TECHNICAL MANUAL

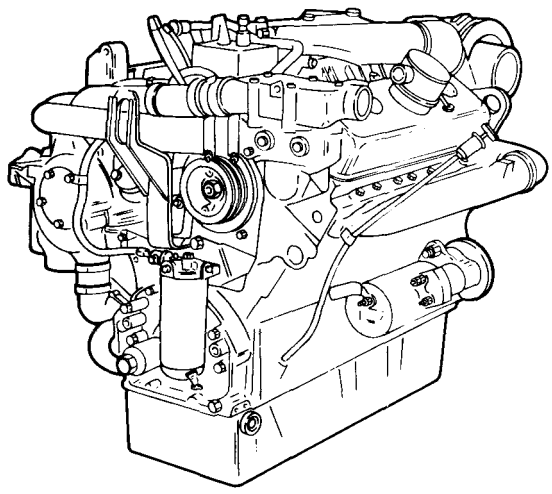
DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

ENGINE, DIESEL W/CONTAINER:
MODEL 7083-7395 (2815-01-043-7092)
(2815-01-260-0211)

ENGINE, DIESEL W/CONTAINER
MODEL 7083-7396 (2815-01-040-3120)
(2815-01-260-0212)

ENGINE, DIESEL W/CONTAINER
MODEL 7083-7398 (2815-00-936-7659)

ENGINE, DIESEL W/CONTAINER
MODEL 7083-7399 (2815-00-134-4845)



HEADQUARTERS, DEPARTMENT OF THE ARMY **20 FEBRUARY 1990**

WARNING SUMMARY

The following is a list of warnings that appear in this manual. Mechanics must become familiar with all warnings. Severe injury or death can be avoided by mechanics who understand the vehicle and are alert to possible dangers.

WARNING

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

WARNING

Protective fan screens must be installed prior to doing maintenance in the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (FM 21-11).

WARNING

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

WARNING

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

WARNiNG

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

WARNING

Wear safety glasses and stand clear of air release ports when purging air from a pressurized container. Make certain air pressure is fully vented before disassembly. Injury to eyes and inner ears can result from failure to properly vent containers 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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

WARNING

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

WARNING

Firmly secure spring-loaded mechanisms during disassembly. The spring can eject parts at high speed If released in an uncontrolled manner. Personal injury may result.

WARNING

Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon-removing compound. Provide adequate ventilation. Avoid inhaling fumes and skin contact. If compound Is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor Is preferable.

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

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.

WARNING

Fuel injector may contain residual fuel oil and can emit a high pressure jet of fuel from spray tip when bumped. Always hold injector so that tip will spray away from skin. Fuel oil which enters blood stream may cause serious infection.

WARNING

Use heat-resistant gloves when handling heated parts. Metal components will dissipate heat quickly. Burns to personnel will result.

WARNING

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

WARNING

Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. Contact with rotating blades will cause injury to personnel.

WARNING

Mercury is a toxic material. Avoid contact with skin. Avoid breathing mercury vapor over prolonged periods of time. Clean up spilled mercury immediately. Dispose of small amounts of mercury by wiping with aluminum foil.

CHANGE

NO. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington D. C., 9 *October 1992*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

ENGINE, DIESEL W/CONTAINER: MODEL 7083-7391 (2815-01-335-4579)

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ENGINE, DIESEL W/CONTAINER: MODEL 7083-7399 (2815-00-134-4845)

TM 9-2815-202-34, 20 February 1990, is changed as follows:

1. Remove old pages and insert new pages as indicated below.

2. New or changed material is indicated by a vertical bar in the margin of the page.

Remove Pages	Insert Pages
i and ii	i and ii
v thru xi/xii Blank	v thru xii
1-1 thru 1-11/1-12 Blank	1-1 thru 1-12
2-1 thru 2-6.	2-1 thru 2-6
2-9 and 2-10	2-9 and 2-10
2-15 and 2-16	2-15 thru 2-16
None	2-19/2-20 Blank
3-1 and 3-2.	3-1 and 3-2
3-7 thru 3-14	3-7 thru 3-14
3-17 thru 3-20	3-17 thru 3-20
3-23 and 3-24	3-23 and 3-24
3-27 thru 3-43/3-44 Blank	3-27 thru 3-43/3-44 Blank
4-1 and 4-2.	4-1and 4-2
4-35 thru 4-42	4-35 thru 4-42
4-45 thru 4-52	4-45 thru 4-52
4-55 thru 4-62	4-55 thru 4-62
4-65 thru 4-70	4-65 thru 4-70
4-77 thru 4-88	4-77 thru 4-88
4-93 and4-94	4-93 and 4-94
4-97 thru 4-100	4-97 thru 4-100
4-103 thru 4-106	4-103 thru 4-106

Approved for public release; distribution unlimited.

Remove Pages	Insert Pages
4-113 thru 4-116	4-113 thru 4-116
4-119 thru 4-124	4-119 thru 4-124
4-131 and 4-132	4-131 and 4-132
4-137 thru 4-146	4-137 thru 4-146
4-149 thru 4-152	4-149 thru 4-152
4-161 thru 4-178	4-161 thru 4-178
4-183 and 4-184	4-183 and 4-184
4-187 thru 4-194	4-187 thru 4-194
4-203 thru 4-206	4-203 thru 4-206
4-213 and 4-214	4-213 and 4-214
4-221 and 4-222	4-221 and 4-222
4-227 thru 4-236	4-227 thru 4-236
4-261 and 4-262	4-261 and 4-262
4-265 and 4-266	4-265 and 4-266
5-1 thru 5-16	5-1 thru 5-16
5-23 and 5-24	5-23 and 5-24
5-27 and 5-28	5-27 and 5-28
5-31 thru 5-64	5-31 thru 5-64.2
5-67 thru 5-72	5-67 thru 5-72
None	5-75 thru 5-102
6-1 and 6-2	6-1 and 6-2
6-43 thru 6-46	6-43 thru 6-46
7-1 and 7-2	7-1 and 7-2
7-7 thru 7-10	7-7 thru 7-10
8-1 and 8-2	8-1 and 8-2
8-5 thru 8-16	8-5 thru 8-16
8-19 thru 8-26	8-19 thru 8-26
8-29 thru 8-34	8-29 thru 8-34
8-37 thru 8-54	8-37 thru 8-54
A-1 and A-2	A-1 and A-2
B-1 thru B-3/B-4 Blank	B-1 thru B-3/B-4 Blank
C-1 thru C-3/C-4 Blank	C-1 thru C-3/C-4 Blank
D-1 and D-2	D-1 and D-2
D-13/D-14 Blank	D-13 thru D-15/D-16 Blank
E-1/E-2Blank	E-1/E-2 Blank
F-1 and F-2	F-1and F-2
F-5/F-6 Blank	F-5 and F-6
G-1 and G-2	G-1 and G-2
G-5 and G-6	G-5 and G-6
Glossary-1 and Glossary-2	Glossary-1 and Glossary-2
lNDEX-1thru lNDEX-6	lNDEX-1thru lNDEX-8
Cover	Cover

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

3. The purpose of this change is to add coverage for the Model 7083-7391 Low Heat Rejection Engine.

By Order of the Secretary of the Army:

GORDON R. SULLIVAN
General, United States Army
Chief of Staff

Official:

MILTON H. HAMILTON
Administrative Assistant to the
Secretary of the Army
03055

Distribution:

To be distributed in accordance with DA Form 12-37-E (Block 2072) Direct Support and General Support maintenance requirements for TM 9–2815-202-34.

Technical Manual
No. 9-2815-202-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C. 20 February 1990

TECHNICAL MANUAL
DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE

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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 Command, ATTN: **AMSTA-MB,** Warren, MI 48397-5000. A reply will be furnished to you.

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Para. No. Page No.

Chapter 4 Repair Procedures For Major Components For Engine Model 7083-7395

Para. No. Page No.

Chapter 5 Repair Procedures for Major Components for Engine Model 7083-7396

Para. No. Page No.

Chapter 5.1 **Repair Procedures for Major Components for Engine Model 7083-7391**

Para. No. Page No.

Chapter 6 Repair Procedures For Major Components For Engine Model 7083-7398

Para. No. **Page No.**

Chapter 7 **Repair Procedures For Major Components For Engine Model 7083-7399**

Para. No. Page No.

HOW TO USE THIS MANUAL

Before starting a procedure, read HOW TO USE THIS MANUAL and Para 3-2, 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 hazards 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 covers the instruction for direct support and general support (DS/GS) level troubleshooting of the engines in the vehicle

CHAPTER 3 tells how to remove/install the engine from the container and install/remove the engine from the maintenance stand. Chapter 3 also includes the cleaning and general repair instructions to use with every procedure.

CHAPTER 4 contains repair procedures to be performed on engine model 7083-7395.

CHAPTER 5 contains repair procedures to be performed on engine model 7083-7396. If a procedure is the same as for model 7083-7395, Chapter 5 will refer to the appropriate paragraph in Chapter 4.

CHAPTER 5.1 contains repair procedures to be performed on engine model 7083-7391. If a procedure is the same as for model 7083-7395 or 7083-7396, Chapter 5.1 will refer to the appropriate paragraph in Chapter 4 or 5.

CHAPTER 6 contains repair procedures to be performed on engine model 7083-7398. If a procedure is the same as for model 7083-7395 or 7083-7396, Chapter 6 will refer to the appropriate paragraph in Chapter 4 or 5.

CHAPTER 7 contains repair procedures to be performed on engine model 7083-7399. If a procedure is the same as for model 7083-7395, 7083-7396, or 7083-7398, Chapter 7 will refer to the appropriate paragraph in Chapter 4, 5, or 6.

CHAPTER 8 tells how to adjust, prepare, and test the engine for operation after the engine 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/durable 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 Iearn 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 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 Mandatory Replacement 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 9-2815-202-24P.

HOW TO USE THIS MANUAL (cont)

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 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.

MANDATORY REPLACEMENT 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.

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 conditions is listed followed by a description of the part removed, repaired, or adjusted.

FEATURES OF THE 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 on the inside of the front cover of this TM. They call attention to hazards that could kill or injure personnel.

CAUTIONS. Cautions are found within the procedure immediately before the step where they apply. They call attention to hazards 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 special 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 authorized 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 NSN of the item to be ordered.

CHAPTER 1

INTRODUCTION

Contents **Para** **Page**

Section I. GENERAL

1-1. SCOPE

a. Type of Manual: Direct Support and General Support Maintenance.

b. Model Number and Equipment Name. Series 8V71T diesel engine, models 7083-7391, 7083-7395, 7083-7396, 7083-7398, and 7083-7399. ■

c. Purpose of Equipment: Powers the M109/M992 and M110/M578 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.

1-3. DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE. For general destruction procedures, refer to TM 750-244-6.

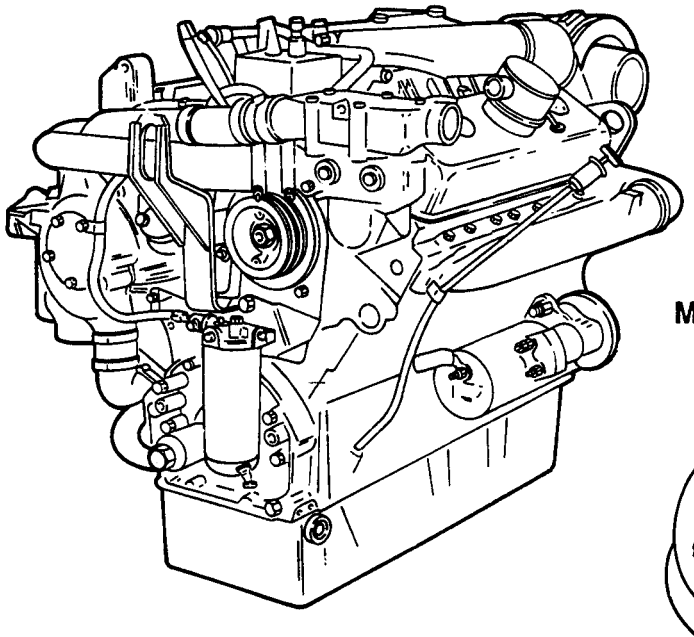
1-4. PREPARATION FOR STORAGE OR SHIPMENT. Preparation for storage or shipment is provided in Paragraph 3-3 or 3-4.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR). If any M109/M992 or M110/M578 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 Command, ATTN: AMSTA-QRT, Warren, Michigan 48397-5000. We'll send a reply.

1-6. WARRANTY INFORMATION. The Series 8V71T diesel engine is warranted for 12 months. Report all defects in material or workmanship in accordance with TB 9-2815-202-34.

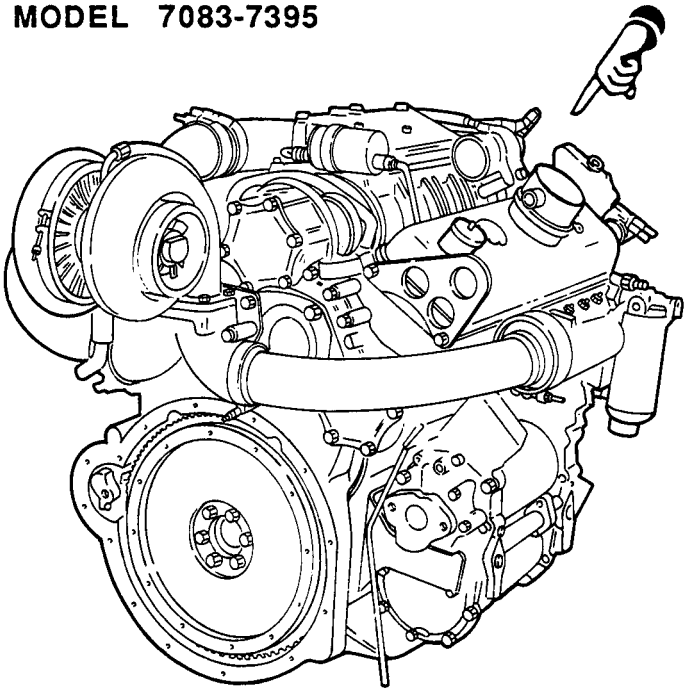
Section II. EQUIPMENT INFORMATION

1-7. EQUIPMENT DESCRIPTION. All the engine models are two cycle, fuel injected, V-type, liquid cooled, and eight cylinder diesel engine with dry cylinder liners. The cylinders are numbered one, two, three, and four 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. The engine serial number and model are stamped on the right side, upper front corner of the cylinder block. On model 7083-7391, an option label is affixed to one valve rocker arm cover which carries the engine serial number, model number, tune-up specifications, and a list of optional equipment used on the engine.

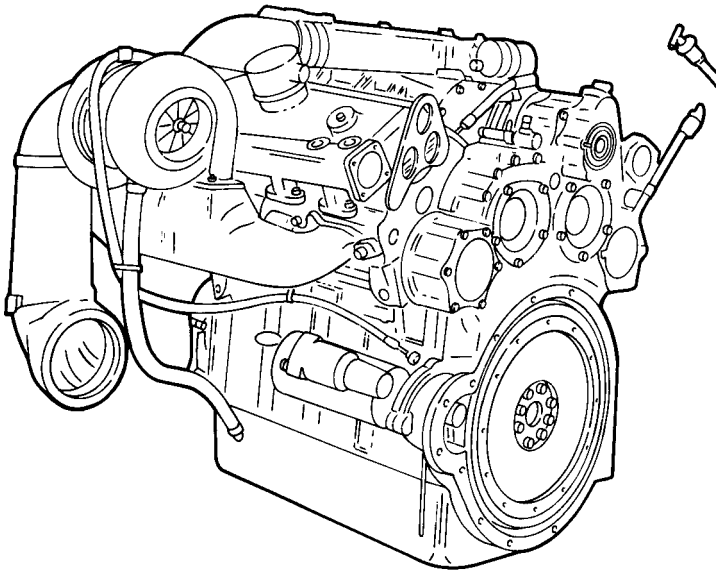


LEFT FRONT VIEW

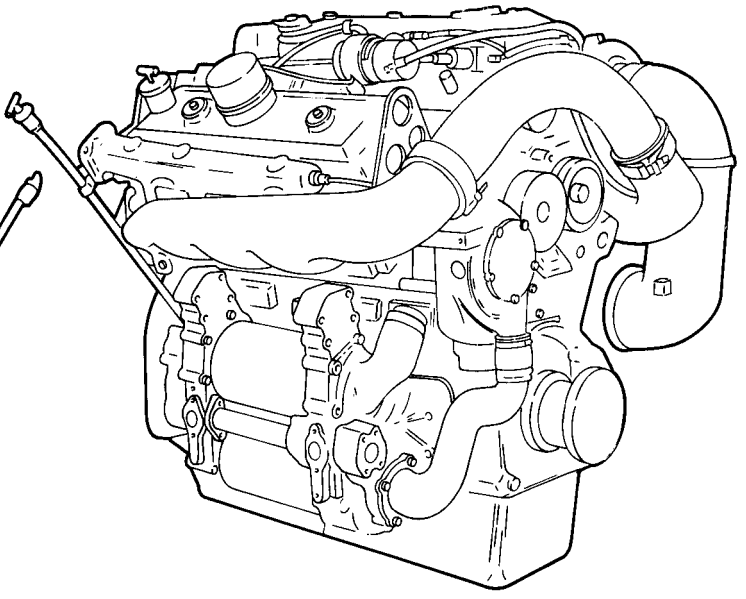
MODEL 7083-7395



RIGHT REAR VIEW

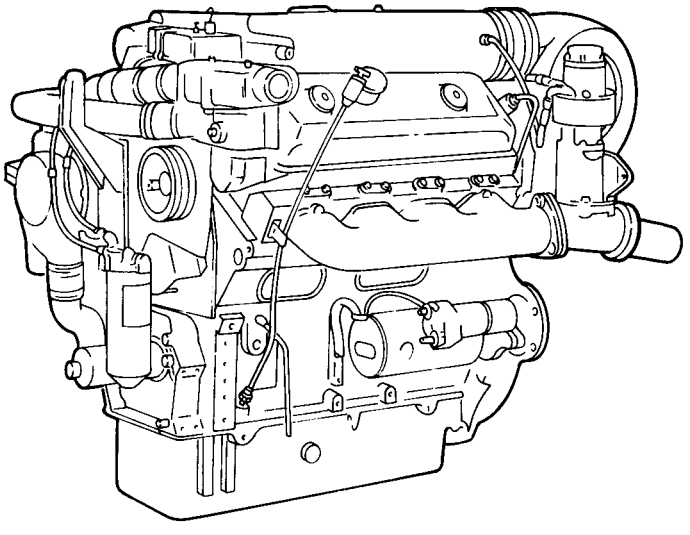


LEFT REAR VIEW



RIGHT FRONT VIEW

MODEL 7083-7396



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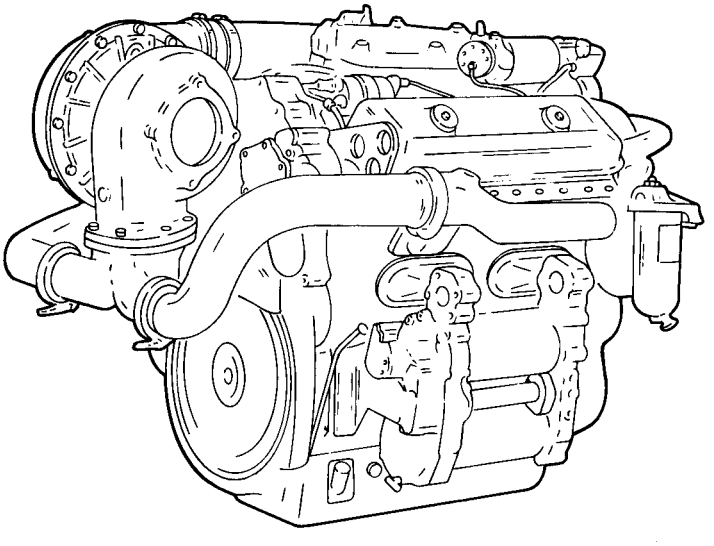
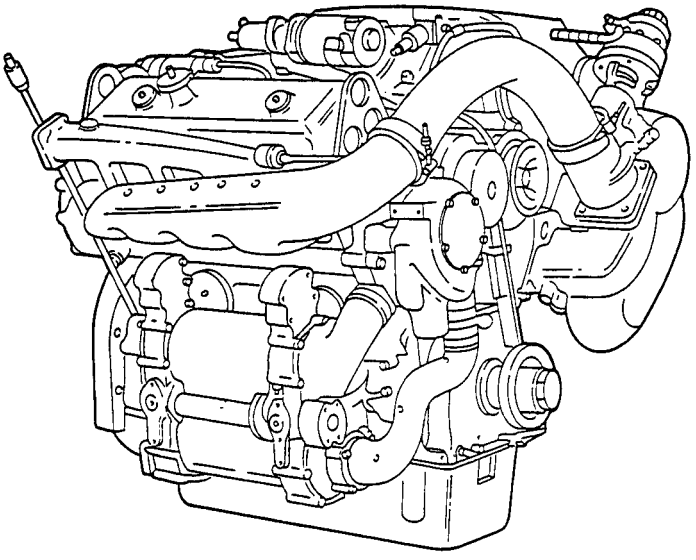


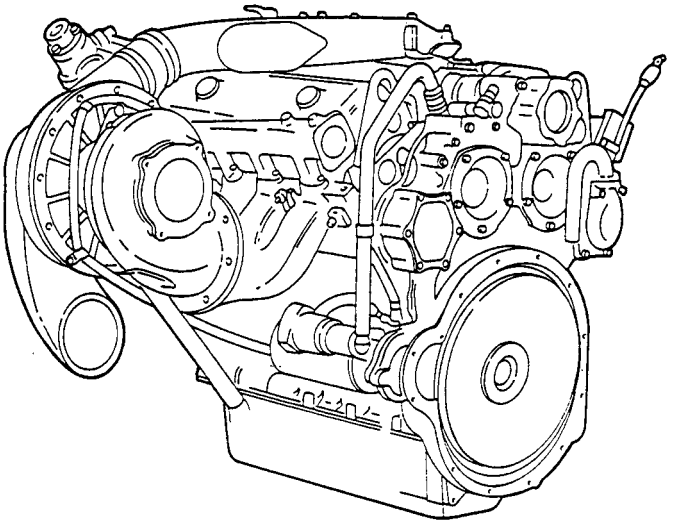
RIGHT REAR VIEW

MODEL 7083-7398

1-7. EQUIPMENT DESCRIPTION (Cont)

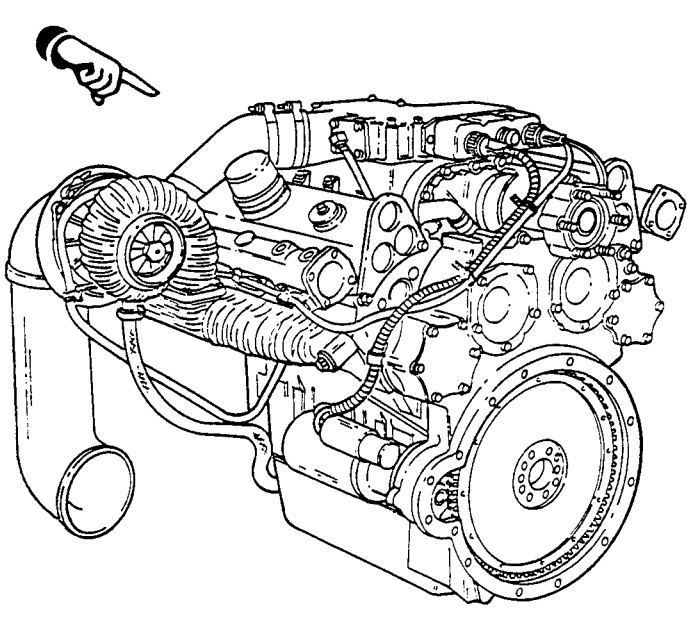


LEFT REAR VIEW

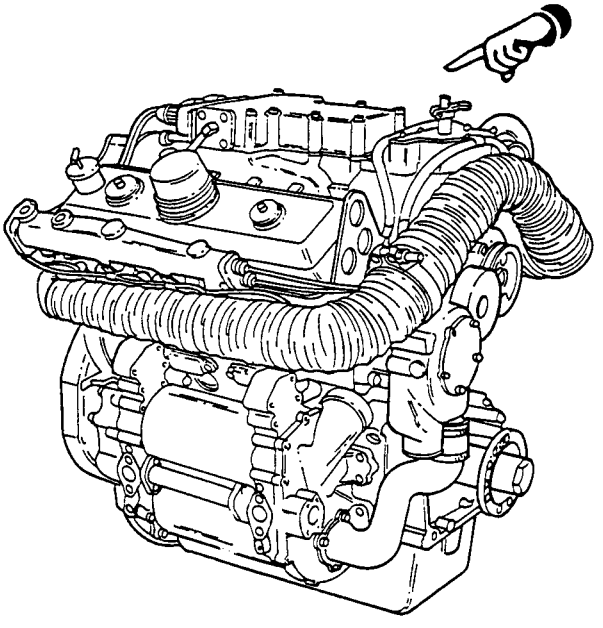


RIGHT FRONT VIEW

■ **MODEL 7083-7399**



LEFT REAR VIEW



RIGHT FRONT VIEW

■ **MODEL 7083-7391**

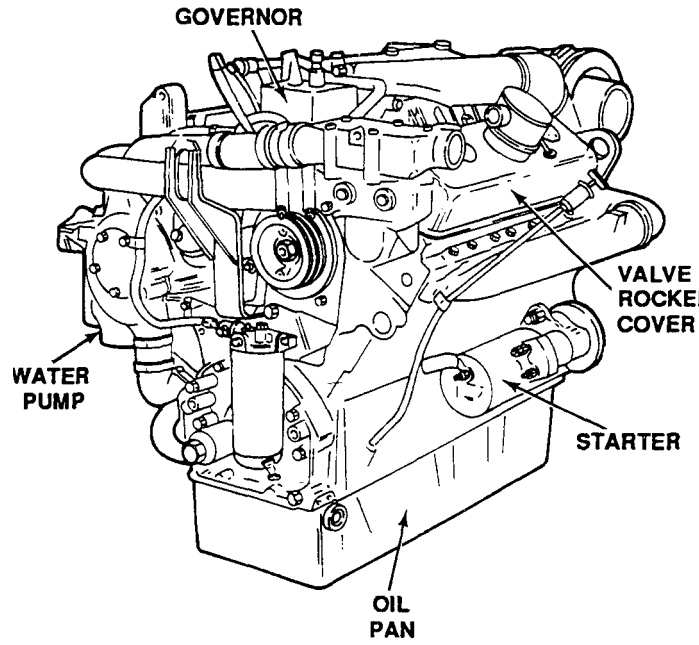
1-8. LOCATION AND DESCRIPTION OF COMPONENTS

a. Water Pump. Mounted on the front engine cover and driven by a right camshaft gear. It circulates coolant through the cylinder block, cylinder heads, and oil cooler.

b. Governor. Mounted on the front end of the blower and driven by a blower rotor. It is used to control the idle and maximum engine operating speeds.

c. Oil Pan. Mounted on the bottom of the cylinder block. It provides a reservoir for engine oil.

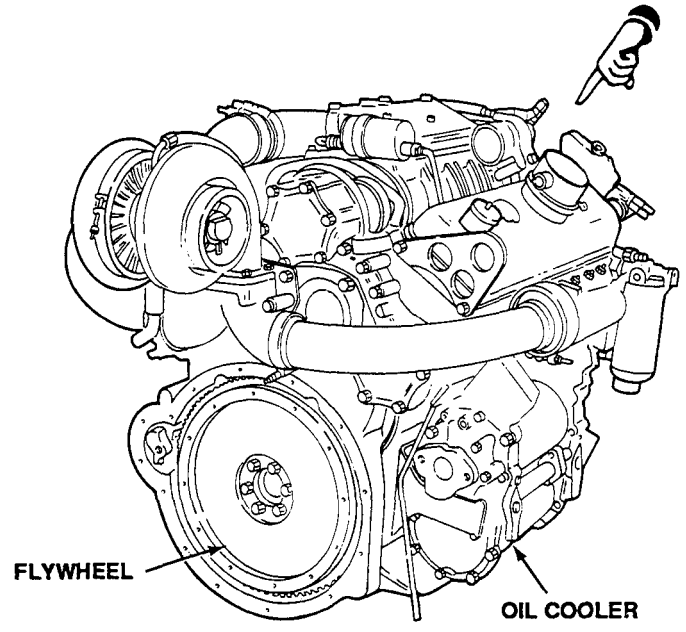
d. Valve Rocker Covers. Encloses the valve and injector rocker arm mechanisms located on top of cylinder heads.



e. Starter. Mounted on left side of flywheel housing. It is an electric starter and engages the flywheel ring gear.

f. Flywheel. Mounted on the rear of the crankshaft. It is used to provide true alinement of transmission flex plate.

g. Oil Cooler. Mounted on lower right side of engine block. It uses engine coolant to cool engine and transmission oil.



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

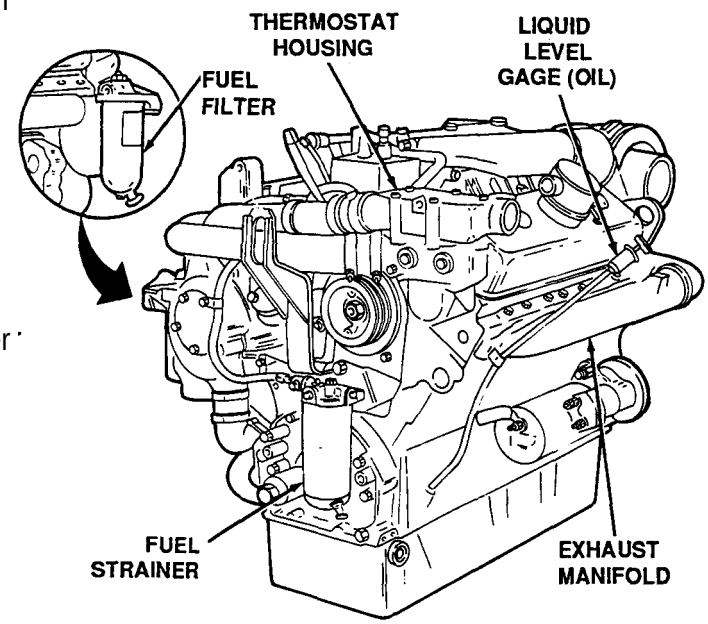
h. Exhaust Manifolds. Attached directly to cylinder heads. They route exhaust gases through attached exhaust piping to the turbocharger.

i. **Liquid Level Gage (Oil).** Mounted on the lower left front cylinder block (models 7083-7395 and 7083-7398) or right rear oil pan (models 7083-7391, 7083-7396, and 7083-7399). It measures the liquid level in the oil pan.

j. Thermostats and Housing Assembly. Mounted on the front of the left cylinder head and connected to the right cylinder head with crossover tubes (models 7083-7395 and 7083-7398). They control coolant temperature by restricting coolant flow to the radiator.

k. **Fuel Strainer.** Mounted on the left front corner of the cylinder block (models 7083-7395 and 7083-7398). It filters fuel to fuel pump.

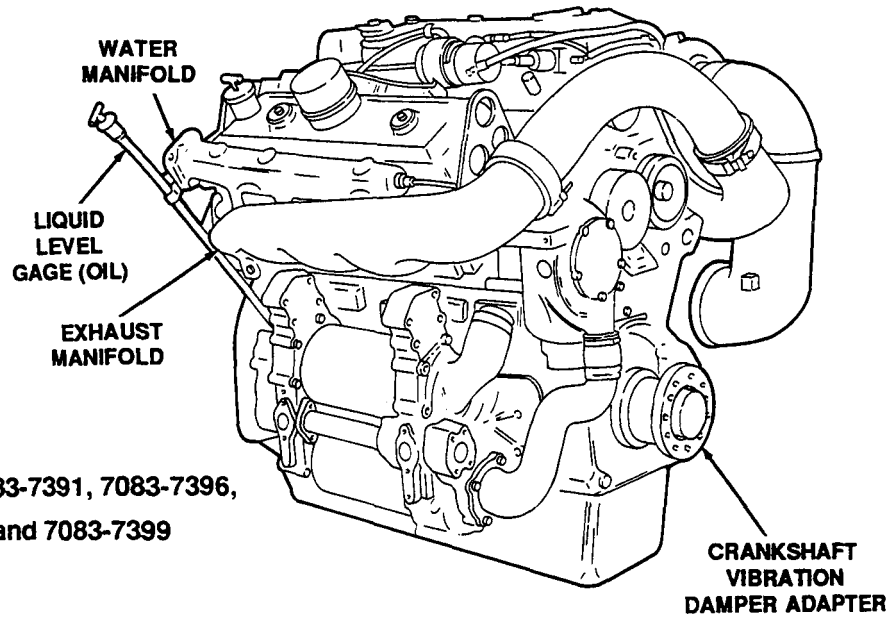
l. **Fuel Filter.** Mounted on the right front corner of the cylinder block (models 7083-7395 and 7083-7398). It filters fuel to fuel inlet manifold.



MODELS 7083-7395 AND 7083-7398

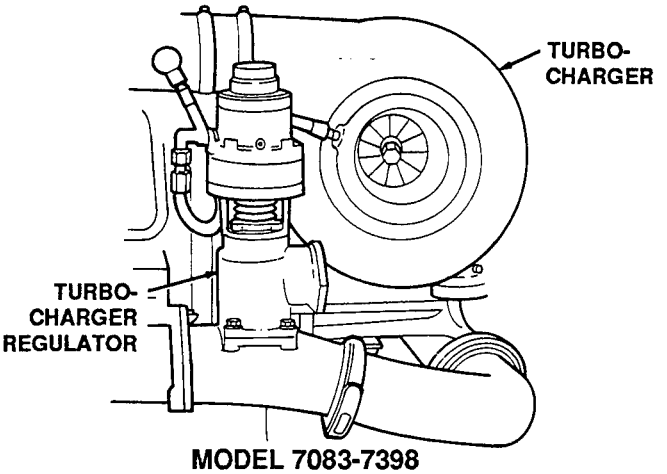
m. Water Manifolds. Mounted on top of cylinder heads (models 7083-7391, 7083-7396, and 7083-7399). They collect coolant as it leaves the cylinder heads.

n. Crankshaft Vibration Damper. Mounted on a hub on the front of the crankshaft (models 7083-7391, 7083-7396, and 7083-7399). It reduces torsional vibration in the crankshaft.



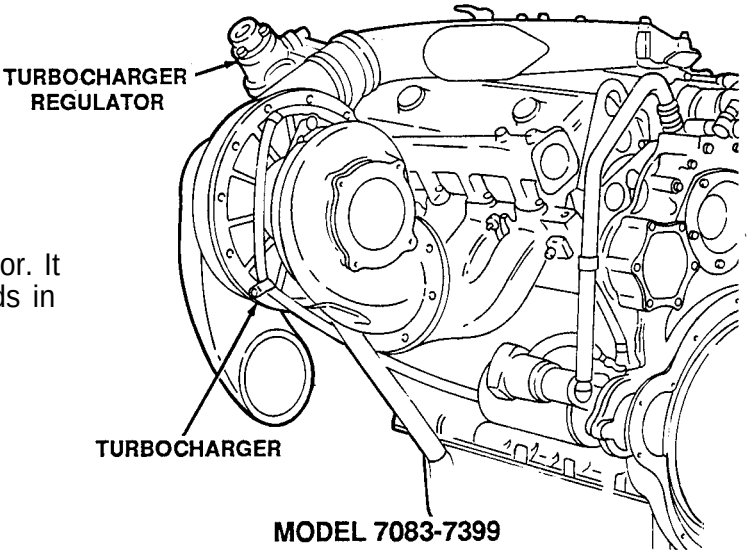
MODEL 7083-7391, 7083-7396, and 7083-7399

o. Turbocharger. Mounted on the rear of the engine (models 7083-7395 and 7083-7398) or on the left exhaust manifold (models 97083-7391,7083-7396, and 7083-7399). It increases engine efficiency by delivering high pressure air to the blower using exhaust gas energy.



MODEL 7083-7398

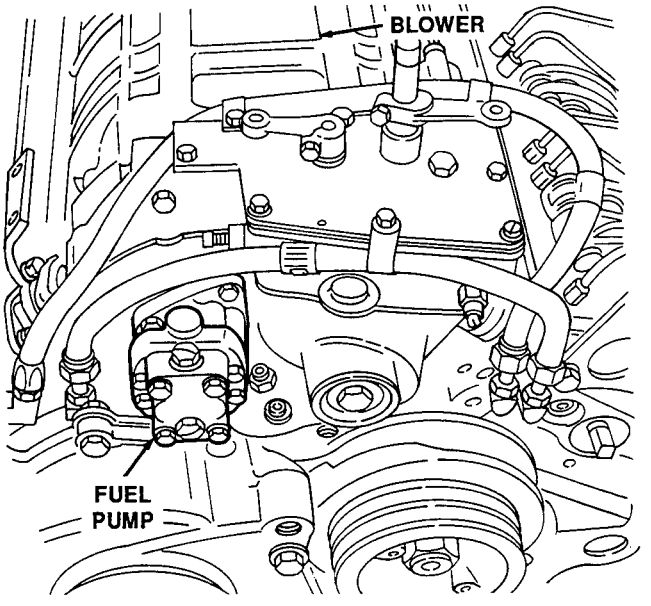
p. Turbocharger Regulator. Mounted on the outlet of the left exhaust manifold (models 7083-7398 and 7083-7399). It bypasses excessive exhaust gas flow to the turbocharger.



MODEL 7083-7399

q. Fuel Pump. Attached to the governor housing and driven off the right side blower rotor. It supplies low pressure fuel to fuel inlet manifolds in cylinder heads.

r. Blower. Mounted on top of the cylinder block. It supplies a constant volume of fresh air per revolution to the cylinders.



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

s. Cylinder Heads. Mounted on the top of each cylinder bank. They contain fuel manifolds, exhaust valves, injectors, injector and valve operating mechanisms, and glow plugs (model 7083-7391). Special Low Heat Rejection (LHR) cylinder heads are used on model 7083-7391. These heads reject less heat to the coolant; therefore, more heat energy in the exhaust gases is available for use by the turbocharger. Built in heat shields in the exhaust ports, which insulate hot exhaust gas from the engine coolant, are the main feature of the LHR cylinder head.

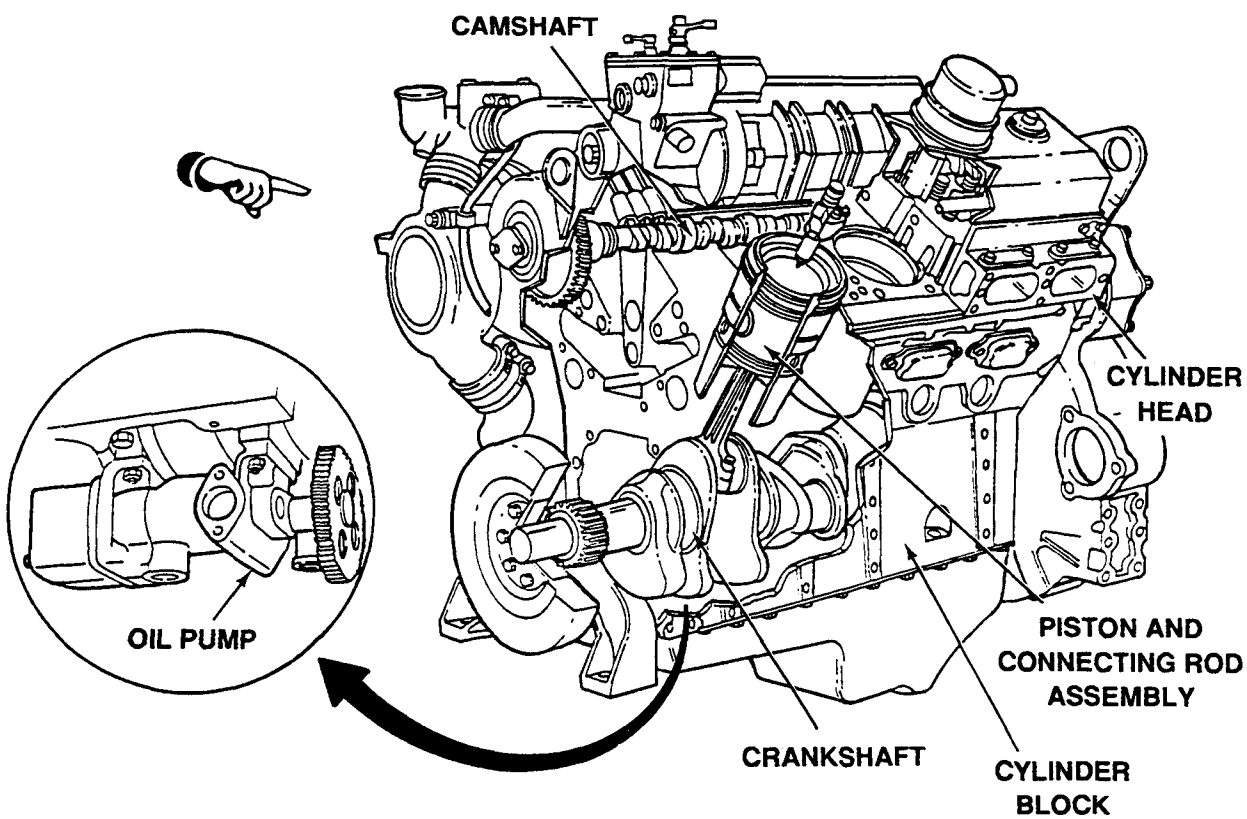
t. Camshafts. Located on top of each cylinder bank. They actuate injector and exhaust valve operating mechanisms.

u. Cylinder Block. Being the main structural part. It provides rigidity and ensures alinement of all load bearing assemblies.

v. Crankshaft. Attached to the bottom of the cylinder block. It transfers the engine load through the flywheel and supplies oil to piston assemblies.

w. Piston and Connecting Rod Assemblies. Four assemblies are located in each bank. Pistons are cooled and lubricated **by oil pressure** fed up through drilled connecting rods.

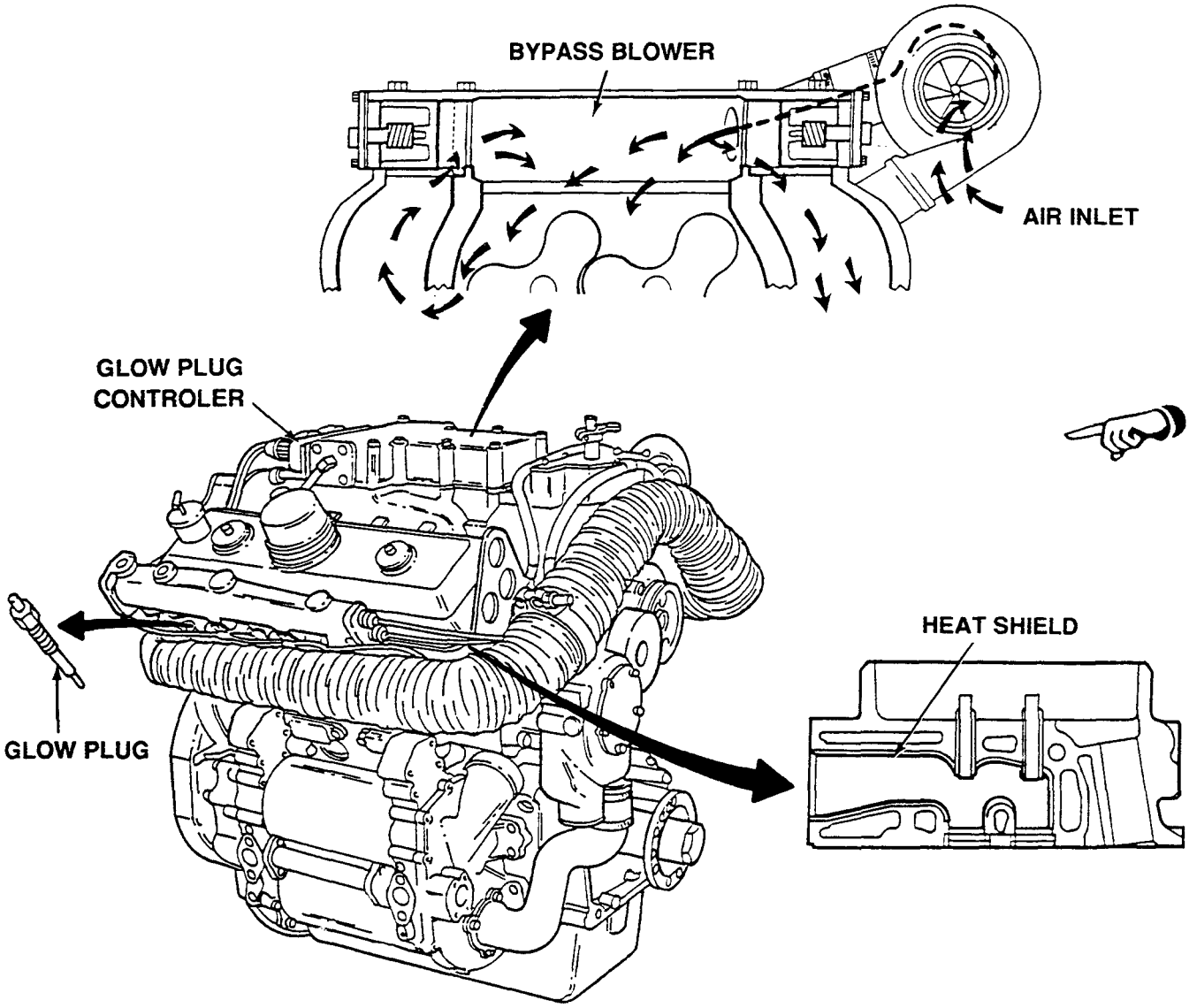
x. Oil Pump. Mounted on the bottom of the cylinder block. It pumps oil throughout the engine for lubrication and cooling.



y. Bypass Blower System. The bypass feature increases fuel efficiency by reducing the amount of engine power required to operate the blower. The bypass feature allows the air in the blower to be bypassed when sufficient airflow from the turbocharger is available to sustain an adequate air/fuel ratio for combustion for model 7083-7391.

z. Glow Plugs. They improve cold weather startability by heating the combustion chamber of each cylinder. The plugs screw into the cylinder head and protrude into the combustion chamber for model 7083-7391.

aa. Glow Plug Controller. Attached to the rear of the air inlet housing, it is a control module used to regulate the glow plug duty cycle for cold starting applications for model 7083-7391.



1-9. DIFFERENCES BETWEEN MODELS

COMPONENT	7083-7391	7083-7395	7083-7396	7083-7398	7083-7399
Rear mounted turbocharger	X	—	X	—	
Side mounted turbocharger	—	X	—	X	
Model T18A90 turbocharger	X	X	—	—	
Model T3030 turbocharger	—	—	X	X	
Model TV8405 turbocharger	—	—	—	—	
Turbocharger regulator	—	—	X	X	
Bypass blower system	—	—	—	—	
Dual range limiting speed governor	X	—	X	—	
Crankshaft and camshaft dampers	—	X	—	X	
Crosshead piston and connecting rod assembly	X	X	X *	X *	
Trunk piston and connecting rod assembly	—	—	X **	X **	
Crankcase breather on flywheel housing	—	—	X	X	
Accessory drive	—	X	—	X	
Throttle delay assembly	X	X	—	—	
Front mounted fuel filter and fuel strainer	X	—	X	—	
Remote mounted fuel filter and fuel strainer	—	X	—	X	
Air box heater air pump	X	X	—	—	
Air box heater fuel pump	—	—	X	X	
Thermostat, housing, and water crossover tubes	X	—	X	—	
Water manifolds	—	X	—	X	
Low heat rejection cylinder heads	—	—	—	—	
Insulated turbocharger turbine housing	—	—	—	—	
Insulated exhaust manifolds	—	—	—	—	
Glow plugs	—	—	—	—	
Glow plug controller	—	—	—	—	

* Effective from serial number 8VA-294357 and above.

** Effective through serial number 8VA-294356.

1-10. EQUIPMENT DATA

GENERAL SPECIFICATIONS

Type	Diesel, two-cycle
Manufacturer	Detroit Diesel Corporation *
■ Models	7083-7391, 7083-7395, 7083-7396, 7083-7398, 7083-7399
Number of Cylinders	8
Cylinder Arrangement	V-type
Crankshaft Rotation (from Front)	Clockwise
Firing Order	1L,3R,3L, 4R,4L, 2R,2L, 1R
Total Displacement	568 cu.in.(9.32L)
Bore	4.25 in. (108 mm)
Stroke	5.0 in. (127 mm)
Number of Main Beatings	5
Compression Ratio	17:1
Minimum Compression Pressure	445 PSI(3068 kPa)@600 RPM
■ Maximum Brake Horsepower(at 2300 RPM)(All Models Except 7083-7391)	405 HP
■ Maximum Brake Horsepower (at 2300 RPM) (Model 7083-7391)	440 HP

ENGINE SPEED RATINGS

Maximum Governed Speed, Full-Load	2300 RPM
Idle Speed	600-650 RPM
Low Maximum No-Load Speed (M578 Vehicle Only)	1350-1375 RPM
Maximum No-Load Speed	2450-2500 RPM

ENGINE LUBRICATION SYSTEM

Type	Sump, pressure
Total Capacity (with Filters)	40 qt (38 L)
Operating Pressure (at 2300 RPM)	50-70 PSI (345-483 kPa)
Minimum operating pressure	30 PSI (207 kPa)
Idle Operating Pressure	5 PSI (34 kPa)
Normal Operating Temperature	200-250°F (93-121°C)
Oil Pump	Gear type

FUEL SYSTEM

Fuel Pump	Gear type
■ Fuel Injectors (All Models Except 7083-7391)	Model N80 unit Injector
Fuel Injectors (Model 7083-7391)	Model 7590 unit injector
Grade	DF2-DF1 below -20°F (-29°C)
Specification	VV-F-800
Supply pressure (to injectors)	50-70 PSI (345-483 kPa)

EXHAUST SYSTEM

■ Exhaust Manifolds (All Models Except 7083-7391)	Air cooled
Exhaust Manifolds (Model 7083-7391)	Insulated
Exhaust Valves per Cylinder	4
Cold Valve Clearance	0.015 in. (0.381 mm)
Hot Valve Clearance	0.013 in. (0.330 mm)

* Formerly Detroit Diesel Allison Division of GMC

COOLING SYSTEM

Type ..... Liquid
Capacity ..... 31 qts. (29.3 L)
Normal Operating Temperature ..... 160-185°F (71-85°C)
Maximum Top Tank Temperature ..... 230°F (110°C)
Coolant Flow (at 2300 RPM) ..... 143 GPM (541 L/min)
Thermostats (Models 7083-7395 and 7083-7398) ..... (2) Blocking Type
Thermostats (Models 7083-7391, 7083-7396, and 7083-7399) ..... Remote mounted

DRIVE RATIOS AND ROTATION

Right Camshaft ..... 1.00:1 CCLW
Left Camshaft ..... 1.00:1 CLW
Blower Drive (Models 7083-7391,7083-7395, and 7083-7396) ..... 1.95:1 CLW
Blower Drive (Models 7083-7398 and 7083-7399) ..... 2.05:1 CLW
Starter Motor ..... 9.27:1 CLW
Fuel Pump (Models 7083-7391, 7083-7395, and 7083-7396) ..... 1.95:1 CLW
Fuel Pump (Models 7083-7398 and 7083-7399) ..... 2.05:1 CLW
WaterPump ..... 1.00:1 CCLW

Table 1-1 Engine Physical Data

Model	7083-7391	7083-7395	7083-7396	7083-7398	7083-7399
Length - in. (cm.)	42.4 (108)	5.35 (136)	42.4 (108)	55.5 (141)	42.4 (108)
Width - in. (cm.)	54.9 (139)	40.7 (103)	54.9 (139)	41.2 (105)	57.8 (147)
Height - in. (cm.)	41.6 (106)	40.8 (104)	41.6 (106)	40.8 (104)	41.6 (106)
Weight - lb. (Kg.)	2495 (1132)	2495 (1132)	2495 (1132)	2617 (1187)	2602 (1180)

Section III. PRINCIPLES OF OPERATION

1-11. PRINCIPLES OF OPERATION. The diesel engine is an internal combustion power unit where the heat energy of fuel is converted into work energy inside the cylinder. This particular engine 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.

1-11. PRINCIPLES OF OPERATION (Cont)

The engine has a turbocharger and a blower to force air into the cylinders (called supercharging) for both the intake and the exhaust functions. When the piston is halfway down, the exhaust valves open. Shortly thereafter, the piston drops below a row of inlet ports in the cylinder liner wall. Pressurized air is then forced through the cylinder. During this process, all of the exhaust gases are removed (or scavenged) from the cylinder. When the exhaust valves close, during the pistons upward stroke, fresh air is trapped in the cylinder for compression.

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

CHAPTER 2

TROUBLESHOOTING PROCEDURES

Contents **Para** **Page**

2-1. GENERAL. Troubleshooting is a logical, systematic search for the cause(s) of malfunction(s). Direct Support troubleshooting of the engine can be performed with the engine installed in the vehicle.

NOTE

When troubleshooting is performed with the engine in a vehicle, the information in this manual will be used in conjunction with the information contained in the applicable vehicle type-20 maintenance manual.

The purpose of troubleshooting is to establish the nature and extent of repair required to return the engine to serviceable condition. Thorough troubleshooting before the engine is removed from the vehicle may reveal malfunctions external to the engine. Correction of such external malfunctions may prevent the unnecessary effort of removing the engine.

Troubleshooting by a Direct Support shop is necessary to verify the diagnosis made before the engine is removed. Such troubleshooting may be the only means of uncovering all defects in an engine received in an unserviceable condition from another activity.

Troubleshooting may be necessary to determine the cause when a repaired engine fails to perform properly.

2-2. PRELIMINARY INSPECTION

CAUTION

Maintenance personnel must have a thorough knowledge of vehicle operation before attempting to troubleshoot an installed engine. The purpose and use of all operator controls must be thoroughly understood. Refer to applicable vehicle operators manual for procedures concerning operation of vehicle.

Verification of all preliminary checks at crew and unit level should be made.

If preliminary troubleshooting of the vehicle is not conclusive, refer to vehicle TM's listed in App A for preliminary inspections.

2-3. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION

Troubleshooting procedures are provided in Malfunction, Test or Inspection, and Corrective Action. The most likely malfunction symptoms to be encountered have been listed followed by tests and inspections to determine the probable cause and the recommended corrective action.

To use this information, first find the malfunction symptom that best describes the actual condition. Perform the tests or inspections to determine the probable cause and make the corrections indicated. If no cause is found or corrective action does not resolve the problem, proceed to the malfunction symptom that next best describes the condition.

2-4. SYMPTOM INDEX

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

HARD STARTING OF ENGINE

1. ENGINE WILL NOT ROTATE

Step l. Inspect starter and battery connections for loose, corroded, or broken cables.

a. Tighten Ioose connections.

b. Clean corroded cables and terminals.

c. Replace broken or frayed cables.

Step 2. Check batteries for low or no voltage (Refer to applicable vehicle type-20 maintenance manual for tests and services).

CAUTION

Do not rotate engine in a counterclockwise direction to avoid loosening the crankshaft bolt.

Step 3. Check for internal seizure by slowly turning engine clockwise with wrench on crankshaft bolt at front of engine. If engine cannot be rotated one complete revolution, internal damage is indicated.

Remove engine from vehicle to determine cause.

END OF TEST

2. ENGINE CRANKS SLOWLY

Step 1. Check batteries (For low or no voltage, refer to vehicle type-20 maintenance manual for test and services).

Step 2. Check starter electrical circuits (Refer to vehicle type-20 maintenance manual for starter operational tests).

Step 3. Check for proper grade of oil for temperature conditions (Refer to applicable vehicle LO for proper grade of oil).

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. ENGINE ROTATES BUT FAILS TO START

Step 1. Check main fuel supply line valves are open and fuel supply level inadequate.

Step 2. Check fuel pump for damaged drive shaft or drive coupling. insert end of 1/8 inch diameter wire through one of the pump flange drain holes. Crank engine momentarily ;note if slight vibration is felt in wire.

If wire vibrates, drive shaft is all right. If no vibration is felt, replace fuel pump.

WARNING

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

Step 3. Check for air in fuel system.

a. Disconnect fuel return line and drain into a bucket.

WARNING

Protective fan screens must be installed prior to doing maintenance in the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).

b. Crank engine momentarily. Observe fuel return flow. Uneven flow or bubbles in fuel indicate air in fuel system.

Step 4. Check for contaminated fuel (water in fuel).

a. Drain and clean fuel strainer and filter.

b. Replace with new element as required (Refer to vehicle type-20 maintenance manual).

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. ENGINE ROTATES BUT FAILS TO START (Cont)

Step 5. Check fuel grade.

a. Check source of supply to determine fuel being used.

b. Refer to applicable vehicle LO for proper grade of fuel.

Step 6. Check fuel lines, fittings, and fuel filters for leaks, loose connections, bends, dents, or kinks.

a. Tighten loose connections and fittings.

b. Repair or replace damaged fuel lines and filters as required.

Step 7. Check for binding of governor to injector linkage that would prevent positioning of injector racks to FULL FUEL position.

a. Correct binding linkage.

b. Readjust governor and injector controls (Refer to Para 8-7).

Step 8. Check condition of blower drive shaft and coupling.

Replace damaged parts (Refer to Paragraphs 4-16, 5-15, or 5.1-15 for appropriate engine model). ■

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

ABNORMAL ENGINE OPERATION

4. UNEVEN RUNNING OR STALLING

Step 1. Check fuel supply level.

Step 2. Check fuel strainer and fuel filter for leaking gaskets, clogged filters, or loose connections.

Step 3. Check fuel lines for loose connections, damage, twists, and bends.

Step 4. Check fuel spill back for air in fuel system.

a. Disconnect fuel return line from fitting at fuel tank. Hold end of fuel line in a container.

WARNING

Protective fan screens must be installed prior to doing maintenance in the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).

b. Start engine and run at 1200 RPM.

NOTE

Air bubbles rising to surface indicate air being drawn into fuel system.

c. Measure fuel; 0.8 GPM is required.

Step 5. Check engine tune up adjustments (Refer to Para 8-5).

WARNING

Protective fan screens must be installed prior to doing maintenance in the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).

Step 6. Check for faulty injectors.

a. Remove rocker arm cover.

b. Start engine.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

4. UNEVEN RUNNING OR STALLING (Cont)

NOTE

If injector is malfunctioning, there will be no noticeable difference in sound and operation of engine.

c. Hold injector follower down with a screwdriver with engine idling to prevent operation of injector.

d. Replace faulty injector.

e. Check injector timing (Refer to Para 8-5).

f. Install rocker arm cover.

Step 7. Check for low compression (Refer to Para 8-14).

Step 8. Check for misfiring cylinders.

a. Remove rocker arm covers.

b. Remove cam follower assemblies.

c. Check for worn cam rollers, camshaft, bent push rods, or worn rocker arm bushings.

d. Replace damaged parts.

e. Install cam follower assemblies.

f. Install rocker arm covers.

Step 9. Check for a clogged or missing restricted fitting on the fuel return line.

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. ENGINE WILL NOT DELIVER RATED POWER

Step 1. Check crankcase oil level.

Fill as required.

Step 2. Check for clogged/dirty air cleaner system.

Clean, repair, or replace as required.

Step3. Check for improper engine adjustments (Refer to Paragraphs 8-4 thru 8-14).

Step 4. Check governor linkage from governor to fuel rack for binding or damage (Refer to Para 8-7).

Step 5. Check for low cylinder compression (Refer to Para 8-14).

NOTE

- Return fuel temperature must be less than 150°F (66°C) or loss of horsepower will occur.
- A power decrease of 0.6 to 4.0 horsepower for each 10° temperature rise above 90°F (32°C) will occur.

Step 6. Check for high return fuel temperature.

Step 7. Inspect turbocharger for damage.

CAUTION

Do not attempt to remove carbon build up on turbine wheel without removing turbocharger from engine. Blades of wheel must be thoroughly cleaned. Chunks of carbon left on blades could cause bearing failure. However, it is not necessary to disassemble turbocharger to remove dirt and dust build up.

a. Remove turbocharger exhaust pipe.

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

5. ENGINE WILL NOT DELIVER RATED POWER (Cont)

b. Check that turbine wheel rotates freely. If turbine does not rotate, then turbocharger bearings have seized.

c. Inspect turbine wheel for nicks, cracks, or contact.

d. Install turbocharger exhaust.

e. Remove vehicle air inlet hose and pipe.

f. Inspect compressor wheel and housing for contact.

g. Inspect compressor wheel for nicks, cracks, or other damage.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

h. Inspect compressor for excessive dirt or foreign material. If necessary, remove compressor housing, clean compressor wheel and housing with dry cleaning solvent, and install compressor housing.

i. Replace turbocharger assembly if damaged (Refer to Paragraphs 4-2, 5-2, 5.1-2, 6-3, or 7-3 for appropriate engine model). ■

j. Install vehicle air inlet hose and pipe.

Step 8. Check for leaks in engine air intake or exhaust manifold.

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

LUBRICATING SYSTEM

6. EXCESSIVE ENGINE OIL CONSUMPTION

Step 1. Check oil lines and connections for leaks.

Step 2. Clean and inspect crankcase breathers (Refer to Paragraphs 4-11, 4-15, 6-16, or 7-14 for appropriate engine model).

Step 3. Check blower oil seals for leaks.

a. Remove air inlet housing.

WARNING

- **When Inspecting a biower on a engine with the engine running, keep fingers, equipment and ciothing away from moving parts of the biower. Run engine at iow speeds oniy.**
- **Protective fan screens must be installed prior to doing maintenance in the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).**

b. Operate engine fluctuating between 650-1200 RPM and inspect blower end plates for evidence of oil leakage past seals.

c. If leakage is detected, replace blower (Refer to Para 4-18).

Step 4. Check for blue smoke. Inspect exhaust manifolds and stacks for wetness or oil discharge.

NOTE

- If wetness or oil discharge is present in exhaust manifolds, it is usually an indication of worn valve guides.
- Low compression readings will indicate worn out cylinders.

Step 5. Check vehicle for leaks in air cleaner system which would allow contaminated air to enter engine. Perform cylinder compression test (Refer to Para 8-14).

Step 6. Check turbocharger oil drain and supply lines for leakage.

END OF TEST

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

7. LOW OIL PRESSURE

NOTE

Make oil pressure checks with minimum water outlet temperature of 160°F(710 °C).

Step 1. Check oil level.

Step 2. Check operation of oil pressure gage (Refer to vehicle type-20 maintenance manual).

Step 3. Check for diluted oil using fuel dilution test set.

a. Replace defective injector fuel tube assemblies.

b. Drain contaminated oil.

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

8. BLUE EXHAUST SMOKE

Step 1. Check blower oil seals for leaks.

a. Remove air inlet housing.

WARNING

- **When Inspecting a blower on a engine with engine running, keep fingers, equipment and clothing away from moving parts of blower. Run engine at low speeds only.**
- **Protective fan screens must be installed prior to doing maintenance In the engine compartment when engine Is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).**

b. Operate engine, fluctuating between 650-1200 RPM and inspect blower end plates for evidence of oil leakage past seals.

c. If leakage is detected, replace blower (Refer to Para 4-18).

Step 2. Check turbocharger for defective oil seals.

a. Remove air intake hose and tube and exhaust pipe.

b. Check for evidence of oil on compressor or turbine.

c. If oil is present, replace turbocharger assembly.

d. Install air intake hose and tube and exhaust pipe.

Step 3. Perform oil analysis for coolant in engine oil. (Refer to DA PAM 738-750)

END OF TEST

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

9. EXCESSIVE BLACK EXHAUST SMOKE

Step 1. Check for excessive fuel or irregular fuel distribution.

a. Check fuel injector timing (Refer to Para 8-5).

b. Check injector rack linkage adjustment (Refer to Para 8-7).

c. If necessary, perform complete engine tune up (Refer to Para 8-4 thru 8-13).

d. Replace faulty injectors if this condition persists after performing steps a, b, and c above (Refer to Para 4-38).

Step 2. Check air inlet for restrictions.

a. Clean air cleaner elements.

b. Clean blower housing screen.

Step 3. Check for proper grade of fuel (Refer to appropriate vehicle LO).

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION

10. WHITE EXHAUST SMOKE

Step 1. Check for malfunctioning injectors.

a. Remove rocker arm covers.

WARNING

Protective fan screens must be Installed prior to doing maintenance In the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).

b. Start engine.

NOTE

if injector is malfunctioning ,there will be no noticeable difference in sound and operation of engine.

c. Hold fuel injector follower down with a screwdriver with engine idling to prevent operation of injector. lf necessary, replace faulty injector (Refer to Para 4-38).

d. Install rocker arm covers.

Step 2. Check for low cylinder compression (Refer to Para 8-14).

Step 3. Check for sticking exhaust valves.

a. Remove rocker arm cover and check for damaged or sticking exhaust valves.

b. Check for correct exhaust valve clearance (Refer to Para 8-4).

END OF TEST

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

COOLING SYSTEM

11. ENGINE COOLANT OPERATING TEMPERATURE ABOVE NORMAL

Step 1. Check coolant level.

Step 2. Check operation of vehicle cooling system (Refer to appropriate vehicle type-20 maintenance manual).

Step 3. Check for collapsed, cracked, or disintegrated hoses.

Step 4. Check thermostats for operation. Remove thermostat and test (Refer to Para 4-8).

Step 5. Check for combustion gases in the cooling system.

a. Remove radiator filler cap.

WARNING

Protective fan screens must be Installed prior to doing maintenance In the engine compartment when engine is running or when engine is in ground hop mode. Contact with rotating fan can cause injury (reference FM 21-11).

b. Operate engine at idle.

c. Check radiator for bubbles in coolant which indicates a damaged cylinder head.

d. Install radiator cap.

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

AIR INTAKE SYSTEM (TURBOCHARGER)

12. EXCESSIVE TURBOCHARGER NOISE OR VIBRATION

Step 1. Check for improper clearance between turbine wheel and housing.

a. Remove vehicle exhaust pipe.

b. Inspect turbine wheel and housing for nicks, cracks, or contact between wheel and housing.

c. Replace turbocharger assembly if damaged (Refer to Paragraphs 4-2,5-2, 5.1-2,6-3, or 7-3 for appropriate engine model).

d. Install vehicle exhaust pipe.

Step 2. Check for leaks in air intake or exhaust manifold.

a. Tighten loose connections.

b. Replace leaking gaskets.

END OF TEST

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

AIR INTAKE SYSTEM (TURBOCHARGER REGULATOR - ENGINE) (MODELS 7083-7398 AND 7083-7399 ONLY)

13. BYPASS VALVE FAILS TO CLOSE

Step 1. Remove turbocharger regulator and check for carbon build-up on bypass valve.

Remove carbon as required.

Step 2. Check for broken bypass valve spring.

Replace turbocharger regulator if spring is broken (Refer to Para 6-2).

END OF TEST

14. EXCESSIVE EXHAUST PRESSURE AT TURBOCHARGER

Step 1. Remove turbocharger regulator and check for carbon build upon bypass valve.

Remove carbon as required.

Step 2. Check for damaged air pressure lines.

Replace air pressure lines.

Step 3. Check turbocharger regulator calibration.

a. Remove air inlet line to turbocharger regulator.

NOTE

If regulator valve moves with 13.0 PSI (90.0 kPa) air pressure at inlet, regulator is within limits.

b. Hookup air supply to regulator inlet port. Slowly apply air pressure and record when valve movement occurs.

c. If regulator is out of limits, replace unit.

d. Install air inlet line to regulator.

END OF TEST

2-5. MALFUNCTION, TEST OR INSPECTION, AND CORRECTIVE ACTION PROCEDURES (Cont)

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

COLD STARTING OPERATION

15. INOPERATIVE AIR BOX HEATER AT LOW AMBIENT TEMPERATURE

Step1. Check spark at air box heater.

a. Using aglow test light, test for spark at electrode. (Refer to Para4-1 or 6-11 for appropriate engine model.)

b. inspect for electrical shorts, defective ignition coil, and cracked electrode porcelain.

c. If necessary, replace faulty parts. (Refer to Para 4-10 or 6-11 for appropriate engine model)

Step 2. Check fuel at air box heater.

a. Replace fuel filter and strainer elements.

b. Clean fuel nozzle.

Step 3. Check solenoid valve using a multimeter.

Replace if faulty (Refer to Para 4-10 or 6-11 for appropriate engine model).

Step 4. Check air pump for air flow.

Replace pump if faulty (Refer to Para 4-10).

Step 5. Check ignition coil for spark at electrode.

Replace coil if faulty (Refer to Para 4-10 or 6-11 for appropriate engine model).

Step 6. Check pump and motor assembly for fuel flow.

Replace assembly if faulty (Refer to Para 6-11).

END OF TEST

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

16. INOPERATIVE GLOW PLUG SYSTEM AT LOW AMBIENT TEMPERATURE (MODEL 7063-7391)

Step 1. Check batteries for low or no voltage (Refer to applicable vehicle type-20 maintenance manual for test and services).

Step 2. Glow plug wait/pilot lamp does not light.

a. Ambient temperature above 50°F.

b. Check wait/pilot lamp bulb (Refer to applicable vehicle type-20 maintenance manual for test and services).

c. All four paired glow plug connector pins short circuited (Refer to applicable vehicle type-20 maintenance manual for test and services).

d. Controller switching device is open (Refer to Para 5.1-8 to remove and replace glow plug controller).

Step 3. Glow plug wait/pilot lamp stays lit.

Fault in glow plug controller (Refer to Para 5.1-8 to remove and replace glow plug controller).

Step 4. Glow plug wait/pilot lamp flashes during preglow and afterglow periods.

Glow plug controller short circuit protection fuse(s) failed. (Refer to applicable vehicle type-20 maintenance manual for test and services).

END OF TEST

CHAPTER 3

GENERAL REPAIR PROCEDURES AND ENGINE PREPARATION

Contents

Section I. INTRODUCTION

3-1. GENERAL. This chapter provides general maintenance practices of engine repair, removal and installation of the engine from container, removal and installation of engine accessories required to install the engine on the maintenance stand, and installation and removal of the engine onto the maintenance stand.

Section II. GENERAL MAINTENANCE PRACTICES

3-2. 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 through 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.

(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.

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.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point Is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

(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 prescribed inspection equipment for inspecting component parts having extremely close tolerances where cracks and other damage cannot be spotted visually. Replace parts or components that fail to meet inspection criteria.

(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.

(c) Inspect machined surfaces of castings for nicks, burrs or raised metal.

3-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS (Cont)

(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.

(9) Inspect all pipe plug and capscrew 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) 011 Seals. Metal encased oil seals should not be replaced unless inspection indicates damage.

(1) Inspect feather edge of oil seal for damage.

(2) Check seal for loss of softness and spring,

(8) Core Hole Plugs.

(1) Inspect core hole plugs for evidence of leakage.

(2) Replace seals if leaking or damaged.

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 App G.

(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 mounting flanges and gasket surfaces by working surfaces across a sheet of emery cloth held tightly on a surface plate or a flat surface. Finish similarly using crocus cloth.

(e) Replace castings having flanges which are warped to the point of impairing assembly or operation.

(9) Repair damaged pipe or cap screw threads in tapped holes with a thread tap.

NOTE

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

(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.

3-2. CLEANING AND GENERAL REPAIR INSTRUCTIONS (Cont)

(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 threaded end is in the aluminum casting. All replacement studs have a special coating and must have a small amount of mica-base antiseize compound (MIL-A-13881) 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 repair standards in App G.

(b) Remove sharp fins and burrs from gear teeth with crocus cloth dipped in cleaning

(6) Bushing and Bushing Type Bearings. When bushings and bushing type bearings are damaged or worn beyond specified limits (App G), generally associated parts must also be replaced. Reference to (a) and (b) below will be made in Chapters 4 thru 7 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).

(b) Installation.

1. Aline bushings or bushing type bearings in casting or retaining cage.

2. Press into place with arbor press or with the special tools provided.

3. Clean repaired parts thoroughly before assembly or installation.

4. Bushing type bearings are machined for proper clearance and need no reaming.

(7) Oil Seals. Oil seals must be replaced when thin feather edge is damaged or when seal material has become hard or brittle.

(a) Removal. Press or pry damaged oil seal from casting or adapter being careful 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 replacer tool.

d. Disassembly/Assembly Instructions

(1) General. Extreme care must be exercised in all component assembly operations to insure 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 (App C, Item 16) 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.

(9) Store all fastening hardware (nuts, bolts, screws, and flat washers) in or with the related component to assist in reassembly.

Section III. REMOVAL AND INSTALLATION OF ENGINE FROM CONTAINER

3-3. ENGINE FROM/TO CONTAINER - 12268285

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

INITIAL SETUP

MODELS

7083-7391 7083-7395 7083-7396

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Three-legged sling (App B, Item 84)
Four-legged sling (App B, Item 82)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

37 Lockwashers (App F, Item 95)
4 Lockwashers (App F, Item 94)

EXPENDABLE/DURABLE SUPPLIES

Desiccant bags (App C, Item 14)
Seal (App C, [tern 35)
Sealant (App C, Item 39)
Preservation oil (App C, Item 31)
Tape (App C, Item 27)
Engine oil (App C, Item 16)
Grease (App C, Item 22)

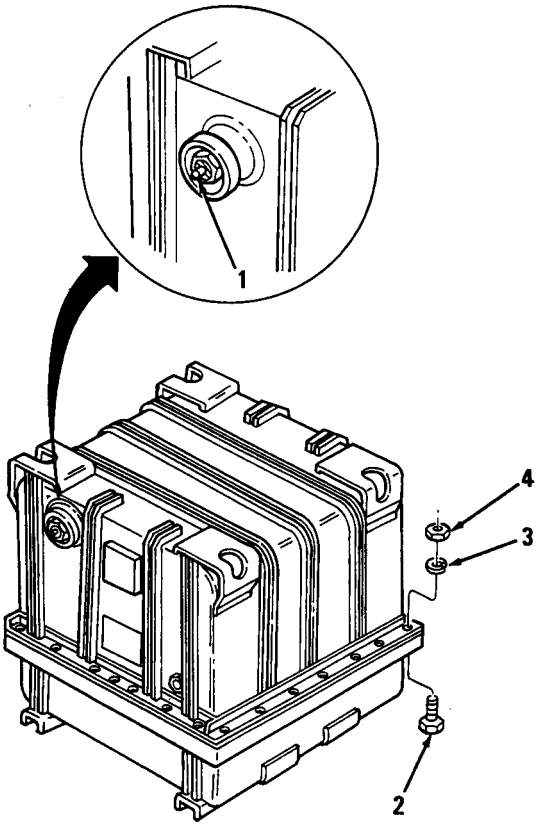
a. Removal

WARNING

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

(1) Release pressure in container by pressing air release button located at center of breather valve (1).

(2) Remove twenty-eight bolts (2), twenty-eight lockwashers (3), and twenty-eight nuts (4), from container. 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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

(3) Using a four hook chain (5), remove top section of container (6).

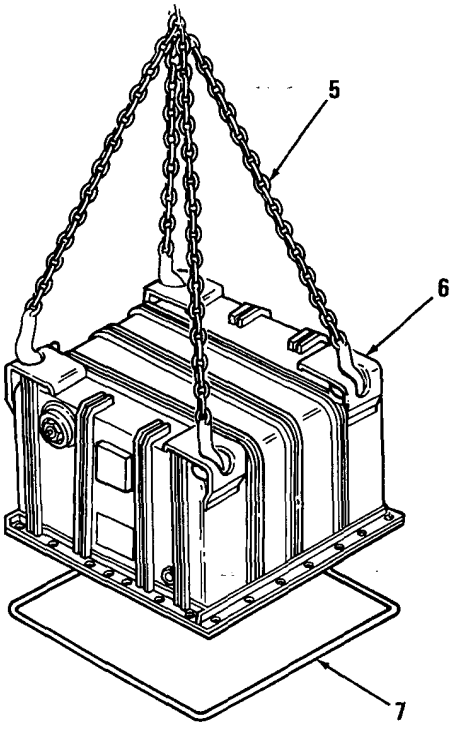
(4) Inspect container seal (7), for cuts, tears, or other damage. Discard seal if unserviceable.

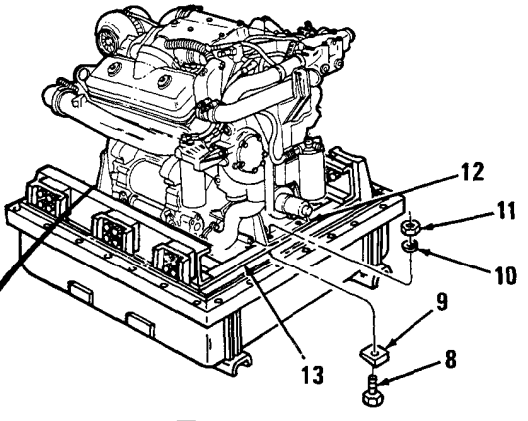
(5) Remove two bolts (8), two bevel washers (9), two lockwashers (10), and two nuts (11) securing front U-shaped bracket (12) to container rail (13). Discard lockwashers.

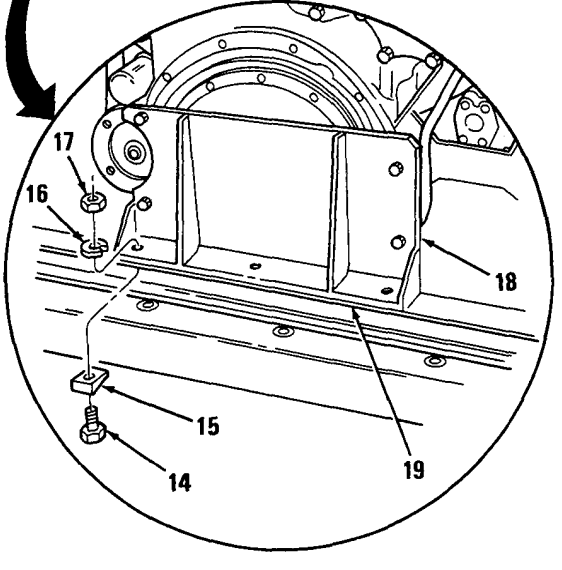
(6) Remove three bolts (14), three bevel washers (15), three lockwashers (16), and three nuts (17) securing rear mounting bracket (18), to container rail (19). Discard lockwashers.

NOTE

- In cases where engine has been returned for repair, forward all engine parts previously removed and stored in container to proper reconditioning aread.
- For models 7083-7391 and 7083-7396, engine crankshaft damper is secured inside shipping container. If engine is to be made operational, install damper (Refer to Para 5-27).







3-3. ENGINE FROM/TO CONTAINER - 12268285 (Cont)

NOTE

- Use the three-legged sling to lift engine models 7083-7395.
- Use four-legged sling to lift engine models 7083-7391 and 7083-7396.

(7) Remove engine from container (20), using a multi-leg sling (21).

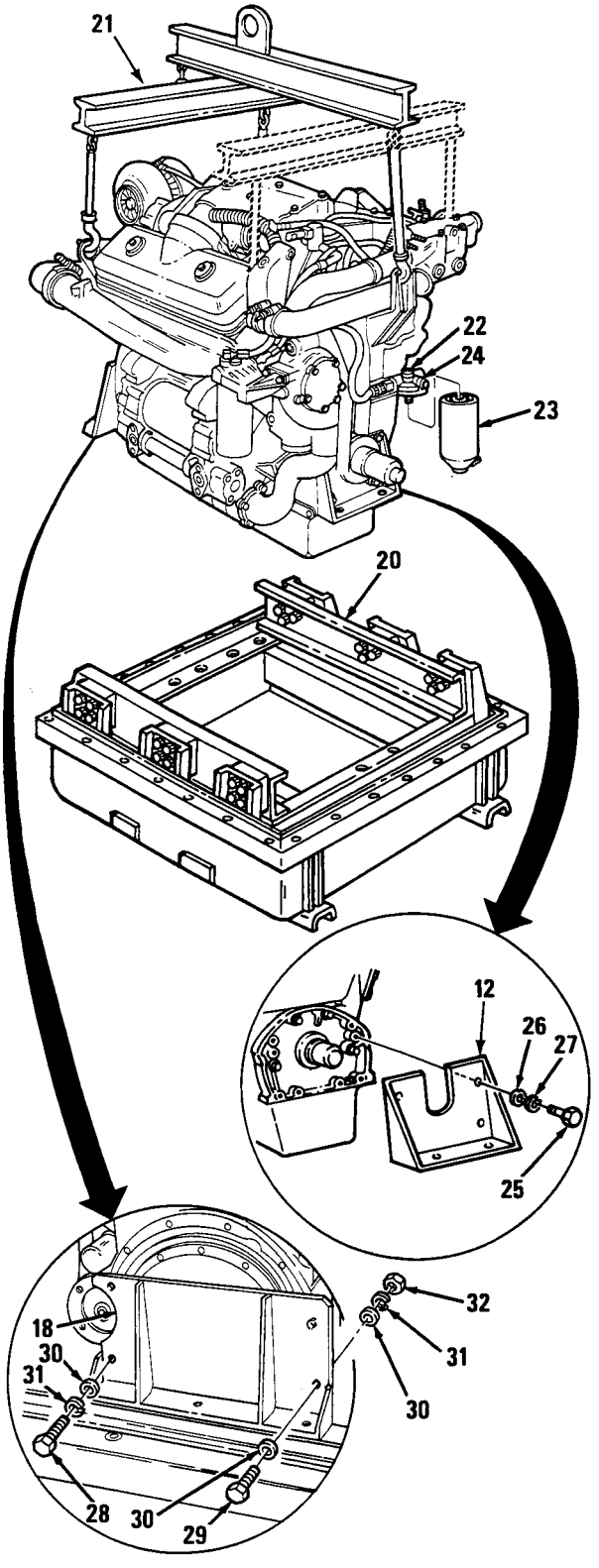
NOTE

- Always install upper section of the container on the bottom section and seal container with bolts, washers, and nuts after the engine has been removed. This action is necessary to avoid weather damage to interior of container.
- Only model 7083-7395 requires removal of fuel strainer in order to remove front U-shaped bracket.
- After removing four bolts and lockwashers to four U-shaped brackets, install four bolts (1/2-13x4) and four lockwashers, located in mailbag, in front engine cover. Place removed bolts (1/2-13x3-3/4) in mailbag. Discard used lockwashers.

(8) Remove bolt (22) securing fuel strainer shell assembly (23) from adapter (24). Remove shell assembly.

(9) With engine supported by sling, remove four bolts (25), four flat washers (26), and four lockwashers (27) securing U-shaped bracket (12) to front of engine. Discard lockwashers.

(10) Remove two bolts (28 and 29), six flat washers (30), four lockwashers (31), and two nuts (32) securing rear mounting bracket (18) to flywheel housing. Discard lockwashers.



b. Engine Preservation

NOTE

All openings such as exhaust manifolds, air intakes, breathers etc. should not be sealed. The engine does not require any special depreservation procedures to be made serviceable.

(1) Preservation of the fuel system.

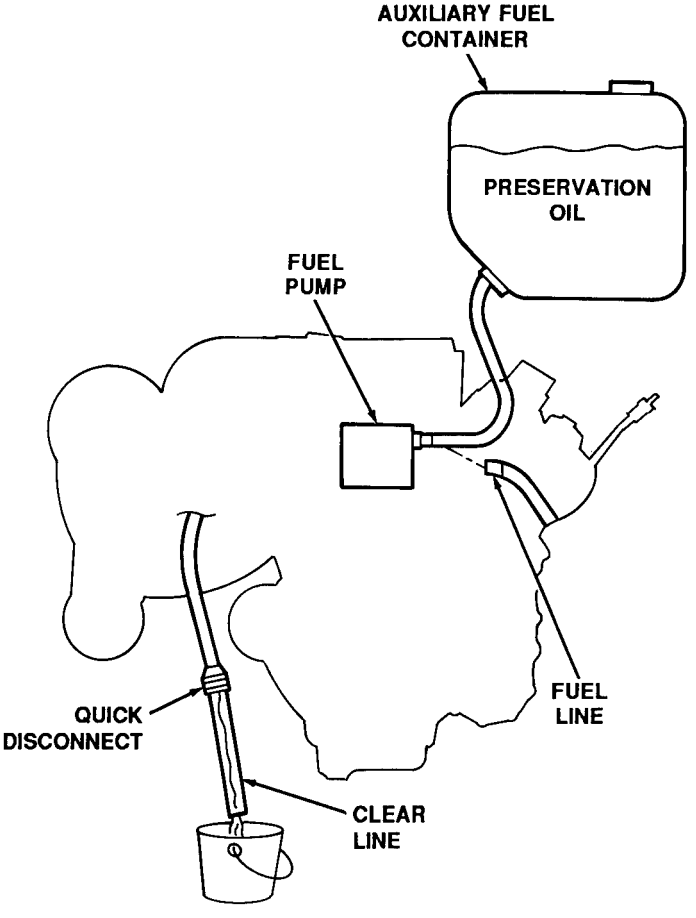
(a) Equip an auxiliary fuel container with a fuel line and fill container with a sufficient amount of presentation oil.

(b) Locate the auxiliary fuel container so as to provide adequate pressure to assure proper supply of preservation oil to the fuel system.

(c) Disconnect the fuel line at the fuel pump inlet connection of the engine and connect the line from the auxiliary fuel container to this point.

(d) Disconnect the engine fuel return at the quick disconnect coupling and connect a transparent plastic line at this point and insert opposite end into a recovery container to collect return fuel.

(e) Turn fuel valve of the auxiliary container to the ON position. Start and run engine no faster than 1200 revolutions per minute (RPM) until undiluted preservation oil is flowing from the fuel return line.



3-3. ENGINE FROM/TO CONTAINER - 12268285 (Cont)

(2) Protection of Unserviceable Assemblies. The following methods should be used in protecting any unserviceable engine assembly.

(a) Loosen clamp (33) securing hose (34) to left rocker arm cover breather (35). Remove hose.

NOTE

For models 7083-7391 and 7083-7396, removal of left rocker arm cover requires removal of turbocharger air outlet tube.

(b) Loosen four clamps (39) connecting air outlet tube (40) to turbocharger and air inlet. Slide two hoses (41) onto outlet tube and remove tube.

(c) Remove two rocker arm cover bolts (36), two flat washers (37), and two rubber isolators (38). Remove left rocker arm cover (42).

(d) Remove rocker arm covers (42). Slowly pour one-half gallon of engine oil over valves and valve train components of cylinder head.

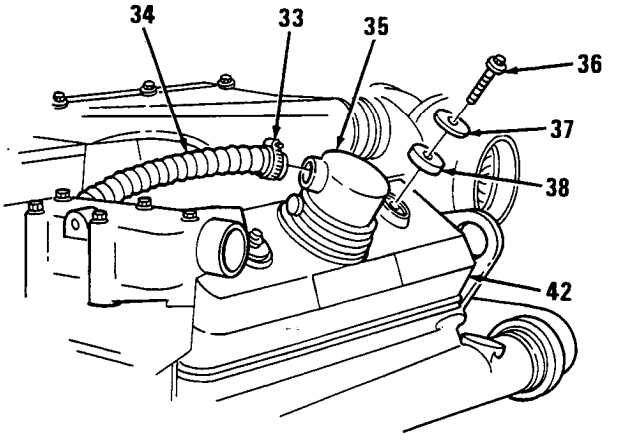
(e) Reinstall rocker arm cover (42).

(f) Install two bolts (36), two flat washers (37), and two rubber isolators (38). Torque bolts to 15-20 lb-ft (20-27 N-m).

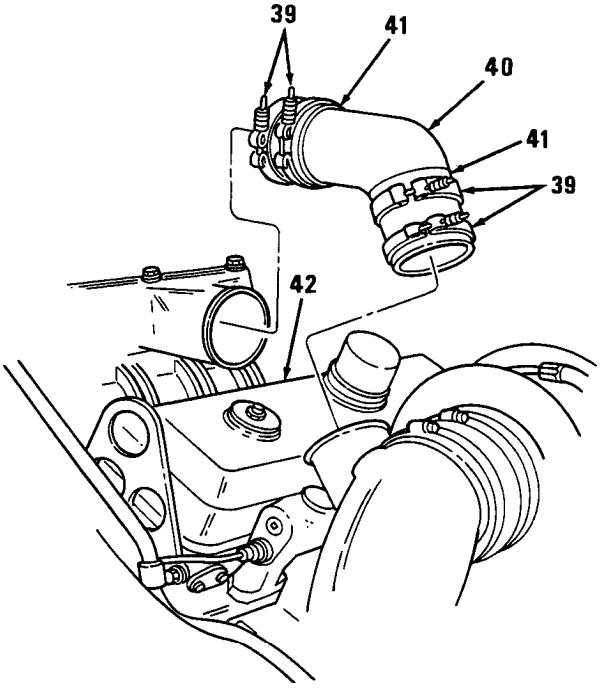
(9) Repeat steps (a), (c), (d), (e), and (f) for right rocker arm cover.

(h) Install hose (34) and clamp (33) on rocker cover arm breather inlet (35). Tighten clamp.

(i) Install air outlet tube (40) with two hoses (41) and four clamps (39) between air inlet and turbocharger. Slide hoses onto air inlet and turbocharger connections. Tighten clamps.



MODEL: 7083-7395



MODELS: 7083-7391
7083-7396

(j) Install oil filler cap or tape opening.

(k) Tape air inlet and exhaust openings closed.

(l) Fill the crankcase with oil to a point approximately 15 inches below the top of the oil gage rod tube. (Used oil can be used for this purpose).

(m) Manually turn engine over at least one complete revolution.

(n) Remove oil pan drain plug and drain oil.

(o) Reinstall oil pan drain plug.

(P) Install the oil gage rod (if missing, tape the tube opening closed).

(q) Apply a light coat of grease to front and rear exposed portions of the crankshaft and any other exposed machined surface.

c. Installation

NOTE

- Do not forward an unserviceable engine missing components or down parts.
- For models 7083-7391 and 7083-7396, if installed, crankshaft damper must be removed from engine and secured in container prior to engine installation in container (Refer to Para 5-27 for damper removal). Crankshaft damper must be protected and secured on shelf in container during shipment.

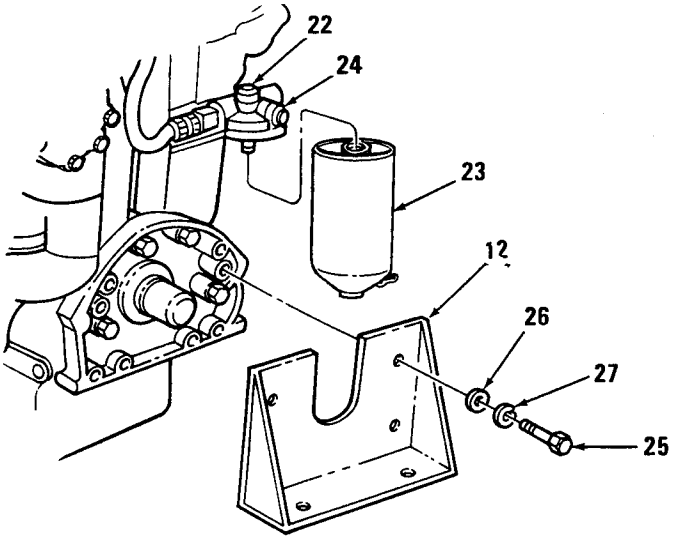
(1) Remove four bolts (25) securing front cover to engine. Store bolts in cloth mailbag in container.

(2) Attach U-shaped bracket (12), to front of engine using four (1/2-13x4) bolts (25) (located in mailbag in engine container), four flat washers (26), and four lockwashers (27).

NOTE

- Only model 7083-7395 will require installation of fuel strainer after front U-shaped bracket has been installed.
- Allow brackets to fit loosely so adjustment is possible.

(3) Secure fuel strainer shell assembly (23) to adapter (24) with bolt (22). Tighten bolt.



3-3. ENGINE FROM/TO CONTAINER - 12268285 (Cont)

(4) Attach rear mounting bracket (18) (with the 2 inch radius cutout on starter side of engine) to flywheel end using two bolts (28), and two bolts (29), six flat washers (30), four lockwashers (31), and two nuts (32).

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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

NOTE

Use three-legged sling to lift engine model 7083-7395. Use four-legged sling to lift engine models 7083-7391 and 7083-7396.

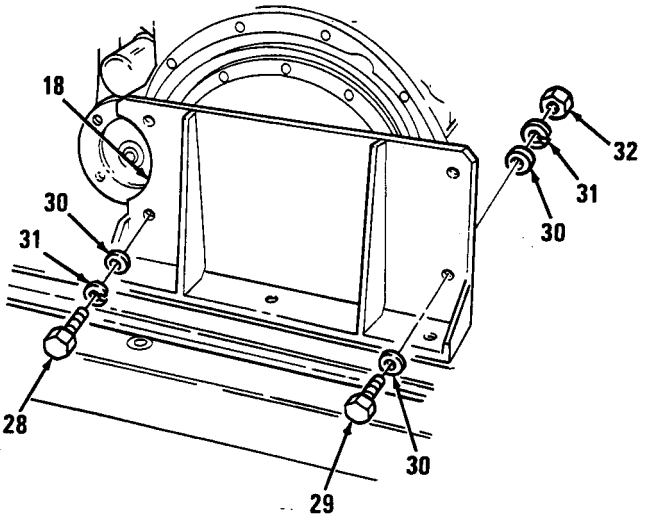
(5) Lower engine into container (20) using a multi-leg sling (21).

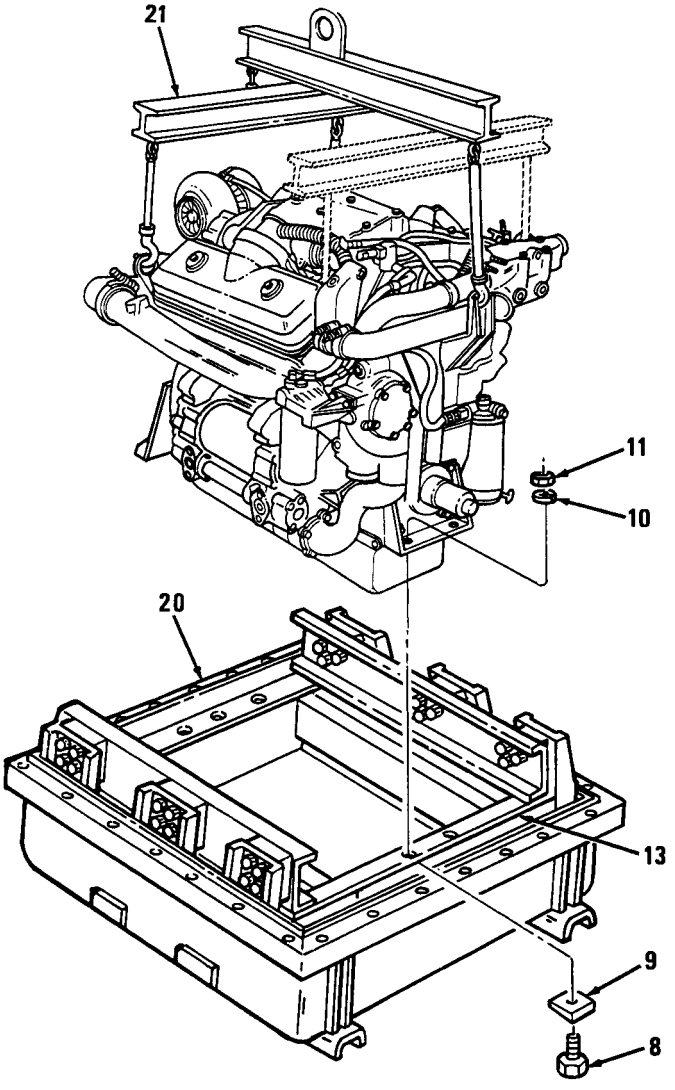
(6) Aline mounting brackets with holes in the container rails.

NOTE

- On model 7083-7395, aline mounting brackets with holes on left and right container rails (front of container has nameplate.
- On models 7083-7391 and 7083-7396, aline mounting brackets with holes on front.

(7) Fasten front U-shaped bracket (12) to container rail (13), underside with two bolts (8) and two bevel washers (9). On upper side, secure with two lockwashers (10), and two nuts (1 1).





(8) Fasten rear mounting bracket (18) to underside of container rail (19) with three bolts (14) and three bevel washers (15). On upper side, secure with three lockwashers (16), and three nuts (17).

(9) Torque all bolts and nuts on brackets to engine and container rail.

(10) Fill desiccant basket, mounted on side wall of container, with 128 units of class 1 desiccant.

CAUTION

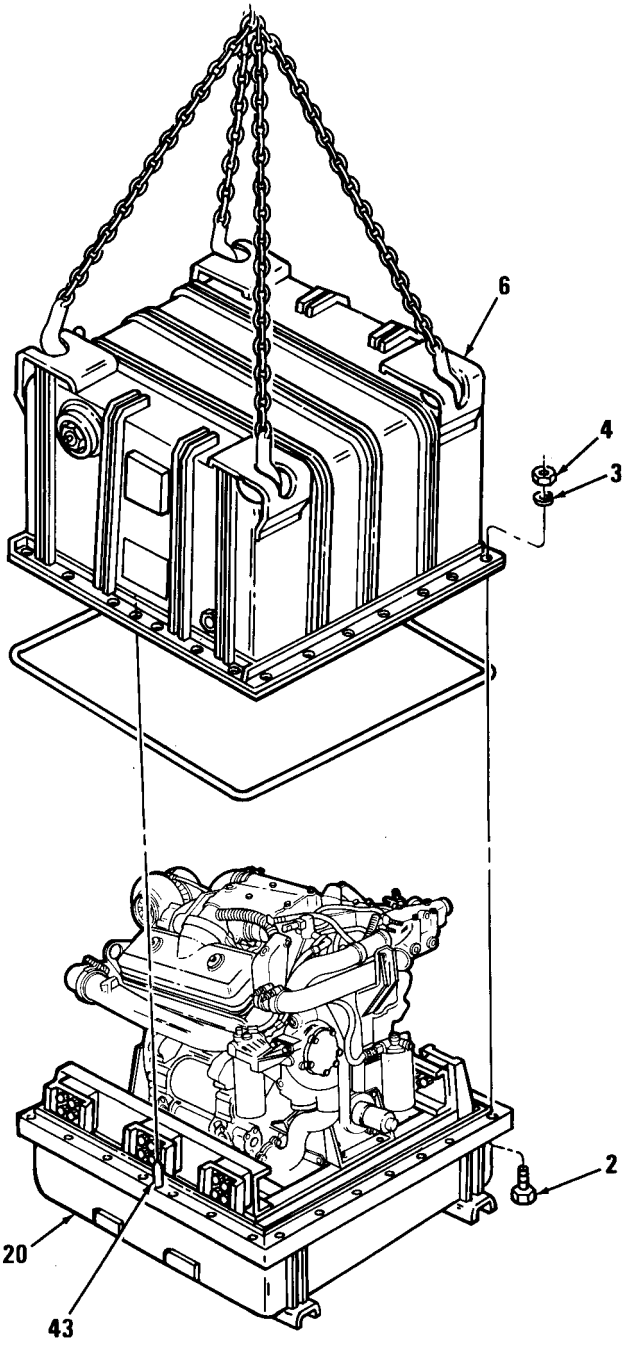
Insure seal is properly sealed in track on lower flange of container

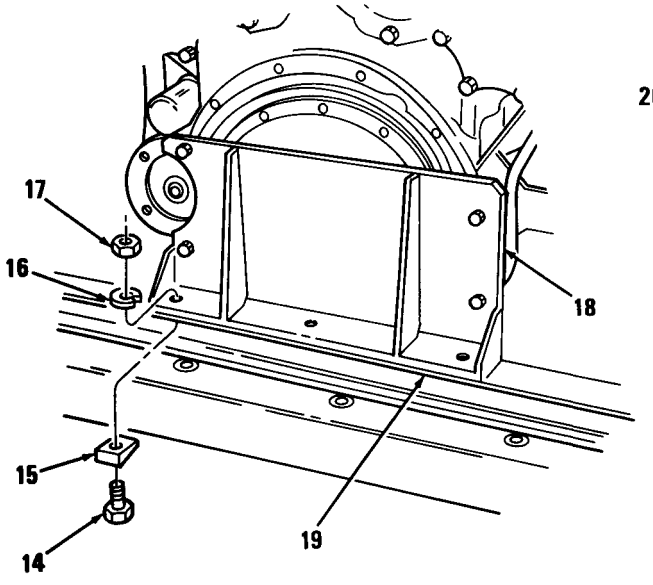
(11) If removed, install seal (7) in container bottom.

(12) Apply sealant to container seal and position seal.

(13) Assemble top section of container (6) to bottom section of container (20) by matching alinement dowels (43) on bottom flange with mating holes on top section.

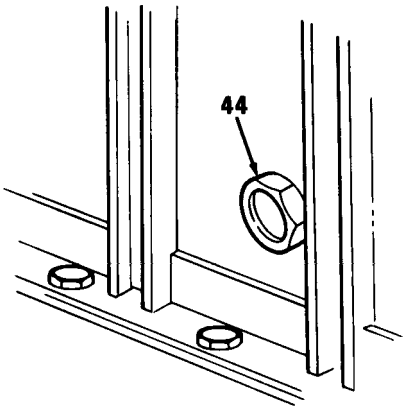
(14) Install twenty-eight bolts (2), twenty-eight lockwashers (3), and twenty-eight nuts (4). Torque bolts to 31-37 lb-ft (43-52 N-m).





3-3. ENGINE FROM/TO CONTAINER - 12268285 (Cont)

(15) Allow container to stand for a minimum of twelve hours; then check and verify condition of humidity indicator (44).



NOTE

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

(16) If indicator is pink, disassemble container and represerve engine. Replace all desiccant bags and replace container sealing gasket. Reassemble and test container as indicated in steps (9) thru (14).

END OF TASK

3-4. ENGINE FROM/TO CONTAINER - 10909159/10923108*

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

INITIAL SETUP

MODELS

7083-7395 7083-7396*
7083-7398 7083-7399*

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Three-legged sling (App B, Item 84)
Four-legged sling (App B, Item 82)
Torque wrench (App B, Item 101)

*Applies to 10923108 container

MANDATORY REPLACEMENT PARTS

46 Lockwashers (App F, Item 97)
12 Lockwashers (App F, Item 95)
8 Lockwashers (App F, Item 94)
8 Lockwashers (App F,Item 93)*

EXPENDABLE/DURABLE SUPPLIES

Desiccant bags (App C, Item 14)
Seal (App C, item 36)
Sealant (App C, Item 39)
Seal (App C, Item 37)
Tape (App C, Item 27)
Engine oil (App C, Item 16)
Grease (App C, Item 22)
Preservation oil (App C, Item 31)

a. Removal

WARNING

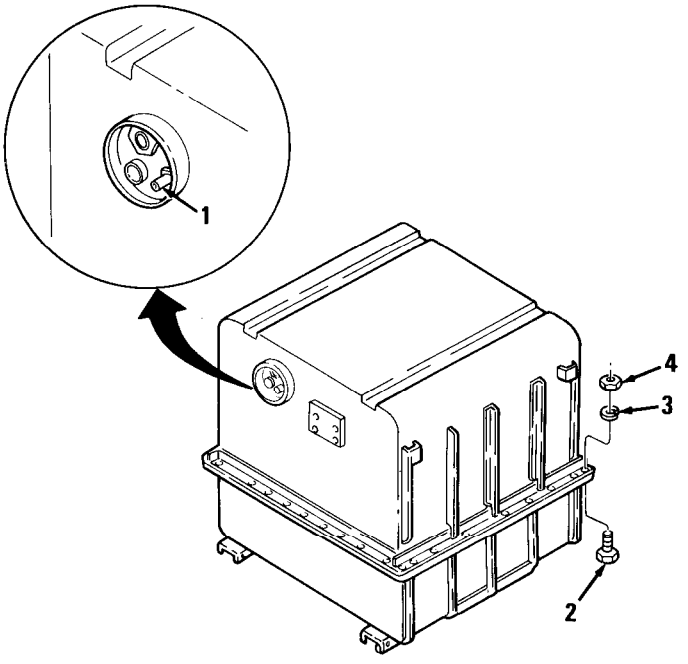
Be sure to release the pressure in the container before opening to avoid injury to personnel.

(1) Release pressure in container by removing insert from pressure valve (1). After pressure is released, reinstall insert.

NOTE

For container 10923108, flat washers are used in place of lockwashers to secure upper and lower sections of container.

(2) Remove forty-six bolts (2), forty-six lockwashers (3), and forty-six nuts (4), from container. Discard lockwashers.



3-4. ENGINE FROM/TO CONTAINER (10909159/10923108*) (Cont)

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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

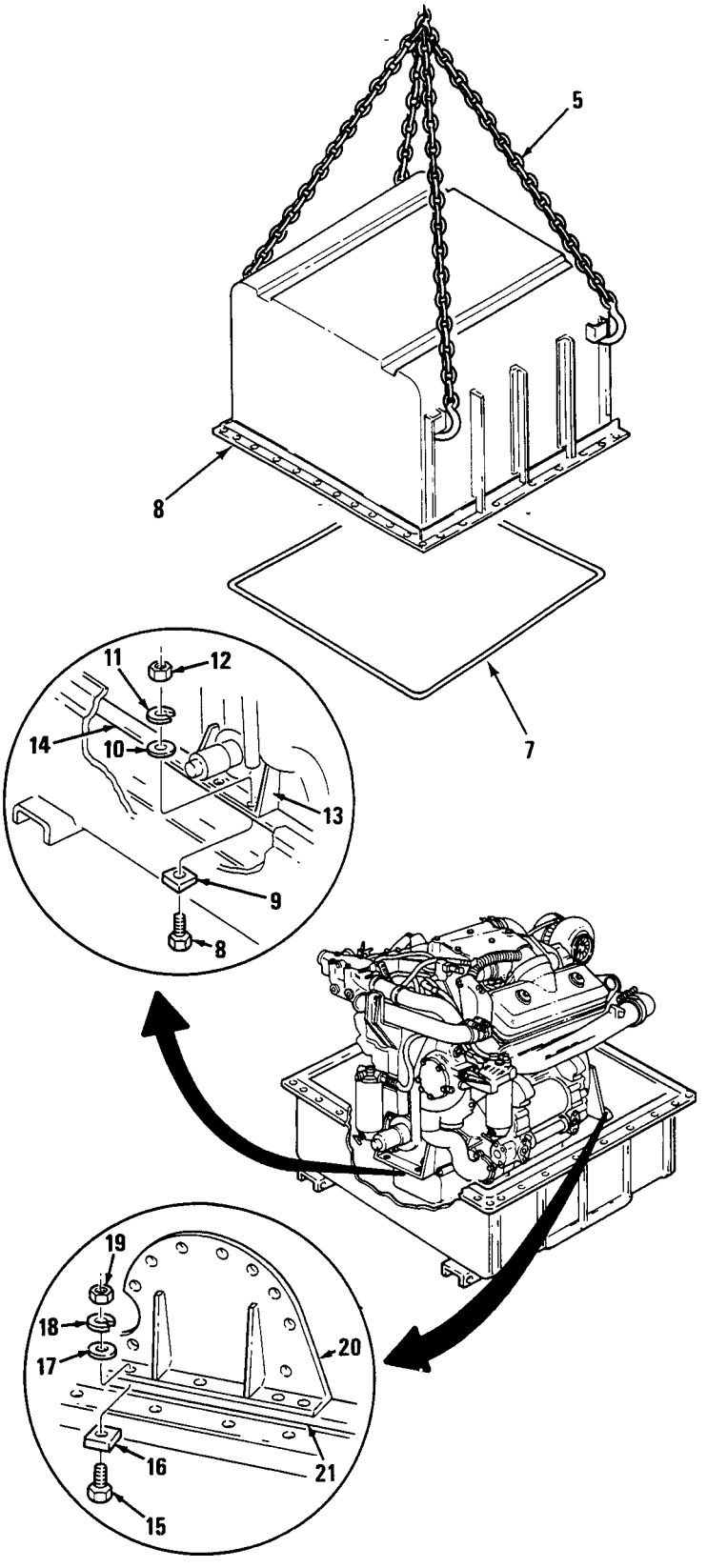
(3) Using a four hook chain (5), remove top section of container (6).

(4) Inspect container seal (7) for cuts, cracks, or other damage. Discard seal if unserviceable.

(5) Remove two bolts (8), two bevel washers (9), two flat washers (1 O), two lockwashers (11), and two nuts (12) securing front U-shaped bracket (13) to container rail (14). Discard lockwashers.

(6) Remove four bolts (15), four bevel washers (1 6), four flat washers (17), four lockwashers (18), and four nuts (19) securing rear mounting bracket (20), to container rail (21). Discard lockwashers.

(7) On models 7083-7396 and 7083-7399 only, remove two bolts (22), two flat washers (23), two bevel washers (24), two lockwashers (25), and two nuts (26) securing engine side support bracket (27), to container rail (28). Discard lockwashers.



NOTE

- For models 7083-7396 and 7083-7399, engine crankshaft damper is secured inside shipping container. If engine is to be made operational, install damper (Refer to Para 5-27).

- In cases where engine has been returned for overhaul, forward all engine parts previously removed and stored in container to proper reconditioning area.

- Use the three-legged sling to lift engine models 7083-7395 and 7083-7398.

- Use the four-legged sling to lift engine models 7083-7396 and 7083-7399.

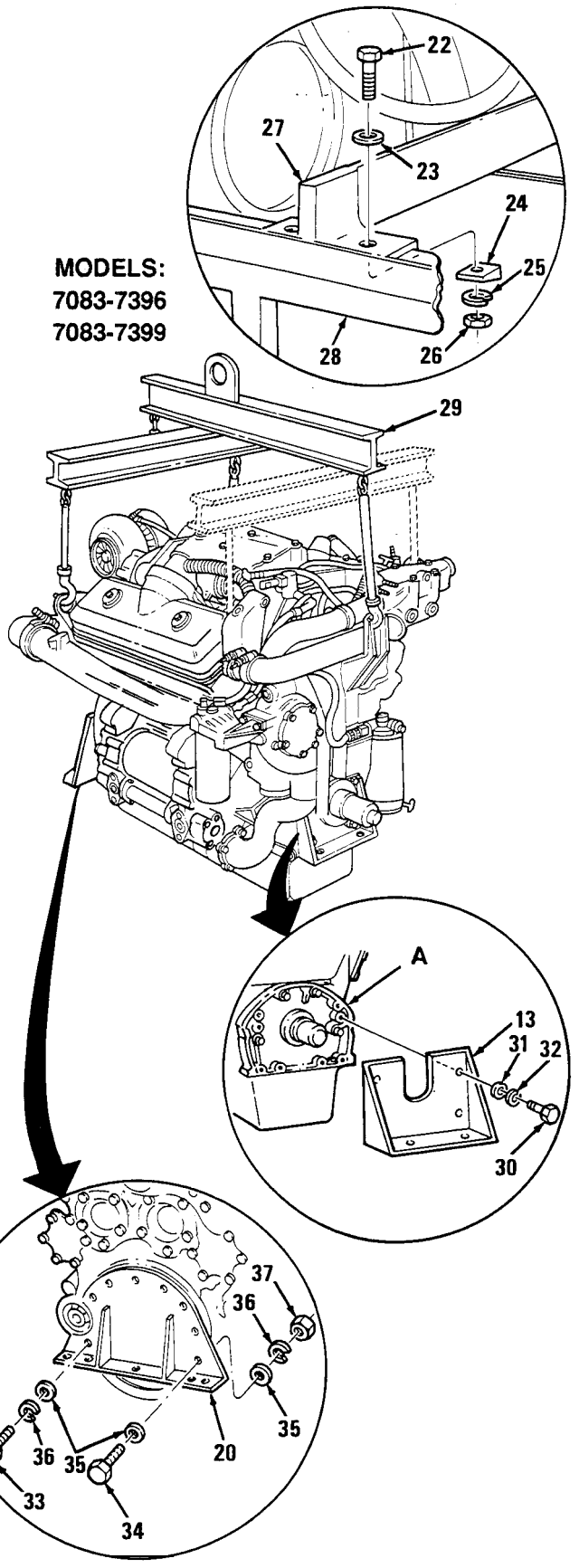
(8) Remove engine from container using a multi-leg sling (29).

NOTE

Always install upper section of the container on the bottom section and seal container with bolts, washers, and nuts after the engine has been removed. This action is necessary to avoid weather damage to interior of container.

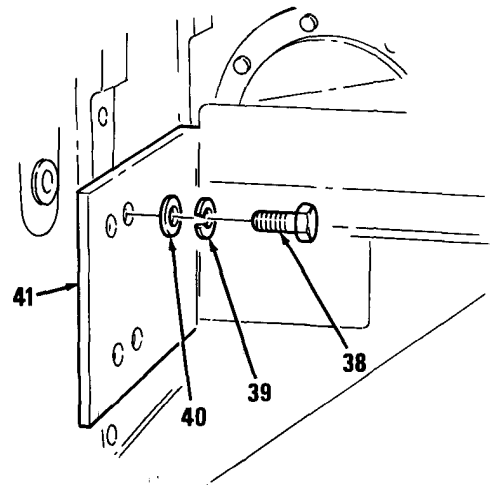
(9) With engine supported by sling, remove three bolts (30), three flat washers (31), and three lockwashers (32). Loosen bolt (30) at position (A) and remove U-shaped bracket (13), from front of engine. Discard lockwashers.

(10) Remove six bolts (33), two bolts (34), ten flat washers (35), eight lockwashers (36), and two nuts (37) securing rear mounting bracket (20) to flywheel housing. Discard lockwashers.



3-4. ENGINE FROM/TO CONTAINER - 10909159/10923108* (Cont)

(11) On models 7083-7396 and 7083-7399 only, remove two bolts (38), two lockwashers (39), and two flat washers (40) securing bracket (41) to left side of engine. Discard lockwashers.



b. Engine Preservation

NOTE

All openings such as exhaust manifolds, air intakes, breathers etc. shall not be sealed. The engine does not require any special depreservation procedures to be made serviceable.

(1) Preservation through the fuel system.

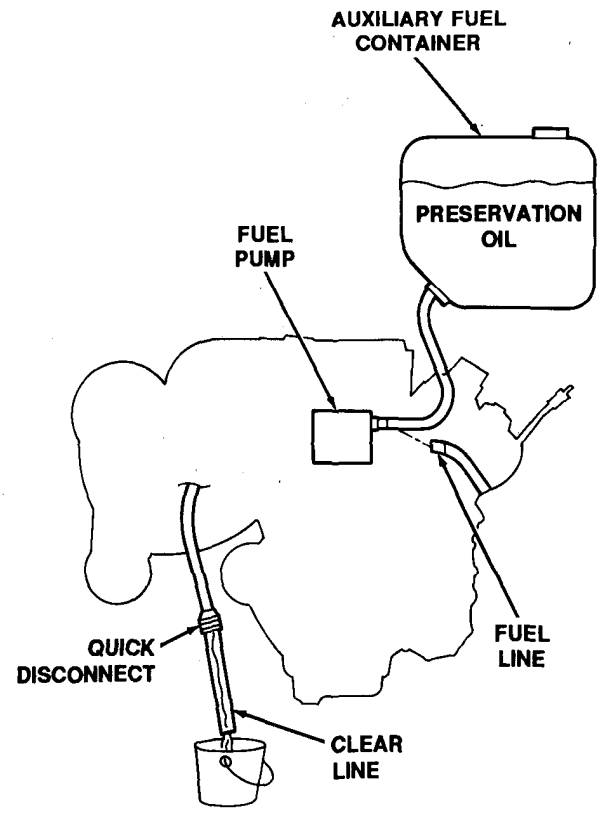
(a) Equip an auxiliary fuel container with a fuel line and fill container with a sufficient amount of preservation oil.

(b) Locate the auxiliary fuel container to provide adequate pressure to assure proper supply of preservation oil to the fuel system.

(c) Disconnect the fuel line at the fuel pump inlet connection of the engine and connect the line from the auxiliary fuel container to this point.

(d) Disconnect the engine fuel return at the quick disconnect coupling and connect a transparent plastic line at this point and insert opposite end into a recovery container to collect the returned fuel.

(e) Turn the fuel valve of the auxiliary container to the ON position. Start and run engine no faster than 1200 revolutions per minute (RPM) until undiluted preservation oil is flowing from the fuel return line.



(2) Protection of Unserviceable Assemblies.

The following methods should be used in protecting any unserviceable engine assembly.

(a) Loosen clamp (42) securing hose (43) to left rocker arm cover breather (44). Remove hose.

NOTE

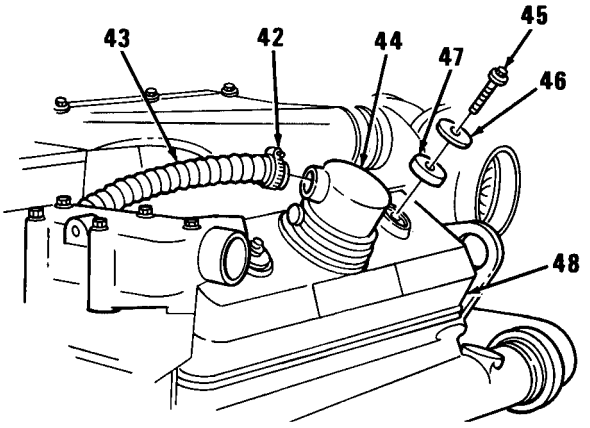
For models 7083-7396 and 7083-7399, removal of left rocker arm cover requires removing turbocharger air outlet tube.

(b) For model 7083-7396 only, loosen four clamps (49) connecting air outlet tube (50) to turbocharger and air inlet. Slides hoses (51), and clamps onto outlet tube and remove tube.

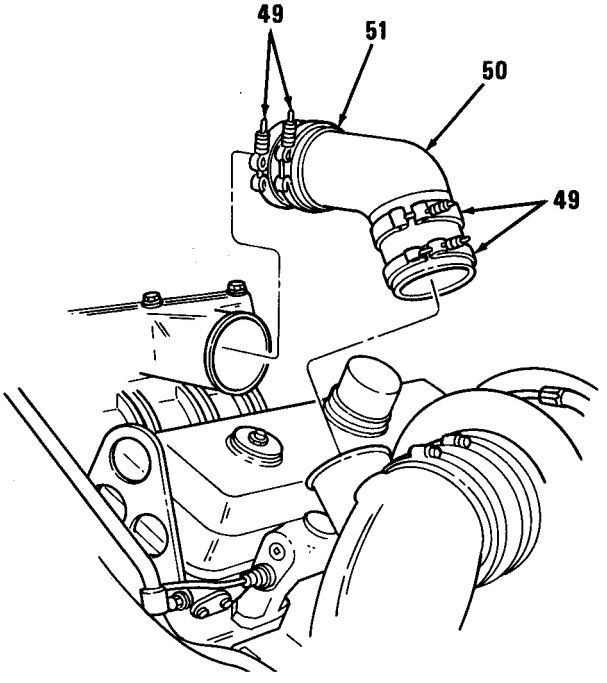
(c) For model 7083-7399 only, disconnect hose assembly (52), at air inlet housing (54). Loosen two clamps (53) connecting air inlet housing to turbocharger. Slide hose (59) and clamps onto housing. Remove three bolts (55 and 56), six lockwashers (57) and six flat washers (58) securing air inlet housing. Remove housing.

(d) Remove two left rocker arm cover bolts (45), two flat washers (46), and two rubber isolators (47). Remove left rocker arm cover(48).

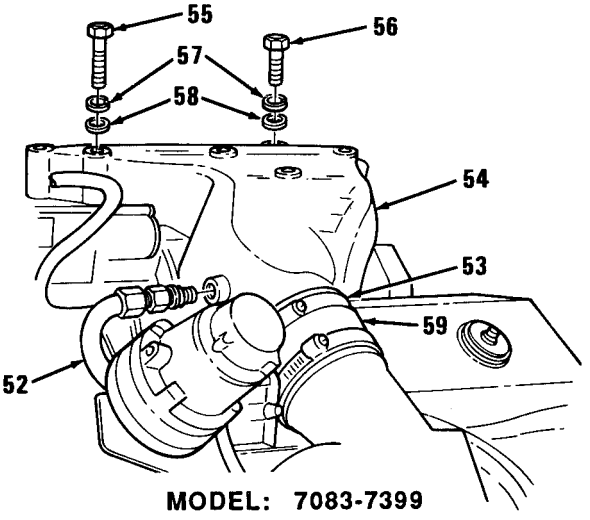
(e) Slowly pour one-half gallon of engine oil over valves and valve train components of cylinder head.



MODELS: 7083-7395 AND 7083-7398



MODEL: 7083-7396



MODEL: 7083-7399

3-4. ENGINE FROM/TO CONTAINER - 10909159/09231080* (Cont)

(f) Reinstall rocker arm covers (48).

(9) Install two bolts (45), two flat washers (46), and two rubber isolators (47). Torque to 15-20 lb-ft (20-27 N-m),

(h) Repeat steps (a), (d), (e), (f), and (g) for right rocker arm cover.

(i) Install hose (43) and clamp (42) on rocker arm cover breather inlets (44). Tighten clamp.

(j) For model 7083-7396, position air outlet tube (50) between turbocharger and air inlet. Slide hoses (51) and clamps (49) onto turbocharger and air inlet. Tighten clamps.

(k) For model 7083-7399, install air inlet housing (54), three bolts (55 and 56), six lockwashers (57) and six flat washers (58). Torque bolts (55 and 56) to 16-20 lb-ft (22-27 N-m). Slide hose (59) onto turbocharger and tighten clamps (53). Connect line (52) from turbocharger waste gate valve (61) to air inlet housing (54).

(1) Install oil filler cap or tape opening.

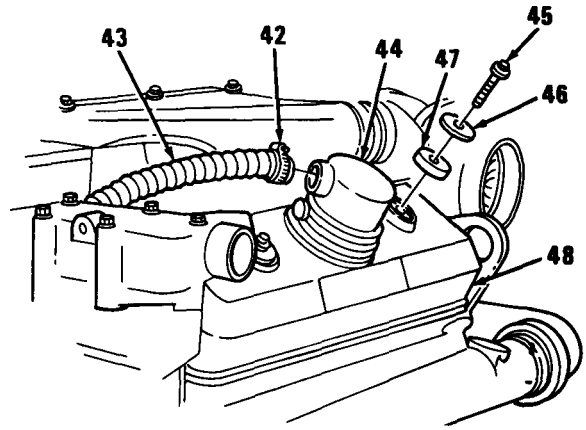
(m) Tape air inlet and exhaust openings closed.

(n) Fill the crankcase with oil to a point approximately 15 inches below the top of the oil gage rod tube, (used oil can be used for this purpose).

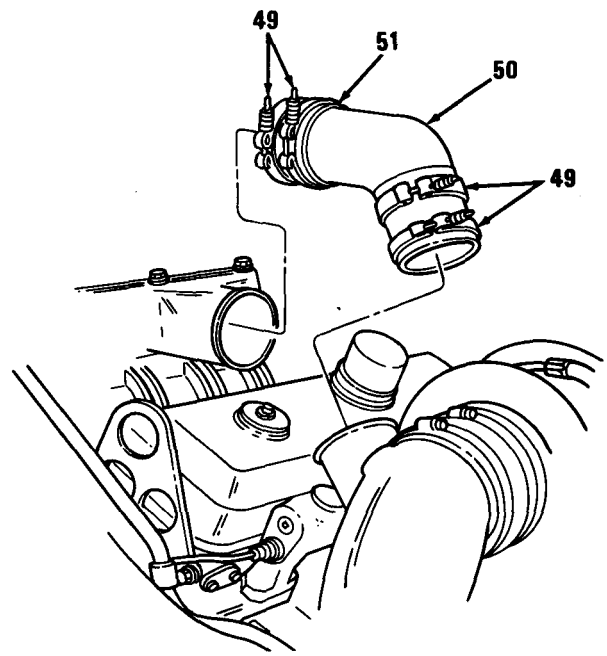
(o) Manually turn engine over at least one complete revolution.

(P) Remove oil drain plug and drain oil.

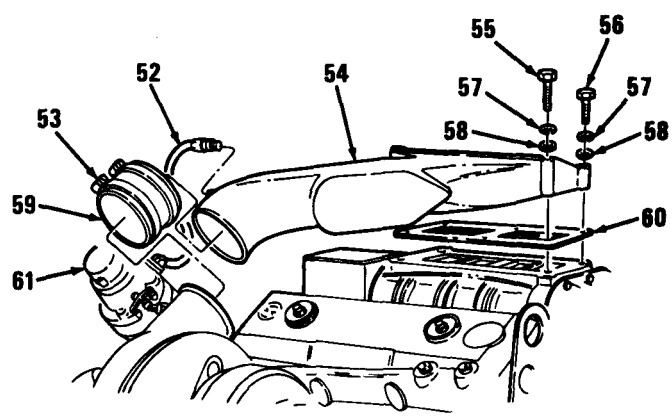
(q) Reinstall oil drain plug.



MODELS: 7083-7395 AND 7083-7398



MODEL: 7083-7396



MODEL 7083-7399

(r) Install oil gage rod (if missing, tape the tube opening closed).

(s) Apply a light coat of grease to front and rear exposed portions of the crankshaft and any other exposed machined surface.

c. Installation

NOTE

- Do not forward an unserviceable engine missing components or down parts.
- .For models 7083-7396 and 7083-7399, if installed, crankshaft damper must be removed from engine and secured in container prior to engine installation in container (Refer to Para 5-27 for damper removal). Crankshaft damper must be protected and secured in container during shipment.

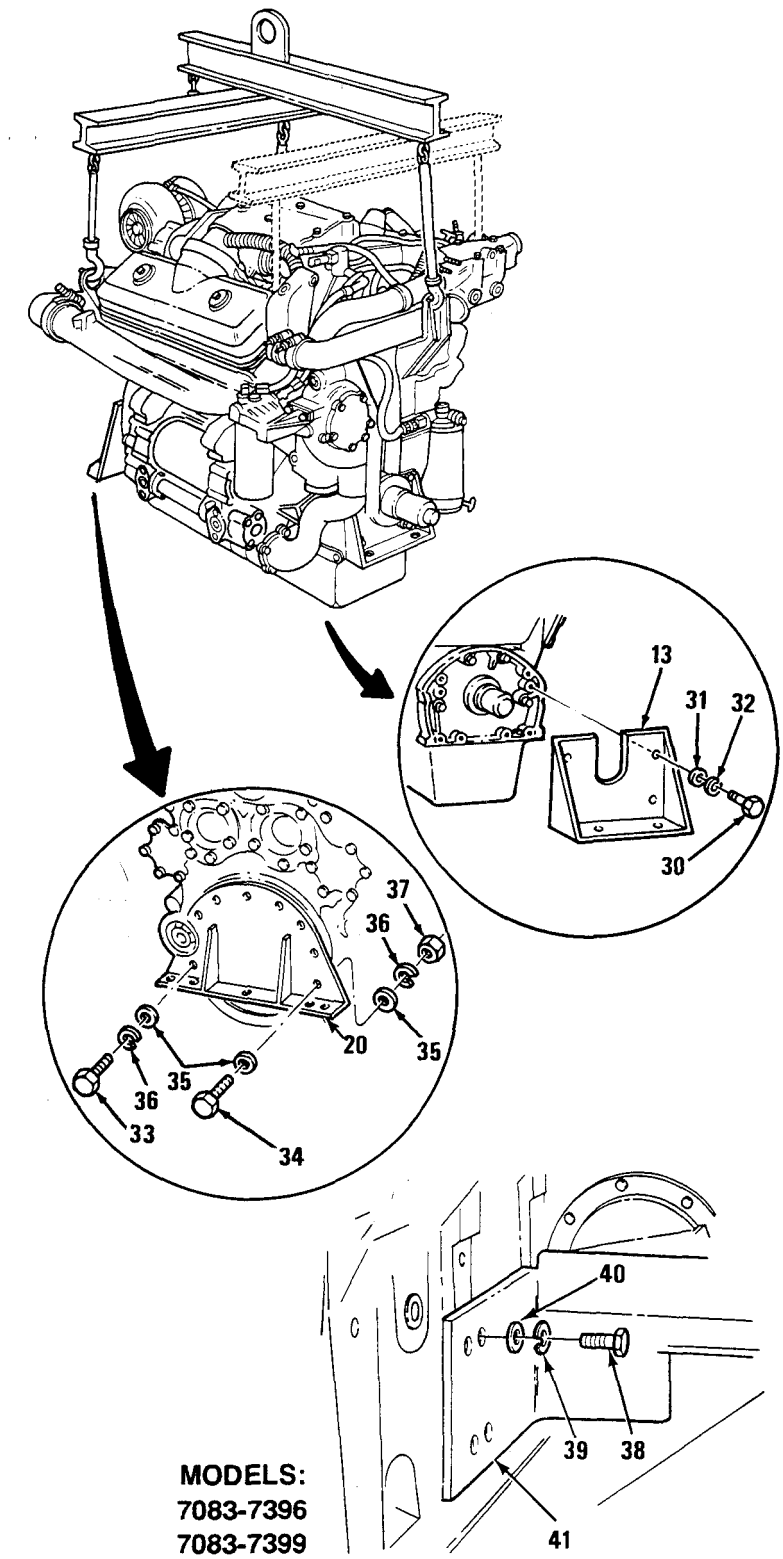
(1) Attach U-shaped bracket (13), to front of engine using four existing (on engine) bolts (30), four flat washers (31), and four lockwashers (32).

NOTE

Allow brackets to fit loosely so adjustment is possible.

(2) Attach rear mounting bracket (20), (with the 2 inch radius cutout on starter side of engine) to flywheel end using six bolts (33), two bolts (34), ten flat washers (35), eight lockwashers (36), and two nuts (37).

(3) On models 7083-7396 and 7083-7399 only, secure bracket (41) to turbocharger side of engine with two bolts (38), two flat washers (40), and two lockvvashers (39).



3-4. ENGINE FROM/TO CONTAINER - 10909159/109231080* (Cont)

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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

NOTE

Use the three-legged sling to lift engine models 7083-7395 and 7083-7398. Use the four-legged sling to lift engine models 7083-7396 and 7083-7399

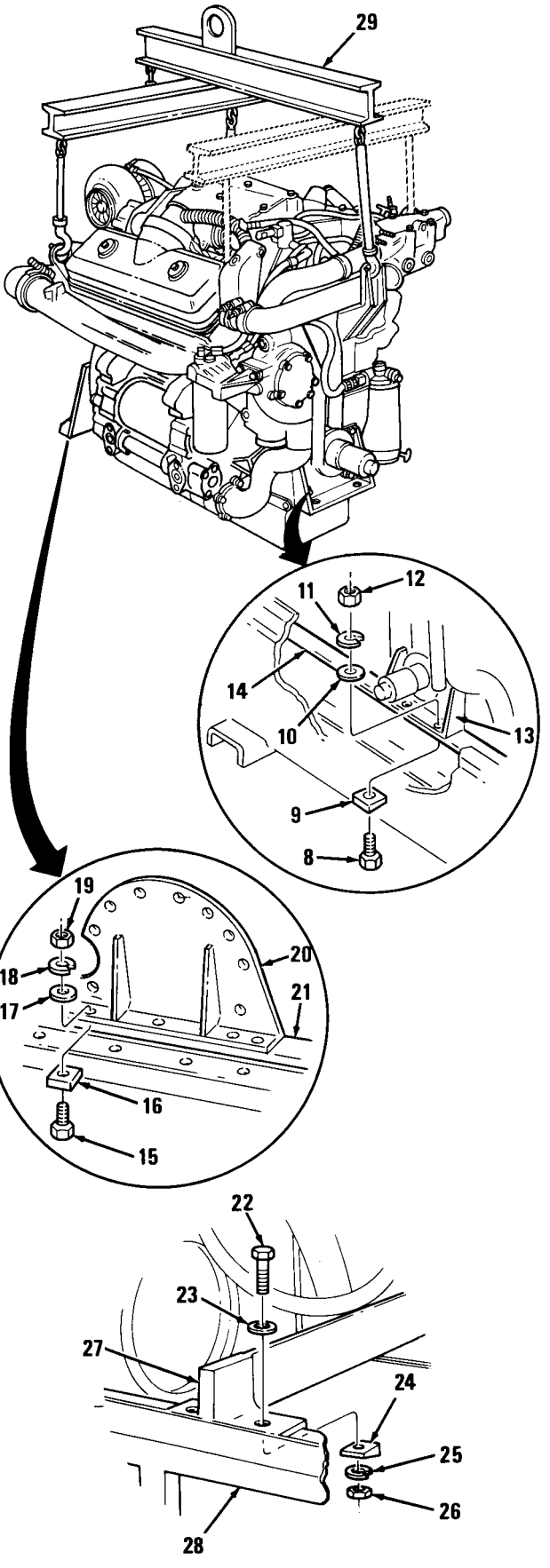
(4) Lower engine into container, using a multi-leg sling (29).

(5) Aline the mounting brackets with the holes in the container rail.

(6) Fasten the rear mounting bracket (20), to underside of container rail (21) with four bolts(15) and four bevel washers (16). On upper side, secure with four flat washers (17), four lockwashers (18), and four nuts (19).

(7) Fasten the front U-shaped mounting bracket (13), to underside of container rail (14) with two bolts (8), and two bevel washers (9). On upper side, secure with two flat washers (10), two lockwashers(11), and two nuts (12).

(8) On models 7083-7396 and 7083-7399 only, secure side mounting bracket (27), to container rail (28), with two bolts (22), two flat washers (23), two bevel washers (24) two lockwashers (25), and two nuts (26).



(9) Torque all bolts and nuts on brackets to engine and container rail.

NOTE

Container 10909159 requires 80 units of desiccant, and container 10923108 requires 112 units.

(10) Fill desiccant basket, mounted on wall of container, with desiccant.

CAUTION

Insure seal is properly seated in track on lower container flange.

(11) If removed, install seal (7) in track on container bottom.

(12) Apply sealant to container seal (7), and position container seal on container flange.

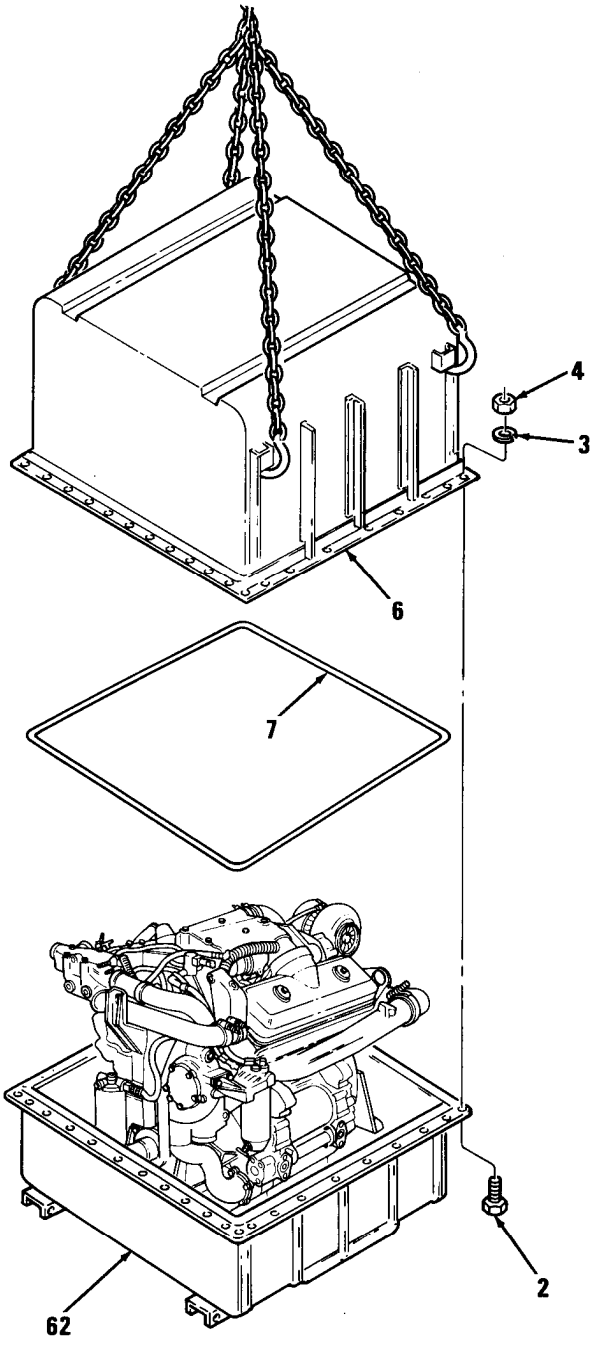
(13) Assemble top section of container (6) to bottom section of container (62) by matching alinement dowel on bottom section flange with mating hole on top section.

NOTE

- For container 10923108, flat washers are used in place of lockwashers to secure upper and lower sections of container.
- For container 10909159, torque container bolts to 40-50 lb-ft (56-70 N-m).
- For container 10923108, torque container bolts to 88-105 lb-ft (123-147 N-m).

(14) Install forty-six bolts (2), forty-six lockwashers (3) and forty-six nuts (4), Torque bolts.

(15) Pressurize the container to 5 psi (34 kPa) of dehydrated air and allow container to stand for a minimum of twelve hours, then check and verify that air pressure is maintained.



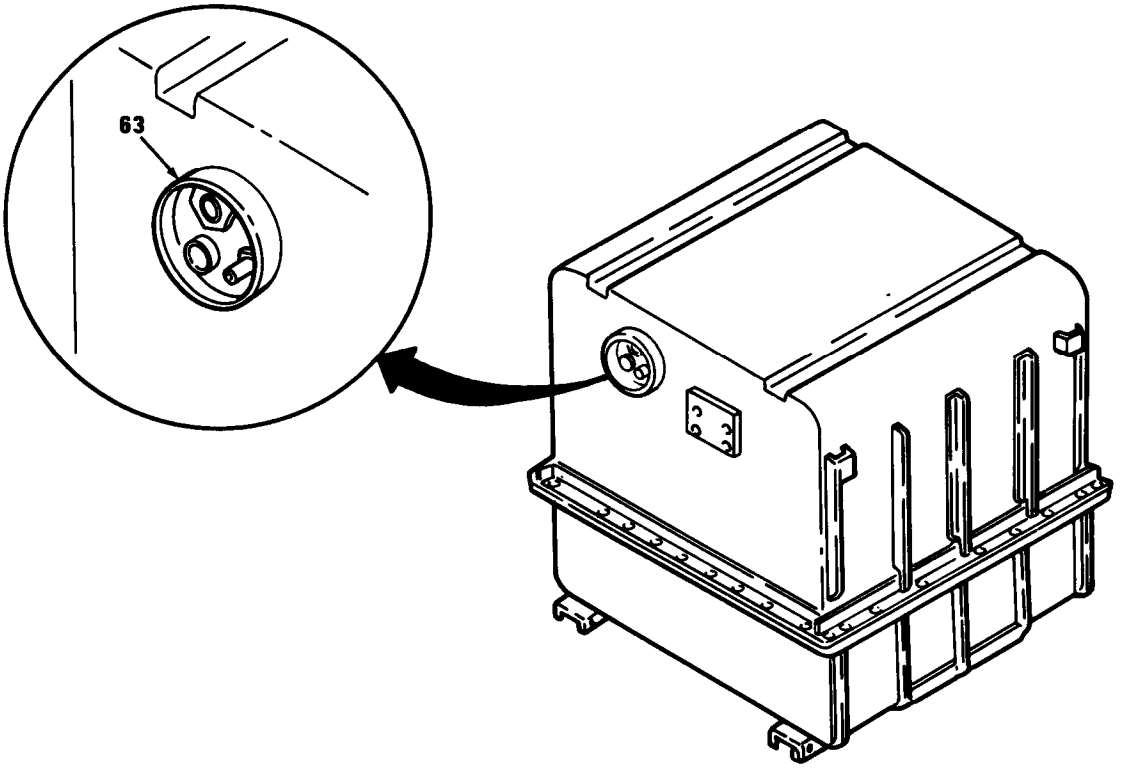
3-4. ENGINE FROM/TO CONTAINER - 10909159/109231080* (Cont)

NOTE

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

(16) If indicator (63) is pink, disassemble container and represeve engine. Replace all desiccant bags and replace container sealing gasket. Reassemble and test container as indicated in steps 11 thru 15.

END OF TASK



3-5. PREPARATION OF ENGINE PRIOR TO REMOVAL OF ENGINE ACCESSORIES AND INSTALLATION ON MAINTENANCE STAND

This task covers: a. Preparation b. Inspection

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Tape (App C, Item 27)
Cleaning solvent (App C, Item 10)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Three-legged sling (App B, Item 84)
Four-legged sling (App B, Item 82)

a. Preparation for Removal of Accessories

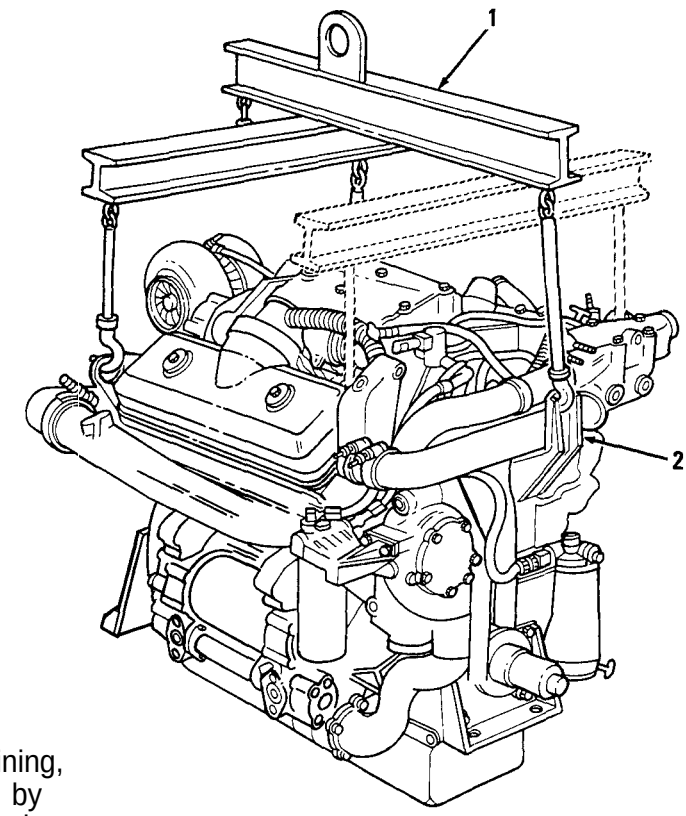
WARNING

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 extreme caution when working near a cable or chain under tension. Equipment may drop or shift and injury to personnel may result.

NOTE

- Use the three-legged sling to lift engine models 7083-7395 and 7083-7398.
- Use four-legged sling to lift engine models 7083-7391, 7083-7396, and 7083-7399.

(1) Lift engine assembly for cleaning, draining, and installation on maintenance stand by using multi-leg sling (1) attached to engine lifting brackets (2). Use a hoist having a minimum lifting capacity of 1.5 tons (1.36 metric tons).



3-5. PREPARATION OF ENGINE PRIOR TO REMOVAL OF ENGINE ACCESSORIES AND INSTALLATION ON MAINTENANCE STAND (Cont)

(2) Draining and Cleaning.

(a) Drain engine coolant from cylinder block into a suitable container, by opening two drain cocks(3) located at rear of block on both sides.

(b) Drain coolant from oil cooler (4) by opening drain cock (5) on rear of cooler.

(c) After coolant has been drained, close drain cocks (3 and 5).

(d) Using a separate container, drain engine oil by removing drain plug (6) in bottom of oil pan (7).

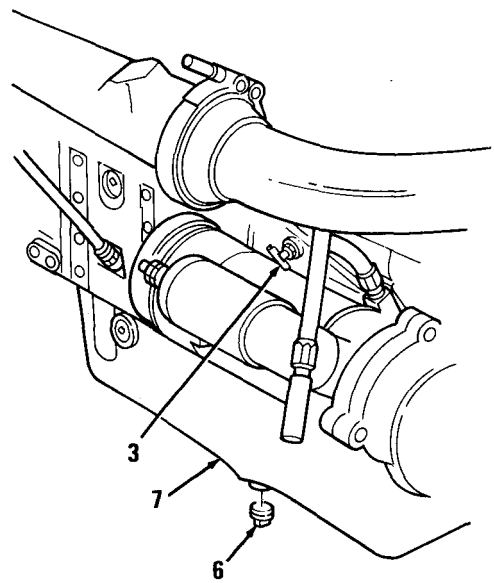
(e) Drain oil from oil cooler (4) by removing two plugs (8) in bottom of oil cooler.

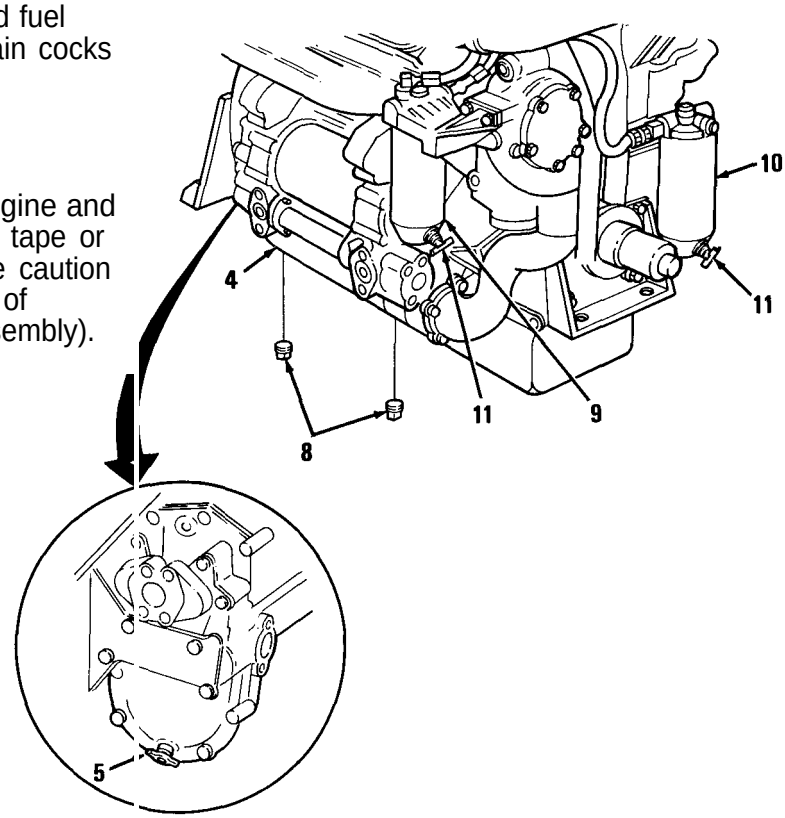
(f) Reinstall oil pan drain plug (6) and two plugs (8) in bottom of oil cooler (4).

(9) Using a separate container, drain fuel oil from fuel filter (9) and fuel strainer (10) by opening drain cocks (11) in bottom of filters.

(h) Close drain cocks (11).

(i) Seal all openings on the engine and accessories with waterproof tape or suitable plugs (Use extreme caution to keep foreign material out of working parts of engine assembly).





(j) Wash exterior of engine using water under pressure to remove dirt and mud.

WARNING

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

(k) Remove oil and grease by using a stiff brush and cleaning solvent.

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.)

(l) Remove moisture from engine by blowing off with compressed air.

b. Preliminary Inspection

(a) After engine has been thoroughly drained and cleaned, inspect external areas of engine to determine leaks, broken or cracked areas and missing parts.

(b) Visually inspect external components for bent, broken or other damaged conditions.

(c) Mark faulty areas with chalk or crayon to serve as a guide in repair or replacement of parts.

END OF TASK

Section IV. REMOVAL/INSTALLATION OF ENGINE ACCESSORIES PRIOR TO INSTALLATION OF ENGINE ONTO MAINTENANCE STAND

3-6. OIL COOLER REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

■ All

MANDATORY REPLACEMENT PARTS

1 Gasket (App F Item 53)
2 Gasket (App F, Item 35)
12 Lockwashers (App F, Item 93)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Guide studs (App D, Item 3)
Torque wrench (App B, Item 101)

PERSONNEL REQUIRED: 2

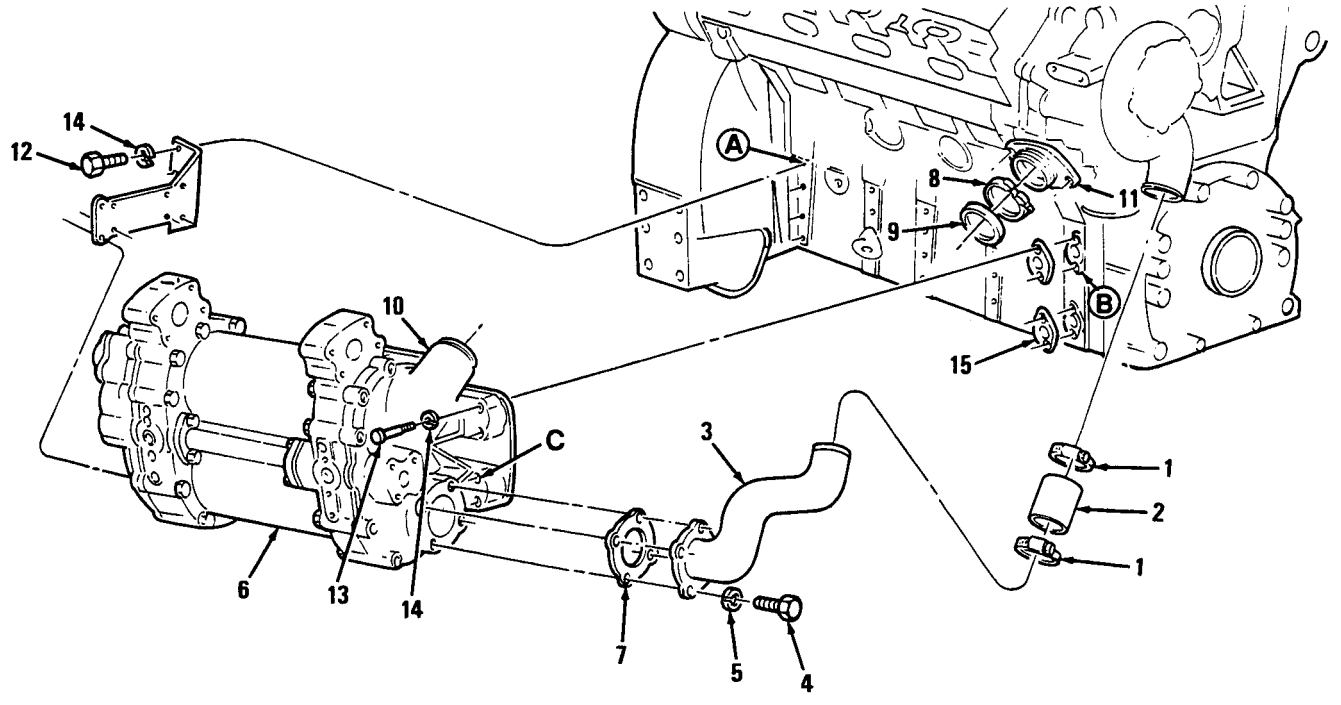
a. Removal

(1) Loosen two clamps (1)securing hose (2)to tube (3)and water pump outlet.

(2) Remove four bolts (4) and four lockwashers (5)securing tube (3)to oil cooler (6). Discard lockwashers.

(3) Remove tube (3), hose (2), and gasket (7). Discard gasket.

(4) Clean and remove all traces of gasket material from tube and oil cooler.



(5) Loosen clamp (8) on water outlet flange seal (9) between elbow (10) and flange (11) on cylinder block.

WARNING

Support oil cooler to prevent cooler from slipping or falling. injury to personnel can occur if oil cooler should fall during removal.

(6) Remove one upper bolt (12) and second bolt from top (13). install guide studs in holes at positions A and B to support oil cooler (6).

(7) Remove remaining six bolts (12 and 13) and six Iockwashers (14) securing oil cooler to cylinder block. Discard lockwashers.

(8) Using second person, remove oil cooler (6), clamp (8), and flange seal (9).

(9) Remove two guide studs from cylinder block.

(10) Remove and discard two gaskets (15) from engine block and oil cooler.

(11) Clean and remove all traces of gasket material.

b. installation

(1) install two guide studs, one in each hole at positions A and B, on cylinder block for mounting oil cooler.

(2) Position one gasket (15) over guide stud at position (B).

(3) install bolt (13) and Iockwasher (14) at position (C) on oil cooler (6).

(4) Position gasket (15) on back of oil cooler at bolt (13) position (C).

(5) Position seal (9) and clamp (8) over water outlet flange (11).

(6) Position oil cooler (6) over guide studs and install bolt (13) and lockwasher (14) at position (c).

(7) install three bolts (12), two bolts (13), and five Iockwashers (14).

(8) Remove two guide studs from cylinder block.

(9) install remaining two bolts (12 and 13) and two lockwashers (14). Torque all bolts (12 and 13) to 30-35 lb-ft (41 -47 N-m).

(10) Position gasket (7) between oil cooler tube (3) and oil cooler (6).

(11) Secure tube (3) with four bolts (4) and four lockwashers (5). Torque bolts to 30-35 lb-ft (41-47 N-m).

(12) Slide hose connection (2) upward onto water pump connection.

(13) Tighten hose clamps (1).

END OF TASK

3-7. OIL LEVEL GAGE REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 101)

a. Removal

NOTE

- on models 7083-7391, 7083-7396, and 7083-7399, the liquid level gage attaches on the right rear of oil pan.
- On models 7083-7391, 7083-7396, and 7083-7399, secure liquid level gage to right water manifold outlet for storage.

(1) Remove nut (1) securing clip (2) to exhaust manifold stud (3).

(2) Remove clip (2) from stud (3).

(3) Unscrew connector (4) from adapter (5).

(4) Remove oil level gauge tube and rod assembly (6).3).

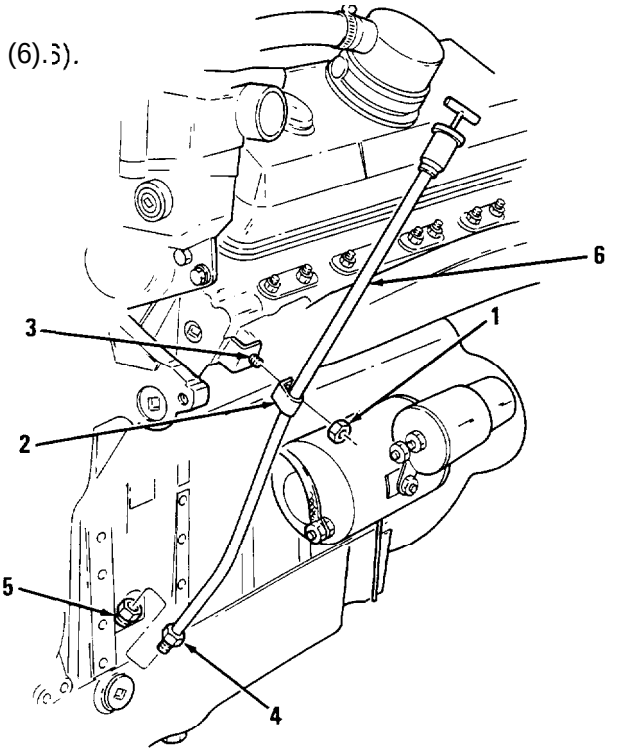
b. Installation

(1) Install oil level gauge tube and rod assembly (6) into adapter (5).

(2) Install clip (2) over exhaust manifold stud (3), and secure with nut (1).

(3) Tighten connector (4) into adapter (5).

END OF TASK



3-8. STARTER REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

2 Lockwashers (App F, Item 98)
3 Lockwashers (App F, Item 97)
1 Lockwasher (App F, Item 99)
1 Gasket (App F, Item 63)

a. Removal

(1) Remove bolt (1) and two lockwashers (2) securing ground strap (3) to side of engine block. Discard lockwashers.

(2) Remove nut (4), lockwasher (5), and starter ground strap (6). Discard lockwasher.

(2.1) For model 7083-7391 only, disconnect glow plug power harness (10) by removing nut (11) and lockwasher (12) securing red power lead connection (13) at battery terminal (14) on solenoid (15). Remove lead and reinstall nut and lockwasher.

(2.2) Remove nut (16) and lockwasher (17) securing orange switch lead connection (18) at switch terminal (19) on solenoid (15). Remove lead and reinstall nut and lockwasher.

(2.3) Remove nut (20) and lockwasher (21) securing black ground lead connection (22) to ground terminal (23) on solenoid (15). Remove lead and reinstall nut and lockwasher.

WARNING

Block or secure starter before removing the three bolts and lockwashers that secure starter to engine flywheel housing. Component is heavy and dropping may result in injury to personnel.

(3) Support starter (6), and remove three bolts (7), three lockwashers (8), and gasket (9) securing starter to flywheel housing. Discard lockwashers.

(4) Remove starter (6) and discard gasket (9).

b. Installation

(1) Position gasket (9) and starter (6) on flywheel housing and secure using three bolts (7) and three lockwashers (8). Torque bolts to 95-105 lb-ft (129-143 N-m).

(2) Install starter ground strap (3) to cylinder block using bolt(1) and two lockwashers (2) (one washer on each side of ground strap). Torque bolt to 23-26 lb-ft (31-35 N-m).

(3) Install starter ground strap (3), nut (4) and lockwasher (5) on starter. Torque nut to 20-25 lb-ft (27-34 N-m).

3-8. STARTER REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

2 Lockwashers (App F, Item 98)
3 Lockwashers (App F,Item 97)
1 Lockwasher(App F, Item 99)
1 Gasket (App F, Item 63)

a. Removal

(1) Remove bolt (1) and two lockwashers (2) securing ground strap (3) to side of engine block. Discard lockwashers.

(2) Remove nut (4), lockwasher (5), and starter ground strap (6). Discard lockwasher.

(2.1) For model 7083-7391 only, disconnect glow plug power harness (1 O) by removing nut (11) and lockwasher (12) securing red power lead connection (13) at battery terminal (14) on solenoid (15). Remove lead and reinstall nut and lockwasher.

(2.2) Remove nut (16) and lockwasher(17) securing orange switch lead connection (18) at switch terminal (19) on solenoid (15). Remove lead and reinstall nut and lockwasher.

(2.3) Remove nut (20) and lockwasher (21) securing black ground lead connection (22) to ground terminal (23) on solenoid (15). Remove lead and reinstall nut and lockwasher.

WARNING

Block or secure starter before removing the three bolts and lockwashers that secure starter to engine flywheel housing. Component is heavy and dropping may result in injury to personnel.

(3) Support starter (6), and remove three bolts (7), three lockwashers (8), and gasket (9) securing starter to flywheel housing. Discard lockwashers.

(4) Remove starter (6) and discard gasket (9).

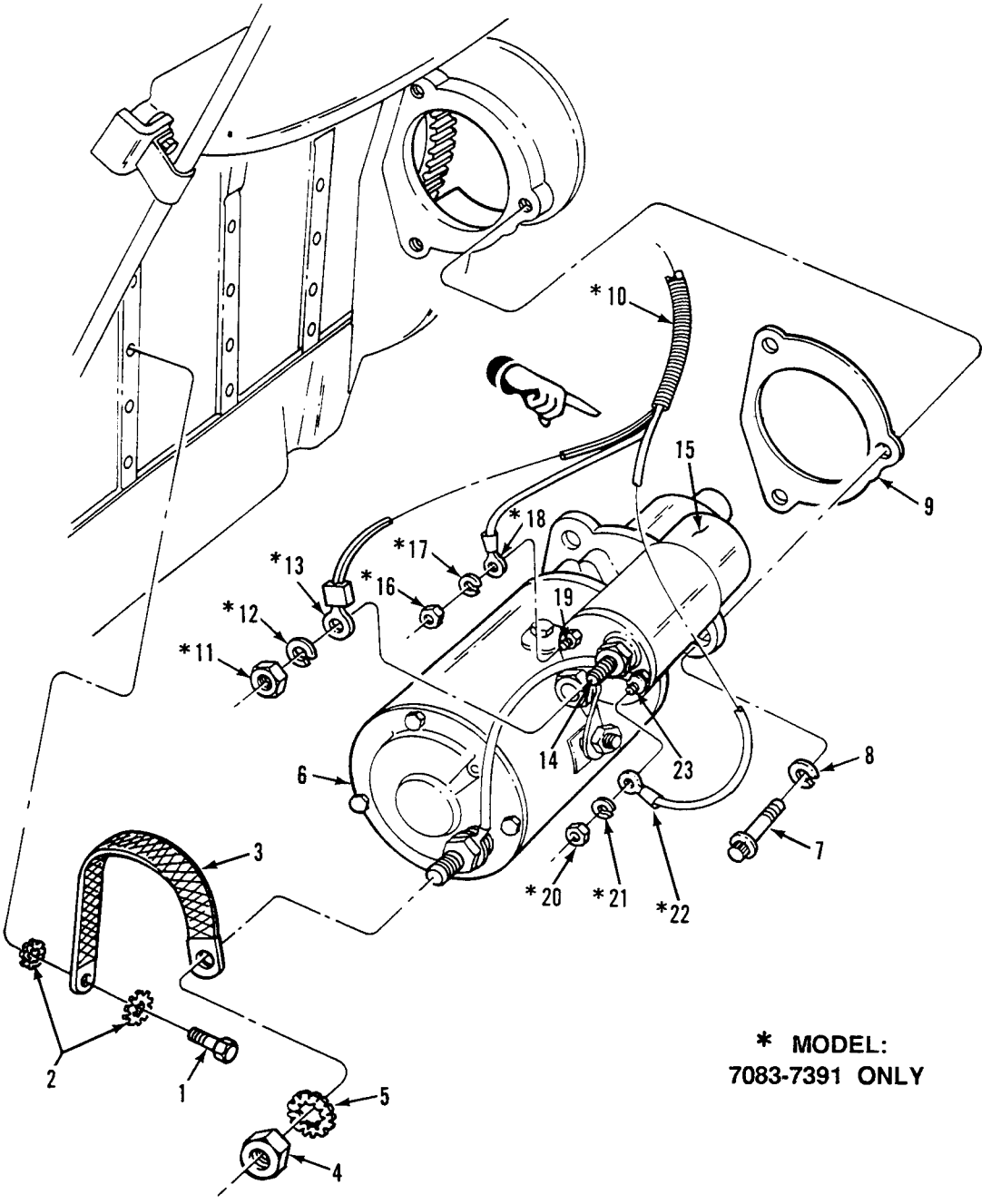
b. Installation

(1) Position gasket (9) and starter (6) on flywheel housing and secure using three bolts (7) and three lockwashers (8). Torque bolts to 95-105 lb-ft (129-143 N-m).

(2) Install starter ground strap (3) to cylinder block using bolt (1) and two lockwashers (2) (one washer on each side of ground strap). Torque bolt to 23-26 lb-ft (31-35 N-m).

(3) Install starter ground strap (3), nut (4) and lockwasher (5) on starter. Torque nut to 20-25 lb-ft (27-34 N-m).

(4) For model 7083-7391 only, connect glow plug power harness (10) by removing nut (20) and lockwasher (21) from ground terminal (23) on solenoid (15). Attach black ground lead connection (22) and secure with nut and lockwasher. Tighten connection.



(5) Remove nut (16) and lockwasher (17) from switch terminal (19) on solenoid (15). Attach orange switch lead connection (18) and secure with nut and lockwasher. Tighten connection.

(6) Remove nut (11) and lockwasher (12) from battery terminal (14) on solenoid (15). Attach red double lead power connection (13) and secure with nut and lockwasher. Tighten connection.

END OF TASK

3-9. AIRBOX DRAINS REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

a. Removal

NOTE

Airbox drains are located on both sides of the cylinder block below the air box covers.

(1) Unscrew connector (1) from 90 degree elbow (2) securing air box drain tubes (3) to side of block.

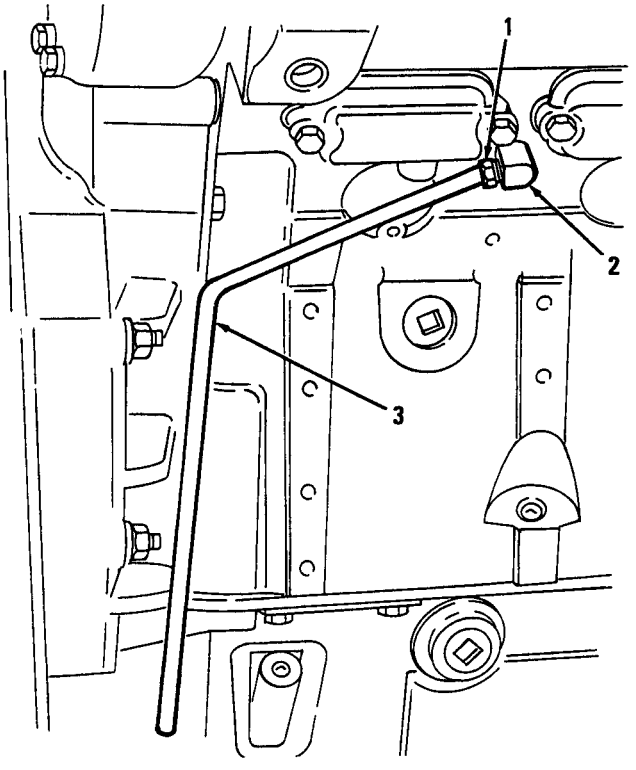
(2) Remove air box drain tubes.

b. Installation

(1) Install air box drain tubes (3) in 90 degree elbow (2) located on both sides of the engine.

(2) Tighten connector (1).

END OF TASK



3-10. TURBOCHARGER OIL RETURN LINE REMOVAL/INSTALLATION (MODELS 7083-7391,7083-7396, AND 7083-7399)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

17083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, item 96)

a. Removal

(1) Loosen two clamps (1) located at each end of turbocharger oil return line (2).

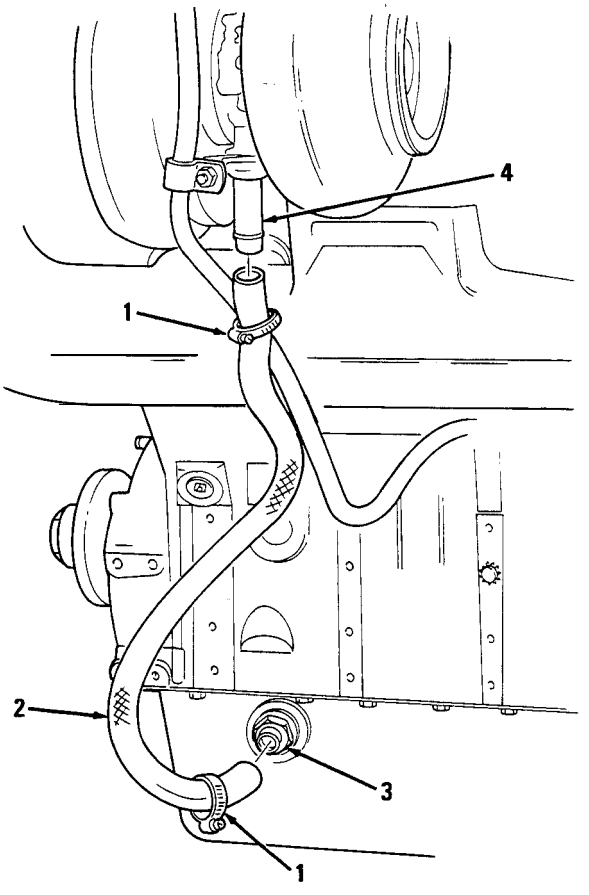
(2) Remove oil return line (2).

b. Installation

(1) Install one end of turbocharger oil return line (2) over elbow (3) at oil pan connection. Install other end of oil return line over oil outlet tube (4) at turbocharger.

(2) Install two clamps (1) onto oil return line (2) and tighten clamps.

END OF TASK



3-11. TURBOCHARGER OIL SUPPLY, LINE REMOVAL/INSTALLATION (MODELS 7083-7395 AND 7083-7398)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS	TOOLS AND SPECIAL TOOLS
7083-7395 7083-7398	General mechanics tool kit (App B, Item 96)

a. Removal

(1) Disconnect turbocharger oil supply line (1) at turbocharger connector (2) and at elbow connector (3) on left rear of engine block.

NOTE

Model 7083-7398 does not have clips securing turbocharger oil supply line.

(2) Remove two bolts (4) and two lockwashers (5) securing oil supply line clips (6) to engine. Reinstall two bolts and two lockwashers that secure clips.

(3) Remove turbocharger oil supply line (1) with clips attached.

b. Installation

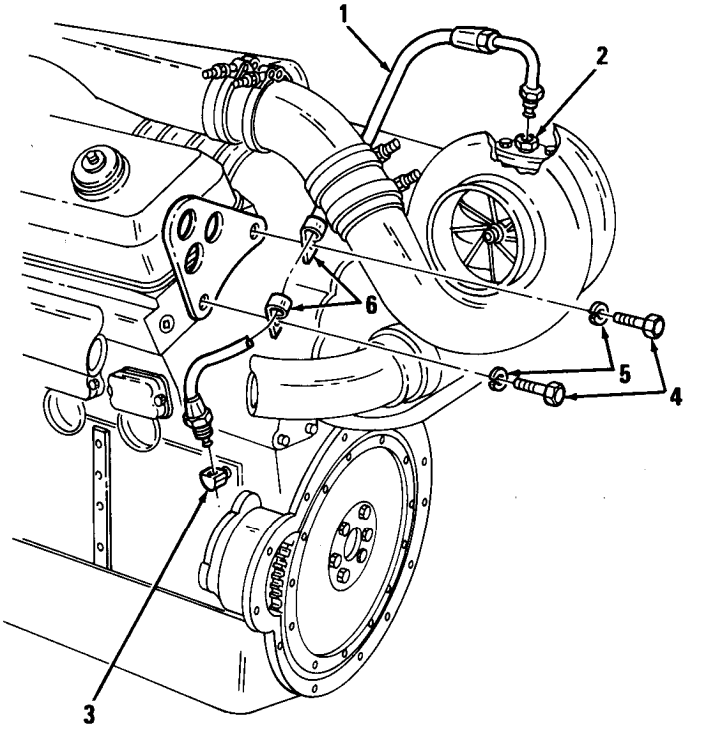
NOTE

On model 7083-7395, the end of the oil supply with the 90 degree fitting is connected at the turbocharger.

(1) Connect turbocharger oil supply line (1) to turbocharger connector (2) and engine block connector (3).

(2) Secure oil supply line (1) to engine using two bolts (4) and two lockwashers (5) to fasten clips (6).

(3) Tighten oil supply line (1) pipe fittings at connectors (2 and 3).



END OF TASK

3-12. TURBOCHARGER OIL SUPPLY LINE REMOVAL/INSTALLATION (MODELS 7083-7391 AND 7083-7396)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7391 7083-7396

MANDATORY REPLACEMENT PARTS

1 Lockwasher (App F,Item 92)

TOOLS AND SPECIAL TOOLS

General mechanics tool set (App B, Item 96)
Torque wrench (App B, Item 101)

a. Removal

(1) Disconnect turbocharger oil supply line (1) at turbocharger connector (2) and at elbow connector (3) on left front of engine block.

(2) Remove bolt (4), flat washer (5), Iockwasher (6), and nut (7) securing oil supply line clamp (8) to angle bracket (9). Discard Iockwasher.

(3) Remove bolt (10) securing clamp (11) to airbox cover (12). Reinstall bolt in airbox cover.

(4) Remove turbocharger oil supply line (1) with clamps attached.

b. Installation

NOTE

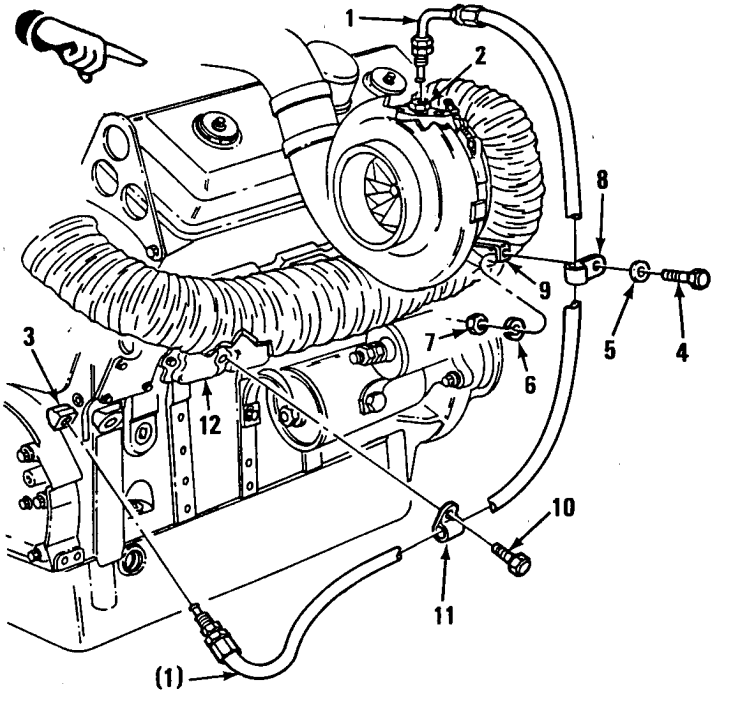
The end of the oil supply line with the 90 degree fitting is connected at the turbocharger.

(1) Connect turbocharger oil supply line (1) to turbocharger connector (2) and elbow connector (3), at left front of block.

(2) Secure oil supply line clamp (8) to angle bracket (9) with bolt (4), flat washer (5), Iockwasher (6), and nut (7). Tighten bolt and nut.

(3) Remove bolt (10) from airbox cover (12) and secure oil supply line clamp (11) to cover. Torque airbox cover bolt to 8-12 lb-ft (11-17 N-m).

(4) Tighten oil supply line (1) pipe fittings at connectors (2 and 3).



END OF TASK

3-13. TURBOCHARGER OIL SUPPLY LINE REMOVAL/INSTALLATION (MODEL 7083-7399)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7399

MANDATORY REPLACEMENT PARTS

3 Lockwashers (App F, Item 93)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

a. Removal

(1) Disconnect turbocharger oil supply line (1) at turbocharger connector (2) and at elbow connector (3) on left rear of engine block.

(2) Remove two bolts (4) and two lockwashers (5) securing oil supply line clips (6) to turbocharger housing. Discard lockwashers. Reinstall two bolts and two lockwashers.

(3) Remove bolt (7), lockwasher (8), and flat washer (9), securing oil supply line clip (10) to left side of engine block. Discard lockwasher.

(4) Remove turbocharger oil supply line (1) with clips attached.

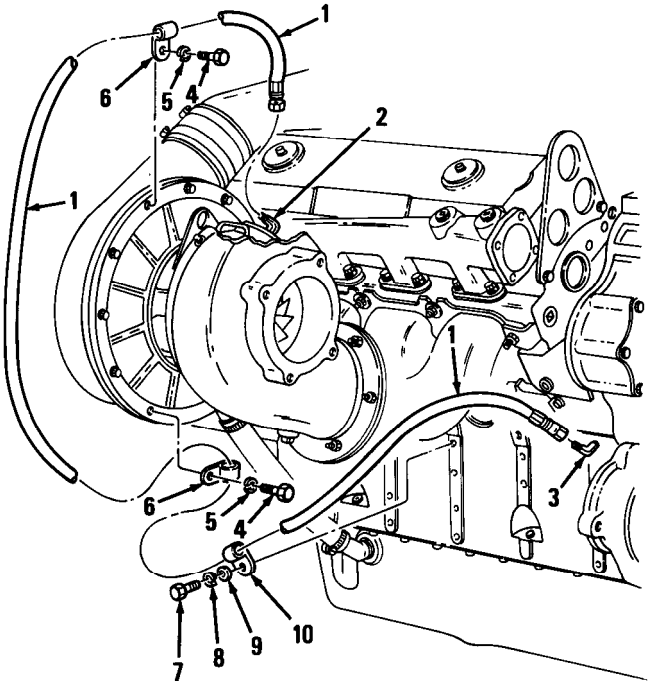
b. Installation

(1) Connect turbocharger oil supply line (1) to turbocharger connector (2) and engine block connector (3).

(2) Secure oil supply line clip (10) to left side of engine block with bolt (7), lockwasher (8), and flat washer (9). Tighten bolt.

(3) Remove two bolts (4) and two lockwashers (5) from turbocharger housing and secure oil supply line clips (6) with two bolts and two lockwashers. Torque bolts to 150-200 lb-in (17-22.6 N-m).

(4) Tighten hose fittings at connectors (2 and 3).



END OF TASK

3-14. AIR INLET MANIFOLD TO TURBOCHARGER REMOVAL/INSTALLATION (MODELS 7083-7391 AND 7083-7396)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7391 7083-7396

TOOLS AND SPECIAL TOOLS

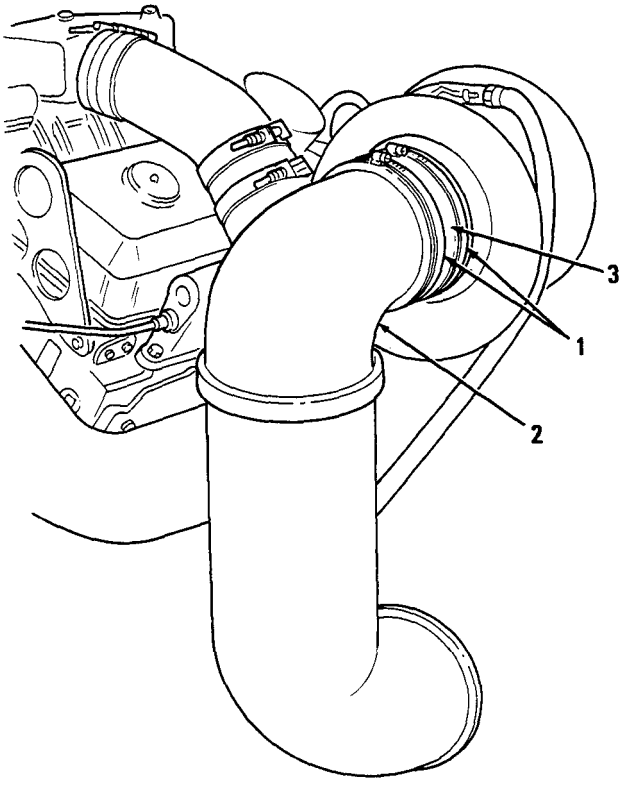
General mechanics tool kit (App B, Item 96)

a. Removal

(1) Loosen two hose clamps (1).

(2) Remove air inlet manifold (2).

(3) Remove two hose clamps (1) and rubber hose connector (3).



b. Installation

(1) Install rubber hose connector (3) on turbocharger air inlet end.

(2) install two hose clamps (1) over hose connector (3).

(3) Tighten hose clamp (1) closest to turbocharger.

(4) Install air inlet manifold (2) into hose connector (3).

(5) Tighten remaining clamp (1) over air inlet manifold.

END OF TASK

3-15. AIR INLET MANIFOLD TO TURBOCHARGER REMOVAL/INSTALLATION (MODEL 7083-7399)

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY Replacement PARTS

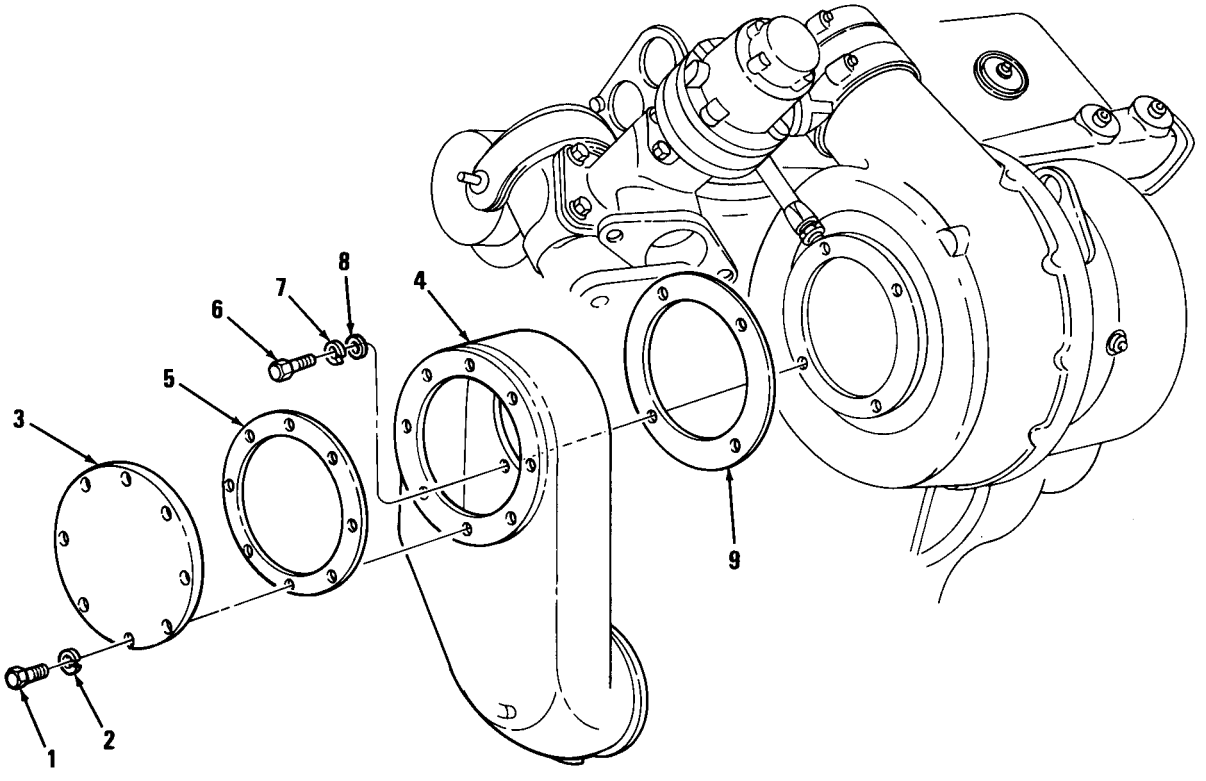
8 Lockwashers (App F, Item 91)
4 Lockwashers (App F, Item 93)
1 Gasket (App F,Item 58)
1 Gasket (App F,Item 59)

a. Removal

(1) Remove eight screws (1) and eight lockwashers (2) securing air inlet manifold cover (3) to air inlet manifold (4). Discard lockwashers.

(2) Remove air inlet manifold cover (3) and gasket (5). Discard gasket.

(3) Remove four bolts (6), four lockwashers (7) , and four flat washers (8) securing air inlet manifold (4) to turbocharger. Discard lockwashers.



NOTE

Support air inlet manifold prior to removing bolts that secure it to the turbocharger.

(4) Remove air inlet manifold (4) and gasket (9). Discard gasket.

b. Installation

(1) Position air inlet manifold gasket (9) on turbocharger at air inlet.

(2) Position air inlet manifold (4) on turbocharger.

(3) Install four bolts (6), four Iockwashers (7) , and four flat washers (8) securing air inlet manifold to turbocharger. Torque bolts to 30-35 lb-ft (41-47 N-m).

(4) Position cover (3) and gasket (5) on air inlet manifold (4).

(5) Install eight bolts (1) and eight Iockwashers (2) securing cover to air inlet manifold. Torque bolts to 7-9Ib-ft(10-12 N-m).

END OF TASK

Section V. ENGINE INSTALLATION/REMOVAL ONTO MAINTENANCE STAND

3-16. ENGINE ON MAINTENANCE STAND INSTALLATION/REMOVIAL

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

INITIAL SETUP

MODELS

All

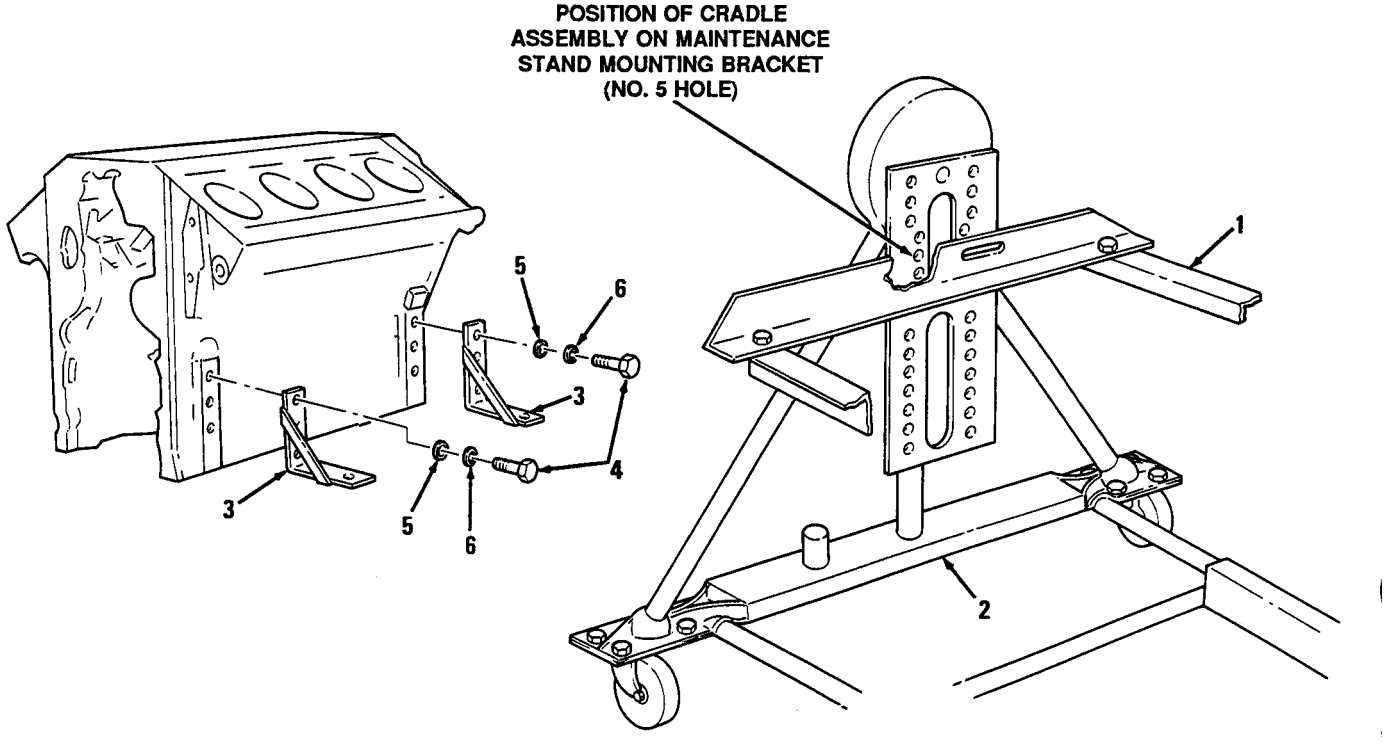
TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Three-legged sling (App B, Item 84)
Four-legged sling (App B, Item 82)
Maintenance stand (App B, Item 85)
Cradle (App B, Item 14)
Drain unit (App B, Item 15)
Brackets (App B, Item 8)

a. Maintenance Stand Preparation

(1) Attach engine cradle assembly (1) to engine maintenance stand (2) at hole location number 5.

(2) Install four mounting brackets (3) to side of engine block using two bolts (4), two flat washers (5), and two lockwashers (6) per bracket. Leave brackets loose for flexibility.



b. Installation

NOTE

- Use the three-legged sling to lift engine models 7083-7395 and 7083-7398.
- Use four-legged sling to lift engine models 7083-7391, 7083-7396, and 7083-7399.

(1) Using a multi-leg sling, position engine assembly with four engine mounting brackets attached on engine maintenance stand (2).

(2) Secure brackets (3) to stand cradle (1) side rails with four bolts (7), four lockwashers (8), eight flat washers (9), and four nuts (10). Tighten bolts.

c. Removal

NOTE

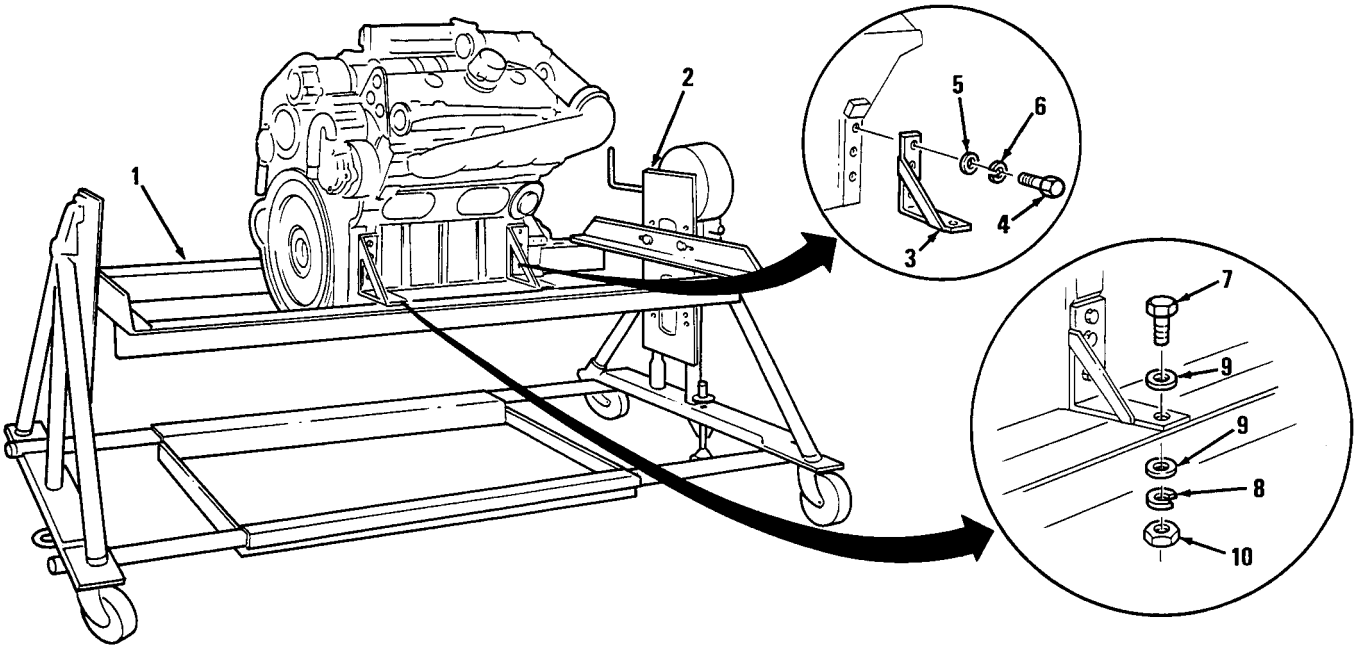
- Use the three-legged sling to lift engine models 7083-7395 and 7083-7398.
- Use four-legged sling to lift engine models 7083-7391, 7083-7396, and 7083-7399.

(1) Attach a multi-leg sling to engine lifting brackets prior to removing engine from maintenance stand (2).

(2) Remove four bolts (7), four lockwashers (8), eight flat washers (9), and four nuts (10) securing engine mounting brackets (3) to cradle assembly (1) side rails. Discard lockwashers.

(3) Remove eight bolts (4), eight flat washers (5), and eight lockwashers (6) securing engine mounting brackets (3) to sides of engine block. Remove brackets. Discard lockwashers.

END OF TASK



CHAPTER 4

REPAIR PROCEDURES FOR MAJOR COMPONENTS OF ENGINE MODEL 7083-7395

Contents

Section I. INTRODUCTION

4-1. GENERAL. This chapter provides the repair procedures performed on engine model 7083-7396 after the engine has been installed on the maintenance stand. 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. Although this chapter deals with model 7083-7395; when other models have identical or nearly identical components, those models will also be covered in the same task.

Section II. GENERAL ENGINE MAINTENANCE

4-2. TURBOCHARGER REMOVAL/INSTALLATION

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

INITIAL SETUP

MODELS

7083-7395

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

4 Locking nuts (App F, Item 105)
1 Gasket (App F, Item 79)
3 Lockwashers (App F, Item 93)
4 Lockwashers (App F, Item 95)

EQUIPMENT CONDITION

Para Description
3-11 Turbocharger oil supply line removed

a. Removal

(1) Loosen four clamps (1) and two rubber connectors (2) securing turbocharger oil drain tube (3). Remove tube, hoses, and clamps.

(2) Loosen four clamps (4) and two hose connectors (5) connecting air inlet tube (6) to turbocharger (7) and air inlet housing (8).

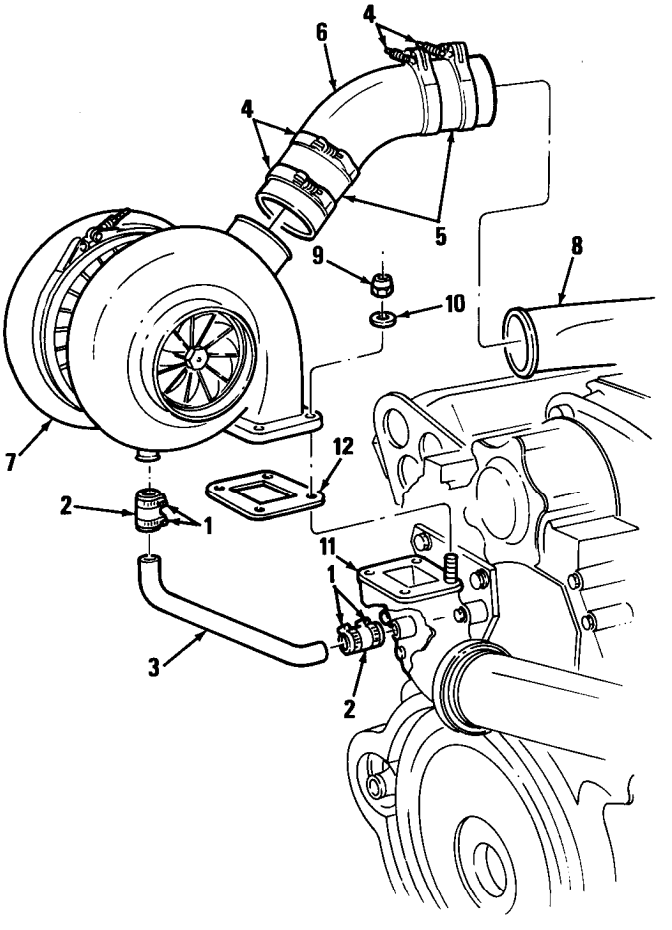
(3) Slide hoses (5) and clamps (4) onto air inlet tube (6) and remove tube. Remove hoses and clamps from tube.

(4) Remove four locking nuts (9) and four flat washers (10) securing turbocharger to exhaust tee (11). Discard locking nuts.

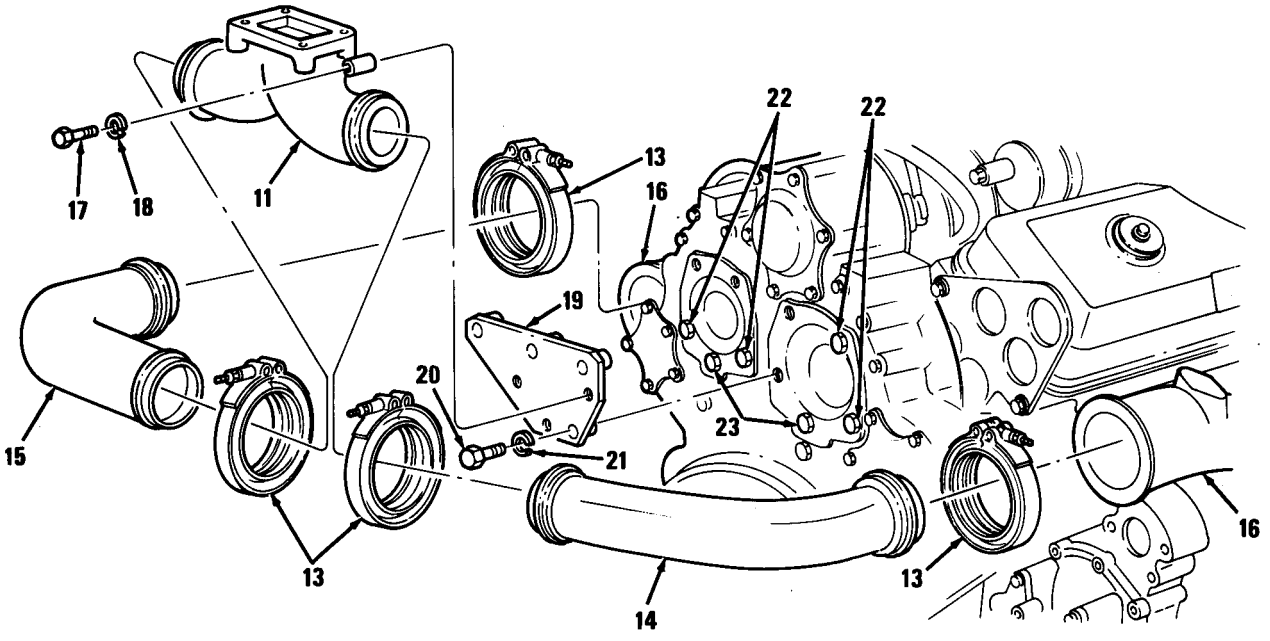
CAUTION

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

(5) Remove turbocharger (7) and gasket (12). Discard gasket.



4-2. TURBOCHARGER REMOVAL/INSTALLATION (Cont)



(7) Remove four clamps (13) securing exhaust tubes (14 and 15), to exhaust tee (11) and exhaust manifolds (16).

(8) Loosen three bolts (17) on exhaust tee (11) to aid in removal of exhaust tubes (14 and 15).

(9) Remove exhaust tubes (14 and 15) and clamps (13).

(10) Remove three bolts (17) and three lockwashers (18) securing exhaust tee (11) to mounting bracket (19). Discard lockwashers.

(11) Remove four bolts (20) and four lockwashers (21) securing mounting bracket (19) to flywheel housing. Discard lockwashers.

(12) Remove turbocharger mounting bracket (19).

b. Cleaning/inspection

(1) Clean all parts. Refer to para 3-2a.

(2) Inspect all parts. Refer to para 3-2b.

(3) Replace all parts failing inspection.

c. Installation

NOTE

Four bolts (22) and two bolts (23) were installed in Para 4-24.

(1) Torque four bolts (22) and two bolts (23) to 30-35 lb-ft (41 -47 N-m).

(2) Install four bolts (20) and four lockwashers (21), fastening mounting bracket (19) to flywheel housing. Torque four bolts to 30-35 lb-ft (41-47 N-m).

(2) Start three bolts (17) and three lockwashers (18) securing exhaust tee (11) to mounting bracket (19).

(3) Install exhaust tubes (14 and 15) and four clamps (13) between exhaust tee (11) and exhaust manifolds (16). Tighten four clamps then torque three bolts (17) to 30-35 lb-ft (41-47 N-m).

(4) Position a gasket (12) on exhaust tee (11),

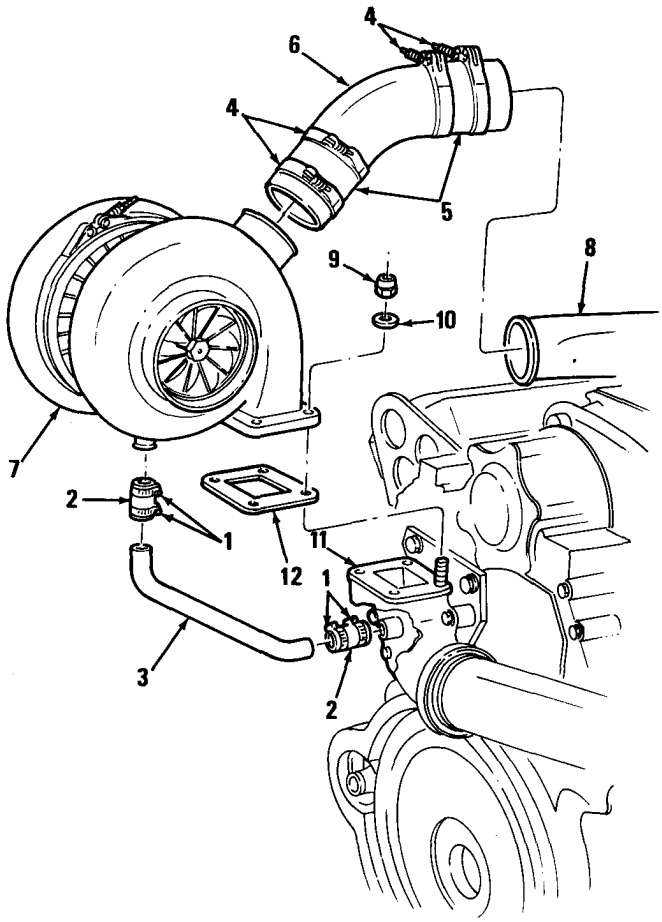
(5) Remove protective covering from bottom of turbocharger (7) and position on exhaust tee (11).

(6) Install four locking nuts (9) and four flat washers (10) securing turbocharger (7) to exhaust tee (11). Torque nuts to 35-39 lb-ft (47-53 N-m).

(7) Slide two hose connectors (5) and four clamps (4) onto air inlet tube (6).

(8) Install air inlet tube (6) between turbocharger (7) and air inlet housing (8). Tighten hose clamps (4).

(9) Install two hoses (2) and four clamps (1) onto turbocharger oil drain tube (3). Connect end of oil drain tube to turbocharger drain and other end to left side outboard flywheel housing cover. Tighten four clamps (1).



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-11	Install turbocharger oil supply line

4-3. EXHAUST MANIFOLD REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS	MANDATORY REPLACEMENT PARTS
7083-7395	4 Gaskets (App F,Item 41)
TOOLS AND SPECIAL TOOLS	**EQUIPMENTCONDITION**
General mechanics tool kit (App B, Item 96) Torque wrench (App B, Item 101)	Para Description 4-2 Turbocharger removed

a. Removal

(1) Loosen five nuts(1) securing exhaust manifold (2) to cylinder head.

(2) SIide exhaust manifold (2) up and off cylinder head.

(3) Remove five nuts (1), three center retainers (3), and two end retainers (4).

(4) Remove two exhaust manifold gaskets (5). Discard gaskets.

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

b. Installation

NOTE

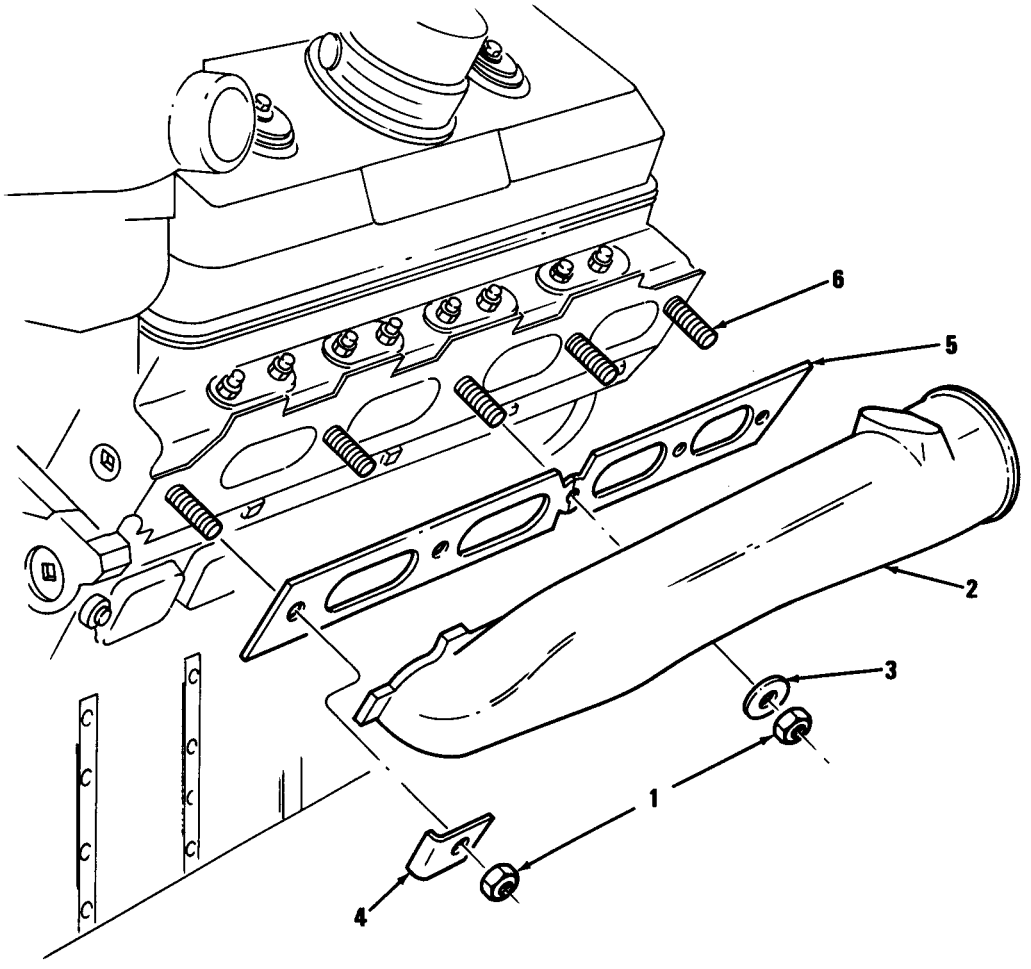
When installing metal clad exhaust manifold gaskets, insure crimped side of gasket is facing cylinder head.

(1) Position two gaskets (5) over exhaust manifold studs (6).

NOTE

Position the bevel washers so outer diameter will rest on manifold and crown at center is next to nut.

(2) Install three center retainers (3), two end retainers (4), and five nuts (1).



NOTE

Insure locating pads on exhaust manifold rest on cylinder block locating pads.

(3) Install exhaust manifold (2) to cylinder head by sliding downward between gaskets and retainers.

(4) Torque five nuts (1) to 30-35 lb-ft (41 -47 N-m) starting from center outward and alternating toward either end.

(5) Repeat steps 1-4 above for opposite side exhaust manifold.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-2 Install turbocharger

4-4. FUEL FILTER REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

MANDATORY REPLACEMENT PARTS

4 Lockwashers (App F, Item 93)
1 Flat washer (App F, Item 17)
1 Filter element (App F, Item 15)
1 Seal (App F, Item 154)

a. Removal

(1) Remove bolt (1) and flat washer (2) securing fuel filter canister (3) to filter head (4). Discard flat washer.

(2) Remove filter element (5) from canister and remove seal (6) from filter head. Discard element and seal.

(3) Disconnect fuel inlet line (7) at elbow connection (8) on fuel pump and at elbow connection (9) on filter head (4). Remove line.

(4) Disconnect fuel line (10) at fuel filter connection (11) and front of right bank cylinder head. Remove line.

(5) Remove two bolts (13), lockwashers (14), and nuts (15) securing filter head (4) to mounting bracket (16). Discard lockwashers. Remove fuel filter head (4).

(6) Remove two bolts (17) and lockwashers (18) securing mounting bracket (16) to water pump (19). Remove mounting bracket and discard lockwashers.

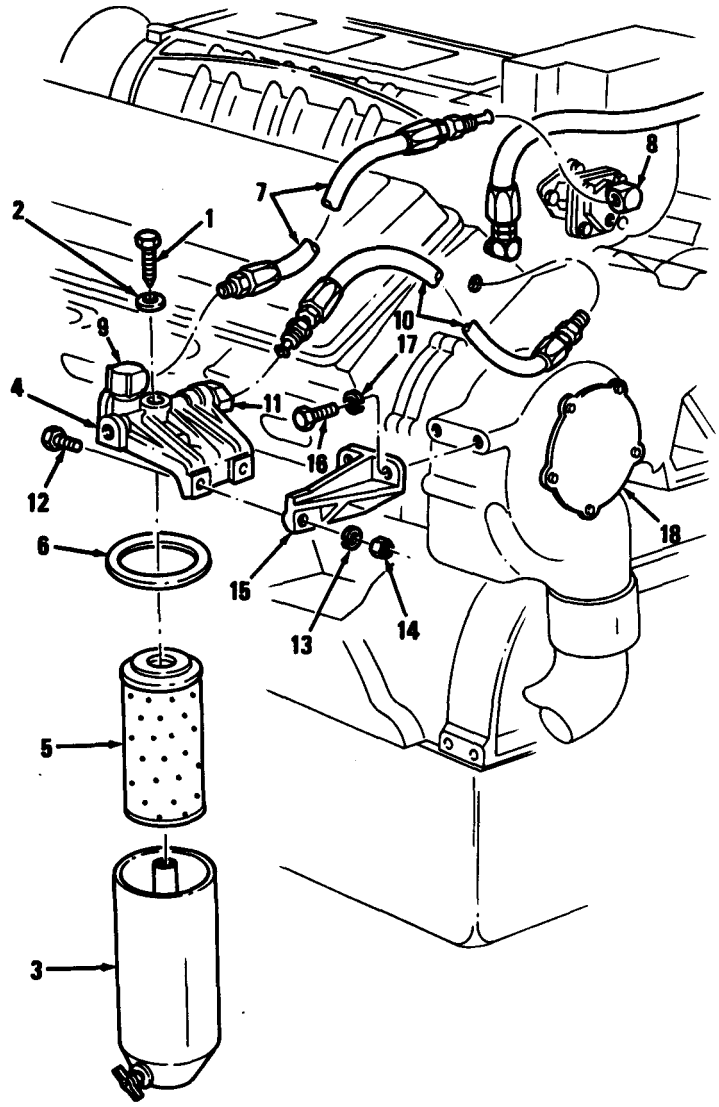
b. Installation

(1) Install two bolts (17) and two lockwashers (18) securing mounting bracket (16) to water pump (19).

(2) Install two bolts (13), two lockwashers (1 4), and two nuts (15) securing filter head (4) to mounting bracket (16).

(3) Connect fuel inlet line (7) to inlet side of fuel filter at elbow (9). Connect other end to fuel pump at elbow connection (8).

(4) Connect fuel outlet line (10) to lower hole in front of right bank cylinder head. Connect other end to connector (11) on outlet side of fuel filter.



(5) Install seal (6) in filter head (4).

(6) Install fuel filter element (5) in canister (3).

(7) Install (1) and flat washer (2) securing canister with filter to filter head (4). Tighten bolt enough to prevent fuel leakage.

END OF TASK

4-5. FUEL STRAINER REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

MANDATORY REPLACEMENT PARTS

4 Lockwashers (App F, Item 93)
1 Filter element Kit (App F, Item 16)
1 Flat washer
1 Filter element
1 Seal

a. Removal

(1) Remove bolt (1) and flat washer (2) securing fuel strainer canister (3) to strainer head (4). Remove canister and discard flat washer.

(2) Remove strainer element (5) from canister and remove seal (6) from strainer head. Discard element and seal.

(3) Remove bolt (7) and flat washer (8) from clip (9) and reinstall in water pump (10).

(4) Disconnect fuel supply line (11) at elbow connection (12) on fuel pump (13) and at tee fitting (14) on fuel strainer head (4). Remove fuel supply line (11).

(5) On model 7083-7398 only, disconnect air heater fuel supply line (15) at elbow on tee fitting (14).

(6) Remove two bolts (16), two lockwashers (17), and two nuts (18) securing fuel strainer head (4) to mounting bracket (19). Remove fuel strainer head and discard lockwashers.

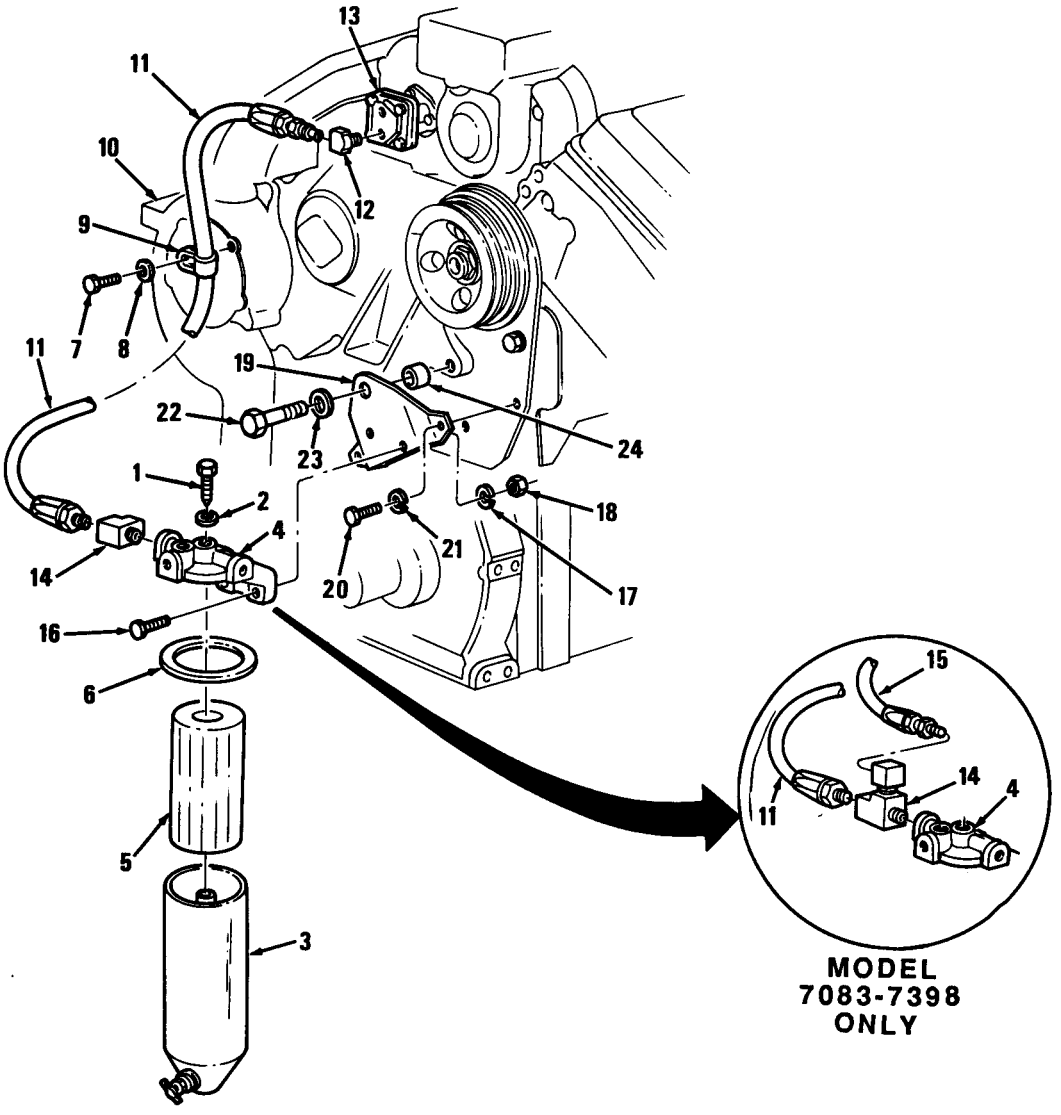
(7) Remove two bolts (20), two lockwashers (21), bolt (22), flat washer (23), and spacer (24) securing mounting bracket (19) to front of engine. Discard lockwashers.

(8) Remove mounting bracket (19).

b. Installation

(1) Install bolt (22), flat washer (23), spacer (24), two bolts (20), and two lockwashers (21) securing mounting bracket (19) to front of engine.

(2) Install two bolts (16), two lockwashers (17), and two nuts(18) securing fuel strainer head (4) to mounting bracket (19).



(3) Connect fuel supply line (11) at tee fitting (14) on fuel strainer head (4) and elbow connection (12) on fuel pump (13).

(4) Install bolt (7) and flat washer (8) securing fuel line clip (9) to water pump (10).

(5) On model 7083-7398 only, install air heater fuel supply line (15) at tee fitting (14) of fuel strainer head (4).

(6) Install seal (6) in strainer head (4).

(7) Install fuel strainer element (5) in canister (3).

(8) Install bolt (1) and flat washer (2) securing canister (3) (with element) to strainer head (4) Tighten bolt just enough to prevent fuel leakage.

END OF TASK

4-6. FUEL LINES REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7395 7083-7398

MANDATORY REPLACEMENT PARTS

3 Lockwashers (App F, Item 91)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

a. Removal

(1) Remove bolt (1), lockwasher (2), and flat washer (3) securing angle bracket (4) to governor cover (5). Reinstall bolt, lockwasher, and flat washer in governor cover.

(2) Remove bolt (6), two flat washers (7), lockwasher (8) and nut (9) attaching fuel line clip (10) to angle bracket (4).

(3) Remove clip (10) from fuel crossover line (11).

(4) Disconnect fuel crossover line (11) from front of engine at elbow connectors (12) and remove line.

(5) Disconnect fuel return crossover line (13) at connectors (14) located on inside rails at rear of cylinder heads.

(6) Remove fuel return crossover line (13).

b. Installation

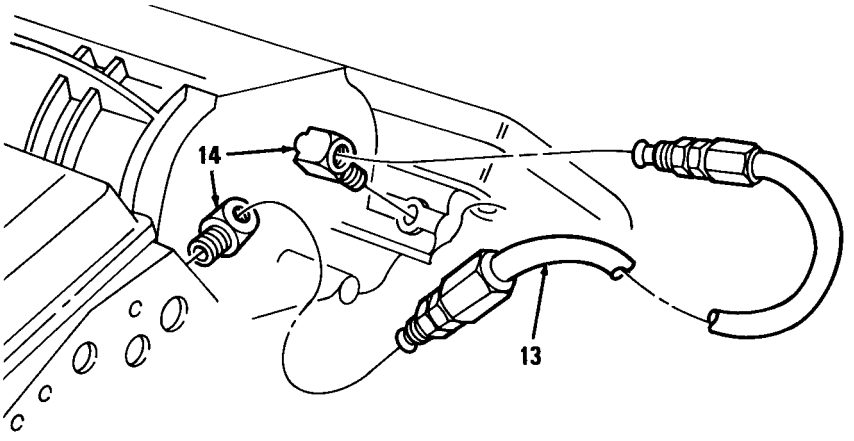
(1) Connect fuel return crossover line (13) to elbow connectors (14) on inside rails at rear of cylinder heads.

(2) Install fuel line clip (10) on fuel crossover line (11).

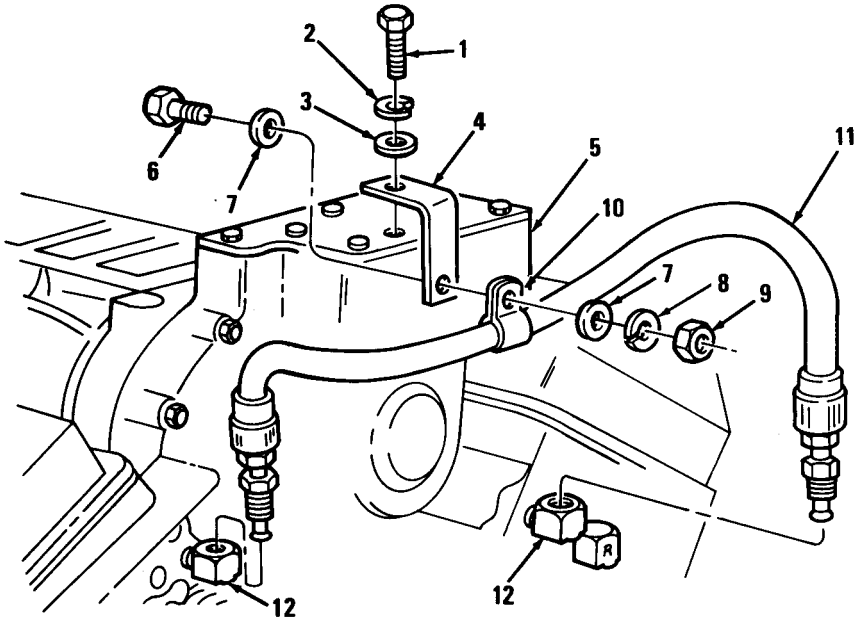
(3) Install bolt (6), two flat washers (7), lockwasher (8) and nut (9) securing angle bracket (4) to clip (10). Torque nut to 15-19 lb-ft (20-26 N-m).

(4) Connect fuel crossover line (11) at elbow connectors (12) at front of cylinder heads.

(5) Use bolt (1), lockwasher (2), and flat washer (3) to secure angle bracket (4) to governor cover (5). Torque bolt to 7-9 lb-ft (10-12 N-m).



