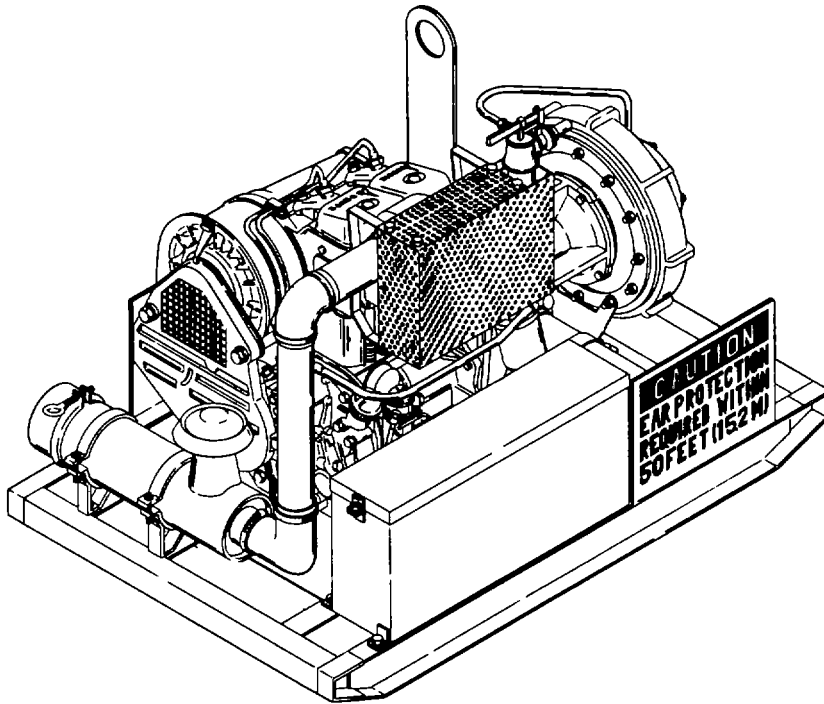


**OPERATOR'S, ORGANIZATIONAL,
DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL**



**PUMP UNIT, CENTRIFUGAL, WATER,
DIESEL-ENGINE-DRIVEN,
2-1/2-INCH, SKID-MOUNTED
200 GPM AT 300 FEET TOTAL HEAD**

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CHANGE
NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 10 October 1990

Operator's, Organizational
Direct Support and General Support
Maintenance Manual
for
**PUMP UNIT, CENTRIFUGAL, WATER,
DIESEL-ENGINE-DRIVEN,
2-1/2-INCH, SKID-MOUNTED,
200 GPM AT 300 FEET TOTAL HEAD**

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4-5 and 4-6	4-5 and 4-6
4-17 and 4-18	4-17 and 4-18
4-25 and 4-26	4-25 and 4-26
4-51 and 4-52	4-51 and 4 52
E-1 and E-2	E-1 and E-2

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By Order of the Secretary of the Army:

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Chief of Staff

Official:

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The Adjutant General

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NO. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 8 April 1988

Operator's, Organizational
Direct Support and General Support
Maintenance Manual
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**PUMP UNIT, CENTRIFUGAL, WATER,
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2-1/2-INCH, SKID-MOUNTED,
200 GPM AT 300 FEET TOTAL HEAD**

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To be distributed in accordance with DA Form 12-25A, Operator, Unit, Direct Support and General Support Maintenance requirements for Pump Unit, Centrifugal, Water (13213E2578)

WARNING**CARBON MONOXIDE**

is produced by the internal combustion engine of this pump.

DEATH

may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

SEVERE BURNS

illness, death, or injury may result if personnel fail to handle diesel fuel properly. Observe the following safety precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill the fuel tank.
- Work in a well-ventilated area.

WARNING**DEATH OR SEVERE INJURY**

might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

EXPLOSION HAZARD

exists when welding repairs are attempted on fuel tank. Purge all fumes from tank before attempting repair involving heat or flame.

SEVERE INJURY

may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

LIVE STEAM

used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

SEVERE BURNS

may result from touching exhaust components during or immediately after operation. Allow unit to cool before performing any service or maintenance.

CAUSTIC CHEMICALS IN BATTERIES

may cause severe burns or blindness if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

WARNING**BATTERIES GENERATE FLAMMABLE GAS**

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.
- Connect positive battery cables to battery first to prevent shocks.

SERIOUS INJURY

could result from improper use of lifting equipment. Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.

HEALTH HAZARD

exists when acetylene torches are used. Operate torches properly and be alert for leaks on any part of the equipment. Inhalation of acetylene produces headache, dizziness, nausea, and possible loss of consciousness. If acetylene is inhaled, seek fresh air immediately.

HEALTH AND SAFETY HAZARD

exists when cleaning solvents are used. Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

SEVERE BURNS OR SERIOUS INJURY

may result from contact with priming discharge mixture of water and exhaust gases. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

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**Operator's, Organizational, Direct Support, and
General Support Maintenance Manual
PUMP UNIT, CENTRIFUGAL, WATER, DIESEL-ENGINE-DRIVEN,
2-1/2-INCH, SKID-MOUNTED, 200 GPM AT 300 FEET TOTAL HEAD
MODEL US2520 HCCD-1**

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistake or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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CHAPTER 1 INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE

Type of Manual: Operator's, Organizational, Direct Support, and General Support Maintenance

Model Number and Equipment Name: US2520 HCCD-1 Pump Unit, Centrifugal, Water, Diesel-Engine-Driven, 2-1/2-Inch, Skid-Mounted, 200 GPM at 300 Feet Total Head

Purpose of Equipment: Pumps Water

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS

Department of the Army forms and procedures used for equipment maintenance will be those prescribed by TM 738-750, The Army Maintenance Management System (TAMMS).

1-3. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

Refer to TM 750-244-3, Procedures for Destruction of Equipment to Prevent Enemy Use, for instructions.

1-4. PREPARATION FOR STORAGE AND SHIPMENT

Instructions for preparation for storage and shipment are in Chapter 4.

1-5. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S)

If your centrifugal pump unit needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 268 (Quality Deficiency Report). Mail it to us at U.S. Army Troop Support Command, ATTN: AMSTR- QX, 4300 Goodfellow Blvd., St. Louis, MIVU 63120-1798. We'll send you a reply.

1-6. NOMENCLATURE CROSS-REFERENCE

For precise identification, simplified nomenclature has been established for clarity and is shown in the nomenclature cross-reference list.

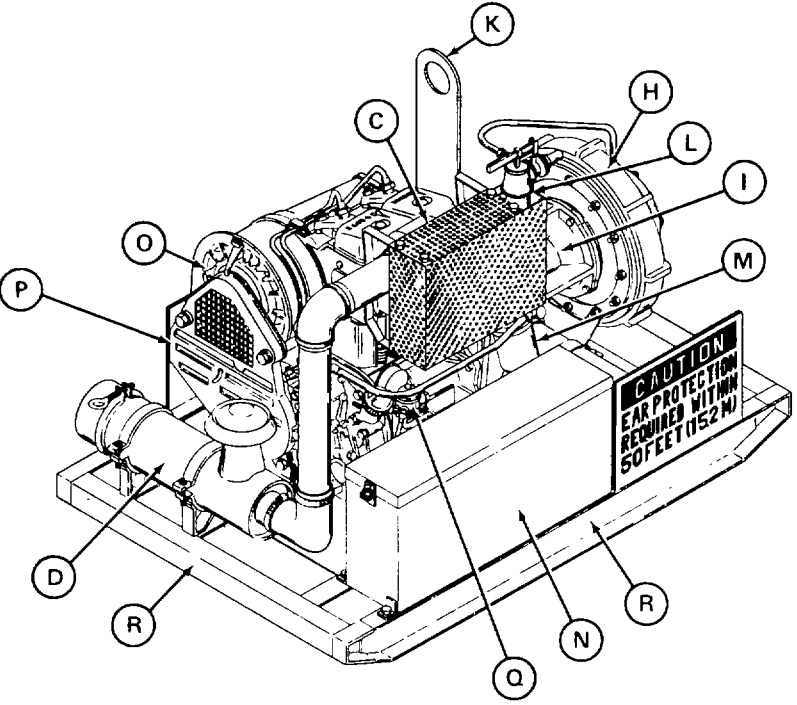
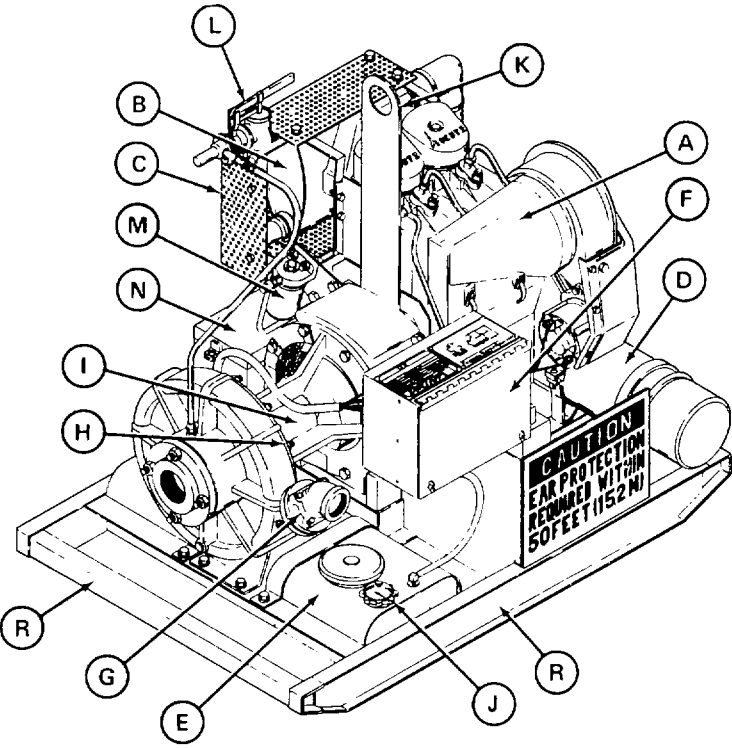
NOMENCLATURE CROSS-REFERENCE LIST

This listing includes nomenclature cross-references used in this manual.

Common Name

Official Nomenclature

Centrifugal Pump Unit	Pump Unit, Centrifugal, Water, Diesel-Engine-Driven, 2-1/2-Inch, Skid-Mounted, 200 GPM at 300 Feet Total Head
Engine	Diesel Engine
Pump	Centrifugal Pump
Starter	Starter Motor



Section II. EQUIPMENT DESCRIPTION AND DATA

1-7. PURPOSE OF CENTRIFUGAL PUMP UNIT

General purpose water pumping applications associated with construction work.

1-8. CHARACTERISTICS

- Variable speed operation
- Skid-mounted
- Exhaust priming

1-9. CAPABILITIES AND FEATURES

- Pumps at a rate of 200 gpm
- Integral check valve retains fluid in the pump body when the pump is shut down
- Twelve-volt alternator
- Twelve-volt starter
- Twelve-volt automatic shutdown for high temperature, low oil pressure, and overspeed
- Variable speed governor
- Throttle control
- Horizontal mount dry-type air cleaner and rain cap
- Horizontal mount exhaust silencer and muffler guard
- Enclosed control panel with tachometer, throttle control, ON-OFF switch and lighted gages

1-10. LOCATION AND DESCRIPTION OF EXTERNAL COMPONENTS

- (A) ENGINE. Power source
- (B) EXHAUST SILENCER. Mounts horizontally on engine.
- (C) MUFFLER GUARD. Metal safety cover for exhaust silencer.
- (D) AIR CLEANER. Dry-type, mounts horizontally on skid.
- (E) FUEL TANK ASSEMBLY. Mounts on skid assembly.
- (F) CONTROL PANEL. Mounts on rear of engine.
- (G) CHECK VALVE BODY ASSEMBLY. Mounts to pump body.
- (H) PUMP AND BEARING ASSEMBLY. Mounts to engine.

- (I) BEARING HOUSING ASSEMBLY. Mounts to pump body and engine.
- (J) FUEL LEVEL INDICATOR. Mounts on fuel tank.
- (K) LIFTING BRACKET. Mounts on rear of engine.
- (L) EXHAUST PRIMER ASSEMBLY. Used to prime pump.
- (M) FUEL FILTER. Filters fuel to engine.
- (N) BATTERY BOX. Contains two 12-volt batteries to start engine.
- (O) COOLING AIR BLOWER. Cools engine.
- (P) V-BELT GUARD. Safety cover for V-belts and pulleys.
- (Q) FUEL FEED PUMP. Pumps fuel from fuel tank to fuel filter.
- (R) SKID ASSEMBLY. Supports engine and pump.

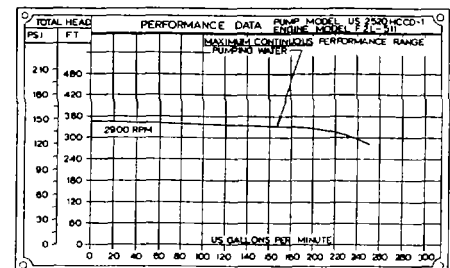
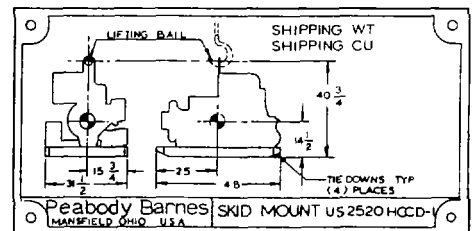
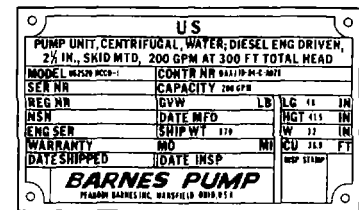
1-11. IDENTIFICATION PLATE

The centrifugal pump has the following identification and instruction plates:

a. *Identification plate.* The identification plate is located on top of the control panel. It provides the pump identification number, serial number, dimensions, weight, and shipping information.

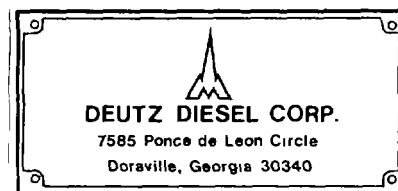
b. *Loading instruction plate.* The loading instruction plate is located on top of the control panel. It provides instructions for lifting, tie down, shipping weight, and applicable dimensions.

c. *Performance data information plate.* The performance data information plate is located on the inside of the control panel cover. It provides the performance range curve based on total head, revolutions per minute, and US gallons per minute.



d. *Engine identification plate.* The engine identification plate is located on the starter side of the engine. It provides engine identification.

e. *Warning plates.* The warning plates are located on both sides of the skid. They provide information for the safety of personnel when operating the centrifugal pump unit without hearing protection.



1-12. DIFFERENCES BETWEEN MODELS

This technical manual covers only Centrifugal Pump Unit, Peabody Barnes Model US2520 HCCD-1, part number 75250CA. No known differences exist for this model number.

1-13. EQUIPMENT DATA

a. *Pump.*

Manufacturer	Peabody Barnes, Inc.
Part number	75250CA
Type.....	Auxiliary priming centrifugal
Service	Water
Duty cycle	Continuous
Rated output	200 gpm at 300 feet total head
Suction port (Intake).....	2-1/2-inch NPT
Discharge port.....	2-1/2-inch NPT
Priming port	3/8-inch NPT
Priming method.....	Exhaust priming system
Drain port.....	1/4-inch NPT
Rotation	Counterclockwise (facing pump inlet)

b. *Engine.*

Manufacturer.....	Deutz Diesel
Model.....	F2L511D
Type.....	Four-stroke-cycle diesel
Number of cylinders	2
Bore.....	3.9370 in. (100.0 mm)
Stroke	4.1339 in. (105.0 mm)
Compression ratio (nominal)	17 to 1
Total displacement.....	100.68 cu in. (1650 cu cm)
Direction of rotation (viewing flywheel).....	Counterclockwise
Firing order	2-1
Number of main bearings.....	3

c. *Engine accessories.*

Starter motor	
Manufacturer	Bosch
Part number	117 1481
Voltage	12
Alternator	
Manufacturer	Bosch
Part number	117 2857
Voltage	12
Air cleaner	
Manufacturer	Donaldson
Type	Dry
Element number	
Primary	P18-2062
Secondary	P11-9539

d. *Capacities.*

Fuel tank.....	6.5 gal (24.6 liters)
Engine crankcase.....	3.7 qt (3.5 liters)
Oil cooling system.....	3.7 qt (3.5 liters)

e. *Dimensions and weight.*

Overall width	31.5 in. (0.80 meter)
Overall length	48.0 in. (1.22 meters)
Overall height	40.75 in. (1.04 meters)
Gross weight	870 lb (395 kg)
Shipping volume	36.9 cu ft (1.05 cu m)

1-14. SAFETY, CARE, AND HANDLING

a. *Before operation.* Do not operate the unit in an enclosed area unless the exhaust is piped to the outside. The exhaust contains carbon monoxide, a colorless, odorless, deadly poisonous gas. Do not smoke or use an open flame in the vicinity when servicing batteries. Batteries generate hydrogen, a highly explosive gas. When filling the fuel tank, always maintain a metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting the diesel oil fumes.

b. *During operation.* Stand clear of venturi during priming. Do not fill the fuel tank while the engine is operating, nor attempt to perform maintenance on the centrifugal pump unit while it is in operation.

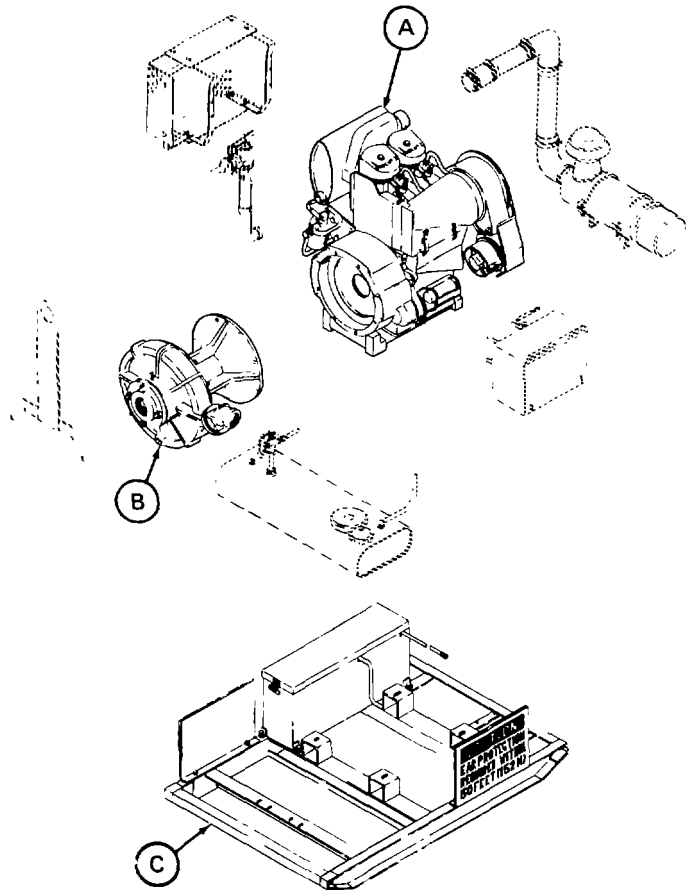
c. *After operation.* Exercise extreme caution when performing any maintenance while the engine is hot. This may result in serious burns to personnel. When filling the fuel tank, always maintain metal-to-metal contact between the filling apparatus and the fuel tank to prevent a static spark from igniting diesel oil fumes.

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-15. CENTRIFUGAL PUMP UNIT

The centrifugal pump mounts on a skid in line with a 35 horsepower diesel engine. Power from the engine is transferred to the pump through a direct drive coupling for maximum torque at rated output. The pump is auxiliary (exhaust) primed (a check valve retains water in the pump body), and is capable of variable speed operation. The pump has a capacity of 200 gallons per minute at 300 feet total head. The pump is equipped with female, 2-1/2-inch NPT suction and discharge ports. The continuous-duty, air/oil-cooled diesel engine uses a 12-volt electrical system, and is equipped with electric start, spin-on oil and fuel filters, a heavy-duty dry-type air cleaner, and a control panel.

- (A) ENGINE. Bolted to the skid assembly. Provides the power necessary to drive the pump.
- (B) CENTRIFUGAL PUMP. Bolted to the skid assembly. Uses power from the engine to pump water from the suction port to the discharge port.
- (C) SKID. Provides a movable mounting platform for the engine and pump assemblies.



The following text functionally describes the interaction of unit components during operation.

(A) ENGINE

1. ELECTRICAL SYSTEM. Major functional components include a battery, starter motor, alternator, and wiring harness. The battery provides electric power to run the starter motor and start the engine. The alternator recharges the battery after the engine is started, and provides power to all electrical components through the wiring harness.
2. LUBRICATION SYSTEM. Major components include a lube oil pump, lube oil cooler, and lube oil filter. The lube oil pump pumps oil to reduce friction between moving parts,

the lube oil cooler reduces the temperature of the lube oil which cools the engine, and the lube oil filter removes impurities from the oil.

3. **COOLING SYSTEM.** Major components include a cooling air blower, cooling air ducting, and a lube oil cooler. The primary coolant is the engine lube oil. The secondary coolant is forced cool air. The cooling air blower blows cool air onto the cylinders and the lube oil cooler, cooling the lube oil while it is being circulated by the engine.
 4. **FUEL SYSTEM.** Major functional components include a fuel feed pump, fuel injection pump, fuel tank, filter, and lines. The fuel feed pump pumps fuel from the fuel tank, through its filter, to the fuel injection pump, then to the engine. The fuel lines connect the major components.
 5. **EXHAUST SYSTEM.** Major functional components are the exhaust manifold, exhaust silencer, elbows and nipples, and an exhaust primer assembly. The exhaust manifold transfers exhaust gases from the engine to the exhaust silencer. The exhaust silencer quiets the sound and reduces the temperature of the exhaust. The exhaust primer assembly is connected to the outlet of the exhaust silencer by an elbow and a nipple. During operation of the engine, exhaust normally flows past the exhaust primer rain cap. If the pump requires priming, the operator can close the rain cap and force the exhaust through a venturi in the exhaust primer assembly. If while doing this the operator opens the valve cock in the line to the pump body, the volute will be primed.
- (B) **CENTRIFUGAL PUMP.** Major components include a volute, impeller, check valve, and pump body with suction and discharge ports. The volute houses the impeller which draws water in through the suction port and forces it out of the pump through the discharge port. The check valve prevents discharged water from running back through the pump.
- (C) **KID.** The skid is the movable mounting support for the engine and centrifugal pump.

**CHAPTER 2
OPERATING INSTRUCTIONS**

Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS AND INDICATORS

WARNING

Personal injury may result if the engine is not turned off during service or maintenance.

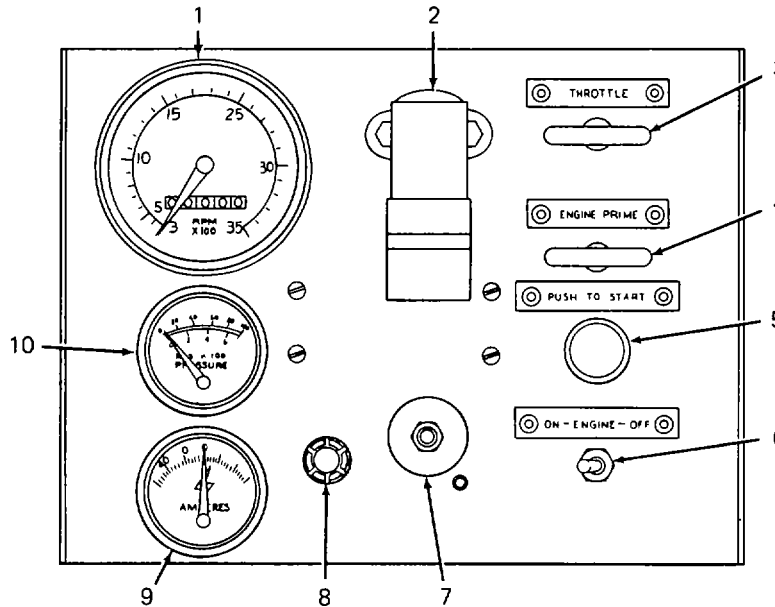


Table 2-1. Operator's Controls and Indicators

Key	Control or Indicator	Function
1	Tachometer	Indicates engine speed in revolutions per minute (rpm) and elapsed time in hours, tenths, and hundredths. Mechanically coupled to rotating cable that is connected to the drive gear. Graduated in 100 rpm increments from 0 to 3500 rpm. The elapsed time meter will record up to 9999.99 hours of operation.
2	Air cleaner intake restriction indicator	Indicates blockage of air filter. A red indication appears in window to indicate the need for cleaning or replacement of elements. Indicator is connected to air inlet housing by a flexible hose, and is actuated by high negative pressure. Indicator can be reset.
3	Throttle T-handle	Push-pull cable. T-handle mechanically connected to throttle. Controls engine speed. Coupled to speed control lever by a control wire. Uses a mechanical lock. Pull throttle T-handle to increase engine speed; push it in to decrease engine speed. Turn clockwise to lock.

Table 2-1. Operator's Controls and Indicators-Continued

Key	Control or Indicator	Function
4	ENGINE PRIME T-handle	Push-pull cable. T-handle mechanically connected to fuel feed pump priming lever. Used to prime engine by forcing fuel from fuel tank into fuel system.
5	PUSH TO START pushbutton	Starts engine. Starter pushbutton when pushed allows electric current to flow to the starting solenoid. The starting solenoid then allows current to flow to the starter motor.
6	ON-ENGINE-OFF switch	Turns engine on and off. Energizes electrical system for engine operation.
7	Fault sensitive control	Shuts down engine if any of the following occur: (1) Low oil pressure-below 20 pounds per square inch (psi) (137.9 kilopascals [kPa]); (2) high engine cylinder head temperature; or (3) engine overspeed-greater than 3050 rpm. Has red pushbutton reset that also has to be pushed when starting engine.
8	Charging indicator light	Charging indicator light comes on when ON-ENGINE-OFF switch is ON before starting engine. Once engine is running, charging indicator light will go out. Charging indicator light will come on again if alternator is not charging the battery and when engine is shut down. The charging indicator light will go out again a few seconds after engine shutdown.
9	Ammeter	Indicates battery charge or discharge in amperes (A). Electrically connected in series to battery circuit. Graduated in 5 A increments from 0 to +60 A and 0 to -60 A.
10	Oil pressure gage	Switchgage indicates engine oil pressure in psi and kilopascals (kPa). Mechanically connected by the oil pressure line hose assembly to the engine oil lubrication system on the outlet side of the lube oil pump. Graduated in 10 psi (68.9 kPa) increments from 0 to 100 psi (0 to 689.5 kPa). Has mechanical lever to set low oil pressure setpoint associated with the fault sensitive control to shut down engine.

Section II. OPERATOR/CREW PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

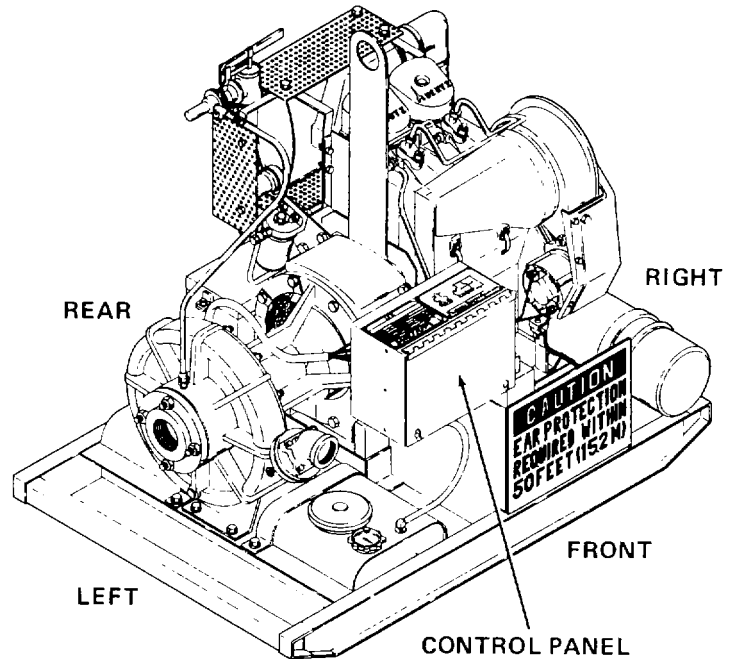
2-1. GENERAL

- a. *Before you operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your before (B) PMCS.
- b. *While you operate.* Always keep in mind the CAUTIONS and WARNINGS. Perform your during (D) PMCS.
- c. *After you operate.* Be sure to perform your after (A) PMCS.
- d. If your equipment fails to operate. Troubleshoot with proper equipment. Report any deficiencies using the proper forms; see TM 738-750.

2-2. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

- a. Table 2-2 lists the preventive maintenance checks and services which shall be performed at specified intervals by the operator/crew.
- b. Item numbers are assigned to each check or service task. These numbers are to be used as a source of item numbers for the TM Number column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
- c. The service intervals are divided into five categories; B-Before Operation; D-During Operation; A-After Operation; W-Weekly; and M-Monthly. A dot (e) is placed in the interval column for each check or service. If the same check or service is made in two or more intervals, a dot is placed in each applicable column.
- d. The ITEM TO BE INSPECTED column lists the item to be checked or serviced. This column is combined with the PROCEDURE column.
- e. The PROCEDURE column describes the procedure by which the check or service is to be performed. Illustrations are included to assist in locating that part of the equipment requiring the check or service. When instructions for removal of assemblies or equipment are required in order to perform PMCS, they are listed and illustrated in the PROCEDURE column.

f. The designations left, right, front, and rear as used in the preventive maintenance checks and services (PMCS) indicate the side or end of the centrifugal pump as viewed when facing the control panel.



g. Leakage definitions for operator/crew PMCS shall be classified as follows:

- Class I Seepage of fluid (as indicated by wetness or discoloration) not great enough to form drops.
- Class II Leakage of fluid great enough to form drops but not enough to cause drops to drip from item being checked/inspected.
- Class III Leakage of fluid great enough to form drops that fall from the item being checked/inspected.



Equipment operation is allowable with minor leakages (Class I or II). Of course, you must consider the fluid capacity in the item/system being checked/inspected. When in doubt, notify your supervisor.

When operating with Class I or Class II leaks, continue to check fluid levels as required in your PMCS.

Class III leaks should be reported to your supervisor or organizational maintenance.

h. The Equipment is Not Ready/Available If: column contains the basis for classifying the equipment as not ready/available because it is unable to perform its primary mission. An entry in this column will:

- (1) Identify conditions that make the equipment not ready/available for readiness reporting purposes.
- (2) Deny use of the equipment until corrective maintenance has been performed.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services**NOTE**

If the equipment must be kept in continuous operation, check and service only those items that can be checked and serviced without disturbing operation. Make the complete checks and services when the equipment can be shut down.

Perform weekly as well as before operation PMCS if:

- (1) You are the assigned operator and have not operated the item since the last weekly.
- (2) You are operating the item for the first time.

Within designated interval, these checks are to be performed in the order listed.

Preventive Maintenance Checks and Services having item numbers 3, 5, 6, 23, 24, and 29 address checks and services that are performed on items spread over equipment. Good planning practices will make the operator aware of the requirements of these checks and services so he can perform them as he moves around the equipment during the course of accomplishing other checks and services having the same intervals.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
1						<ul style="list-style-type: none"> Control Panel Cover Assembly. <p>Visually inspect for:</p> <p>Loose attaching hardware. Cracks in welds.</p> <p>Damaged control panel door piano hinge.</p> <p>Distortion that would prevent closing of control panel door. Broken pop-type rivets. Stripped or damaged wing head studs. Instruction/identification plates that cannot be read.</p>	<p>Engine speed or engine oil pressure cannot be monitored. Indications exist that engine shutdown, or speed control might not be possible. Class III oil leakage is present.</p>

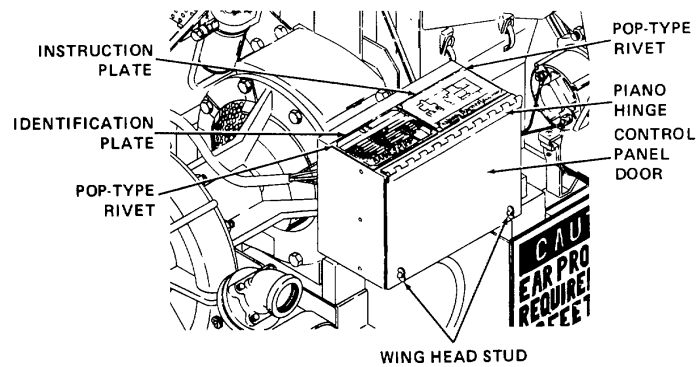


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Visually inspect for:</p> <ul style="list-style-type: none"> Damaged pop-type rivets. Identification plates or performance data information plate that cannot be read. Damaged gage faces. Loose controls and indicators. Damaged cap. Damaged switch boot. Oil leakage around 2-inch switchgage. Damaged wing head stud retainers and receptacles. 	

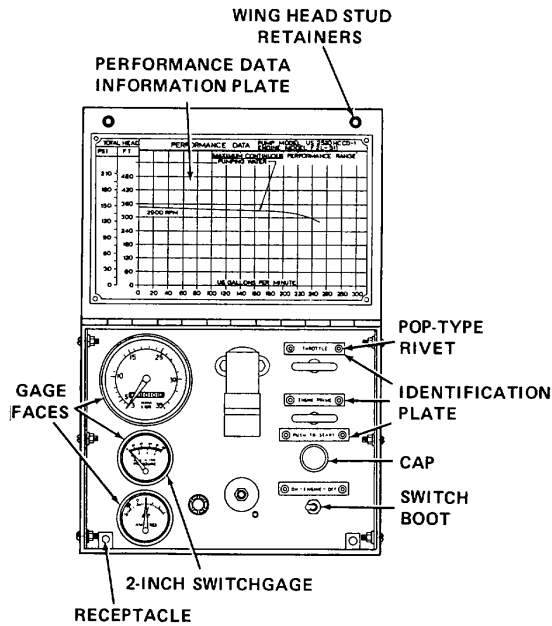


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

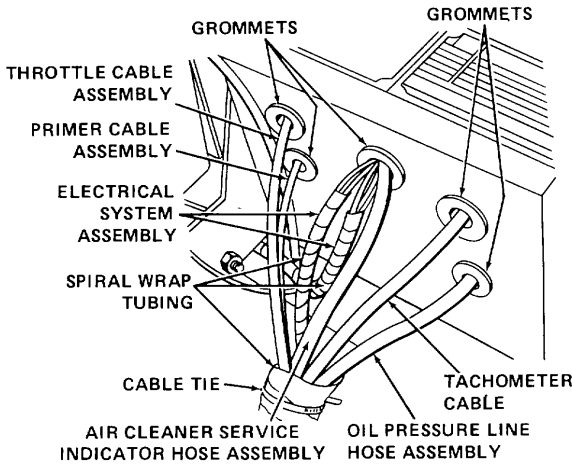
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Visually inspect for:</p> <ul style="list-style-type: none"> Missing or worn grommets. Frayed, worn, or leaking oil pressure line hose assembly. Damaged or broken cable ties. Frayed or worn spiral wrap tubing. Frayed or worn tachometer cable. Frayed or worn electrical system assembly. Frayed, worn, or leaking air cleaner service indicator hose assembly. Frayed, worn, or binding throttle cable assembly. Frayed, worn, or binding primer cable assembly. 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
2	•	•				<p><i>Control Panel Cover Assembly Controls, Meters, Gages, and Indicators.</i></p> <p>Check for broken lenses and indications of proper operation. Readings or indications during operation shall fall within the ranges given below:</p> <p>2-inch switchgauge-Oil pressure must be 60 psig to 80 psig (413.7 kPa to 551.6 kPa). No evidence of leakage.</p> <p>Air cleaner restriction indicator-No red flag in window of indicator. No evidence of leakage.</p> <p>Tachometer-2750 rpm to 2950 rpm. Hourmeter recording elapsed time.</p> <p>Ammeter-Charging rate 0 to 60 amps maximum.</p> <p>Check for smooth operation when using throttle cable assembly and priming cable assembly.</p>	Oil pressure is below 20 psig (137.9 kPa) or air cleaner restriction indicator shows red.

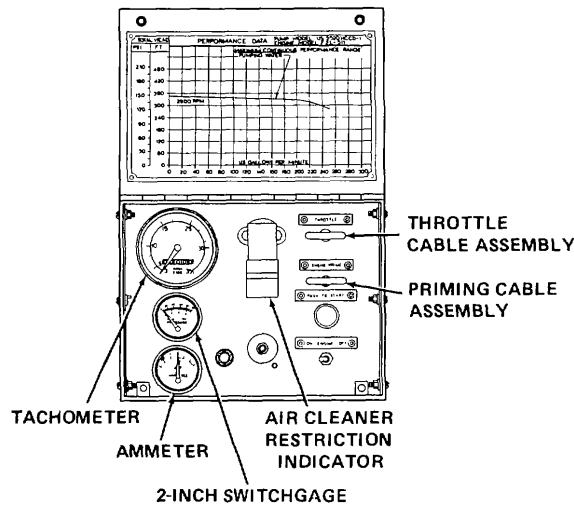


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
3					•	<p><i>Skid Assembly and Warning Plates.</i></p> <p>Check attaching hardware used to mount components of centrifugal pump unit. Attaching hardware shall be tight and free of corrosion and damage. Components of pump attached directly to skid are:</p> <p>Warning plates Pump body mounting angle Fuel tank straps Engine Battery box Air cleaner clamps</p> <p>Visually inspect all skid welds for cracks. Inspect only those welds that can be seen without disassembly.</p> <p>Check that warning plates can be read.</p> <p>If sufficient clearance is available, check that drain holes are not blocked.</p> <p>Check for indications of corrosion on skin crossmember around fuel tank assembly.</p> <p>Check for indications of corrosion in areas between all mated parts.</p> <p>Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal shall be refinished as soon as possible in accordance with MI L-T-704.</p>	Cracks are detected, or engine or pump and bearing housing assembly is loose.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

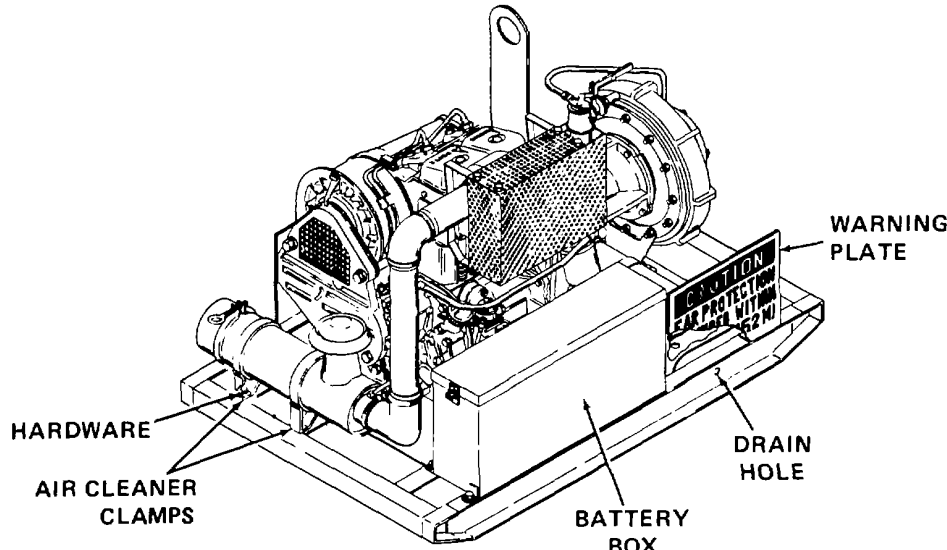
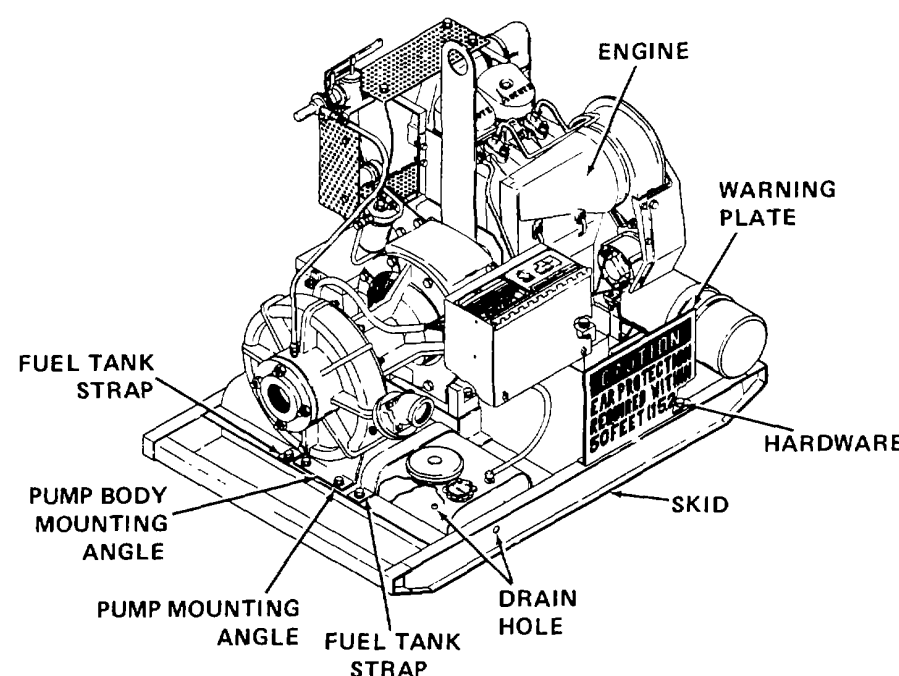
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
							
							

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
4						<ul style="list-style-type: none"> • <i>Lifting Bracket.</i> <p>Check that hex head cap screws are tight and not corroded.</p> <p>Check for cracks in base metal and/or welds.</p> <p>Check 3-inch diameter hole for wear and cracks.</p> <p>Check for corrosion, especially at mating areas.</p> <p>Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal shall be refinished as soon as possible in accordance with MI L-T-704.</p>	Equipment must be lifted, and lifting bracket weldment condition prohibits a safe lift.

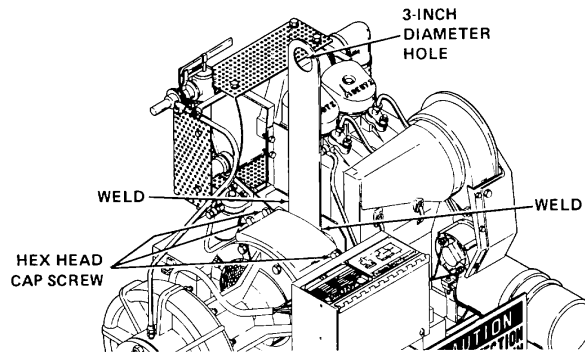


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

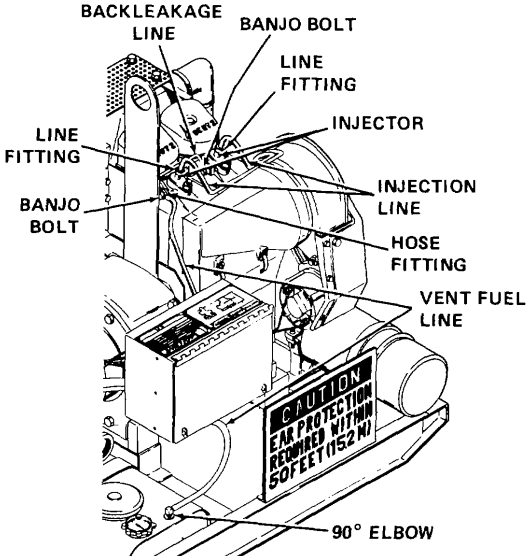
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
5		•				<p><i>Fuel Lines and Fittings (Front).</i></p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Check vent fuel line for line leaks and leaks at 90 degree elbow and hose fitting. Check for leaks at banjo bolts. Check for leaks in backleakage line. Check for leaks at injectors, injection line fittings, and in injection lines.</p> 	Class III leakage is present or fire hazard exists.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
6					•	<p><i>Fuel Lines and Fittings (Front).</i></p> <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">WARNING</div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Check vent fuel line for cracks, holes, line leaks, abrasions, leaks at 90 degree elbow, and leaks at hose fitting.</p> <p>Check backleakage line for cracks, line leaks, and leaks at banjo bolts.</p> <p>Check injectors for leaks.</p> <p>Check injection lines for cracks, line leaks, worn spots, and leakage at injector fittings.</p> <p>Check that pipe clip is tight, enclosed rubber sleeves are in place, rubber sleeves are in place and protecting lines from wear.</p>	Class III leakage is present or fire hazard exists.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						2-15	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

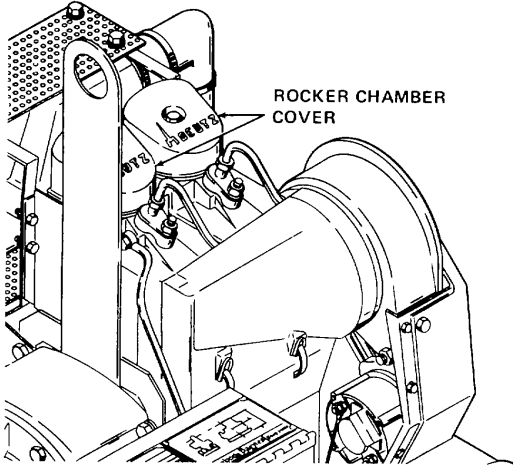
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
7		•				<p><i>Rocker Chamber Cover.</i></p> <p>Check for oil leaks at base of cover.</p> <p>Check for loose cover.</p> 	Class III leakage is present.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

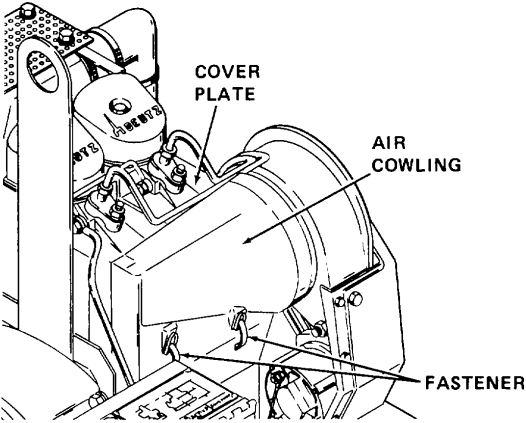
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
8				•		<p><i>Cooling Air Ducting.</i></p> <p>Rotate latch handle of fasteners down. Lift air cowling up, unhook from cover plate, and set aside.</p>  <p>Check that cover and stay plates are tight. Check that thermoswitch is positioned as shown. Check lead is firmly connected to thermoswitch. Check lead for abrasion, cracking, or damage. Check cylinder cooling fins for damage, or dirt. Remove dirt using a dry, stiff-bristle brush. Check bottom roller of cooling air blower for rubbing, binding, obstruction, or dirt. Remove dirt using a dry, stiff-bristle brush. Check for damaged or deformed fan blades. Check lube oil cooler cooling fins for damage, dirt, or obstructions. Remove dirt using a dry, soft-bristle brush. Check lube oil line for leakage, abrasion, cracking, or damage.</p>	Accumulated dirt cannot be removed, cooling blower is binding or rubbing, or tripping of thermoswitch indicates over-heat condition.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

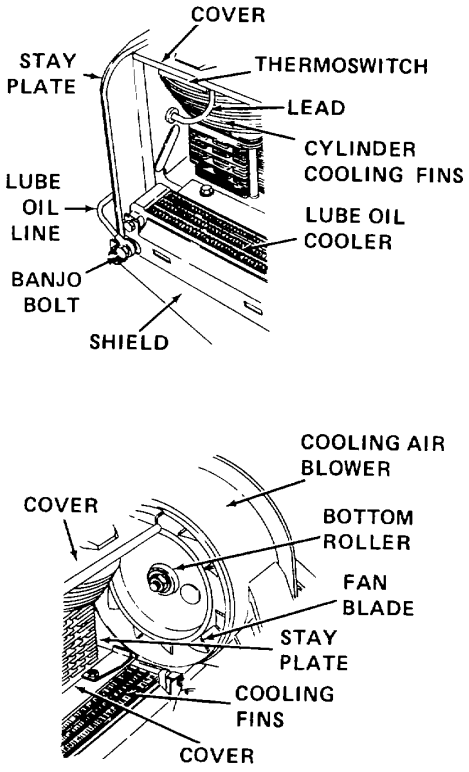
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Check lube oil line end and banjo bolt for leakage.</p> <p>Check engine side beneath shield for evidence of oil leakage.</p> <p>Check shield attaching hardware for tightness.</p> <p>Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal shall be refinished as soon as possible in accordance with MIL-T-704.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

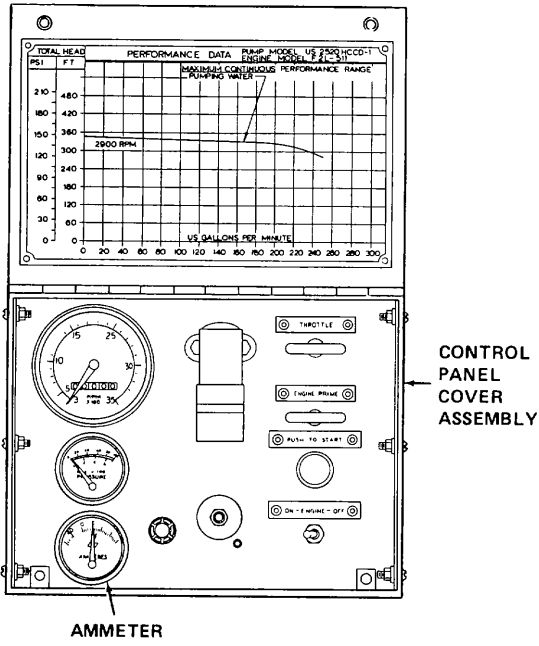
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
9		•				<p><i>Alternator.</i></p> <p>Check ammeter for positive charging rate indication or, if battery is fully charged, a 0 (zero) charging rate.</p> 	<p>Ammeter indicates a negative charging rate during normal operation.</p>

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

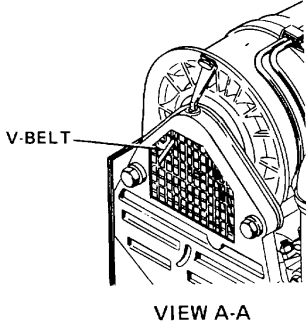
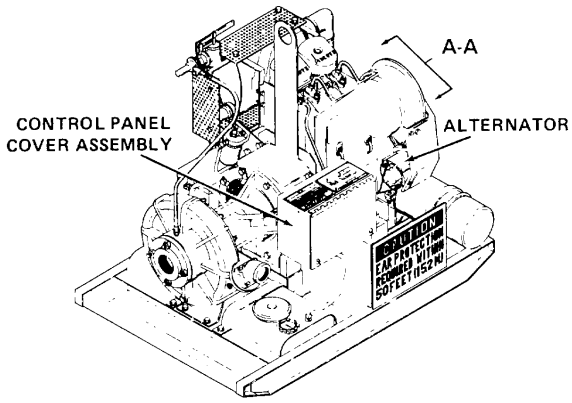
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Visually inspect for excessive vibration or looseness.</p> <p>Listen for noisy operation.</p> <p>Observe alternator operation for evidence of binding, V-belt slip, or overheating.</p>  	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

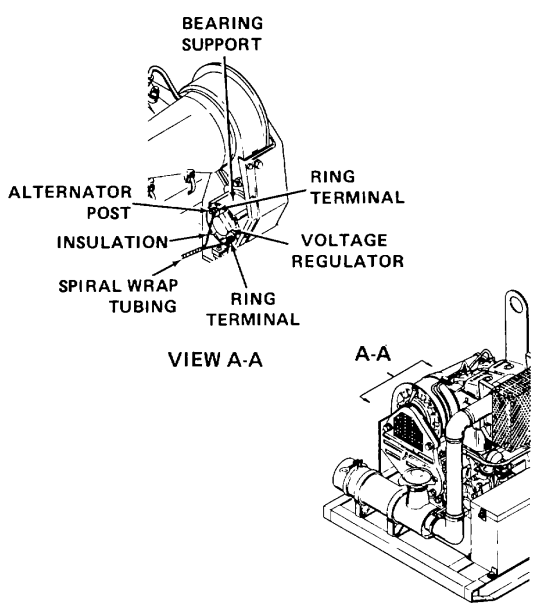
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
10					•	<p><i>Alternator.</i></p> <p>Visually inspect wires for:</p> <p>Loose ring terminals. Loose connection at alternator post.</p> <p>Corrosion at ring terminals or alternator posts. Burn marks at connections (arcing). Damaged insulation. Burned or melted insulation (overheating). Frayed or worn spiral wrap tubing. Visually inspect alternator bearing support for cracks, or discoloration due to overheating. Visually inspect voltage regulator for looseness.</p> 	Evidence of arcing, overheating, binding, or cracking or discoloration of bearing support.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

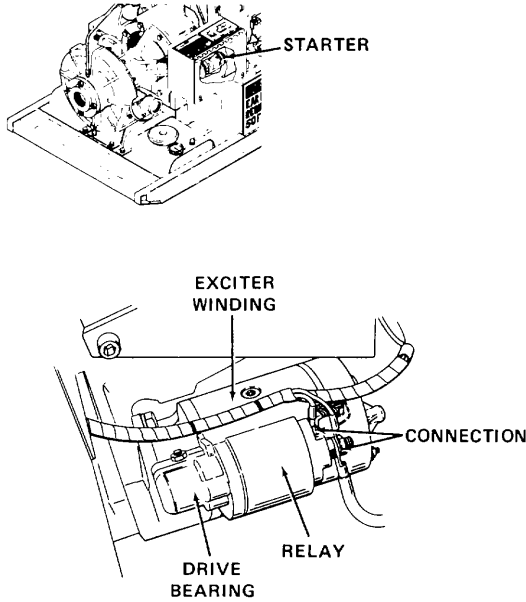
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
11		•				<p><i>Starter.</i></p> <p>During starting, pinion and flywheel engagement is smooth and quick, and no arcing is seen at connections.</p> <p style="text-align: center;">NOTE</p> <p>Pinion is driven by relay (solenoid) located above exciter winding and attached to drive bearing.</p> <p>Visually inspect for excessive vibration. Listen for noisy operation.</p> <p>Observe starter operation for evidence of binding, looseness, or overheating.</p> <div style="text-align: center;">  <p>The diagram consists of two parts. The top part is a perspective view of the starter assembly with a label 'STARTER' pointing to the main component. The bottom part is a side-view cross-section of the assembly with labels: 'EXCITER WINDING' at the top, 'DRIVE BEARING' at the bottom left, 'RELAY' in the middle, and 'CONNECTION' on the right side.</p> </div>	Evidence of binding, overheating, or failure of pinion to properly mate with flywheel.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
12					•	<p><i>Starter.</i></p> <p>Visually inspect wires for:</p> <p>Loose ring terminals. Loose connection at starter posts.</p> <p>Burn marks at connections (arcing). Corrosion of ring terminals or starter posts. Damaged wire insulation. Burned or melted insulation (overheating). Frayed or worn spiral wrap tubing.</p> <p>Visually inspect starter bearing support and drive bearing for cracks or discoloration due to overheating. Visually inspect starter for loose mounting hardware.</p> <div style="text-align: center;"> </div>	Evidence of arcing, overheating, binding, or cracking or discoloration of bearing support or drive bearing.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
13				•		<p><i>V-Belt Guard.</i></p> <p>Visually inspect for:</p> <p>Loose attaching hardware.</p> <p>Missing or damaged rubber grommets.</p> <p>Any indication that V-belt guard is preventing free movement of rotating parts.</p> <div style="text-align: center;"> <p>VIEW A-A</p> </div>	V-belt guard stops or interferes with free movement of the rotating parts it covers.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

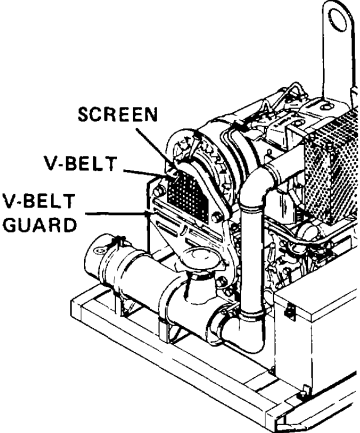
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
14	•	•				<p><i>V-Belts.</i></p> <p>Visually inspect V-belts through screen of V-belt guard. Inspect for:</p> <p>Cuts.</p> <p>Tears.</p> <p>Frayed edges.</p> <p>Shiny surfaces of V portion of belt (this indicates slipping).</p> 	One or more of the V-belts is broken, or slipping so badly that ammeter is showing discharge.
15	•	•				<p><i>Air Cleaner Primary and Secondary Element.</i></p> <p>Air Cleaner Element Replacement-If red flag appears in window of air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as follows:</p> <p>Removal.</p> <p>Loosen clamp assembly.</p> <p>Remove cup assembly.</p> <p>Remove baffle assembly.</p> <p>Wipe off cup and baffle assemblies with a clean, dry cloth.</p>	Dirt in element blocks air flow enough to cause red flag to appear in window of air cleaner intake restriction indicator.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY



ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Remove nut assembly from threaded rod. Remove and discard primary element. Remove nut assembly from threaded rod. Remove and discard secondary element. Wipe out interior of body assembly with a clean, dry cloth. Installation. Install secondary element into body assembly. Aline hole in element with threaded rod.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.</p> <p>Install nut assembly and hand tighten. Install primary element over secondary element. Aline hole in element with threaded rod.</p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.</p> <p>Install nut assembly and hand tighten. Install baffle assembly. Install cup assembly.</p> <p style="text-align: center;">NOTE</p> <p>Install cup assembly with arrows pointing up. Seat cup assembly against body assembly.</p>	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

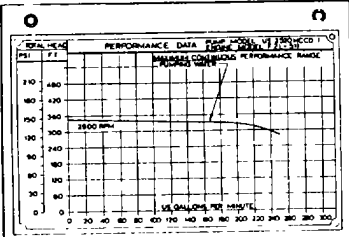
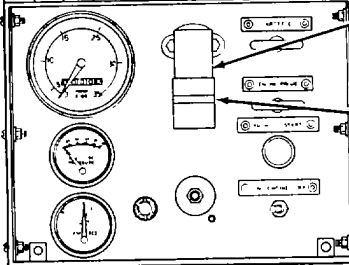
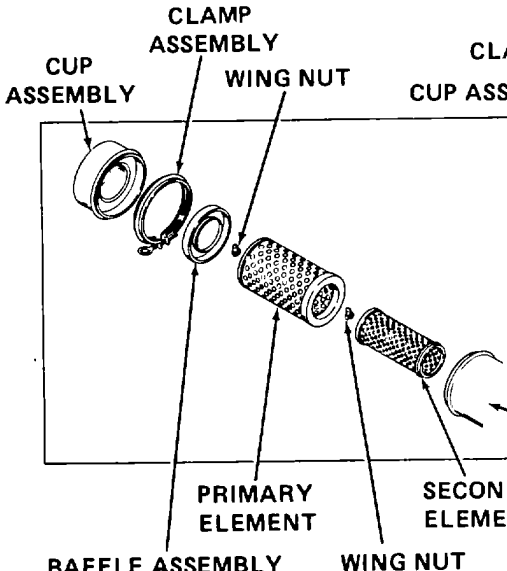
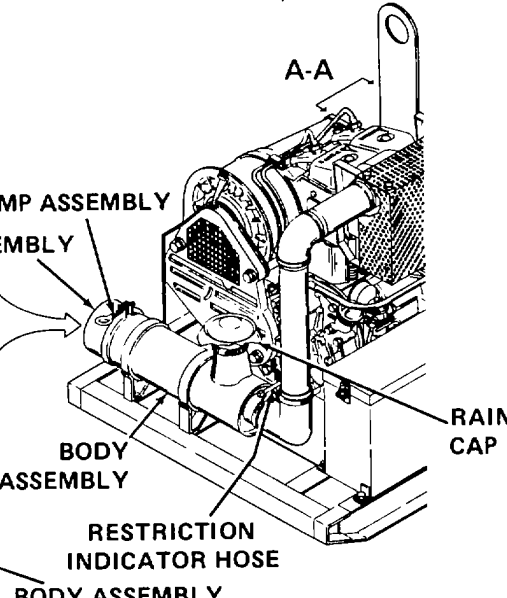
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<div style="border: 1px dashed black; padding: 5px; text-align: center; margin-bottom: 10px;">CAUTION</div> <p>Hand tighten clamp assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the cup assembly or the body assembly.</p> <p>Hand tighten clamp assembly. Reset air cleaner intake restriction indicator.</p>	
							
							
	<p style="text-align: center;">VIEW A-A</p>						
							
							

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

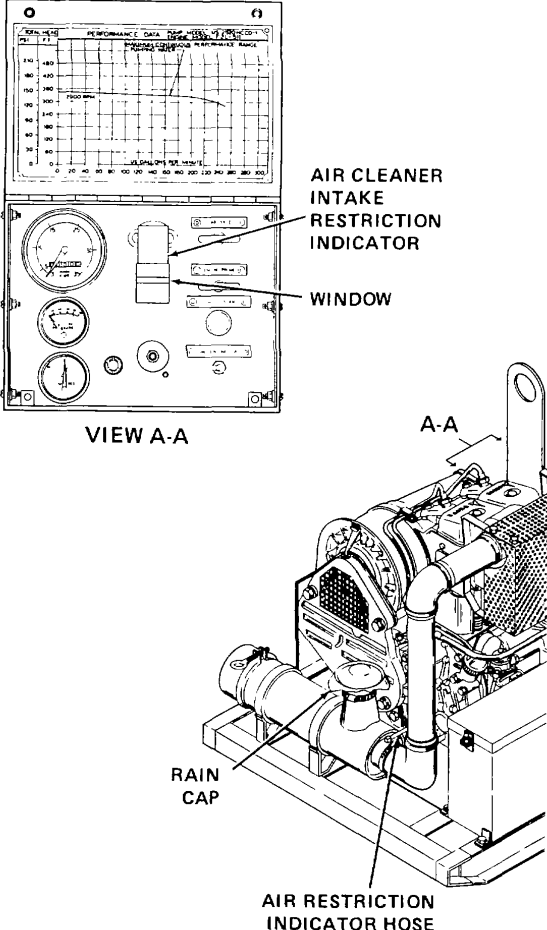
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
16	•					<p><i>Rain Cap.</i></p> <p>Check rain cap for damage or blockage.</p> 	<p>Damage or blockage prevents air flow to engine and trips air cleaner intake restriction indicator.</p>

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
17					•	<p><i>Air Intake System.</i></p> <p>Check system components for damage that could prevent the replacement of elements, allow dirt to enter air flow after the elements, cause air cleaner intake restriction indicator to provide inaccurate readings, or obstruct air flow to the engine.</p>	Damage or blockage prevents air flow to engine and trips air cleaner intake restriction indicator.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
18		•				<p><i>Engine Shutdown Valve and Injection Pump.</i></p> <p>Check for loose or missing electrical connector. Check for frayed insulation or other damage to wires running to electrical connector.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Check for fuel leakage at engine shutdown valve. Check for fuel leakage at injection pump connections and fittings. Check for oil leakage around shims and gasket.</p>	<p>Engine shut-down valve, injection pump, or fuel line connection leaks, or electrical connector loose or missing.</p>

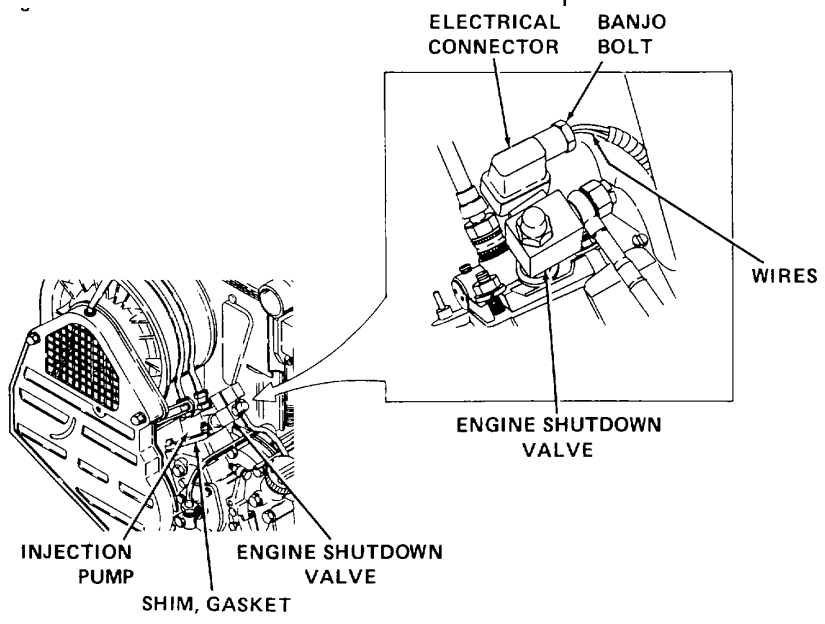


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

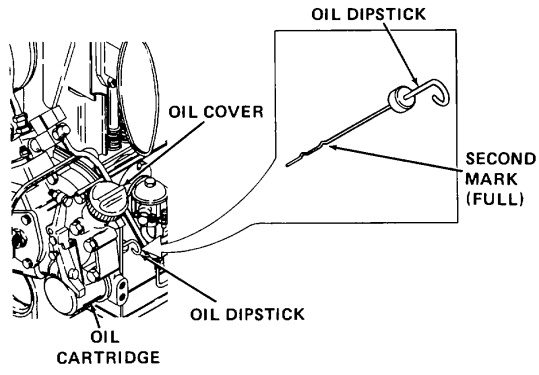
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
19	•		•			<p><i>Oil Level, Oil Dipstick, Cover, and Cartridge (Oil Filter).</i></p> <p>With engine level, check oil level as follows:</p> <p>Remove oil dipstick. Wipe oil dipstick with lintless cloth. Insert oil dipstick all the way into engine. Withdraw oil dipstick. Engine oil should coat oil dipstick to second mark (FULL). If oil coating is below second mark, remove oil cover and add oil to bring level up to second mark (FULL). Again check oil level, be sure oil coats oil dipstick to second mark (FULL). If oil coating extends to second mark (FULL), continue check procedure. Check that oil cover is tight. Check cartridge (oil filter) for oil leaks in cartridge or at a point where cartridge and front cover meet.</p> 	Oil level is low or Class III oil leak present.

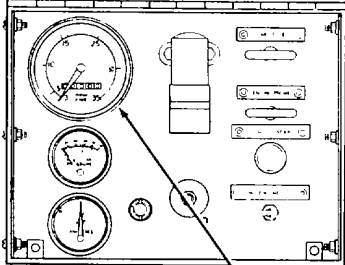
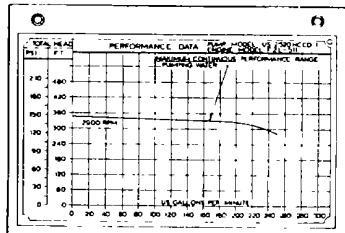
Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
20					•	<p><i>Front Cover.</i></p> <p>Check for oil leak at joint between front cover and crankcase.</p> <p>Check for oil leak at joint between front cover and injection pump.</p> <p>Check for oil leak at joint between front cover and flange.</p>	Class III oil leakage is present, engine speed cannot be controlled, or tachometer does not indicate engine speed.



TACHOMETER

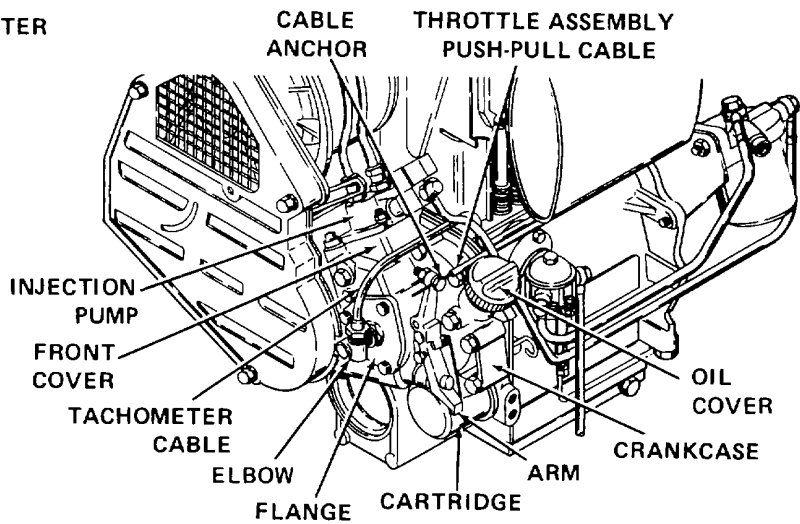


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY


ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
21						<p>Check that tachometer cable is tightly threaded onto elbow. Check tachometer cable for fraying and wear.</p> <p>Check that jam nut on cable anchor is tight and throttle assembly push-pull cable is held securely in cable anchor.</p> <p>Remove front cover and check that cover gasket is not torn or missing. Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted shall be refinished as soon as possible in accordance with MIL-T-704.</p> <p>• <i>Positive Battery Cable and Ground Cable.</i></p> <div style="text-align: center;">  <p>CAUTION</p> </div> <p>Damage to insulation of positive battery cable that would allow conductor to contact any metallic surface of the pump will cause battery charge to be drained. Check for abraded or worn insulation of positive battery cable.</p> <p>Check for worn or missing grommet.</p>	<p>Evidence of arcing, or potential grounding of positive side of battery exists.</p>

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

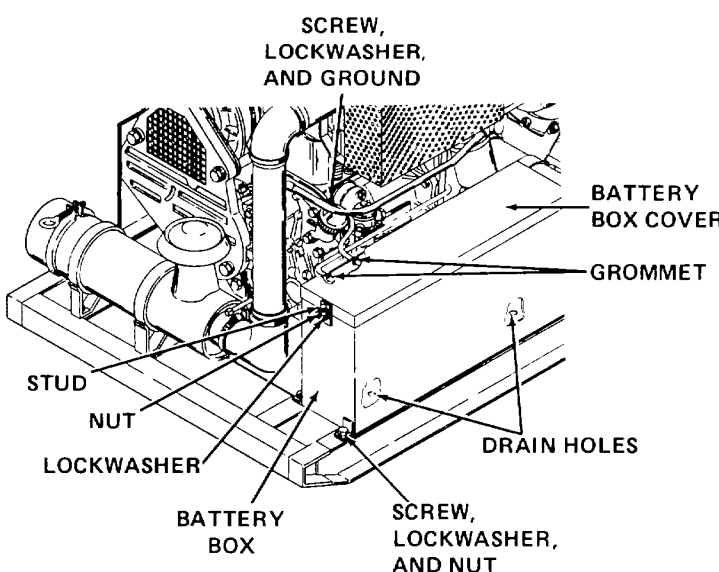
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE: CHECK FOR AND HAVE REPAIRED, FILLED, OR ADJUSTED AS NEEDED	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Check for abraded or worn insulation of ground cable. Check for worn or missing grommet.</p> <p>Check for loose screw attaching ground cable lug to pump.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
22		•				<p><i>Battery Electrolyte.</i></p> <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;"> WARNING </div> <p>CAUSTIC CHEMICALS IN BATTERIES Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.</p> <p>BATTERIES GENERATE FLAMMABLE GAS</p> <ul style="list-style-type: none"> • Leave battery vent plugs installed while battery is being charged. • Charge battery in a well-ventilated area. • Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery. <p>Remove nuts and lockwashers from studs and remove battery box cover.</p> <p>Check positive and ground cable assemblies for any signs of damage, corrosion, or looseness.</p> <p>Check grommets for damage that would allow fraying of cable insulation.</p> <p>Remove filler caps and check electrolyte level. If electrolyte level is low, add distilled water until level is above battery plates and reaches split ring in filler neck.</p> <p>Check that all filler caps are in place.</p> <p>Place battery box cover over studs and onto battery box. Install lockwashers and nuts. Tighten nuts securely.</p>	Evidence exists that indicates leakage of battery acid.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
23						<ul style="list-style-type: none"> <i>Battery Box and Battery Box Cover.</i> <p>Visually inspect for:</p> <p>Loose, damaged, or corroded screws, nuts, or lockwashers. Damaged or corroded studs. Physical damage to either battery box cover or battery box that would indicate possible damage to enclosed batteries. Corrosion or acid leakage at two 7/16-inch diameter drain holes in bottom of battery box. Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted shall be refinished as soon as possible in accordance with MIL-T-704.</p>	Evidence exists that indicates leakage of battery acid.

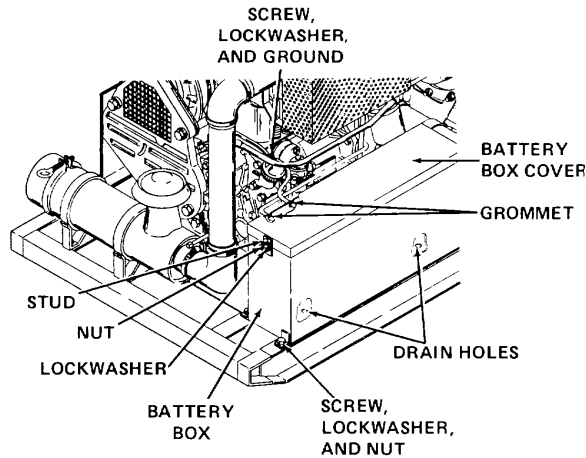


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
24		•				<p><i>Fuel Lines and Fittings (Rear), Filter Cartridge, and Fuel Feed Pump.</i></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Check fuel lines and fuel line assembly (fuel feed pump end) for leaks at banjo fittings and banjo bolts.</p> <p>Check for fuel leaks at filter cartridge.</p>	Class III leakage is present or fire hazard exists.

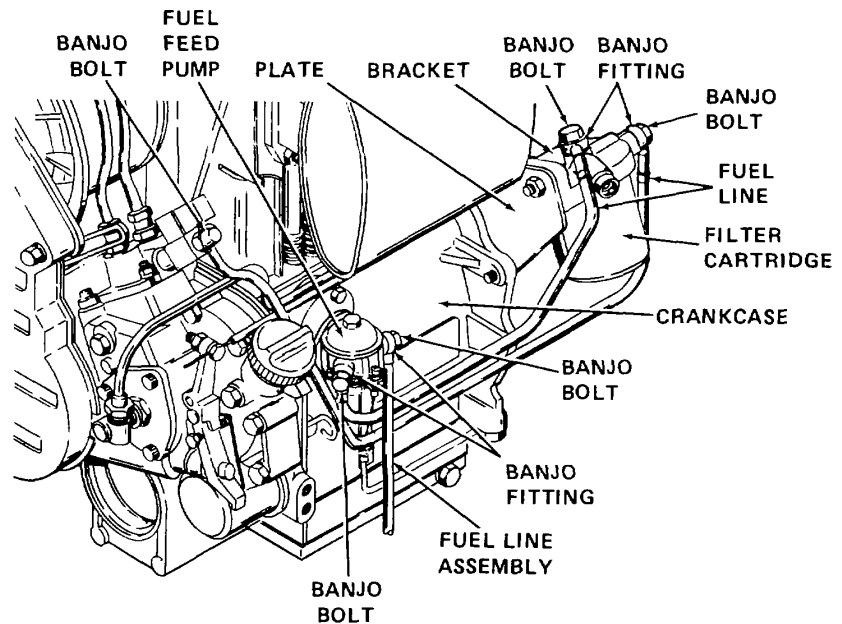


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

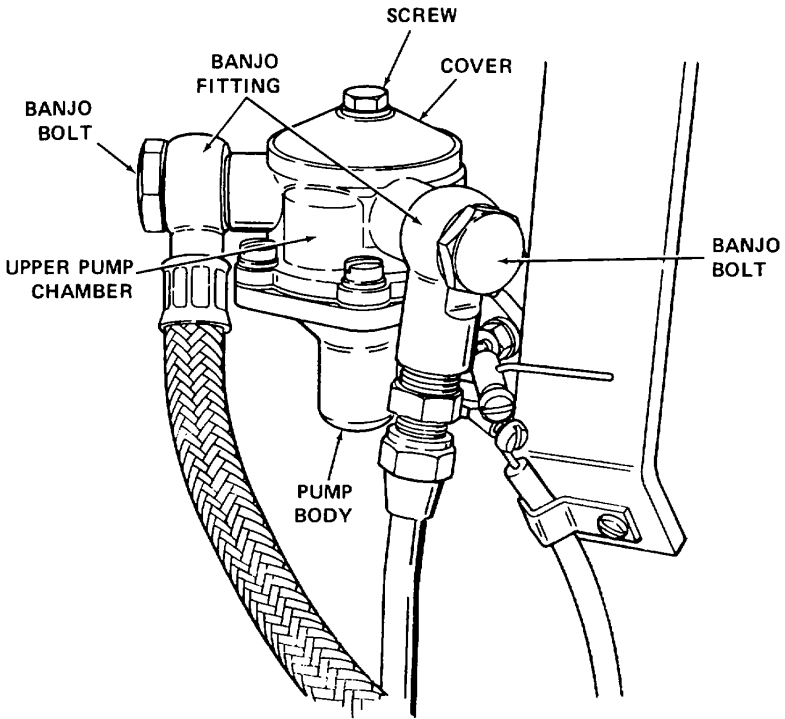
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Check for fuel leaks at fuel feed pump. Check for leaks between screw and cover, cover and upper chamber, upper chamber and pump body.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
25						<ul style="list-style-type: none"> Fuel Lines and Fittings (Rear), Filter Cartridge, and Fuel Feed Pump. <div style="border: 1px solid black; padding: 5px; text-align: center; margin: 10px 0;"> WARNING </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> Do not inhale vapor. Be certain fuel lines and connections are secure. Work in a well-ventilated area. <p>Check fuel lines and fuel line assembly (fuel feed pump end) for cracks, holes, abrasions, line leaks, and leaks at banjo fittings and banjo bolts.</p> <p>Check that plate and bracket are securely mounted to engine.</p> <p>Check for oil leak between crankcase and pump body.</p>	Class III leakage is present or fire hazard exists.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

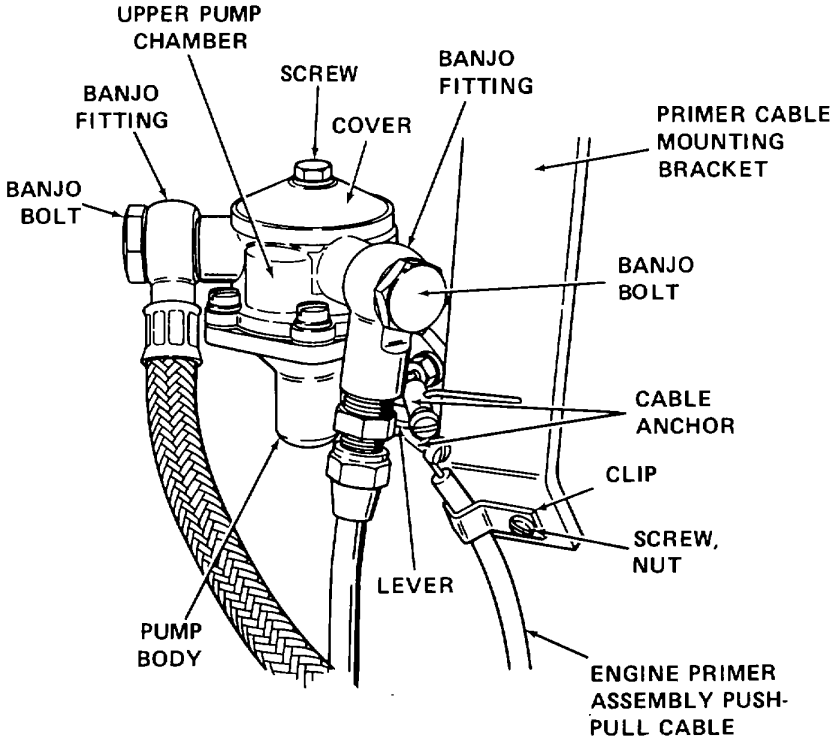
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>Check fuel feed pump for cracks, and for loose attaching hardware.</p> <p>Check that engine primer assembly push-pull cable is tightly held in clip on primer cable mounting bracket.</p> <p>Check that cable anchors are tightly clamped onto push-pull wire.</p> <p>Check operation of engine prime during next startup. When operating, engine primer assembly push-pull cable shall operate without binding and shall move lever of fuel feed pump enough to make sure fuel system is properly primed.</p> 	

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
26	•					<p><i>Exhaust Primer Assembly.</i></p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Exhaust primer assembly may be hot from previous operation. Prior to touching portions of exhaust system, make sure that equipment has cooled.</p> <div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>An exhaust valve that fails to open easily can cause excessive exhaust back pressure, which can damage the engine.</p> <p>Check that handle is not in contact with exhaust valve.</p> <p>Check that exhaust valve moves easily, without binding in either the open or closed position.</p> <p>Open and close cock valve to check operation. Leave cock valve in closed position.</p> <p>Visually check venturi for obstructions. Remove any obstruction.</p>	<p>Engine exhaust gases cannot exit exhaust system without causing excessive back pressure.</p>

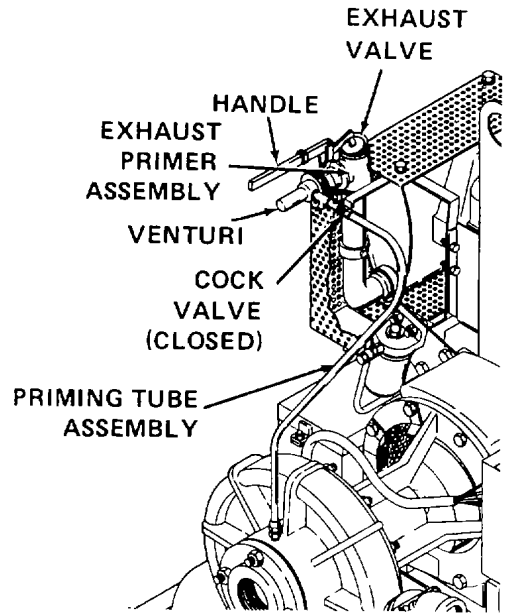


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
27		•				<p><i>Exhaust Silencer, Exhaust Elbow, 1-1/2-Inch Nipple, Exhaust Primer Assembly, and Muffler Guard.</i></p> <div style="border: 1px solid black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">WARNING</div> <p>Exhaust silencer and related components get hot enough during pump operation to cause severe burns. Avoid contact with exhaust silencer and related components during checks described in this text.</p> <p>Visually inspect muffler guard for excessive vibration during operation. Listen for leaking exhaust gases. Identify leaking components.</p> <div style="border: 2px dashed black; padding: 2px; text-align: center; width: fit-content; margin: 10px auto;">CAUTION</div> <p>An exhaust valve that fails to open easily can cause excessive exhaust back pressure, which can damage the engine.</p> <p>Visually inspect operation of exhaust valve. Be sure that it does not bind during engine operation. Be sure that exhaust gases cause it to open smoothly.</p>	<p>Personnel hazard exists as a result of escaping exhaust gases or engine exhaust is restricted causing excessive back pressure.</p>

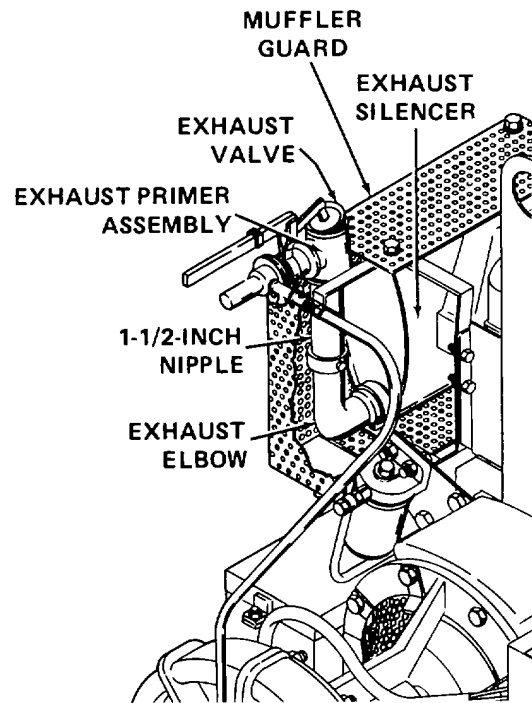


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
D—DURING OPERATION

A—AFTER OPERATION
W—WEEKLY

M—MONTHLY

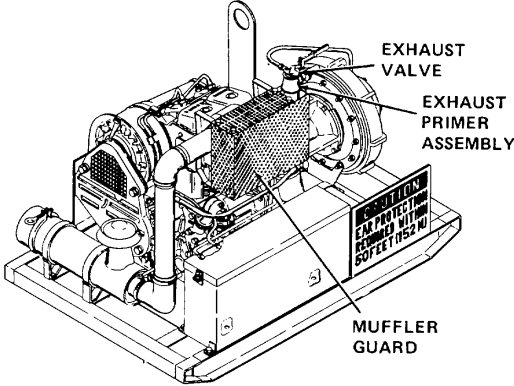
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
28			•			<p><i>Exhaust Primer Assembly.</i></p> <p>Visually check position of exhaust valve. Valve shall close upon engine shutdown. In closed position, exhaust valve shall prevent entry of rain or any foreign object into exhaust system.</p> 	Exhaust valve does not open and close smoothly and without binding.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

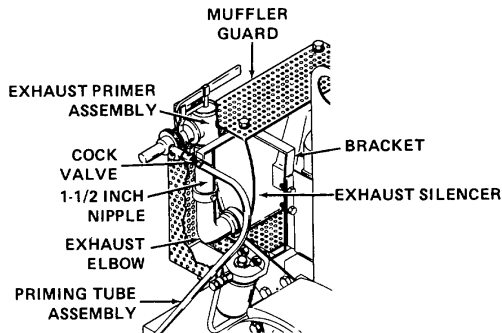
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
29						<ul style="list-style-type: none"> Exhaust Silencer, Exhaust Elbow, 1- 1/2-Inch Nipple, Exhaust Primer Assembly, and Muffler Guard. <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> WARNING </div> <p>Prior to touching portions of exhaust system, make sure that equipment has cooled.</p> <p>Check that muffler guard and brackets are mounted securely to engine. Visually inspect exhaust silencer, exhaust elbow, and 1-1/2-inch nipple for exhaust leaks caused by damage or corrosion. Visually inspect exhaust primer assembly for damage or corrosion that would prevent proper operation of exhaust valve or pump priming. Visually inspect priming tube assembly for loose line fittings or cock valve, or leaks that would prevent pump from priming. Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted shall be refinished as soon as possible in accordance with MI L-T-704.</p> <div style="text-align: center; margin-top: 20px;">  </div>	<p>Personnel hazard exists as a result of escaping exhaust gases, or engine exhaust is restricted causing excessive back pressure.</p>

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

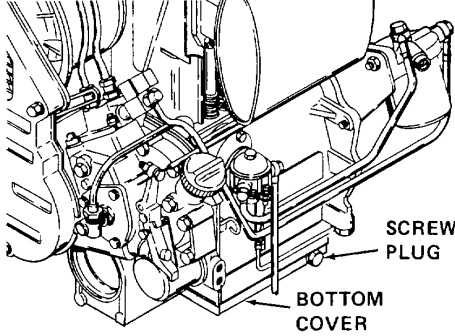
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
30					•	<p>Bottom Cover and Screw Plug.</p> <p>Check for oil leaks.</p>  <p>The diagram shows a cross-section of the engine's bottom cover and screw plug. Labels include 'SCREW PLUG' and 'BOTTOM COVER'.</p>	Class III oil leak is found.
31	•					<p><i>Fuel Line Assembly, 3-Way Selector Valve, and Fuel Tank Assembly.</i></p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. • Maintain metal-to-metal contact between filling apparatus and fuel tank. <p>Check that valve handle is positioned to allow fuel to be drawn from desired fuel source (UNIT TANK or AUXILIARY). If selected fuel source is UNIT TANK</p>	Fuel cannot be supplied to engine.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

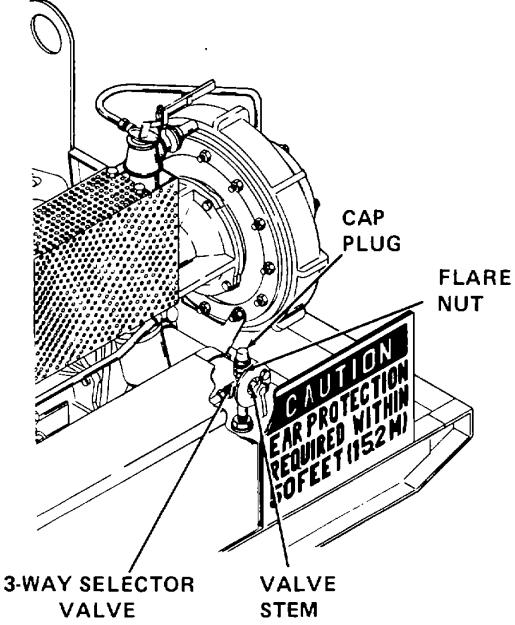
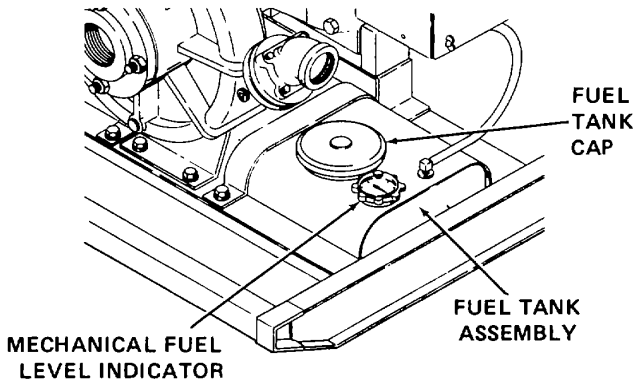
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
						<p>and no AUXILIARY fuel source is attached to 3-way selector valve, check that cap plug is in place and secure on flare nut.</p> <p>Remove fuel tank cap. Check that valve is in OPEN-NORMAL position.</p> <p>Check for adequate fuel level in selected fuel source. Add fuel as required. When fueling, always maintain metal-to-metal contact between filling apparatus and fuel tank. This contact will prevent static sparks that could ignite fuel.</p>	
<div style="display: flex; justify-content: space-around;">   </div>							

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

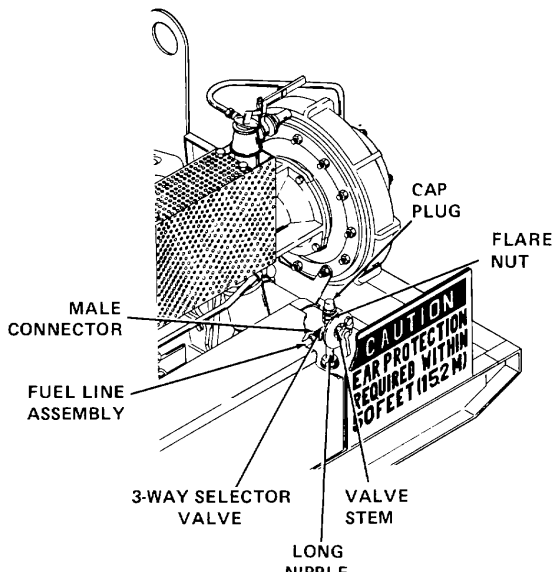
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
32		•				<p><i>3-Way Selector Valve and Fuel Line Assembly.</i></p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> WARNING </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. <p>Visually check for fuel leaks at long nipple, valve stem, cap plug (if present), flare nut, male connector, and fuel line assembly.</p> 	Class III fuel leaks or fire hazard resulting from leakage present.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
33					•	<p><i>Fuel Tank Assembly and 3-Way Selector Valve.</i></p> <div style="border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. <p>Visually check tank for physical damage that could cause leaks or contamination of fuel supply. Remove fuel tank cap and check operation of inside valve. Check that chain and strainer are present and in good condition. Clean strainer of foreign materials. Check that mechanical fuel level indicator is legible and accurately registers level of fuel in tank. Check operation of 3-way selector valve.</p>	Fuel cannot be supplied to engine; Class II I leakage is present.

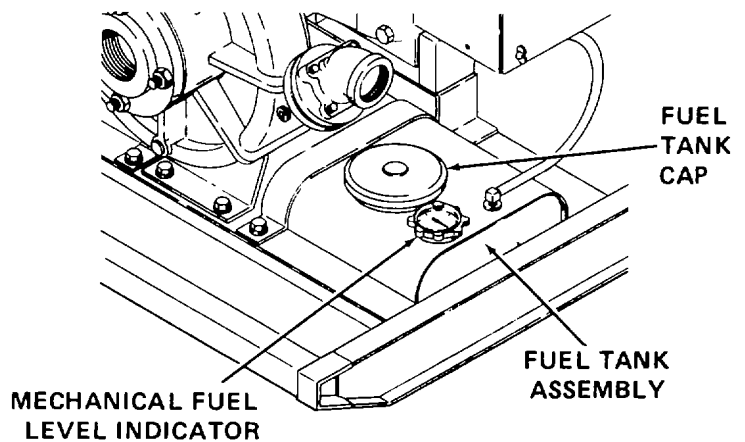
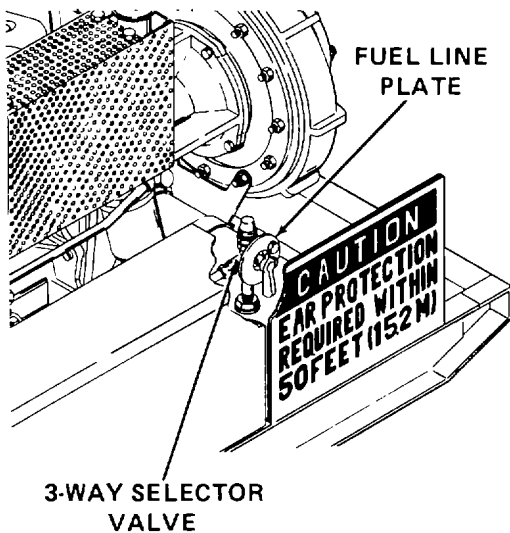


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
34						<p>Check legibility of callouts on fuel line plate. Check fuel tank assembly and surrounding portions of skid for corrosion. Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted shall be refinished as soon as possible in accordance with MI L-T-704.</p> <ul style="list-style-type: none"> • <i>Throttle Cable Assembly, Primer Cable Assembly, Electrical System Assembly, Air Cleaner Service System Assembly, Air Cleaner Service Indicator Hose Assembly, Tachometer Cable, and Oil Pressure Line Hose Assembly.</i> <p>Check all spiral wrap tubing for damage. Check all cables, hoses, and insulated wires for damage and deterioration.</p> <div style="text-align: center;"> <p>The diagram shows a top-down view of an engine compartment. Several assemblies are labeled with lines pointing to their locations: 'ELECTRICAL SYSTEM ASSEMBLY' at the top center, 'THROTTLE CABLE ASSEMBLY' on the left, 'AIR CLEANER SERVICE INDICATOR HOSE ASSEMBLY' on the right, 'PRIMER CABLE ASSEMBLY' on the far left, 'TACHOMETER CABLE' on the right, 'OIL PRESSURE LINE HOSE ASSEMBLY' on the right, and 'SPIRAL WRAP TUBING' at the bottom center.</p> </div>	Class III leakage, arcing, or evidence of arcing is identified.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE:	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
35	•		•			<p><i>Pump and Bearing Housing Assembly and Check Valve Body Assembly.</i></p> <p>Visually check attaching hardware. Be sure that pump and bearing housing assembly is securely mounted on pump body mounting angle. Check that bearing housing assembly is securely attached to volute and seal plate. Check that bearing housing assembly is securely attached to adapter housing.</p> <p>Check that pipe plugs are securely installed in volute.</p> <p>Check that suction flange (intake) and check valve body assembly (discharge) are securely mounted onto volute. Check threads in suction flange (intake) and check valve body assembly (discharge). Be sure threads are clean and free of damage that would prevent hose connections.</p>	<p>Pump and bearing housing assembly attaching hardware loose or broken. Foreign material, capable of damaging pump, found in pump body. Suction flange (intake) or check valve body assembly (discharge) damaged to such an extent that secure connections cannot be made to hose lines.</p>

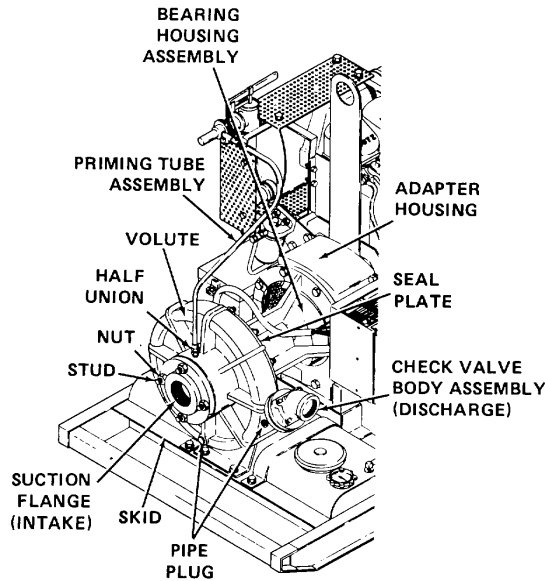


Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

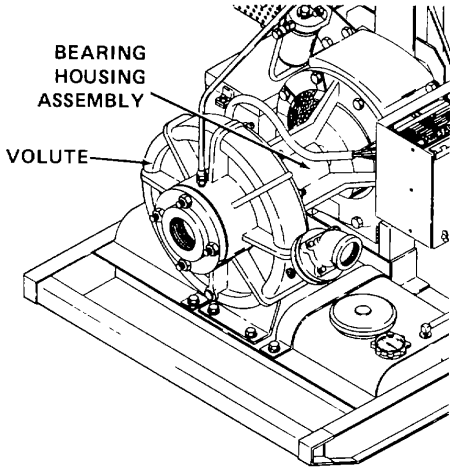
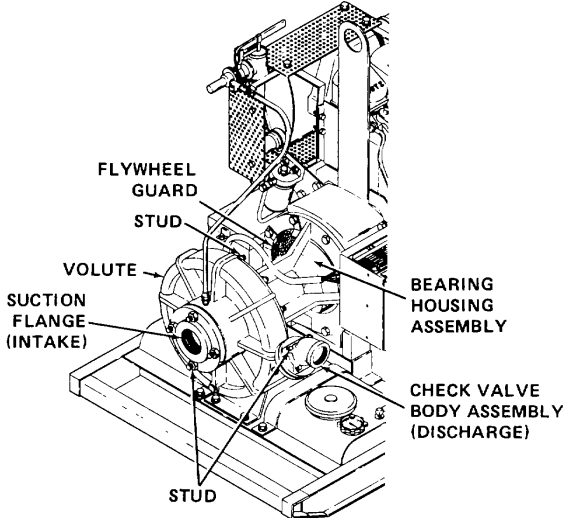
ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
36		•				<p>Visually check interior of pump volute for foreign matter that could damage pump during operation. Check through suction flange (intake).</p> <p>Visually check interior of check valve body assembly (discharge) for foreign matter that could be discharged into attached hose lines during operation.</p> <p>Check half union is securely installed into volute. Be sure priming tube assembly is tightly installed onto half union.</p> <p><i>Pump and Bearing Housing Assembly.</i></p> <p>Listen to pump during operation. Excessive pump noise may indicate pump binding or cavitation.</p> <p>Monitor volute and bearing housing assembly temperatures. Excessive heat indicates possibility of pump damage.</p> 	Excessive noise indicates damage to pump and bearing housing assembly.

Table 2-2. Operator/Crew Preventive Maintenance Checks and Services-Continued

B—BEFORE OPERATION
W—WEEKLY

D—DURING OPERATION
M—MONTHLY

A—AFTER OPERATION

ITEM NO.	INTERVAL					ITEM TO BE INSPECTED PROCEDURE	EQUIPMENT IS NOT READY/AVAILABLE IF:
	B	D	A	W	M		
37						<ul style="list-style-type: none"> <p><i>Pump and Bearing Housing Assembly and Check Valve Body Assembly (Discharge).</i></p> <p>Check following components for cracks, and corrosion: bearing housing assembly, volute, suction flange (intake), and check valve body assembly (discharge).</p> <p>Check studs for damaged or corroded threads.</p> <p>Visually inspect, through flywheel guard, the condition of disc coupling. Be sure coupling components are fully engaged.</p> <p>Check condition of paint. Paint shall be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted shall be refinished as soon as possible in accordance with MI L-T-704.</p> 	<p>Pump and bearing housing assembly components are cracked or damaged severely enough to prevent safe use. Inspection indicates pump may bind during operation. Inspection indicates damaged disc coupling.</p>

Section III. OPERATION UNDER USUAL CONJITIONS

2-3. ASSEMBLY AND PREPARATION FOR USE

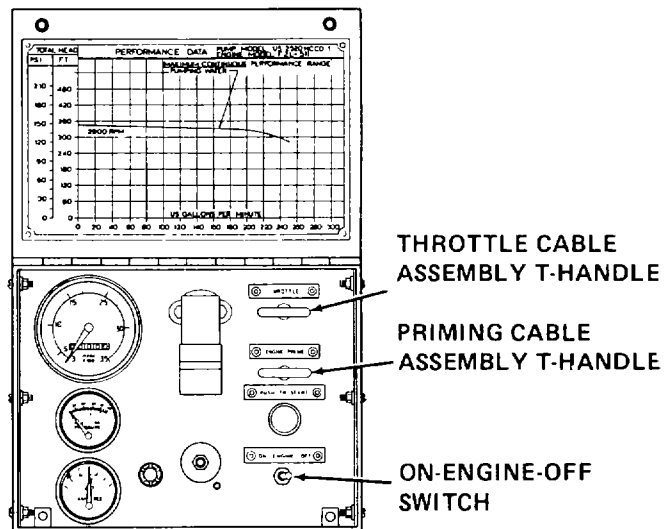
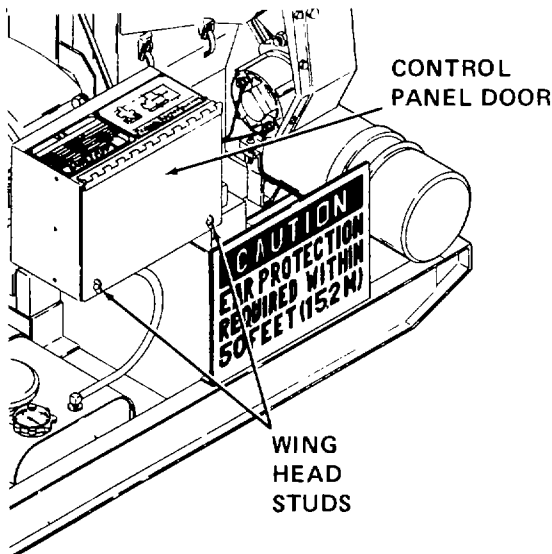
- a. Accomplish procedures contained in Chapter 3, Section I, Lubrication.
- b. Accomplish all preventive maintenance checks and services (PMCS) that are required by centrifugal pump unit use intervals given in Table 2-2. If centrifugal pump unit has not been operated for more than one month, accomplish all PMCS described in Table 2-2. Report any problems to organizational maintenance.
- c. Accomplish category B operator/crew PMCS contained in Table 2-2 or verify that category B PMCS was accomplished above. Report any problems to organizational maintenance.
- d. The operator must know how to perform every operation of which the unit is capable. The following paragraphs contain instructions on starting and stopping the unit, on operation of the centrifugal pump unit, and on coordinating the basic motions to perform the specific tasks for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.

CAUTION

This pump is not intended to pump trash. Due to close internal tolerances, it is advisable to keep suction intake off of bottom when pumping.

2-4. INITIAL ADJUSTMENTS

- a. Loosen wing head studs on control panel door. Lift door.
- b. Position controls as follows:
 Throttle cable assembly T-handle-fully depressed
 Priming cable assembly T-handle-fully depressed
 ON-ENGINE-OFF switch-OFF



2-5. OPERATING PROCEDURE

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

a. *Setup Instructions.* Proper selection of an operating site is important for efficient and trouble-free pump operation. Since the pump unit is self-contained, it can be moved to the most favorable operating site. Select operating site with the following characteristics:

- (1) Locate unit as close as possible to the water to be pumped. Keep the suction hose and the amount of lift as short as possible.
- (2) The operating site should be as level as possible (no more than 15 degrees slope) or the engine lubrication system may not work properly.
- (3) Keep the suction and discharge hoses as short and straight as possible.
- (4) Allow adequate space to permit support of the suction and discharge hoses where they enter the pump.

b. *Suction Hose Installation.*

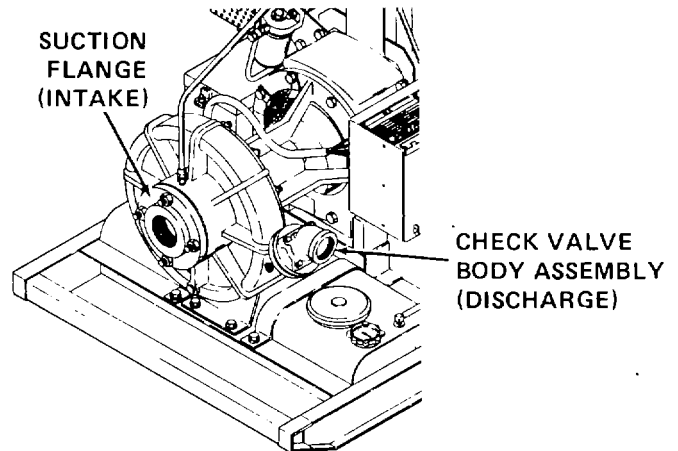
CAUTION

This pump is not intended to pump trash. Due to close internal tolerances, it is advisable to keep suction intake off of bottom when pumping.

(1) Connect the suction hose to pump suction intake.

(2) Highest point in the suction hose should be at the pump.

(3) Make sure that connections and pipe joints in the suction hose are tight.



c. *Discharge Hose Installation.* Connect the discharge hose to the check valve body assembly (discharge). Be certain discharge hose is tight.

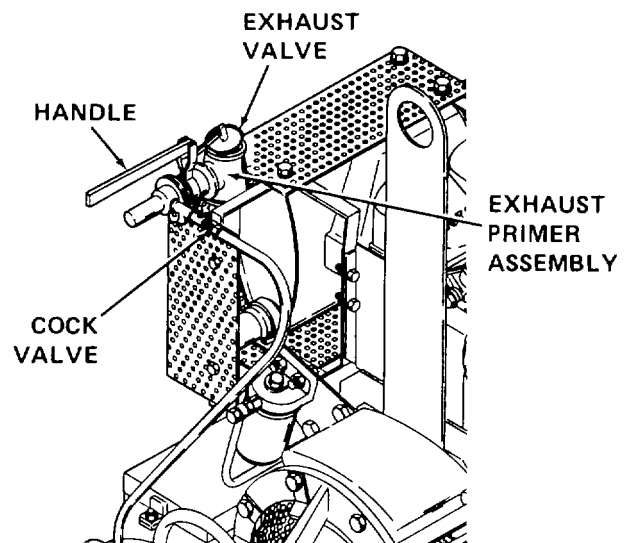
d. *Preparation for Starting.*

WARNING

If centrifugal pump unit has been run recently, the exhaust primer assembly may be hot enough to cause severe burns. Wear protective gloves or allow exhaust primer assembly to cool prior to touching exhaust valve.

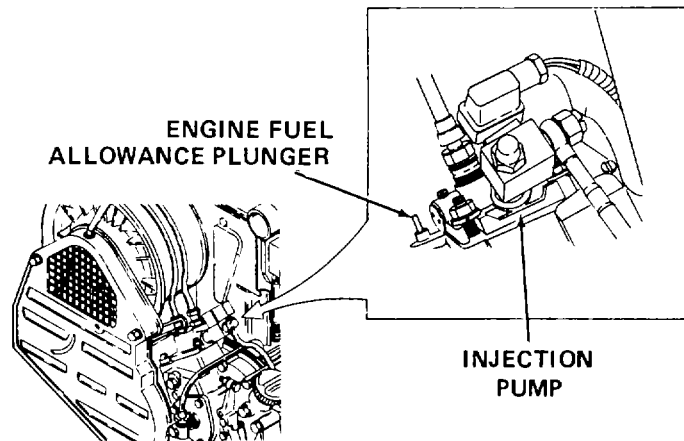
(1) Check position of handle. If necessary, move handle of exhaust primer assembly from top of exhaust valve. Check that exhaust valve is free to open and close with exhaust gas pressure.

(2) Check position of cock valve. Cock valve shall be closed.



e. *Starting.*

- (1) Depress engine fuel allowance plunger.



- (2) If necessary, loosen wing head studs and lift up control panel door for access to controls and indicators.
- (3) Carefully pull THROTTLE T-handle out until a definite stop is felt. Push THROTTLE T-handle in half the distance to panel. Turn THROTTLE T-handle clockwise to lock THROTTLE in this position.
- (4) Place ON-ENGINE-OFF switch in ON position. Charging indicator light and tachometer dial light shall come on.

NOTE

Depressing fault sensitive control pushbutton overrides control during starting. Engine low oil pressure during starting would cause fault sensitive control to prevent engine start.

- (5) Depress and hold fault sensitive control pushbutton.

WARNING

Priming discharge of water and exhaust gases may cause burns or injury. Wear gloves and safety glasses when priming pump.

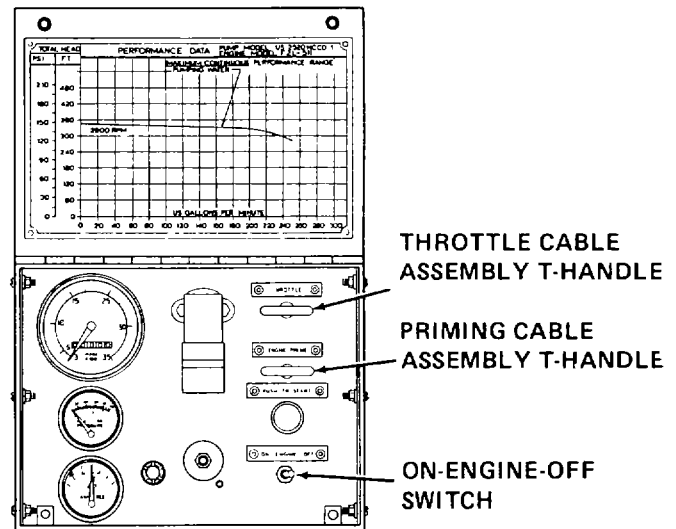
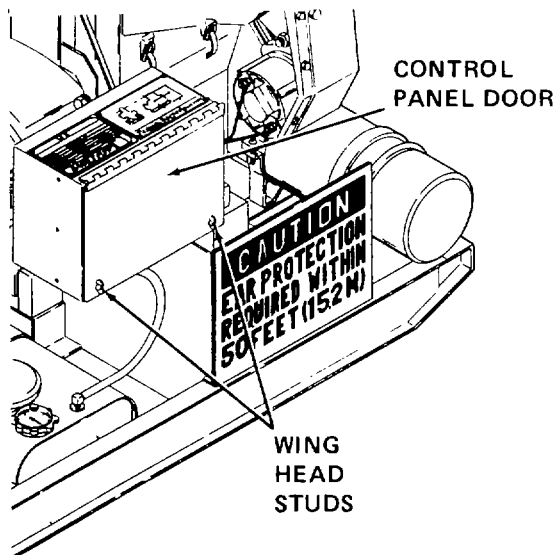
- Stand clear of venturi during priming.

CAUTION

To prevent starter from overheating, do not crank engine with starter for more than 10 seconds. Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts. Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter.

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

- (6) While depressing fault sensitive control pushbutton, depress PUSH TO START pushbutton. Release PUSH TO START pushbutton when engine starts. Continue to depress fault sensitive control pushbutton. When 2-inch switchgauge indicates oil pressure has risen above 20 psi (137.9 kPa), release fault sensitive control pushbutton.
- (7) Check that fault sensitive control pushbutton stays in. This indicates normal engine operation.



- (8) Check that charging indicator light has gone out. This indicates batteries are being adequately charged by alternator.
- (9) Adjust engine speed to 2800 RPM and lock THROTTLE T-handle, then prime the centrifugal pump as described below.

f. *Priming Centrifugal Pump.*

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

Pump shall prime within 1 minute. If pump volute does not fill with water, check suction hose connection and suction hose for leaks. Be sure that suction hose end is completely immersed in water to be pumped.

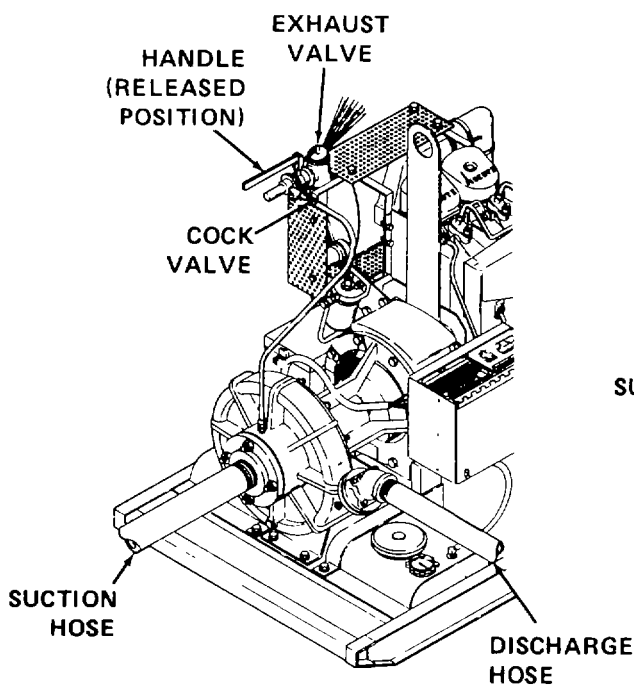
- (1) Open cock valve.
- (2) Swing handle over onto exhaust valve.

- (3) Press down on handle closing exhaust valve.

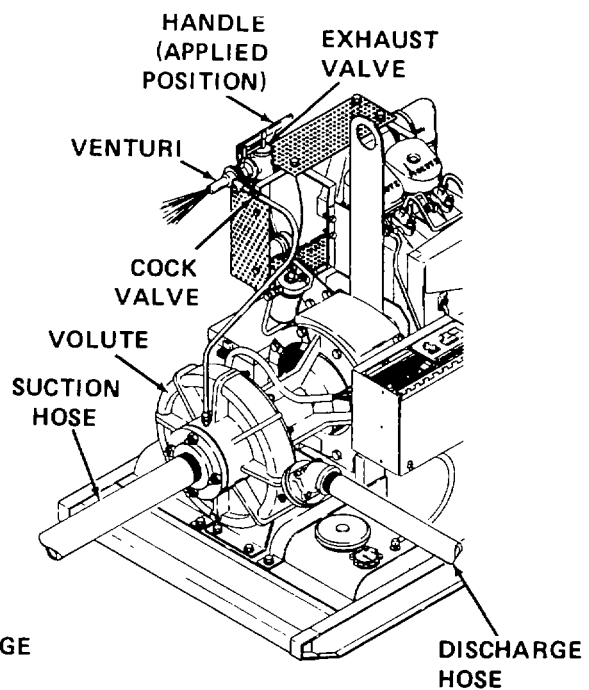
NOTE

Exhaust is directed through venturi. This draws air from centrifugal pump volute. As air is removed from volute, water from suction side of pump will be drawn into volute. This water will fill volute and pump will draw on its own.

- (4) Close cock valve and swing handle off exhaust valve as soon as water flow through pump is indicated by expansion of discharge hose.
- (5) Place handle in released position.
- (6) Allow exhaust valve to float in exhaust gas stream.



PRIOR/AFTER PRIMING



DURING PRIMING

g. *Adjusting Speed.* If necessary, adjust centrifugal pump unit speed and pumping rate by unlocking THROTTLE T-handle and raising or lowering engine rpm as required. Lock THROTTLE T-handle in position after adjustment is complete.

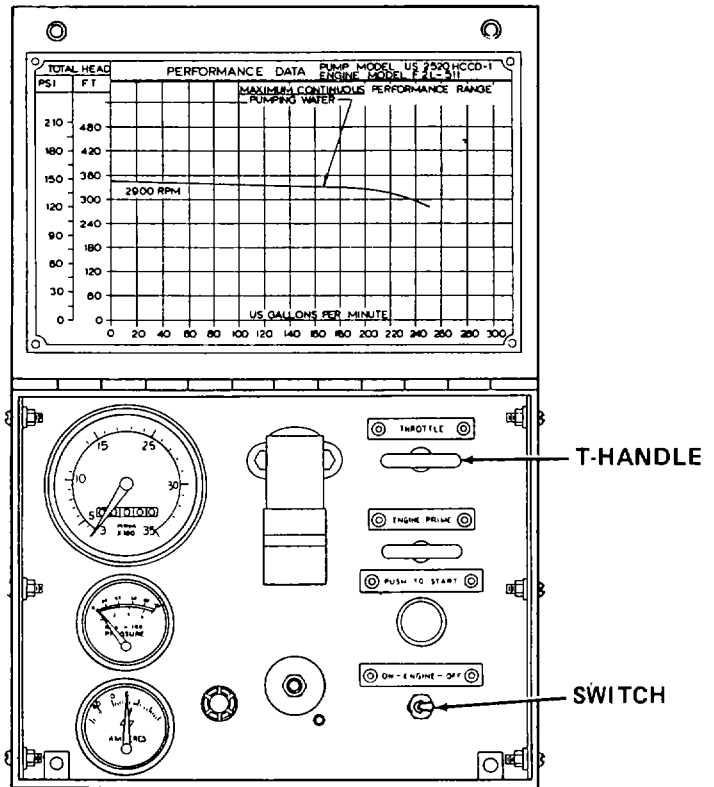
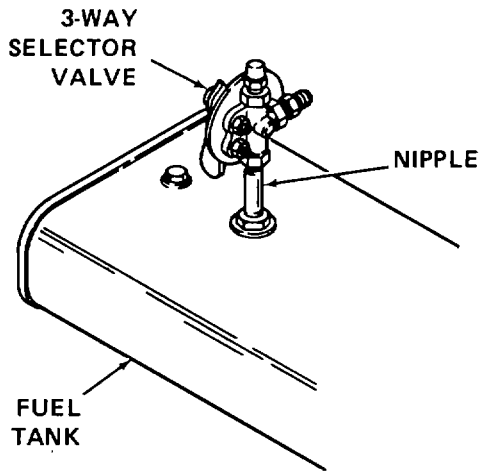
h. *Stopping.*

CAUTION

Immediate shutdown of the engine without a 5-minute idle time may cause damage to engine. Do so only when made necessary by overriding system requirements or emergency conditions.

For emergency stopping, turn 3-way selector valve to OFF.

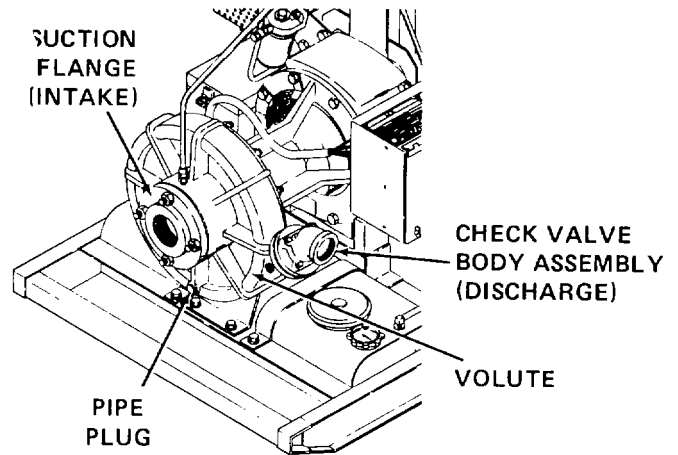
- (1) Slowly position THROTTLE T-handle to the idle (fully depressed) position. Allow engine to idle for 5 minutes to allow engine operating temperature to stabilize.



- (2) Place ON-ENGINE-OFF switch to the OFF position.
- (3) If pump is to be removed from system, remove pipe plug and drain pump.

2-6. PREPARATION FOR MOVEMENT

- a. Shut down the centrifugal pump unit according to paragraph 2-5.h.
- b. Remove pipe plug, drain volute, and replace pipe plug.
- c. Drain the discharge hose, then remove it from the check valve body assembly.
- d. Remove suction hose from suction flange (intake).
- e. Cover check valve body assembly (discharge) port.
- f. Cover suction flange (intake) threaded port.
- g. Make sure that battery box assembly is closed securely.



Section IV. OPERATION UNDER UNUSUAL CONDITIONS

2-7. OPERATION IN COLD

- a. Use proper engine oil for cold weather. See Lubrication Order, Figure 4-1.

WARNING

Severe burns, illness or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

CAUTION

Drain pump volute after operation to prevent freezing.

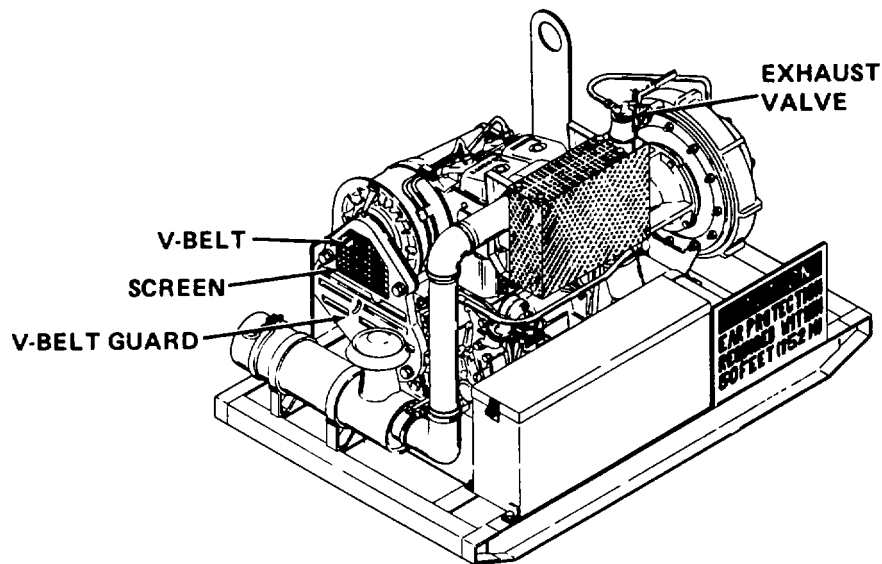
- b. Keep fuel tank full to prevent condensation. Condensation can freeze and clog lines, filters, and injectors.

2-8. OPERATION IN EXTREME HEAT

The engine of the centrifugal pump unit is air cooled. Heat is removed from the engine in three ways: engine exhaust, engine oil, and the passage of ducted air across and through cylinder cooling fins. Therefore, when operating in high ambient temperatures, observe the following:

a. *Exhaust Valve.* Be sure that exhaust valve moves easily and does not restrict the outflow of exhaust gases more than absolutely necessary. Exhaust valve should be checked to be sure that when engine is not in operation it closes to protect exhaust system from entry of debris and/or rain.

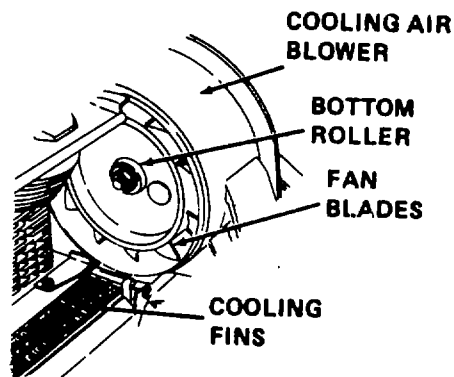
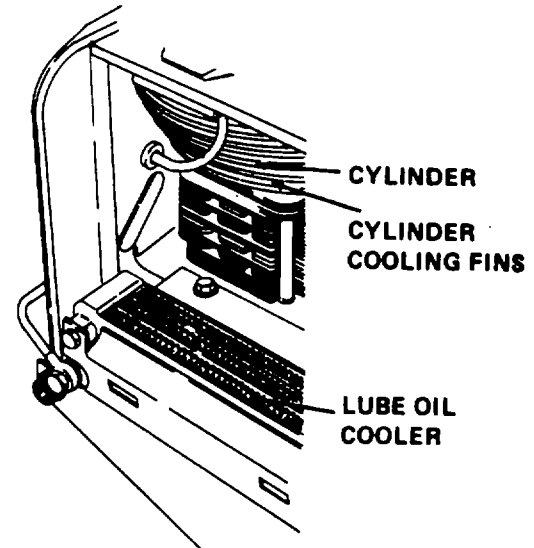
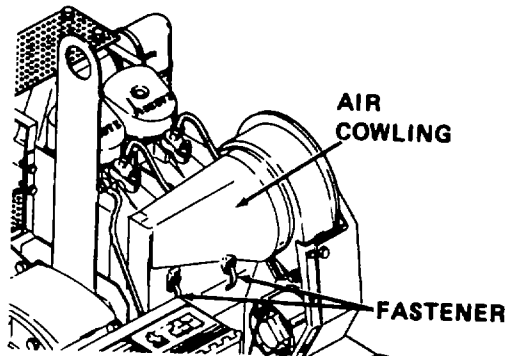
b. *V-Belt.* Be sure that V-belts driving air blower assembly are properly adjusted and drive air blower without slipping. Check V-belts through screen on V-belt guard.



c. *Cylinder Cooling Fins.* With engine stopped, inspect frequently to be sure that cylinder cooling fins are clean and free of dirt that inhibits cooling. Clean cooling fins with a stiff-bristled brush.

d. *Bottom Roller.* With engine stopped, inspect frequently to be sure that bottom roller is clean and free of dirt. Clean bottom roller with a stiff-bristled brush. Check for damaged or deformed fan blades.

e. *Lube Oil Cooler Cooling Fins.* With engine stopped, inspect frequently to be sure that lube oil cooler cooling fins are clean and free of dirt. Clean fins with a soft-bristled brush. Check for damaged or deformed fins



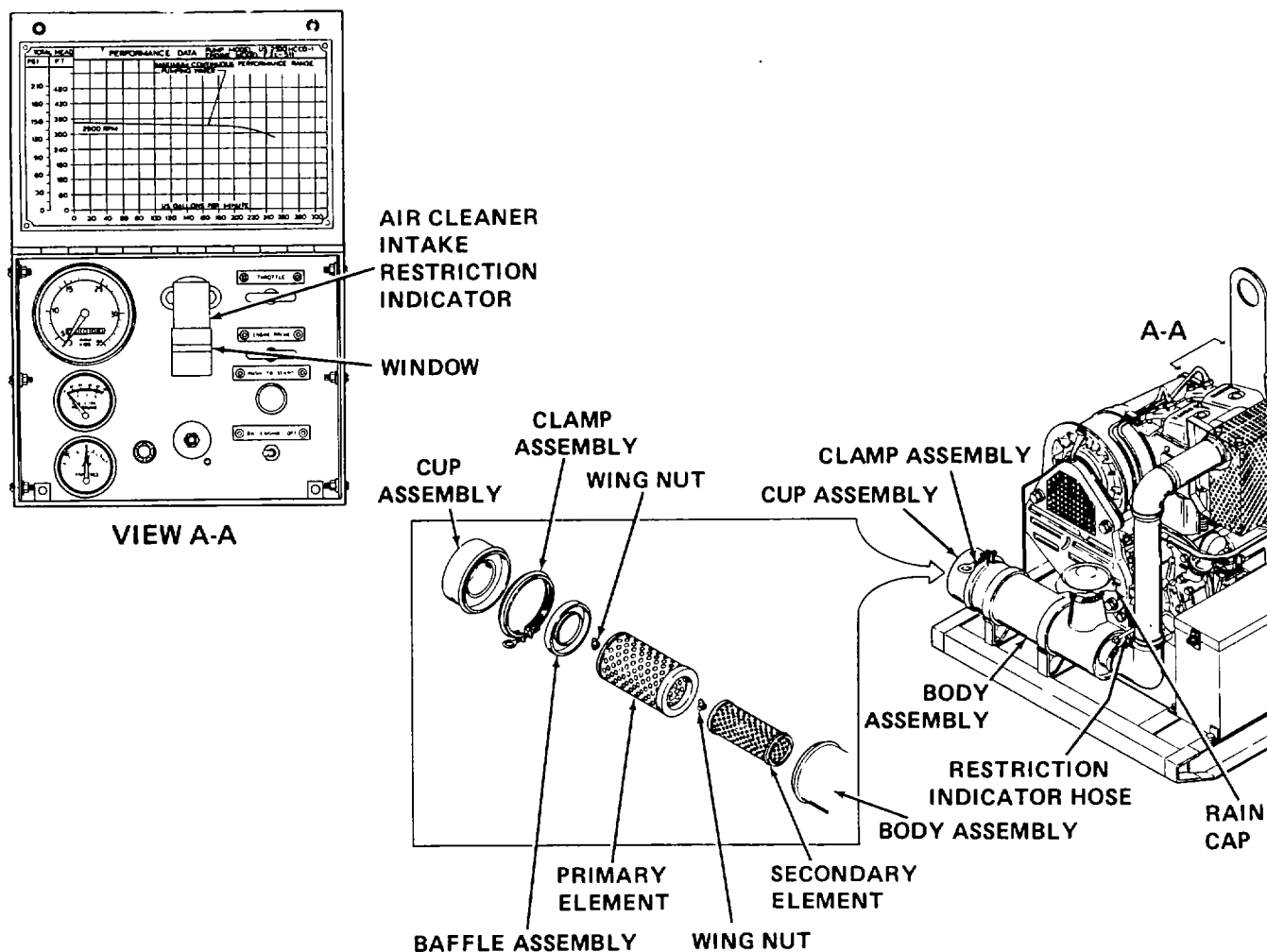
f. *Batteries.* Increase frequency of battery PMCS. Use distilled water or a good grade drinking water (excluding mineral water) to bring electrolyte to proper levels.

g. *Air Flow.* High ambient temperatures change density of air used by the engine in combustion. Monitor engine's ability to breathe using the air cleaner intake restriction indicator. Air filter elements should be changed at first indication of unacceptable restriction of air flow.

(1) Removal.

- (a) Loosen clamp assembly.
- (b) Remove cup assembly.
- (c) Remove baffle assembly.
- (d) Wipe off cup and baffle assemblies with a clean, dry cloth.

- (e) Remove nut assembly from threaded rod.
- (f) Remove and discard primary element.
- (g) Remove nut assembly from threaded rod.
- (h) Remove and discard secondary element.
- (i) Wipe out interior of body assembly with a clean, dry cloth.



(2) Installation.

- (a) Install secondary element into body assembly.
- (b) Aline hole in element with threaded rod.

CAUTION

Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.

- (c) Install nut assembly and hand tighten.
- (d) Install primary element over secondary element.
- (e) Aline hole in element with threaded rod.

CAUTION

Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.

- (f) Install nut assembly and hand tighten.
- (g) Install baffle assembly.
- (h) Install cup assembly.

NOTE

Install cup assembly with arrows pointing up.

- (i) Seat cup assembly against body assembly.

CAUTION

Hand tighten clamp assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the cup assembly or the body assembly.

- (j) Hand tighten clamp assembly.
- (k) Reset air cleaner intake restriction indicator.

2-9. OPERATION IN HIGH ALTITUDES

The operating efficiency of the engine diminishes at higher altitudes. Be sure that engine is operating at peak efficiency.

2-10. OPERATION IN SANDY OR DUSTY AREAS**CAUTION**

Monitor air cleaner intake restriction indicator more closely in sandy or dusty locations. At first sign of restriction, change filter elements.

- a. If red flag appears in window of air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as described in paragraph 2.8.f.
- b. With engine stopped, inspect to be sure that cylinder cooling fins are clean and free of dirt that inhibits cooling. Clean cooling fins with a stiff-bristled brush.
- c. With engine stopped, inspect to be sure that bottom roller is clean and free of dirt. Clean bottom roller with a stiff-bristled brush. Check for damaged or deformed fan blades.

- d. With engine stopped, inspect to be sure that lube oil cooler cooling fins are clean and free of dirt. Clean fins with a soft-bristled brush. Check for damaged or deformed fins.
- e. During fueling and PMCS, be sure that sand or dust is not allowed to enter fuel or lubrication system.
- f. Close control panel door whenever possible to limit damage to gage faces resulting from blowing sand or grit.
- g. If centrifugal pump unit is not in use and suction and/or discharge hoses are not installed, be sure that suction flange (intake) and check valve body assembly (discharge) ports are covered.
- h. Increase the frequency of organizational maintenance PMCS in accordance with local conditions and requirements.

2-11. OPERATION UNDER RAINY OR HUMID CONDITIONS

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Do not refuel near open flame, sparks, or excessive heat.**
- **Be certain fuel lines and connections are secure.**
- **Do not overfill fuel tank.**
- **Work in a well-ventilated area.**

- a. Check that gas tank filler cap is tight and gasket is not torn. Fill fuel tank immediately after every operating period to prevent condensation.
- b. Take special care to prevent rust and corrosion. If surfaces become rusty or corroded, remove corrosion, coat with primer, and paint as necessary.

2-12. OPERATION IN SALT WATER AREAS

- a. Salt water causes corrosion. Use fresh water to wash off any salt water that comes in contact with the equipment.
- b. If surfaces become rusty or corroded, remove corrosion, coat with primer, and paint as necessary.

**CHAPTER 3
OPERATOR MAINTENANCE INSTRUCTIONS**

Section I. LUBRICATION INSTRUCTIONS

Refer to figure 4-1 for lubrication instructions.

Section II. TROUBLESHOOTING PROCEDURES

3-1. TROUBLESHOOTING

a. Table 3-1 lists common malfunctions which you may find during operation or maintenance of the centrifugal pump or its components. You should perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections or corrective actions. If a malfunction is not listed or cannot be corrected by listed corrective actions, notify your supervisor.

Table 3-1. Operator/Crew Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

Notify organizational maintenance.

2. ENGINE CRANKS BUT FAILS TO START

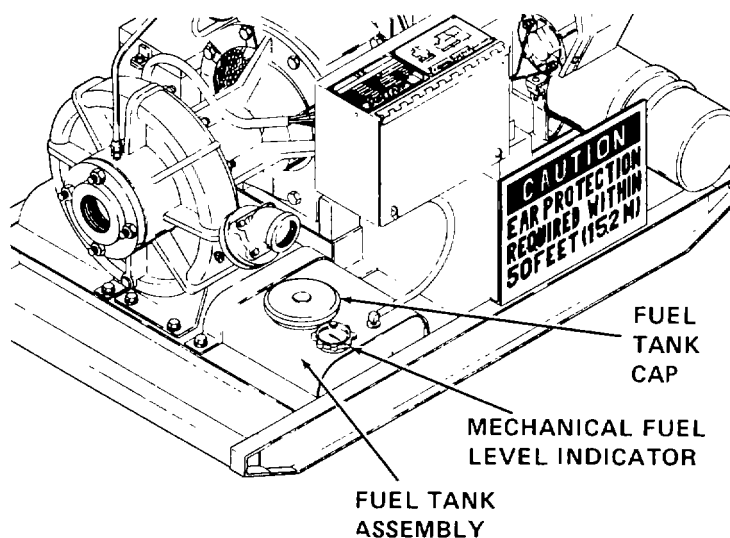
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 1. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.



Step 2. Check starting procedures under prevailing conditions.

If procedures have been accomplished as described, notify organizational maintenance.

Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

Step 3. Check air cleaner intake restriction indicator on control panel.

If indicator shows red with engine shut off, and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as described in paragraph 2-8.f.

3. UNEVEN RUNNING OR FREQUENT STALLING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

CAUTION

- High ambient air temperature at high altitude operation will tend to make the engine run hotter. A high temperature condition may cause abnormal engine operation.

Step 1. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.

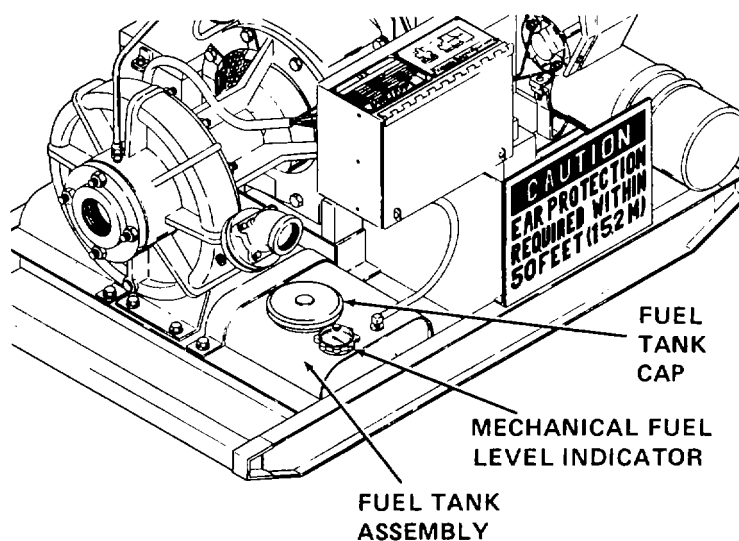


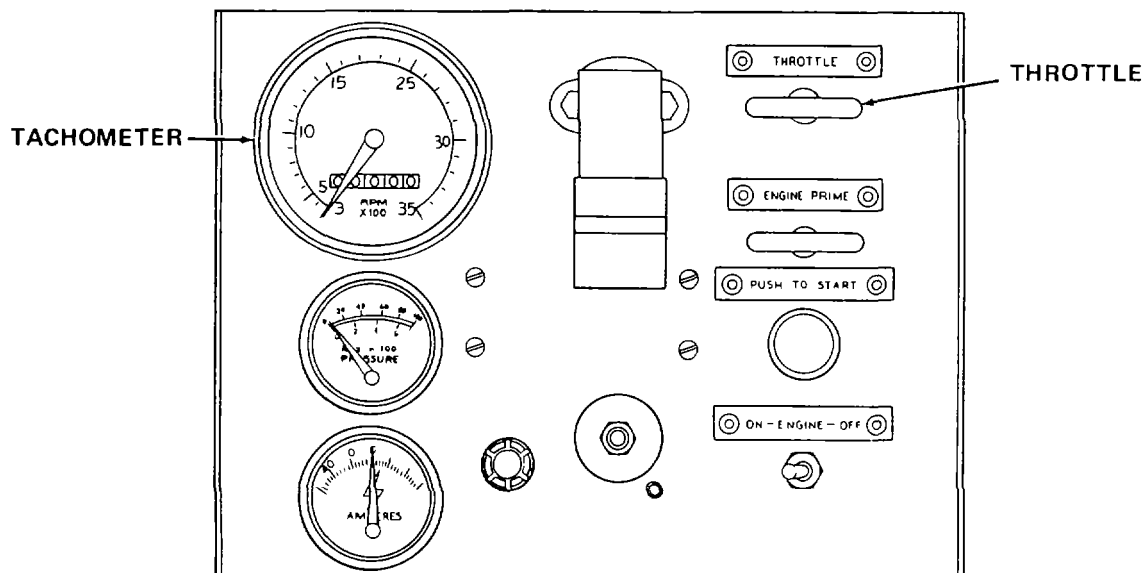
Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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4. LACK OF POWER

Step 1. Check for low engine speed.

Adjust throttle to 2800 to 3000 rpm (for rated engine output 35 hp).

**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 2. Check for insufficient fuel supply.

Refill low tank. If empty, notify organizational maintenance.

Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 3. Check air cleaner intake restriction indicator on control panel.

If indicator shows red with engine shut off, and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as described in paragraph 2.8.f.

Step 4. Check for loose connections or a restricted or damaged line between fuel pump and tank, and between fuel pump and engine.

Tighten loose connections. Report damaged lines to organizational maintenance.

Step 5. Inspect for leakage around the fuel filter gasket.

Hand tighten leaking filter. If filter continues to leak, notify organizational maintenance.

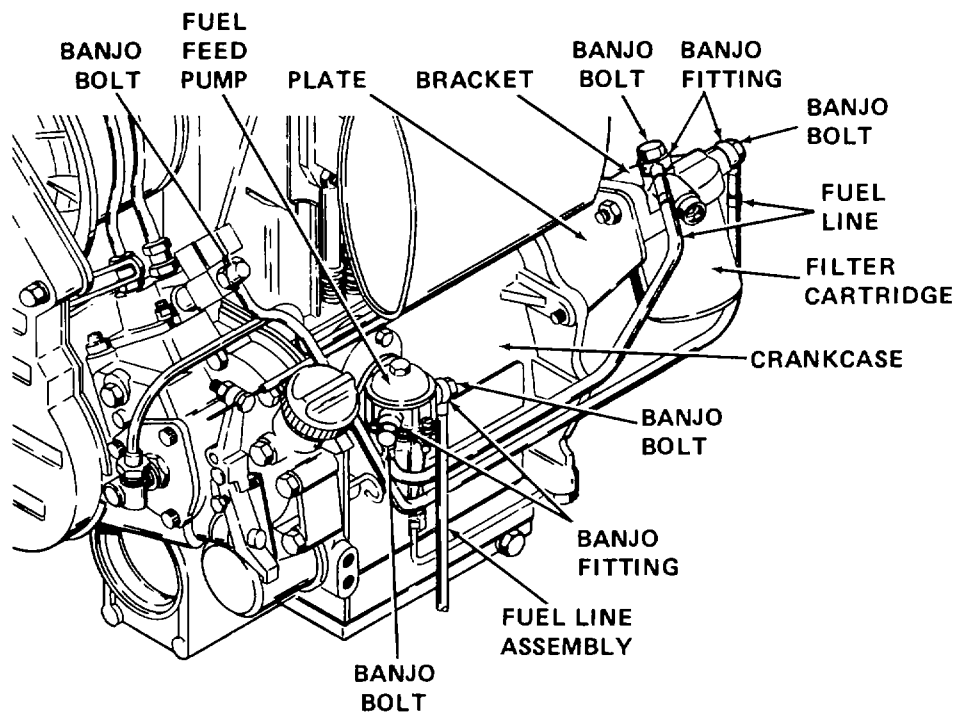


Table 3-1. Operator/Crew Troubleshooting-Continued

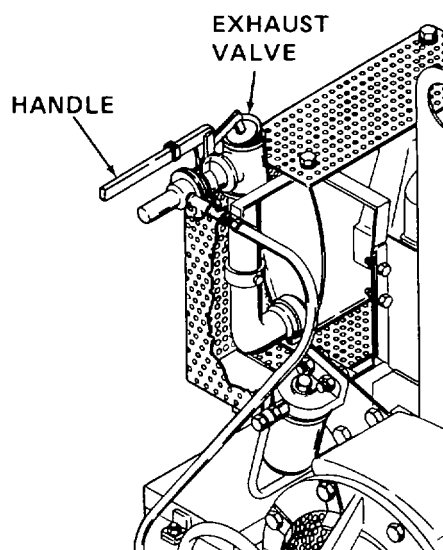
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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WARNING

Severe burns could result if exhaust valve is handled after engine has been running. Do not touch exhaust valve until engine has cooled. If burns occur get medical help immediately.

Step 6. Make sure that exhaust valve is not stuck shut or is only slightly open when engine is running. Check that handle is not resting on exhaust valve.

Move exhaust valve up and down several times to loosen it. If exhaust valve does not loosen, notify organizational maintenance.



Step 7. Check for restrictions in suction or discharge hoses or hose end.

Clean away debris. If hoses are severely damaged or restricted, replace.

Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

5. ENGINE STOPS RUNNING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Step 1. Check for insufficient fuel supply.
 Refill low tank. If empty, notify organizational maintenance.

Step 2. Check air cleaner intake restriction indicator on control panel for indication of restrictions or excessive dirt in air filter.
 If indicator shows red with engine shut off, and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as described in paragraph 2.8.f.

Step 3. Check for tripped fault sensitive control on control panel.

If tripped, notify organizational maintenance.

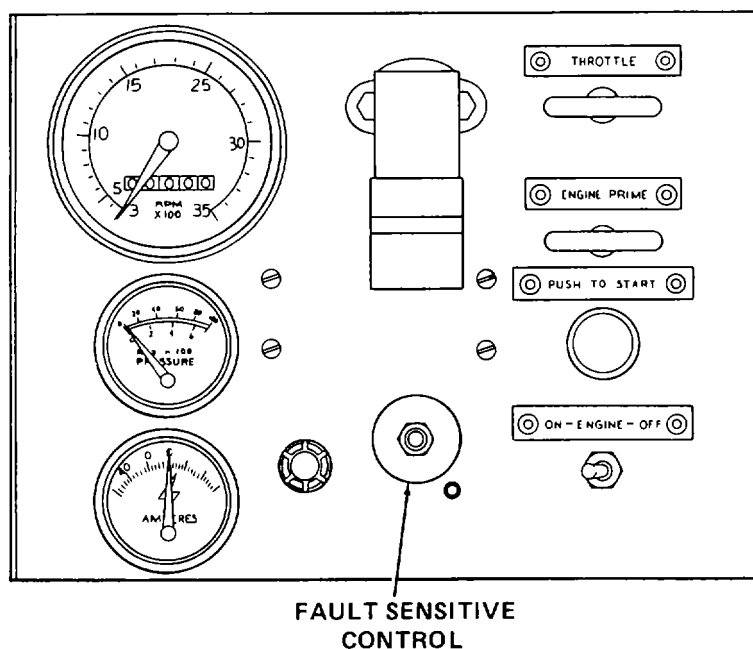


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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6. EXCESSIVE LUBRICATING OIL CONSUMPTION

Step 1. Check for leaking bottom cover, screw plug, cartridge, or front cover.

If cartridge or screw plug is leaking, try to tighten. If leak continues or if bottom cover gasket is leaking, notify organizational maintenance.

