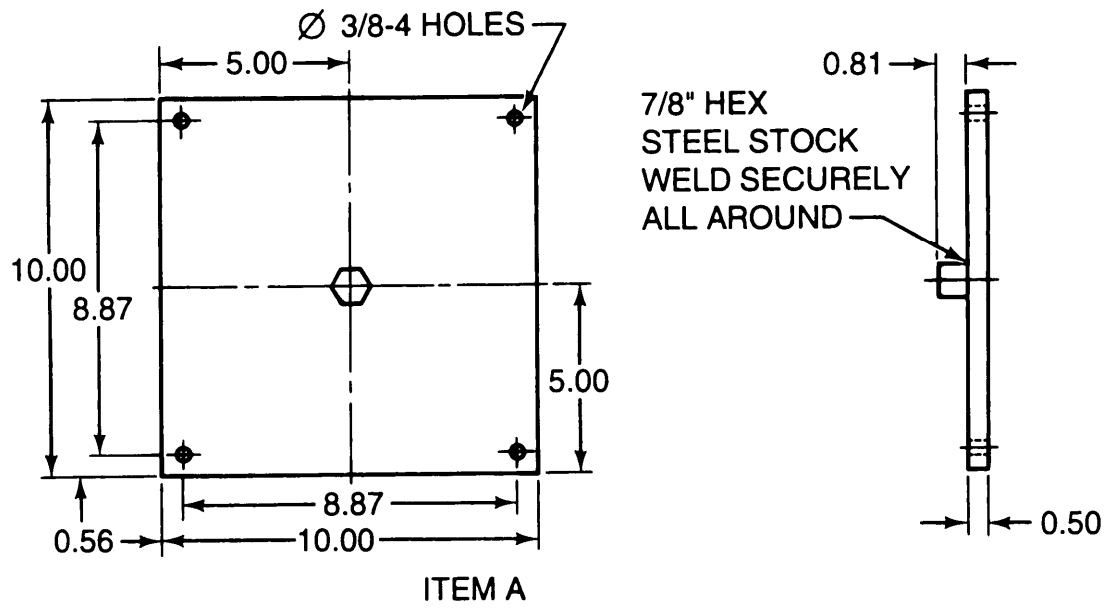
FIGURE D-2. GUIDE STUD (P/N 12384628)



NOTES:

1. Fabricate from 1/2-inch thick steel square stock.
2. Weld a 1/2-inch drive socket NSN 5120-00237-0984 (ratchet side up) to plate.
3. Quantity required, one.
4. Additional items: Two bolts (5/16-18 x 1) NSN 5306-00-225-8499.
5. All dimensions are in inches.

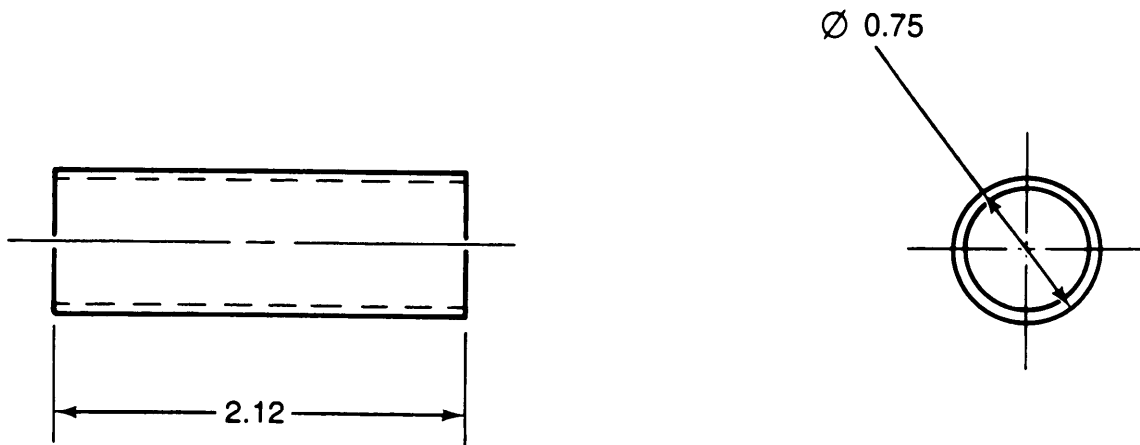
FIGURE D-3. ADAPTOR (P/N 12384630)



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.

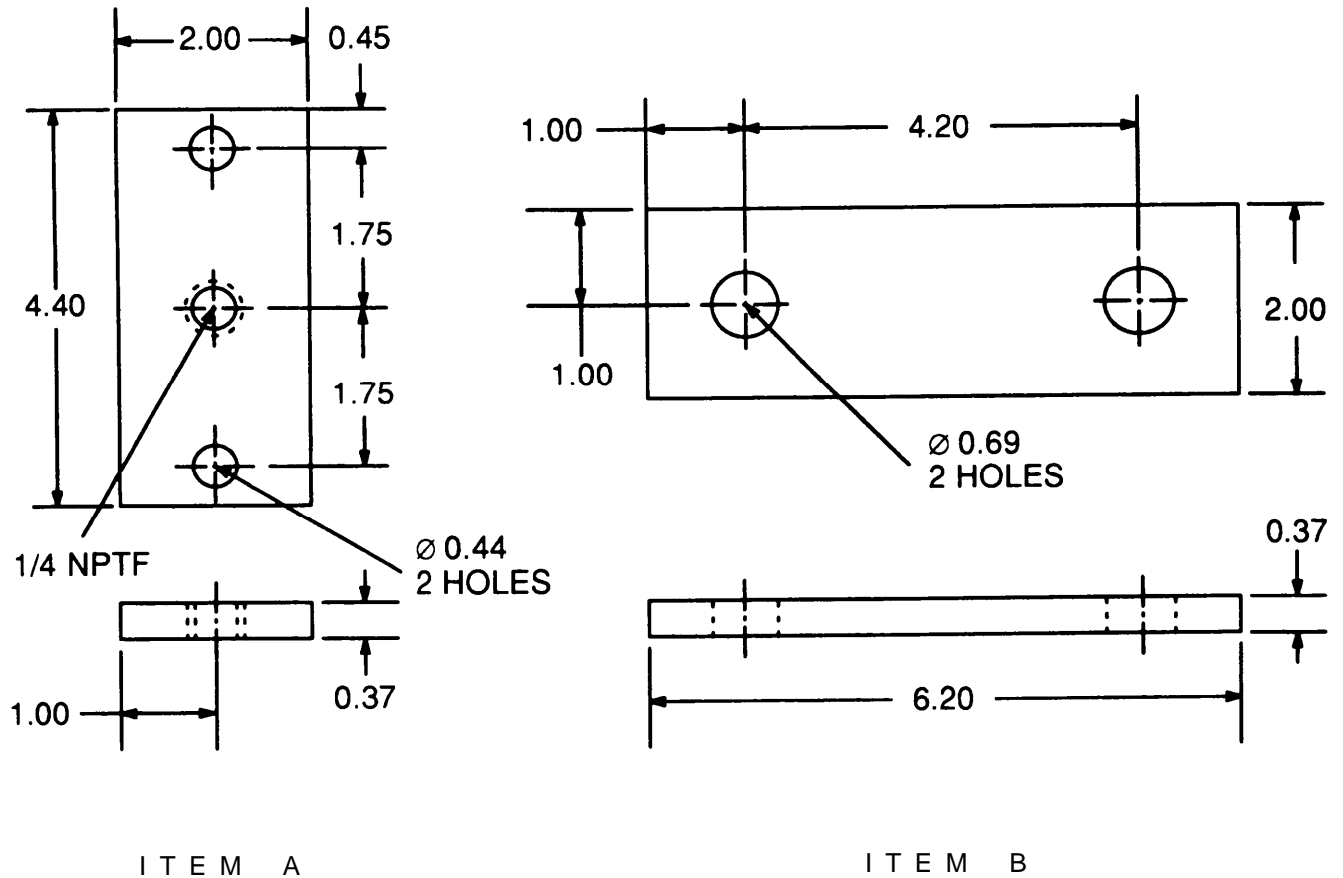
FIGURE D-4. TURBOCHARGER HOLDING FIXTURE (P/N 12334633)



NOTES:

1. Fabricate from 3/4-inch diameter steel tubing.
2. Grind off all burrs.
3. Quantity required: one.
4. All dimensions are in inches.

