

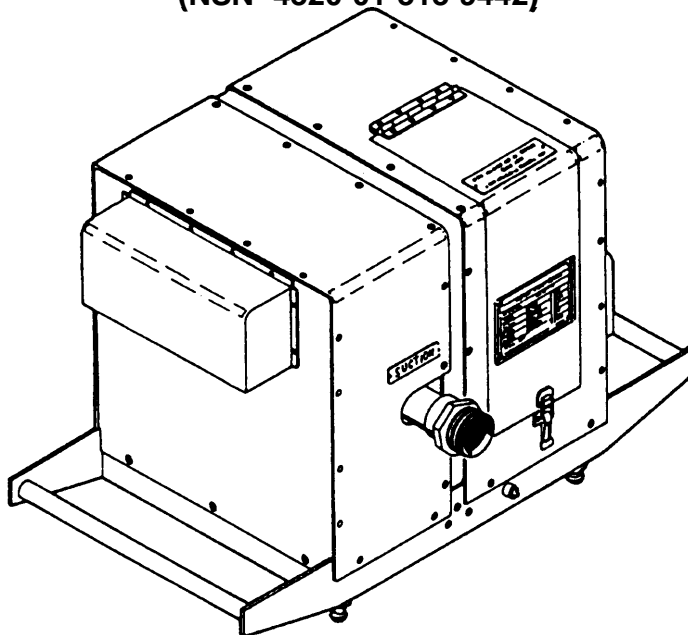
**TECHNICAL MANUAL**

**OPERATOR, UNIT,  
DIRECT SUPPORT, AND GENERAL  
SUPPORT MAINTENANCE  
FOR  
PUMP UNIT, CENTRIFUGAL,  
SELF-PRIMING  
125 GPM WATER  
CLASS 3  
DIESEL-DRIVEN  
ARMY**

(NSN 4320-01-247-7127)

**MARINE CORPS**

(NSN 4320-01-313-9442)



**INTRODUCTION 1-1**

**OPERATING  
INSTRUCTIONS 2-1**

**UNIT  
MAINTENANCE  
INSTRUCTIONS 3-1**

**DIRECT SUPPORT  
MAINTENANCE  
INSTRUCTIONS 4-1**

**GENERAL SUPPORT  
MAINTENANCE  
INSTRUCTIONS 5-1**

**MAINTENANCE  
ALLOCATION CHART B-1**

**GLOSSARY**

**ALPHABETICAL INDEX**

**Distribution Statement A: Approved for public release; distribution is unlimited.**

**\* This manual supersedes TM 5-4320-309-14, dated 22 January 1990, including all changes.**

---

**HEADQUARTERS, DEPARTMENT OF THE ARMY  
AND HEADQUARTERS, U.S. MARINE CORPS  
30 JUNE 1993**

# WARNING

## **CARBON MONOXIDE (EXHAUST GAS) CAN KILL YOU**

Carbon monoxide is without color or smell, but can kill you. Breathing air with carbon monoxide produces symptoms of headache, dizziness, loss of muscular control, a sleepy feeling, and coma. Heavy exposure can cause brain damage or death. Carbon monoxide gas occurs in the exhaust fumes of internal combustion engines, and can become dangerously concentrated under conditions of no air movement. To ensure your safety and that of other maintenance personnel, always observe the following precautions:

- DO NOT operate engine in a closed place unless the place has a lot of moving air. Engine should be kept at least five feet away from buildings and other equipment during operation.
  - DO NOT idle engine for long periods without proper ventilation.
  - BE ALERT at all times for exhaust odors and exposure symptoms. If either is present, IMMEDIATELY VENTILATE personnel compartments; remove affected crew to fresh air; keep warm; if necessary, give artificial respiration. FOR ARTIFICIAL RESPIRATION REFER TO FM 21-11.
- Ž BE AWARE; the field protective mask for chemical-biological-radiological (CBR) protection will not protect you against carbon monoxide poisoning.

**THE BEST DEFENSE AGAINST CARBON MONOXIDE POISONING IS GOOD VENTILATION.**

## **MISHANDLING FUEL COULD RESULT IN DEATH OR SERIOUS INJURY**

Engine must be turned off and cool before refueling. Use proper refueling procedures and equipment to avoid spillage. Wipe away fuel spills with a clean cloth. Refuel only in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Do not run engine near open fuel containers. Always store fuel in proper, marked containers. DO NOT SMOKE when refueling.

## **SEVERE BURNS COULD RESULT FROM HANDLING HEATED PARTS**

Muffler and related components get hot enough during pump operation to cause severe burns. Avoid contact with muffler and related components during repair procedures described in this text. Do not perform any repair procedures until the unit has cooled down sufficiently.

## **OPERATING ENGINE WITHOUT PROTECTIVE COVERS COULD RESULT IN SERIOUS INJURY**

If any item becomes loose or cracked, immediately stop the engine and repair. After completing any "Remove, Replace, or Repair" procedures ensure that protective covers are reinstalled before operating the pump.

## **OPERATE ENGINE ON A LEVEL SURFACE**

The allowable inclination of the engine for continuous use is within 20 degrees from horizontal. There may be fuel spillage if the engine is tilted beyond that point.

# **WARNING**

## **APPLICATION OF CHEMICAL AGENT RESISTANT COATING (CARC) PAINT**

An approved or accepted pressure demand or continuous flow, type C, full-facepiece hood or helmet supplied air respirator must be worn when CARC painting. The local safety office, Preventive Medicine Activity, and local medical support facility must be consulted prior to initiating CARC painting.

## **MISUSE OF COMPRESSED AIR COULD RESULT IN DEATH OR SERIOUS INJURY**

Death or serious injury could occur if compressed air is directed against skin. Do not use compressed air for cleaning or drying unless the pressure has been reduced to 30 PSI or less. When working with compressed air, always use eye protection and any other protective equipment.

Pump Units must be grounded prior to operation, when pumping flammable liquids.

Potential health hazards result from inhalation of petroleum solvent vapors and from contact of solvent with the skin. Use rubber gloves and hand cream for protection, and work with adequate ventilation.

Do not use fuel transfer pump to transfer drinking water.

Do not use drinking water transfer pump to transfer fuel.

TECHNICAL MANUAL

NO. 10-4320-309-14

HEADQUARTERS  
DEPARTMENT OF THE ARMY and  
HEADQUARTERS U.S. MARINE CORPS  
WASHINGTON, D. C., 30 JUNE 1993

**OPERATOR, UNIT, DIRECT SUPPORT, AND  
GENERAL SUPPORT MAINTENANCE MANUAL  
FOR  
PUMP UNIT, CENTRIFUGAL, SELF-PRIMING  
125 GPM WATER, CLASS 3, DIESEL-DRIVEN  
(Army)  
NSN 4320-01-247-7127  
(Marine Corps)  
NSN 4320-01-313-9442**

**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes, 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 Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Boulevard, St. Louis, MO 63120-1798. Marine Corps users submit NAVMC Form 10/22 to Commanding General, Marine Corps Logistics Base (Code 850), 814 Radford Blvd., Albany, GA 31704-1128. A reply will be furnished direct to you.

Distribution Statement A: Approved for public release; distribution is unlimited.

**TABLE OF CONTENTS**

	Page
CHAPTER 1 INTRODUCTION	
Section I General Information . . . . .	1-1
Section II Equipment Description and Data . . . . .	1-4
Section III Technical Principles of Operation . . . . .	1-8
CHAPTER 2 OPERATING INSTRUCTIONS	
Section I Description and Use of Operator's Controls and Indicators . . . . .	2-1
Section II Operator's Preventive Maintenance Checks and Services (PMCS) . . . . .	2-4
Section III Operation Under Usual Conditions . . . . .	2-16
Section IV Operation Under Unusual Conditions . . . . .	2-23
CHAPTER 3 UNIT MAINTENANCE INSTRUCTIONS	
Section I Lubrication Instructions . . . . .	3-1
Section II Repair Parts, Special Tools, Test, Measurement and Diagnostic Equipment (TMDE), and Support Equipment. . . . .	3-4
Section III Service Upon Receipt of Equipment . . . . .	3-4

\* This manual supersedes TM 5-4320-309-14, dated 22 January 1990, including all changes.

Section	IV	Preventive Maintenance Checks and Services (PMCS) . . . . .	3-7
Section	V	Unit Troubleshooting Procedures . . . . .	3-13
Section	VI	Maintenance Procedures. . . . .	3-16
Section	VII	Preparation for Storage or Shipment . . . . .	3-36
CHAPTER	4	DIRECT SUPPORT (DS) MAINTENANCE INSTRUCTIONS	
Section	I	Troubleshooting . . . . .	4-1
Section	II	Maintenance Procedures . . . . .	4-4
CHAPTER	5	GENERAL SUPPORT MAINTENANCE INSTRUCTIONS	
Section	I	Troubleshooting . . . . .	5-1
Section	II	Maintenance Procedures. . . . .	5-1
Appendix	A	REFERENCES . . . . .	5-1
Appendix	B	MAINTENANCE ALLOCATION CHART	
Section	I	Introduction . . . . .	B-1
Section	II	Maintenance Allocation Chart . . . . .	B-4
Section	III	Tool and Test Equipment Requirements . . . . .	B-9
Section	IV	Remarks . . . . .	B-11
Appendix	C	COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS LIST (BILL)	
Section	I	Introduction . . . . .	C-1
Section	II	Components of End Item . . . . .	C-2
Section	III	Basic Issue Items . . . . .	C-3
Appendix	D	ADDITIONAL AUTHORIZED LIST	
Section	I	Introduction . . . . .	D-1
Section	II	Additional Authorization List . . . . .	D-1
Appendix	E	EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST	
Section	I	Introduction . . . . .	E-1
Section	II	Expendable/Durable Supplies and Materials List . . . . .	E-2
Appendix	F	ILLUSTRATED LIST OF MANUFACTURED ITEMS	
Section	I	Introduction . . . . .	F-1
Section	II	illustrated List of Manufactured Items . . . . .	F-1
Appendix	G	TORQUE LIMITS . . . . .	G-I
		GLOSSARY	
Section	I	Abbreviations . . . . .	Glossary-1
Section	II	Definitions of Unusual Terms . . . . .	Glossary-2
		ALPHABETICAL INDEX . . . . .	Index-1

## LIST OF ILLUSTRATIONS

Figure No.	Title	Page No.
1-1	Diesel-Driven Centrifugal Pump . . . . .	1-2
1-2	Diesel-Driven Centrifugal Pump, Major Components . . . . .	1-5
1-3	Diesel-Driven Centrifugal Pump, Major Components . . . . .	1-6
1-4	Diesel-Driven Centrifugal Pump, Major Components . . . . .	1-9
1-5	Diesel Engine, Major Components . . . . .	1-10
2-1	Operator's View of Controls and Indicators (ViewThrough Access Door).... .	2-1
2-2	Installation Items . . . . .	2-17
2-3	Priming Pump . . . . .	2-18
2-4	Starting Procedures . . . . .	2-19
2-5	Adjusting Speed . . . . .	2-20
2-6	Preparation for Movement . . . . .	2-22
2-7	Identification Nameplate . . . . .	2-23
2-8	Cold Weather Starting Aid . . . . .	2-24
3-1	Oil Level . . . . .	3-2
3-2	Lubrication Points . . . . .	3-3
3-3	Pump Setup . . . . .	3-5
3-4	Priming Pump . . . . .	3-6
3-5	Replacing Air Cleaner Element . . . . .	3-17
3-6	Diesel-Driven Centrifugal Pump Assembly . . . . .	3-20
3-7	Replace/Inspect Sound Endosure Assembly . . . . .	3-21
3-8	Replace/RepairSuction Check Valve Assembly . . . . .	3-24
3-9	Replace/Service Fuel Tank . . . . .	3-25
3-10	Replace/Service Fuel Cock and Fuel Filter . . . . .	3-27
3-11	Replace/Service Fuel Injection Pipe.... .	3-29
3-12	Replace/Inspect Exhaust Silencer Assembly/Spark Arrestor . . . . .	3-32
3-13	Valve Rocker Arm Cover Removal . . . . .	3-34
3-14	Adjusting Valve Clearance . . . . .	3-35
4-1	inlet Air Sound Enclosure Assembly . . . . .	4-6
4-2	Access Door Assembly . . . . .	4-9
4-3	Outlet Air Sound Endosure Assembly . . . . .	4-12
4-4	Sound Enclosure Bracket . . . . .	4-14
4-5	Air Flow Baffle . . . . .	4-17
4-6	Replacing Volute . . . . .	4-18
4-7	Replacing Impeller, Shaft Seal, and Shaft Adapter . . . . .	4-21
4-8	Replace Wear Plate . . . . .	4-24
4-9	Pump Casing Assembly . . . . .	4-26
4-10	Engine Mounting Assembly . . . . .	4-28
4-11	Replace Fuel Injection Nozzle . . . . .	4-29
4-12	Fuel Injection Nozzle Gasket . . . . .	4-30
4-13	Replace Fuel Injection Pump . . . . .	4-32
4-14	Top Dead Center Position . . . . .	4-34
4-15	Configuration of Fuel Injection Pump.... .	4-35
4-16	Fuel injection Volume Limitation Adjustment . . . . .	4-36
4-17	Air Intake Bend . . . . .	4-37
4-18	Recoil Starter Removal . . . . .	4-40
4-19	Replacing Cooling Case Cover . . . . .	4-43

Figure No.	Title	Page No.
4-20	Replacing Lube Oil Strainer .....	4-45
4-21	Engine Mounting Assembly .....	4-48
5-1	Fuel Injection Nozzle Repair .....	5-3
5-2	Cylinder Head Assembly .....	5-6
5-3	Removing Cylinder Head .....	5-7
5-4	Typical Valve.....	5-8
5-5	Valve Recess .....	5-8
5-6	Intake Exhaust Valve Assembly .....	5-9
5-7	Spring Inclination .....	5-9
5-8	Measuring Valve Rocker Arm Support .....	5-10
5-9	Replacing Crankcase Cover .....	5-13
5-10	Crankcase Cover Oil Passages .....	5-14
5-11	Main Bearing Metal Insert .....	5-14
5-12	Tightening Sequence for Crankcase Cover Bolts .....	5-15
5-13	Lubricating Oil Route .....	5-16
5-14	Lube Oil Pump Assembly .....	5-17
5-15	Installation of Lubricating Oil Pump .....	5-18
5-16	Removing the Camshaft .....	5-19
5-17	Recess of Needle Bearing .....	5-20
5-18	Camshaft Bearings .....	5-21
5-19	Cam and Tappet .....	5-21
5-20	Camshaft and Tappet Assembly .....	5-22
5-21	Inserting Camshaft .....	5-23
5-22	Timing Marks .....	5-23
5-23	Removing the Balancer Shaft .....	5-24
5-24	Balancer Shaft Assembly .....	5-25
5-25	Timing Marks .....	5-25
5-26	Speed Control Device Assembly .....	5-27
5-27	Governor Assembly .....	5-28
5-28	Speed Control Device Springs .....	5-29
5-29	Piston and Connecting Rod Assembly .....	5-31
5-30	Check of Crankpin Bearing Insert .....	5-31
5-31	Removing and Installing Piston .....	5-34
5-32	Removing the Rod Bolts and Nuts .....	5-35
5-33	Measuring Point of Piston Pin .....	5-36
5-34	Piston Ring Dimensions .....	5-36
5-35	Piston Ring Side Clearance .....	5-36
5-36	Measuring of Ring End Gap .....	5-37
5-37	Piston Ring Identification Mark .....	5-37
5-38	Piston Ring Installation .....	5-38
5-39	Installing the Connecting Rod End Cap.....	5-39
5-40	Crankshaft and Flywheel Assembly .....	5-41
5-41	Flywheel Tightening Handle .....	5-42
5-42	Flywheel Extractor. ....	5-42
5-43	Loosening the Flywheel Nut .....	5-42
5-44	Removing the Flywheel .....	5-42
5-45	Tightening the Flywheel .....	5-43
5-46	Crankshaft Assembly .....	5-45
5-47	Removing the Bearing Holder .....	5-46

Figure No.	Title	Page No.
5-48	Removing Crankshaft . . . . .	5-46
5-49	Crankcase Cross-Section . . . . .	5-47
5-50	Installing the Bearing Holder . . . . .	5-47
5-51	Crankcase . . . . .	5-49

### **List of Tables**

Figure No.	Title	Page No.
2-1	Preventive Maintenance Checks and Services . . . . .	2-6
2-2	Installation Items . . . . .	2-25
3-1	Recommended Oil Lubrication Chart . . . . .	3-1
3-2	Unit Preventive Maintenance Checks and Services . . . . .	3-8
3-3	Troubleshooting by Exhaust Color . . . . .	3-13
3-4	Unit Troubleshooting . . . . .	3-13
3-5	Valve Clearance . . . . .	3-35
4-1	Direct Support Troubleshooting Chart . . . . .	4-2
5-1	Piston Ring Wear Limits . . . . .	5-36
5-2	Maximum Side Clearance . . . . .	5-36
5-3	Piston Ring Top Identification Mark . . . . .	5-37



## CHAPTER 1

### INTRODUCTION

#### Section I. GENERAL INFORMATION

##### INDEX

Para	Para
Scope . . . . . 1-1	Preparation for Storage or Shipment . . . . . 1-5
Maintenance Forms and Records . . . . . 1-2	Reporting Equipment Improvement
Consolidated Index of Army Publications	Recommendations . . . . . 1-6
and Blank Forms . . . . . 1-3	warranty . . . . . 1-7
Destruction of Army Materiel to	
Prevent Enemy use . . . . . 1-4	

#### 1-1. SCOPE

##### NOTE

This manual does not differentiate between the Army (water) and the Marine Corps Fuel uses of the centrifugal pump, Self-Priming Diesel Engine Driven, 125 GPM Water/Fuel Class 3, Model No. PAD 125A. The National Stock Number (NSN) for the Army is 4320-01-247-7127 and the NSN for the Marine Corps is 4320-01-313-9442.

This manual is for use by personnel responsible for operation and maintenance of the Centrifugal Pump, Self-Priming, Diesel-Driven, 125 GPM, Water/Fuel, Class 3, Model No. PAD 125A, which will be referred to as the diesel-driven centrifugal pump. It provides the user with necessary instructions to operate the pump and to perform required maintenance in accordance with the Maintenance Allocation Chart (MAC) in Appendix B. The purpose of the diesel-driven centrifugal pump is to provide a method of pumping water/fuel with a self-contained, transportable pumping unit.

#### 1-2. MAINTENANCE FORMS AND RECORDS

- Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, as contained in Maintenance Management Update. USMC personnel refer to TM 4700-15/1 for equipment records and form procedures.
- Report of Packing and Handling Deficiencies. Fill out and forward SF 364 Report of Discrepancy (ROD) as prescribed in AR 735-11-2/DLAR4140.55/NAVSUPINST 4355.73B/MCO 4430.3H.
- Discrepancy in Ship Report (DISREP) (SF361). Fill out and forward Discrepancy in Shipment Report (DISREP) (SF 361) as prescribed in AR 55-38/NAVSUPINST 4610.33C/MCOP4610.19D/DLAR 4500.15.

**1-3. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS.** Refer to the latest issue of DA PAM 25-30 to determine whether there are new additions, changes, or additional publications pertaining to the equipment. USMC users refer to SL-1-2.

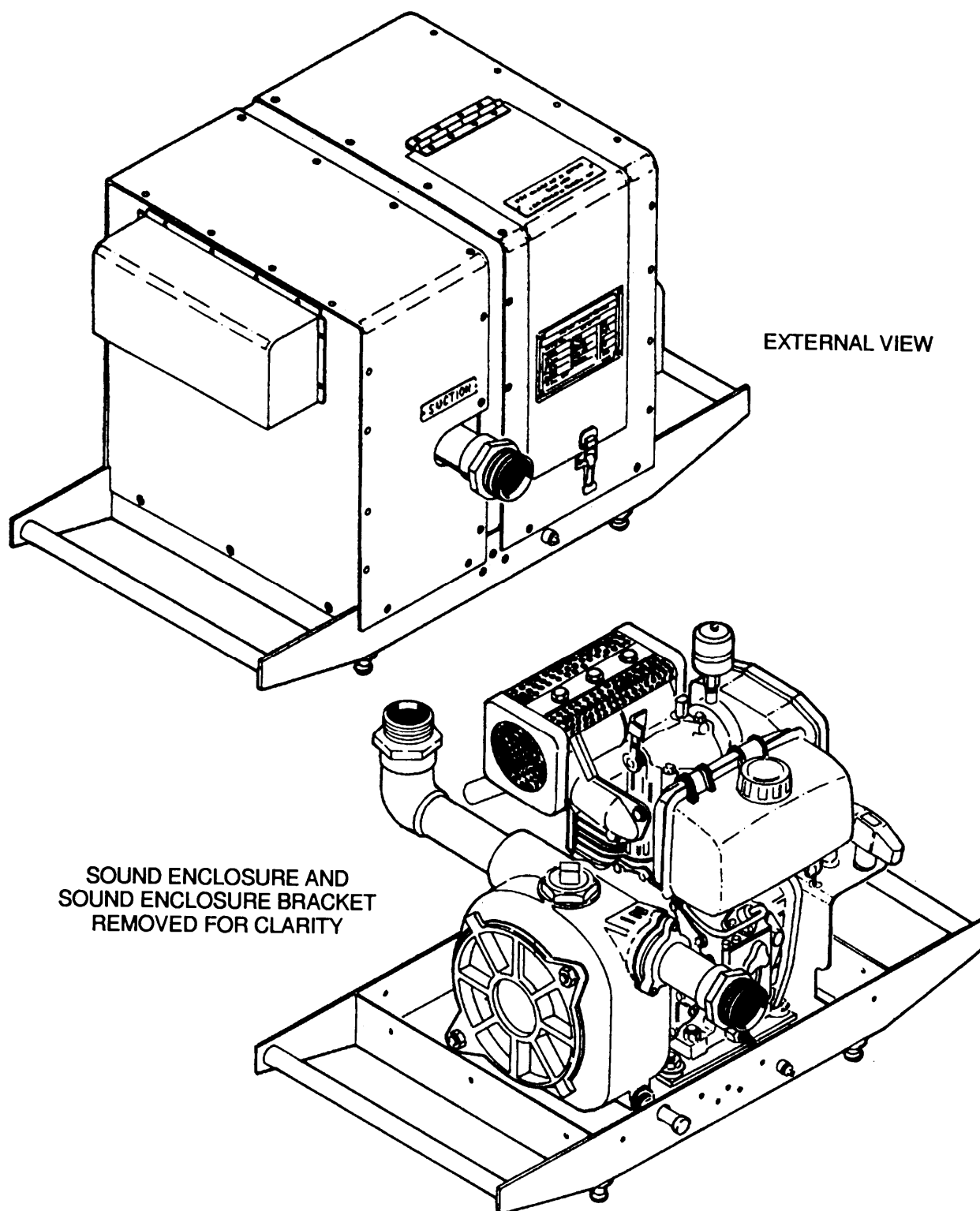


Figure 1-1. Diesel-Driven Centrifugal Pump

#### **1-4. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE**

For destruction procedures for materiel refer to TM 750-244-3.

#### **1-5. PREPARATION FOR STORAGE OR SHIPMENT**

For procedures and inspections required for administrative storage refer to paragraph 3-24

#### **1-6. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR'S)**

If your diesel-driven centrifugal pump 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. Put it on a SF 368 (Quality Deficiency Report). Mail it to: Commander, U.S. Army Troop Support Command, ATTN: AMSAT-I-MDO, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We'll send you a reply.

#### **1-7. WARRANTY**

The diesel-driven centrifugal pump is warranted by Mechanical Equipment Company (MECO®) for a period of two years from the date of delivery as shown on the Material Inspection and Receiving Report (DD Form 250). The contractor shall be notified in writing of any failure of a line item or component subject to the guarantee within thirty days after the discovery of the failure.

Report all defects in material or workmanship to your supervisor, who will take appropriate action through your unit maintenance shop.

In order to promptly handle all warranty parts claims, MECO® insists that the following procedures be followed. Avoiding this policy will jeopardize the warranty claim, since prompt and proper documentation is mandatory.