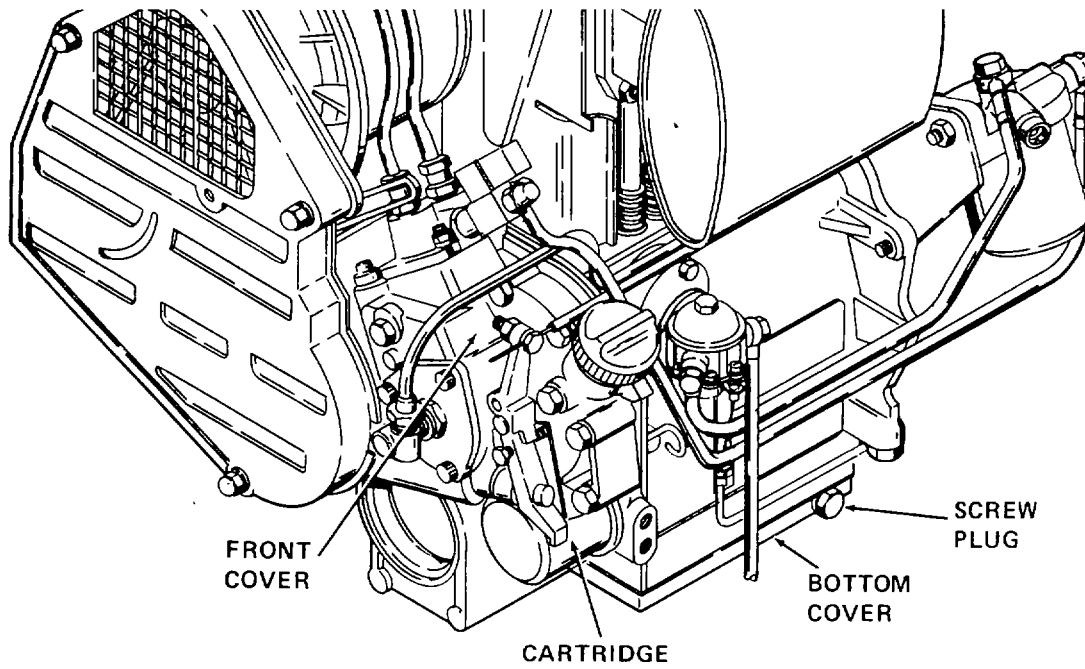


Table 3-1. Operator/Crew Troubleshooting-Continued

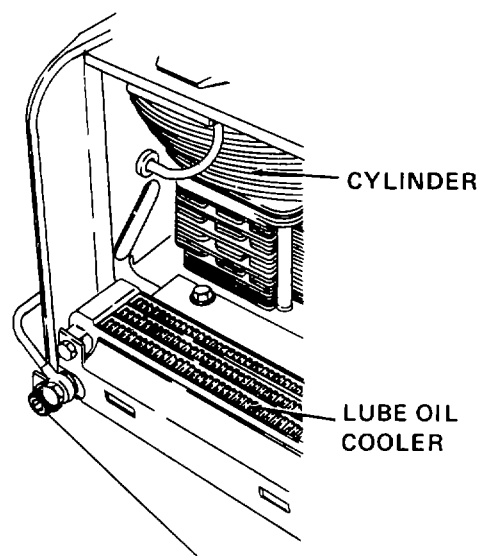
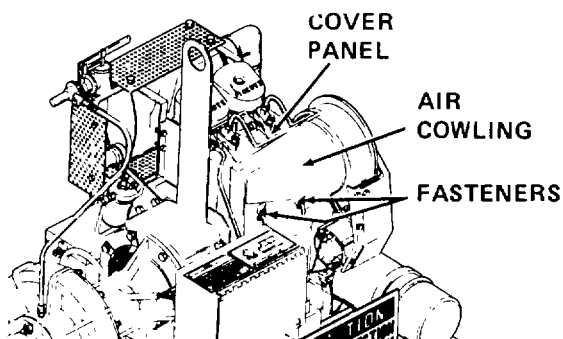
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Remove air cowling and check for leaking lube oil cooler.

If leaking, notify organizational maintenance.

Step 3. Check for oil leaking around cylinder heads.

If leaking, notify organizational maintenance.



Step 4. Check for smoky exhaust. If exhaust discharge contains oil, excessive oil is being burned in engine cylinders or around cylinder valve stems.

Notify organizational maintenance.

Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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7. LOW OIL PRESSURE

Step 1. Check that crankcase is filled to the correct level.

- a. If level is low, remove oil cover and add proper grade oil as required to maintain correct oil level on the dipstick.

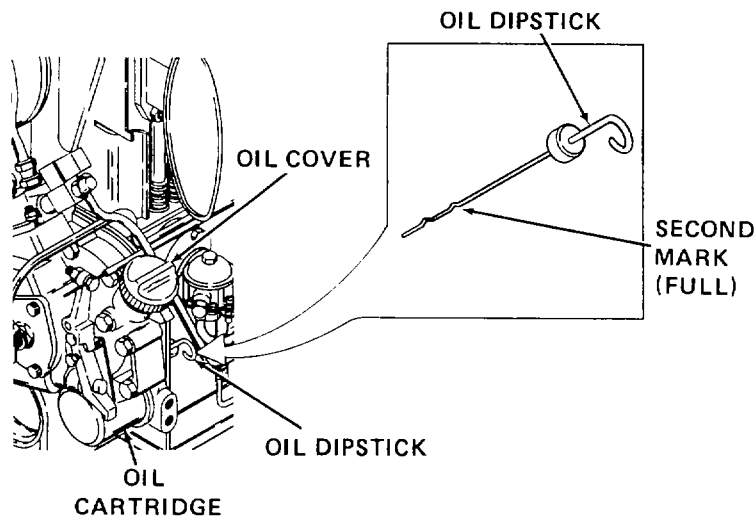


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION
 TEST OR INSPECTION
 CORRECTIVE ACTION

WARNING

Priming discharge of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Do not overfill. Oil will be blown out through the crankcase breather if crankcase is overfilled. Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

- b. Start engine and observe oil pressure. If oil pressure is still low, notify organizational maintenance.

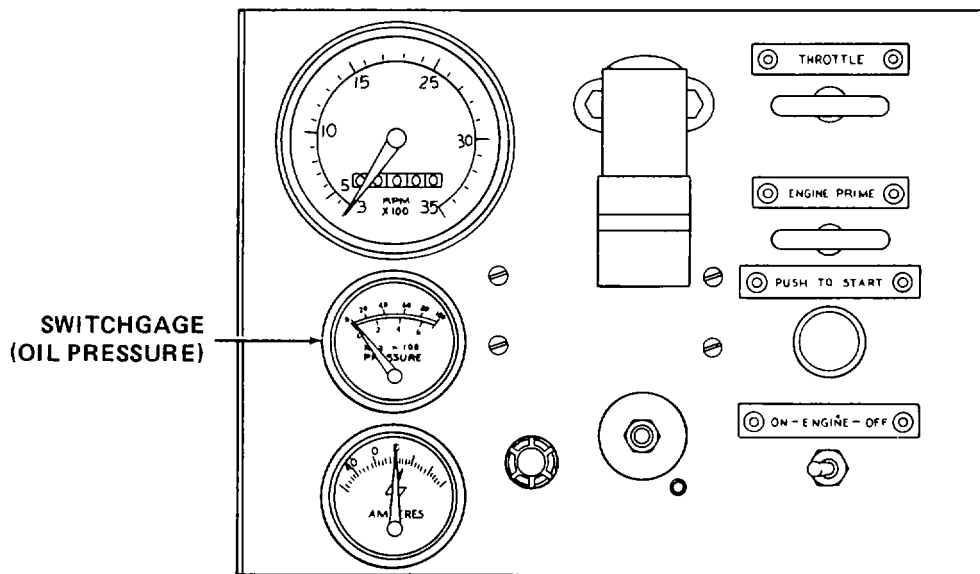


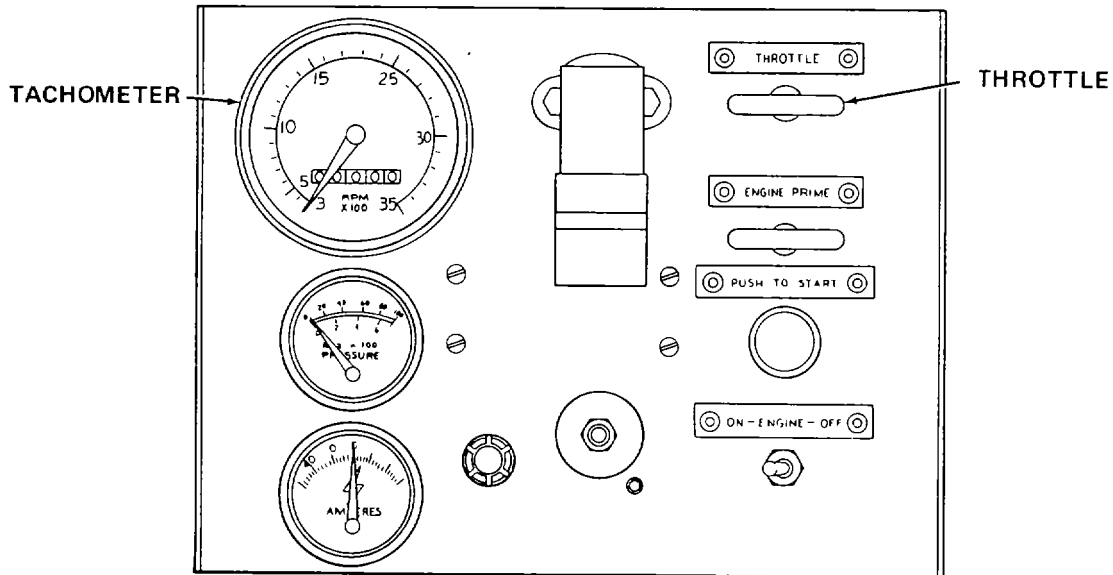
Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

8. PUMP FAILS TO PRIME

Step 1. Check for low engine speed.

Adjust throttle to increase engine speed to 2800 rpm.



Step 2. Check for leaks at the suction flange (intake) and gasket.

Tighten nuts on suction flange (intake) at pump body flange.

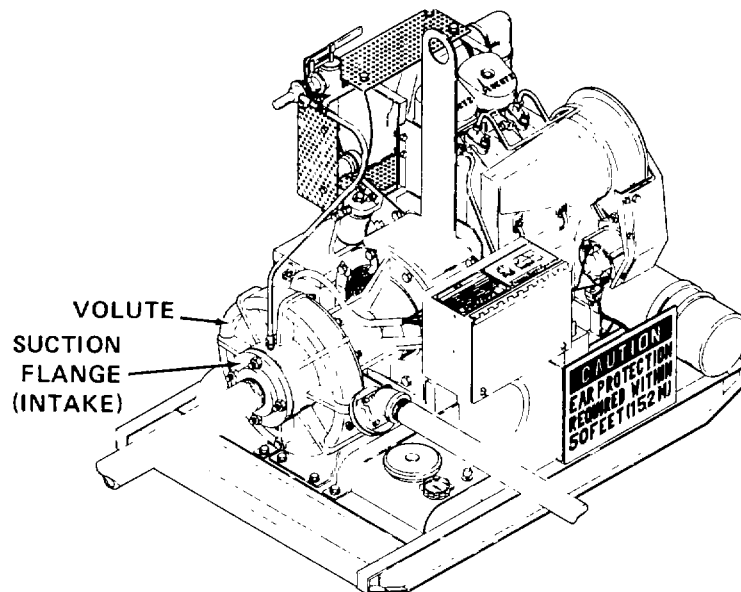


Table 3-1. Operator/Crew Troubleshooting-Continued

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

9. PUMP FAILS TO DELIVER CAPACITY

Check for excessive suction lift.

Refer to operator's instruction plate.

10. NOISY PUMP OPERATION

Notify organizational maintenance.

11. LOW DISCHARGE PRESSURE

Step 1. Check for low engine speed.

Adjust throttle to increase engine speed to 2800 rpm.

Step 2. Check suction line for loose connections.

Tighten loose connections.

CHAPTER 4 ORGANIZATIONAL MAINTENANCE INSTRUCTIONS

INTRODUCTION

This chapter contains the following frequently used maintenance information.

- a. Information on repair parts, special tools, test measurement diagnostic equipment (TMDE), and support equipment.
- b. Instructions for service upon receipt of equipment.
- c. Lubrication.
- d. Preventive maintenance checks and services (PMCS).
- e. Troubleshooting.
- f. Maintenance procedures.
- g. Preparation for storage or shipment.

Section I. REPAIR PARTS, SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

4-1. COMMON TOOLS AND EQUIPMENT

For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your unit.

4-2. SPECIAL TOOLS, TMDE. AND SUPPORT EQUIPMENT

The special tooling required to service the engine and pump assemblies is listed and illustrated in detail in TM 5-4320-302-24P, Repair Parts and Special Tools List (RPSTL).

4-3. REPAIR PARTS

Repair parts are listed and illustrated in TM 5-4320-302-24P, Repair Parts and Special Tools List (RPSTL).

Section II. SERVICE UPON RECEIPT OF EQUIPMENT

4-4. UNLOADING EQUIPMENT

- a. Before attempting to unload the Model US2520 HCCD-1 Centrifugal Pump Unit, make sure that the unloading facility is capable of handling 870 pounds (395 kilograms).
- b. Remove shipping tiedowns.

CAUTION

Do not attempt to lift unit manually. Use crane securely fastened to lifting bracket. Do not allow unit to swing while suspended. Failure to observe this caution may result in severe damage to the pump unit.

- c. Unload the centrifugal pump unit by lifting with a crane secured to lifting bracket. As an alternate but less desirable method of unloading, the unit can be slid down a ramp on the skid assembly.



4-5. INSPECTING AND SERVICING EQUIPMENT

- a. Inspect centrifugal pump unit for any damage that may have occurred during shipping.
- b. Inspect unit for loose mounting hardware.
- c. Inspect unit for missing components.
- d. Refer to figure 4-1 for lubrication instructions.
- e. Refer to table 4-1 and perform preventive maintenance checks and services.

LUBRICATION ORDER

LO 5-4320-302-12

**PUMP UNIT, CENTRIFUGAL, WATER,
DIESEL-ENGINE-DRIVEN, 2-1/2-INCH, SKID-MOUNTED
200 GPM AT 300 FEET TOTAL HEAD
MODEL US2520 HCCD-1
NSN 4320-01-181-4148**

Reference TM 5-4320-302-14 and C9100-1L

Intervals and the related man-hour times are based on normal operation. The man-hour time specified is the time required to perform all the services prescribed for a particular interval. Change the interval if lubricants are contaminated or if the equipment is operated under adverse operating conditions. The interval may be extended during periods of low level activity, commensurate with adequate preservation precautions.

Intervals are given in elapsed time as indicated on hourmeter of tachometer. The intervals have been adjusted for applicability to this unit when operated at 2900 RPM. This adjustment is made necessary because hourmeter only indicates accurate elapsed time if

unit has been operated at a constant speed of 1500 RPM. Accomplish lubrication procedures using the calculated interval, without correction, from the readings of the hourmeter.

Clean fittings before lubricating. Clean parts with thinner, paint, volatile mineral spirits (EPM), or solvent, dry cleaning (SD). Dry before lubricating. Dotted arrow points indicate lubrication on both sides of the equipment. The lowest level of maintenance authorized to lubricate a point is Organizational Maintenance indicated by the symbol (O). Lubricate all chassis ports after washing. Do not over-lubricate, wipe off excess.

LUBRICANT • INTERVAL

INTERVAL • LUBRICANT

NOTE

Intervals are given in actual time shown as elapsed on the hourmeter contained in the tachometer. These intervals are in operating hours as recorded on the meter face and the intervals have been adjusted to accommodate recommended intervals.

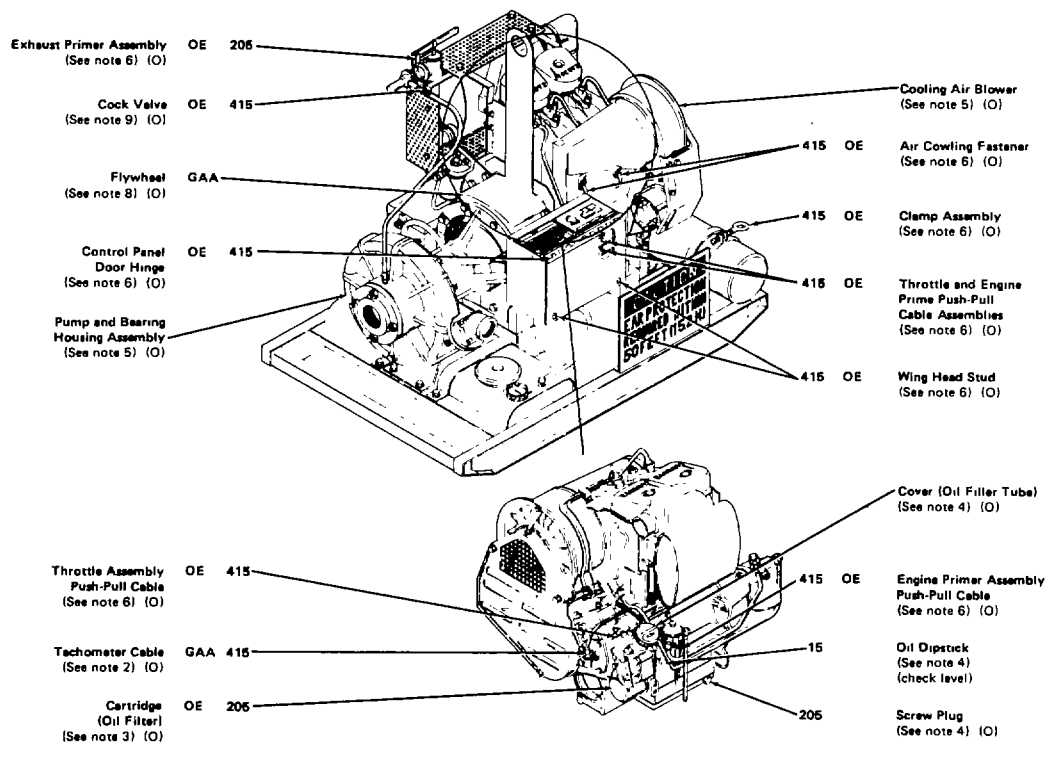


Figure 4-1. Lubrication Order (Sheet 1 of 2)

TOTAL MAN HR	
INTERVAL	MAN-HR
15	0 1
205	0 7
415	1 0

KEY

LUBRICANT*	EXPECTED TEMPERATURE	INTERVALS
OE (MIL-L-2104, Grade 30 or 40) or OEA (MIL-L-46167)	- LUBRICATING OIL, internal combustion engine - LUBRICATING OIL, internal combustion engine, arctic	OE Grade 40 OE Grade 30 OEA
GAA (MIL-G-10924)	- GREASE automotive and artillery	All temperatures
SD-2 (P-D-680)	- SOLVENT, dry cleaning	

For arctic operation refer to TM 9-207

Intervals given are in hours of normal operation as determined using tachometer hour meter

*SAE 15W -40 may be substituted for single grade oils

NOTES

1. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW -10°F (-23°C) Remove lubricants prescribed in the key for temperatures above -10°F (-23°C) Clean parts with dry cleaning solvent. Re-lubricate with lubricants specified in the key for temperatures 0° to -65°F (-18° to -54°C) See note 7
2. TACHOMETER CABLE Grease tachometer cable with GAA every 415 hours. Remove cable from elbow
3. CARTRIDGE (ENGINE OIL FILTER) Replace oil filter cartridge every time oil is changed. Use hand or strap wrench to unscrew filter in counterclockwise direction. Discard filter. Install new filter hand tight after lubricating oil filter gasket with engine oil. Wipe off oil filter and immediate area of engine with rag. Refill crankcase with correct grade of engine oil as shown in the key. Capacity is 3.7 quarts (3.5 liters) with filter.
4. COVER (OIL FILLER TUBE) Check oil level every 10 hours. Add oil through cover if dipstick level is low. Run engine a few minutes, shut down engine, wait 20 minutes, then recheck level. Refill if necessary. Remove screw plug to drain crankcase at oil change interval. Drain oil while engine is hot. Replace plug after oil has drained completely, and wipe off plug and immediate area of oil pan with a rag. Tighten plug if leaks appear.
5. PUMP AND BEARING HOUSING ASSEMBLY AND COOLING AIR BLOWER BEARINGS Bearings are lubricated by the manufacturer at assembly and require no subsequent lubrication except at scheduled overhaul periods.
6. OIL CAN POINTS Clean and lightly coat with engine oil all pivot points, linkages, hinges, clevis pins, wing nuts, and adjusting threads.

Copy of this lubrication order will remain with the equipment at all times, instructions contained herein are mandatory.

7. OPERATIONAL ENVIRONMENT Design parameters of centrifugal pump unit relative to operating temperatures have been given as 32° to 125°F (0° to 52°C). Information relative to lubrication of equipment when operated at temperatures below 32°F (0°C) is provided for storage and general information only. See note 8.

8. FLYWHEEL LUBRICATION If for any reason, the centrifugal pump unit must be operated at temperatures below -4°F (-20°C), the ring gear of the flywheel shall be lubricated. Remove starter to allow access to teeth of flywheel ring gear. Lubricate starter drive gear while starter is removed. Only a light coating of grease shall be applied. See note 7.

9. COCK VALVE To lubricate, remove cock from valve body and clean components with dry cleaning solvent. Clean cock seat. Lubricate cock, seat, and threads.

BY ORDER OF THE SECRETARY OF THE ARMY

General, United States Army,
Chief of Staff

OFFICIAL

The Adjutant General

Figure 4-1. Lubrication Order (Sheet 2 of 2).

4-6. INSPECTION AND SERVICING OF BATTERIES

- a. The centrifugal pump unit battery box contains two waterproof, lead acid storage batteries.
- b. Remove the batteries from battery box and inspect for damage.
- c. Clean positive and negative battery terminals.
- d. Remove filler caps.

WARNING**CAUSTIC CHEMICALS IN BATTERIES**

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

BATTERIES GENERATE FLAMMABLE GAS

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.

NOTE

Use an electrolyte with a specific gravity of 1.280. Do not use a tropical electrolyte which will lower the batter reserve capacity.

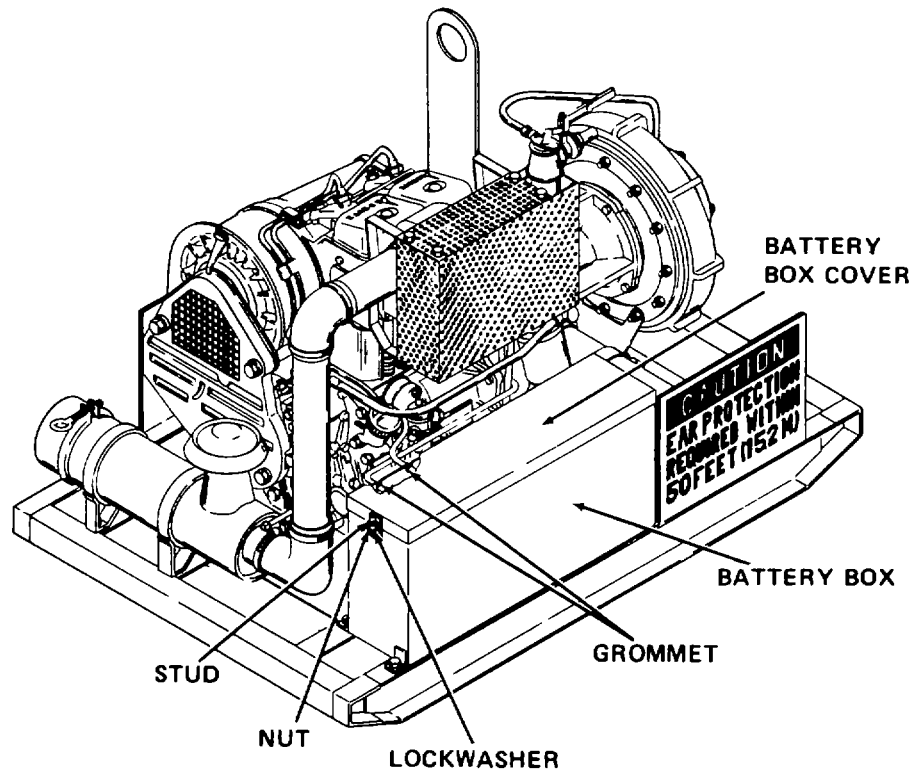
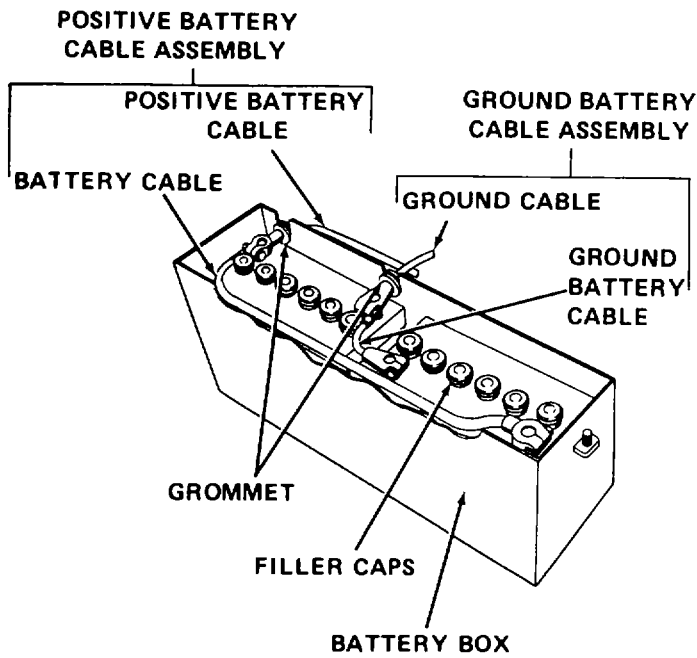
- e. If batteries are dry add electrolyte to each cell. Fill until level is above battery plates and reaches split ring in filler neck.
- f. Install filler caps.
- g. Charge batteries fully.
- h. Check that interior of battery box is clean. Be sure drain holes are open and not painted closed.
- i. Place batteries into battery box. Orient terminals as shown.
- j. Clean terminal clamps of cables.

CAUTION

Be sure that during installation the batteries are installed and connected in parallel. If batteries are not connected in parallel, damage to starter and controls may occur.

- k. Connect positive battery cable assembly to positive (+) battery terminals. Position grommet in cutout of battery box. Tighten terminals securely.
- l. Connect ground battery cable assembly to negative (-) battery terminals. Position grommet in cutout of battery box. Tighten terminals securely.
- m. Lightly coat both terminals and clamps with M1L-G-10924 grease.

n. After placing batteries into battery box, place battery box cover onto battery box. Install lockwashers and nuts onto studs. Tighten securely.



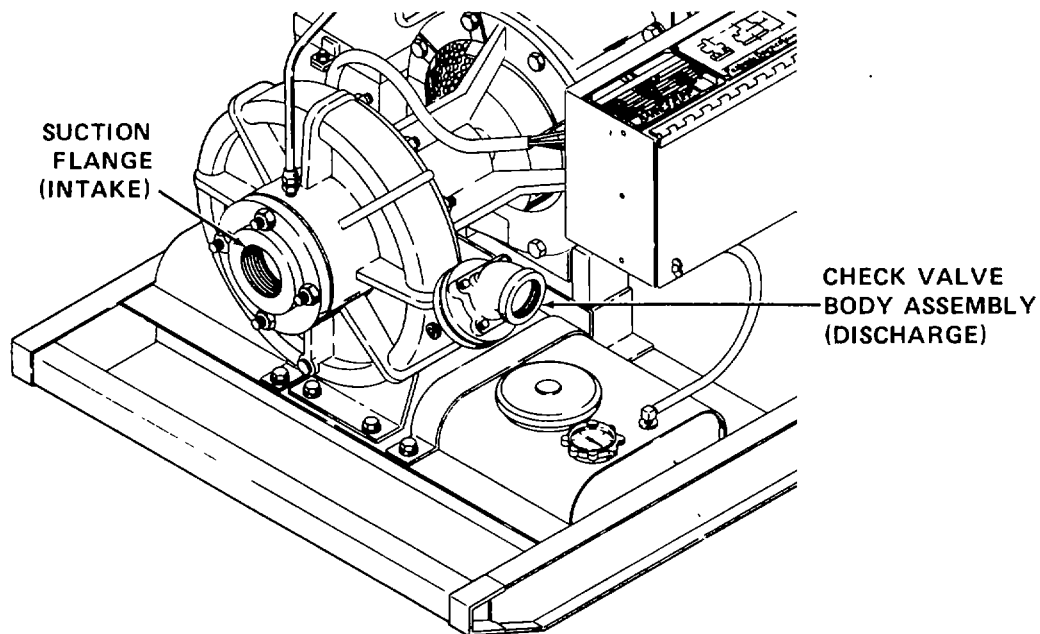
4-7. SETUP INSTRUCTIONS

- a. Locate unit as close as possible to the water to be pumped. Keep the suction hose and the amount of lift as short as possible.
- b. The operating site should be as level as possible (no more than 15 degrees slope) or the engine lubrication system may not work properly.

CAUTION

This pump is not intended to pump trash. Due to close internal tolerances it is advisable to keep suction intake off of bottom when pumping.

- c. Keep the suction and discharge hoses as short and straight as possible.
- d. Allow adequate space to permit support of the suction and discharge hoses where they enter the pump.
- e. Connect the suction hose to the suction flange (intake).
 - (1) Highest point in the suction hose should be at the pump.
 - (2) Make sure that connections and pipe joints in the suction hose are tight.
- f. Connect the discharge hose to the check valve body assembly (discharge). Be certain discharge hose is tight.



Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-8. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Table 4-1 lists preventive maintenance checks and services (PMCS) which shall be performed at specified intervals by organizational maintenance personnel. It expands upon the preventive maintenance services performed by operator/crew maintenance and includes additional services which are allocated to organizational maintenance. The columns, codes, and location designations used in the table are as follows:

- a. Item numbers are assigned to each check or service task. These numbers are to be used as a source of item numbers for the TM Number column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
- b. The service intervals are divided into four categories: W-Weekly; M-Monthly; Q-Quarterly; S-Semiannually. A dot (•) is placed in the Interval column for each check or service. If the same check or service is made in two or more intervals, a dot is placed in each applicable column.
- c. The Item To Be Inspected column lists the item to be checked or serviced.
- d. The Procedures column describes the procedure by which the check or service is to be performed. Illustrations are included to assist in locating that part of the equipment requiring the check or service.
- e. The designations left, right, front, and rear as used in PMCS indicate the side or end of the centrifugal pump as viewed when facing the control panel.

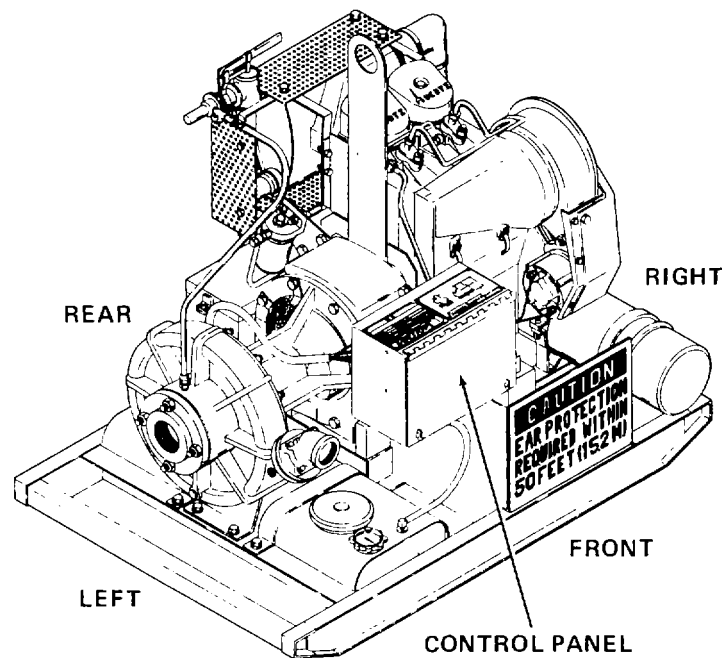


Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<div style="border: 2px dashed black; padding: 5px; text-align: center; margin-bottom: 10px;"> CAUTION </div> <p>During PMCS it is necessary to run the engine to be sure that the work has been accomplished satisfactorily. Since the pump is directly coupled to the engine, the pump will run when the engine runs. Running the pump for longer than a few seconds without water in the volute will damage the pump. When necessary to run the pump for longer than a few seconds, make sure that suction and discharge hoses are installed and a source of water to be pumped is available. Start engine, prime and operate pump to duplicate normal operation and prevent pump from overheating.</p> <p style="text-align: center;">NOTE</p> <p>When accomplishing Organizational PMCS, inspect all painted surfaces. Paint must be in good condition with no bare metal or corrosion. Bare or corroded metal that was originally painted must be refinished as soon as possible in accordance with MI L-T-704.</p> <p>When accomplishing PMCS, intervals provided in figure 4-1, Lubrication Order, take precedence over those in table 4-1. However, intervals provided in this table should be considered minimum intervals and should not be exceeded unless the centrifugal pump unit has been preserved for storage.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
1			•		V-Belt Guard, V-Belts, Alternator V-Belt Pulley, Alternator Fan, Cooling Blower V-Belt Pulley, and Drive Shaft V-Belt Pulley	V-Belt Guard Removal <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> WARNING </div> <p>Be sure engine is shut down and control panel is closed to prevent accidental starting while guard is removed. If necessary to run engine without guard, be sure that area around V-belts is clear of personnel and tooling.</p> <p>Loosen clamp and remove rain cap. Unthread nut and remove bolt and retainer. Unthread and remove cap nuts and washers. Unthread and remove bolt and washer from side of guard. Slide guard off studs and remove guard from engine.</p>

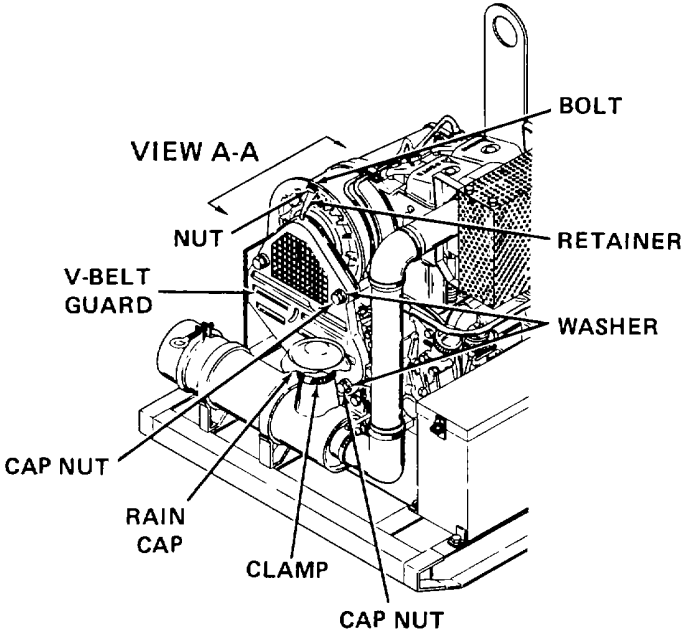
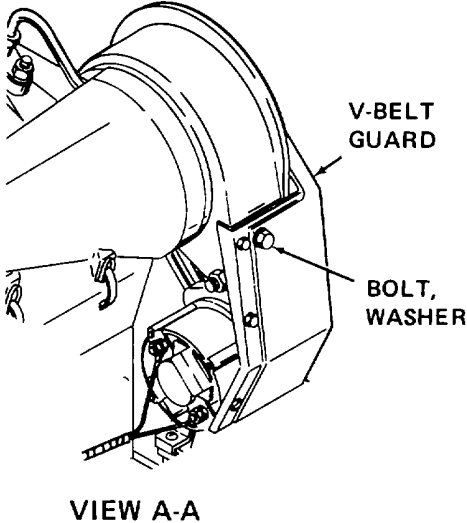


Table 4-1. Organizational Preventive Maintenance Checks and Services

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<p>Check interior of V-belt guard for signs of rubbing that would indicate inadequate clearance between guard and the rotating engine components it protects. Check guard for other signs of damage, dents, rust or corrosion. Be sure that prior to installation of guard;-the guard has been repaired or replaced as necessary to prevent interference with rotating components of engine.</p> <p>V-Belt Check and Adjustment</p> <p>Check matched set of V-belts for glazing, wear, abrasions, cracks, or cuts. Using thumb pressure, check V-belt tension. Firm thumb pressure shall deflect V-belts 3/8-5/8 inch (9.5-15.9 mm). If V-belts are damaged, replace as matched set. Determine that detected V-belt damage has not been caused by damaged or worn pulleys. Be sure damaged or worn pulleys are replaced prior to replacing V-belts. To adjust V-belt tension loosen hex bolts, move alternator away from engine centerline far enough to take up slack, and tighten hex bolts securely. Check tension on V-belts after tightening.</p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> • Stand clear of venturi during priming. <div style="border: 2px dashed black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p> <p>Run engine for 10 minutes and recheck tension of belts. Adjust as needed.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

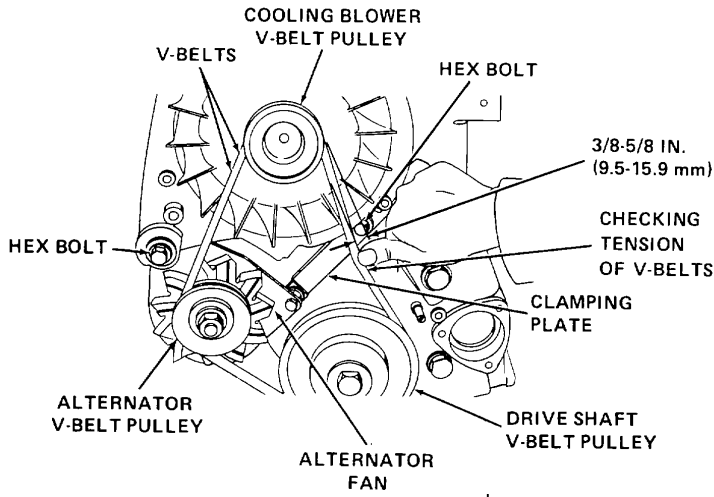
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<p>Alternator V-Belt Pulley, Cooling Blower V-Belt Pulley, and Drive Shaft V-Belt Pulley Check</p> <p>Check all pulleys for sharp edges, nicks, corrosion, or wear sufficient to form sharp edges on pulley outside diameters. Check all pulleys for looseness on shafts. Check attaching hardware for tightness and corrosion. Replace damaged pulleys and attaching hardware.</p> <p>Alternator Fan Check</p> <p>Check alternator fan for broken or damaged blades which could interfere with rotation.</p>
						<p>V-Belt Guard Installation and Check</p> <p>Install guard over V-belts and onto studs.</p> <p>Place washer onto bolt. Install bolt through side of V-belt guard. Tighten securely.</p> <p>Thread cap nuts and washers onto studs. Tighten securely.</p> <p>Install retainer into guard. Secure retainer in place using bolt and nut. Tighten securely.</p> <p>Place rain cap onto air cleaner. Tighten clamp securely.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

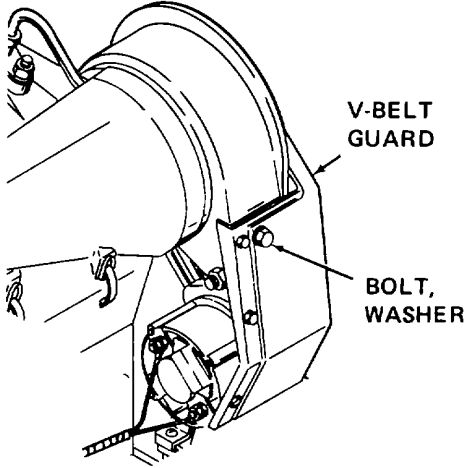
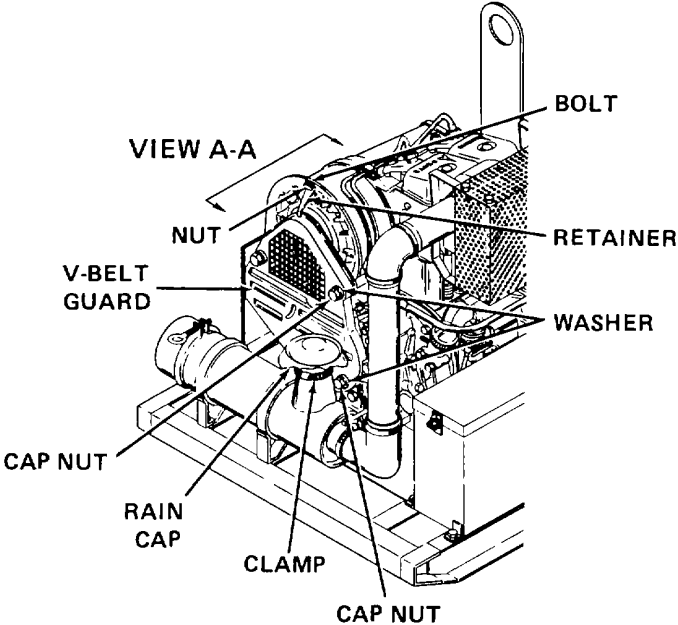
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"> WARNING </div> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> • Stand clear of venturi during priming. <div style="border: 2px dashed black; padding: 5px; text-align: center; margin-bottom: 10px;"> CAUTION </div> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p> <p>Run engine briefly to be sure V-belt guard does not interfere with engine operation and V-belts do not contact any portion of guard.</p>
					 <p>Diagram showing the V-belt guard assembly. Labels include: V-BELT GUARD, BOLT, WASHER. The view is labeled VIEW A-A.</p>	 <p>Diagram showing a detailed view of the engine components. Labels include: BOLT, RETAINER, WASHER, NUT, V-BELT GUARD, CLAMP, RAIN CAP, CAP NUT. The view is labeled VIEW A-A.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

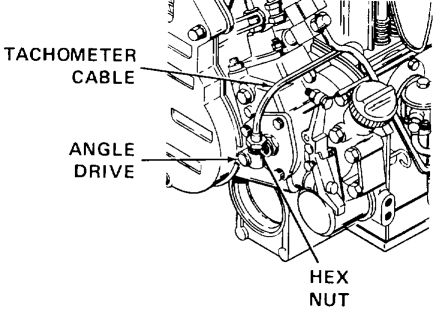
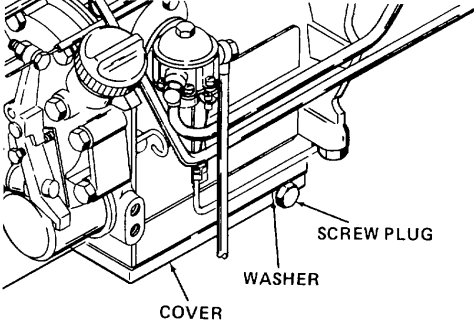
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
2				•	Tachometer Cable	<p>Unthread hex nut from angle drive. Remove tachometer cable from angle drive. Check tachometer cable end and angle drive for damage, corrosion, dirt, and wear. Lubricate cable end and angle drive with M IL-G-10924 grease. Replace damaged angle drive or tachometer cable. Carefully engage cable to angle drive. Tighten hex nut securely.</p> 
3			•		Lube Oil Filter (Cartridge)	<p>Drain oil. With engine off but warmed up, place a suitable container beneath screw plug and remove plug. After all oil has drained, install screw plug and tighten securely.</p>  <p>Replace lube oil filter (cartridge). Remove lube oil filter by rotating counterclockwise. Discard filter. Using a lint-free rag, wipe off sealing surface onto which filter seats. Lubricate seal of new filter with MIL-L-2104 oil.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

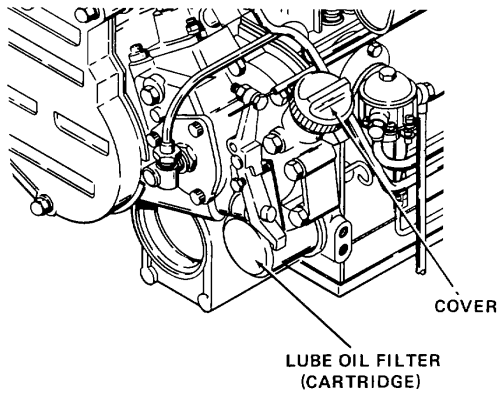
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<p>Install filter. Thread filter onto front cover by rotating clockwise until seal of filter contacts seal surface. Rotate filter clockwise an additional 1/2 turn.</p> <p>Add oil. Remove cover (oil filler tube). Fill with 3.6 quarts (3.4 liters) of MIL-L-2104 oil.</p> <div style="border: 1px solid black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> • Stand clear of venturi during priming. <div style="border: 2px dashed black; padding: 5px; text-align: center; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p> <p>Start engine, run engine 5 minutes. Be sure oil pressure is satisfactory and no oil leaks are found. Shut engine down. Check oil level using dipstick. Add additional oil as needed to bring oil level up to mark on dipstick.</p> 

Table 4-1. Organizational Preventive Maintenance Checks and Services

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
4				•	Fuel Feed Pump	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;">WARNING</div> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle fuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct air-stream against skin.</p> <p>Check fuel feed pump. Unthread screw from fuel feed pump. Remove, as an assembly, screw, washer, and cover. Separate screw from washer. Remove gasket and strainer. Discard gasket and washer.</p> <p>Using diesel fuel oil and a soft-bristled brush, clean strainer, cover, and screw. If deposits in strainer cannot be removed, discard strainer. Dry with low pressure compressed air.</p> <p>Operate engine prime T-handle. Check proper operation of fuel feed pump diaphragm. Check diaphragm for leaks.</p> <p>If diaphragm leaks, replace fuel feed pump by removing screws and washers. Remove and discard O-seal. Install new O-seal. Install new fuel feed pump. Install screws and washers. Tighten screws securely.</p> <p>Install strainer onto fuel feed pump. Place gasket onto sealing surface of pump. Install screw through washer and cover.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
					<p>The diagram shows a detailed view of an engine's fuel system and control panel. Labels include: INJECTOR FITTING, BANJO BOLT, CONTROL PANEL ASSEMBLY (FRONT), FAULT SENSITIVE CONTROL SWITCH PUSHBUTTON, SCREW, WASHER, COVER, GASKET, STRAINER, BANJO BOLT, O-SEAL, FUEL FEED PUMP, and SCREW. A callout shows the assembly of the fuel feed pump cover with a gasket, strainer, and screw.</p>	<p>Place cover over gasket and strainer. Mate cover to fuel feed pump. Thread screw into pump. Tighten screw securely.</p> <p>WARNING</p> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> • Stand clear of venturi during priming. <p>CAUTION</p> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components. Start engine and observe fuel feed pump for leaks.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
5			•		Batteries, battery Cables, and battery box	<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;">WARNING</div> <p>CAUSTIC CHEMICALS IN BATTERIES Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.</p> <p>BATTERIES GENERATE FLAMMABLE GAS</p> <ul style="list-style-type: none"> • Leave battery vent plugs installed while battery is being charged. • Charge battery in a well-ventilated area. • Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery. <p style="text-align: center;">NOTE</p> <p>Do not fill batteries with tropical electrolyte which will lower the battery reserve capacity.</p> <p>Remove nuts and lockwashers from studs and remove battery box cover. Disconnect ground battery cable assembly. Disconnect positive battery cable assembly. Remove batteries. Check positive and ground cable assemblies for any signs of damage, corrosion, or looseness. Check that battery box drains are open and no corrosion is detected in interior of box. Check grommets for damage that would allow fraying of cable insulation. Using a hydrometer, check each cell's charge. Fill battery with distilled water as needed. Clean battery posts. Install batteries in battery box. Connect positive battery cable assembly. Connect negative battery cable assembly.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<p>After installing terminals and terminal clamps, lightly coat with MI L-G-10924 grease. Check that all filler caps are in place. Place battery box cover over studs and onto battery box. Install lockwashers and nuts. Tighten nuts securely.</p>
6			•		Crankcase Breather	<p>Check hose for cracks.</p> <p>Check hose strap is tight and hose and breather are firmly attached.</p> <p>Check hose is retained by retaining plate.</p> <p>Check sealing nut is tight and shows no signs of leakage.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

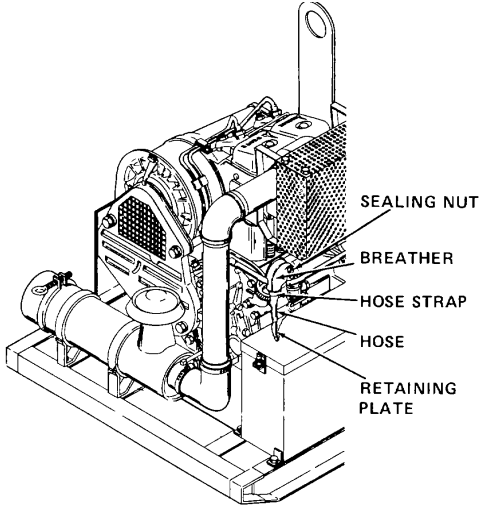
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
7				•	Fuel Filter	<p>Check parting surface of crankcase and breather for leaks.</p>  <p>WARNING</p> <p>Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:</p> <ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle fuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Work in a well-ventilated area. <p>Replace fuel filter. Unthread fuel filter from bracket. Discard filter. Wipe filter sealing surface of bracket clean with lint-free cloth.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

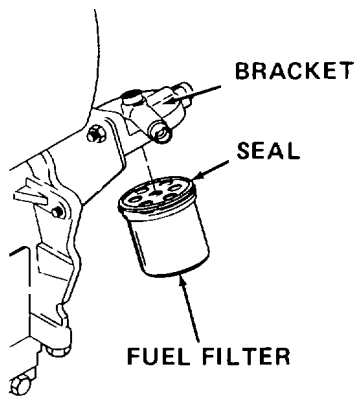
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<p>Lubricate seal of new fuel filter with VV-F-800 diesel fuel oil. Thread fuel filter onto bracket until seal surfaces firmly contact. Tighten fuel filter an additional 1/2 turn.</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump. Stand clear of venturi during priming.</p> <div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p> <p>Start engine and observe fuel filter for leaks.</p> <div style="text-align: center; margin-top: 20px;">  </div>

Table 4-1. Organizational Preventive Maintenance Checks and Services

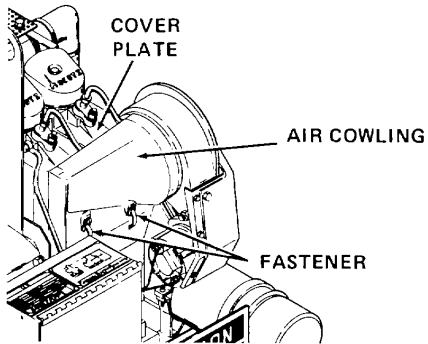
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
8			•		Cooling Air Ducting	<p>Pull latch handles of fasteners down. Lift air cowling up, unhook from cover plate, and set aside.</p>  <p>Check cylinder cooling fins for damage, or dirt.</p> <p>Check bottom roller of cooling air blower for dirt.</p> <p>Check lube oil cooler cooling fins for damage, dirt, or obstructions.</p>

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

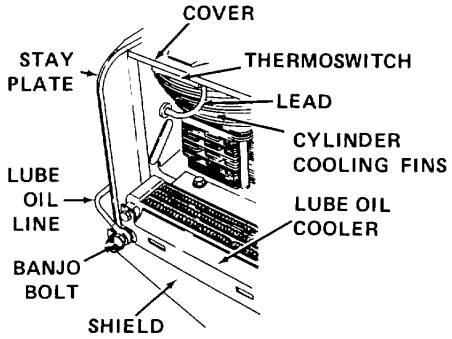
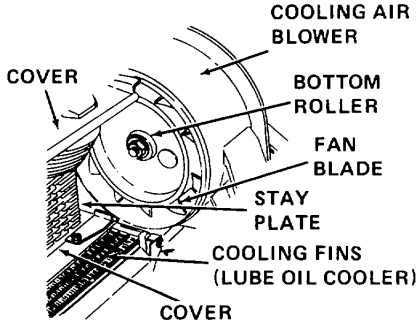
ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
						<div style="border: 1px solid black; padding: 5px; text-align: center; margin-bottom: 10px;"> WARNING </div> <p>Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.</p> <p>Remove accumulated dust and dirt with compressed air. Install air cowling and retain with fasteners.</p>  

Table 4-1. Organizational Preventive Maintenance Checks and Services

W-Weekly
M-Monthly

Q-Quarterly
S-Semiannually

ITEM NO.	INTERVAL				ITEM TO BE INSPECTED	PROCEDURES
	W	M	Q	S		
9		•			<p>Check Valve Assembly</p>	<p>Inspect check valve body assembly for cracks or damaged threads. Check that attaching hardware is tight and free of corrosion.</p> <p>Inspect check valve assembly for evidence of leakage or gasket damage, and presence of outer check valve weight. Machine screw should be tight. All components must be free of corrosion. When in closed position, check valve gasket flapper must make an airtight seal on pump outlet. Be sure valve gasket flapper is free to open with pump flow.</p>

Section IV. TROUBLESHOOTING

4-9. TROUBLESHOOTING

a. Table 4-2 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of organizational maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of organizational maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1.

4-10. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the centrifugal pump unit. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks very slowly	4-26
2	Engine cranks but fails to start	4-29
3	Engine runs unsteadily and power output is low	4-38
4	Dense smoke from exhaust valve after warm-up	4-39
5	Engine overheats	4-40
6	Low engine oil pressure	4-41
7	Charging indicator lamp lights when engine is running	4-44
8	Pump makes excessive noise	4-44
9	Pump output low	4-45

Table 4-2. Organizational Maintenance Troubleshooting

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

1. ENGINE FAILS TO CRANK OR CRANKS VERY SLOWLY

WARNING**CAUSTIC CHEMICALS IN BATTERIES**

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

BATTERIES GENERATE FLAMMABLE GAS

- Leave battery vent plugs installed while battery is being charged.
- Charge battery in a well-ventilated area.
- Do not smoke or use open flame or spark-producing equipment in the vicinity of charging battery.

Step 1. Check for weak batteries or dirty, corroded, or loose battery cable connections:

- a. Remove battery box cover and check batteries with hydrometer.

NOTE

Distilled water or a good grade drinking water (excluding mineral water) may be used.

Add distilled water to batteries as needed. Recharge batteries or replace if defective.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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- b. Inspect and remove battery terminals and/or terminal clamps and connections.

Clean as required. Install terminal clamps and tighten securely. Lightly coat terminals and terminal clamps with MIL-G-10924 grease.

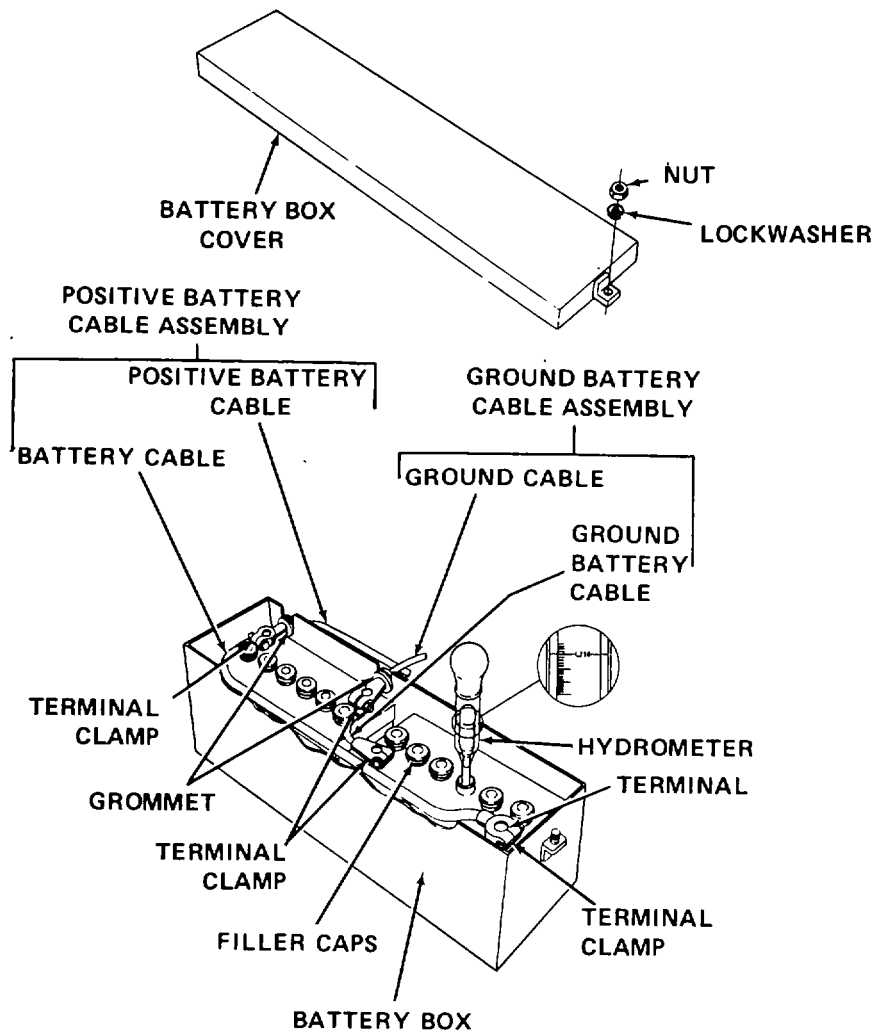
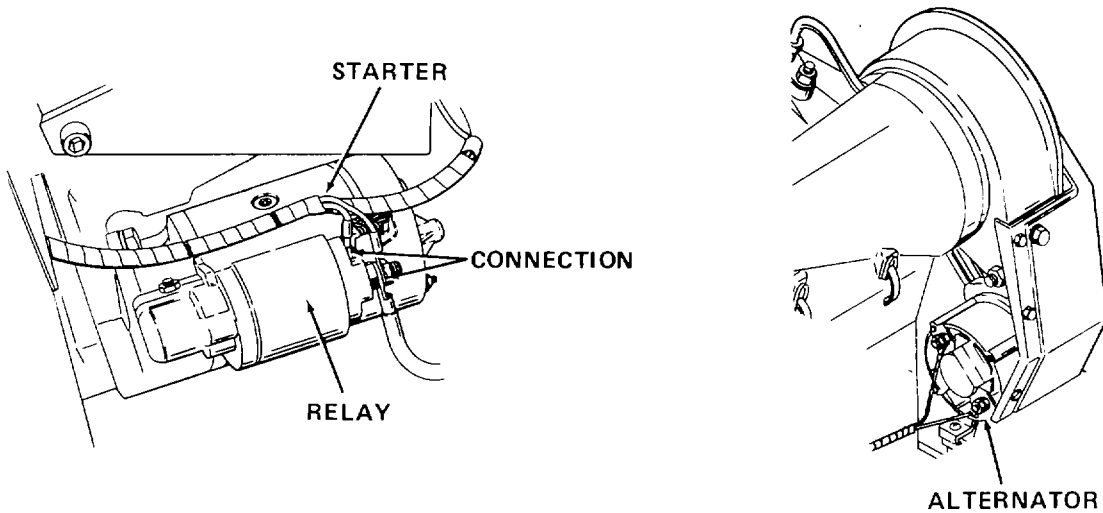


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check for dirty, corroded, or loose cable connections on starter and alternator.

Clean and tighten starter and/or alternator connections if necessary.



Step 3. Check V-belts for breaks or cracks. Check belt tension.

Tighten or replace V-belts as necessary (para 4-26 and 4-27).

NOTE

V-belts must be replaced as a matched set.

Step 4. Remove and check starter (para 4-37).

Replace defective starter.

Step 5. If engine still will not crank or cranks slowly, the engine may be frozen or bound.

Notify direct support.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

2. ENGINE CRANKS BUT FAILS TO START

Step 1. Check that the fault sensitive control has been overridden during starting.

CAUTION

To prevent starter from overheating, do not crank engine with starter for more than 10 seconds.

Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts.

Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter.

Depress pushbutton on fault sensitive control during starting.

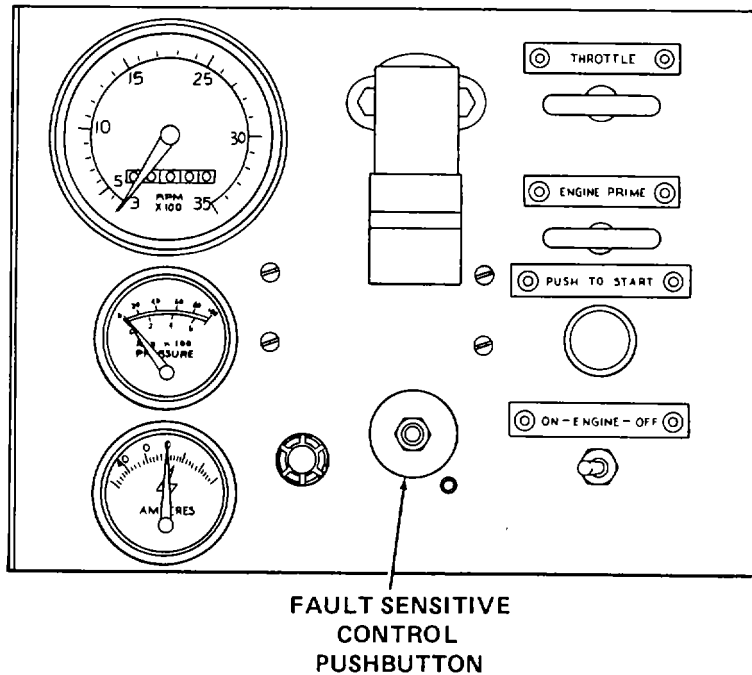


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

Step 2. Check that engine fuel allowance plunger has been depressed prior to starting.

WARNING

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

Depress engine fuel allowance plunger and attempt to start engine.

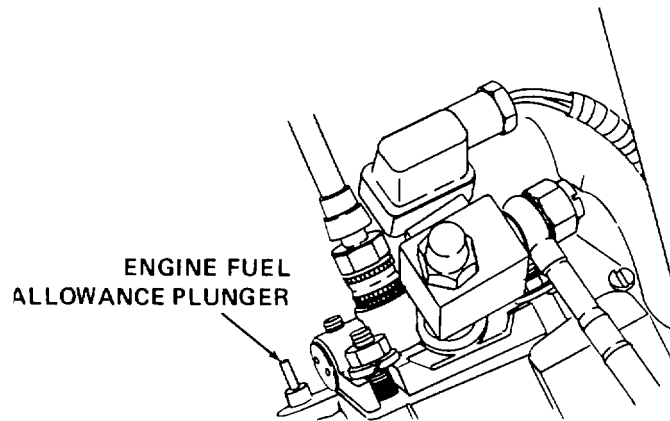


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

Step 3. Check window of air cleaner intake restriction indicator for red band indicating blocked air cleaner elements.

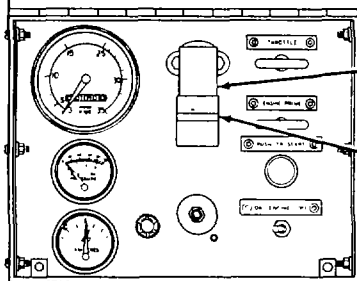
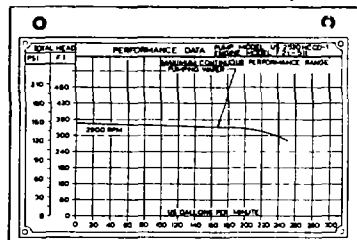
If red band appears in window of air cleaner restriction indicator and rain cap is not blocked and no damage to system components is found, replace primary and secondary elements as follows:

Loosen clamp assembly.

Remove cup assembly.

Remove baffle assembly.

Wipe off cup and baffle assemblies' with a lint-free cloth.



VIEW A-A

AIR CLEANER
INTAKE
RESTRICTION
INDICATOR
WINDOW

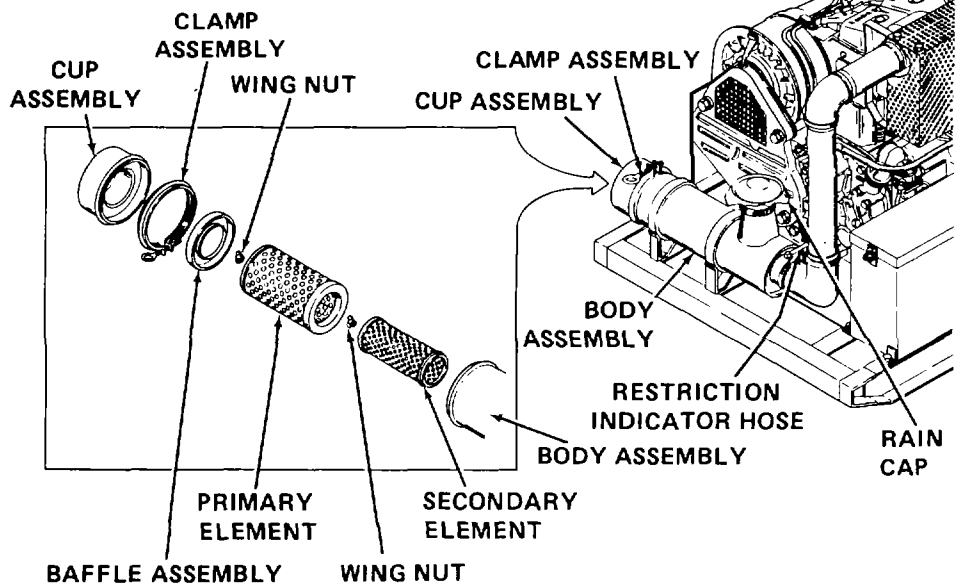


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
		<p>Remove nut assembly from threaded rod.</p> <p>Remove and discard primary element.</p> <p>Remove nut assembly from threaded rod.</p> <p>Remove and discard secondary element.</p> <p>Wipe out interior of body assembly with a lint-free cloth.</p> <p>Install secondary element into body assembly. Aline hole in element with threaded rod.</p>
		<div> </div> <p>Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.</p>
		<p>Install nut assembly and hand tighten.</p> <p>Install primary element over secondary element. Aline hole in element with threaded rod.</p>
		<div> </div> <p>Hand tighten nut assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the element.</p>
		<p>Install nut assembly and hand tighten.</p> <p>Install baffle assembly.</p> <p>Install cup assembly.</p> <p>Seat cup assembly against body assembly.</p>

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

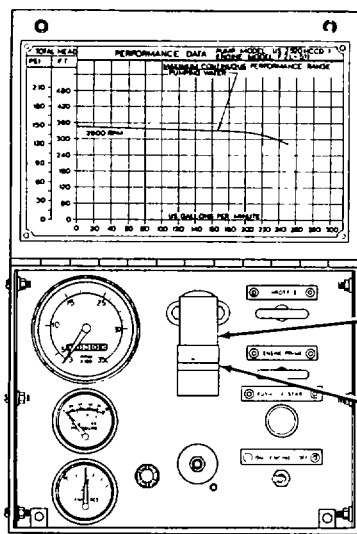
CORRECTIVE ACTION

CAUTION

Hand tighten clamp assembly as necessary to make a tight, vibration-free installation. Overtightening will deform the cup assembly or the body assembly.

Hand tighten clamp assembly.

Reset air cleaner intake restriction indicator.



AIR CLEANER
INTAKE
RESTRICTION
INDICATOR

WINDOW

VIEW A-A

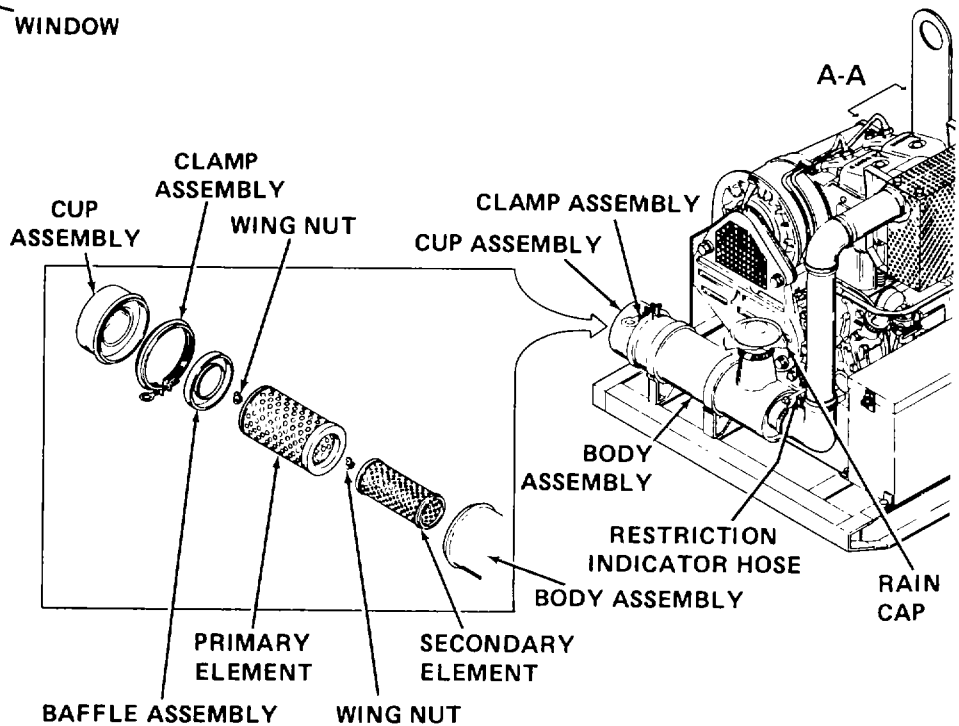
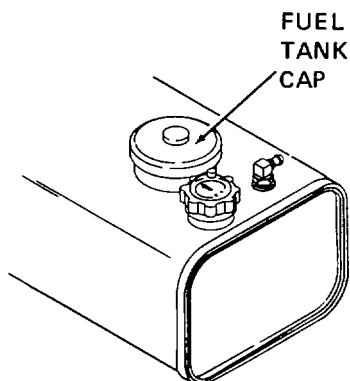


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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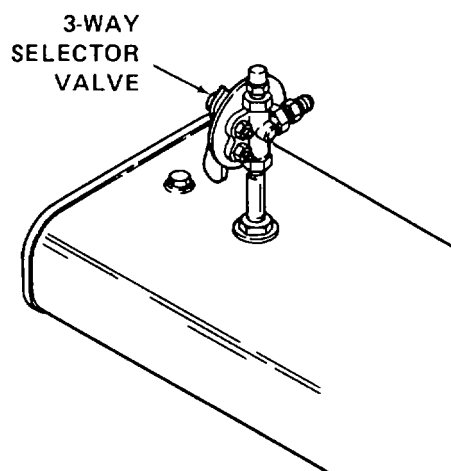
Step 4. Be sure that fuel tank cap vent is in open position. A closed vent will cause a vacuum in the fuel tank and not allow fuel to flow freely to the fuel feed pump.

If vent is in closed position, rotate cap vent to open position.



Step 5. Check alinement of 3-way selector valve.

Aline 3-way selector valve to open position.



Step 6. Check for empty fuel tank.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor
- Do not use near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

If fuel tank is empty, fill with diesel fuel oil and bleed air from fuel system.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

- a. Loosen vent screw on top of fuel filter, four complete turns.
- b. Push and pull ENGINE PRIME T-handle until all air is removed from fuel filter and fuel flows freely.

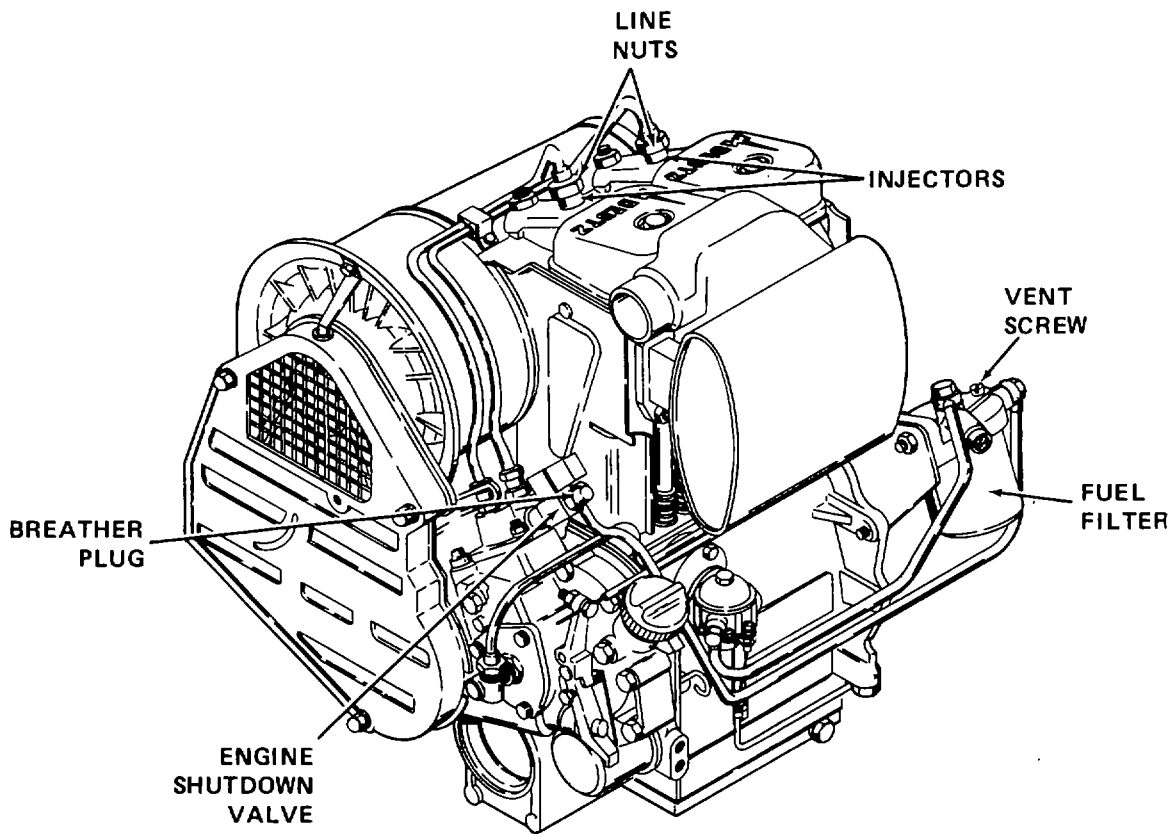
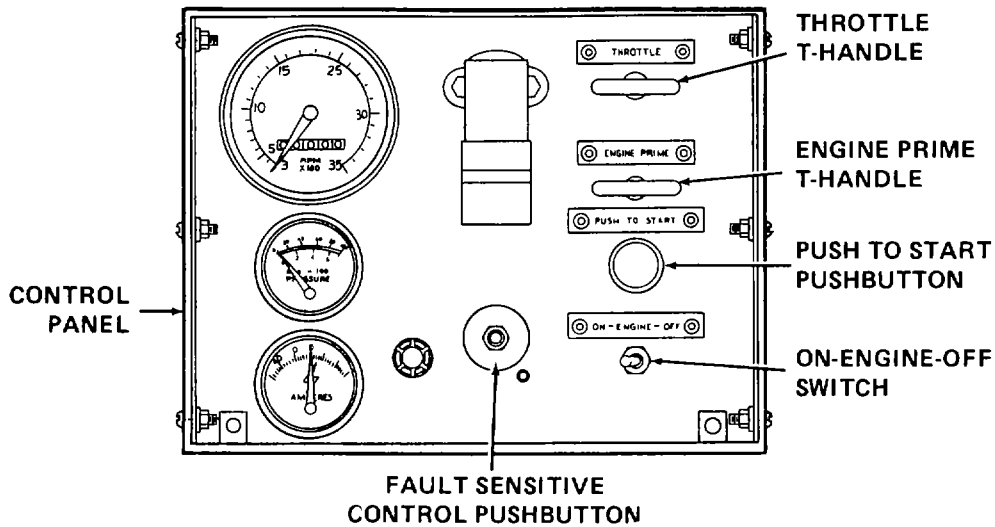


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION****NOTE**

The fuel feed pump is cam driven. If high point of camshaft cam is in contact with fuel feed pump cam lever, fuel system cannot be primed nor air bled from fuel system using fuel feed pump.

- c. Tighten vent screw on top of fuel filter.
- d. Loosen breather plug on top of engine shutdown valve, four complete turns.
- e. Place ON-ENGINE-OFF switch in ON position.
- f. Press and hold in the fault sensitive control button.
- g. Push and pull ENGINE PRIME T-handle until all air is removed from engine shutdown valve and fuel flows freely.
- h. Tighten breather plug on top of engine shutdown valve.
- i. Loosen line nuts on injectors, one full turn.
- j. Hold a lint-free cloth below injectors to collect leakage.

WARNING

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

To prevent starter from overheating, do not crank engine with starter for more than 10 seconds.

Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts.

Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter.

- k. Pull throttle full open and lock by turning clockwise.
- l. Press and hold in the fault sensitive control button, push START button and observe fuel flow from injector fittings until air is cleared from lines.
- m. Tighten line nuts on injectors.
- n. Push throttle closed.
- o. Start engine as described in paragraph 2-5.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

Step 7. Check fuel supply to injectors.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- • Do not inhale vapor.
- • Do not check fuel supply near open flame, sparks, or excessive heat.
- • Be certain fuel lines and connections are not disconnected.
- Work in a well-ventilated area.

- a. With engine cool, loosen line nuts on injectors one full turn. Check that 3-way selector valve is properly aligned.
- b. Hold a lint-free cloth around injector line nuts to collect leakage.

CAUTION

To prevent starter from overheating, do not crank engine with starter for more than 10 seconds.

Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts. Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter. Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

- c. Without depressing pushbutton of fault sensitive control switch, push START button and observe fuel flow from injector fittings until air is cleared from lines.

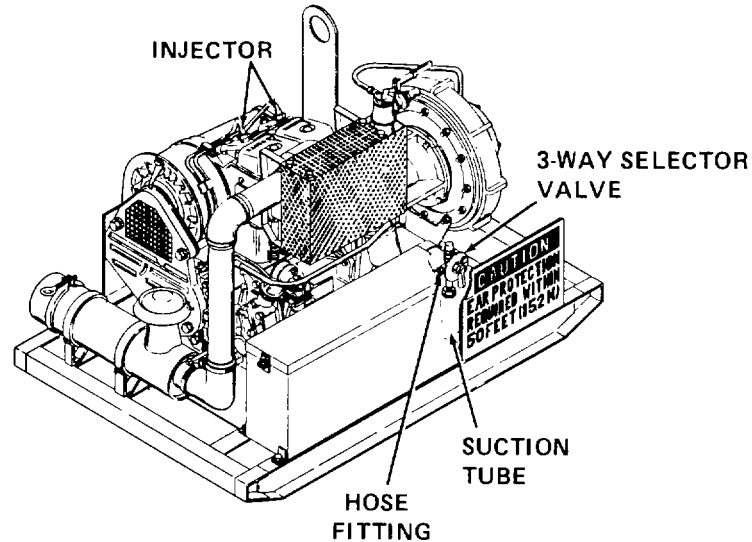
If there is no fuel flow, replace fuel filter and clean fuel feed pump strainer as described in table 4-1, step 4.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

Step 8. Check for cracked suction tube in fuel tank. Loosen hose fitting and remove fuel supply hose from 3-way selector valve at fitting. Remove 3-way selector valve with suction tube from fuel tank. Inspect suction tube.

If tube is cracked, bent, clogged, or damaged, replace it (para 4-24).

**3. ENGINE RUNS UNSTEADILY AND POWER OUTPUT IS LOW**

Step 1. See Malfunction 2, step 3.

Step 2. See Malfunction 2, step 4.

Step 3. See Malfunction 2, step 6.

Step 4. Notify direct support.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION**TEST OR INSPECTION****CORRECTIVE ACTION**

4. DENSE SMOKE FROM EXHAUST VALVE AFTER WARMUP

Step 1. Shut down engine. With engine level, check oil as follows:

Remove oil dipstick.

Wipe oil dipstick with lint-free cloth.

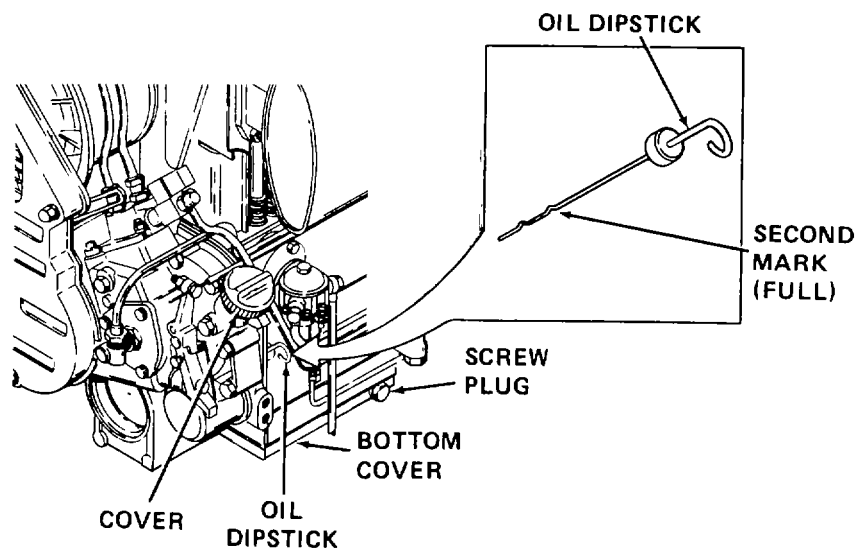
Insert oil dipstick all the way into engine.

Withdraw oil dipstick.

Engine oil should coat oil dipstick to second mark (FULL).

If oil coating is below second mark, remove cover and add oil to bring level up to second mark (FULL). Again check oil level, make sure oil coats oil dipstick to second mark (FULL).

If oil coating extends above second mark (FULL), loosen screw plug, drain enough oil from bottom cover to lower oil level to FULL mark on dipstick, then tighten screw plug securely.



Step 2. Notify direct support.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION

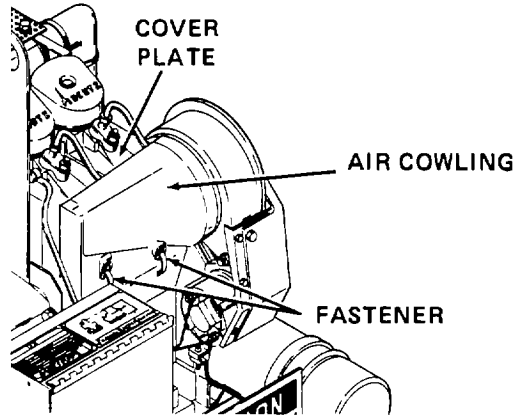
TEST OR INSPECTION

CORRECTIVE ACTION

5. ENGINE OVERHEATS

Step 1. Check cooling air ducting for damage and dirt.

- a. Pull latch handle of fasteners down. Lift air cowling up, unhook from cover plate, and set aside.



- b. Check cylinder cooling fins for damage or dirt.
- c. Check bottom roller of cooling air blower for dirt.
- d. Check lube oil cooler cooling fins for damage, dirt, or obstructions.

WARNING

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Remove accumulated dust and dirt with compressed air. Install air cowling and retain with fasteners.

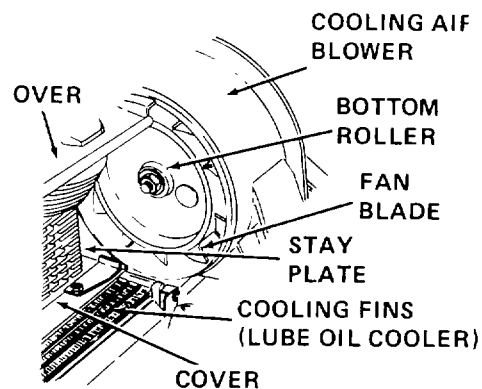
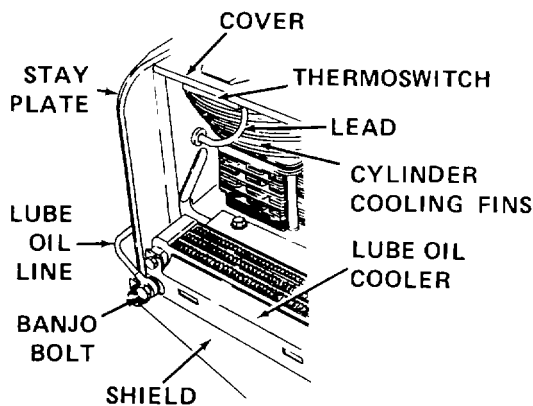


Table 4-2. Organizational Maintenance Troubleshooting - Continued

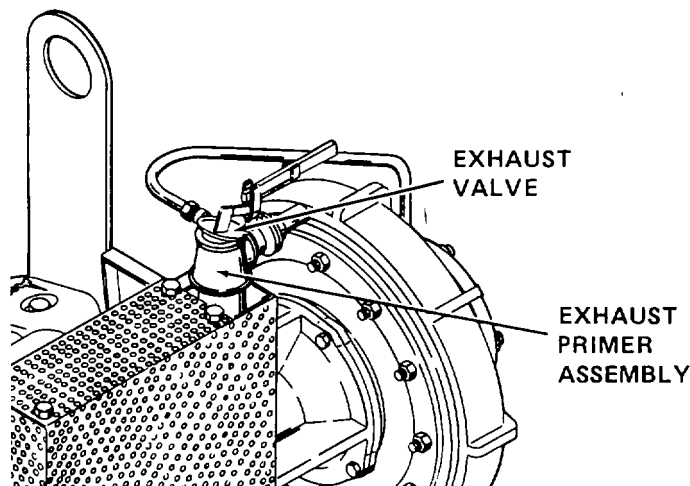
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 2. Check V-belts for breaks or damage. Check tension of belts.

Tighten or replace V-belts as necessary (para 4-26 and 4-27).

Step 3. Check exhaust system for an obstruction or damaged exhaust primer assembly.

Remove obstruction, free-up, and lubricate exhaust valve with MIL-L-2104 lubricating oil; or replace exhaust primer assembly (para 4-18).



Step 4. Notify direct support.

6. LOW ENGINE OIL PRESSURE

WARNING

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

* Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

Step 1. Shut down engine and check oil system for leaks. Check for damaged and leaking oil lines and fittings. Check inside control panel cover assembly for evidence of leakage from oil pressure switchgauge or oil pressure line hose. Check

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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lube oil cooler for leaks. Examine area of crankcase directly below shield and lube oil cooler. If leaks cannot be easily detected and it can be determined that engine can be run without damage, clean the engine as described below. After engine is clean, start the engine and observe lubrication system for leaks. If necessary, clean with compressed air as follows:

WARNING

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Tighten loose components. Replace leaking components (para 4-16, 4-31, and 4-32). If cover, front cover, or associated surfaces, other than fittings or fasteners, are leaking, notify direct support.

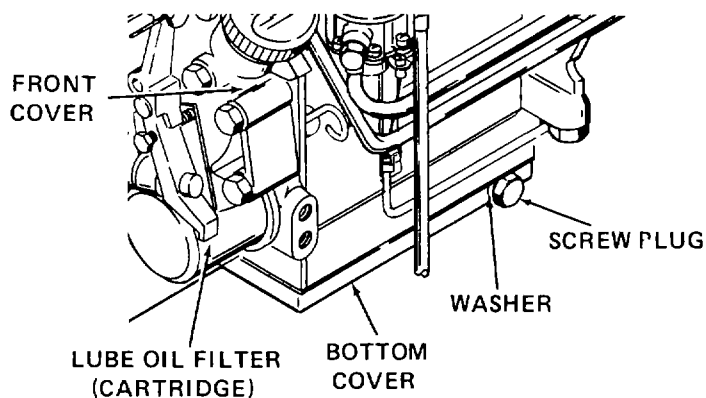
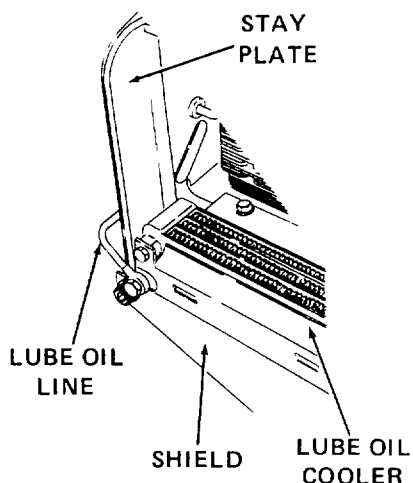
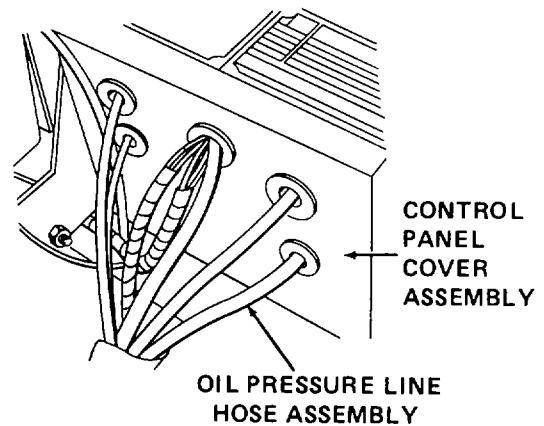
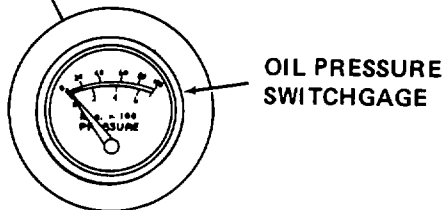
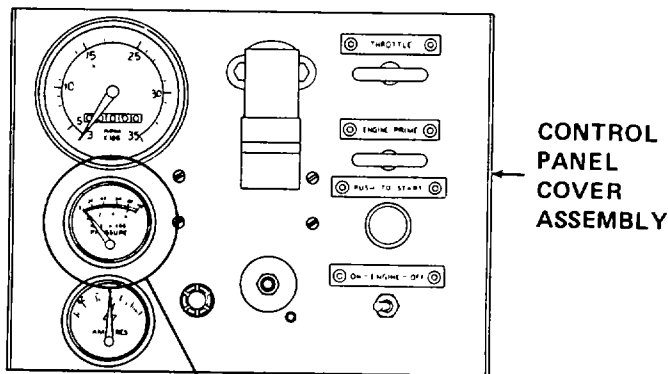
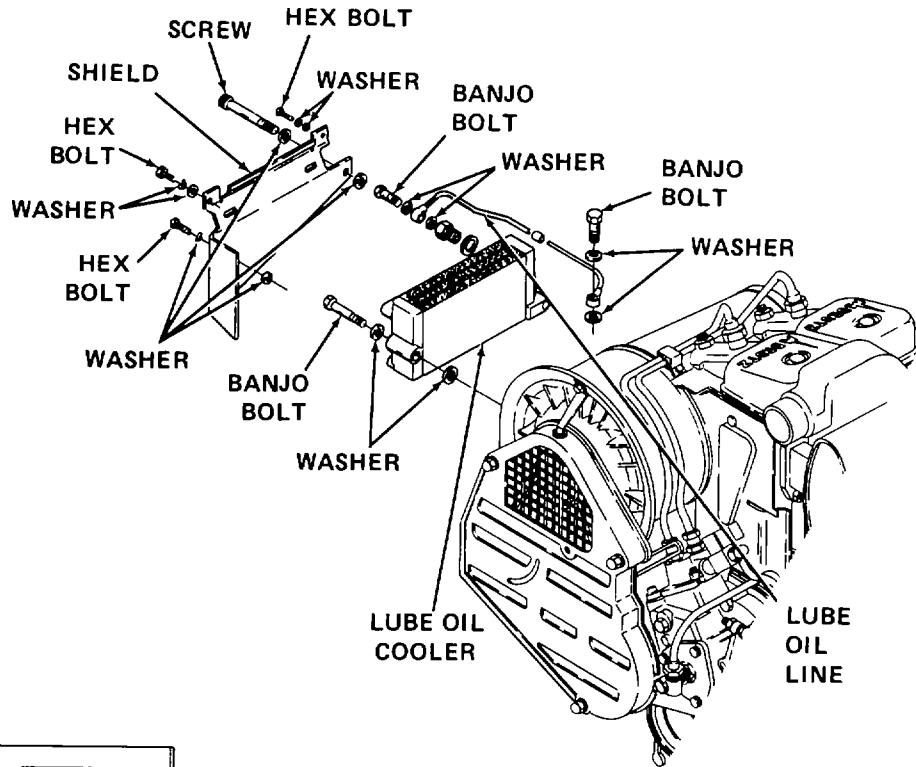


Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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NOTE: EXPLODED VIEW ONLY SHOWN TO IDENTIFY LUBE OIL SYSTEM COMPONENTS.

Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
7. CHARGING INDICATOR LAMP LIGHTS WHEN ENGINE IS RUNNING	<p>Step 1. See Malfunction 1, step 1.</p> <p>Step 2. Check V-belts for breaks or damage. Check tension of belts. Check for damaged or frozen pulleys. See table 4-1, item 1.</p>	<p>Tighten or replace V-belts as necessary (para 4-27). Replace drive shaft V-belt pulley (para 4-29). Replace alternator V-belt pulley (para 4-28). Replace cooling air blower (para 4-30).</p>
	Step 3. Check alternator.	<p>Remove and test/inspect alternator (para 4-38). Replace alternator as required.</p>
8. PUMP MAKES EXCESSIVE NOISE	Step 1. Check volute for foreign material.	<p>With engine stopped and suction hose removed, inspect pump volute for any foreign material or obstruction.</p>
		<div style="border: 2px dashed black; padding: 5px; width: fit-content; margin: 0 auto;">CAUTION</div>
		<p>Excessive pump noise can indicate that pump is running dry or is cavitating. Either of these conditions can cause serious pump damage. The centrifugal pump unit should not be run in this condition any longer than necessary to isolate trouble.</p>
	Step 2. Check that suction hose is immersed in water being pumped or properly connected to container from which water is being pumped. Water level in container shall be above suction hose connection.	<p>Relocate suction hose connection below surface of water. Keep suction intake off of bottom when pumping.</p>
	Step 3. Check suction hoses, connections, or parting surface of suction flange for leaks. Check pipe plugs are not leaking.	
	Step 4. Check that pump has been properly primed.	<p>If pump has not been properly primed, prime pump (para 2-5.f).</p>

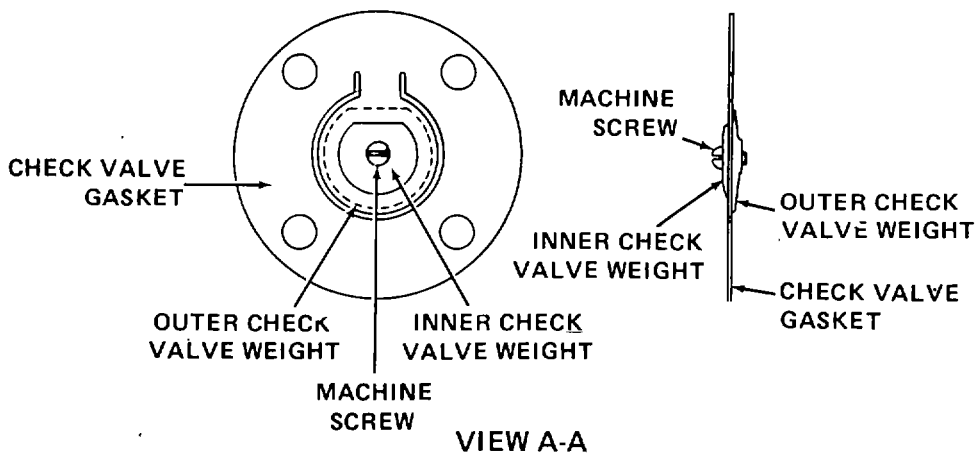
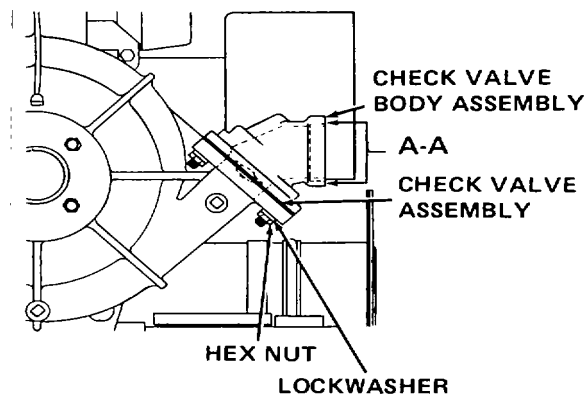
Table 4-2. Organizational Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
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Step 5. Make sure that exhaust primer assembly works properly.
 Replace defective exhaust valve primer assembly (para 4-18).

Step 6. Inspect check valve assembly for proper operation. Inspect check valve body assembly for cracks or damaged threads. Check that attaching hardware is tight and free of corrosion. Inspect check valve assembly for evidence of leakage, gasket damage, and presence of outer check valve weight. Machine screw shall be tight. All components must be free of corrosion. When in closed position, check valve gasket flapper must make an airtight seal on pump outlet. Be sure valve gasket flapper is free to open with pump flow.

Replace check valve assembly (para 4-19).



9. PUMP OUTPUT LOW

- Step 1. Check that engine speed is properly adjusted for desired flow and conditions.
 Adjust engine speed (para 2-5).
- Step 2. See Malfunction 8, steps 1 thru 6.
- Step 3. See Malfunction 8, steps 4 and 5.
- Step 4. See Malfunction 8, step 6.

Section V. MAINTENANCE PROCEDURES

INDEX

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4-11. GENERAL INSTRUCTIONS

Maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and ON-ENGINE-OFF switch turned off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix F to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in procedure. Standard torque values given in Appendix F are determined by thread size.

4-12. CENTRIFUGAL PUMP UNIT INSPECTION

Component	Acceptable	Repairable	Not Repairable
Control panel cover assembly	Clean. Tight. Mounting hardware, not stripped. Lenses tight, not cracked. Cover tight, in place. Electrical connections tight, no corrosion. Fittings tight, not stripped, no leaks.	Dirty. Loose. Replace defective component.	
Skid assembly	Clean. Components present. No corrosion. Mounting hardware tight, not stripped. No distortion. No cracks.	Dirty. Loose. Paint. Replace defective component.	
Fuel lines and fittings	Clean. Tight. No leaks. Mounting hardware tight, not stripped. Fittings tight, not stripped. Valves move freely.	Dirty. Loose. Replace.	
Cooling air blower	Clean. Tight. Belts tight, not frayed, cut, or damaged. Mounting hardware not stripped.	Dirty. Loose. Replace.	
Cylinder fins	Clean. Cooling fins straight. No leaks. Shield mounting hardware tight, not stripped.	Dirty. Loose.	
Lube oil cooler	No corrosion. Clean. Tight. Shield fasteners tight, not stripped.	Dirty. Loose.	
Electrical system assembly	Clean. Slight abrading of spiral wrap. Terminals tight. No corrosion. Tie wraps tight and tape. Replace tie wraps.	Dirty. Loose. Tape abrasions. Splice damaged individual wires	Harness severed.
Alternator	Clean. Connections tight. No corrosion. Belts tight; not frayed, cut, or damaged. No physical damage. Mounting hardware tight, not stripped.	Dirty. Loose. Replace.	
Starter	Clean. Connections tight. No corrosion. Mounting hardware tight, not stripped. No physical damage.	Dirty. Loose. Replace.	
V-belts	Tight. Not frayed, glazed, or cut. Mounting hardware tight, not stripped.	Loose. Replace.	

Component	Acceptable	Repairable	Not Repairable
Air cleaner and rain cap	Clean. Air flow not restricted. No leaks, no damage. Clamps tight. Mounting bands tight. Fasteners not stripped.	Dirty. Loose. Replace components.	
Lube oil filter (cartridge) Oil lines, fittings, and front cover	Clean. Tight. No leaks. Fittings not stripped. Clean. Tight. Fittings not stripped. No leaks.	Dirty. Loose. Replace filter cartridge. Dirty. Loose. Replace.	
Batteries, cables, battery box, and cover stripped.	Clean. No corrosion. Cable ends tight. No leaks. No physical damage. Fasteners tight, not stripped.	Dirty. Loose. Replace components.	
Fuel feed pump assembly	Clean. No leaks. Tight	Dirty. Loose.	
Fuel filter (cartridge)	Clean. Tight. No leaks. Bracket mounting hardware tight, not stripped. Fittings not stripped.	Dirty. Loose. Replace filter cartridge.	
Exhaust primer assembly	Clean. Heat discoloration. Tight Fasteners not stripped. Exhaust valve free. Cock valve free.	Dirty. Loose. Replace.	
Exhaust silencer and muffler guard	Heat discoloration. No leaks. No holes. Fasteners tight, not stripped.	Loose. Replace.	
Exhaust elbow and 1-1/2 inch nipple	Heat discoloration. No leaks. No holes. Tight. Fasteners tight, not stripped.	Loose. Replace.	
Fuel tank assembly	Clean. No sediment. No leaks. Gage works. Valve moves freely. Mounting hardware tight, not stripped.	Dirty. Loose. Drain sediment and flush. Replace gage. Replace valve. Replace tank.	
Throttle cable assembly and primary cable assembly	Clean. Moves freely through range. Mounting hardware tight.	Dirty. Loose. Replace.	
Pump and bearing housing assembly and check valve assembly	Clean. Mounting hardware tight, not stripped. Housing not cracked. No leaks at parting surfaces. Plugs tight, not stripped.	Dirty. Loose	
Crankcase, valve cover, and cylinder head	Clean. Tight. No leaks at parting surfaces. Threads not stripped.	Dirty. Loose.	

4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES

- This task covers:
- a. Removal
 - b. Inspection/Test/Repair
 - c. Installation/Replacement
-

INITIAL SETUP

Tools

- Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654
- Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

- Malfunction 1, steps 1 and 2
- Malfunction 7, step 1

General Safety Instructions

Materials/Parts

WARNING

- Batteries (2)
- Battery cable assemblies (2)
- Baking soda (Item 3, Appendix E)
- Electrolyte (Item 4, Appendix E)
- Grease (Item 6, Appendix E)

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

Location/Item	Action	Remarks
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REMOVAL

WARNING

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

- 1. Battery box cover
 - a. Remove hex nuts and lockwashers.

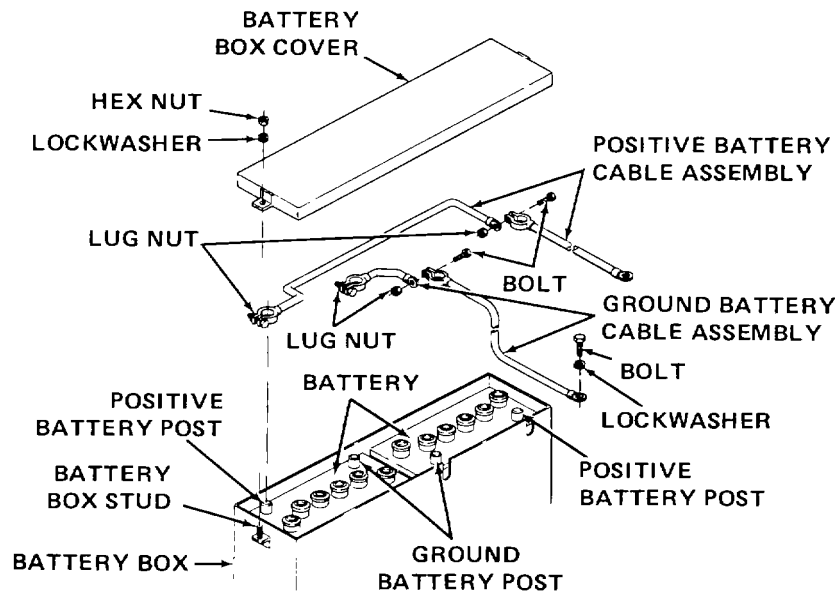
4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES (CONT)

Location/Item	Action	Remarks
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b. Lift battery box cover and remove.

Set aside, top down, to prevent damage to battery supports.

b. Lift battery box cover and remove.



WARNING

Avoid making contact across the two battery posts. This can result in severe arcing which could cause an explosion resulting in bodily injury.

CAUTION

Disconnect battery cable from ground battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

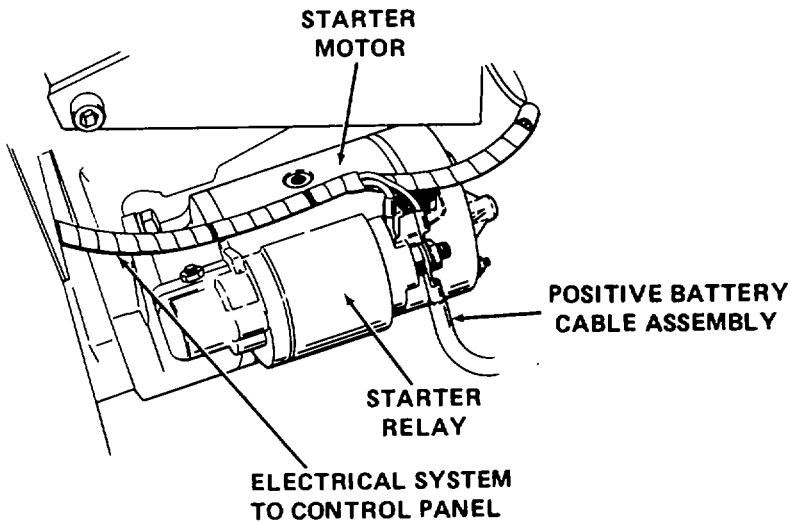
When removing battery cable, use battery terminal puller to remove loosened terminals. Forcing battery terminals off without using puller may damage the battery posts. Never disconnect battery while alternator is operating. Never attempt to polarize the alternator.

2. Ground battery cable assembly

Loosen terminal lug nuts. Remove from ground battery posts using battery terminal puller.

4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES (CONT)

Location/Item	Action	Remarks
3. Positive battery cable assembly	Loosen terminal lug nuts. Remove from positive battery posts using battery terminal puller.	
4. Batteries	Lift and remove from battery box.	
NOTE		
Remove battery cables for replacement only, not repair.		
5. Ground battery cable	Remove from engine.	Engine serves as ground.
6. Positive battery cable	Remove spiral wrap and cable from starter relay.	



4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

**INSPECTION/
TEST/ REPAIR**

WARNING

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

7. Batteries

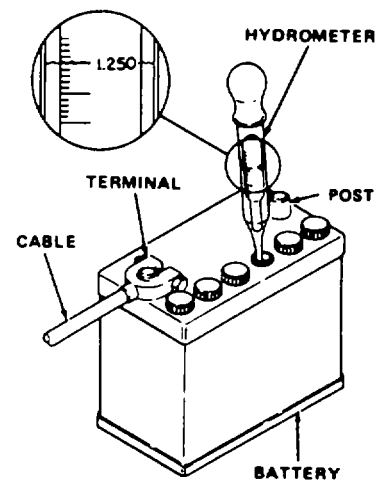
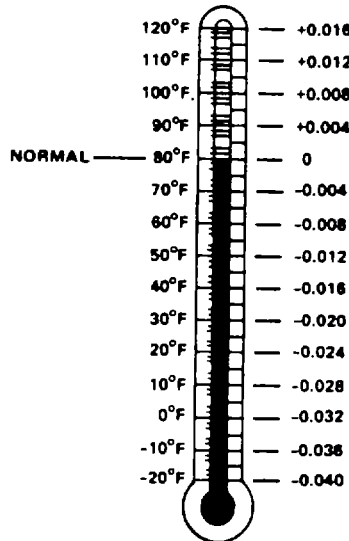
Inspect battery terminals and posts for corrosion. If corroded, clean with a solution of baking soda (Federal Specification EE-B-86) and water. Take care not to get baking soda solution in the battery cells.

Inspect battery for cracks, loose posts, leakage, and other damage.

NOTE

Do not use a tropical electrolyte which will lower the battery reserve capacity.

Using a hydrometer, check the specific gravity of the electrolyte. The specific gravity of a fully charged battery must be 1.250 minimum at 80°F (26.70C). Measure the temperature of the battery electrolyte with an accurate thermometer. Compare the electrolyte temperature and the hydrometer specific gravity reading to the battery condition chart. Add or subtract (from your specific gravity reading) the decimal next to the temperature in °F that closely approximates the obtained electrolyte temperature. If the temperature corrected reading is below 1.250, charge the battery.



4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

If battery will not hold the charge, discard and replace with new battery. Add electrolyte to new battery and charge before reinstallation.

8. Battery cable assemblies

Test cables for electrical continuity. If cables and/or connectors are stripped or broken, replace them. Do not try to repair broken cables. Clean cables and connectors.

INSTALLATION/REPLACEMENT

9. Positive battery cable

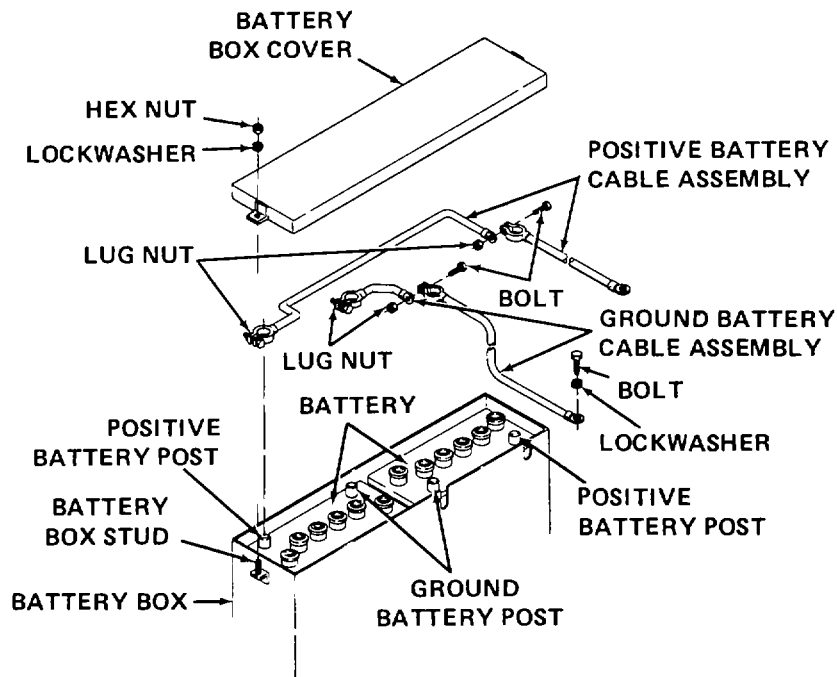
Reconnect to starter relay.

10. Ground battery cable

Reconnect to engine.

11. Batteries

Place batteries in battery box.



4-13. BATTERY CABLE ASSEMBLIES AND BATTERIES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

WARNING

Connect positive battery cables to battery first to prevent shocks and damage to other electrical system components.

12. Positive battery cable assembly

Make sure posts and terminals are clean. Reinstall positive battery cable assembly to posts on both batteries and tighten lug nuts securely. Cover terminals and posts with MIL-G-10924 grease.

13. Negative battery cable assembly

Reinstall ground battery cable assembly to ground battery posts on both batteries and tighten lug nuts securely. Cover terminals and posts with MIL-G-10924 grease.

14. Battery box cover

- a. Position grommets on positive and ground battery cables. Place cover on battery box studs.
- b. Place lockwashers and hex nuts on studs. Tighten hex nuts securely.

4-14. BATTERY BOX ASSEMBLY

This task covers: a. Removal c. Installation/Replacement
 b. Inspect/Repair

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Equipment Condition Para

4-13

Condition Description

Battery cable assemblies, batteries, and battery box cover removed.

Materials/Parts

Battery box assembly

Materials required by MIL-T-704

Electrolyte (Item 4, Appendix E)

General Safety Instructions

WARNING

References

MIL-T-704 Treatment and Painting of Materiel

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

Troubleshooting References (Table 4-2)

Malfunction 1, steps 1 and 2

Malfunction 7, step 1

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

4-14. BATTERY BOX ASSEMBLY (CONT)

Location/Item	Action	Remarks
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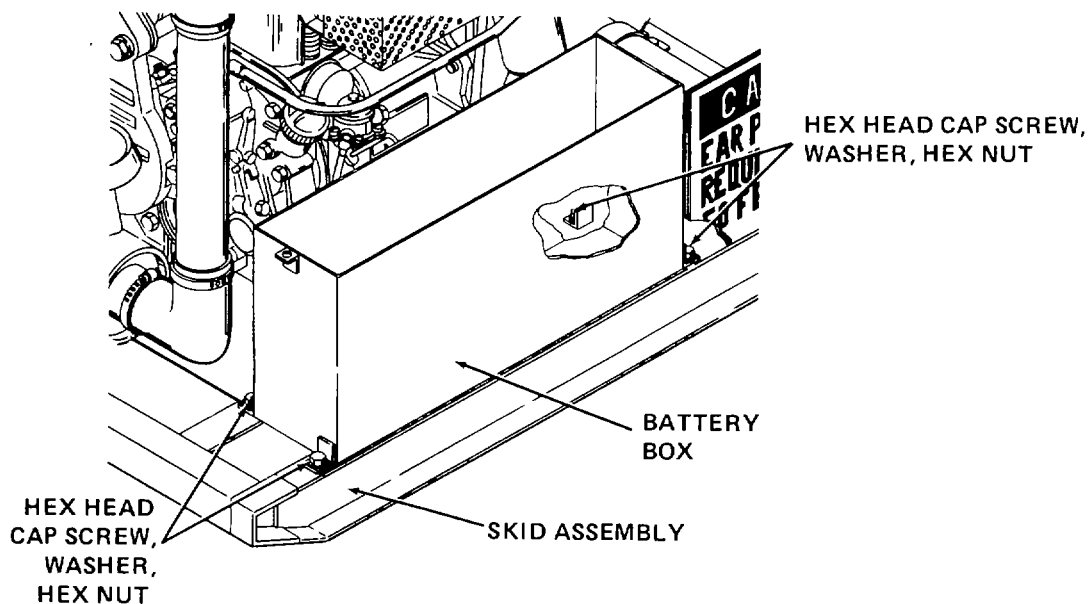
REMOVAL

WARNING

Severe burns or blindness may result if battery electrolyte comes in contact with skin or eyes. Rinse skin and eyes thoroughly with cold water if in contact with electrolyte.

Do not smoke or use open flame or spark-producing equipment in the vicinity of battery.

1. Battery box
 - a. Remove hex head cap screws, washers, and hex nuts.
 - b. Remove battery box from skid assembly.



4-14. BATTERY BOX ASSEMBLY (CONT)

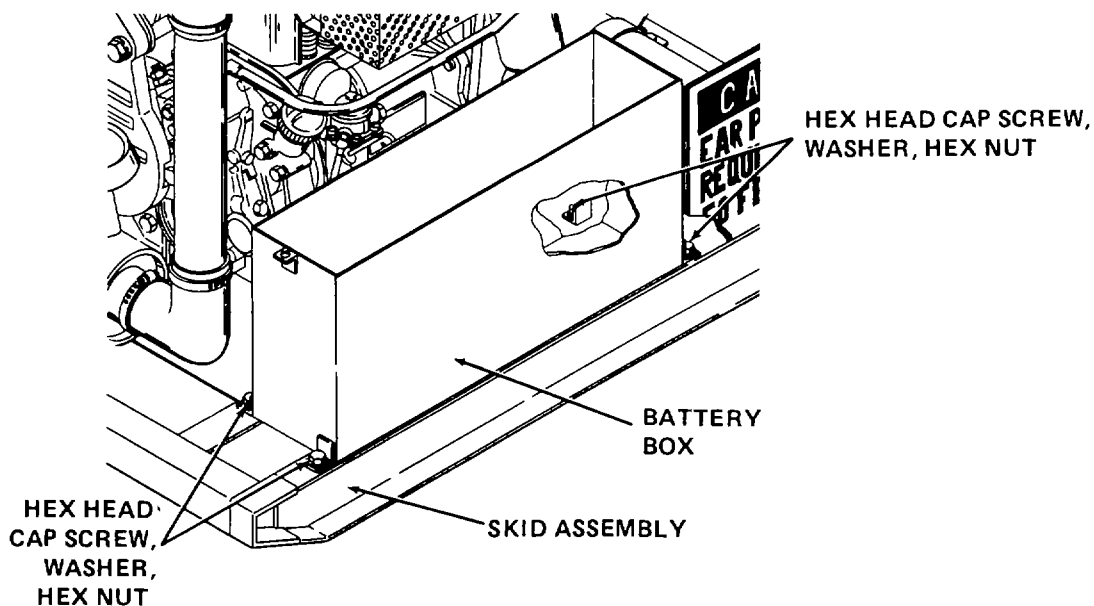
Location/Item	Action	Remarks
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INSPECT/REPAIR

- | | | |
|--------------------------------------|---|--|
| 2. Battery box and battery box cover | Inspect for minor dents, rust, acid corrosion, or other damage. Repair minor dents, rust, or corrosion in accordance with MIL-T-704. If damage is major or acid has corroded the battery box extensively, replace unit. If there are holes in box or cover, replace both. If weld stud threads are stripped, replace battery box. | |
|--------------------------------------|---|--|

**INSTALLATION/
REPLACEMENT**

- | | | |
|---|---|--|
| 3. Battery box | <ul style="list-style-type: none"> a. Position over mounting holes on skid assembly. b. Install hex head cap screws, washers, and hex nuts. Tighten securely. | |
| 4. Batteries, battery cable assemblies, and battery box cover | Install in accordance with paragraph 4-13. | |



4-15. ELECTRICAL SYSTEM ASSEMBLY

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

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Materials/Parts

Wires and cables from alternator, starter, engine shutdown valve, and thermoswitch to control panel

Insulation tape (Item 18, Appendix E)

References

Para 4-16

Control Panel Cover Assembly, Control Panel Assembly, Instruments, and Switches

Troubleshooting References (Table 4-2)

Malfunction 1, steps 1 through 5
 Malfunction 7, steps 1 and 3

Equipment Condition Para

4-13

Condition Description

Ground battery cable disconnected.

4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

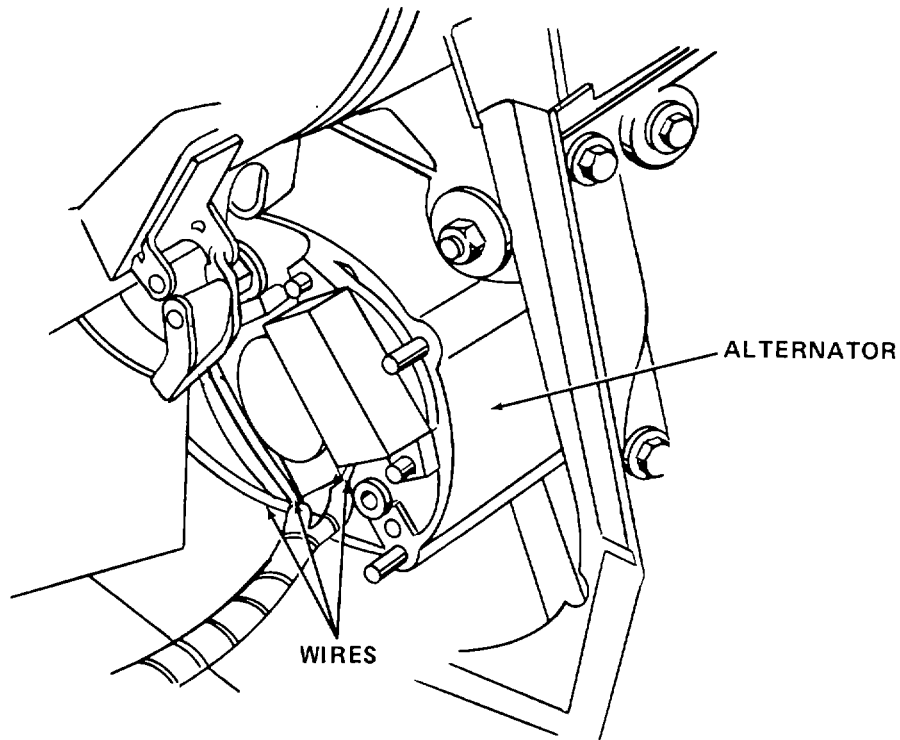
Location/Item	Action	Remarks
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REMOVAL

CAUTION

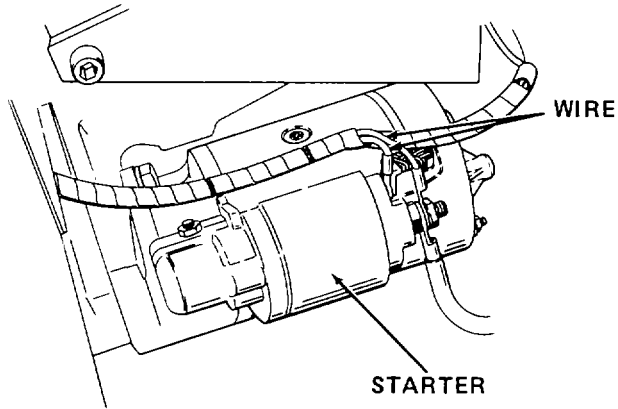
Disconnect ground battery cable before attempting repairs on electrical system.

1. Wires Tag and remove from alternator.

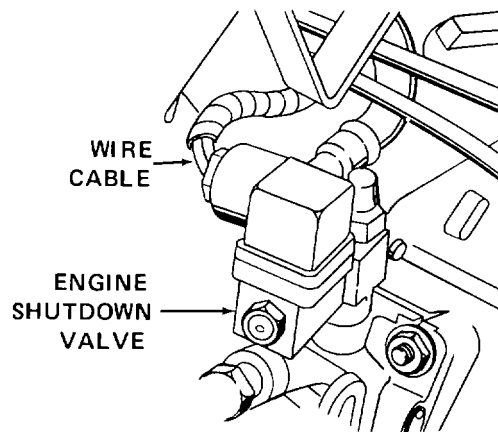


4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Wires	Tag and remove from starter.	



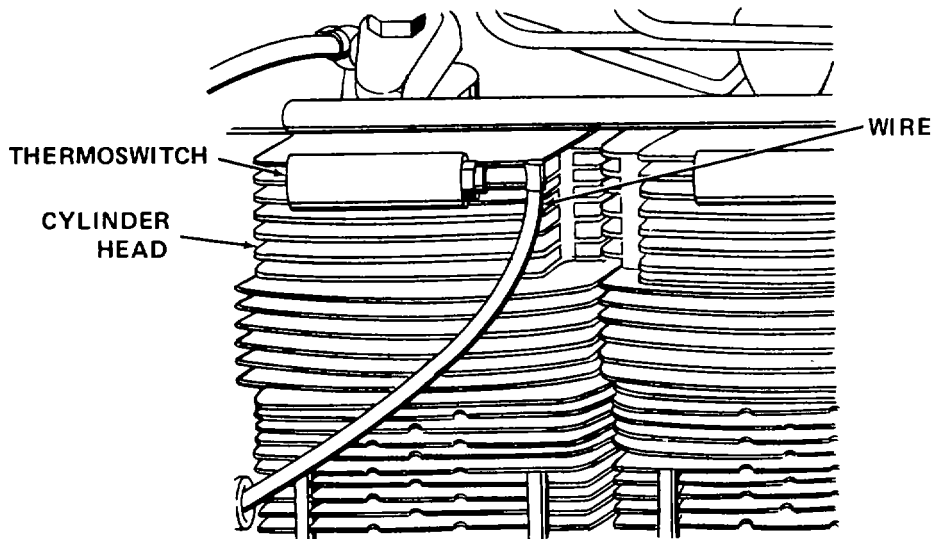
3. Wire cable	Tag and remove from engine shutdown valve.	
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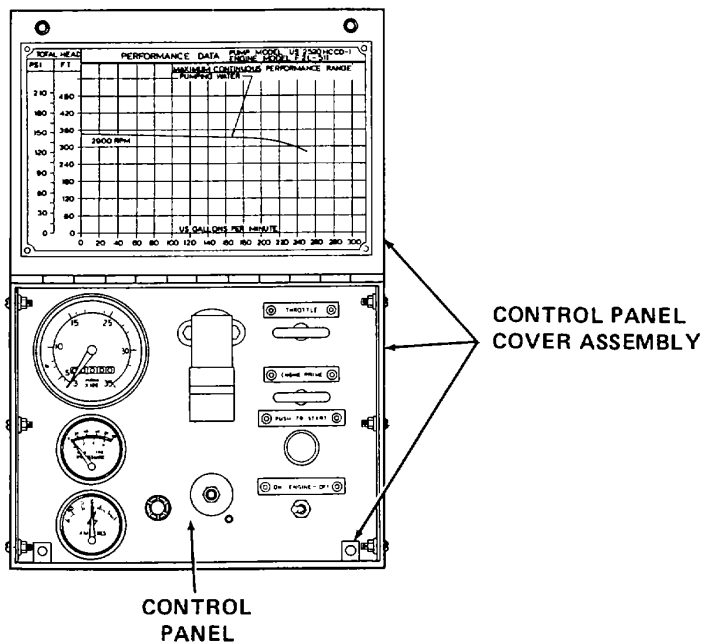
4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---------|--|--|
| 4. Wire | Tag and remove from thermoswitch on cylinder head. | |
|---------|--|--|

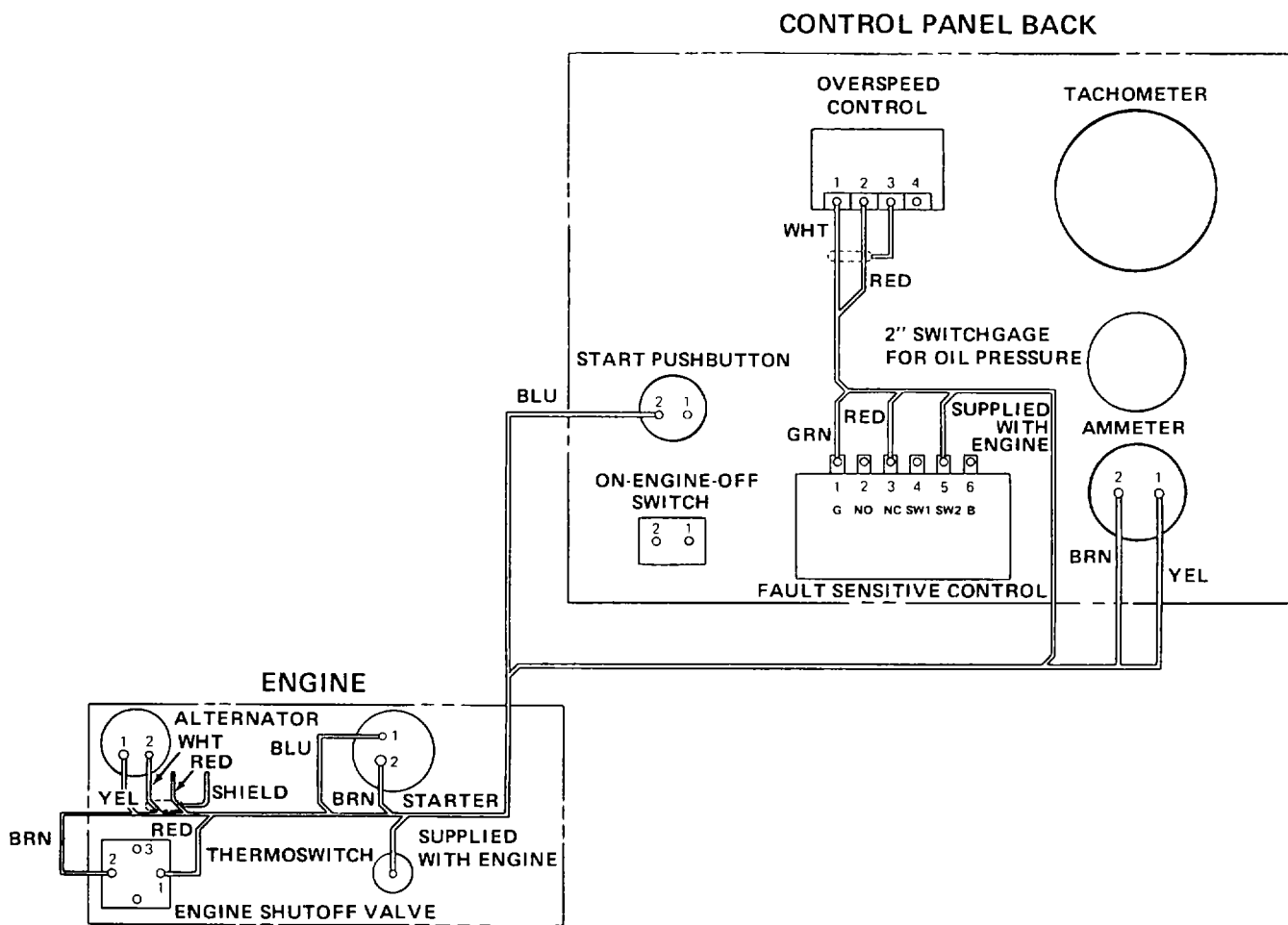


- | | | |
|---------------------------------|-----------------------|--------------------------------------|
| 5. Control panel cover assembly | Remove control panel. | See para 4-16 for removal procedure. |
|---------------------------------|-----------------------|--------------------------------------|



4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

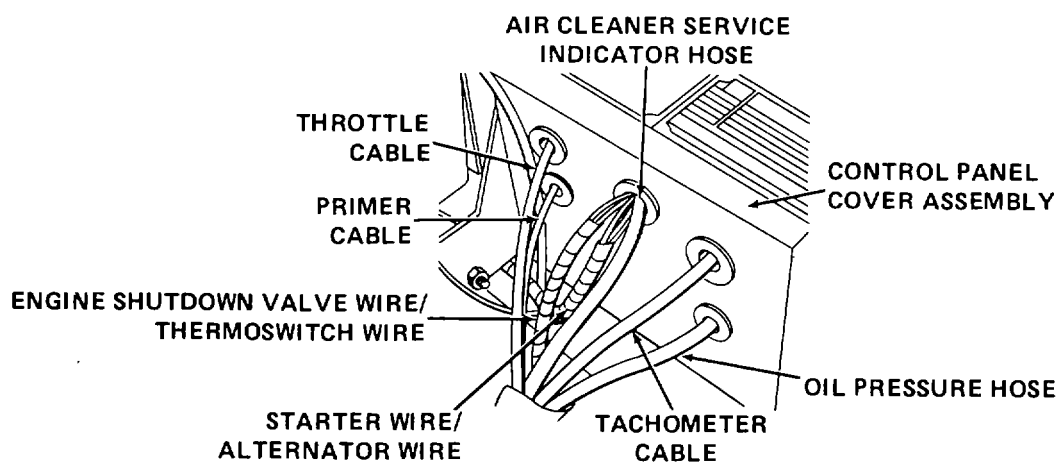
Location/Item	Action	Remarks
6. Electrical system assembly	Tag and disconnect from back of control panel.	



4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
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7. Wires	Remove from control panel cover assembly.	
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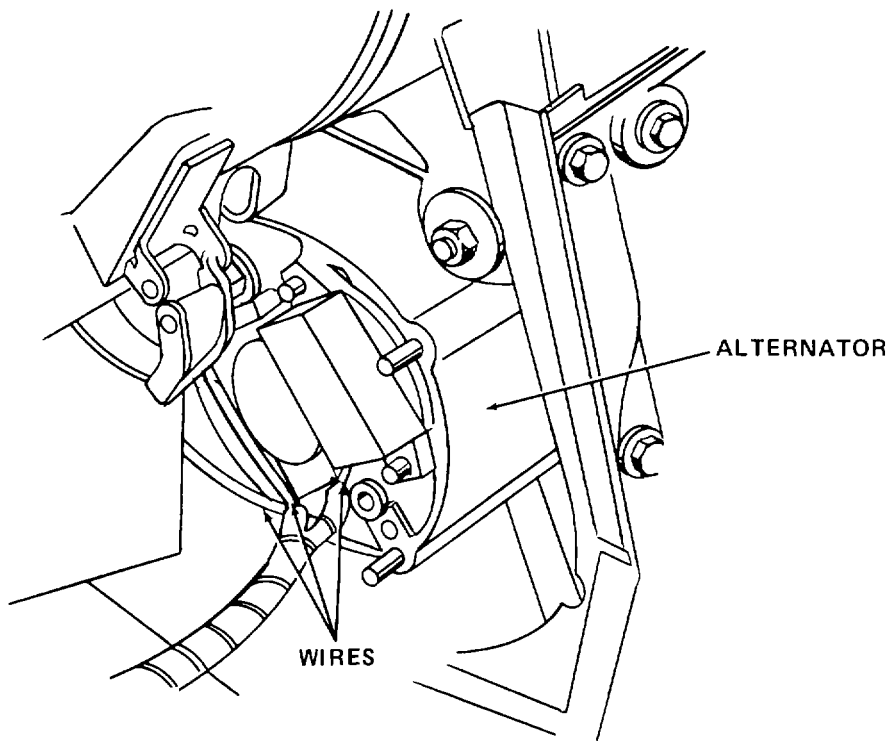


**TESTING/
INSPECTION**

8. Wires and cables	Test and inspect for continuity, broken, burned, damaged, or frayed wiring. Check for loose or damaged connectors on wires and cables.	
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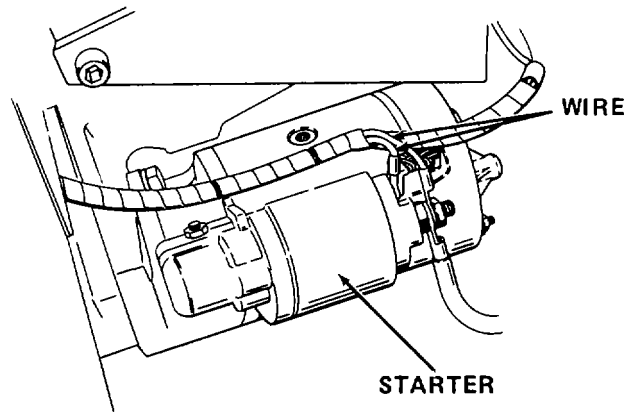
4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
INSTALLATION/ REPLACEMENT		
9. Wires, cables, and connectors	Replace if broken or damaged.	
10. Wires	Connect to alternator.	If wires could not be removed but are damaged, replace associated component and wiring.

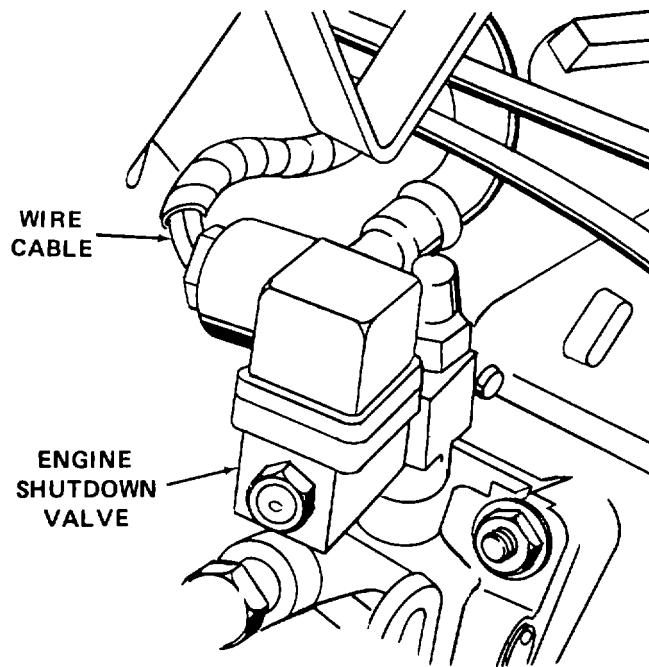


4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
11. Wires	Connect to starter.	



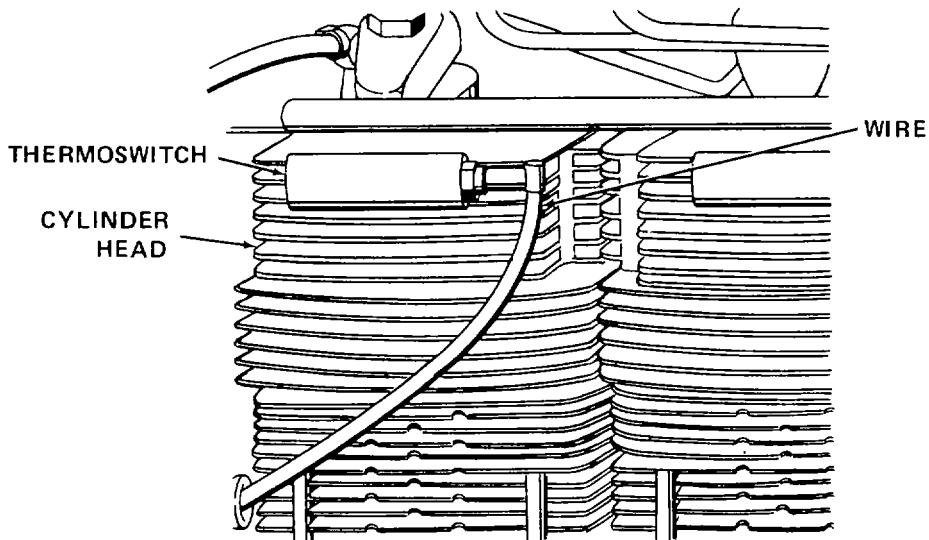
12. Wire cable	Connect to engine shutdown valve.	
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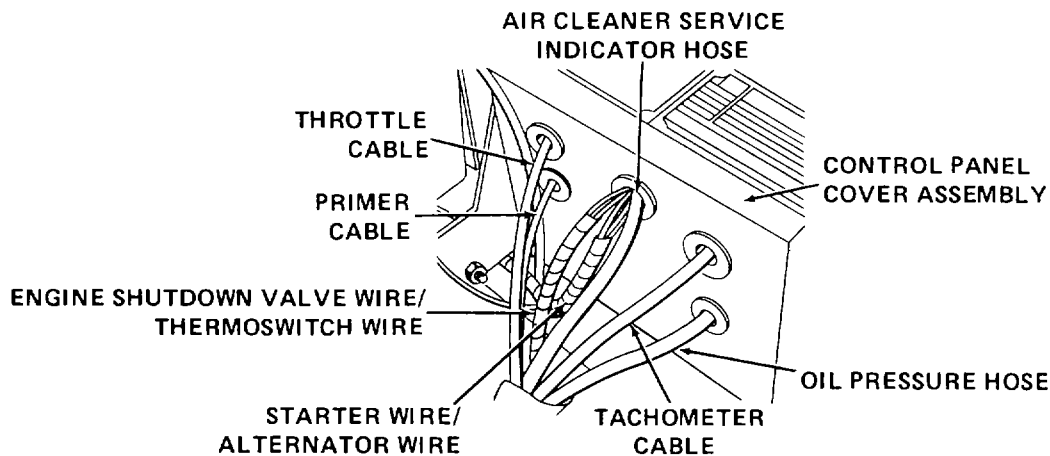
4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
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13. Wire	Connect to thermoswitch on cylinder head.	
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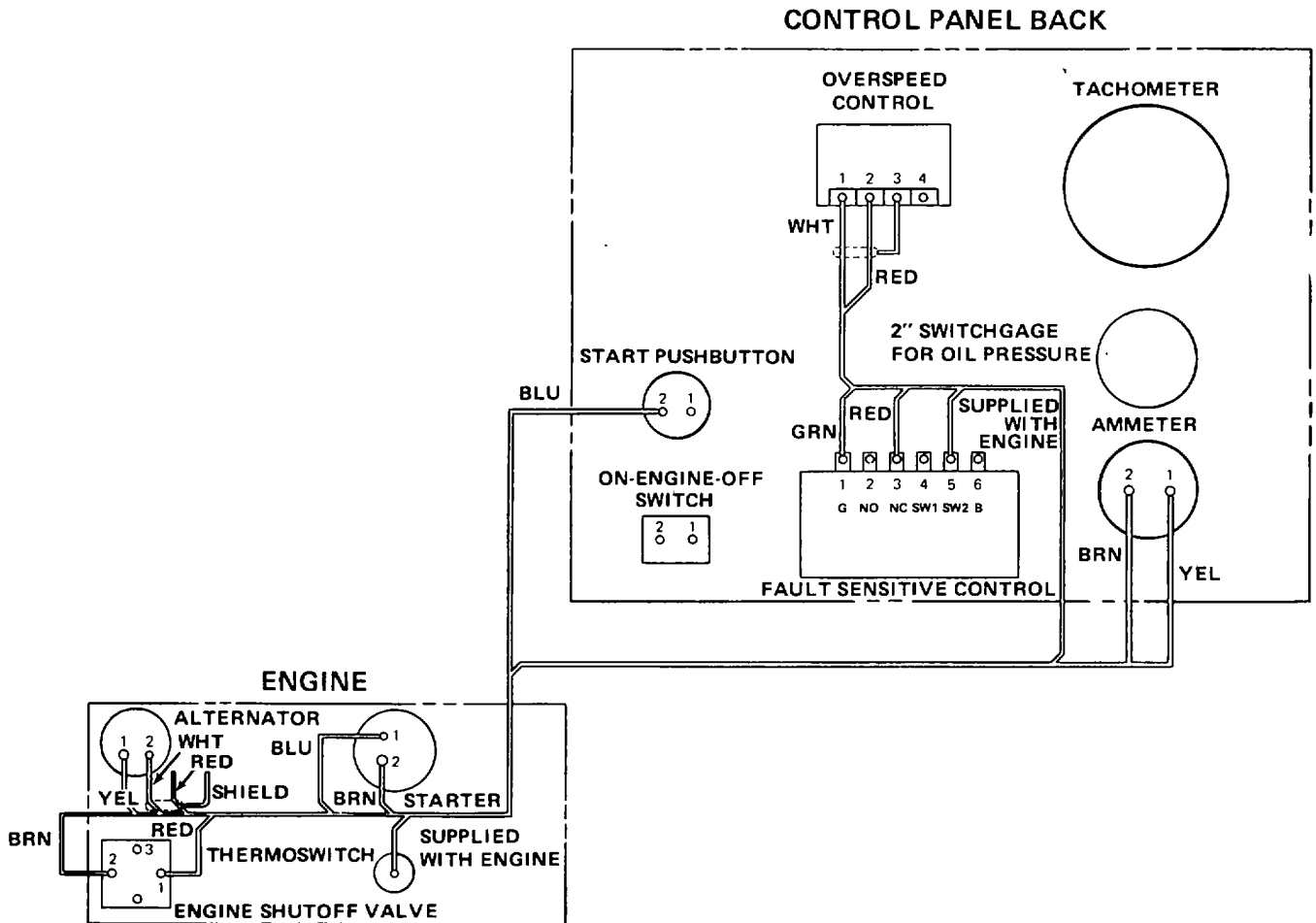


14. Wires	Insert through center grommet hole in back of control panel cover assembly.	
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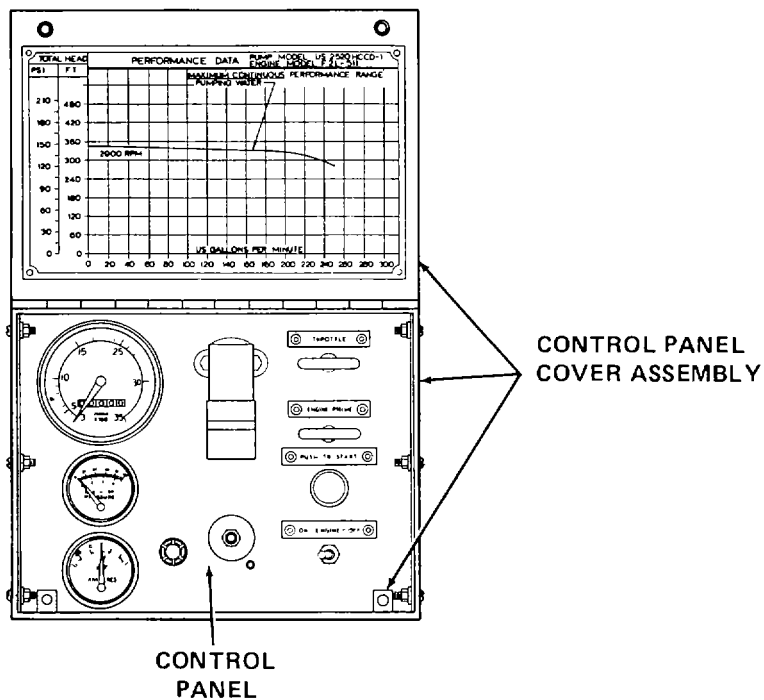
4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
15. Electrical system wires	Connect to components located on back of control panel.	



4-15. ELECTRICAL SYSTEM ASSEMBLY (CONT)

Location/Item	Action	Remarks
16. Control panel	Install in control panel cover assembly.	See para 4-16 for installation procedure.



4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES

This task covers: a. Removal c. Repair
 b. Testing/Inspection d. Installation/Replacement

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Para 4-38 Alternator

MIL-T-704 Treatment and Painting of Materiel

Troubleshooting References (Table 4-2)

Malfunction 1, step 2

Malfunction 2, steps 1 through 3

Malfunction 3, step 1

Malfunction 6, step 1

Malfunction 7, step 1

Materials/Parts

Materials required by MIL-T-704

References

Para 4-15 Electrical System

Para 4-17 Wiring Harness

Para 4-21 Air Cleaner, Air Intake Tubes, Elbows, and Rain Cap

Para 4-35 Engine Shutdown Valve

Para 4-37 Starter Motor

Equipment Condition

Para

Condition Description

4-13

Engine shut down and cool.

Ground battery cable disconnected.