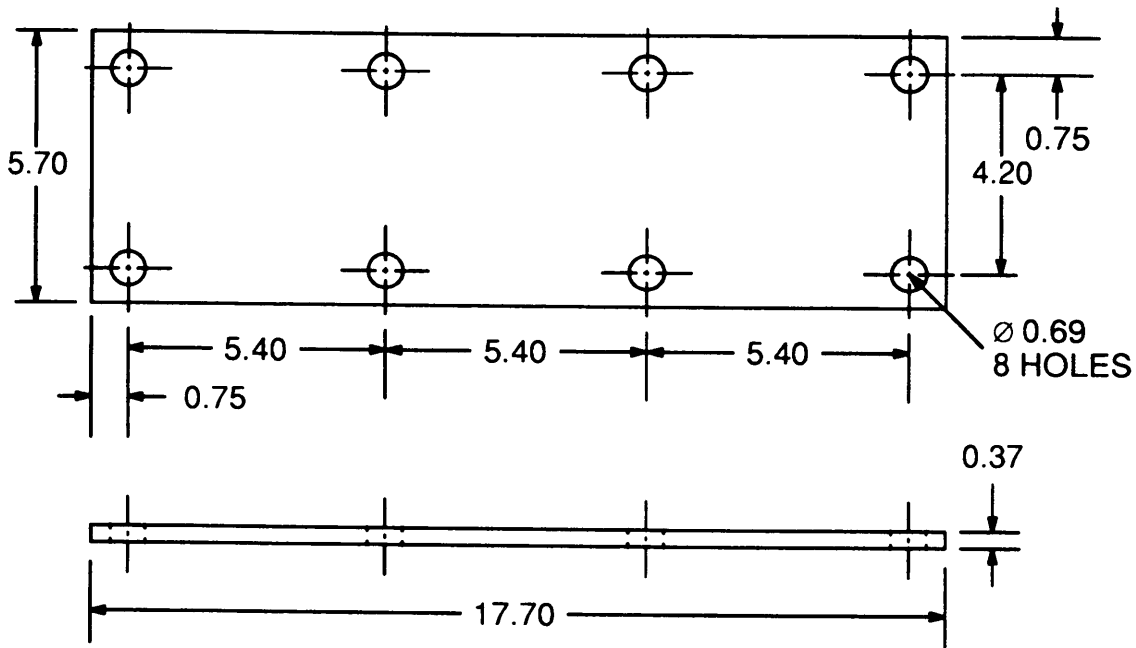
FIGURE D-5. SLEEVE (PIN 12384637)



NOTES

1. Fabricate end plate from 3/8-inch thick steel plate, 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, 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 5305-00-724-6767
 Sixteen flat washers (5/8) NSN 5310-00-003-9174
 Eight nuts (5/8-11) NSN 5310-00-763-8920.
9. All dimensions are in inches.

FIGURE D-6 . CYLINDER HEAD PRESSURE TESTING KIT (P/N 11 650232)



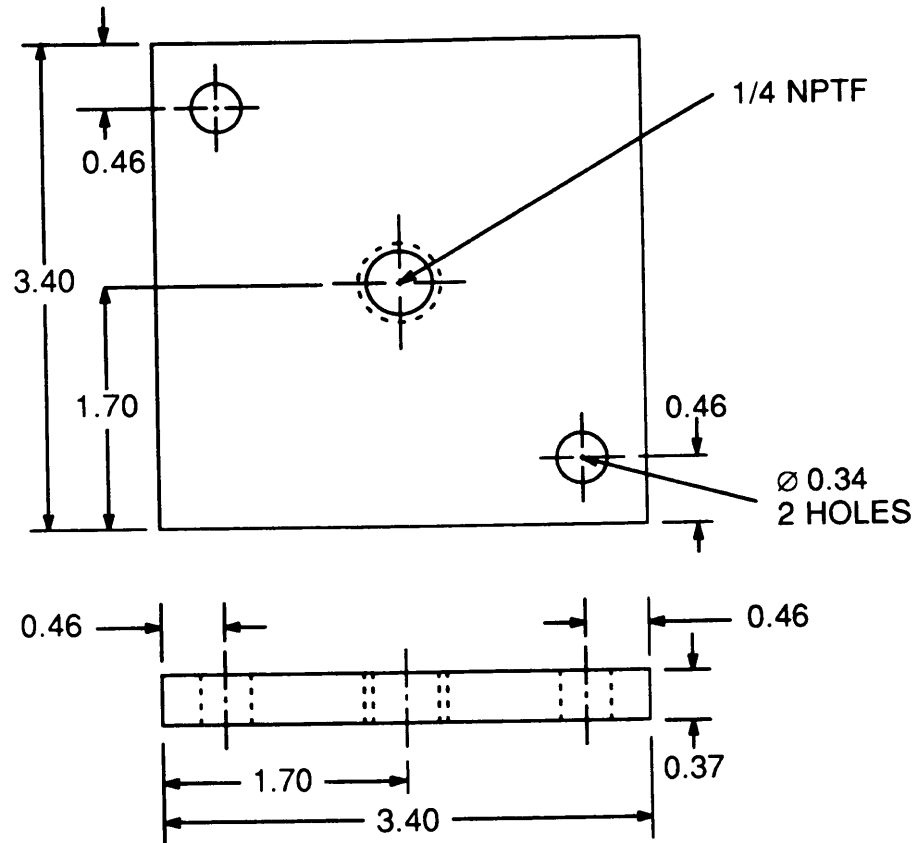
I T E M A

NOTES:

1. Fabricate from 3/8-inch thick steel plate.
2. Quantity required: Two, Item A
One, Item B (model 5063-5398 only)
3. Additional items:
 - a. For all except model 5063-5398:

Six compression gaskets	NSN	5305-00-780-5243
Twelve preformed packings	NSN	5330-00-179-6227
Eight seals	NSN	5310-00-880-1263
Eight seals	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
Sixteen flat washers (5/8)	NSN	5310-00-003-9174
Sixteen 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

FIGURE D-7. CYLINDER BLOCK PRESSURE TESTING KIT (P/N 11650233)



I T E M B

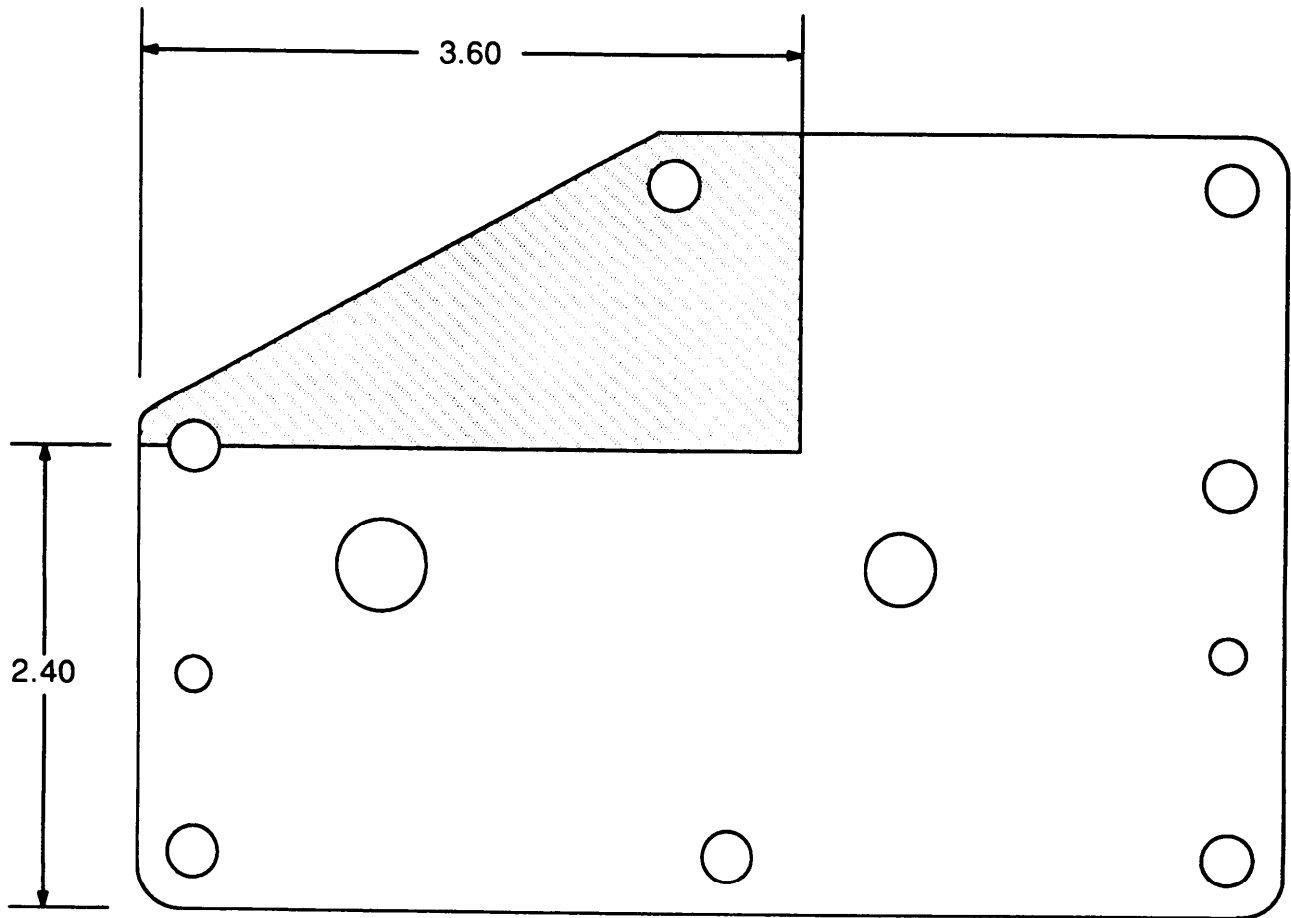
NOTES: (Cont)