##### **General Requirements**

- a. Supply the unit model number, serial number, date of failure, part number, description of the defective part, and description of failure.
- b. Advance shipping approval must be obtained by contacting the MECO® Paris Department by letter, telex, or telephone, at which time the customer will receive a return authorization number.  
Mechanical Equipment Co. (MECO®)  
861 Carondelet Street  
New Orleans, LA 70130  
504-523-7271
- c. All parts or components returned to MECO® for inspection must be identified with the authorization number. The packing and return of the parts is the customer's responsibility. All freight and handling must be prepaid by the most economical routing. MECO® will ship the replacement parts prepaid to customer.
- d. The general shipping requirements are as follows:
  - (1) All parts should be returned in "as removed" condition. Do not clean prior to return.
  - (2) Major components, such as pumps and meters, must show no sign of prior disassembly.
  - (3) All fluids, such as water, acids, oil, or other chemical solutions, must be drained prior to shipment.
  - (4) All parts and components should be properly packaged to avoid damage during shipment.
- e. MECO® will acknowledge receipt of the customer's warranty claim shipment by telex and, likewise, inform the customer of the disposition.

Processing a warranty claim is the responsibility of the customer and is a transaction between MECO® and the customer. If a MECO® sales or stocking parts agent is involved in the transaction, it is still the responsibility of the customer to return the parts to MECO®.

On notification of warranty claim, MECO® will ship the replacement parts direct from New Orleans or, if a local stocking parts agent has the parts in stock, the customer can obtain the parts from the agent. A purchase order is required

in both cases. MECO® will handle the appropriate credits with the agent or customer, provided that MECO® received the defective parts within 60 days from the date of authorization of return.

Section II. EQUIPMENT DESCRIPTION AND DATA

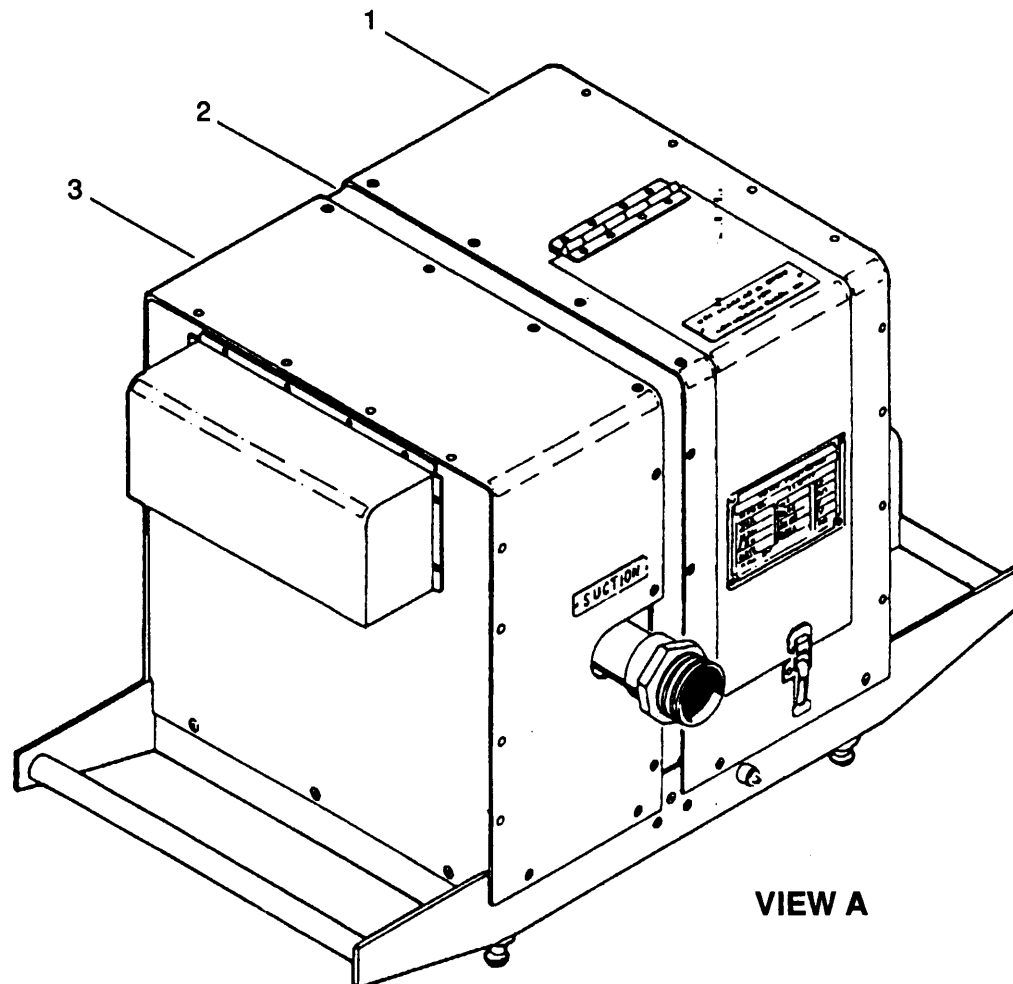
INDEX	
Para	Para
Equipment Characteristics, Capabilities, and Features . . . . .	1-8
Location and Description of Major Components . . . . .	1-9
Equipment Data . . . . .	1-10

1-8. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES

Characteristics of the diesel-driven centrifugal pump include:

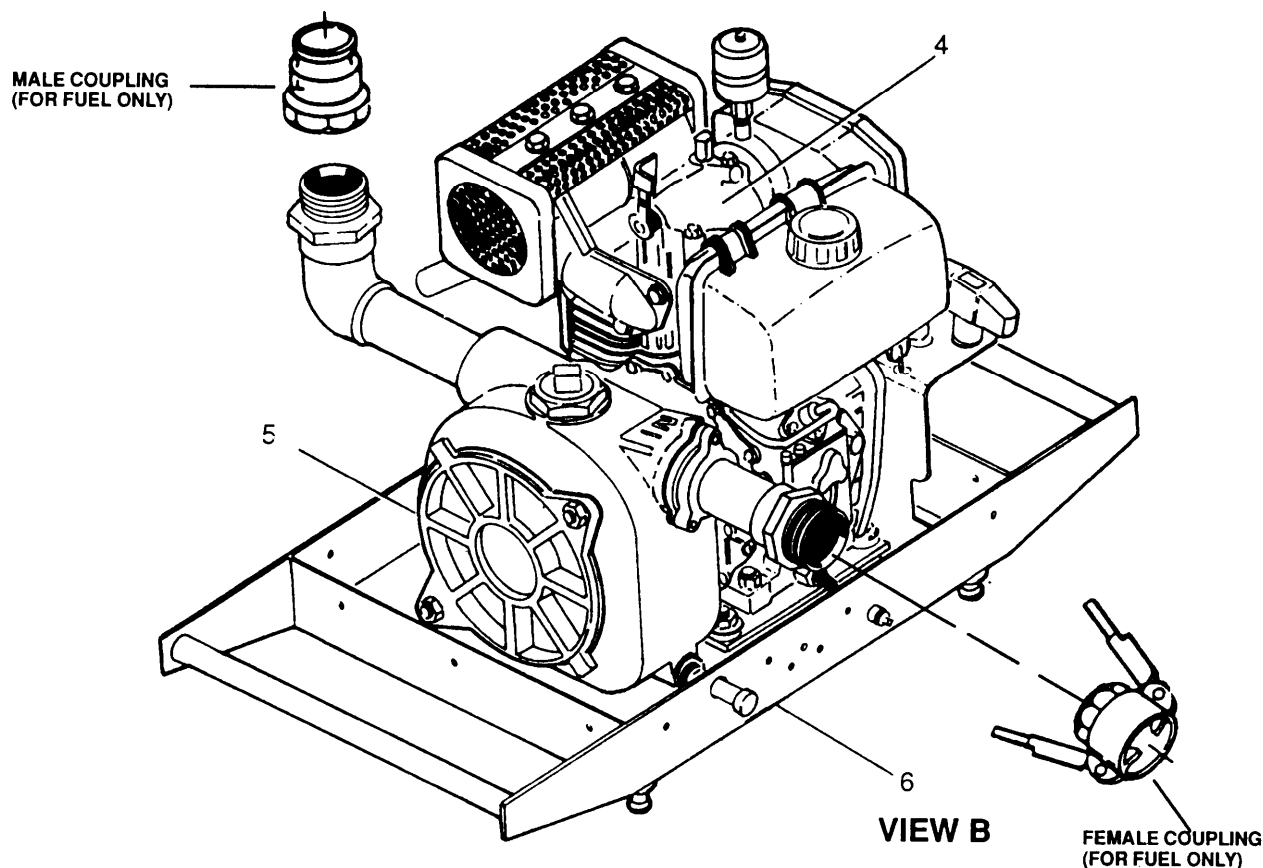
- Variable speed operation
- Frame-mounted
- Self-priming
- Recoil starter
- Dry-type air cleaner with air cleaner restriction indicator
- 125 GPM at 50 ft of head
- Check valve retains water in pump body when pump is shut down
- Sound enclosure to reduce noise level

## 1-9. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS



**Figure 1-2. Diesel-Driven Centrifugal Pump, Major Components**

- a. **INLET AIR SOUND ENCLOSURE.** Provides noise reduction and directs engine intake air to air cleaner and flywheel fan. Contains hinged door which swings up to provide operator access to engine controls.
- b. **OUTLET AIR SOUND ENCLOSURE.** Provides noise reduction and directs air out of sound enclosure.
- c. **SOUND ENCLOSURE BRACKET.** Provides structural support for inlet and outlet sound enclosures. Mounts to frame.
- d. **DIESEL ENGINE.** Four-stroke, vertical cylinder, air-cooled diesel. Provides power necessary to drive the pump.
- e. **CENTRIFUGAL PUMP.** Continuous duty, self-priming, 125 GPM at 50 ft of head.
- f. **FRAME.** Aluminum, all welded construction. Provides for easy transportability and supports engine and pump.



**NOTE:** Sound enclosure not shown for clarity.

Figure 1-3. Diesel Centrifugal Pump, Major Components

## 1-10. EQUIPMENT DATA

### PUMP

Manufacturer .....	Mechanical Equipment Company
Part Number .....	5500233000(water)550233001(fuel)
Service .....	Water and fuel
Duty Cycle .....	Continuous
Rated Output .....	125 GPM at 50 ft total head
Suction (Intake) Port .....	2 in. NPT
Suction (Intake) Port .....	2 in. Quick Disconnect Coupling (female)
Discharge Port .....	2in. NPT
Discharge Port .....	2 in. Quick Disconnect Coupling (male)
Priming Port .....	2 in. NPT
Priming Method .....	Self-priming system after initial filling
Drain Port .....	1/2 in.NPT (Bushed to 3/8 in.NPT)
Rotation .....	Counterclockwise (facing pump side)

## **ENGINE**

Manufacturer . . . . . Yanmar  
 Model . . . . . L40E-D  
 Horsepower . . . . . 3.8  
 Type . . . . . Four-stroke, forced air cooled by  
 .. flywheel fan  
 Number of Cylinders . . . . . One  
 Bore . . . . . 2.677in. (68mm)  
 Stroke . . . . . 2.165 in. (55mm)  
 Displacement . . . . . 12.14cu in...(0.99 liter)  
 Compression Ratio (nominal) . . . . . 20.5 to 1  
 Direction of Rotation . . . . . Counterclockwise (facing shaft end)  
 Number of Main Bearings . . . . . Two

## **AIR CLEANER**

Manufacturer . . . . . Yanmar  
 Part Number (Air Cleaner Assembly) . . . . . 714250-12560  
 Type . . . . . Dry type, paper cleaner element  
 Cleaner Element Part Number . . . . . 114250-12580

## **CAPACITIES**

Fuel Tank . . . . . 0.92 gallon (3.51 liters)  
 Engine Crankcase . . . . . 0.79 quart (0.75 liter)

## **DIMENSIONS AND WEIGHT**

Overall Width . . . . . 32.00 in. (81.3 cm)  
 Overall Length . . . . . 37.25 in. (94.6 cm)  
 Overall Height . . . . . 23.75 in. (60.3 cm)  
 Gross Weight . . . . . 144 lb (65.3kg)  
 Shipping Volume . . . . . 16 cubic feet (0.453 cubic meter)

## **AIR CLEANER RESTRICTION INDICATOR**

Manufacturer . . . . . Donaldson  
 Part Number . . . . . RAX-00-2350/P10-0089

Section III. TECHNICAL PRINCIPLES OF OPERATION

INDEX

	Para		Para
Functional Description . . . . .	1-10	Diesel-Driven Centrifugal Pump . . . . .	1-11

1-10. FUNCTIONAL DESCRIPTION

This section contains essential information which a maintenance technician must know to do the overall job properly. Description of components and assemblies which are not maintained at unit maintenance are included when necessary to provide continuity.

1-11. DIESEL-DRIVEN CENTRIFUGAL PUMP

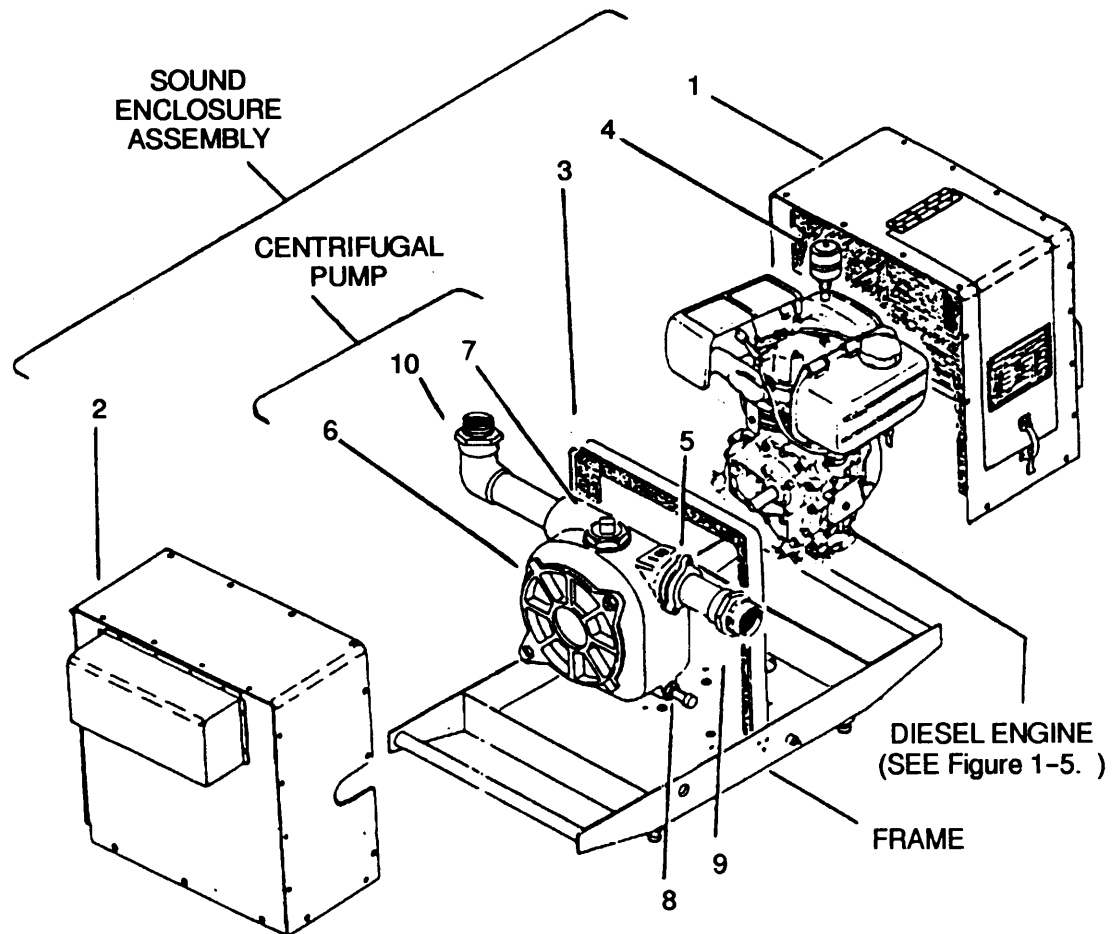
This is a self-contained, transportable, diesel driven centrifugal pump for pumping water. Consists of a self-priming centrifugal pump, a four-stroke, air-cooled diesel engine, and sound enclosure for noise reduction.

- Ž **SOUND ENCLOSURE ASSEMBLY.** Aluminum enclosures, riveted, urethane polyester acoustical foam with adhesive backing as noise reducing material, secured to frame with screws. Aluminum enclosures are painted with Chemical Agent Resistant Coating (CARC).
- **CENTRIFUGAL PUMP.** Aluminum casing with bronze impeller, integral check valve, 3/8 inch drain port. Counterclockwise rotation, 2 inch suction and discharge connections.
- Ž **FRAME** Aluminum, all-welded construction. Chemical Agent Resistant Coating (CARC).
- **DIESEL ENGINE.** Four-stroke, vertical cylinder, air-cooled diesel, recoil starter, forced lubrication by trochoid pump. Direct fuel injection system, dry-type air cleaner with air cleaner restriction indicator. 3.8 horsepower (continuous) at 3600 RPM.

1-12. DIFFERENCE IN MODELS

- Fuel pump requires grounding application. (refer to paragraph 2-8 for use)
- CAM-Lock Couplings (2 inch) required on fuel pump suction and discharge ports
- Ž Fuel pump requires the use of a spark arrestor muffler with 6 baffles.
- Ž National Stock Numbers (NSN'S)
  - For Water (Army) NSN 4320-01-247-7127
  - For Fuel (Marine Corps) NSN 4320-01-313-9442





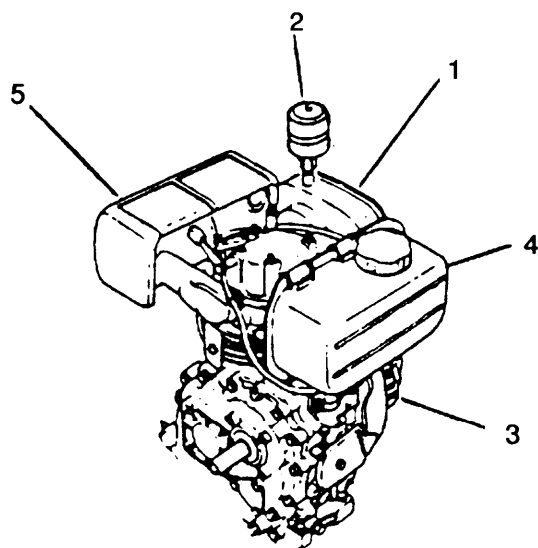
**Figure 1-4. Diesel-Driven Centrifugal Pump, Major Components**

**Sound Enclosure Assembly**

1. Inlet Air Sound Enclosure Assembly
2. Outlet Air Sound Enclosure Assembly
3. Sound Enclosure Bracket
4. Acoustical Foam

**Centrifugal Pump Assembly**

5. Check Valve
6. Pump Casing
7. Priming Port
8. Drain Port
9. Suction Connection
10. Discharge Connection



**Figure 1-5. Diesel Engine, Major Components**

1. Air Cleaner
2. Air Cleaner Restriction Indicator
3. Recoil Starter
4. Fuel Tank
5. Exhaust Silencer/Spark arrestor

## CHAPTER 2

### OPERATING INSTRUCTIONS

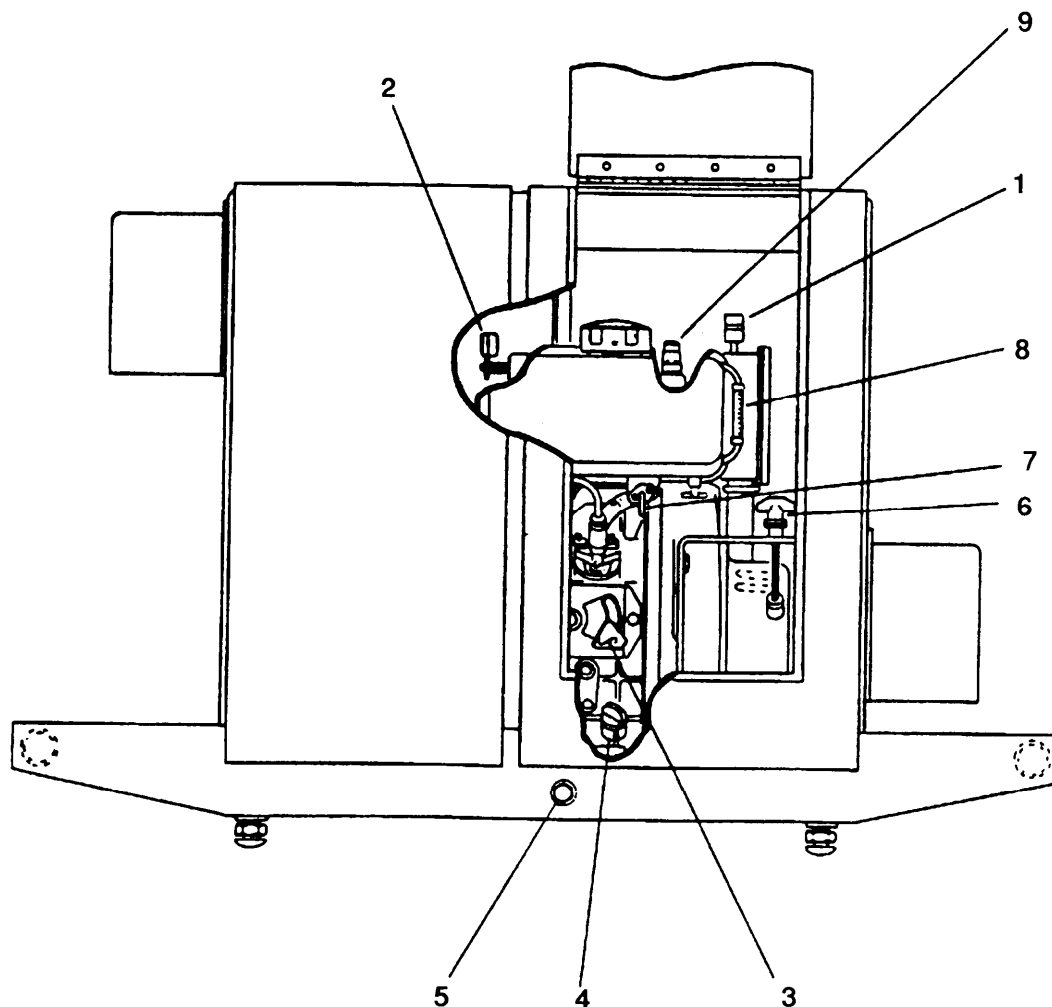
#### Section I DESCRIPTION AND USE OF OPERATOR'S CONSOLES AND INDICATORS

##### INDEX

Para	Para
Scope . . . . . 2-1	Operator's Controls and Indicators . . . . . 2-2

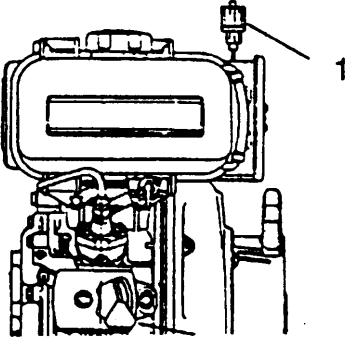
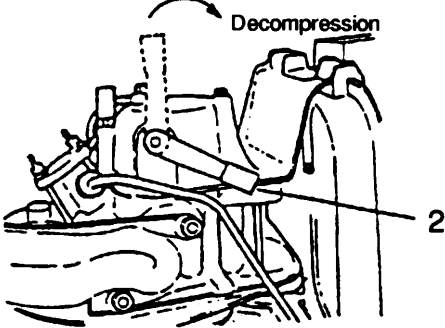
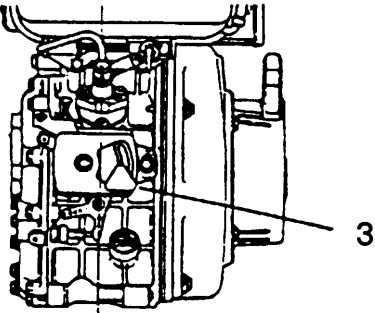
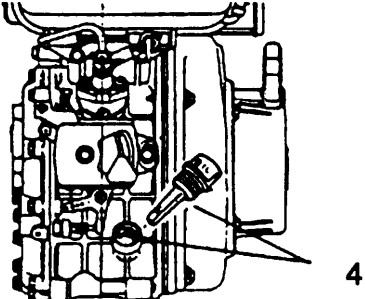
#### 2-1. SCOPE

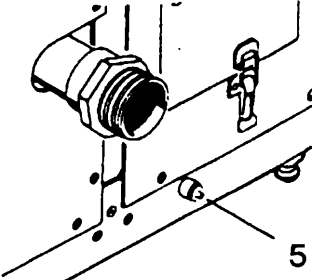
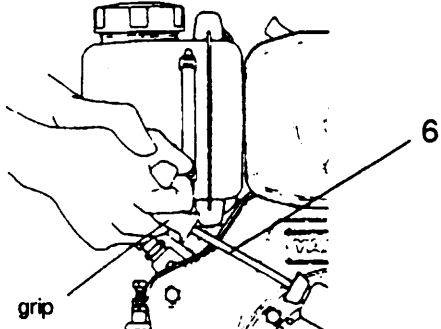
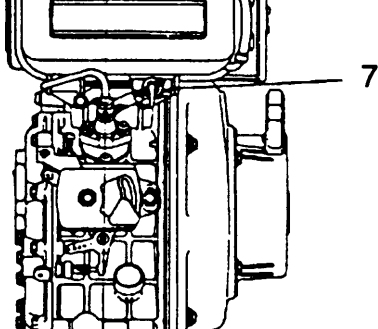
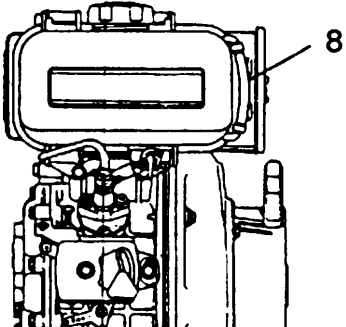
This section provides description and use of operator controls needed to operate the diesel-driven centrifugal pump.