REAR VIEW



FRONT VIEW

END OF TASK

4-7. ENGINE LIFTING BRACKETS REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7395
7083-7398

TOOLSANDSPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Lockwasher (App F,Item 92)
4 Lockwashers (App F,Item 94)
1 Lockwasher (App F, Item 95)
1 Lockwasher (App F, Item 96)
2 Gaskets (App F, Item 34)

a. Removal

(1) Remove bolt (1), flat washer (2), lockwasher (3), and nut (4) securing angle bracket (5) to front engine lifting bracket (6). Discard lockwasher.

(2) Remove bolt (7), Iockwasher (8), and nut (9) securing engine front lifting bracket (6), to engine front cover (10). Discard lockwasher.

(3) Remove bolt (11), lockwasher (12), and spacer (13) securing engine front lifting bracket (6) to engine front cover (10). Remove lifting bracket. Discard lockwasher.

(4) Remove two bolts (14) and two lockwashers (15) securing rear engine lifting bracket (16) to back of cylinder head (17). Remove bracket and discard lockwashers.

(5) Remove gasket (18) from back of cylinder head. Discard gasket.

(6) Repeat steps (3) and (4) for removal of opposite bank rear lifting bracket.

b. Installation

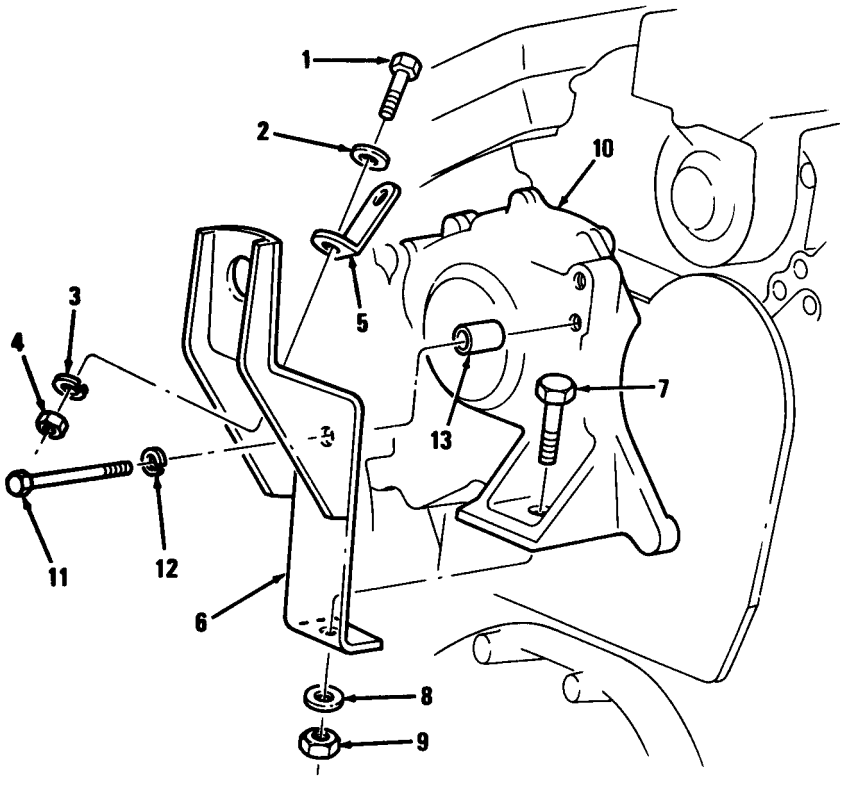
(1) Install two bolts (14), two lockwashers (15), and gasket (18) securing rear engine lifting bracket (16) to cylinder head (17). Torque bolts to 46-50 lb-ft (62-68 N-m).

(2) Repeat step (1) for installation of opposite bank rear engine lifting bracket.

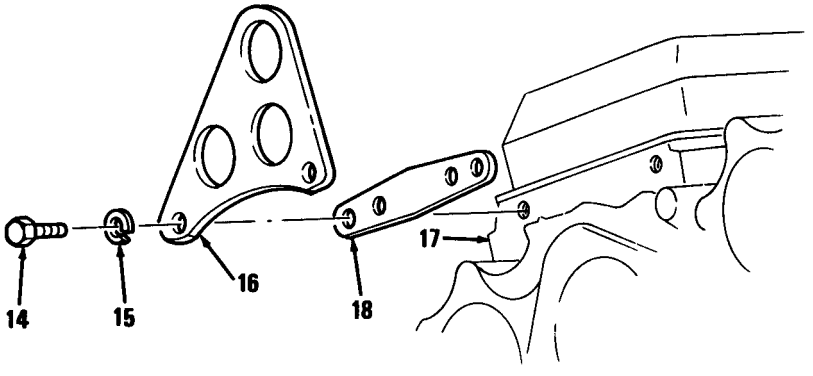
(3) Install bolt (11), lockwasher (12), and spacer (13) securing engine front lifting bracket (6) to engine front cover (10). Torque bolt to 71-75 lb-ft (96-102 N-m).

(4) Install bolt (7), lockwasher (8), and nut (9) securing front engine lifting bracket (6) to engine front cover (10). Torque nut to 107-117 lb-ft (145-159 N-m).

(5) Install bolt (1), flat washer (2), lockwasher (3), and nut (4) securing angle bracket (5) to front engine lifting bracket (10). Torque nut to 13-17 lb-ft (18-23 N-m).



FRONT



REAR

END OF TASK

4-8. THERMOSTAT, THERMOSTAT HOUSING, AND CROSSOVER TUBES REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Seal installer (App B. Item 59)
Driver handle (App B, Item 41)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Lockwasher (App F, Item 92)
9 Lockwashers (App F, Item 93)
1 Lockvvasher (App F, Item 94)
2 Seals (App F, Item 152)
1 Gasket (App F, Item 27)
2 Gaskets (App F, Item 39)

EQUIPMENT CONDITION

Para. Description
4-7 Front engine lifting bracket removed

a. Removal

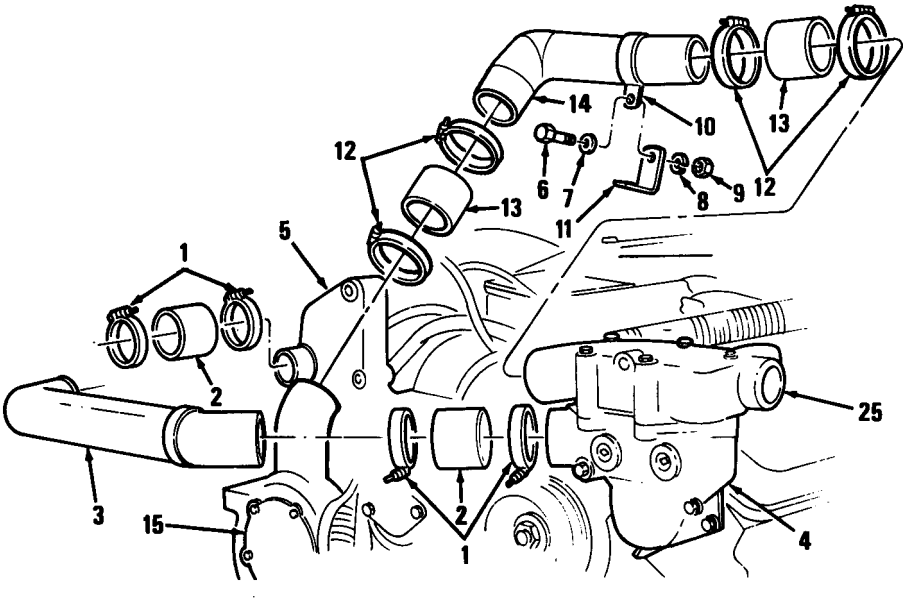
(1) Loosen four clamps (1) and two rubber connectors (2) securing water crossover tube (3) to thermostat housing (4) and water outlet connection (5).

(2) Slide clamps (1) and rubber connectors (2) onto water crossover tube (3). Remove tube.

(3) Remove clamps (1) and rubber connectors (2) from crossover tube (3).

(4) Remove bolt (6), flat washer (7), lockwasher (8), and nut (9) securing water bypass tube clamp (10) to angle bracket (11). Discard lockwasher.

(5) Loosen four clamps (12) and two rubber connectors (13) securing water bypass tube (14) to thermostat housing (4) and water pump (15).



(6) Slide clamps (12) and rubber connectors (13) onto water bypass tube (14). Remove tube.

(7) Remove clamps (12) and rubber connectors (13) from bypass tube (14).

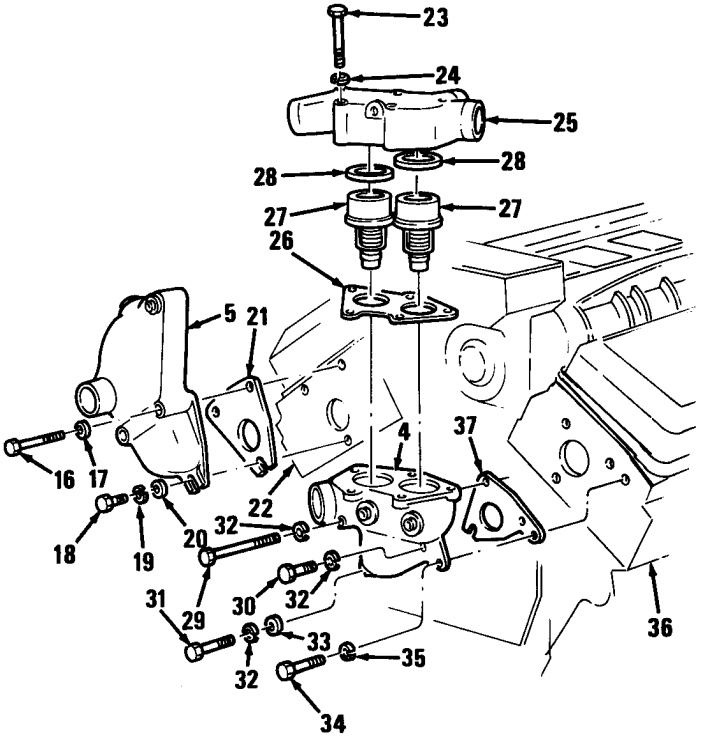
(8) Remove two bolts (16) and two flat washers (17). Loosen bolt (18) and remove water outlet connection (5) by sliding upward.

(9) Remove bolt (18), lockwasher (19), flat washer (20), and gasket (21) from right bank cylinder head (22). Discard lockwasher and gasket.

(10) Remove five bolts (23) and five lockwashers (24) securing thermostat cover (25) to thermostat housing (4). Remove gasket (26) and two thermostats (27). Discard gasket and lockwashers.

(11) Remove two thermostat seals (28) from thermostat cover (25). Discard seals.

(12) Remove bolts (29, 30, and 31), three lockwashers (32) flat washer (33). bolt (34), and lockwasher (35) securing thermostat housing (4) to left cylinder head (36). Remove thermostat housing (4) and gasket (37). Discard gasket and lockwashers.

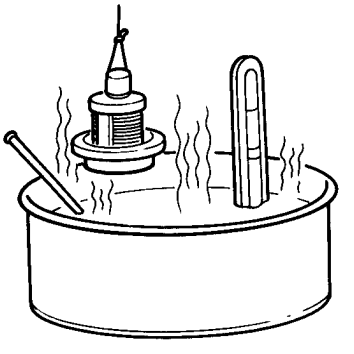


b. Inspection

(1) Immerse thermostat in container of water and apply heat to container.

(2) Place a thermometer in the container, but do not allow it to touch bottom of container.

(3) Agitate water to maintain an even temperature throughout the container. When temperature reaches approximately 167°F to 172°F, the thermostat should begin to open. The thermostat should be fully opened when the water temperature reaches approximately 187°F. Allow at least 10 minutes for thermostat to react. If thermostats do not meet requirements, replace thermostats.



4-8. THERMOSTAT, THERMOSTAT HOUSING, AND CROSSOVER TUBES REPLACEMENT (Cont)

c. Installation

NOTE

Using seal installer assures seal is positioned the correct distance from bottom face of cover and parallel with cover face.

(1) Install two thermostat seals (28) in thermostat cover (25) using installer and driver handle. Position seals so lip of seal faces up toward top of thermostat cover.

(2) Install bolts (29,30, and 31), three lockwashers (32), flatwasher (33), bolt (34), and lockwasher (35) securing thermostat housing (4) and housing gasket (37) to left bank cylinder head. Torque bolts (29, 30, and 31) to 30-35 lb-ft (41-47 N-m). Torque bolt (34) to 46-50 lb-ft (62-68 N-m).

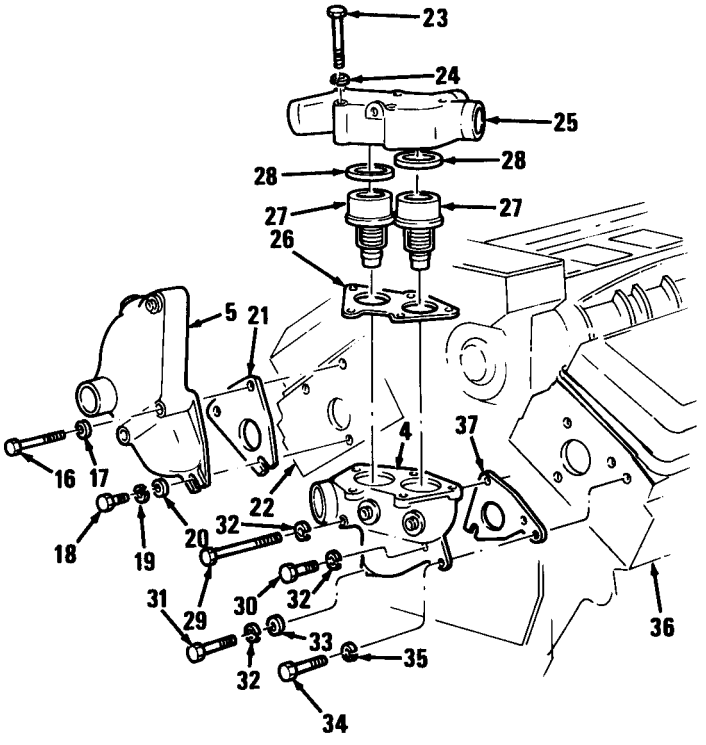
(3) Position thermostat cover gasket (26) and two thermostats (27) in thermostat housing (4).

(4) Install five bolts (23) and five lockwashers (24) securing thermostat cover (25) to thermostat housing (4). Torque five bolts to 30-35 lb-ft (41 -47 N-m).

(5) Start bolt (18), lockwasher (1 9), and flat washer (20) in right bank cylinder head (22).

(6) Position water outlet connection (5) and gasket (21) on cylinder head (22) by sliding down onto bolt (18).

(7) Install two bolts (16) and two flat washers (17) securing water outlet connection (5) to cylinder head (22). Torque all bolts (16 and 18) to 30-35 lb-ft (41-47 N-m).



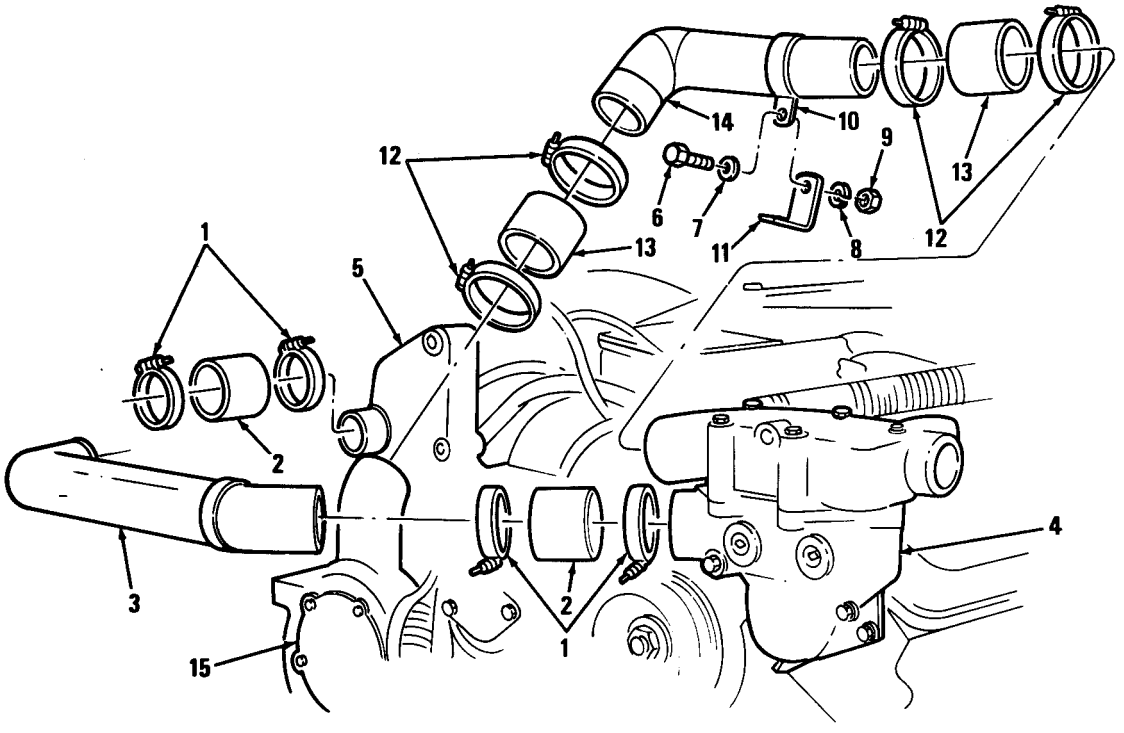
(8) Slide two rubber connectors (13) and four clamps (12) onto ends of water bypass tube (14).

(9) Install water bypass tube (14) between water pump (15) and thermostat housing cover (25). Slide rubber connectors (13) onto water pump and thermostat housing; secure with clamps (12).

(10) Install bolt (6), flatwasher (7), lockwasher (8), and nut(9) securing water bypass clamp (10) to angle bracket(11). Loosely secure bolt to clamp and angle bracket until front engine lifting bracket is installed.

(11) Slide rubber connectors (2) and four clamps (1) onto ends of water crossover tube (3).

(12) Install water crossover tube (3) between thermostat housing (4) and water outlet connection (5). Slide rubber connectors (2) onto thermostat housing and water outlet connection; secure with clamps (1).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-7 Install Engine Front Lifting Bracket

4-9. WATER PUMP REMOVAL/INSTALLATION

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Magnetic base dial indicator (App B, item 45)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

3 Lockwashers (App F, Item 94)
1 Seal ring (App F, Item 133)

EQUIPMENT CONDITION

Para	Description
4-4	Fuel filter bracket removed
4-6	Fuel line clip removed
4-8	Water bypass tube removed
3-6	Water outlet removed

a. Removal

(1) Remove bolt (1), two bolts (2), three lockwashers (3), and flat washer (4) securing water pump (5) to engine front cover (6). Discard lockwashers.

CAUTION

Use care when removing water pump to prevent damage to gear teeth.

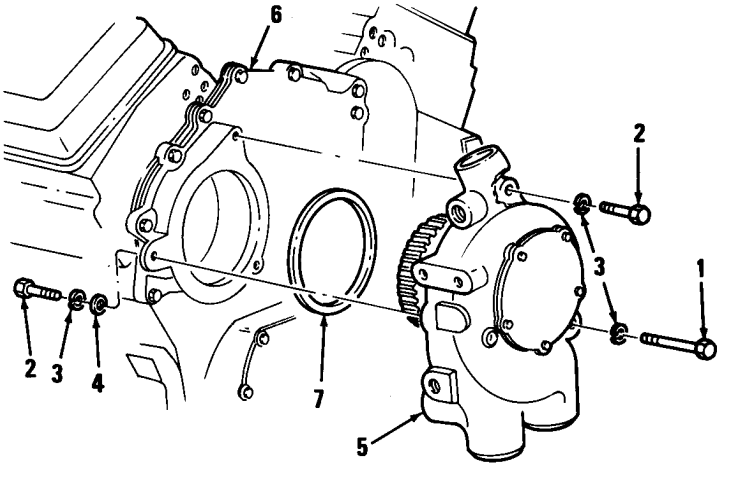
(2) Remove water pump (5) from engine front cover (6). Remove seal ring (7) and discard.

b. Installation

(1) Affix seal ring (7) to back of water pump (5).

(2) Install water pump (5), alining gear teeth with drive gear in engine front cover (6).

(3) Install bolt (1), two bolts (2), three lock- washers (3), and flat washer (4) securing water pump (5) to front cover (6). Torque bolts to 46-50 lb-ft (62-68 N-m).



c. Gear Backlash Adjustment

(1) Remove five bolts (8), pump cover (9), and gasket (10).

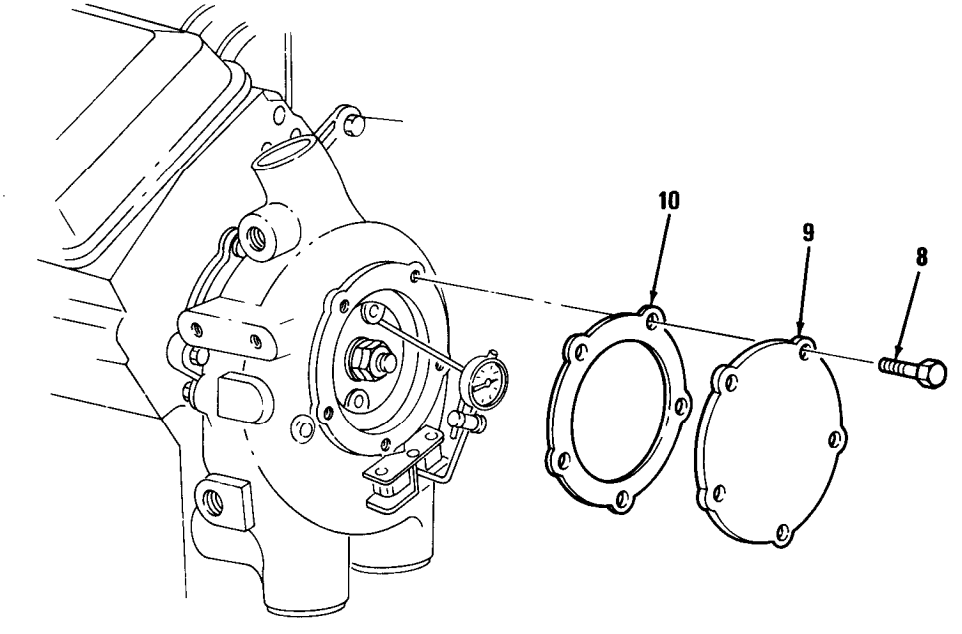
(2) Check gear backlash by installing a bolt or equivalent in impeller puller hole. Measure backlash with a dial indicator at this point. Backlash setting should be between 0.001 and 0.006 inch. If setting is not correct, loosen bolts (1 and 2); pivot water pump until proper setting is obtained. Tighten bolts (1 and 2).

(3) Install gasket (10), pump cover (9), and five bolts (8). Torque bolts to 13-17 lb-ft (1 8-23 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-8 Install water bypass tube
4-6 Install fuel line clip
4-4 Install fuel filter bracket
3-6 Install water outlet hose and elbow



4-10. AIR BOX HEATER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7396

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Test lead (App D, Item 1)

MANDATORY REPLACEMENT PARTS

1 Vane set (App F, Item 159)
1 Gasket (App F, Item 68)

MANDATORY REPLACEMENT PARTS

2 Lockwashers (App F, Item 90)
4 Lockwashers (App F, Item 89)
1 LockWasher (App F, Item 91)
2 LockWashers (App F, Item 92)
6 Lockwashers (App F, Item 93)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)

EQUIPMENT CONDITION

Para	Description
4-8	Left lifting bracket removed
4-9	Crossover tubes removed

AIR PUMP

a. Removal

(1) Disconnect hose (1) from check valve (2).

(2) Disconnect hose (3) from elbow (4) on air pump (5).

NOTE

Only model 7083-7396 has clamp (6) on hose (3) and uses an elbow (7) instead of an adapter (7).

(3) Remove screw assembly (8) and clamp (6) from governor cover. If necessary, remove adapter (7) and clamp from hose (3). Remove hose and reinstall screw assembly on cover.

(4) Remove nuts (9 and 10) securing wiring harness leads(11 and 12) to terminals (13 and 14) on air pump (5). Disconnect leads from pump.

(5) Remove bolt (15), lockwasher (16), flat washer (17), air pump clamp (18), cushion (19), and air pump (5) from bracket (20). Discard lockwasher.

(6) Remove hose (21) and check valve (2) from adapter (22). Remove hose from check valve.

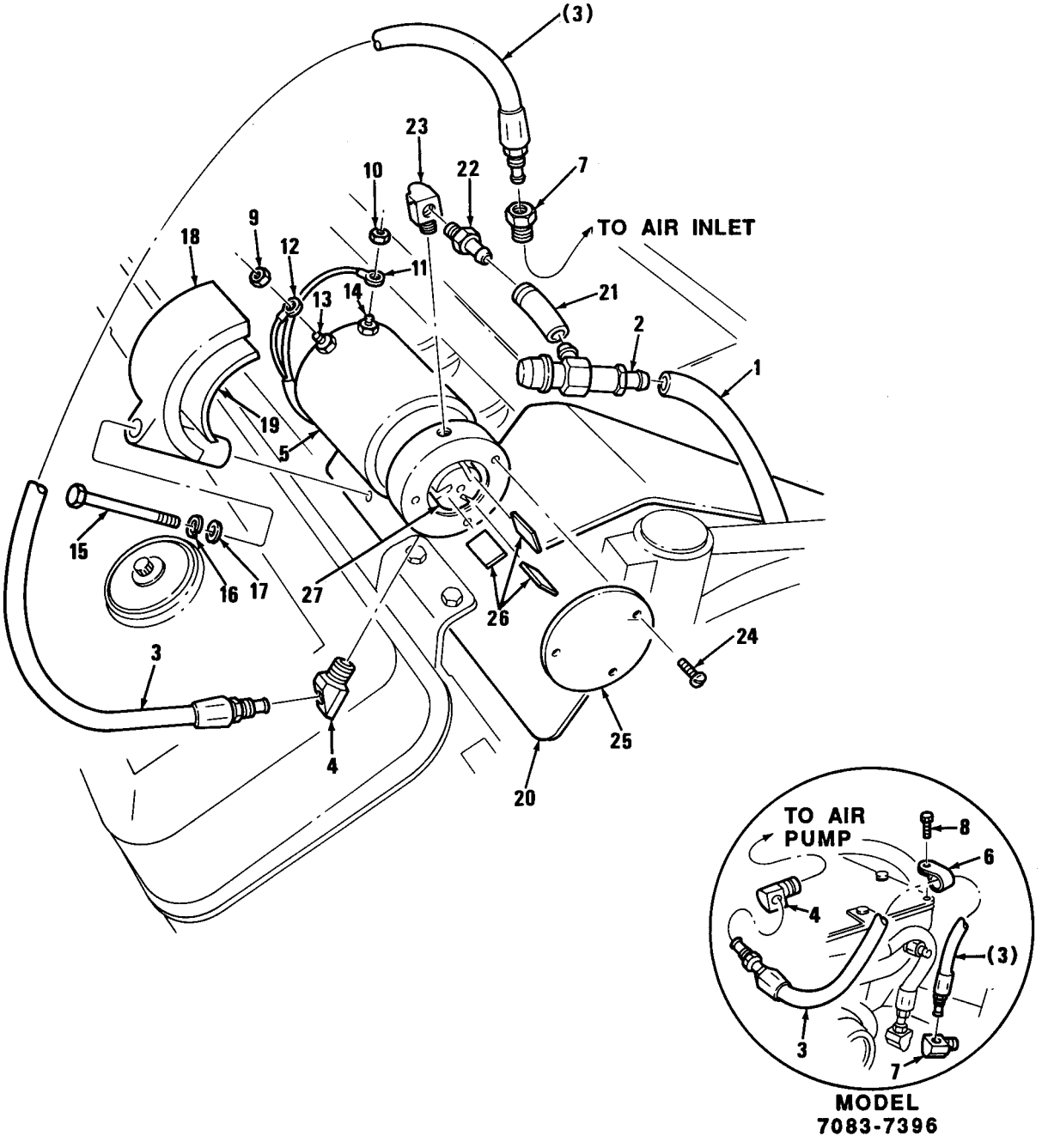
(7) Remove adapter (22) from elbow (23).

b. Disassembly

(1) If necessary, remove elbows (4 and 23) from air pump (5).

(2) Remove three screws (24) and cover (25) from air pump (5).

(3) Remove three vanes (26) from eccentric hub (27). Discard vanes.



4-10. AIR BOX HEATER REPLACEMENT (Cont)

c. Cleaning/inspection

WARNING

- **Dry cleaning solvent P-D-680 Is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated areas. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your 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 outside surface of pump with cleaning solvent and dry with compressed air.

(2) Inspect electrical terminals for damage or corrosion. Remove corrosion with a wire brush.

(3) Inspect pump rotor and body for excessive wear, corrosion, or other damage.

(4) Inspect air hose for cuts, tears, kinks, or damage.

d. Assembly

(1) Install three vanes (26) in eccentric hub (27).

(2) Install three screws (24) and cover (25) on air pump (5). Tighten screws securely.

(3) If removed, install elbows (4 and 23) to air pump (5).

e. Test/Adjustment

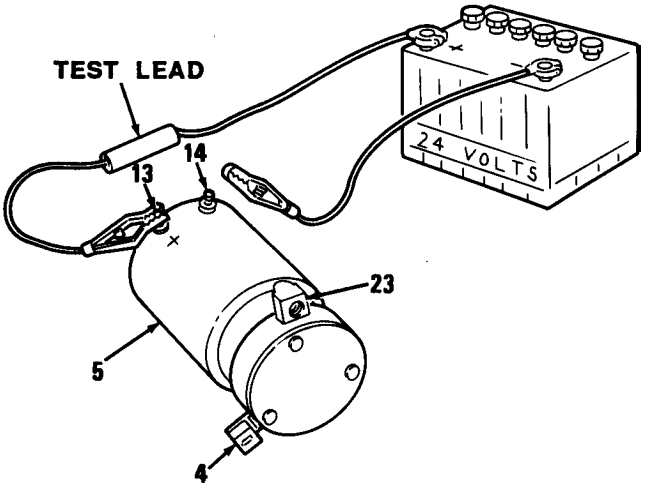
CAUTION

Do not exceed 18 V dc on air pump. Excessive voltage will overspeed air pump and damage pump vanes.

NOTE

Use fabricated test lead to reduce a 24 V dc power source to 18 V dc and connected in series with positive terminal of power source.

(1) Connect an 18 V dc power source to air pump (5). Connect positive lead to terminal (13) marked (+) and negative lead to unmarked terminal (14).



(2) Air pressure at outlet port elbow (23) should be 10 psi at 18 V dc. Pump should draw a maximum of 25 amperes.

(3) Remove power source from terminals (13 and 14).

f. Installation

(1) Install adapter (22) to elbow (23).

(2) Position air pump (5), cushion (19), and air pump clamp (18) on bracket (20). Install bolt (15), lockwasher (16), and flat washer (17). Torque bolt to 35-39 lb-ft (47-53 N-m).

(3) Install hose (21) and check valve (2) onto adapter (22).

(4) Connect hose (1) to check valve (2).

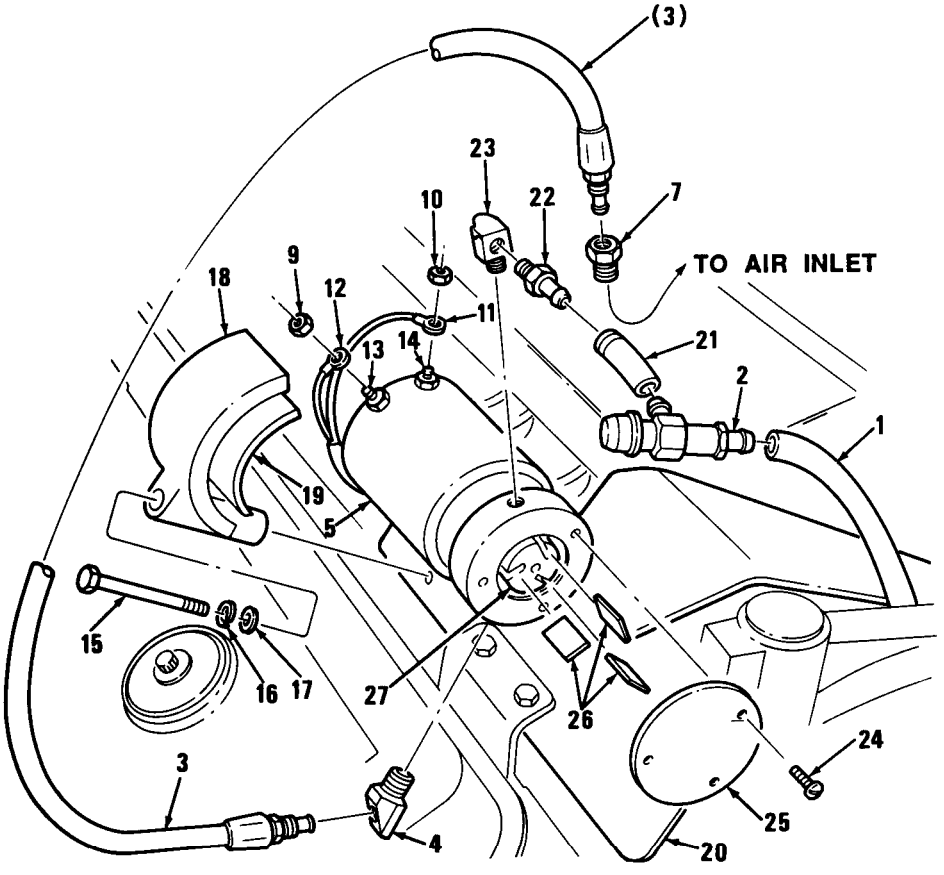
(5) Connect hose (3) onto elbow (4) of air pump (5).

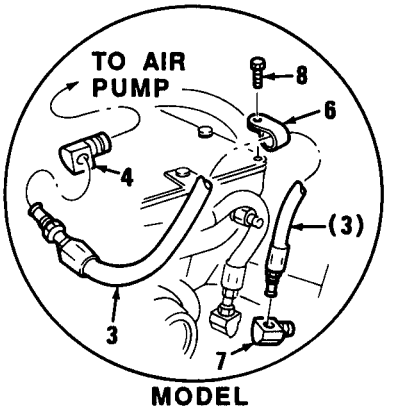
NOTE

Only model 7083-7396 has clamp (6) on hose (3) and uses an elbow (7) instead of an adapter (7).

(6) If removed, install adapter (7) and clamp (6) on hose (3). Secure clamp to governor cover using screw assembly (8).

(7) Connect large wiring harness lead (12) to terminal (13) marked (+) on air pump (5) and secure with nut (9). Connect wiring harness lead (11) to terminal (14) on pump and secure with nut (10).





MODEL 7083-7396

4-10. AIR BOX HEATER REPLACEMENT (Cont)

AIR BOX HEATER

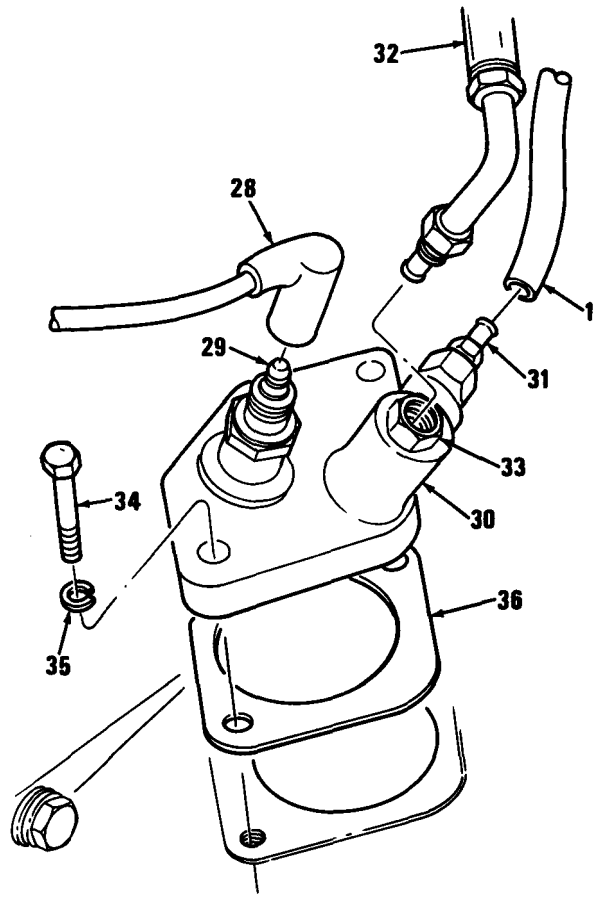
a. Removal

(1) Remove high tension lead (28) from electrode (29) on air heater assembly (30).

(2) Disconnect hose (1) from adapter (31) on air heater assembly (30). Remove hose.

(3) Disconnect hose (32) from connector (33) on air heater assembly (30).

(4) Remove two bolts (34), two lockwashers (35), air heater assembly (30), and gasket (36) from block. Discard gasket and lockwashers. Discard lockwasher.



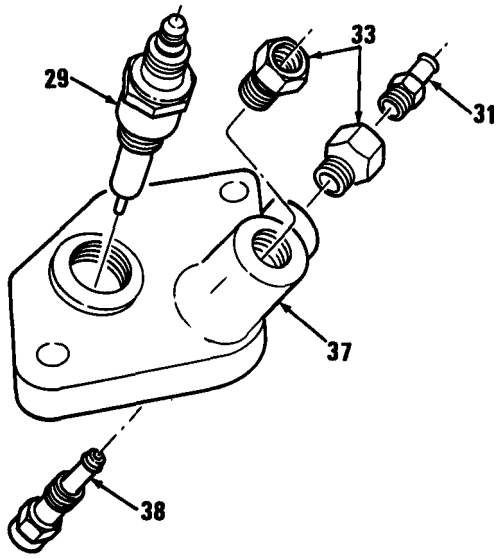
b. Disassembly

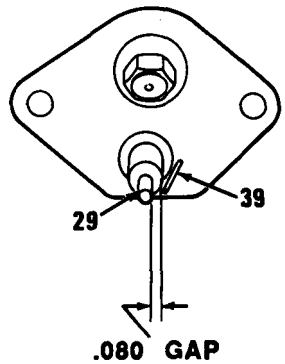
(1) Unscrew electrode (29) from air heater body (37).

(2) Remove fuel injector nozzle (38) from air heater body (37).

(3) Remove adapter (31) from connector (33).

(4) Remove two connectors (33) from air heater body (37).





c. Cleaning/inspection

WARNING

- **Dry cleaning solvent P-D-680 Is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated areas. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point 100 °F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes Is made, wash your 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 air heater body and fuel injector nozzle with cleaning solvent and dry with compressed air.

(2) Inspect electrode, fuel injector nozzle, and air heater body for cracks, pitting, or wear.

d. Assembly

(1) Install two connectors (33) into air heater body (37).

(2) Install adapter (31) into connector (33).

(3) Install fuel injector nozzle (38) into air heater body (37).

(4) Screw electrode (29) into air heater body (37).

e. Test/Adjustment

Using gap gages, adjust wire (39) to electrode (29) to obtain air gap of 0.080 inch.

f. Installation

NOTE

Do not install air box heater body on engine until all ignition coil testing is complete.

(1) Install two bolts (34), two lockwashers (35), air heater assembly (30), and gasket (36) onto block. Torque bolts to 13-17 lb-ft (1 8-23 N-m).

(2) Connect hose (1) to adapter (31) on air heater assembly (30).

NOTE

Test air nozzle assembly (38) by applying power (18 V dc) to air pump and feel for suction at fuel line connector (33). If no suction is felt, replace air nozzle assembly.

(3) Connect hose (32) to connector (33) on air heater assembly (30).

(4) Connect high tension lead (28) to electrode (29).

4-10. AIR BOX HEATER REPLACEMENT (Cont)

IGNITION COIL

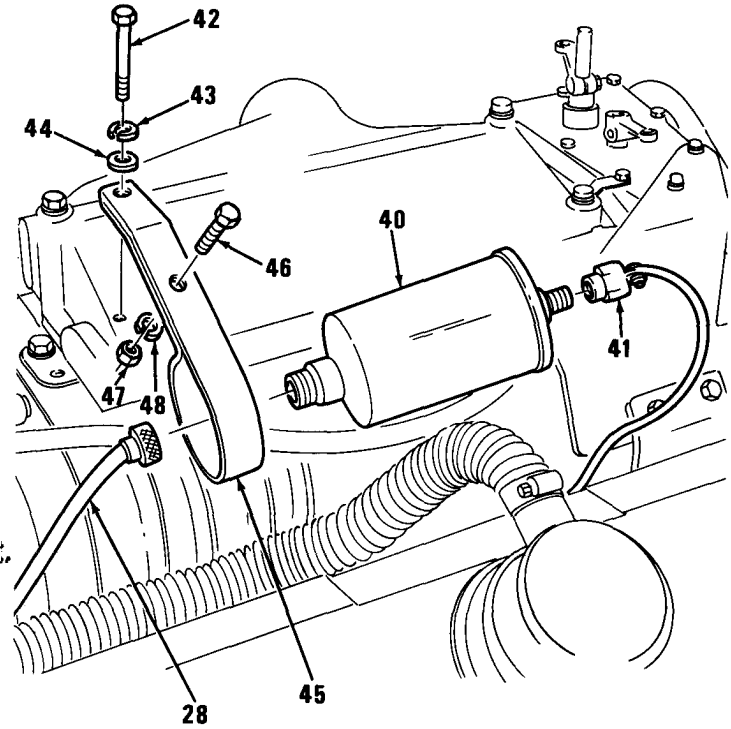
a. Removal

(1) Disconnect high tension lead (28) from ignition coil (40). Remove lead.

(2) Disconnect wiring harness connector (41) from ignition coil (40).

(3) Remove bolt (42), lockwasher (43), and flat washer (44) securing bracket (45) and ignition coil (40) to air inlet housing. Remove coil and bracket as an assembly. Discard lockwasher.

(4) Remove bolt (46), nut (47), and lockwasher (48) from bracket (45). Remove ignition coil (40) from bracket. Discard lockwasher.



c. Cleaning/inspection

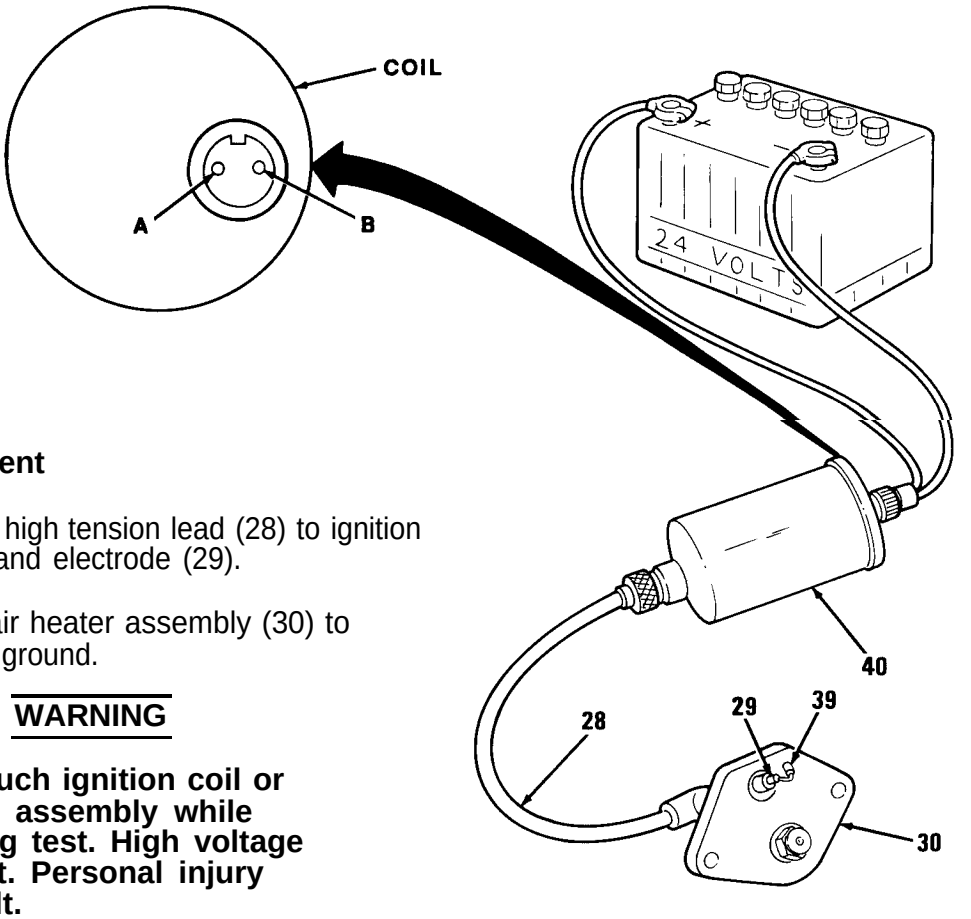
WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in well-ventilated areas. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your 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 outside surface with cleaning solvent and dry with compressed air.

(2) Inspect ignition coil for oil seepage or damage to electrical connectors.



e. Test/Adjustment

(1) Connect high tension lead (28) to ignition coil (40) and electrode (29).

(2) Connect air heater assembly (30) to common ground.

WARNING

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

CAUTION

- Do not apply voltage to ignition coil without a coil to air heater connection. Coil and air heater must be grounded.
- Apply positive lead to pin (A) and negative lead to pin (B) or damage to coil will result.

(3) Connect a 24 V dc power source to the coil input side of ignition coil (40). Observe electric arc between electrode (29) and wire (39). Arc "may be steady or intermittent (about ten pulses a second) with a popping noise.

(4) Disconnect power source to coil (40) and remove lead (28).

(5) Disconnect air heater assembly (30) from common ground.

f. Installation

(1) Insert ignition coil (40) into bracket (45). Secure with bolt (46), lockwasher (48), and nut (47). Torque bolt to 7-9lb-ft(10-12 N-m).

(2) Position coil (40) and bracket (45) on air inlet housing. Secure with bolt (42), lockwasher (43), and flat washer (44). Torque bolt to 16-20 lb-ft (22-27 N-m).

(3) Connect high tension lead (28) to ignition coil (40).

4-10. AIR BOX HEATER REPLACEMENT (Cont)

SOLENOID VALVE AND BRACKET

a. Removal

NOTE

- Remove air pump, ignition coil, and air box heater before removing solenoid valve and bracket.
- Only model 7083-7396 has no clamp (6) on hose (50) and uses a connector (49) instead of an elbow (49) on the solenoid valve inlet.

(1) Disconnect fuel hoses (50 and 32) from elbows (49 and 51) on solenoid valve (52). Remove screw assembly (8) and clamp (6) from governor cover. Reinstall screw assembly.

NOTE

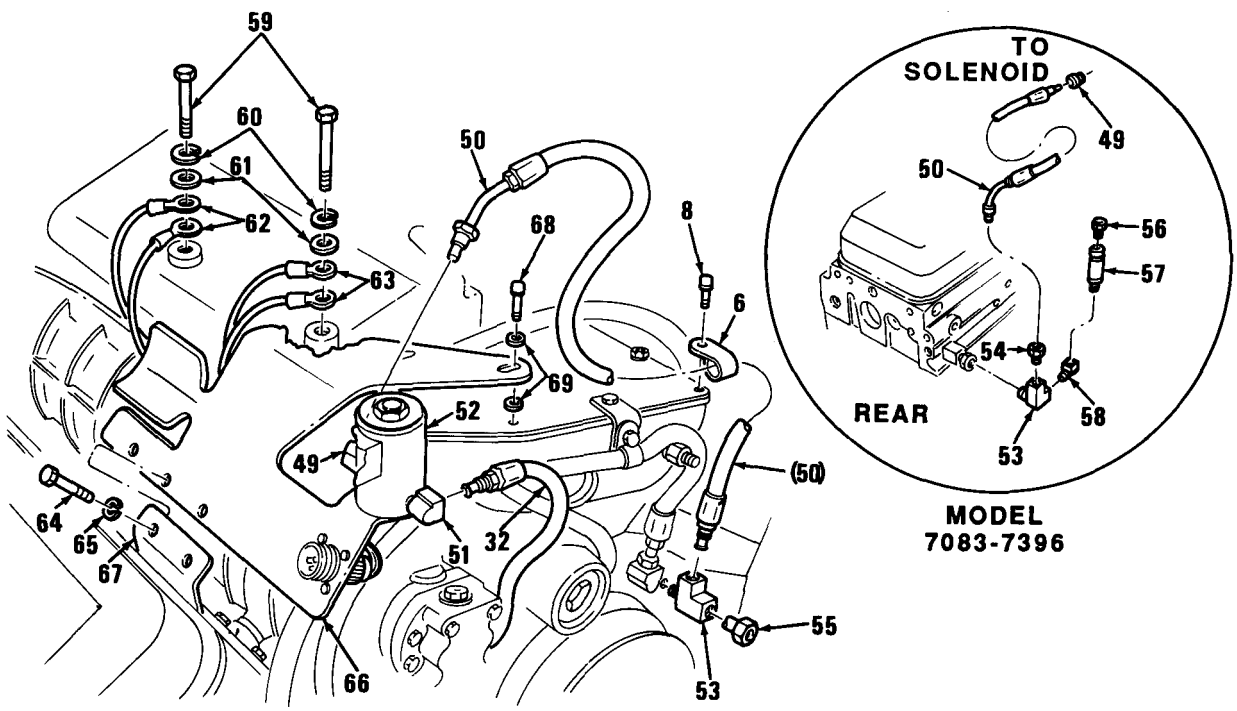
Tee (53) is on the front of left cylinder head on model 7083-7395 and on the rear inboard side of left cylinder head on model 7083-7396.

(2) For model 7083-7395, disconnect hose (50) from tee (53) on left cylinder head. If necessary, remove clamp (6) from hose. Remove hose.

(3) For model 7083-7396, disconnect hose (50) from connector (54) on left cylinder head. Remove connector from tee (53). Remove hose.

(4) For model 7083-7396, remove connector (55) from tee (53).

(5) For model 7083-7396, remove connector (56), check valve (57), elbow (58) from tee (53).



(6) Remove tee (53) from left cylinder head.

(7) Remove two bolts (59), two lockwashers (60), and two flat washers (61) securing two wiring harness leads (62 and 63) to air inlet housing. Remove leads and discard lockwashers.

(8) Remove two bolts (64) and two lockwashers (65) securing solenoid valve and bracket assembly (66) to support (67).

(9) Remove two screw assemblies (68) and four flat washers (69) securing solenoid valve and bracket assembly (66) to governor housing. Remove assembly.

b. Disassembly

(1) Disconnect wiring harness connector (70) from solenoid valve (52).

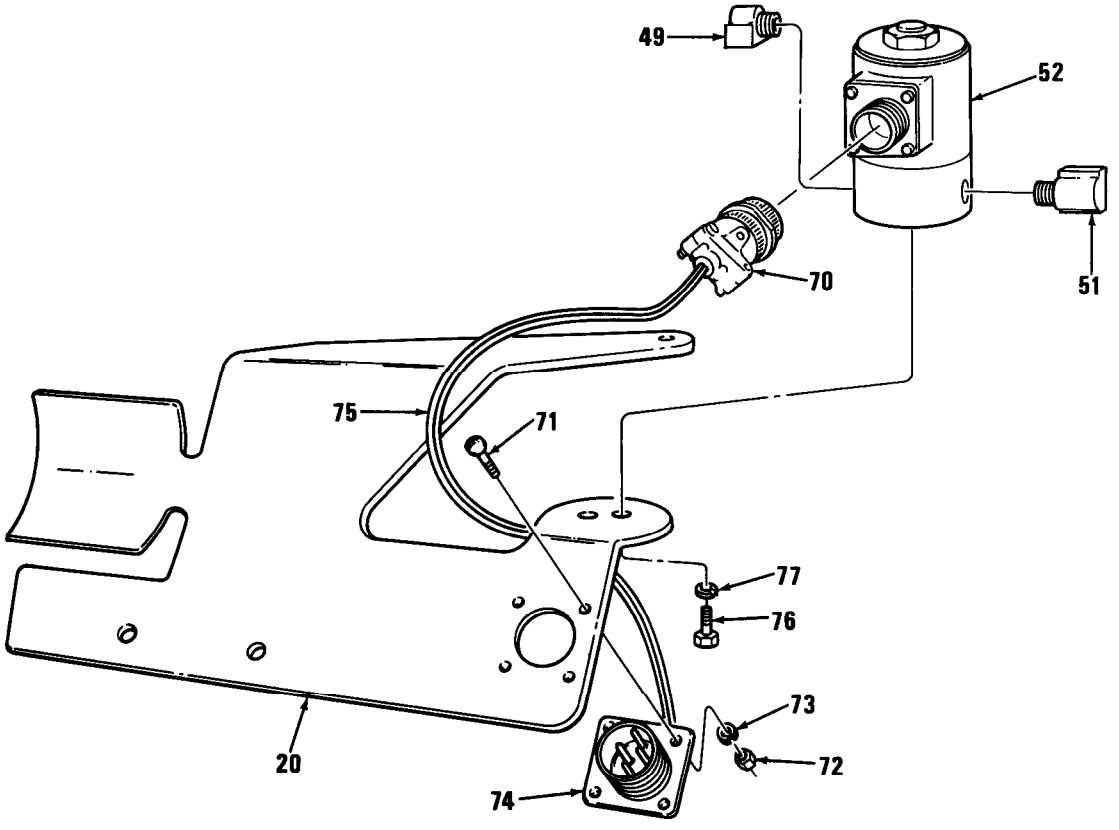
(2) Remove four screws (71), four nuts (72), and four lockwashers (73) securing wiring harness connector (74) to bracket (20). Remove wiring harness (75). Discard lockwashers.

(3) Remove two screws (76) and two lockwashers (77) securing solenoid valve (52) to bracket (20). Remove solenoid valve. Discard lockwashers.

NOTE

Model 7083-7396 uses a connector instead of an elbow for item (49) on the solenoid valve inlet.

(4) Remove elbows (49 and 51) from solenoid valve (52).



4-10. AIR BOX HEATER REPLACEMENT (Cont)

c. Cleaning/inspection

WARNING

- **Dry cleanlng solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only In well-ventilated areas. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point Is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your 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 solenoid valve and bracket with cleaning solution. Dry with compressed air.

(2) Inspect fuel hoses for cuts, tears, kinks, or damage.

(3) Inspect wiring harness for cuts, tears, burns, or damage.

d. Assembly

(1) Install two screws (76), two lockwashers (77), and solenoid valve (52) to bracket (20). Tighten securely.

NOTE

Model 7083-7396 uses a connector instead of an elbow for item (49) on the solenoid valve inlet.

(2) Install elbows (49 and 51) to solenoid valve (52). Tighten securely.

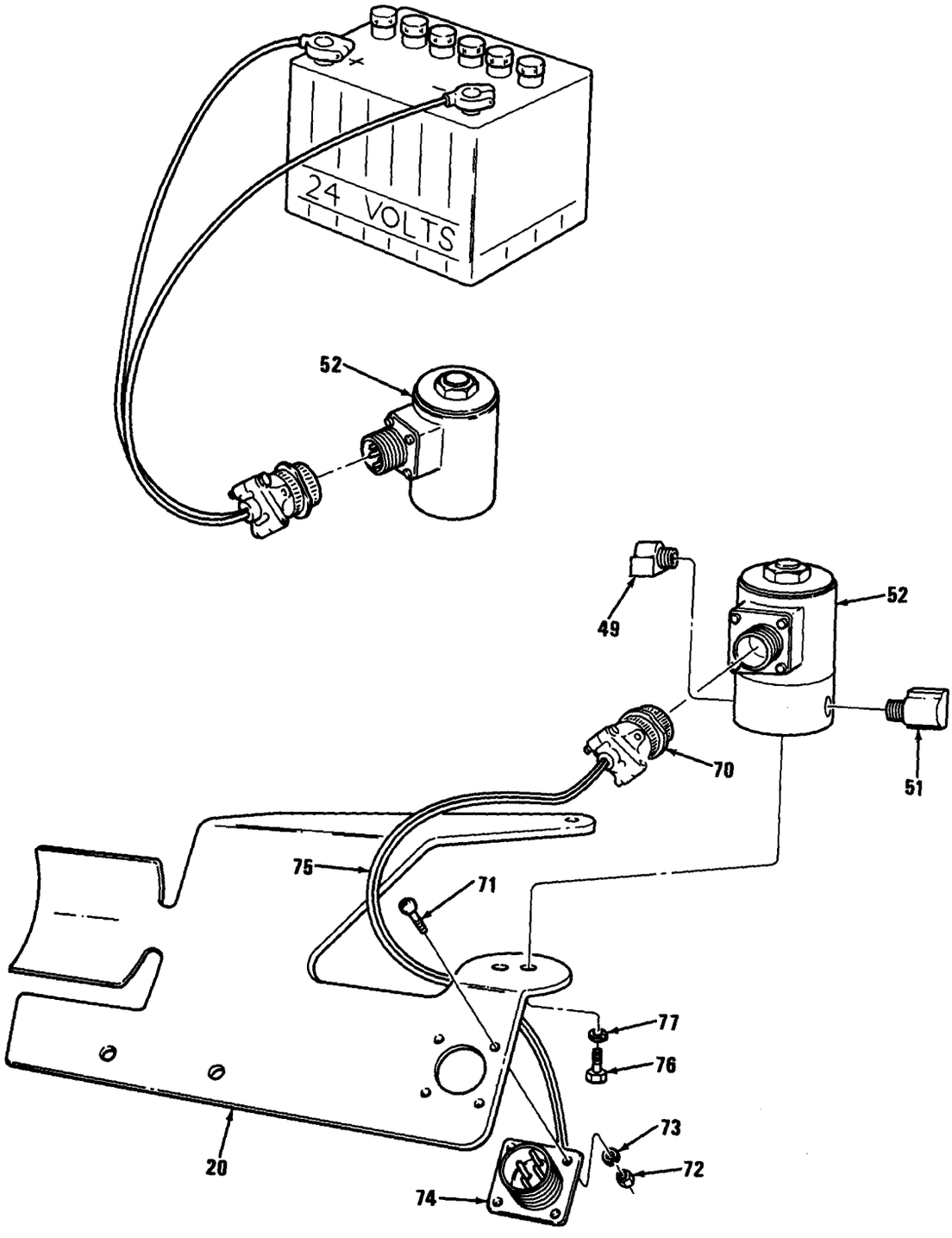
(3) Install four screws (71), four lockwashers (73), and four nuts (72) securing wiring harness connector (74) to bracket (20).

(4) Screw wiring harness connector (70) onto solenoid valve (52).

e. Test/Adjustment

(1) Connect fabricated test lead to terminal on solenoid valve (52). Apply a 24 V dc power source and listen or feel to confirm valve is opening and closing as power is applied. If no indication of movement is present, replace solenoid valve.

(2) Disconnect power source and test lead from solenoid valve (52).


24 VOLTS
52
49
52
70
51
75
71
77
76
73
72
74
20

4-10. AIR BOX HEATER REPLACEMENT (Cont)

f. Installation

(1) Secure wiring harness connectors (62 and 63) to air inlet housing with two bolts (59), two lockwashers (60), and two flat washers (61). Torque bolts to 16-20 lb-ft (22-27 N-m).

(2) Install hose (50) onto elbow (49) on solenoid valve (52).

(3) Position solenoid valve and bracket assembly (66) on governor housing and inboard of bracket (67). Route harness wiring to prevent cuts, chaffing, burns, or interference with components. Loosely secure assembly to governor housing with two screw assemblies (68) and four flat washers (69).

(4) Install two bolts (64) and two lockwashers (65) securing solenoid valve and bracket assembly (66) to support (67). Torque bolts to 30-35 lb-ft (41 -47 N-m). Tighten two screw assemblies (68).

NOTE

- Tee (53) is on the front of the left cylinder head on model 7083-7395 and on the inside rear of the left cylinder head on model 7083-7396.
- For model 7083-7396, position arms of tee (53) at 12 o'clock and 3 o'clock positions.

(5) Install tee (53) into left cylinder head.

(6) For model 7083-7395, install connector (55) to tee (53).

(7) For model 7083-7396, install elbow (58), check valve (57), and connector (56) to tee (53).

NOTE

Model 7083-7396 has no clamp (6) on hose (50) and uses a connector (49) instead of an elbow (49) on the solenoid inlet.

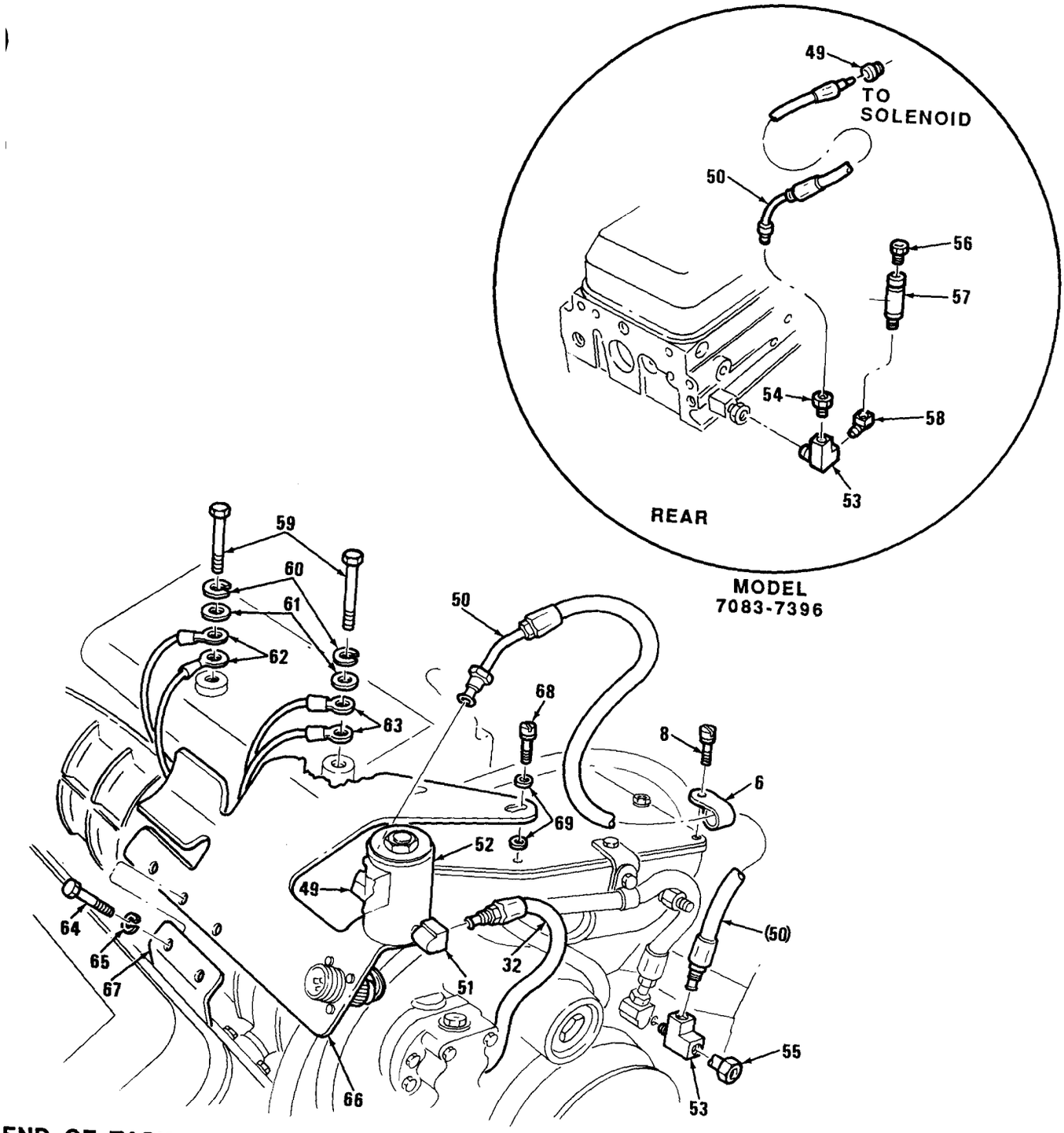
(8) For model 7083-7395, install hose (50) into tee (53) on left cylinder head. If removed, install clamp (6) on hose (50) and secure to governor cover using screw assembly (8).

(9) For model 7083-7396, install hose (50) into connector (54) in tee (53) on left cylinder head.

(10) Install hose (32) onto elbow (51) on solenoid valve (52).

NOTE

Install air pump, ignition coil, and air box heater after installation of solenoid valve and bracket.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-9	Crossover tubes installed
4-8	Left rear lifting bracket installed

4-11. ENGINE ROCKER ARM COVER AND CRANKCASE BREATHER REPLACEMENT

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

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Gaskets (App F, Item 24)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)

EQUIPMENT CONDITION

Para	Description
4-13	Air inlet housing removed (7083-7399)
5 - 2	Air inlet tube removed (7083-7396)

NOTE

This procedure is for the left bank. Removal and installation for the right bank is similar except the right bank has no oil fill hole. Repeat the same steps for the right bank except those involving the filler cap, cap chain, chain hook, and sediment strainer.

a. Removal

(1) Remove hose clamp (1) securing breather hose (2) to breather (3). Remove hose.

(2) Remove two bolts (4 and 5), two flat washers (6), and two resilient mounts (7) securing rocker arm cover (8) to cylinder head. Remove rocker arm cover.

(3) Remove rocker arm cover gasket (9) from rocker arm cover (8).

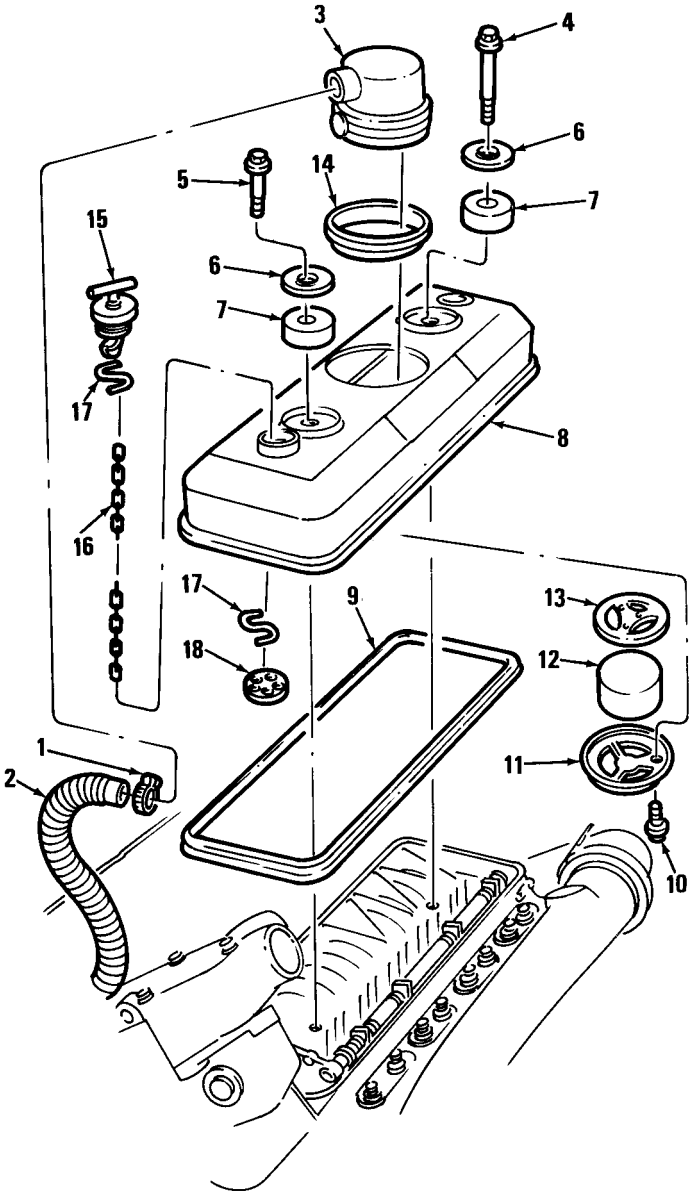
(4) Remove three screws (10) securing filtering disk retainer(11), fluid filtering disk (12), and breather retainer (13) to breather (3).

(5) Remove seal (14) from rocker arm cover (8).

(6) Unscrew and remove filler cap (15) and cap chain (16) from rocker arm cover (8).

(7) Remove cap chain (16) and chain hook (17) from filler cap (15).

(8) If necessary, drive sediment strainer(18) out of rocker arm cover (8). Remove sediment strainer from chain hook (17).



4-11. ENGINE ROCKER ARM COVER AND CRANKCASE BREATHER REPLACEMENT (Cont)

b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

(1) Clean rocker arm cover with cleaning solvent. Inspect cover for cracks, dents, 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.)

(2) **Dry rocker** arm cover with compressed air,

(3) Inspect fluid filtering disk and sediment strainer. Clean or repair as necessary.

(4) Inspect seal and gasket for cracks, deformation, or wear.

(5) Inspect breather hose for cracks, tears, or damage.

c. Installation

(1) Install seal (14) on rocker arm cover (8).

(2) Install breather (3) to rocker arm cover (8).

(3) Install breather retainer (13), fluid filtering disk (12), and filtering disk retainer (11) to breather (3). Secure with three screws (1 O).

(4) Install chain hook (17) and cap chain (16) to filler cap (15).

(5) If removed, press sediment strainer(18) into rocker arm cover (8). Install chain hook(17) to sediment strainer and cap chain (16). Crimp hook to secure on chain.

(6) Install gasket (9) into four corners of rocker arm cover (8). Press remainder of gasket into rocker arm cover.

NOTE

- Rocker arm cover with oil filler is installed on left side with filler toward fronton models 7083-7395 and 7083-7398. For models 7083-7391, 7083-7396, and 7083-7399, install rocker arm cover on right side with oil filler toward rear.
- When gasket is properly installed, it should not fall out of rocker arm cover.

(7) Lubricate surface of gasket (9) with a thin film of engine oil.

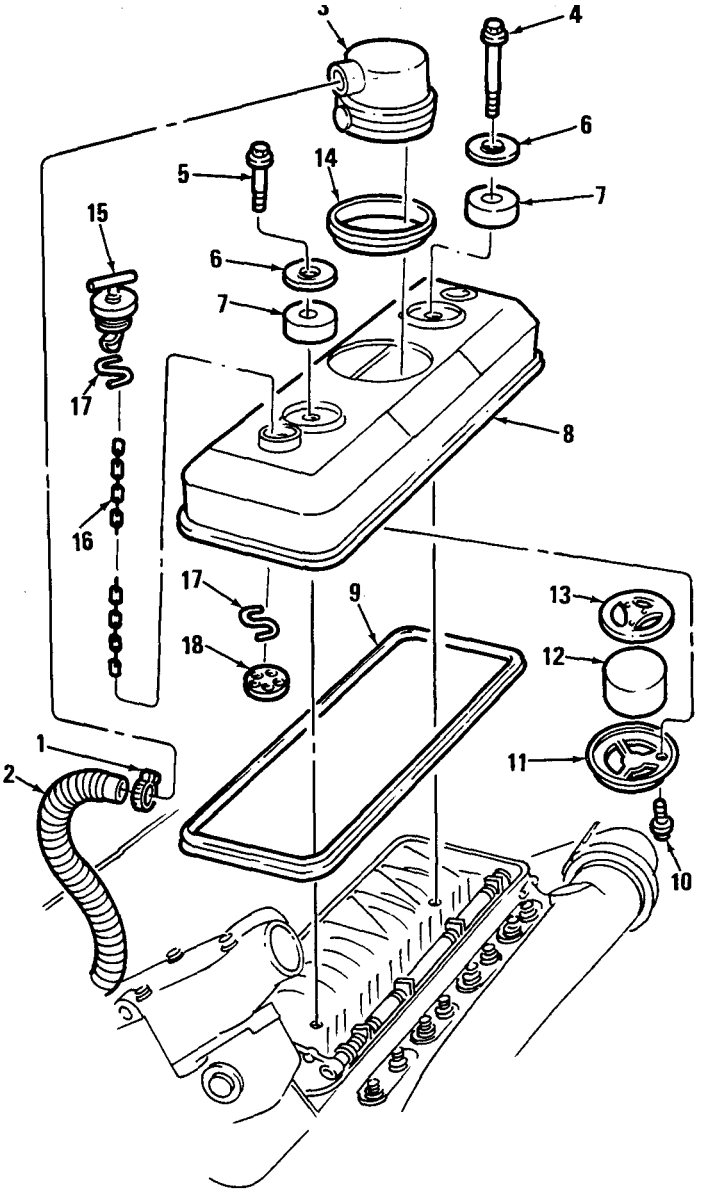
(8) Install rocker cover (8) to cylinder head.

(9) With rocker arm cover (8) properly alined and seated on cylinder head, install two bolts (4 and 5), two flat washers (6), and two resilient mounts (7).

(10) Torque bolts (4 and 5) to 15-20 lb-ft (20-27 N-m).

(11) Install and tighten filler cap (15) to rocker arm cover (8).

(12) Install breather hose (2) to breather (3) and secure with hose clamp (1). Tighten clamp securely.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-2 Install air inlet tube (7083-7396)
4-13 Install air inlet housing (7083-7399)

4-12. 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

General mechanics tool kit (App B, Item 96)
Oil seal remover (App B, Item 97)
Installer handle (App B, Item 97)
Adapter (App B, Item 97)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F,Item 72)
4 Lockwashers (App F,Item 91)
1 Gasket (App F, Item 70)
2 Seals (App F, Item 147)

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)
Engine oil (App C, Item 16)
Sealant (App C, Item 39)

EQUIPMENT CONDITION

Para	Description
4-6	Fuel lines removed (7083-7395 and 7083-7398)
4-8	Thermostat housing and crossover tubes removed (Except on 7083-7391, 7083-7396, and 7083-7399)
5-4	Fuel lines removed (7083-7396 and 7083-7399)
5.1-4	Fuel lines removed (7083-7391)

a. Removal

(1) Remove three bolts (1)securing fuel pump assembly (2) and gasket (3) to governor. Remove fuel pump assembly and discard gasket.

(2) Remove drive coupling fork (4) from drive shaft (5).

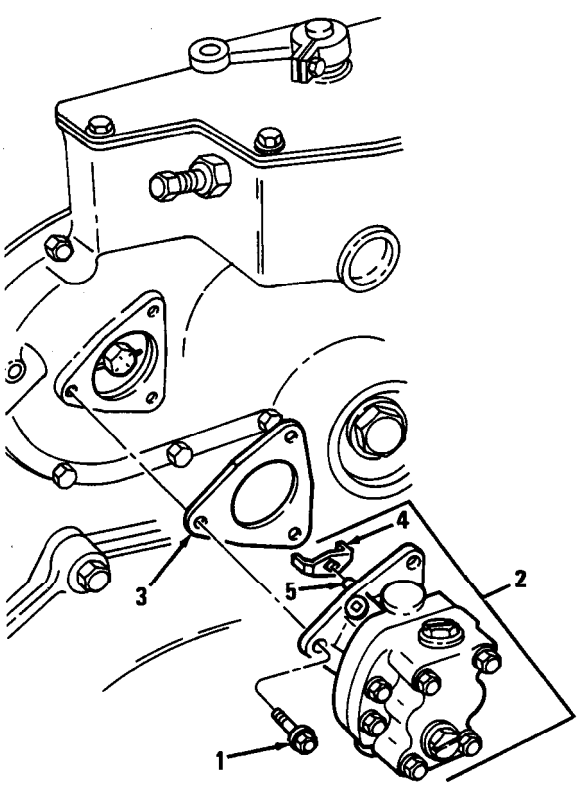
b. Disassembly

(1) Place fuel pump assembly in a soft-jawed vise. Remove four bolt and lockwasher assemblies (6) securing pump body cover (7) to fuel pump body (8).

(2) Remove four bolts (9) and four lockwashers (10) securing pump body cover (7) to fuel pump body (8). Separate cover and body. Discard lockwashers.

(3) Remove drive shaft (5) and drive gear (11).

(4) Remove driven gear assembly (12).



NOTE

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

(5) Press drive shaft (5) far enough to remove check ball (13). Invert drive shaft (5), and press drive gear (11) off from round end of drive shaft (5). Remove drive gear.

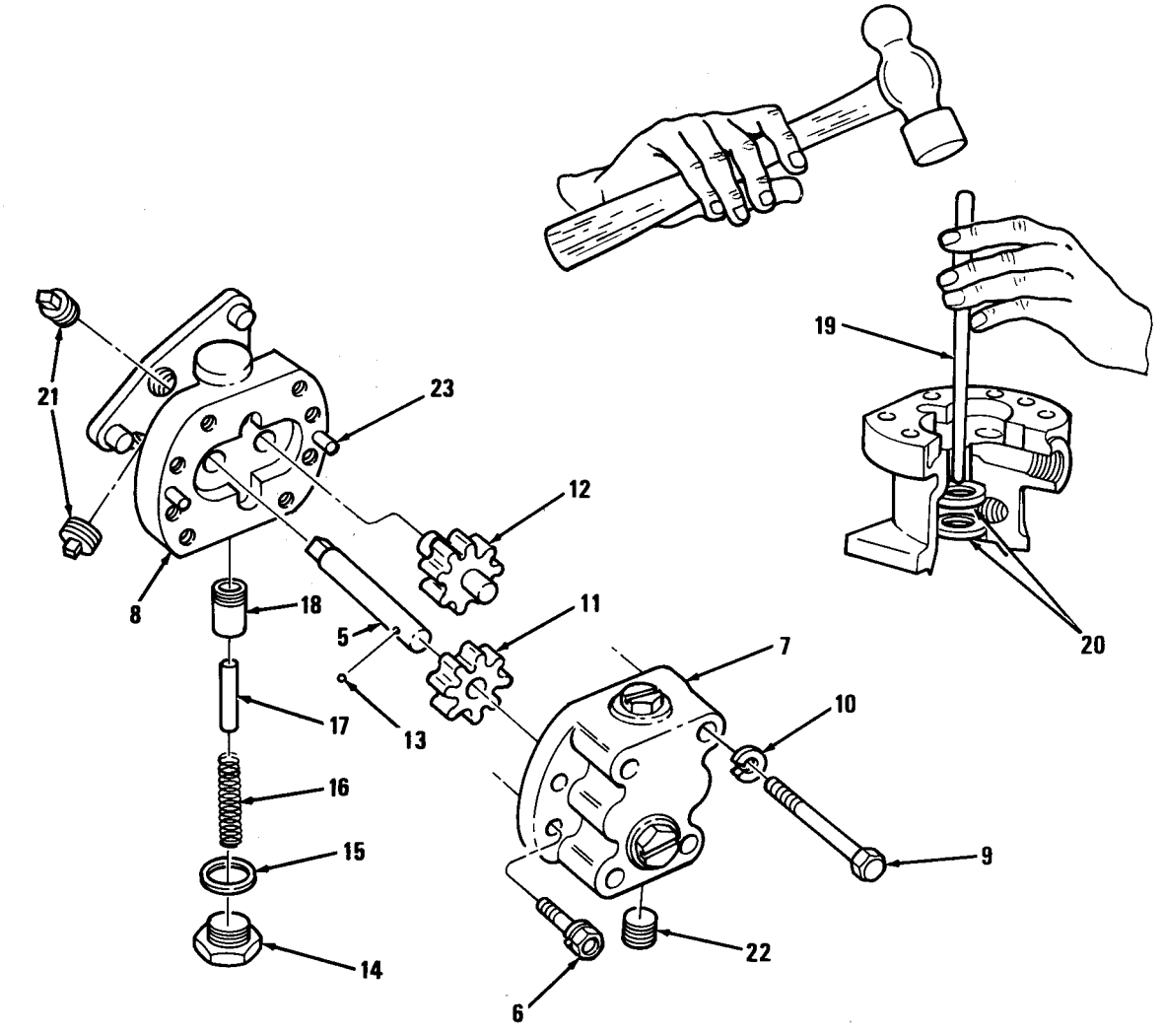
(6) Unscrew plug (14). Remove gasket (15), spring (16), straight pin (17), and relief valve (18) from fuel pump body (8). Discard gasket.

(7) Using seal remover (19), remove two oil seals (20) from fuel pump body (8). Discard seals.

(8) If necessary, unscrew two pipe plugs (21) from fuel pump body (8).

(9) If necessary, unscrew pipe plug (22) from pump body cover (7).

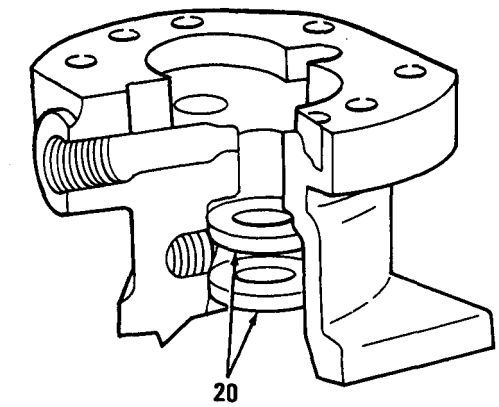
(10) If necessary, remove two straight pins (23) from fuel pump body (8).



4-12. FUEL PUMP REPLACEMENT (Cont)

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 equipment (goggles/shieid, gloves, etc.).

(2) Dry all parts with compressed air.

(3) Inspect drive gear and drive shaft for scoring, burrs, or wear.

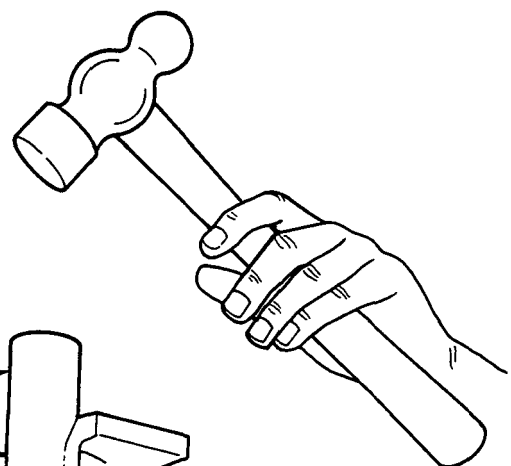
(4) Inspect driven gear assembly for scoring, burrs, or wear.

NOTE

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

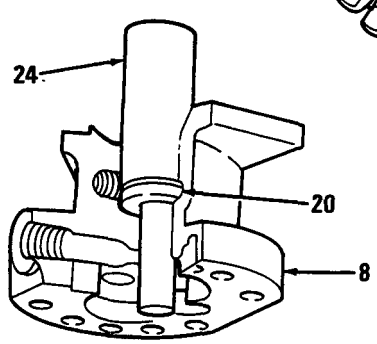
(5) Inspect fuel pump body and pump body cover carefully for scratches, nicks, or burrs.

(6) inspect relief valve for scoring or burrs.



d. Assembly

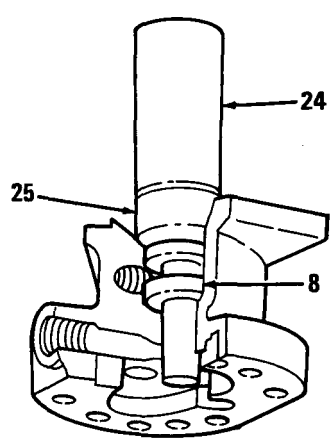
(1) Lubricate oil seals (20) with a thin coat of clean engine oil or vegetable shortening.



NOTE

Install new oil seals with seal lips facing each other. Refer to illustration on right.

(2) Support fuel pump body (8) on wood blocks. Using installer (24), install inner oil seal (20) into fuel pump body (8).



(3) Using adapter (25), install outer seal (20) into fuel pump body (8).

(4) Lubricate outside diameter of relief valve (18) with clean engine oil. Insert valve into fuel pump body (8) with hollow end of valve facing outward.

(5) Install spring (16) and straight pin (17) into relief valve (18).

(6) Install gasket (15) on plug (14) and screw into fuel pump body (8). Torque plug to 18-22 lb-ft (24-30 N-m).

(7) If removed, install two pipe plugs (21) into fuel pump body (8).

(8) If removed, install pipe plug (22) into pump body cover (7).

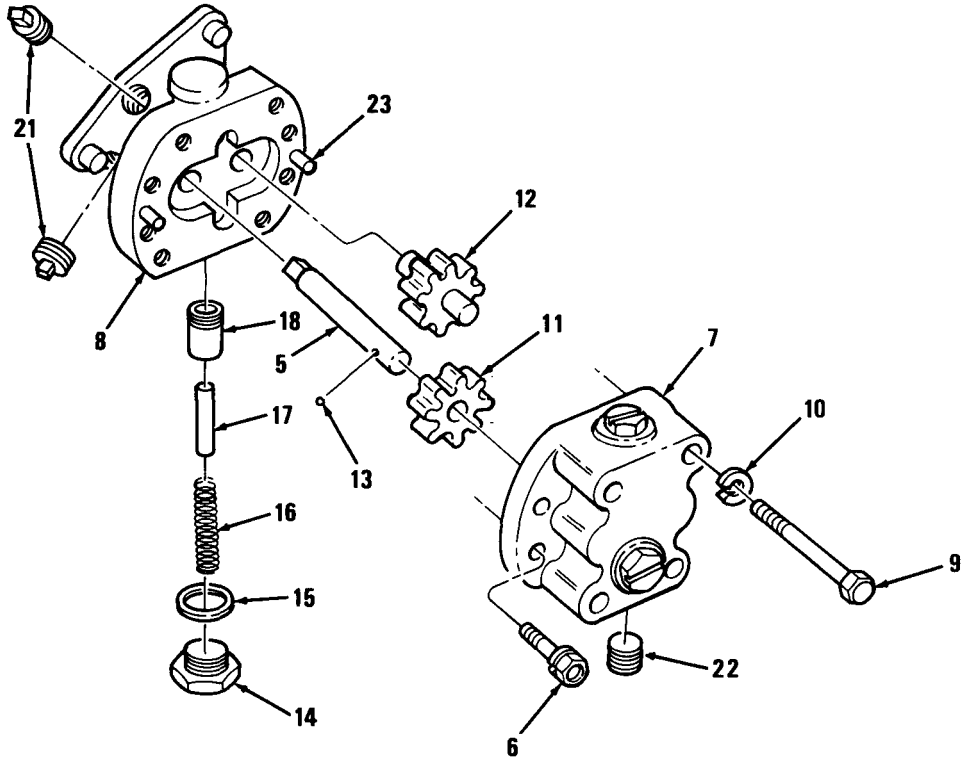
(9) If removed, install two straight pins (23) into fuel pump body (8).

NOTE

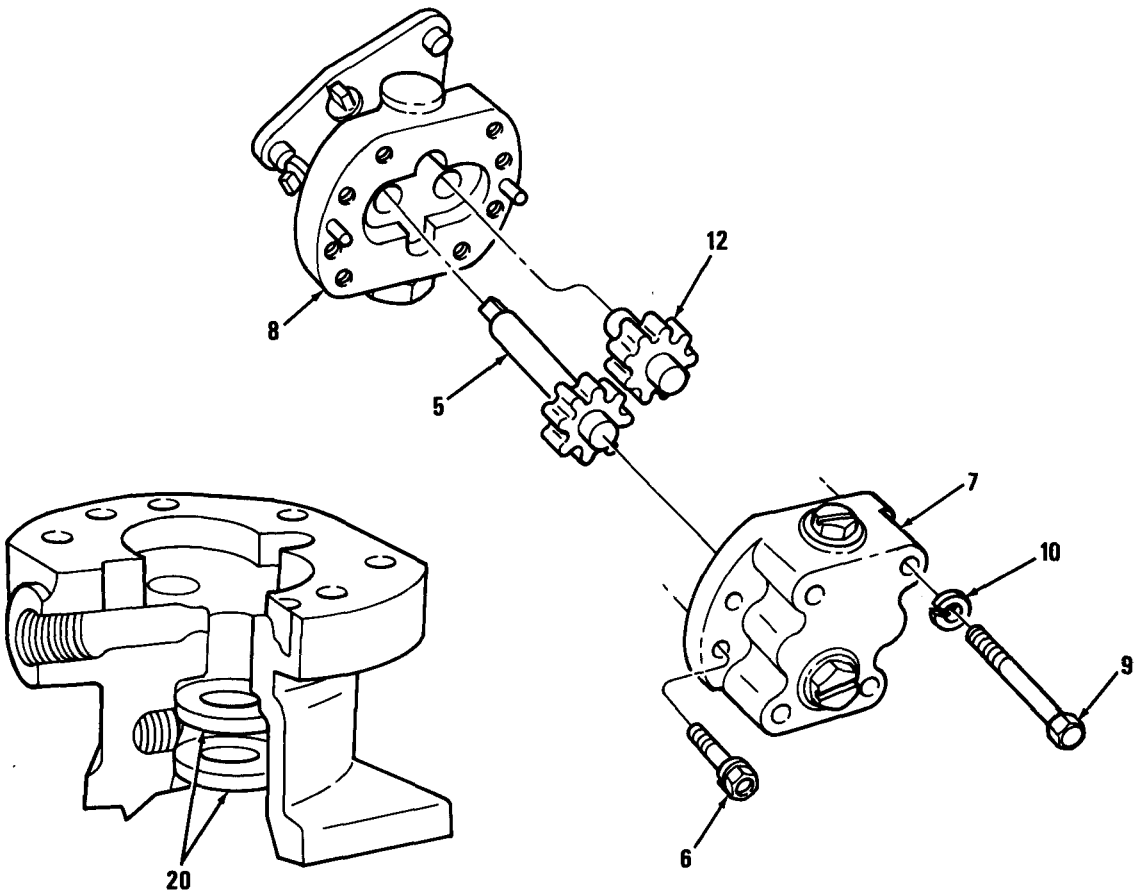
Install drive gear with slot facing round end of drive shaft.

(10) Install drive gear(11) on round end of drive shaft (5). Press drive gear beyond check ball (13) detent on drive shaft (5).

(11) Install check ball (13) into drive shaft (5) detent. Invert drive shaft and press drive gear (11) until slot of gear contacts check ball.



4-12. FUEL PUMP REPLACEMENT (Cont)



(12) Lubricate drive shaft (5) with clean engine oil. Insert square end of drive shaft (5) from gear side of fuel pump body (8) through oil seals (20).

NOTE

If driven gear assembly is chamfered, install gear facing fuel pump body. If driven gear assembly has a slot, install gear so slot faces pump body cover.

(13) Install driven gear and shaft assembly (12) in fuel pump body (8).

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

(15) Apply a very thin coat of sealant on pump body cover (7) surface. Do not allow sealant to enter gear compartment.

(16) Aline fuel pump body (8) with pump body cover (7). Secure with four bolt and lockwasher assemblies (6).

(17) Install four bolts (9) and four lockwashers (10). Tighten all bolts alternately and evenly. Torque bolts to 7-9 lb-ft (10-12 N-m).

(18) Rotate drive shaft (5) by hand. Shaft should rotate freely. If not, gently tap corner of fuel pump body (8) with hammer to free up.

e. Installation

(1) Install gasket (3) on fuel pump body (8).

(2) Install drive coupling fork (4) on square end of drive shaft (5).

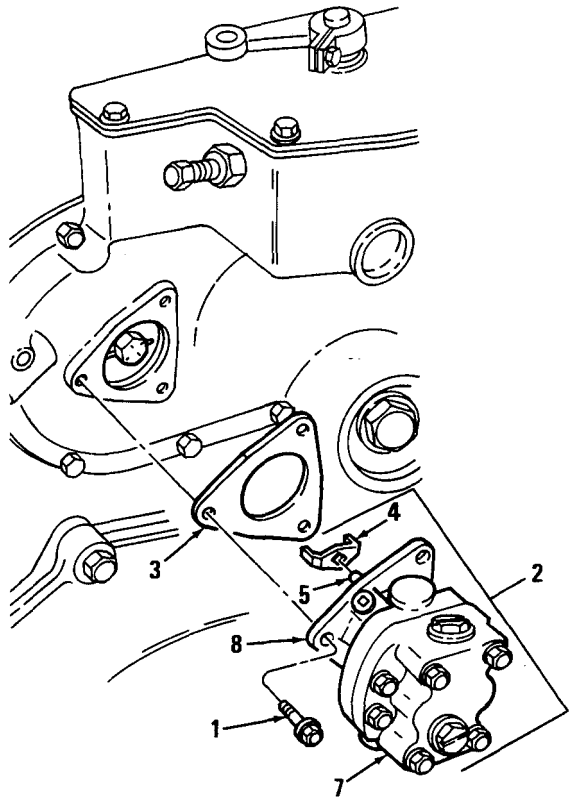
(3) Position inlet opening on pump body cover (7) (marked L.H. IN) facing down.

(4) Install fuel pump assembly (2) to governor housing.

NOTE

Insure drive coupling fork (4) is alined and contacts slots in the drive disc.

(5) Install three bolts (1) securing fuel pump assembly (2) to governor housing. Torque bolts to 13-17 lb-ft (18-23 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-8 Thermostat housing and crossover tubes installed (Except on 7083-7391, 7083-7396, and 7083-7399)
4-6 Fuel lines installed (7083-7395 and 7083-7398)
5-4 Fuel lines installed (7083-7396 and 7083-7399)
5.1-4 Fuel lines installed (7083-7391)

4-13. AIR INLET HOUSING REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7396
7083-7398 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

3 Lockwashers (App F, Item 93)
1 Gasket (App F, Item 23)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)

EQUIPMENT CONDITION

Para	Description
4-2	Air inlet tube removed (7083-7395)
4-10	Air box heater removed (7083-7395 and 7083-7396)
5-2	Air inlet tube removed (7083-7396)
6-3	Air inlet tube removed (7083-7398)

a. Removal

(1) Remove three bolts (1), three flat washers (2), and three lockwashers (3) securing air inlet housing (4) and gasket (5) to blower. Remove air inlet housing and gasket. Discard lockwashers and gasket.

NOTE

For models 7395 and 7398 only.

(2) If necessary, remove pipe plugs **(6** and 7) from air inlet housing (4).

b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes. Don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

(1) Clean air inlet housing with cleaning solvent.

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 air inlet housing with compressed air.

(3) Inspect air inlet housing for cracks, warps, or other damage.

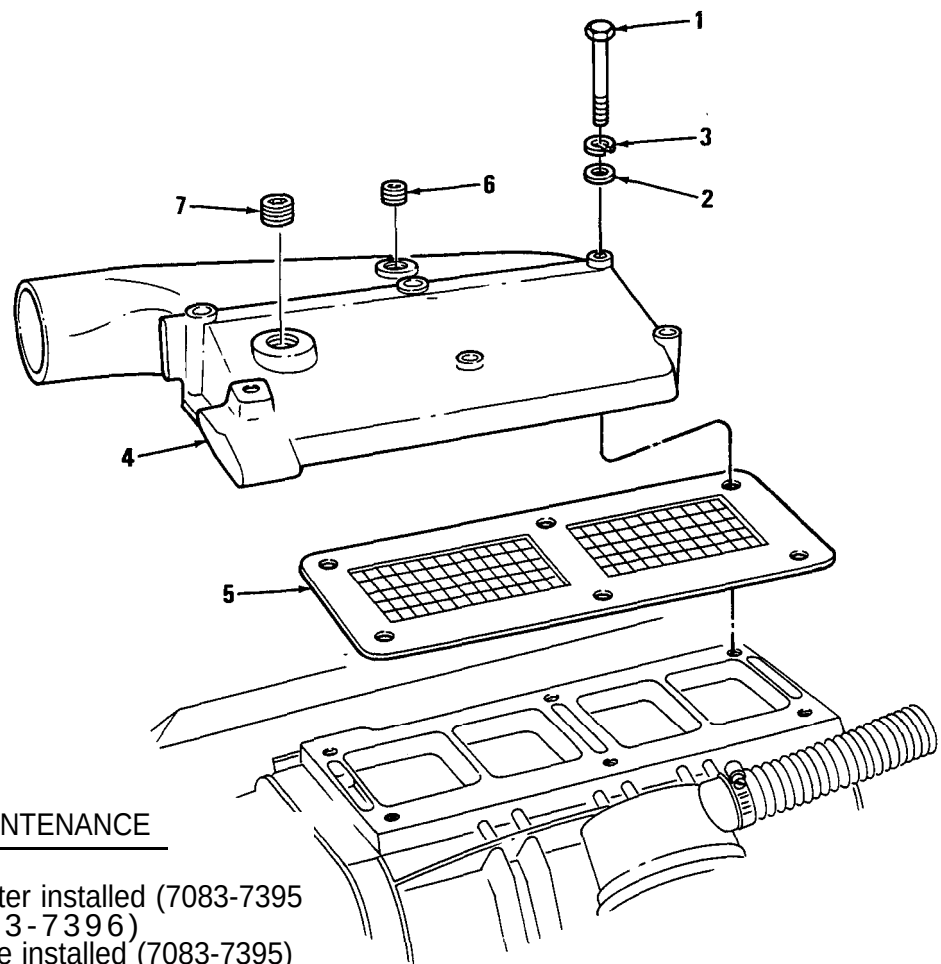
c. Installation

NOTE

For models 7395 and 7398 only

(1) If removed, install pipe plugs (6 and 7).

(2) Install & inlet housing (4) with gasket (5) to blower. Secure with three bolts (1), three lockwashers (3), and three flat washers (2). Torque bolts to 16-20 Ib-ft (22-27 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-10	Air box heater installed (7083-7395 and 7083-7396)
4-2	Air inlet tube installed (7083-7395)
5-2	Air inlet tube installed (7083-7396)
6-3	Air inlet tube installed (7083-7398)

4-14. TACHOMETER DRIVE REPLACEMENT

This task covers: a. Removal b. inspection c. -Installation

INITIAL SETUP

MODELS

All

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 75)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B,Item 96)

a. Removal

(1) Unscrew tachometer drive adapter (1) from adapter fitting (2). Remove key (3).

(2) Unscrew adapter fitting (2) from rear blower cover and remove gasket (4). Discard gasket.

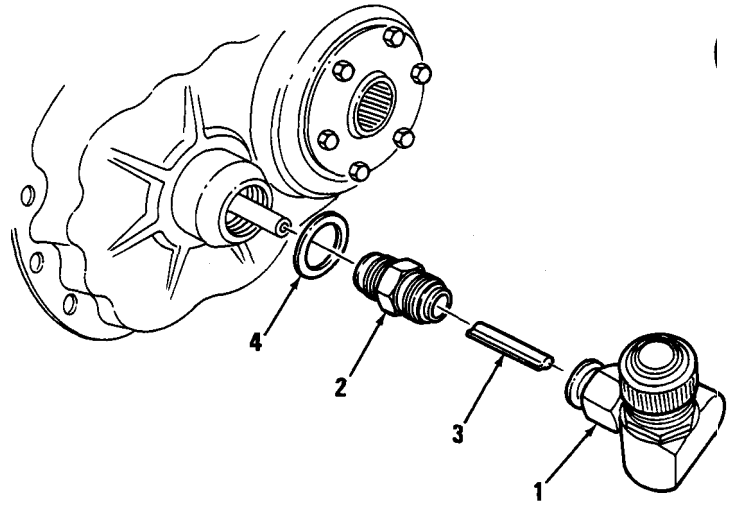
b. Inspection

(1) Inspect key for damage or wear.

(2) Inspect tachometer drive adapter for damage or cracks.

NOTE

Check for free movement of internal shafts in tachometer drive adapter.



c. Installation

(1) Install adapter fitting (2) with gasket (4) to rear blower cover.

(2) Install key (3) to shaft assembly.

(3) Screw tachometer drive adapter (1) onto adapter fitting (2). Tighten securely.

END OF TASK

4-15. BLOCK MOUNTED CRANKCASE BREATHER REPLACEMENT

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

INITIAL SETUP

MODELS

■ 7083-7391 7083-7395 7083-7396

MANDATORY REPLACEMENT PARTS

4 Lockwashers (App F, Item 91)
2 Gaskets (App F, Item 49)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EXPENDABLE/DURABLE SUPPLIES

Gasket cement (App C, Item 39)

a. Removal

(1) Remove two bolts (1) and two lockwashers (2) securing breather elbow (3) and gasket (4) to cylinder head. Discard gasket and lockwashers.

(2) Loosen two hose clamps (5) securing hose (6) to breather Y-tube (7) and breather elbow (3).

(3) Remove breather elbow (3), hose (6), and two hose clamps (5).

(4) Remove two bolts (8) and two lockwashers (2) securing breather tube (9) and gasket (4) to cylinder head. Discard gasket and lockwashers.

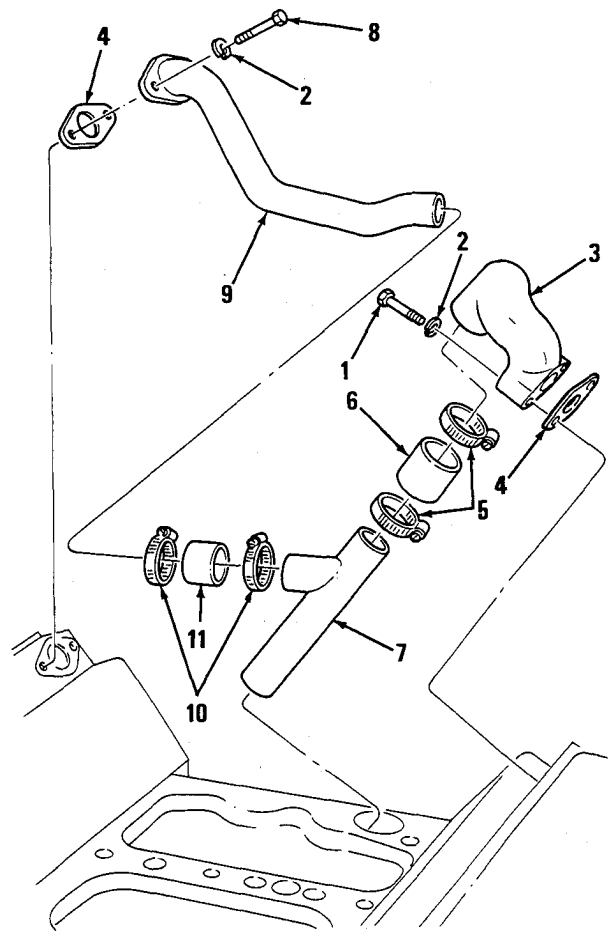
(5) Loosen two hose clamps (10) securing hose (11) to breather Y tube (7) and breather tube (9).

(6) Remove breather tube (9), hose 11), and two hose clamps (1 O).

NOTE

Do not remove breather Y-tube unless damaged or loose. Removal requires replacement with new tube.

(7) If necessary, remove breather Y-tube (7) from block.



4-15. BLOCK MOUNTED CRANKCASE BREATHER REPLACEMENT (Cont)

b. Inspection

(1) Inspect breather tube, breather elbow, and breather Y-tube for cracks, holes, or damage.

(2) Inspect all clamps for wear or damage.

(3) Inspect all hoses for cracks, tears, or damage.

c. Installation

(1) If removed, drive new breather Y-tube (7) into block with a collar and soft hammer. Tube is seated when distance from block surface to top of tube is 3.85 in. (9.78 cm).

(2) Install hose (6) onto breather Y-tube (7) and snug with hose clamp (5).

(3) Install breather elbow (3) and hose clamp (5) to hose (6). Snug hose clamp (5).

(4) Install breather tube (9), hose (11), and two hose clamps (10). Snug hose clamps (10).

(5) Install hose (11) to breather Y-tube (7). Snug with hose clamp (10).

(6) Apply gasket cement to two gaskets (4).

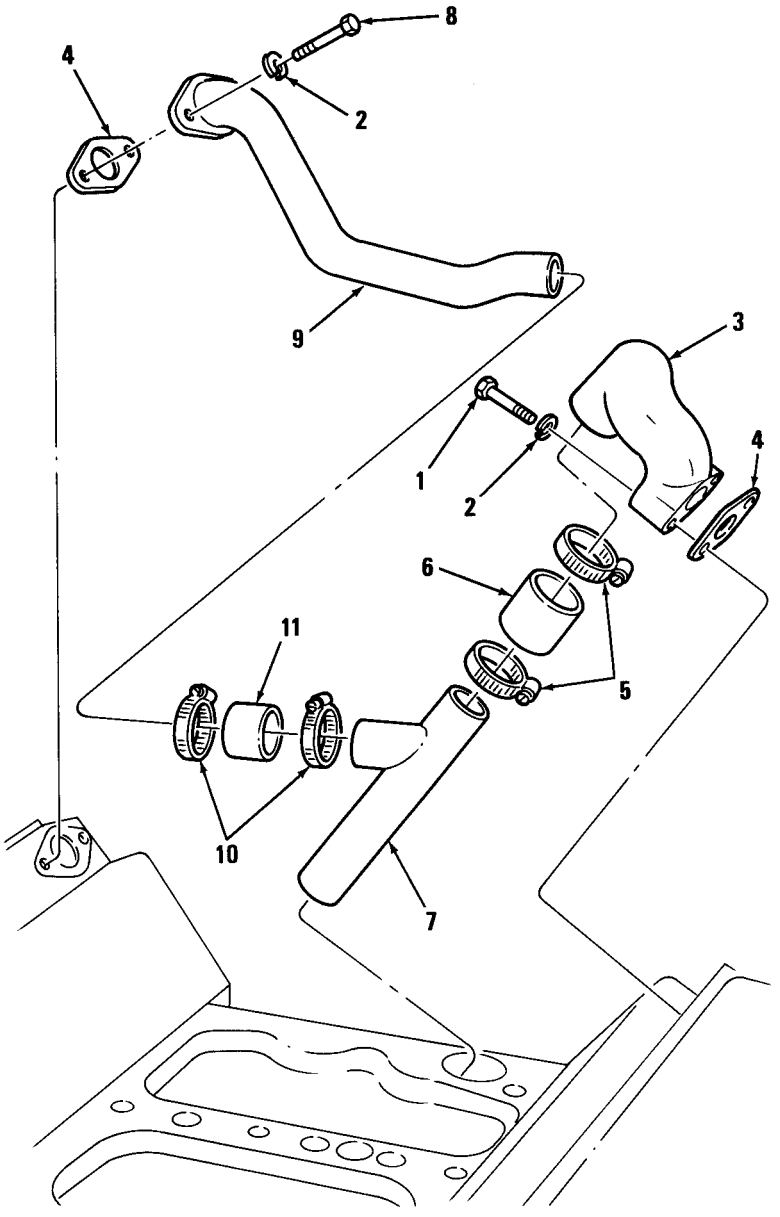
(7) Install gaskets (4) on cylinder heads.

(8) Aline breather elbow (3) with gasket (4). Secure with two bolts (1) and two lockwashers (2). Torque bolts to 7-9lb-ft(10-12 N-m).

(9) Aline breather tube (9) with gasket (4). Secure with two bolts (8) and two lockwashers (2) Torque bolts to 7-9lb-ft(10-12 N-m).

(Io) Tighten four hose clamps (5 and 10).

END OF TASK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4-16. BLOWER DRIVE SHAFT AND HUB REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

6 Lockwashers (App F, Item 95)
1 Gasket (App F,Item 26)

EXPENDABLE/DURABLE SUPPLIES

Bolt 10-32 x 1 (App C, Item 33)
Dry cleaning solvent (App C, Item 10)

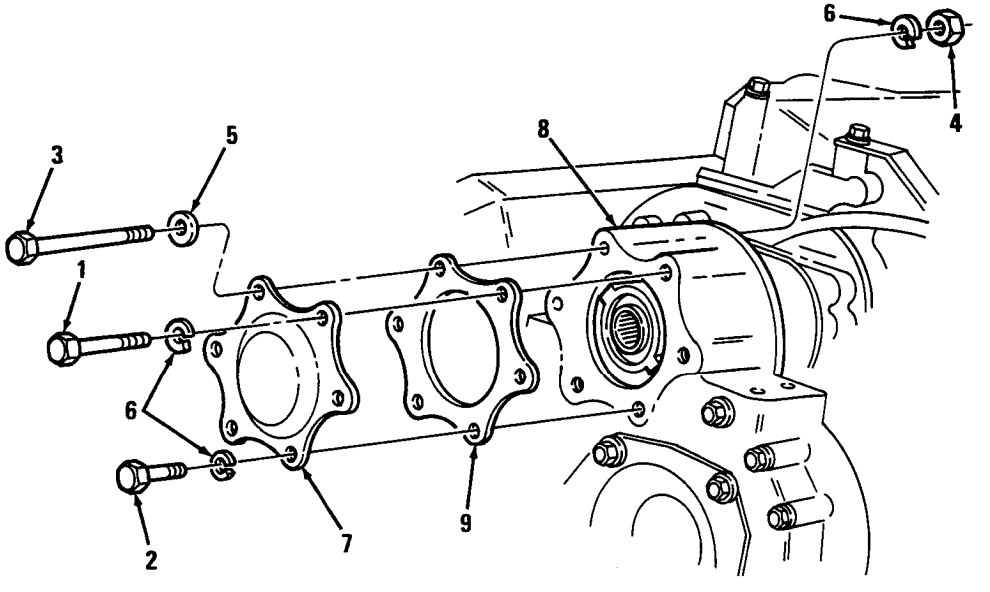
EQUIPMENT CONDITION

Para	Description
4-2	Turbocharger removed (7083-7395)
6-3	Turbocharger removed (7083-7398)

a. Removal

(1) Remove three bolts (1), two bolts (2), bolt (3), nut (4), flat washer (5), and six lockwashers (6) securing cover (7) to flywheel housing (8).

(2) Remove cover (7) and cover gasket (9) from flywheel housing (8). Discard gasket.



(3) Install 10-32 x 1 inch bolt (10) in blower drive shaft(11). Remove snap ring (12) and extract blower drive shaft. Remove bolt.

NOTE

Place a rag below the hub and spring plate assembly to prevent bolts from falling into the flywheel housing

(4) Remove three bolts (13) securing hub and spring plate assembly (14) to blower drive gear (15). Remove hub and spring plate assembly (14).

b. Disassembly

Remove three bolts (16) securing two spring plates (17) to blower drive hub (18).

c. Cleaning/Inspection

WARNING

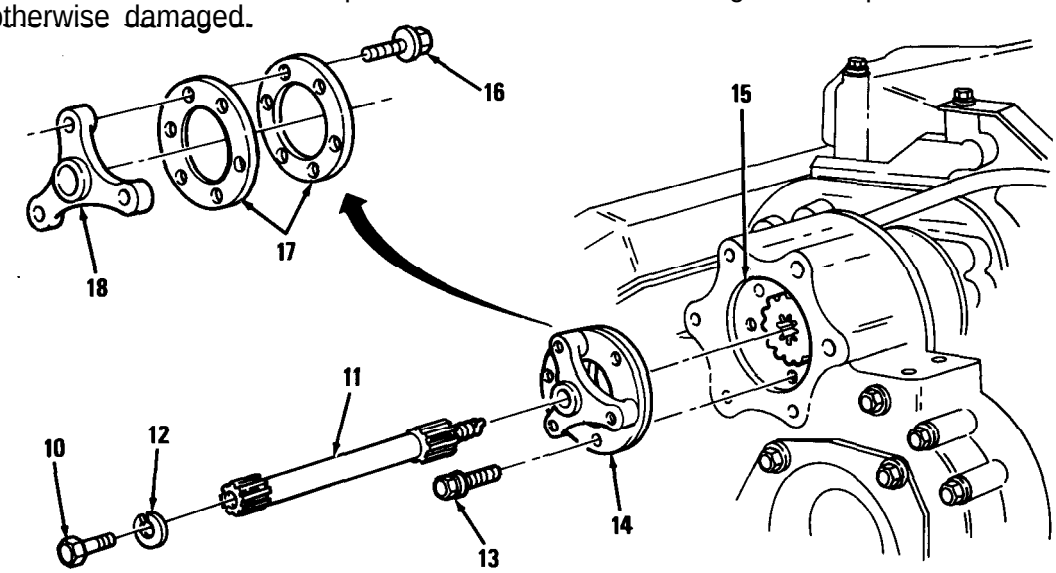
- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frame or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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/shieid, gloves, etc).**

(1) Clean all parts with dry cleaning solvent P-D-680 and dry with compressed air.

(2) Examine blower drive shaft. Replace blower drive shaft if splines are worn, cracked, or otherwise damaged.

(3) Examine blower drive hub. Replace hub if cracked or damaged or if spline is cracked, worn, or otherwise damaged.



4-16. BLOWER DRIVE SHAFT AND HUB REPLACEMENT (Cont)

(4) Examine spring plates. Replace if cracked, kinked, or if bolt holes show signs of distortion.

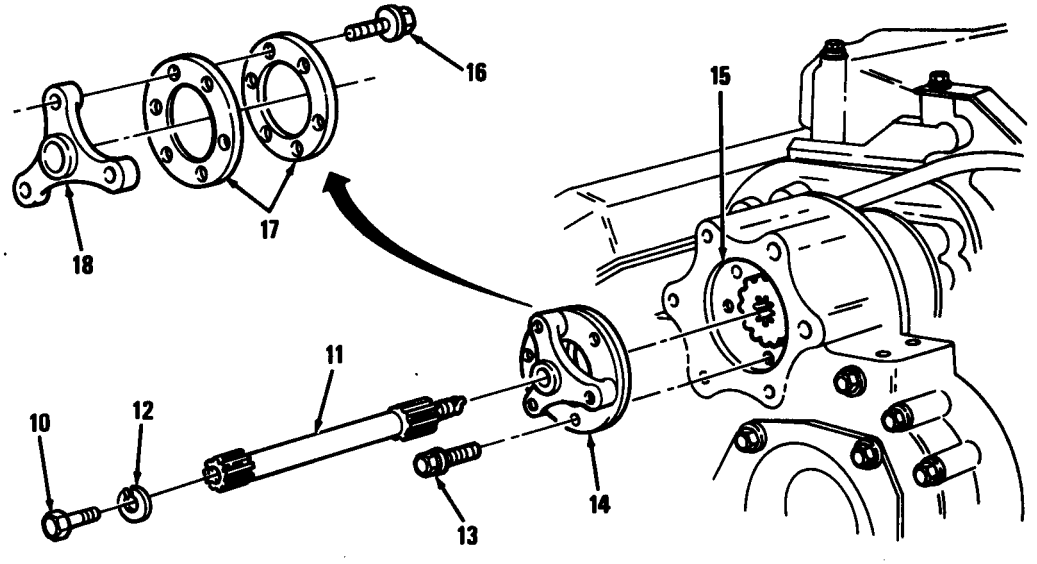
d. Assembly

Attach two spring plates (17) to blower drive hub (18) using three bolts (16). Torque bolts to 35-39 lb-ft (47-53 N-m).

e. Installation

(1) Attach drive hub and spring plate assembly (14) to blower drive gear (15) using three bolts (13). Torque bolts to 35-39 lb-ft (47-53 N-m)

(2) Insert 10-32 x l-inch bolt (10) in blower drive shaft (1 1).



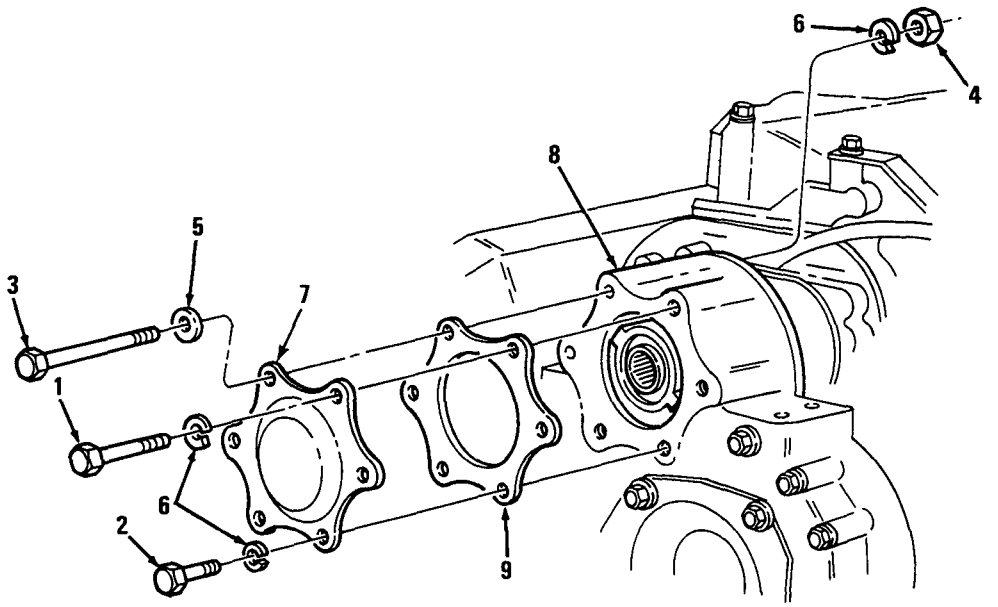
(3) Insert drive shaft (11)through blower drive gear(15). If binding occurs, refer to blower alinement procedure in para 4-18.

(4) Install snap ring (12) in blower drive hub (18). Remove 10-32 x 1- inch bolt (10) from shaft (11).

(5) Install blower drive cover (7) and gasket (9) on flywheel housing (8) and secure with two bolts (1) and two lockwashers (6).

(6) Install bolt (1), two bolts (2), bolt (3), two lockwashers (6), flat washer (5), and nut (4) in remaining holes.

(7) Torque bolt (3) and nut (4) to 35-39 lb-ft (47-53 N-m). Torque five remaining bolts to 30-35 lb-ft (41-47 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-2 Turbocharger installed (7083-7395)
6-3 Turbocharger installed (7083-7398)

4-17. GOVERNOR COVER AND THROTTLE CONTROL ROD REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 82)
2 Cotter pins (App F, Item 7)

EQUIPMENENT CONDITION

Para	Description
4-10	Air box heater removed (7083-7395 and 7083-7396)
4-11	Rocker arm covers removed
6-11	Air box heater removed (7083-7398 and 7083-7399)

a. Removal

(1) Remove eight screw assemblies (1) from governor cover (2).

(2) Remove governor cover (2) and gasket (3). Discard gasket.

NOTE

Position clean rag over cylinder head oil drain holes, left and right bank, to prevent cotter pins from failing into engine.

(3) Remove two cotter pins (4) and two clevis pins (5) on left and right bank of engine. Discard two cotter pins (4).

(4) Remove connecting pin (6) and connecting screw (7) from governor (8).

(5) Remove two fuel connecting rods (9 and 10) through ieft and right bank cylinder heads (11).

b. Installation

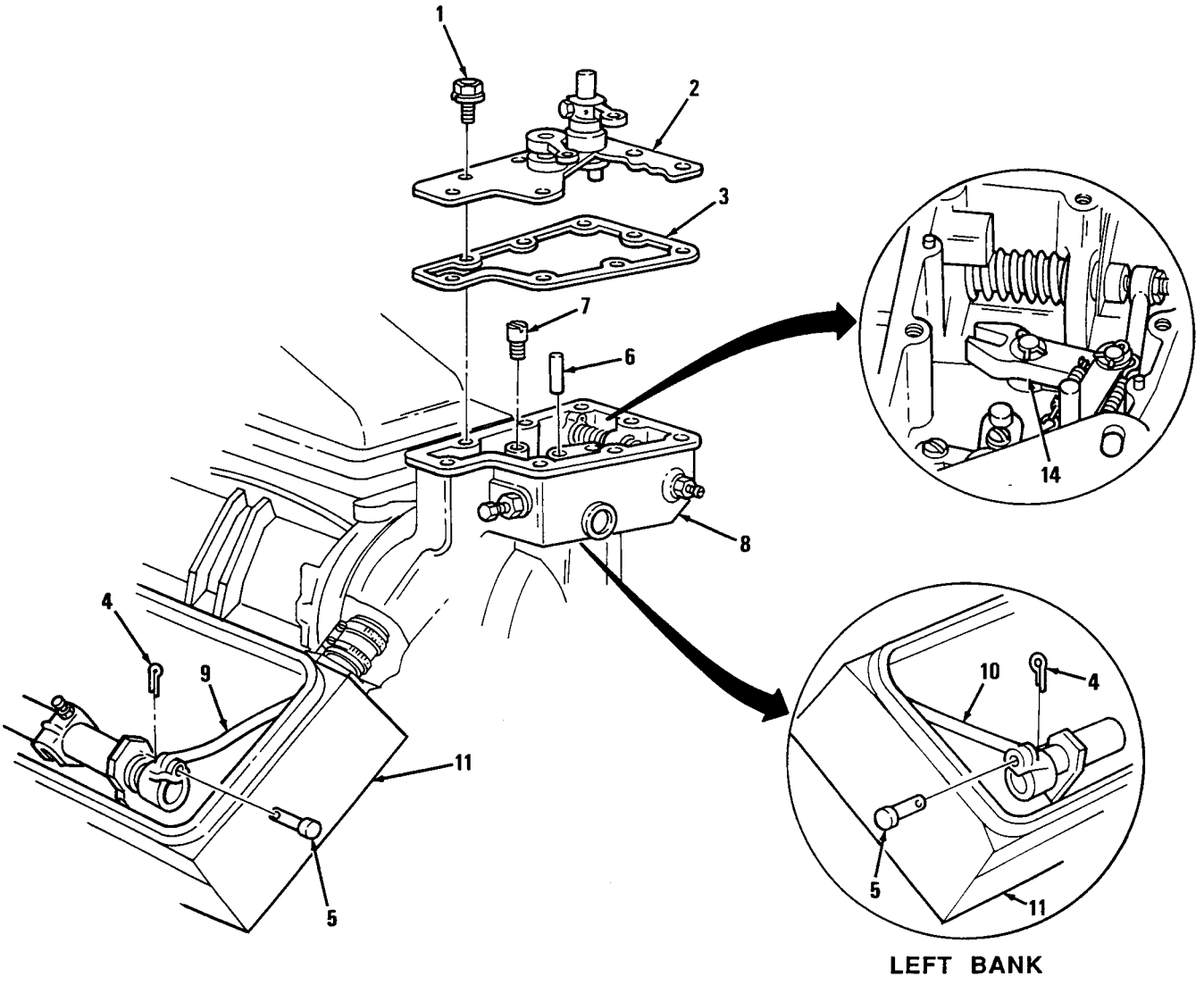
(1) Install fuel control rod (10) through left bank and fuel control rod (9) through right bank, cylinder heads.

(2) Connect right bank control rod (9) in governor (8) with connecting screw (7).

(3) Connect left bank control rod (10) in governor (8) with connecting pin (6).

(4) Install two clevis pins (5) in right and left bank fuel control tube clevs (12) and fuel control rods (9 and 10).

(5) Install two cotter pins (4) in clevis pins (5) on left and right banks.



NOTE

- Remove rag from cylinder head oil drain holes left and right bank.
- Insure throttle control arm pin (13) is engaged in fork (14).

(6) Position gasket (3) and governor cover (2) on governor (8). Secure with eight screw assemblies (1).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-11 Rocker arm covers installed
4-10 Air box heater installed (7083-7395 and 7083-7396)
6-11 Air box heater installed (7083-7398 and 7083-7399)

4-18. GOVERNOR AND BLOWER ASSEMBLY REMOVAL/INSTALLATION

This task covers: a: Removal b: Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Multiple sling (App B, [tern 83)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F,Item 56)
1 Gasket (App F,Item 65)
2 Copper washers (App F, Item 164)
8 Lockwashers (App F, Item 92)
1 Hose (App F,Item 84)
2 Hoses (App F, Item 85)

EQUIPMENT CONDITION

Para	Description
4-2	Turbocharger removed (7083-7395)
4-10	Air box heater removed (7083-7395 and 7083-7396)
4-11	Rocker arm covers removed
4-12	Fuel Dump removed
4-13	Air inlet housing removed (Except 7083-73911
4-16	Blower drive shaft removed (7083-7395 and 7083-7398)
4-17	Governor rover and throttle control rods removed
5-15	Blower drive shaft removed (7083-7391, 7083-7396, and 7083-7399)
5.1-11	Air inlet housing removed (7083-7391)
6-3	Turbocharger removed (7083-7398)
6-11	Air box heater removed (7083-7398 and 7083-7399)

a. Removal

(1) Loosen four clamps (1). Slide two hoses (2) up on governor fuel rod tubes (3) clear of cylinder heads.

(2) Disconnect oil tube nuts (4 and 5) on tube (6). Slide oil tube into fitting (7).

(3) Loosen two clamps (8) on hose assembly (9).

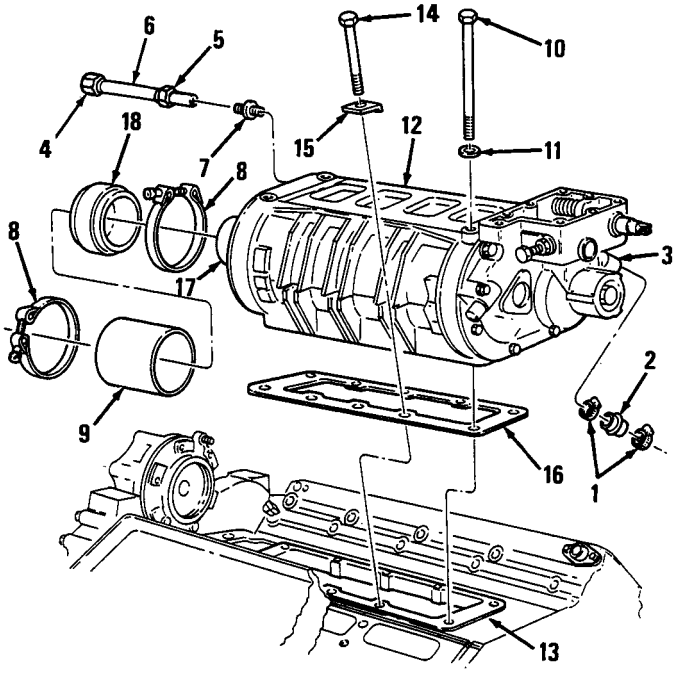
(4) Remove two bolts (10) and flat washers (11) securing blower (12) to engine block (13).

(5) Remove six bolts (14) and retaining clips (15) securing blower (12) to engine block (13).

NOTE

When removing blower, lift blower up slightly and move blower forward to detach from hose.

(6) Using multiple sling, lift blower (12) up from engine block (13). Remove blower gasket (16). Discard gasket.

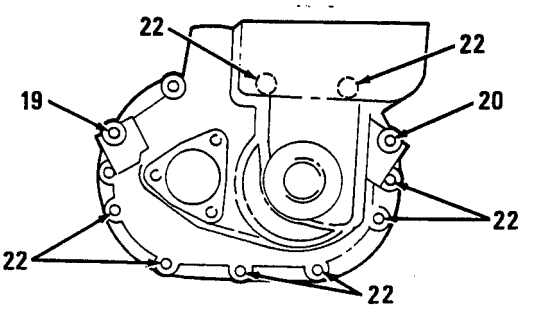


(7) Remove four clamps (1) and two hoses (2) from left and right governor fuel rod tubes (3). Discard hoses.

(8) Remove two clamps (8) and blower drive hose (9) from flange (17). Remove cover (18) from inside of hose (9), Discard hose.

(9) Remove tube (6) with oil tube nuts (4 and 5). Remove oil tube fitting (7).

(10) Remove bolts (19 and 20) and two copper washers (21) from governor assembly. Discard copper washers.



NOTE

Two bolts (22) are inside governor housing assembly.

(11) Remove eight bolts (22), eight lockwashers (23), and eight washers (24). Discard lockwashers.

(12) Tap sides of governor housing (25) lightly with soft hammer to loosen governor from blower.

(13) Remove governor housing (25) and gasket (26) from blower housing (12). Discard gasket.

b. Installation

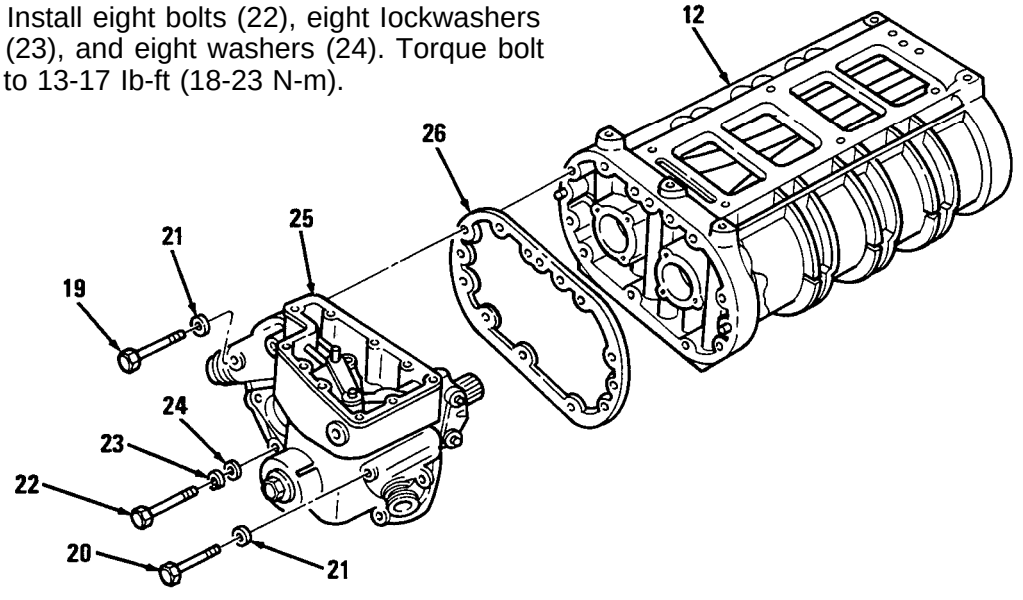
(1) Position governor to blower gasket (26) on blower housing (12).

(2) Install governor housing (25) on blower housing (12).

(3) Install bolt (19) and copper washer (21). Torque bolt to 13-17 lb-ft (18-23 N-m).

(4) Install bolt (20) and copper washer (21). Torque bolt to 13-17 lb-ft (18-23 N-m).

(5) Install eight bolts (22), eight lockwashers (23), and eight washers (24). Torque bolt to 13-17 lb-ft (18-23 N-m).



4-18. GOVERNOR AND BLOWER ASSEMBLY REMOVAL/INSTALLATION (Cont)

(6) Aline holes in new gasket (1 6). Place gasket (16) on engine block (1 3).

(7) Position cover (18) in hose assembly (9). Install hose assembly (9) and two clamps (8) on blower drive support (27).

(8) Install oil tube fitting (7) on blower. Tighten securely.

(9) Slide oil tube (6) with oil tube nuts (4 and 5) into oil tube fitting (7).

(10) Position two hoses (2) and four clamps (1) on governor housing fuel rod tubes (3).

CAUTION

Lower blower assembly carefully onto block to avoid damaging or moving gasket.

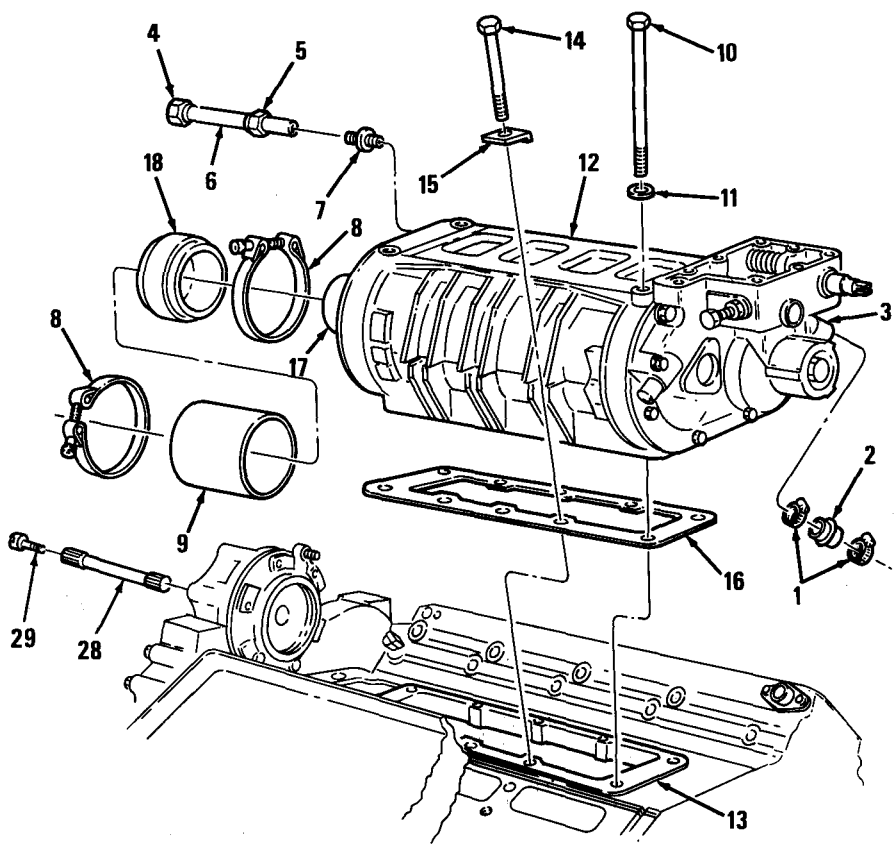
NOTE

Attach sling to blower. Lift blower assembly at a slight angle. Lower blower on top of cylinder block with flange of rear end plate cover inside of seal ring.

(11) Install two bolts (10) and two washers (11) securing blower (12) to block (1 3). Hand tighten.

NOTE

Lip on beveled end of retaining clip (15) goes in small recess in blower housing.



(12) Install six bolts (14) and six retaining clips (15) securing blower to block. Hand tighten only.

(13) Thread blower drive shaft (28) on 10-32 x 1 inch bolt (29). Position blower so shaft can be removed and installed easily without drag.

(14) Install blower drive shaft (28) using bolt (29). Rotate rotors of blower in 90° increments while removing and inserting drive shaft. Position blower as necessary. Check alinement at 90° increments through full 360° of blower rotation.

(15) Torque two bolts (10) to 40-45 lb-ft (54-61 N-m). Securing blower to cylinder block.

(16) Torque six side angle bolts (14) uniformly to 30-35 lb-ft (41-47 N-m) in 5 lb-ft (7 N-m) increments.

(17) Remove blower drive shaft (28) using bolt (29).

(18) Remove bolt (29) from blower drive shaft (28).

(19) Position hose (9). Tighten two clamps (8) on hose assembly (9).

(20) Tighten oil tube nut (5) to fitting (7) and oil tube nut (4) to blower drive support (27).

(21) Position two hoses (2) on governor fuel rod tubes (3) and tighten four clamps (1).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
6-11	Air box heater installed (7083-7398 and 7083-7399)
6-3	Turbocharger installed (7083-7398)
5-15	Blower drive shaft installed (7083-7391, 7083-7396, and 7083-7399)
5.1-11	Air inlet housing installed (7083-7391)
4-17	Governor cover and throttle control rods installed
4-16	Blower drive shaft installed (7083-7395 and 7083-7398)
4-13	Air inlet housing installed (Except 7083-7391)
4-12	Fuel pump installed
4-11	Rocker arm covers installed
4-10	Air box heater installed (7083-7395 and 7083-7396)
4-2	Turbocharger installed (7083-7395)

4-19. BLOWER DRIVE GEAR AND SUPPORT REPLACEMENT

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

INITIAL SETUP

MODELS

ALL

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Dial indicator (App B, Item 44)
Micrometer (1-2") (App B, Item 65)
Vernier caliper (App B, Item 10)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 69)
1 Key washer (App F, Item 167)
2 Copper washers (App F, Item 163)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
4 Bolts 3/8-24 x 4-1/2 (App C, Item 5)
Nut 3/8-24 (App C, Item 29)
Dry cleaning solvent (App C, Item 10)

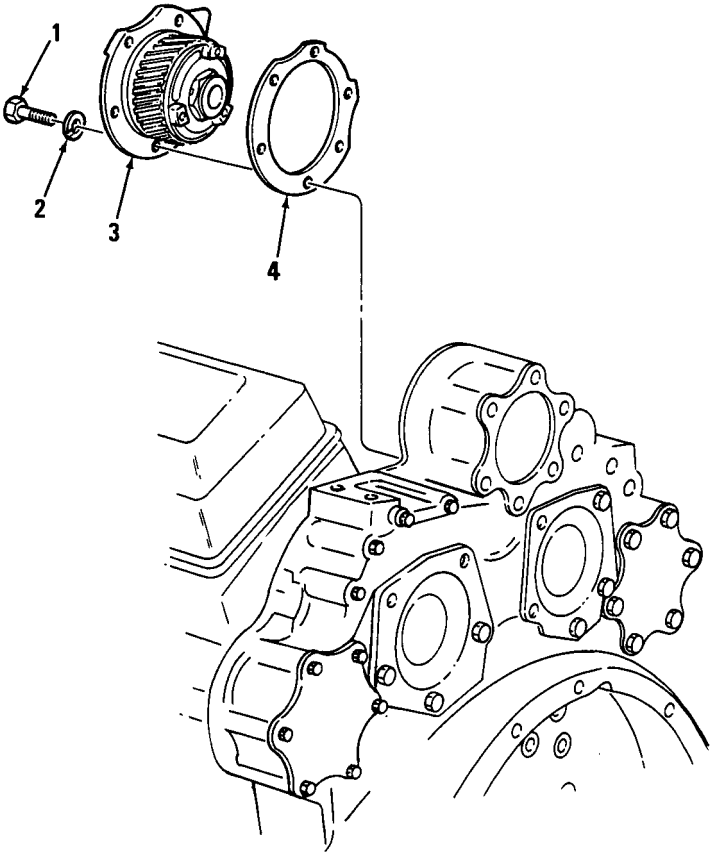
EQUIPMENT CONDITION

Para Description
4-15 Breather removed
4-16 Blower drive shaft and hub removed (7083-7395 and 7083-7398)
4-18 Blower removed
5-15 Blower drive shaft and hub removed (7083-7391, 7083-7396, and 7083-7399)

a. Removal

(1) Remove two bolts (1) and two copper washers (2) securing blower drive support assembly (3) to rear end plate. Discard copper washers.

(2) Remove blower drive gear support assembly (3) and gasket (4) from rear end plate. Discard gasket.



b. Disassembly

(1) Clamp blower drive gear support assembly (3) in a soft-jawed vise with blower drive gear (5) on top.

(2) Straighten tangs on key washer (6). Remove nut (7). Discard key washer.

(3) Remove thrust washer (8), thrust bearing (9), gear (5), and thrust bearing (10) from gear support (11).

c. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-680 Is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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 all parts with dry cleaning solvent and dry with compressed air.

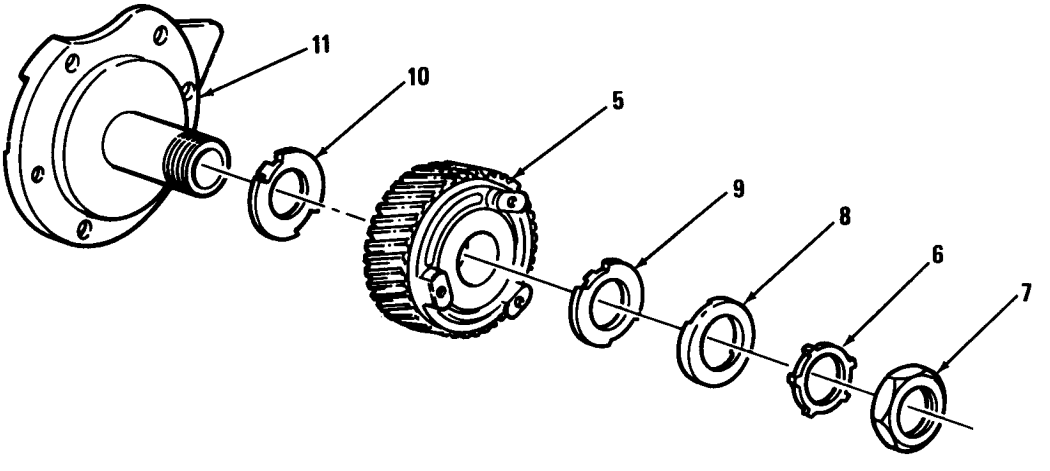
(2) Insure oil passage in gear support (11) is not clogged.

(3) Examine thrust washer (8) and thrust bearings (9 and 10). Replace if scored or worn.

(4) Using micrometer, measure outside diameter of blower drive gear support shaft (11). Diameter must be between 1.6240 inches minimum and 1.6250 inches maximum. Replace blower drive gear support if diameter is not within limits.

(5) Examine teeth of blower drive gear (5). Replace gear if teeth are scored, pitted, worn, or missing.

(6) Using vernier caliper, measure inside diameter of blower drive gear bearing (5). Replace gear if inside diameter is more than 0.005 inches larger than outside diameter of blower drive gear support shaft.



4-19. BLOWER DRIVE GEAR AND SUPPORT REPLACEMENT (Cont)

d. Assembly

(1) Clamp blower drive gear support (11) in a soft-jawed vise with drive gear support shaft on top.

(2) Lubricate blower drive gear support shaft (11), blower drive gear bearing (5) inside diameter, thrust bearings (9 and 10), and thrust washer (8) with clean engine oil.

(3) Install thrust bearing (10) on drive gear support (11) with tang alined with slot in support,

(4) Install blower drive gear (5) on drive gear support (11) with flat side of gear towards support.

(5) Install thrust bearing (9) on drive gear support (11) with flat side towards gear (5).

(6) Install thrust washer (8) on drive gear support (11) with slots alined to tangs on thrust bearing (9) and alining tab in slot of drive gear support shaft.

(7) Install lock plate (6) on drive gear support shaft (11) with alining tab in slot of shaft.

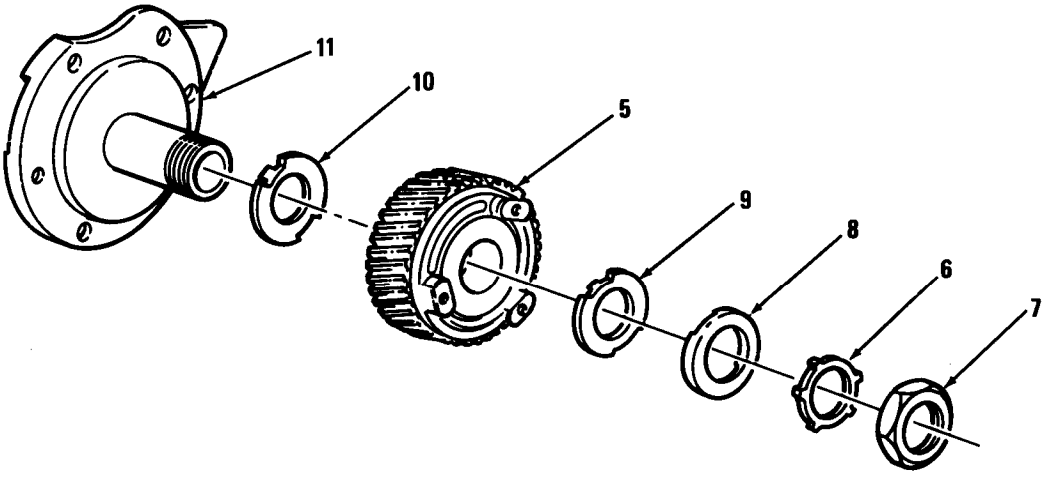
NOTE

Blower drive gear (5) must turn freely after torque is applied.

(8) Install nut (7) on drive gear support shaft and torque to 50-60 lb-ft (68-81 N-m).

(9) Using a set of feeler gages, measure clearance between thrust washer (8) and thrust bearing (9). Minimum allowable clearance is 0.005 and maximum allowable clearance is 0.010 inches for new parts or 0.012 inches for used parts.

(10) Bend tangs on lock plate (6) to secure nut (7).



e. Installation

(1) Install a drive gear support gasket (4) on drive gear support assembly (3).

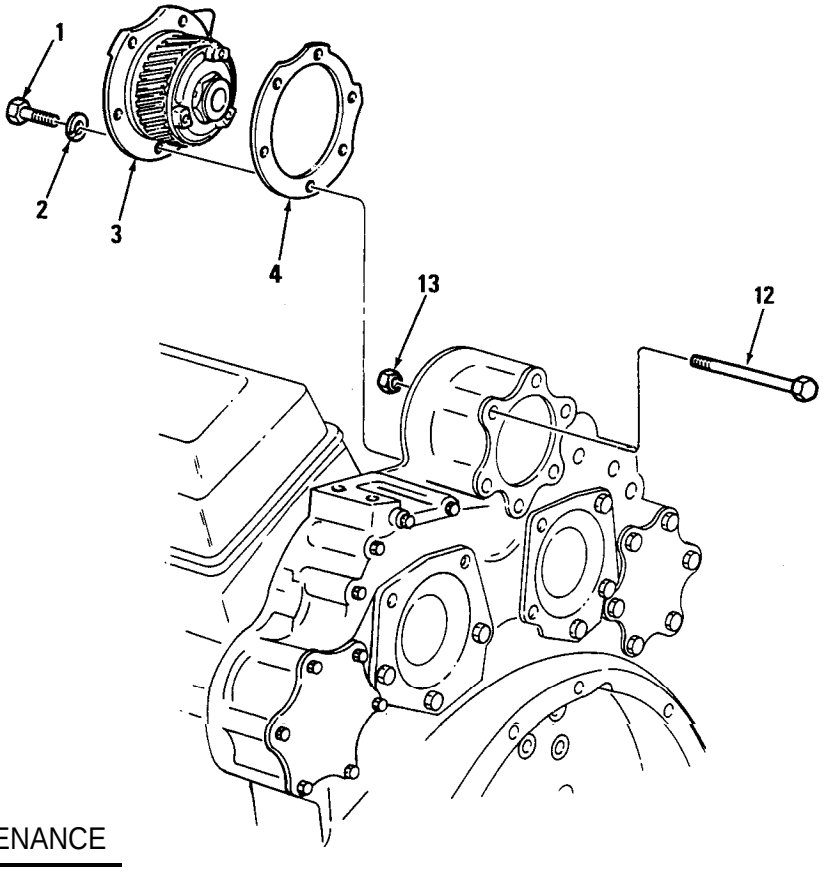
(2) Insert drive gear support assembly through rear end plate so blower drive gear meshes with right bank camshaft gear.

(3) Install two bolts (1) and two copper flat washers (2) in two lower holes of blower drive support assembly (3). Torque bolts to 25-30 Ib-ft (34-41 N-m).

(4) Install four bolts (12) , 3/8-24 x 4 1/2 inch, and one nut (13), 3/8-24, in remaining four holes of blower drive support. Bolts to be installed from rear to front. Torque bolts to 25-30 Ib-ft (34-41 N-m).

(5) Using dial indicator, measure backlash between blower drive gear and right bank camshaft gear. Backlash must be between 0.002 inches minimum and either 0.008 inches maximum with new gears or 0.010 inches maximum with used gears.

(6) Remove four bolts (12), 3/8-24 x 4 1/2 inch, and one nut (13), 3/8-24.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
- 5-15 Blower drive shaft and hub installed (7083-7391, 7083-7396, and 7083-7399)
- 4-18 Blower installed
- 4-16 Blower drive shaft and hub installed (7083-7395 and 7083-7398)
- 4-15 Breather installed

4-20. OIL PAN REPLACEMENT

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

INITIAL SETUP

MODELS

■ All

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 30)
2 Lockwashers (App F,Item 93)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EXPENDABLE/DURABLE SUPPLIES

Gasket cement (App C, Item 39)
Fuel oil (App C, Item 21)

a. Removal

(1) Remove two bolts (1) and two Iockwashers (2) from flywheel housing (3). Discard Iockwashers.

(2) Remove two bolts (4) and two flat washers (5) from rear corners of oil pan (6).

(3) Remove twenty-six bolts (4) from oil pan (6).

(4) Remove oil pan (6) and gasket (7). Discard gasket.

(5) If required, remove following fittings from oil pan:

(a) For models 7083-7395 and 7083-7398, two plugs (8), plug (9), and plug (10).

(b) For models 7083-7391,7083-7396, and 7083-7399, plug (8), plug (9), dipstick adaptor (11), and turbocharger drain elbow (12).

(c) For models 7083-7391 and 7083-7396, bushing (13).

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 oil pan with fuel oil and dry with compressed air.

(2) Inspect pan for holes, cracks, and other damage which may require replacement. Check for misalined flanges or raised surfaces surrounding bolt holes.

c. Installation

(1) Coat upper flange of oil pan (6) with gasket cement.

(2) Install cork gasket (7) by alining holes in gasket with holes in oil pan (6).

(3) Position oil pan and gasket on cylinder block.

(4) Install two bolts (4) in right and left center holes of oil pan (6).

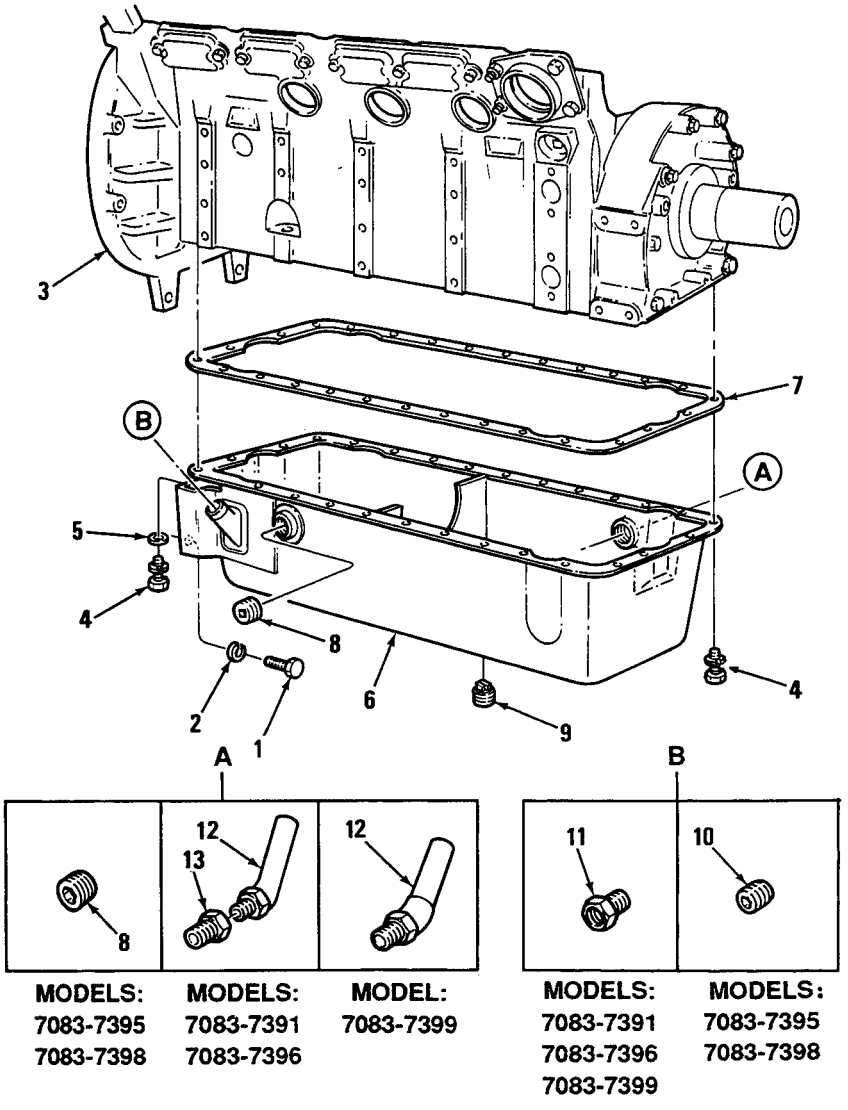
(5) Install two bolts (4) and two flat washers (5) in rear corners of oil pan.

(6) Install twenty-four bolts (4) in oil pan and tighten finger tight.

(7) Install two bolts (1) and two lockwashers (2) to flywheel housing (3).

(8) Torque twenty-eight oil pan bolts (4) to 10-20 lb-ft (14-27 N-m) starting with center bolts and working alternately towards each end.

(9) Torque two bolts (1) to 30-35 lb-ft (41-47 N-m).



END OF TASK

4-21. CAMSHAFT FRONT GEAR COVER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 46)
1 Gasket (App F, Item 48)
Lockwasher (App F, Item 95)
1 Lockwashers (App F, Item 93)
1 Jam nut (App F, Item 86)

EQUIPMENT CONDITION

Para	Description
4-5	Fuel strainer bracket removed
4-7	Front lifter bracket removed
4-9	Water pump removed

a. Removal

(1) Remove two self tapping bolts (1) securing access cover (2) and gasket (3) to assembly cover (4). Discard gasket.

NOTE

Bolts securing assembly cover vary in length and diameter. For ease of assembly note location of bolts, washers, and nuts when removing.

(2) Remove five bolts (5), four nuts (6), five lockwashers (7), and five flat washers (8). Remove bolt (5), jam nut (9), and lockwasher (7). Discard lockwashers and jam nut.

(3) Remove bolt (10), lockwasher (11), and flat washer (12). Discard lockwasher.

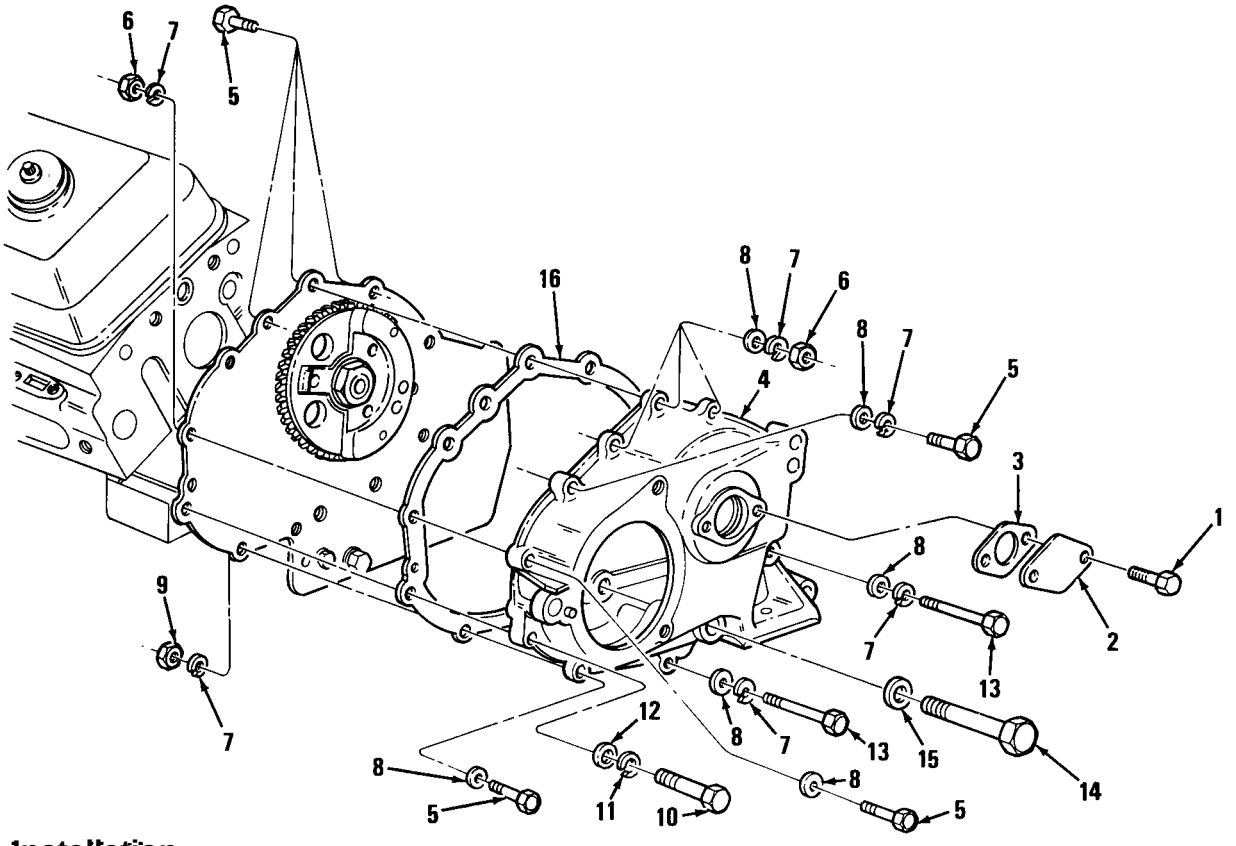
(4) Remove two bolts (13), two lockwashers (7), and two flat washers (8). Discard lockwashers.

(5) Remove bolt (14) and flat washer (15).

(6) Remove assembly cover (4) and gasket (16) from block. Discard gasket.

b. Inspection

Inspect assembly cover and access cover for cracks, pitting, or damage.



c. Installation

(1) Install access cover (2), gasket (3), and two self tapping bolts (1) to assembly cover (4). Torque bolts to 13-17 lb-ft (18-23 N-m).

NOTE

Assemble top three bolts with nuts toward front of engine.

(2) Install assembly cover (4) and gasket (16) to block. Secure with five bolts (5), five flat washers (8), five lockwashers (14), and four nuts (6). Torque bolts to 30-35 lb-ft (41-47 N-m).

(3) Install bolt (5), lockwasher (7), and jam nut (9). Torque bolt to 30-35 lb-ft (41-47 N-m).

(4) Install bolt (10), lockwasher (11), and flat washer (12). Torque bolt to 71-75 lb-ft (96-102 N-m).

(5) Install two bolts (13), two lockwashers (7), and two flat washers (8). Torque bolts to 30-35 lb-ft (41-47 N-m).

(6) Install bolt (14) and flat washer (15). Torque bolt to 137-147 lb-ft (186-200 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-9	Water pump installed
4-7	Front lifter bracket installed
4-5	Install fuel strainer bracket

4-22. FLYWHEEL ASSEMBLY REPLACEMENT

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

INITIAL SETUP

MODELS

All

MANDATORY REPLACEMENT PARTS

8 Bolts (App F, Item 3)

TOOLS/SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Multiple sling (App B, Item 83)
Guide studs (App B, Item 86)
Torque wrench (App B, Item 101)
Dial indicator gage (App B, Item 44)
Flywheel housing gage (App B, Item 30)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)
Heat indicating crayon (App C, Item 23)
Wood block (App C, Item 46)
International compound no.2 (App C, Item 24)

a. Removal

NOTE

To aid in reinstallation, aline and mark two holes of scuff plate, crankshaft, and flywheel assembly.

(1) Attach multiple sling (1) to flywheel (2) with two 3/8-16 eye bolts (3).

(2) Attach lifting sling (1) to chain hoist (4).

(3) Remove two flywheel attaching bolts (5) and discard. Install two guide studs (6) in bolt holes to support flywheel assembly (2).

(4) Remove six remaining flywheel attaching bolts (5) and scuff plate (7). Discard bolts.

(5) Remove flywheel assembly (2) from crankshaft (8) and flywheel housing (9).

(6) Remove guide studs (6) from crankshaft (8).

b. Cleanlng/inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact **with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.**

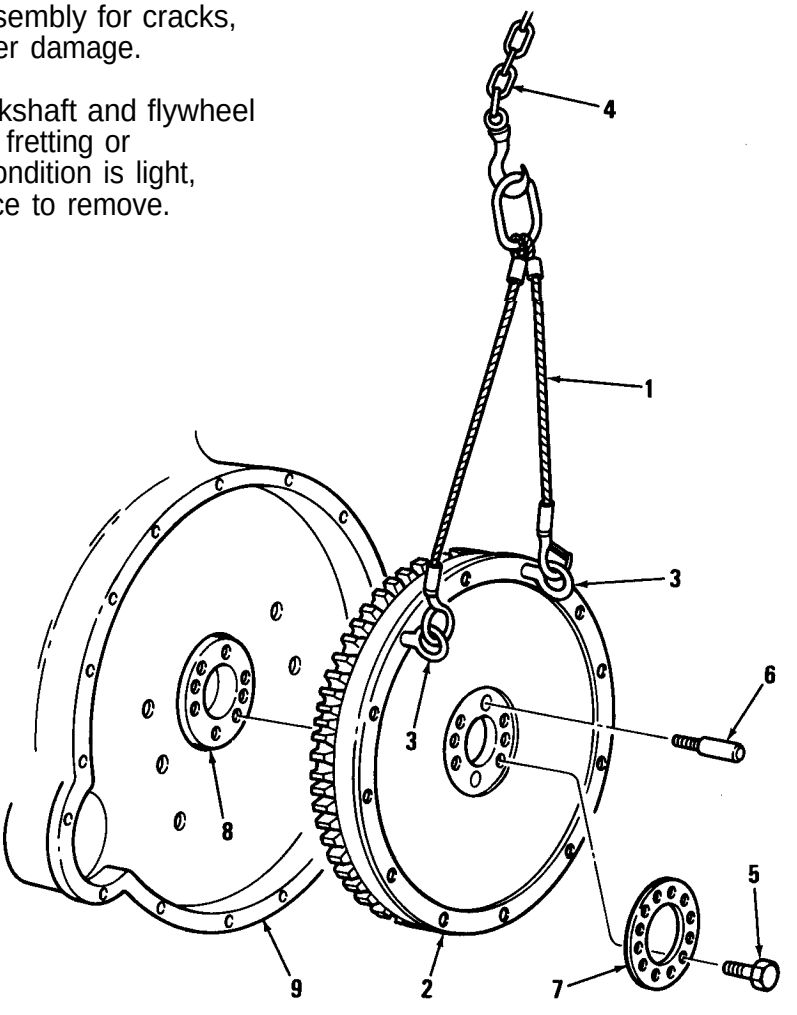
(1) Clean flywheel assembly with cleaning solvent.

NOTE

Although flywheels seldom require replacement, 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 new replacement gear is required.

(2) Check flywheel assembly for cracks, worn teeth, or other damage.

(3) Check end of crankshaft and flywheel mating surface for fretting or brinelling. If this condition is light, lightly stone surface to remove.



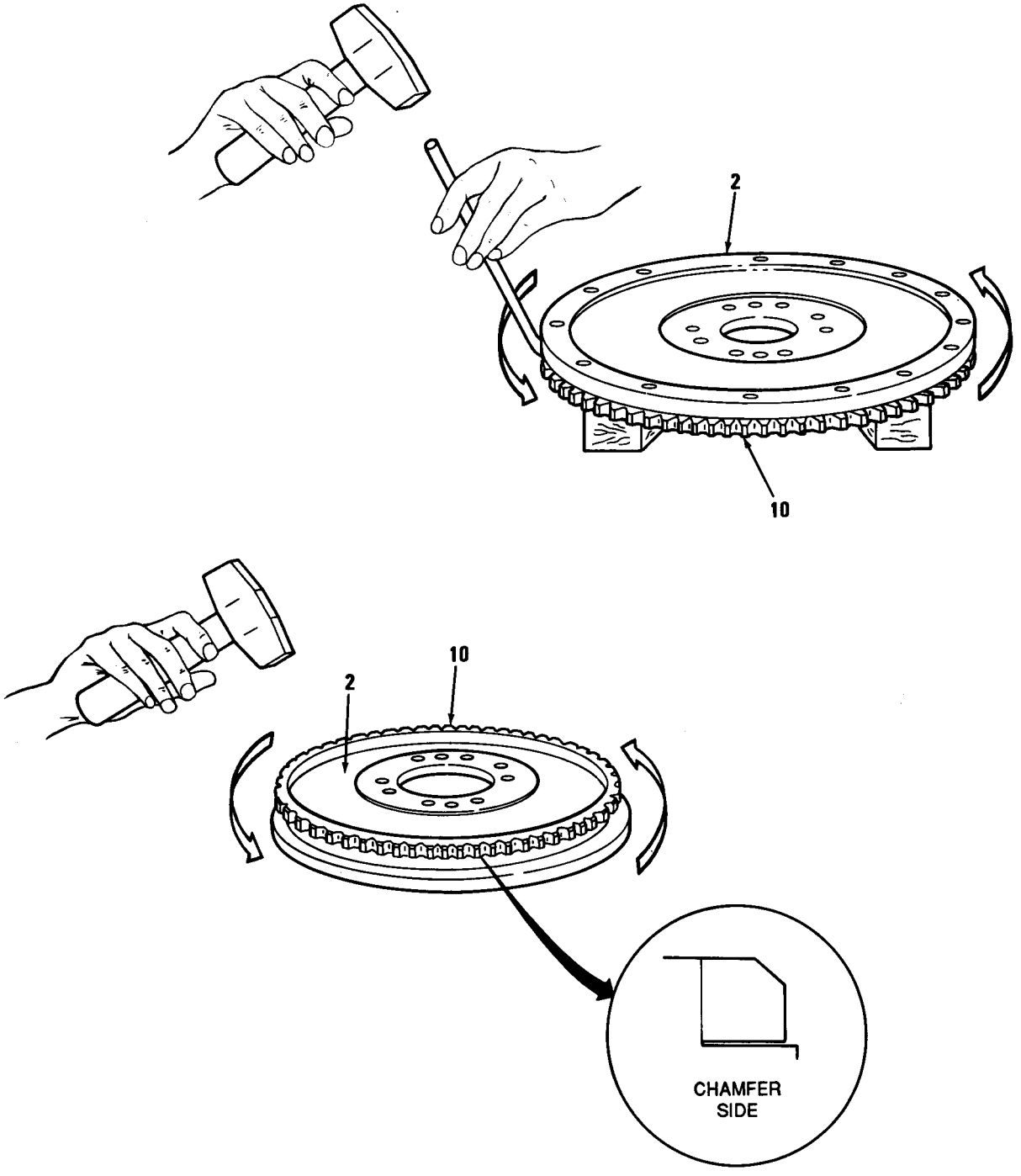
4-22. FLYWHEEL ASSEMBLY REPLACEMENT (Cont)

c. Repair

(1) Remove ring gear (10)from flywheel as follows:

(a) Place flywheel assembly (2), crankshaft side down, on a solid flat surface or hardwood blocks which fit inside diameter of flywheel.

(b) Drive gear (10) off flywheel using a brass drift and hammer. Work around circumference of ring gear to avoid binding.



(2) Install ring gear (10) on flywheel (2) as follows:

(a) Place flywheel (2), crankshaft side up, on a solid flat surface.

CAUTION

If a torch is used, keep torch moving around circumference of gear to avoid hot spots. Under no circumstances should gear be heated over 400°F (204°C). Excessive heat may destroy original heat treatment. Heat indicating "crayon", which melts at a predetermined temperature, should be placed on work surface to determine heat range.

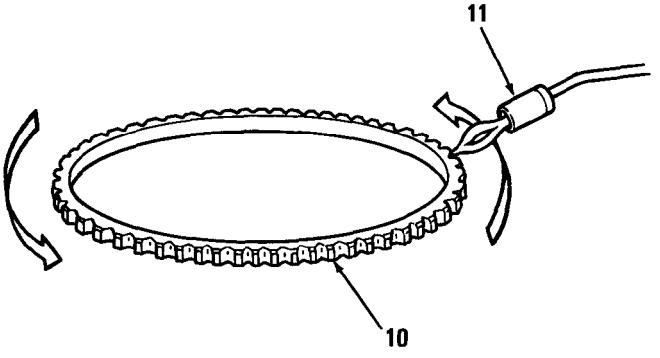
(b) Place ring gear (10) on a metal surface and heat uniformly. Heat source can be a blow torch, acetylene torch (11), or oven.

(c) After ring gear has been heated, place it in position on flywheel (2) with chamfer side up.

(d) Tap ring gear into place against shoulder of flywheel. Working around circumference to avoid binding.

NOTE

If ring gear cannot be tapped into place readily, remove ring gear and apply additional heat. Follow above caution about not overheating ring gear.



4-22. FLYWHEEL ASSEMBLY REPLACEMENT (Cont)

d. Installation

(1) Apply International Compound No. 2 or equivalent to threads and to bolt head contact area (underside) of all flywheel attaching bolts (5). Threads must be completely filled with compound and excess removed.

(2) Insert two guide studs (6) into crankshaft flywheel bolt holes.

(3) Attach flywheel lifting sling (1) to flywheel assembly (2) using two eye bolts (3).

(4) Using chain hoist (4), lift and guide flywheel assembly (2) into flywheel housing (9).

(5) Aline flywheel bolt holes with crankshaft bolt holes marked at removal. Guide flywheel assembly (2) onto guide studs (6).

(6) Install scuff plate (7) and two bolts (5) 180 degrees apart. Snug bolts to hold scuff plate and flywheel assembly (2) in place on crankshaft (8).

(7) Remove lifting sling (1) and two eye bolts (3) from flywheel (2).

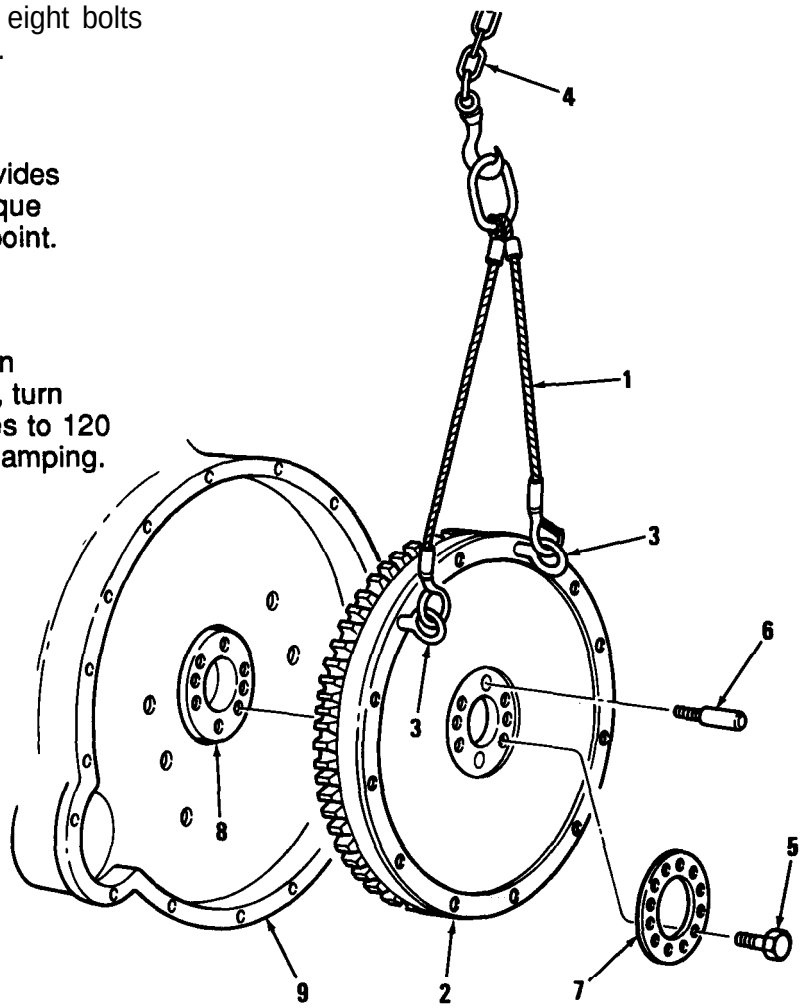
(8) Remove two guide studs (6). Install remaining six bolts (5) and run in snug.

(9) Using torque wrench, tighten eight bolts (5) to 50 lb-ft (68 N-m) torque.

NOTE

TORQUE TURN METHOD provides more consistent clamping. Torque value stated is only a starting point. Bolt torque values should be ignored.

(10) **After eight bolts (5) have been tightened to 50 lb-ft (68 N-m), turn bolts an additional 90 degrees to 120 degrees to obtain required clamping.**



4-22. FLYWHEEL ASSEMBLY REPLACEMENT (Cont)

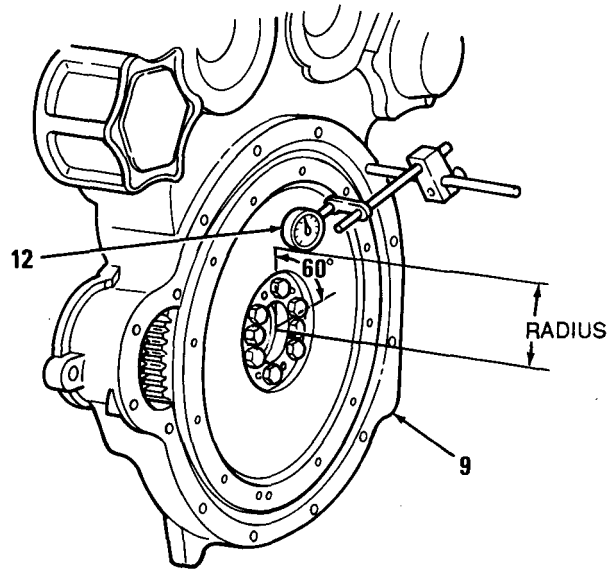
e. Testing

(1) Flywheel face runout

a. Mount dial indicator (12) on flywheel housing (9) with dial indicator needle against clutch contact face.

b. Pry flywheel toward engine block (at six o'clock position) to insure end play is in one direction,

c. Adjust dial indicator to read zero at twelve o'clock position.



CAUTION

When using hexagon head bolt at front of crankshaft to turn crankshaft, always turn bolt clockwise. Serious engine damage may result if bolt becomes loose.

d. Rotate crankshaft and record readings at 60 degree intervals (6 readings). Pry flywheel toward engine block before taking each reading.

NOTE

- Runout is the maximum negative reading plus the maximum positive reading. For example, if maximum readings were 0.004 and -0.007 inch, then runout is 0.011 inch.
- Maximum allowable runout is 0.001 inch per inch of radius. Measure radius from center of flywheel 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 and check for dirt or foreign material between crankshaft and flywheel. Remount flywheel. If readings are still out of limits, replace flywheel.

4-22. FLYWHEEL ASSEMBLY REPLACEMENT (Cont)

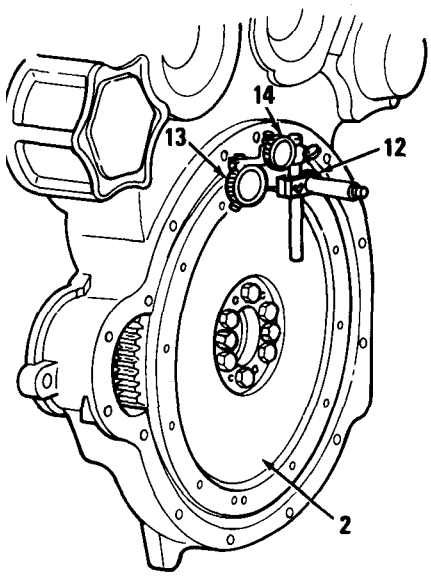
(2) Flywheel housing bore concentricity and face runout

a. Mount dial indicator base (12) to flywheel (2).

b. Position one dial indicator(13) perpendicular to flywheel housing bell face and a second dial indicator (14) against flywheel housing bell bore.

c. Pry flywheel toward engine block (at six o'clock position) to insure end play 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 turn 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. Rotate crankshaft and record readings at 60 degree intervals (6 readings each for bell bore and face). Pry flywheel 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. Remount end plate and housing. If either reading is still out of limits, replace flywheel housing (see Para 4-24).

END OF TASK

4-23. REAR OIL SEAL REPLACEMENT

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

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Magnetic base dial indicator (App B, Item 45)
Seal expander (App B, Item 17)
Seal installer (App B, Item 51)
Installer handle (App B, Item 51)
Guide studs (App B, Item 86)
Guide studs, seal installer (App B, Item 51)

MANDATORY REPLACEMENT PARTS

Oil seal (App F, Item 106)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
2 Metal screws (App C, Item 34)
2 Flat washers (App C, Item 17)
Crocus cloth (App C, Item 12)
Nonhardening sealant (App C, Item 38)

EQUIPMENT CONDITION

Para	Description
4-22	Flywheel removed

a. Removal

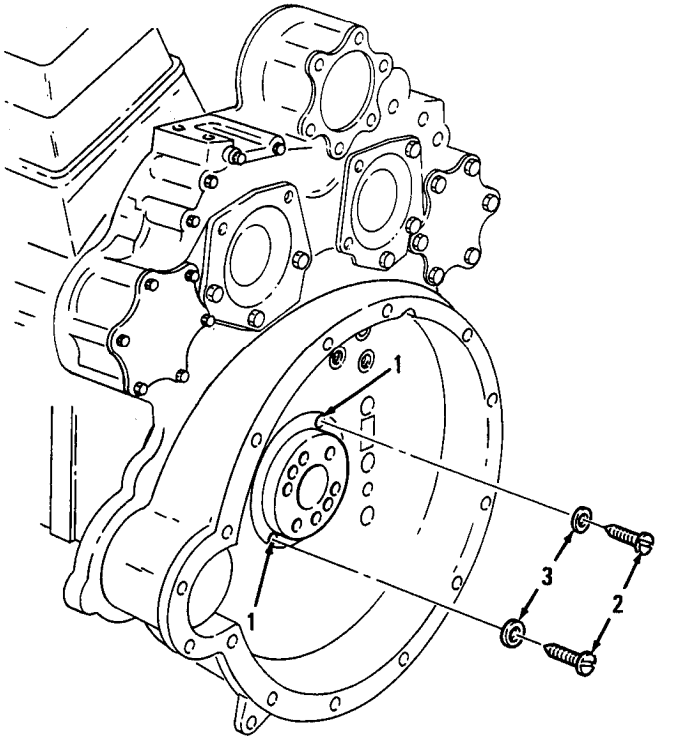
(1) Center punch two holes in oil seal casing (1) on opposite sides.

(2) Install two #10 x 1-1/4 inch metal screws (2) and two flat washers (3).

CAUTION

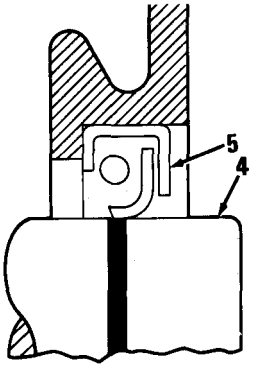
Do not pry against crankshaft or gouging will result.

(3) Remove seal by prying against washers with pry bars. Discard seal.



4-23. REAR OIL SEAL REPLACEMENT (Cont)

b. Cleaning/Inspection



(1) Clean flywheel housing seal bore.

CAUTION

Do not polish parallel to crankshaft or ridges will result and cause oil leakage.

(2) Inspect rear end of crankshaft (4) for wear due to rubbing action of oil seal (5), dirt build up, or fretting by action of flywheel. Remove slight ridges from crankshaft by polishing with crocus cloth in circular motion.

CAUTION

Rotate crankshaft in counterclockwise direction only. Do not rotate crankshaft bolt clockwise or loosening will result.

(3) Check runout of seal bore by mounting a dial indicator on crankshaft and note reading while crankshaft is rotated. Measure with flywheel housing installed on engine and seal removed. Maximum runout of bore is 0.008 inch.

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.

NOTE

If new seal is not precoated, apply a nonhardening sealant to metal casing.

(1) Coat lip of rear oil seal (5) with engine oil.

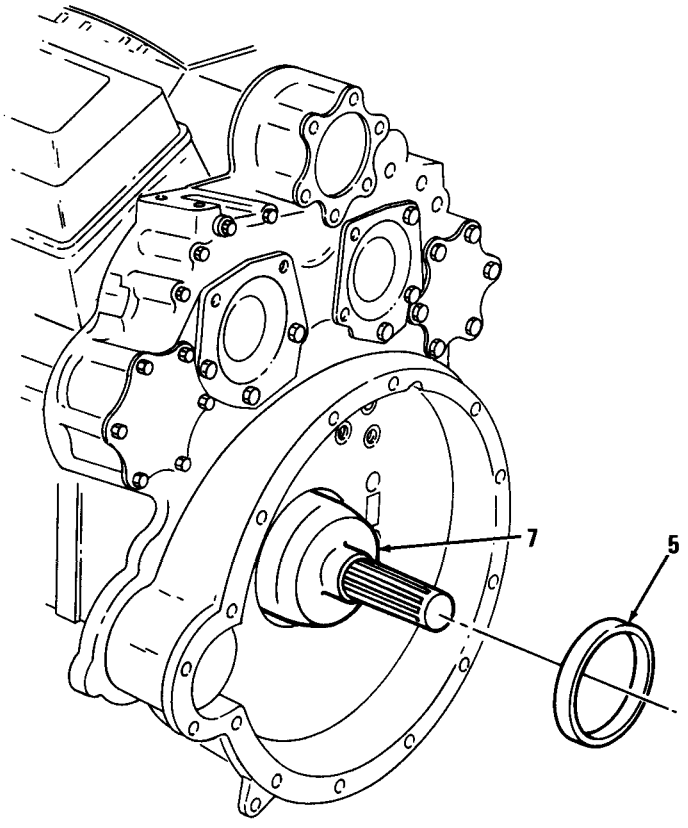
(2) Install two guide studs (6) and oil seal expander (7) to end of crankshaft.

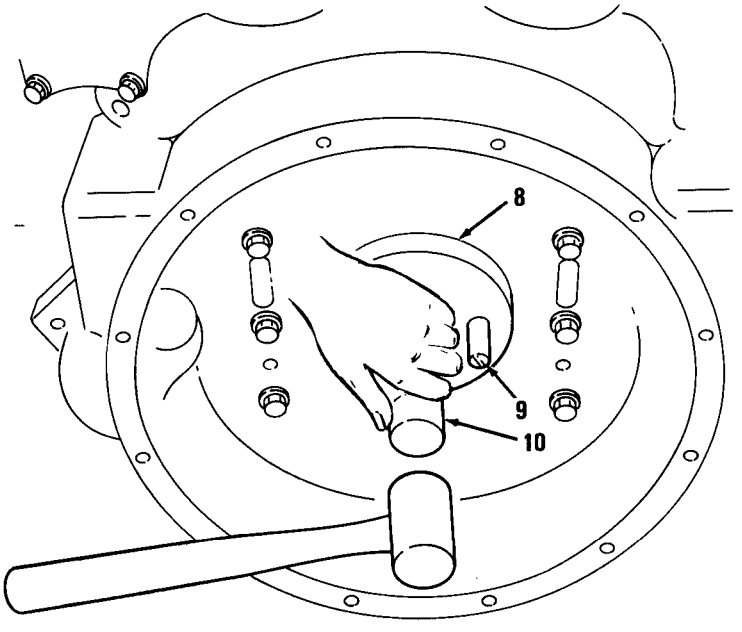
(3) Position seal (5) with lip pointed toward inner face of housing. Slide seal over seal expander (7) and onto crankshaft. Remove seal expander and guide studs.

(4) Using seal installer (8), guide studs (9), and driver handle (10), drive seal in place.

(5) Remove seal installer (8) and guide studs (9).

(6) Remove excess sealant from flywheel housing or seal.





END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-22 Install flywheel

4-24. FLYWHEEL HOUSING REPLACEMENT

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

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General Mechanics Tool Kit (App B, Item 96)
Torque wrench (App B, Item 101)
Guide studs (App B, Item 86)
Multiple sling (App B, Item 83)

MANDATORY REPLACEMENT PARTS

21 Lockwashers (App F,Item 93)
8 Lockwashers (App F,Item 95)
1 Gasket (App F, Item 66)
2 Gasket (App F, Item 25)
2 Gasket (App F, Item 26)
1 Copper washer (App F, Item 163)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Grease (App C, Item 22)
Cleaning solvent (App C, Item 10)
Nonhardening sealant (App C, 39)

EQUIPMENT CONDITION

Para Description
4-2 Turbocharger mounting bracket removed (7083-7395)
4-19 Blower drive removed
4-20 Oil pan removed
4-22 Flywheel removed
4-23 Rear oil seal removed
6-4 Exhaust manifold and tube removed (7083-7398)
6-16 Crankcase breather removed

a. Removal

NOTE

When removing flywheel housing bolts, note location of various size bolts and washers so they may be reinstalled in their proper location.

(1) Install two eye bolts (1) to top of flywheel housing (2). Attach multiple sling (3) to eye bolts.

NOTE

Effective after engine number 8VA-349268, bolt (4) and flat washer (5) replaced three bolts (6) and three flat washers (7) on left side of flywheel housing.

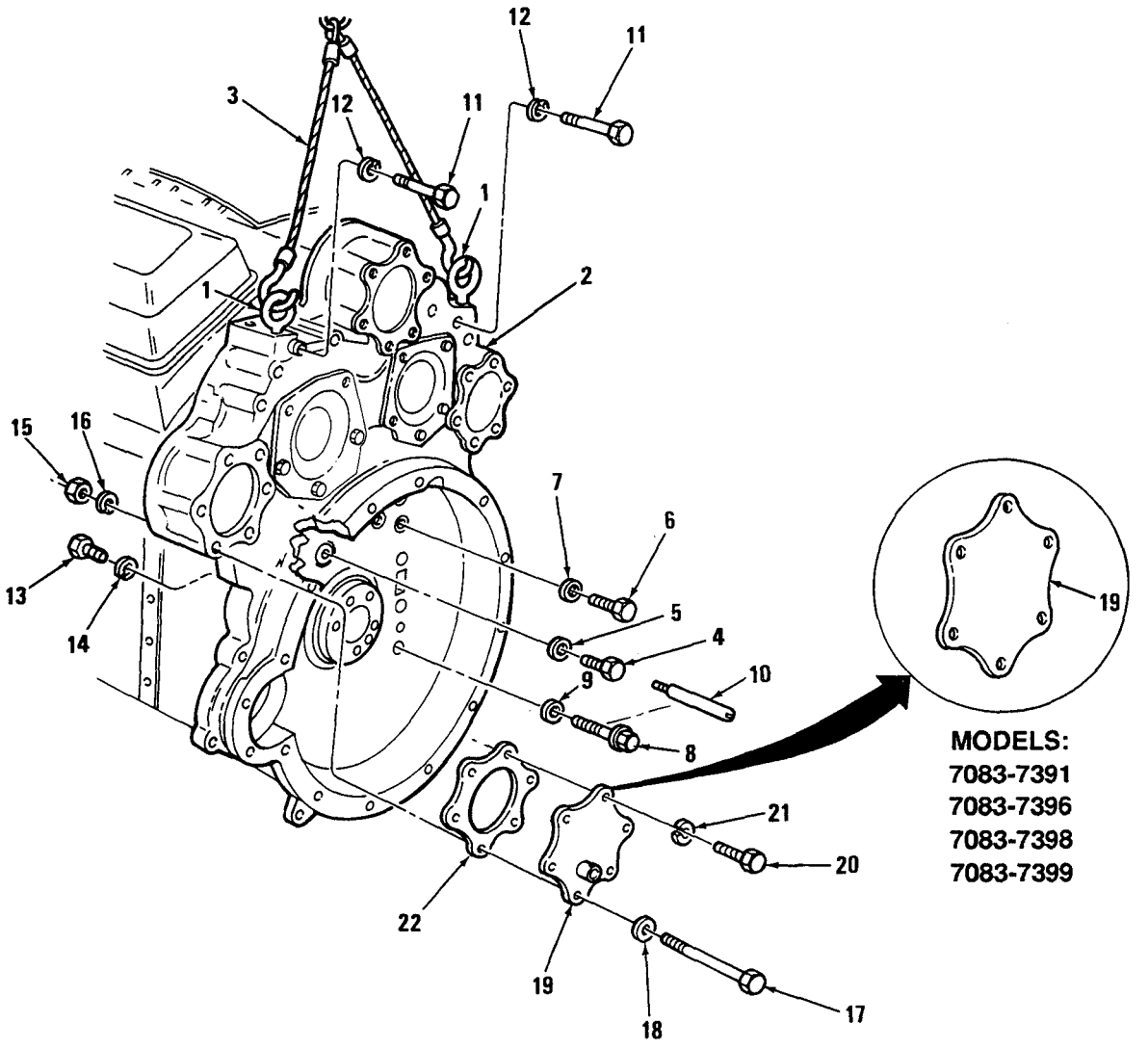
(2) Remove bolt (4), flat washer (5), three bolts (6), three flat washers (7), six bolts (8), and six flat washers (9) from bell of flywheel housing.

(3) Thread four guide studs (10) into cylinder block to guide flywheel housing clear of crankshaft.

(4) Remove seven bolts (11) and seven lockwashers (12) from upper part of flywheel housing. Discard lockwashers.

(5) Remove two bolts (13) and two lockwashers (14) from front of flywheel housing. Discard lockwashers.

(6) Remove four nuts (15), four lockwashers (16), four bolts (17), and four flat washers (18) from access cover (19). Remove two bolts (20) and two lockwashers (21) from cover (19). Remove cover (19) and gasket (22) from flywheel housing. Discard gasket and lockwashers.



4-24. FLYWHEEL HOUSING REPLACEMENT (Cont)

(7) For models 7083-7391,7083-7395, and 7083-7396, remove five bolts. (23), five lockwashers (24), bolt (25), and copper washer (26) from right bank flywheel housing cover (27). Remove cover (27) and gasket (28) from flywheel housing. Discard gasket, copper washer, and lockwashers.

(8) Remove bolt (29) and lockwasher (30) from right side of flywheel housing behind cover (27). Discard lockwasher.

NOTE

For model 7083-7395, remove four bolts (31) and four lockwashers (32) (other four attaching bolts and lockwashers were removed with turbocharger mounting bracket).

For models 7083-7391,7083-7396, 7083-7398, and 7083-7399, remove eight bolts (31) and four lockwashers (32).

(9) Remove two bolts (33), two flat washers (34), bolts (31), and lockwashers (32) from two flywheel housing inspection covers (35). Remove covers and mating gaskets (36) from flywheel housing. Discard gaskets and lockwashers.

NOTE

Effective after engine number 8VA-349268, shim (37) is used with flywheel housing.

(1 O) Strike front face of housing on each side alternately with a soft headed hammer to work it off dowels and away from cylinder block end plate. Remove housing (2), shim (37), and flywheel housing gasket (38) from engine. Discard gasket.

(11) Remove four guide studs (10) from cylinder block.

b. Cleaning/Inspection

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). **If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.**

(1) Clean the flywheel housing with cleaning solvent.

(2) Inspect flywheel housing for cracks or damage.

c. Installation

(1) Lubricate gear teeth with clean engine oil.

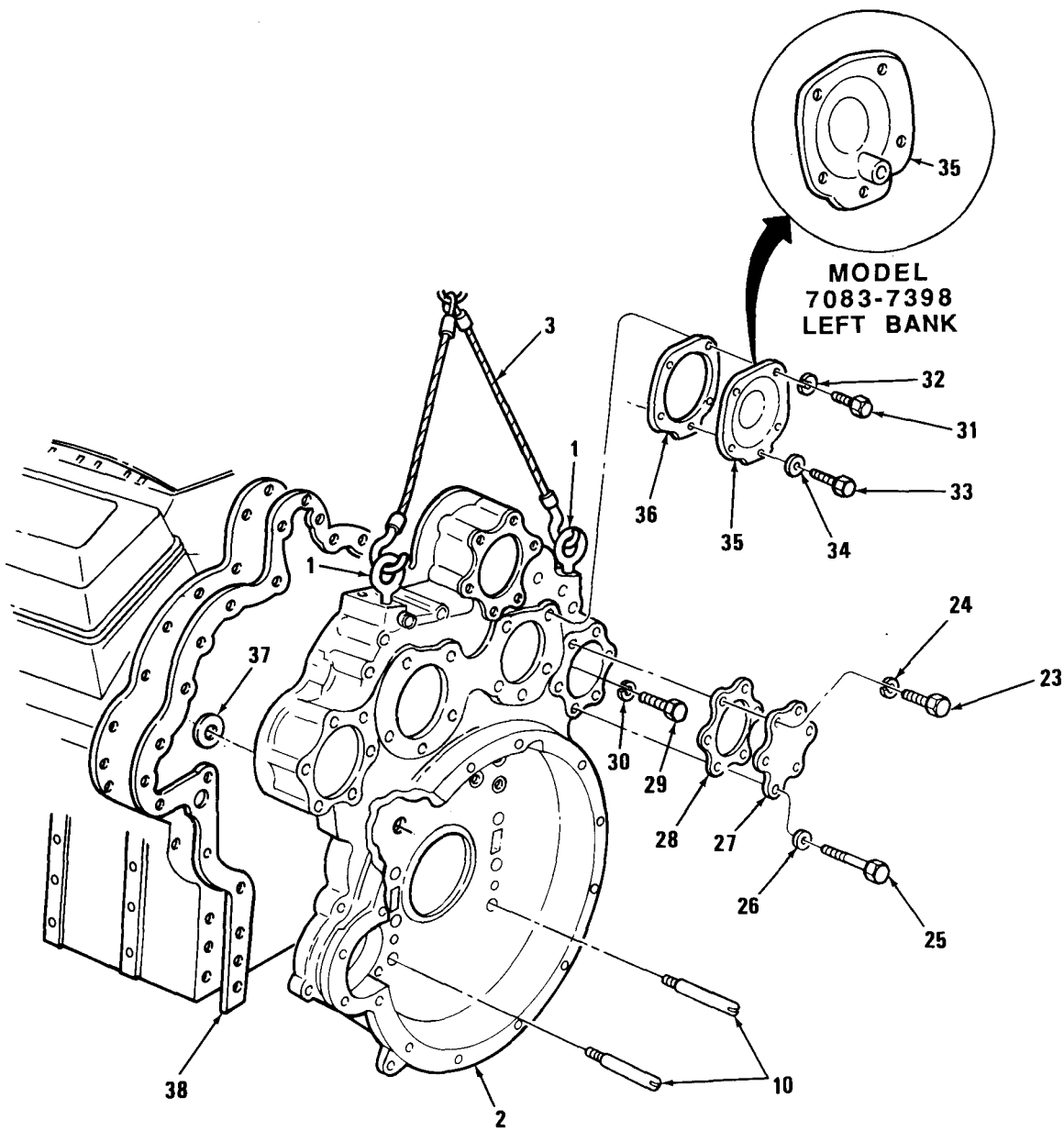
NOTE

Effective after engine number 8VA-349268, shim (37) is used with flywheel housing.

(2) Affix gasket (38) to flywheel housing (2) using nonhardening sealant. Install shim (37) to integral cast spacer on flywheel housing using grease to hold it in position.

(3) Thread four guide studs (1 O) into cylinder block to guide housing in position.

(4) Using multiple sling (3) and chain hoist, position flywheel housing over crankshaft and up against cylinder block end plate.



4-24. FLYWHEEL HOUSING REPLACEMENT (Cont)

NOTE

- Install all flywheel housing attaching bolts finger tight.
- Insure shim (37) is in position before installing bolt (4) and flat washer (5).
- Effective after engine number 8VA-349268, bolt (4) and flat washer (5) is used with flywheel housing.

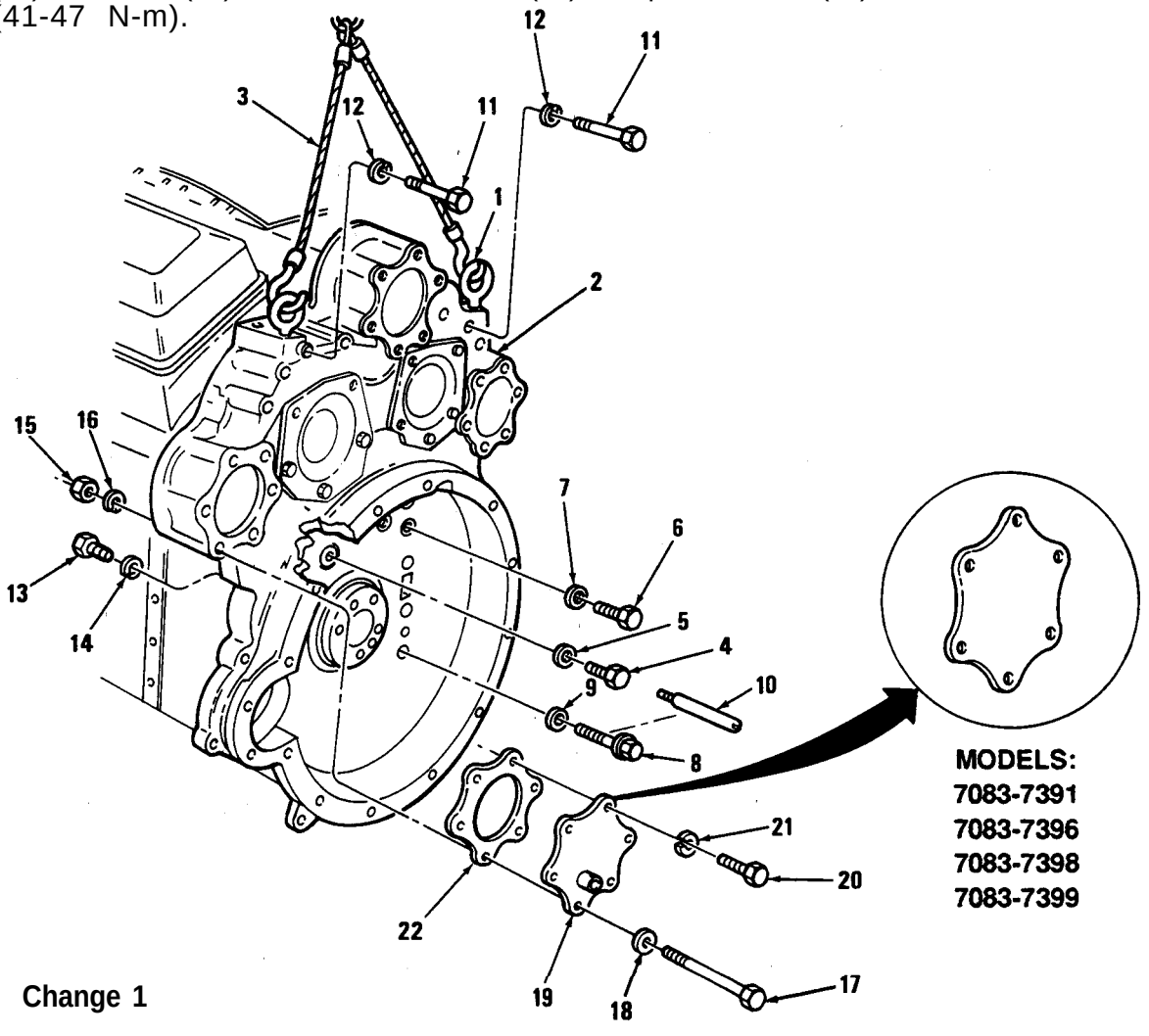
(5) Install bolt (4), flat washer (5), three bolts (6), and three flat washers (7) into bell area of flywheel housing.

(6) Remove four guide studs (10). Install six bolts (8) and six flat washers (9) into bell area of flywheel housing.

(7) Install seven bolts (11) and seven lockwashers (12) to upper partof flywheel housing.

(8) Install two bolts (13) and two lockwashers (14) to front of flywheel housing (one on each side).

(9) Install gasket (22) and access cover (19) to left bank inspection hole in flywheel housing. Secure in place with four bolts (17), four flat washers (18), four lockwashers (16), four nuts (15),t wo bolts (20), and two lockwashers (21). Torque two bolts (20) to 30-35 lb-ft (41-47 N-m).



(10) Install bolt (29) and lockwasher (30) to right side of flywheel housing.

CAUTION

When tightening idler gear hub bolts, turn engine crankshaft to prevent any bind of idler gear bearing. Also rotate crankshaft when tightening flywheel housing bell bolts.

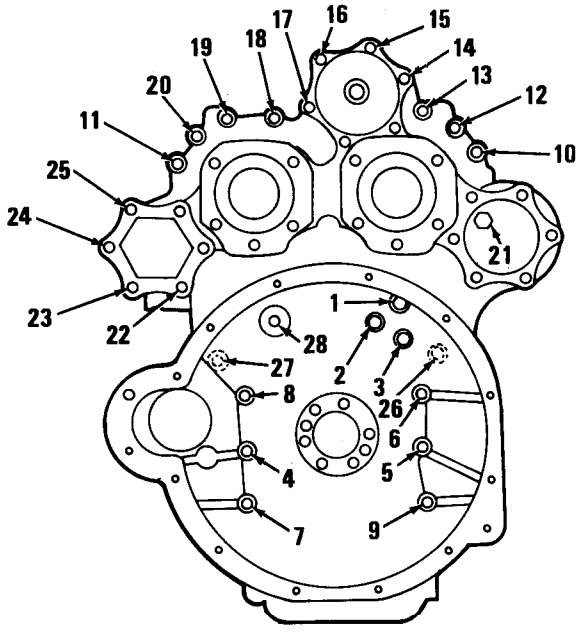
(11) Tighten flywheel housing attaching bolts to specifications shown in Table 4-1 (Operation 1). Draw mating parts together evenly. See Operation 1 figure for initial bolt tightening sequence.

(12) Torque all flywheel housing attaching bolts to specifications shown in Table 4-1 (Operation 2). Refer to Operation 2 figure for final bolt tightening sequence.

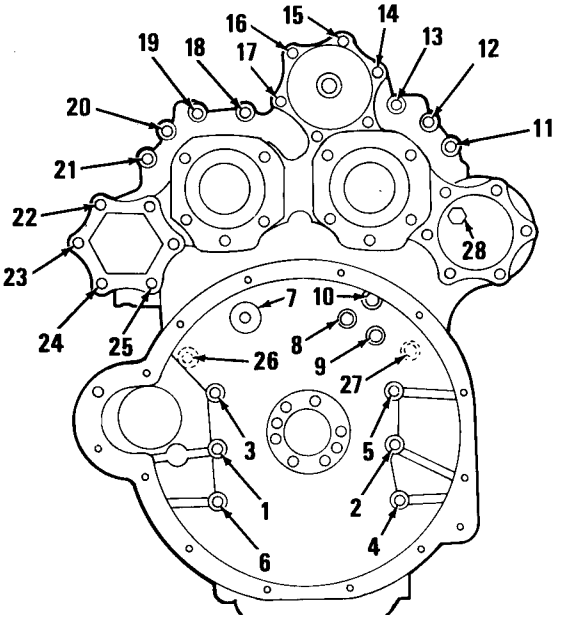
TABLE 4-1 FLYWHEEL BOLT TORQUE SPECIFICATIONS

Item	Bolt Size	Quantity	Torque Operation 1	Torque Operation 2
8	1/2-13x3 1/4	6	60-65 lb-ft (81-88 N-m)	71-75 lb-ft (96-102 N-m)
4	1/2-13x2 3/8	1	60-65 lb-ft (81-88 N-m)	71-75 lb-ft (96-102 N-m)
6	3/8-16x1 1/8	3	30-35 lb-ft (41-47 N-m)	40-45 lb-ft (54-61 N-m)
11	3/8-24x3 7/8	7	15-20 lb-ft (20-27 N-m)	25-30 lb-ft (34-41 N-m)
17	3/8-24x4 1/2	4 *	15-20 lb-ft (20-27 N-m)	25-30 lb-ft (34-41 N-m)
29	3/8-16x1 1/4	1	20-25 lb-ft (27-34 N-m)	30-35 lb-ft (41-47 N-m)
13	3/8-16x7/8	2	20-25 lb-ft (27-34 N-m)	30-35 lb-ft (41-47 N-m)

* Three 3/8-24x4 1/2 inch bolts and one 3/8-24x4 3/4 inch bolt required for model 7083-7398.



OPERATION 1



OPERATION 2

4-24. FLYWHEEL HOUSING REPLACEMENT (Cont)

NOTE

Cover (27) is not used on models 7083-7398 and 7083-7399.

(13) Install gasket (28) and cover (27) to right side of flywheel housing. Secure in place with five bolts (23), five lockwashers (24), bolt (25), and copper washer (26). Torque bolts to 30-35 lb-ft (41-47 N-m).

NOTE

- Do not torque cover bolts until turbocharger mounting bracket is installed (model 7083-7395).
- For model 7083-7395, install four bolts (31) and four lockwashers (32). For models 7083-7391, 7083-7396, 7083-7398, and 7083-7399, install eight bolts (31) and four lockwashers (32).

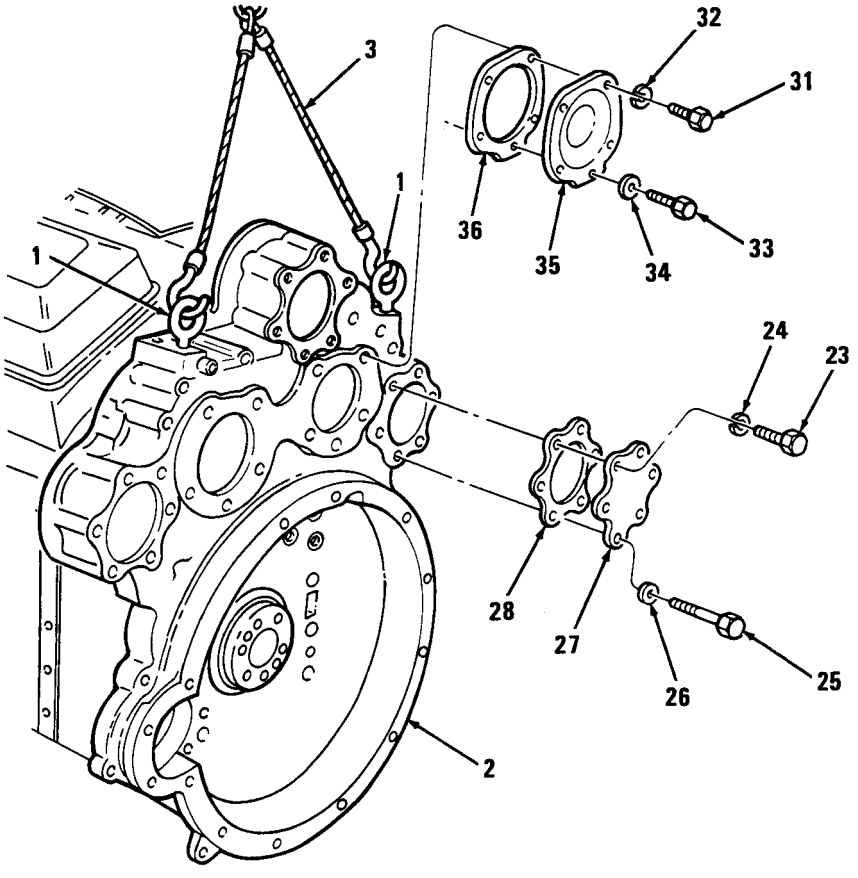
(14) Install two gaskets (36) and two covers (35) to flywheel housing. Secure in place with two bolts (33), two flat washers (34), bolts (31), and lockwashers (32). Torque bolts to 30-35 lb-ft (41-47 N-m).

(15) Remove lifting sling (3) and two eye bolts (1) from flywheel housing (2).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
6-16 Install crankcase breather
6-4 Install exhaust manifold and tube (7083-7398)
4-23 Install rear oil seal
4-22 Install flywheel
4-20 install oil pan
4-19 Install blower drive
4-2 Install turbocharger mounting bracket (7083-7395)



4-25. IDLER GEAR REPLACEMENT

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

INITIAL SETUP

MODELS

All

TOOLS/SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Bearing test fixture (App D, Item 2)
Magnetic base dial indicator (App B, Item 45)
Spring scale (App B, Item 24)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT (PARTS)

6 Bolts (App F, Item 4)

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)
Engine oil (App C, Item 16)
Lintless cord (App C, Item 26)

EQUIPMENT CONDITION

Para Description
4-24 Flywheel housing removed

NOTE

Before removing idler gear assembly from engine, check idler gear assembly for any wobble or shake. Firmly grasp rim of gear with both hands and rock it. If gear wobbles or shakes, bearing is bad and must be replaced.

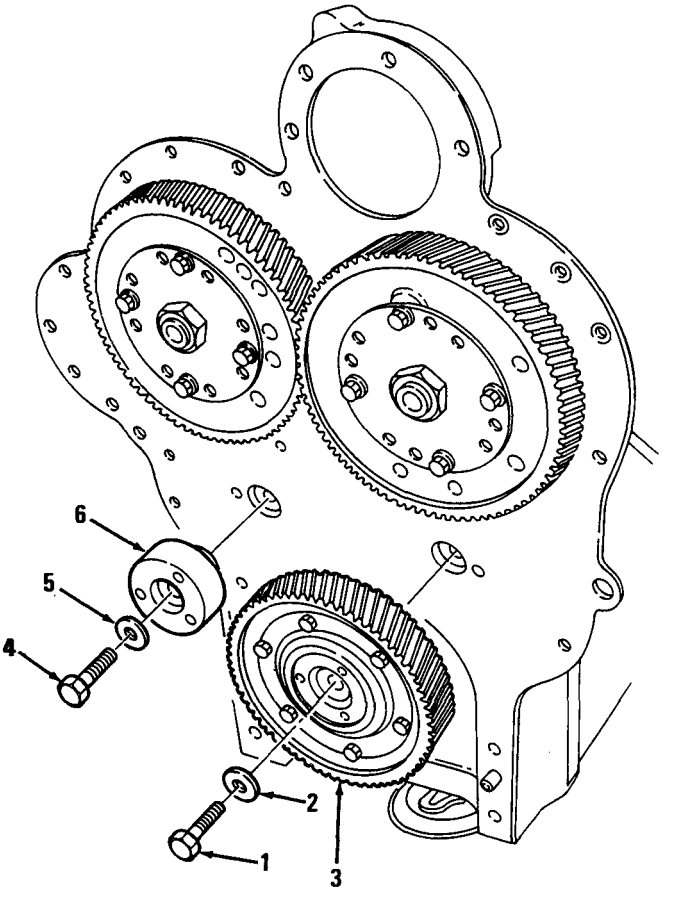
a. Removal

(1) Remove bolt (1) and flat washer (2) securing idler gear assembly (3) to cylinder block. Remove idler gear assembly from engine block.

NOTE

Effective up to engine number 8VA-349267, a dummy hub was installed opposite idler gear hub to fit the original flywheel housing.

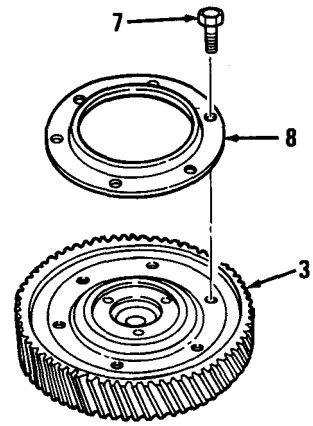
(2) Remove bolt (4) and flat washer (5) securing dummy hub (6) to cylinder block. Remove dummy hub (6) from engine block.



4-25. IDLER GEAR REPLACEMENT (Cont)

b. Disassembly

(1) Remove six bolts (7) securing bearing retainer (8) to idler gear assembly (3). Remove retainer. Discard bolts.



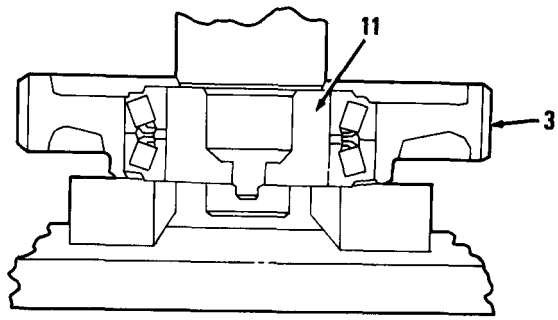
NOTE

Each bearing cone and bearing cup of idler gear assembly are a matched set. During disassembly, match mark bearing to cup to ensure proper reassembly.

(2) Place idler gear assembly (3) in arbor press with inner bearing cone supported on steel blocks.

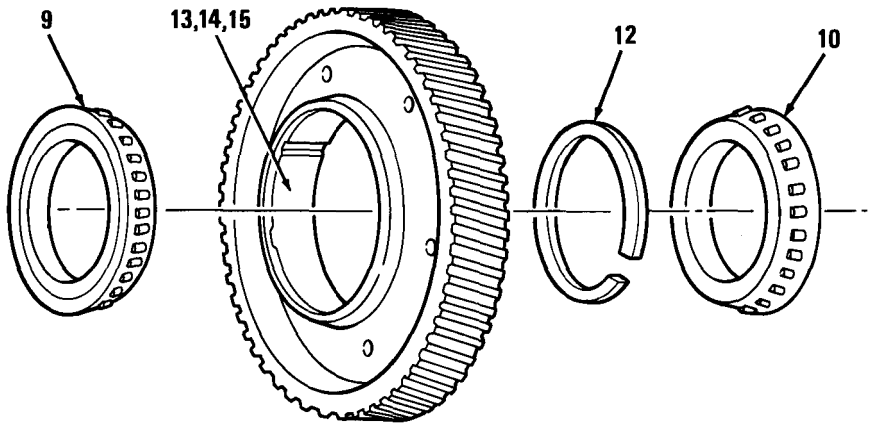
CAUTION

Idler gear assembly (3) must be rotated during pressing operation to prevent damage to bearing cones (9 and 10).



(3) Simultaneously rotate idler gear assembly (3) and press hub (11) out of bearing cones (9 and 10). Remove gear assembly from press.

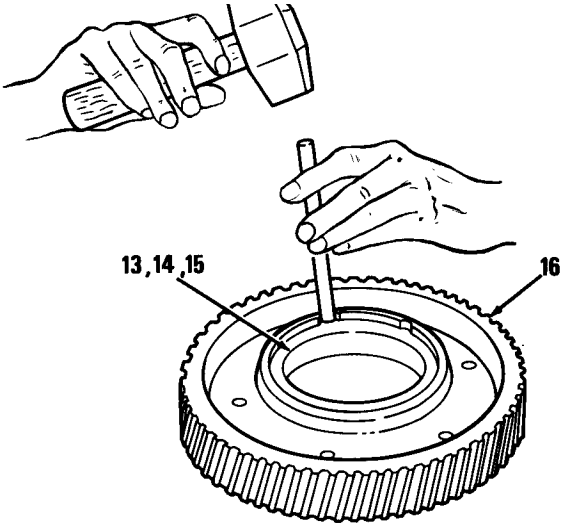
(4) Remove bearing cones (9 and 10) and inner spacer ring (12).



NOTE

Do not remove bearing cups (13 and 14) and spacer ring (15) unless loose or damaged.

(5) Tap bearing cups (13 and 14) and outer spacer ring (15) out of idler gear (16) using a brass rod alternating around four notches on shoulder of gear.



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) Clean all parts using fuel oil. Dry with compressed air.

(2) Inspect all parts and replace if worn or damaged.

NOTE

Replace bearing cones, cups, and spacer rings as a set.

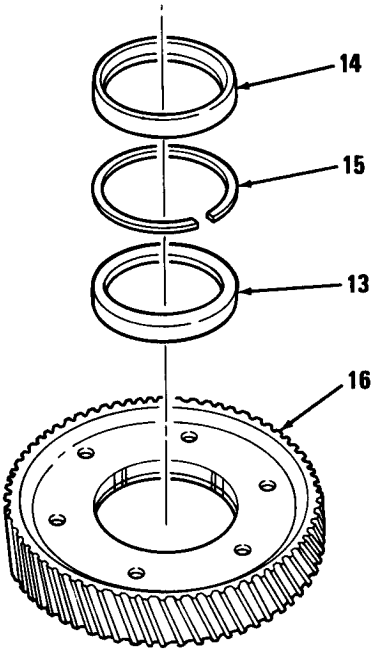
(3) Coat all parts with engine oil.

d. Assembly

(1) Place idler gear (16) shoulder down on bed of arbor press.

(2) Place inner bearing cup (13), numbered side up, into bore of gear. Press bearing cup against shoulder of gear (16) using a steel plate under ram of arbor press.

(3) Lay outer spacer ring (15) on face of bearing cup (13).



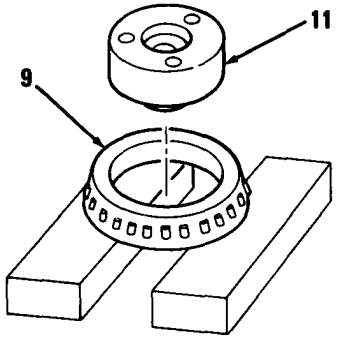
4-25. IDLER GEAR REPLACEMENT (Cont)

(4) Lay outer bearing cup (14), numbered side down, on top of outer spacer ring (1 5). Using a steel plate under ram of arbor press, press bearing cup into bore of gear until seated against outer-spacer ring.

(5) Place inner bearing cone (9), outside face down, on parallel bars on bed of arbor press. Press idler gear hub (11) into inner bearing cone until inner hub mounting face is flush with inner bearing cone outside face.

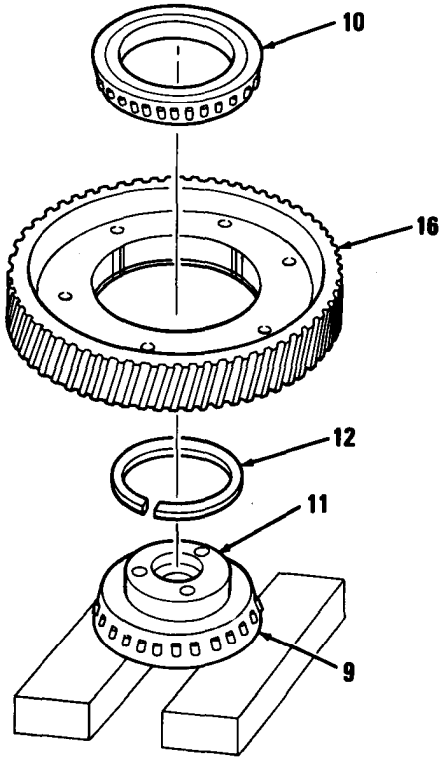
(6) Install inner spacer ring (12) on idler gear hub so oil hole in hub is 180° from gap in inner spacer ring.

(7) Place idler gear (16) and cups over hub (11) and inner bearing cone. Place outer bearing cone (10) over hub.



CAUTION

- Inner bearing cone and hub mounting face must be supported so bearing rollers are not loaded during this assembly operation.
- Turn idler gear while installing outer bearing cone on hub to prevent damage.



(8) Press outer bearing cone (10) onto hub while rotating idler gear (16) to seat rollers.

(9) Hold hub (11) and turn gear assembly (3) to see if binding occurs.

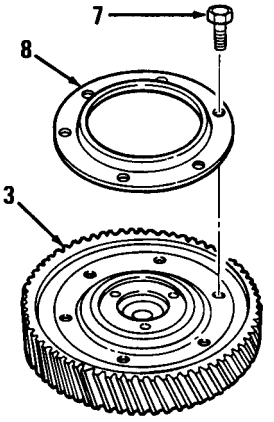
NOTE

Bearings must be clean and lubricated with engine oil before checking preload. Work in bearings by rotating gear back and forth several times.

4-25. IDLER GEAR REPLACEMENT (Cont)

(10) Mount idler gear assembly (3) in soft jaw vise.

(11) Install retainer (8) and six bolts (7) on idler gear assembly (3). Torque bolts to 24-29 lb-ft (33-39 N-m).



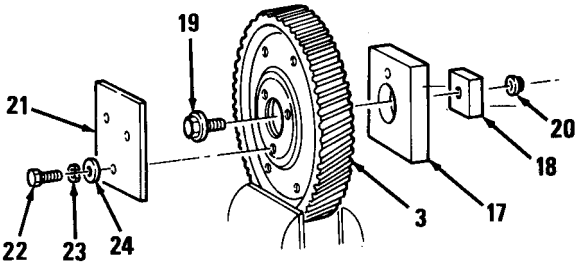
(12) Mount two test fixture plates (17 and 18) on idler gear (3) with bolt (19) and nut (20). Torque to 80-90 lb-ft (108-122 N-m).

(13) Mount test fixture plate (21) to gear assembly (3) with three bolts (22), three lockwashers (23), and three flat washers (24). Torque bolts to 25-40 lb-ft (34-54 N-m).

(14) Secure plate (18) in jaws of vise.

(15) Wrap lintless cord several times around gear assembly (3) and attach to spring scale.

(16) Pull gear assembly (3) at least three times and record pull required to start moving gear.



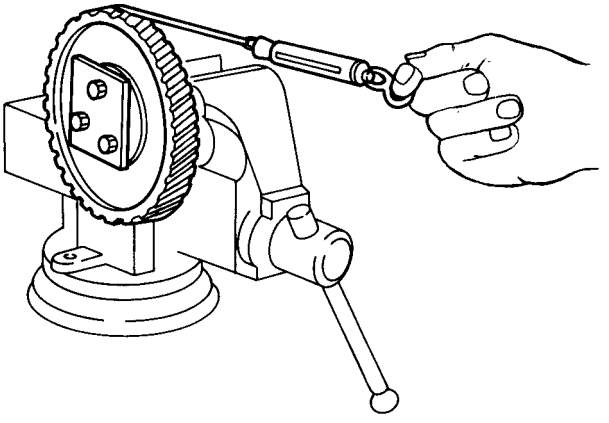
NOTE

Pull must be more than 0.5 lbs (0.23 kg) and less than 4.0 lbs (1.8 kg) and fluctuation less than 2.7 lbs (1.22 kg) to assure idler gear and bearing assembly are satisfactory for use.