b. For model 5063-5398:

Six compression gaskets	NSN 5305-00-780-5243
Twelve preformed packings	NSN 5330-00-179-6227
Eight seals	5135548 (72582)
Eight seals	5135663 (72582)
Two gaskets	NSN 5330-00-904-4567
One plate	NSN 5340-00-478-2875
Sixteen flat washers (5/8	NSN 5310-00-003-9174
Seven screws (5/8-11 x 3 1/2)	NSN 5305-00-724-7247
Nine screws (5/8-11 x 2 1/2) . . .	NSN 5305-00-724-7224
Four bolts (5/16-18 x 3/4)	NSN 5306-00-226-4825
Eight sleeves	NSN 4730-00-003-0039
Eight sleeves	NSN 2815-00-003-0040

4. All dimensions are in inches.

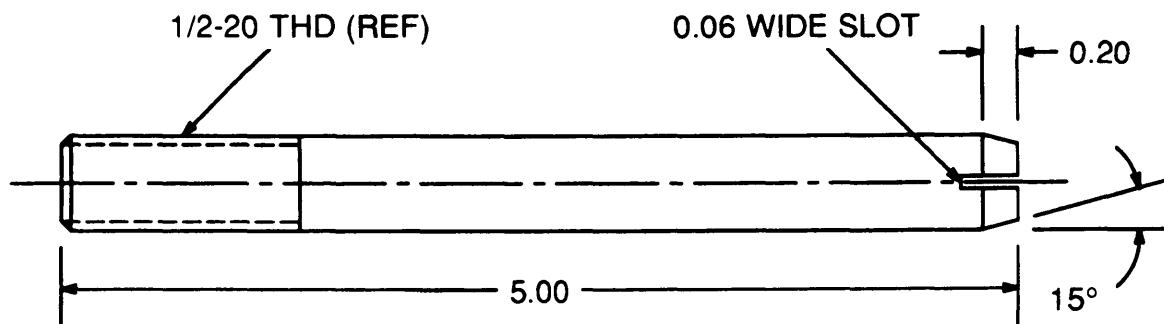
FIGURE D-7. CYLINDER BLOCK PRESSURE TESTING KIT (P/N 11650233) - (Cont)



NOTES:

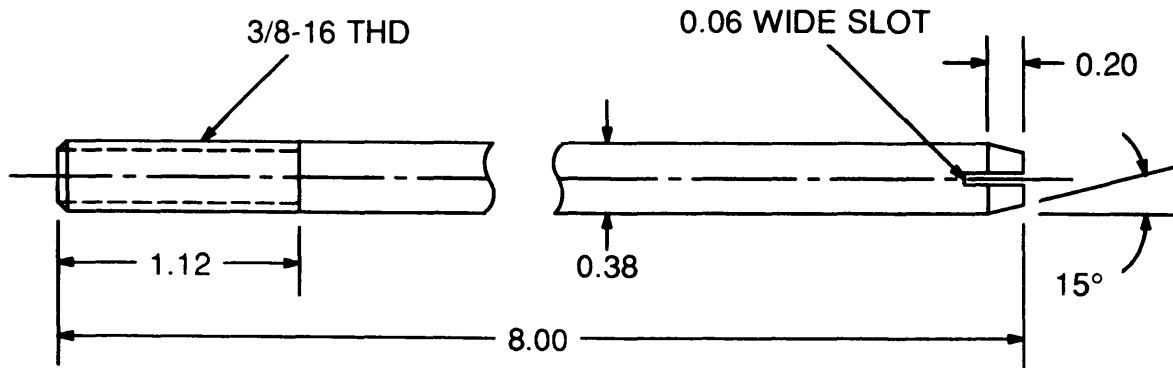
- 5. Fabricate from NSN 2990-00-944-2053 governor cover by cutting out cross-hatched section.
- 6. Quantity required: one.
- 7. All dimensions are in inches.

FIGURE D-8. CUT-AWAY GOVERNOR COVER (PIN 11 650234)

**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.

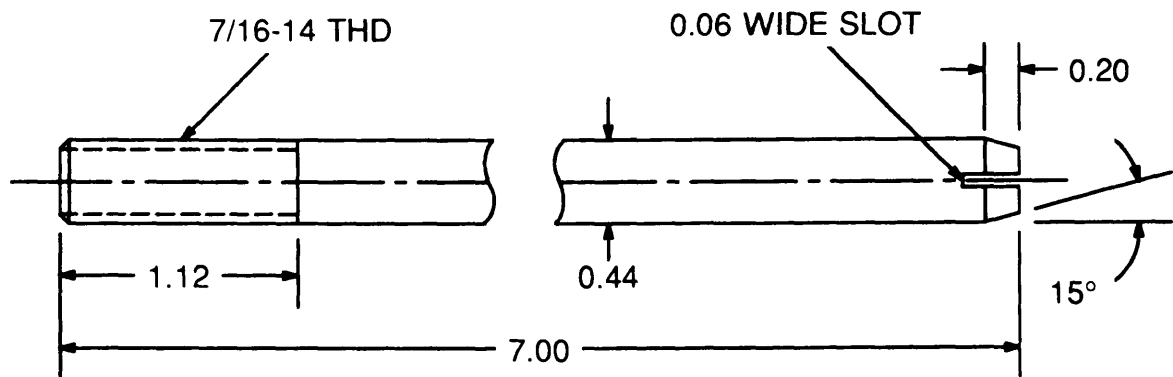
FIGURE D-9. GUIDE STUD (P/N 11650235)



NOTES:

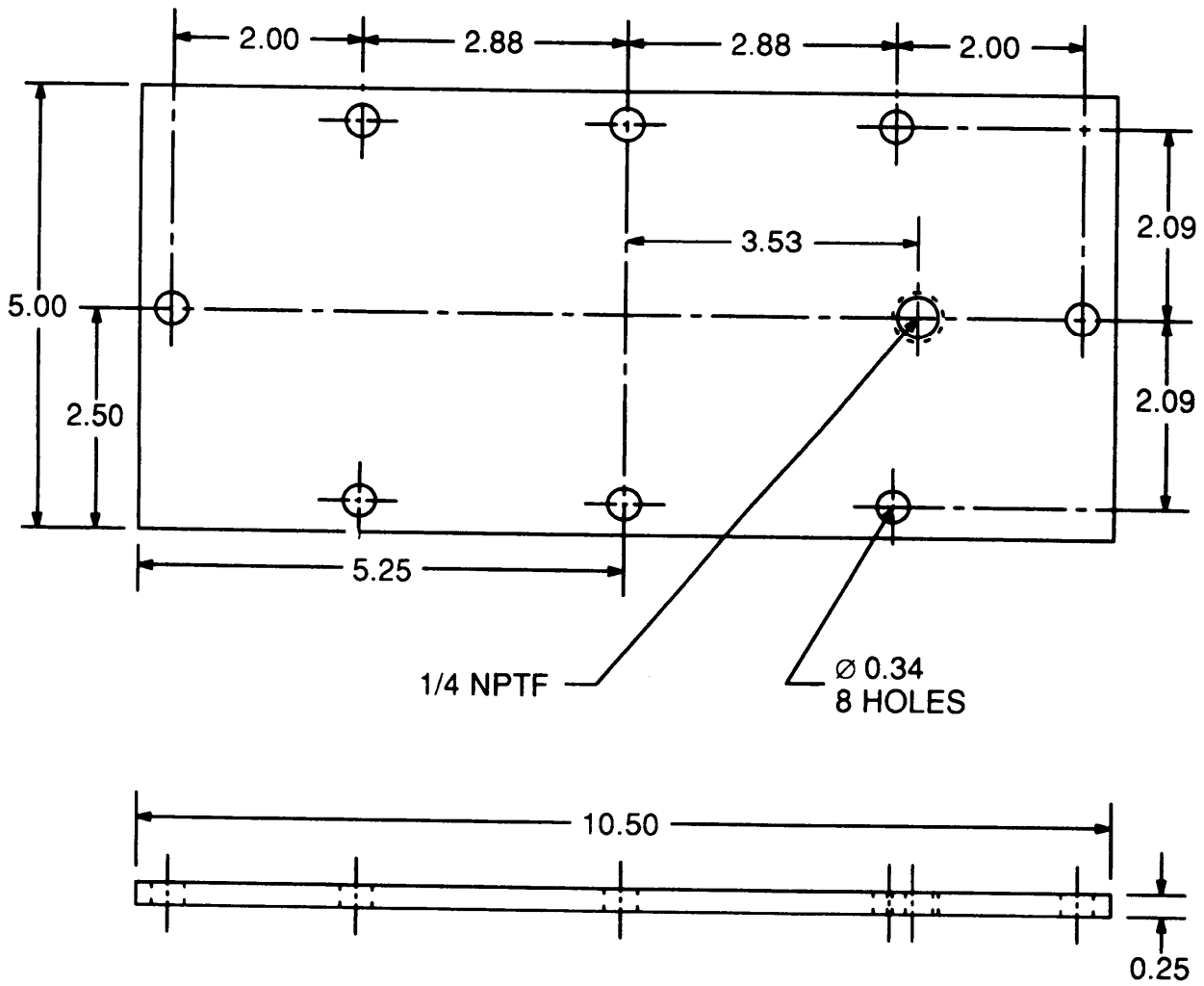
- 4. Fabricated from 3/8-inch diameter steel rod. Thread one end and saw or file a 0.06-inch screwdriver slot in other end.
- 5. Quantity required, two.
- 6. All dimensions are in inches.

FIGURE D-10. GUIDE STUD (P/N 11650236)

**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.

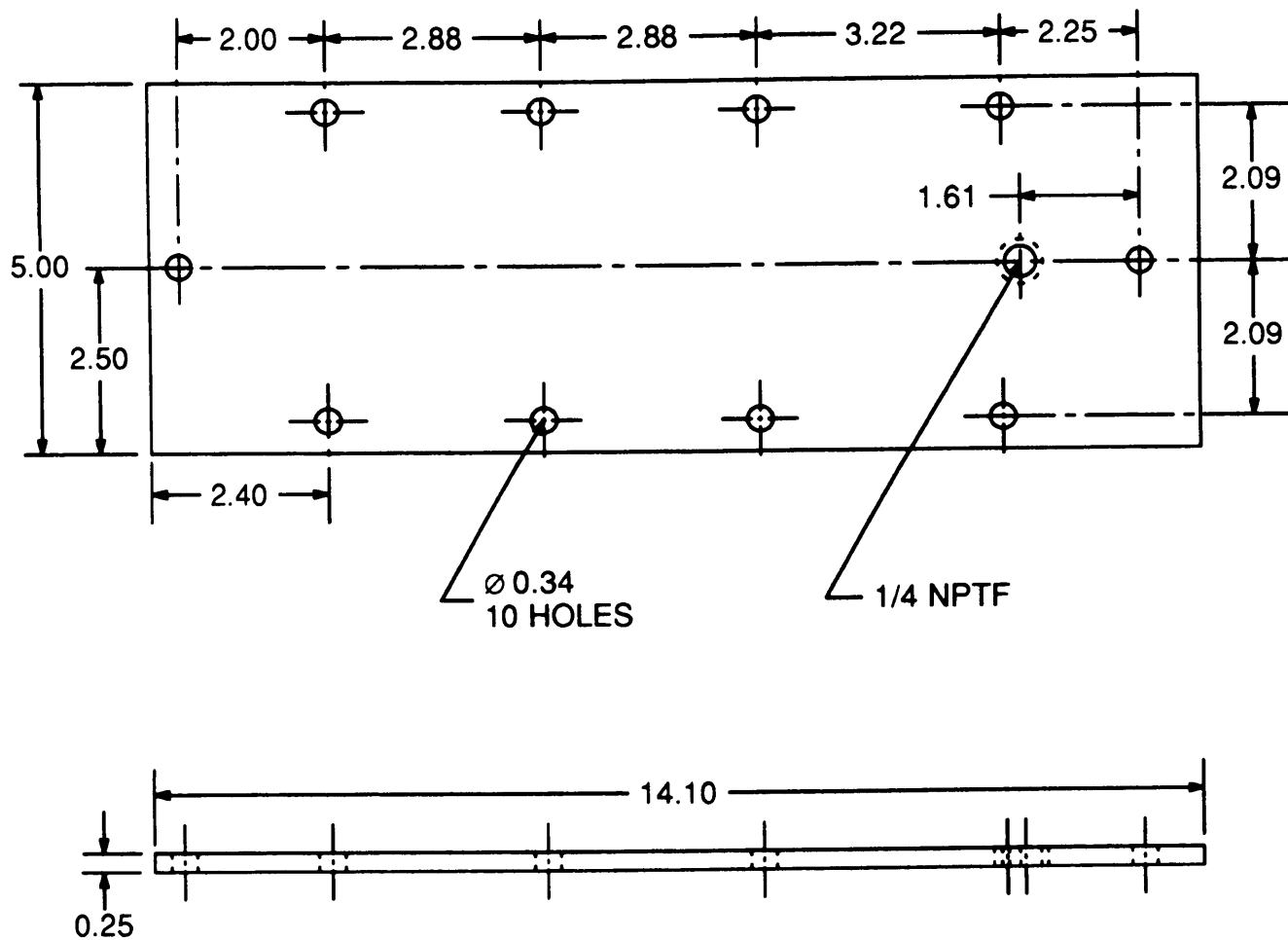
FIGURE D-11. GUIDE STUD (PIN 11650237)



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 531 0-00-880-7744
5. All dimensions are in inches.

FIGURE D- 12. OIL COOLER CORE PRESSURE TESTING KIT (P/N 11650238)

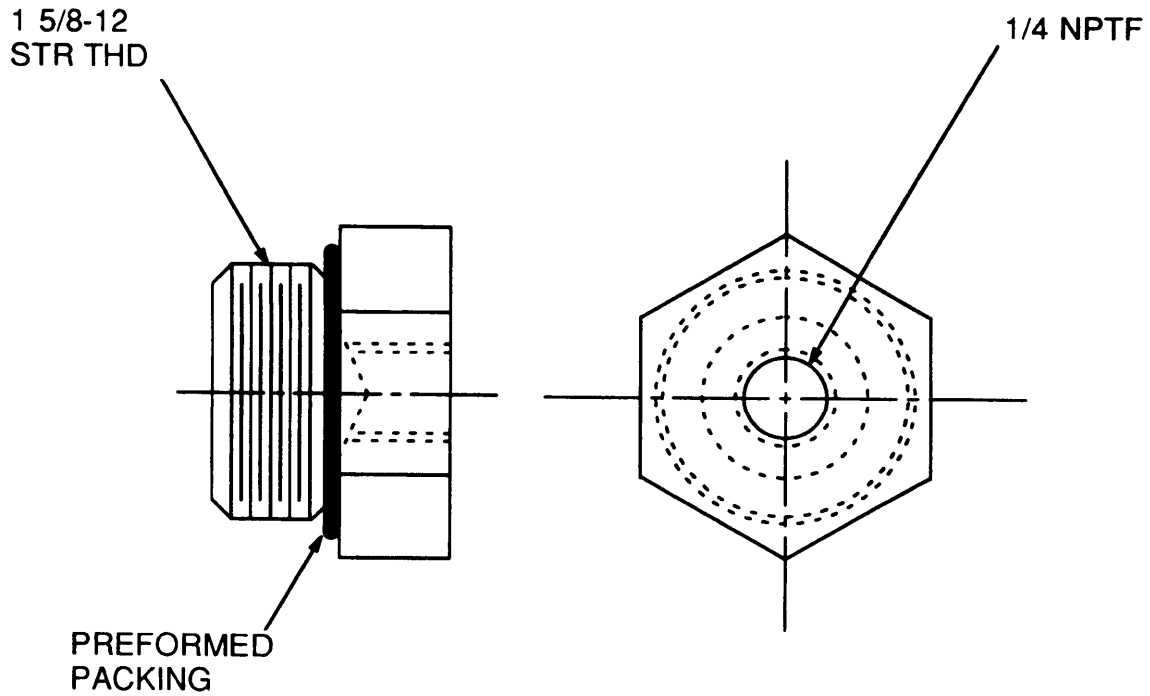


ITEMS A and B

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: Ten screws 5/16-18 x 1 NSN 5305-00-226-4827
 Ten flat washers 5/16 NSN 531 0-00-081-4219
 Ten nuts 5/16-18 NSN 5310-00-880-7744
5. All dimensions are in inches.