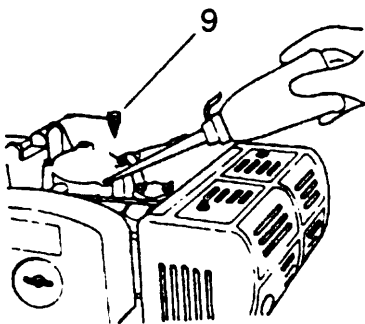


**Figure 2-1. Operator's View of Controls and Indicators (View Throught Access Door)**

## 2-2. OPERATOR'S CONTROLS AND INDICATORS

CONTROL OR INDICATOR	FUNCTION
<b>1 AIR CLEANER RESTRICTION INDICATOR</b>	
	Indicates blockage of air cleaner element. A red band appears in window to indicate the need for replacement of the air cleaner element. The indicator is threaded into the air cleaner housing and is activated by high negative pressure. Indicator can be reset.
<b>2 DECOMPRESSION LEVER</b>	
	Controls engine compression when starting (the engine turns over easier when starting). Lever is depressed for starting and returns automatically on the next piston compression cycle.
<b>3 SPEED CONTROL</b>	
	Controls engine speed. When positioned in the START position the engine operates at highest speed. By moving lever between START and STOP positions, the desired operating speed can be obtained.
<b>4 OIL DIPSTICK/FILLER PORT</b>	
	Indicates lube oil level in crankcase. Filler port for oil fill/change and adding oil.

CONTROL OR INDICATOR	FUNCTION
<p><b>5 LUBE OIL DRAIN PLUG</b></p> 	<p>Provides external fitting to allow draining engine lube oil.</p>
<p><b>6 RECOIL STARTER</b></p> 	<p>Handle grip and pull rope with automatic recoil for starting engine.</p>
<p><b>7 FUEL COCK</b></p> 	<p>Shutoff valve for diesel fuel. In the 6 o'clock position (OPEN), diesel fuel will flow to injection pump. In the 3 o'clock position (CLOSED), diesel fuel is shut off.</p>
<p><b>8 FUEL GAUGE PIPE</b></p> 	<p>Sight gauge for diesel fuel level in fuel tank.</p>

CONTROL OR INDICATOR	FUNCTION
9 <b>COLD WEATHER PLUG</b> 	The engine is equipped with a rubber plug in the rocker arm cover to aid in cold weather starting. The plug is removed and a small quantity of engine oil is added before starting.

Section II. OPERATOR’S PREVENTIVE MAINTENANCE CHECKS AND SERVICES  
 (PMCS)

INDEX

	Para		Para
General . . . . .	2-3	Leakage Definitions . . . . .	2-5
PMCS Procedures . . . . .	2-4		

2-3. GENERAL

- For the diesel-driven centrifugal pump to be ready at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure.
- BEFORE YOU OPERATE** Always keep in mind the CAUTIONS and WARNINGS. Perform your “before” PMCS (refer to Table 2-1)
  - WHILE YOU OPERATE.** Always keep in mind the CAUTIONS and WARNINGS. Perform your “during” PMCS (refer to Table 2-1)
  - AFTER YOU OPERATE.** Always keep in mind the CAUTIONS and WARNINGS. Perform your “after” PMCS (refer to Table 2-1)
  - MONTHLY.** Always keep in mind the CAUTIONS and WARNINGS. Perform your “monthly” PMCS (refer to Table 2-1)
  - If your equipment fails to operate, troubleshoot using recommended troubleshooting procedures (refer to para 3-13), and proper equipment. Report deficiencies in accordance with DA PAM 738-750.

## 2-4. PMCS PROCEDURES

- a The purpose of the PMCS table is to give the operator a list of preventive maintenance checks and services to perform in order to keep the equipment operating safely and efficiently. The PMCS table also provides the operator with the service interval between the checks and services. The service intervals on the PMCS are as follows:

Before Operation	During Operation
After Operation	Monthly

- b. The column "Not Fully Mission Capable If" provides the operator with the criteria that will cause the equipment to be not ready/available for service because of inability to perform its primary function. If equipment is found to be not fully mission capable, the operator should notify unit maintenance personnel.
- c. Perform 'monthly' as well as "before" operation PMCS if:
  - (1) You are the assigned operator and have not operated the item since the last monthly inspection.
  - (2) You are operating the item for the first time.

## 2-5. LEAKAGE DEFINITIONS

Equipment operation is allowable with minor leakage (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 unit maintenance.

- a. 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.

**Table 2-1. 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.

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
		<p><b>SOUND ENCLOSURE ASSEMBLY</b></p> <div> </div> <p><b>APPLICATION OF CARC PAINT</b></p> <p>An approved for or accepted pressure demand or continuous flow, type C, full-facepiece hood or helmet supplied air respirator must be worn when CARC painting. The local safety office, Preventive Medicine Activity, and local medical support facility must be consulted prior to initiating CARC painting.</p> <div> </div>	



**Table 2-1. Preventive Maintenance Checks and Services- Continued**

<b>Item No.</b>	<b>Interval</b>	<b>ITEM TO BE INSPECTED PROCEDURES</b>	<b>Not Fully Mission Capable If:</b>
1	Before	<p><b>Chemical Agent Resistant Coating (CARC)</b></p> <p>Check condition of Chemical Agent Resistant Coating. Coating shall be in good condition with no base metal or corrosion.</p>	<p>Enclosure components visibly separated at rivet seams. Notify Unit Maintenance.</p>
2	Before	<p><b>Identification Plate</b></p> <p>Check that identification plate (1) can be read.</p>	
3	Before	<p><b>Door Latch</b></p> <p>Check that access door latch (2) and fastening hardware (3) are secure.</p>	
4	Before	<p><b>Enclosure Acoustical Foam, Rivets, and Screws</b></p> <p>Check condition of sound enclosure rivets (4) and self-tapping screws (5).</p> <p>Inspect acoustical foam within the enclosure. Check to make sure acoustical foam does not block air flow, is not torn or scarred, and does not show signs of contacting a hot surface.</p>	

Table 2-1. Preventive Maintenance Checks and Services - Continued

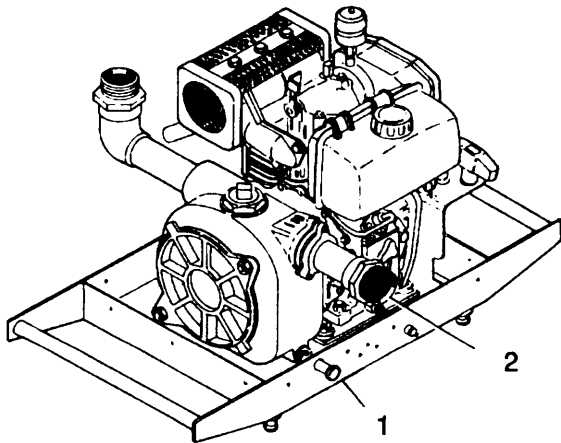
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
		<p><b>CENTRIFUGAL PUMP ASSEMBLY</b></p>  <p><b>WARNING</b></p> <p>When draining, do not smoke or use open flame in the area. Always make metal-to metal contact between the container and the fuel hose. This will prevent a spark as fuel flows over metallic surfaces. Failure to observe this warning may result in death to personnel.</p> <p><b>NOTE</b></p> <p>When pump is not in use, water should be drained.</p>	
5	Before	<p><b>Drain Plug</b></p> <p>Check that pipe cap (1) is securely installed.</p>	Drain plug is not properly installed. Notify Unit Maintenance.
6	Before	<p><b>Check Valve</b></p> <p>Look through suction port and check for damage to suction check valve (2).</p>	Suction check valve is damaged. Notify Unit Maintenance.
7	Before	<p><b>Suction Piping</b></p> <p>Visually check interior of suction port for foreign matter that could enter into pump during operation.</p>	Suction line is dogged with foreign matter. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

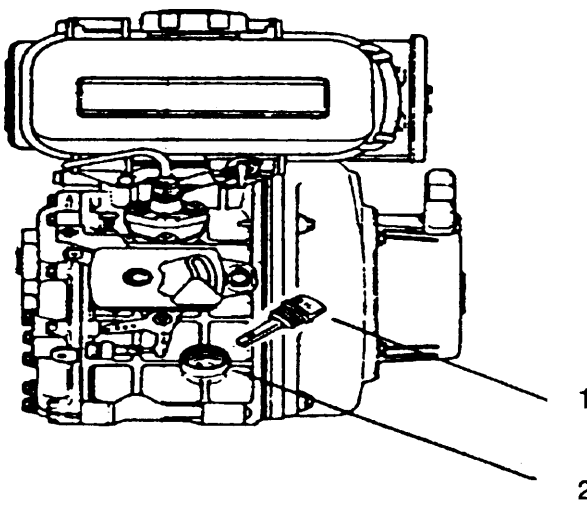
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
8	Before	<b>SEAL</b> Visually inspect pump casing for leaks.	Class III leakage of water/fuel. Notify Unit Maintenance.
9		<b>ENGINE</b> Oil Level  <p>With engine level, remove oil dipstick (1), wipe with lint-free cloth (Appendix E, Section II, Item 11)</p> <p>Insert dipstick all the way into engine, then withdraw. Engine oil should coat dipstick to top mark.</p> <p><b>NOTE</b></p> <p><b>Do not overfill engine with lube oil.</b></p> <p>If oil is below top mark, add oil to dipstick connection (2), to bring oil up to top mark; check oil level again. Repeat the previous two steps until oil coats the dipstick to the top mark.</p> <p>Check that the dipstick is tightly closed.</p>	Oil level is low.

Table 2-1. Preventive Maintenance Checks and Services - Continued

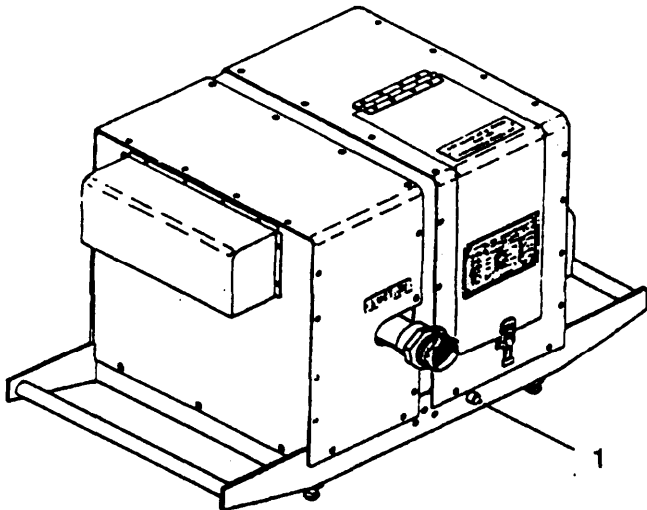
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
10	Before	<p><b>Lube Oil Drain Plug</b></p>  <p>Check condition of lube oil drain plug (1).</p> <p><b>FUEL SYSTEM</b></p> <div><p><b>WARNING</b></p></div> <p><b>MISHANDLING FUEL COULD RESULT IN DEATH OR SERIOUS INJURY</b></p> <p>Engine must be turned off and cool before refueling. Use proper refueling procedures and equipment to avoid spillage. Wipe away fuel spills with a clean cloth. Refuel only in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Do not run engine near open fuel containers. Always store fuel in proper, marked containers. <b>DO NOT SMOKE</b> when refueling.</p>	<p>Plug missing or Class III leakage of lube oil. Notify Unit Maintenance.</p>

Table 2-1. Preventive Maintenance Checks and Services - Continued

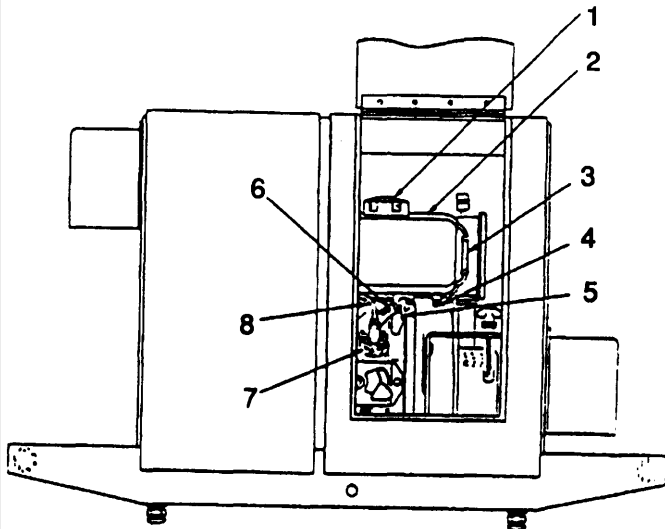
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
11	Before	 <p><b>Fuel Tank</b></p> <p>Remove fuel tank cap (1). Check for adequate fuel level and inspect fuel fill screen (9) for dirt or damage.</p> <p>Fill fuel tank (2) with diesel fuel until fuel level reaches red plastic ring in fuel tank.</p> <p>Tighten fuel tank cap (1).</p> <p>Check for leaks from fuel level gauge (3).</p>	Class III leak of fuel is present. Notify Unit Maintenance.
12	Before	<p><b>Fuel Cock</b></p> <p>Check for leaks from fuel cock (5).</p>	Class III leak of fuel is present. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
13	Before	<p><b>Fuel Injection Pump</b></p> <p>Check for leaks on fuel cock to fuel injection pump hose and clamps (6).</p> <p>Check for leaks from fuel injection pump (7).</p> <p>Check for leaks from fuel injection line and fittings (8).</p>	<p>Class III leak of fuel is present. Notify Unit Maintenance.</p> <p>Class III leak of fuel is present. Notify Unit Maintenance.</p> <p>Class III leak of fuel is present. Notify Unit Maintenance.</p>

Table 2-1. Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
14	Before	<p><b>Exhaust Silencer/Spark Arrestor</b></p> <div> </div> <p><b>Exhaust system is very hot during operation. Avoid contact with muffler and related components during checks described in this section. Before touching portions of the exhaust system, make sure that equipment has cooled.</b></p> <div> </div> <p>Check to make sure exhaust pipe (1) is installed and tight.</p> <p>Inspect for clogged or damaged spark arrestor.</p>	<p>Exhaust extension pipe is not properly installed. Notify Unit Maintenance.</p> <p>Clogged or damaged spark arrestor. Notify Unit Maintenance.</p>

Table 2-1. Preventive Maintenance Checks and services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
15	Before	<p><b>Air Cleaner</b></p> <div> </div> <p><b>Insulation or any other foreign matter may cause blockage of vent hoods which could damage engine.</b></p> <div> </div> <p>Check for red band in window of air cleaner restriction indicator (1).</p> <p>Check that air intake hose clamp (2) is tight.</p> <p>Check for restrictions in inlet and outlet vent hood (3).</p>	<p>Dirt in air cleaner blocks air flow enough to cause red band to appear in window of air cleaner restriction indicator. Notify Unit Maintenance.</p> <p>Air intake hose is not in place. Notify Unit Maintenance.</p>



Table 2-1. Preventive Maintenance Checks and services - Continued

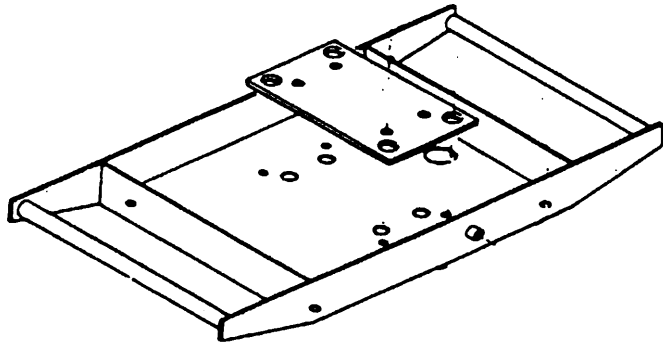
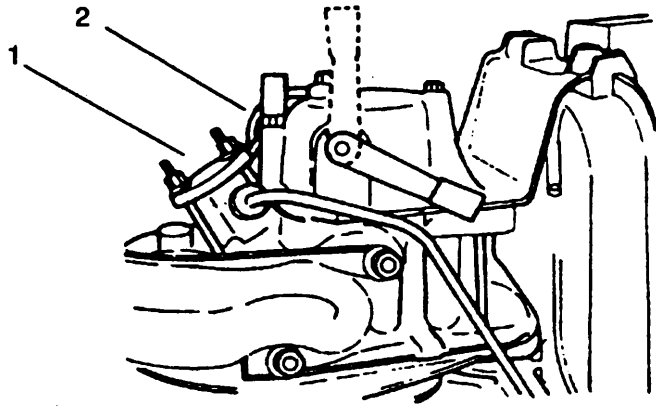
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
16	Before	<b>FRAME ASSEMBLY</b> Frame  <p>Visually inspect all frame welds for cracks and indications of corrosion. Inspect only welds that can be seen without disassembly.</p>	Cracks are detected. Notify Unit Maintenance.
17	During	<b>Fuel injection Nozzle</b>  <p>Check for leaks from fuel injection nozzle (1).</p> <p>Check for leaks from fuel return hose back to tank (2).</p>	Class III leak of fuel is present. Notify Unit Maintenance.  Class III leak of fuel is present. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
18	During	<p><b>Exhaust Silencer/Spark Arrestor</b></p> <div> </div> <p>Exhaust system is very hot during operation. Avoid contact with muffler and related components during checks described in this section. Before touching portions of the exhaust system, make sure that equipment has cooled.</p> <div> </div> <p>Check to make sure exhaust pipe (1) is installed and tight.</p> <p>Inspect for dogged or damaged spark arrestor.</p>	<p>Exhaust extension pipe is not properly installed. Notify Unit Maintenance.</p> <p>Clogged or damaged spark arrestor. Notify Unit Maintenance.</p>

Table 2-1. Preventive Maintenance Checks and Services - continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission capable If:
19	After	<b>Chemical Agent Resistant Coating (CARC)</b>  Check condition of Chemical Agent Resistant Coating. Coating shall be in good condition with no bare metal or corrosion.	
20	After	<b>Identification Plate</b>  Check that identification plate (1) can be read.	
21	After	<b>Door Latch</b>  Check that access door latch (2) and fastening hardware (3) are secure.	
22	After	<b>Enclosure Acoustical Foam, Rivets, and Screws</b>  Check condition of sound enclosure rivets (4) and self-tapping screws (5).  Inspect acoustical foam within the enclosure. Check to make sure acoustical foam does not block air flow, is not torn or scarred, and does not show signs of contacting a hot surface.	Enclosure components visibly separated at rivet seams. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

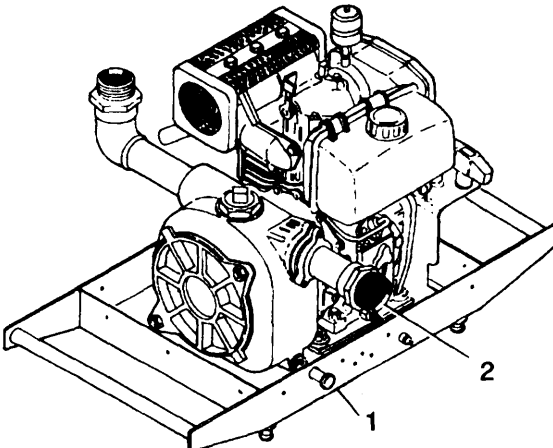
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
		<p><b>CENTRIFUGAL PUMP ASSEMBLY</b></p>  <p><b>WARNING</b></p> <p>When draining, do not smoke or use open flame in the area. Always make metal-to-metal contact between the container and the fuel hose. This will prevent a spark as fuel flows over metallic surfaces. Failure to observe this warning may result in death to personnel.</p> <p><b>NOTE</b></p> <p>When pump is not in use, water/fuel should be drained.</p> <p>Inspect for dogged or damaged spark arrestor.</p>	
23	After	<p><b>Drain Plug</b></p> <p>Check that pipe cap (1) is securely installed.</p>	Drain plug is not properly installed. Notify Unit Maintenance.
24	After	<p><b>Check Valve</b></p> <p>Look through suction port and check for damage to suction check valve (2).</p>	Suction check valve is damaged. Notify Unit Maintenance.
25	After	<p><b>Suction Piping</b></p> <p>Visually check interior of suction port for foreign matter that could enter into pump during operation.</p>	Suction line is dogged with foreign matter. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

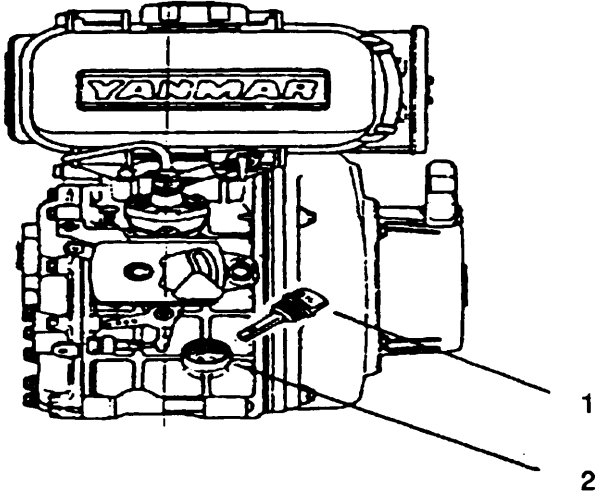
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable if:
26	After	<b>Seal</b> Visually inspect pump casing for leaks.	Class III leakage of water/fuel. Notify Unit Maintenance.
27	After	<b>ENGINE</b> Oil Level  <p>With engine level, remove oil dipstick (1), wipe with lint-free cloth (Appendix E, Section II, Item 11)</p> <p>Insert dipstick all the way into engine, then withdraw. Engine oil should coat dipstick to top mark.</p> <p><b>NOTE</b></p> <p><b>Do not overfill engine with lube oil.</b></p> <p>If oil is below top mark, add oil to dipstick connection (2), to bring oil up to top mark; check oil level again. Repeat the previous two steps until oil coats the dipstick to the top mark.</p> <p>Check that the dipstick is tightly closed.</p>	

Table 2-1. Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
28	After	<div> </div> <p><b>Fuel Tank</b></p> <p>Remove fuel tank cap (1). Check for adequate fuel level and inspect fuel fill screen (9) for dirt or damage.</p> <p>Fill fuel tank (2) with diesel fuel until fuel level reaches red plastic ring in fuel tank</p> <p>Tighten fuel tank cap (1).</p> <p>Check for leaks from fuel level gauge. (3)</p>	Class III leak of fuel is present. Notify Unit maintenance.
29	After	<p><b>Fuel Cock</b></p> <p>Check for leaks from fuel cock (5).</p>	Class III leak of fuel is present. Notify Unit maintenance.