(17) Secure gear assembly (3) in soft jaw vise.

(18) Remove three bolts (22), three lockwashers (23), three flat washers (24), and test fixture plate (21).

(19) Remove nut (20), bolt (19), and two test fixture plates (17 and 18).



4-25. IDLER GEAR REPLACEMENT (Cont)

e. Installation

(1) Aline timing marks on camshaft gear (25) and crankshaft gear (26) with timing marks on idler gear assembly (3).

(2) Slide idler gear assembly (3) into position until crankshaft gear and camshaft gear are fully meshed.

(3) Rotate gear hub (11) until dowel alines with hole in end plate. Tap hub until it seats against end plate.

(4) Install bolt (1) and flat washer (2) securing idler gear assembly (3) to cylinder block. Torque bolt to 80-90 lb-ft (108-122 N-m).

NOTE

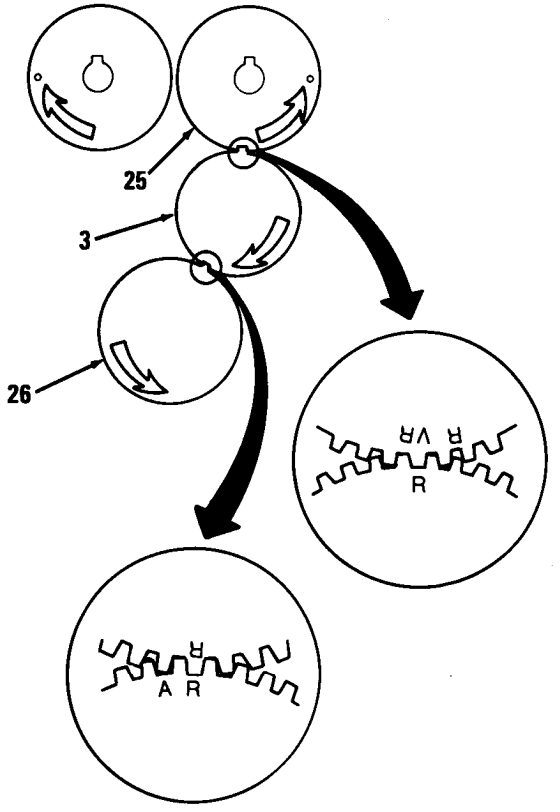
Backlash can only be checked with cylinder head removed,

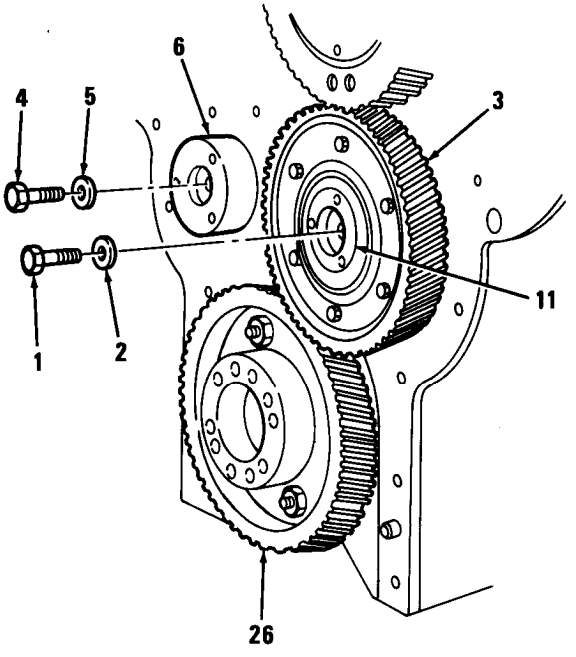
(5) Mount dial indicator on end plate and check backlash between idler gear assembly (3) and mating gears. Minimum backlash is 0.002 in.. Maximum backlash is 0.008 in. for new gears and 0.010 in. for used gears.

NOTE

Effective up to engine number 8VA-349267, a dummy hub was installed opposite idler gear hub to fit the original flywheel housing.

(6) Install dummy hub (6) on end plate. Install bolt (4) and flat washer (5). Torque bolt to 80-90 lb-ft (108-122 N-m).





END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-24 Install flywheel housing

4-26. INJECTOR CONTROL TUBES & THROTTLE DELAY REPLACEMENT

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

INITIAL SETUP

MODELS

■ All

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)

EQUIPMENT CONDITION

Para	Description
4-11	Rocker arm covers removed
4-17	Fuel control rods disconnected

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Cotter pin (App F, Item 7)
2 Lockwashers (App F, Item 91)

a. Removal

NOTE

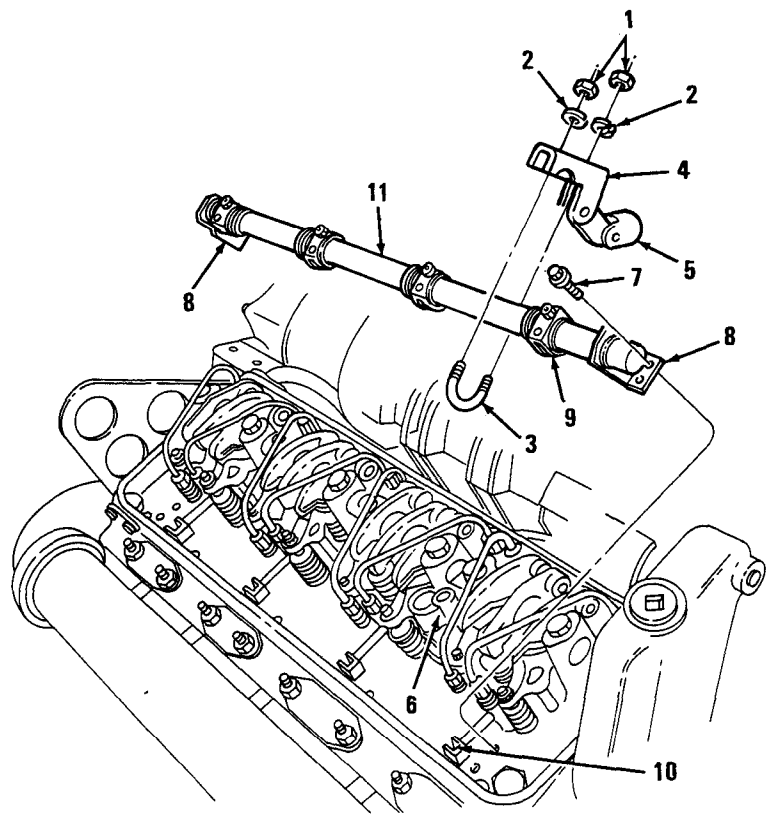
Steps (1) and (2) for throttle delay assembly only apply to models 7083-7395 and 7083-7396.

(1) Remove two nuts (1), two lockwashers (2), and U-bolt (3) from throttle delay bracket (4). Discard lockwashers.

(2) Remove piston and linkage assembly (5) from throttle delay housing (6).

(3) Remove four bolts (7) securing injector control tube brackets (8) to cylinder head.

(4) Disengage rack levers (9) from injector control racks (10) and lift tube assembly (11) from cylinder head.



b. Disassembly

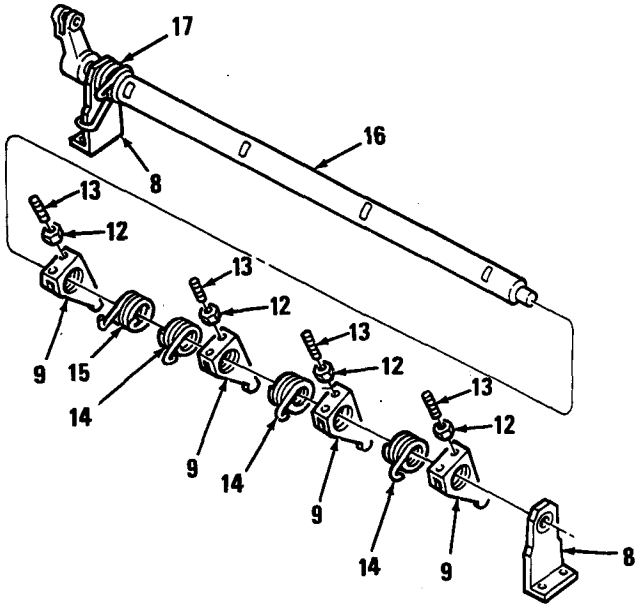
(1) Injector control tube

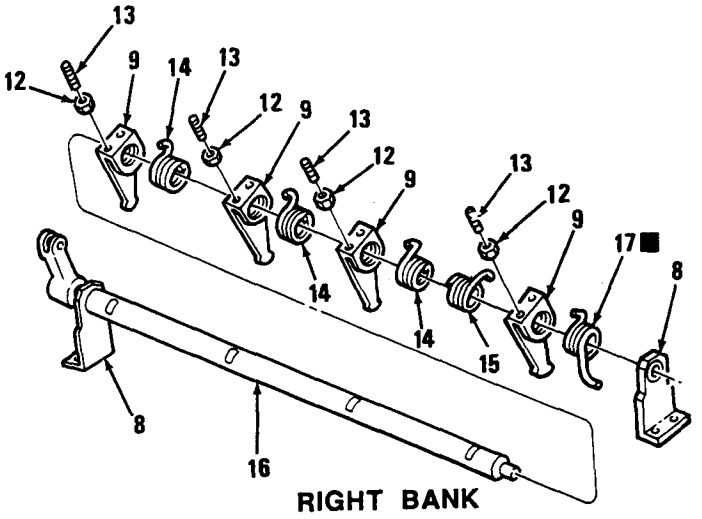
(a) Remove bracket (8) from rear of left bank injector control tube assembly.

(b) Loosen four nuts (12) and four adjusting screws (13) from control levers (9).

(c) Disconnect three right hand helix yield springs (14) and left hand helix yield spring (15) from four control levers (9). Roll yield springs out of slots and notches of control tube (16).

(d) Disconnect return spring (17) from bracket (8) and control lever (9) at front of left bank control tube and at rear of right bank control tube.





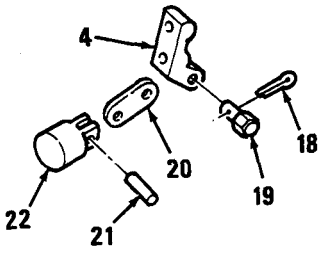
(e) Remove bracket (8) from rear of right bank control tube assembly.

(f) Slide four control levers (9), four yield springs (14) and (15), and return spring (17) off rear of each control tube (16).

(2) Throttle delay assembly

(a) Remove cotter pin (18) from pin (19). Slide pin (19) from bracket (4) and link (20).

(b) Remove pin (21) from piston (22) and link (20).



c. Cleanlng/inspection

WARNING

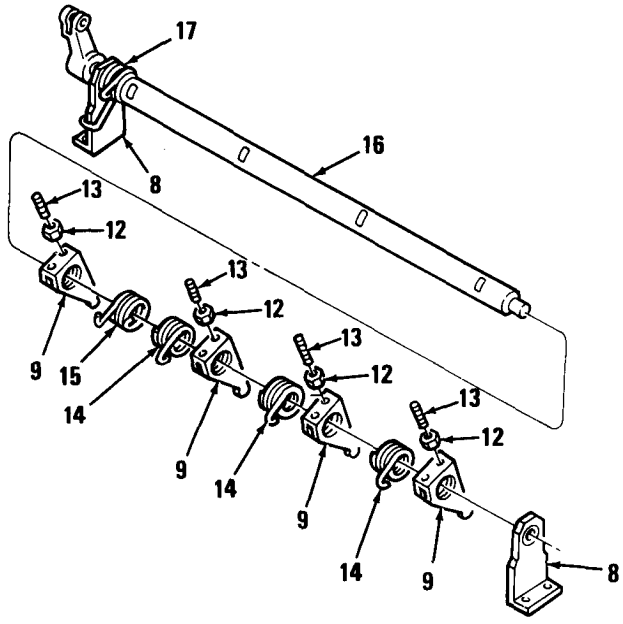
Compressed air used for cleaning purposes will not exceed 30 psi. Use only with effective chip guarding and personal protective equipment (goggles/ shield, gloves, etc).

(1) Wash components with fuel oil and dry with compressed air.

(2) Inspect components for excessive wear, cracks, or damage and replace if necessary.

d. Assembly

(1) Left bank injector control tube



LEFT BANK

(a) Install return spring (17) on control tube (16) and against front bracket (8).

(b) Install control lever (9) and left hand helix yield spring (15) on control tube (16). Control lever must face rear of control tube.

(c) Install three right hand helix yield springs (14) and three control levers (9) on control tube (16). Control levers must face rear of control tube.

(d) Attach curled end of four yield springs (14 and 15) to four control levers (9) and roll yield springs into notch or slots in control tube (16). Turn four adjusting screws (13) with four nuts (12) into slots far enough to position levers on control tube.

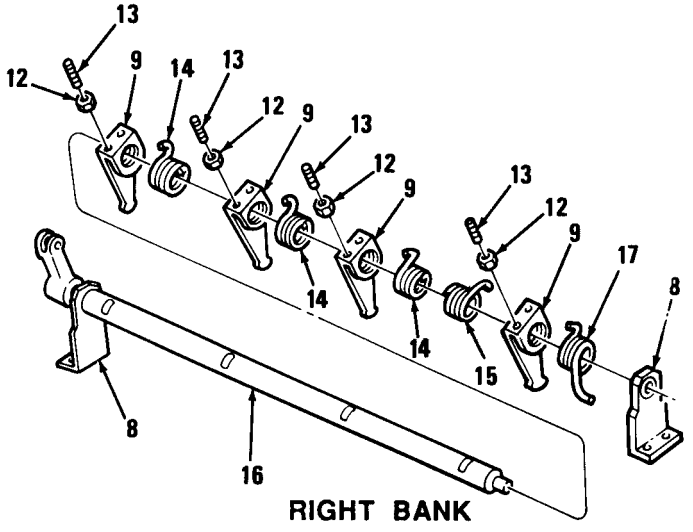
(e) Attach curled end of control tube return spring (17) to control lever (9) and extended end of spring behind front bracket (8).

(f) Install bracket (8) to rear of control tube (16).

(2) Right bank injector control tube

(a) Install three control levers (9) and three right hand helix yield springs (14) on control tube (16). Control lever must face front of control tube.

(b) Install left hand helix yield spring (15) and control lever (9) on control tube (16). Control lever must face front of control tube.



RIGHT BANK

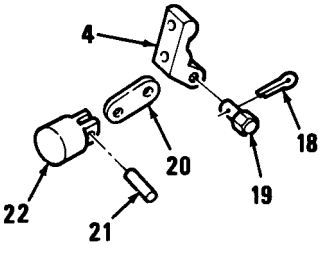
(c) Attach curled end of four yield springs (14 and 15) to four control levers (9) and roll springs into notch or slots in control tube (16). Turn four adjusting screws (13) with four nuts (12) into slots far enough to position levers on control tube.

(d) Install control tube return spring (17) and bracket (8) at rear of control tube (16). Attach curled end of return spring to control lever and extended end of spring behind bracket.

(3) Throttle delay assembly

(a) Connect link (20) to piston (22) **with** pin (21).

(b) Connect link (20) to bracket (4) with pin (19) and cotter pin (18).



e. Installation

(1) Place injector control tube assembly (11) on cylinder head and install four bolts (7) through end brackets (8) and into cylinder head. Tighten bolts finger tight. Insure ball end of injector rack control lever engages in slot of injector control rack. Torque bolts (7) to 10-12 Ib-ft (14-16 N-m).

(2) Check control tube to be sure it is free in brackets. If necessary, tap control tube lightly to aline bearing in brackets.

NOTE

Steps (3) and (4) for throttle delay assembly only applies to models 7083-7395 and 7083-7396.

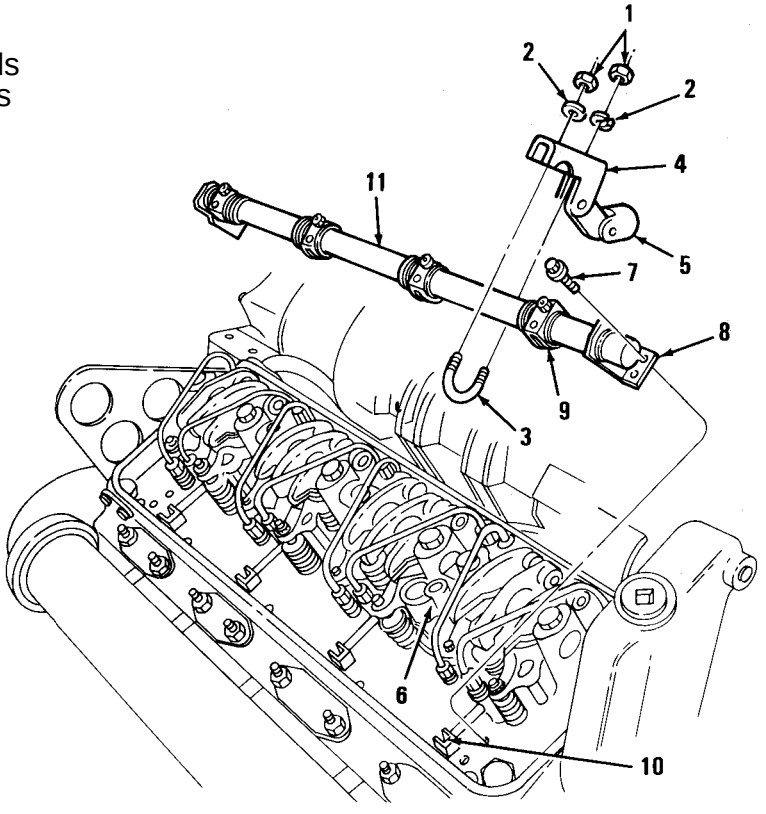
(3) Slide throttle delay piston and linkage assembly (5) in bore of housing (6),

(4) Place U-bolt (3) around control tube and through bracket (4). Secure in position with two nuts (1) and two lockwashers (2). Tighten nuts to 7-9 Ib-ft (9~12 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-17 Connect fuel control rods
4-11 Install rocker arm covers



4-27. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B Item 96)
Cylinder head lifting fixture (App B Item 19)
Guide studs (App B, Item 88)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

2	Seal rings (App F, Item 134)
8	Compression gaskets (App F, Item 83)
2	Seal rings (App F, Item 136)
	Seal rings (App F, Item 137)
12	Seal rings (App F, Item 138)

EXPENDABLE/DURABLE SUPPLIES

International compound no. 2 (App C, Item 24)

EQUIPMENT CONDITION

Para	Description
4-2	Turbocharger oil line clips removed (7083-7395)
4-3	Exhaust manifolds removed (7083-7395)

EQUIPMENT CONDITION (Cent)

Para	Description
4-6	Fuel lines removed (7083-7395 and 7083-7398)
4-8	Thermostat housings removed (7083-7395 and 7083-7398)
4-10	Air box heater removed (7083-7395 and 7083-7396)
4-11	Rocker arm covers removed
4-15	Block mounted breather disconnected (Except 7083-7398 and 7083-7399)
4-17	Governor cover and throttle-control rods
4-18	Fuel rod hoses detached
4-26	Injector control tubes removed
5-3	Exhaust manifolds removed (7083-7391 and 7083-7396)
5-4	Fuel lines removed (7083-7396 and 7083-7399)
5-6	Water manifolds removed (7083-7396 and 7083-7399)
5.1-4	Fuel lines removed (7083-7391)
5.1-6	Water manifolds removed (7083-7391)
5.1-8	Glow plug harness removed (7083-7391)
5.1-11	Air inlet by-pass valve hoses detached (7083-7391)
6-4	Exhaust manifolds removed (7083-7398)
6-11	Air box heater removed (7083-7398 and 7083-7399)
7 - 4	Exhaust manifolds removed (7083-7399)

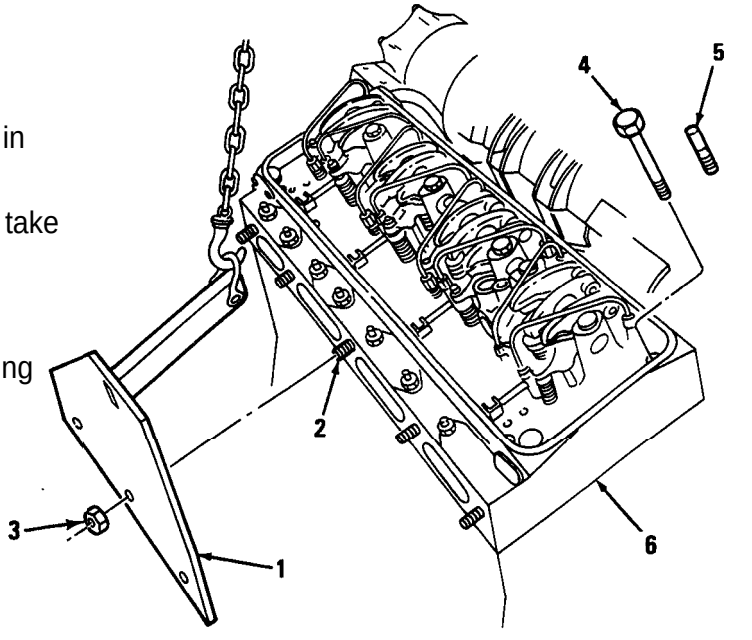
a. Removal

(1) Attach lifting bracket (1) to center three exhaust manifold studs (2) located at outboard side of cylinder head. Secure in place with three 7/1 6-20-inch nuts (3).

(2) Attach a chain to lifting bracket (1) and take up slack in chain.

(3) Remove two cylinder head bolts (4) at outboard corners of cylinder head and install guide studs (5). Remove remaining eight cylinder head bolts (4).

(4) Lift cylinder head assembly (6) from cylinder block.



CAUTION

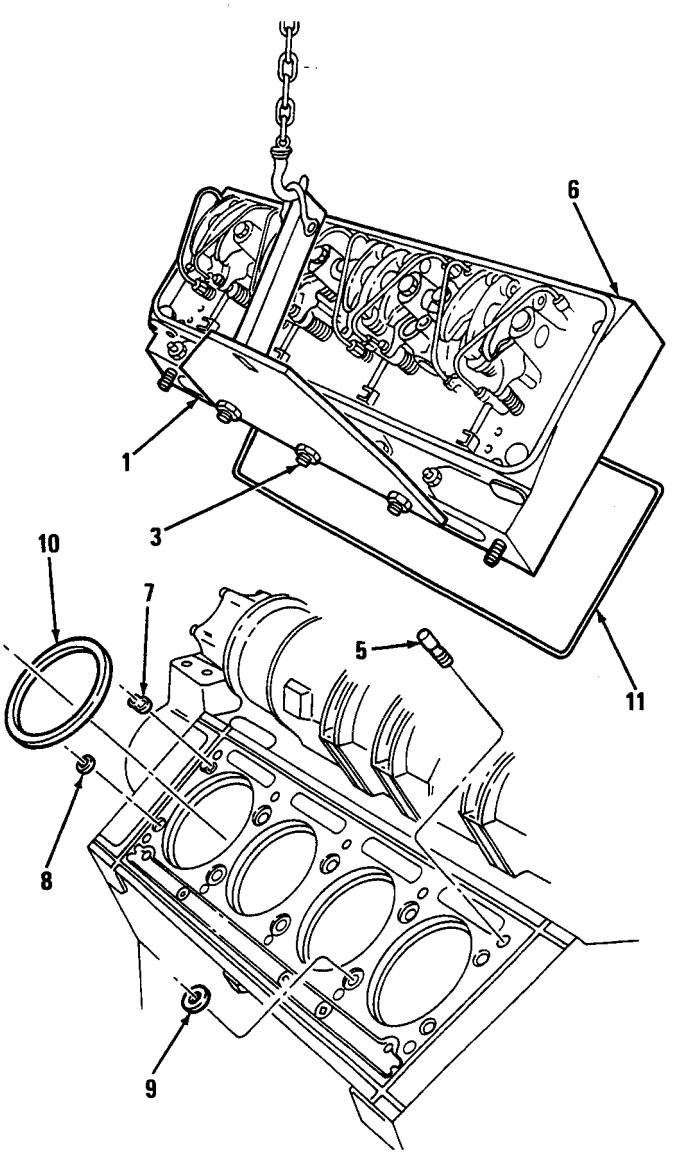
- Model 7083-7391 has exhaust shields cast in place in the exhaust ports of cylinder head. Do not pry or lift in exhaust ports or damage to cylinder head will result.
- When placing cylinder head on bench, protect cam followers, glow plugs (7083-7391 only), and fuel injector tips by placing two-inch thick wooden blocks underneath each end of head,

(5) Remove two guide studs (5) from cylinder block.

(6) Remove figure eight seal ring (7), three seal rings (8), six seal rings (9), four compression gaskets (10), and gasket (11) from cylinder bank. Discard seal rings and gaskets.

(7) Remove lifting bracket (1) from cylinder head by removing three nuts (3).

(8) Repeat steps (1) thru (7) for opposite cylinder head.



b. Installation

(1) Install figure eight seal ring (7), three seal rings (8), six seal rings (9), four compression gaskets (10), and gasket (11) to cylinder bank.

(2) Install two guide studs (5) in cylinder head bolt holes at outboard corner positions in cylinder block.

(3) Attach lifting bracket (1) to center three exhaust manifold studs (2) located at outboard side of cylinder head. Secure in place with three 7/1 6-20 inch nuts (3).

CAUTION

Before installing cylinder head, insure all seal rings and gaskets are in place.

(4) Using chain hoist, lift cylinder head above cylinder block and lower over guide studs (5). Lower head to 1/2 inch from surface of cylinder block.

4-27. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION (Cont.)

(5) Apply International Compound No. 2 to cylinder head bolt threads arid underside of bolt heads. Install eight bolts (4) through cylinder head and thread into cylinder block, Continue to lower head onto cylinder block and tighten bolts snug.

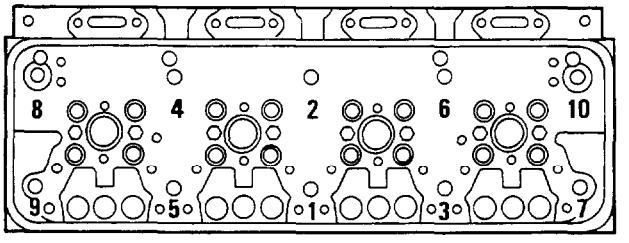
(6) Remove two guide studs (5) and install remaining two bolts (4). Tighten all bolts to 15-20 lb-ft (20-27 N-m) torque.

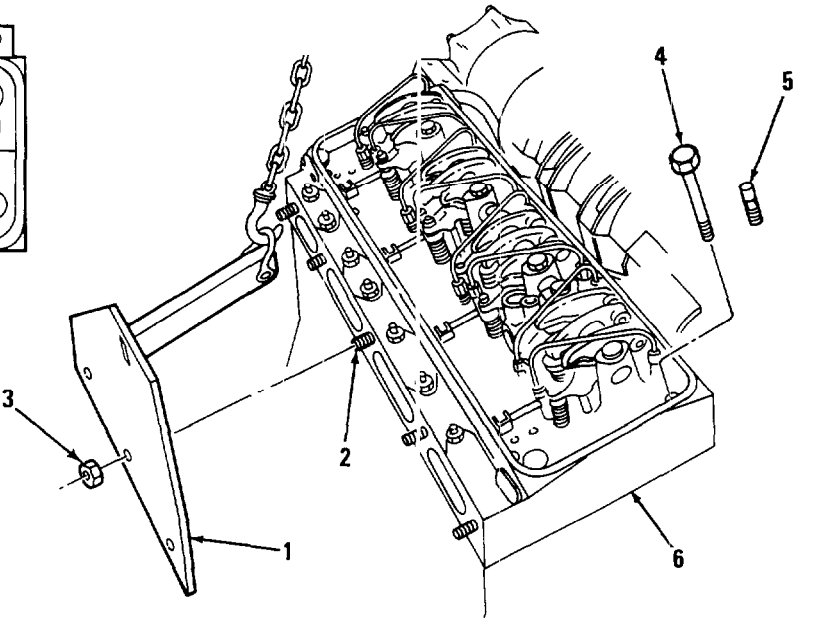
(7) Remove lifting bracket (1) from cylinder head (6) by removing three nuts (3).

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.

(8) Torque cylinder head bolts to 170-180 lb-ft (231-244 N-m) in 50 lb-ft (68 N-m) increments. Tighten bolts in sequence shown in cylinder head illustration below.





FOLLOW-ON MAINTENANCE

Para Description
7-4 Install exhaust manifolds (7083-7399)
6-11 Install air box heater (7083-7398 and 7083-7399)
6-4 Install exhaust manifolds (7083-7398)
5.1-11 Attach air inlet by-pass valve hoses (7083-7391)
5.1-8 Install glow plug harness (7083-7391)
5.1-6 Install water manifolds (7083-7391)
5.1-4 Install fuel lines (7083-7391)
5-6 Install water manifolds (7083-7396 and 7083-7399)
5-4 Install fuel lines (7083-7396 and 7083-7399)
5-3 Install exhaust manifolds (7083-7391 and 7083-7396)
4-26 Install injector control tubes
4-18 Attach fuel rod hoses
4-17 Install governor cover and throttle control rods
4-15 Connect block mounted breather (Except 7083-7398 and 7083-7399)
4-11 Install rocker arm covers
4-10 Install air box heater (7083-7395 and 7083-7396)
4-8 Install thermostat housings (7083-7395 and 7083-7398)
4-6 Install fuel lines (7083-7395 and 7083-7398)
4-3 Install exhaust manifolds (7083-7395)
4-2 Install turbocharger oil line clips (7083-7395)

4-28. ENGINE LOWER FRONT COVER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Torque wrench (App B, Item 102)
Oil seal installer (App B, Item 50)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 42)
2 LockWashers (App F, Item 93)
6 Lockwashers (App F, Item 95)
1 Seal (App F, Item 150)

EXPENDABLE/DURABLE SUPPLIES

Grease (App C, Item 22)
Nonhardening sealant (App C, Item 38)
Crocus cloth (App C, Item 12)

EQUIPMENT CONDITION

Para	Description
4-5	Fuel strainer removed
4-20	Oil pan removed

a. Removal

NOTE

Secure gear train in place to prevent crankshaft from turning when loosening crankshaft end bolt.

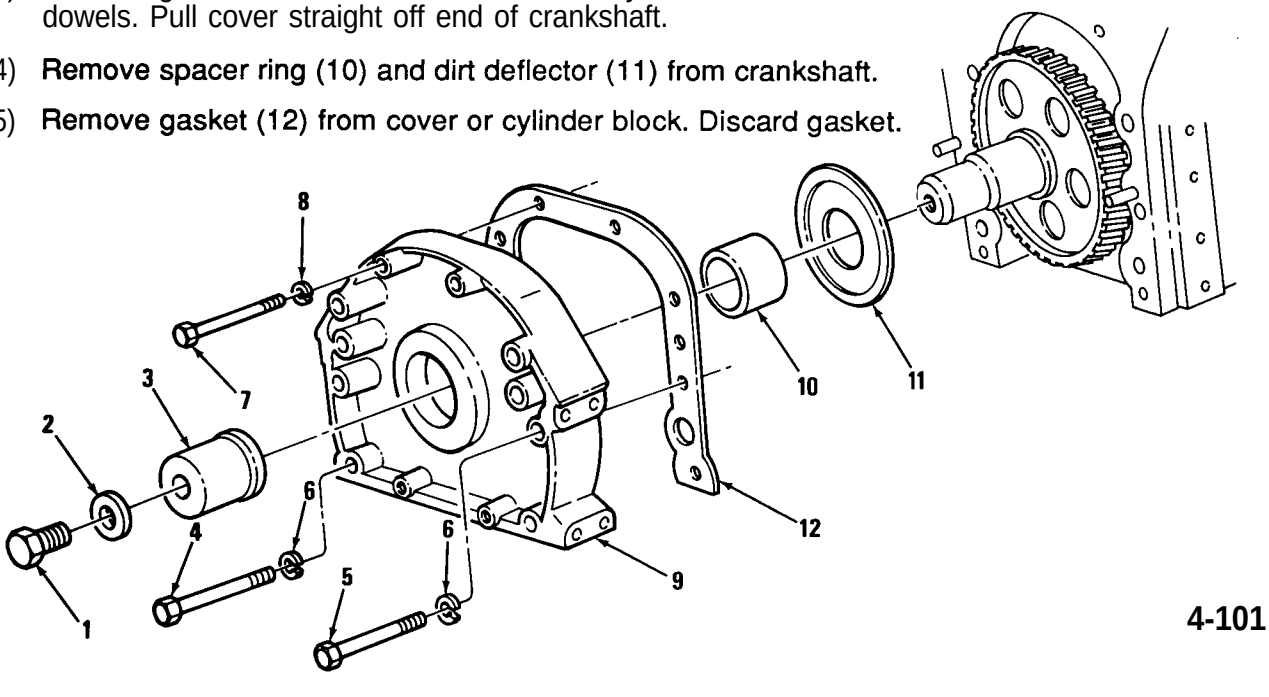
(1) Remove bolt (1) and washer (2) from front of crankshaft. Slide end cap (3) off crankshaft.

(2) Remove four bolts (4), two bolts (5), six lockwashers (6), two bolts (7), and two lockwashers (8) from front lower cover (9). Discard lockwashers.

(3) Strike edges of cover on each side alternately with a soft head hammer to free it from dowels. Pull cover straight off end of crankshaft.

(4) Remove spacer ring (10) and dirt deflector (11) from crankshaft.

(5) Remove gasket (12) from cover or cylinder block. Discard gasket.



4-28. ENGINE LOWER FRONT COVER REPLACEMENT (Cent)

b. Cleaning/inspection

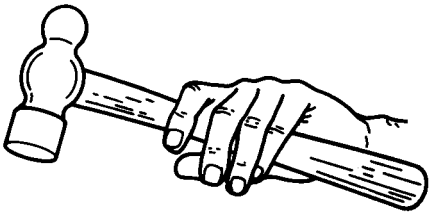
(1) Clean front cover and inspect sealing and mating surfaces for cracks, nicks, and damage that would prevent proper sealing.

(2) Check inside of spacer and crankshaft for burrs and nicks. Clean up burrs using crocus cloth in circular motion.

(3) Inspect spacer ring for nicks or burrs that would prevent proper sealing.

c. Repair/Replacement

(1) Support outer face of front cover (9) on two wooden blocks and drive seal (13) out with a soft drift. Discard seal.



(2) Clean seal bore.

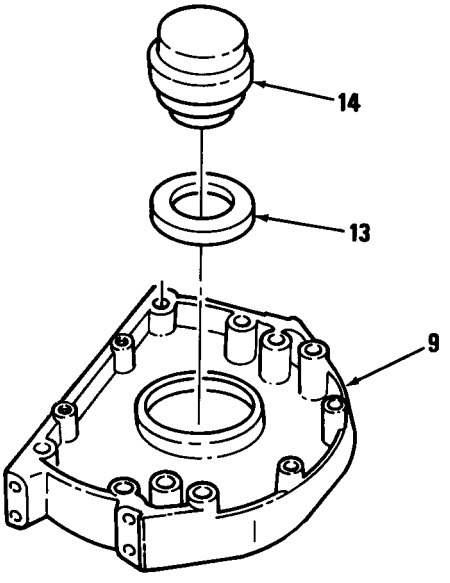
NOTE

If new oil seal is not precoated, apply nonhardening sealant to outer edge of metal casing.

(3) Position seal (13) in front cover (9) with seal lip pointed toward inner face of cover.

(4) Drive seal in with seal installation tool (14).

(5) Remove any excess sealant.



d. Installation

(1) Affix gasket (12) to inner face of front cover (9).

(2) Install dirt deflector (11) onto crankshaft with flat surface toward engine.

(3) Coat lip of oil seal lightly with grease or vegetable shortening.

(4) Position front cover (9) over two alinement pins and tap cover until it contacts cylinder block.

(5) Install four bolts (4), two bolts (5), six lockwashers (6), two bolts (7), and two lockwashers (8) to lower front cover (9).

(6) Torque bolts (7) to 25-30 lb-ft (34-41 N-m) and bolts (4 and 5) to 80-90 lb-ft (108-122 N-m),

(7) Install spacer ring (10) onto crankshaft.

(8) Install end cap (3), flat washer (2), and bolt (1) to front of crankshaft.

(9) Tighten crankshaft end bolt (1) as follows:

NOTE

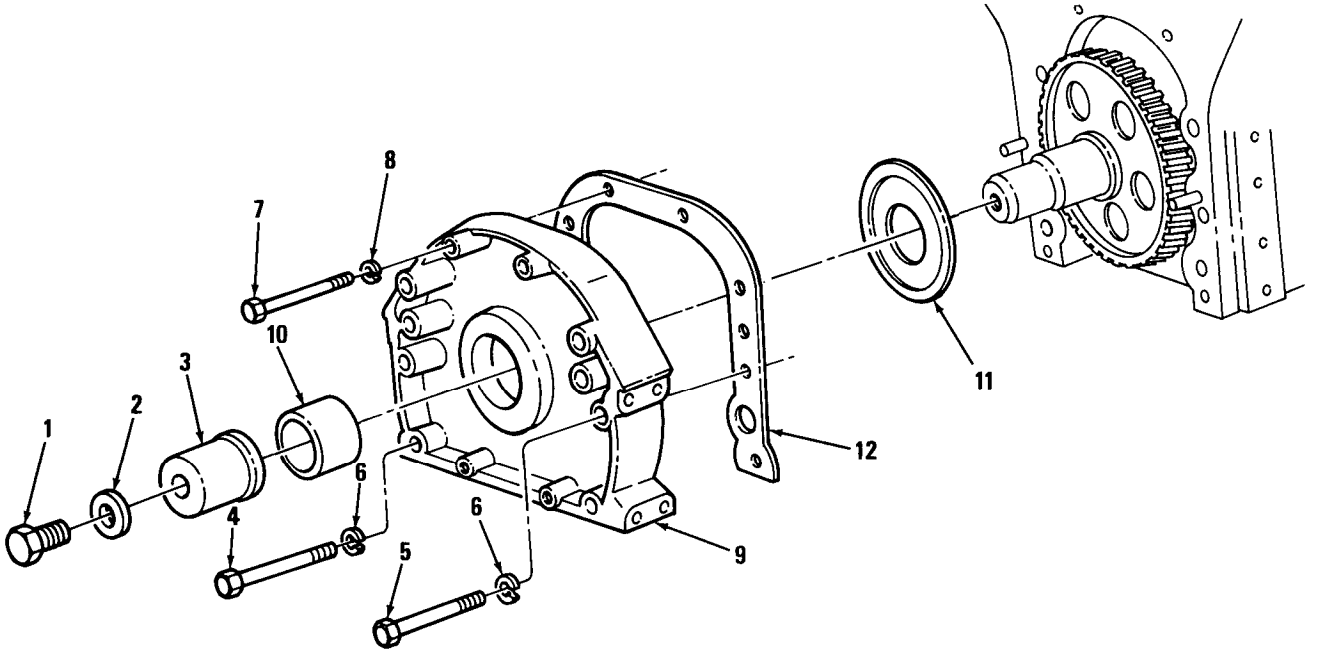
Secure gear train in place to prevent crankshaft from turning when loosening crankshaft end bolt.

(a) Torque bolt to 180 lb-ft (244 N-m).

(b) Strike end of bolt a sharp blow three times with a 3 pound soft head hammer.

(c) Torque bolt to 300 lb-ft (407 N-m) and strike bolt again three times.

(d) Torque bolt to 290-310 lb-ft (393-421 N-m). Do not strike bolt after final torque has been applied.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-20 Install oil pan
4-5 Install fuel strainer

4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT

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

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Magnetic base dial indicator (App B, Item 45)
Universal puller (App B, Item 71)
Mechanical puller (App B, Item 69)
Adaptor (App B, Item 1)
Slide hammer (App B, Item 39)
Adapter (App B, Item 2)
Torque wrench (App B, Item 102)

MANDATORY REPLACEMENT PARTS

20 Lockwashers (App F,Item 93)
1 Gasket (App F, Item 31)
2 Lockwashers (App F, Item 100)
1 Camshaft oil seal (App F, Item 146)
3 Lockwashers (App F, Item 92)
4 Camshaft plugs (App F, Item 116)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Grease (App C, Item 22)
Crocus cloth (App C, Item 12)
Oil stone (App B, Item 43)

EQUIPMENT CONDITION

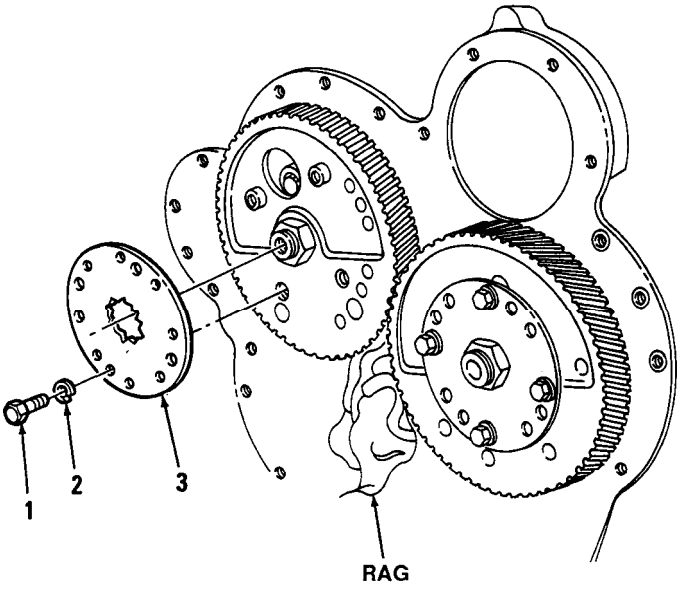
Para Description
4-21 Camshaft front cover removed
4-24 Flywheel housing removed
4-27 Cylinder heads removed

a. Removal

(1) Remove four bolts (1), four lockwashers (2), and retainer plate (3) from each rear camshaft gear. Discard lockwashers.

(2) For models 7083-7391, 7083-7396, and 7083-7399 only, remove three bolts (4), three lockwashers (5), and camshaft adaptor (6) from water pump drive gear (7). Discard lockwashers.

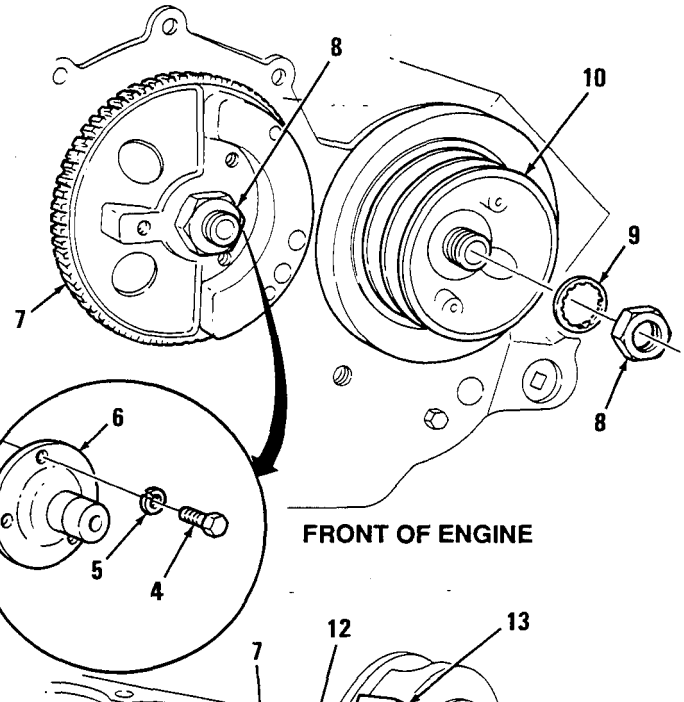
(3) Wedge a rag between teeth of camshaft gears and loosen nuts (8) at each camshaft end.



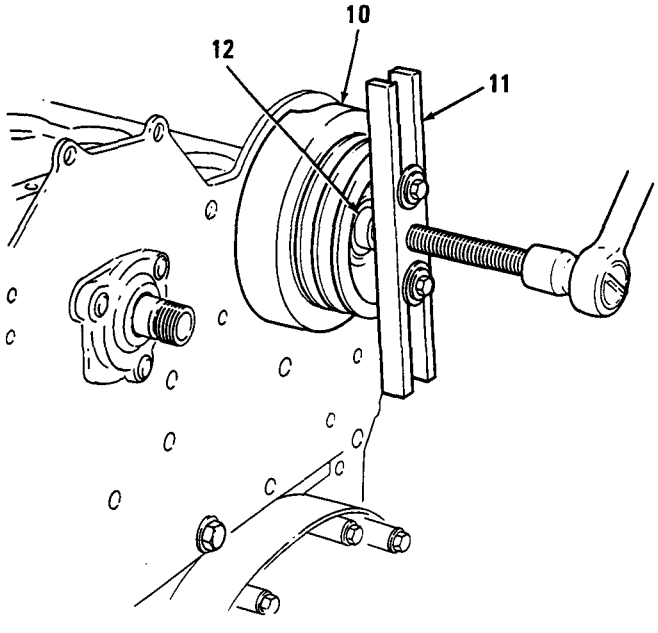
(4) Remove nut (8) and lockwasher (9) from front of each camshaft. Discard lockwashers.

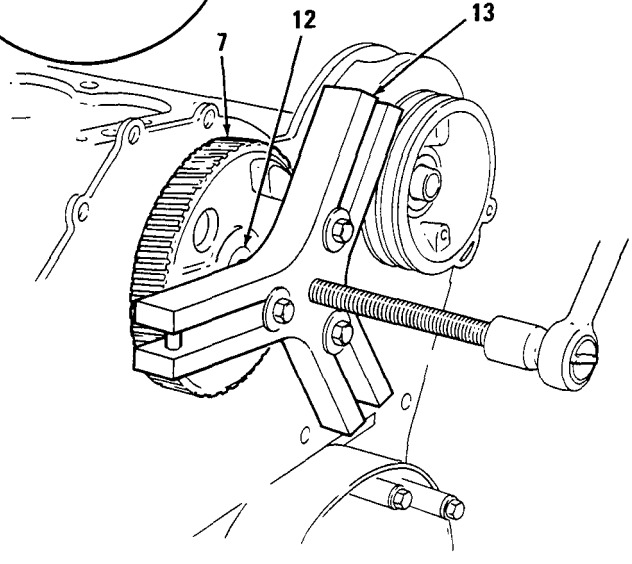
(5) Remove pulley (10) at front of engine using puller (1 1). Use an adaptor (12) between end of camshaft and puller screw to protect end of camshaft.

(6) Using puller (13) and adaptor (12), remove water pump drive gear (7) from front of engine.



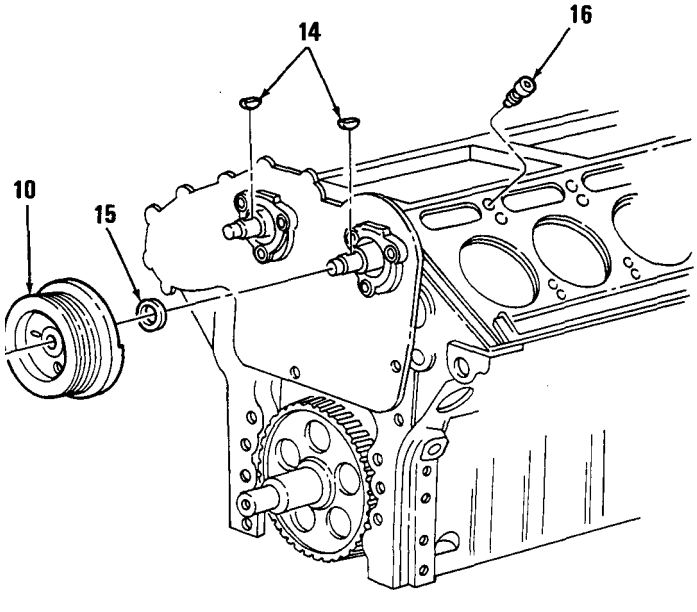
MODELS:
■ **7083-7391**
7083-7396
7083-7399





(7) Remove woodruff key (14) and spacer (15) from front of each camshaft.

(8) Remove three camshaft intermediate bearing lock screws (16) from top of each cylinder block bank.



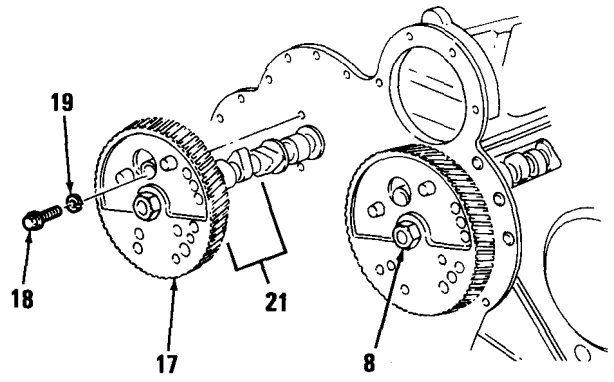
4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT **(Cent)**

(9) Rotate each camshaft gear (17) until three bolts (18) are accessible. Remove three bolts (18) and three lockwashers (19) from each rear camshaft end bearing (20). Discard lockwashers.

(Io) Remove two camshaft, bearing, and gear assemblies (21) from cylinder block.

(11) Remove three bolts (22) and three lockwashers (23) from each front camshaft end bearing (24 and 25). Remove end bearings from cylinder block. Discard lockwashers.

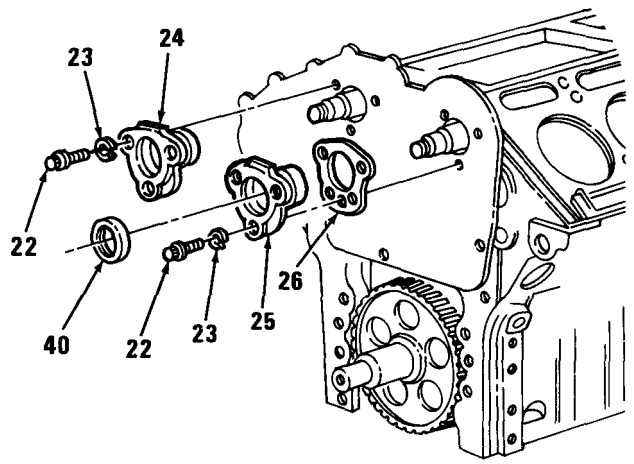
(12) Remove camshaft end bearing gasket (26) from left bank front position. Discard gasket.



b. Disassembly

NOTE

- Use gear puller if press is unavailable to remove gear.
- Disassemble left and right camshafts by same procedure.



FRONT OF ENGINE

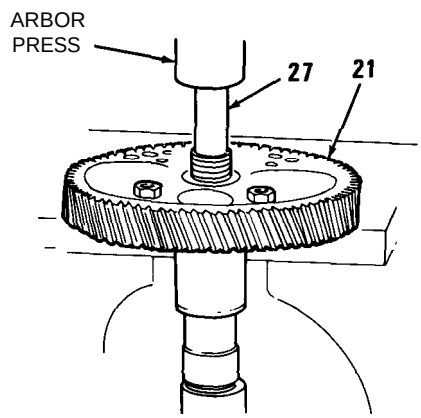
(1) Remove nut (8) from end of camshaft. Place camshaft, bearing, and gear assembly (21) in an arbor press. Insert short one-inch diameter brass rod (27) on end of camshaft. Press camshaft from gear.

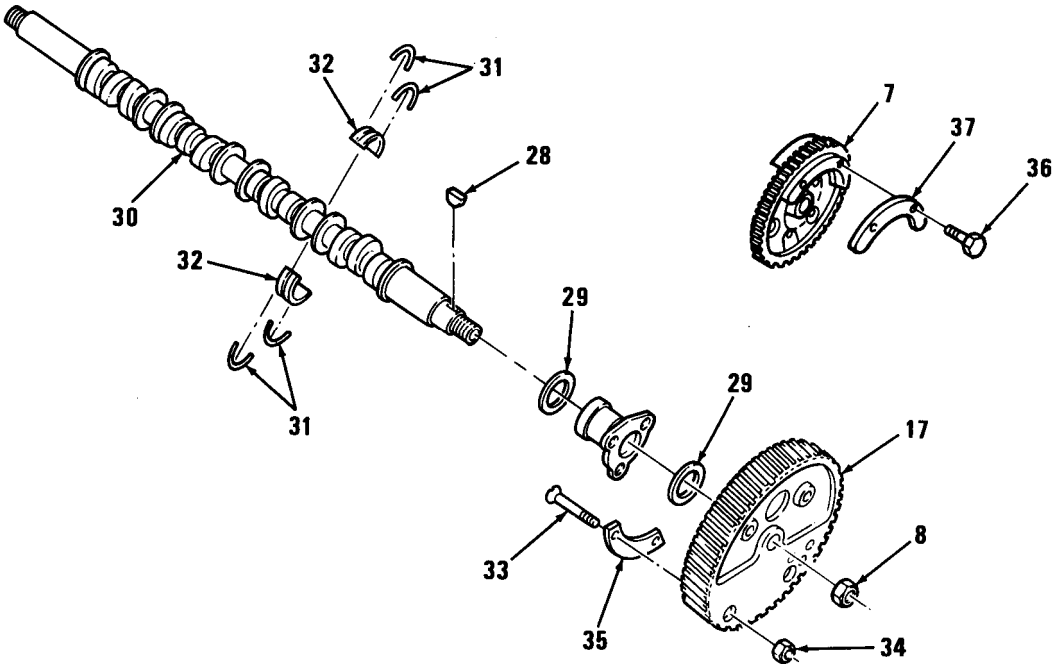
(2) Remove woodruff key (28), two thrust washers (29), and rear end bearing (20) from end of camshaft (30).

(3) Remove six lock rings (31) from camshaft (30). Remove six intermediate bearing halves (32).

(4) Remove two screws (33) and two nuts (34) from rear camshaft gear (17). Remove balance weight (35) from gear.

(5) Remove two bolts (36) from water pump drive gear (7) (right camshaft only). Remove balance weight (37).





(6) Remove two camshaft **end plugs (38) from camshaft** in following manner:

(a) Clamp camshaft in a soft-jawed vise. Use care not to damage cam lobes or machined surfaces of shaft.

(b) Make indentation in center of end plug with 31/64-inch drill.

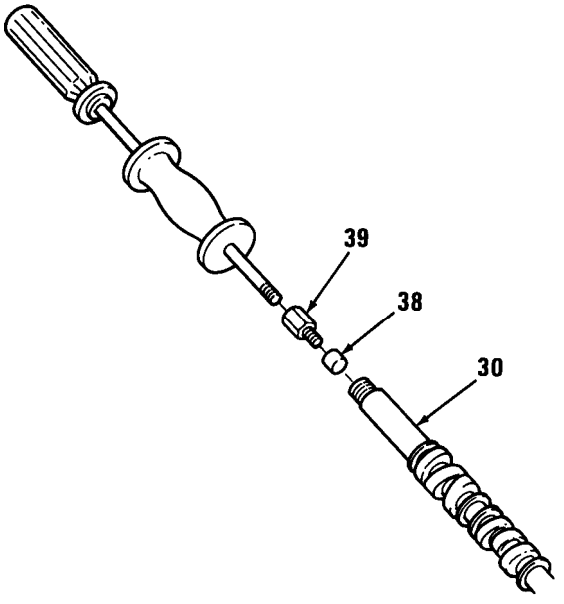
(c) Punch a hole as deep as possible with a center punch to aid in breaking through hardened surface of plug.

(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 5/1 6-inch drill.

(f) Tap drilled hole with a 3/8-16 tap.

(9) Thread 3/8-1 6 adaptor (39) into plug. Attach a slide hammer to adaptor. Remove 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 in camshaft. Drive out remaining plug. Discard plug.

(7) Remove camshaft oil seal (40) from left bank front end bearing (25). Discard seal.

4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT (Cent)

c. Cleaning

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) Soak camshafts in clean fuel oil. Run a bore brush through oil gallery to remove any sludge or foreign material. Clean exterior of camshaft. Blow out oil gallery and oil holes with compressed air.

(2) Clean gears, bearings, and related parts with fuel oil. Dry with compressed air.

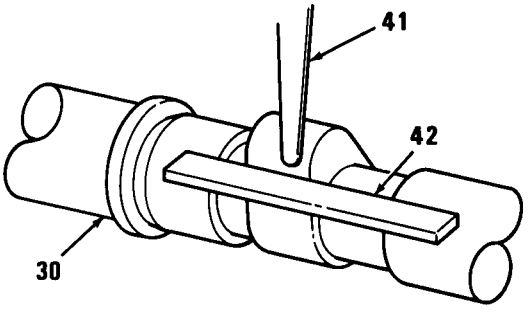
d. Inspection

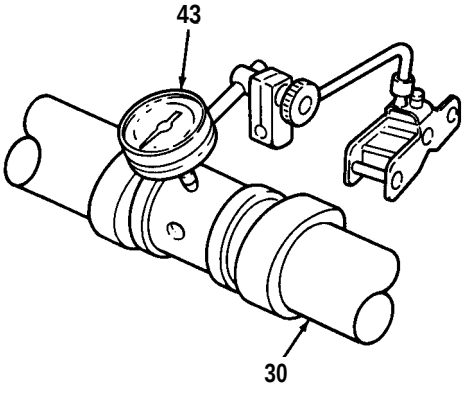
(1) Check camshaft keyways and threads for damage.

(2) Inspect camshaft journals and lobes for wear and scoring. Check wear on camshaft lobes as follows:

(a) Measure flat of cam lobes with a set of tapered feeler gages (41) and straight edge (42).

(b) Replace camshaft if flats are more than 0.003 inch deep.





(3) Using dial indicator (43), measure runout of center camshaft journal with end journals mounted on V-blocks. Replace camshaft if runout exceeds 0.002 inch.

(4) Check camshaft thrust surfaces for scoring or wear. Thrust surfaces maybe smoothed with an crocus cloth if only slightly scratched.

(5) Examine faces of camshaft rear end bearings, thrust washers, and camshaft gear hubs for scoring. Camshaft gear hubs not severely scored may be smoothed with an oil stone.

(6) Inspect bushings in end bearings for wear and scoring. Using calipers, measure outside diameter of camshaft journals and inside diameter of camshaft end bearing bushings. Difference must be between 0.0035 to 0.005 inch with new parts and a maximum of 0.006 inch with used parts.

(7) Inspect spacers and seal at front end of camshafts. Outside diameter of spacer on left bank must provide a smooth oil seal contact surface.

(8) Inspect camshaft intermediate bearings. Replace bearings if excessively scored or worn. Clearance between camshaft journals and intermediate bearings is 0.0025 to 0.005 inch with new parts and a maximum of 0.009 inch with used parts.

(9) Examine intermediate bearing lock screws and tapped holes in cylinder block for damaged threads.

(1 O) Inspect teeth on water pump drive gear and camshaft gears for scoring, pitting, and wear. Examine keyways and tapped holes in gears and camshaft pulley for damage.

4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT (Cent)

e. Assembly

(1) Install two plugs (38) in ends of camshaft.

NOTE

Steel faces of thrust washers must face toward flange on rear end bearings.

(2) Apply grease to steel face of each thrust washer (29). Place washer against end of rear camshaft end bearing (20).

(3) Lubricate rear camshaft bearing journal with engine oil. Slide rear end bearing (20) on camshaft with bolting flange of bearing toward camshaft gear (17).

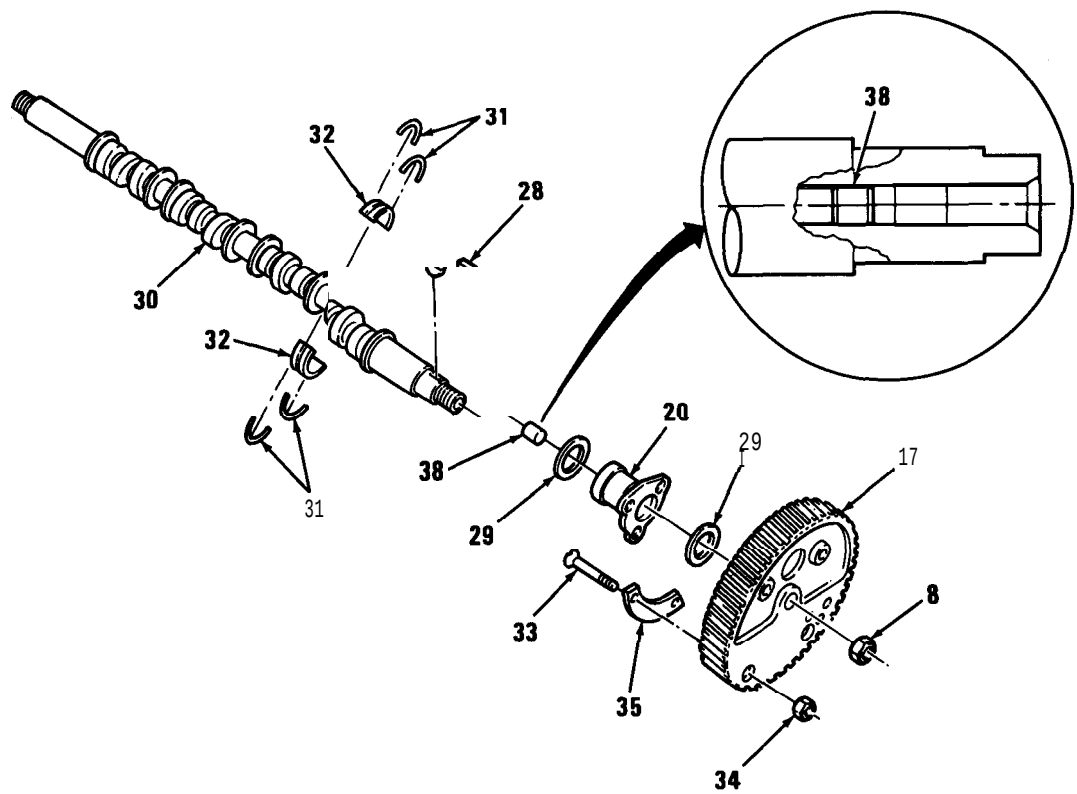
(4) Install rear camshaft gear on camshaft as follows:

NOTE

Install camshaft gear stamped 'R' on right bank camshaft.

(a) Install woodruff key (28) in camshaft keyway.

(b) Aline keyway in gear (17) with key (28) in shaft. Start gear over end of shaft.



(c) Support camshaft (30) in arbor press. Place a sleeve (44) on top of gear (1 7). Press gear tight against shoulder on shaft.

(d) Thread camshaft gear retaining nut (8) on camshaft. Hand tighten.

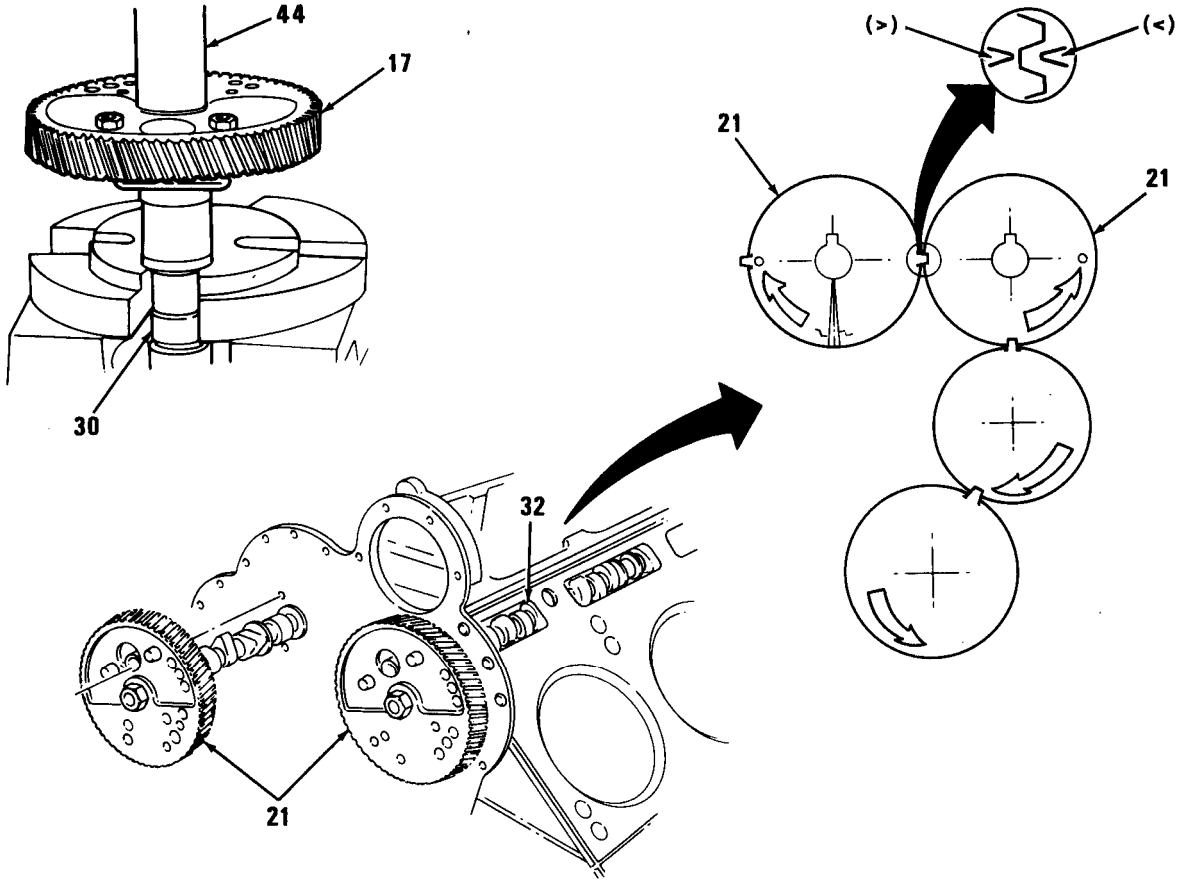
(e) Install gear on other camshaft in similar manner.

(5) Lubricate camshaft intermediate bearing journals. Place two halves of each intermediate bearing (32) on camshaft journal. Lock halves together with two lock rings (31). Assemble each lock ring with gap over upper bearing and ends an equal distance above split line of bearing.

(6) Attach balance weight (35) to front of each camshaft gear (17) with two bolts (33) and two nuts (34). Torque nuts to 25-30 lb-ft (34-41 N-m).

f. Installation

(1) Insert front end of camshaft assembly (21) with right hand helix gear through opening on right bank side in rear end plate. Work camshaft and intermediate bearings (32) into cylinder block until camshaft gear teeth are about to engage teeth on mating gear (if installed). Aline timing marks (V) on camshaft gears as shown. Slide camshaft assembly in place.



4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT (Cent)

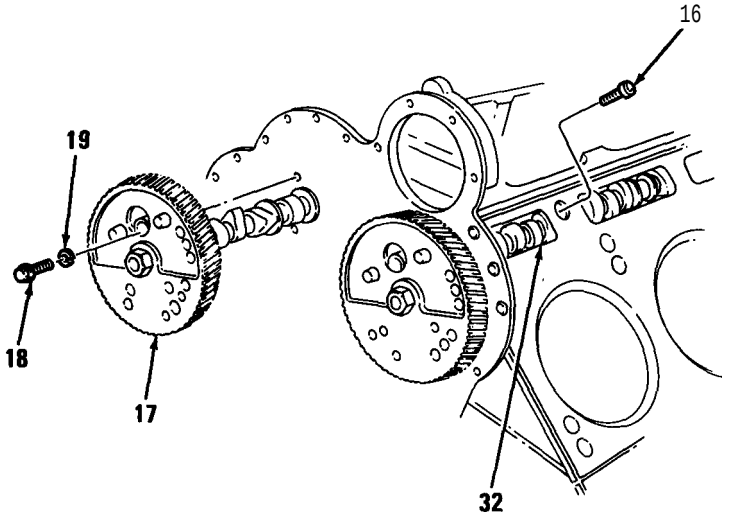
(2) Rotate camshaft gear (17) until web in gear alines with camshaft end bearing bolt hole. Install three bolts (18) and three lockwashers (19) to rear end bearing. Torque bolts to 35-40 lb-ft (47-54 N-m).

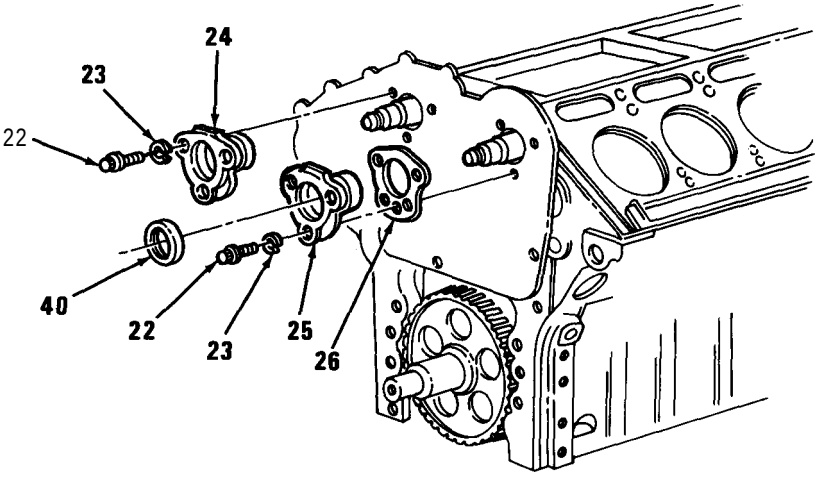
NOTE

Intermediate bearings must have a slight play when locked in position in block bore.

(3) Revolve camshaft intermediate bearings (32) as required to aline locking hole in upper half of bearing with tapped hole in top of cylinder block. Install three lock screws (16) to each bank and torque screws to 15-20 lb-ft (47-54 N-m).

(4) Install other camshaft assembly in same manner.





(5) Install seal (40) in left bank front end bearing (25).

(6) Attach gasket (26) to left bank front end bearing (25). Lubricate bearing journal with engine oil. Slide end bearing over end of camshaft and against front end plate. Secure bearing in place with three bolts (22) and three lockwashers (23). Torque bolts to 35-40 lb-ft (47-54 N-m).

(7) Lubricate right bank front end bearing journal (24) with engine oil. Slide it over end of camshaft and against front end plate. Secure bearing in place with three bolts (22) and three lockwashers (23). Torque bolts to 35-40 lb-ft (47-54 N-m).

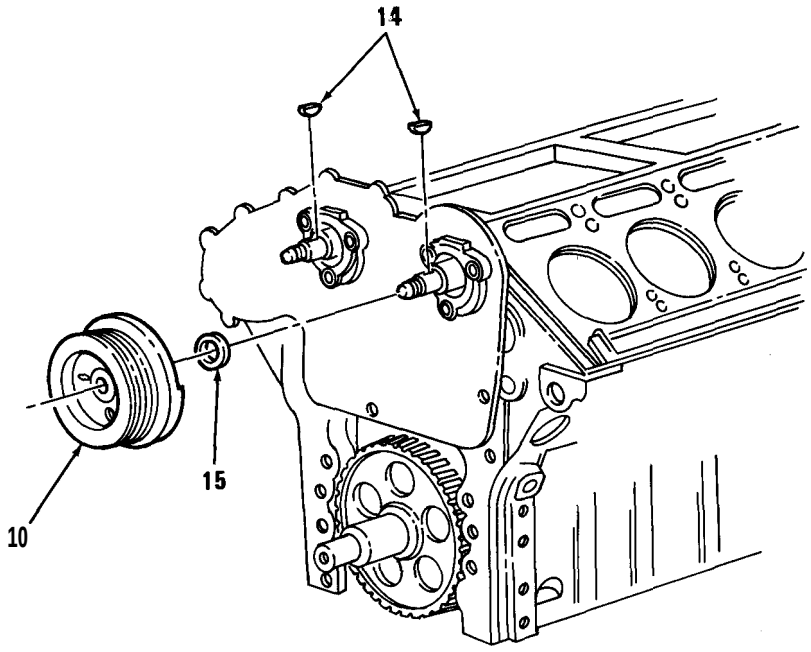
NOTE

Nonmachined spacer is used only on right bank camshaft.

(8) Install spacer (15) to front of each camshaft. Lubricate left bank spacer with engine oil prior to installation.

(9) Install woodruff key (14) to front of each camshaft.

(1 O) Install pulley (1 O) to left bank camshaft.



4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT (Cent)

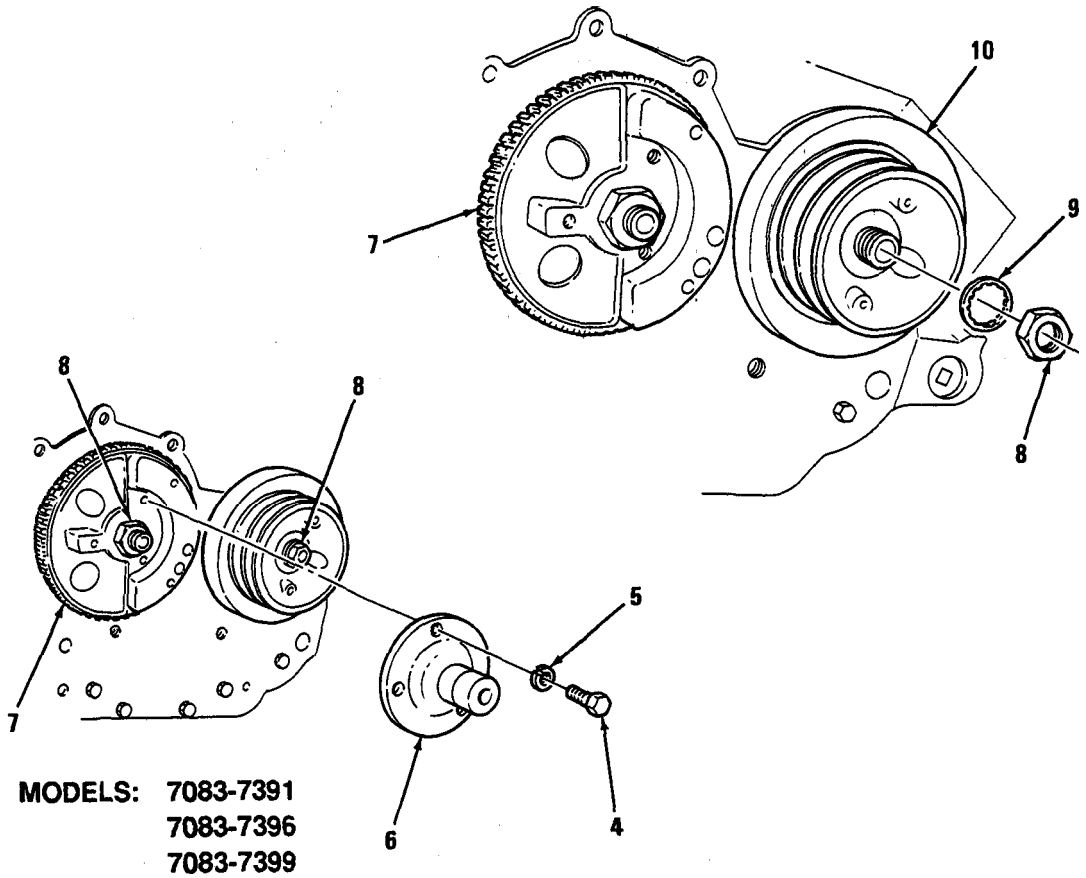
(11) Install water pump drive gear (7) to right bank camshaft.

(12) Slip lockwasher (9) over front end of each camshaft. Install nut (8) to front end of each camshaft and finger tighten.

(13) Wedge a rag between rear camshaft gears to prevent rotation. Torque nut (8) on each end of both camshafts to 300-325 lb-ft (407-441 N-m),

■ (14) For models 7083-7391, 7083-7396, and 7083-7399, install camshaft adaptor (6) to water pump drive gear (7). Secure in place with three bolts (4), and three lockwashers (5). Torque bolts to 15-19 lb-ft (20-26 N-m).

(15) Install camshaft gear nut retainer (3) to each camshaft gear. Secure retainer plate in position with four bolts (1) and four lockwashers (2). Torque bolts to 35-39 lb-ft (47-53 N-m).



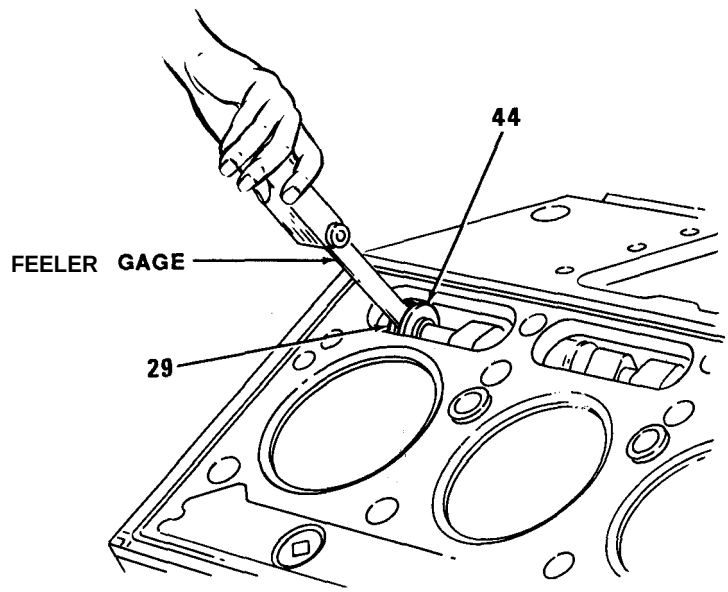
MODELS: 7083-7391
7083-7396
7083-7399

4-29. CAMSHAFT AND GEAR ASSEMBLIES REPLACEMENT (Cent)

NOTE

Oversize thrust washers are available in sizes of 0.005 and 0.010 inch to compensate for excessive end thrust.

(16) Using feeler gage, measure end thrust between thrust washer (29) and thrust shoulder (44) on each camshaft assembly. Required clearance is 0.003 to 0.015 inch with new parts and a maximum of 0.018 inch with used parts. If necessary, install an oversize thrust washer for required end thrust clearance.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-27	Install cylinder heads
4-24	Install flywheel housing
4-21	Install camshaft front cover

4-30. CYLINDER BLOCK END PLATES REPLACEMENT

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

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Gasket nonhardening cement (App C, Item 39)
Cleaning solvent (App C, Item 10)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para	Description
4-5	Fuel strainer bracket removed (7083-7395 and 7083-7398)
4-19	Blower drive-support removed
4-25	Idler gear removed
4-29	Camshaft and camshaft end bearings removed

MANDATORY REPLACEMENT PARTS

2 Lockwashers (App F, Item 95)
13 Lockwashers (App F, Item 93)
1 Gasket (App F, Item 22)
1 Gasket (App F, Item 43)
1 Gasket (App F, Item 67)

a. Removal

(1) Front End Plate

NOTE

Models 7083-7391, 7083-7396, and 7083-7399 require removal of two bolts (1) and two lockwashers (2).

(a) Remove bolt (1) and lockwasher (2) from end plate (3). Discard lockwasher.

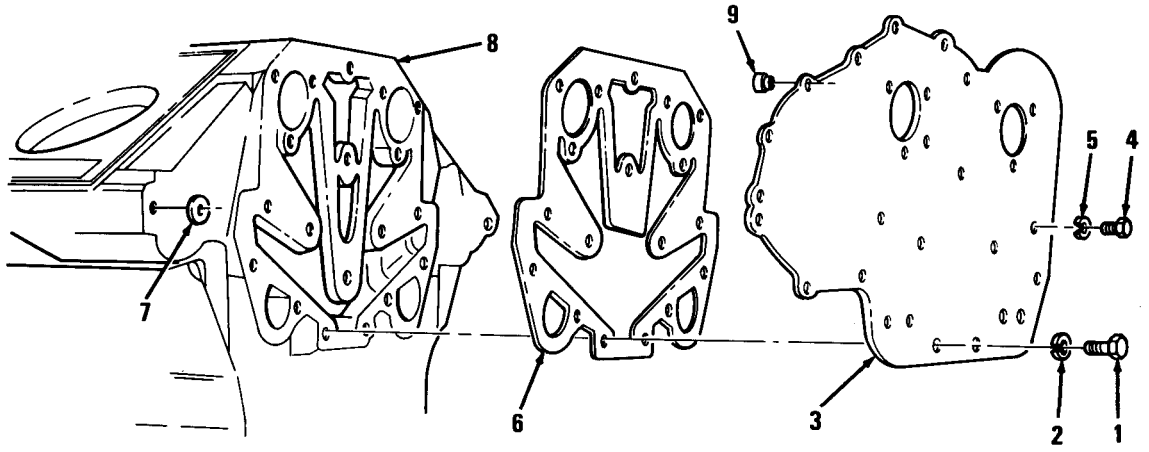
NOTE

Models 7083-7391, 7083-7396, and 7083-7399 require five bolts (4) and five lockwashers (5).

(b) Remove four bolts (4) and four lockwashers (5) from end plate. Discard lockwashers.

(c) Remove end plate (3) and gaskets (6 and 7) from cylinder block (8). Discard gaskets.

(d) If required, remove screw insert (9) by pressing from end plate. Support end plate on a flat surface when removing insert to prevent warping or bending.

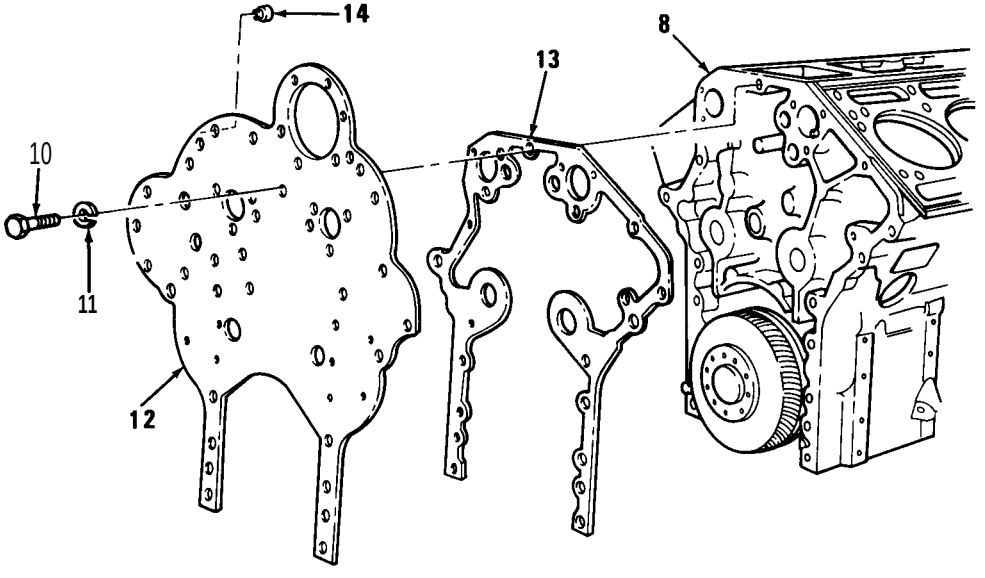


(2) Rear End Plate

(a) Remove eight bolts (1 O) and eight lockwashers (11) from end plate (1 2). Discard lockwashers.

(b) Remove end plate (12) and gasket (13) from cylinder block (8). Discard gasket.

(c) If required, remove nine screw inserts (14) by pressing from end plate. When removing inserts, support end plate on flat surface to prevent warping or bending.



4-30. CYLINDER BLOCK END PLATES REPLACEMENT (Cent)

b. Cleanlng/inspection

(1) Remove **all gasket** material from end plates (3 and 12).

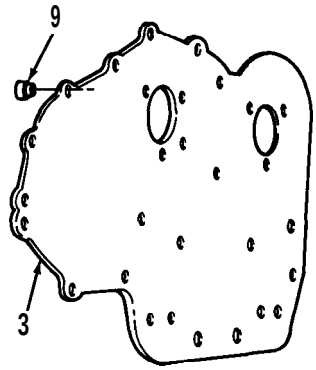
WARNING

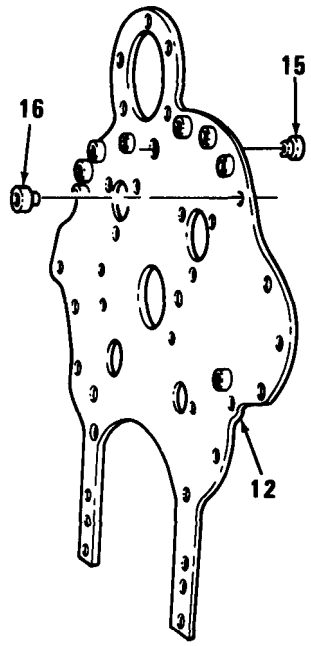
Dry cleaning solvent P-D-680 Is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

(2) Clean end plates with suitable cleaning solvent.

(3) Check plates for nicks, dents, scratches, score marks, and **warpage.**

(4) Inspect screw inserts for cracks and damaged threads.

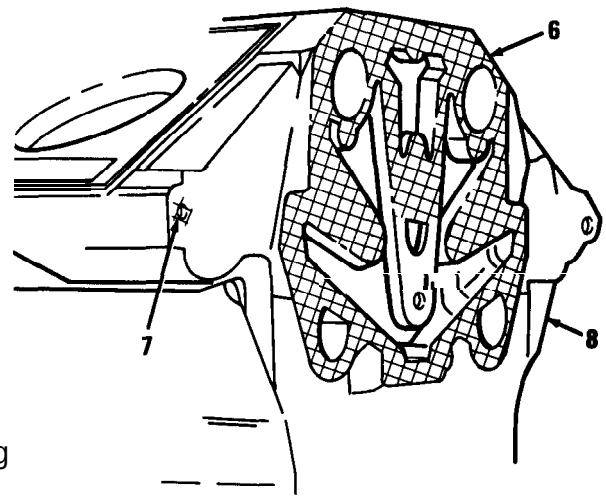




c. **Repair**

(1) If screw insert **(9)** was removed from front end plate, install new insert by supporting end plate (3) on flat surface and press insert into back of end plate until head on insert seats on end plate.

(2) If screw inserts were removed from rear end plate, install new inserts (nine total) by supporting end plate (12) on flat surface and press inserts into end plate until head on insert seats on end plate. Two inserts (15) are pressed from back and seven (16) inserts are pressed from front of end plate.



d. Installation

(1) Front End Plate

(a) Affix gaskets (6 and 7) to front of cylinder block (8) using non-hardening gasket cement. Also apply coat of non-hardening gasket cement to outer surface of each gasket.

NOTE

Models 7083-7391, 7083-7396, and 7083-7399 require removal of five bolts (4) and five lockwashers (5).

(b) Attach front end plate (3) to cylinder block with bolt (1), lockwasher (2), four bolts (4), and four lockwashers (5). Tighten bolts finger tight.

(c) Wipe excess gasket cement from bores in end plate and cylinder block.

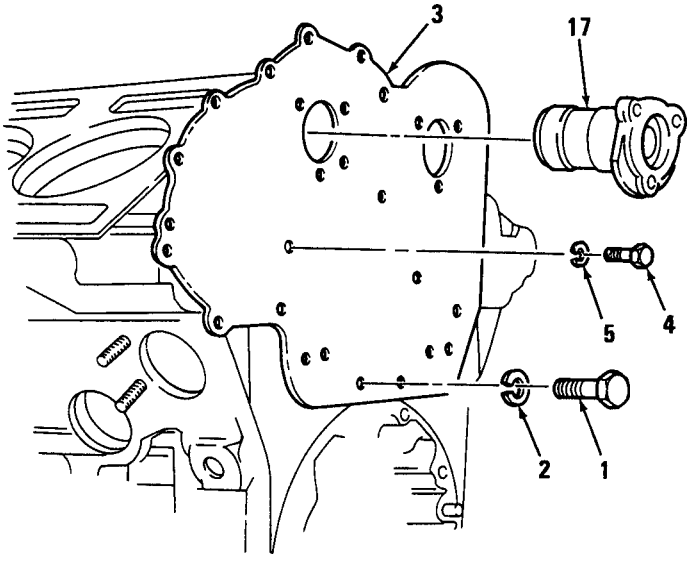
NOTE

Holes in end plate for camshaft end bearings are not same size. Smaller hole is accurately machined for alinement purposes and is always located on right side of engine.

(d) Insert right bank camshaft end bearing (17) through smaller bearing bore in end plate and into bore of block to accurately aline plate with block.

(e) With end bearing in place, torque bolts (1) to 71-75 lb-ft (96-102 N-m) and bolts (4) to 30-35 lb-ft (41-47 N-m).

(f) Remove camshaft end bearing (17) which served as a pilot while attaching end plate.



4-30. CYLINDER BLOCK END PLATES REPLACEMENT (Cent)

(2) Rear End Plate

(a) Apply nonhardening gasket cement on cylinder block. Then install gasket (13) over two dowel pins (18) on cylinder block (8).

(b) Apply coat of nonhardening gasket cement to outer surface of gasket (13).

(c) Attach rear end plate (12) to cylinder block with eight bolts (1 O) and eight lockwashers (11). Tighten bolts finger tight.

(d) Wipe excess gasket cement from bores in end plate and cylinder block.

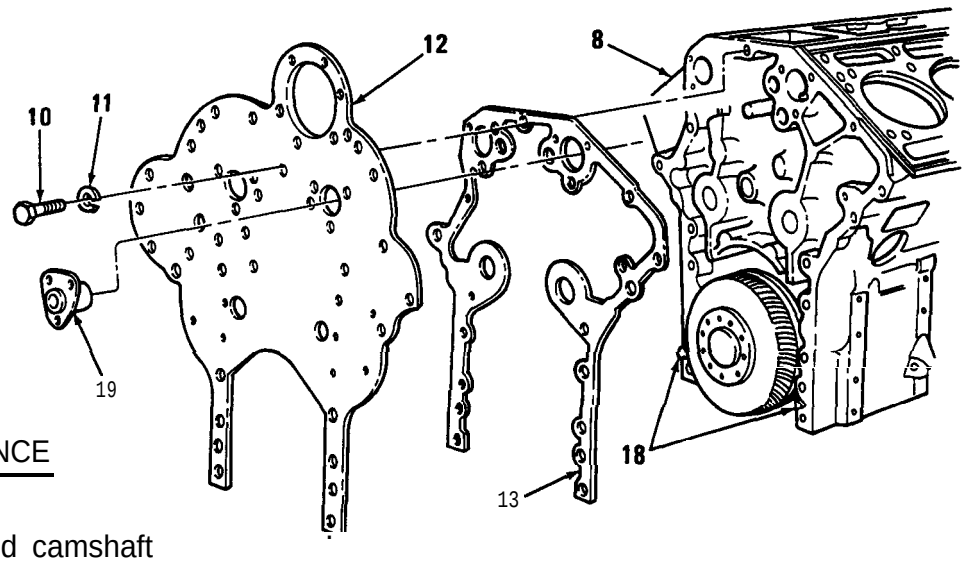
NOTE

Holes in end plate for camshaft end bearings are not same size. Smaller hole is accurately machined for alinement purposes and is always located on right side of engine.

(e) Insert right bank camshaft end bearing (19) through smaller bearing bore in end plate (12) and into bore of block to accurately aline plate with block.

(f) With end bearing in place, torque all bolts to 30-35 lb-ft (41-47 N-m).

(9) Remove camshaft end bearing (19) which served as a pilot while attaching end plate.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-29 Install camshafts and camshaft end bearings
4-25 Install idler gear
4-19 Install blower drive support
4-5 Install fuel strainer bracket (7083-7395 and 7083-7398)

4-31. OIL PRESSURE REGULATOR AND RELIEF VALVE REPLACEMENT

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

INITIAL SETUP

MODELS

■ All

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Fuel oil (App C, Item 21)
Crocus cloth (App C, Item 12)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para Description
4-20 Oil pan removed

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 47)
2 Gaskets (App F, Item 33)
6 Lockwashers (App F, Item 93)

a. Removal

(1) Oil pressure regulator valve

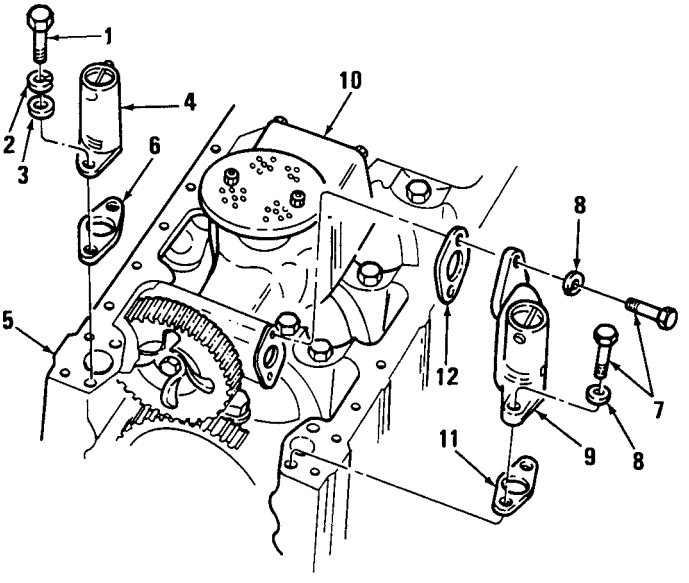
(a) Remove two bolts (l), two lockwashers (2), and two flat washers (3) securing oil pressure regulator valve (4) to cylinder block (5).

(b) Tap regulator valve body lightly to loosen it from gasket (6). Remove regulator and discard gasket.

(2) Oil pressure relief valve

(a) Remove four bolts (7) and four lockwashers (8) securing oil pressure relief valve (9) to cylinder block (5) and oil pump (l0).

(b) Tap relief valve body lightly to loosen it from gaskets (11 and 12). Remove relief valve and discard gaskets.



4-31. **OIL PRESSURE REGULATOR AND RELIEF VALVE REPLACEMENT (Cent)**

b. Repair

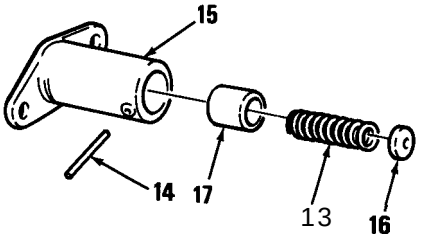
(1) Regulator Valve

WARNING

Firmly secure spring during removal. A spring loaded mechanism ejects parts at high speed If released In an uncontrolled manner. Personal injury may result.

(a) Clamp regulator assembly in a vise with soft jaws. Compress spring (13) and remove retaining pin (14) from regulator body (15).

(b) Remove spring seat (16), spring (13), and valve (17) from regulator body (15).



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) Clean all parts with fuel oil and dry with compressed air.

(d) Inspect parts for wear and damage. Regulator valve must move freely in valve body. Replace valve and valve body if parts are scored and cannot be cleaned with crocus cloth.

(e) Replace a pitted or fractured spring.

(f) Assemble valve assembly by first applying **engine** oil to outer face of valve (17) and slide it into regulator body (15), closed end first.

(9) Install spring (13) and spring seat (16) into regulator body (15).

(h) While compressing spring, install retaining pin (14) above spring seat (16).

(2) Relief Valve

WARNING

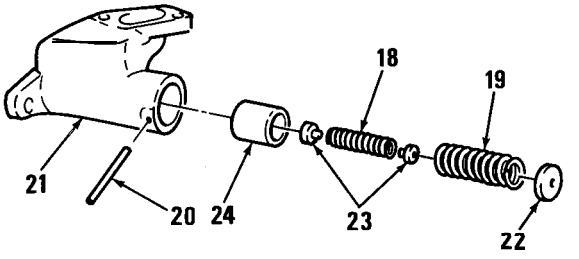
Firmly secure spring during removal. A spring loaded mechanism ejects parts at high speed If released In an uncontrolled manner. Personal injury may result.

(a) Clamp relief valve assembly in a vise with soft jaws. Compress springs (18 and 19) and remove retaining pin (20) from relief valve body (21).

(b) Remove spring seat (22), springs (18 and 19), two inner spring seats (23), and valve (24) from relief valve body (21).

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) Clean all parts with fuel oil and dry with compressed air.

(d) inspect parts for wear and damage. Relief valve must move freely in valve body. Replace valve and valve body if parts are scored and cannot be cleaned with crocus cloth.

(e) Replace pitted or fractured springs.

(f) Assemble valve assembly by first applying engine oil to outer face of valve (24) and slide it into relief valve body (21), closed end first.

(9) Install two inner spring seats (23), springs (18 and 19), and spring seat (22) into relief valve body (21).

(h) While compressing springs, install retaining pin (20) above spring seat (22).

c. installation

(1) Oil pressure regulator valve

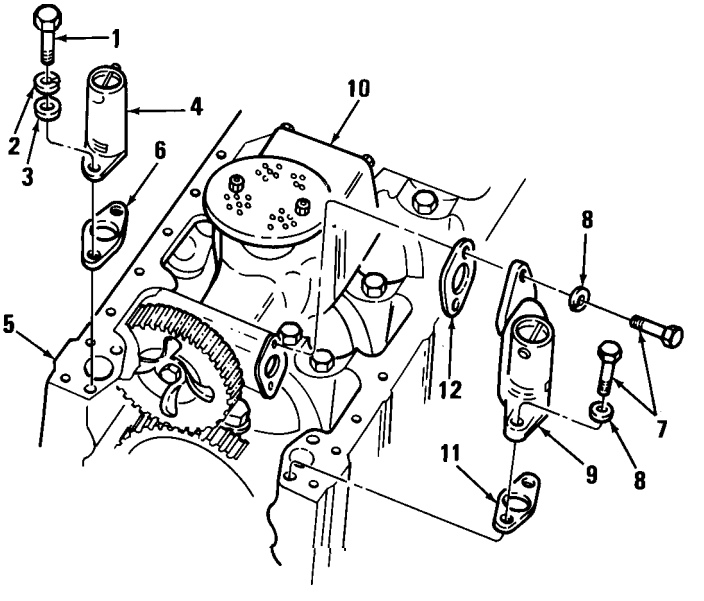
(a) Install gasket (6) and oil pressure regulator valve (4) to cylinder block (5).

(b) Secure regulator valve to block with two bolts (1), two lockwashers (2), and two flat washers (3). Torque bolts to 30-35 lb-ft (41-47 N-m).

(2) Oil pressure relief valve

(a) Install gaskets (11 and 12) and oil pressure relief valve (9) to cylinder block (5).

(b) Secure relief valve to block and oil pump (10) with four bolts (7) and four lockwashers (8). Torque bolts to 30-35 lb-ft (41-47 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-20 Install oil pan

4-32. OIL PUMP REPLACEMENT

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

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, [tern 96)
Gear installer (App B, Item 55)
Gear installer (App B, Item 56)
Gear puller (App B, Item 70)
Magnetic base dial indicator (App B, Item 45)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

7 Lockwashers (App F, Item 93)
2 Self-locking nuts (App F, Item 101)
2 Lockwashers (App F, Item 92)
1 Spring washer (App F, Item 168)
1 Gasket (App F, Item 54)
2 Gaskets (App F, Item 55)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)

EQUIPMENT CONDITION

Para Description
4-20 Oil pan removed
4-31 Oil pressure relief valve removed

a. Removal

(1) Remove two bolt and lockwasher assemblies (1) securing two bracket assemblies (2) to rear bearing cap (3).

(2) Remove four nuts (4) and four lockwashers (5) securing oil pump assembly (6) to main bearing caps (7). Discard lockwashers.

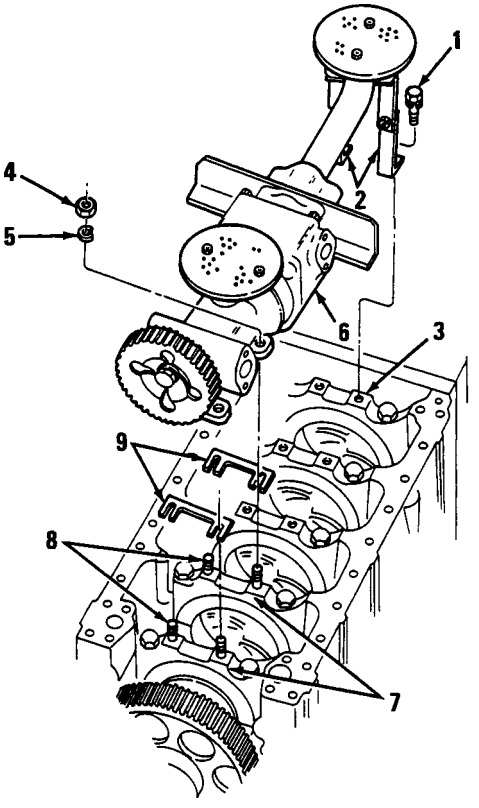
(3) Lift oil pump assembly (6) off main bearing caps (7) and four studs (8).

NOTE

Mark quantity and location of shims on main bearing caps. Shims must be installed in same location as removed.

(4) Remove shims (9) from main bearing caps (7).

(5) If necessary, remove four studs (8) from main bearing caps (7).



b. Disassembly

(1) Remove four bolts (1 O), four flat washers (11), and two strainer element screens (12) from tube assembly (13) and adaptor (14).

(2) Remove two bolts (15), two lockwashers (16), tube assembly (13), baffle (17), and two gaskets (18) from oil pump assembly (6). Discard lockwashers and gaskets.

(3) Remove two bolt and lockwasher assemblies (19) securing two bracket assemblies (2) to tube assembly (13).

(4) If necessary to separate bracket (2) assemblies, remove two bolts (20), two self-locking nuts (21), and eight flat washers (22) from four brackets. Discard self-locking nuts.

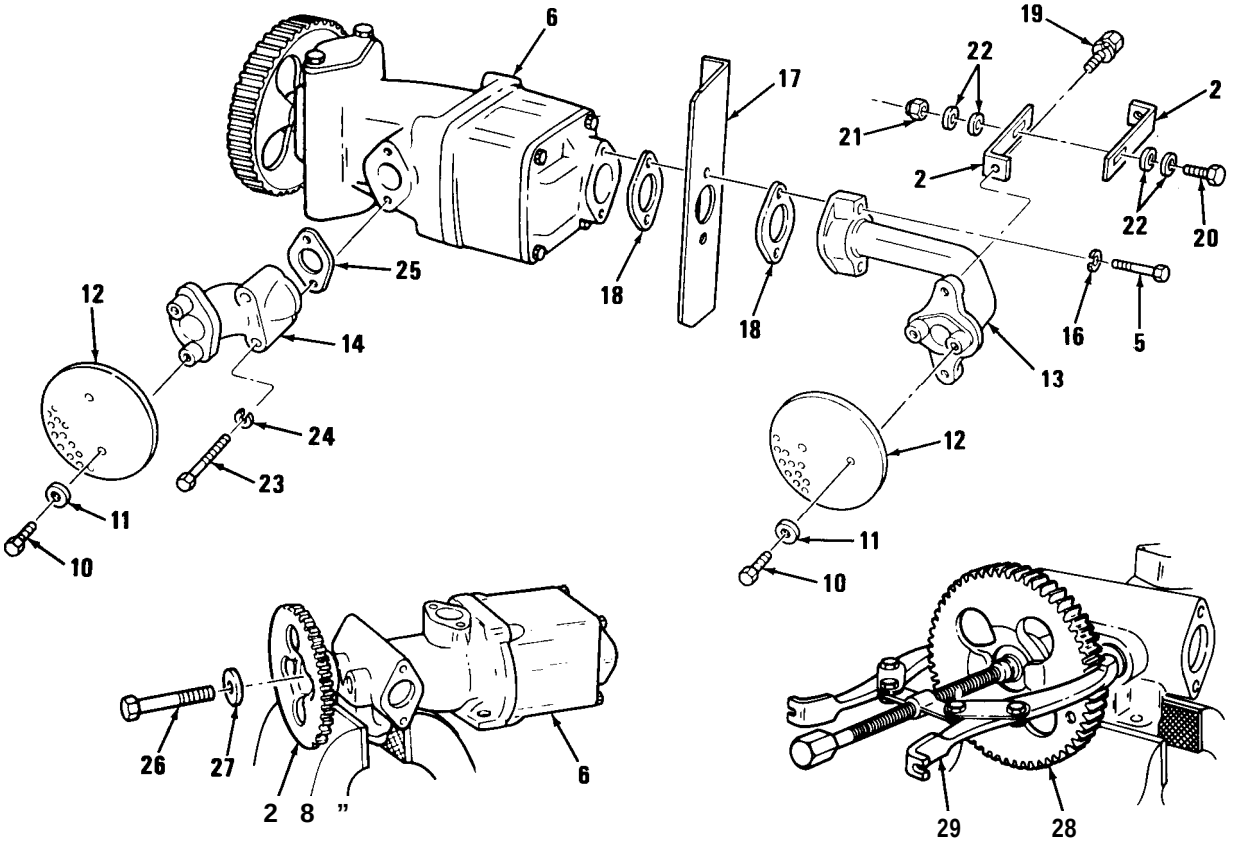
(5) Remove two bolts (23), two lockwashers (24), adapter (14), and gasket (25) from oil pump assembly (6). Discard lockwashers and gasket.

(6) Secure oil pump assembly (6) in a soft-jawed vise.

(7) Remove bolt (26) and spring washer (27) securing spur gear (28) to drive shaft on oil pump assembly (6). Discard spring washer.

(8) Using puller (29), remove spur gear (28) from drive shaft. Remove puller from spur gear.

(9) Remove oil pump assembly (6) from soft-jawed vise.



4-32. OIL PUMP REPLACEMENT (Cent)

(10) Remove four bolts (30) securing scavenger pump housing (31) to oil pump housing (32). Remove scavenger pump housing.

(11) Remove scavenger side helical gear (33) from drive shaft (34).

(12) Remove scavenger side oil pump gear (35) from driven shaft (36).

(13) Remove spacer plate (37) from drive and driven shafts (34 and 36).

(14) Remove driven shaft (36) and helical gear (38) as an assembly from oil pump housing (32).

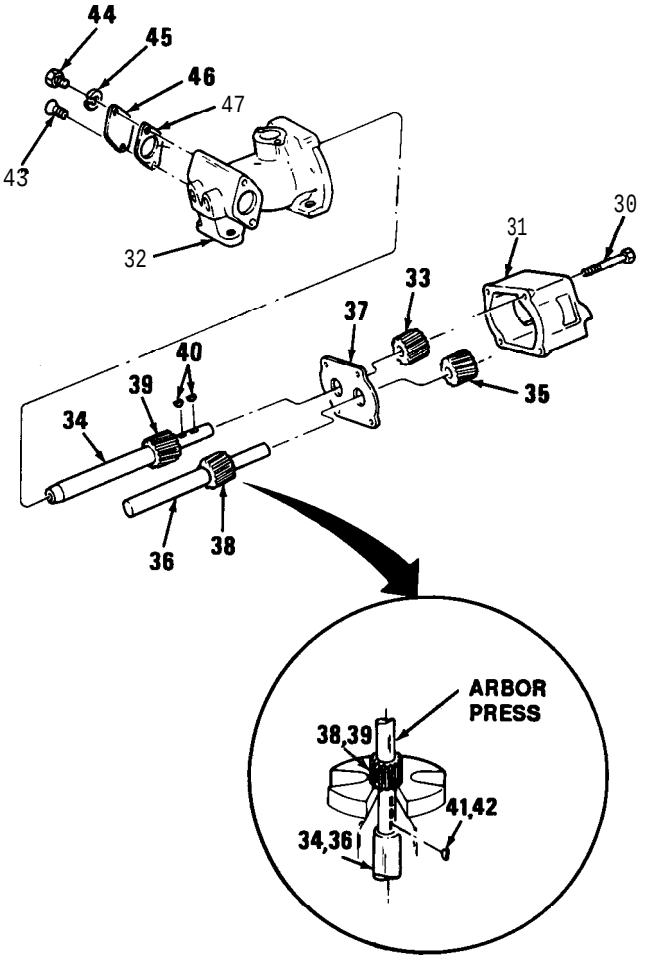
(15) Remove drive shaft (34) and oil pump gear (39) as an assembly from oil pump housing (32).

(16) Remove two woodruff keys (40) from drive shaft (34).

(17) Using arbor press, remove oil pump gear (39) from drive shaft (34). Remove woodruff key (41) from drive shaft.

(18) Using arbor press, remove helical gear (38) from driven shaft (36). Remove woodruff key **(42)** from driven shaft.

(19) Remove screw (43), bolt (44), and lockwasher (45) securing access cover (46) and gasket (47) to oil pump housing (32). Discard lockwasher and gasket.



c. Cleanlng/inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air Immediately and get medical aid. If contact with eyes Is made, wash your 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 all parts with dry cleaning solvent and dry with compressed air.

(2) Inspect scavenger pump housing, oil pump housing, and access cover for cracks or damage.

(3) Inspect four helical gears, two oil pump gears, and spur gear for chipped teeth, burrs, wear, or damage.

(4) Inspect drive and driven shaft for scoring, wear, or damage.

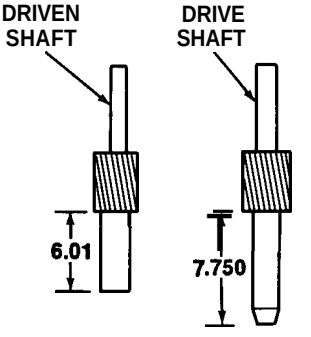
(5) Inspect bushings in oil pump housing and scavenger pump housing for wear, If worn, replace oil pump housing and scavenger pump housing.

(6) inspect strainer element screens for cracks, tears, or damage.

(7) Inspect tube assembly and adaptor for cracks or damage.

(8) Inspect studs for continuity or damage to threads.

d. Assembly

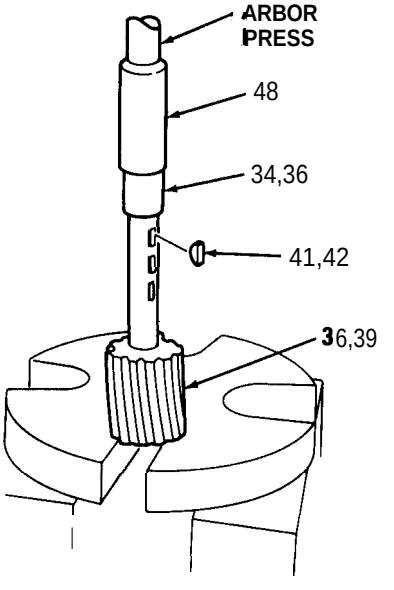


(1) Insert woodruff key (42) into driven shaft (36).

(2) Lubricate driven shaft (36) with engine oil, and aline helical gear (38) keyway with woodruff key (42) on driven shaft.

NOTE

Position of helical gear should be 6.01 inch from end of driven shaft.



(3) Using driven gear installer (48) and arbor press, install helical gear (38) onto driven shaft (36).

(4) Insert woodruff key (41) into drive shaft (34).

(5) Lubricate drive shaft (34) with engine oil and aline oil pump gear (39) keyway with woodruff key (41) on drive shaft.

NOTE

Position of oil pump gear should be 7.750 inch from end of drive shaft.

(6) Using drive gear installer (48) and arbor press, install oil pump gear (39) onto drive shaft (34).

(7) Install drive shaft (34) and oil pump gear (39) as an assembly into oil pump housing (32).

(8) Install driven shaft (36) and helical gear (38) as an assembly into oil pump housing (32).

(9) Place oil pump housing (32) in a soft-jawed vise and place a rag between oil pump gear (39) and helical gear (38).

4-32. OIL PUMP REPLACEMENT (Cent)

NOTE

Install spring washer with crown side toward bolt.

(10) Position spur gear (28) onto drive shaft (34) and secure with spring washer (27) and bolt (26). Tighten bolt to install spur gear. Torque bolt to 60-65 lb-ft (81-85 N-m). Remove oil pump housing (32) from soft-jawed vise and rag from gears (38 and 39).

(11) Install two remaining woodruff keys (40) onto drive shaft (34).

(12) Install spacer plate (37) on shafts (34 and 36).

(13) Install scavenger side helical gear (33) onto drive shaft (34).

(14) Install scavenger side oil pump gear (35) onto driven shaft (36) .

NOTE

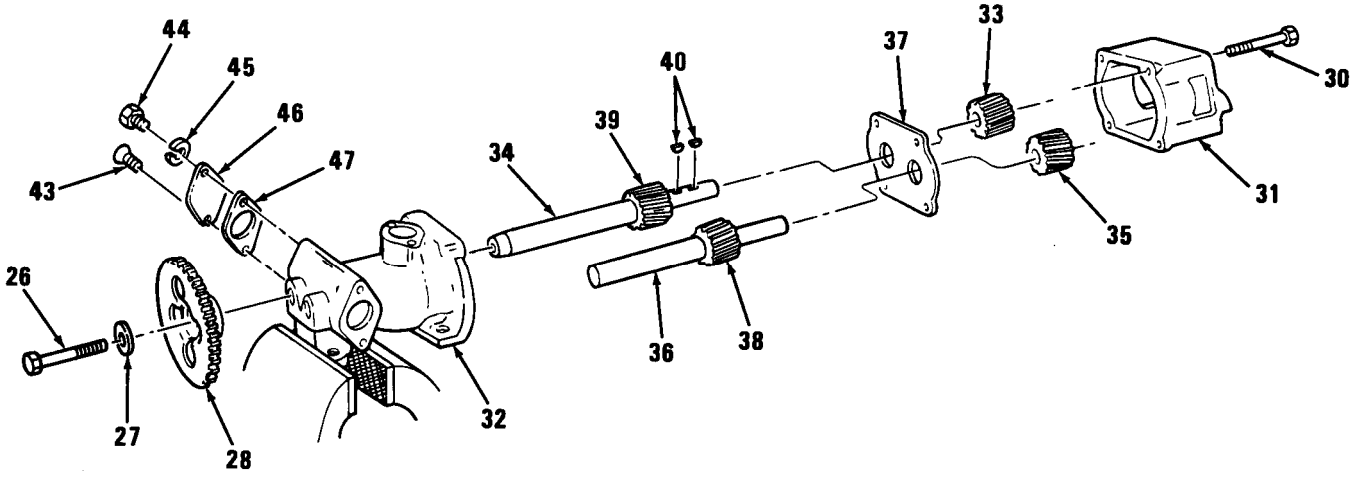
The scavenger side oil pump gear and helical gear must be in the same relative position as the oil pump gear and helical gear on the housing side.

(15) Position shafts (34 and 36) into scavenger pump housing (31) and join with oil pump housing (32). Secure housings with four bolts (30). Torque bolts to 30-35 lb-ft (41-47 N-m).

NOTE

Oil pump gears must turn freely. Any bind in pump gears must be eliminated before oil pump is installed on engine.

(16) Install gasket (47) and access cover (46) to oil pump housing (32) and secure with screw (43), bolt (44), and lockwasher (45). Torque bolt to 23-26 lb-ft (31-35 N-m).



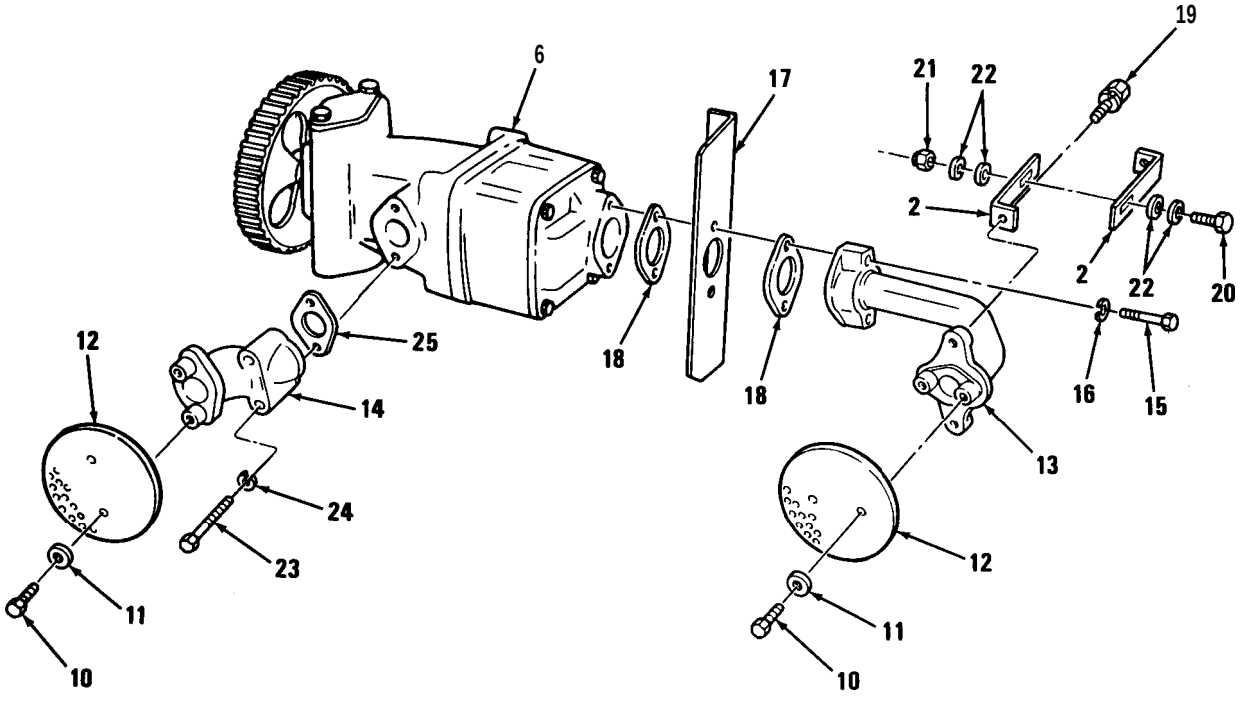
(17) Secure gasket (25) and adaptor (14) to oil pump assembly (6) with two bolts (23) and two lockwashers (24). Torque bolts to 10-13 lb-ft (1 4-18 N-m).

(18) Secure tube assembly (13), two gaskets (18), and baffle (17) to oil pump assembly (6) with two bolts (15) and two lockwashers (16). Torque bolts to 23-26 lb-ft (31-35 N-m).

(19) If separated, assemble four brackets (2) with two bolts (20), eight flat washers (22), and two self-locking nuts (21). Snug bolts.

(20) Secure two bracket (2) assemblies to tube assembly (13) with two bolt and lockwasher assemblies (19). Torque bolts to 10-13 lb-ft (14-18 N-m).

(21) Install two strainer element screens (12) on tube assembly (13) and adaptor (1 4). Secure with four bolts (10) and four flat washers (1 1). Torque bolts to 10-13 lb-ft (14-18 N-m).



4-32. OIL PUMP REPLACEMENT (Cont)

e. Installation

(1) If removed, install four studs (8) into main bearing caps (7).

(2) Place same number of shims (9) as were removed on main bearing caps (7).

(3) Position oil pump assembly (6) over studs (8) and onto main bearing caps (7 and 3). Aline teeth on spur gear (30) with teeth on drive gear (49).

(4) Secure oil pump assembly (6) with four lockwashers (5) and nuts (4). Torque nuts to 26-29 lb-ft (35-40 N-m).

(5) Install two bolts (1) through brackets (2) into rear main bearing cap (3). Torque bolts to 23-26 lb-ft (31-35 N-m).

(6) Aline four brackets (2), eight flat washers (22) and two self-locking nuts (21). Torque nuts to 26-29 lb-ft (35-40 N-m).

(7) With engine in upright position, check gear tooth clearance between driven gear (28) and drive gear (49). Using dial indicator (50) mounted on cylinder block, measure clearance. Gear tooth clearance should be 0.006 to 0.012 inch.

NOTE

Shims control gear tooth clearance. One set of 0.005 inch shims will change gear tooth clearance by 0.0035 inch.

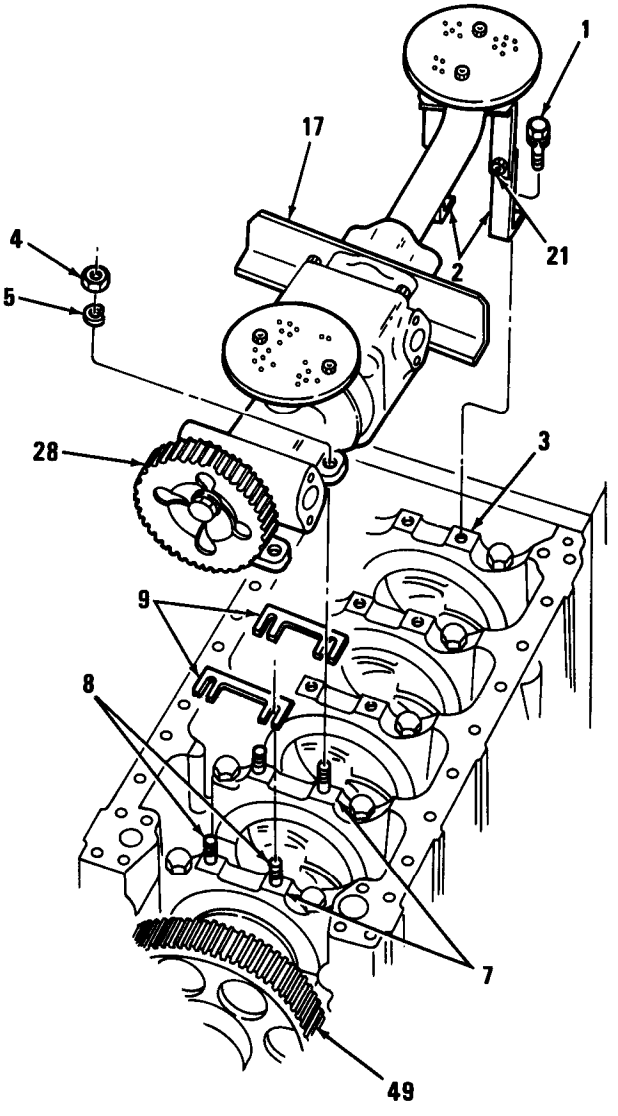
(8) If gear tooth clearance is not within specifications, follow steps (a) thru (d).

(a) Invert engine.

(b) Loosen four nuts (4) and two bolts (1). Lift oil pump assembly (6) enough to remove shims (9).

(c) Install new quantity or correct thickness of shims (9).

(d) Repeat steps (4), (5), and (7).

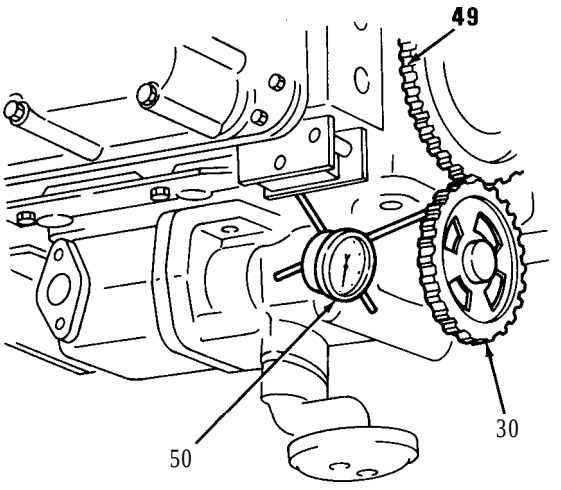


(9) Remove dial indicator (50) from cylinder block.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-31 Oil pressure relief valve installed
4-20 Oil pan installed



SECTION III. ENGINE DISASSEMBLY/ASSEMBLY

4-33. PISTON AND CONNECTING ROD MAINTENANCE (CROSS-HEAD)

This task covers: a. Removal b. Disassembly c. Cleaning
d. Inspection e. Fitting Piston f. Fitting Piston Rings
g. Assembly h. Installation-Cylinder Kit Assembly

INITIAL SETUP

MODELS

■ All *

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Piston ring pliers (App B, Item 66)
Micrometer 1-2 inch (App B, Item 65)
Piston pin retainer installer (App B, Item 57)
Piston pin retainer leak detector (App B, Item 63)
Piston ring compressor (App B, Rem 12)
Cylinder liner hold down clamps (App B, Item 11)
Spring scale (App B, Item 24)
Feeler gage set (App B, Item 24)
Torque wrench (App B, Item 101)
Micrometer 0-1 inch (App B, Item 65)
Micrometer 4-5 inch (App B, Item 65)
Piston groove gage (App B, Item 36)
Ridge reamer (App B, Item 72)
Ball attachment (App B, Item 6)

MANDATORY REPLACEMENT PARTS

2 Rings (App F, Item 125)
1 Ring (App F, Item 124)
2 Rings (App F, Item 122)
■ 1 Ring (App F, Item 169)**
2 Expanders (App F, Item 13)
1 Ring (App F, Item 120)
2 Piston pin retainers (App F, Item 118)
2 Piston pin bolts (App F, Item 5)
2 Piston pin bolt spacers (App F, Item 157)
1 Seal ring (App F, Item 142)

EXPENDABLE/DURABLE SUPPLIES

Flat stone (App C, Item 43)
Carbon-removing compound (App C, Item 7)
Plastic gage (App C, Item 30)
Engine oil (App C, Item 16)
International compound no. 2 (App C, Item 24)
Wood block (App C, Item 46)
Crocus cloth (App C, Item 12)
Fuel oil (App C, Item 21)

EQUIPMENT CONDITION

Para	Description
4-20	Oil pan removed
4-27	Cylinder head removed
4-31	Oil pressure regulator and relief valve removed
4-32	Oil pump and oil pump tubes removed

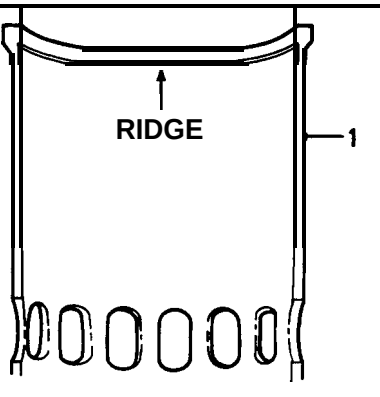
* Applies to engine **serial number 8VA-294357 and above for** models 7083-7398 and 7083-7399.
** Model 7083-7391 only.

a. Removal

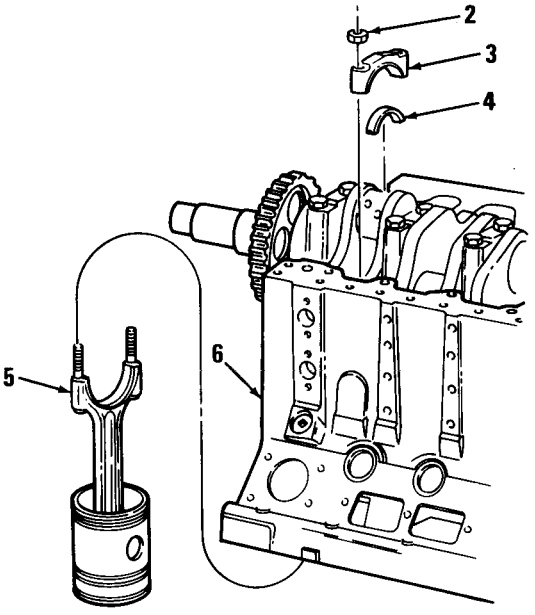
CAUTION

Remove ridge at top of liner or piston ring breakage can occur.

(1) Remove carbon deposits and ridge from upper inner surface of cylinder liner (1) using ridge removing tool.



(2) Remove two nuts (2), cap (3), and lower bearing shell (4) from connecting rod (5).



NOTE

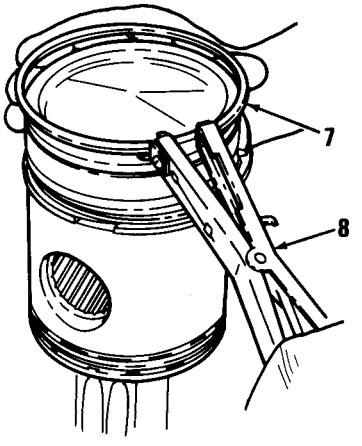
Tag piston to insure it is installed with same liner.

(3) Push piston and rod assembly out through top of cylinder block (6).

(4) Reassemble bearing cap (3) and lower bearing shell (4) to connecting rod (5).

b. Disassembly

(1) Secure connecting rod (5) in a vise equipped with soft jaws and remove piston rings (7) with piston ring pliers (8). Discard piston rings.

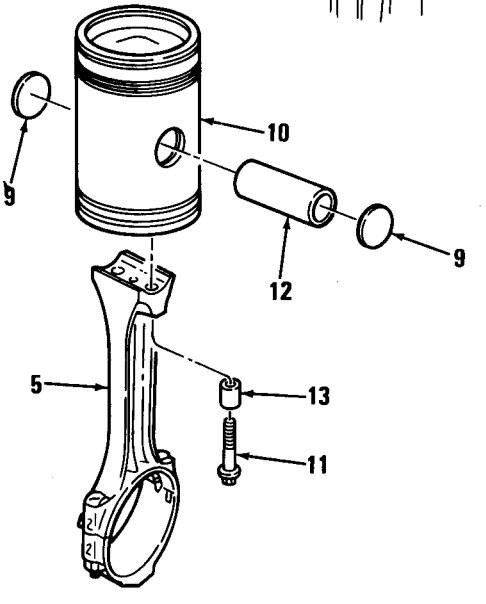


CAUTION

Do not damage piston or bushing while removing piston pin retainers.

(2) Punch a hole through center of one piston pin retainer (9) with a narrow chisel or punch and pry retainer from piston assembly (1 O). Remove opposite retainer in same manner. Discard retainers.

(3) Loosen two bolts (11) which secure connecting rod (5) to piston pin (12). Remove rod and piston assembly from vise and place assembly on a bench. Remove two bolts (11), two spacers (13), and connecting rod (5). Discard bolts and spacers.



NOTE

Match mark used piston dome, piston pin, and pin bushing and keep together as a set for reassembly to maintain proper fit and wear.

(4) Remove piston pin (12) from piston assembly (10).

4-33. PISTON AND CONNECTING ROD MAINTENANCE (CROSS-HEAD) (Cent)

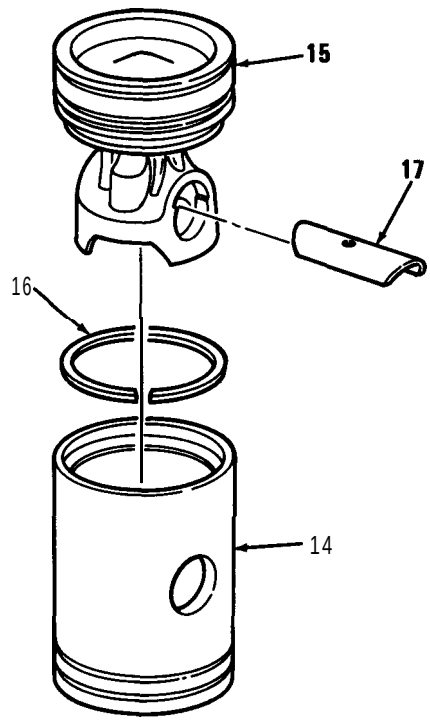
WARNING

Keep fingers out of piston pin holes and wear steel-toed shoes when disassembling piston dome from skirt. Personal Injury may result.

(5) Separate piston skirt (14) from piston dome (15).

(6) Remove seal ring (16) from piston dome (15). Discard seal.

(7) Remove piston pin bushing (17) from piston dome (15).



c. Cleaning

WARNING

- **Use goggles, rubber gloves, and rubber apron when cleaning parts In carbon-removing compound. Provide adequate ventilation. Avoid inhaling fumes and skin contact. If compound Is splashed on skin, flush with fresh water and wash with alcohol. Alcohol containing 2 to 3 percent camphor Is preferable.**
- **Compressed ah' 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 fuel oil and dry with compressed air. If fuel oil does not remove carbon deposits, use carbon-removing compound which will not harm bushings or tin plate on piston.

(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 or 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 and/or corrosion on connecting rod saddle to piston pin contact surface.

d. Inspection

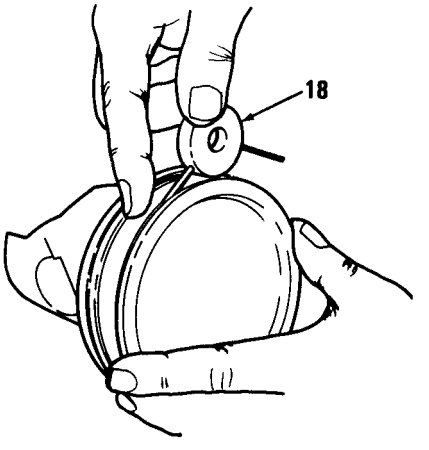
(1) Dome and Skirt

NOTE

Indications of overheating or burned spots may be result of an obstruction in connecting rod oil passage.

(a) Examine piston skirt and dome for score marks, cracks, damaged ring groove lands, loss of tin plating, or indications of overheating. Replace any piston severely scored or overheated.

(b) Check tapered fire ring groove width with piston groove gage **(18).** Slide NO-GO wire (0.106 inch diameter) of tool completely around fire ring groove. Replace dome if wire is below flush at any one area. The GO wire (0.100 inch diameter) should be flush or protrude slightly from fire ring groove.



(c) Check cylinder liner and block bore for excessive out of round, taper, or high spots which could cause failure of piston (see Para 4-34).

(2) Piston Pin

CAUTION

When using a piston pin, do not refinish highly polished and lapped surface of pin in any way.

NOTE

New piston pin has diameter of 1.4996 to 1.5000 inches. Replace piston pin if worn to diameter of 1.4980 inches or less.

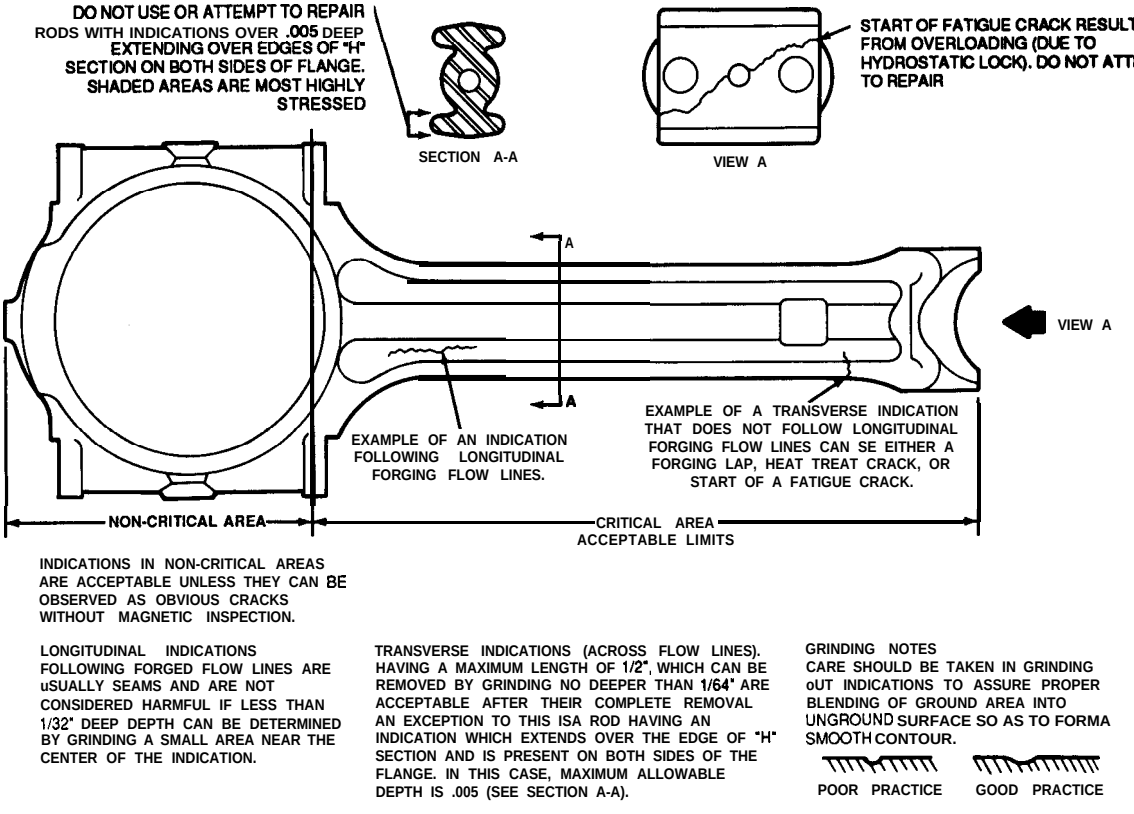
Inspect piston pin for signs of fretting.

4-33. PISTON AND CONNECTING ROD MAINTENANCE (CROSS-HEAD) (Cent)

(3) Connecting Rod

(a) Check connecting rod for visual damage. Scrap rod if it is bent, had previous bearing failure. was overheated (blue) 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 method.



INDICATIONS IN NON-CRITICAL AREAS ARE ACCEPTABLE UNLESS THEY CAN BE OBSERVED AS OBVIOUS CRACKS WITHOUT MAGNETIC INSPECTION.

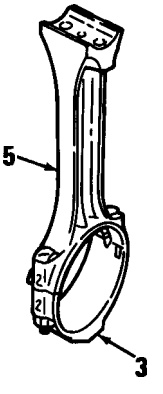
LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE uSUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 1/32" DEEP DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

TRANSVERSE INDICATIONS (ACROSS FLOW LINES). HAVING A MAXIMUM LENGTH OF 1/2", WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 1/64" ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL AN EXCEPTION TO THIS ISA 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 .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 FORMA SMOOTH CONTOUR.

(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 (5) and cap (3).



(4) Connecting Rod Bearings

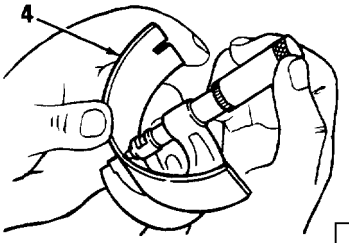
(a) Inspect bearing shells for scoring, pitting, flaking, etching, and dirt grooving. If any of these defects are present, discard bearing shells.

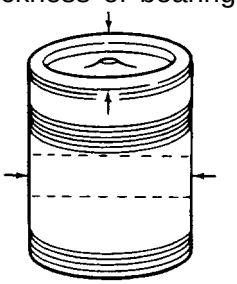
(b) Discard bearing shells with bright spots on backs indicating movement in bearing caps or supports.

NOTE

If one bearing shell is less than minimum thickness shown in Table 4-2, replace both bearing shells (upper and lower).

(c) Using a micrometer and ball attachment, measure thickness of bearing shells (4) at point "C", 90 degrees from parting line.





e. Fitting Piston

(1) Using micrometer, measure piston skirt outside diameter parallel and perpendicular to piston pin bore, obtain measurements at room temperature (70°F-21°C). Diameter must be 4.2428 to 4.2450 inches (Diameter above and below pin bore may be 4.2414 inches).

TABLE 4-2
BEARING SHELL CONNECTING ROD THICKNESS

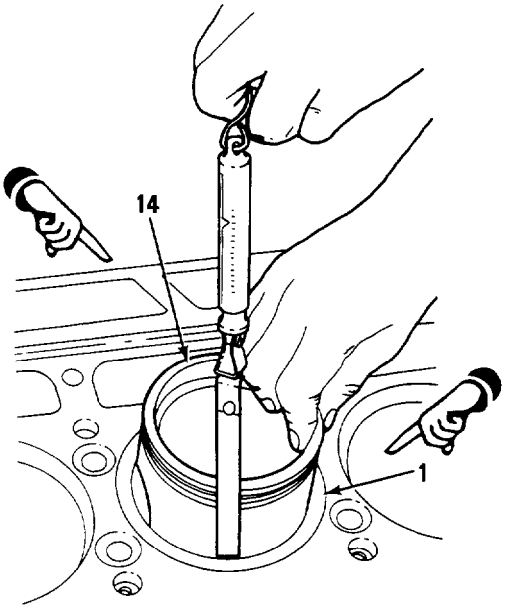
BEARING SIZE	*NEW BEARING THICKNESS	MINIMUM WORN THICKNESS
STANDARD	.1240"/.1245"	.1230"
.002" UNDERSIZE	.1250'/.1255'	.1240'
.010" UNDERSIZE	.1290'/.1295'	,1280"
.020" UNDERSIZE	.1340'/.1345"	.1330"
.030" UNDERSIZE	.1390"/.1395"	.1380"

'Thickness 90° from parting line of bearing.

NOTE

- Use feeler gage to check piston skirt to liner clearance. Use a spring scale attached to feeler gage to measure amount of force in pounds required to withdraw feeler gage from between piston and liner. Select feeler gage with thickness that will require six pounds pull to move. Piston to liner clearance will be 0.001 inch greater than thickness of feeler gage used. For example, a 0.004 inch feeler gage indicates 0.005 inch clearance when withdrawn with a six pound pull.
- Feeler gage must be perfectly flat and free of nicks and bends.

(2) With cylinder liner (1) installed in cylinder block, hold piston skirt (14) upside down in liner and check clearance in four places 90 degrees apart. Clearance must be 0.0045 to 0.0083 inch with new parts. Maximum clearance of 0.012 inch is allowed for used parts.



(3) If binding occurs between piston and liner, remove piston and examine piston and liner for burrs. Remove burrs with fine flat hone and recheck clearance.

4-33. PISTON AND CONNECTING ROD MAINTENANCE (CROSS-HEAD) (Cont)

f. Fitting Piston Rings

(1) Insert top piston ring inside cylinder liner in normal area of ring travel. Use a piston skirt to push ring down to insure ring is parallel with top of liner. Measure ring gap with feeler gage. Refer to Table 4-3 for ring gap specifications. Repeat procedure for balance of compression and oil rings.

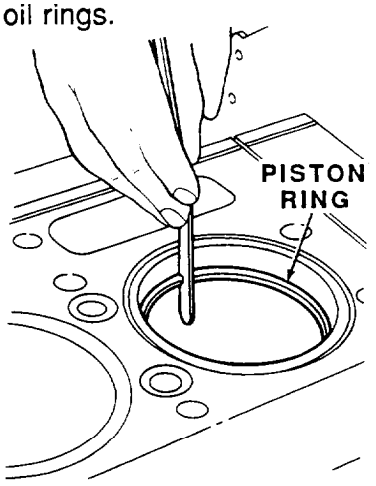
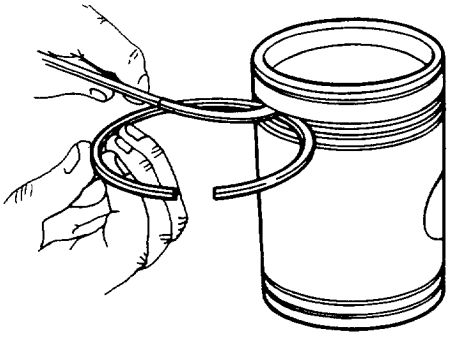


TABLE 4-3 PISTON RING SPECIFICATIONS

	MINIMUM	MAXIMUM
GAP (NO.2, AND 3)	.0230 IN (.0286CM .0180 IN. (.0457CM)	.0380 IN. (.0965CM) .0430 IN. (.1092CM)
CLEARANCE RING TO GROOVE: TOP RING NO.2 N003	.C080 IN. (.0025CM) ,0100 IN. (.0254CM) .0040 IN. (.0101CM)	.0050 IN (.0127CM) .0130 IN (.0330CM) .0070 IN. (.0177 CM)
OIL CONTROL RINGS GAP (TWO RINGS IN LOWER GROOVE) GAP (ONE RING IN UPPER GROOVE) CLEARANCE (TWO RINGS IN LOWER GROOVE) CLEARANCE (ONE RING IN UPPER GROOVE)	.0080 IN (.0203CM) .0050 IN. (.0127CM) .)015 IN. (.0038CM) .0010 IN. (.0025CM)	.0230 IN. (.0584CM) .0140 IN. (.0356CM) .0055 IN. (0139CM) .0040 IN (.0101CM)

CAUTION

File or stone both ends of compression ring from outer surface to inner surface to prevent chipping or peeling of chrome plating on ring. Ends of ring must remain square, and chamfer on outer edge must be approximately 0.015 inch.



(2) File ends of compression ring if ring gap is too small.

(3) Using feeler gage, measure ring side clearance by inserting edge of ring in appropriate groove of piston. Refer to Table 4-3 for ring side clearance specifications.

g. Assembly

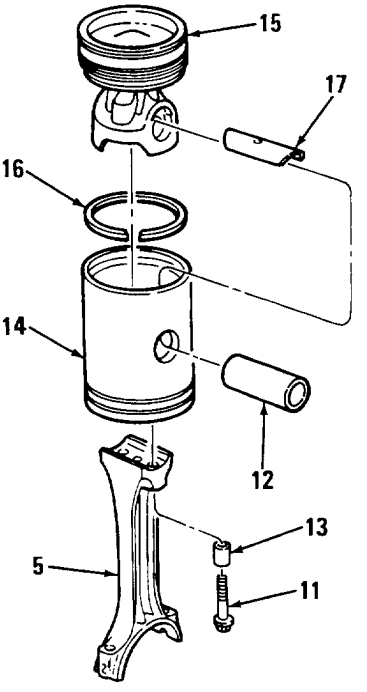
(1) Piston and Rod Assembly

(a) Install pin bushing (17) in piston dome (15). It should slide into piston dome without force.

NOTE

Soak seal rings in engine oil for 15 minutes prior to installation on dome.

(b) Lubricate seal ring (16) and install in groove on piston dome (15).



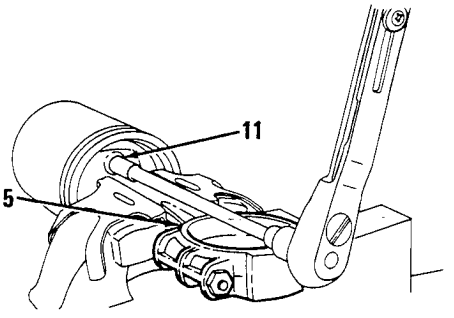
(c) Aline piston pin holes in skirt (14) and dome (15), then push skirt into position on dome.

(d) Lubricate piston pin (12) and piston pin bushing (17) with engine oil and install piston pin.

(e) Install spacers (13) on piston pin bolts (11). Apply small amount of International Compound No. 2, or equivalent, to bolt threads and bolt head contact surfaces.

(f) Attach connecting rod (5) to piston pin (12) with two bolts (11) and two spacers (13). Tighten bolts finger tight.

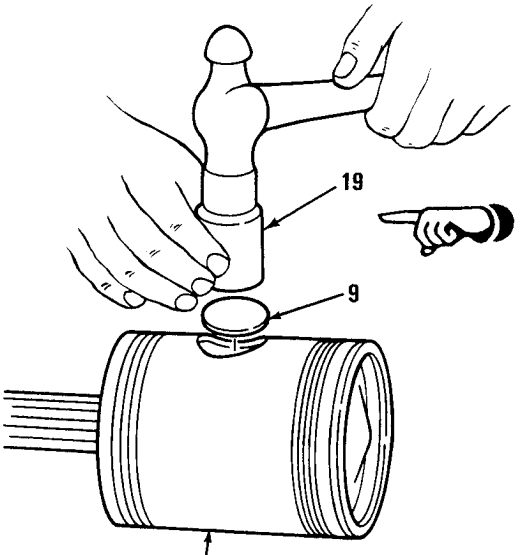
(9) Clamp connecting rod (5) in soft-jawed vise and torque piston pin bolts (11) to 55-60 lb-ft (75-81 N-m). Do not exceed this torque.



CAUTION

Insure piston pin retainers do not buckle during installation and seat completely in counterbore with width of land even around retainer to seal properly.

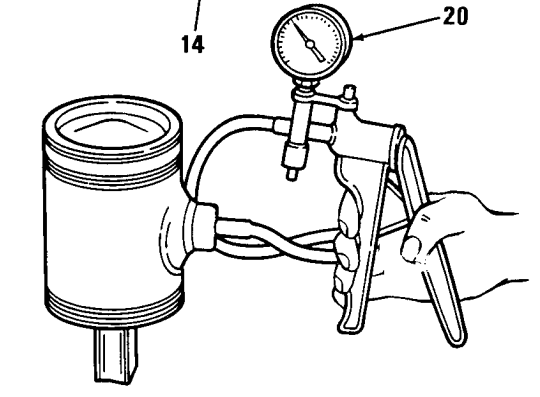
(h) Insert piston pin retainer (9) in position. Place crowned end of piston pin installer (19) against retainer. Strike tool just hard enough to deflect retainer and to seat it evenly in skirt (14), Install second retainer in same manner.



(i) Check each retainer for proper sealing with leak detector (20). Place suction cup over retainer and hand operate lever to pull a vacuum of ten inches of Hg. on gage. A drop in gage reading indicates air leakage at retainer.

(2) Installation - Piston Rings

(a) Lubricate piston rings and piston with engine oil before installing rings.



4-33. PISTON AND CONNECTING ROD MAINTENANCE (Cont)

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.

NOTE

Upper oil ring groove requires a one-piece oil ring and lower groove requires a two-piece oil ring (upper and lower halves).

(b) Install two ring expanders (21) in oil control ring grooves in piston skirt (14) with legs of free ends toward top of piston.

CAUTION

. For all models except 7083-7391, scraper edges of all oil control rings must face down (toward bottom of piston) for proper oil control.

. For model 7083-7391, the upper oil ring in the lower groove must face up (toward top of piston) for proper oil control.

(c) Install upper and lower halves of lower oil control ring by hand. Install lower half (22) in bottom groove with gap 180° from gap in expander. Install upper half (23) in lower groove wtih gap 45° from gap in lower half of ring and scraper edge facing down. For model 7083-7391 only, the scraper edge of the upper oil ring half (23) in the lower groove MUST face up for proper oil control.

(d) Using piston ring pliers, install upper oil ring (24) by positioning it over upper ring groove with scraper edge facing down. Align oil ring gap 180° from gap in expander (21). Press ring against gap side of expander to prevent ends of expander from overlapping. Then align ring with groove and release tension on ring pliers permitting ring to slip in position.

CAUTION

Do not spread rings any more than necessary to slip them over piston. Ring breakage and overstressing will result.

NOTE

- Compression rings have one mark on top of ring and fire ring has two marks on top of ring. Clamp connecting rod of piston assembly in soft-jawed vise.
- Model 7083-7391 has a nongrooved-face fire ring. All other models have a grooved face fire ring.

(e) Starting with bottom compression ring, install two compression rings (25) and fire ring (26) using piston ring pliers. Install rings with marks toward top of piston.

(f) Stagger ring gaps around piston 90° from each other.

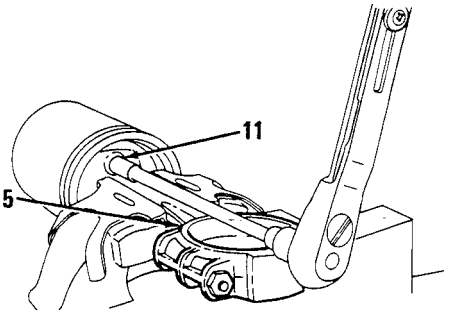
(c) Aline piston pin holes in skirt (14) and dome (15), then push skirt into position on dome.

(d) Lubricate piston pin (12) and piston pin bushing (17) with engine oil and install piston pin.

(e) Install spacers (13) on piston pin bolts (11). Apply small amount of International Compound No. 2, or equivalent, to bolt threads and bolt head contact surfaces.

(f) Attach connecting rod (5) to piston pin (12) with two bolts (11) and two spacers (13). Tighten bolts finger tight.

(9) Clamp connecting rod (5) in soft-jawed vise and torque piston pin bolts (11) to 55-60 lb-ft (75-81 N-m). Do not exceed this torque.

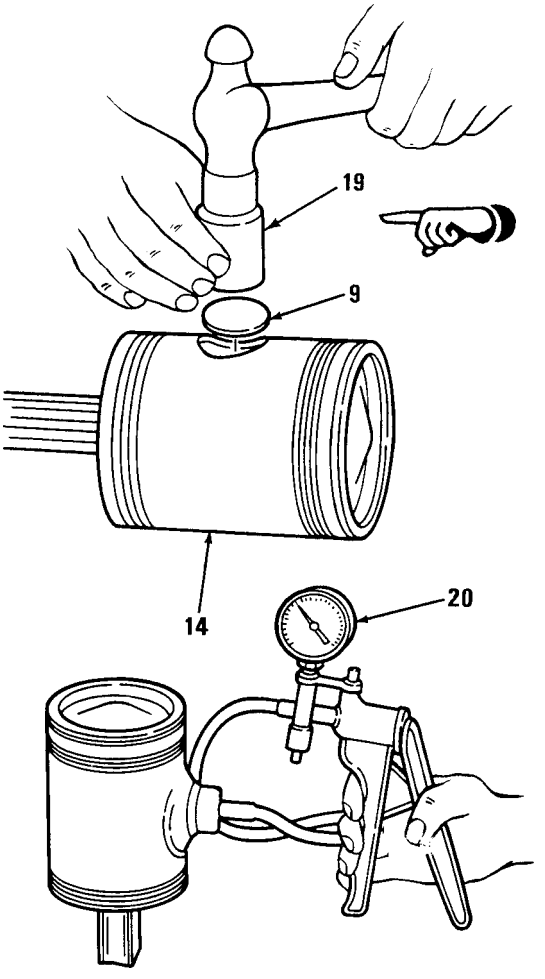


CAUTION

Insure piston pin retainers do not buckle during installation and seat completely in counterbore with width of land even around retainer to seal properly.

(h) Insert piston pin retainer (9) in position. Place crowned end of piston pin installer (19) against retainer. Strike tool just hard enough to deflect retainer and to seat it evenly in skirt (14), Install second retainer in same manner.

(i) Check each retainer for proper sealing with leak detector (20). Place suction cup over retainer and hand operate lever to pull a vacuum of ten inches of Hg. on gage. A drop in gage reading indicates air leakage at retainer.



(2) Installation - Piston Rings

(a) Lubricate piston rings and piston with engine oil before installing rings.

4-33. PISTON AND CONNECTING ROD MAINTENANCE (Cent)

CAUTION

- Do not allow ends of oil tina 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.

NOTE

Upper oil ring groove requires a one-piece oil ring and lower groove requires a two-piece oil ring (upper and lower halves).

(b) Install two ring expanders (21) in oil control ring grooves in piston skirt (14) with legs of free ends toward top of piston.

CAUTION

. For all models except 7083-7391, scraper edges of all oil control rings must face down (toward bottom of piston) for proper oil control.

. For model 7083-7391, the upper oil ring in the lower groove must face up (toward top of piston) for proper oil control.

(c) Install upper and lower halves of lower oil control ring by hand. Install lower half (22) in bottom groove with gap 180° from gap in expander. Install upper half (23) in lower groove with gap 45° from gap in lower half of ring and scraper edge facing down. For" model 7083-7391 only, the scraper edge of the upper oil ring half (23) in the lower groove MUST face up for proper oil control.

(d) Using piston ring pliers, install upper oil ring (24) by positioning it over upper ring groove with scraper edge facing down. Align oil ring gap 180° from gap in expander (21). Press ring against gap side of expander to prevent ends of expander from overlapping. Then align ring with groove and release tension on ring pliers permitting ring to slip in position.

CAUTION

Do not spread rings any more than necessary to slip them over piston. Ring breakage and overstressing will result.

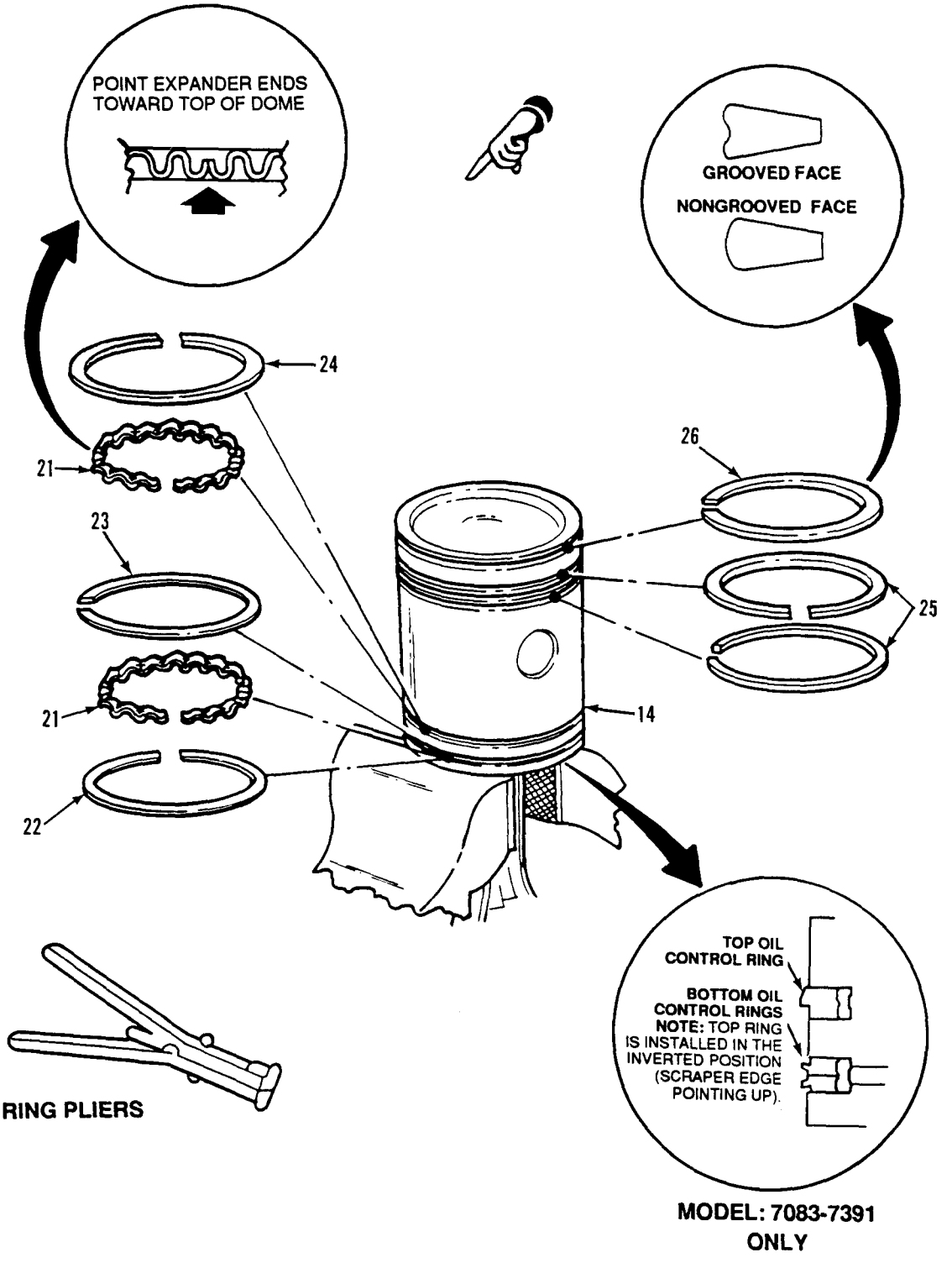
NOTE

- Compression rings have one mark on top of ring and fire ring has two marks on top of ring. Clamp connecting rod of piston assembly in soft-jawed vise.

. Model 7083-7391 has a nongrooved-face fire ring. All other models have a grooved face fire ring.

(e) Starting with bottom compression ring, install two compression rings (25) and fire ring (26) using piston ring pliers. Install rings with marks toward top of piston.

(f) Stagger ring gaps around piston 90° from each other.


POINT EXPANDER ENDS TOWARD TOP OF DOME
GROOVED FACE
NONGROOVED FACE
24
21
23
21
22
26
25
14
TOP OIL CONTROL RING
BOTTOM OIL CONTROL RINGS
NOTE: TOP RING IS INSTALLED IN THE INVERTED POSITION (SCRAPER EDGE POINTING UP).
RING PLIERS
MODEL: 7083-7391 ONLY

4-33. PISTON AND CONNECTING ROD MAINTENANCE (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.

NOTE

Inspect ring compressor for nicks or burrs, especially at nontapered inside diameter end. Nicks or burrs on inside diameter of compressor will result in damage to piston rings.

(b) Place piston ring compressor (27) on wood block, with tapered end of ring compressor facing up.

(c) Stagger piston ring gaps 90° apart on piston. Make sure ends of oil control ring expanders are not overlapped.

(d) Start top of piston straight into ring compressor (27). Then push piston down until it contacts wood block.

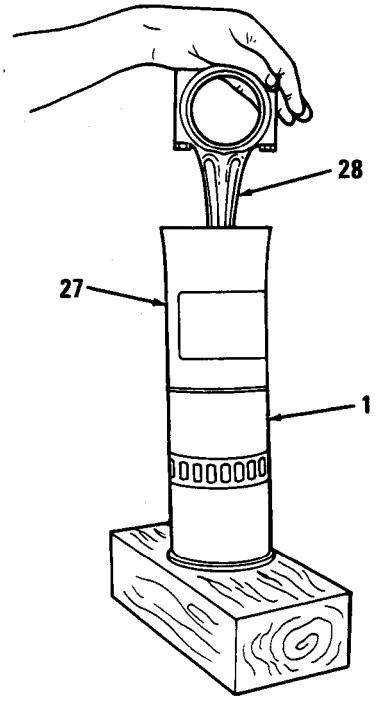
(e) Place liner (1) with flange end down on wood block. Note position of matchmark on liner.

NOTE

Numbers on side of connecting rod and cap identify rod with cap and indicate particular cylinder in which they are used.

(f) Place ring compressor (27) and piston and connecting rod assembly (28) on liner (1) with numbers on side of connecting rod and cap aligned with matchmark on liner.

(g) Push piston and connecting rod assembly (28) down into liner (1) until piston is-free of ring compressor (27).



CAUTION

Do not force piston into liner. Expanders apply considerable force on oil rings; therefore, extra care must be taken during loading operation to prevent ring breakage.

(h) Remove connecting rod cap and ring compressor. Then push piston down until compression rings pass cylinder liner ports.

h. Installation - Cylinder Kit Assembly

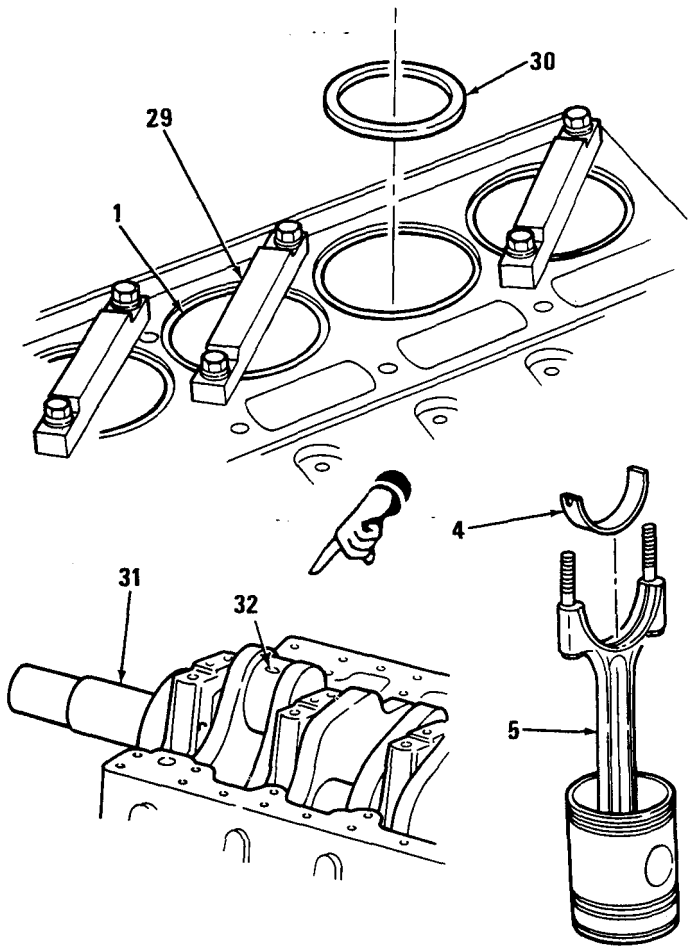
NOTE

If any pistons and liners are already in engine, use hold down clamps (29) to retain liners (1) in place when crankshaft is rotated.

(1) Install cylinder liner insert (30) in block counterbore.

(2) Rotate crankshaft (31) until connecting rod journal (32) of particular cylinder being worked on is at bottom of its travel. Wipe journal clean and lubricate it with clean engine oil.

(3) Install upper bearing shell (4) (without continuous oil groove) in connecting rod (5). Lubricate bearing shell with clean engine oil.

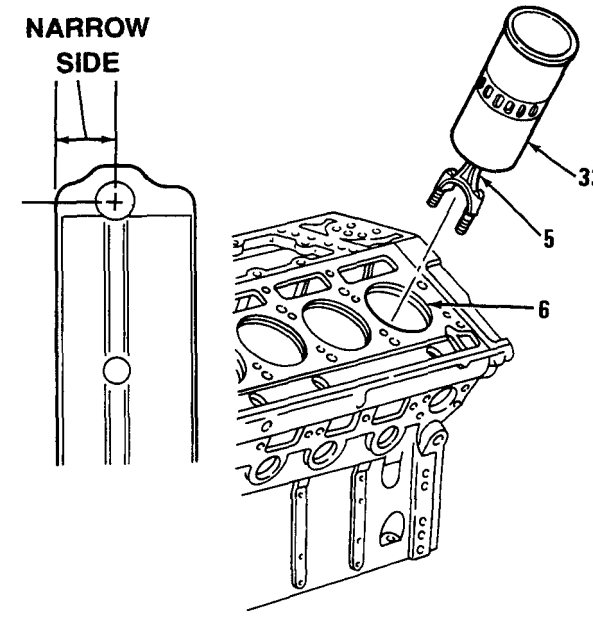


NOTE

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 connecting rods on crankshaft journal are together to avoid cocking of rod.

(4) Position piston, rod, and liner assembly (33) above 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 (5) through block bore carefully to avoid damaging or dislodging bearing shell. Then slide piston, rod, and liner assembly straight into block bore until liner flange rests against insert in block counterbore (6).

Push or pull piston and connecting rod into liner until upper bearing shell is firmly seated on crankshaft journal.



4-33. PISTON AND CONNECTING ROD MAINTENANCE (Cont)

(6) Check bearing to crankshaft journal clearance by placing a plastic gage strip (34) between crankshaft journal (32) and connecting rod cap (3). Tighten connecting rod nuts (2) to 60-70 lb-ft (81-95 N-m.). Remove connecting rod nuts and cap, and measure width of plastic gage with measuring strip (35). Maximum clearance with used parts is 0.006 inch.

(7) Place lower bearing shell (4) in connecting rod cap (3). Lubricate bearing shell with clean engine oil.

NOTE

Ensure connecting rod bolt has not turned in connecting rod before torquing nuts.

(8) Install bearing cap (3) and bearing shell (4) on connecting rod (5) with identification numbers on cap and rod adjacent to each other. Torque connecting rod bolt nuts (2) to 60-70 lb-ft (81-95 N.m.).

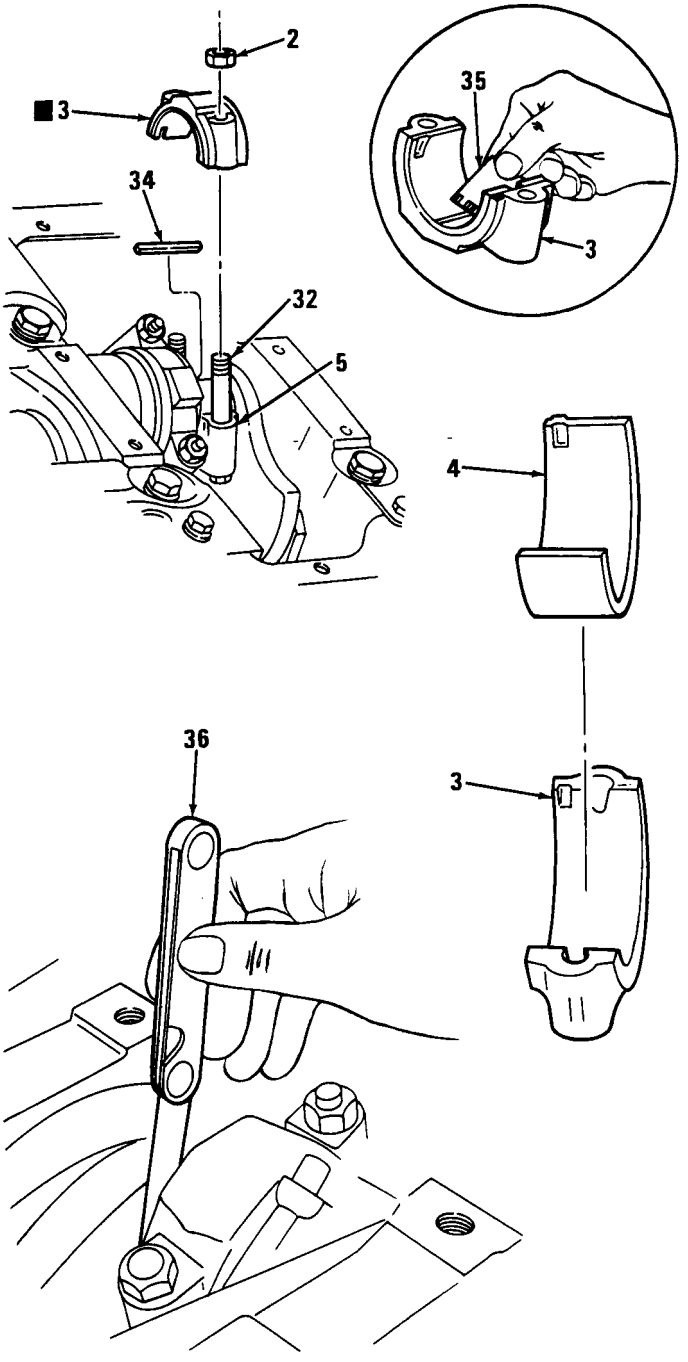
NOTE

If necessary, pry connecting rods apart before measuring side clearance.

(9) Using feeler gage (36), measure side clearance between each pair of connecting rods. Clearance limits are 0.008 to 0.016 inch.

(10) Install additional liners, pistons, and rod assemblies in same manner. Use hold-down clamps to hold each liner in place.

(11) Remove all liner hold-down clamps.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-32	Install oil pump and oil pump tubes
4-31	Install oil pressure regulator and relief valve
4-27	Install cylinder head
4-20	Install oil pan

4-34. CYLINDER LINER MAINTENANCE

This task covers: a. Removal b. Cleaning c. Inspection - d. Measurements e. Honing f. Selection of New Cylinder Liner g. Fitting Cylinder Liner in Block Bore h. Installation

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Depth gage (App B, Item 28)
Cylinder liner remover (App B, Item 76)
Cylinder hone (App B, Item 42)
Cylinder bore gage (App B, Item 27)
Micrometer 4-5 inch (App B, Item 65)
Cylinder liner hold-down clamps (App B, kern 11)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para Description
4-20 Oil pan removed
4-27 Cylinder head removed
4-31 Oil pressure regulator and relief valve removed
4-32 Oil pump and oil pump tubes removed
4-33 Piston and rod assembly removed

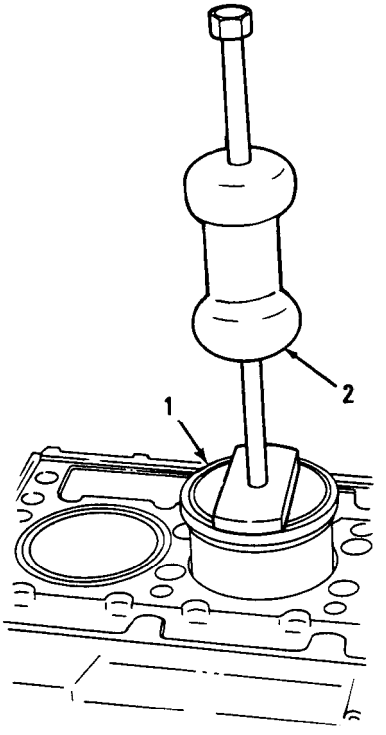
a. Removal

CAUTION

Do not insert bar in liner ports and rotate crankshaft to push out liner. Piston may be damaged or upper ring groove may collapse.

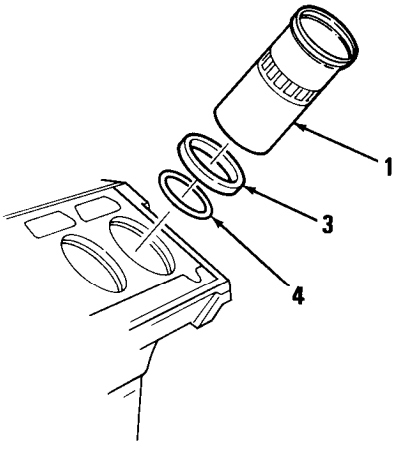
(1) Loosen cylinder liner (1) using cylinder liner removing tool (2).

(2) Remove tool from liner. Then remove liner from cylinder block.



(3) Remove liner insert (3) and shims (4) (if used) from counterbore in block.

(4) Tag liner, insert, and shims with cylinder position number.



b. Cleaning

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).

CAUTION

Always store liners in an upright position until ready for use. Liners left on their side can become distorted.

Clean cylinder liner with fuel oil and dry with compressed air.

c. Inspection

(1) Check outside of liners for cracks, scoring, and flange irregularities.

(2) Discard cracked or excessively scored liners. Clean up slightly scored liners using cylinder hone.

NOTE

Excessive liner to block clearance or block bore distortion will reduce heat transfer from liner to block and to engine coolant. Stains or low pressure areas on outer surface of liner indicate poor contact between liner and block bore.

(3) Examine outside surface of liner for fretting. Remove metal particles from surface of liner with a coarse flat stone.

(4) Liner flange and liner insert must be smooth and flat on both top and bottom surfaces. Replace liner if cracked at flange. Replace insert if there is evidence of brinelling.

4-34. CYLINDER LINER MAINTENANCE (Cont.)

(5) Check inside diameter of liner for glazing, cracking, scoring, and unusual wear.

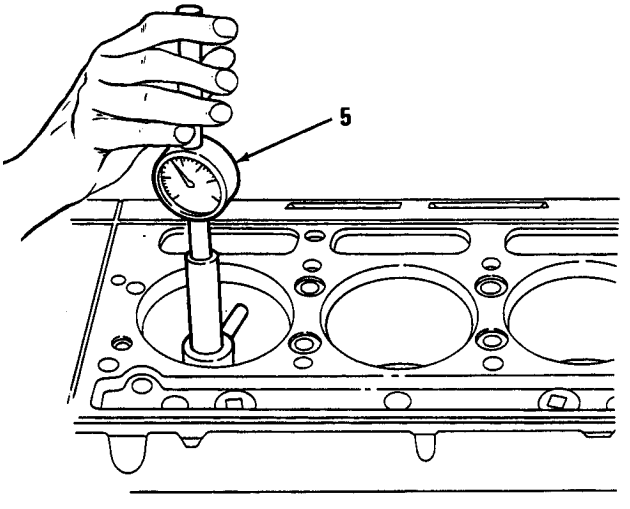
(6) Replace cracked, scuffed, or scored liners.

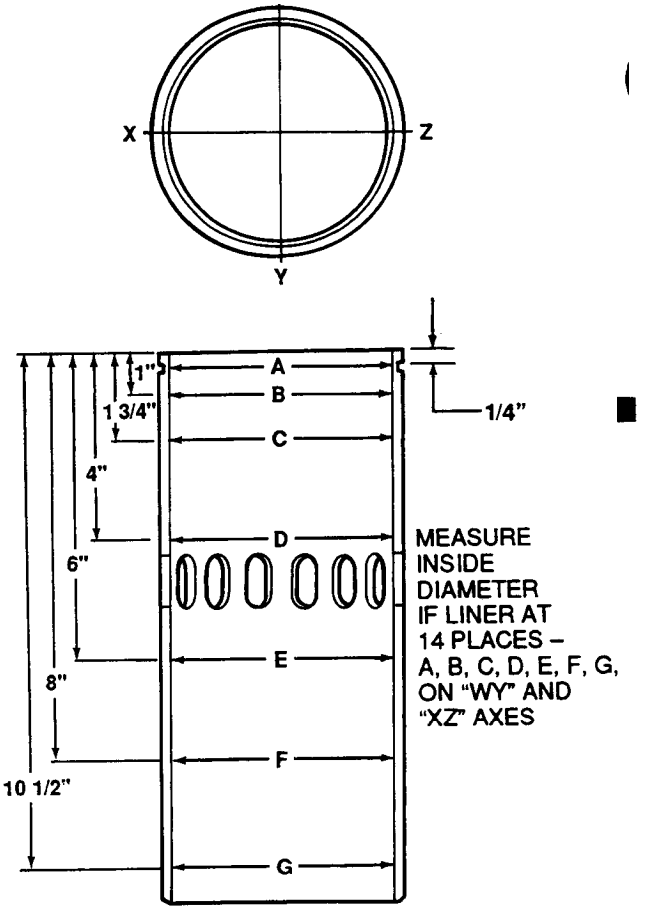
d. Measurements

(1) Measure block bore and outside diameter of liner. If liner to block clearance exceeds 0.0025 inch, block must be bored for an oversize liner.

(2) Using liner O.D. measurements from four positions (0.625, 3.375, 5.875, and 9.875 inches from top of flange), classification of liner O.D. is determined as average of these measurements.

(3) Install liner in proper bore - based on measurements in step (1) - of cylinder block. Measure inside diameter of liner at 14 places shown using cylinder bore gage (5).





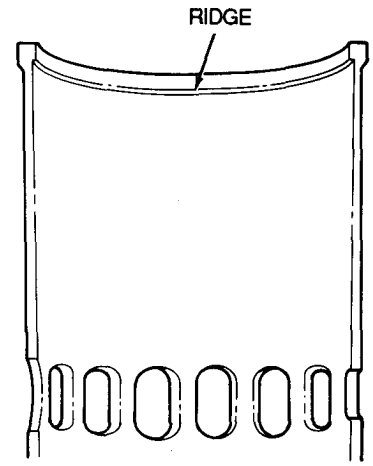
(4) Check used liner for taper and out of round. Liner taper is difference between O.D. at 0.625 and 9.875 inches positions. Taper must not exceed 0.002 inch and out of round must not exceed 0.0025 inch. If out of round exceeds 0.0025 inch, rotate liner 90 degrees in block bore and recheck.

NOTE

Liners, standard and oversize, have an inside diameter of 4.2489 to 4.2511 inches. Liners are available in 0.005, 0.010, 0.020, 0.030 inch oversize on outside diameter.

(5) When an oversize liner is installed, stamp amount of oversize on top of cylinder block bore adjacent to liner counterbore.

e. Honing



CAUTION

Do not modify surface finish of new liner. Liner is properly finished at factory so changes will adversely affect piston ring seating.

NOTE

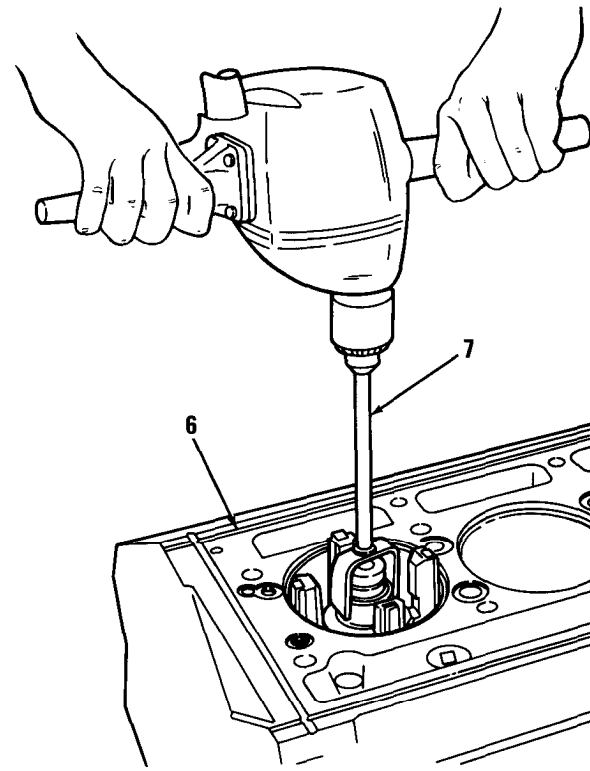
- Used cylinder liners must be honed to break glaze resulting from extended operation and to remove ridge formed at top of piston ring travel. If glaze is not removed, time required to seat new piston rings will be lengthened.
- A scrap cylinder block makes an excellent honing fixture.

(1) Place liner in fixture (6).

CAUTION

If liner is honed in block, completely dismantle engine to insure all abrasive material is cleaned out.

(2) A hone (7) equipped with 120 grit stones should be worked up and down full length of liner a few times to produce a crisscross pattern of hone marks on 45 degree axis.



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) Remove liner from fixture and clean thoroughly. Dry with compressed air and check surface for burrs.

4-34 CYLINDER LINER MAINTENANCE (Cont.)

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.

f. Selection Of New Cylinder Liner

NOTE

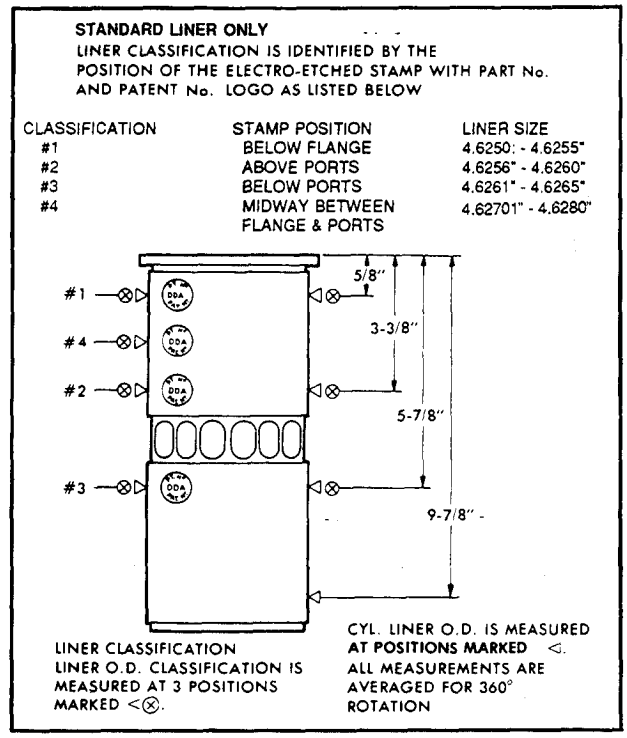
Cylinder bores in a new cylinder block are classified as #0, #1, #2, #3 or #4 (Table 4-4), designating size range for each bore. An appropriate cylinder liner is fitted to each bore. This number is stamped on fire deck of cylinder block next to each cylinder bore.

TABLE 4-4. NEW CYLINDER LINER TO NEW CYLINDER BLOCK BORE FITS

Classification Number Stamped Adjacent to Each Cyl. Bore	Cylinder Bore Classification Diameter (I. D.)	Standard Cylinder Liner Diameters and Liner-to-Block Clearances When Properly Matched		
		Liner (0. D.) Classification	Liner (0. D.) Diameter	Liner/Block Clearance
CAST IRON BLOCK				
#0	4.6256"/4.6259"	#1	4.6250"/4.6255"	.0001"/.0009"
#1	4.6260"/4.6265"	#1 #2	4.6250"/4.6255" 4.6256"/4.6260"	.0005"/.0015" .0000"/.0009"
#2	4.6266"/4.6270"	#2 #3	4.6256"/4.6260" 4.6261"/4.6265"	.0006"/.0014" .0001"/.0009
#3	4.6271"/4.6275"	#3	4.6261"/4.6265"	.0006"/.0014"
#4	—	#4	4.62701"/4.62800	.0005"/.0015"
METRIC				
#0	117.490/117.498 mm	#1	117.475/117.488 mm	.002/.023 mm
#1	117.500/117.513 mm	#1 #2	117.475/117.488 mm 117.490/117.500 mm	.012/.038 mm .000/.023 mm
#2	117.516/117.526 mm	#2 #3	117.490/117.500 mm 117.503/117.513 mm	.0161.036 mm .003/.023 mm
#3	117.528/117.539 mm	#4	117.503/117.513 mm	. 015/.036 mm
#4	—	#4	117.527/117.551 mm	.012/.038mm

NOTE

A new standard size cylinder liner is also classified as #1 (stamped below flange), #2 (stamped above ports), #3 (stamped below ports), or #4 (stamped between ports and flange).



(1) Before installing liner in used cylinder block, always lightly hone block bore (Para 4-36).

(2) After honing block bore, check bore measurements to determine if standard liner (Classification #1, #2, #3 or #4) can be used. A push fit between liner and block is desirable. If a push fit cannot be obtained, block must be bored to receive an oversize liner.

TABLE 4-5. OVERSIZE CYLINDER LINER SIZE

Service Liner Oversize	Liner Outside Diameter		Liner/Block Clearance Req'd After Boring Block
	Inches	mm	
0.005"	4.6315 4.6300	117.640 117.602	0.0005"/0.0015" (0.013/0.038mm)
0.010"	4.6363 4.6350	117.767 117.729	0.0005"/0.0015" (0.013/0.038mm)
0.020"	4.6465 4.6450	118.021 117.983	0.0005"/0.0015" (0.013/0.038mm)
0.030"	4.6565 4.6550	118.275 118.237	0.0005"/0.0015" (0.013/0.038mm)

4-34 CYLINDER LINER MAINTENANCE (Cont.)

NOTE

- Maximum liner out of round and taper is 0.002 inch. Maximum block bore diameter is 4.6285 inches for standard liner. If block bore exceeds limit, block must be bored oversize.

- Measure each liner on outside diameter for size in three places (under flange, between flange and ports, and above ports). Cylinder bore size is average of three measurements.

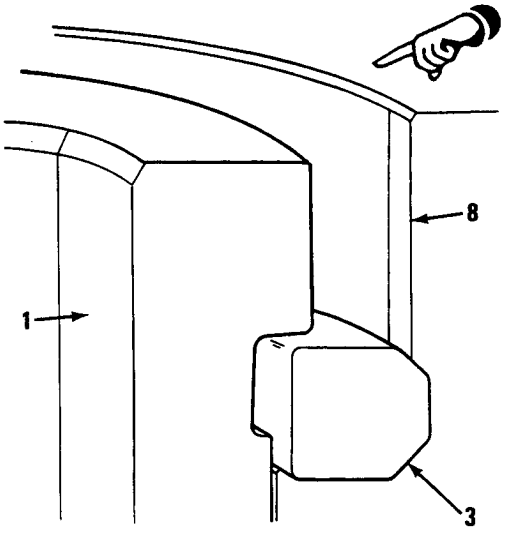
g. Fitting Cylinder Liner In Block Bore

CAUTION

If a new liner and piston are installed in block without properly fitting a liner, galling and seizing of piston may result.

(1) Wipe inside and outside of liner clean and clean block bore and counterbore thoroughly.

(2) Place a standard size cylinder liner insert (3) (0.1795-0.1800 inch thick) in block counterbore.

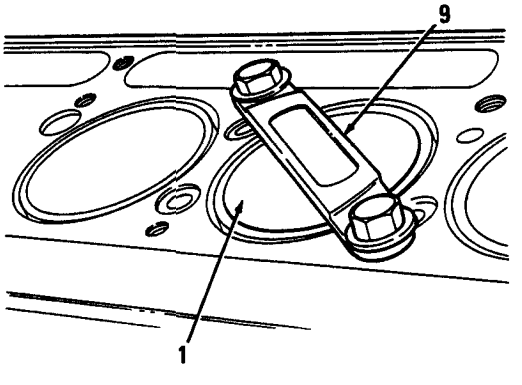


NOTE

If a new liner cannot be pushed in place, lightly hone block bore to obtain desired fit.

(3) Push cylinder liner (1) into cylinder block bore (8) until liner flange rests on insert (3). Liner should slide smoothly in place with hand pressure.

(4) Install a cylinder liner hold down clamp (9) at top of liner (1). Torque two bolts to 50 lb-ft (68 N-m).



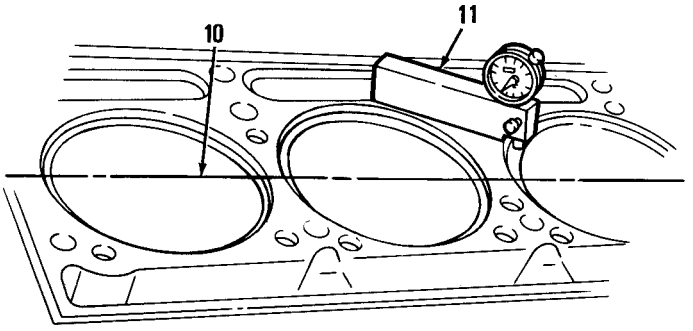
CAUTION

Do not cut liner shims at installation. Shims must be unbroken to seat insert properly.

NOTE

Maximum liner height difference of 0.002 inch between any two adjacent liners is allowed as measured lengthwise along cylinder center line (10).

(5) Measure distance from top of liner to top of block with a depth gage (11). Liner flange must be 0.045 to 0.050 inch below surface of block.



NOTE

Liner inserts 0.0015 inch thicker or 0.0015, 0.004, and 0.008 inch thinner than standard are available.

(6) If necessary, adjust liner height by adding 0.002 inch shims underneath liner insert or use alternate inserts.

(7) Matchmark liner and cylinder block on outboard side with felt pen so liner is reinstalled in same position and same cylinder bore.

(8) Remove hold down clamp and cylinder liner. Do not remove liner insert.

h. Installation

Cylinder liner is installed as a complete assembly including piston assembly, connecting rod, and cylinder liner. See Para 4-33 for installation instructions.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-33 Install piston and rod assembly
4-32 Install oil pump and oil pump tubes
4-31 Install oil pressure regulator and relief valve
4-27 Install cylinder head
4-20 Install oil pan

4-35. CRANKSHAFT MAINTENANCE

This task covers: a. Removal b. Disassembly c.- Cleaning
d. Inspection e. Measurements f. Assembly
g. Installation

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Magnetic base dial Indicator (App B, Item 45)
Micrometer 0-1 inch (App B, Item 65)
Micrometer 2-3 inch (App B, Item 65)
Micrometer 4-5 inch (App B, Item 65)
Universal puller (App B, Item 71)
Ball attachment (App B, Item 6)
Telescoping gage set (App B, Item 25)

EXPENDABLE/DURABLE SUPPLIES

Dry cleaning solvent (App C, Item 10)
Engine oil (App C, Item 16)
Plastic gage (App C, Item 30)
Crocus cloth (App C, Item 12)
Emery cloth (App C, Item 15)
Fuel oil (App C, Item 21)
International compound no. 2 (App C, Item 24)

EQUIPMENT CONDITION

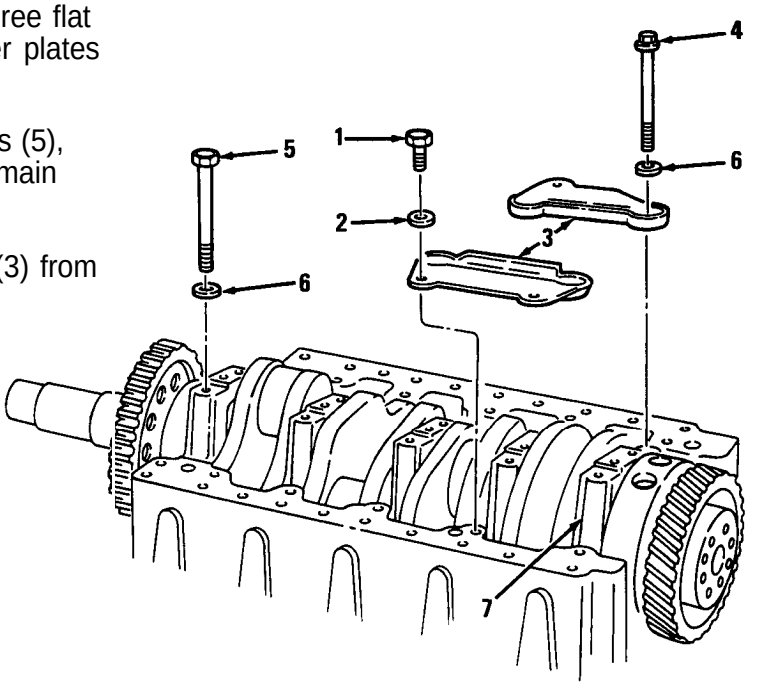
Para Description
4-24 Flywheel housing removed
4-25 Idler gear removed
4-28 Lower front cover removed (7083-7395 and 7083-7398)
4-33 Pistons and connecting rods removed
5-27 Lower front cover removed (7083-7391, 7083-7396, and 7083-7399)

a. Removal

(1) Remove three bolts (1) and three flat washers (2) from two stabilizer plates (3).

(2) Remove four bolts (4), six bolts (5), and ten flat washers (6) from main bearing caps (7).

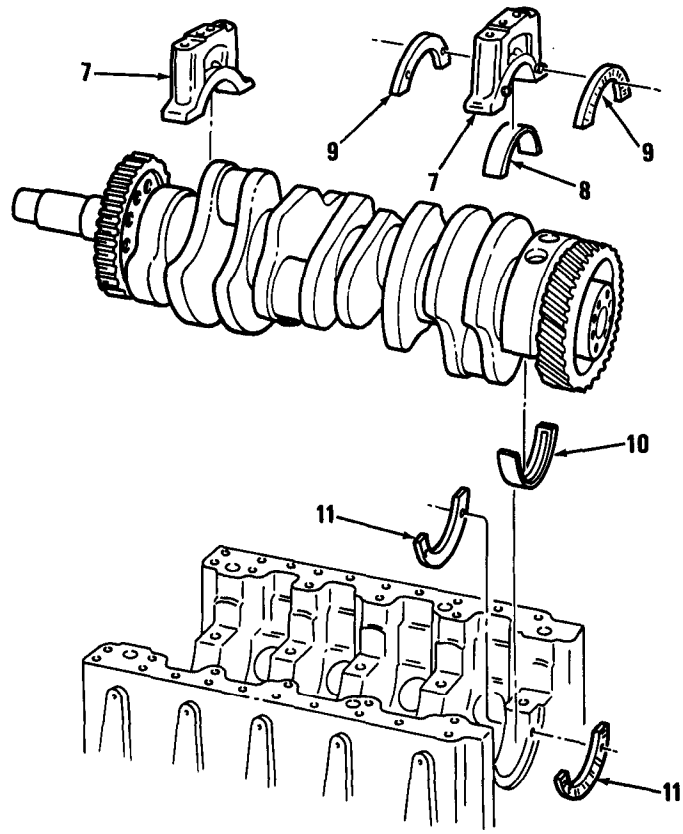
(3) Remove two stabilizer plates (3) from rear main bearing caps (7).



CAUTION

Install main bearing caps and main bearing shells in their original position. Main bearing caps are numbered 1,2,3,4, and 5. Upper bearing shell has an oil hole and groove for lubrication, and lower bearing shell is smooth with no groove or oil hole.

(4) Remove five main bearing caps (7) from cylinder block. Attach lower shell of main bearings (8) and lower thrust washers (9) (rear cap only) to appropriate cap.



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.

(5) Remove crankshaft from cylinder block. Do not dislodge upper bearing shells (10) and upper thrust washers (11).

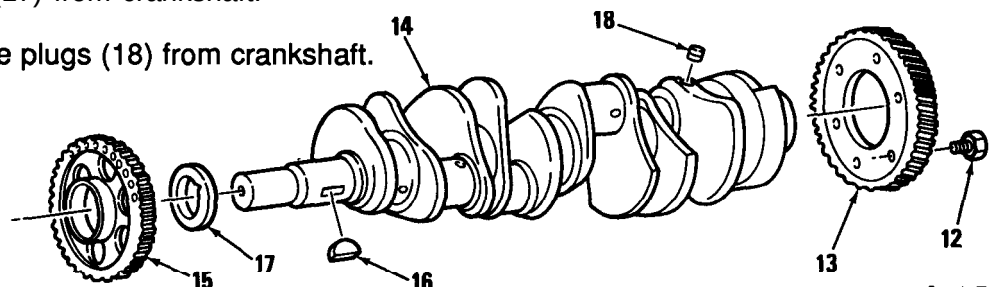
(6) Remove five upper bearing shells (10) and two upper thrust washers (11) from block and mark with corresponding main bearing identification number.

b. Disassembly

(1) Remove six bolts (12) from rear crankshaft gear (13). Use universal puller to remove gear from crankshaft (14).

(2) Remove slip fit oil pump driving gear (15) from front of crankshaft. Remove Woodruff key (16) and spacer ring (17) from crankshaft.

(3) Remove four pipe plugs (18) from crankshaft.



4-35. CRANKSHAFT MAINTENANCE (Cont)

c. Cleaning

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only In a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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/shieid, gloves, etc).**

(1) Clean all crankshaft oil passages thoroughly with cleaning solvent and dry with compressed air.

(2) Clean front and rear crankshaft gears with cleaning solvent.

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 if it shows evidence of excessive overheating since heat treatment has probably been destroyed.
- Ridges on crankshaft journals must be removed. If ridges are not removed, localized high unit pressures are placed on new bearing shells and short bearing life can result.

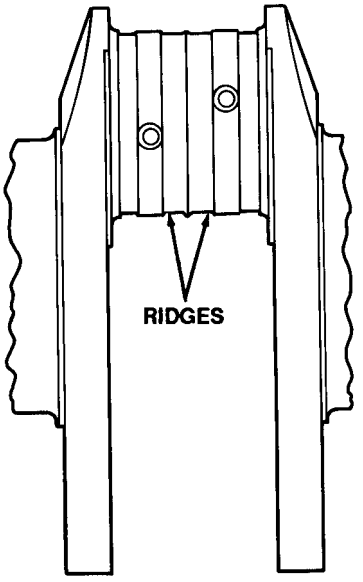
(3) Inspect crankshaft journals for ridges and grooves. Ridges exceeding 0.0002 inch must be removed.

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 end of crankshaft at area of oil seal contact surface for evidence of rough or grooved condition. Slight ridges on crankshaft oil seal contact surface may be cleaned up with crocus cloth. If crankshaft cannot be cleaned up satisfactorily, reposition oil seal in flywheel housing.

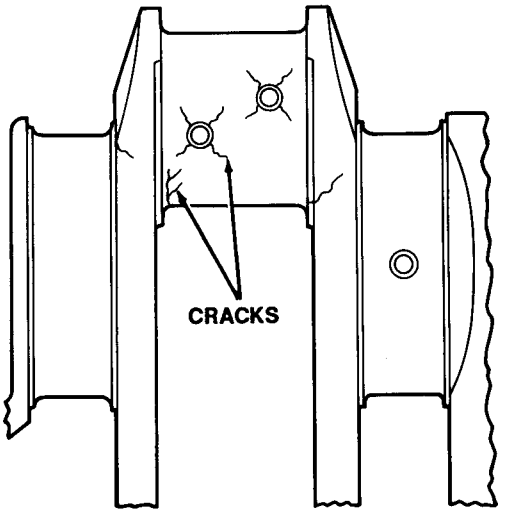


(6) Check crankshaft thrust surfaces for excessive wear or grooving. If only slightly worn, surfaces may be dressed with an oil stone.

NOTE

- Minute cracks can be detected by using Magnetic Particle Inspection Method.
- Crankshaft failures are rare and when one cracks or breaks completely, it is very important to make a thorough inspection for contributory factors.

(7) Inspect crankshaft for fatigue cracks which start at an oil hole and follow journal surface at an angle of 45 degrees to axis. Reject crankshaft with cracks.



(8) Inspect main bearing shells for bright spots on backs indicating movement in bearing caps or supports. Discard shells if this condition is present.

CAUTION

Install all upper and lower bearing shells as a set. Do not replace one main bearing shell alone. When new crankshaft is used, install all new bearing shells.

4-35. CRANKSHAFT MAINTENANCE (Cont.)

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, measure thickness of bearing shells at point (C), 90 degrees from parting line. Replace all bearing shells if minimum thickness is less than 0.1540 inch. A standard bearing is 0.1545 to 0.1552 inch thick. Refer to Table 4-6 for thickness of undersize bearings.

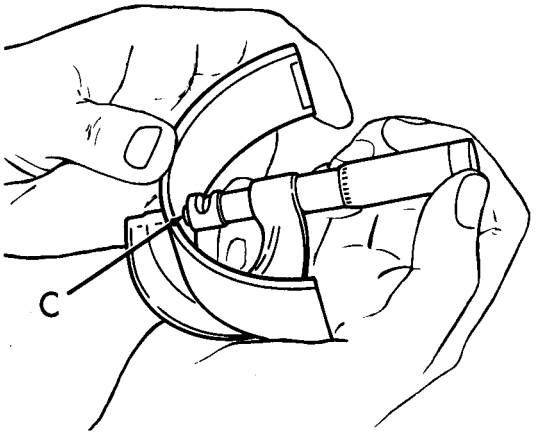


TABLE 4-6. CRANKSHAFT BEARING SHELL THICKNESS

BEARING SIZE	BEARING THICKNESS	MINIMUM THICKNESS
STANDARD	.1545"/.1552"	.154"
.002" UNDERSIZE	.1555"/.1562"	.155"
.010" UNDERSIZE	.1595"/.1602"	.159"
.020 UNDERSIZE	.1645"/.1652"	.164"
.030" UNDERSIZE	.1695"/.1702"	.169"

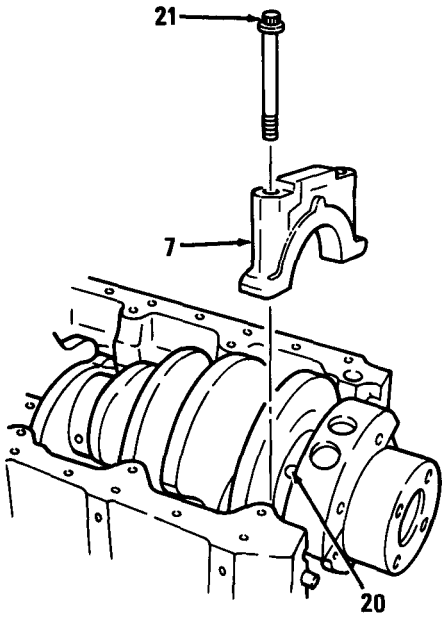
NOTE

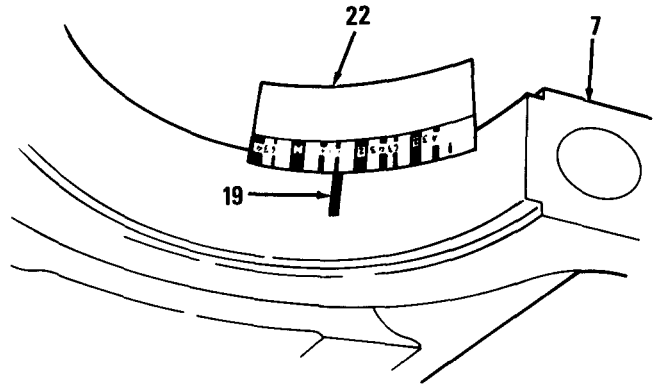
If clearance between any crankshaft journal and its bearing shells exceeds 0.0060 inch, all bearing shells must be discarded and replaced. Clearance for new parts is 0.0016 to 0.0050 inch.

(2) Check clearance between main bearings and crankshaft journals by using method (a) or (b) below:

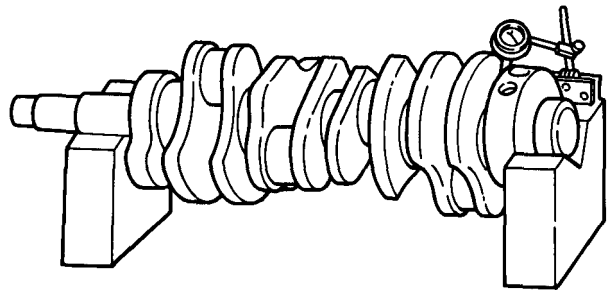
(a) With crankshaft removed, measure outside diameter of crankshaft main bearing journals and inside diameter of main bearing shells in place with required bearing cap bolt torque. When installed, bearing shells are 0.001 inch larger in diameter at parting line than 90 degrees from parting line.

(b) With crankshaft installed, place plastic gage strip (19) between crankshaft journal (20) and main bearing cap (7). Tighten main bearing bolts (21) to required torque. Remove main bearing bolts and cap and measure width of plastic gage with measuring strip (22).





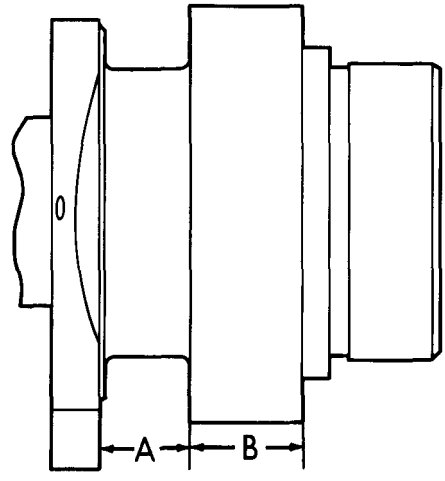
(3) Measure intermediate main bearing journal runout with dial indicator. Support crankshaft on its front and rear journals on V-blocks or an inverted engine block with front and rear upper bearing shells in place. When high spots of runout on adjacent journals are in opposite directions, sum must not exceed 0.003 inch total indicator reading. When high spots of runout on adjacent journals is in same direction, difference must not exceed 0.003 inch total indicator reading. When high spots of runout on adjacent journals are at right angles to each other, sum must not exceed 0.004 inch total indicator reading or 0.002 inch on each journal. If runout limit is greater than 0.002 inch on No. 2 and No. 4 journals or greater than 0.004 inch on No. 3 journal, crankshaft must be replaced.



4-35. CRANKSHAFT MAINTENANCE (Cont.)

NOTE

Maximum clearance between connecting rod journal and bearing shell is 0.0045 inch (with new shells). Maximum clearance between main bearing journal and bearing shell is 0.0055 inch (with new shells). Main bearing journal taper must not exceed 0.0006 inch or out of round must not be greater than 0.0005 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 should be accurate to nearest 0.0002 inch.

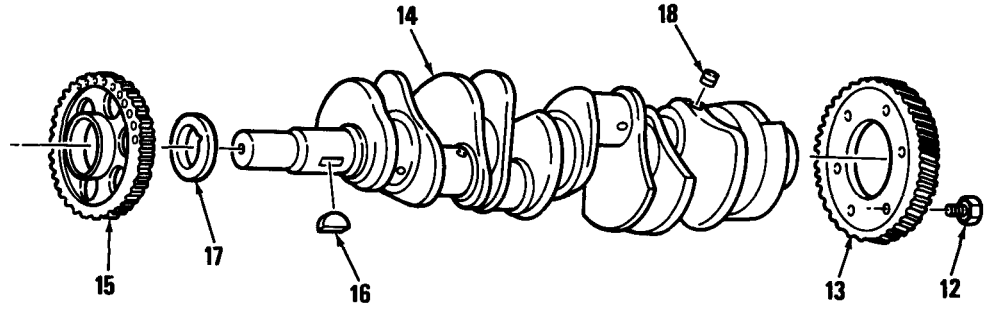
(5) Measure crankshaft thrust surfaces at points A and B. Dimension A must be 1.499 to 1.501 inches and dimension B must be 1.915 to 1.925 inches.

f. Assembly

(1) Install four pipe plugs (18) into crankshaft (14). Torque plugs to 10-12 lb-ft (14-16 N-m).

(2) Position gear (13) on rear end of crankshaft (14) with bolt holes in gear alined with tapped holes in crankshaft. One bolt hole is offset so gear can be attached in only one position. Install six bolts (12) through gear and into crankshaft. Torque bolts to 35-39 lb-ft (47-53 N-m).

(3) Install spacer ring (17), with beveled side toward main bearing cap, and woodruff key (16) on front of crankshaft. install oil pump driving gear (5) with chamfer toward main bearing cap and slide gear on shaft and over woodruff key. Install gear tight against spacer ring (17).



g. Installation

CAUTION

When a new or rearound crankshaft is installed, all new main and connecting rod bearing shells and-thrust washers must be installed. If used components are-installed, short life will result.

(1) Install upper main bearing shells (10) in block. If bearings are being reused, install them in same locations from which they were removed.

(2) Apply clean engine oil to upper bearing shells and crankshaft main bearing journals.

CAUTION

Do not damage journals or main bearing shells when lowering crankshaft into position. Damage will result in short component life.

(3) Position crankshaft on upper bearing shells in cylinder block using lifting sling (23).

(4) Install upper crankshaft thrust washers (11) on each side of rear main bearing support with grooved side of thrust washers toward crankshaft thrust surfaces.

NOTE

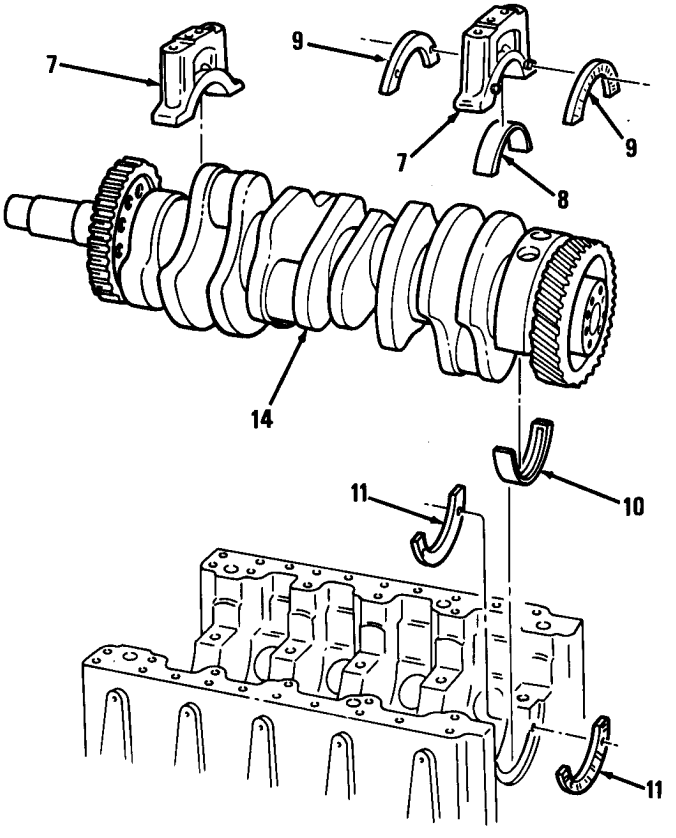
Install used bearings in same bearing caps from which removed.

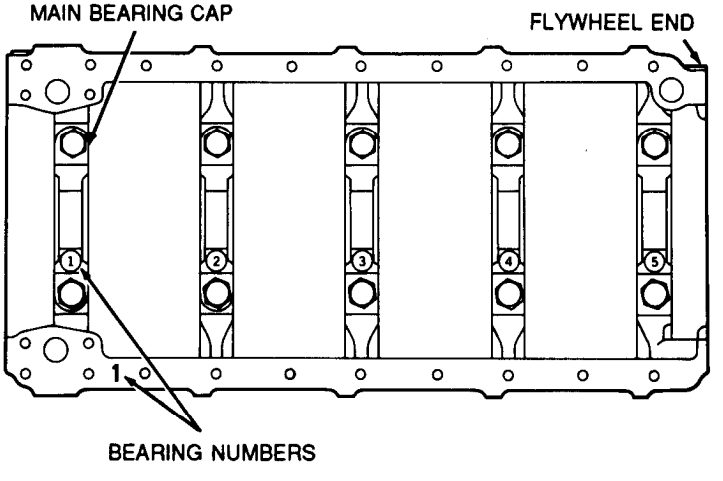
(5) Install lower main bearing shells (8) in bearing caps (7) and two thrust washers (9) to rear main bearing cap.

NOTE

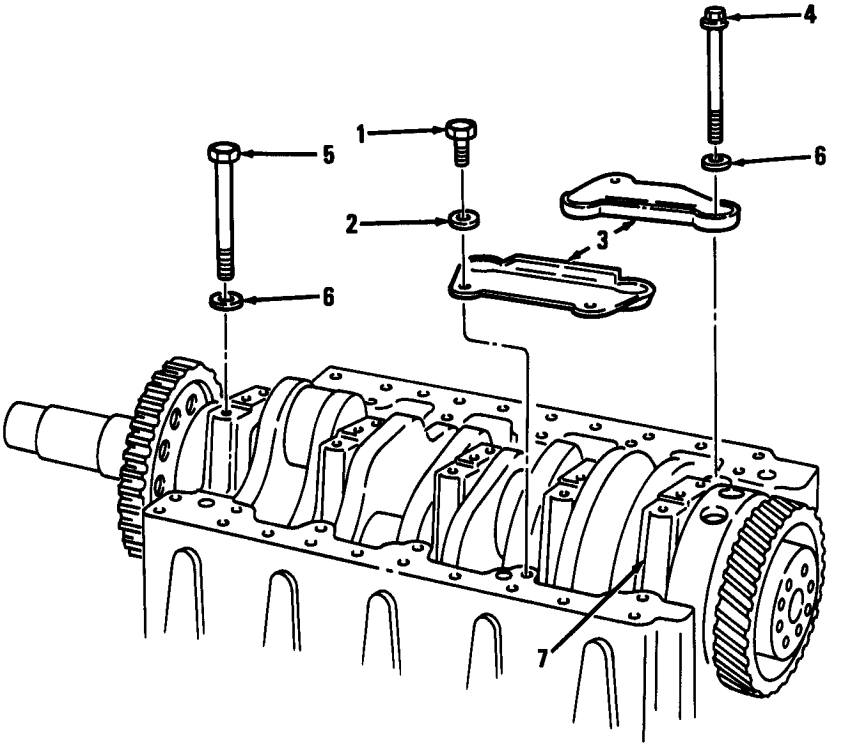
Main bearing caps are bored in position and stamped 1, 2, 3, 4, and 5, Install caps with identification stamp on right side of engine.

(6) Install five main bearing caps (7) along with mating lower bearing shells (8) and lower thrust washers (9).





4-35. CRANKSHAFT MAINTENANCE (Cont)



(7) Install two stabilizer plates (3) on rear main bearing caps.

(8) Apply a small quantity of international Compound No. 2, or equivalent to main bearing bolt threads and bolt head contact area. Install six main bearing bolts (5) and six flat washers (6) to front bearing caps and four main bearing bolts (4) and four flat washers (6) to rear bearing caps. Rear bolts (4) go through stabilizer plates (3). Draw bolts up snug.

(9) Install three bolts (1) and three flat washers (2) securing stabilizer plates (3) to cylinder block. Finger tighten bolts.

(10) Strike main bearing caps sharply with a soft-headed hammer to seat them properly. Starting with center bearing cap bolts and working alternately towards both ends of block, torque main bearing bolts to 45-55 Ib-ft (61-75 N-m). Turn all bolts, except two rear main bearing bolts, an additional 110-130 degrees of bolt head rotation.

(11) Strike both ends of crankshaft two or three sharp blows with soft-headed hammer to insure proper positioning of rear main bearing cap in block saddle. Turn two rear main bearing cap bolts an additional 110-130 degrees of bolt head rotation.

(12) Tighten three stabilizer plate bolts (1) to 70-75 Ib-ft (95-102 N-m) torque.

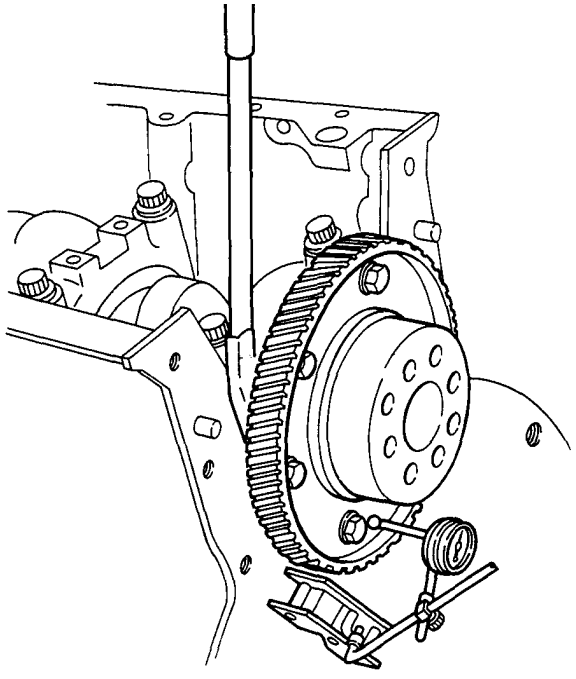
NOTE

[f bearings are installed properly, crankshaft will turn freely with all of bearing cap bolts drawn to specified torque.

(13) Measure Crankshaft End Play

(a) Mount dial indicator on rear of cylinder block with indicator point resting on end of crankshaft assembly.

(b) Using a pry bar or 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 end play 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 0.011 inch with new parts and maximum of 0.018 inch with used parts.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
■ 5-27 Install lower front cover (7083-7391, 7083-7396, and 7083-7399)
4-33 Install pistons and connecting rods
■ 4-28 Install lower front cover (7083-7395 and 7083-7398)
4-25 Install idler gear
4-24 Install flywheel housing

4-36. CYLINDER BLOCK MAINTENANCE

This task covers: a. Disassembly b. Installation c. Inspection d. Assembly e. Pressure check

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Plug adapter (App B, Item 67)
Bore gage (App B, Item 27)
Depth gage (App B, Item 28)
Cup plug installer (App B, Item 58)
Cylinder hone (App B, Item 42)
Water outlet plate (App D, Item 11)
Blocking plates (App D, Item 10)
Torque wrench (App B, Item 102)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
International compound no. 2 (App C, Item 24)
Thread sealant (App C, Item 40)
Cleaning solvent (App C, Item 10)
20 Bolts 5/8-11 X 2.0(App C, Item 6)
Teflon pipe sealant (App C, Item 49)
Gasket cement (App C , Item 50)

MANDATORY REPLACEMENT PARTS

2 Washers (App F, Item 160)
8 Lockwashers (App F, Item 93)
2 Gaskets (App F, Item 80)
4 Gaskets (App F, Item 81)
1 Gasket (App F, Item 32)
11 Cup plugs (App F, Item 8)
2 Cup plugs (App F, Item 9)
5 Cup plugs (App F, Item 10)
4 Pins (App F, Item 109)
1 Cup plug (App F, Item 12)
1 Solid plug (App F, Item 117)
4 Pins (App F, Item 108)
1 Solid plug (App F, Item 115)
3 Solid plugs (App F, Item 114)
1 Gasket (App F, Item 37)
1 Cup plug (App F, Item 170) *

EQUIPMENT CONDITION

Para	Description
3-6	Oil cooler
4-18	Blower removed
4-30	Front and rear end plates removed
4-33	Cylinder kits removed
4-35	Crankshaft removed

* Model 7083-7391 only.

NOTE

If pressure testing of cylinder block is required, proceed to steps (14) and (15) and then do pressure testing (step e.) before disassembling the cylinder block.

a. Disassembly

(1) Remove two each of cup plug (1 and 2), four cup plugs (3), one each of pipe plugs (4, 5,6, and 7) and two pipe plugs (8) from front of cylinder block. Discard cup plugs.

(1a) For models 7083-7395, 7083-7398 and 7083-7399, remove two pipe plugs (9) from front of cylinder block.

(1b) For models 7083-7391 and 7083-7396, remove pipe plug (9) from right front and turbocharger oil feed elbow (9.1) from left front of cylinder block.

(2) Remove drain cock (10) from front of block.

(3) If necessary, remove two locating pins (11) from front of block.

(4) Remove cup plug (12) from bottom of block. Discard plug.