4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
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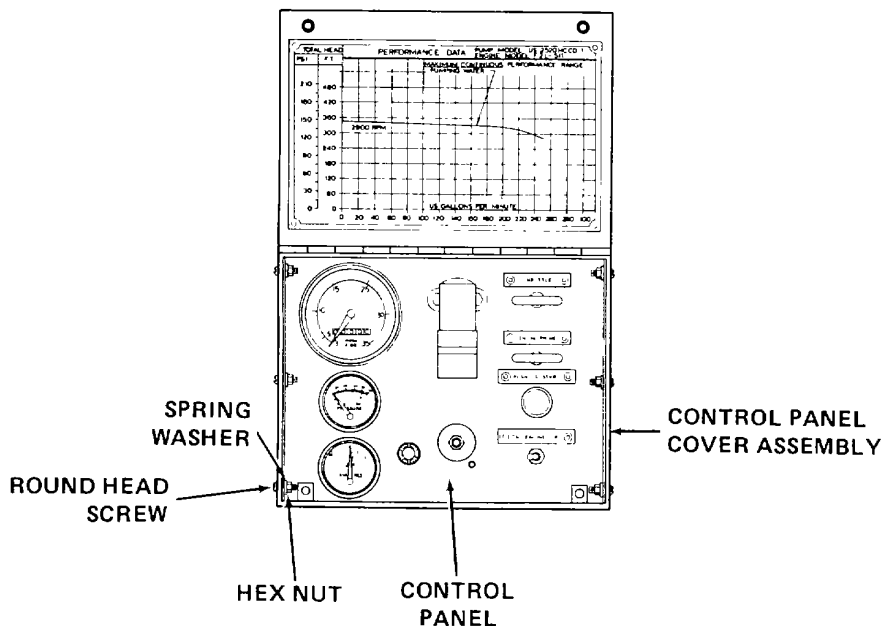
REMOVAL

CAUTION

Control panel assembly must be removed carefully in order not to damage cables or instruments.

For ease of reassembly, all wires and mounting hardware should be tagged when removed.

- | | | |
|------------------|---|---|
| 1. Control panel | <ul style="list-style-type: none"> a. Remove round head screws, spring washers, and hex nuts. b. Carefully slide out from control panel cover assembly. | Allow sufficient slack in cables, hoses, and wiring during control panel removal. |
|------------------|---|---|

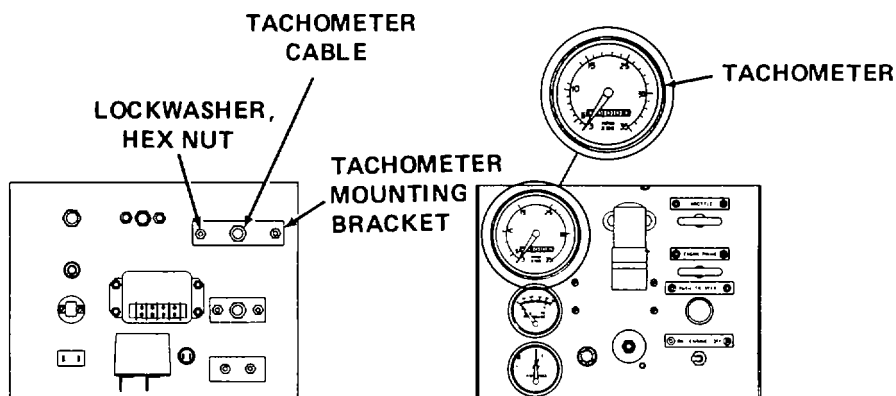


- | | | |
|--------------------------------|--|--|
| 2. Tachometer cable | Tag, disconnect, and remove from back of tachometer. | |
| 3. Tachometer mounting bracket | <ul style="list-style-type: none"> a. Remove hex nuts and lockwashers from back of tachometer mounting bracket. b. Remove tachometer mounting bracket. | |

4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
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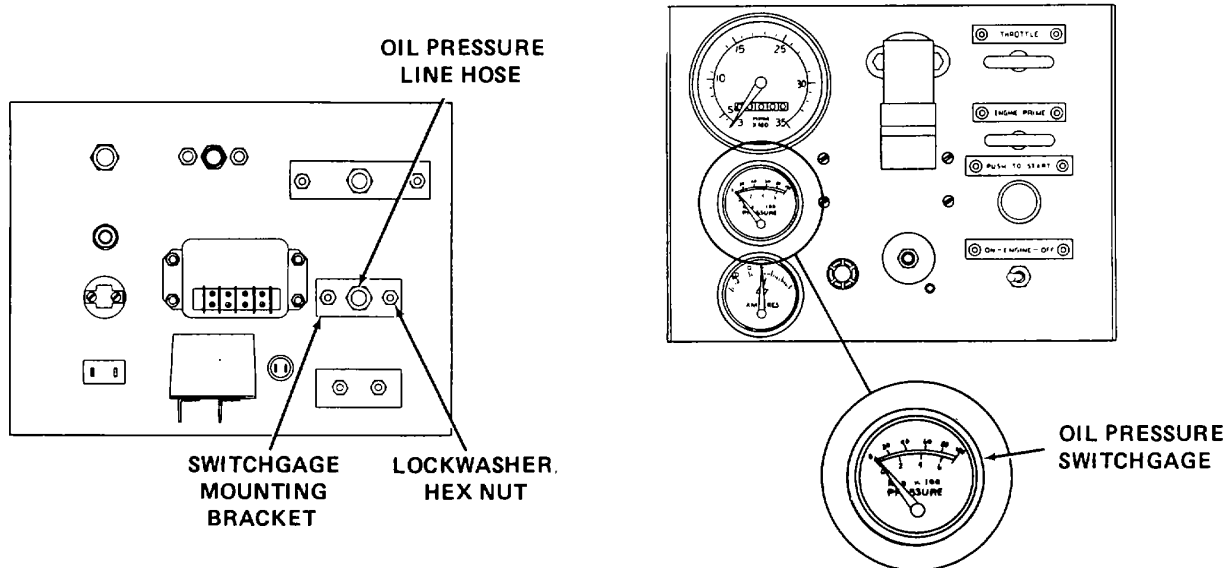
- | | | |
|---------------|---|--|
| 4. Tachometer | Carefully slide out through front of control panel. | |
|---------------|---|--|



- | | | |
|---------------------------|--|--|
| 5. Oil pressure line hose | Disconnect, plug, and tag. Remove from back of oil pressure switchgauge. | |
|---------------------------|--|--|

- | | | |
|--|---|--|
| 6. Oil pressure switchgauge mounting bracketing bracket. | a. Remove hex nuts and lockwashers from switchgauge mounting bracket.
b. Remove oil pressure switchgauge mounting bracket. | |
|--|---|--|

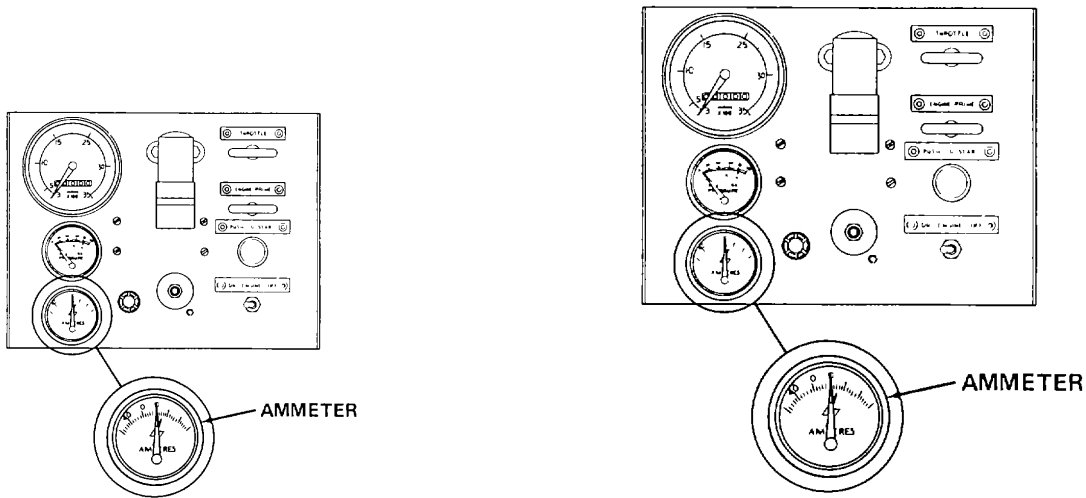
- | | | |
|-----------------------------|---|--|
| 7. Oil pressure switchgauge | Carefully slide out through front of control panel. | |
|-----------------------------|---|--|



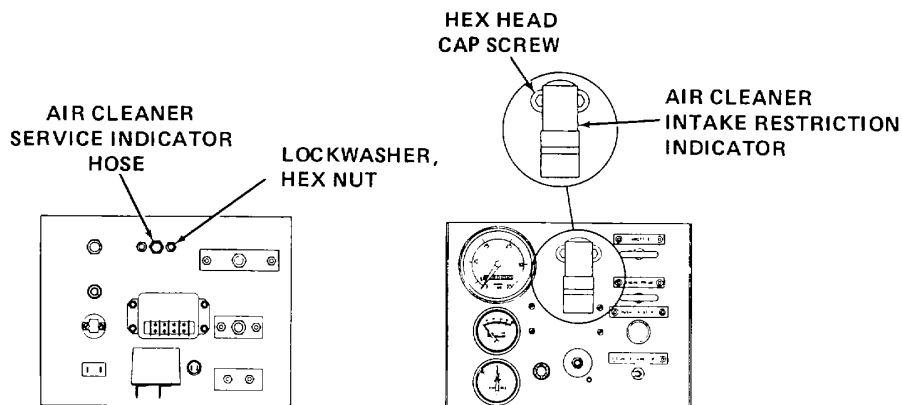
4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|------------|--|--|
| 8. Ammeter | <ol style="list-style-type: none"> a. Tag and remove wires from ammeter. b. Remove hex nuts and lockwashers from ammeter mounting bracket. c. Remove mounting bracket. d. Carefully remove ammeter through front of control panel. | |
|------------|--|--|



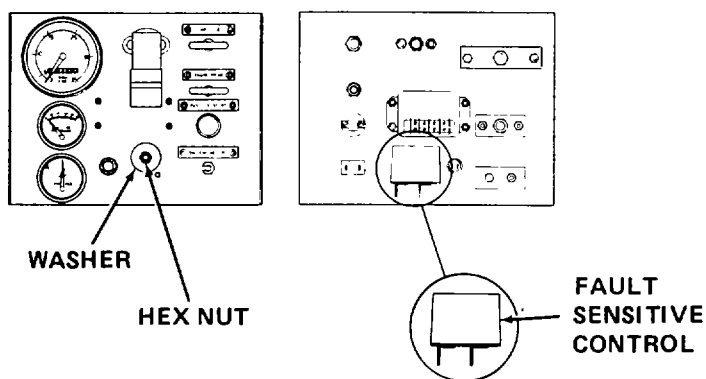
- | | | |
|--|--|--|
| 9. Air cleaner service indicator hose | Loosen clamp and remove air cleaner service indicator hose from restriction indicator. | |
| 10. Air cleaner intake restriction indicator | <ol style="list-style-type: none"> a. Remove hex nuts and lockwashers. b. Remove restriction indicator from control panel. | |



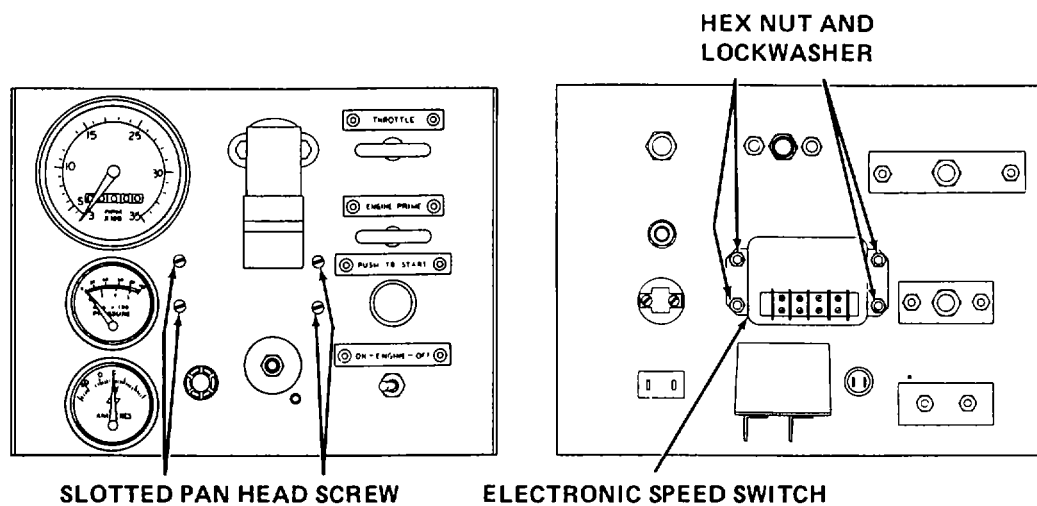
4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------------------|---|--|
| 11. Fault sensitive control | <ol style="list-style-type: none"> Remove wires from fault sensitive control. Remove hex nut and washer from fault sensitive control. Remove fault sensitive control from back of control panel. | |
|-----------------------------|---|--|

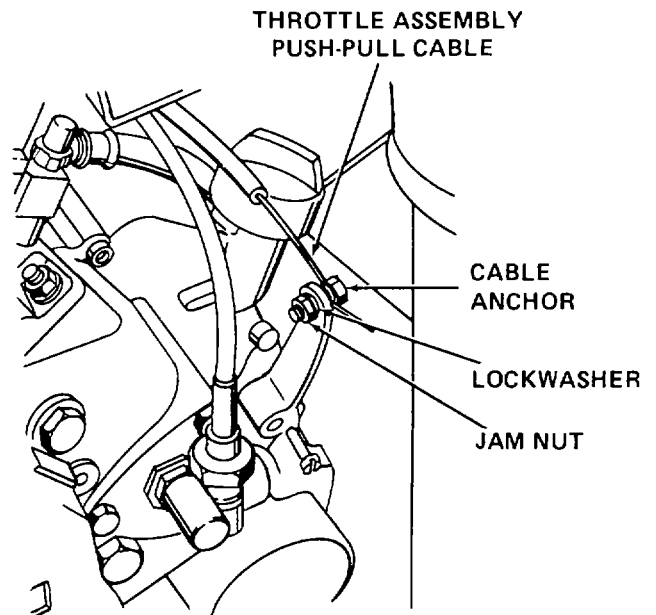
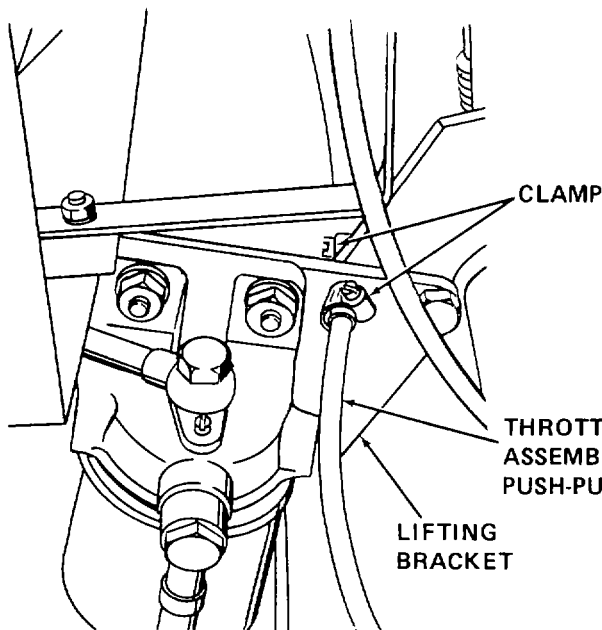


- | | | |
|-----------------------------|--|--|
| 12. Electronic speed switch | <ol style="list-style-type: none"> Tag and remove wires from electronic speed switch. Remove slotted pan head screw, lockwasher, and hex nut from electronic speed switch. Remove electronic speed switch from back of control panel. | |
|-----------------------------|--|--|



4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS. AND SWITCHES (CONT)

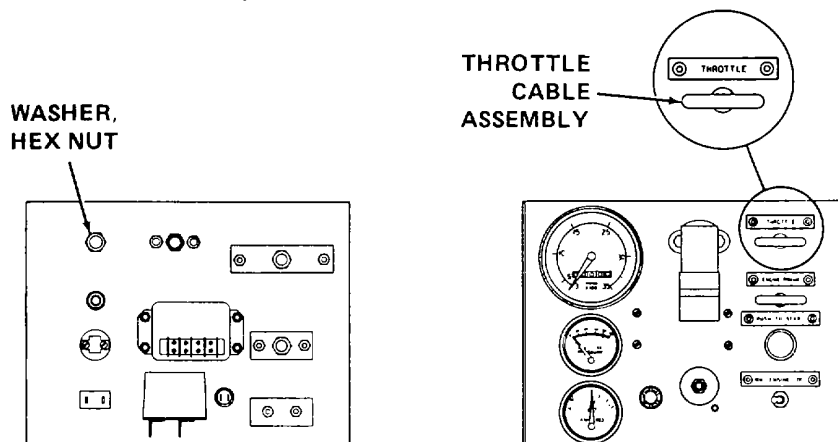
Location/Item	Action	Remarks
13. Throttle cable assembly push-pull cable	a. Remove clamps from throttle assembly push-pull cable. b. Loosen jam nut and lockwasher on cable anchor. c. Remove cable assembly from cable anchor. d. Pull cable assembly through hole in lifting bracket.	



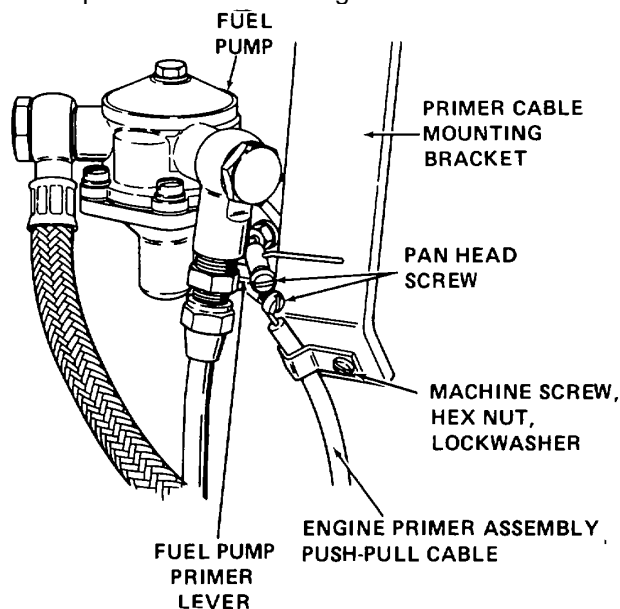
4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS. AND SWITCHES (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------------------|---|--|
| 14. Throttle cable assembly | <ol style="list-style-type: none"> a. Remove hex nut from throttle cable assembly. b. Remove throttle cable assembly from front of control panel. | |
|-----------------------------|---|--|



- | | | |
|--|--|--|
| 15. Engine primer assembly push-pull cable | <ol style="list-style-type: none"> a. Loosen hex nut and lockwasher on machine screw. b. Loosen slotted pan head screw and remove cable anchors from fuel pump primer lever. c. Remove engine primer assembly push-pull cable from primer cable mounting bracket. | |
|--|--|--|

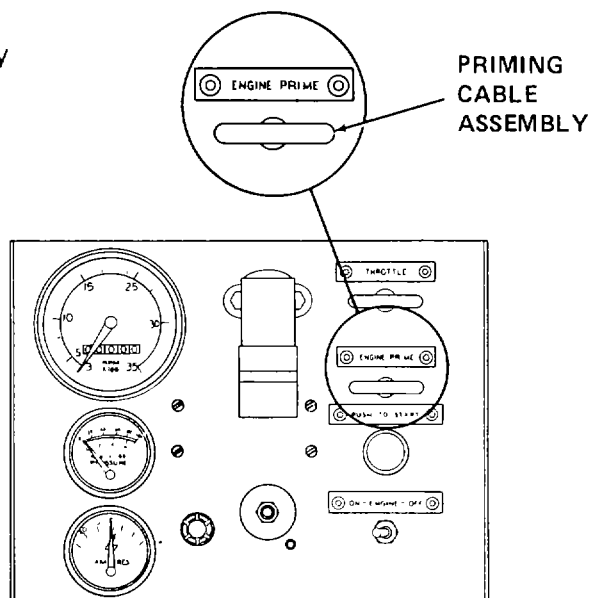
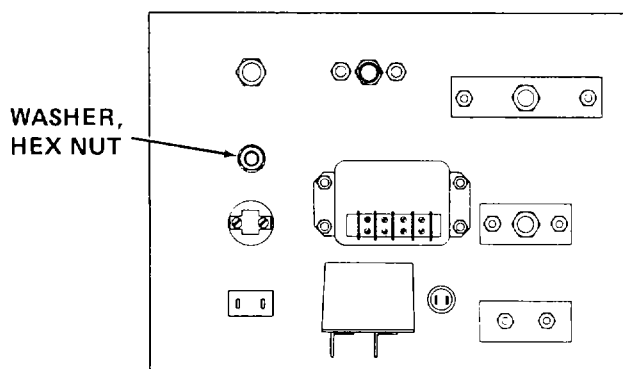


4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS. AND SWITCHES (CONT)

Location/Item	Action	Remarks
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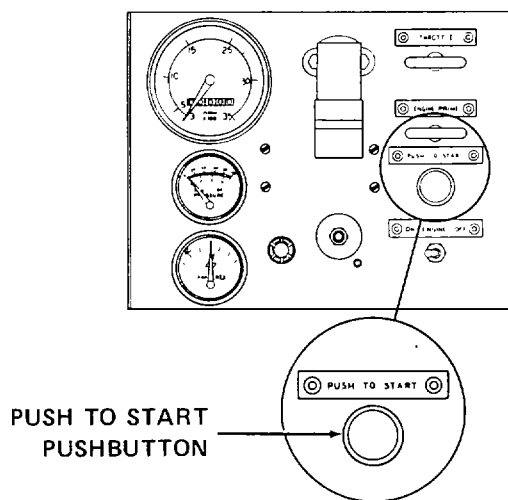
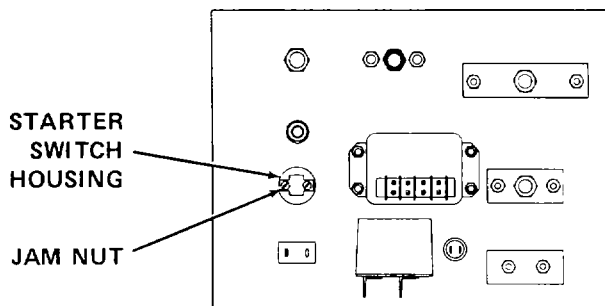
16. Priming cable assembly

- a. Loosen hex nut on back of control panel on priming cable assembly.
- b. Remove priming cable assembly from front of control panel.



17. Starter switch housing

- a. Tag and remove PUSH TO START push-button wires.
- b. Loosen jam nut from back of control panel and unscrew rubber protective boot from front of control panel.

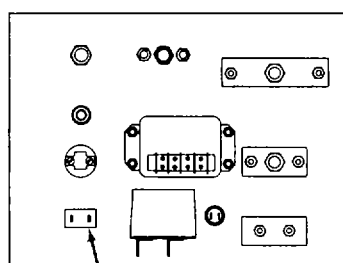


4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES
(CONTI)

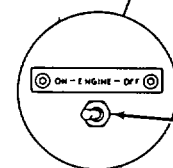
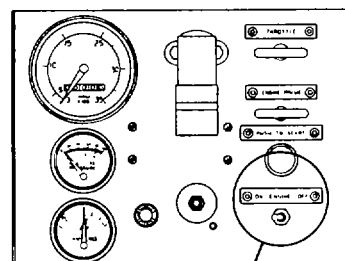
Location/Item	Action	Remarks
---------------	--------	---------

18. ON-ENGINE-OFF switch

- a. Tag wires and remove.
- b. Remove hex nut with rubber boot from front of control panel.
- c. Remove switch from rear of control panel.



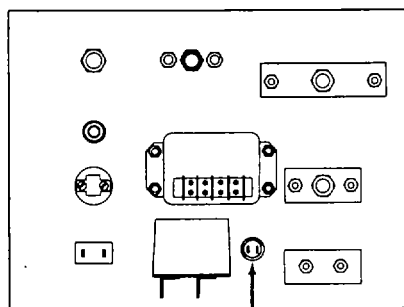
ON-ENGINE-OFF SWITCH



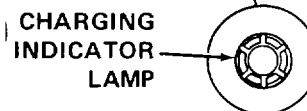
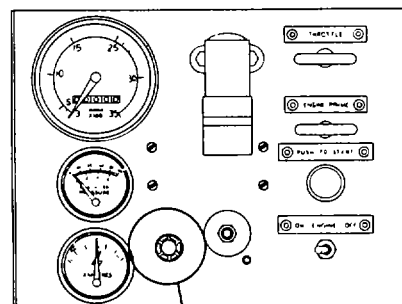
HEX NUT WITH RUBBER BOOT

19. Charging indicator lamp

- a. Tag and remove wires.
- b. Remove charging indicator lamp through front of control panel.



SLEEVE



CHARGING INDICATOR LAMP

20. Control panel cover assembly

- a. Remove hex head cap screws, washers, and hex nuts.
- b. Remove control panel cover assembly.

Support control panel cover assembly during removal.

**4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES
(CONT)**

Location/Item	Action	Remarks
---------------	--------	---------

TESTING/INSPECTION

- | | | |
|---|---|--|
| 21. Tachometer, oil pressure switchgauge, and ammeter | If damaged or defective, do not attempt repair; replace components. | |
| 22. Air cleaner intake restriction indicator, fault sensitive control, electronic speed switch, START push-button, ON-ENGINE-OFF switch, or charging indicator lamp | If damaged or defective, do not attempt repair; replace components. | |
| 23. Push-pull throttle or primer cable assemblies | If damaged or defective, do not attempt repair; replace components. | |

REPAIR

- | | | |
|--|---|--|
| 24. Push-pull throttle or primer cable assemblies | Make minor adjustments to cables or handle position if necessary. | |
| 25. Control panel and control panel cover assembly | Repair minor dents, rust, or corrosion, and refinish in accordance with MIL-T-704 if necessary. If severely damaged, dented, rusted, or corroded, replace. Replace identification and performance data plates as necessary. | |

INSTALLATION/REPLACEMENT

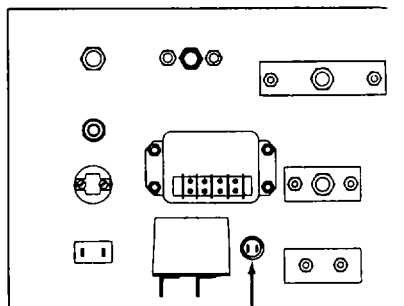
- | | | |
|--|--|--|
| 26. Control panel cover including mounting bracket | Remount on engine with hex head cap screws, washers, and hex nuts. | |
|--|--|--|

4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

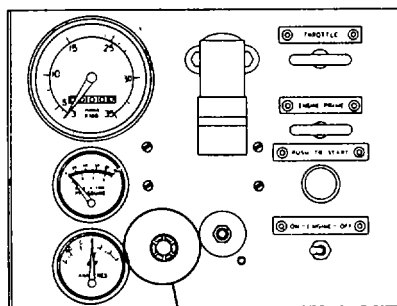
Location/Item	Action	Remarks
---------------	--------	---------

27. Control panel	Position control panel on control panel cover.	
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28. Charging indicator lamp	Reinstall on control panel and attach tagged wires.	
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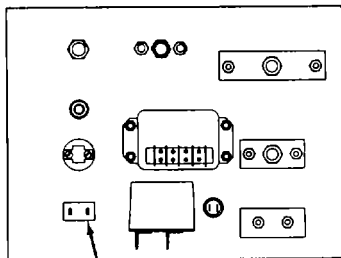


SOCKET

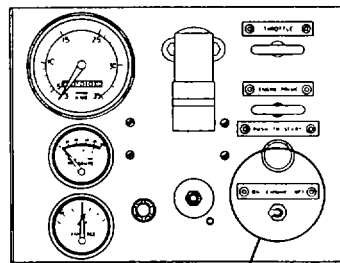


CHARGING INDICATOR LAMP

29. ON-ENGINE-OFF switch	Reinstall and attach wires.	
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ON-ENGINE-OFF SWITCH

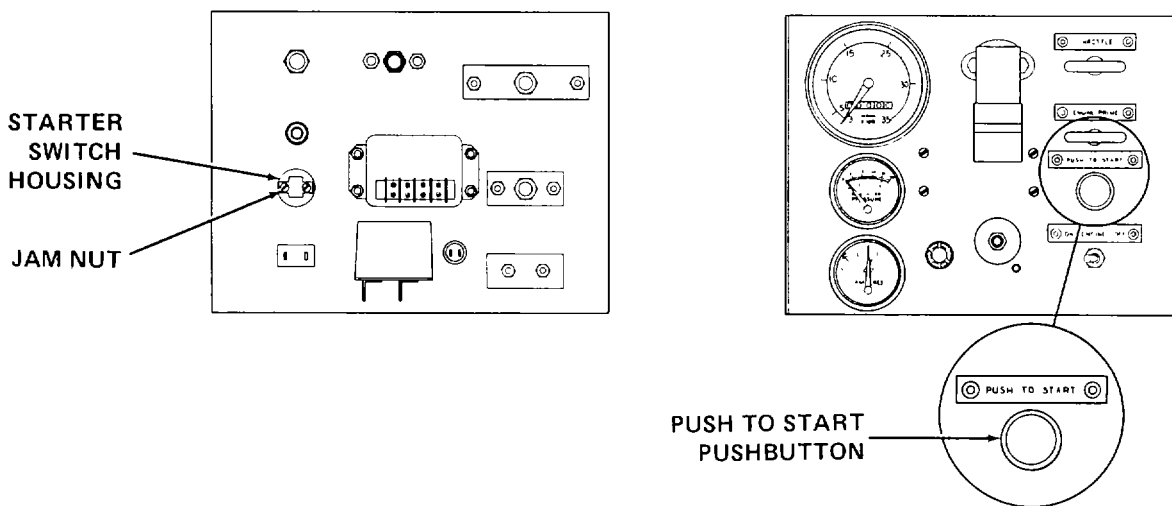


HEX NUT

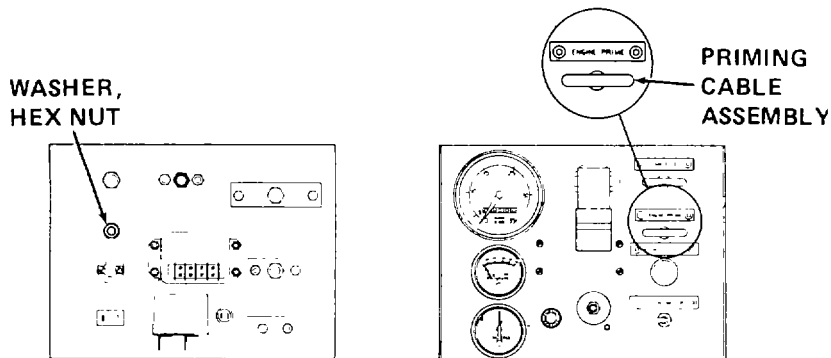
4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
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30. PUSH TO START push-button	Reinstall and attach wires.	
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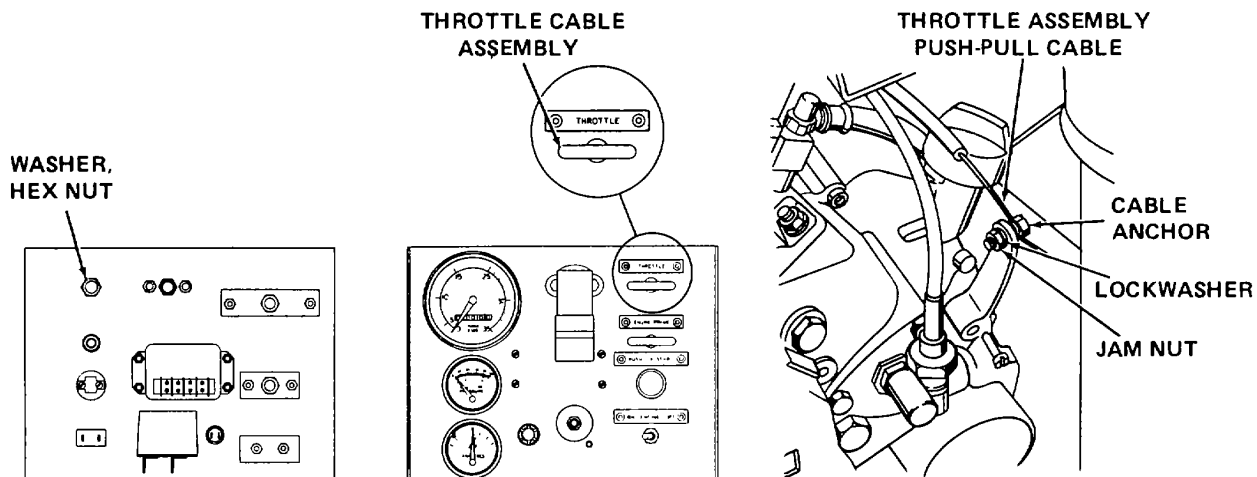


31. Priming cable assembly	Reinstall on control panel. Reinstall engine primer assembly push-pull cable on primer cable mounting bracket.	
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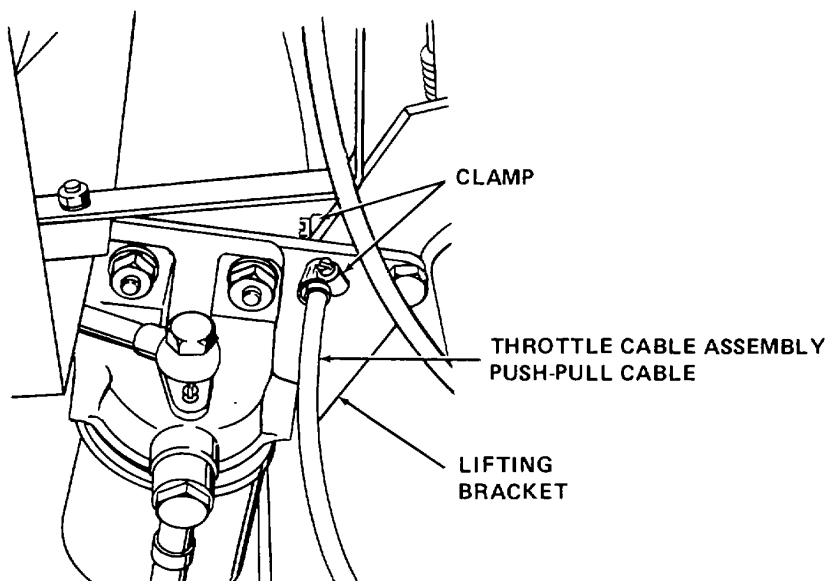


4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
32. Throttle cable assembly	Reinstall on control panel. Attach cable to cable anchor.	



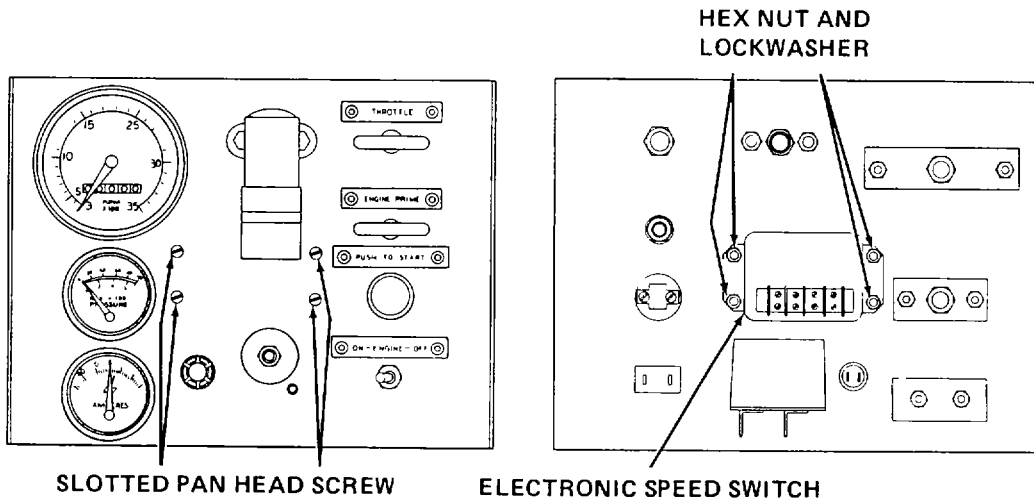
33. Throttle cable assembly push-pull cable	Reinstall clamps.	
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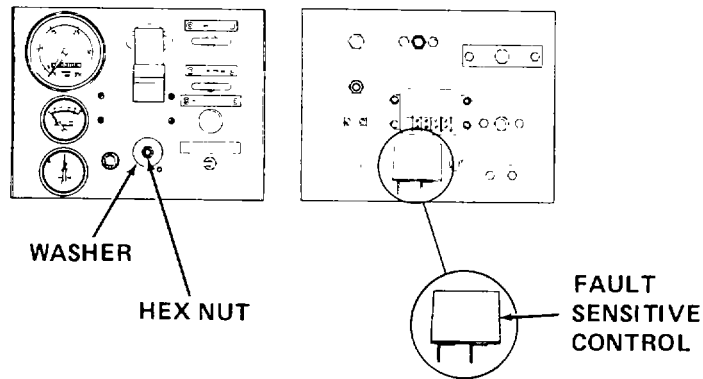
**4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS AND SWITCHES
(CONT)**

Location/Item	Action	Remarks
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34. Electronic speed switch	Reinstall and attach tagged wires.	
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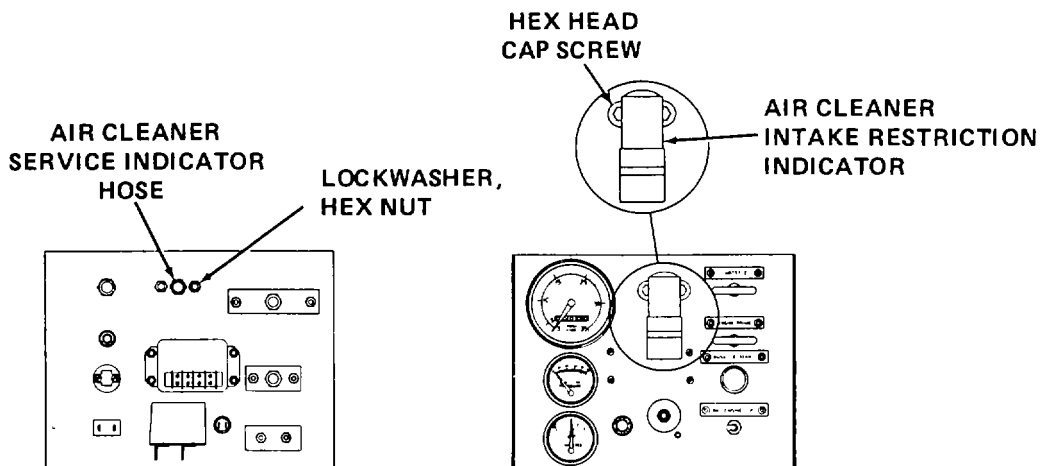
35. Fault sensitive control	Reinstall and attach tagged wires.	
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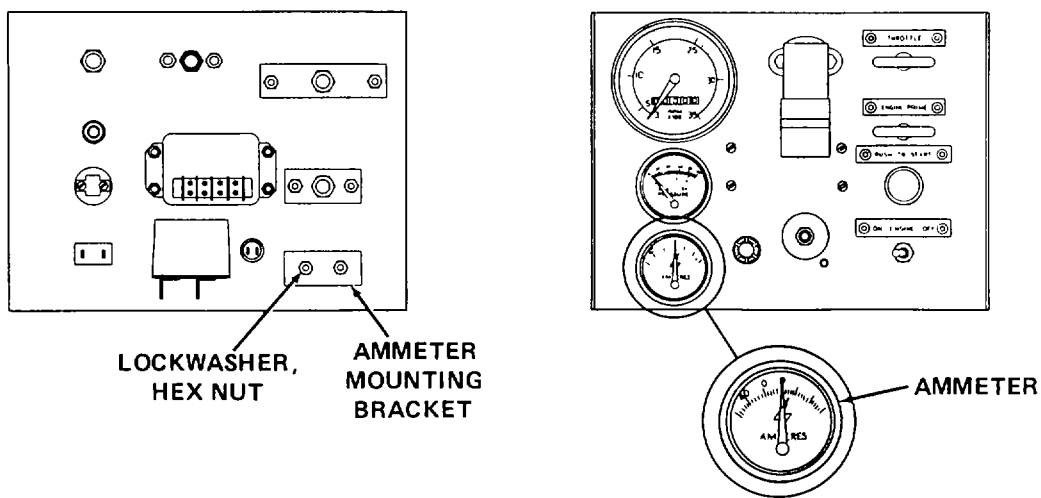
**4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES
(CONT)**

Location/Item	Action	Remarks
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36. Air cleaner intake restriction indicator	Reinstall and attach hose.	
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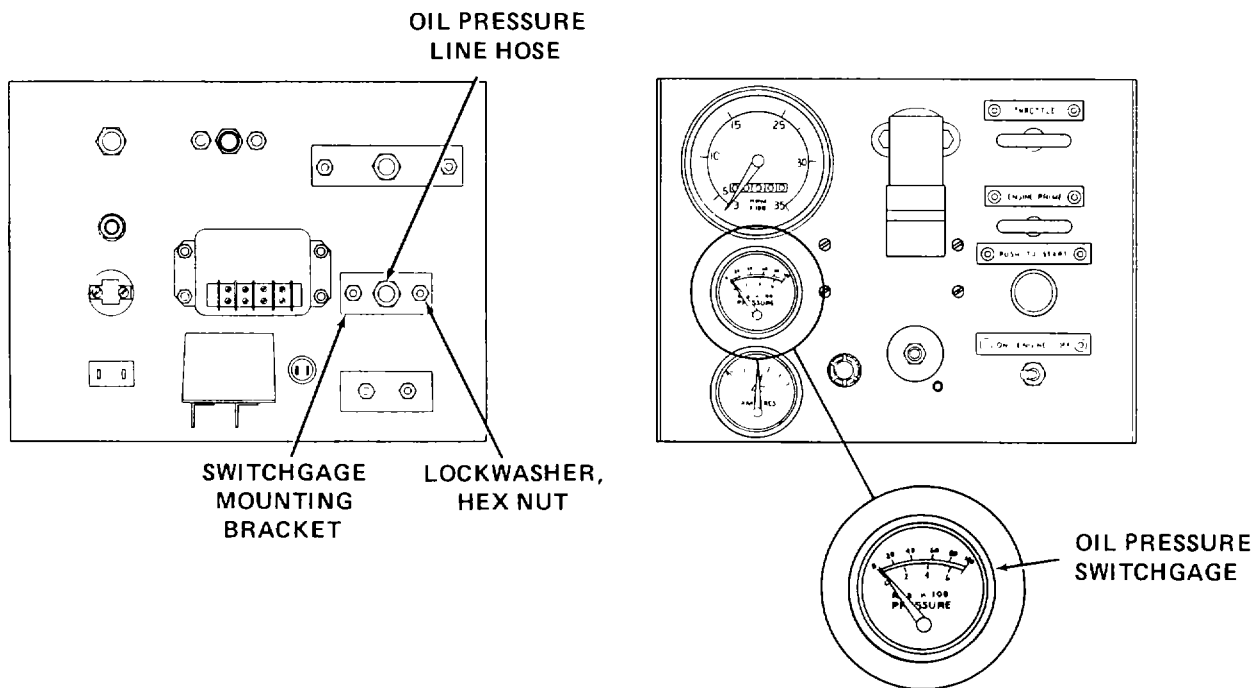
37. Ammeter	Reinstall and attach tagged wires.	
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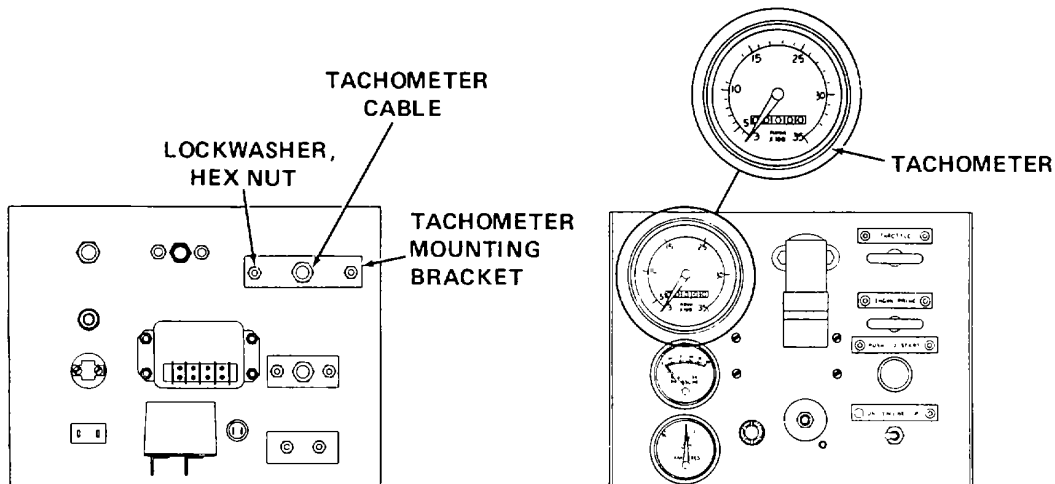
4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
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38. Oil pressure switchgauge Reinstall and attach hose.

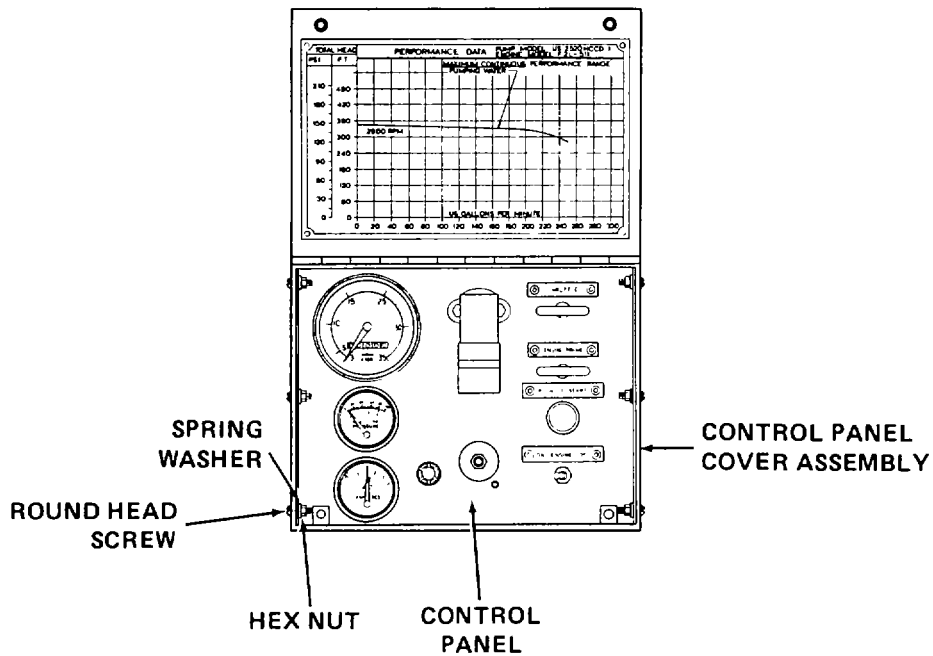


39. Tachometer Reinstall and attach tachometer cable.



4-16. CONTROL PANEL COVER ASSEMBLY, CONTROL PANEL ASSEMBLY, INSTRUMENTS, AND SWITCHES (CONT)

Location/Item	Action	Remarks
40. Control panel	Reinstall control panel cover assembly with round head screws, spring washers, and hex nuts. Tighten securely.	



4-17. WIRING HARNESS (CONTROL PANEL)

This task covers: a. Removal c. Replacement
 b. Testing/Inspection d. Installation

INITIAL SETUP

Tools

Shop equipment automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

Malfunction 1, steps 1 through 4

Malfunction 2, steps 1 through 3

Malfunction 7, steps 1 and 3

Materials/Parts

Control panel wiring harness

Insulation tape (Item 18, Appendix E)

Equipment Condition

Para

Condition Description

Engine shut down.

References

Para 4-16 Control Panel Cover Assembly, Control Panel Assembly, Instruments, and Switches

4-13

Ground battery cables removed from batteries.

4-16

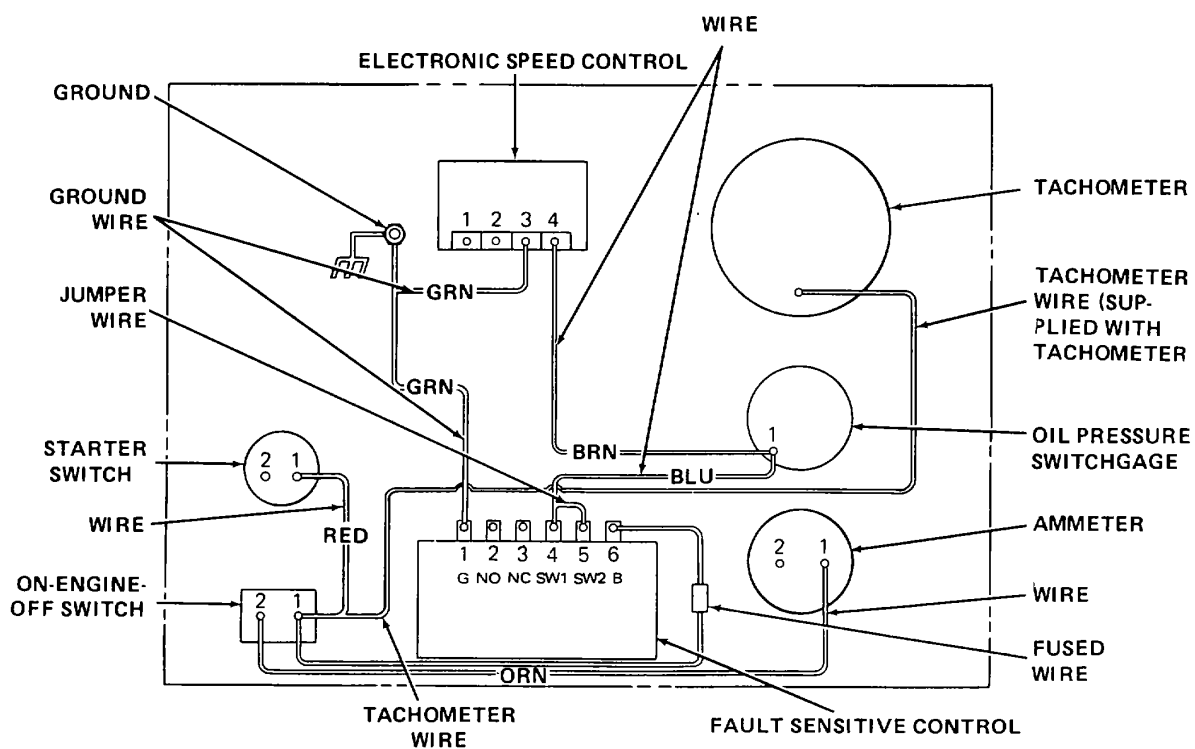
Control panel removed from control panel cover assembly.

4-17. WIRING HARNESS (CONTROL PANEL) (CONT)

Location/Item	Action	Remarks
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REMOVAL

1. Wires and connectors Remove and tag.



TESTING/INSPECTION

2. Wires and connectors Test for continuity. Inspect for broken, damaged, burned, frayed, or abraded wires or connectors.

4-17. WIRING HARNESS (CONTROL PANEL) (CONT)

Location/Item	Action	Remarks
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REPLACEMENT

3. Wiring and connectors	Replace any wires or connectors that are frayed, damaged, burned, or broken. Replace entire wiring harness if necessary.	
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INSTALLATION

4. Wiring	Install replaced wiring (as tagged) onto appropriate instruments and controls on control panel. Tighten mounting hardware securely.	
-----------	---	--

5. Control panel	Reinstall in control panel cover assembly in accordance with paragraph 4-16.	
------------------	--	--

4-18. EXHAUST PRIMER ASSEMBLY

- This task covers:
- | | |
|--------------------------------|-----------------------------|
| a. Removal/Disassembly | d. Lubrication |
| b. Cleaning/Testing/Inspection | e. Installation/Replacement |
| c. Repair | |

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

Malfunction 5, step 3

Malfunction 8, steps 4 and 5

Malfunction 9, step 3

Materials/Parts

Exhaust primer assembly

Lubricating oil (Item 9, Appendix E)

**Equipment
Condition
Para**

Condition Description

Engine shut down and cool.

4-18. EXHAUST PRIMER ASSEMBLY (CONT)

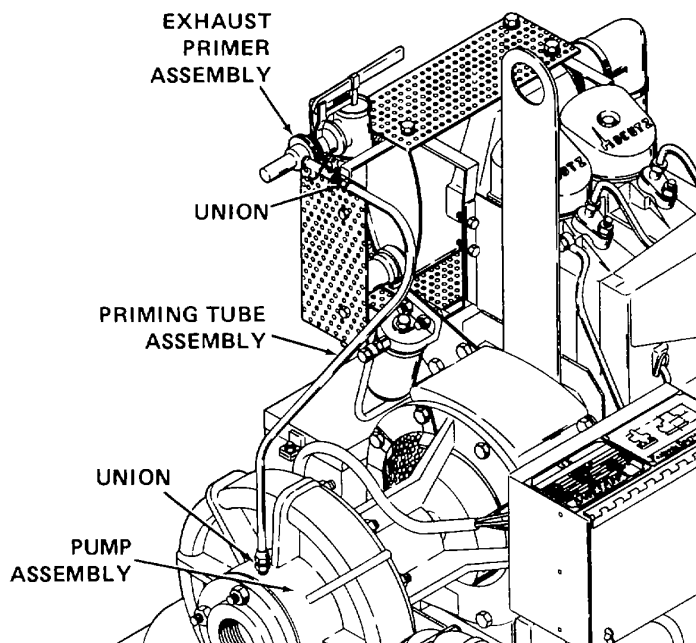
Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL/DISASSEMBLY

WARNING

Handling a hot exhaust pipe can cause severe burns. Allow unit to cool before handling.

1. Priming tube assembly Remove from unions on pump assembly and exhaust primer assembly.



2. Exhaust elbow Loosen hex head cap screw on exhaust elbow.

4-18. EXHAUST PRIMER ASSEMBLY (CONT)

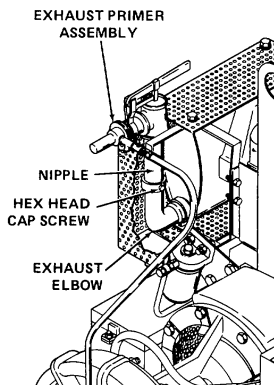
Location/Item	Action	Remarks
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3. Exhaust primer assembly and nipple

Remove from exhaust elbow.

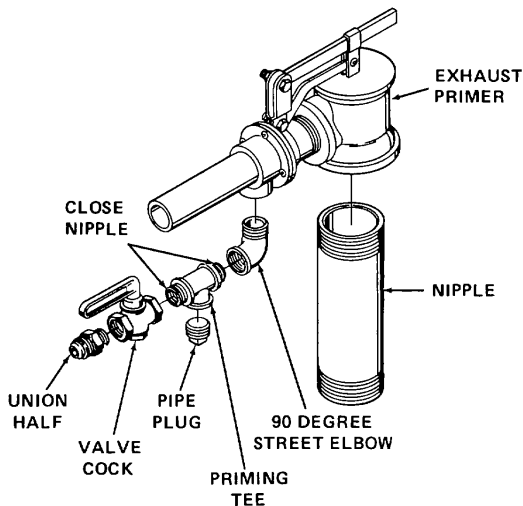
4. Nipple

Remove from exhaust primer.



5. Union half, valve cock, close nipple, pipe plug, priming tee, close nipple, and 90 degree street elbow

Remove from exhaust primer.



4-18. EXHAUST PRIMER ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CLEANING/TESTING/INSPECTION

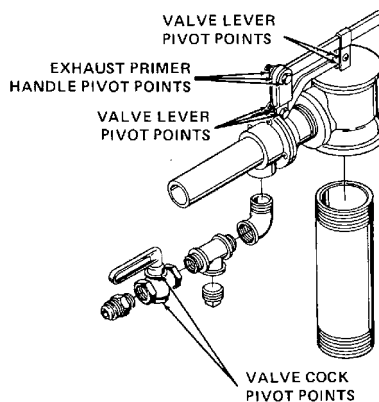
- | | | |
|---|---|--|
| 6. Exhaust primer assembly components and priming tube assembly | Clean, test, and inspect for damage, stripped threads, excessive rust or corrosion, or malfunction. | |
|---|---|--|

REPAIR

- | | | |
|---|---|--|
| 7. Exhaust primer assembly components and priming tube assembly | Repair any components which are repairable. Replace damaged components that cannot be repaired. | |
|---|---|--|

LUBRICATION

- | | | |
|---|--|--|
| 8. Pivot points on valve cock, exhaust primer handle, and valve lever | Lubricate with MIL-L-2104 lubricating oil. | |
|---|--|--|



4-18. EXHAUST PRIMER ASSEMBLY (CONT)

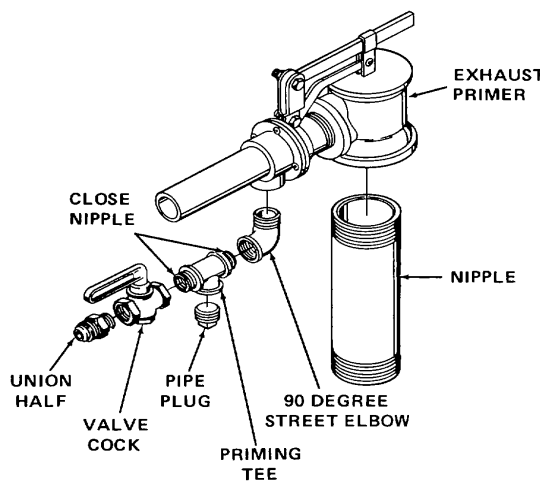
Location/Item	Action	Remarks
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**INSTALLATION/
REPLACEMENT**

- | | | |
|--|---|--|
| <p>9. 90 degree street elbow, close nipple, priming tee, pipe plug, close nipple, valve cock, union half, and nipple</p> | <p>Install. Tighten connections securely:</p> | |
|--|---|--|

NOTE

Make sure components are aligned properly during installation. If not, loosen and align.

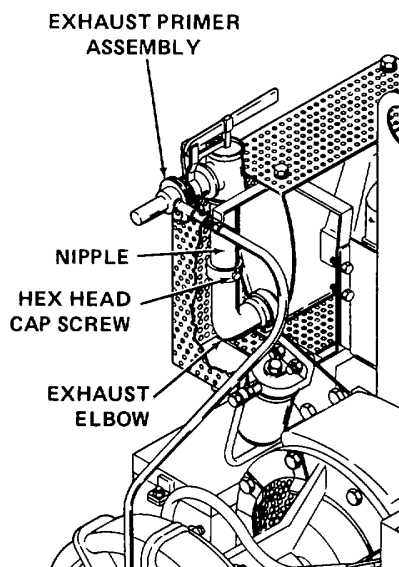


- | | | |
|---|---|--|
| <p>10. Nipple and exhaust primer assembly</p> | <p>Install. Tighten connections securely.</p> | |
|---|---|--|

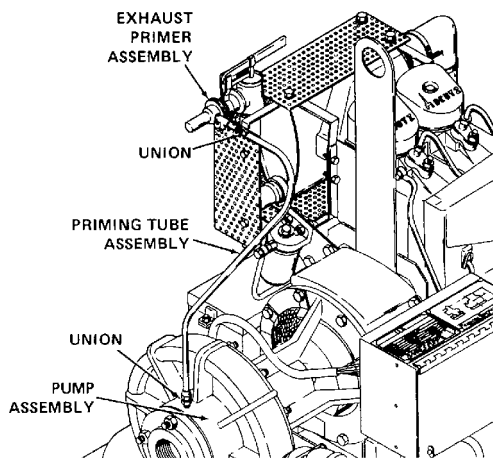
4-18. EXHAUST PRIMER ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

11. Exhaust elbow Tighten hex head cap screw securely.



12. Priming tube assembly Install. Tighten securely.



4-19. CHECK VALVE BODY ASSEMBLY AND CHECK VALVE ASSEMBLY

This task covers: a. Removal c. Repair
 b. Disassembly/Inspection d. Installation/Replacement

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Troubleshooting References (Table 4-2)

Malfunction 8, step 6
 Malfunction 9, step 4

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Equipment Condition Para

Condition Description

Materials/Parts

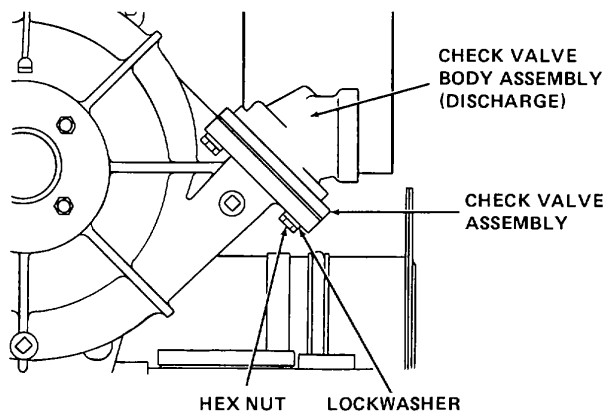
Check valve assembly
 Check valve body assembly

Engine shut down.
 Discharge hose removed, and water drained from pump via drain port at bottom of pump assembly.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

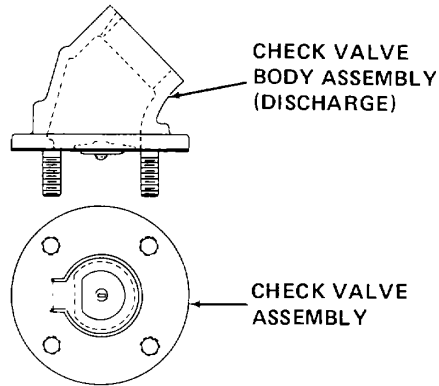
1. Check valve body assembly
 - a. Remove hex nuts and lockwashers.
 - b. Remove check valve body assembly with check valve assembly.



4-19. CHECK VALVE BODY ASSEMBLY AND CHECK VALVE ASSEMBLY (CONT)

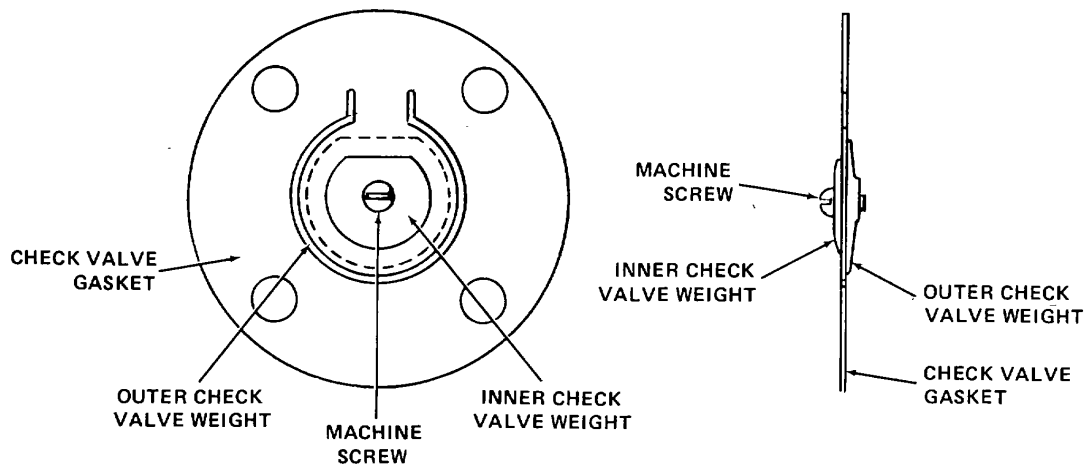
Location/Item	Action	Remarks
---------------	--------	---------

2. Check valve assembly	Remove.	
-------------------------	---------	--



DISASSEMBLY/INSPECTION I

3. Check valve assembly	a. Remove machine screw. b. Disassemble outer check valve weight, inner check valve weight, and check valve gasket.	
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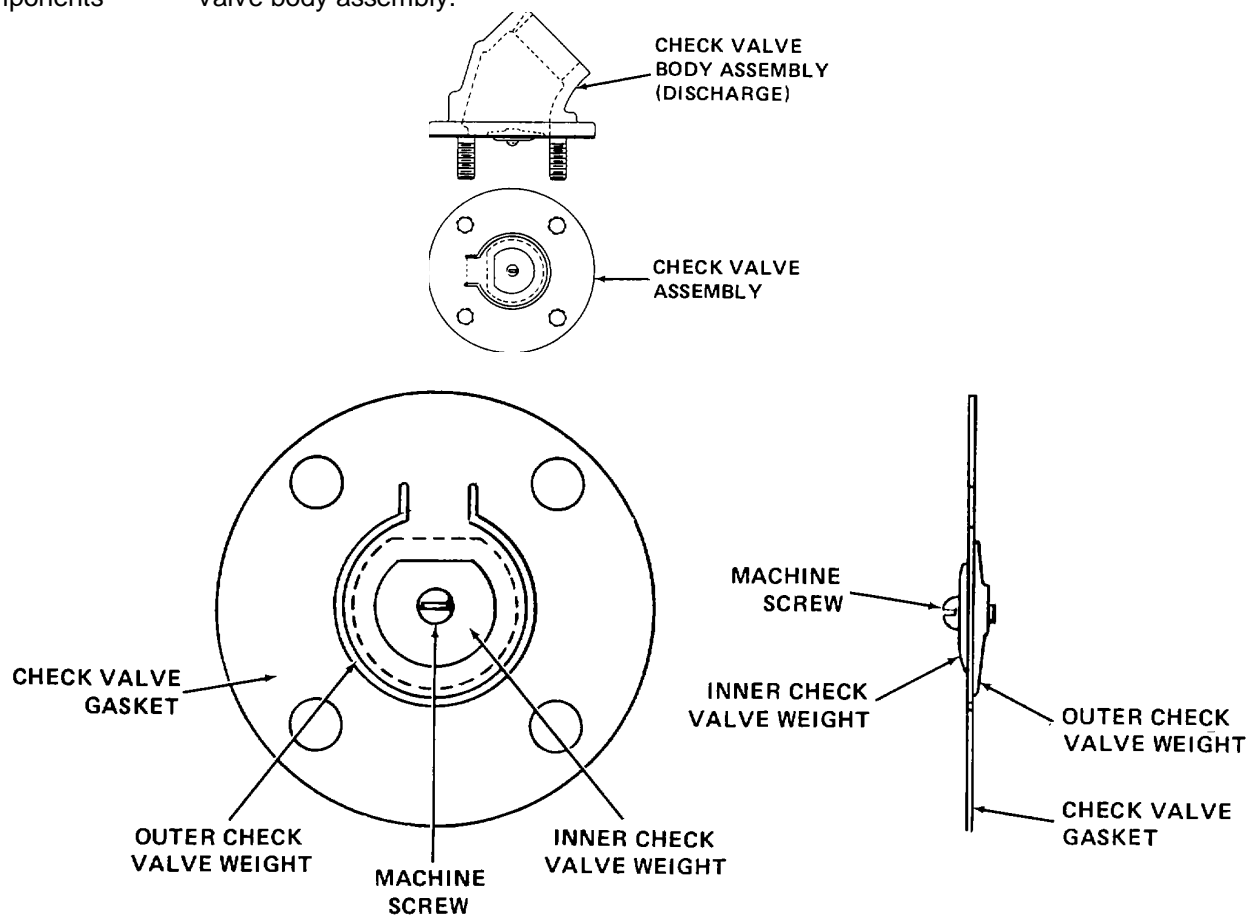


4-19. CHECK VALVE BODY ASSEMBLY AND CHECK VALVE ASSEMBLY (CONT)

Location/Item	Action	Remarks
4. Check valve body assembly and check valve assembly	Inspect hex nuts, lockwashers, machine screw, outer check valve weight, inner check valve weight, and check valve gasket for unusual wear, damage, rust, corrosion, or malfunction.	

REPAIR

5. Check valve body and check valve assembly components	Repair minor damage, wear, rust, or corrosion. If damage is severe, replace components or check valve assembly and/or check valve body assembly.
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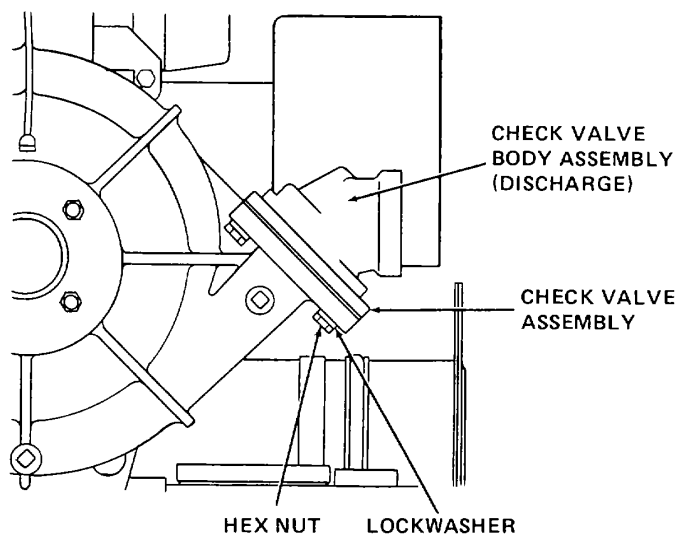


4-19. CHECK VALVE BODY ASSEMBLY AND CHECK VALVE ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION/REPLACEMENT

- | | | |
|------------------------------|---|--|
| 6. Check valve assembly | <ul style="list-style-type: none"> a. Assemble outer check valve weight, check valve gasket, and inner check valve weight. b. Install machine screw and tighten securely. c. Install on check valve body assembly. | |
| 7. Check valve body assembly | <ul style="list-style-type: none"> a. Install. b. Install lockwashers and hex nuts. Tighten securely. | |



4-20. EXHAUST ELBOW AND GUARD

- This task covers:
- | | |
|------------------------|-----------------------------|
| a. Removal | d. Installation/Replacement |
| b. Cleaning/Inspection | e. Test |
| c. Repair | |

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Equipment Condition

Para

Condition Description

Engine shut down and cool.

4-18

Exhaust primer assembly removed.

Materials/Parts

Exhaust elbow
Muffler guard
Muffler guard mounting bracket

Muffler mounting bracket
Materials required by MIL-T-704

Diesel fuel oil (Item 5, Appendix E)

References

MIL-T-704 Treatment and Painting of Materiel

Troubleshooting References (Table 4-2)

Malfunction 5, step 3

General Safety Instructions

WARNING

Handling hot exhaust system can cause severe burns. Allow unit to cool before handling.

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.

4-20. EXHAUST ELBOW AND GUARD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

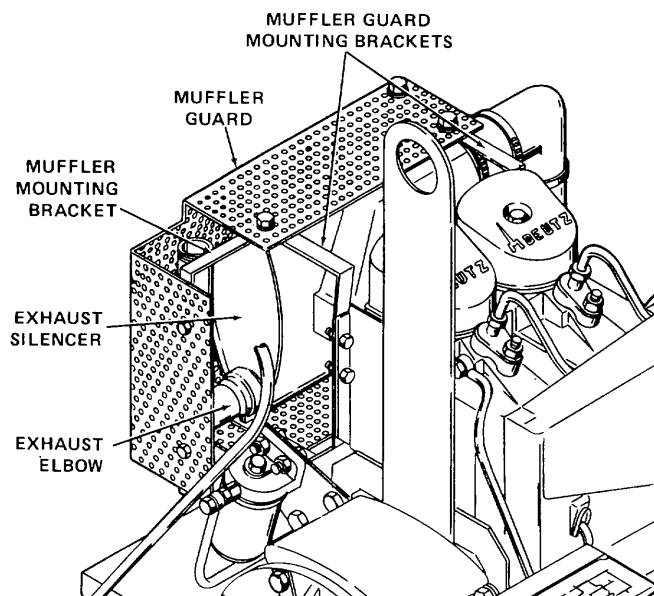
WARNING

Handling hot exhaust system can cause severe burns. Allow unit to cool before handling.

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

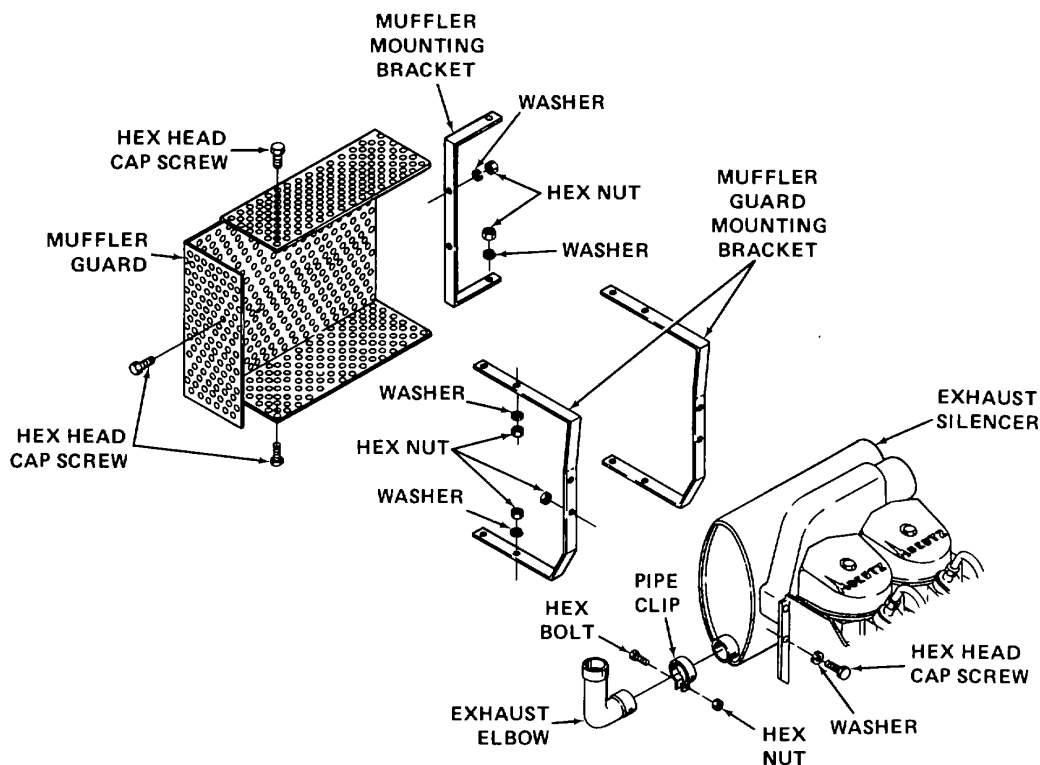
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

1. Muffler guard
 - a. Remove hex head cap screws, washers, and hex nuts (10 sets).
 - b. Remove muffler guard.



4-20. EXHAUST ELBOW AND GUARD (CONT)

Location/Item	Action	Remarks
2. Muffler mounting bracket	Remove.	
3. Muffler guard mounting brackets	a. Remove hex head cap screws, washers, and hex nuts (4 sets). b. Remove muffler guard mounting brackets.	
4. Pipe clip	a. Loosen hex bolt and hex nut. b. Slide pipe clip off exhaust elbow.	
5. Exhaust elbow	Slide off exhaust silencer.	



4-20. EXHAUST ELBOW AND GUARD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|--|---|
| 6. Muffler guard, muffler mounting bracket, muffler guard mounting brackets, and exhaust elbow | Clean with VV-F-800 diesel fuel oil and dry with compressed air. Inspect for minor rust, corrosion, or other damage. Replace if severely rusted or damaged. |
|--|---|

REPAIR

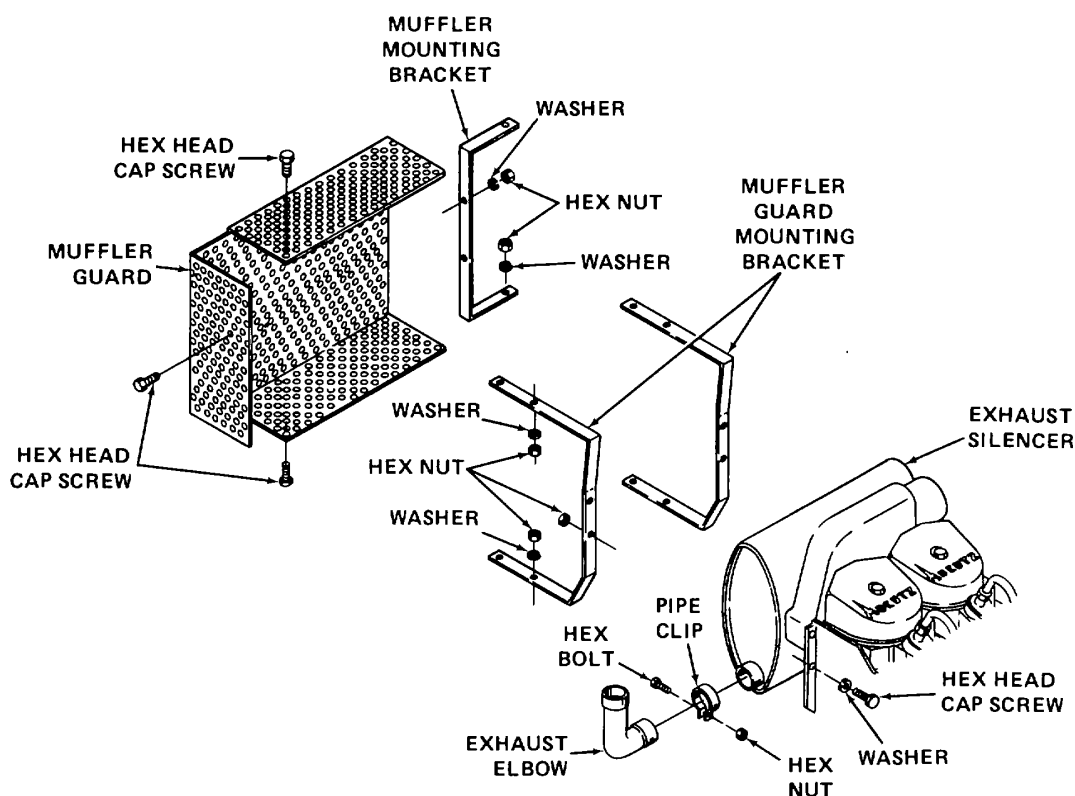
- | | |
|--|--|
| 7. Muffler guard, muffler mounting bracket, muffler guard Mounting brackets, and exhaust elbow | Repair minor dents, rust, or corrosion. Straighten bent mounting brackets, if necessary. Repair rust or corrosion and refinish in accordance with MIL-T-704. |
|--|--|

4-20. EXHAUST ELBOW AND GUARD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION/REPLACEMENT

- | | | |
|--------------------------------|--|--|
| 8. Exhaust elbow and pipe clip | a. Slide elbow onto exhaust silencer.
b. Slide pipe clip over elbow onto silencer. Tighten hex bolt and hex nut on pipe clip. | |
|--------------------------------|--|--|



- | | | |
|---|---|--|
| 9. Muffler guard and mounting brackets | Install two muffler guard mounting brackets with hex head cap screws, washers, and hex nuts (4 sets). Tighten securely. | |
| 10. Muffler mounting bracket | Install on muffler guard. | |
| 11. Muffler guard with muffler mounting bracket | a. Install.
b. Install hex head cap screws, washers, and hex nuts. Tighten securely. | |

4-20. EXHAUST ELBOW AND GUARD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

TEST

WARNING

Touching exhaust system during test can cause severe burns.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

12. Exhaust elbow and guard	Start engine and observe components for leaks and/or looseness or rattles. Tighten mounting hardware as necessary.
-----------------------------	--

4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP

- This task covers:
- | | |
|---------------|-----------------------------|
| a. Removal | d. Installation/Replacement |
| b. Inspection | e. Test System |
| c. Repair | |

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

References

Para 4-16 Control Panel Cover Assembly,
Control Panel Assembly, Instruments, and Switches

Materials/Parts

Air cleaner

MIL-T-704 Treatment and Painting of Materiel

Air cleaner mounting brackets

Troubleshooting References (Table 4-2)

Malfunction 2, step 3

Air cleaner service indicator hose assembly

Malfunction 3, step 1

Air intake tubes, elbows, hoses, clamps,
and adapters

Rain cap

Special Environmental Conditions

Adequate ventilation required during cleaning
and testing.

Materials required by MIL-T-704

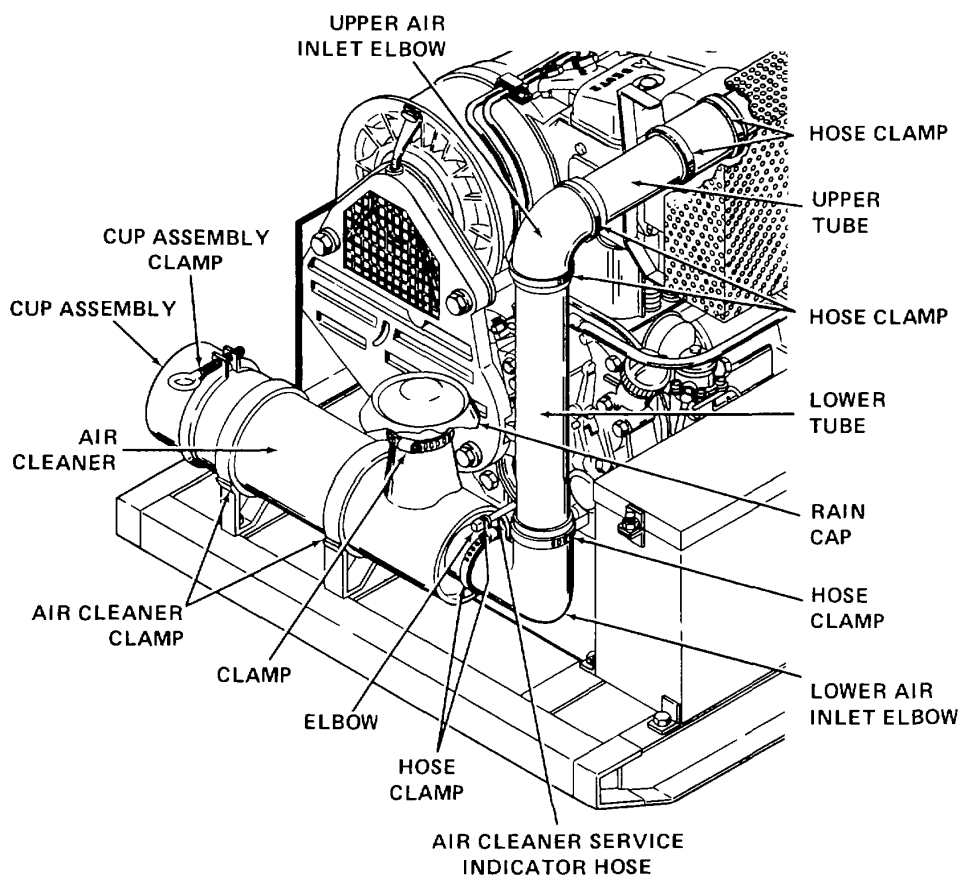
Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|---------------------------------------|--|
| 1. Air cleaner service indicator hose | Loosen hose clamp and remove hose from elbow. |
| 2. Elbow | Remove. |
| 3. Lower air inlet elbow | Loosen two hose clamps and remove lower air inlet elbow. |

4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

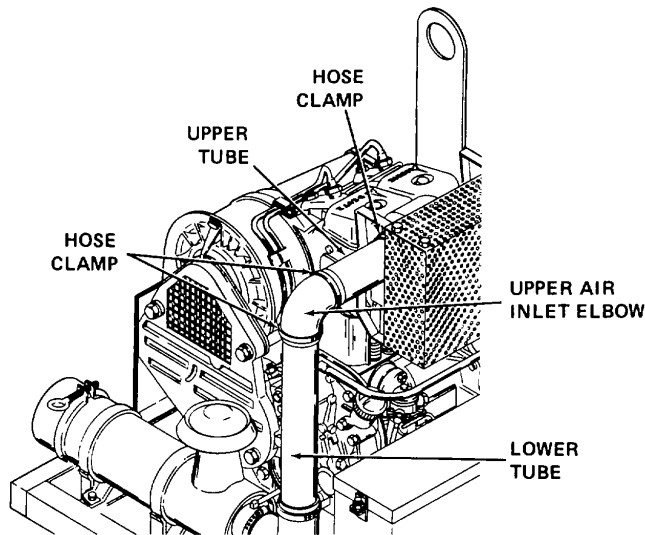
Location/Item	Action	Remarks
4. Cup assembly	Loosen cup assembly clamp. Remove clamp and cup assembly.	
5. Air cleaner and rain cap	Loosen two air cleaner clamps and clamp under rain cap. Remove air cleaner and rain cap.	



4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

6. Air inlet tubes and upper air inlet elbow	Loosen four hose clamps. Remove air inlet upper and lower tubes and upper air inlet elbow.	
--	--	--



7. Air cleaner service indicator hose assembly	Remove from back of control panel in accordance with paragraph 4-16.	
--	--	--

4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

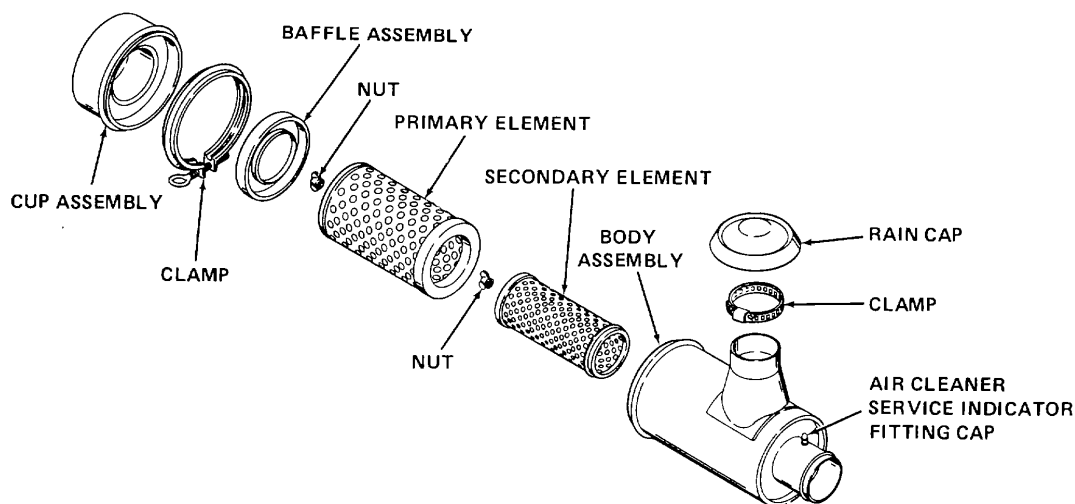
INSPECTION

NOTE

Replace air filter elements if air cleaner service indicator signal indicates replacement.

- 8. Air cleaner assembly, rain cap, and air cleaner clamps

Inspect air cleaner body assembly, cup assembly, baffle assembly, rain cap, air cleaner service indicator fitting cap, and clamps for damage, dents, holes, rust, or corrosion. Replace if severely damaged or rusted.



- 9. Elbows, tubes, and clamps

Inspect rubber elbows and adapter. Replace if brittle, cracked, or deteriorated. Inspect tubes and clamps for damage, dents, rust, or corrosion. Replace if severely damaged or rusted.

- 10. Air cleaner service indicator hose, hose cap, elbow, and hose clamp

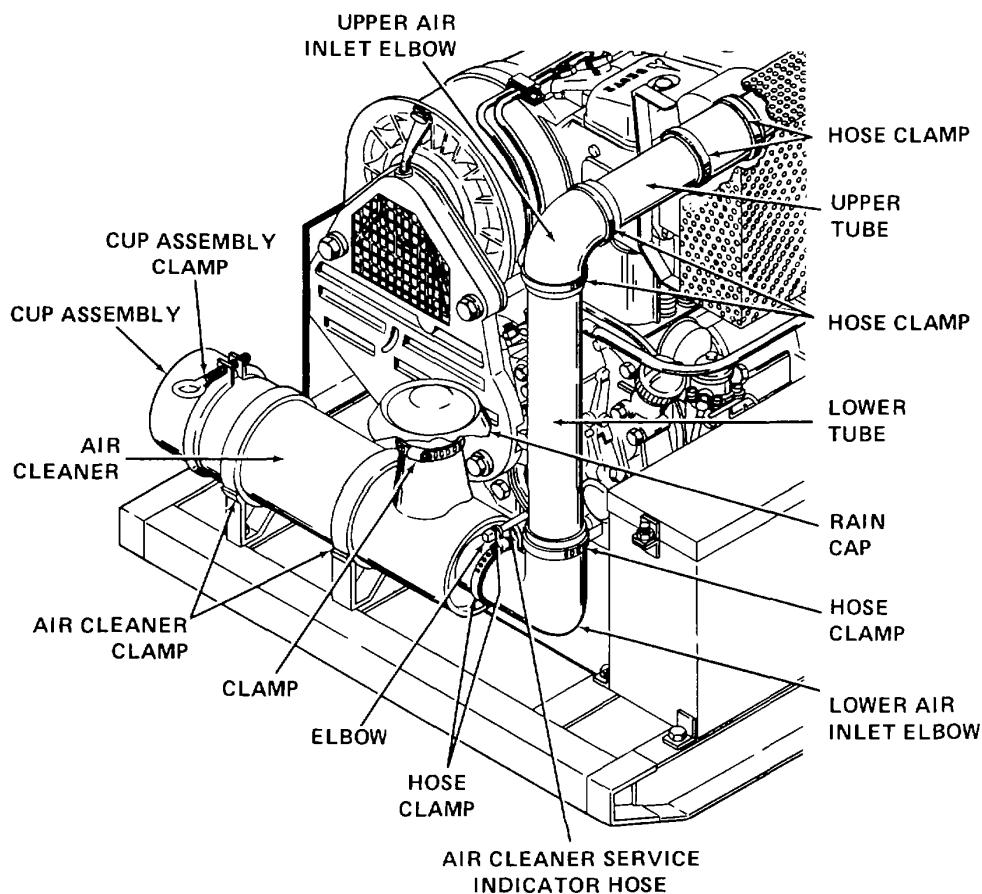
Inspect hose. Replace if brittle, cracked, or deteriorated. Inspect cap, elbow, and hose clamp for damage, rust, or corrosion. Replace if severely damaged or rusted.

4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

Location/Item	Action	Remarks
REPAIR		
11. Air cleaner assembly, rain cap, clamps, and element(s)	Repair minor dents, abraded areas, rust, or corrosion. Repair or replace severely worn, damaged, or rusted components. Clean or replace element(s) if element(s) cannot be cleaned properly.	
12. Elbows, tubes, and clamps	Do not attempt to repair brittle, cracked, or deteriorated rubber components. Replace as necessary. Repair rust or corrosion on tubes and elbows. If damaged severely, replace components.	
13. Air cleaner service indicator hose assembly and hose clamp	Do not attempt to repair brittle, cracked, or deteriorated hoses. Replace as necessary. Do not attempt to repair rusted or corroded clamp; replace clamp.	
INSTALLATION/REPLACEMENT		
14. Air cleaner service indicator hose assembly	Install in back of control panel in accordance with paragraph 4-16.	
15. Air cleaner assembly and rain cap	Install on skid-mounted air cleaner clamps with inlet stack up. Tighten clamps securely. Install rain cap on stack and tighten clamp under rain cap.	Rain cap on stack.
16. Cup assembly and cup assembly clamp	Install on air cleaner. Tighten cup assembly clamp securely.	
17. Lower air inlet elbow	Install on air cleaner. Tighten hose clamp securely.	
18. Air inlet lower tube, upper air inlet elbow, and air inlet upper tube	Install. Tighten hose clamps securely.	

4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

Location/Item	Action	Remarks
19. Air cleaner service indicator elbow and hose	Install. Tighten hose clamp securely.	



4-21. AIR CLEANER, AIR INTAKE TUBES, ELBOWS, AND RAIN CAP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

TEST SYSTEM

WARNING

Touching exhaust system during test can cause severe burns. Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM 21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

20. Air cleaner assembly and air cleaner intake restriction indicator	Start engine and observe installed components for looseness, rattles, or leaks. Tighten. If red band is visible in window of restriction indicator, shut down engine. Recheck installation and elements. Reset indicator. Restart engine. If red band is still visible, replace indicator in accordance with paragraph 4-16. Restart engine and check indicator. If indicator still shows red band, refer to direct support.
---	--

4-22. FUEL TANK LINES AND FITTINGS

This task covers:

a. Removal	c. Installation
b. Repair	d. Bleeding Air From Fuel System

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Special Environmental Conditions

Well-ventilated area required.

Materials/Parts

Fuel line and flare nuts
Fuel line vent and banjo bolt

General Safety Instructions

WARNING

Troubleshooting References (Table 4-2)

Malfunction 2, steps 6 and 7

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

Equipment Condition

Para	Condition Description
	Engine shut down and cool.

4-22. FUEL TANK LINES AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

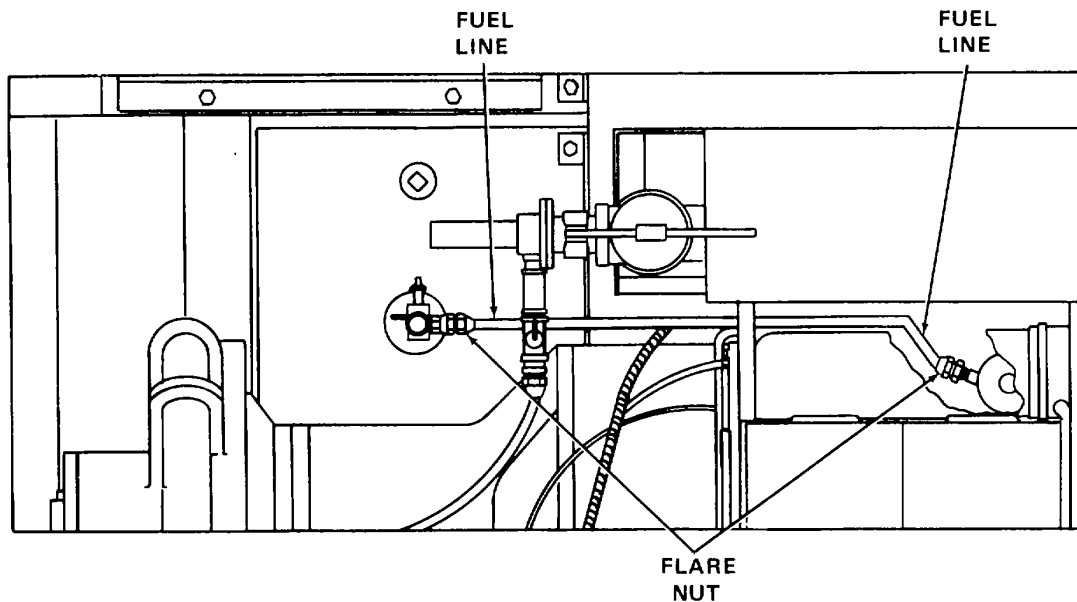
REMOVAL

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

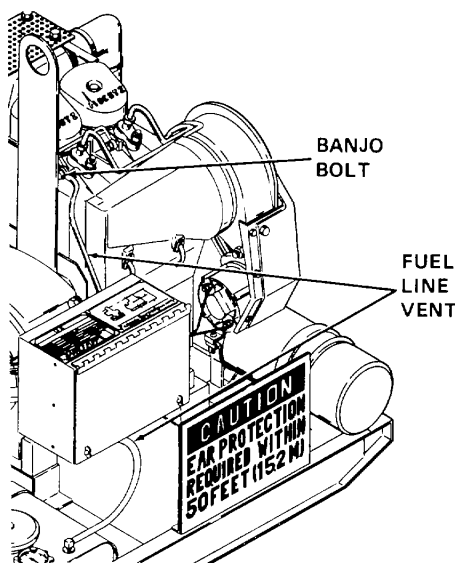
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

1. Fuel line
 - a. Loosen and remove flare nuts.
 - b. Tag and remove fuel line.



4-22. FUEL TANK LINES AND FITTINGS (CONT)

Location/Item	Action	Remarks
2. Fuel line vent	a. Loosen and remove banjo bolt. b. Tag and remove fuel line vent.	



3. Fuel lines and ports	Tape over exposed fuel ports and lines so no contaminants enter the fuel system.	
-------------------------	--	--

REPAIR

4. Fuel line, fuel line vent, and fittings	Inspect fuel line for damage, rust, and corrosion. Inspect fuel line vent for cracking or brittleness. Test both lines for leakage. Repair only minor rust or corrosion. Replace damaged or leaking fuel lines and fittings.	
--	--	--

INSTALLATION

5. Fuel line and fuel line vent	Install. Tighten banjo bolt and flare nuts securely. Fit fuel line vent to 90 degree elbow port on fuel tank and push on securely.	
---------------------------------	--	--

4-22. FUEL TANK LINES AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

BLEEDING AIR FROM FUEL SYSTEM
--

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- | | | |
|--------------------------|--|--|
| 6. Fuel filter | Loosen vent screw on top of fuel filter, four complete turns. | |
| 7. ENGINE PRIME T-handle | Push and pull ENGINE PRIME T-handle until all air is removed from fuel filter and fuel flows freely. | |

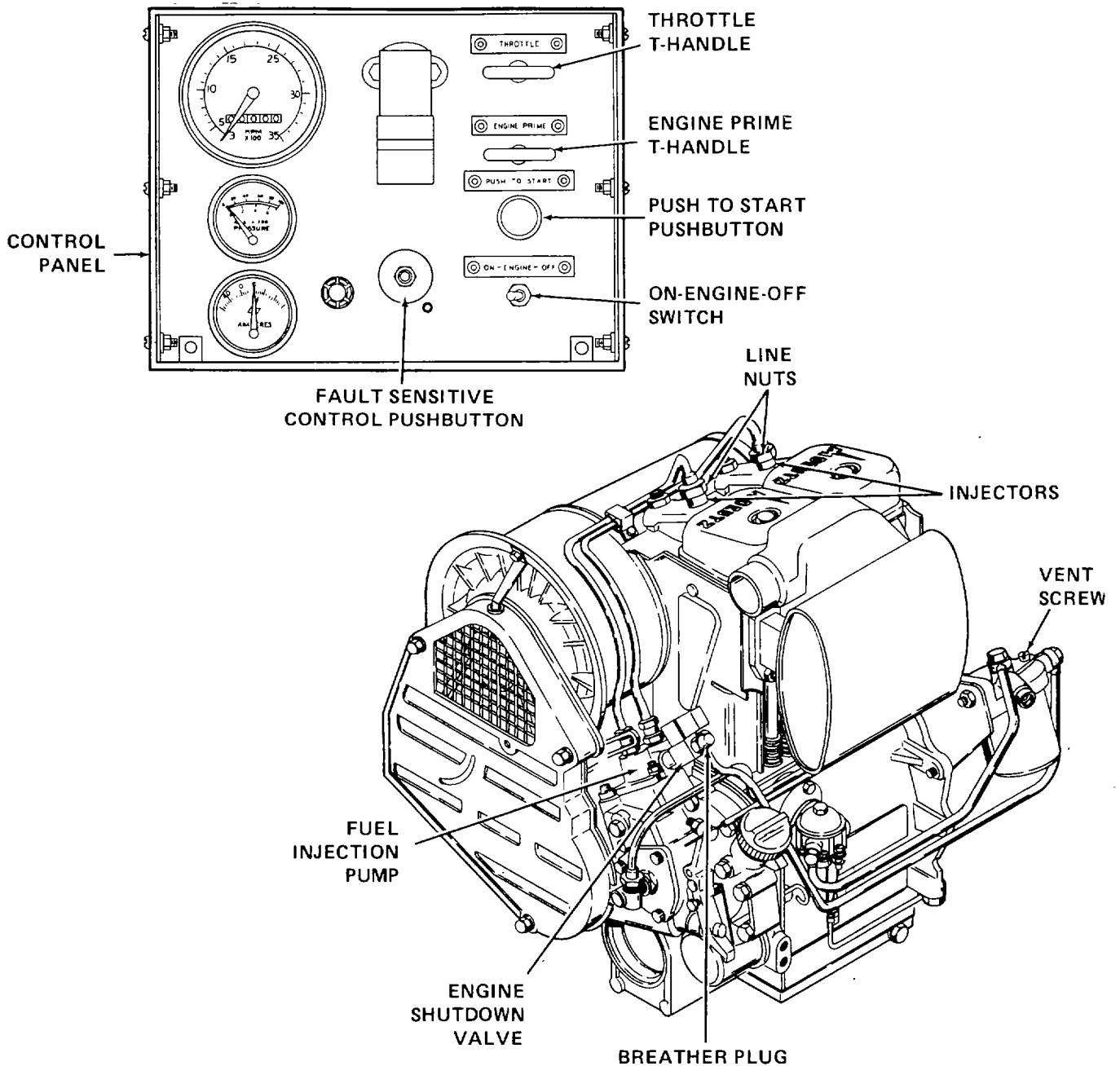
NOTE

The fuel feed pump is cam driven. If high point of camshaft cam is in contact with fuel feed pump cam lever, fuel system cannot be primed nor air bled from fuel system using fuel feed pump.

- | | | |
|--|--|--|
| 8. Fuel filter | Tighten vent screw on top of fuel filter. | |
| 9. Engine shut-down valve | Loosen breather plug on top of engine shutdown valve, four complete turns. | |
| 10. ON-ENGINE-OFF switch | Place in ON position. | |
| 11. Fault sensitive control pushbutton | Press and hold in. | |
| 12. ENGINE PRIME T-handle | Push and pull ENGINE PRIME T-handle until all air is removed from engine shutdown valve and fuel flows easily. | |

4-22. FUEL TANK LINES AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------



- | | |
|----------------------------|---|
| 13. Engine shut-down valve | Tighten breather plug on top of engine shutdown valve. |
| 14. Injectors | <ul style="list-style-type: none"> a. Loosen line nuts on injectors, one full turn. b. Hold a lint-free cloth below injectors to collect leakage. |

4-22. FUEL TANK LINES AND FITTINGS (CONT)

Location/Item	Action	Remarks
<u>WARNING</u>		
<p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> • Stand clear of venturi during priming. 		
<u>CAUTION</u>		
<p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p> <p>To prevent starter from overheating, do not crank engine with starter for more than 10 seconds.</p> <p>Battery life will be lengthened if 60 seconds is allowed to elapse between starting attempts.</p> <p>Under any condition, if engine does not start on initial attempt, allow engine rotation to stop completely before again engaging starter.</p>		
15. THROTTLE T-handle	Pull THROTTLE T-handle full open and lock by turning clockwise.	
16. Control panel	Press and hold in the fault sensitive control push-button, push START button and observe fuel flow from injector fittings until air is cleared from lines.	
17. Injectors	Tighten line nuts on injectors.	
18. THROTTLE T-handle	Push THROTTLE T-handle closed.	
19. Engine	Start engine as described in paragraph 2-5.	

4-23. 3-WAY SELECTOR VALVE

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

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

3-way selector valve
Materials required by MIL-T-704
Diesel fuel oil (Item 5, Appendix E)
Lubricating oil (Item 9, Appendix E)

References

MIL-T-704 Treatment and Painting of
Materiel

Troubleshooting References (Table 4-2)

Malfunction	2,	step	5
-------------	----	------	---

Equipment Condition

Para

4-22
fittings removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

4-23. 3-WAY SELECTOR VALVE (CONT)

Location/Item	Action	Remarks
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REMOVAL

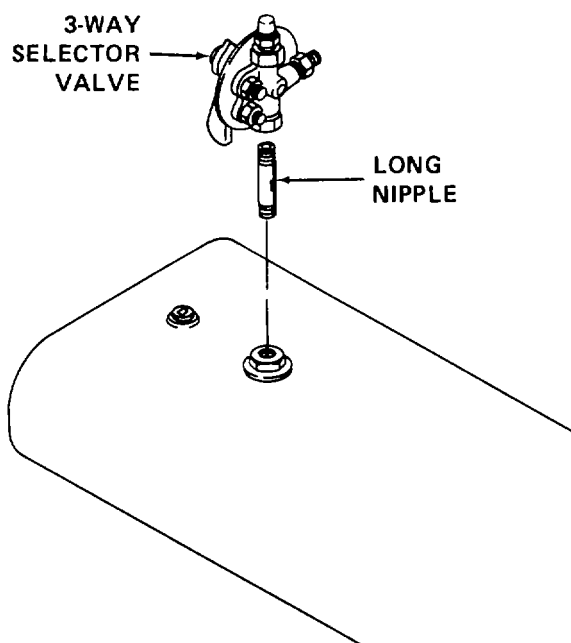
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

1. 3-way selector valve and long nipple

Remove from fuel tank. Tape over exposed ports so no contaminants enter fuel system.



2. Valve handle

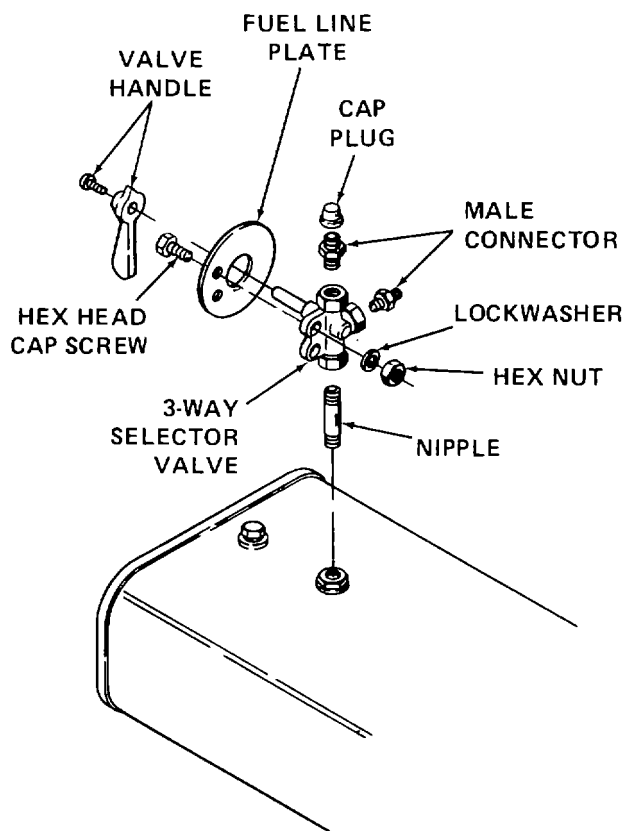
Remove.

3. Fuel line plate

- a. Remove hex head cap screws, lockwashers, and hex nuts.
- b. Remove fuel line plate.

4-23. 3-WAY SELECTOR VALVE (CONT)

Location/Item	Action	Remarks
4. Cap plug	Remove.	
5. Male connectors	Remove.	



REPAIR

- | | |
|--|--|
| 6. 3-way selector valve and components | Inspect all components for damage or damaged threads. Replace components as necessary. Inspect for rust, corrosion, or for frozen or sticking valve. Remove rust or corrosion in accordance with MIL-T-704, if necessary. Lubricate frozen or sticking valve, as necessary, with MIL-L-2104 lubricating oil. If valve components are severely damaged or valve remains frozen, replace as necessary. |
|--|--|

INSTALLATION

- | | |
|--------------------|-------------------------------|
| 7. Male connectors | Install and tighten securely. |
| 8. Cap plug | Install. |

4-23. 3-WAY SELECTOR VALVE (CONT)

Location/Item	Action	Remarks
9. Fuel line plate	a. Position on 3-way valve. b. Install hex head cap screws, lockwashers, and hex nuts. Tighten nuts securely.	
10. Valve handle	Install.	
11. Long nipple	Install on 3-way valve and tighten securely.	
12. 3-way valve and long nipple	Install on fuel tank and tighten securely.	
13. Flare nuts and fuel line	Install in accordance with paragraph 4-22.	
<u>WARNING</u>		
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:		
<ul style="list-style-type: none"> • Do not inhale vapor. • Do not refuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. 		
14. Fuel tank assembly	Fill with VV-F-800 diesel fuel oil.	
15. Fuel system	Bleed fuel system in accordance with paragraph 4-22.	

4-24. FUEL TANK ASSEMBLY

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

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Special Environmental Conditions

Well-ventilated area required.

Materials/Parts

Fuel tank assembly
Fuel tank straps
Diesel fuel oil (Item 5, Appendix E)

General Safety Instructions

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly.

Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Troubleshooting References (Table 4-2)

Malfunction 2, steps 4, 6, 7, and 8
Malfunction 3, steps 2 and 3

Equipment

Condition

Para

Description

Description	Condition
4-22	Fuel tank lines and fittings removed.
4-23	3-way selector valve removed.

4-24. FUEL TANK ASSEMBLY (CONT)

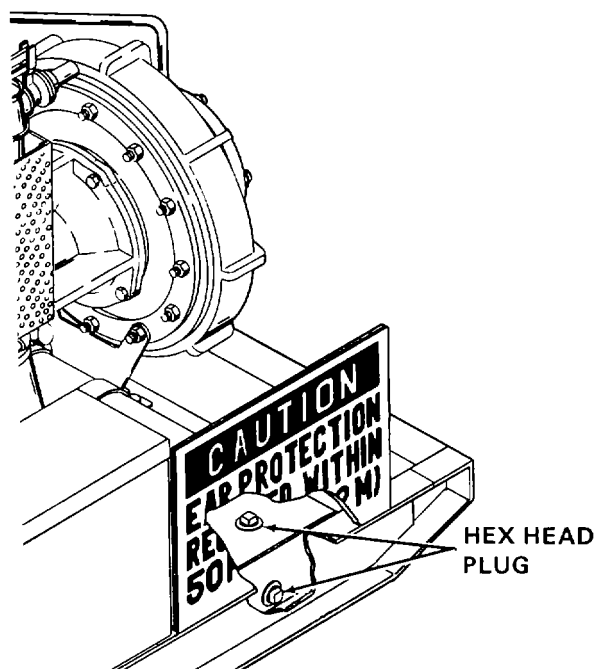
Location/Item	Action	Remarks
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REMOVAL**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

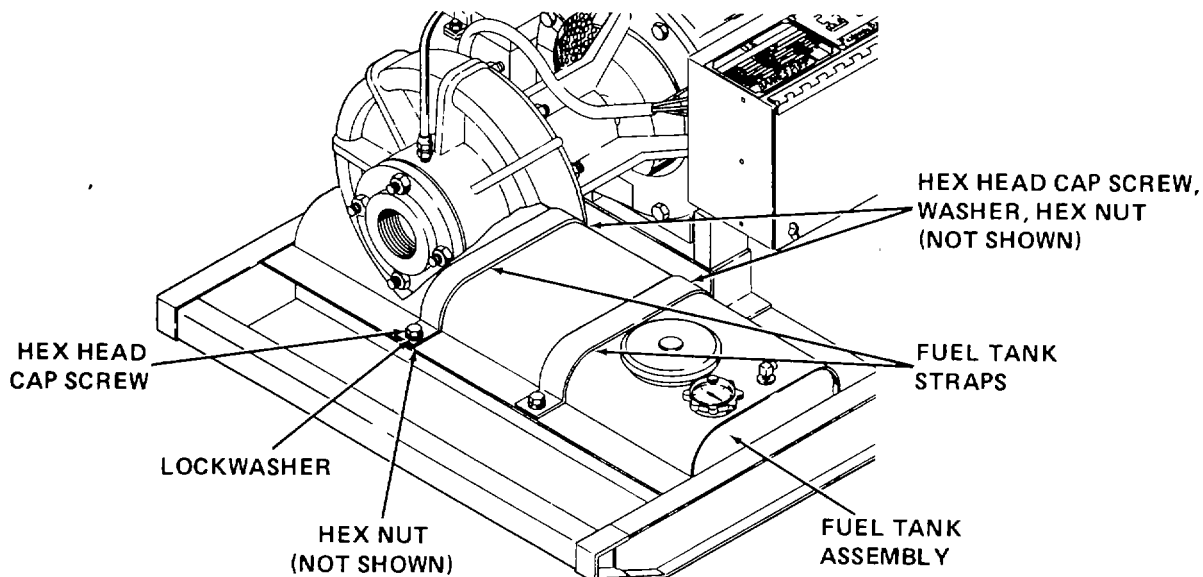
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive Heat.
- Work in a well-ventilated area.

1. Fuel tank
 - a. Remove hex head plugs.
 - b. Drain fuel into suitable container.
 - c. Reinstall hex head plugs.



4-24. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Fuel tank straps	a. Remove hex head cap screws, lockwashers, and hex nuts on both sides of fuel tank straps. b. Remove fuel tank straps.	
3. Fuel tank assembly	Lift and remove.	

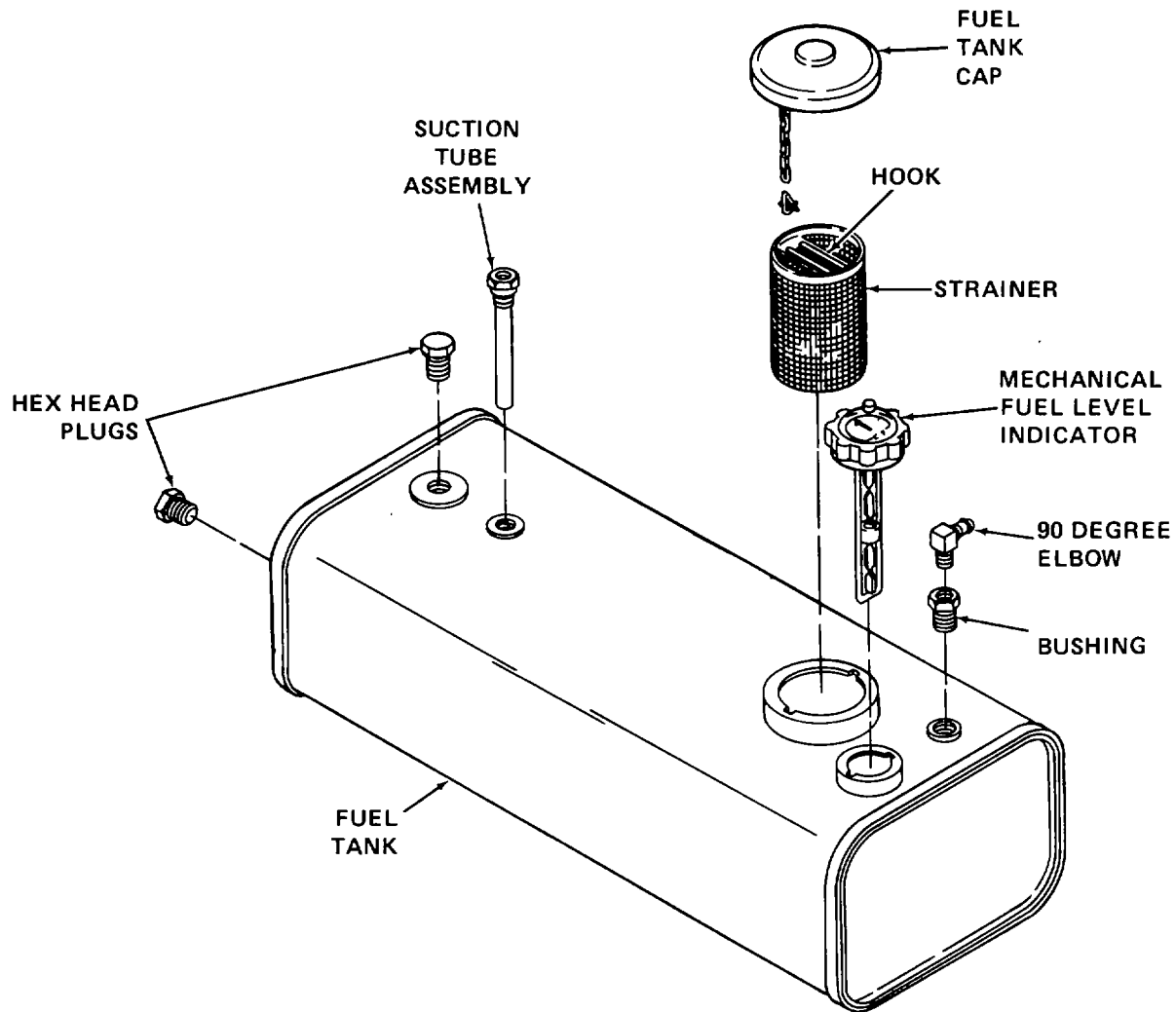


DISASSEMBLY

4. Strainer and fuel tank cap assembly	Remove. Disengage hook from strainer to separate fuel tank cap.
5. Suction tube assembly	Remove.
6. Hex head plugs	Remove.

4-24. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
7. Fuel level indicator	Remove.	
8. 90 degree elbow and bushing	Remove.	



4-24. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|---|---|--|
| 9. Fuel tank straps | Clean with VV-F-800 diesel fuel oil and dry with compressed air. Inspect for minor rust, corrosion, or other damage. Replace if severely rusted or damaged. | |
| 10. Fuel tank assembly | Clean outside and remove sediment with VV-F-800 diesel fuel oil and dry with compressed air. Inspect for minor rust, corrosion, or broken welds. If tank needs repair, notify direct support. | |
| 11. Strainer and fuel tank cap assembly | Clean with VV-F-800 diesel fuel oil and dry with compressed air. Inspect for minor rust or corrosion. Make sure fuel tank cap vent is open. Replace if damaged. | |
| 12. Suction tube assembly | Check for cracks or other damage. Replace suction tube if cracked, bent, clogged, or damaged. | |
| 13. Fuel level indicator | Check for damage. Replace fuel level indicator if damaged. | |
| 14. 90 degree elbow and bushing | Check for damage. Replace 90 degree elbow and bushing if damaged. | |

4-24. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
ASSEMBLY		
15. 90 degree elbow and bushing	Install.	
16. Fuel level indicator	Install.	
17. Hex head plugs	Install.	
18. Suction tube assembly	Install.	
19. Strainer and fuel tank cap assembly	Engage hook into strainer and install. Be sure fuel tank cap vent is in open position.	
INSTALLATION		
20. Fuel tank assembly and fuel tank straps	<ol style="list-style-type: none"> Install fuel tank assembly and position fuel tank straps. Install hex head cap screws, lockwashers, and hex nuts. Tighten hex nuts securely. 	
21. 3-way selector valve	Install 3-way selector valve in accordance with paragraph 4-23.	
22. Fuel line and fuel line vent	Install in accordance with paragraph 4-22.	
<u>WARNING</u>		
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:		
<ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle fuel near open flame, sparks, or excessive heat. • Be certain fuel lines and connections are secure. • Do not overfill fuel tank. • Work in a well-ventilated area. 		
23. Fuel tank assembly	Fill with VV-F-800 diesel fuel.	
24. Fuel system	Bleed fuel system in accordance with paragraph 4-22.	

4-25. LIFTING BRACKET

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

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

References

Para. 416 Control Panel Cover Assembly, Control Panel Assembly, Instruments, and Switches

Para 4-34 Fuel System Lines and Fittings, Fuel Feed Pump, and Fuel Filter

Materials/Parts

Lifting bracket

Equipment Condition Para

Condition Description
 Engine shut down and cool.

Location/Item	Action	Remarks
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REMOVAL

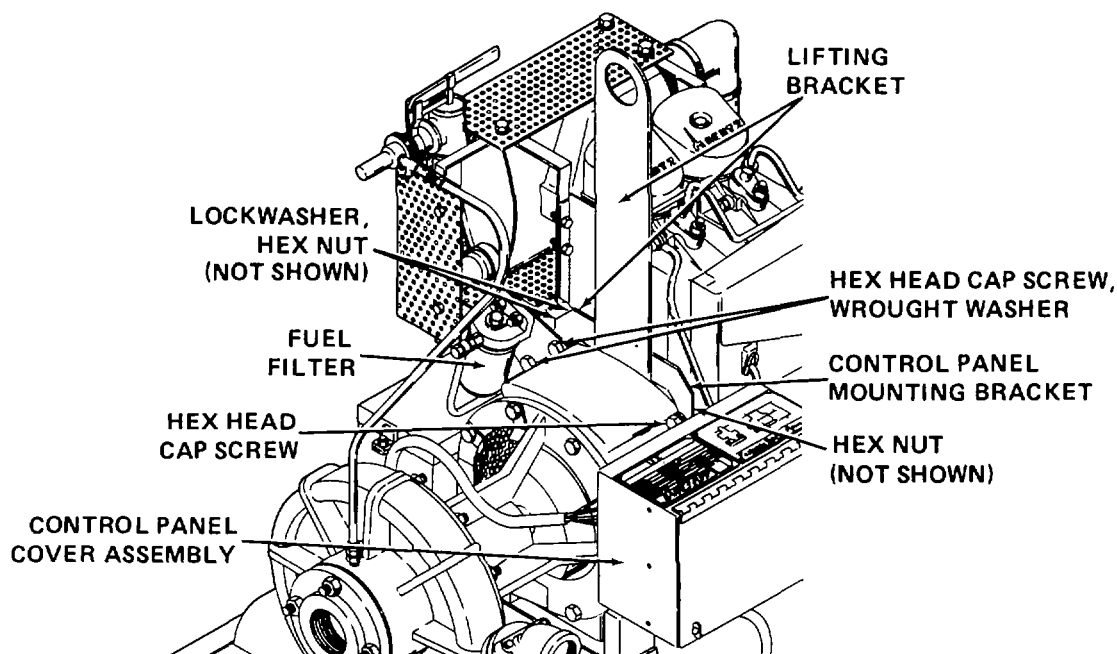
WARNING

Handling hot exhaust and/or engine assembly can cause severe burns. Allow unit to cool before handling.

- | | |
|--------------------------------|--|
| 1. Throttle cable assembly | Mark throttle cable assembly position on lever/arm of speed control and remove in accordance with paragraph 4-16. Pass cable back through hole in rear lifting bracket mounting bracket. |
| 2. Fuel lines (On fuel filter) | Remove in accordance with paragraph 4-34. |

4-25. LIFTING BRACKET (CONT)

Location/Item	Action	Remarks
3. Fuel filter	Support fuel filter and remove hex head cap screws, wrought washers, lockwasher, and hex nut. Tape over ports on fuel filter and set aside in upright position so that fuel in filter does not drain out.	
4. Control panel cover assembly	Support control panel cover assembly and remove in accordance with paragraph 4-16.	
5. Lifting bracket remove, and set aside.	Still supporting control panel cover assembly, lift,	
6. Control panel cover assembly	Insert hex head cap screw through control panel mounting bracket and engine mount to support control panel assembly. Thread on hex nut loosely.	



INSPECTION

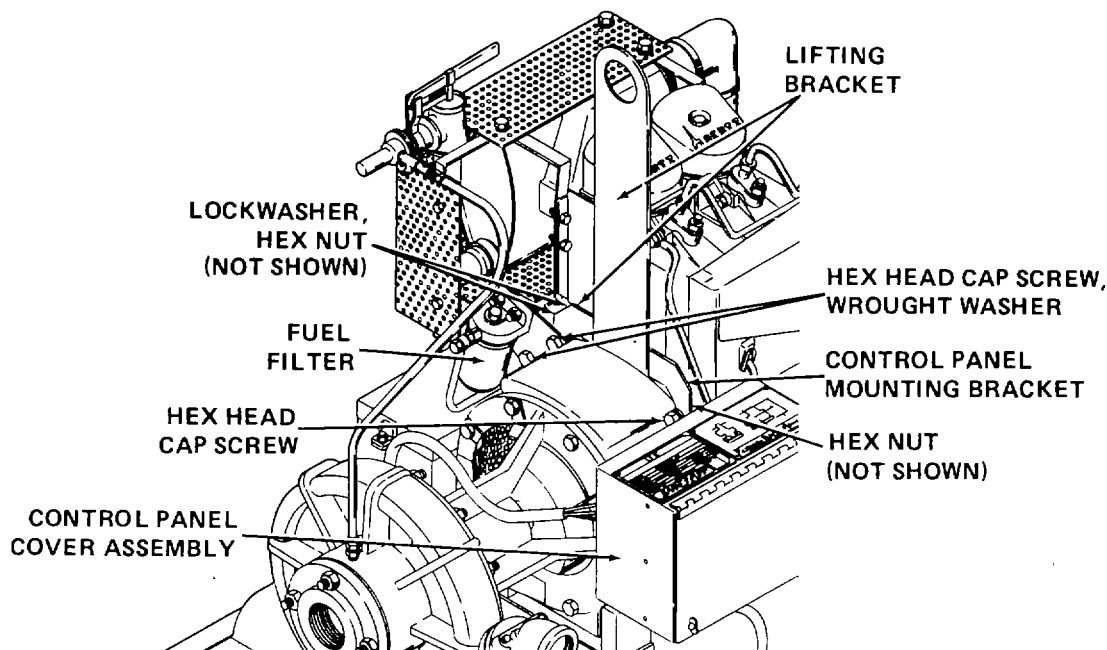
7. Lifting bracket	Inspect for rust, corrosion, or damage. Replace if necessary.
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4-25. LIFTING BRACKET (CONT)

Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

- | | | |
|---|---|--|
| 8. Control panel cover assembly | Support control panel cover assembly and remove hex nut and hex head cap screw. | |
| 9. Lifting bracket | Still supporting control panel assembly and its mounting bracket, align lifting bracket over engine mounting holes. | |
| 10. Control panel mounting bracket | <ol style="list-style-type: none"> Align over same holes. Insert hex head cap screws and wrought washers, then install lockwashers and hex nuts on control panel side only. Do not tighten securely. | |
| 11. Lifting bracket and fuel filter mounting brackets | <ol style="list-style-type: none"> While supporting fuel filter, align lifting bracket and fuel filter mounting brackets with engine mounting holes. Insert hex head cap screws and wrought washers. Add lockwashers and thread on hex nut loosely. | |



4-25. LIFTING BRACKET (CONT)

Location/Item	Action	Remarks
12. Lifting bracket, fuel filter mounting bracket, control panel cover assembly mounting bracket, and hardware	Realign fuel filter bracket and lifting bracket, if necessary. Reinsert hex head cap screws, wrought washers, and lockwashers and thread on hex nuts, if necessary. Tighten down securely. Tighten down control panel mounting bracket hex nuts securely. Check and retighten front or rear hex nuts as necessary.	
13. Throttle cable assembly	Insert throttle cable assembly through hole in lifting bracket. Reconnect cable in accordance with paragraph 4-16. Align cable and lever/arm of speed control using matchmarks made during removal.	
<u>WARNING</u>		
Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.		
<ul style="list-style-type: none"> • Stand clear of venturi during priming. 		
<u>CAUTION</u>		
Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.		
14. Engine	Start engine and check performance. Adjust throttle cable assembly as necessary.	

4-26. V-BELT GUARD

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

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

General Safety Instructions

WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

Materials/Parts

V-belt guard

Equipment

Condition

Para	Condition Description
	Engine shut down and cool.

Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
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REMOVAL

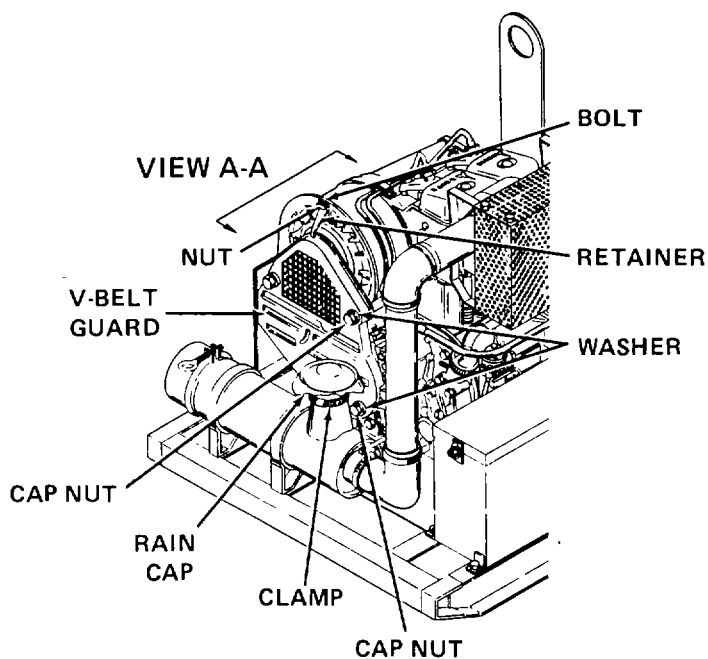
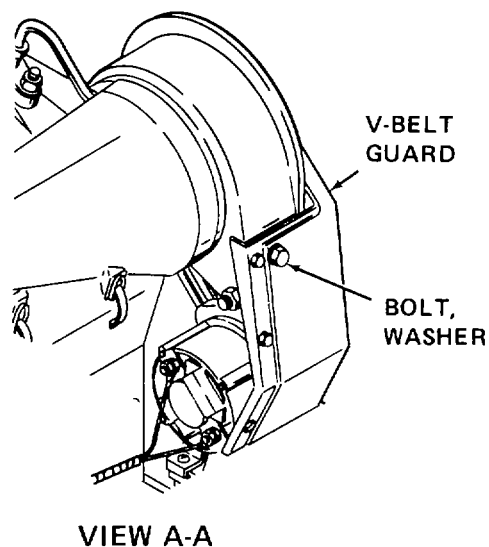
- | | | |
|----|--------------|--|
| 1. | Rain cap | Loosen clamp and remove rain cap. |
| 2. | Retainer | Remove nut and bolt and remove retainer. |
| 3. | V-belt guard | a. Remove cap nuts and washers.
b. Remove bolt and washer from side of guard.
c. Slide guard off studs and remove from engine. |

4-26. V-BELT GUARD (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | |
|-----------------|---|
| 4. V-belt guard | Inspect for damage, dents, rust, or corrosion. If repairable, notify direct support and replace unit. |
|-----------------|---|



REPLACEMENT

- | | |
|-----------------|--|
| 5. V-belt guard | <ol style="list-style-type: none"> a. Install over V-belts and onto studs. b. Install bolt and washer. c. Install cap nuts and washers. |
| 6. Retainer | <ol style="list-style-type: none"> a. Install retainer on guard. b. Install nut and bolt. Tighten nut securely. |
| 7. Rain cap | Place rain cap onto air cleaner. Tighten clamp securely. |

4-27. V-BELTS

This task covers:	a. Removal b. Replacement	c. Adjustment
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INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Special Environmental Conditions

Well-ventilated area required.

Materials/Parts

V-belts

General Safety Instructions

WARNING

Troubleshooting References (Table 4-2)

- Malfunction 1, step 3
- Malfunction 5, step 2
- Malfunction 7, step 2

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

Equipment Condition

Para	Condition Description
4-26	Engine shut down and cool. V-belt guard removed

Location/Item	Action	Remarks
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REMOVAL

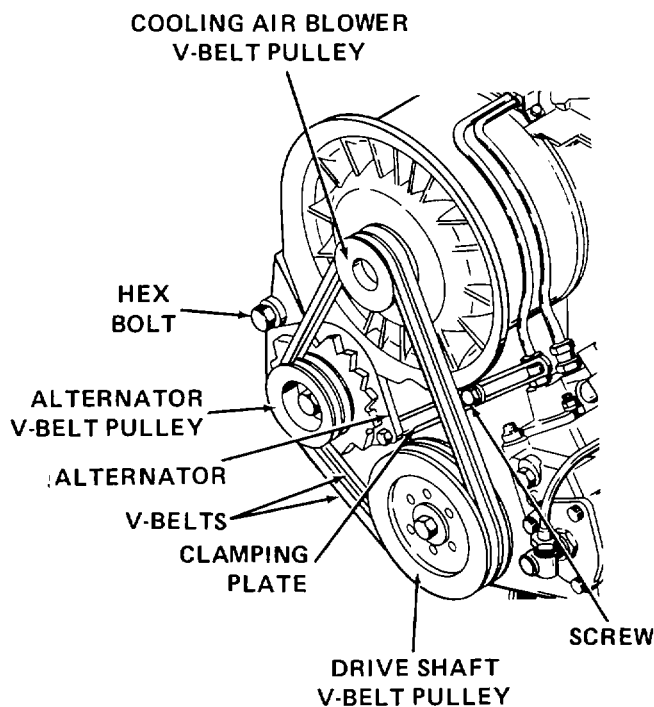
CAUTION

V-belts can only be replaced as a matched pair. Failure to replace both V-belts may result in severe damage to the engine.

- | | |
|----------------------------------|---|
| 1. Alternator and clamping plate | Loosen hex bolt and screw. Carefully push alternator toward engine centerline until slack in V-belts is sufficient to allow for V-belt removal. |
|----------------------------------|---|

4-27. V-BELTS (CONT)

Location/Item	Action	Remarks
2. V-belts	Remove. Inspect for worn or frayed edges; brittle, cracked, or broken rubber. If replacement is necessary, replace as a matched pair.	



REPLACEMENT

3. V-belts	Install new pair over V-belt pulleys.	
4. Alternator and clamping plate	<ol style="list-style-type: none"> a. Carefully push away from engine centerline until V-belt tension is correct. b. Tighten screw and hex bolt securely. 	When thumb pressure is applied to V-belts, a deflection of 3/8-5/8 inch (9.5-15.9 mm) is required.

4-27. V-BELTS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

WARNING

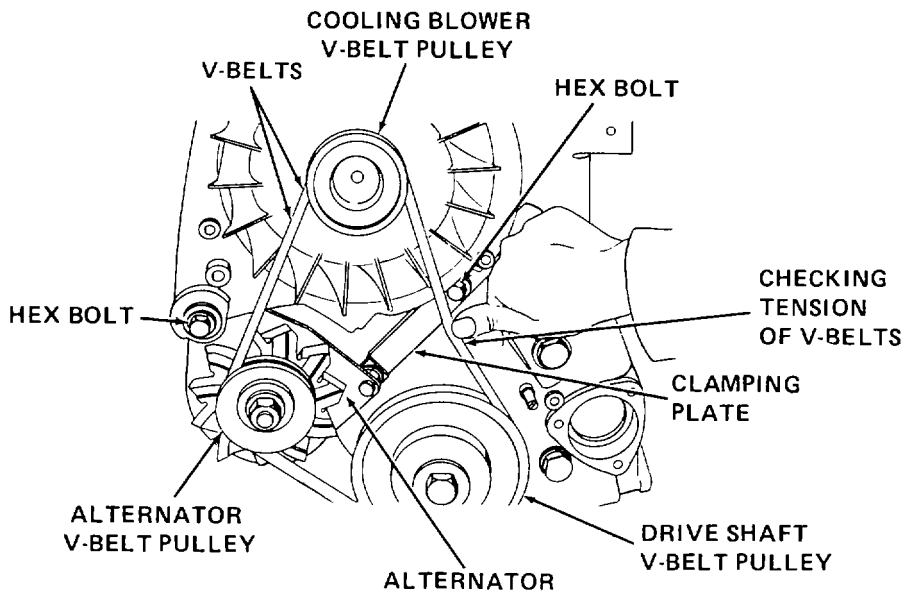
Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump. Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

- 5. Engine Run engine for 10 minutes prior to replacing V-belt guard.
- 6. V-belts Check for proper tension after run-in.



4-27. V-BELTS (CONT)

Location/Item	Action	Remarks
ADJUSTMENT		
7. Alternator and clamping plate	a. Loosen hex bolt and screw. Carefully push alternator away from engine centerline until V-belt tension is correct. b. Tighten screw and hex bolt securely. is required.	When thumb pressure is applied to V-belts, a deflection of 3/8-5/8 inch (9.5-15.9 mm)
8. V-belt guard	Install in accordance with paragraph 4-26.	

4-28. ALTERNATOR V-BELT PULLEY AND FAN

This task covers: a. Removal b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Special Environmental Conditions

Well-ventilated area required.

Materials/Parts

Alternator V-belt pulley
Fan

General Safety Instructions

WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

Troubleshooting References (Table 4-2)

Malfunction 7, steps 2 and 3

Equipment

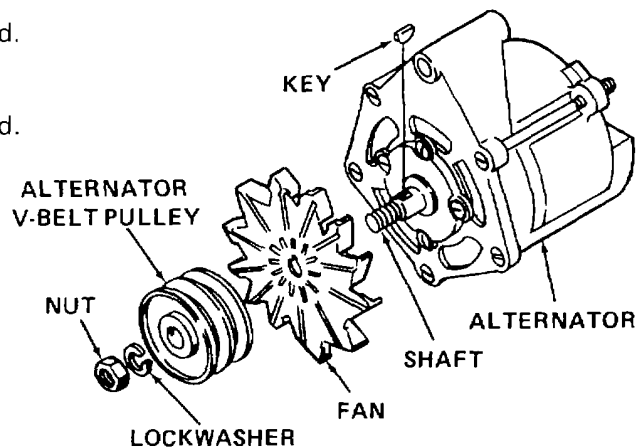
Condition

Para	Condition Description
	Engine shut down and cool.
4-26	V-belt guard removed.
4-27	V-belts removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|-----------------------------|--|
| 1. Shaft | Hold shaft securely. Remove nut and lock-washer. |
| 2. Alternator V-belt pulley | Remove. Replace if damaged. |
| 3. Fan | Remove. Replace if damaged. |
| 4. Shaft | Remove key. |



4-28. ALTERNATOR V-BELT PULLEY AND FAN CONT)

Location/Item	Action	Remarks
REPLACEMENT		
5. Shaft	Install key.	
6. Fan	Install onto shaft over key with fan blades toward alternator.	
7. Alternator V-belt pulley	a. Install onto shaft over key. b. Install nut and lockwasher. Tighten to 66 ft lb (90 N.m) using torque gage.	
8. Shaft	Check shaft for free rotation.	
9. V-belts and V-belt guard	Install and adjust in accordance with paragraphs 4-26 and 4-27.	

4-29. DRIVE SHAFT V-BELT PULLEY

This task covers: a. Removal b. Replacement

INITIAL SETUP

Tools

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Tool kit, master mechanics
NSN 5180-00-699-5273

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions

WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts. Close control panel to prevent accidental starting while V-belt guard is removed. If necessary to run engine without V-belt guard, be sure that area around V-belts is clear of personnel and tooling.

Materials/Parts

Drive shaft V-belt pulley

Troubleshooting References (Table 4-2)

Malfunction 7, step 2

Equipment

Condition

Para	Condition Description
-------------	------------------------------

4-26	Engine shut down and cool.
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4-27	V-belt guard removed.
------	-----------------------

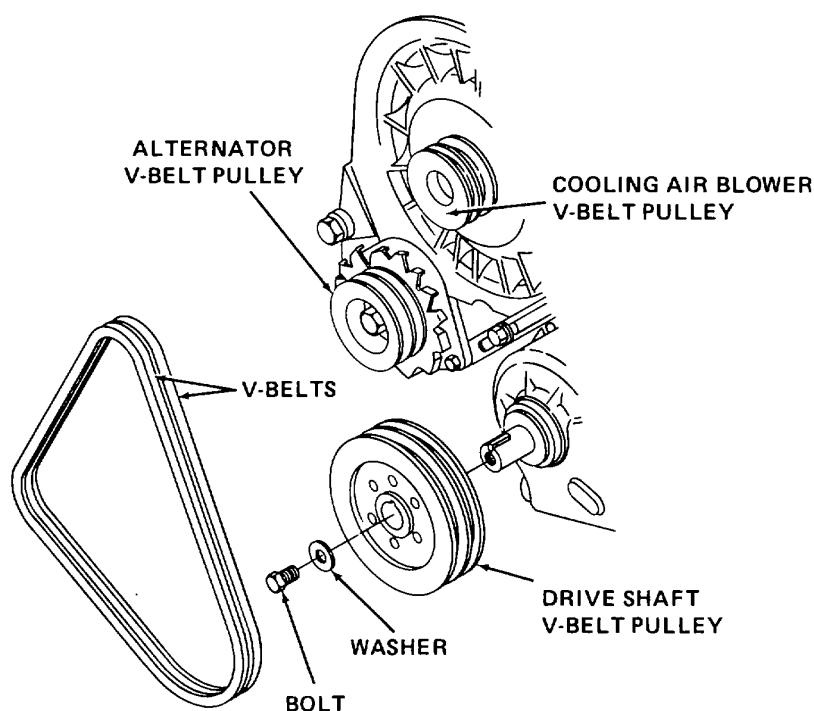
4-27	V-belts removed.
------	------------------

4-29. DRIVE SHAFT V-BELT PULLEY (CONT)

Location/Item	Action	Remarks
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REMOVAL

- | | | |
|------------------------------|--|--|
| 1. Drive shaft V-belt pulley | <ol style="list-style-type: none"> a. Remove bolt and washer. b. Remove drive shaft V-belt pulley from drive shaft using gear puller. c. Replace unit if damaged. | |
| 2. Shaft | Remove key. | |

**REPLACEMENT**

- | | | |
|-------------------------------------|--|--|
| 3. Shaft | Install key. | |
| 4. Drive shaft V-belt pulley shaft. | <ol style="list-style-type: none"> a. Install drive shaft V-belt pulley onto drive shaft, aligning slot in pulley with key on drive shaft. b. Install bolt and washer. Tighten to 66 ft lb (90 N.m) using torque gage. | |
| 5. V-belts | Install, test, and adjust V-belts over pulleys in accordance with paragraph 4-27. | |
| 6. V-belt guard | Install and tighten securely in accordance with paragraph 4-26. | |

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING

- This task covers:
- a. Removal
 - b. Installation/Replacement
 - c. Inspection
 - d. System Test

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654
 Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Materials/Parts

Cooling air blower
 Cooling air ducting

References

Para 4-15 Electrical System Assembly
 Para 4-16 Control Panel Cover Assembly,
 Control Panel Assembly,
 Instruments, and Switches

Troubleshooting References (Table 4-2)

Malfunction 3, step 1
 Malfunction 5, step 1
 Malfunction 7, step 2

Equipment Condition

Para	Condition Description
	Engine shut down and cool.
4-15	Wire from thermostitch to control panel removed from thermostitch on cylinder head.
4-20	Muffler guard and muffler guard mounting brackets removed from engine.
4-25	Lifting bracket removed from engine.
4-26	V-belt guard removed.
4-27	V-belts removed.
4-38	Alternator removed (with clamping plate attached).

Special Environmental Conditions

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

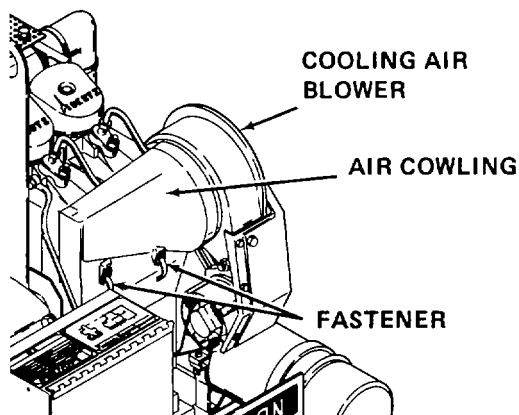
GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
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REMOVAL

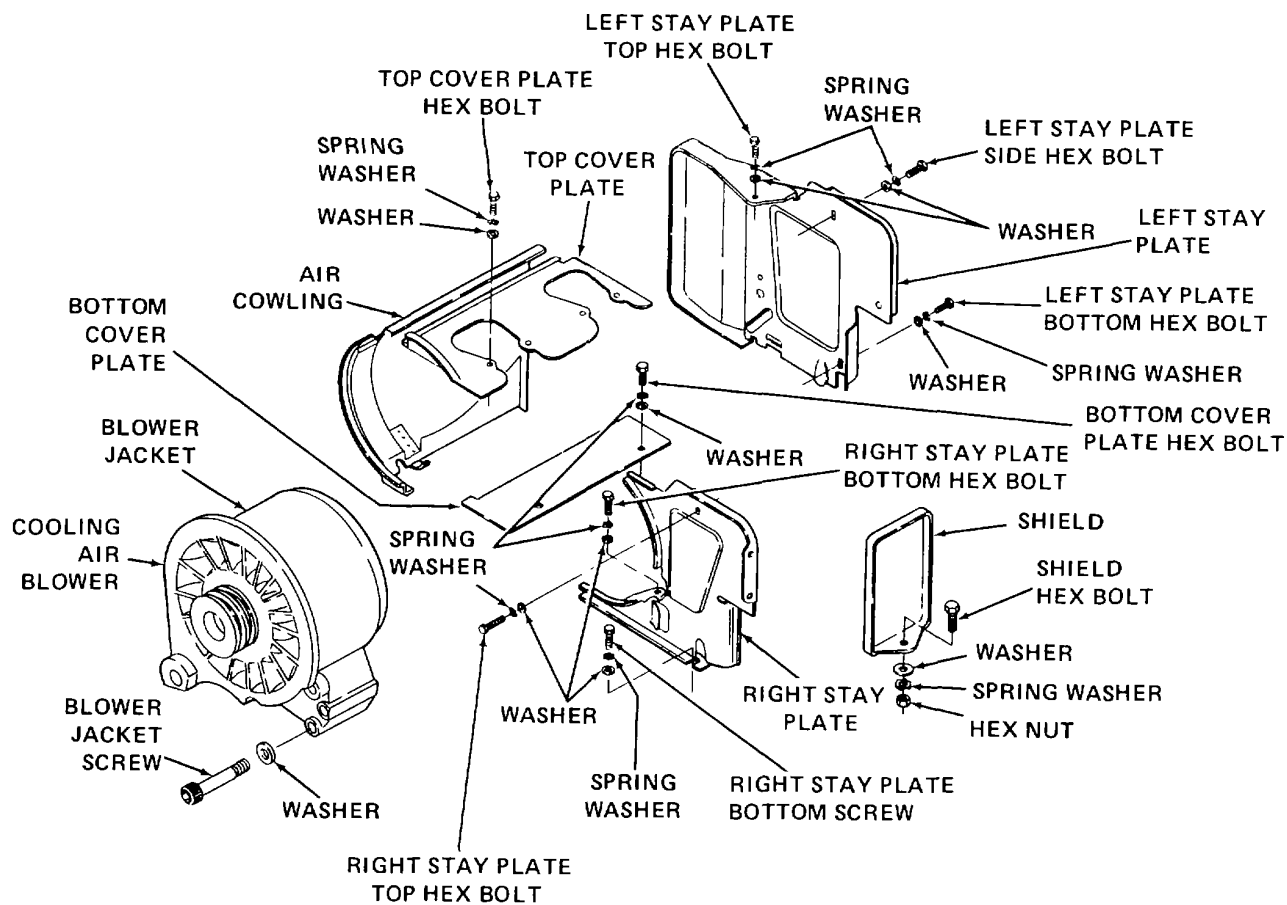
1. Air cowling Loosen two bottom fasteners and remove.