**Table 2-1. Preventive Maintenance Checks and Services - Continued**

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
30	After	<p><b>Fuel Injection Pump</b></p> <p>Check for leaks on fuel cock to fuel injection pump hose and clamps (6).</p> <p>Check for leaks from fuel injection pump (7).</p> <p>Check for leaks from fuel injection line and fittings (8).</p>	<p>Class III leak of fuel is present. Notify Unit Maintenance.</p> <p>Class III leak of fuel is present. Notify Unit Maintenance.</p> <p>Class III leak of fuel is present. Notify Unit Maintenance.</p>

Table 2-1. Preventive Maintenance Checks and Services - Continued

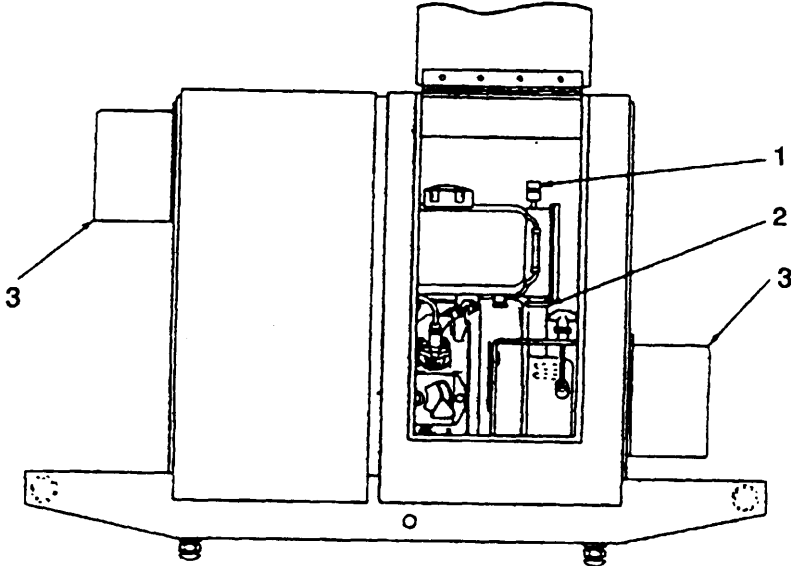
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable if:
31	After	<div><p><b>Air Cleaner</b></p><div><div>WARNING</div><p>Insulation or any other foreign matter may cause blockage of vent hoods which could damage engine.</p></div></div> <div><p>Check for red band in window of air cleaner restriction indicator (1).</p><p>Check that air intake hose damp (2) is tight.</p><p>Check for restrictions in inlet and outlet vent hood (3).</p></div>	<p>Dirt in air cleaner blocks air flow enough to cause red band to appear in window of air cleaner restriction indicator. Notify Unit Maintenance.</p> <p>Air intake hose is not in place. Notify Unit Maintenance.</p>



Table 2-1. Preventive Maintenance Checks and Services - Continued

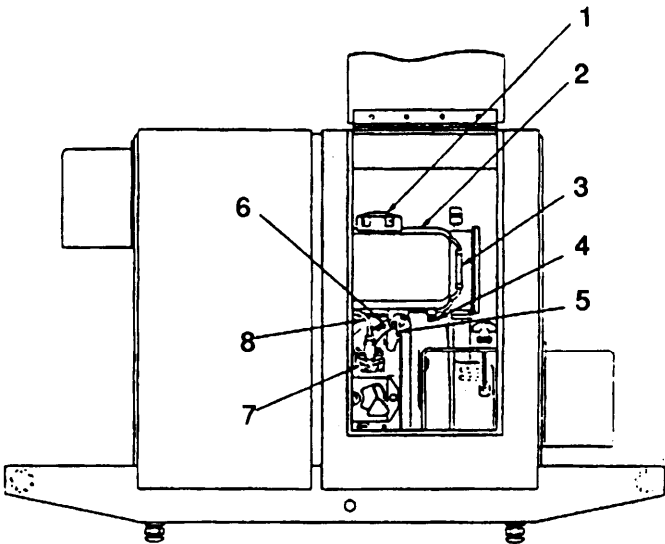
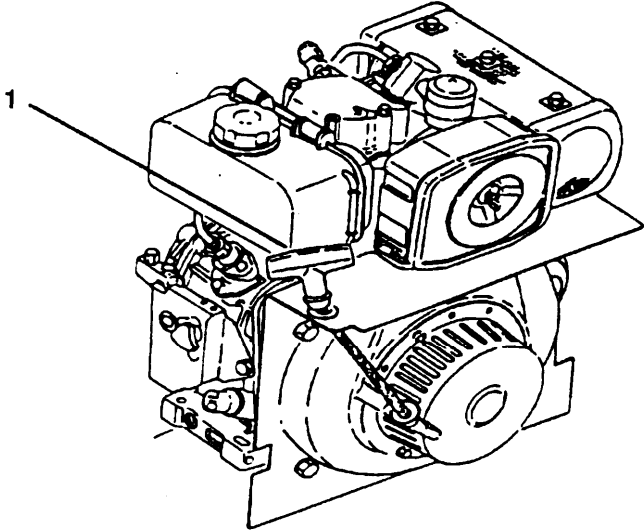
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable if:
32	Monthly	 <p><b>Drain Plug</b> Check for leaks from drain plug (4).</p>	Glass III leak of fuel is present. Notify Unit Maintenance.

Table 2-1. Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
33	Monthly	<div><p><b>Recoil Starter</b></p><p>Check recoil starter (1) to ensure it will crank the engine and return to its recoiled position.</p></div>	<p>Recoil starter does not function properly. Notify Unit Maintenance.</p>

### Section III. OPERATION UNDER USUAL CONDITIONS

#### INDEX

	Para	Para
Scope .....	2-6	Preparation for Movement .....
Installation .....	2-7	Identification and Information
Preparation for Use .....	2-8	Nameplates .....
Operating Procedures .....	2-9	2-11

#### 2-6. SCOPE

This section provides step-by-step instructions for all actions necessary to operate the equipment.

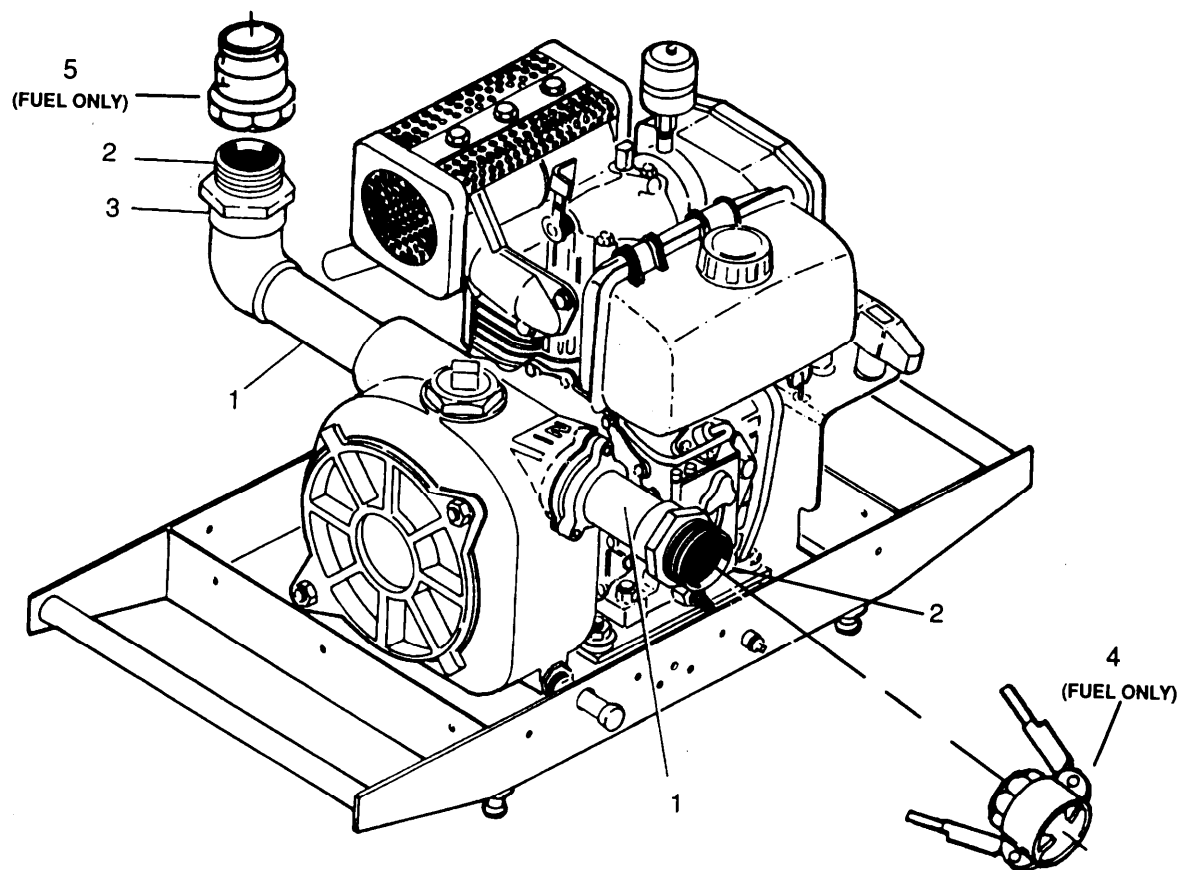
#### 2-7. INSTALLATION (Refer to Figure 2-2)

- a. The centrifugal pump unit is shipped in a cleated plywood box which is easily disassembled.
  - (1) Cut loose the three steel straps holding the box together.
  - (2) Remove the top cover.
  - (3) Remove the four sides in one piece.
  - (4) Loosen the four J-bolts and remove the centrifugal pump from the skid bottom.
- b. Inspect the pump for dirt, grease, chipped paint, scratches, or dents.
- c. If damage has occurred during shipment or transportation, report the damage on DD Form 6. Request Direct Support Maintenance to refurbish, repaint, or repair the pump assembly.
- d. The discharge and suction extensions are shipped loose and need to be installed before operating pump.

**Table 2-2. Installation Items**

ITEM	DESCRIPTION	QUANTITY
1. Water	2 X 6 inch long brass nipple	2
2. Water	2 inch brass adapter	2
3. Water	2 inch FPT x 2 inch MPT brass elbow	1
4. Fuel	2 inch female quick disconnect coupling	1
5. Fuel	2 inch male quick disconnect coupling	1

- (1) Items that require installation before pump is ready for operation are listed in Table 2-2
- (2) Install one 2 x 6 inch long nipple (1) into the pump suction port. Install the other 2 x 6 inch long nipple (1.) into the pump discharge port.
- (3) Install one 2 inch adapter (2) onto the 6 inch nipple (1) in the pump suction port. Install the 2 inch elbow (3.) onto the 6 inch nipple (1) in the pump discharge port.



**NOTE:** Sound enclosure not shown for clarity

**Figure 2-2. Installation Items**

- (4) Install the other 2 inch adapter (2) onto elbow (3) in the pump discharge port.
- (5) With the fuel pump application install the 2 inch female quick disconnect coupling (4) onto the 2 inch adapter (2) on the pump suction side. Install the 2 inch male quick disconnect coupling (5) onto the 2 inch adapter (2) on the discharge side.
- (6) Make sure all connections are tight.

## 2-8. PREPARATION FOR USE

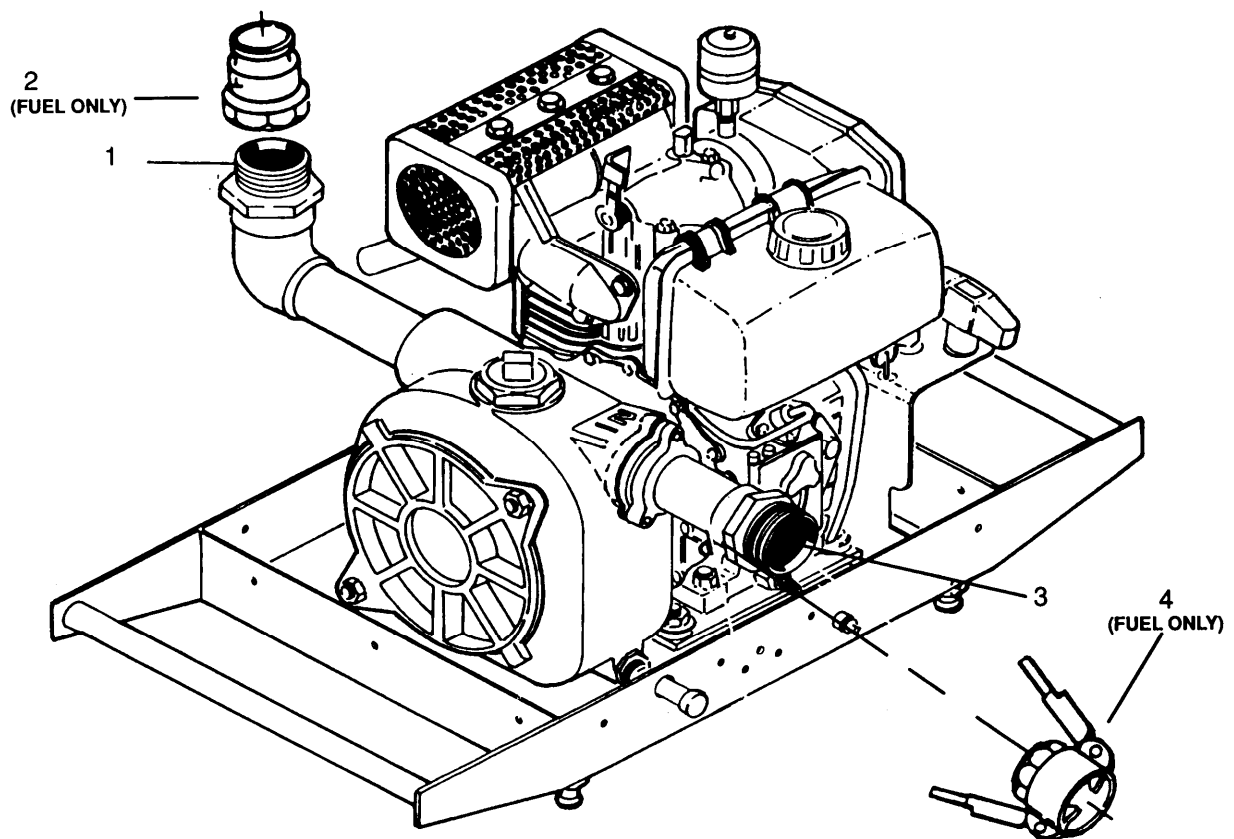


**Fuel version must be grounded with appropriate hardware.**

- a. Prime the centrifugal pump by filling the volute with approximately two gallons of water/fuel through the discharge port of the pump (1). (Refer to figure 2-3)

### NOTE

**As water/fuel fills the volute, air is removed through the discharge port.**



**NOTE: Sound enclosure not shown for clarity**

**Figure 2-3. Priming Pump**

- b. Connect discharge hose to hose adapter (1) for water or to male quick disconnect coupling (2) for fuel on pump discharge port.
- c. Connect suction hose to hose adapter (3) for water or to female quick disconnect coupling (4) for fuel on pump suction port. Highest point in the suction hose should be at the pump.

**WARNING**

**Fuel version must be grounded with appropriate hardware.**

- d. Grounding. Ground the fuel pump assembly by driving a grounding rod at least 36 inches deep before connecting the ground cable. In the event that impregnable soil is encountered, bury a ground rod with the cable attached at least 8 inches beneath the surface.

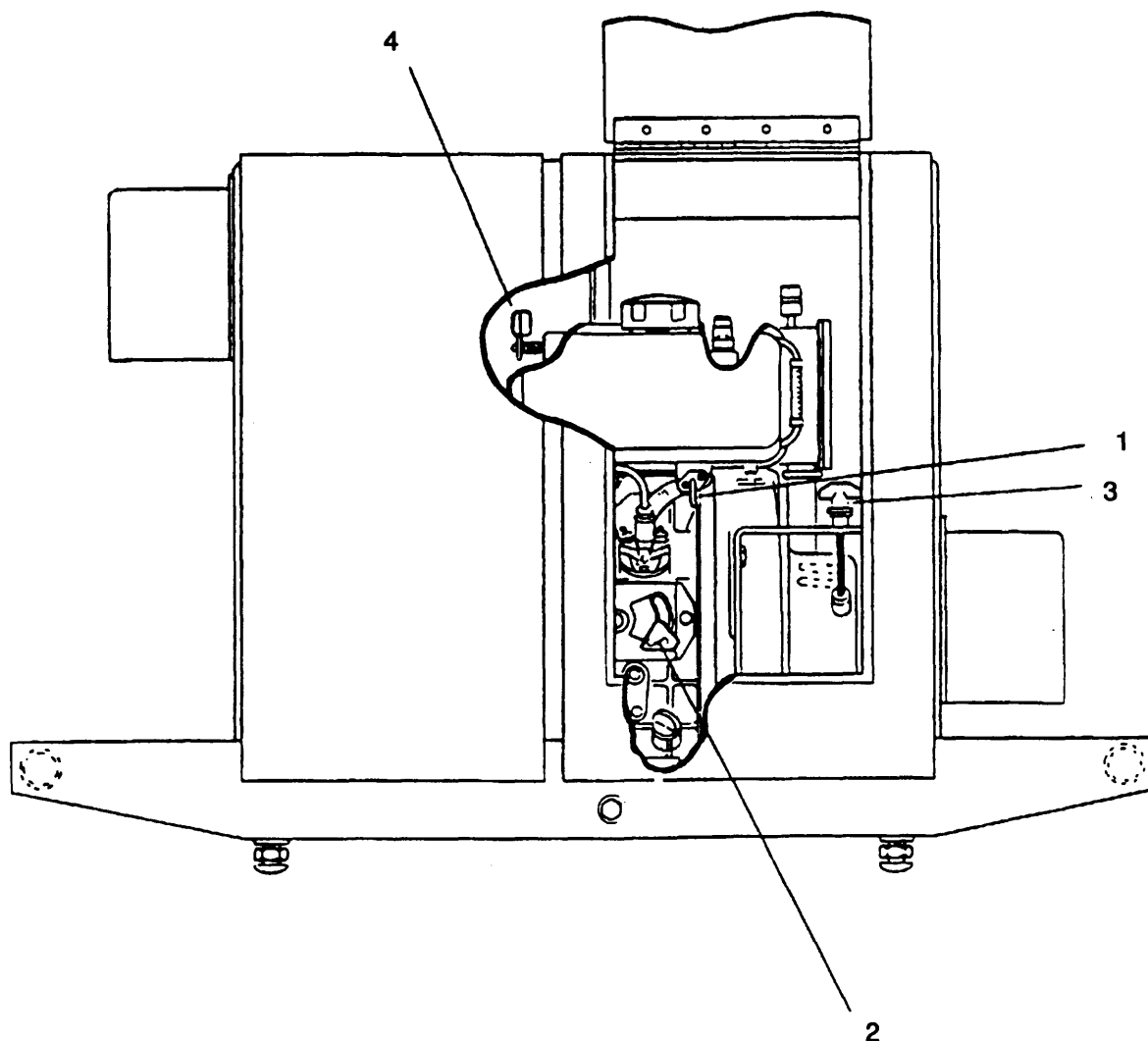


Figure 2-4. Starting Procedures

## 2-9. OPERATING PROCEDURES

- a. STARTING (Refer to Figure 2-4)



**The volute must be filled with water/fuel before starting.**

- (1) Verify that Preparation For Use Procedures listed in paragraph 2-8 have been performed.
- (2) Set fuel cock (1) to open position (6 o'clock) by turning handle to the downward position.
- (3) Loosen engine speed control lever knob and move engine speed control lever (2) to the "START" (downward) position. Tighten knob to hold in start position.
- (4) Slowly pull out starting handle (3) until you feel resistance, and then return it to the initial position.
- (5) Push the decompression lever down (4) and release. It will return automatically to the normal position (12 o'clock) when the recoil starter is pulled.

- (6) Hold recoil starting handle (2) firmly and pull out the handle briskly. Engine will start and go to maximum operating speed.