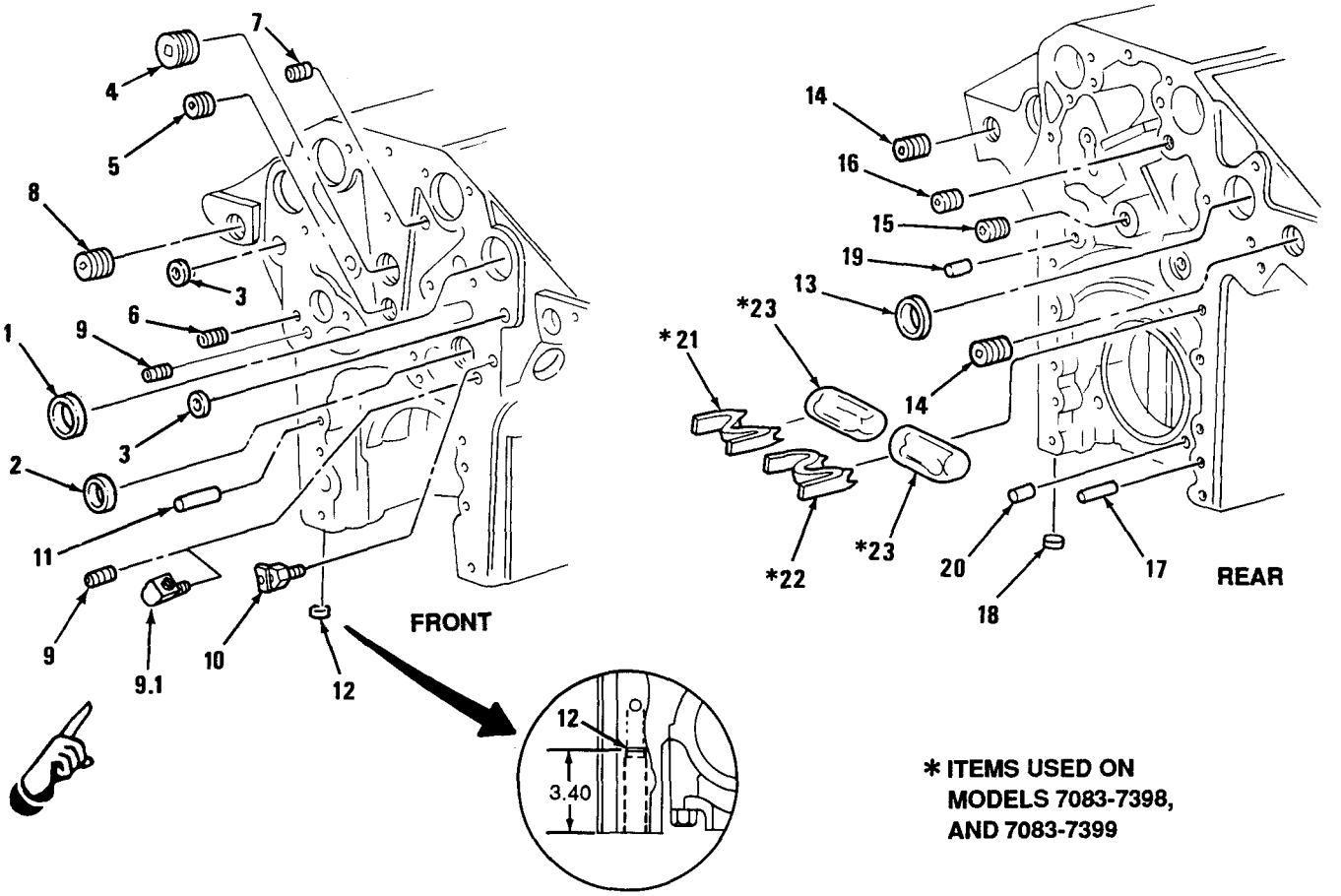
(5) Remove two cup plugs (13), two pipe plugs (14), and pipe plugs (15 and 16) from rear of block. If necessary, remove two locating pins (17). Discard cup plugs.

(6) Remove cup plug (18) from bottom of block. Discard plug.

(7) Remove brass plug (19) from rear of block. Discard plug.

(8) If necessary, remove four pins (20) from rear main bearing cap.

(9) For models 7083-7398 and 7083-7399 only, remove breather retainers (21 and 22) and two filter elements (23) from rear of block.



4-36. CYLINDER BLOCK MAINTENANCE (Cont.)

(10) For models 7083-7395 and 7083-7398 only, remove dipstick adapter (24) from left side of block.

(11) Remove two each of pipe plugs (25 and 26) from left side of block.

(12) For models 7083-7395,7083-7398 and 7083-7399, remove turbocharger oil feed elbow (27). For models 7083-7391 and 7083-7396, remove pipe plug (27.1).

(12.1) Remove drain cock (28), and four cup plugs (29) from left side of block. Discard cup plugs.

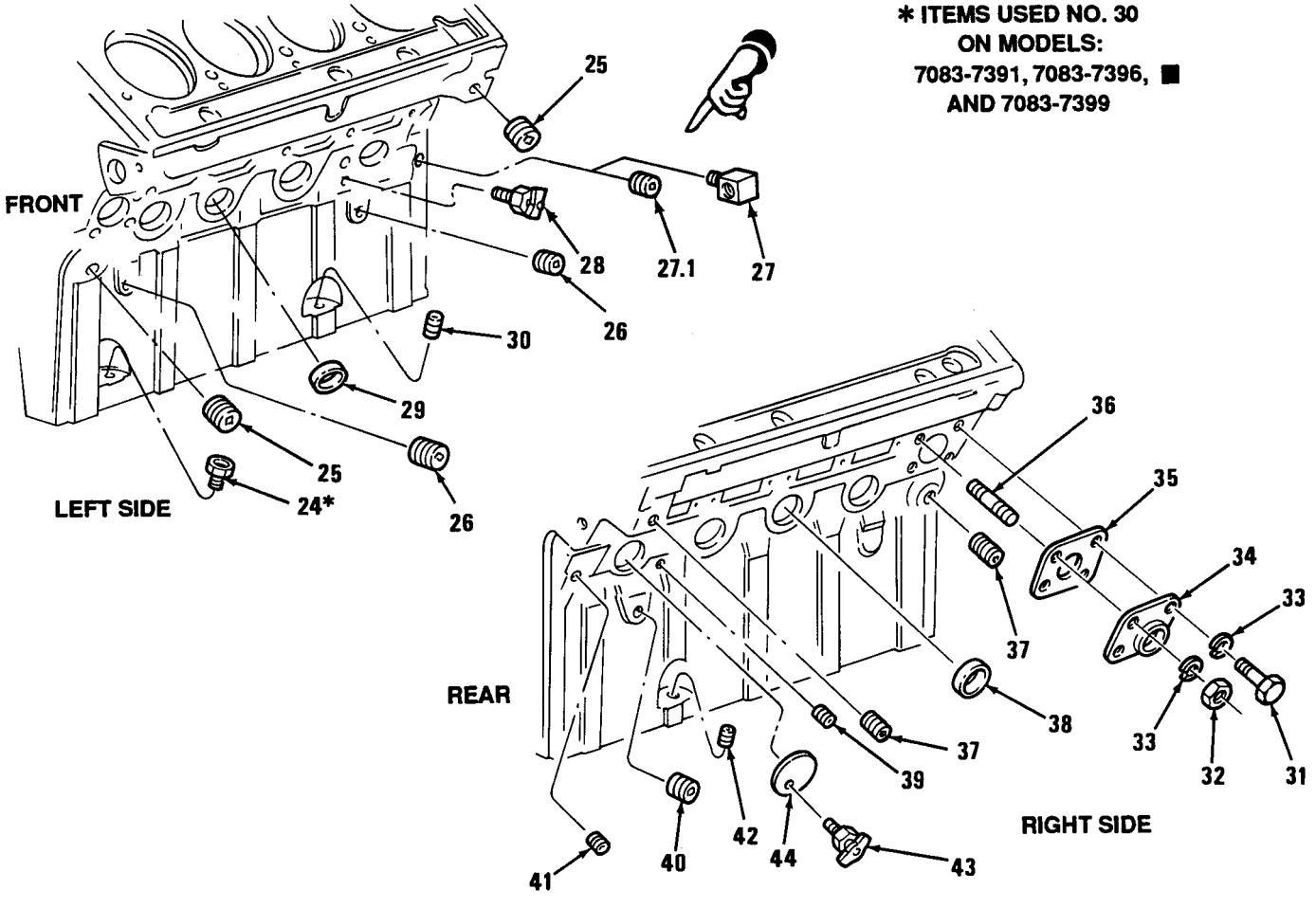
(13) For models 7083-7395 and 7083-7398, remove pipe plug (30) from rear left side of block. For models 7083-7391, 7083-7396 and 7083-7399, remove two pipe plugs (30) from left side.

(14) Remove two bolts (31), two nuts (32), and four lockwashers (33) securing oil cooler flange (34) to cylinder block. Remove flange (34) and gasket (35). Discard gasket and lockwashers.

(15) Remove two studs (36) from right side of block.

(16) Remove two pipe plugs (37), three cup plugs (38), and one each of pipe plugs (39, 40,41, and 42) from right side of block. Discard cup plugs.

(17) Remove drain cock (43) and solid plug (44) from right side of block.



(18) If necessary, remove three solid plugs (45) from top surface of cylinder banks.

(19) Remove two pipe plugs (46) from top of block.

(19.1) For model 7083-7391: If necessary, remove cup plug (46.1) from top front of block. Discard plug.

(20) Using plug adaptor, remove two threaded plugs (47) and two washers (48) from floor of airbox. Discard washers.

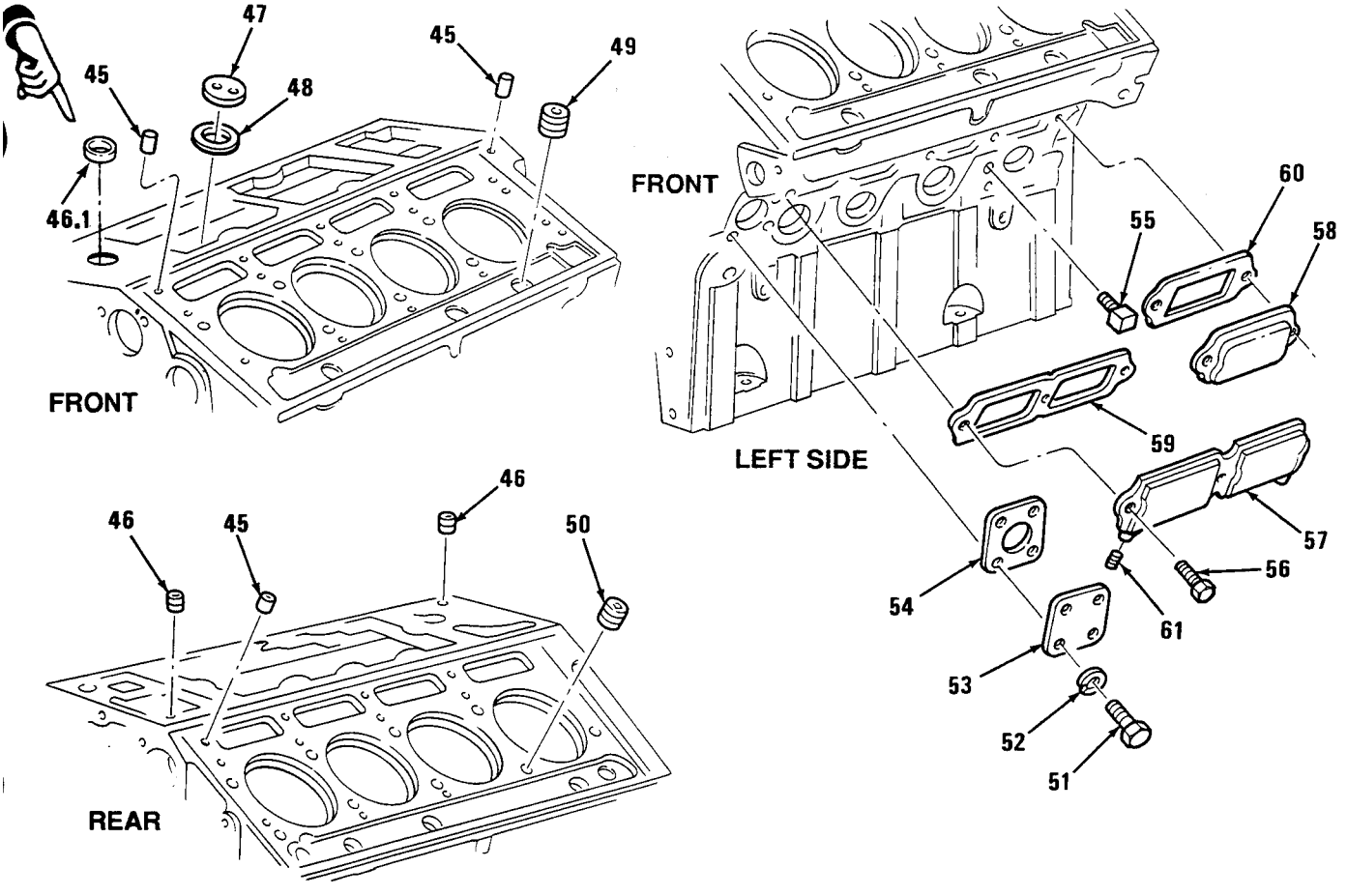
(21) Remove six pipe plugs (49) from top surface of cylinder banks.

(22) If necessary, remove fourteen pipe plugs (50) from bottom of cylinder head bolt holes.

(23) Remove four bolts (51), four lockwashers (52), cover plate (53), and gasket (54) from left side of block. Discard lockwashers and gasket.

(24) Remove airbox drain tube elbow (55) from each side of block.

(25) Remove seven bolts (56), cover (57), two covers (58), gasket (59), and two gaskets (60) from each side of cylinder block. If necessary, remove two plugs (61) from each cover (57). Discard gaskets.



4-36. CYLINDER BLOCK MAINTENANCE (Cont)

b. Cleaning

NOTE

Remove all pipe plugs except fourteen plugs in cylinder head bolt holes. Do not remove solid plugs.

(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 only in a well ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. f contact with eyes is made, wash your eyes with water and get medical aid immediately.

(2) Clean inner and outer surfaces of cylinder block with cleaning solvent.

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 water, air, and oil passages with bore brush. Wash passages by flushing with cleaning solvent and blow out with compressed air.

(4) Dry cylinder block with compressed air.

c. Inspection

NOTE

After cylinder block is thoroughly cleaned and pressure tested (step e), cylinder bores must be honed before inspection.

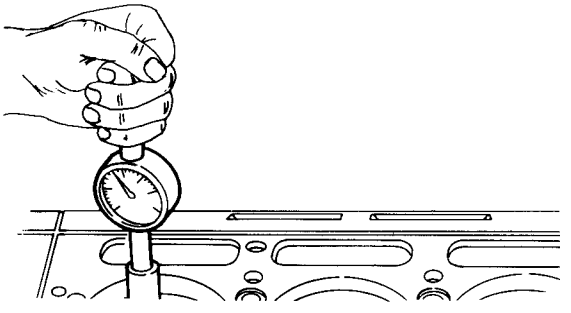
(1) Hone cylinder block bores as follows:

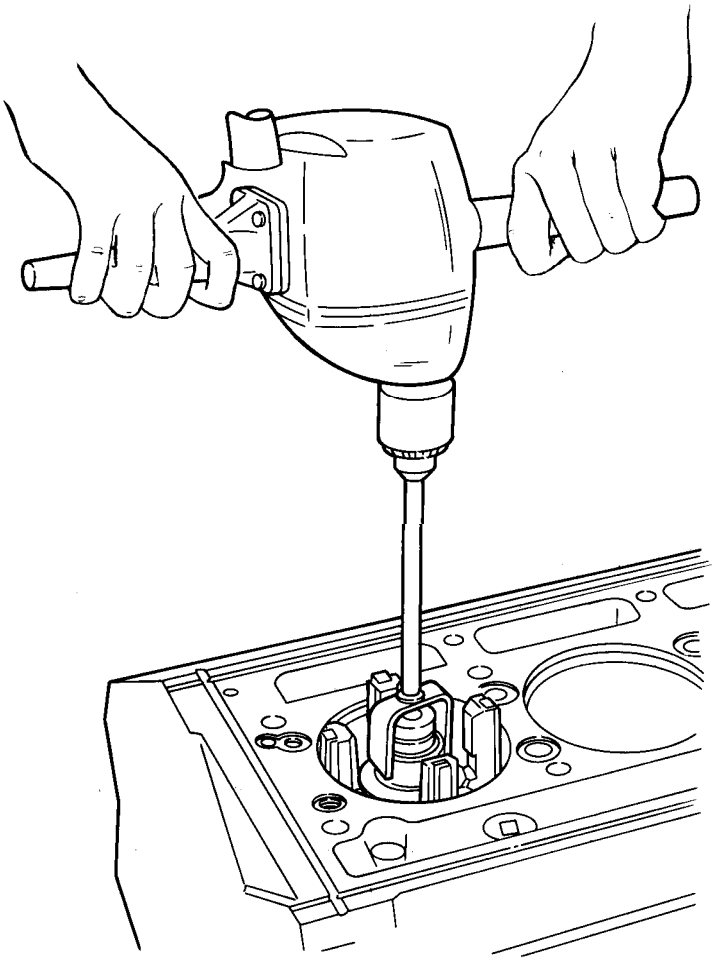
NOTE

Use a hone in which cutting radius of stones can be set in a fixed position to remove irregularities in bore. Do not use spring-loaded hone. Clean stones frequently with wire brush to prevent stone loading. Follow hone manufacturer's instructions regarding use of oil or kerosene on stones. Do not use such cutting agents with dry hone. Use 120-grit stones.

(a) Insert hone in bore and adjust stones snugly to narrowest section. When correctly adjusted, hone will not shake in bore but will drag freely up and down bore when hone is not running.

(b) Start hone and “feel out” bore for high spots which cause an increased drag on stones. Move hone up and down bore with short overlapping strokes about 1 inch long. Concentrate on high spots in first cut. As these are removed, drag on hone will become lighter and smoother.





CAUTION

Do not hone as long in air inlet port area as in rest of bore because this area cuts away more rapidly. Feed lightly to avoid an excessive increase in bore diameter. Some stones cut rapidly under low tension.

(c) When bore is fairly clean, remove hone, inspect stones, and measure bore. Determine which spots must be honed again.

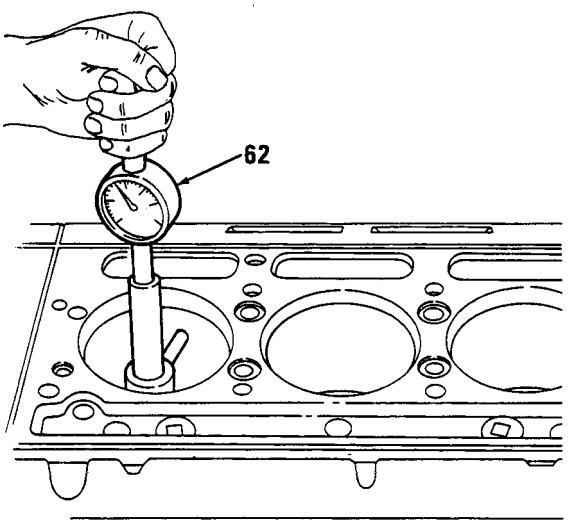
(d) Clean cylinder block thoroughly after honing operation is completed per step (b).

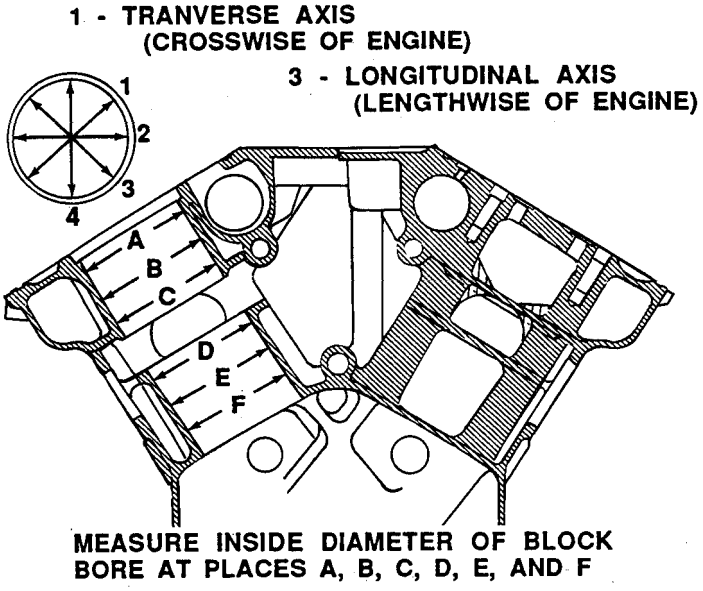
4-36. CYLINDER BLOCK MAINTENANCE (Cont)

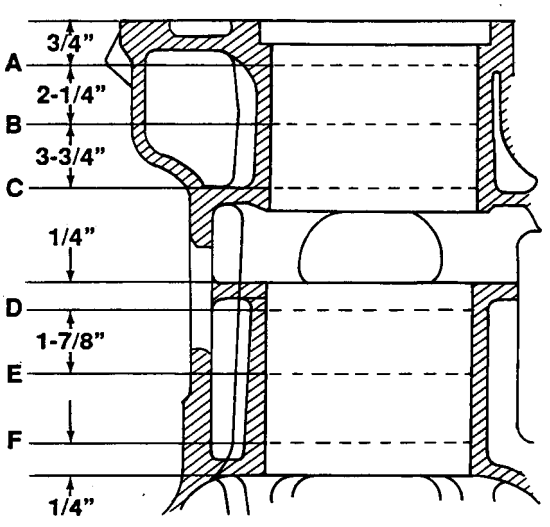
(2) Check cylinder block bores as follows:

(a) After honing, check for low spots in cylinder bore. There must not be any low spots larger than one inch in diameter.

(b) Measure entire bore of each cylinder with a cylinder bore gage (62). Take measurements on cleaned-up surface only at positions A, B, C, D, E, and F in bore on axes 45 degrees apart. Block bore I.D. is classified as #0, #1, #2, #3, or #4 (see Para 4-34).







NOTE

Diameter of standard block bore is 4.6256 to 4.6275 inches. Maximum liner to block clearance is 0.0025 inch with used parts and is 0.0015 inch with new parts.

(c) "A" Diameter - Must be same size as “B” diameter within +0.0006 inch and never smaller (no bottleneck allowed).

(d) "B" Diameter - Is classification area for determining whether a cylinder bore is a #0, #1, #2, or #3 size. "B" has a 0.0019 inch tolerance band.

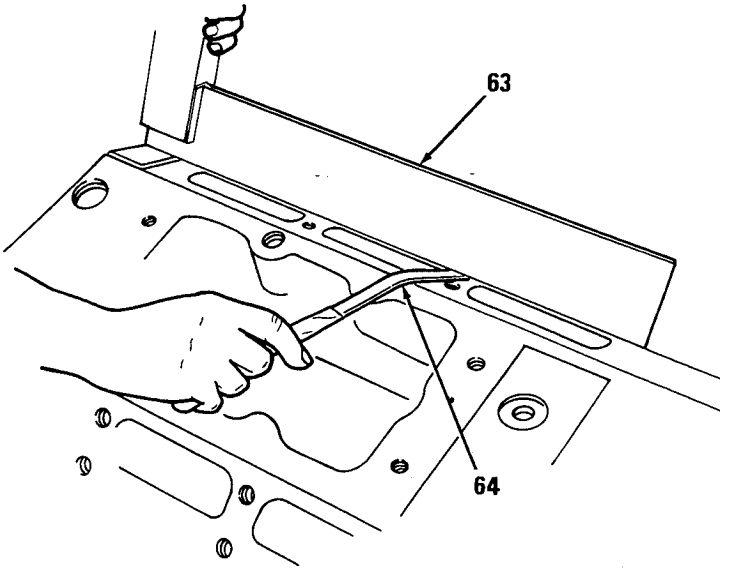
(e) "C" Diameter - Should be same size as "B" diameter. However, due to a bell mouth flare caused by honing stones traveling through air box area, a maximum +0.0022 inch diameter flare over "B" diameter is allowed.

(f) "D" Diameter - should be same size as "B" diameter. However, due to a bell mouth flare caused by honing stone's vertical travel, a maximum +0.0022 inch diameter flare over "B" diameter is allowed in lower air box area.

(9) "E" Diameter - Must be within 0.0005 inch classification range as determined by "B"

(h) "F" Diameter - should be same size as"B" diameter. However, due to a bell mouth flare caused by honing stone's vertical travel, a maximum +0.0012 inch diameter flare over "B" diameter is allowed in lower crank area of bore.

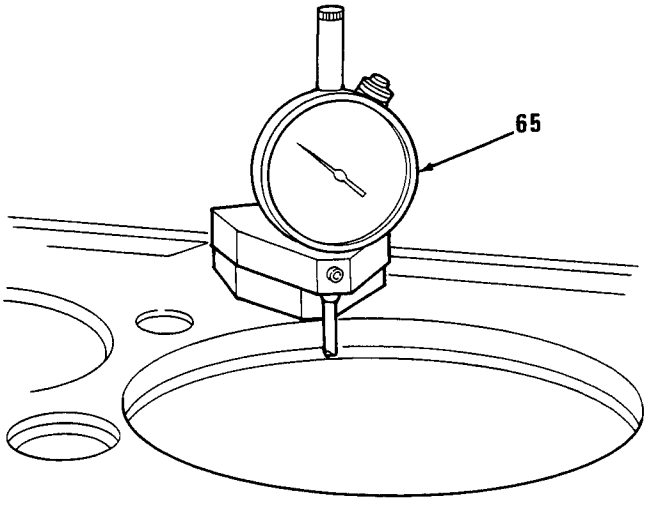
(3) Check cylinder head contact area for flatness with straight edge (63) and feeler gage (64). Measurements must not vary more than 0.003 inch crosswise and over 0.007 inch lengthwise.



(4) Check cvlinder liner counterbore depth by using dial indicator (65).

NOTE

Counterbore depth must be 0.4770 to 0.4795 inch and must not vary more than 0.0015 inch through entire circumference. Counterbore surfaces must be smooth and square with cylinder bore and within 0.001 inch total indicator reading. There must not be over 0.001 inch difference between any two adjacent cylinder counterbores when measured along cylinder lengthwise center line of cylinder block.

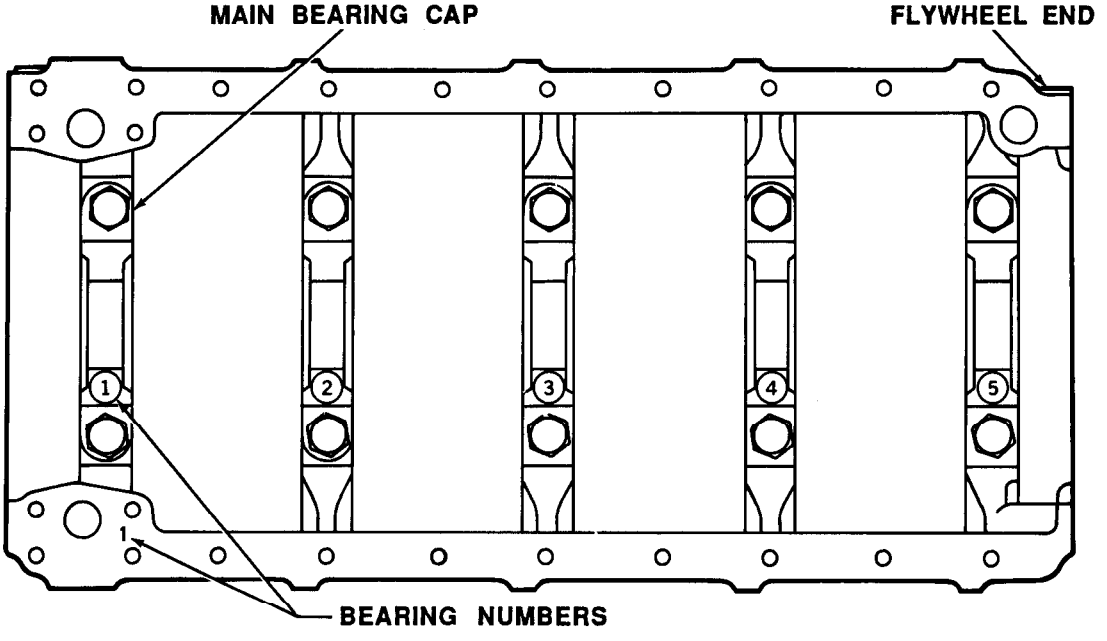


4-36. CYLINDER BLOCK MAINTENANCE (Cont)

(5) Using a bore gage, check main beating bore diameters with bearing caps in original position and bolts torqued to 165-175 Ib-ft (224-238 N-m). Apply International Compound No. 2 to bolt threads and bolt head contact area. Do not install main bearing cap stabilizers when performing this check.

NOTE

- Main bearing bore diameter is 4.812 to 4.813 inches. If bores do not meet these limits, replace cylinder block.
- 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) Check remainining 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.

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 in polar-type rust-preventive compound. Castings free of oil will rust when exposed to atmosphere.

d. Assembly

NOTE

Apply pipe sealant to all plugs and fittings. Install cup plugs 0.090 to 0.140 inch below surface unless otherwise noted.

(1) Install two each of cup plugs (1 and 2), four cup plugs (3), one each of pipe plugs (4, 5,6, and 7), and two pipe plugs (8) in front of cylinder block.

(1a) For models 7083-7395, 7083-7398 and 7083-7399, install two pipe plugs (9) in front of the cylinder block. For models 7083-7391 and 7083-7396, install pipe plug (9) in right front of block.

(1b) For models 7083-7391 and 7083-7396, install turbocharger oil feed elbow (9.1) in left front of cylinder block.

(2) Install drain cock (10) on front of block.

(3) If necessary, install two locating pins (11) so they protrude 0.630 +/-0.030 inch from front face of block.

(4) Install cup plug (12), in bottom of block to depth of 3.40 inches below surface using cup plug installation tool (66).

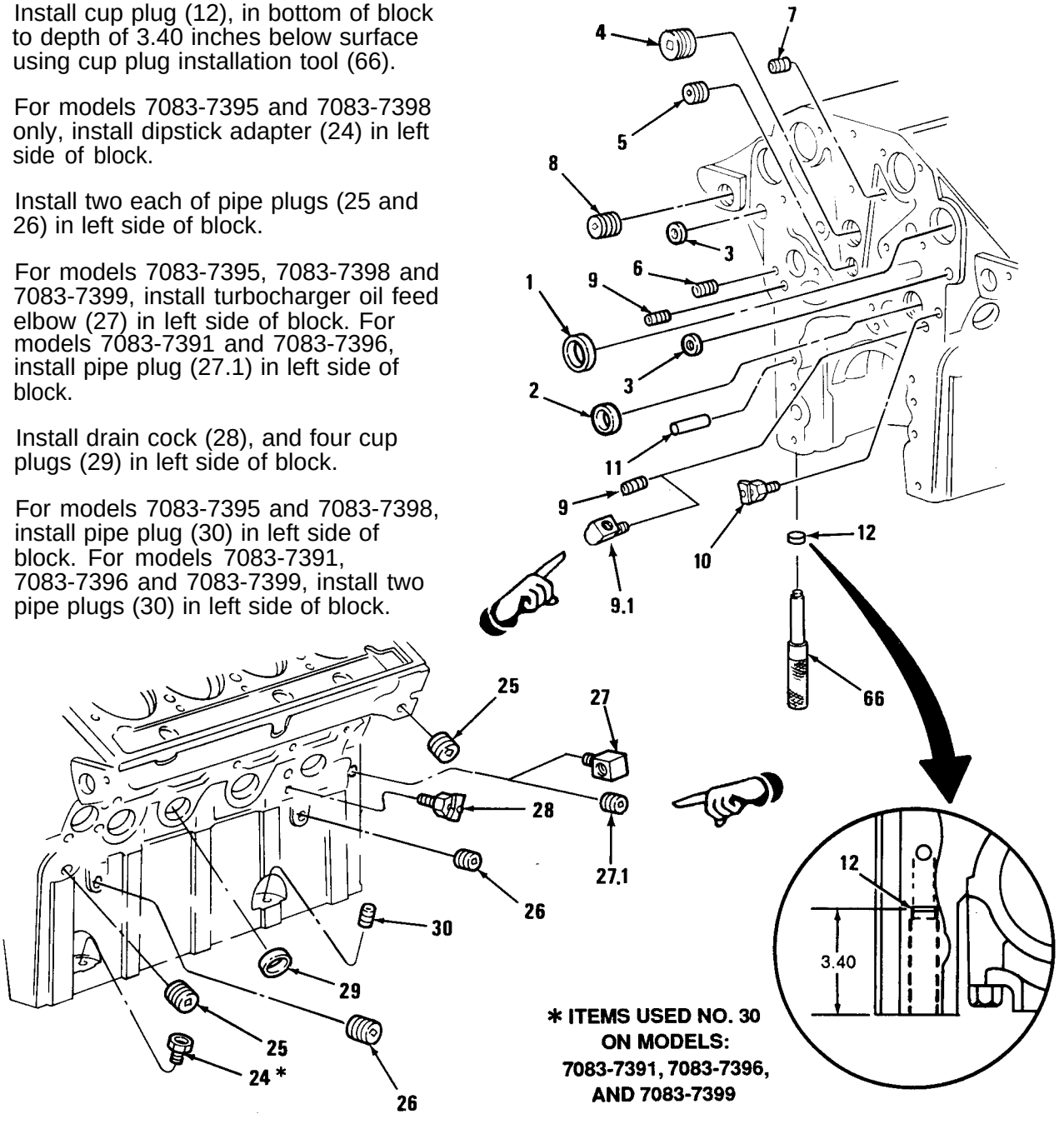
(5) For models 7083-7395 and 7083-7398 only, install dipstick adapter (24) in left side of block.

(6) Install two each of pipe plugs (25 and 26) in left side of block.

(7) For models 7083-7395, 7083-7398 and 7083-7399, install turbocharger oil feed elbow (27) in left side of block. For models 7083-7391 and 7083-7396, install pipe plug (27.1) in left side of block.

(7a) Install drain cock (28), and four cup plugs (29) in left side of block.

(8) For models 7083-7395 and 7083-7398, install pipe plug (30) in left side of block. For models 7083-7391, 7083-7396 and 7083-7399, install two pipe plugs (30) in left side of block.



4-36. CYLINDER BLOCK MAINTENANCE (Cont)

(9) Install two cup plugs (13), two pipe plugs (14), pipe plugs (15 and 16), and brass plug (19) to rear of block.

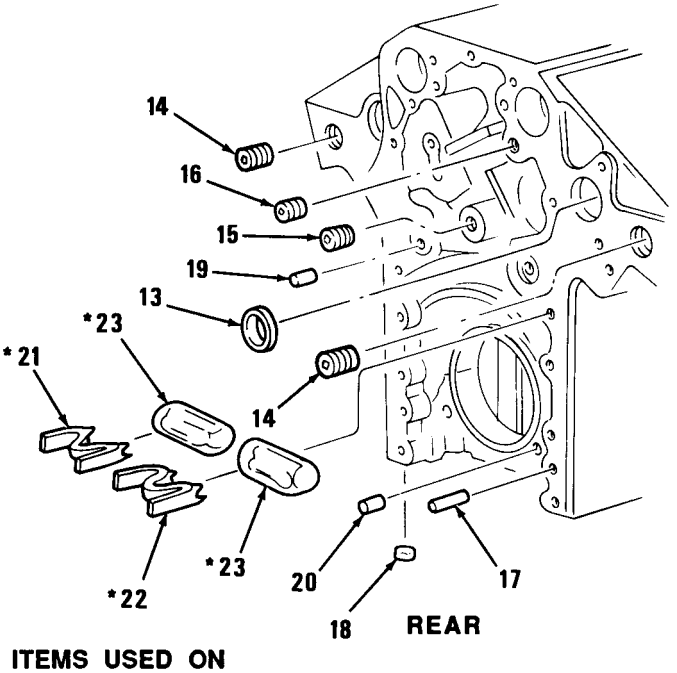
(10) If necessary, install two locating pins (17) so they protrude 0.630 +/- 0.030 inch from rear face of block.

(11) Install cup plug (18) in bottom of block 0.12 inch below surface.

(12) If necessary, install four pins (20) in rear main bearing cap so they protrude 0.115 +/-0.005 inch.

(13) For models 7083-7398 and 7083-7399 only, install two filter elements (23) and breather retainers (21 and 22) in rear of block.

(14) Install two pipe plugs (37), three cup plugs (38), and one each of pipe plugs (39, 40,41, and 42) into right side of block.

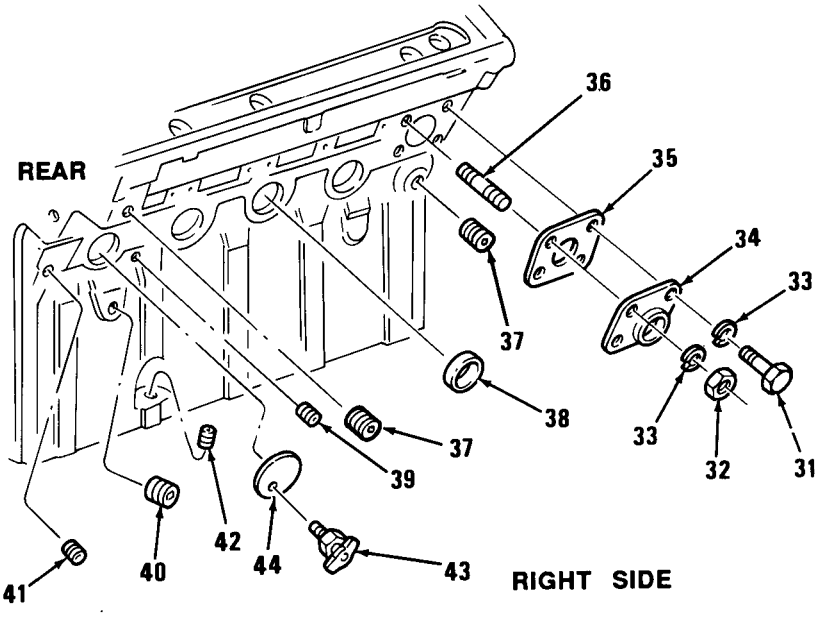


* ITEMS USED ON MODELS 7083-7398 AND 7083-7399

(15) Install two studs (36) into right side of block.

(16) Install gasket (35) and oil cooler flange (34) on right side of block. Secure in place with four lockwashers (33), two nuts (32), and two bolts (31). Torque bolts and nuts to 30-35 lb-ft (41-47 N-m).

(17) Install solid plug (44) and drain cock (43) in right side of block. Install plug 0.090 to 0.140 inch below surface.



(18) If necessary, install three solid plugs (45) flush with top surface of cylinder banks.

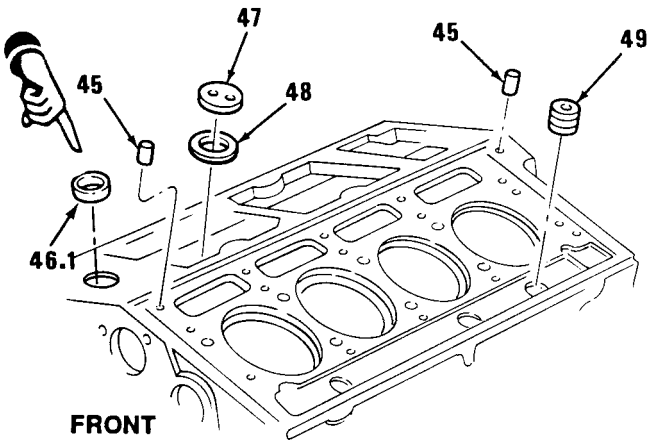
(19) Install two pipe plugs (46) in top of block.

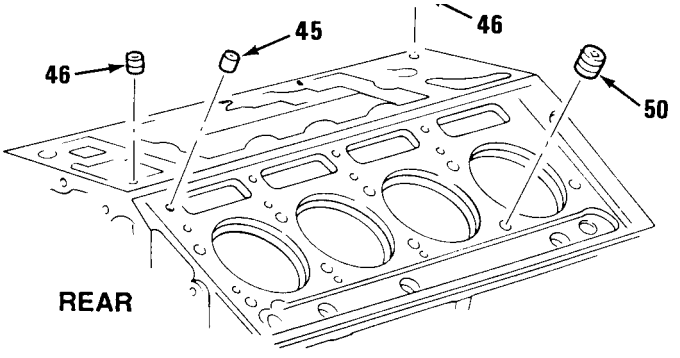
(19.1) For model 7083-7391: If necessary, coat cup plug (46.1) with gasket cement and install in top front of cylinder block at a depth of approximately 1.0 inch.

(20) Using plug installer, install two washers (48) and two threaded plugs (47) to floor of airbox. Torque plugs to 230-270 lb-ft (312-366 N-m).

(21) Install six pipe plugs (49) to a minimum depth of 0.24 inch below top surface of cylinder banks.

(22) If necessary, install fourteen pipe plugs (50) in bottom of cylinder head bolt holes to a minimum depth of 2.04 inches.

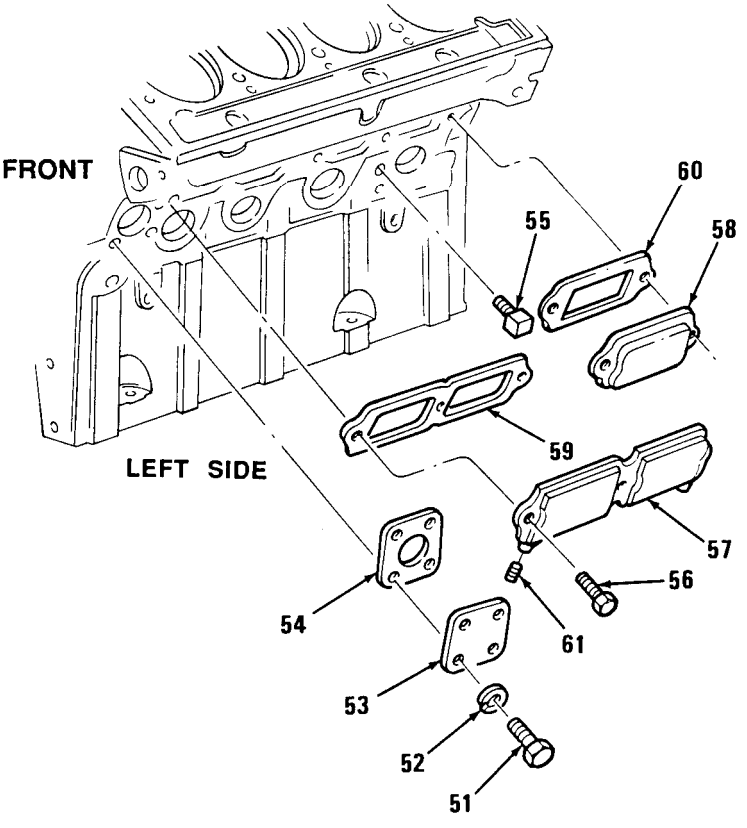




(23) Install gasket (54), cover plate (53), four lockwashers (52), and four bolts (51) to left side of engine. Torque bolts to 30-35 lb-ft (41-47 N-m).

(24) Install airbox drain tube elbow (55) to each side of block.

(25) Install gasket (59), two gaskets (60), cover (57), two covers (58), and seven bolts (56) to each side of cylinder block. Torque bolts to 8-12 lb-ft (1 1-16 N-m). If removed, install two plugs (61) in each cover (57).



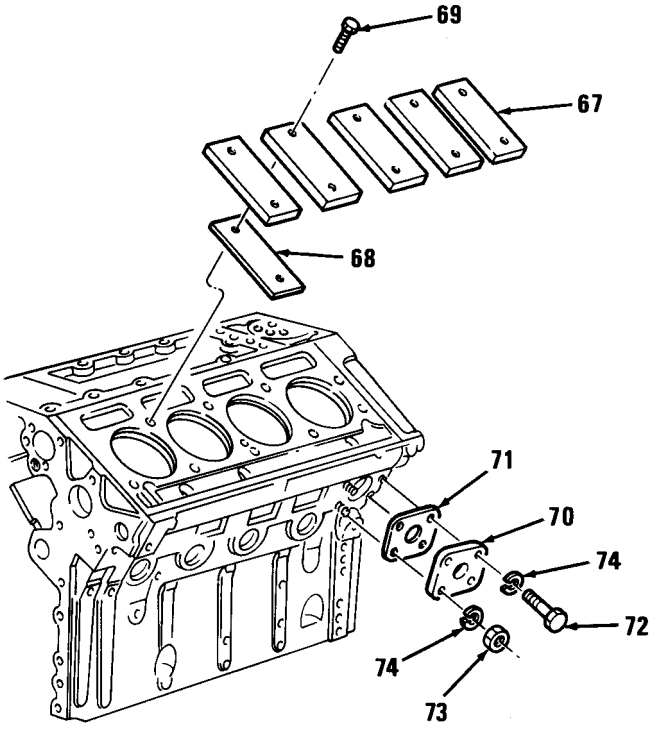
4-36 CYLINDER BLOCK MAINTENANCE (Cont.)

e. Pressure Check

(1) With all cylinder block plugs in place, install ten blocking plates (67) and ten gaskets (68), found in cylinder head pressure testing kit, over water outlet holes. Secure plates to top of cylinder block with twenty 5/8-11 x 2 inch bolts (69).

(2) Install fabricated water outlet plate (70) and rubber gasket (71). Secure with two bolts (72), two nuts (73), and four lockwashers (74).

(3) Attach an air line connection at plate (70). Immerse block in a tank of water heated to 180 to 200 °F (82-93 °C) for twenty minutes.



WARNING

Never work on air system components without first gradually relieving air pressure. Sudden release of air pressure can throw debris resulting in serious personal injury.

(4) Apply 40 psi (276 kPa) air pressure to water jacket and observe water in tank for bubbles which indicate a crack or leak in block. Replace block if cracked.

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) After competing pressure test, remove block from water tank. Remove ten blocking plates (67), ten rubber gaskets (68), twenty bolts (69), oil cooler plate (70), gasket (71), two bolts (72), two nuts (73), and four lockwashers (74). Dry block with compressed air.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3 - 6 Install oil cooler
4-18 Install blower
4-30 Install front and rear end plates
4-33 Install cylinder kits
4-35 Install crankshaft

SECTION IV. COMPONENT REPAIR

4-37. TURBOCHARGER REPAIR

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

INITIAL SETUP

MODELS

7083-7395 7083-7396

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Dial indicator adaptor (App B, Item 4)
Turbocharger holding fixture (App B, Item 21)
Magnetic base dial indicator (App B, Item 45)
Torque wrench (App B, Item 100)

MANDATORY REPLACEMENT PARTS

4 Locking plates (App F, Item 112)
1 Seal ring (App F, Item 140)
1 Piston ring (App F, Item 129)
4 Lock tabs (App F, Item 87)
2 Piston rings (App F, Item 130)
1 Thrust washer (App F, Item 162)
2 Bearing kits (App F, Item 2)
3 Snap rings (App F, Item 144)
2 LockWashers (App F, Item 93)
1 Gasket (App F, Item 74)
1 Nut, special (App F, Item 171)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)
Crocus cloth (App C, Item 12)
Silicone carbide cloth (App C, Item 41)
Antiseize compound (App C, Item 1)

EQUIPMENT CONDITION

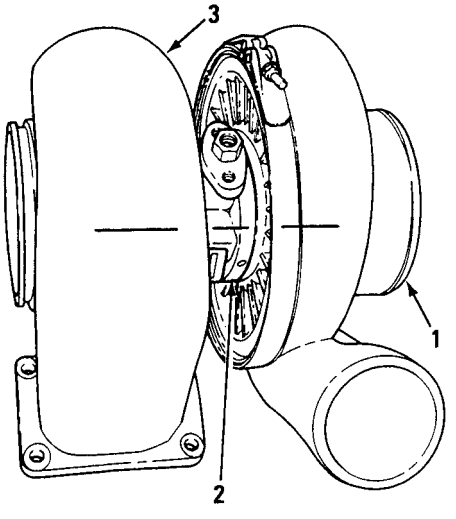
Para	Description
4-2	Turbocharger removed (7083-7395)
5-2	Turbocharger removed (7083-7396)

a. Disassembly

(1) Mark relative position of compressor housing (1), center housing (2), and turbine housing (3) with a scribe to assure reassembly in same relative location.

CAUTION

Exercise care when removing compressor housing and turbine housing to prevent damage to compressor and turbine wheels.



4-37. TURBOCHARGER REPAIR (Cont)

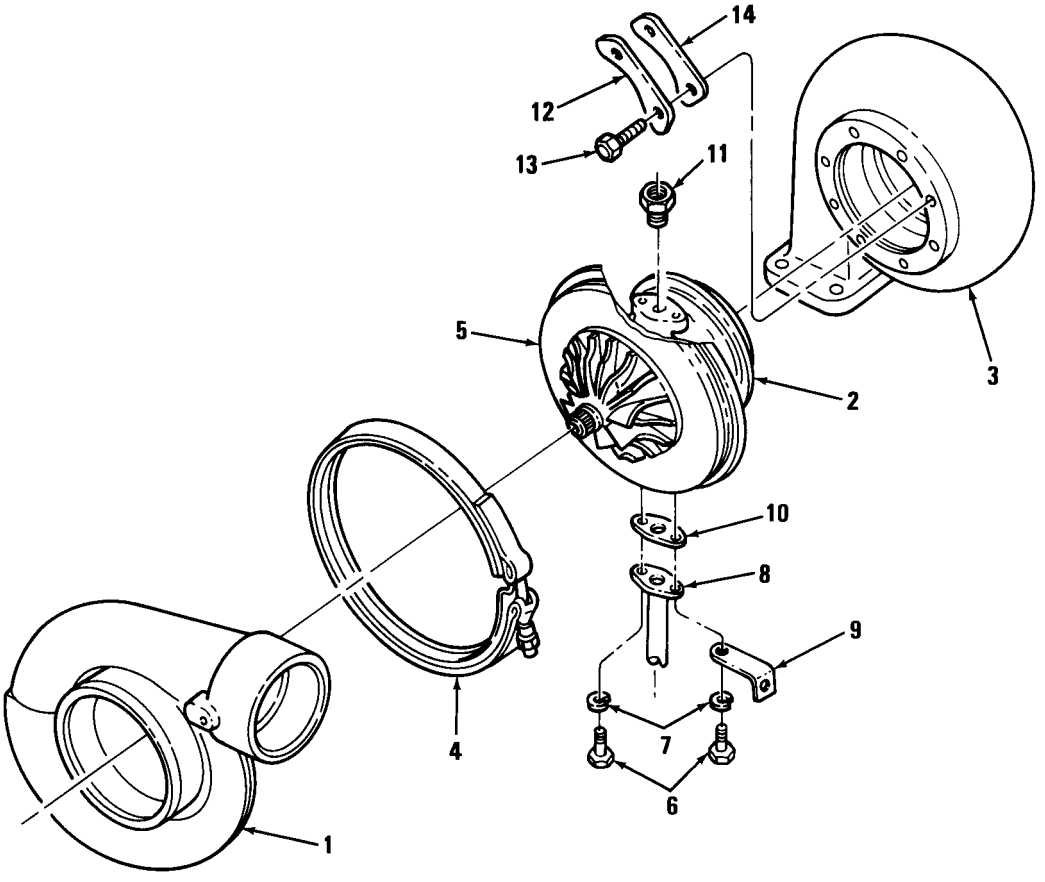
(2) Loosen V-band clamp (4) securing compressor housing (1) to backplate assembly (5). Remove clamp and housing.

(3) Remove two bolts (6) and two lockwashers (7) securing turbocharger drain tube (8) to center housing (2). Remove bracket (9) (used only on model 7083-7396), drain tube (8), and gasket (10) from center housing. Discard lockwashers and gasket.

(4) Remove adaptor bushing (11) from top of center housing (2).

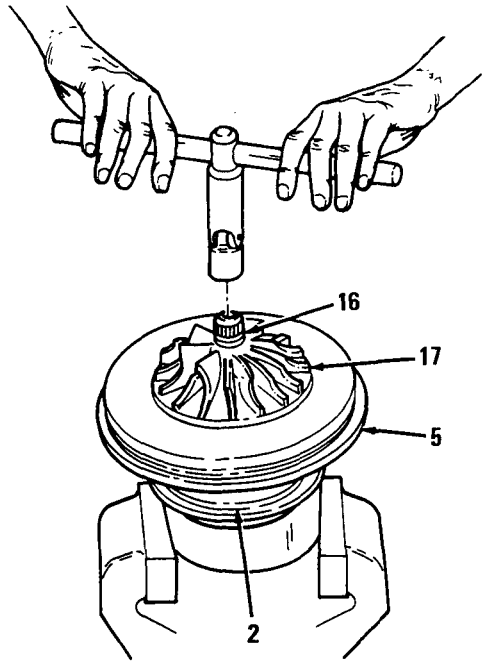
(5) Bend down ends of four locking plates (12). Remove eight bolts (13), four locking plates (12), and four clamps (14) from turbine housing (3). Discard locking plates.

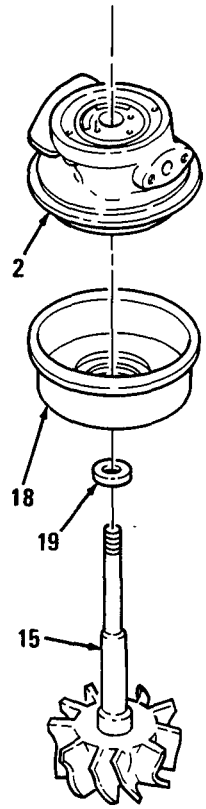
(6) Remove turbine housing (3) from center housing (2).



CAUTION

Remove compressor wheel nut from shaft with a double universal socket and tee handle to prevent bending turbine wheel shaft.





Position turbine wheel assembly (15) in holding fixture. Remove wheel nut (16) from compressor wheel (17) end of shaft. Discard nut.

CAUTION

Catch wheel shroud before it falls from press. Wheel shroud (18) will fall free when wheel shaft assembly is removed.

(8) Remove compressor wheel (17) from wheel shaft assembly (15) by using a press.

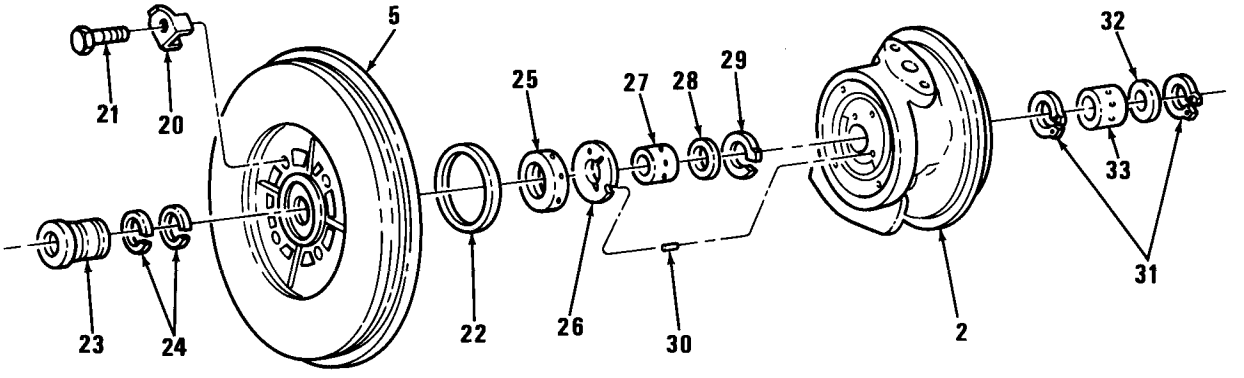
(9) Withdraw wheel shaft assembly (15) from center housing (2).

NOTE

If groove in shaft (15) is not present, turbocharger does not require a piston ring (19) near turbine wheel.

(10) Remove piston ring (19) from wheel shaft assembly (15). Discard piston ring.

4-37. TURBOCHARGER REPAIR (Cont)



(11) Bend down tangs on four locking plates (20). Remove four bolts (21) and locking plates (20) securing backplate (5) to center housing (2). Discard locking plates.

(12) Remove backplate (5) from center housing (2) by tapping it lightly.

(13) Remove seal ring (22) from groove in center housing (2). Discard seal ring.

(14) Remove thrust spacer (23) and two piston rings (24) from backplate (5). Discard piston rings.

(15) Remove thrust collar (25) and thrust washer (26). Discard thrust washer.

(16) Remove bearing (27), bearing washer (28), and retaining ring (29) from center housing (2). Discard bearing, washer, and retaining ring,

(17) If necessary, remove two pins (30) from center housing (2).

(18) Remove two retaining rings (31), bearing washer (32), and bearing (33) from turbine end of center housing (2). Discard retaining rings, bearing washer, and bearing.

b. Cleaning

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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

Never use caustic cleaning solution for cleaning. 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.
- Insure 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 may be 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.

4-37. TURBOCHARGER REPAIR (Cont)

d. Assembly

(1) Lubricate bearings (27 and 33) with engine oil.

(2) Install inner retaining ring (31), bearing (33), bearing washer (32), and outer retaining ring (31) in turbine end of center housing (2).

(3) Install retaining ring (29), bearing washer (28), and bearing (27) in compressor end of center housing (2).

(4) If removed, install two pins (30) in compressor end of center housing (2). Pins must extend 0.075 to 0.085 inch above surface.

(5) Install thrust washer (26) with hole and cutout in thrust washer in alinement with pins (30). Install thrust washer with smooth side against center housing.

(6) Lubricate thrust collar (25) and thrust washer (26) with engine oil. With center housing assembly (2) laying flat on bench, compressor end up, place thrust collar snugly against thrust washer.

(7) Install seal ring (22) in groove at compressor end of center housing (2).

(8) Aline oil feed hole in center housing (2) and backplate assembly (5). Attach backplate to center housing with four bolts (21) and four locking plates (20). Torque bolts to 13-15 lb-ft (18-20 N-m) and bend locking-plate tangs up against side of bolt head.

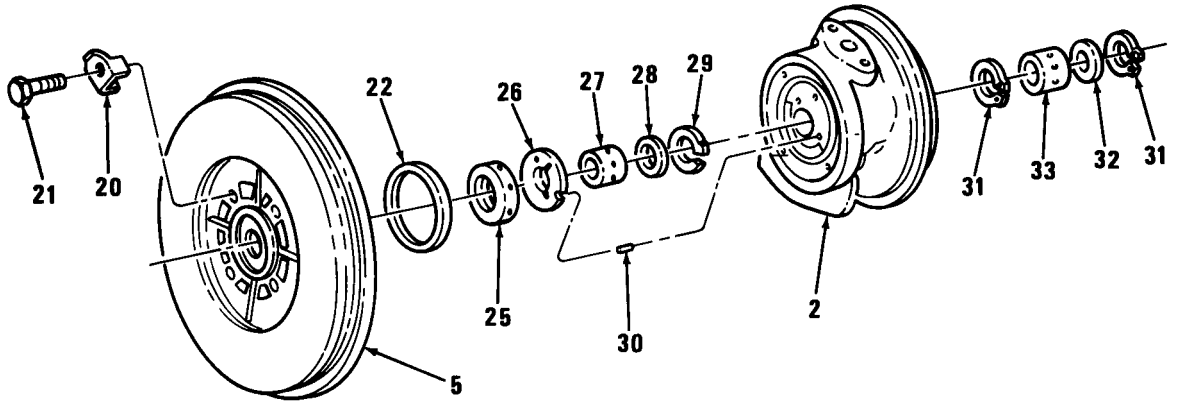
CAUTION

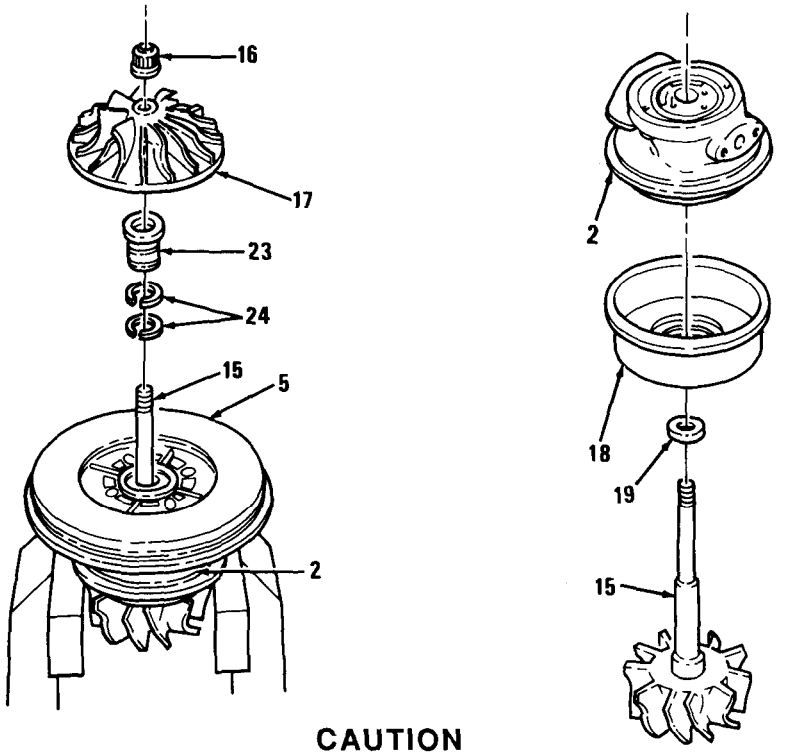
Do not cock or force piston ring (19) in groove. Ring is brittle and will snap easily.

NOTE

Piston ring (19) is used only on some turbochargers. If there is no groove in shaft, ring is not required.

(9) Install piston ring (19) on wheel shaft assembly (15).





CAUTION

Do not scuff or scratch bearings when installing shaft or bearing will seize during operation.

(10) Lubricate wheel shaft assembly (15) with engine oil. Position wheel shroud (18) against center housing (2). Insert wheel shaft assembly (15) through wheel shroud and into center housing.

(11) Place wheel shaft assembly (15), shroud (18), center housing (2), and backplate (5) upright in holding fixture.

CAUTION

Do not cock or force piston rings (24) in grooves. Rings are brittle and will snap easily.

(12) Install two piston rings (24) on thrust spacer (23).

(13) Lubricate thrust spacer (23) and piston rings (24) with engine oil. Slide spacer with rings over shaft assembly (15) and into bore in backplate (5).

(14) With compressor wheel (17) at 68 -78°F, position it over shaft assembly (15).

(15) Lubricate shaft threads of shaft assembly (15) and wheel face on compressor wheel (17) with engine oil. Install retaining nut (16). Torque nut to 10-12 lb-ft (14-17 N-m) to seat compressor wheel against thrust spacer.

(16) Loosen nut (16) and inspect nut face and front face of compressor wheel to insure they are smooth and clean.

(17) Tighten nut to 15-25 lb-in (2-3 N-m) torque.

4-37. TURBOCHARGER REPAIR (Cont)

CAUTION

Tighten compressor wheel nut with a double universal socket to prevent bending turbine wheel shaft.

(18) Tighten nut an additional 110 degrees of rotation.

(19) Check bearing axial end play as follows:

(a) Clamp center housing assembly in bench vise equipped with soft jaws.

(b) Fasten dial indicator and magnetic base (34) to center housing with indicator tip resting on end of rotating shaft on compressor side.

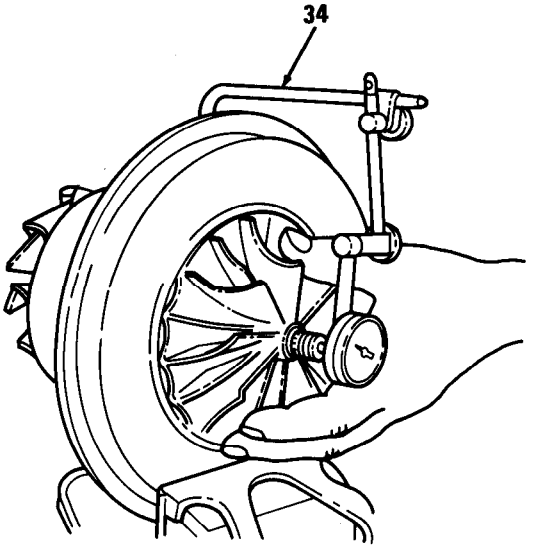
(c) Move shaft axially back and forth by hand. Total indicator reading should be between 0.004 and 0.009 inch. Repair or replace shaft assembly if readings do not fall within limits.

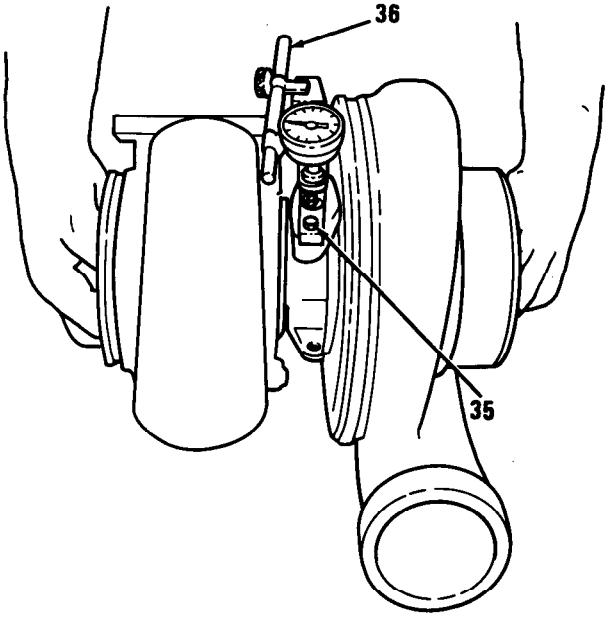
(20) Check shaft radial movement as follows:

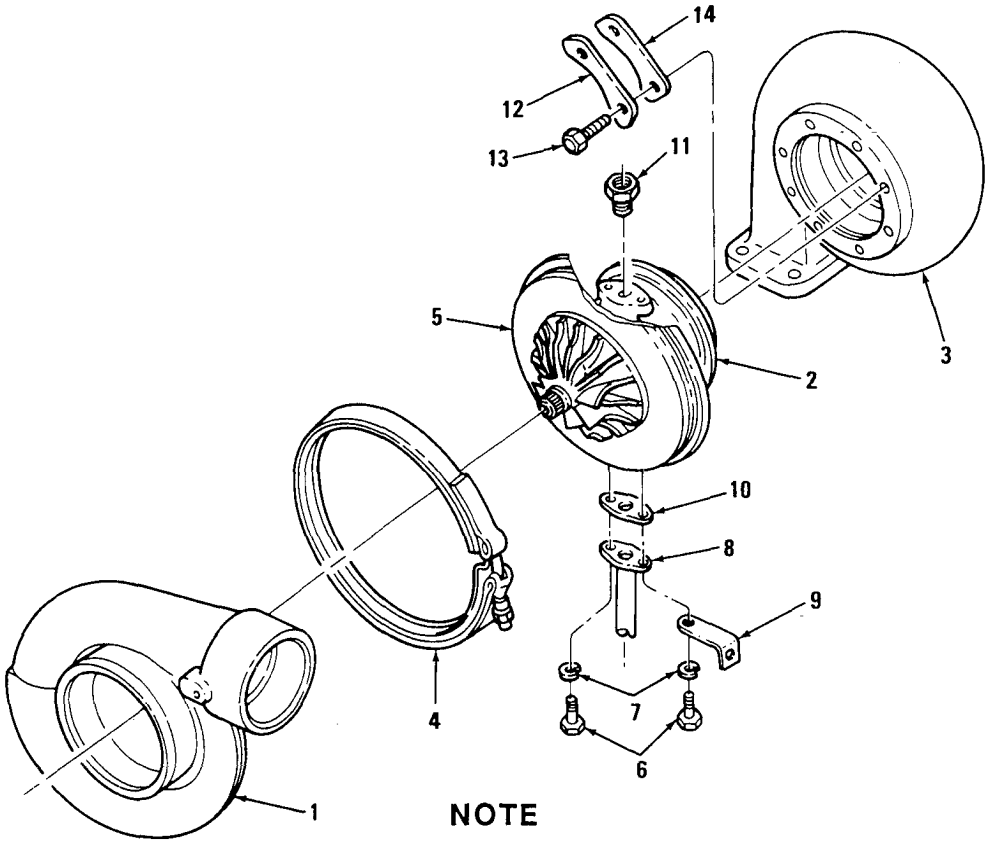
(a) Bolt dial indicator adaptor (35) to oil drain tube mounting pad.

(b) Mount dial indicator (36) on dial indicator adaptor (35).

(c) Place dial indicator tip against indicator adaptor rod.







NOTE

Insure adaptor rod 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. If not within limits, disassemble and repair or replace rotating assembly.

(21) Aline match marks on turbine housing (3) with marks on center housing (2). Secure with four clamps (14), four locking plates (12), and eight bolts (13). Apply antiseize compound to bolts (13). Torque bolts to 100-130 lb-in (11-15 N-m) and bend locking plate tangs over side of bolt heads.

(22) Aline match marks on compressor housing (1) with marks on center housing (2). Secure compressor housing to backplate (5) with V-band clamp (4). Lubricate threads on toggle bolt with engine oil and torque nut on toggle bolt to 110-130 lb-in (12-15 N-m).

(23) Install adaptor bushing (11) in oil inlet hole in center housing (2).

NOTE

On model 7083-7396, install angle bracket (9) with bolt (6) away from turbine inlet.

(24) Install gasket (10), oil drain tube (8), two lockwashers (7), and two bolts (6) on oil outlet of center housing (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-2	Turbocharger removed (7083-7395)
5-2	Turbocharger removed (7083-7396)

4-38. CYLINDER HEAD REPAIR

This task covers: a. Disassembly b. Cleaning c. Pressure Check
d. Inspection/Repair e. Assembly

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Valve insert remover (App B, Item 80
Bridge guide installer (App B, Item 49)
Injector tube installer - new style (App B, Item 54)
Valve spring compressor (App B, Item 13)
Cylinder head pressure testing kit (App D, Item 10)
Valve guide remover (App B, Item 79)
Spring tester (App B, Item 93)
Valve bridge guide remover set (App B, Item 74)
Valve insert installer (App B, Item 61)
Slide hammer (App B, Item 39)
Reamer (App B, Item 47)
Depth gage (App B, Item 28)
Valve guide installer (App B, Item 60)
Fuel nut wrench (App B, Item 99)
Reamer (App B, Item 47)
Upsetting die (App B, Item 47)
Injector tube pilot (App B, Item 47)
Micrometer 0-1 inch (App B, Item 65)
Cam follower holding fixture (App B, Item 18)
Injector protrusion gage (App B, Item 32)
Injector tube tip refinisher (App B, Item 47)
Insert runout dial gage (App B, Item 29)
Magnetic base dial indicator (App B, Item 45)
Bridge guide remover - broken (App B, Item 75)
Adaptor kit - insert grinding (App B, Item 3)
Valve insert grinder (App B, Item 38)
Telescoping gage (App B, Item 25)
Injector tube installer - old style
(App B, Item 47)
Torque wrench (App B, Item 100)

MANDATORY REPLACEMENT PARTS

8 Gaskets (App F, Item 71)
2 Cup plugs (App F, Item 11)
8 Gaskets (App F, Item 49)
18 Lockwashers (App F, Item 93)
4 Bushings (App F, Item 6)
16 Lockwashers (App F, Item 91)
2 Cup plugs (App F, Item 8)
8 Injector tube kits (App F, Item 158)
8 Fuel lines (App F, Item 18)
8 Fuel lines (App F, Item 19)

EXPENDABLE/DURABLE SUPPLIES

Sealant (App C, Item 40)
Engine oil (App C, Item 16)
Cindol 1705 oil (App C, Item 8)
Sulphurized oil - E.P. type (App C, Item 45)
Cutting oil (App C, Item 13)
Sealant (App C, Item 38)
Fuel oil (App C, Item 21)
Crocus cloth (App C, Item 12)
Prussian blue (App C, Item 32)

EQUIPMENT CONDITION

Para	Description
4-7	Lifting brackets removed
4-27	Cylinder head removed

a. Disassembly

NOTE

Immediately after removing fuel lines, cover each injector opening with caps to keep out dirt.

(1) Remove four inlet fuel lines (1) and four outlet fuel lines (2) from fuel injectors (3) and fuel connectors (4). Discard fuel lines.

NOTE

- Tag rocker arms, shafts, brackets, valves, cam followers, and associated hardware so they can be installed in their original position.
- On model 7083-7395, one rocker arm shaft bracket on right cylinder head contains throttle delay housing (5).

(2) Remove eight bolts (6) securing rocker arm shafts (7) and brackets (8) to cylinder head.

NOTE

Inspect throttle delay check valve for leakage. Fill throttle delay cylinder with fuel oil and watch check valve leakage while moving engine throttle from idle to full fuel position. If more than a drop of leakage occurs, replace check valve.

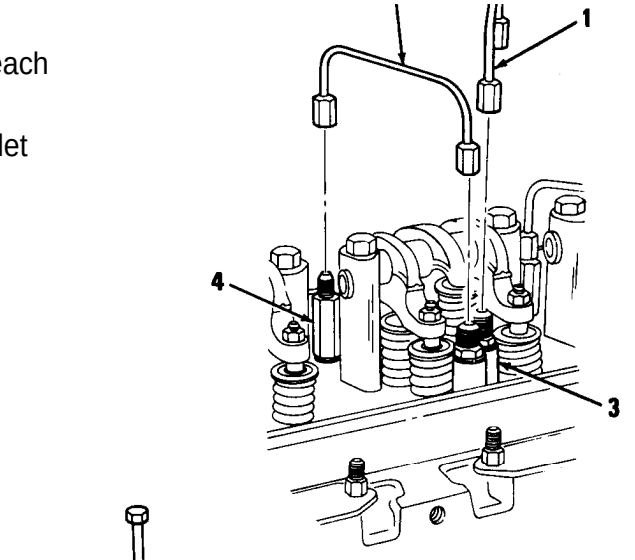
(3) Remove four rocker arm shafts (7) and eight rocker shaft brackets (8) from cylinder head. If necessary, remove check valve (9) and oil supply fitting (10) from throttle delay housing (5) used on model 7083-7395.

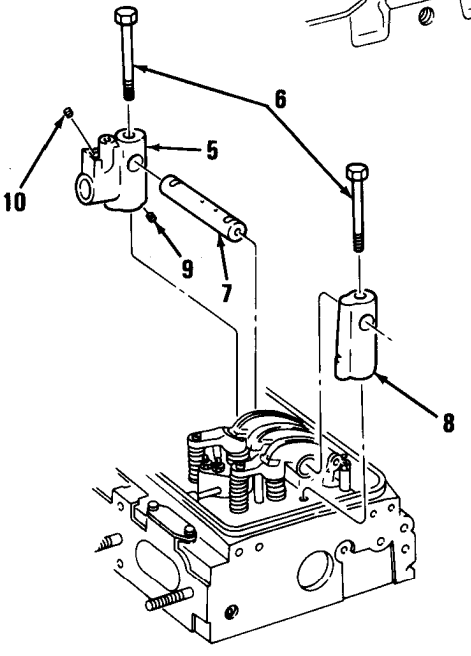
(4) Swing rocker arms (11) away from injector and valves. Remove four injector clamp bolts (12), four washers (13), and four clamps (14).

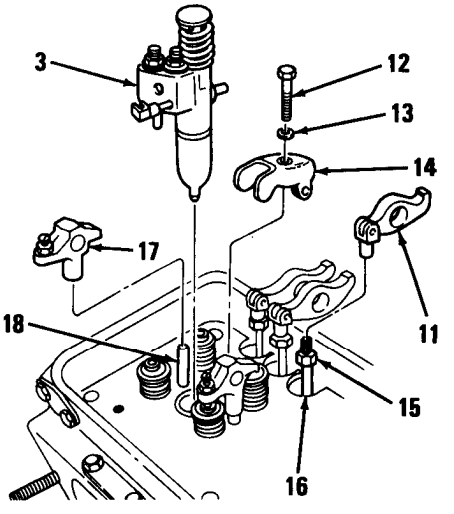
(5) Remove four fuel injectors (4) from cylinder head.

(6) Loosen twelve locknuts (15) at upper end of push rods (16) next to rocker arm clevis. Unscrew twelve rocker arms (11) from push rods.

(7) Remove eight valve bridges (17) from bridge guides (18).







4-38. CYLINDER HEAD REPAIR (Cont)

(8) Rest cylinder head on its side and remove eight cam follower guide bolts (19), eight lockwashers (20), and four cam follower guides (21). Discard lockwashers.

(9) Remove twelve cam follower spring retainers (22) from cam follower bores in cylinder head.

(10) Pull twelve cam followers (23) and twelve push rods (16) assemblies from bottom of cylinder head. Remove twelve push rod nuts (15), twelve upper spring seats (25), twelve cam follower springs (24), and twelve lower spring seats (26) from twelve push rods.

NOTE

Mark location of valve for reinstallation. With used valves, valves must go back in original location.

(11) Remove sixteen exhaust valves as follows:

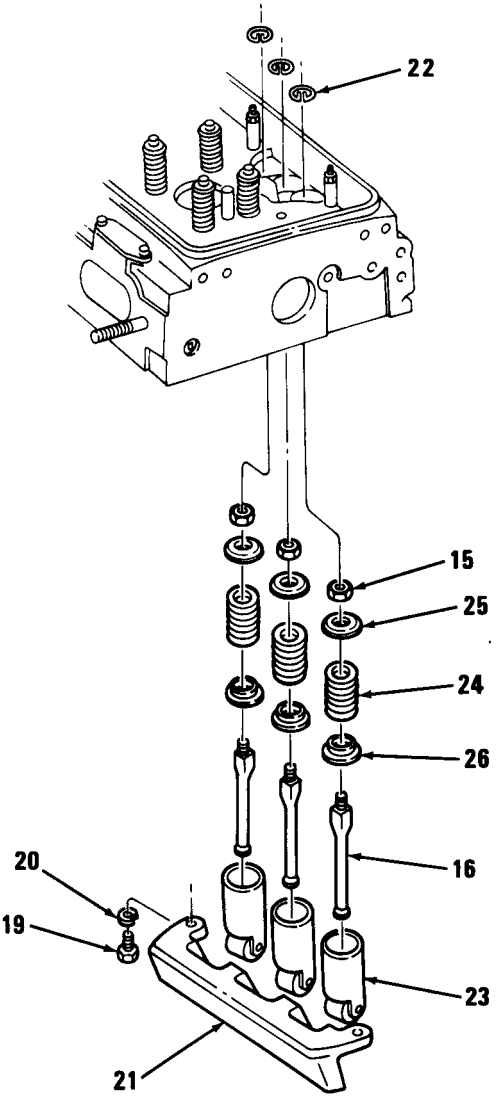
(a) Position cylinder head on its side.

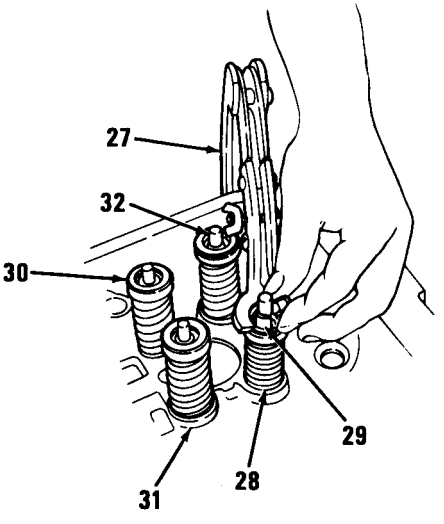
(b) Using valve spring compressor (27), compress valve spring (28). Remove two-piece tapered valve locks (29).

(c) Remove upper spring seat (30), valve spring (28), lower spring seat (31) , and exhaust valve (32).

NOTE

- Model 7083-7395 contains four bolts (33), four flat washers (34), two cover plates (35), and two gaskets (36) per head.
- Model 7083-7398 contains six bolts, six flat washers, three cover plates, and three gaskets per head.





(12) Remove bolts (33), flat washers (34), cover plates (35) and gaskets (36) from corners of cylinder head. Discard gaskets.

(13) If necessary, remove support bracket (37), two bolts (38), and two lockwashers (39) from right cylinder head. Discard lockwashers.

(14) Remove two bolts (40), two flat washers (41), adaptor (42), and gasket (43) from inboard corner or cylinder head. Discard gasket.

(15) Remove eight fuel connectors (4) and eight washers (44) from cylinder head.

NOTE

If the cylinder head is to be pressure checked, do not remove parts in steps (16) thru (21).

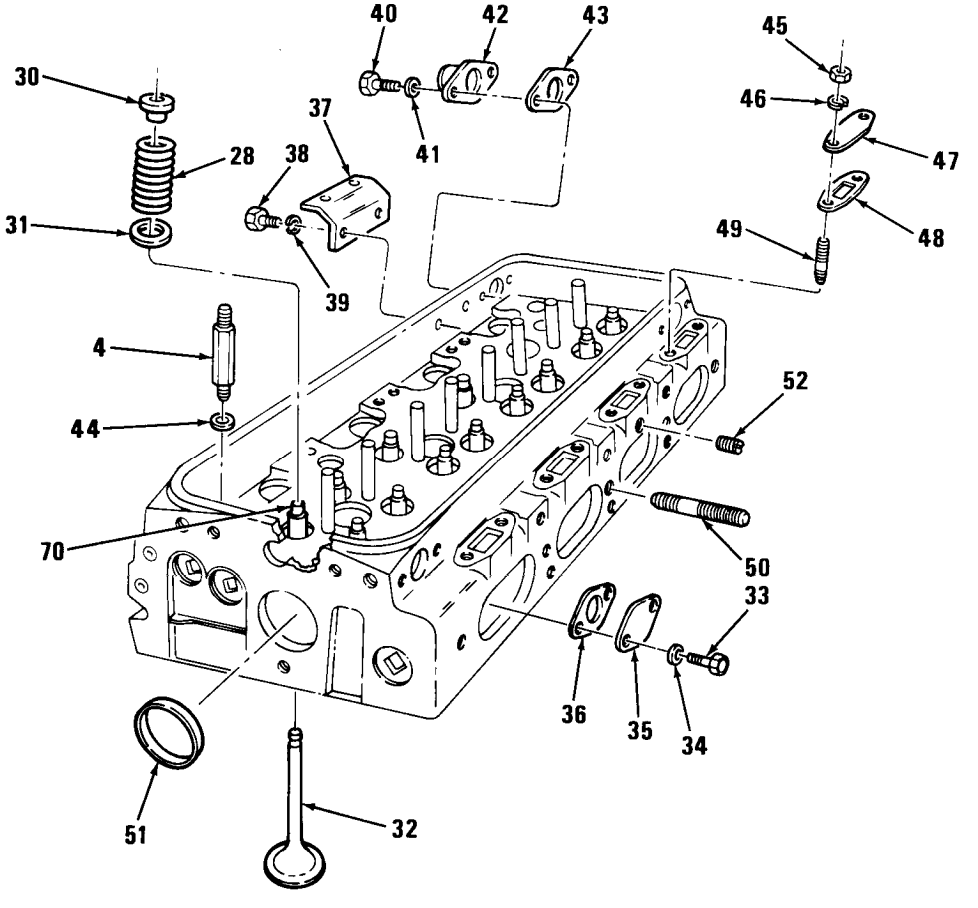
(16) Remove eight nuts (45), eight lockwashers (46), four cover plates (47), and four gaskets (48) from outboard side of cylinder head. Discard gaskets and lockwashers.

(17) Remove eight studs (49) from outboard side of cylinder head.

(18) Remove five studs (50) from outboard side of cylinder head.

(19) Remove cup plug (51) from rear of cylinder head. Discard plug.

(20) Remove fuse plug (52) from outboard side of cylinder head.



4-38. CYLINDER HEAD REPAIR (Cont)

(21) Remove two each of pipe plugs (53 and 54) from ends of head.

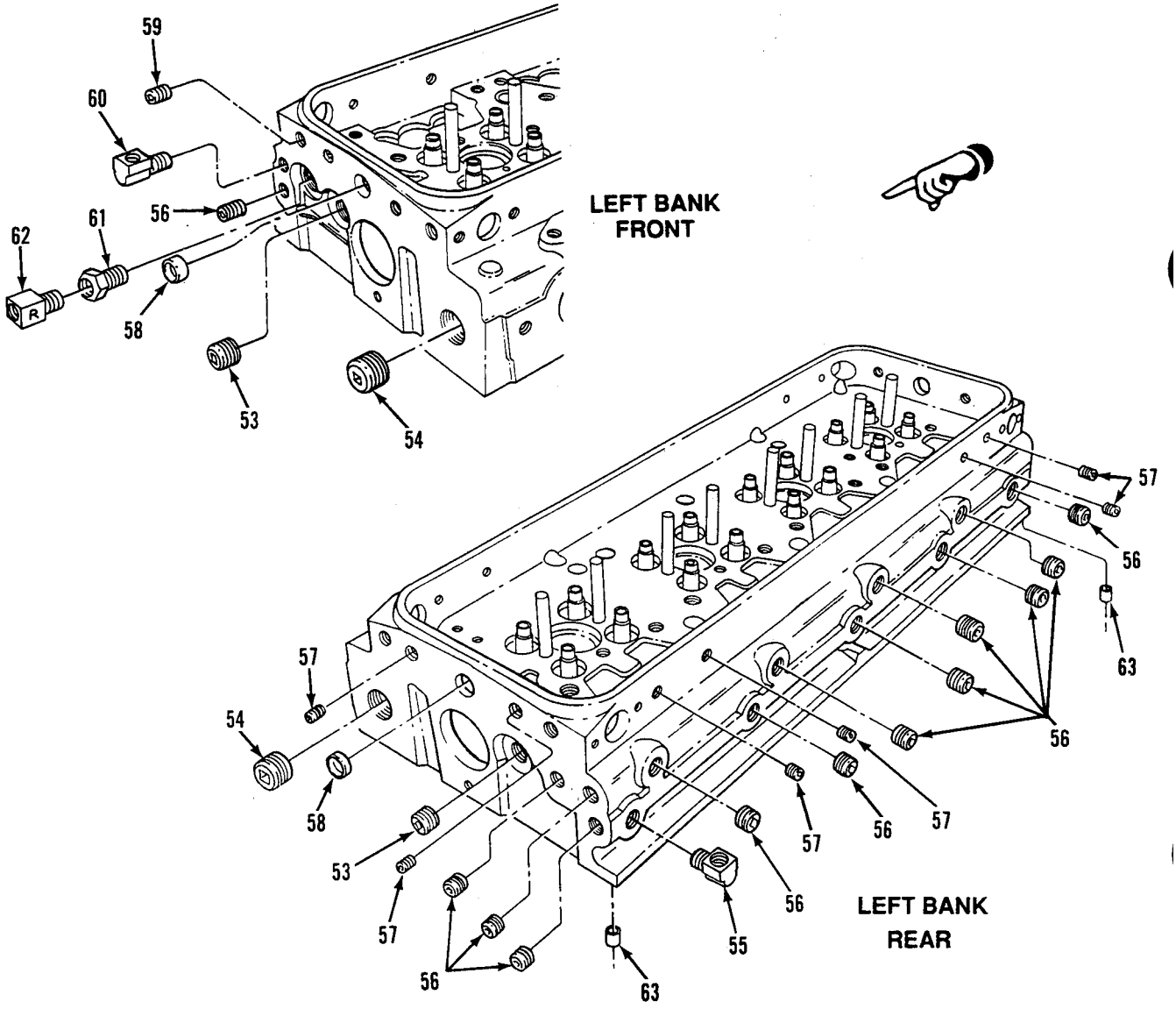
(22) Remove fuel spill crossover elbow (55) from cylinder head.

(23) Remove twelve pipe plugs (56) from inboard side and ends of cylinder head.

(24) Remove six threaded plugs (57) from left cylinder head or four plugs from right cylinder head.

(25) If necessary, remove two cup plugs (58) from front rear of cylinder head. Discard plugs.

(26) If necessary, remove two threaded plugs (59) from front of right cylinder head or one plug from front of left cylinder head.



(27) Remove elbow (60) from front of left cylinder head or two elbows (60) from front of right cylinder head.

(28) Remove adaptor bushing (61) and restrictive fitting (62) from front of left cylinder head.

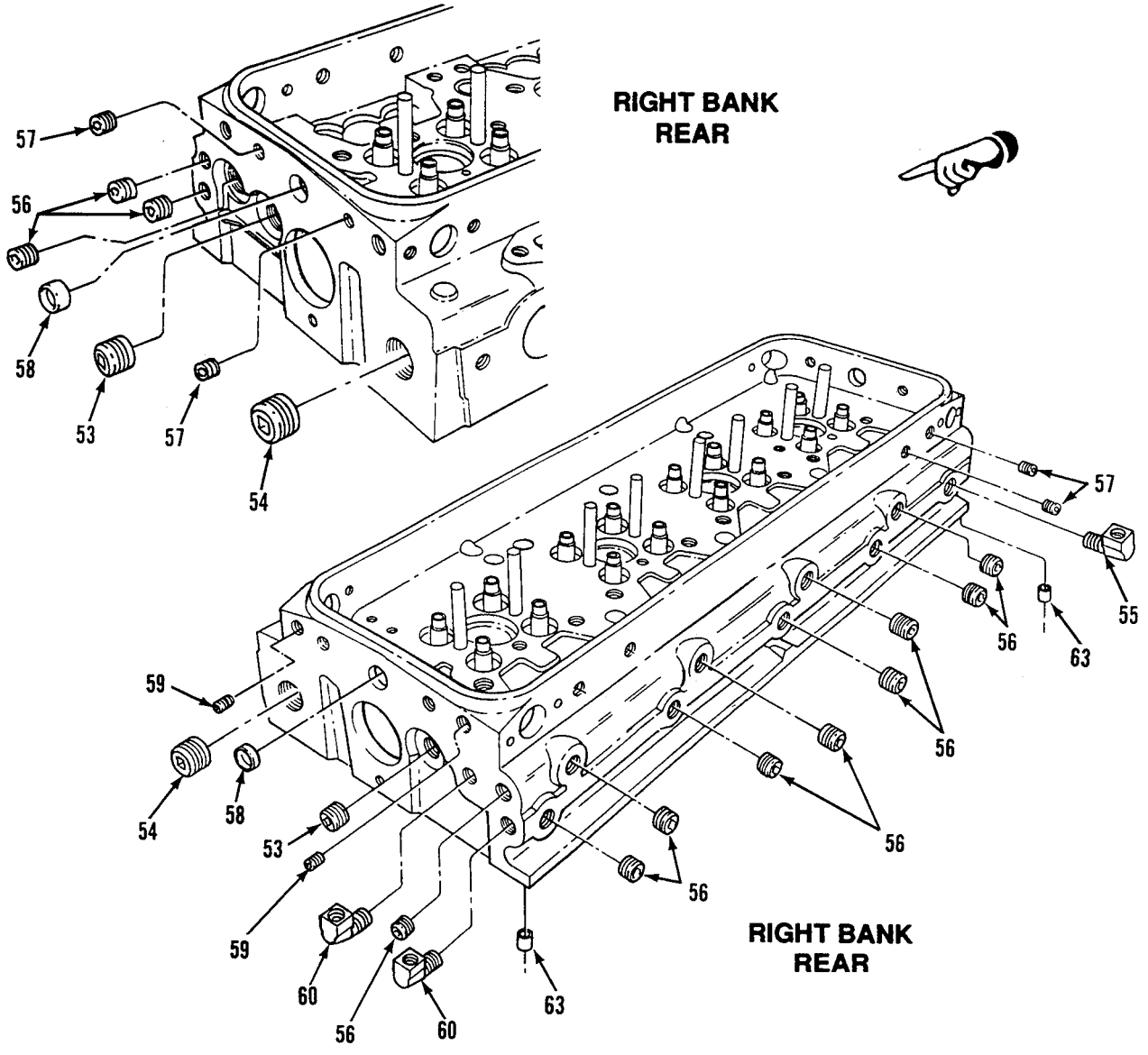
(29) If necessary, remove two bushings (63) from cylinder head bolt holes.

b. Cleaning

(1) Thoroughly clean cylinder head and cylinder head components (refer to Para 3-2).

(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.



4-38. CYLINDER HEAD REPAIR (Cont)

c. Pressure Check

NOTE

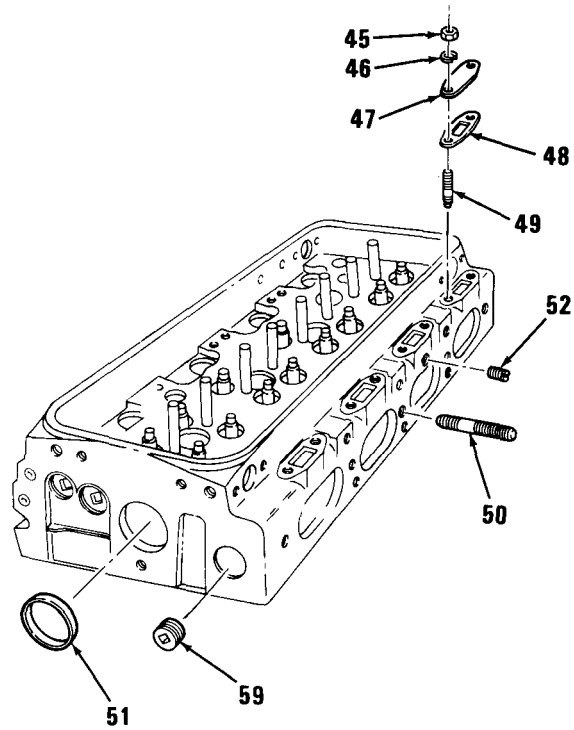
Before pressure checking cylinder head, insure four cover plates (47), cup plug (54), two pipe plugs (54), fuse plug (52), and five exhaust manifold studs (50) are in position.

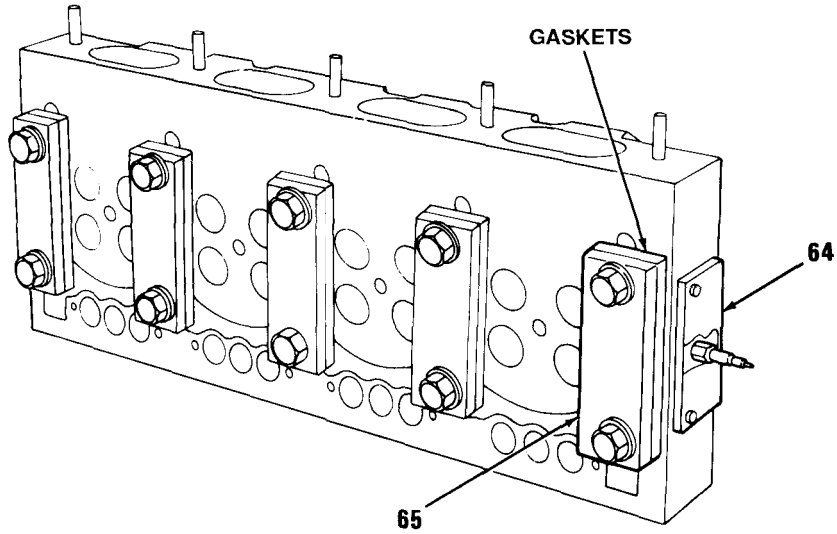
(1) Install scrap or dummy injectors to properly seal injector tubes. Torque injector clamp bolts to 20-25 lb-ft (27-34 N-m).

(2) Using cylinder head pressure testing kit, install fabricated end plate (64) and gasket over hole in front of cylinder head. Secure with bolts from kit. Torque bolts to 30-35 lb-ft (41-47 N-m).

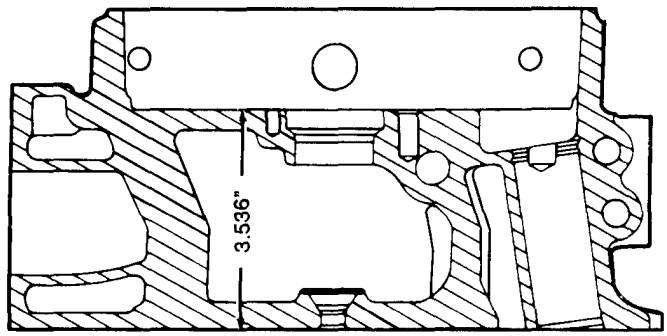
(3) Using cylinder head pressure test kit, install fabricated blocking plates (65) and rubber gaskets to seal off ten water holes on fire deck. Secure with bolts, flat washers, and nuts from kit. Torque bolts to 50-60 lb-ft (71-85 N-m).

(4) Attach a regulated air supply to end plate (64) and gradually apply pressure of 40 psi (276 kPa) to water jacket.





(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.

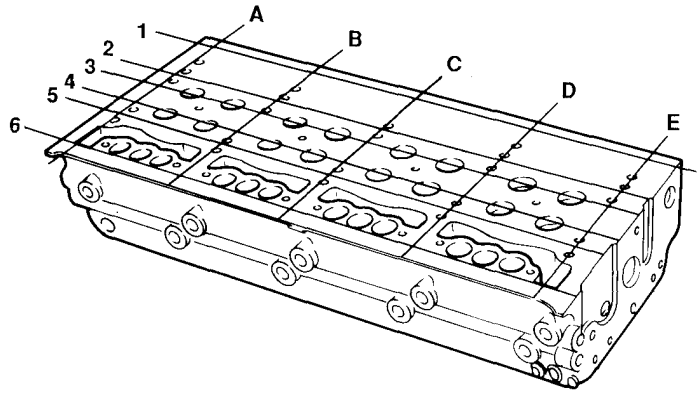


(6) Relieve air pressure and remove cylinder head from water tank. Remove regulated air supply, end plate, injectors, and blocking plates from cylinder head.

d. Inspection/Repair

NOTE

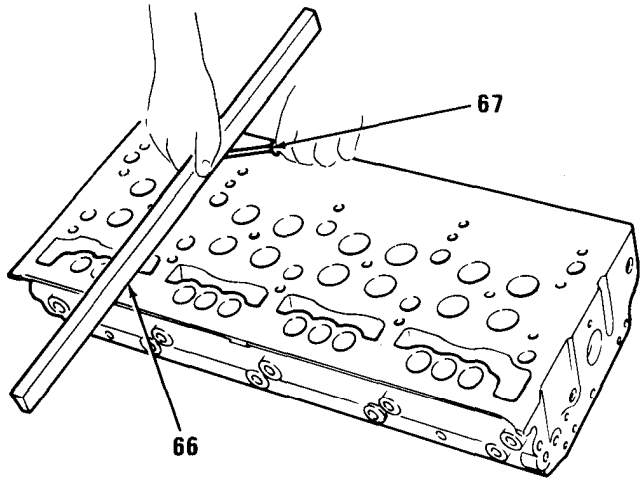
If warpage exceeds limits, reface cylinder head. Do not remove more metal from fire deck than minimum distance of 3.536 inches from top of deck to bottom of fire deck.



(1) Cylinder head

(a) Check fire deck surface of cylinder head for flatness. Using a straight edge (66) and a set of feeler gages (67), check lengthwise (six places) and crosswise (five places) warpage. Maximum lengthwise warpage is 0.008 inch and maximum crosswise warpage is 0.004 inch.

(b) Inspect cam follower bores in cylinder head for scoring and wear. Clean light score marks with crocus cloth wet with fuel oil. Measure diameter of cam follower body and cam follower bore to determine clearance. Maximum clearance is 0.006 inch. Replace cylinder head if bores are excessively worn or scored.



(2) Water nozzles

Check water hole nozzles (68 and 69) for looseness. If necessary, replace nozzles as follows:

(a) Remove old nozzle (68 or 69) and clean bore in cylinder head.

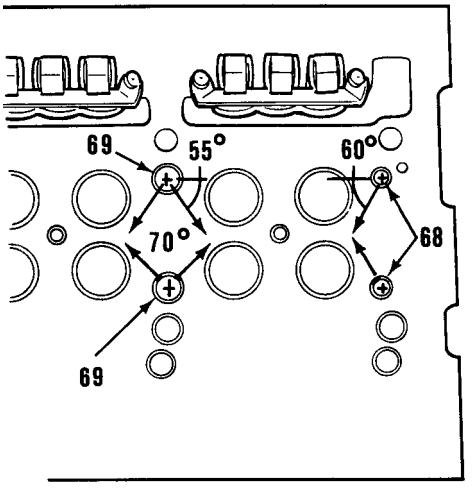
4-38. CYLINDER HEAD REPAIR (Cont)

(b) Position nozzles (68) in end bore or nozzles (69) in inner bore as shown.

(c) Press nozzles (68 or 69) 0.003 inch above to 0.010 inch below surface of cylinder head.

(3) Exhaust valve guides

Inspect valve guides 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, replace valve guide. Replace valve guide as follows:

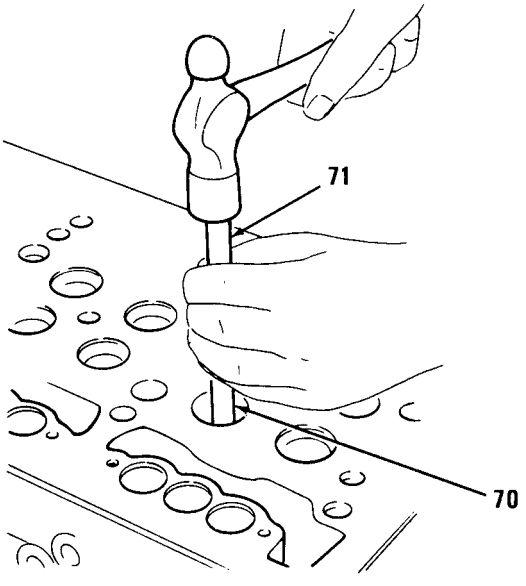


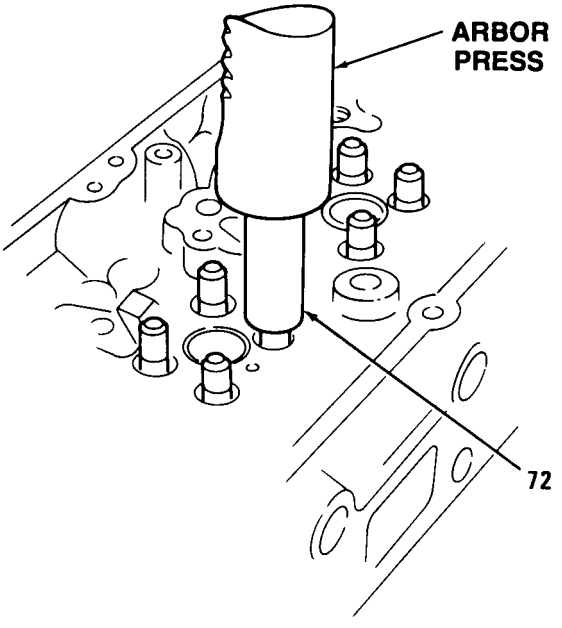
(a) Support cylinder head, bottom side up, on three inch thick wood blocks.

(b) Drive valve guide (70) out of cylinder head with valve guide remover (71).

(c) Place cylinder head right side up in arbor press.

(d) Position valve guide squarely in bore. Using valve guide installer tool (72), press guide into position until tool contacts cylinder head.

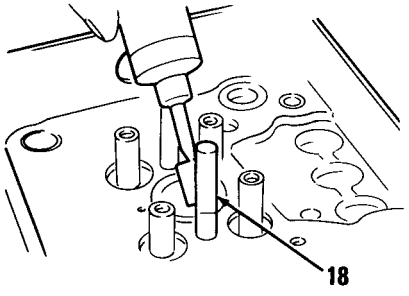


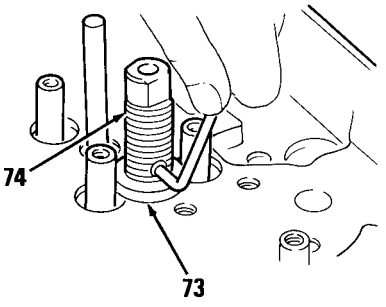


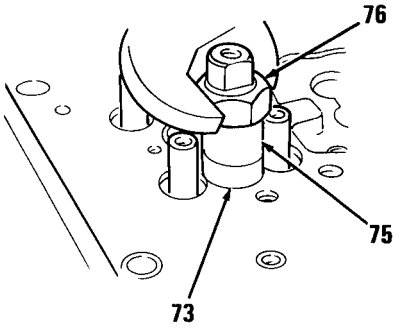
(4) Valve bridge guides

(a) Inspect valve bridge guides for wear. If necessary, replace guides as follows:

1. File or grind two opposite notches 0.06 inch deep in side of bridge guide (18) approximately 1.25 inches from top.
2. Using bridge guide remover tool set, place spacer (73) over guide.
3. Slide guide remover (74) over guide and aline set screws with notches ground in guide. Tighten set screws to secure tool in place.
4. Place spacer (75) over guide remover (74).
5. Thread nut (76) on guide remover and turn clockwise to withdraw guide from cylinder head.

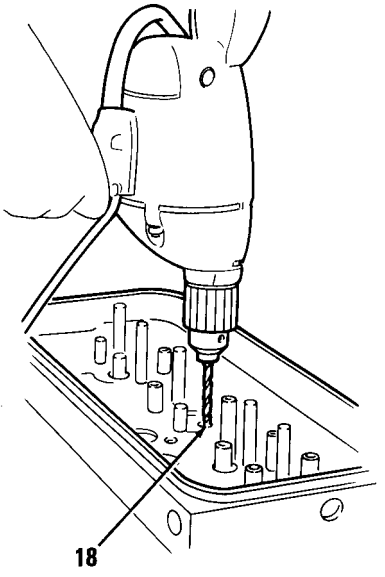


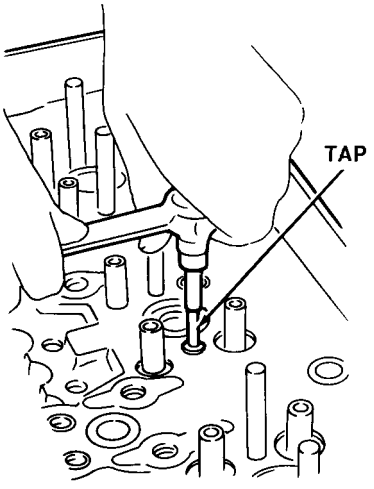


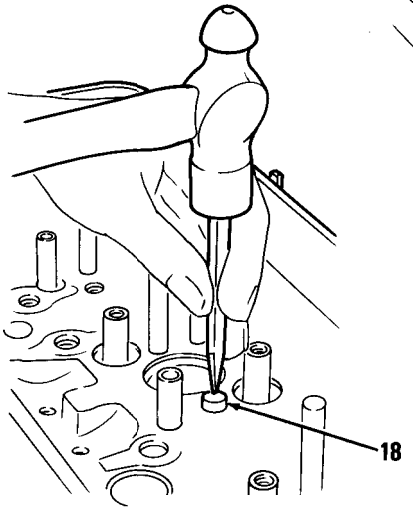


(b) Remove broken valve bridge guides as follows:

1. Center punch end of valve bridge guide (18).
2. Drill hole 0.5 inch deep in end of guide (18) with No. 3 (0.2130 inch) drill bit.
3. Tap guide with 1/4-28 bottoming tap.







4-38. CYLINDER HEAD REPAIR (Cont)

4. Thread bridge guide remover (77) into tapped hole.

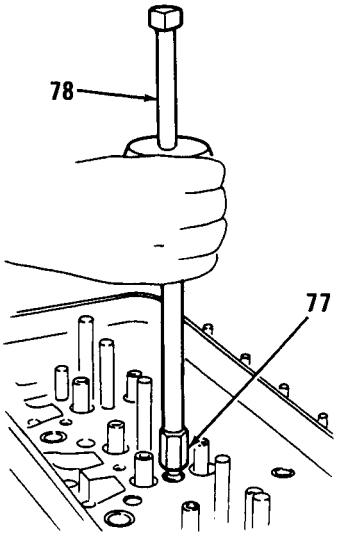
5. Attach slide hammer (78) to guide remover (77) and remove guide.

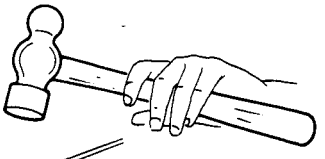
(c) Install valve bridge guides as follows:

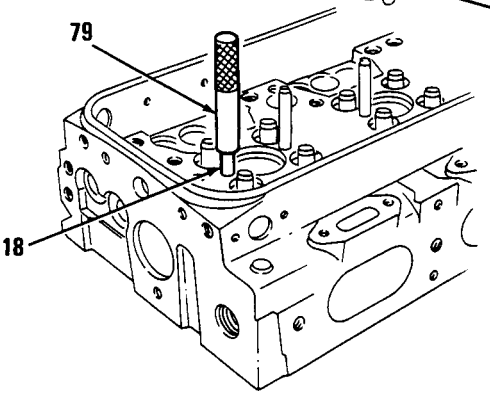
1. Apply a coat of sealant to bridge guide (18).

2. Start guide (18) in cylinder head with undercut end first.

3. Place bridge guide installer (79) over guide (18) and drive into place. Installer will position guide to correct height (2.040 inches) in cylinder head.







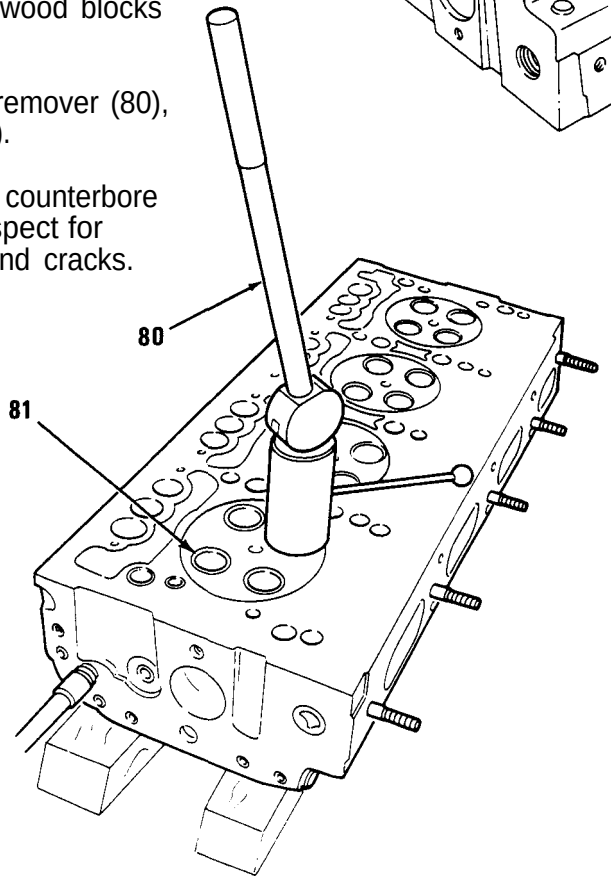
(5) Valve inserts

Inspect valve inserts for excessive wear, pitting, cracking, or improper seat angle. Replace inserts as follows:

(a) Place cylinder head on wood blocks with bottom side up.

(b) Using valve seat insert remover (80), remove valve insert (81).

(c) Clean valve seat insert counterbore in cylinder head and inspect for concentricity, flatness, and cracks.



NOTE

Insert counterbore has a diameter of 1.2600 to 1.2610 inches and a depth of 0.3380 to 0.3520 inch. Counterbores must be concentric with valve guides within 0.003 inch 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 insert in cylinder head while head is still hot and insert is at room temperature or when insert is chilled and head is at room temperature.

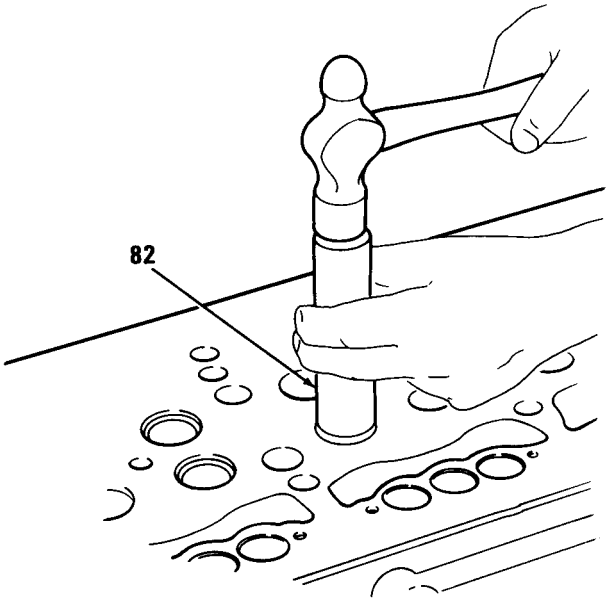
(e) Place cylinder head on a bench with bottom side up. Place insert in counterbore with valve seat side facing up.

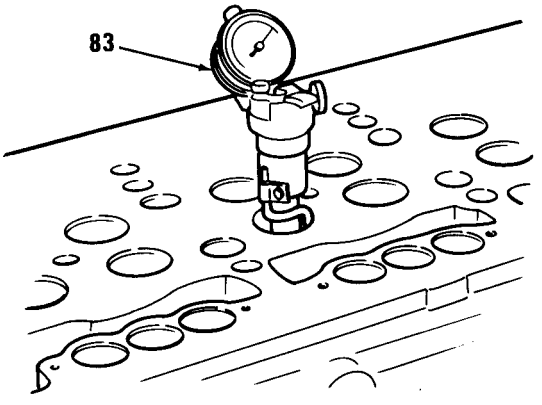
(9 Using insert installer (82), drive insert in place until it seats solidly in cylinder head.

(9) Check exhaust valve seat inserts for concentricity in relation to valve guides using insert runout gage (83).

NOTE

Exhaust valve seat inserts are prefinished. Only check for concentricity after installation. Grind insert only if runout exceeds 0.002 inch.





4-38. CYLINDER HEAD REPAIR (Cont)

(6) Valve seat insert grinding

Use a valve seat grinder (84) and valve seat grinder adapter kit to grind inserts. Grind valve inserts as follows:

CAUTION

Do not permit grinding wheel to contact cylinder head when grinding insert. If an insert has been ground until grinding wheel contacts cylinder head, then install new insert.

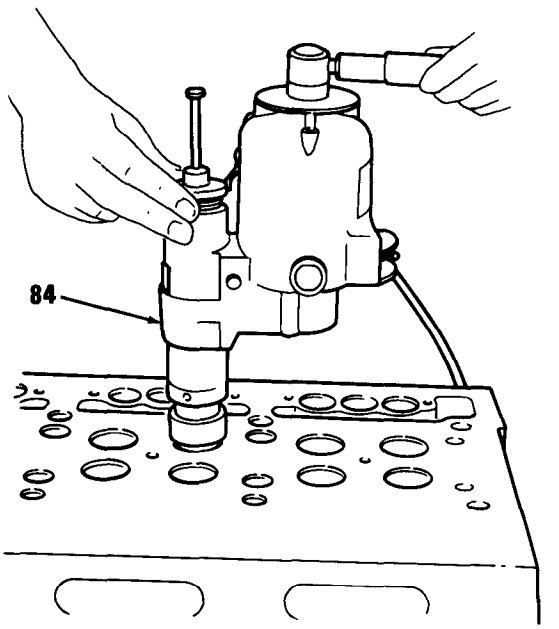
(a) Apply 31-degree grinding wheel on valve seat insert.

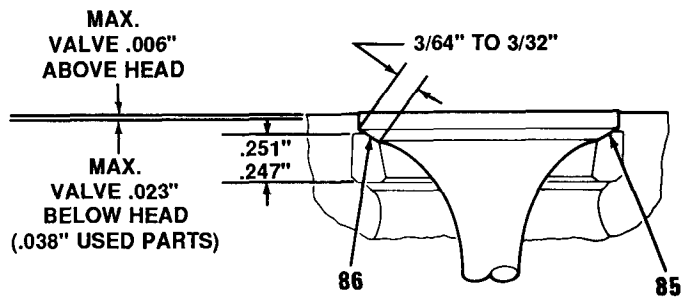
(b) Grind throat of insert using 60-degree grinding wheel.

(c) Grind top surface of insert with 15degree grinding wheel to narrow seat width to dimensions shown in figure. The 31-degree face (85) of insert maybe adjusted relative to center of valve face (86) with 15 and 60-degree grinding wheels.

NOTE

Maximum amount exhaust valve should protrude beyond cylinder head and still maintain proper piston to valve clearance is shown. Grinding will reduce thickness of valve seat insert and cause valve to recede into cylinder head. Replace valve seat insert if valve recedes beyond limits.





(d) After grinding is completed, clean valve seat insert thoroughly. Measure concentricity of insert in relation to valve guide. If runout exceeds 0.002 inch, check for bent or worn valve guide before regrinding insert.

(e) Determine position of contact area between valve and valve seat insert as follows:

1. Apply a light coat of Prussian blue or equivalent to valve seat insert.

2. Lower stem of valve in valve guide and bounce valve on seat. Do not rotate valve.

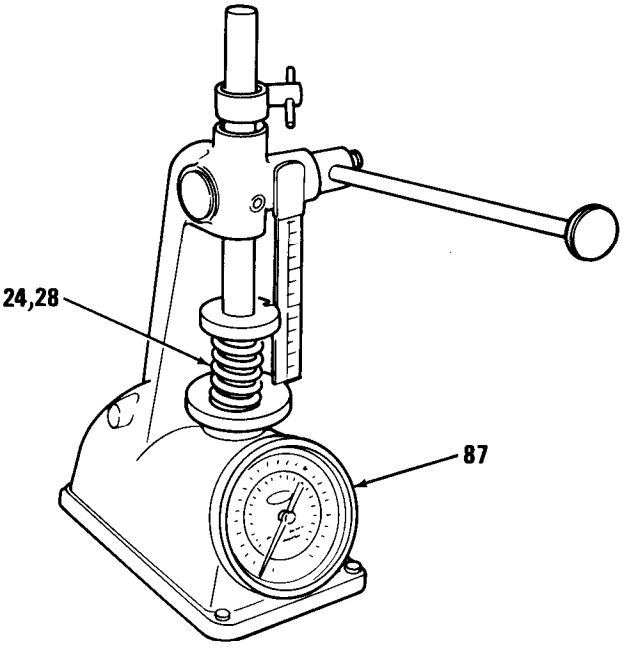
3. Remove valve and observe area of contact on valve face. Most desirable area of contact is at center of valve face.

(7) Exhaust valves and springs

(a) Insure valve stems are 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 (87), replace valve spring (28) when a load of less than 25 lbs will compress it to 1.80 inches.



CAUTION

Replace both springs under an exhaust valve bridge together. Mating a new spring with a used spring can cause unbalanced valve operation.

(8) Cam followers and cam follower springs.

(a) Examine cam follower springs (24) for wear or damage. Using spring tester (87), check spring load. Replace spring when a load of less than 172 lbs will compress it to a length of 2.125 inches.

4-38. CYLINDER HEAD REPAIR (Cont)

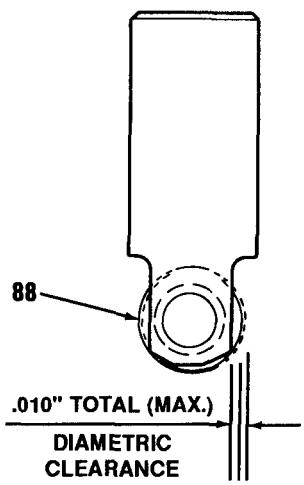
CAUTION

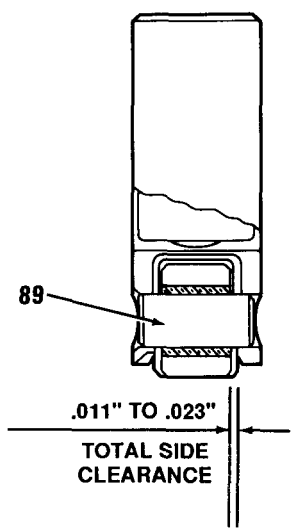
Do not use fuel oil to clean cam followers. Lubricating oil will be washed away and cause scoring of cam roller bushing at startup.

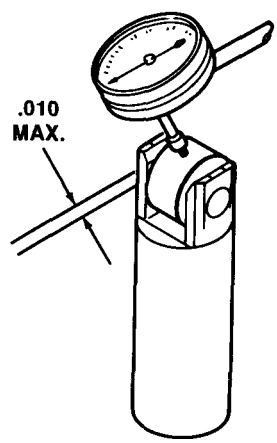
(b) Wash cam followers with engine oil and wipe dry. Examine cam follower rollers for pitting, scoring, and flat spots. Rollers (88) must turn freely on their pins (89).

(c) Using a dial indicator and holding fixture, measure total diametric clearance on cam follower roller. Secure cam follower assembly in a vise or other holding device and place dial indicator needle against outside diameter of roller. Obtain total clearance by moving roller in crosswise direction. Maximum clearance is 0.010 inch.

(d) Using a feeler gage, measure side clearance on cam follower. Insert gage between end of roller and leg of cam follower body. Side clearance must be 0.015 to 0.023 inch.







(e) If necessary, install new cam follower rollers and pins as follows:

1, Clamp cam follower holding fixture (90) in a vise and place cam follower in groove at top of assembly with cam follower pin resting on top of small plunger in holding assembly.

WARNING

Restrain cam follower body and roller during removal from cam follower holding fixture (90). 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

Remove any burrs on cam follower surfaces at pin holes prior to installing roller and pin to prevent scoring of roller bushing and pin.

2. Drive pin (89) from roller (88) with a drift.

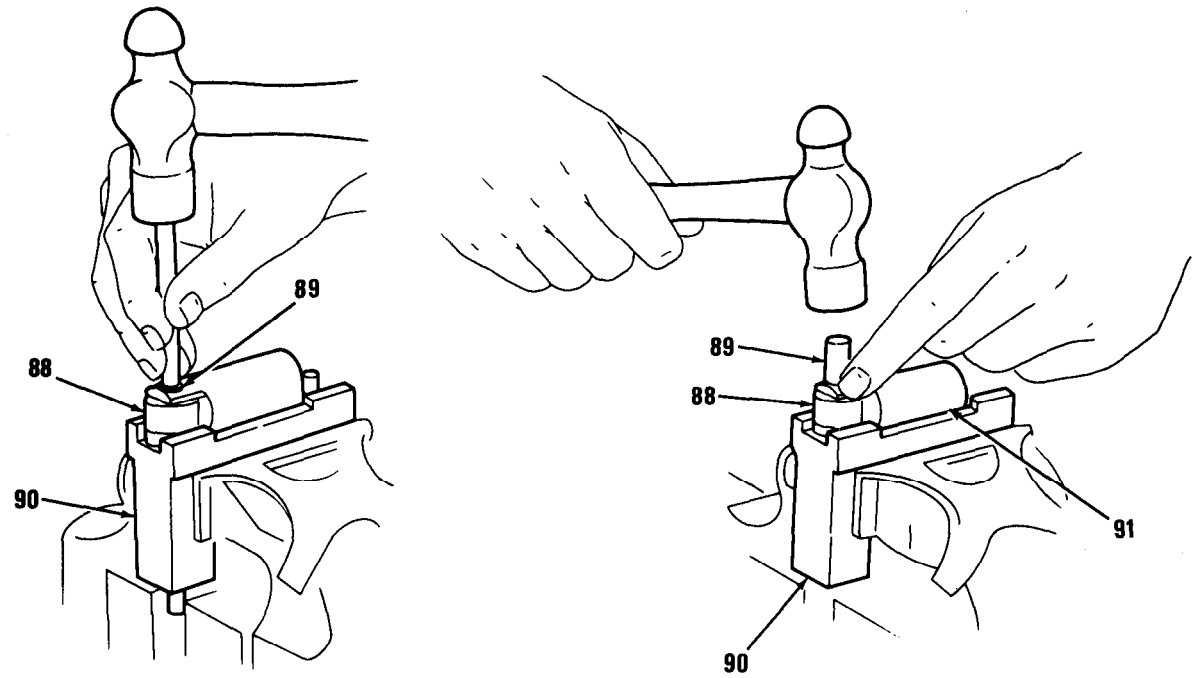
3. Position follower body in groove of holding assembly with small plunger extending through roller pin hole in one leg of follower body.

4. Coat pin and roller with engine oil.

5. Position roller (88) in cam follower body (91). Plunger will extend into roller bushing and assure accurate alinement of bushing with roller pin holes in follower body.

6. Start pin (89) squarely into follower body (91) and drive into position until pin is centered in legs of follower.

7. Check side clearance between roller (88) and follower body (91). Clearance must be between 0.011 and 0.023 inch.



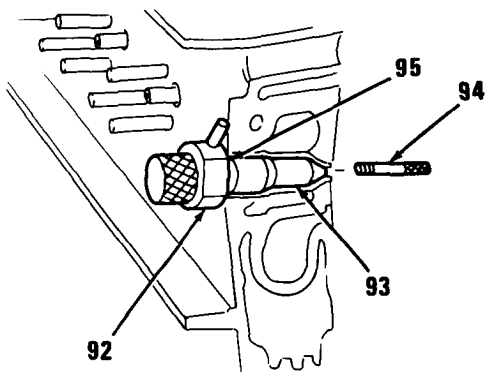
(9) Rocker arms and shafts

Inspect rocker arm shafts and bushings for wear. Maximum shaft to bushing clearance is 0.004 inch.

4-38. CYLINDER HEAD REPAIR (Cont)

(10) Injector tube

Replace injector tubes if found leaking during pressure test. Replace injector tubes as follows:



(a) Place injector tube installer (92) in injector tube (93).

(b) Insert pilot (94) through small hole in injector tube (93) and thread pilot in threaded hole of installer (92).

(c) Tap end of pilot (94) to loosen injector tube (93). Lift injector tube, pilot, and installer (92) from cylinder head. Discard injector tube and seal ring (95).

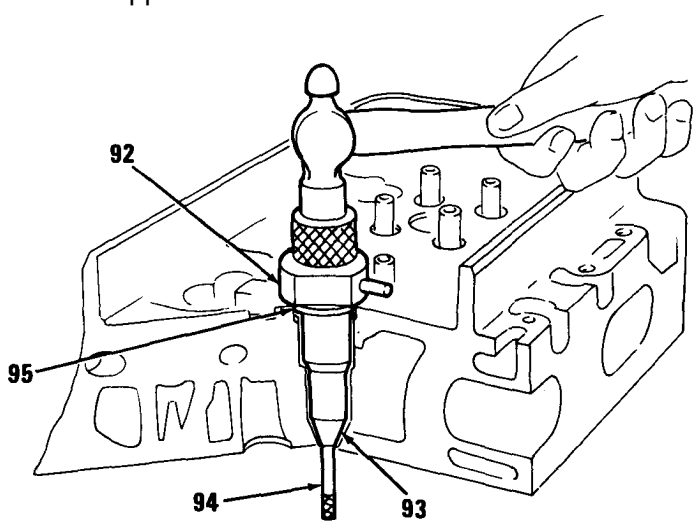
(d) Thoroughly clean injector tube hole in cylinder head to remove dirt, burrs, or foreign material preventing tube from seating properly.

(e) Lubricate injector tube seal (95) with engine oil and place in counterbore of cylinder head.

NOTE

- There are two injector tube installation tools, a fixed tool for the old style tube and an adjustable tool the current injector tube. The current tube has “606” stamped on top flange.
- For proper installation of current injector tube, adjustable installation tool must contact bottom of injector tube before it touches flange at top. Clearance at top, between flange and tool, should be 0.001 to 0.010 inch.

(f) Place installer (92) in injector tube (93). Insert pilot (94) through small hole in injector tube and thread into tapped hole at end of installer.



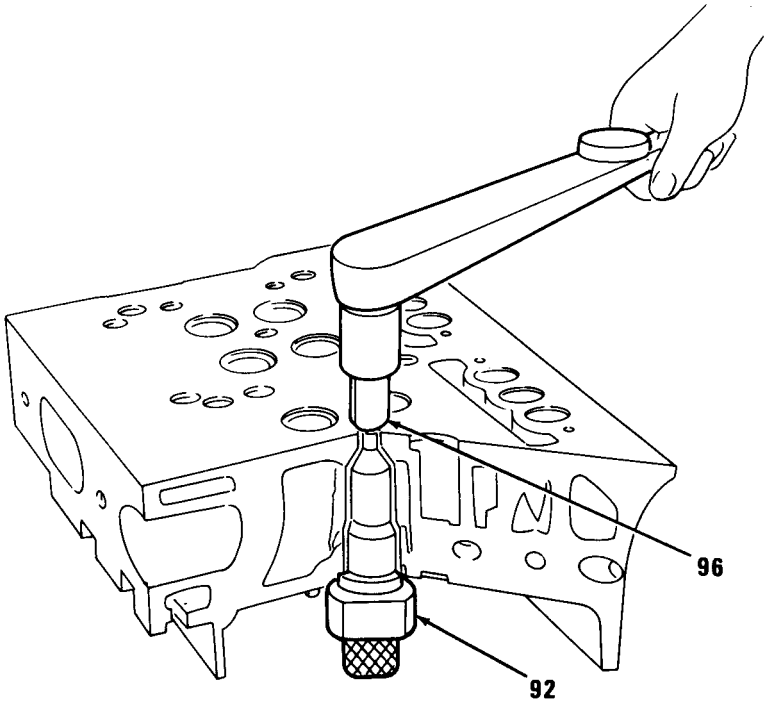
(9) Slip injector tube (93), installer (92), and pilot (94), into injector bore and drive into place.

(h) Upset lower end of injector tube as follows:

1. Turn cylinder head bottom up and remove insert pilot (94). Thread upsetting die (96) into tapped hole of installer (92).

2. Using socket and torque wrench, apply 30 lb-ft (41 N-m) torque to upsetting die (96).

3. Remove upsetting die (96) and installer (92) from injector tube.



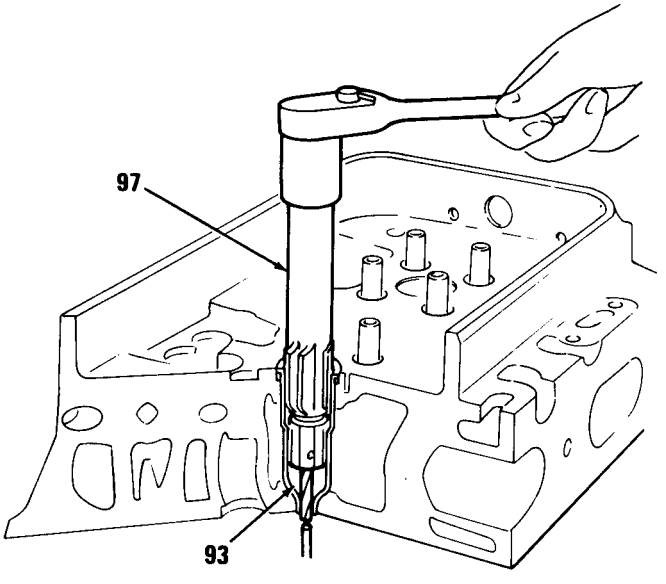
NOTE

Reamer does not contact large inside diameter of current injector tube. Ream only at small inside diameter and injector nut seat.

(i) Ream injector tube as follows:

1. Clean injector tube (93) and place cylinder head right side up.

2. Apply a few drops of cutting oil on reamer flutes and carefully position reamer (97) in injector tube (93).



4-38. CYLINDER HEAD REPAIR (Cont)

CAUTION

Turn reamer only in clockwise direction, both when inserting and removing reamer. Movement in opposite direction will dull cutting edges on flutes.

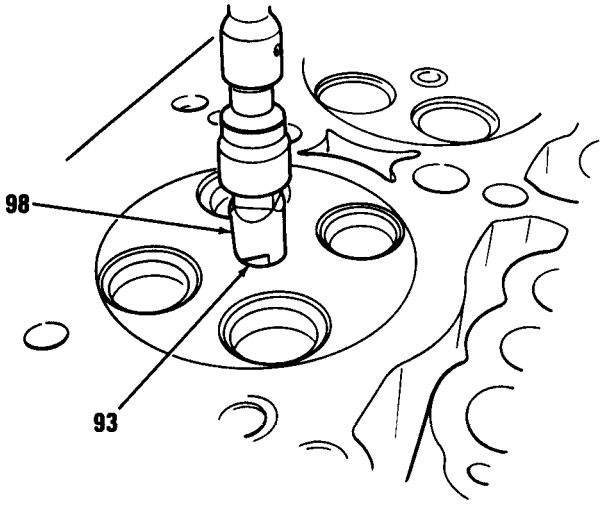
3. Turn reamer (97) clockwise (withdraw reamer frequently to remove chips) until lower shoulder of reamer contacts injector tube (93). Clean out all chips.

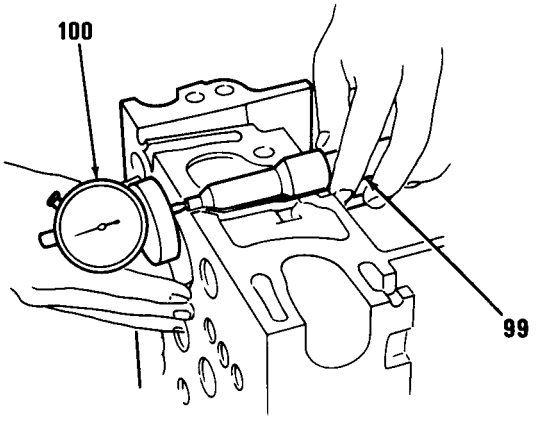
4. Rotate cylinder head to bottom up position. Insert pilot of cutting tool (98) into small hole of injector tube (93).

5. Apply a few drops of cutting oil on tool (98). Using a socket and speed handle, remove excess stock so lower end of injector tube (93) is from flush to 0.005 inch below finished surface of cylinder head.

6. Install injector gage (99) in injector tube. Using dial indicator gage (100), premeasure distance from fire deck to gage. Reading must be within +/-0.014 inch of fire deck.

7. Wash interior of injector tube (93) to prepare for second reaming operation.





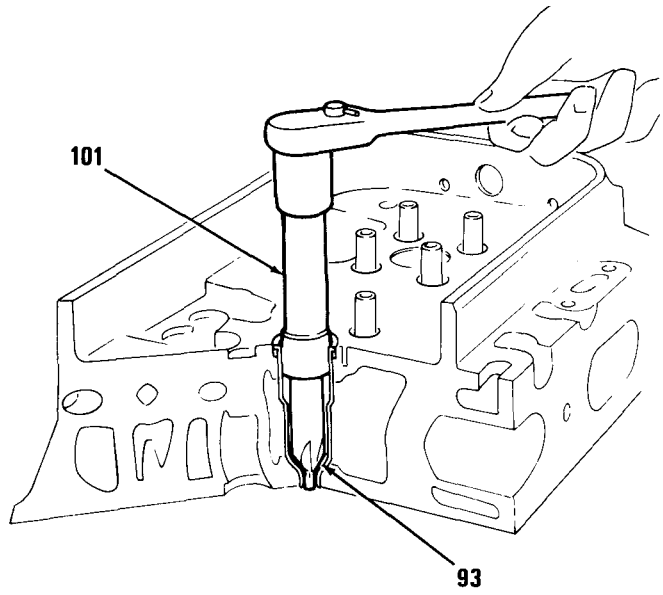
8. Apply a few drops of cutting oil on bevel seat of injector tube (93). Lower reamer (101) carefully into injector tube until it contacts bevel seat.

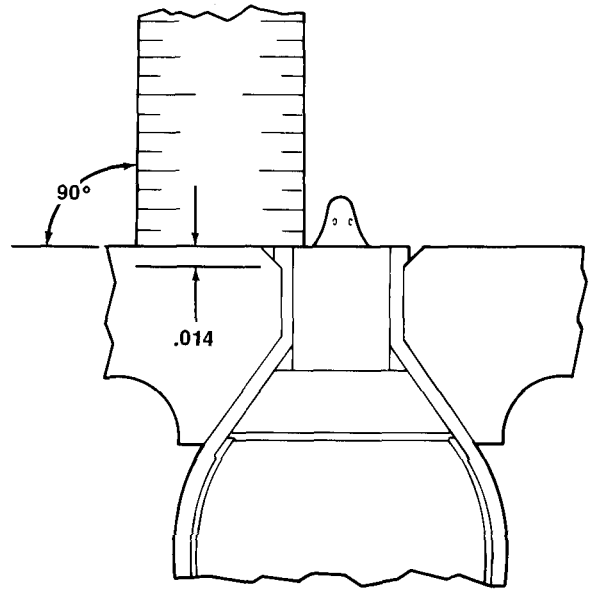
9. For trial cut, turn reamer (101) steadily without applying any downward force. Remove reamer, clean out chips, and observe bevel seat to see what portion of seat was cut.

10. Proceed with reaming and withdraw tool occasionally to observe progress.

11. Continue reaming until shoulder of spray tip is within +/- 0.014 inch of fire deck. Use gages (99 and 100) to measure distance.

12. Wash interior of injector tube (93).





4-38. CYLINDER HEAD REPAIR (Cont)

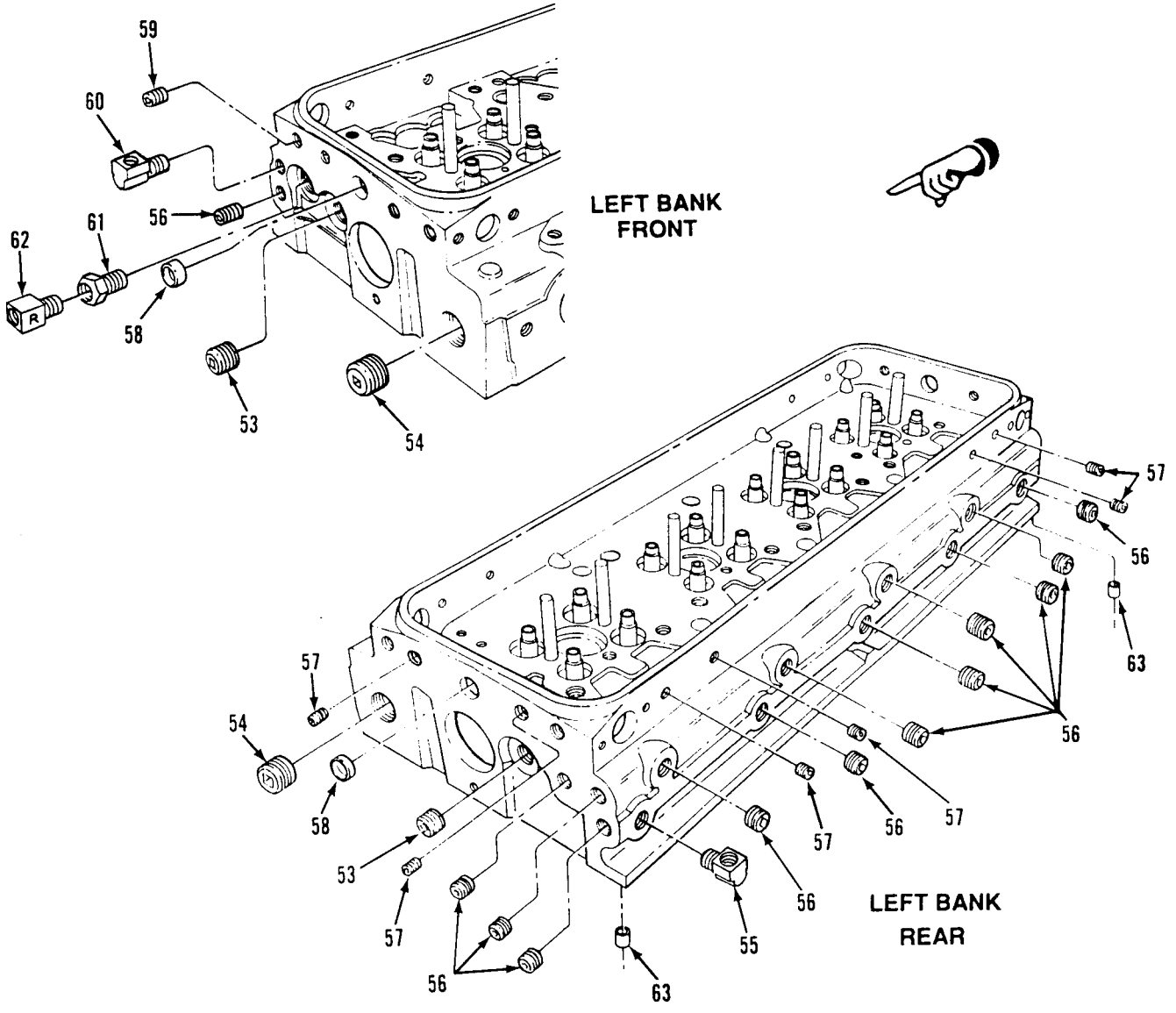
e. Assembly

(1) If necessary, install two bushings (63) in cylinder head bolt holes. Press flush to 0.02 inch below surface.

(2) Install adaptor bushing (61) and restrictive fitting (62) in front of left cylinder head.

(3) Install elbow (60) to front of left cylinder head or two elbows (60) to front of right cylinder head.

(4) If necessary, install threaded plugs (59) - two in right head or one in left head. Coat cup plug (58) with gasket cement and install in front of cylinder head.

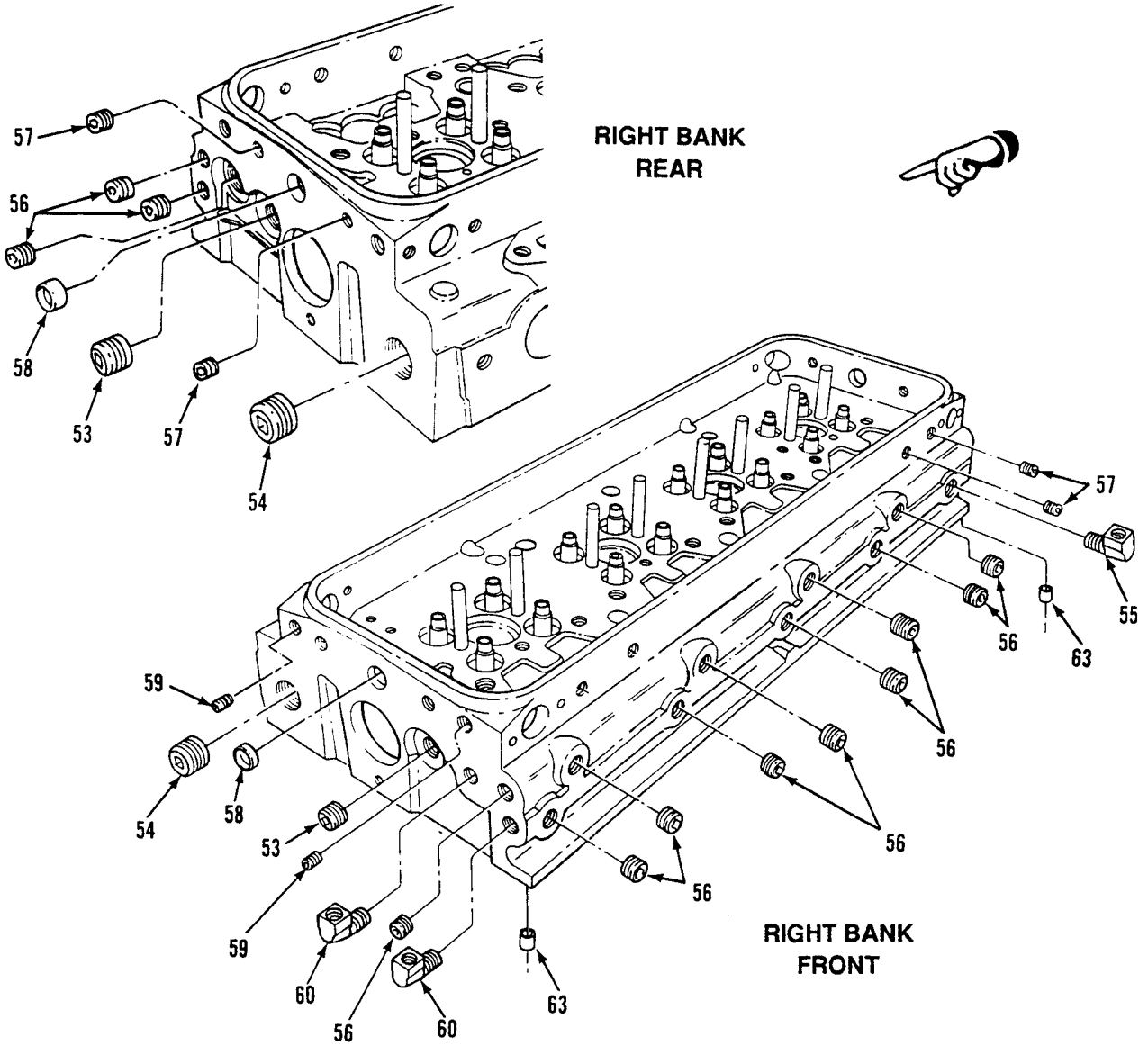


(5) If necessary, install six threaded plugs (57) in left cylinder head and four plugs in right cylinder head.

(6) Install twelve pipe plugs (56) in inboard side and ends of cylinder head.

(7) Install fuel spill crossover elbow (55) at inboard side of cylinder head.

(8) Install two each of pipe plugs (53 and 54) in ends of cylinder head. Plugs must be flush to 0.18 inch below surface.



4-38. CYLINDER HEAD REPAIR (Cont)

(9) Install fuse plug (52) in outboard side of cylinder head. Plug must be flush to 0.16 inch below surface.

(10) Coat cup plug (51) with gasket cement and install in rear of cylinder head.

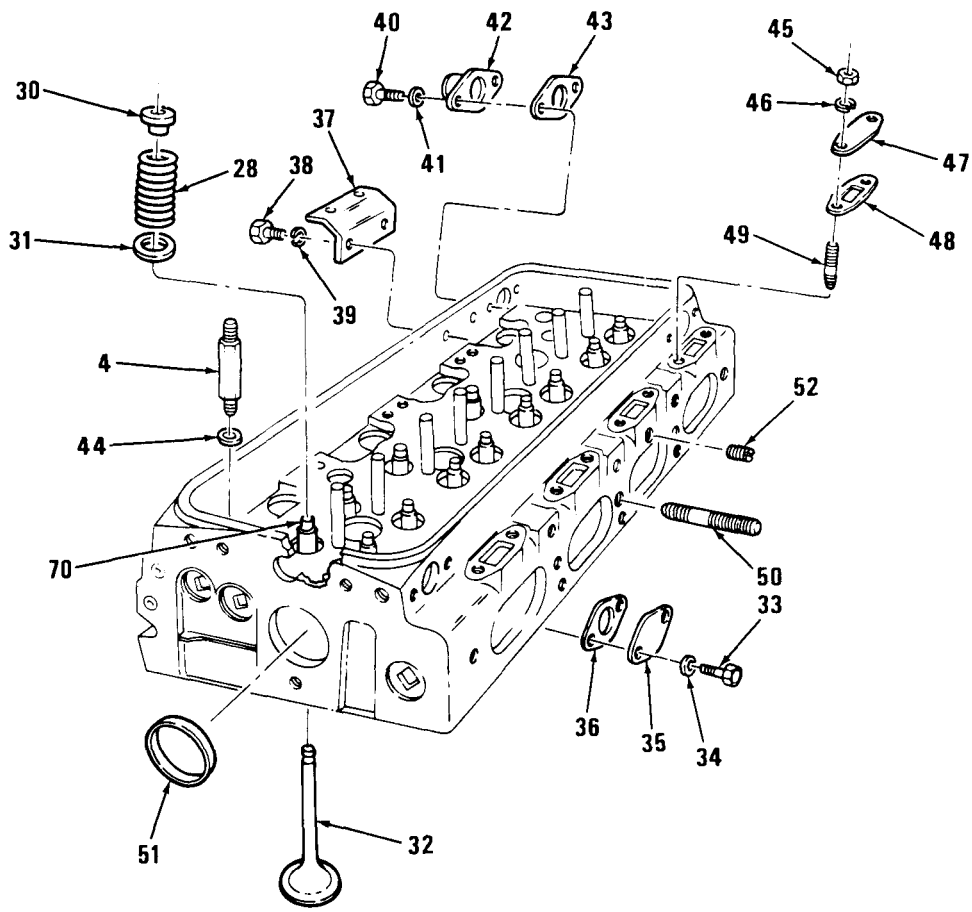
(11) Install five exhaust manifold studs (50) in outboard side of cylinder head. Torque studs to 25-40 lb-ft (34-54 N-m).

(12) Install eight water manifold studs (49) in cylinder head. Torque studs to 10-25 lb-ft (14-34 N-m).

(13) Install four gaskets (48), four cover plates (47), eight lockwashers (46), and eight nuts (45) to cylinder head. Torque nuts to 20-25 lb-ft (27-34 N-m).

(14) Install eight washers (44) and eight fuel connectors (4) to cylinder head. Torque connectors to 40-45 lb-ft (54-61 N-m).

(15) Install gasket (43), adaptor (42), two flat washers (41), and two bolts (40) to front inboard corner of cylinder head. Torque bolts to 7-9 lb-ft (10-12 N-m).



N O T E

- Model 7083-7395 contains four bolts (33), four flat washers (34), two cover plates (35), and two gaskets (36) per head and no cover plate on inboard rear corner.
- Model 7083-7398 contains six bolts (33), six flat washers (34), three cover plates (35), and three gaskets (36) per head.

(16) Install gaskets (36), cover plates (35), flat washers (34), and bolts (33) to remaining corners of cylinder head. Torque bolts to 7-9 lb-ft (10-12 N-m).

(17) If necessary, install support bracket (37), two lockwashers (39), and two bolts (38) to right cylinder head. Torque bolts to 30-35 lb-ft (41-47 N-m).

(18) Install sixteen exhaust valves as follows:

(a) Position cylinder head on its side. Lubricate valve stems with sulphurized oil (E.P. type) and slide valves (32) all the way into guides (70).

NOTE

With used valves, install valves in their original location.

(b) Install lower spring seat (31), valve spring (28), and upper spring seat (30) over valve stem.

CAUTION

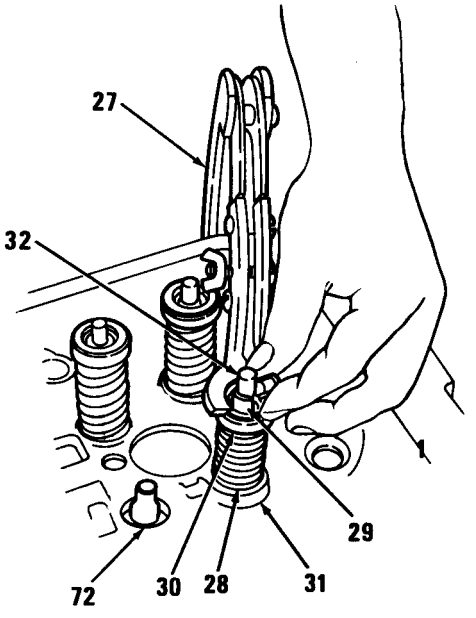
Avoid scoring valve stem with valve seat when compressing spring.

(c) Using valve spring compressor (27), compress valve spring (28) and install two piece tapered valve locks (29).

(d) Release pressure on valve spring compressor (27) and remove tool.

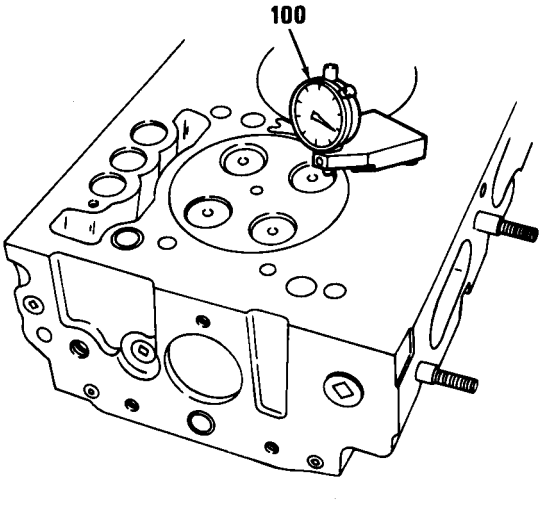
(e) Repeat steps (a) thru (d) for remaining valves.

(f) Support cylinder head on wood blocks at both ends (right side up). Give end of valve stems a sharp tap with soft-headed hammer to seat valve locks (29).



4-38. CYLINDER HEAD REPAIR (Cont)

(9) Using depth gage (100), measure exhaust valve protrusion beyond fire deck. If out of limits, regrind or replace insert.



NOTE

- Before installing cam followers, immerse in Cindol 1705 oil heated to 100°F-125°F (38°C-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 their original locations.

(19) Assemble lower spring seat (26), cam follower spring (24), upper spring seat (25), and locknut (15) on push rod (16).

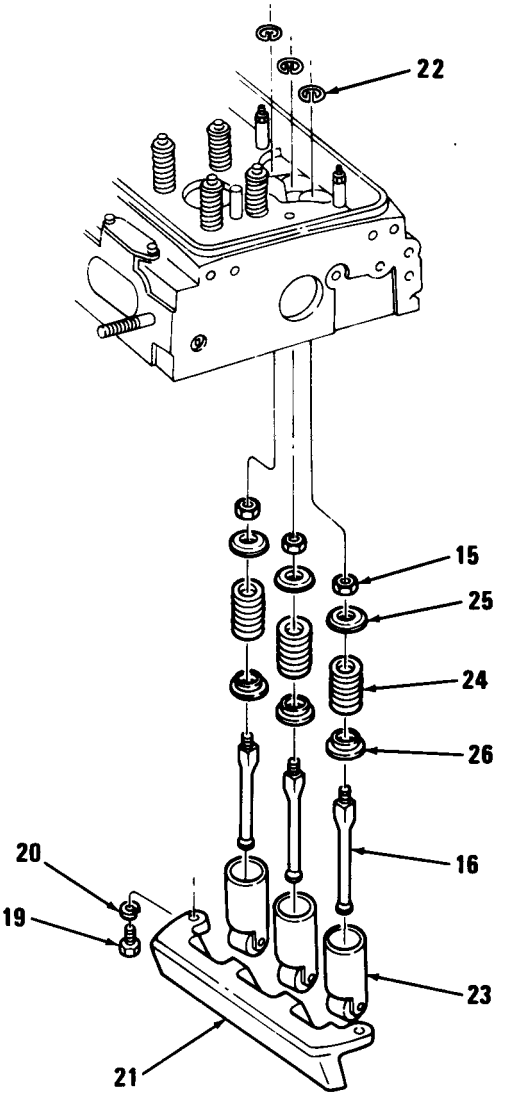
(20) Install twelve cam follower spring retainers (22) in cam follower bores from top of cylinder head.

(21) Slide twelve push rod (16) assemblies in position from bottom of cylinder head.

NOTE

Install cam followers with oil hole directed away from exhaust valves.

(22) Slide twelve cam followers (23) in position from bottom of cylinder head.



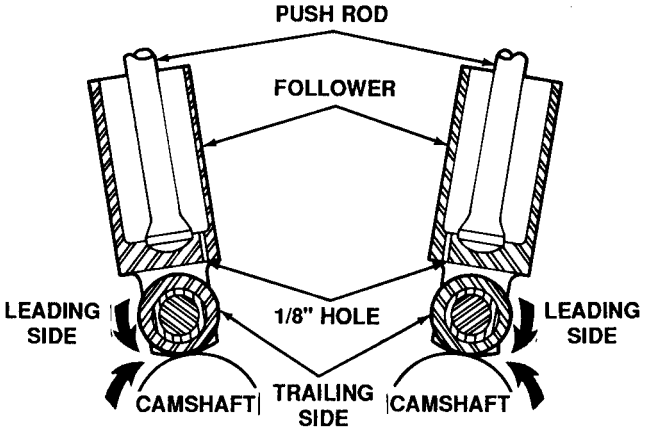
CAUTION

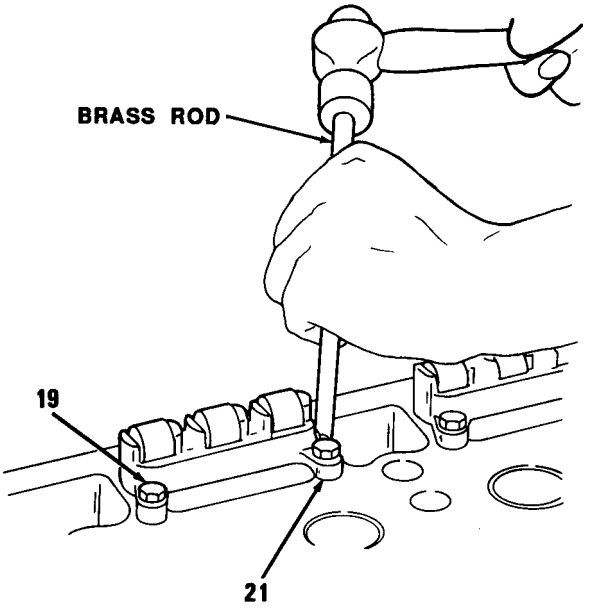
Insure cam follower is not cocked in cam follower bore. With cam follower guide installed, bottom of cam follower body must be flush with fire deck.

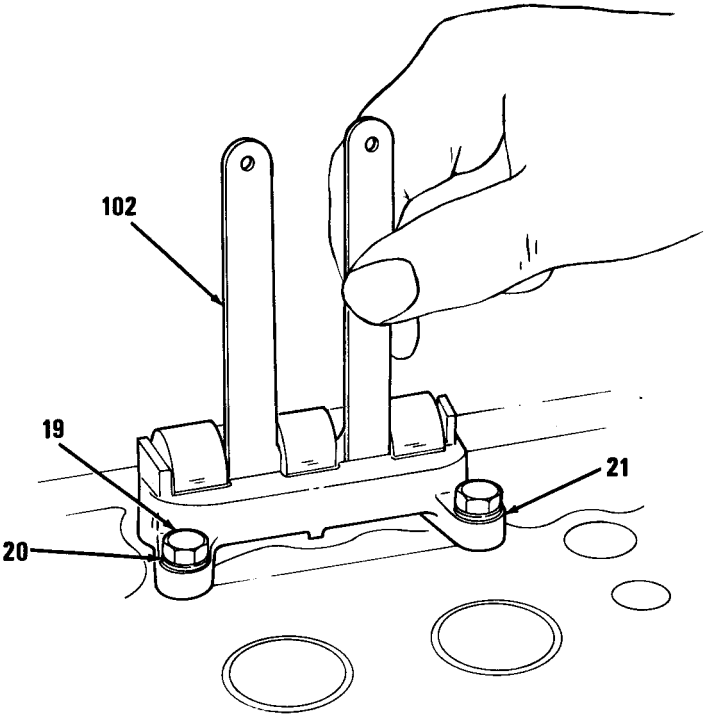
(23) . Attach four cam follower guides (21) to cylinder head using eight lockwashers (20) and eight bolts (19). Torque bolts to 12-15Ib-ft (16-20 N-m).

(24) Measure clearance between cam follower guide (21) and cam follower legs using feeler gages (102). Clearance must beat least 0.005 inch.

(25) If clearance is insufficient, slightly loosen bolts (19) and tap corners of guide (21) with brass rod. Retorque bolts with proper clearance.







4-38. CYLINDER HEAD REPAIR (Cont)

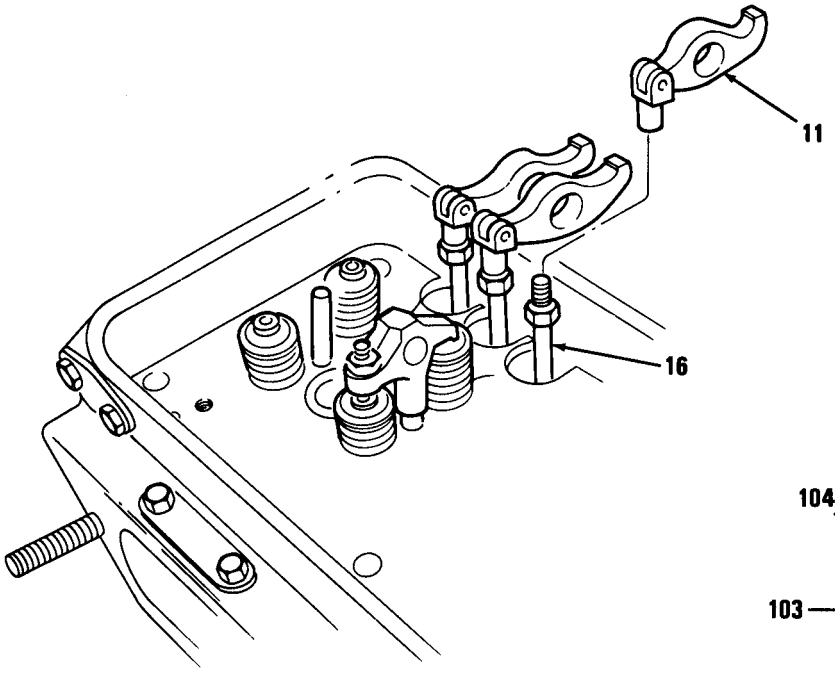
NOTE

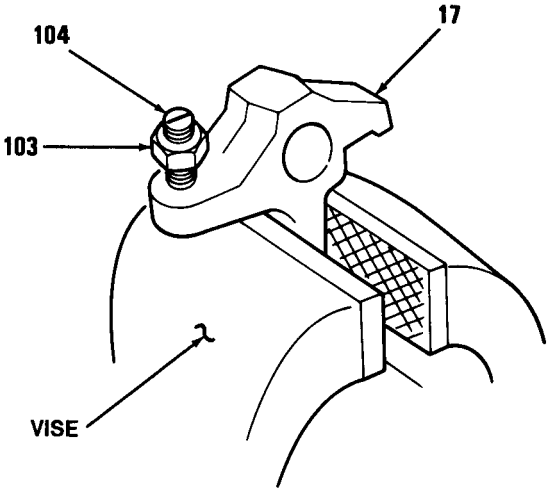
- Injector rocker arm is different than exhaust valve rocker arms. Boss for rocker arm shaft on right and left hand exhaust valve rocker arms is longer on one side. Extended boss of each rocker arm must face toward injector rocker arm.
- If a new rocker arm is installed, also install a new push rod.
- Refer to Chapter 8 for push rod locknut adjustment during engine tune-up.

(26) Thread each rocker arm (11) on its push rod (16) until end of push rod is flush with inner side of clevis yoke.

NOTE

Adjust valve bridges after cylinder head disassembly or extended engine operation.





(27) Adjust bridges as follows:

CAUTION

Do not loosen or tighten locknut with bridge installed in cylinder head. Bent bridge guide or rear valve stem may result.

(a) Place valve bridge (17) in a vise or bridge holding fixture and loosen locknut (103)on bridge adjusting screw (104).

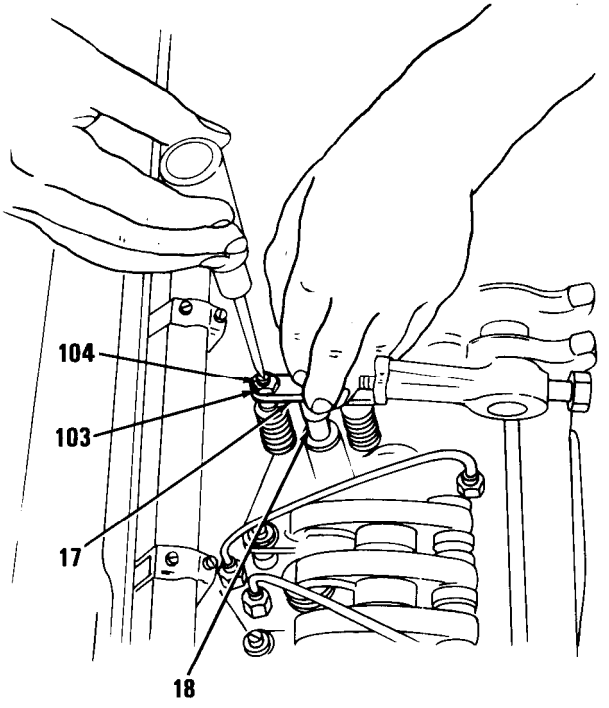
(b) Install valve bridge (17) on valve bridge guide (18).

(c) While firmly pressing straight down on pallet surface of valve bridge (17), turn adjusting screw (104) clockwise until it just touches valve stem. Then turn screw an additional 1/8 to 1/4 turn and tighten locknut (103) finger tight.

(d) Remove valve bridge (17) and place in a vise or holding fixture. Hold adjustment screw (104) from turning with screwdriver and torque locknut (103) on adjustment screw to 20-25 lb-ft (27-34 N-m).

(e) Lubricate valve bridge (17) and valve bridge guide (18) with engine oil and install bridge in original position.

(f) Place 0.0015 inch feeler gage under each end of valve bridge (17). When pressing down on pallet surface of valve bridge, both gages must be tight. If both feeler gages are not tight, readjust screw as outlined in steps (a) thru (e).



4-38. CYLINDER HEAD REPAIR (Cont)

CAUTION

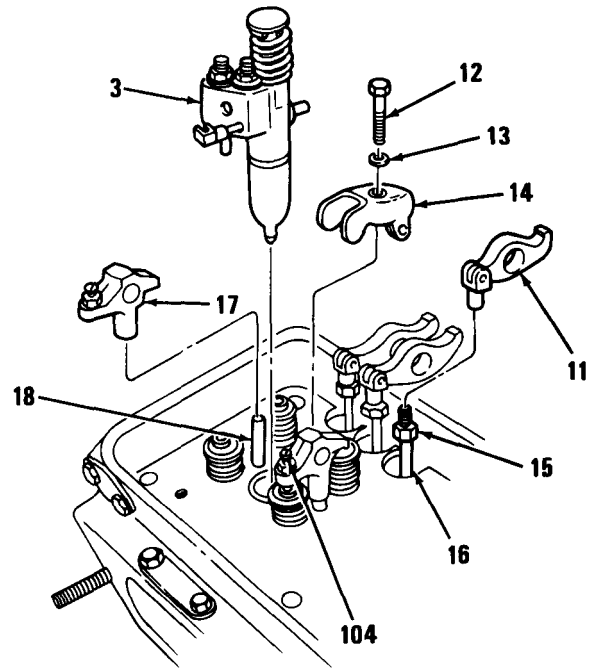
Seat slot in valve bridges over inboard exhaust valve stem to prevent valve damage.

(28) Position eight valve bridges (17) on bridge guides (18) with adjustment screw (104) toward outboard side of engine.

CAUTION

Insure injector hold down clamp does not contact exhaust valve spring.

(29) Install four fuel injectors (3) in cylinder head and secure in place with four clamps (14), four washers (13), and four bolts (12) putting curved side of washer against clamp. Torque bolts to 20-25 lb-ft (27-34 N-m).



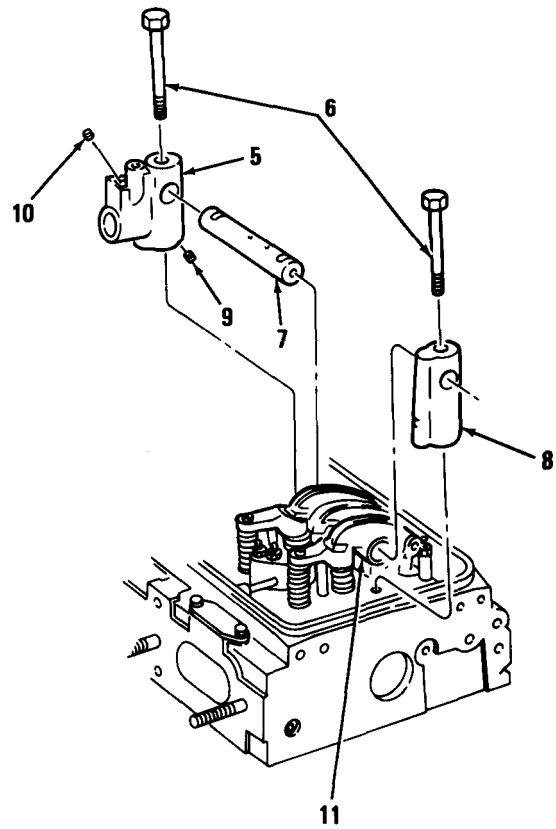
NOTE

Install special rocker arm shaft bracket (5) containing throttle delay housing at right bank No. 1 cylinder on model 7083-7395.

(30) If necessary, install check valve (9) and oil supply fitting (10) into throttle delay housing (5).

(31) Apply engine oil to rocker arm shafts (7) and slide shaft through rocker arms (11). Place rocker shaft bracket (8) over each end of shaft with finished face of bracket toward rocker arm.

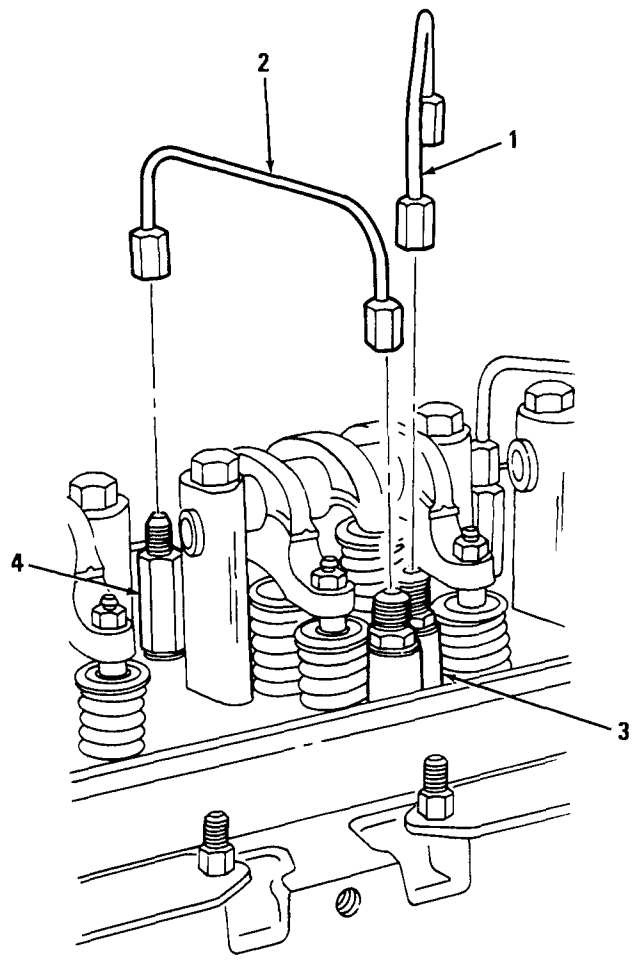
(32) Insert eight rocker arm bracket bolts (6) through eight brackets (8) and four shafts (7). Swing rocker arms, shafts, and brackets into position and thread bolts into cylinder head. Torque bolts to 90-100 lb-ft (122-136 N-m).



CAUTION

- Do not bend fuel lines and do not exceed specified torque on fuel line nuts. Excessive tightening will twist or fracture flared end of fuel line and result in leaks.
- Never reuse fuel lines regardless of their appearance. Always use new fuel lines. Reused fuel lines may not seal properly and result in leaks.

(33) Remove caps from fuel injectors (3) and connect four inlet fuel lines (1) and four outlet fuel lines (2) to injectors and fuel connectors (4). Using special socket, torque fuel lines to 130-160 lb-in (14.7-18.3 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

4-27 Install cylinder head
4-7 Install lifting brackets

4-39. OIL COOLER ASSEMBLY REPAIR

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

INITIAL SETUP

MODELS

■ All

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)
Cleaning solution (App C, Item 9)
Engine oil (App C, Item 16)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Air nozzle plate kit (App D, Item 7)
Universal puller (App B, Item 71)
Bar tool (App D, Item 4)
Spring tester (App B, Item 93)
Torque wrench (App B, Item 101
Plate kit (App D, Item 6)

EQUIPMENT CONDITION

Para	Description
3-6	Oil cooler removed

MANDATORY REPLACEMENT PARTS

39 Lockwashers (App F, Item 93)
5 Gaskets (App F, Item 51)
1 Gasket (App F, Item 52)
1 Gasket (App F, Item 57)
4 Seals (App F, Item 149)
1 Gasket (App F, Item 64)
2 Preformed packings (App F, Item 107)

a. Cleaning Prior to Disassembly

NOTE

Do not clean oil cooler if an engine or transmission failure caused metal particles (from worn or broken parts) to enter lubricating oil. Replace tube bundle.

(1) Clean engine oil section of oil cooler as follows:

(a) Remove two bolts (1) two lockwashers (2), flange (3) and gasket (4) from oil cooler assembly (5).

(b) Remove two bolts (6) and two lockwashers (2) securing flange (3), oil cooler bypass (7) assembly, and two gaskets (4) to oil cooler assembly (5).

(c) Remove metal tube (8), flange (3), and oil cooler bypass (7) assembly.

(d) Remove screw (9) securing retainer (1 O), spring (1 1), and valve (12) from oil cooler bypass (7).

(e) Install tube (8) with two flanges (3), three gaskets (4), and oil cooler bypass (7) to oil cooler assembly (5). Secure with four bolts (1 and 6) and four lockwashers (2).

(f) Install plate kit (13) blocking inlet from oil filter and outlet from oil cooler to filter. Secure two plates and two gaskets with eight bolts and eight lockwashers from kit.

(g) Attach air nozzle plate kit (14) to front cover at oil outlet to block. Secure plate and gasket with two bolts, two flat washers, two lockwashers and two nuts from kit.

WARNING

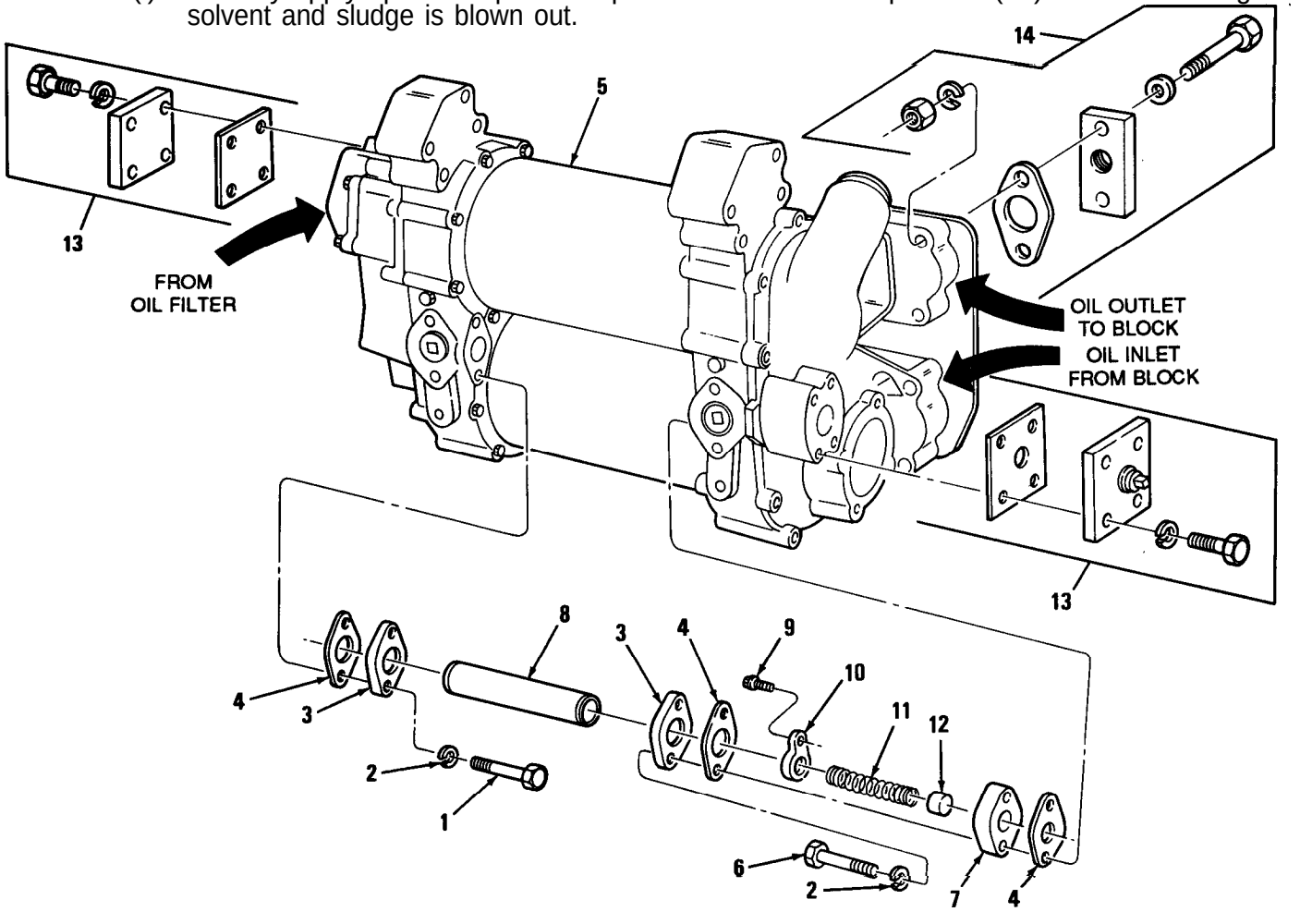
Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid Immediately.

(h) Place oil cooler assembly (5) in a barrel or suitable container with tube bundles laying horizontal. Fill oil cooler with cleaning solvent at oil inlet opening on front cover.

WARNING

Compressed air used for debris removal will not exceed 100 psi. Increase pressure gradually. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

(i) Gradually apply up to 100 psi of air pressure to air nozzle plate kit (14) until all cleaning solvent and sludge is blown out.



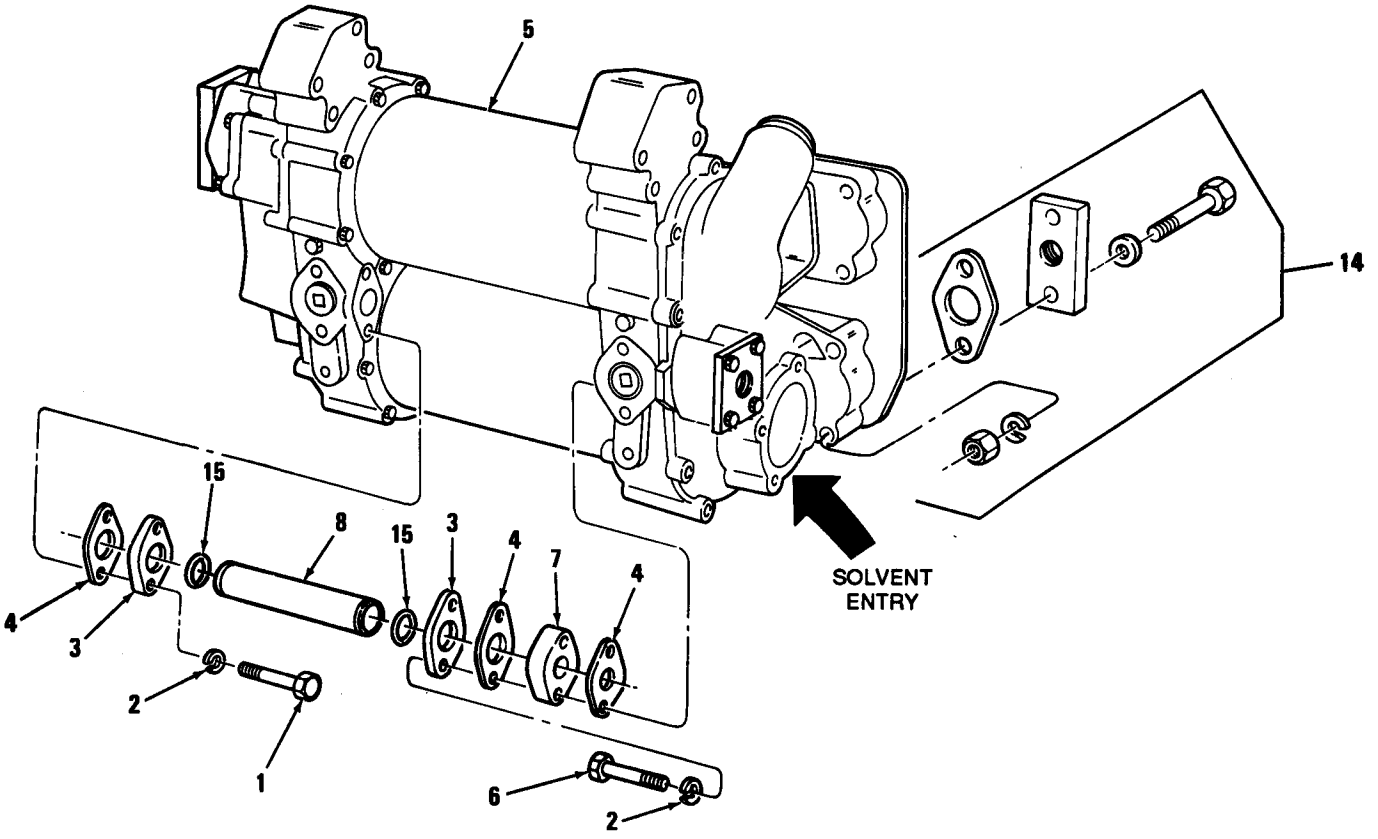
4-39. OIL COOLER ASSEMBLY REPAIR (Cont)

(j) Move air nozzle plate kit (14) to front cover of oil cooler assembly at oil inlet opening. Attach with two bolts, two lockwashers, two flat washers and two nuts from kit.

(k) Fill oil cooler assembly (5) with cleaning solvent, at front cover at oil outlet. Gradually apply up to 100 psi of air pressure to air nozzle plate kit (14) until all cleaning solvent and sludge is blown out.

(l) Repeat steps (g) thru (k) until cleaning solvent comes out clean.

(m) Remove four bolts (1 and 6) and four lockwashers (2) securing tube (8), two flanges(3), oil cooler bypass (7), and three gaskets (4) to oil cooler assembly (5). Remove two preformed packings (15) from flange (3) and tube (8).



(2) Clean transmission oil section of the oil cooler as follows:

(a) Attach plate kit (13), with air connection in tapped hole, at transmission outlet using four bolts, four flat washers, four lockwashers, and four nuts from kit.

WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frames or excessive heat. The flash point is 100°F-138°F (38 °C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

(b) Place oil cooler assembly (5) in a barrel or suitable container with tube bundles horizontal. Fill oil cooler with cleaning solvent at transmission inlet.

WARNING

Compressed air used for debris removal will not exceed 100 psi. Increase pressure gradually. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

(c) Gradually apply up to 100 psi of air pressure to plate kit (13) until all cleaning solvent and sludge is blown out.

(d) Move plate kit (13) to transmission inlet opening.

(e) Fill oil cooler assembly (5) with cleaning solvent at transmission outlet. Gradually apply up to 100 psi of air pressure to plate kit (13) until all cleaning solvent and sludge is blown out.

(f) Repeat steps (a) thru (e) until cleaning solvent comes out clean.

WARNING

Cleaning solution is an acid. Wear protective goggles and equipment. Avoid contact with skin, eyes and clothing. If contact Is made, flush with water and seek medical aid or Injury may result.

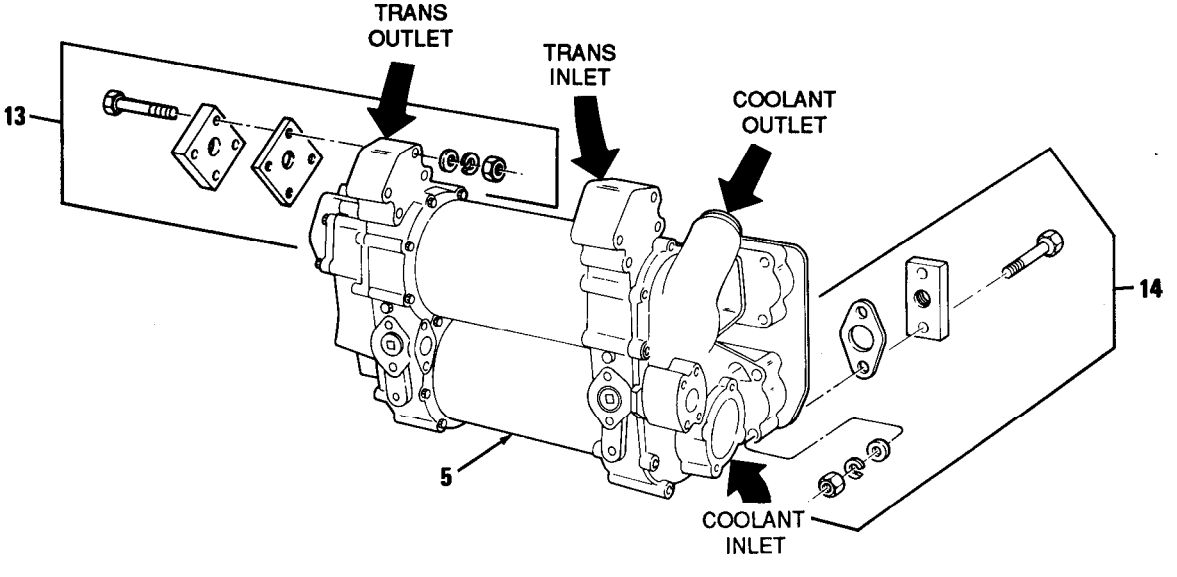
(3) Clean coolant side of oil cooler assembly (5) by circulating cleaning solution through coolant inlet and outlet passages of oil cooler assembly, front cover.

CAUTION

Cleaning solution is an acid. Thoroughly rinse oil coolant passages with water after using the cleaning solution, or corrosion of tube bundles may result.

(4) Remove oil cooler assembly (5) from barrel or container.

(5) Remove plate kit (13), and air nozzle plate kit (14) from front and rear of oil cooler assembly.



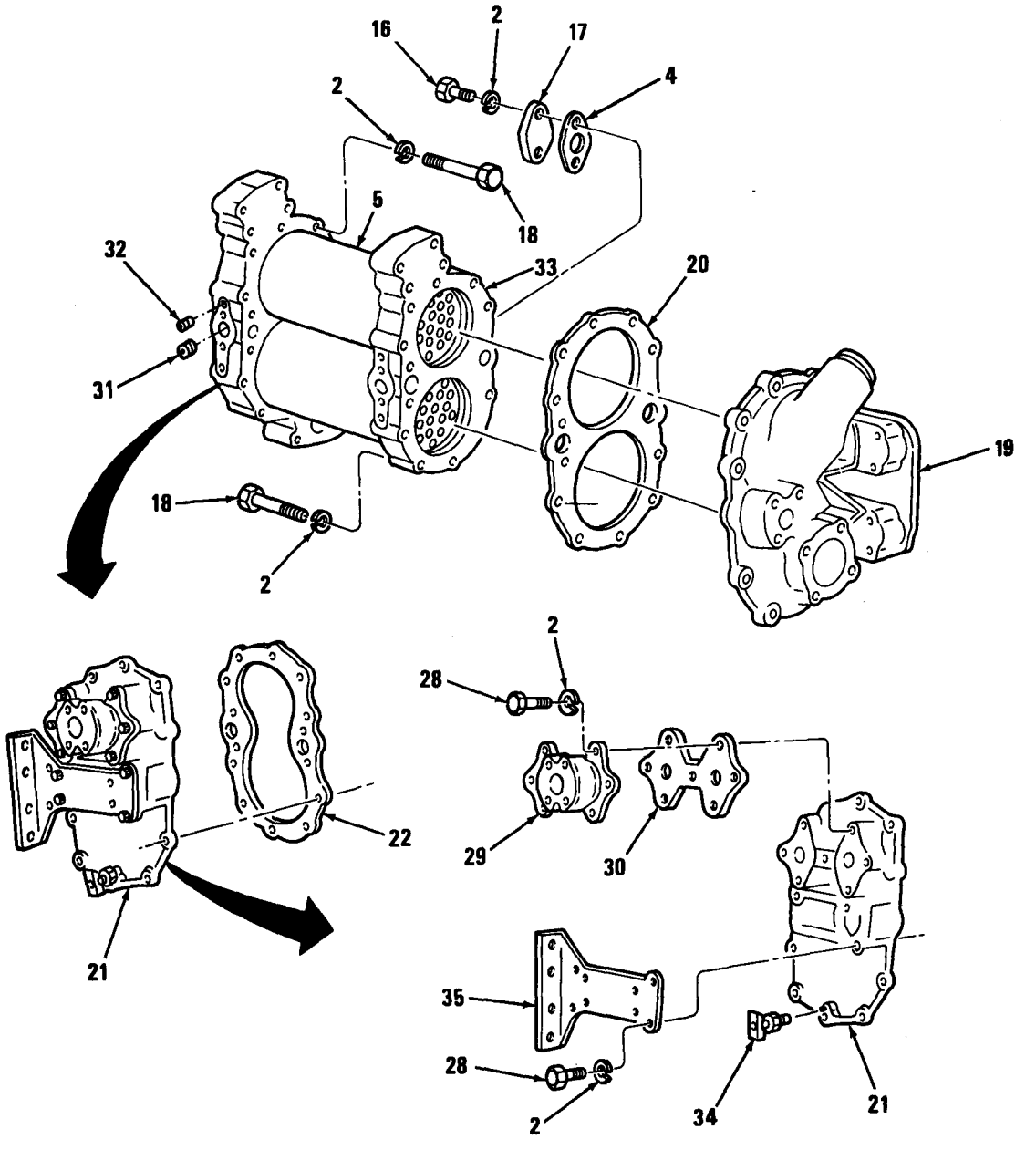
4-39. OIL COOLER ASSEMBLY REPAIR (Cont)

b. Disassembly

(1) Remove four bolts (16), four lockwashers (2), two access covers (17), and two gaskets (4) from oil cooler assembly (5). Discard lockwashers and gaskets.

(2) Remove ten bolts (18), ten lockwashers (2), front cover (19), and gasket (20) from oil cooler assembly (5). Discard lockwashers and gaskets.

(3) Remove ten bolts (18), ten lockwashers (2), rear cover (21), and gasket (22) from oil cooler assembly (5). Discard lockwashers and gaskets.

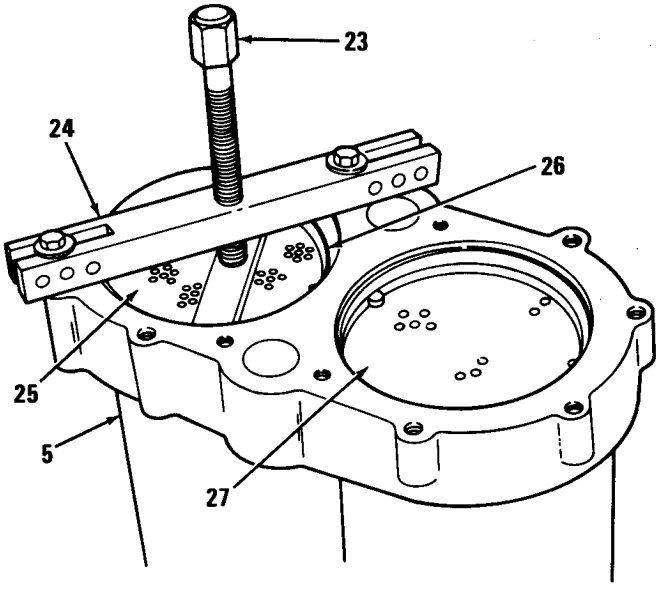


(4) Support one end of oil cooler assembly (5) on blocks. Attach puller (23) to oil cooler assembly and place bar tool (24) on upper tube bundle (25).

(5) Press upper tube bundle (25) down enough to remove seal (26) from oil cooler assembly (5). Remove puller (23) and bar tool (24). Discard seal.

(6) Invert oil cooler assembly (5). Using puller (23) and bar tool (24), press upper tube bundle (25) down enough to remove remaining seal (26) from oil cooler shell. Remove puller, bar tool, and upper tube bundle. Discard seal.

(7) Repeat steps (4, 5, and 6) for lower tube bundle (27).



(8) Remove seven bolts (28), seven lockwashers (2), oil return junction (29), and gasket (30) from rear cover (21). Remove oil return junction. Discard lockwasher and gasket.

(9) If necessary, remove two plugs (31) and seven plugs (32) from cooler shell (33).

(10) If necessary, remove drain cock (34) from rear cover (21).

(11) If necessary, remove four bolts (28), four lockwashers (2), and support bracket (35) from rear cover (21). Discard lockwashers.

c. CleanIng/inspection

(1) Inspect front and rear oil cover, access cover, and oil cooler shell for cracks or damage.

(2) Using spring tester (36), check valve spring (11) load. Replace spring if it compresses to a length of 0.813 inch (20.65 mm) with a 6.5 lb load.

(3) Inspect retainer for cracks, warps, or damage.

(4) Inspect tube bundles for damaged baffles, cracks, or plugged tubes.

d. Assembly

(1) If removed, install support bracket (35) to rear cover (21). Secure with four bolts (28) and four lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

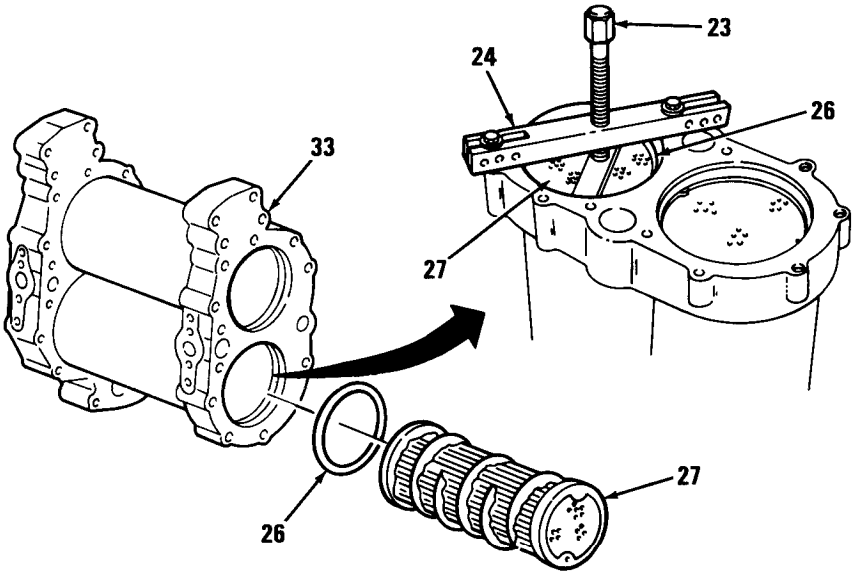
(2) If removed, install drain cock (34) into rear cover (21).

(3) Secure gasket (30) and oil return junction (29) to rear cover (21) with seven bolts (28) and seven lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

(4) If removed, install two plugs (31) and seven plugs (32) into oil cooler assembly (5). Tighten securely.

(5) Support one end of oil cooler assembly (5) on blocks.

4-39. OIL COOLER ASSEMBLY REPAIR (Cont)



CAUTION

Seal ring grooves must be free of burrs and foreign material or damage to seals will occur.

(6) Install first seal (26) into seal ring groove at bottom end of lower oil cooler shell (33). Lubricate seal with engine oil.

NOTE

Oil cooler shell and tube bundles are marked with numbers. Match and a line numbers when installing tube bundles.

(7) Insert lower tube bundle (27) into end of lower oil cooler shell (33) without any seal (26) in top seal ring groove. Attach puller (23) to oil cooler shell and place bar tool (24) on tube. Carefully press tube bundle past top seal ring groove.

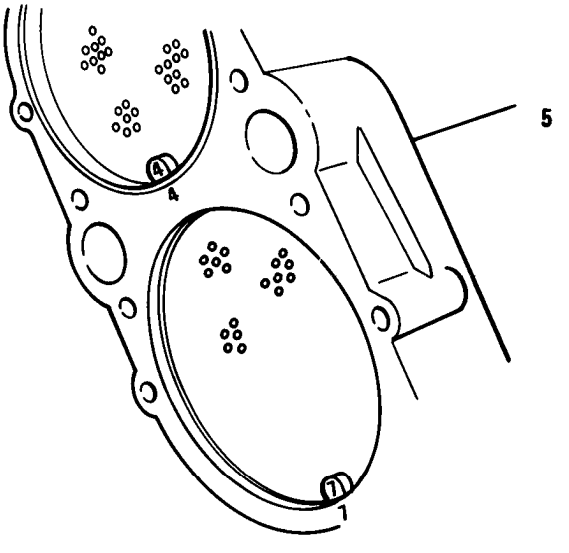
(8) Remove puller (23) and bar tool (24). Install seal (26) into top seal ring groove of oil cooler (5). Lubricate seal with engine oil.

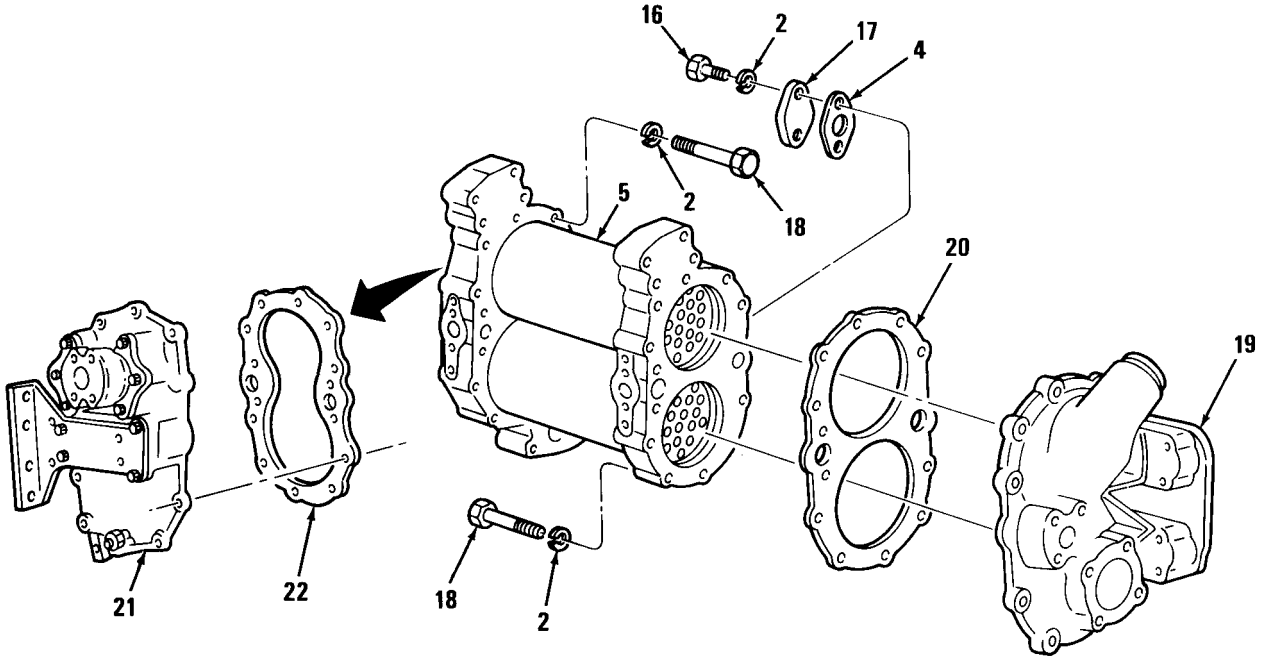
(9) Invert oil cooler shell (5). Using puller (23) and bar tool (24), carefully press tube bundle (27) until ends are flush with shell.

(10) Repeat steps (5) thru (9) for installing upper tube bundle (25).

(11) Install gasket (20) and front cover (19) to oil cooler assembly (5) securing with ten bolts (18) ten lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

(12) Install gasket (22) and rear cover (21) to oil cooler assembly (5) securing with ten bolts (20) and ten lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).





(13) Install two gaskets (4) and two access covers (17) to oil cooler assembly (5), securing with four bolts (16) and four lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

(14) Install two preformed packings (15) and two gaskets (4) on flange (3).

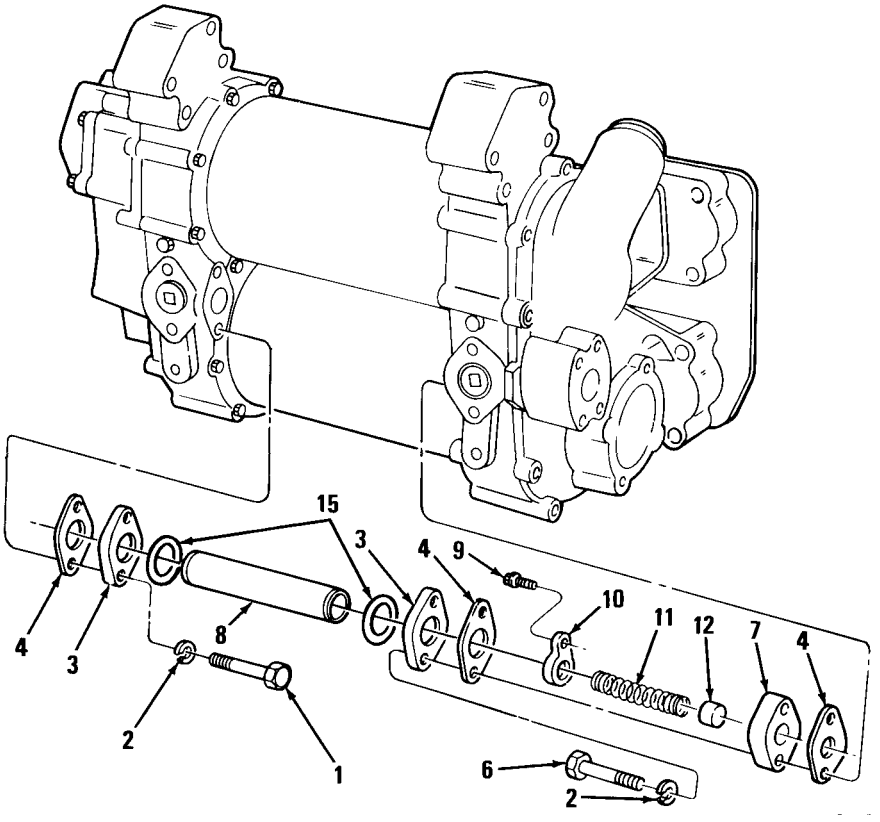
(15) Install valve (12), spring (11), and retainer (10) into oil cooler bypass (7). Secure retainer with screw (9). Tighten securely.

(16) Install oil cooler bypass (7), gasket (4), and tube (8) on oil cooler shell (5). Secure with two bolts (1 and 6) and four lockwashers (2). Torque bolts to 30-35 lb-ft (41-47 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-6 Oil Cooler Installed



4-40. FUEL INJECTOR ASSEMBLY REPAIR

This task covers: a. Disassembly b. Cleaning c. Inspection/Measurements d. Lapping e. Assembly f. Testing

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Injector holding fixture (App B, Item 20)
Spray tip remover (App B, Item 95)
Rack hole cleaning brush (App B, Hem 95)
Pin vise (App B, Item 95)
Spray tip wire (App B, Item 95)
Fuel hole cleaning brush (App B, Item 95)
Injector body reamer (App B, Item 95)
Nut reamer (App B, Item 95)
Nut reamer - tip hole (App B, Item 95)
Spring tester (App B, Item 93)
Needle valve height gage (App B, Item 35)
Torque wrench (App B, Item 101)
Lapping blocks (App B, Item 7)
Diesel test fixture (App B, Item 89)
Injector nut socket (App B, Item 95)
Injector tip concentricity gage and rack freeness tester (App B, Item 92)
Wire rotary brush (App B, Item 9)
Spray tip carbon remover (App B, Item 95)
Diesel fuel tester (App B, Item 91)
Micrometer (1-2") (App B, Item 65)
Micrometer (0-1") (App B, Item 65)

MANDATORY REPLACEMENT PARTS

1 Seal ring (App F, Item 141)
2 Gaskets (App F, Item 77)
1 Filter (App F, Item 14)

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)
Cleaning solvent (App C, Item 10)
Lapping compound (App C, Item 25)
Engine oil (App C, Item 16)

EQUIPMENT CONDITION

Para Description
4-38 Injectors removed (7083-7395 and 7083-7398)
5-37 Injectors removed (7083-7391, 7083-7396 and 7083-7399)

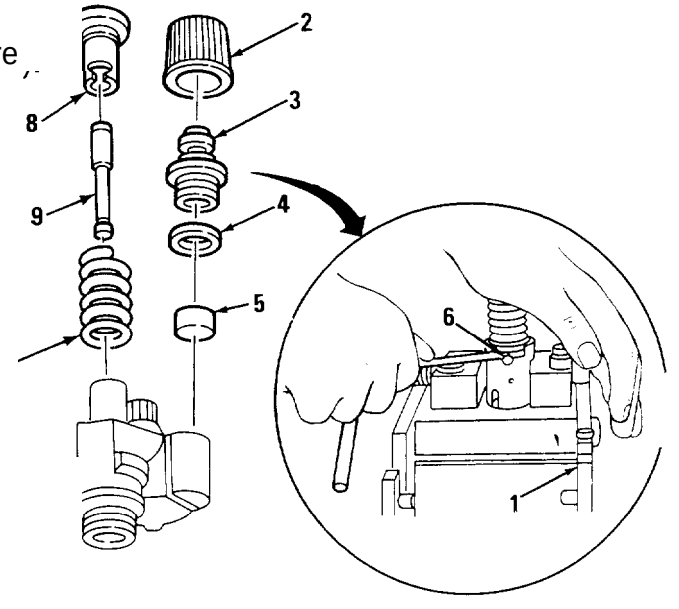
a. Disassembly

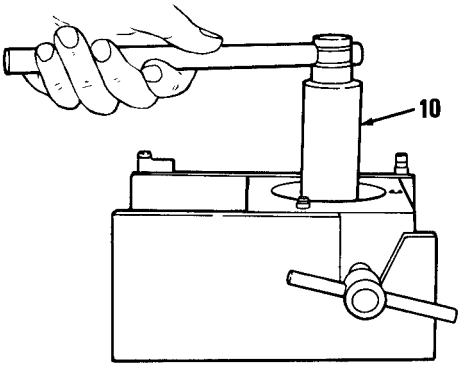
(1) Place injector upright in injector holding fixture.

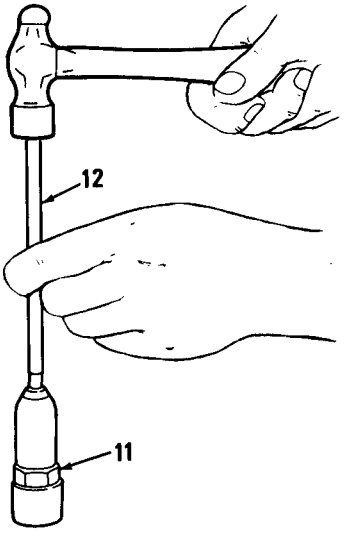
(2) Remove two shipping caps (2), two fuel line connectors (3), two gaskets (4), and fuel filter (5) from injector. Discard filter and gaskets.

(3) Rotate spring until spring end is clear of pin (6). Compress follower spring (7) by pressing down on follower (8). Then raise follower spring above stop pin (6) with a screwdriver and withdraw stop pin. Allow spring to rise gradually by releasing pressure on follower.

(4) Remove follower (8), follower spring (7), and plunger (9) from injector as an assembly.



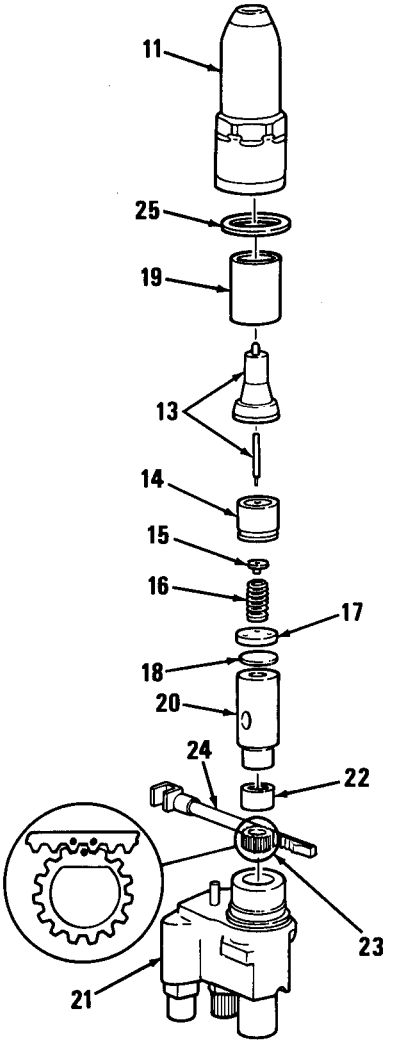




(5) Invert injector on fixture. Using injector nut socket (10), loosen nut (11) on injector body.

NOTE

- When injector has been in service for an extended period, spray tip may not be easily pushed from nut. In this case, support nut on a wood block and drive tip out with special tool (12).
- Do not dislodge spray tip and valve parts during injector nut removal.



(6) Lift injector nut (11) straight up.

(7) Remove spray tip assembly (13), spring cage (14), spring seat (15), valve spring (16), check valve cage (17), and check valve (18).

(8) Remove spill deflector (19).

(9) Lift bushing (20) straight out of injector body (21).

(10) Remove injector body from fixture. Turn body upside down and catch gear retainer (22) and gear (23) in hand as they fall from body.

(11) Remove injector control rack (24) from body (21).

(12) Remove seal ring (25) from body. Discard seal ring.

4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

b. Cleaning

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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).**

Wash all parts with cleaning solvent and dry with clean, filtered compressed air. Use lint free towels to wipe off parts. Clean out passages, drilled holes and slots in all injector parts.

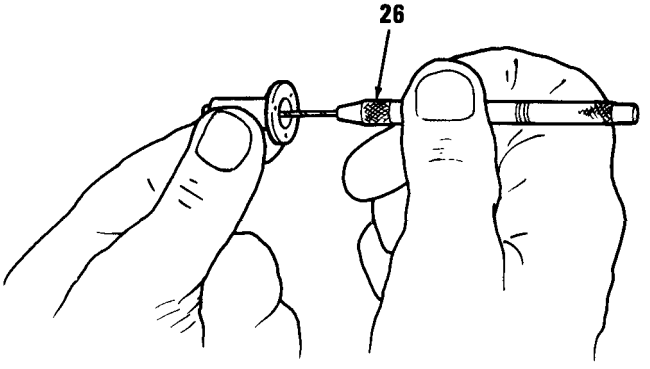
(1) Injector spray tip

(a) Soak spray tip in cleaning solvent to loosen carbon.

CAUTION

Do not contact needle valve seat with carbon removing tool during spray tip insertion or-valve seat could be damaged.

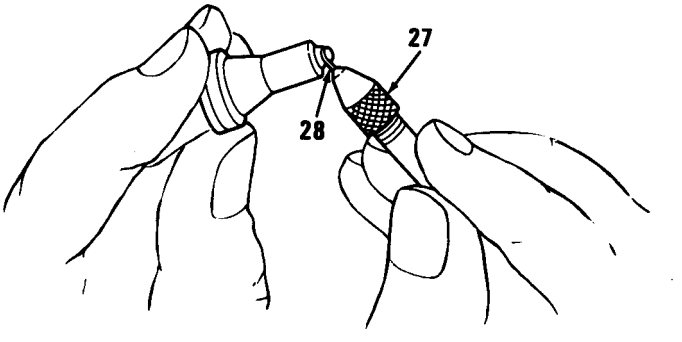
(b) Insert carbon removing tool (26) and clean.



(c) Clean spray tip orifices with pin vise (27) and cleaning wire (28).

CAUTION

Do not buff spray tip area excessively. Do not use a steel wire buffing wheel or spray tip holes may be distorted.

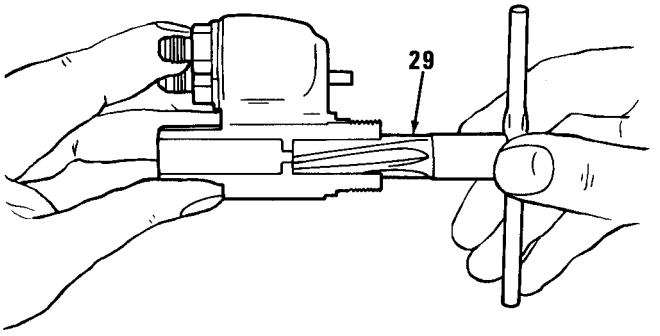


(d) Clean exterior of spray tip with brass wire buffing wheel.

(2) Injector body

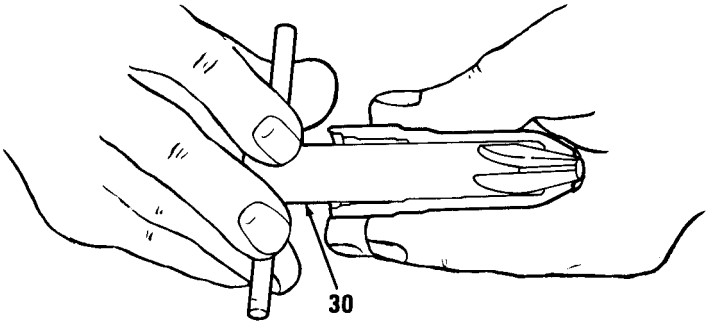
(a) Clean and brush all passages in injector body using fuel hole cleaning brush and rack hole cleaning brush.

(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

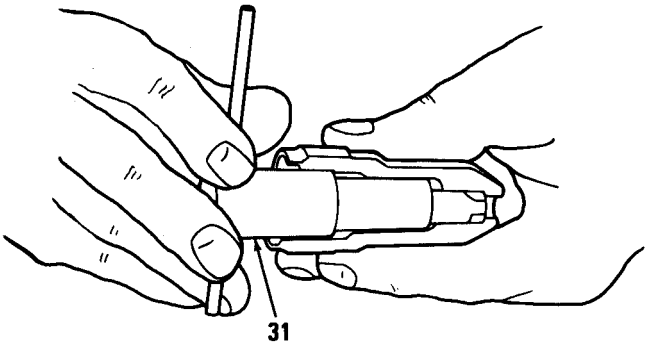
(a) Using injector nut reamer (30), turn clockwise to remove carbon deposits from lower end of nut.



CAUTION

Carbon deposits on spray tip seating surfaces of injector nut will cause poor seating and may result in fuel leakage around spray tip.

(b) Using injector nut reamer (31), turn clockwise to remove carbon deposits from bottom of tip seat 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 nut in clean solvent and blow dry.

(d) If necessary, repeat steps (a thru c) until all carbon is removed.

4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

(4) Injector plunger and bushing

CAUTION

Make sure 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 they are matched sets. Keep parts of each injector assembly together.

Wash with cleaning solvent and dry with compressed air.

c. Inspection/Measurements

(1) Follower

(a) Measure distance between top of follower (8) and slot. Dimension must be 1.645 to 1.649 inches.

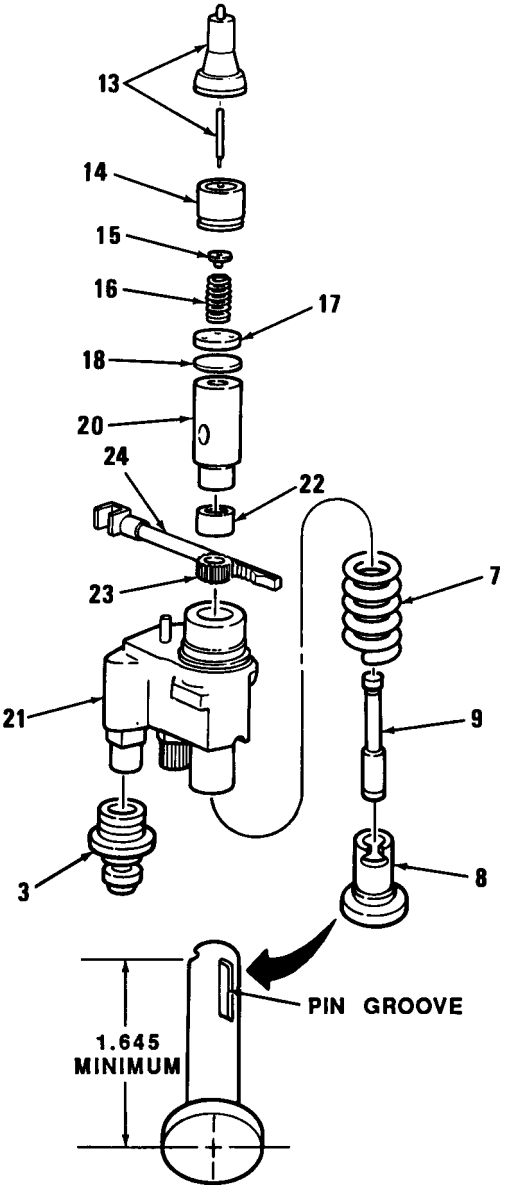
(b) Inspect stop pin groove in side of follower to make sure it is smooth and not damaged. Do not reuse follower if there is more than 0.002 inch wear on top or there is other visual damage or wear.

(2) Follower spring

(a) Examine outside diameter of follower spring coils (7) for wear caused by rocker arms contacting coils. Replace if worn.

(b) Inspect follower springs for rust, pitting, nicks, or notches in coils, broken coils, broken coil ends, and notches under coil ends.

(c) 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 (21) threads, bushing seating surface, and fuel connector gasket sealing surfaces for damage. Inspect rack hole, body seal ring sealing surface, clamp radius, and dowel pin. Replace if necessary.

(4) Fuel connectors

Check condition of jumper line sealing surfaces, copper gasket sealing surfaces, and fuel connector (3) threads. Replace if necessary.

(5) Control rack

(a) Check injector control rack (24) for straightness, rack teeth for damage, and notch in clevis for wear. Check rack for nicks, burrs, rust, and hardness.

(b) Notch in clevis should be 0.3125 to 0.3145 inch.

(6) Gear and gear retainer

Inspect gear (23) and gear retainer (22) 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. Observe condition of dowel pin. Check for corrosion and varnish. Replace if necessary.

(8) Plunger

Check plunger (9) for 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 (18) and check valve cage (17). Minimum cage thickness is 0.163 inch and minimum check valve thickness is 0.022 inch.

(10) Valve spring

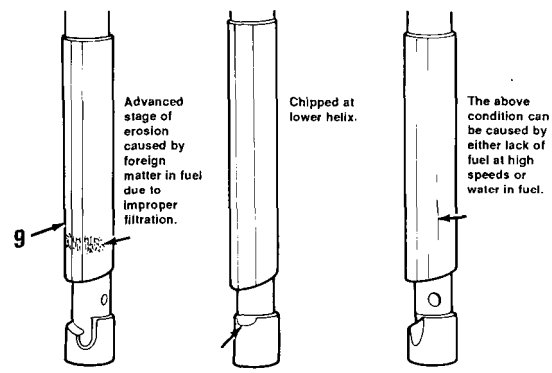
Check valve spring (16) for wear on coil ends, broken coil ends, and notches under coil ends. Check for corrosion, nicks, and erosion on inside at armroximatety 1 1/2 coils from end. Replace if necessary.

(11) Spring seat

Check spring seat (15) surfaces for wear. Replace if necessary.

(12) Spring cage

(a) Inspect spring gage (14) for cracks, corrosion or varnish, and scratches on lapped sealing surfaces. Inspect spring set surface and needle valve seating surface for wear.



(b) Measure thickness of spring cage. Minimum thickness is 0.602 inch.

4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

(13) Spray tip

(a) Check spray tip (33) 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 reuse if there is scale, cracks, or enlarged spray holes.

(b) Measure thickness of spray tip shoulder. Minimum thickness is 0.199 inch.

(14) Needle valve

Check spray tip needle valve for erosion at seat shoulder, scratches, and overheating.

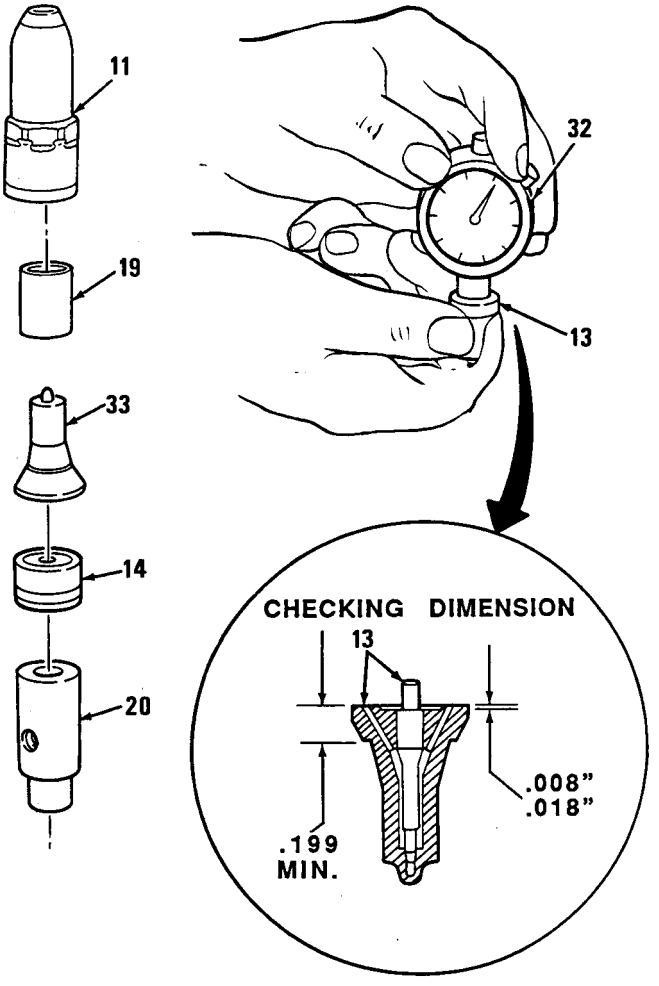
(15) Needle valve lift

Using needle valve height gage (32), measure needle valve lift as follows:

(a) Zero indicator by placing bottom surface of plunger assembly on a flat surface and zero indicator dial.