FIGURE D-13. OIL COOLER CORE PRESSURE TESTING KIT (P/N 11650239)



ITEM C

NOTES: (Cont)

6. Item C, for model 5063-5393:

Two plugs, machine thread 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

FIGURE D- 13. OIL COOLER CORE PRESSURE TESTING KIT (P/N 11650239) - (Cont)

APPENDIX E

GENERAL TORQUE LIMITS REQUIRED FOR FASTENERS IN ENGINE

Section I. INTRODUCTION

E-1. SCOPE

This appendix provides the general torque limits for fasteners used on the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L 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.

E-2. TORQUE LIMITS

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. The torques given are suitable for grade 5, 5.1, 7, and 8 fasteners. No grade 1 or 2 fasteners are used on the 6V53 series engines.

E-3. HOW TO USE THE TORQUE TABLE

- a. Measure the shaft diameter of the fastener and count the number of threads per inch.
- b. 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.

Section II. TORQUE LIMITS FOR DRY FASTENERS

<u>THREAD SIZE inches</u>	<u>TORQUE LIMIT lb-ft</u>	<u>TORQUE LIMIT N•m</u>
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
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

APPENDIX F

MANDATORY REPLACEMENT PARTS LIST

Section I. INTRODUCTION

F-1 SCOPE

This appendix is a cross-reference of item numbers to part numbers for the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L engines and is included for that purpose only.

F-2 EXPLANATION OF COLUMNS

- a. Column 1 — 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 (App F, Item 118)").
- b. Column 2 — Description.** This column identifies the parts which appear in the Initial Setup of the procedure under the heading "Mandatory Replacement Parts."
- c. Column 3 — 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

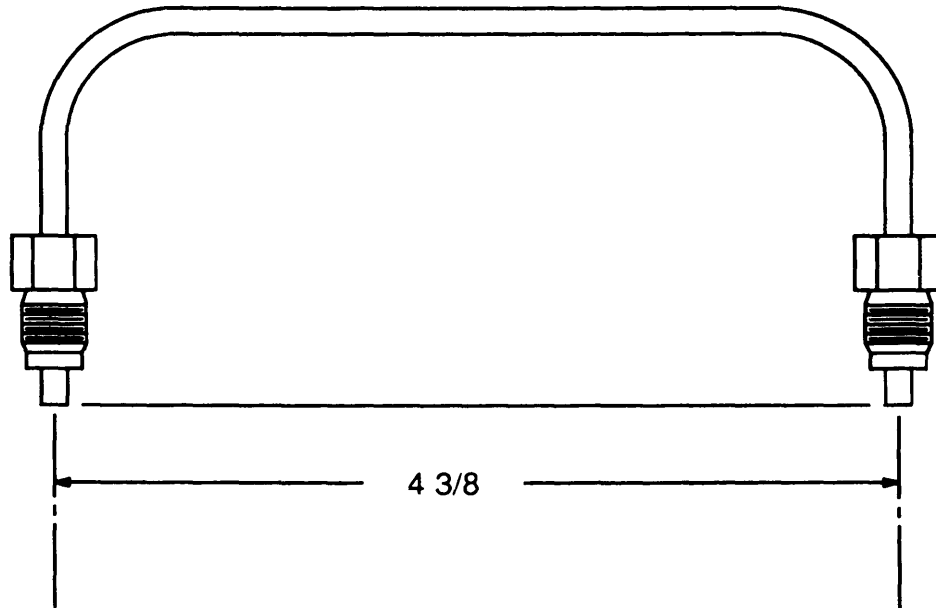
When using the National Stock Number (NSN) to requisition a part, the part you get may have a different part number from the number ordered, but go ahead and use or furnish it as the supply part.

- d. Column 4 — National Stock Number.** This column is the National Stock Number (NSN) assigned to the item; use it to requisition the item.

Section II. MANDATORY REPLACEMENT PARTS LIST

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>
1	BEARING KIT	5149460	3120-01-086-8270
2	BEARING SET, SLEEVE	11650207	3120-00-089-3536
3	BEARING, SLEEVE	441843-1	3120-01-239-1369
4	BEARING, SLEEVE	5136097	3120-00-930-3265
5	BEARING, WASHER, THRUST	408593	3120-01-205-5814
6	BEARING,WASHER, THRUST	408598 (081 79)	
7	BEARING,WASHER, THRUST	442030-1	3120-01-239-5139
8	BEARING,WASHER, THRUST	5199852	3120-01-038-1499
9	BOLT	8927580	5306-01-282-1372
10	BOLT, MACHINE	8924734	5306-01-254-6351
11	BOLT, SELF-LOCKING	MS35764-1277	5306-01-020-6895
12	BOLT, SELF-LOCKING	9409034	5306-00-940-9034
13	BOLT, SELF-LOCKING	9409062	5306-00-940-9062
14	BOLT, SELF-LOCKING	9409071	5306-00-940-9071
15	BOLT, SELF-LOCKING	9409126	5306-00-543-5696
16	BOLT, SELF-LOCKING	9409129	5306-00-057-8494
17	BOLT, SELF-LOCKING	9409215	5306-00-949-5758
18	BOLT, SELF-LOCKING	9409219	5306-00-781-7777
19	BOLT, SELF-LOCKING	9409221	5306-00-780-8109
20	BOLT, SELF-LOCKING	9414215	5306-00-053-8378
21	FILTER ELEMENT, FLUID	CW226MP	2910-00-287-1912
22	FILTER ELEMENT, FLUID	FL804FP	2940-01-197-7106
23	FILTER ELEMENT, FLUID	MS35802-3	2940-00-580-6283
24	FILTER ELEMENT, FLUID	T552	2940-00-745-7730
25	FILTER ELEMENT, FLUID	5228587	2910-00-374-4929
26	GASKET	MS35769-7	5310-00-136-8454
27	GASKET	1503536	5310-00-551-0433
28	GASKET	23501591	5330-01-299-3160
29	GASKET	23504956	5330-00-290-7860
30	GASKET	5103474	5330-01-143-2300
31	GASKET	5104846	5330-01-157-3771
32	GASKET	5104866	5330-01-157-3770
33	GASKET	5104868	5330-01-157-3772
34	GASKET	5104881	5330-01-157-3773
35	GASKET	5104978	5330-01-163-8179
36	GASKET	5107441	5330-01-118-5600
37	GASKET	5107889	5330-01-241-5104
38	GASKET	5109496	5330-00-689-8265
39	GASKET	5116205	5330-00-780-5221
40	GASKET	5116242	5330-00-055-1584
41	GASKET	5116357	5330-00-613-9397
42	GASKET	5117786	5330-00-781-7117
43	GASKET	5119266	5330-00-999-7210