#### NOTE

**If engine does not start on first pull, repeat steps (4), (5), and (6).**

- (7) After 1 to 3 minutes, the centrifugal pump will start pumping water/fuel.

b. ADJUSTING SPEED

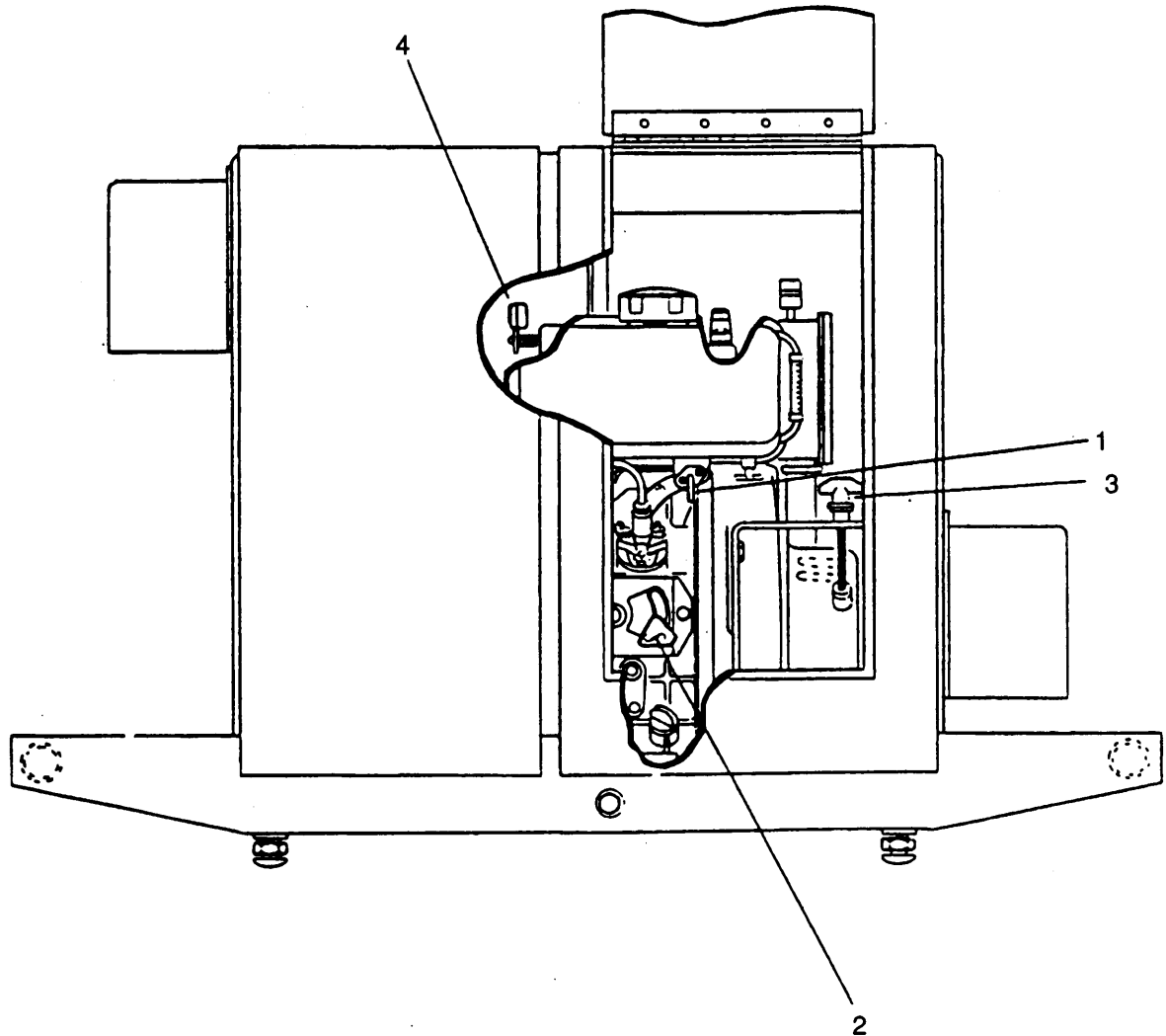


Figure 2-5. Adjusting Speed

#### CAUTION

**Do not allow the handle grip to snap back against the engine. Return it gently to prevent damage to the starter.**

- (1) If necessary, loosen speed control lever knob (2), adjust speed control lever to desired speed and pumping rate by moving the lever.
- (2) Tighten up speed control lever knob (2) at desired speed. Move up to decrease speed and down to increase speed.

c. STOPPING

**CAUTION**

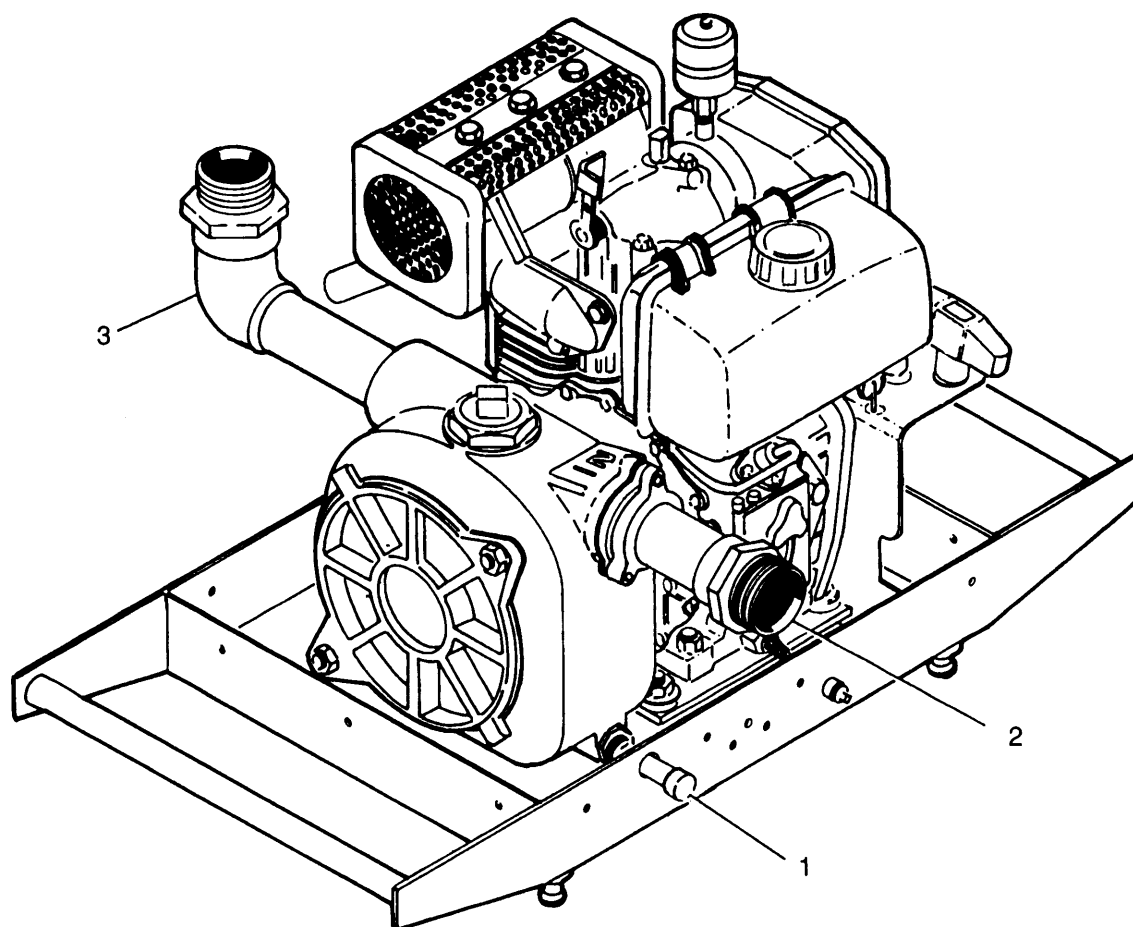
- **Do not stop engine suddenly since it may cause the temperature to rise abnormally high and possible damage to the engine may result. When stopping the engine, reduce the load slowly and allow the engine to run at idle speed for one minute.**

**⚡ Do not stop engine with the decompression lever as engine damage may result. If the engine cannot be stopped by the speed control lever knob, then move the fuel cock to the closed ( 3 o'clock) position.**

- (1) Slowly move speed control lever knob (2) upward until engine is running at idle speed. Allow engine to run at idle speed for 3 minutes.
- (2) Close any discharge valves, then any suction valves that are installed in the hoses. This will retain liquid in pump volute and reduce or eliminate priming requirements for the next pumping application.
- (3) Move engine speed control lever knob (2) all the way upward to the "STOP" position.



## 2-10. PREPARATION FOR MOVEMENT



**NOTE:** Sound enclosure not shown for clarity

**Figure 2-6. Preparation for Movement**

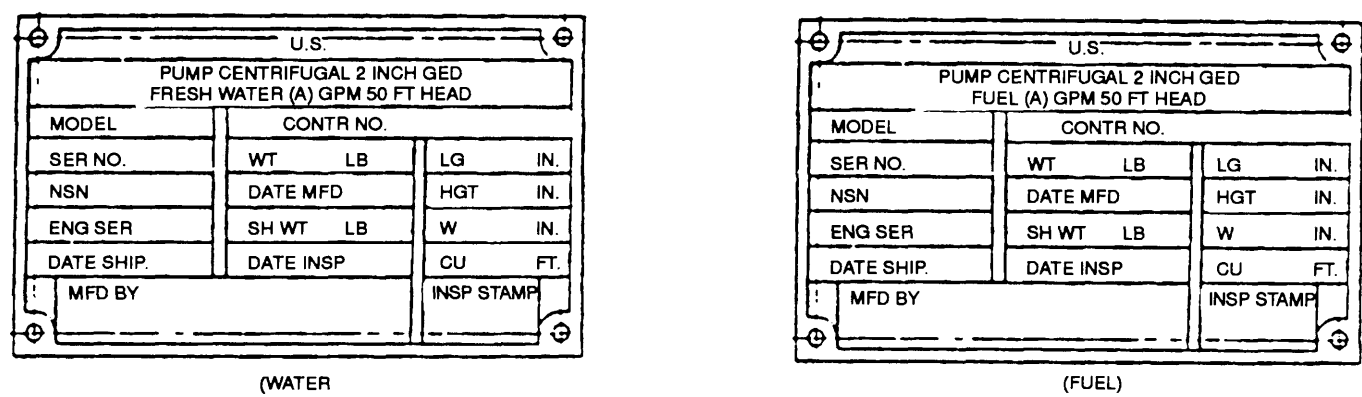
- a. Remove drain pipe cap (1) and allow pump to drain.
- b. Remove suction hose from pump suction connection (2).
- c. Remove discharge hose from pump discharge connection (3).
- d. Pump is now ready for relocation.

## 2-11. IDENTIFICATION AND INFORMATIONAL NAMEPLATES

The centrifugal pump has the following identification and instruction plates.

### a. Identification Nameplates

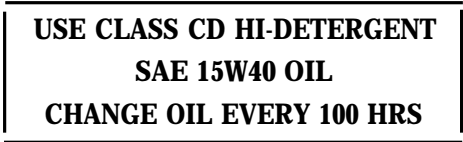
Located on the front of the access door. Provides the operator with the pump model number, serial number, NSN, dimensions, weight, and shipping information.



**Figure 2-7. Identification Nameplate**

**b. Oil Usage Nameplate**

Located in the top of the access door. Provides the operator with the type of oil to be used and the oil change interval required.



**c. Suction Nameplate**

Located on the sound enclosure above the pump suction port. Identifies the pump suction connection to the operator.



**Section IV. OPERATION UNDER UNUSUAL CONDITIONS**

INDEX

	Para		Para
Operation in Extreme Cold . . . . .	2-12	Operation Under Rainy or Humid	
Operation in Extreme Heat . . . . .	2-13	Conditions . . . . .	2-16
Operation in High Altitudes . . . . .	2-14	Operation in Salt Water Areas . . . . .	2-17
Operation in Sandy or Dusty Areas . . . . .	2-15		

## 2-12. OPERATION IN EXTREME COLD

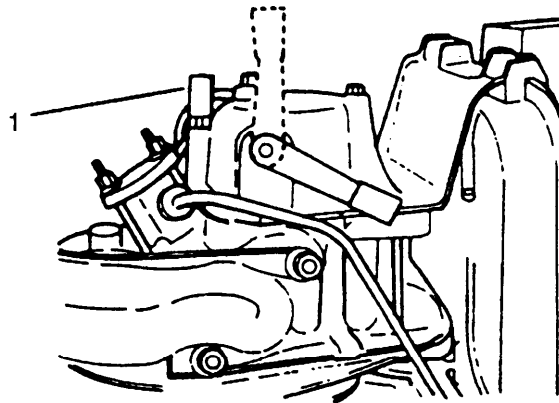
- a. Use proper engine oil for cold weather. See lubrication instructions in Chapter 3, paragraph 3-2, for the correct type of oil.



**Fuel version must be grounded with appropriate hardware.**

**Death or serious Injury could occur if fuel is not handled properly. Us in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in properly marked containers. DO NOT SMOKE.**

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



**Figure 2-8. Cold Weather Starting Aid**

- c. Cold weather starting can be improved by the addition of engine oil in rocker arm cover. Remove rubber plug (1) of rocker arm cover and add 5 drops of engine oil before starting.

### **CAUTION**

Do not us more oil than specified as a starting agent. Too much oil could result in engine reversal. Should this occur, engine exhaust will be emitted from the air intake. Stop engine at once using speed control lever knob or decompression lever. Engine oil pump does not work in reverse, and severe engine damage could result.

- d. Replace rubber plug (1) immediately after oil is added.



**Fuel version must be grounded with appropriate hardware.**

**Never use gasoline, paint thinner, or any other volatile liquid either as a fuel or as a starting aid. Addition of highly volatile liquids put directly into engine could cause an explosion.**

**CAUTION**

**Keep rubber plug in rocker arm cover except when adding oil. If plug is not in place contaminants may enter engine and cause accelerated wear of internal parts.**

- e. Start the engine immediately as described in paragraph 2-9.

**CAUTION**

**Change engine oil after initial 20 hours of operation or at end of first month. Thereafter, every three months or 100 hours operation.**

- f. When changing oil, drain engine oil while engine is warm. Later it may be difficult to drain the oil completely.
- g. Drain the pump immediately after stopping to prevent freezing.

## **2-13. OPERATION IN EXTREME HEAT**



**Fuel version must be grounded with appropriate hardware.**

**Death or serious injury could occur if fuel is not handled properly. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Always store fuel in properly marked containers. DO NOT SMOKE.**

- a. Protect pump assembly from direct heat of the sun.
- b. Make sure oil is kept maintained on the top oil level mark.

**CAUTION**

**Change engine oil after initial 20 hours of operation or at end of first month. Thereafter, every three months or 100 hours operation.**

- c. If overheating occurs in extreme conditions, shut down engine immediately. If possible, protect pump assembly from direct heat or the sun, and remove sound enclosure covers.

- d. Inspect cooling fins to ensure they are clean and free of dirt that inhibits cooling.
- e. Check the air cleaner restriction indicator frequently. If the red band appears in window of restriction indicator, change air cleaner element.

## **2-14. OPERATION IN HIGH ALTITUDES**

- a. Peak efficiency of the engine is reduced at higher altitudes. Be sure engine is operating at peak efficiency.
- b. Observe normal operation.

## **2-15 OPERATION IN SANDY OR DUSTY AREAS**

- a. Monitor the air cleaner intake restriction more closely. If the air cleaner restriction indicator shows its red band, replace air cleaner element.
- b. Make sure oil level is maintained at the top mark.

### **CAUTION**

**Change engine oil after Initial 20 hours of operation or at end of first month. Thereafter, every three months or 100 hours operation.**

- c. During the handling of fuel, PMCS, and refueling, be sure that sand or dust is not allowed to enter fuel or lubrication system.
- d. If centrifugal pump unit is not in use and suction and/or discharge hoses are not installed, be sure that suction (intake) flange and discharge ports are covered.
- e. With engine stopped, inspect frequently to be sure that cylinder cooling fins are clean and free of dirt that inhibits cooling.

## **2-16. OPERATION UNDER RAINY OR HUMID CONDITIONS**

- a. Keep fuel tank cap secured. Immediately close the operator's lid. During handling of fuel, PMCS, and refueling, be sure that water is not allowed to enter fuel or lubrication system.
- b. Take special care to prevent rust and corrosion. If surfaces become rusty or corroded, remove corrosion, then reprime and paint as necessary.



**Fuel version must be grounded with appropriate hardware.**

### **APPLICATION OF CARC PAINT**

**An approved or accepted pressure demand or continuous flow, type C, full-facepiece hood or helmet supplied air respirator must be worn when CARC painting. The local safety office, Preventive Medical Activity, and local medical support facility must be consulted prior to initiating CARC painting.**

Paint with Chemical Agent Resistant Coating (CARC) in accordance with MIL-T-704, Type G (for non-ferrous metals) or Type F (for ferrous metals). Color to be Sand.

## **2-17. OPERATION IN SALT WATER AREAS**

- a. Salt water causes corrosion. Use fresh water to wash off any salt that comes in contact with the equipment.
- b. If surfaces become rusty or corroded, remove corrosion, then reprime the paint as necessary.  
Paint with Chemical Agent Resistant Coating (CARC) in accordance with MIL-T-704, Type G (for non-ferrous metals) or Type F (for ferrous metals). Color to be Sand.

## CHAPTER 3

### UNIT MAINTENANCE INSTRUCTIONS

#### 3-1. GENERAL

This chapter is provided for unit level maintenance instructions. It presents to the operator the instructions and tied information needed to keep the equipment in good running order.

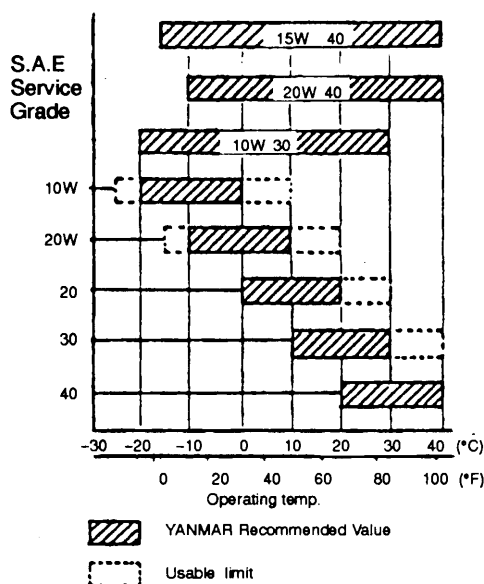
#### Section I. LUBRICATION INSTRUCTIONS

##### INDEX

	Para	Para
Lubrication .....	3-2	Lubrication Points ..... 3-4
Lube Oil Capacity .....	3-3	

#### 3-2. LUBRICATION

**Table 3-1. Recommended Oil Lubrication Chart**



Nothing affects the performance and durability of your engine more than the lube oil used. If an inferior oil is used, or the oil is not changed regularly, the risk of piston seizure, piston ring sticking, and accelerated wear increases significantly. Engine life may be seriously shortened.

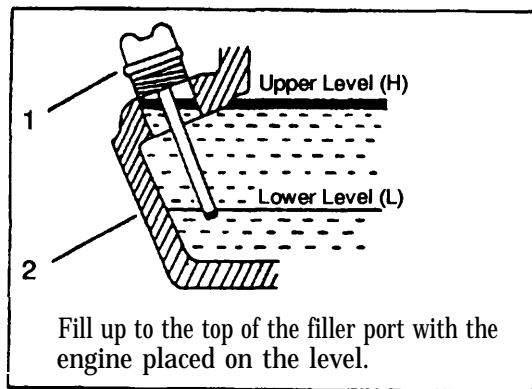
This engine adopts a forced oil lubrication system driven by a trochoid pump. Lubricating oil is circulated as follows: lubricating oil filter, trochoid pump, crankshaft <flat metal>, crankpin bearing insert. The rocker arm chamber is lubricated by lube oil vapors.

Always use oil with the right viscosity for the ambient temperature in which the engine is being operated. Refer to Table 3-1 when choosing the engine oil.

**CAUTION**

- **When checking oil level, make sure engine is stopped and sitting level. If engine is tilted, you may add either too much or too little oil.**
- **Do not overfill. Engine damage could result. If overfilled, notify unit maintenance.**
- **Always check the lube oil level before starting engine and refill if necessary.**
- **Recommended oil to use is Class CC/CD Hi-Detergent SAE 15W40 Oil of API Engine Service Classification. Never use automotive engine oil. Engine damage may result.**
- **Change engine oil after initial 20 hours of operation and every 100 hours thereafter.**

### **3-3. LUBE OIL CAPACITY**



**Figure 3-1. Oil Level**

With the engine level, perform the following steps to check oil level.

- a. Unscrew dipstick (1).
- b. Wipe with lint-free cloth (Appendix E, Section 11, Item 11). Place dipstick into oil pan (2). Do not screw in the dipstick; this could cause a false reading.

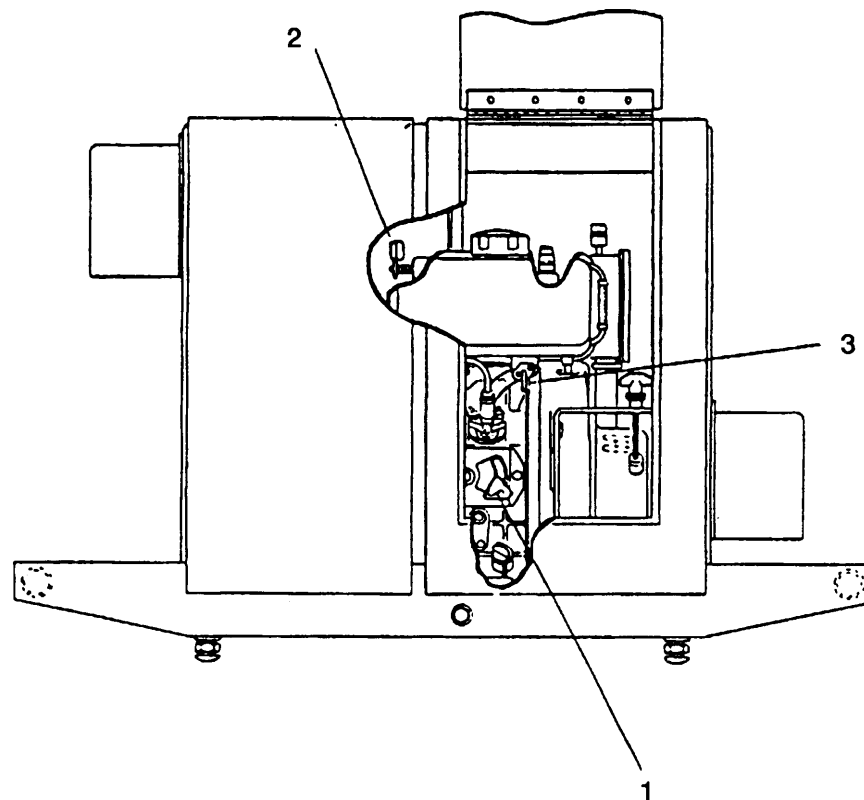


**NOTE**

**Do not overfill crankcase.**

- c. Add oil if necessary. Fill up to top mark "H" on the dipstick. Maximum oil pan capacity is 0.79 quart.
- d. Replace dipstick by screwing into oil pan connection. Make sure dipstick is tightly closed.

**3-4. LUBRICATION POINTS**



**Figure 3-2. Lubrication Points**

Apply a drop of engine oil (Appendix E, Section 11, Item 8) to the exposed movable parts of the engine and pump, points, speed control device (1), decompression lever (2), and fuel cock (3) as shown in Figure 3-2

Section II. REPAIR PARTS, SPECIAL TOOLS, TEST, MEASUREMENT AND  
DIAGNOSTIC EQUIPMENT (TMDE), AND SUPPORT EQUIPMENT.

INDEX

	Pam	Para
Common Tools and Equipment . . . . .	3-5	Repair Parts . . . . . 3-7
Special Tools, TMDE, and Support Equipment . . . . .	3-6	

3-5. COMMON TOOLS AND EQUIPMENT

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

3-6. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT

The special tools required to service the centrifugal pump are listed and illustrated in TM 10-4320-309-24P, Repair Parts and Special Tools List (RPSTL), and in the Maintenance Allocation Chart (MAC) located in Appendix B of this manual.

3-7. REPAIR PARTS

Repair parts are listed and illustrated in TM 10-4320-309-24P.

Section III. SERVICE UPON RECEIPT OF EQUIPMENT

INDEX

	Para	Para
Unpacking the Equipment . . . . .	3-8	Preliminary Servicing and Adjusting of Equipment . . . . . 3-11
Checking Unpacked Equipment . . . . .	3-9	
Installation Instructions . . . . .	3-10	

3-8. UNPACKING THE EQUIPMENT

Instructions for unpacking this equipment are given in paragraph 2-7.

Reusable containers of special design are not required. If sufficient storage facilities are available, it maybe convenient to store the shipping container for reuse. Equipment should be returned in the same manner in which it was received.

### 3-9. CHECKING UNPACKED EQUIPMENT

- a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, report the damage on DD Form 6, Packaging Improvement Report.
- b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA PAM 738-750.
- c. Check to see if the equipment has been modified.

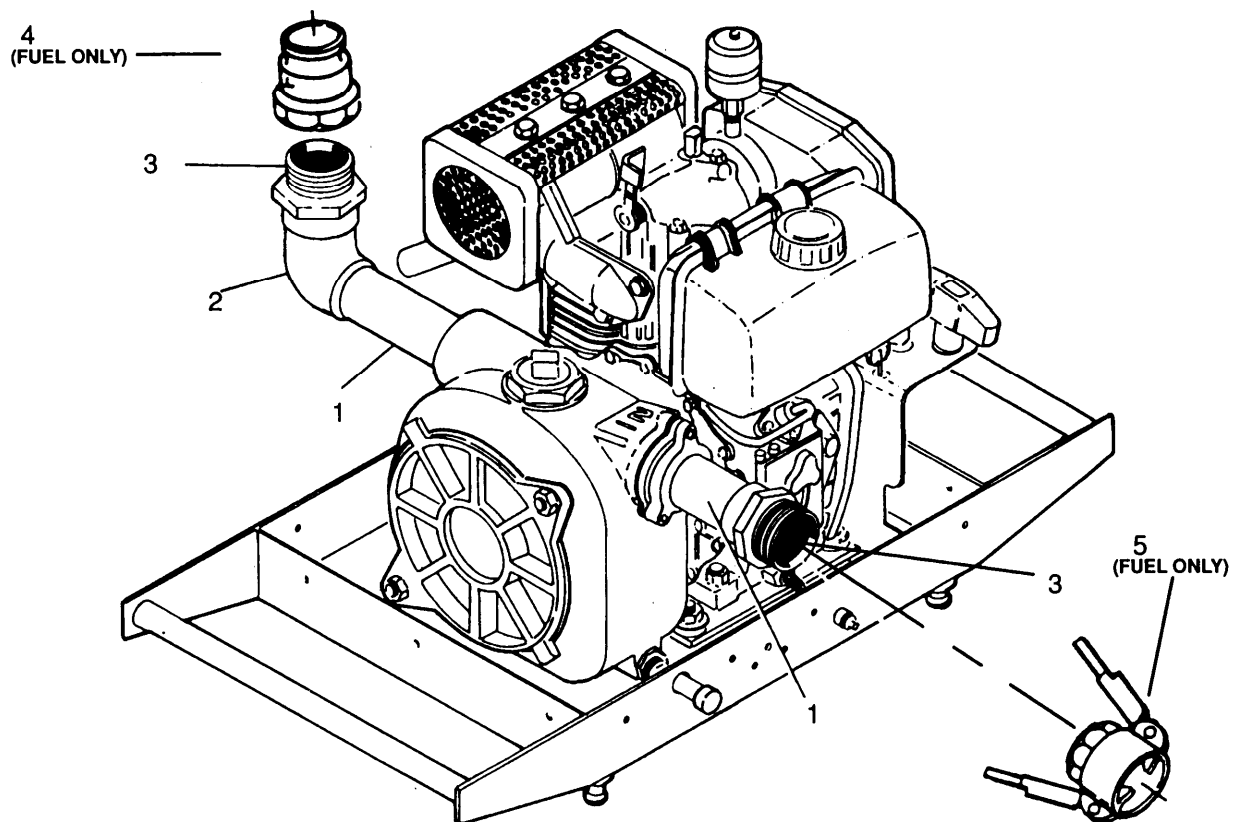
### 3-10. INSTALLATION INSTRUCTIONS

#### a. Installation Before Use

#### NOTE

The discharge and suction extensions are shipped loose and need to be installed before operating the pump.