(b) Place spray tip and needle valve assembly (13) tight against bottom of gage with quill of needle valve in hole in plunger.

(c) While holding spray tip and needle valve assembly (13) tight against gage (32), read needle valve lift indicator. Lift should be 0.008 to 0.018 inch. If tip assembly exceeds 0.018 inch, replace it. If less than 0.008 inch, inspect tip assembly for foreign material between needle valve and tip seat.



(16) Nut

Check nut (11) for damaged threads, condition of seal ring seating area, and condition of spray tip seating area. Check spray tip hole for corrosion.

(17) Spill deflector

Inspect ends of deflector (19) 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 (33). 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 (34) with compressed air. Do not use cloth or any other-material for this purpose.

(2) Spread 600 grit dry lapping powder on lapping block (34).

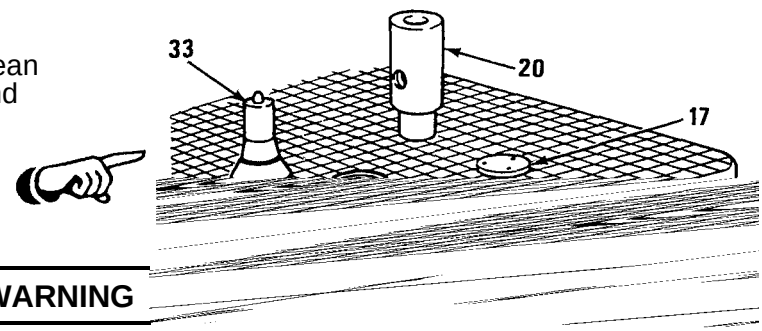
CAUTION

Ensure no lapping compound is accidently 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 (34). Using 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 a clean piece of tissue placed on flat surface and clean lapping powder 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 (34). Apply 600 grit lapping powder to block and repeat steps (3) and (6).

(8) Place part on third block (34). Do not apply lapping powder to this block and repeat steps (3) and (6).

4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

e. Assembly

(1) Secure injector body (21) infolding fixture(1).

(2) install filter (5) in inlet port of body (located above injector rack). Position filter with dimple end down and slotted end up. No filter is required at outlet port.

(3) Install two gaskets (4) and two fuel connectors (3) to injector body. Lubricate connector threads with engine oil before installation. Torque connectors to 70 lb-ft (95 N-m) (blued components) or to 62 lb-ft (84 N-m) (mixed and nonblued components).

(4) Install two shipping caps (2) to connectors (3) to prevent dirt from entering injector.

(5) Support injector body assembly, bottom end up, in holding fixture.

(6) Install seal ring (25) onto shoulder of injector body (21).

(7) Slide injector control rack (24) into injector body (21).

(8) Look into injector body bore and move control rack (24) until you see two drill marks on rack. Hold rack in this position.

(9) Place gear (23) in injector body so that marked tooth on gear is engaged between two marked teeth on control rack (24).

(10) Place gear retainer (22) on top of gear (23).

(11) Aline locating pin in bushing (20) with slot in injector body (21). Slide end of bushing into place.

(12) Install spill deflector (19) over barrel of bushing (20).

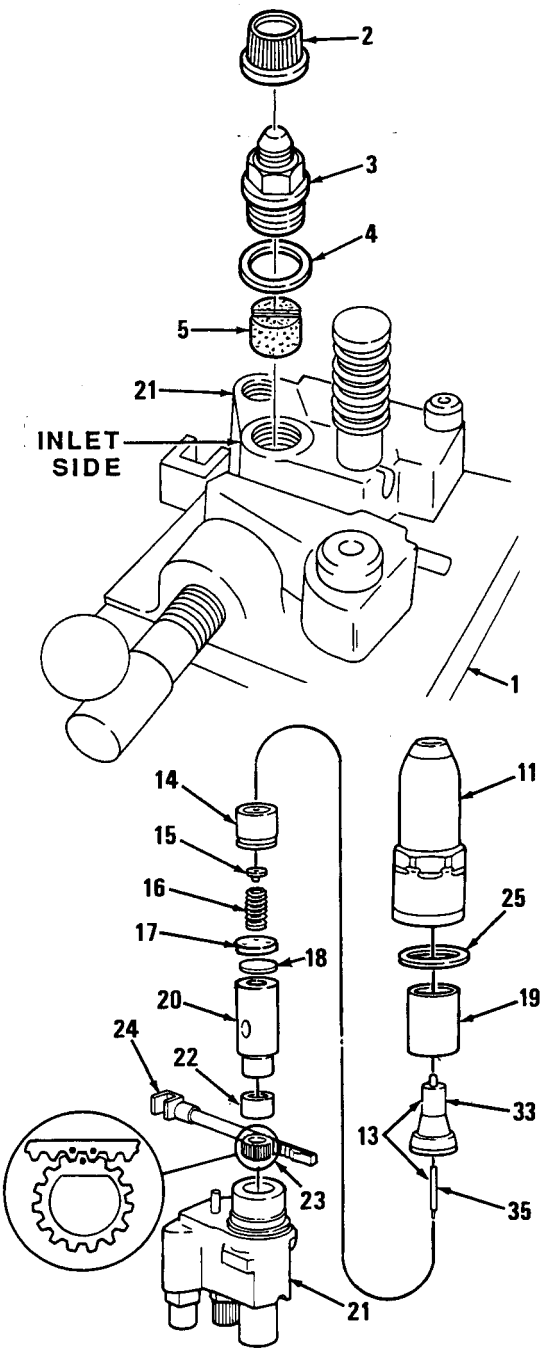
NOTE

Perform needle valve opening pressure test [ref. step f.(5)] at this time before completing assembly.

(13) Place check valve (18) centrally on top of bushing (20).

(14) Place check valve cage (17), flat side up, over check valve (18) and against bushing (20). Check valve cage must not rest on check valve.

(15) Insert spring seat (15) in valve spring (16). Install assembly on check valve cage (17) with seat up.



(16) Place spring cage (14) over spring seat (15) and spring (16).

(17) Insert needle valve (35) into spray tip (33) with tapered end down. Place spray tip assembly (13) on top of spring cage (14) with quill end of needle valve in hole in spring cage.

(18) Lubricate threads on injector nut (11) with engine oil and carefully thread nut on injector body. Tighten nut as tight as possible by hand.

(19) Turn injector over and push rack (24) all way in.

(20) Place follower spring (7) on injector body (21).

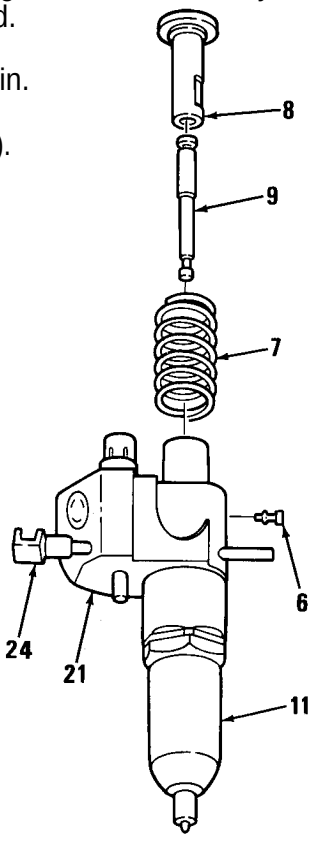
(21) Slide head of plunger (9) into follower (8).

(22) Aline slot in follower (8) with stop pin hole in injector body (21).

(23) Aline flat side of plunger (9) with flat in gear.

(24) Insert free end of plunger (9) in injector body (21).

(25) Place stop pin (6) in slot on injector body (21). Rotate spring (7) so flat part of end coil is clear of pin (6). Then push pin in place while pressing down on follower (8). Once in place, rotate spring (7) so flat on end coil is positioned over pin.

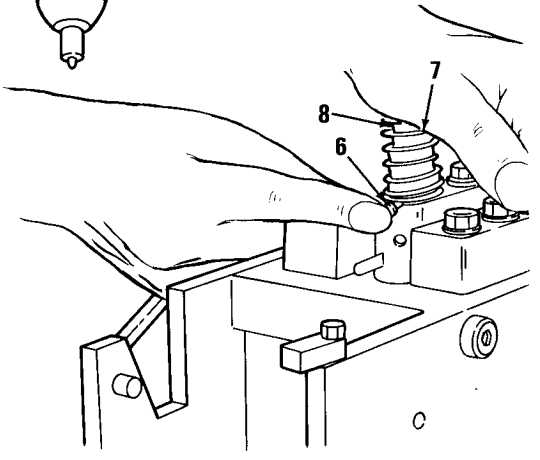


CAUTION

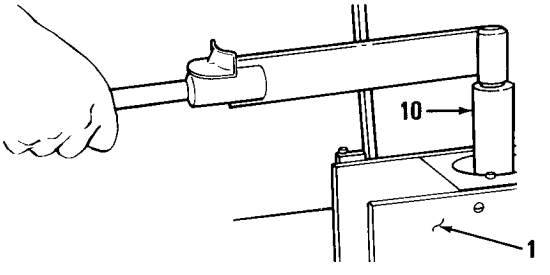
Do not exceed specified torque. Otherwise, nut may be stretched and result in improper sealing of lapped surfaces in overhauled injector.

NOTE

After assembling fuel injector, always check area between nut and body. If seal is still visible after nut is torqued, try another nut and seal.



(26) With injector in holding fixture (1) and using injector nut socket (10), torque injector nut (11) to 80 lb-ft (108 N-m) for blued components or 50 lb-ft (68 N-m) for nonblued components or 65 lb-ft (88 N-m) for mixed components.



4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

f. Testing

NOTE

Injectors that were disassembled must pass all tests outlined below prior to installation in engine. Injectors which were removed from engine should be checked prior to any disassembly to avoid unnecessary repair.

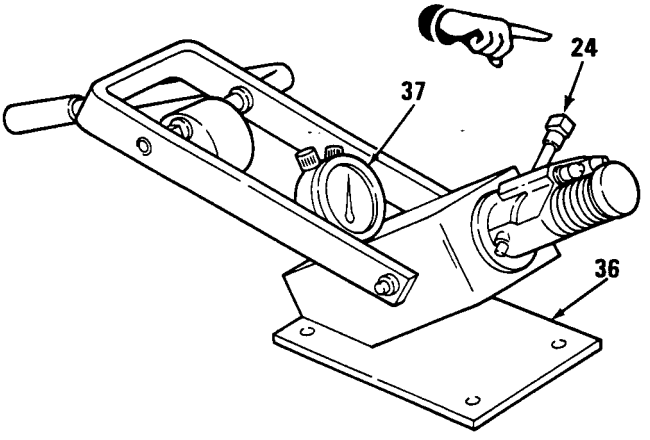
(1) Injector control rack freeness

(a) Place injector in fixture (36).

(b) Hold injector control rack (24) in NO FUEL position. (Rack all the way extended).

(c) Using handle, depress follower to bottom of its stroke.

(d) Slowly release pressure on handle while moving control rack in and out until follower reaches top of its travel. Injector passes test if rack falls freely.



(e) If rack binds, loosen injector nut, turn tip, and then torque nut to 80 lb-ft (108 N-m) for blued components, 50 lb-ft (68 N-m) for nonblued components, or 65 lb-ft (88 N-m) for mixed components. Loosen and torque nut a couple of 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 fixture (36).

(b) Adjust dial indicator (37) 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 fixture. Loosen injector nut, center spray tip, and retorque nut. Recheck sprav tip concentricity. If, after several attempts, spray tip cannot be positioned satisfactorily, replace injector nut.

(3) High pressure leak test

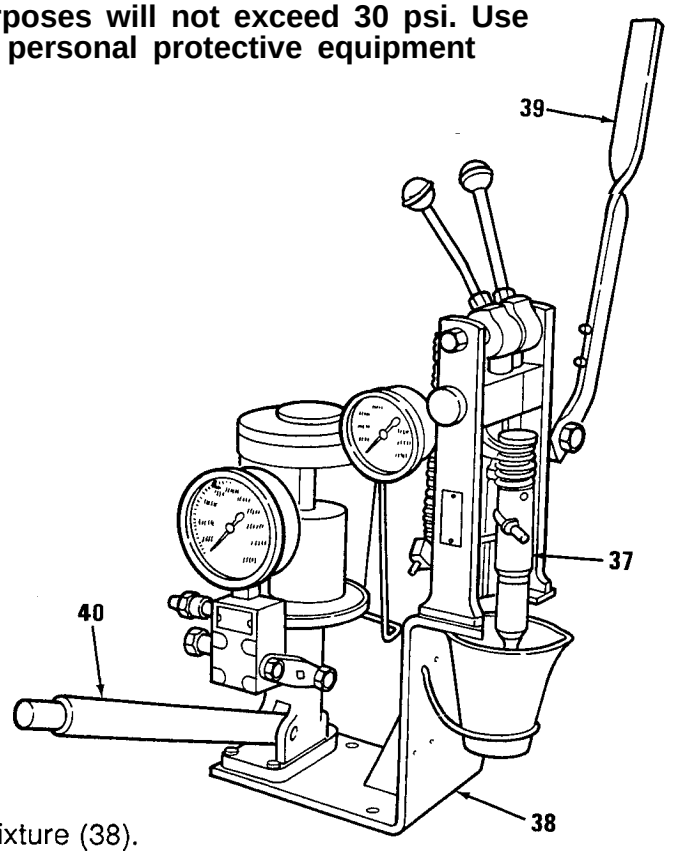
WARNING

Fuel injector may contain residual fuel oil and can emit a high pressure jet of fuel oil from spray tip when bumped. Always hold injector so that tip will spray away from skin. Fuel oil which enters blood stream may cause serious infection.

(a) Place fuel injector (37) in injector test fixture (38).

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).



(b) Thoroughly dry injector with compressed air.

(c) Check fuel connections for leaks. If leaks have occurred, tighten connections, dry injector, and recheck.

(d) With injector rack in FULL FUEL position (fully depressed) and popping handle (39) locked in downward position, operate pump handle (40) 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 gaskets, injector body plugs, and injector nut seal ring.

(4) Spray pattern

(a) Place fuel injector (37) in injector test fixture (38).

■ (b) Place injector rack in FULL FUEL position (fully depressed).

(c) Operate pump handle (40) to build up slight pressure (10 psi minimum) in system.

(d) Pop fuel injector several times with popping handle (39). Observe spray pattern emitted from fuel injector spray tip. If spray tip does not produce uniform pattern, dirty or damaged spray tip orifice is indicated.

4-40. FUEL INJECTOR ASSEMBLY REPAIR (Cont)

NOTE

If needle valve opening pressure check was previously preformed, bypass this step.

(5) Needle Valve Opening Pressure

(a) Operate pump handle (40) on diesel fuel injector nozzle tester (41) until a clear flow of test oil comes out of mounting pedestal (42).

(b) Place check valve (18) centrally on pedestal (42).

(c) Place check valve cage (17), flat side up, and check valve (18) on pedestal (42) with check valve in recess of check valve cage.

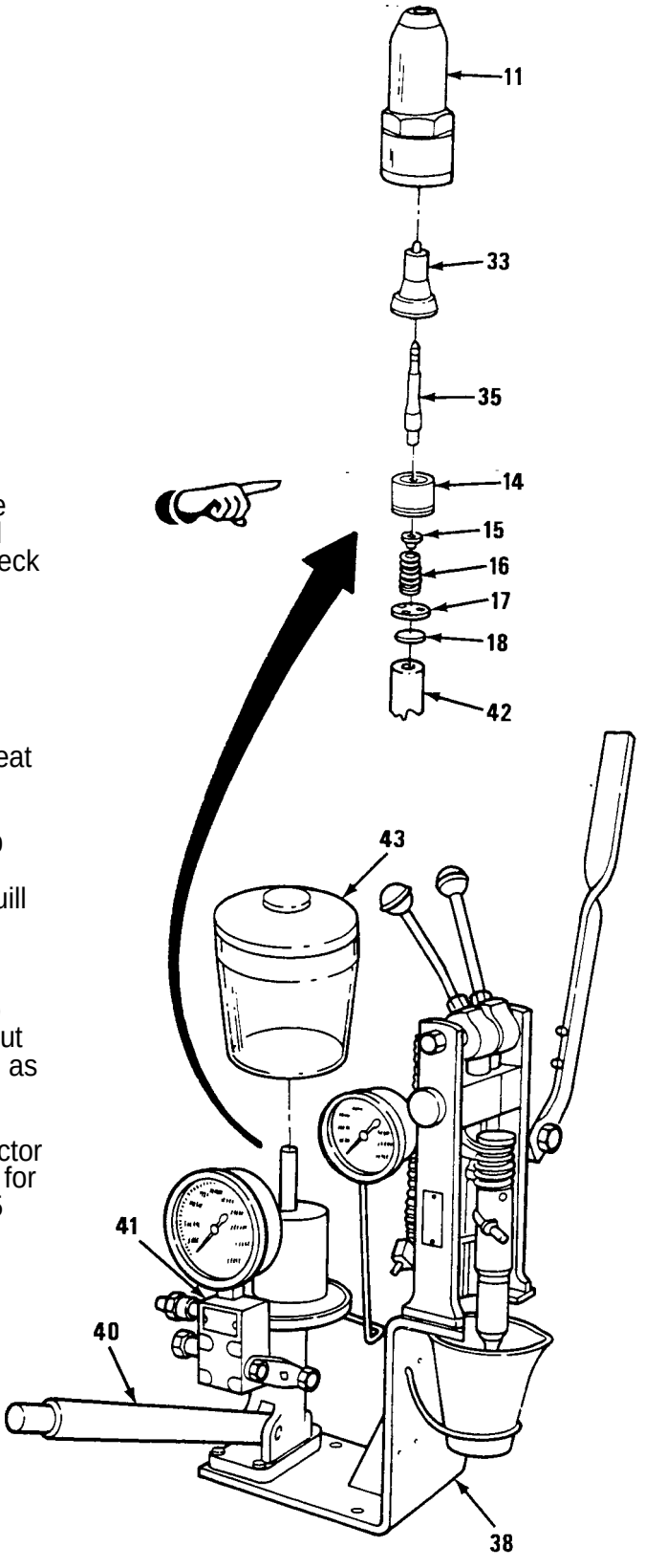
(d) Insert spring seat (15) in valve spring (16) and install on check valve cage (17) with seat up.

(e) Place spring cage (14) over spring seat (15) and spring (16).

(f) Insert needle valve (35) into spray tip (33) with tapered end down. Place assembly on spring cage (14) with quill end of needle valve in hole in spring cage.

(9) Lubricate threads on injector nut (11) with engine oil and carefully thread nut on pedestal (42). Tighten nut as tight as possible by hand.

(h) Using injector nut socket, torque injector nut (11) 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

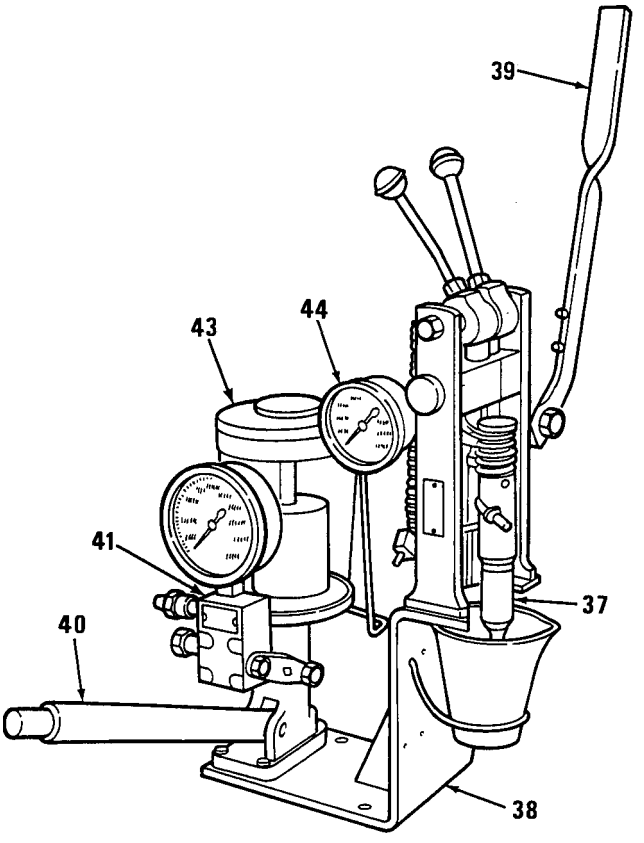
Do not operate diesel fuel injector nozzle tester without shield. Fuel spray can penetrate skin. Fuel oil entering blood stream may cause serious infection.

(i) Place shield (43) on diesel fuel injector nozzle tester (41). Operate pump handle (40) with smooth even strokes and record fuel injector needle valve opening pressure (pop pressure). Needle valve opens when fuel sprays from tip. Pop needle valve several times to purge air from system. Record test gage (44) opening pressure. Final needle valve opening pressure must be 3450-4050 PSI.

(j) Remove injector nut (11), spray tip (33), needle valve (35), spring (16), spring seat (15), spring cage (14), check valve cage (17), and check valve (18) from mounting pedestal (42).

NOTE

After needle valve opening pressure test is complete, continue injector assembly [ref. step e.(13)].



(6) Needle Valve Holding Pressure

(a) Place fuel injector in fixture (38).

(b) Operate pump handle (39) to bring pressure up to 2200 PSI.

NOTE

Pop fuel injector several times with popping handle (39) until no pressure is observed on injector test fixture (41) before removing injector from test fixture to avoid fuel spray as injector is removed from fixture.

(c) Close fuel shut off valve. Start timing when pressure reaches 2000 PSI and stop at **1500** PSI. Minimum time is 20 seconds.

(d) If pressure drops in less than 20 seconds, check for leaks around spray tip, seal ring, and fuel connectors.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-37 Install injectors (7083-7391, 7083-7396, and 7083-7399)
4-38 Install injectors (7083-7395 and 7083-7398)

4-41. BLOWER REPAIR

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

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Gear and bearing puller (App B, Item 94)
Oil seal installer App B, Item 94)
Seal ring carrier adaptor (App B, Item 94)
Oversized seal pilot (App B, Item 94)
Seal ring installer (App B, item 94)
Gage set (App B, Item 26)
Torque wrench (App B, Item 101)
Dial indicator (App B, Item 44)
Tachometer drive alignment tools (App B, Item 5)

- Lip type oil seal (replacement part)
- * Ring type oil seal (replacement part)

MANDATORY REPLACEMENT PARTS

16 Lockwashers (App F, Item 92)
12 Lockwashers (App F, Item 91)
1 Gasket (App F, Item 56)
1 Key washer (App F, Item 166)
4 Seals ** (App F, Item 145)
1 Seal set* (App F, Item 156)

EXPENDABLE/DURABLE SUPPLIES

5 Bolts 5/16-24 x 1 1/2 inch (App C, Item 3)
2 Wood blocks (App C, Item 46)
Engine oil (App C, Item 16)
4 Bolts 5/16-18 x 1 7/8 (App C, Item 2)
4 Washers 5/16 (App C, Item 18)
Form-A-Gasket sealant (App C, Item 39)

EQUIPMENT CONDITION

4-12 Fuel pump removed
4-17 Governor cover and throttle control rod removed
4-18 Governor and blower assembly removed

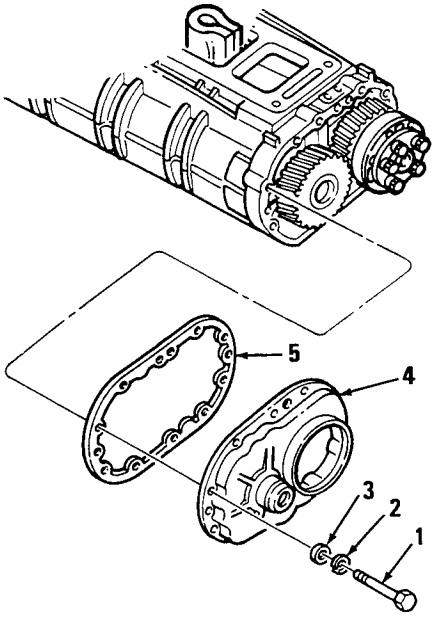
a. Disassembly

NOTE

Matchmark blower housing to front and rear end plates before disassembly.

(1) Remove ten bolts (1), ten lockwashers (2), and ten special washers (3) from blower end plate cover (4). Discard lockwashers.

(2) Remove blower end plate cover (4) and gasket (5). Discard gasket.



4-41. BLOWER REPAIR (Cont)

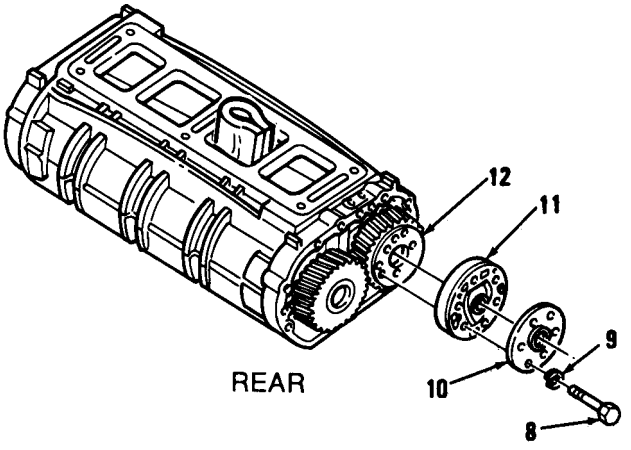
(3) Place clean folded wiping rag between rotors (6 and 7). Remove six bolts (8) and six lockwashers (9) securing blower drive coupling (10) and retainer (11) to gear (12). Discard lockwashers.

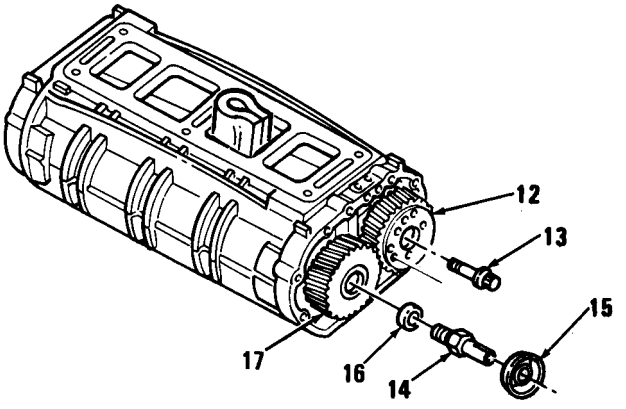
(4) Remove bolt (13), shaft (14), deflector (15), and spacer (16).

(5) Place flanges of two gear and bearing pullers (with center screw backed out) against faces of gears(12 and 17). Aline flange holes with tapped holes in gears.

(6) Secure pullers to gears (12 and 17) with 5/1 6-24 x 1 1/2-inch bolts. Install two bolts on gear (17) and three bolts on gear (12).

(7) Turn two pullers uniformly and remove gears (12 and 17) from shafts of rotors (6 and 7). Remove pullers from gears.



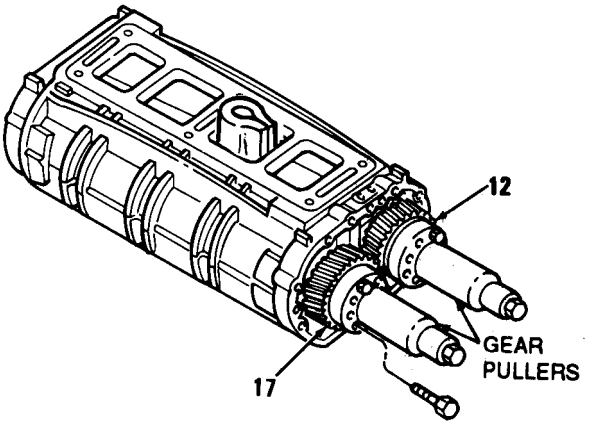


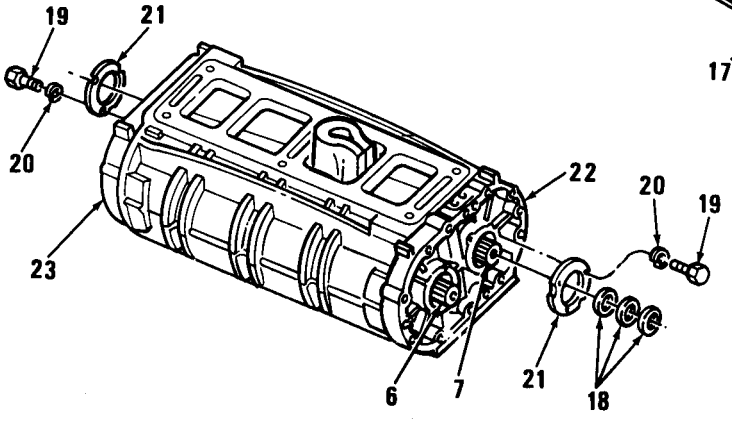
NOTE

Secure shims to matching gears to insure identical number and size of replacement shims during reassembly.

(8) Remove shims (18) from shafts of rotors (6 and 7).

(9) Remove twelve bolts (19), twelve lockwashers (20), and four retainers (21) from blower end plates (22 and 23). Discard lockwashers.





(10) Remove fuel pump drive bolt (24), key washer (25), disc (26), and spacer (27) from shaft of rotor (6). Discard key washer.

(11) Remove four fillister head screws (28) securing end plates (22 and 23) to blower housing (29).

(12) Place flanges of gear and bearing pullers (with center backed out) flat against face of rear end plate (22).

CAUTION

Bolts must be threaded all the way into tapped holes of end plate to provide maximum anchorage for pullers and to eliminate possible damage to end plate.

(13) Aline holes in puller flanges with tapped holes in end plate (22). Secure pullers to end plate with six 1/4-24 x 11/4-inch bolts.

(14) Turn two pullers uniformly and remove rear end plate (22) from blower housing (29) and shafts of rotors (6 and 7). Remove pullers and rag from rotors.

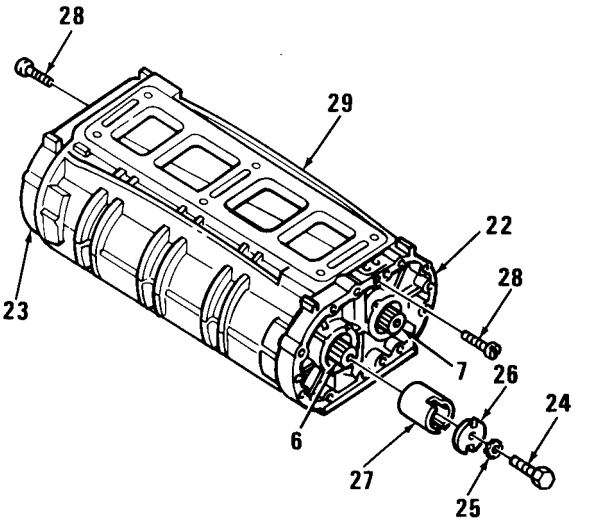
CAUTION

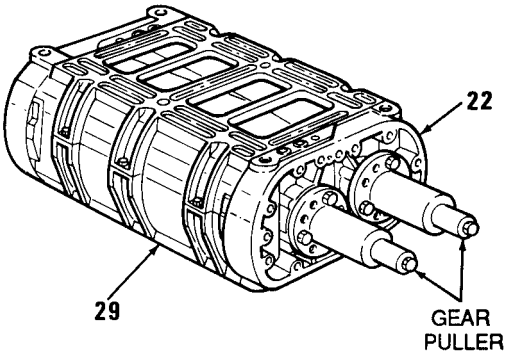
To avoid damage to rotors, handle them with care. Do not force rotors out of housing and pull out slowly and evenly.

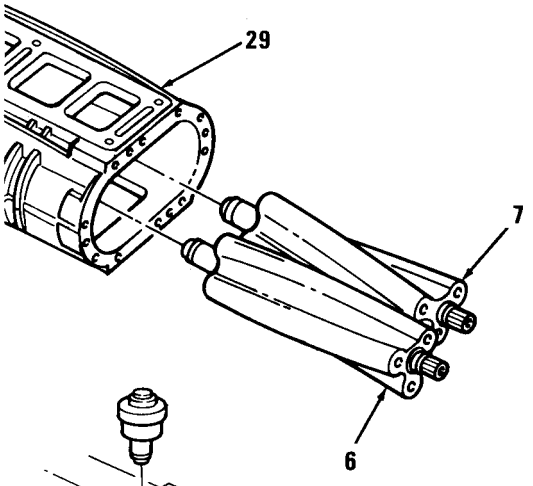
(15) To remove front end plate (23), repeat steps (12) thru (14).

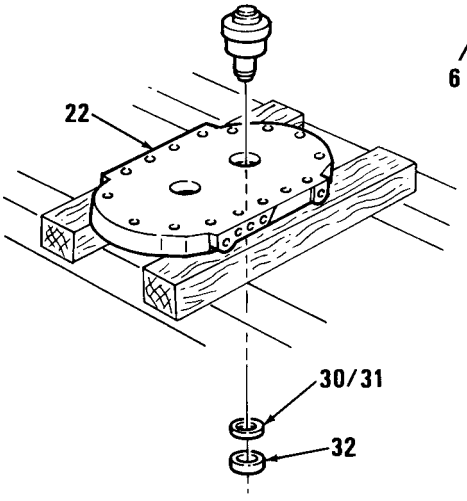
(16) Remove rotors (6 and 7) from blower housing (29).

(17) Support outer face of rear end plate (22) on two wood blocks. Place long end of oil seal installer through oil seal ring collar (30) or lip-type seal (31). Tap two rear roller bearings (32) and two collars or seals from end plate. If unit has oil seals, discard seals.









4-41. BLOWER REPAIR (Cont)

(18) Apply step (16) to front end plate (23) and remove two front bearings (33) and two seal ring collars (30) or two lip-type seals (31).

(19) Clamp lobe of rotor (6) in soft-jawed vise just tight enough to hold rotor stationary.

CAUTION

To avoid breakage or distortion, do not spread or twist oil ring seals more than necessary to remove.

NOTE

Steps (20) thru (23) provide information to remove oil seal rings (34) and carriers (35) from rotor shafts if original oil seals are installed.

(20) Remove oil ring seal (34) from seal ring carrier (35) with snap-ring pliers.

(21) Place seal ring carrier adapter over carrier (35) for seal. Secure adaptor to flange of gear puller (with center screw backed out) with two supplied bolts.

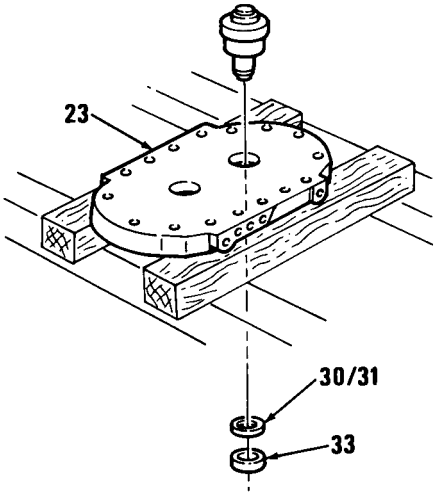
(22) Turn puller screw and pull oil seal ring carrier (34) from shaft of rotor (6).

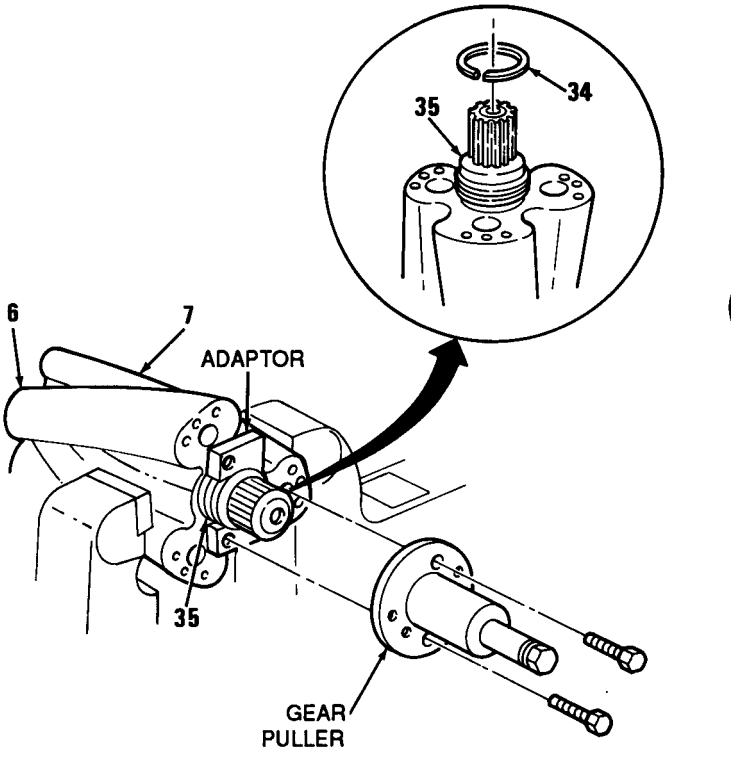
(23) To remove remaining oil seal ring carriers from shafts of rotors (6 and 7), repeat steps (20) thru (22).

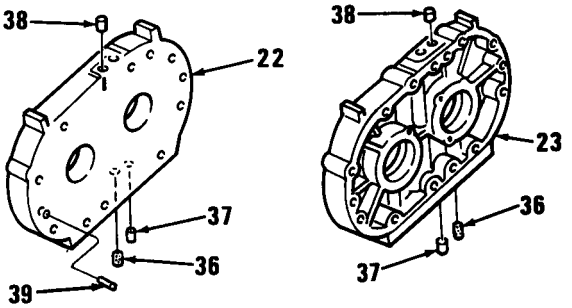
(24) If necessary, remove two oil strainers (36) and two sleeve bushings (37) from blower end plates (22 and 23).

(25) Remove two plugs (38) from top of blower end plate covers (22 and 23).

(26) If necessary, remove two dowel pins (39) from each end plate (22 or 23). Discard dowel pins.







b. Cleaning

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).

Wash all blower parts In clean fuel oil and dry with compressed air.

c. Inspection

(1) Examine bearings for indications of corrosion and pitting. Lubricate each ball bearing with clean engine oil. Hold bearing inner race from turning and revolve outer race slowly by hand, checking for rough spots.

(2) Check oil seal rings, carriers, and collars for wear and scoring. When replacement of an oil seal ring or carrier is necessary, replace both parts together.

(3) Inspect blower lobes and sealing ribs for burrs and scoring. If rotors are slightly scored or burred, clean up with emery cloth.

(4) Examine rotor shaft serrations for wear, burrs, or peening. Inspect bearing and oil seal contact surfaces of shafts for wear and scoring.

(5) Inspect inside surface of blower housing for burrs and scoring. Inside surface must be smooth for efficient operation. If inside surface is slightly scored or burred, clean up with emery cloth.

(6) Check finished ends of blower housing for flatness and burrs. End plates must be flat against blower housing.

CAUTION

Use care not to remove metal at joint face between end plates and housing. Air or oil leaks could develop after assembly.

(7) Finished inside face of each end plate must be smooth and flat. If finished face is slightly scored or burred, clean up with emery cloth.

NOTE

When required, replace blower gears as a set.

(8) Examine serrations in blower timing gears for wear and peening. Check gear teeth for wear, chipping, or damage. Gear backlash between gear teeth must not exceed 0.004 inch.

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).

(9) Clean oil strainer in vertical oil passage at bottom of each blower end plate and blow out all oil passages with compressed air.

(10) Examine blower drive support, coupling seats, spring seats, and springs for cracks and broken parts.

4-41. BLOWER REPAIR (Cont)

d. Assembly

NOTE

Dowel pins must project 0.320 inch (8.23 mm) from flat face of front end plate to assure proper alinement of end plate with housing.

(1) If removed, install two dowel pins (39) in each end plate (22 or 23). Pins must project 0.320 inch (8.23 mm) above face of plate.

(2) If removed, install two oil strainers (36) and two sleeve bushings (37) in bottom of end plates (22 and 23). Strainer must be flush to 0.015 inch (0.38 mm) below surface.

(3) Install two plugs (38) in top of end plates (22 and 23).

NOTE

Steps (4) thru (6) provide information to install oversized replacement lip-type oil seals on rotor shafts and end plates. If the ring-type oil seals, carriers, and collars are still available from existing stock, proceed to steps (9) thru (16).

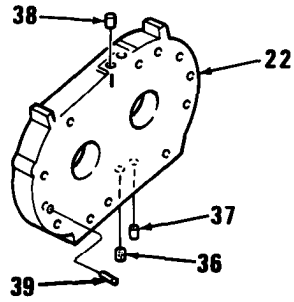
(4) Support blower rear end plate (22), finished surface facing up, on two wooden blocks.

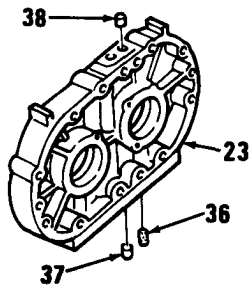
(5) Start oil seal (31) straight into bore of end plate with part number facing up (away from bore).

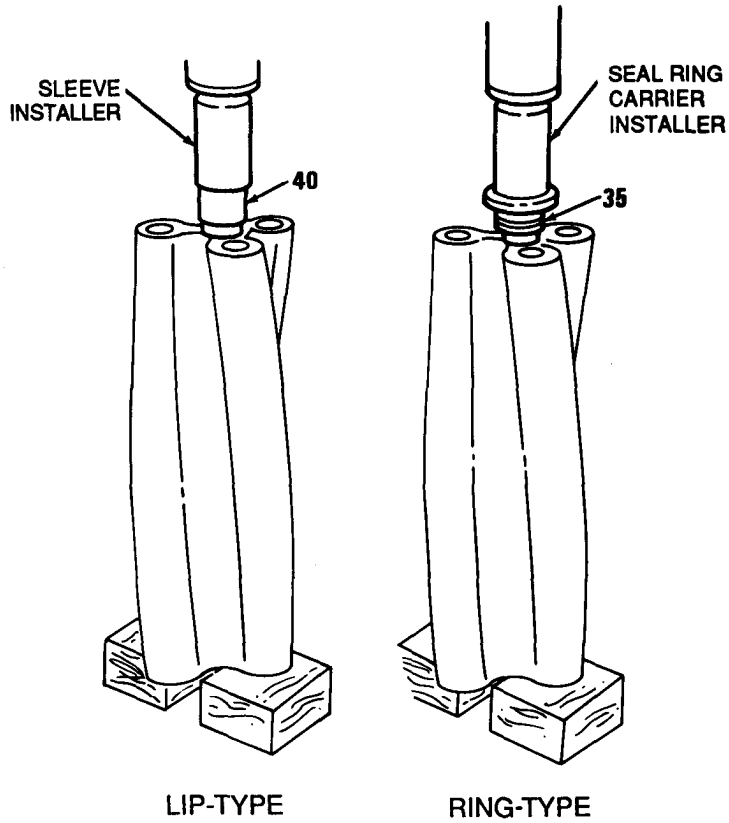
(6) Place short end of oil seal installer in oil seal (31). Tap oil seal into end plate (22) until shoulder of installer contacts end plate.

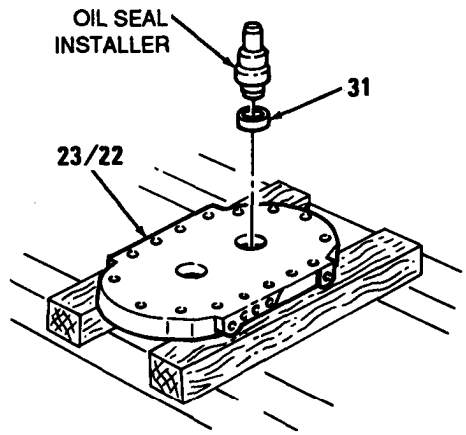
(7) To install remaining oil seals (31) in end plates (22 and 23), repeat steps (4) thru (6).

(8) Position rotor on two wood blocks under arbor press. Using oversized seal pilot, press oil seal sleeves (40) on rotor shaft until sleeve contacts rotor.









NOTE

Steps (9) thru (16) provide information to install oil seal rings, carriers, and collars (old style) on rotor shafts and end plates. These three parts are only available from existing stock and have been superseded.

(9) Support rotor assembly on wood block in arbor press.

(10) Lubricate inside diameter of oil seal ring carrier (35) with engine oil. Start carrier over end of rotor shaft with chamfered inside diameter end facing rotor.

NOTE

A step under shoulder of installer will position collar 0.005 inch (0.12 mm) below finished face of end plate.

(11) Place oil seal ring carrier installer over end of rotor shaft and against carrier (35). With installer under ram of press, press carrier down tight against rotor.

(12) To install remaining oil seal ring carriers (35) on shafts of rotors (6 and 7), repeat steps (9) thru (11).

NOTE

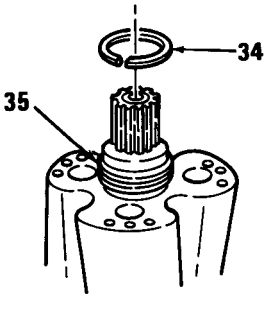
To avoid breakage or distortion, do not spread or twist oil seal rings more than necessary to install.

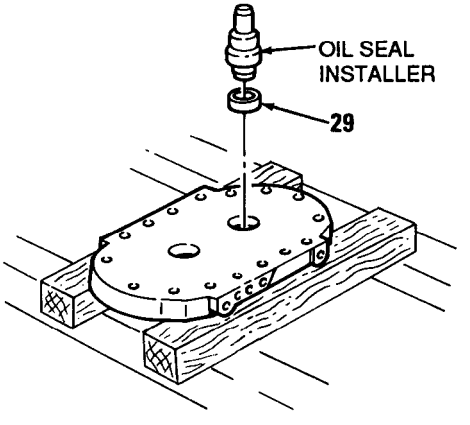
(13) Install ring-type oil seal (34) in ring groove of carrier (35) with snap ring pliers.

(14) Support one blower end plate, inner face up, on two wood blocks in arbor press.

(15) Lubricate outside diameter of oil seal ring collar (29) with engine oil. Start chamfered outside diameter end of collar straight into bore of end plate using short end of oil seal installer.

(16) To install remaining ring-type oil seals (34) on rotors and oil seal ring collars (29) in end plates, repeat steps (13) thru (15).





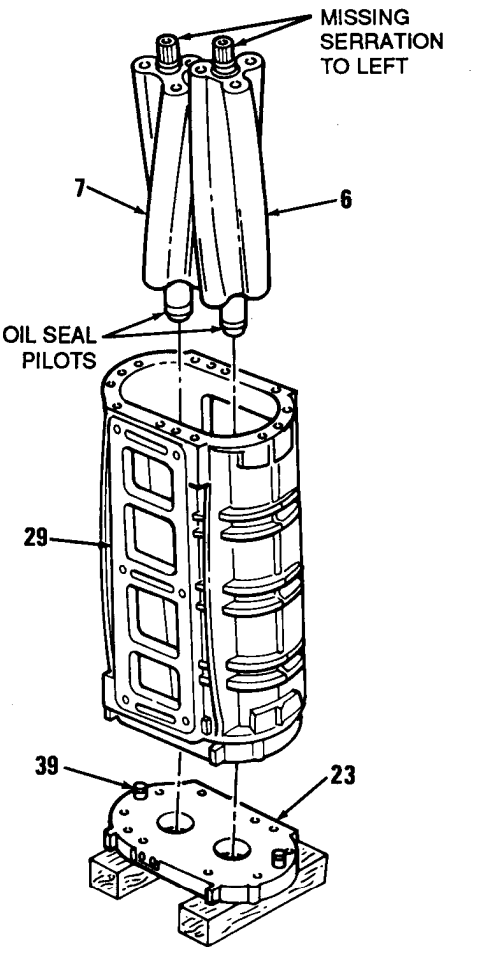
4-41. BLOWER REPAIR (Cont)

NOTE

- Top of front end plate is identified by three bolt holes and one oil hole. Bottom of end plate has three bolt holes and three oil holes. Dowel pins extend from both sides of front end plate.
- The horizontal oil passage in top of front end plate intersecting the vertical oil passages is plugged. Do not install this end plate on rear of blower housing.
- Mating surfaces between blower end plates and blower housing must be flat and smooth. No gasket is used.

(17) Apply light coating of Form-A-Gasket sealant to mating surfaces of end plate and blower housing. Sealant must not protrude into housing.

(18) Position front end plate (23) on two wood blocks, finished side up. Install blower housing (29), with match marks alined, on two dowel pins (39).

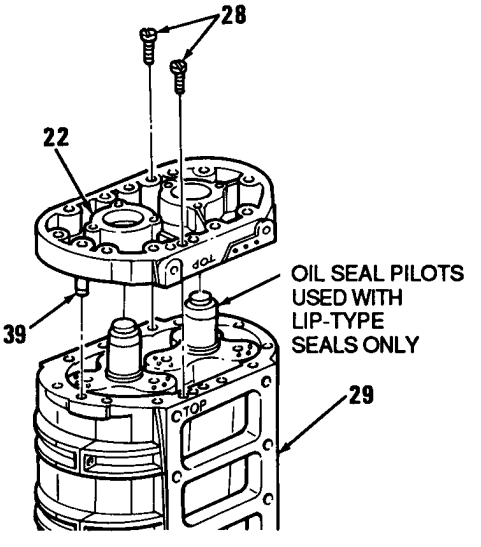


NOTE

Right hand helix rotor is marked "GEAR END" on one end. Gear end of left hand rotor has serrated shaft.

(19) Place rotors (6 and 7) in mesh with missing teeth in rotor shafts in position and facing to left as viewed from gear end.

(20) For replacement lip-type oil seal set only, install two oversized oil seal pilots over underrated end of each shaft of rotors (6 and 7).



(21) Insert rotors (6 and 7) straight into housing (29) and through bores of front blower end plate (25). If installed, remove oversized oil seal pilots.

(22) For replacement lip-type seal set only, install two oversized oil seal pilots over serrated end of each shaft of rotors (6 and 7).

NOTE

Mating surfaces between blower end plates and blower housing must be flat and smooth. No gasket is used.

(23) Apply light coating of Form A Gasket sealant to mating surfaces of end plate and blower housing. Sealant must not protrude into housing.

(24) Aline match marks on rear end plate (22) and blower housing (29). Install rear end plate with flat finished surface towards blower housing. Slide end plate down over oil seal pilots. Aline dowel pins (39) with holes in blower housing. Push end plate against blower housing. If installed, remove oil seal pilots.

(25) Install two screws (28) through rear end plate (22) into blower housing (29). Invert blower housing and install two screws through front end plate (23). Torque screws to 5-10 lb-ft (7-14 N-m).

CAUTION

Check relationship of blower end plates to blower housing on the bottom face. Protrusion must not be more than 0.0005 above or 0.0065 inch below end plate. Excessive protrusion could distort blower housing when end plate mounting bolts are tightened and could cause rotor to housing contact.

(26) Lubricate rear ball bearings (32) with light engine oil. Position two bearings, numbered end up, on rear end plate (22) and straight on shafts of rotors (6 and 7).

(27) Place seal and rear bearing installer on top of rear ball bearings (32). Tap bearings straight and onto shafts of rotors (6 and 7) into rear end plate (22).

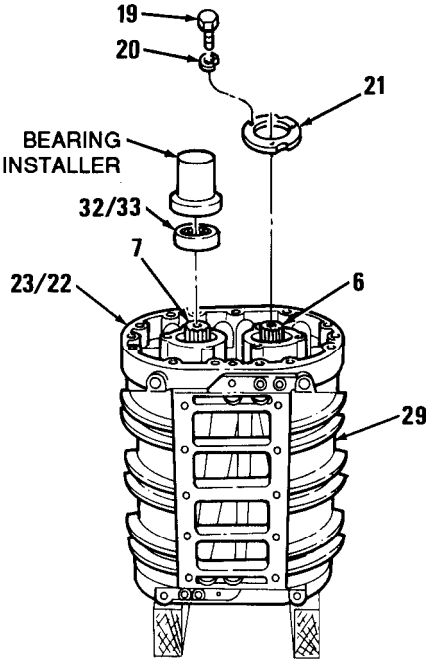
NOTE

Position retainer with word “OUT” away from end plate.

(28) Position two bearing retainers (21) on rear end plate (22). Install six bolts (19) and six lockwashers (20). Torque bolts to 7-9 lb-ft (9-12 N-m).

(29) Invert blower housing (29). To install two front roller bearings (32) and two retainers (21) on front end plate (23), repeat steps (24) thru (26) using front bearing installer.

Place blower housing (29) in upright position with gear end up on two wood blocks.



NOTE

Rotors must turn freely for proper assembly.

4-41. BLOWER REPAIR (Cont)

(31) Rotate rotors (6 and 7) to bring flat in spline on shafts in alinement and facing left.

(32) Install original number and thickness of shims (18) on shafts of rotors (6 and 7) that were removed at disassembly.

(33) Lubricate serrations of shafts of rotors (6 and 7) with engine oil.

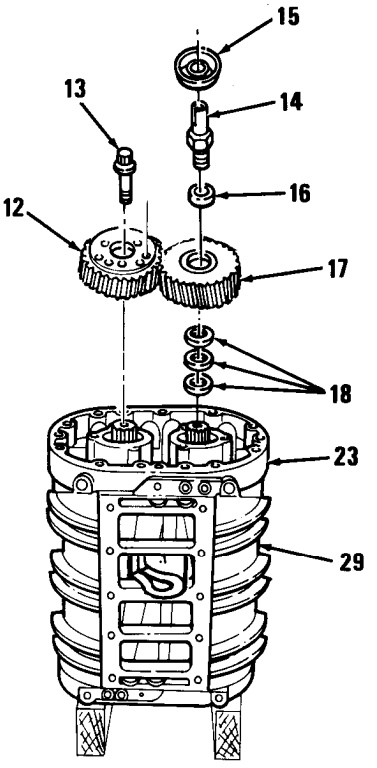
(34) Place teeth of rotor gears (12 and 17) so missing teeth on inside of gears are alined and facing same direction as missing teeth on shafts of rotors (6 and 7).

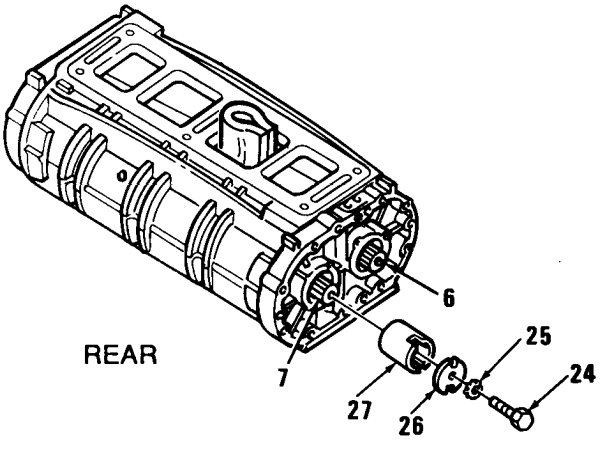
(35) Using a soft-headed hammer, drive gear (12) on shaft of rotor (7) and gear (17) on shaft of rotor (6).

(36) Install bolt (13) into end in shaft of rotor (7). Install spacer (16), shaft (14) and deflector (15) in shaft of rotor (6). Place folded rag between rotors to prevent gears (12 and 17) from turning. Torque bolt and shaft to 100-110 lb-ft (136-150 N-m).

(37) Reverse blower assembly. Install spacer (27), disc (26), key washer (25) and bolt (24) to rotor (7). Aline tang on key washer with groove in disc. Torque bolt to 55-65 lb-ft (75-88 N-m). Bend one tang of key washer into groove in disc and two tangs against side of bolt head. Remove rag from rotors.

(38) Install four 5/16-18x1 7/8-inch bolts with flat washers through holes in each end plate (top and bottom) to blower housing. Torque bolts to 13-17 lb-ft (18-23 N-m) (bolts are temporarily securing blower housing to end plates to determine clearance between rotors and end plates).



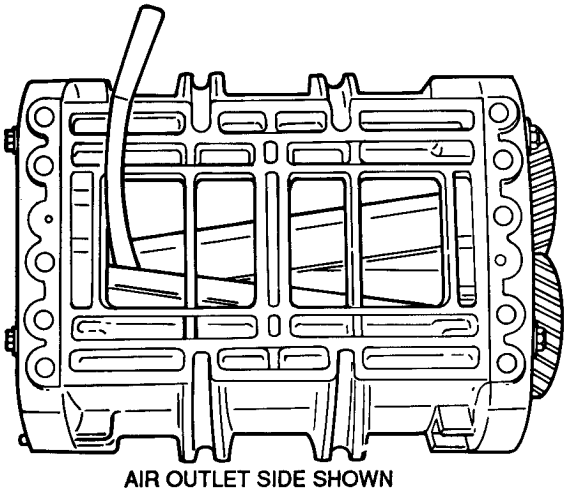


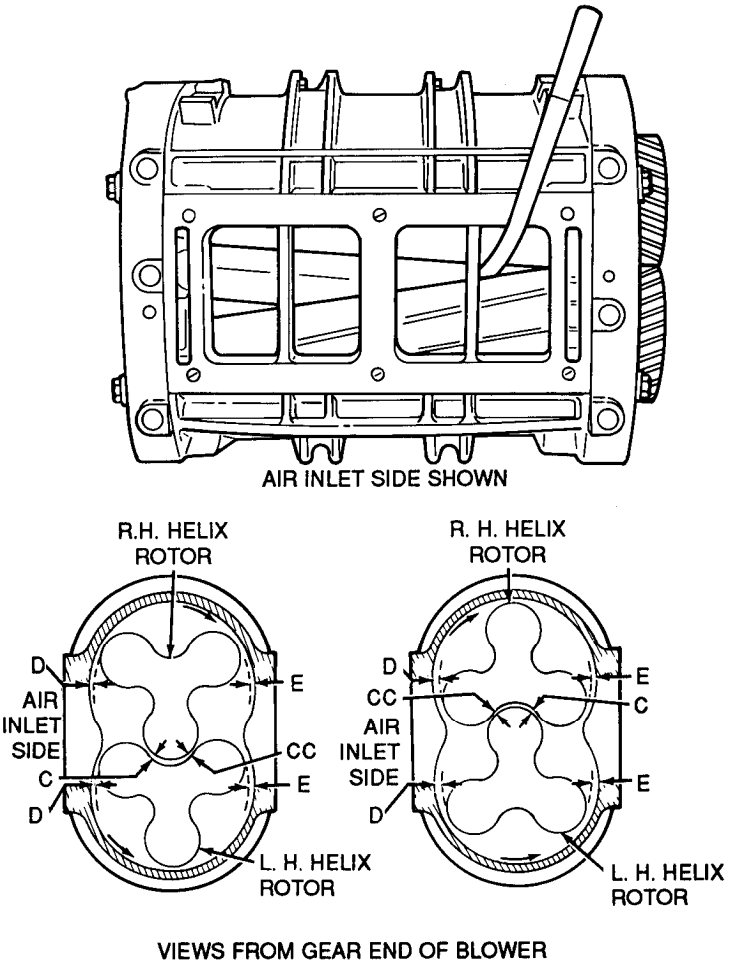
NOTE

- When measuring clearances between rotor lobes, 1/2-inch wide feeler gages are recommended. When measuring clearances of more than 0.005 inch, laminated feeler gages made up of 0.002, 0.003 or 0.005-inch feeler stock are recommended.
- Rotor to rotor measurement should be taken one inch from each end and at center of blower.

(39) Measure clearance between trailing edge of right hand helix rotor and left hand helix rotor, (CC) clearance, from both inlet and outlet sides. Clearance must be 0.004 to 0.008 inch.

(40) Measure clearance between leading edge of right hand helix rotor and trailing edge of left hand helix rotor, (C) clearance. Minimum clearance is 0.010 inch.



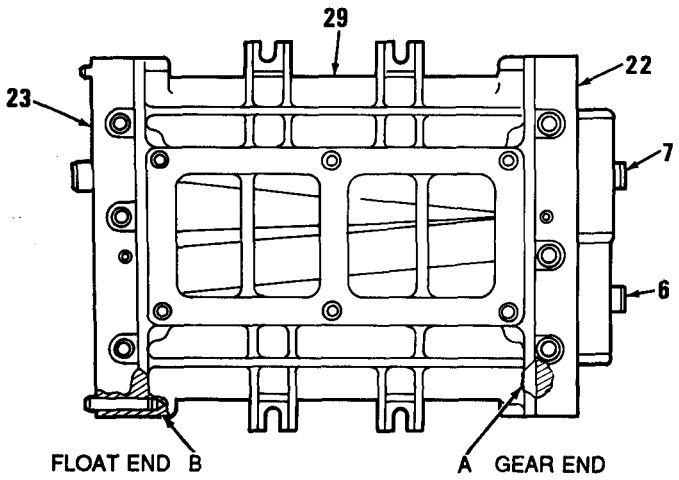


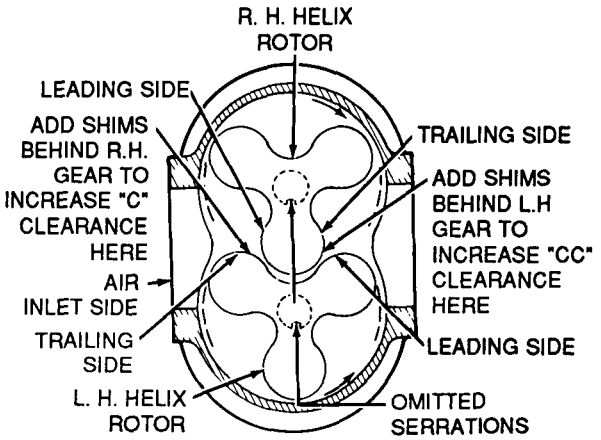
NOTE

When different shims are required, always remove both gears from rotors. Placing a 0.003-inch shim in back of a right hand helix rotor gear (11) will decrease (CC) clearance 0.001 inch.

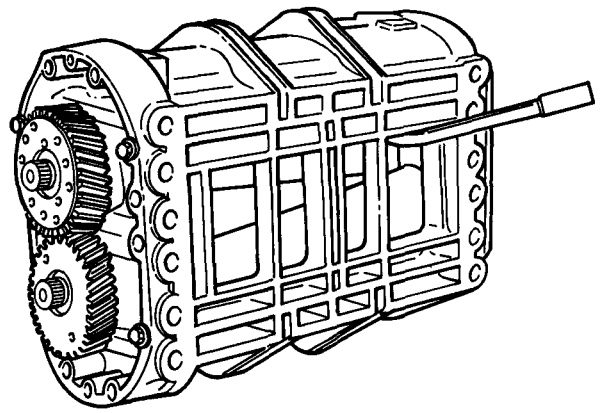
(41) Remove blower gears (12 and 17) and install required thickness of shims in back of proper gear. Install gears and check clearance as outlined in steps (37) and (38).

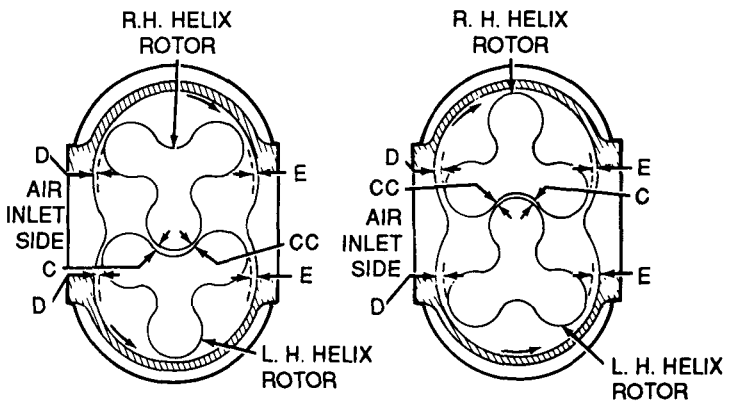
(42) Check clearances at points (A) and (B). Insert feeler gages between end plates (22 and 23) and ends of rotors (6 and 7). Measure clearance for each lobe end (total of twelve). Minimum clearance at (A) is 0.007 inch and at (B) is 0.014 inch.





VIEWS FROM GEAR END OF BLOWER





VIEWS FROM GEAR END OF BLOWER

(43) Check clearances at points (D) and (E). Insert feeler gages between lobes of rotors (6 and 7) and blower housing (29). Measure clearance for each lobe at both inlet and outlet side (total of twelve). Minimum clearance at (D) is 0.015 inch and at (E) is 0.004 inch.

(44) Place blower assembly on end on two wood blocks with gear end up. Place blower drive coupling (1 O) on gear (12) with groove inside coupling next to gear. Install coupling, retainer (11), six bolts (8), and six lockwashers (9) to gear(11). Insert folded rag between rotors (6 and 7). Torque bolts to 20-25 lb-ft (27-34 N-m). Remove rag.

(45) Using dial indicator, measure cam spline runout. Maximum runout must not exceed 0.020 inch total indicator reading.

(46) Remove four bolts and four flat washers holding each end plate to blower housing (installed to check blower clearances).

(47) Position gasket (5) on blower rear end plate cover (4) and loosely secure cover and gasket to rear end plate (22) with ten bolts (1), ten lockwashers (2), and ten special washers (3).

NOTE

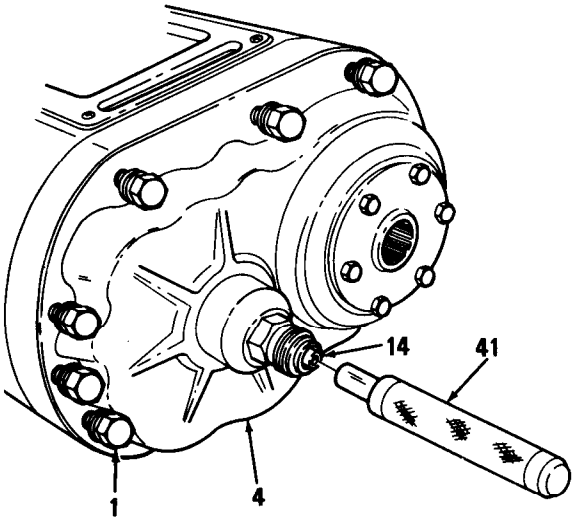
Whenever installing a tachometer drive cover assembly or drive adaptor, maintain proper alinement between cover and tachometer drive shaft. Correct alinement is when no binding occurs between drive shaft and inside diameter of alinement tool when rotating blower rotors.

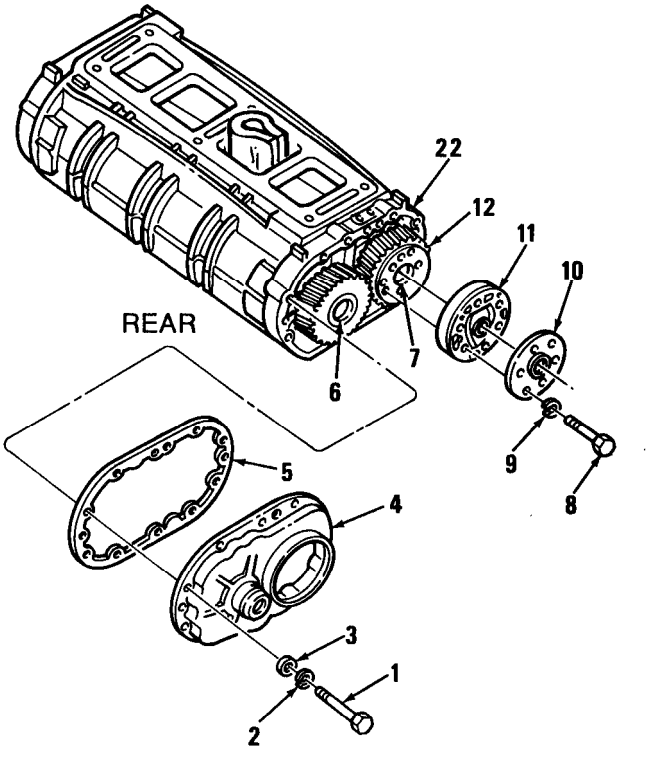
(48) Using tachometer drive alinement set (41), aline cover (4) with tachometer drive shaft (14) by selecting tool with best fit. Torque bolts (1) to 13-17 lb-ft (1 8-23 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-12 Install fuel pump
4-17 Install governor cover and throttle control rod
4-18 Install governor and blower assembly





4-42. GOVERNOR REPAIR

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

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Governor cover bushing remover (App B, Item 78)
Governor cover bearing installer (App B, Item 77)
Governor cover bushing installer (App B, Item 53)
Torque wrench (App B, Item 101)

EXPENDABLE/DURABLE SUPPLIES

Grease (App C, Item 22)
Sealant (App C, Item 40)
Engine oil (App C, Item 16)
Cleaning solvent (App C, Item10)
Bolt 5/1 6-24 x 3 (App C, Item 4)
Sealant (App C, Item 38)

EQUIPMENT CONDITION

Para Description
4-17 Throttle control rods removed
4-18 Governor removed from blower

MANDATORY REPLACEMENT PARTS

1 Seal ring (App F, Item 131)
1 Seal ring (App F, Item 132)
2 Lockwashers (App F, Item 92)
2 Gaskets (App F, Item 78)
1 Seal ring (App F,Item 135)
1 Gasket (App F,Item 82)
1 Key washer (App F, Item 165)
1 Expansion plug (App F, Item 113)

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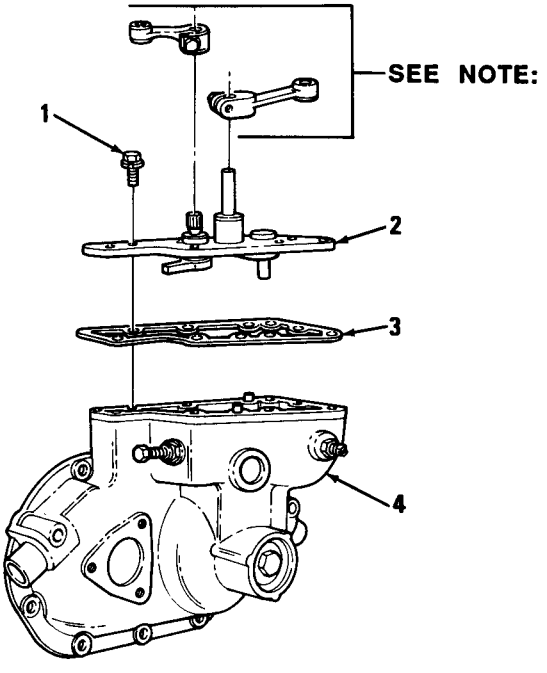
a. Disassembly

NOTE

- Before and during disassembly of governor, clean entire unit and visually inspect for worn or damaged parts which may be repaired or replaced without complete disassembly.
- If remote control levers are on governor cover, remove prior to disassembly of cover.

(1) Remove eight bolts (1) securing governor cover (2) to governor (3). Remove cover and gasket (4). Discard gasket.



(2) Remove retaining ring (5) and two washers (6) from stop lever shaft (7).

(3) Remove stop lever shaft (7) and return spring (8) from governor cover (2).

(4) Remove seal ring (9) from governor cover (2). Discard seal ring.

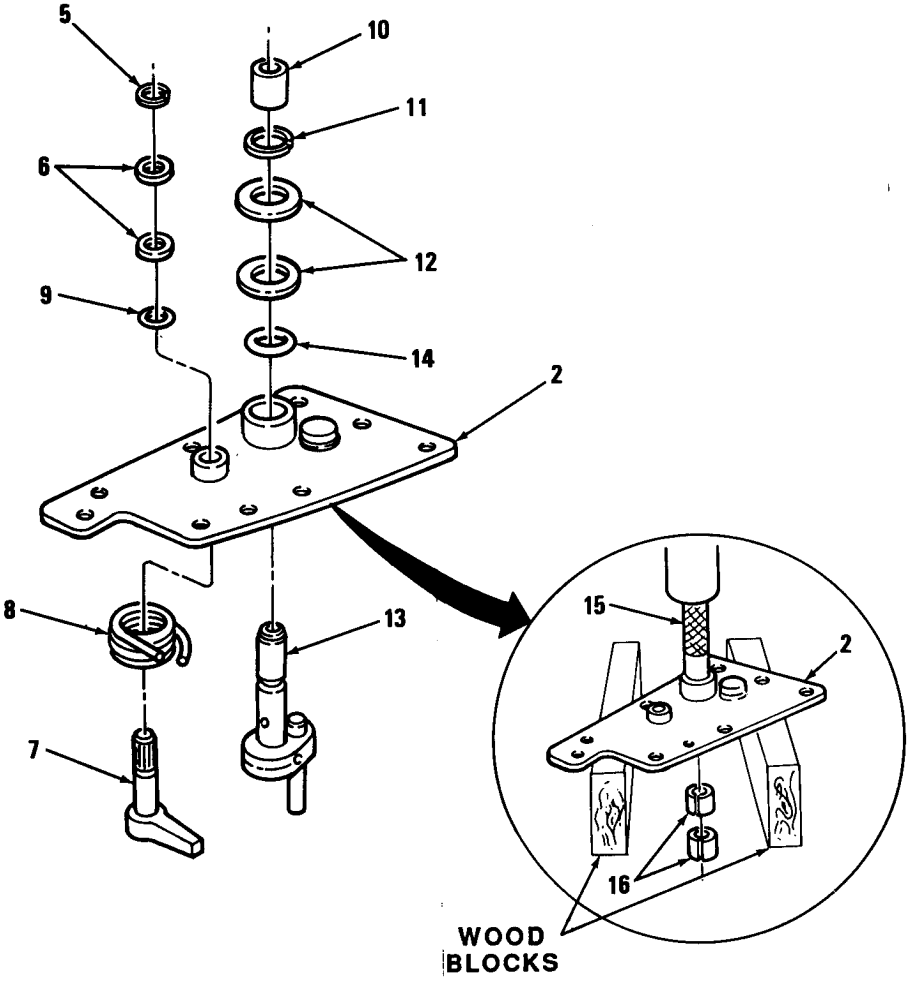
(5) Remove spacer (10), retaining ring (11), and two washers (12) from speed control shaft (13).

(6) Remove speed control shaft (13) from governor cover (2).

(7) Remove seal ring (14) from governor cover (2). Discard seal ring.

(8) Support governor cover (2) on wooden blocks in an arbor press, top facing down.

(9) Using bushing remover tool (15), remove two control shaft bushings (16) from governor cover (2).



4-42. GOVERNOR REPAIR (Cont)

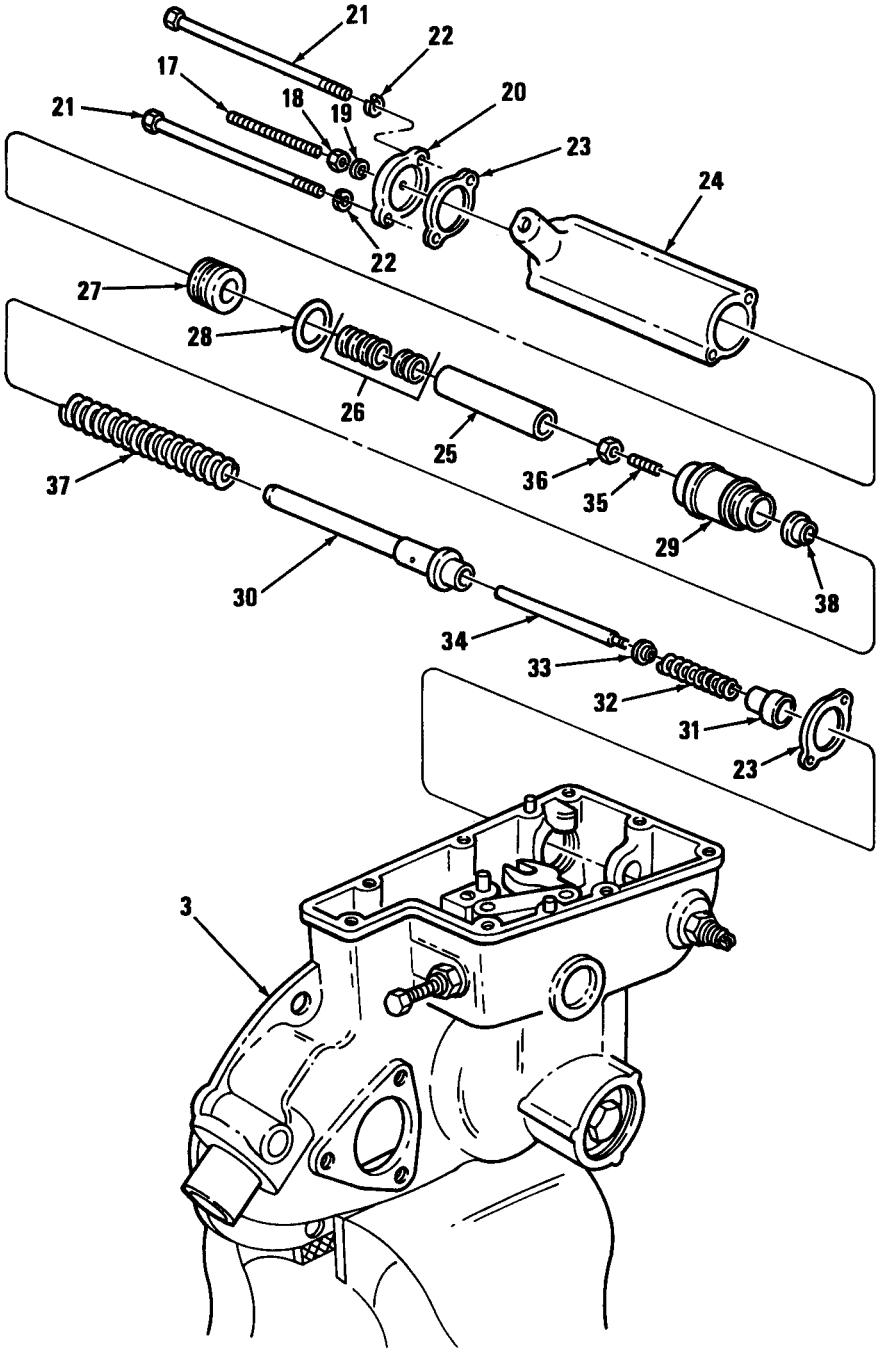
(10) Place governor housing (3)in soft-jawed vise.

(11) Remove setscrew (17), locking nut (18), and washer (19) from access cover (20).

NOTE

When removing governor high speed spring housing, do not lose shims located inside housing.

(12) Remove two bolts (21) and two lockwashers (22) securing access cover (20), two gaskets (23), and housing (24) to governor housing (3). Discard gaskets and lockwashers.



NOTE

Record quantity and thickness of shims (26) for reinstallation.

(13) Remove sleeve (25), shims (26), and piston (27) from housing (24).

(14) Remove seal ring (28) from piston (27). Discard seal ring.

(15) Remove high speed spring retainer (29) and plunger (30) assembly from governor housing (3).

(16) Remove low speed spring cap (31), low speed spring (32) spring seat (33), and adjusting pin (34) from plunger (30).

(17) Using a socket head wrench, hold screw (35) and loosen nut (36).

WARNING

High speed spring is under pressure and personal injury could occur if downward pressure is not applied to retainer.

(18) While applying pressure to high speed spring (37), remove screw **(35)** from plunger (30).

(19) Remove high speed spring (37) and seat (38) from plunger (30).

(20) Remove plug (39) and gasket (40) from governor housing (3). Discard gasket.

(21) Bend tang of key washer (41) away from retainer bolt (42).

(22) While holding weight carrier assembly (43), remove retainer bolt (42), flat washer (44), and key washer (41). Discard key washer.

(23) Thread a 5/16-24 x 3 inch bolt (45) into hole for retainer bolt (42).

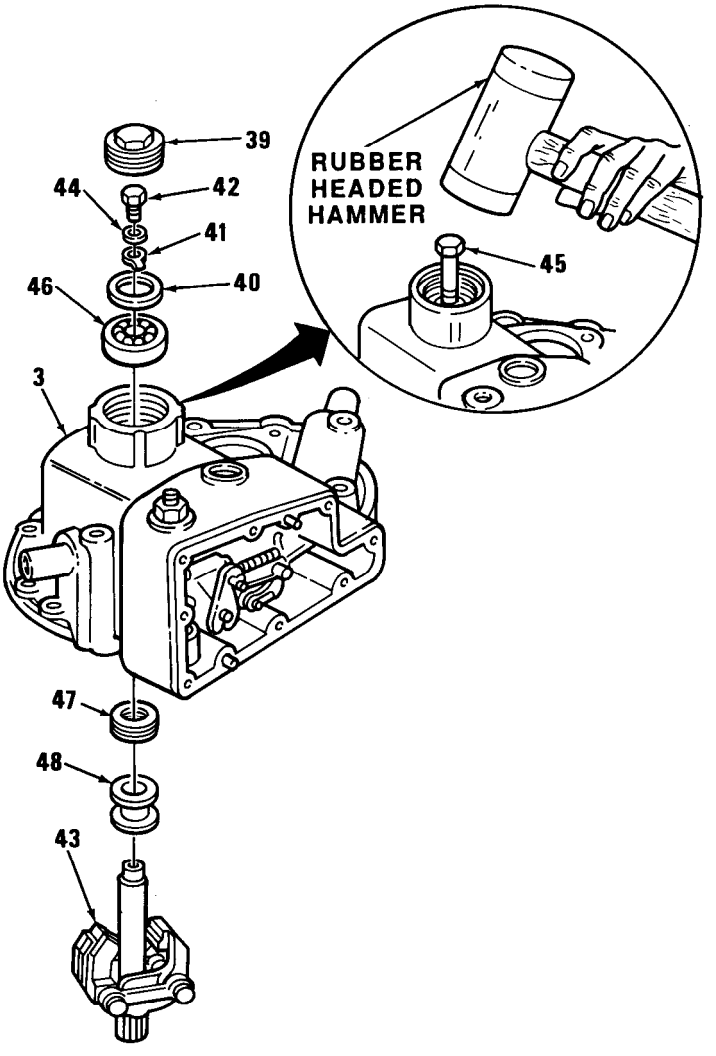
(24) Remove governor housing (3) from vise and place on a flat surface with bolt (45) facing up. Tap weight carrier assembly (43) out of bearing (46) with a soft headed hammer.

(25) Slide riser bearing (47) and riser (48) off weight carrier assembly (43).

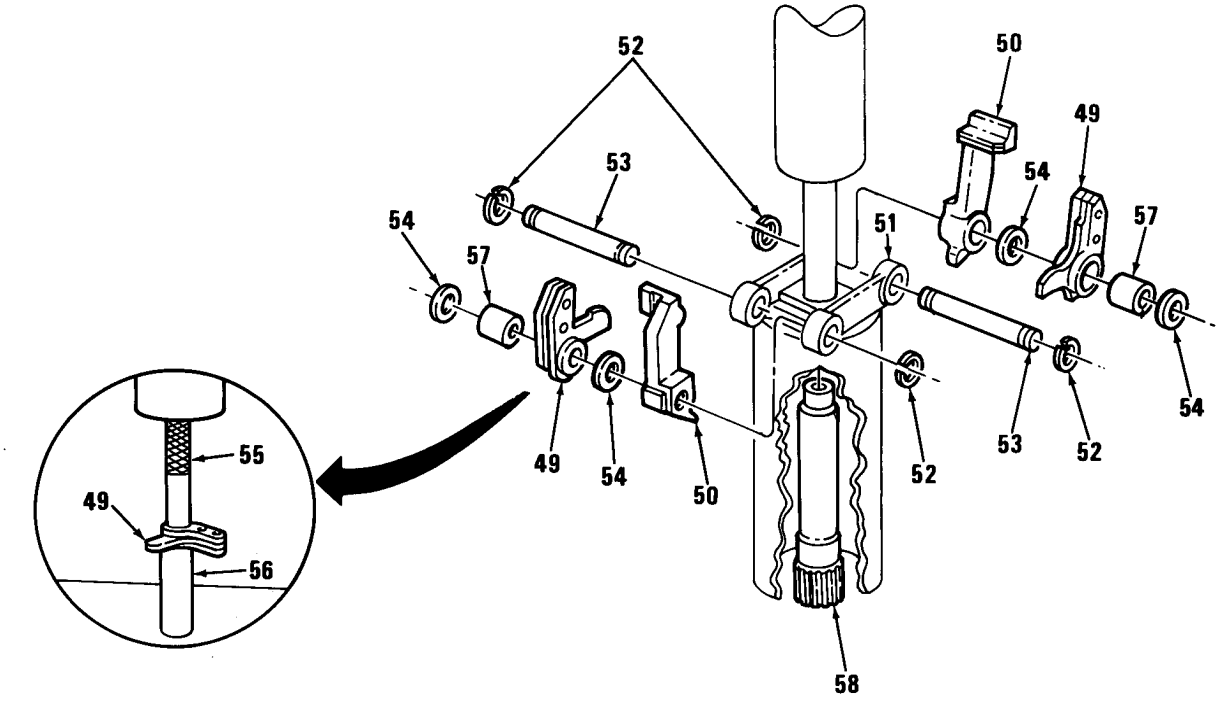
NOTE

Inspect weight carrier bearing in governor housing to determine need for removal.

(26) If necessary, remove weight carrier bearing (46) from governor housing (3). Use a small brass rod and hammer to tap bearing from inside housing.



4-42. GOVERNOR REPAIR (Cont)



(27) Matchmark two high speed and two low speed weights (49 and 50) to weight carrier (51).

(28) Remove four retaining rings (52).

(29) Press two pins (53) from weight carrier (51) and remove four washers (54), two high speed weights (49), and two low speed weights (50).

(30) Using bearing remover tool (55), sleeve (56), and arbor press, remove needle bearing (57) from one high speed weight (49). Repeat procedure for other high speed weight.

(31) Using an arbor press, remove carrier shaft (58) from weight carrier (51) by placing spline end into a sleeve (59) having a one inch hole.

(32) Remove retaining clip (60) and flat washer (61) from differential lever pin (62) and remove operating lever connecting link (63).

(33) Remove retaining clip (64) and flat washer (65) from operating lever pin (66). Remove differential lever (67) from operating lever (68).

(34) If damaged, remove pin (62) from differential lever (67).

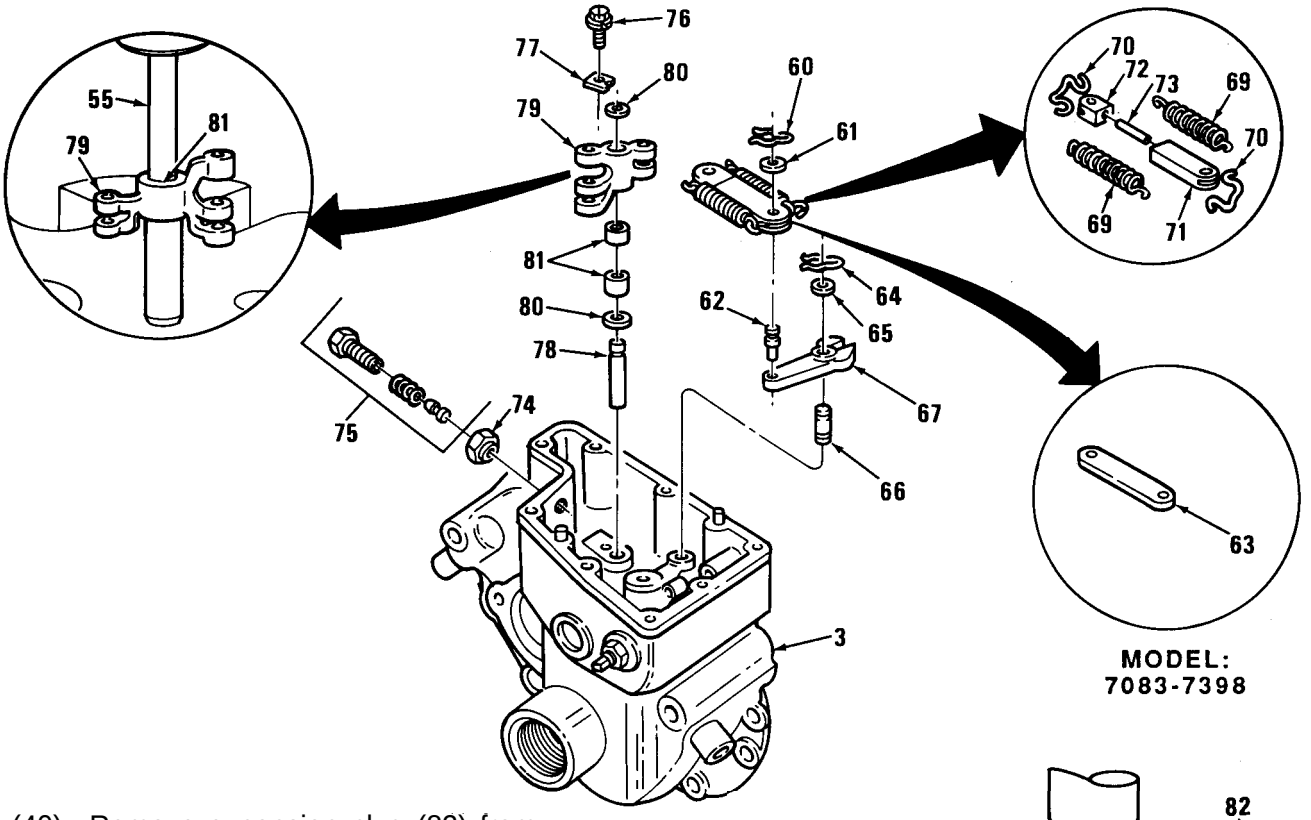
(35) For model 7083-7395 only, remove two springs (69) and retainer clips (70). Separate governor links (71 and 72) and remove pin (73).

(36) Loosen locknut (74) and remove buffer screw assembly (75).

(37) Remove screw and washer assembly (76) and locking clip (77) securing operating lever shaft (78) to governor housing (3).

(38) Remove operating lever shaft (78), control link operating lever (79), and two washers (80).

(39) If bearings are damaged, support control link operating lever (79) on sleeve and rest sleeve on bed of arbor press. Place bearing remover (55) on top of bearing (81) and press two bearings (81) out of operating lever (79).



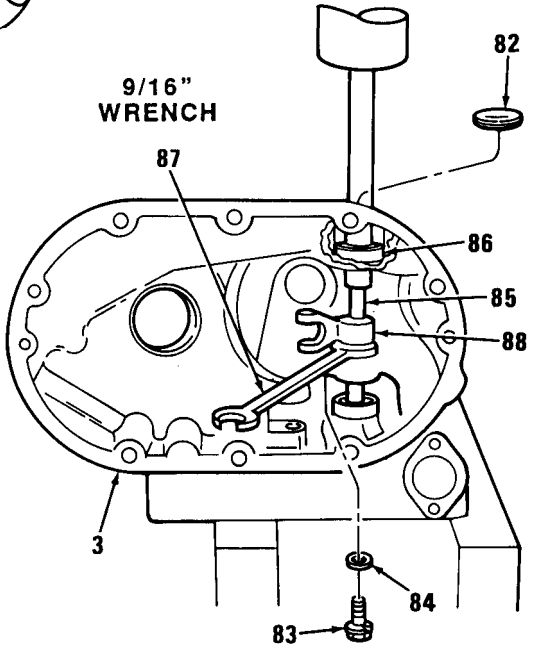
(40) Remove expansion plug (82) from bottom of governor housing (3). Discard expansion plug.

(41) Remove operating shaft upper bearing retainer screw and washer assembly (83) and flat washer (84) securing bearing in governor housing (3).

(42) Place governor housing (3) in press, bottom side up.

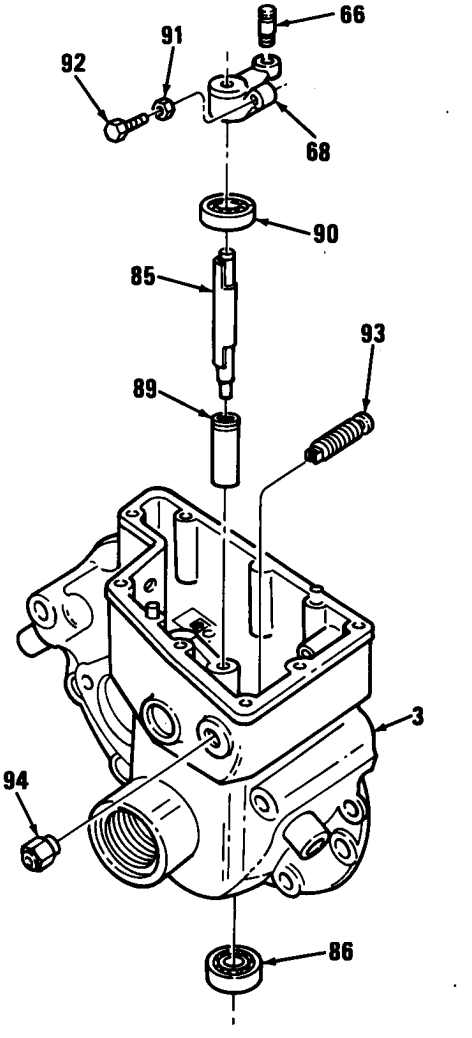
(43) Press operating shaft (85) out of lower bearing (86) located in governor housing (3).

(44) Place a 9/16 inch open end wrench (87) under operating fork (88) and press fork off operating shaft (85).



4-42. GOVERNOR REPAIR (Cont)

(45) Remove spacer (89), operating shaft (85), upper operating lever bearing (90), and operating lever (68) from governor housing (3). Slide spacer (89) from shaft (85).



CAUTION

When pressing operating shaft from operating lever and bearing, catch shaft by hand to prevent it from falling and being damaged.

(46) Press operating shaft (85) from upper bearing (90) and operating lever (68).

(47) Loosen locknut (91) and remove adjusting screw (92).

(48) If damaged, remove pin (66) from operating lever (68).

(49) Press lower bearing (86) from governor housing (3).

(50) For model 7083-7395 only, hold starting aid screw (93) and remove nut (94) from governor housing (3).

CAUTION

External starting aid screw can only be removed by screwing inward through governor housing. Removing the screw outward through the governor housing will damage the threads in the housing due to oversize button on end.

(51) Remove external starting aid screw (93) through governor housing (3) by turning screw clockwise.

b. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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 all parts with dry cleaning solvent and dry with compressed air. Inspect all parts.

(2) Inspect all bearings and shafts for corrosion, pitting, rough spots, and excessive wear.

(3) Inspect governor housing and cover for cracks, warpage, and damaged threads.

(4) Inspect governor weights after assembly for free movement.

c. Assembly

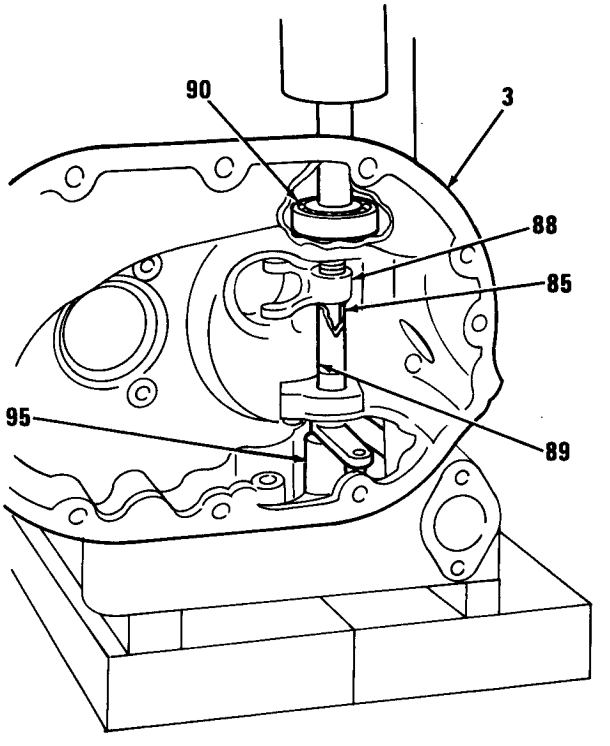
(1) For model 7083-7395 only, install starting aid screw (93) through inside of governor housing (3) and secure with nut (94) on outside of governor housing.

(2) If removed, install pin (66) in operating lever (68).

(3) Install adjusting screw (92) and locknut (91) in operating lever (68).

(4) Coat inside diameter of operating shaft upper bearing (90) with engine oil. Using an arbor press, install upper bearing (90), numbered side up, on large end of operating shaft (85).

(5) Using an arbor press, install operating lever (68), with pin (66) facing up, onto operating shaft (85), alining flat on lever with flat on shaft, until flush with operating shaft (85).



(6) Install spacer (89) onto operating shaft (85).

(7) Insert end of governor operating shaft (85), bearing (90), spacer (89), and operating lever (68) through upper bearing bore in governor housing (3) with operating fork (88) facing rear of governor housing.

(8) Place governor housing (3) in arbor press with top facing down.

(9) Place a support (95) under operating shaft (85) and press operating fork (88) until spacer (89) does not move up or down.

(10) Lubricate operating lever bearing (90) with engine oil and seat bearing in governor housing (3). Install screw and washer assembly (83), and washer (84) to secure bearing.

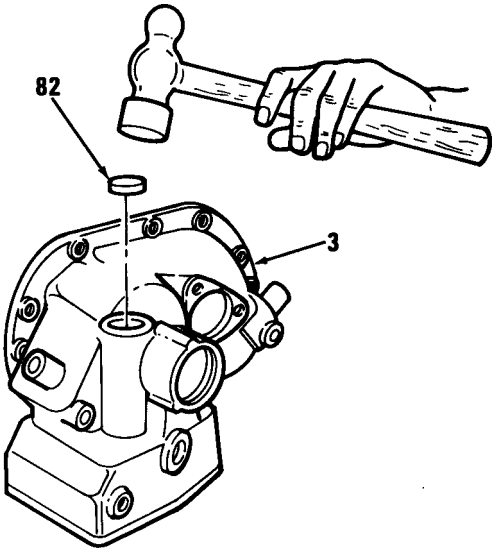
(11) Lubricate lower bearing (86) with engine oil and start bearing into governor housing (3) on operating shaft (85).

(12) Place a 7/16 inch inside diameter sleeve on inner race of lower bearing (86). Using arbor press, install bearing on operating shaft (85) until bearing seats on shoulder in governor housing (3).

4-42. GOVERNOR REPAIR (Cont)

(13) Apply a thin coat of sealant to edge of expansion plug (82).

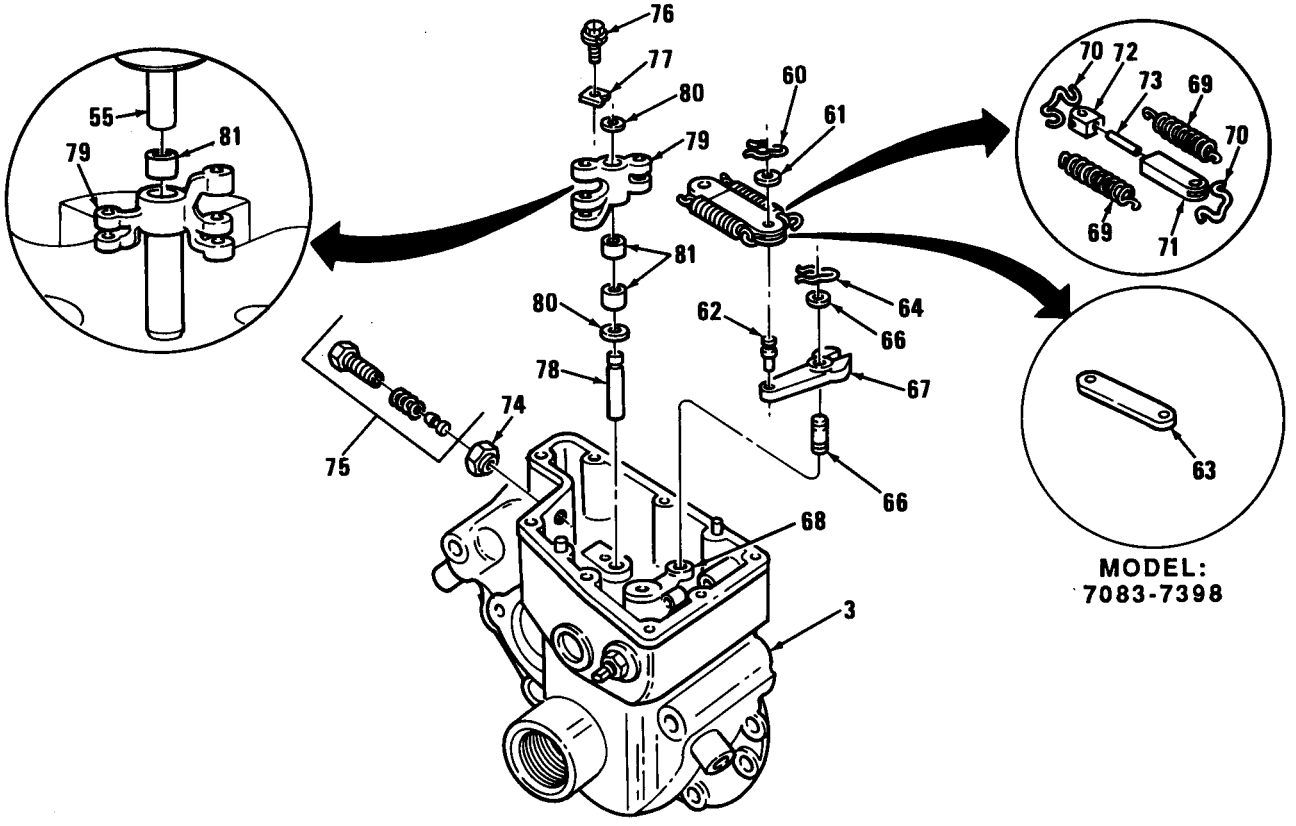
(14) Using a ballpeen hammer, tap expansion plug (82), convex side up, into governor housing (3).



(15) If removed, lubricate outside of two control link operating lever bearings (81) with engine oil and lubricate inside of bearings with grease. Using bearing installing tool (55), press one bearing (81), numbered side up, into control link operating lever (79) until flush with top of lever. Reverse operating lever and install second bearing in same manner.

(16) Insert control link operating lever (79) and two washers (80) between two bosses inside governor housing (3).

(17) Install operating lever shaft (78) with grooved end up.



(18) Install locking clip (77) and screw and washer assembly (76) securing operating lever shaft (78) in governor housing (3). Tighten screw and washer assembly.

(19) Install buffer screw (75) and locknut (74).

(20) Place governor housing (3) in soft-jawed vise.

(21) For model 7083-7395 only, assemble pin (73), governor link (71), and link (72) together. Install two retainer clips (70) and two springs (69).

(22) If removed, install pin (62) into differential lever (67).

(23) Install differential lever (67), washer (65), and spring clip (64) on operating lever (68) with slot facing rear of governor housing (3).

(24) If removed, install operating lever connecting link (63) on differential lever (67) and secure with washer (61) and retaining clip (60) to pin (62).

(25) Using an arbor press and one-inch inside diameter sleeve, press weight shaft (58) into weight carrier (51) until shoulder of weight shaft is seated in carrier.

NOTE

When installing weights, insure matchmarks made at disassembly are alined.

(26) Lubricate outside diameter of needle bearing (57) with engine oil and inside diameter with grease. Using bearing installer tool (55), sleeve (56), and arbor press, install needle bearing (57) into high speed weight (49). Repeat procedure for other high speed weight.

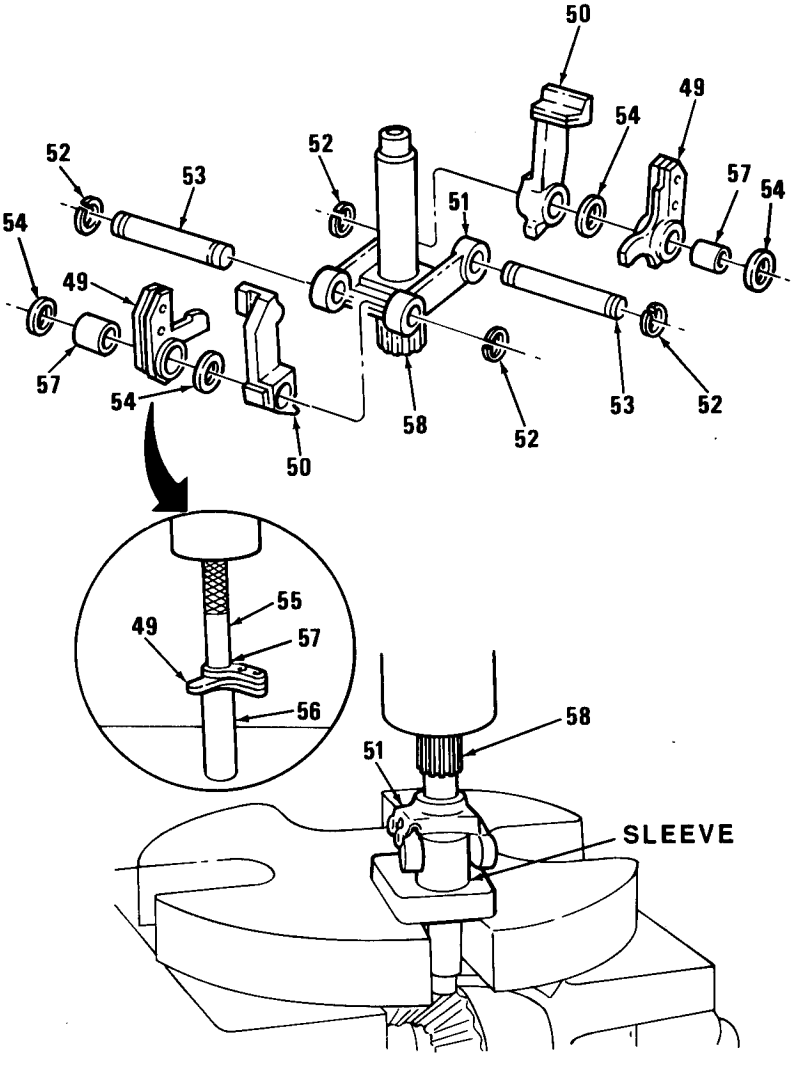
CAUTION

Maintain 0.004-0.012 inches clearance between carrier and low speed weight; otherwise, low speed weight will bind causing erratic operation of governor.

(27) Install retaining clip (52) on one end of weight pin (53). Slide weight pin consecutively through weight carrier (51), washer (54), high speed weight (49), and second washer (54). Place low speed weight (50) in position and then insert a 0.004- 0.012-inch shim between low speed weight and carrier. Press pin through weight carrier until retaining clip bottoms against carrier.

(28) Remove shim and install second retaining clip (52).

(29) Repeat steps (27) and (28) to install opposite side weights in carrier (51).



4-42. GOVERNOR REPAIR (Cont)

(30) Install riser (48) on shaft of weight carrier assembly (43).

NOTE

Incorrect installation of riser thrust bearing will result in erratic operation of governor.

(31) Install riser bearing (47) with smaller inside diameter against riser (48) on weight carrier assembly (43).

(32) Insert weight carrier assembly (43) in governor housing (3). Support spline end of shaft and governor housing on arbor press bed.

(33) Place weight carrier bearing (46) in governor housing (3) with number side up. Place a 1/2 inch diameter sleeve on top of inner race of bearing (46) and press into governor housing (3) and against shoulder of shaft on weight carrier assembly (43).

(34) Clamp spline end of weight carrier assembly (43) in soft-jawed vise.

(35) Place key washer (41) on end of weight carrier assembly (43) with tang on inner diameter of washer in notch in end of carrier shaft.

(36) Install washer (44) and retaining bolt (42), Torque bolt to 15-19 lb-ft (20-26 N-m). Bend tang on key washer (41) against head of bolt.

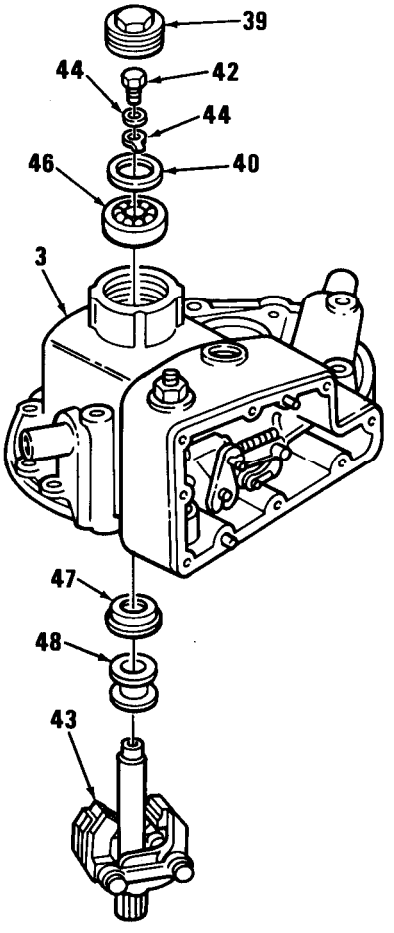
(37) Install washer (40) against bearing (46).

(38) Apply sealant to threads of plug (39) and install in governor housing (3). Torque plug to 45 lb-ft (61 N-m).

(39) Place seat (38) and high speed spring (37) on plunger (30).

(40) Thread screw (35) one-half inch into threaded end of plunger (30) and install nut (36) onto screw until it contacts end of plunger,

(41) Place low speed spring (32) into low speed spring cap (31).



(42) Place small end of spring seat (33) into low speed spring (32). Place adjusting pin (34) into spring seat.

(43) Install adjusting pin (34), spring seat (33), low speed spring (32), and low speed spring cap (31) into plunger (30).

(44) Install high speed spring retainer (29) and plunger (30) assembly into governor housing (3). Tighten spring retainer in governor housing.

(45) Place seal ring (28) in groove of piston (27).

(46) Apply a thin coat of grease on inside diameter of housing (24). Insert solid end of piston (27) in housing.

NOTE

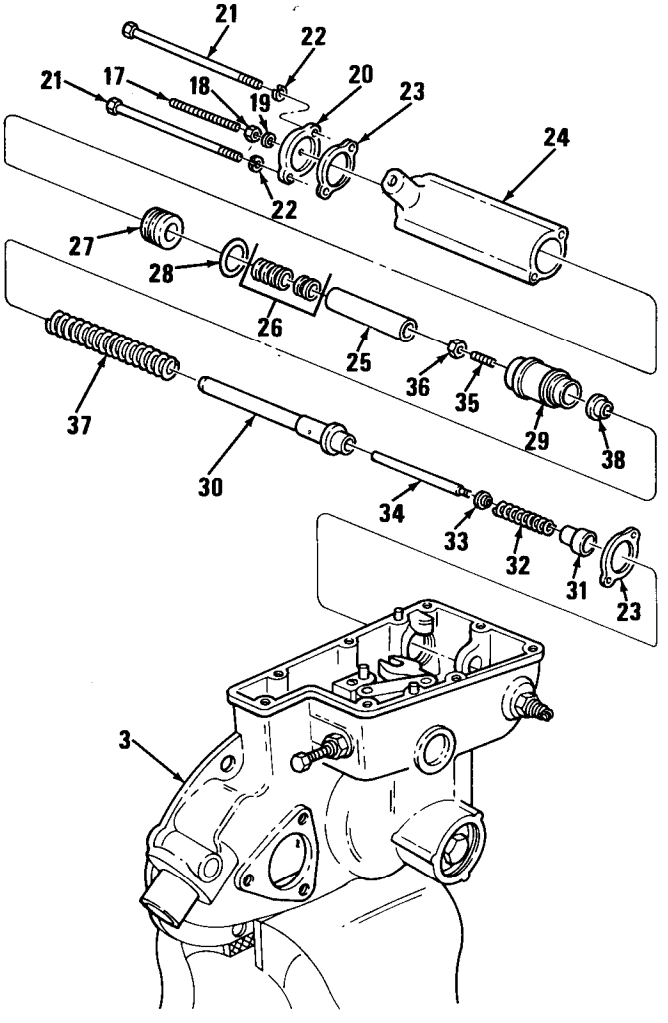
Quantity and thickness of shims installed must match quantity and thickness removed.

(47) Install shims (26) down inside piston (27). Insert piston sleeve (25) against shims (26) in bore of piston (27).

(48) Affix a gasket (23) to governor housing (3) and another to access cover (20).

(49) Attach housing (24) with piston (27), shims (26), sleeve (25), and access cover (19) to governor housing (3) with two bolts (21) and lockwashers (22). Tighten bolts.

(50) Install set screw (17), locking nut (18), and washer (19) in access cover (20) one inch from locking nut.

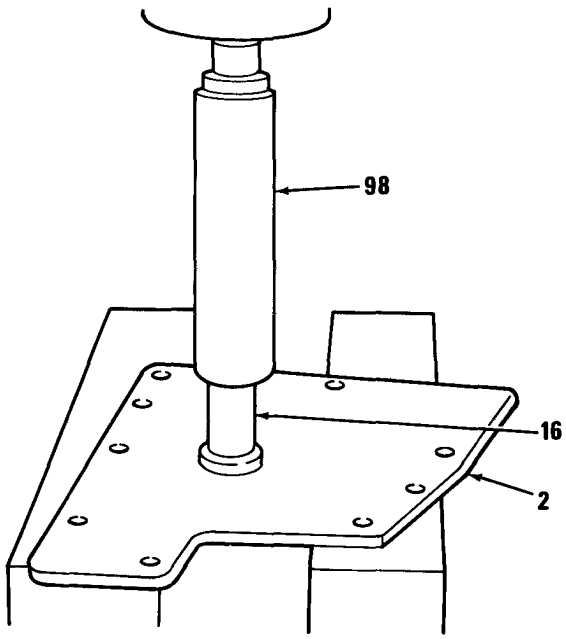


4-42. GOVERNOR REPAIR (Cont)

(51) Place governor cover (2) in press with top facing up.

(52) Using bushing installer tool (98), press two bushings (16), numbered side up, into governor cover (2) until flush.

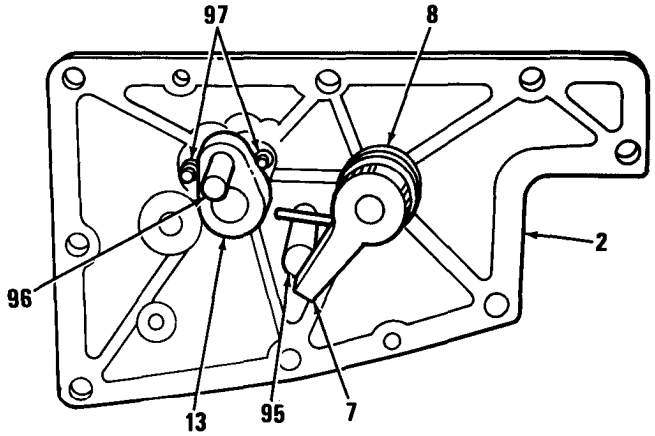
(53) Lubricate inside diameter of two bushings (16) with grease.

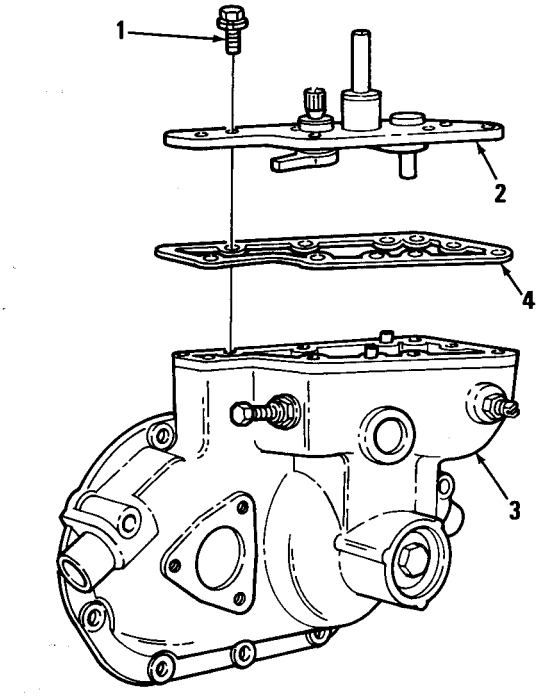


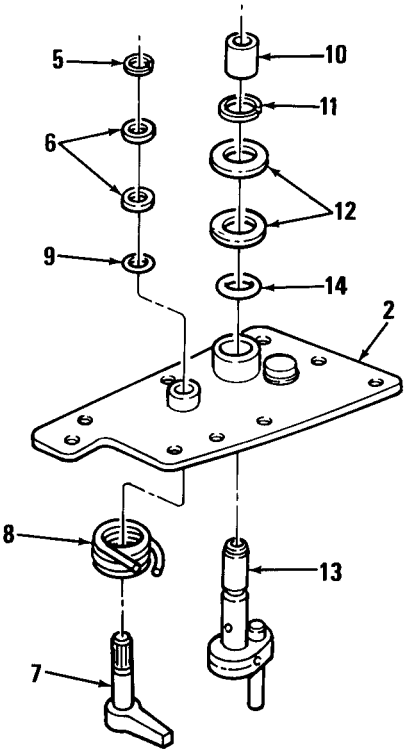
(54) Place stop lever return spring (8) over boss on inner face of governor cover (2).

(55) Insert stop lever shaft (7) part way through hole in governor cover (2) and hook end of return spring (8) over end of lever. Push shaft up in cover.

(56) Position stop lever (7) against stop pin (95), opposite spring (8).







(57) Install seal ring (9), two washers (6), and retaining ring (5) securing stop lever to governor cover (2).

(58) Install speed control shaft (13) into governor cover (2) with guide pin (96) between two pins (97) in cover.

(59) Install seal ring (14), two washers (12), and retaining ring (11) securing speed control shaft to governor cover (2).

(60) Install spacer (10) on speed control shaft (1 3).

(61) Install governor cover (2) and gasket (4) on governor (3). Secure with eight bolts (1) and tighten bolts.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-18 Install governor on blower

4-43. WATER PUMP REPAIR

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

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)
Engine oil (App C, Item 16)
Sealant (App C, Item 38)
Compound (App C, Item 24)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Puller combination leg (App B, Item 68)
Installer water pump drive gear (App B, Item 62)
Adaptor (App D, Item 5)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para	Description
4-9	Water pump removed (7083-7395 and 7083-7398)
5-7	Water pump removed (7083-7391, 7083-7396, and 7083-7399)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 38)
1 Locknut (App F, Item 88)
1 Seal (App F, Item 151)
1 Seal (App F, Item 155)

a. Disassembly

(1) Remove five bolts (1) securing pump cover (2) and gasket (3) to pump body (4). Discard gasket.

CAUTION

When securing gear in vise, use care to prevent damaging gear teeth.

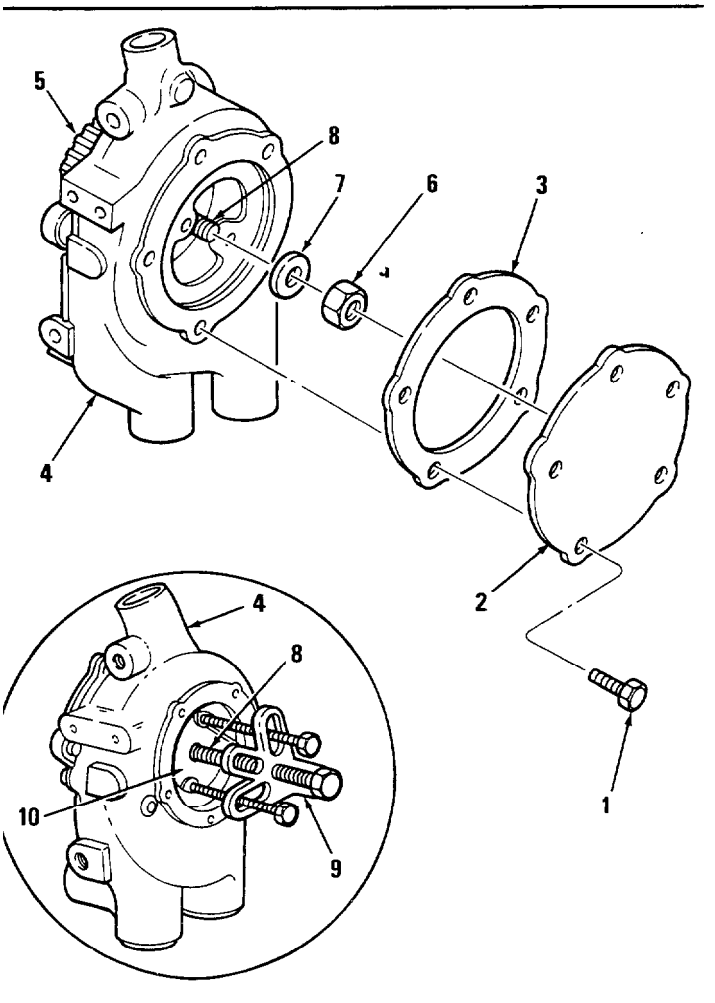
(2) Secure gear (5) in vise. Remove locknut (6) and flat washer (7) from shaft (8). Remove locknut

(3) Using puller (9), remove pump impeller (10) from shaft (8).

(4) Insert snap ring pliers through gear (5). Remove lock ring (11) from groove on shaft (8). Remove gear and shaft as an assembly from pump body (4).

(5) Support gear (5) on arbor press. Place shaft (8) with threaded end facing downward.

(6) Using a 5/8 inch diameter bar, press shaft (8) off gear (5). Remove gear.

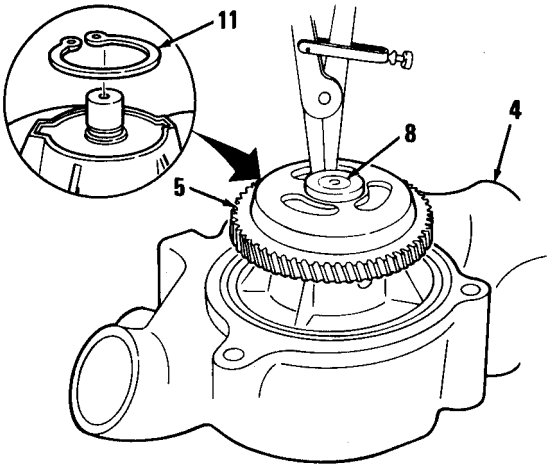


CAUTION

When removing bearings, support inner race only, or damage to bearing may result.

(7) Support shaft (8) on inner race of inner bearing (12). Remove inner bearing.

(8) Invert shaft (8) in arbor press. Support shaft on inner race of outer bearing (13). Press shaft off outer bearing. Remove outer bearing.



(9) Remove oil seal (14) from pump body (4). Discard oil seal.

(10) Remove water pump seal (15) from pump body (4). Discard seal.

NOTE

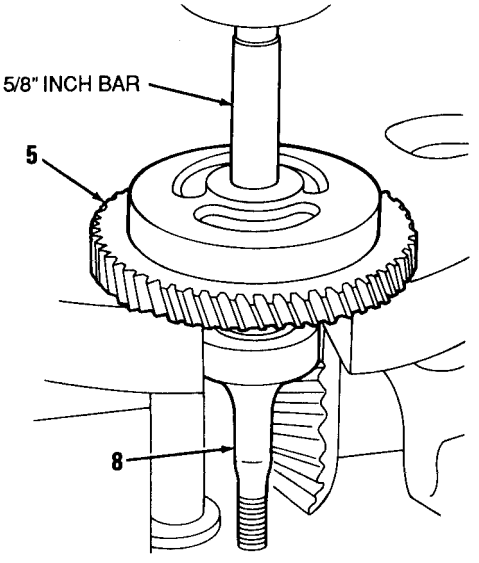
Step (11) is for models 7395 and 7398.

(11) If necessary, remove two pipe plugs (16) and pipe plug (17) from pump body (4).

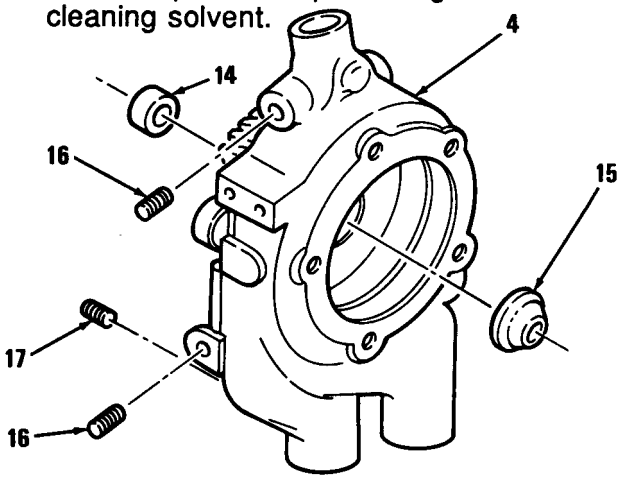
b. Cleaning/Inspection

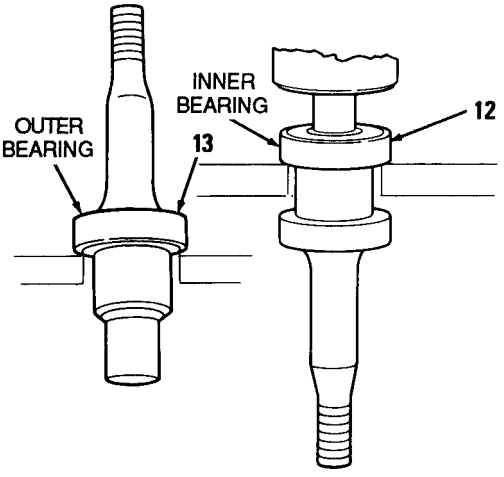
WARNING

Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes and clothes and don't breath vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.



(1) Clean all parts except bearings with cleaning solvent.





4-43. WATER PUMP REPAIR (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.).

(2) Dry all parts with compressed air.

(3) Inspect pump impeller for cracks, burrs, or damage. If ceramic insert is damaged, replace pump impeller.

(4) Inspect housing and cover for cracks, wear, or damage.

(5) Inspect shaft for scores, discoloration, or damage.

(6) Inspect inner and outer bearings for pits, discoloration, or damage.

c. Assembly

(1) Lubricate bearings (12 and 13) inner surfaces and shaft (8) bearing surfaces with engine oil.

CAUTION

When installing bearings, support inner race only or damage to bearing may result.

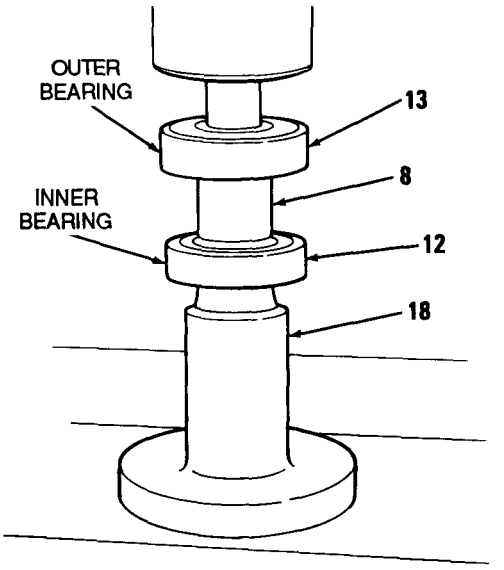
(2) Using installer (18), press inner bearing (12) and outer bearing (13) onto shaft (8).

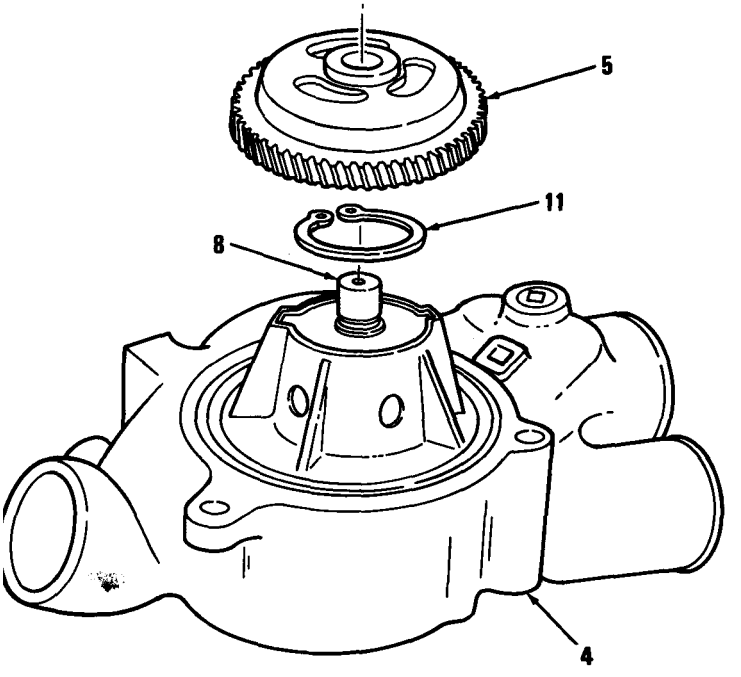
(3) Support pump body (4) with cover side down, and press bearings and shaft into pump body.

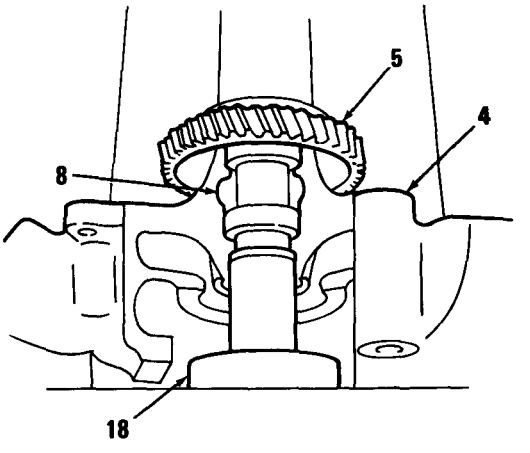
(4) Install lock ring (11) in groove of shaft (8).

(5) Using installer (18), press gear (5) onto impeller end of shaft (8) until gear is flush with end of shaft.

(6) Lubricate new oil seal (14) and shaft (8) seal surface with engine oil.







NOTE

Use correct size sleeve to press seal into pump body. Sleeve should only contact metal part of seal.

(7) Install new oil seal (14) into pump body (4).

NOTE

Oil seal must be flush with the water pump seal counter bore in pump body.

(8) Invert pump body (4) on arbor press.

(9) Apply sealant to outer diameter of new water pump seal (15).

NOTE

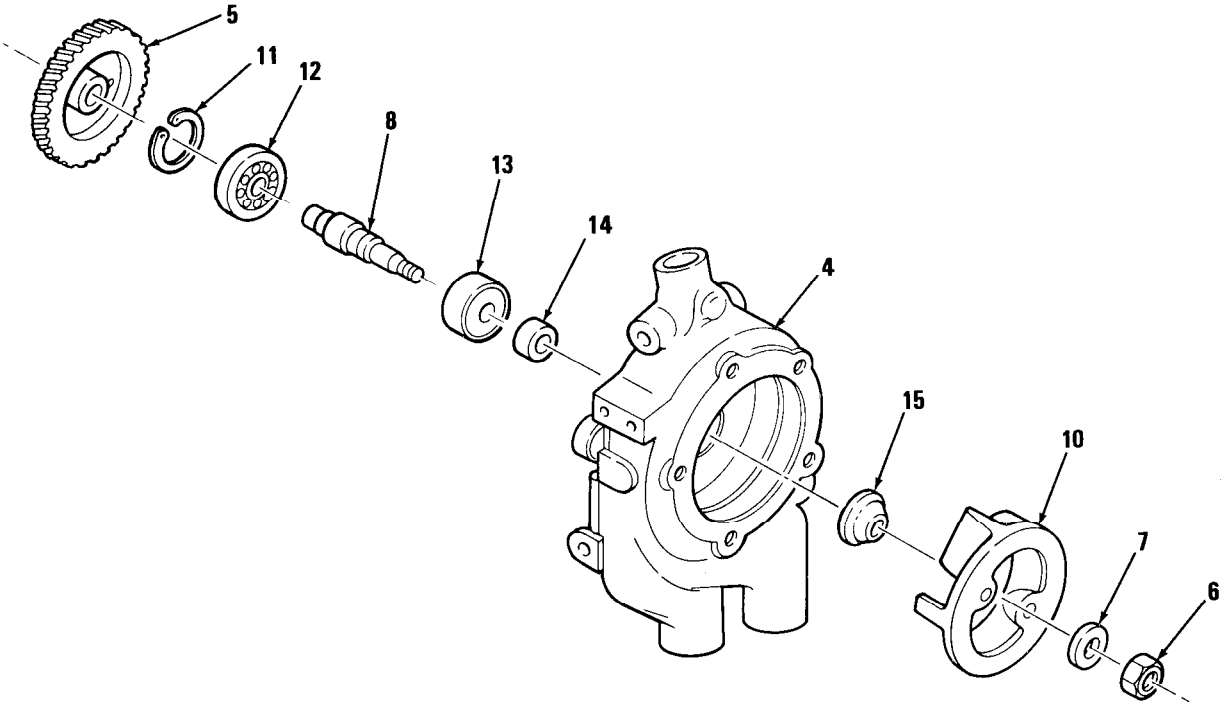
Use correct size sleeve to press seal into pump body. Sleeve should only contact metal part of seal.

(10) Press water pump seal (15) into pump body (4). Remove from arbor press.

CAUTION

When securing gear in soft-jawed vise, hold gear securely. Use care to prevent damaging gear teeth.

(11) Hold gear (5) securely. Apply compound to threads on shaft (8). Place pump impeller (10), flat washer (7), and lock nut (6) on shaft (8).



4-43. WATER PUMP REPAIR (Cont)

(12) Tighten lock nut (6) to install pump impeller (10) on shaft (8). Torque lock nut (6) to 35-40 lb-ft (47-54 N-m).

(13) Before installing pump assembly, check the slip torque as follows:

a. Scribe a line across gear (5) and shaft (8).

b. Scribe a line across pump impeller (10), lock nut (6), and shaft (8).

c. Attach adaptor (19) onto a torque wrench.

CAUTION

When securing gear in vise, hold gear securely. Use care to prevent damaging gear teeth.

d. Hold gear (5) securely. Insert adapter (19) into pump impeller (10), and apply 80 lb-ft (108 N-m) of torque.

e. If slippage occurs, examine scribed marks to determine if gear (5) or pump impeller (1 O) has turned on shaft (8).

f. If slippage occurred, replace shaft (8) and part that turned.

g. After replacing necessary parts, retest pump assembly.

(14) Insert feeler gage into water outlet opening of pump body (4). Measure clearance between pump impeller (1 O) and pump body (4). Clearance must be 0.015 inch minimum.

(15) Install new gasket (3) and pump cover (2) to pump body (4). Secure with five bolts (1). Torque bolts to 13-17 lb-ft (18-23 N-m).

NOTE

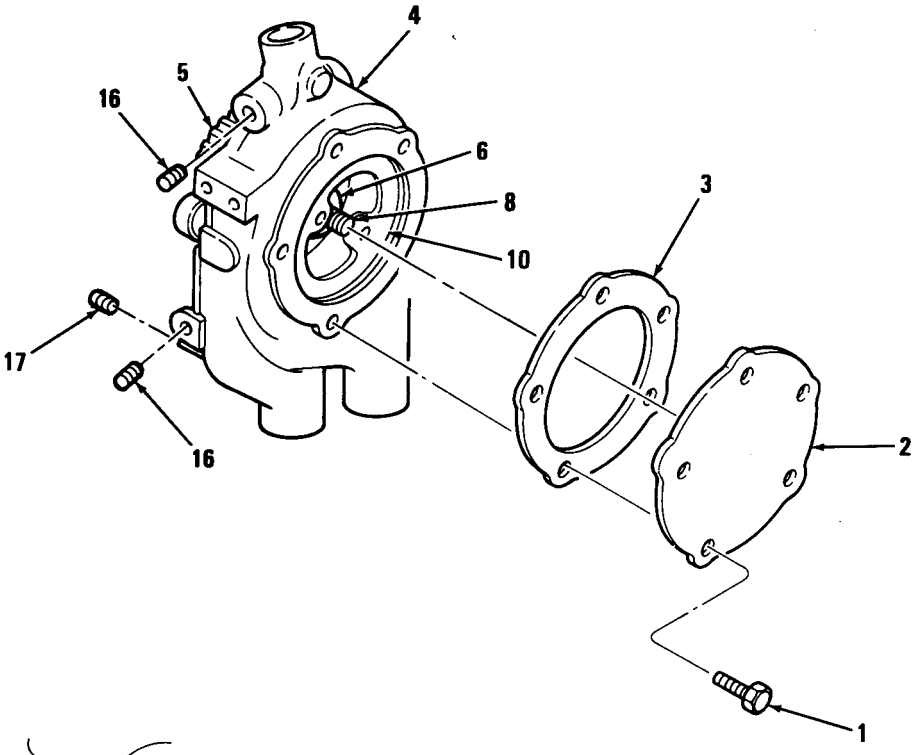
Step (16) is for models 7395 and 7398.

(16) If removed, install two pipe plugs (16) and pipe plug (17) into pump body (4). Remove pump from vise.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-7 Install water pump (7083-7391, 7083-7396, and 7083-7399)
4-9 Install water pump (7083-7395 and 7083-7398)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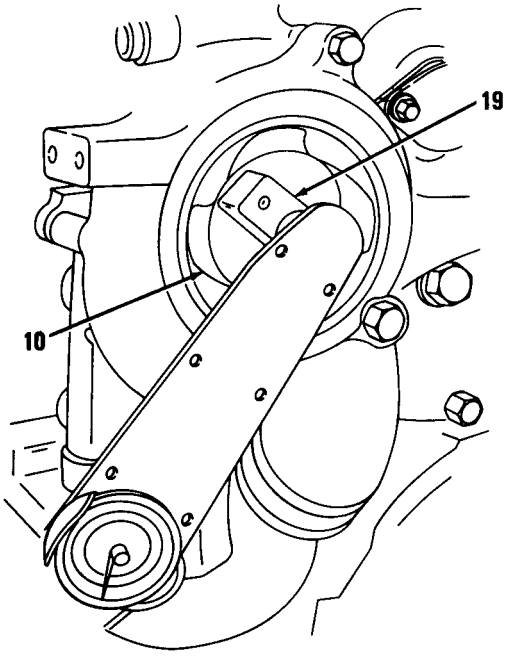
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CHAPTER 5

REPAIR PROCEDURES FOR MAJOR COMPONENTS OF ENGINE MODEL 7083-7396

Contents

Section I. INTRODUCTION

5-1. GENERAL. This chapter provides the repair procedures performed on engine model 7083-7396 after the engine has been installed on the maintenance stand. 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.

This chapter deals with model 7083-7396. However, if a model in a previous chapter has identical or nearly identical components, this chapter will refer to the previous chapter. If models in subsequent chapters have identical or nearly identical components, this chapter will also cover those models.

Section II. GENERAL ENGINE MAINTENANCE

5-2. TURBOCHARGER REMOVAL/INSTALLATION

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

INITIAL SETUP

MODELS

7083-7391 7083-7396

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

4 Locking nuts (App F, Item 105)
1 Gasket (App F, Item 79)

EQUIPMENT CONDITION

Para	Description
3-8	Starter removed
3-10	Turbocharger oil return line removed
3-12	Turbocharger oil supply line removed
3-14	Air inlet manifold removed

a. Removal

(1) Loosen four clamps (1) and two hoses (2) connecting air inlet tube (3) to turbocharger (4) and air inlet housing (5).

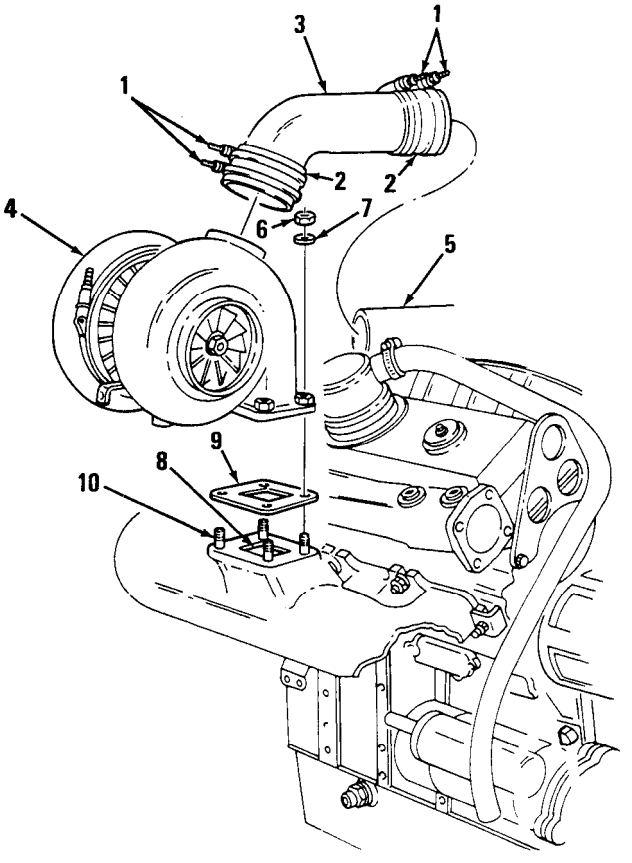
(2) Slide two hoses (2) and four clamps (1) onto air inlet tube (3) and remove tube. Remove hoses and clamps from tube.

CAUTION

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

(3) Remove four locking nuts (6) and four washers (7) securing turbocharger (4) to exhaust manifold (8). Discard locking nuts.

(4) Remove turbocharger (4) and gasket (9). Discard gasket.



5-2. TURBOCHARGER REMOVAL/INSTALLATION (Cont)

b. Cleanlng/inspection

(1) Inspect hoses for cuts, cracks, and brittleness.

(2) Replace all parts failing inspection.

c. Installation

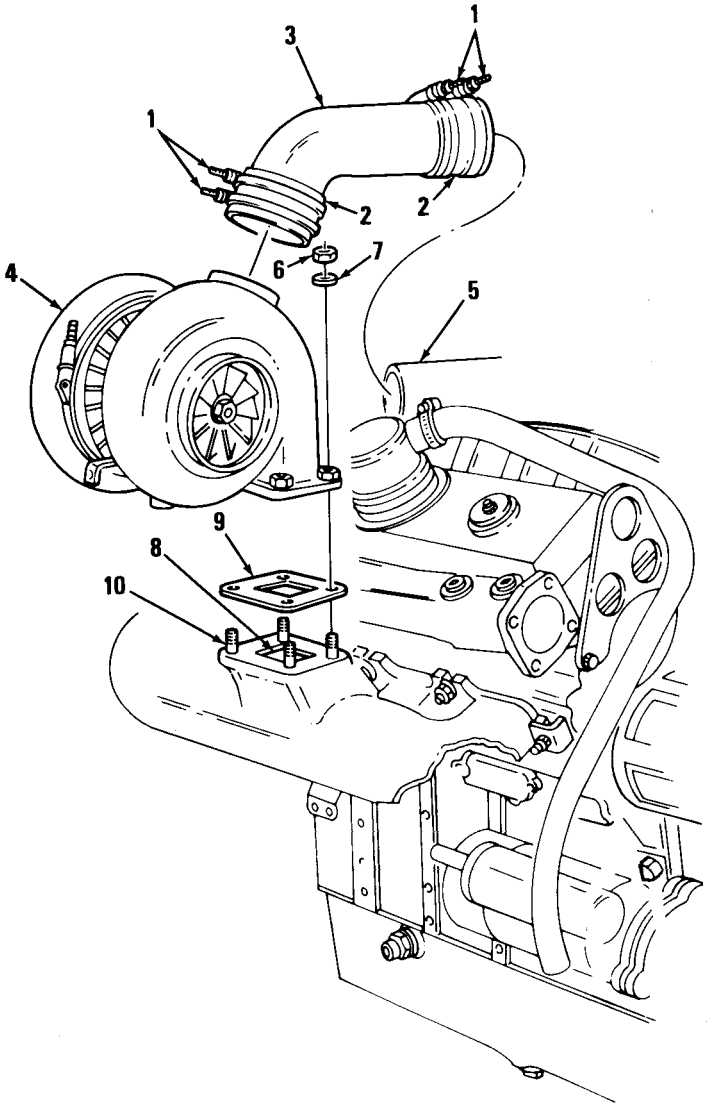
(1) Install gasket (9) over studs (10) on exhaust manifold (8).

(2) Install turbocharger (4) over studs (10); secure with four washers (7) and four locking nuts (6). Torque locking nuts to 35-39 lb-ft (47-53 N-m).

(3) Slide two hoses (2) and four clamps (1) onto air inlet tube (3).

(4) Position air inlet tube (3) between turbocharger (4) and air inlet housing (5).

(5) Slide hoses (2) and clamps (1) onto turbocharger (4) and air inlet housing (5). Tighten hose clamps.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-14 Install air inlet manifold
3-12 Install turbocharger oil supply line
3-10 Install turbocharger oil return line
3-8 Install starter

5-3. EXHAUST MANIFOLD AND TUBE REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7391 7083-7396

TOOLS AND SPECIAL TOOLS

General Mechanics Tool Set (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

2 Gaskets App F, Item 29)
2 Gaskets (App F, Item 172)*
13 Locking Nuts (App F, Item 173)
14 Locking nuts (App F, Item 173) *

EQUIPMENT CONDITION

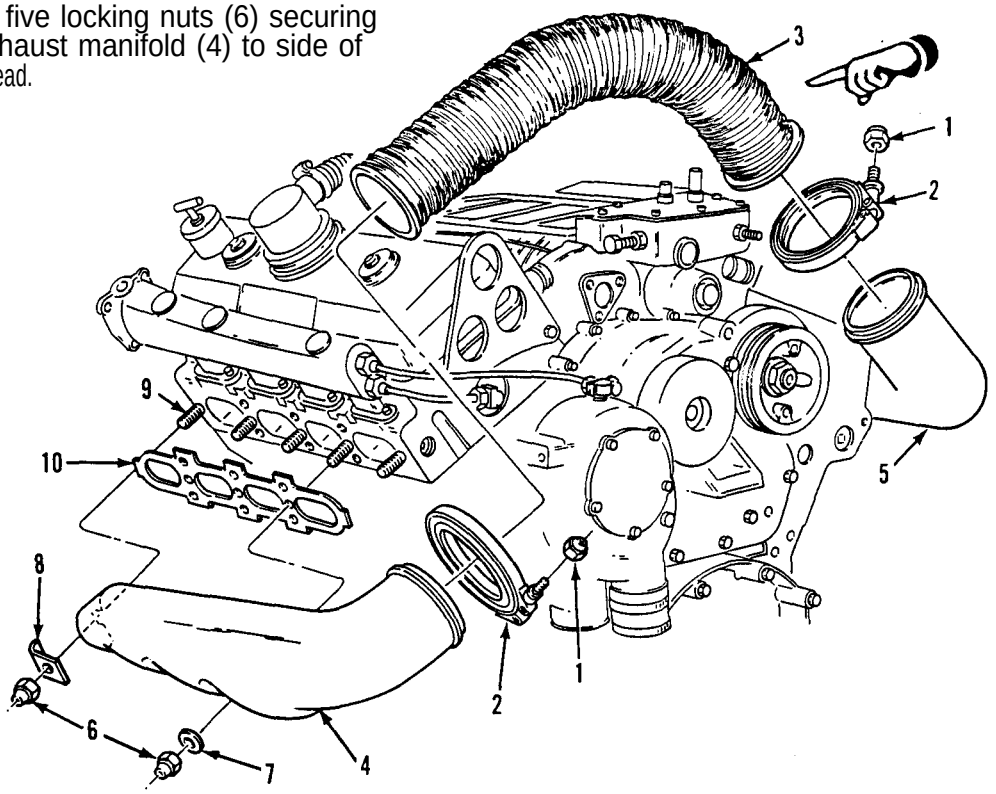
Para Description
3-10 Turbocharger oil return line removed
3-12 Turbocharger oil supply line removed
3-14 Air inlet manifold removed
5-2 Turbocharger removed

* Used on model 7083-7391

a. Removal

(1) Remove two nuts (1) from two clamps (2) securing exhaust crossover tube (3) to right exhaust manifold (4) and left exhaust manifold (5). Slide clamps onto manifolds.

(2) Loosen five locking nuts (6) securing right exhaust manifold (4) to side of cylinder head.



5-3. EXHAUST MANIFOLD AND TUBE REPLACEMENT (Cont)

(3) Remove exhaust crossover tube (3) from exhaust manifolds (4 and 5). Slide right exhaust manifold (4) upward and off cylinder head. Remove clamp (2) from manifold.

NOTE

Model 7083-7391 has five beveled washers and no end retainers.

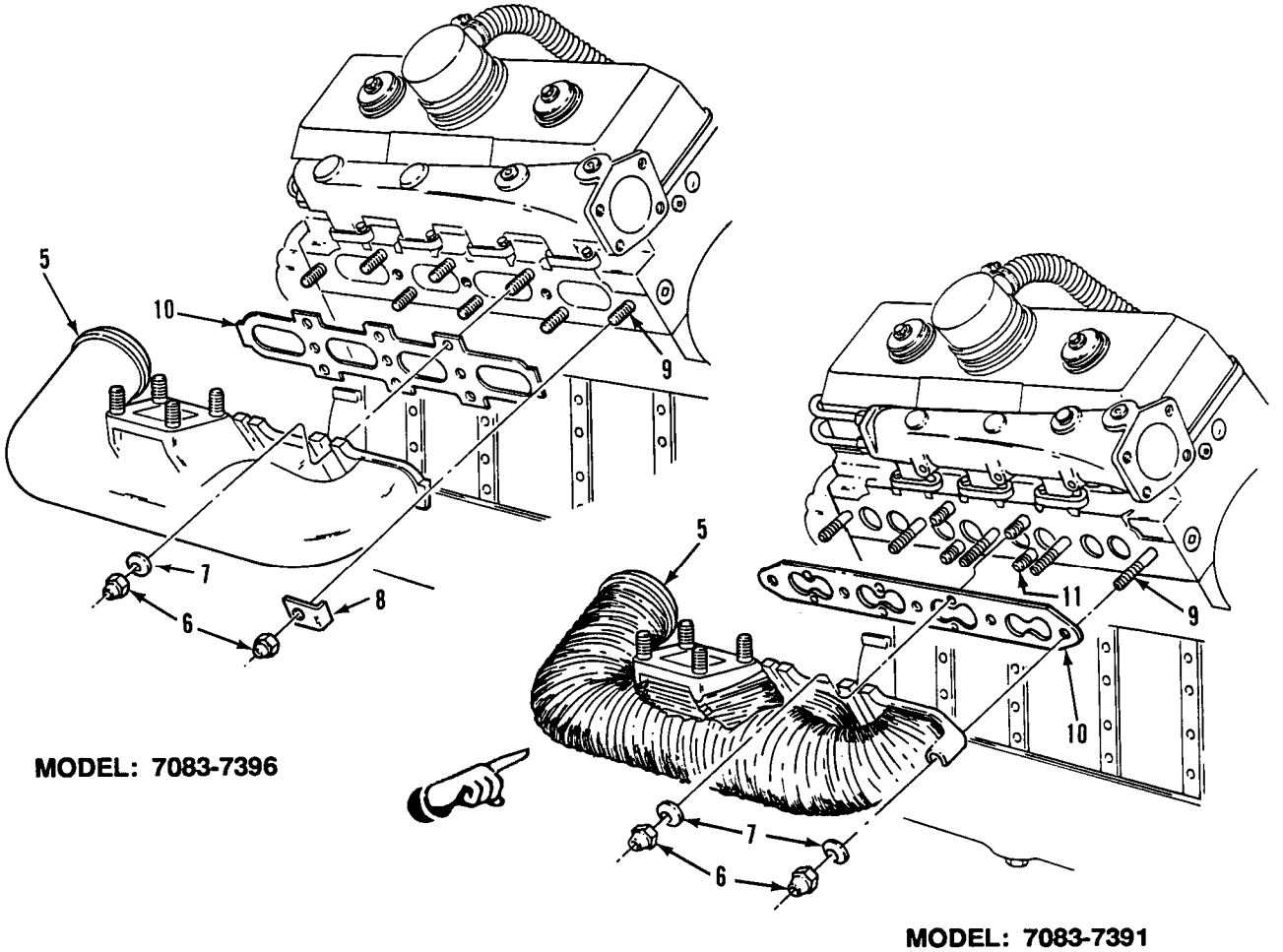
(4) Remove five locking nuts (6), three beveled washers (7), and two end retainers (8) from studs (9) on right cylinder head. Discard locking nuts.

(5) Remove exhaust manifold gasket (10). Discard gasket.

(6) For model 7083-7396 remove eight locking nuts (6), six beveled washers (7), and two end retainers (8) from studs (9) on left cylinder head. Remove exhaust manifold and discard locking nuts.

(7) For model 7083-7391, remove nine locking nuts (6), and nine beveled washers (7) from studs (9 and 11) on left cylinder head. Remove exhaust manifold and discard locking nuts.

(8) Remove exhaust manifold gasket (10). Discard gasket.



b. Installation

NOTE

Model 7083-7391 has an unidirectional exhaust manifold gasket which must be installed with embossed word "TOP" facing outward and at the top.

(1) Position gasket (10) over exhaust manifold studs (9) on left cylinder head.

NOTE

- Position beveled washers with crown facing nut.
- Insure locating pads on exhaust manifold rest on cylinder block locating pads.
- For model 7083-7391, install glow plugs prior to installing exhaust manifolds. (Refer to Para 5.1-8.)

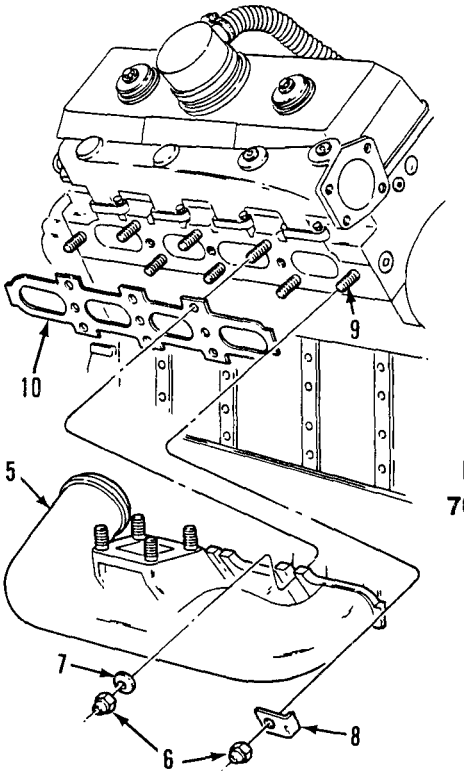
(2) For model 7083-7396, position left exhaust manifold (5) over studs (9) on cylinder head and secure with six beveled washers (7), two end retainers (8) and eight locking nuts (6). Torque nuts to 30-35 lb-ft (41-47 N-m) starting from center and working outward alternately toward either end.

(3) For model 7083-7391, position left exhaust manifold (5) over studs (9 and 11) on cylinder head and secure with nine beveled washers (7), and nine locking nuts (6). Torque nuts to 43-48 lb-ft (59-67 N-m) starting from the center and working outward alternately toward either end.

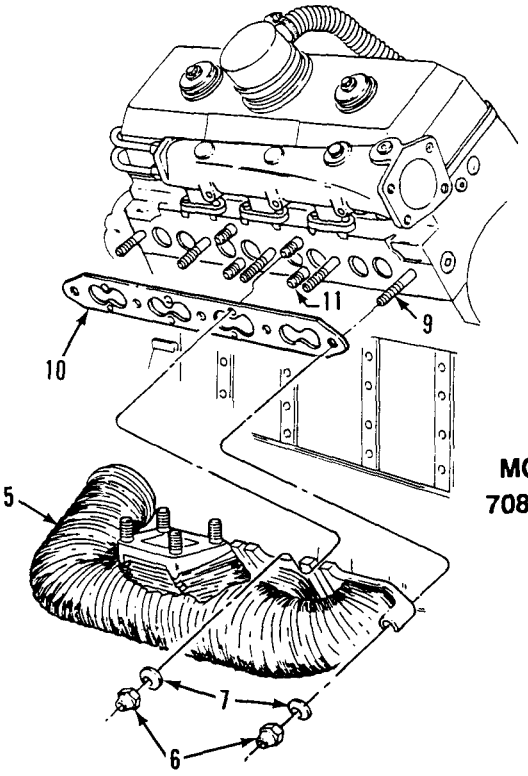
NOTE

Model 7083-7391 has an unidirectional exhaust manifold gasket which must be installed with the embossed word "TOP" facing outward and at the top.

(4) Position gasket (10) over exhaust manifold studs (9) on right cylinder head.



MODEL: 7083-7396



MODEL: 7083-7391

5-3. EXHAUST MANIFOLD AND TUBE REPLACEMENT (Cont)

NOTE

- Position beveled washers with crown facing nut.
- Model 7083-7391 has five beveled washers and no end retainers.

(5) Install three beveled washers (7), two end retainers (8), and five locking nuts (6) on right exhaust manifold studs (9).

CAUTION

Use care when sliding exhaust manifold down pass exhaust gasket so not to bend or damage gasket or exhaust leaks will result.

NOTE

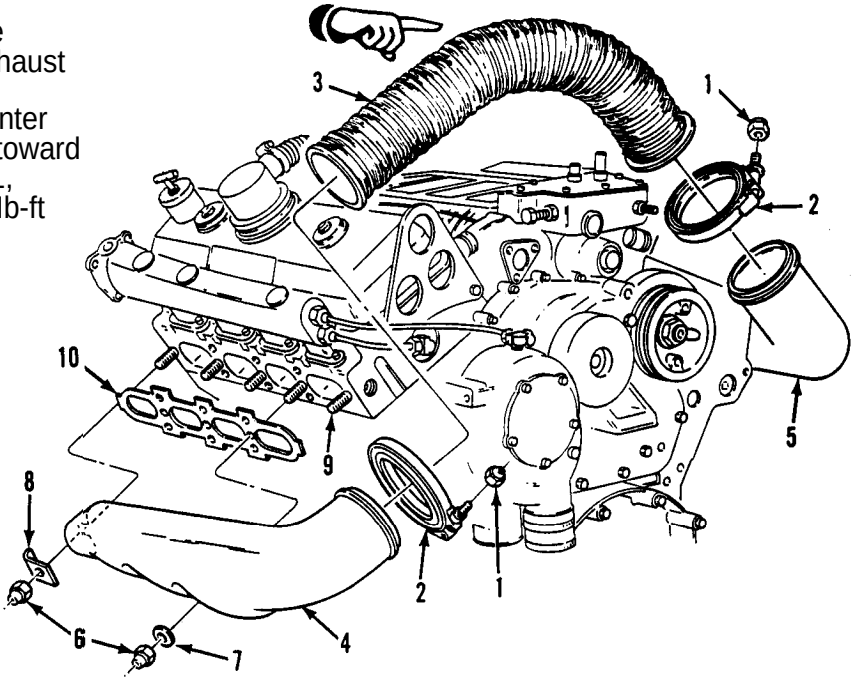
- Do not tighten or torque exhaust manifold nuts until crossover tube has been installed.
- Insure locating pads on exhaust manifold rest on cylinder block locating pads.

(6) Install right exhaust manifold (4) onto cylinder head by sliding downward between gasket and retainers.

(7) Position two clamps (2) on crossover tube (3). Install exhaust crossover tube between exhaust manifolds (4 and 5).

(8) Secure exhaust manifolds (4 and 5) to crossover tube (3) with two clamps (2) and two nuts (1). Tighten nuts.

(9) For model 7083-7396, torque five locking nuts (6) securing right exhaust manifold (4) to cylinder head to 30-35 lb-ft (41-47 N-m) starting from center and working outward alternately toward either end. For model 7083-7391, torque five locking nuts to 43-48 lb-ft (59-67 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5 - 2 Install turbocharger
3-14 Install air inlet manifold
3-12 Install turbocharger oil supply line
3-10 Install turbocharger oil return line

5-4. FUEL LINES REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS	TOOLS AND SPECIAL TOOLS
7083-7396 7083-7399	General mechanics tool kit (App B, Item 96) Torque wrench (App B, Item 101)

a. Removal

(1) Remove bolt (1) and flat washer (2) securing fuel crossover return line clamp (3) to front of governor cover (4). Reinstall bolt and flat washer in governor cover.

(2) Disconnect fuel return crossover line (5) at elbows (6) on front of right and left cylinder heads. Remove crossover return line.

(3) Remove two bolts (7) and two flat washers (8) attaching fuel supply crossover line clamps (9) to rear of governor cover (4). Reinstall bolts and flat washers in governor cover.

(4) Disconnect fuel supply crossover line (10) at elbow (11) on front of left cylinder head and at tee (12) on front of right cylinder head. Remove supply crossover line.

b. Installation

(1) Connect one end of fuel supply crossover line (10) to elbow(11) at front of left cylinder head and connect other end to tee (12) at front of right cylinder head. Tighten connections.

NOTE

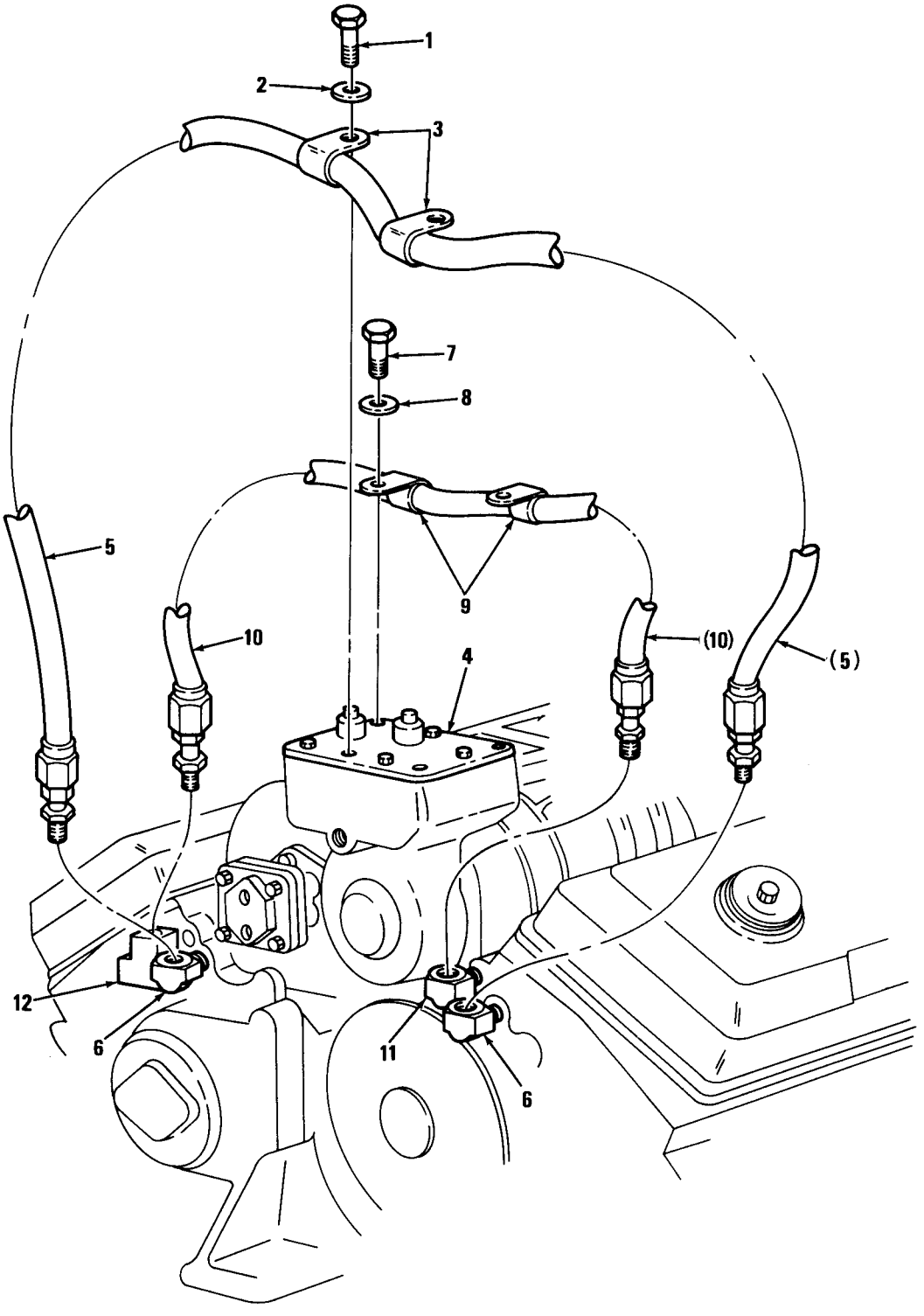
Drape and clip lines around governor cover. Do not mount lines over top of cover.

(2) Secure fuel line clamps (9) on fuel supply crossover line (10) to rear of governor cover (4) by installing two bolts (7) and two flat washers (8) from governor cover. Torque bolts to 7-9 lb-ft . (10-12 N-m).

(3) Connect fuel return crossover line (5) to elbow connectors (6) at front of right and left cylinder heads. Tighten connections.

(4) Secure fuel line clamps (3) on fuel return crossover line (5) to front of governor cover (4) by installing two bolts (1) and two flat washers (2) from governor cover. Torque bolts to 7-9 lb-ft (10-12 N-m).

END OF TASK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5-5. ENGINE LIFTING BRACKETS REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

■ 7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY Replacement PARTS

8 Lockwashers (App F, Item 94)
4 Gaskets (App F,Item 34)

EQUIPMENT CONDITION

Para Description
5-8 Air box heater line removed (Except 7083-7391)

a. Removal

(1) Remove two bolts (1) and two lockwashers (2) securing engine lifting bracket (3) to front of right cylinder head. Remove bracket and discard lockwashers.

(2) Remove gasket (4) from front of cylinder head. Discard gasket.

(3) Remove two bolts (5) and two lockwashers (6) securing engine lifting bracket (7) to rear of right cylinder head. Remove bracket and discard lockwashers.

(4) Remove gasket (8) from rear of cylinder head. Discard gasket.

(5) Repeat steps (1) thru (4) for removal of left cylinder head lifting brackets.

b. Installation

(1) Install two bolts (5), two lockwashers (6), and gasket (8) securing rear engine lifting bracket (7) to right cylinder head. Torque bolts to 46-50 lb-ft (62-68 N-m).

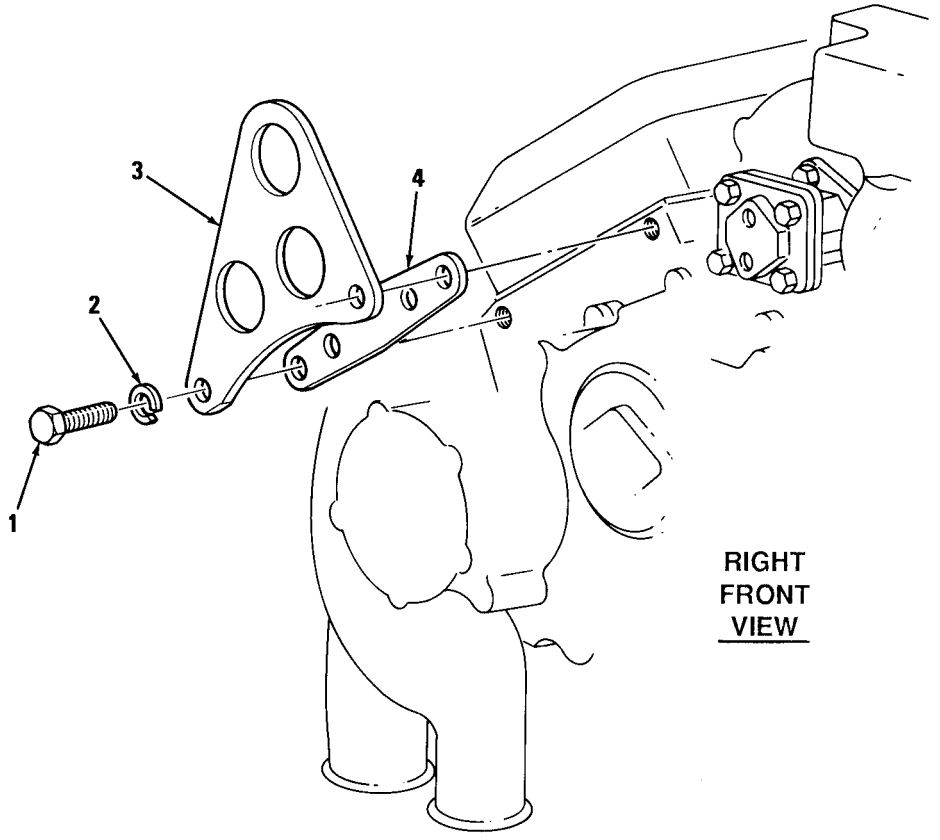
(2) Install two bolts (1), two lockwashers (2), and gasket (4) securing front engine lifting bracket (3) to right cylinder head. Torque bolts to 46-50 lb-ft (62-68 N-m).

(3) Repeat steps 1 and 2 for installation of left engine lifting brackets.

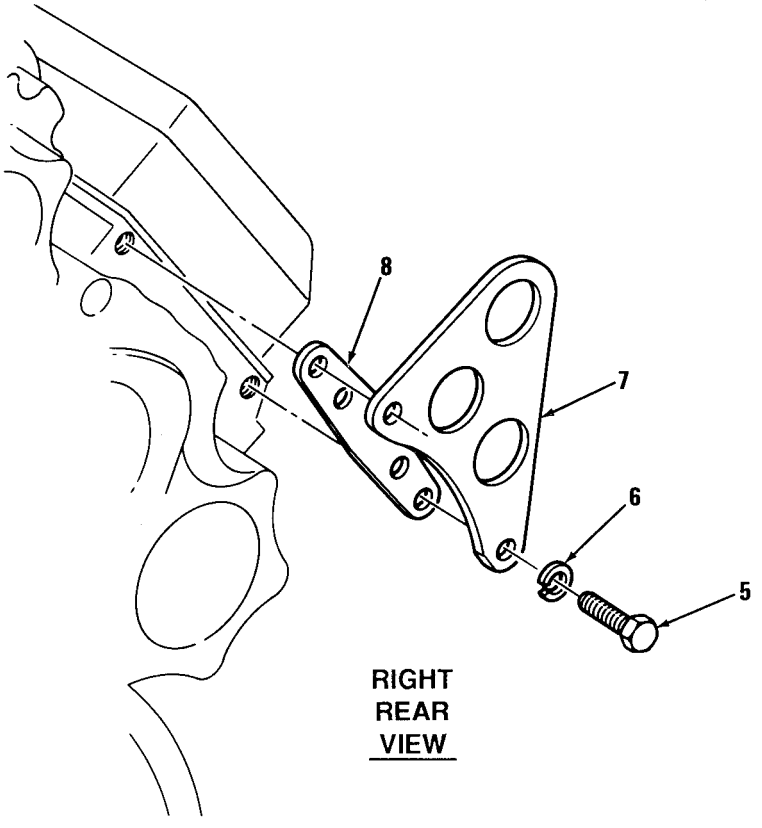
END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
■ 5-8 Install air box heater line (Except 7083-7391)



RIGHT
FRONT
VIEW



RIGHT
REAR
VIEW

5-6. ENGINE WATER MANIFOLDS REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7396 7083-7399

MANDATORY REPLACEMENT PARTS

16 Lockwashers (App F,Item 93)
8 Gaskets (App F, Item 71)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para Description
3-7 Oil level gauge rod removed
3-14 Air inlet manifold removed (7083-7396)
3-15 Air inlet manifold removed (7083-7399)
5-2 Turbocharger removed (7083-7396)
5-3 Exhaust manifolds removed (7083-7396)
7-3 Turbocharger removed (7083-7399)
7-4 Exhaust manifolds removed (7083-7399)

a. Removal

(1) Disconnect tube assembly (1) at upper fitting (2) on right water manifold (3) and at elbow fitting (4) on top of water pump (5). Remove tube assembly.

(2) Disconnect tube assembly (6) at lower fitting (7) on right water manifold (3) and at elbow fitting (8) on front of right cylinder head (9). Remove tube assembly.

(3) Remove eight nuts (10) and eight lockwashers (11) securing water manifold (3) to right cylinder head (9). Discard lockwashers and remove water manifold.

(4) Remove four gaskets (12) from bottom of water manifold or top of cylinder head. Discard gaskets.

(5) If necessary, remove four fittings (2,7,13, and 14) from end of right water manifold (3), and two plugs (15) from top of water manifold.

(6) Repeat steps (2) thru (4) above for left water manifold.

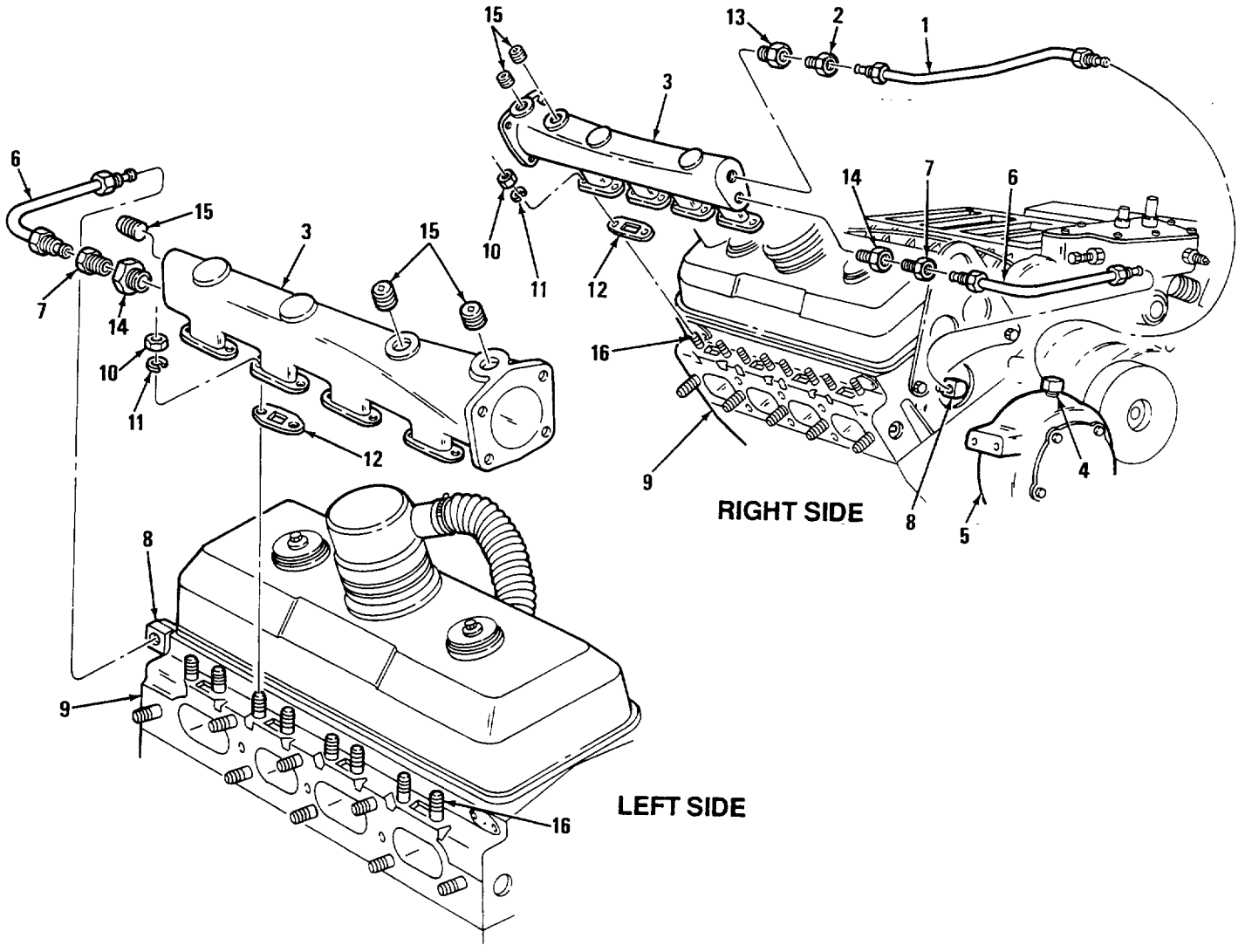
(7) If necessary, remove two fittings (7 and 14) and three plugs (15) from left bank water manifold (3).

b. Installation

(1) If removed, install four fittings (2,7,13, and 14) in the front of right water manifold (3) and two plugs (15) in top of manifold.

(2) Install four gaskets (12) over studs (16) on right cylinder head.

(3) Install water manifold (3) on right cylinder head and secure with eight lockwashers (11) and eight nuts (10). Torque nuts to 20-25 lb-ft (27-34 N-m).



(4) Connect tube assembly (1) at elbow fitting (4) on water pump (5) and at upper fitting (2) on water manifold (3). Tighten connections.

(5) Repeat steps (2) and (3) above for left water manifold.

(6) If removed, install two fittings (7 and 14) and three plugs (15) in left water manifold (3).

(7) Connect tube assembly (6) at elbow fitting (8) on cylinder head (9) and at lower fitting (7) on each water manifold (3). Tighten connections.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
5-3	Install exhaust manifolds (7083-7396)
5-2	Install turbocharger (7083-7396)
7-4	Install exhaust manifolds (7083-7399)
7-3	Install turbocharger (7083-7399)
3-14	Install air inlet manifold (7083-7396)
3-15	Install air inlet manifold (7083-7399)
3-7	Install oil level gauge rod

5-7. WATER PUMP REMOVAL/INSTALLATION

This task covers: a. Removal b. Installation c. Gear-Backlash Adjustment

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool Kit (App B, Item 96)
Magnetic base dial indicator (App B, Item 45)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

3 LockWashers (App F, Item 94)
1 Seal ring (App F, Item 133)

EQUIPMENT CONDITION

Para Description
3-6 Water outlet removed
5-6 Water manifold tube assembly removed (7083-7396 and 7083-7399)
5.1-6 Water manifold tube assembly removed (7083-7391)

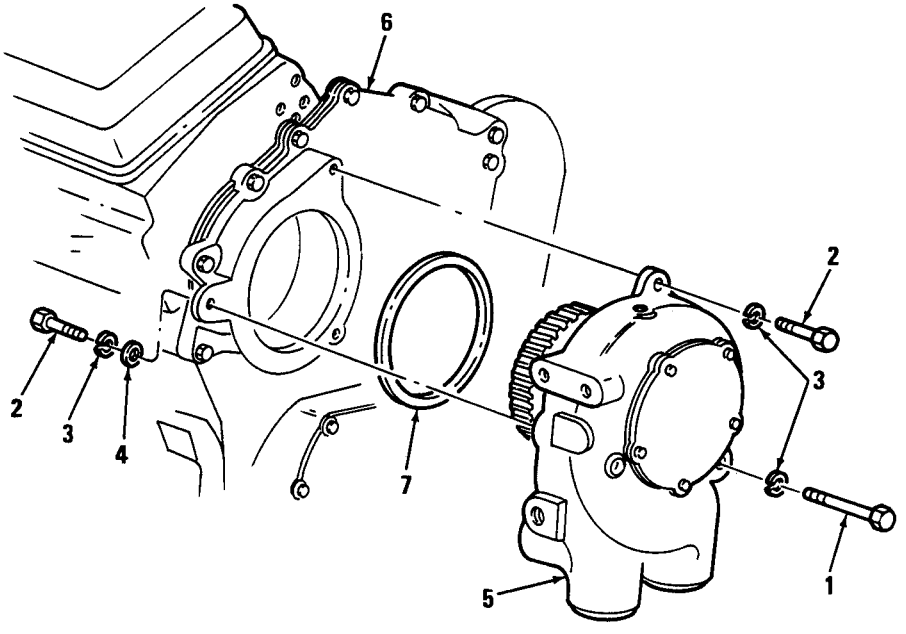
a. Removal

(1) Remove bolt (1), two bolts (2), three lockwashers (3), and flat washer (4) securing water pump (5) to engine front cover (6). Discard lockwashers.

CAUTION

Use care when removing water pump to prevent damage to gear teeth.

(2) Remove water pump (5) from engine front cover (6). Remove seal ring (7) and discard.



b. Installation

(1) Affix seal ring (7) to back of water pump (5).

(2) Install water pump (5), alining gear teeth with drive gear in engine front cover (6).

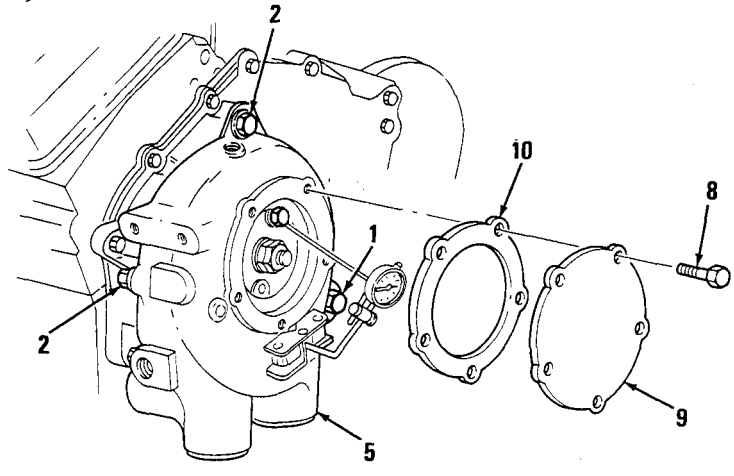
(3) Install bolt (1), two bolts (2), three lockwashers (3), and flat washer (4) securing water pump (5) to front cover (6). Torque bolts to 46-50 lb-ft (62-68 N-m).

c. Gear Backlash Adjustment

(1) Remove five bolts (8), pump cover (9), and gasket (10) from water pump (5).

(2) Check gear backlash by installing a bolt or equivalent in impeller puller hole. Measure backlash with a dial indicator at this point. Backlash setting should be between 0.001 and 0.006 inch. If setting is not correct, loosen bolts (1 and 2) and pivot water pump until properly set. Retorque bolts (1 and 2).

(3) Install gasket (10), pump cover (9) and five bolts (8) to water pump (5). Torque bolts to 13-17 lb-ft (1 8-23 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-6 Install water manifold tube assembly (7083-7396 and 7083-7399)
5.1-6 Install water manifold tube assembly (7083-7391)
3-6 Install water outlet

5-8. AIR BOX HEATER REPLACEMENT (See Para 4-10)

5-9. ENGINE ROCKER ARM COVER AND CRANKCASE BREATHER REPLACEMENT (See Para 4-11)

5-10. FUEL PUMP REPLACEMENT (See Para 4-12)

5-11. AIR INLET HOUSING REPLACEMENT (See Para 4-13)

5-12. TACHOMETER DRIVE REPLACEMENT (See Para 4-14)

5-13. BLOCK MOUNTED CRANKCASE BREATHER REPLACEMENT (See Para 4-15)

5-14. ACCESSORY DRIVE REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

6 Lockwashers (App F,Item 93)
1 Gasket (App F,Item 26)
1 Seal (App F, Item 148)
1 CUP plug (App F, Item 12)

EXPENDABLE/DURABLE SUPPLIES

Fuel oil (App C, Item 21)
Sealant (App C, Item 38)
Engine oil (App C, Item 16)

a. Removal

(1) Remove bolt (1), nut (2), flat washer (3), and lockwasher (4) from accessory drive assembly (5) and flywheel housing (6). Discard lockwasher.

(2) Remove three bolts (7) and three lockwashers (4) securing accessory drive assembly (5) to flywheel housing (6). Discard lockwashers.

(3) Remove two bolts (8), two lockwashers (4), and accessory drive assembly (5) from flywheel housing (6). Discard lockwashers.

(4) Remove fiber coupling (9) from blower drive hub (10).

(5) Remove gasket (11) from accessory drive assembly (5). Discard gasket.

b. Disassembly

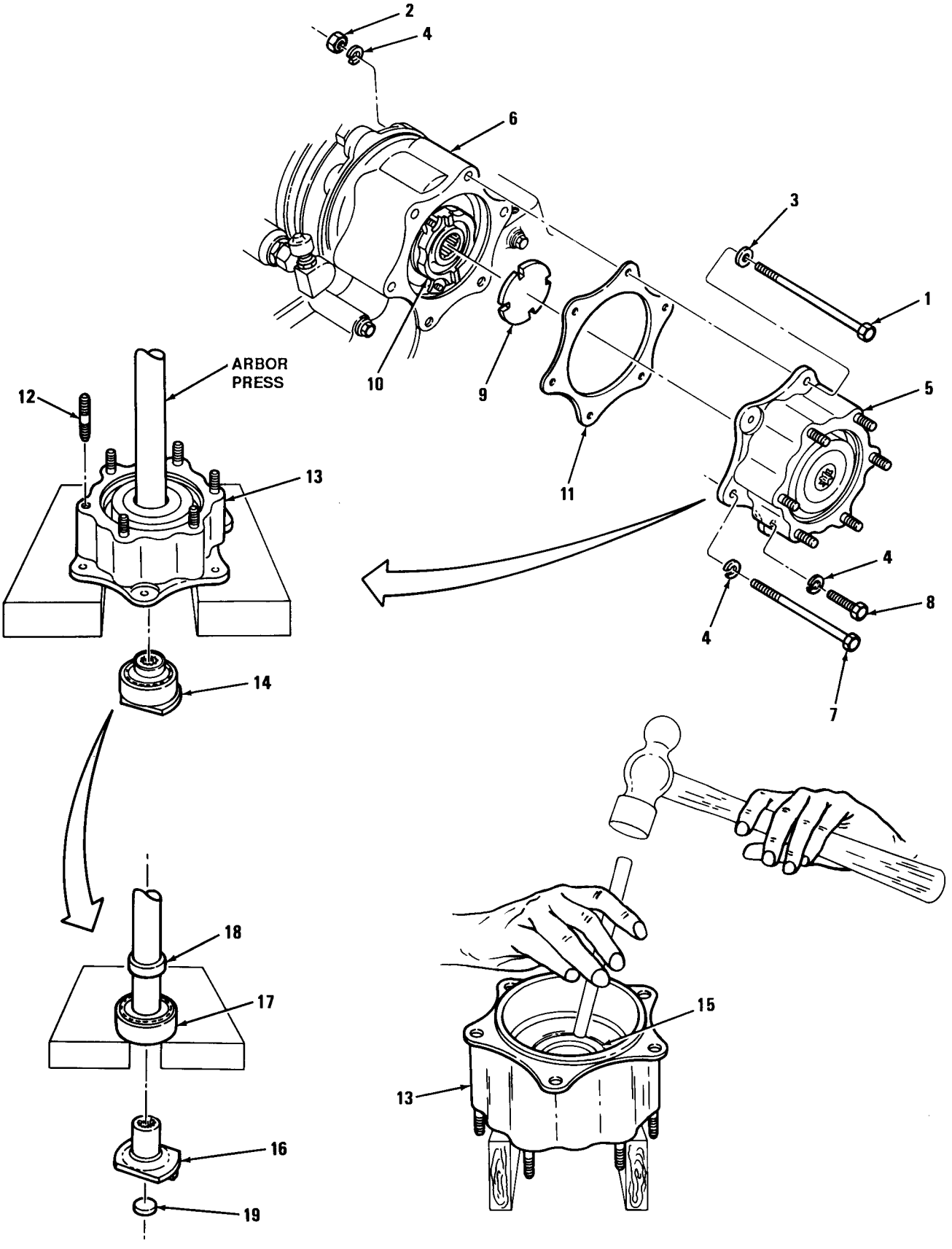
(1) If necessary, remove six studs (12) from accessory drive housing (13).

(2) Using arbor press, press shaft coupling half assembly (14) from accessory drive housing (13).

(3) If necessary, remove seal (15) from accessory drive housing (13) using a brass drift. Discard seal.

(4) Using arbor press, press shaft coupling half (16) from bearing (17) and sleeve (18).

(5) If necessary, remove cup plug (19) from shaft coupling half (16). Discard cup plug.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19

5-14. ACCESSORY DRIVE REPLACEMENT (Cont)

c. Cleanlng/inspection

(1) Clean all parts with fuel oil except bearing.

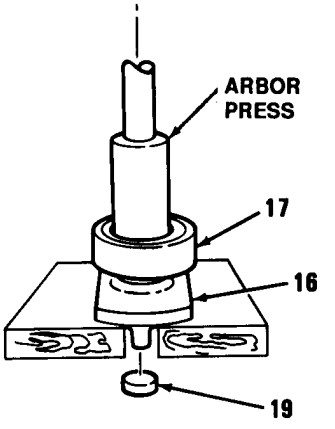
WARNING

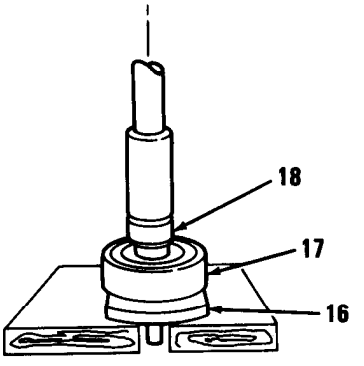
Compressed air used for cleaning purposes will not exceed 30 PSI. Use only with effective chip guarding and personal protective equipment (goggles/shield, gloves, etc.).

(2) Dry all parts with compressed air.

(3) Inspect fiber coupling and shaft coupling half for cracks, wear, or damage.

(4) Inspect bearing and sleeve for scores, pitting, or wear.





d. Assembly

(1) If removed, install cup plug (19) into shaft coupling half (16).

(2) Apply lubricant to each side of bearing (17) prior to installing on shaft coupling half (16).

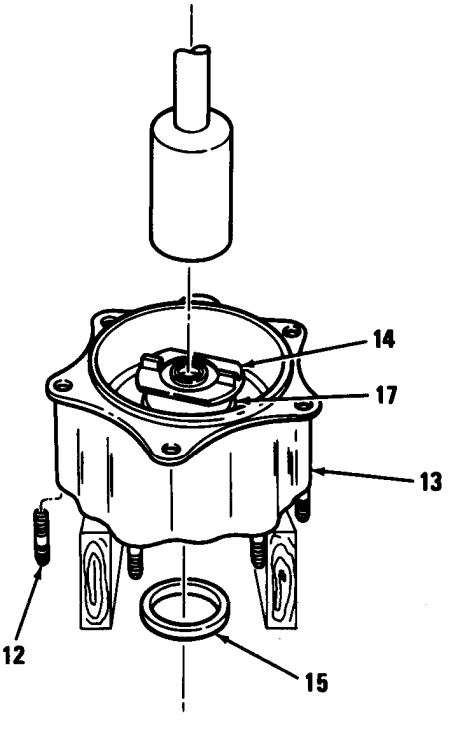
(3) Apply sealant to inner diameter of bearing (17). Using arbor press, press bearing onto shaft coupling half (16).

(4) Apply sealant to inner diameter of sleeve (18). Using arbor press, press sleeve onto shaft coupling half (16). Sleeve must be flush with end of shaft.

(5) Apply sealant to outer diameter of bearing (17). Using arbor press, press shaft coupling half assembly (14) into accessory drive housing (13).

(6) If removed, install seal (15), part number out, into accessory drive housing (13).

(7) If removed, install six studs (12) into accessory drive housing (13). Torque studs to 12-17 lb-ft (1 6-23 N-m).



e. Installation

(1) Install gasket (11) onto accessory drive assembly (5).

(2) Install fiber coupling (9) onto blower drive hub (10). Aline accessory drive assembly (5) with slots in fiber coupling.

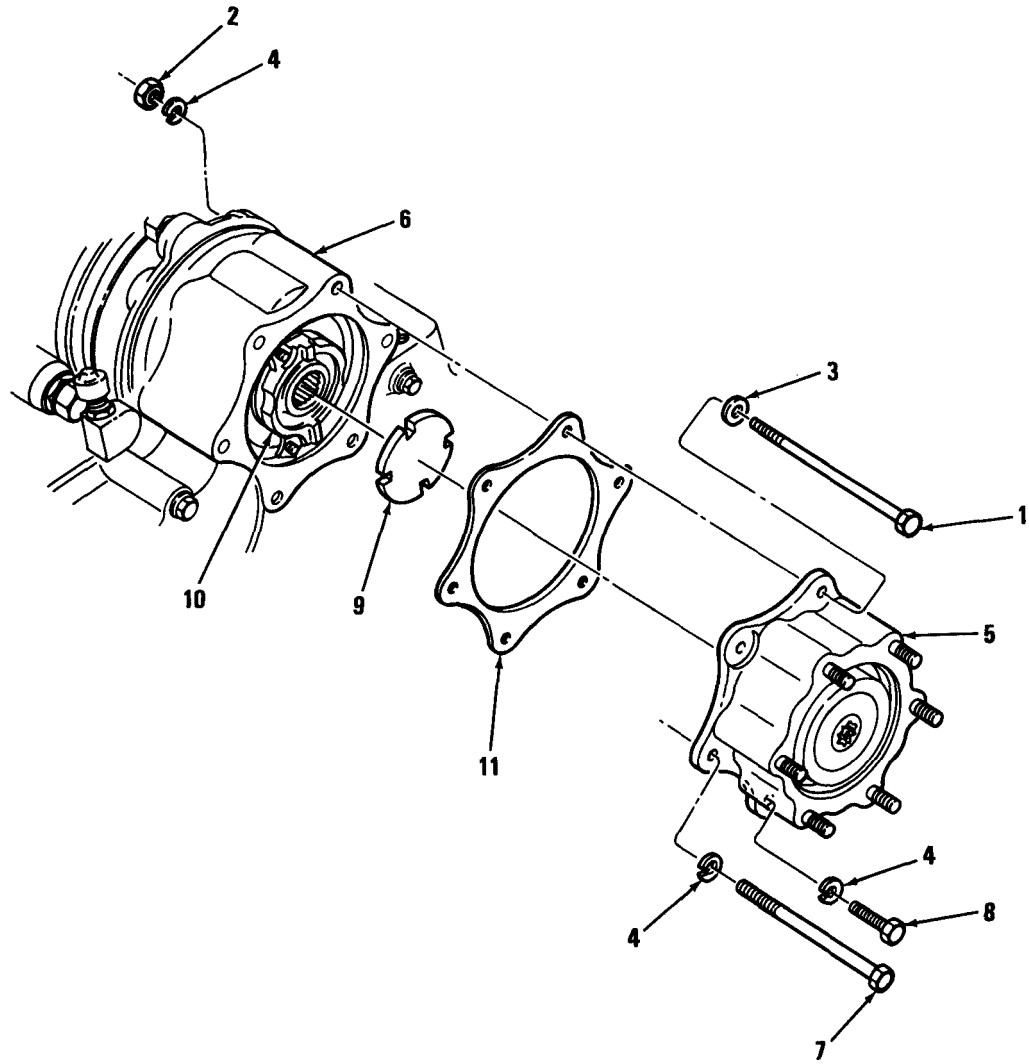
(3) Install accessory drive assembly (5) onto flywheel housing (6). Install two bolts (8) and two lockwashers (4).

(4) Install three bolts (7) and three lockwashers (4).

(5) Install bolt (1), flat washer (3), lockvvasher (4), and nut (2).

(6) Torque two bolts (8) to 30-35 lb-ft (41-47 N-m). Torque three bolts (7) and bolt (1) to 35-39 lb-ft (47-53 N-m).

END OF TASK



5-15. BLOWER DRIVE SHAFT AND HUB REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EXPENDABLE/DURABLE SUPPLIES

1Bolt, 10-32 x1-inch (App C, Item 33)
Dry cleaning solvent (App C, Item 10)

EQUIPMENT CONDITION

Para Description
5-14 Accessory drive removed

a. Removal

(1) Install 10-32 x 1 inch bolt (1) in blower drive shaft (2). Remove snap ring (3) and extract blower drive shaft.

NOTE

Place a rag below the hub and spring plate assembly to prevent bolts from falling into flywheel housing.

(2) Remove three bolts (4) securing hub and spring plate assembly (5) to blower drive gear (6). Remove hub and spring plate assembly.

b. Disassembly

Remove three bolts (7) securing two spring plates (8) to blower drive hub (9).

c. Cleanlng/inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes Is made, wash your 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 all parts with dry cleaning solvent and dry with compressed air.

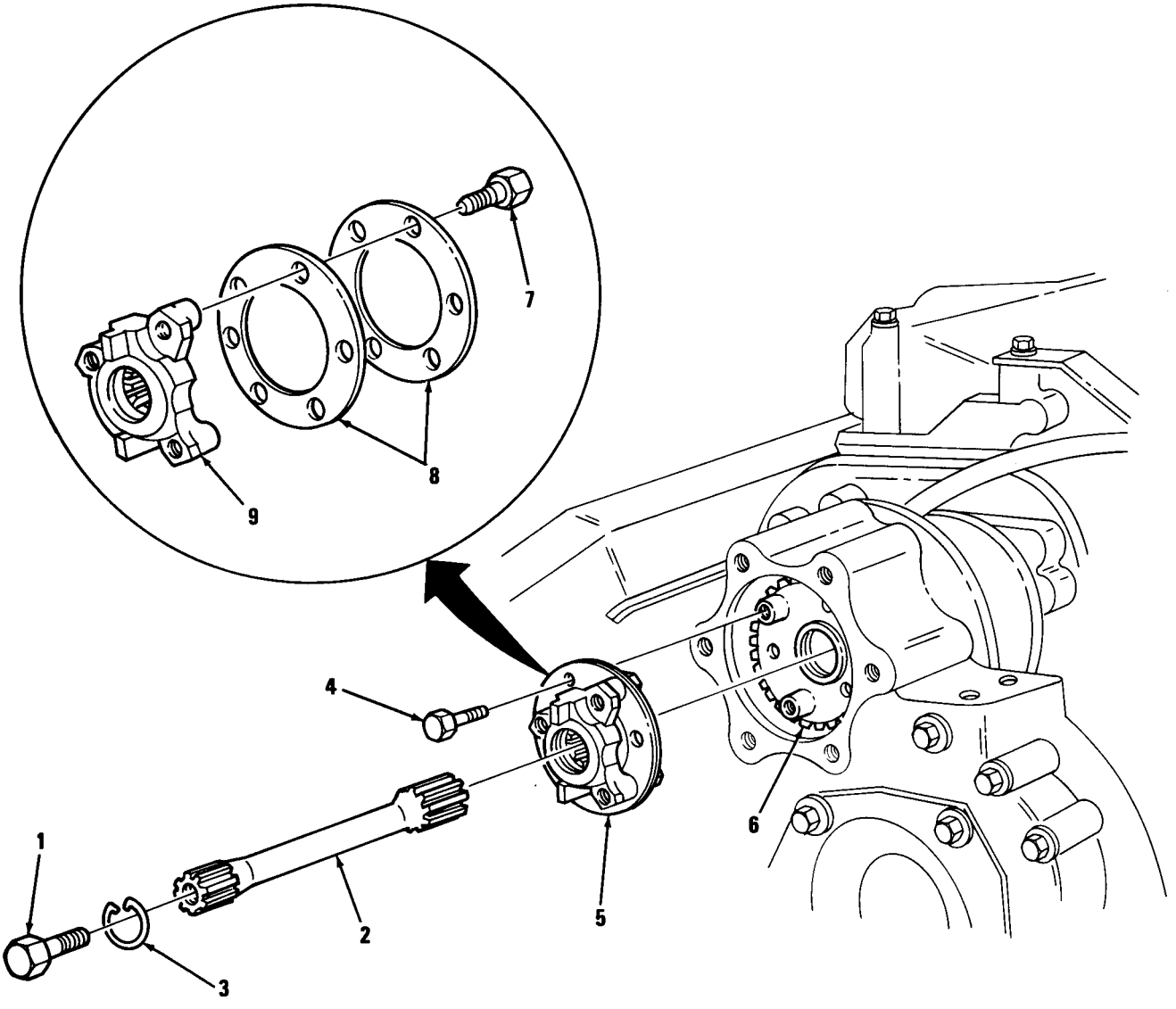
(2) Examine blower drive shaft. Replace blower drive shaft if splines are worn, cracked, or otherwise damaged.

(3) Examine blower drive hub. Replace hub if cracked or damaged or if spline is cracked, worn, or otherwise damaged.

(4) Examine spring plates. Replace if cracked, kinked, or if bolt holes show signs of distortion.

d. Assembly

Attach two spring plates (8) to blower drive hub (9) using three bolts (7). Torque bolts to 35-39 lb-ft (47-53 N-m).



5-15. BLOWER DRIVE SHAFT AND HUB REPLACEMENT (Cont)

e. Installation

NOTE

Place a rag below the hub and spring plate assembly to prevent bolts from falling into flywheel housing.

(1) Attach drive hub and spring plate assembly (5) to blower drive gear (6) using three bolts (4). Torque bolts to 35-39 lb-ft (47-53 N-m).

(2) Thread 10-32 x 1 inch bolt (1) in blower drive shaft (2).

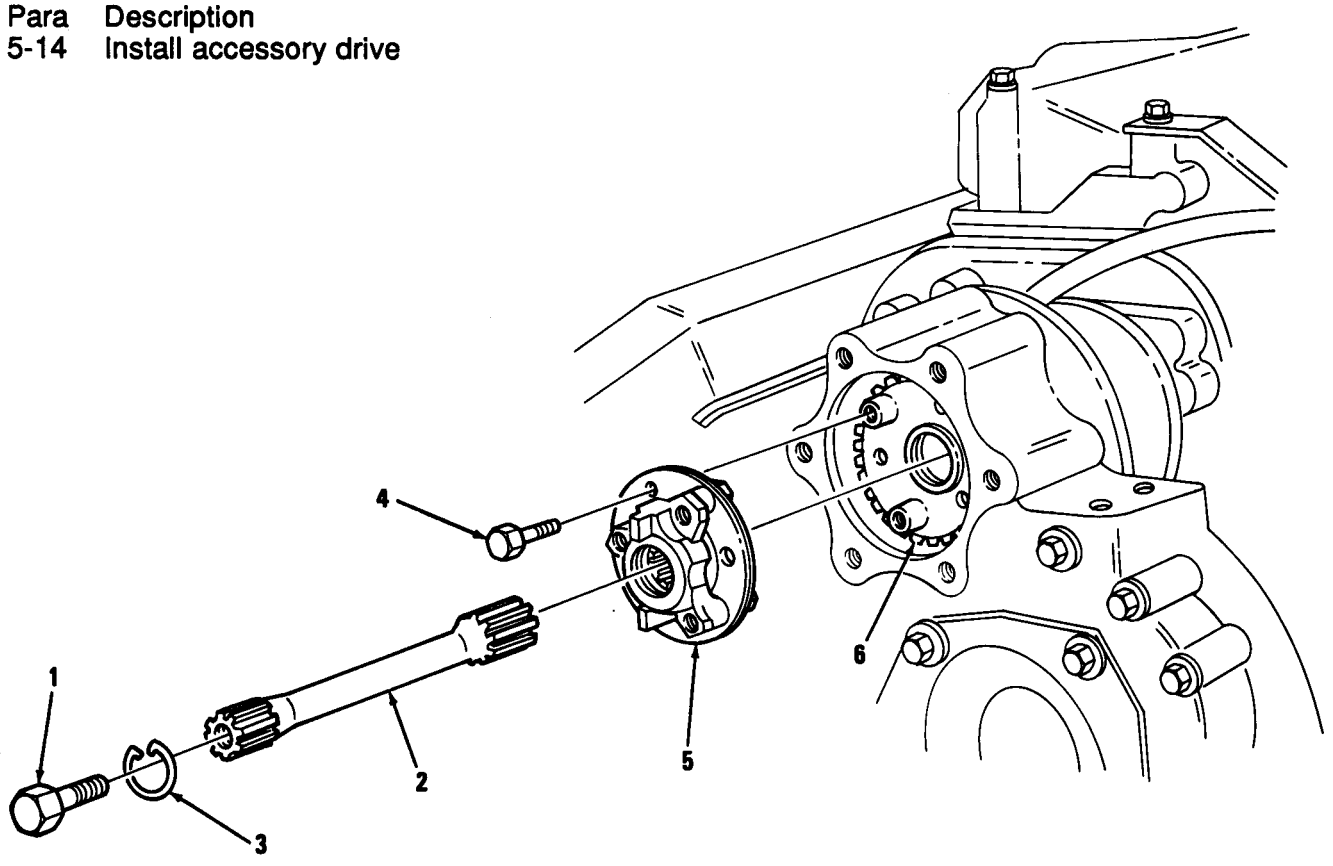
(3) Insert drive shaft (2) through blower drive gear (6). If binding occurs, refer to blower alinement procedure in Para 4-18.

(4) Install snap ring (3) in blower drive hub (9). Remove 10-32 x 1 inch bolt.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
5-14	Install accessory drive



5-20. CAMSHAFT FRONT GEAR COVER AND DAMPER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B,Item 96)
Mechanical 2-jaw puller (App B, Item 70)
Torque wrench (App B, Item 101)
Balance weight cover seal installer (App B, Item 48)

MANDATORY REPLACEMENT PARTS

9 Lockwashers (App F, Item 93)
1 Jam nut (App F, Item 86)
1 Lockwasher (App F, Item 95)
1 Gasket (App F, Item 48)
1 Seal (App F, Item 153)

EQUIPMENT CONDITION

Para	Description
5-7	Water pump removed

a. Removal

(1) Remove bolt (1), lockwasher (2), and flat washer (3) securing damper (4) to shaft pulley drive (5). Discard lockwasher.

(2) Using mechanical puller (6), remove damper (4) from shaft pulley drive (5). Remove woodruff key (7).

NOTE

Bolts securing front gear cover vary in length and diameter. For ease of assembly, note location of bolts, washers, and nuts when removing.

(3) Remove bolt (8) and flat washer (9).

(4) Remove five bolts (10), four nuts (11), five lockwashers (2), and five flat washers (12) from top of front gear cover (1 3). Remove bolt (10), flat washer (12), lockwasher (2), and jam nut (14) from lower left corner of gear cover. Discard lockwashers.

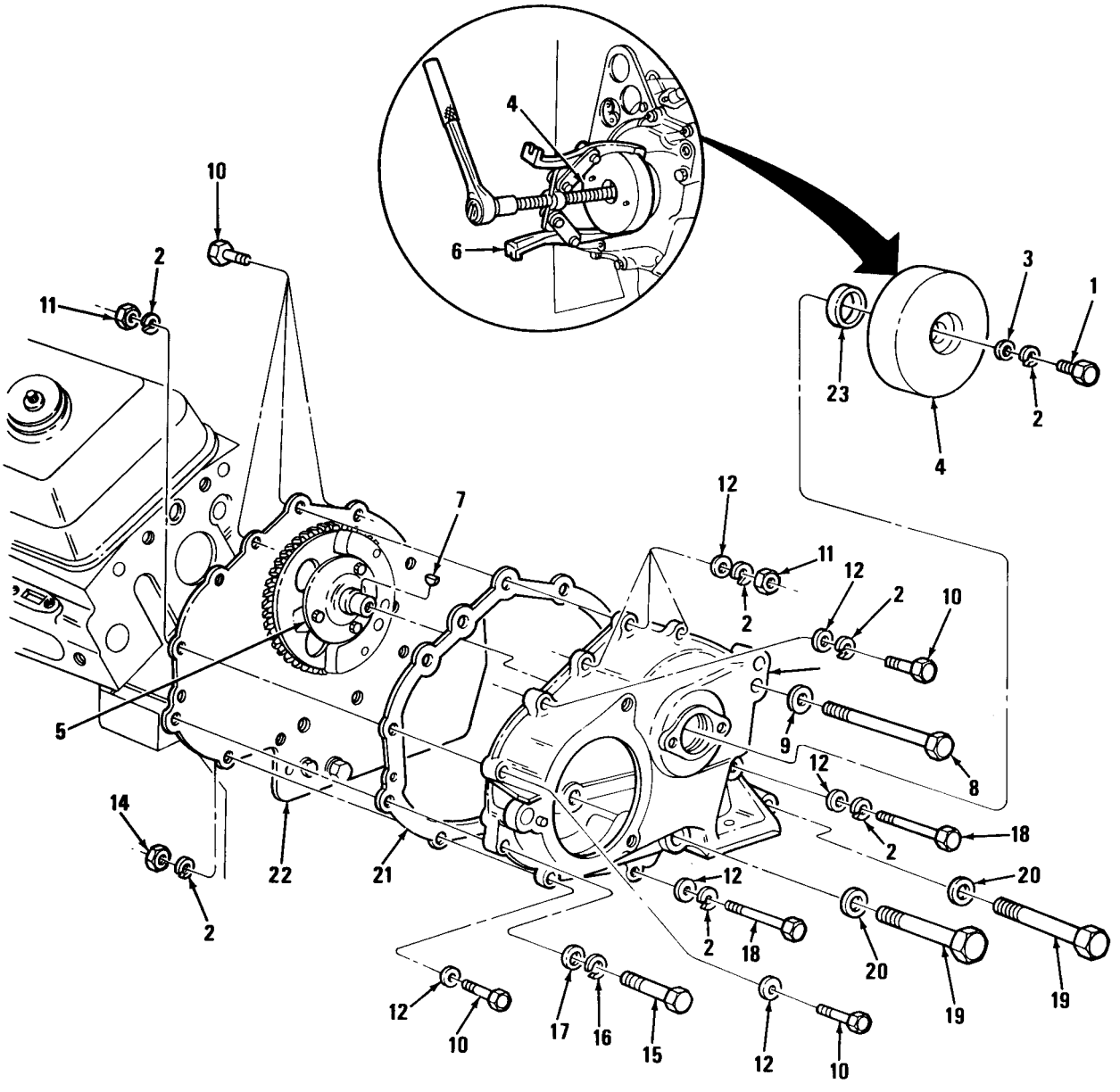
(5) Remove bolt (15), lockwasher (16), and flat washer (17). Discard lockwasher.

(6) Remove two bolts (18), two lockwashers (2), and two flat washers (12). Discard lockwashers.

(7) Remove two bolts (19) and two flat washers (20).

(8) Remove front gear cover (13) and gasket (21) from front end plate (22). Discard gasket.

(9) If necessary, remove seal (23) from front gear cover (13).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5-20. CAMSHAFT FRONT GEAR COVER AND DAMPER REPLACEMENT (Cont)

b. Inspection

Inspect front gear cover and damper for cracks, pitting, or damage.

c. Installation

(1) If removed, install seal (23) into front gear cover (13). Position seal with lip facing inward. Using seal installer, drive seal into cover until installer is flush with cover.

NOTE

Assemble top three bolts with nuts toward front of engine.

(2) Position front gear cover (13) and gasket (21) on front end plate (22). Secure with five bolts (10), five flat washers (12), five lockwashers (2), and four nuts (11) at top of cover.

(3) Install bolt (10), flat washer (12), lockwasher (2), and jam nut (14) at lower left corner of cover.

(4) Install bolt (15), lockwasher (16), and flat washer (17).

(5) Install two bolts (18), two lockwashers (2), and two flat washers (12).

(6) Install two bolts (19) and two flat washers (20).

(7) Install bolt (8) and flat washer (9).

(8) Torque two bolts (18) to 30-35 lb-ft (41 -47 N-m). Torque six bolts (10) to 35-39 lb-ft (47-53 N-m). Torque bolt (15) and bolt (8) to 71-75 lb-ft (96-102 N-m). Torque two bolts (19) to 137-147 lb-ft (186-200 N-m).

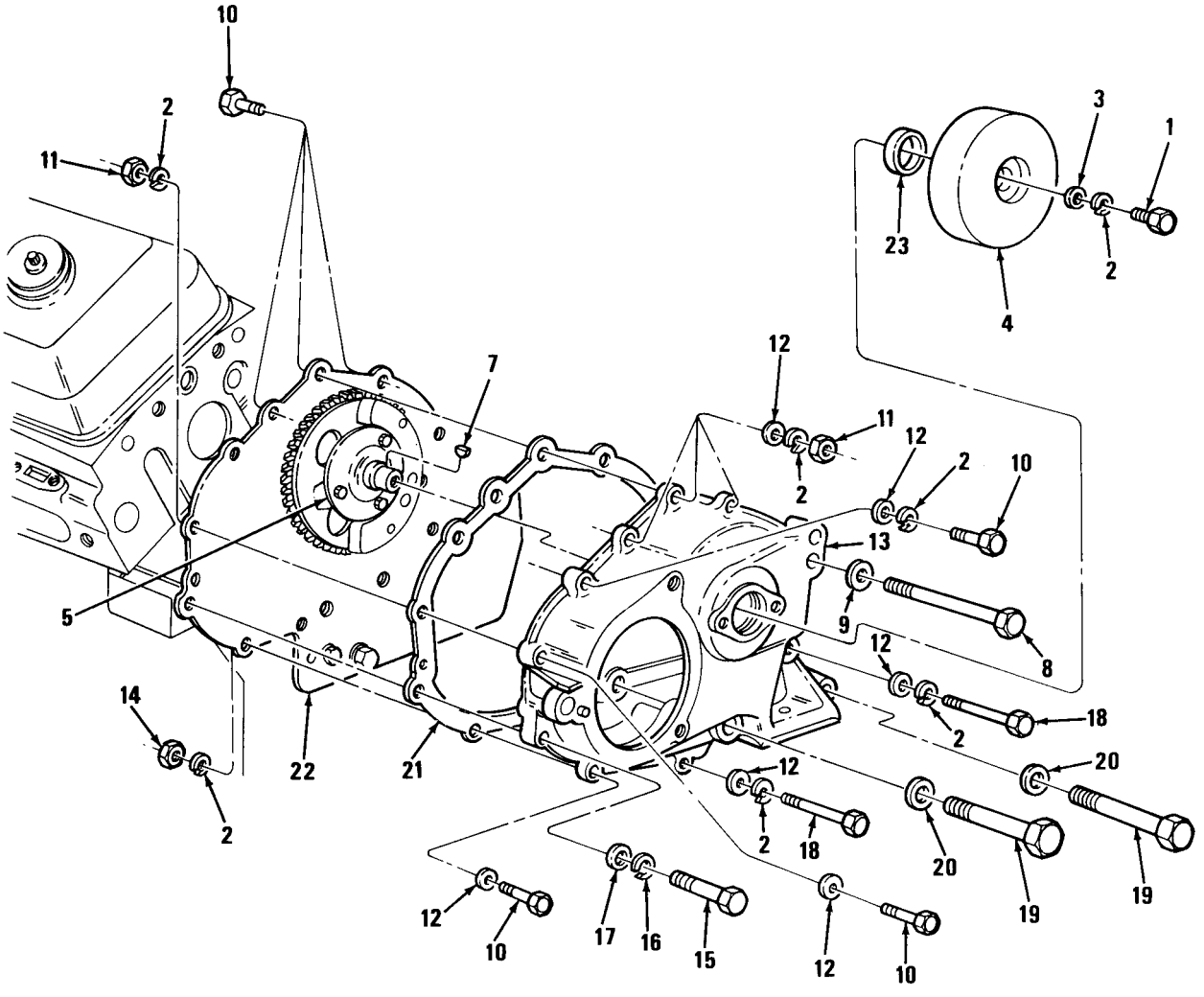
(9) Install woodruff key (7) into shaft pulley drive (5). Aline keyway in damper (4) with woodruff key on shaft pulley drive and install damper.

(lo) Secure damper (4) to shaft pulley drive (5) with bolt (1), lockwasher (2), and flat washer (3). Torque bolt to 30-35 lb-ft (41-47 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
5-7	Install water pump



5-21. FLYWHEEL ASSEMBLY REPLACEMENT (See Para 4-22)

5-22. REAR OIL SEAL REPLACEMENT (See Para 4-23)

5-23. FLYWHEEL HOUSING REPLACEMENT (See Para 4-24)

5-24. IDLER GEAR REPLACEMENT (See Para 4-25)

5-25. INJECTOR CONTROL TUBE AND THROTTLE DELAY REPLACEMENT (See Para 4-26)

5-26. CYLINDER HEAD ASSEMBLY REMOVAL/INSTALLATION (See Para 4-27)

5-27. ENGINE LOWER FRONT COVER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Oil seal installer (App B, Item 50)
Universal puller (App B, Item 71)
Torque wrench (App B, Item 102)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F,Item 42)
2 Lockwashers (App F,Item 93)
6 Lockwashers (App F, Item 94)
6 Lockwashers (App F, Item 95)

EXPENDABLE/DURABLE SUPPLIES

Grease (App C, Item 22)
Nonhardening sealant (App C, Item 38)
Emery cloth (App C, Item 15)
Crocus cloth (App C, Item 12)

EQUIPMENT CONDITION

Para Description
5-19 Oil pan removed

a. Removal

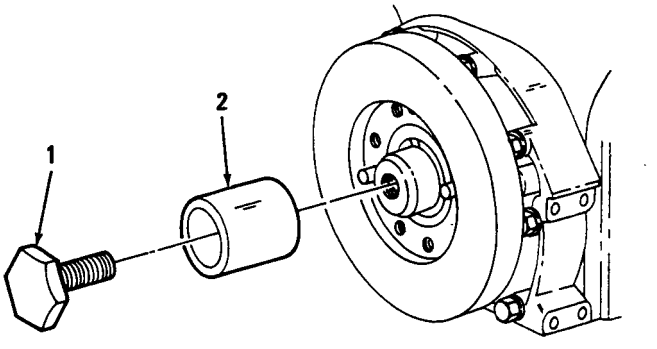
NOTE

Secure gear train in place to prevent crankshaft from turning during removal of front crankshaft bolt.

(1) Remove bolt (1) and spacer (2) from front of crankshaft.

(2) Reinstall bolt (1) on crankshaft.

(3) Attach universal puller (3) to vibration damper hub (4) with two long bolts threaded into tapped holes in hub.



CAUTION

Do not pound or pry on vibration damper during removal. Dents in damper outer case may cause it to function ineffectively. Damper cannot be repaired.

(4) Pull damper assembly (5) and outer cone (6) until cone is loose on crankshaft.

(5) Remove universal puller (3) from damper hub (4).

(6) Remove bolt (1) from crankshaft.

(7) Slide outer cone (6), damper assembly (5), and inner cone (7) from end of crankshaft by hand.

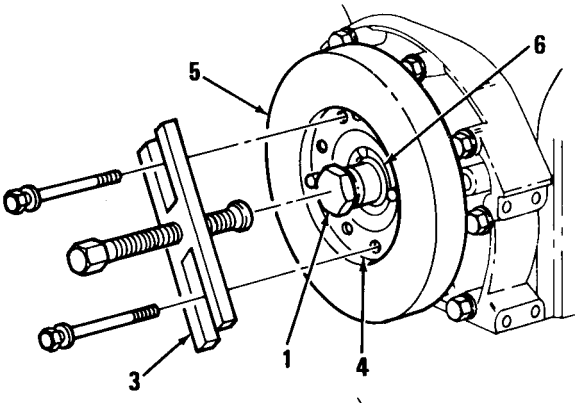
(8) Remove six bolts (8) and six lockwashers (9); then, separate damper (10) from hub (4). Discard lockwashers.

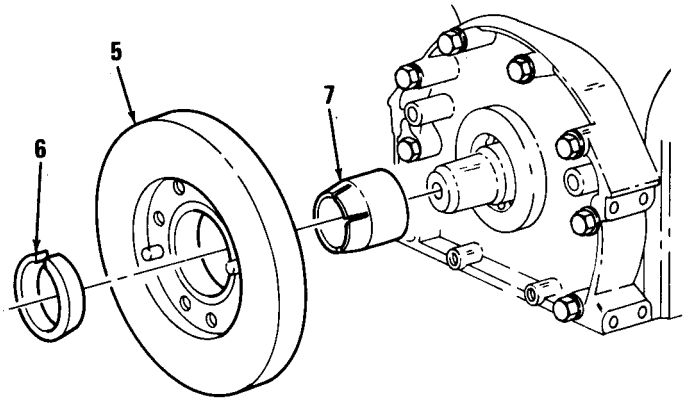
(9) Remove four bolts (11), two bolts (12), six lockwashers (13), two bolts (14), and two lockwashers (15) from lower front cover (16). Discard lockwashers,

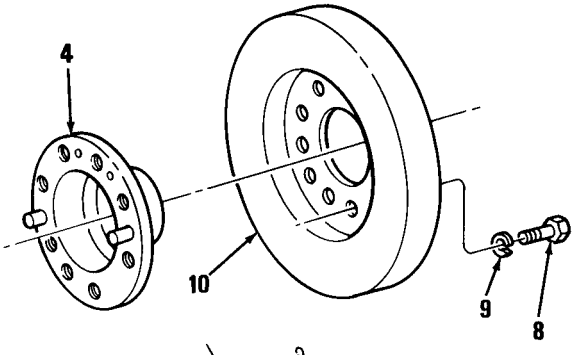
(10) Strike edges of cover (16) alternately on each side with a soft-head hammer to free it from dowels. Pull cover straight off end of crankshaft.