2. Blower jacket Remove blower jacket screws and washers from blower jacket.
3. Cooling air Remove from inside cooling air ducting. blower
4. Right stay plate
- Remove right stay plate bottom hex bolt and washer.
 - Remove right stay plate top hex bolt, washers, right stay plate bottom, and washers.
 - Remove right stay plate.
5. Bottom cover plate
- Remove bottom cover plate hex bolt and washers.
 - Remove bottom cover plate.
6. Left stay plate
- Remove bottom, side, and top hex bolts, and washers.
 - Remove left stay plate.

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
7. Top cover plate	a. Remove top cover plate hex bolts and washers. b. Remove top cover plate.	
8. Shield	a. Remove shield hex bolt, hex, nut, and washers. b. Remove shield.	



INSPECTION

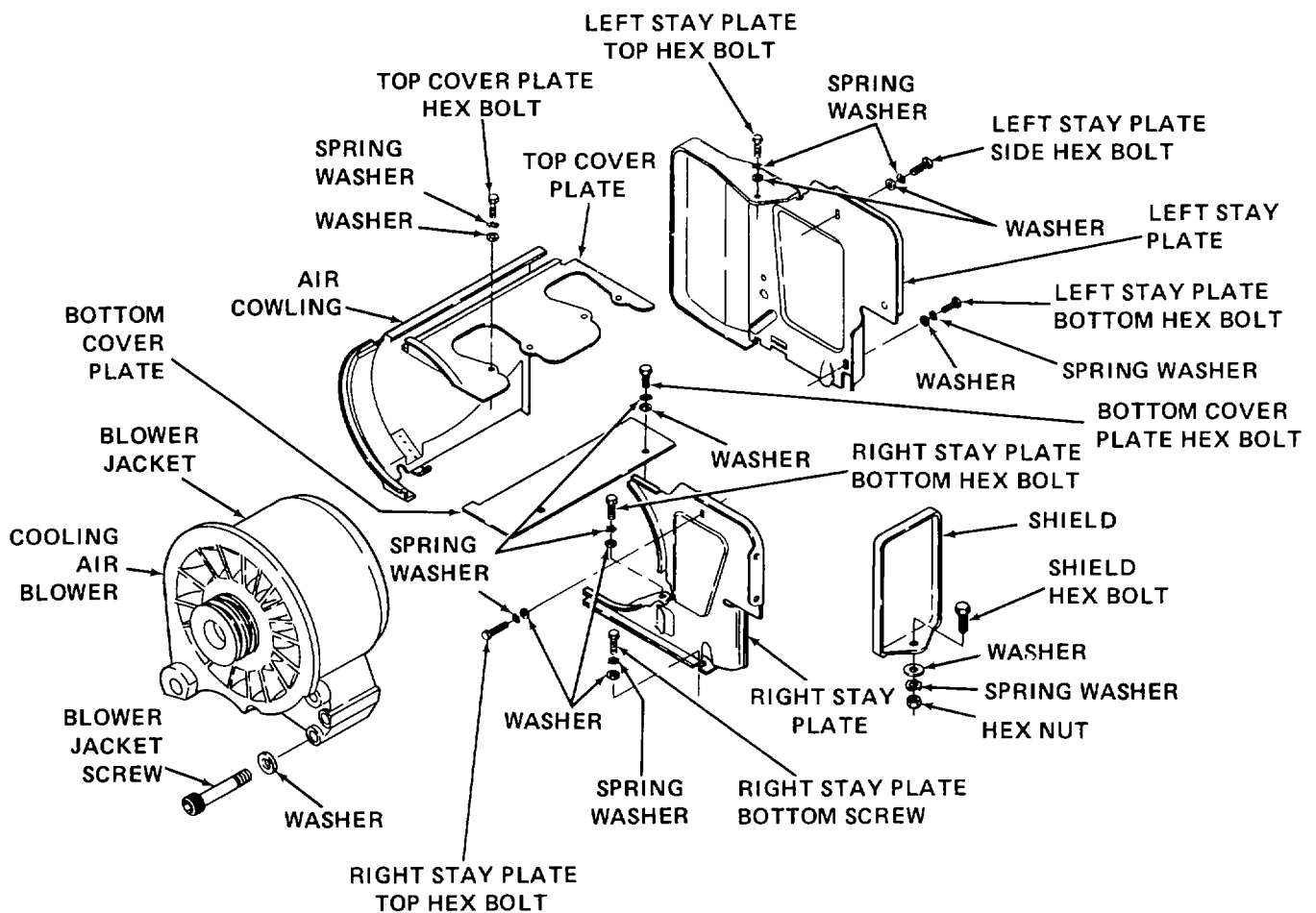
9. Cooling air blower	Replace if damaged.
10. Cooling air ducting (air cowling, stay plates, cover plates, and shield)	Replace if damaged.

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
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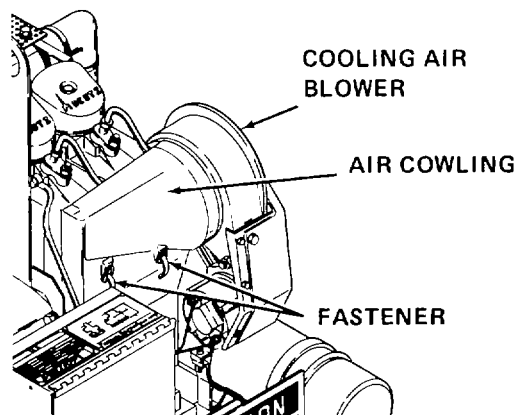
INSTALLATION/REPLACEMENT

- 11. Shield
 - a. Install.
 - b. Install shield hex bolt, hex nut, and washers. Tighten securely.
- 12. Top cover plate
 - a. Install.
 - b. Install top cover plate hex bolts and washers. Tighten securely.
- 13. Left stay plate
 - a. Install.
 - b. Install bottom, top, and side hex bolts, and washers. Tighten securely.



4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
14. Bottom cover plate	a. Install. b. Install bottom cover plate hex bolt and washers. Tighten securely.	
15. Right stay plate	a. Install. b. Install right stay plate top hex bolt, washers, right stay plate bottom screw, and washers. Tighten securely. c. Install right stay plate bottom hex bolt and washer. Tighten securely.	
16. Blower jacket	Install blower jacket screws and washers. Tighten securely.	
17. Air cowling	Install. Clamp fasteners.	



18. Alternator and clamping plate	Install in accordance with paragraph 4-38.	
19. V-belts	Install and adjust tension in accordance with paragraph 4-27.	
20. V-belt guard	Install in accordance with paragraph 4-26.	
21. Muffler guard and muffler guard mounting brackets	Install in accordance with paragraph 4-20.	
22. Lifting bracket	Install in accordance with paragraph 4-25.	
23. Thermostat wire	Install in accordance with paragraph 4-15.	

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

SYSTEM TEST

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

4-30. COOLING AIR BLOWER AND COOLING AIR DUCTING (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

24. Engine	Start engine and check for loose, rattling components. Tighten as necessary to prevent rattles. Check for fuel leaks around injection lines and fuel vent. Tighten connections as necessary. Check for positive deflection of ammeter. If ammeter shows a negative current flow, check electrical system (paragraph 4-15) or ammeter (paragraph 4-16). Shut down engine.	
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4-31. LUBE OIL FILTER

This task covers: a. Removal b. Installation/Replacement

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

Malfunction 4, step 1

Malfunction 6, step 1

Equipment Condition Para

Condition Description

Engine shut down and cool.

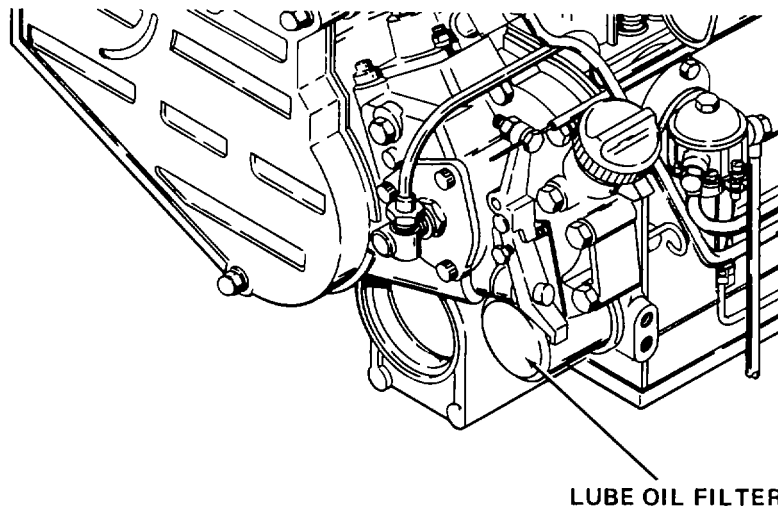
Materials/Parts

Lube oil filter
Lubricating oil (Item 9, Appendix E)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Lube oil filter
 - a. Rotate counterclockwise to remove from engine.
 - b. Discard.



4-31. LUBE OIL FILTER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION/REPLACEMENT

2. Lube oil filter
 - a. Coat gasket of replacement filter with clean MIL-L-2104 lubricating oil.
 - b. Rotate filter clockwise to install.
 - c. Tighten hand tight.
-

4-32. LUBE OIL COOLER AND LUBE OIL LINE AND FITTINGS

- This task covers:
- a. Removal
 - b. Inspection
 - c. Installation/Replacement
 - d. System Test

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

Malfunction 6, step 1

Equipment Condition Para

Condition Description

Materials/Parts

Lube oil cooler
Lube oil line and fittings.

4-30

Engine shut down and cool.
Cooling air blower and cooling air ducting removed from engine.

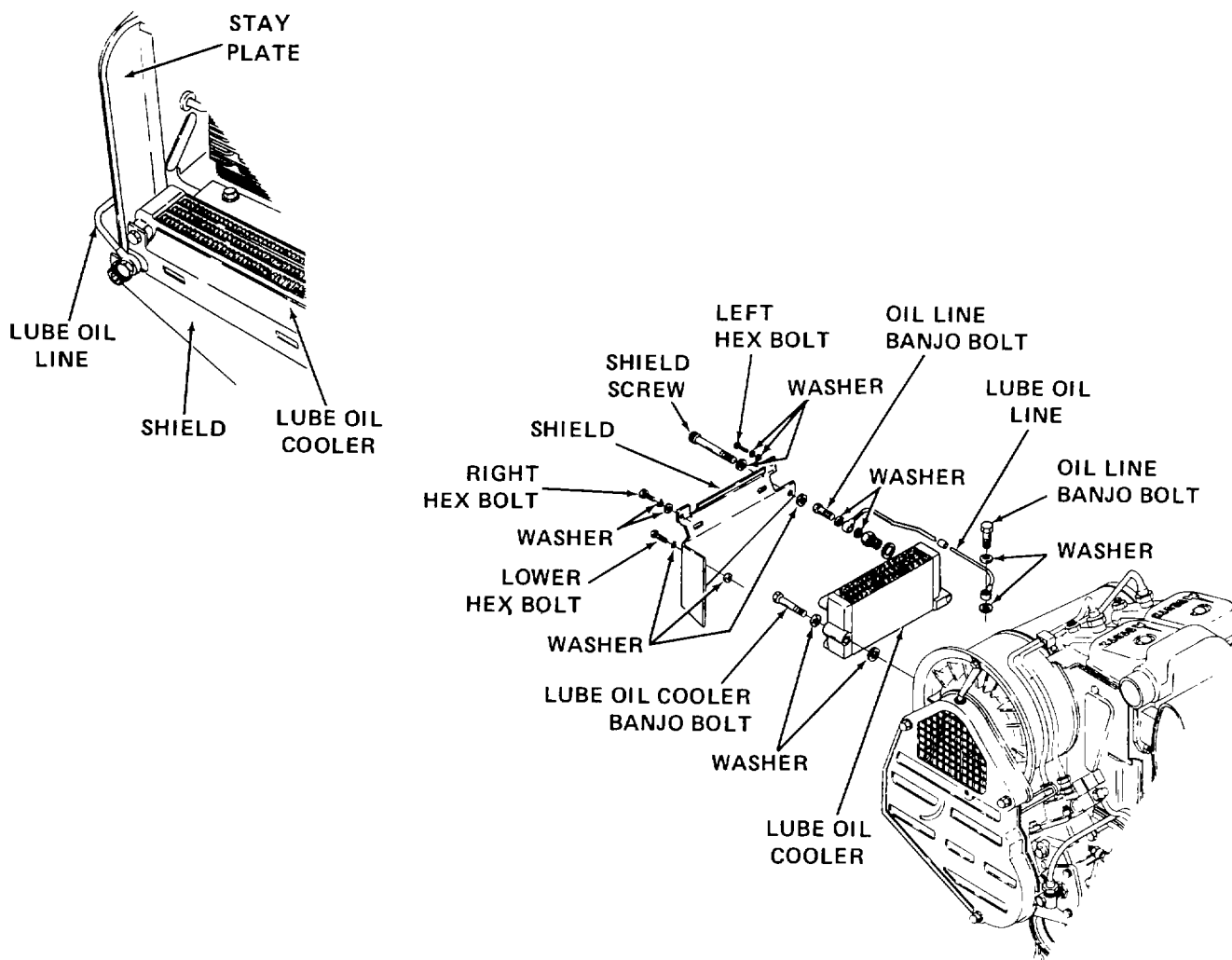
Location/Item	Action	Remarks
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REMOVAL

1. Lube oil line
 - a. Remove oil line banjo bolts and washers from both ends of lube oil line.
 - b. Remove lube oil line.
2. Lube oil cooler and shield
 - a. Remove lube oil cooler banjo bolt and washers.
 - b. Remove shield screw and washers.
 - c. Remove lube oil cooler and shield.

4-32. LUBE OIL COOLER AND LUBE OIL LINE AND FITTINGS (CONT)

Location/Item	Action	Remarks
3. Shield	a. Remove left, right, and lower hex bolts, and washers. b. Remove from lube oil cooler.	



INSPECTION

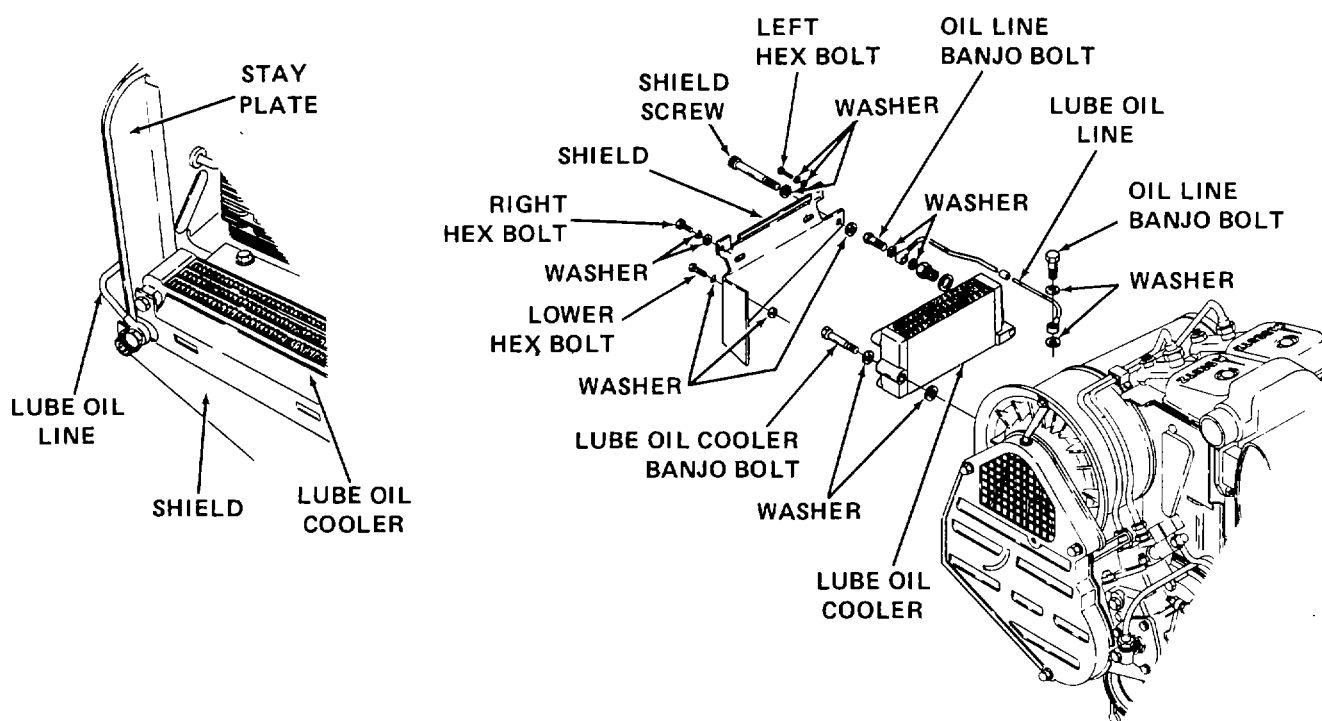
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|-------------------------------|---------------------|
| 4. Lube oil cooler and shield | Replace if damaged. |
| 5. Lube oil line | Replace if damaged. |

4-32. LUBE OIL COOLER AND LUBE OIL LINE AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSTALLATION/REPLACEMENT

- | | |
|-------------------------------|---|
| 6. Shield | <ul style="list-style-type: none"> a. Install shield on lube oil cooler. b. Install left, right, and lower hex bolts, and washers. Tighten hex bolts securely. |
| 7. Lube oil cooler and shield | <ul style="list-style-type: none"> a. Install. b. Install lube oil cooler banjo bolt and washers. Tighten securely. c. Install shield screw and washers. Tighten securely. |
| 8. Lube oil line | <ul style="list-style-type: none"> a. Install. b. Install oil line banjo bolts and washers. Tighten securely. |



- | | |
|---|---|
| 9. Cooling air blower and cooling air ducting | Install in accordance with paragraph 4-30 |
|---|---|

4-32. LUBE OIL COOLER AND LUBE OIL LINE AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

SYSTEM TEST

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

4-32. LUBE OIL COOLER AND LUBE OIL LINE AND FITTINGS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

10. Engine	Start engine and check for oil leaks around lube oil cooler and lube oil line. Tighten banjo bolts, as necessary. Check for fuel leaks around injection lines and fuel line vent. Tighten connections as necessary.	
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4-33. CRANKCASE BREATHER

This task covers:

- a. Removal
- b. Disassembly
- c. Inspection
- d. Repair
- e. Installation/Replacement

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

References

MIL-T-704 Treatment and Painting of Materiel

Materials/Parts

Crankcase breather assembly
Lubricating oil (Item 9, Appendix E)
Materials required by MIL-T-704

Equipment Condition Para

Condition Description

Engine shut down and cool.

Location/Item	Action	Remarks
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REMOVAL

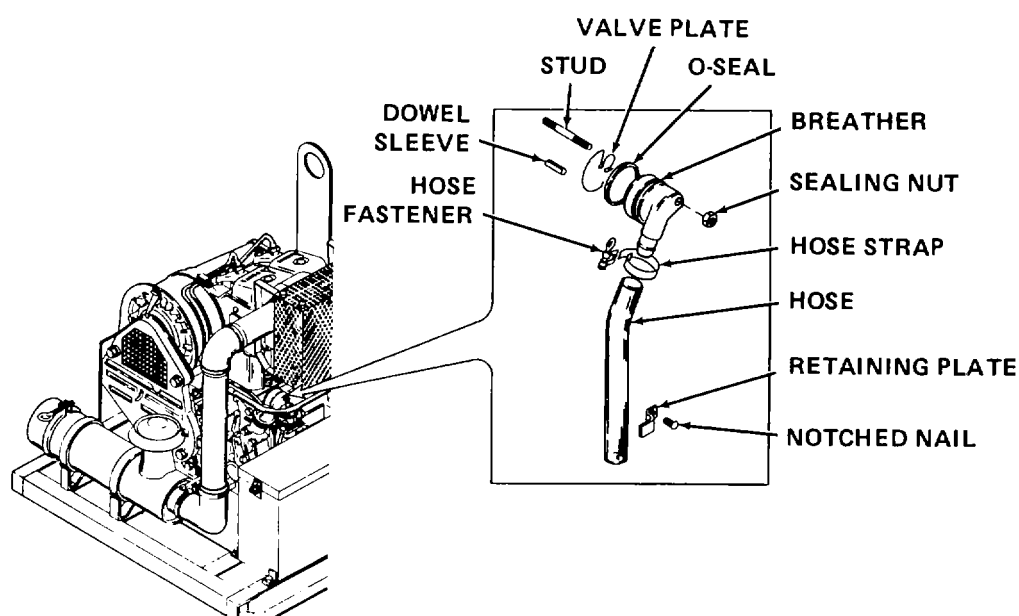
- | | |
|---|------------------------|
| 1. Notched nail and retaining plate | Remove. Discard nail. |
| 2. Crankcase breather and assembled parts | a. Remove sealing nut. |
| | b. Remove from stud. |

4-33. CRANKCASE BREATHER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

DISASSEMBLY

- | | | |
|-----------------|--|--|
| 4. Valve plate | Remove. | |
| 5. O-seal | Remove and discard. | |
| 6. Dowel sleeve | Remove and discard. | |
| 7. Hose | a. Remove hose fastener and hose strap.
b. Remove hose. | |



INSPECTION

- | | | |
|---|-----------------------------|--|
| 9. Breather, retaining plate, sealing nut, valve plate, hose fastener, hose strap, and hose | Replace damaged components. | |
|---|-----------------------------|--|

4-33. CRANKCASE BREATHER (CONT)

Location/Item	Action	Remarks
REPAIR		
10. Breather	Repair minor rust or corrosion in accordance with MIL-T-704. If blocked, remove debris. Replace if damaged.	
11. Hose	If damaged, replace.	
12. Hose fastener and hose strap	Refinish in accordance with MIL-T-704.	
INSTALLATION/REPLACEMENT		
13. Hose, hose fastener, and hose strap	Assemble on breather. Tighten hose fastener snugly but not too tight. Overtightening hose fastener will crimp or damage hose.	
14. Crankcase breather, valve plate, new O-seal, new dowel sleeve, and sealing nut	Install onto crankcase stud. Make sure O-seal has been coated with MIL-L-2104 lubricating oil. Tighten sealing nut on crankcase stud securely.	Install new O-seal and new dowel sleeve.
15. Retaining plate and notched nail	Install retaining plate with new notched nail. Make sure retaining plate is securely fastened to crankcase.	Install new notched nail.

4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER

This task covers:

a. Removal	b. Installation/Replacement
c. Inspection	

INITIAL SETUP**Tools**

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Fuel feed pump

Fuel filter

Fuel injector lines

Fuel line (fuel feed pump to fuel filter)

Fuel line (fuel filter to fuel injection pump)

Fuel line (fuel tank to fuel feed pump)

O-seal

Tie wraps

Diesel fuel (Item 5, Appendix E)

Troubleshooting References (Table 4-2)

Malfunction 2, steps 6 and 7
Malfunction 3, step 3

**Equipment
Condition
Para****Condition Description**

Engine shut down and cool.

4-22

Fuel line and fuel line vent removed.

General Safety Instructions**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER (CONT)

Location/Item	Action	Remarks
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REMOVAL

WARNING

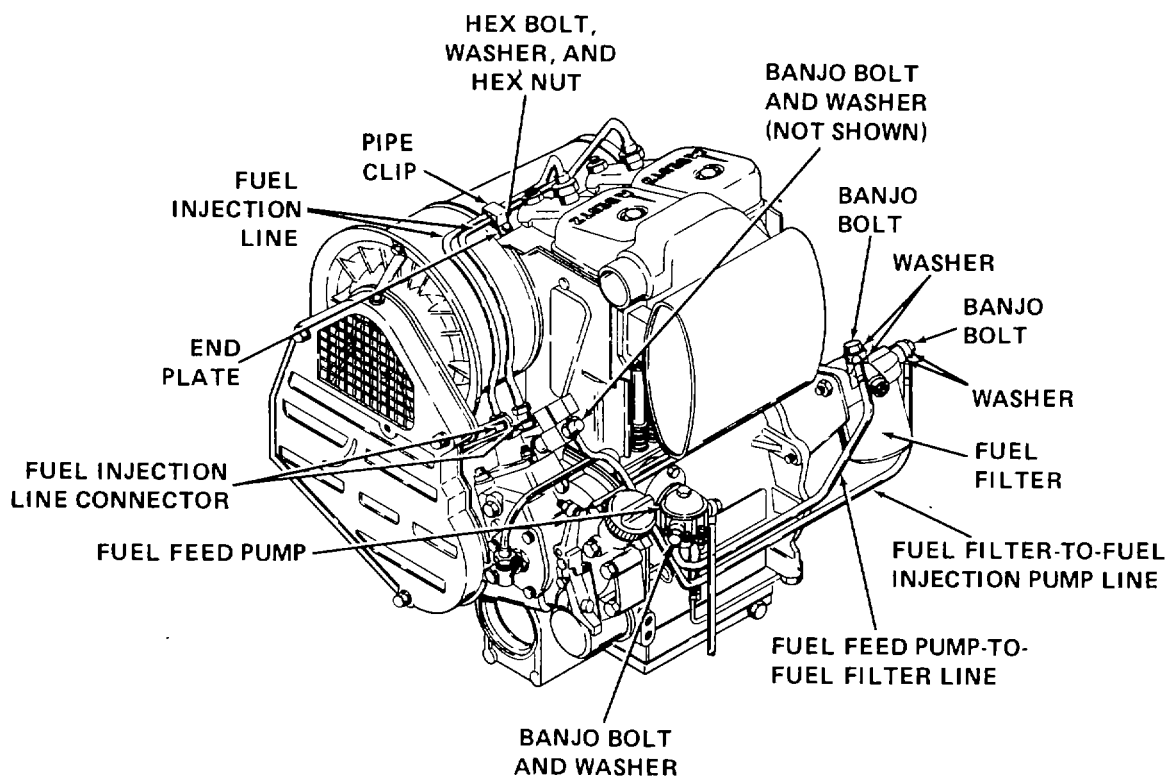
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

CAUTION

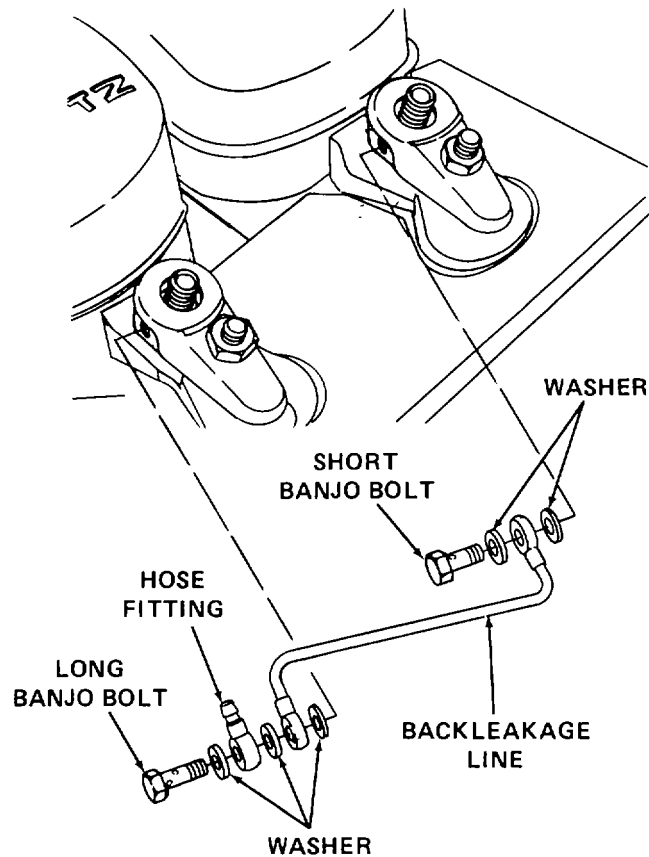
As each fuel line, connection, or connecting port is removed, be sure to tape over or plug each open connection to prevent contaminants from entering fuel system.

1. Fuel feed pump-to-fuel filter line
 - a. Remove banjo bolts and washers.
 - b. Remove fuel line.
 - c. Tape or plug fittings and ports.



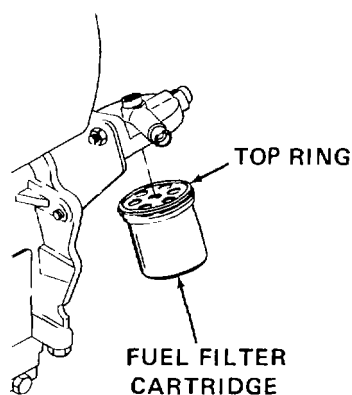
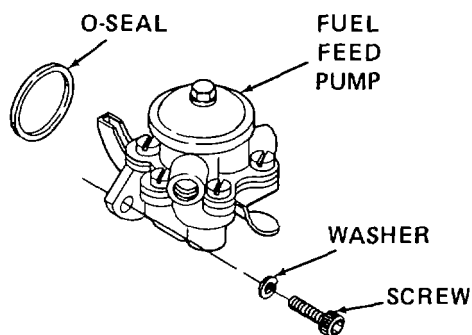
4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER (CONT)

Location/Item	Action	Remarks
2. Fuel filter-to-fuel injection pump line	a. Remove banjo bolts and washers. b. Remove fuel line. c. Tape or plug fittings and parts.	
3. Pipe clip and end plate	a. Remove hex bolt, washer, and hex nut. b. Remove pipe clip and end plate.	
4. Fuel injection lines connectors	Remove from fuel injection pump and injectors.	
5. Fuel injection lines	Remove with connectors attached.	
6. Backleakage line	a. Remove banjo bolts, washers, and hose fitting. b. Remove backleakage line.	



4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER (CONT)

Location/Item	Action	Remarks
7. Fuel feed pump	a. Remove screws and washers. b. Remove fuel feed pump and set aside for inspection. c. Tape off fuel ports. d. Discard O-seal.	
8. Fuel filter	Remove fuel filter cartridge. Rotate counterclockwise to remove. Discard cartridge.	



INSPECTION

9. Fuel lines and back-leakage line	Replace damaged fuel lines and banjo bolts.	
10. Fuel feed pump	If not operational, replace.	

4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER (CONT)

Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

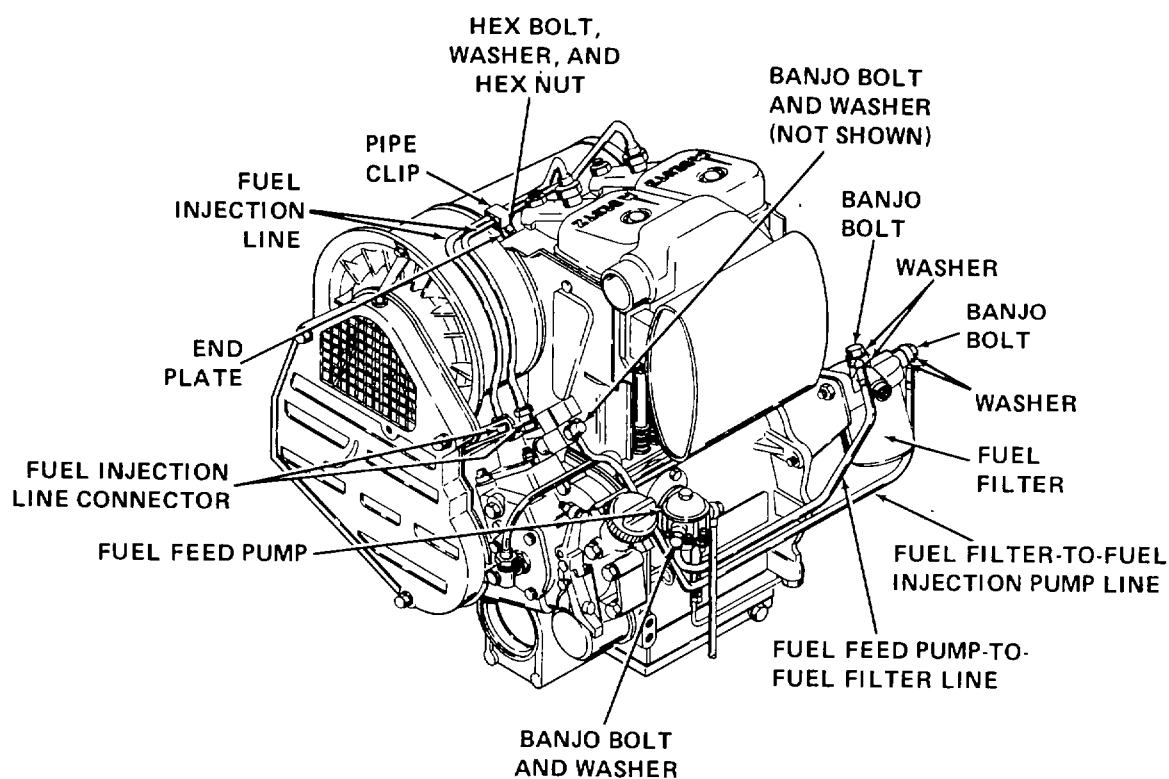
- **Do not inhale vapor.**
- **Do not handle fuel near open flame, sparks, or excessive heat.**
- **Work in a well-ventilated area.**

11. Fuel filter	Fill new fuel filter cartridge 2/3 full with VV-F-800 diesel fuel oil and coat top ring. Install by rotating fuel filter cartridge clockwise and tighten hand tight.	Install new fuel filter.
12. Fuel feed pump	a. Install fuel feed pump with new O-seal. b. Install washers and screws. Tighten screws securely.	Install new O-seal.
13. Backleakage line	a. Install. b. Install long banjo bolt, hose fitting, and three washers. c. Install short banjo bolt and two washers.	
14. Fuel injection lines and connectors	Reinstall and tighten connectors securely.	
15. End plate and pipe clip	Install with hex bolt, washer, and hex nut. Tighten hex bolt securely.	
16. Fuel filter-to-fuel injection pump line	Install with banjo bolts and new washers.	

4-34. FUEL SYSTEM LINES AND FITTINGS, FUEL FEED PUMP, AND FUEL FILTER (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|--|---|--|
| 17. Fuel feed pump-to-fuel filter line | Install with banjo bolts and new washers. Tighten banjo bolts securely. | |
|--|---|--|



- | | | |
|----------------------------------|---|--|
| 18. Fuel line and fuel line vent | Install in accordance with paragraph 4-22. | |
| 19. Fuel lines | Bleed air from fuel system in accordance with paragraph 4-22. | |

4-35. ENGINE SHUTDOWN VALVE

- This task covers:
- | | |
|--------------------|-----------------------------|
| a. Removal | d. Installation/Replacement |
| b. Test/Inspection | e. System Test |
| c. Inspection | |

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Engine shutdown valve

Fuel filter-to-injection pump line

Diesel fuel (Item 5, Appendix E)

References

- | | |
|-----------|---|
| Para 4-15 | Electrical System Assembly |
| Para 4-16 | Control Panel Cover Assembly,
Control Panel Assembly,
Instruments, and Switches |
| Para 4-22 | Fuel Tank Lines and Fittings |

Engine shut down and cool.

Troubleshooting References (Table 4-2)

- Malfunction 2, steps 1, 6, and 7
- Malfunction 3, step 3

Equipment Condition Para

Condition Description

Engine shut down and cool.

General Safety Instructions

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Do not handle fuel near open flame, sparks, or excessive heat.**
- **Work in a well-ventilated area.**

4-35. ENGINE SHUTDOWN VALVE (CONT)

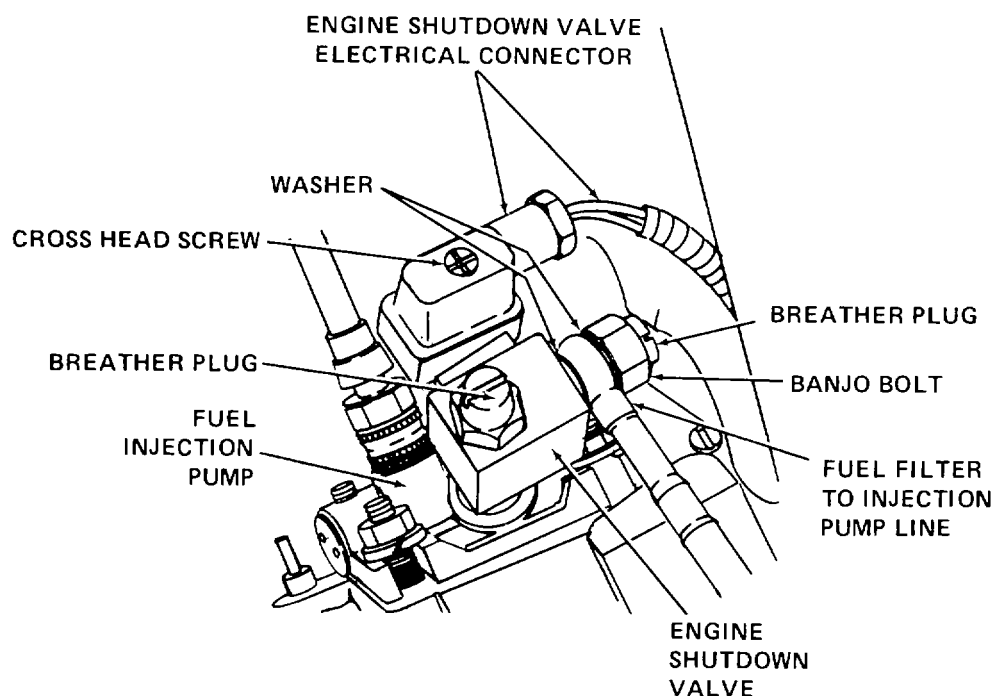
Location/Item	Action	Remarks
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REMOVAL**WARNING**

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

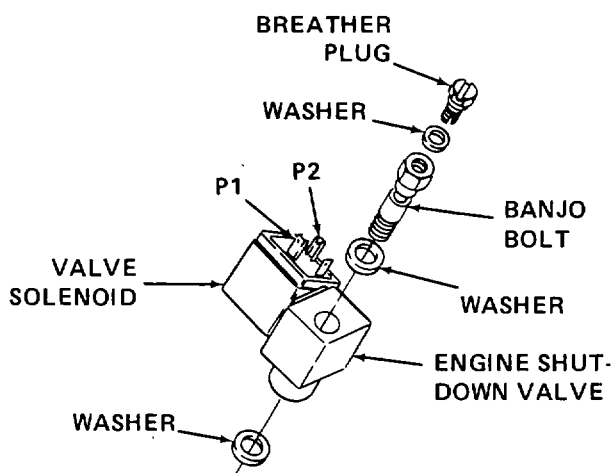
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- | | |
|---|---|
| 1. Fuel filter-to-injection pump line | a. Remove banjo bolt and washers.
b. Remove fuel filter-to-injection pump lines. |
| 2. Engine shutdown valve electrical connector | a. Remove cross head screw from electrical connector and attached wiring (to control panel) from engine shutdown valve.
b. Pull square three-prong connector upward and off. |



4-35. ENGINE SHUTDOWN VALVE (CONT)

Location/Item	Action	Remarks
3. Engine shut-down valve	Remove breather plug, washer, and banjo bolt from fuel injection pump by rotating counterclockwise. Remove and discard washers.	



TEST/INSPECTION

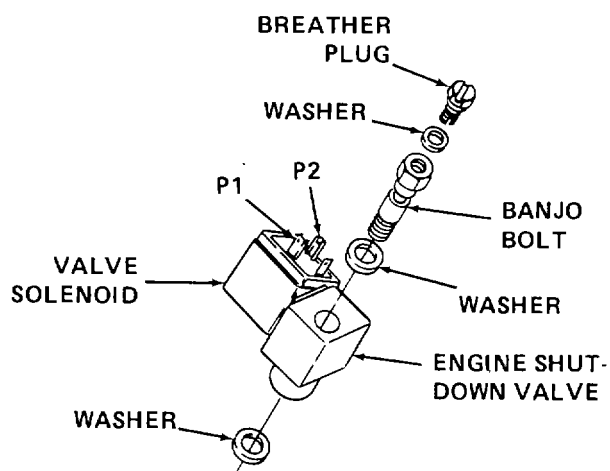
4. Engine shut-down valve	Electrically test operation of engine shutdown valve and valve solenoid. Connect pin (P2) to ground. Intermittently apply +12 vdc to pin 1 (P1). The valve should normally be open with +12 volts applied to pin 1 (P1) but should close when no voltage is applied to pin 1 (P1). These signals simulate the engine fault sensitive control signals from the control panel. Test valve is open when an electrical signal (+12 vdc) is applied to the valve solenoid pin 1 (P1), simulating the reset signal. If either malfunction, replace engine shutdown valve and solenoid.	
5. Engine shut-down valve	Inspect valve, breather plug, and banjo bolt for damage, rust, corrosion, or restrictions in fuel flow. If damaged, severely rusted, or corroded, replace valve. If valve needs to be adjusted, follow adjustment procedure below. Inspect electrical contacts on both ends of electrical connectors at engine shutdown valve. Inspect wiring to and from control panel. For connections at control panel, follow procedures in paragraphs 4-15 and 4-16. If any electrical problems or malfunctions exist, replace wiring and/or connectors as necessary.	

4-35. ENGINE SHUTDOWN VALVE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

ADJUSTMENT

- | | | |
|---------------------------|--|--|
| 6. Engine shut-down valve | Adjust valve with slotted breather plug and banjo bolt. Adjustment should allow completely open fuel flow when engine shutdown has not been activated and completely closed fuel flow or shutdown when engine shutdown has been activated. | |
|---------------------------|--|--|



INSTALLATION/REPLACEMENT

- | | | |
|-------------------------------------|--|----------------------|
| 7. Engine shut-down valve securely. | Install assembled engine shutdown valve with new washers. Rotate clockwise and tighten | Install new washers. |
|-------------------------------------|--|----------------------|

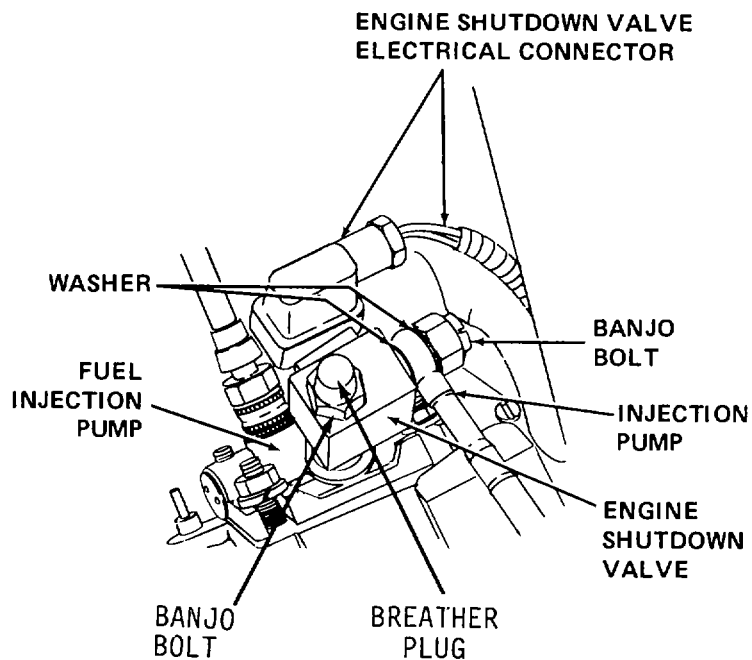
4-35. ENGINE SHUTDOWN VALVE (CONT)

Location/Item	Action	Remarks
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CAUTION

Do not force. Be careful to match slots in connector to plug prongs on engine shutdown valve.

- | | |
|---|---|
| 8. Engine shutdown valve electrical connector | <ul style="list-style-type: none"> a. Reinstall three-slot square electrical connector onto three-prong plug on engine shutdown valve. b. Install cross head screw. |
| 9. Fuel filter-to-injection pump line | Install with banjo bolt and new washers. Tighten banjo bolt securely. |



- | | |
|----------------|---|
| 10. Fuel lines | Bleed air from fuel system in accordance with paragraph 4-22. |
|----------------|---|

4-35. ENGINE SHUTDOWN VALVE (CONT)

Location/Item	Action	Remarks
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SYSTEM TEST

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

4-35. ENGINE SHUTDOWN VALVE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

11. Engine shutdown valve	<p>Test engine shutdown capability and fuel flow when engine shutdown valve is normally open and closed. Try to start engine without pushing in reset button. Engine should not start. Do not crank engine for more than 30 seconds. This procedure will test the valve's shutdown (closed) capability. Start engine with reset button pushed in. If engine starts and oil pressure reaches at least 25 psi (172 kPa), release button. Engine should continue to run. Some adjustment of the valve may be necessary. Follow procedure outlined in step 6 above.</p>	
12. Engine	<p>Start engine. If engine still runs rough after 5 minutes, try further adjustment of engine shutdown valve. If engine continues to malfunction, refer to troubleshooting guide.</p>	

4-36. EXHAUST SILENCER

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

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654

Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Equipment Condition Para

Condition Description

4-20 Exhaust elbow and guard removed.

WARNING

Handling a hot exhaust silencer can cause severe burns. Allow unit to cool before handling.

Materials/Parts

Exhaust silencer
 Gaskets

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | | |
|--------------------------------------|--|--|
| 1. Exhaust silencer and gaskets back | a. Remove hex nuts and washers from studs.

b. Remove exhaust silencer. Discard gaskets, nut and washer. | Loosen hose clamp and pull tube (paragraph 4-21) to gain access to hex |
|--------------------------------------|--|--|

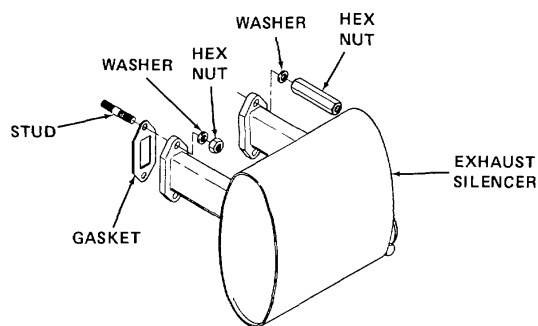
INSPECTION

- | | | |
|---|---------------------|--|
| 2. Exhaust silencer and mounting hardware | Replace if damaged. | |
|---|---------------------|--|

INSPECTION/REPLACEMENT

- | | | |
|---------------------------------|---|--|
| 3. Gaskets and exhaust silencer | a. Install new gaskets and silencer.

b. Install hex nuts and washers. Tighten hex nuts securely. | |
|---------------------------------|---|--|



4-172

4-36. EXHAUST SILENCER

Location/Item	Action	Remarks
---------------	--------	---------

TEST

WARNING

Touching exhaust system during test can cause severe burns.

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- Operate engine in a ventilated area only.
- Do not idle the engine for long periods without maintaining adequate ventilation.
- Be alert at all times for exhaust odors and exposure symptoms.
- Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

4-36. EXHAUST SILENCER

Location/Item	Action	Remarks
---------------	--------	---------

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

4. Engine exhaust silencer	Start engine and observe installed components for leaks and/or rattles. Tighten nuts as necessary to prevent rattles. If silencer leaks, replace unit.	
----------------------------	--	--

4-37. STARTER MOTOR

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

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
NSN 4910-00-754-0654

Tool kit, general mechanics automotive
NSN 5180-00-177-7033

Materials/Parts

Starter motor

Troubleshooting References (Table 4-2)

Malfunction 1, steps 2 and 4

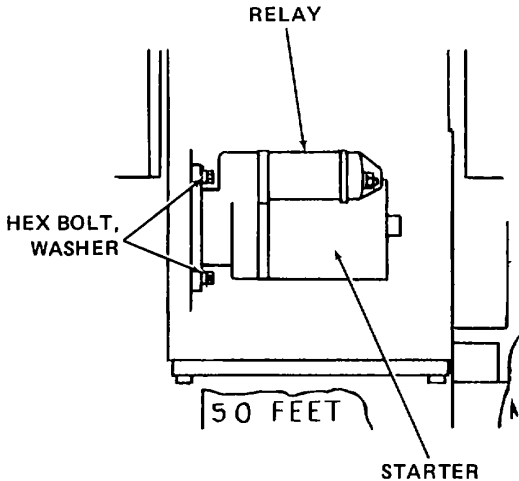
Equipment Condition

Para	Condition Description
	Engine shut down and cool.
4-13	Battery cables removed.
4-15	Starter electrical system wiring removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Starter
 - a. Support starter and remove hex bolts and washers.
 - b. Remove starter with relay attached.



4-37. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
TEST/INSPECTION		
2. Relay and starter	Remove. Test and inspect relay. If relay does not activate when excited with ground and +12 vdc from 12 vdc power supply, the unit is not operating properly. Test starter with ground and +12 vdc. If starter does not run and activate pinion, it is malfunctioning. If repairable, notify direct support and replace starter motor and relay.	
INSTALLATION/REPLACEMENT		
3. Starter with relay	Support starter and relay, and install hex bolts and washers. Make sure starter pinion is correctly aligned with flywheel ring gear. Tighten bolts securely.	
4. Starter electrical system wiring and positive battery cable	Install tagged electrical system wires and positive battery cable in accordance with paragraphs 4-13 and 4-15. Tighten lug nuts securely.	
5. Ground battery cable	Install. Tighten lug nuts securely.	

SYSTEM TEST

WARNING

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

4-37. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div> <p>Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:</p> <ul style="list-style-type: none"> ● Operate engine in a ventilated area only. ● Do not idle the engine for long periods without maintaining adequate ventilation. ● Be alert at all times for exhaust odors and exposure symptoms. ● Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning. <p>Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-1 1. Seek medical attention. Administer oxygen, if available.</p> <p>GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.</p> <p>Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.</p> <ul style="list-style-type: none"> ● Stand clear of venturi during priming. <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;">CAUTION</div> <p>Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.</p>		
6. Control panel	Move ON-ENGINE-OFF switch to ON and pull out engine throttle 1/2 way. Press starter pushbutton. Pump engine primer handle, if necessary. Engine should start within 30 seconds.	
<div>NOTE</div> <p>Starter pinion must be correctly aligned with flywheel ring gear.</p>		
7. Engine	If engine does not start, check starter, electrical system, and batteries. If systems are working properly and engine still will not start and does not crank, notify direct support, and replace starter. If engine still will not start, refer to troubleshooting guide.	

4-38. ALTERNATOR

This task covers:	a. Removal b. Test/Inspection	c. Installation/Replacement d. System Test
-------------------	----------------------------------	---

INITIAL SETUP

Tools

Shop equipment, automotive maintenance and repair, common no. 1
 NSN 4910-00-754-0654
 Tool kit, general mechanics automotive
 NSN 5180-00-177-7033

Troubleshooting References (Table 4-2)

Malfunction 1, step 2
 Malfunction 7, step 3

Materials/Parts

Alternator assembly

Equipment Condition

Para	Condition Description
	Engine shut down and cool.
4-15	Alternator wires disconnected.
4-28	Alternator V-belt pulley and fan removed.

References

Para 4-16 Control Panel Cover Assembly, Control Panel Assembly, Instruments, and Switches
 Para 4-26 V-Belt Guard
 Para 4-27 V-Belts
 Para 4-27 V-Belts
 Para 4-28 Alternator V-Belt Pulley and Fan

Special Environmental Conditions

Adequate ventilation required for testing.

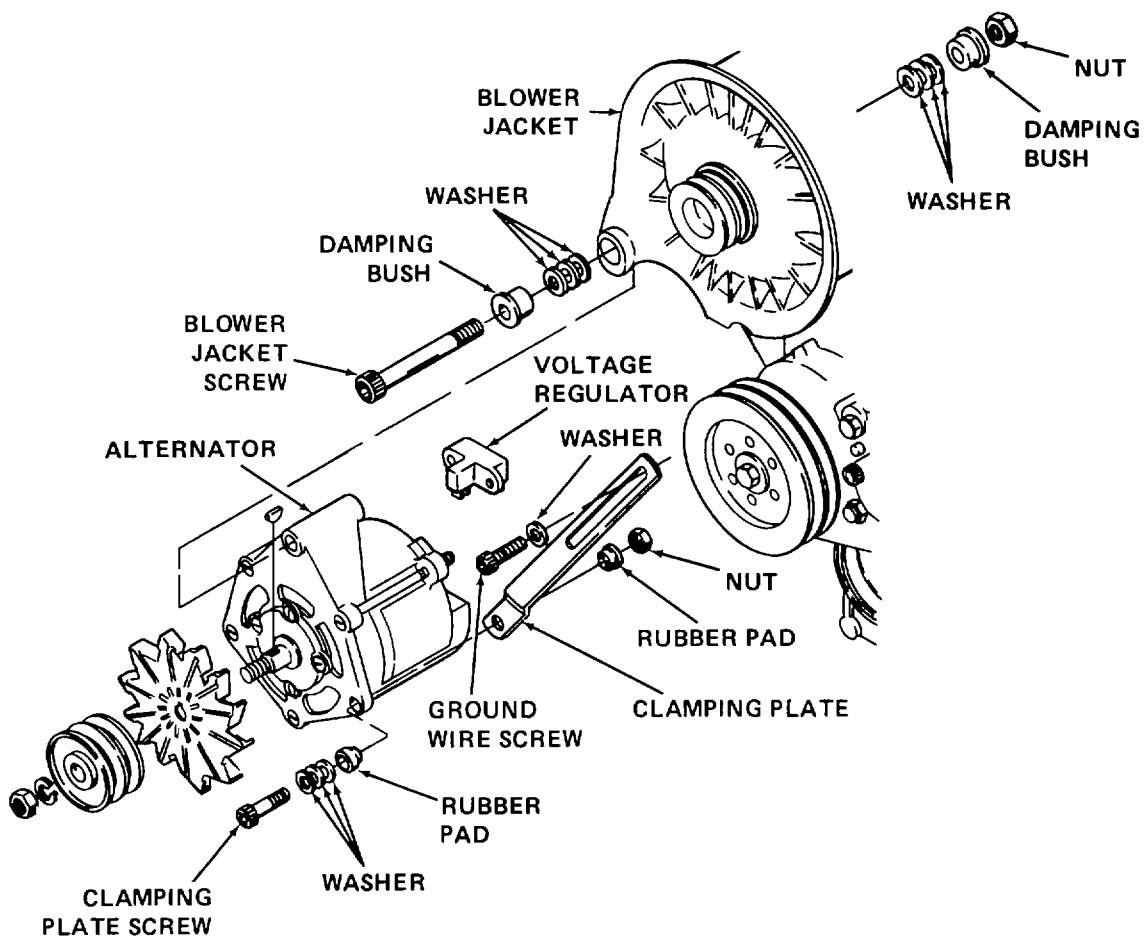
Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|------------------|--|
| 1. Blower jacket | Remove ground wire screw and washer with alternator ground wire from right side of blower jacket. |
| 2. Alternator | Remove clamping plate screw, washers, rubber pads, and nuts from alternator and clamping plate. |
| 3. Blower jacket | Support alternator and remove blower jacket screw, damping bushes, washers, and nut from alternator and blower jacket. |

4-38. ALTERNATOR (CONT)

Location/Item	Action	Remarks
4. Alternator with voltage regulator	Remove from blower jacket.	
5. Voltage regulator	Remove from alternator.	



TEST/INSPECTION

6. Alternator and voltage regulator	Test/inspect alternator and voltage regulator for damage, rust, corrosion, or electrical or mechanical malfunction (i.e., frozen shaft). If repairable, notify direct support and replace unit.
-------------------------------------	---

4-38. ALTERNATOR (CONT)

Location/Item	Action	Remarks
INSTALLATION/ REPLACEMENT		
7. Alternator and voltage regulator	If replacement alternator and voltage regulator are supplied with new mounting hardware, discard old hardware. Install voltage regulator on alternator, if necessary. Aline alternator with blower jacket mounting hole.	
8. Alternator	Support alternator and secure with blower jacket screw, damping bushes, washers, and nut to blower jacket. Tighten nut only hand tight.	
9. Clamping plate	Install clamping plate on alternator with clamping plate screw, washers, rubber pads, and nut. Tighten nut only hand tight.	
10. Alternator	Install ground wire with ground wire screw and washer. Tighten screw only hand tight.	
11. Alternator V-belt pulley and fan	Install in accordance with paragraph 4-28.	
12. V-belts	Install in accordance with paragraph 4-27. Adjust V-belt tension in accordance with paragraph 4-27.	
13. V-belt guard	Install V-belt guard in accordance with paragraph 4-26.	
14. Alternator wires	Connect in accordance with paragraph 4-15.	

SYSTEM TEST**WARNING**

Carbon monoxide is produced by the internal combustion engine of this pump. Death may result if personnel fail to observe safety precautions.

Carbon monoxide is a colorless, odorless, deadly poisonous gas which, when breathed, deprives the body of oxygen and causes suffocation. Exposure to air contaminated with carbon monoxide produces symptoms of headache, dizziness, loss of muscle control, or apparent drowsiness. Coma, permanent brain damage, or death can result from severe exposure.

4-38. ALTERNATOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

WARNING

Carbon monoxide occurs in the exhaust fumes of internal combustion engines and becomes dangerously concentrated under conditions of inadequate ventilation. Observe the following safety precautions whenever the engine is running:

- **Operate engine in a ventilated area only.**
- **Do not idle the engine for long periods without maintaining adequate ventilation.**
- **Be alert at all times for exhaust odors and exposure symptoms.**
- **Be aware: the field protective mask for chemical biological radiological (CBR) protection will not protect you from carbon monoxide poisoning.**

Expose victims to fresh air, keep warm, and do not permit physical exercise. For artificial respiration, refer to FM21-11. Seek medical attention. Administer oxygen, if available.

GOOD VENTILATION IS THE BEST DEFENSE AGAINST EXHAUST POISONING.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- **Stand clear of venturi during priming.**

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

15. Engine, alternator, and ammeter

Start engine. Ammeter on control panel should indicate zero or a positive current flow. If ammeter indicates a negative current flow, check batteries and electrical system (paragraphs 4-13 and 4-15). If battery and electrical systems are operating properly, replace alternator. If condition still exists, recheck batteries and electrical system, then replace ammeter in accordance with paragraph 4-16.

Section VI. PREPARATION FOR STORAGE OR SHIPMENT

4-39. GENERAL

This section provides instructions for preparing the centrifugal pump unit for short term and intermediate storage or shipment.

4-40. ADMINISTRATIVE STORAGE

- a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.
- b. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be completed, shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.
- c. Storage site selection. Inside storage is preferred for items selected for administrative storage. If inside storage is not available, trucks, vans, conex containers and other containers may be used.

4-41. SHORT TERM STORAGE (30 days or less)

NOTE

When centrifugal pump unit is taken out of service, take special precautions to protect the interior and exterior of the unit from rust accumulation and corrosion.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not refuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Do not overfill fuel tank.
- Work in a well-ventilated area.

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

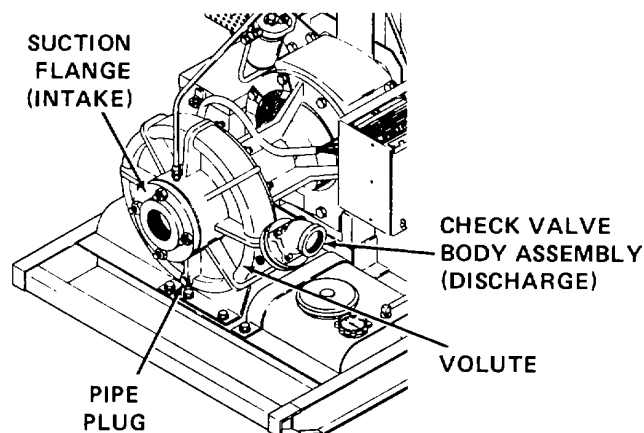
a. Fill fuel tank with VV-F-800 diesel fuel oil. Connect centrifugal pump unit to a water supply. Operate the engine for 2 minutes at 2800 rpm.

NOTE

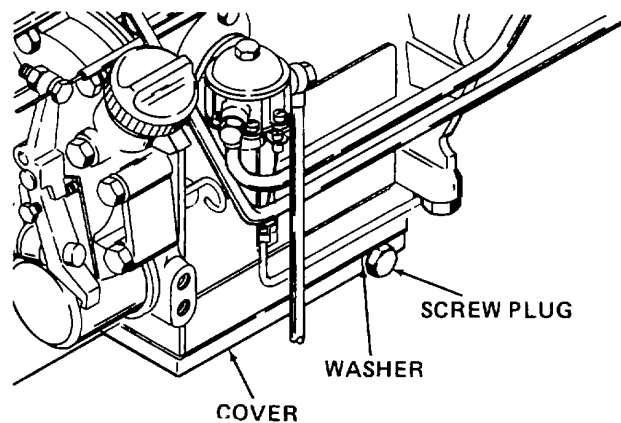
Do not drain the fuel system after this run. Remove water supply after this run.

b. Remove pump drain plug and drain pump body. Replace drain plug.

- c. Remove suction hose from suction flange (intake).
- d. Remove discharge hose from check valve body assembly (discharge).
- e. Clean intake and discharge port threads using a wet cloth.
- f. Cover intake and discharge port openings.

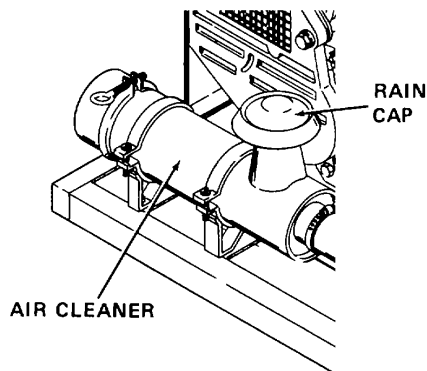


- g. Remove screw plug from bottom cover and drain crankcase. Replace screw plug and fill crankcase to the proper level with the recommended viscosity and grade of oil in accordance with LO 5-4320-302-12 (figure 4-1).



- h. Service air cleaner primary and secondary elements in accordance with table 2-2, item 15.

- i. Tape the rain cap in place and oil the cap surfaces. Seal all engine openings with moisture-proof, vaporproof tape, strong enough to resist puncture and damage from the expansion of entrapped air.



4-42. INTERMEDIATE TERM STORAGE (more than 30 days)**WARNING**

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- **Stand clear of venturi during priming.**

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

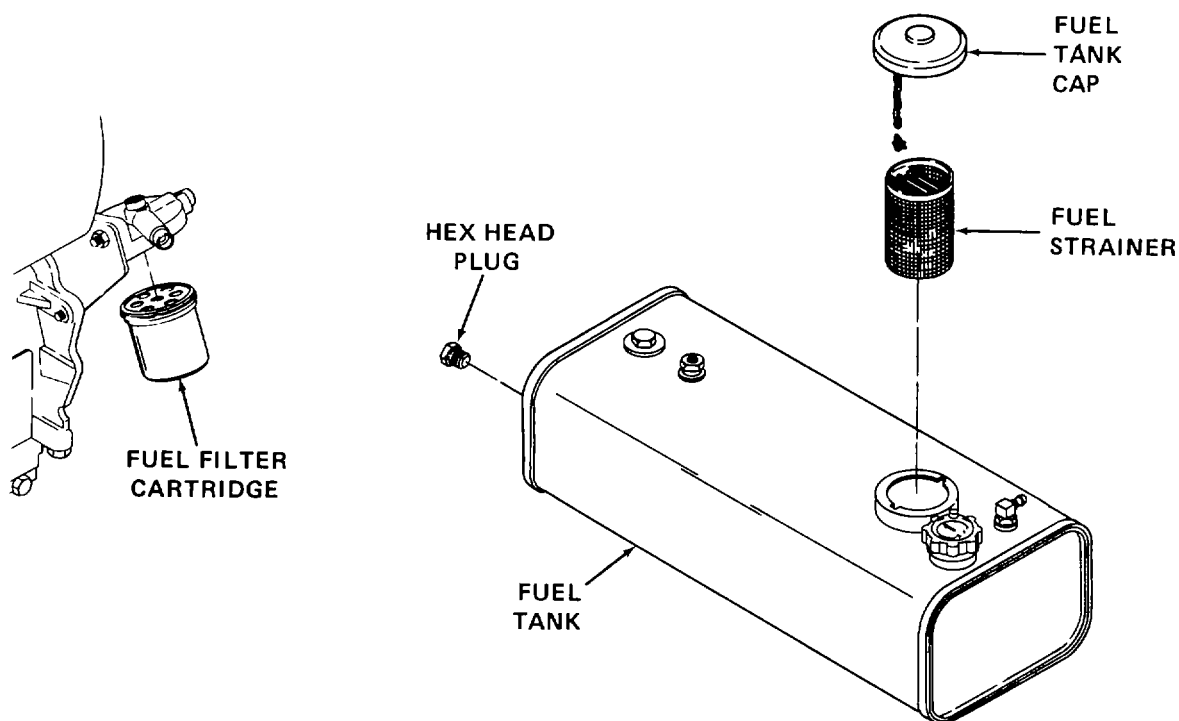
- Start engine and allow to operate at 2800 rpm for 10 to 12 minutes or until normal operating temperature is reached. Shut down engine.
- Drain crankcase oil and replace oil filter cartridge as described in table 4-1, item 3. Then fill crankcase to proper level using preservative lubricating oil (MIL-L-21260, Grade 2, or equivalent).

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Do not handle fuel near open flame, sparks, or excessive heat.**
- **Be certain fuel lines and connections are secure.**
- **Work in a well-ventilated area.**

- Remove fuel tank cap and hex head plug in bottom of fuel tank. Collect fuel in a suitable metal container.
- Replace fuel strainer and filter cartridge and fill cartridge 2/3 full with MIL-L-46002 corrosion-inhibited preservation oil in accordance with paragraph 4-34.
- Replace hex head plug and fill fuel tank with sufficient MIL-L-46002 preservative oil, Grade 1, to permit 10-15 minutes of operation.



WARNING

Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

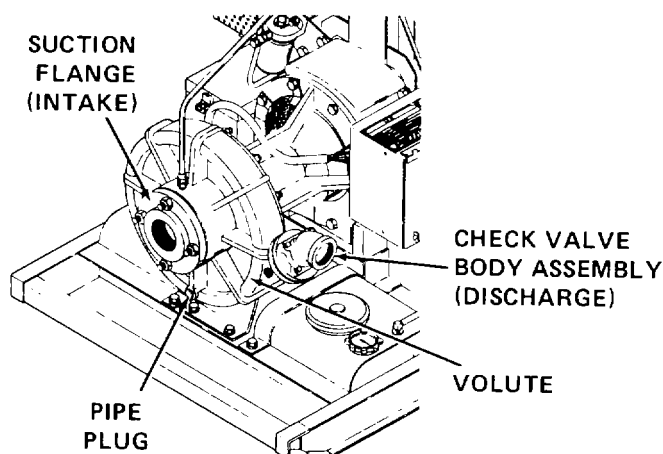
- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

- Start engine and allow to operate at 2800 rpm for not less than 5 minutes. Shut down engine.
- Service air cleaner primary and secondary elements in accordance with table 2-2, item 15.
- Remove pump drain plug and drain pump body. Replace drain plug.
- Remove suction hose from suction flange (intake).

- j. Remove discharge hose from check valve body assembly (discharge).



- k. Coat all accessible flange and part surfaces with MIL-L-21260 preservative oil, Type I, Grade 30. Wipe excess oil from intake and discharge port threads and cover port openings.
- l. Remove pump drain plug and pour approximately one quart of MIL-L-21260 preservative oil, Type I, Grade 30, into pump body. Replace pump drain plug.

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

- m. Drain crankcase and fuel tank into suitable metal containers.
- n. Remove pump drain plug and drain preservative oil. This will leave a protective coating of preservative oil on interior surface of pump. Replace pump drain plug.
- o. Tape rain cap in place and oil the cap surfaces. Seal air cleaner inlet hose with a moisture-proof, vaporproof tape.

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

- p. Inspect exterior of centrifugal pump unit for damaged paint. Refinish in accordance with Military Specification MIL-T-704, Type A, color as specified.
- q. Remove and clean battery in accordance with table 4-1, item 5.

4-43. SHIPMENT

- a. Use shipping plugs, closures, or sealing tape to cover all openings in the pump assembly.
- b. Attach to the pump assembly all forms, tags, and records applicable to the unit.

WARNING

Avoid making contact across the two battery posts. This can result in severe arcing which could cause an explosion resulting in bodily injury.

CAUTION

Disconnect battery cable from ground battery post before disconnecting any other leads from engine components. This precaution will prevent short circuits which could damage the alternator, voltage regulator, or other electrical components.

When removing battery cable, use battery terminal puller to remove loosened terminals. Forcing battery terminals off without using puller may damage the battery posts.

**Never disconnect battery while alternator is operating.
Never attempt to polarize the alternator.**

- c. Disconnect battery cables in accordance with table 4-1, item 5. Tape the battery cables to prevent contact with battery terminals. Replace battery box cover.

CAUTION

Do not attempt to lift unit manually. Use crane securely fastened to lifting bracket. Do not allow unit to swing while suspended. Failure to observe this caution may result in severe damage to the pump unit.

- d. Before attempting to load the Model US2520 HCCD-1 Centrifugal Pump Unit, make sure that the loading facility is capable of handling 870 pounds (395 kilograms).
- e. Load the centrifugal pump unit by lifting with a crane secured to lifting bracket. As an alternate but less desirable method, loading can be done with a fork lift.
- f. Attach shipping tiedowns.

**CHAPTER 5
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS**

INTRODUCTION

This chapter contains the following frequently used maintenance information:

- a. Troubleshooting
- b. Maintenance procedures

The Symptom Index on page 5-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 5-6.

Section	Title	Page
I	Troubleshooting	5-1
II	Maintenance Procedures.....	5-6

Section I. TROUBLESHOOTING

5-1. TROUBLESHOOTING

a. Table 5-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of direct support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take. Perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of direct support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1. For troubleshooting procedures within the scope of organizational maintenance, refer to table 4-2.

5-2. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the centrifugal pump unit. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine fails to crank or cranks at low speed	5-2
2	Engine cranks but fails to start	5-2
3	Engine starts but runs unevenly, stalls, or surges	5-3
4	Engine stops running or produces black, white, or grey smoke	5-4
5	Engine consumes excessive lube oil	5-5
6	Pump does not discharge or has low discharge pressure	5-5
7	Pump makes excessive noise	5-5

Table 5-1. Direct Support Troubleshooting

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
-------------	--------------------	-------------------

1. ENGINE FAILS TO CRANK OR CRANKS AT LOW SPEED

Step 1. Check for faulty starter motor. Remove and test (para 5-18).
Repair faulty starter motor (para 5-18).

Step 2. Check for restricted impeller.
Remove volute (para 5-4) and remove foreign objects restricting impeller.

2. ENGINE CRANKS BUT FAILS TO START

Step 1. Check for loose cylinder head bolts.

If loose, tighten in a crosswise manner with socket spanner No. 120040/120050 to 22 ft lb (30 N.m).
Using torque gage 101900, tighten bolts three additional 45 degree increments.

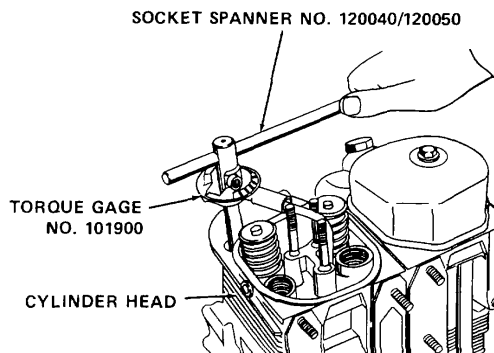


Table 5-1. Direct Support Troubleshooting - Continued

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

3. ENGINE STARTS BUT RUNS UNEVENLY, STALLS, OR SURGES

WARNING

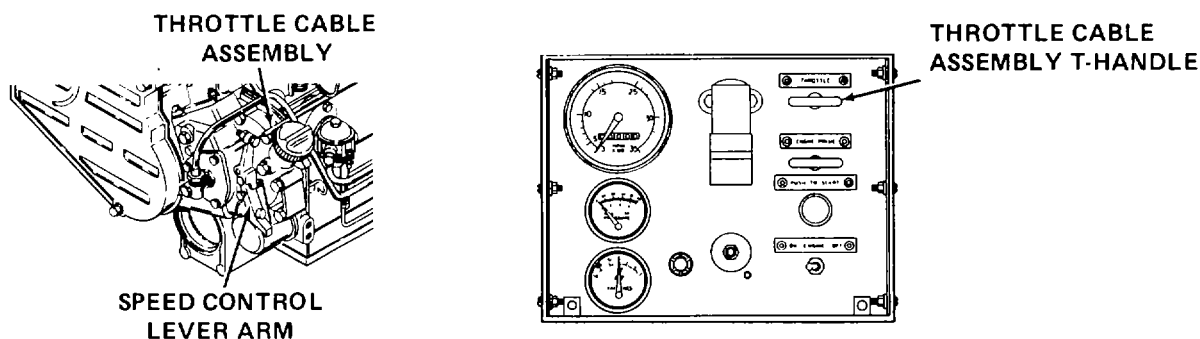
Priming discharge mixture of water and exhaust gases may cause severe burns or injury. Wear gloves and safety glasses when priming pump.

- Stand clear of venturi during priming.

CAUTION

Prime the centrifugal pump as soon as possible after engine starts. Rotation of impeller without water in volute will damage pump components.

Step 1. Check for binding speed control lever arm or throttle cable assembly. Start engine. Watch the moving speed control lever arm while increasing and decreasing engine speed with the throttle cable assembly T-handle.



If components bind, repair or replace throttle cable assembly (para 4-16).

Step 2. Check for mistimed injectors.

Time injectors (para 6-4).

Step 3. Check for faulty injectors. Remove and test injectors (para 5-16).

Repair or replace faulty injectors (para 5-16).

Table 5-1. Direct Support Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

Step 4. Check for malfunctioning governor.

Replace governor (para 6-13).

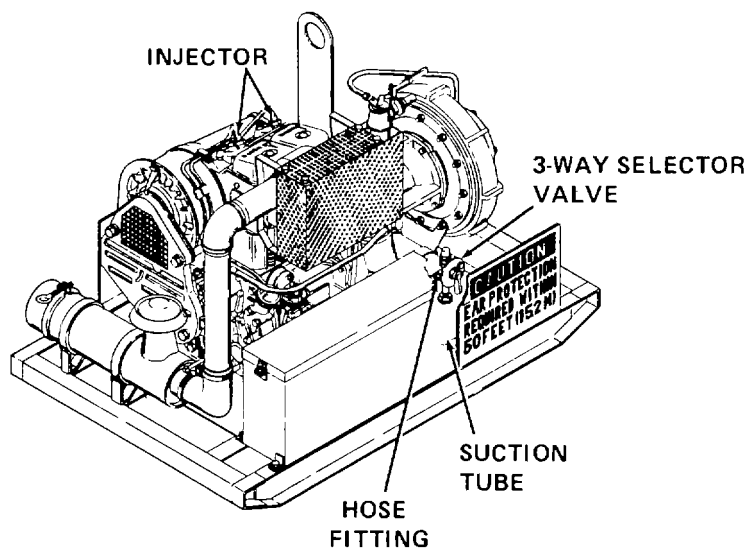
Step 5. Check for air in the fuel system.

Service fuel feed pump (para 4-34).

4. ENGINE STOPS RUNNING OR PRODUCES BLACK, WHITE, OR GREY SMOKE

Step 1. Check for faulty injectors. Remove and test injectors (para 5-16).

Repair or replace faulty injectors (para 5-16).



Step 2. Check for faulty fuel feed pump.

Repair or replace damaged fuel pump (para 5-15).

NOTE

The wrong grade of diesel fuel oil will also not undergo complete combustion. This condition may result in black or grey smoke.

Table 5-1. Direct Support Troubleshooting - Continued

MALFUNCTION

TEST OR INSPECTION

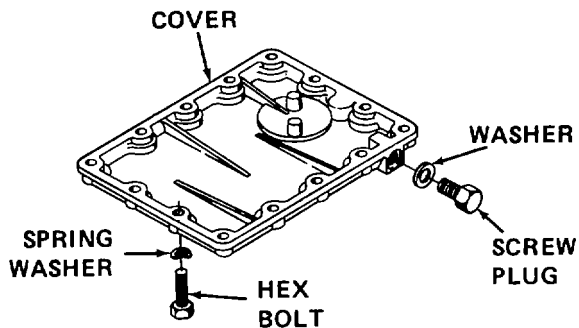
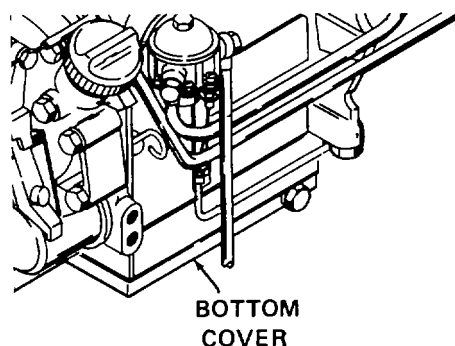
CORRECTIVE ACTION

5. ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)

Step 1. Check for leaking bottom cover.

If bottom cover is leaking, remove from crankcase and reinstall (para 5-22).

If bottom cover continues to leak, replace it (para 5-22).



Step 2. Check for lube oil cooler core leaks. Clean lube oil cooler and check for core leaks (para 5-14).

If leakage is evident, replace lube oil cooler (para 5-14).

6. PUMP DOES NOT DISCHARGE OR HAS LOW DISCHARGE PRESSURE

Step 1. Check for broken impeller. Disassemble pump (para 5-4). Inspect impeller.

Replace impeller if necessary.

7. PUMP MAKES EXCESSIVE NOISE

Step 1. Check for foreign matter in pump. Disassemble pump (para 5-4). Inspect for foreign matter.

Remove foreign matter.

Section II. MAINTENANCE PROCEDURES

INDEX

	Para		Para
Adapter housing and bearing plate	5-24	Fuel injectors	5-6
Alternator	5-19	Fuel tank assembly	5-16
Alternator V-belt pulley	5-9	Lube oil cooler	5-14
Bearing housing assembly	5-5	Pump and bearing housing assembly	5-4
Bottom cover	5-22	Skid assembly	5-25
Cooling air blower	5-17	Starter motor	5-18
Cooling air ducting	5-13	Tachometer drive	5-23
Cylinder head assembly, rocker arms, and tappets	5-20	V-belt guard	5-8
Drive shaft V-belt pulley	5-11	V-belt pulley	
Engine assembly	5-7	Alternator	5-9
Fan (alternator)	5-10	Drive shaft	5-11
Flywheel	5-12	Valves, valve guides, and valve seats	5-21
Fuel feed pump	5-15		

5-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and ON-ENGINE-OFF switch turned off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix F to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in procedure. Standard torque values given in Appendix F are determined by thread size.

5-4. PUMP AND BEARING HOUSING ASSEMBLY

This task covers:

a. Removal	d. Repair
b. Disassembly	e. Assembly
c. Inspection/Test	f. Installation/Replacement

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Troubleshooting References (Table 5-1)

Malfunction 1, step 2

Malfunction 6, step 1

Malfunction 7, step 1

Materials/Parts

Pump and bearing housing assembly

Materials required by MIL-T-704
Crocus abrasive cloth (Item 1, Appendix E)
Grease (Item 6, Appendix E) assembly.

References

Para 5-5 Bearing Housing Assembly
MIL-T-704 Treatment and Painting of Materiel

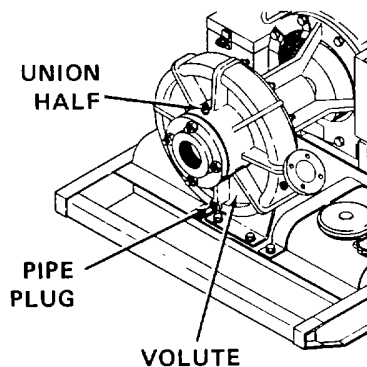
Equipment Condition

Para	Condition Description
4-16	Cables and wiring removed to permit access to bearing housing
4-18	Priming tube assembly removed.
4-19	Check valve body assembly and check valve assembly removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|----------------------|----------------------------|
| 1. Pipe plug volute. | Remove pipe plug and drain |
| 2. Union half | Remove. |



5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

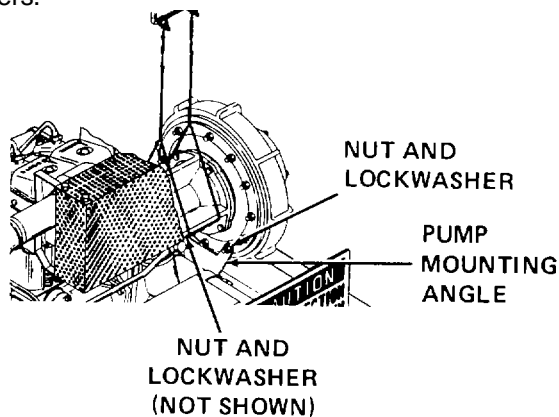
WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.

3. Pump and bearing housing assembly

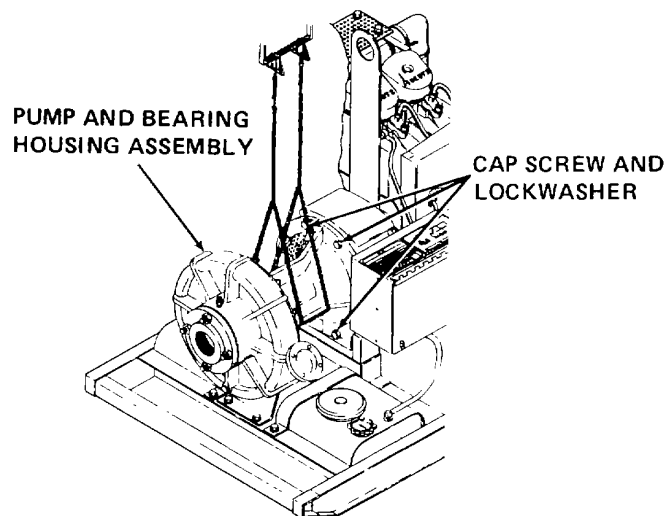
- a. Position a suitable lifting device equipped with a spreader bar and slings over pump and bearing housing assembly. Attach slings around assembly and put tension on slings. Make sure assembly is properly supported.
- b. Remove nuts and lockwashers.

Spread slings on spreader bar so that slings hang vertically when attached to assembly.



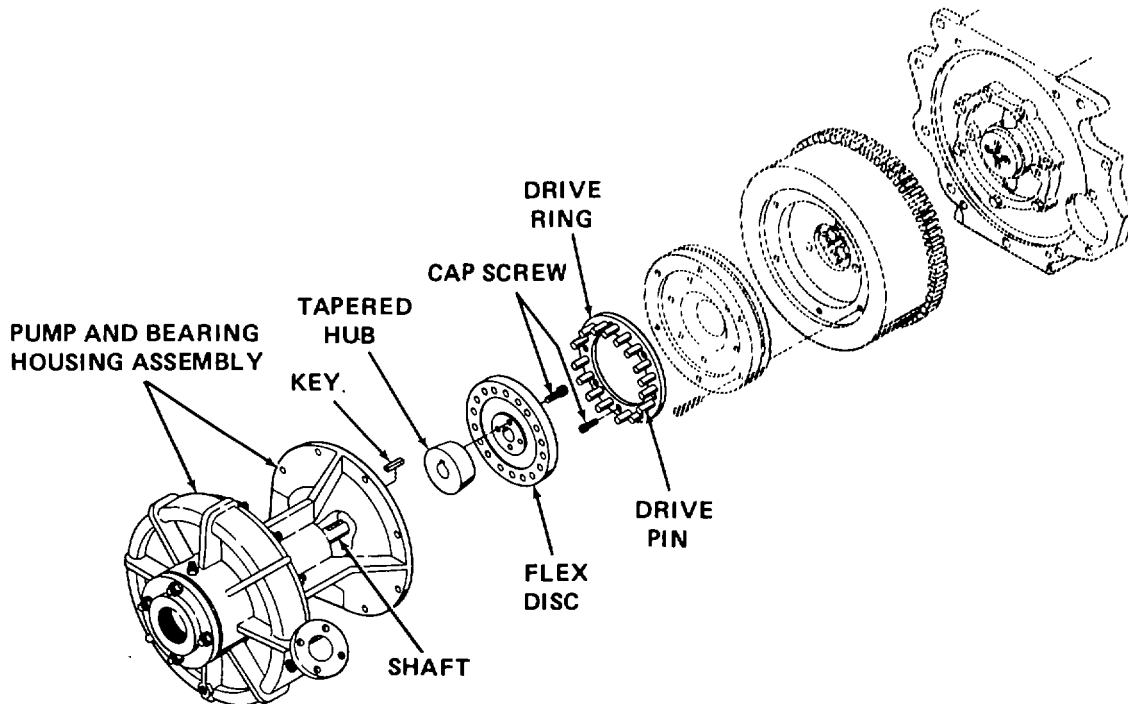
4. Pump and bearing housing assembly

- a. Remove cap screws and lockwashers.
- b. Lift and remove pump and bearing housing assembly from skid and engine assembly, and lower onto blocks on a stable, level work platform.



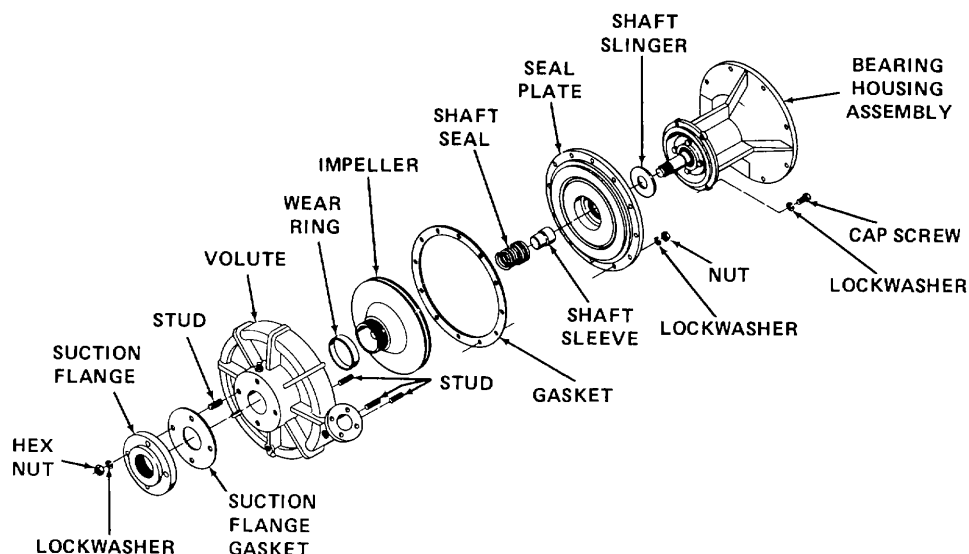
5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
5. Tapered hub	Measure and record distance of flex disc machined metal face to end of shaft.	
6. Flex disc and tapered hub	a. Loosen cap screws until tapered hub moves freely on shaft. b. Remove flex disc and tapered hub from shaft. c. Remove key.	
7. Drive ring	a. Remove cap screws. b. Remove drive ring from carrier mounted to flywheel.	

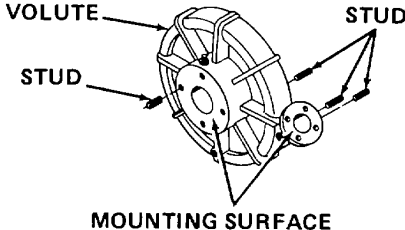


5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
DISASSEMBLY		
8. Suction flange	a. Remove hex nut and lockwasher. b. Remove suction flange. c. Remove and discard gasket suction flange.	
9. Volute with studs	a. Remove nut and lockwasher. b. Matchmark volute and seal plate to aid in assembly. Remove volute. c. Remove and discard gasket.	
10. Impeller	Remove.	
11. Shaft seal discard.	Remove seal spring and rotating seal half and	
12. Shaft sleeve	Remove.	
13. Wear ring	Remove from volute and discard.	
14. Seal plate	a. Remove cap screws and lockwashers. b. Remove seal plate.	
15. Shaft seal	Remove stationary seal half from seal plate and discard.	
16. Shaft slinger	Remove.	
17. Bearing housing assembly	Set aside.	

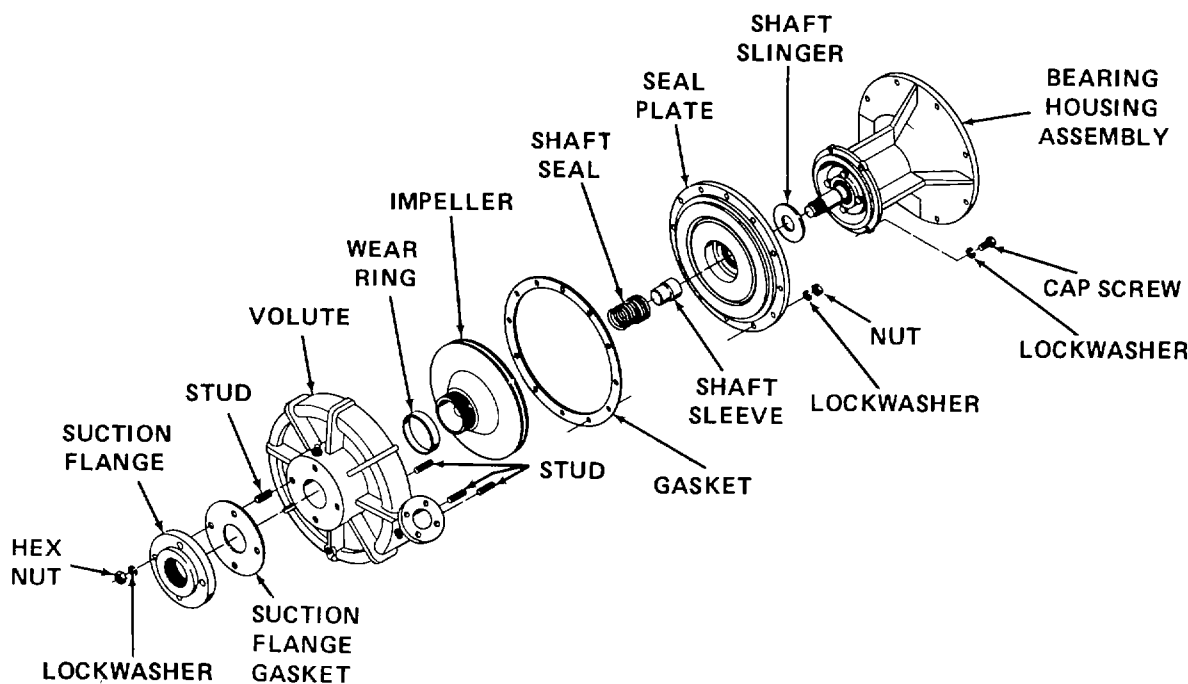


5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
INSPECTION/TEST		
18. Suction flange	Inspect for cracks, rust, corrosion, and for damaged or stripped threads. Inspect mounting surfaces. Make sure they are smooth and flat with no nicks or burrs. If severely damaged or cracked, replace suction flange.	
19. Volute	Inspect volute for cracks, rust, corrosion, or other damage. Inspect mounting surfaces. Make sure they are smooth and flat with no nicks or burrs. Inspect mounted studs. Make sure they are not cracked, bent, rusted, or corroded. Inspect for damaged or stripped threads. If severely damaged or cracked, replace volute. Replace any studs that are damaged, rusted, or corroded.	 <p>The diagram shows a cross-section of a pump volute assembly. It features a central shaft with an impeller. The volute is the outer casing that surrounds the impeller. Two studs are shown mounted on the volute, which are used to secure the mounting surface. Labels with arrows point to the VOLUTE, a STUD, and the MOUNTING SURFACE.</p>
20. Impeller	Inspect impeller for cracks, broken blades, rust, corrosion, or excessive wear. If severely damaged, cracked, or worn, replace impeller.	
21. Seal plate, shaft slinger, shaft sleeve, and disc coupling	Inspect for cracks, rust, corrosion, or other damage. Inspect mounting surfaces. Make sure they are smooth and flat. Inspect for excessive wear where shaft sleeve and shaft slinger contact seal plate. Replace damaged, cracked, or excessively worn parts.	
REPAIR		
22. Suction flange, volute, and seal plate	Repair minor nicks or burrs and/or smooth out mounting surfaces with P-C-458 crocus abrasive cloth. Repair rust or corrosion in accordance with MIL-T-704. Clean and treat interior or mounting surfaces. Clean, treat, and refinish outside surfaces. Remove only a minimal amount of surface material; replace parts if necessary.	

5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
ASSEMBLY	CAUTION	
Be sure all seal surfaces are free of fingerprints and grease.		
23. Shaft slinger	Install on shaft of bearing housing assembly.	
24. Shaft seal	Install stationary seal half in seal plate, polished surface out.	
25. Seal plate	Install seal plate with lockwashers and cap screws. Tighten cap screws securely in an alternating pattern.	
26. Shaft sleeve	Install shaft sleeve over shaft, larger outside diameter out.	
27. Shaft seal	Lubricate inside bore of rotating seal half with MIL-G-10924 grease. Install rotating seal half over shaft, carbon side in. Install seal spring.	
28. Impeller	Hold shaft securely and install impeller. Tighten securely on shaft.	

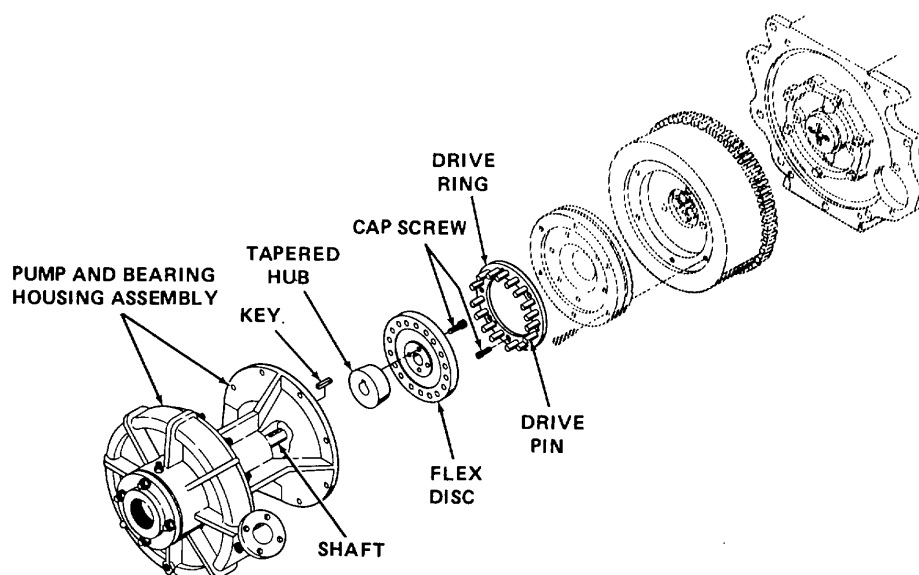


5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
29. Gasket	Install on seal plate.	
30. Wear ring	Install into volute.	
31. Volute	a. Aline volute and seal plate matchmarks. Aline studs with mounting holes on seal plate. b. Install lockwashers and nuts. Tighten nuts securely in a cross pattern.	
32. Suction flange gasket	Install on volute studs.	
33. Suction flange	Attach suction flange to volute with lockwashers and hex nuts. Tighten nuts securely in a cross pattern.	
34. Partial assembly	Rotate shaft by hand. Be sure that assembly does not bind.	

INSTALLATION/REPLACEMENT

- 35. Drive ring
 - a. Install drive ring on carrier mounted to flywheel.
 - b. Install cap screws and tighten in a cross pattern.
 - c. Insert key in shaft.

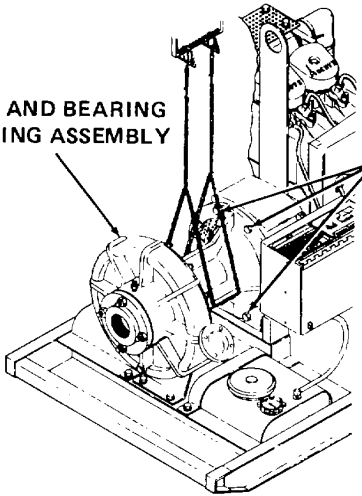


5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
36. Tapered hub	Install tapered hub on shaft, alining keyway in hub with key on shaft.	
37. Flex disc	a. Install flex disc over shaft and onto tapered hub. b. Install cap screws fingertight.	
38. Tapered hub and flex disc assembly	Using previously recorded dimension, position tapered hub and flex disc assembly on shaft. Secure in place by tightening cap screws in a cross pattern.	

WARNING

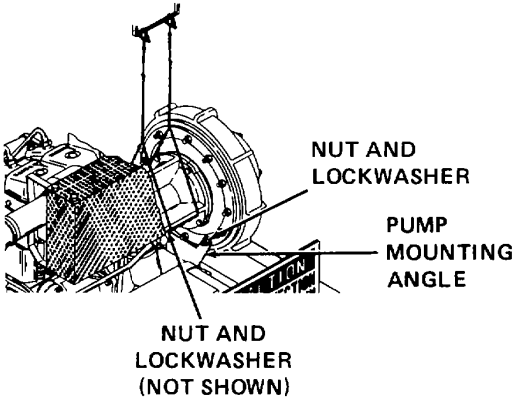
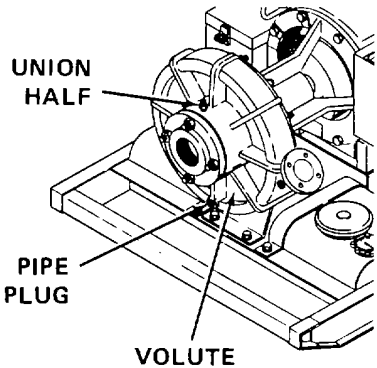
Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment. Before lifting, be sure load is balanced.

39. Pump and bearing housing assembly	Position a suitable lifting device equipped with a spreader bar and slings over pump and bearing housing assembly. Attach slings around assembly and put tension on slings. Make sure assembly is properly supported.	Spread slings on spreader bar so that slings hang vertically when attached to assembly.
40. Pump and bearing housing assembly	Lift and remove from blocks on work platform. Lower carefully so that bearing housing assembly aligns with engine adapter housing. Aline holes in flex disc with drive pins on drive ring, and pump mounting studs in pump mounting angle. When these holes and pins are alined, slide pump and bearing housing assembly toward engine so that this disc coupling mates and engages properly.	 <p>The diagram illustrates the final assembly step. A spreader bar with slings is used to lift the pump and bearing housing assembly. The assembly is being lowered into position on a work platform. Labels indicate the 'PUMP AND BEARING HOUSING ASSEMBLY' and a 'CAP SCREW AND LOCKWASHER' being used to secure the assembly.</p>

NOTE

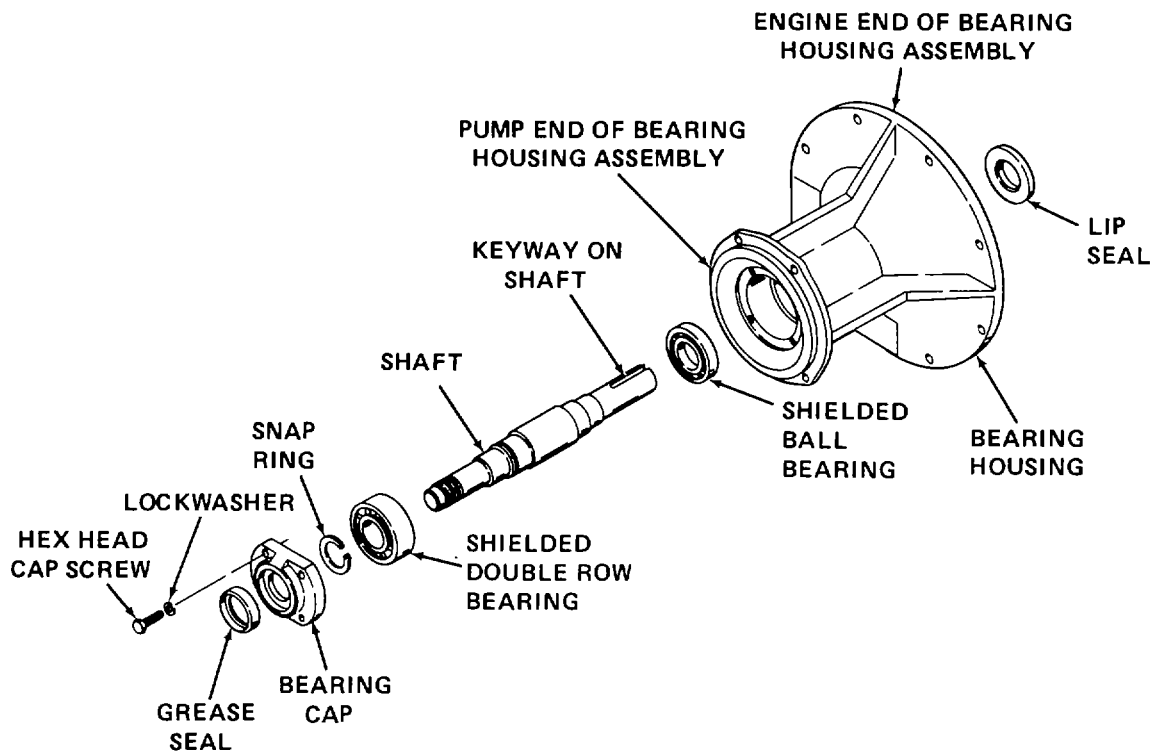
Alinement of the flex disc and drive ring may be checked and corrected by viewing through flywheel guard.

5-4. PUMP AND BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
41. Pump and bearing housing assembly	a. Install cap screws and lockwashers. Do not tighten. b. Install lockwashers and nuts. Do not tighten nuts.	 <p>NUT AND LOCKWASHER</p> <p>PUMP MOUNTING ANGLE</p> <p>NUT AND LOCKWASHER (NOT SHOWN)</p>
42. Bearing housing assembly	Tighten cap screws securely in a cross pattern.	
43. Pump mounting angle	Tighten nuts alternately until secure.	
44. Lifting device	Remove.	
45. Union half and pipe plug	Install on volute. Tighten securely.	 <p>UNION HALF</p> <p>PIPE PLUG</p> <p>VOLUTE</p>
46. Priming tube assembly	Install in accordance with paragraph 4-18.	
47. Check valve assembly and check valve body assembly	Install in accordance with paragraph 4-19.	

5-5. BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
4. Lip seal	Remove lip seal from bearing housing.	
5. Snap ring	Remove.	
6. Shielded double row bearing	Remove.	
7. Shielded ball bearing	Remove.	



5-5. BEARING HOUSING ASSEMBLY (CONT)

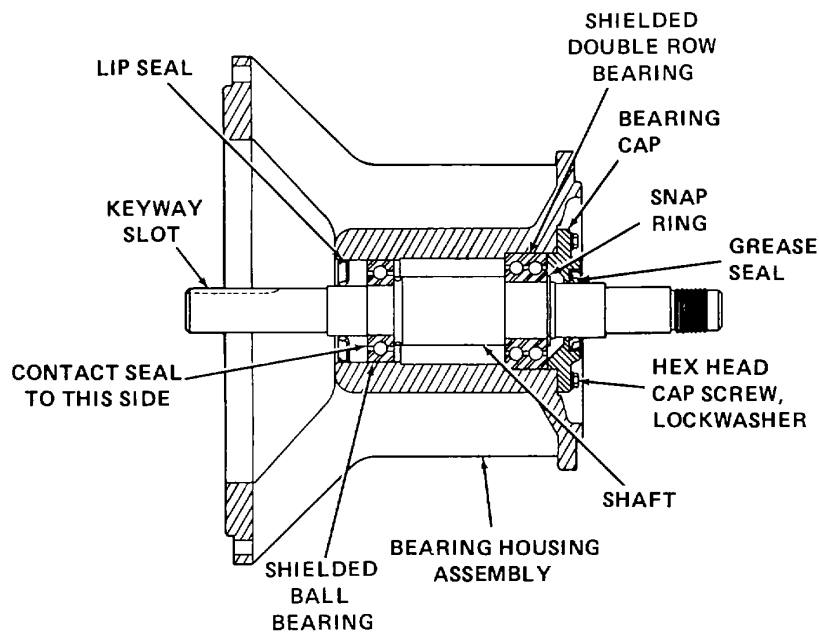
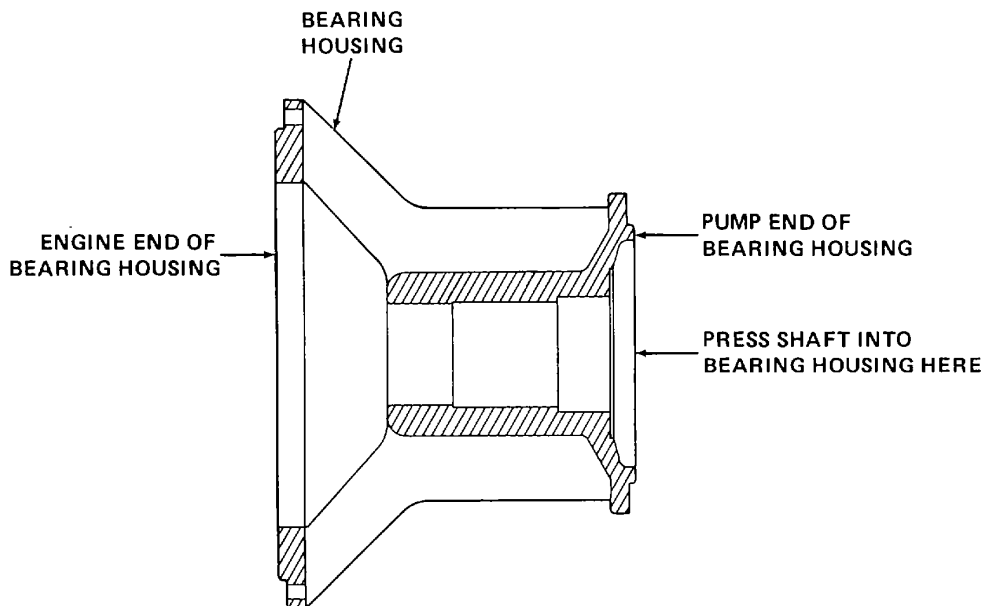
Location/Item	Action	Remarks
<div style="border: 1px solid black; padding: 2px; display: inline-block;">CLEANING/INSPECTION</div>	<div style="border: 1px solid black; padding: 2px; display: inline-block;">WARNING</div>	<p>Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59° C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly. Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.</p>
		<p>8. Bearing housing assembly metal components</p>
<p>9. Bearing housing</p>	<p>Inspect for cracks, rust, corrosion, or other damage. Inspect both engine and pump end mounting surfaces. Make sure they are smooth and flat. Inspect for excessive wear around mounting holes and main bore. Repair rust or corrosion in accordance with MIL-T-704. Clean and treat interior or mounting surfaces. Clean, treat, and refinish outside surface. If unit is severely damaged, cracked, or worn, replace unit.</p>	
<p>10. Bearing cap</p>	<p>Inspect for excessive wear, rust, corrosion, or other damage. Replace if worn or damaged.</p>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;">WARNING</div>		<p>Do not rotate bearings with compressed air.</p>
<p>11. Bearings</p>	<p>Inspect bearings for rough or tight spots. Replace bearings if rough or tight. Inspect bearing exterior for rust, corrosion, or other damage. Replace bearings if damaged.</p>	

5-5. BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
12. Shaft	Inspect shaft for excessive wear, rust, corrosion, or other damage. Replace shaft if damaged.	
ASSEMBLY		
13. Ball bearing	Apply coating of MIL-T-22361 thread compound to inside diameter of bearing. Press onto shaft from engine end.	
14. Shielded double row bearing	Press onto shaft from pump end with loading notch toward keyway slot and away from pump end of shaft.	
15. Snap ring	Install into ring groove on shaft.	
16. Lip seal	Press a replacement lip seal into the bearing housing assembly. Install with lip toward engine.	
17. Shaft	Press shaft with bearings and snap ring into bearing housing from pump end.	
18. Grease seal	Press a new grease seal into bearing cap. Install with lip toward pump end.	
19. Bearing cap	Install with new grease seal. Slide in onto shaft, and install lockwashers and hex head cap screws. Tighten hex head cap screws securely.	

5-5. BEARING HOUSING ASSEMBLY (CONT)

Location/Item	Action	Remarks
20. Bearing housing assembly	Turn shaft by hand to make sure that shaft moves freely in bearing housing assembly.	



5-6. FUEL TANK ASSEMBLY

This task covers: a. Inspection/Test c. Repair
 b. Disassembly d. Assembly

INITIAL SETUP

Tools

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

Materials/Parts

Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of
 Materiel

Troubleshooting References (Table 5-1)

Malfunction 4 step 2

**Equipment
 Condition
 Para**

Condition Description

4-24 Fuel tank removed from skid as-
 sembly.

Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION/TEST

1. Fuel tank	Inspect exterior of tank for dents, broken welds, flaking paint, excessive rust, or other damage. If fuel tank is severely dented or rusted, replace it. Pressure test fuel tank for leakage. Test to 5 psi (34 kPa). If fuel tank leaks, repair it. If it cannot be repaired, replace it.	
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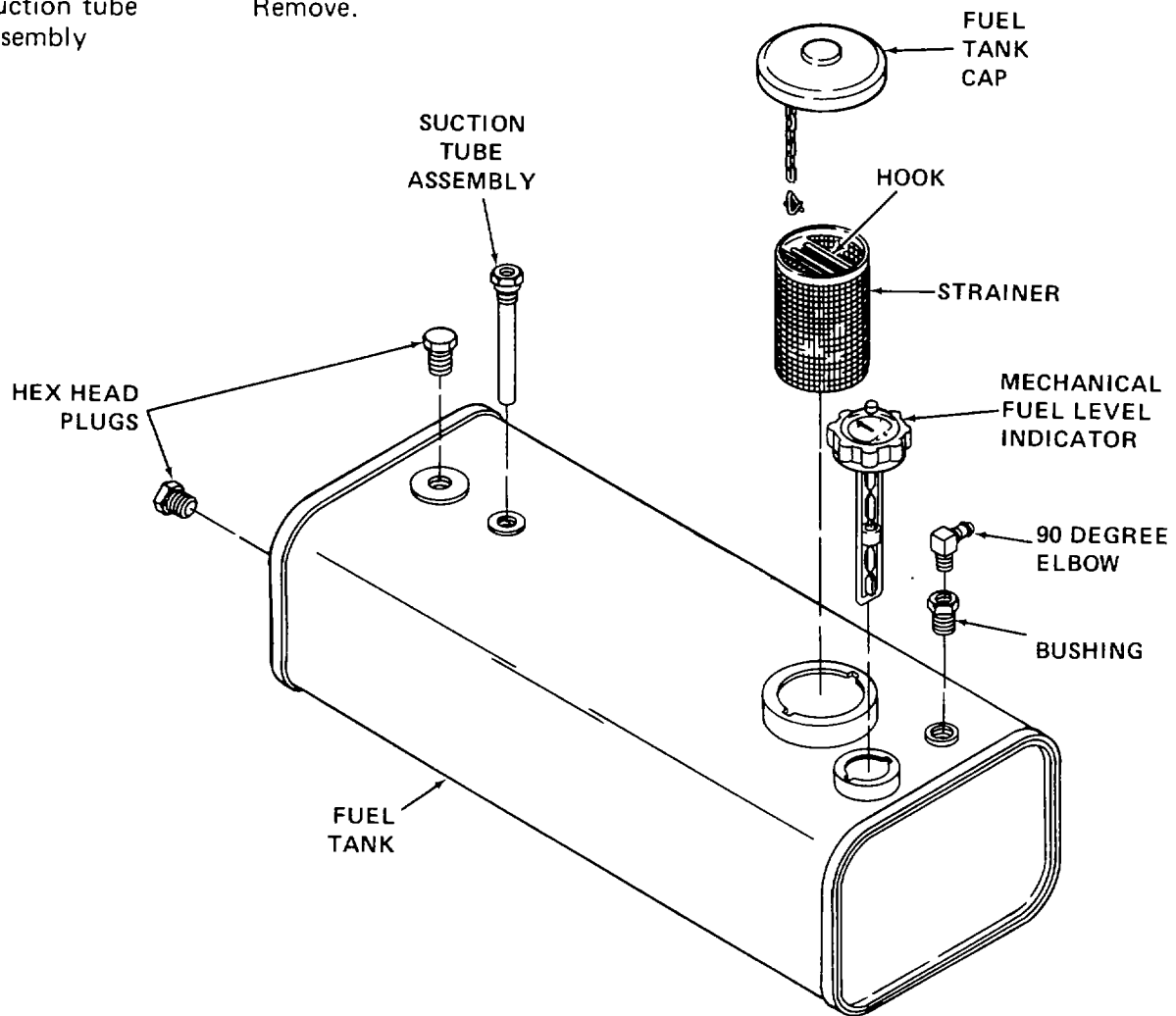
DISASSEMBLY

2. Mechanical fuel level indicator	Remove.	
3. 90 degree elbow and bushing	Remove.	

5-6. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|--------------------------|---------|--|
| 4. Fuel tank cap | Remove. | |
| 5. Strainer | Remove. | |
| 6. Suction tube assembly | Remove. | |



5-6. FUEL TANK ASSEMBLY (CONT)

Location/Item	Action	Remarks
<div style="border: 1px solid black; padding: 2px; display: inline-block; margin-right: 100px;">REPAIR</div> <div style="border: 1px solid black; padding: 2px; display: inline-block;">WARNING</div>		
<p>Explosion hazard exists when fuel tank is welded.</p> <p>Purge all fumes from tank before attempting repair involving heat or flame.</p>		
7. Fuel tank	<p>If tank has broken welds, dry it thoroughly before reworking the cracked weld. If the tank has flaking paint or severe rust, sandpaper an area larger than the damaged area. Sandpaper to bare metal. Then clean, treat, and paint tank in accordance with MIL-T-704, Type A, color as specified.</p>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;">ASSEMBLY</div>		
8. Suction tube assembly	Install.	
9. Strainer	Install.	
10. Fuel tank cap	Install.	
11. 90 degree elbow and bushing	Install.	
12. Mechanical fuel level indicator	Install.	

5-7. ENGINE ASSEMBLY

This task covers: a. Removal b. Installation/Replacement

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

4-16 Control panel cover assembly removed. Cables and hoses removed from engine side only.

4-18 Exhaust primer assembly removed (as a unit).

4-20 Exhaust elbow and guard removed.

4-21 Air intake system removed (as a unit).

Materials/Parts

Engine assembly

4-22 Fuel tank lines and fittings removed.

Equipment

Condition

Para	Condition Description
4-14	Battery box assembly removed.
4-15	Electrical system removed from engine side only.

5-4 Pump and bearing housing assembly removed.

Location/Item

Action

Remarks

REMOVAL

WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to engine assembly. Before lifting, be sure load is balanced.

CAUTION

Engine damage will occur if engine is set on bottom cover. Provide adequate blocking to support engine after removal from skid assembly.

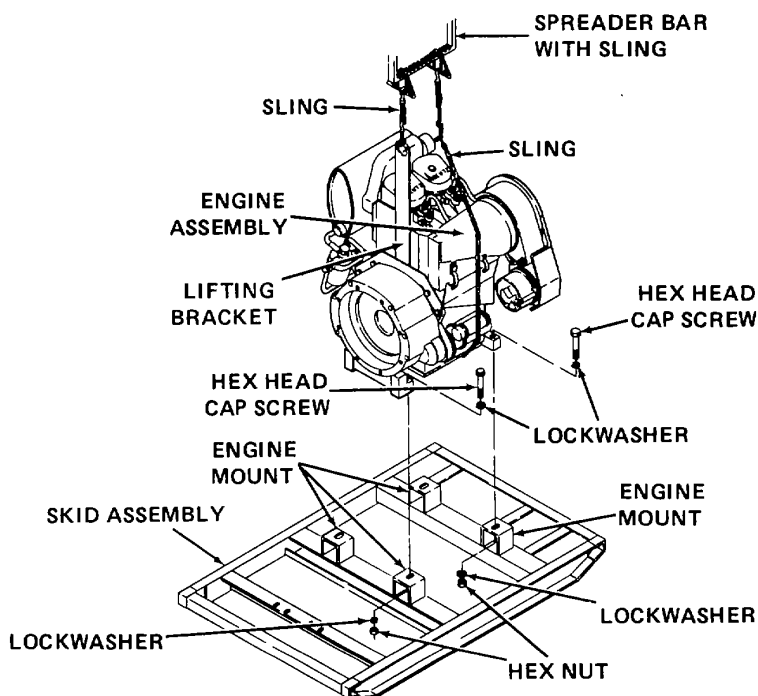
1. Engine assembly

a. Position a suitable lifting device equipped with a spreader bar and slings over engine assembly. Attach slings to lifting bracket and around engine assembly. Put tension on slings. Make sure engine is properly supported.

Spread slings on spreader bar so that slings hang vertically when attached to engine assembly.

5-7. ENGINE ASSEMBLY (CONT)

Location/Item	Action	Remarks
	<p>b. Remove hex head cap screws, lockwashers, and hex nuts from both sides of engine and engine mounts on skid assembly.</p>	
	<p>c. Lift engine assembly from skid assembly and lower onto blocks on a stable, level work platform.</p>	



INSTALLATION/REPLACEMENT

WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to engine assembly. Before lifting, be sure load is balanced.

- | | |
|---------------------------|--|
| <p>2. Engine assembly</p> | <p>a. Attach lifting equipment. Lift and carefully lower engine assembly onto engine mounts on skid assembly.</p> <p>b. Install hex head cap screws, lockwashers, and hex nuts and tighten securely.</p> |
|---------------------------|--|

5-8. V-BELT GUARD

This task covers: a. Inspection b. Repair

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

References

MIL-T-704 Treatment and Painting of
Material

Equipment Condition Para

Condition Description

4-26 V-belt guard removed from
engine.

Materials/Parts

Materials required by MIL-T-704

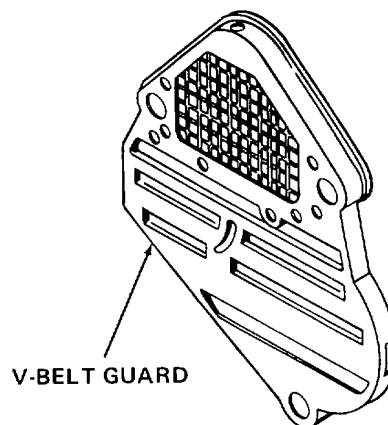
Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | |
|-----------------|---|
| 1. V-belt guard | Inspect for dents, rust, or other damage. |
|-----------------|---|

REPAIR

- | | |
|-----------------|---|
| 2. V-belt guard | Straighten dents. Remove rust. Clean, treat, and refinish in accordance with MIL-T-704, Type A, color as specified. |
|-----------------|---|



5-9. ALTERNATOR V-BELT PULLEY

This task covers: a. Inspection b. Repair.

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of
Material

Equipment Condition Para

4-28

Condition Description

Alternator V-belt pulley re-
moved from engine.

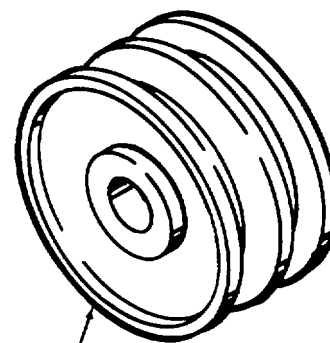
Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | |
|-----------------------------|---|
| 1. Alternator V-belt pulley | Inspect for nicks, dents, rust, corrosion, or other damage. |
|-----------------------------|---|

REPAIR

- | | |
|-----------------------------|--|
| 2. Alternator V-belt pulley | File off burrs. Remove rust and clean, treat, and refinish in accordance with MIL-T-704, Type A, color as specified. Replace if damaged. |
|-----------------------------|--|



ALTERNATOR V-BELT PULLEY

5-10. FAN (ALTERNATOR)

This task covers: a. Inspection b. Repair

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic NSN 4910-00-754-0705

Tool kit, master mechanics NSN 5180-00-699-5273

Materials/Parts

Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of Materiel

Equipment Condition

Para 4-28 Condition Description Fan removed from alternator.

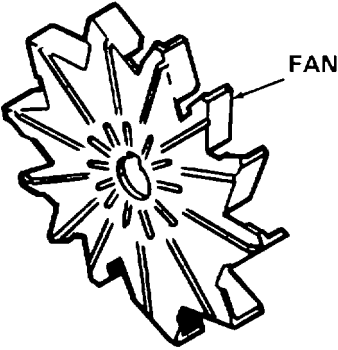
Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

1. Fan Inspect for nicks, dents, rust, or other damage. If fan is damaged beyond repair, replace it.

REPAIR

2. Fan Straighten and align fan blades. Remove rust and clean, treat, and refinish in accordance with MIL-T-704, Type A, color as specified.



5-11. DRIVE SHAFT V-BELT PULLEY

This task covers: a. Inspection b. Repair

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of
Material

**Equipment
Condition
Para**

Condition Description

4-29 Drive shaft V-belt pulley re-
moved from engine.

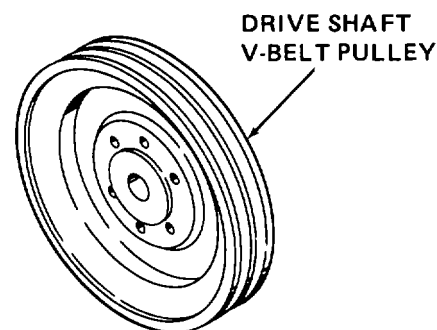
Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | |
|---------------------------------|---|
| 1. Drive shaft
V-belt pulley | Inspect for nicks, dents,
or other damage. |
|---------------------------------|---|

REPAIR

- | | |
|---------------------------------|--|
| 2. Drive shaft
V-belt pulley | File off burrs. Remove
rust and clean, treat,
and refinish in accord-
ance with MIL-T-704,
Type A, color as
specified. Replace if
damaged. |
|---------------------------------|--|



5-12. FLYWHEEL

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

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Equipment Condition

Para

5-4

Condition Description

Engine shut down and cool.

Pump and bearing housing assembly removed from engine.

Materials/Parts

- Flywheel
- Ring gear
- Diesel fuel oil (Item 5, Appendix E)

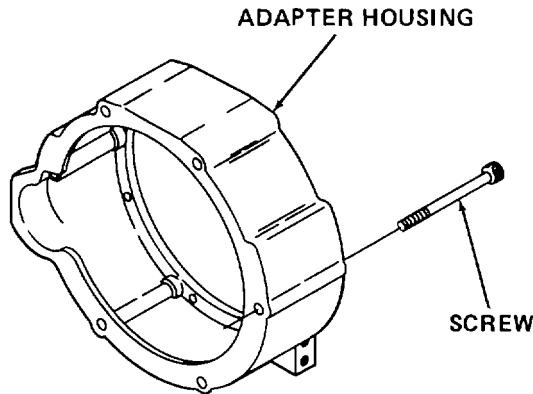
Special Environmental Conditions

Well-ventilated area required for cleaning.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|--------------------|------------------------------------|
| 1. Adapter housing | Remove screws and adapter housing. |
|--------------------|------------------------------------|



5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
2. Carrier	a. Restrain flywheel and carrier and remove screws. b. Remove carrier from flywheel.	
3. Flywheel	a. Restrain flywheel and remove hex bolts. b. Remove flywheel from crankshaft.	

CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
 - Work in a well-ventilated area.
 - Do not use near open flame, sparks, or excessive heat.
- Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|-------------------------|--|
| 4. Flywheel and carrier | a. Clean thoroughly with VV-F-800 diesel fuel oil. Use wire brush if necessary. Dry with compressed air.

b. Inspect for cracks, rust, corrosion, or other damage. Check for damaged, chipped, or broken teeth on flywheel ring gear. Check for unusual or uneven wear of ring gear. If units are severely damaged, cracked, or worn, replace flywheel or carrier. |
|-------------------------|--|

5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REPAIR

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

5. Flywheel and carrier mounting surfaces

Smooth out nicks or burrs. Remove rust or corrosion, then clean with VV-F-800 diesel fuel oil. Dry with compressed air.

CAUTION

Starter pinion damage may occur if chamfered side of replacement ring gear is not facing same direction as chamfer on replaced gear. Note chamfered side of gear before replacement.

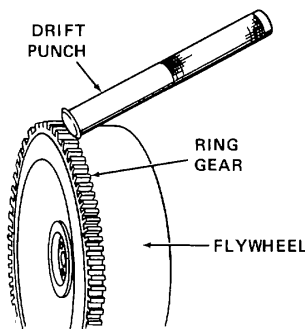
NOTE

Only remove a ring gear if it is to be replaced.

6. Ring gear removal

To remove ring gear from flywheel, support flywheel on a solid flat surface, position a drift punch on upper edge of ring gear, and lightly tap punch while moving it around the gear.

Support flywheel crankshaft side down.



5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

WARNING

Operate acetylene torches properly and be alert for leaks on any part of the equipment. Inhalation of acetylene produces headache, dizziness, nausea, and possible loss of consciousness. If acetylene is inhaled, seek fresh air immediately.

CAUTION

Ring gear damage may occur if gear is overheated. Do not heat gear over 400°F (204°C). Use minimum amount of heat required to fit ring gear on flywheel. Keep flame moving at all times.

7. Ring gear installation

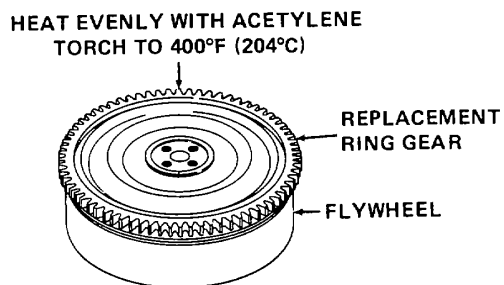
Mount replacement ring gear on flywheel as follows:

- a. Support flywheel (ring gear side up) on a solid flat surface.
- b. Rest ring gear on a flat metal surface.

NOTE

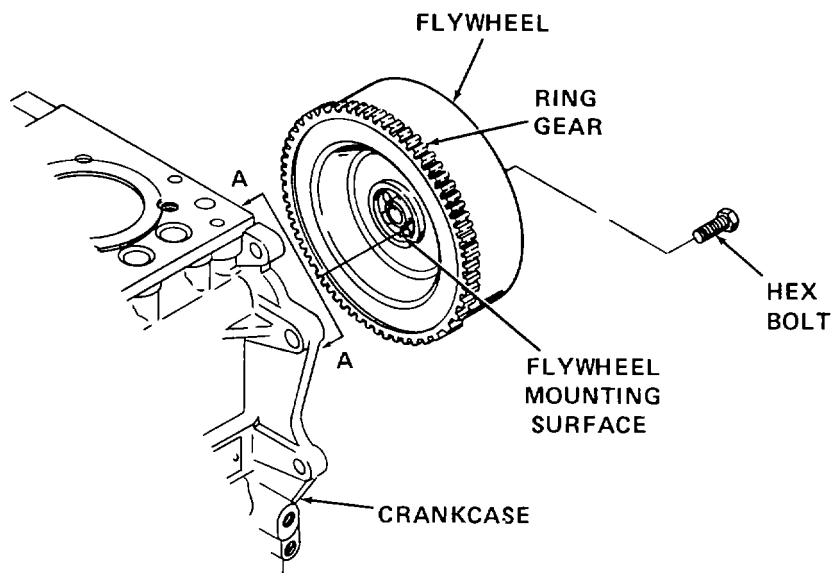
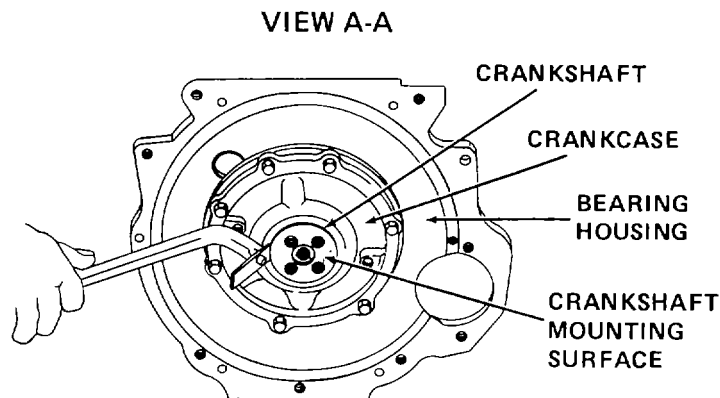
Heat indicating crayons, which are placed on the ring gear, and melt at a predetermined temperature, may be obtained from most vendors. Use of crayons will guard against overheating the gear.

- c. Heat the gear evenly with an acetylene torch. Keep moving flame rapidly over surface of gear.
- d. Use tongs to position replacement gear in identical position to old gear.



5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
8. Crankshaft and flywheel mounting surfaces	<p>e. Tap gear in place against shoulder. If gear will not seat flatly on shoulder, remove it and carefully repeat the heating operation.</p> <p>Inspect. Lightly stone to remove any fretting or brinnelling. Remove dirt and debris.</p>	



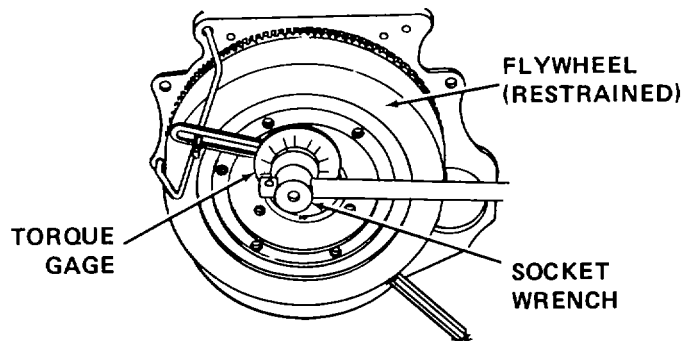
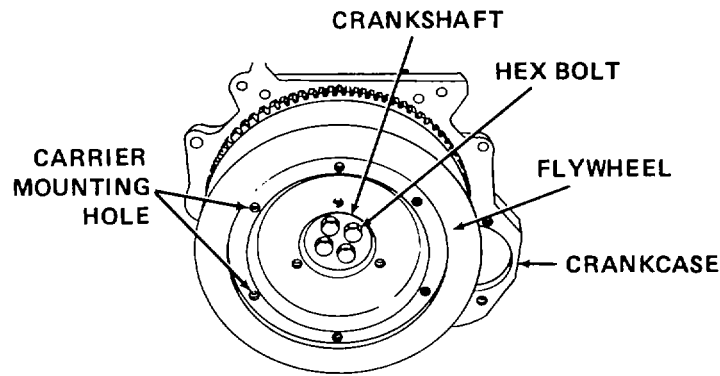
5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
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**INSTALLATION/
REPLACEMENT**

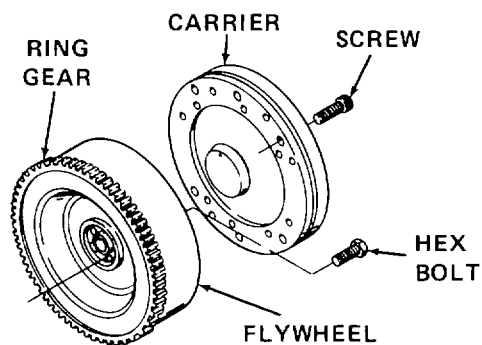
9. Flywheel

Aline flywheel mounting holes with mounting holes on crankshaft. Insert hex bolts and tighten hand tight. Restrain flywheel and tighten hex bolts alternately and evenly across flywheel to 22 ft lb (30 N.m) with socket wrench. Using socket wrench and angular torque gage, tighten hex bolts alternately and evenly an additional 30 degrees, then another 60 degrees.



5-12. FLYWHEEL (CONT)

Location/Item	Action	Remarks
10. Flywheel and carrier	<p>Restrain flywheel. Aline carrier mounting holes with flywheel mounting holes and install screws. Tighten alternately and evenly across carrier until tightened securely. Take restraint off flywheel. Make sure flywheel turns freely with no hitches or tight spots.</p>	



5-13. COOLING AIR DUCTING

This task covers: a. Inspection b. Repair

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of
Material

Equipment Condition Para

4-30 Cooling air ducting removed
from engine.

Condition Description

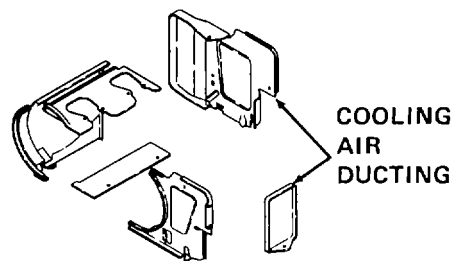
Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | |
|------------------------|---|
| 1. Cooling air ducting | Inspect for dents, rust, or other damage. |
|------------------------|---|

REPAIR

- | | |
|------------------------|---|
| 2. Cooling air ducting | Straighten dents. Remove rust or corrosion then clean, treat, and refinish cooling air ducting in accordance with MI L-T-704, Type A, color as specified. |
|------------------------|---|



5-14. LUBE OIL COOLER

This task covers: a. Inspection/Test b. Repair

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Troubleshooting References (Table 5-1)

Malfunction 5, step 2

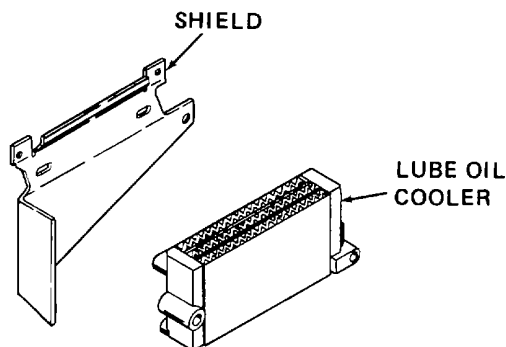
Equipment Condition

Para	Condition Description
4-32	Lube oil cooler and shield removed.

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION/TEST

- | | |
|--------------------|--|
| 1. Shield | Inspect for dents, rust, or damage. |
| 2. Lube oil cooler | a. Inspect for dents, rust, or damage.
b. Pressure test to 188 psi (1300 kPa) for leakage. Repair or replace. |



REPAIR

- | | |
|--------------------|---------------------------------------|
| 3. Lube oil cooler | Remove rust or corrosion, then clean. |
|--------------------|---------------------------------------|

5-15. FUEL FEED PUMP

This task covers:

	a. Disassembly	c. Reassembly
	b. Inspection/Repair	

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Equipment Condition

Para	Condition Description
4-34	Fuel feed pump removed from engine.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix E)

Diesel fuel oil (Item 5, Appendix E)

Emery abrasive cloth (Item 2, Appendix E)

Lubricating oil (Item 9, Appendix E)

Troubleshooting Reference (Table 5-1)

Malfunction 4, step 2

5-15. FUEL FEED PUMP (CONT)

Location/Item	Action	Remarks
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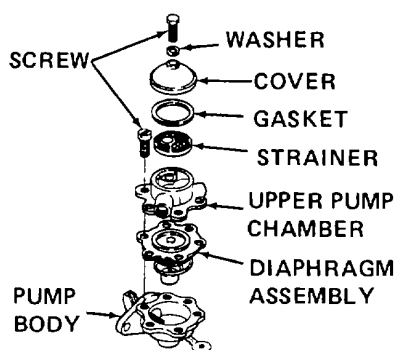
DISASSEMBLY

CAUTION

Do not scratch or mar mating surfaces of cover, upper pump chamber, or pump body. The pump may leak or otherwise malfunction after reassembly.

- | | |
|-----------------------|--|
| 1. Cover | Remove screw, washer, and cover. |
| 2. Gasket | Remove and discard. |
| 3. Strainer | Remove. |
| 4. Upper pump chamber | a. Remove screws.

b. Remove upper pump chamber. |
| 5. Diaphragm assembly | Remove from pump body and discard. |



INSPECTION/REPAIR

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

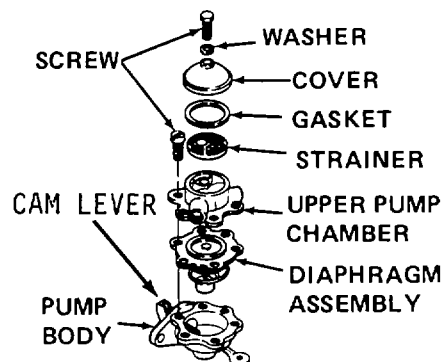
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|----------------------------|--|
| 6. All parts except gasket | a. Clean in clean VV-F-800 diesel fuel oil and dry with low pressure compressed air. |
|----------------------------|--|

5-15. FUEL FEED PUMP (CONT)

Location/Item	Action	Remarks
	<p>b. Inspect mating surfaces of cover and pump body parts for roughness or other damage. Scratches or other damage may result in pressure leaks. Also check for wear at contact areas. Replace pump body or cover if necessary.</p> <p>c. All parts must be free from score marks and burrs and must fit together tightly. If scored or burred, clean with P-C-1673 emery cloth or P-C-458 crocus cloth. If parts are not repairable, replace.</p>	
REASSEMBLY		
7. Diaphragm assembly	Install on pump body.	
8. Upper pump chamber	<p>a. Install on diaphragm assembly.</p> <p>b. Install screws finger tight. Move cam lever to compress diaphragm spring.</p> <p>c. Tighten screws.</p>	
9. Strainer	Install.	
10. Gasket	Lubricate with very thin coat of MIL-L-2104 oil, and install.	
11. Cover	Install screw, washer, and cover.	



5-16. FUEL INJECTORS

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

INITIAL SETUP

Test Equipment

Bosch pump adapter kit No. 003-3346

Bosch pump outfit No. 003-3345

Tools

Injector extractor No. 150800

Injector gasket remover No. 120630

Nozzle holder extractor No. 110030

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

Materials/Parts

Fuel injector and component parts

Diesel fuel oil (Item 5, Appendix E)

Grease (Item 6, Appendix E)

Troubleshooting References (Table 5-1)

Malfunction 3, steps 2 and 3

Malfunction 4, step 1

Equipment

Condition

Para	Condition Description
4-34	Fuel injection lines removed.

Special Environmental Conditions

Well-ventilated area required.

5-16. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

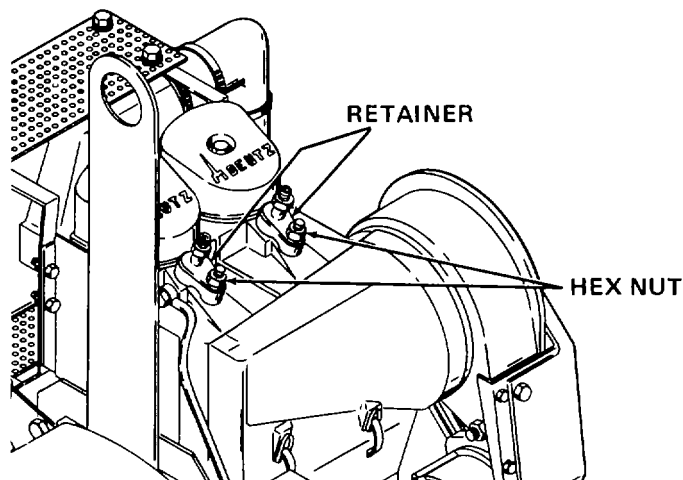
- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

CAUTION

The fuel injection system is extremely intricate and complex. All possible care should be taken in the removal, inspection, testing, and reassembly of these components. While handling the fuel injector, be extremely careful not to touch the nozzle or the pin assembly on the nozzle end.

1. Retainers

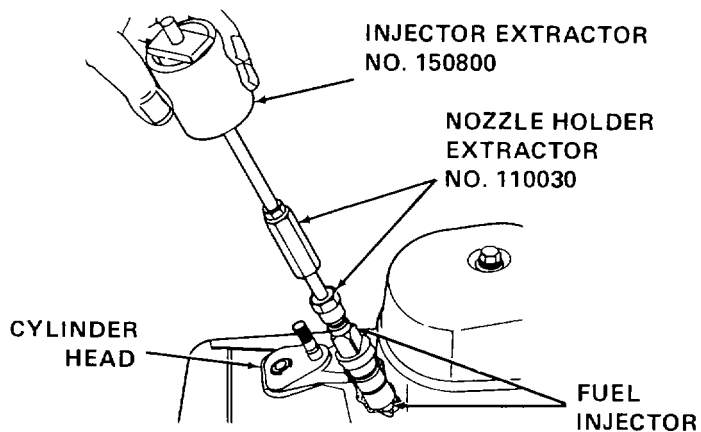
Remove hex nuts and retainers.



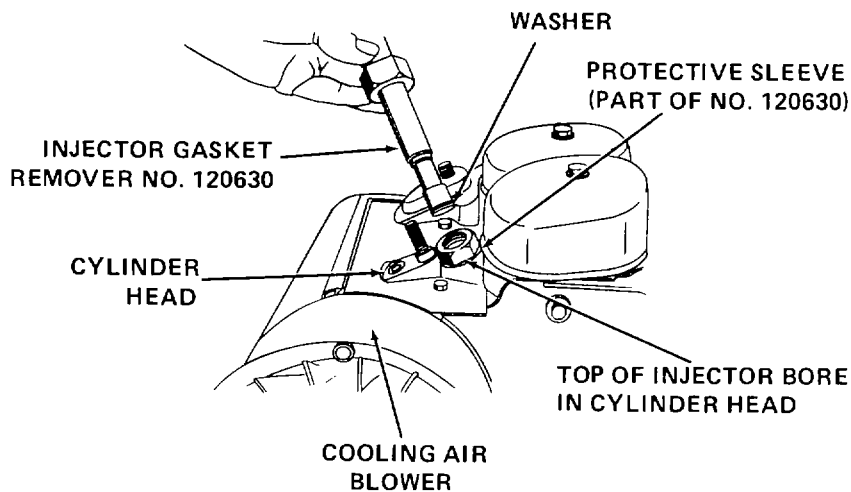
5-16. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
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2. Fuel injectors
 Remove from cylinder heads using nozzle holder extractor No. 110030 and injector extractor No. 150800.



3. Washer
 Remove from cylinder head using injector gasket remover No. 120630. Discard washer.



5-16. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
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INSPECTION/TEST

4. Fuel injectors

Visually inspect for damage, scoring, or burning. Inspect to see if units are bent, cracked, or damaged. If repairable, contact general support maintenance for repair, and replace injectors.

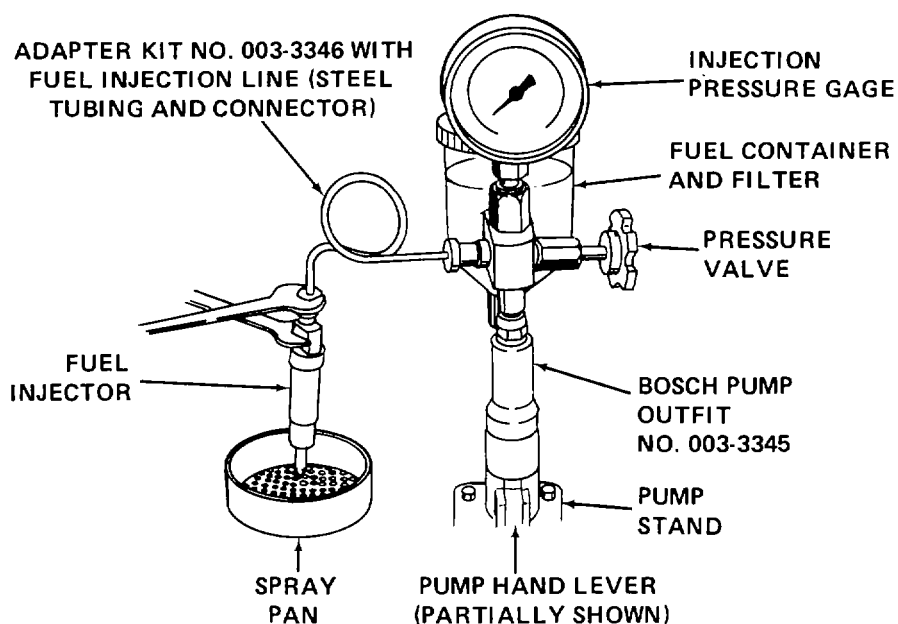
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle near open flame, sparks, or excessive heat.
- Be certain fuel line and connections are secure.
- Do not overfill fuel reservoir.
- Work in a well-ventilated area.

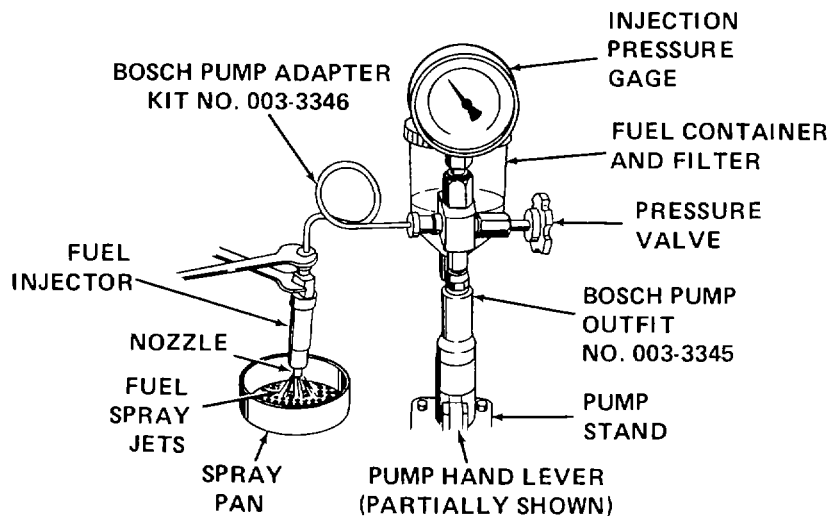
5. Fuel injectors

- a. Connect Bosch pump outfit No. 003-3345 with adapter kit No. 003-3346.
- b. Fill Bosch pump fuel container 3/4 full with VV-F-800 diesel fuel oil. Do not overfill.