- (1) Items that require installation before the pump is ready for operation are listed in Appendix C, Section II, Components of End Item (COEI).

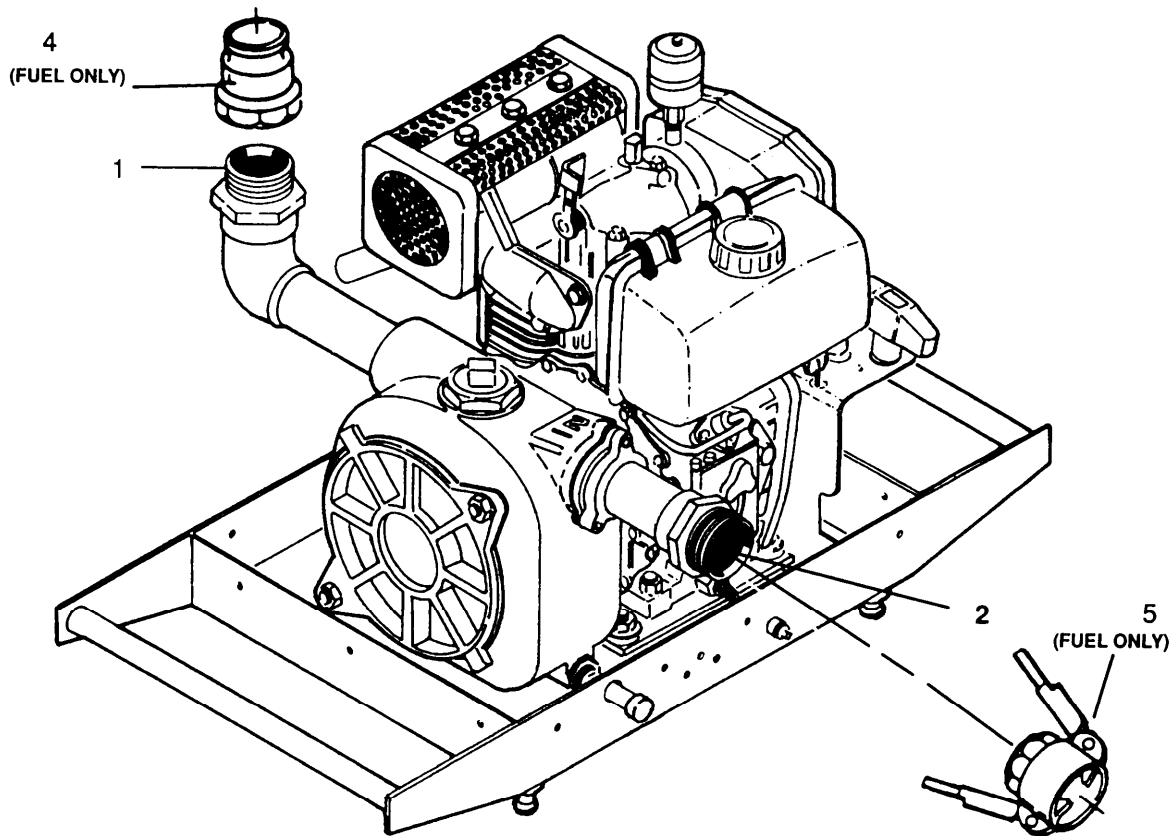


NOTE: Sound enclosure not shown for clarity

Figure 3-3. Pump Setup

- (2) Install the 2 x 6 inch long nipples (1) into the pump suction and discharge ports.
- (3) Install the 2 inch 90 degree elbow (2) onto the pump discharge port.
- (4) Install the 2 inch adapter (3) onto the 6 inch nipple in the suction port and one 2 inch adapter (3) on the 90 degree elbow (2). For fuel pump attach a 2 inch quick disconnect male coupling (4) to discharge side of the pump and a 2 inch quick disconnect female coupling (5) on the suction side of the pump.
- (5) Make sure all connections are tight.

b. **Set-Up Instructions**



**NOTE:** Sound enclosure not shown for clarity

**Figure 3-4. Priming Pump**

- (1) Prime the centrifugal pump by pouring approximately two gallons of water/fuel into discharge port of pump (1).

**NOTE**

**As water/fuel fills volute, air is removed through the discharge port.**

- (2) Connect suction hose to hose adapter (2) or quick disconnect coupling (3) on pump suction port. Highest point in the suction hose should be at the pump.

- (3) Connect discharge hose to hose adapter (1) or quick disconnect coupling (4) on pump discharge port.

### 3-11. PRELIMINARY SERVICING AND ADJUSTING OF EQUIPMENT

After the centrifugal pump assembly has been assembled, set-up, and transported to the operation site, the following steps must be performed before attempting to start the engine:

- a. Fill the fuel tank with diesel fuel. Fuel should have a cetane value of more than 45 in order to prevent difficult starting. This also avoids misfiring and excessive white exhaust smoke.
- b. Make sure the engine is perfectly level. Remove the dipstick cap and fill with Society of Automotive Engineers (SAE) service grade oil according to the ambient temperature. (Refer to Table 3-1)
- c. Check the oil level by inserting the dipstick into the oil pan without screwing in the dipstick. (Refer to para 3-3)
- d. Check that there is no obstruction in front of the air intake opening that might impede the flow of cooling air.
- e. Check that there is no obstruction that might hinder pull-rope action.

## Section IV. Preventive MAINTENANCE CHECKS AND SERVICES (PMCS)

### 3-12. UNIT PREVENTIVE MAINTENANCE CHECKS AND SERVICES

This section provides a list of periodic maintenance checks to be performed at specified intervals. Table 3-2 provides a listing of PMCS to be performed by unit maintenance personnel. It expands on preventive maintenance performed by the operator. Services allocated to unit maintenance have been included:

- a. **Item Number Column**  
This column is a list of every check and service task in the PMCS. They are numbered in logical order of performance regardless of the interval. This column is 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. **Interval Column**  
This column lists four sequences. Weekly, Monthly, Quarterly, and Semiannually, which signify the intervals at which a specific item needs to be checked or serviced.
- c. **Item To Be Inspected/Procedures Column**  
This column provides the name of the item to be checked or serviced and describes the procedures to check or service. It includes all the information required to perform the checks or services. It indicates tolerances where applicable, adjustment limits, and reading levels where required.

Table 3-2. Unit Preventive Maintenance Checks and Services

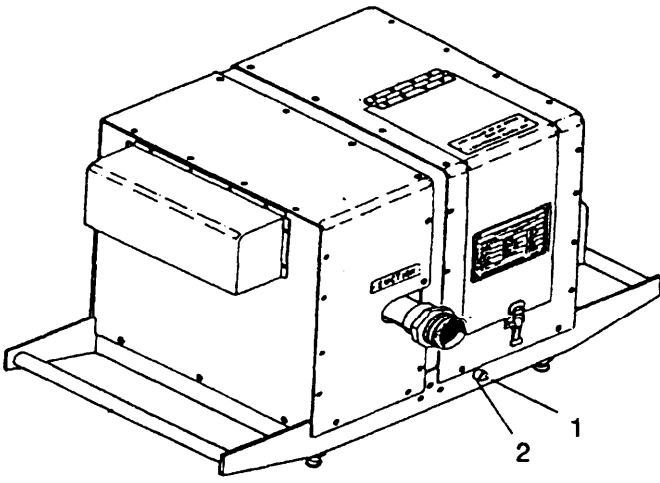
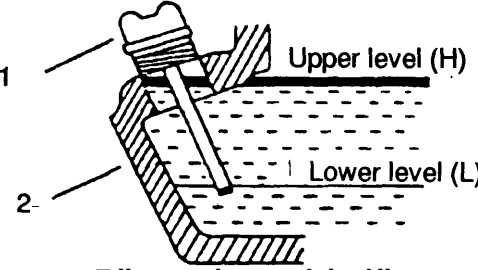
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
1	Quarterly	<p>Engine</p>  <p>Drain lube oil from engine crankcase by removing oil drain plug (1) from pipe coupling (2) located on frame underneath access door. Replace drain plug (1) after oil drains.</p> <p>Refill engine crankcase with approximately 0.75 quart of the proper lube oil. (Refer to para 3-2).</p>  <p>Fill up to the top of the filler port with the engine placed on the level.</p> <p>With engine sitting level, unscrew dipstick (1), remove, and wipe dean.</p>	Oil level is low. Oil is contaminated, shows moisture or appears milky. Scheduled oil change has not been made.

Table 3-2. Unit Preventive Maintenance Checks and Services - Continued

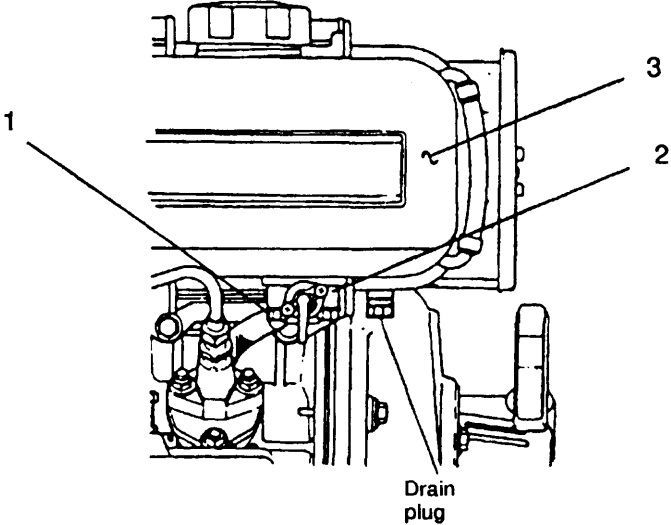
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
2	Semiannually	<p>Replace dipstick (1 ) into oil pan (2) but do not screw in the dipstick (1).</p> <p>Add or drain oil until oil level is at top mark "H" on dipstick (1) .</p> <p>Replace dipstick (1) by screwing into oil pan connection. Tighten it securely.</p> <p><b>Fuel Filter</b></p>  <p>Remove two nuts (1) holding fuel cock (2) to fuel tank(3).</p> <p>Remove fuel cock (2) from two studs.</p> <p>Remove gasket from two studs.</p> <p>Remove fuel filter from inside of fuel tank (3).</p> <p>Inspect fuel filter for dirt or damage and replace if necessary.</p>	Fuel filter is dirty or damaged.

Table 3-2. Unit Preventive Maintenance Checks and Services - Continued

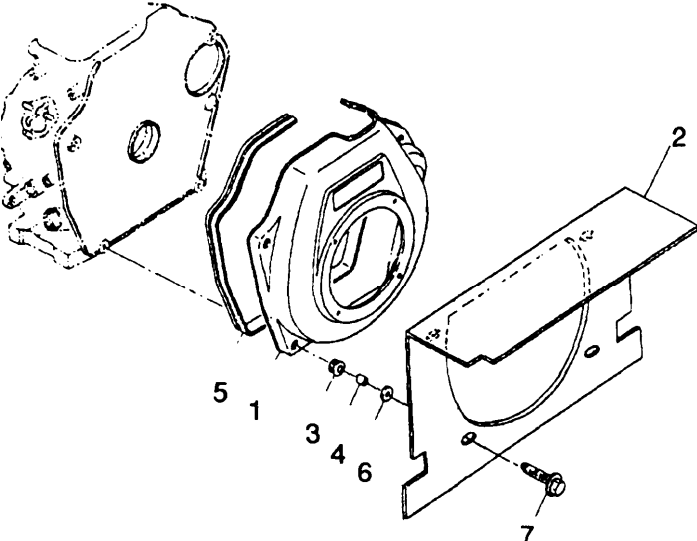
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
3	Semiannually	<p><b>Cooling Case Cover</b></p>  <p>Remove inlet air sound enclosure assembly by removing 17 screws.</p> <p>Remove four bolts (7) attaching cooling case cover (1) and air flow baffle (2) to engine.</p> <p>Remove air flow baffle (2) and cooling case cover (1).</p> <p>Inspect cooling case cover seal (5) and replace if damaged.</p> <p>Place cooling case cover (1) onto engine.</p> <p>Place air flow baffle (2) onto engine.</p> <p>Attach cooling case cover (1) and air flow baffle (2) onto engine with four bolts (7).</p>	Cooling case cover seal is damaged.



Table 3-2. Unit Preventive Maintenance Checks and Services - Continued

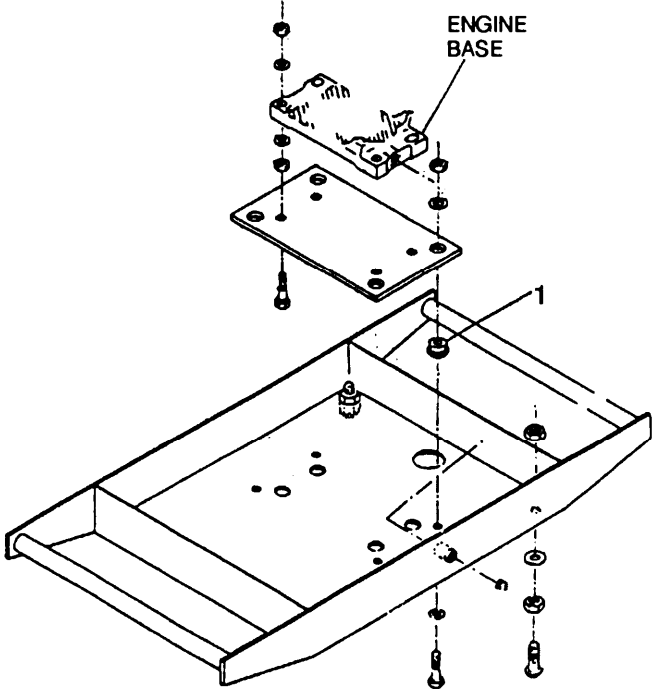
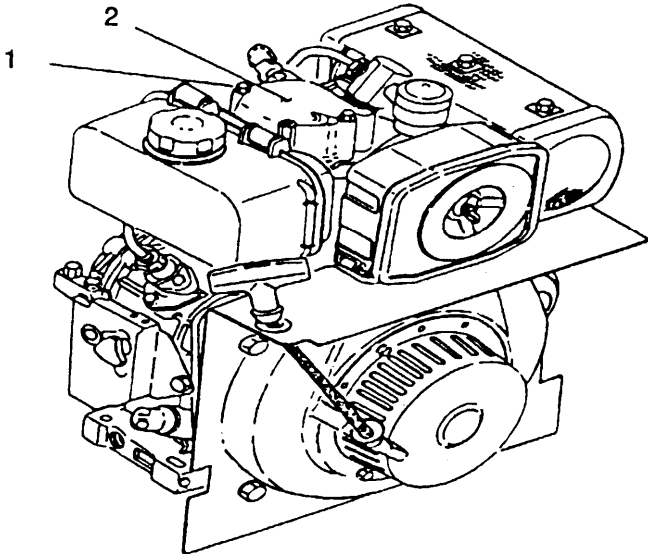
Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable if:
4	Semiannually	<p><b>Shock Mounts</b></p>  <p>Remove air inlet sound enclosure assembly by removing 17 screws.</p> <p>Remove air outlet sound enclosure assembly by removing 18 screws.</p> <p>Visually inspect the four shock mounts (1) for physical damage.</p> <p>Notify Direct Support Maintenance if shock mounts are damaged.</p>	Shocks mounts are damaged.

Table 3-2. Unit Preventive Maintenance Checks and Services - Continued

Item No.	Interval	ITEM TO BE INSPECTED PROCEDURES	Not Fully Mission Capable If:
5	Semiannually	<div>Valve Rocker Arm Clearance</div> <div></div> <div>Remove bolts (1) and rocker arm cover (2). For detailed adjusting procedure, refer to para 3-22.</div>	Valve clearance is not 0.006 inch (0.15mm).

## Section V. UNIT TROUBLESHOOTING PROCEDURES

### 3-13 GENERAL

- a. Common malfunctions which you may find during operation or maintenance of the centrifugal pump or its components are listed in Table 3-4 that follows. You should perform the test inspections and corrective actions in the order they appear.
- b. In general, engine exhaust is an excellent way to tell what kind of condition your centrifugal pump is in. Exhaust color of black, or bluish-white, smoke is normal before the engine warms up fully. As the engine reaches normal operating temperature, the exhaust becomes clear or light blue, provided there are no problems. If the exhaust does not clear up, a problem is indicated.
- c. When exhaust color is abnormal, turn off the engine immediately and notify your supervisor. Use the following chart as a guideline to exhaust symptoms.

**Table 3-3. Troubleshooting by Exhaust Color**

Clear or light bluish condition	Normal operating
Continuous black smoke	Overloading
	Seizure of moving part
	Incorrect combustion
Continuous bluish-white smoke	Lubricating oil is being consumed

- d. This manual cannot list all malfunctions that may occur, nor all tests and corrective actions. If you find a malfunction not listed, or listed incorrectly, notify your supervisor.

#### NOTE

**Before using this table, be sure all applicable Operator and Unit PMCS have been performed.**

**Table 3-4. Unit Troubleshooting**

#### MALFUNCTION

#### TEST OR INSPECTION

#### CORRECTIVE ACTION

#### 1. STARTING HANDLE FAILS TO PULL

Step 1. Check decompression lever.

Push decompression lever down to release engine compression.  
[Refer to para 2-9(5).]

Step 2. Notify Direct Support Maintenance.

**Table 3-4. Unit Troubleshooting — Continued**

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
<b>2. STARTING HANDLE PULLS BUT ENGINE FAILS TO START</b>		
Step 1.	Check for insufficient fuel supply. Fill fuel tank, if necessary.	
Step 2.	Check fuel cock. Open fuel cock, if closed. [Refer to para 2-9(2).]	
Step 3.	Check position of speed control lever. Move to START position. [Refer to para 2-9(3).]	
Step 4.	Check for air binding in fuel pipe to injection nozzle. Remove inlet air sound enclosure assembly by removing the 17 screws. Remove fuel injection pipe from fuel injection nozzle. Push decompression lever down. Hold pipe in same hand as decompression lever. Pull the recoil starter several times with no compression until fuel is ejected from pipe. Reconnect injection pipe to injection nozzle. Reinstall the inlet air sound enclosure assembly with the 17 screws.	
Step 5.	Check the starting procedure under prevailing conditions. (Refer to Chapter 2, Section IV.) If the starting procedures have been performed correctly but engine still fails to start, notify Direct Support Maintenance.	
<b>3. UNEXPECTED REVERSE ROTATION AT STARTUP</b>		
Step 1.	Too much lube oil. Verify that lube oil level is correct. (Refer to para 3-3.) Stop engine at once using speed control lever knob or decompression lever.	
Step 2.	Slow recoil pull may cause reverse engine rotation. Review starting procedures under prevailing conditions. Pull faster. If starting procedure has been performed correctly but engine rotation is reversed, notify Unit Maintenance.	
<b>4. UNEVEN RUNNING OR FREQUENT STALLING</b>		
Step 1.	Check fuel cock. Fully open the fuel cock, if closed. [Refer to para 2-9(2).]	
Step 2.	Check for insufficient fuel supply. Fill fuel tank, if necessary.	

Table 3-4. Unit Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
<b>5. LACK OF POWER</b>		
Step 1. Check position of speed control lever knob.		Move to START position to increase engine speed. [Refer to para 2-9(3).]
Step 2. Check for insufficient fuel supply.		Fill fuel tank, if necessary.
Step 3. Check air cleaner restriction indicator.		If a red band appears in window of air cleaner restriction indicator, replace air cleaner element. (Refer to para 3-14.)
<b>6. ENGINE STOPS RUNNING</b>		
Step 1. Check for insufficient fuel supply.		Fill fuel tank, if necessary.
Step 2. Check air cleaner restriction indicator.		If a red band appears in window of air cleaner restriction indicator, replace air cleaner element. (Refer to para 3-14.)
<b>7. EXCESSIVE LUBRICATION OIL CONSUMPTION</b>		
Step 1. Check for leakage at oil drain plug or oil filler cap.		Tighten oil drain plug or oil filler cap.
Step 2. Check for a black smoky exhaust and oil in exhaust discharge.		Notify Direct Support Maintenance.
<b>8. PUMP FAILS TO PRIME</b>		
Step 1. Check for low engine speed.		Move speed control lever knob to START position to increase engine speed. [Refer to para 9(3).]
Step 2. Check for an air-locked pump.		Remove discharge hose connection. Prime pump by filling volute with water/fuel. (Refer to para 2-8.) Leave discharge hose connection on.
Step 3. Check for a clogged suction hose.		If clogged, clean suction hose.
Step 4. Check for leaks in the pump suction line.		Repair leaks in suction port connections or in suction line hoses.

Table 3-4. Unit Troubleshooting - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
9. LOW DISCHARGE PRESSURE		
	Step 1. Check for low engine speed.	Move speed control lever knob to START position to increase engine speed. [Refer to para 2-9(3).]
	Step 2. Check for a clogged suction hose.	If clogged, clean suction hose.
	Step 3. Check for leaks in the pump suction line.	Repair leaks in suction port connections or in suction line hoses.

Section VI. MAINTENANCE PROCEDURES

INDEX

	Para		Para
Replace Air Cleaner Element . . . . .	3-14	Replace/Service Fuel Cock and	
Replace/Inspect/Service Centrifugal		Fuel Filter . . . . .	3-19
Pump, Diesel-Driven . . . . .	3-15	Replace/Service Fuel Injection	
Replace/Inspect Sound Enclosure		Pipe . . . . .	3-20
Assembly . . . . .	3-16	Replace/Inspect Exhaust Silencer . . . . .	3-21
Replace/Repair Check Valve Assembly . . . .	3-17	Replace/Inspect/Adjust Valve	
Replace/Service Fuel Tank . . . . .	3-18	Rocker Arm Assembly . . . . .	3-22

---

### 3-14. REPLACE AIR CLEANER ELEMENT

---

This task covers:     a) Removal            b) Installation

---

#### INITIAL SETUP

##### Tools

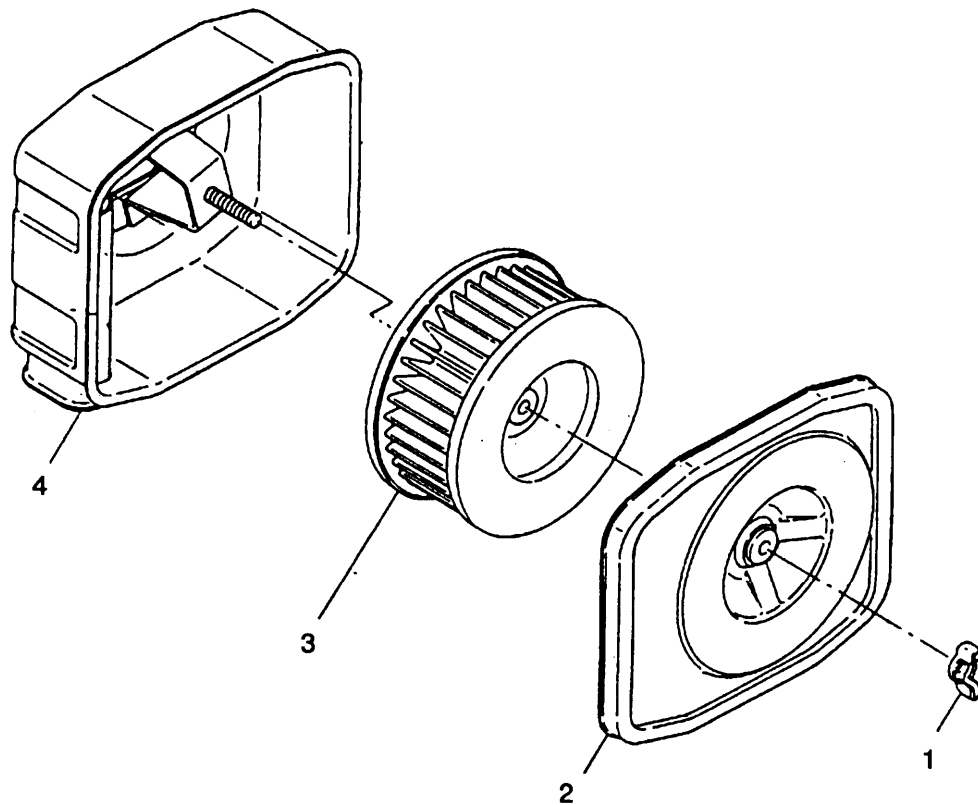
Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

##### Materials/Parts

None

##### Equipment Condition

Engine shut down.