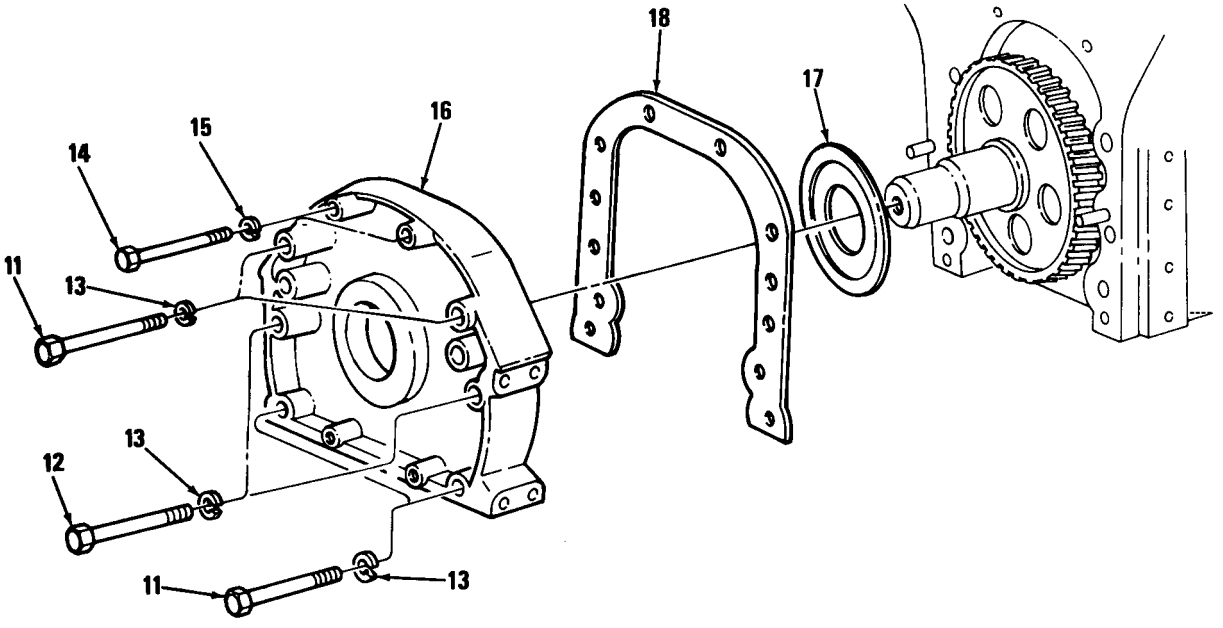
(11) Remove dirt deflector (17) from end of crankshaft.

(12) Remove gasket (18) from cylinder block. Discard gasket.









5-27. ENGINE LOWER FRONT COVER REPLACEMENT (Cont)

b. Cleaning/inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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 front cover with dry cleaning solvent and dry with compressed air.

(2) Inspect front cover sealing and mating surfaces for cracks, nicks, and damage that would prevent proper sealing.

(3) Check inside of spacer and crankshaft for burrs and nicks. Clean up burrs using crocus cloth in circular motion.

(4) Inspect spacer ring for nicks or burrs that would prevent proper sealing.

(5) Inspect damper for dents, nicks, bulges or leakage in outer case. Replace damper if any of above conditions are present.

NOTE

Regardless of condition, replace damper at time of normal periodic major engine overhaul.

(6) Inspect inner cone, outer cone, and damper hub for galling or burrs. Remove sight scratches or burrs with emery cloth.

c. Repair (seal replacement)

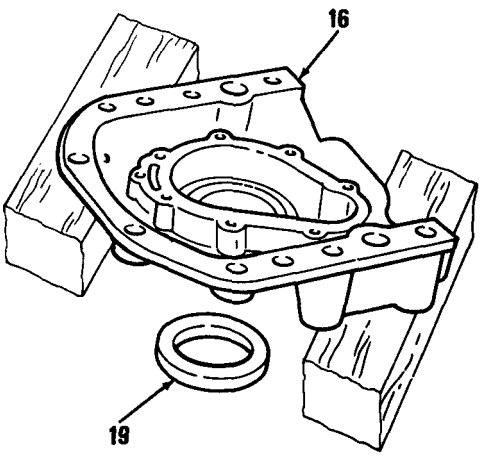
(1) Support outer face of front cover (16) on two wooden blocks and drive seal (19) out of front cover. Discard seal.

(2) Clean seal bore.

NOTE

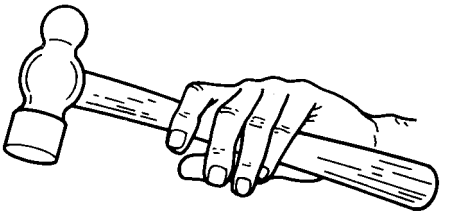
if new oil seal is not precoated, apply nonhardening sealant to outer edge of metal casing.

(3) Position seal (19) in front cover (16) with seal lip pointed toward inner face of cover.



(4) Drive seal (19) into front cover (16) with seal installer tool (20).

(5) Remove any excess sealant.



d. Installation

(1) Affix gasket (18) to inner face of front cover (16).

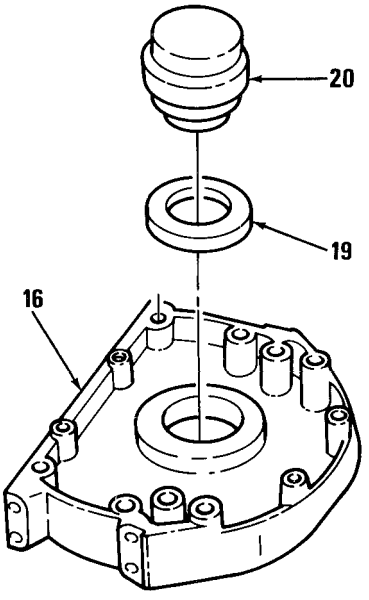
(2) Position dirt deflector (17) onto crankshaft with flat surface toward engine.

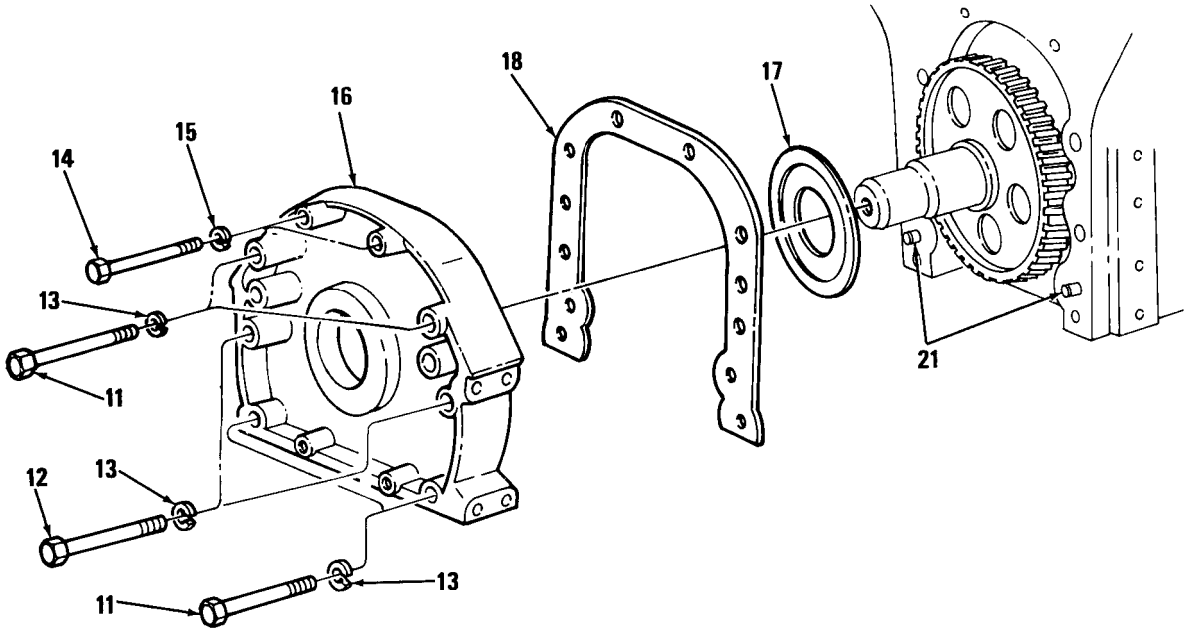
(3) Coat lip of oil seal lightly with grease or vegetable shortening.

(4) Position front cover (16) over two alinement pins (21) and tap cover until it contacts cylinder block.

(5) Install four bolts (11), two bolts (12), six lockwashers (13), two bolts (14), and two lockwashers (15) to lower front cover (16).

(6) Torque bolts (14) to 25-30 lb-ft (34-41 N-m) and bolts (11 and 12) to 80-90 lb-ft (108-122 N-m).





5-27. ENGINE LOWER FRONT COVER REPLACEMENT (Cont)

(7) Place vibration damper (10)against hub (4) with dished side of damper towards inner side of hub flange.

CAUTION

When attaching damper hub (4) to vibration damper (10), insure two dowels in hub aline with two smaller holes in vibration damper. Incorrect assembly will allow for movement between hub and damper and serious engine damage will result.

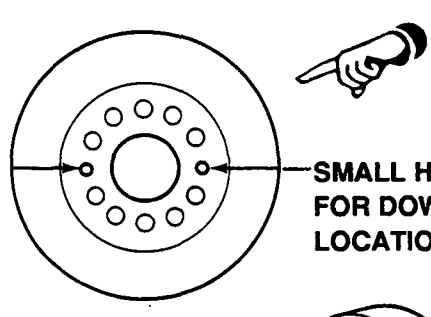
(8) Attach vibration damper (10) to hub (4) with six bolts (8) and six Iockwashers (9). Torque bolts to 57-61 lb- ft (77-83 N-m).

(9) Slide inner cone (7), damper assembly (5), outer cone (6), and spacer (2) on end of crankshaft.

(10) Install bolt (1) in end of crankshaft,

NOTE

Secure gear train in place to prevent crankshaft from turning during installation of front crankshaft bolt.



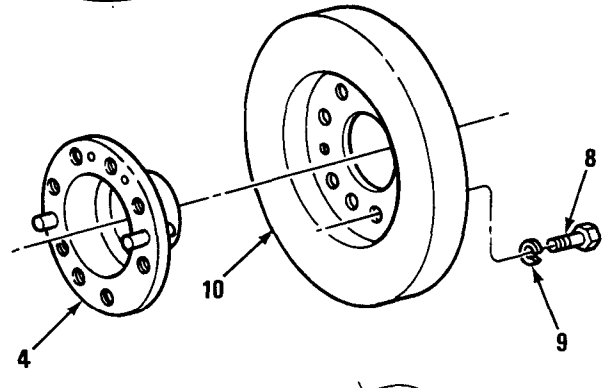
(11) Tighten crankshaft end bolt (1) as follows:

(a) Torque bolt to 180 lb-ft (244 N-m).

(b) Strike end of bolt a sharp blow three times with 3 pound soft-head hammer.

(c) Torque bolt to 300 lb-ft (407 N-m) and strike bolt again three times.

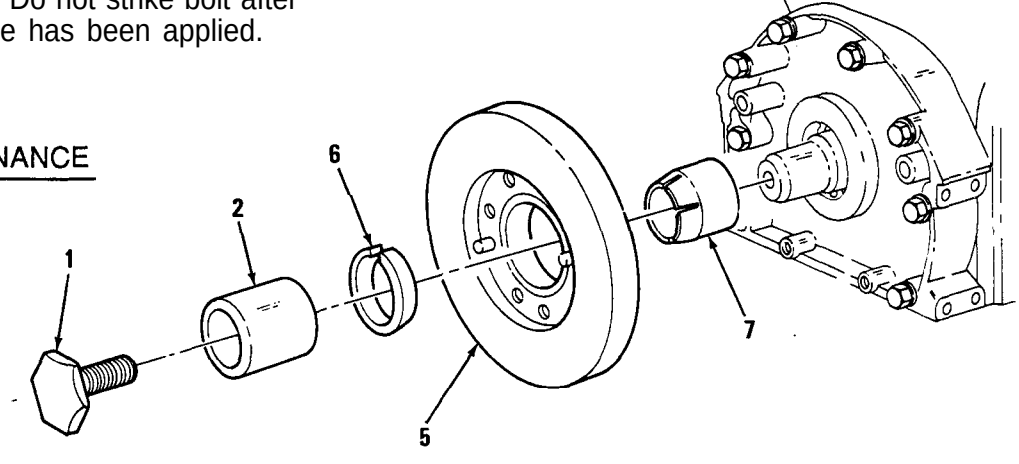
(d) Torque bolt to 290-310 lb-ft (393-421 N-m). Do not strike bolt after final torque has been applied.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
5-19	Install oil pan



Section III. ENGINE DISASSEMBLY/ASSEMBLY

Section IV. COMPONENT REPAIR

5-37. CYLINDER HEAD REPAIR

This task covers: a. Disassembly b. Cleaning c. Pressure check
d. Inspection/Repair e. Assembly

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Valve insert remover (App B, Item 80)
Bridge guide installer (App B, Item 49)
Injector tube installer - new style (App B, Item 54)
Valve spring compressor (App B, Item 13)
Cylinder head pressure test kit (App D, Item 10)
Valve guide remover (App B, Item 79)
Spring tester (App B, Item 93)
Valve bridge guide remover set (App B, Item 74)
Valve insert installer (App B, Item 61)
Slide hammer (App B, Item 39)
Reamer (App B, Item 47)
Depth gage (App B, Item 28)
Valve guide installer (App B, Item 60)
Fuel nut wrench (App B, Item 99)
Reamer (App B, Item 47)
Upsetting die (App B, Item 47)
Injector tube pilot (App B, Item 47)
Micrometer 0-1 inch (App B, Item 65)
Cam follower fixture (App B, Item 18)
Injector protrusion gage (App B, Item 32)
Injector tube tip refinisher (App B, Item 47)
Insert runout dial gage (App B, Item 29)
Magnetic base dial indicator (App B, Item 45)
Bridge guide remover (App B, Item 75)
Adaptor kit - insert grinding (App B, Item 3)
Valve insert grinder (App B, Item 38)
Telescoping gage (App B, Item 25)
Injector tube installer - old style tube (App B, Item 47)
Torque wrench (App B, Item 100)
Installer, exhaust seal (App D, Item 14)

MANDATORY REPLACEMENT PARTS

8 Gaskets (App F, Item 49)
2 Lockwashers (App F, Item 93)
Bushings (App F, Item 6)
16 Lockwashers (App F, Item 91)
2 Cup plugs (App F, Item 8)
8 Injector tube kit (App F, Item 158)
8 Fuel lines (App F, Item 18)
8 Fuel lines (App F, Item 19)
6 Gaskets (App F, Item 71)
4 Cup plugs (App F, Item 174)
2 Plugs (App F, Item 175)

EXPENDABLE/DURABLE SUPPLIES

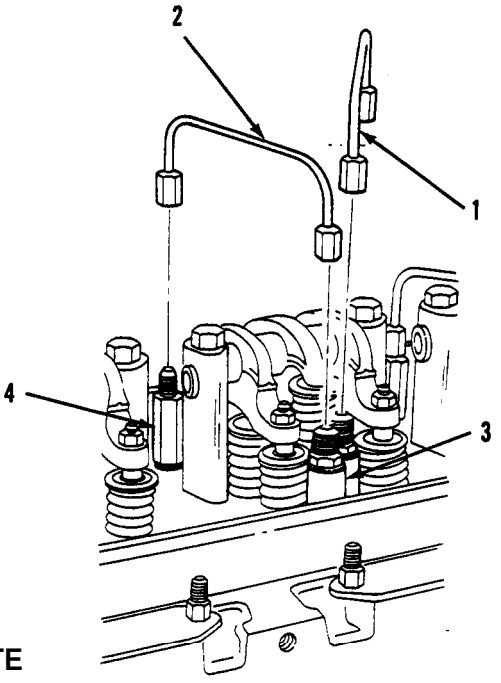
Engine oil (App C, Item 16)
Cindol 1705 oil (App C, Item 8)
Sulphurized oil - E.P. type (App C, Item 45)
Cutting oil (App C Item 38)
Sealant (App C,Item 38)
Four cover plates (App C, Item 11)
Fuel oil (App C, Item 21)
Crocus cloth (App C, Item 12)
Sealant (App C, Item 40)
Prussian blue (App C, Item 32)
Teflon pipe sealant (App C, Item 49)
Gasket cement (App C, Item 50)

EQUIPMENT CONDITION

Para Description
4-27 Cylinder head removed
5-5 Lifting brackets removed
5-6 Water manifolds removed (7083-7396 and 7083-7399)
5.1-6 Water manifolds removed (7083-7391)
5.1-8 Glow plugs removed (7083-7391)

5-37. CYLINDER HEAD REPAIR (Cont)

a. Disassembly



NOTE

Immediately after removing fuel lines, cover each injector opening with cap to keep out dirt.

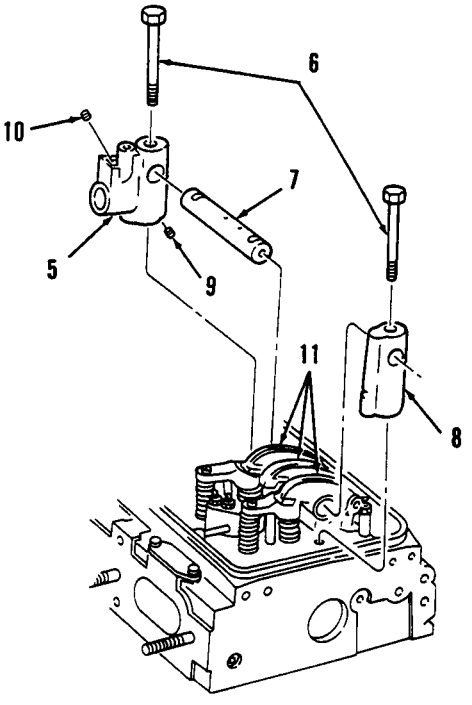
(1) Remove four inlet fuel lines (1) and four outlet fuel lines (2) from fuel injectors (3) and fuel connectors (4). Discard fuel lines.

NOTE

- Tag rocker arms, shafts, brackets, valves, cam followers, and associated hardware so they can be installed in their original position.

- On models 7083-7396 and 7083-7391, one rocker arm shaft bracket on right cylinder head contains throttle delay housing (5).

(2) Remove eight bolts (6) securing rocker arm shafts (7) and brackets (8) to cylinder head.



NOTE

On model 7083-7396, inspect throttle delay check valve for leakage. Fill throttle delay cylinder with fuel oil and watch check valve for leakage while moving engine throttle from idle to full fuel position. If more than a drop of leakage occurs, replace check valve.

(3) Remove four rocker arm shafts (7) and eight rocker shaft brackets (8) from cylinder head. If necessary, remove check valve (9) used on model 7083-7396 and oil supply fitting (10) from throttle delay housing (5) used on models 7083-7396 and 7083-7391.

(4) Swing rocker arms (11) away from injector and valves. Remove four injector clamp bolts (12), four washers (13), and four clamps (14).

(5) Remove four fuel injectors (3) from cylinder head.

(6) Loosen twelve lock nuts (15) at upper end of push rods (16) next to rocker arm clevis. Unscrew twelve rocker arms (11) from push rods.

(7) Remove eight valve bridges (17) from bridge guides (18).

(8) Rest cylinder head on its side and remove eight cam follower guide bolts (19), eight lockwashers (20), and four cam follower guides (21). Discard lockwashers.

(9) Remove twelve cam follower spring retainers (22) from cam follower bores in cylinder head.

(10) Pull twelve cam followers (23) and twelve push rod (16) assemblies from bottom of cylinder head. Remove twelve push rod nuts (15), twelve upper spring seats (25), twelve cam follower springs (24), and twelve lower spring seats (26) from twelve push rods.

NOTE

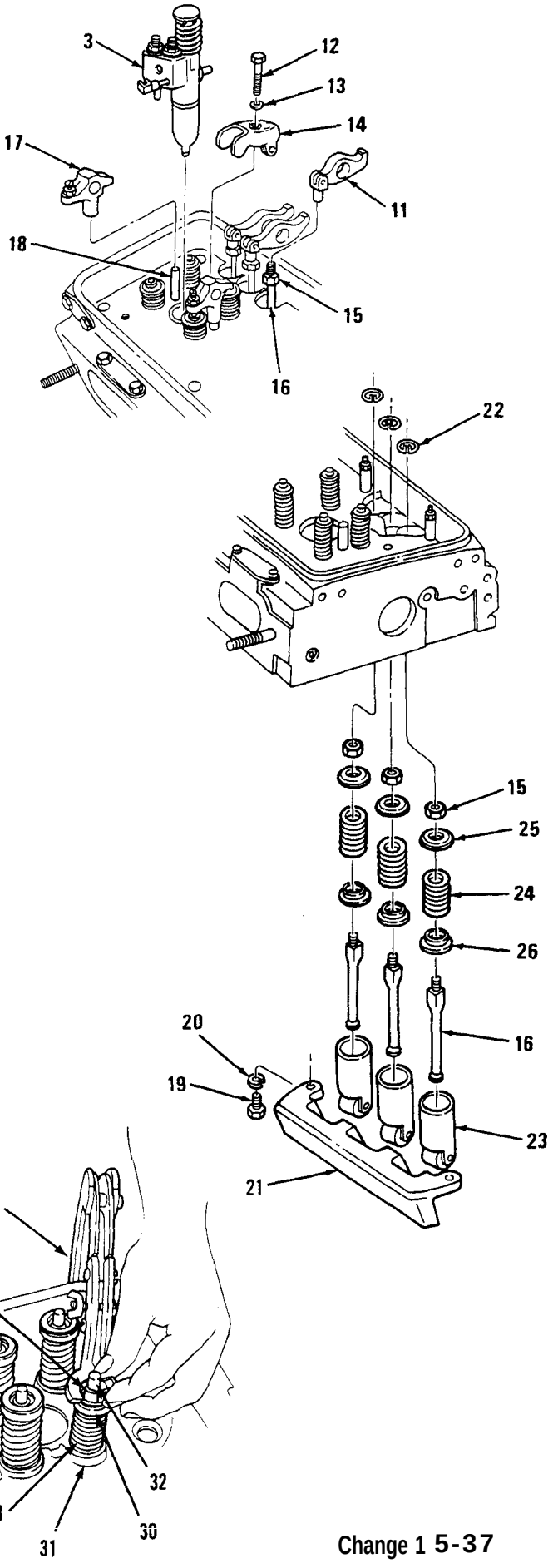
Mark location of valve for reinstallation. With used valves, valves must go in original location.

Remove sixteen exhaust valves as follows:

(a) Position cylinder head on its side.

(b) Using valve spring compressor (27), compress valve spring (28). Remove two piece tapered valve locks (29).

(c) Release compressor (27) and remove upper spring seat (30), valve spring (28), lower spring seat (31), and exhaust valve (32).



5-37. CYLINDER HEAD REPAIR (Cont)

NOTE

- Models 7083-7396 and 7083-7391 contain four bolts (33), four flat washers (34), two cover plates (35), and two gaskets (36) per head.
- Model 7083-7399 contains six bolts (33), six flat washers (34), and three cover plates (35), and three gaskets (36)per head.

(12) Remove bolts (33), flat washers (34), cover plates (35), and gaskets (36) from corners of cylinder head. Discard gaskets.

(13) If necessary, for models 7083-7396 and 7083-7399, remove support bracket (37), two bolts (38), and two lockwashers (39) from right cylinder head. Discard lockwashers.

(14) Remove two bolts (40), two flat washers (41), adaptor (42), and gasket (43) from inboard corner of cylinder head. Discard gasket.

(15) Remove eight fuel connectors (4) and eight washers (44) from cylinder head.

NOTE

If the cylinder head is to be pressure checked, do not remove parts in steps (16) thru (21).

(16) For models 7083-7396 and 7083-7399, remove eight studs (45) from outboard side of cylinder head.

(16.1) For model 7083-7391, remove six studs (45) from outboard side of cylinder head.

(17) For models 7083-7396 and 7083-7399, remove five exhaust manifold studs (46) from right cylinder head or eight exhaust manifold studs (46) from left cylinder head.

(17.1) For model 7083-7391, remove five exhaust manifold studs (46) from right exhaust manifold or five studs (46) and four studs (46.1) from left exhaust manifold.

(18) For models 7083-7396 and 7083-7399, remove three pipe plugs (47) from outboard side of left cylinder head.

(18.1) For model 7083-7391, remove four pipe plugs (47) from outboard side of right cylinder head.

NOTE

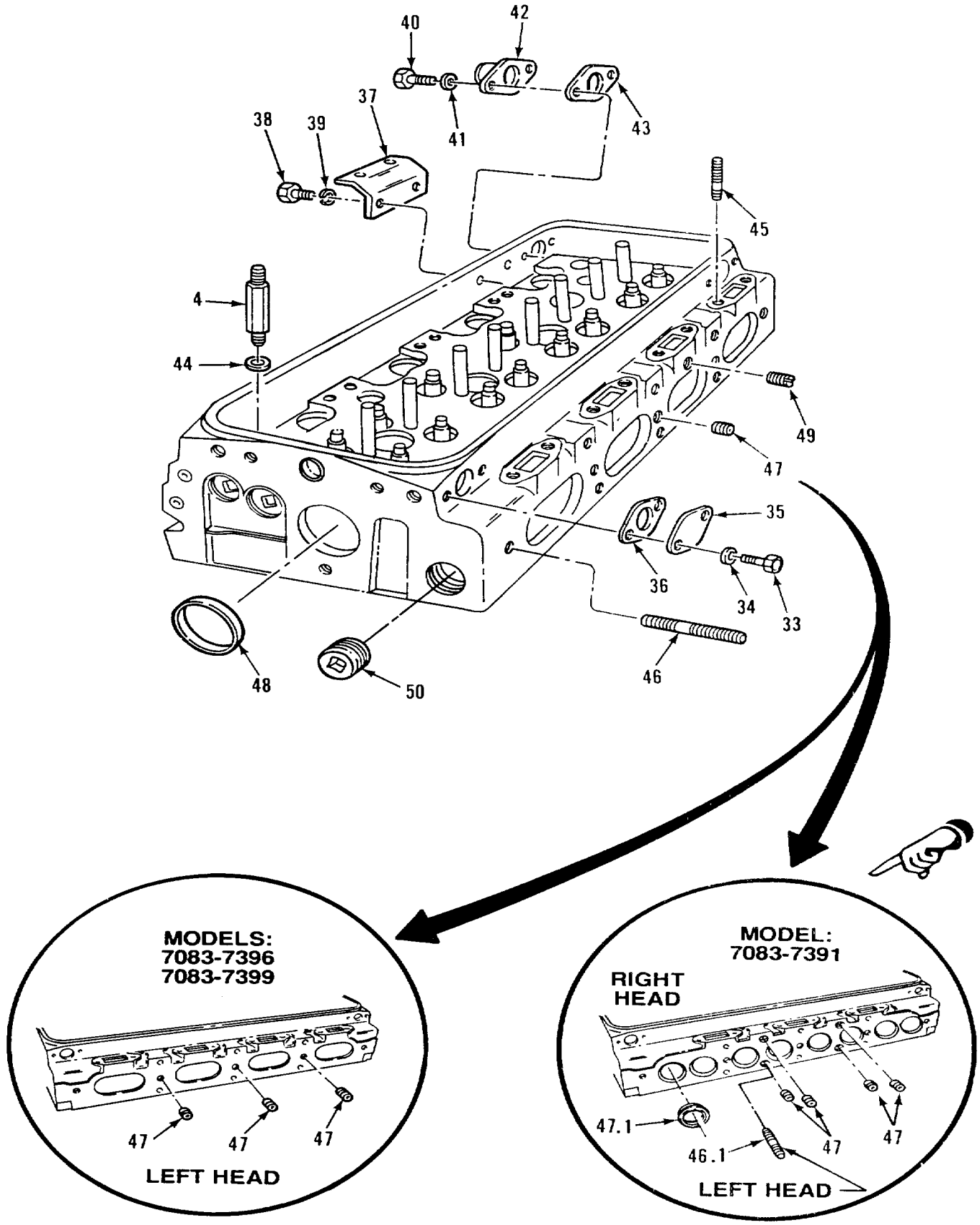
Model 7083-7391 has eight exhaust port seals in each cylinder head which seal the exhaust gases from the air gap built within the head. These seals are reusable and only need to be removed and replaced if damaged.

(18.2) For model 7083-7391, if necessary, remove eight exhaust port seals (47.1) from cylinder head.

(19) Remove cup plug (48) from rear of cylinder head. Discard plug.

(20) Remove fuse plug (49) from outboard side of cylinder head.

(21) Remove two pipe plugs (50) from ends of cylinder head.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MODELS:
7083-7396
7083-7399
47
47
47
LEFT HEAD
MODEL:
7083-7391
RIGHT
HEAD
47.1
46.1
47
47
LEFT HEAD

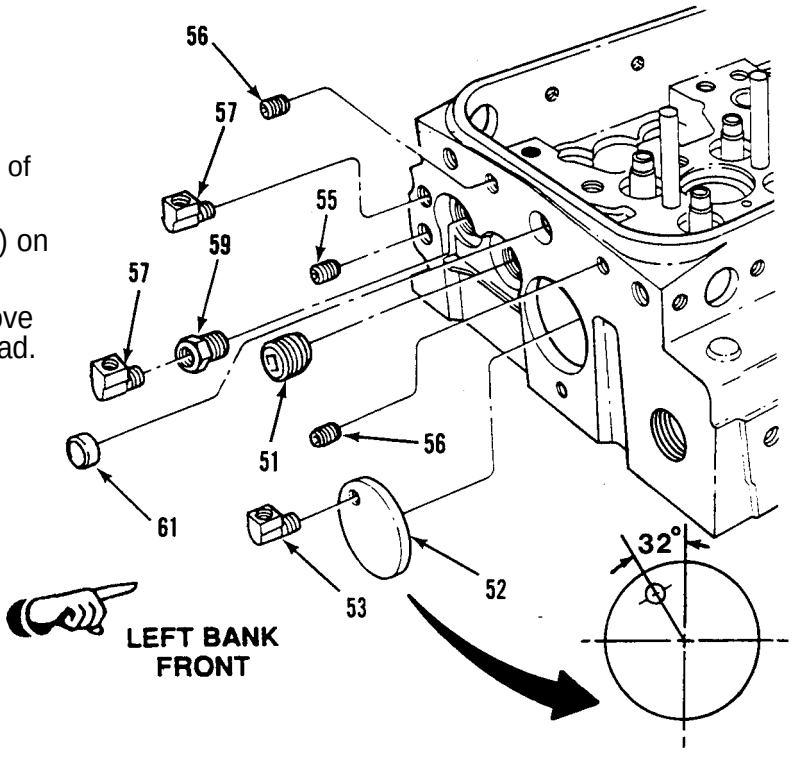
Change 1 5-39

5-37. CYLINDER HEAD REPAIR (Cont)

(22) Remove two pipe plugs (51) from ends of cylinder head.

(23) Remove elbow (53) from solid plug (52) on front of cylinder head.

(23.1) Using adaptor and slide hammer, remove solid plug (52) from front of cylinder head. Discard solid plug.

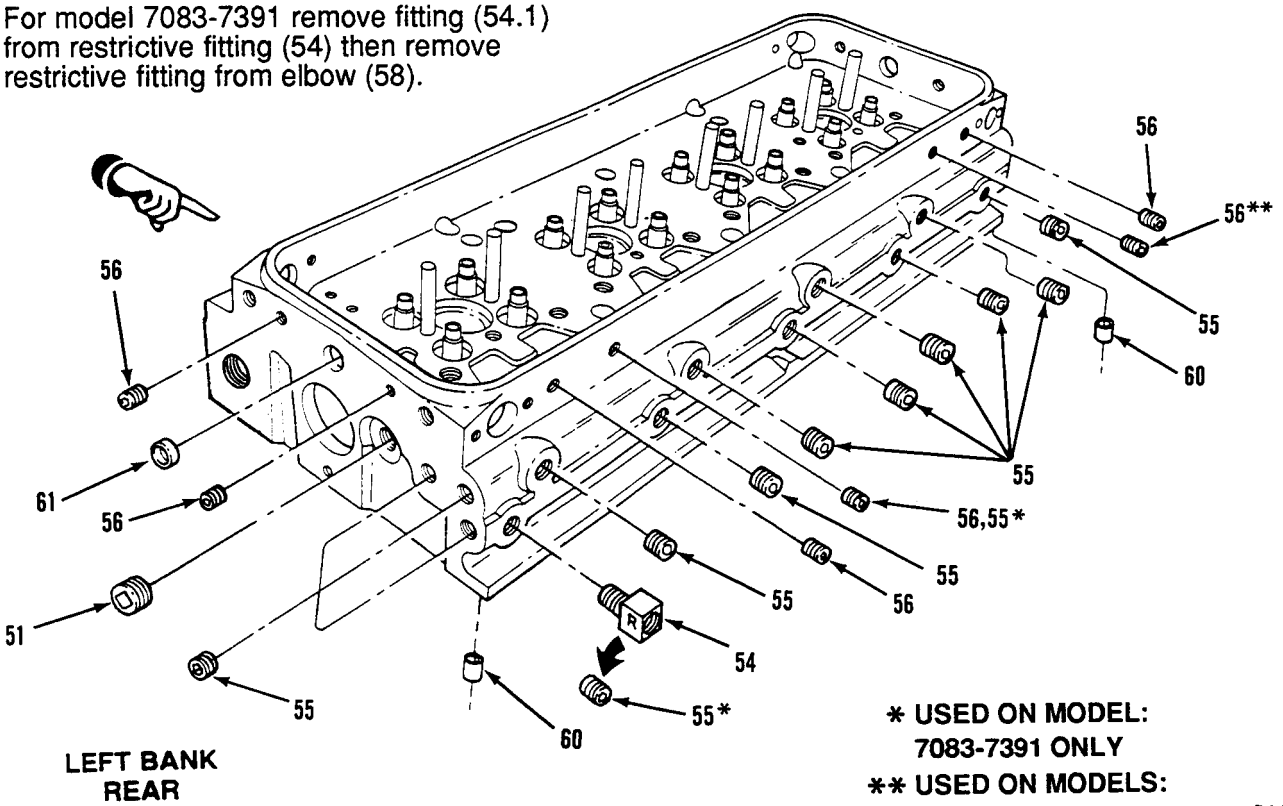


NOTE

- Model 7083-7396 has restrictive fitting on rear inboard side of left cylinder head.
- Model 7083-7399 has restrictive fitting on rear inboard side of right cylinder head.
- Model 7083-7391 has restrictive fitting on front of right cylinder head.

(24) For models 7083-7396 and 7083-7399, remove restrictive fitting (54) from cylinder head.

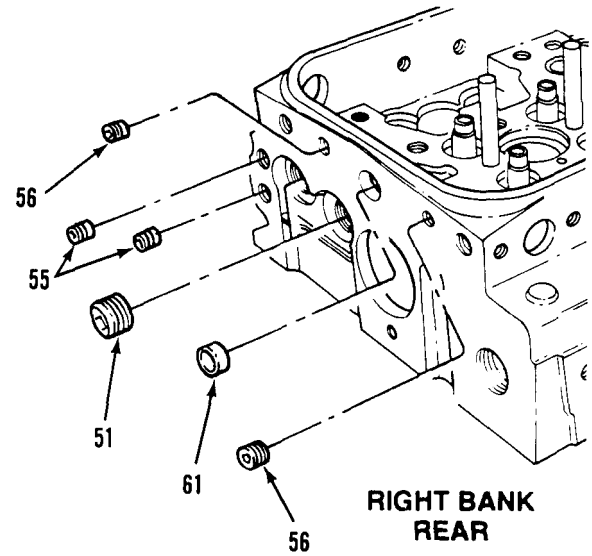
(24.1) For model 7083-7391 remove fitting (54.1) from restrictive fitting (54) then remove restrictive fitting from elbow (58).



(25) For right cylinder head of model 7083-7396 and left cylinder head of model 7083-7399, remove twelve pipe plugs (55) from inboard side and ends of cylinder head. For left cylinder head of model 7083-7396 and right cylinder head of model 7083-7399, remove thirteen pipe plugs (55) from inboard side and ends of cylinder head.

(25.1) For model 7083-7391, remove thirteen pipe plugs (55) from inboard side and ends of right cylinder head or fourteen from left cylinder head.

(26) For models 7083-7396 and 7083-7399, remove eight threaded plugs (56) from left cylinder head or six plugs (56) from right cylinder head.



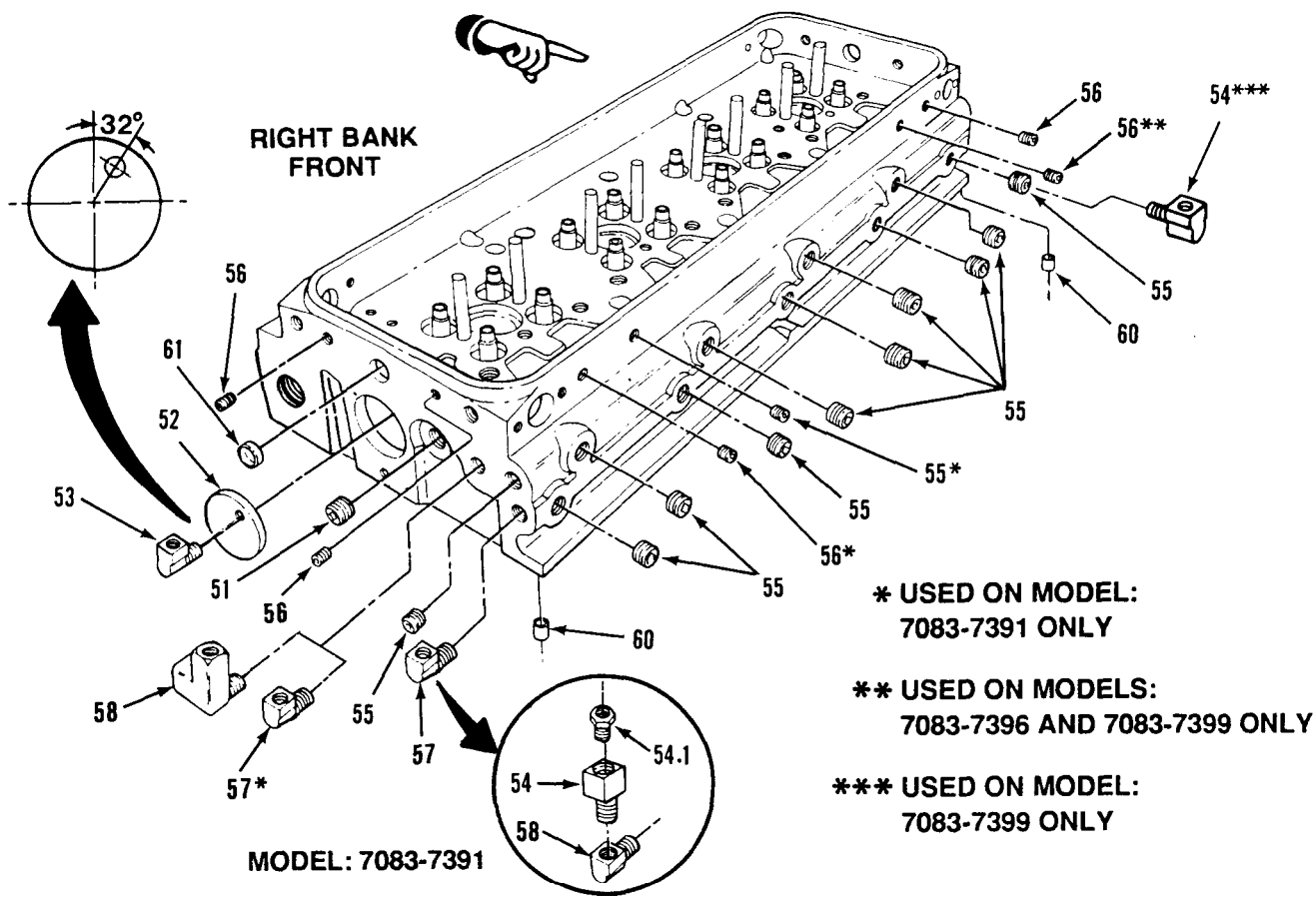
(26.1) For model 7083-7391, remove six threaded plugs (56) from cylinder head.

(27) Remove elbow (57) from front of right cylinder head or two elbows (57) from front of left cylinder head.

(28) Remove fitting (58) from front of right cylinder head or reducer (59) from front of left cylinder

(29) If necessary, remove two bushings (60) from cylinder head bolt holes.

(30) If necessary, remove two cup plugs (61) from front and rear of cylinder head. Discard cup



5-37. CYLINDER HEAD REPAIR (Cont)

b. Cleaning

(1) Thoroughly clean cylinder head and cylinder head components (refer to Para 3-2).

(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

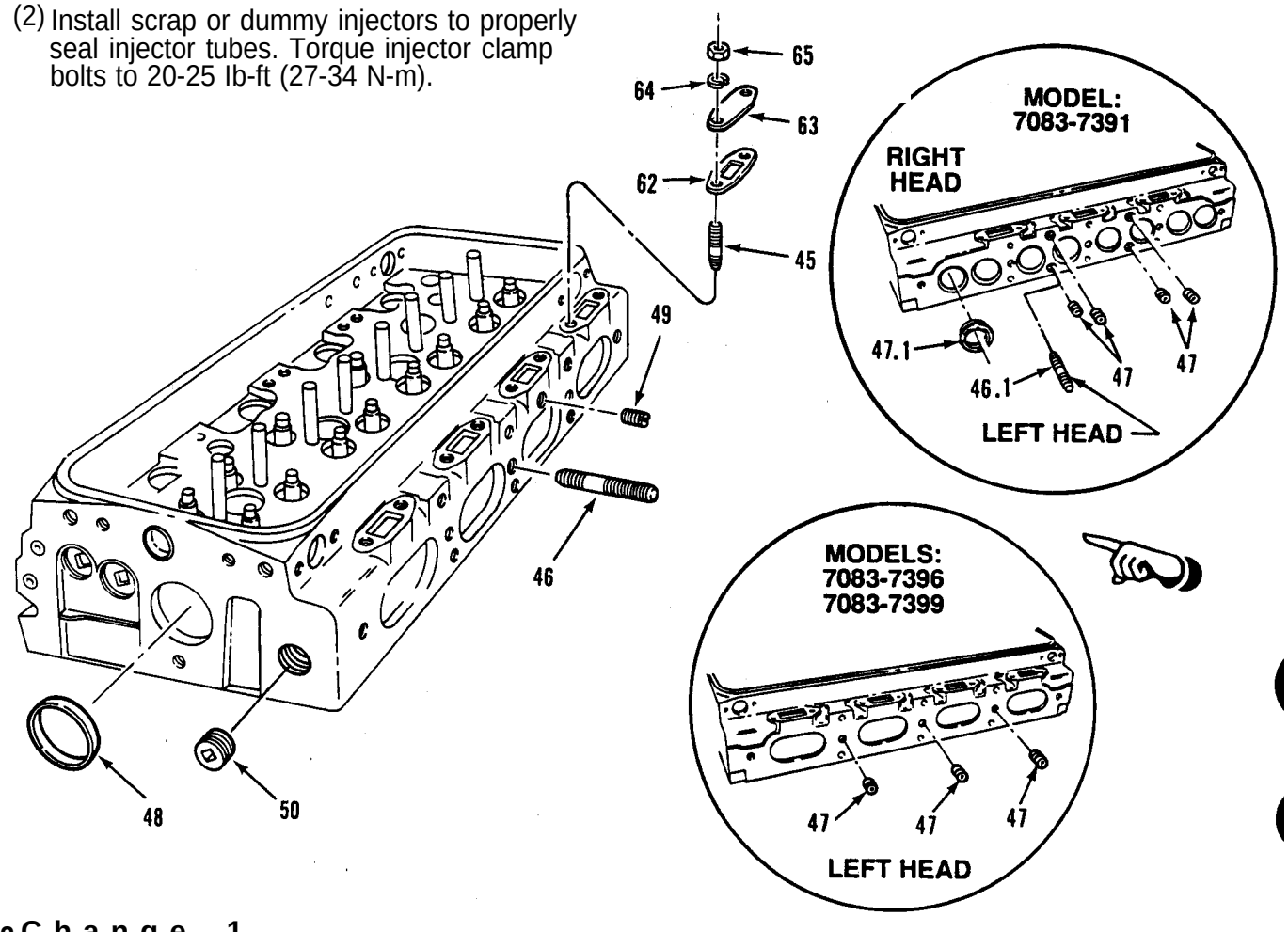
NOTE

Before pressure checking cylinder head, cup plug (48), water manifold studs (45), two pipe plugs (50), fuse plug (49), exhaust manifold studs (46), four exhaust manifold studs (46.1) (left head only model 7083-7391, and three pipe plugs (47) (left head only models 7083-7396 and 7083-7399) or our pipe plugs (47) (right head only model 7083-7391) must be in position.

(1) For models 7083-7396 and 7083-7399, position four gaskets (62) and four cover plates (63) over studs (45) and secure with eight lockwashers (64) and eight nuts (65). Torque nuts to 20-25 lb-ft (27-34 N-m).

(1.1) For model 7083-7391, position three gaskets (62) and three cover plates (63) over studs (45) and secure with six washers (64) and six nuts (65). Torque nuts to 20-25 lb-ft (27-34 N-m).

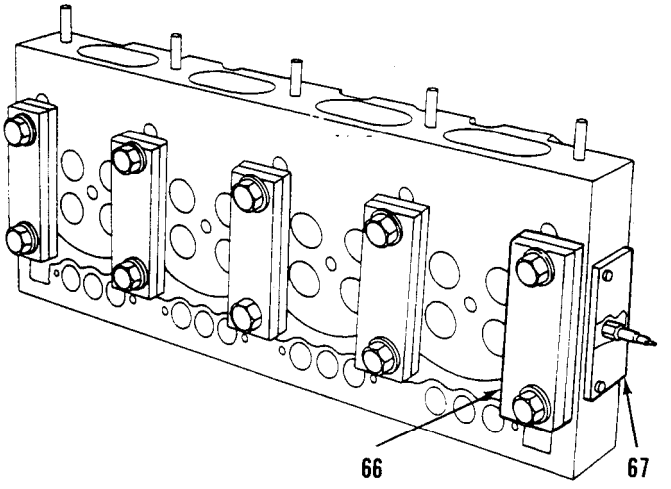
(2) Install scrap or dummy injectors to properly seal injector tubes. Torque injector clamp bolts to 20-25 lb-ft (27-34 N-m).



(3) Using cylinder head pressure testing kit, install fabricated blocking plates (66) and rubber gaskets to seal ten water holes on fire deck. Secure with bolts, flat washers, and nuts from kit. Torque bolts to 50-60 lb-ft (71-47 N-m).

(4) Using cylinder head pressure testing kit, install fabricated end plate (67) and gasket over hole in front of cylinder head. Secure with bolts from kit. Torque bolts to 30-35 lb-ft (41-47 N-m).

(5) Attach a regulated air supply to end of plate (67) and gradually apply pressure of 40 psi (276 kPa.1) to water jacket.

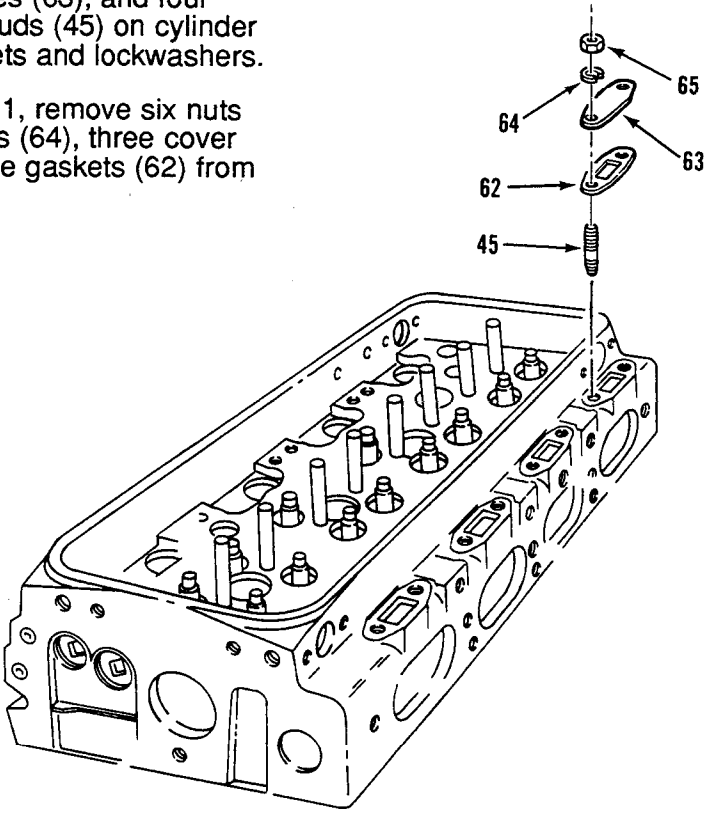


(6) Immerse cylinder head in a tank of water heated to 180°F-200°F (82°C-93°C) for twenty minutes to heat head. Observe water in tank for bubbles which indicate a leak or crack. Check for leaks at top and bottom of injector tubes, oil gallery, exhaust ports, fuel galleries, and at top and bottom of cylinder head.

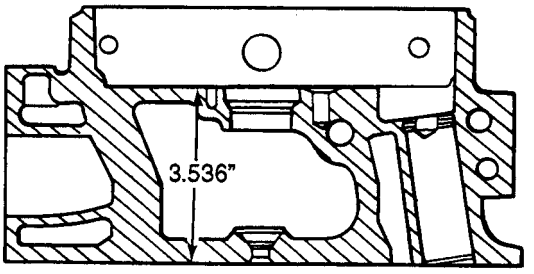
(7) Relieve air pressure and remove regulated air supply, injectors, end plate, and blocking plates from cylinder head.

(8) For models 7083-7396 and 7083-7399, remove eight nuts (65), eight lockwashers (64), four cover plates (63), and four gaskets (62) from studs (45) on cylinder head. Discard gaskets and lockwashers.

(9) For model 7083-7391, remove six nuts (65), six lockwashers (64), three cover plates (63), and three gaskets (62) from studs (45)



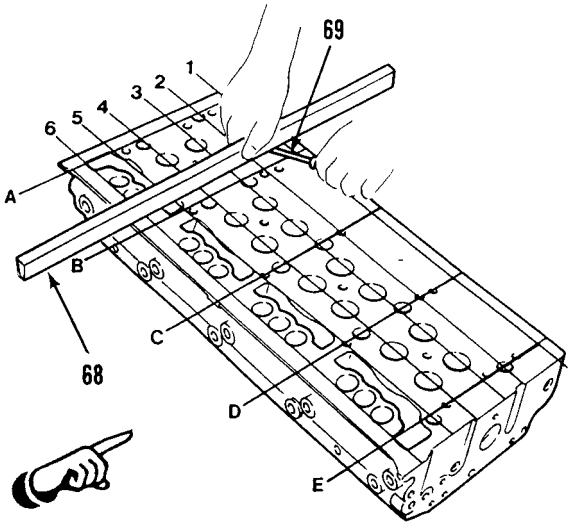
5-37. CYLINDER HEAD REPAIR (Cont)



d. Inspection/Repair

NOTE

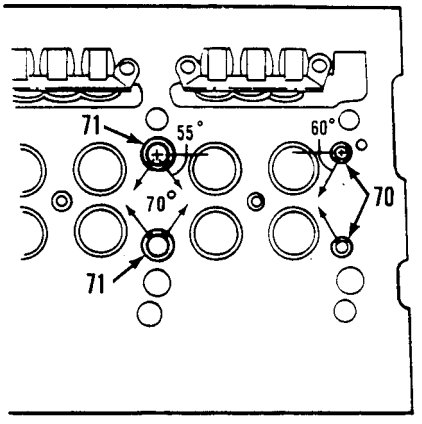
If warpage exceeds limits, reface cylinder head. Do not remove more metal from fire deck than minimum distance of 3.536 inches from top of deck to bottom of fire deck.



(1) Cylinder head

(a) Check fire deck surface of cylinder head for flatness. Using a straight edge (68) and a set of feeler gages (69), check lengthwise (six places) and crosswise (five places) warpage. Maximum lengthwise warpage is 0.008 inch and maximum crosswise warpage is 0.004 inch.

(b) Inspect cam follower bores in cylinder head for scoring and wear. Clean up light score marks with crocus cloth wet with fuel oil. Measure diameter of cam follower body and cam follower bore to determine clearance. Maximum clearance is 0.006 inch. Replace cylinder head if bores are excessively worn or scored.



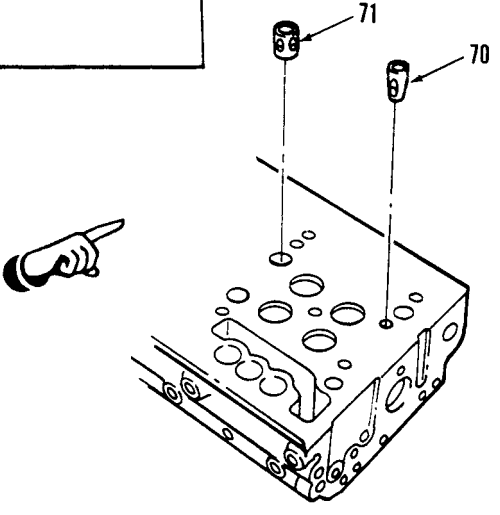
(2) Water nozzles

Check water hole nozzles (70 and 71) for looseness. If necessary, replace nozzles as follows:

(a) Remove old nozzle (70 or 71) and clean bore in cylinder head.

(b) Position nozzle (70) in end bore or nozzle (71) in inner bore as shown.

(c) Press nozzle (70 or 71) 0.003 inch above to 0.010 inch below surface of cylinder head.



(3) Exhaust valve guides

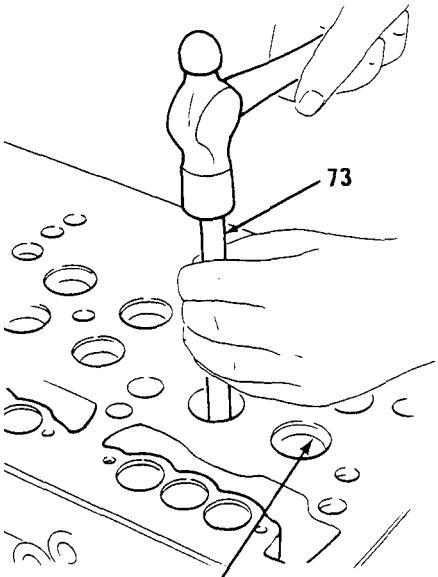
Inspect valve guides for fractures, chipping, scoring, or excessive wear. 'Measure inside diameter of valve guide and diameter of valve stem to determine clearance between guide and valve stem. If clearance exceeds 0.005 inch, replace valve guide, Replace valve guide as follows:

(a) Support cylinder head, bottom side up, on three inch thick wood blocks.

(b) Drive valve guide (72) out of cylinder head with valve guide remover (73).

(c) Place cylinder head right side up on bed of an arbor press.

(d) Position valve guide squarely in bore. Using valve guide installer (74), press into position until tool contacts cylinder head.



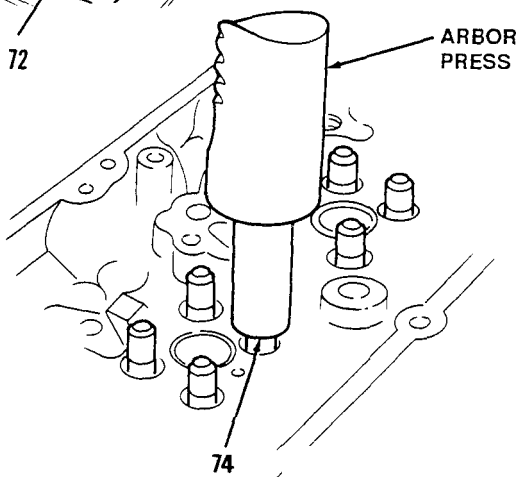
(4) Valve bridge guides

(a) Inspect valve bridge guides for wear. Replace guides as follows:

1. File or grind two opposite notches 0.06 inch deep in side of bridge guide (18) approximately 1.25 inches from top.

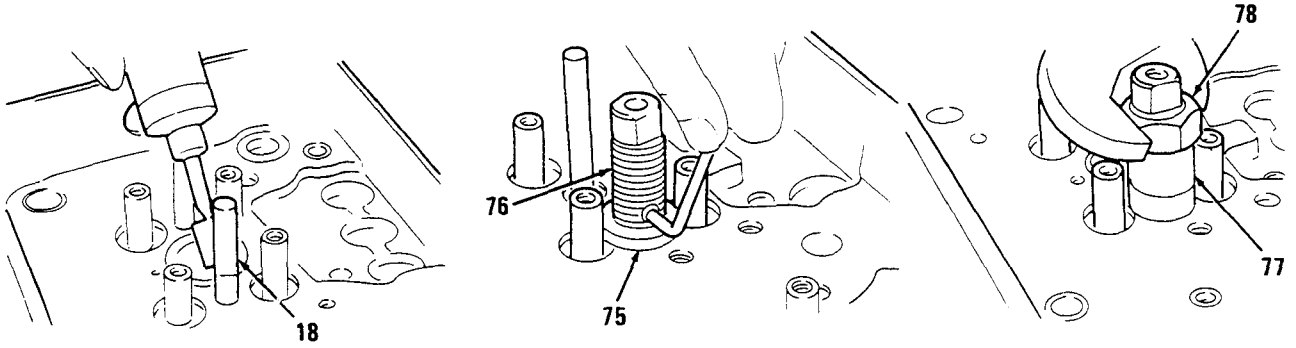
2. Using bridge guide remover set, place spacer (75) over guide.

3. Slide guide remover (76) over guide and aline set screws with notches ground in guide. Tighten set screws to secure guide remover in place.



4. Place spacer (77) over guide remover (76).

5. Thread nut (78) on guide remover and turn clockwise to withdraw guide from cylinder head.



5-37. CYLINDER HEAD REPAIR (Cont)

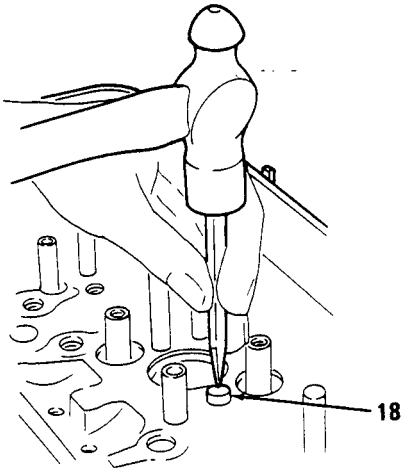
(b) Remove broken valve bridge guides as

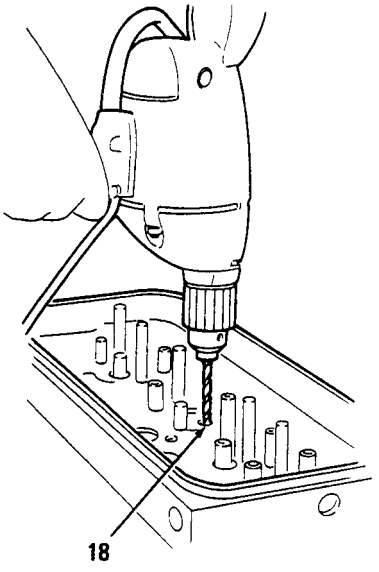
1. Center punch end of valve bridge guide (18).

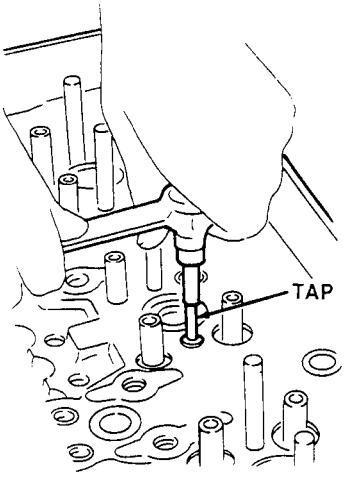
2. Drill hole 0.5 inch deep in end of guide (18) with No. 3 (0.2130 inch) drill bit.

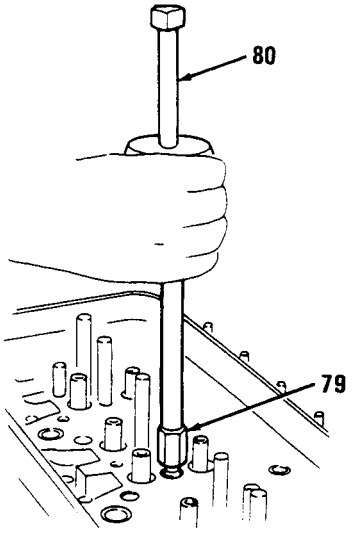
3. Tap guide with 1/4-28 bottoming tap.

4. Thread bridge guide remover (79) into tapped hole.









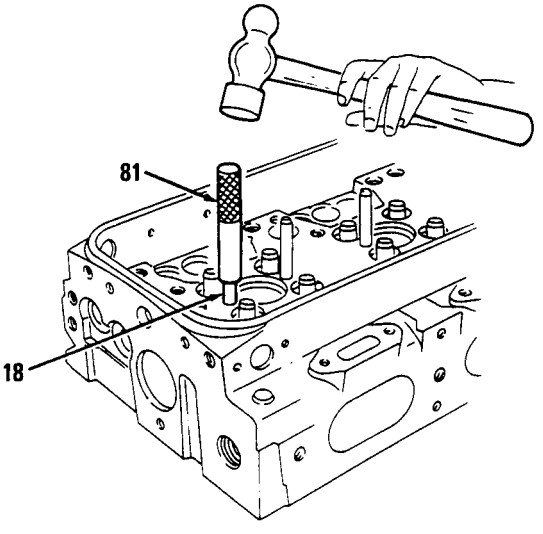
5. Attach slide hammer (80) to guide remover (79) and remove guide.

(c) Install valve bridge guides as follows:

1. Apply a coat of sealant to bridge guide (18).

2. Start guide (18) in cylinder head with undercut end first.

3. Place bridge guide installer (81) over guide (18) and drive into place. Installer will position guide to correct height (2.040 inches) in cylinder head.

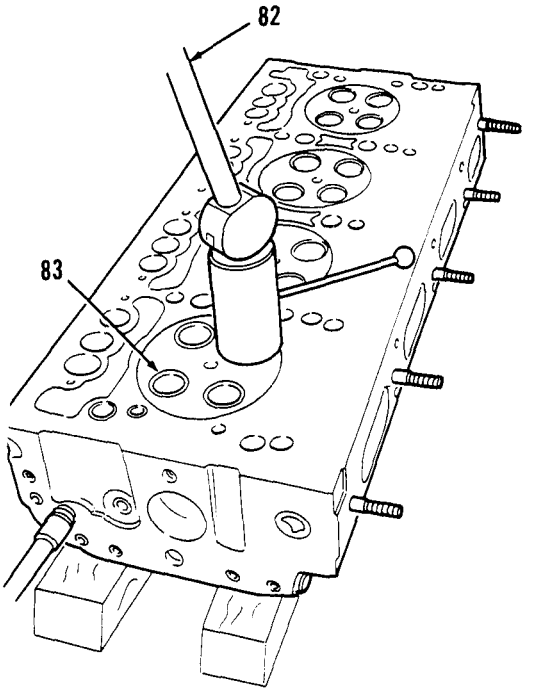


(5) Valve inserts

Inspect valve inserts for excessive wear, pitting, cracking, or improper seat angle. Replace inserts as follows:

(a) Place cylinder head on wood blocks with bottom side up.

(b) Using valve seat insert remover (82), remove valve seat insert (83).



(c) Clean valve seat insert counterbore in cylinder head and inspect for concentricity, flatness, and cracks.

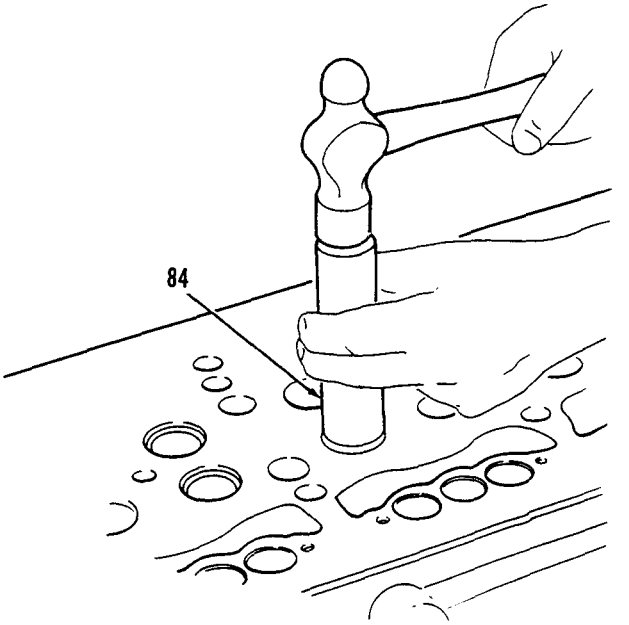
NOTE

Insert counterbore has a diameter of 1.2600 to 1.2610 inches and a depth of 0.3380 to 0.3520 inch. Counterbores must be concentric with valve guides within 0.003 inch total indicator reading.

(d) Immerse cylinder head in water heated to 180°F-200°F (82°C-93°C) for 30 minutes or cool insert with liquid nitrogen.

NOTE

Install insert in cylinder head while head is still hot and insert is at room temperature or when insert is chilled and head is at room temperature.



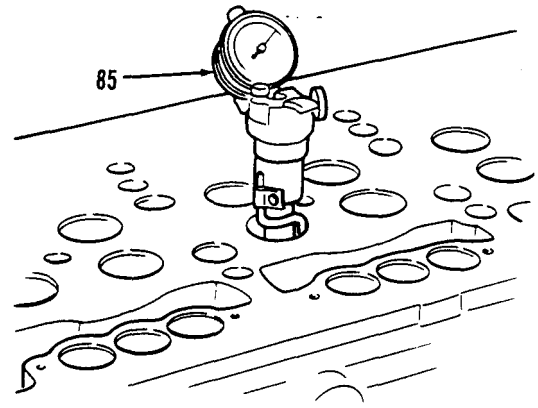
(e) Place cylinder head on a bench with bottom side up. Place insert in counterbore with valve seat side facing up.

(f) Using valve seat insert installer (84), drive insert in place until it seats solidly in cylinder head.

5-37. CYLINDER HEAD REPAIR (Cont)

NOTE

Exhaust valve seat inserts are prefinished. Only check inserts for concentricity after installation. Grind inserts only if runout exceeds 0.002 inch.



(g) Check exhaust valve seat inserts for concentricity in relation to valve guides using dial indicator (85).

(6) Valve seat insert grinding

Grinding inserts requires a valve seat grinder (86) and valve seat grinder adapter kit. Grind valve inserts as follows:

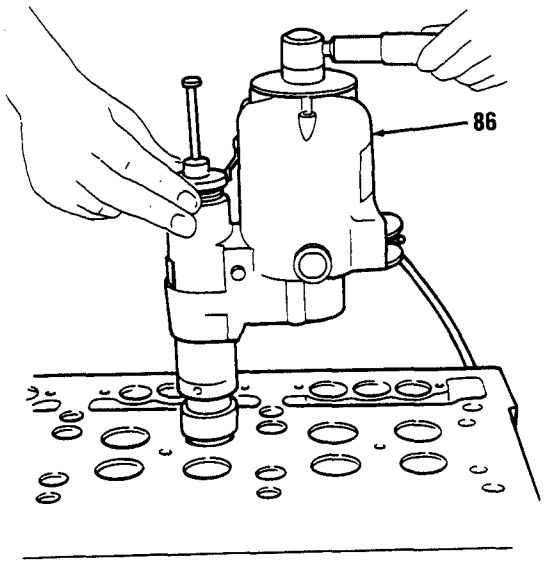
CAUTION

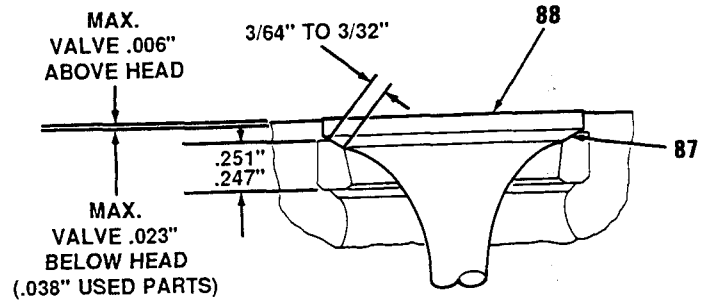
Do not permit grinding wheel to contact cylinder head when grinding insert. If an insert has been ground until grinding wheel contacts cylinder head, then install new insert.

(a) Apply 31 degree grinding wheel on valve seat insert.

(b) Grind throat of insert using 60 degree grinding wheel.

(c) Grind top surface of insert with 15 degree grinding wheel to narrow seat width to dimensions shown in figure. If required, adjust the 31 degree face (87) of insert relative to center of valve face (88) with 15 and 60 degree grinding wheels.





NOTE

Maximum amount exhaust valve should protrude beyond cylinder head" and still maintain proper piston to valve clearance is shown. Grinding reduces thickness of valve seat insert and valve recedes into cylinder head. Replace valve seat insert if valve recedes beyond limits.

(d) After grinding is completed, clean valve seat insert. Measure concentricity of insert in relation to valve guide. If runout exceeds 0.002 inch, check for bent or worn valve guide before regrinding insert.

(e) Determine position of contact area between valve and valve seat insert as follows:

1. Apply a light coat of Prussian blue or equivalent to valve seat insert.

2. Lower stem of valve in valve guide and bounce valve on seat, Do not rotate valve.

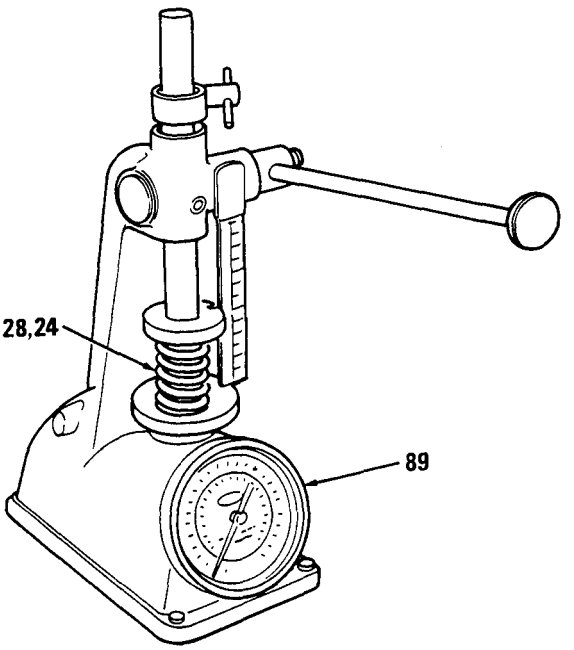
3. Observe area of contact on valve face. Most desirable area of contact is at center of valve face.

(7) Exhaust valves and springs

(a) insure valve stems are 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 (89), replace valve spring (28) when a load of less than 25 pounds will compress it to 1.80 inches.



CAUTION

Replace both springs under an exhaust valve bridge together. Mating a new spring with a used spring can cause unbalanced valve operation.

(8) Cam followers and cam follower springs.

(a) Examine cam follower springs (24) for wear or damage. Using spring tester (89), check spring load. Replace spring when a load of less than 172 pounds will compress it to a length of 2.125 inches.

5-37. CYLINDER HEAD REPAIR (Cont)

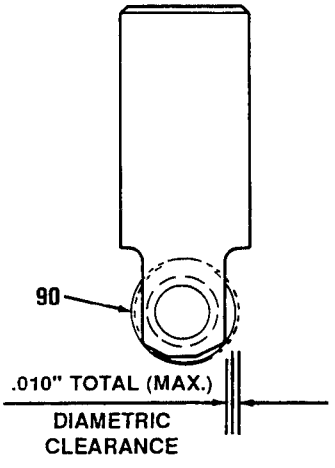
CAUTION

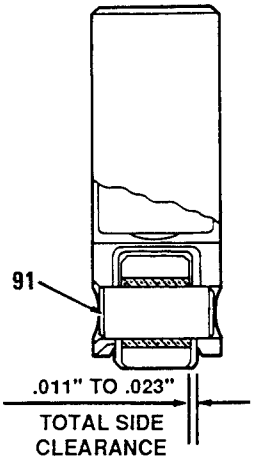
Do not use fuel oil to clean cam followers. It will wash away lubricating oil and cause scoring of cam roller bushing at startup.

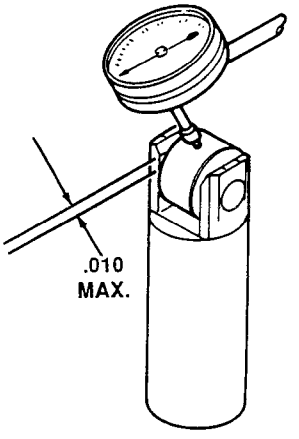
(b) Wash cam followers with engine oil and wipe dry. Examine cam follower rollers for pitting, scoring, and flat spots. Rollers (90) must turn freely on their pins (91).

(c) Using a dial indicator and holding fixture, measure total diametric clearance on cam follower roller. Secure cam follower assembly in a vise or other holding device and place dial indicator needle against outside diameter of roller. Obtain total clearance by moving roller in crosswise direction. Maximum clearance is 0.010 inch.

(d) Using a feeler gage, measure side clearance on cam follower. Insert gage between end of roller and leg of cam follower body. Side clearance must be 0.015 to 0.023 inch.

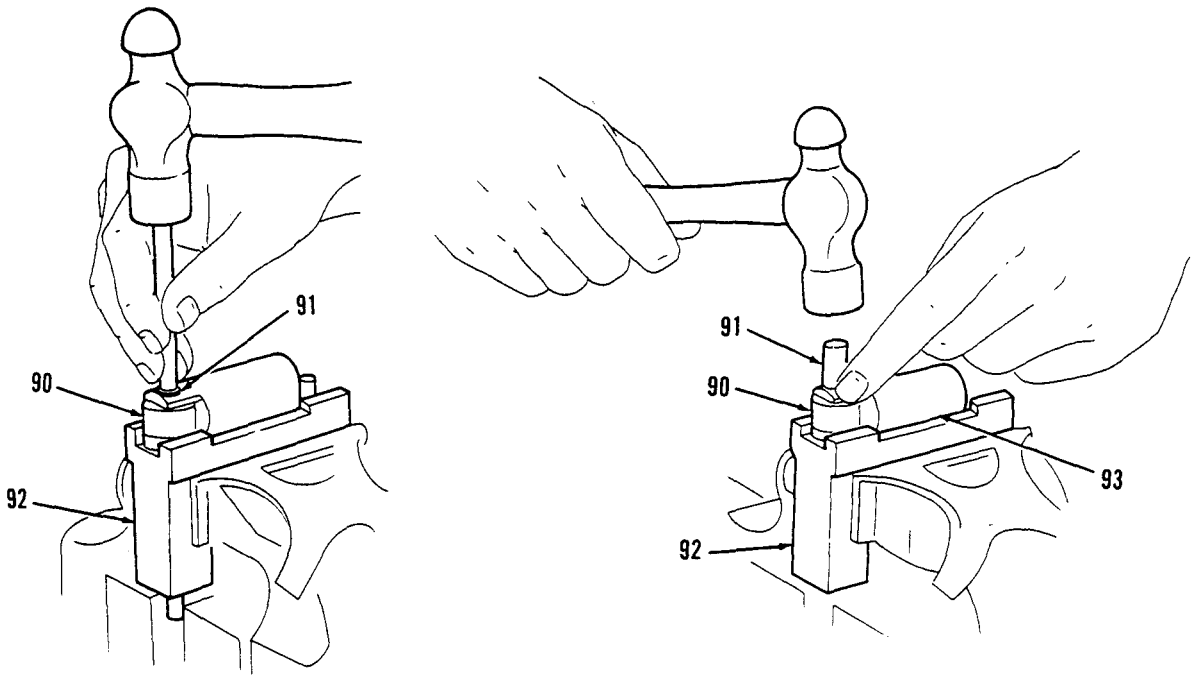






(e) If necessary, install new cam follower rollers and pins as follows:

1. Clamp cam follower holding fixture (92) in a vise and place cam follower in groove at top of assembly with cam follower pin resting on top of small plunger in holding assembly.



WARNING

Restrain cam follower body and roller during removal from holder assembly (92). Follower pin is seated on top of spring loaded plunger in holder assembly and a sudden release could eject cam follower and cause injury to personnel.

CAUTION

Remove any burrs on cam follower surfaces at pin holes prior to installing roller and pin to prevent scoring of roller bushing and pin.

2. Drive pin (91) from roller (90) with a drift.
3. Position follower body in groove of holding assembly with small plunger extending through roller pin hole in one leg of follower body.
4. Coat pin and roller with engine oil.
5. Position roller (90) in cam follower body (93). Plunger will extend into roller bushing and assure accurate alinement of bushing with roller pin holes in follower body.
6. Start pin (91) squarely into follower body (93) and drive into position until pin is centered in legs of follower.
7. Check side clearance between roller (90) and follower body (93). Clearance must be between 0.011 and 0.023 inch.

(9) Rocker arms and shafts

Inspect rocker arm shafts and bushings for wear. Maximum shaft to bushing clearance is 0.004 inch.

5-37. CYLINDER HEAD REPAIR (Cont)

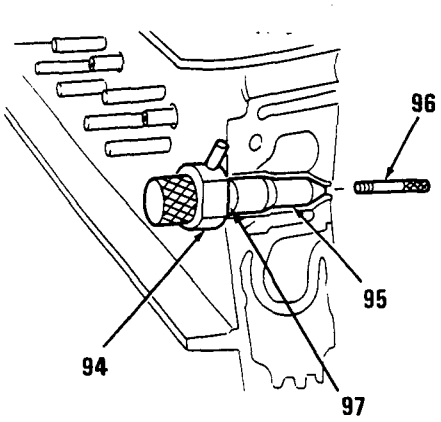
(10) Injector tube

Replace injector tubes if cylinder head leaked at injector tube during pressure test. Replace injector tubes as follows:

(a) Place injector tube installer (94) in injector tube (95).

(b) Insert pilot (96) through small hole in injector tube and thread pilot in threaded hole at end of installer (94).

(c) Tap end of pilot (96) to loosen injector tube. Lift injector tube, pilot, and installer from cylinder head. Discard injector tube (95) and seal ring (97).



(d) Thoroughly clean injector tube hole in cylinder head to remove dirt, burrs, or foreign material preventing tube from seating properly.

(e) Lubricate injector tube seal (97) with engine oil and place in counterbore of cylinder head.

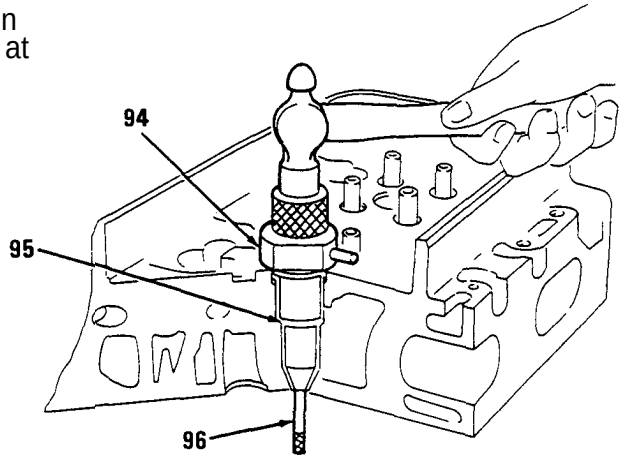
NOTE

There are two injector tube installers, a fixed installer for the old style tube and an adjustable installer for the current injector tube. The current tube has “606” stamped on top flange.

For proper installation of current injector tube, the installer must contact bottom of injector tube before it touches flange at top. Clearance at top, between flange and tool, should be 0.001 to 0.010 inch.

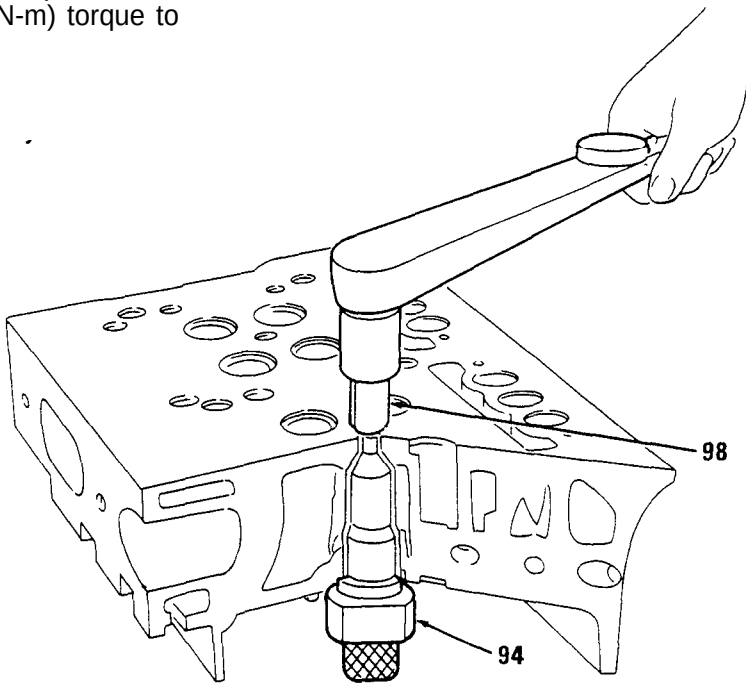
(f) Place installer (94) in injector tube (95). Then insert pilot (96) through small hole in injector tube and thread into tapped hole at end of installer.

(g) Slip injector tube (95), installer (94), and pilot (96) into injector bore and drive in place.



(h) Upset lower end of injector tube as follows:

1. Turn cylinder head bottom side up and remove insert pilot (96). Thread upsetting die (98) into tapped hole of installer (94).
2. Using socket and torque wrench, apply 30 lb-ft (41 N-m) torque to upsetting die (98).
3. Remove upsetting installer (94) from

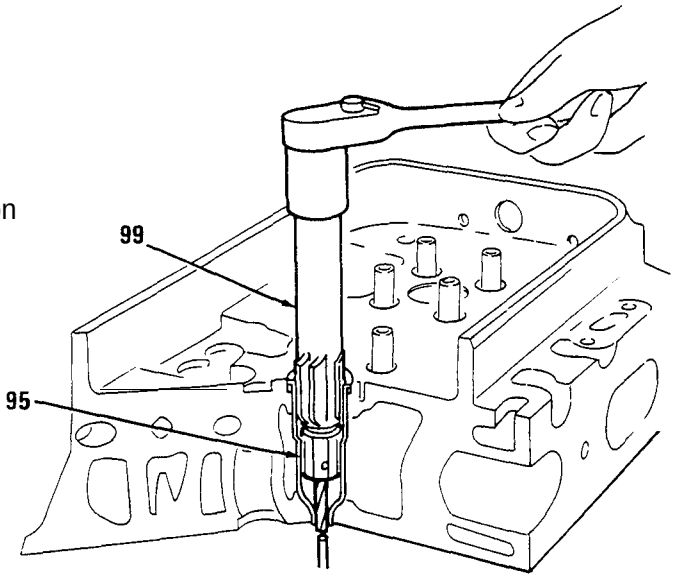


NOTE

Reamer does not contact large diameter of current injector tube. Ream only at small inside diameter and injector nut seat.

(i) Ream injector tube as follows:

1. Clean injector tube and place cylinder head right side up.
2. Apply few drops of cutting oil on reamer flutes and carefully position reamer (99) in injector tube (95).

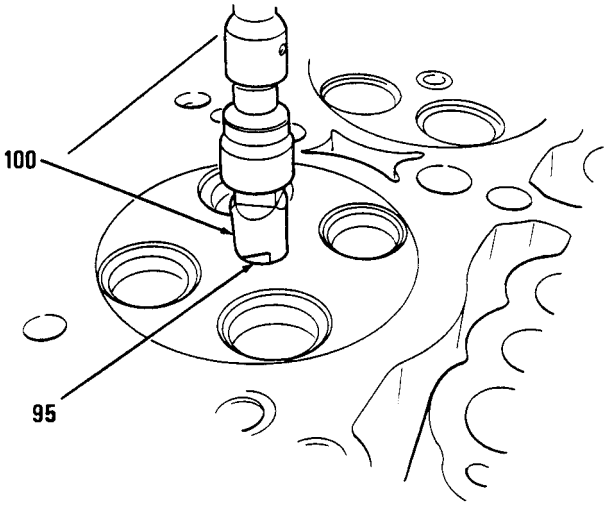


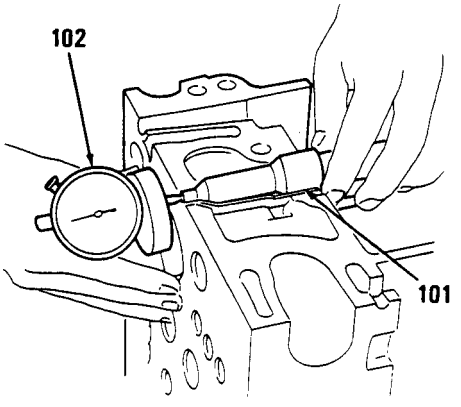
5-37. CYLINDER HEAD REPAIR (Cont)

CAUTION

Turn reamer in clockwise direction only, both when inserting and when removing reamer. Movement in opposite direction will dull cutting edges on flutes.

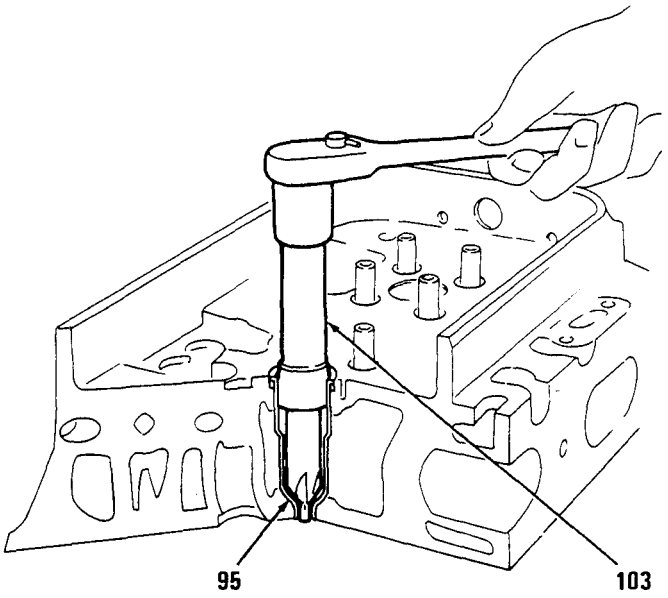
3. Turn reamer (99) clockwise (withdraw reamer frequently to remove chips) until lower shoulder of reamer contacts injector tube (95). Clean out all chips.
4. Rotate cylinder head to bottom side up position. Insert pilot of tube tip refinisher (100) into small hole of injector tube (95).
5. Apply few drops of cutting oil on refinisher (100). Using a socket and speed handle, remove excess stock so lower end of injector tube is from flush to 0.005 inch below finished surface of cylinder head.
6. Install gage (101) in injector tube. Using dial indicator gage (102), premeasure distance from fire deck to gage. Reading must be within +/- 0.014 inch of fire deck.
7. Wash interior of injector tube (95) to prepare for second reaming operation.





8. Apply few drops of cutting oil on bevel seat of injector tube (95). Lower reamer (103) carefully into injector tube until it contacts bevel seat.

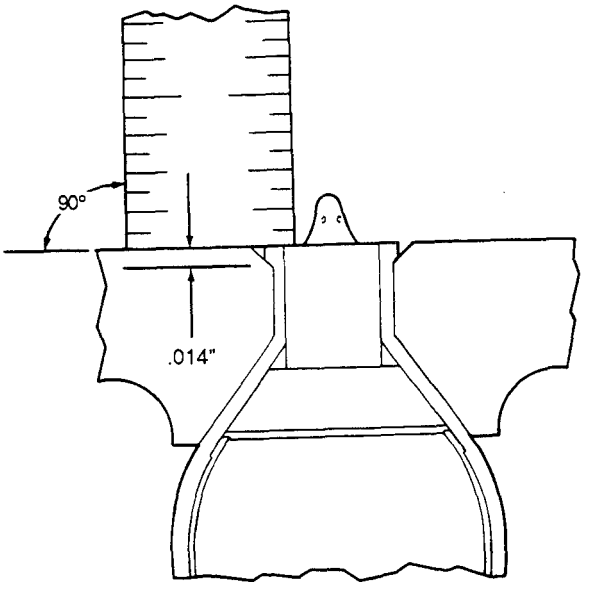
9. For the trial cut, turn reamer (103) steadily without applying any downward force on reamer. Remove reamer, clean out chips, and observe bevel seat to see where seat was cut.



10. Proceed with reaming and withdraw tool occasionally to observe progress.

11. Continue reaming until shoulder of spray tip is within +/- 0.014 inch of fire deck. Use gages (101) and (102) to measure distance.

12. Wash interior of injector tube (95).



5-37. CYLINDER HEAD REPAIR (Cont)

e. Assembly

(1) If necessary, install two bushings (60) in cylinder head bolt holes. Press flush to 0.02 inch below surface.

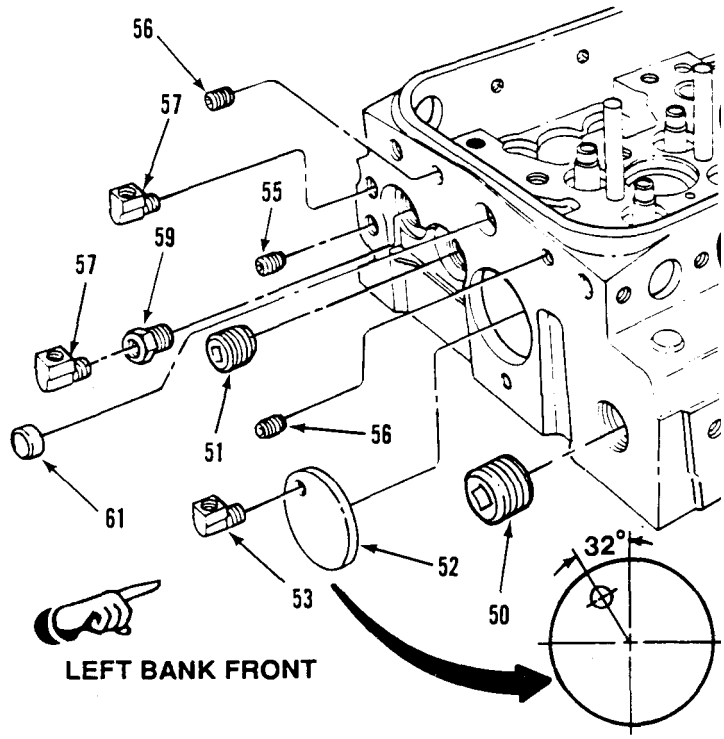
(1.1) Apply gasket cement to cup plug (61) and install in front and rear of cylinder head.

(2) Apply gasket cement to solid plug (52) and install at a 32 degree angle to the right of perpendicular in front of right cylinder head or 32 degrees to the left of perpendicular in front of left cylinder head as shown.

(2.1) Install elbow (53) in solid plug (52) for right cylinder head or left cylinder head.

(3) Install fitting (58) to front of right cylinder head or reducer (59) to front of left cylinder head.

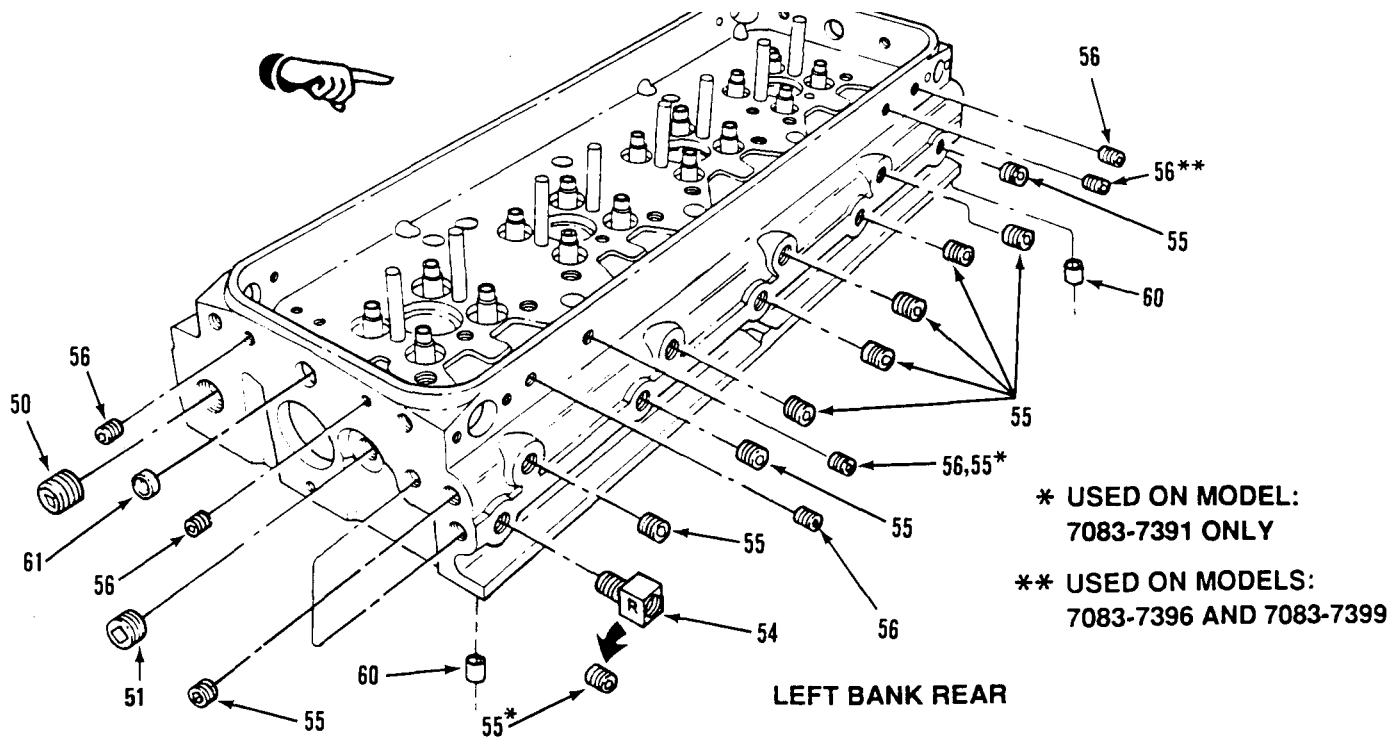
(4) Install elbow (57) to front of right cylinder head or two elbows (57) to front of left cylinder head.



(5) For models 7083-7396 and 7083-7399, install eight threaded plugs (56) in left cylinder head or six plugs (56) in right cylinder head.

(5.1) For model 7083-7391, install six threaded plugs (56) in left or right cylinder head.

(6) For right cylinder head of model 7083-7396 and left cylinder head of model 7083-7399, install twelve pipe plugs (55) in inboard side and ends of cylinder head. For left cylinder head of model 7083-7396 and right cylinder head of model 7083-7399, install thirteen pipe plugs (55) in inboard side and ends of cylinder head.



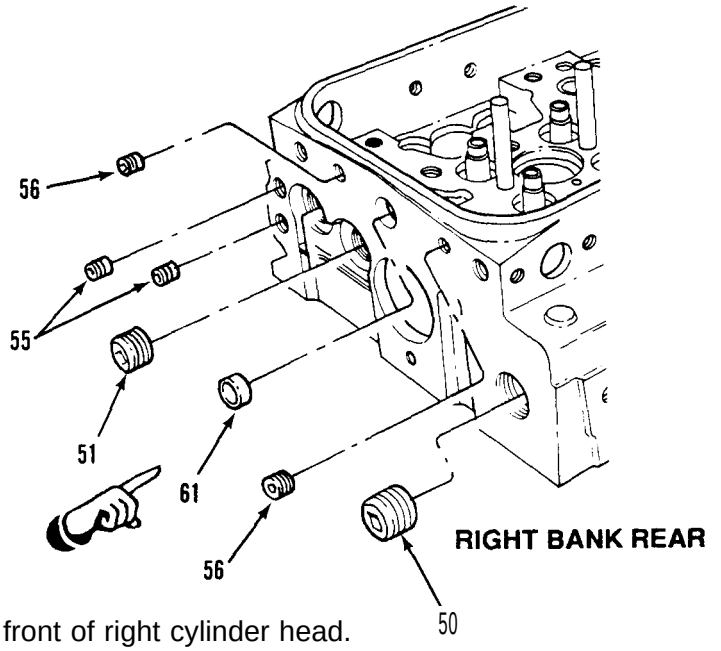
(6.1) For model 7083-7391, install thirteen pipe plugs (55) in inboard side and ends of right cylinder head and fourteen pipe plugs (55) in left cylinder head.

(7) Install two each of pipe plugs (50 and 51) in ends of cylinder head. Plugs must be flush to 0.18 inch below surface.

NOTE

Model 7083-7396 has restrictive fitting on rear inboard side of left cylinder head.

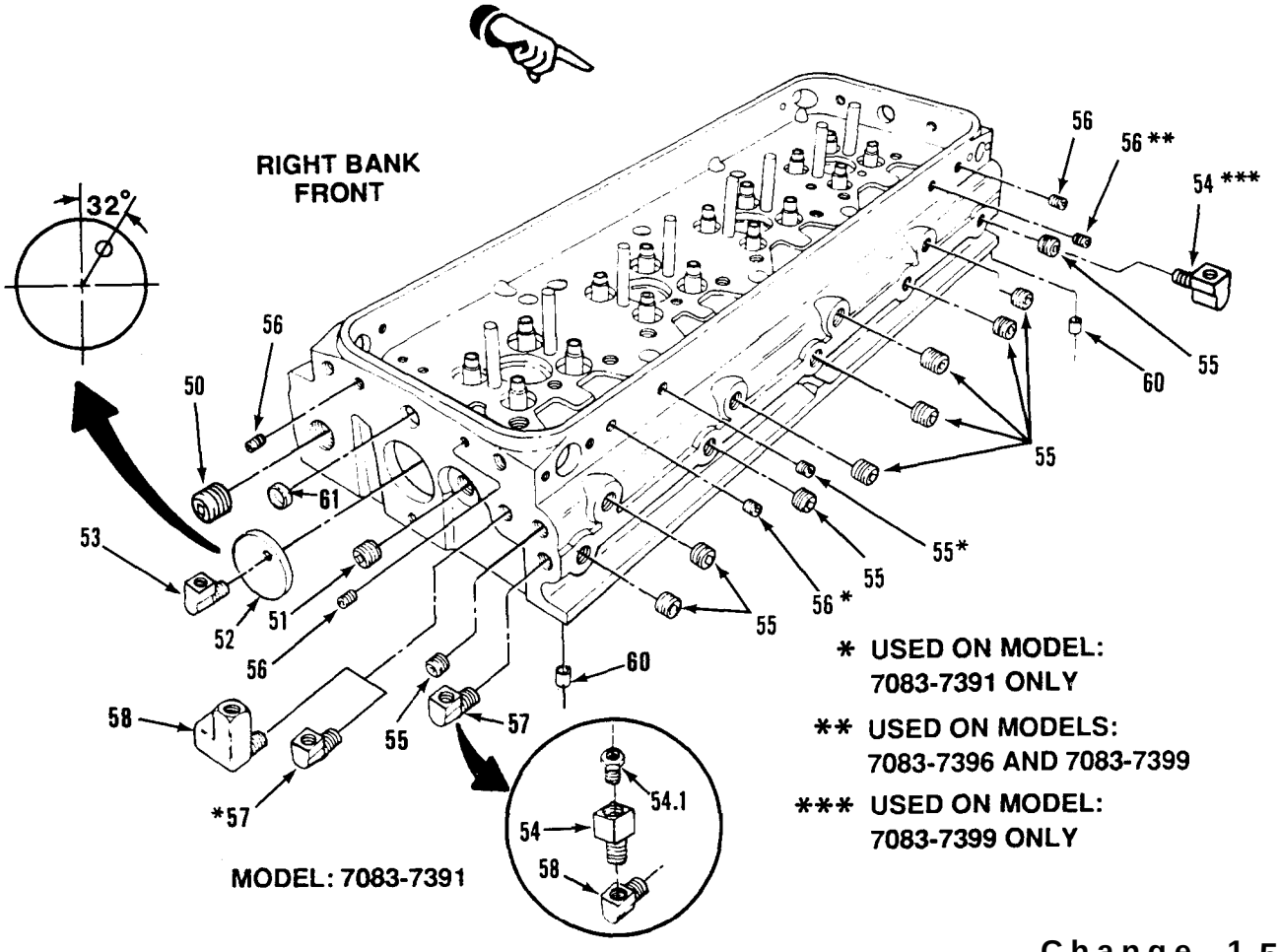
- Model 7083-7399 has restrictive fitting on rear inboard side of right cylinder head.



- Model 7083-7391 has restrictive fitting on front of right cylinder head.

(8) Install restrictive fitting (54) in cylinder head.

(8.1) For model 7083-7391, install fitting (54.1) in restrictive fitting (54) at fornt of right cylinder head.



5-37. CYLINDER HEAD REPAIR (Cont)

(9) Install fuse plug (49) in outboard side of cylinder head. Plug must be flush to 0.16 inch below surface.

(10) Apply pipe sealant with teflon to cup plug (48) and install in rear of cylinder head.

(11) For models 7083-7396 and 7083-7399, install five exhaust manifold studs (46) in right cylinder head or eight exhaust manifold studs (46) in left cylinder head. Torque studs to 25-40 lb-ft (34-54 N-m).

(11.1) For model 7083-7391, install five exhaust manifold studs (46) in right head or five exhaust manifold studs (46) and four studs (46.1) in left cylinder head. Torque studs to 25-40 lb-ft (34-54 N-m).

(12) For models 7083-7396 and 7083-7399, install three pipe plugs (47) in outboard side of left cylinder head.

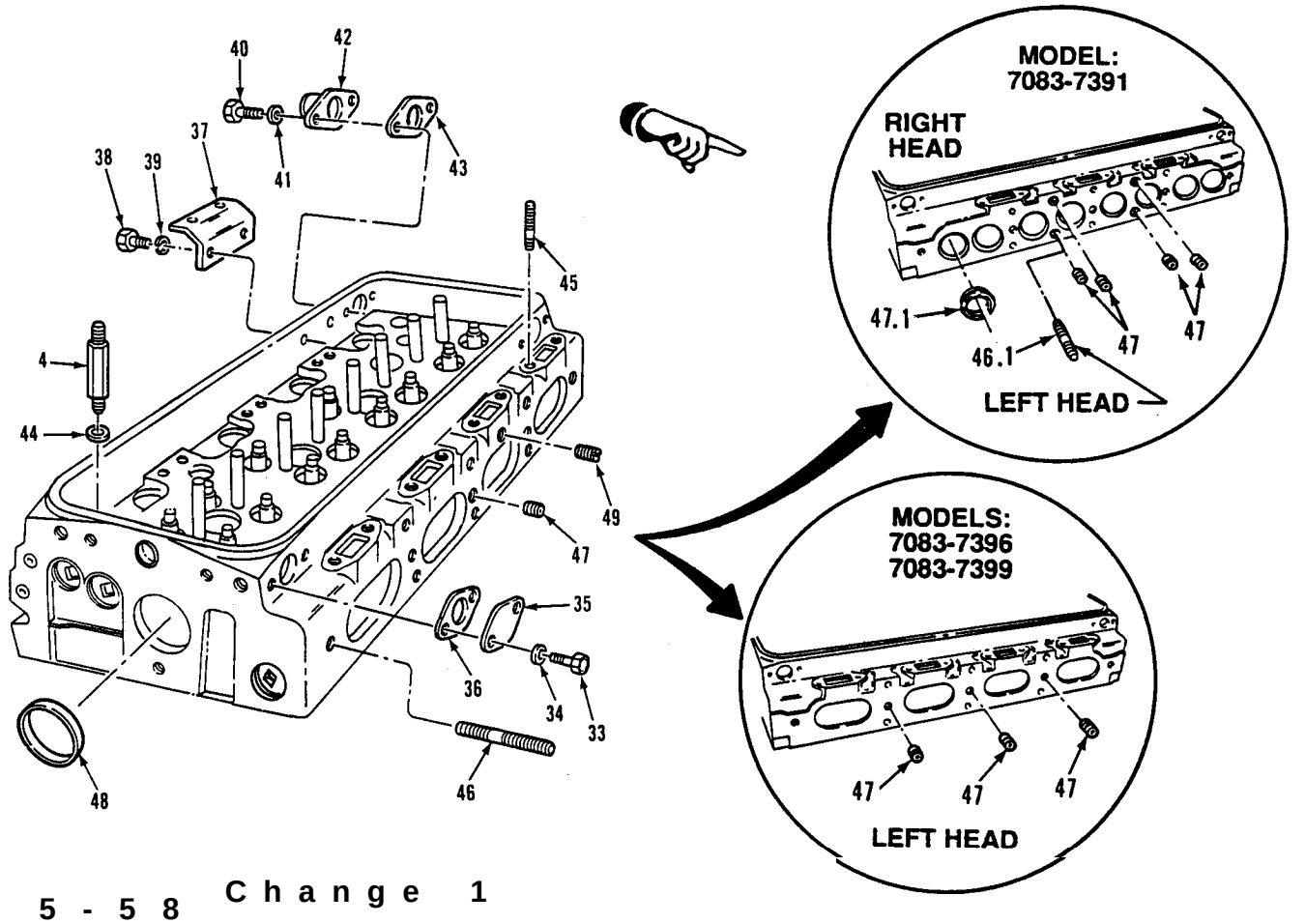
(12.1) For model 7083-7391, install four pipe plugs (47) in outboard side of right cylinder head.

(13) For models 7083-7396 and 7083-7399, install eight water manifold studs (45) in cylinder head. Torque studs to 10-25 lb-ft (14-34 N-m).

(13.1) For model 7083-7391, install six water manifold studs (45) in cylinder head. Torque studs to 10-25 lb-ft (14-34 N-m).

(14) Install eight washers (44) and eight fuel connectors (4) to cylinder head. Torque connectors to 40-45 lb-ft (54-61 N-m).

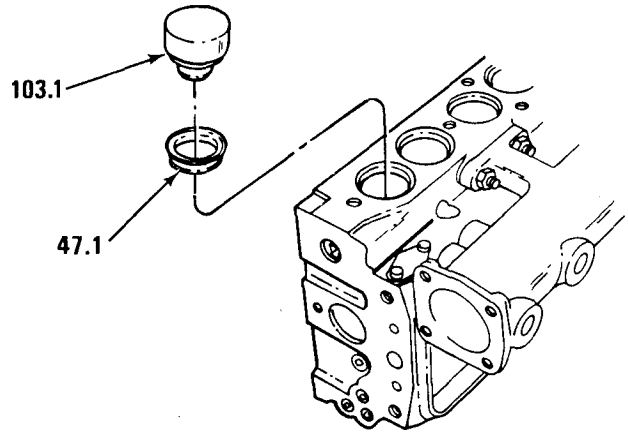
(15) Install gasket (43), adaptor (42), two flat washers (41), and two bolts (40) to front inboard corner of cylinder head. Torque bolts to 7-9 lb-ft (10-12 N-m).



(15.1) For model 7083-7391 only, if necessary, install eight exhaust port seals (47.1) in cylinder head. Using hammer and exhaust seal installer (103.1), carefully tap seal in place.

NOTE

- Models 7083-7396 and 7083-7391 contain four bolts (33), four flat washers (34), two cover plates (35), and two gaskets (36) per head and no cover plate on rear inboard corner.
- Model 7083-7399 contains six bolts (33), six flat washers (34), three cover plates (35), and three gaskets (36) per head.



(16) Install gaskets (36), cover plates (35), flat washers (34), and bolts (33) to remaining corners of cylinder head. Torque bolts to 7-9 lb-ft (10-12 N-m).

(17) If necessary for models 7083-7396 and 7083-7399, install support bracket (37), two lockwashers (39), and two bolts (3$) to right cylinder head. Torque bolts to 30-35 lb-ft (41-47 N-m).

(18) Install sixteen exhaust valves as follows:

(a) Position cylinder head on its side. Lubricate valve stems with sulphurized oil (E. P. type) and slide valves (32) all the way into guides (72).

NOTE

With used valves, install in their original location.

(b) Install lower spring seat (31), valve spring (28), and upper spring seat (30) over valve stem.

CAUTION

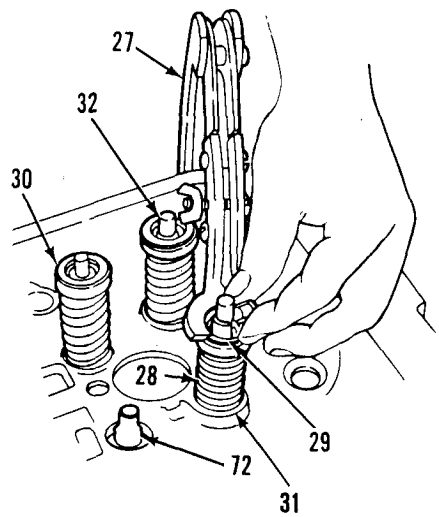
Avoid scoring valve stem with valve seat when compressing spring.

(c) Using valve spring compressor (27), compress valve spring (28) and install two piece tapered valve locks (29).

(d) Release pressure on valve spring compressor (27) and remove tool.

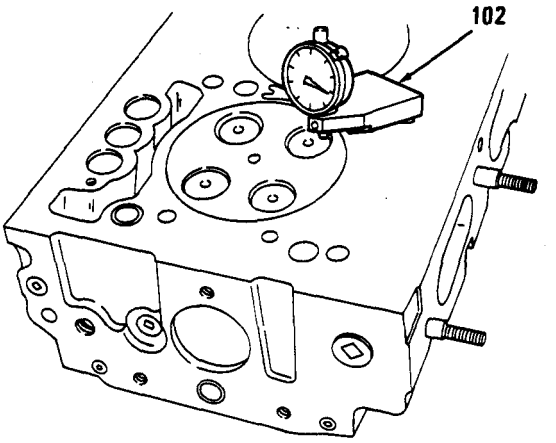
(e) Repeat steps (a) thru (d) for remaining valves.

(f) Support cylinder head on wood blocks at both ends (right side up). Give end of valve stems a sharp tap with soft headed hammer to seat valve locks (29).



5-37. CYLINDER HEAD REPAIR (Cont)

(9) Using depth gage (102), measure exhaust valve protrusion beyond fire deck of cylinder head. If out of limits, regrind or replace insert.



NOTE

- Before installing cam followers, immerse in Cindol 1705 oil heated to 100°F-125°F (38 °C-52°C) for one hour to insure 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 their original locations.

(19) Assemble lower spring seat (26), cam follower spring (24), upper spring seat (25), and locknut (15) on twelve push rods (16).

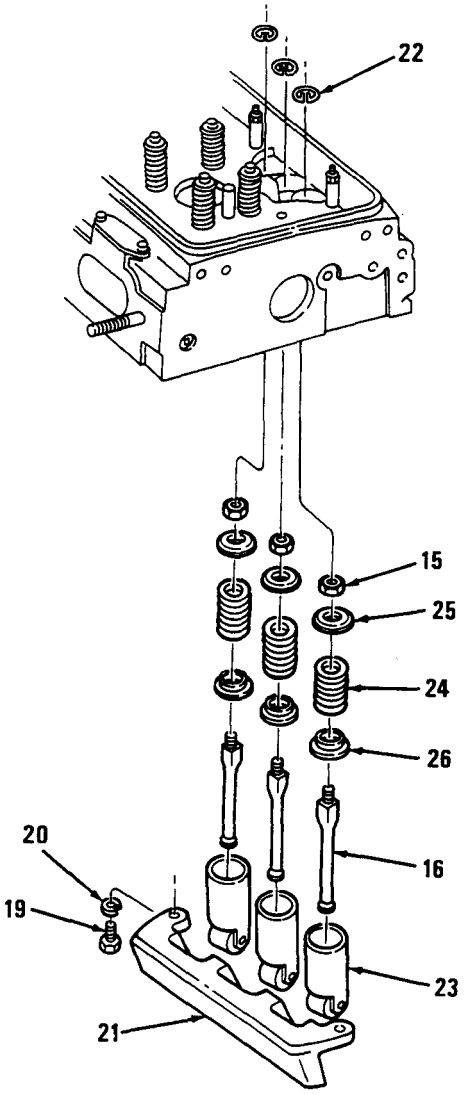
(20) Install twelve cam follower spring retainers (26) in cam follower bores from top of cylinder head.

(21) Slide twelve push rod (16) assemblies in position from bottom of cylinder head.

NOTE

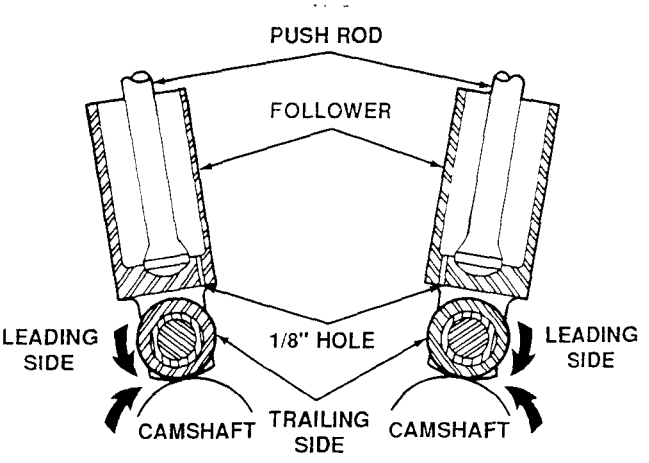
Install cam followers with oil hole directed away from exhaust valves.

(22) Slide twelve cam followers (23) in position from bottom of cylinder head.



CAUTION

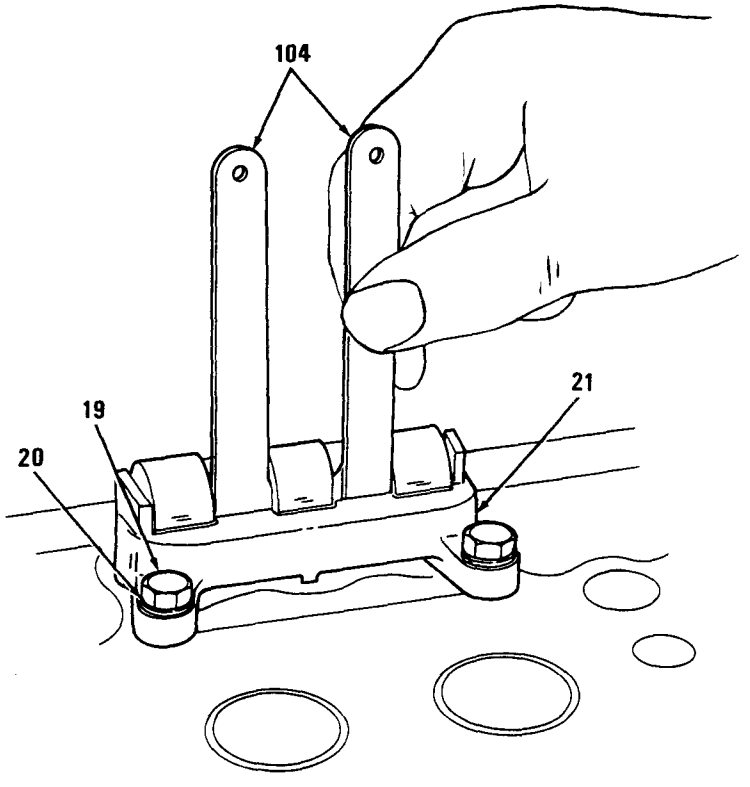
Insure cam follower is not cocked in cam follower bore. With cam follower guide installed, bottom of cam follower body must be flush with fire deck.

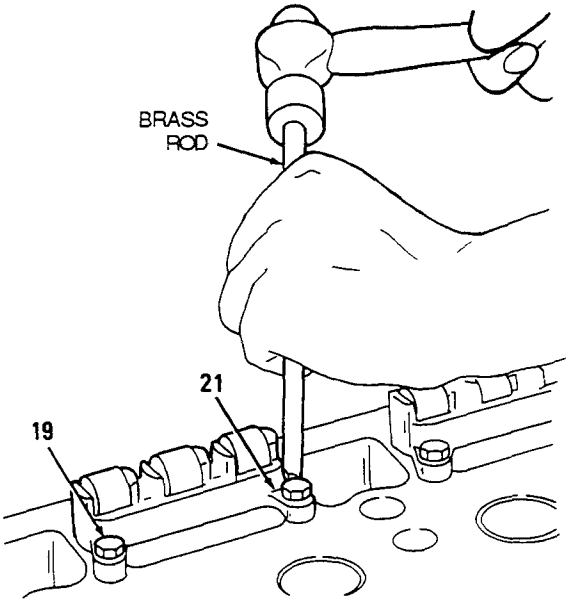


(23) Attach four cam follower guides (21) to cylinder head using eight lockwashers (20) and eight bolts (19). Torque bolts to 12-15 lb-ft (16-20 N-m).

(24) Measure clearance between cam follower guide (21) and cam follower legs using feeler gages (104). Clearance must be at least 0.005 inch.

(25) If clearance is insufficient, slightly loosen bolts (19) and tap corners of guide (21) with brass rod. Retorque bolts with proper clearance.



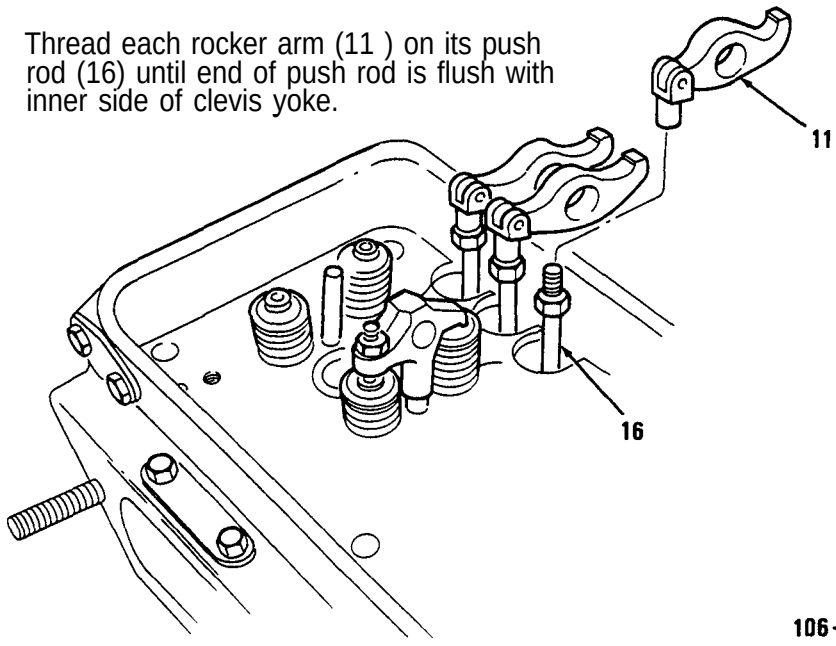


5-37. CYLINDER HEAD REPAIR (Cont)

NOTE

- Injector rocker arm is different than exhaust valve rocker arms. Boss for rocker arm shaft on right and left hand valve rocker arms is longer on one side. Extended boss of each rocker arm must face toward injector rocker arm.
- If a new rocker arm is installed, also install a new push rod.
- Refer to Chapter 8 for push rod locknut adjustment during engine tune-up.

(26) Thread each rocker arm (11) on its push rod (16) until end of push rod is flush with inner side of clevis yoke.



NOTE

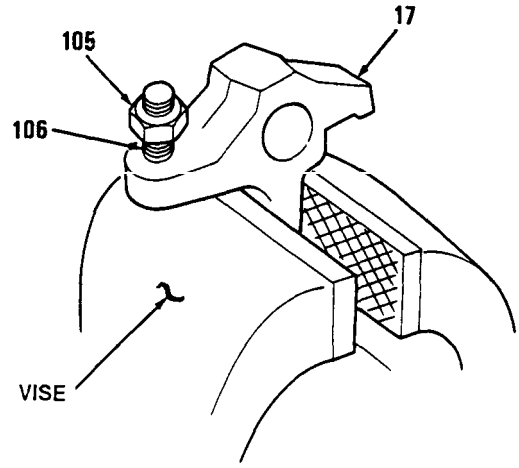
Adjust valve bridges after cylinder head disassembly or extended engine operation.

(27) Adjust bridges as follows:

CAUTION

Do not loosen or tighten locknut with bridge installed in cylinder head. Bent bridge guide or rear valve stem may result.

(a) Place valve bridge (17) in a vise or bridge holding fixture and loosen locknut (105) on bridge adjusting screw (106).



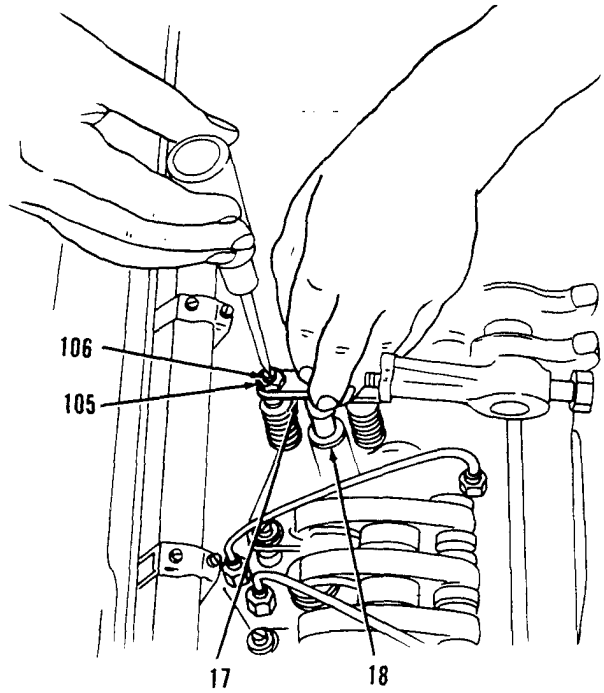
(b) Install valve bridge (17) on valve bridge guide (18).

(c) While firmly pressing straight down on pallet surface of valve bridge (17), turn adjusting screw (106) clockwise until it just touches valve stem. Then turn screw an additional 1/8 to 1/4 turn and tighten locknut (105) finger tight.

(d) Remove valve bridge and place in a vise or holding fixture. Hold adjustment screw (106) from turning with screwdriver and torque locknut (105) on adjusting screw to 20-25 lb-ft (27-34 N-m).

(e) Lubricate valve bridge (17) and valve bridge guide (18) with engine oil and install bridge in original position.

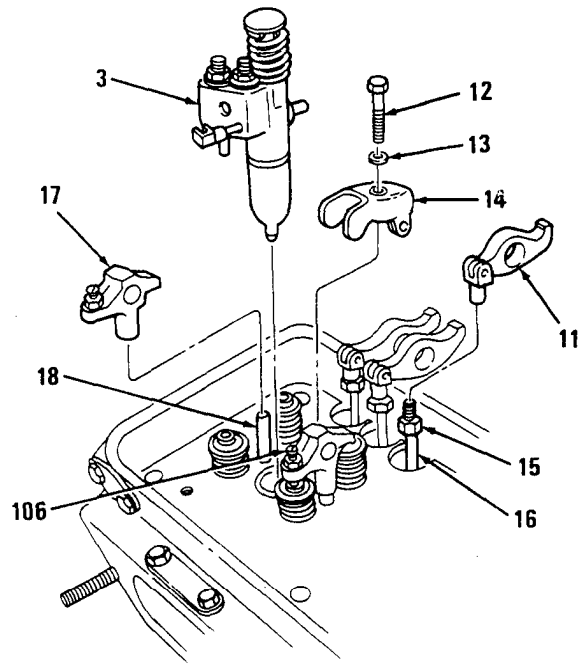
(f) Place 0.0015 inch feeler gage under each end of valve bridge (17). When pressing down on pallet surface of valve bridge, both gages must be tight. If both feeler gages are not tight, readjust screw as outlined in steps (a) thru (e).



CAUTION

Seat slot in valve bridges over outboard exhaust vale stem to prevent valve damage.

(28) Position eight valve bridges (17) on bridge guides (18) with adjusting screw (106) toward outboard side of engine.



CAUTION

Insure injector hold-down clamp does not contact exhaust valve spring.

(29) Install four fuel injectors (3) in cylinder head and secure in place with four clamps (14), four washers (13), and four bolts (12). Torque bolts to 20-25 lb-ft (27-34 N-m).

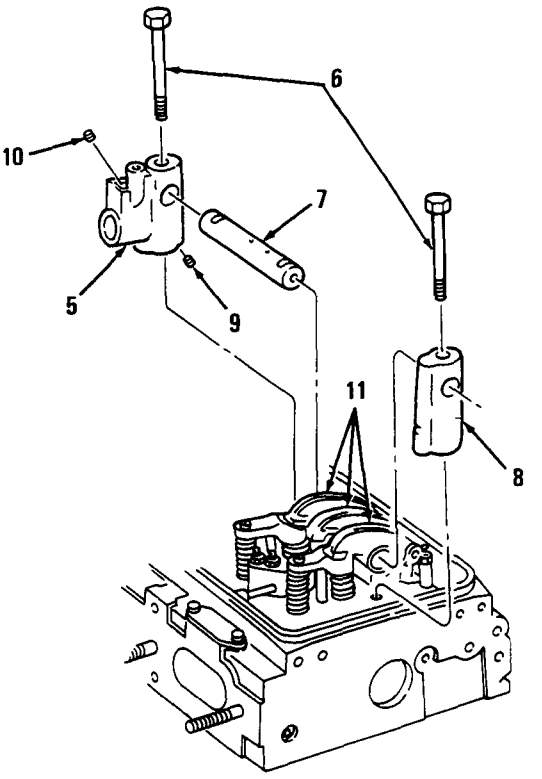
5-37. CYLINDER HEAD REPAIR (Cont)

CAUTION

Insure oil supply fitting (10) is installed in throttle delay housing (5) or low oil pressure will result in engine failure.

NOTE

Install special rocker arm shaft bracket (5) containing throttle delay housing at right bank No. 1 cylinder on models 7083-7396 and 7083-7391. Model 7083-7391 does not require an operational throttle delay system.



(30) if necessary, install check valve (9) used on model 7083-7396 and oil supply fitting (1 O), used on models 7083-7396 and 7083-7391, into throttle delay housing (5).

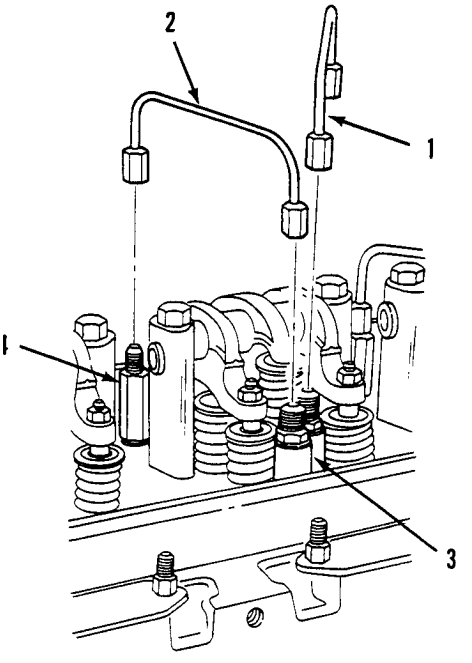
(31) Apply engine oil to rocker arm shafts (7) and slide shaft through rocker arms (11). Place rocker shaft bracket (8) over each end of shaft with finished face of bracket toward rocker arm.

(32) Insert eight rocker arm bracket bolts (6) through eight brackets (8) and four shafts (7). Swing rocker arms, shafts, and brackets in position and thread bolts in cylinder head. Torque bolts to 90-100 lb-ft (122-136 N-m).

CAUTION

- Do not bend fuel lines and do not exceed specified torque on fuel line nuts. Excessive tightening will twist or fracture flared end of fuel line and result in leaks.
- Never reuse fuel lines regardless of their appearance. Always use new fuel lines. Reused fuel lines may not seal properly and result in leaks.

(33) Remove caps from fuel injectors (3) and connect four inlet fuel lines (1) and four outlet fuel lines (2) to injectors and fuel connectors (4). Using special socket, torque fuel lines to 130-160 lb-in (14.7 -18.3 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-6 Install water manifolds (7083-7396 and 7083-7399)
5.1-6 Install water manifolds (7083-7391)
5-5 Install lifting brackets
4-27 Install cylinder head
5.1-8 Install glow plugs (7083-7391)

5-38. OIL COOLER ASSEMBLY REPAIR (See Para 4-39)

5-39. FUEL INJECTOR ASSEMBLY REPAIR (See Para 4-40)

5-40. BLOWER REPAIR (See Para 4-41)

5-41. GOVERNOR REPAIR

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

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Governor cover bushing remover (App B, Item 78)
Governor cover bearing installer (App B, Item 77)
Governor cover bushing installer (App B, Item 53)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

1 Seal ring (App F, Item 131)
1 Seal ring (App F, Item 132)
1 Gasket (App F, [tern 78)
1 Gasket (App F, Item 82)
1 Key washer (App F, Item 165)
1 Expansion plug (App F, Item 113)
1 Washer (App F, Item 161)

EXPENDABLE/DURABLE SUPPLIES

Sealant (App C, Item 38)
Grease (App C, Item 22)
Sealant (App C, Item 40)
Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)
Bolt 5/1 6-24 x 3 (App C, Item 4)

EQUIPMENT CONDITION

Para Description
5-17 Governor removed from blower

a. Disassembly

NOTE

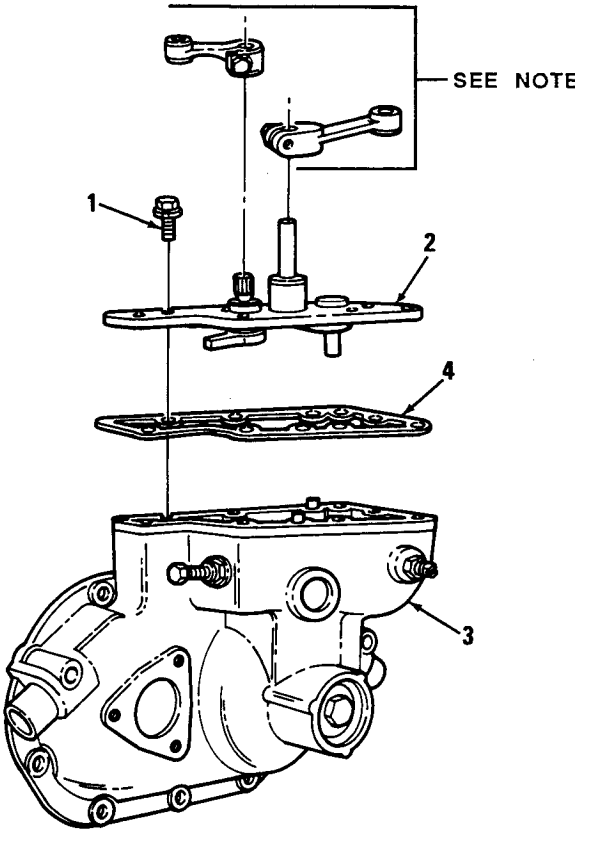
- Before and during disassembly of governor, clean entire unit and visually inspect for repairs of worn or damaged parts not requiring complete disassembly.
- If remote control levers are on governor cover, remove prior to disassembly of cover.

(1) Remove eight screws (1) securing governor cover (2) to governor (3). Remove cover and gasket (4). Discard gasket.

(2) Remove retaining ring (5) and two washers (6) from stop lever shaft (7).

(3) Remove stop lever shaft (7) and return spring (8) from governor cover (2).

(4) Remove seal ring (9) from governor cover (2). Discard seal ring (9).



(5) Remove spacer (10), retaining ring (11), and two washers (12) from speed control shaft (13).

(6) Remove speed control shaft (13) from governor cover (2).

(7) Remove seal ring (14) from governor cover (2). Discard seal ring (14).

(8) Support governor cover (2) on wooden blocks in a press, top facing down.

(9) Using bushing remover (15), remove two control shaft bushings (16) from governor cover (2).

(10) Place governor housing (3) in soft-jawed vise.

(11) Remove two bolts (17) and two flat washers (18) securing access cover (19) and gasket (20) to governor housing (3). Discard gasket.

(12) Loosen retainer nut (21) and remove high speed spring retainer (22), retainer nut (21), and plunger (23) assembly from governor housing (3).

(13) Remove low speed spring cap (24), low speed spring (25) spring seat (26), and adjusting pin (27) from plunger (23).

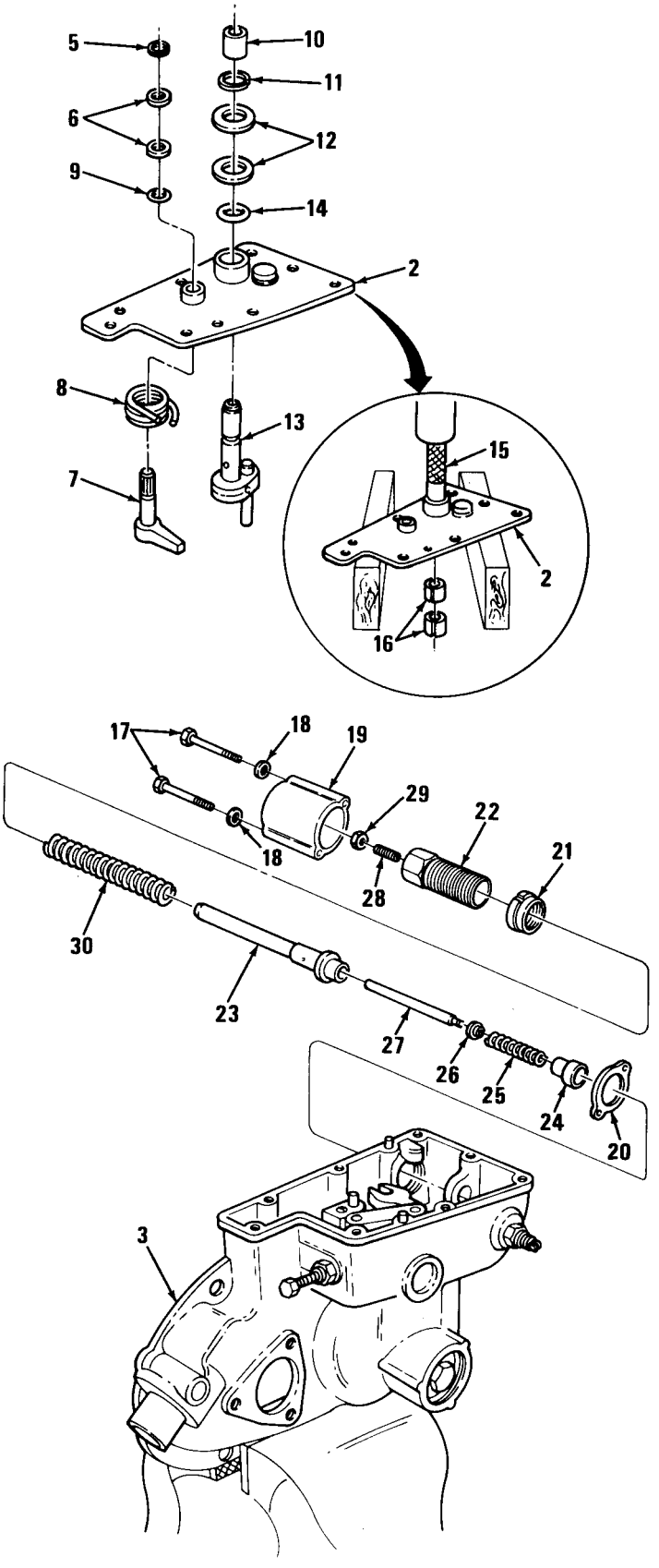
(14) Using a socket head wrench, hold screw (28) and loosen nut (29).

WARNING

High speed spring is under pressure, and personal injury could occur if downward pressure Is not applied to retainer.

(15) While applying pressure to high speed spring (30), remove screw (28) from plunger (23).

(16) Remove high speed spring (30) from plunger (23).



5-41. GOVERNOR REPAIR (Cont)

(17) Remove plug (31) and gasket (32). Discard gasket.

(18) Bend tang of key washer (33) away from retainer bolt (34).

(19) While holding weight carrier (35), remove retainer bolt (34), washer (36) and key washer (33). Discard key washer.

(20) Thread a 5/16-24 x 3 inch bolt (37) into hole for retainer bolt (34).

(21) Remove governor housing (3) from vise.

(22) Place governor housing (3) on a flat surface with bolt (37) facing up. Tap weight carrier shaft (38) out of bearing (39) with a soft-headed hammer.

(23) Slide riser bearing (40) and riser (41) off weight carrier shaft (38).

NOTE

Inspect weight carrier bearing in governor housing to determine need for removal.

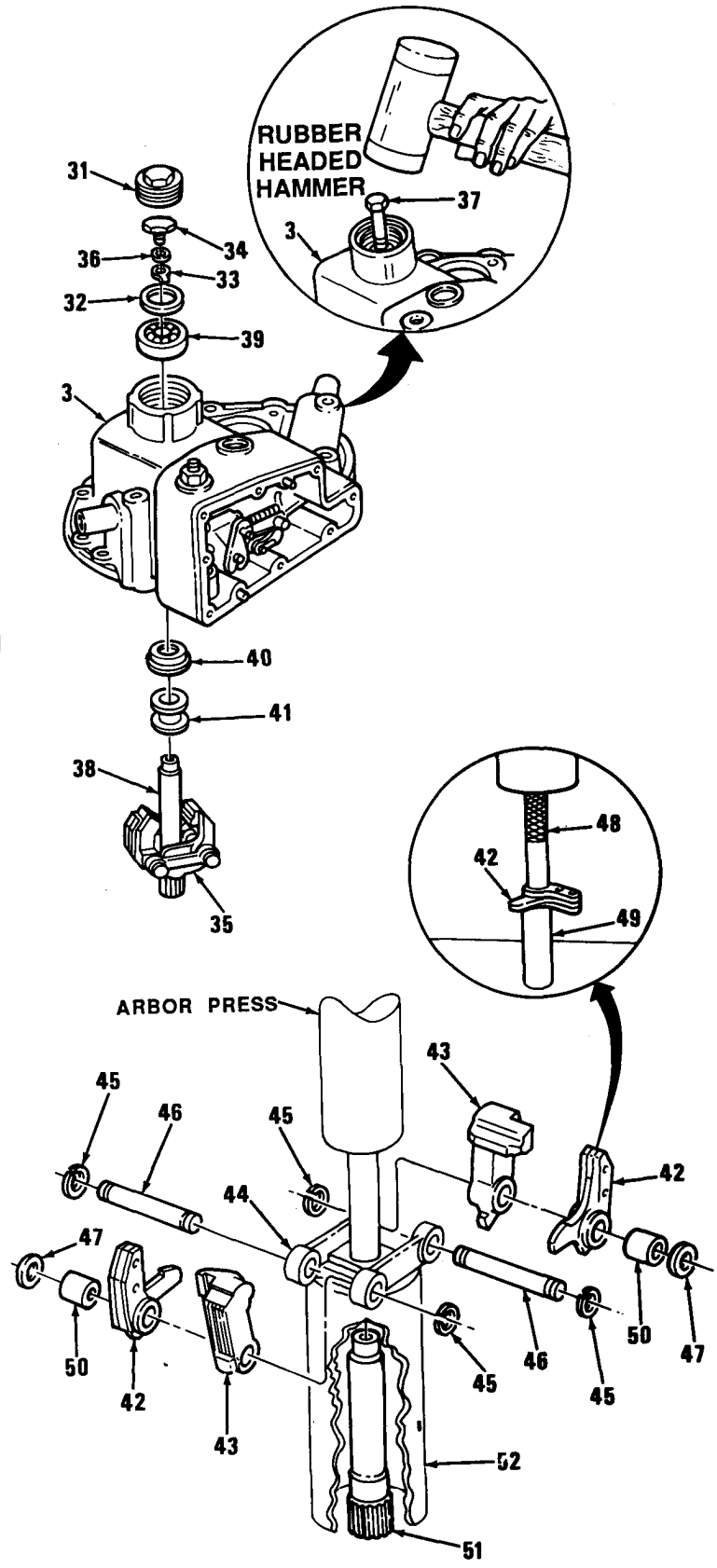
(24) If necessary, remove weight carrier bearing (39) from governor housing (3). Use a small brass rod and hammer to tap bearing from inside housing.

(25) Matchmark two high speed and two low speed weights (42 and 43) to weight carrier (44).

(26) Remove four retaining rings (45).

(27) Press two pins (46) from weight carrier (44) and remove two washers (47), two high speed weights (42), and low speed weights (43).

(28) Using bearing remover (48), sleeve (49) and arbor press, remove needle bearing (50) from one high speed weigh{; Repeat procedure for other high speed weight.



(29) Using an arbor press, remove carrier shaft (51) from weight carrier (44) by placing spline end into a sleeve (52) having a one-inch hole.

(30) Remove retaining clip (53) and washer (54) from differential lever pin (55) and remove operating lever connecting link (56).

(31) Remove retaining clip (57) and washer (58) from operating lever pin (59). Remove differential lever (60) from operating lever (61).

(32) If damaged, remove pin (55) from differential lever (60).

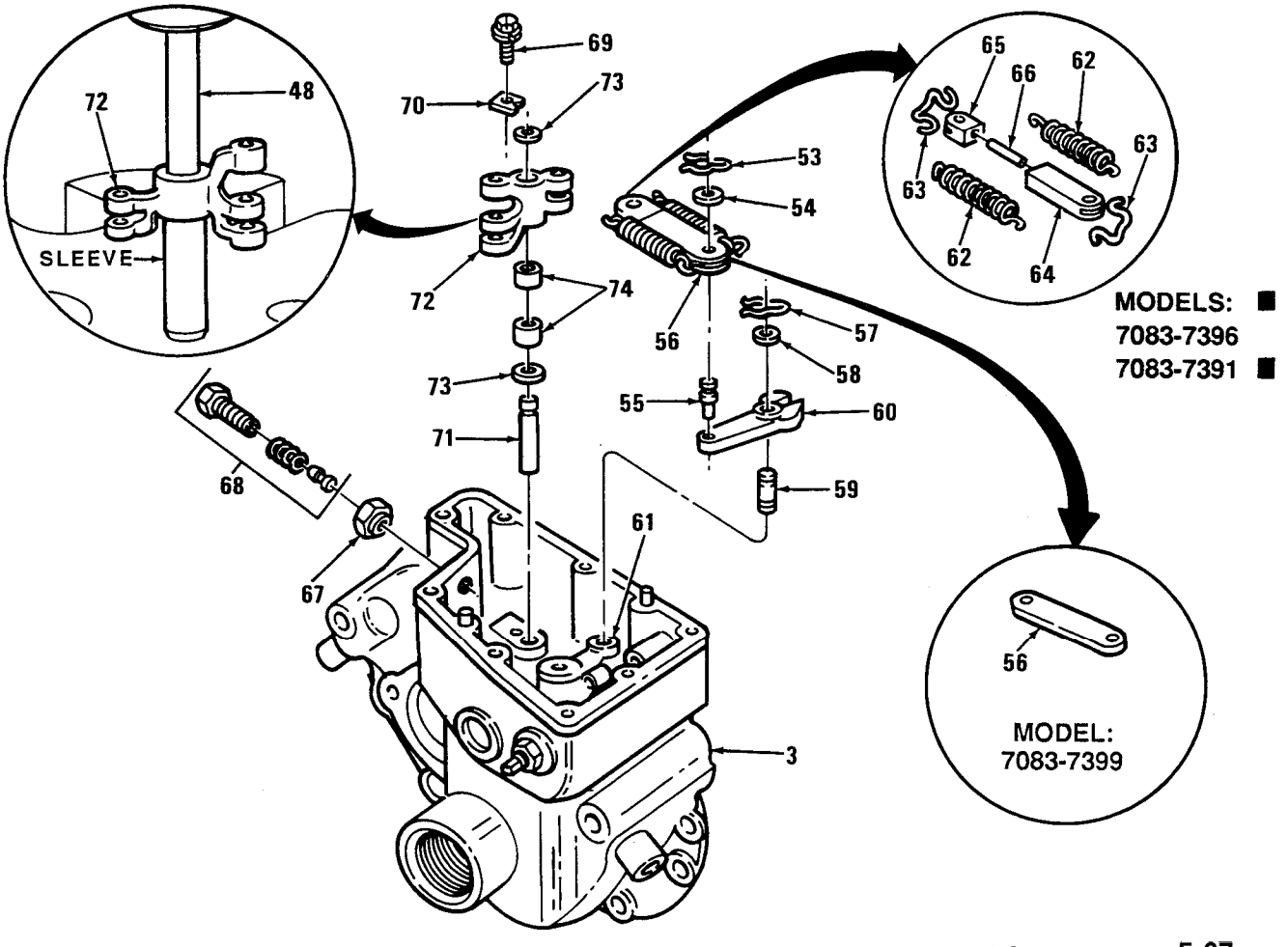
(33) For models 7083-7391 and 7083-7396, remove two springs (62) and two retainer clips (63). Separate governor links (64 and 65) and remove pin (66).

(34) Loosen locknut (67) and remove buffer screw assembly (68).

(35) Remove screw and washer assembly (69) and locking clip (70) securing operating lever shaft (71) to governor housing (3).

(36) Remove operating lever shaft (71), control link operating lever (72) and two washers (73).

(37) If bearings are damaged, support control link operating lever (72) on sleeve and rest sleeve on bed of arbor press. Place bearing remover (48) on top of bearing (74) and press two bearings (74) out of operating lever (72).



5-41. GOVERNOR REPAIR (Cont)

(38) Remove expansion plug (75) from bottom of governor housing (3). Discard expansion plug.

(39) Remove operating shaft upper bearing retainer screw and washer assembly (76) and flat washer (77) securing bearing in governor housing (3).

(40) Place governor housing (3) in press, bottom side up.

(41) Press operating shaft (78) out of lower bearing (79) located in governor housing (3).

(42) Place a 9/16-inch open end wrench (80) under operating fork (81) and press fork off operating shaft (78).

(43) Remove spacer (82), operating shaft (78), upper operating lever bearing (83), and operating lever (61) from governor housing (3). Slide spacer (82) from shaft (78).

CAUTION

When pressing operating shaft from operating lever and bearing, catch shaft by hand to prevent it from falling and being damaged.

(44) Press operating shaft (78) from upper bearing (83) and operating lever (61).

(45) Loosen locknut (84) and remove adjusting screw (85).

(46) If damaged, remove pin (59) from operating lever (61).

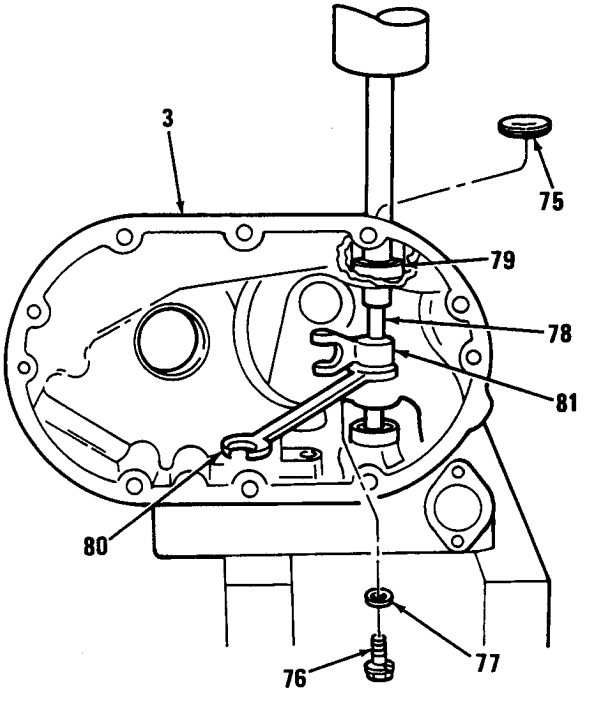
(47) Press lower bearing (79) from governor housing (3).

(48) For models 7083-7391 and 7083-7396 only, hold starting aid screw (86) and remove nut (87) from governor housing (3).

CAUTION

External starting aid screw is removed by screwing inward through governor housing. Removing the screw outward through the governor housing will damage the threads in the housing due to oversize button on end.

(49) For models 7083-7391 and 7083-7396 only, remove external starting aid screw (86) through governor housing (3) by turning screw clockwise.



b. **Cleaning/Inspection**

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F** (38°C-50°C). **If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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 all parts with dry cleaning solvent and dry with compressed air. Inspect all parts.

(2) Inspect all bearings and shafts for corrosion, pitting, rough spots and excessive wear.

(3) Inspect governor housing for cracks, warpage, and damaged threads.

(4) Inspect governor weights after assembly for free movement.

(5) Inspect governor cover for cracks, wear on pins, or shaft deflection.

c. Assembly

(1) For models 7083-7391 and 7083-7396 only, install external starting aid screw (86) through inside of governor housing (3) and secure nut (87) on outside of governor housing.

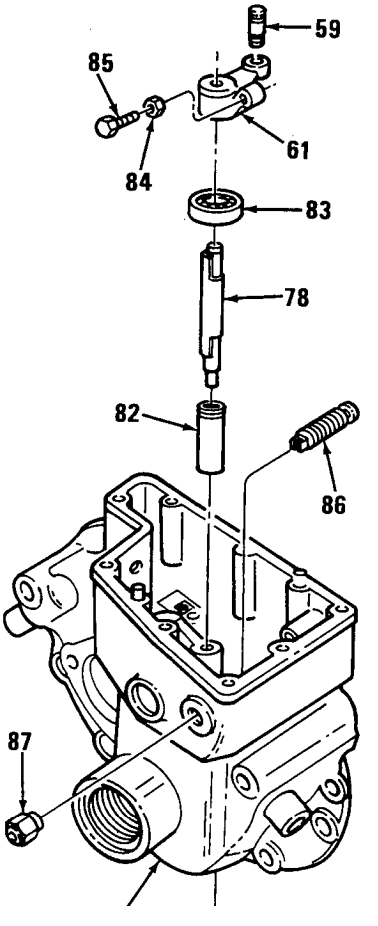
(2) If removed, install pin (59) in operating lever (61).

(3) Install adjusting screw (85) and locknut (84) in operating lever (61).

(4) Coat inside diameter of operating shaft upper bearing (83) with engine oil. Using an arbor press, install upper bearing (83), numbered side up, on large end of operating shaft (78).

(5) Using an arbor press, install operating lever (61), with pin (59) facing up, onto operating shaft (78), alining flat on lever with flat on shaft, until flush with operating shaft (78).

(6) Install spacer (82) onto operating shaft (78).



5-41. GOVERNOR REPAIR (Cont)

(7) Insert end of governor operating shaft (78), bearing (83), spacer (82),and operating lever (61) through upper bearing bore in governor housing (3) with operating fork (81) facing rear of governor housing.

(8) Place governor housing (3) in press with top facing down.

(9) Place a support (88) under operating shaft (78) and press operating fork (81) until spacer (82) does not move up or down.

(10) Lubricate operating shaft upper bearing (83). with engine oil and seat bearing in governor housing (3). Install screw and washer assembly (76), and washer (77) to secure bearing.

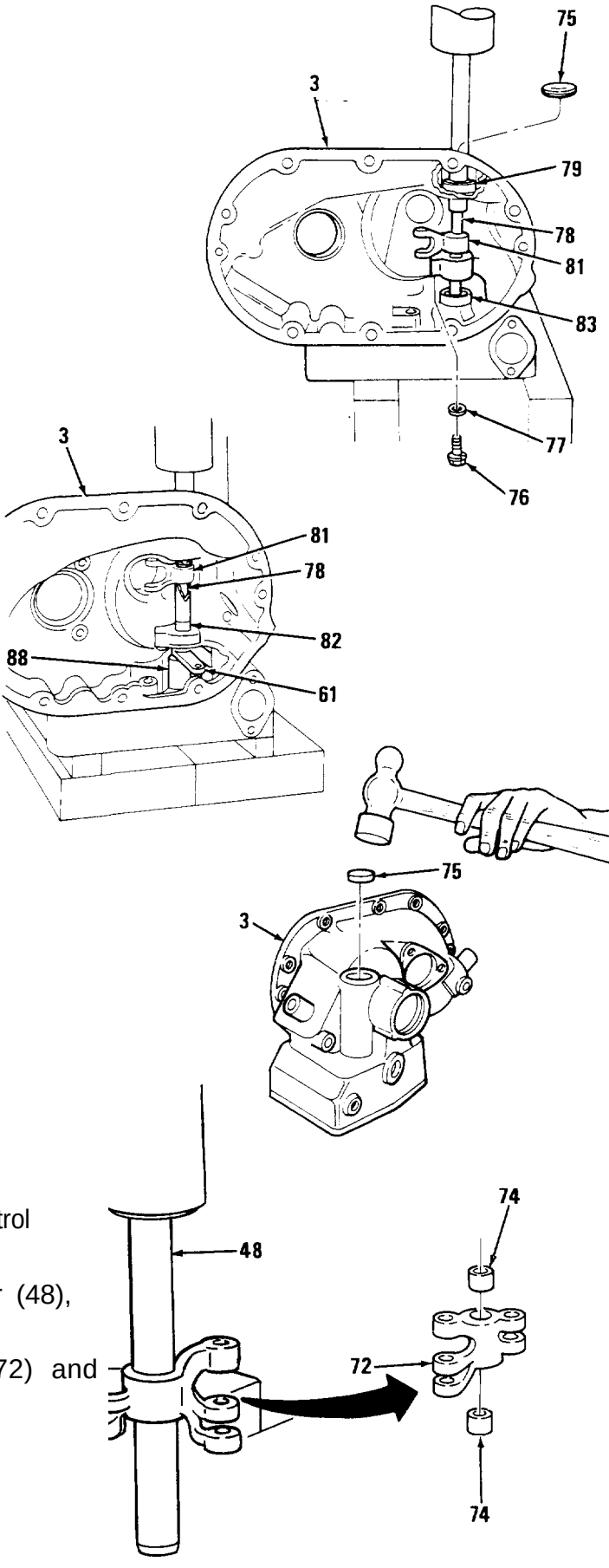
(11) Lubricate lower bearing (79) with engine oil and start bearing into governor housing (3) on operating shaft (78).

(12) Place a 7/16-inch inside diameter sleeve on inner race of lower bearing (79). Using arbor press, install bearing on operating shaft (78) until bearing seats on shoulder in governor housing (3).

(13) Apply a thin coat of sealant to edge of expansion plug (75).

(14) Using a ballpeen hammer, tap expansion plug (75), convex side up, into governor housing (3).

(15) If removed, lubricate outside of two control link operating lever bearings (74) with engine oil and lubricate inside bearings with grease. Using bearing installer (48), press one bearing into control link operating lever (72) until flush with top lever. Reverse operating lever (72) and install second bearing (74) in same manner.



(16) Insert control link operating lever (72) and two washers (73) between two bosses inside governor housing (3).

(17) Install operating lever shaft (71) with grooved end up.

(18) Install locking clip (70) and screw and washer assembly (69) securing operating lever shaft in governor housing (3). Tighten screw (69) securely.

(19) Install buffer screw assembly (68) and locknut (67).

(20) Place governor housing (3) in soft-jawed vise.

(21) For models 7083-7391 and 7083-7396 only, assemble pin (66), governor link (64), and link (65) together. Install two retainer clips (63) and two springs (62).

(22) If removed, install pin (55) into differential lever (60).

(23) Install differential lever (60), washer (58), and spring clip (57) on operating lever (61) with slot facing rear of governor housing (3).

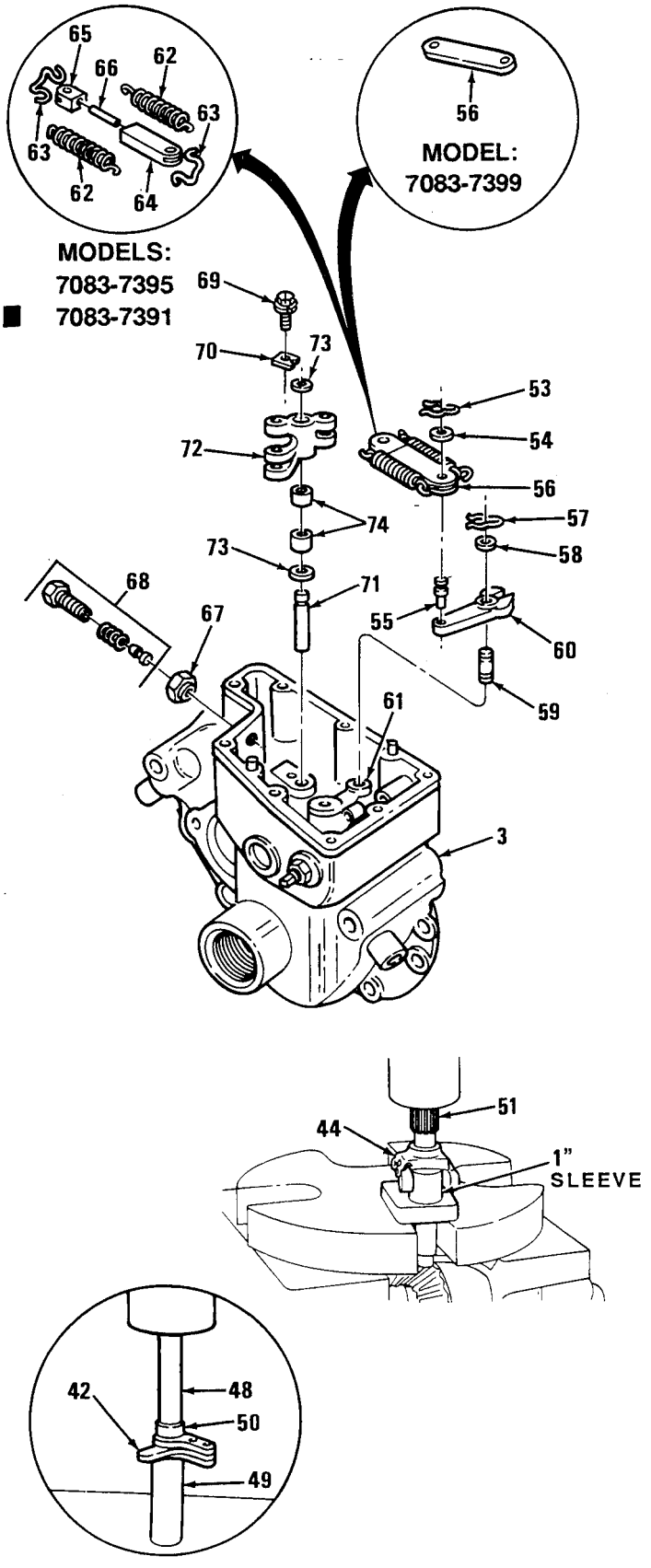
(24) Install operating lever connecting link (56) on differential lever (60) and secure with washer (54) and retaining clip (53) to pin (55).

(25) Using an arbor press and one-inch inside diameter sleeve, press weight shaft (51) into weight carrier (44) until shoulder of weight shaft is seated in carrier.

NOiTE

When installing weights, insure matchmarks made at disassembly are alined.

(26) Lubricate outside diameter of needle bearing (50) with engine oil and inside diameter with grease. Using bearing installer (48), sleeve (49) and arbor press, install needle bearing (50) into high speed weight (42). Repeat procedure for other high speed weight (42).



5-41. GOVERNOR REPAIR (Cont)

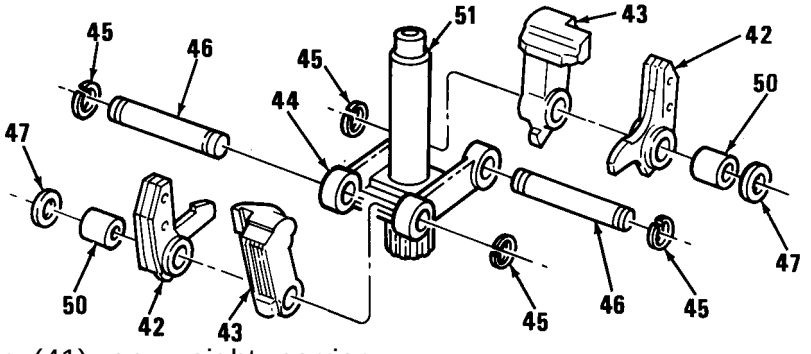
CAUTION

Maintain 0.004- 0.012-inch clearance between carrier and low speed weight; otherwise, low speed weight will bind causing erratic operation of governor.

(27) Install retaining clip (45) on one end of weight pin (46). Slide weight pin through weight carrier (44), washer (47), and high speed weight (42). Place low speed weight (43) in position, insert a 0.004 - 0.012-inch shim between low speed weight and weight carrier while pressing weight pin through weight carrier. Press until retaining clip bottoms against carrier.

(28) Remove shim and install second retaining clip (45).

(29) Repeat steps (27) and (28) to install opposite side weights in carrier (44).



(30) Install riser (41) on weight carrier shaft (38).

NOTE

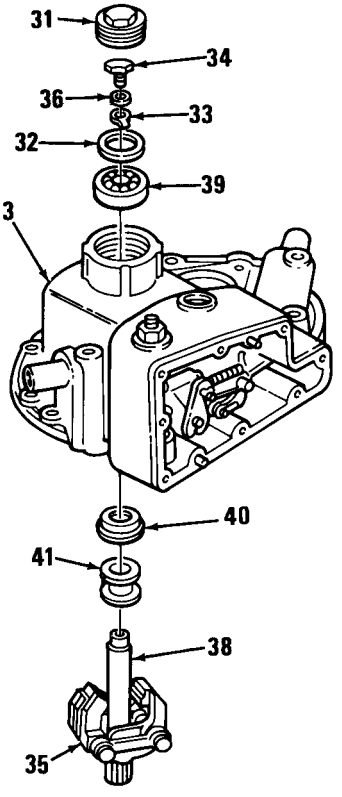
Incorrect installation of riser thrust bearing will result in erratic operation of governor.

(31) Install riser bearing (40) with smaller inside diameter against riser (41) on weight carrier shaft (38).

(32) Insert weight carrier assembly (35) in governor housing (3). Support splined end of shaft and governor housing on arbor press bed.

(33) Place weight carrier bearing (39) in governor housing (3) with number side up. Place a 0.5-inch diameter sleeve on top of inner race of weight carrier bearing (39) and press into governor housing (3) and against shoulder on carrier shaft (38).

(34) Clamp spline end of weight shaft (38) in soft-jawed vise.



(35) Place key washer (33) on end of carrier shaft (38) with tang on inner diameter of washer in notch in end of carrier shaft (38).

(36) Install washer (36) and retaining bolt (34). Torque bolt to 15-19 lb-ft (20-26 N-m). Bend tang on key washer (33) against head of bolt.

(37) Install washer (32) against bearing (39).

(38) Apply sealant to threads of plug (31) and install in governor housing (3). Torque plug to 45 lb-ft (61 N-m).

(39) Thread retainer nut (21) onto retainer (22) 1.5 inches. Install high speed spring (30) on plunger (23) and insert into retainer (22).

(40) Thread screw (28) 0.5 inch, through retainer (22), into threaded end of plunger (23) and install nut (29) onto screw (28) until it contacts end of plunger.

(41) Insert low speed spring (25) into low speed spring cap (24).

(42) Place small end of spring seat (26) into low speed spring (25). Place adjusting pin (27) into spring seat.

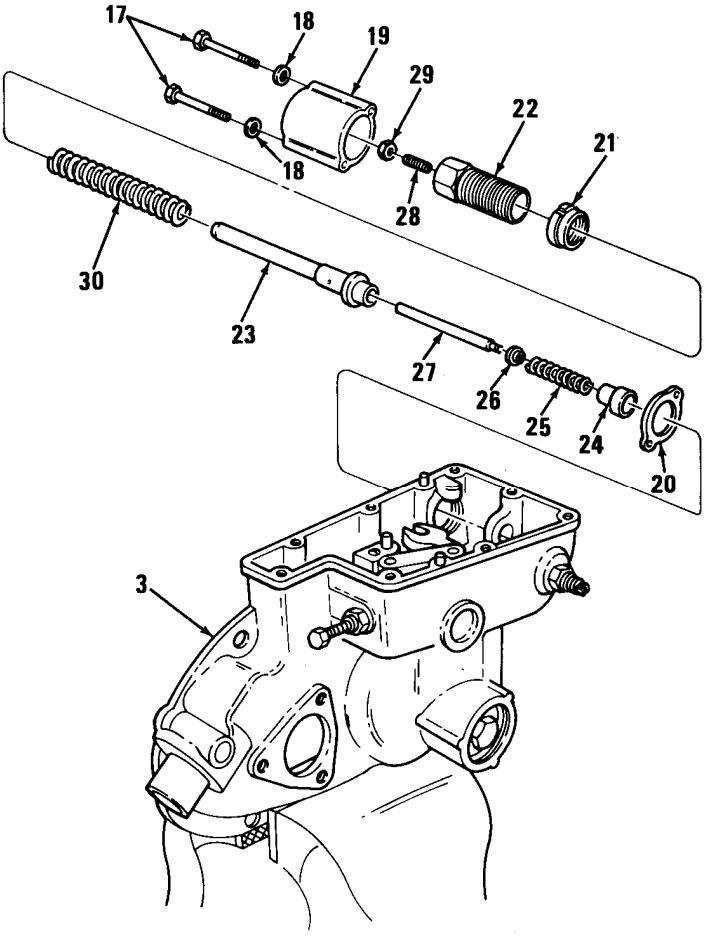
(43) Install adjusting pin (27), spring seat (26), low speed spring (25), and low speed spring cap (24) into plunger (23).

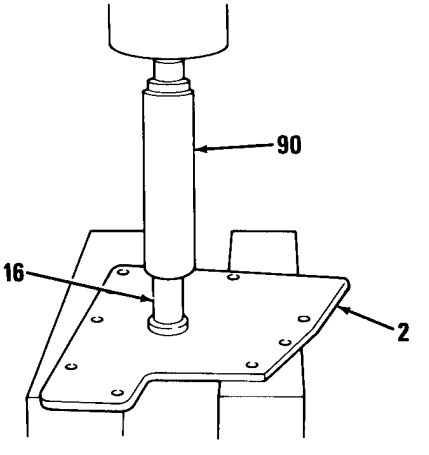
(44) Place gasket (20) on shoulder of retainer nut (21) and install high speed spring retainer (22) and plunger (23) assembly into governor housing (3) 1.0 inch. Tighten retainer nut.

(45) Fasten access cover (19) to governor (3) with two bolts (17) and two flat washers (18). Tighten bolts.

(46) Place governor cover (2) in press with top facing up.

(47) Using bushing installer (90), press two bushings (16), numbered side up, into governor cover (2) until flush.





5-41. GOVERNOR REPAIR (Cont)

(48) Lubricate inside of two bushings (16) with grease.

(49) Place stop lever return spring (8) over boss on inner face of governor cover (2).

(50) Insert stop lever shaft (7) part way through hole in governor cover (2) and hook end of return spring (8) over end of lever. Push shaft up in cover.

(51) Position stop lever (7) against stop pin (91), opposite spring (8).

(52) Install seal ring (9), two washers (6), and retaining ring (5) securing stop lever to governor cover (2).

(53) Install speed control shaft (13) into governor cover (2) between two pins (92).

(54) Install seal ring (14), two washers (12), and retaining ring (11) securing speed control shaft to governor cover (2).

(55) Install spacer (10) on speed control shaft (13).

NOTE

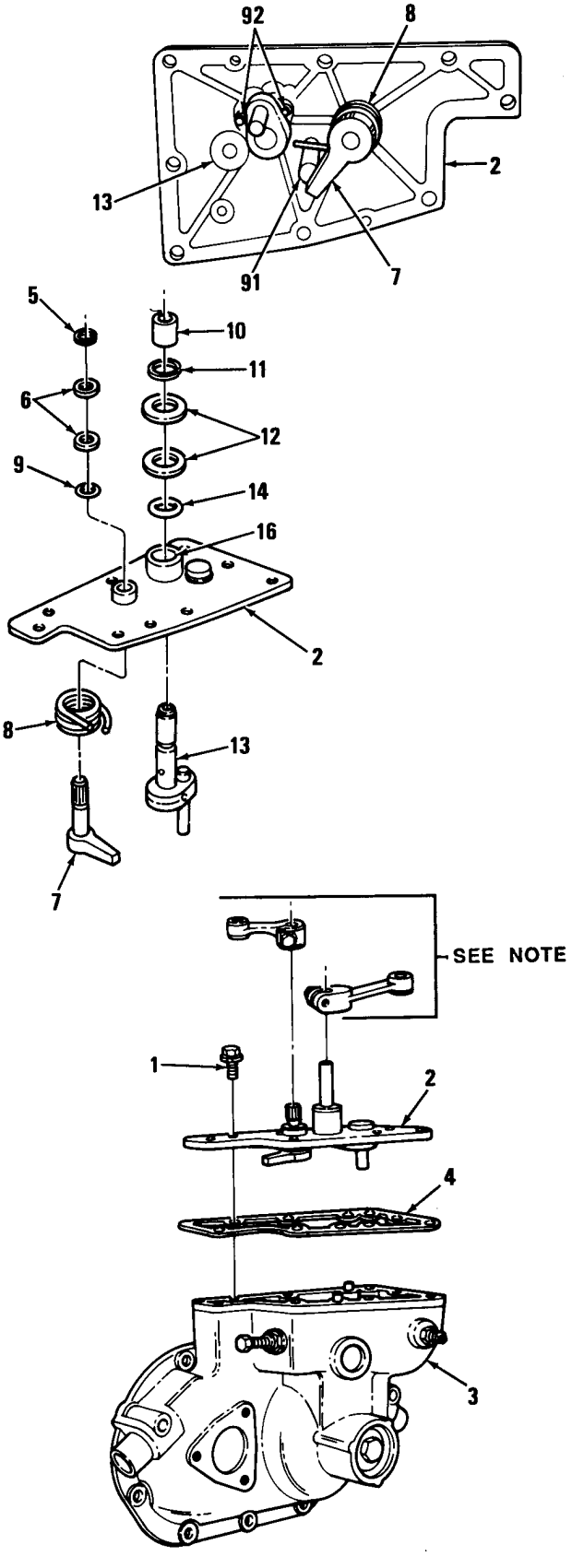
If remote control levers were removed during disassembly of governor cover, reinstall levers.

(56) Install governor cover (2) and gasket (4) on governor (3). Secure with eight screws (1) and tighten screws.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
5-17 Install governor on blower



5-42. WATER PUMP REPAIR

(See para 4-43)

CHAPTER 5.1

REPAIR PROCEDURES FOR MAJOR COMPONENTS OF ENGINE MODEL 7083-7391

Contents

Section I. INTRODUCTION

5.1-1. GENERAL. This chapter provides the repair procedures performed on engine model 7083-7391 after the engine has been installed on the maintenance stand. 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.

This chapter deals with model 7083-7391. However, if a model in a previous chapter has identical or nearly identical components, this chapter will refer to that previous chapter. If a model in a subsequent chapter has identical or nearly identical components, this chapter will also cover that models.

Section II. GENERAL ENGINE MAINTENANCE

5.1-4. FUEL LINES REPLACEMENT

This task covers: a. Removal b. Installation

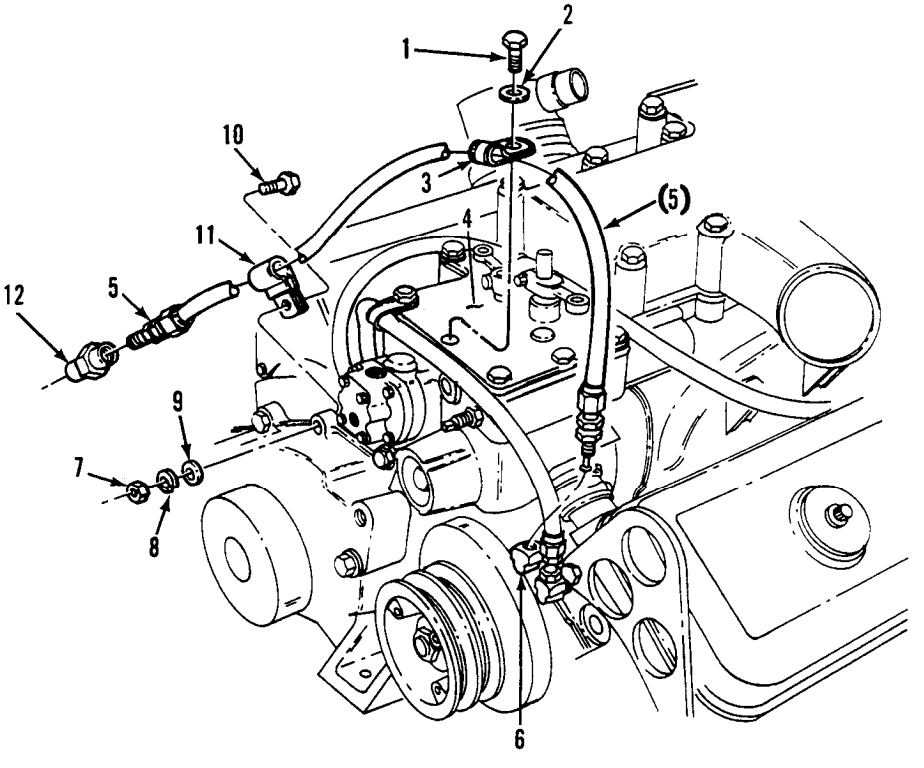
INITIAL SETUP

MODELS	TOOLS AND SPECIAL TOOLS
7083-7391	General Mechanics Tool Set (App B, Item 96) Torque wrench (App B, Item 100) Torque wrench (App B, Item 101)

a. Removal

(1) Remove bolt (1) and flat washer (2) securing fuel supply line clip (3) to front of governor cover (4). Reinstall bolt and flat washer in governor cover.

(2) Disconnect fuel supply line (5) at elbow (6) on front of left cylinder head.



(3) Remove nut (7), lockwasher (8), flat washer (9), and bolt (10) securing fuel supply line clamp (11) at right side rear of front cover and remove fuel line. Reinstall bolt, flat washer, lockwasher and nut in front cover.

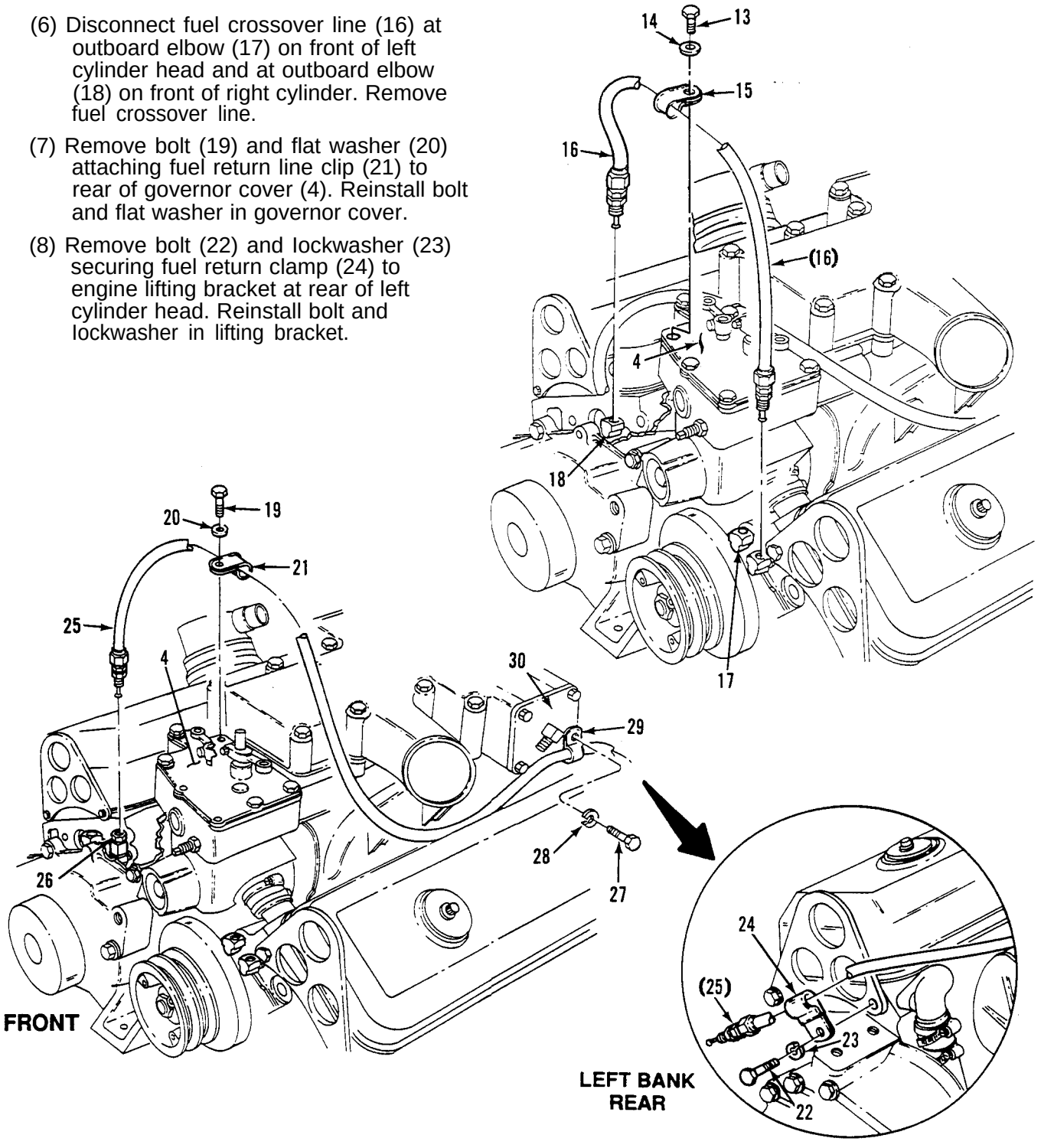
(4) If necessary, remove clamp (11), clip (3), and coupling (12) from fuel supply line (5).

(5) Remove bolt (13) and flat washer (14) attaching fuel crossover line clip (15) to front of governor cover (4). Reinstall bolt and flat washer in governor cover. If necessary remove clip from crossover line.

(6) Disconnect fuel crossover line (16) at outboard elbow (17) on front of left cylinder head and at outboard elbow (18) on front of right cylinder. Remove fuel crossover line.

(7) Remove bolt (19) and flat washer (20) attaching fuel return line clip (21) to rear of governor cover (4). Reinstall bolt and flat washer in governor cover.

(8) Remove bolt (22) and lockwasher (23) securing fuel return clamp (24) to engine lifting bracket at rear of left cylinder head. Reinstall bolt and lockwasher in lifting bracket.



(9) Disconnect fuel return line (25) at adaptor fitting (26) on front of right cylinder head. Remove fuel return line.

(10) Remove bolt (27) and lockwasher (28) securing clip (29) on fuel return line (25) to left side by-pass valve cover (30). Remove fuel return line and reinstall bolt and lockwasher.

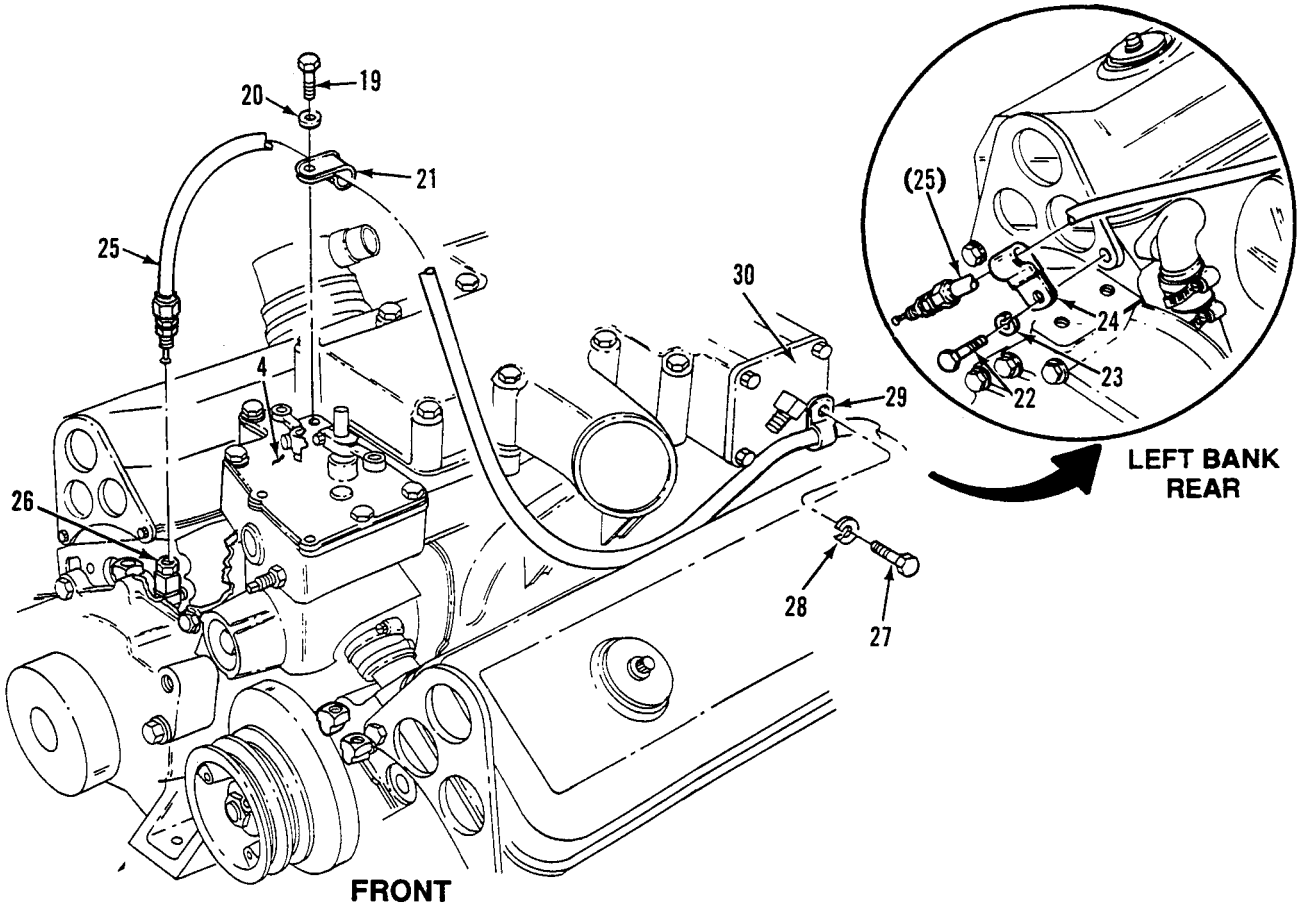
(11) If necessary, remove clamp (24) and clips (21 and 29) from fuel return line (25).

5.1-4. FUEL LINES REPLACEMENT (Cont)

b. Installation

(1) Connect end of fuel return line (25) to adaptor fitting (26) at front of right cylinder head and tighten connection.

(2) If removed, install clips (21 and 29) and clamp (24) on fuel return line (25).



NOTE

- For all lines attached to governor cover, drape and clip lines around governor cover. Do not mount lines overtop of cover.
- Route fuel return line under turbocharger air inlet tube between blower and left cylinder head toward rear of engine.

(3) Secure clip (21) on fuel return line (25) to rear of governor cover (4) by removing bolt (19) and flat washer (20) from governor cover. Torque bolt to 7-9 lb-ft (1 0-12 N-m).

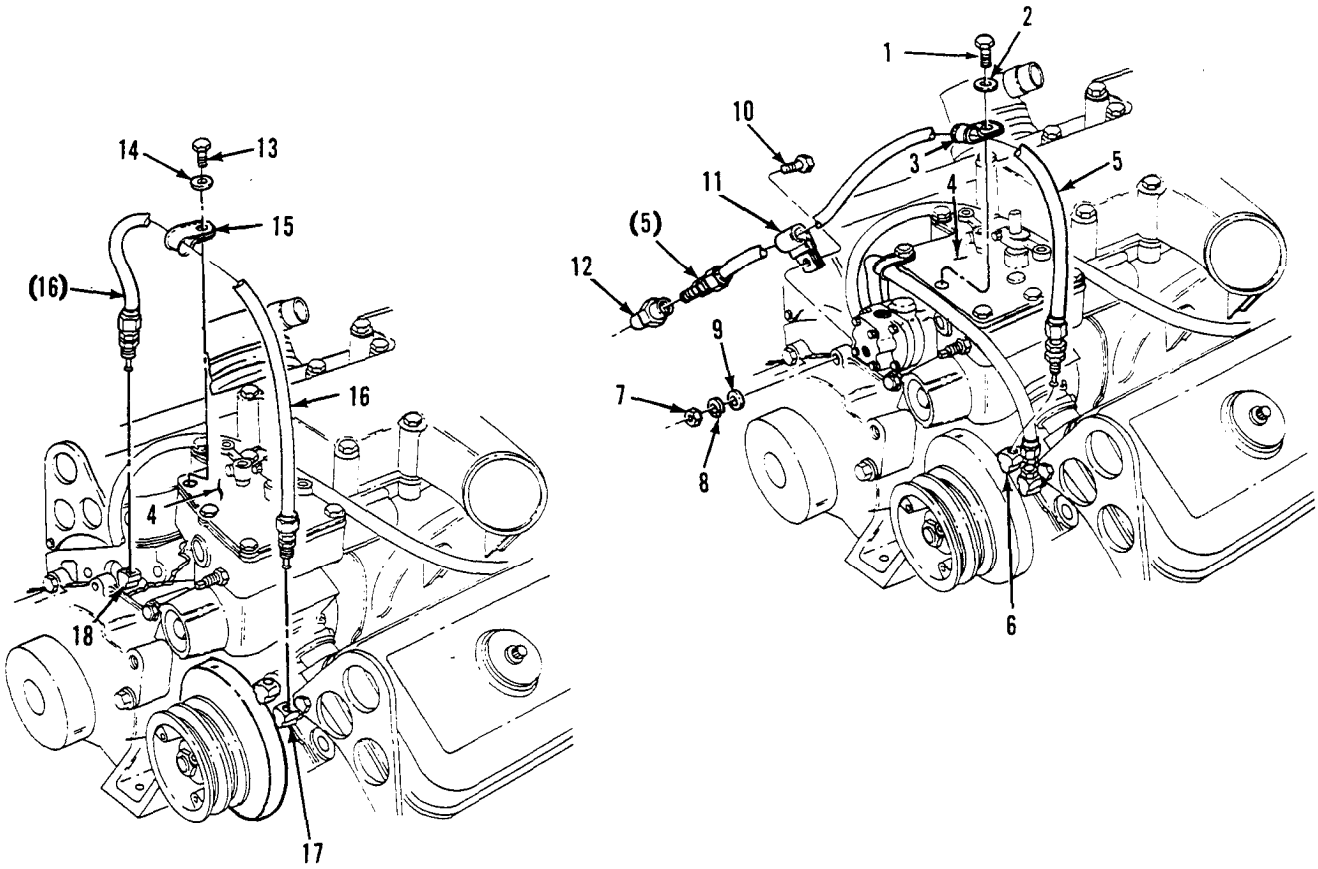
(4) Secure clip (29) to left side by-pass valve cover (30) by removing bolt (27) and lockwasher (28) from by-pass valve cover. Torque bolt to 84-108 lb-in (9-12 N-m).

(5) Secure clamp (24) of fuel return line (25) to lifting bracket at rear of left cylinder head by removing bolt (22) and lockwasher (23) from lifting bracket. Torque bolt to 40-50 lb-ft (62-68 N-m).

(6) If removed, install clip (15) on fuel crossover line (16). Connect fuel crossover line to outboard elbows (18) and (17) at front of right and left cylinder heads. Tighten connections.

(7) Secure clip (15) on fuel crossover line (16) to front of governor cover (4) by removing bolt (13) and flat washer (14) from governor cover. Torque bolt to 7-9 lb-ft (10-12 N-m).

(8) If removed, install pipe coupling (12), clamp(11) and clip (3) on fuel supply line (5).



(9) Connect fuel supply line (5) to elbow (6) at front of left cylinder head. Tighten connection.

(10) Secure clamp (11) on fuel supply line (5) to right side rear of front cover by removing nut (7), lockwasher (8), flat washer (9), and bolt (10). Torque bolt to 30-35 lb-ft (41-47 N-m).

(11) Secure clip (3) on fuel supply line (5) to front of governor cover (4) by removing bolt (1) and flat washer (2) from governor cover. Torque bolt to 7-9 lb-ft (10-12 N-m).

END OF TASK

5.1-5. ENGINE LIFTING BRACKETS REPLACEMENT

(See Para 5-5)

5.1-6. ENGINE WATER MANIFOLDS REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7391

TOOLS AND SPECIAL TOOLS

General Mechanics Tool Set (App B, Item 96)
Torque wrench (App B,Item 101)

MANDATORY REPLACEMENT PARTS

12 Lockwashers (App F, Item 93)
6 Gaskets (App F, Item 71)

EQUIPMENT CONDITION

Para Description
3-7 Oil level gauge rod removed
3-14 Air Inlet manifold removed
5.1-2 Turbocharger removed
5.1-3 Exhaust manifolds removed
5.1-8 Glow plug harness clips removed

a. Removal

(1) Disconnect tube assembly (1) at upper fitting (2) on right water manifold (3) and at elbow fitting (4) on top of water pump (5). Remove tube assembly.

(2) Disconnect tube assembly (6) at lower fitting (7) on right water manifold (3) and at elbow fitting (8) on front of right cylinder head. Remove tube assembly.

(3) Remove six nuts (9) and six lockwashers (10) securing water manifold (3) to right cylinder head. Discard lockwashers and remove water manifold.

(4) Remove three gaskets (11) from bottom of water manifold or top of cylinder head. Discard gaskets.

(5) If necessary, remove four fittings (2, 7, 12, and 13) from end of water manifold (3) and three plugs (14) and plug (15) from water manifold.

(6) Repeat steps (2) thru (4) move for left water manifold (3). If necessary, remove two fittings (7 and 13), four plugs (14) and plug (15) from left water manifold.

b. Installation

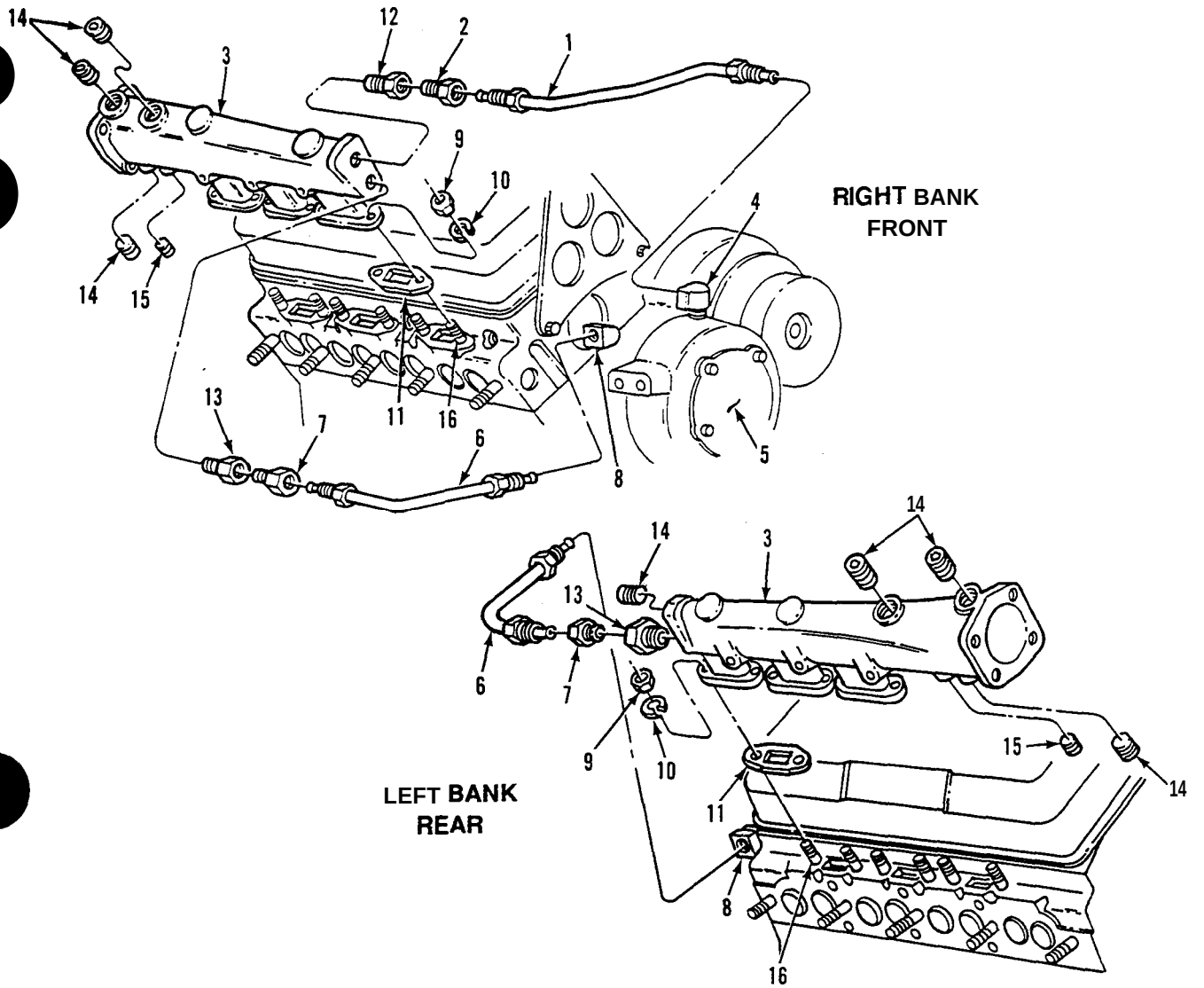
(1) If removed, install four fittings (2, 7, 12, and 13) in front of right water manifold (3) and three plugs (14) and plug (15) at rear of manifold.

(2) Install three gaskets (11) over studs (16) on right cylinder head.

(3) Install water manifold (3) on right cylinder head and secure with six lockwashers (10) and six nuts (9). Torque nuts to 20-25 lb-ft (27-34 N-m).

(4) Connect tube assembly (1) at elbow fitting (4) on water pump (5) and at upper fitting (2) on right water manifold (3). Tighten connections.

(5) Connect tube assembly (6) at elbow fitting (8) on front of cylinder head and at lower fitting (7) on right water manifold (3). Tighten connections.



(6) If removed, install two fittings (7 and 13), four plugs (14) and plug (15) in left water manifold (3).

(7) Repeat steps (2) and (3) above for left water manifold.

(8) Connect tube assembly (6) at elbow fitting (8) on front of cylinder head and at lower fitting (7) on left water manifold (3). Tighten connections.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-8	Install glow plug harness clips
3-3	Install exhaust manifolds
3-2	Install turbocharger
3-14	Install air inlet manifold
3-7	Install oil level gauge rod

7. WATER PUMP **REMOVAL/INSTALLATION** (See Para 5-7)

5.1-8. GLOW PLUG CONTROLLER AND HARNESSES REMOVAL/iNSTALLATION

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7391

MANDATORY REPLACEMENT PARTS

5 Lockwashers ((App F,Item 92)
2 Lockwashers (App F,Item 91)
1 Lockwasher (App F,Item 93)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 100)

EQUIPMENT CONDITION

Para Description
3-8 Glow plug power harness disconnected from starter

a. Removal

(1) Remove nut (1), lockwasher (2) and flat washer (3), securing clip (4) and glow plug power harness (5) to bolt (6) on flywheel housing (7). Discard lockwasher. If necessary, remove clip from harness.

(2) Disconnect and remove glow plug power harness (5) from rear left side of glow plug controller (8).

(3) Remove three bolts (9), three lockwashers (10), and three flat washers (11) securing three clips (12) on glow plug harness (13) to left side water manifold (14). Discard lockwashers.

(4) Disconnect four plug ends (15) of glow plug harness (13) at glow plugs (16) in left cylinder head.

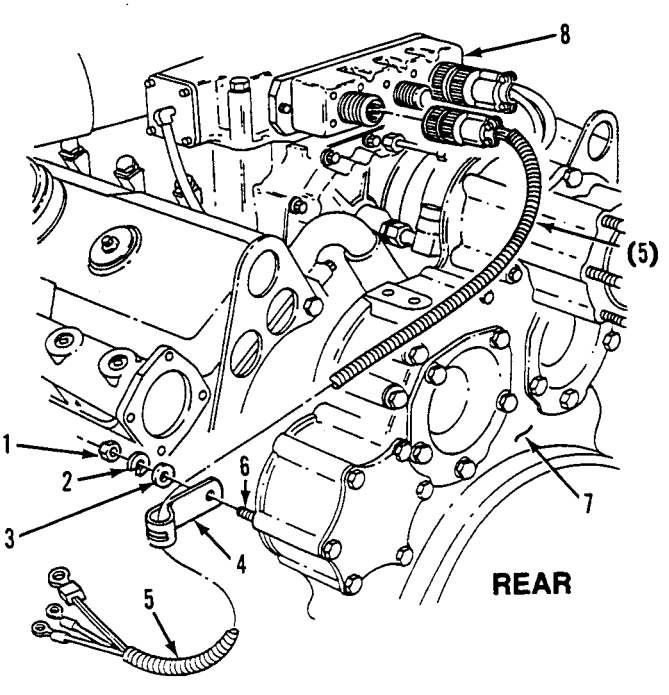
(5) Remove four glow plugs (16) from left cylinder head.

(6) Remove two bolts (9), two lockwashers (10), and two flat washers (11) securing two clips (12) on glow plug harness (13) to right side water manifold (14). Discard lockwashers.

(7) Repeat steps 4 and 5 above for opposite side.

(8) Disconnect and remove glow plug harness (13) from rear right side of glow plug controller (8).

(9) If necessary, remove five clips (12) from glow plug harness (13).



(10) Remove two bolts (17), two lockwashers (18), two flat washers (19), and glow plug controller (8) from rear of air inlet housing (20). Discard lockwashers.

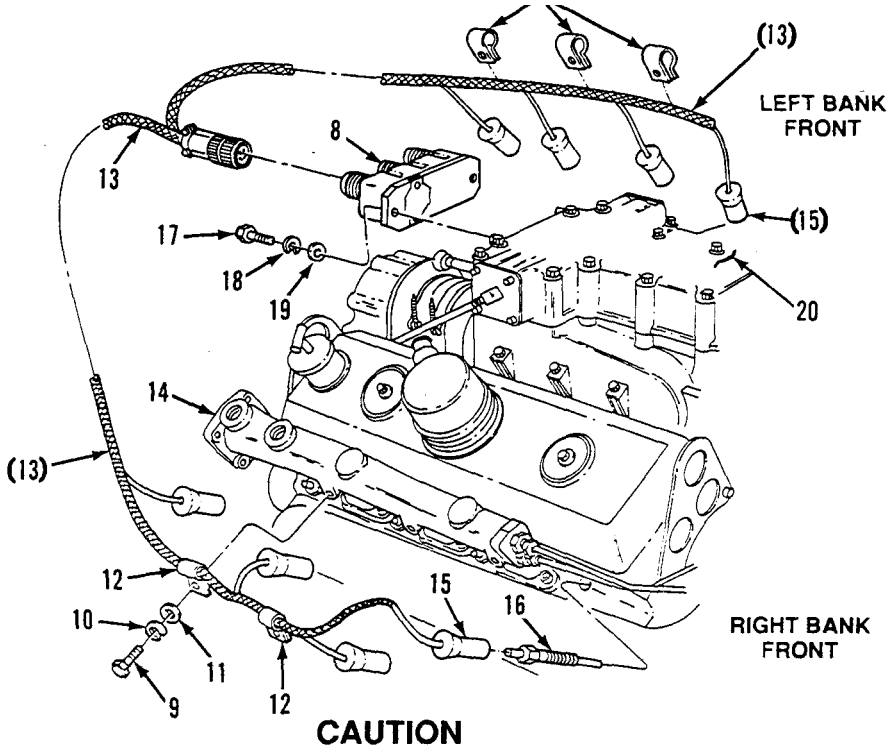
b. Installation

(1) Secure glow plug controller (8) to rear of air inlet housing (20) with two flat washers (1 9), two lockwashers (18), and two bolts (17). Torque bolts to 84-108 lb-in (9-12 N-m).

(2) If removed, install three clips (12) on left side or two clips on right side of glow plug harness (13).

(3) Attach plug connection end of glow plug harness (13) to rear right side connector on glow plug controller (8). Tighten securely.

(4) Install four glow plugs (16) in left cylinder head. Torque glow plugs to 11-13 lb-ft (15-18 N-m).



CAUTION

Glow plug harness leads are identified with location near ends of wires. Correct installation of wires is necessary for proper diagnostics to aid in locating a failed glow plug.

(5) Install four plug ends (15) of glow plug harness (13) to corresponding glow plug (16) locations in cylinder head.

(6) Attach glow plug harness (13) to left side water manifold (14) by securing three clips (12) with three flat washers (11), three lockwashers (10), and three bolts (9). Torque bolts to 13-17 lb-ft (18-23 N-m).

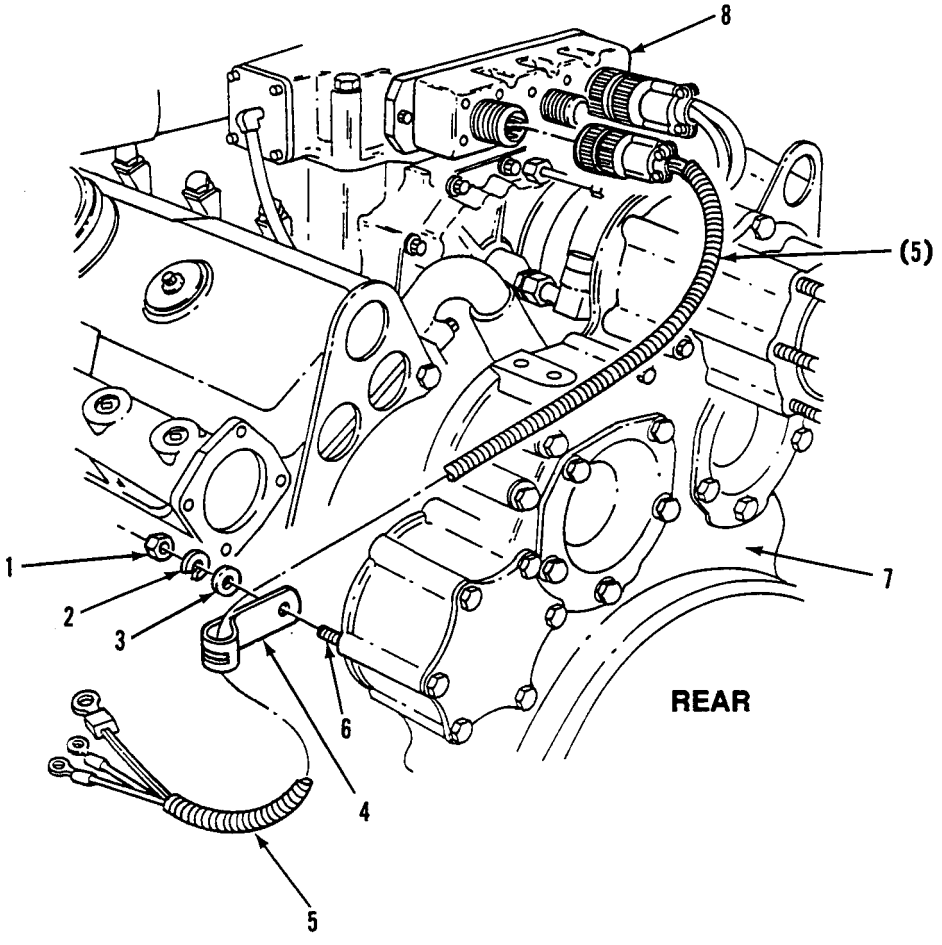
(7) Attach glow plug harness (13) to right side water manifold (14) by securing two clips (12) with two flat washers (11), two lockwashers (10), and two bolts (9). Torque bolts to 13-17 lb-ft (18-23 N-m).

(8) Repeat steps (4) and (5) above for opposite side.

5.1-8. GLOW PLUG CONTROLLER AND HARNESSES REMOVAL/INSTALLATION (Cont)

(9) Attach plug connection end of glow plug power harness (5) to left side connector on glow plug controller (8). Tighten securely.

(10) Attach glow plug power harness (5) to left side rear of flywheel housing (7) by securing clip (4) to bolt (6) with flat washer (3), lockwasher (2), and nut (1). Torque nut to 25-30 lb-ft (34-41 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-8 Connect glow plug power harness to starter

5.1-9. ENGINE ROCKER ARM COVER AND CRANKCASE BREATHER REPLACEMENT (See Para 4-11)

5.1-10. FUEL PUMP REPLACEMENT (See Para 4-12)

5.1-11. AIR INLET HOUSING REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7391

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 100)
Torque wrench (App B, Item 101)
Piston ring compressor (App B, Item 103)
Threaded rod (App D, Item 13)

MANDATORY REPLACEMENT PARTS

8 LockWashers (App F, Item 91)
12 LockWashers (App F, Item 94)
2 Gaskets (App F, Item 176)
1 Gasket (App F, Item 177)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)
Hex nut 3/8-1 6 (App C, Item 47)
Flat washer 3/8 (App C, Item 48)
Engine oil (App C, Item 16)
Teflon pipe sealant (App C, Item 49)

EQUIPMENT CONDITION

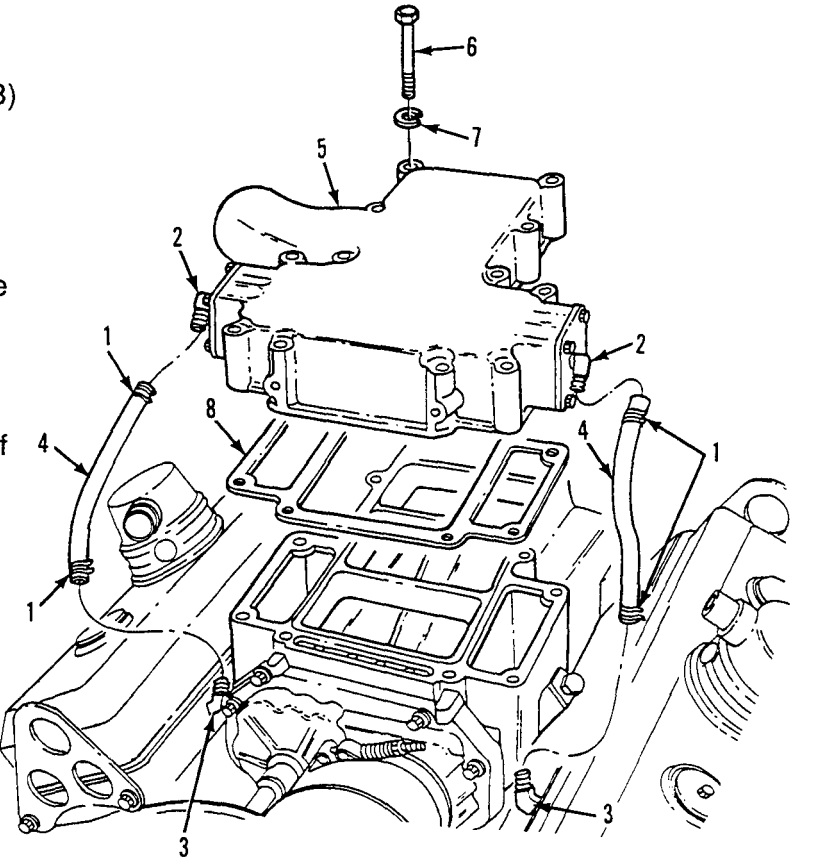
Para Description
3-3 Air inlet tube removed
5.1-4 Fuel return line clip removed from by-pass valve cover
5.1-8 Glow plug controller removed

Removal

(1) Slide two clamps (1) off fittings (2 and 3) and onto hose (4) for right side of air inlet housing assembly (5). Remove hose with clamps from ends of fittings. Remove clamps from hose.

(2) Repeat step (1) above for opposite side of air inlet housing assembly (5).

(3) Remove twelve bolts (6), twelve lockwashers (7), air inlet housing assembly (5) and gasket (8) from top of blower. Discard lockwashers and gasket.



5.1-11. AIR INLET HOUSING REPLACEMENT (Cont)

b. Disassembly

(1) Secure air inlet housing assembly (5) in soft-jawed vise with side of by-pass valve cover (9) facing upward.

(2) Remove elbow fitting (2) from by-pass valve cover (9).

WARNING

Firmly secure spring-loaded mechanisms during disassembly. The spring can eject parts at high speed if released in an uncontrolled manner. Personal injury may result.

(3) Insert threaded rod (10) through hole in by-pass valve cover (9), then thread rod into by-pass valve assembly (11) located in air inlet housing. Install 5/16 inch flat washer (12) and 5/1 6-18 inch hex nut (13) on threaded rod and tighten to compress spring (14) between cover and by-pass valve assembly.

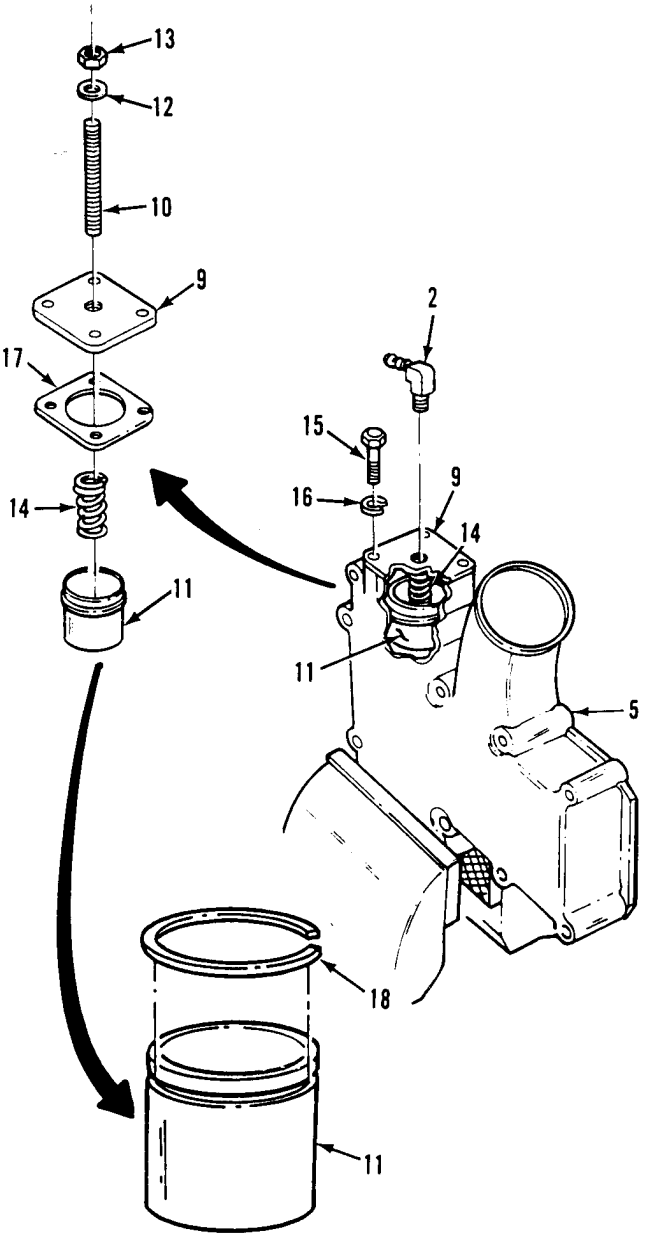
(4) Remove four bolts (15) and four lockwashers (16) securing cover (9) to air inlet housing (5). Discard lockwashers.

(5) Remove cover (9) and valve assembly (11), while under compression with threaded rod (10).

(6) Remove nut (13), flat washer (12), cover (9), gasket (17), and spring (14) from by-pass valve assembly (11). Remove threaded rod (10) from by-pass valve.

(7) Place by-pass valve assembly (11) on bench with ring side up and remove ring (18).

(8) Repeat steps 1 thru 7 above for opposite side of air inlet housing (5).



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 immediate y.**

- **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 valve with cleaning solvent and dry with compressed air.

(2) Inspect air inlet housing for cracks, warpage, scoring or other damage.

(3) Check by-pass valve for scores or ring groove damage. Replace any valve severely scored or damaged.

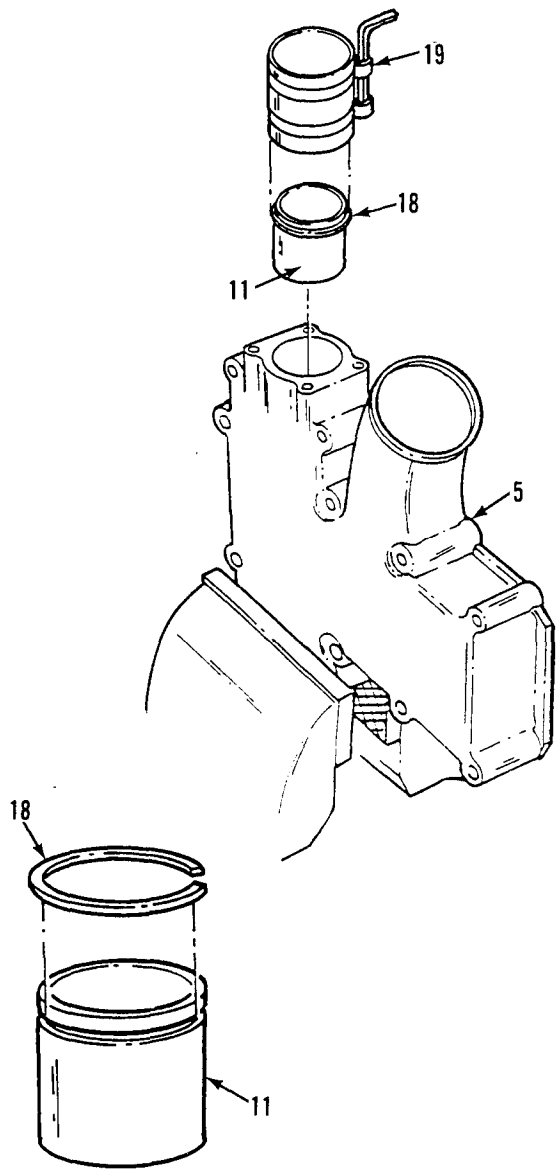
(4) Check ring for chips or scoring. Replace any ring chipped, scored or severely damaged.

d. Assembly

(1) Install ring (18) in groove of by-pass valve (11). Lubricate by-pass valve, ring and by-pass valve bore with engine oil.

(2) Secure one side of air inlet housing (5), in soft-jawed vise, with valve bore facing upward.

(3) Use a piston ring compressor (19) to compress ring (18) on by-pass valve assembly (11). Install valve, with ring side facing up, in bore of air inlet housing (5) by lightly tapping valve with handle end of hammer.



5.1-11. AIR INLET HOUSING REPLACEMENT (Cont)

(4) Screw threaded rod (10) into by-pass valve (11). Install spring (14) in valve, and place gasket (17) over valve bore on air inlet housing (5). Place hole in cover (9) over threaded rod , with words "OUT" facing outward. Install 5/1 6 inch flat washer (12) over rod. Using 5/1 6-18 hex nut (13) compress spring so cover is within 1/4 inch of air inlet housing.

(5) Aline gasket (17) and cover (9) with four holes in air inlet housing (5). Install four bolts (15) and four Iockwashers (16) and secure cover and gasket to housing. Torque bolts to 84-108 lb-in (9-12 N-m).

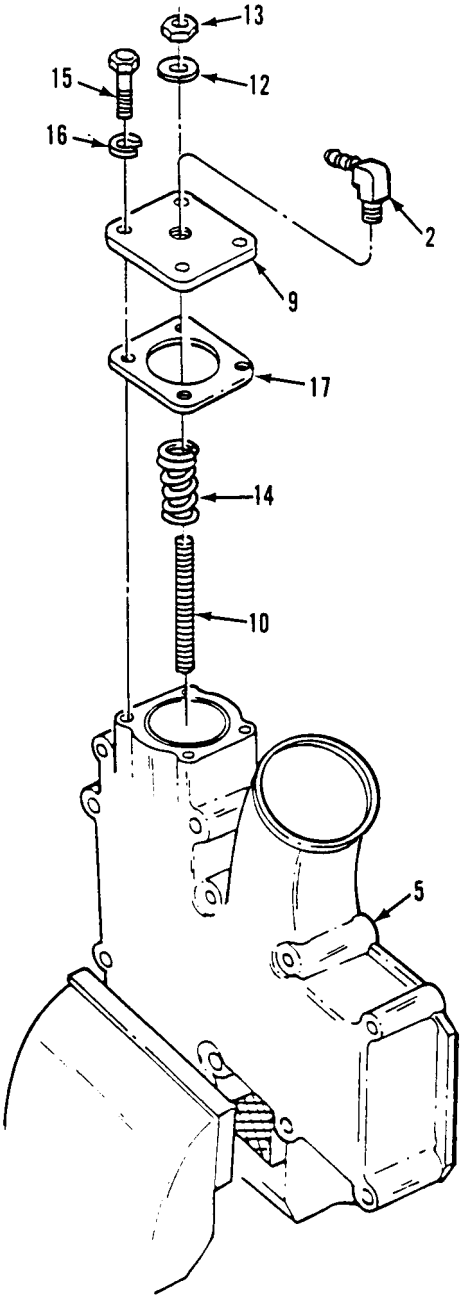
(6) Remove nut (13), flat washer (12) and threaded rod (10) from cover (9).

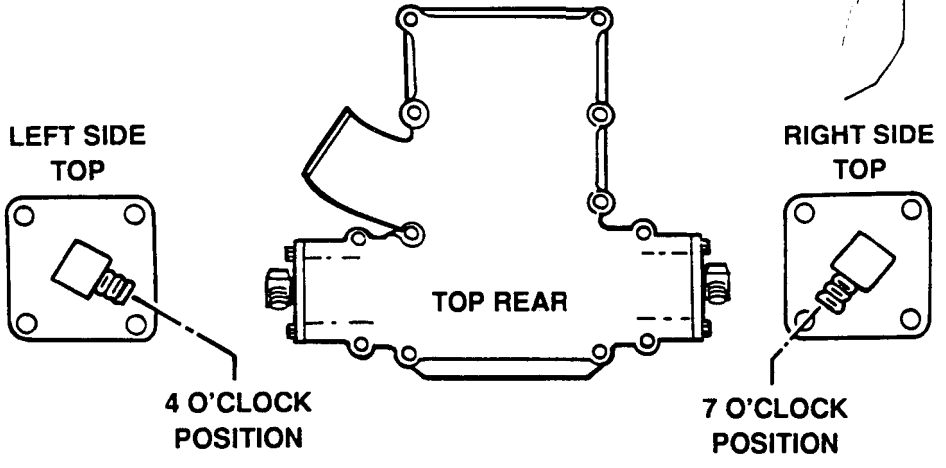
(7) Apply sealant to threads of elbow fitting (2) and install in by-pass valve cover (9) so end of fitting faces rear and downward at approximately 7:00 O'clock position for the right side cover.

(8) Repeat steps (1) thru (6) for opposite side.

(9) Apply sealant to threads of elbow fitting (2) and install in by-pass valve cover (9) so end of fitting faces rear and downward at approximately 4:00 O'clock position for the left side cover.