5-16. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
6. Bosch pump outfit No. 003-3345	Make sure pressure valve is turned all the way clockwise and closed. Pump up air pressure in unit by pumping the pump hand lever up and down several times.	
7. Pump outfit, pressure valve, injector, and nozzle	Slowly turn pressure valve counterclockwise. As the valve starts to open, read fuel injection pressure on gage. Continue to open valve to increase fuel injection pressure to injector until fuel sprays out of nozzle. Read and record injection pressure. Injection pressure should be 2611 to 2727 psi (18 000 to 18 800 kPa) for a new injector, or 2538 to 2654 psi (17 500 to 18 300 kPa) for an injector in operation and being tested. Injection pressure may be adjusted if it does not fall within the limits above. Refer injector to general support for adjustment or repair, and replace injector.	
8. Injector and nozzle	Check fuel spray pattern from injector nozzle. Fuel should spray out in several evenly spaced jets of equal thickness and with no mist surrounding the jets. If spray pattern does not conform to above, refer injector to general support for repair, and replace injector. If injector nozzle drips fuel at approximately 2100 to 2360 psi (14 500 to 16 300 kPa) before it has reached recommended injection pressure, refer injector to general support for repair, and replace injector. If nozzle drips fuel after injection pressure test, refer injector to general support for repair, and replace injector.	



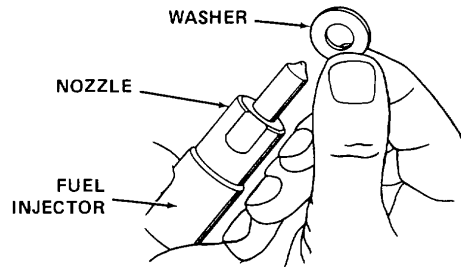
5-16. FUEL INJECTORS (CONT)

Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

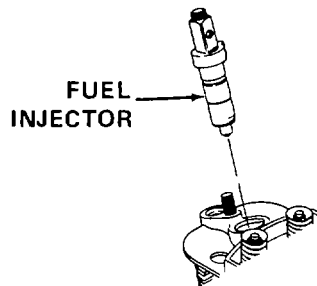
9. Washer

Lightly coat graphited side of washer with MIL-G-10924 grease and install on injector nozzle. Make sure graphited side of washer points toward injector. Be certain injector seat in cylinder head is clean. Make sure washer sticks to nozzle during installation of fuel injector in cylinder head.



10. Fuel injector

Carefully insert into injector bore in cylinder head. Make sure not to damage nozzle needle. Insert injector until it seats properly at bottom of bore in cylinder head.

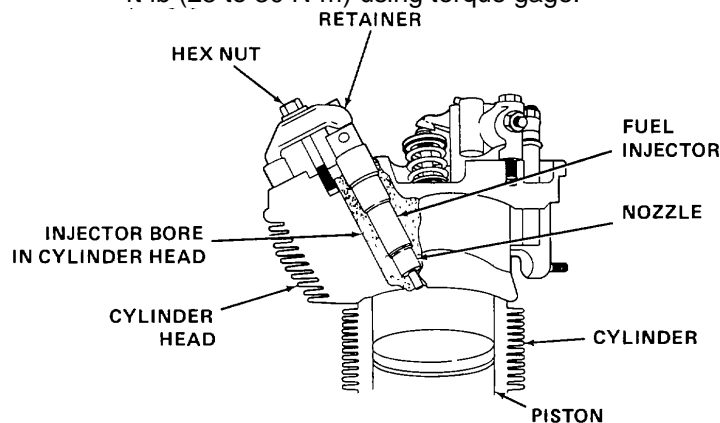


CAUTION

Use care when cleaning injector seat in cylinder head to prevent scratches. Scratches will cause a carbon track.

11. Retainers

Install retainer and hex nut. Tighten hex nut to 18 to 23 ft lb (25 to 30 N-m) using torque gage.



5-17. COOLING AIR BLOWER

This task covers: a. Disassembly
 b. Cleaning
 c. Inspection
 d. Repair
 e. Assembly

INITIAL SETUP

Tools

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

References

MIL-T-704 Treatment and Painting of
 Materiel

Materials/Parts

Ball bearings
 Materials required by MIL-T-704
 Crocus abrasive cloth (Item 1, Appendix E)
 Diesel fuel oil (Item 5, Appendix E)
 Emery abrasive cloth (Item 2, Appendix E)
 Grease (Item 7, Appendix E)

**Equipment
 Condition
 Para**

4-30

Condition Description

Cooling air blower removed from
 engine.

Special Environmental Conditions

Well-ventilated area required for cleaning.

Location/Item	Action	Remarks
---------------	--------	---------

DISASSEMBLY

- | | | |
|------------------|--|--|
| 1. V-belt pulley | a. Restrain hex bolt. Remove hex nut.
b. Remove hex bolt. | |
| 2. Bottom roller | Lift up and out of blower jacket. | |
| 3. V-belt pulley | Pull from quill shaft. | |
| 4. Blower jacket | Compress and remove circlip from groove in
blower jacket. | |

5-17. COOLING AIR BLOWER (CONT)

Location/Item	Action	Remarks
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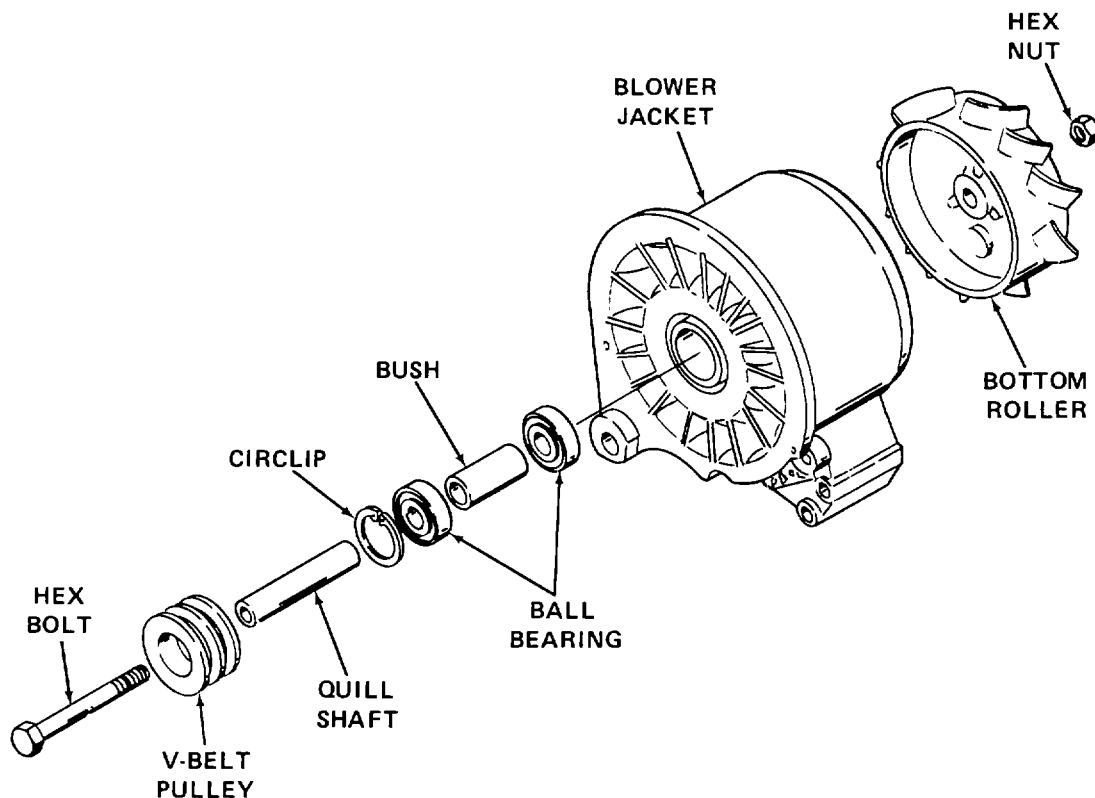
CAUTION

Use care to avoid damage to quill shaft and blower jacket during following step.

- | | |
|---|---|
| 5. Assembled quill shaft, bush, and ball bearings | Press out of blower jacket. Press from bottom roller side of blower jacket. |
| 6. Ball bearings | Press from quill shaft. Discard ball bearings. |

NOTE

Leave bush on quill shaft.



5-17. COOLING AIR BLOWER (CONT)

Location/Item	Action	Remarks
CLEANING		
<u>WARNING</u>		
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:		
<ul style="list-style-type: none"> • Do not inhale vapor. • Do not handle near open flame, sparks, or excessive heat. • Work in a well-ventilated area. 		
7 All parts	Wash with clean VV-F-800 diesel fuel oil. If necessary, scrub with soft-bristled brush. Allow parts to air dry.	
INSPECTION		
8. Assembled quill shaft and bush	Inspect assembly for evidence of corrosion on mating surfaces. If corrosion is evident, mark location of bush on quill shaft, and press quill shaft out of bush. Inspect inside diameter of bush and outside diameter of quill shaft for corrosion and/or damage that would prevent reuse of parts. If no corrosion is evident at mating surfaces of bush and quill shaft, inspect all exposed surfaces for corrosion and/or physical damage that would prevent reuse of components. Be sure quill shaft is straight. Replace bent quill shaft.	
9. V-belt pulley	<p>a. Check hex bolt and hex nut threads for cross-threading, damage, and/or corrosion that would prevent reuse. Replace damaged hex bolt or hex nut.</p> <p>b. Check pulley sheaves for sharp edges and/or corrosion or damage that could damage V-belts during operation.</p>	
10. Bottom roller	Check blades of roller for indications that roller has been rubbing on blower jacket. Physical damage to roller blades could indicate damaged blower jacket or bent quill shaft. Check surface of roller and inside diameter of the bore into which the quill shaft is installed for corrosion or damage.	

5-17. COOLING AIR BLOWER (CONT)

Location/Item	Action	Remarks
11. Blower jacket	Check area of jacket into which the bottom roller is installed for physical damage or corrosion that would indicate roller is rubbing jacket during operation. Check inside diameter of jacket for corrosion or damage that would prevent reuse of blower jacket. Check inside diameter for discoloration caused by overheated bearings. Check circlip groove for damage that would prevent proper seating of circlip during installation.	
REPAIR		
12. All reusable components	<p>a. Remove corrosion from components using P-C-1673 emery cloth or P-C-458 crocus cloth.</p> <p>b. Remove surface damage and blend in damaged areas of components using P-C-1673 emery cloth or P-C-458 crocus cloth. Remove sharp edges caused by wear or repair effort.</p>	
13. Blower jacket	Repair surfaces from which paint has been removed or damaged. Sand area to be painted using P-C-1673 emery cloth or P-C-458 crocus cloth. Sand down edges of good paint until transition from painted area to area to be painted is smooth with no visible difference in height. Roughen good paint surrounding area to be painted. Refinish blower jacket in accordance with MIL-T-704, Type A color as specified.	
ASSEMBLY		
14. Bush	If bush was removed from quill shaft, press quill shaft into bush.	
15. Ball bearings	Pack with MIL-G-18709 grease. Press onto quill shaft. Seat against bush.	

5-17. COOLING AIR BLOWER (CONT)

Location/Item	Action	Remarks
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CAUTION

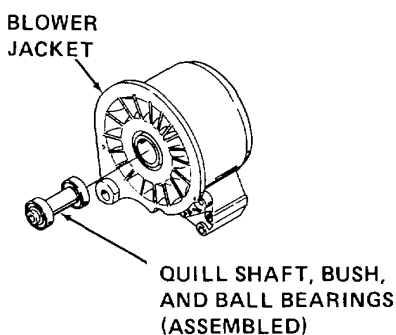
Use care to avoid damage to quill shaft and blower jacket during following step.

16. Assembled quill shaft, bush, and ball bearings

Press into blower jacket.
Press from V-belt pulley side of blower jacket.

17. Blower jacket

Compress and install circlip into groove in blower jacket. Be sure circlip expands fully into groove.



18. V-belt pulley

Install onto quill shaft.

19. Bottom roller

Install into blower jacket.

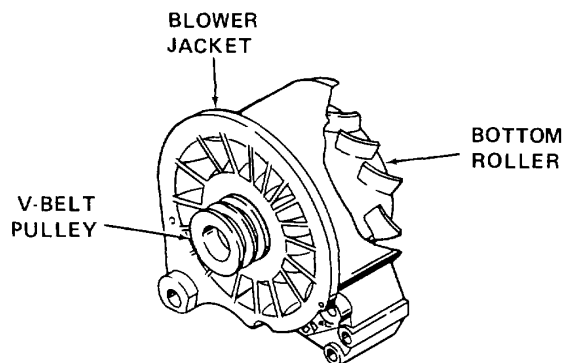
20. V-belt pulley

- a. Install hex bolt through V-belt pulley, quill shaft, and bottom roller.
- b. Thread hex nut onto hex bolt. Tighten securely.

21. Cooling air binding, blower

Slowly rotate bottom roller. Check for rubbing, or excessive resistance to rotation. Check that V-belt pulley runs true relative to blower jacket. Slowly rotate V-belt pulley. Check that bottom roller runs true to blower jacket.

rotate relative



5-18. STARTER MOTOR

This task covers: a. Test d. Assembly
 b. Disassembly e. Final Test
 c. Cleaning/Inspection/Repair

INITIAL SETUP

Test Equipment

Battery (12V)

Starter switch w/leads

Tools

Shop set, automotive repair, field maintenance, basic NSN 4910-00-754-0705

Tool kit, master mechanics NSN 5180-00-699-5273

Materials/Parts

Dry cleaning solvent (Item 16, Appendix E)

Rosin flux core solder (Item 15, Appendix E)

Troubleshooting Reference (Table 5-1)

Malfunction 1, step 1

Equipment Condition

Para	Condition Description
4-37	Starter motor removed from engine.

Location/Item	Action	Remarks
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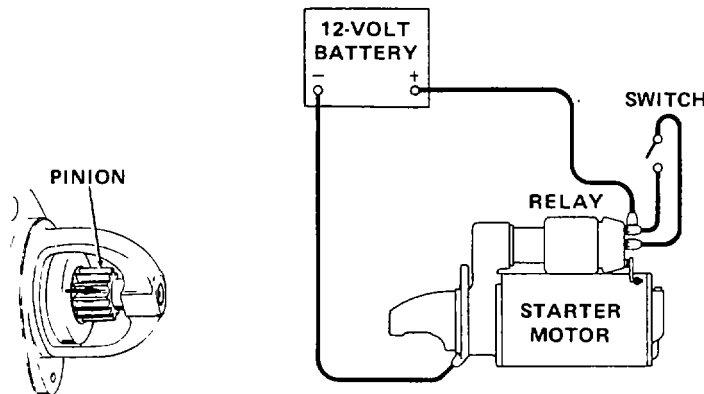
TEST

CAUTION

Under no-load condition the starter will exceed safe RPM's.

1. Starter

Connect starter in series with a fully charged 12-volt battery and connect a remote starting switch as shown. Energize starter by momentarily depressing switch; observe whether pinion moves forward and begins rotating at a high rate of speed. If it does not, consult the following symptom chart.



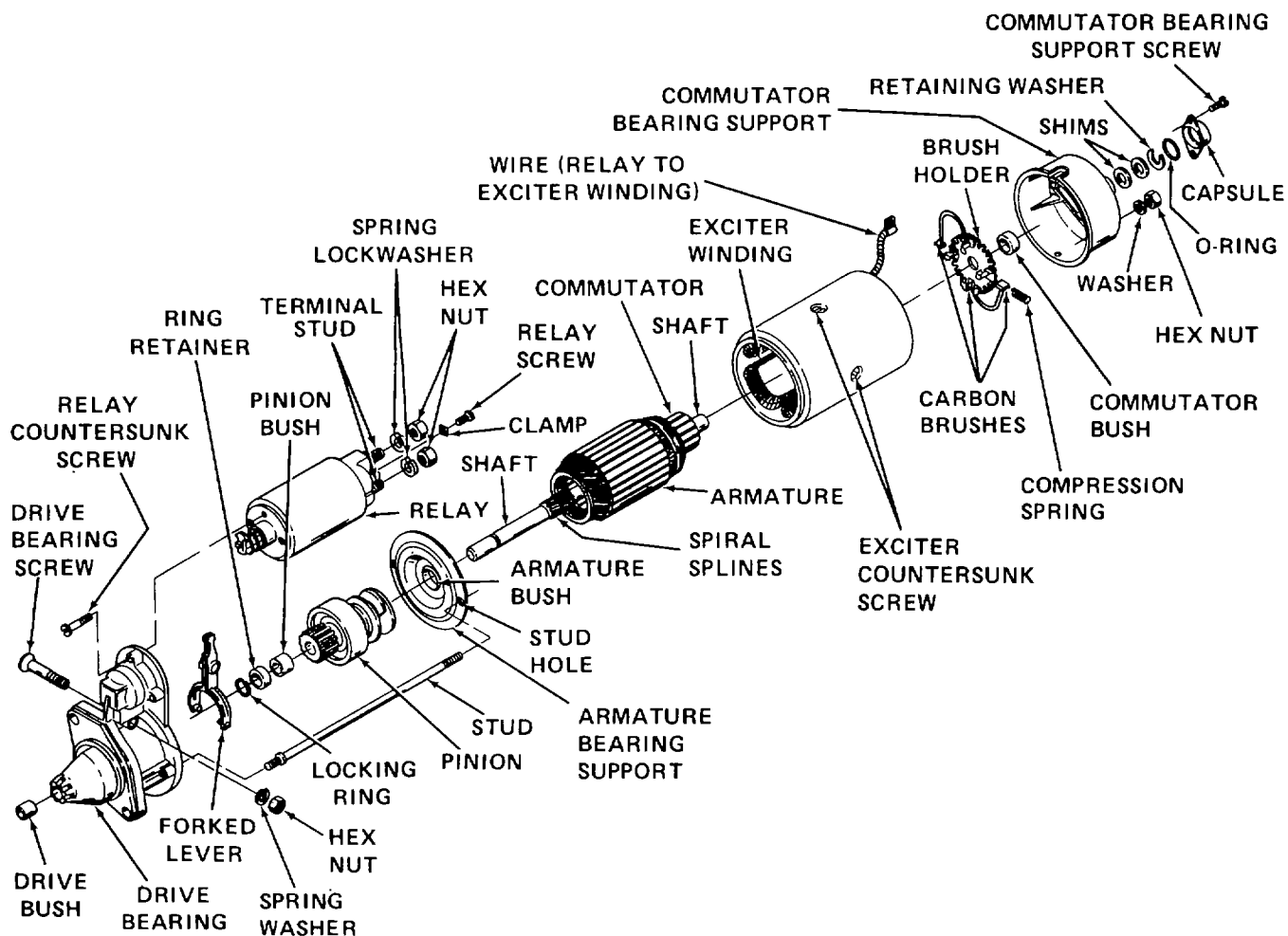
5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
SYMPTOM	REASON	
Pinion rotates slowly	Damaged bearings, poor connections, dirty or damaged commutator, damaged leads.	
Pinion does not rotate	Frozen bearings, poor contact between brushes and commutator, field terminal shorted out to starter motor frame.	

DISASSEMBLY

2. Relay

- a. Remove relay screw and clamp.
- b. Remove hex nuts and spring lockwashers.
- c. Remove wire (relay to exciter winding) from terminal stud on relay.



5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
	d. Remove relay countersunk screws.	
	e. Remove relay.	
3. Commutator bearing	a. Remove commutator bearing support screws.	
	b. Remove capsule.	
	c. Remove O-ring, retaining washer, and shims.	
	d. Remove hex nuts and washers.	
	e. Remove commutator bearing support.	
4. Brush holder and compression springs	Remove.	
5. Carbon brushes	Remove from brush holder.	
6. Commutator bush	Remove from commutator bearing support.	
7. Exciter winding	Remove from armature and studs.	
8. Drive bearing	a. Remove drive bearing screw, spring washer, and hex nut from drive bearing.	
	b. Remove drive bearing.	
9. Forked lever	Remove.	
10. Locking ring and ring retainer	Remove.	
11. Pinion	Remove from armature.	
12. Pinion bush	Remove.	
13. Armature bearing support and armature bush	Remove.	
14. Armature bush	Remove from armature bearing support.	
15. Drive bush	Remove drive bush and studs from drive bearing.	

5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION/
REPAIR**WARNING**

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

16. Starter components

Clean with P-D-680 solvent and dry with compressed air. When cleaning armature, exciter winding, and relay, use soft cloth wet with solvent. Do not soak these components in solvent. Dry with soft cloth or compressed air.

17. Brush holder, carbon brushes, and brush components

Clean accumulated dirt, carbon, or other foreign material from brush holder, carbon brushes, and other brush components with P-D-680 solvent. Dry with soft cloth or low pressure compressed air. Inspect for excessive wear or damage. Inspect commutator end of brushes for dirt, glaze, or other material preventing good electrical contact with commutator. Replace glazed brushes or brush components that are excessively worn or damaged. Replace brushes and leads if leads are frayed or broken.

18. Armature and commutator

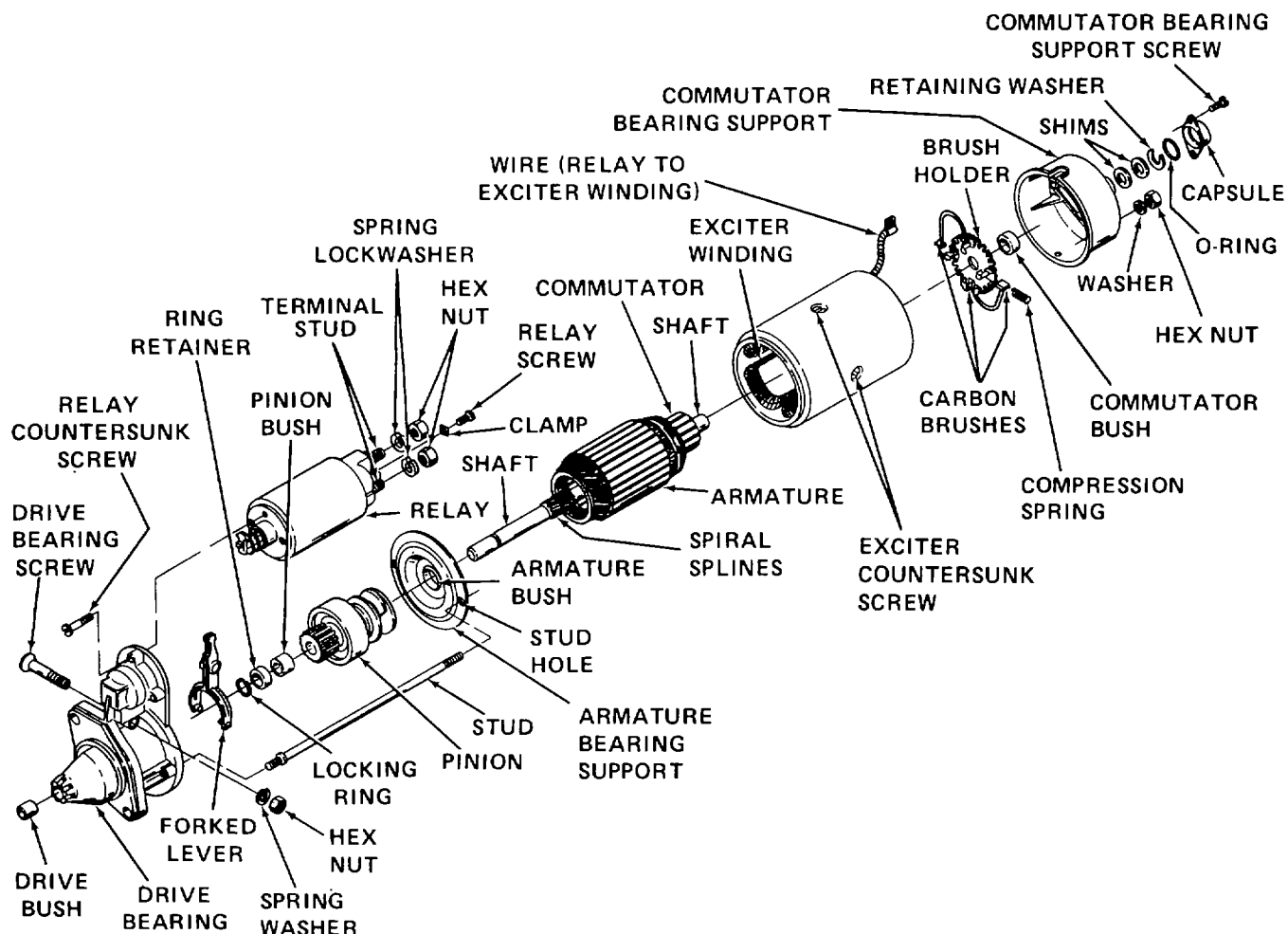
Remove dirt and carbon from between commutator bars. Inspect armature and its commutator for excessive wear, missing bars, or broken solder connections. Replace armature if commutator is excessively worn or has missing commutator bars. Repair any loose or frayed solder connections at commutator.

5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
19. Commutator bush, pinion bush, armature bush, and drive bush	Rotate armature shaft in bush to determine if bushes are frozen or excessively worn. Worn bush will permit the shaft to be moved sideways. Replace bushes if excessively worn or frozen.	
20. Exciter winding and wire (exciter Winding to relay)	Inspect exciter winding and wire to relay for loose, burned, frayed, or shorted wires. Repair loose connections on exciter winding or relay if necessary. Replace exciter winding if frayed, shorted, or damaged.	
21. All other starter components	Inspect for excessive wear or damage. Replace any worn, damaged, cracked, or broken components.	
ASSEMBLY		
22. Drive bush	Install drive bush and studs in drive bearing.	
23. Armature bush	Install in armature bearing support.	
24. Armature bearing support	Install on armature shaft.	
25. Pinion bush	Install.	
26. Pinion	Install on armature shaft.	
27. Ring retainer and locking ring	Install.	
28. Forked lever	Position on pinion.	
29. Drive bearing	<p>a. Carefully slide onto armature shaft and pinion making sure studs are properly inserted through stud holes in armature bearing support.</p> <p>b. Install drive bearing screw in drive bearing and through forked lever. Install spring washer and hex nut. Tighten securely.</p>	

5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------



- | | |
|--|---|
| 30. Exciter winding | Install onto armature and studs. |
| 31. Commutator bush | Install in commutator bearing support. |
| 32. Carbon brushes | Install in brush holder. |
| 33. Brush holder and compression springs | Install in commutator bearing support. |
| 34. Commutator bearing support | <ul style="list-style-type: none"> a. Install on armature shaft and studs. b. Install hex nuts and washers and tighten securely. c. Install shims, retaining washer, and O-ring. |

5-18. STARTER MOTOR (CONT)

Location/Item	Action	Remarks
35. Relay holes.	<ul style="list-style-type: none"> d. Position capsule over armature shaft and aline with screw holes in commutator bearing support. e. Install commutator bearing support screws and tighten securely. a. Position on drive bearing and aline mounting b. Install relay countersunk screws and tighten securely. c. Position wire (exciter winding to relay) on terminal stud on relay. d. Install spring lockwashers and hex nuts on terminals on relay and tighten securely. e. Install clamp and relay screw and tighten securely. 	

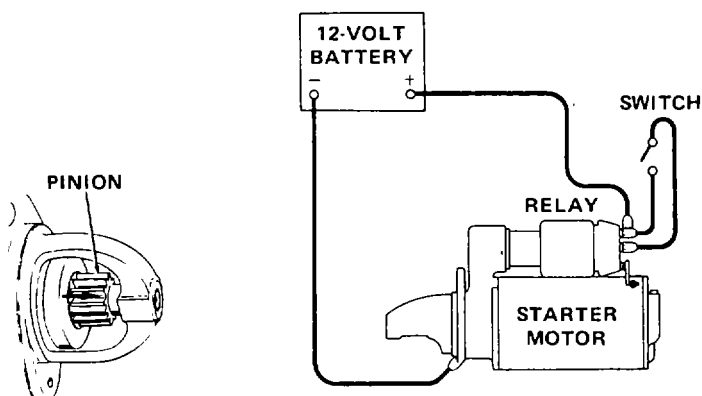
FINAL TEST

CAUTION

Under no-load conditions the starter will exceed safe RPM's.

36. Starter

Retest assembled starter as in step 1. Connect starter in series with a fully charged 12-volt battery and connect a remote starting switch as shown. Energize starter by momentarily depressing switch; observe whether pinion moves forward and begins rotating at a high rate of speed. If it does not, consult the symptom chart in step 1 and proceed accordingly.



5-19. ALTERNATOR

This task covers: a. Disassembly
 b. Cleaning/Inspection
 c. Test
 d. Repair/Replacement
 e. Assembly

INITIAL SETUP

Test Equipment

Multimeter

Crocus abrasive cloth (Item 1, Appendix E)

Dry cleaning solvent (Item 16, Appendix E)

Tools

Arbor press

Rosin flux core solder (Item 15, Appendix E)

Surfacing stone (Item 17, Appendix E)

Bearing extractor

References

Electronics soldering iron, 25-watt

MIL-T-704

Treatment and Painting of Materiel

Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705

Equipment Condition Para

Condition Description

Tool kit, master mechanics
 NSN 5180-00-699-5273

4-38

Alternator removed from engine.

Materials/Parts

O-seal

Special Environmental Conditions

Materials required by MIL-T-704

Well-ventilated area required during cleaning.

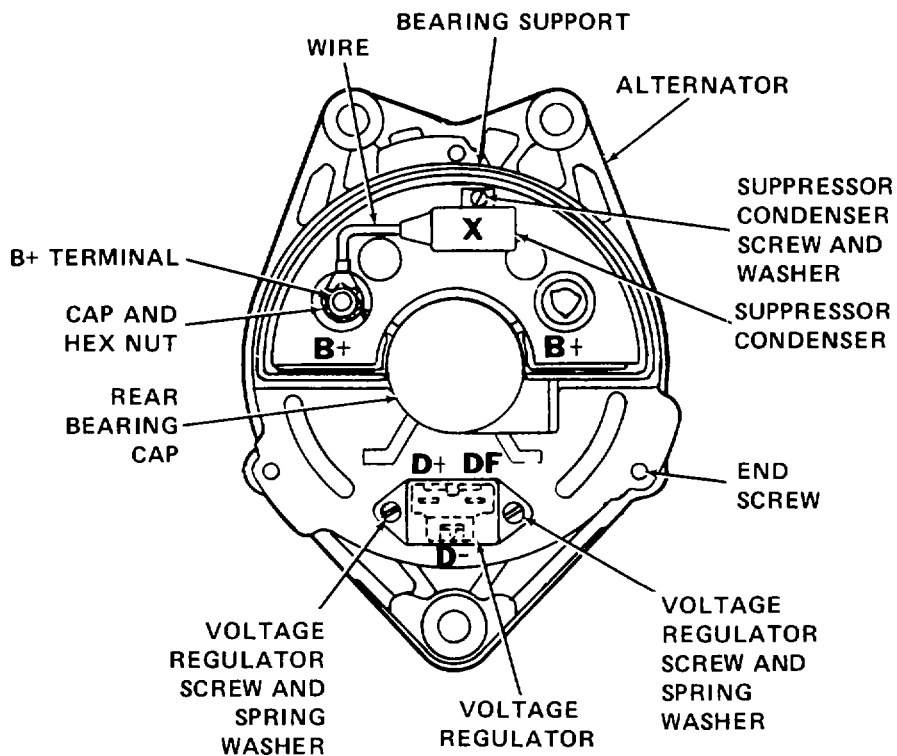
5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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DISASSEMBLY

- | | |
|-------------------------|--|
| 1. Bearing support | a. Remove suppressor condenser screw and washer from bearing support.

b. Remove cap, hex nut, and suppressor condenser wire from B+ terminal. |
| 2. Suppressor condenser | Remove from bearing support. |
| 3. Voltage regulator | Remove voltage regulator screws and spring washers. |

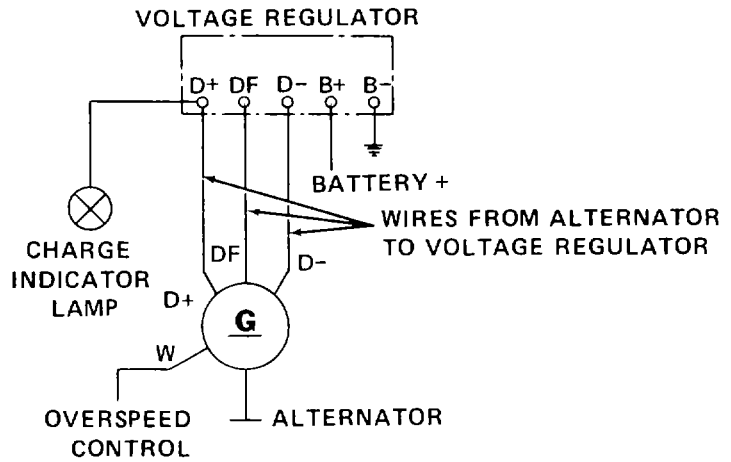


5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|---------------------------------|--|--|
| 4. Wires from voltage regulator | Remove from D+, DF, and D- terminals on alternator. Tag wires for easy reassembly. | |
|---------------------------------|--|--|

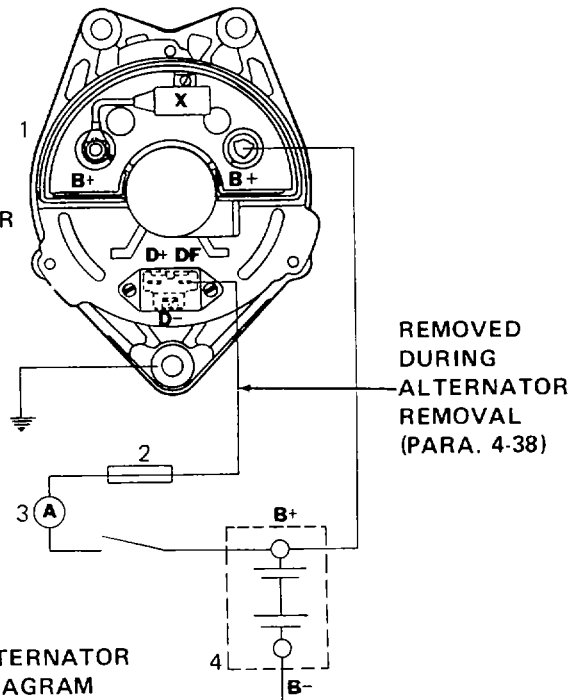
On the Alternator and Voltage Regulator	
B+	Battery positive
B-	Batttery negative
D+	Positive recitifier diodes
D-	Negative recitifier diodes
DF	Columix common lead
Alternator	
W	Individual phase terminal for speed control sensing



NOTE: VOLTAGE REGULATOR REMOVED.

- 1 ALTERNATOR
- 2 6 A FUSE
- 3 AMMETER
- 4 BATTERY

TYPICAL ALTERNATOR WIRING DIAGRAM



5-19. ALTERNATOR (CONT)

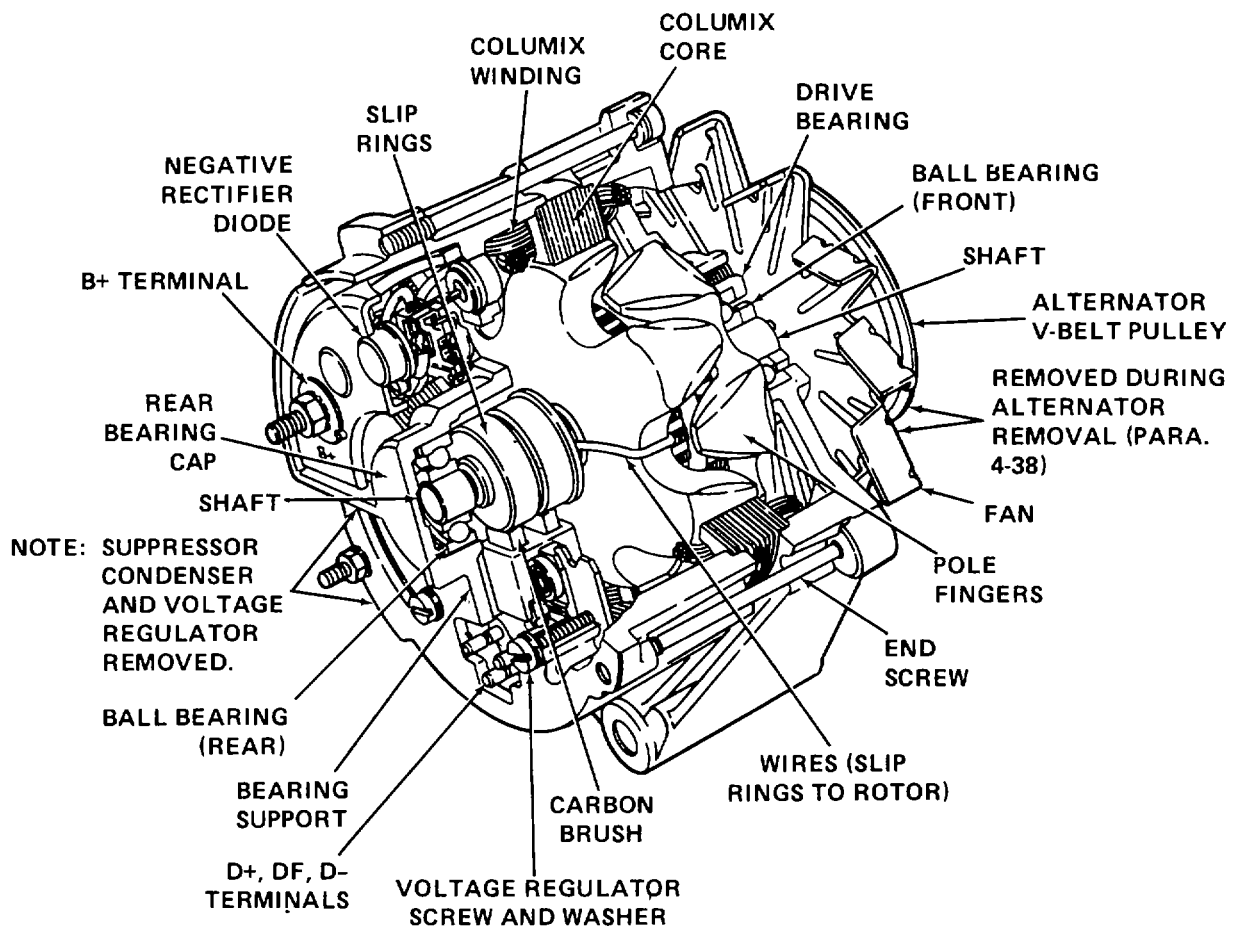
Location/Item	Action	Remarks
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WARNING

Be very careful handling the carbon brushes when removing voltage regulator, sealing frame, and attached carbon brush holder. Brushes are spring loaded and will fly out if not restrained during removal.

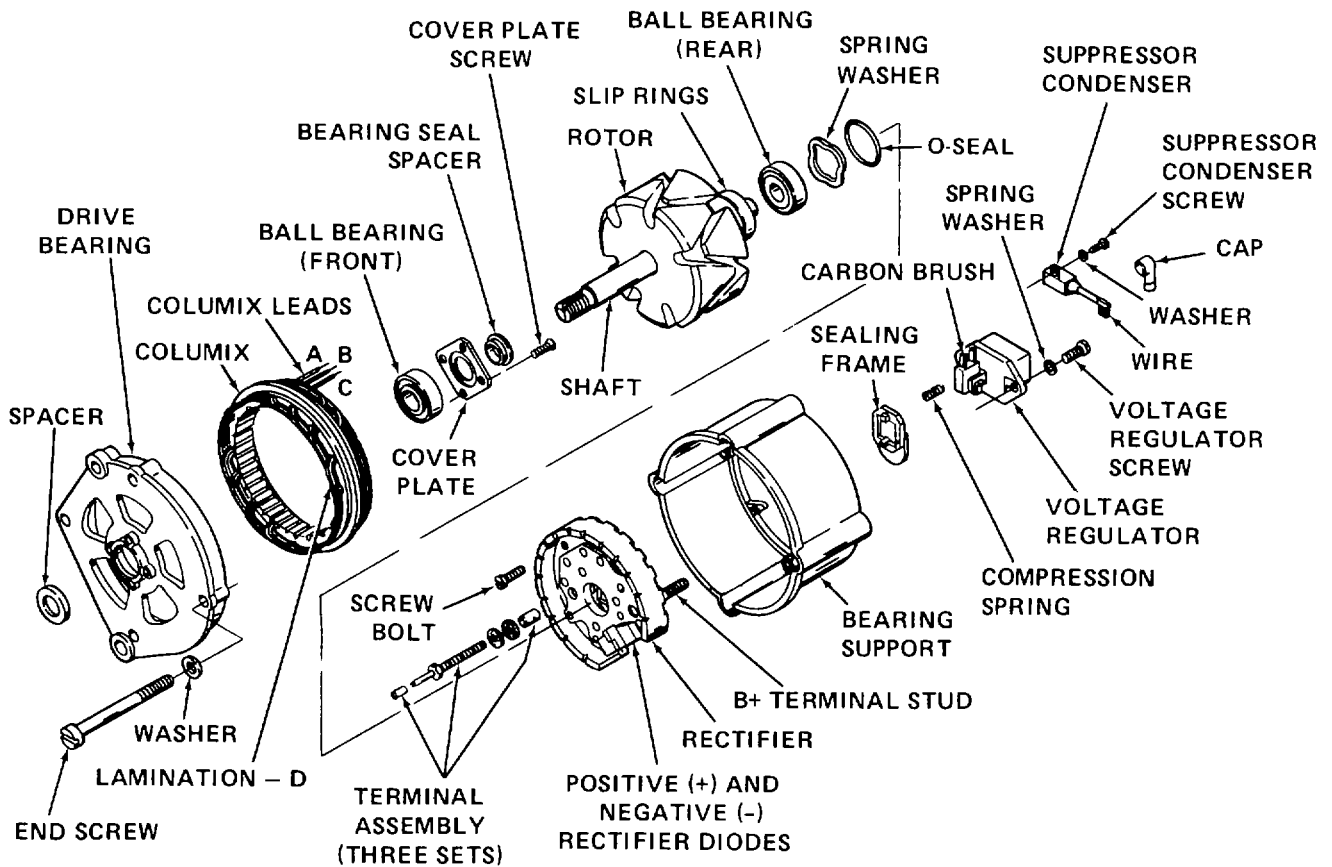
- 5. Voltage regulator and sealing frame sealing frame

Remove with carbon brush holder attached.



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
6. Carbon brushes and compression springs	Remove from voltage regulator/carbon brush holder.	
7. Spacer	Remove from rotor shaft.	
8. Drive bearing reassembly.	Mark position of column and drive bearing for Remove end screws and washers.	



5-19. ALTERNATOR (CONT)

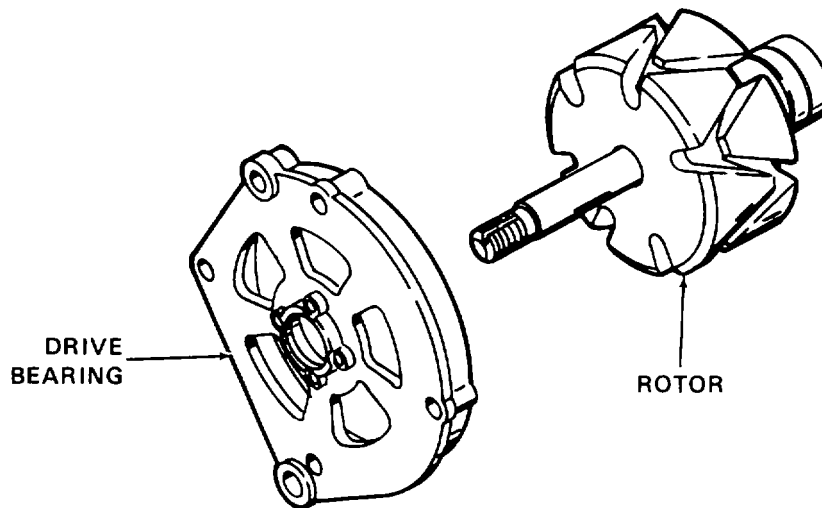
Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------------------|---|--|
| 9. Drive bearing with rotor | Carefully remove from bearing support. Remove spring washer and O-seal. Discard O-seal. | |
|-----------------------------|---|--|

CAUTION

If bearing support and drive bearing do not come apart easily and a screwdriver is used to pry them apart, be extremely careful not to insert screwdriver past inner lip of either side. If screwdriver is inserted too far, the columix (stator windings) will be damaged.

- | | | |
|-----------|---|--|
| 10. Rotor | Press out of drive bearing with arbor press while holding rotor securely. | |
|-----------|---|--|



5-19. ALTERNATOR (CONT)

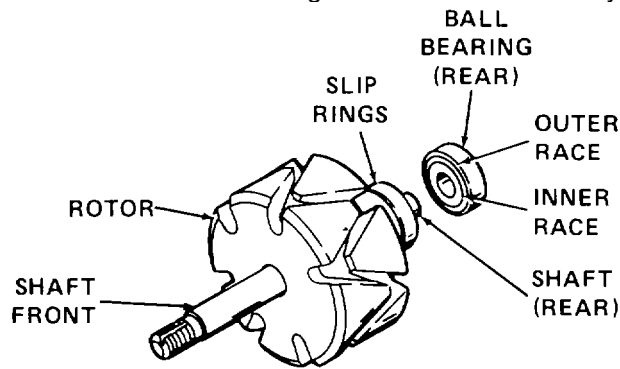
Location/Item	Action	Remarks
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CAUTION

Do not press on outer race of bearing. Excessive pressure on the bearing outer race will damage the ball bearing retainer.

11. Rear ball bearing

Press off rotor shaft with arbor press, or pull off with claw-type extractor tool. Do not use outer race to extract ball bearing. Use the inner race only.

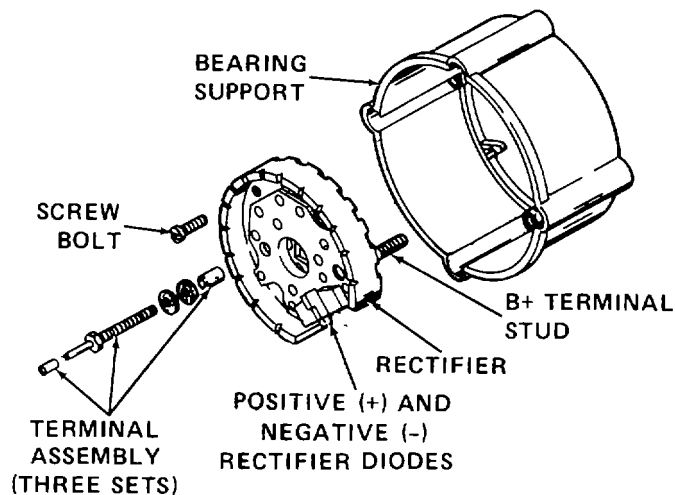


12. Rectifier

- a. Remove screw bolts and terminal assemblies from rectifier and bearing support.
- b. Remove rectifier from bearing support.

13. Positive (+) and negative (-) rectifier diodes

Remove from rectifier.



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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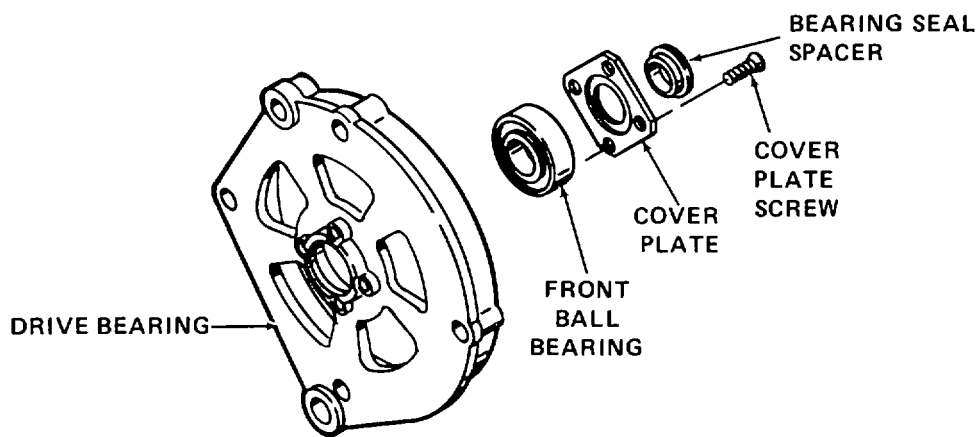
CAUTION

Equipment damage may occur if acid core solder is used to solder diodes to columix leads. Use only ASTM B284-79 rosin core solder.

NOTE

For disassembly and individual testing, it will be necessary to unsolder the leads from stems of positive and negative rectifier diodes. When soldering or unsoldering leads from the diodes, use long nose pliers to grasp diode stem between the diode and columix lead to be removed. This will give better heat dissipation and protect diode from damage. Make note of diode to columix lead connections to facilitate reassembly.

- | | |
|----------------------------------|--|
| 14. Rectifier diodes | Using a 25-watt electronics type soldering iron, desolder and remove diodes from columix leads. |
| 15. Rectifier diodes and columix | Remove. |
| 16. Cover plate and bearing | <ul style="list-style-type: none"> a. Remove cover plate screws. b. Remove cover plate and bearing seal spacer seal spacer from drive bearing. |
| 17. Ball bearing (front) | Press out from drive bearing with arbor press. |



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

CAUTION

Do not use solvent to clean any materials made of plastic. Solvent could dissolve plastic.

18. All alternator components except plastic parts

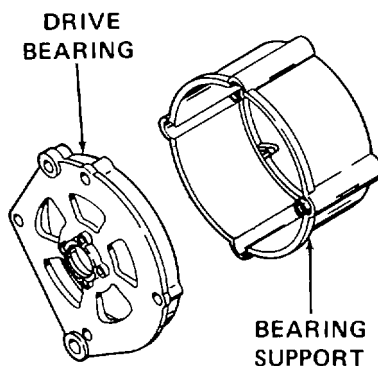
Clean with P-D-680 dry cleaning solvent and dry with compressed air.

19. Terminal assemblies

Inspect for cracks, separations, stripped threads, and other damage. Replace as necessary.

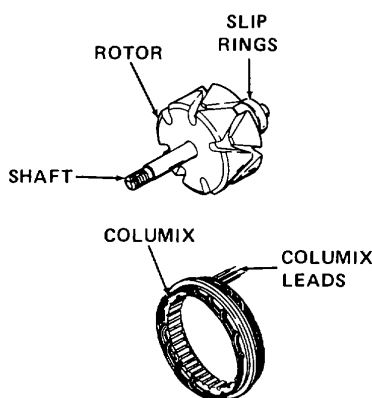
20. Drive bearing and bearing support

Inspect for rust, cracks, bearing bore wear, distortion, damaged threads, and other obvious damage. Remove any burrs with MIL-S-17243 surfacing stone. Replace either unit if not repairable.



5-19. ALTERNATOR (CONT)

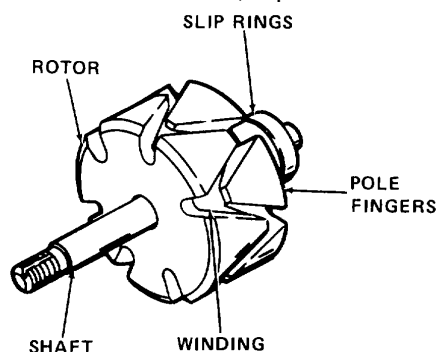
Location/Item	Action	Remarks
21. Columix and rotor	Inspect for gouged or discolored windings. Discoloration of winding insulation indicates an overheated columix or rotor that may result in shorted or grounded windings.	
22. Rotor slip rings	Inspect for cracks, wear grooves, or other damage. Restore a smooth surface to the slip rings with P-C-458 crocus cloth. Reclean with P-D- 680 solvent and wipe all residue from slip rings.	
23. Rotor shaft and body	Inspect shaft for stripped threads, cracks, wear, or other damage. Inspect body for cracked or marred pole fingers. Replace rotor if damaged.	
24. All other parts	Inspect for cracks, distortion, or damaged threads. Replace damaged parts.	



TEST

25. Rotor

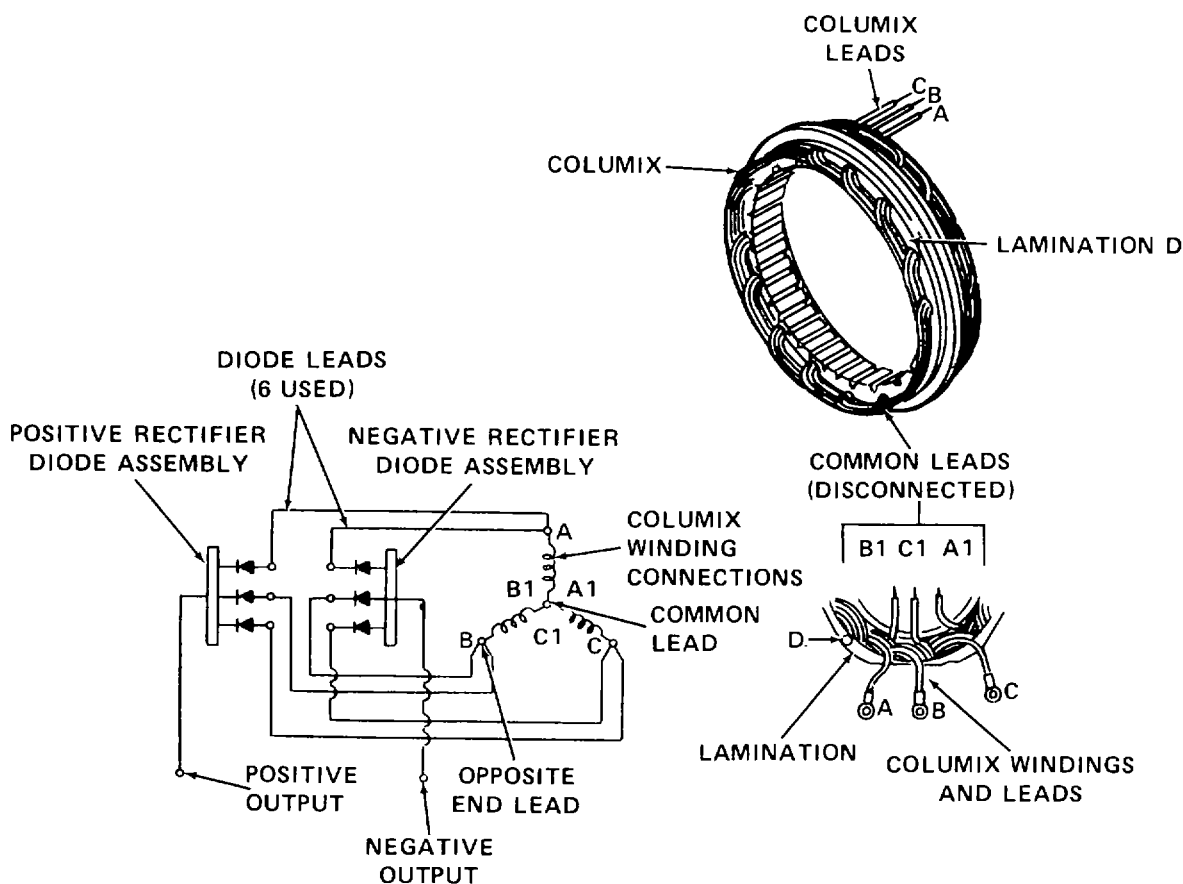
Set multimeter to resistance scale, touch probes together, and adjust OHMS ADJUST for zero resistance. Place a probe on each slip ring. A reading of zero resistance indicates a short circuit in rotor winding; replace rotor. A reading of infinite resistance indicates an open circuit in rotor winding; replace rotor. Place one test probe on one of the slip rings and the other probe on a rotor pole finger. The multimeter should indicate infinite resistance. If anything less than infinite resistance is indicated, replace rotor.



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
26. Rectifier diodes and suppressor condenser	Test diodes with a multimeter. If one is bad, replace the entire positive (+) or negative (-) rectifier diode assembly. Test zener diode in suppressor condenser. Replace if diode is bad.	
27. Columix windings	Disconnect columix winding terminals from rectifier diode assemblies, and test columix windings for leakage and continuity. Set multimeter to read resistance on the X1 scale. Connect multimeter leads to each pair of the following test points:	

- Point A to point B
- Point A to point C
- Point B to point C
- Point A to point D
- Point B to point D
- Point C to point D



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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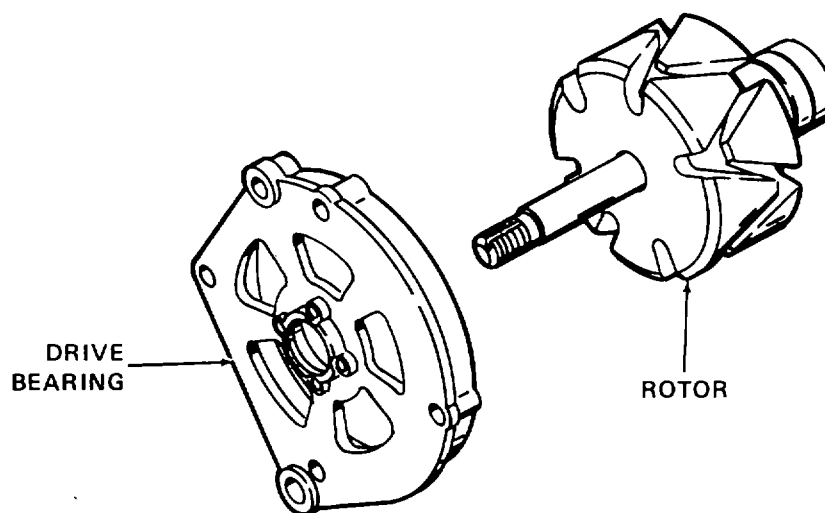
Resistance should be infinite in all of the above tests. If resistance reading is not infinite in any test, high leakage or a short exists between column windings, or between a column winding and the lamination. Replace the column. Test for column continuity by connecting ohmmeter probes to each pair of the following test points:

- Point A to point A¹
- Point B to point B¹
- Point C to point C¹

A low resistance reading (approximately 1.0 ohm or less) in each test indicates column continuity. Infinite resistance indicates an open winding. Replace column if it fails any of the above tests or, if alternator has been disassembled because of an electrical malfunction, replace column after all other components have been checked and found to be satisfactory.

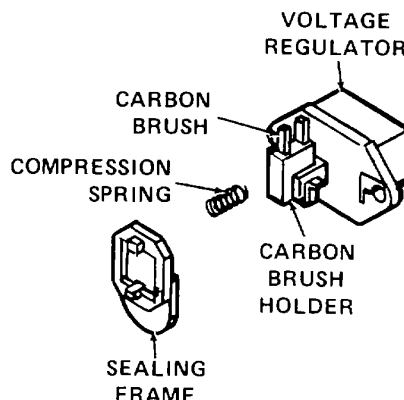
28. Bearings

Insert rotor shaft into rear ball bearing and rotate rotor. Check for looseness, binding, or noise during rotation, and for other damage. Check front ball bearing in the same way. Replace faulty bearing.



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
29. Carbon brushes and voltage regulator/carbon brush holder	Inspect voltage regulator/carbon brush holder for cracks, signs of overheating and distortion. Inspect brushes for cracks, oil saturation, and wear. If brushes are worn, oil soaked, or cracked, replace the entire assembly. Depress brushes in brush holders. Brushes should slide freely in brush holders. Replace compression springs if they are weak. Check that continuity exists between each brush and its respective lead wire. If assembly is electrically faulty, replace it.	



REPAIR/REPLACEMENT

30. Terminal assemblies	Replace if cracked, separated, or broken, or if threads are stripped.
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WARNING

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Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

31. Drive bearing and bearing support	Replace if severely distorted, worn, or damaged. Repair any minor nicks or burrs with MIL-S-17243 surfacing stone. Reclean with P-D-680 solvent and dry with compressed air. Remove any rust or corrosion and refinish in accordance with MIL-T-704.
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5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
32. Columix and rotor	Replace if windings are gouged, broken, or discolored colored or if units show misalignment or damage. Do not attempt to repair columix or rotor windings. If there is a short or open circuit in the rotor windings, or if slip rings are shorted to each other or to any pole finger, replace the rotor. If any columix winding is shorted to any other or to the columix lamination, or if any winding shows an open circuit to its common lead, replace columix.	
33. Rectifier diodes and suppressor condenser	Replace positive (+) or negative (-) rectifier diode assembly if any diode is defective. Replace suppressor condenser if zener diode is defective.	
34. Voltage regulator/ carbon brush holder, carbon brushes, and compression springs	Replace voltage regulator/carbon brush holder if cracked, overheated, distorted, damaged or if carbon brushes do not slide freely into holder. Replace if mechanically or electrically faulty. Replace carbon brushes if worn, cracked, or oil soaked. Replace weak compression springs.	
35. Ball bearings (front and rear)	Replace if excessively worn, out-of-round, binding, or damaged.	
36. All other components	Replace if excessively worn, cracked, distorted, or otherwise damaged, or if threads are stripped.	
ASSEMBLY		
37. Ball bearing (front)	Press into drive bearing.	
38. Cover plate and bearing seal spacer	Position cover plate and bearing seal spacer on drive bearing. Install and tighten cover plate screws securely.	

5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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CAUTION

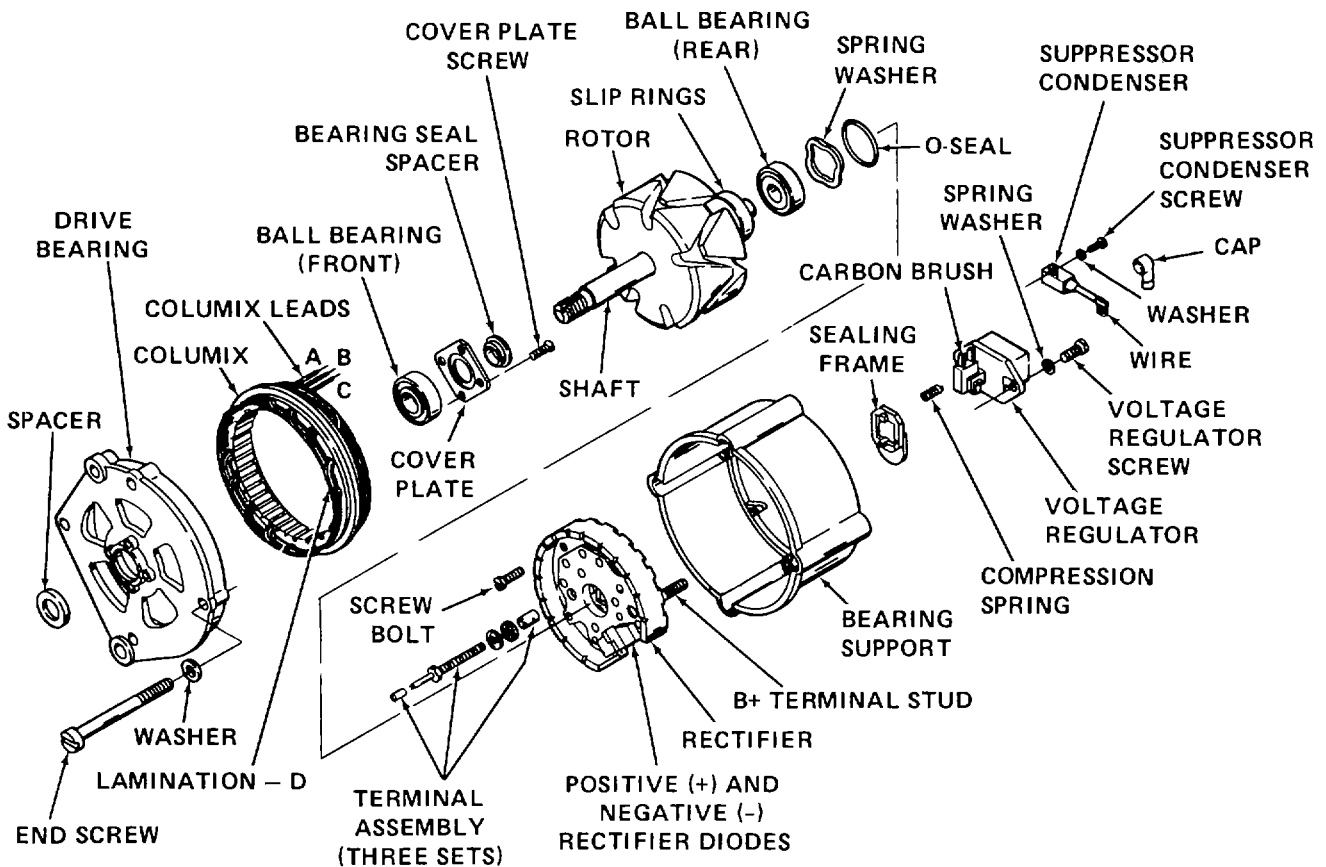
Equipment damage may occur if acid core solder is used to solder diodes to columix leads. Use only ASTM B284-79 rosin core solder.

NOTE

To assemble, it will be necessary to solder the columix leads to the stems of the positive and negative rectifier diode assemblies. When soldering the leads to the diodes, use long nose pliers to grasp diode stem between the diode and columix lead to be soldered. This will give better heat dissipation and protect diode from damage. Match up the diodes to the columix lead connections to facilitate reassembly.

39. Rectifier diodes and columix

Match diodes to columix leads and solder using a 25-watt electronics soldering iron and ASTM B284-79 rosin core solder. Hold long nose pliers in place until solder hardens.

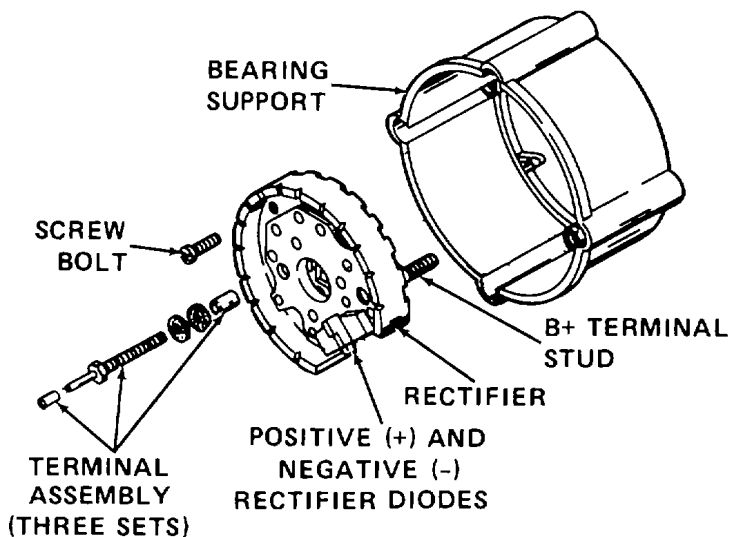


5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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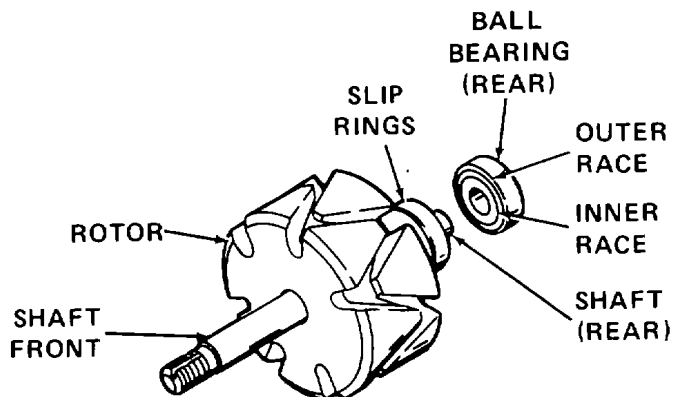
40. Columix with positive and negative rectifier diodes, terminal assemblies, and rectifier

Install in bearing support. Install screw bolts. Tighten screw bolts and terminal assemblies *securely*



41. Rear ball bearing

Press onto rotor shaft using inner race.



42. Rotor and drive bearing

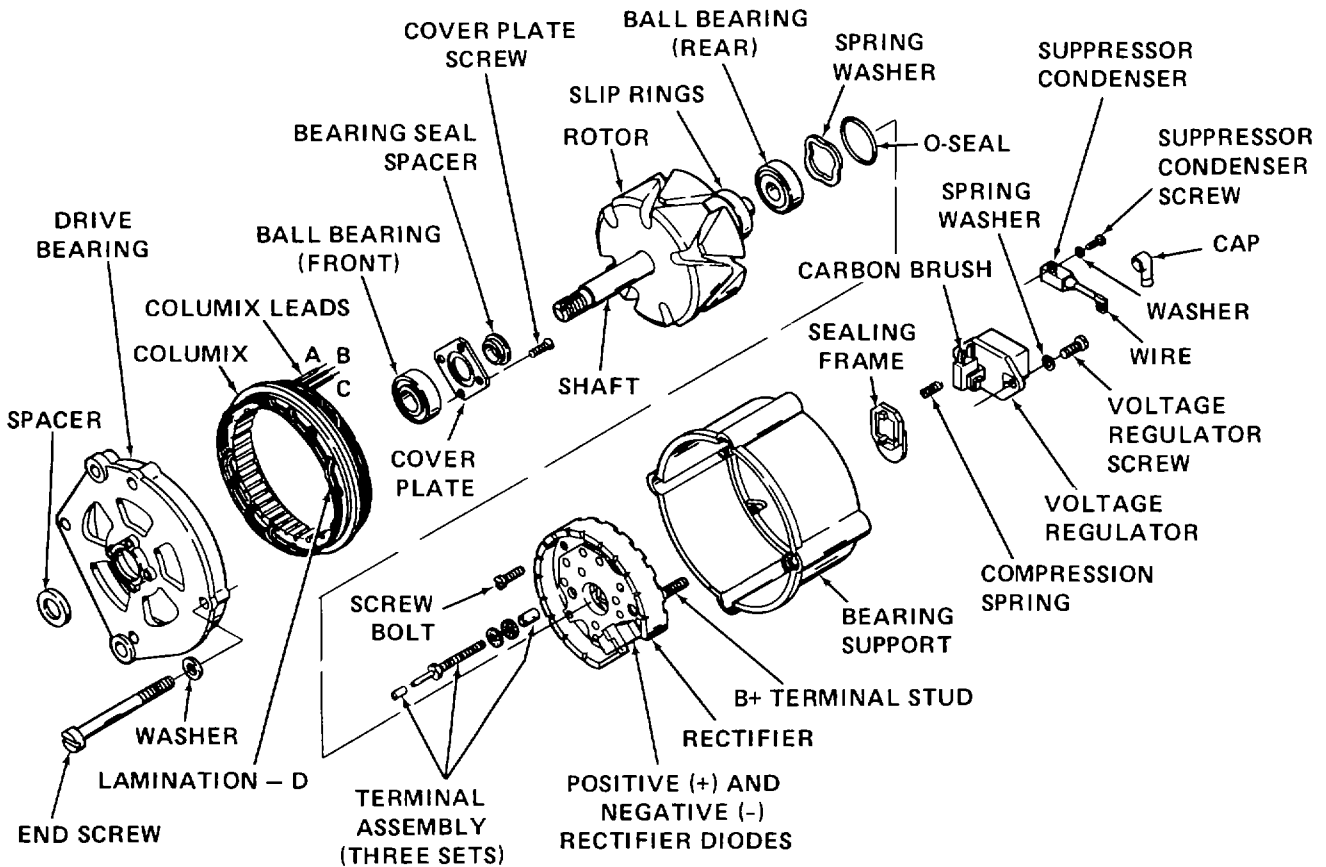
Align rotor with ball bearings on drive bearing and press on drive bearing.

43. Drive bearing rotor, spring washer, and new O-seal

Install spring washer and new O-seal on rotor shaft. Align bearing support, rotor, and drive bearing and bring them together. Make sure columix and drive bearing matchmarks line up correctly.

5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
44. Drive bearing	Install end screws and washers through drive bearing into bearing support. Tighten alternately and evenly across drive bearing with socket head wrench until tightened securely.	
45. Spacer	Install on rotor shaft.	
46. Compression springs and carbon brushes	Install in voltage regulator/carbon brush holder.	
47. Voltage regulator with sealing frame and carbon brush holder	While depressing carbon brushes, install in bearing support. Make sure carbon brushes make good contact with slip rings on rotor.	

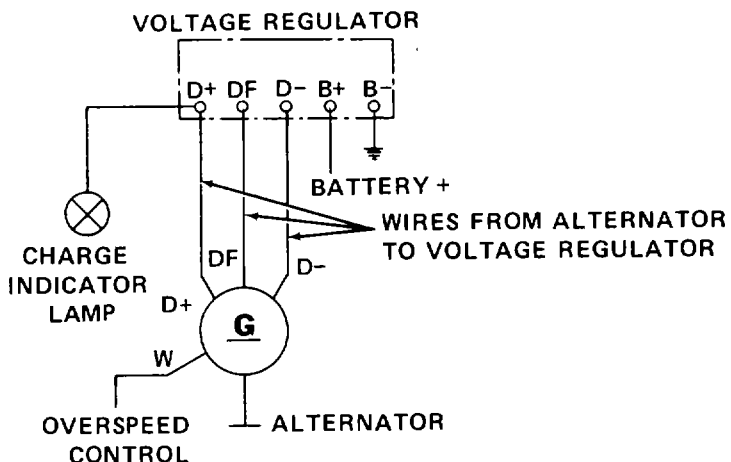


5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
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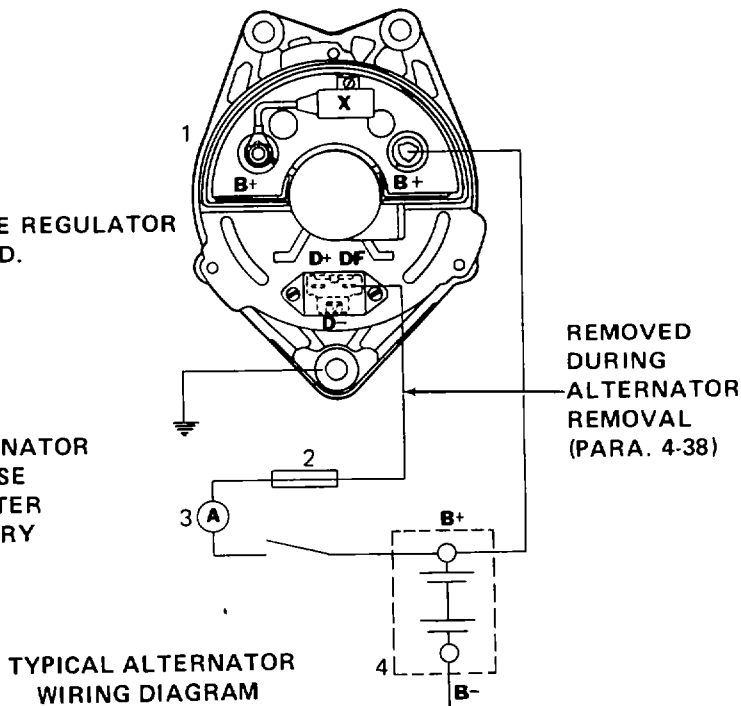
48. Wires from voltage regulator
Connect tagged wires to D+, DF, and D- terminals on alternator.

On the Alternator and Voltage Regulator	
B+	Battery positive
B-	Battery negative
D+	Positive recitifier diodes
D-	Negative recitifier diodes
DF	Columix common lead
Alternator	
W	Individual phase terminal for speed control sensing



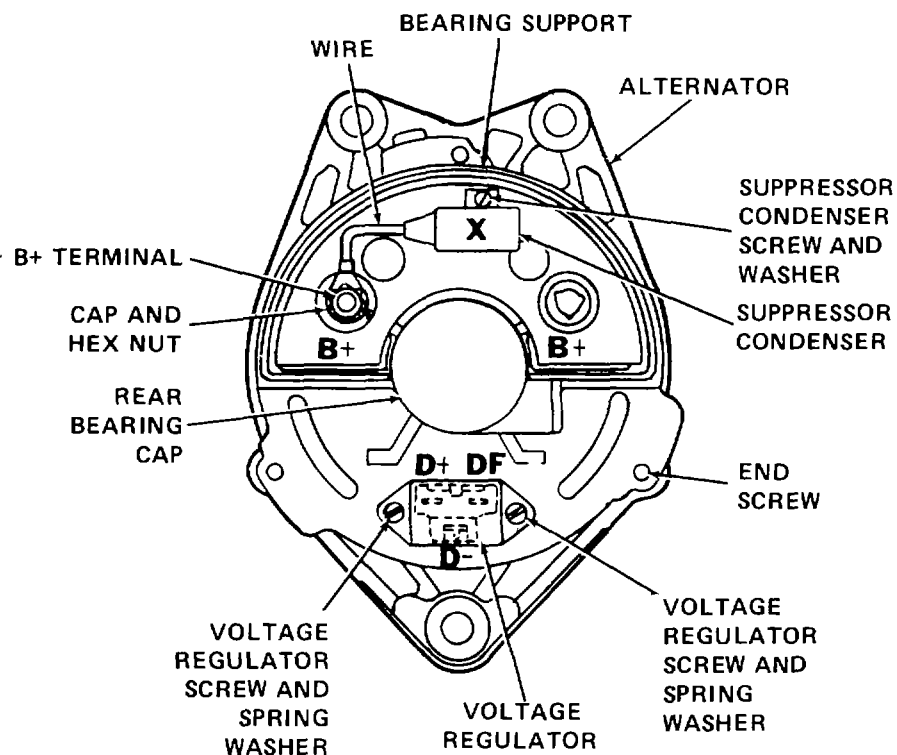
NOTE: VOLTAGE REGULATOR REMOVED.

- 1 ALTERNATOR
- 2 6 A FUSE
- 3 AMMETER
- 4 BATTERY



5-19. ALTERNATOR (CONT)

Location/Item	Action	Remarks
49. Voltage regulator	Install spring washers and voltage regulator screws and tighten securely.	
50. Suppressor condenser	Install washer and screw and tighten securely.	
51. Wire on suppressor condenser	Install wire and hex nut on B+ terminal of alternator. Tighten hex nut securely and slide cap over terminal connection.	



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

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

INITIAL SETUP

Tools

Pushrod tube compressor No. 125300

Shop set, automotive repair, field maintenance, basic NSN 4910-00-754-0705

Socket spanner No. Tool kit, master mechanics NSN 5180-00-699-5273 Torque gage No. 101900

Troubleshooting References (Table 5-1)

Malfunction 2, step 1

Equipment Condition

120040/120050

Para Condition Description

- 4-21 Air inlet system removed.
- 4-30 Cooling air blower and cooling air ducting removed.
- 4-36 Exhaust silencer removed.
- 5-16 Fuel injectors removed.

Materials/Parts

Cylinder head intermediate ring
 Rocker chamber cover gasket
 Washer on screw plug

Diesel fuel oil (Item 5, Appendix E)
 Sealing compound (Item 14, Appendix E)

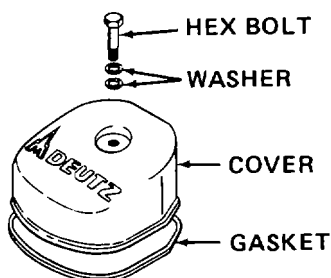
Special Environmental Conditions

Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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REMOVAL

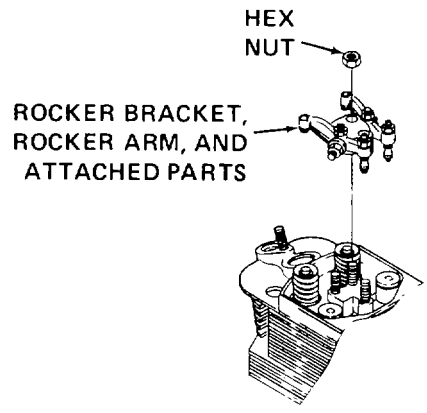
1. Cover
 - a. Remove hex bolt and washers.
 - b. Remove cover.
2. Gasket
 - Remove and discard.



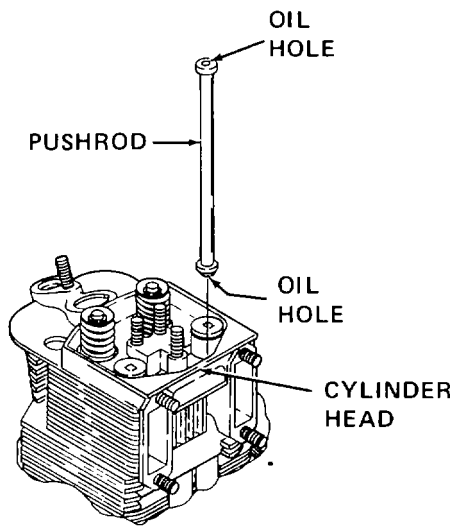
5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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- | | | |
|--|--|--|
| <p>3. Rocker bracket and rocker arms with attached parts</p> | <p>a. Remove hex nuts.
b. Remove rocker bracket and rocker arms with attached parts.</p> | |
|--|--|--|

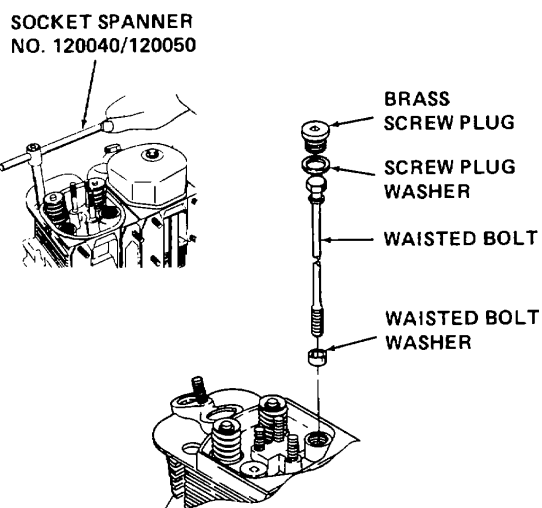


- | | | |
|--------------------|----------------|--|
| <p>4. Pushrods</p> | <p>Remove.</p> | |
|--------------------|----------------|--|



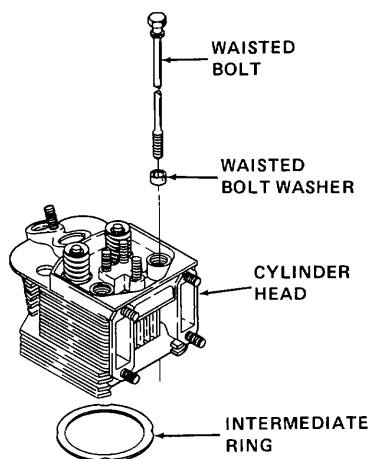
5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
5. Cylinder head plugs.	a. Remove brass screw b. Remove and discard screw plug washers. c. Loosen waisted bolts alternately and evenly across cylinder head with socket spanner No. 120040/120050 and remove. d. Remove waisted bolt washers.	



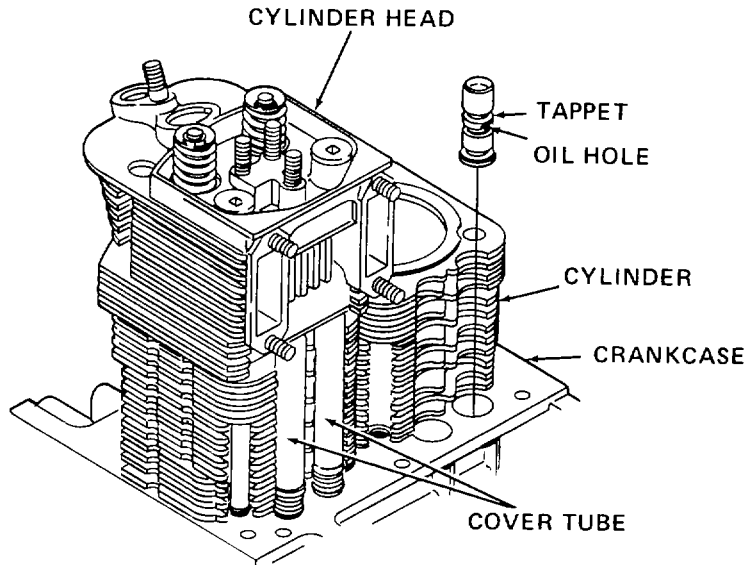
6. Cylinder head and intermediate ring

Remove from cylinder. Match-mark cylinder head and cylinder to facilitate installation. Discard card intermediate ring.



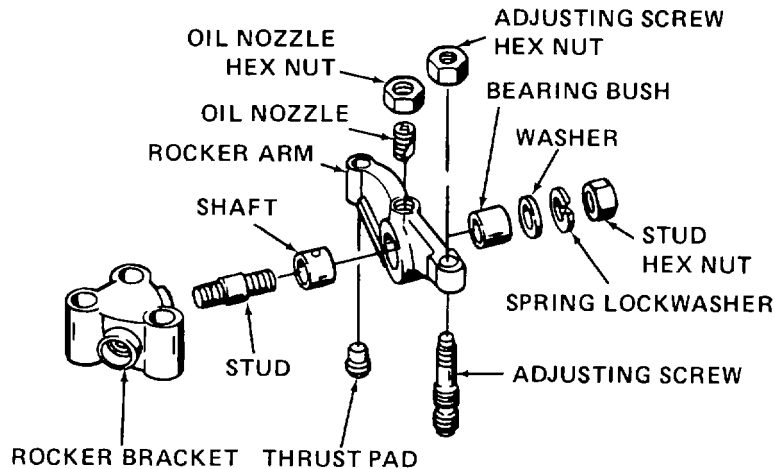
5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
7. Cover tubes	Remove.	
8. Tappets	Remove from crankcase.	



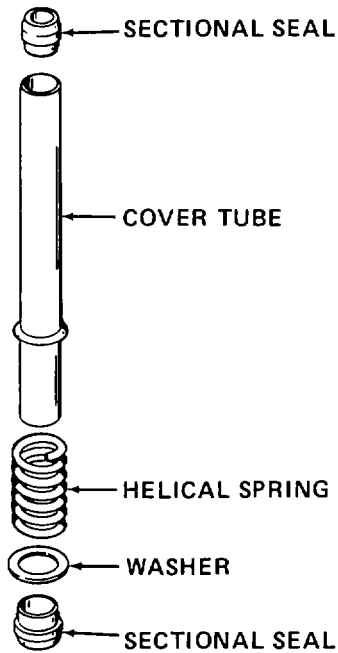
DISASSEMBLY

9. Rocker arm and shaft
 - a. Remove stud hex nut, spring lockwasher, and washer.
 - b. Remove rocker arm and shaft.
 - c. Remove stud from rocker bracket.
 - d. Remove adjusting screw hex nut and adjusting screw from rocker arm.
 - e. Remove oil nozzle hex nut and oil nozzle from rocker arm. Note chamfer on adjusting screw. It should point toward thrust pad.



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
10. Thrust pad	Remove.	
11. Bearing bush	Press out.	
12. Helical spring and washer	Remove from cover tube.	
13. Sectional seals	Remove.	



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

14. Cylinder head, intermediate ring, cover, Dry rocker arms, pushrods, cover tubes, tappets, and associated parts

Clean with a clean cloth dampened with VV-F-800 diesel fuel oil. Use wire brush where necessary.

with compressed air. Inspect for cracks, rust, corrosion, and excessive heat damage. Inspect cylinder head for carbon build up near injector area.

Inspect bolt holes for chipped or cracked edges. Check that cylinder head seat is smooth and flat. Replace cylinder head assembly if it is excessively worn or damaged and refer unit to general support for repair.

excessively

Inspect all other components for excessive wear, alinement, dents, rust, corrosion, stripped threads, or other damage. Replace any damaged or

worn components. Refer replaced rocker arms and tappets to general support for repair. Inspect waisted bolts. If strained past their normal length of 7.42 inches (188.50 mm), replace any strained bolts.

REPAIR

15. Cylinder head, rocker arms, and tappets

Refer to general support for repair as necessary.

5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

16. Pushrods and cover tubes

Straighten misaligned pushrods and cover tubes as necessary. Open oil holes in pushrods with small wire. If necessary, soak pushrods in VV-F-800 diesel fuel oil to loosen deposits in oil holes, then open with wire. If pushrods or cover tubes are damaged beyond repair, replace.

ASSEMBLY

17. Pushrod tube compressor No. 125300

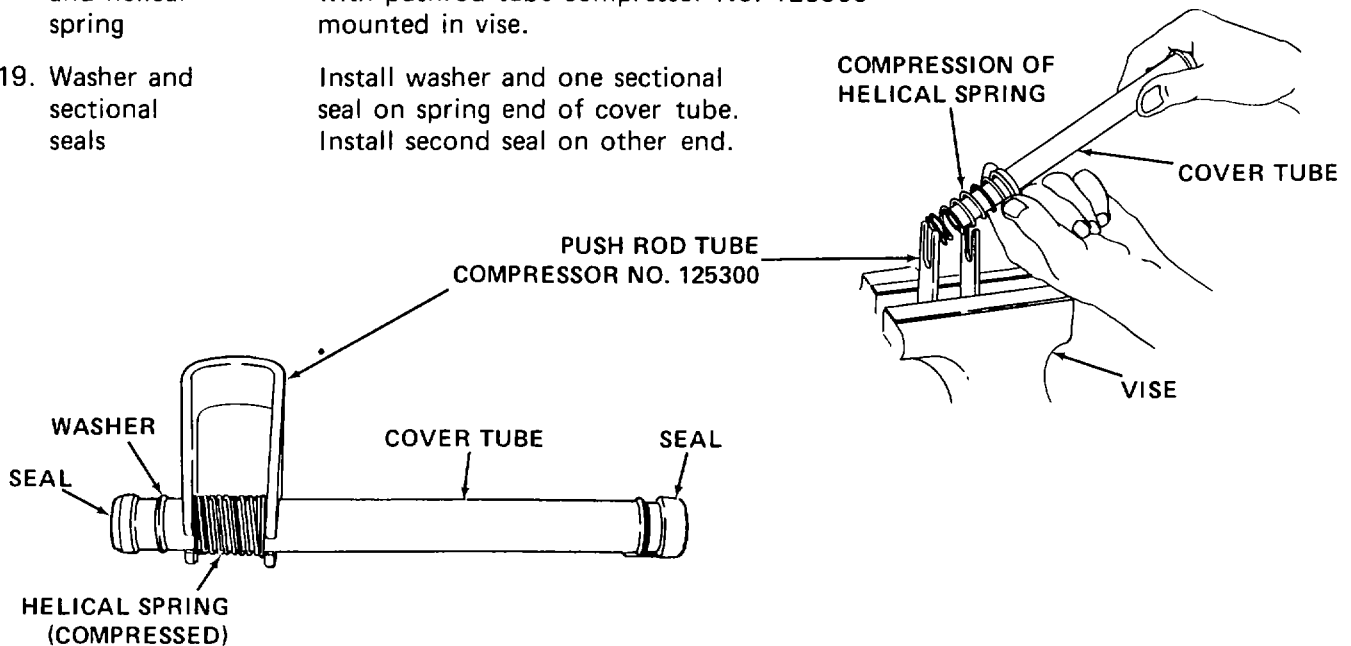
Mount in vise.

18. Cover tube and helical spring

Fit helical spring onto cover tube. Compress with pushrod tube compressor No. 125300 mounted in vise.

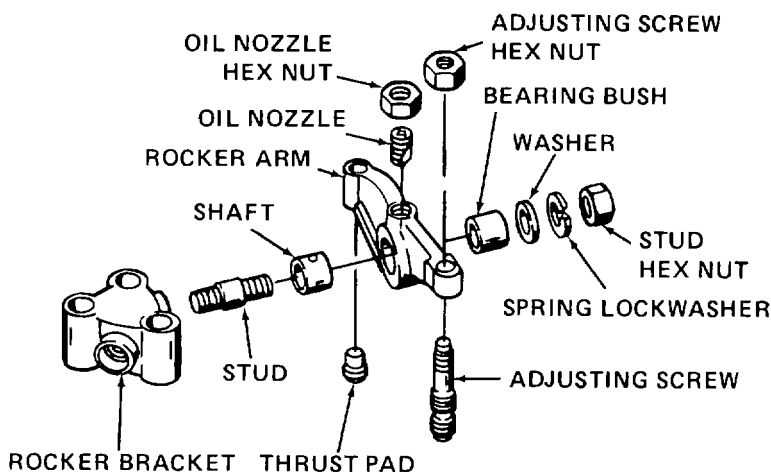
19. Washer and sectional seals

Install washer and one sectional seal on spring end of cover tube. Install second seal on other end.



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
20. Bearing bush	Press into rocker arm. Make sure oil hole is aligned with rocker arm oil hole.	
21. Thrust pad	Install.	
22. Rocker arm	<p>a. Install oil nozzle and oil nozzle hex nut in rocker arm so that chamfered edge of oil nozzle points toward thrust pad. Make sure that one thread turn of the oil nozzle projects out from hex nut when hex nut has been tightened securely.</p> <p>b. Install adjusting screw and adjusting screw hex nut in rocker arm and tighten adjusting screw hex nut securely.</p> <p>c. Install stud in rocker bracket.</p>	
23. Shaft and rocker arm	<p>a. Install on stud.</p> <p>b. Install washer, spring, lockwasher, and stud hex nut. Tighten stud hex nut securely.</p>	



15-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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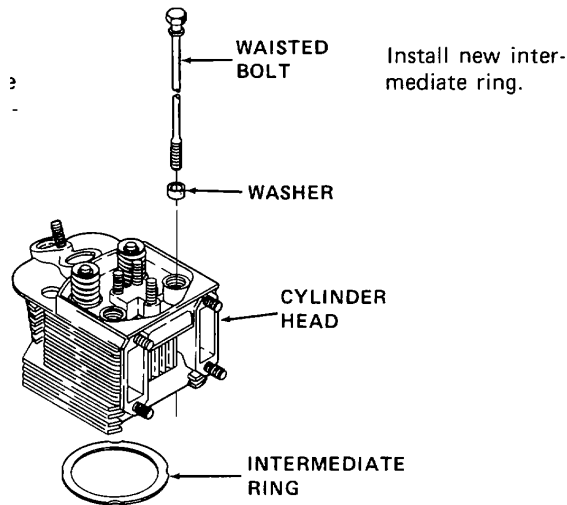
INSTALLATION/REPLACEMENT

24. New intermediate ring and cylinder head

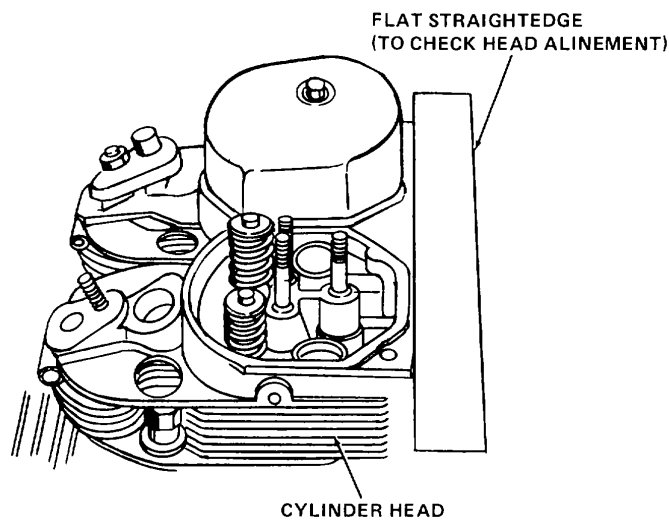
Position on cylinder, aligning matchmarks made on cylinder head and cylinder during removal.

25. Cylinder head

a. Install washers and waisted bolts loosely.



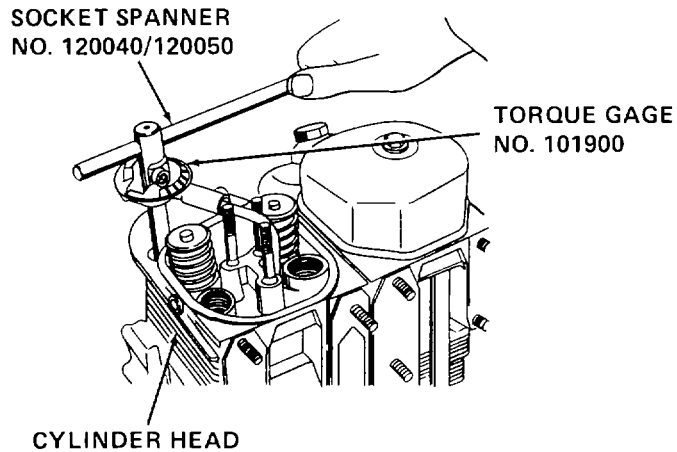
b. Check and align cylinder head with flat straightedge.



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

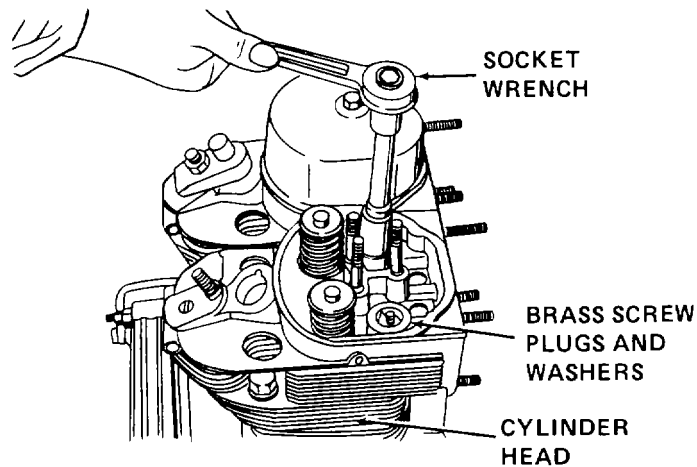
Location/Item	Action	Remarks
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- c. Tighten waisted bolts alternately and evenly across cylinder head with socket spanner No. 120040/120050 to 22.13 ft lb (30 N.m) torque. Using torque gage No. 101900, tighten bolts three additional 45 degree increments.



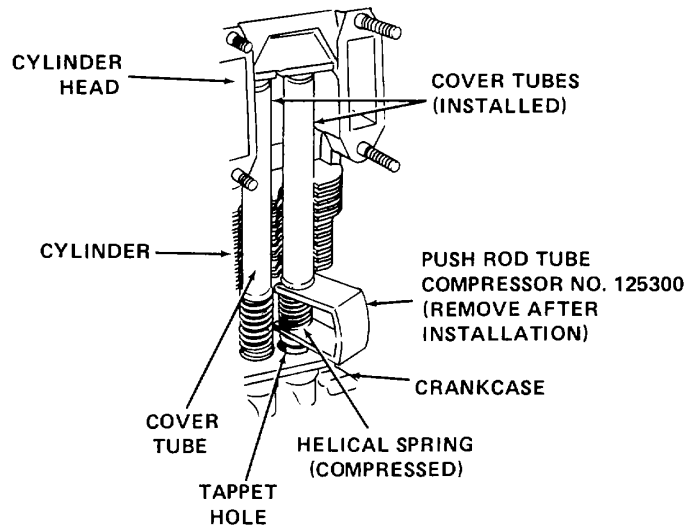
- d. Install new washers. Install screw plugs and tighten securely. If screw plugs have been replaced, make sure replacements are brass.

Install new washers.

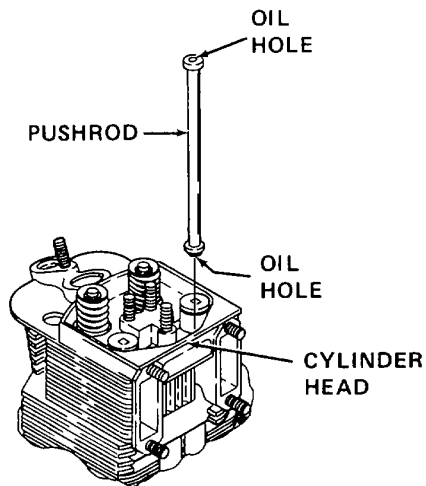


5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
26. Tappets	Install in tappet holes in crankcase.	
27. Cover tube with spring compressed	Install spring end into tappet hole and opposite end into hole in cylinder head.	
28. Pushrod tube compressor No. 125300	Remove.	



29. Pushrods Install.



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
30. Rocker bracket with assembled rocker arms	Install rocker assembly and hex nuts. Tighten hex nuts to 21 ft lb (28 N.m) using torque gage.	
31. Cover	Install cover, new gasket, hex bolt, and washers after valve clearance adjustment.	Install new gasket.

ADJUSTMENT

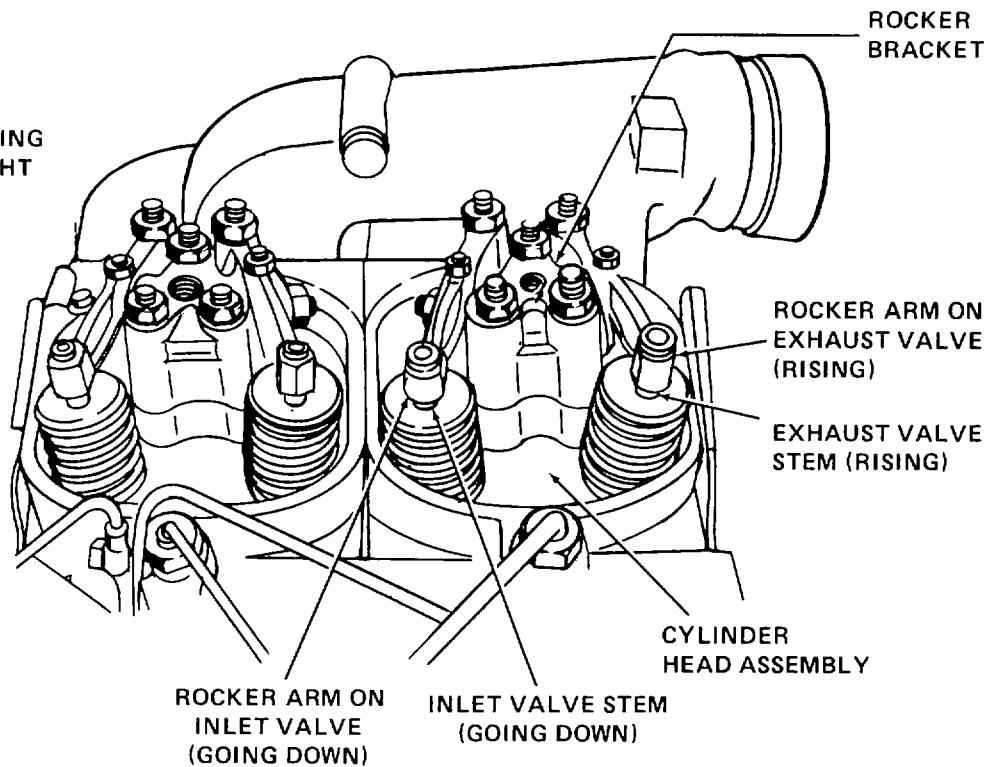
NOTE

Adjust valve clearance only when engine is cold.

32. Flywheel or V-belt pulley

Rotate crankshaft by rotating flywheel or V-belt pulley clockwise until valve stems and rocker arms overlap. The exhaust valve should be closing and its valve stem rising. The inlet valve should be opening and its valve stem going down. Both valve stems should be at the same height. Rotate crankshaft another complete revolution, or 360 degrees of travel of the flywheel or pulley. The piston should be at the top of its compression stroke and the valve clearance can be checked and adjusted.

NOTE: VALVES OVERLAPPING AND AT SAME HEIGHT IN THEIR TRAVEL.

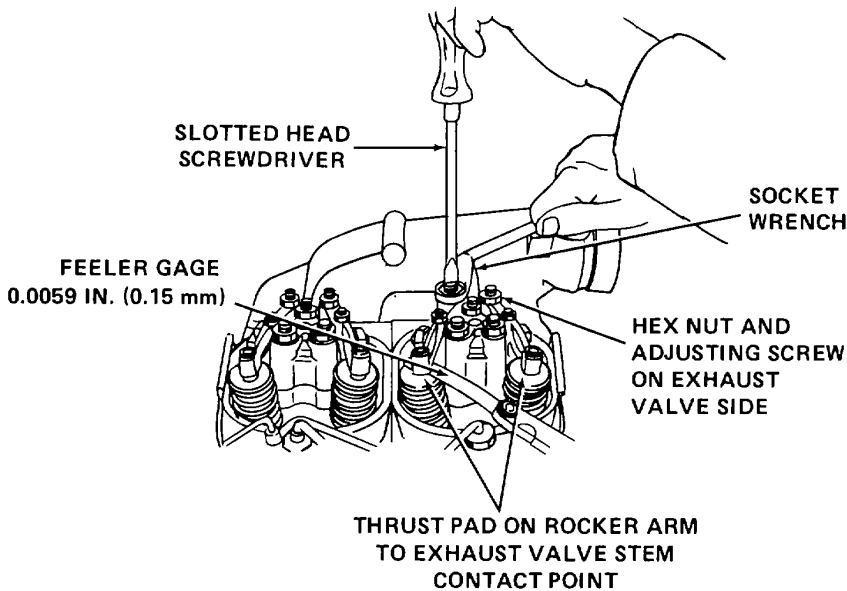
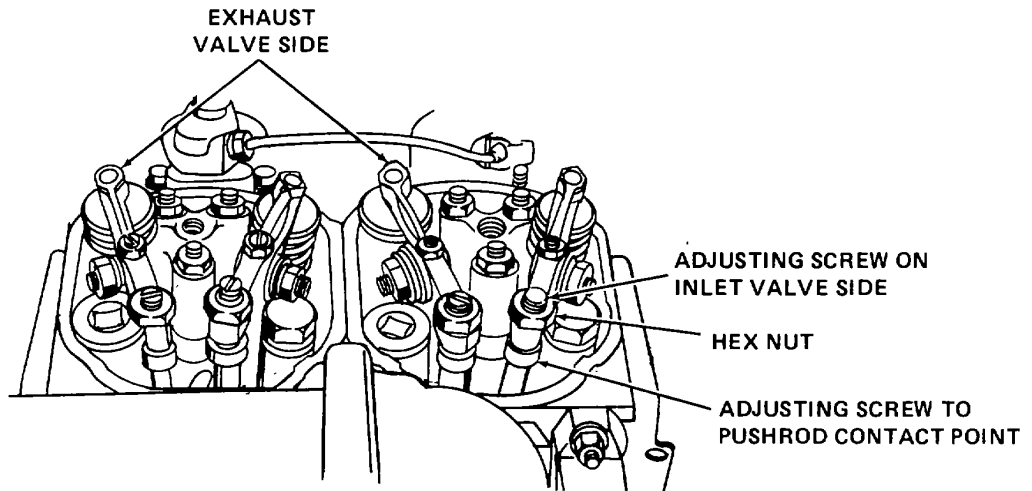


5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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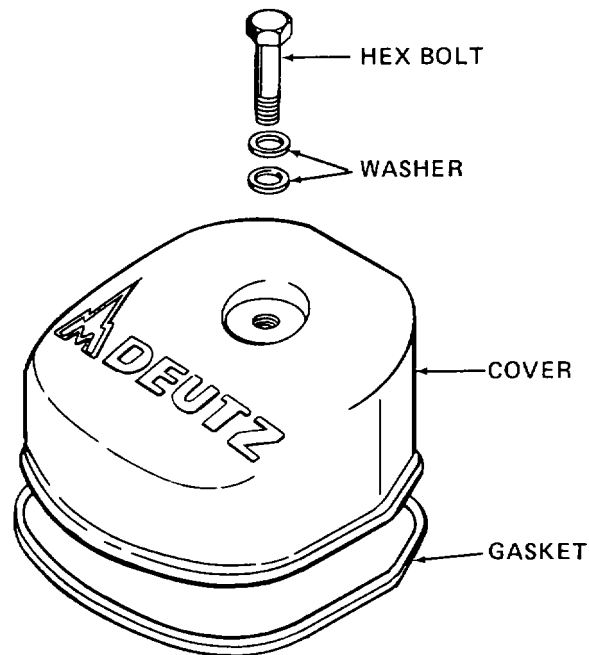
33. Adjusting screw on rocker arms

Loosen hex nuts on adjusting screws on inlet and exhaust valve rocker arms. Insert a feeler gage of 0.0059 inch (0.15 mm) thickness between valve stem and thrust pad of each rocker arm. Turn slotted adjusting screws until they are in contact with their respective pushrods and exerting approximately the same contact pressure against pushrods as thrust pads are against the feeler gage and valve stems. Retighten hex nuts securely.



5-20. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, PUSHRODS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
34. Crankshaft	Rotate in running direction several complete revolutions.	
35. Valve clearance	Recheck. Make sure that feeler gage distance and contact pressures are the same as adjusted previously in step 33 above.	
36. Cover	Install new gasket with MIL-S-45180 sealing compound. Install cover, washers, and hex bolt. Tighten hex bolt securely.	



5-21. VALVES, VALVE GUIDES, AND VALVE SEATS

This task covers:

a. Removal	d. Inspection of Valve Seats
b. Cleaning/Inspection of Valves	e. Installation/Replacement
c. Inspection of Valve Guides	

INITIAL SETUP

Tools

Calipers

Clamping plate No. 120910

Cylinder head clamping stand No. 120900

Depth gage

Micro feeler gage

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705
from engine.

Tool kit, master mechanics
NSN 5180-00-699-5273

Valve spring compressor No. 121120

Materials/Parts

Exhaust valve

Intake valve

Dry cleaning solvent (Item 16, Appendix E)

Lubricating oil (Item 9, Appendix E)

Equipment Condition

Para	Condition Description
5-20	Cylinder head assembly removed

Special Environmental Conditions

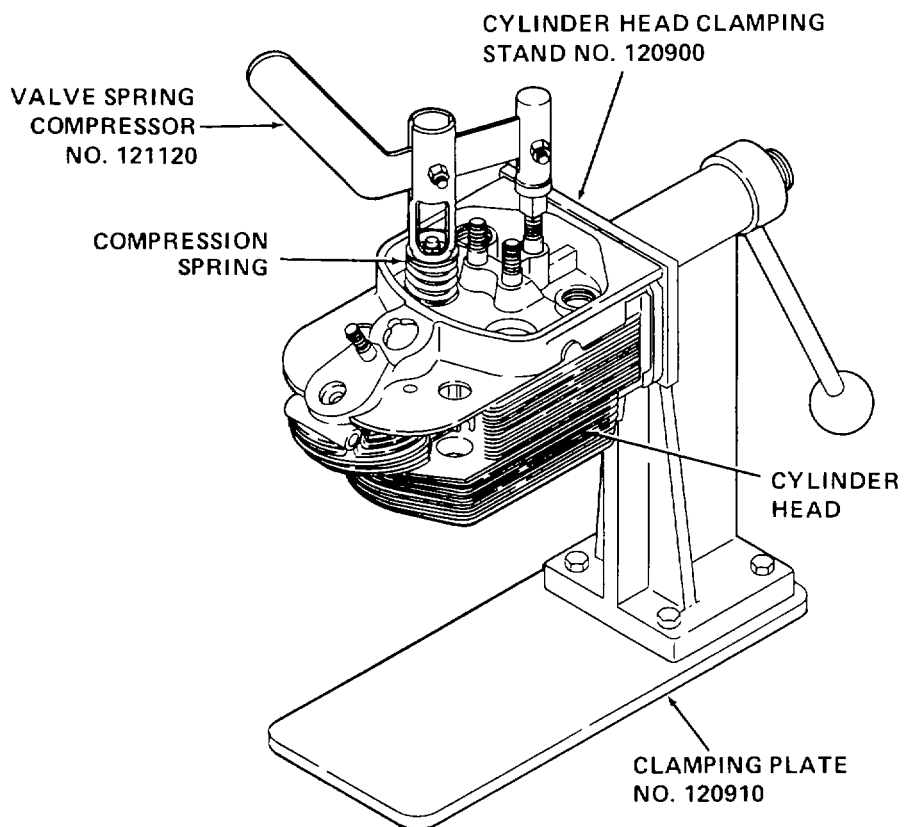
Well-ventilated area required.

5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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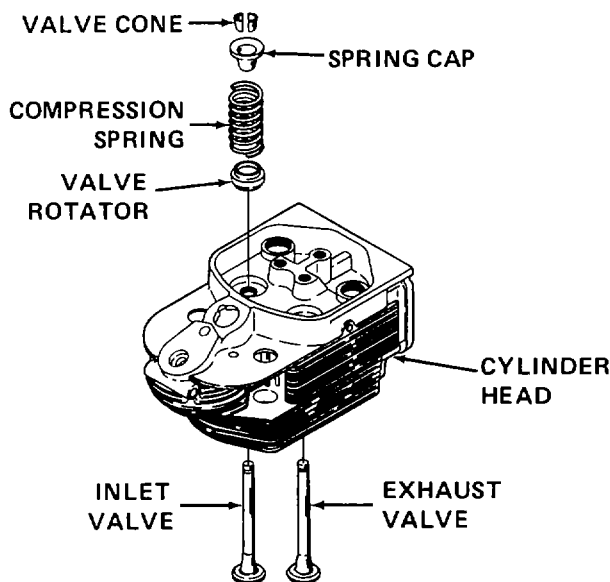
REMOVAL

1. Cylinder head
Mount on cylinder head clamping stand No. 120900 with clamping plate No. 120910.
2. Compression springs
Compress springs with valve spring compressor No. 121120.



5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
3. Valve cones, spring caps, compression springs, valve rotators, inlet valve, and exhaust valve	Remove from cylinder head.	



CLEANING/INSPECTION OF VALVES

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly. Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

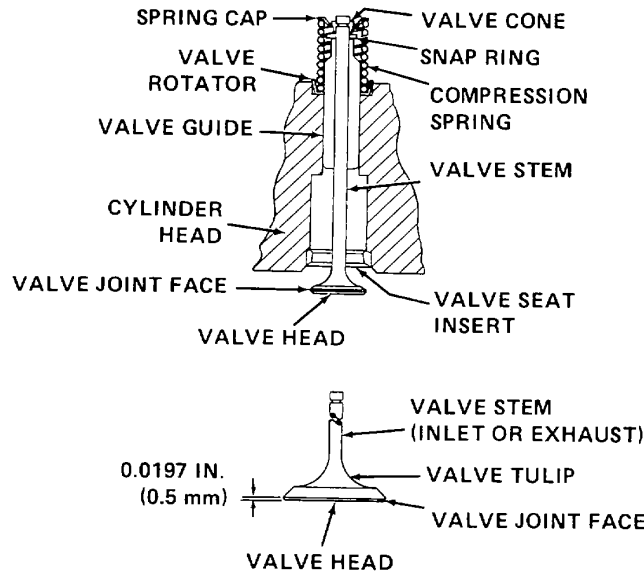
4. All valve components	Clean with P-D-680 dry cleaning solvent and dry with compressed air.	
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5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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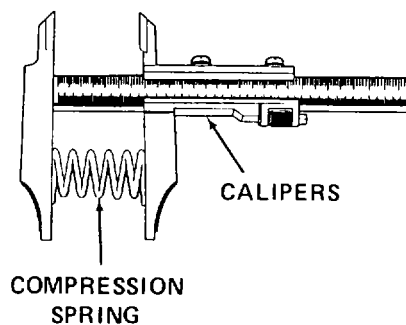
5. Inlet and exhaust valves

Inspect valves and valve stems. Replace any valves that show head warping, burning, or other damage. Replace valves that have seriously scratched or scuffed stems; or pitted, ridged, or cracked faces. Check that valve joint face thickness is no less than 0.0197 inch (0.5 mm). Replace valve(s) if joint face thickness is less than required.



6. Compression springs, valve cones, spring caps, and valve rotators

Replace any compression springs that are pitted, fractured, excessively worn, or damaged. Replace cones, caps, and valve rotators that are fractured, excessively worn, or damaged. Replace any spring that has a fatigued (unloaded) length of less than 2.2047 inches (56 mm). Normal (replacement) length (unloaded) is 2.3228 inches (59 mm). Replace both valve springs if necessary.



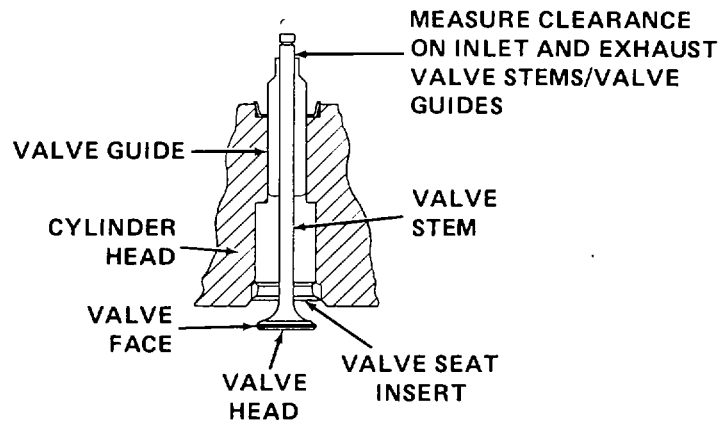
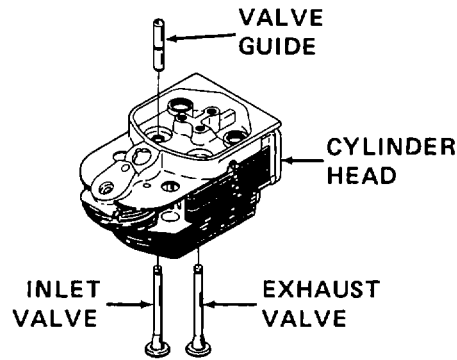
5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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INSPECTION OF VALVE GUIDES

7. Valve guide

Measure valve stem/valve guide clearance on inlet and exhaust valves with micro feeler gage. The inlet valve stem/valve guide clearance limit is 0.0118 inch (0.3 mm). The exhaust valve stem/guide clearance limit is 0.0197 inch (0.5 mm). If the clearance is greater than the limit specified for either inlet or exhaust valve guide or if any valve guides are fractured, chipped, scored, or show excessive wear, notify general support for repair or replacement.



5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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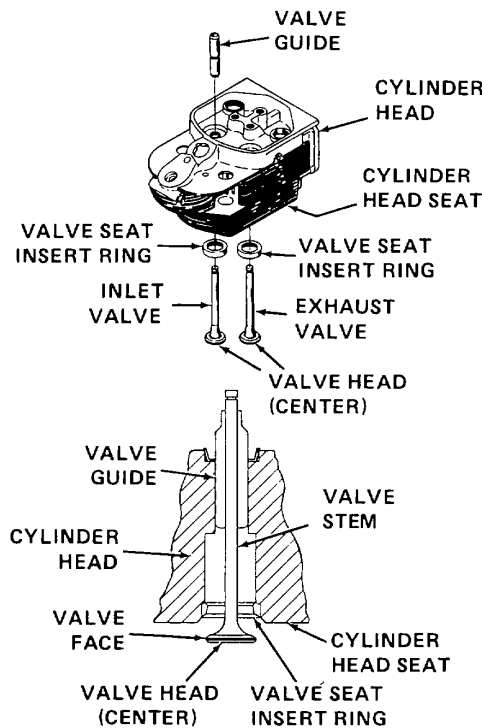
INSPECTION OF VALVE SEATS

NOTE

Always use a NEW valve in making valve seat insert ring measurements.

8. Valve seat insert ring
0.2323
or if
wear, cracks,

Measure distance between installed valve head center and cylinder head seat with depth gage. Distance should be between 0.2047 inch (5.2 mm) and inch (5.9 mm). If distance is less than specified, any valve seat insert rings show excessive pitting, or improper valve seat angle (greater or less than 45 degrees), notify general support for repair or replacement.



INSTALLATION/REPLACEMENT

9. Valve rotators

Install rotators on valve guides.

NOTE

Make sure valve rotator recess is on top to accommodate springs.

5-21. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
10. Compression springs and spring caps	Install.	
11. Valves, springs, and valve cones	Apply MIL-L-2104 lubricating oil to stems, insert valves, compress springs, and fit valve cones.	

NOTE**Be sure valve cones are properly and firmly seated.**

5-22. BOTTOM COVER

This task covers: a. Removal
 b. Cleaning/inspection
 c. Repair
 d. Installation/Replacement

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

References

MIL-T-704 Treatment and Painting of Materiel

Troubleshooting References (Table 5-1)
 Malfunction 5 step 1

Materials/Parts

Bottom cover

Materials required by MIL-T-704

Diesel fuel oil (Item 5, Appendix E)

Sealing compound (Item 14, Appendix E)

Equipment Condition

Para Condition Description

5-7 Engine removed from skid assembly.

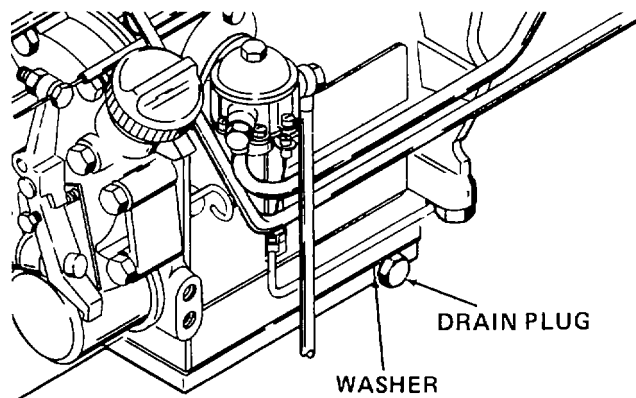
Special Environmental Conditions

Well-ventilated area required.

Location/Item	Action	Remarks
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REMOVAL

1. Engine oil drain plug
 Remove drain plug and washer. Drain engine crankcase oil.



5-22. BOTTOM COVER (CONT)

Location/Item	Action	Remarks
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WARNING

Make sure that hoists and other lifting equipment are in good repair and of sufficient capacity to safely handle loads without injury to personnel or damage to equipment. Securely attach lifting equipment to engine assembly. Before lifting, be sure load is balanced.

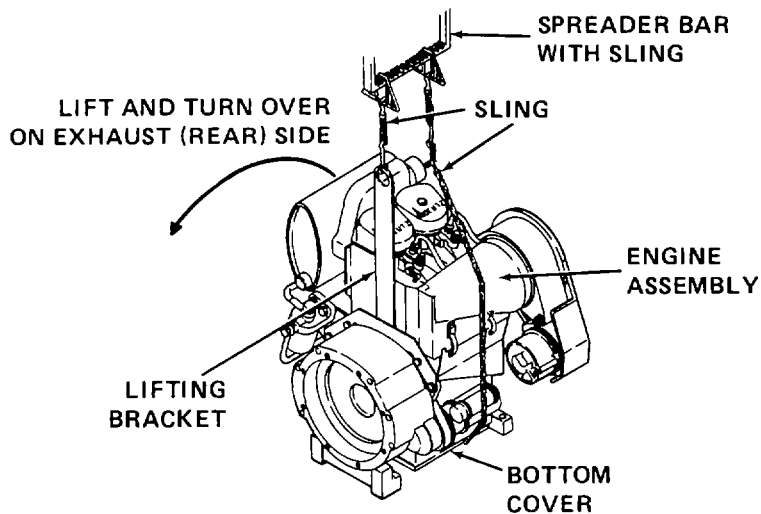
CAUTION

Engine damage will occur if engine is set on bottom cover. Provide adequate blocking to support engine after removal from skid assembly.

2. Engine assembly

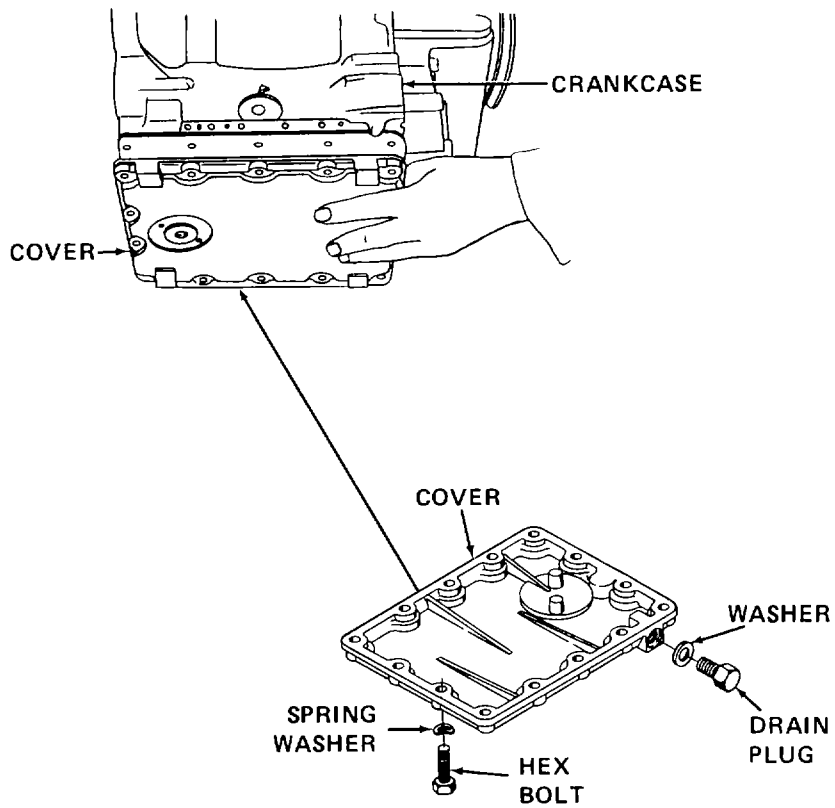
Position a suitable lifting device equipped with a spreader bar and slings over engine assembly. Attach slings to lifting bracket and around engine assembly. Put tension on slings. With the engine properly supported, lift engine and turn it over onto its exhaust (rear) side.

Spread slings on spreader bar so that slings hang vertically when attached to engine assembly.



5-22. BOTTOM COVER (CONT)

Location/Item	Action	Remarks
3. Cover	a. Remove hex bolts and spring washers from cover. b. Remove cover from crankcase.	



5-22. BOTTOM COVER (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

4. Bottom cover

Clean all components with VV-F-800 diesel fuel oil. Inspect for damage, nicks, burrs, rust, corrosion, and warpage. Inspect threads in oil drain port. Replace unit if severely damaged, rusted, or warped. Replace components with stripped or damaged threads.

REPAIR

5. Cover

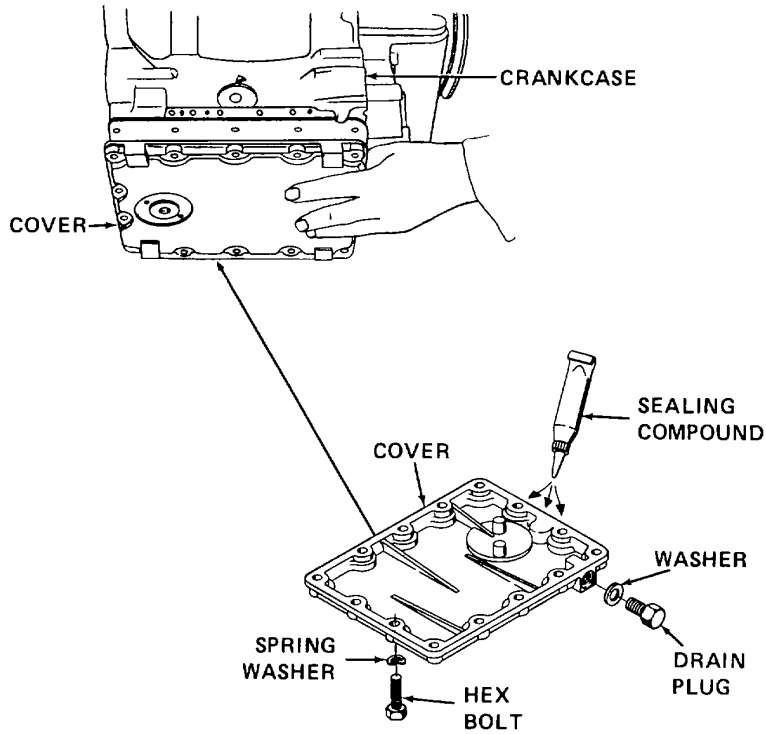
Repair minor damage. File nicks or burrs. Remove rust with sandpaper, then clean, treat, and refinish outside surfaces in accordance with MIL-T-704, Type A, color as specified.

5-22. BOTTOM COVER (CONT)

Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

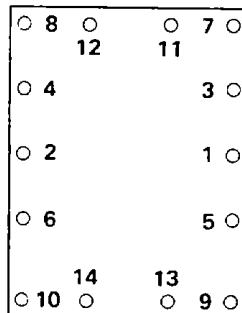
6. Cover a. Install using MIL-S-45180 sealing compound.



- b. Install hex bolts and spring washers. Tighten bolts securely in order shown.

7. Engine oil drain plug Install drain plug and washer.

8. Engine Install on skid assembly in accordance with paragraph 5-7.



5-23. TACHOMETER DRIVE

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

INITIAL SETUP

Tools

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

Materials/Parts

Ring

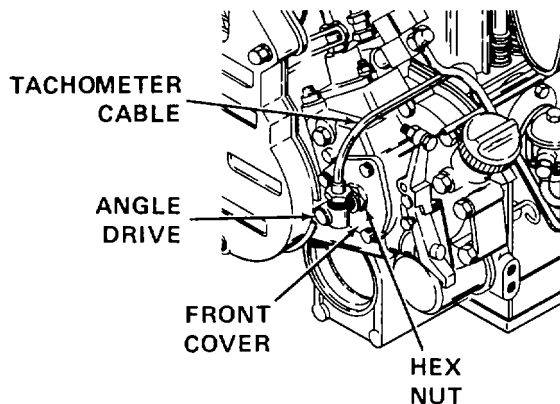
Shaft seal

Tachometer drive

Location/Item	Action	Remarks
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REMOVAL

- | | |
|---------------------|--|
| 1. Tachometer cable | Remove from angle drive. |
| 2. Angle drive | a. Loosen hex nut.
b. Remove angle drive. |
| 3. Flange | a. Remove ring and screw plug. Discard ring.
b. Remove hex bolts and spring washers.
c. Remove flange from front cover.
d. Remove shaft seal and discard.
e. Remove driver/actuator.
f. Remove pin/spigot.
g. Remove hex bolt and spring lockwasher. |

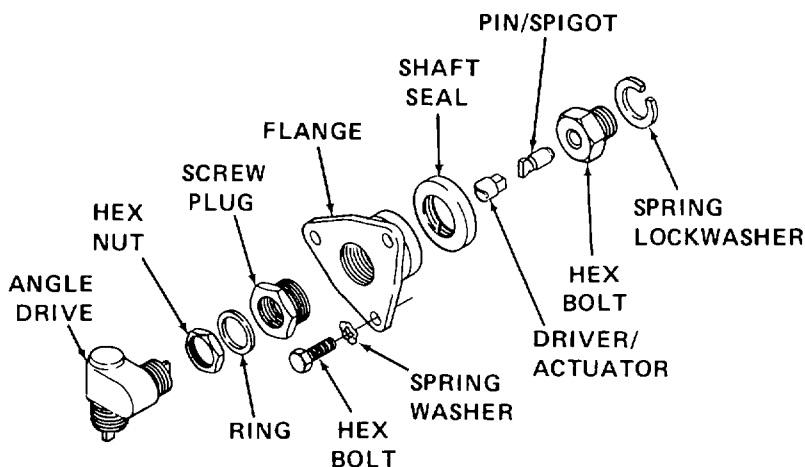


5-23. TACHOMETER DRIVE (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

INSPECTION

- | | | |
|---------------------|--|--|
| 4. Tachometer drive | Inspect components for damage, rust, wear, or malfunctions. If repairable, notify general support, and replace unit. | |
|---------------------|--|--|



INSTALLATION/REPLACEMENT

- | | | |
|---------------------|--|---|
| 5. Flange | <ol style="list-style-type: none"> Install hex bolt and spring lockwasher. Install pin/spigot. Install driver/actuator. Install shaft seal. Install flange on front cover. Install hex bolts and spring washers. Install ring and screw plug. | <p>Install new seal.</p> <p>Install new ring.</p> |
| 6. Angle drive | Install angle drive and hex nut. | |
| 7. Tachometer cable | Install. | |

5-24. ADAPTER HOUSING AND BEARING PLATE

This task covers: a. Inspection

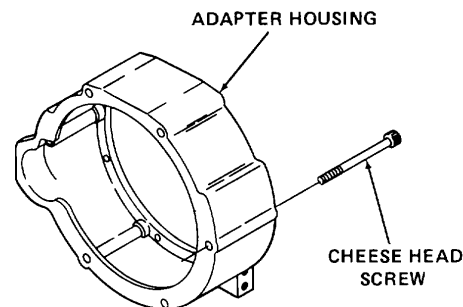
INITIAL SETUP

Tools	Equipment Condition	Condition Description
Shop set, automotive repair, field maintenance, basic NSN 4910-00-754-0705	Para 5-12	Flywheel removed from engine.
Tool kit, master mechanics NSN 5180-00-699-5273		

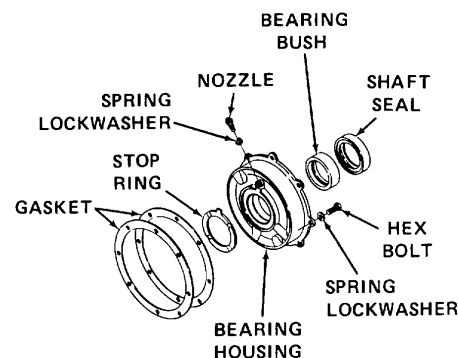
Location/Item	Action	Remarks
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INSPECTION

1. Adapter housing
Inspect for damage, rust, corrosion, and loose mounting hardware. Tighten cheese head screws securely if necessary. Notify general support for repair or replacement.



2. Bearing plate housing
Inspect for damage, rust, corrosion, and loose mounting hardware. Tighten hex bolts securely, if necessary. Notify general support for repair or replacement.



5-25. SKID ASSEMBLY

This task covers: a. Removal c. Repair
 b. Inspection d. Installation/Replacement

INITIAL SETUP

Tools

Shop set, automotive repair,
 field maintenance, basic
 NSN 4910-00-754-0705

Tool kit, master mechanics
 NSN 5180-00-699-5273

References

MIL-T-704 Treatment and Painting of
 Materiel

**Equipment
 Condition
 Para**

Condition Description

Materials/Parts

4-14

Battery box assembly removed.

Skid assembly

4-24

Fuel tank assembly removed.

Materials required by MIL-T-704

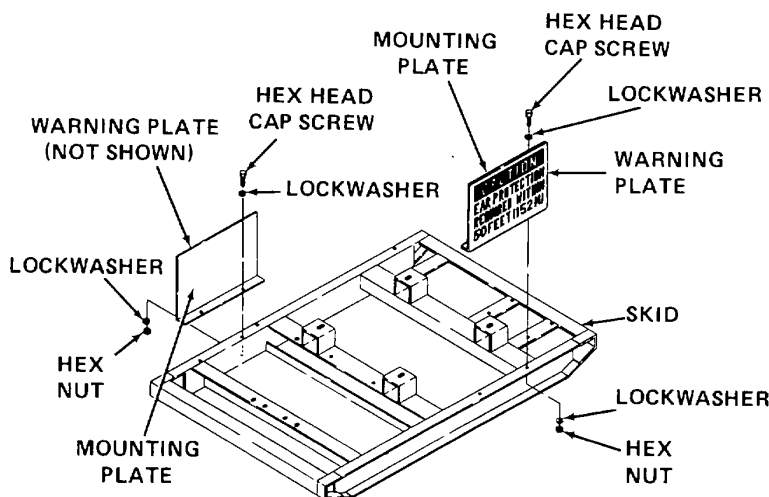
5-7

Engine assembly removed.

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

1. Mounting plates and warning plates
 - a. Remove hex head cap screws, lockwashers, and hex nuts.
 - b. Remove mounting plates and warning plates.



5-25. SKID ASSEMBLY (CONT)

Location/Item	Action	Remarks
INSPECTION		
2. Skid assembly	Inspect for dents, rust, corrosion, structural damage, broken welds, or warpage. If damaged or warped, or if welds are broken, replace skid assembly.	
REPAIR		
3. Skid assembly	Straighten minor dents. Remove rust or corrosion with sandpaper. Clean, treat, and refinish in accordance with MI L-T-704.	
INSTALLATION/ REPLACEMENT		
4. Mounting plates and warning plates	a. Position on skid assembly. b. Install hex head cap screws, lockwashers, and hex nuts. Tighten securely.	

**CHAPTER 6
GENERAL SUPPORT MAINTENANCE INSTRUCTIONS**

INTRODUCTION

This chapter contains the following frequently used maintenance information:

- a. Troubleshooting
- b. Maintenance procedures

The Symptom Index on page 6-2 is a guide to the troubleshooting information. There is also an index to the maintenance procedures on page 6-6.

Section	Title	Page
I	Troubleshooting	6-1
II	Maintenance Procedures.....	6-4

Section I. TROUBLESHOOTING

6-1. TROUBLESHOOTING

a. Table 6-1 contains troubleshooting information for locating and correcting most of the operating troubles which are the responsibility of general support maintenance. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will help you to determine probable causes and corrective actions to take.

Perform the tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify your supervisor.

c. Only those functions within the scope of general support maintenance are listed. For troubleshooting procedures within the scope of operator/crew maintenance, refer to table 3-1. For troubleshooting procedures within the scope of organizational maintenance, refer to table 4-2. For troubleshooting procedures within the scope of direct support maintenance, refer to table 5-1.

6-2. SYMPTOM INDEX

Refer to the Symptom Index below. Locate the malfunction which is the same, or most nearly the same, as the trouble you are having with the centrifugal pump unit. The Symptom Index lists the first page of troubleshooting information for that malfunction. Follow the steps one by one, and perform the corrective actions listed.

Malfunction Number	Description	Page
1	Engine is hard to start	6-3
2	Engine consumes excessive lube oil (may produce blue smoke)	6-3
3	Engine produces excessive crankcase pressure	6-4
4	Engine has low oil pressure	6-4

Table 6-1. General Support Maintenance Troubleshooting

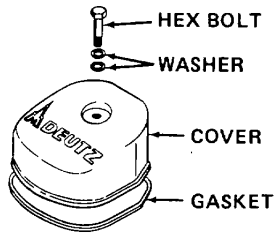
MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1.	ENGINE IS HARD TO START	<p>Step 1. Check for sticking or burned exhaust valves. Inspect valves (para 6-9). Repair or replace faulty valves (para 6-9).</p> <p>Step 2. Check for broken or worn piston rings. Inspect pistons and rings (para 6-16). Inspect cylinder head assembly (para 6-8). Repair or replace pistons (para 6-16) and cylinder head assembly (para 6-8). Replace piston rings (para 6-16).</p> <p>Step 3. Check for improper exhaust valve clearance. a. Wipe off rocker chamber cover. Remove hex bolt, cover, and gasket. Discard gasket.</p> <div style="text-align: right;">  </div> <p>b. Check and adjust exhaust valve clearance (para 6-9).</p>
2.	ENGINE CONSUMES EXCESSIVE LUBE OIL (MAY PRODUCE BLUE SMOKE)	<p>Step 1. Check for worn or broken oil control rings. Inspect pistons and rings (para 6-16). Inspect cylinder head assembly (para 6-8). Repair or replace faulty pistons (para 6-16) and cylinder head assembly (para 6-8). Replace piston rings (para 6-16).</p>

Table 6-1. General Support Maintenance Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
	Step 2. Check for scored cylinders or pistons. Inspect cylinders (para 6-8). Inspect pistons (6-16).	Repair or replace faulty cylinder head assembly (para 6-8) and piston (para 6-16).
	Step 3. Check for loose piston pin circlips. Inspect piston pin circlips (para 6-16).	Replace a loose piston pin circlip (para 6-16).
	Step 4. Check for piston and connecting rod alignment. Inspect pistons (para 6-16) and connecting rods (para 6-17). Check crankshaft thrust surfaces for wear or grooving (para 6-18).	Replace a faulty piston (para 6-16) or connecting rod (para 6-17). If necessary, replace crankshaft (6-18).
3. ENGINE PRODUCES EXCESSIVE CRANKCASE PRESSURE		
	Step 1. Check for worn piston rings, a hole or crack in a piston crown, or excessive exhaust back pressure.	Replace worn or damaged parts (para 6-16).
4. ENGINE HAS LOW OIL PRESSURE		
	Step 1. Check for clogged lube oil cooler. Inspect lube oil cooler (para 5-14).	Replace a clogged or otherwise faulty lube oil cooler (para 5-14).
	Step 2. Check for partially clogged oil suction pipe inlet screen. Inspect oil suction pipe inlet screen (para 6-11).	Replace an oil suction pipe that is damaged or cannot be cleaned adequately (para 6-11).
	Step 3. Check for air leak in oil suction pipe. Inspect oil suction pipe (para 6-11).	Replace a faulty oil suction pipe (para 6-11).
	Step 4. Check for worn or damaged lube oil pump. Inspect lube oil pump (para 6-11).	Repair or replace a faulty lube oil pump (para 6-11).
	Step 5. Check for excessive wear on crankshaft main bearing journals or bearings. Inspect crankshaft (para 6-18). Inspect main bearings (para 6-18).	Replace faulty crankshaft or main bearings, if necessary (para 6-18).

Section II. MAINTENANCE PROCEDURES

INDEX

	Para		Para
Adapter housing and bearing plate assembly	6-12	Drive shaft	6-14
Adjustment of fuel injection timing	6-4	Front cover	6-7
Camshaft	6-19	Fuel injection pump	6-5
Connecting rod assembly	6-17	Fuel injector	6-6
Crankcase assembly	6-20	Governor assembly	6-13
Crankshaft assembly	6-18	Lube oil pump	6-11
Cylinder	6-15	Piston assembly	6-16
Cylinder head assembly, rocker arms, and tappets	6-8	Tachometer drive	6-10
		Valves, valve guides, and valve seats	6-9

6-3. GENERAL INSTRUCTIONS

Most maintenance instructions in this section will list resources required, personnel required, and equipment condition for the start of the procedure. Note the following:

- Resources required are not listed unless they apply to the procedure.
- Personnel required are listed only if the task requires more than one. If PERSONNEL is not listed, it means one person can do the task.
- The normal standard equipment condition to start a maintenance task is engine stopped and ON-ENGINE-OFF switch turned off. EQUIPMENT CONDITION is not listed unless some other condition is required besides the power being off.
- Refer to Appendix F to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in procedure. Standard torque values given in Appendix F are determined by thread size.

6-4. ADJUSTMENT OF FUEL INJECTION TIMING

This task covers: a. Adjustment

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Adjusting device No. 100640

Dial gage (0.01 mm) No. 100400

Fuel reservoir No. 003-0777

High pressure timing device No. 003-0714

Materials/Parts

Gasket

Marking pen

Shim

References

Para 6-5 Fuel Injection Pump

Equipment Condition

Para

4-22

Condition Description

Fuel line removed.

4-26

V-belt guard removed.

4-34

Fuel line (fuel filter to fuel injection pump), fuel injection lines, and engine shut-down valve removed.

5-20

Rocker chamber cover removed.

Special Environmental Conditions

Well-ventilated area required.

General Safety Instructions

WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts.

6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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ADJUSTMENT

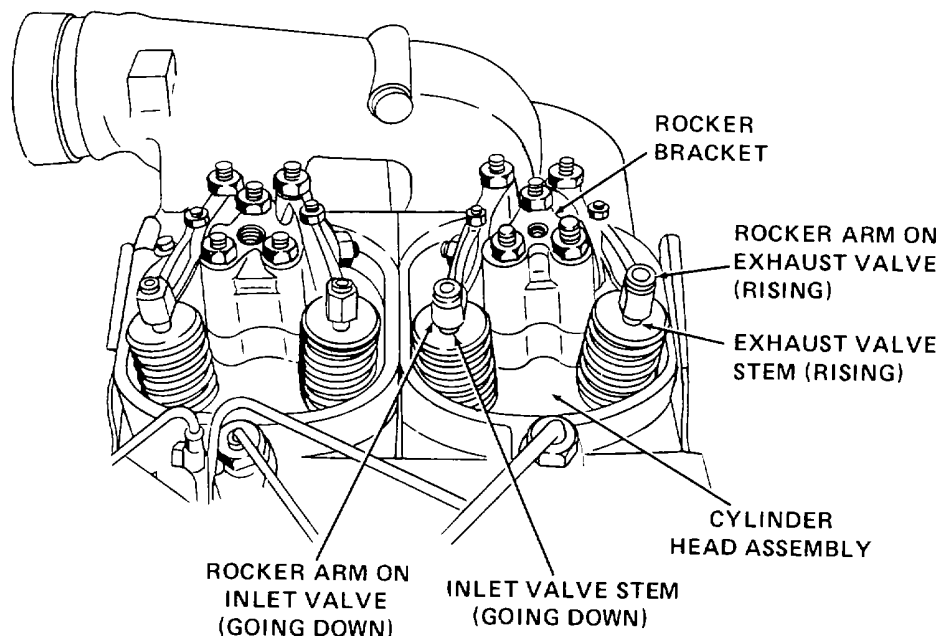
WARNING

Severe injury may result from contact with rotating engine parts, V-belts, or fan. Shut off the engine when it is necessary to inspect, service, or perform maintenance on any moving parts.

NOTE

Use the following procedure to determine top dead center TDC if it has not been marked on flywheel or V-belt pulley. Normal running direction of engine, flywheel and crankshaft is counterclockwise viewing flywheel from pump end. V-belt pulley also runs counterclockwise viewing from V-belt guard end.

1. Flywheel or V-belt pulley Rotate crankshaft by rotating flywheel or V-belt pulley counterclockwise until valve stems and rocker arms overlap. The exhaust valve should be closing and its valve stem rising. The inlet valve should be opening and its valve stem going down.



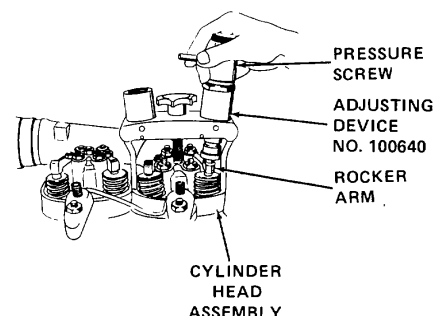
NOTE: VALVES OVERLAPPING AND AT SAME HEIGHT IN THEIR TRAVEL.