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>
44	GASKET	5119282	5330-00-792-8988
45	GASKET	5119368	5330-00-780-5242
46	GASKET	5119433	5330-00-792-8977
47	GASKET	5119438	5330-00-780-5231
48	GASKET	5120540	5330-00-953-2014
49	GASKET	5121205	5330-00-735-4298
50	GASKET	5121342	5330-00-780-5232
51	GASKET	5121344	5330-00-074-1925
52	GASKET	5121345	5330-00-780-5233
53	GASKET	5124055	5330-00-074-1931
54	GASKET	5126473	5330-00-682-7195
55	GASKET	5127247	5330-00-682-7197
56	GASKET	5128039	5330-00-866-9385
57	GASKET	5130995	5330-00-980-1546
58	GASKET	5132474	5330-00-904-4567
59	GASKET	5133107	5330-00-235-4885
60	GASKET	5133263	5330-00-074-1923
61	GASKET	5133397	5330-00-789-4846
62	GASKET	5133425	7330-00-945-3382
63	GASKET	5133426	5330-00-930-3263
64	GASKET	5133537	5330-00-789-4871
65	GASKET	5133619	5330-00-789-4867
66	GASKET	5134818	5330-00-930-3262
67	GASKET	5135877	5330-00-944-7073
68	GASKET	5135935	5330-00-466-0467
69	GASKET	5137470	5330-00-944-4148
70	GASKET	5144038	5330-00-421-4848
71	GASKET	5147994	5330-00-792-9026
72	GASKET	5150193	5330-00-212-6290
73	GASKET	5161003	5330-00-599-5577
74	GASKET	5170468	5330-00-725-2388
75	GASKET	5175882	5330-01-109-6608
76	GASKET	5574126	5330-00-612-3123
77	GASKET	5574161	5330-00-846-9841
78	GASKET	6437298	
79	GASKET	8922593	5330-01-186-7543
80	GASKET	8923223	5330-01-196-2504
81	GASKET	8923492	5330-01-037-4129
82	GASKET	8923566	5330-01-242-2697
83	GASKET	8923792	5330-01-206-3265
84	GASKET	8925273	5330-01-242-0467
85	GASKET	8928716	5330-01-248-9559
86	GASKET	8928720	5330-01-254-1389
87	GASKET	8928812	5330-01-252-0201
88	GASKET SET	6437298	5330-00-833-0870



1. Fabricate from tube assembly, fuel NSN 4710-00-792-8984
2. Quantity required, one.
3. Bend as dimensioned.
4. All dimensions are in inches.

FIGURE D - 14. FABRICATED FUEL TUBE ASSEMBLY (P/N 11650240)

MANDATORY REPLACEMENT PARTS LIST (Cont)

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>
89	GASKET, COMPRESSION	5121254	5 3 3 0 - 0 0 - 7 8 0 - 5 2 4 3
90	INJECTOR TUBE KIT	8925981	5330-01-207-7789
91	LOCKING PLATE	405694 (96906)	
92	LOCKING PLATE	5149158	2835-01-015-5416
93	LOCKING PLATE	585726	2815-00-150-5064
94	LOCKNUT	23505398	
95	LOCKWASHER	MS35337-7	5310-00-011-2723
96	LOCKWASHER	MS35338-43	5310-00-045-3296
97	LOCKWASHER	MS35338-44	5310-00-582-5965
98	LOCKWASHER	MS35338-45	5310-00-407-9566
99	LOCKWASHER	MS35338-46	5310-00-637-9541
100	LOCKWASHER	MS35338-47	5310-00-209-0965
101	LOCKWASHER	MS35338-48	5310-00-584-5272
102	LOCKWASHER	MS35338-50	5310-00-820-6653
103	LOCKWASHER	MS35338-51	5310-00-584-7888
104	NUT, SELF-LOCKING	BH00163-6	5310-00-070-6870
105	NUT, SELF-LOCKING	MS17829-4F	5310-00-483-8791
106	NUT, SELF-LOCKING	MS21045-7	5310-00-274-9364
107	NUT, SELF-LOCKING	MS51922-17	5310-00-087-4652
108	NUT, SELF-LOCKING	MS51922-21	5310-00-959-1488
109	NUT, SELF-LOCKING	192481	5 3 1 0 - 0 1 - 0 5 8 - 3 3 5 3
110	NUT, SELF-LOCKING	400768-13	5310-01-238-6378
111	NUT, SELF-LOCKING	454749	5310-00-164-1790
112	NUT, SELF-LOCKING	5198579	5310-00-162-3826
113	PACKING, PREFORMED	MS28775-112	5330-00-599-2934
114	PACKING, PREFORMED	2-024 V747-75	5330-00-166-1020
115	PACKING, PREFORMED	5109517	5330-00-403-0024
116	PACKING, PREFORMED	5121256	5330-00-179-6227
117	PACKING, PREFORMED	5229167	5330-00-364-3434
118	PIN, COTTER	A82-1	5315-00-839-2325
119	PIN, DOWEL	5157933	5315-00-238-0838
120	PLUG	5119218	2815-00-921-5348
121	PLUG	5151277	5315-00-276-4818
122	PLUG	9417025	4730-00-921-5736
123	PLUG, CUP	5109157	5340-00-919-2876
124	PLUG, CUP	5138183 (72582)	
125	PLUG, CUP	5138184 (72582)	
126	PLUG, CUP	5139988	5340-01-144-1937
127	PLUG, CUP	9421753	5340-01-157-8867
128	PLUG, EXPANSION	116337	5 3 4 0 - 0 0 - 0 8 9 - 8 0 3 7
129	PLUG, EXPANSION	5117186	5340-00-728-3491
130	PLUG, EXPANSION	5139997	5340-00-202-0765
131	PLUG, EXPANSION	5150130	5340-00-237-8324

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>
132	PLUG, EXPANSION	5150829	5340-00-921-5379
133	PLUG, EXPANSION	5151449	5340-00-921-5380
134	RETAINER, PISTON PIN	5108131	2815-01-075-7813
135	RETAINER, PISTON PIN	8924731	5340-01-224-1560
136	RING SET, OIL	5149313 (72582)	
137	RING SET, OIL	5198092	2815-00-112-4606
138	RING SET, OIL	8927224	2815-01-230-0207
139	RING, PISTON	5103382	2815-00-866-1344
140	RING, PISTON	5116184	2815-00-883-5593
141	RING, PISTON	8923328	2815-01-187-4704
142	RING, PISTON	8925779	2815-01-220-6659
143	RING, PISTON	8925780	2815-01-220-3302
144	RING, RETAINING	5149154	2835-01-015-5414
145	RING, RETAINING	5198049	5365-00-930-3257
146	RING, RETAINING	5574120	5365-00-543-3615
147	RING, SEAL	5198257	5330-00-930-3259
148	RING, SEAL	5198936	5330-01-016-0443
149	SCREEN, AIR INLET	5122610	2990-00-866-9378
150	SCREEN, AIR INLET	8927733	2815-01-238-8792
151	SCREW	400959-410	5305-01-240-8005
152	SCREW	9414523	5305-00-921-5364
153	SCREW, DRIVE	MS21318-29	5305-00-253-5620
154	SEAL	5116122	5310-00-774-9545
155	SEAL	5116290	5310-00-880-1264
156	SEAL	5121207	5310-00-880-1263
157	SEAL	5135548 (72582)	
158	SEAL	5135663 (72582)	
159	SEAL RING	5141210	2815-00-406-8948
160	SEAL RING, METAL	403818-0	2990-00-930-3254
161	SEAL STRIP	5116292	5330-00-921-5344
162	SEAL RING, METAL	5197583	2990-00-930-3254
163	SEAL, BLOWER	5127963	2990-00-780-5236
164	SEAL, NONMETALLIC	10955138	5330-00-945-3351
165	SEAL, NONMETALLIC	11650220	5340-01-241-2797
166	SEAL, NONMETALLIC	11678205	5330-01-052-7673
167	SEAL, PLAIN	5103646	5330-01-088-2740
168	SEAL, PLAIN ENCASED	3S9643-00	5330-00-961-9806
169	SEAL, PLAIN ENCASED	5106223	5330-01-083-3980
170	SEAL, PLAIN ENCASED	5107223	5330-01-083-3063
171	SEAL, PLAIN ENCASED	5116224	5330-00-792-9841
172	SEAL, PLAIN ENCASED	5138796	5330-00-944-7065
173	SEAL, PLAIN ENCASED	5142266	5330-00-079-8421
174	SEAL, PLAIN ENCASED	8926902	5330-01-176-7872
175	SEAL, RING	8924733	5330-01-224-1474
176	SEAL, SPECIAL	5101691	5330-01-105-6889

MANDATORY REPLACEMENT PARTS LIST (Cent)