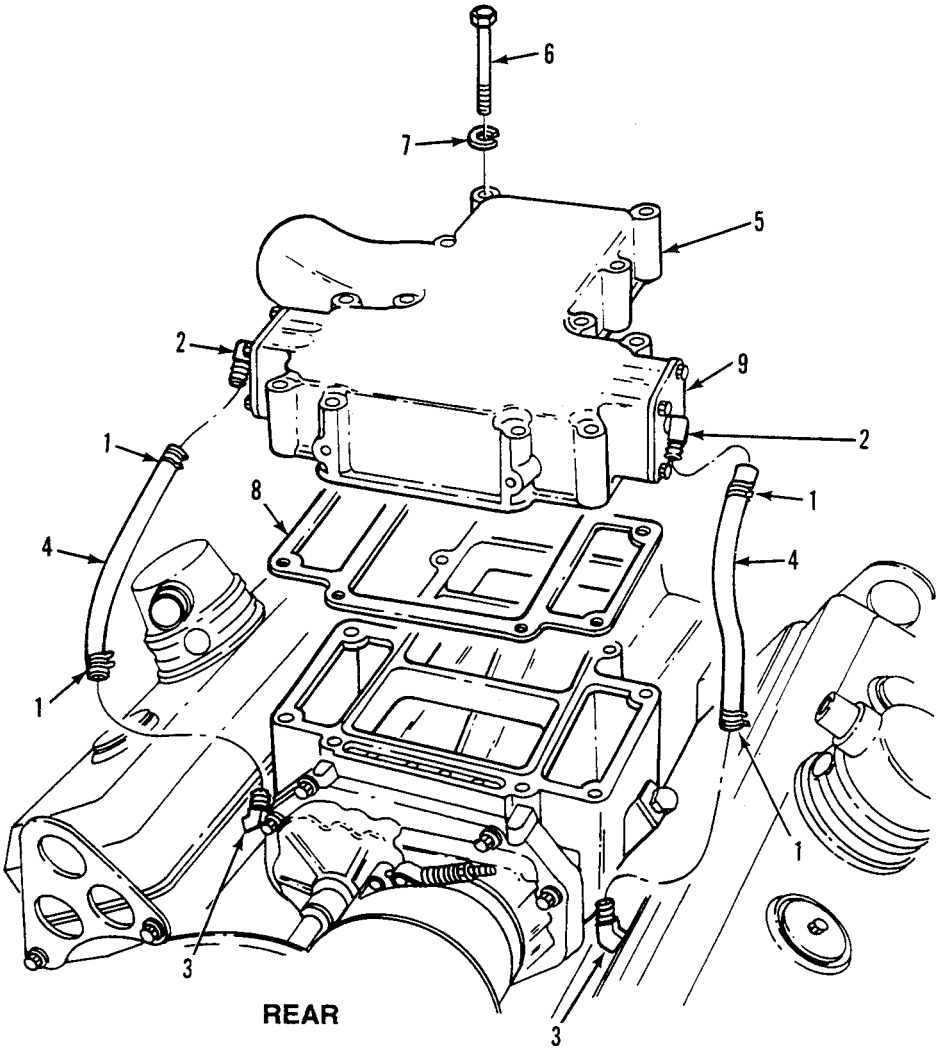
(10) Remove air inlet housing assembly (5) from soft-jawed vise.





e. Installation

(1) Install air inlet housing assembly (5) and gasket (8) on blower. Secure with twelve bolts (6) and twelve lockwashers (7). Torque bolts to 42-48 lb-ft (57-65 N-m).



(2) Install two clamps (1) on hose (4). Attach one end of hose to elbow fitting (2) on right side bypass valve cover (9) and attach other end of hose to fitting (3) on cylinder head. Slide clamps onto fittings and secure hose.

(3) Repeat step (2) above for opposite side.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-3 Air inlet tube installed
5.1-8 Glow plug controller installed
5.1-4 Fuel return line clip installed on by-pass valve cover

Section III. ENGINE DISASSEMBLY/ASSEMBLY

SECTION IV. COMPONENT REPAIR

5.1-36. TURBOCHARGER REPAIR

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

INITIAL SETUP

MODELS

7083-7391

TOOLS AND SPECIAL TOOLS

General mechanics tool set (App B, Item 96)
Torque wrench (App B, Item 100)
Dial indicator adaptor (App B, Item 4)
Turbocharger holding fixture (App B, Item 21)
Magnetic base dial indicator (App B, Item 45)
Torque wrench (App B, Item 101)
Impeller Nut Box Wrench (App B, Item 104)

MANDATORY REPLACEMENT PARTS

1 Piston ring (App F, Item 178)
1 Seal ring (App F, Item 179)
2 Piston rings (App F, Item 180)
1 Thrust washer (App F, Item 181)
2 Bearings (App F, Item 182)
2 Washers (App F, Item 183)
3 Retaining rings (App F, Item 184)
2 LockWashers (App F, [tern 93)
1 Gasket (App F, Item 74)
3 Self-locking screws (App F, Item 185)
1 Self-locking nut (App F, Item 186)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)
Crocus cloth (App C, Item 12)
Silicone carbide cloth (App C, Item 41)
Antiseize compound (App C, Item 1)
Silicone lubricant (App C, Item 42)

EQUIPMENT CONDITION

Para Description
5-2 Turbocharger removed

a. Disassembly

(1) Mark relative position of compressor housing (1), center housing (2), and turbine housing (3) with a marking pen to assure reassembly in same relative location.

CAUTION

Exercise care when removing compressor housing and turbine housing to prevent damage to compressor and turbine wheels.

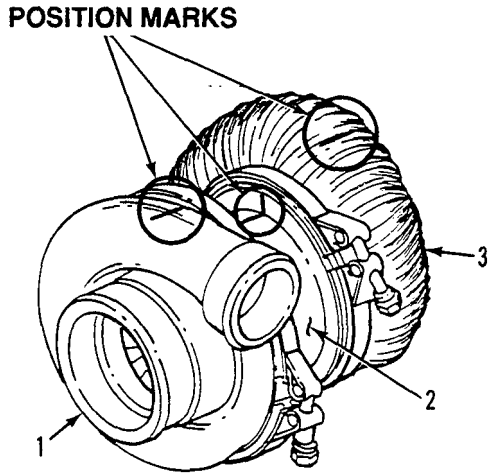
(2) Loosen V-band coupling (4) securing compressor housing (2) to backplate assembly (5). Remove coupling and housing.

(3) Remove two bolts (6) and two lockwashers (7) securing turbocharger drain tube (8) to center housing (2). Remove bracket (9), drain tube (8), and gasket (10) from center housing. Discard lockwashers and gasket.

(4) Remove adaptor bushing (11) from top of center housing (2).

(5) Loosen V-band coupling (12) securing turbine housing (3) to center housing (2). Remove clamp.

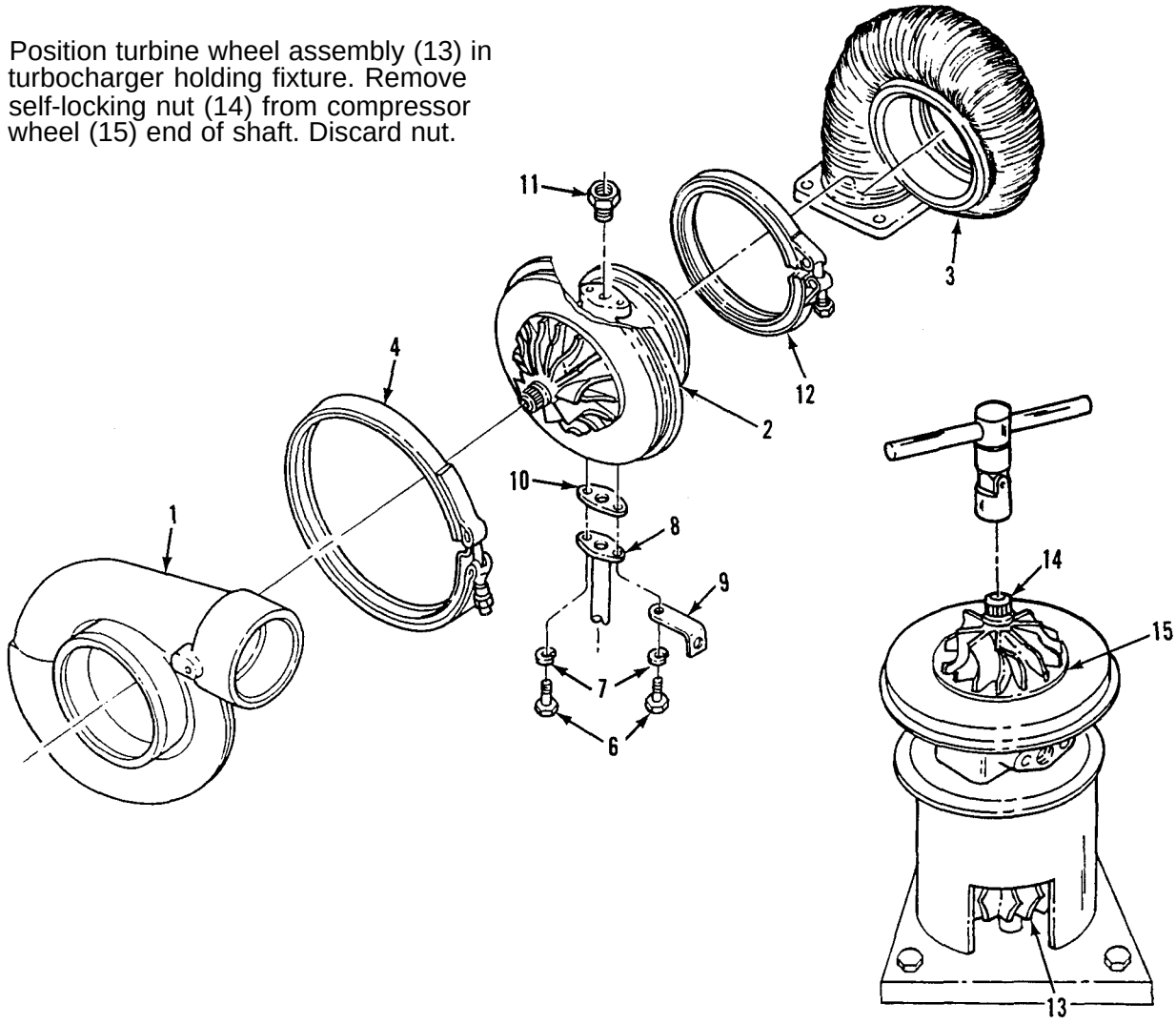
(6) Remove turbine housing (3) from center housing (2).



CAUTION

Remove compressor wheel nut from shaft with a double universal socket and tee handle to prevent bending turbine wheel shaft.

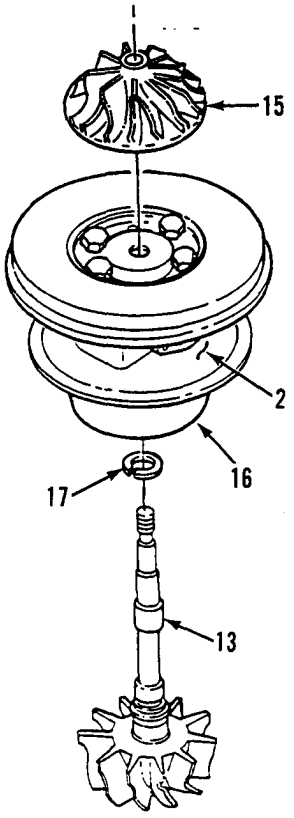
(7) Position turbine wheel assembly (13) in turbocharger holding fixture. Remove self-locking nut (14) from compressor wheel (15) end of shaft. Discard nut.



5.1-36. TURBOCHARGER REPAIR (Cont)

CAUTION

Catch wheel shroud before it falls from press. Wheel shroud (16) will fall free when wheel shaft assembly is removed.



(8) Remove compressor wheel (15) from turbine wheel shaft assembly (13) by using a press.

(9) Withdraw turbine wheel shaft assembly (13) and wheel shroud (16) from center housing (2).

NOTE

If groove in turbine wheel shaft (13) is not present, turbocharger does not require a piston ring (17) near turbine wheel.

(10) Remove piston ring (17) from turbine wheel shaft assembly (13). Discard piston ring.

(11) Remove four bolts (18) securing backplate (5) to center housing (2).

(12) Remove backplate (5) from center housing (2) by tapping it lightly.

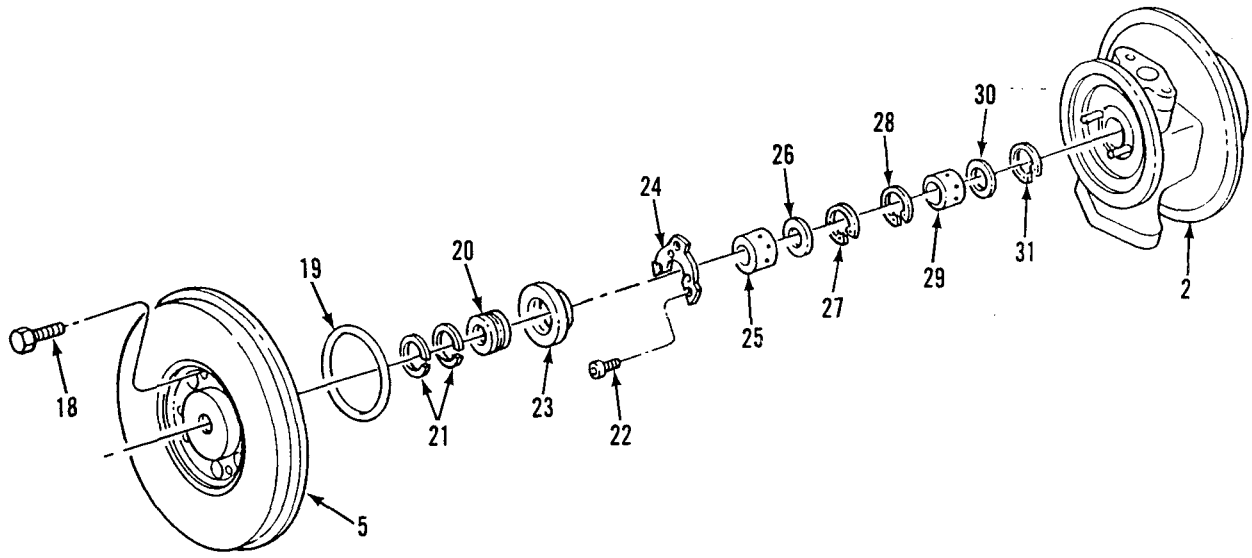
(13) Remove seal ring (19) from groove in center housing (2). Discard seal ring.

(14) Remove thrust spacer (20) with two piston rings (21) from backplate (5). Remove two piston rings from thrust spacer. Discard piston rings.

(15) Remove three self-locking screws (22) securing thrust collar (23) and thrust washer (24) to center housing (2). Discard thrust washer and self-locking screws.

(16) Remove bearing (25), bearing washer (26) and retaining ring (27) from compressor end of center housing (2). Discard retaining ring, bearing washer, and bearing.

(17) Remove outer retaining ring (28), bearing (29), bearing washer (30) and inner retaining ring (31) from compressor end of center housing (2). Discard retaining rings, bearing washer, and bearing.



b. Cleaning

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.)**
- **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.**

CAUTION

Never use caustic cleaning solution for cleaning. 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.
- Insure 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.

5.1-36. TURBOCHARGER REPAIR (Cont)

CAUTION

When polishing surfaces, use silicone carbide abrasive cloth for aluminum parts and crocus cloth for steel parts.

(4) Minor surface damage may be 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.

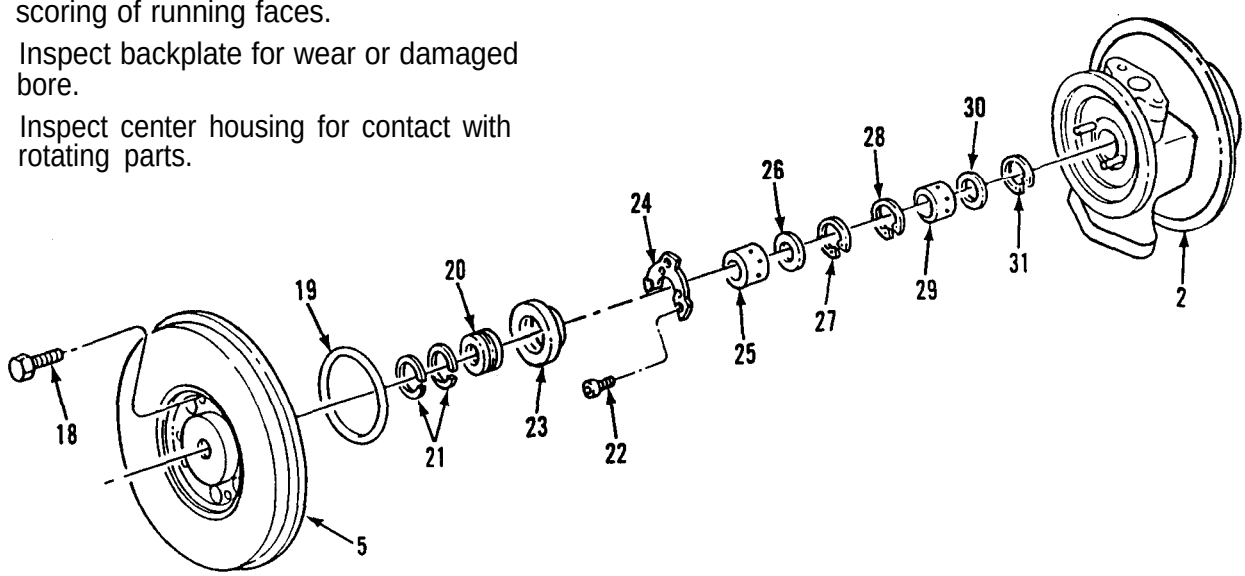
(3) Inspect shaft for signs of scoring, scratches, or bearing seizure.

(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 (25) and bearing (29) with engine oil.

(2) Install inner retaining ring (31), bearing washer (30), bearing (29), and outer retaining ring (28) in compressor end of center housing (2).

(3) Install retaining ring (27), bearing washer (26), and bearing (25) in compressor end of center housing (2).

(4) Lubricate thrust collar (23) and thrust washer (24) with engine oil.

(5) Insert thrust collar (23) into thrust washer (24) and install thrust collar, thrust washer, and three self-locking screws (22) in center housing (2). Torque screws to 30-35 lb-in (3.4-3.9 N-m).

(6) Install seal ring (19) in groove at compressor end of center housing (2).

CAUTION

Do not cock or force piston rings (21) into grooves. Rings are brittle and will snap easily.

(7) Install two piston rings (21) on thrust spacer (20).

(8) Lubricate thrust spacer (20) and piston rings (21) with engine oil. Gently insert thrust spacer with rings into bore in backplate (5).

(9) Aline oil feed hole in center housing (2) and backplate assembly (5). Attach backplate to center housing with four bolts (1 8). Torque bolts to 110-130 lb-in (12.4 -14.7 N-m)

CAUTION

Do not cock or force piston ring (17) into groove. Ring is brittle and will snap easily.

NOTE

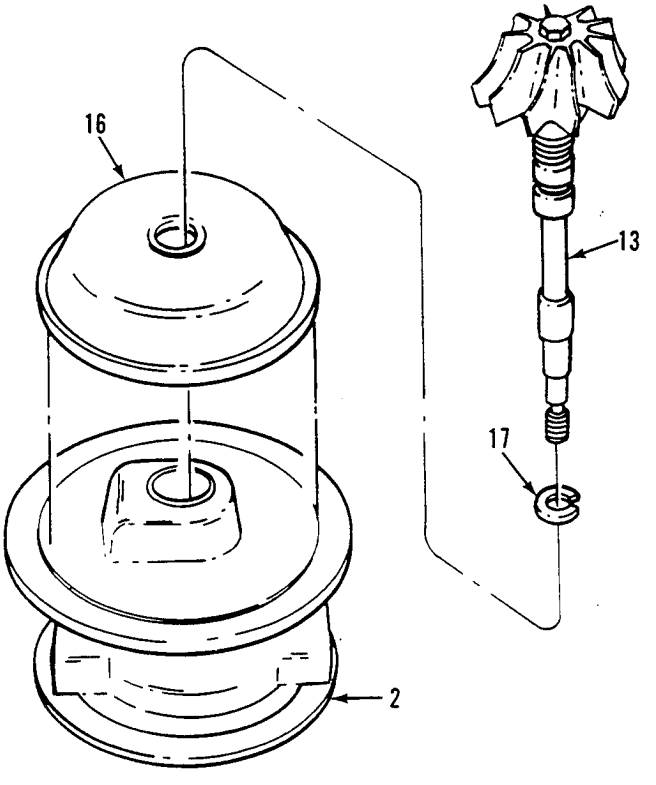
Piston ring (17) is used on some turbochargers. If there is no groove in shaft (1 3), ring is not required.

(10) Fill piston ring groove with high vacuum silicone lubricant and install piston ring (17) on wheel shaft assembly (13).

CAUTION

Do not scuff or scratch bearings when installing shaft or bearing will seize during operation.

(11) Lubricate turbine wheel shaft assembly (13) with engine oil. Position wheel shroud (16) against center housing (2). Insert turbine wheel shaft assembly through wheel shroud and into center housing.



5.1-36. TURBOCHARGER REPAIR (Cont)

(12) Place turbine wheel shaft assembly (13), shroud (16), center housing (2), and backplate (5) upright in turbocharger holding fixture.

(13) With compressor wheel (15) at room temperature, position it over turbine wheel shaft assembly (13).

CAUTION

When torquing compressor wheel nut on shaft, use two universal joints connected in tandem or a single universal joint and a universal socket to prevent bending turbine wheel shaft.

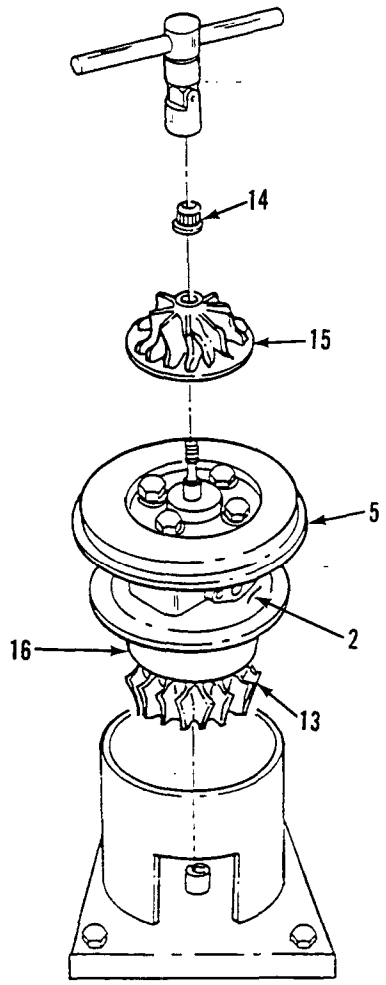
(14) Lubricate shaft threads of turbine wheel shaft assembly (13) and wheel face on compressor wheel (15) with engine oil. Install self-locking nut (14). Torque nut to 125-150 lb-in (14-17 N-m) to seat compressor wheel against thrust spacer.

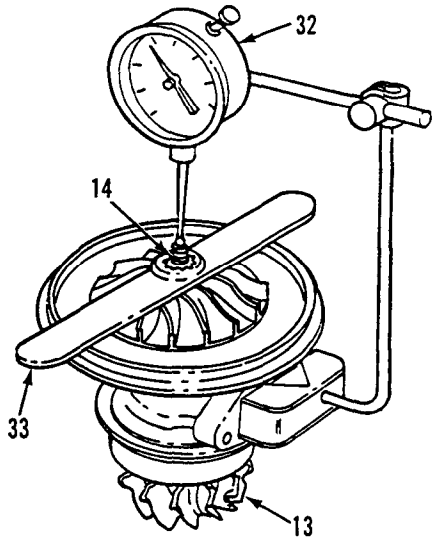
(15) Loosen self-locking nut (14) and inspect nut face and front face of compressor wheel to insure they are smooth and clean.

(16) Torque self-locking nut (14) to 35-55 lb-in (4-6 N-m).

(17) Attach magnetic base dial indicator (32) to center housing.

(18) Place impeller nut box wrench (33) on impeller nut (14) and position dial indicator on tip of turbine shaft assembly (13). Set dial indicator to zero. Tighten nut to obtain shaft stretch of 0.009-0.010 inch.





(19) Check bearing axial end play as follows:

(a) Clamp center housing assembly in soft-jawed vise.

(b) Fasten magnetic base dial indicator (32) 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. Repair or replace shaft assembly if readings do not fall within limits.

(20) Install turbine housing (3) on center housing (2) and align match marks.

(21) Install V-band coupling (12) on turbine housing (3) and center housing (2) so T-bolt end does not interfere with turbine housing. Apply antiseize compound to threads on T-bolt and tighten nut to 160 lb-in (18 N-m). Loosen to 50 lb-in (5.6 N-m) and retorque to 152-168 lb-in (17.2-19.0 N-m).

(22) Check shaft radial movement as follows:

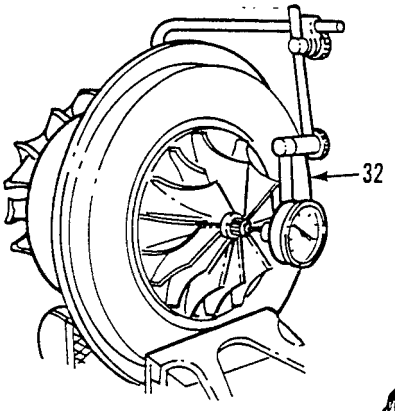
(a) Position magnetic base dial indicator (32) on flat surface of turbine housing inlet flange.

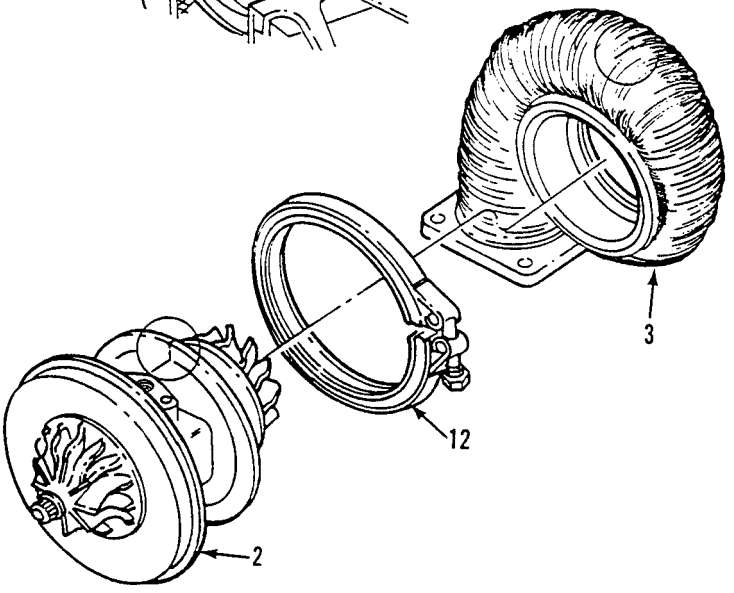
(b) Insert dial indicator tip extension rod into oil drain hole with rod touching shaft and perpendicular.

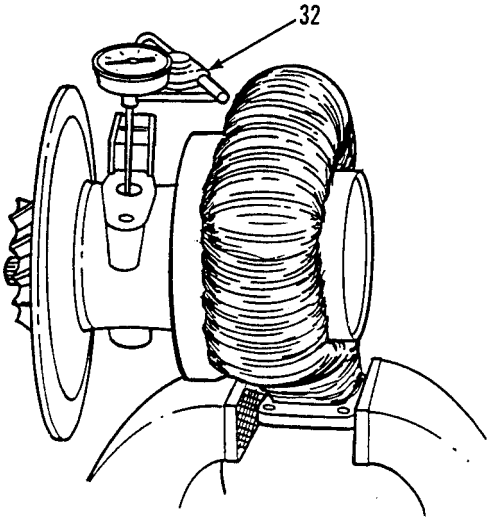
NOTE

Insure adaptor rod does not contact sides of center housing or readings are invalid.

(c) 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.





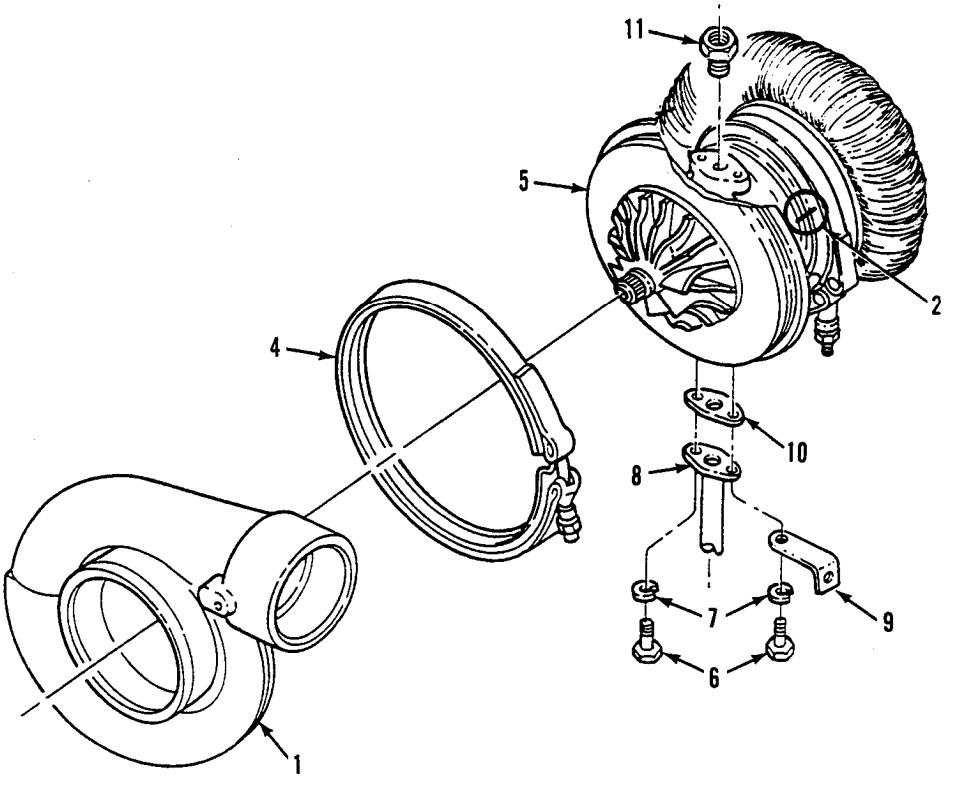


5.1-36. TURBOCHARGER REPAIR (Cont)

(23) Aline match marks on compressor housing (1) with marks on center housing (2). Secure compressor housing to backplate (5) with V-band coupling (4). Lubricate threads on T-bolt with engine oil and torque nut to 110-130 lb-in (12-15 N-m).

(24) Install adaptor bushing (11) in oil inlet hole in center housing (2).

(25) Install gasket (10), oil drain tube (8), bracket (9), two lockwashers (7), and two bolts (6) on oil outlet of center housing (2). Torque bolts to 30-35 lb-ft (41-47 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description	
4-2	Install turbocharger	
5.1-37.	CYLINDER HEAD REPAIR	(See Para 5-37)
5.1-38.	OIL COOLER ASSEMBLY REPAIR	(See Para 4-39)
5.1-39.	FUEL INJECTOR ASSEMBLY REPAIR	(See Para 4-40)
5.1-40.	BLOWER REPAIR	(See Para 4-41)
5.1-41.	GOVERNOR REPAIR	(See Para 5-41)
5.1-42.	WATER PUMP REPAIR	(See Para 4-43)

CHAPTER 6

REPAIR PROCEDURES FOR MAJOR COMPONENTS OF ENGINE MODEL 7083-7398

Contents **Para** **Page**

Section I. INTRODUCTION

6-1. GENERAL. This chapter provides the repair procedures performed on engine model 7083-7398 after the engine has been installed on the maintenance stand. 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.

This chapter deals with engine model 7083-7398. However, if a model in previous chapters has identical or nearly identical components, this chapter will refer to the previous chapter. If a model in the subsequent chapter has identical or nearly identical components, this chapter also covers that model.

Section II. GENERAL ENGINE MAINTENANCE

6-2. TURBOCHARGER REGULATOR REPLACEMENT

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

INITIAL SETUP

MODELS

7083-73987083-7399

MANDATORY REPLACEMENT PARTS

4 Lockwashers (App F,Item 93)
1 Gasket (App F,Item 73)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

a. Removal

(1) Disconnect line (1)at elbow (2) on air inlet housing (3) and at elbow (4) on regulator valve (5).

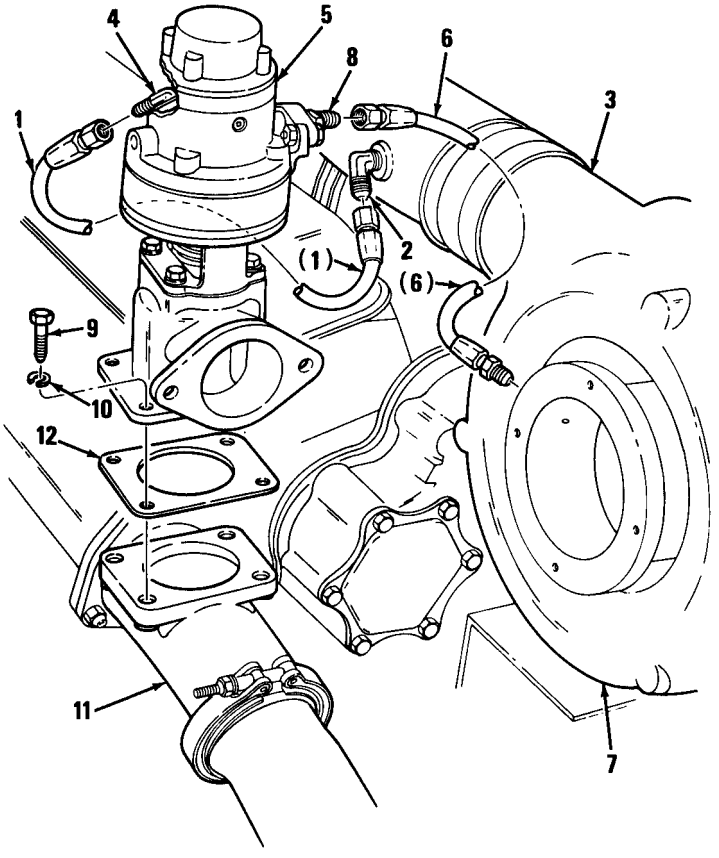
NOTE

Model 7083-7399 uses an elbow instead of an adaptor at the regulator valve connection.

(2) Disconnect line (6) from turbocharger (7) and at adaptor (8) on regulator valve (5).

(3) Remove four bolts (9) and four lockwashers (1O) securing regulator valve (5) to exhaust adaptor (11). Discard lockwashers.

(4) Remove regulator valve (5) and gasket (12) from exhaust adaptor (11). Discard gasket.



6-2. TURBOCHARGER REGULATOR REPLACEMENT (Cont)

b. Test

Applv air pressure to regulator valve inlet port at elbow (4). Valve should move 0.30 inch (0.76 cm) with 12.7-13.6 PSI (87.6-89.8 kPa). If valve is out of limits, replace valve.

c. Installation

NOTE

- Outlet flange on turbocharger regulator valve must face rear of engine on model 7083-7398
- Outlet flange on turbocharger regulator valve must face left side of engine on model 7083-7399.

(1) Position gasket (12) and regulator valve (5) on exhaust adaptor (11).

(2) Install four Iockwashers (10) and four bolts (9) securing regulator valve (5) to exhaust adaptor (11). Torque bolts to 30-35 Ib-ft (41-47 N-m).

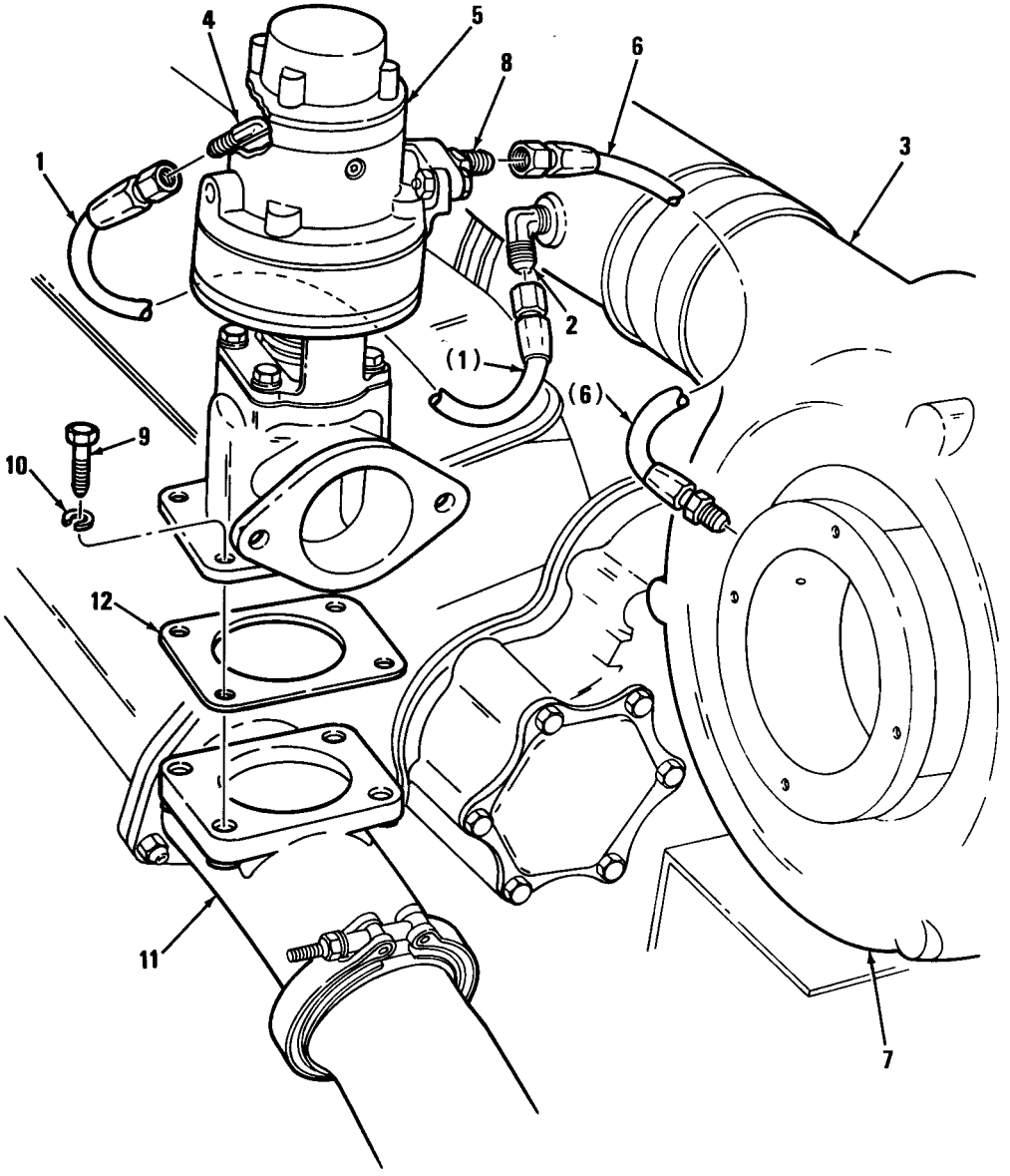
NOTE

Model 7083-7399 uses an elbow instead of an adaptor at the regulator valve connection.

(3) Connect line (6) to turbocharger (7) and to adaptor (8) on regulator valve (5). Tighten line connections.

(4) Connect line (1) at elbow (2) on air inlet housing (3) and to elbow (4) on regulator valve (5). Tighten line connections.

END OF TASK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6-3. TURBOCHARGER REMOVAL/INSTALLATION

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

INITIAL SETUP

MODELS

7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

6 Locking nuts (App F, Item 104)
1 Gasket (App F, Item 40)

EXPENDABLE/DURABLE SUPPLIES

Tape (App C, Item 27)

EQUIPMENT CONDITION

Para	Description
3-11	Turbocharger oil supply line removed
6-2	Turbocharger air regulator line removed

PERSONNEL REQUIRED: 2

a. Removal

(1) Loosen two clamps (1) and slide rubber connector (2) onto turbocharger oil drain tube (3).

(2) Loosen two clamps (4) on hose connector (5) connecting air inlet housing (6) to turbocharger (7). Slide hose and two clamps onto air inlet housing.

(3) Remove six locking nuts (8) securing turbocharger (7) to exhaust tee (9). Discard locking nuts.

WARNING

Engine components are heavy. To prevent personal injury, use extreme caution when removing large components from engine.

CAUTION

- Turbocharger is heavy. Use two persons or lifting device to prevent dropping and damage to turbocharger.
- Tape all openings of turbocharger after removal to keep foreign particles from entering and damaging turbocharger blades.

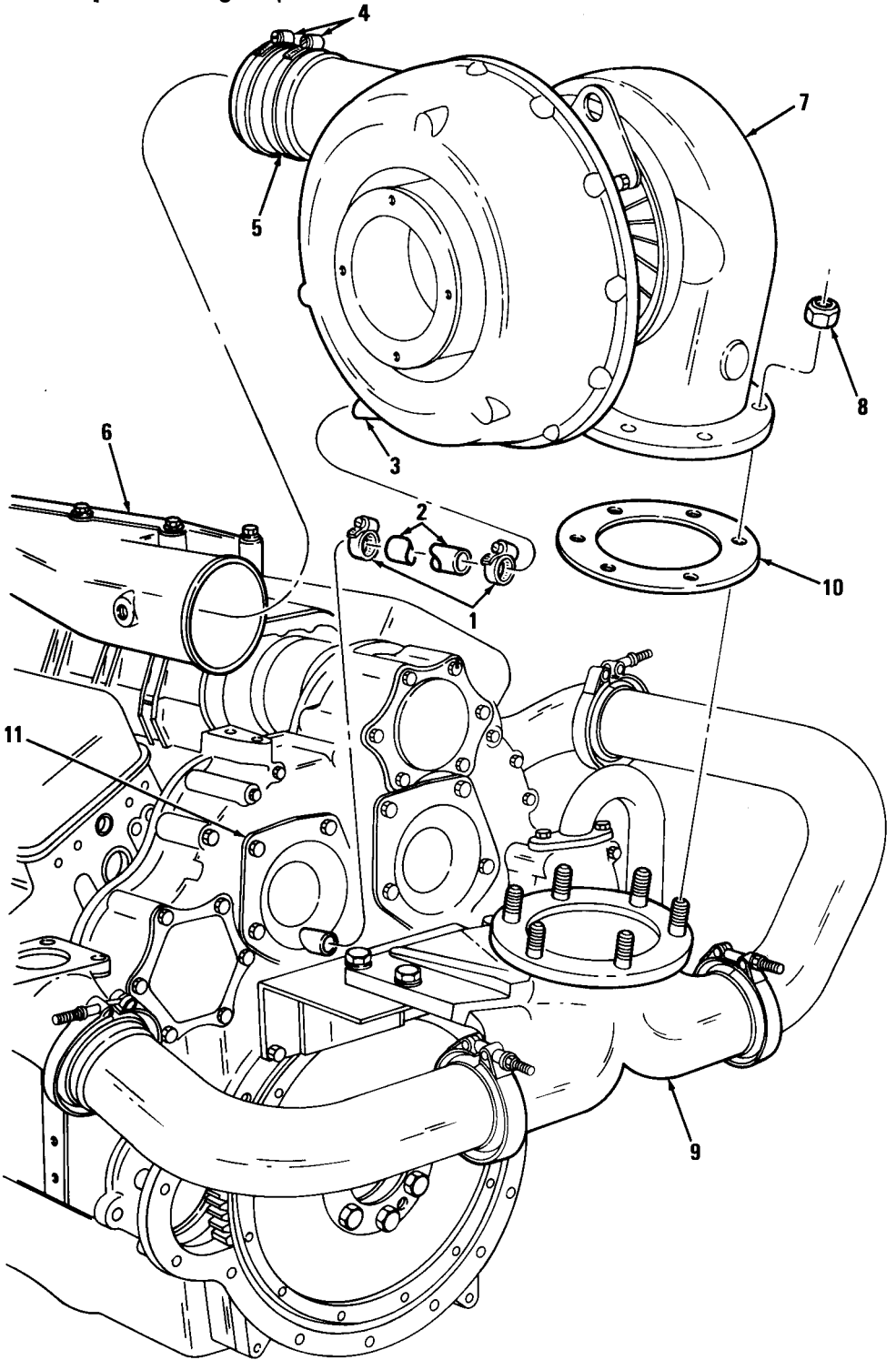
(4) Remove turbocharger (7) and gasket (10). Discard gasket.

(5) Remove rubber connector (2) and two clamps (1) from drain tube (3). Remove hose (5) and two clamps (4) from air inlet housing (6).

b. Inspection

(1) Inspect hoses and rubber connector for cuts, cracks, and brittleness.

(2) Replace all parts failing inspection.



6-3. TURBOCHARGER REMOVAL/INSTALLATION (Cont)

c. Installation

(1) install gasket (10)on exhaust tee (9).

(2) Slide hose (5) and two clamps (4) onto air inlet housing (6). Slide rubber connector (2) and two clamps (1) onto oil drain tube (3).

WARNING

Engine components are heavy. To prevent personal injury, use extreme caution when removing large components from engine.

CAUTION

Turbocharger is heavy. Use two persons or lifting device to prevent dropping and damage to turbocharger.

(3) Install turbocharger (7) on exhaust tee (9) and secure with six locking nuts (8). Torque nuts to 83-93 lb-ft (113-126 N-m).

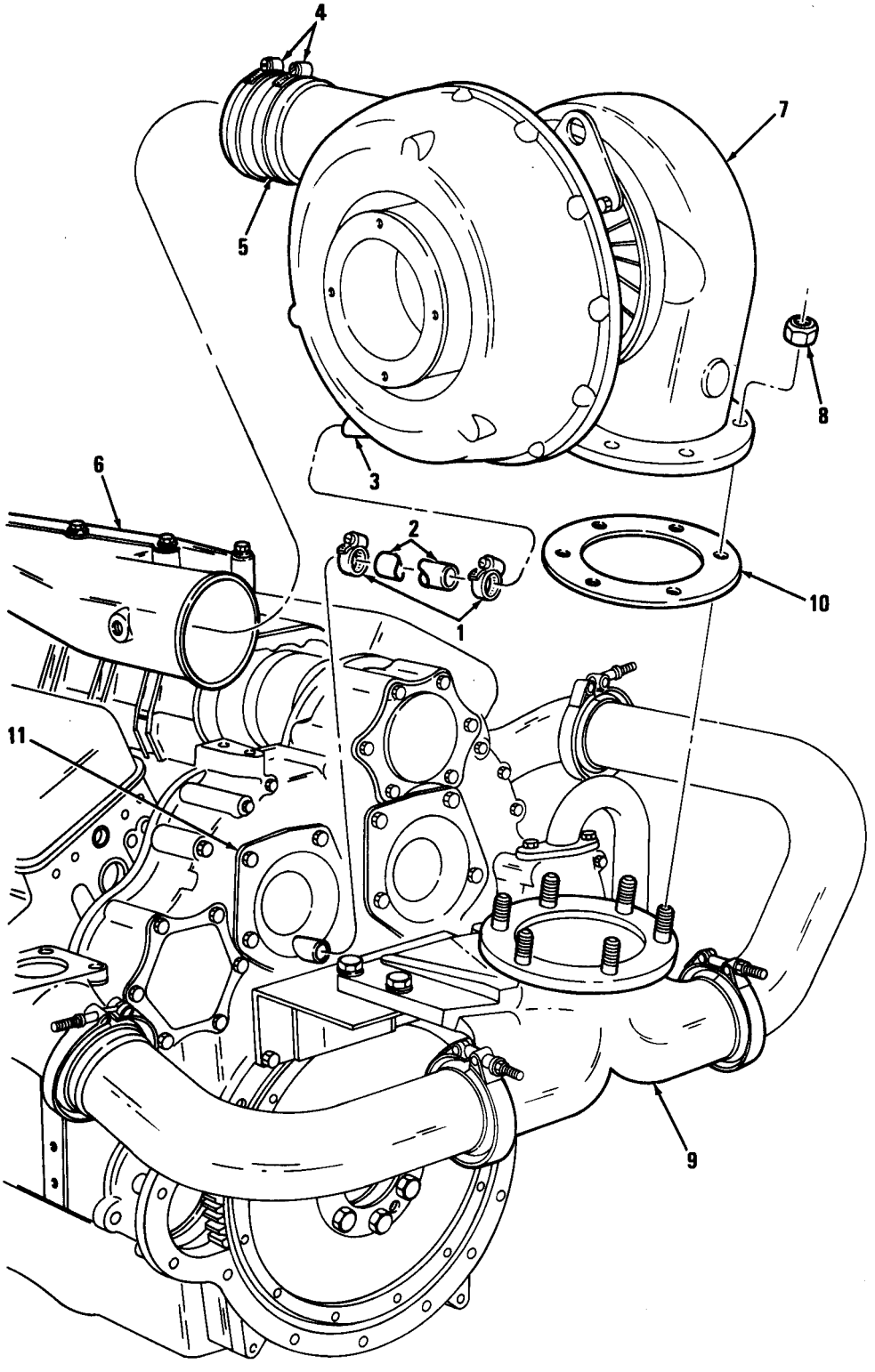
(4) Slide hose (5) and two clamps (4) from air inlet housing (6) onto turbocharger (7). Tighten clamps.

(5) Slide rubber connector (2) and two clamps (1) on turbocharger oil drain tube (3) onto flywheel housing cover (11). Tighten clamps.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
6-2 Install turbocharger regulator air line
3-11 Install turbocharger oil supply line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6-4. EXHAUST MANIFOLD AND TUBE REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para	Description
3-7	Oil level gauge removed
6-2	Turbocharger regulator removed
6-3	Turbocharger removed

PERSONNEL REQUIRED: 2

MANDATORY REPLACEMENT PARTS

10 Locking nuts (App F, Item 103)
3 Locking nuts (App F, Item 102)
4 Gaskets (App F, Item 28)
4 Gaskets (App F, Item 41)
4 Locking nuts (App F, Item 104)
1 Gasket (App F, Item 50)
4 Lockwashers (App F, Item 94)

a. Removal

(1) Remove four nuts (1) from four clamps (2) securing exhaust tubes (3 and 4) to exhaust housing (5), exhaust manifold (6), and adaptor (7), Slide clamps onto tubes and reinstall nuts on clamps.

(2) Loosen four nuts (8) securing exhaust housing (5) to bracket (9) to aid in removal of exhaust tubes (3 and 4).

(3) Remove exhaust tubes (3 and 4), four clamps (2), and four gaskets (10). Discard gaskets and remove clamps from tubes.

(4) Remove four bolts (11), four flat washers (1 2), and four locking nuts (8) securing housing (5) to bracket (9). Remove housing. Discard locking nuts.

(5) Remove four bolts (13), four lockwashers (14), and four flat washers (15) securing bracket (9) to flywheel housing. Remove bracket and discard lockwashers,

(6) Remove three locking nuts (16) from studs (17) securing adaptor (7) to left exhaust manifold (18). Discard locking nuts and remove adaptor.

(7) Remove gasket (19) from end of left manifold (18) and discard.

(8) Loosen five locking nuts (20) securing right exhaust manifold (6) to cylinder head.

(9) Slide exhaust manifold (6) up and off cylinder head.

(10) Remove five locking nuts (20), three beveled washers (21), and two end retainers (22). Discard locking nuts.

(11) Remove two exhaust manifold gaskets (23). Discard gaskets.

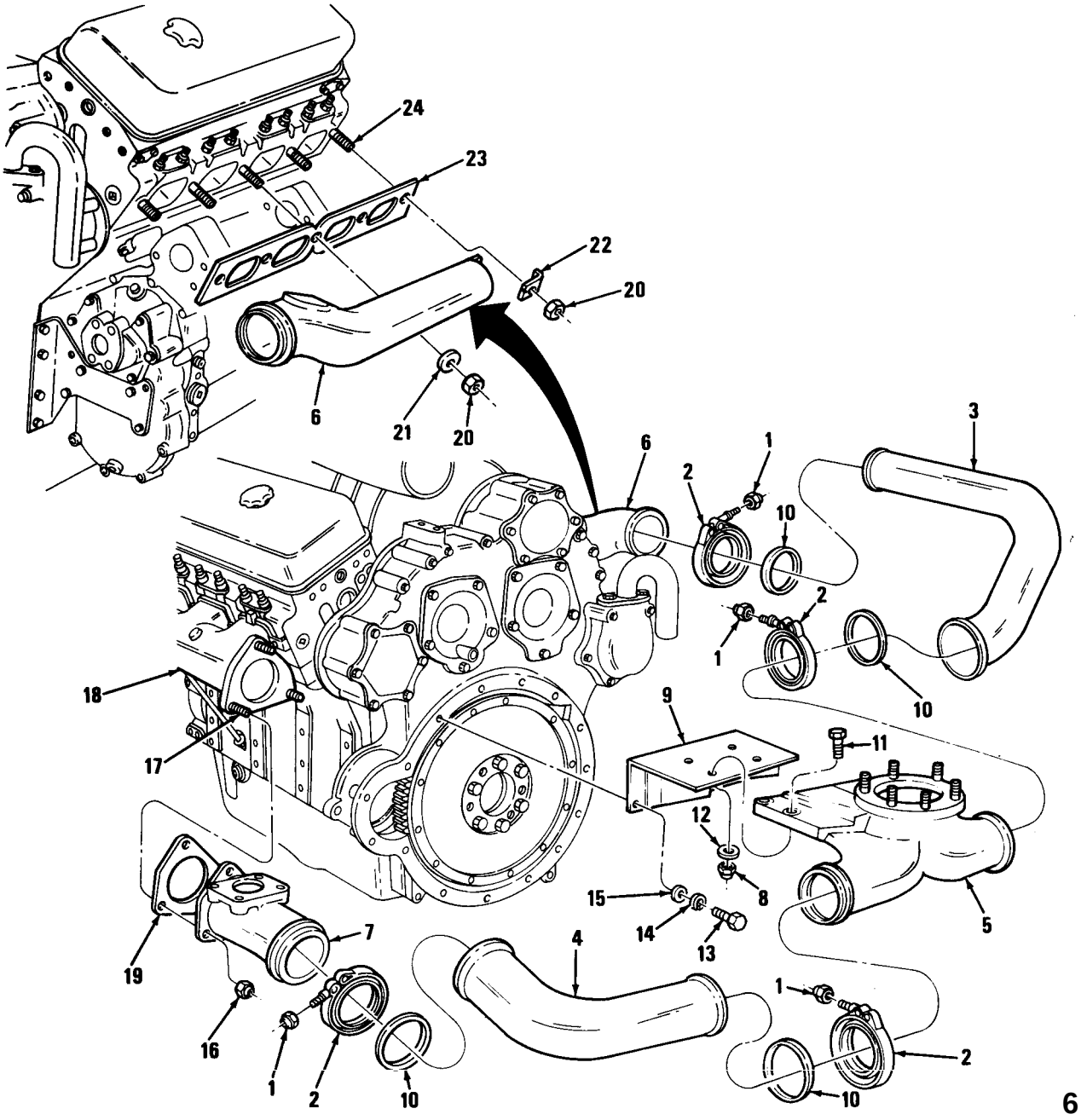
(12) Repeat steps (8) thru (11) above for left exhaust manifold.

b. Installation

NOTE

When installing metal clad exhaust manifold gaskets, place crimped side of gasket against cylinder head.

(1) Position two gaskets (23) over right exhaust manifold studs (24).



6-4. EXHAUST MANIFOLD AND TUBE REPLACEMENT (Cont)

NOTE

Position beveled washers with crown facing nut.

(2) install three beveled washers (21), two end retainers (22) and five locking nuts(20).

NOTE

Insure locating pads on exhaust manifold rest on cylinder block locating pads.

(3) Install right exhaust manifold (6) onto cylinder head by sliding downward between gaskets and retainers.

(4) Repeat steps (1) thru (3) above for left exhaust manifold.

(5) Position gasket (19) over studs (17) on rear of left exhaust manifold (18).

(6) Install adaptor (7) on studs (17) and secure with three locking nuts (16). Torque nuts to 57-61 lb-ft (77-83 N-m),

(7) Attach bracket (9) to rear of flywheel housing with four bolts (13), four Iockwashers (14), and four flat washers (15). Torque bolts to 46-50 lb-ft (62-68 N-m).

(8) Position exhaust housing (5) on top of bracket (9) and loosely secure with four bolts (11), four flat washers (12), and four locking nuts (8).

(9) Slide two clamps (2) on left exhaust tube (4). Affix one gasket (10) on end of adaptor (7) and one on end of exhaust housing (5).

(10) Install left exhaust tube (4) between adaptor (7) and housing (5) and secure with two clamps (2).

(11) Slide two clamps (2) on right exhaust tube (3). Affix one gasket (10) to housing (5) and one gasket on end of exhaust manifold (6).

(12) Install right exhaust tube (3) between housing (5) and exhaust manifold (6) and secure with two clamps (2).

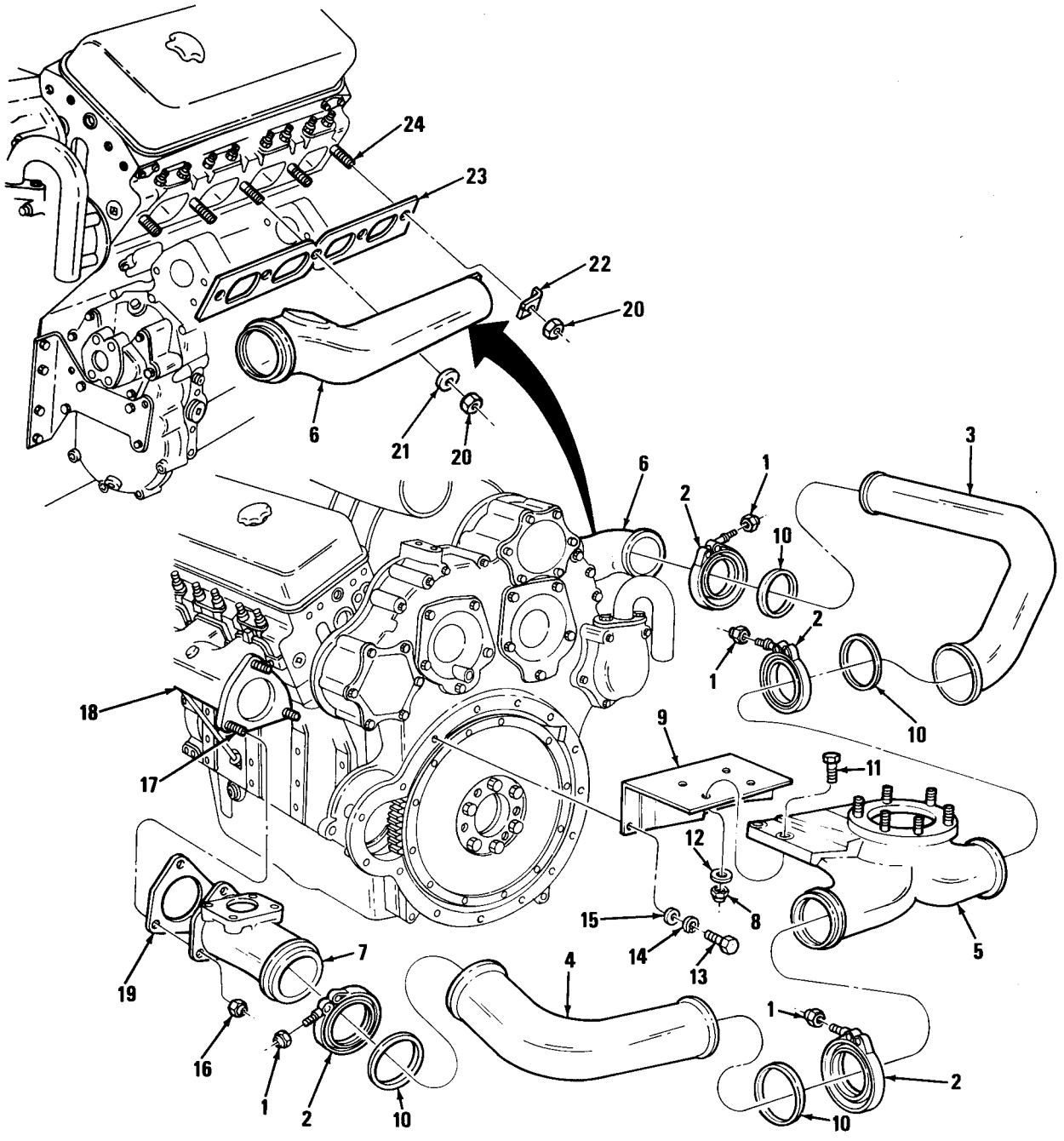
(13) Torque ten nuts (20) to 30-35 lb-ft (41-47 N-m) starting from center and working outward alternately toward either end.

(14) Torque four nuts (8) to 46-50 lb-ft (62-68 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
6-3	Turbocharger installed
6-2	Turbocharger regulator installed
3-7	Liquid level gauge installed



6-5. FUEL FILTER REPLACEMENT (See Para 4-4)

6-6. FUEL STRAINER REPLACEMENT (See Para 4-5)

6-7. FUEL LINES REPLACEMENT (See Para 4-6)

6-8. ENGINE LIFTING BRACKETS REPLACEMENT (See Para 4-7)

6-9. THERMOSTAT, THERMOSTAT HOUSING, AND CROSSOVER TUBES REPLACEMENT (See Para 4-8)

6-10. WATER PUMP REMOVAL\INSTALLATION (See Para 4-9)

6-11. AIR BOX HEATER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7398 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tools kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

Lockwasher (App F, Item 95)
1 Lockwashers (App F, Item 91)
2 LockWashers (App F, Item 92)
1 Gasket (App F, Item 61)
1 Gasket (App F, Item 77)
2 Gaskets(App F, Item 45)
3 LockWashers (App F, Item 93)
2 Lockwashers (App F, Item 98)
2 Lockwashers (App F, Item 90)
4 LockWashers (App F, Item 89)

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)
Fuel oil (App C, Item 21)

PUMP AND MOTOR ASSEMBLY

a. Removal

NOTE

If present, remove safety wire from connector.

(1) Disconnect wiring harness connector (1) from terminal on pump and motor assembly (2).

(2) Remove nut (3) and lockwasher (4) securing wiring harness lead (5) to pump. Discard lockwasher.

(3) Disconnect tube (6) from elbow (7) on pump.

(4) Disconnect hose (8) from elbow (9) on pump.

(5) For model 7083-7398 only, disconnect hose (8) from elbow (1 O) on fuel strainer.

(6) Disconnect wiring harness connector (11) from ignition coil (12).

(7) Remove nut (13) and lockwasher (14) securing two wiring harness leads (15) to stud (16) mounted in cylinder head. Remove leads. Discard lockwasher.

(8) Disconnect tube (17) from elbow (18) on solenoid valve.

(9) For model 7083-7399 only, remove bolt (19), lockwasher (20), and flat washer (21), securing clamp (22) and hose (8) to upper front cover.

(10) Remove two bolts (23) and two lockwashers (24) securing bracket (25) and clamp (22) to support (26). Remove hose (8). If necessary, remove clamp. Discard lockwashers.

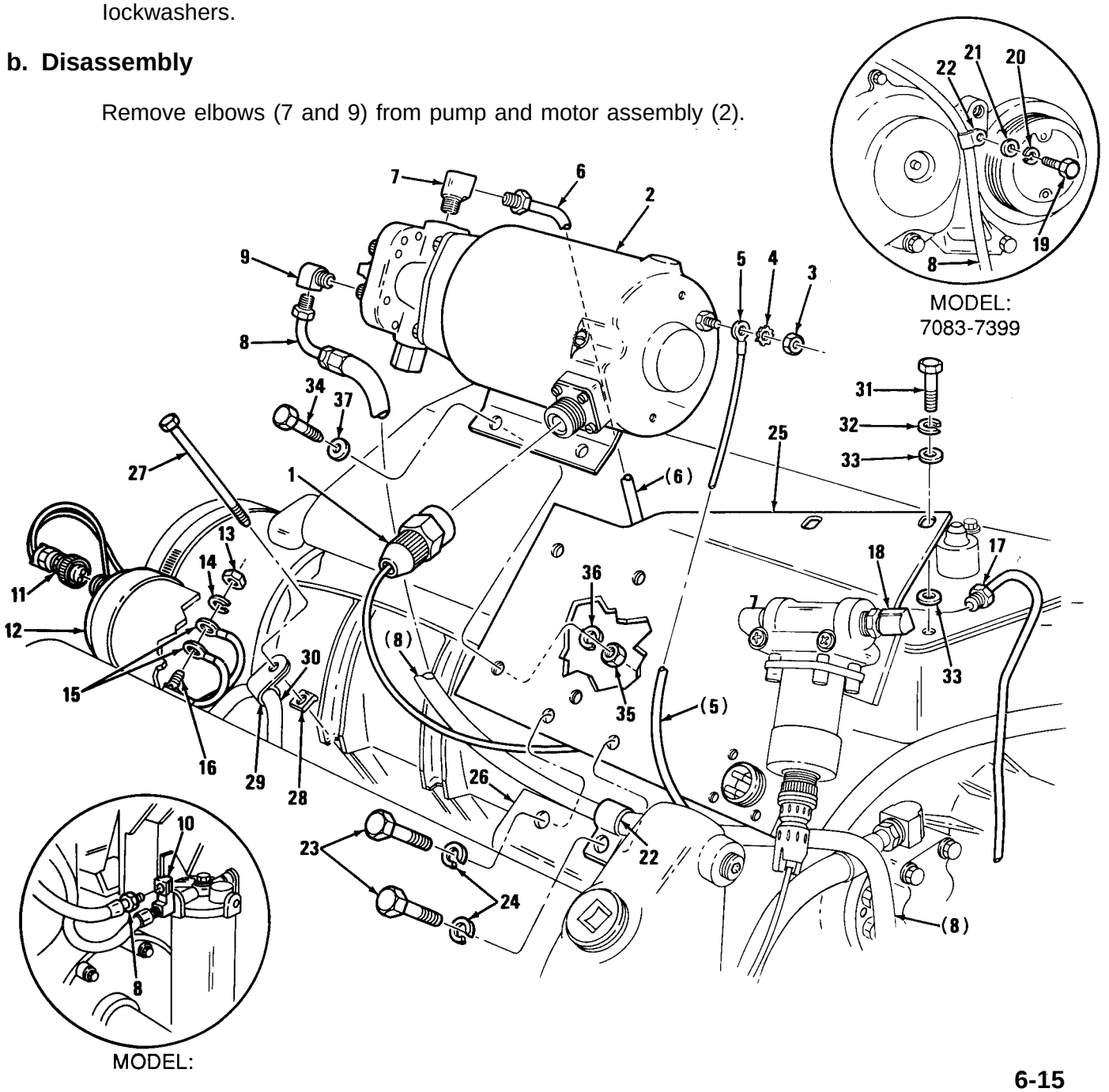
(11) Remove bolt (27), retainer (28), and clamp (29) securing wiring harness (30) to blower.

(12) Remove two bolts (31), two lockwashers (32), and four flat washers (33) securing bracket (25) assembly to governor. Remove bracket assembly. Discard lockwashers and install bolts into governor.

(13) Remove four bolts (34), four nuts (35), four lockwashers (36), and four flat washers (37) securing pump and motor assembly (2) to bracket (25). Remove assembly. Discard lockwashers.

b. Disassembly

Remove elbows (7 and 9) from pump and motor assembly (2).



6-11. AIR BOX HEATER REPLACEMENT (Cont)

c. Cleanlng/inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only In a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes Is made, wash your 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 outside surface of pump with dry cleaning solvent and dry with compressed air.

(2) Inspect pump and motor for cracks, dents, or damage.

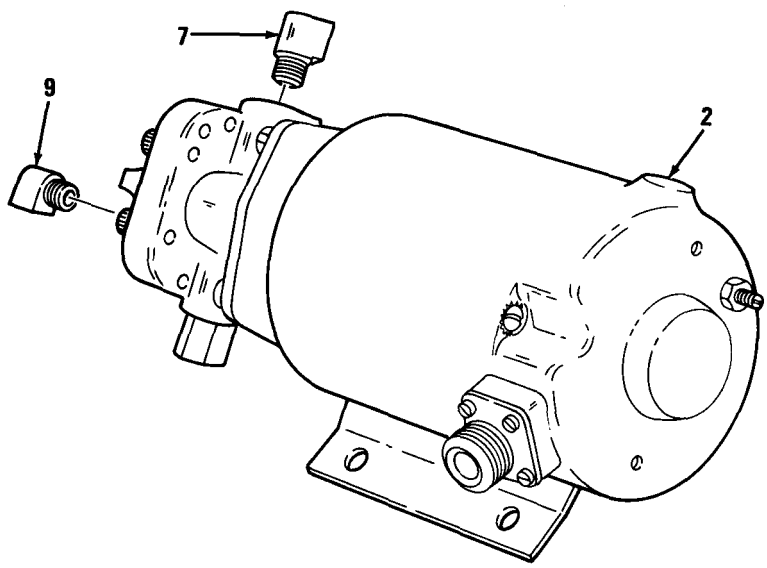
(3) Inspect electrical terminals for damage or corrosion.

(4) Inspect wiring harness for cuts, tears, burns, or other damage.

(5) Inspect hose for cuts, tears, or other damage.

d. Assembly

Install elbows (7 and 9) onto pump and motor assembly (2).



e. Test/Adjustment

(1) Connect end of hose (8) to inlet port and hose (6) to outlet port of pump.

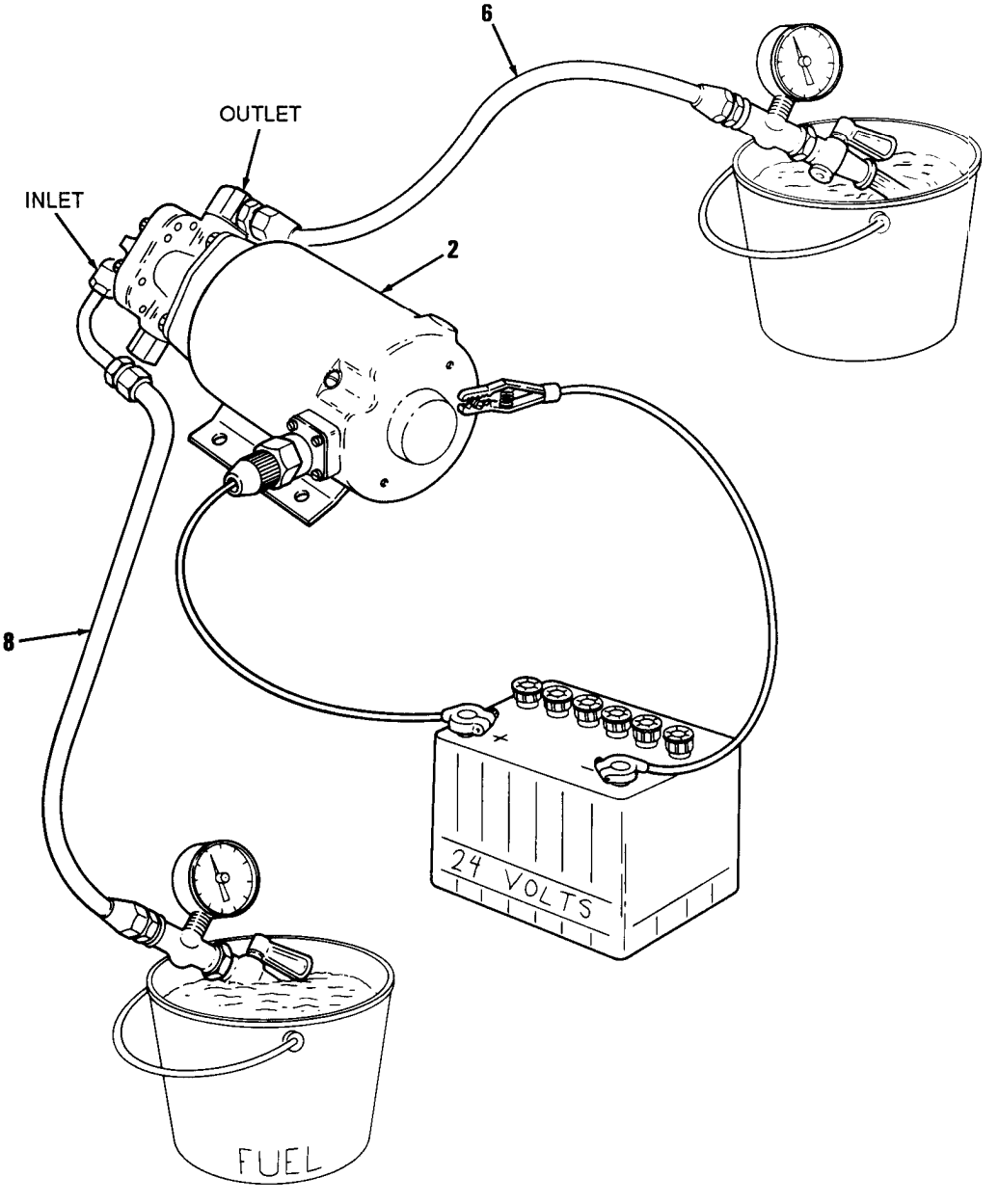
(2) Attach a 24 V dc power source to pump and motor assembly (2). After pump is primed and fuel flow established, flow with no restrictions is 0.2 GPM.

(3) Connect a pressure gage and cutoff valve to hose (6) and power up pump. Pressure with outlet shut off must be 40 PSI minimum.

(4) Connect a vacuum gage and cutoff valve to hose (8) and power up pump. Suction with inlet shut off must be 18 inches of mercury minimum.

(5) Disconnect 24 V dc power source.

(6) Remove gages, valves, and hoses (6 and 8) from pump and motor assembly (2).



f. Installation

(1) Secure pump and motor assembly (2) to bracket (25) with four bolts (34), four flat washers (37), four lockwashers (36), and four nuts (35). Torque bolts to 7-9 lb-ft (1 0-12 N-m).

(2) Install wiring harness lead (5) to terminal on pump and secure with nut (3) and lockwasher (4).

(3) Connect wiring harness connector (1) to terminal on pump and motor assembly (2).

(4) For model 7083-7399 only, route hose (8) to front of engine. If removed, install clamp (22) onto hose (8) and secure hose to upper front cover with bolt (19), lockwasher (20), flat washer (21), and clamp. Torque bolt to 71-75 lb-ft (96-102 N-m).

NOTE

When positioning wiring harness (30) on engine, route harness to prevent cuts, chaffing, burns, or interference with components,

(5) Install bracket (25) assembly onto governor. Secure with two bolts (31), two lockwashers (32), and four flat washers (33).

(6) If removed, install clamp (22) onto hose (8). Install two bolts (23) and two lockwashers (24), securing bracket (25) and clamp to support (26). Torque bolts (23) to 35-39 lb-ft (47-53 N-m). Torque bolts (31) to 7-9 lb-ft (1 0-12 N-m).

(7) Install bolt (27), retainer (28), and clamp (29) securing wiring harness (30) to blower. Torque bolt to 30-35 lb-ft (41-47 N-m).

(8) Connect tube (6) to elbow (7) on pump.

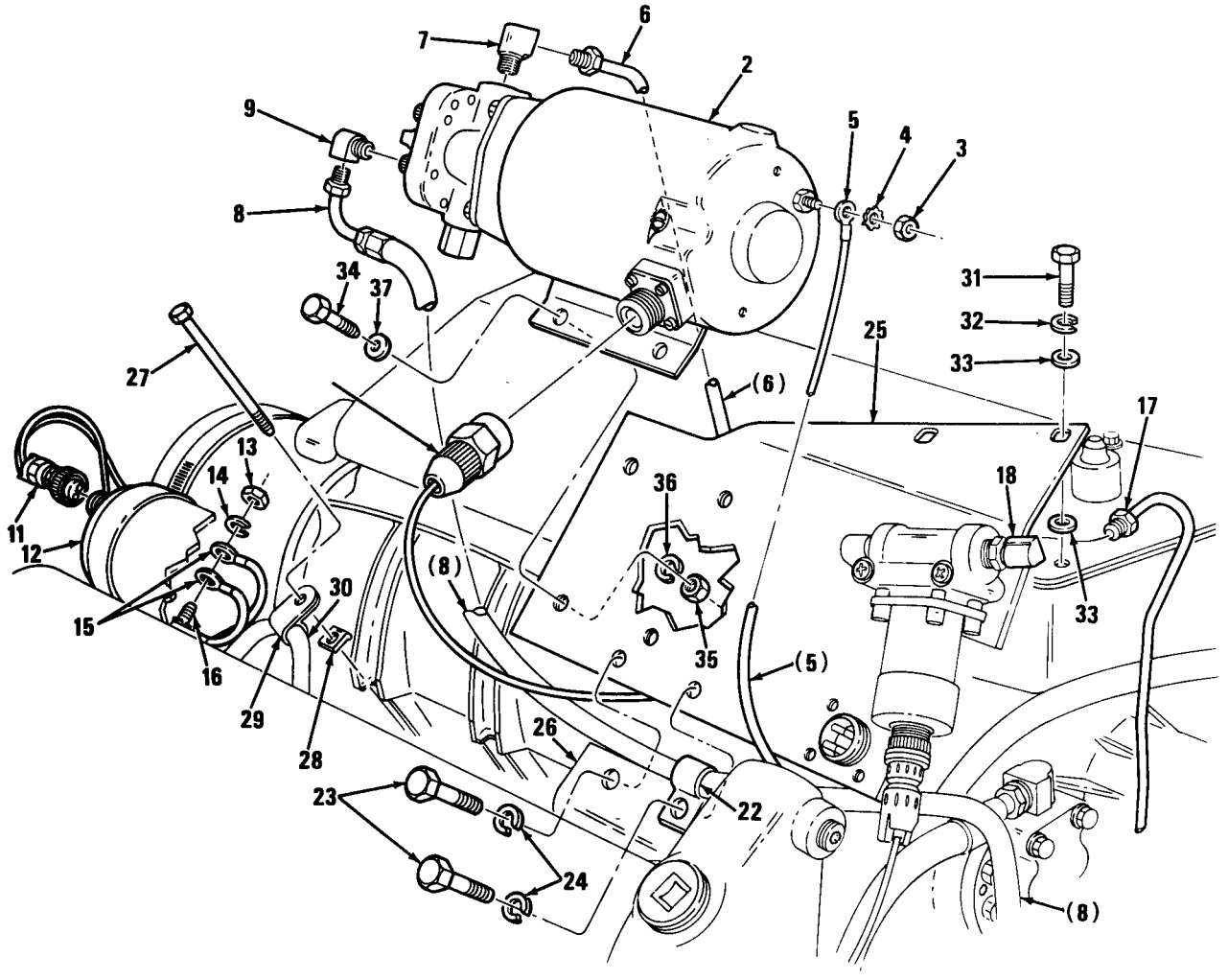
(9) For model 7083-7398 only, connect hose (8) to elbow (10) on fuel strainer,

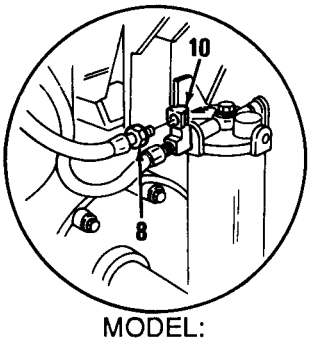
(10) Connect tube (17) to elbow (18) on solenoid valve (38).

(11) Connect hose (8) to elbow (9) on pump and motor assembly (2).

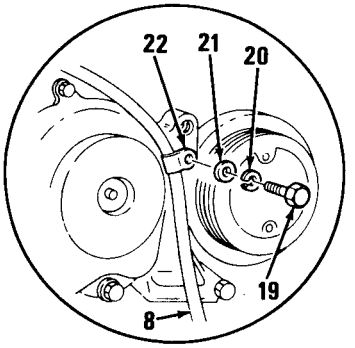
(12) Install wiring harness connector (11) onto ignition coil (12).

(13) Install two wiring harness leads (15) to stud (16). Secure with lockwasher (14) and nut (13).





MODEL:
7083-7398



MODEL:
7083-7399

6-11. AIR BOX HEATER REPLACEMENT (Cont)

AIR BOX HEATER

a. Removal

(1) Disconnect wire (39) from terminal nut pin (40).

NOTE

Disconnect tube (17) from solenoid during pump and motor assembly removal.

(2) Disconnect tube (17) from adapter (41) on air box heater assembly (42). Remove tube.

(3) Remove two bolts (43) and two lockwashers (44) securing air box heater assembly (42) and gasket (45) to block. Remove heater assembly and gasket. Discard lockwashers and gasket.

b. Disassembly

(1) Remove adapter (41), gasket (46), and filter element (47) from heater body (48). Discard ring spacer.

(2) Unscrew insulator nut (49) from heater body (48).

(3) Remove electrode (50) and two gaskets (51). Discard ring spacers.

(4) Unscrew terminal nut pin (40) from electrode (50).

(5) Remove spray nozzle (52) and flat washer (53) from heater body (48).

c. Cleaning/Inspection

(1) Inspect electrode and filter element for cracks, corrosion, or damage.

(2) Inspect spray nozzle and insure orifice is not plugged. If necessary, clean orifice.

(3) Inspect ignition wire for cuts, tears, burns, or other damage.

(4) Inspect tube bends or other damage.

d. Assembly

(1) Install spray nozzle (52) and flat washer (53) into heater body (48).

(2) Screw terminal nut pin (40) onto electrode (50).

(3) Install electrode (50) and two gaskets (51) into heater body (48).

(4) Screw insulator nut (49) into heater body (48).

(5) Install filter element (47), gasket (46), and adapter (41) into heater body (48).

e. Test/Adjustment

Using feeler gage set, adjust gap between electrode (50) and wire (54) to 0.080 inch.

f. Installation

NOTE

Do not install ignition coil if air box heater assembly testing is required.

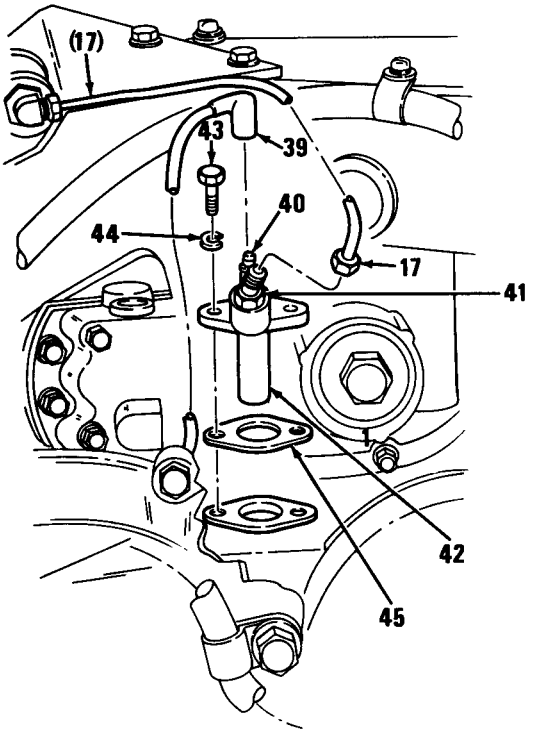
(1) Install air box heater assembly (42) and gasket (45) into block. Secure with two bolts (43) and two lockwashers (44). Torque bolts to 15-19 lb-ft (20-26 N-m).

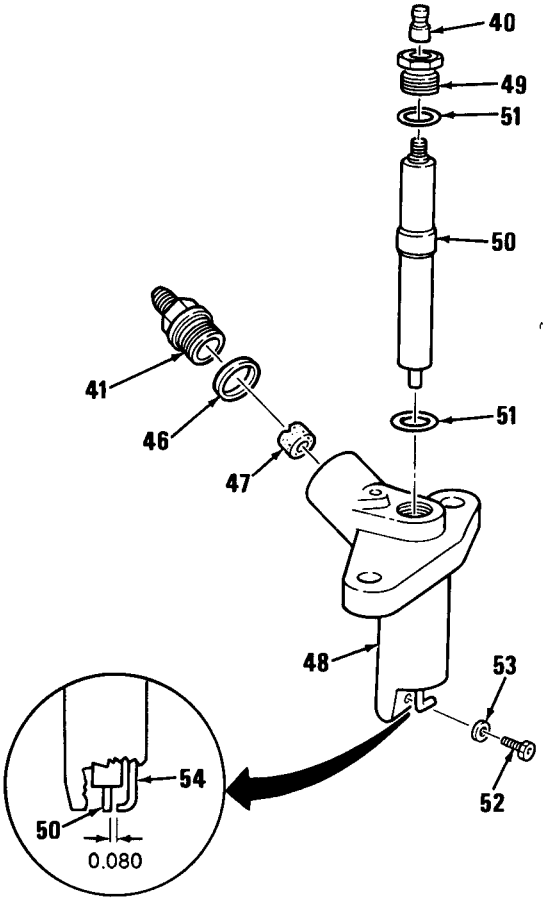
NOTE

Connect tube (17) to solenoid during pump and motor assembly installation.

(2) Connect tube (17) to adapter (41) on air box heater assembly (42).

(3) Connect wire (39) to terminal nut pin (40).





6-11. AIR BOX HEATER REPLACEMENT (Cont)

IGNITION COIL

a. Removal

NOTE

Remove wire (39) from air box heater during air box heater removal.

(1) Disconnect wire (39) from ignition coil (12).

NOTE

Remove nut, lockwasher, and harness leads from stud (16) and remove connector (11) from coil (12) during pump and motor assembly removal.

(2) Remove lockwasher (55), flat washer (56), ignition coil (12) with tension clip (57), and spacer (58) from stud (16). Discard lockwasher.

(3) Remove ignition coil (12) from tension clip (57).

(4) If necessary, remove stud (16) from cylinder head.

c. **Cleaning/Inspection**

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your 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 outside surface of ignition coil with cleaning solvent and dry with compressed air.

(2) Inspect ignition coil for cracks, oil seepage, or damage to electrical connectors.

e. Test/Adjustment

(1) Connect wire (39) to ignition coil (12) and terminal nut pin (40) on air box heater assembly (42).

(2) Connect air box heater assembly (42) to common ground.

WARNING

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

CAUTION

- Do not apply voltage to ignition coil without a coil to air heater connection. Coil and air heater must be grounded.
- Apply positive lead to pin (A) and negative lead to pin (B) or damage to coil will result.

(3) Connect a 24 V dc power source to the coil input side of ignition coil (12). Observe electric arc between electrode (48) and wire (54). Arc may be steady or intermittent (about ten to thirty pulses a second) with a popping noise.

f. Installation

(1) If removed, install stud (16) into cylinder head.

(2) Install tension clip (57) on ignition coil (12).

NOTE

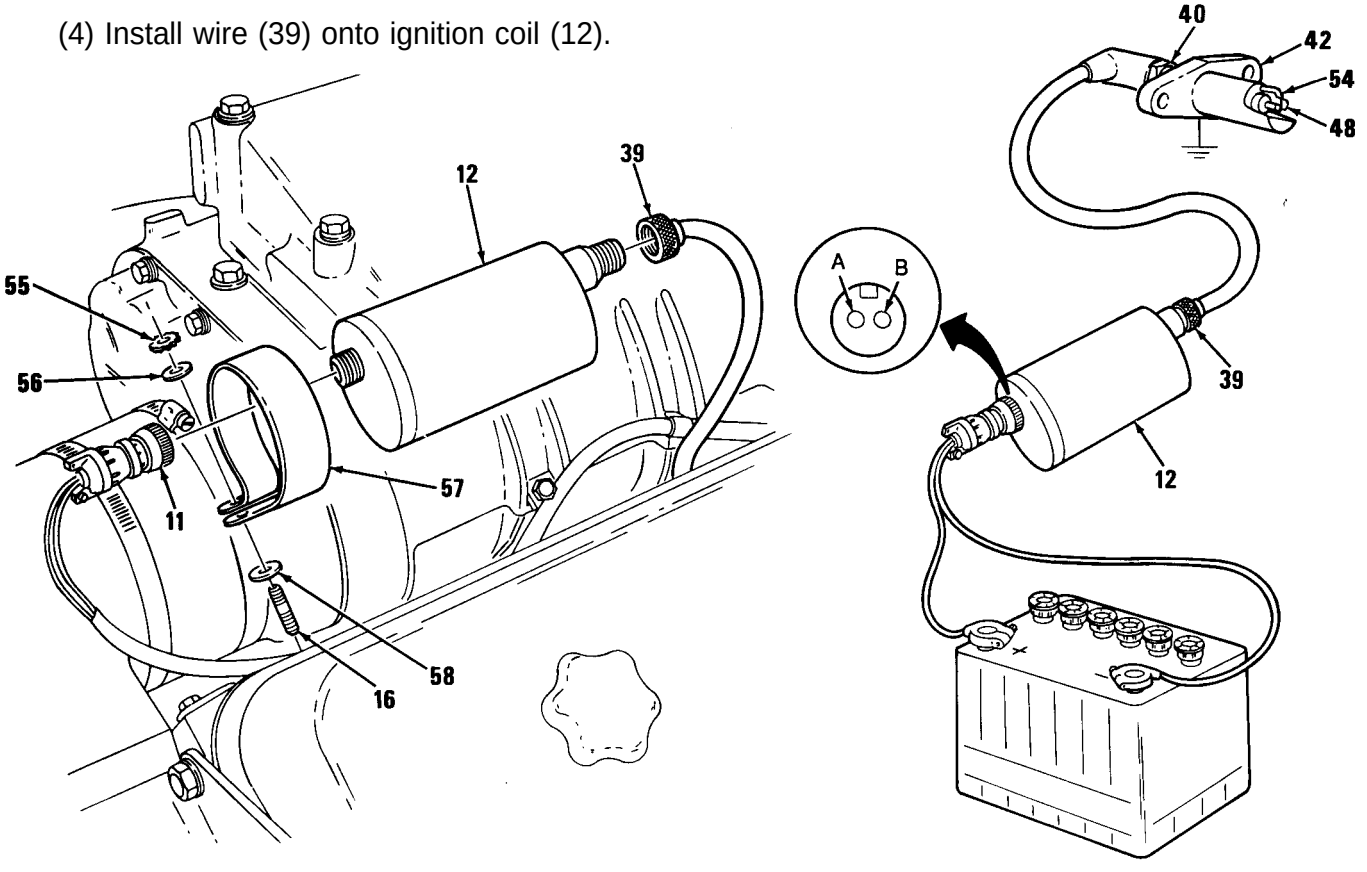
Install nut, lockwasher, and harness leads on stud during pump and motor assembly installation.

(3) Install spacer (58), ignition coil (12), with tension clip (57), lockwasher (55), and flat washer (56) onto stud (16).

NOTE

Install ignition wire from air box heater during air box heater installation.

(4) Install wire (39) onto ignition coil (12).



6-11. AIR BOX HEATER REPLACEMENT (Cont)

SOLENOID VALVE

a. Removal

NOTE

Remove pump, motor, and bracket assembly before removing solenoid.

(1) Disconnect wiring harness terminal (59) from solenoid (38).

(2) Remove four screws (60), four nuts (61), and four lockvvashers (62) securing wiring harness connector (63) to bracket (25). Remove connector from bracket. Discard lockwashers.

(3) Remove wiring harness (30). If necessary, remove clamp (29) from harness.

NOTE

Disconnect tube (17) during pump and motor assembly removal.

(4) Disconnect tube (6) from elbow (64) on solenoid (38). Remove tube.

(5) Remove two screws (65), two nuts (66), two lockwashers (67), and two flat washers (68), securing solenoid (38) to bracket (25). Remove solenoid.

b. Disassembly

(1) Remove elbow (64) from solenoid (38).

(2) Remove elbow (18) from bushing (69).

(3) Remove bushing (69) from solenoid (38).

c. Inspection

Inspect solenoid for cracks, damage, or valve leakage.

d. Assembly

(1) Install bushing (69) into solenoid (38).

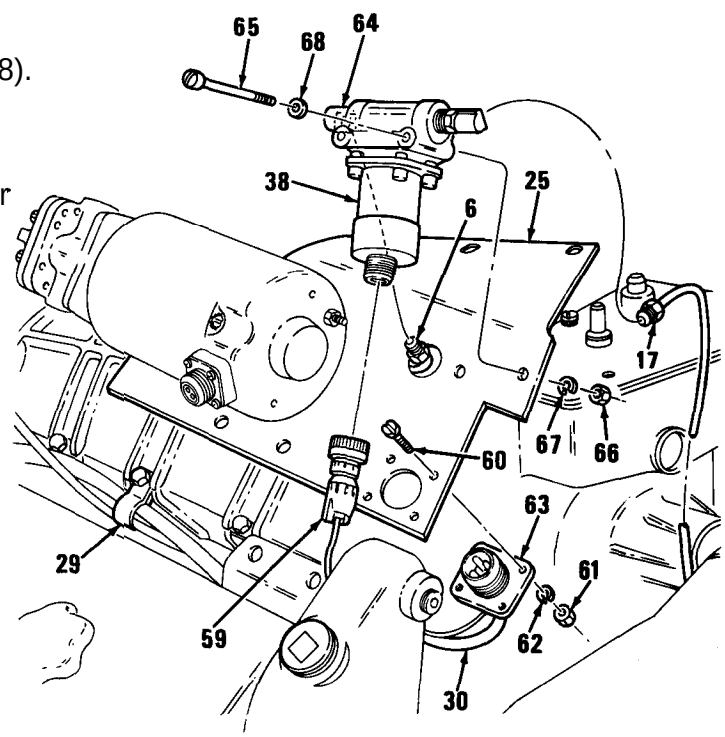
(2) Install elbow (18) into bushing (69).

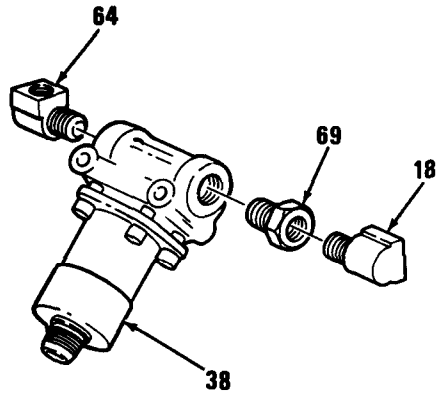
(3) Install elbow (64) into solenoid (38).

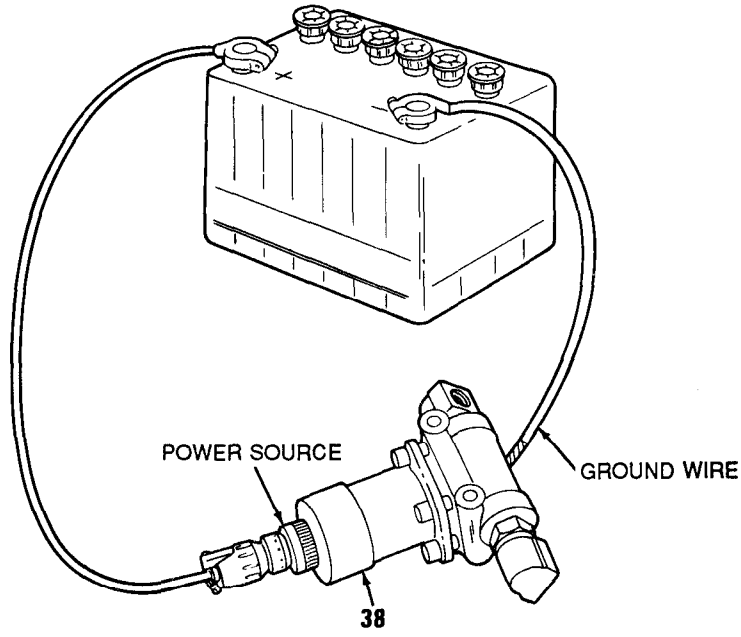
e. Test/Adjustment

(1) Attach 24 V dc power source to solenoid (38) and listen to confirm solenoid valve is opening and closing. If no indication of movement, replace solenoid valve.

(2) Disconnect and remove 24 V dc power source from solenoid (38).







f. Installation

(1) install solenoid (38), two screws (65), two flat washers (68), two lockwashers (67), and two nuts (66) on bracket (25). Tighten securely.

(2) Secure wiring harness connector (63) to bracket (25) with four screws (60), four lockwashers (62), and four nuts (61). Tighten securely.

(3) Connect wiring harness terminal (59) to solenoid (38).

NOTE

Connect tube (6) to pump during pump and motor assembly installation.

(4) Connect tube (6) onto elbow (64) on solenoid (38).

NOTE

Install pump and motor assembly.

END OF TASK

6-12. ENGINE ROCKER ARM COVER REPLACEMENT (See Para 4-11)

6-13. FUEL PUMP REPLACEMENT (See Para 4-12)

6-14. AIR INLET HOUSING REPLACEMENT (See Para 4-13)

6-15. TACHOMETER DRIVE REPLACEMENT (See Para 4-14)

6-16. CRANKCASE BREATHER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7398

EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

EQUIPMENT CONDITION

Para Description
6-14 Air Inlet housing removed

MANDATORY REPLACEMENT PARTS

11 Lockwashers (App F,Item 93)
1 Gasket (App F, Item 26)
1 Gasket (App F, Item 36)
1 Gasket (App F, Item 44)

FLYWHEEL HOUSING CRANKCASE BREATHER

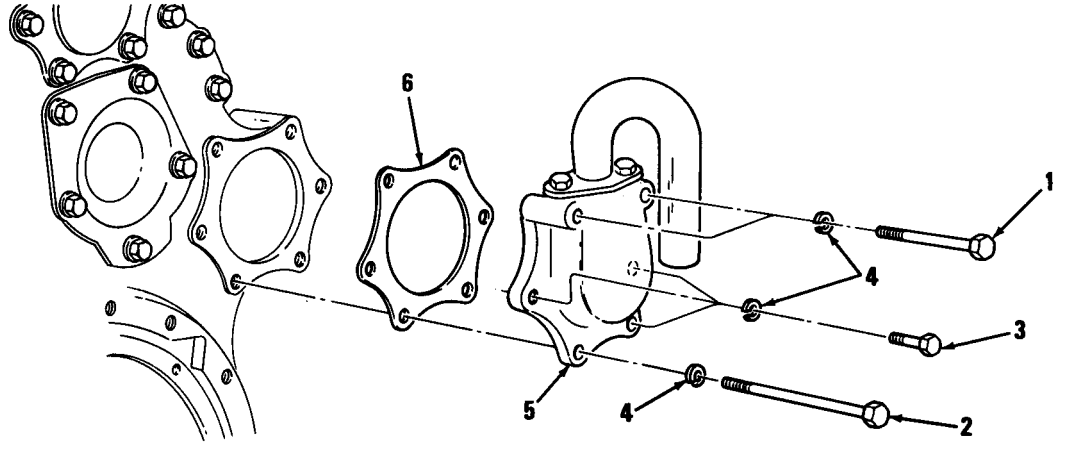
a. Removal

Remove two bolts (1), bolt (2), three bolts (3), and six lockwashers (4) securing breather assembly (5) and gasket (6) to flywheel housing. Remove breather assembly. Discard lockwashers and gasket.

h. Disassembly

(1) Remove bolt (7), flat washer (8), and spacer (9) securing filter element (10) and shell (11) to adaptor (12). Remove shell from element.

(2) Remove two bolts (13) and two lockwashers (14) securing breather pipe (15) and gasket (16) to adaptor (1 2). Discard gasket and lockwashers.



c. Cleaning/Inspection

WARNING

- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open frames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.**

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

(1) Clean all parts with dry cleaning solvent and dry with compressed air.

(2) Inspect adaptor, pipe, and shell for cracks, pitting, or damage.

(3) Inspect filter element for cuts, tears, or damaged.

d. Assembly

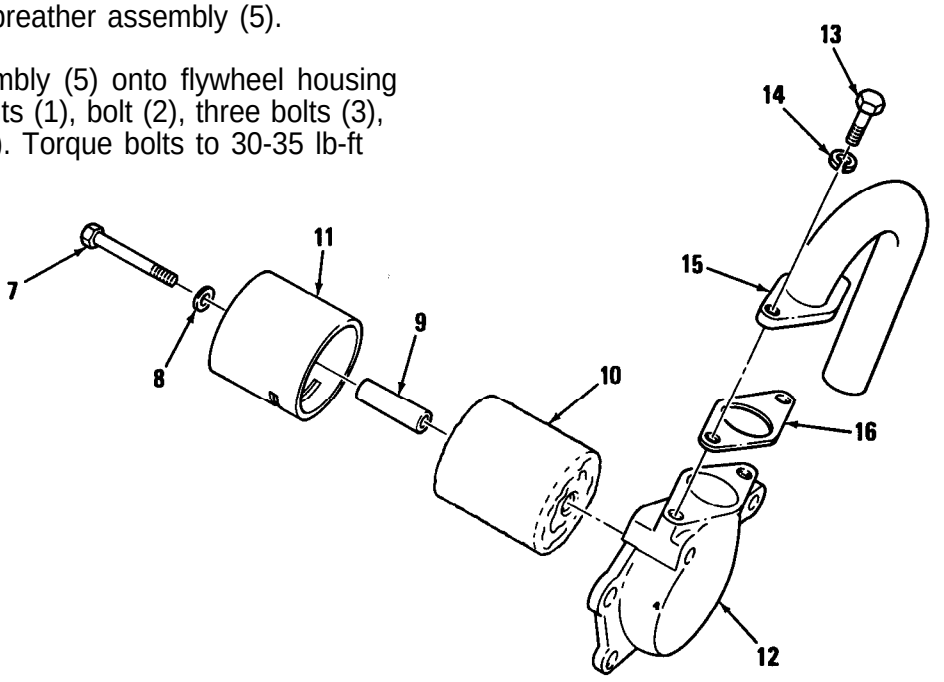
(1) Install gasket (16) and breather pipe (15) onto adaptor (12). Secure with two lockwashers (14) aid two bolts (1 3). Torque bolts to 30-35 lb-ft (41-47 N-m).

(2) Install filter element (10) and shell (11) onto adaptor (12) and secure with spacer (9), fiat washer (8), and bolt (7). Torque bolt to 30-35 lb-ft (41-47 N-m).

e. installation

(1) Install gasket (6) onto breather assembly (5).

(2) Position breather assembly (5) onto flywheel housing and secure with two bolts (1), bolt (2), three bolts (3), and six lockwashers (4). Torque bolts to 30-35 lb-ft (41-47 N-m).



6-16. CRANKCASE BREATHER REPLACEMENT (Cont)

CRANKCASE BREATHER TUBE REPLACEMENT

a. Removal

(1) Remove bolt (17), nut (18), and lockwasher (19) securing clip (20) and tube (21) to flywheel housing. If necessary, remove clip from tube. Discard lockwasher.

(2) Remove twobolts (22), two clockwashers (19), and flatwasher (23) securing tube (21) and gasket (24) to cylinder block. Remove tube from block. Discard lockwashers and gasket.

NOTE

Do not remove breather pipe unless damaged. Removal of pipe will destroy it and require its replacement.

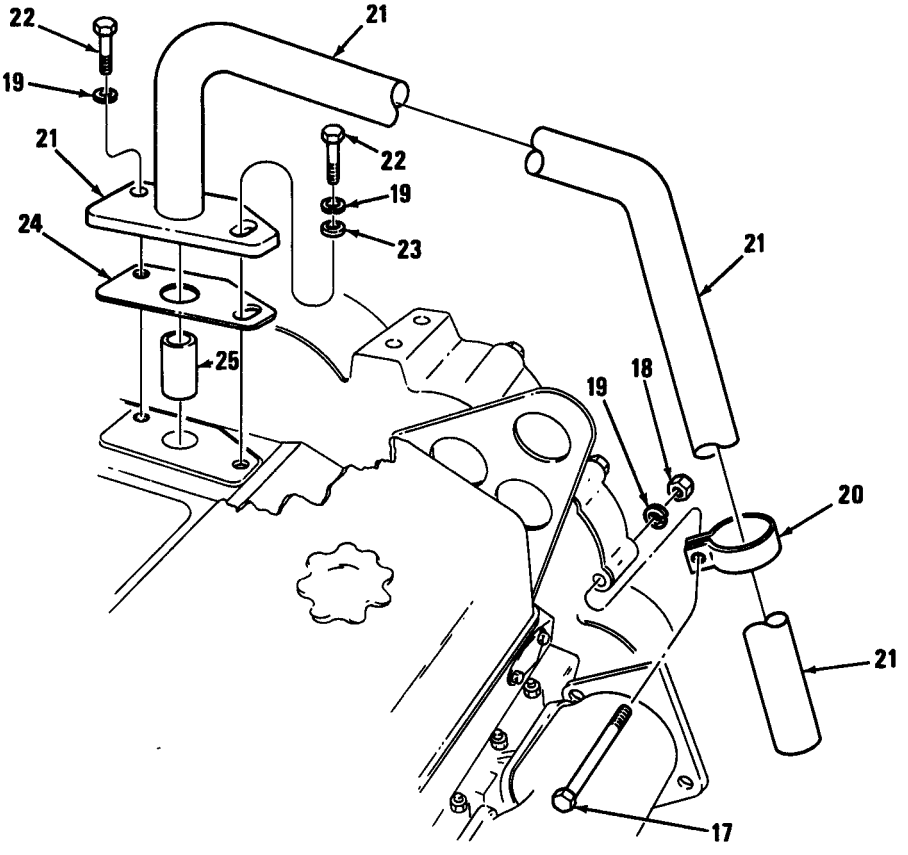
(3) If necessary, remove breather pipe (25) from cylinder block,

b. Inspection

Inspect tube and breather pipe for cracks, holes, or damage.

c. Installation

(1) If removed, drive new breather pipe (25) into cylinder block with a collar and soft-headed hammer until flush with counterbore.



(2) Install gasket (24) and tube (21) onto block. Secure with two bolts (22), two Iockwashers (19), and flat washer (23). Torque bolts to 30-35 Ib-ft (41 -47 N-m).

(3) If removed, install clip (20) onto tube (21). Secure clip and tube on flywheel housing with bolt (17), Iockwasher (19), and nut (18). Torque bolt to 30-35 Ib-ft (41-47 N-m).

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
6-14 Install air inlet housing

Section III. ENGINE DISASSEMBLY\ASSEMBLY

6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE)

This task covers: a. Removal b. Disassembly c. Cleaning
d. Inspection e. Fitting Piston f. Fitting Piston Rings
g. Assembly h. Installation - Cylinder Kit Assembly

INITIAL SETUP

MODELS

7083-7398 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Piston ring pliers (App B, Item 12)
Ball attachment (App B, Item 6)
Piston pin retainer installer (App B, Item 57)
Piston pin retainer leak detector (App B, Item 63)
Piston ring compressor (App B, Item 12)
Cylinder liner hold down clamps (App B, Item 11)
Spring scale (App B, Item 24)
Feeler gage set (App B, Item 24)
Torque wrench (App B, Item 101)
Micrometer 0-1 inch (App B, Item 65)
Micrometer 4-5 inch (App B, Item 65)
Micrometer 1-2 inch (App B, Item 65)
Ridge reamer (App B, Item 72)

MANDATORY REPLACEMENT PARTS

1 Ring Set (App F, Item 127)
1 Ring Set (App F, Item 126)
1 Ring (App F, Item 121)
3 Rings (App F, Item 123)
2 Piston pin retainers (App F, Item 119)

EXPENDABLE/DURABLE SUPPLIES

Flat Stone (App C, Item 43)
Engine oil (App C, Item 16)
Wood block (App C, Item 46)
Carbon removing compound (App C, Item 7)
Plastic gage (App C, Item 30)
Crocus cloth (App C, Item 12)
Fuel oil (App C, Item 21)

EQUIPMENT CONDITION

Para Description
6-21 Oil pan removed
6-28 Cylinder head removed
6-32 Oil pressure regulator and relief valve removed
6-33 Oil pump removed

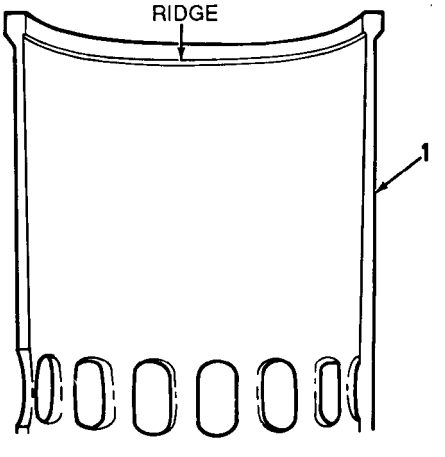
•Applies to engines thru serial number 8VA-294356

a. Removal

CAUTION

Piston ring breakage can occur if carbon deposits at top of liner are not removed.

(1) Using a ridge reamer, remove carbon deposits from upper inner surface of cylinder liner (1).



(2) Remove two nuts (2), cap (3), and lower bearing shell (4) from piston and connecting rod assembly (5).

NOTE

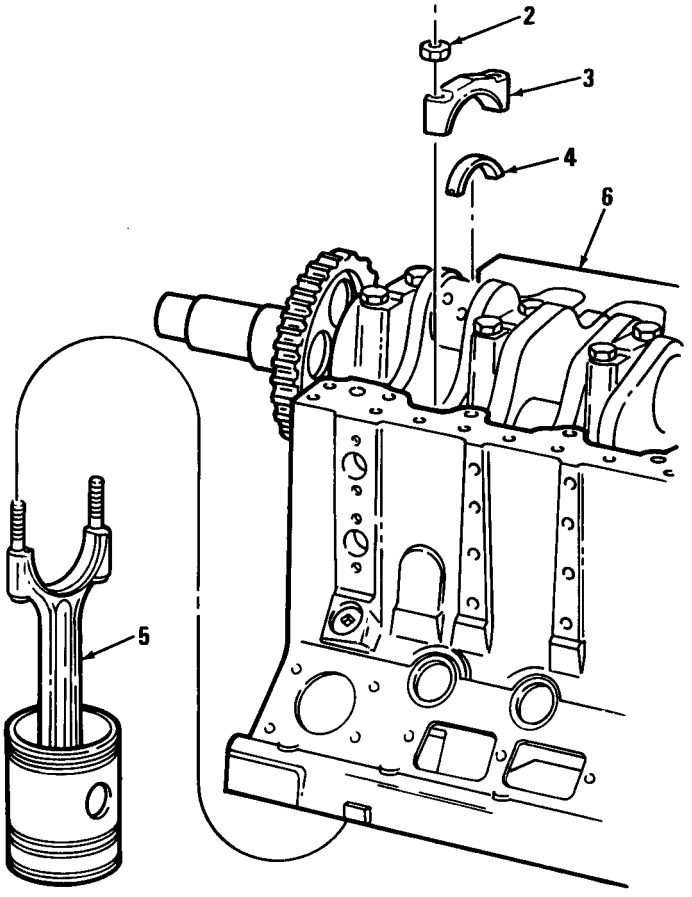
Tag piston assembly with cylinder number for matching during reassembly.

(3) Push piston and connecting rod assembly (5) out through top of cylinder block (6).

NOTE

Reassemble cap with stamped number on same side as connecting rod to assure cap is not rotated 180 degrees.

(4) Reassemble bearing cap (3) and lower bearing shell (4) to piston and connecting rod assembly (5) using two nuts (2).



b. Disassembly

(1) Secure piston and connecting rod assembly (5) in a soft-jawed vise and remove piston rings (7) with piston ring pliers (8). Discard piston rings.

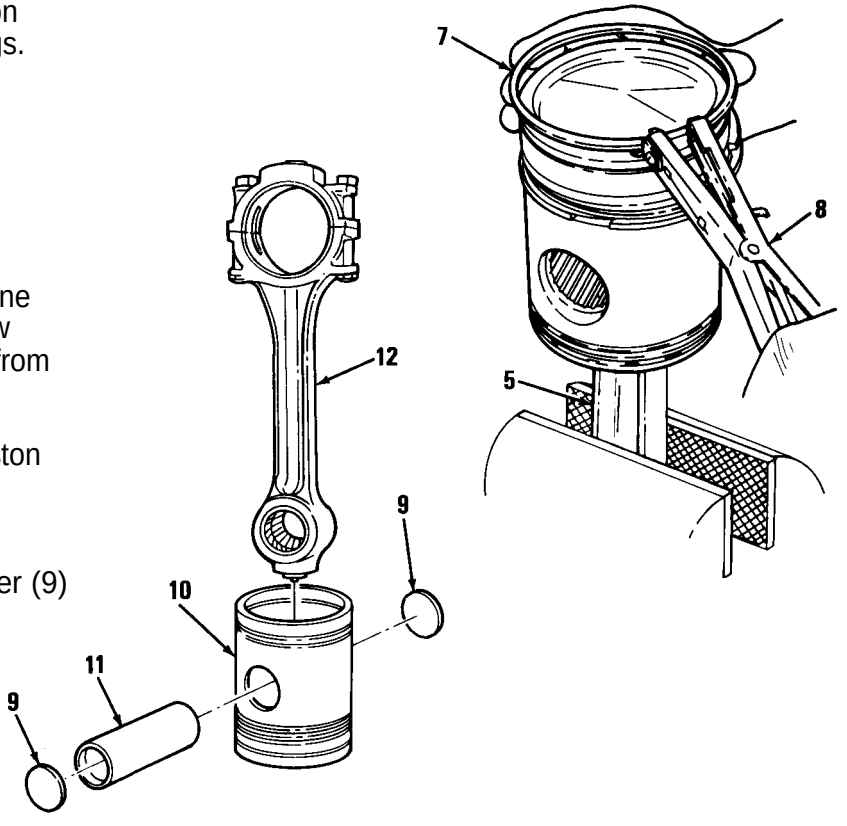
CAUTiON

Do not damage piston or bushings during removal of piston pin retainers.

(2) Punch a hole through center of one piston pin retainer (9) with narrow chisel or punch and pry retainer from piston (10). Discard retainer.

(3) Withdraw piston pin (11) from piston (1 0) and remove connecting rod assembly (12).

(4) Drive remaining piston pin retainer (9) out from inside with a brass rod. Discard retainer.



6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (Cont)

c. Cleaning

WARNING

- **Use goggles, rubber gloves, and rubber apron when cleaning parts in carbon-removing corn-pound. 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 fuel oil and dry with compressed air. If fuel oil does not remove carbon deposits, use carbon-removing compound which will not harm bushings or tin plating on piston.

CAUTION

Do not damage tin plating on piston skirt. Upper section of piston, including compression ring lands and grooves, is not tin-plated. Wire brush upper section only to remove any hard carbon.

(2) Clean ring grooves with suitable tool or a piece of an old compression ring ground to a beveled edge.

(3) Clean inside surfaces of piston and oil drain holes in piston skirt. Do not enlarge holes while cleaning them.

d. Inspection

(1) Piston

CAUTION

Do not remove bushings in piston or connecting rod. These parts are not serviced.

(a) Check cylinder liner and block bore for excessive out of round, taper, or high spots which could cause failure of piston (see Para 4-34).

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.

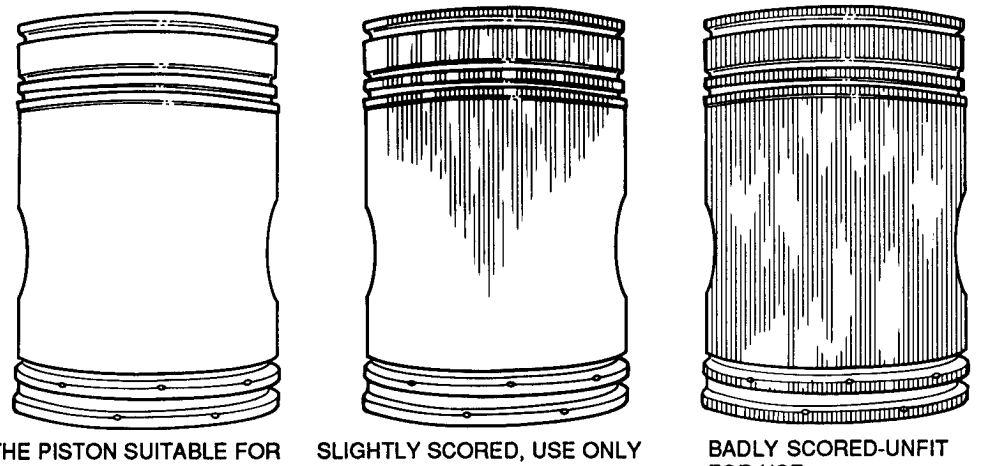
(2) Piston Pin

CAUTION

Do not polish or refinish piston pin. Hand polishing will destroy precision finish required against bushing and result in rapid bushing wear.

(a) Inspect piston pin for signs of fretting. Discard pin if fretting is present.

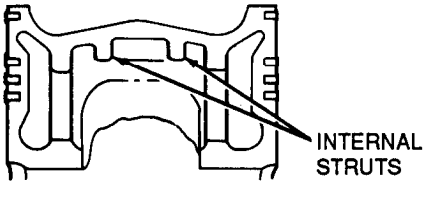
(b) Measure piston pin diameter. New pin must be 1.4996 to 1.5000 inches in diameter. Replace used pin if diameter is 1.4980 inches or less.

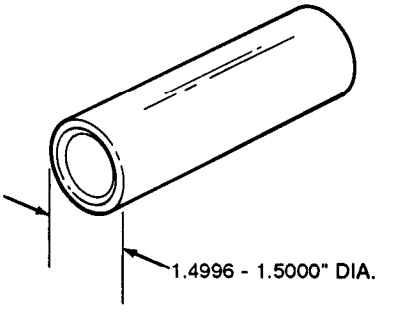


THE PISTON SUITABLE FOR INSTALLATION AS IS

SLIGHTLY SCORED, USE ONLY AFTER REMOVING SCORE MARKS BY POLISHING WITH CROCUS CLOTH OR HARD INDIA STONE

BADLY SCORED-UNFIT FOR USE





6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (Cont)

(3) Connecting Rod

(a) Check connecting rod for visual damage. Scrap rod if bent, had previous bearing failure, was overheated (blued) at top or bottom end, or fretted at split line between rod and cap.

(b) Check for cracks by the magnetic particle method.

NOTE

Overheated bushings may become loose and creep together, thus blocking off supply of lubricating oil to piston pin and spray nozzle.

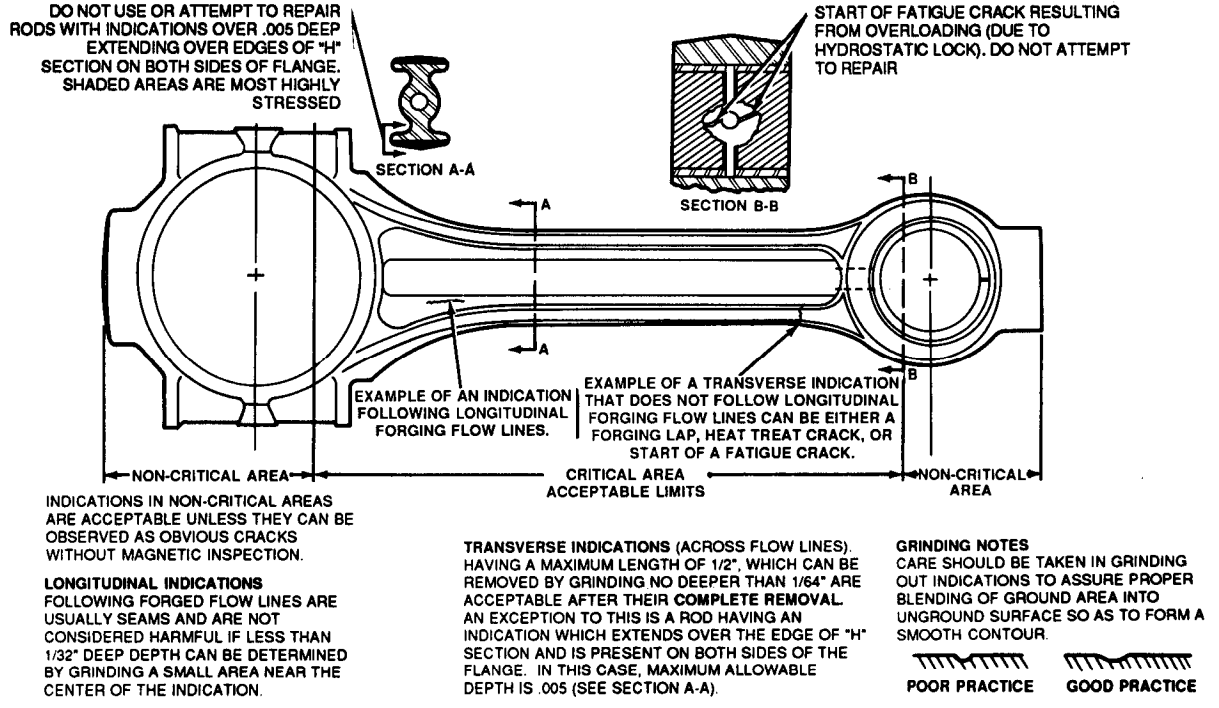
(c) Check connecting rod bushings for indications of scoring, overheating, or other damage.

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 insure 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.



(9) When installing a new connecting rod assembly, stamp cylinder number on connecting rod (5) and cap (3).

(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 6-1, replace both bearing shells (upper-and lower).

(c) Using a micrometer and ball attachment, measure thickness of lower bearing shell (4) and upper bearing shell (13) at point "C", 90 degrees from parting line.

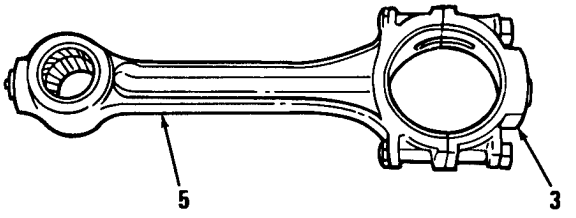
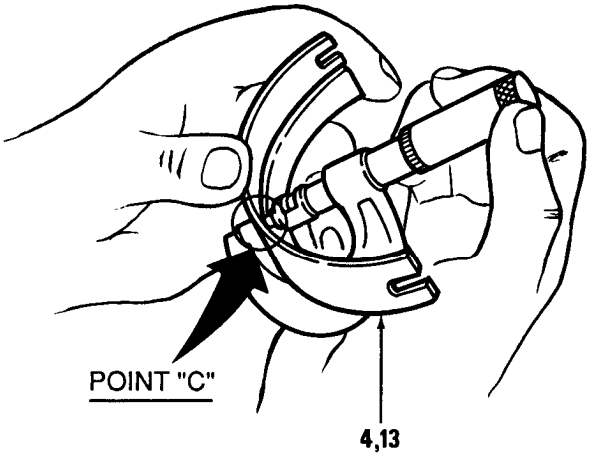


TABLE 6-1. CONNECTING ROD BEARING SHELL THICKNESS

BEARING SIZE	*NEW BEARING THICKNESS	MINIMUM WORN THICKNESS
STANDARD	.1240"/.1245"	.1230"
.002" UNDERSIZE	.1250"/.1255"	.1240"
.010" UNDERSIZE	.1290"/.1295"	.1280"
.020" UNDERSIZE	.1340"/.1345"	.1330"
.030" UNDERSIZE	.1390"/.1395"	.1380"

*Thickness 90° from parting line of bearing.

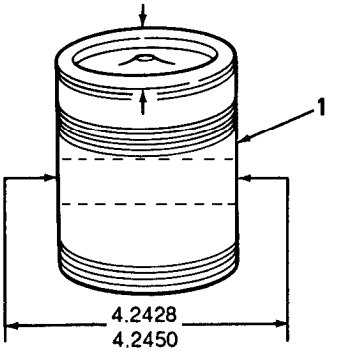


e. Fitting Piston

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 parallel to and perpendicular with piston pin bore at room temperature, 70°F (21 °C). Diameter must be 4.2428 to 4.2450 inches. Taper and out of round must not exceed 0.0005 inch.



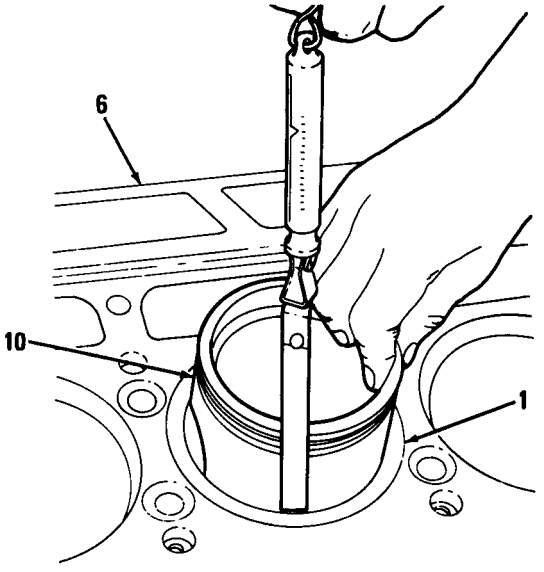
6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (Cont)

NOTE

- Use feeler gage to check piston to liner clearance. Use a spring scale attached to feeler gage to measure amount of force in pounds required to withdraw feeler gage from between piston and liner. Select feeler gage with thickness requiring six pounds pull to move. Piston to liner clearance is 0.001 inch greater than thickness of feeler gage used. For example, a 0.004 inch feeler gage indicates 0.005 inch clearance when withdrawn with a six pound pull.
- Feeler gage must be perfectly flat and free of nicks and bends.

(2) With cylinder liner (1) installed in cylinder block (6), hold piston (10) upside down in liner and measure clearance in four places, 90 degrees apart. Clearance must be 0.0045 to 0.0083 inch with new parts. Allow a maximum clearance of 0.0120 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 a fine stone. Remove burrs in liner with fine flat hone and recheck clearance.



f. Fitting Piston Rings

(1) Insert ring inside cylinder liner in normal area of ring travel. Using piston to push ring down, measure ring gap with feeler gage. Refer to Table 6-2 for ring gap specifications. Repeat procedure for balance of compression and oil rings.

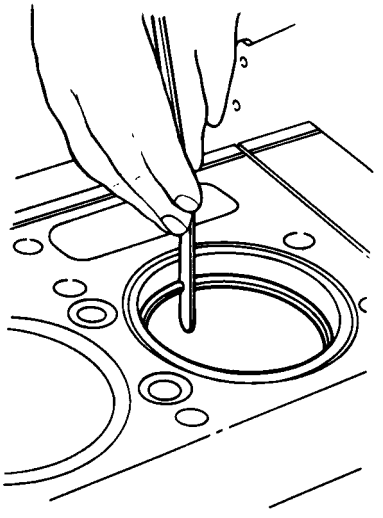
CAUTION

File or stone both ends of compression ring 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 6-2 PISTON RING SPECIFICATIONS

	MINIMUM	MAXIMUM
COMPRESSION RINGS		
GAP (TOP RING)	.0230 IN. (.0586CM)	.0380 IN. (.0965CM)
GAP (NO.2, 3, AND 4)	.0180 IN. (.0457CM)	.0430 IN. (.1092CM)
CLEARANCE RING TO GROOVE:		
TOP RING	.0040 IN. (.0101CM)	.0070 IN (.0177CM)
NO.2	.0095 IN. (.0241CM)	.0130 IN. (.0330CM)
NO.3	.0075 IN. (.0190CM)	.0110 IN. (.0279CM)
NO.4	.0055 IN (.0139CM)	.0090 IN. (.0228CM)
OIL CONTROL RINGS		
GAP (TWO RINGS IN LOWER GROOVE)	.0050 IN (.0127CM)	.0140 IN. (.0355CM)
GAP (ONE RING IN UPPER GROOVE)	.0050 IN. (.0127CM)	.0140 IN. (.0355CM)
CLEARANCE (TWO RINGS IN LOWER GROOVE)	.0015 IN. (.0038CM)	.0055 IN. (.0139CM)
CLEARANCE (ONE RING IN UPPER GROOVE)	.0010 IN. (.0025CM)	.0035 IN. (.0088CM)



(3) Using feeler gage, measure ring side clearance. Refer to Table 6-2 for ring side clearance specifications.

g. Assembly

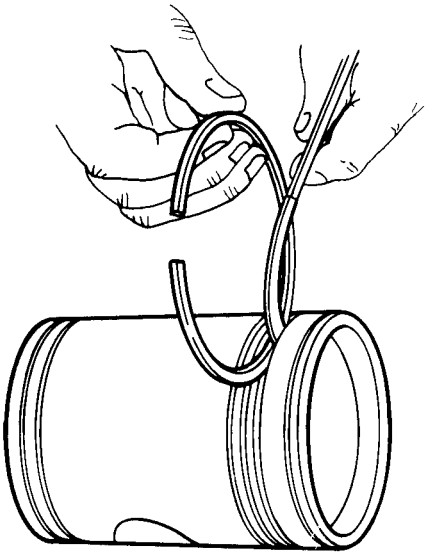
(1) Connecting Rod Assembly to Piston

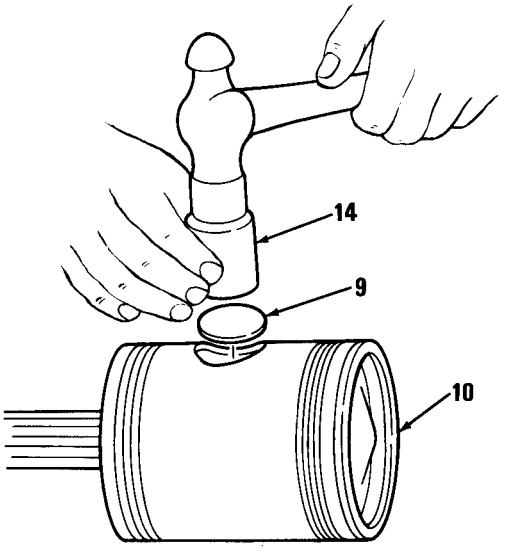
(a) Apply clean engine oil to piston pin and piston pin bushings.

CAUTION

Do not drive piston pin retainer in too far. Retainer may move piston bushing inward and result in reduce piston pin end clearance.

(b) Insert one piston pin retainer (9) in position. Then place crowned end of installer (14) against retainer and strike installer just hard enough to deflect retainer and seat it evenly in piston (10).





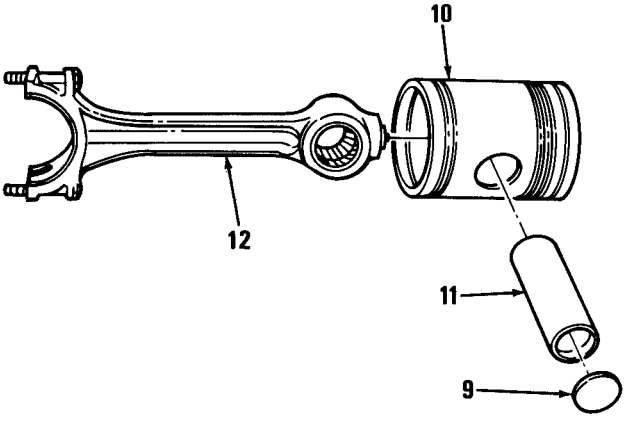
NOTE

Since loading on the piston pin is downward, it must have free movement to secure perfect alinement and uniform wear. Therefore, the 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 (12) between piston pin bosses and in line with piston pin holes. Then slide piston pin (11) in place.

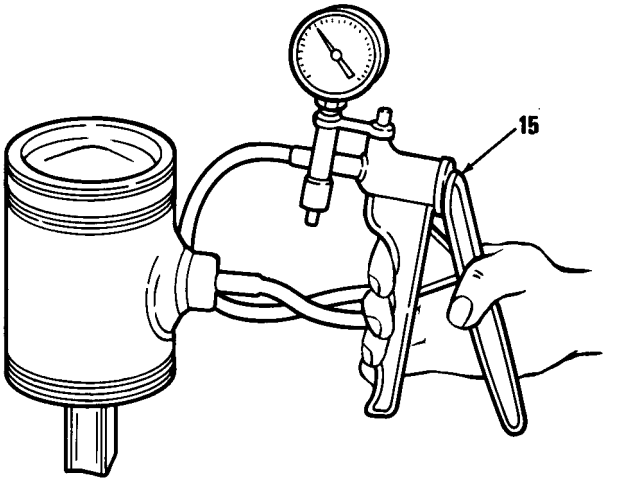
(d) Install second piston pin retainer (9) as directed in step (b).

(e) Check for piston pin end clearance by cocking connecting rod and shifting pin in bushings.



6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (Cont)

(f) Check each piston pin retainer for proper sealing with leak detector (15). Place suction cup over retainer and hand operate lever to pull a vacuum of ten inches of mercury on gage. A drop in gage reading indicates air leakage at retainer.



(2) Installation - Piston Rings

NOTE

Before installing piston rings, assemble piston and rod as directed in previous section.

(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.

NOTE

Scraper edges of all oil control rings must face downward (toward bottom of piston) for proper oil control.

(b) Install two ring expanders (16) in oil control ring grooves in piston (10). Install oil ring expanders with legs of free ends toward top 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.

NOTE

- Upper oil control ring groove requires a one-piece ring, and lower groove requires a two-piece ring (upper and lower halves).
- Install upper and lower oil control rings by hand.

  Scraper edges of all oil control rings must face downward (toward bottom of piston) for proper oil control.

(c) Install lower half of lower oil control ring (17) with gap 90 degrees from gap in expander. Then install upper half of lower oil control ring (18) with gap 180 degrees from gap in expander.

(d) Install upper oil control ring (19) over upper groove. Aline gap in oil ring 180 degrees from gap in expander (1 6). Press ring against gap side of expander to prevent ends of expander from overlapping.

CAUTION

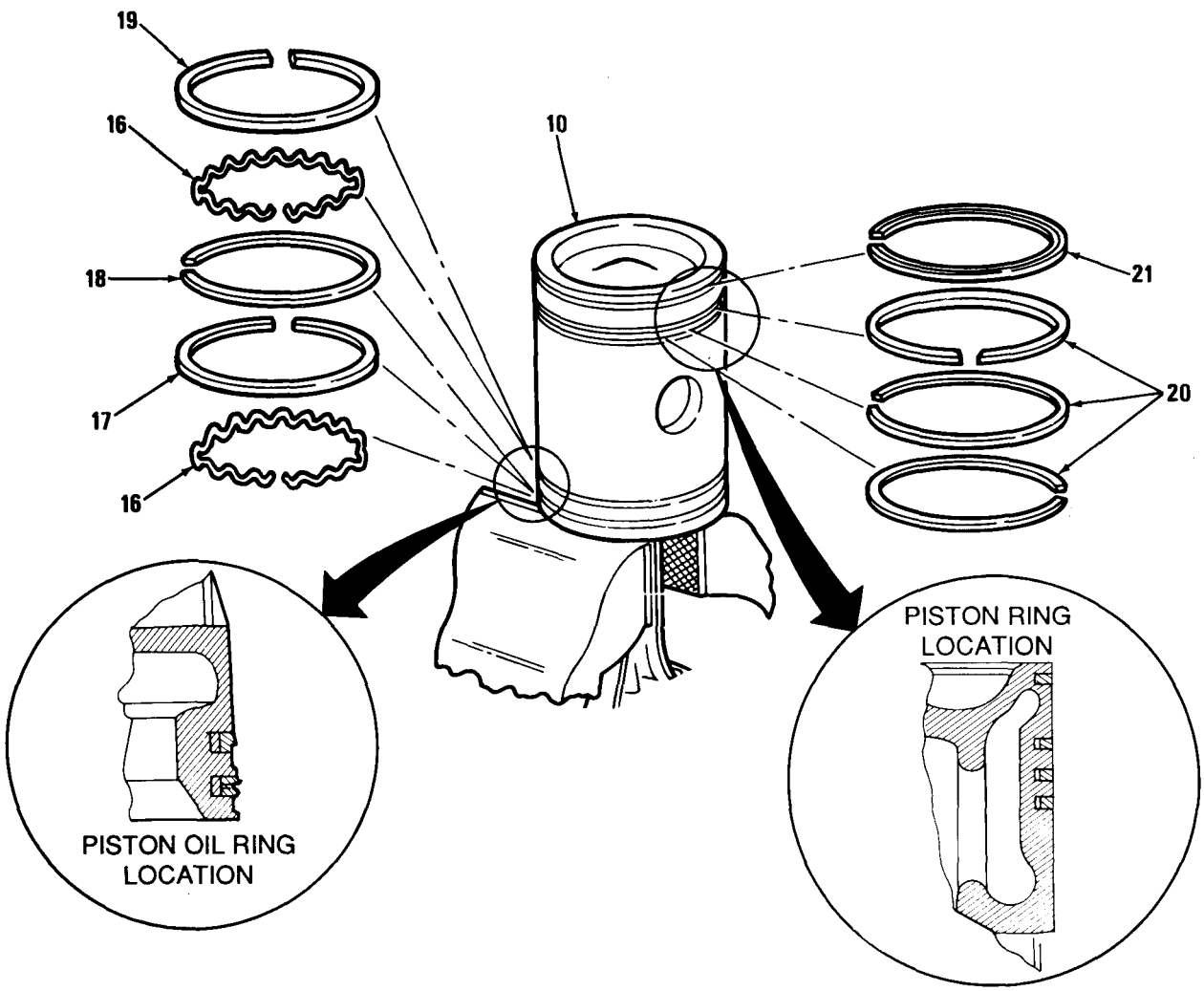
Do not spread rings more than necessary to slip over piston. Ring breakage and overstressing will result.

NOTE

Compression rings have no marks on top or bottom of rings. Fire ring has one mark (indentation near gap) on top of ring.

(e) Starting with bottom compression ring (20), install three compression rings using piston ring pliers. Install fire ring (21) with identification mark toward top of piston (10).

(f) Stagger ring gaps around piston a minimum of 90 degrees from each other.



6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (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.

NOTE

Inspect ring compressor for nicks or burrs, especially at nontapered inside diameter end. Nicks or burrs on inside diameter of compressor will result in damage to piston rings.

(b) Place piston ring compressor (22) on a wood block with tapered end of ring compressor facing up.

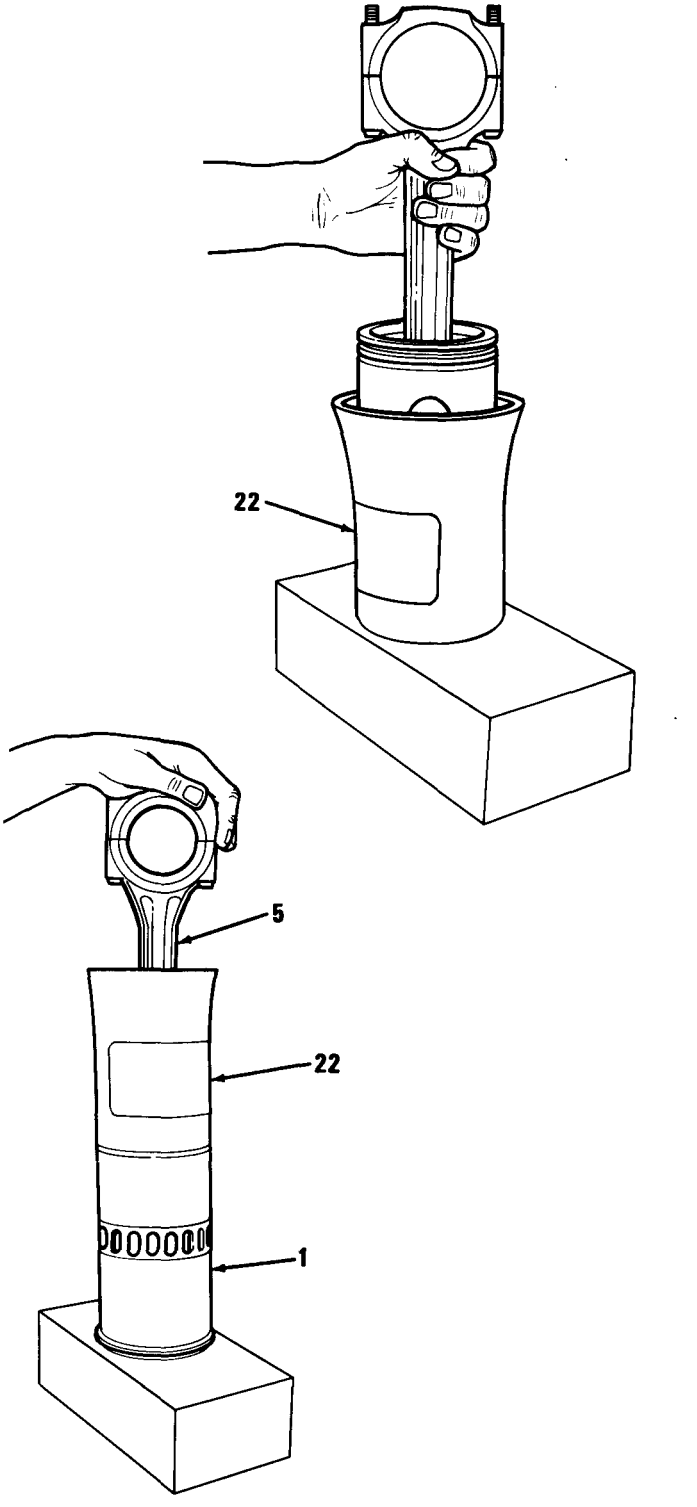
(c) Stagger piston ring gaps 90 degrees apart on piston. Make sure ends of oil control ring expanders do not overlap.

(d) Start top of piston and connecting rod assembly (5) straight into ring compressor (22). Then push piston down until it contacts wood block.

(e) Place cylinder liner (1) with flange end down on wood block.

NOTE

Numbers on side of connecting rod and cap identify rod with cap and indicate cylinder where used.



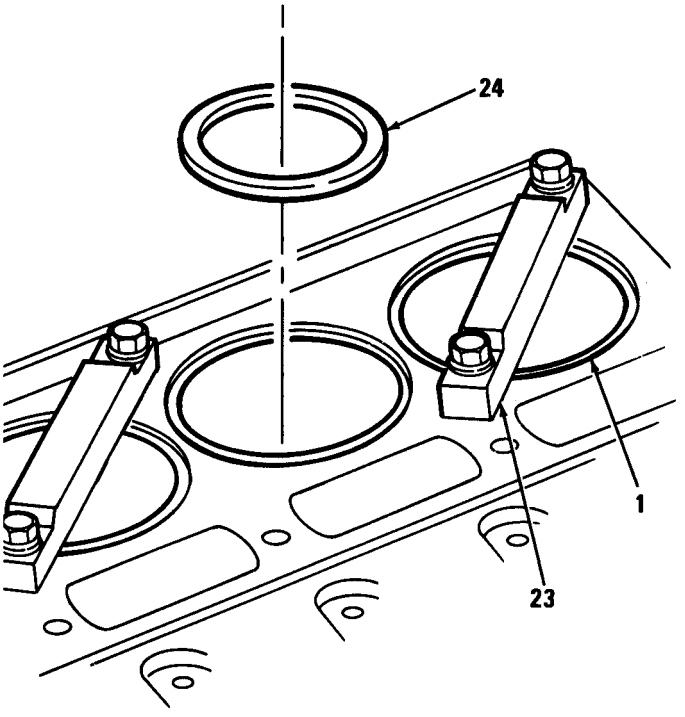
(f) Place ring compressor (22) and piston and connecting rod assembly (5) on liner (1) with numbers on side of connecting rod and cap alined with matchmark on liner.

(g) Push piston and connecting rod assemblv (5) down into liner until piston is-free of ring compressor (22).

CAUTION

Do not force piston into liner. Expanders apply considerable force on oil rings; therefore, take care during loading operation to prevent ring breakage.

(h) Remove connecting rod cap and ring compressor. Then push piston down until compression rings pass cylinder liner ports.



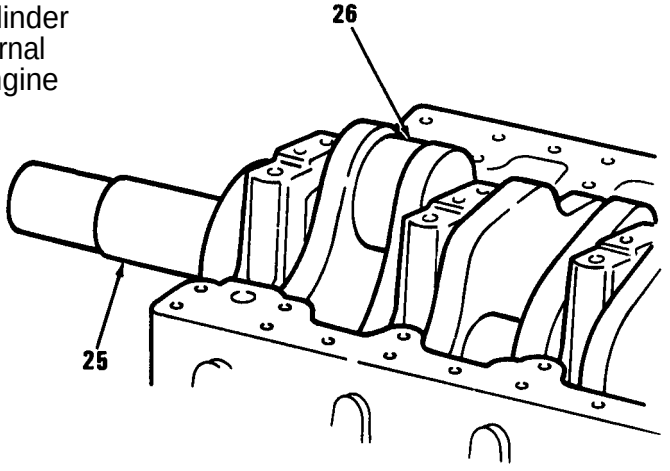
h. Installation - Cylinder Klt Assembly

NOTE

If any pistons and liners are already in engine, use hold down clamps (23) to retain liners (1) in place when rotating crankshaft.

(1) Install cylinder liner insert (24) in block counterbore.

(2) Rotate crankshaft (25) until connecting rod journal (26) of cylinder is at bottom of its travel. Wipe journal clean and lubricate with clean engine oil.



6-34. PISTON AND CONNECTING ROD MAINTENANCE (TRUNK TYPE) (Cont)

NOTE

Tang on bearing shell must fit in indentation on connecting rod.

(3) Install upper bearing shell (13) (without continuous oil groove) in connecting rod. Lubricate bearing shell with clean engine oil.

NOTE

Distance from vertical center line of connecting rod bolts to edges of rod are not equal. Therefore, when installing piston and connecting rod assembly, insure narrow side of two adjoining connecting rods are together to avoid cocking of rod.

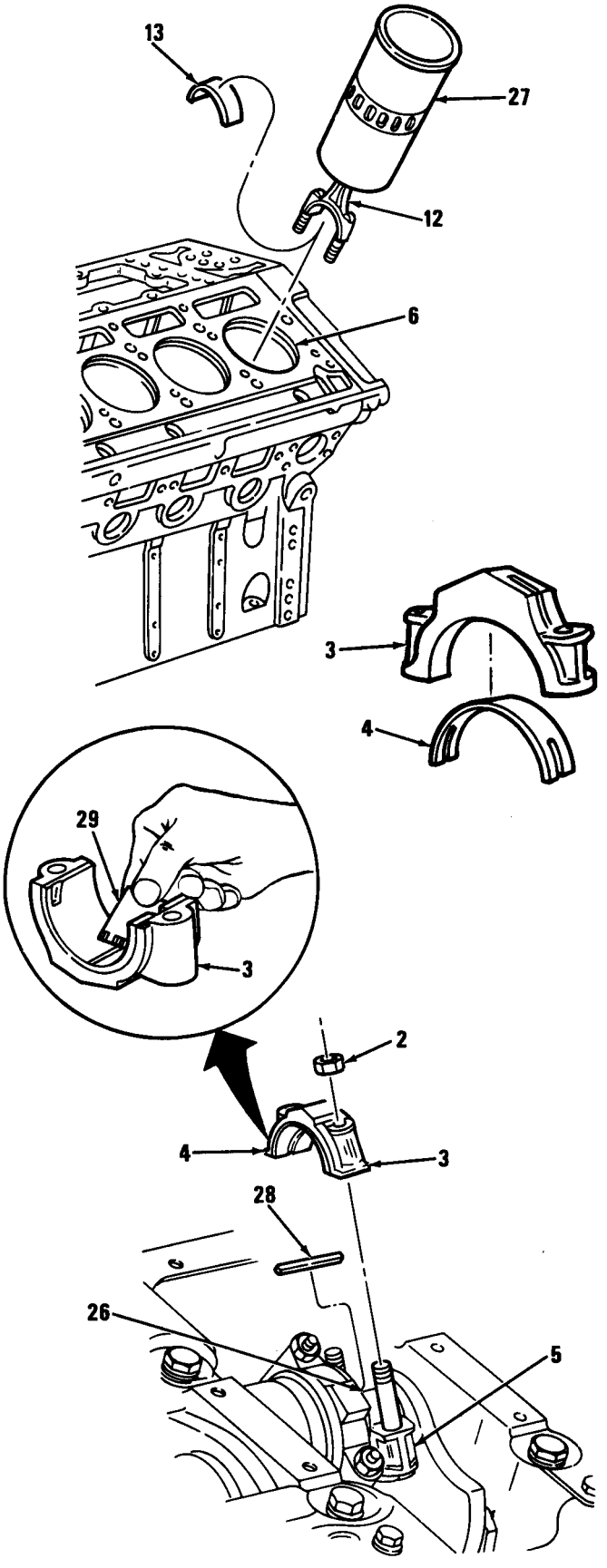
(4) Position piston, rod, and liner assembly (27) above cylinder block bore. Aline identification number and letter on rod with outer edge of cylinder block and matchmarks on liner. Guide end of connecting rod assembly (12) through block bore carefully to avoid damaging or dislodging bearing shell. Then slide piston, rod, and liner assembly straight into block bore until liner flange rests against insert in block counterbore (6).

(5) Push piston and connecting rod into liner until upper bearing shell seats firmly on crankshaft journal.

(6) Place lower bearing shell (4) (with continuous oil groove) in connecting rod cap (3).

NOTE

- Tang on bearing shell must fit in indentation in connection rod cap.
- Insure connecting rod bolt has not turned in connecting rod before torquing nut.



(7) To check bearing to crankshaft journal clearance, place a plastic gage strip (28) between crankshaft journal (26) and connecting rod cap (3). Tighten connecting rod nuts (2) to 60-70 lb-ft (81-95 N-m). Remove connecting rod nuts and cap, and measure width of plastic gage with measuring strip (29). Maximum clearance with used parts is 0.0056 inch.

(8) Lubricate bearing with clean engine oil and install bearing cap (3) and lower bearing shell (4) on connecting rod (5) with identification numbers on cap and rod adjacent to each other. Install two connecting rod bolt nuts (2) and torque to 60-70 lb-ft (81-95 N-m).

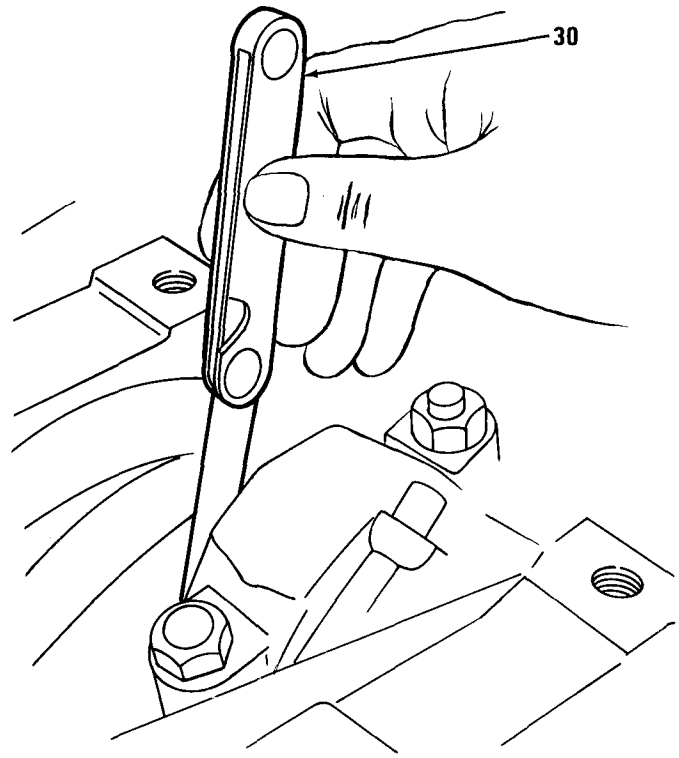
NOTE

If necessary, pry connecting rods apart before measuring side clearance.

(9) Using feeler gage (30), measure side clearance between each pair of connecting rods. Clearance limits are 0.008 to 0.016 inch.

(10) Repeat steps (1) thru (9) to install additional liners, pistons, and rod assemblies. Use hold-down clamps to hold each installed liner in place.

(11) Remove all liner hold down clamps.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
6-33	Install oil pump
6-32	Install oil pressure regulator and relief valve
6-28	Install cylinder head
6-21	Install oil pan

6-35. CYLINDER LINER MAINTENANCE (See Para 4-34)

6-36. CRANKSHAFT MAINTENANCE (See Para 4-35)

6-37. CYLINDER BLOCK MAINTENANCE (See Para 4-36)

Section IV. COMPONENT REPAIR

6-38. TURBOCHARGER REPAIR

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

INITIAL SETUP

MODELS

7083-7398 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)
Magnetic base dial indicator (App B, Item 45)
Turbocharger holding fixture (App D, Item 8)
Micrometer depth gage (App B, Item 23)
Sleeve (App D, Item 12)
Back plate torquing tool (App D, Item 9)
Torque wrench, (App B, Item 100)

MANDATORY REPLACEMENT PARTS

8 Lockwashers (App F, Item 93)
1 Gasket (App F, Item 21)
1 Gasket (App F, Item 60)
4 Locking plates (App F, Item 111)
3 Gaskets (App F, Item 20)
3 Locking plates (App F, Item 11O)
1 Piston ring (App F, Item 128)
1 Seal ring (App F, Item 139)
1 Gasket (App F, Item 76)
2 Bearings (App F, Item 1)
1 Snap ring (App F, Item 143)
1 Locking nut (App F, Item 187)

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)
Cleaning solvent (App C, Item 10)
Crocus cloth (App C, Item 12)
Silicone carbide cloth (App C, Item 41)
Silicone lubricant (App C, Item 42)
Sealing compound (App C, Item 40)
Sealant (App C, Item 39)

EQUIPMENT CONDITION

Para	Description
6-2	Turbocharger removed

a. Disassembly

(1) Remove oil inlet elbow (1) from cover plate(2).

(2) Remove two bolts (3) and two lockwashers (4) securing cover plate (2) to turbocharger assembly (5). Remove cover plate and gasket (6). Discard gasket and lockwashers.

(3) Remove two bolts (7) and two lockwashers (8) securing oil drain tube (9) to turbocharger assembly (5). Remove drain tube and gasket (10). Discard lockwashers and gasket.

CAUTION

Do not nick compressor and turbine wheels when removing compressor and turbine housings. These wheels are highly balanced and can become unbalanced by small nicks.

NOTE

Mark relative position of compressor housing (11), center housing assembly (12), and turbine housing (13) with a scribe to insure assembly in same location.

(4) Remove twelve bolts (14) securing compressor housing (11) to center housing assembly (12). Remove compressor housing.

NOTE

Mark location of lifting bracket (15) to insure assembly in same location.

(5) Bend locking plates (16) away from nuts (17). Remove eight nuts, four locking plates, and lifting bracket (15). Discard locking plates.

(6) Remove turbine housing (13) and shims (18).

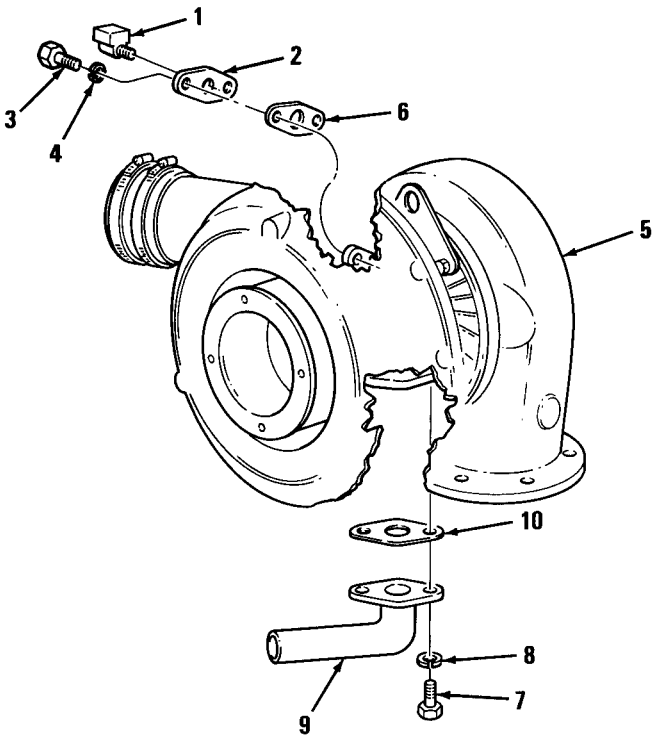
(7) Remove three nuts (19), three gaskets (20), and three bolts (21) securing turbine nozzle (22) to turbine housing (13). Remove turbine nozzle and discard gaskets.

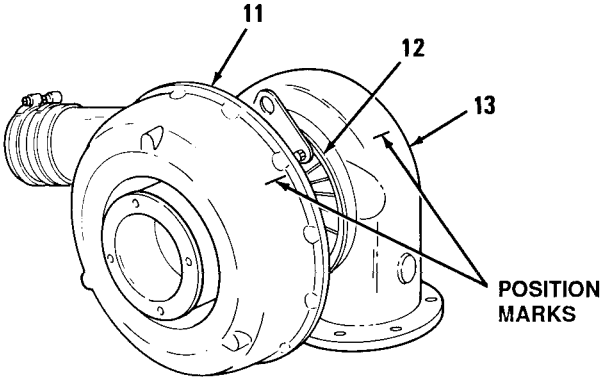
NOTE

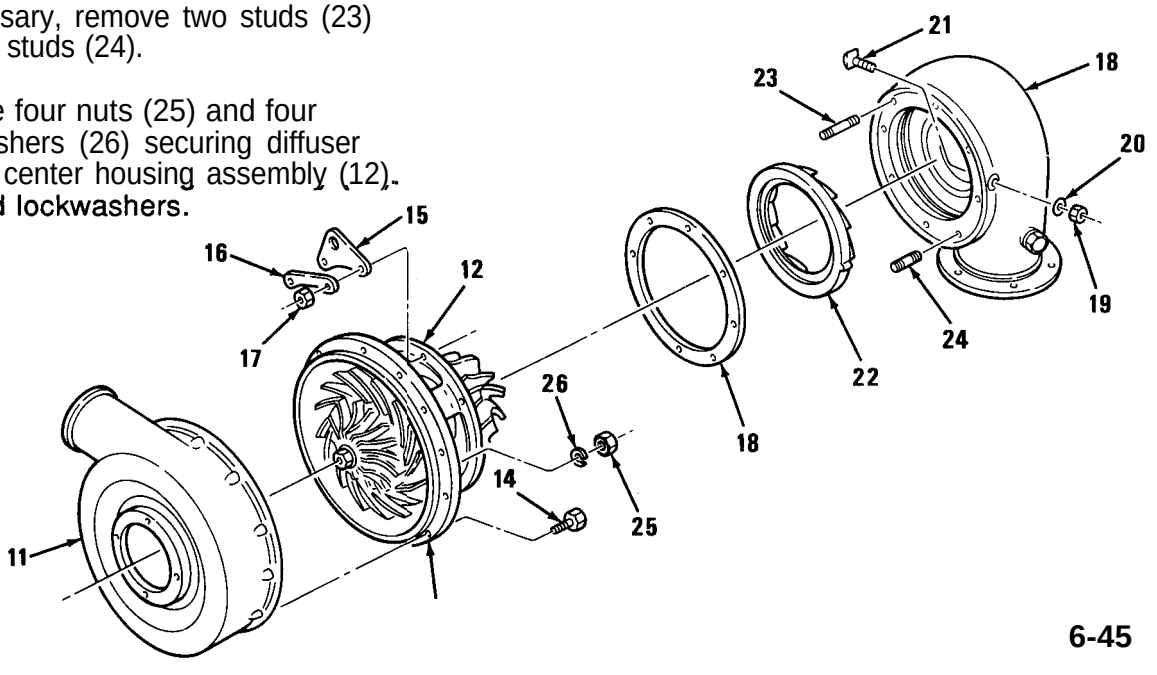
Mark location of two long studs (23) to insure assembly in same location.

(8) If necessary, remove two studs (23) and six studs (24).

(9) Remove four nuts (25) and four lockwashers (26) securing diffuser (27) to center housing assembly (12). Discard lockwashers.







6-38. TURBOCHARGER REPAIR (Cont)

(10) Place center housing assembly (12) in holding fixture to prevent rotating assembly (28) from turning.

CAUTION

Use a wrench with a double-universal joint to remove impeller nut. A fixed wrench or ratchet can side load impeller and bend shaft.

(11) Remove impeller locking nut (29) and washer (30) from rotating assembly (28).
■ Discard nut.

WARNING

Use heat-resistant gloves when handling heated parts. Metal components will dissipate heat quickly. Burns to personnel will result.

(12) Heat center housing assembly (12) at temperature of 350-375°F (177-190°C) for period of not longer than 10 minutes.

(13) Using arbor press, press rotor assembly (31) from impeller (32). Lift center housing assembly (5) from rotor assembly.

NOTE

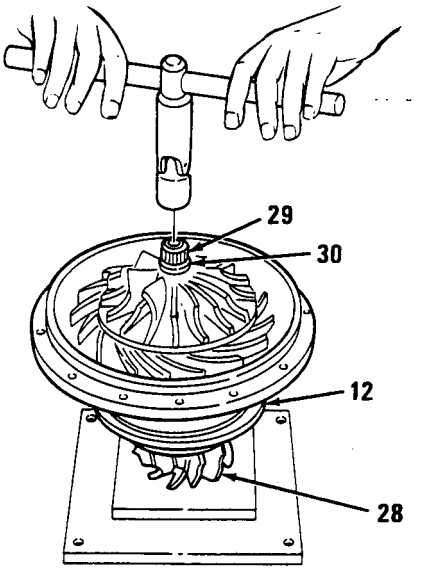
Retain original shims for use during reassembly to obtain proper size and quantity for rotor clearance.

(14) Remove impeller (32), diffuser (27), and shims (33) from center housing assembly (12).

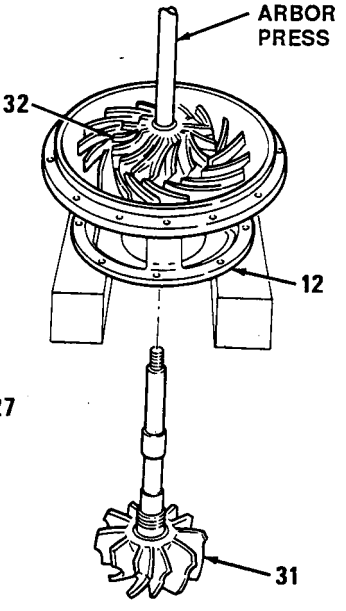
(15) Bend locking plates (34) away from heads of bolts (35). Remove six bolts and three locking plates securing thrust plate assembly (36) to center housing assembly (5). Discard locking plates.

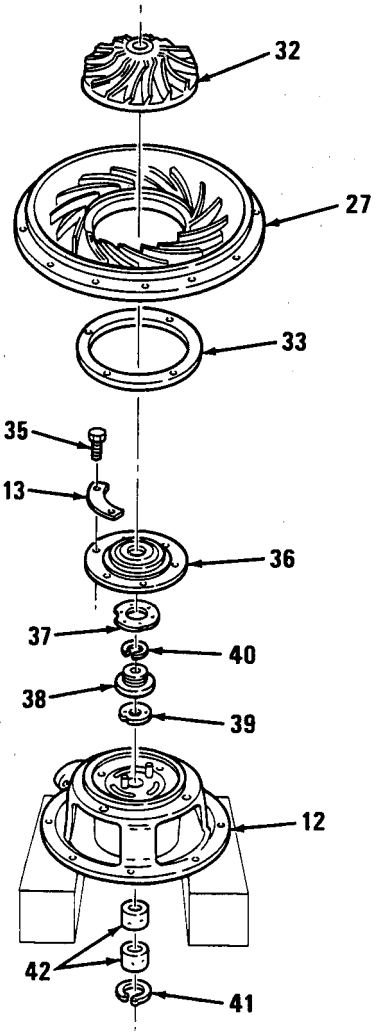
(16) Remove thrust plate assembly (36), thrust plate (37), thrust ring (38), and thrust washer (39) from center housing assembly (12).

(17) Remove piston ring (40) from thrust ring (38). Discard piston ring.



HOLDING FIXTURE





CAUTION

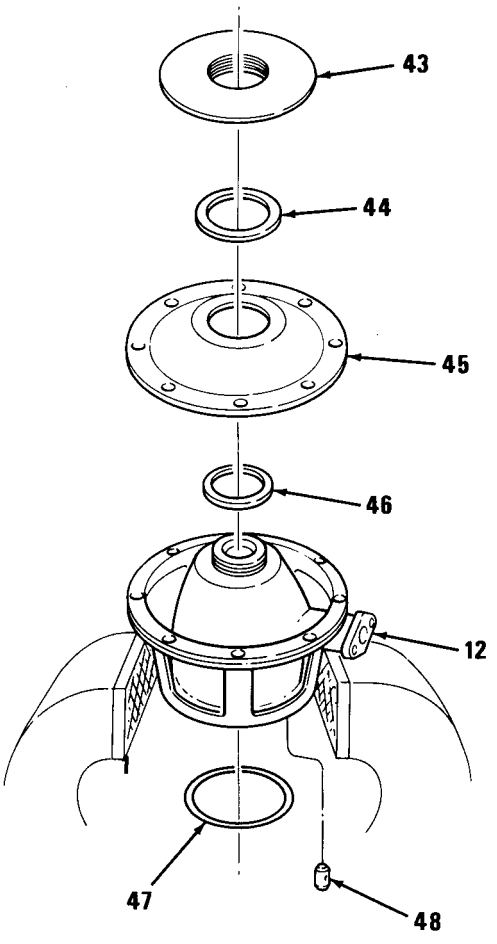
Do not scuff bearing journal surfaces of shaft. Journal surfaces are machined to high tolerances.

(18) Remove snap ring (41) and two bearings (42) from center housing assembly (12). Discard snap ring and bearings.

(19) Install center housing assembly (12) in a soft-jawed vise. Unscrew back plate (43) from center housing assembly. Remove shims (44), diaphragm (45), and gasket (46). Discard gasket.

(20) Remove seal ring (47) from center housing assembly (12). Discard seal ring.

(21) If necessary, remove two pins (48) from center housing assembly (12).



b. Cleaning

WARNING

Dry cleanlng solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only in a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flame or excessive heat. The flash point is 100°F-138°F (38 °C-50°C). If you become dizzy while using cleaning solvent, get fresh air immediately and get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.

CAUTION

- Do not use a caustic solution to clean aluminum components. A caustic solution will erode aluminum parts.
- Do not use wire brush or steel-bladed scraper to clean bearing surfaces or aluminum parts. Metal to metal contact will mar bearing finishes and deform aluminum parts.
- Clean compressor and turbine wheel blades thoroughly. Deposits left on blades will affect balance of rotating assembly.

6-38. TURBOCHARGER REPAIR (Cont)

NOTE

Before cleaning, inspect parts for signs of burning, rubbing, or other damage which might not show after cleaning.

(1) Soak all part is in dry cleaning solvent for 25 minutes. Using a stiff bristle brush, remove all dirt particles. Dry all parts thoroughly.

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) Using compressed air, blow clean all internal cavities and oil passages in center housing.

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 signs of rubbing or wear.

(3) Inspect shaft for signs of scoring, scratches, or bearing seizure,

(4) Check impeller for signs of rubbing or blade damage. Check wheel bore for galling.

(5) Inspect seal parts for signs of rubbing or scoring of running faces.

(6) Inspect turbine nozzle for erosion and bent vanes.

(7) Inspect diffuser for dirt and foreign matter.

(8) Inspect center housing, compressor housing, and turbine housing for contact with rotating parts.

(9) Replace thrust washer if faces are worn unevenly or scratched excessively.

(10) Smooth or polish minor surface damage. Use silicone carbide abrasive cloth for aluminum parts and crocus cloth for steel parts.

d. Assembly

(1)If removed, install two pins (48) in compressor end of center housing assembly (1 2). Pins must extend 0.075 to 0.085 inch above surface.

(2) Install gasket (46) and diaphragm (45) on center housing assembly (12). Aline holes in diaphragm (45) to holes in center housing.

NOTE

Place four bolts through diaphragm and center housing holes to prevent diaphragm from turning when torquing back plate.

(3) Install shims (44) and back plate (43) on center housing assembly (12). Using fabricated back plate torquing tool, torque back plate to 25-30 lb-ft (34-41 N-m).

(4) Lubricate bearing (42) with engine oil. Install bearing in turbine side of center housing assembly (12). Install snap ring (41) in center housing assembly.

(5) Turn center housing assembly (12) so compressor side is up. Install second bearing (42).

(6) Lightly coat seal ring (47) with silicone lubricant. Install ring in center housing assembly (12).

CAUTION

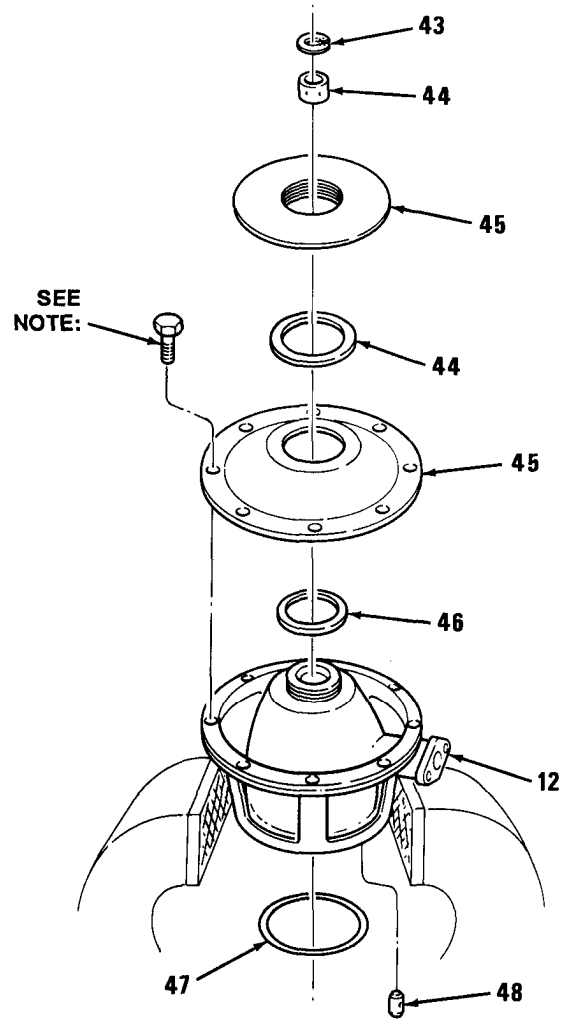
Do not scuff or score inner surface of bearings while pushing shaft through bearings. Turbocharger will not operate long with damaged bearing surfaces.

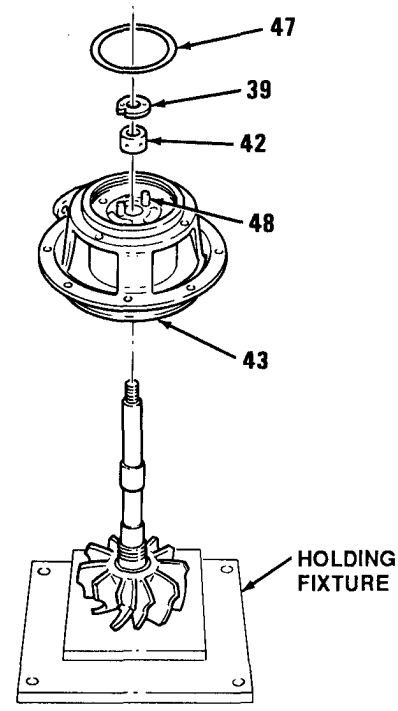
(7) Lubricate bearing journals of rotor assembly (31) with engine oil. Lower center housing assembly (12), with back plate (43) down, over rotor assembly.

(8) Install thrust washer (39) on shaft of rotor assembly (31). Position holes and cutout in thrust washer over pins (48). Seat thrust washer flat against center housing assembly (12).

(9) Install piston ring (40) on thrust collar (38).

(10) Install thrust plate washer (37) and thrust collar (38) in thrust plate (36).





6-38. TURBOCHARGER REPAIR (Cont)

(11) Slide thrust plate assembly (50) over rotor assembly (31). Aline holes in thrust plate assembly with holes in center housing assembly (12).

(12) Install three locking plates (34) and six bolts (35) securing thrust plate assembly (50) to center housing assembly (12). Torque bolts to 80-100 lb-in (9-11.4 N-m).

NOTE

Back plate shim comes in a 0.010 inch thickness.

(13) Push rotor assembly (31) toward compressor end of turbocharger. Using feeler gage, measure clearance between rotor assembly and back plate (43). Repeat steps (2) thru (12) to add or remove shims (44) until clearance is between 0.020 to 0.030 inch.

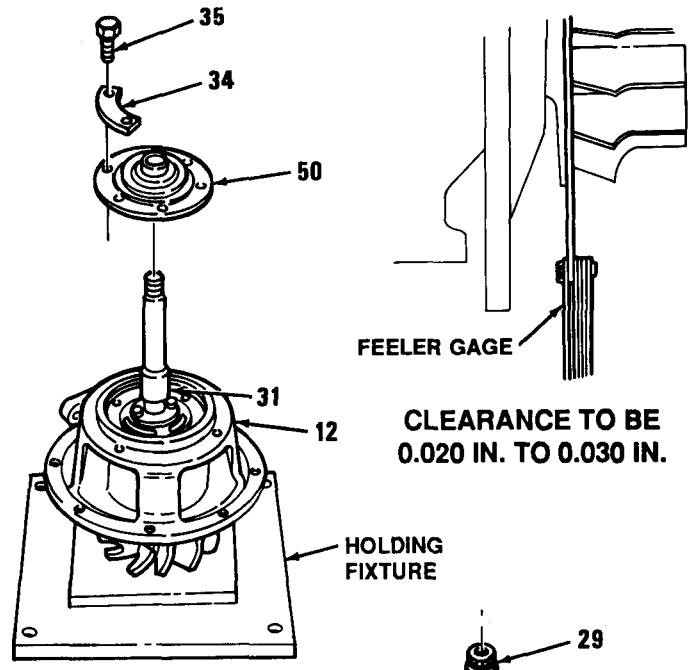
(14) Bend up tangs on locking plates (34) against heads of bolts (35).

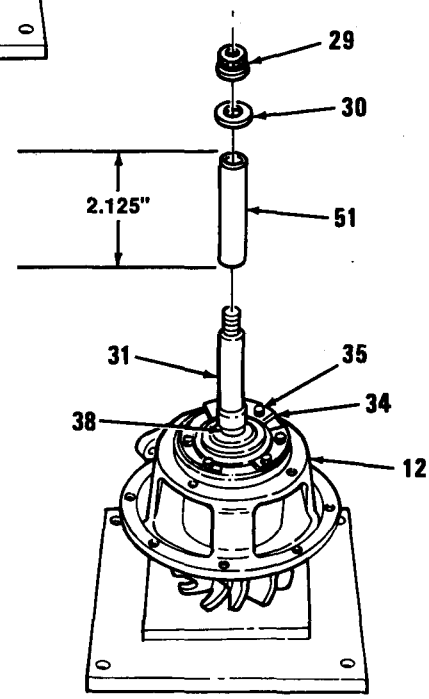
(15) Install fabricated sleeve (51) over shaft of rotor assembly (31) and against face of thrust collar (38). Sleeve length is 2.125 inches. Secure rotor assembly and center housing assemblv (12) in place with washer (30) and nut (29). Tighten nut securely.

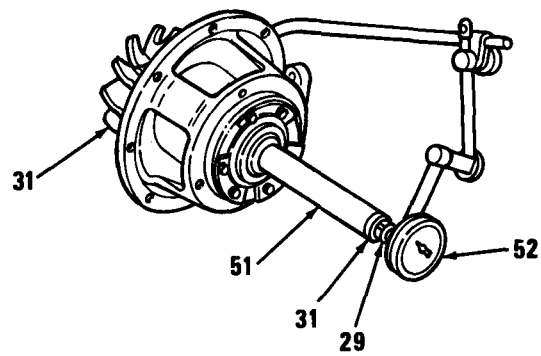
(16) Using dial indicator (52), measure axial play of rotor assembly (31). Play should be 0.005 to 0.010 inch.

(17) Remove nut (29), washer (30), and sleeve (51).

(18) Install diffuser shims (33) and diffuser (27) on center housing assembly (12) and secure with four nuts (25) and four lockwashers (26). Torque nuts to 150-200 lb-in (17-22 N-m).







(19) Determine quantity of diffuser shims (33) as follows:

(a) Place center housing assembly (12) upright with turbine wheel resting on flat surface.

(b) Place flat bar (53) across diffuser vanes (54).

(c) Measure distance from top of bar (53) to face of thrust collar (38) with depth gage (55).

(d) Measure distance from top of bar (53) to face of diffuser vanes (54).

(e) Subtract two readings. Difference is height of diffuser vanes above face of thrust collar.

(f) Rotate bar (53) 180 degrees and repeat measurements. Results should agree within 0.001 inch.

(9) Place impeller (32), blades up, on flat surface and measure height of impeller blades from flat surface. Measure at least 1/8 inch back from blade tip edge.

(h) Rotate impeller 180 degrees and repeat measurement. Results should agree within 0.001 inch.

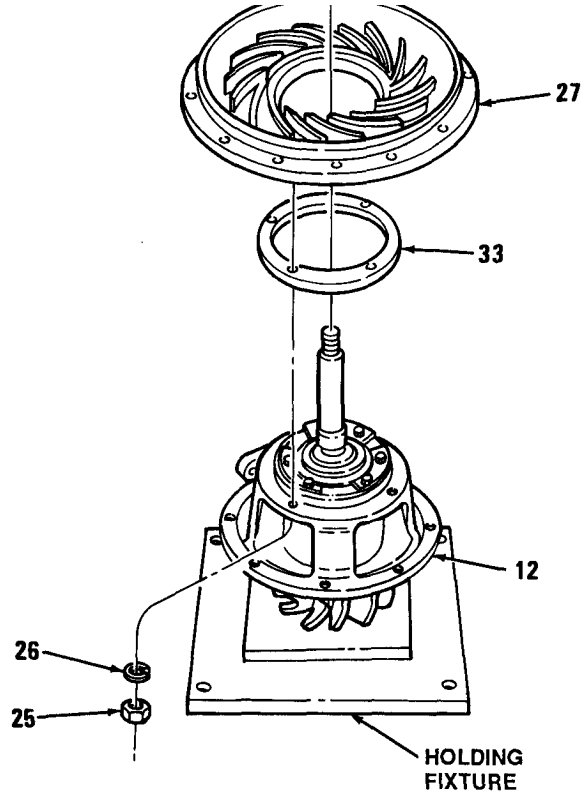
NOTE

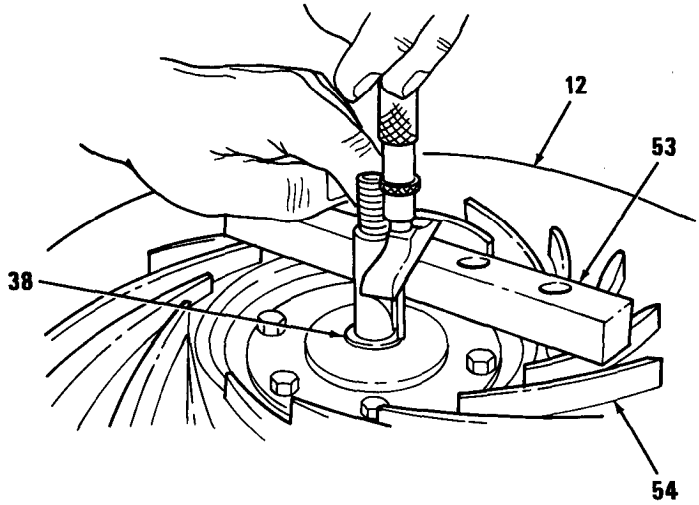
Diffuser shims come in 0.005,0.010, and 0.020 inch thicknesses.

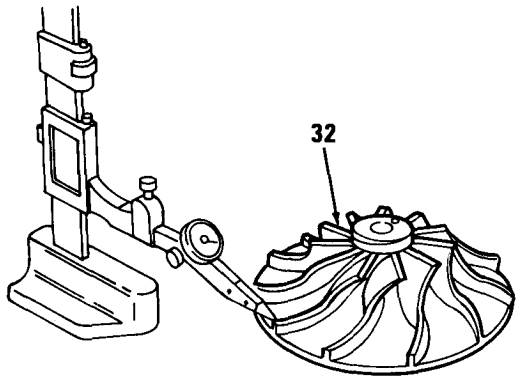
(i) Subtract impeller blade tip height from diffuser vane height. Answer is height difference diffuser is higher than impeller blade tips. Add or remove shims (33), as directed in step (18), to attain a height difference of 0.013 to 0.017 inch.

WARNING

Wear heat-resistant gloves when handling heated parts. Metal components will dissipate heat quickly. Burns to personnel will result.







6-38. TURBOCHARGER REPAIR (Cont)

(20) Heat impeller (32) temperature of 350-375°F (177-191°C) for 10 minutes maximum.

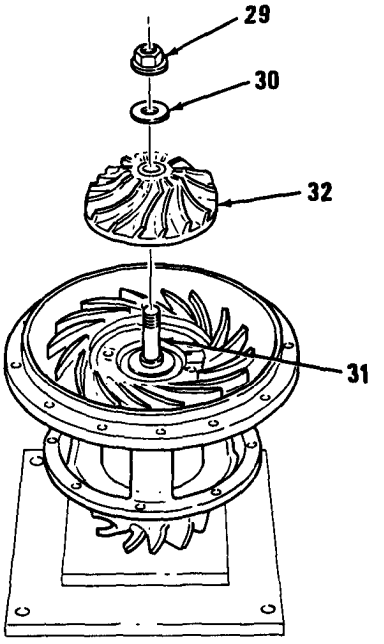
(21) Install impeller (32) on rotor assembly (31)

CAUTION

Use a wrench with a double-universal joint to tighten impeller nut. A fixed wrench or ratchet can side load rotor assembly and bend shaft.

(22) While impeller (32) is still hot, install washer (30) and nut (29). Torque nut to 30-35 lb-ft (41-47 N-m).

(23) After impeller (32) has cooled to less than 150°F (66°C), torque nut (29) to 40-45 lb-ft (54-61 N-m).



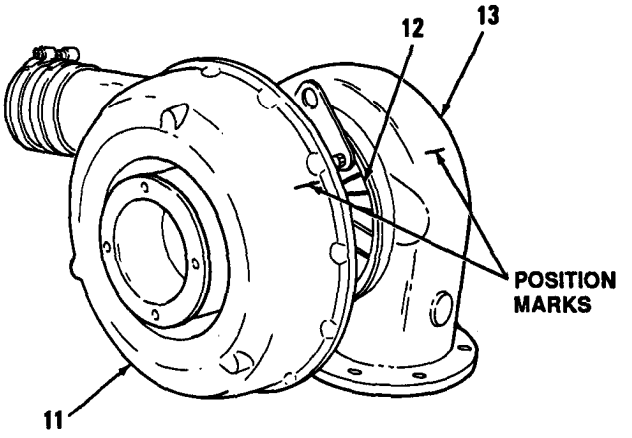
(24) Apply thin coat of sealing compound to diffuser face (27) mating with compressor housing (11). Apply sealing compound around bolt holes in compressor housing.

(25) Install compressor housing (11) on diffuser (27). Aline scribe marks on compressor housing and center housing,

(26) Secure compressor housing (11) in place with twelve bolts (14). Torque bolts to 150-200 lb-in (17-22.6 N-m).

NOTE

Nozzle bolts are not symmetrical, Sides of bolt heads must press firmly against nozzle. If the bottom of any bolt head contacts the turbine housing, rotate that bolt 180 degrees.



(27) Install nozzle (22) in turbine housing (13) and secure with three bolts (21), three gaskets (20), and three nuts (19). Torque nuts to 35-45 lb-in (4-5.1 N-m).

(28) If removed, install studs (23 and 24) into original locations as marked.

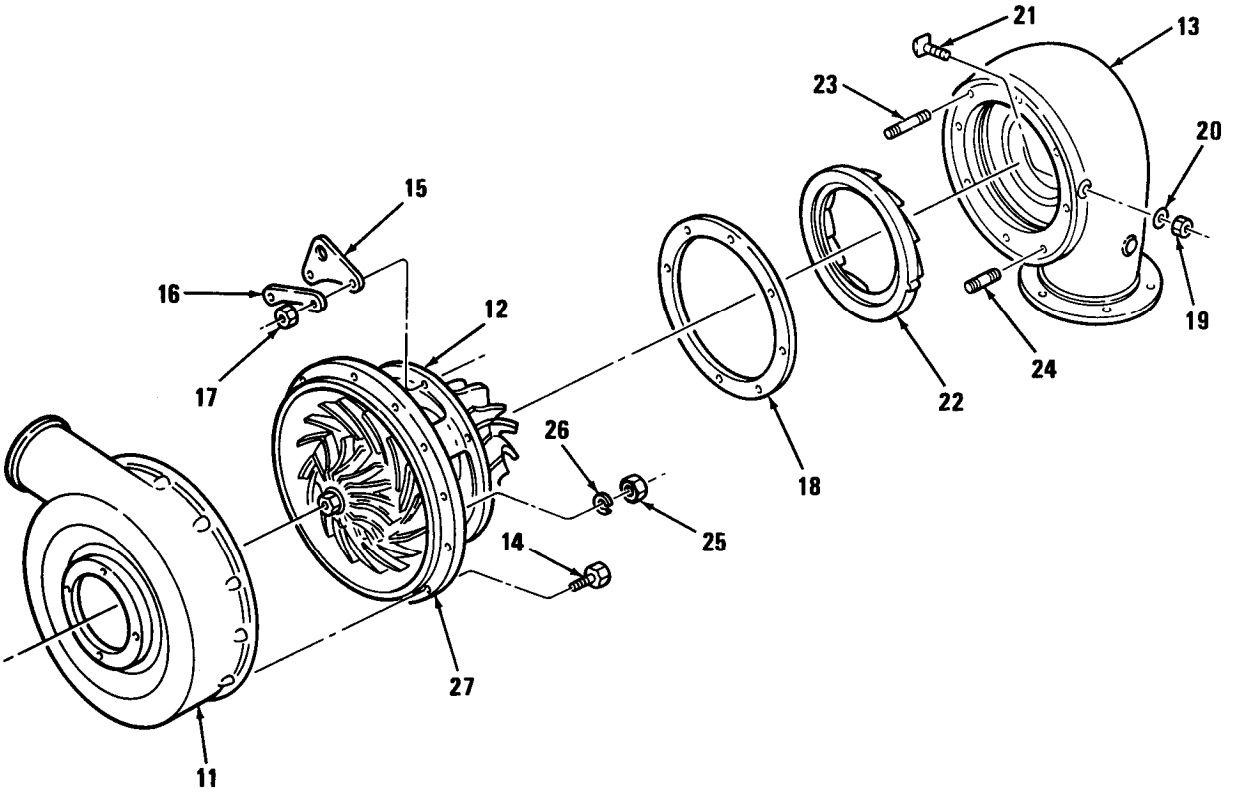
(29) Place shims (18) over studs (23 and 24) in turbine housing (13).

NOTE

Aline scribe marks on center housing assembly and turbine housing.

(30) Place turbine housing (13) on center housing assembly (12).

(31) Place lifting bracket (15) over studs (23) where marked.



(32) Secure lifting bracket (15) and turbine housing (13) to center housing assembly (12) with four locking plates (16) and eight nuts (17). Torque nuts to 20-25 lb-ft (34-41 N-m).

(33) Adjust turbine housing to turbine wheel clearance as follows:

(a) Place turbine housing (13) flat on bench resting on exhaust flange.

NOTE

When turning rotor assembly during adjustment, turbine should rub just lightly enough to hear a soft contact noise but not heavy enough to feel any binding.

(b) Check impeller (32) for free spin. Rotor assembly (31) should rub lightly on turbine housing (13).

NOTE

Turbine housing shims come in 0.010 and 0.042 inch thicknesses.

(c) If turbine wheel does not rub lightly on turbine housing (13), remove housing and add or remove shims (18) until light rubbing is achieved.

(d) Remove turbine housing (13) from center housing assembly (12). Add shims (18) to provide an additional clearance of 0.019 to 0.029 inch.

(e) Reinstall turbine housing according to steps (30) thru (32).

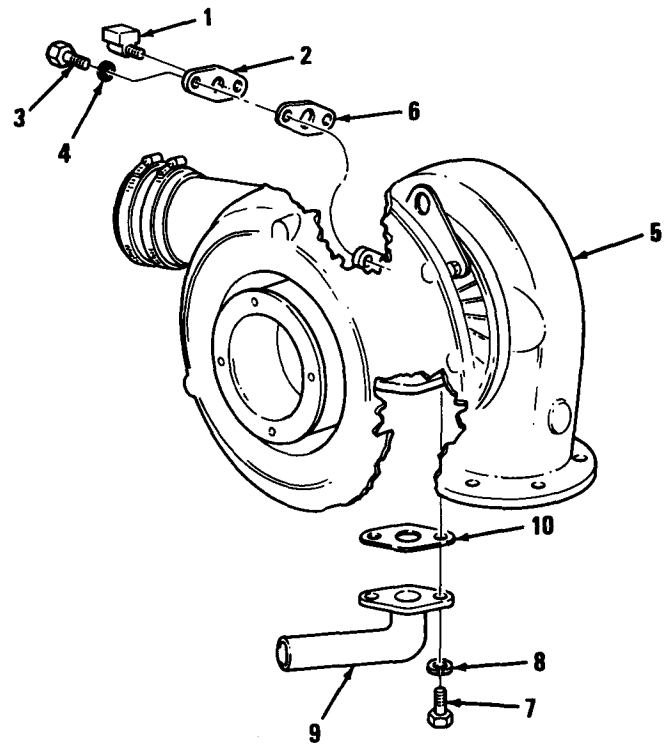
(34) Bend four locking plates (16) over sides of eight nuts (17).

6-38. TURBOCHARGER REPAIR (Cont)

(35) Install gasket (6) and adaptor plate (2) to oil inlet port in turbocharger assembly (5) and secure with two bolts (3) and two lockwashers (4). Torque bolts to 30-35 lb-ft (41-47 N-m).

(36) Install elbow (1) in adaptor plate (2).

(37) Install gasket (10) and drain tube (9) to oil outlet port in turbocharger assembly (5) and secure with two bolts (7) and two lockwashers (8). Torque bolts to 30-35 lb-ft (41-47 N-m).



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
6-2 Install turbocharger

* Dual-range limiting speed governor for M578
**Single-range limiting speed governor for M110.

CHAPTER 7

REPAIR PROCEDURES FOR MAJOR COMPONENTS OF ENGINE MODEL 7083-7399

Contents

Section I. INTRODUCTION

7-1. GENERAL. This chapter provides the repair procedures performed on engine model 7083-7399 after the engine has been installed on the maintenance stand. 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.

This chapter deals with model 7083-7399. However, if a model in previous chapters has identical or nearly identical components, this chapter will refer to the previous chapter.

Section II. GENERAL ENGINE MAINTENANCE

7-2. TURBOCHARGER REGULATOR REPLACEMENT

(See Para 6-2)

7-3. TURBOCHARGER REMOVAL/INSTALLATION

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

INITIAL SETUP

MODELS

7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

6 Locking nuts (App F, Item 104)
1 Gasket (App F, Item 40)

EQUIPMENT CONDITION

Para Description
3-10 Turbocharger oil return line removed
3-13 Turbocharger oil supply line removed
3-15 Air inlet manifold removed
6-2 Regulator air line removed

PERSONNEL REQUIRED: 2

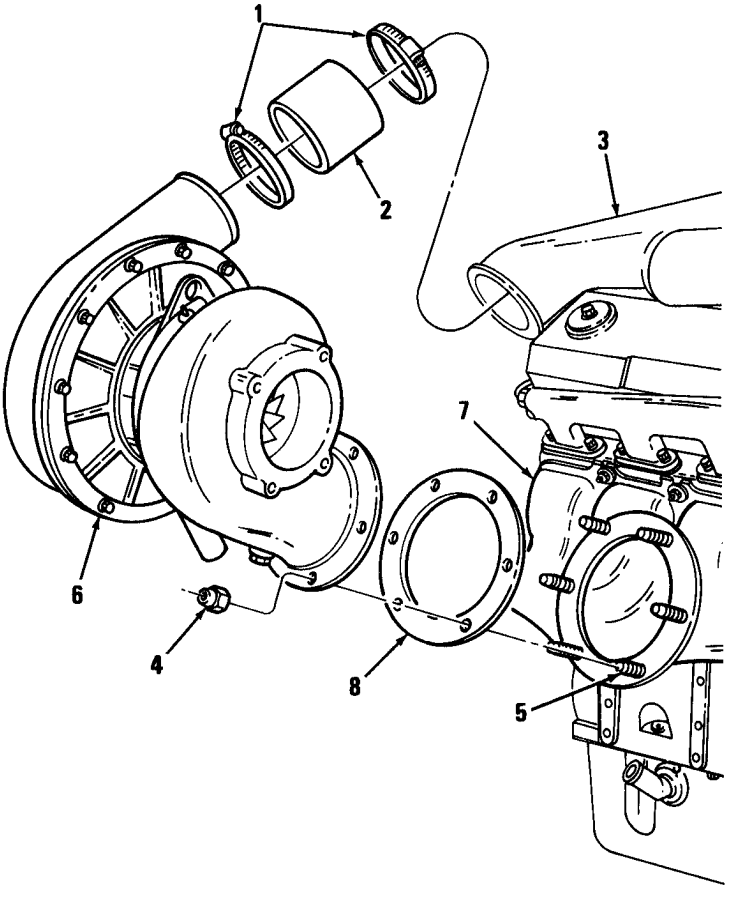
a. Removal

(1) Loosen two clamps (1) and slide hose (2) and clamps onto air inlet housing (3).

(2) Remove six locking nuts (4) from exhaust manifold studs (5) securing turbocharger (6) to exhaust manifold (7). Discard locking nuts.

WARNING

Engine components are heavy. To prevent personal injury, use extreme caution when removing large components from engine.



7-3. TURBOCHARGER REMOVAL/INSTALLATION (Cont)

CAUTION

- Turbocharger is heavy. Use two persons or lifting device to prevent dropping or damage to turbocharger.
- Tape all openings of turbocharger after removal to keep foreign particles from entering and damaging turbocharger blades.

(3) Remove turbocharger (6) and gasket (8). Discard gasket.

(4) Remove hose (2) and two clamps (1) from air inlet housing (3).

b. Inspection

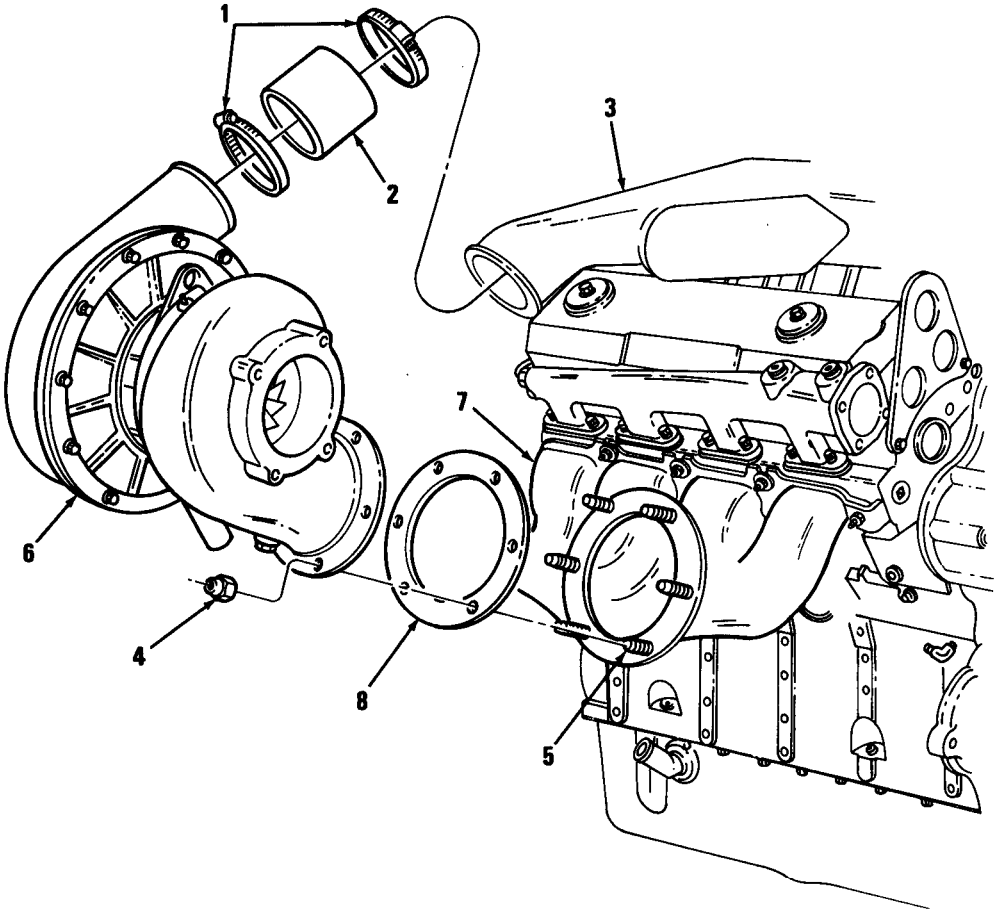
(1) Inspect hoses for cuts, cracks, and brittleness.

(2) Replace all parts failing inspection.

c. Installation

(1) Install hose (2) and two clamps (1) on air inlet housing (3).

(2) Install gasket (8) over studs (5) on exhaust manifold (7).



WARNING

Engine components are heavy. To prevent personal injury, use extreme caution when removing large components from engine.

CAUTION

Turbocharger is heavy. Use two persons or lifting device to prevent dropping or damage to turbocharger.

(3) Install turbocharger (6) over studs (5) and secure with six locking nuts (4). Torque locking nuts to 83-93 lb-ft (113-126 N-m).

(4) Slide hose (2) and two clamps (1) from air inlet housing (3) onto turbocharger (6). Tighten clamps.

END OF TASK

FOLLOW ON MAINTENANCE

Para Description
6-2 Install regulator air line
3-15 Install air inlet manifold
3-13 install turbocharger oil supply line
3-10 Install turbocharger oil return line

7-4. EXHAUST MANIFOLD AND TUBE REPLACEMENT

This task covers: a. Removal b. Installation

INITIAL SETUP

MODELS

7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

17 Locking nuts (App F, Item 103)
1 Gasket (App F, Item 62)
2 Gaskets (App F,Item29)

EQUIPMENT CONDITION

Para Description
3-10 Turbocharger oil return line removed
3-13 Turbocharger oil supply line removed
3-15 Air inlet manifold removed
7-2 Turbocharger regulator removed
7-3 Turbocharger removed

PERSONNEL REQUIRED: 2

a. Removal

(1) Remove two nuts (1) from two clamps (2) securing exhaust crossover tube (3) to right exhaust manifold (4) and adaptor (5) on left exhaust manifold (6). Slide clamps onto crossover tube.

(2) Loosen five locking nuts (7) securing right exhaust manifold (4) to cylinder head.

(3) Remove exhaust crossover tube (3) and clamps (2) from exhaust manifold (4) and adaptor (5). Remove clamps from tube.

(4) Slide exhaust manifold (4) upward and off cylinder head. Remove five locking nuts (7), three beveled washers (8), and two end retainers (9) from studs (10) on right cylinder head. Discard locking nuts.

(5) Remove exhaust manifold gasket (11). Discard gasket.

(6) Remove four locking nuts (12) securing adaptor (5) to left exhaust manifold (6). Discard locking nuts.

(7) Remove adaptor (5) and gasket (13) from exhaust manifold. Discard gasket.

WARNING

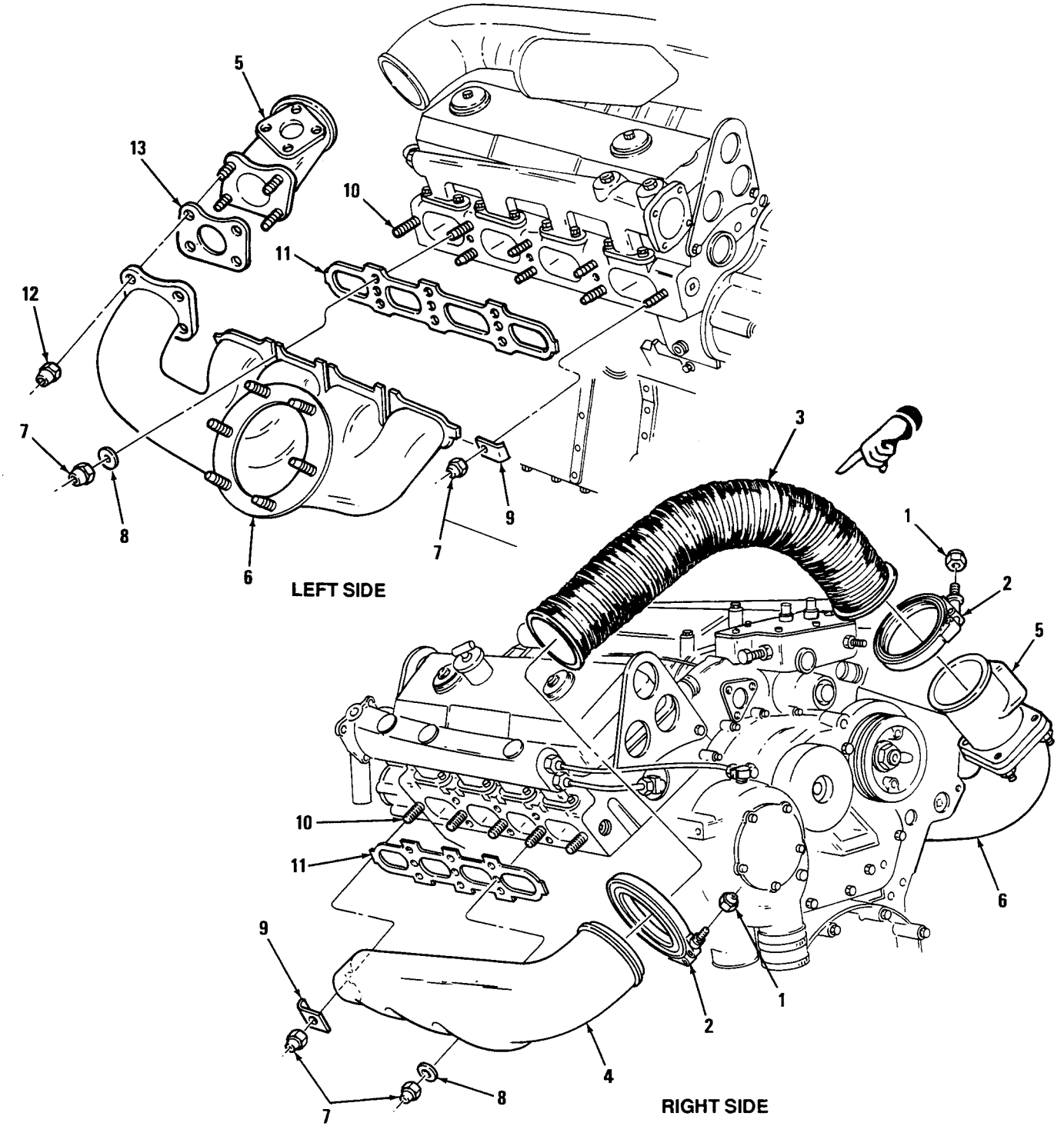
Use a second person to hold or secure exhaust manifold when loosening self-locking nuts to prevent manifold from slipping or falling. Injury to personnel can occur if manifold is not secured.

(8) Loosen eight locking nuts (7) securing left exhaust manifold (6) to cylinder head.

(9) Slide exhaust manifold (6) upward and off cylinder head.

(10) Remove eight locking nuts (7), six beveled washers (8), and two end retainers (9) from studs (10) on left cylinder head. Discard locking nuts.

(11) Remove exhaust manifold gasket (11). Discard gasket.



7-4. EXHAUST MANIFOLD AND TUBE REPLACEMENT (Cont)

b. Installation

(1) Position gasket (11) over exhaust manifold studs (10) on left cylinder head.

NOTE

Position beveled washers with crown facing nut.

(2) Install six beveled washers (8), two end retainers (9), and eight locking nuts (7) on left exhaust manifold studs (10).

WARNING

Use a second person to hold or secure exhaust manifold when installing self-locking nuts to prevent manifold from slipping or falling. Injury to personnel can occur if manifold is not secured.

NOTE

Insure locating pads on exhaust manifold rest on cylinder block locating pads.

(3) Install left exhaust manifold (6) onto cylinder head by sliding downward between gasket (11) and retainers (9) and beveled washers (8).

(4) Torque eight locking nuts (7) on exhaust manifold (6) to 30-35 Ib-ft (41-47 N-m) starting from center and working outward alternately toward either end.

(5) Install gasket (13) and adaptor (5) on exhaust manifold (6) and secure with four locking nuts (12). Torque nuts to 30-35 Ib-ft (41-47 N-m).

(6) Position gasket (11) over exhaust manifold studs (1 O) on right side of cylinder head.

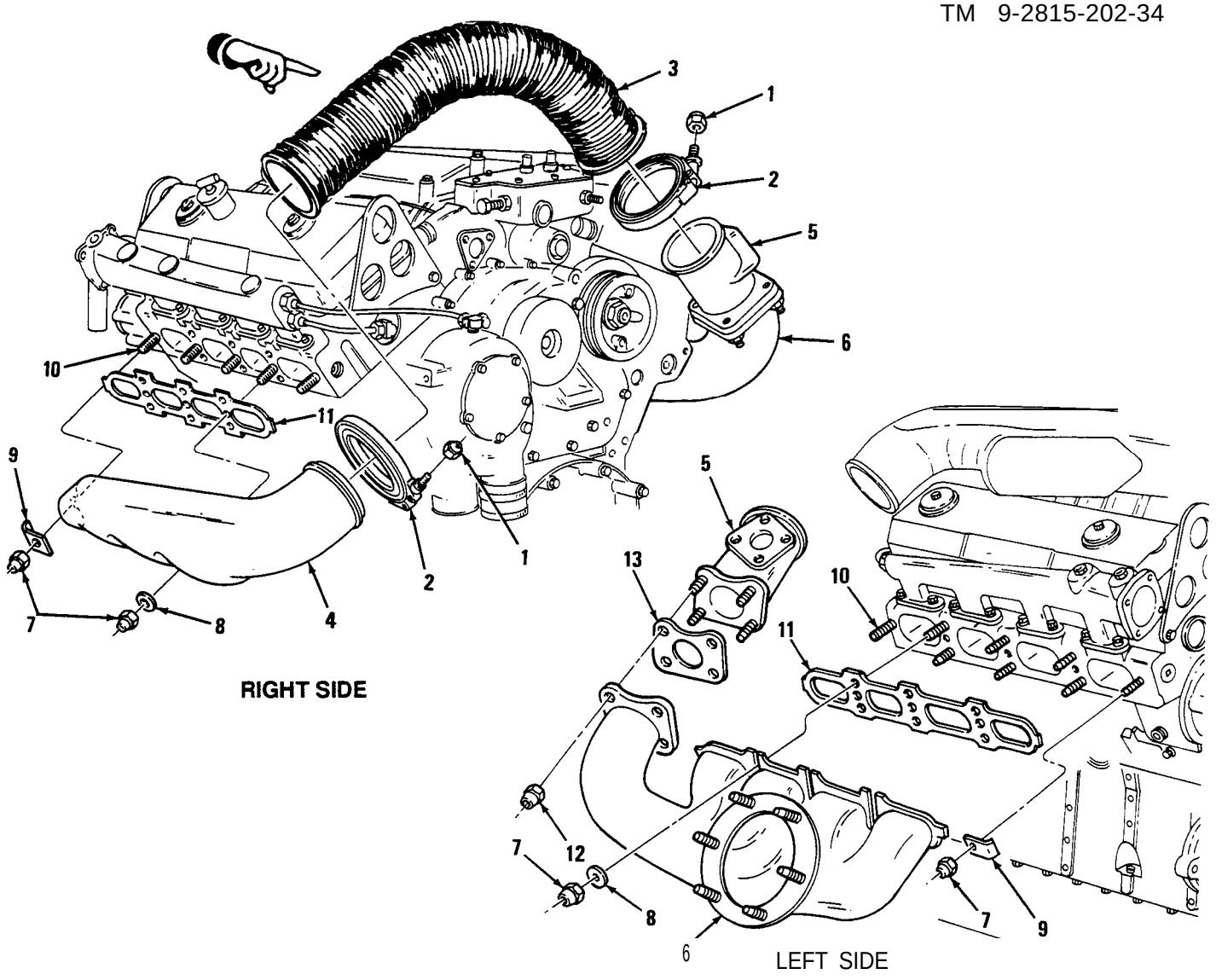
NOTE

Position beveled washers with crown facing nut.

(7) Install three beveled washers (8), two end retainers (9), and five locking nuts (7) on right exhaust manifold studs (10).

NOTE

- Do not tighten or torque exhaust manifold nuts until crossover tube has been installed.
- Insure locating pads on exhaust manifold rest on cylinder block locating pads.



(8) Install right exhaust manifold (4) onto cylinder head by sliding downward between gasket and retainers and beveled washers.

(9) Install exhaust crossover tube (3) between exhaust manifold (4) and adaptor (5). Position two clamps (2) on crossover tube (3).

(10) Torque five locking nuts (7), securing right exhaust manifold (4) to cylinder head, to 30-35 lb-ft (41-47 N-m) starting from center and working outward alternately toward either end. Install two nuts (1) on two clamps (2) and tighten nuts.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
7-3	Install turbocharger
7-2	Install turbocharger regulator
3-15	Install air inlet manifold
3-13	Install turbocharger oil supply line
3-10	Install turbocharger oil return line

7-5	**Fuel Lines Replacement**	(See Para 5-4)
7-6	**Engine Lifting Brackets Replacement**	(See Para 5-5)
■ 7-7	**Engine Water Manifolds Replacement**	(See Para 5-6)
7-8	**Water Pump Removal/installation**	(See Para 5-7)
7-9	**Air Box Heater Replacement**	(See Para 6-11)
7-10	**Engine Rocker Arm Cover Replacement**	(See Para 4-11)
7-11	**Fuel Pump Replacement**	(See Para 4-12)
7-12	**Air Inlet Housing Replacement**	(See Para 4-13)
7-13	**Tachometer Drive Replacement**	(See Para 4-14)

7-14. CRANKCASE BREATHER REPLACEMENT

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

INITIAL SETUP

MODELS

7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Torque wrench (App B, Item 101)

MANDATORY REPLACEMENT PARTS

8 LockWashers (App F,Item 93)
1 Gasket (App F, Item 26)
1 Gasket (App F, Item 36)
1 LockWasher (App F, Item 92)

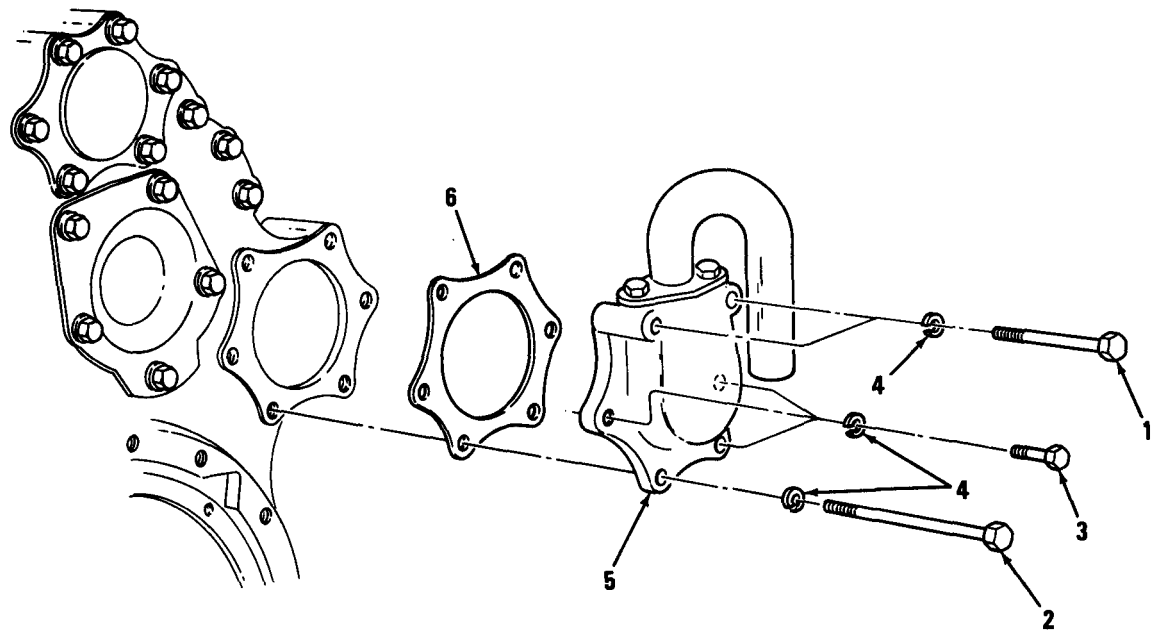
EXPENDABLE/DURABLE SUPPLIES

Cleaning solvent (App C, Item 10)

FLYWHEEL HOUSING CRANKCASE BREATHER

a. Removal

Remove two bolts (1), bolt (2), three bolts (3), and six lockwashers (4) securing breather assembly (5) and gasket (6) to flywheel housing. Remove breather assembly. Discard lockwashers and gasket.



7-14. CRANKCASE BREATHER REPLACEMENT (Cont)

b. Disassembly

(1) Remove bolt (7), flat washer (8), and spacer (9) securing filter element (10) and shell (11) to adaptor (12). Remove shell from element.

(2) Remove two bolts (13) and two lockwashers (14) securing breather pipe(15) and gasket (16) to adaptor (12). Discard gasket and lockwashers.

c. Cleanlng/Inspection

WARNING

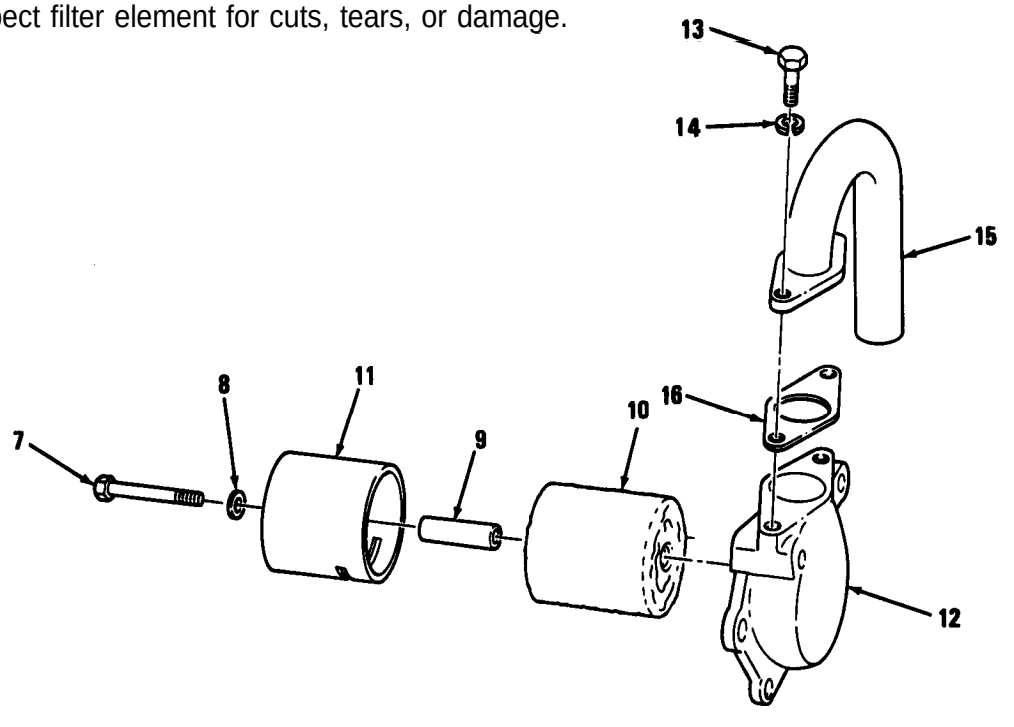
- **Dry cleaning solvent P-D-680 is toxic and flammable. Wear protective goggles and gloves and use only In a well-ventilated area. Avoid contact with skin, eyes, and clothes and don't breathe vapors. Do not use near open flames or excessive heat. The flash point is 100°F-138°F (38°C-50°C). If you become dizzy while using cleaning solvent, get medical aid. If contact with eyes is made, wash your eyes with water and get medical aid immediately.**

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

(1) Clean all parts with dry cleaning solvent and dry with compressed air.

(2) Inspect adaptor, pipe, and shell for cracks, pitting, or damage.

(3) Inspect filter element for cuts, tears, or damage.



d. Assembly

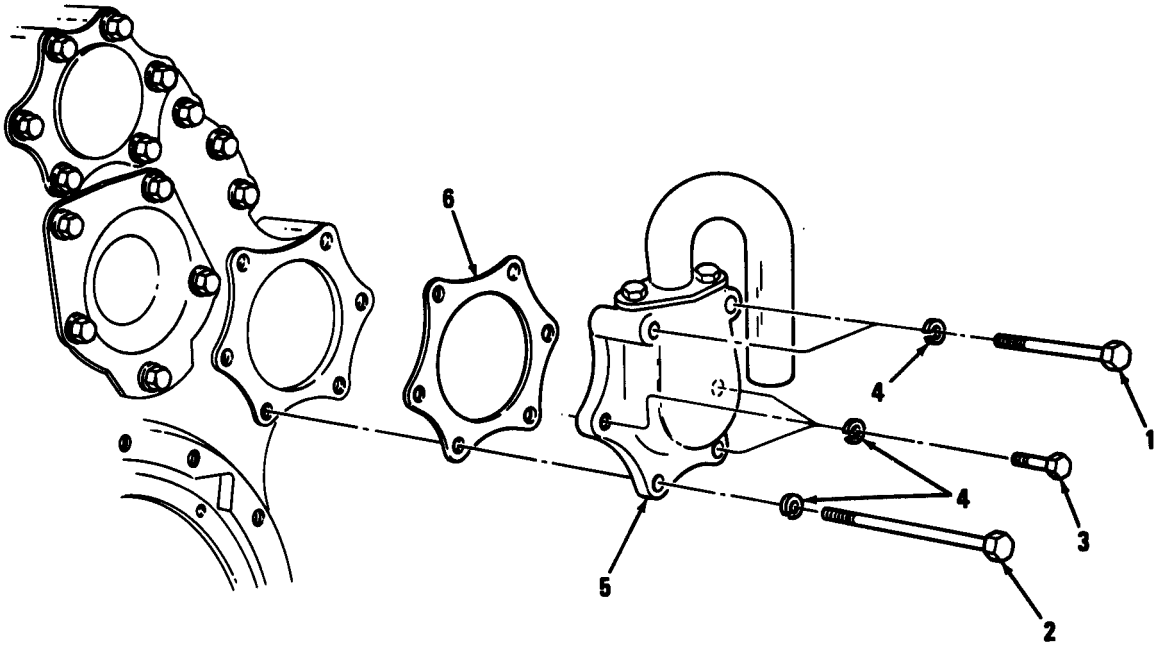
(1) Install gasket (16) and breather pipe (15) onto adaptor (12). Secure with two lockwashers (14) and two bolts (13). Torque bolts to 30-35 lb-ft (41 -47 N-m).

(2) Install filter element (10) and shell (11) onto adaptor (12) and secure with spacer (9), flat washer (8), and bolt (7). Torque bolt to 30-35 lb-ft (41-47 N-m).

e. Installation

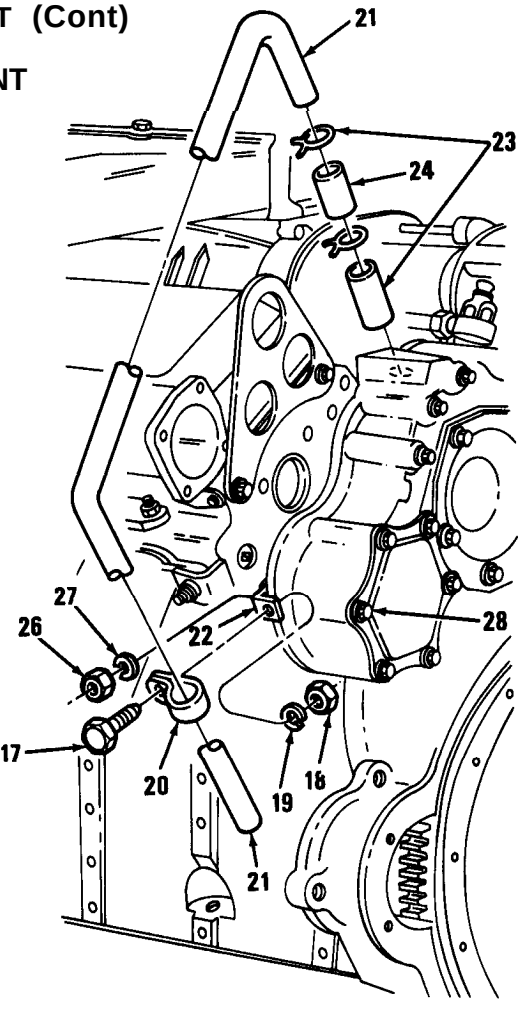
(1) Install gasket (6) onto breather assembly (5).

(2) Position breather assembly (5) onto flywheel housing and secure with two bolts (1), bolt (2), three bolts (3), and six lockwashers (4). Torque bolts to 30-35 lb-ft (41-47 N-m).