6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

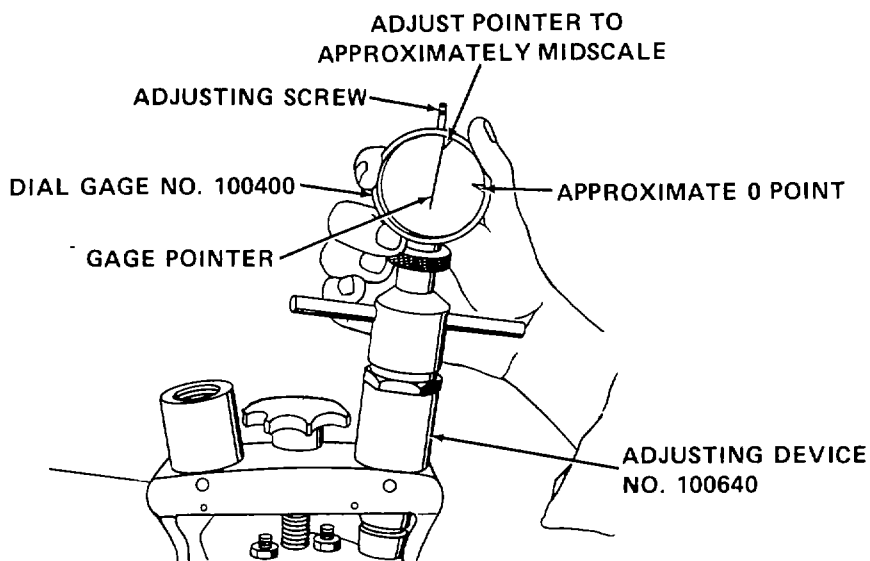
Location/Item	Action	Remarks
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Both valve stems should be at the same height. Rotate crankshaft another one-half revolution or 180 degrees of travel of the flywheel or pulley.

- 2. Adjusting device No. 100640
 Mount on cylinder head assembly. Turn pressure screw until rocker arm has been pushed down 0.197 to 0.236 inch (5.0 to 6.0 mm).



- 3. Dial gage No. 100400
 Turn adjusting screw until gage pointer reads approximately midscale. Mount on adjusting device.

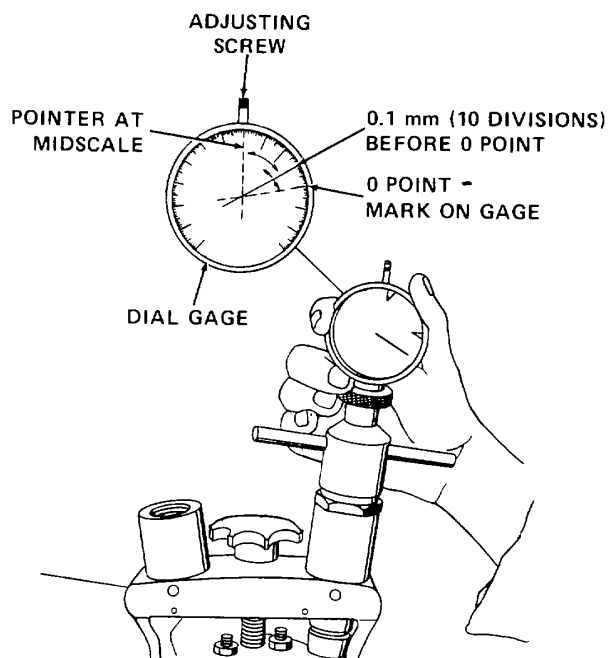


- 4. Flywheel or V-belt pulley
 Rotate crankshaft as in step 1. Rotate slowly until piston starts to push up valve. Gage pointer will move up scale clockwise. Continue to rotate crankshaft until gage pointer stops moving up scale/clockwise and just starts to change direction to down scale/counter-clockwise. Mark this point on gage as the 0 point.

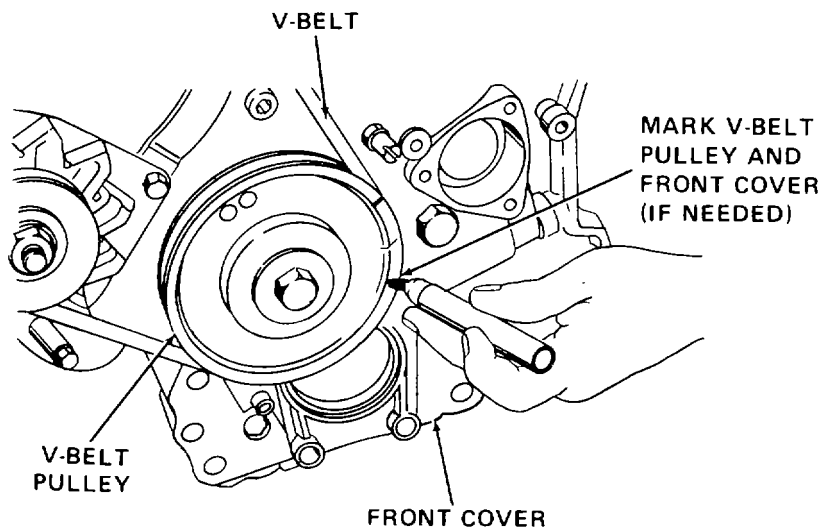
6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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5. Flywheel or V-belt pulley
 Rotate flywheel and crankshaft or V-belt pulley clockwise (opposite normal direction) until gage pointer has made one complete swing down and back up to 0 point. Referse direction and rotate crankshaft counterclockwise until gage pointer swings down 0.1 mm or 10 divisions on dial gage. Mark this point on dial gage and stop rotating crankshaft.

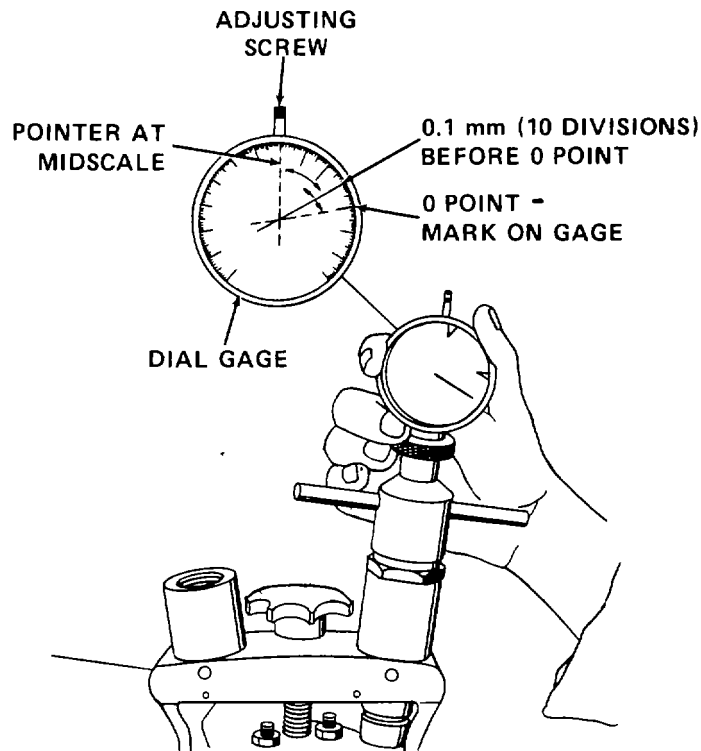


6. V-belt pulley
 Mark V-belt pulley opposite marking on front cover. If there is no marking on the front cover, make both marks in approximately the four o'clock position in line with each other.



6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

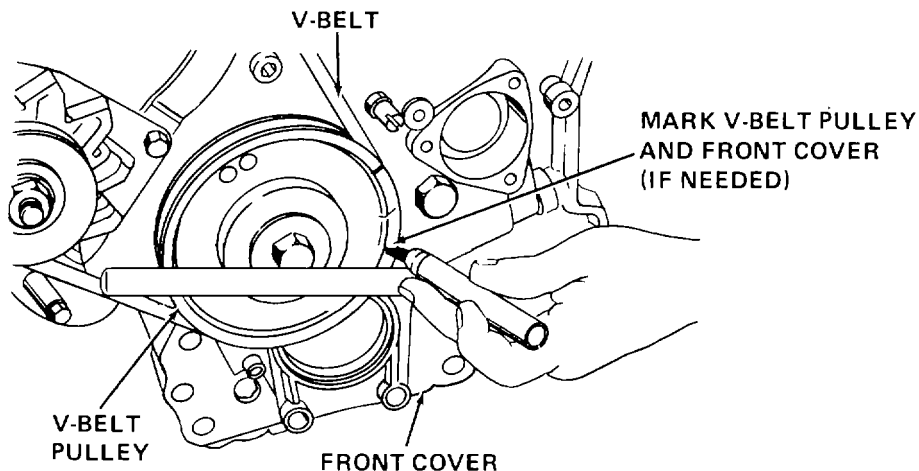
Location/Item	Action	Remarks
7. Flywheel or V-belt pulley	Rotate flywheel and crankshaft or V-belt pulley counterclockwise (in normal direction) until gage pointer on dial gage has made one complete swing down scale and back up scale. Stop rotating crankshaft at the point on the dial gage marked 0.1 mm or 10 divisions before the 0 point.	



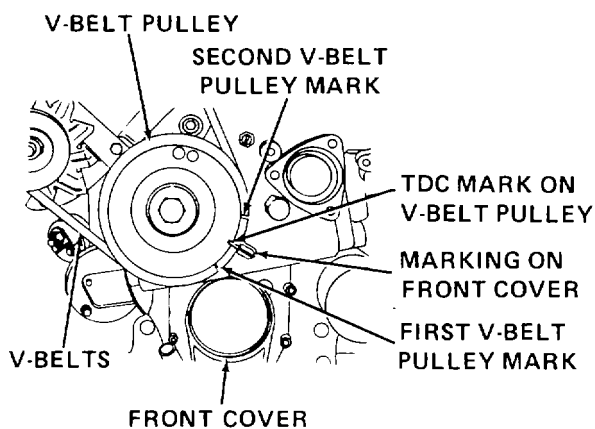
6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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- | | | |
|------------------|--|--|
| 8. V-belt pulley | Mark V-belt pulley opposite the same marking on front cover as in step 6. Determine midpoint between two marks with tape measure and mark midpoint on V-belt pulley. | |
|------------------|--|--|



- | | | |
|-----------------|---|--|
| 9. TDC position | When midpoint is lined up with marking on front cover, the piston is in TDC (top dead center) position. | |
|-----------------|---|--|



6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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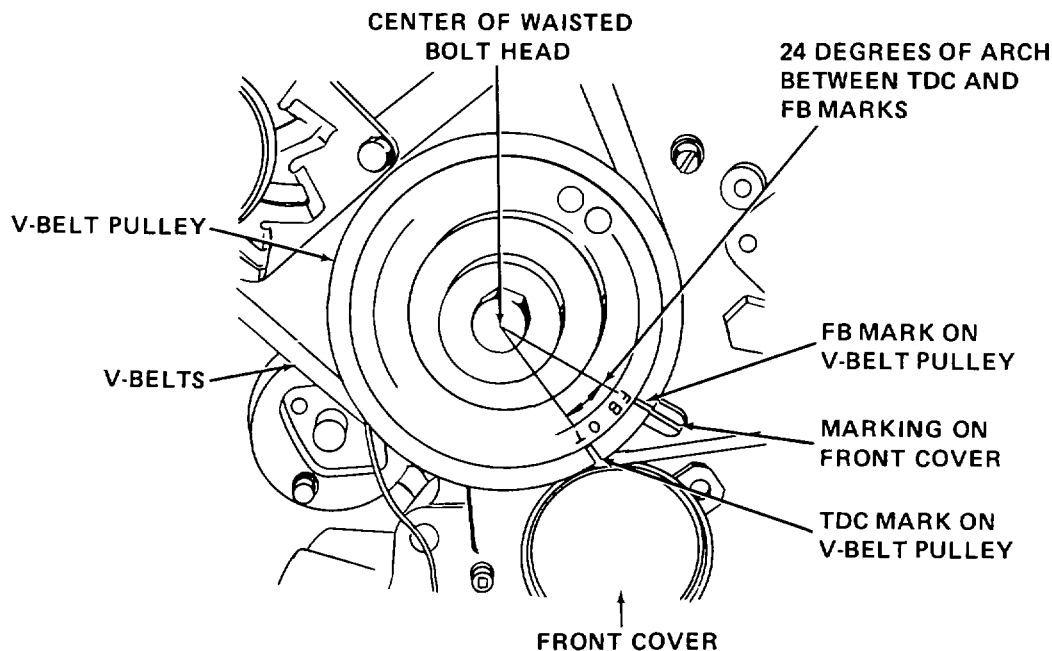
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Be certain fuel lines and connections are secure.
- Work in a well-ventilated area.

10. FB mark on V-belt pulley

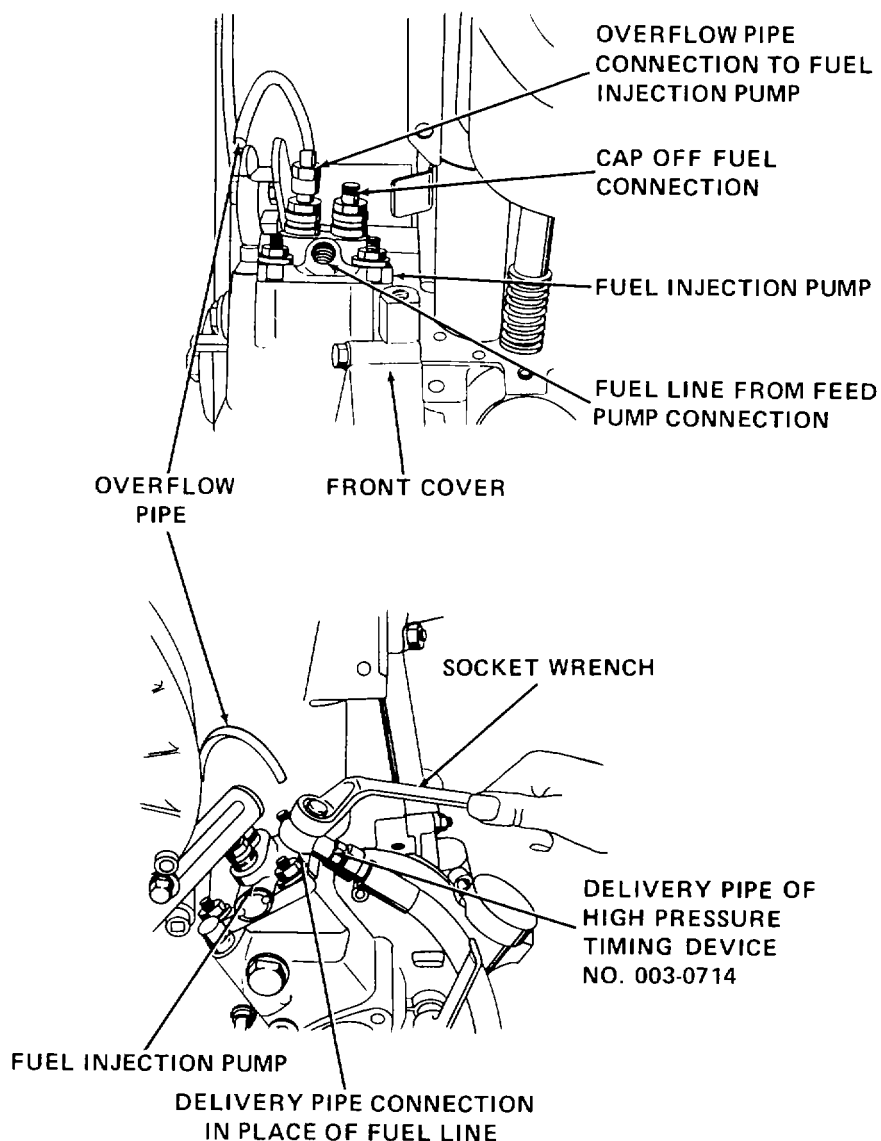
Measure on the V-belt pulley circumference 24 degrees of arc from the TDC mark determined above and mark this point on the V-belt pulley. This is the FB or commencement of injection flow point and, when lined up with the marking on the front cover, indicates that the fuel injection pump is just starting to feed fuel to the injectors.



6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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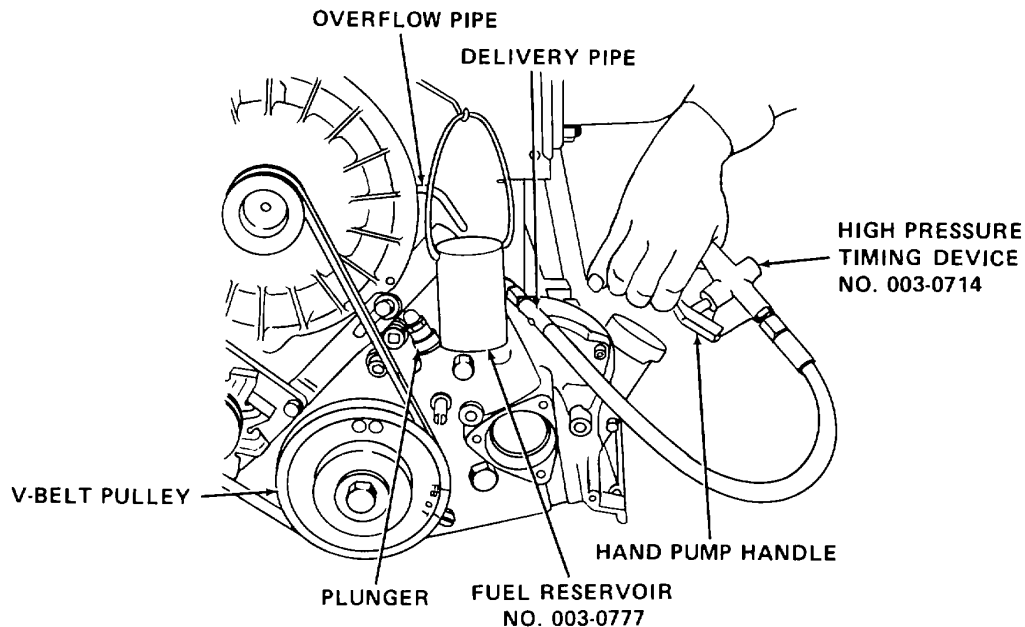
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|---|---|--|
| 11. Overflow pipe and delivery pipe of high pressure timing device No. 003-0714 | Connect overflow pipe to fuel injection pump in place of fuel injection line. Cap off other fuel injection line connection on pump. Connect delivery pipe to fuel line connection on pump. Tighten securely with socket wrench. | |
|---|---|--|



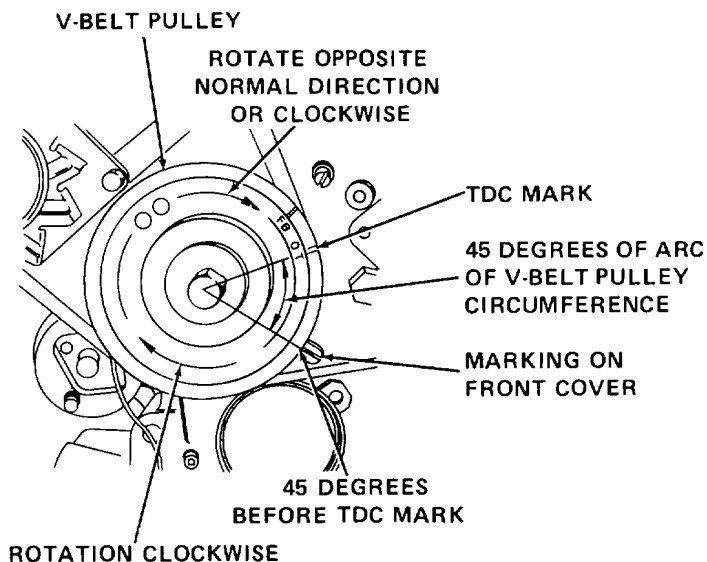
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|--|--------------------------------------|--|
| 12. Suction pipe of high pressure timing device No. 003-0714 | Connect to fuel line from fuel tank. | |
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6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

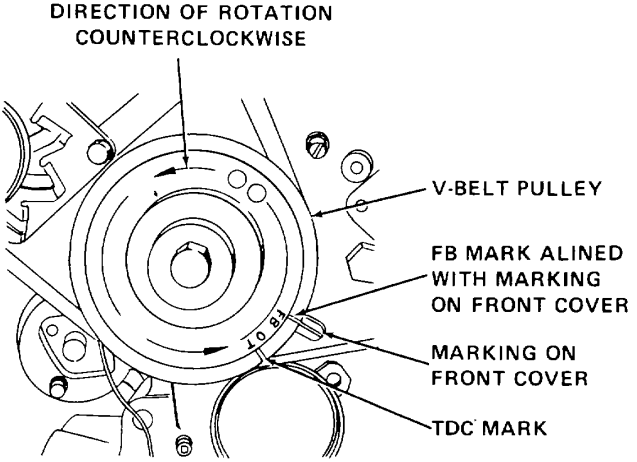
Location/Item	Action	Remarks
13. Fuel reservoir No. 003-0777	Position under overflow pipe so that fuel runs into reservoir during injection timing test and adjustment.	
14. Plunger	Do not push in. If pushed in, pull out.	



15. Flywheel or V-belt pulley
 Rotate flywheel and crankshaft or V-belt pulley clockwise to approximately 45 degrees before TDC mark.



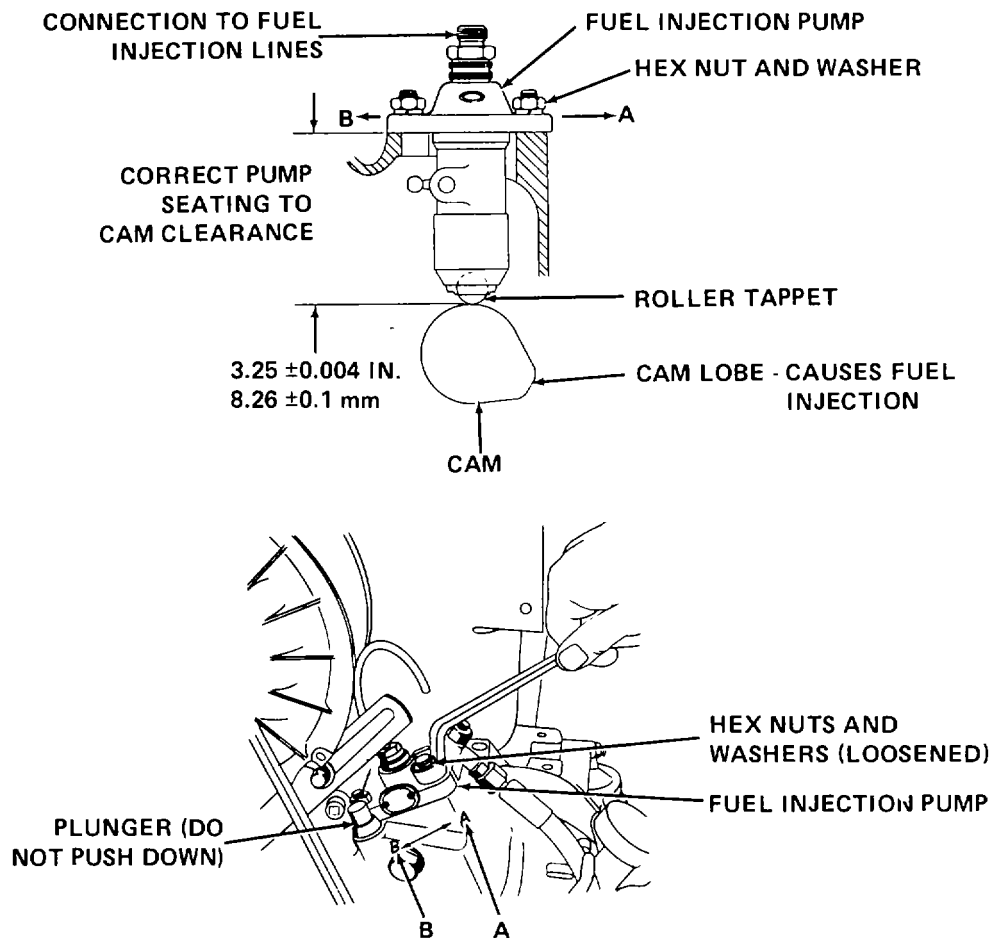
6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
16. High pressure timing device No. 003-0714	Pump hand pump handle until fuel flows out of overflow pipe into reservoir.	
17. Flywheel or V-belt pulley	Rotate flywheel, crankshaft, or V-belt pulley counterclockwise (in normal running direction) slowly and continue to pump hand pump handle until fuel flow decreases to a drip. When the interval between droplets is 5 to 8 seconds, the fuel injection rate is correct. Stop rotation of crankshaft.	
18. FB mark	Make sure FB mark lines up with marking on front cover. If so, the fuel injection timing is adjusted correctly and there is no need for further adjustment. If not, proceed with the following steps to adjust fuel injection timing.	 <p style="text-align: center;">DIRECTION OF ROTATION COUNTERCLOCKWISE</p> <p style="text-align: right;">V-BELT PULLEY</p> <p style="text-align: right;">FB MARK ALINED WITH MARKING ON FRONT COVER</p> <p style="text-align: right;">MARKING ON FRONT COVER</p> <p style="text-align: right;">TDC MARK</p> <p style="text-align: center;">NOTE: CORRECT FUEL INJECTION TIMING ADJUSTMENT POSITION.</p>
19. Fuel injection pump	Remove and adjust fuel injection pump seating surface to base circle of cam clearance in accordance with procedure in paragraph 6-5. Reinstall but do not tighten hex nuts.	
20. Fuel injection timing	Adjust by moving fuel injection pump sideways. Move pump toward A if FB mark has not reached marking on front cover after proceeding with step 17. If FB mark has not reached marking on front cover, fuel injection will occur earlier than it should. Moving pump toward A will make fuel injection occur later. Move pump toward B if the	

6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

Location/Item	Action	Remarks
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FB mark has gone by the marking on the front cover after proceeding with step 17. Fuel injection will occur later than it should and moving pump toward B will make fuel injection occur earlier.



- | | | |
|---------------------------|--|--|
| 21. Fuel injection pump | Tighten hex nuts securely in accordance with paragraph 6-5. | |
| 22. Fuel injection timing | Recheck and adjust if necessary. To readjust, repeat procedure starting with step 14. If no adjustment is necessary, fuel injection timing is now correct. | |

6-5. FUEL INJECTION PUMP

This task covers: a. Removal b. Installation

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Fuel injection pump

Gasket

Shims

Equipment Condition

Para

Condition Description

4-34

Engine shut down and cool.
Fuel filter-to-fuel injection
pump line and fuel injection
lines removed.

4-35

Engine shutdown valve
removed.

4-38

Alternator clamping plate
removed.

Special Environmental Conditions

Well-ventilated area required.

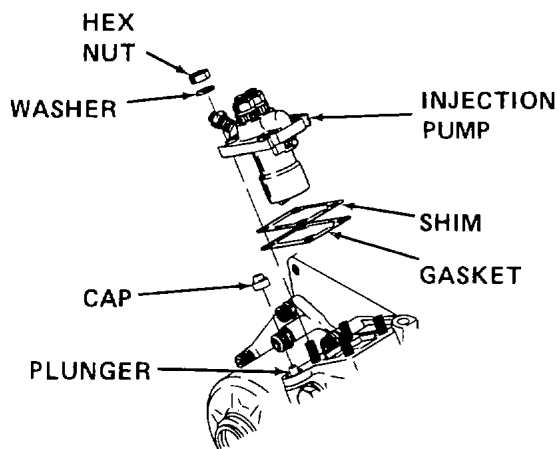
Location/Item	Action	Remarks
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REMOVAL

CAUTION

Fuel injection pump cannot be removed with plunger depressed.

- 1. Plunger Pull up.
- 2. Fuel injection pump
 - a. Remove hex nuts and washers.
 - b. Remove fuel injection pump.
 - c. Remove shim(s) and gasket(s); discard gasket(s).



6-5. FUEL INJECTION PUMP (CONT)

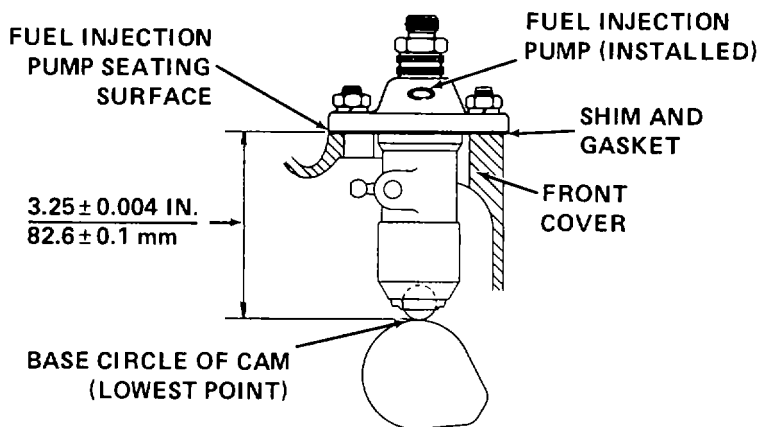
Location/Item	Action	Remarks
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INSTALLATION

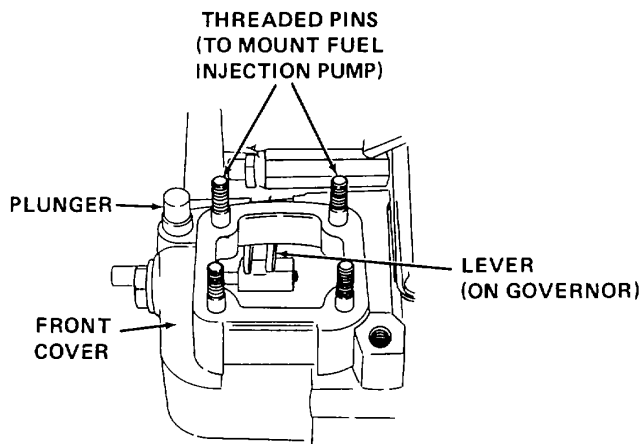
- 3. Gasket
Install new gasket(s) and measure clearance between fuel injection pump seating surface and lowest point or base circle of cam. Measurement should be 3.25 ± 0.004 inches (82.6 ± 0.1 mm).
- 4. Shims
If necessary, correct measurement with shims.

NOTE

Regardless of details given on the fuel injection pump identification plate, the clearance between the seating surface and the lowest point or base circle of the cam should be $3.25 + 0.004$ inches ($82.6 + 0.1$ mm).



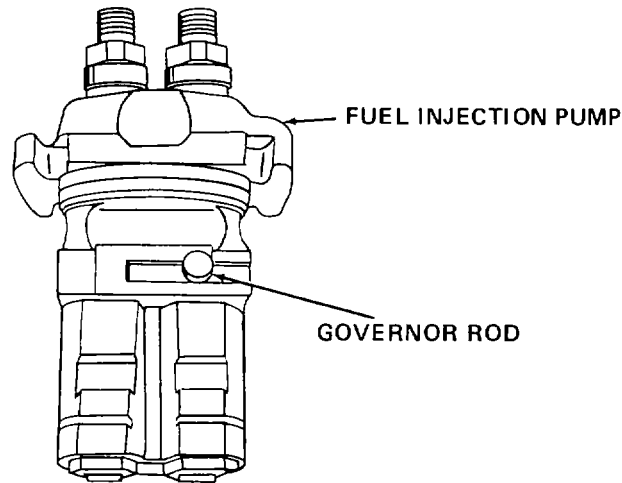
- 5. Lever (on governor)
Position to mate with fuel injection pump governor rod.



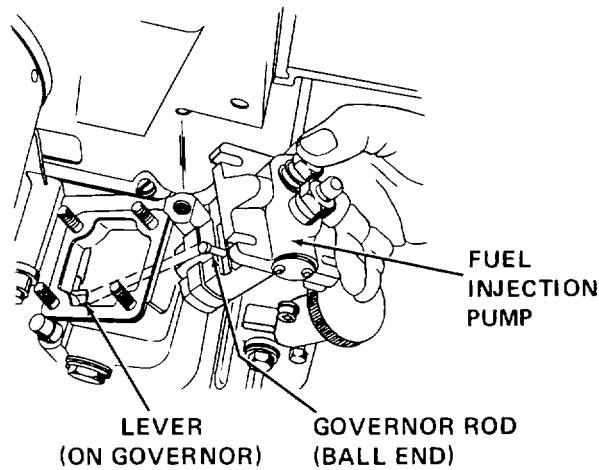
6-5. FUEL INJECTION PUMP (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

- | | | |
|-----------------|--|--|
| 6. Governor rod | Place flush against injector pump housing. | |
|-----------------|--|--|



- | | | |
|------------------------|--|--|
| 7. Fuel injection pump | a. Reinstall with ball end of governor rod facing lever (on governor). | |
|------------------------|--|--|



- | | |
|--|--|
| b. Reinstall hex nuts and washers and tighten alternately and evenly until secure. | |
|--|--|

6-6. FUEL INJECTOR

This task covers: a. Disassembly d. Assembly
 b. Cleaning e. Adjustment/Testing
 c. Inspection/Repair

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic NSN 4910-00-754-0705

Tool kit, master mechanics NSN 5180-00-699-5273

Equipment Condition Para

5-16

5-16 for 6-4

Condition Description

Fuel injectors removed from engine.
 Install in engine as needed for adjustment and testing.

Materials/Parts

Diesel fuel oil (Item 5, Appendix E)

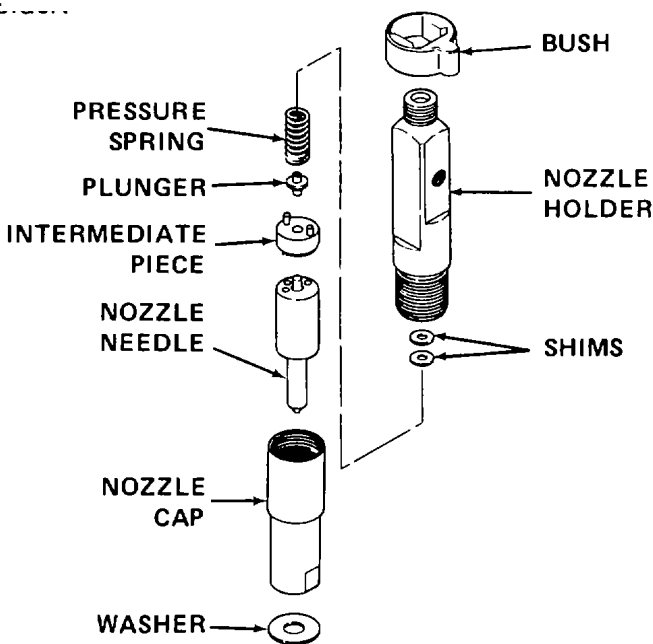
Special Environmental Conditions

Well-ventilated area.

Location/Item	Action	Remarks
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DISASSEMBLY

- Nozzle cap Unscrew from nozzle holder.
- Nozzle needle, intermediate piece, plunger, pressure spring, and shims Remove.



6-6. FUEL INJECTOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

CLEANING

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|--------------|--|
| 3. All parts | Wash in clean VV-F-800 diesel fuel oil and blow out with compressed air. |
|--------------|--|

CAUTION

The nozzle needle and nozzle body are lapped together and should not be mixed up or replaced separately. Do not touch the nozzle needle seating surface which is coated with protective grease.

- | | |
|------------------|---|
| 4. Nozzle needle | Holding the nozzle vertically, the nozzle needle must be allowed to slide slowly and smoothly on its seating under its own weight. If nozzle needle does not slide smoothly, wash with fuel again and replace if necessary. |
|------------------|---|

INSPECTION/REPAIR

- | | |
|-----------------------|---|
| 5. Intermediate piece | Check seating surfaces and centering pins for wear and be sure that pins seat properly. |
|-----------------------|---|

6-6. FUEL INJECTOR (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

ASSEMBLY

- | | | |
|----------|---|--|
| 6. Shims | Insert existing shims into nozzle holder. | |
|----------|---|--|

NOTE

Spraying pressure is increased by adding shims and reduced by removing them.

- | | | |
|---------------------------|---|--|
| 7. Pressure spring | Insert in nozzle holder. | |
| 8. Plunger | Insert plunger with spigot facing pressure spring. | |
| 9. Intermediate piece | Insert guide pins into holes in nozzle holder. | |
| 10. Nozzle and nozzle cap | Aline nozzle on intermediate piece and tighten nozzle cap to nozzle holder. | |

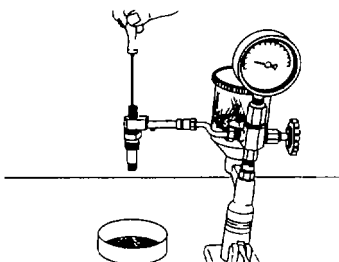
ADJUSTMENT/TESTING

- | | | |
|------------------------------|--|--|
| 11. Nozzle spraying pressure | Adjust by adding or removing shims below the spring. | |
|------------------------------|--|--|

NOTE

Spraying pressure is increased by adding shims and reduced by removing them.

- | | | |
|-------------------|--|--|
| 12. Spray pattern | Test and check spray pattern. Jet(s) should be solid without surrounding mist. | |
|-------------------|--|--|



- | | | |
|-------------|--|--|
| 13. Leakage | Check that there is no after-dribble. If nozzle is defective, replace. | |
|-------------|--|--|

6-7. FRONT COVER

- This task covers:
- | | |
|------------------------|-----------------------------|
| a. Removal | d. Repair |
| b. Disassembly | e. Assembly |
| c. Cleaning/Inspection | f. Installation/Replacement |
-

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Drive shaft seal mandrel No. 144720

Drive shaft sleeve mandrel No. 144730

Materials/Parts

Front cover assembly
O-seal, inside cover

O-seal, plunger

Shaft seal, front cover

Washers

Diesel fuel oil (Item 5, Appendix E)

Grease

Lubricating oil (Item 9, Appendix E)

Materials required by MIL-T-704
Sealing compound (Item 12 or 14, Appendix E)

References

Para 6-4 Adjustment of Fuel Injection Timing
Para 6-5 Fuel Injection Pump

MIL-T-704 Treatment and Painting of
Materiel

Equipment Condition

Para	Condition Description
4-16	Throttle cable assembly removed from engine.
4-21	Air cleaner, air intake tubes, elbows, and rain cap removed from engine.
4-28	Alternator V-belt pulley removed from engine.
4-29	Drive shaft V-belt pulley removed from engine.
4-31	Lube oil filter removed from engine.
5-23	Tachometer drive removed from engine.
6-5	Fuel injection pump removed from engine.

Special Environmental Conditions

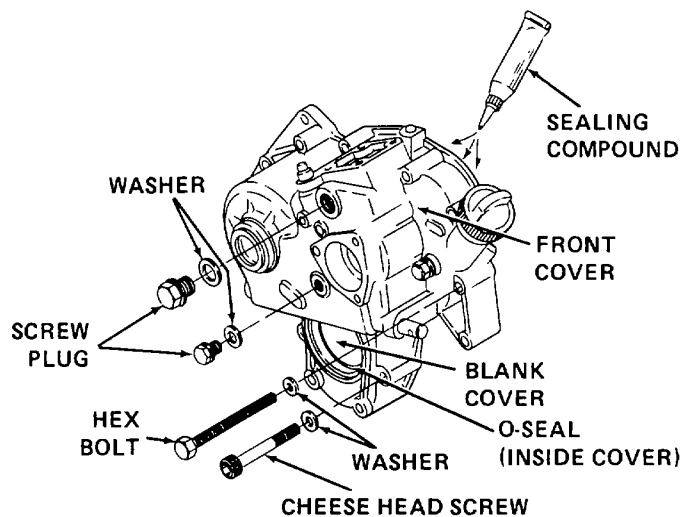
Well-ventilated area required for cleaning.

6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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REMOVAL

- | | | |
|---------------------------|---|--|
| 1. Front cover | <ul style="list-style-type: none"> a. Remove hex bolts and washers. b. Remove cheese head screws and washers. c. Remove screw plugs and washers. | |
| 2. Blank cover and O-seal | Remove. | |
| 3. Front cover engine. | Remove from | |

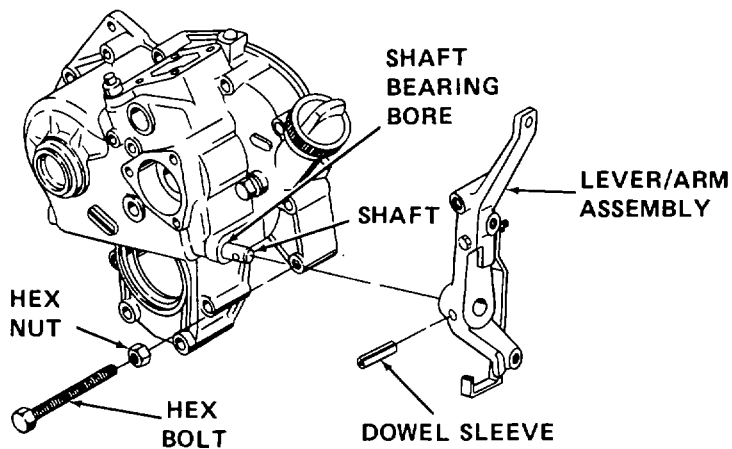


DISASSEMBLY

NOTE

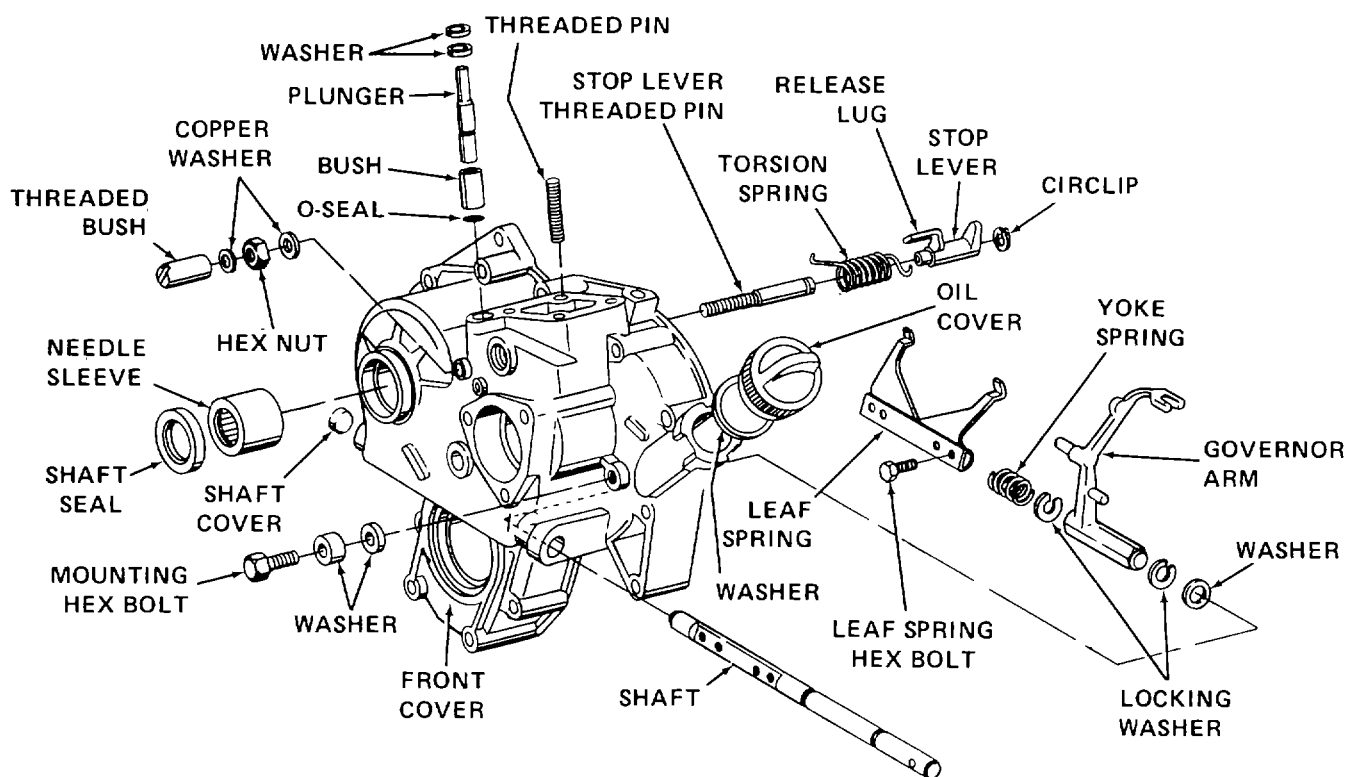
Some front cover components are disassembled from inside the unit.

- | | |
|-------------------------------|---|
| 4. Dowel sleeve and lever/arm | Drive out dowel sleeve and pull off lever/arm of speed control from shaft. Remove hex bolt and hex nut. |
|-------------------------------|---|



6-4. ADJUSTMENT OF FUEL INJECTION TIMING (CONT)

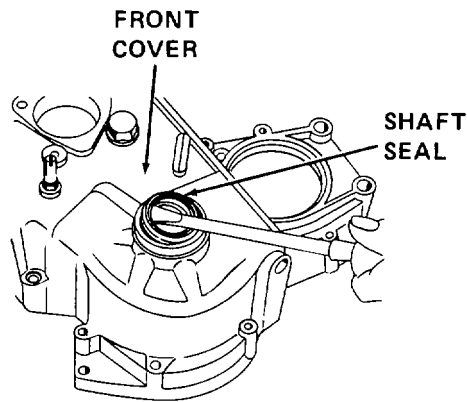
Location/Item	Action	Remarks
5. Governor lever arm and yoke spring	a. Unscrew leaf spring hex bolts from shaft and remove leaf spring from inside front cover. b. Remove locking washers from both ends of governor arm from inside front cover. c. Withdraw governor lever arm and yoke spring from inside front cover.	



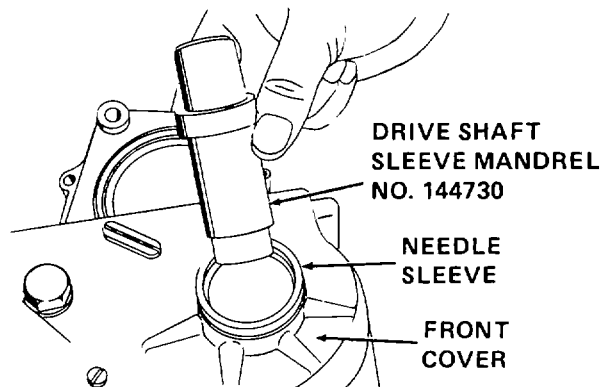
6. Stop lever and torsion spring	a. Remove circlip from stop lever threaded pin from inside front cover. b. Withdraw stop lever and torsion spring from inside front cover.	
7. O-seal	Remove from plunger from inside front cover.	
8. Plunger and bush	Remove plunger and press out bush from inside front cover.	

6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
9. Front cover	a. Remove four threaded pins from top of front cover. b. Remove oil cover and washer. c. Remove mounting hex bolt and washers. d. Remove shaft cover. e. Remove threaded bush, washers, and hex nut.	
10. Shaft seal	Work loose, remove, and discard.	



11. Needle sleeve	Press out with drive shaft sleeve mandrel No. 144730 and remove.	
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6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

12. Front cover assembly, blank cover, and speed control assembly	Clean with VV-F-800 diesel fuel oil and dry with low pressure compressed air. Inspect all components for damage or excessive wear. Replace any components that are severely damaged or worn. Replace all O-seals and any washers that seal or are worn. Replace all springs.	
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REPAIR

NOTE

After cleaning and repair, do not refinish shaft.

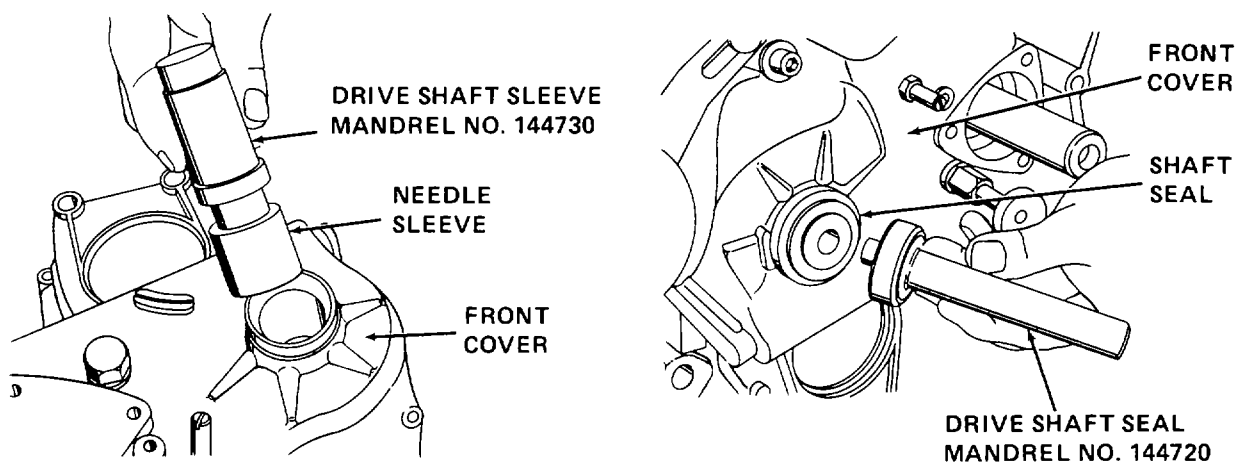
13. Front cover, blank cover, lever/arm, and shaft	Reclean with VV-F-800 diesel fuel oil and dry with compressed air. Repair any minor damage, nicks, burrs, rust, or corrosion in accordance with MIL-T-704. Refinish outside surfaces in accordance with MIL-T-704.	
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6-7. FRONT COVER (CONT)

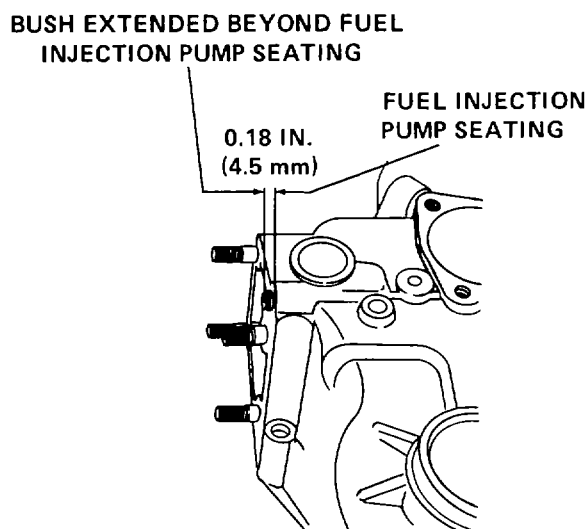
Location/Item	Action	Remarks
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ASSEMBLY

- 14. Needle sleeve Press in with drive shaft sleeve mandrel No. 144730 until flush with recess in front cover.
- 15. Shaft seal Press in with drive shaft seal mandrel No. 144720. Apply MIL-L-2104 lubricating oil to seal lip.

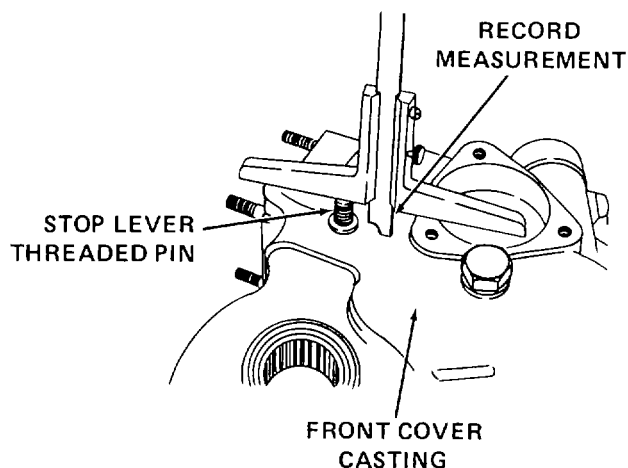


- 16. Bush Press in from inside front cover. Make sure bush extends 0.18 inch (4.5 mm) out past fuel injection pump seating.



6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
17. Stop lever threaded pin	a. Before replacement or adjustment, measure distance between stop lever threaded pin and front cover casting. Record measurement.	



NOTE

Following replacement or adjustment of stop lever threaded pin, be sure to reset engine power lever on test stand.

- b. If replacement is necessary, unthread inward, remove and thread in new pin from inside front cover. When installing new pin, thread on to measurement recorded above.

18. Threaded bush

- a. Install hex nut and copper washers and tighten securely to maintain clearance of stop lever threaded pin.

NOTE

Always use, copper washers with hex nut.

- b. Thread threaded bush onto stop lever threaded pin. Add copper washers to compensate for clearance between bush and nut.

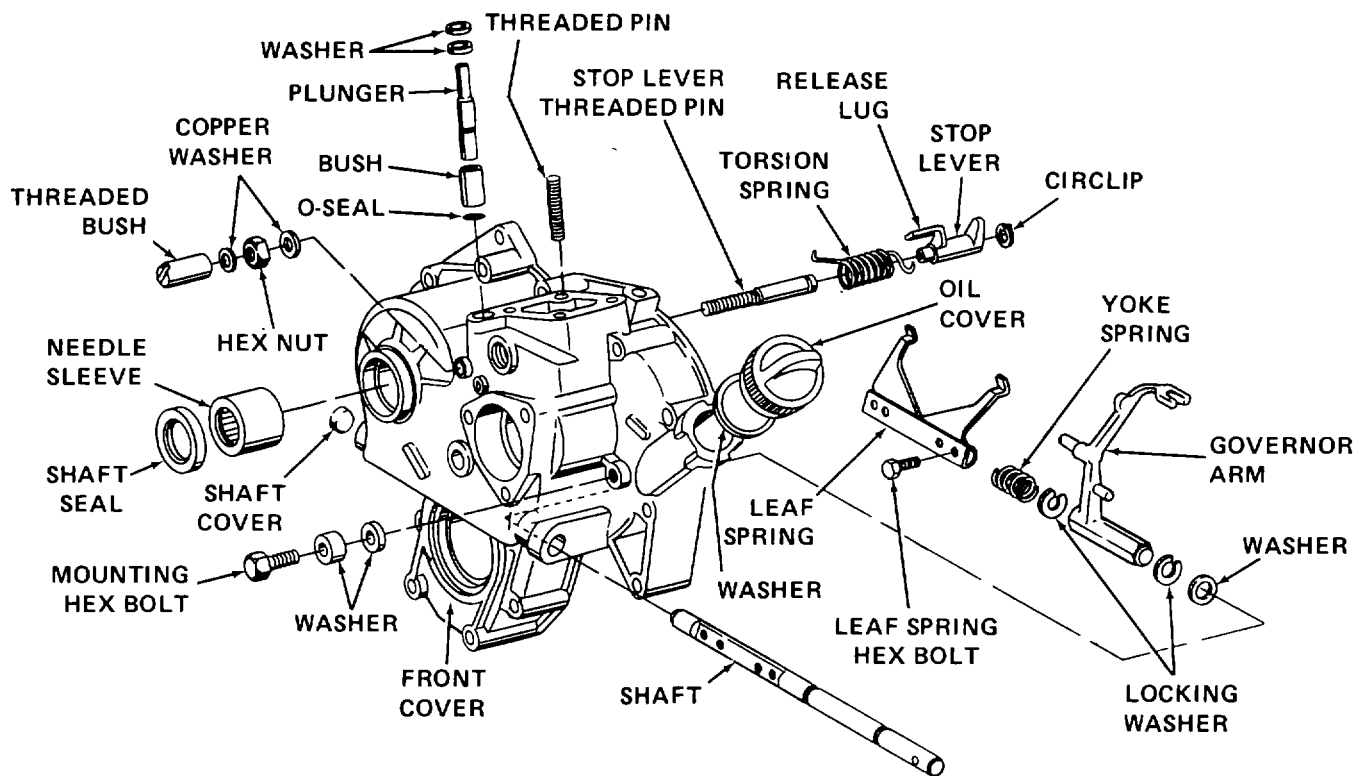
6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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NOTE

The long end of plunger must point toward fuel injection pump seating.

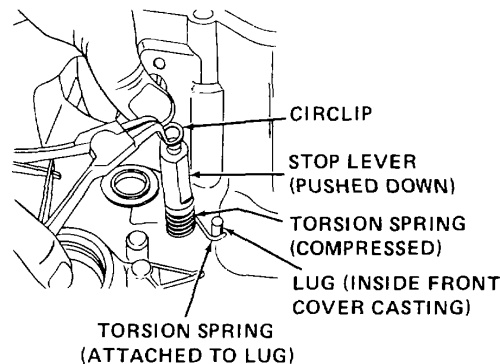
- | | |
|------------------------|---|
| 19. Plunger and O-seal | Fill top groove of plunger with MIL-G-10924 grease. Install new O-seal in bottom groove. Install plunger and washers. Install O-seal on bush. |
| 20. Torsion spring | Install torsion spring over stop lever threaded pin with long end toward inside front cover. |
| 21. Stop lever cover. | Install with release lug toward inside front |



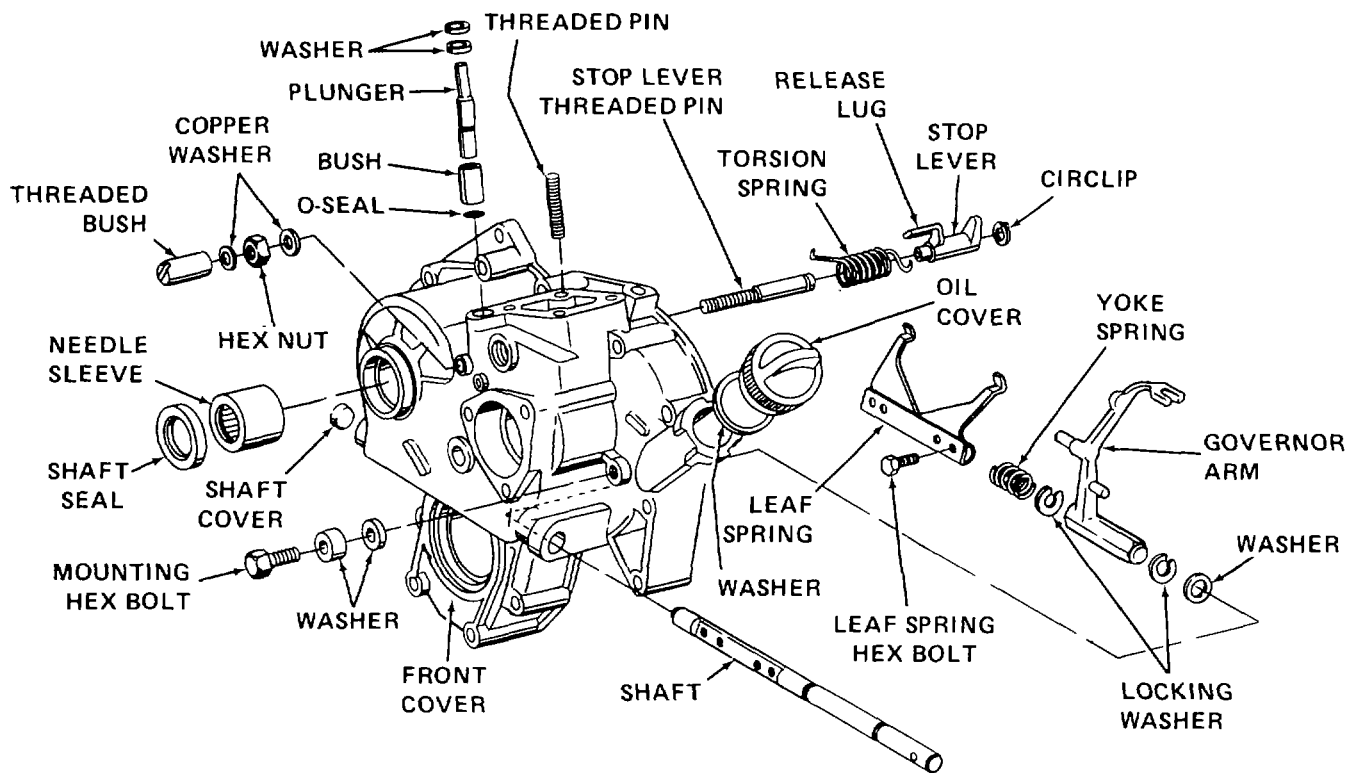
6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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22. Torsion spring
- Attach to stop lever release lug and lug inside front cover casting.
 - Compress torsion spring by turning stop lever and pushing down so that the release lug is situated under plunger. Press on circlip.



23. Shaft
- Slide shaft into front cover flattened end first through shaft bearing bore on lever/arm side.
 - Install washer and locking washer on shaft inside front cover.
 - Push shaft back out through shaft bearing bore in order to temporarily install lever/arm.

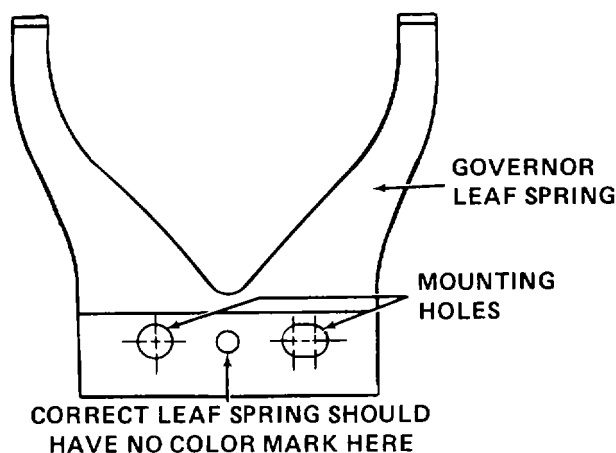


6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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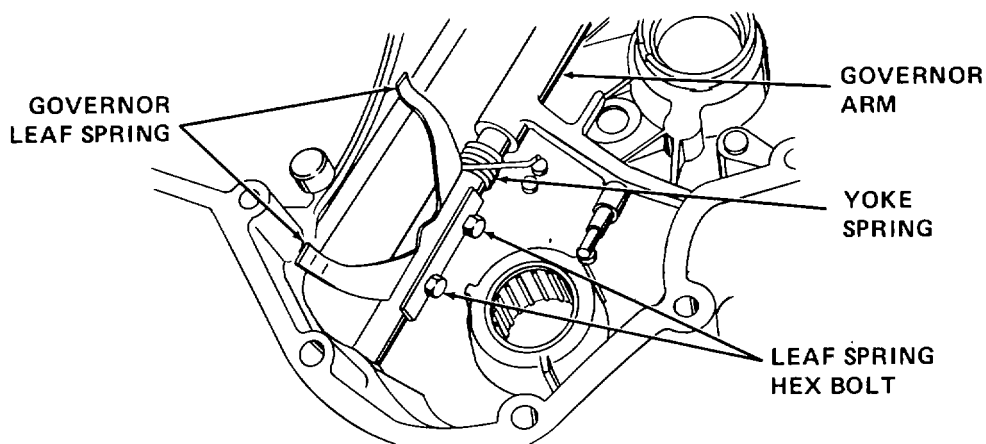
CAUTION

Governor leaf springs vary in thickness according to rated speed. Make sure replacement leaf spring has no color mark on dot between the two mounting holes, and has a thickness of 0.063 inch (1.6 mm). This leaf spring will be correct for rated speed of 2500 to 3000 rpm. If replacement leaf spring has a red, white, or yellow color dot, do not use it.



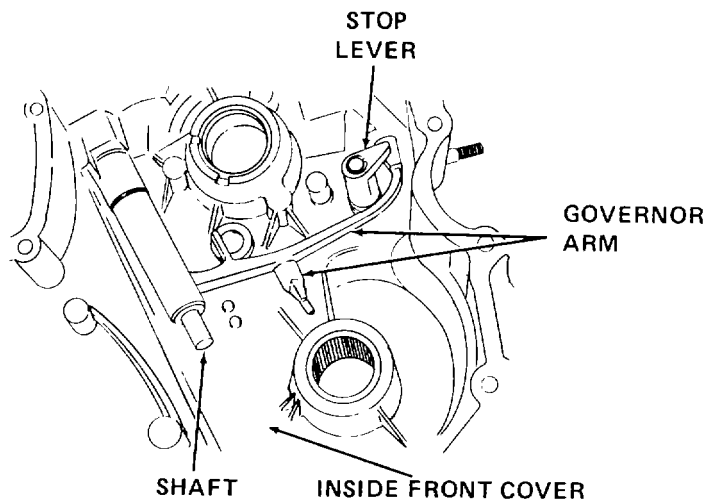
28. Governor leaf spring

Install governor leaf spring on shaft. Tighten leaf spring hex bolts securely.

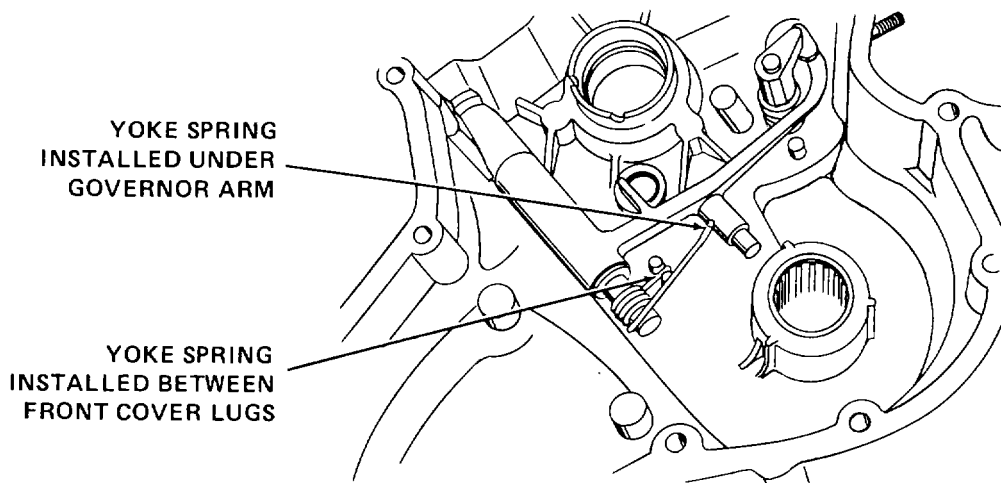


6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
26. Governor arm	a. Remove locking washer, dowel sleeve, and lever/arm. b. Push in shaft and install governor arm on shaft. Continue to push in shaft.	



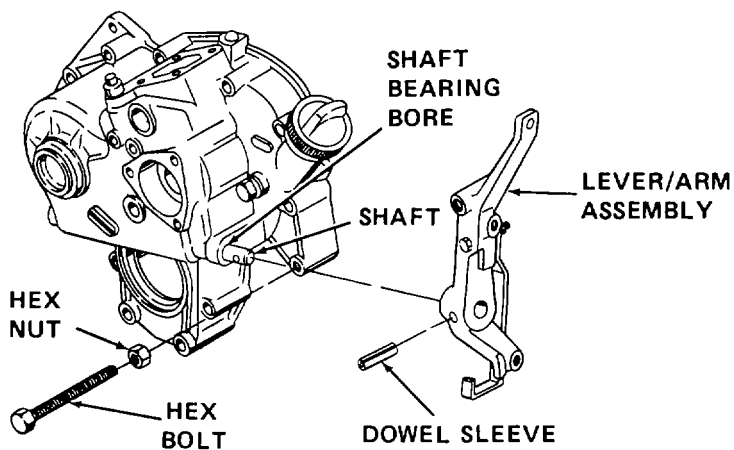
27. Yoke spring Install on shaft.



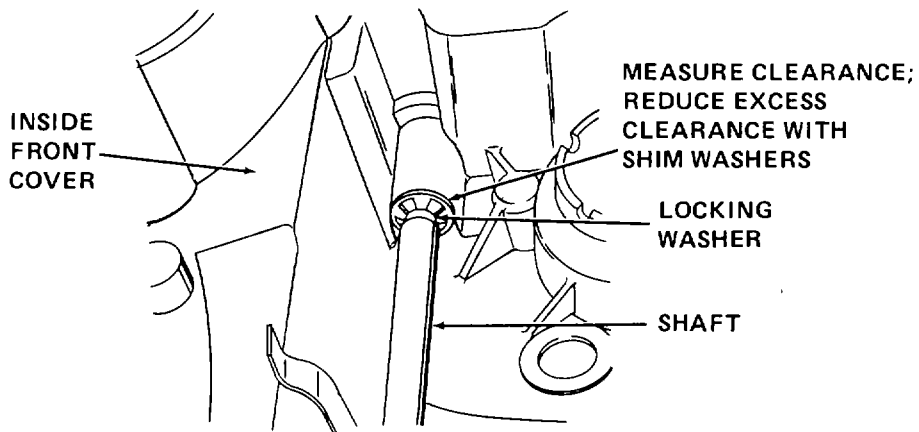
6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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24. Lever/arm	Slide on shaft and lock with dowel sleeve.	
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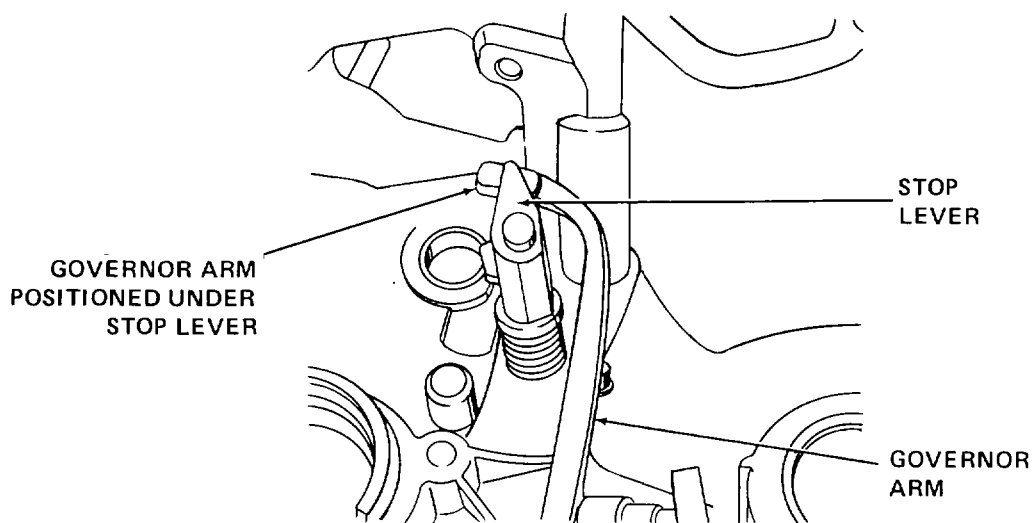
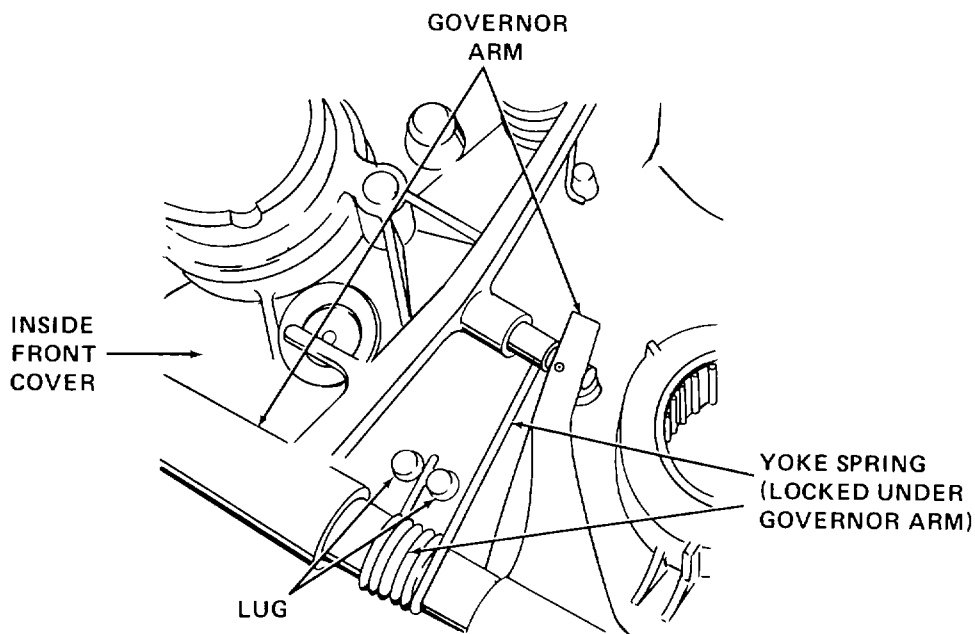


25. Shaft	Check axial clearance of shaft between locking washer and inside front cover. Shim washers between locking washer and cover to reduce clearance as required.	
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6-7. FRONT COVER (CONT)

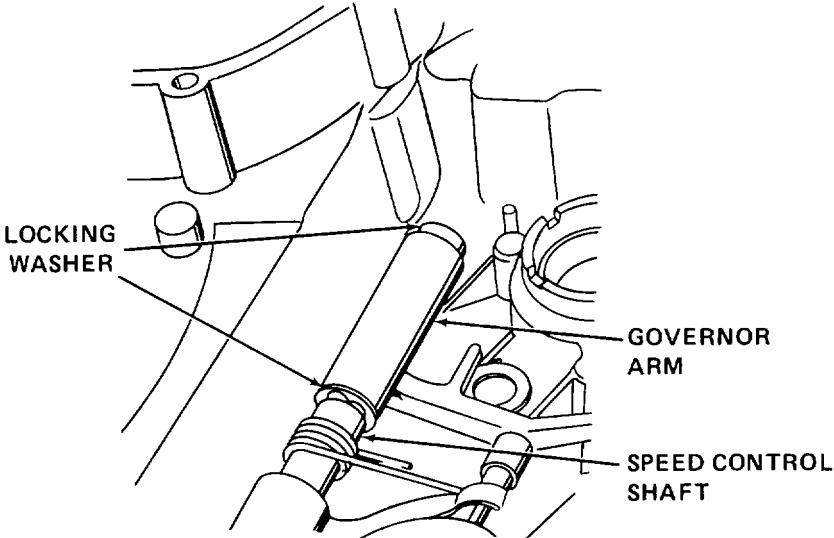
Location/Item	Action	Remarks
29. Yoke spring	Make sure yoke spring is locked under governor arm and is inside front cover lugs.	
30. Governor arm	a. Make sure governor arm is positioned under stop lever.	



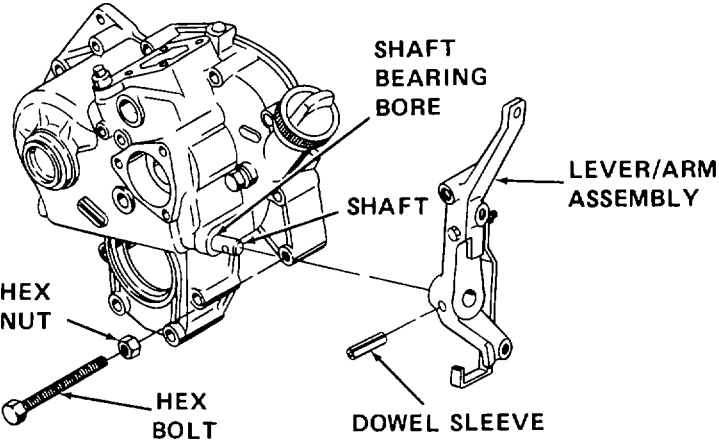
6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
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- b. Install locking washers on speed control shaft on both sides of governor arm.

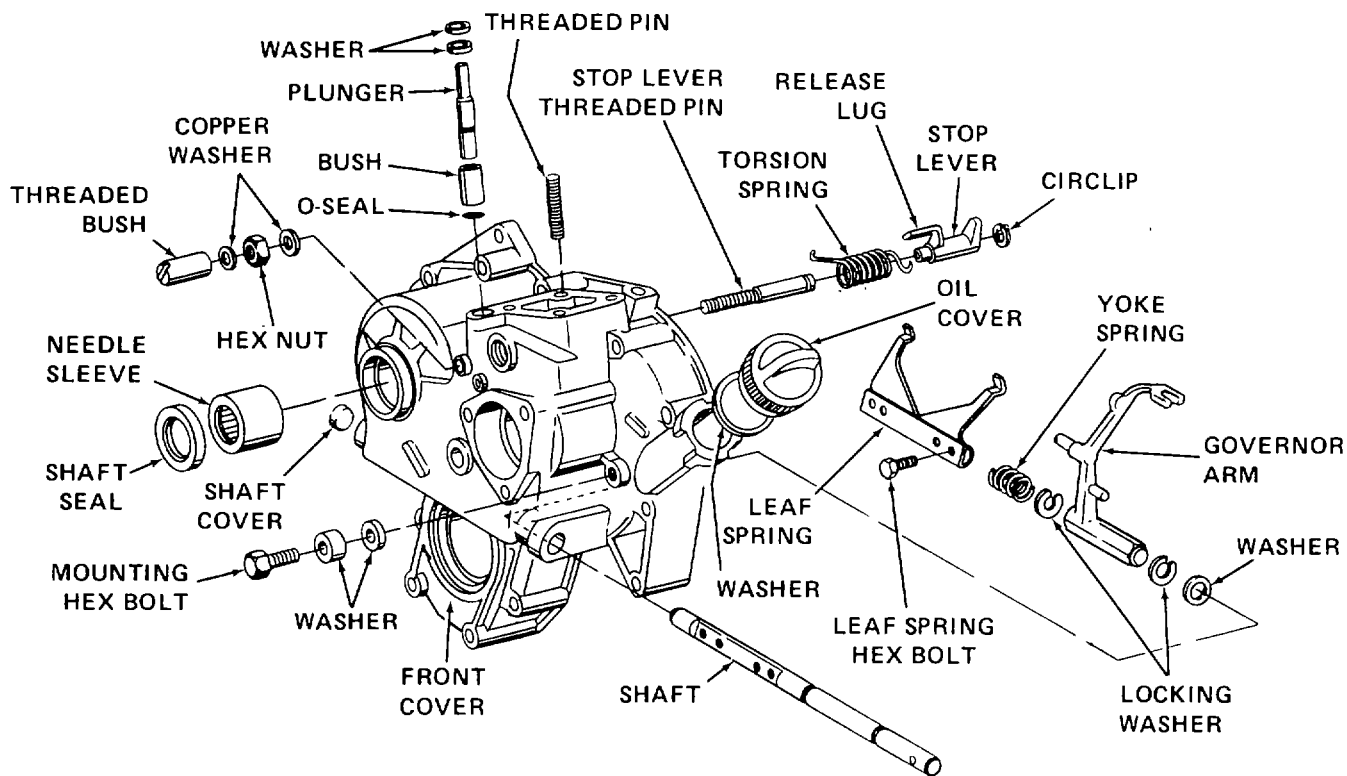


- 31. Shaft
Slip rubber O-seals over shaft and push into shaft bearing bore in front cover.
- 32. Speed control lever/arm
Install hex bolt, hex nut, and speed control lever/arm. Lock lever/arm with dowel sleeve.



6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
33. Front cover	a. Install shaft cover in front cover opposite speed control lever arm.	
	b. Install four threaded pins in top of front cover.	
	c. Install oil cover and washer.	Install new washer.
	d. Install mounting hex bolt and washers.	Install new washers.

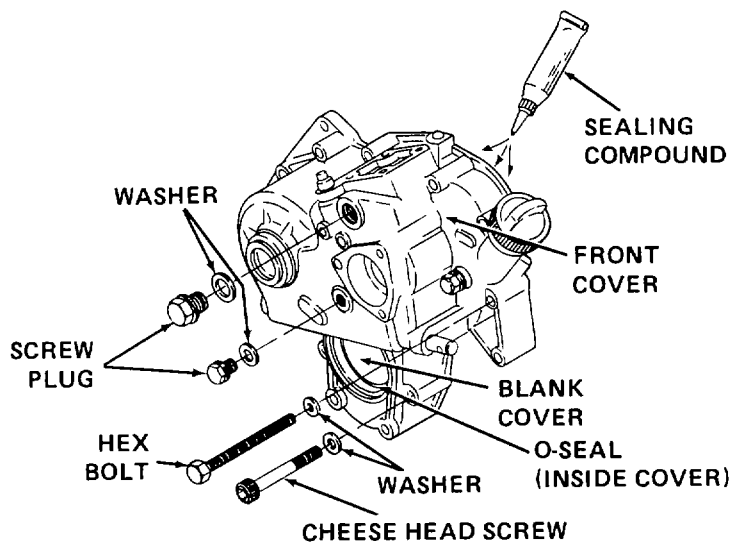


6-7. FRONT COVER (CONT)

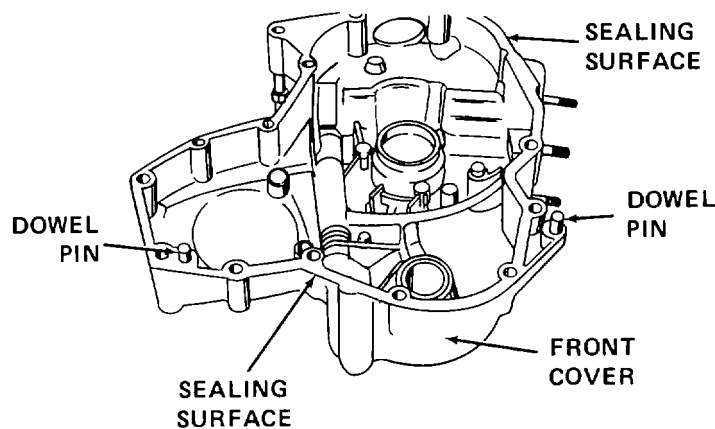
Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

34 Front cover	a. Install screw plugs and washers.	Install new washers.
	b. Install blank cover and new O-seal.	Install new O-seal.

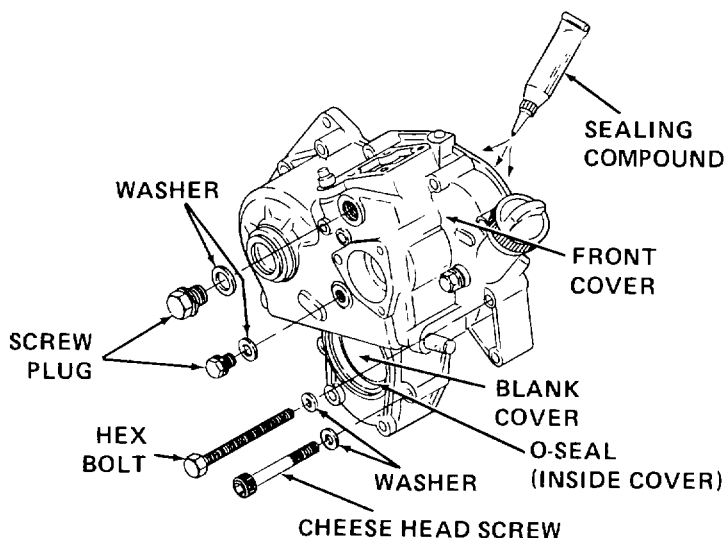


- c. Check that dowel pins are firmly seated and coat sealing surface with MIL-S-45180 (or Deutz DW 47) sealing compound.



6-7. FRONT COVER (CONT)

Location/Item	Action	Remarks
d. Position front cover on crankcase so that dowel pins are alined with mating holes in crankcase.		
e. Install screws, hex bolts, and washers. Tighten alternately and evenly until all screws and bolts are tightened securely.		Install new washers.



- 35. Fuel injection pump
Install with new gasket in accordance with paragraph 6-5.
- 36. Injection timing
Adjust in accordance with paragraph 6-4.

6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS

- This task covers:
- | | |
|------------------------|--------------------------|
| a. Cleaning/Inspection | d. Adjustment |
| b. Repair | e. Assembly/Installation |
| c. Test | |
-

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Clamping plate No. 120910

Cylinder head clamping stand No. 120900

Cylinder head lathe fixture No. 125500

No. 124480

Depth gage

Micrometer gage

Socket spanner No. 120040/120050

Torque gage No. 101900

Turning lathe

Materials/Parts

Copper or lead wire - 12.0 inches (305 mm)
long and 0.0787 inch (2.0 mm) in diameter
Diesel fuel oil (Item 5, Appendix E)
Grease (Item 6, Appendix E)

Lapping and grinding compound, 600 grit
(Item 8, Appendix E)

**Equipment
Condition**

Para	Condition Description
5-20	Cylinder head assembly re- moved from engine. Rocker Cylinder head sealing surface cutter arms and pushrods removed
5-21	from cylinder head assembly. Tappets removed from crank- case. Valves, valve guides, and valve seats removed from cylinder head.

Environmental Conditions

Well-ventilated area requi.ed during cleaning.

6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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**CLEANING/
INSPECTION**

WARNING

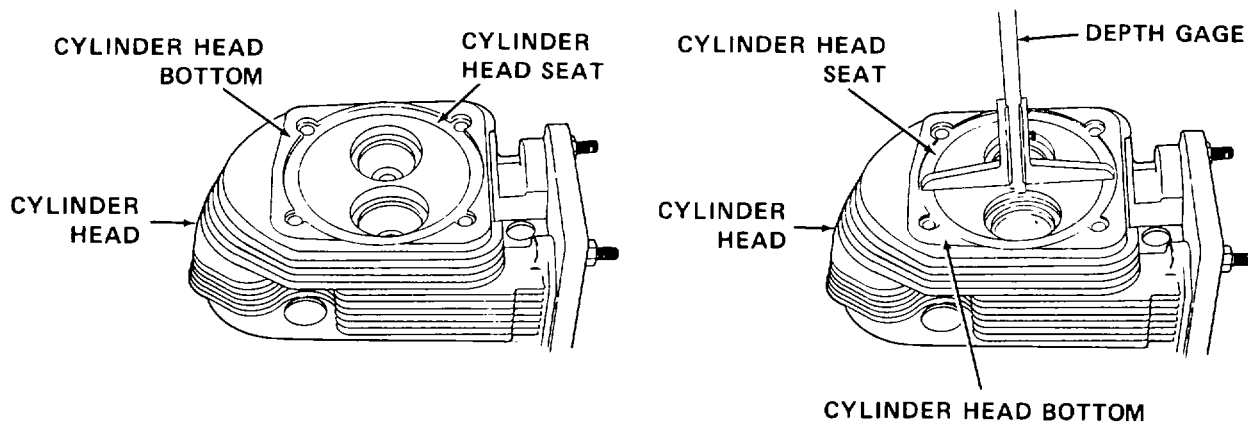
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

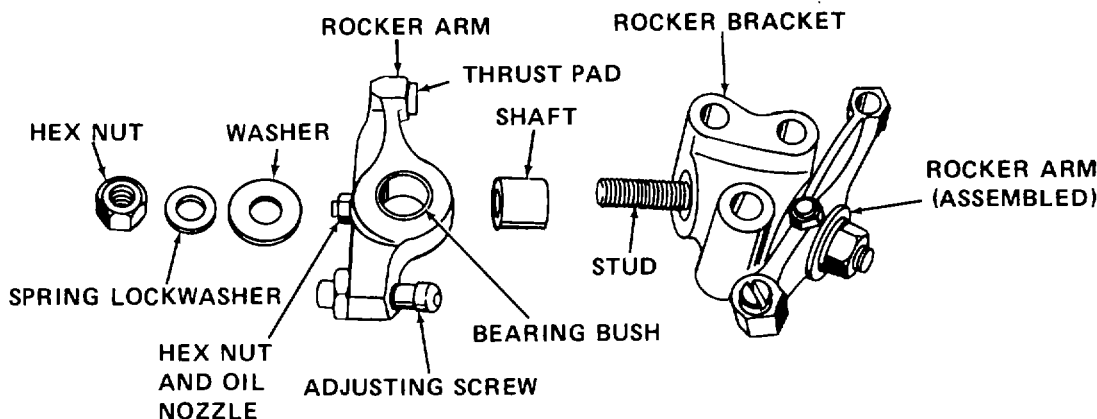
1. Cylinder head

Mount on cylinder head clamping stand No. 120900 and clamping plate No. 120910. Clean with a clean cloth dampened with VV-F-800 diesel fuel oil. Use wire brush where necessary. Dry with compressed air. Inspect for cracks, rust, corrosion, and excessive heat damage. Inspect for accumulated carbon around injector spray tips. Replace cylinder head if it is damaged. Check that cylinder head seat is smooth and flat. If not, measure distance from the cylinder head bottom to cylinder head seat or sealing surface. If the cylinder head bottom-to-cylinder head seat distance is between 0.2283 inch (5.8 mm) and 0.2480 inch (6.3 mm), the cylinder head seat can be smoothed and flattened by remachining. If distance is not within the specified limits, replace cylinder head.

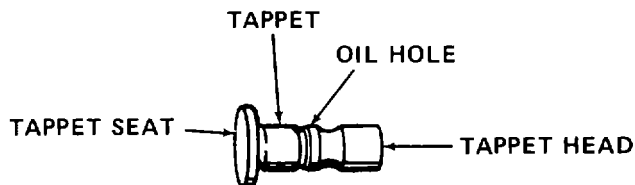


6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
2. Rocker arms, rocker brackets, and associated components	Clean rocker arms, brackets, and associated components with VV-F-800 diesel fuel oil. Use a small wire to clean drilled oil passages in rocker arms, oil nozzle, and bearing bush. Dry parts with low pressure compressed air. Inspect rocker bracket and stud for excessive wear or other damage. Inspect rocker arm, shaft and bearing bush bores for wear. Inspect shaft-to-bush clearance for excessive wear. Inspect bearing bush exterior surface and oil nozzle for excessive wear. Inspect rocker arms, adjusting screw (pushrod contact surface), and thrust pads (valve contact surfaces) for excessive wear.	



3. Tappets, tappet head, tappet seat, and oil hole	Clean thoroughly with VV-F-800 diesel fuel oil and dry with low pressure compressed air. Inspect for damage, wear, or clogged oil hole.
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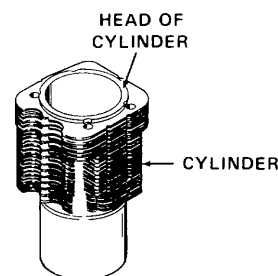


6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REPAIR

- | | | |
|---------------------|---|--|
| 4. Head of cylinder | Smooth and flatten head of cylinder with A-A-1203 grinding compound (600 grit) to compensate for minor surface defects on cylinder head seat. | |
|---------------------|---|--|

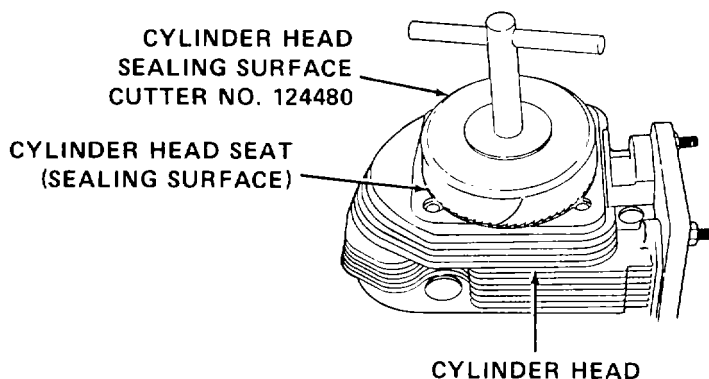


CAUTION

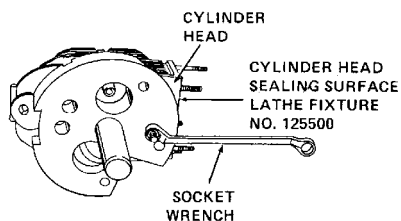
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|-----------------------|--|--|
| 5. Cylinder head seat | | |
|-----------------------|--|--|

Do not remove any more material from cylinder head seat surface than is absolutely necessary to smooth and flatten seat.

Smooth out and/or flatten major damage to cylinder head seat with cylinder head sealing surface cutter No. 124480.



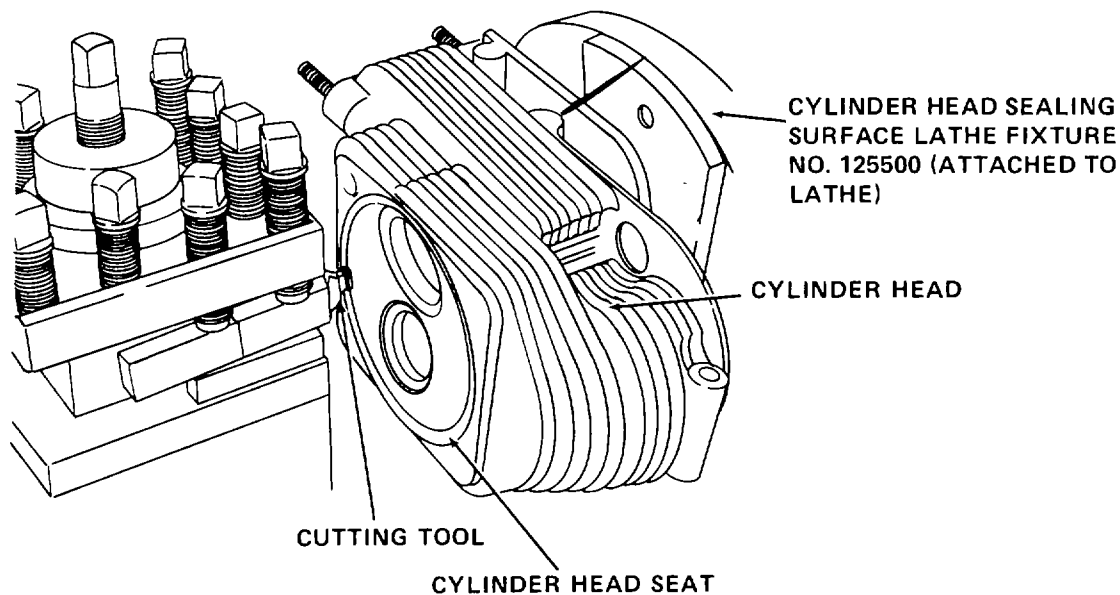
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|------------------|---|--|
| 6. Cylinder head | Bolt to cylinder head lathe fixture No. 125500. | |
|------------------|---|--|



6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

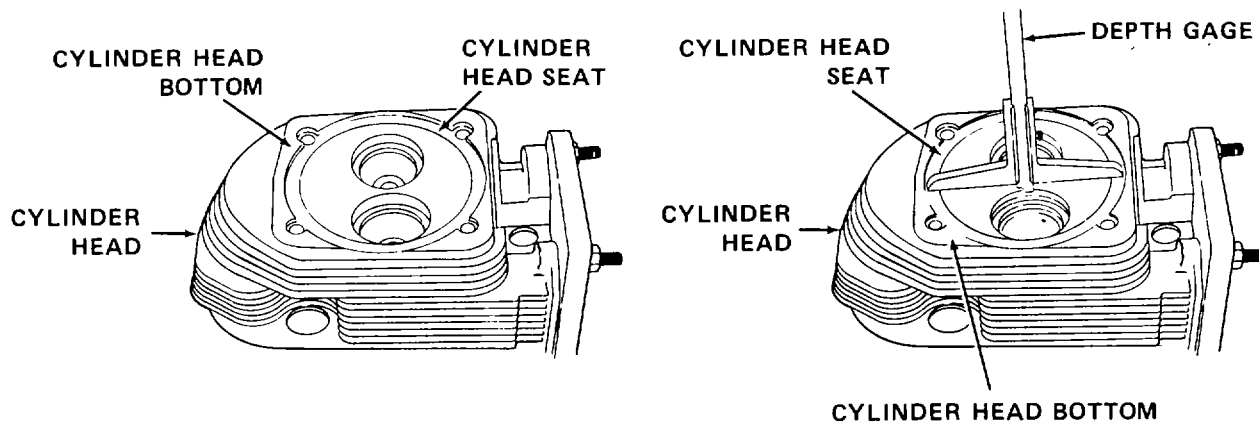
Location/Item	Action	Remarks
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- | | | |
|-----------------------|--|--|
| 7. Cylinder head seat | Turn on lathe until cylinder head seat is smooth and flat. | |
|-----------------------|--|--|



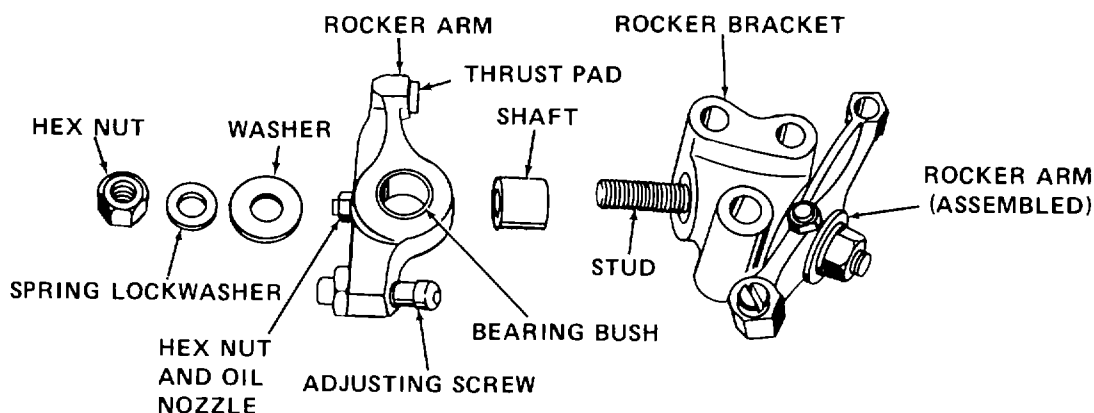
NOTE

Make sure cylinder head bottom-to-seat distance does not exceed 0.2480 inch (6.3 mm). If it does, the cylinder head must be replaced.

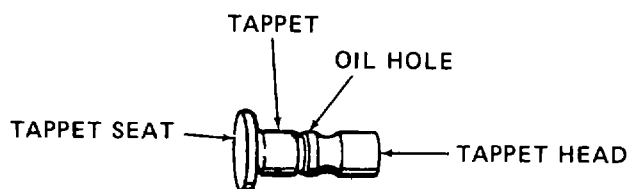


6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
8. Rocker arms, rocker brackets, and associated components	Replace bearing bushes, rocker arms, or rocker brackets if extremely worn or damaged. Replace rocker arms or bushes if clearance to rocker arm shaft is too great. Replace thrust pads if they are galled or worn. Replace any component if its oil passage is permanently blocked.	



9. Tappets	Open clogged oil hole with small wire. Repair only minor nicks or burrs in tappet head or seat if possible. Major damage such as dents or warpage, excessive wear, or permanently restricted oil hole will require replacement. Replace as necessary.
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NOTE

Before installing repaired or new cylinder head, piston top clearance should be measured and checked. Use the following procedure.

6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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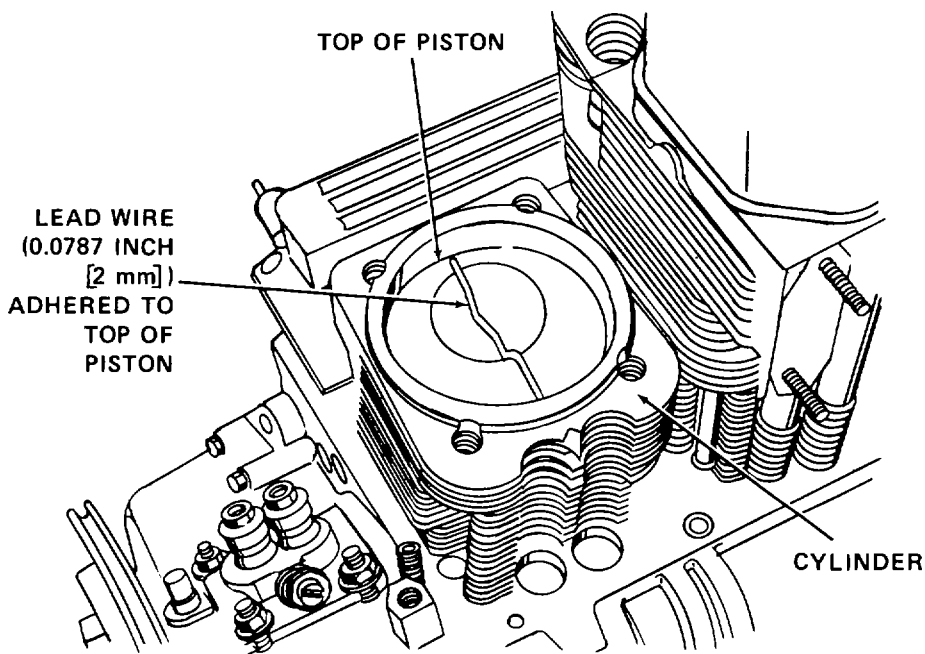
TEST

NOTE

Make sure piston is below TDC position. Refer to paragraph 6-4 to determine TDC position.

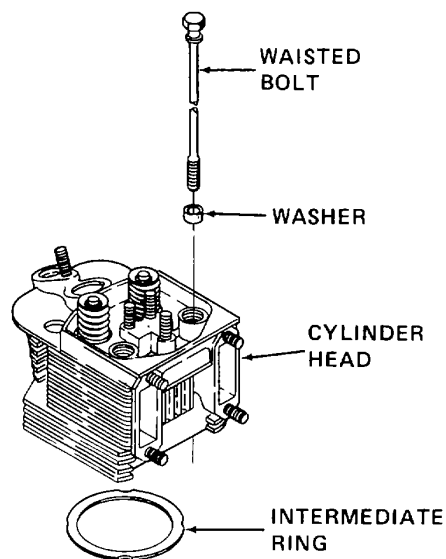
- 10. Piston and lead wire

Apply coating of MIL-L-10924 grease to approximately 4.0 inches (102 mm) of 0.0787 inch (2 mm) lead wire and mold wire to top of piston. Grease will allow wire to adhere to piston. Trim off wire that overlaps top of piston.

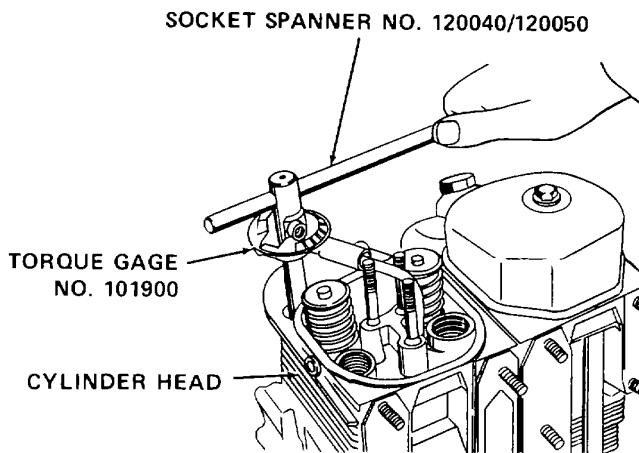


6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
11. Cylinder head	a. Mount cylinder head and intermediate ring on cylinder. b. Insert waisted bolts and washers in cylinder head.	

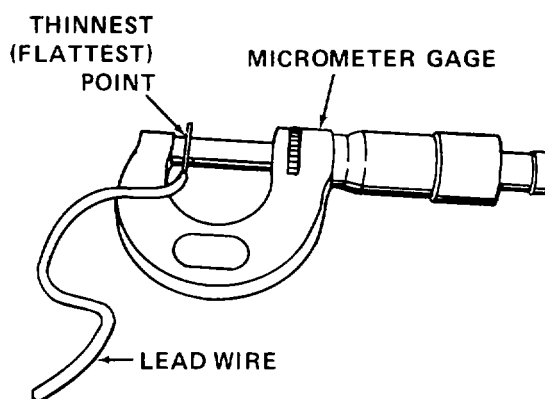


- c. Pretighten waisted bolts alternately and evenly across cylinder head with socket spanner No. 120040/120050 to 22.13 ft lb (30 N.m) torque. Tighten an additional 45 degrees using torque gage No. 101900.



6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
12. Crankshaft	Rotate two complete revolutions of 360 degrees.	
13. Cylinder head	Remove waisted bolts and washers. Mark and remove cylinder head(s) and intermediate rings.	
14. Lead wire	Remove and measure thickness with micrometer at thinnest point. Thickness should be 0.0394 to 0.0472 inch (1.0 to 1.2 mm). The measured thickness or piston top clearance should be compared to the specified limits. If measurement is outside limits, piston to clearance may be adjusted using the following procedure. If measurement is within limits, proceed to assembly.	



THICKNESS (PISTON TOP CLEARANCE) SHOULD BE 0.0394 to 0.0472 INCH (1.0 to 1.2 mm).

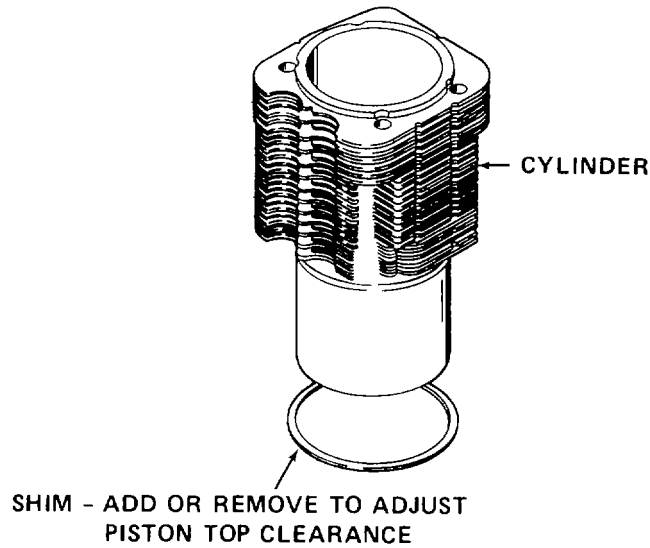
ADJUSTMENT

- 15. Cylinder shims
 - a. Piston top clearance may be increased or decreased by adding or removing shims. Shims are available in two thicknesses: 0.0079 inch (0.2 mm) or 0.0197 inch (0.5 mm).
 - b. If piston top clearance is below 0.0394 inch (1.0 mm), remove cylinder and add appropriate number of shims. Use thicker shims rather than thinner shims whenever possible.

6-8. CYLINDER HEAD ASSEMBLY, ROCKER ARMS, AND TAPPETS (CONT)

Location/Item	Action	Remarks
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- c. If piston top clearance is greater than 0.0472 inch (1.2 mm), lift cylinder up and remove appropriate number of shims with side-cutting pliers.



ASSEMBLY/INSTALLATION

- 16. Cylinder head assembly, rocker arms, and tappets
Refer to paragraphs 5-20 and 5-21.

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS

- This task covers:
- | | |
|------------------------|-------------------------------|
| a. Cleaning/Inspection | d. Installation/Replacement |
| b. Removal | e. Cleaning/Inspection/Repair |
| c. Repair | After Installation |
-

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0750

Tool kit, master mechanics
NSN 5180-00-699-5273
Calipers
Clamping plate No. 120910
Cylinder head clamping stand No. 120900
Depth gage
Holder No. 122304
Valve seat insert rings
Mallet or hammer

Micro feeler gage
Milling lathe

Valve guide mandrel, 8 mm, No. 123310

Valve guide reamer, 8 mm, No. 123510
Valve guide wire bristle brush
Valve seat ring cutter No. 122302

Valve seat ring mandrel No. 122450
Valve seat ring mandrel No. 123950/123960

Valve seat wire bristle brush

Materials/Parts

Exhaust valve
Exhaust valve seat
Inlet valve
Inlet valve seat
Snap ring
Valve guides

Crocus abrasive cloth (Item 1, Appendix E)
Diesel fuel oil (Item 5, Appendix E)

**Equipment
Condition**

Para	Condition Description
5-21	Valves removed from cylinder head assembly.

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

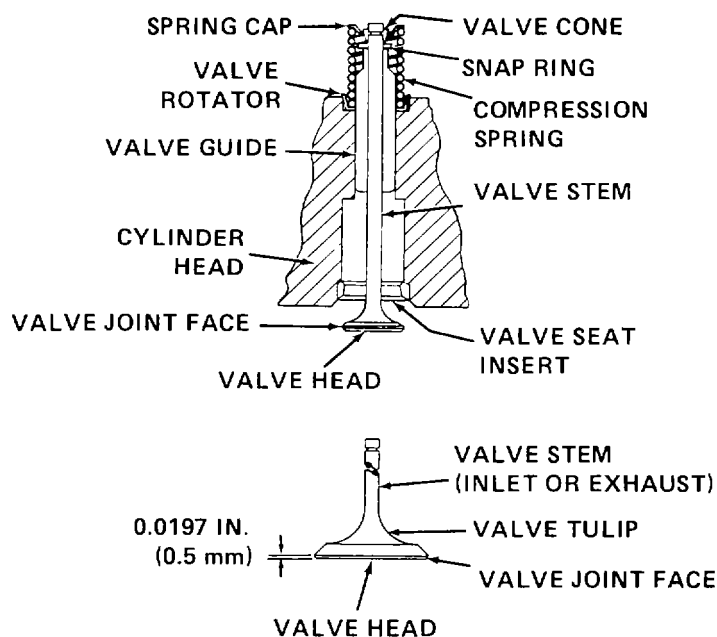
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

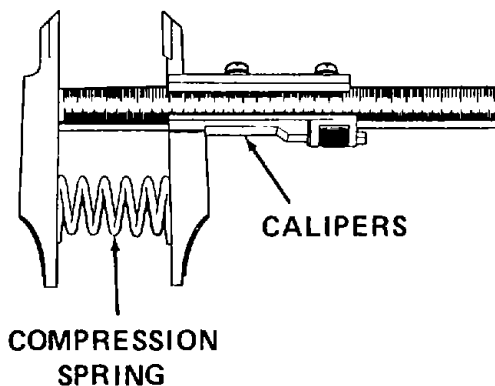
1. Valves, valve stems, valve rotator, compression spring, spring cap, and valve cone
 - a. Clean valves and components with VV-F-800 diesel fuel oil and dry with low pressure compressed air. Inspect for valve warpage, burning, or other damage. Inspect valve stems for scratches, scuff marks, or other damage. Inspect valve tulips, faces, and heads for pitting, ridges, or cracks. Check that valve joint face thickness is no less than 0.0197 inch (0.5 mm).



6-9. VALVES, VALVE GUIDES, AND VALVE SEAT (CONT)

Location/Item	Action	Remarks
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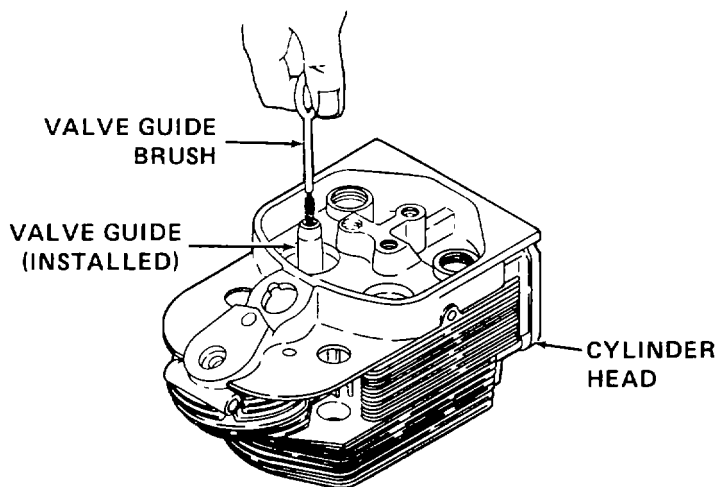
b. Inspect other components for pitting, fractures, excessive wear, or other damage. Inspect compression spring for proper length. Fatigued (unloaded) length shall be not less than 2.2047 inches (56 mm). Normal (replacement) length (unloaded) is 2.3228 inches (59 mm).



2. Valve guides

Use a guide brush to clean the inside of valve guides, and inspect the guides for fractures, excessive wear.

Valve guides and valve seat inserts can be inspected and cleaned without being removed from the cylinder head.



3. Valve guide/valve stem clearance

Measure with micro feeler gage. The valve stem/valve guide clearance limit is 0.0118 inch (0.3 mm). The exhaust valve stem/guide clearance limit is 0.0197 inch (0.5 mm). If the clearance is greater than the limit specified, replace valve guides.

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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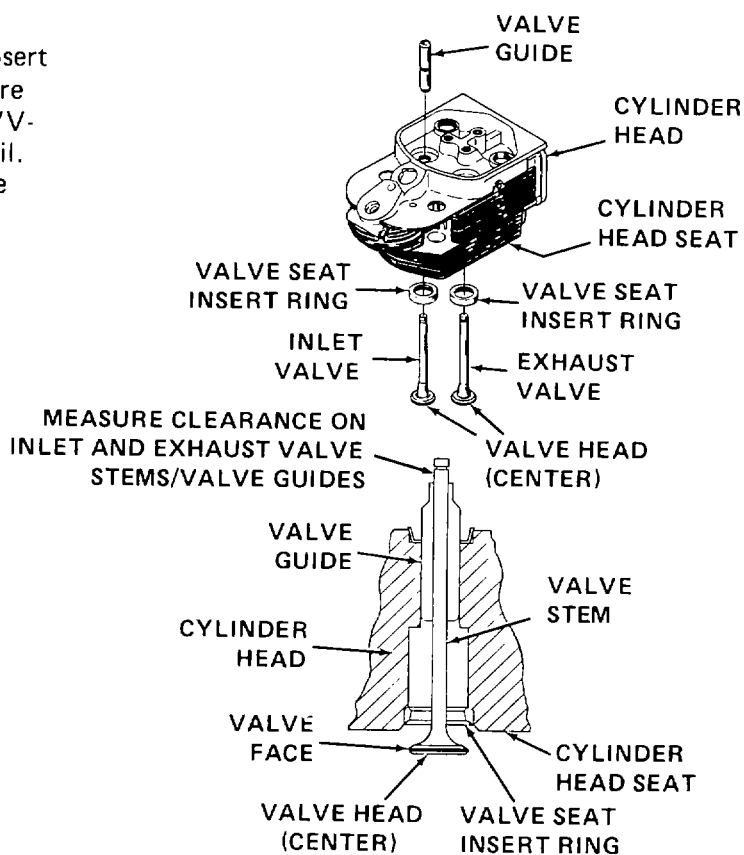
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Do not handle fuel near open flame, sparks, or excessive heat.
- Work in a well-ventilated area.

4. Valve seat insert rings

a. Clean valve seat insert rings with small wire bristle brush and VV-F-800 diesel fuel oil. Inspect and replace for excessive wear, pitting, cracking, or improper valve seat insert ring angle (greater or less than 45 degrees).



NOTE

Always use NEW valve in making valve seat insert ring measurements.

b. Measure distance between installed valve head center and cylinder head seat with depth gage. Distance should be between 0.2047 inch (5.2 mm) and 0.2323 inch (5.9 mm). If distance exceeds upper limit, replace valve seat insert ring.

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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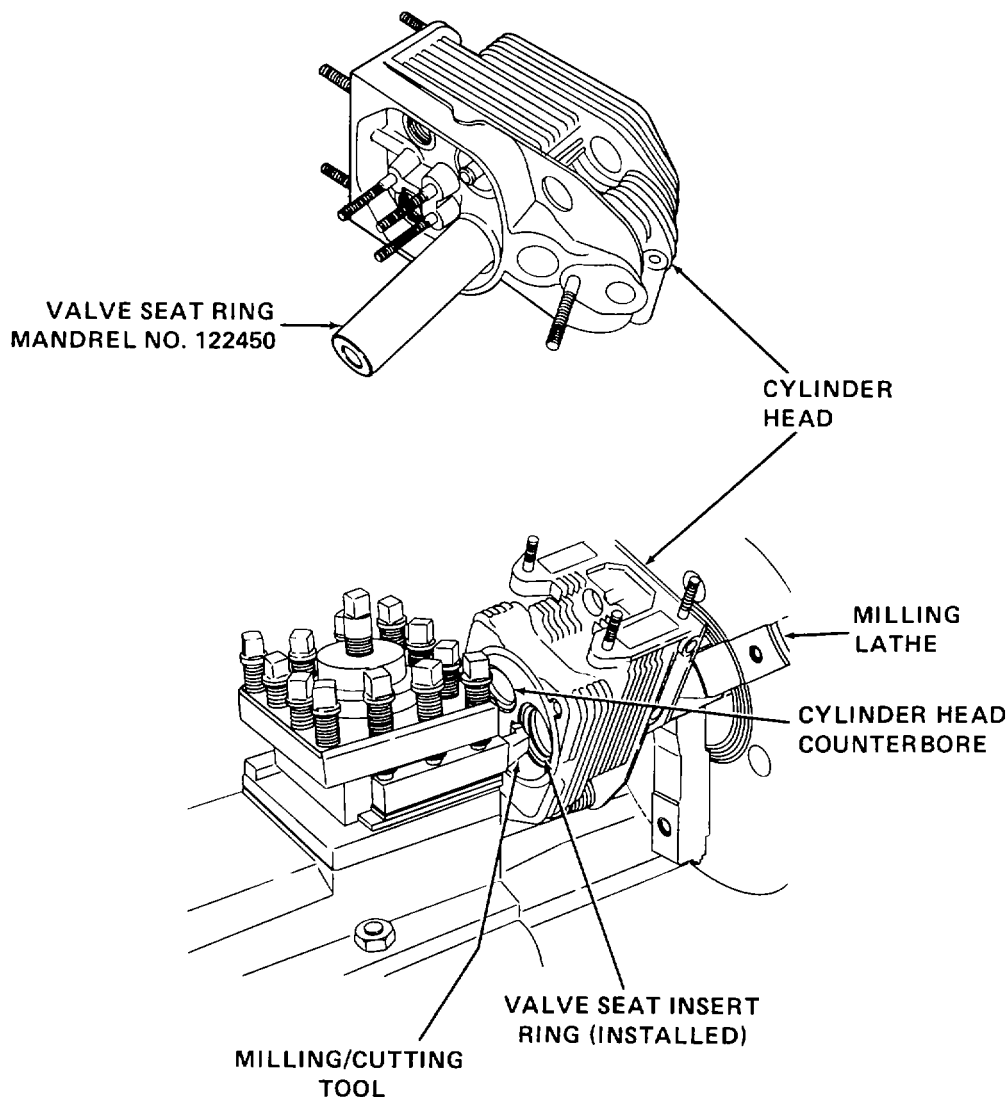
REMOVAL

CAUTION

Do not damage cylinder head.

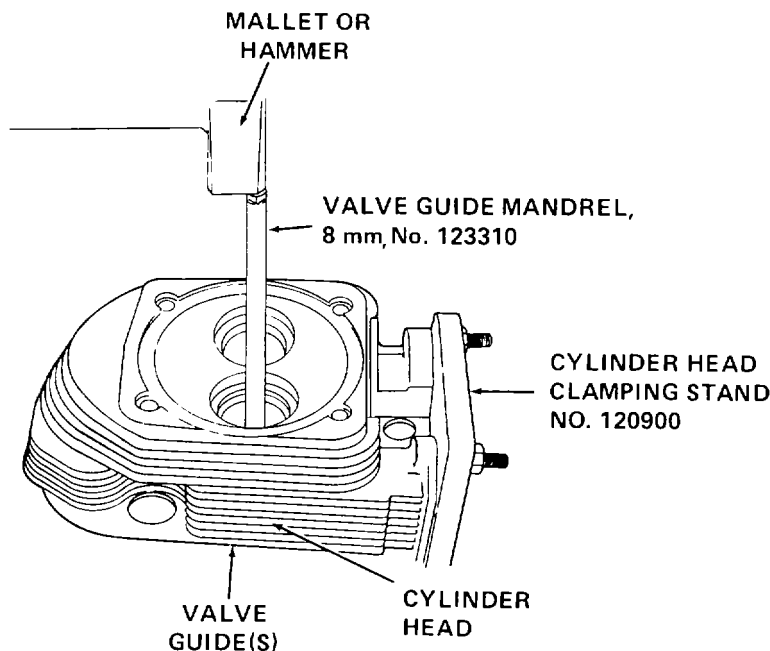
5. Valve seat insert rings

Insert valve seat ring mandrel No. 122450 into cylinder head. Clamp down valve seat ring mandrel and cylinder head into milling lathe and bore out valve seat ring inserts. Take care not to bore into cylinder head counterbore.



6-9. VALVE, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
6. Cylinder head 7. Valve guides	Heat cylinder head to 428°F (220°C) in furnace. Press out old guides with valve guide mandrel, 8 mm, No. 123310.	



REPAIR

- 8. Valves
Replace any valves that show head warping, burning, or other damage. Replace valves that have seriously scratched or scuffed stems; or pitted, ridged, or cracked tulips, faces, or heads. Replace valves that have a valve joint face thickness less than 0.0197 inch (0.5 mm) for inlet or exhaust valve. Remove slight scratches or scuff marks with P-C-458 crocus cloth.
- 9. Compression springs, valve cones, caps, valve rotators, and snap rings
Replace compression springs that are pitted, fractured, excessively worn, or damaged. Replace any compression spring that has an unloaded fatigue length of less than 2.2047 inches (56 mm). Replace both compression springs if necessary. Replace valve cones, caps, and rotators that are fractured, excessively worn, or damaged. Replace snap rings.

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

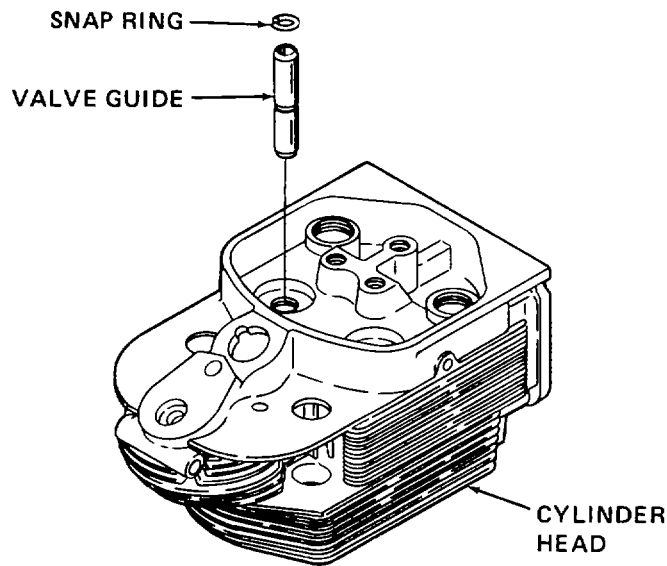
Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

NOTE

If both valve seat inserts and valve guides need to be replaced, inserts should be replaced at the same time as the guides as long as the head is heated to 428°F (220°C). Follow procedure described below.

- | | |
|----------------------------------|---|
| 10. Valve guides with snap rings | Install new valve guides with snap rings installed. Lightly press into heated cylinder heads with chamfered ends toward top of cylinder head. |
|----------------------------------|---|



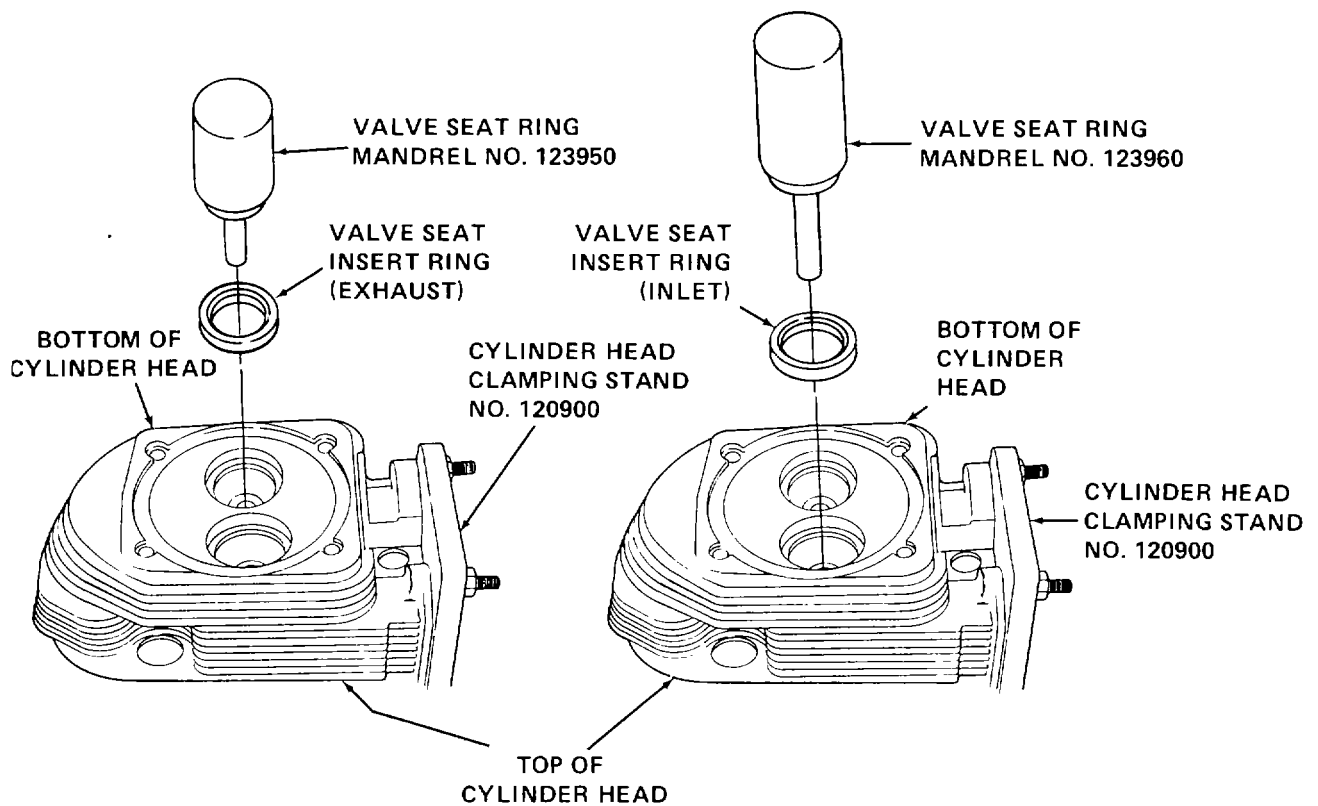
6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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NOTE

Valve seat insert rings are inserted and seated from bottom of cylinder head which has been heated to 428°F (220°C).

- | | | |
|-----------------------------|--|--|
| 11. Valve seat insert rings | Insert and evenly seat new valve seat insert rings with valve seat ring mandrel No. 123950/123960. | |
|-----------------------------|--|--|



NOTE

When installing oversized valve seat insert rings, make sure to enlarge counterbore in cylinder head with precision borer in accordance with dimensions given below.

- | | | |
|---------------------------------------|---|--|
| 12. Oversized valve seat insert rings | If required for replacement, valve seat insert rings are available in nominal size and three oversizes: | |
|---------------------------------------|---|--|

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
VALVE SEAT INSERT RING	OUTSIDE DIAMETER OF INLET VALVE SEAT INSERT RING inches (millimeters)	OUTSIDE DIAMETER OF EXHAUST VALVE SEAT INSERT RING inches (millimeters)
Nominal	1.7968 to 1.7976 (45.64 to 45.66)	1.5803 to 1.5811 (40.14 to 40.16)
First oversize	1.8008 to 1.8016 (45.74 to 45.76)	1.5843 to 1.5850 (40.24 to 40.26)
Second oversize	1.8047 to 1.8055 (45.84 to 45.86)	1.5882 to 1.5890 (40.34 to 40.36)
Third oversize	1.8087 to 1.8094 (45.94 to 45.96)	1.5921 to 1.5929 (40.44 to 40.46)

CLEANING/INSPECTION/REPAIR AFTER INSTALLATION
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

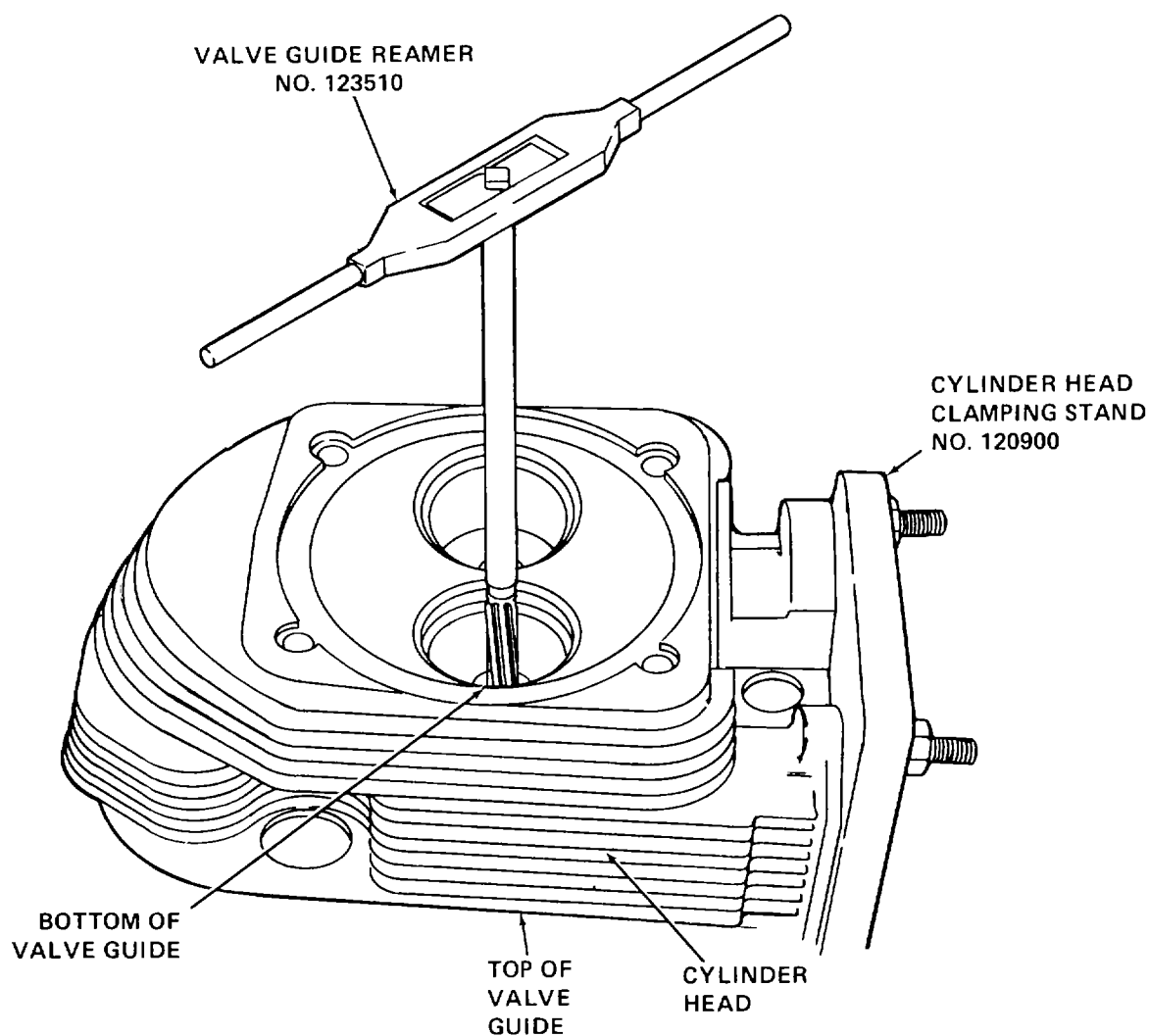
- * Do not inhale vapor.
- * Work in a well-ventilated area.
- * Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

13. Cylinder head Allow head to cool to room temperature, 75°F (23.8°C).

6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

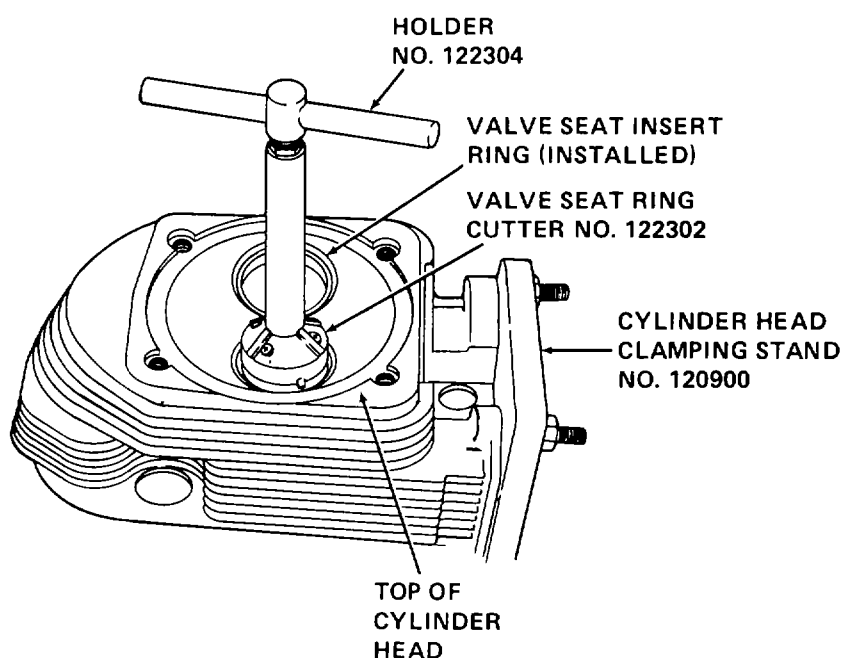
Location/Item	Action	Remarks
14. Valve guides	Clean with valve guide brush and VV-F-800 diesel fuel oil. Dry with compressed air.	
15. Valve seats	Clean with VV-F-800 diesel fuel oil and dry with compressed air.	
16. Valve guides	Inspect and ream with valve guide reamer No. 123510.	



6-9. VALVES, VALVE GUIDES, AND VALVE SEATS (CONT)

Location/Item	Action	Remarks
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17. Valve seat insert rings	<p>a. Inspect for nicks, burrs, or other minor damage to valve mating surfaces of installed valve seat insert rings. Very carefully smooth out any nicks, burrs, or other minor damage with valve seat ring cutter No. 122302 using holder No. 122304.</p>	
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b. Check valve head/cylinder head seat clearance with NEW valve in accordance with procedure in step 4.

Maximum clearance is 0.2323 inch (5.9 mm).

Minimum clearance is 0.2047 inch (5.2 mm).

If maximum clearance is exceeded, replace valve seat insert rings again. Follow procedure as described in step 11. If clearance is below minimum, remachine valve seat insert rings with valve seat ring cutter No. 122302 and holder No. 122304. Reconfirm that clearance falls within limits after remachining.

NOTE

If remachining will cause either limit to be exceeded, replace valve seat insert rings or valves, respectively.

6-10. TACHOMETER DRIVE (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

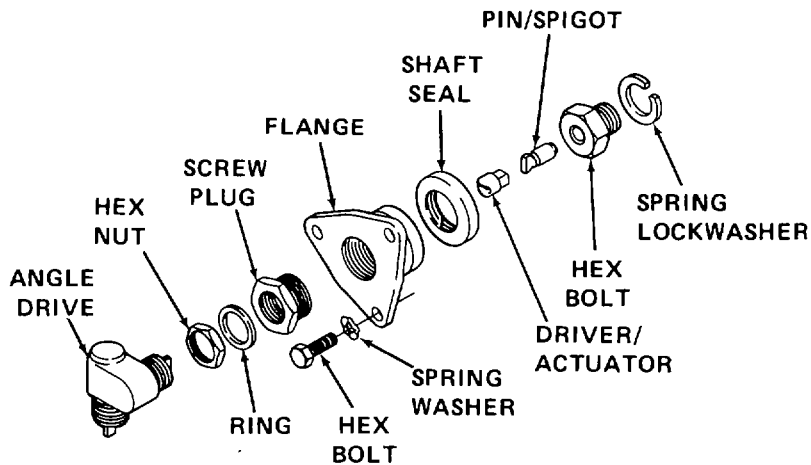
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- * Do not inhale vapor.
- * Work in a well-ventilated area.
- * Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

1. Tachometer drive mechanism components

Clean with VV-F-800 diesel fuel oil and dry with compressed air. Inspect only reusable or repairable components for damage, rust, or wear. Replace all other components.



6-10. TACHOMETER DRIVE (CONT)

Location/Item	Action	Remarks
REPAIR		
2. Angle drive and flange	Repair as necessary. Remove rust or corrosion with fine sandpaper. Clean, treat, and refinish according to MIL-T-704. If angle drive is sticking or frozen, soak in VV-F-800 diesel fuel oil and work free. Dry with compressed air. Lubricate with MIL-L-2104 lubricating oil.	
3. Tachometer drive threaded components	Replace any component with stripped or damaged threads.	

6-11. LUBE OIL PUMP

- This task covers:
- a. Removal
 - b. Disassembly
 - d. Cleaning/Inspection
 - d. Repair
 - e. Assembly
 - f. Installation/Replacement

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Materials/Parts

Duplex ring
Lube oil pump
Materials required by MIL-T-704

Crocus abrasive cloth (Item 1, Appendix E)
Diesel fuel oil (Item 5, Appendix E)

Troubleshooting References (Table 6-1)

Malfunction 4, steps 1, 2, and 3

Equipment Condition

Para	Condition Description
6-7	Front cover removed from engine.
5-22	Bottom cover removed from engine.

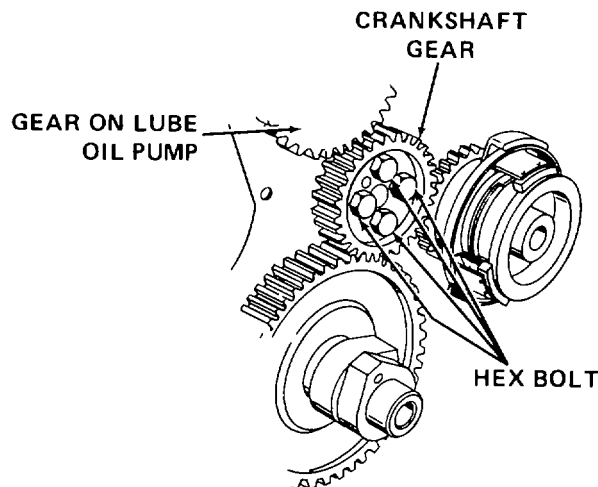
Special Environmental Conditions

Well-ventilated area required during cleaning.

Location/Item	Action	Remarks
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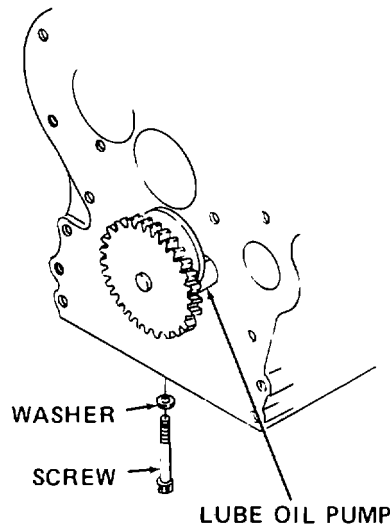
REMOVAL

1. Crankshaft Remove hex bolts and crankshaft gear.
gear



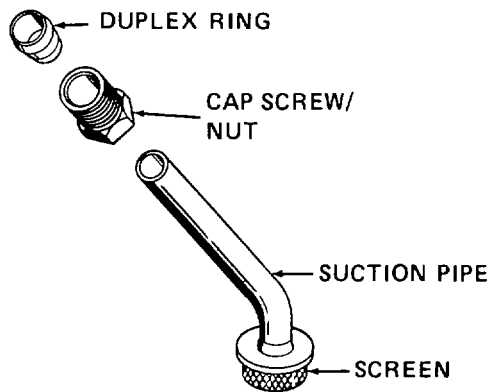
6-11. LUBE OIL PUMP (CONT)

Location/Item	Action	Remarks
2. Lube oil	a. Remove screw and washer. pump b. Twist pump and remove complete with the suction pipe.	



DISASSEMBLY

3. Suction pipe Remove cap screw/nut, suction pipe, and duplex ring. Discard duplex ring.



6-11. LUBE OIL PUMP (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|-----------------------------|--|--|
| 4. Lube oil pump | Clean with VV-F-800 diesel fuel oil. Dry with compressed air and/or soft clean cloth. Inspect components for excessive wear, rust, damage, and/or warpage. Replace if worn or damaged. | |
| 5. Suction pipe with screen | a. Inspect for clogs or holes in screen. Replace suction pipe if necessary.

b. Inspect cap screw/nut for stripped or worn threads. Replace if stripped or worn. | |

REPAIR

- | | | |
|--------------------------------------|---|--|
| 6. Lube oil pump interior components | Do not attempt repairs on interior of lube oil pump. Replace lube oil pump and send replaced pump to depot maintenance for repair. | |
| 7. Lube oil pump outer gear | a. Remove any rust or corrosion. Clean and treat in accordance with MIL-T-704 if necessary.

b. Repair only minor nicks or burrs with P-C-458 crocus cloth. If gear is severely damaged, replace lube oil pump.

c. Replace any stripped or damaged hardware. | |

6-11. LUBE OIL PUMP (CONT)

Location/Item	Action	Remarks
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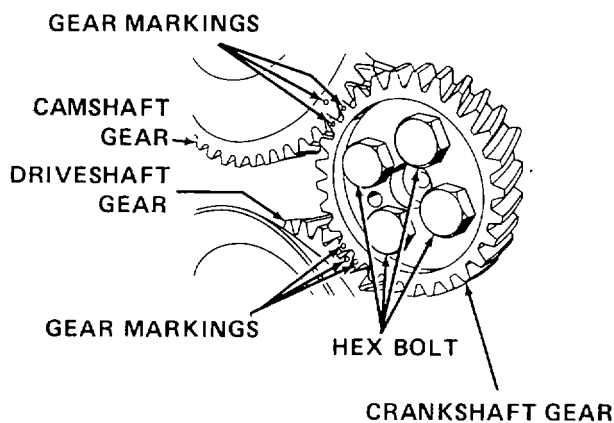
ASSEMBLY

8. Suction pipe	Assemble duplex ring, cap screw/nut, and suction pipe on lube oil pump.	
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**INSTALLATION/
REPLACEMENT**

9. Lube oil pump	Install lube oil pump, screw, and washer. Tighten screw securely.	
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10. Crankshaft gear	Make sure gear markings line up and install gear on crankshaft. Install hex bolts and tighten alternately and evenly across gear with socket wrench to 22.13 ft lb (30 N.m) torque. Using angular torque gage, tighten bolts two additional 30 degree increments.	
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6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY

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

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Gear puller No.141000
Main bearing mandrel No. 143700 with (camshaft) bearing mandrel No. 143620

Main bearing shaft seal guide No. 142510
Main bearing shaft seal press No. 142530 assembly removed from engine.

Materials/Parts

Adapter

Bearing plate assembly
Gaskets
Spring lockwasher

Crocus abrasive cloth (Item 1, Appendix E)
Diesel fuel oil (Item 5, Appendix E)

Grease (Item 6, Appendix E)
Lubricating oil (Item 9, Appendix E)
Materials required by MIL-T-704

References

MIL-T-704 Treatment and Painting of Materiel

Equipment Condition

Para	Condition Description
5-4	Pump and bearing housing
5-12	Flywheel assembly removed from engine.
5-22	Bottom cover removed.

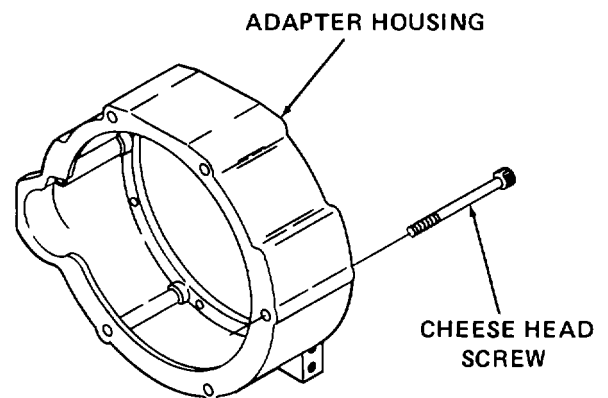
Special Environmental Conditions

Well-ventilated area required for cleaning.

Location/Item	Action	Remarks
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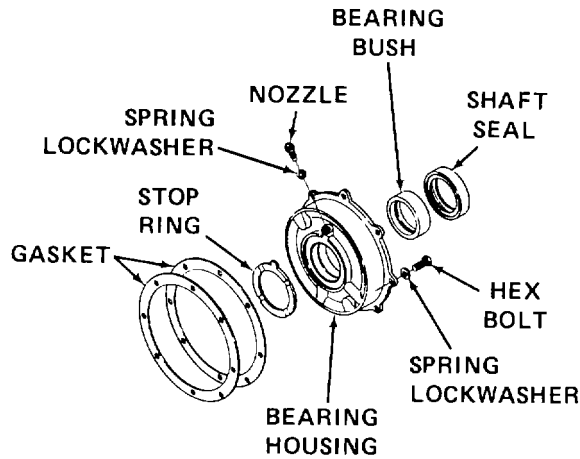
REMOVAL

1. Adapter housing
 - a. Remove cheese head screws.
 - b. Remove adapter housing from engine.

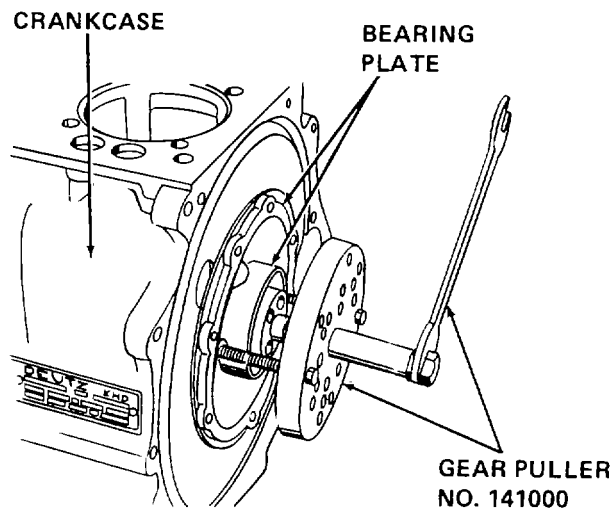


6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Bearing	a. Remove shaft seal. housing b. Remove hex bolts and spring lockwashers from bearing housing and crankcase.	



3. Bearing plate assembly	Remove from crankcase using gear puller No. 141000.	
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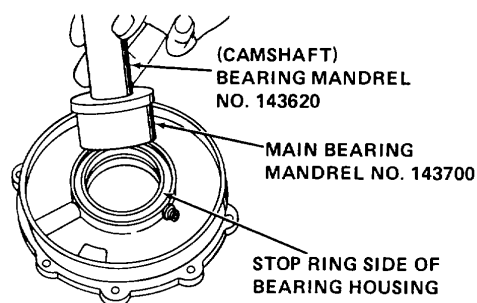


6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
4. Stop ring	Remove stop ring from crankcase and bearing housing.	
5. Gaskets	Remove and discard.	