**Figure 3-5. Replacing Air Cleaner Element**

#### REMOVAL:

- a. Remove 17 screws holding the inlet air sound enclosure assembly to the frame.
- b. Loosen and remove wing nut (1).
- c. Detach air cleaner housing cover (2).
- d. Remove air cleaner element (3).

INSTALLATION:

**CAUTION**

Never run the engine without the air cleaner element. Rapid engine wear may result.

- a. Install air cleaner element (3) into air cleaner housing (4).
- b. Replace air cleaner housing cover (2).
- c. Replace and tighten wing nut (1).
- d. Reset the air cleaner restriction indicator by depressing the black button on top.
- e. Install 17 screws holding inlet air sound enclosure assembly.



---

### 3-15. REPLACE/INSPECT/SERVICE CENTRIFUGAL PUMP, DIESEL-DRIVEN

---

This task covers:      a) Removal              c) Service  
                                 b) Inspection          d) Installation

---

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

##### Equipment Condition Para

2-7 Centrifugal pump assembled.

##### Material/Parts

Cloth, Lint-free (Item 11,  
Appendix E, Section II)

Detergent, Mild (Item 13, Appendix E,  
Section II)

#### REMOVAL:

- a. Remove 17 screws from inlet air sound enclosure assembly and remove sound enclosure.
- b. Remove 18 screws from outlet air sound enclosure assembly and remove sound enclosure.

#### INSPECTION:

- a. Inspect the pump for dirt, grease, chipped paint, scratches, or dents.
- b. If damage has occurred during shipment or transportation, report the damage on DD Form 6. Request Direct Support Maintenance to refurbish, repaint, or repair the pump assembly. Refer to para 3-16 for inspection of the sound enclosure assembly.

#### SERVICE:

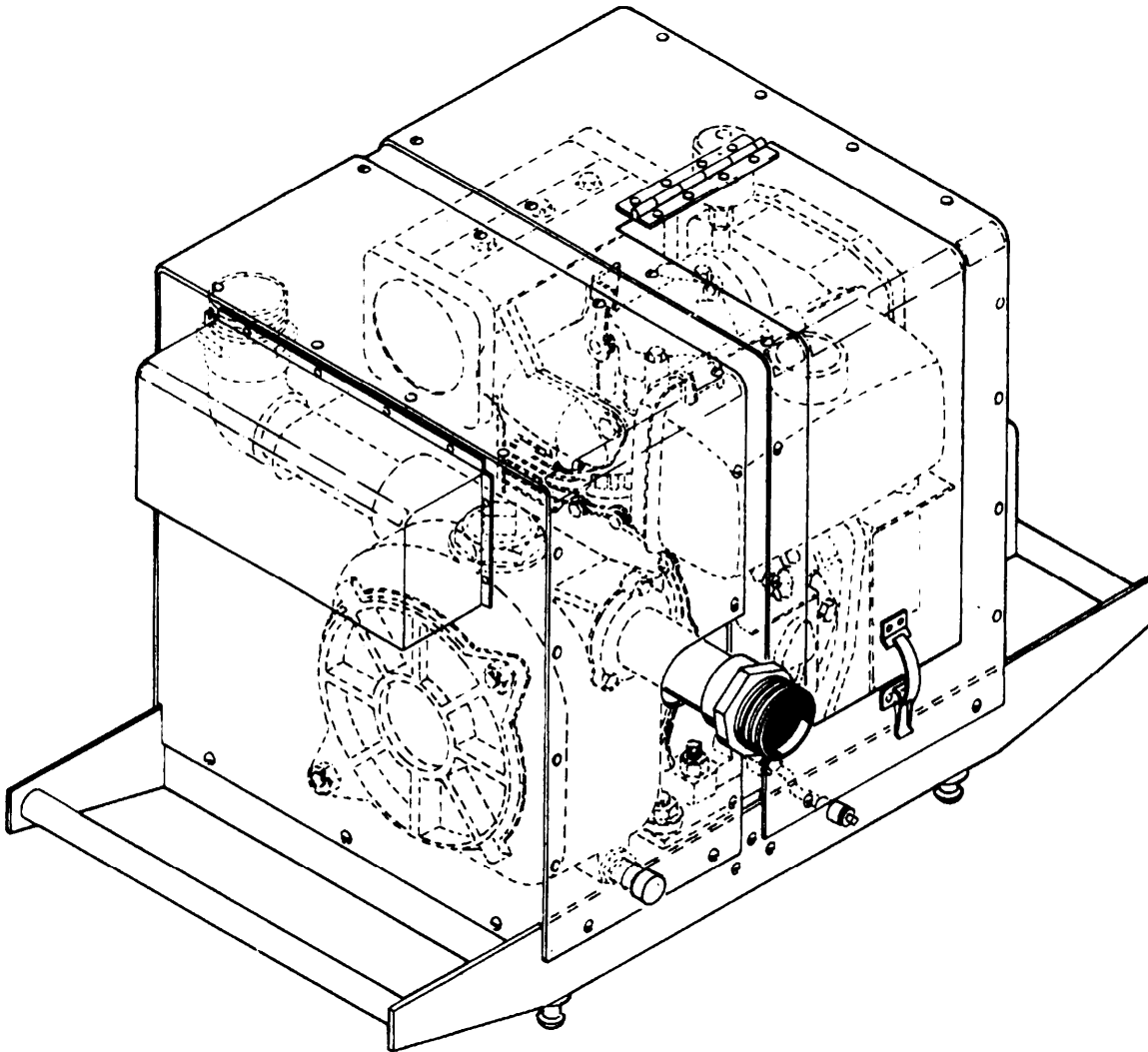
- a. Wipe away all grease and dirt from the pump and engine with a dean, dry cloth. If a mild detergent is required to cut oil or grease, do not allow water or detergent into the engine.
- b. Make sure the rubber plug is in place in the rocker arm assembly.
- c. Thoroughly dry water and detergent after cleaning.

#### INSTALLATION:

#### NOTE

**Follow the installation procedures at initial installation to install a new unit. To replace a unit, make sure the discharge and suction extensions are installed as per para 3-10.**

- a. Connect suction and discharge hoses and perform before operators PMCS (refer to Table 2-1)
- b. Check that sound enclosure is installed (refer to para 3-16).



**Figure 3-6. Diesel-Driven Centrifugal Pump Assembly**

- c. Make sure the engine is secured and perfectly level. Check and/or fill the oil pan with Class CD Hi-De-tergent Oil to the top of the filler port (refer to para 3-3).
- d. Fill the fuel tank with diesel fuel most suitable for the engine (refer to para 3-11).
- e. Prime the pump by pouring water into the discharge connection of the pump (refer to para 3-10). As water/fuel fills the volute, air is forced out.

---

### 3-16. REPLACE/INSPECT SOUND ENCLOSURE ASSEMBLY

---

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

---

#### INITIAL SETUP

##### Tools

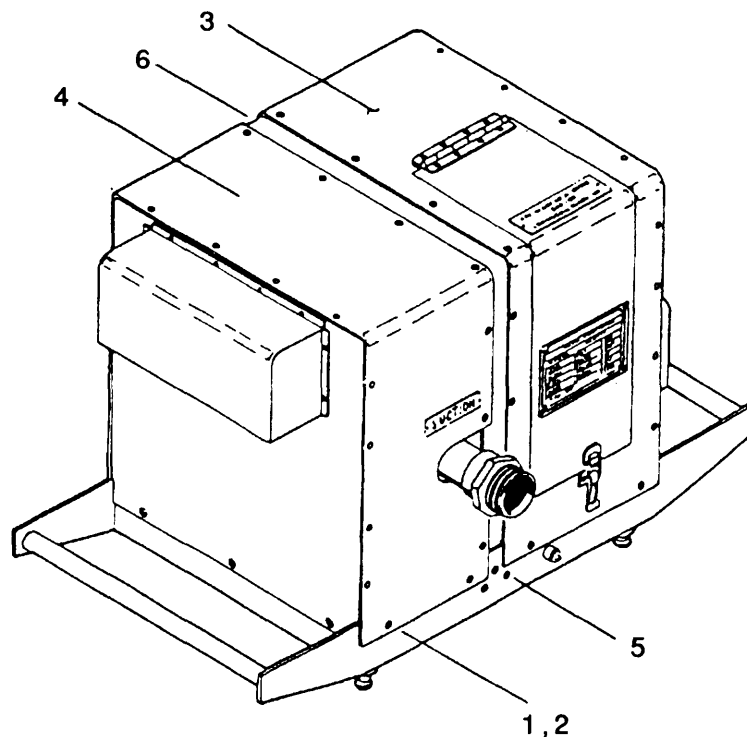
Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

##### Material/Parts

None

##### Equipment Condition

Engine shut down.



**Figure 3-7. Replace/Inspect Sound Enclosure Assembly**

#### REMOVAL:

- a. Remove 17 thread-cutting screws (1) and star type lockwashers (2) from the top and sides of the inlet air sound enclosure assembly (3).
- b. Remove 18 thread-cutting screws (1) and star type lockwashers (2) from the top and sides of the outlet air sound enclosure assembly (4).
- c. Remove both halves of the sound enclosure assembly to a suitable working area for inspection.
- d. Remove six screws (5) holding sound enclosure bracket (6) and then remove bracket.

**INSPECTION:**

- a. Inspect the riveted components of the enclosure assembly. Replace rivets on the components if more than half of the rivets on any surface have failed.
- b. Inspect the acoustical foam on the inside of the sound enclosure. If acoustical foam is torn, scarred, shows signs of overheating, or has come loose to impede airflow, call Direct Support Maintenance Personnel to replace it.

**INSTALLATION:**

- a. Position sound enclosure bracket (6) and install with six screws (5).
- b. Position both halves of the air sound enclosure assembly in place on the sound enclosure bracket.
- c. Install 18 thread-cutting screws (1) and star type lockwashers (2) first on the outlet enclosure, then install 17 screws (1) and star type lockwashers (2) on the inlet enclosure.

---

### 3-17. REPLACE/REPAIR CHECK VALVE ASSEMBLY

---

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

---

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

Shop Equipment Automotive Maintenance and Repair: Unit Maintenance, Common No. 1 (Item 3, Appendix B, Section III)

##### Materials/Parts

Cloth, Lint-free (Item 11, Appendix E, Section II)

##### Equipment Condition

##### Para

3-16              Outlet air sound enclosure removed.

#### REMOVAL:

- a. Remove suction pipe nipple (1) and hose adapter/coupling (2).
- b. Remove three hex nuts (4) and separate inlet flange (5) from pump casing (3).
- c. Remove inlet flange (5) and check valve assembly (6 through 9).

#### REPAIR:

- a. Disassemble the check valve by removing screw (6).
- b. Separate small weight (7), gaskets (8), and large weight (9).
- c. Carefully inspect the gasket. If it is damaged, replace it. If not, thoroughly dean and wipe dry with lint-free cloth.
- d. Clean deposits from both weights and inside of flange using stiff bristled brush. Repeat as necessary. Wipe dry with clean cloth.
- e. Reassemble check valve assembly [small weight (7), gasket (8), and large weight (9)], with screw (6) as removed.

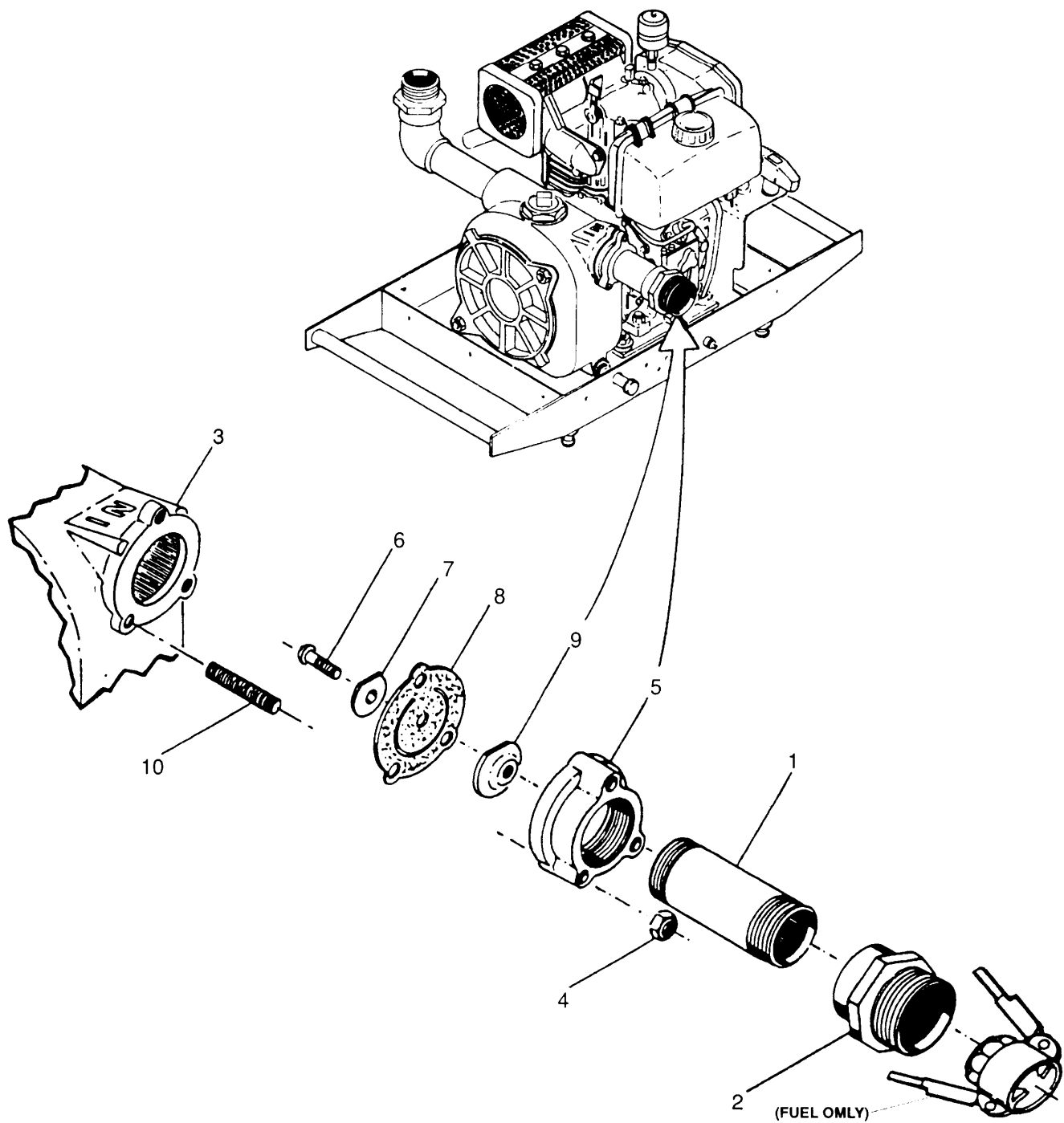
#### INSTALLATION:

#### NOTE

**Hinged area of gasket faces the top stud. Large weight should face the pump.**

**Install suction flange with tapered, protruding edge facing bottom.**

- a. Position check valve assembly onto three studs (10) of pump casing (3).



**Figure 3-8. Replace/Repair Suction Check Valve Assembly**

- b. Position inlet flange (5) on studs (10).
- c. Push inlet flange and check valve assembly against pump casing. Secure with three hex nuts (4).
- d. Replace suction pipe nipple (1) and hose adapter/coupling (2).
- e. Replace outlet air sound enclosure assembly.

### 3-18. REPLACE/SERVICE FUEL TANK

This task covers: a) Removal c) Service c) Installation

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

Drain Pan (Item 7, Appendix B, Section III)

##### Materials/Parts

None

##### Equipment condition

Para	
3-16	Inlet air sound enclosure assembly removed.
3-16	Outlet air sound enclosure assembly removed.

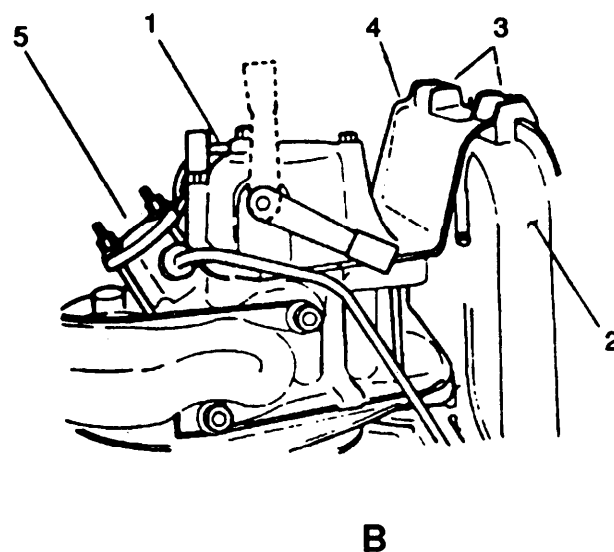
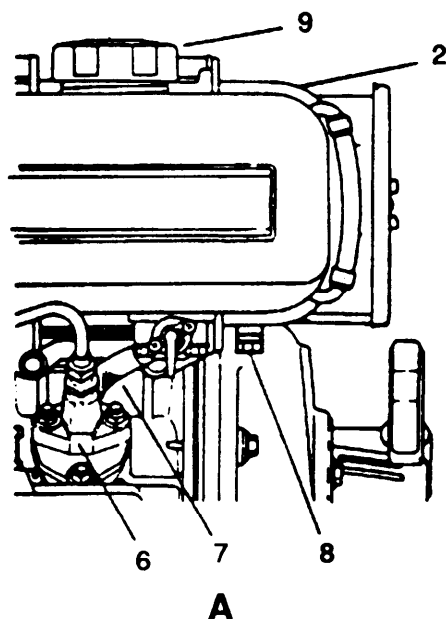


Figure 3-9. Replace/Service Fuel Tank

#### REMOVAL:

#### NOTE

Before removing the fuel tank or tank connections remove drain plug located at the bottom right corner of the tank and drain out all fuel into a clean container.

- Release hose clamps on injection nozzle (5) side of overflow hose (1).

- b. Release hose clamps on fuel line at injection pump side (7).
- c. Remove two hex head screws (3) securing the upper part of the fuel tank stay bracket and remove stay bracket (4).
- d. Remove fuel tank (2).

**SERVICE:**

- a. Wipe outside of fuel tank with clean, dry, lint-free cloth to remove any oil or grease deposits.
- b. When tank is completely dean of any residual fuel, remove cap and clean away any deposits with compressor air.

**INSTALLATION:**

- a. Connect fuel line hose (7) to fuel injection pump (6).
- b. Attach fuel tank (2) using upper stay bracket (4) and two hex head screws (3).
- c. Connect overflow hose (1) to fuel injection nozzle (5).
- d. Replace drain plug (8) and fuel cap (9).
- e. Check carefully for any leaks when filling the fuel tank.



### 3-19. REPLACE/SERVICE FUEL COCK AND FUEL FILTER

This task covers: a) Removal b) Service c) Installation

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

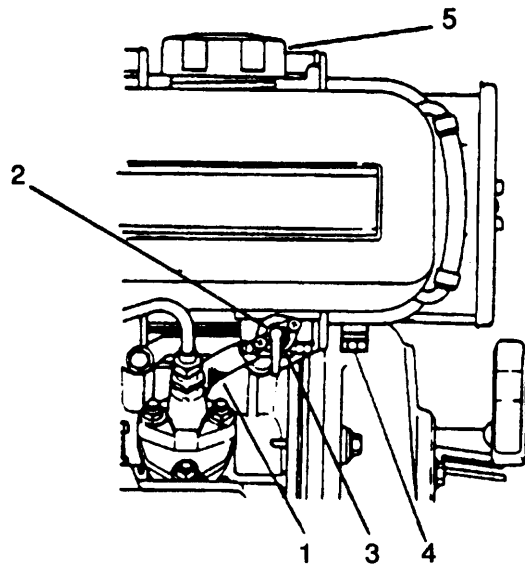
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

##### Materials/Parts

Fuel, Diesel (Item 4, Appendix E, Section II)

##### Equipment Condition Para

3-16 Inlet air sound enclosure assembly removed.  
3-16 Outlet air sound enclosure assembly removed.



**Figure 3-10. Replace/Service Fuel Cock and Fuel Filter**

REMOVAL:

#### NOTE

**The fuel filter must be cleaned every six months or every 500 hours. It must be replaced every year or every 1000 hours. When filter is cleaned or replaced, clean fuel cock at the same time.**

- Remove fuel tank cap (5) and strainer.
- Drain all fuel from fuel tank by removing drain plug (4) at the bottom of the tank.

- c. Release fuel line hose damp (1) at the fuel cock end (2) of the hose.
- d. Remove hex head nuts (3) securing the fuel cock to studs on the tank, and remove fuel cock.
- e. Remove gasket from two studs.
- f. Remove fuel filter from inside of fuel tank

**SERVICE:**

- a. Wash the fuel cock and filter thoroughly with diesel fuel.
- b. Check the filter for cracks or damage. Replace damaged filter.
- c. Dry fuel cock thoroughly before reinstalling.

**INSTALLATION:**

- a. Insert fuel filter into fuel tank through fuel tank cap (5) opening and position fuel cock gasket to bottom of fuel tank over studs.
- b. Position fuel cock (2) over the two studs.
- c. Secure onto studs with two hex head nuts (3). Be sure filter is correctly inserted in fuel tank filler port (5).
- d. Replace fuel line hose with damp (1) onto fuel cock (2).
- e. Reinsert and thoroughly tighten drain plug (4). Check for leaks on refilling.