7-14. CRANKCASE BREATHER REPLACEMENT (Cont)

CRANKCASE BREATHER TUBE REPLACEMENT



STEP 2 C. INSTALLATION

a. Removal

(1) Remove bolt (17), nut (18), and lockwasher (19) securing clip (20) and tube (21) to bracket (22). Remove tube. If necessary, remove clip from tube. Discard Lockwasher.

(2) Loosen two clamps (23) securing hose (24) to tube (21) and breather pipe (25). Remove tube from hose.

(3) Remove two clamps (23) from hose (24). Remove hose from breather pipe (25).

(4) If necessary, remove nut (26) and lockwasher (27) from bolt (28) securing bracket (22) to flywheel housing. Discard lockwasher.

NOTE

Do not remove breather pipe unless damaged. Removal of pipe will destroy it and require its replacement.

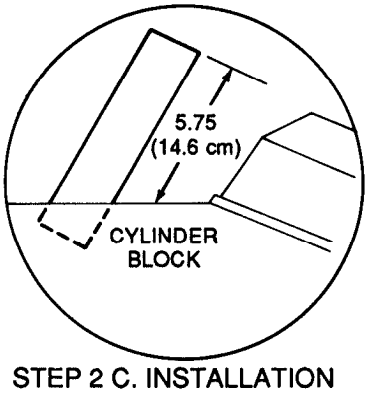
(5) If necessary, remove breather pipe (25) from cylinder block.

b. Inspection

(1) Inspect breather pipe and tube for cracks, holes, or other damage.

(2) Inspect hose for cuts, cracks, or brittleness.

c. Installation



(1) If removed, secure bracket (22) to bolt (28) with nut (26) and lockwasher (27) to flywheel housing. Torque bolt 25-30 lb-ft (34-41 N-m).

(2) If removed, drive new breather pipe (25) into cylinder block with a piece of wood and soft-headed hammer until distance from surface of block to top of pipe is 5.75 inches (14.6 cm).

(3) Install hose (24) and two clamps (23) onto breather pipe (21). Install tube (25) into hose and tighten two clamps.

(4) If removed, install clip (20) onto tube (21).

(5) Secure clip (20) and tube (21) to bracket (22) with bolt (17), lockwasher (19), and nut (18). Torque bolt to 13-17 lb-ft (18-23 N-m).

END OF TASK

Section Ill. ENGINE DISASSEMBLY\ASSEMBLY

Section IV. COMPONENT REPAIR

CHAPTER 8

TESTING AND INSPECTION PROCEDURES

Contents

SECTION I. INTRODUCTION

8-1. GENERAL. This chapter provides the necessary instructions for engine preparation, adjustments, tests, and run-in 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 insure against inadequate lubrication at start-up.

Whenever a major repair involves the governor, blower, cylinder head, or fuel injector controls, adjustment 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.

SECTION II. ENGINE PREPARATION

8-2. ENGINE PREPARATION FOR START-UP

This task covers:
a. Priming Fuel System
b. Prelubrication of Oil Gallery (with Pressure Lubricator)
c. Prelubrication of Oil Gallery (without Pressure Lubricator)
d. Prelubrication of Turbocharger
e. Initial Start-up

INITIAL SETUP

MODELS
All

TOOLS AND SPECIAL TOOLS
General mechanics tool kit (App B, Item 96)

a. 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 (41 3-552 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.

b. Prelubrication of Oil Gallery (With Pressure Lubricator)

(1) Remove plug from engine main oil gallery and attach lubricator hose.

(2) Remove rocker arm covers.

(3) Pump in lubricating oil until oil flows from rocker arms.

8-2. ENGINE PREPARATION FOR START-UP (Cont)

(4) Disconnect lubricator hose and install oil gallery plug.

(5) Install rocker arm covers.

(6) Check and fill crankcase to proper level.

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 (Without Pressure Lubricator)

(1) Remove rocker arm covers.

(2) Pour lubricating oil on rocker arm assemblies.

(3) Install rocker arm covers.

(4) Check and fill crankcase to proper level.

d. 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.

8-2. ENGINE PREPARATION FOR START-UP (Cont)

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.

NOTE

Following any repair involving the exhaust valve or injector operating mechanisms, reset exhaust valve clearance (Para 8-4.) and injector timing (Para 8-5.) before starting engine.

e. Initial Start-up

(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

SECTION III. ADJUSTMENT SEQUENCE

8-3. INTERVALS AND ADJUSTMENT SEQUENCE

a. Intervals. Following any engine repair, the adjustments specified in Para 8-4.b must be performed.

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 Lever Adjustment

(5) Throttle Delay Adjustment

(6) Starting Aid Screw Adjustment (External Starting Aid Screw)

(7) Idle Speed Adjustment

(8) Maximum No-Load Speed Adjustment (Dual Range Limiting Speed Governor)

(9) Maximum No-Load Speed Adjustment (Limiting Speed Governor)

(10) Governor Buffer Screw Adjustment

8-4. EXHAUST VALVE CLEARANCE ADJUSTMENT (HOT OR COLD ENGINE)

This taskcovers: Adjustment

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

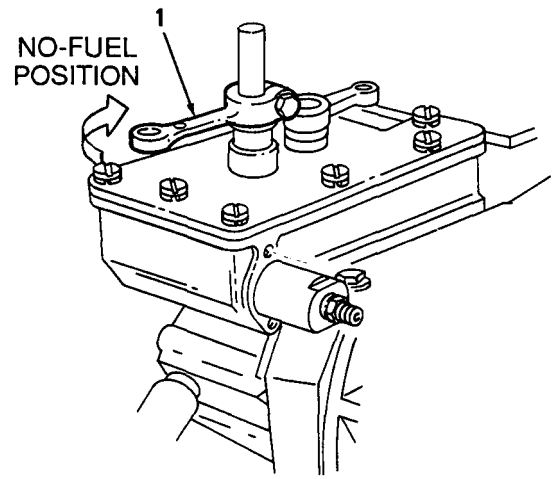
Para Description
4-11 Rocker arm covers removed

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

Adjustment

a. Place governor speed control lever (1) in NO-FUEL position.

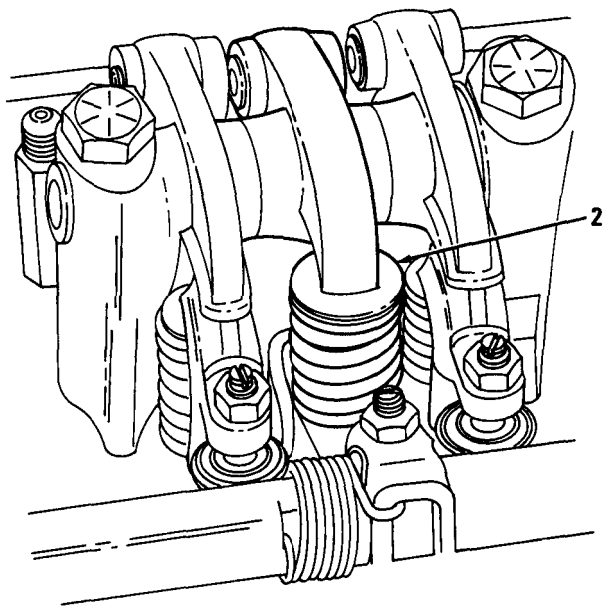


CAUTION

Do not turn engine in counterclockwise direction as crankshaft bolt will be loosened.

b. Rotate crankshaft clockwise, by turning crankshaft end bolt, until fuel injector follower (2) is fully depressed on cylinder to be adjusted.

c. Hold push rod (3) in position and loosen push rod locknut (4).



8-4. EXHAUST VALVE CLEARANCE ADJUSTMENT (HOT OR COLD ENGINE) (Cont)

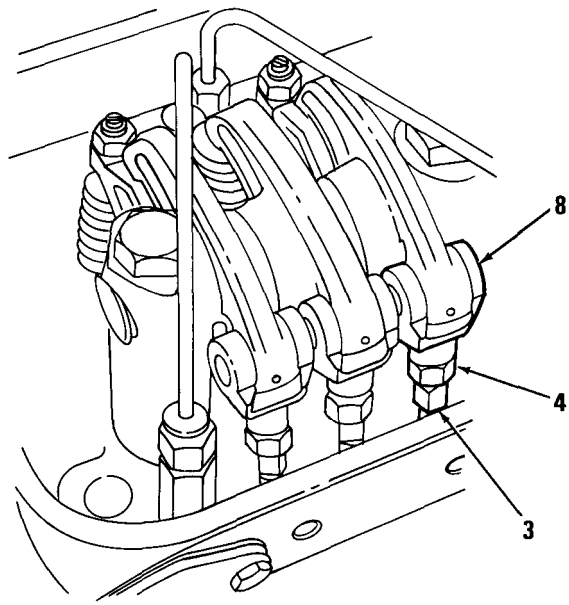
NOTE

Normal engine coolant operating temperature is 160-185°F (71.1-85.0°C).

d. Place a 0.015 inch (0.381 mm) feeler gage (5) (cold engine) or a 0.013 inch (0.330 mm) feeler gage (5) (hot engine) between valve bridge (6) and rocker arm (7).

e. Turn push rod (3) in or out of clevis (8) until a smooth pull is obtained on feeler gage (5).

f. Remove feeler gage (5). Hold push rod (3) and tighten locknut (4).

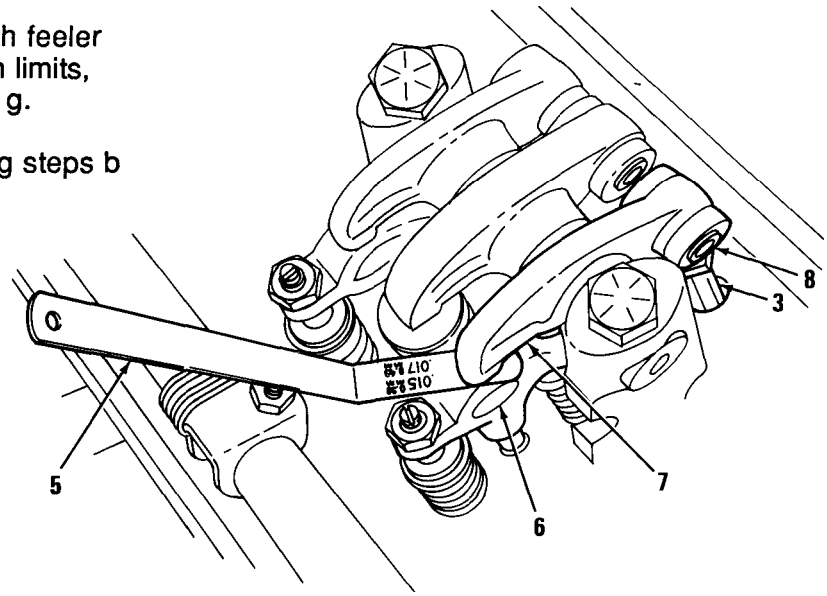


NOTE

A 0.015 inch (0.381 mm) feeler gage (5) (cold engine) or a 0.013 inch (0.330 mm) feeler gage (hot engine) must pass freely between valve bridge (6) and rocker arm (7). A 0.017 inch (0.432 mm) feeler gage (5) (cold engine) or a 0.015 inch (0.381 mm) feeler gage (hot engine) must not pass through bridge clearance.

g. Check valve bridge clearance with feeler gage (5). If clearance is not within limits, repeat procedures in steps b thru g.

i. Adjust all exhaust valves following steps b thru g.



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-11	Install rocker arm covers

8-5. FUEL INJECTOR TIMING ADJUSTMENT

This taskcovers: Adjustment

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

Para Description
4-11 Rocker arm covers removed

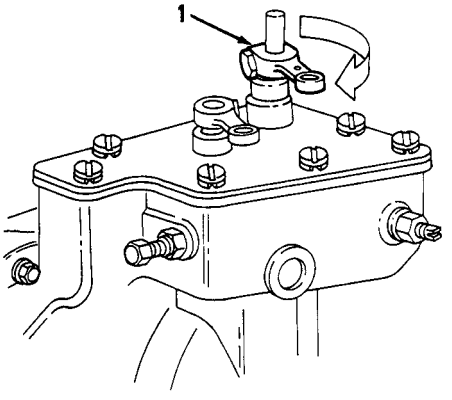
TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Injector timing gage (App B, Item 46)
injector timing gage (App B, Item 105)*

* 7083-7391

Adjustment

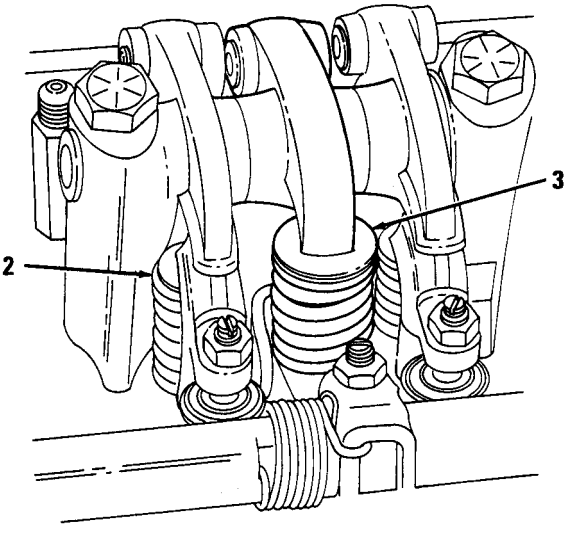
a. Place governor speed control lever (1) in NO-FUEL position.



CAUTION

Do not turn engine in counterclockwise direction as crankshaft bolt will be loosened.

b. Rotate crankshaft clockwise, by turning crankshaft end bolt, until exhaust valves (2) are fully depressed on cylinder to be timed.

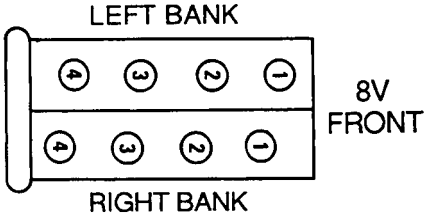


NOTE

Ail fuel injectors should be timed during one full revolution of crankshaft. Firing order: 1L, 3R, 3L, 4R, 4L, 2R, 2L, 1R.

c. Place drop of oil from cylinder head on injector follower (3).

d. Place small end (5) of fuel injector timing gage (4), 1.484 inches (for model 7083-7391 only, use 1.460 inches), in opening (6) in top of fuel injector body (7) with flat of timing gage on fuel injector follower (3).



FIRING ORDER
RH.1L.3R.3L.4R.4L.2R.2L.1R

NOTE

Proper adjustment is when rotating injector timing gage wipes a thin even film of oil on injector follower behind flat of injector timing gage.

Rotate injector timing gage (4). Flat of timing gage should wipe oil from follower (3).

Adjust injector timing as follows:

(1) Hold fuel injector push rod (8) in position and loosen locknut (9).

NOTE

Turn push rod in clockwise direction (as viewed from above) to lower fuel injector follower. Turn push rod in counterclockwise direction to raise fuel injector follower.

(2) Turn push rod (8) to adjust fuel rocker arm (10) until top of follower (3) is flush with flat of gage (4).

(3) Hold push rod (8) and tighten locknut (9).

g. Recheck injector timing adjustment, repeat steps c thru e.

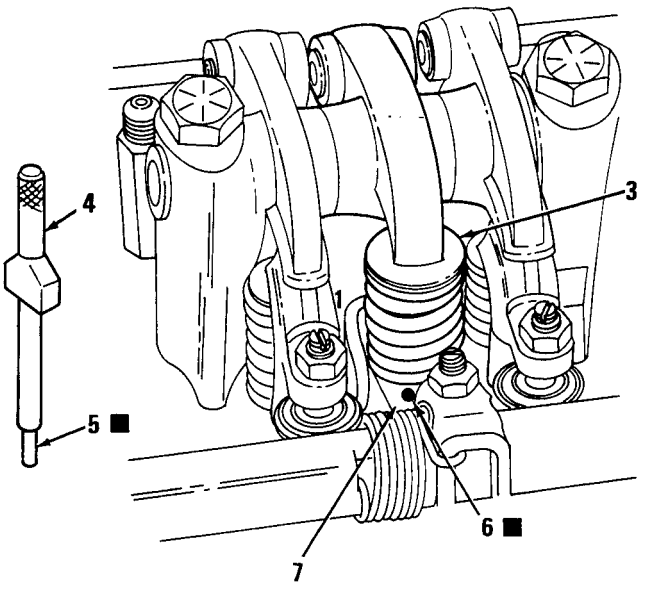
h. If adjustment is needed, repeat steps c thru f.

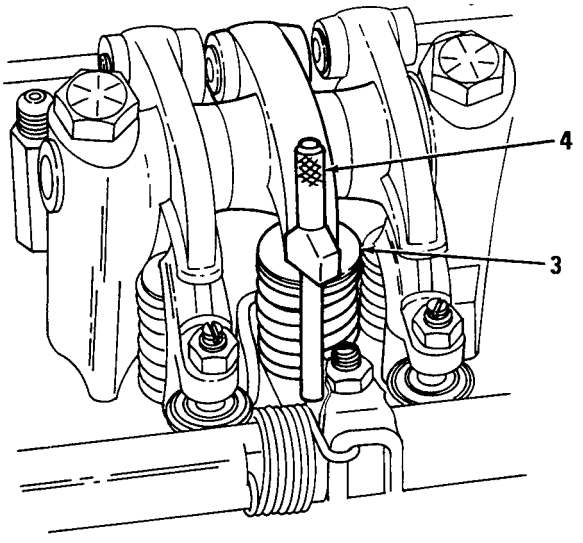
i. Time remaing seven fuel injectors as outlined in stess a thru h above.

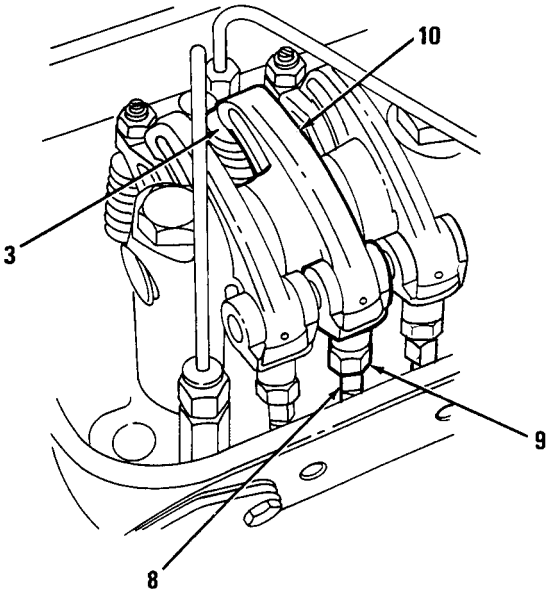
END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-11 Install rocker arm covers







8-6. GOVERNOR GAP ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

■ All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger inlet shield (App B, Item 81)

MANDATORY REPLACEMENTS PARTS

1 Gasket (App F,Item 82)
2 Gaskets (App F, Item 78)
2 Lockwashers (App F,Item 92)

EQUIPMENT CONDITION

4-11 Rocker arm covers removed

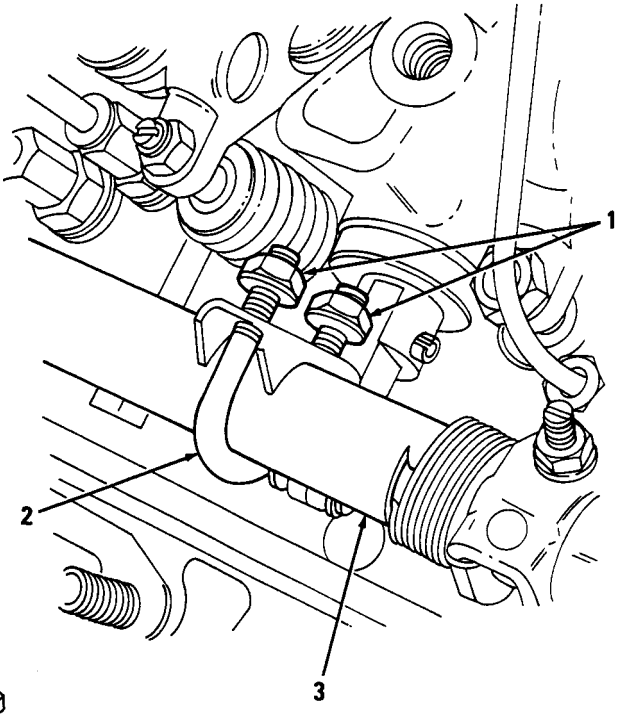
Adjustment

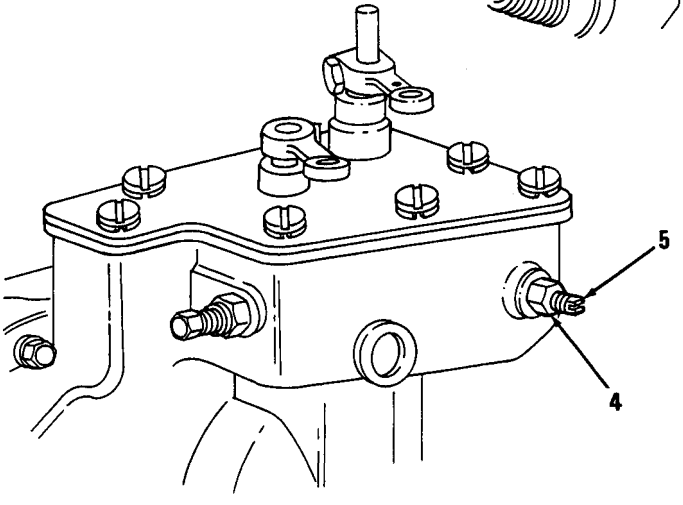
NOTE

Before proceeding with governor adjustments, disconnect cables from governor cover lever.

a. For models 7083-7395 and 7083-7396, loosen two nuts (1) on throttle delay U-bolt (2) on right bank injector control tube (3). Injector control tube must move freely in U-bolt.

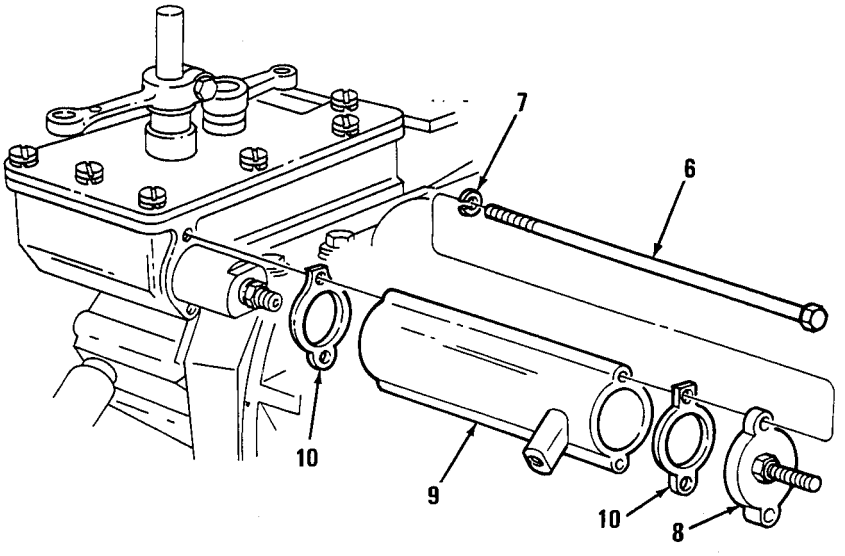
■ b. For models 7083-7391 ,7083-7395, and 7083-7396, loosen and hold starting aid nut (4). Back out starting aid screw (5) to make it ineffective.





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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. Contact with rotating blades will cause injury to personnel.**

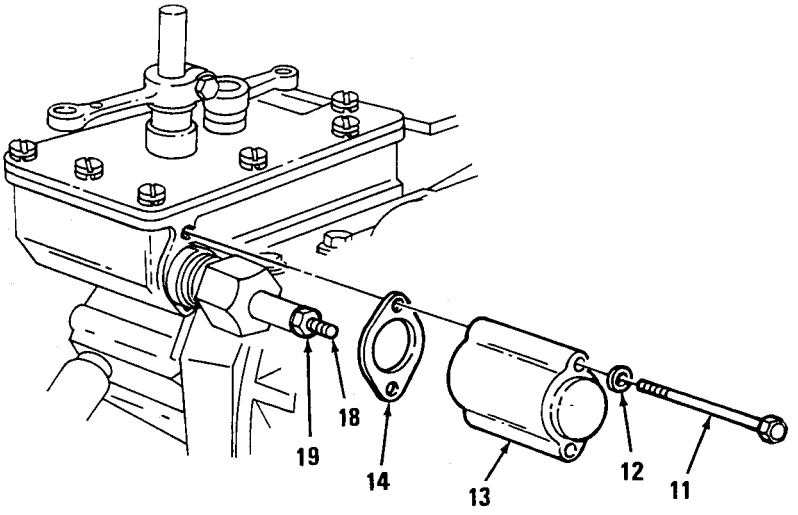


CAUTION

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.

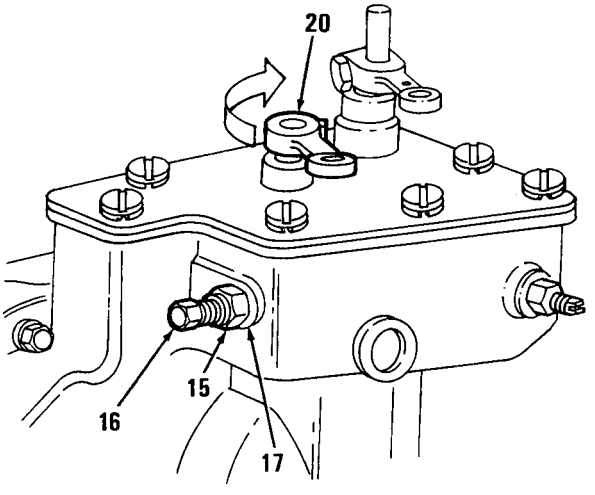
NOTE

Start and operate engine to attain a coolant operating temperature of 160-185°F (71.1-85.0oC) before adjusting governor gap.



c. For models 7083-7395 and 7083-7398, remove two bolts (6), two lockwashers (7), access cover (8), and spring housing (9) from governor housing. Discard two gaskets (1O) and lockwashers.

d. For models 7083-7391, 7083-7396, and 7083-7399, remove two bolts (11) and two flat washers (12) from access cover (13). Remove cover and gasket (14) from governor housing. Discard gasket.



e. Hold buffer screw locknut (15) and back out buffer screw (16) until it extends 0.63 inch from locknut. Snug locknut to governor housing (17).

f. Hold idle speed screw (18) and loosen idle screw locknut (19). Adjust idle speed screw to obtain idle speed of 625+/-25 RPM. Hold idle speed screw and tighten locknut.

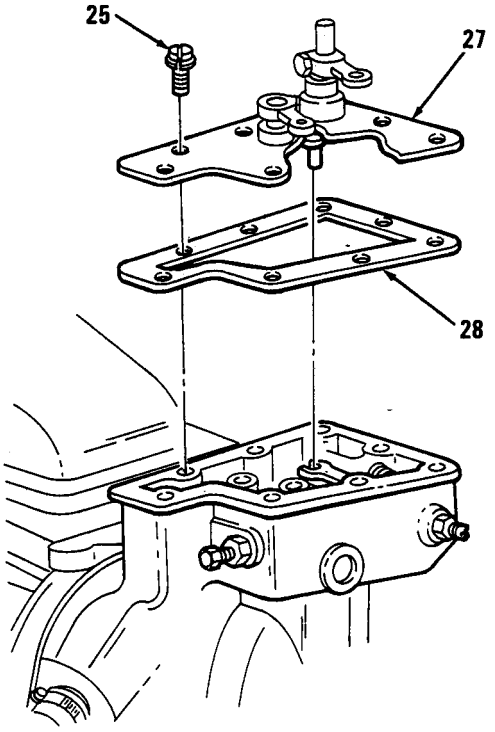
g. Stop engine using engine stop lever (20).

8-6. GOVERNOR GAP ADJUSTMENT (Cont)

h. For all models except 7083-7391. remove two bolts (21) and two lockwashers (22) securing bracket (23) to support (24).

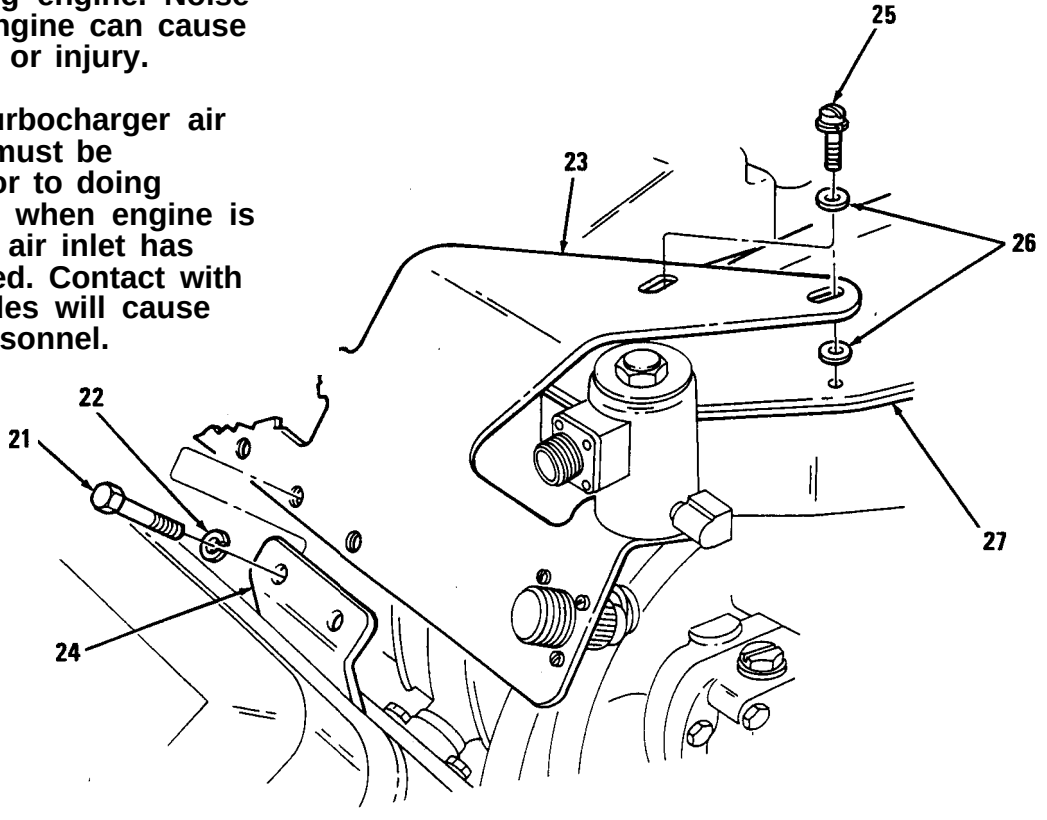
i. For all models except 7083-7391, remove two screws (25) and four flat washers (26) and move bracket (23) away from governor cover (27).

j. For all models except 7083-7391, remove remaining six screws (25) from governor cover (27). For model 7083-7391, remove eight screws (25) from governor cover. Remove cover and gasket (28). Discard gasket.



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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. 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.

- Do not exceed engine speed required to set governor gap adjustment. Hand operation of governor differential lever bypasses the governor function. Overspeeding could cause engine damage.

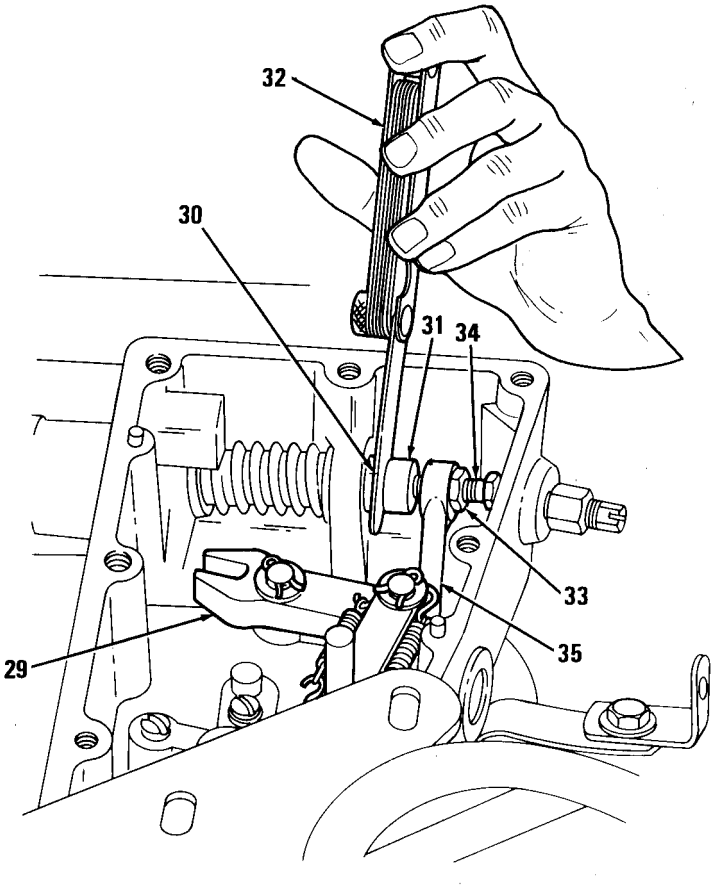
k. Start and operate engine between 1100 and 1300 RPM by manually operating the differential lever (29).

l. Check gap between low speed spring cap (30) and high speed spring plunger (31) with feeler gage (32). Gap must be 0.0015 to 0.0020 inches.

m To adjust governor gap, loosen nut (33) and turn screw (34) in governor operating shaft lever (35). Governor gap must be 0.0015 to 0.002 inch with engine operating between 1100 to 1300 RPM.

n. Stop engine. Move the differential lever (29) to NO FUEL position.

o. Hold adjusting screw (34) in position and tighten locknut (33).

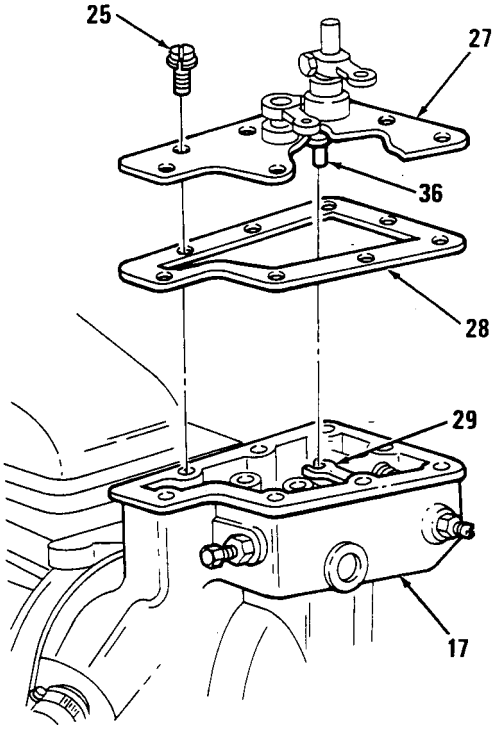


8-6. GOVERNOR GAP ADJUSTMENT (Cont)

Aline shaft (36) in governor cover (27) with differential lever (29) inside governor housing (17).

Position gasket (28) and governor cover (27) on governor assembly (17). For all models except 7083-7391, secure with six screws (25). For model 7083-7391, secure with eight screws (25).

For all models except 7083-7391, place bracket (23) on governor cover (28) and secure with two remaining screws (25) and four flat washers (26).



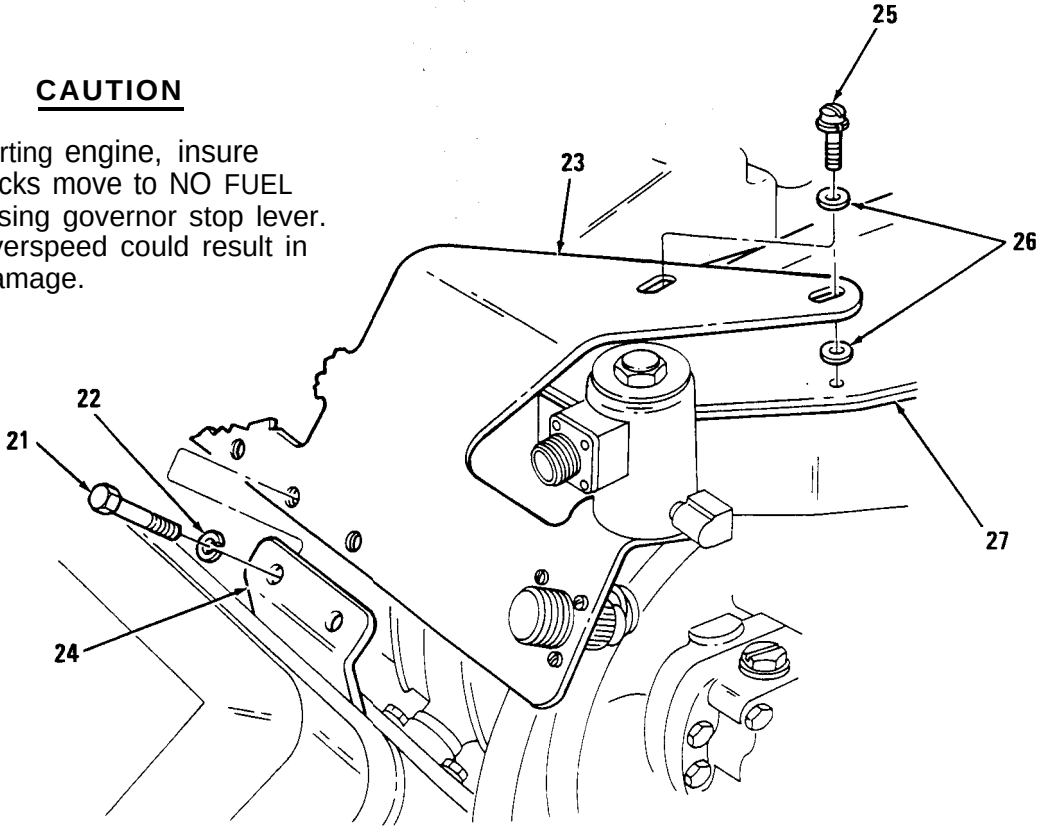
NOTE

Models 7083-7398 and 7083-7399 have a fuel line clamp under rear bolt (21).

For all models except 7083-7391, secure bracket (23) to support (24) with two bolts (21) and two lockwashers (22).

CAUTION

Before starting engine, insure injector racks move to NO FUEL position using governor stop lever. Engine overspeed could result in engine damage.

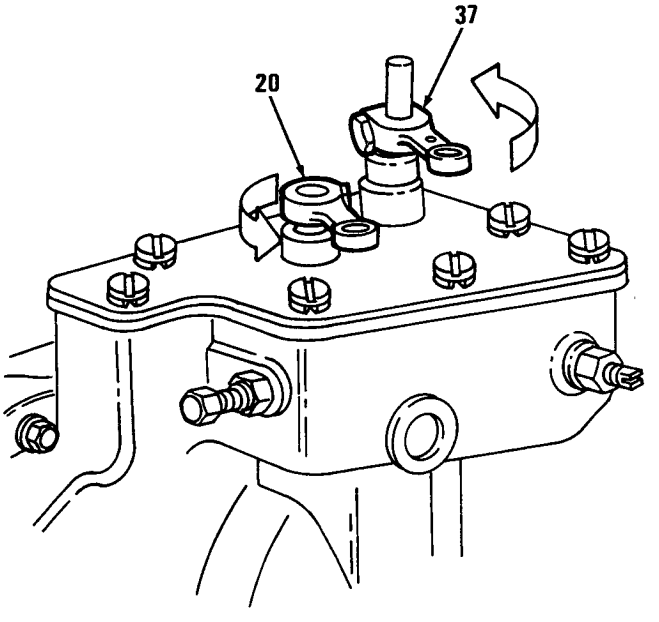


Hold speed control lever (37) in full fuel position and operate stop lever (20). If correctly installed, operating stop lever will return speed control lever to idle position and related movement will be felt in governor and injector control rack linkage.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-11	Install rocker arm covers.
	Adjust throttle delay (7083-7395 and 7083-7396).
■ 8-8	Adjust starting aid screw (7083-7391, 7083-7395, and 7083-7396).
8-10	Adjust idle speed.
■ 8-11	Install governor spring housing (Dual range limiting speed governor) (7083-7395 and 7083-7398).
■ 8-12	Install governor spring housing (Limiting speed governor) (7083-7391, 7083-7396, and 7083-7399).
8-13	Adjust buffer screw.



8-7. FUEL INJECTOR CONTROL LEVER ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

, All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

MANDATORY REPLACEMENT PARTS

2 Cotter pins (App F, Item 7)

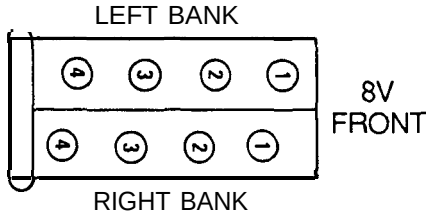
EQUIPMENT CONDITION

Para	Description
4-11	Rocker arm covers removed
8-6	Throttle delay disconnected (7083-7395 and 7083-7396)
8-6	Starting aid screw backed out (7083-7391, 7083-7395, and 7083-7396)
8-6	Governor spring housing removed (Dual range limiting speed governor)
8-6	Governor spring housing removed (Limiting speed governor)
8-6	Buffer screw backed out

Adjustment

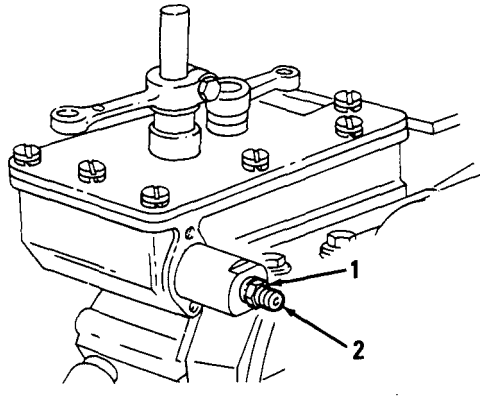
NOTE

- To ensure proper injector control rack adjustment, adjust injector control racks with yield link and governor cover used with governor.
- 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. 1 L injector control lever first to establish a guide for adjusting remaining injector control levers.
- A false fuel injector rack setting may result if idle speed adjusting screw is not backed out.



FIRING ORDER

RH.1L.3R.3L.4R.4L.2R.2L.1R



a. Loosen and hold locknut (1). Turn idle speed adjusting screw (2) until 0.5 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.

b. Loosen eight rack control lever locknuts (3) and back out eight adjusting screws (4). Eight injector control levers (5) should be loose on control tubes (6).

c. Move linkage (7) connecting governor to control racks. Linkage must not bind.

d. Rotate clevis pins (8) in right and left bank control tube levers (9). Pins must rotate freely.

e. Check for slight movement between brackets (1 O), at each end of control tubes (6), on right and left banks.

f. Rotate control tube lever (9) to FULL FUEL position; then release lever (9). Control tube must return to NO FUEL position.

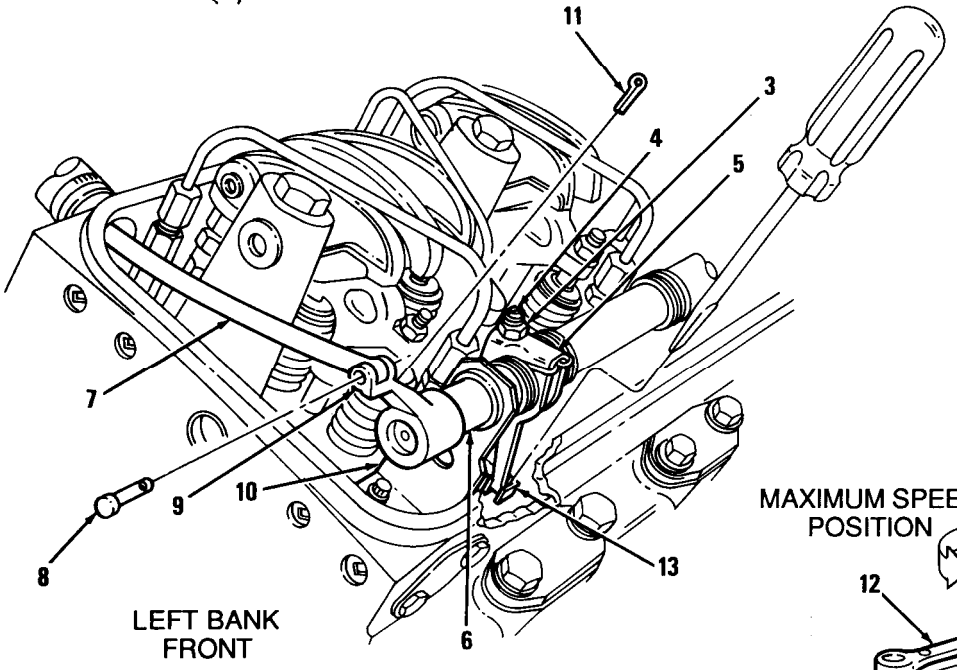
g. Remove cotter pin (11) and clevis pin (8) from right bank control tube lever (9). Discard cotter pin.

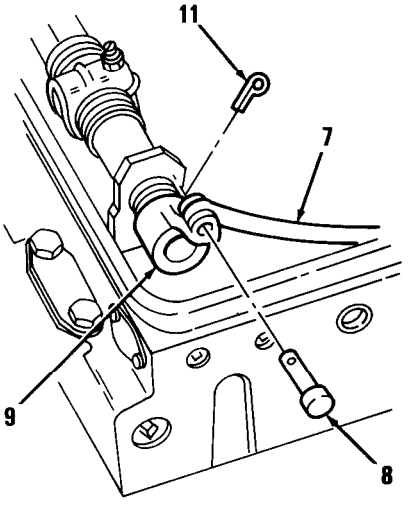
h. Move governor speed control lever (12) to maximum speed position and hold with light finger pressure.

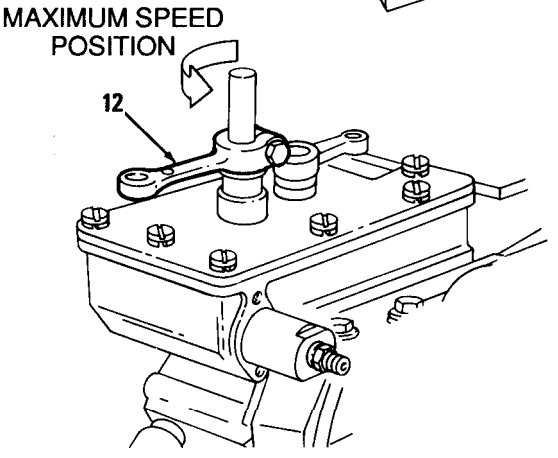
CAUTION

Do not overtighten injector rack control lever adjusting screws during installation or adjustment. Overtightening can result in damage to injector control tube. Recommended torque of adjusting screws is 24-36 lb-in (3-4 N-m).

i. Turn adjusting screw (4) on 1 L injector rack control lever until slight movement is felt on governor speed lever (12), injector control rack (13) rolls up on control lever (5), or an increase in effort to turn screw (4) is felt.







8-7. FUEL INJECTOR CONTROL LEVER ADJUSTMENT (Cent)

j. **Tighten adjusting screw (4) 1/8 turn.** Hold adjusting screw and tighten locknut (3).

k. Check **clevis** pin (8). Pin must turn freely in control tube lever (9) when 1 L is in FULL FUEL position.

1. If **clevis** pin (8) fails to rotate freely in control tube lever (9), adjust injector control rack lever (5) again.

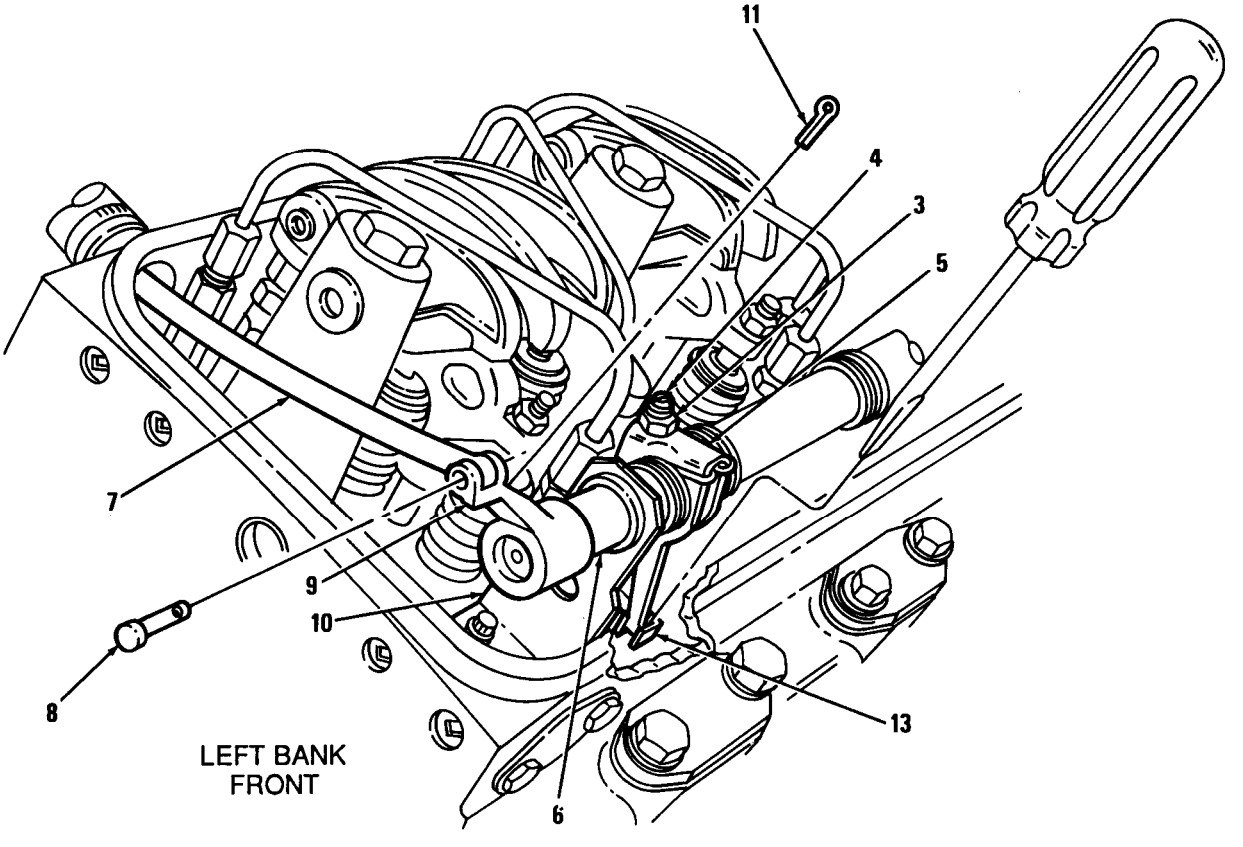
m Check injector control rack lever adjustments. Hold speed control lever (12) in maximum engine speed position. Using a screw driver, press downward on injector control rack (13); then slide screw driver off from injector control rack. Control rack should spring back upward.

n. If injector control **rack (13)** does not spring back, loosen adjusting screw locknut (3) and tighten adjusting screw (4) slightly. Tighten locknut. Check adjustment using steps h and i.

o. Move governor speed control lever (12) to maximum engine speed position. If injector control rack (13) becomes tight before governor speed control lever reaches end of travel, setting is to tight. Loosen locknut (3) and turn screw (4) slightly counterclockwise. Tighten locknut. Check setting using steps i **thru** j.

p. Connect right bank throttle control rod (7) to control tube lever (9) using **clevis** pin (8) and cotter pin (1 1).

q. Adjust 1 R injector rack control lever as outlined in steps e **thru** k.



r. Repeat check on 1 L and 1 R injector rack control levers as outlined in step i. If 1 L is loose, then 1R should be readjusted. If 1 R is loose, than 1 R should be adjusted.

NOTE

Once 1 L and 1 R injector rack control levers are adjusted, do not alter their settings. Make further adjustments only on remaining control racks.

s. Hold governor speed control lever (12) in FULL FUEL position. Check clevis pin (8) for drag on right and left control tube lever. Both pins should be free.

t Move governor speed control lever (12) to maximum speed position and hold in position with light finger pressure.

u. Adjust 2L, 3L, and 4L, as outlined in steps e thru k. Check adjustment on each injector control rack (13). Do not readjust 1 L.

v. Move speed control lever (12) to maximum speed position and hold in position with light finger pressure.

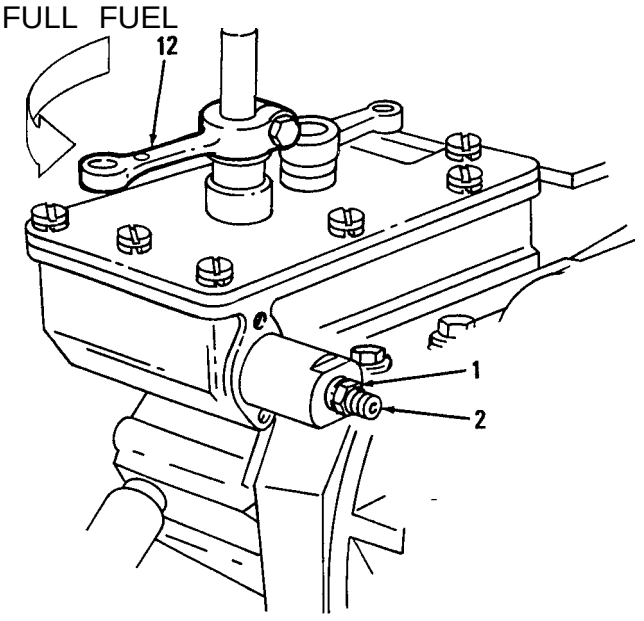
w. Adjust 2R, 3R, and 4R as outlined in steps e thru k. Do not readjust 1 R.

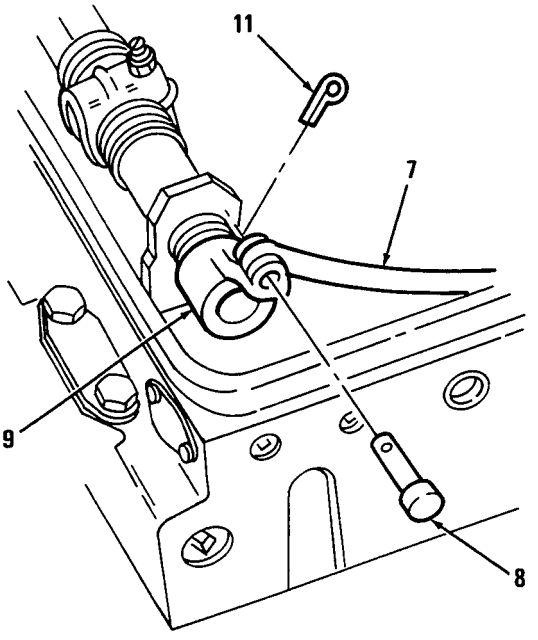
x. Turn idle speed adjusting screw (2) in until it projects 0.20 inch from-locknut (1) to permit starting of engine. Tighten locknut.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-11	Install rocker arm covers.
8-8	Adjust throttle delay (7083-7395 and 7083-7396).
8-9	Adjust starting aid screw (7083-7391, 7083-7395, and 7083-7396).
8-10	Adjust idle speed.
8-11	Install governor spring housing (Dual range limiting speed governor) (7083-7395 and 7083-7398).
8-12	Install governor spring housing (Limiting speed governor) (7083-7391, 7083-7396, and 7083-7399).
8-13	Adjust buffer screw.





8-8 THROTTLE DELAY ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

7083-7395 7083-7396

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Throttle delay gage (App B, Item 37)
Throttle delay gage pin (App B, Item 22)

EQUIPMENT CONDITION

Para	Description
4-11	Rocker arm covers removed
8-7	Buffer screw backed out
8-6	Throttle delay disconnected
8-6	Starting aid screw backed out
8-6	Governor spring housing cover removed

Adjustment

NOTE

To provide adequate Lubrication of mechanical components, fill throttle delay reservoir with clean engine oil. The oil reservoir does not have to remain full during adjustment procedure.

a. Insert throttle delay timing gage (1) on rack between injector body (2) and shoulder of injector rack clevis (3) on 2R injector.

b. Secure throttle lever (4) in maximum fuel position to put injector rack (5) against throttle delay timing gage (1).

c. Insert 0.069 inch end of throttle delay pin gage (6) into throttle delay cylinder fill hole (7).

d. Push throttle delay link (8) until piston (9) contacts pin gage (6).

CAUTION

Do not overtighten two U-bolt nuts. Damage to injector control tube or U-bolt clamp could result.

NOTE

If either U-bolt nut is tightened without pin gage being inserted, recheck the setting.

e. Loosen two U-bolt nuts (1 O). Apply light pressure on delay link (8) towards pin gage (6). Tighten two U-bolt nuts equally. Remove pin gage (6).

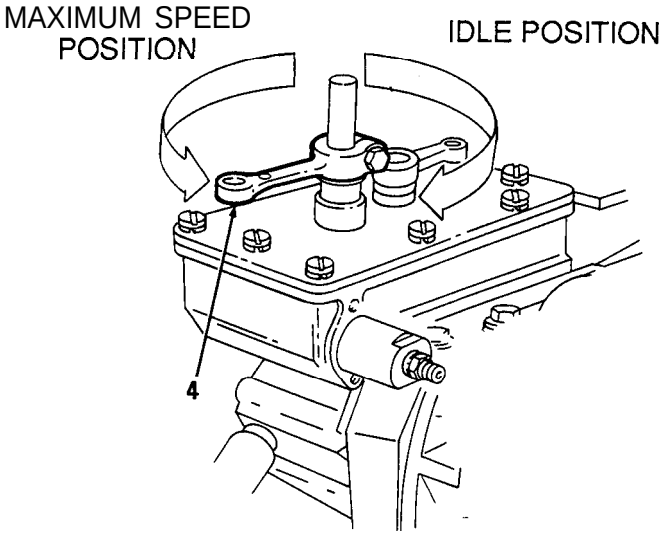
f. Check the throttle delay setting. If 0.072 inch end of pin gage enters fill hole (7), tighten upper U-bolt nut (1 O). If 0.069 inch end will not enter fill hole (7) without resistance, tighten lower U-bolt nut (1 O).

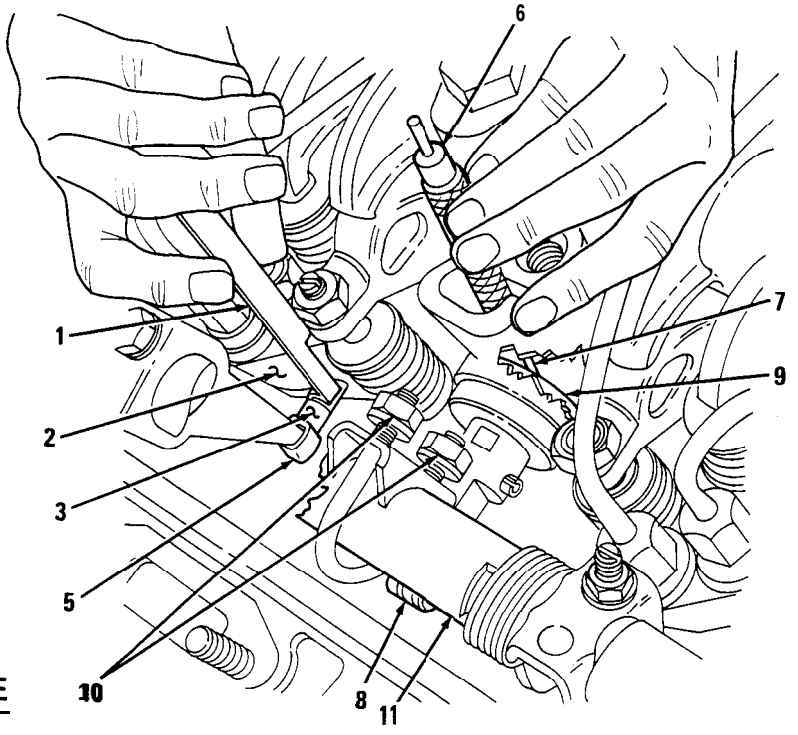
g. Insert 0.072 inch end of pin gage (6) in cylinder fill hole (7). Pin gage should not fit back in hole.

h. Reverse pin gage (6) to 0.069 inch end and insert pin gage in cylinder fill hole (7). It should enter without resistance.

i. Release throttle speed control lever (4) and remove timing gage (1) and pin gage (6).

j. Move throttle speed control lever (4) from idle position to maximum speed position. There should be no binding in movement of control tube assembly (11).





END OF TASK

FOLLOW.-ON MAINTENANCE

Para Description
4-11 Install rocker arm covers.
8-9 Adjust starting aid screw (7083-7391, 7083-7395, and 7083-7396).
8-10 Adjust idle speed.
8-11 Install governor spring housing (Dual range limiting speed governor) (7083-7395 and 7083-7398).
8-12 Install governor spring housing (Limiting speed governor) (7083-7391, 7083-7396, and 7083-7399).
8-13 Adjust buffer screw.

8-9. ADJUST STARTING AID SCREW ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

7083-7391 7083-7395 7083-7396

EQUIPMENT CONDITION

Para Description
4-11 Rocker arm covers removed

TOOLS AND SPECIAL TOOLS

General mechanic tool kit (App B, Item 96)
Injector rack gage (App B, Item 33)

Adjustment

NOTE

Perform starting aid screw adjustment with engine shutdown.

a. Position shutdown lever (1) in RUN position and throttle lever (2) in IDLE position.

NOTE

Increase injector rack clevis to body clearance by turning starting aid screw against governor gap adjusting screw or reduce by backing it out.

b. Hold starting aid screw (3) and loosen locknut (4). Position 0.385 inch gage (5) between 1 R shoulder of injector rack clevis (6) and injector body (7) so that gage stays at about a 60 degree slant without being held. Adjust starting aid screw until gage falls over from its own weight.

c. Hold starting aid screw (3) and tighten locknut (4).

NOTE

Movement of speed control lever is to take up clearance in governor linkage.

d. Check injector rack clevis (6) to injector body (7) clearance.

(1) Position stop lever (1) in RUN position.

(2) Move engine speed control lever (2) from IDLE speed to maximum speed position,

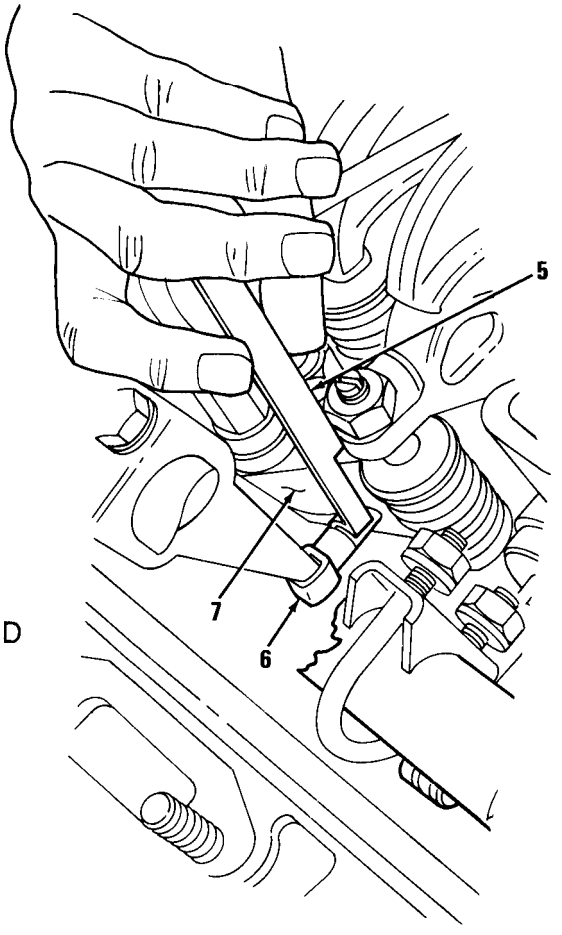
(3) Return speed control lever (2) to IDLE position.

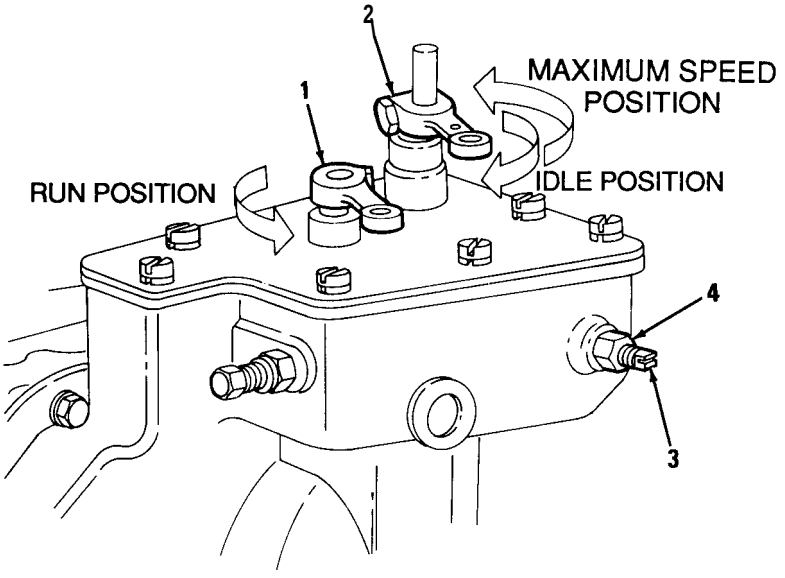
(4) Check clearance of injector rack clevis (6) to injector body (7) and if necessary, adjust using steps a thru d. Remove gage.

END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-11	Install rocker arm covers





8-10. IDLE SPEED ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

Para Description

4-11 Rocker arm covers removed
8-6 Governor spring housing cover removed (Dual range)
8-6 Governor spring housing cover removed (Limited speed)
8-6 Buffer screw backed out

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger inlet sheild (App B, Item 81)

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.**
- **Protective turbocharger air inlet sheild musr be installed prior to doing maintenance when engine is running and air inlet has been removed. Contact with rotating blades will cause injury to personel**

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. Start engine and operate coolant temperature of 160-185° (71.1-85.0°C) is attained.

b. PLace governor speed control lever (1) in IDLE position.

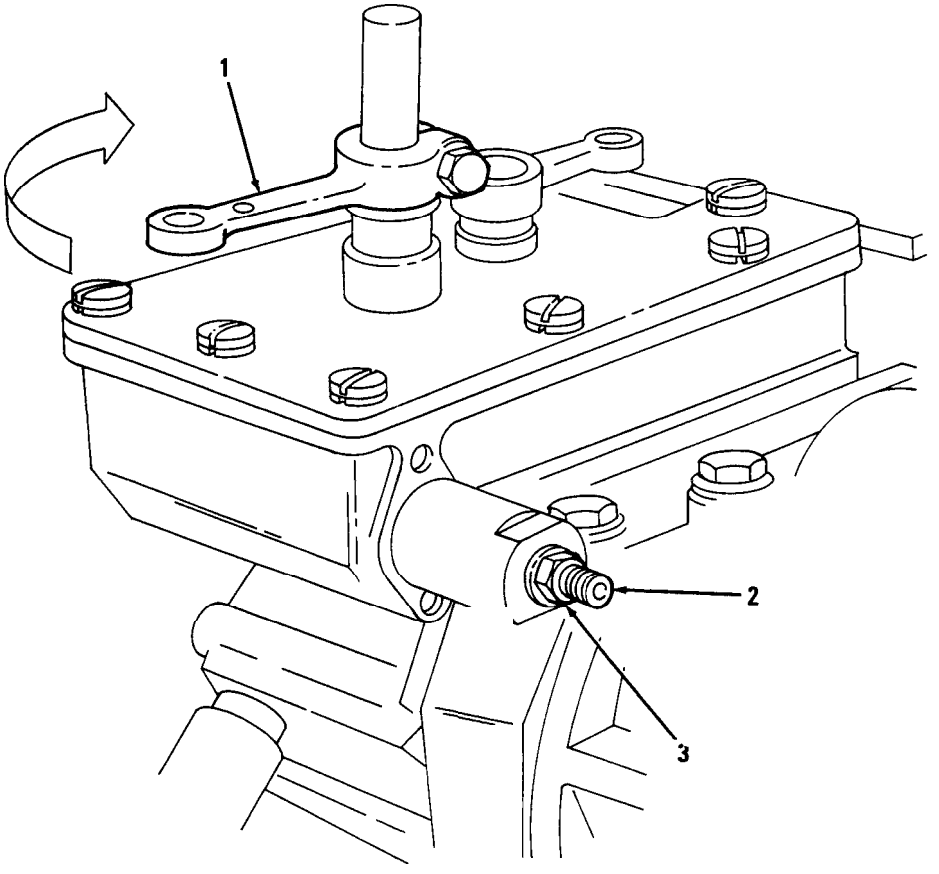
c Hold screw (2) and loosen locknut (3). Adjust engine speed screw (2) to obtain 625+/-25 RPM. Hold adjusting screw (2) in position, and tighten locknut (3).

NOTE

If necessary use buffer screw to eliminate engine speed roll. Back out buffer screw after engine idle speed is established.

d. Check engine idle speed RPM. If adjustment is needed, repeat steps a and b.

e. Stop engine.



END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-11 Install rocker arm covers.
8-11 Install governor spring housing (Dual range limiting speed governor) (7083-7395 and 7083-7398).
8-12 Install governor spring housing (Limiting speed governor) (7083-7391, 7083-7396, and 7083-7399).
8-13 Adjust buffer screw.

8-11. MAXIMUM NO LOAD SPEED ADJUSTMENT (DUAL RANGE LIMITING SPEED GOVERNOR)

This task covers: Adjustment

INITIAL SETUP

MODELS

7083-7395 7083-7398

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger inlet shield (App B, Item 81)

MANDATORY REPLACEMENT PARTS

2 Lockwashers (App F, Item 92)
2 Gaskets (App F, Item 78)

EQUIPMENT CONDITION

Para	Description
8-6	Governor spring housing cover removed
8-6	Buffer screw backed out

Adjustment

NOTE

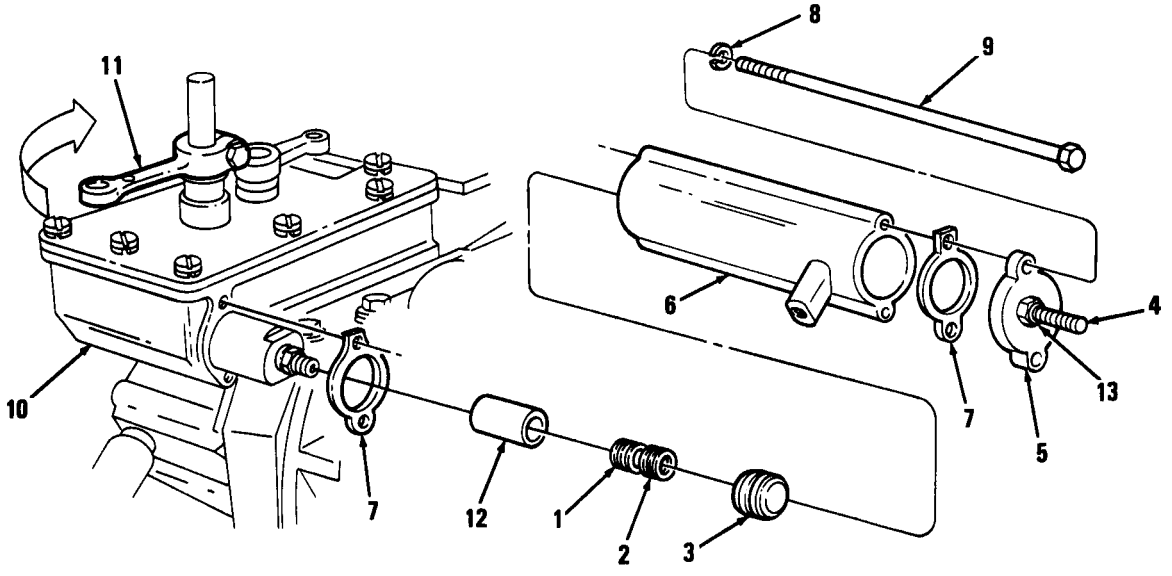
- Buffer screw must project 0.625 inch from locknut to prevent interference while adjusting the maximum No Load speed.
- If the engine has not been adjusted since overhaul, insure four 0.100 inch shims (1) and four 0.010 inch shims (2) should be in governor spring housing piston (3).
- Maximum low speed screw (4) should extend from spring housing cover (5) 1.25 inch.

a. Install governor spring housing (6), cover (5), two gaskets (7), two lockwashers (8), and two bolts (9) on governor housing (10).

b. Connect oil or air supply line to governor spring housing (6).

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.**
- **Protective turbocharger air Inlet shield must be Installed prior to doing maintenance when engine Is running and air inlet has been removed. 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.

c. Start engine and run engine to attain coolant operating temperature of 160-185°F (71.1 -85.0°C).

d. Move speed control lever (11) in maximum speed position. Apply oil or air pressure to governor and note engine speed. Return engine to idle position.

e. Discontinue oil or air pressure to governor and stop engine. If additional adjustment is needed, proceed with steps f thru k.

f. Remove two bolts (9) and two lockwashers (8) securing governor spring housing (6) and cover (5) to governor housing (1 O). Remove governor spring housing and cover. Discard two lockwashers and two gaskets (7).

CAUTION

Do not permit seal ring on piston to slide past inlet port, or seal ring will be damaged.

g. Remove piston (3) and sleeve (12) from governor spring housing (6).

8-11. MAXIMUM NO LOAD SPEED ADJUSTMENT (DUAL RANGE LIMITING SPEED GOVERNOR) (Cent)

NOTE

Removing shims will decrease engine speed and adding shims will increase the engine speed. Each 0.010 inch shim will change engine speed approximately 10 RPM.

h. Remove or add shims (1 and 2) as required in piston (3) to adjust engine speed.

i. Place sleeve (12) into piston (3) and insert into governor spring housing (6).

j. Position governor spring housing (6) with two gaskets (7) and cover (5) on governor housing (1 O) and secure with two bolts (9) and two lockwashers (8).

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.**
- **Protective turbocharger air Inlet shield must be Installed prior to doing maintenance when engine Is running and ah' inlet has been removed. 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.

k. Checking HIGH MAXIMUM NO-LOAD ENGINE SPEED

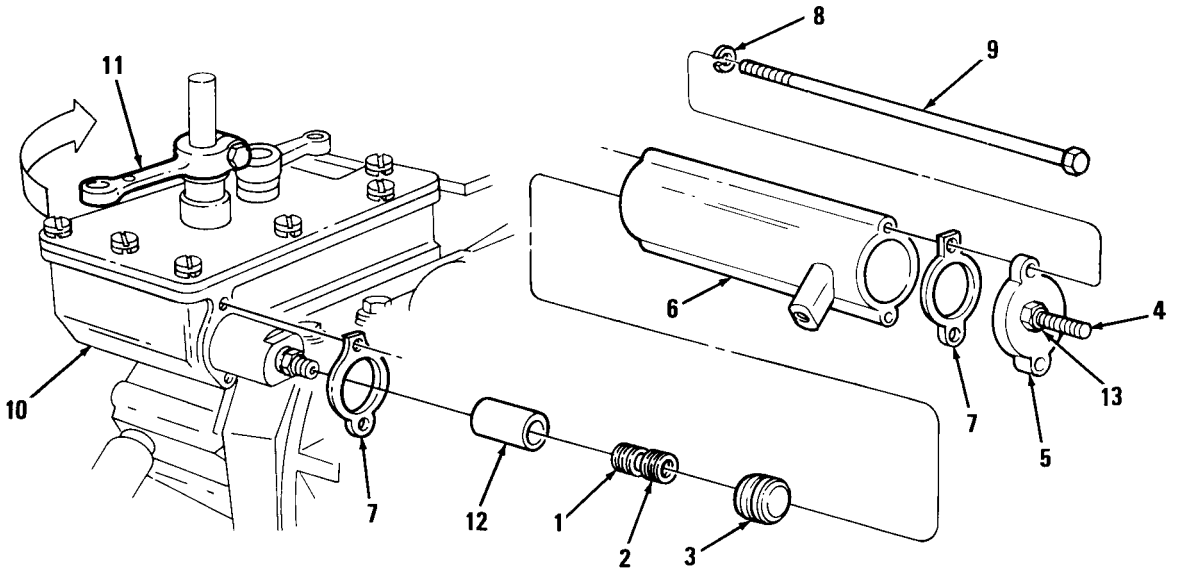
(1) Start engine.

(2) Move speed control lever (11) to maximum speed position.

(3) Apply oil or air pressure to governor and note engine speed.

(4) Discontinue oil or air pressure to governor.

(5) Stop engine. If additional adjustment is needed, repeat steps f thru k.



1. Adjusting LOW MAXIMUM NO-LOAD SPEED

(1) Loosen nut (13) and hold speed control lever (11) in maximum speed position.

NOTE

Turn adjusting screw (4) in to increase or out to decrease the engine speed.

(2) Adjust screw (4) to obtain low maximum speed 1350-1375 RPM.

(3) Hold screw and secure nut to cover (5).

m. Recheck both high maximum and low maximum engine speeds. Make adjustments if necessary as outlined in steps b thru m.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
8-13 Adjust buffer screw

8-12. MAXIMUM NO-LOAD SPEED ADJUSTMENT (LIMITING SPEED GOVERNOR)

This task covers: Adjustment

INITIAL SETUP

MODELS

7083-7391 7083-7396 7083-7399

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger inlet shield (App B, Item 81)

MANDATORY REPLACEMENT PARTS

1 Gasket (App F, Item 78)
2 Copper washers (App F, Item 164)

EQUIPMENT CONDITION

Para	Description
8-6	Governor spring housing cover removed
8-6	Buffer screw backed out

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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. 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.

NOTE

Buffer screw must project 0.625 inch from locknut to prevent interference while adjusting maximum NO-LOAD speed.

a. Start engine and run engine to attain coolant operating temperature of 160-185°F (71.1 -85. 0°C).

b. Loosen spring retainer locknut (1). Back off high-speed spring retainer (2) approximately five turns.

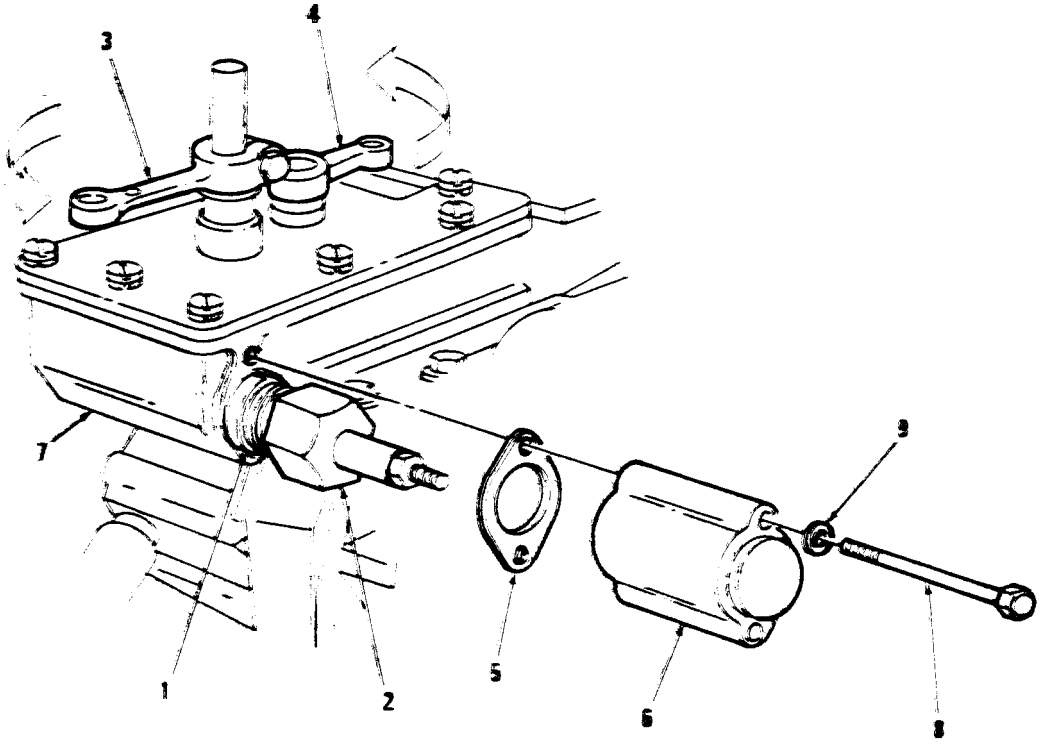
c. Move speed control lever (3) in maximum position. Turn high speed spring retainer (2 to obtain 2450 RPM. For model 7083-7391, obtain 2475 RPM.

d. Hold high-speed spring retainer (2) and secure locknut (1).

e. Recheck engine maximum NO-LOAD speed. If adjustment is required repeat steps b thru d.

f. Stop engine. Move stop lever (4) to NO-FUEL position to stop engine.

g. Install gasket (5) and governor spring housing cover (6) to governor assembly (7). Secure with two screws (8) and two washers (9).



END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
3-13	Adjust buffer screw

8-13. GOVERNOR BUFFER SCREW ADJUSTMENT

This task covers: Adjustment

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

Para Description
8-6 Buffer screw backed out

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger Inlet shield (App B, Item 81)

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 in jury.-**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and ah' inlet has been removed. 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. Start engine and operate until normal operating temperature is 165-185°F (71.1 -85. 0°C).

b. Place governor speed control lever (1) in IDLE position.

c. Hold buffer screw (2) and loosen buffer screw locknut (3).

NOTE

Do not increase engine idle speed more than 15 RPM with buffer screw.

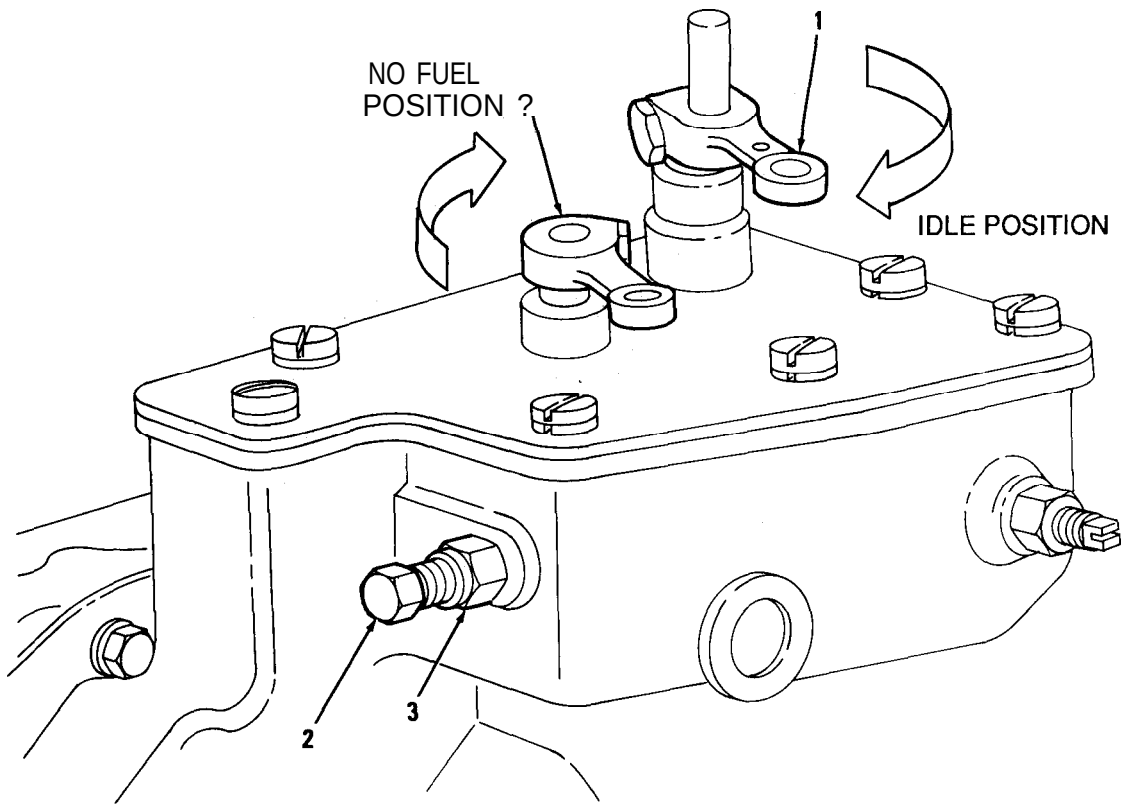
d. Hold nut (3) and turn screw (2) until it contacts differential lever as lightly as possible and eliminates engine roll.

e. Move speed control lever (1) to FULL FUEL position. If maximum No Load speed has increased more than 25 RPM, hold buffer screw nut (3) and back out buffer screw (2) until No-load speed increase is less than 25 RPM.

f. Hold buffer screw (2) and tighten locknut (3).

g. Move governor stop lever (4) to NO FUEL position.

END OF TASK



SECTION IV. ENGINE TESTING

8-14. CYLINDER COMPRESSION TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Cylinder adapter (App B, Item 90)
Cylinder tester (App B, Item 90)
Fuel nut wrench (App B, Item 99)
Turbocharger inlet shield (App B, Item 81)
Torque wrench (App B, Item 100)
Torque wrench (App B, Item 101)

EXPENDABLE/DURABLE SUPPLIES

1 Spare fuel line (App C, Item 20)

EQUIPMENT CONDITION

Para	Description
4-11	Rocker arm covers removed

Testing

WARMING

- 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.
- Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. Contact with rotating blades will cause injury to personnel.

CAUTION

Run engine in dean area when air intake ducting is removed. Dirt, dust, and particles in unfiltered air can enter engine and damage parts or cause mechanical failure.

NOTE

Start engine and operate until coolant operating temperature is 165-185°F (71.1-85.0°C). Stop engine and remove rocker arm covers.

a. Move governor control lever (1) to NO FUEL position.

b. Loosen four fuel line nuts (2) and remove two fuel lines (3).

NOTE

Bar engine over to bring upper ends of push rods of injector and valve rocker arms in line horizontally.

c. Remove two rocker shaft bracket bolts (4) and swing rocker arms (5) away from injector and valves.

d. Loosen locknut (6) and back out adjusting screw (7). Slide injector control lever (8) on injector control tube (9) away from injector control rack (10),

e. Remove bolt (1 1), convex washer (12), and clamp (13) securing injector (14). Remove injector.

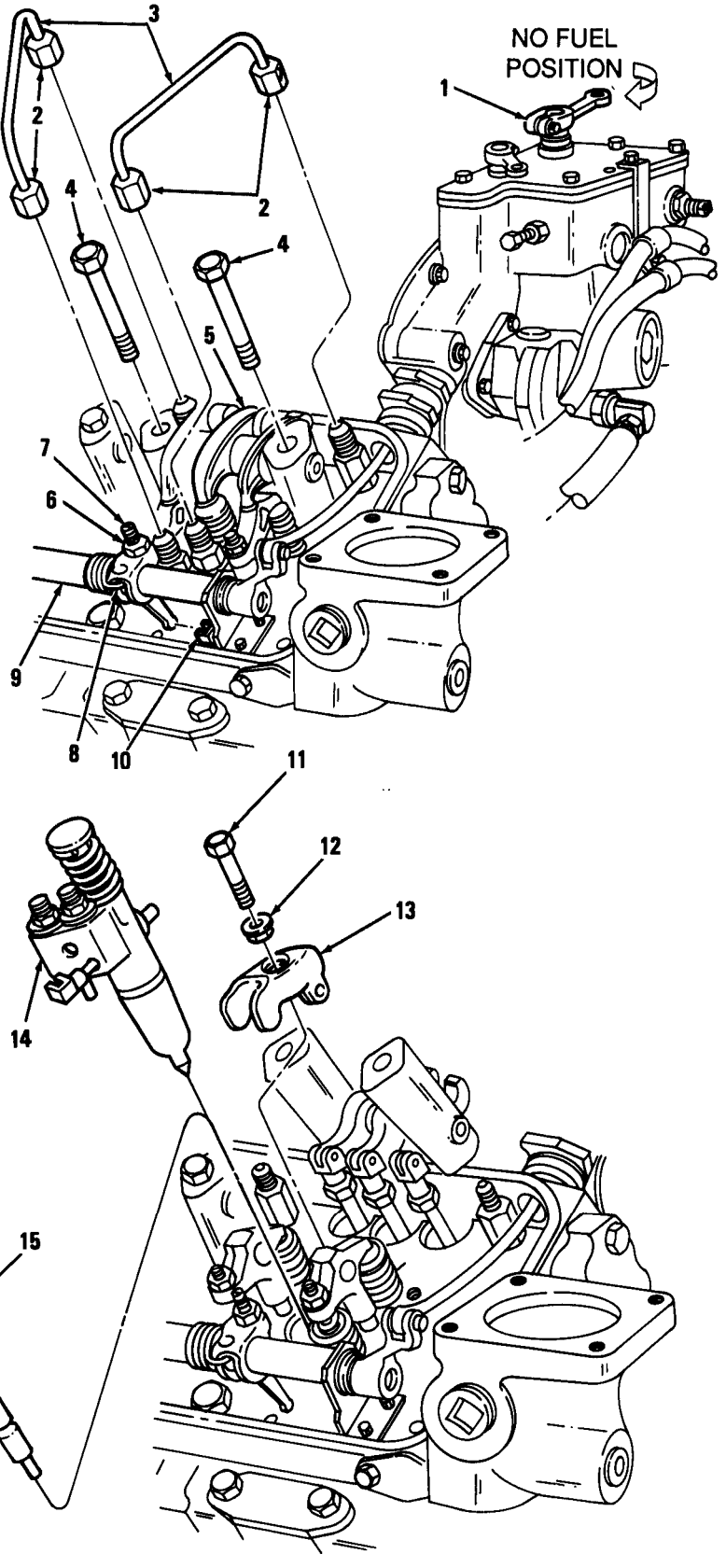
CAUTION

Injector clamp must not interfere with follower spring or exhaust valve springs when installed. Damage could occur to engine valve or injector clamp.

f. Install cylinder adapter (15) in injector tube. Secure with clamp (13), convex washer (12), and bolt (11). Torque bolt to 20-25 lb-ft (27-34 N-m). Attach cylinder tester (16) to adapter.

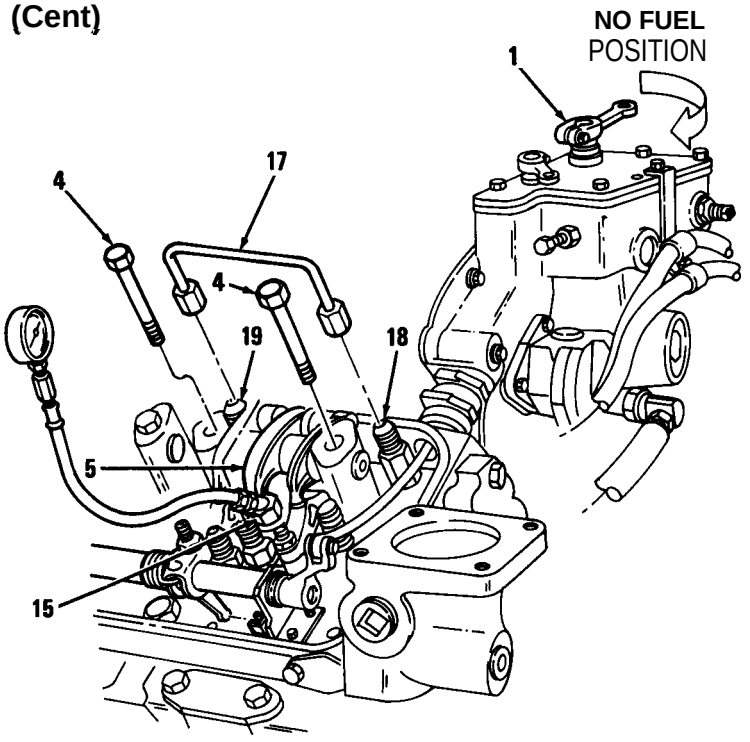
CAUTION

Exhaust valve bridges must rest on ends of exhaust valves when tightening rocker arm shaft bolts or damage to exhaust valves will result.



8-14. CYLINDER COMPRESSION TEST (Cent)

g. Position rocker arms (5) over pressure gage and adapter (15) and exhaust valves. Install two rocker arm shaft bolts (4) and torque to 90-100 lb-ft (122-136 N-m).



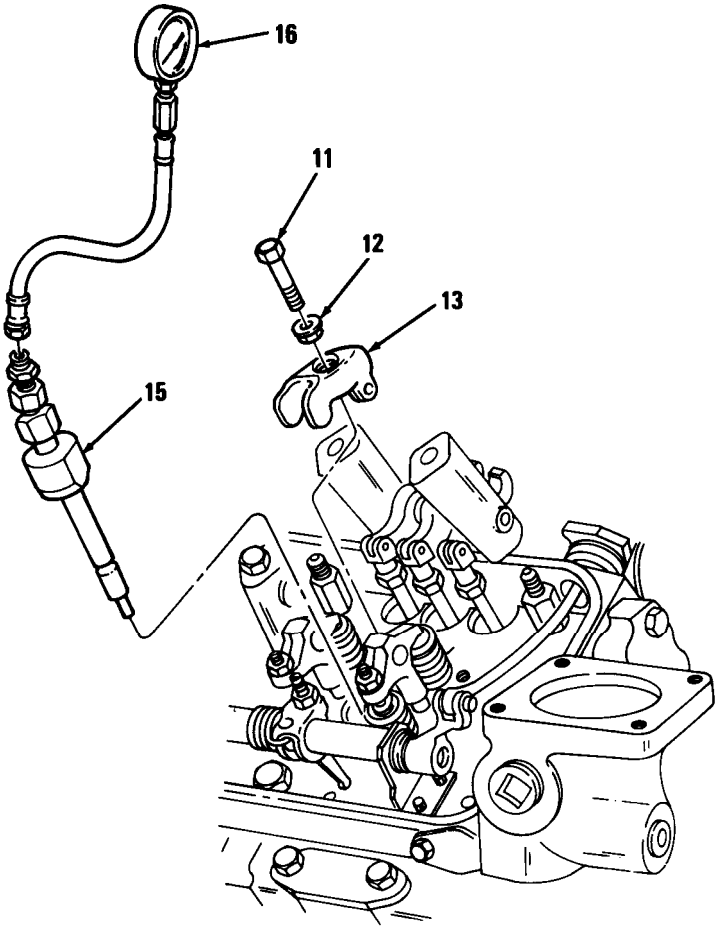
NOTE

- 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 line to fabricate a jumper connection between fuel inlet and return manifold connectors. Fuel line cannot be reinstalled on engine.

h. Install spare fuel line (17) between inlet manifold (18) and return manifold (19).

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.**
- **Protective turbocharger air inlet shield must be Installed prior to doing maintenance when engine Is running and air Inlet has been removed. 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.

i. Start engine and run at 600 RPM. Record pressure shown on cylinder tester gage.

8-14. CYLINDER COMPRESSION TEST (Cent)

j. Stop engine. Move governor control lever (1) to NO-FUEL position.

k. Remove spare fuel line (17), remove two rocker arm shaft bolts (4) and swing rocker arms (5) away from pressure gage adaptor (15).

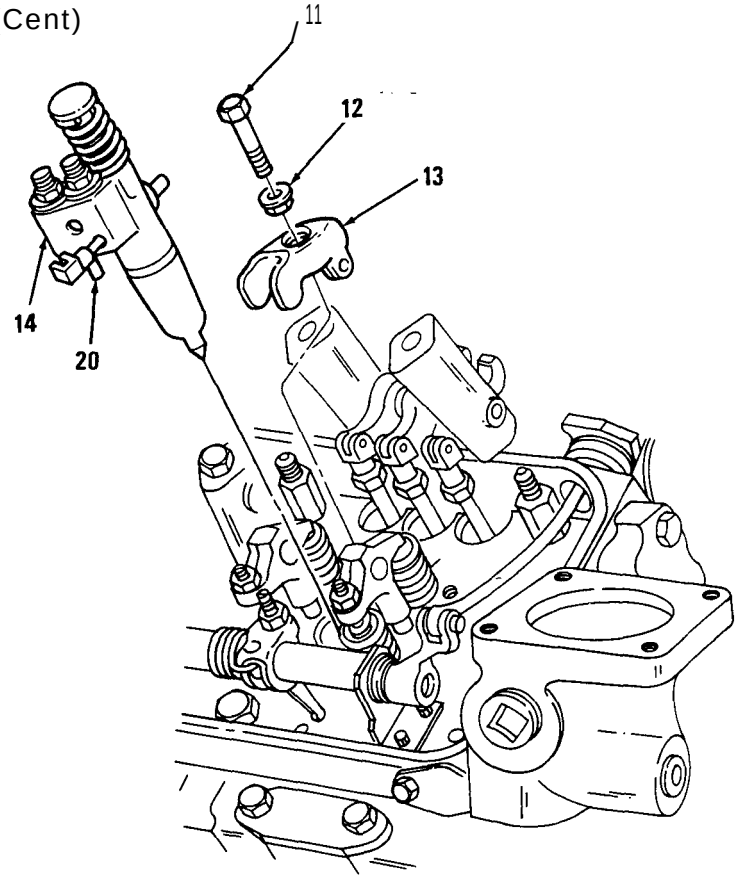
l. Remove bolt (1 1), convex washer (12), clamp (13), cylinder tester (16), and cylinder adapter (15).

m. Aline dowel (20) on injector (14) with locating hole in cylinder head. Install injector in injector tube.

n. Install clamp (13), convex washer (12), and bolt (11) with convex side of washer facing clamp (13). Torque bolt to 20-25 lb-ft (27-34 N-m).

o. Position rocker arms (5) over injector and valves. Install two rocker arm shaft bolts (4). Torque bolts to 90-100 lb-ft (122-136 N-m).

p. Slide injector control tube lever (8) into injector rack (1 O).

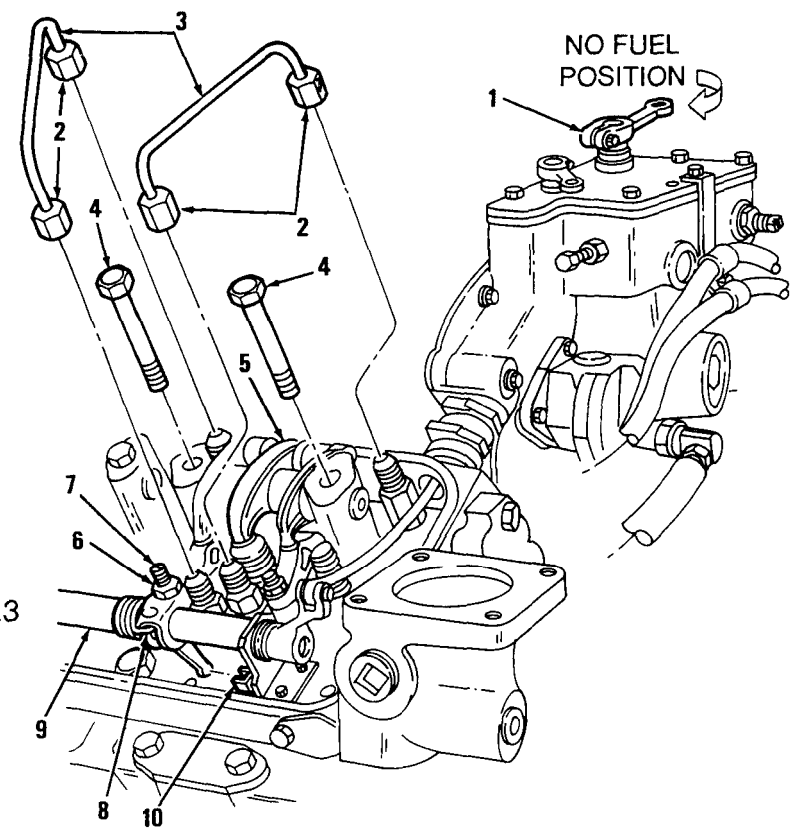


CAUTION

- Do not bend fuel lines and do not exceed specified torque on fuel line nuts. Excessive tightening will twist or fracture flared end of fuel line and result in leaks.
- Never reuse fuel lines regardless of their appearance. Always use new fuel lines. Reused fuel lines may not seal properly and result in fuel leakage.

q. Install two fuel lines (3). Using fuel nut wrench, torque four fuel line nuts (2). Torque fuel lines to 130-160 lb-in (14.7-18.3 N-m).

r. Repeat steps b thru q on remaining cylinders.



8-14. CYLINDER COMPRESSION TEST (Cent)

s. Cylinder compression pressure of any one cylinder, measured in steps a thru r above, must not be less than minimum pressures shown in Table 8-1.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Paragraph
4-11 Install rocker arm covers
8-7 Adjust injector control racks

Table 8-1. Minimum Compression Pressure at 600 rpm

		Altitude above 'Sea Level		t Air Density lbs. per cu. ft.
psi	kPa	feet	meters	
425	2928	500	152	.0715
395	2722	2,500	762	.0663
365	2515	5,000	1,524	.0613
340	2343	7,500	2,286	.0567
315	2170	10,000	3,048	.0525

t Air density at 500 ft. altitude based on 85° F(29.4°C) and 29.38 in. Hg (99.49 kPa) wet barometer.

8-15. FUEL FLOW TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Turbocharger inlet shield (App B, Item 81)

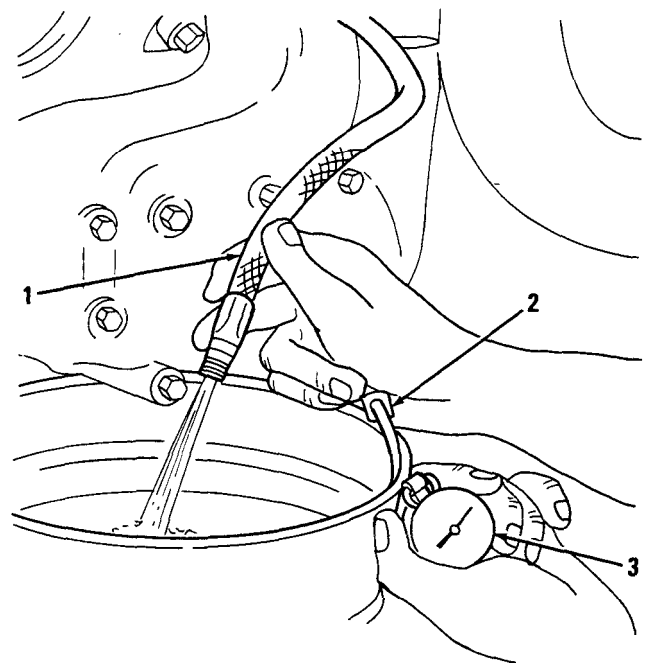
Testing

NOTE

if necessary, adapt a fuel line extension to the fuel return line to reach container.

a. Attach a fuel return line (1) beyond restricted fitting on engine.

b. Hold open end of fuel return line (1) in a container (2).



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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. 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.

c. Start engine and run at 1200 RPM NO-LOAD. Using a stop watch (3), measure fuel flow from fuel return line (1) for one minute. Minimum fuel return rate is 0.8 GPM.

d. Stop engine. Remove fuel line extension if adapted. Connect fuel return line (1).

END OF TASK

8-16. FUEL PRESSURE TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

EQUIPMENT CONDITION

Para Description
4-11 Rocker arm covers removed

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Fuel pressure gage (App B, Item 31)
Fuel nut wrench (App B, Item 99)
Turbocharger inlet shield (App B, Item 81)
Torque wrench (App B, Item 100)

Testing

a. Remove fuel inlet tube (l) from injector (2) and fuel inlet manifold (3).

b. Connect pressure gage (4) to injector (2) and fuel manifold (3).

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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed . 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.

c. Start engine and operate at 1800 RPM. Note reading on fuel pressure gage (4). Fuel pressure must be 50-70 PSI (345-482 kPa) at 1800 RPM.

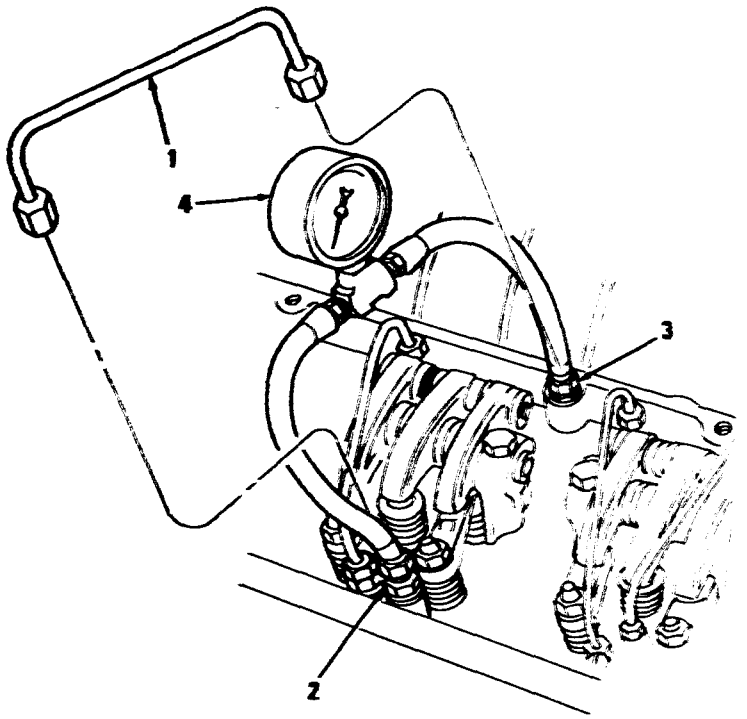
d. Move governor stop lever (5) to NO-FUEL position to stop engine.

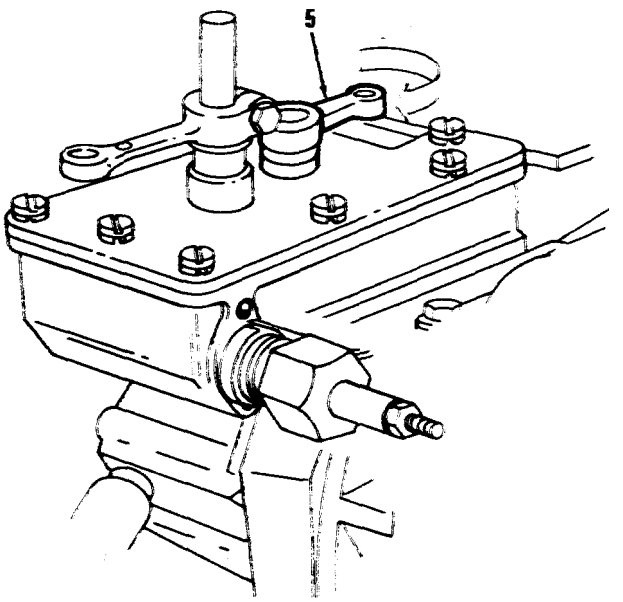
e. Remove fuel pressure gage (4) from connection at injector (2) and fuel inlet manifold (3).

CAUTION

- Do not bend fuel lines and do not exceed specified torque on fuel line nuts. Excessive tightening will twist or fracture flared end of fuel line and result in leaks.
- Never reuse fuel lines regardless of their appearance. Always use new fuel lines. Reused fuel lines may not seal properly and result in fuel leakage.

f. Install fuel inlet tube (1) on injector (2) and fuel manifold (3). Using fuel nut wrench, torque fuel inlet tube nuts to 130-160 b-in (14.7-18.3 N-m).





END OF TASK

FOLLOW-ON MAINTENANCE

Para	Description
4-11	Install rocker arm covers

8-17. CRANKCASE PRESSURE TEST

This task covers: Testing

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Food coloring (App C, Item 19)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)
Manometer (App B, Item 64)
Nonmetallic tubing (App B, Item 98)
Turbocharger Inlet shield (App B, Item 81)

Testing

a. Remove one tube connector (1) from manometer (2) by rotating in counterclockwise direction.

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 manometer scale with manometer in a vertical position.

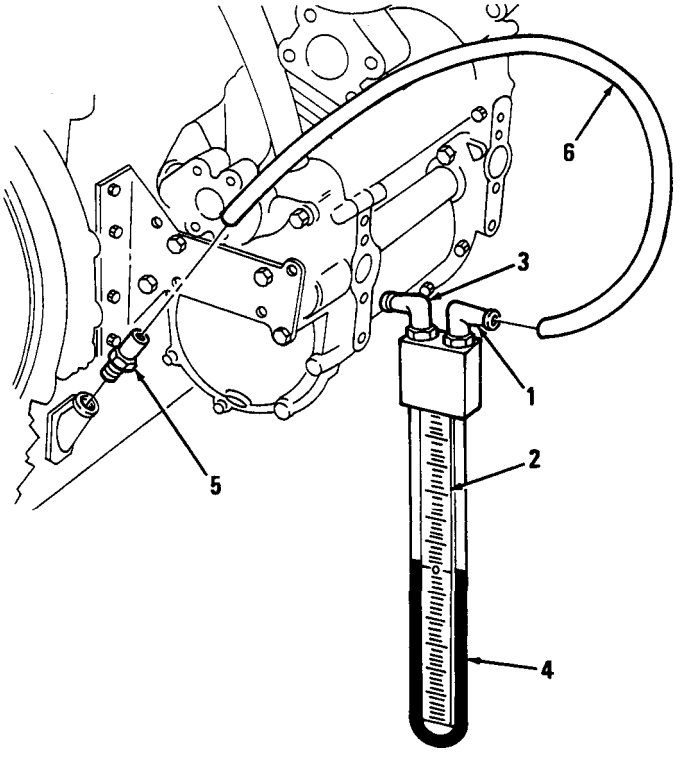
NOTE

Eliminate air bubbles by tilting manometer and gently tapping manometer.

e. Install tube connector (1) until fully engaged and then back out one full turn.

f. Remove oil level gage and tube from oil pan. Install hose adaptor (5) in oil pan.

g. Connect hose (6) to adaptor (5) and tube connector (1). Mount manometer in vertical position. Close manometer tube connector attached to hose.



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.**
- **Protective turbocharger air inlet shield must be installed prior to doing maintenance when engine is running and air inlet has been removed. 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.
- 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 1800 RPM FULL LOAD. Slowly open manometer tube connector (1) attached to hose (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 models 7083-7391, 7083-7395, and 7083-7396, measurements must not exceed 4.5 inches of water at 2300 RPM, FULL LOAD.
- For the 7083-7398 and 7083-7399, measurements must not exceed 1.5 inches of water at 2300 RPM, FULL LOAD.

i. When manometer tube connector (1) has been opened one full turn, measure crankcase pressure on manometer scale.

j. Move governor stop lever to NO-FUEL position to stop engine.

k. Disconnect hose (6) and remove adaptor (5).

l. Install oil level gage rod and tube.

END OF TASK

8-18. AIR BOX PRESSUIRE TEST

This task covers: Testing

INITIAL SETUP

MODELS

AM

EXPENDABLE/DURABLE SUPPLIES

Mercury (App C, Item 28)

TOOLS AND SPECIAL TOOL

Manometer (App B, Item 64)
Nonmetallic tubing (App B, Item 98)
Turbocharger Inlet Shield (App B, Item 81)

Testing

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.

a. Remove one tube connector (1) from manometer (2) by rotating connector in a counterclockwise direction.

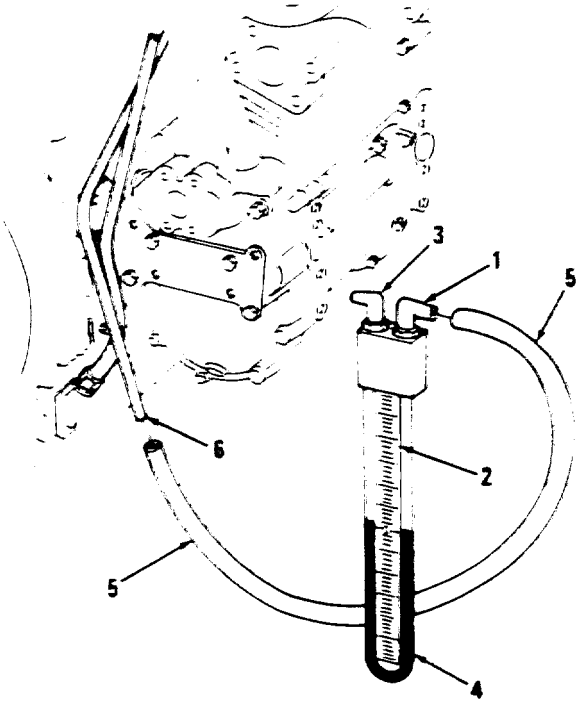
b. Turn remaining tube connector (3) until fully engaged and then back out one full turn.

c. Add mercury (4) to manometer (2) until mercury level is opposite zero mark on manometer scale with manometer in a vertical position.

d. Install tube cnnector (1) until fully engaged and then back out one full turn.

e. Connect hose (5) to air box drain tube (6) and connect opposite end of hose to manometer tube connector (1). Close manometer tube connector (1) attached to hose.

f. Mount manometer (2) in a vertical position and adjust scale until zero mark is opposite of mercury level.



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.**
- **Protective turbocharger air inlet shield must be installed** prior **to doing maintenance when engine is running and air inlet has been removed. 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.

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.

g. Start engine and operate at FULL LOAD at 2300 RPM, slowly open tube connector (1) and measure air box pressure indicated on manometer.

h. For models 7083-7395 and 7083-7396, measurement is a maximum of 55.0 and a minimum of 45.0 inches of mercury. For models 7083-7398 and 7083-7399, measurement is a maximum of **44.0** and a minimum of 36.0 inches of mercury. For model 7083-7391, measurement is a maximum of 62.0 and a minimum of 50.0 inches of mercury.

i. Move **governor stop lever to NO-FUEL** position to stop engine.

j. Disconnect hose (5) from air box drain tube (6) and manometer (2).

END OF TASK

SECTION **V. ENGINE RUN-IN**

8-19. ENGINE RUN-IN PREPARATION

This task covers: Engine Preparation

INITIAL SETUP

MODELS

All

EXPENDABLE/DURABLE SUPPLIES

Engine oil (App C, Item 16)

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

EQUIPMENT CONDITION

Para	Description
4-11	Rocker arm covers removed
8-2	Fuel system primed
8-2	Engine prelubricated

a. Preparation

WARNING

Position exhaust piping to carry toxic carbon monoxide exhaust gases away from test area.

(1) Position and secure engine to a dynamometer.

(2) Fill crankcase with correct grade of engine oil to FULL mark on oil gage rod. Do not over fill.

CAUTION

Prolonged use of starter motor and engine fuel pump to prime fuel systems can result in damage to starter, fuel pump, injectors, and erratic running of engine due to the amount of air in fuel lines and filters.

(3) Connect external source of fuel supply and fuel return to engine. Fill fuel filters with clean fuel.

(4) Connect same type of air cleaners that are used with engine when installed in vehicle.

NOTE

Locate air intake so engine inducts cool fresh air.

(5) Connect engine cooling system to a heat exchanger or radiator, similar to vehicle type, to cool engine. Fill cooling system with coolant.

(6) Provide an external source of 24 V dc electrical power for starting engine.

(7) Install oil pressure gage to main oil gallery.

(8) Install water temperature gage in thermostat housing or water outlet manifold.

(9) Connect tubing to exhaust outlet of turbocharger to conduct exhaust gases from engine.

(lo) Connect throttle control linkage to throttle control levers on governor.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
4-11 Install rocker arm covers

8-20. ENGINE RUN-IN

This task covers: a. Run-In Procedure b. Horsepower Correction and Acceptance Test

INITIAL SETUP

MODELS

All

TOOLS AND SPECIAL TOOLS

General mechanics tool kit (App B, Item 96)

EQUIPMENT CONDITION

Para Description
8-19 Engine prepared for run-in

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

- When any original bearings, piston rings, pistons, or cylinder liners were replaced during repair, use the long run-in schedule (Table 8-2).
- When all original bearings, piston rings, pistons, or cylinder liners were reused during repair, use the short run-in schedule (Table 8-3) or (Table 8-3.1) for model 7083-7391 only.
- During Period 1, Table 8-2, 8-3, or 8-3.1; remove rocker arm covers, inspect for fuel oil and coolant leaks in the rocker arm compartment, and install rocker arm covers (Refer to Para 4-1 1).
- After completion of Period 2, Table 8-2 or 8-3; adjust governor gap (Refer to Para 8-6).
- After completion of Period 8, Table 8-2; Period 5, Table 8-3; or Period 4, Table 8-3.1; adjust idle speed (Refer to Para 8-1 O), no-load speed (Refer to Para 8-11 for dual range limiting speed governor or Para 8-12 for limiting speed governor), and governor buffer screw (Refer to Para 8-13).

(1) Using run-in schedule (Table 8-2.$-3. or 8-3.1.), start engine and run in engine. Record the following data for each rim-h 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 9, Table 8-2; Period 6. Table 8-3: or Period 5, Table 8-3.1).

(j) Barometric pressure

(k) Ambient air wet bulb temperature.

(l) Ambient air dry bulb temperature.

Table 8-2. Long Run-In Schedule

Period Number	Time (Minutes)	Engine Speed (RPM)	Load (Brake Horsepower)
1	15	600	0
2	15	900	60
3	15	1100	105
4	15	1400	160
5	20	1800	240
6	20	2100	300
7	20	2300	332
8	20	2300	345
9	30	2300	Full Power Check
10	5	600 (Cooling Off)	0

8-20. ENGINE RUN-IN (Cent)

Table 8-3. Short Run-In Schedule

Period Number	Time (Minutes)	Engine Speed (RPM)	Load (Brake Horsepower)
1	5	600	0
2	5	1200	0
3	30	2500	0
4	15	2300	107
5	15	2300	230
6	15	2300	Full Power Check
7	5	600 (Cooling Off)	0

Table 8-3.1. Run-In Schedule (Model 7083-7391 Only)

Period Number	Time (Minutes)	Engine Speed (RPM)	Load (Brake Horsepower)
1	10	1200	56
2	5	2475	0
3	10	2300	396
4	5	2475	0
5	20	2300	Full Power Check
6	5	2475 (Cooling Off)	0

(2) Tighten cylinder head bolts and adjust exhaust valve clearance after run-in (Refer to Para 4-27 and 8-4 respectively).

(3) For model 7083-7391 only, retorque right bank exhaust manifold stud nuts to 43-48 lb-ft (59-67 N-m) after run-in (Refer to Para 5.1-3).

b. Horsepower Correction and Acceptance Test.

(1) See Table 8-4 for listing of measurement term definitions.

Table 8-4. List of Measurement Term Definition

Symbol	Name	Units
$BARO_o$	Observed Barometric Pressure (Not corrected to Sea Level)	inches Hg
$BARO_d$	Dry Barometric Pressure	inches Hg
VP	Water Vapor Pressure	inches Hg
T_{db}	Dry Bulb Temperature	'F
T_{wb}	Wet Bulb Temperature	"F
T_a	Air Intake Temperature (At Air Cleaner)	"F
CF_a	Air Correction Factor	" HP
CF_{sg}	Fuel Specific Gravity Correction Factor	HP
CF_{ft}	Fuel Temperature Correction Factor (At Fuel Filter Outlet)	HP
BHP_o	Brake Horsepower Observed	HP
BHP_c	Brake Horsepower Corrected (To 77°F and 29.31 inches Hg Dry)	HP

(2) Dry Barometric Pressure ($BARO_d$) using wet-bulb and dry-bulb temperatures.

(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 8-5 for water vapor pressure (VP) at observed wet-bulb and dry-bulb temperatures.

8-20. ENGINE RUN-IN (Cont)

Table 8-6. Water Vapor Pressure (inches HG)

		Wet Bulb Temperature - T_{wb} - °F								
		50	55	60	65	70	75	80	85	90
D	55	0.31	0.43							
r	60	0.25	0.38	0.52						
y	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
T_{db}	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

(d) Dry barometric pressure is:

$$BARO_d = BARO_b - VP$$

(3) Air Correction Factor (CF_a).

(a) Measure the air inlet temperature (T_a) at air cleaner during test.

(b) For all models except 7083-7391, refer to Table 8-6 for air correction factor (CF_a).

Table 8-6. Air Correction Factor (CF_a) in BHP

		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	11	8	5	1	-2	-3	-5	-6	-7
e	65	13	10	6	3	0	-1	-3	-4	-6
m	70	15	11	8	5	2	0	-1	-3	-4
p	75	17	13	10	7	4	2	1	-1	-2
e	80	19	15	12	8	5	4	2	1	-1
r	85	20	17	13	10	7	5	4	2	1
a	90	22	18	15	12	9	7	6	4	3
t	95	24	20	17	13	10	9	7	6	4
u	100	25	22	18	15	12	10	9	7	6
r	105	27	23	20	17	14	12	11	9	8
e	110	29	25	22	18	15	14	12	11	9
	115	31	27	23	20	17	15	14	12	11
T_a	120	32	29	25	22	18	17	15	14	12
	125	34	30	27	23	20	19	17	15	14
°F										

(c) For model 7083-7391, refer to Table 8-7 for air correction factor (CFa).

Table 8-7. Air Correction Factor (CFa) in BHP (Model 7083-7391 Only)

		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	13	9	5	2	-2	-3	-5	-7	-8
e	65	15	11	7	3	0	-2	-3	-5	-6
m	70	17	13	9	5	2	0	-1	-3	-4
p	75	18	15	11	7	4	2	1	-1	-3
e	80	20	16	13	9	6	4	2	1	-1
r	85	22	18	15	11	8	6	4	3	1
a	90	24	20	16	13	9	8	6	5	3
t	95	26	22	18	15	11	10	8	6	5
u	100	28	24	20	17	13	11	10	8	7
r	105	30	26	22	18	15	13	12	10	8
e	110	32	28	24	20	17	15	13	12	10
	115	34	30	26	22	19	17	15	14	12
T_a	120	35	31	28	24	20	19	17	15	14
	125	37	33	29	26	22	20	19	17	15
°F										

(4) Fuel specific gravity correction factor (CF_{sg}).

(a) Measure fuel specific gravity and correct to 60 °F (15.6 °C).

(b) Refer to Table 8-8 fuel specific gravity correction factor (CF_{sg}).

Table 8-8. Fuel Specific Gravity Correction Factor (CF_{sg}) in BHP

Specific Gravity	Correction Factor		Specific Gravity	Correction Factor
0.860	-1		0.833	5
0.853	0		0.828	6
0.849	1		0.822	7
0.845	2		0.815	8
0.841	3		0.800	9
0.837	4			

8-20. ENGINE RUN-IN (Cont)

(5) Fuel temperature correction factor (CF_{ft}).

(a) Measure fuel temperature at fuel filter outlet.

(b) Refer to Table 8-9 and find fuel temperature correction factor (CF_{ft}).

Table 8-9. Fuel Temperature Correction Factor (CF_{ft}) in BHP

Temperature °F	Correction Factor		Temperature °F	Correction Factor
60	-7		100	0
65	-6		105	1
70	-5		110	2
80	-4		115	3
85	-3		120	4
90	-2		125	5

(6) Corrected brake horsepower (BHP_c) is:

$$BHP_c = BHP_o + CF_a + CF_{sg} + CF_{ft}$$

(7) For all models except 7083-7391, a minimum of 380 corrected brake horsepower is acceptable.

(8) For model 7083-7391, a minimum of 418 corrected brake horsepower is acceptable.

END OF TASK

FOLLOW-ON MAINTENANCE

Para Description
3-3 Install engine in container (12268285)
3-4 Install engine in container (10909159/10923108).

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 Recovery Vehicle, Full Tracked,
Light, Armored: M578 (NSN 2350-00-439-6242) . . . . . LO 9-2350-238-12
Lubrication Order for Carrier, Ammunition, Tracked:
M992 (NSN 2350-01-110-4660) . . . . . LO 9-2350-267-12
Lubrication Order for Howitzer, Heavy, Self-Propelled:
8-inch, M110A2 (NSN 2350.01.041.4590) . . . . . LO 9-2350-304-12
Lubrication Order for Howitzer, Medium, Self-Propelled:
155-mm M109A2 (NSN 2350-01-031-0586),
155-mm M109A3 (NSN 2350-01-031 -8851), and
155-mm M109A4 (NSN 2350-01-305-0028) . . . . . LO 9-2350-311-12

A-6. FIELD MANUALS

Principles of Automotive Vehicles . . . . . TM 9-8000
First Aid for Soldiers . . . . . FM 21-11

A-7. TECHNICAL MANUALS

Inspection, Care, and Maintenance of Antifriction Bearings . . . . . TM 9-214
Welding: Theory and Application . . . . . TM 9-237
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
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
Direct Support and General Support Maintenance
Repair Parts and Special Tools List for Engine, Diesel w/Container:
■ Model 7083-7391 (NSN 2815-01-335-4579), Engine, Diesel w/Container:
Model 7083-7395 (NSN 2815-01-043-7092) and (NSN 2815-01-260-0211),
Engine, Diesel w/Container: Model 7083-7396 (NSN 2815-01-040-3120) and
(NSN 2815-01-260-0212), Engine, Diesel w/Container:
Model 7083-7398 (NSN 2815-00-936-7659), Engine, Diesel w/Container:
■ Model 7083-7399 (NSN 2815-00-134-4845) . . . . . TM 9-2815-202-24P
Operator's Manual for Recovery Vehicle, Full Tracked,
Light Armored: M578 (NSN 2350-00-439-6242) . . . . . TM 9-2350-238-10
Organizational Maintenance Manual for Recovery Vehicle, Full Tracked,
Light Armored: M578 (NSN 2350-00-439-6242) TM9-2350-238-20
Direct Support and General Support Maintenance Manual for Recovery Vehicle,
Full Tracked, Light Armored: M578 (NSN 2350-00-439-6242) . . . . . TM 9-2350-238-34
Operator's Manual for Carrier, Ammunition, Tracked:
M992 (NSN 2350-00-1 10-4660) . . . . . TM 9-2350-267-10
organizational Maintenance Manual for Hull, Powerpack, Drive Controls,
Tracks, Suspension and Associated Components, Carrier, Ammunition,
Tracked: M992 (NSN 2350-00-1 10-4660) TM9-2350-267-20
Direct Support and General Support Maintenance Manual for Hull, Powerpack,
Drive Controls, Tracks, Suspension and Associated Components, Carrier,
Ammunition, Tracked: M992 (NSN 2350-00-1 10-4660) . . . . . TM 9-2350-267-34
Operator's Manual for Howitzer, Heavy, Self-Propelled:
8-inch, M110A2 (NSN 2350-01-041-4590) . . . . . TM 9-2350-304-10
Organizational Maintenance Manual for Howitzer, Heavy, Self-Propelled:
8-inch, M110A2 (NSN 2350-01-041-4590) . . . . . TM 9-2350-304-20
Direct Support and General Support Maintenance Manual for Hull and
Related Components: Howitzer, Heavy, Self-Propelled:
8-inch, M110A2 (NSN 2350-01-041-4590) . . . . . TM 9-2350-304-34-1
Operator's Manual for Howitzer, Medium, Self-Propelled:
155-mm M109A2 (NSN 2350-01-031-0586),
155-mm M109A3 (NSN 2350-01-031-8851), and
155-mm M109A3 (NSN 2350-01-031-8851) . . . . . TM 9-2350-311-10
Organizational Maintenance Manual for Hull, Powerplant, Drive Controls, Tracks,
Suspension, and Associated Hardware for Howitzer, Medium, Self-Propelled:
155-mm M109A2 (NSN 2350-01-031-0586),
155-mm M109A3 (NSN 2350-01-031-8851), and
155-mm M109A4 (NSN 2350-01-305-0028) . . . . . TM 9-2350 -311-20-1

Direct Support and General Support Maintenance
Manual for Hull, Powerplant, Drive Controls,
Tracks, Suspension, and Associated Hardware for
Howitzer, Medium, Self-Propelled:
155-mm M109A2 (NSN 2350-01-031-0586),
155-mm M109A3 (NSN 2350-01-031-8851), and
155-mm M109A4 (NSN 2350-01-305-0028) . . . . . TM 9-2350-311-34-1
Direct Support, General Support, and Depot Maintenance
(including Repair Parts) for Starter, Engine, Electric, Assembly
(NSN 2920-00-226-6545) (Delco-Remy Model 1113943)
(Military PN 10911018-1); (NSN 2920-00-91 1-5637)
(Delco-Remy Model 1113904) (Military PN 10911018);
(NSN 2920-00-912-9510) (Delco-Remy Model 1113944) . . . . . TM 9-2920-242-35
Direct Support and General Support Maintenance Manual
(including RPSTL) for Starter, Engine, Electric Assembly
(Leece-Neville M001 072 MB) (NSN 2920.00.267.9987) . . . . . TM 9-2920-243-34
Direct Support, General Support, and Depot Maintenance
(including Repair Parts) for Starter, Engine, Electrical, Assembly
(NSN 2920-00-999-6216) (Prestolite Model-MFY61 01IUT) . . . . . TM 9-2920-248-35

A-8. TECHNICAL BULLETINS

DA Technical Bulletin Warranty Program
Direct Support and General Support Maintenance . . . . . TB 9-2815-202-34
Ordnance Engines: Run-In and Test Procedures . . . . . TB 9-2800-200-50

A-9. MILITARY SPECIFICATIONS

Clean Process MIL-P-116
Military Standard Marking for Shipment and Storage MIL-STD-129

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 4910.00.91 9. 0078) . . . . . SC 4910-95-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) . . . . . SC 4910-95-A63
Shop Equipment, General Purpose Repair,
Semitrailer Mounted: (NSN 4940-00-287-4894) . . . . . SC 4940-95-CL-B02
Tool Kit, General Mechanic's . . . . . SC 5180-90-CL-N05

APPENDIX B

TOOLS AND TEST EQUIPMENT
SPECIAL TOOLS AND COMMON TOOL SETS

Section I. INTRODUCTION

B-1 SCOPE

This appendix lists all common tool sets and supplemem sets and special tools needed to maintain the 8V71T Model 7083-7391. 7083-7395. 7083-7396, 7083-7398, and 7083-7399 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 13)").
Initial Setup to identify the item (e.g., "Cradle (App B, Item 13)").

b.Column2-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). 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.

d. Column 4- **National Stock Number.** This 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

(1) ITEM NUMBER	(2) DESCRIPTION	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER	(5) REFERENCE
001	ADAPTER	J7932	5120-00-733-8890	TM9-2815-202-24P
002	ADAPTER 3/8-1 6		5120-00-316-9170	SC4940-CL-B02
003	ADAPTER KIT-INSERT GRINDING	J6390-02	5180-01-026-0307	TM9-2815-202-24P
004	DIAL INDICATOR	J21224	4910-00-907-0713	TM9-2815-202-24P
005	ALIGNMENT TOOLS, TACHOMETER DRIVE	J23068	5180-01-025-8062	TM9-2815-202-24P
006	BALL ATTACHMENT, MICROMETER	J4757	5210-00-494-1738	TM9-2815-202-24P
007	BLOCKS, LAPPING	J22090-A	3460-00-937-5521	TM9-2815-202-24P
008	BRACKET	10903999	4910-00-737-0432	TM9-2815-202-24P
009	BRUSH, WIRE ROTARY	J7944	5130-00-937-7281	TM9-2815-202-24P
010	CALIPER, VERNIER (0-6.0 IN)		5210-00-277-7549	SC4940-CL-B02
011	CLAMP, CYLINDER LINER HOLD-DOWN	J21793-B	5120-00-999-8618	TM9-2815-202-24P
012	COMPRESSOR, PISTON RING	J3272-03	5120-00-859-6259	TM9-2815-202-24P
013	COMPRESSOR, VALVE SPRING, HEAD OFF ENGINE	J8062	5120-00-254-5049	TM9-2815-202-24P
013	COMPRESSOR, VALVE SPRING, HEAD ON ENGINE		5120-00-239-8686	SC4940-CL-B02
014	CRADLE	7950198	4910-00-795-0198	TM9-2815-202-24P
015	DRAIN UNIT	8706359	4930-00-545-8639	TM9-2815-202-24P
016	DRIVER, CAM	5344997	4910-00-363-7556	TM9-2815-202-24P
017	EXPANDER, SEAL		5120-00-443-2508	SC4940-95-CL-B02
018	FIXTURE, CAM FOLLOWER HOLDING	10881910	2815-00-705-9278	TM9-2815-202-24P
019	FIXTURE, CYLINDER HEAD LIFTING	J22062-01	4910-00-456-7620	TM9-2815-202-24P
020	FIXTURE, HOLDING INJECTOR	J22396-1	5220-01-061-4248	TM9-2815-202-24P
021	FIXTURE, TURBOCHARGER HOLDING	J29086	4910-01-170-4914	TM9-2815-202-24P
022	GAGE PIN, THROTTLE DELAY	J25558	5220-01-138-7558	TM9-2815-202-24P
023	GAGE SET, DEPTH MICROMETER		5210-00-619-4045	SC4940-CL-B02
024	GAGE SET, PISTON-LINER FEELER	J5438-01	5210-00-116-1631	TM9-2815-202-24P
025	GAGE SET, TELESCOPING		5210-00-473-9350	SC4940-CL-B02
026	GAGE SET, THICKNESS	J1698-02	5210-01-245-9564	TM9-2815-202-24P
027	GAGE, CYLINDER BORE		5210-01-070-4543	SC4940-95-A63
028	GAGE, DEPTH	J22273-01	5210-00-023-4798	TM9-2815-202-24P
029	GAGE, DIAL INSERT RUNOUT	9320	4910-00-779-7103	TM9-2815-202-24P
030	GAGE, FLYWHEEL HOUSING	J9737-C	5210-00-937-7284	TM9-2815-202-24P
031	GAGE, FUEL PRESSURE	J8151	6620-00-671-4509	TM9-2815-202-24P
032	GAGE, INJECTOR PROTRUSION	J25521	5220-01-167-4281	TM9-2815-202-24P
033	GAGE, INJECTOR RACK	J24882	5210-01-214-0246	TM9-2815-202-24P
034	GAGE, INJECTOR TIP & CONCENTRICITY	J29584	5210-00-990-3327	TM9-2815-202-24P
035	GAGE, NEEDLE VALVE HEIGHT	J9462-02	5210-00-937-7285	TM9-2815-202-24P
036	GAGE, PISTON RING GROOVE	J24599	5220-01-028-1109	TM9-2815-202-24P
037	GAGE, THROTTLE DELAY	J25559	5120-01-048-2200	TM9-2815-202-24P
038	GRINDER, VALVE INSERT	HT-80540	4910-00-779-7078	TM9-2815-202-24P
039	HAMMER, SLIDE	J2619-01	5120-00-910-7868	TM9-2815-202-24P
040	HANDLE, DRIVER	J3154-1	5120-00-808-5082	TM9-2815-202-24P
041	HANDLE, THERMOSTAT SEAL INSTALLER	J7079-2	5120-00-977-5578	TM9-2815-202-24P
042	HONE, CYLINDER		5130-00-991-0699	SC-4910-95-A63
043	HOOK, LIFTING, FLYWHEEL	10881880	4910-00-722-3877	TM9-2815-202-24P
044	INDICATOR, DIAL		5210-00-277-8840	SC4940-95-CL-B02
045	INDICATOR, DIAL MAGNETIC BASE	J7872	5210-00-402-9619	TM9-2815-202-24P
046	INJECTOR TIMING GAGE	J1242	5210-00-474-6400	TM9-2815-202-24P
047	INJECTOR, TUBE, RECONDITIONING SET		2910-00-146-9619	SC4940-95-CL-B02
048	INSTALLER, BALANCE WEIGHT COVER SEAL	J9791	5120-01-013-1678	TM9-2815-202-24P
049	INSTALLER, BRIDGE GUIDE	J7482	5120-00-999-8616	TM9-2815-202-24P
050	INSTALLER, CRANKSHAFT OIL SEAL FRONT	J9783	5120-00-936-4377	TM9-2815-202-24P
051	INSTALLER, CRANKSHAFT OIL SEAL REAR	J9727-A	5120-01-189-9623	TM9-2815-202-24P
052	INSTALLER, GEAR	CPR109365	5120-01-008-1600	TM9-2815-202-24P

(1) ITEM NUMBER	(2) DESCRIPTION	(3) PART NUMBER	(4) NATIONAL STOCK NUMBER	(5) REFERENCE
053	INSTALLER, GOVERNOR COVER BEARING	J21068	4910-00-779-6078	TM9-2815-202-24P
054	INSTALLER, INJECTOR TUBE NEW STYLE	J5286-20	5120-01-248-7737	TM9-2815-202-24P
055	INSTALLATION CAP, VALVE GUIDE OIL SEAL	5199913		TM9-2815-202-24P
056	INSTALLER, OIL PUMP DRIVEN GEAR	J22398	5120-01-232-0001	TM9-2815-202-24P
057	INSTALLER, PISTON PIN RETAINER	J23762-A	5120-00-127-7757	TM9-2815-202-24P
058	INSTALLER, PLUG CUP	J33420	5120-01-297-2457	TM9-2815-202-24P
059	INSTALLER, THERMOSTAT SEAL	J8550	5120-00-977-5579	TM9-2815-202-24P
060	INSTALLER, VALVE GUIDE	10881889	5120-00-733-8881	TM9-2815-202-24P
061	INSTALLER, VALVE INSERT	10881873	5120-00-733-8876	TM9-2815-202-24P
062	INSTALLER, WATER PUMP DRIVE GEAR	J25257	5120-01-033-8902	TM9-2815-202-24P
063	LEAK DETECTOR, PISTON PIN RETAINER	J23987-01	5210-01-061-4253	TM9-2815-202-24P
064	MANOMETER	J21478-1	6685-00-857-4895	TM9-2815-202-24P
065	MICROMETER SET		5210-00-554-7134	SC4910-95-A63
066	PLIERS, PISTON RING	79500177	5120-00-494-1846	TM9-2815-202-24P
067	PLUG ADAPTOR	J23019	5120-01-130-8864	TM9-2815-202-24P
068	PULLER, COMBINATION LEG	J24420-A	5180-00-999-4053	TM9-2815-202-24P
069	PULLER, MECHANICAL	J4871	5120-00-740-3345	TM9-2815-202-24P
070	PULLER, MECHANICAL 2-JAW		5120-00-595-9305	SC4940-95-A62
071	PULLER, UNIVERSAL	8708724	5180-00-338-6721	TM9-2815-202-24P
072	REAMER, CYLINDER RIDGE		5110-00-237-8598	SC4940-95-CL-B02
073	REAMER, INJECTOR BODY	J21089	5110-00-937-7628	TM9-2815-202-24P
074	REMOVER SET, VALVE BRIDGE GUIDE	J7091-01	5120-00-999-8614	TM9-2815-202-24P
075	REMOVER, BRIDGE GUIDE BROKEN	J7453	5120-00-999-8615	TM9-2815-202-24P
076	REMOVER, CYLINDER LINER	6248510	5120-00-387-9615	TM9-2815-202-24P
077	REMOVER, GOVERNOR COVER BEARING	J21967-01	5120-01-145-4490	TM9-2815-202-24P
078	REMOVER, GOVERNOR COVER BUSHING	J8985	4910-00-779-7315	TM9-2815-202-24P
079	REMOVER, VALVE GUIDE	10919987	5120-00-733-8880	TM9-2815-202-24P
080	REMOVER, VALVE INSERT	J23479-E	5120-01-165-1935	TM9-2815-202-24P
081	SHIELD, TURBOCHARGER INLET	J26554-A	4910-01-127-7959	TM9-2815-202-24P
082	SLING, FOUR LEG	11643468	4910-00-140-6876	TM9-2815-202-24P
083	SLING, MULTIPLE	10930560	3940-00-977-7398	TM9-2815-202-24P
084	SLING, THREE-LEGGED	11643469	4910-00-001-3993	TM9-2815-202-24P
085	STAND, MAINTENANCE	7950189	4910-00-795-0189	TM9-2815-202-24P
086	STUD, GUIDE	5345162	5315-00-779-7364	TM9-2815-202-24P
087	STUD, GUIDE SET	J25002	5120-01-048-2155	TM9-2815-202-24P
088	STUDS, CYLINDER HEAD GUIDE	J9665	4910-00-591-6634	TM9-2815-202-24P
089	TEST FIXTURE, DIESEL		4910-00-255-8641	SC4940-95-CL-B02
090	TESTER, CYLINDER COMPRESSION		4910-00-808-4300	SC4940-95-CL-B02
091	TESTER, DIESEL FUEL		4910-00-355-6248	SC4940-95-CL-B02
092	TESTER, INJECTOR TIP CONCENTRICTY FREENESS	J29584	5210-00-990-3327	TM9-2815-202-24P
093	TESTER, SPRING		6635-00-641-7346	SC4940-95-A63
094	TOOL KIT, BLOWER	J6270-F	4940-00-611-7945	TM9-2815-202-24P
095	TOOL KIT, DIESEL INJECTOR	J23435-02	5180-01-038-0251	TM9-2815-202-24P
096	TOOL KIT, GENERAL MECHANICS		5180-00-699-5273	SC5180-90-CL-N05
097	TOOL SET, FUEL PUMP	J1508-D	5180-00-219-8407	TM9-2815-202-24P
098	TUBING, NONMETALLIC	564-0077-011	4720-00-271-9839	TM9-2815-202-24P
099	WRENCH, FUEL NUT	10881875	5120-01-147-7923	TM9-2815-202-24P
100	WRENCH, TORQUE 300 LB-IN	F3001	5120-00-247-2536	TM9-2815-202-24P
101	WRENCH, TORQUE 0-175 LB-FT		5120-00-640-6364	SC4940-95-CL-B02
102	WRENCH, TORQUE 100-500 LB-FT	9033917	5120-00-542-5577	TM9-2815-202-24P
103	COMPRESSOR, PISTON RING	NT5	5120-00-250-6050	SC4940-95-CL-B02
104	WRENCH, BOX	J21223-02	5120-00-907-8989	TM9-2815-202-24P
105	GAGE, INJECTOR TIMING	J1853	5220-00-387-9581	TM9-2815-202-24P

APPENDIX C
EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1. SCOPE. This appendix lists expendable supplies and materials needed to operate and maintain the 8V71T series 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 narrative SETUP to identify the material (e.g., "Antiseize compound (App C, Item 1)").

b. Column 2 -- Description. Indicates the federal item name and, a description to identify the item.

c. Column 3 -- National Stock Number. This is the national stock number (NSN) assigned to the item; use it to request or requisition the item.

d. Column 4 -- Unit of Measure (U/M). 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

(1) ITEM NUMBER	(2) DESCRIPTION	(3) NATIONAL STOCK NUMBER	(4) U/M
001	ANTISEIZE COMPOUND (MIL-A-907)	8030-00-597-5367	LB
002	BOLT 5/16-18 X 1 7/8 IN.		
003	BOLT 5/1 6-24 X 1 1/2 IN.	5306-00-225-9093	EA
004	BOLT 5/16-24 X 3 IN.	5306-00-225-9099	EA
005	BOLT 3/8-24 X 4 1/2 IN.	5305-00-269-2820	EA
006	BOLT 5/8-1 1 X 2 IN.	5305-00-051-0827	
007	CARBON REMOVING COMPOUND MIL-S-12382 (ORD) TYPE 1	6850-00-281-3044	GAL
008	CINDOL 1705 LUBRICATING OIL		
009	CLEANING SOLUTION, KIT	6850-00-598-7328	
010	CLEANING SOLVENT, P-D-680		
	1 -QT CAN	6850-00-664-5685	QT
	1 -GAL CAN	6850-00-281-1985	GAL

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST (Cont)

(1) ITEM NUMBER	(2) DESCRIPTION	(3) NATIONAL STOCK NUMBER	(4) U/M
011	COVER PLATE, WATER HOLE	2815-01-046-1965	EA
012	CROCUS CLOTH, P-C-458	5350-00-221-0872	EA
013	CUTTING OIL	9150-00-076-1567	GAL
014	DESICCANT	6850-00-264-6572	PK
015	EMERY CLOTH		
016	ENGINE OIL-SAE 15/40 (MIL-L-21 04)		
	1-QT CAN	9150-01-152-4117	QT
	5-GAL DRUM	9150-01-152-4118	GAL
	55-GAL DRUM	9150-01-152-4119	GAL
017	FLAT WASHER, 1/4 IN.	5310-00-823-8804	EA
018	FLAT WASHER, 5/16 IN.	5310-00-081-4219	EA
019	FOOD COLORING		
020	FUEL LINE	4710-00-020-2734	EA
021	FUEL OIL, DIESEL DF-2 REGULAR		
	BULK	9140-00-286-5294	GAL
	5-GAL CAN	9140-00-286-5295	GAL
	55-GAL DRUM, 16 GAGE	9140-00-286-5296	GAL
	55-GAL DRUM, 18 GAGE	9140-00-286-5297	GAL
022	GREASE, GENERAL PURPOSE, LITHIUM BASE	9150-01-091-9336	LB
023	HEAT INDICATING CRAYON		
024	INTERNATIONAL COMPOUND NO. 2 (72582) P/N 5198563		QT
025	LAPPING COMPOUND, J3179-5	5350-01-157-6916	EA
026	LINTLESS CORD		
027	MASKING TAPE	7510-00-290-2027	RL
028	MERCURY	6810-00-281-7453	BTL
029	NUT 3/8-24	5310-00-732-0559	EA
030	PLASTIC GAGE		
031	PRESERVATION OIL, MIL-C-16173		
	1-GAL	8030-00-062-5866	GAL
	5-GAL	8030-00-244-1293	GAL
	55-GAL	8030-00-244-1294	GAL
032	PRUSSIAN BLUE		
033	SCREW #10-32 X 1.0 IN.	5305-01-098-7194	EA
034	SCREW, SHEET METAL #1 O X 1 1/4 IN.		
035	SEAL, CONTAINER	5330-01-288-4550	EA
036	SEAL, CONTAINER	5330-01-142-4882	EA
037	SEAL, CONTAINER	5330-01-288-9435	EA
038	SEALANT, LOCTITE RC-620		
	50-CC	8030-00-181-7603	CC
	250-CC	8030-00-181-7529	CC

(1) ITEM NUMBER	(2) DESCRIPTION	(3) NATIONAL STOCK NUMBER	(4) U/M
039	SEALANT, RTV106	8040-00-941-9984	Oz
040	SEALANT, 567-47	8030-01-166-0675	Oz
041	SILICONE CARBIDE CLOTH, P-P-121	5350-00-224-7203	EA
042	SILICONE LUBRICANT		
043	STONE, SHARPENING	5345-00-198-8050	EA
044	STONE, SHARPENING X-FINE	5345-00-584-4607	EA
045	SULPHURIZED OIL, E.P. TYPE		
046	WOOD BLOCK, 2 X 4 IN.		
047	NUT 3/8-1 6	5310-00-732-0558	EA
048	FLAT WASHER, 3/8 IN.	5310-00-080-6004	EA
049	SEALANT, PIPE, TEFLON	1015-01-255-4144	TU
050	GASKET CEMENT	8040-01-170-6503	TU

APPENDIX D

ILLUSTRATED LIST OF MANUFACTURED ITEMS

Section I. INTRODUCTION

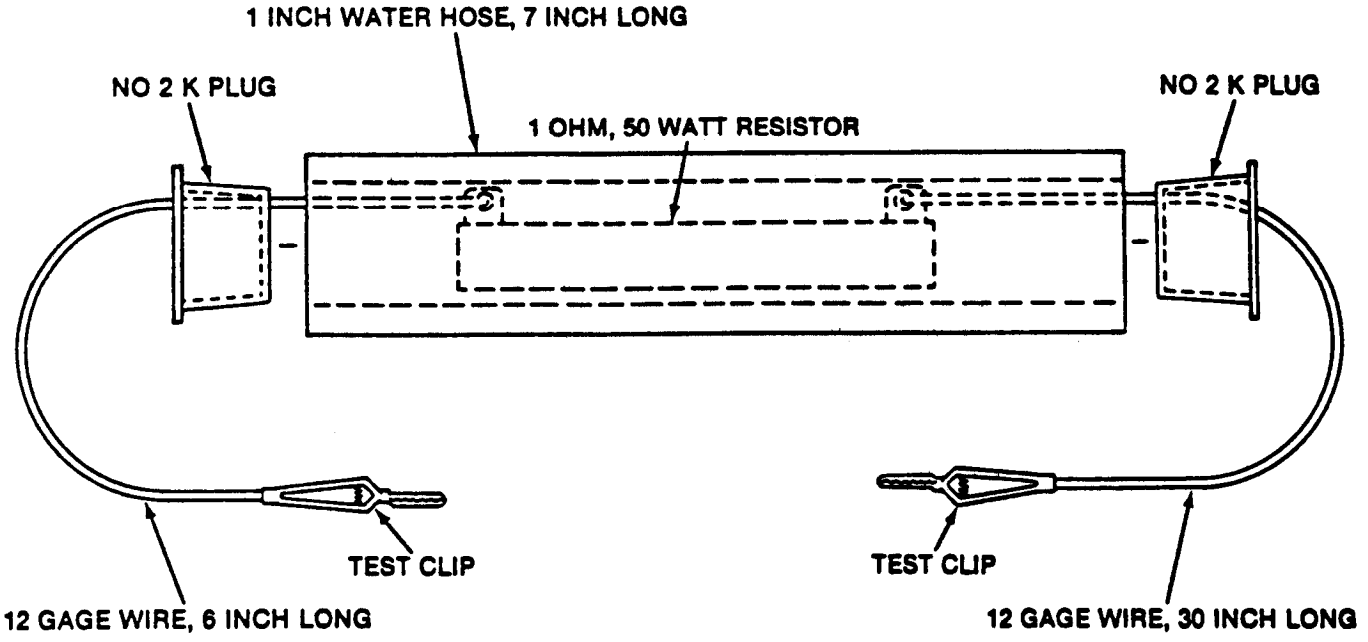
This appendix includes complete instructions for making items authorized to be manufactured or fabricated at direct and general support maintenance.

A part number index in alphanumeric order is provided for cross–referencing the part number of the item to be manufactured to the figure which covers fabrication criteria.

All bulk materials needed for manufacture of an item are listed by part number or specification number in a tabular list on the illustration.

Section II. MANUFACTURED ITEMS PART NUMBER INDEX

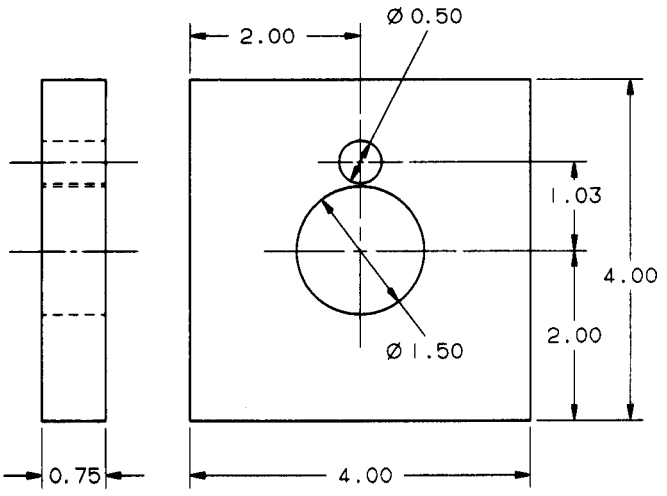
ITEM NO.	PART NO.	NATIONAL STOCK NUMBER	DESCRIPTION	FIGURE NO.
1	12384626		TEST LEAD	1
2	12384627		BEARING TEST FIXTURE	2
3	12384628		GUIDE STUD	3
4	12384629		BAR TOOL	4
5	12384630		ADAPTOR	5
6	12384631		PLATE KIT	6
7	12384632		AIR NOZZLE PLATE KIT	7
8	12384633		TURBOCHARGER HOLDING FIXTURE	8
9	12384634		BACKPLATE TORQUING TOOL	9
10	12384635		CYLINDER HEAD PRESSURE TESTING KIT	10
11	12384636		WATER OUTLET PLATE	11
12	12384637		SLEEVE	12
13	12384638		THREADED ROD	13
14	12384639		EXHAUST SEAL INSTALLER	14



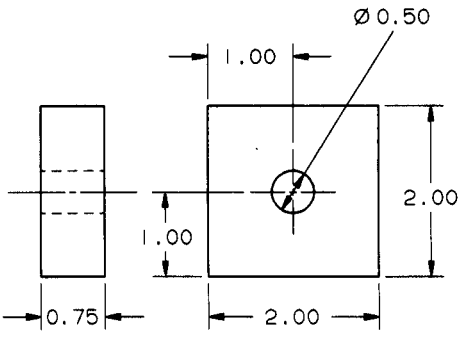
NOTES: To reduce 24 V dc to 18 V dc.

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. 2 K 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.

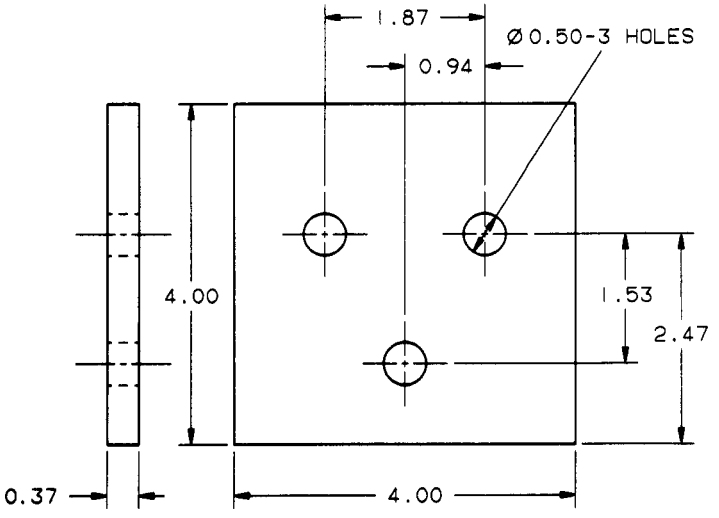
FIGURE D-1 . TEST LEAD (P/N 12384626)



ITEM A



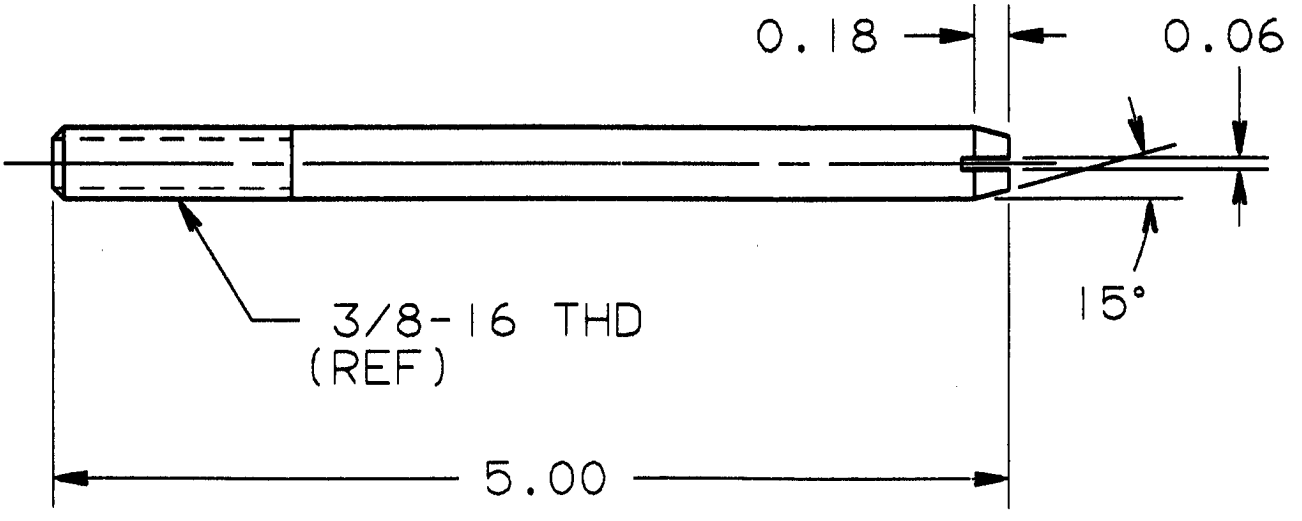
ITEM B



ITEM C

1. Fabricate from 3/4-inch thick steel plate, items (A) and (B).
2. Fabricate from 3/8-inch thick steel plate, item (C).
3. Quantity required: one each, items A, B and C.
4. Additional items: One bolt 1/2-13 x 3 NSN 5305-00-071-1772. Three bolts 3/8-16 x 1 NSN 5305-00-269-3211. Two flat washers 1/2 NSN 5310-00-809-5997. Three flat washers 3/8 NSN 5310-00-080-6004. One nut 1/2-13 NSN 5310-00-768-0318.
5. All dimensions are in inches.

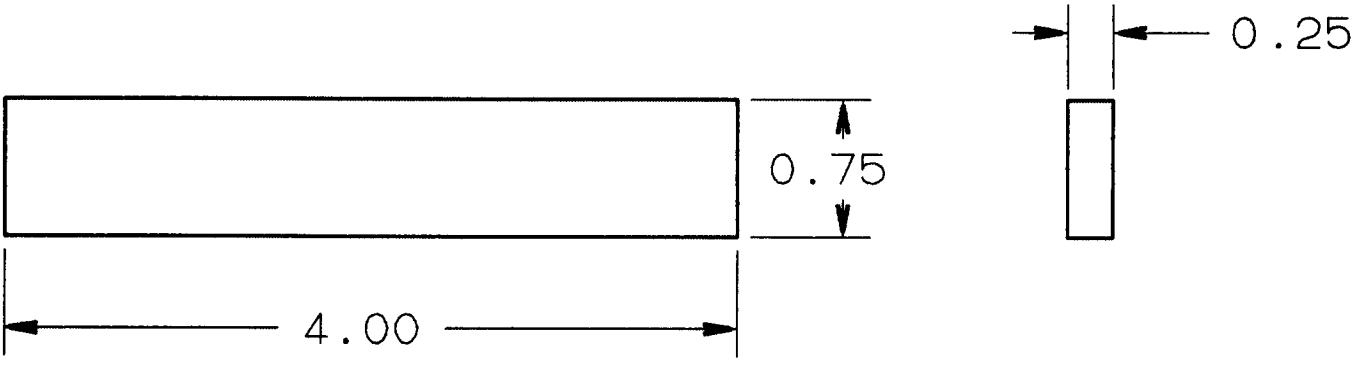
FIGURE D-2. BEARING TEST FIXTURE (P/N 12384627)



NOTES:

1. Fabricated from NSN 5305-00-269-3228 (3/8-16 x 5) bolt by cutting off head of bolt. Saw or file a 1/16-inch screwdriver slot in unthreaded end.
2. Quantity required, four.
3. All dimensions are in inches.

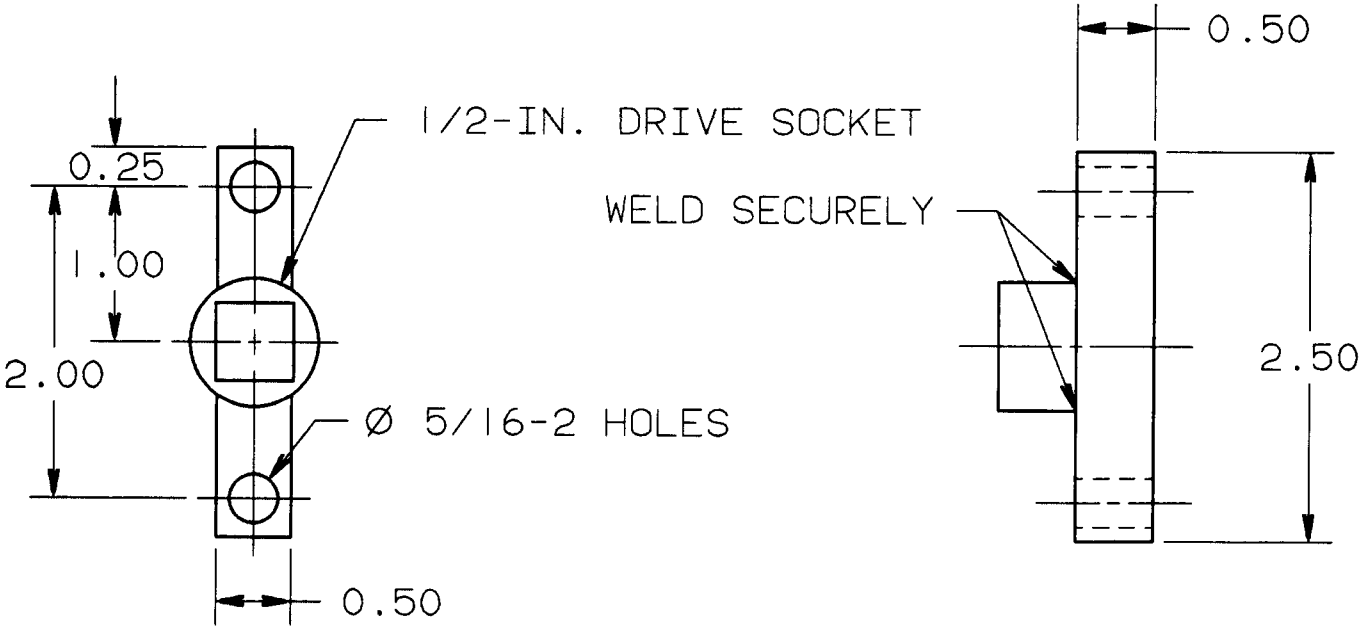
FIGURE D-3. GUIDE STUD (P/N 12384628)



NOTES:

1. Fabricate from 1/4-inch thick steel plate.
2. Quantity required, one.
3. All dimensions are in inches.

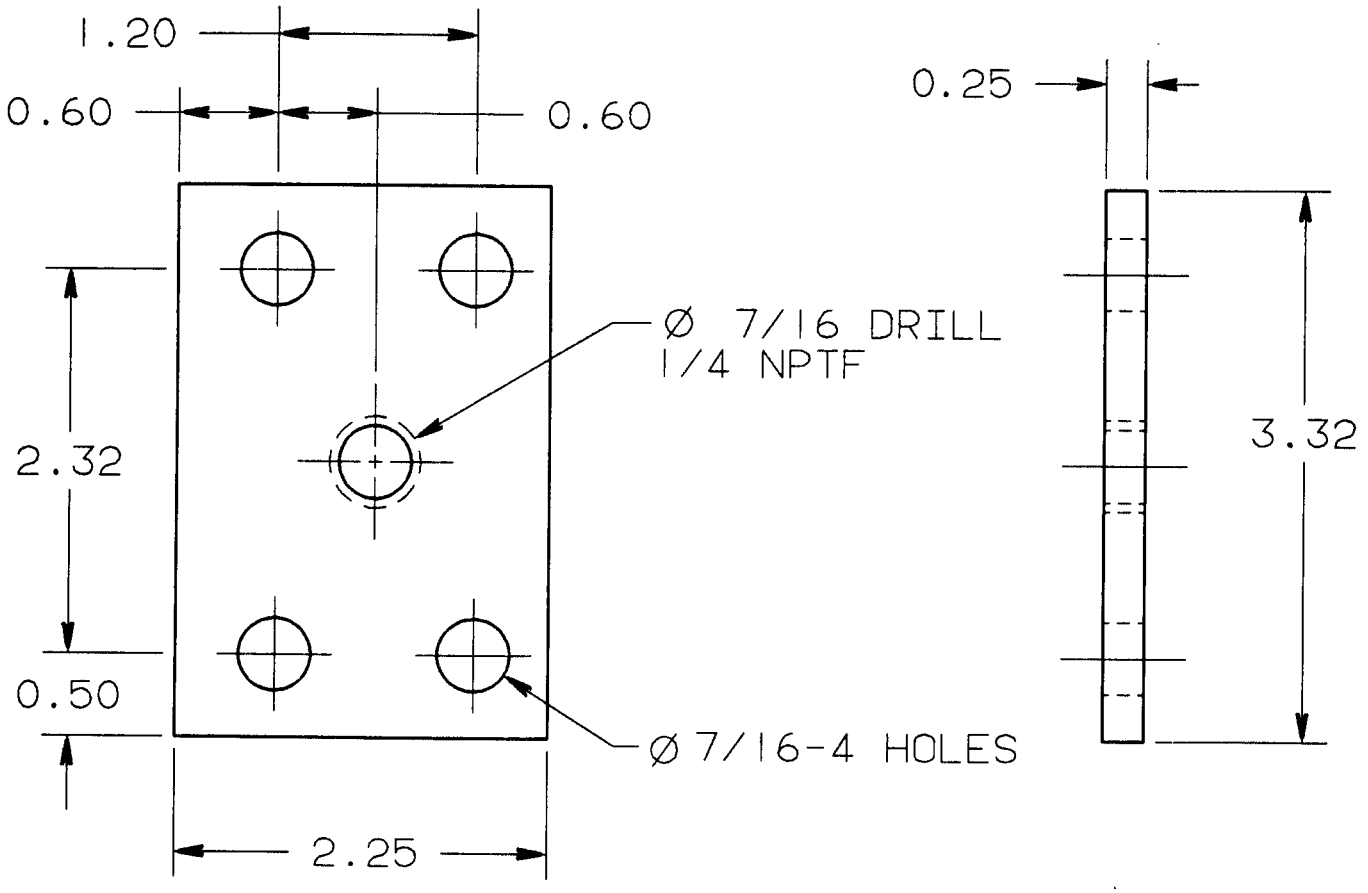
FIGURE D-4. BAR TOOL (P/N 12384629)



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 5/16-18 x 1 bolts NSN 5306-00-225-8499.
5. All dimensions are in inches.

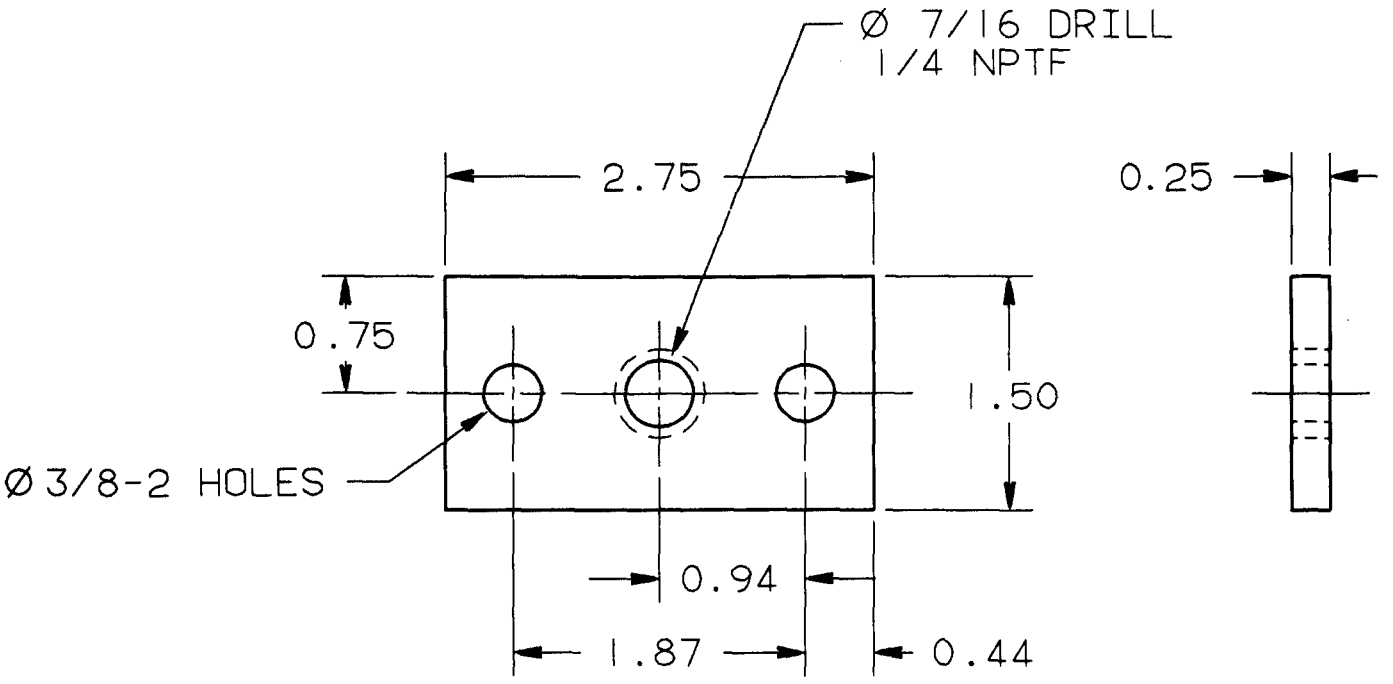
FIGURE D-5. ADAPTOR (P/N 12384630)



NOTES:

1. Fabricate from 1/4-inch thick steel plate. Two required, one with tapped hole and one without.
2. Fabricate from gasket material. Two required, one with hole in center and one without.
3. Additional items:
   Eight bolts 7/16-14 x 3/4 NSN 5305-00-069-5571.
   Eight lockwashers 7/16 NSN 5310-00-209-0965.
   Eight flat washers 7/16 NSN 5310-00-809-4061.
   Eight nuts 7/16-14 NSN 5310-00-880-8189.
   Eight bolts 7/16-14 x 3-1/4 NSN 5305-00-069-5580.
4. All dimensions are in inches.

FIGURE D-6. PLATE KIT (P/N 12384631)



NOTES:

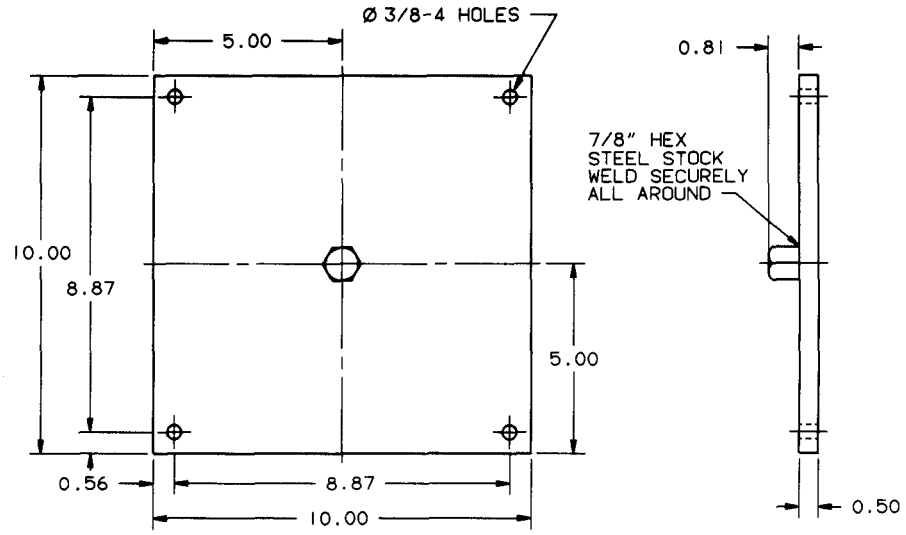
1. Fabricate from 1/4-inch thick steel plate. Two required, one with 1/4 NPTF threaded hole in center and one without.

2. Fabricate from gasket material. Two required, one with hole in center and one without.

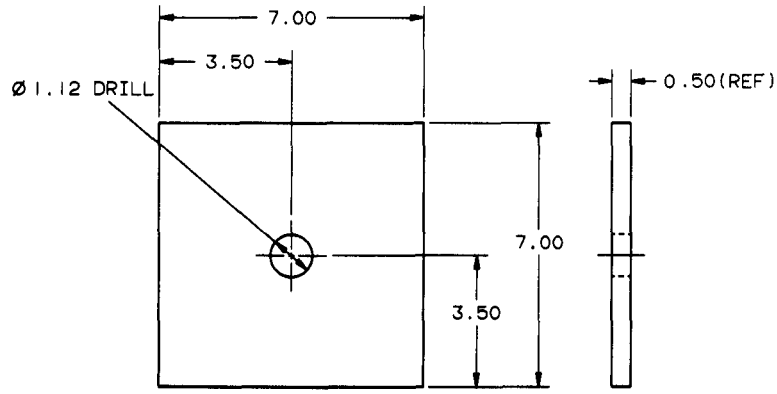
3. Additional items:
   Two bolts 3/8-16 x 2-1/2 NSN 5305-00-269-3218.
   Two lockwashers 3/8 NSN 5310-00-637-9541.
   Two flat washers 3/8 NSN 5310-00-080-6004.
   Two nuts 3/8-16 NSN 5310-00-732-0558.

4. All dimensions are in inches.

FIGURE D-7. AIR NOZZLE PLATE KIT (P/N 12384632)



ITEM A

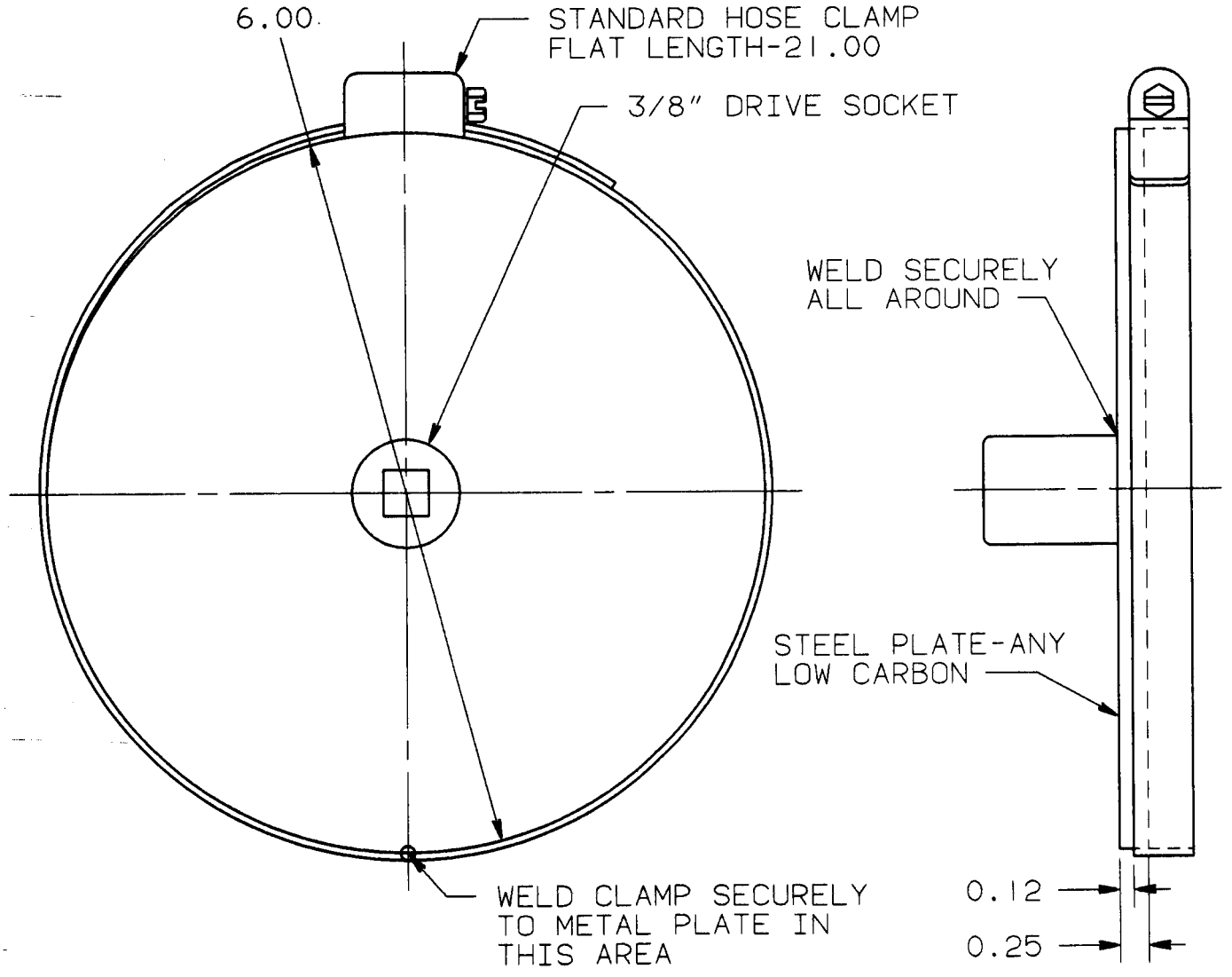


ITEM B

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.

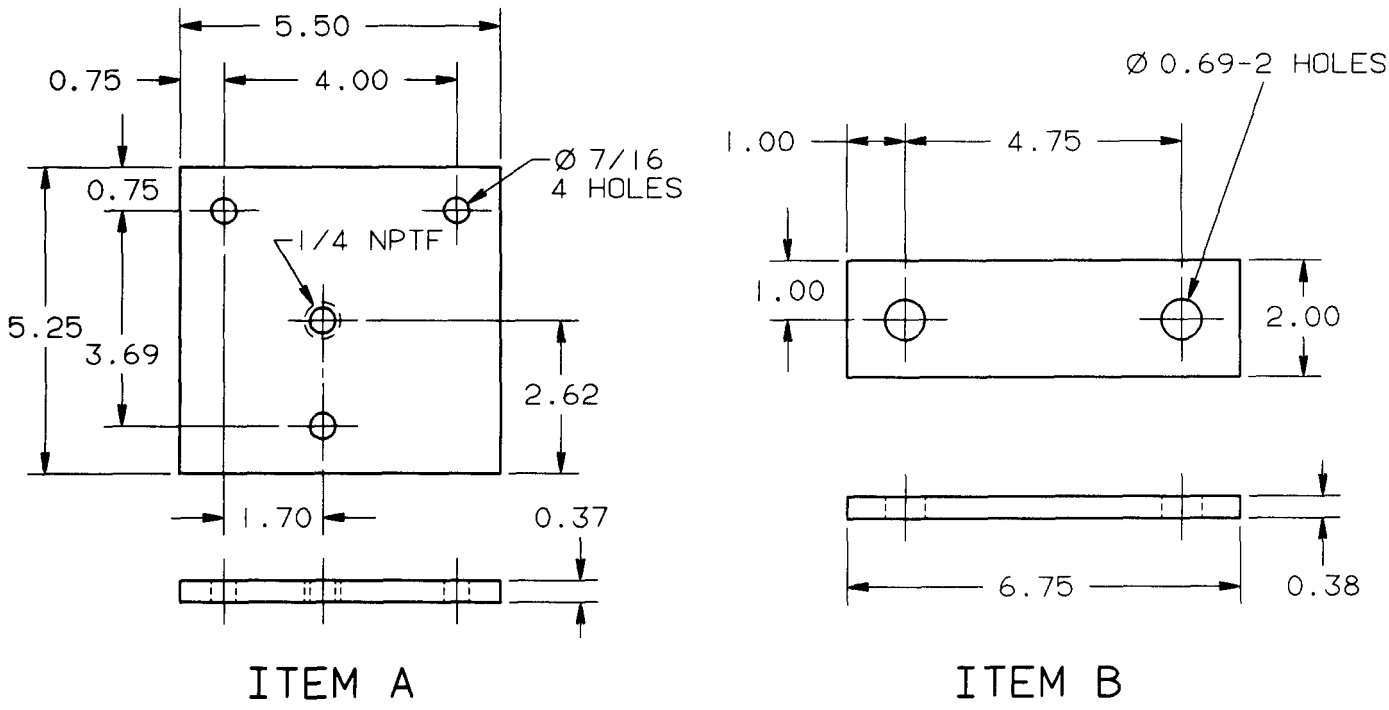
FIGURE D-8. TURBOCHARGER HOLDING FIXTURE (P/N 12334633)



NOTES:

1. Fabricate from 1/4-inch thick steel plate.
2. Weld a 5/8-inch socket 3/8-inch drive (ratchet side up) to center of 6 inch diameter plate.
3. Weld Suretite #96 band to outside rim of 6-inch round plate.
4. All dimensions are in inches.

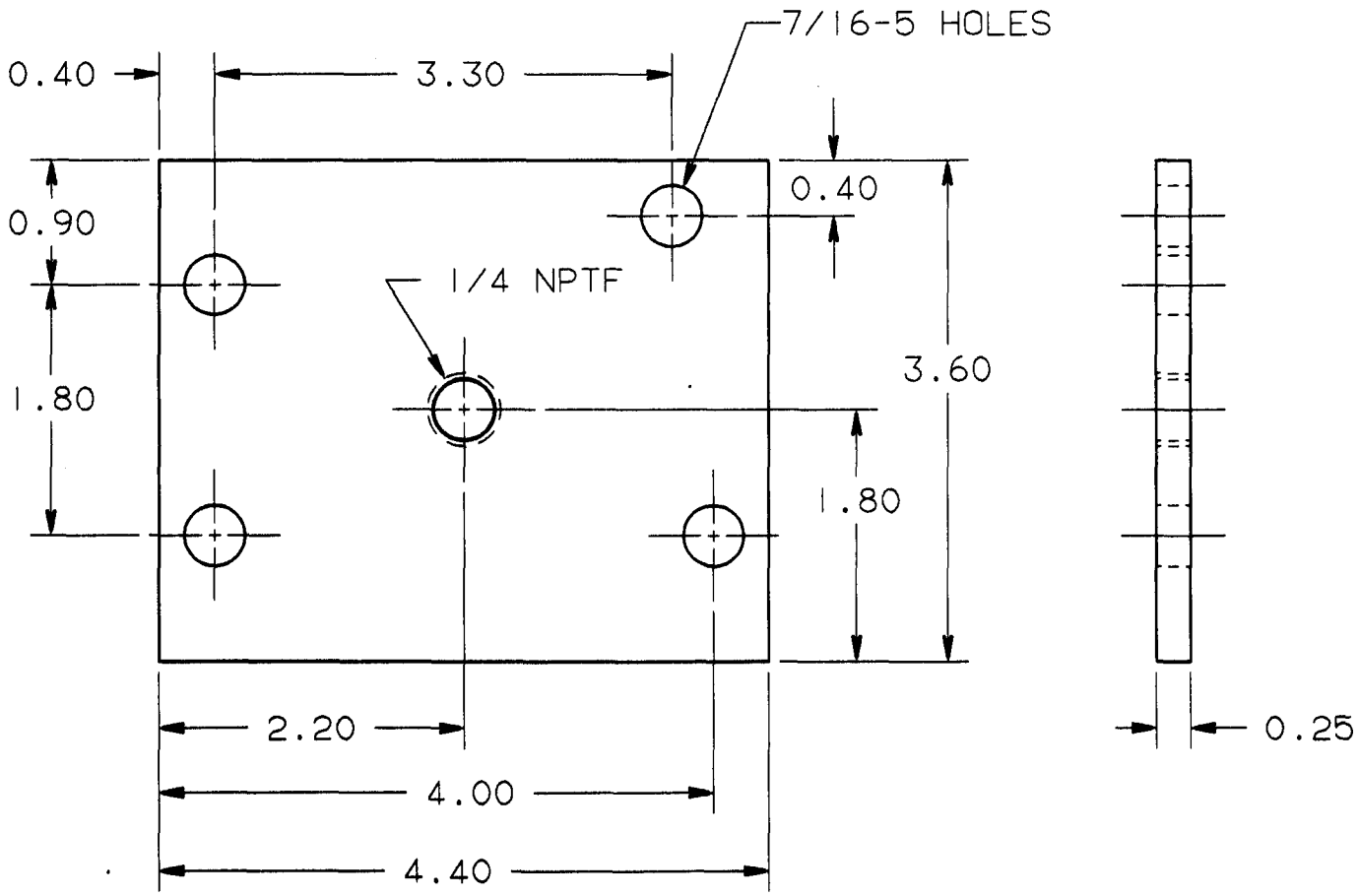
FIGURE D-9. BACKPLATE TORQUING TOOL (P/N 12384634)



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 2-inch diameter hole in center.
3. Quantity required, one each.
4. Additional items: Three 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, ten each.
8. Additional items: Ten bolts 5/8-11 x 5 NSN 5305-00-724-6758. Twenty washers 5/8 NSN 5310-00-003-9174. Ten nuts 5/8-11 NSN 5310-00-763-8920.
9. All dimensions are in inches.

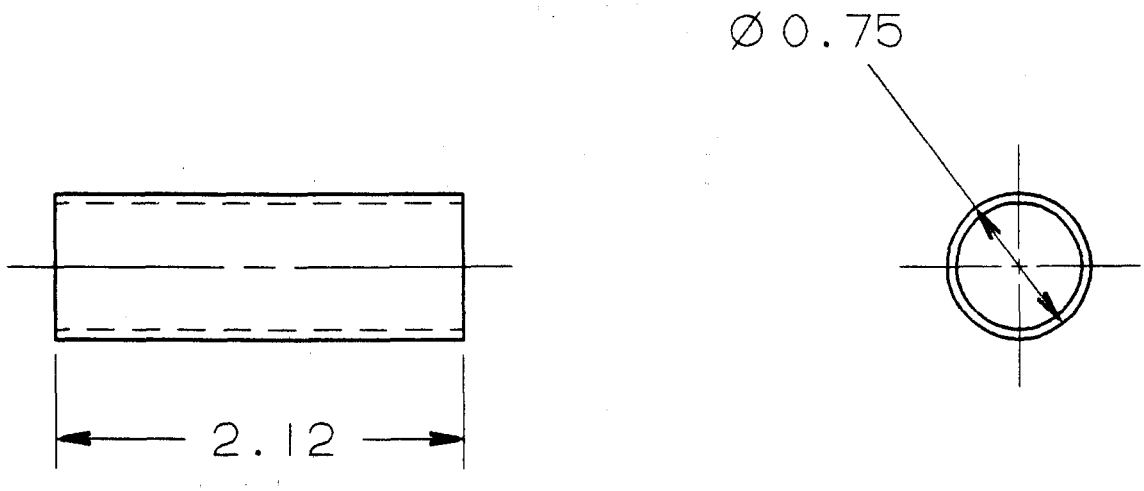
FIGURE D-10. CYLINDER HEAD PRESSURE TESTING KIT (P/N 12384635)



NOTES:

1. Fabricate from 1/4-inch thick steel plate.
2. Fabricate from 1/8-inch thick rubber gasket material.
3. Quantity required: one each.
4. All dimensions are in inches.

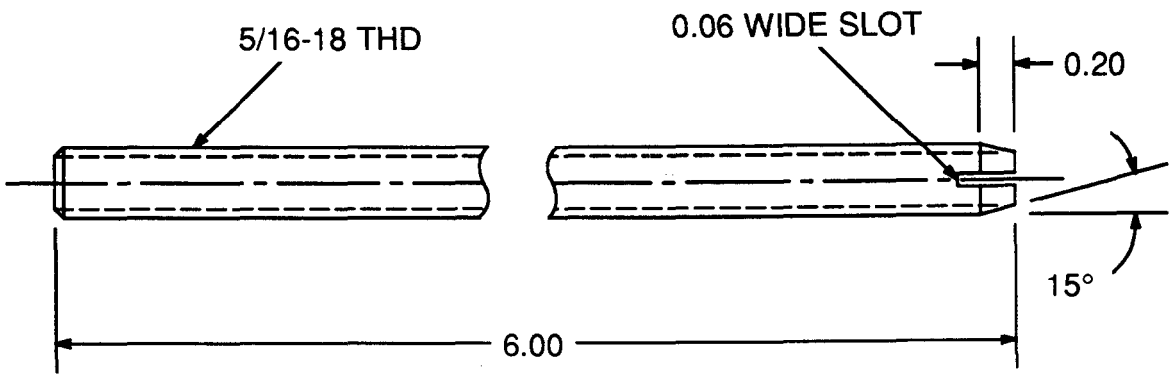
FIGURE D-11. WATER OUTLET PLATE (P/N 12384636)



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.

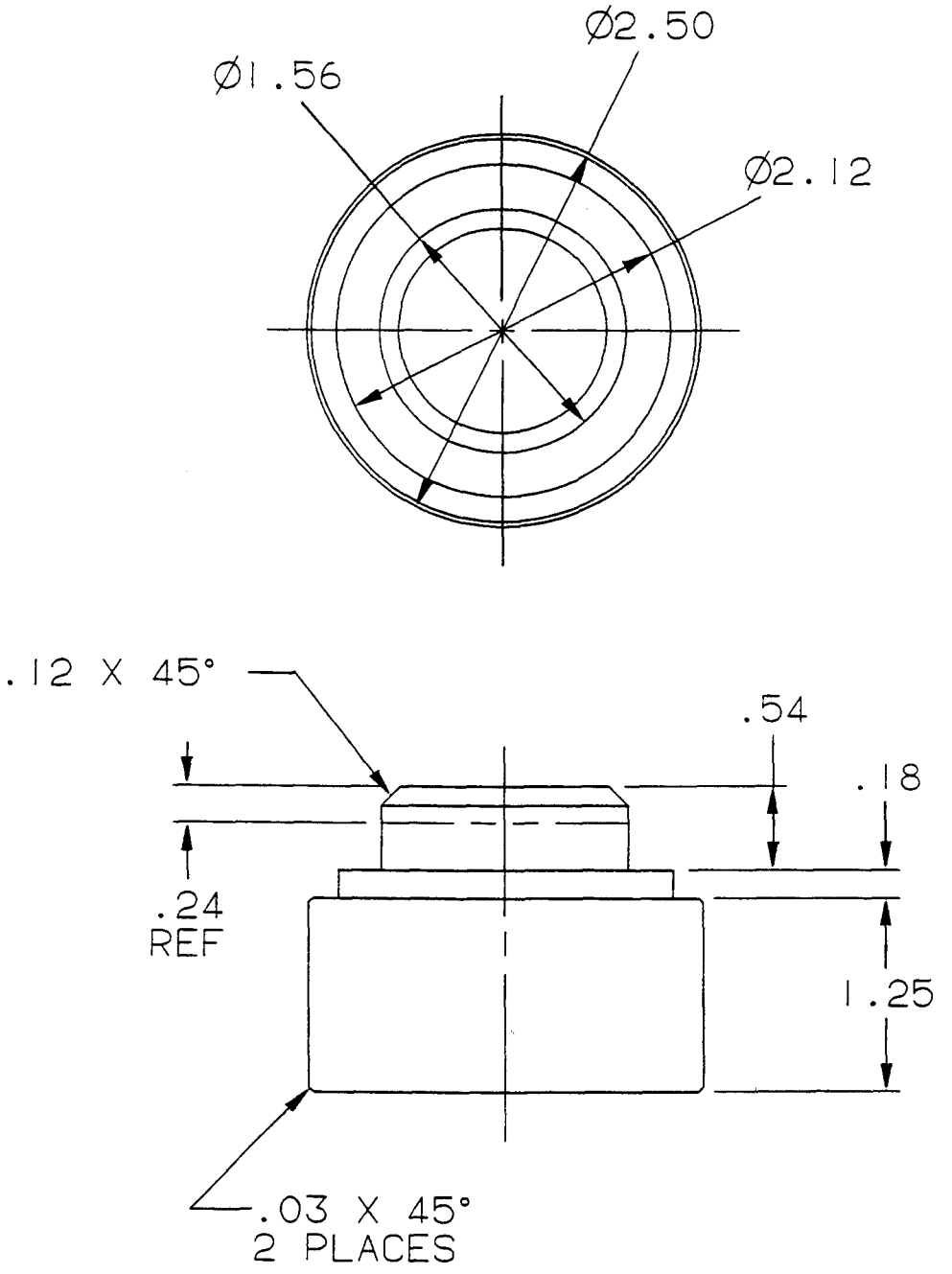
FIGURE D-12. SLEEVE (P/N 12384637)



NOTES:

1. Fabricated from NSN 5306-01-072-5799 (5/16-18 x 36) rod, continous thread by cutting to length of 6 inches. Saw or file a 0.06-inch screwdriver slot in one end.
2. Quantity required, one.
3. All dimensions are in inches.

FIGURE D-13. THREADED ROD (P/N 12384638)



NOTES:

1. Fabricated from steel round stock
2. Quantity required, one.
3. All dimensions are in inches.

FIGURE D-14. EXHAUST SEAL INSTALLER (P/N 12384639)

APPENDIX E
GENERAL TORQUE LIMITS REQUIRED FOR FASTENERS IN ENGINE

E-1. GENERAL

This section provides the general torque limits for fasteners used on the 8V71T series 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

Table E-1 lists 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 an 8V71T series engine.

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.

Table E-1. Torque Limits for Dry Fasteners

THREAD SIZE inches	TORQUE LIMIT lb-ft	N-m
1/4-20		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
7/1 6-20	57-61	77-83
1/2-13	71-75	96-102
1/2-20	83-93	113-126
9/1 6-12	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 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., “Cotter pin (App F, Item 7)”).

b. Column 2-- Description. This column identifies 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 part 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 indicates the NSN assigned to the item; use it to request or requisition the item.

Section II. REPLACEMENT PARTS LIST

(1) ITEM NO.	(2) DESCRIPTION	(3) PART NO.	(4) NSN
001	BEARING	403877	3120-00-851-4483
002	BEARING KIT	5149460	3120-01-086-8270
003	BOLT	5103248	5306-01-078-4175
004	BOLT	5103534	5306-01-078-4981
005	BOLT	5148373	5306-00-514-6973
006	BUSHING	5100929	3120-00-831-8646
007	COTTER PIN	103361	5315-00-234-1650
008	CUP PLUG	5117186	5340-00-728-3491
009	CUP PLUG	5132410	5340-00-231-0941
010	CUP PLUG	5139988	5340-01-144-1937
011	CUP PLUG	5150132	5340-00-939-1192
012	CUP PLUG	9428477	5340-00-450-5712
013	EXPANDER	5148261 (72582)	
014	FILTER	5228587	2910-00-374-4929
015	FILTER ELEMENT	CW226MP	2910-00-287-1912
016	FILTER ELEMENT KIT	5575032	2940-00-745-7730
017	FLAT WASHER	1503536	5310-00-551-0433
018	FUEL LINE	5111526	4710-00-020-2733
019	FUEL LINE	5111527	4710-00-020-2734
020	GASKET	105451	5330-00-197-8116
021	GASKET	3291975	5330-00-735-6163
022	GASKET	5102551	5330-01-058-3197
023	GASKET	5103602	4730-00-745-7786
024	GASKET	5104081	5330-01-078-7186
025	GASKET	5104506	5330-01-079-9963
026	GASKET	5104507	5330-01-088-5984
027	GASKET	5108329	5330-00-973-1416
028	GASKET	5108715	5330-00-081-3419
029	GASKET	5113954	5330-00-735-4284
030	GASKET	5117231	5330-00-972-8108
031	GASKET	5117243	5330-00-735-4289
032	GASKET	5117254	5330-00-745-7831
033	GASKET	5117269	5330-00-735-4291
034	GASKET	5117332	5330-00-725-2301
035	GASKET	5117535	5330-00-844-2907
036	GASKET	5117636	5330-00-735-4293
037	GASKET	5117734	5330-00-745-7776
038	GASKET	5117975	5330-00-847-6223
039	GASKET	5117993	5330-00-973-1415
040	GASKET	5118793	5330-00-844-2906
041	GASKET	5120224	5330-00-862-6929

(1) ITEM NO.	(2) DESCRIPTION	(3) PART NO.	(4) NSN
042	GASKET	5121714	5330-00-745-7669
043	GASKET	5121835	5330-00-847-4967
044	GASKET	5121894	5330-00-276-1842
045	GASKET	5122839	5365-00-846-5985
046	GASKET	5123123	5330-00-982-1053
047	GASKET	5123240	5330-00-054-8290
048	GASKET	5123638	5330-00-862-6934
049	GASKET	5123812	5330-00-892-1764
050	GASKET	5124225	5330-00-844-2905
051	GASKET	5124798	5330-00-844-2904
052	GASKET	5124806	5330-00-961-9807
053	GASKET	5124822	5330-00-844-2903
054	GASKET	5126160	5330-00-458-2325
055	GASKET	5126161	5330-00-458-2324
056	GASKET	5126499	5330-00-736-0228
057	GASKET	5126618	5330-00-751-9011
058	GASKET	5128944	5330-00-899-8325
059	GASKET	5128945	5330-00-894-0200
060	GASKET	5128964	5330-00-735-6167
061	GASKET	5129743	5330-00-844-2908
062	GASKET	5130800	5330-00-972-8100
063	GASKET	5130995	5330-00-980-1546
064	GASKET	5136701	5330-00-745-7827
065	GASKET	5141588	5330-00-915-4511
066	GASKET	5144875	5330-01-058-0584
067	GASKET	5144901	5330-01-054-2399
068	GASKET	5145581	5330-00-222-0801
069	GASKET	5148810	5330-01-058-0585
070	GASKET	5150193	5330-00-212-6290
071	GASKET	5150361	5330-00-364-3550
072	GASKET	5161003	5330-00-599-5577
073	GASKET	5162747	5330-00-810-9308
074	GASKET	5170468	5330-00-725-2388
075	GASKET	5190566	5330-00-246-8237
076	GASKET	5197654	5330-01-102-0193
077	GASKET	5226186	5365-00-255-0296
078	GASKET	8922593	5330-01-186-7543
079	GASKET	8923492	5330-01-037-4129
080	GASKET	8923791	5330-01-088-5982
081	GASKET	8923792	5330-01-206-3265
082	GASKET	8924869	5330-00-735-4296
083	GASKET, COMPRESSION	5103659	5330-01-064-3386
084	HOSE	5146040	2815-01-089-6878

REPLACEMENT PARTS LIST (Cont)

(1) ITEM NO.	(2) DESCRIPTION	(3) PART NO.	(4) NSN
085	HOSE	8924267	4720-01-226-8070
086	JAM NUT	9413533	5310-01-018-5266
087	LOCK TAB	407648-2	5310-01-147-3135
088	LOCKNUT	5117972	5310-00-043-0427
089	LOCKWASHER	MS35338-41	5310-00-045-4007
090	LOCKWASHER	MS35338-43	5310-00-045-3296
091	LOCKWASHER	MS35338-44	5310-00-582-5965
092	LOCKWASHER	MS35338-45	5310-00-407-9566
093	LOCKWASHER	MS35338-46	5310-00-637-9541
094	LOCKWASHER	MS35338-47	5310-00-209-0965
095	LOCKWASHER	MS35338-48	5310-00-584-5272
096	LOCKWASHER	MS35338-49	5310-00-167-0680
097	LOCKWASHER	MS35338-50	5310-00-820-6653
098	LOCKWASHER	MS45904-76	5310-00-061-1258
099	LOCKWASHER	178591	5310-00-017-8591
100	LOCKWASHER	5177769	5310-00-209-1543
101	NUT	192481	5310-01-058-3353
102	NUT, LOCKING	MS21045-7	5310-00-274-9364
103	NUT,LOCKING	MS51968-11	5310-00-880-7745
104	NUT, LOCKING	9174753	5310-00-811-3627
105	NUT, LOCKING	9411981	5310-01-044-0769
106	OIL SEAL	SF534 (35311)	
107	PACKING, PREFORMED	5193598	5330-00-590-1717
108	PIN	141346	5315-00-014-1346
109	PIN	5151576	5315-00-524-7660
110	PLATE,LOCKING	5197378	2950-01-102-0127
111	PLATE, LOCKING	5197385	5340-01-138-5407
112	PLATE, LOCKING	585726	2815-00-150-5064
113	PLUG	116337	5340-00-089-8037
114	PLUG	5103045	5315-01-137-3373
115	PLUG	5126389	2815-00-646-6940
116	PLUG	5151277	5315-00-276-4818
117	PLUG	5154319	5315-00-241-7484
118	RETAINER	5180250	2815-00-792-9020
119	RETAINER	5188405	2815-00-551-6146
120	RING	5100764 (72582)	
121	RING	5102648	2815-01-078-8886
122	RING	5179824	2815-00-271-8983
123	RING	5185325	2815-00-278-1536
124	RING	8924083	2815-01-126-9533
125	RING	8926351 (72582)	
126	RING SET	5194961	2815-00-770-8406
127	RING SET	5197180	2815-00-745-7829

(1) ITEM NO.	(2) DESCRIPTION	(3) PART NO.	(4) NSN
128	RING, PISTON	403671	2990-00-852-9031
129	RING, PISTON	403818-31	5310-00-153-2717
130	RING, PISTON	5197583	2990-00-930-3254
131	RING, SEAL	MS28775-112	5330-00-599-2934
132	RING, SEAL	5101691	5330-01-105-6889
133	RING, SEAL	5103544	5330-01-088-6596
134	RING, SEAL	5119973	5330-00-171-8763
135	RING, SEAL	5133752	5330-00-936-6379
136	RING, SEAL	5183305	5330-00-591-7657
137	RING, SEAL	5186577	5310-00-291-2958
138	RING, SEAL	5186579	5330-00-814-9196
139	RING, SEAL	5197377	2815-00-169-0041
140	RING, SEAL	5198257	5330-00-930-3259
141	RING, SEAL	5229167	5330-00-364-3434
142	RING, SEAL	8922221	2815-00-080-5738
143	RING, SNAP	400105	5365-01-137-8829
144	RING, SNAP	400408	5365-00-930-3257
145	SEAL	5100617 (72582)	
146	SEAL	5106223	5330-01-083-3980
147	SEAL	5107223	5330-01-083-3063
148	SEAL	5107673	5330-01-207-7590
149	SEAL	5108071	5330-01-126-4618
150	SEAL	5115454	5330-00-154-8358
151	SEAL	5117983	5330-00-973-8213
152	SEAL	5132155	5330-00-961-9806
153	SEAL	5177786	5330-00-961-9801
154	SEAL	5574161	5330-00-846-9841
155	SEAL	8924297	2930-00-866-9403
156	SEAL SET	23500533(72582)	
157	SPACER	5144846	3120-00-091-4679
158	TUBE KIT	8925981	5330-01-207-7789
159	VANE SET	8921167	2540-01-105-3037
160	WASHER	5138659	5330-00-769-4882
161	WASHER	5165221	5310-00-599-1616
162	WASHER	5199852	3120-01-038-1499
163	WASHER, COPPER	5152148	5310-00-264-1939
164	WASHER, COPPER	5155596	5310-00-271-7426
165	WASHER, KEY	5150897	5310-00-274-9232
166	WASHER,KEY	7520854(19207)	
167	WASHER,KEY	8926285	5310-01-233-1338
168	WASHER,SPRING	5104439	5310-00-595-8121

Section II. REPLACEMENT PARTS LIST (Cont)

(1) ITEM NO.	(2) DESCRIPTION	(3) PART NO.	(4) NSN
169	RING	23509270 (72582)	
170	PLUG, EXPANSION	5144559	5340-00-228-7441
171	NUT SPECIAL	5149038	5310-01-084-5253
172	GASKET	12368978 (19207)	
173	NUT, LOCKING	23505398	5310-01-317-8619
174	CUP PLUG	5150132	5340-00-939-1192
175	PLUG	5126389	2815-00-646-6940
176	GASKET	23506395 (72582)	
177	GASKET	12368975 (19207)	
178	RING, RETAINING	5149154	2835-01-015-5414
179	RING, SEAL	5198936	5330-01-016-0443
180	SEAL RING, METAL	5197583	5330-00-930-3254
181	THRUST WASHER	442030-1	3120-01-239-5139
182	BEARING, SLEEVE	441843-1	3120-01-239-1369
183	WASHER, FLAT	5198988	5310-00-153-2717
184	RING, RETAINING	MS16627-100	5365-00-285-7124
185	SCREW, SELF-LOCKING	23503754 (72582)	
186	NUT, SELF-LOCKING	400768-13	5310-00-070-6870
187	NUT, LOCKING	5197402	5310-01-165-2272

APPENDIX G
ENGINE REPAIR SPECIFICATIONS

Section I. INTRODUCTION

G-1. SCOPE

This appendix lists the repair specifications for the 8V71T series 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			
Inside diameter of bore	4.6256	4.6275	4.6275
Oversize (0.010)	4.6360	4.6370	4.6375
Oversize (0.020)	4.6460	4.6470	4.6475
Oversize (0.030)	4.6560	4.6570	4.6575
Sleeve bore out-of-round		0.0010	0.0020
Taper of sleeve bore		0.0010	0.0020
Cylinder Sleeve Counterbore			*
Inside diameter of counterbore	5.0460	5.0510	*
Depth of counterbore	0.4770	0.4795	
Main Bearing Bore			*
Inside diameter of bearing bore	4.8120	4.8130	
Camshaft Bearing Bore			*
Inside diameter of bearing bore	2.1875	2.1889	

Section II. ENGINE REPAIR SPECIFICATIONS (Cont)

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	MAXIMUM (inches)	4) WEAR LIMIT (inches)
CRANKSHAFT WITH MAIN BEARING			
Crankshaft Journals			
Diameter of main bearing journal	4.4985	4.5002	*
Diameter of connecting rod journal	2.9985	3.0002	*
Main bearing journal out-of-round		0.00025	0.0010
Connecting rod journal out-of-round		0.0005	0.0005
Taper of main bearing journal		0.0006	0.0006
Taper of connecting rod journal		0.0008	*
Main Bearings			
Inside diameter of bearing, vertical axis	4.5016	4.5040	*
Bearing to journal clearance	0.0014	0.0055	0.0055
Thickness of bearing	0.1545	0.1552	*
Thrust Washer Bearings			
Thickness of thrust washer bearings	0.1190	0.1220	*
Crankshaft end thrust clearance	0.004	0.011	0.018
PISTON, CONNECTING ROD, AND CYLINDER LINER ASSEMBLY			
Cylinder sleeve			
Inside diameter of cylinder sleeve	4.2489	4.2511	*
Outside diameter Standard size	4.6250	4.6265	•
Oversize (0.010)	4.6350	4.6365	*
Oversize (0.020)	4.6450	4.6465	
Oversize (0.030)	4.6550	4.6565	
Sleeve to cylinder block bore clearance	0.0000	0.0020	0.025
Sleeve out-of-round	0.0000	0.0020	0.0025
Taper of sleeve		0.0010	0.0020
Depth of cylinder sleeve below block	0.0450	0.0500	0.0500
Variation in depth between adjacent sleeves		0.0020	0.002
Piston (trunk)			
Outside diameter of piston (at skirt)	4.2393	4.2415	•
Piston to cylinder sleeve clearance	0.0080	0.0118	0.0140
Piston out-of-round		0.0005	•
Taper of piston		0.0005	•
Inside diameter of piston pin bushing	1.5025	1.5030	1.505
Piston (cross-head)			
Outside diameter of dome (top)	4.2389	4.2423	*
Piston skirt outside diameter	4.2428	4.2450	*
Skirt to cylinder sleeve clearance	0.0045	0,0083	0.0120
Piston pin bore diameter	1.5000	1.5030	1.5040
Piston Pin (trunk)			
Diameter of piston pin	1.4996	1.5000	1.498
Length of piston pin	3.605	3.620	*
Pin-to-piston bushing clearance	0.0025	0.0034	0.010
Pin to connecting rod bushing clearance	0.0025	0.0034	0.010
Pin end to retainer clearance	0.016	0.064	0.064

(1) POINT OF MEASUREMENT	(2) MINIMUM (inches)	(3) MAXIMUM (inches)	4) WEAR LIMIT (inches)
PISTON, CONNECTING ROD, AND CYLINDER LINER ASSEMBLY (Cont)			
Piston Pin (cross-head)			
Piston pin diameter	1.4996	1.5000	1.4980
Piston pin length	3.6150	3.6250	*
Slipper bushing clearance	0.0005	0.0105	0.012
Slipper bushing thickness	0.0870	0.0880	0.0860
Piston Rings (trunk)			
Gap of compression rings			
Top compression (fire) ring	0.0230	0.0380	0.0600
Second,third,and lower compression rings	0.0180	0.0430	0.0600
Ring to groove side clearance			
First ring	0.0040	0.0070	0.0100
Second ring	0.0095	0.0130	0.0220
Third ring	0.0075	0.0110	0.0150
Fourth ring	0.0055	0.0090	0.0130
Gap of oil control rings	0.0008	0.023	0.043
Ring-to-groove side clearance			
Fifth ring	0.0015	0.0055	0.0080
Sixth ring	0.0015	0.0055	0.0080
Piston Rings (cross-head)			
Fire Ring Gap	0.023	0.038	0.060
Fire Ring Clearance	0.0010	0.0050	0.0070
Second and Third Compression Ring Gap	0.018	0.043	0.060
Second Compression Ring Clearance	0.0100	0.0130	0.0220
Third Compression Ring Clearance	0.0040	0.0070	0.0130
Oil Rings - Gap - Lower Groove	0.0080	0.0230	0.0430
Oil Rings - Gap - Upper Groove	0.0050	0.0140	0.0340
Oil Ring Clearance - Top Groove	0.0010	0.0040	0.0060
Oil Ring Clearance - Bottom Groove	0.0010	0.0040	0.0060
Connecting Rod (trunk)			
Length of connecting rod			
(center bore to center bore - trunk)	10.1240	10.1260	*
(center bore to center of pin - crosshead)	3.2495	3.2515	
Diameter of lower bore	3.2495	3.2515	*
Inside diameter of upper bushing	1.5025	1.5030	1,5080
Inside diameter of lower connecting rod bearing	3.0005	3.0035	•
Thickness of bearing	0.1240	0.1245	*
Bearing-to-crankshaft journal clearance	0.0008	0.0045	0.0045
Side clearance between rods	0.0080	0.0160	*
CAMSHAFT WITH BEARINGS			
Diameter of end bearing surface	1.4960	1.4965	*
Diameter of intermediate bearing surface	1.4980	1.4985	*
Diameter of drive gear surface	1.1875	1.1885	*
Runout at center bearing surface			
(camshaft supported on end bearings)		0.0020	*

Section II. ENGINE REPAIR SPECIFICATIONS (Cont)

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) WEAR LIMIT (inches)
CAMSHAFT WITH BEARINGS (Cont)			
Camshaft Bearings			
Outside diameter of end bearings	**2.1875**	**2.1880**	
Bearing-to-block bore clearance (end bearings)	**0.0005**	**0.0014**	*
Inside diameter of end bearings	**1.5000**	**1.5010**	*
Bearing-to-camshaft clearance (end bearings)	**0.0035**	**0.0050**	**0.0060**
Outside diameter of intermediate bearings	**2.1840**	**2.1860**	*
Bearings-to-block bore clearance (intermediate bearings)	**0.0015**	**0.0045**	*
Inside diameter of intermediate bearings	**1.5010**	**1.5030**	*
Bearing-to-camshaft clearance (intermediate bearings)	**0.0025**	**0.0050**	**0.0090**
Thickness of thrust washer bearing	**0.1190**	**0.1220**	*
Camshaft end thrust washer bearing end thrust	**0.0003**	**0.0150**	**0.0180**
GEAR TRAIN			
Crankshaft gear			
Inside diameter of crankshaft timing gear surface	**5.2490**	**5.2510**	*
Inside diameter of timing gear	**5.2490**	**5.2510**	*
Timing gear-to-crankshaft clearance	**0.001 (pressure)**	**0.001 (loose)**	
Idler gear			
Bearing preload	**0.5 lb**	**4.0 lb**	*
Variation in pull		**2.7 lb**	*
Blower Drive Gear			
Inside diameter gear bushing	**1.6260**	**1.6265**	*
Support-to-gear bushing clearance	**0.0010**	**0.0025**	**0.0050**
Diameter of gear support	**1.6240**	**1.6250**	*
Thrust washer thickness	**0.2350**	**0.2450**	*
Gear and thrust	**0.0050**	**0.0100**	**0.0120**
Thickness of thrust bearing	**0.0590**	**0.0610**	*
Camshaft Gear			
Inside diameter of gear	**1.1865**	**1.1875**	*
Gear-to-camshaft clearance	**0.0015 (pressure)**	**0.0000**	*
Gear Train Backlash			
Backlash between various mating gears	**0.002**	**0.008**	**0.0100**

(1) POINT OF MEASUREMENT	(2) NEW MINIMUM (inches)	(3) NEW MAXIMUM (inches)	(4) WEAR LIMIT (inches)
OIL PUMP AND REGULATOR VALVES			
Oil Pump Gears			
Backlash adjustment with shims (pump drive gear)	0.006	0.012	0.012
Pressure Relief Valve			
Free length of large spring, inches		2.96	*
Compressed length of large spring (64.5 +3 lb)		2.11	58 lb
Free length of small spring, inches		2.57	*
Compressed length of small spring (32 + 1 lb force)		2.01	28 lb
Pressure Regulating Valve			
Free length of spring, inches		2.96	*
Compressed length of spring (64.5 + 3 lb)		2.11	58 lb
Oil Cooler Bypass Valve			
Force to compress spring to 0.75 inch			6.5 lbs.
CYLINDER HEAD ASSEMBLY			
Exhaust Valves, Guides and Inserts			
Diameter of valve stem	0.3100	0.3105	0.3090
Inside diameter of valve guide	0.3125	0.3135	0.3140
Valve stem-to-guide clearance	0.0020	0.0035	0.005
Valve face seat angle (degrees)	30		*
Valve head-to-cylinder head position -- (-) is recessed and (+) is protruding	-0.0230	+0.0060	+0.038
Height of valve guide above cylinder head		0.880	*
Height of bridge guide above cylinder head		2.0400	*
Diameter of valve head	1.175	1.185	*
Outside diameter of valve seat insert	1.2615	1.2625	*
Width of valve seat insert	0.0468	0.0937	0.0937
Runout of valve seat		0.0020	0.0020
Cylinder Head Casting			
Transverse warpage of cylinder head			0.0040
Longitudinal warage of cylinder head			0.0080
Diameter of cam follower bore	1.0620	0.0630	1.0650
Diameter of valve seat insert counterbore	1.2600	1.2610	*
Depth of counterbore	0.3380	0.3520	*
Thickness of cylinder head (top deck-to-fire-deck)	3.5560	3.5680	3.5360
Diameter of cam follower	1.0600	1.0610	*
Follower-to-cylinder head clearance	0.0010	0.0030	0.0060
Width of roller slot	0.590	0.598	*
Diameter of roller pin hole	0.4362	0.4372	*
Diameter of roller pin	0.4374	0.4377	*
Outside diameter of roller	0.9077	0.9082	*
Inside diameter of roller bushing	0.4390	0.4395	*
Pin-to-bushing clearance	0.0013	0.0021	0.010
Roller-to-follower side clearance	0.0110	0.0230	0.0230

Section II. ENGINE REPAIR SPECIFICATIONS (Cont)

(1) POINT OF MEASUREMENT	(2) MINIMUM (inches)	(3) MAXIMUM (inches)	(4) LIMIT (inches)
CYLINDER HEAD ASSEMBLY (Cont)			
Rocker Arms and Shafts			
Diameter of rock arm shaft	0.8735	0.8740	•
Shaft-to-bushing clearance	0.0010	0.0025	0.0040
Inside diameter of rocker arm shaft bushing	0.8750	0.8760	•
Valve and Push Rod Springs			
Free length of push rod spring		2.625	•
Compressed length of push-rod spring (184 lb force)		2.125	172 lb
BLOWER ASSEMBLY			
Blower Timing Gears			
Blower timing gear backlash	0.0005	0.0025	0.0040
Rotors			
Rotor-to-gear side of housing clearance	0.010		*
Rotor-to-float side of housing clearance	0.012		*
Clearance between rotors			
Trailing edge of of right hand rotor to leading edge of left hand rotor	0.013		
Leading edge of right hand rotor to trailing edge of left hand rotor	0.020		*
BLOWER BY-PASS ASSEMBLY			
By-pass valve spring load (at 2.65 inches)	100 lb	ll0 lb	

GLOSSARY

Section I. ABBREVIATIONS

AOAP	Army Oil Analysis Program
ATTN	attention
BHP	brake horsepower
CCLW	counterclockwise
CLW	clockwise
Cont	continued
cm	centimeter
cu	cubic
DA	Department of the Army
V dc	volts direct current
DF	diesel fuel
DS	Direct Support
EIR	Equipment Improvement Recommendation
FOV	Family of Vehicles
ft	foot, feet
gpm	gallons per minute
GS	General Support
Hg	mercury
kg	kilogram
kPa	kilopascal
lb	pound
lb-ft	pound-foot
lb-in	pound-inch
min	minute
mm	millimeter
N-m	newton-meter
NSN	National Stock Number
PAM	Pamphlet
Para	Paragraph
psi	pounds per square inch
qt	quart
REV	revolution
rpm	revolutions per minute
SAE	Society of Automotive Engineers

Section H. UNUSUAL TERMS

air box	a chamber in the cylinder block containing cylinder inlet ports
brinelling	hardening of metal causing brittleness from fatigue
concentricity	roundness of 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	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 reassemble in the position
multimeter	multiple purpose electrical meter
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
scored	grooved, scratched, or notched
spline	a set of teeth on a shaft or bore for coupling
trunk type piston	a one-piece piston
turbocharger	an air compressor driven by an exhaust gas turbine
woodruff key	a standard key used in mating grooves of a gear and shaft

Section III. NOMENCLATURE CROSS-REFERENCE

air box cover	access cover
bearing shell	bearing sleeve
bolt	hexagon head cap screw
brass wire buffing wheel	wire rotory brush
cylinder liner	cylinder sleeve
dipstick	liquid level gage (oil)
engine rocker arm cover	engine poppet cover
engine coolant	antifreeze, ethylene glycol mixture
fiber coupling	flexible insert
feeler gage	thickness gage
gasket	ring spacer (injector)
seal sleeve	seal spacer (blower rotor shaft)

ALPHABETICAL INDEX

ALPHABETICAL INDEX (Cont)

SUBJECT **PARA**

C

SUBJECT **PARA**

C (Cont)

D

E

ALPHABETICAL INDEX (Cont)

SUBJECT PARA

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ALPHABETICAL INDEX (Cont)

SUBJECT **PARA**

R

S

T

ALPHABETICAL INDEX (Cont)

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Chief of Staff

Official:

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3		2		Item 10. Change illustration. Reason: Tube end shown assembled on wrong side of lever cam.
109		51		Item 3. The NSN and P/N are not listed on the AMDF nor the MCRL. Request correct NSN and P/N be furnished.
2-8			2-1	Preventive Maintenance Checks and Services. Item 7 under "Items to be inspected" should be changed to read as follows: Firing linkage and firing mechanism pawl.
12	1-6a			Since there are both 20- and 30- round magazines for this rifle, data on both should be listed.

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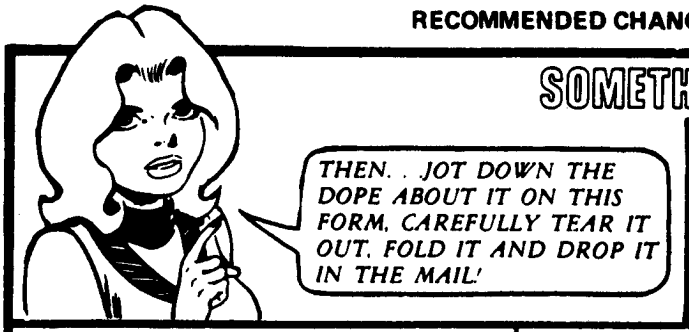

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THE METRIC SYSTEM AND EQUIVALENTS

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 = 2.2 Lb
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

SQUARE MEASURE

1 Sq Centimeter = 100 Sq Millimeters = 0.155 Sq Inches
1 Sq Meter = 10,000 Sq Centimeters = 10.76 Sq Feet
1 Sq Kilometer = 1,000,000 Sq Meters = 0.386 Sq Miles

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0.06 Cu Inches
1 Cu Meter = 1,000,000 Cu Centimeters = 35.31 Cu Feet

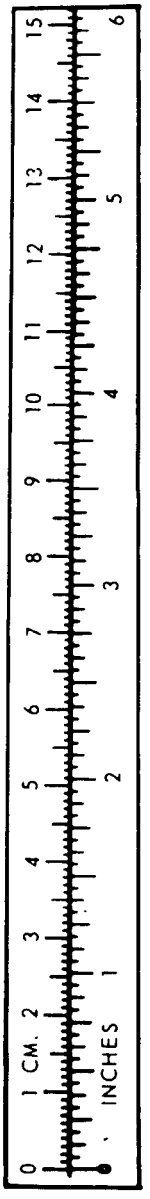
TEMPERATURE

$5/9\ (^0F - 32) = {}^0C$
212^0 Fahrenheit is equivalent to 100^0 Celsius
90^0 Fahrenheit is equivalent to 32.2^0 Celsius
32^0 Fahrenheit is equivalent to 0^0 Celsius
$9/5\ C^0 + 32 = F^0$

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid Ounces	Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.454
Short Tons	Metric Tons	0.907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0.155
Square Meters	Square Feet	10.764
Square Meters	Square Yards	1.196
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	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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