DISASSEMBLY

6. Nozzle	Remove nozzle and spring lockwasher from bearing housing. Discard lockwasher.
7. Bearing bush	Press out bush from bearing housing using main bearing mandrel No. 143700 with (camshaft) bearing mandrel No. 143620.



CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

8. Adapter housing and bearing plate assembly	Clean components with VV-F-800 diesel fuel oil. Dry with compressed air.
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6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
9. Adapter housing and mounting hardware housing.	Inspect adapter housing for cracks, rust, corrosion, warpage, or other damage. Inspect for stripped mounting hardware and excessively worn mounting holes in adapter housing.	
10. Bearing plate assembly	Inspect for cracks, warpage, excessive wear, rust, corrosion, or other damage.	
11. Bearing housing main bearing bore	Measure. Bore should measure 2.7165 to 2.7173 inches (69.0 to 69.019 mm). If bearing housing main bearing bore is outside these limits or is worn out of round, replace bearing housing.	
12. Stop ring	Inspect for cracks, warpage, excessive wear, rust, corrosion, or other damage. Measure stop ring thickness. It should measure 0.1176 inch (2.985 mm). If stop ring is damaged, rusted, or worn to less than specified thickness, replace stop ring.	
13. Nozzle	Inspect for rust, damage, or malfunction. Make sure nozzle has free oil flow. If nozzle is damaged or malfunctioning, replace it.	
14. Bearing bush	Inspect for damage or excessive wear. Measure inside diameter. Measurement should be 2.5216 to 2.5232 inches (64.05 to 64.089 mm). If measurement is outside tolerance limits, replace bearing bush with one of normal or undersized inside diameter, or a corresponding nominal or oversized wall thickness bearing bush listed below:	

6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
BEARING BUSH	NORMAL INSIDE DIAMETER AND UNDERSIZES inches (millimeters)	NOMINAL WALL THICKNESS AND OVERSIZES inches (millimeters)
Normal inside diameters and Nominal wall thickness	2.5216 to 2.5232 (64.05 to 64.089)	0.0974 to 0.0976 (2.475 to 2.480)
First undersize	2.5020 to 2.5035 (63.55 to 63.589)	0.1073 to 0.1075 (2.725 to 2.730)
Second undersize	2.4823 to 2.4838 (63.05 to 63.089)	0.1171 to 0.1173 (2.975 to 2.980)
Third undersize	2.4626 to 2.4641 (62.55 to 62.589)	0.1270 to 0.1272 (3.225 to 3.230)

15. Shaft seal Inspect for rust, damage, warpage, or excessive wear; replace if necessary.

REPAIR

16. Adapter housing Replace if cracked, worn, or damaged. Replace unit if minor hairline cracks are present. Do not attempt repairs by welding or brazing. If adapter housing is nicked or burned on mounting surfaces, grind smooth or smooth out with P-C-458 crocus cloth. Be careful not to remove any more material than is absolutely necessary. If adapter housing is rusted or corroded, remove rust or corrosion, reclean, treat, and refinish in accordance with MIL-T-704. Refinish only exterior surfaces.
17. Bearing housing a. Replace if cracked, worn, or damaged. Replace unit if minor hairline cracks are present. Do not attempt repairs by welding or brazing. If bearing housing is nicked or burred on mounting surfaces, grind smooth or smooth out with P-C-458 crocus cloth. Be careful not to remove any more material than is absolutely necessary. If

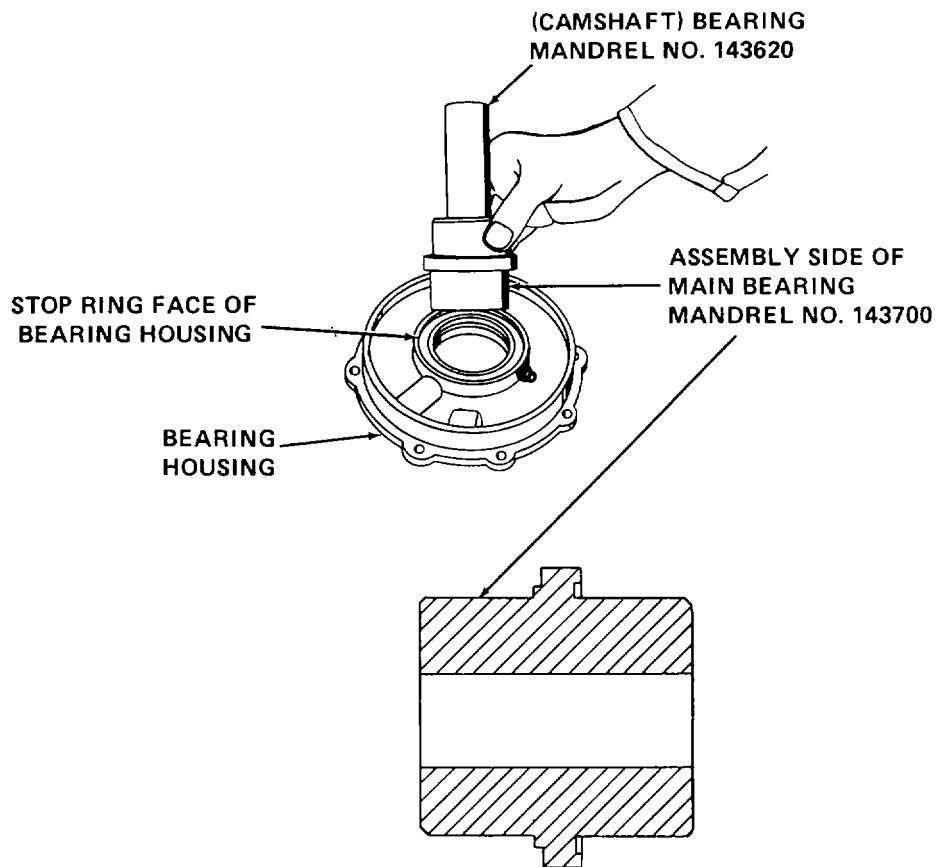
6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
	bearing housing is rusted or corroded, remove rust or corrosion, reclean, and treat surfaces in accordance with MIL-T-704. Do not finish surfaces with any paint-type materials.	
	b. Replace mounting hardware, stop ring, nozzle, washers, and bearing bush if damaged, worn, rusted, or corroded. Do not attempt repairs.	

ASSEMBLY

NOTE

When bearing bush is pressed into bearing housing, make sure that oil holes are alined properly.

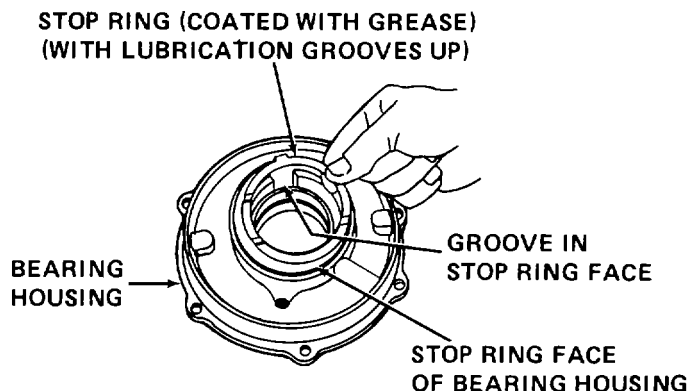


6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
18. Bearing bush and bearing housing	Press bearing bush into bearing housing from stop ring side. Press in 0.0551 to 0.0669 inch (1.4 to 1.7 mm) beyond stop ring face using main bearing mandrel No. 143700 with (camshaft) bearing mandrel No. 143620.	
19. Nozzle	Install with new spring lockwasher.	Install new spring lockwasher.

**INSTALLATION/
REPLACEMENT**

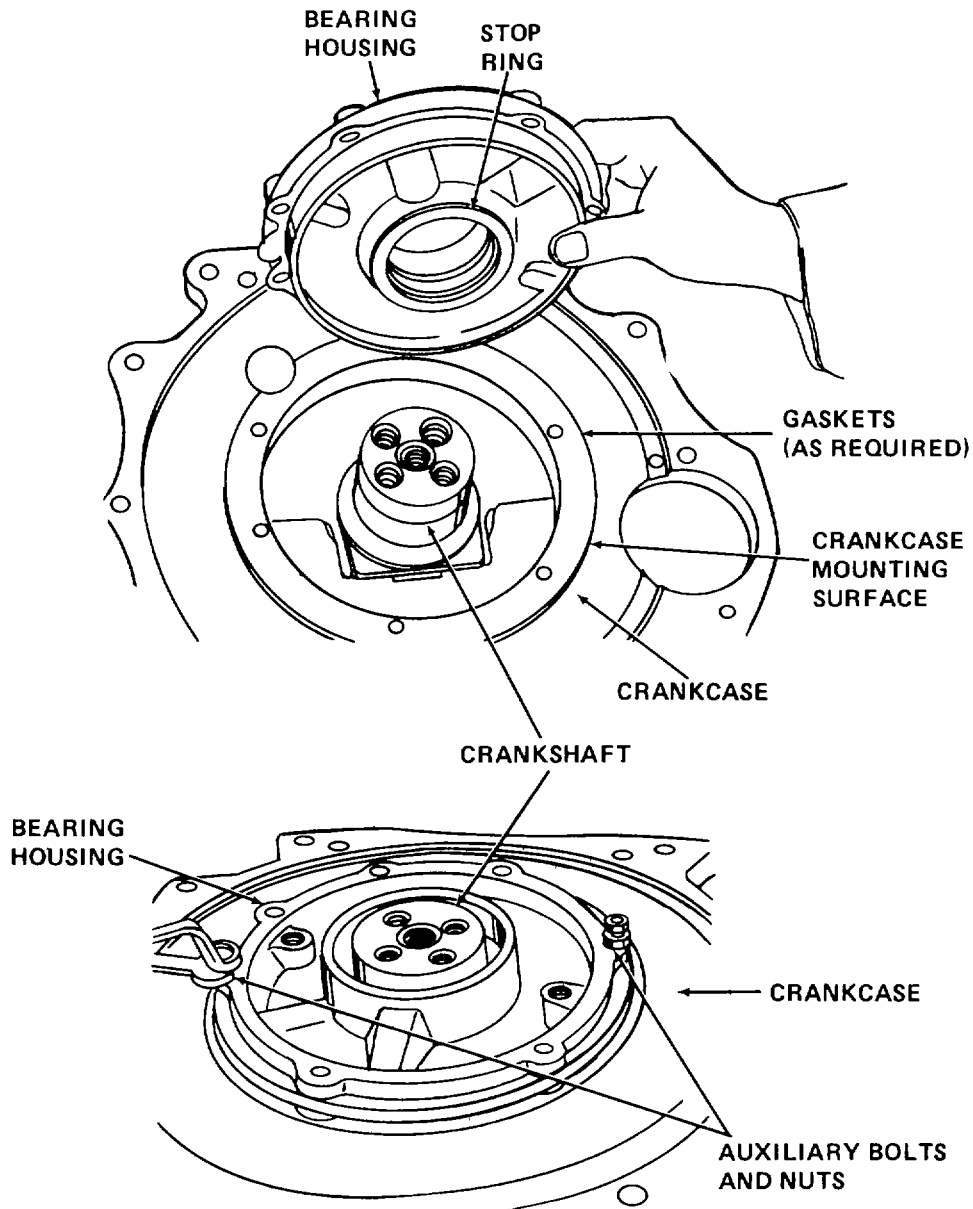
20. Stop ring	Coat stop ring with MIL-G-10924 grease and position on bearing housing so that stop ring lines up with groove on stop ring face of bearing housing. Make sure lubricating oil grooves face thrust shoulder of crankshaft.
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21. Gaskets	Install new gaskets on crankcase mounting surface. Gaskets are available in 0.0059 inch (0.15 mm) and 0.0197 inch (0.5 mm) thicknesses. Start by installing one 0.0197 inch (0.5 mm) gasket and two 0.0059 inch (0.15 mm) gaskets. After installation of bearing housing, gaskets may be added or removed to insure proper axial play or radial clearance of crankshaft and bearing housing.	Install new gaskets.
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6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
22. Bearing housing with stop ring attached	a. Position on crankcase and install auxiliary bolts and nuts temporarily. Tighten bearing housing onto crankcase with auxiliary bolts and nuts. Make sure stop ring does not fall out during installation.	



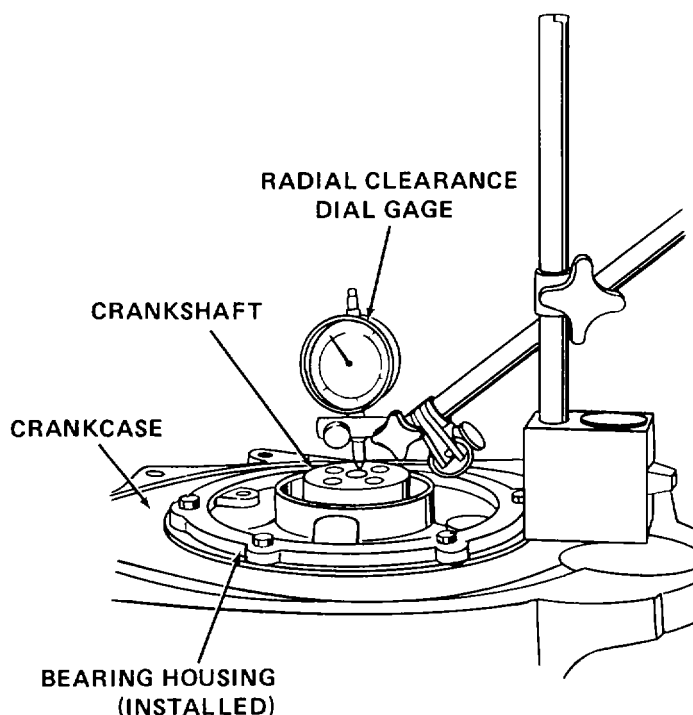
6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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b. Remove auxiliary nuts and bolts. Install hex bolts and spring lockwashers in bearing housing. Using a socket wrench, alternately and evenly tighten bolts across bearing housing to 22.13 ft lb (30 N.m) torque. Using an angular torque gage, tighten bolts an additional 60 degrees.

23. Bearing housing and crankshaft

Measure axial play or radial clearance between outside of bearing housing and crankshaft. Normal radial clearance ranges from 0.0024 to 0.0046 inch (0.06 to 0.118 mm). Maximum radial clearance limit is 0.0118 inch (0.30 mm). If axial play or radial clearance is not as specified, remove bearing housing and add or remove gaskets as required.



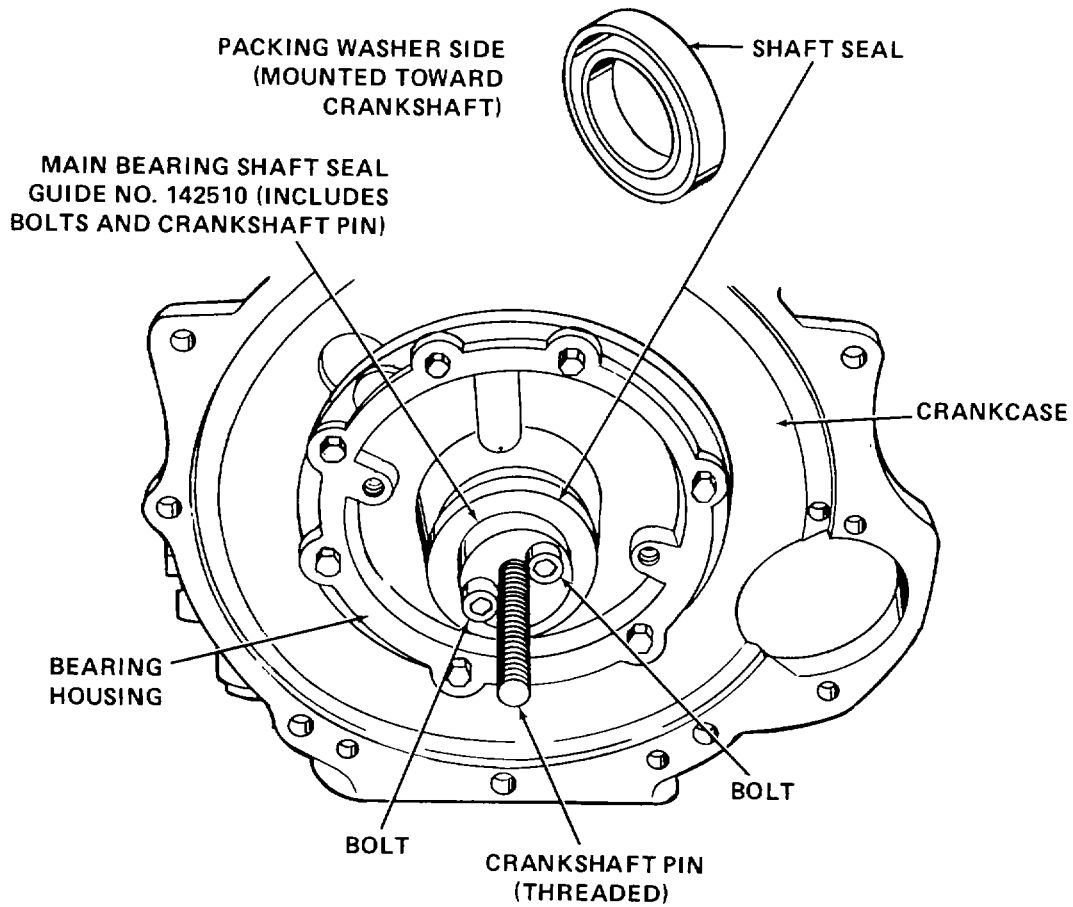
24. Main bearing shaft seal guide

Install main bearing shaft seal guide No. 142510 on crankshaft and tighten two bolts.

6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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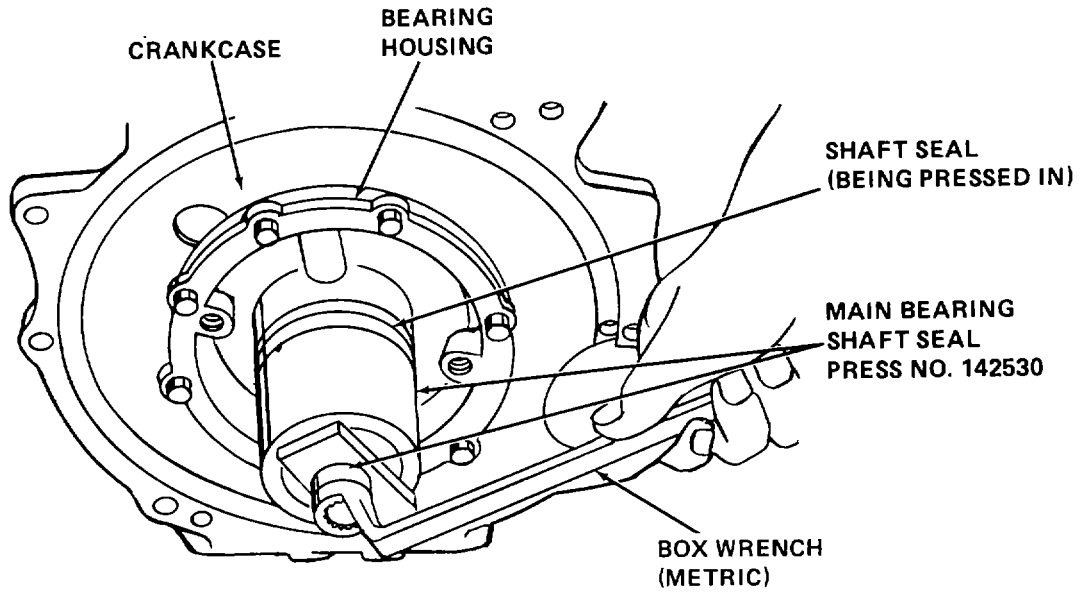
25. Shaft seal	Lubricate packing washer side of shaft seal with MIL-L-2104 lubricating oil, and install on main bearing shaft seal guide with packing washer side toward crankshaft.	
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6-12. ADAPTER HOUSING AND BEARING PLATE ASSEMBLY (CONT)

Location/Item	Action	Remarks
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26. Main bearing shaft seal press No. 142530	Mount on shaft seal guide and press shaft seal into bearing housing and crankshaft until seal is flush with bearing housing.	
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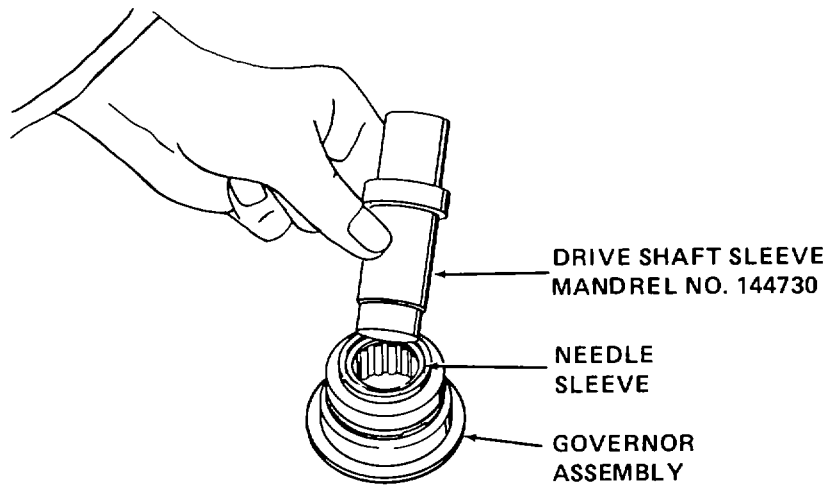
27. Adapter housing	Install adapter housing and screws.	
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6-13. GOVERNOR ASSEMBLY (CONT)

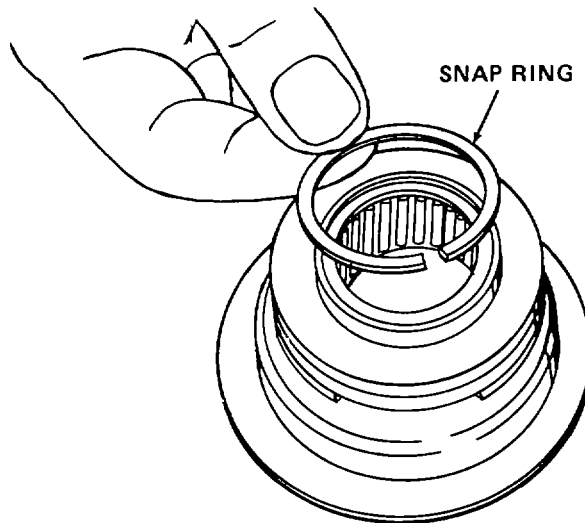
Location/Item	Action	Remarks
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DISASSEMBLY

- | | |
|------------------|--|
| 2. Needle sleeve | Press out needle sleeve with small end of drive shaft sleeve mandrel No. 144730. |
|------------------|--|



- | | |
|--------------|---------|
| 3. Snap ring | Remove. |
|--------------|---------|



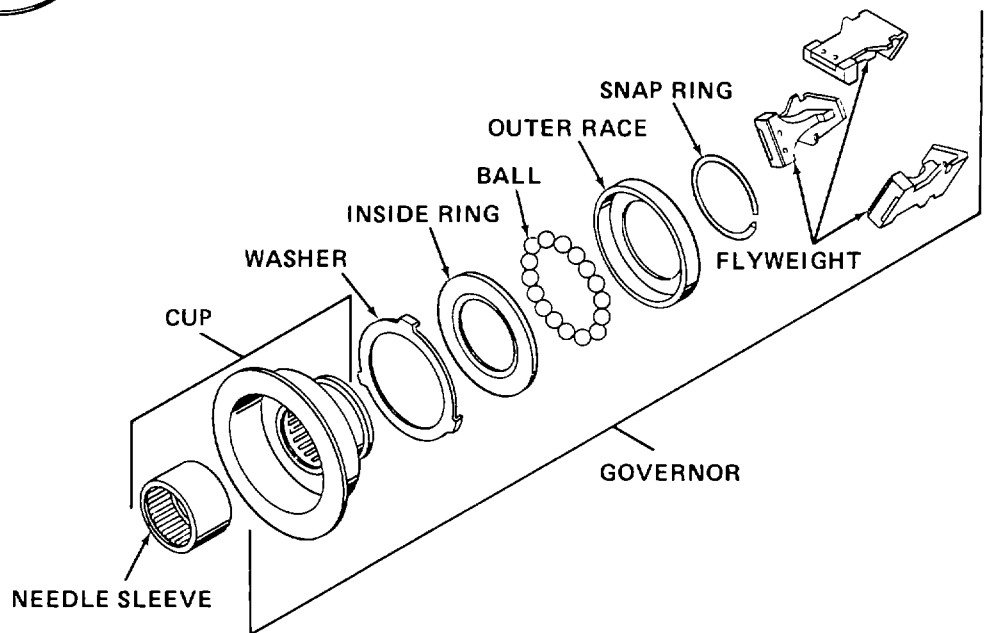
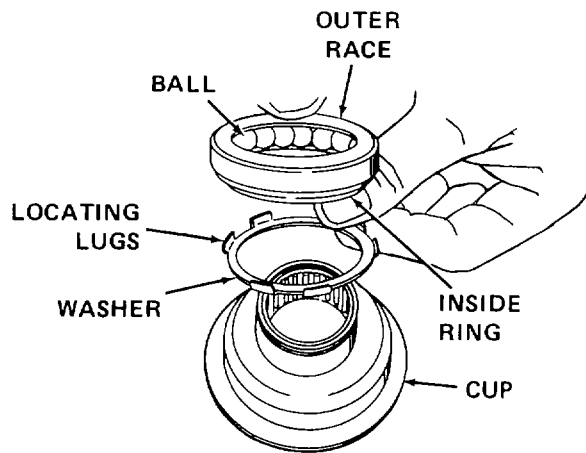
6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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NOTE

The inside ring, balls, and outer race when assembled make up the thrust bearing.

- | | |
|---------------------------------------|----------------------|
| 4. Inside ring, balls, and outer race | Remove and separate. |
| 5. Washers with locating lugs | Remove. |



6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CLEANING

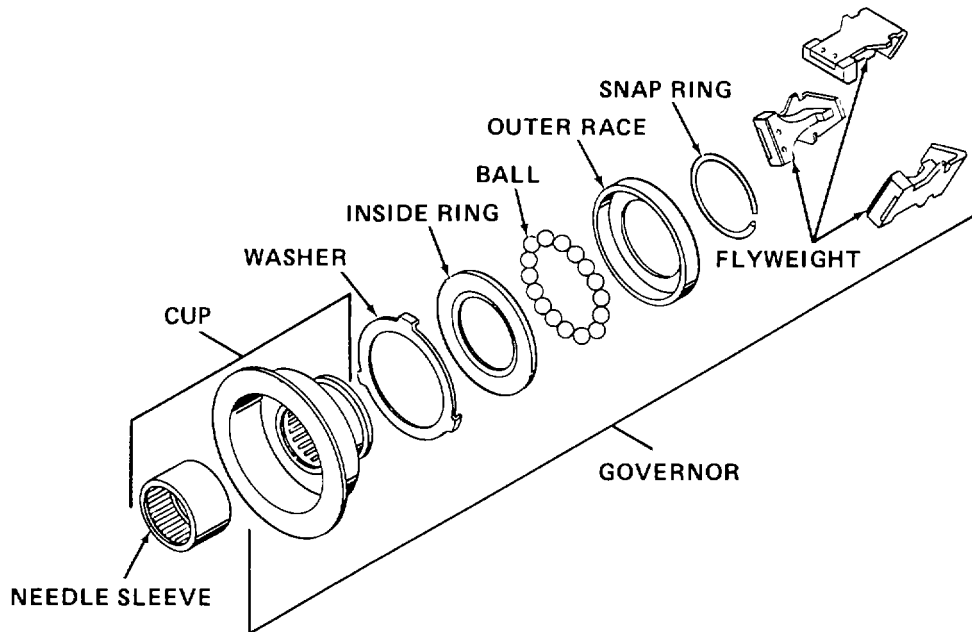
WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

6. All parts
 Clean with V V-F-800 diesel fuel oil and dry with low pressure compressed air.

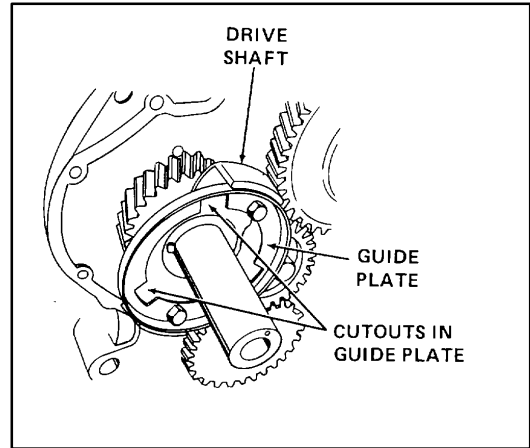


6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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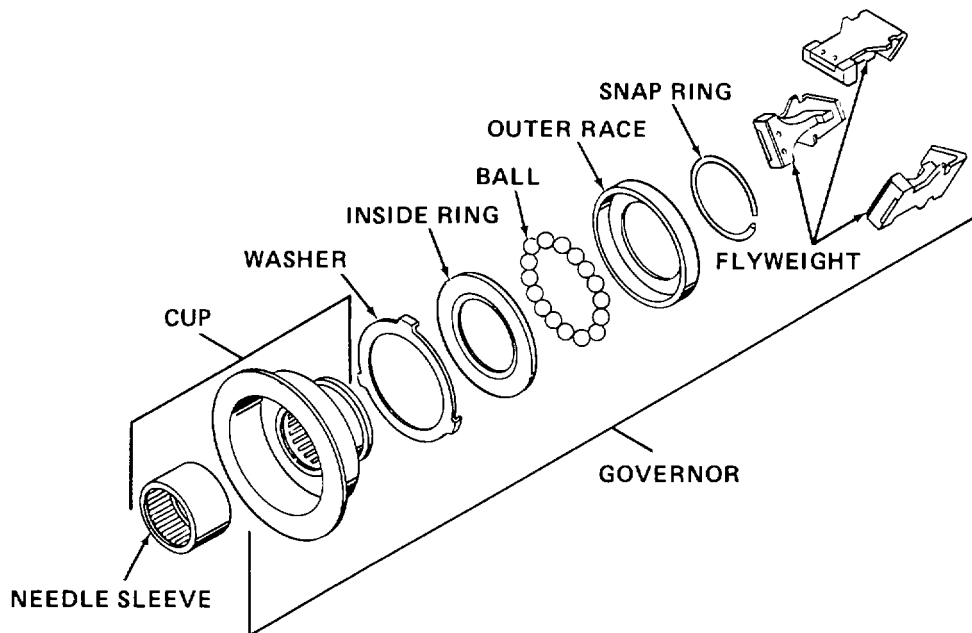
INSPECTION

7. Flyweights
 Inspect for damage, excessive wear, rust, or corrosion. Replace if necessary. Check that flyweights fit tightly when installed in cutouts in drive shaft guide plate. Replace flyweights if they do not fit tightly. Refer to paragraph 6-14 for replacement of guide plate if necessary.



8. Needle sleeve
 Inspect for damage or excessive wear. Replace if necessary.

9. Snap ring, washer, inside ring, balls, outer race, and cup
 Inspect and replace if damaged or excessively worn. Inspect the 19 balls that are part of the thrust bearing. Each ball should be 0.3150 inch (8.0 mm) diameter. Inspect each ball for wear or out-of-round condition. Replace any that are worn or out of round.

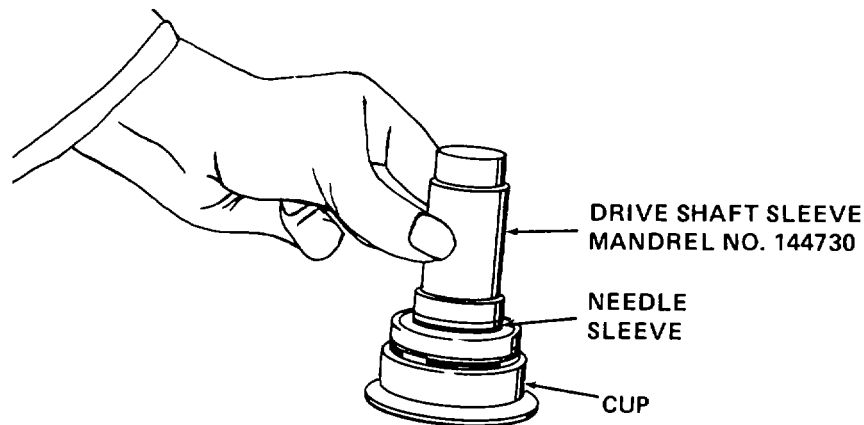


6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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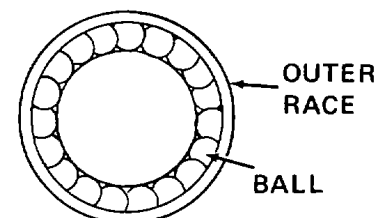
ASSEMBLY/REPLACEMENT

- | | | |
|-------------------|--|--|
| 10. Needle sleeve | Press into cup with larger end of drive shaft sleeve mandrel No. 144730. | |
|-------------------|--|--|



- | | | |
|----------------|-------------------------------|--|
| 11. Outer race | Fill with MIL-G-18709 grease. | |
|----------------|-------------------------------|--|

- | | | |
|-----------|---|--|
| 12. Balls | Install in outer race. Make sure that there are 19 balls installed. | |
|-----------|---|--|



- | | | |
|-----------------|---|--|
| 13. Inside ring | Complete thrust bearing assembly by installing inside ring. | |
|-----------------|---|--|

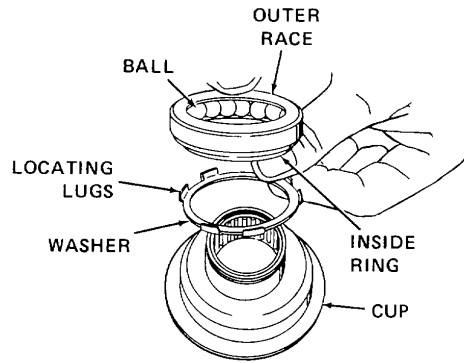
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|--------------------------------|---|--|
| 14. Washers with locating lugs | Install same number of washers as were removed. Make sure that locating lugs point toward thrust bearing. | |
|--------------------------------|---|--|

6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
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15. Outer race, balls, and inside ring

Install.



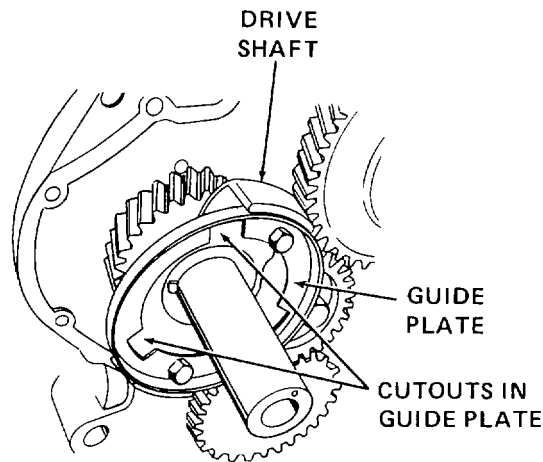
16. Snap ring

Install.

**INSTALLATION/
ADJUSTMENT**

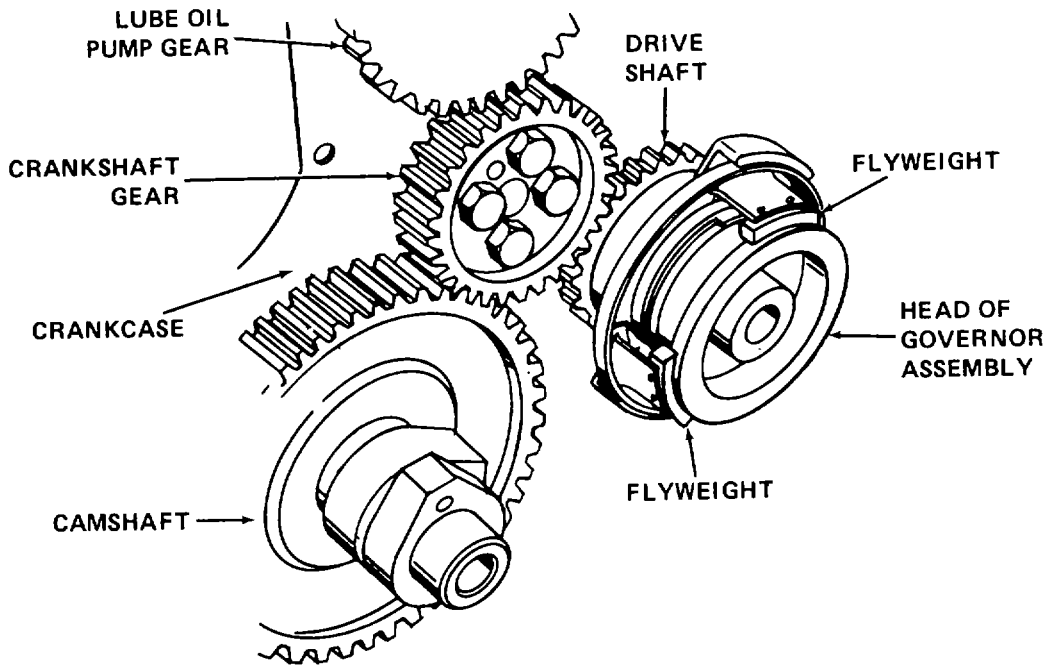
17. Flyweights

Install in drive shaft guide plate cutouts.



6-13. GOVERNOR ASSEMBLY (CONT)

Location/Item	Action	Remarks
18. Governor assembly	a. Install on drive shaft.	
	b. Measure distance from head of installed governor assembly to crankcase. The distance should be 3.3346 to 3.3740 inches (84.7 to 85.7 mm). If measurement is not as specified, remove governor assembly and add or remove washers as necessary. Reinstall governor assembly and recheck distance from head of governor assembly to crankcase.	



6-1 4. DRIVE SHAFT

- This task covers.
- | | |
|------------------------|-----------------------------|
| a. Removal | c. Repair |
| b. Cleaning/Inspection | d. Installation/Replacement |

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Grease (Item 7, Appendix E)

Lubricating oil (Item 9, Appendix E)

Sealant (Item 13, Appendix E)

Tool kit, master mechanics
NSN 5180-00-699-5273

**Equipment
Condition
Para**

Condition Description

Bearing puller

5-20

Cylinder head assembly removed
from engine.

Materials/Parts

Dowel sleeve

5-22

Bottom cover removed from engine.

Drive shaft assembly

6-7

Front cover removed.

Hex bolts

Crocus abrasive cloth (Item 1, Appendix E)

Special Environmental Conditions

Diesel fuel oil (Item 5, Appendix E)

Well-ventilated area required during cleaning.

6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
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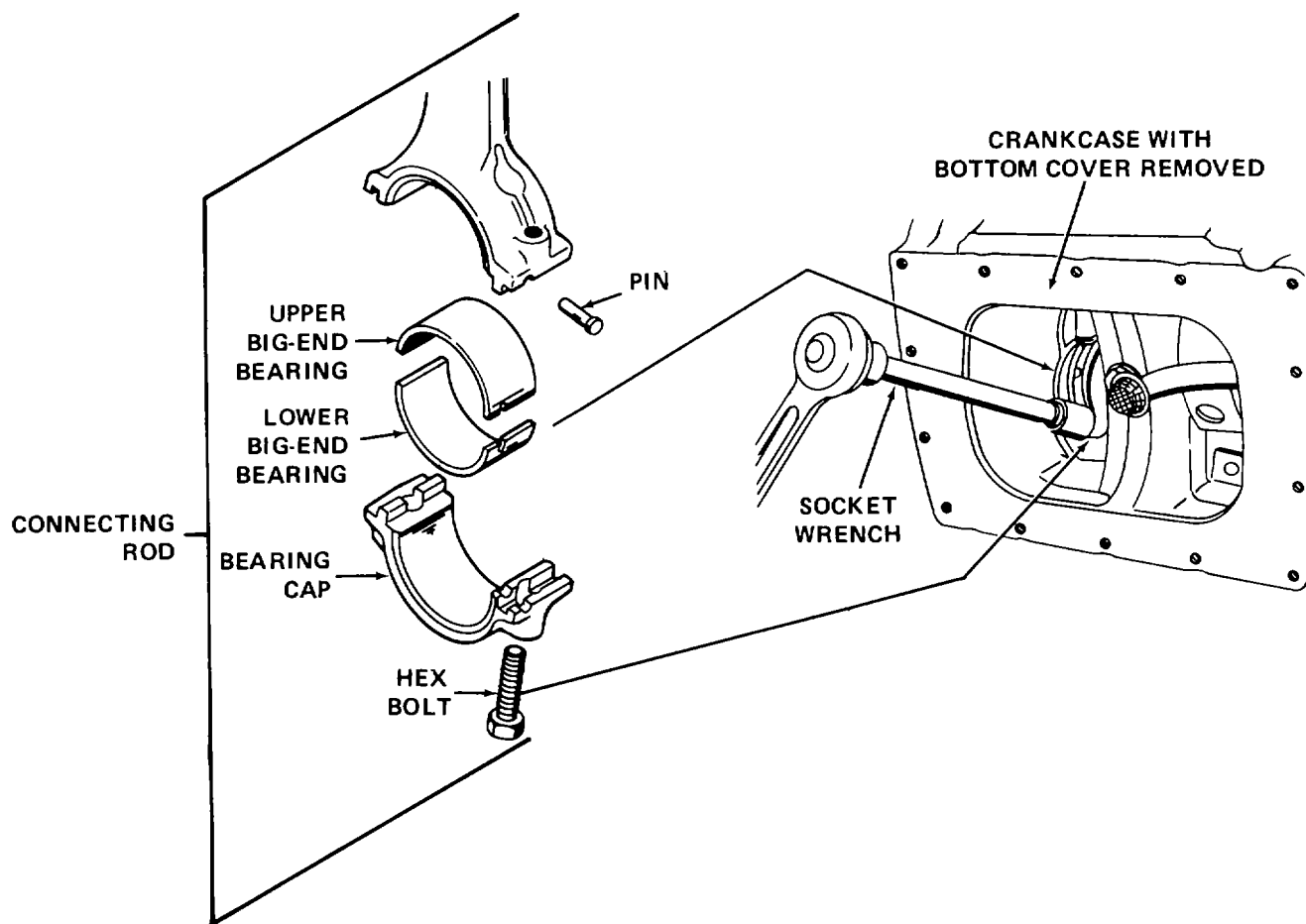
REMOVAL

- | | | |
|--------------------|---|--|
| 1. Connecting rods | Remove hex bolts and pins from connecting rods with socket wrench. Discard hex bolts. | |
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NOTE

Protect big-end bearings against damage during removal. After removal, mark each set so that bearings can be matched at assembly with corresponding connecting rods.

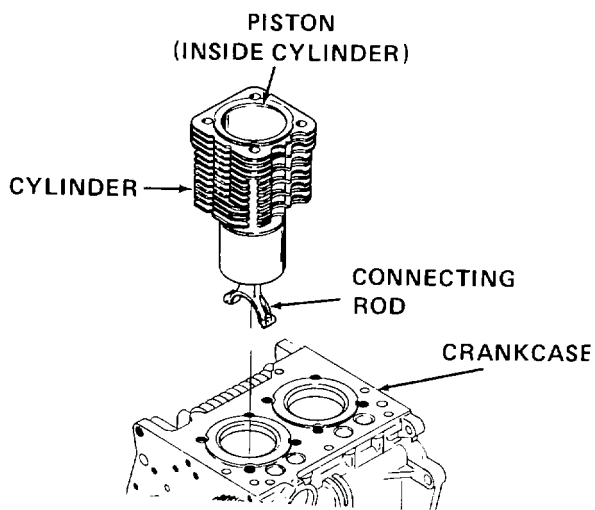
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| 2. Bearing cap and big-end bearings | Remove from connecting rods. Mark each with cylinder number. | |
|-------------------------------------|--|--|



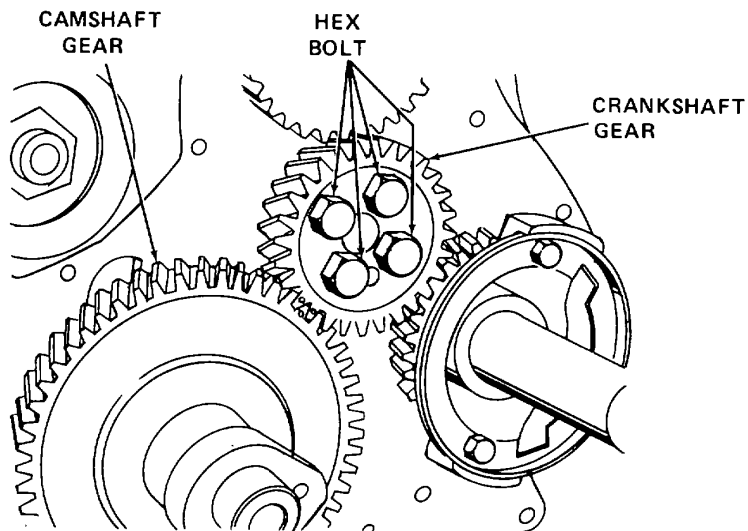
6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
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|---|---|--|
| 3. Cylinder, piston, and connecting rod | Remove cylinder with piston and connecting rod intact from crankcase. | |
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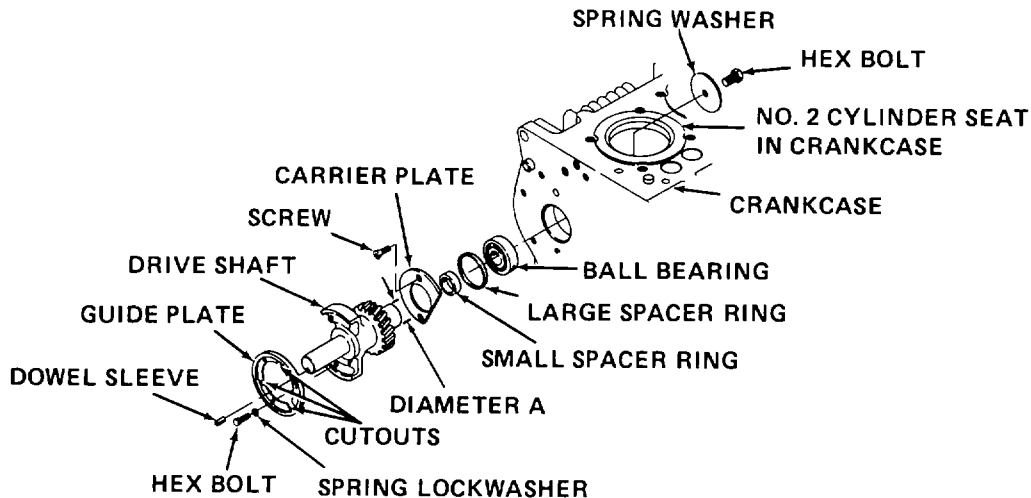
- | | | |
|--------------------|---------------------------------------|--|
| 4. Crankshaft gear | Remove hex bolts and crankshaft gear. | |
|--------------------|---------------------------------------|--|



6-14. DRIVE SHAFT (CONT)

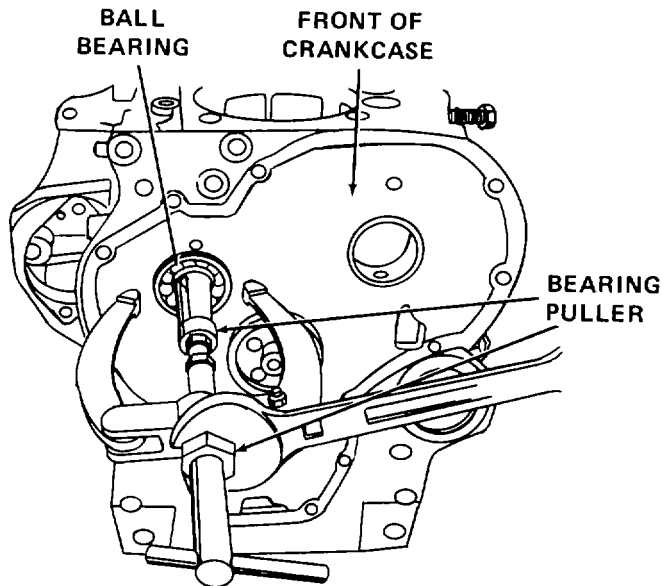
Location/Item	Action	Remarks
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5. Drive shaft a. Remove hex bolt and spring washer.



6. Carrier plate b. Remove drive shaft and small spacer ring.
Remove two screws and remove carrier plate and large spacer ring.

7. Ball bearing Use a conventional bearing puller to remove ball bearing.



6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

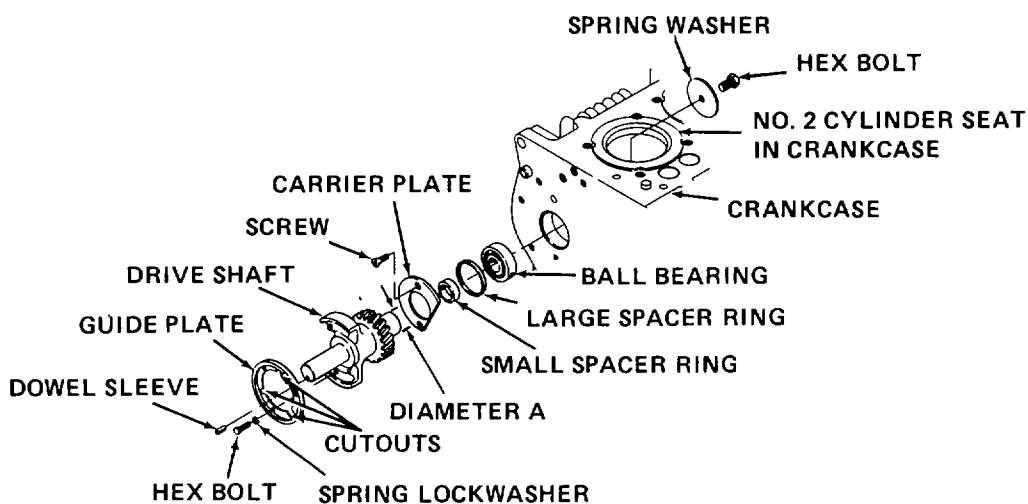
- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | |
|-------------------------------|--|
| 8. All drive shaft components | Clean with VV-F-800 diesel fuel oil and dry with low pressure compressed air. |
| 9. Drive shaft | <p>a. Inspect for excessive wear, damage, rust, corrosion, or stripped or broken gear teeth. Replace if necessary. Measure diameter A which should be 1.4550 to 1.4555 inches (36.955 to 36.971 mm). Replace drive shaft if diameter is smaller.</p> <p>b. Inspect hex bolt and spring washer for damage, rust, corrosion, or stripped threads. Replace if necessary.</p> <p>c. Inspect large and small spacer rings for damage, rust, corrosion, or excessive wear. Replace if necessary.</p> |
| 10. Ball bearing | Inspect for smooth operation, excessive wear, damage, rust, or corrosion. Replace if worn, damaged, rusted, or corroded. Measure ball bearing bore. Bore should be 1.4550 to 1.4555 inches (36.955 to 36.971 mm). If bore is larger than 1.4555 inches (36.971 mm), replace ball bearing. |

6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
11. Carrier plate	Inspect carrier plate and screws for damage, rust, corrosion, or stripped threads. Replace if necessary. Measure carrier plate bore. Bore should be 1.4550 to 1.4555 inches (36.955 to 36.971 mm). If bore is larger, replace carrier plate.	
12. Guide plate	<p>a. Inspect for excessive wear, damage, rust, or corrosion. Inspect cutouts for excessive wear. Replace if necessary.</p> <p>b. Inspect hex bolts and spring lockwashers for damage or wear. Replace if necessary.</p>	
13. Dowel sleeve	Replace.	



6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
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REPAIR

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

14. Ball bearing	Reclean thoroughly with VV-F-800 diesel fuel oil and dry with low pressure compressed air. Repack with MIL-G-18709 grease. Make sure ball bearing operates smoothly.	
15. Drive shaft	Repair only minor nicks, burrs, or scoring on gear teeth with P-C-458 crocus cloth. Chipped, bent, or broken gear teeth require replacement of drive shaft. Do not attempt major repairs on the drive shaft.	

6-14. DRIVE SHAFT (CONT)

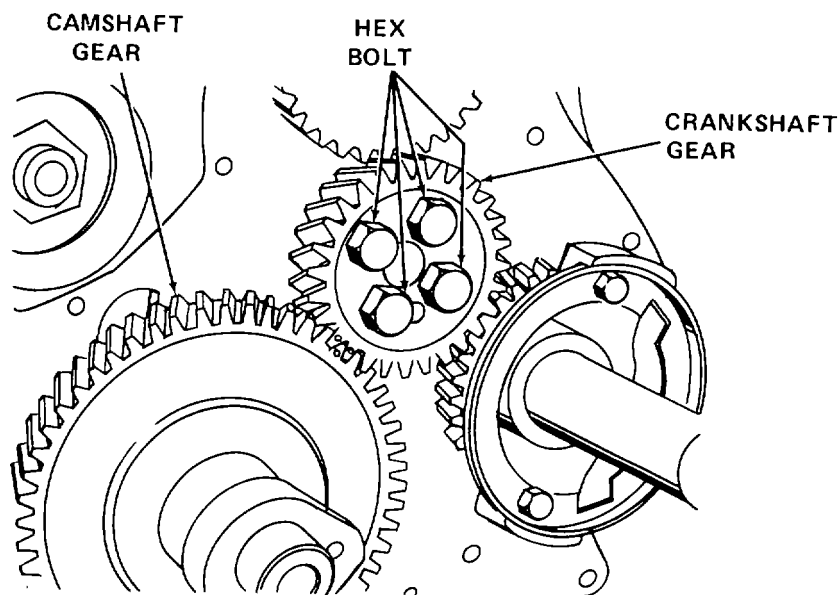
Location/Item	Action	Remarks
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INSTALLATION/REPLACEMENT

NOTE

Make sure markings on camshaft gear and crankshaft gear are alined.

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|---------------------|---|
| 16. Crankshaft gear | Install gear on crankshaft with hex bolts. Tighten bolts alternately and evenly to 22.13 ft lb (30 N.m) torque. Using torque gage, tighten bolts two additional 30 degree increments. |
|---------------------|---|



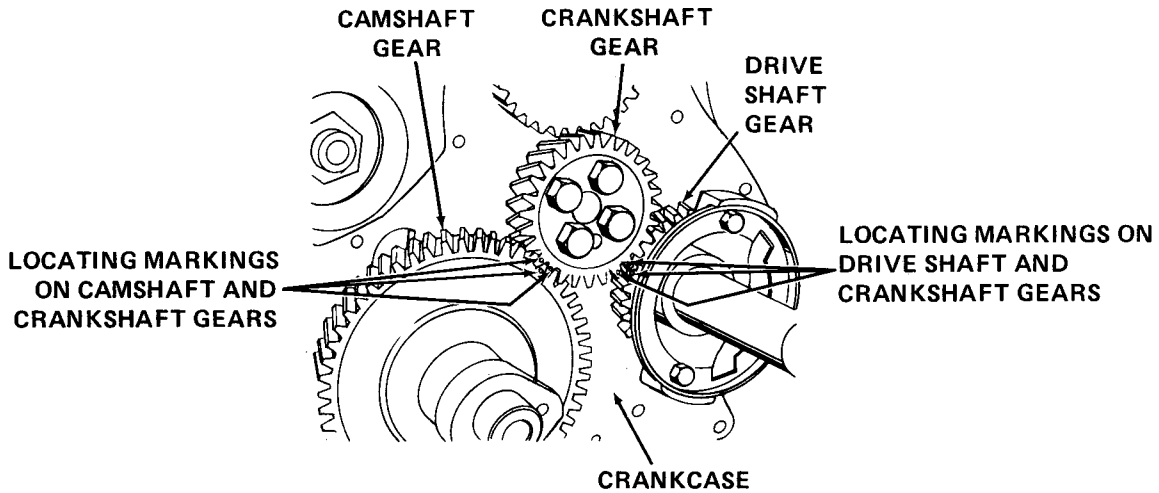
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|---|---|
| 17. Large spacer ring and carrier plate | Install with screws. Tighten screws securely. |
|---|---|

6-14. DRIVE SHAFT (CONT)

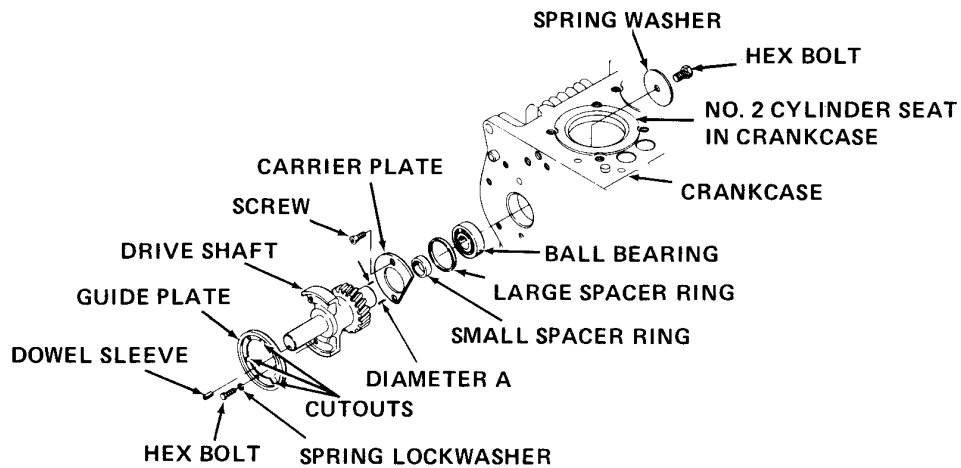
Location/Item	Action	Remarks
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NOTE

Make sure markings on the gears on camshaft, crankshaft, and drive shaft are alined.



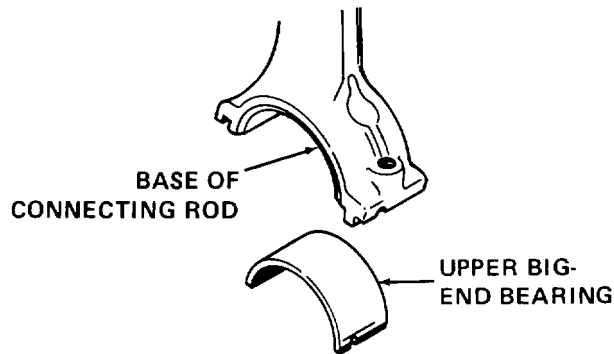
- a. Install with small spacer ring between gear and ball bearing.
- b. Secure drive shaft with hex bolt and spring washer. Tighten bolt securely. Seal and lock the bold with DEUTZ DW 60 sealant



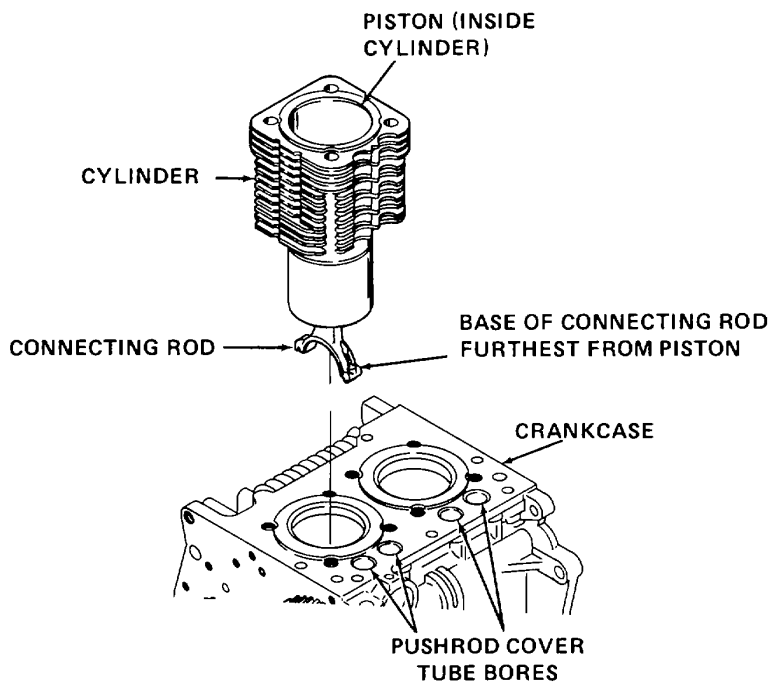
6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
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19. Big-end bearing	Insert upper big-end bearings into base of connecting rods, alining matchmarks made during removal. Lubricate upper big-end bearings with MIL-L-2104 lubricating oil.	
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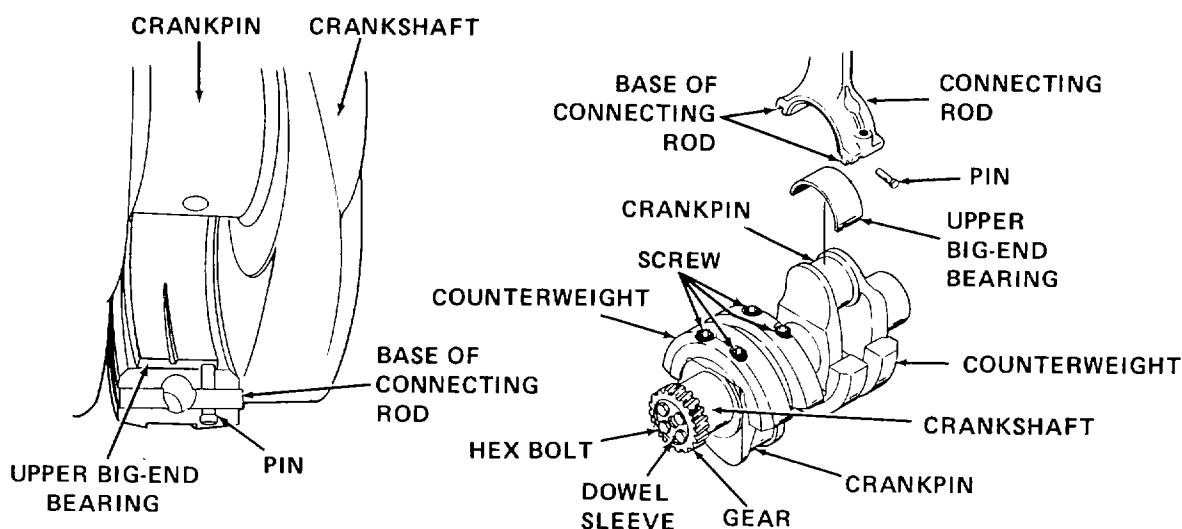


20. Cylinder, piston, and connecting rod	Install cylinder, piston, and connecting rod into crankcase as a unit. Insert carefully noting the correct cylinder markings. Install so that the part of the connecting rod base that extends furthest from the piston is pointing toward the pushrod cover tube bores in the crankcase.	
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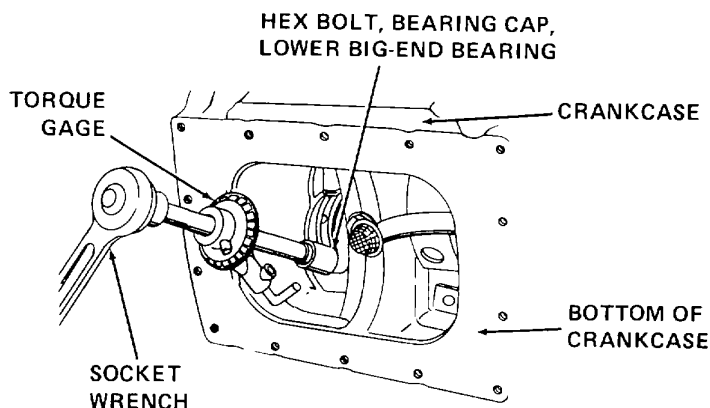


6-14. DRIVE SHAFT (CONT)

Location/Item	Action	Remarks
21. Connecting rod	Position base of connecting rod with upper big-end bearing installed onto crankpin on crankshaft.	
22. Bearing cap	a. Install with lower big-end bearing in place. Check matchmarks made during removal to make sure bearings are installed in same connecting rods from which they were removed.	



- b. Install pins.
- c. Make sure that hex bolts are new and the same type as were removed from connecting rods. Install and tighten alternately and evenly to 22.13 ft lb (30 N.m) torque with socket wrench. Using torque gage, tighten bolts three additional 30 degree increments.



6-15. CYLINDER

- This task covers.
- | | |
|------------------------|-----------------------------|
| a. Removal | d. Adjustment |
| b. Cleaning/Inspection | e. Installation/Replacement |
| c. Repair | |

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Bore gage

Hone with 120-grit stones

Piston ring compressor, 100 mm, No.130530

Materials/Parts

Cylinder
Piston
Piston rings
Piston rings
Shims

Dry cleaning solvent (Item 16, Appendix E)

Grease (Item 6, Appendix E)

Lubricating oil (Item 9, Appendix E)

Reference

Para 6-20 Crankcase Assembly

Equipment Condition

Para	Condition Description
5-20	Cylinder head assembly removed from engine.

Special Environmental Conditions

Well-ventilated area required during cleaning.

6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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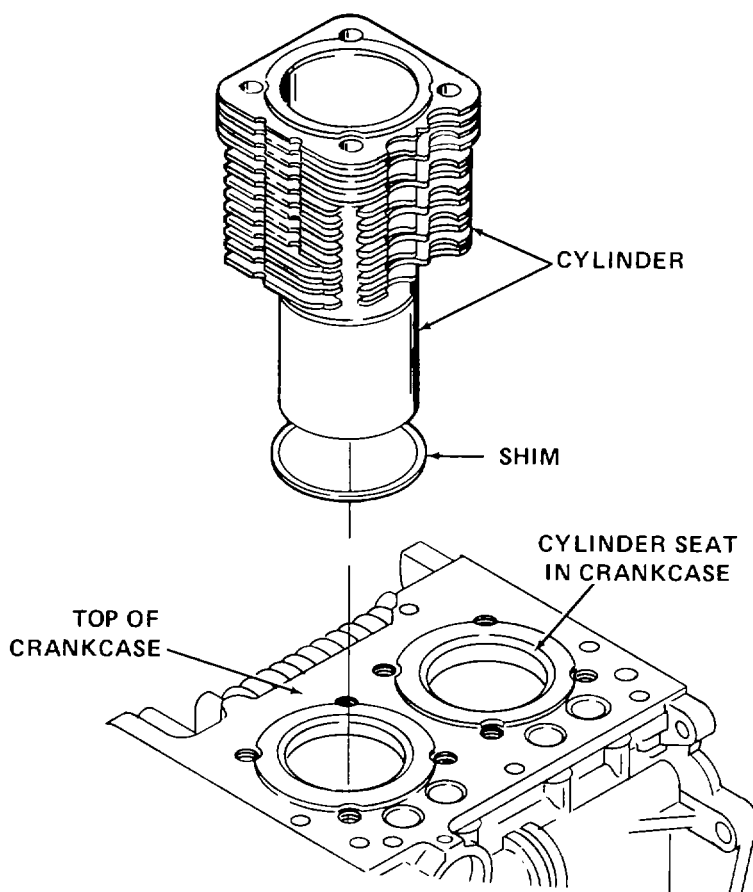
REMOVAL

CAUTION

When removing cylinder and shims, make sure piston or connecting rods do not knock against crankcase. This could result in serious damage to piston or connecting rod.

1. Cylinder, shims, and piston

Remove and matchmark each cylinder and corresponding piston.



6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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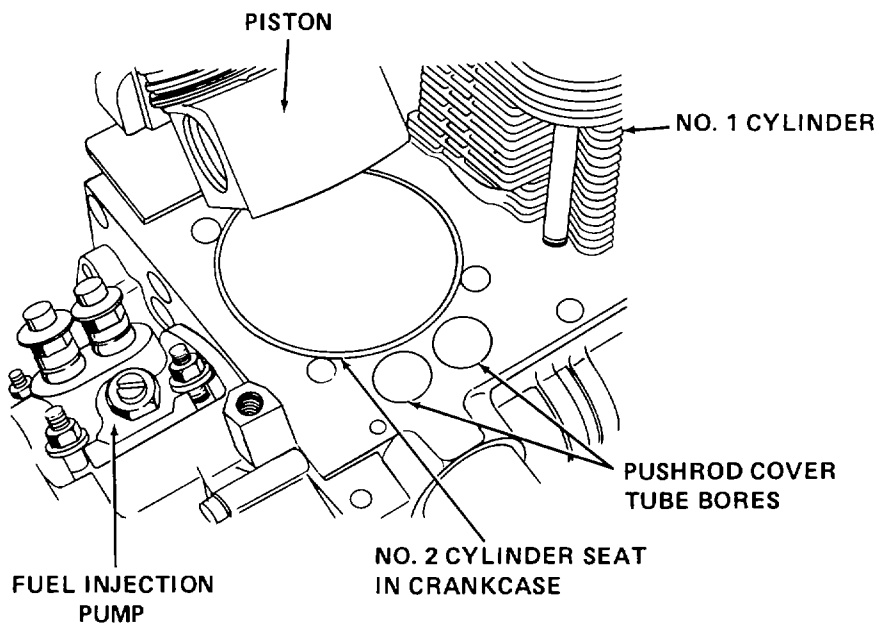
CLEANING/INSPECTION I

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 1380F (38° to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

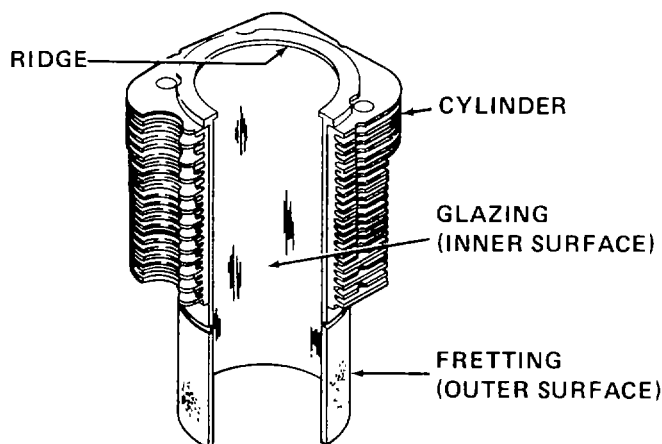
- | | |
|-------------------|---|
| 2. Cylinder seats | Clean with P-D-680 solvent and dry with compressed air. Check that cylinder seats in crankcase are smooth and flat (90 degrees). If not, refer to paragraph 6-20 for remachining procedure. |
|-------------------|---|



6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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- 3. Cylinder
 - a. Clean thoroughly with P-D-680 solvent. Dry with compressed air. Inspect for damage, warpage, rust, or corrosion. If severely damaged or warped, replace complete with new piston as necessary.
 - b. Inspect cylinder for cracks, scoring, glazing, a ridge on the upper portion of inner surface, or adhering metal particles (fretting) on outer surface.



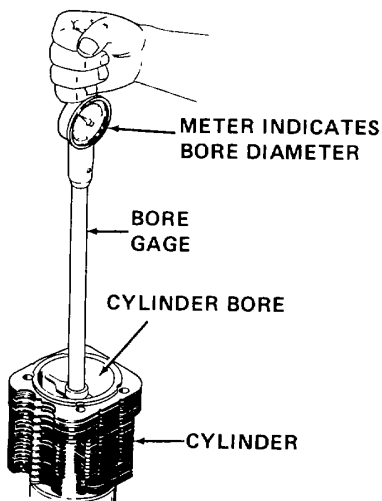
- c. Set precision bore gage to normal or oversized cylinder bore:

CYLINDER BORE	NORMAL AND OVERSIZED CYLINDER BORE inches (millimeters)	CYLINDER BORE WEAR LIMIT inches (millimeters)
Normal	3.9370 to 3.9457 (100.0 to 100.22)	3.9488 to 3.9575 (100.3 to 100.52)
First oversize	3.9567 to 3.9654 (100.5 to 100.72)	3.9685 to 3.9772 (100.8 to 101.02)
Second oversize	3.9764 to 3.9850 (101.0 to 101.22)	3.9882 to 3.9969 (101.3 to 101.52)

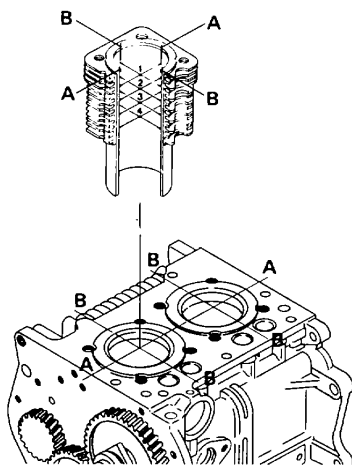
6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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- d. Measure cylinder bore as indicated with bore gage.



- e. Measure cylinder bore at levels 1 to 4 of engine centerline axis A and crossline axis B. Compare measurements with cylinder bore specification data above. If wear limits for normal or oversized bore cylinders have been reached or exceeded, replace cylinder and/or piston. If measurements on axis A and axis B are different, cylinder is out-of-round or has high spots. Replace cylinder and/or piston as necessary.



MEASURE CYLINDER BORE AT LEVELS 1, 2, 3, AND 4 ON BOTH AXIS A AND B

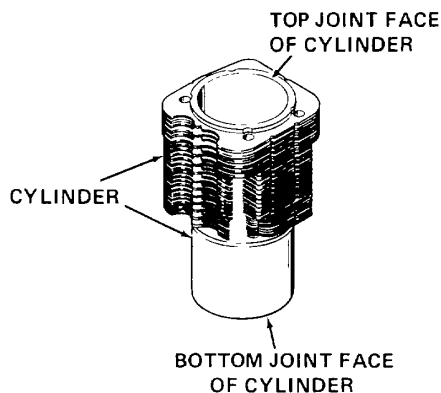
6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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Pistons are available in two oversizes:

PISTON DIAMETER	NORMAL AND OVERSIZED PISTON DIAMETER inches (millimeters)
Normal	3.9351 to 3.9358 (99.951 to 99.969)
First oversize	3.9548 to 3.9555 (100.451 to 100.469)
Second oversize	3.9744 to 3.9752 (100.951 to 100.969)

- f. Check that top and bottom joint faces are smooth and flat. If severely damaged, replace cylinder and/or piston if necessary. If joint faces have only minor nicks or burrs or minor high spots, repair.



4. Cylinder replacement

Replace a cylinder and/or piston if:

It is cracked, severely scored, or has a high ridge at the top of its inner surface.

Out-of-round exceeds the tolerable limits.

Cylinder bore exceeds the tolerable limits.

6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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REPAIR

5. Cylinder honing	Remove slight ridges, score marks, and glaze with a hone equipped with 120-grit stones. Work hone up and down rapidly the full length of the cylinder bore several times in a criss-cross pattern.	Criss-cross pattern produces hone marks on a 45 degree axis, which aids piston movement and helps prevent formation of ridges.
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CLEANING

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 1000 to 138°F (38° to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

6. Cylinder	Reclean each repaired cylinder with P-D-680 dry cleaning solvent and dry with compressed air. Remove any burrs.
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ADJUSTMENT I

7. Cylinder	Recheck cylinder bore and out-of-round on repaired cylinder as described in step 3.c. Replace if necessary.
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6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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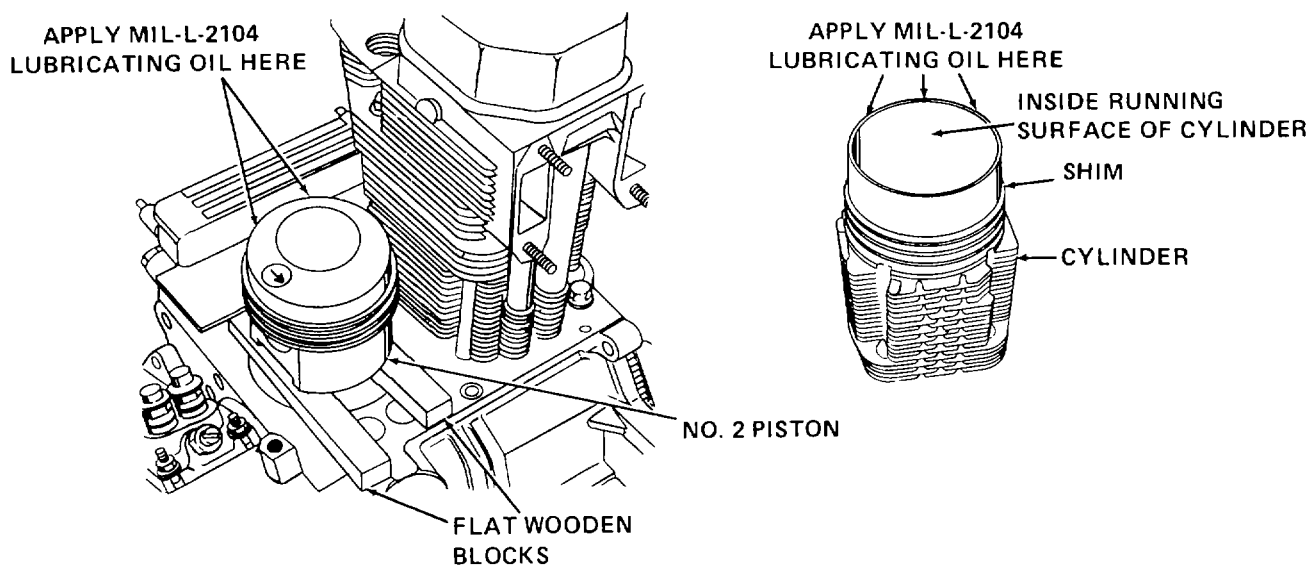
CAUTION

Piston and cylinder damage may result if pistons are not returned to their original cylinders. Observe matchmarks so that mixups do not occur.

8. Piston and cylinder clearance	Insert each piston in its respective cylinder or replacement and measure the piston skirt-to-cylinder clearance. If clearance is not within 0.0012 to 0.0224 inch (0.031 to 0.569 mm), replace piston.	
9. Cylinder within crankcase measurement	Install cylinder (new or replacement) in proper bore of crankcase and measure cylinder bore and out-of-round with a bore gage at the locations described above. Rehone or replace as needed.	

INSTALLATION/REPLACEMENT

10. Shims	Apply MIL-G-10924 grease to shims. Install cylinder base.
11. Piston	Place piston on flat wooden blocks. Apply MIL-L-2104 lubricating oil to inside running surface of cylinder and to piston.



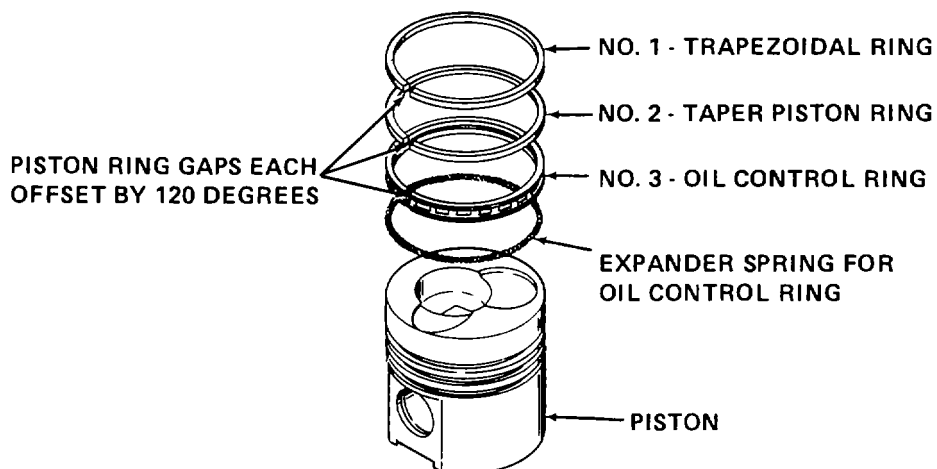
6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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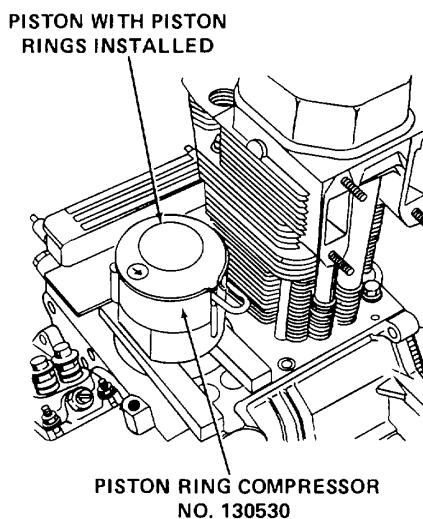
12. Piston rings

a. Check that piston ring gaps are offset by 120 degrees. The piston ring set contains three rings:

- No. 1 - Double trapezoidal compression ring
- No. 2 - Tapered compression ring
- No. 3 - Spring-loaded oil control ring



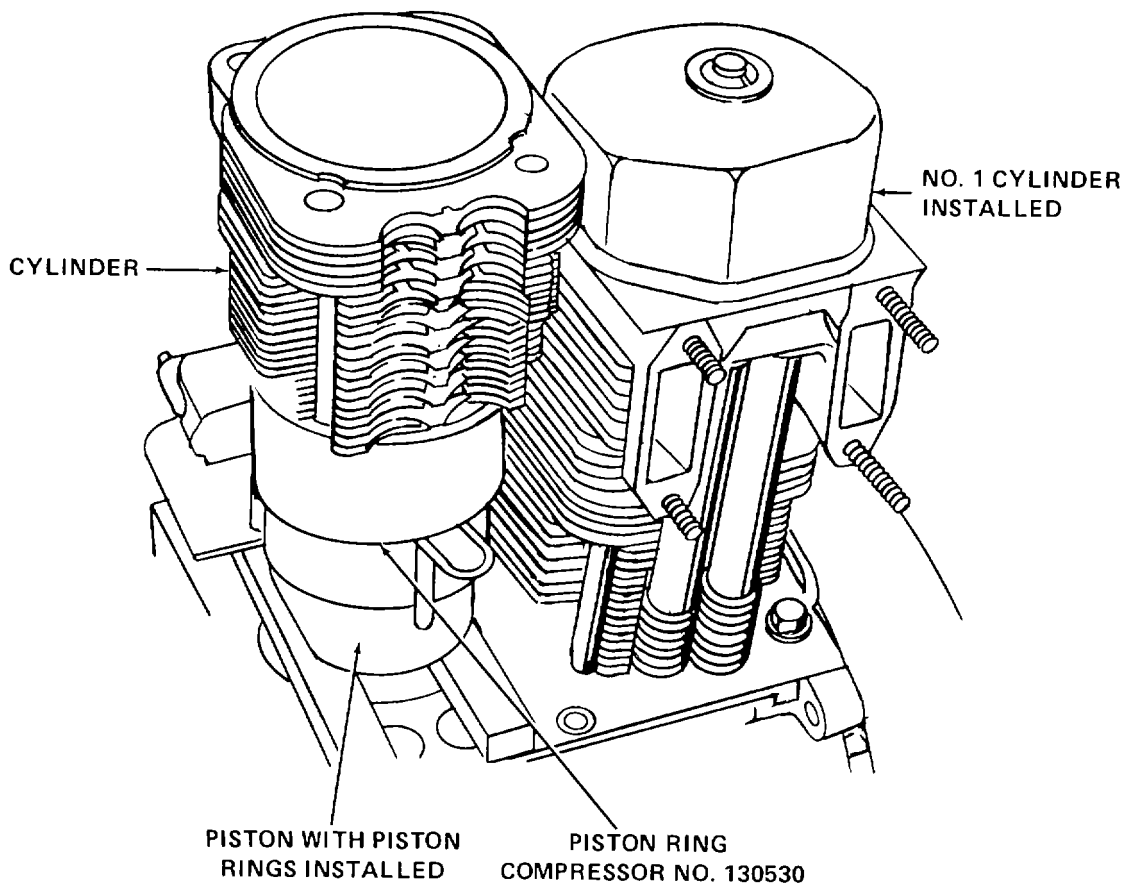
b. Compress rings with piston ring compressor No. 130530.



6-15. CYLINDER (CONT)

Location/Item	Action	Remarks
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13. Cylinder	Install cylinder with recesses facing pushrod cover tube bores in crankcase and aline cylinder properly.	
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6-16. PISTON ASSEMBLY

- This task covers.
- | | |
|---|---------------------------|
| a. Removal | e. Repair |
| b. Disassembly | f. Reassembly/Replacement |
| c. Cleaning/Inspection | g. Installation |
| d. Replacement of Piston, Piston Pin, Piston Rings, or Cylinder | |

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Micrometer

Piston heating unit No.

Piston ring plier No.

Piston ring groove gage No.

Straightedge, beveled steel

References

Para 6-15 Cylinder

Para 6-17 Connecting Rod Assembly

Para 6-18 Crankshaft Assembly

Troubleshooting References (Table 6-1)

139000 Malfunction 1, step 2

130300 Malfunction 2, steps 1 through 4

130360 Malfunction 3, step 1

Equipment Condition

Materials/Parts

Circlips

5-20

Cylinder head assembly removed from engine.

Expander spring

Piston bushing

5-22

Bottom cover removed from engine.

Piston pin

6-15

Cylinder removed from engine and piston up on wooden blocks.

Set of piston rings

Crocus abrasive cloth (Item 1, Appendix E)

Diesel fuel oil (Item 5, Appendix E)

Special Environmental Condition

Dry cleaning solvent (Item 16, Appendix E)

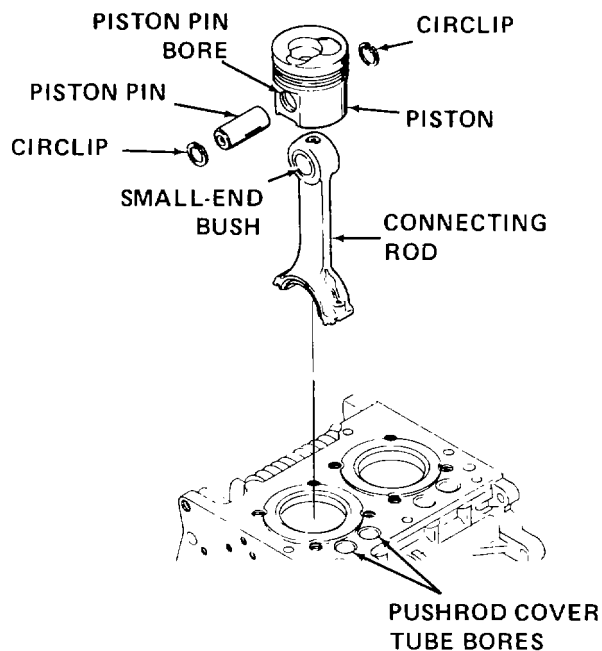
Well-ventilated area required during cleaning.

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
---------------	--------	---------

REMOVAL

- | | |
|---------------------------------|--|
| <p>1. Piston pin</p> | <p>a. Remove and discard circlips.</p> <p>b. Press piston pin out far enough to remove piston pin and piston from connecting rod. If piston pin has seized, heat piston with piston heating unit No. 139000 and press out pin.</p> |
| <p>2. Piston pin and piston</p> | <p>Remove.</p> |

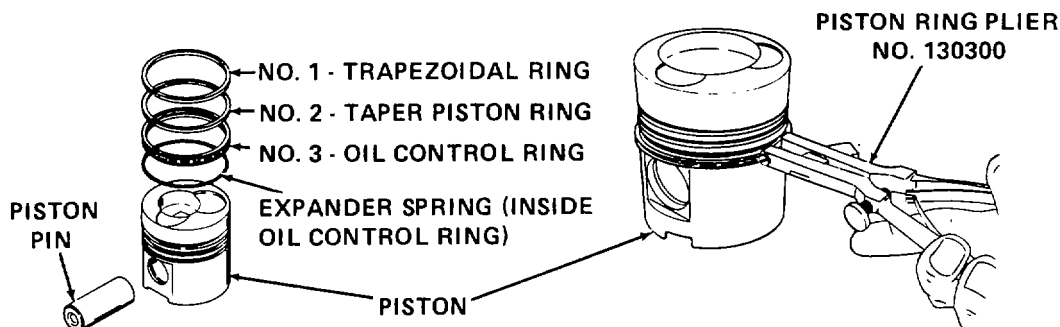


6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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DISASSEMBLY

- | | | |
|-------------------------------------|--|--|
| 3. Piston pin | Remove from piston. | |
| 4. Piston rings and expander spring | Remove from piston and piston ring plier No. 130300. Discard piston rings and expander spring. | |



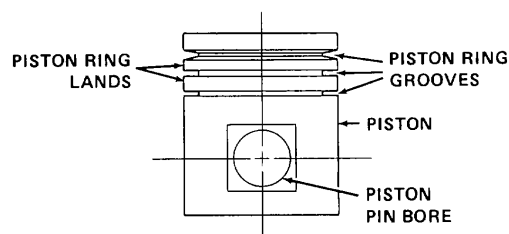
CLEANING/INSPECTION

WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138° F (380 to 590C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|---|--|--|
| 5. Piston, piston pin, and piston rings | Clean with P-D-680 dry cleaning solvent and dry with compressed air. Remove carbon from piston ring lands and grooves with a wire brush. Clean inside surface of piston and piston skirt. Clean piston pin bore with small wire brush. | |
|---|--|--|



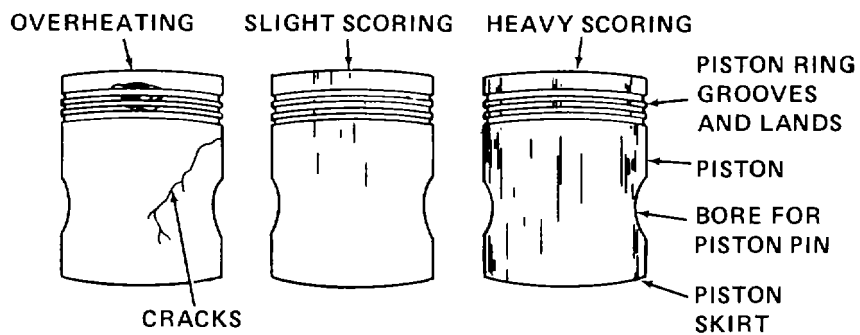
6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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NOTE

Excessively worn pistons, rings, or cylinders may be an indication of abnormal maintenance practices or operating conditions. Check for and correct any abnormalities.

- | | |
|-----------|---|
| 6. Piston | Inspect piston, piston skirt, and all grooves for excessive wear and damage. Examine piston for scoring, fretting, pitting, cracks (especially on the interior surfaces), damaged ring grooves or lands, or indications of overheating. Slight scoring may be cleaned with P-C-458 crocus cloth. Follow procedure described under repair. |
|-----------|---|

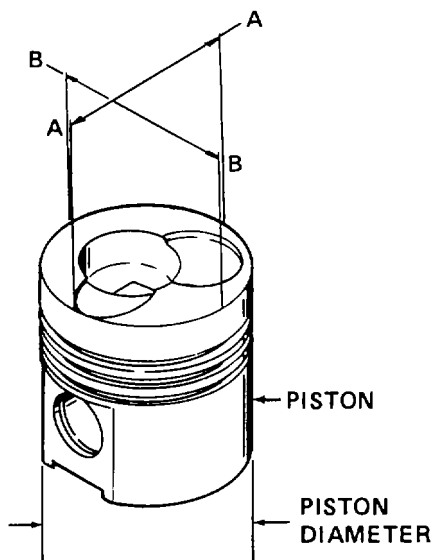


- | | |
|-------------|---|
| 7. Cylinder | If piston is badly worn or damaged, check cylinder for excessive out-of-round, high spots, or other damage in accordance with paragraph 6-15. |
|-------------|---|

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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8. Piston a. Measure piston diameter along axis A and B. A normal or new piston diameter should be 3.9351 to 3.9358 inches (99.951 to 99.969 mm). If piston is out-of-round, replace piston. Normal and two oversizes are available:



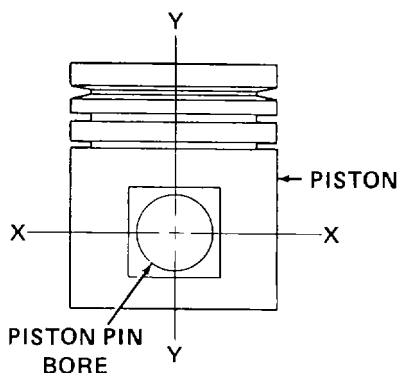
PISTON DIAMETER	NORMAL AND OVERSIZED PISTON DIAMETER inches (millimeters)
Normal	3.9351 to 3.9358 (99.951 to 99.969)
First oversize	3.9548 to 3.9555 (100.451 to 100.469)
Second oversize	3.9744 to 3.9752 (100.951 to 100.969)

b. If cylinder has been replaced, piston must also be replaced. Use normal or oversized piston as described in step a., above, depending on bore of new cylinder. If oversized bore cylinders have been used, the piston must also be oversized. Refer to paragraph 6-15 for more detail on cylinder oversizes and replacement.

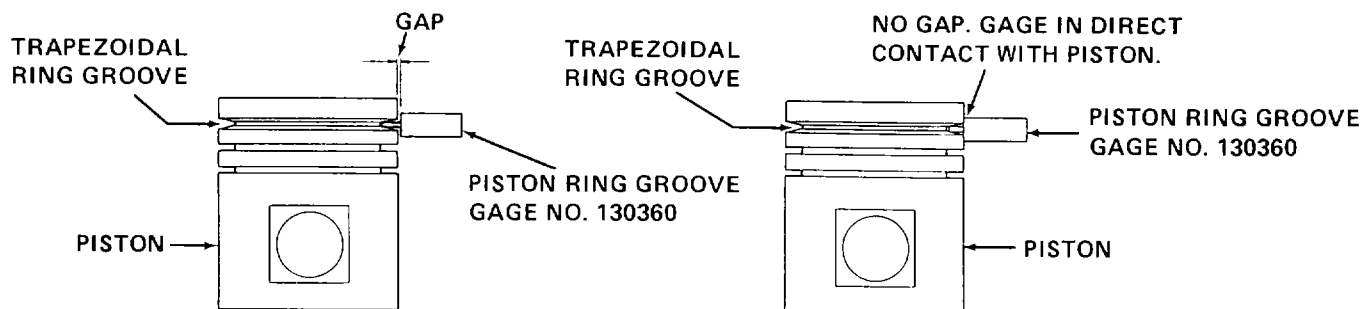
6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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9. Piston pin bore	Measure piston pin bore on X and Y axis with precision bore gage. Measurement should be 1.3781 to 1.3783 inches (35.004 to 35.01 mm). If bore measurement is larger than 1.3783 inches (35.01 mm) or is out-of-round, replace piston. This is also an indication of unusual wear. Check cylinder in accordance with paragraph 6-15 and also connecting rod in accordance with paragraph 6-17.	
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10. Trapezoidal ring groove	Measure axial clearance with piston ring groove gage No. 130360. Insert gage into ring groove. If a gap exists between the inserted gage and the piston, the axial ring clearance is 0.1 to 0.1064 inch (2.54 to 2.702 mm) and the piston is still usable. Do not replace piston. If the gage contacts the side of the piston with no gap, the axial ring clearance is too great and the piston must be replaced.	
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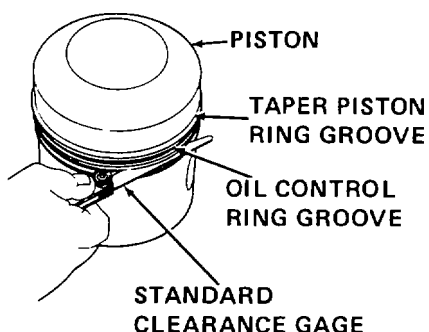


11. Taper piston ring groove	Measure axial ring clearance with standard clearance gage. Measurement should be 0.1016 to 0.1024 inch (2.58 to 2.60 mm). If measurement is greater than 0.1024 inch (2.6 mm), replace piston.	
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6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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12. Oil control ring groove	Measure axial ring clearance with standard clearance gage. Measurement should be 0.1980 to 0.1988 inch (5.03 to 5.05 mm). If measurement is greater than 0.1988 inch (5.05 mm), replace piston.	
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WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 1000 to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

13. Piston ring grooves	If any axial ring clearance measurements are smaller than the minimum values given above, piston ring grooves may be clogged with carbon deposits. Reclean piston with P-D-680 solvent and wire brush. Dry with compressed air. Take measurements again. If still smaller than minimum values, piston is damaged or defective. Replace piston.	
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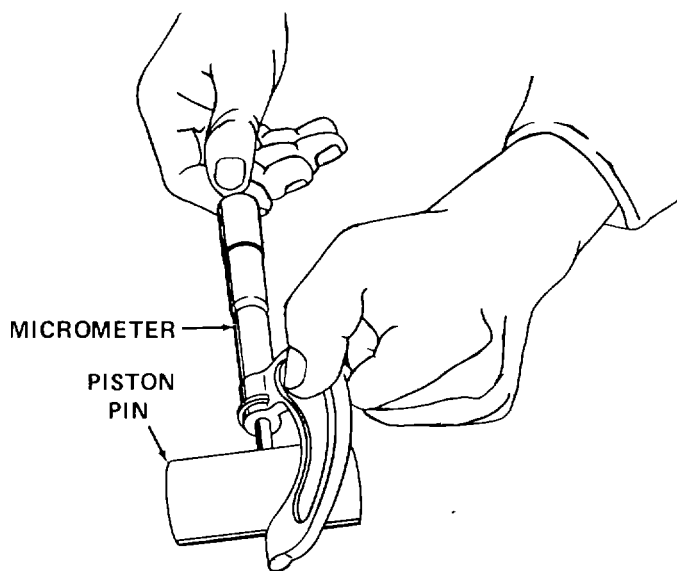
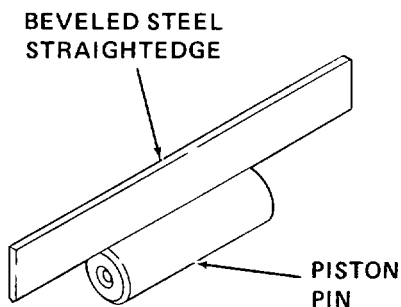
6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CAUTION

Small-end bush damage may result if piston pin is refinished. Do not refinish highly polished or lapped piston pin surface.

- | | |
|-----------------------|--|
| <p>14. Piston pin</p> | <p>a. Inspect for scoring, fretting, pitting, or indications of overheating. If damaged, replace piston pin.</p> <p>b. Measure for wear and check alinement. Measure alinement with beveled steel straightedge. This measurement will also indicate relative wear along the piston pin. Measure diameter of piston pin with micrometer at several points along the length of the pin. The diameter should be 1.3777 to 1.3780 inches (34.994 to 35.0 mm). The diameter should not be greater than 1.3780 inches (35.0 mm) under normal conditions. However, if it is, replace piston pin and recheck piston bore measurements. Replace piston if necessary. If piston pin is worn and any diameter measurements are less than 1.3777 inches (34.994 mm), replace piston pin.</p> |
|-----------------------|--|



NOTE: MEASURE DIAMETER AT SEVERAL POINTS ALONG LENGTH OF PIN.

NOTE: MEASURE DIAMETER AT SEVERAL POINTS ALONG LENGTH OF PIN.

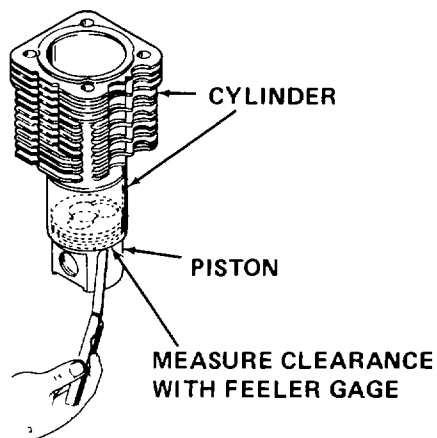
6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Piston and cylinder damage may result if pistons are not returned to their original cylinders. Observe matchmarks so that mixups do not occur.

15. Piston to cylinder clearance

Insert each piston in its respective cylinder or replacement and measure the piston skirt-to-cylinder clearance with feeler gage. If clearance is not within 0.0012 to 0.0224 inch (0.031 to 0.569 mm), inspect pistons and replace if necessary.



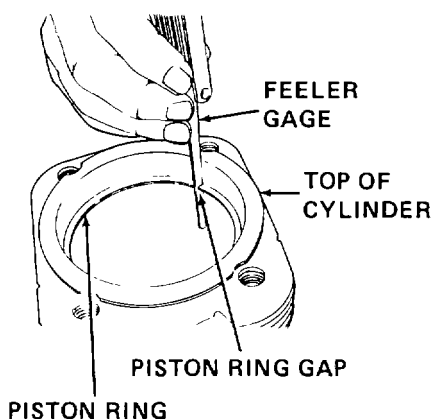
NOTE

Each piston is fitted with three rings: two compression rings and an oil control ring. The top compression or trapezoidal ring can be identified by the bright chrome plating. The second compression or taper piston ring can be identified by its cast iron construction. A two-piece oil control ring is used in the oil ring groove. All new piston rings must be installed whenever a piston is removed, replaced, or when a new cylinder is installed.

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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- | | | |
|---------------------|--|---|
| 16. Piston ring gap | a. Use piston to push rings, one at a time, down into the cylinder. With a feeler gage, measure ring gap according to the following chart. | Push ring in far enough to be in the normal area of ring travel, about 1.18 to 1.57 inches (30 to 40 mm). |
|---------------------|--|---|



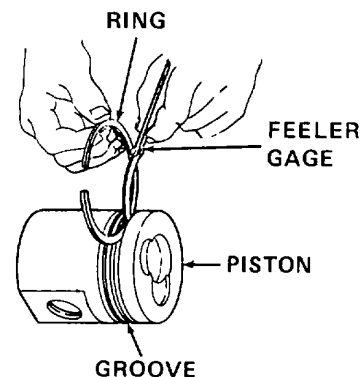
PISTON RING	NORMAL RING GAP inches (millimeters)	RING GAP WEAR LIMIT inches (millimeters)
Compression rings	0.0138 to 0.0217 (0.35 to 0.55)	0.0787 (2.00)
Oil control ring	0.0098 to 0.0157 (0.25 to 0.40)	0.0787 (2.00)

- b. If the compression ring gap measurements are less than 0.0138 inch (0.35 mm), the gap may be widened by very carefully filing or stoning. See step 25 for details. If the oil control ring gap measurement is less than 0.0098 inch (0.25 mm), replace the oil control ring. If any ring gap measurement is greater than 0.0787 inch (2.0 mm), replace the piston ring set.

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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17. Piston ring side clearance	a. Measure piston ring side clearance with new piston rings only. Measure side clearance of each piston ring with feeler gage in its corresponding piston ring groove in accordance with the chart below.	
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PISTON RING	NORMAL SIDE CLEARANCE inches (millimeters)	SIDE CLEARANCE WEAR LIMIT inches (millimeters)
First or trapezoidal ring	0.0041 to 0.0057 (0.105 to 0.145)	0.0197 (0.5)
Second or taper piston ring	0.0035 to 0.0048 (0.090 to 0.122)	0.0118 (0.3)
Third or oil control ring	0.0016 to 0.0028 (0.040 to 0.072)	0.0059 (0.15)

b. If piston ring side clearance for any piston ring is less than normal lower limit value given in chart, replace piston ring and measure side clearance again. If condition still exists, replace piston. If side clearance for any piston ring exceeds wear limit in chart, replace piston. Also replace cylinder, if necessary.

18. Pistons, cylinders, and piston rings	If piston replacement is necessary, piston rings must also be replaced. Normal sized pistons/cylinders require normal sized piston rings. Oversized pistons/cylinders require oversized piston rings.	
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6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Pistons are available in normal and two oversizes:

PISTON DIAMETER	NORMAL AND OVERSIZE PISTON DIAMETER inches (millimeters)
Normal	3.9351 to 3.9358 (99.951 to 99.969)
First oversize	3.9543 to 3.9555 (100.451 to 100.469)
Second oversize	3.9744 to 3.9752 (100.951 to 100.969)

Cylinders for the correspondingly sized pistons are also available in normal as well as two oversizes:

CYLINDER	NORMAL AND OVERSIZED CYLINDER BORE inches (millimeters)
Normal	3.9370 to 3.9457 (100.0 to 100.22)
First oversize	3.9567 to 3.9653 (100.5 to 100.72)
Second oversize	3.9764 to 3.9850 (101.0 to 101.22)

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Piston rings for the correspondingly sized pistons and cylinders are also available in normal and two oversizes:

PISTON RING (outside diameter x inside diameter x width)	FIRST TRAPEZOIDAL RING DIMENSIONS inches (millimeters)	SECOND TAPER PISTON RING DIMENSIONS inches (millimeters)	THIRD OIL CONTROL RING DIMENSIONS inches (millimeters)
Normal	3.9370 x 3.5984 x 0.1181 (100.0 x 91.4 x 3.0)	3.9370 x 3.5984 x 0.0984 (100.0 x 91.4 x 2.5)	3.9370 x 3.5787 x 0.1969 (100.0 x 90.9 x 5.0)
First oversize	3.9567 x 3.6181 x 0.1181 (100.5 x 91.9 x 3)	3.9567 x 3.6181 x 0.0984 (100.5 x 91.9 x 2.5)	3.9567 x 3.5984 x 0.1969 (100.5 x 91.4 x 5.0)
Second oversize	3.9764 x 3.6378 x 0.1181 (101.0 x 92.4 x 3.0)	3.9764 x 3.6378 x 0.0984 (101.0 x 92.4 x 2.5)	3.9764 x 3.6181 x 0.1969 (101.0 x 91.9 x 5.0)

REPLACEMENT OF PISTON, PISTON PIN, PISTON RINGS, OR CYLINDERS

CAUTION

Pistons, piston rings, and cylinders must always be matched to the same size or oversize. Failure to match all three in size could cause serious damage to the engine.

19. Piston

Replace piston if tin plate or ring grooves are excessively worn or damaged, ring lands are damaged, piston is heavily scored or cracked, or piston shows signs of excessive overheating. Replace piston if skirt diameter or out-of-round is not within tolerance. If piston ring side clearance exceeds the limit, replace piston. If piston pin bore is not within tolerance or is out-of-round, replace piston.

6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
20. Piston pin	Replace if finish is destroyed or fretting is visible.	
21. Piston rings	Replace.	
22. Piston-to-cylinder clearance	Replace piston and/or cylinder if clearance is not within tolerance.	
23. Cylinder	If worn or damaged, repair or replace in accordance with paragraph 6-15.	

REPAIR

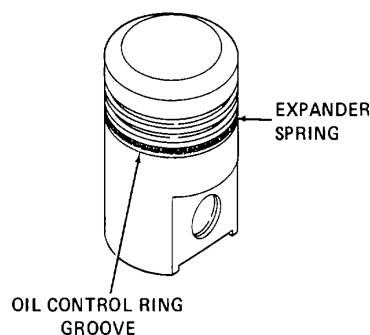
24. Piston	Remove slight scoring or fretting with P-C-458 crocus cloth. Reclean and repeat procedure if necessary.	
25. Piston rings	If gap on new compression ring is insufficient, it may be increased by filing or stoning the ends of the ring. File or stone both ends of ring so cutting action is from outer surface to inner surface. This will prevent any chipping or peeling of chrome plate on ring. The ends of the ring must remain square with chamfer on outer edge.	
26. Cylinder	If worn or damaged, repair or replace in accordance with paragraph 6-15.	

REASSEMBLY/REPLACEMENT

CAUTION

Piston ring breakage may occur if rings are opened more than necessary when removing or installing them. Do not strain rings.

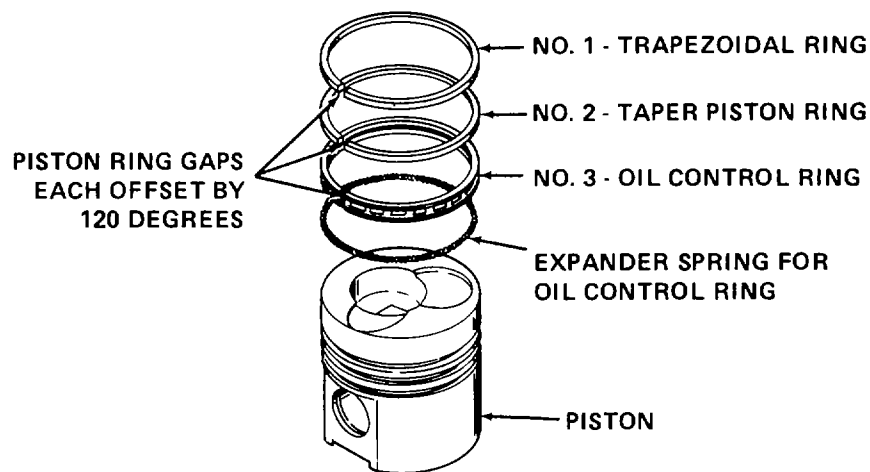
27. Piston rings and expander spring	Install new expander spring in oil control ring groove.	
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Install new expander spring.

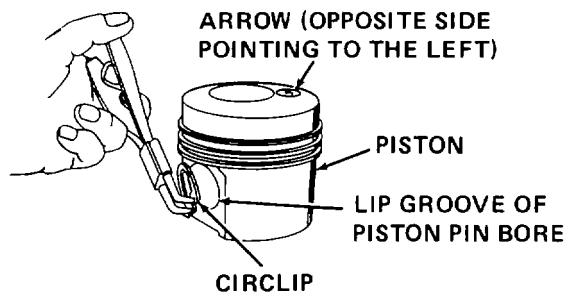
6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
28. Oil control ring, taper piston ring, and trapezoidal ring	Install new piston rings with piston ring plier No. 130300. Install rings in the order listed, starting with the oil control ring. Be careful not to strain rings by opening them too wide during installation. Make sure that the piston ring gaps are equally spaced around the piston 120 degrees from each other.	Install new piston rings.



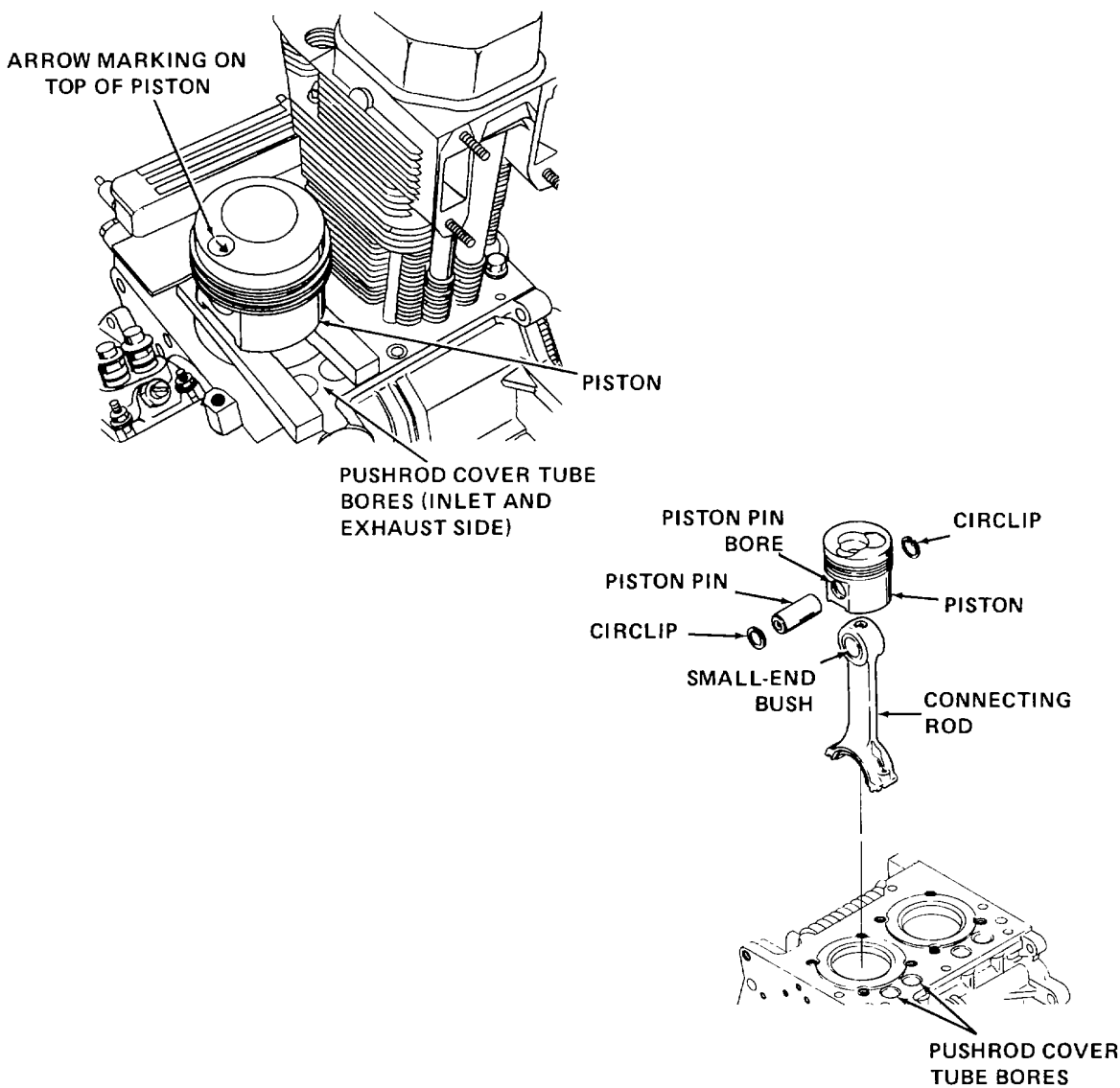
INSTALLATION

29. Piston pin	Install new circlip in lip groove of piston pin bore opposite arrow marked on the top of piston. Arrow should be on the opposite side of the piston and pointing to the left as circlip is installed.	Install new circlip.
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6-16. PISTON ASSEMBLY (CONT)

Location/Item	Action	Remarks
30. Piston, connecting rod, and piston pin	<p>a. Insert connecting rod into bottom of piston and place piston on two flat wooden blocks. Insert piston pin into piston pin bore and through small-end bush of connecting rod. Push pin in until it contacts installed circlip and stops. Make sure arrow on top of piston points toward pushrod cover tube bores (inlet and exhaust side).</p> <p>b. Install new circlip.</p>	Install new circlip.



6-17. CONNECTING ROD ASSEMBLY

- This task covers.
- | | |
|------------------------|-----------------------|
| a. Cleaning/Inspection | c. Repair/Replacement |
| b. Disassembly | d. Reassembly |

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Inside micrometer

Outside micrometer

Piston pin bush inserter No.131310

Materials/Parts

Connecting rod assembly

Hex bolts

Piston pin

Materials required by MIL-T-704

Diesel fuel oil (Item 5, Appendix E)
Dry cleaning solvent (Item 16, Appendix E)
Lubricating oil (Item 9, Appendix E)

References

- | | |
|------------|------------------------------------|
| Para 6-15 | Cylinder |
| Para 6-16 | Piston Assembly |
| Para 6-18 | Crankshaft Assembly |
| MIL-I-6868 | Magnetic Particle Inspection |
| MIL-T-704 | Treatment and Painting of Material |

Equipment Condition

Para	Condition Description
6-16	Piston assembly removed from connecting rod.

Special Environmental Condition

Well-ventilated area required during cleaning.

6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CLEANING/INSPECTION

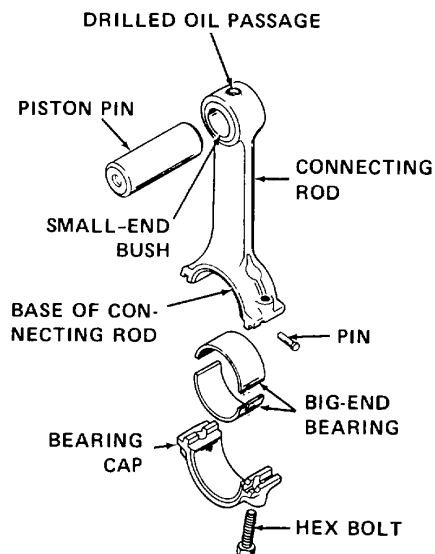
WARNING

Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

1. Connecting Rod assembly

Clean connecting rod components with P-D-680 solvent and dry with compressed air. Remove any carbon deposits with a wire brush. Clean inside surface of small-end bush, connecting rod, big-end bearings, and bearing cap. Blow compressed air through the drilled oil passage in connecting rod, so that air flows freely through oil holes in connecting rod and bush to clean them out.



6-17. CONNECTING ROD ASSEMBLY (CONT)

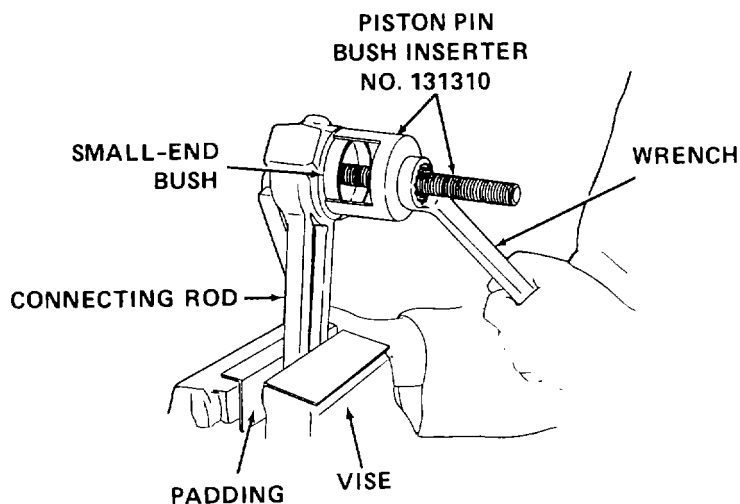
Location/Item	Action	Remarks
2. Small-end bush	<p>a. Adjust inside micrometer to 1.3780 inches (35.0 mm).</p> <p>b. Measure and record small-end bush bore or inside diameter. Measure bush at points 1 and 2 along axis A and B. Measurements should be 1.3794 to 1.3811 inches (35.036 to 35.080 mm). If any measurement is outside these limits, replace small-end bush.</p>	
<p>The diagram shows a technical drawing of a small-end bush. On the left is a side view of the bush, which is a hollow cylinder with hatched ends. Two vertical arrows labeled '1' and '2' indicate measurement points along the length of the bush. On the right is a top view of the bush, showing two concentric circles. Two horizontal arrows labeled 'A' and two vertical arrows labeled 'B' indicate measurement axes for the inner and outer diameters.</p>		
3. Piston pin	<p>Measure and record diameter of corresponding piston pin with micrometer at several points along the length of the pin. The diameter should be 1.3777 to 1.3780 inches (34.994 to 35.0 mm). If any measurement is outside these limits, replace piston pin.</p>	
4. Piston pin	<p>Determine piston pin clearance in small-end clearance bush. Subtract piston pin diameter measured in step 4 from small-end bush bore measurement recorded in step 3. Clearance should be 0.0014 to 0.0034 inch (0.036 to 0.086 mm) under normal conditions. If it is greater than 0.0098 inch (0.25 mm), piston pin and small-end bush should be remeasured and clearance redetermined. If clearance is still greater than 0.0098 inch (0.25 mm), replace piston pin or small-end bush, or both. Be sure to recheck measurements and clearances to see that they fall within their respective tolerance limits.</p>	

6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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DISASSEMBLY

- | | | |
|-------------------|---|--|
| 5. Small-end bush | Clamp connecting rod in a padded vise and remove small-end bush with piston pin bush inserter No. 131310. | |
|-------------------|---|--|



CLEANING/INSPECTION

WARNING

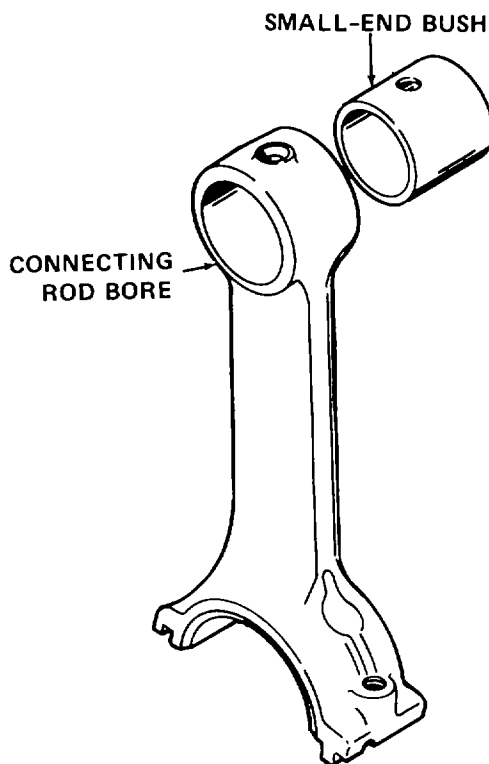
Dry cleaning solvent is flammable and potentially dangerous to people and property. Do not use near open flame, sparks, excessive heat, or on hot surfaces. Flash point of P-D-680 solvent is 100° to 138°F (38° to 59°C). Use solvent in a well-ventilated area, and avoid inhaling fumes. If repeatedly exposed to fumes, seek fresh air and immediate medical help. Avoid prolonged exposure of skin to solvent. Wash exposed skin immediately and thoroughly.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

- | | | |
|--------------------------------------|--|--|
| 6. Small-end and connecting rod bore | Clean thoroughly with P-D-680 cleaning solvent and dry with compressed air. Remove any carbon deposits with wire brush. Clean connecting rod bore with small wire brush. | |
|--------------------------------------|--|--|

6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
7. Small-end bush	Inspect for scoring, overheating, or other damage. Replace as necessary. Measure outside diameter of bush with outside micrometer. Measurement should be 1.4980 to 1.4992 inches (38.050 to 38.080 mm). If measurement is outside specified limits, replace small-end bush.	
8. Connecting rod bore	Measure bore with inside micrometer. Bore should measure 1.4961 to 1.4967 inches (38.0 to 38.016 mm). If measurement is outside specified limits, replace connecting rod.	

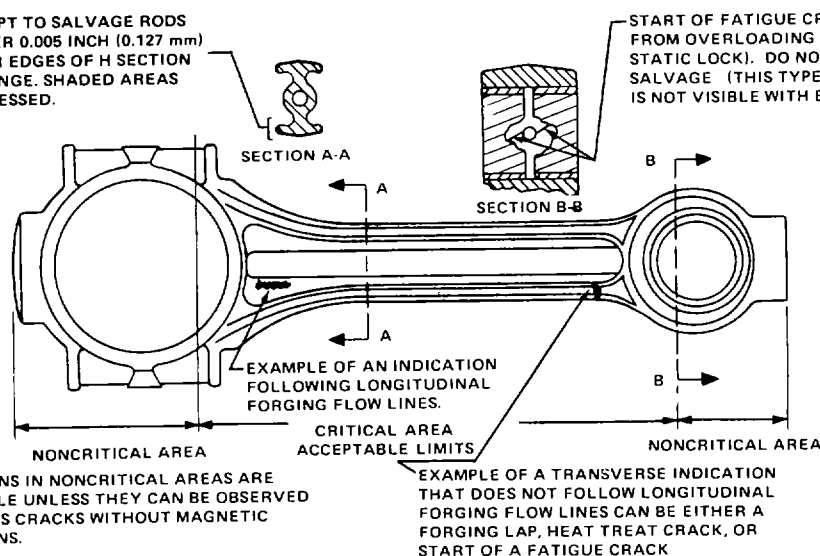


6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
9. Connecting rod	Visually inspect for bending, warping, cracking, rust, or other damage. Check for cracks using MIL-I-6868 magnetic particle inspection. Replace if twisted or bent. Grind or replace if indications of cracks are revealed by magnetic particle inspection. Stamp the cylinder number on a replacement connecting rod and bearing cap.	

DO NOT USE OR ATTEMPT TO SALVAGE RODS WITH INDICATIONS OVER 0.005 INCH (0.127 mm) DEEP EXTENDING OVER EDGES OF H SECTION ON BOTH SIDES OF FLANGE. SHADED AREAS ARE MOST HIGHLY STRESSED.

START OF FATIGUE CRACK RESULTING FROM OVERLOADING (DUE TO HYDROSTATIC LOCK). DO NOT ATTEMPT TO SALVAGE (THIS TYPE OF INDICATION IS NOT VISIBLE WITH BUSHINGS IN PLACE.)



INDICATIONS IN NONCRITICAL AREAS ARE ACCEPTABLE UNLESS THEY CAN BE OBSERVED AS OBVIOUS CRACKS WITHOUT MAGNETIC INSPECTIONS.

TRANSVERSE INDICATIONS (ACROSS FLOW LINES), HAVING A MAXIMUM LENGTH OF 1/2 INCH (12.7 mm), WHICH CAN BE REMOVED BY GRINDING NO DEEPER THAN 1/64 INCH (0.3969 mm) ARE ACCEPTABLE AFTER THEIR COMPLETE REMOVAL. AN EXCEPTION TO THIS IS A ROD HAVING AN INDICATION WHICH EXTENDS OVER THE EDGE OF H SECTION AND IS PRESENT ON BOTH SIDES OF THE FLANGE. IN THIS CASE MAXIMUM ALLOWABLE DEPTH IS 0.005 (SEE SECTION A-A)

LONGITUDINAL INDICATIONS FOLLOWING FORGED FLOW LINES ARE USUALLY SEAMS AND ARE NOT CONSIDERED HARMFUL IF LESS THAN 1/32 INCH (0.7938 mm) DEEP. DEPTH CAN BE DETERMINED BY GRINDING A SMALL AREA NEAR THE CENTER OF THE INDICATION.

GRINDING NOTES
CARE SHOULD BE TAKEN IN GRINDING OUT INDICATIONS TO ASSURE PROPER BLENDING OF GROUND AREA INTO UNGROUND SURFACE SO AS TO FORM A SMOOTH CONTOUR.



6-17. CONNECTING ROD ASSEMBLY (CONT)

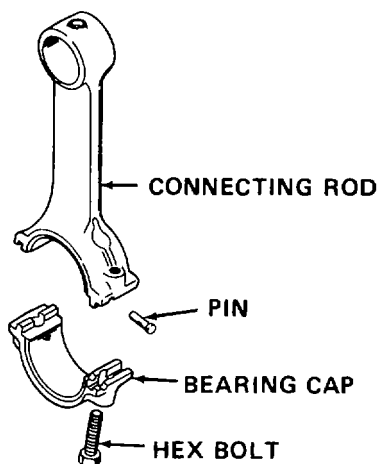
Location/Item	Action	Remarks
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NOTE

Clean rust preventive from replacement connecting rod. Also make sure the bearing cap is thoroughly cleaned to prevent trapped contaminants from adversely affecting the big end bearings.

10. Connecting rod and bearing cap

Temporarily reassemble pin and bearing cap with hex bolts onto matchmarked connecting rod. Tighten bolts to 22.13 ft lb (30 N•m) torque. Using a torque gage, tighten bolts three additional 30 degree increments.



11. Connecting rod and connecting rod bore for big-end bearing

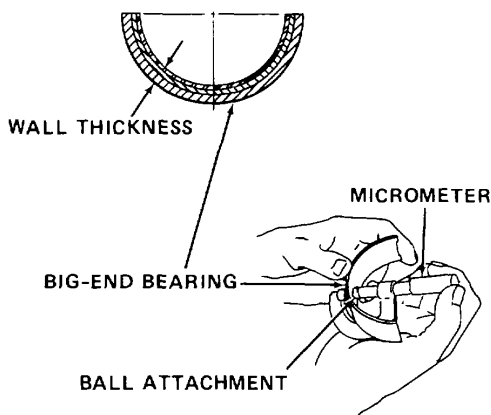
Measure width of connecting rod with micrometer, measurement should be 1.3294 to 1.3319 inches (33.768 to 33.83 mm). If measurement is outside specified limits, replace connecting rod. Measure bore with inside micrometer. Measurement should be 2.2441 to 2.2448 inches (57.0 to 57.019 mm). If measurement is outside specified limits, replace connecting rod including bearing cap, small-end bush, big-end bearings, and hex bolts.

6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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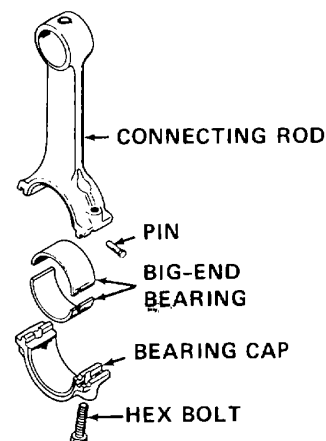
12. Big-end bearings

Inspect upper and lower bearing for excessive wear, scoring, pitting, flaking, etching, and signs of overheating. Inspect bearing backs for bright spots (bearing moving in supports). Measure bearing width. Measurement should be 0.9724 to 0.9843 inch (24.7 to 25.0 mm). If measurement is outside specified limits, replace bearings. Measure bearing wall thickness with a micrometer and ball attachment. The minimum thickness of a worn standard big-end bearing is 0.0975 inch (2.476 mm). If measurement is below specified limit, replace big-end bearings.



13. Connecting rod, big-end bearing, and bearing cap

Remove hex bolts, bearing cap, and pin and carefully insert big-end bearing. Reinsert pin and tighten hex bolts following procedure described in step 10 above.



6-17. CONNECTING ROD ASSEMBLY (CONT)

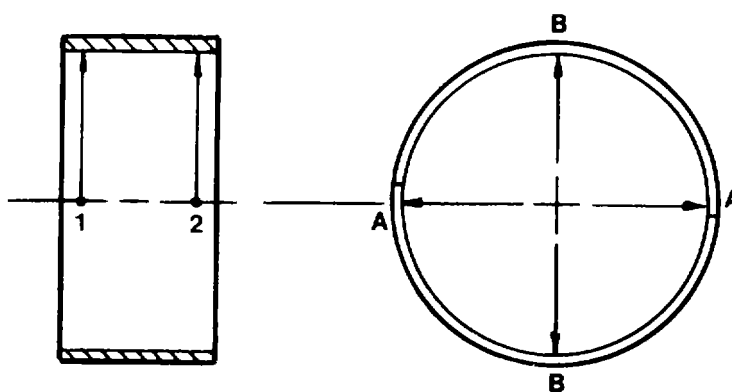
Location/Item	Action	Remarks
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14. Big-end bearing bore	a. Measure with inside micrometer at points 1 and 2 and along axis A and B. Measurement should be 2.0488 to 2.0501 inches (52.04 to 52.073 mm) for nominal bearing bore but respectively smaller for undersized bores.	
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NOTE

See chart for nominal and undersized bore sizes for big-end bearing.

- b. If any measurement is outside the tolerance limits, replace the big-end bearing. Make sure that measurements at points 1 and 2 are not different nor outside the tolerance limits indicating that bearing is wearing in a conical shape. Make sure measurements along axis A and B are not different nor outside the tolerance limits indicating the bearing is wearing in an oval shape. If bearing is wearing out-of-round, replace it and check the crankpin on the crankshaft. Follow procedure described in paragraph 6-18. Also check pistons and cylinders for unusual wear. Follow procedures described in paragraphs 6-15 and 6-16.



6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Big-end bearings are available in the following nominal and undersized bore diameters:

BIG-END BEARING NOMINAL AND UNDERSIZES	BEARING BORE DIAMETER inches (millimeters)
Nominal (new)	2.0488 to 2.0501 (52.040 to 52.073)
First oversize	2.0291 to 2.0304 (51.540 to 51.573)
Second oversize	2.0094 to 2.0107 (51.040 to 51.073)
Third oversize	1.9899 to 1.9911 (50.540 to 50.573)

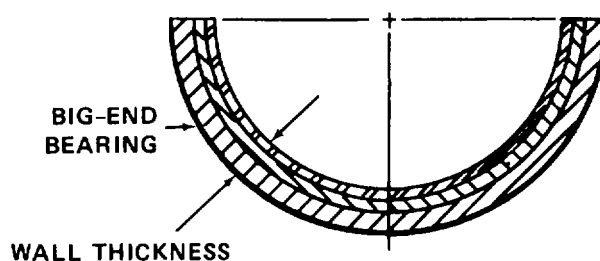
Big-end bearings are available in the following nominal and oversized wall thickness W.

BIG-END BEARING NOMINAL AND OVERSIZES	WALL THICKNESS inches (millimeters)
Nominal (new)	0.0975 to 0.0977 (2.476 to 2.481)
First oversize	0.1073 to 0.1075 (2.726 to 2.731)
Second oversize	0.1172 to 0.1174 (2.976 to 2.981)
Third oversize	0.1270 to 0.1272 (3.226 to 3.231)

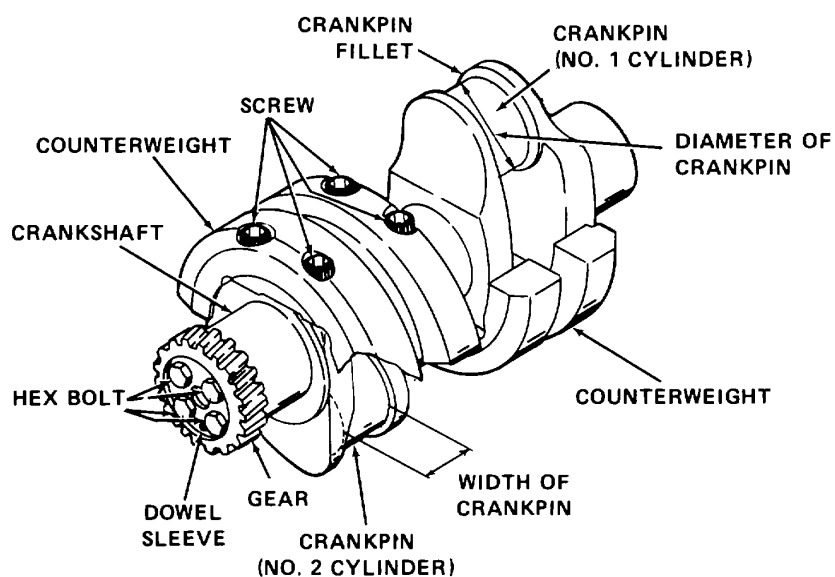
6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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15. Big-end bearings	Big-end bearings are available in nominal and three undersizes. Nominal and three undersizes are available for the bearing bore corresponding to the nominal and three oversizes available for the bearing wall thickness. These sizes are indicated in the preceding chart.	
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16. Crankpins on crankshaft	Measure diameter and width of both crankpins and record measurements. Make sure measurements are identified as cylinder No. 1 and cylinder No. 2. Cylinder No. 1 is closest to the flywheel end of the engine; cylinder No. 2 is closest to the V-belt guard end.	
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6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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NOTE

When determining big-end bearing radial and side clearance, make sure connecting rods and big-end bearings are properly matched and also properly matched to the corresponding crankpin.

17. Big-end bearing radial clearance	Take the smallest measurement of the big-end bearing bore that is still within the tolerance limits, measured in step 14, and subtract largest crankpin diameter measurement measured in step 16. The radial difference between these two measurements is the big-end bearing clearance. It should be 0.0020 to 0.0043 inch (0.05 to 0.108 mm) under normal conditions. Radial clearance upper limit value is 0.0118 inch (0.3 mm). If radial clearance is less than 0.0020 inch (0.05 mm), replace big-end bearing and remeasure bearing bore. Make sure radial clearance falls within tolerance limits. If radial clearance is larger than 0.0118 inch (0.3 mm), replace big end bearing with bearing having the next smaller size bore.	
18. Big-end bearing side clearance	Measure crankpin width and record the measurement. Subtract connecting rod width measured in step 11. The difference is big-end bearing side clearance and it should be 0.0067 to 0.0107 inch (0.170 to 0.271 mm) under normal conditions. The side clearance upper limit value is 0.0236 inch (0.6 mm). If the side clearance is less than 0.0067 (0.170 mm), the connecting rod should be rechecked and remeasured. Replace the connecting rod if necessary. If the side clearance is greater than 0.0236 inch (0.6 mm), either the connecting rod or the crankpin fillets on the crankshaft have worn. Recheck and remeasure connecting rod. Replace connecting rod if width is below tolerance limits. If not, recheck crankpin width on crankshaft. Crankpin width should be 1.3386 to 1.3401 inches (34.0 to 34.039 mm). If crankpin width is greater than 1.3401 inch (34.039 mm), replace crankshaft. Connecting rods and big-end bearings may also have to be replaced.	

6-17. CONNECTING ROD ASSEMBLY (CONT)

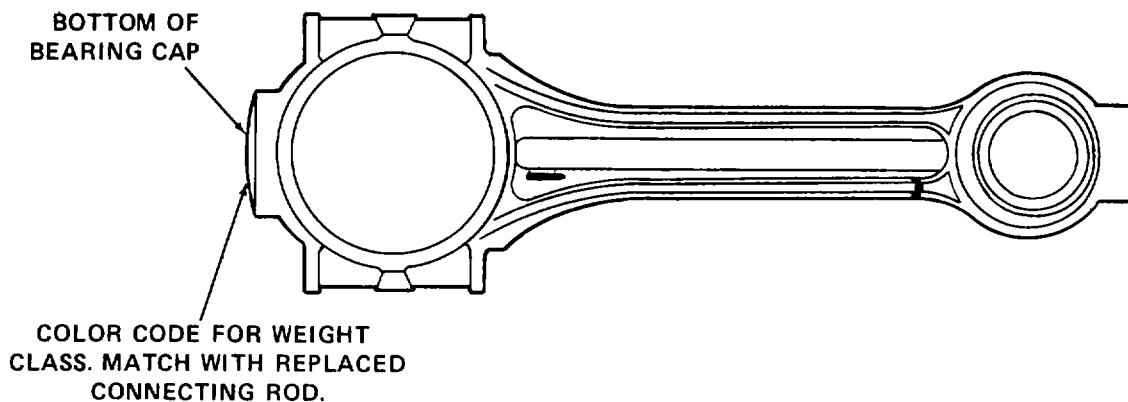
Location/Item	Action	Remarks
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REPAIR/REPLACEMENT

19. Small-end bush	Replace if scored, overheated, out-of-round, or damaged. Replace if inside diameter (pressed in) or outside diameter is beyond the tolerance limits. Replace if piston pin (new or acceptable) clearance is outside the tolerance limits.	
20. Piston pin	Replace if piston pin clearance in new or acceptable small-end bush is outside the tolerance limits.	

NOTE

When replacing connecting rods, make sure color code on bottom of bearing cap is the same as the replaced rod, indicating the same weight class. The connecting rods within any weight class should not differ more than 1.058 ounce (30 grams).



21. Connecting rod	Replace if bent, warped, cracked, or damaged. Replace if bore for small-end bush is outside tolerance limits. Replace if big-end bearing bore or side clearance is outside tolerance limits.	
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6-17. CONNECTING ROD ASSEMBLY (CONT)

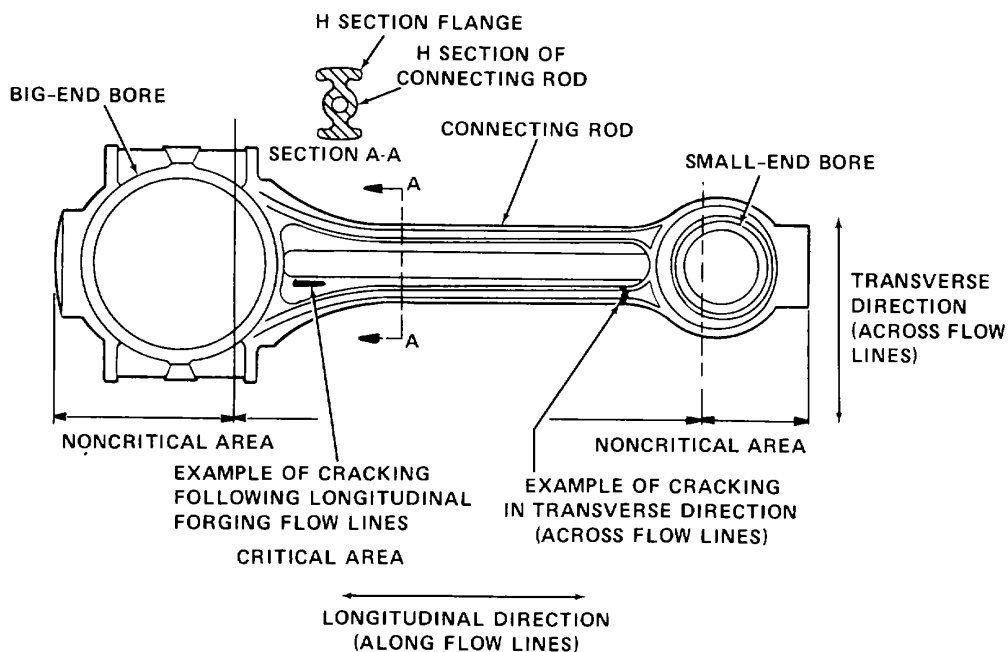
Location/Item	Action	Remarks
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NOTE

When grinding out minor nicks, abrasions, or cracks on connecting rod, make sure ground areas form smooth contours with adjacent unground areas.

22. Connecting rod

Repair minor cracking in the transverse direction (across flow lines) of the connecting rod as long as the cracks are no longer than 0.50 inch (12.70 mm) and can be completely removed by grinding no deeper than 0.0156 inch (0.3969 mm). If the cracking extends over the edge of the H section and on both sides of the connecting rod flange, the crack must be completely removable, by grinding no deeper than 0.0050 inch (0.1270 mm). Otherwise, replace connecting rod in either case. Minor cracking in the longitudinal direction (along flow lines) may be removed by grinding no deeper than 0.0313 inch (0.7938 mm). If crack is deeper, replace connecting rod. Remove rust and treat in accordance with MIL-T-704. Do not finish connecting rod.



6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
23. Big-end bearings	<p>a. Replace if bearings are excessively worn, out-of-tolerance, out-of-round, or show any scoring, pitting, flaking, etching, or signs of overheating. Replace if bearings show any bright spots on the back or outside surfaces. Replace with nominal or undersized bore bearings or oversized wall thickness bearings as appropriate for the size of the corresponding crankpin on the crankshaft.</p> <p>b. Install new big-end bearings in connecting rod only if necessary. Follow procedure described in step 13. Tighten and retighten hex bolts in accordance with procedure described in step 10. Remeasure bearing bore in accordance with step 14. Measurements for nominal or undersized bore should correspond correctly to those in the chart on page 6-132. The nominal big-end bearing bore, for example, should be 2.0488 to 2.0501 inches (52.040 to 52.073 mm). However, if the bore measures an additional 0.0008 inch (0.020 mm) on either side of tolerance limits, the connecting rod and big-end bearing would still be acceptable for reinstallation. The tolerance limits would then become 2.0480 to 2.0509 inches (52.020 to 52.093 mm) and the connecting rod and big-end bearing would be acceptable for further use. This would also apply to any of the undersized bore bearings where the acceptable tolerance limits would also be increased by an additional 0.0008 inch (0.020 mm) on either side. If big-end bearing bore measurements are still outside the extended tolerance limits, the connecting rod must be replaced. This would include replacement of small end bush, big-end bearing, bearing cap, pin, and hex bolts.</p>	

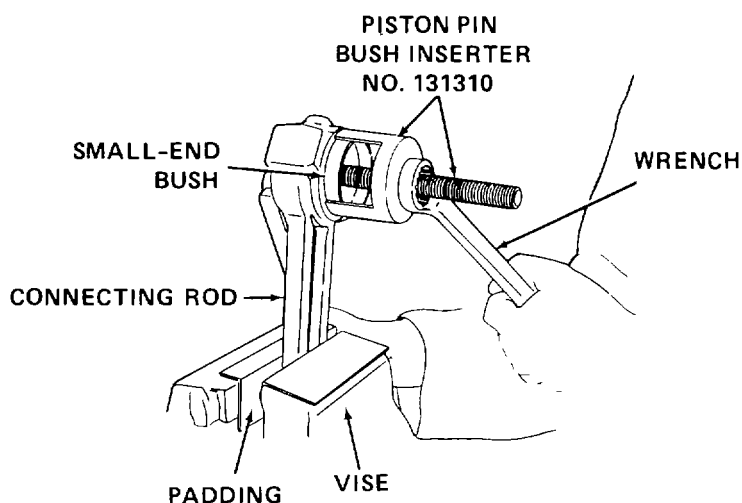
6-17. CONNECTING ROD ASSEMBLY (CONT)

Location/Item	Action	Remarks
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REASSEMBLY

24. Connecting rod and small-end bush

If connecting rod has been replaced, clamp new connecting rod into padded vise and pull in small-end bush with piston pin bush inserter No. 131310.



25. Connecting rod, big-end bearing, and bearing cap

If connecting rod and/or big-end bearings have been replaced, matchmark connecting rod, bearings, and bearing cap with one mark for cylinder No. 1 and two marks for cylinder No. 2. Always use new hex bolts for installation of connecting rod and bearings onto crankpin on crankshaft.

Install new hex bolts.

6-18. CRANKSHAFT ASSEMBLY

- This task covers.
- | | |
|---------------|-----------------------------|
| a. Removal | d. Repair |
| b. Cleaning | e. Installation/Replacement |
| c. Inspection | |

INITIAL SETUP

Tools

Shop set, automotive repair, field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Dial indicator

Micrometer

References

- | | |
|------------|------------------------------|
| Para 6-20 | Crankcase Assembly |
| MIL-1-6868 | Magnetic Particle Inspection |

Troubleshooting References (Table 6-1)

- | |
|-----------------------|
| Malfunction 2, step 4 |
| Malfunction 4, step 5 |

Materials/Parts

Crocus abrasive cloth (Item 1, Appendix E)
Diesel fuel oil (Item 5, Appendix E)
Emery abrasive cloth (Item 2, Appendix E)

Grease (Item 6, Appendix E)
Lubricating oil (Item 9, Appendix E)
Sealing compound (Item 14, Appendix E)
Surfacing stone (Item 17, Appendix E)

Thread compound (Item 19, Appendix E)

Equipment Condition

Para	Condition Description
6-12	Adapter housing and bearing plate assembly removed from engine.
6-17	Connecting rods removed from engine.