<u>(1)</u> <u>ITEM</u> <u>NUMBER</u>	<u>(2)</u> <u>DESCRIPTION</u>	<u>(3)</u> <u>PART</u> <u>NUMBER</u>	<u>(4)</u> <u>NATIONAL</u> <u>STOCK NUMBER</u>
177	SEAL, WATER PUMP	8924297	2930-00-866-9403
178	SLEEVE	5135662	4730-00-003-0039
179	SLEEVE, WATER INLET	5135547	2815-00-003-0040
180	SPACER, RING	5226186	5365-00-255-0296
181	SPACER, RING	8924732	5365-01-223-7179
182	TUBE ASSEMBLY, FUEL	5116204	4710-00-792-8984
183	VANE SET	8921167	2540-01-105-3037
184	WASHER, COPPER	60598	5310-00-663-7617
185	WASHER, COPPER	7375429	5310-00-737-5429
186	WASHER, COPPER	5152148	5310-00-264-1939
187	WASHER, COPPER	520275	5310-00-737-5429
188	WASHER, COPPER	8925644	5310-01-239-5071
189	WASHER, COPPER	5151921	5310-00-532-8136
190	WASHER, FLAT	5198988	5310-00-153-2717
191	WASHER, KEY	5133539	5310-00-789-4870
192	BOLT, SELF-LOCKING	9409010	5306-00-940-9010
193	BOLT, SELF-LOCKING	9409073	5306-00-822-3685
194	BOLT, SELF-LOCKING	9409203	5306-00-846-3246
195	BOLT, MACHINE	8920631	5306-01-169-5526

APPENDIX G

ENGINE REPAIR SPECIFICATIONS

Section L INTRODUCTION

G-1 SCOPE

This appendix lists the repair specifications for the 6V53 Model 5063-5299, 5063-5392, 5063-5393, 5063-5395, 5063-5398, 5063-539F and 5063-539L engines.

G-2 EXPLANATION OF COLUMNS

a. 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").

b. Column 2 — New Minimum. This column lists the minimum acceptable dimension of the new part. All dimensions are in inches unless stated differently.

c. Column 3 — New Maximum. This column lists the maximum acceptable dimension of the new part. All dimensions are in inches unless stated differently.

d. 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.

Section II. ENGINE REPAIR SPECIFICATIONS

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (Inches)	(3) NEW MAXIMUM (Inches)	(4) WEAR LIMIT (Inches)
CYLINDER BLOCK			
Cylinder Sleeve Bore			
Diameter (top)	4.5195	4.5215	4.5235
Diameter (center)	4.4865	4.4880	4.4900
Diameter (bottom)	4.3565	4.3575	4.3595
Out-of-round	0.0015	0.0020	•
Taper		0.0015	0.0020
Cylinder liner counterbore			
Diameter	4.8200	4.8350	•
Depth	0.3000	0.3020	•
Main bearing bore			
Inside diameter (vertical axis)	3.7510	3.7520	•
Camshaft Bore (oversize bearing)			
Intermediate	2.3850	2.3860	•
Top surface of block	2.3750	2.3760	•
Flatness (transverse)		0.0030	•
Flatness (longitudinal)		0.0060	•
Depth of Counterbores (top surface)			
Cylinder head seal strip groove	0.0970	0.1070	•
Water holes (intermediate)	0.1090	0.1150	•
Water holes (end)	0.0920	0.0980	•
Oil holes	0.0920	0.0980	•
CYLINDER LINERS			
Outside diameter (upper seal ring surface)	4.4850	4.4860	•
Outside diameter (lower seal ring surface)	4.3550	4.3560	•
Inside diameter	3.8752	3.8767	•
Out-of-round (inside diameter)	0.0020	0.0030	•
Taper (inside diameter)	0.0010	0.0020	•
Depth of flange below block	0.0465	0.0500	0.0500
Variation in depth between adjacent liners	0.0020	0.0020	•
PISTON ASSEMBLY (TRUNK TYPE)			
Piston			
Diameter (at skirt-turbocharged)	3.8699	3.8721	•
Diameter (at skirt-nonturbocharged)	3.8679	3.8701	•
Clearance (skirt to liner-turbocharged)	0.0027	0.0068	0.0100
Clearance (skirt to liner-nonturbocharged)	0.0047	0.0088	0.0120
Out-of-round and taper		0.0005	•
Inside diameter (pin bushing)	1.3775	1.3780	•
Compression Rings			
Gap	0.0200	0.0460	0.0600

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) WEAR LIMIT (inches)
PISTON ASSEMBLY (TRUNK TYPE) (Cont)			
Clearance (ring to groove)			
No. 1	0.0030	0.0060	0.0120
No. 2	0.0070	0.0100	0.0140
No. 3 and 4 (turbocharged)	0.0050	0.0080	0.0130
No. 3 and 4 (nonturbocharged)	0.0045	0.0070	0.0120
Oil Control Rings			
Gap	0.0100	0.0250	0.0440
Clearance (ring to groove)	0.0015	0.0055	0.0080
Piston Pin			
Diameter	1.3746	1.3750	
Clearance (pin to piston bushing)	0.0025	0.0034	0.0100
Clearance (pin to connecting rod bushing)	0.0010	0.0019	0.0100
PISTON ASSEMBLY (CROSS-HEAD TYPE)			
Piston Crown			
Saddle to crown distance	2.8325	2.8395	*
Diameter			
Top	3.8486	3.8516	*
Below both compression rings	3.8636	3.8666	*
Above/below seal ring groove	3.8666	3.8676	*
Above/below bearing saddle	2.8350	2.8380	*
Compression rings			
Gap (top ring)	0.0230	0.0380	0.0600
Gap (No.2 and 3)	0.0200	0.0300	0.0600
Clearance (ring to groove)			
Top ring	0.0030	0.0066	0.0086
No. 2	0.0070	0.0100	0.0140
No. 3	0.0050	0.0080	0.0130
Oil Control Rings			
Gap (two rings-lower groove)	0.0100	0.0250	0.0440
Gap (one ring-upper groove)	0.0070	0.0170	0.0370
Clearance (two rings-lower groove)	0.0015	0.0055	0.0080
Clearance (one ring-upper groove)	0.0005	0.0040	0.0065
Piston Skirt			
Diameter	3.8695	3.8717	*
Clearance (skirt to liner)	0.0035	0.0072	0.0110
Seal ring bore	3.7000	3.7040	3.7060
Piston pin bore	1.3775	1.3785	1.3790
Piston Pin			
Length	3.2250	3.2450	*
Diameter	1.3746	1.3750	1.3730
Piston Pin Bushing			
Thickness	0.0870	0.0880	0.0860
Clearance (bushing to groove)	0.0005	0.0105	0.0120

Section II. ENGINE REPAIR SPECIFICATIONS (Cont)

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) WEAR LIMIT (inches)
CONNECTING RODS			
Length			
center bore to center bore-trunk	8.7990	8.8010	*
center bore to center of pin-crosshead	8.7990	8.8010	*
Side clearance	0.0080	0.0160	*
CRANKSHAFT			
Journal Diameter			
Main bearing	3.4990	3.5000	*
Connecting rod bearing	2.7490	2.7500	*
Journal out-of-round	0.00025	0.0030	*
Journal taper	0.0005	0.0030	*
Runout (intermediate journals)			0.0020
Thrust washer thickness	0.1190	0.1220	
End play	0.0040	0.0160	0.0180
CONNECTING ROD BEARINGS			
Inside diameter (vertical axis)	2.7511	2.7531	*
Bearing to journal clearance	0.0011	0.0041	0.0;60
Bearing thickness (90° part line)	0.1247	0.1252	0.1230
MAIN BEARINGS			
Inside diameter (vertical axis)	3.5030	3.5040	*
Bearing to journal clearance	0.0010	0.0040	0.0060
Bearing thickness (90° part line)	0.1240	0.1245	0.1230
CAMSHAFTS			
Diameter (bearing journals)	2.1820	2.1825	*
Runout (intermediate journals)		0.0020	*
End thrust	0.0030	0.0150	0.0190
Thrust washer thickness	0.2080	0.2100	
CAMSHAFT BEARINGS			
Inside diameter	2.1870	2.1880	*
Clearance (bearing to shaft)	0.0035	0.0070	0.0080
CAMSHAFT GEARS			
Backlash	0.0005	0.0050	0.0070
IDLER GEAR			
Backlash	0.0005	0.0050	0.0070
Inside diameter (bearing)	2.1860	2,1870	*
Clearance (bearing to hub)	0.0025	0.0045	0.0070
Endplay	0.0060	0.0130	0.0170
Hub outside diameter	2.1825	2.1835	*
Thrust washer thickness	0.1180	0.1200	*