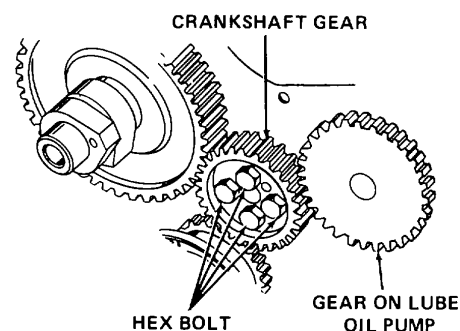
Special Environmental Conditions

Well-ventilated area required during cleaning and repair.

Location/Item	Action	Remarks
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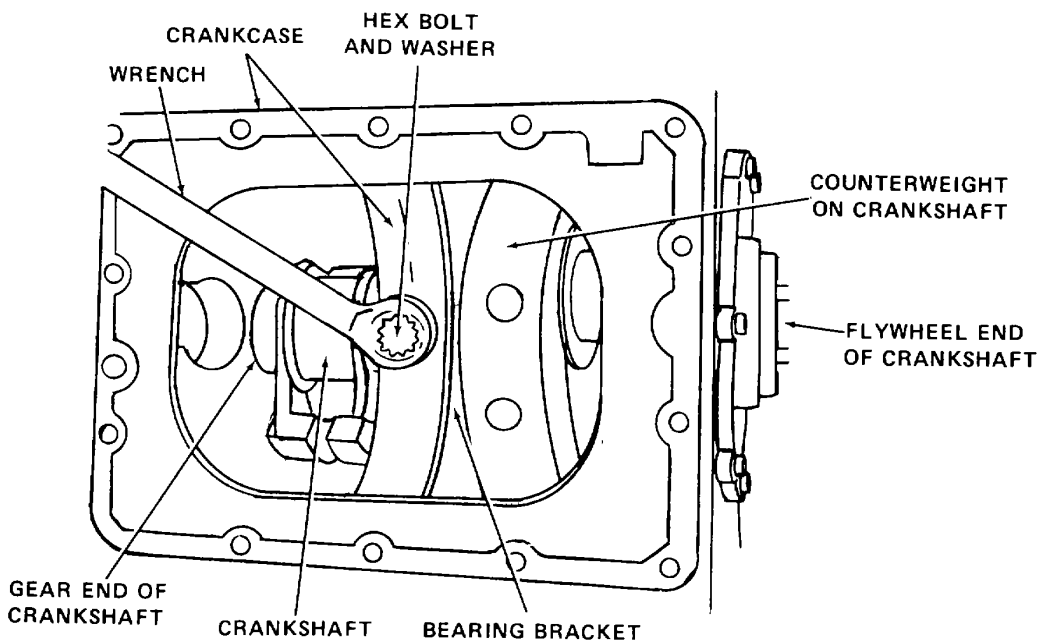
REMOVAL

1. Crankshaft gear Remove hex bolts and crankshaft gear.

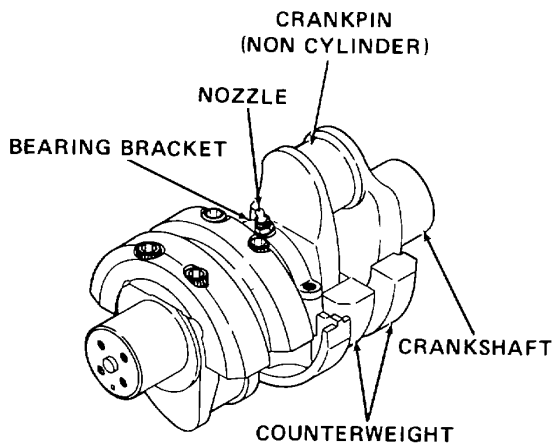


6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
2. Crankshaft and bearing bracket	a. Remove hex bolt and washer from bearing bracket and crankcase.	

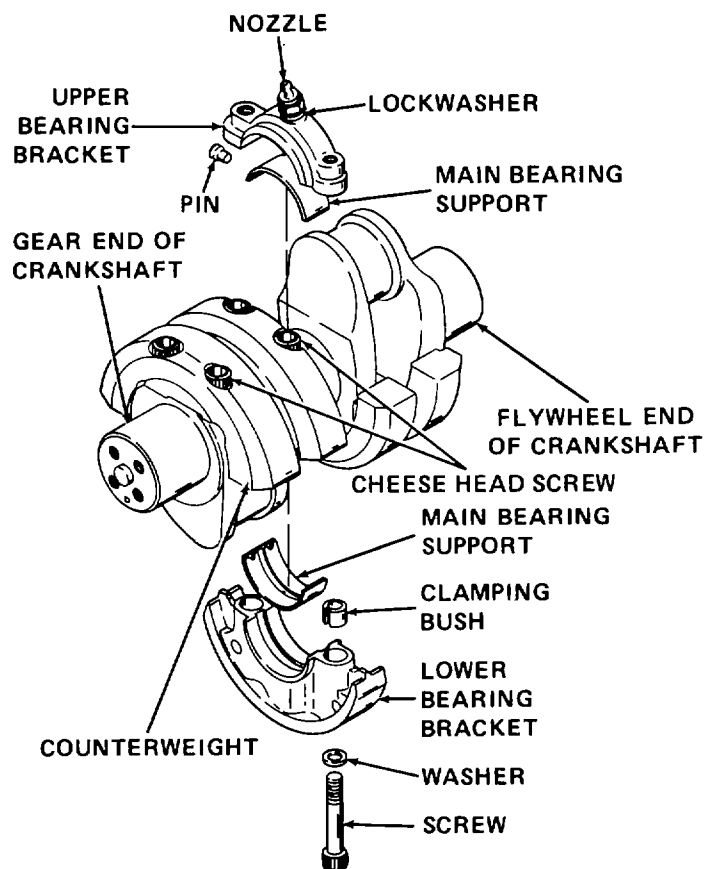


b. Remove crankshaft and bearing bracket from flywheel end of engine.



6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
3. Bearing bracket, main bearing supports, pin, clamping bushes, and counterweights	<p>a. Remove screws and washers from bearing bracket.</p> <p>b. Separate upper and lower bearing brackets, remove, and matchmark. Remove pin and clamping bush. Remove and matchmark main bearing supports. Follow procedure described in paragraph 6-20 for inspection, repair, or replacement of bearing bracket and main bearing supports.</p> <p>c. Remove cheese head screws and counterweights.</p>	



6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CLEANING

WARNING

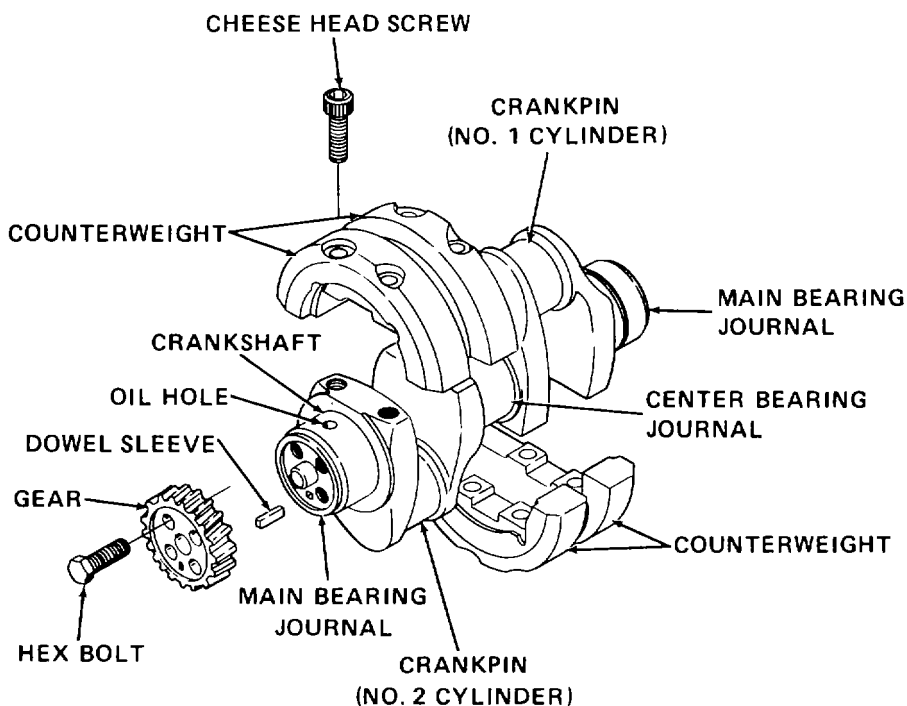
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

4. Crankshaft and associated components

Clean oil passages with a stiff wire brush. Clean crankshaft and associated components with VV-F-800 diesel fuel oil and dry with compressed air.

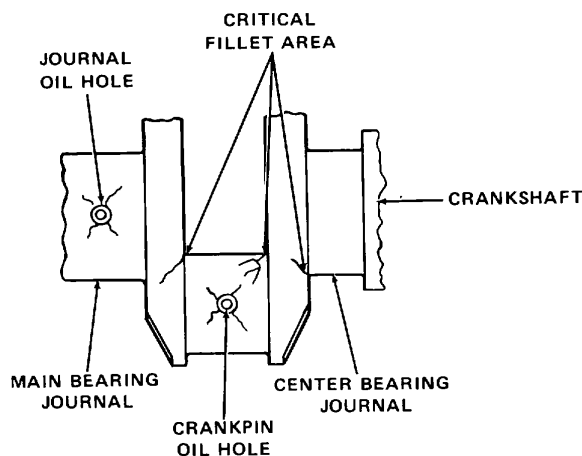


6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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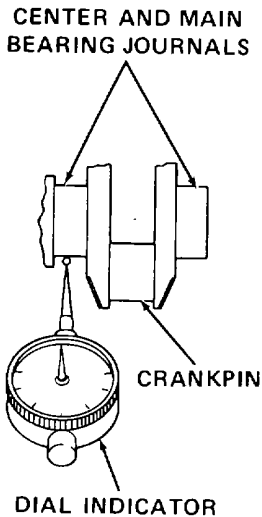
INSPECTION

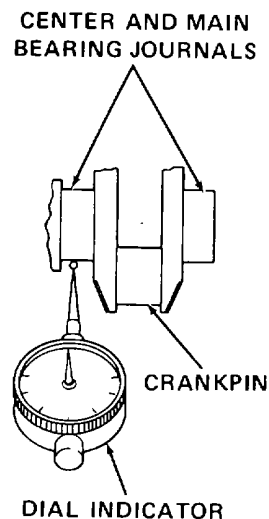
- | | | |
|---|--|--|
| <p>5. Crankshaft gear</p> | <p>a. Inspect for cracking, excessive wear, cracked or broken gear teeth, rust, corrosion, or other damage. If gear is damaged or excessively worn, replace it. Inspect dowel sleeve keyhole. Make sure it has not been worn out of its square shape or that dowel sleeve has not been broken off in dowel sleeve keyhole. If keyhole is worn and/or part of dowel sleeve is lodged in keyhole, replace gear.</p> <p>b. Inspect hex bolts for excessive wear, stripped threads, or other damage. If worn or damaged, replace.</p> <p>c. Inspect dowel sleeve for excessive wear. Replace if worn or damaged.</p> | |
| <p>6. Crankshaft journals and crankpins</p> | <p>Visually inspect for overheating, cracking, excessive wear, or other damage. Visually inspect for cracks which start at an oil hole and follow the journal or crankpin surface at an angle of 45 degrees to the axis. Inspect for cracks in critical fillet areas. Replace crankshaft if cracks are visible. Inspect for minute cracks using MIL-1-6868 Magnetic Particle Inspection. Replace crankshaft if any cracks are found or if it has been overheated.</p> | |



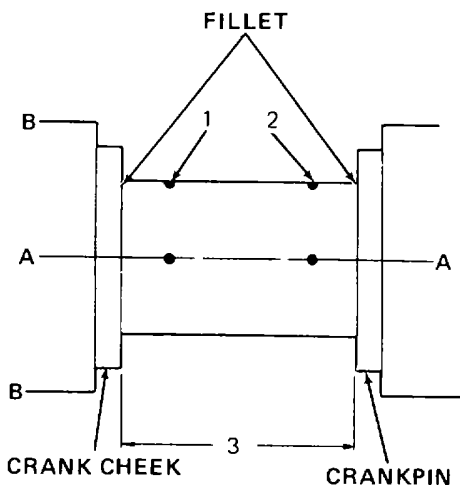
6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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7. Center and main bearing journals	Check alinement at adjacent center and main bearing journals with a dial indicator. Maximum allowable runout is 0.002 inch (0.0508 mm). Replace crankshaft, if necessary.	
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8. Crankpins	<p>a. Measure diameter of both crankpins at points 1 and 2 and along axis A and B with micrometer. Measure width of crankpin at point 3. Measure radius of fillets between crankpin and crank cheek.</p> 	
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	<p>b. Diameter should be 2.0461 to 2.0469 inches (51.971 to 51.990 mm). If any measurement is outside the specified limits, crankshaft must be replaced.</p>	
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6-18. CRANKSHAFT ASSEMBLY (CONT)

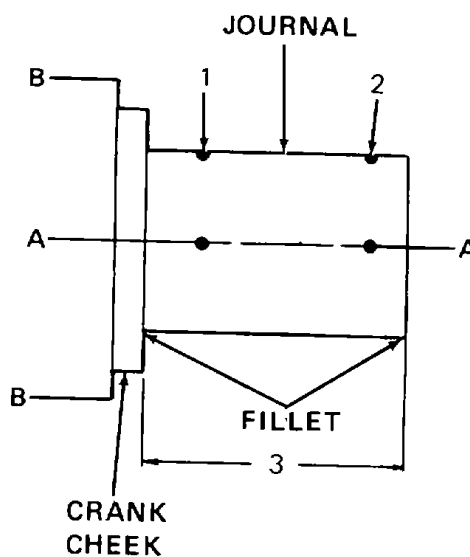
Location/Item	Action	Remarks
	<p>c. However, if the crankpins are evenly worn, not out-of-round, and the crankshaft journal diameters are within specified limits, the condition may be rectified by replacing connecting rod big-end bearings. Replace the big-end bearings in accordance with paragraph 6-17. Check the big-end bearing radial clearance. If it exceeds the tolerance limits of 0.0020 to 0.0118 inch (0.05 to 0.3 mm), the crankshaft must be replaced.</p> <p>d. If the measurements at points 1 and 2 differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the tolerance limits, the crankpin is worn into a conical shape and the crankshaft must be replaced. If the measurements along axis A and B differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the tolerance limits, the crankpin is worn into an oval shape and the crankshaft must be replaced. For both these out-of-round conditions, also check connecting rods, pistons, and cylinders for unusual wear.</p> <p>e. The crankpin width at point 3 should be 1.3386 to 1.3401 inches (34.0 to 34.039 mm). The fillet radius measurement should be 0.1693 to 0.1772 inch (4.30 to 4.50 mm). If either measurement is outside the specified limits, the crankshaft must be replaced.</p>	
9. Replacement crankshaft crankpins	If the crankshaft must be replaced, the following crankpin diameter normal and undersizes are available:	

6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
CRANKSHAFT/CRANKPIN NORMAL AND UNDERSIZES		CRANKPIN DIAMETER inches (millimeters)
Normal		2.0461 to 2.0468 (51.971 to 51.990)
First undersize		2.0264 to 2.0272 (51.471 to 51.490)
Second undersize		2.0067 to 2.0075 (50.971 to 50.990)
Third undersize		1.9870 to 1.9878 (50.471 to 50.490)

10. Crankshaft main bearing journals

- a. Measure diameter of both crankshaft main bearing journals at points 1 and 2 and along axis A and B with micrometer. Measure width of journal at point 3. Measure radius of fillets between main bearing journal and crank cheek.



6-18. CRANKSHAFT ASSEMBLY (CONT)

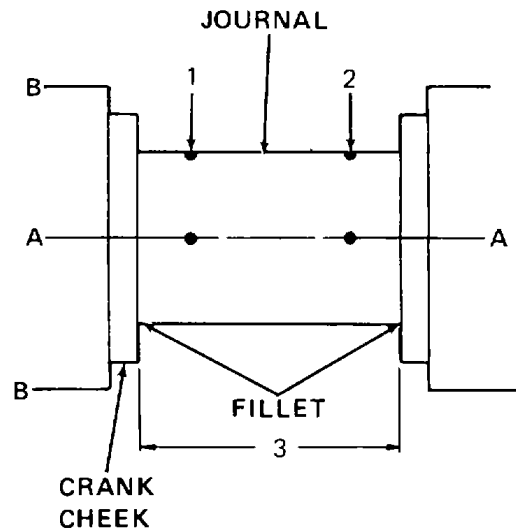
Location/Item	Action	Remarks
	<p>b. Normal main bearing journal diameter should be 2.5185 to 2.5193 inches (63.971 to 63.990 mm). If any measurement is outside the specified limits, the crankshaft must be replaced. However, if journals are evenly worn, not out-of-round, and crankpin diameters are within specified limits, only main bearing bushes need be replaced.</p> <p>c. Replace bearing bushes in accordance with paragraph 6-12. Make sure that main bearing bush radial clearance does not exceed 0.0024 to 0.0118 inch (0.06 to 0.3 mm). If specified limits are exceeded, the crankshaft must be replaced.</p> <p>d. If measurements at points 1 and 2 differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the specified limits, the journal is worn into a conical shape and crankshaft must be replaced. If measurements along axis A and B differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the specified limits, the journals are worn into an oval shape and crankshaft must be replaced. For both of these out-of-round conditions, also check connecting rods, pistons, cylinders, and main bearing bushes for unusual wear. Journal width measured at point 3 should be 1.3130 to 1.3189 inches (33.350 to 33.500 mm). Fillet radius measurement should be 0.1693 to 0.1772 inch (4.30 to 4.50 mm). If either measurement is outside specified limits, the crankshaft-must be replaced.</p>	
<p>11. Replacement crankshaft main bearing journals</p>	<p>If the crankshaft must be replaced, the following main bearing journal diameter normal and undersizes are available:</p>	

6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
MAIN BEARING JOURNALS NORMAL AND UNDERSIZES		JOURNAL DIAMETER inches (millimeters)
Normal		2.5185 to 2.5193 (63.971 to 63.990)
First undersize		2.4989 to 2.4996 (63.471 to 63.490)
Second undersize		2.4792 to 2.4799 (62.971 to 62.990)
Third undersize		2.4595 to 2.4602 (62.471 to 62.490)

12.Crankshaft center bearing journal

a. Measure diameter of crankshaft center bearing journal at points 1 and 2 and along axis A and B with micrometer. Measure width of journal at point 3. Measure radius of fillets between center bearing journal and crank cheeks.



b. Nominal center bearing journal diameter should be 2.3611 to 2.3618 inches (59.971 to 59.990 mm). If any measurement is outside the specified limits, the crankshaft must be replaced. However, if journal is evenly worn, not out-of-round, and main bearing journal and crankpin diameters are within their specified limits, only center main bearing supports need be replaced.

6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
	<p>c. Replace main bearing supports in accordance with paragraph 6-20. Make sure that main bearing support radial clearance does not exceed 0.0020 to 0.0118 inch (0.05 to 0.3 mm). If specified limits are exceeded, the crankshaft must be replaced.</p> <p>d. If measurements at points 1 and 2 differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the specified limits, the journal is worn into a conical shape and crankshaft must be replaced. If measurements along axis A and B differ by more than 0.0028 inch (0.07 mm) and/or one set is outside the specified limits, the journal is worn into an oval shape and crankshaft must be replaced. For both these out-of-round conditions, also check connecting rods, pistons, cylinders, main bearing bushes, and main bearing supports for unusual wear. Journal width measured at point 3 should be 1.5709 to 1.5787 inches (39.900 to 40.100 mm). Fillet radius measurement should be 0.1693 to 0.1772 inch (4.30 to 4.50 mm). If either measurement is outside specified limits, the crankshaft must be replaced.</p>	

13. Replacement crankshaft center bearing journals

If the crankshaft must be replaced, the following center bearing journal diameter normal and undersizes are available:

CENTER BEARING JOURNALS NORMAL AND UNDERSIZES	JOURNAL DIAMETER inches (millimeters)
Normal	2.3611 to 2.3618 (59.971 to 59.990)
First undersize	2.3414 to 2.3421 (59.471 to 59.490)
Second undersize	2.3217 to 2.3224 (58.971 to 58.990)
Third undersize	2.3020 to 2.3028 (58.471 to 58.490)

6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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REPAIR

14. Crankshaft drive end contact surface	Inspect crankshaft drive end (to flywheel) contact surface. Lightly stone crankshaft drive end contact surface with MIL-S-17243 surfacing stone to remove any fretting or brinnelling. Remove dirt and debris from contact surface.	
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WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

15. Crankshaft crankpins and bearing journals	If crankpins and/or bearing journals are only slightly outside specified limits because of nicks, burrs, or high spots, remove these slight imperfections with P-C-458 crocus cloth wet with VV-F-800 diesel fuel oil. Work wet crocus cloth evenly around circumference of crankpin or journal until surface is polished smooth. If wet crocus cloth is not effective, use P-C-1673 emery cloth, 120 grit for removing imperfections and 240 grit for finishing. Polish smooth with wet crocus cloth. Use of a piece of rawhide or other suitable rope wrapped around the emery cloth or crocus cloth and drawn back and forth will minimize the possibility of an out-of-round condition developing (keep the strands of rawhide apart to avoid bind). If rawhide or rope is not used, the crankshaft should be rotated at intervals. If the above procedure is not effective or imperfections are too great, the crankshaft must be replaced and crankpins and/or bearing journals must be ground. Procedures for regrinding are not included in this technical manual. Send the crankshaft to depot maintenance for grinding.	
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6-18. CRANKSHAFT ASSEMBLY (CONT)

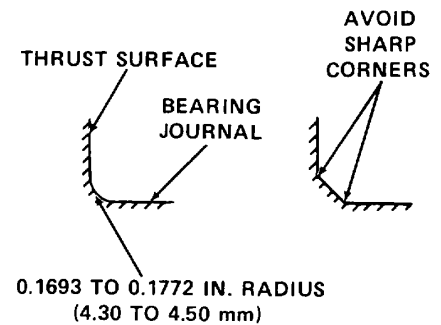
Location/Item	Action	Remarks
16. Crankpin and journals fillets	All fillets must have a 0.1693 to 0.1772 inch (4.30 to 4.50 mm) radius between crank cheek and crankpin or journal and must not have any sharp grind marks. Fillet must blend smoothly into crankpin or journal and crank cheek, and must be free of scratches. Check radius with a fillet gage and polish smooth any slight imperfections with P-C-458 crocus cloth wet with VV-F-800 diesel fuel oil. If radius is too far outside specified limits, the crankshaft crankpins and/or journals and crank cheeks must be re-ground and the crankshaft replaced.	
17. Crankpin and bearing journal oil holes	Stone edges of all oil holes in crankpin and journal surfaces with MIL-S-17243 surfacing stone to provide a smooth radius.	

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

18. Ground surfaces diesel fuel oil.	Polish ground surfaces to an 8 to 12 RMS finish with P-C-458 crocus cloth wet with VV-F-800	
19. Crankshaft thrust surfaces	Inspect. If slightly worn or grooved, smooth out and polish surfaces with wet crocus cloth. Make sure to leave a 0.1693 to 0.1772 inch (4.30 to 4.50 mm) radius on crankshaft between each thrust surface and bearing journal or crankpin.	



6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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CLEANING AFTER REPAIR

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

20. Crankshaft and oil passages

Clean crankshaft and oil passages with VV-F-800 diesel fuel oil and dry with compressed air.

NOTE

If a new crankshaft is to be installed, steam clean it to remove the rust preventive. Blow through oil passages with compressed air.

6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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**INSTALLATION/
REPLACEMENT**

CAUTION

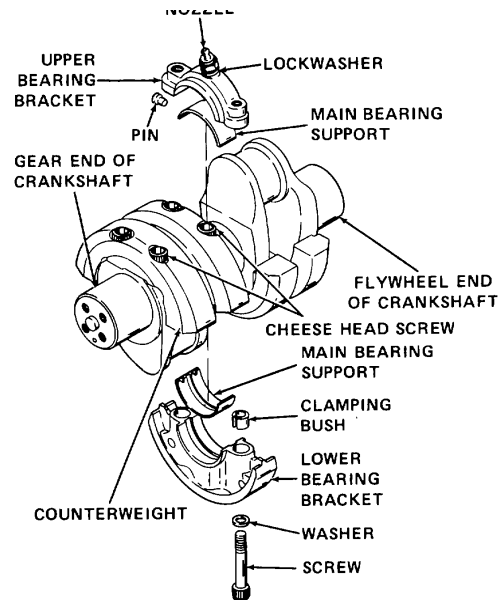
Equipment damage could occur if bearing caps or bearings are not returned to their original positions. Follow match-marks made during disassembly.

NOTE

When a new or reground crankshaft is installed, ALL new main, center, and big-end (upper and lower) bearings must also be installed.

21. Bearing bracket, main bearing supports, pin, clamping counterweights

Make sure upper and lower bearing brackets are correctly matched. Coat main bearing supports with MIL-L-2104 lubricating oil, and install correctly matched main bearing supports, clamping bushes, and pin bushes, and into bearing bracket. Make sure main bearing support with oil groove is installed in upper bearing bracket. Position upper and lower bearing brackets on crankshaft making sure nozzle points toward gear end of crankshaft. Install cheese head screws and counterweights. Tighten screws alternately and evenly to 22.13 ft lb (30 N.m) torque with socket wrench. Using an angular torque gage, tighten screws two additional 30 degree increments.

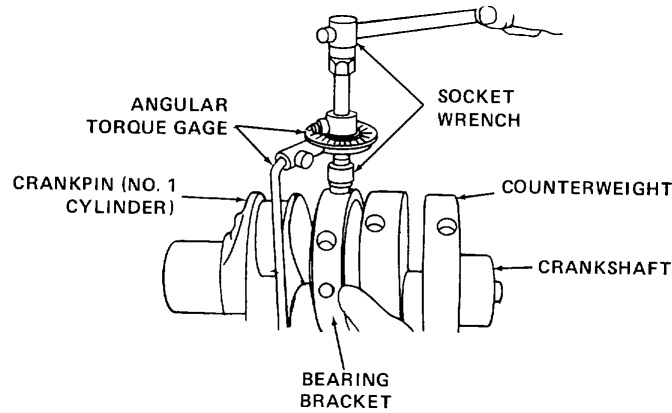


6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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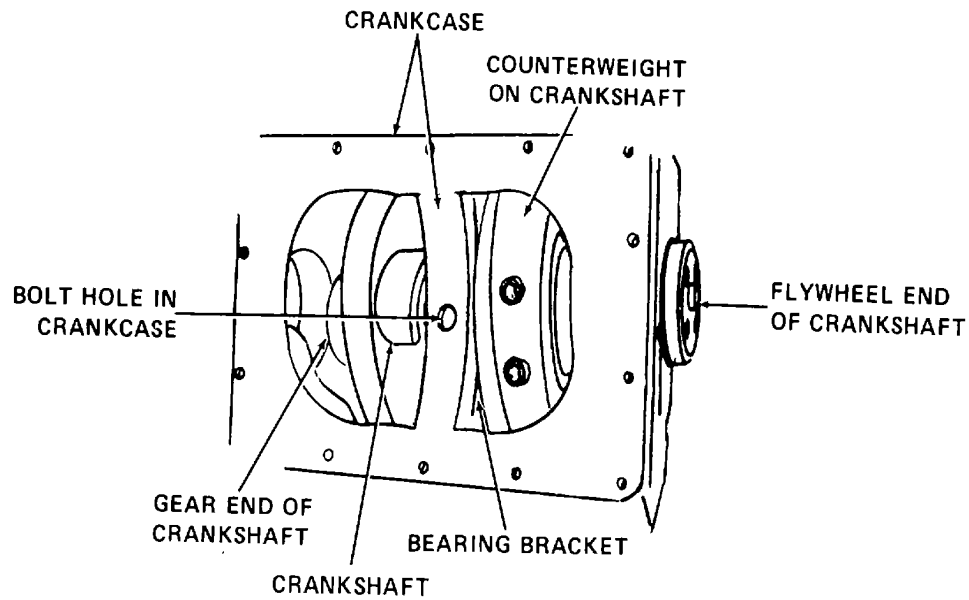
22. Bearing bracket

Install washers and screws in bearing bracket. Tighten screws alternately and evenly to 22.13 ft lb (30 N.m) torque with socket wrench. Using an angular torque gage, tighten screws two additional 30 degree increments.



23. Crankshaft and bearing bracket

Apply MIL-L-2104 lubricating oil to all crankshaft journals and crankpins, and install in crankcase with gear end of crankshaft first. Align bolt holes in bearing bracket and crankcase.

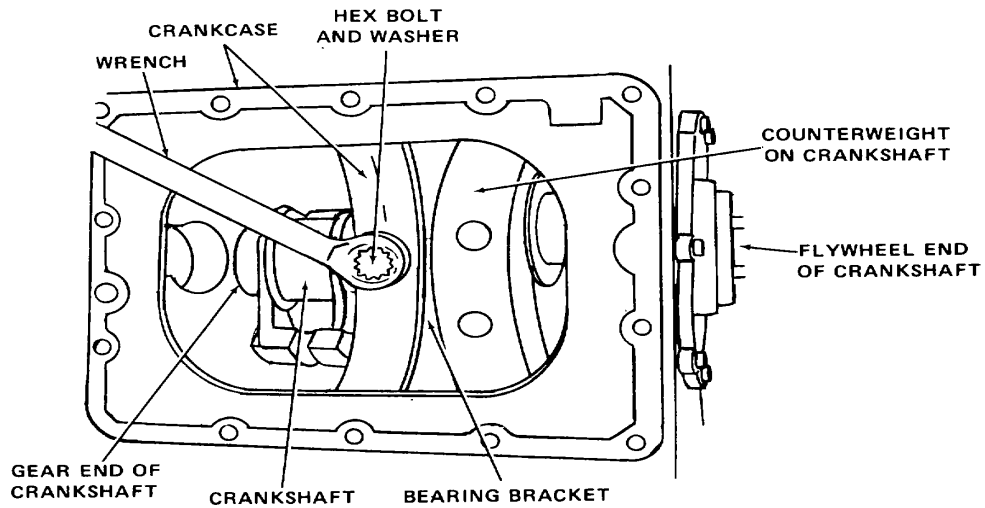
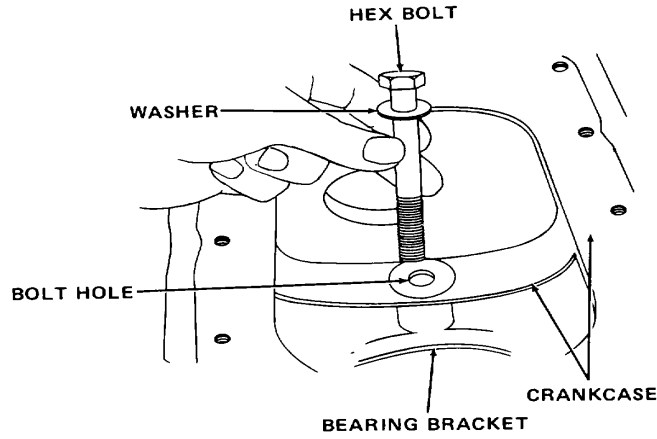


6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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24. Crankcase

Install hex bolt and washer through bolt hole in crankcase into bolt hole in bearing bracket. Tighten hex bolt to 22.13 ft lb (30 N.m) torque with wrench. Using an angular torque gage, re-tighten hex bolt an additional 60 degrees.

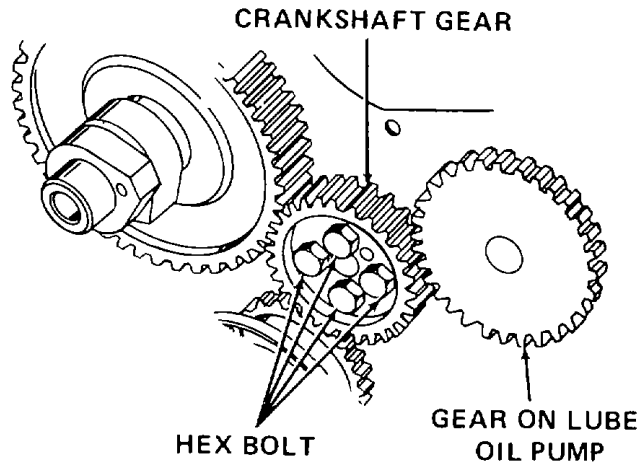


6-18. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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25. Crankshaft gear

Install hex bolts and crankshaft gear. Tighten bolts alternately and evenly to 22.13 ft lb (30 N.m) torque with socket wrench. Using an angular torque gage, tighten bolts two additional 30 degree increments.



6-19. CAMSHAFT

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

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Bore gage

Camshaft plug installer No. 143600

Micrometer

Materials/Parts

Dished plug

Crocus abrasive cloth (Item 1, Appendix E)

Diesel fuel oil (Item 5, Appendix E)

Lubricating oil (Item 9, Appendix E)

Surfacing stone (Item 17, Appendix E)

References

Para 6-20 Crankcase Assembly
Para 6-8 Cylinder Head Assembly,
Rocker Arms, and Tappets

Equipment Condition

Para 6-18	Condition Description Crankshaft removed.
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Special Environmental Conditions

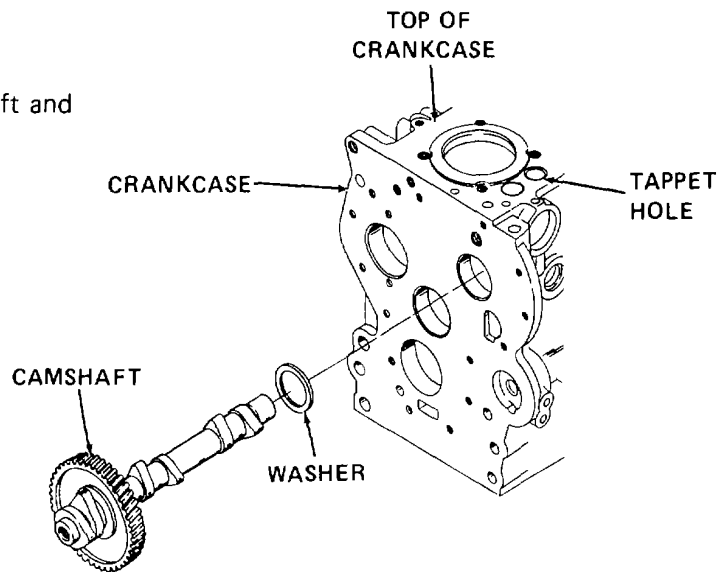
Well-ventilated area required during cleaning
and repair.

6-19. CRANKSHAFT (CONT)

Location/Item	Action	Remarks
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REMOVAL

- | | |
|-------------|-----------------------------|
| 1. Camshaft | Remove camshaft and washer. |
|-------------|-----------------------------|



CLEANING/INSPECTION

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

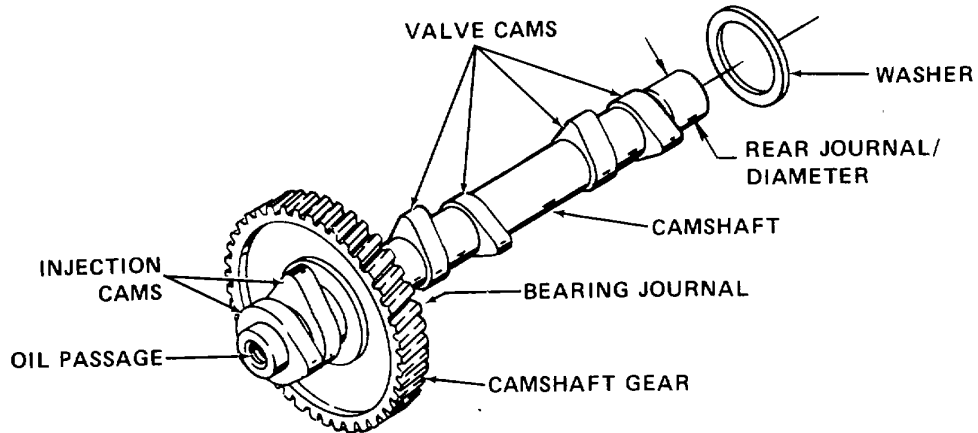
Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

- | | |
|-------------|---|
| 2. Camshaft | Soak camshaft in clean VV-F-800 diesel fuel oil. Then run a wire brush through the camshaft oil passage to remove any foreign material or sludge. Clean exterior of camshaft and blow |
|-------------|---|

6-19. CRANKSHAFT (CONT)

Location/Item	Action	Remarks
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through the oil passage with compressed air. Clean gear, cams, and washer with diesel fuel and dry with compressed air. Inspect washer and replace if damaged or worn.



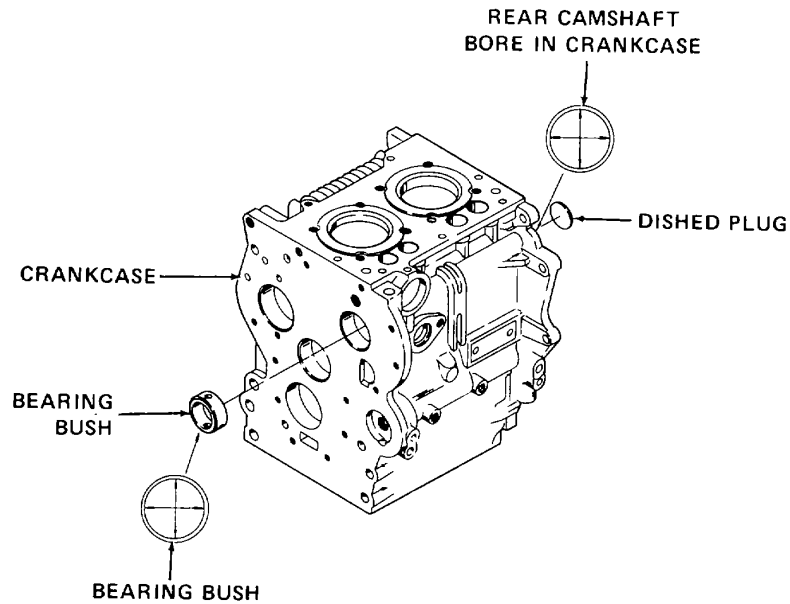
NOTE

If a new camshaft is to be installed, steam clean it to remove the rust preventive. Blow out the oil passages with compressed air.

- | | |
|-----------------------------|---|
| 3. Cams and bearing journal | Inspect for wear and scoring. If cams are scored, inspect tappets in accordance with paragraph 6-8. Replace camshaft if bearing journal or cams are excessively worn or scored. |
| 4. Camshaft | Replace camshaft if bent or damaged. |
| 5. Contact surfaces | Examine all contact surfaces. If surfaces are scratched but not severely scored, they may be smoothed down with a MIL-S-17243 surfacing stone. If the score marks are too deep to be removed, replace camshaft. |

6-19 CRANKSHAFT (CONT)

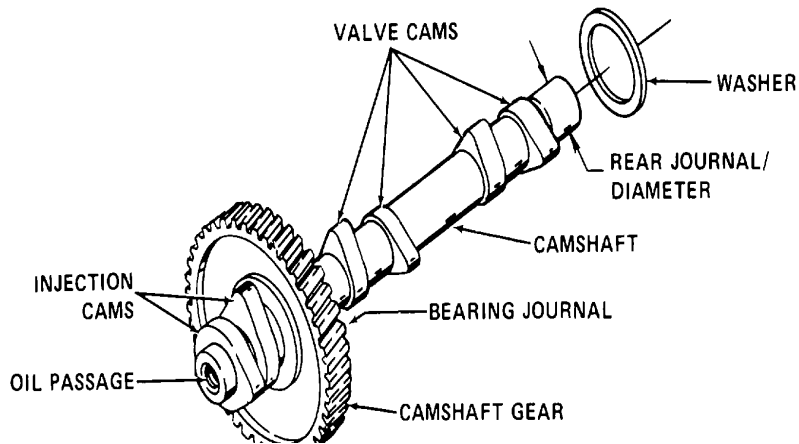
Location/Item	Action	Remarks
6. Camshaft gear	Inspect for cracking, excessive wear, cracked or broken teeth, rust, corrosion, or other damage. If gear is excessively worn or damaged, replace camshaft. Minor nicks, burrs, or wear may be smoothed out with P-C-458 crocus cloth.	
7. Bearing bush	Measure inside diameter with a precision bore gage at 90 degree axes as shown. Diameter should be 1.8902 to 1.8923 inches (48.01 to 48.064 mm). If diameter is outside specified limits, replace bearing bush in accordance with paragraph 6-20.	



8. Bearing journal	Measure outside diameter. Diameter should be 1.8878 to 1.8888 inches (47.950 to 47.975 mm). If diameter is outside specified limits, replace camshaft.	
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6-19. CRANKSHAFT (CONT)

Location/Item	Action	Remarks
9. Radial clearance	The radial clearance (difference between above measurements) for new camshaft bearing should be 0.0014 to 0.0045 inch (0.035 to 0.114 mm) or for worn parts a maximum of 0.0079 inch (0.200 mm). Replace bearing journal or bearing as needed to restore tolerance.	
10. Rear camshaft bore in crankcase and dished plug	Knock out dished plug and discard. Measure rear camshaft bore in crankcase. Record measurement.	
11. Rear journal on camshaft	Measure diameter of journal. Record measurement.	



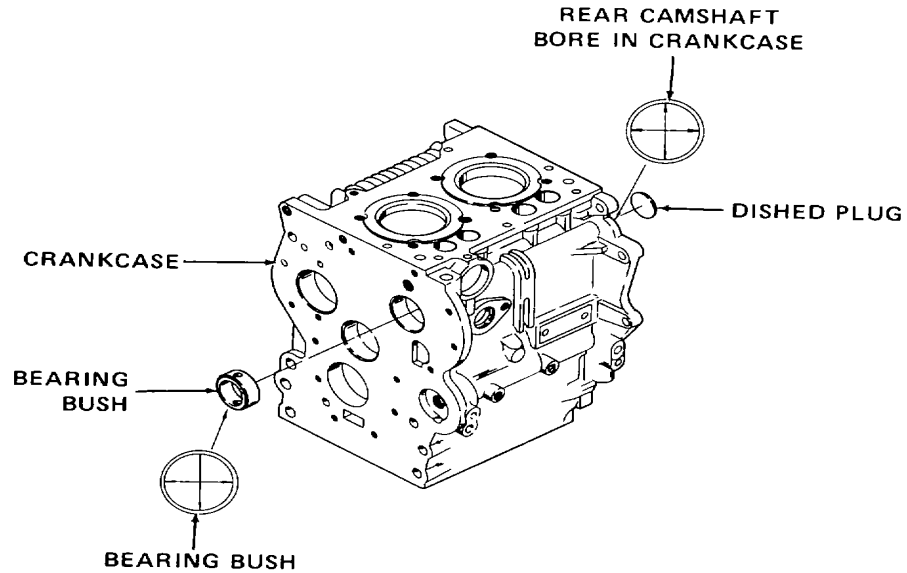
12. Radial clearance and dished plug

Under normal conditions, the radial clearance (difference between above measurements) should be 0.0016 to 0.0037 inch (0.040 to 0.094 mm). If clearance is greater than 0.0079 inch (0.200 mm), the camshaft and/or crankcase must be replaced. If camshaft rear journal diameter is within its specified limits, replace the crankcase in accordance with paragraph 6-20. If camshaft rear journal is worn and outside its specified limits, replace the camshaft. Measure bore, journal, and radial clearance

6-19 CRANKSHAFT (CONT)

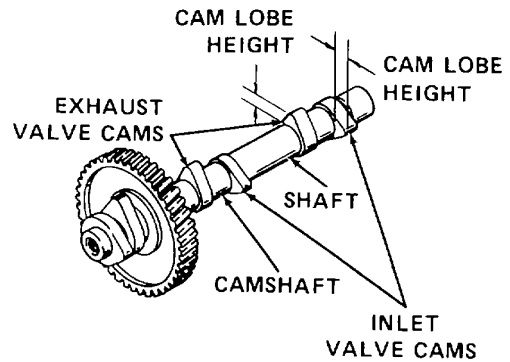
Location/Item	Action	Remarks
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again to check that the clearance is within specified limits. Install new dished plug with camshaft plug installer No. 143600.



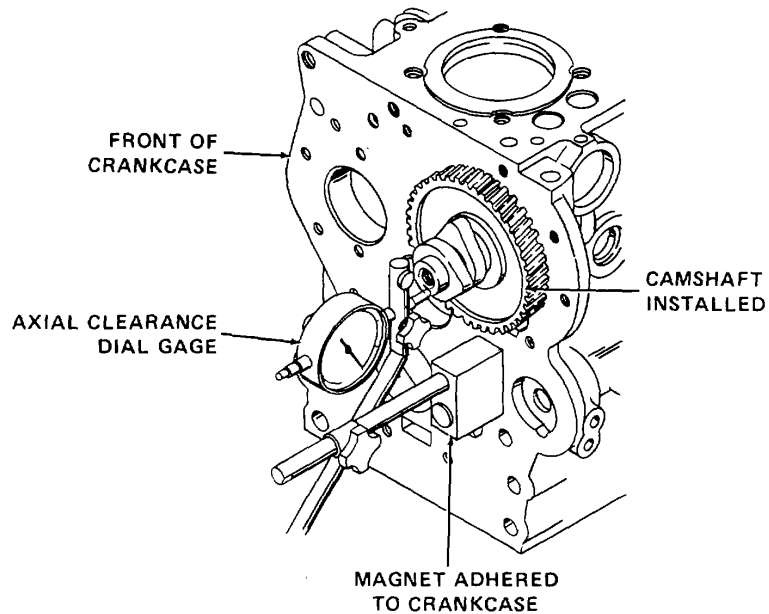
13. Inlet and exhaust cam lobe height

Measure height of cam lobe from shaft to top of lobe. Height should be 0.3110 to 0.3189 inch (7.90 to 8.10 mm). If cam lobes are damaged or worn, and do not measure within the specified limits, replace camshaft. Minor nicks, burrs, or wear may be smoothed out with a MIL-S-17243 surfacing stone or P-C-458 crocus cloth. Reclean camshaft as described in step 2.



6-19. CRANKSHAFT (CONT)

Location/Item	Action	Remarks
14. Axial clearance	<p>Install camshaft and measure axial clearance. Clearance should be 0.0098 to 0.0236 inch (0.250 to 0.600 mm). If clearance is not within specified limits, recheck bearing bush. Make sure bearing bush bore is within specified limits and bush is seated properly in crankcase. Replace in accordance with paragraph 6-20 if necessary. Recheck bearing journal on camshaft for wear. Replace if worn close to camshaft gear. Recheck washer and camshaft gear for wear. Replace washer or camshaft if necessary. Recheck axial clearance to see that it is within specified limits.</p>	



6-19 CRANKSHAFT (CONT)

Location/Item	Action	Remarks
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REPAIR/REPLACEMENT

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

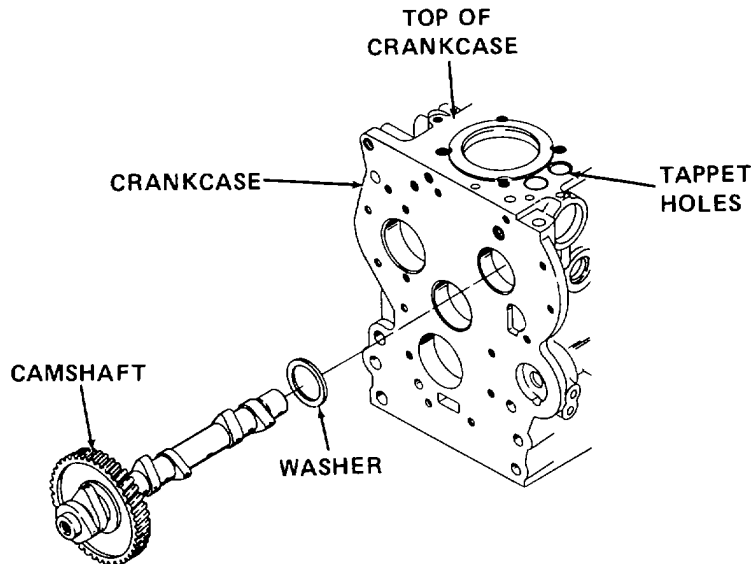
15. Contact surfaces	If surfaces are severely scratched, worn, or scored, replace camshaft. Repair minor nicks, burrs, or wear with MIL-S-17243 surfacing stone. Clean with VV-F-800 diesel fuel oil and dry with compressed air.	
16. Camshaft gear	Repair minor nicks, burrs, or wear with P-C-458 crocus cloth. Clean with VV-F-800 diesel fuel oil and dry with compressed air. Replace camshaft for severe cracking or damage to gear.	
17. Bearing bush	Replace in accordance with paragraph 6-20 if bore is outside specified limits. Do not repair bearing bush.	
18. Bearing journal	Replace if diameter is outside specified limits. Do not repair bearing journal.	
19. Bearing bush and camshaft	Replace bearing bush or camshaft if radial clearance is outside specified limits. Replace bearing bush in accordance with paragraph	
6-20.		
20. Camshaft and crankcase assembly	Replace camshaft or crankcase assembly if radial clearance at rear camshaft bore is outside specified limits. Replace crankcase in accordance with paragraph 6-20.	

6-19. CRANKSHAFT (CONT)

Location/Item	Action	Remarks
21. Valve cams on camshaft	Replace camshaft if any inlet or exhaust valve cam lobe height is outside specified limits. Repair only minor nicks, burrs, or worn spots with MIL-S-17243 surfacing stone or P-C-458 crocus cloth. Repair only if repairs will not cause the tolerance limits to be exceeded.	
22. Washer	Replace if excessively worn, bent, cracked, or otherwise damaged. Do not repair washer.	

INSTALLATION

23. Camshaft, washer, and bearing bush
 Lubricate with MIL-L-2104 lubricating oil and install in crankcase. If tappets are already installed in crankcase, make sure they are in top dead center position.



6-20. CRANKCASE ASSEMBLY

This task covers:

a. Disassembly	c. Repair/Replacement
b. Cleaning/Inspection	d. Reassembly

INITIAL SETUP

Tools

Shop set, automotive repair,
field maintenance, basic
NSN 4910-00-754-0705

Tool kit, master mechanics
NSN 5180-00-699-5273

Camshaft bearing mandrel No.143620

Camshaft plug installer No.143600

Crankcase cylinder seat refacing tool No.
150010

Main bearing mandrel No.143700

Precision micrometer

Torque gage No.101910

Materials/Parts

Dished plug

Large wire bristle brush

Plug and washer sets

Small wire bristle brush

Crocus abrasive cloth (Item 1, Appendix E)
Diesel fuel oil (Item 5, Appendix E)
Lubricating oil (Item 9, Appendix E)

Materials required by MI L-T-704

References

Para 6-15 Cylinder

Para 6-18 Crankshaft Assembly
Para 6-19 Camshaft

MIL-I-6868 Magnetic Particle Inspection
MI L-T-704 Treatment and Painting of
Materiel

**Equipment
Condition**

Para	Condition Description
4-33	Crankcase breather removed.
4-37	Starter motor removed.
6-19	Camshaft removed.

Special Environmental Conditions

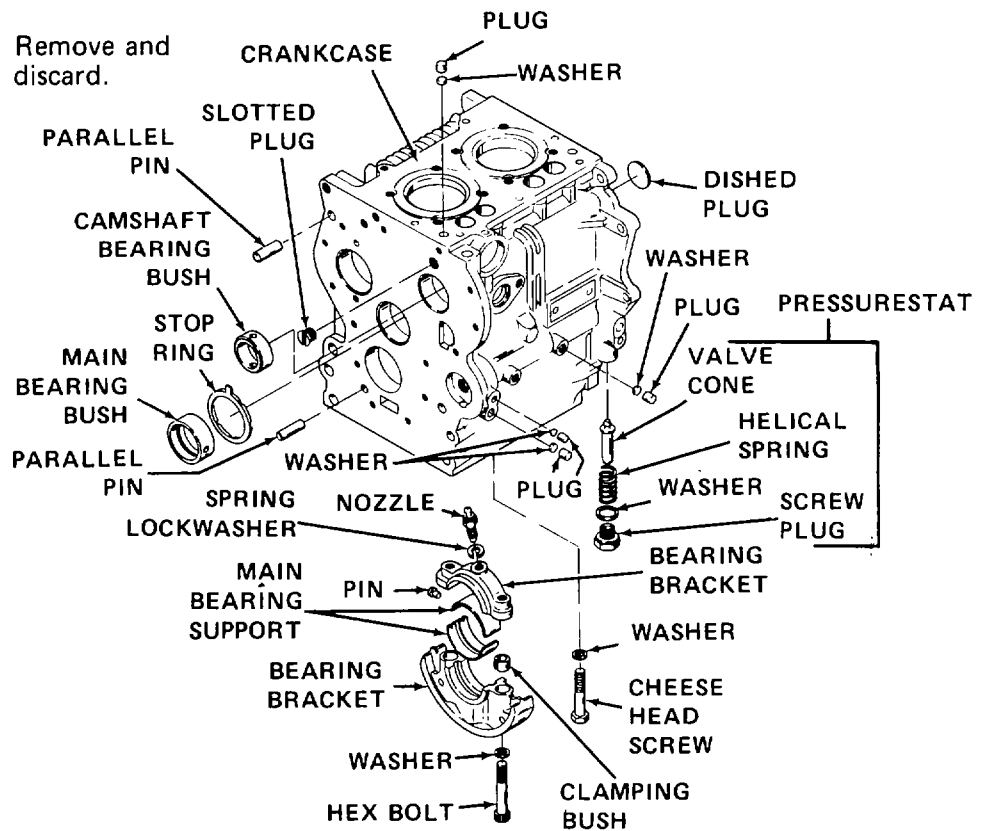
Well-ventilated area required during cleaning.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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DISASSEMBLY

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Bearing bracket and main bearing supports 2. Pressurestat 3. Oil pressure line hose assembly 4. Dished plug 5. Stop ring 6. Parallel pins 7. Slotted plug 8. All plug and washer sets | <p>Remove in accordance with paragraph 6-18.</p> <p>Remove screw plug, washer, helical spring, and valve cone from crankcase.</p> <p>Check that hose assembly has been removed from crankcase. If not, remove.</p> <p>The dished plug has a special conical shape. Do not remove unless absolutely necessary. If plug must be removed, it cannot be reused and must be discarded. Special tooling is required for replacement.</p> <p>Remove.</p> <p>Remove.</p> <p>Remove.</p> <p>Remove and discard.</p> |
|---|--|



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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**CLEANING/
INSPECTION**

WARNING

Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- **Do not inhale vapor.**
- **Work in a well-ventilated area.**
- **Do not use near open flame, sparks, or excessive heat.**

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

Live steam used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct live steam against skin.

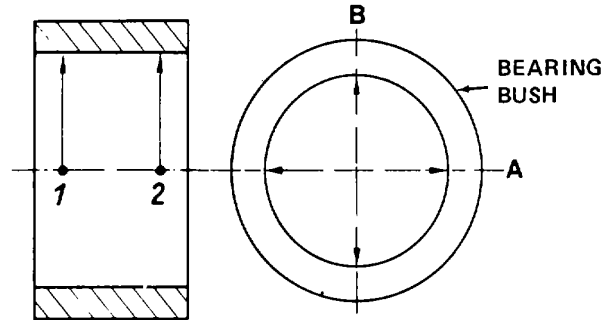
9. Crankcase	Clean thoroughly with live steam. Clean all exterior openings and surfaces. Be especially careful to clean all oil passages to make sure they are free. Use a small and/or large wire bristle brush where necessary to remove carbon or other deposits from openings and surfaces. Use VV-F-800 diesel fuel oil as necessary to soften and remove carbon or hardened oil deposits. Dry with compressed air.	
10. Crankcase	Thoroughly inspect crankcase for any cracks, discoloration, distortion, rust, corrosion, or other damage. Use MIL-1-6868 magnetic particle inspection to detect cracks. If crankcase is cracked, distorted, overheated, seriously rusted or corroded on machined surfaces, or exhibits other serious damage, replace crankcase.	

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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11. Main bearing bush

a. Make sure bush is seated properly in crankcase. Inspect for damage or excessive wear. Measure bearing bush bore with precision micrometer at points 1 and 2 and along axis A and B.

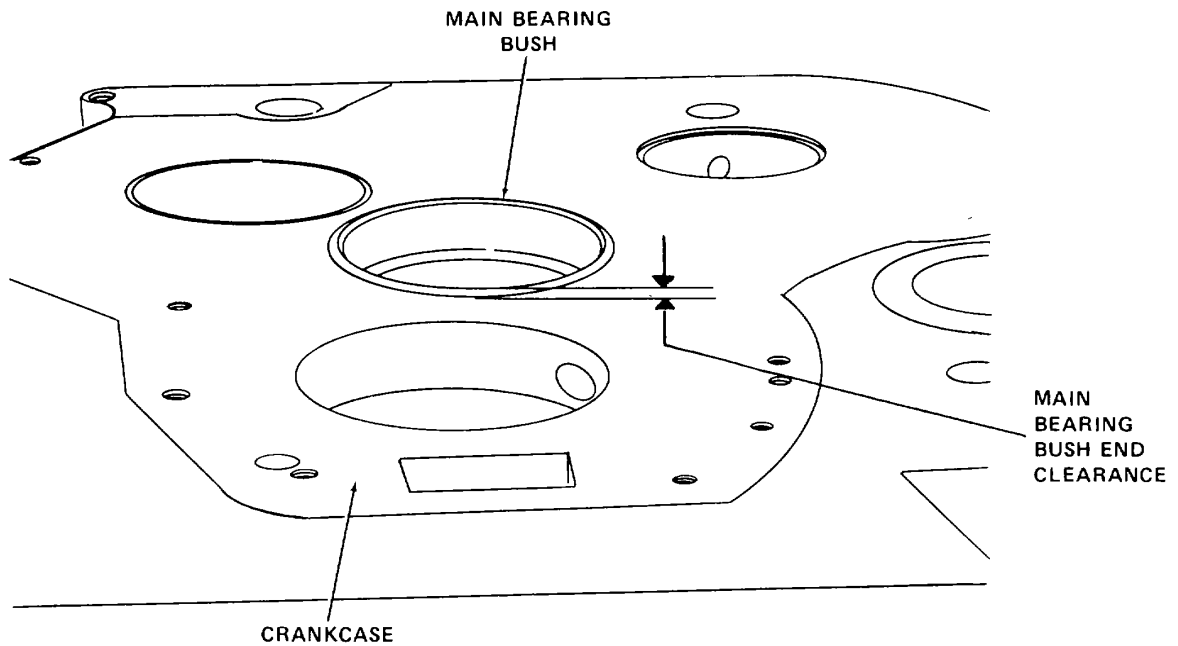


b. The bore of a normal size bearing bush should measure 2.5216 to 2.5232 inches (64.050 to 64.089 mm). If measurements are outside the tolerance limits, replace main bearing bush with one of the normal or undersized bore (oversized wall thickness) bearing bushes listed below:

BEARING BUSH	NORMAL INSIDE DIAMETER AND UNDERSIZES inches (millimeters)	NOMINAL WALL THICKNESS AND OVERSIZES inches (millimeters)
Normal inside diameters and Nominal wall thickness	2.5216 to 2.5232 (64.05 to 64.089)	0.0974 to 0.0976 (2.475 to 2.480)
First undersize	2.5020 to 2.5035 (63.55 to 63.589)	0.1073 to 0.1075 (2.7254 to 2.730)
Second undersize	2.4823 to 2.4838 (63.05 to 63.089)	0.1171 to 0.1173 (2.975 to 2.980)
Third undersize	2.4626 to 2.4641 (62.55 to 62.589)	0.1270 to 0.1272 (3.225 to 3.230)

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
12. Crankshaft main bearing journal and main bearing bush	Replacement of main bearing bush depends on diameter of crankshaft main bearing journal. Measure journal diameter in accordance with paragraph 6-18.	
13. Radial clearance	Determine main bearing bush/crankshaft main bearing journal radial clearance by subtracting journal diameter from bearing bush bore. Clearance should be 0.0024 to 0.0046 inch (0.060 to 0.118 mm). Maximum allowable clearance is 0.0118 inch (0.3 mm). Make sure radial clearance is within tolerance limits. If not, recheck bearing bush, crankshaft, and/or crankcase. Replace components in that order if necessary until radial clearance falls within tolerance limits.	
14. Main bearing bush end clearance	Measure distance that bush extends from crankcase. This measurement is the main bearing bush end clearance. It should be 0.0551 to 0.0669 inch (1.40 to 1.70 mm). If measurement is not within these tolerance limits, bush is either worn down or protrudes too far from crankcase and must be replaced.	

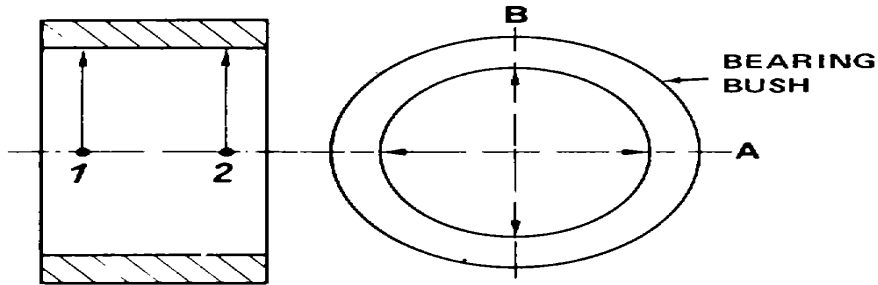


6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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15. Camshaft bearing bush

Make sure bush is seated properly in crankcase. Inspect for damage or excessive wear. Measure bearing bush bore with precision micrometer at points 1 and 2 and along axis A and B.



16. Camshaft bearing bush bore

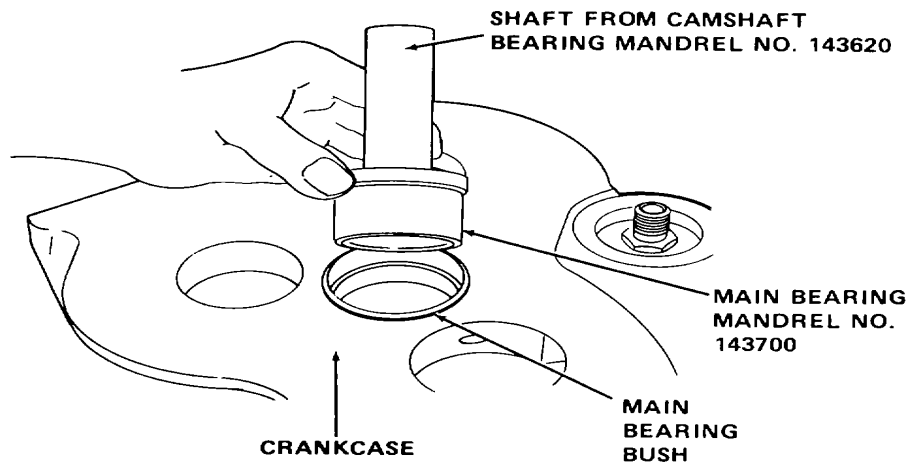
Bore measurements should be 1.8902 to 1.8923 inches (48.01 to 48.064 mm). If measurement in step 15 is outside these tolerance limits, replace bearing bush.

17. Camshaft bearing journal and radial clearance

Measure camshaft bearing journal diameter and determine radial clearance in accordance with paragraph 6-19. If radial clearance is not within tolerance limits, replace bearing bush or camshaft to bring radial clearance within tolerance limits.

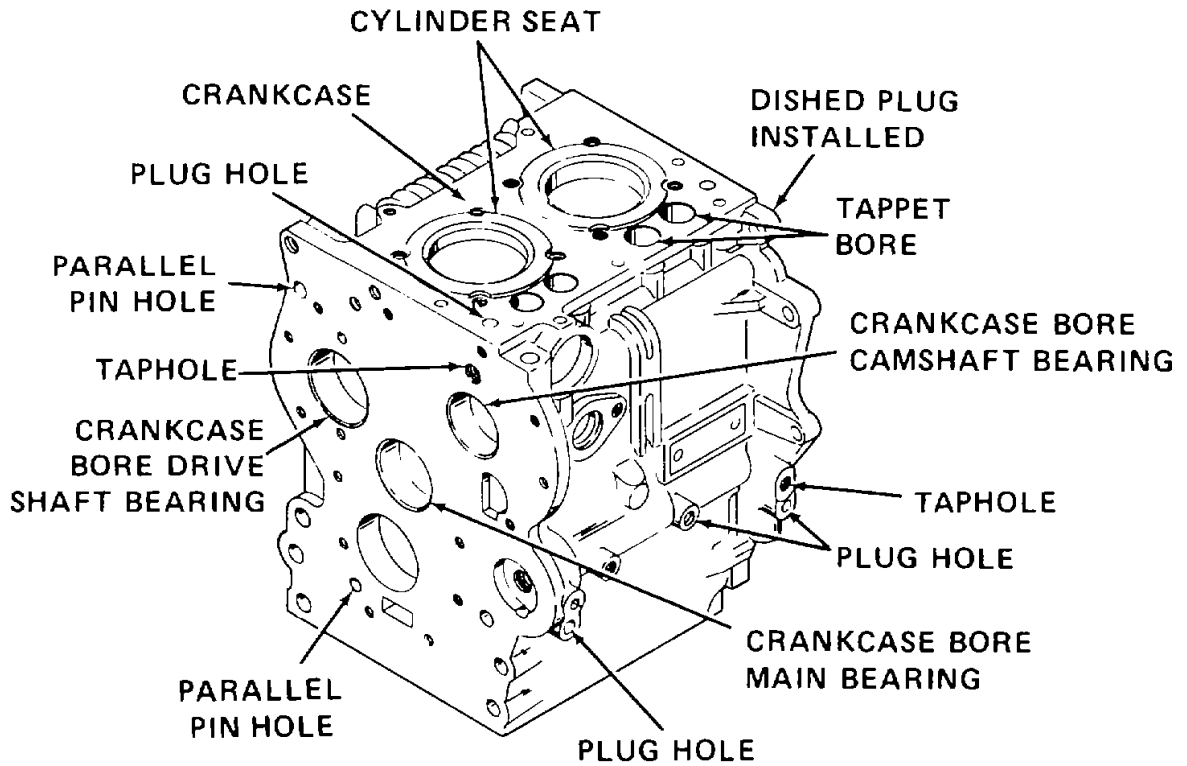
18. Main bearing bush

Drive out main bearing bush with main bearing mandrel No. 143700 and shaft from camshaft bearing mandrel No. 143620.



6-20. CRANKSHAFT ASSEMBLY (CONT)

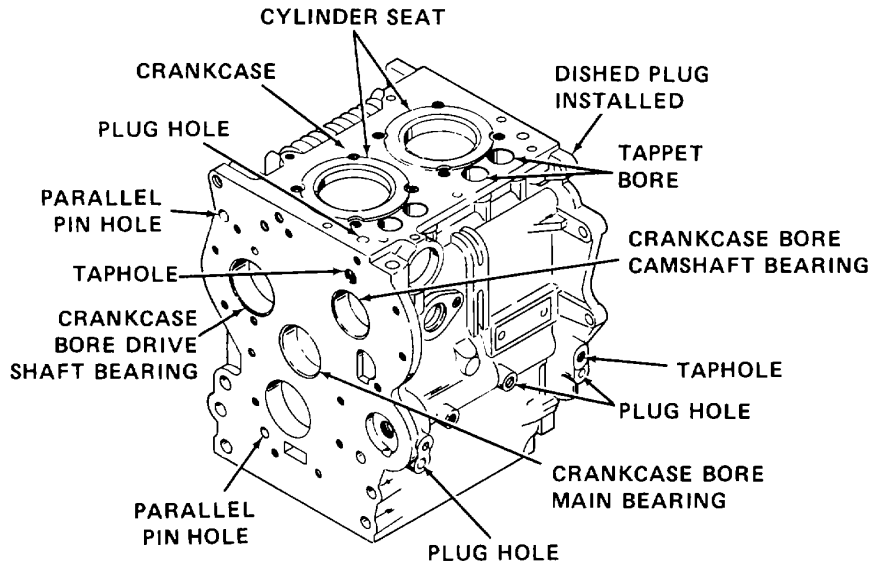
Location/Item	Action	Remarks
19. Camshaft bearing bush	Remove.	
20. Crankcase bore main bearing	Measure bore with precision micrometer. Measurement should be 2.7165 to 2.7173 inches (69.0 to 69.019 mm). If bore measurement is not within these tolerance limits, replace crankcase.	



21. Crankcase bore camshaft bearing	Measure bore with precision micrometer. Measurement should be 2.0472 to 2.0484 inches (52.0 to 52.030 mm). If measurement is not within these tolerance limits, replace crankcase.
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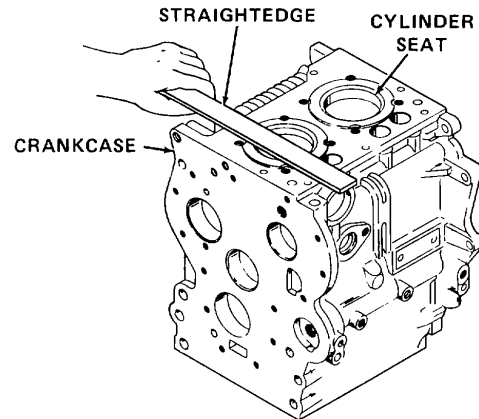
6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
22. Crankcase bore drive shaft bearing	Measure bore with precision micrometer. Measurement should be 2.4392 to 2.4399 inches (61.955 to 61.974 mm). If measurement is not within these tolerance limits, replace crankcase.	



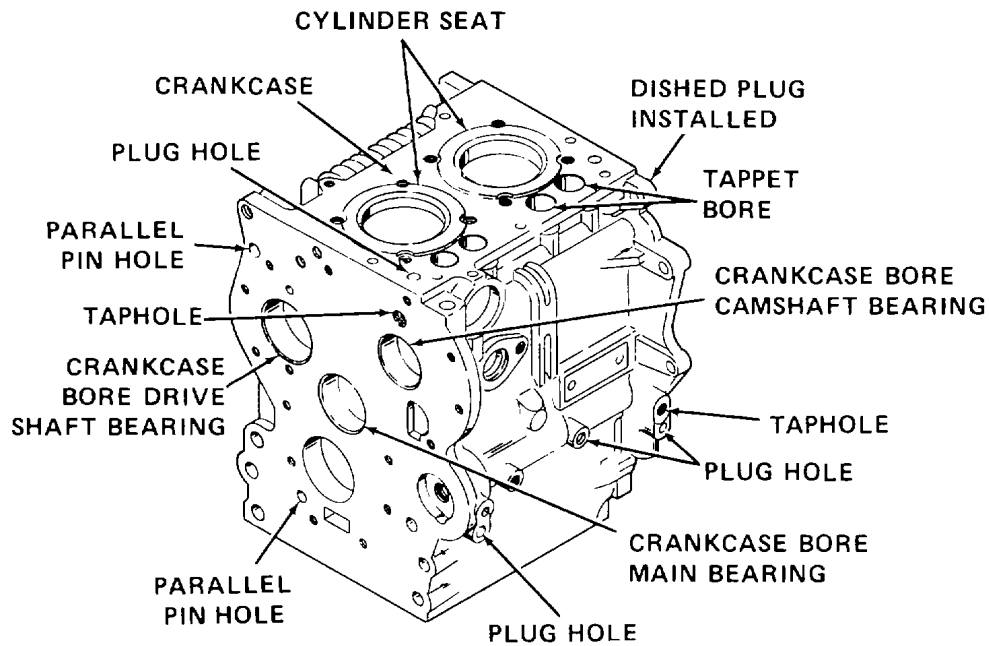
23. Cylinder seats

Inspect seats. Make sure they are smooth and flat. Use a steel straightedge to check flatness. If seats are damaged beyond repair, replace crankcase. If seats can be ground smooth or have minor nicks or burrs, repair in accordance with REPAIR instructions.



6-20. CRANKSHAFT ASSEMBLY (CONT)

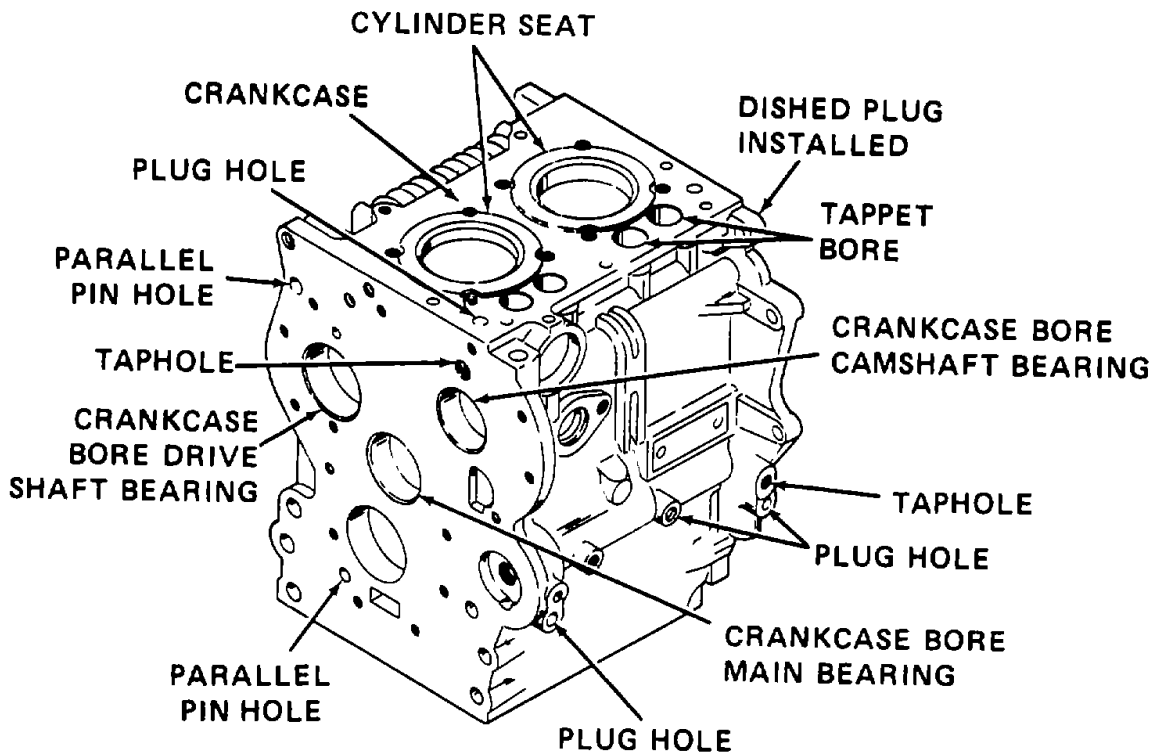
Location/Item	Action	Remarks
24. Tappet bores	Inspect bores for excessive wear or damage. If repairable, follow REPAIR instructions. If severely worn, cracked, or damaged, replace crankcase.	
25. Tapholes	Inspect all tapholes. Make sure they are clean. If necessary, retap in accordance with REPAIR instructions.	



26. Dished plug	Inspect. Make sure plug is tightly seated in crankcase. If not, replace plug.	
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6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
27. Parallel pin holes and plug holes	Inspect all parallel pin and plug holes for wear or damage. If excessively worn or damaged but repairable, retap holes. If not repairable, replace crankcase.	

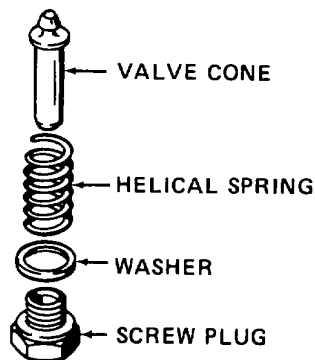


1

INSPECTION

28. Pressurestat

Inspect valve cone, helical spring, washer, and screw plug for excessive wear or damage. Replace valve cone if worn or damaged. Check and replace spring if weak. Replace washer if worn, distorted, or damaged. Replace screw plug for stripped threads, wear, or damage.



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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WARNING

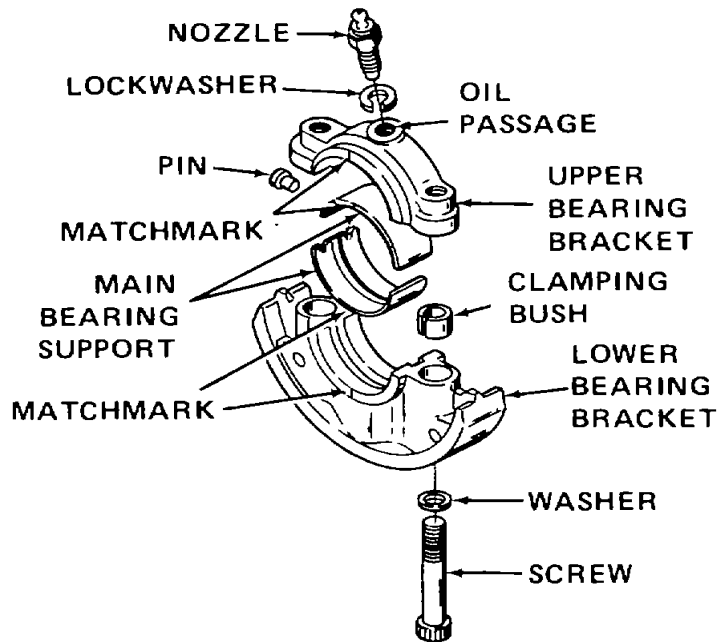
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

29. All main bearing bracket components

Check that matchmarks have been made on main bearing bracket(s) and supports. If not, do so. Clean thoroughly with VV-F-800 diesel fuel oil. Dry with compressed air. Make sure nozzle and oil passage are clean and free of any deposits or restrictions. Inspect nozzle. If worn, clogged, cracked, or damaged, replace. Inspect oil passage. If stripped, worn, cracked, or damaged, replace main bearing bracket (upper and lower). Replace clamping bushes and pin if worn, overheated, cracked, or damaged. Inspect screws and washers. Replace if stripped, worn, bent, or damaged.



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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30. Main bearing bracket

Inspect and replace for excessive wear, overheating, distortion, cracking, high spots, or other damage.

NOTE

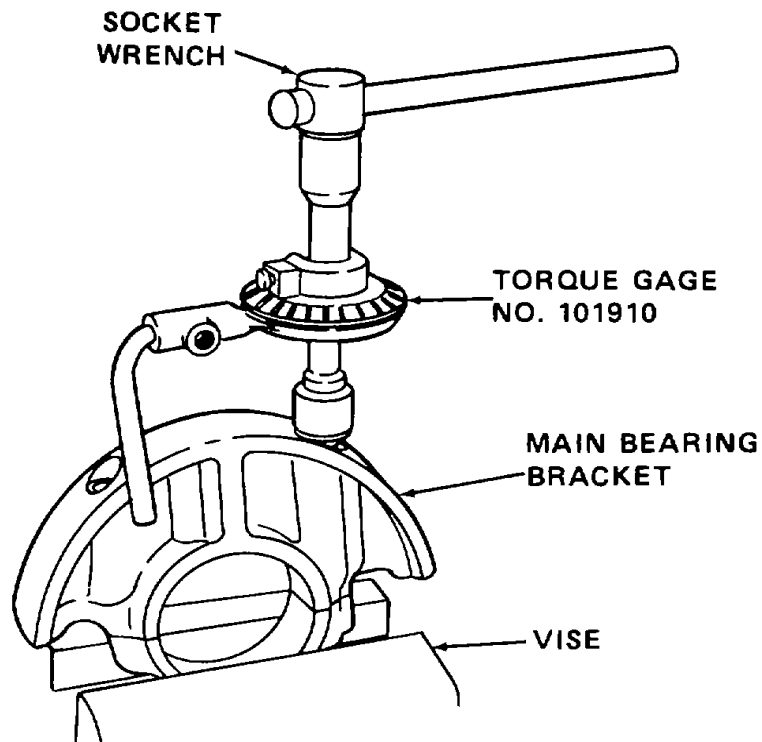
If main bearing bracket is replaced, main bearing support must also be replaced.

31. Main bearing supports

Inspect for excessive wear, overheating, distortion, cracking, or other damage. Measure bearing support wall thickness, which should not be less than 0.1170 inch (2.973 mm). If measurement is less than tolerance limit, replace main bearing supports with normal or oversized wall thickness bearing support.

32. Main bearing bracket bore

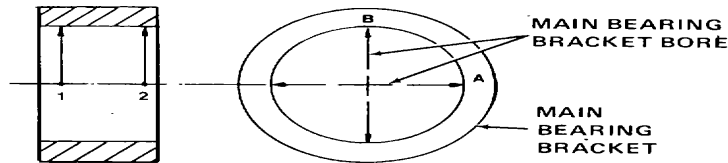
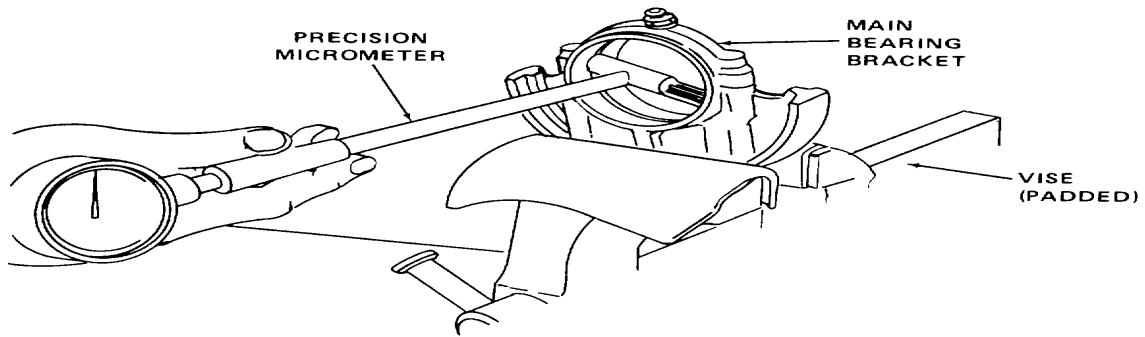
Assemble bearing bracket, clamping bush, washers, and screws. Make sure matchmarks line up properly and clamp in vise. Make sure threads and seat areas are clean. Lightly lubricate them with MIL-L-2104 lubricating oil. Tighten screws alternately and evenly, in small increments, to 22.13 ft lb (30 N.m) torque. Using torque gage No. 101910, tighten screws two additional times in increments of 30 degrees.



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Measure bore with precision micrometer at points 1 and 2 and along axis A and B. Measurements should be 2.5984 to 2.5992 inches (66.00 to 66.019 mm). If all measurements are far from within these tolerance limits, replace bearing bracket. If measurements are only slightly outside the tolerance limits, install new main bearing supports and measure main bearing support bore; otherwise replace main bearing bracket.

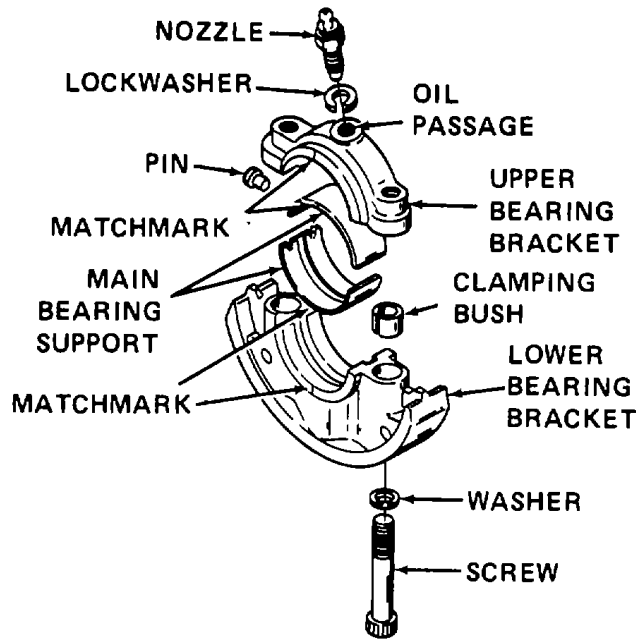


6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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33. Main bearing support bore

If main bearing bracket bore is within or just slightly outside tolerance limits or if a new main bearing bracket is being used, loosen screws alternately and evenly far enough to be able to install main bearing supports and pin. Make sure matchmarks are correctly aligned if new supports are not being installed. Make sure support with oil passage is installed in upper main bearing bracket. If new brackets or supports are being installed, matchmark them. Tighten and retighten screws as in step 32.

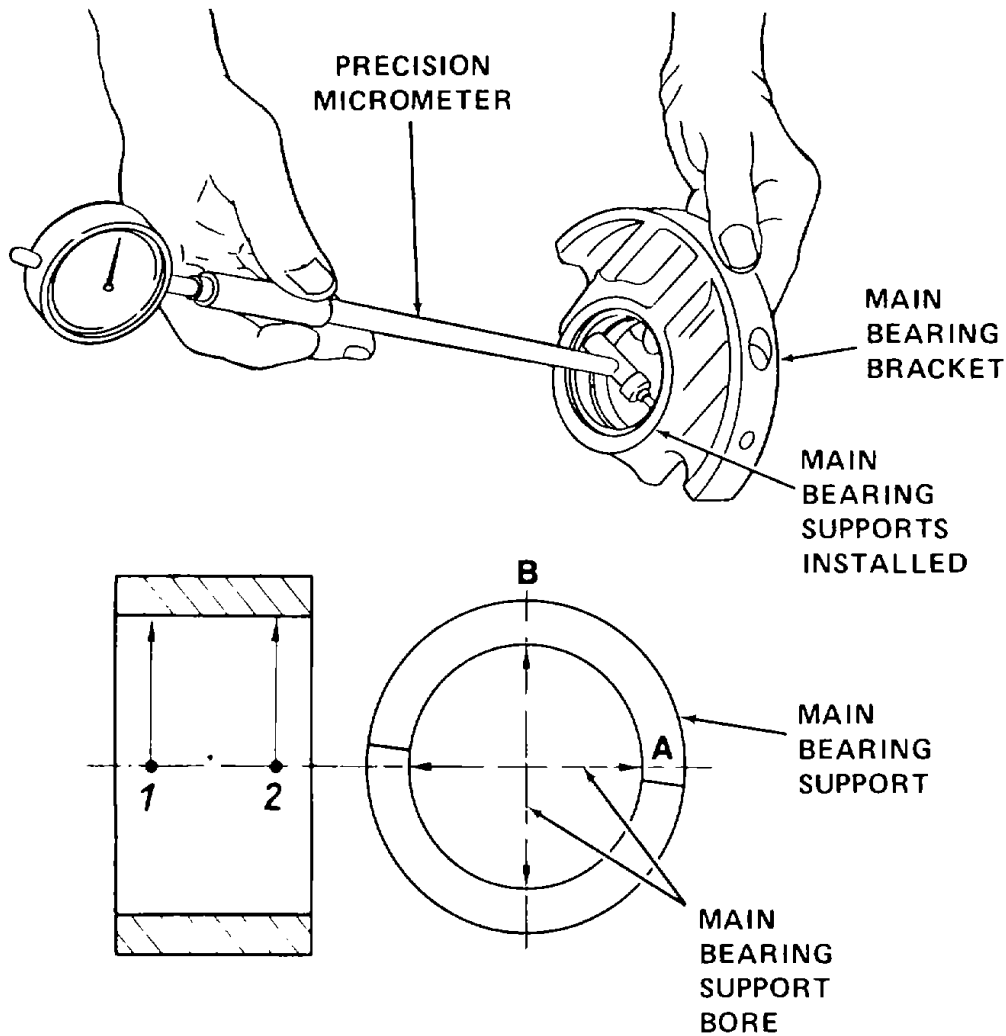


Measure main bearing support bore with precision micrometer at points 1 and 2 and along axis A and B as in step 32. Measurements for a normal size main bearing support should be 2.3638 to 2.3655 inches (60.040 to 60.083 mm). If any measurement is not within these tolerance limits, replace main bearing support.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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If measurements were taken with new main bearing supports and a main bearing bracket that was only slightly outside tolerance limits, the acceptable main bearing support tolerance limits may be increased to 2.3630 to 2.3663 inches (60.020 to 60.103 mm). If measurements are still not within these extended tolerance limits, replace the main bearing bracket.



34. Main bearing support

If replacement bearing supports are necessary, the following normal and undersizes (oversized wall thickness) are available:

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
MAIN BEARING SUPPORT	MAIN BEARING SUPPORT BORE (NORMAL AND UNDERSIZES) inches (millimeters)	MAIN BEARING SUPPORT WALL THICKNESS (NORMAL AND OVERSIZES) inches (millimeters)
Normal	2.3638 to 2.3655 (60.040 to 60.083)	0.1170 to 0.1175 (2.973 to 2.985)
First undersize	2.3441 to 2.3458 (59.540 to 59.583)	0.1269 to 0.1274 (3.223 to 3.235)
Second undersize	2.3244 to 2.3261 (59.040 to 59.083)	0.1367 to 0.1372 (3.473 to 3.485)
Third undersize	2.3047 to 2.3064 (58.540 to 58.583)	0.1466 to 0.1470 (3.723 to 3.735)

35. Radial clearance

Replacement of main bearing supports depends on the diameter of the crankshaft center bearing journal. Measure diameter and determine radial clearance by subtracting journal diameter from bearing support bore. Clearance should be 0.0020 to 0.0044 inch (0.05 to 0.112 mm). Maximum allowable clearance is 0.0118 inch (0.3 mm). If radial clearance is not within these tolerance limits, recheck main bearing supports, main bearing bracket, and/or crankshaft. Replace components in that order until clearance is within tolerance limits.

36. Side clearance

Measure width of crankshaft center bearing journal. Measure width of main bearing bracket at bearing bore. Determine side clearance by subtracting bearing bracket width from bearing journal width. Side clearance should be 0.0079 to 0.0157 inch (0.200 to 0.400 mm). Maximum allowable clearance is 0.0197 inch (0.5 mm). If side clearance is not within these tolerance limits, recheck main bearing bracket and crankshaft center bearing journal. Replace in that order until side clearance is within tolerance limits.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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37. Stop ring

Inspect and replace for excessive wear, cracks, warpage, rust, corrosion, or other damage. Measure thickness. Measurement should be 0.1156 to 0.1175 inch (2.935 to 2.985 mm). If measurement is not within tolerance limits, replace stop ring. Stop rings are available in normal and over-size thickness as shown below:

STOP RING	THICKNESS (NORMAL AND OVERSIZED) inches (millimeters)
Normal	0.1156 to 0.1175 (2.935 to 2.985)
First oversize	0.1254 to 0.1274 (3.185 to 3.235)
Second oversize	0.1352 to 0.1372 (3.435 to 3.485)
Third oversize	0.1451 to 0.1470 (3.685 to 3.735)

38. Parallel pins and screw plug

Inspect and replace if excessively worn, warped, rusted, corroded, or otherwise damaged.

REPAIR/REPLACEMENT

39. Crankcase

Replace if:

Crankcase is cracked, overheated, distorted, or seriously damaged.

Crankcase machined surfaces are severely rusted or corroded.

New main bearing bush or camshaft bush will not seat properly in crankcase.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
	Crankcase bore for main bearing or camshaft bearing bush is outside tolerance limits.	
	Crankcase bore for drive shaft bearing is outside tolerance limits.	
	Cylinder seats are worn, not flat, or damaged beyond repair.	
	Tapholes, tappet bore, dished plug bore, parallel pin, or plug holes are excessively worn, cracked, or damaged beyond repair.	
40. Crankcase	Repair minor rust, corrosion, nicks, or burrs in accordance with MIL-T-704. Use P-C-458 crocus cloth to smooth out surfaces if necessary. Clean, treat, and refinish nonmachined surfaces. Do not finish machined surfaces. Rebore tappet bores if necessary. Retap tapholes if necessary.	
41. Bearing bores	Do not attempt to rebore or otherwise repair any crankcase bearing bores. If bearing bushes or ball bearings do not fit tightly into bore, replace crankcase.	
42. Cylinder seats	Repair minor nicks, burrs, rust, or corrosion with P-C-458 crocus cloth. Clean and treat in accordance with MIL-T-704. Do not refinish. If seats need to be refaced smooth or flat, use crankcase cylinder seat refacing tool No. 150010.	

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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WARNING

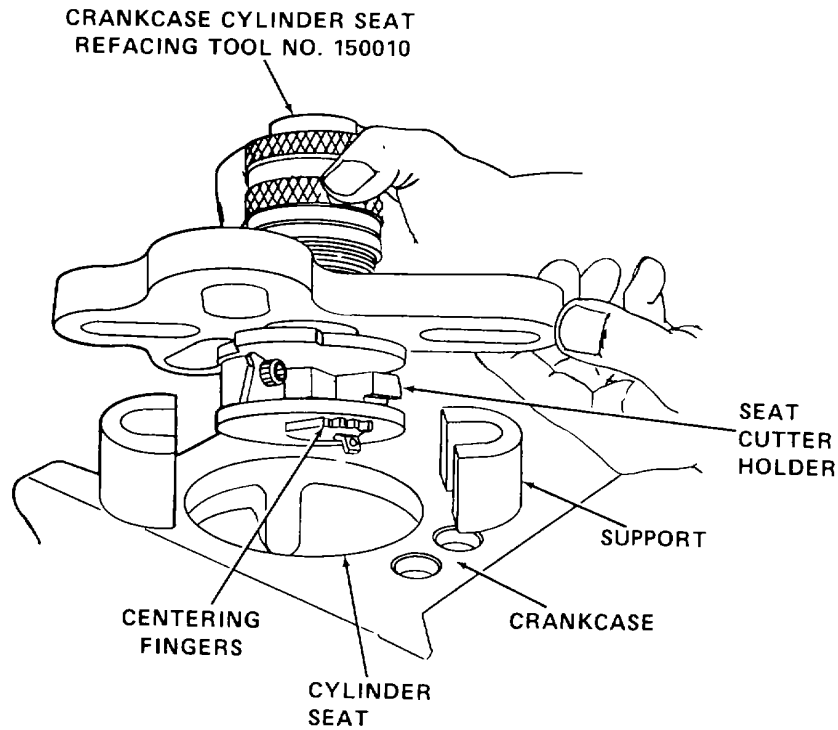
Severe burns, illness, or death may result if personnel fail to handle diesel fuel oil properly. Observe the following precautions:

- Do not inhale vapor.
- Work in a well-ventilated area.
- Do not use near open flame, sparks, or excessive heat.

Death or severe injury might result when compressed air is used to blow dirt from skin or clothing. Air entering body openings is extremely dangerous. Compressed air used for cleaning shall not exceed 100 psi (690 kPa). Use goggles or face shield for eye protection. Do not direct airstream against skin.

43. Crankcase
cylinder seat
refacing tool
No. 150010

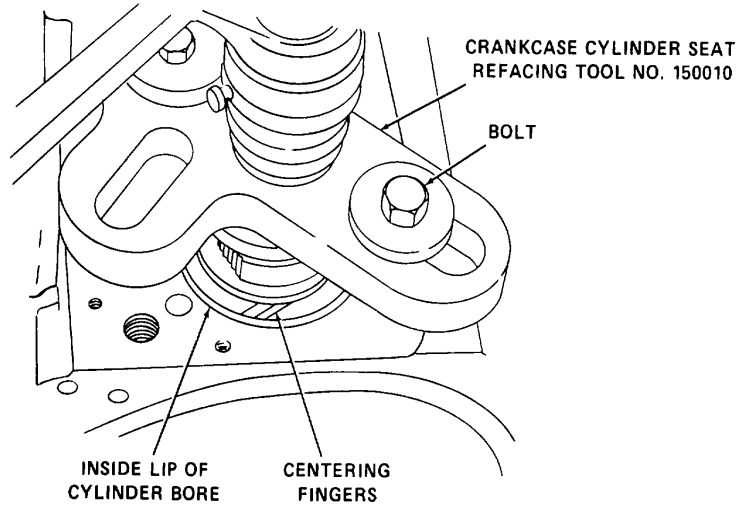
a. Clean cylinder seats thoroughly with VV-F-800 diesel fuel oil and dry with compressed air. Mount crankcase cylinder seat refacing tool No. 150010 with supports onto cylinder seat. Install bolts but do not tighten. Make sure tool is still movable.



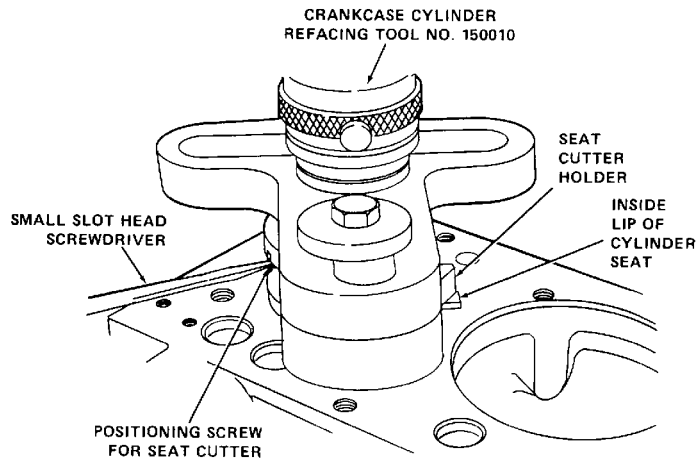
6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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- b. Center refacing tool on inside lip of cylinder bore with centering fingers. Tighten bolts securely.



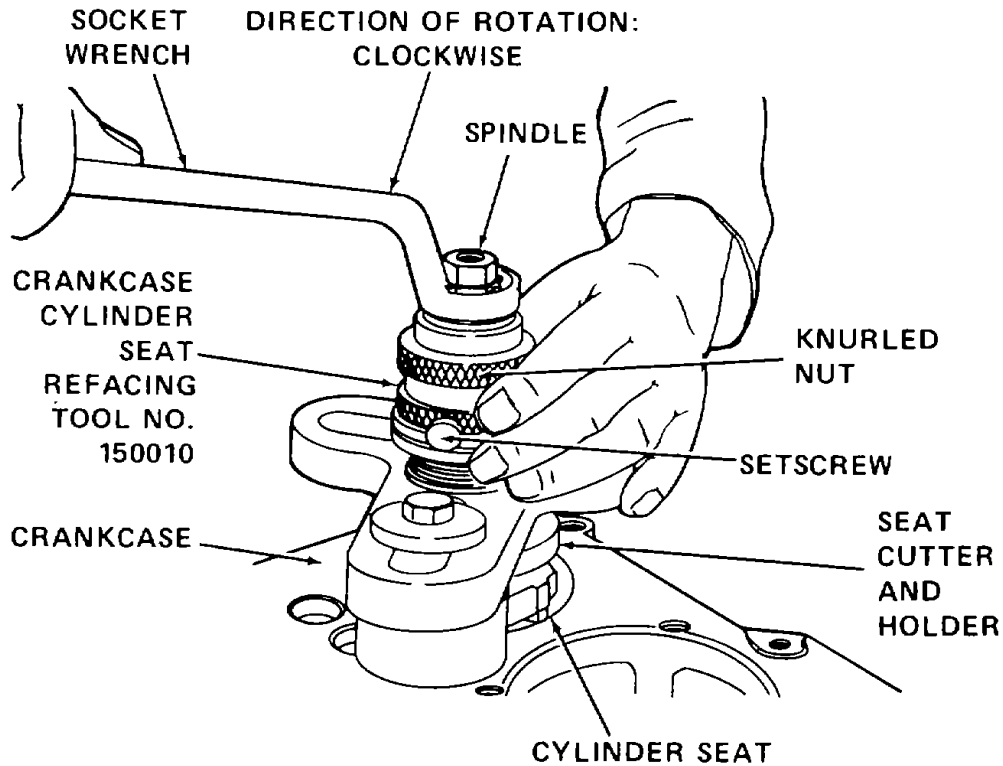
- c. Withdraw centering fingers and position seat cutter holder over inside lip of cylinder seat with positioning screw and small slot-head screwdriver.



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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d. Turn spindle and knurled nut clockwise (viewing unit from top) until seat cutter and holder just contact cylinder seat. Lock knurled nut in place with setscrew.



CAUTION

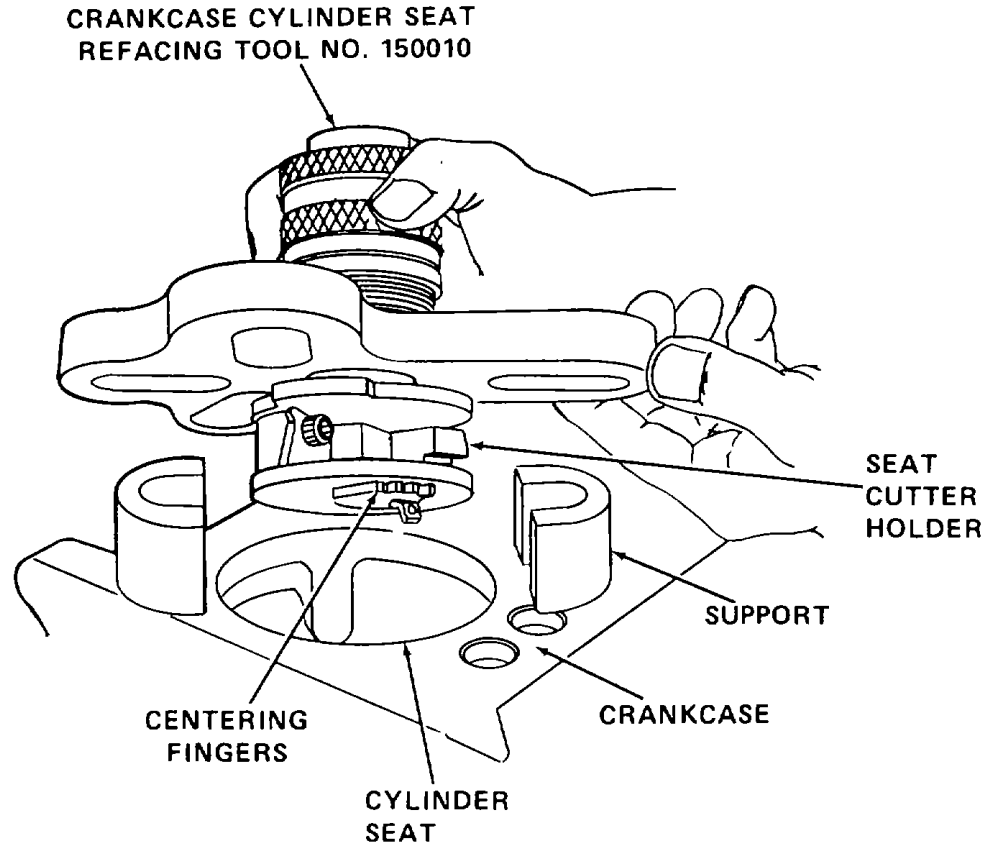
Do not turn spindle counterclockwise. This will damage the cylinder seat and may damage the crankcase bore. Turn only in clockwise direction as shown.

44. Cylinder seat refacing

Turn spindle clockwise to smooth, flatten, and reface cylinder seat as necessary. Do not remove more material than absolutely necessary.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
45. Crankcase cylinder seat refacing tool No. 150010	After refacing cylinder seat, loosen setscrew and turn knurled nut counterclockwise to back seat cutter and holder away from cylinder seat. Withdraw seat cutter holder with positioning screw and remove refacing tool.	



46. Cylinder seat refacing

If other cylinder seat also needs to be refaced, smoothed, and or flattened, repeat above process starting with step 43.

NOTE

If cylinder seats are refaced, check piston top clearance when cylinder and cylinder head are installed. If too much of the cylinder seat has not been removed, the difference in height can be corrected with additional shims when the cylinder is installed. Follow procedure in paragraph 6-15.

47. Dished plug, parallel pins, plugs, and washers

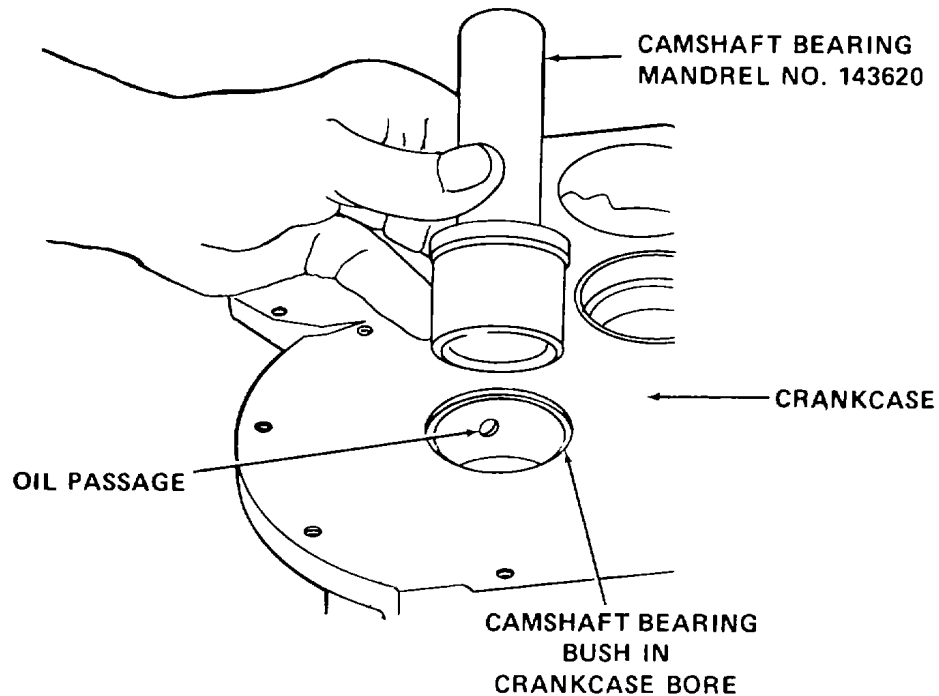
Do not attempt repairs on these components. Replace if worn, cracked, or damaged.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
48. Pressuresta	Do not attempt repairs on valve cone, helical spring, washer, or screw plug. Replace if worn, distorted, or damaged.	
49. Main bearing bracket components	Do not attempt repairs on these components. Replace if excessively worn, out-of-tolerance, overheated, distorted, cracked, or damaged in any way. Replace main bearing bracket and main bearing supports as necessary to maintain correct bore clearances and radial clearances with crankshaft. Replace with normal or oversized bore main bearing supports as required.	
50. Stop ring	Do not attempt repairs. Replace if worn, cracked, warped, rusted, corroded, or damaged. Replace with normal or oversized thickness stop ring as required.	

REASSEMBLY

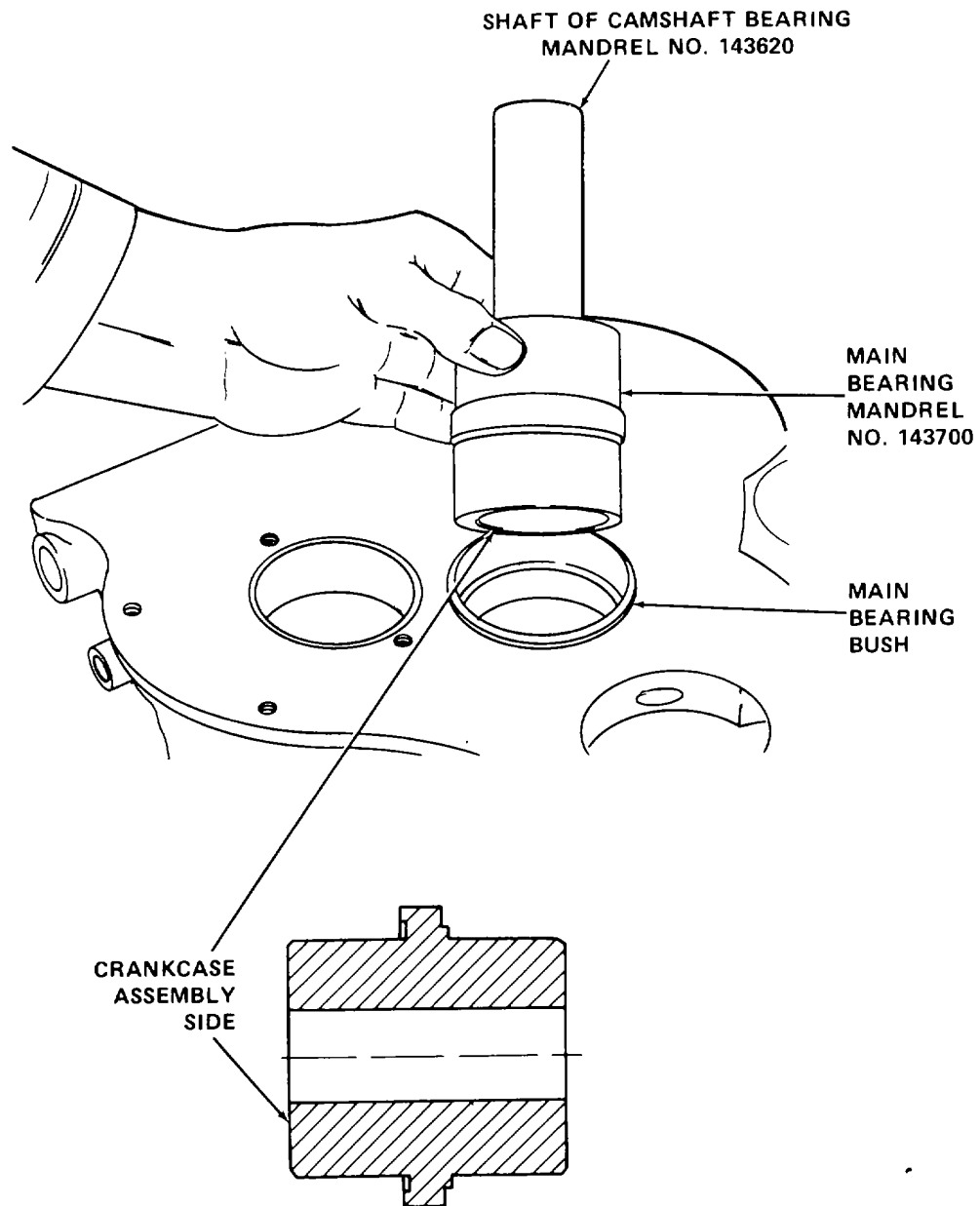
51. Camshaft bearing bush
 Install with camshaft bearing mandrel No. 143620. Make sure bearing bush is properly seated and that oil passages are aligned correctly.



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
52. Main bearing bush	Install using main bearing mandrel No. 143700 (on crankcase assembly side) and shaft of camshaft bearing mandrel No. 143620. Make sure main bearing mandrel has crankcase assembly side toward crankcase and main bearing bush. Make sure that oil passages are aligned correctly and that bearing bush is well seated in crankcase.	

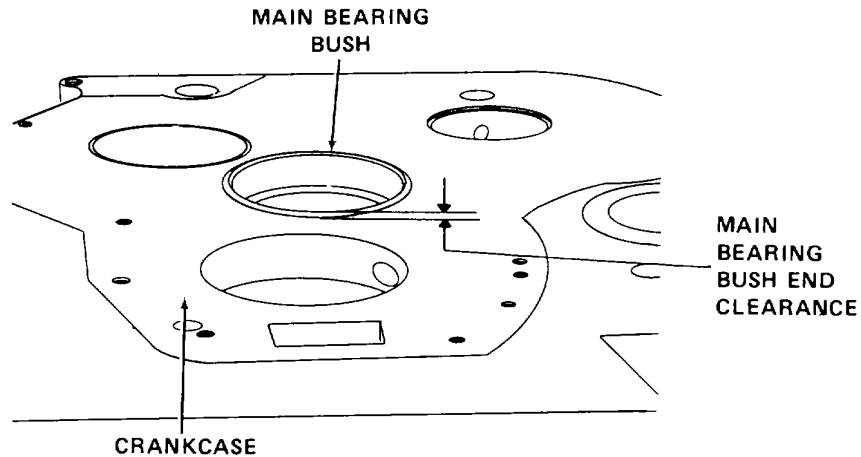
SHAFT OF CAMSHAFT BEARING



6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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Check that main bearing bush end clearance is 0.0551 to 0.0669 inch (1.40 to 1.70 mm). See step 14.



53. All plug and washer sets

Install in crankcase and seat properly.

54. Slotted plug and parallel pins

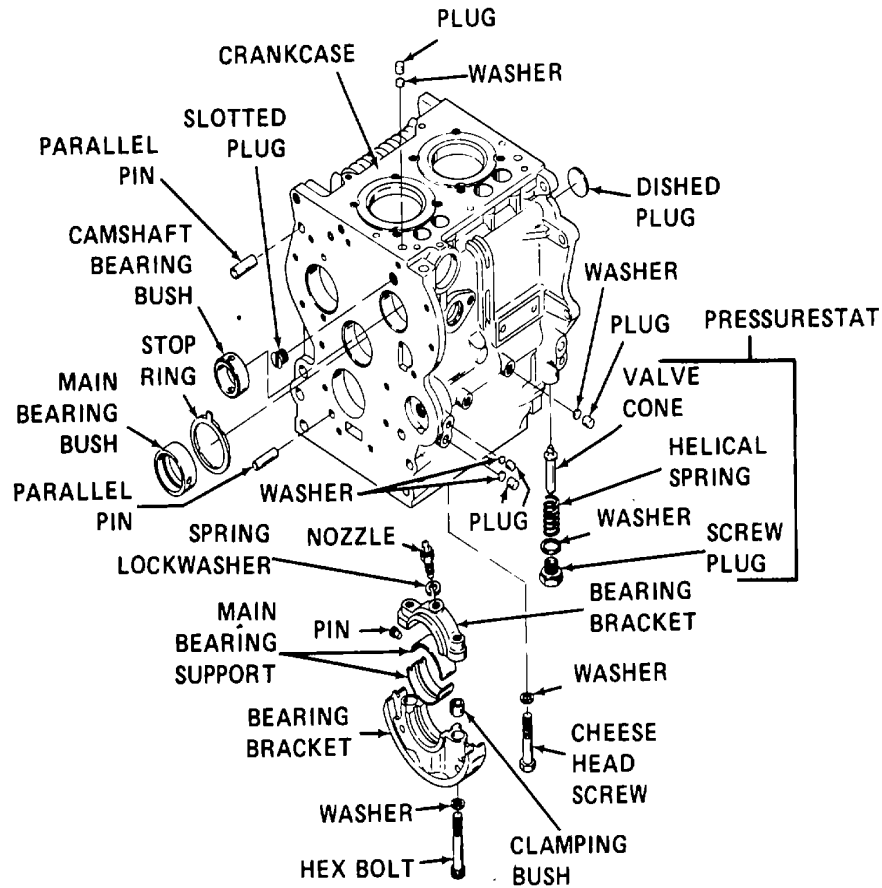
Install and seat properly.

55. Stop ring

Install.

6-20. CRANKSHAFT ASSEMBLY (CONT)

Location/Item	Action	Remarks
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56. Dished plug	If removed, install new plug in crankcase using camshaft plug installer No. 143600.	
57. Pressurestat	Install valve cone, helical spring, washer, and screw plug. Tighten screw plug securely.	
58. Main bearing supports and main bearing bracket	Install in accordance with paragraph 6-18. Make sure size of main bearing supports and crankshaft center bearing journal are directly compatible and that the radial clearance is within tolerance limits.	

APPENDIX A

REFERENCES

A-1. PUBLICATIONS INDEX

The following index should be consulted frequently for latest changes or revisions of references given in this appendix and for new publications relating to material covered in this manual.

Index of Administrative PublicationsDA Pam 310-1

A-2. FORMS AND RECORDS

Equipment Inspection and Maintenance WorksheetDA Form 2404

Quality Deficiency ReportSF 368

Recommended Changes to Publications and Blank FormsDA 2028

A-3. TECHNICAL MANUALS

Administrative Storage Requirements.....TM 740-90-1

Hand Portable Fire Extinguishers for Army UsersTM 5-4200-200-10

Organizational, Direct Support and General Support

Maintenance Repair Parts and Special Tools List,

Centrifugal Pump..... TM5-4320-302-24P

Procedures for Destruction of Equipment to Prevent Enemy UseTM 750-244-3

The Army Maintenance Management System (TAMMS)TM 38-750

A-4. OTHER PUBLICATIONS

Fuel, Lubricants, Oils and WaxesC91001L

**APPENDIX B
MAINTENANCE ALLOCATION CHART**

Section I. INTRODUCTION

B-1. GENERAL

a. This section provides a general explanation of all maintenance and repair functions authorized at various maintenance categories.

b. The Maintenance Allocation Chart (MAC) in section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III lists the special tools and test equipment required for each maintenance function as referenced from section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS

Maintenance functions will be limited to and defined as follows:

a. *Inspect.* To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. *Test.* To verify serviceability by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. *Service.* Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontaminate, when required), to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. *Adjust.* To maintain, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. *Aline.* To adjust specified variable elements of an item to bring about optimum or desired performance.

f. *Calibrate.* To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. *Install.* The act of emplacing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. *Replace.* The act of substituting a serviceable like type part, subassembly, or module (component or assembly) for an unserviceable counterpart.

i. *Repair*. The application of maintenance services¹ or other maintenance actions² to restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, sub-assembly, module (component or assembly), end item, or system.

j. *Overhaul*. That maintenance effort (service/action) necessary to restore an item to a completely serviceable/operational condition as prescribed by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. *Rebuild*. Consists of those services/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours/miles, etc.) considered in classifying Army equipments/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II

a. *Column (1) - Group Number*. Column 1 lists functional group code numbers, the purpose of which is to identify components, assemblies, subassemblies, and modules with the next higher assembly.

b. *Column (2) - Component/Assembly*. Column 2 contains the names of components, -assemblies, subassemblies, and modules for which maintenance is authorized.

c. *Column (3) - Maintenance Function*. Column 3 lists the functions to be performed on the item listed in Column 2. (For detailed explanation of these functions, see paragraph B-2.)

d. *Column (4) - Maintenance Category*. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time, troubleshooting time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

- C.....Operator or crew.
- O.....Organizational maintenance.
- F.....Direct support maintenance.
- H.....General support maintenance.
- D.....Depot maintenance.

e. *Column (5) - Tools and Equipment*. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. *Column (6) - Remarks*. This column shall, when applicable, contain a letter code, in alphabetical order, which shall be keyed to the remarks contained in Section IV.

¹Services - inspect, test, service, adjust, align, calibrate, or replace.

²Actions - welding, grinding, riveting, straightening, facing, remachining, or resurfacing.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III

- a. *Column (1)-Reference Code.* The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.
- b. *Column (2)--Maintenance Category.* The lowest category of maintenance authorized to use the tool or test equipment.
- c. *Column (3)-Nomenclature.* Name or identification of the tool or test equipment.
- d. *Column (4)-National Stock Number.* The National stock number of the tool or test equipment.
- e. *Column (5)-Tool Number.* The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV

- a. *Column (1)-Reference Code.* The code recorded in column 6, Section II.
- b. *Column (2)-Remarks.* This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOLS AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
00	PUMP 200 GPM								
01	Battery Cable Assemblies	Inspect Service Replace	0.2 0.5	1.0				1, 2 A	
02	Battery	Inspect Service Test Replace	0.2 0.5	0.8 1.0				1, 2 B	
03	Battery box Assy	Inspect Service Replace Repair	0.2 0.5	2.0 2.0				1, 2 C	
04	Electrical System	Inspect Test Replace	0.5	1.0 2.0				1, 2 D, E	
05	Control Panel, Gages, Controls, Indicators	Inspect Replace Repair	0.2	1.0 1.0				1, 2 C	
06	Wiring Harness (Control Panel)	Inspect Test Replace Repair		0.2 1.0 1.5 2.0				1, 2 D, E	
07	Exhaust Primer Assembly	Inspect Test Replace	0.5	0.5 1.0				1, 2 C	
08	Check Valve Body Assembly	Inspect Replace Repair		0.5 0.5 1.0				1, 2 C	

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOLS AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
09	Check Valve Assembly	Inspect		0.5				1, 2	C
		Replace		1.0					
		Repair		2.0					
10	Pump Assembly Pump and Bearing Assembly	Inspect	0.2					1, 2, 3	C
		Replace			4.0				
		Repair			4.0				
	Bearing Housing Assembly	Inspect			0.2			1, 2, 3	C
		Replace			4.5				
		Repair			5.0				
11	Exhaust Elbow and Guard	Inspect	0.5					1, 2, 3	C
		Replace		1.5					
		Repair		1.0					
12	Air Inlet System Tubes, Hose and Adaptors	Inspect	0.5					1	C
		Replace		0.5					
		Repair		0.5					
	Rain Cap	Inspect	0.2					1	C
		Replace		0.2					
		Repair		0.3					
	Air Cleaner	Inspect	0.5	0.2				1	G, H
		Service							
		Replace		1.0					
	Repair	Repair		1.0					
		Inspect	0.3					1, 2	C
		Replace		1.0					
Repair		1.0							
13	Fuel System Fuel Lines and Fittings	Inspect	0.3					1, 2	C
		Replace		1.0					
		Repair		1.0					
	3-Way Selector Valve	Inspect	0.3					1, 2	C
		Replace		0.5					
		Repair		1.0					

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOLS AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
14	Fuel Tank Assembly	Inspect Replace Repair	0.2	2.5	4.0			1, 2, 3, 4	I
	Lifting Bracket	Inspect Replace	0.5	2.5				1, 2	C
15	Engine Assembly	Inspect Service Replace Repair Overhaul	0.5 0.5	1.0 2.5	4.0			1, 2, 3, 4 5, 6, 7, 8	
		V-Belt Guard	Inspect Replace Repair	0.2	0.5	1.0			1, 2, 3
	V-Belts	Inspect Adjust Replace	0.2	0.2 1.0				1, 2	J
	Alternator V-Belt Pulley	Inspect Replace Repair	0.2	1.0	1.5			1, 2, 3	C
	Alternator Fan Drive Shaft V-Belt Pulley	Inspect Replace Repair	0.2	1.0	1.0			1, 2, 3	C
	Flywheel	Inspect Replace Repair	0.2	1.0	1.5			1, 2, 3, 10	C
	Cooling Air Blower	Inspect Replace Repair	0.2	4.0	6.0			1, 2, 3	C
	Cooling Air Ducting	Inspect Replace Repair	0.2	1.0	1.0			1, 2, 3	C

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOLS AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
	Oil Filter	Inspect Replace	0.1	0.5				1	G
	Oil Lines and Fittings	Inspect Replace	0.2	1.0				1, 2	C
	Breather	Inspect Replace Repair	0.2	1.0 1.0				1, 2	C
	Lube Oil Cooler	Inspect Repair Test Repair	0.2	1.0	1.5 2.0			1, 2, 3	C, k
	Fuel Filter	Inspect Replace	0.2	0.5				1	G
	Fuel Lines and Fittings	Inspect Replace	0.2	1.0				1, 2	C
	Injection Lines	Inspect Replace	0.2	1.0				1, 2	C
	Fuel Feed Pump	Inspect Service Replace Repair	0.2	0.2 1.0	2.0			1, 2, 3	C
	Engine Shutdown Valve	Inspect Test Replace Adjust	0.2	0.5 0.5 0.5				1, 2	A, C, F, N
	Fuel Injection Pump	Inspect Adjust Replace Repair	0.2			1.0 4.0	**	1, 2, 3, 4	F, L

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOLS AND EQUIP.	(6) REMARKS	
			UNIT		INTERMEDIATE		DEPOT			
			C	O	F	H	D			
	Fuel Injector	Inspect Test Replace Repair	0.2		1.5 2.0		2.0		11, 14	M 48
	Exhaust Silencer	Inspect Replace	0.5	1.5					49	C
	Starter Assembly	Inspect Test Replace Repair	0.2	0.5 1.5	3.0				1, 2, 3	A, N, O
	Alternator	Inspect Test Replace Repair	0.2	0.5 1.5	3.0				1, 2, 3	A, D, P
	Front Cover	Inspect Service Replace Repair	0.2	0.5			3.0 3.0		1, 2, 3, 4	C
	Cylinder Head Assembly	Inspect Service Replace Repair	0.2 0.5		3.0		3.0		9, 12, 13 15, 16, 27, 29	Q
	Rocker Arms	Inspect Replace Repair			1.0 2.0		1.0		3, 4	C
	Pushrod	Inspect Replace Repair			1.0 2.5		0.5		28	C
	Tappets	Inspect Replace Repair			1.0 2.5		0.5		3, 4	C
	Valves	Inspect Replace Repair			1.0 2.0		2.0		17, 19	C

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOL AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
	Valve Guides	Inspect Replace			1.0	3.0		20, 21 23, 24	C
	Valve Seats	Inspect Replace Repair			1.0	3.0 3.0		20, 21, 23, 24	C
	Bottom Cover	Inspect Replace Repair	0.5		2.0 2.0			1, 2, 3	C
	Tachometer Drive	Inspect Replace Repair		0.5	1.5	2.0		1, 2, 3, 4	C
	Lube Oil Pump	Inspect Replace Repair				3.0 4.0 4.0		1, 2, 3, 4	C
	Adaptor Housing and Bearing Plate	Inspect Replace Repair			1.0	4.0 2.0		1, 2, 3, 4	C
	Governor Assembly	Inspect Replace Repair		0.5		4.0	**	1, 2, 3, 4	C
	Drive Shaft	Inspect Replace Repair				3.0 4.0 4.0		44, 45 46	C
	Cylinder	Inspect Service Replace Repair	0.2 0.5		3.0 3.0			47	C
	Piston Assembly	Inspect Replace Repair				1.0 6.0 6.0		30, 31 32, 33 34	C, R
	Connecting Rod Assembly	Inspect Replace Repair				1.0 6.0 6.0		4	C, S

Section II. MAINTENANCE ALLOCATION CHART

(1) GROUP NUMBER	(2) COMPONENT ASSEMBLY	(3) MAINTENANCE FUNCTION	MAINTENANCE LEVEL					(5) TOOL AND EQUIP.	(6) REMARKS
			UNIT		INTERMEDIATE		DEPOT		
			C	O	F	H	D		
16	Crankshaft Assembly	Inspect				2.0		35, 36 38, 39, 43	T
		Replace				6.0			
		Repair				6.0			
	Camshaft	Inspect				2.0		40, 41 42	T
		Replace				6.0			
		Repair				4.0			
	Crankcase Assembly	Inspect	0.2					10, 36 37, 43	C, T
		Replace				8.0			
		Repair				4.0			
	Skid Assembly	Inspect	0.5					1, 2, 3	
		Replace			4.0				
		Repair			3.0				

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
1	O	Tool Kit, General Mechanics Automotive	5180-00-177-7033	
2	O	Shop Equipment, Automotive Maintenance and Repair, Common No. 1	4910-00-754-0654	
3	F, H	Shop Set, Automotive Repair Field Maintenance, Basic	4910-00-754-0705	
4	F, H	Tool Kit, Master Mechanics	5180-00-699-5273	
5	F	Fitting for Compression Check		100020
6	F	Fitting for Compression Check		100050
7	F	Dial Gage, 0.01 mm		100400
8	F	Adjusting Device for TDC		100640
9	F, H	Gage for Cylinder Head Bolts Torque		101900
10	F, H	Gage for Main Bearing and Flywheel Bolts Torque		101910
11	F, H	Nozzle Holder Extractor		110030
12	F, H	Socket Spanner for Cylinder Head Bolts		120040
13	F, H	Socket Spanner for Cylinder Head Bolts		120050
14	F, H	Injector Gasket Remover		120630
15	F, H	Cylinder Head Clamping Stand		120900
16	F, H	Clamping Plate for Cylinder Head Clamping Stand		120910
17	F, H	Valve Spring Compressor		121120
18	F, H	Valve Seat Ring Cutter		122302

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
19	F, H	Valve Holder		122304
20	H	Valve Guide Mandrel, 8 mm		122305
21	H	Valve Guide Mandrel Handles		122306
22	H	Valve Seat Ring Mandrel		122450
23	H	Valve Guide Mandrel, 8 mm		123310
24	H	Valve Guide Reamer, 8 mm		123510
25	H	Valve Seat Ring Mandrel		123950
26	H	Valve Seat Ring Mandrel		123960
27	H	Cylinder Head Sealing Surface Cutter		124480
28	F	Pushrod Tube Compressor		125300
29	H	Cylinder Head Lathe Fixture		125500
30	H	Piston Ring Pliers		130300
31	H	Piston Ring Groove Gage		130360
32	H	Piston Ring Compressor, 100 mm		130530
33	H	Piston Pin Bush Inserter		131310
34	H	Piston Heating Unit		139000
35	H	Gear Puller		141000
36	H	Main Bearing Shaft Seal Guide		142510
37	H	Main Bearing Shaft Seal Press		142530
38	H	Gasket Ring Inserter		142540
39	H	Gasket Ring Remover		142700
40	H	Camshaft Plug Installer		143600
41	H	Camshaft Bearing Mandrel		143620
42	H	Camshaft Bearing Mandrel		143690

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
43	H	Main Bearing Mandrel		143700
44	H	Drive Shaft Seal Mandrel		144720
45	H	Drive Shaft Sleeve Mandrel		144730
46	H	Drive Shaft Bearing Mandrel		144740
47	H	Crankcase Cylinder Refacing Tool		150010
48	F, H	Injector Extractor		150800
49	O	Universal		170800

Section IV. REMARKS

Reference Code	Remarks
A	Continuity test
B	Check specific gravity
C	Repair by replacing defective components
D	Insulation breakdown and continuity test
E	Repair by replacing defective wire
F	Adjust to specifications
G	Replace element
H	Service by cleaning filter
I	Weld
J	Adjust belt tension
K	Test for leakage
L	Repair by bleeding air from fuel system
M	Test timing and pressure output
N	Operational test
O	Test for opens, grounds, and shorts
P	Test for known voltage
Q	Includes replacing valve seats and guides
R	Includes replacing rings
S	Includes replacing rod bearings
T	Includes replacing main bearings

Change 1 B-13/(B-14 Blank)

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
19	F, H	Valve Holder		122304
20	H	Valve Guide Mandrel, 8 mm		122305
21	H	Valve Guide Mandrel Handles		122306
22	H	Valve Seat Ring Mandrel		122450
23	H	Valve Guide Mandrel, 8 mm		123310
24	H	Valve Guide Reamer, 8 mm		123510
25	H	Valve Seat Ring Mandrel		123950
26	H	Valve Seat Ring Mandrel		123960
27	H	Cylinder Head Sealing Surface Cutter		124480
28	F	Pushrod Tube Compressor		125300
29	H	Cylinder Head Lathe Fixture		125500
30	H	Piston Ring Pliers		130300
31	H	Piston Ring Groove Gage		130360
32	H	Piston Ring Compressor, 100 mm		130530
33	H	Piston Pin Bush Inserter		131310
34	H	Piston Heating Unit		139000
35	H	Gear Puller		141000
36	H	Main Bearing Shaft Seal Guide		142510
37	H	Main Bearing Shaft Seal Press		142530
38	H	Gasket Ring Inserter		142540
39	H	Gasket Ring Remover		142700
40	H	Camshaft Plug Installer		143600
41	H	Camshaft Bearing Mandrel		143620
42	H	Camshaft Bearing Mandrel		143690

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE CATEGORY	NOMENCLATURE	NATIONAL/NATO STOCK NUMBER	TOOL NUMBER
43	H	Main Bearing Mandrel		143700
44	H	Drive Shaft Seal Mandrel		144720
45	H	Drive Shaft Sleeve Mandrel		144730
46	H	Drive Shaft Bearing Mandrel		144740
47	H	Crankcase Cylinder Refacing Tool		150010
48	F, H	Injector Extractor		150800
49	O	Universal		170800

Section IV. REMARKS

Reference Code	Remarks
A	Continuity test
B	Check specific gravity
C	Repair by replacing defective components
D	Insulation breakdown and continuity test
E	Repair by replacing defective wire
F	Adjust to specifications
G	Replace element
H	Service by cleaning filter
I	Weld
J	Adjust belt tension
K	Test for leakage
L	Repair by bleeding air from fuel system
M	Test timing and pressure output
N	Operational test
O	Test for opens, grounds, and shorts
P	Test for known voltage
Q	Includes replacing valve seats and guides
R	Includes replacing rings
S	Includes replacing rod bearings
T	Includes replacing main bearings

APPENDIX C
COMPONENTS OF END ITEMS AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

C-1. SCOPE

This appendix lists components of end item and basic issue items for the centrifugal pump unit to help inventory items required for safe and efficient operation.

C-2. GENERAL

The Components of End Item and Basic Issue Items are divided into the following sections:

a. *Section II.* Not applicable to this unit.

b. *Section III. Basic Issue Items.* These are the minimum essential items required to place the centrifugal pump unit in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged BII must be with the centrifugal pump unit during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TOE/MTDE authorization of the end item.

C-3. EXPLANATION OF COLUMNS

The following provides an explanation of columns found in the tabular listings:

a. *Column (1) - Illustration Number (Illus Number).* This column indicates the number of the illustration in which the item is shown.

b. *Column (2) - National Stock Number.* Indicates the national stock number assigned to the item and will be used for requisitioning purposes.

c. *Column (3) - Description.* Indicates the National item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the FSCM (in parentheses) followed by the part number.

d. *Column (4) - Unit of Measure (U/M).* Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in., pr).

e. *Column (5) - Quantity required (Qty rqr).* Indicates the quantity of the item authorized to be used with/on the equipment.

Section III. BASIC ISSUE ITEMS

Illus No.	NSN	Description FSCM & Part No.	Unit of Measure	Quantity Required
1	N/A	Technical Manual TM 5-4320-302-14	each	1

**APPENDIX D
ADDITIONAL AUTHORIZATION LIST**

Section I. INTRODUCTION

D-1. SCOPE

This appendix lists additional items you are authorized for the support of the centrifugal pump unit.

D-2. GENERAL

This list identifies items that do not have to accompany the centrifugal pump unit and that do not have to be turned in with it. These items are all authorized to you by CTA, MTOE, TDA, or JTA.

D-3. EXPLANATION OF LISTING

National stock numbers, descriptions, and quantities are provided to help you identify and request the additional items you require to support this equipment. The items are listed in alphabetical sequence by item name under the type document (i.e., CTA, MTOE, TDA, or JTA) which authorizes the item(s) to you.

Section II. ADDITIONAL AUTHORIZATION LIST

(1) NATIONAL STOCK NUMBER	(2) DESCRIPTION FSCM and PART NUMBER USABLE ON CODE		(3) U/M	(4) QTY AUTH
4240-00-022-2946	(-) AUTHORIZED ITEMS			
	Protector, Aural	DNN	Pr	1

APPENDIX E
EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

E-1. SCOPE

This appendix lists expendable supplies and materials you will need to operate and maintain the centrifugal pump unit. These items are authorized to you by CTA 50-970, Expendable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

E-2. EXPLANATION OF COLUMNS

a. *Column (1) - Item Number.* This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., Dry Cleaning Solvent, Item 16, Appendix E).

b. *Column (2) - Level.* This column identifies the lowest level of maintenance that requires the listed item.

C - Operator/Crew
O - Organizational Maintenance
F - Direct Support Maintenance
H- General Support Maintenance

c. *Column (3) - National Stock Number.* This is the National stock number assigned to the item; use it to request or requisition the item.

d. *Column (4) Description.* Indicates the Federal item name, and, if required, a description to identify the item. The last line for each item indicates the part number followed by Federal Supply Code for Manufacturer (FSCM) in parentheses.

e. *Column (5) Unit of Measure (U/M).* Indicates the measure used in performing the actual maintenance function. This measure is expressed by two-character alphabetical abbreviations (e.g., ea, in., pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

SECTION II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	F, H		Abrasive Cloth Crocus, P-C-458	ea
1	F, H		Abrasive Cloth, Emery, P-C-1673	ea
3	0		Baking Soda, EE-B-86	8 oz box
4	0	6810-00-249-9354	Sulphuric Acid, Electrolyte, (96906) MIL-STD-605	gal
		6810-00-843-1640	Sulphuric Acid, Electrolyte, (81348) O-S-801	gal
5	C, O, F, H		Fuel Oil, Diesel, VV-F-800	gal
6	Q, F, H	9150-00-190-0907	Grease, Automotive and Artillery, MIL-G-10924	5 gal can
7	F, H	9150-00-754-2595	Grease, Ball and Roller Bearing, MIL-G-18709	1 lb can
8			Lapping and Grinding Compound (Valve), 600 grit, A-A-1203	
9	O, F, H	9150-00-186-6681	Oil, Lubricating, Internal Combustion Engine, MIL-L-2104	qt
10	0		Oil, Lubricating, Preservative, MI L-L-21260	qt
11	0		Oil, Preservative, Corrosion-Inhibited MIL-L-46002	qt
12	H		Sealant, Deutz DW 47	
13	H		Sealant, Deutz DW 60	
14	F, H		Sealing Compound, MIL-S-45180	oz
15	F		Solder, Rosin Flux Core, ASTM B284-79	lb
16	F, H	6850-00-274-5421	Solvent, Dry Cleaning, P-D-680	5 gal can
17	F		SLone, Commutator Surfacing, MIL-S-17243	ea
18	0		Tape, Electrician's Insulating, M I L-T-50886	roll
19	F, H		Thread Compound, Antiseize, MIL-T-22361	oz

**APPENDIX F
TORQUE LIMITS**

Paragraph Reference	Item	Preload Torque Values ft lb (N•m)	Torque Angle Values	Torque Value ft lb (N•m)
4-28 step 7	Alternator V-belt pulley hex bolts			66 (90)
4-29 step 4	Drive shaft V-belt pulley hex bolts			66 (90)
5-2 step 2 5-20 step 25 5-12 step 9	Cylinder head bolts	22 (30)	45+45+45	
	Flywheel hex bolts	22 (30)	30+60	
5-16 step 11	Fuel injector hex nuts			18-23 (25-30)
5-20 step 30	Rocker bracket hex nuts			21 (28)
6-8 step 11	Cylinder head waisted bolts	22 (30)	45	
6-11 step 10 6-14 step 16 6-18 step 25 6-12 step 22	Crankshaft gear hex bolts	22 (30)	30+30	
	Bearing housing bolts	22 (30)	60	
6-14 step 22 6-17 step 10 6-17 step 13 6-17 step 23 6-18 step 21	Connecting rod hex bolts	22 (30)	30+30+30	
	Counterweight bolts	22 (30)	30+30	
6-18 step 22 6-20 step 32 6-20 step 33 6-18 step 24	Bearing bracket bolts	22 (30)	30+30	
	Bearing bracket hex bolt	22 (30)	60	

NOTE

If preload torque values and torque angle values are listed, then tighten to preload torque value and finish tightening by turning threaded fasteners the additional number of degrees specified by the torque angle value.

GLOSSARY
Section I. ABBREVIATIONS

amps	Amperes
°C	Degree Celsius
v.	Degree Celsius
CBR	Chemical biological radiological
cm	Centimeter
cu	Cubic
EIR	Equipment Improvement Recommendations
°F	Degree Fahrenheit
FB	Commencement of injection flow
ft	Foot; feet
ft lb	Foot pound
gal	Gallon
gpm	Gallons per minute
in	Inch
kg	Kilogram
kPa	Kilopascal
lb	Pound
m	Meter
mm	Millimeter
N-m	Newton-meter
NPT	National pipe thread
oz	Ounce
phr	Pounds per hour
PMCS	Preventive maintenance checks and services
psi	Pounds per square inch
qt	Quart
rpm	Revolutions per minute
TDC	Top dead center
TMDE	Test, measurement, and diagnostic equipment

Section II. DEFINITION OF UNUSUAL TERMS

A

ABRASION - A scraped or scuffed area. A hose may become abraded if an unshielded portion of it rubs against a piece of bracket or another hose.

ACTUATE - To cause an action. When electric power is applied to a solenoid, it actuates a valve, causing a part in the valve to move.

ALINE - To arrange in a line vertically and/or horizontally.

APPROVED - Permitted to be used for a specific purpose by the person or group who is authorized to grant approval.

ARC - A discharge of electric current crossing a gap between two electrodes.

ASSEMBLY A combination of parts that may be taken apart without destruction, which has no application or use of its own but is needed for the completeness of a more complex item with which it is combined, or to which it is attached.

B

BRINNELLED - A deformation of a bearing by an impact.

C

CAPACITY - The volume, amount, or quantity that can be held or contained.

CARBON MONOXIDE A poisonous gas that is made while a fuel is burning, especially if there is not quite enough air. The gas is colorless, odorless, and tasteless, but it can cause illness or death. See the warnings on the Warning page at front of manual.

COMBUSTION A chemical change, especially oxidation, accompanied by the production of heat and light. A combustion engine functions by burning fuel to produce heat, i.e., energy.

COMPONENT - A part or a combination of parts which together accomplish a function.

COMPRESSED AIR - Air that is under pressure. When the compressed air in a hose or pipe is allowed to escape (such as when you use an air gun), the air moves very fast and is used to blow away dirt and chips for cleaning.

CONDENSATION - A liquid formed from a vapor. Moisture carried in warm air will condense when it reaches a cold area, such as the surface of a fuel tank in subzero weather.

CORROSION - A gradual wearing away caused by chemical action. Metals exposed to salt water are likely to corrode.

D

DEBRIS - The scattered remains of something broken or destroyed.

DEFLECT - To bend or move from a straight line.

DETERIORATE - A worsening of condition usually as a result of age or hostile environment, as opposed to mechanical damage.

DIAMETRIC - Measurement across the center.

DISTORTION - The bending, twisting, or any other dynamic change of a surface.

E

EXHAUST - The gases that leave the engine through the tailpipe while the engine is running.

EXPENDABLE - An item that is not repairable and is discarded if damaged.

EXPOSURE - Being in the presence of something, or in contact with something. Skin is exposed to cleaning solvent when the solvent contacts the skin during cleaning operations.

F

FILTER - A device which removes dirt from the air or a fluid.

FLASH POINT - The lowest temperature at which the vapors of a solvent will ignite and burn.

FLUID - A substance that can flow; that is, either a gas or a liquid.

FRAYED - Something which has been worn away or unravelled, usually by rubbing.

FRETTING - A wearing away or corroding of an area.

G

GASKET - A seal or packing used between matched machine parts or around pipe joints to prevent the escape of gas or fluid.

GOGGLES - A device used to protect the eyes from dust, dirt, flying chips, etc.

I

IMMERSE - To completely cover by fluid.

INHALATION - The act of breathing in. The breathing in or inhalation of carbon monoxide can cause illness or death.

INITIAL - The first or starting condition.

L

LEGIBLE - Capable of being read. A legible nameplate can be read; an illegible plate cannot.

M

MALFUNCTION - Occurs when a unit fails to operate normally.

MANUFACTURER - The company which makes an item or piece of equipment for sale.

MATERIEL - Equipment, apparatus, and supplies of an organization such as an army.

O

OBSTRUCTION - An obstacle.

PIVOT - A short rod or shaft about which a related part rotates; the act of turning on or as if on a pivot.

PORT - A threaded hole through which fluid may pass, or pressure may be measured. Ports on the pump are used to connect hoses, and to measure pressure.

PRIME - The act of introducing a liquid into a pump to increase the pump's ability to overcome negative head pressure.

R

RACE - A grooved part of a component, such as a bearing, in which a moving part slides or rolls.

RECOMMENDATIONS - Suggestions for change; advice given usually to make an improvement.

REQUIRE - To demand or need.

RESPIRATION - The process of breathing; inhaling and exhaling.

S

SATURATED - Soaked or drenched with a liquid.

SCOPE - The extent of an activity or concept; the amount of information covered as in a book.

SEIZURE - The act of being held, bound; unable to function as usual.

SOLVENT - A liquid that can dissolve another substance.

SYMPTOM - The external sign or indication of a condition.

T

TIEDOWN - Strap or fastening device used to hold an object in position.

TORQUE - Force around an axis. It produces a rotary or twisting motion, and is measured in foot pounds (ft lb) or newton-meters (N•m).

TRANSVERSE - Situated or lying across; crosswise.

V

VALVE - A device used to control the flow of a fluid.

VAPOR - The gaseous form of any substance which is usually a liquid; vapors are present in the air around the substance.

VENTILATE - To provide with a source of fresh or uncontaminated air.

VISUAL - Visible; detected by the unaided eye.

VOLATILE - Evaporates rapidly at normal temperatures and pressures; unstable.

Section III. NOMENCLATURE CROSS-REFERENCE

Nomenclature	Common Name
Bottom cover	Oil pan
Bottom roller	Rotor wheel
Breather plug	Bleed screw
Bush	Bushing
Cheese head screw	Socket head cap screw
Circlip	Retaining ring
Clamping plate	Alternator adjusting arm
Columix	Stator windings
Cover	Oil filler cap
Dished plug	Expansion plug
Dowel sleeve	Split pin
Drive shaft pulley	Accessory drive pulley
Exhaust silencer	Muffler
Hose strap	Hose clamp
Notched nail	Drive fastener
O-seal	Preformed packing
Screw plug	Oil drain plug
Valve cone	Valve keeper

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By Order of the Secretary of the Army:

JOHN A. WICKHAM, JR.
General, United States Army
Chief of Staff


Official:

R. L. DILWORTH
Brigadier General, United States Army
The Adjutant General

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To be distributed in accordance with DA Form 12-25A, Operator, Organizational, Direct Support and General Support Maintenance requirements for Pumping Assembly, Diesel Driven, Wheel Mounted, 350 GPM, 275 Ft Head (FUEL: 13220E1070, 13226E2289; WATER: 13225E9200) (TM 5-4320-226-14).

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3, 280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigram = .035 ounce
 1 decagram = 10 grams = .35 ounce
 acres
 1 hectogram = 10 decagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. ounces
 1 dekaliter = 10 liters = 2.64 gallons
 1 hectoliter = 10 dekaliters = 26.42 gallons
 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1, 076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29, 573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit	5/9 (after	Celsius	°C
	temperature	subtracting 32)	temperature	