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) WEAR LIMIT (inches)
CRANKSHAFT TIMING GEAR			
Backlash	0.0005	0.0050	0.0070
Inside diameter	4.0575	4.0585	*
Outside diameter (crankshaft)	4.0600	4.0610	*
BLOWER DRIVE GEAR			
Backlash	0.0030	0.0050	0.0070
Thrust washer thickness	0.0930	0.1030	*
Endplay (blower drive gear shaft)	0.0040	0.0120	*
FUEL PUMP DRIVE GEAR			
Backlash	0.0030	0.0050	0.0070
Bearing (inside diameter)	1.1220	1.1230	*
Clearance (bearing to hub)	0.0020	0.0035	*
Endplay	0.0050	0.0180	0.0220
Hub (outside diameter)	1.1200	1.1205	*
Thrust washer thickness	0.1580	0.1600	*
CYLINDER HEAD			
Cam follower bore	1.0626	1.0636	*
Valve insert counterbore (diameter)	1.1590	1.1600	*
EXHAUST VALVE INSERTS			
Outside diameter	1.1605	1.1615	*
Seat width	0.0468	0.0781	0.0781
Valve seat runout	0.0020	0.0020	*
EXHAUST VALVES			
Stem diameter	0.2480	0.2488	*
Valve head to cylinder head distance	.flush.	0.0240 recess.	0.0390 recess
EXHAUST VALVE SPRINGS			
Load at 1.93 inches (length)	25. lb		
VALVE GUIDES			
Distance below top of head	0.1500	0.1800	*
Inside diameter	0.2505	0.2515	*
Clearance (valve stem to guide)	0.0017	0.0035	0.0050
ROCKER ARMS AND SHAFTS			
Diameter (rocker shaft)	0.8735	0.8740	*
Diameter (injector rocker arm)	0.8750	0.8760	*
Diameter (valve rocker arm)	0.8753	0.8763	*
Clearance (shaft to injector rocker arm bushing)	0.0010	0.0025	0.0040
Clearance (shaft to valve rocker arm bore)	0.0013	0.0028	0.0040

Section II. ENGINE REPAIR SPECIFICATIONS (Cont)

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) W E A R LIMIT (inches)
CAM FOLLOWERS			
Diameter (follower body)	1.0600	1.0610	*
Diameter (roller pin hole)	0.4362	0.4372	*
Diameter (roller pin)	0.4374	0.4377	*
Outside diameter (roller)	0.9077	0.9082	*
Inside diameter (roller bushing)	0.4390	0.4395	*
Clearance (follower body to head)	0.0016	0.0036	0.0060
Roller and Pins			
Clearance (pin to bushing)	0.0013	0.0021	horiz 0.010
Side clearance (roller to follower)	0.0150	0.0230	0.0230
Clearance (cam follower guide to cam follower legs)	0.0050		
CAM FOLLOWER SPRINGS			
Load at 2.1406 inches (length)	250. lb		
BLOWER			
Backlash (rotor gears)	0.0005	0.0025	0.0035
Backlash (between blower drive gear and camshaft gear)	0.0030	0.0070	..
Oil seal depth (below end plate surface)	0.0020	0.0080	*
Clearances			
Thrust plate to thrust washers	0.0025	0.0050	*
Rotor to air outlet side of housing		0.0040	*
Rotor to air inlet side of housing		0.0100	*
Rotor to front end plate (turbocharged)		0.0100	*
Rotor to front end plate (nonturbocharged)		0.0080	*
Rotor to rear end plate (turbocharged)		0.0120	*
Rotor to rear end plate (nonturbocharged)		0.0100	*
Rotor to rotor (turbocharged)		0.0130	*
Rotor to rotor (nonturbocharged)		0.0090	*
OIL PUMP			
Lobe clearance (inner and outer rotors)	0.0005	0.0110	*
Clearance (pump body to side of inner and outer rotor)	0.0010	0.0035	*
FUEL INJECTOR			
Follower spring load at 1.028 inches (length)	70. lb		*

GLOSSARY

Section I. ABBREVIATIONS

AOAP	Army Oil Analysis Program
App	Appendix
ATTN	Attention
BHP	Brake horsepower
CCLW	Counterclockwise
CLW	Clockwise
Cent	Continued
cm	Centimeter
Cu	Cubic
DA	Department of the Army
V dc	Volts, direct current
DF	Diesel fuel
EIR	Equipment Improvement Recommendation
FOV	Family of Vehicles
ft	Foot, feet
gpm	Gallons per minute
Hg	Mercury
hr	Hour
kg	Kilogram
kPa	Kilopascal
lb	Pound
lb-ft	Pound-foot
lb-in	Pound-inch
min	Minute
mm	Millimeter
N·m	Newton-meter
NPT	Nation Pipe Thread
NPTF	Nation Pipe Thread Fine
NSN	National Stock Number
OVS	Oversized
PAM	Pamphlet
Para	Paragraph
psi	Pounds per square inch
qt	Quart
REV	Revolution
rpm	Revolutions per minute
SAE	Society of Automotive Engineers
STD	Standard
thru	Through
u s	Undersized

Section II. UNUSUAL TERMS

air box:	a chamber in the cylinder block containing cylinder inlet ports
brinelling:	hardening of metal causing brittleness from fatigue
capstan:	a shaft to wrap or pull a wire or cord
concentricity:	roundness of an inner surface
chamfer:	a beveled or grooved edge
counterbore:	a recessed surface around a bore
cross-head piston:	a two-piece piston with a crown and skirt
detent:	a spring loaded device for positioning a part
dynamometer:	a mechanical device to measure engine power
endplay:	axial movement
ferrous:	contains iron
fillister head screw:	slotted cylindrical screw head with a convex top
hone:	sharpen, enlarge, and smooth out
lap:	smooth and polish
matchmark:	to mark two mating surfaces to assemble in the position
multimeter:	multiple purpose electrical meter
muriatic acid:	hydrochloric acid
NO-GO gage:	a thickness gage designed for piston ring grooves
no-load speed:	the maximum speed the governor allows the engine without any load
nonferrous:	has no iron content
peen:	to misshapen from pounding
preload:	the internal bearing load
run-in:	engine break-in period
runout:	length of variation of an axially turning surface
scavenging:	to sweep away exhaust gases with fresh air
scored:	grooved, scratched, or notched
spline:	a set of teeth on a shaft or bore for coupling
sprag:	a pointed stake or bar
trunk type piston:	a one-piece piston
turbocharger:	an air compressor driven by an exhaust gas turbine
underrated:	missing a tooth or notch
woodruff key:	a standard key used in mating grooves of a gear and shaft

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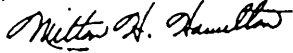
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GORDON R. SULLIVAN
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MILTON H. HAMILTON
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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 inches
 1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
 1 Kilometer = 1000 Meters = 0.621 Miles

WEIGHTS

1 Gram -0.001 Kilograms = 1000 Milligrams = 0.035 Ounces
 1 Kilogram = 1000 Grams= 2.2Lb
 1 Metric Ton = 1000 Kilograms = 1 Megagram= 1.1 Short Tons

LIQUID MEASURE

1 Millimeter = 0.001 Liters = 0.0338 Fluid Ounces
 1 Liter = 1 000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter = 100^{Sq} Millimeters = 0.555 Sq inches
 1 Sq Meter = 10,000 Sq Centimeters = 100.176 Sq Feet
 1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
 1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

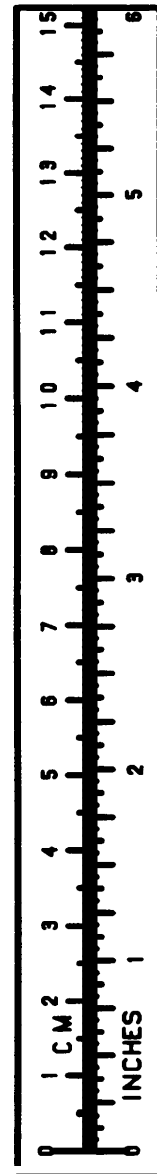
TEMPERATURE

$5/9 (^{\circ}\text{F} - 32) = ^{\circ}\text{C}$
 212° Fahrenheit is equivalent to 100° Celsius
 90° Fahrenheit is equivalent to 32.2° Celsius
 32° Fahrenheit is equivalent to 0° Celsius
 $9/5^{\circ}\text{C} + 32 = \text{OF}$

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 per Square 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
Square Centimeters	Square inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters	Fluid Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	ounces	0.035
Kilograms	Pounds	2.205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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