---

### 3-20. REPLACE/SERVICE FUEL INJECTION PIPE

---

This task covers:      a) Removal                      c) Installation  
                                 b) Service

---

#### INITIAL SETUP

##### Tools

Wrench, 17 mm (item 14,  
Appendix B, Section III)

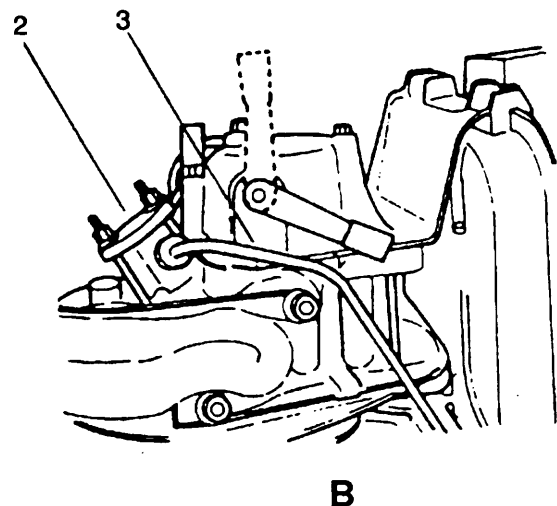
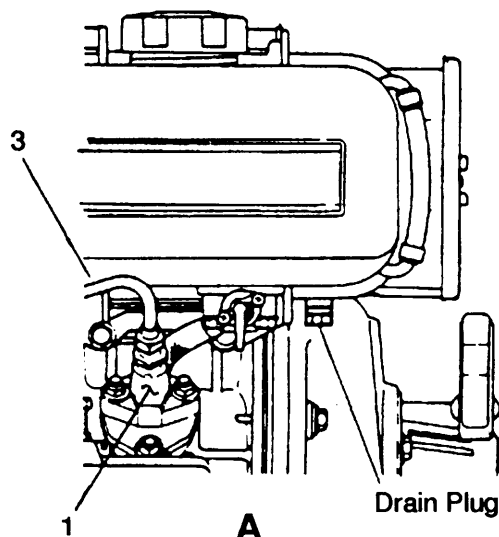
##### Materials/Parts

Fuel, Diesel (Item 4,  
Appendix E, Section II)

Cloth, Lint-free (Item 11,  
Appendix E, Section II)

##### Equipment Condition Para

- |      |  |
|------|--|
| 3-16 | Inlet air sound enclosure assembly removed.  |
| 3-17 | Outlet air sound enclosure assembly removed. |



**Figure 3-11. Replace/Service Fuel Injection Pipe**

#### REMOVAL:

- Turn fuel cock to OFF (3 o'clock) position.
- Use open end wrench to loosen connectors at both ends [pump end (1) and injection nozzle end (2)] of fuel injection pipe (3).
- Be careful to wipe up any fuel that leaks during removal or replacement.
- Remove fuel injection pipe (3).

#### SERVICE:

- Thoroughly wash the fuel injection pipe (3) in diesel fuel. Force compressed air through the pipe.

- b. Wipe with clean, lint-free cloth.

**INSTALLATION:**

- a. Position fuel injection pipe (3) between fuel injection nozzle (2) and fuel injection pump (1). Position the pipe so that the fittings line up.
- b. Carefully hand tighten pipe connectors. Slowly tighten with the open end wrench taking care not to strip the fittings.
- c. Turn fuel cock to OPEN (6 o'clock) position.
- d. Bleed air from fuel system.

**NOTE**

**Air can enter the fuel pipe system when the engine is first installed, the fuel pipe removed, etc. No air bleeding will be required when the fuel tank runs out of fuel. Bleed the air according to the following instructions:**

- (1) Place the speed control handle in the run position.
- (2) Open all cocks of the fuel system.
- (3) Set the decompression lever to the non-compression position.
- (4) Make sure fuel comes out from the fuel injection nozzle while pulling the recoil starter. The injection sound can be heard. The fuel injection valve holder may need to be loosened to bleed the air easily.
- e. Carefully inspect the fuel injection pipe connections for leaks. Retighten as necessary.

### 3-21. REPLACE/INSPECT EXHAUST SILENCER/SPARK ARRESTOR

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

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

Wrench, 10 mm (Item 15, Appendix B, Section III)

##### Materials/Parts

None

##### Equipment Condition Para

3-16 Inlet sound enclosure assembly removed  
3-17 Outlet sound enclosure assembly removed.

#### REMOVAL:



**Make sure engine has cooled down before performing maintenance on exhaust silencer/spark arrestor. Exhaust system is very hot during operation and severe burns could result.**

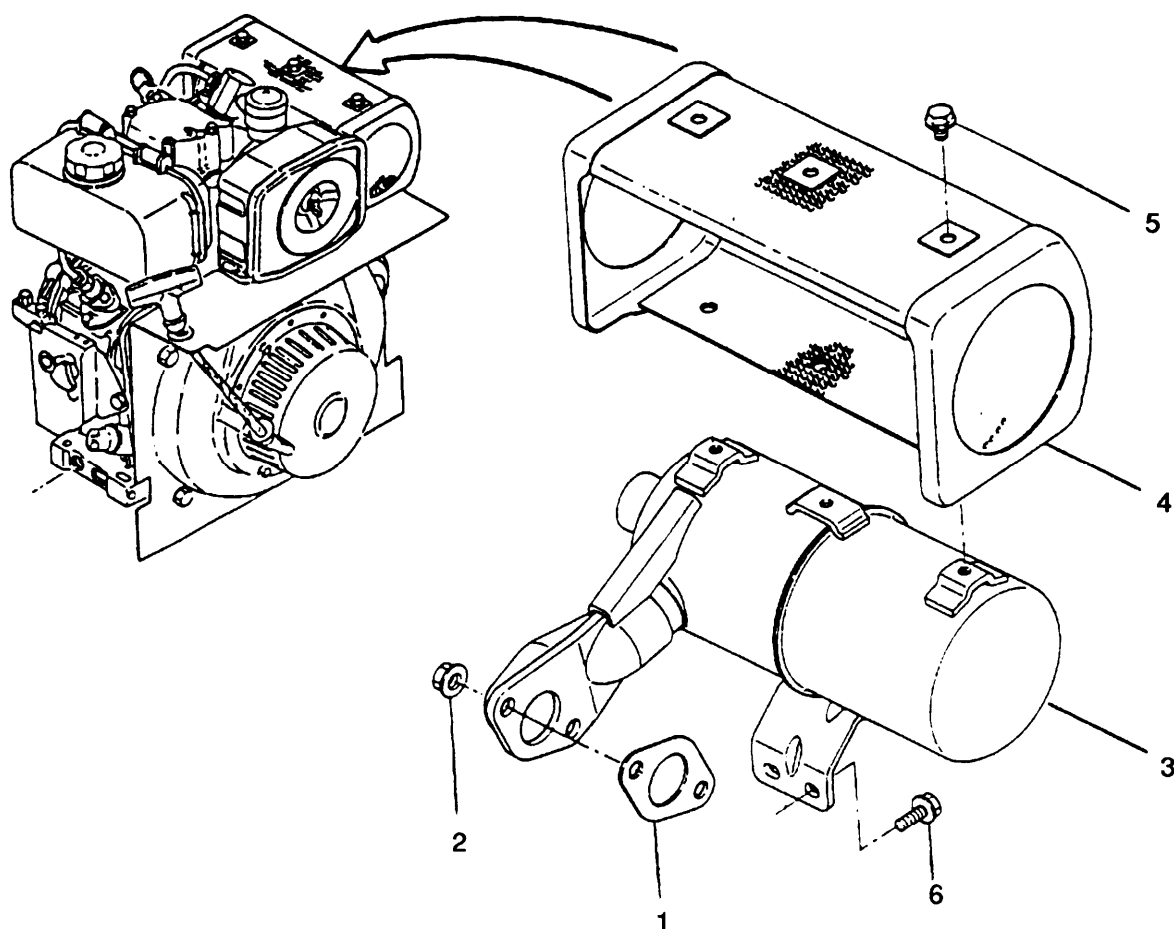
- a. Remove exhaust extension pipe by removing clamp.
- b. Remove heat shield (4) by removing six screws (5).
- c. Remove two hex head nuts (2) securing the exhaust silencer/spark arrestor (3) to studs on the exhaust port of the engine.
- d. Remove two hex head screws (6) securing the exhaust silencer/spark arrestor bracket to the rear of the engine.
- e. Carefully lift off exhaust silencer/spark arrestor (3) and gasket (1) from the studs.

#### INSPECTION:

- a. Carefully inspect exhaust silencer/spark arrestor (3) for cracks, rust, or pin holes.
- b. Replace gasket (1) at reassembly.

#### INSTALLATION:

- a. Place gasket (1) onto the studs at the engine exhaust port.
- b. Carefully position exhaust silencer/spark arrestor (3) onto the studs and lineup holes in bracket with rear mounting holes in the engine.
- c. Secure with two hex head nuts (2) onto the studs and two hex head screws (6) in the mounting holes.



**Figure 3-12. Replace/Inspect Exhaust Silencer/Spark Arrestor Assembly**

- d. Install heat shield (4) using six screws (5).
- e. Install exhaust extension pipe using the clamp.
- f. Tighten all securely.

---

### 3-22. REPLACE/INSPECT/ADJUST VALVE ROCKER ARM ASSEMBLY

---

This task covers:      a) Removal              c) Adjust  
                                    b) Inspection          d) Installation

---

#### INITIAL SETUP

##### Tools

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6,  
Appendix B, Section III)

Wrench, 10 mm (Item 15,  
Appendix B, Section III)

##### Equipment Condition Para

3-16	Inlet sound enclosure assembly removed.
3-16	Outlet sound enclosure assembly removed.
4-20	Cooling case cover removed.

##### Materials/Parts

Fuel, Diesel (item 4,  
Appendix E, Section II)

Cloth, tint-free (item 11,  
Appendix E, Section II)

#### REMOVAL:

- a. Remove two bolts (1) holding rocker arm cover (2) to cylinder head.
- b. Remove rocker arm cover(2).

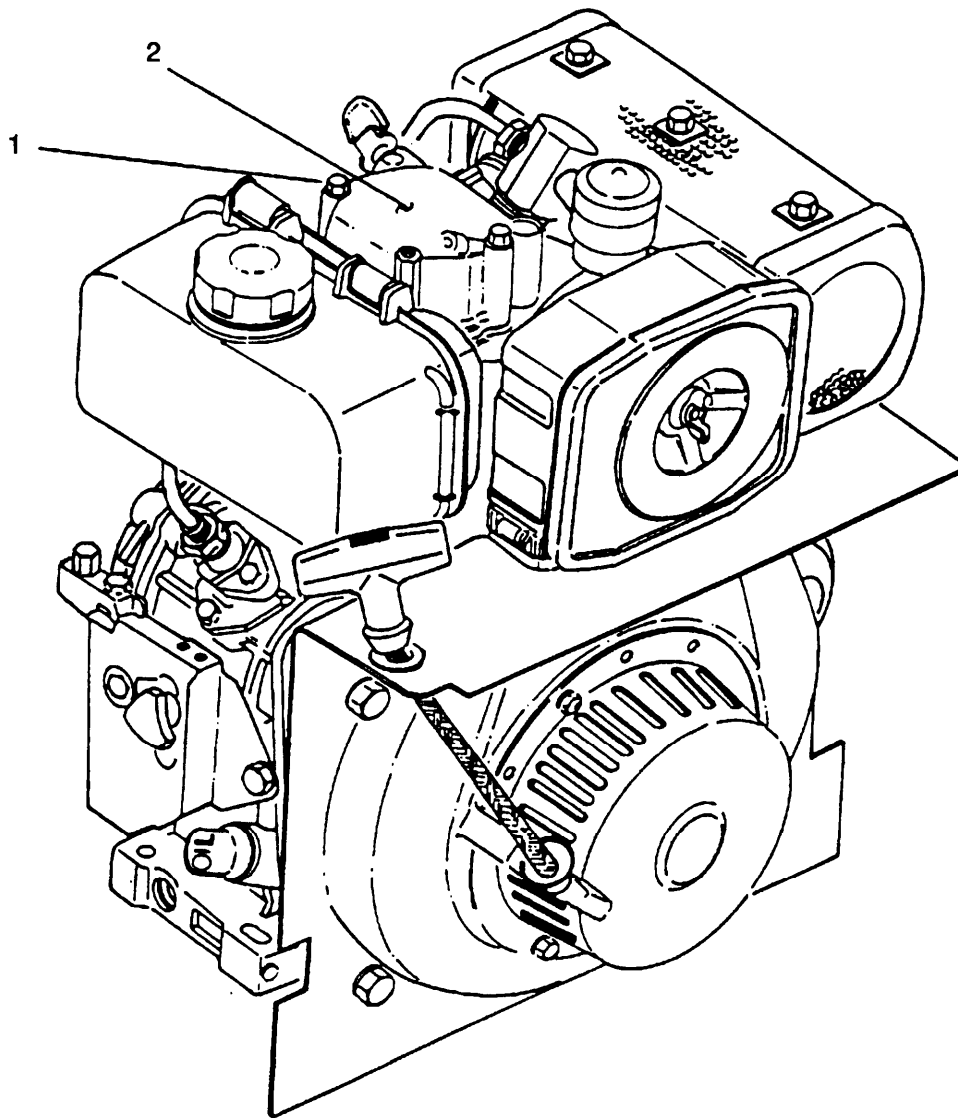
#### INSPECTION:

- a. Check for loose carbon, oil deposits, or caked dirt. Use clean, lint-free cloth dipped in diesel fuel to dean area of rocker arm assembly. Wipe dry when thoroughly dean.

#### ADJUST:

#### NOTE

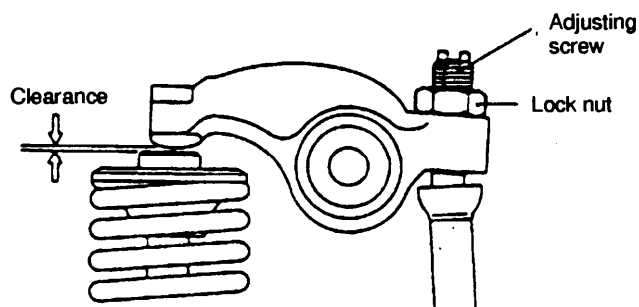
- Valve clearance should be adjusted when engine is mid.
  - Conduit Table 3-5 for proper valve clearance.
- a. Turn flywheel so "T" mark on flywheel aligns with alignment mark on cylinder block.
  - b. Slightly rotate flywheel (approximately 20 degrees in both directions). If valves move up and down, this is the exhaust top dead center. Do not adjust the valve clearance with the flywheel in this position.
  - c. Give flywheel another turn until "T" mark on flywheel aligns with alignment mark on cylinder block. Slightly rotate flywheel (approximately 20 degrees in both directions). If valves do not move up and down, the flywheel is in correct position to check valve clearance.



**Figure 3-13. Valve Rocker Arm Cover Removal**

- d. Check that "T" mark and alignment mark are aligned correctly.
- e. Insert screwdriver into adjusting bolt and loosen locknut.
- f. Turn screwdriver counterclockwise to obtain a clearance. Move valve lever inside for adjustments.
- g. Insert feeler gauge between valve rocker arm and top of the valve spring cotter.
- h. While turning the adjusting screw clockwise, slowly slide the feeler gauge back and forth. Stop turning adjusting screw when slight resistance is felt on the feeler gauge.
- i. Remove feeler gauge and tighten locknut. Keep screwdriver inserted into adjusting screw to prevent adjusting screw from turning.





**Figure 3-14. Adjusting Valve Clearance**

- j. Verify valve clearance of 0.006 inch (0.15 mm) after completion.
- k. Repeat on both intake and exhaust valves.
- l. After securing both locknuts, check that clearance is still 0.006 inch (0.15 mm).

**INSTALLATION:**

- a. Replace valve rocker arm assembly cover (2) and secure with two bolts (1).

**Table 3-5. Valve Clearance**

ITEM	VALVE CLEARANCE
Intake Valve	0.006 inch (0.15 mm)
Exhaust Valve	0.006 inch (0.15 mm)

## **Section VII. PREPARATION FOR STORAGE OR SHIPMENT**

### **3-23. PRESERVATION FOR STORAGE OR SHIPMENT**

- a. Remove drain pipe cap and allow pump to drain.



- b. Remove drain plug on fuel tank and allow tank to drain.
- c. Replace fuel tank drain plug and pump drain plug.
- d. Preserve engine.
  - (1) Operate engine for about 3 minutes and then stop.
  - (2) Drain the engine lube oil while the engine is still warm.
  - (3) Fill engine with new lube oil.
  - (4) Remove rubber plug on cylinder head and add about 5 drops of lube oil. Replace rubber plug.
  - (5) Hold decompression lever down and slowly pull recoil starter rope 2 or 3 times (do not start engine).
  - (6) Pull decompression lever up.
  - (7) Pull the recoil starter rope slowly, stop when it feels tight. This closes the intake and exhaust valves and helps to prevent rust from forming.

### **3-24. 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 approximate maintenance records will be kept.
- b. Before placing equipment in administrative storage, current preventive maintenance checks and services should be completed, shortcomings and deficiencies should be corrected, and modification work orders (MWOs) 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, or other containers may be used.

CHAPTER 4  
DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

4-1. INTRODUCTION

This chapter of the technical manual provides intermediate maintenance instructions for direct support maintenance personnel. It provides the means to locate and correct operating symptom problems. Chapter 4 is divided into two sections, Section I Troubleshooting, and Section II Maintenance Procedures. Troubleshooting contains those symptoms noted during operation and provides the checks to isolate defects and localize faulty parts. Maintenance procedures provide the information to correct, repair, or replace the faulty components of the Diesel-Driven Centrifugal Pump Assembly Model PAD125A.

Section I. TROUBLESHOOTING

INDEX

Para	Para
Scope . . . . . 4-2	Troubleshooting Procedures . . . . . 4-3

4-2. SCOPE

This level of troubleshooting contains checks and corrective maintenance actions which will isolate defects to be corrected by specific maintenance procedures. Table 4-1 is a direct support troubleshooting chart. Symptoms listed in this table are accompanied by suggested tests or inspections which, in turn, suggest corrective action and the appropriate maintenance paragraph reference. Corrective action sometimes suggests additional checks to confirm the troubled area or further localize and isolate trouble to a more specific component. Maintenance procedures include removal, cleaning, inspection, repair, replacement, and installation. These maintenance procedures can be found in Section II of this chapter.

4-3. TROUBLESHOOTING PROCEDURE

Refer to Table 4-1 to locate problematic symptoms, corrective action steps to isolate a faulty component, and references to provide corrective maintenance. The following paragraphs briefly explain the different column headings of Table 4-1.

- a. **Column 1 Malfunction Number**  
This column of the table is a sequential listing of problematic symptoms. The malfunction number is used for cross reference purposes and to avoid needless repetition.

- b. **Column 2 Symptom**  
This column of the table lists the various indications that alert the operator that a probable fault exists describes the symptoms only to the extent necessary to recommend appropriate tests and inspection
- c. **Column 3 Test or Inspection**  
This column of the table suggests further test or inspection checks to localize the symptom cause to a more specific area. It allows corrective action flexibility depending on the outcome of these checks.
- d. **Column 4 Corrective Action/Reference**  
This column of the Table lists the corrective action to be taken and the paragraph reference to locate the step-by-step maintenance procedures to fix the fault.

Table 4-1. Direct Support Troubleshooting Chart

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
1. RECOIL STARTER ROPE DOES NOT UNWIND FREELY		
	Step 1. Visually inspect rope for fraying, wear, or jamming.	Replace frayed or worn rope. (Refer to para 4-19.)
	Step 2. Check recoil spring for jamming.	Replace defective coil spring. (Refer to para 4-19.)
2. RECOIL STARTER ROPE DOES NOT REWIND		
	Step 1. Visually check if rope and mechanism are binding.	Replace starter rope. (Refer to para 4-19.)
	Step 2. Check recoil spring for bends, breaks, or spring tension.	Replace recoil spring. (Refer to para 4-19.)
	Step 3. Check that the starter rope assembly is assembled properly.	Reassemble ratchet cam for correct rotation. (Refer to para 4-19.)
3. ENGINE CRANKSHAFT DOES NOT TURN AS THE ROPE IS PULLED		
	Step 1. Inspect ratchet cam.	Replace defective ratchet cam. (Refer to para 4-1 9.) Reassemble ratchet cam for correct rotation. (Refer to para 4-19.)
4. ENGINE WILL NOT START		
	Step 1. Check fuel injection pump or nozzle. Check that diesel fuel reaches the fuel injection pump or nozzle.	Adjust/replace fuel injection nozzle or pump. (Refer to para 4-16 or 4-17.)

Table 4-1. Direct Support Troubleshooting Chart - Continued

MALFUNCTION	TEST OR INSPECTION	CORRECTIVE ACTION
5. BLACK SMOKE EXHAUST		
<div> </div> <p><b>Do not operate pump without liquid in the volute over 3 minutes.</b></p>		
Step 1. Reduce load by removing suction hose from water/fuel.		
If color improves, refer to para 4-16 or 4-17.		
if color does not improve, check drop in rotation speed, Malfunction Number 6.		
6. DROP IN ENGINE ROTATION SPEED		
Step 1. Check exhaust smoke color. Check abnormal operating sound.		
Fuel system maintenance. (Refer to para 4-16 and 4-17.)		
7. BLUISH-WHITE EXHAUST SMOKE.		
Step 1. Check engine rotation.		
Uneven rotation. (Refer to para 4-16 and 4-17.)		
8. PUMP DOES NOT PUMP		
Step 1. Check pump priming procedure. (Refer to para 2-8.)		
Replace shaft seal. (Refer to para 4-12.)		

## **Section II. MAINTENANCE PROCEDURES**

### INDEX

	Para		Para
Maintenance Procedures . . . . .	4-4	Replace Wear Plate . . . . .	4-13
General Instructions . . . . .	4-5	Replace/Inspect/Repair Pump Casing . . . . .	4-14
Inspect/Repair Inlet Air Sound		Replace Diesel Engine . . . . .	4-15
Enclosure Assembly . . . . .	4-6	Replace Fuel Injection Nozzle . . . . .	4-16
Replace/Inspect/Repair Door, Latch,		Replace/Test/Adjust Fuel Injection	
Hinge . . . . .	4-7	Pump . . . . .	4-17
Inspect/Repair Outlet Air Sound		Replace/Inspect Air Intake Bend . . . . .	4-18
Enclosure Assembly . . . . .	4-8	Replace/inspect/Repair Recoil Starter	
Replace/Inspect/Repair Sound Enclosure		Assembly . . . . .	4-19
Bracket Assembly . . . . .	4-9	Replace/Inspect Flywheel Cooling	
Replace/Inspect Sound Enclosure Air		Case Cover . . . . .	4-20
Flow Baffle . . . . .	4-10	Replace/Inspect/Service Lube Oil Strainer. .	4-21
Replace/inspect/Service Volute . . . . .	4-11	Replace Frame, Base Plate, and Shock	
Replace/Inspect Impeller Shaft Seal		Mounts . . . . .	4-22
and Shaft Adapter . . . . .	4-12		

### **4-4. MAINTENANCE PROCEDURES**

Maintenance procedures at this intermediate level of direct support maintenance include as necessary: removal, cleaning and inspection, repair or replacement, and installation.

### **4-5. GENERAL INSTRUCTIONS**

Unless the procedure requires special resources or tools, more than one maintenance person or specific equipment conditions, these are not listed for each maintenance procedure. They are listed only for those procedures that require them.

4-6. INSPECT/REPAIR INLET AIR SOUND ENCLOSURE ASSEMBLY

This task covers:      a) Inspection      c) Repair

INITIAL SETUP

Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Riveter, Blind, Hand (Item 1, Appendix B, Section III)

Shop Equipment Automotive Maintenance and Repair: Unit Maintenance, Common No. 1 (Item 3, Appendix B, Section III)

Materials/Parts

Toluol Solvent (Item 10, Appendix E, Section II)

Cloth, Lint-free (Item 11, Appendix E, Section II)

Equipment  
Condition  
Para

3-16      Inlet air sound enclosure assembly removed.

Inspection:

- a. Inspect the riveted components of the inlet air sound enclosure assembly. If half the rivets of any surface are missing, the components must be repaired.
- b. inspect the acoustical foam within the inlet air sound enclosure assembly. Carefully inspect acoustical foam (2) within inlet vent hood (1). If acoustical foam blocks airflow or is torn, scarred, or shows sign of contacting a hot engine surface, it must be replaced.

REPAIR:



Wear safety goggles during blind rivet removal to protect your eyes from  
flying metal chips

- a. Select drill bit the same diameter as installed blind rivet.
- b. Install selected drill bit in hand drill chuck.
- c. Hold drill perpendicular to the surface to prevent enlargement or damage to existing hole.
- d. Drill through center of rivet just deep enough to sever rivet head from shank.
- e. Remove remainder of rivet with needle nose pliers.
- f. Remove all rivets until damaged component can be removed.
- g. Replace damaged component.
- h. Select proper diameter and length of blind rivet.
- i. Select appropriate nose piece for hand blind riveter and install nose piece.

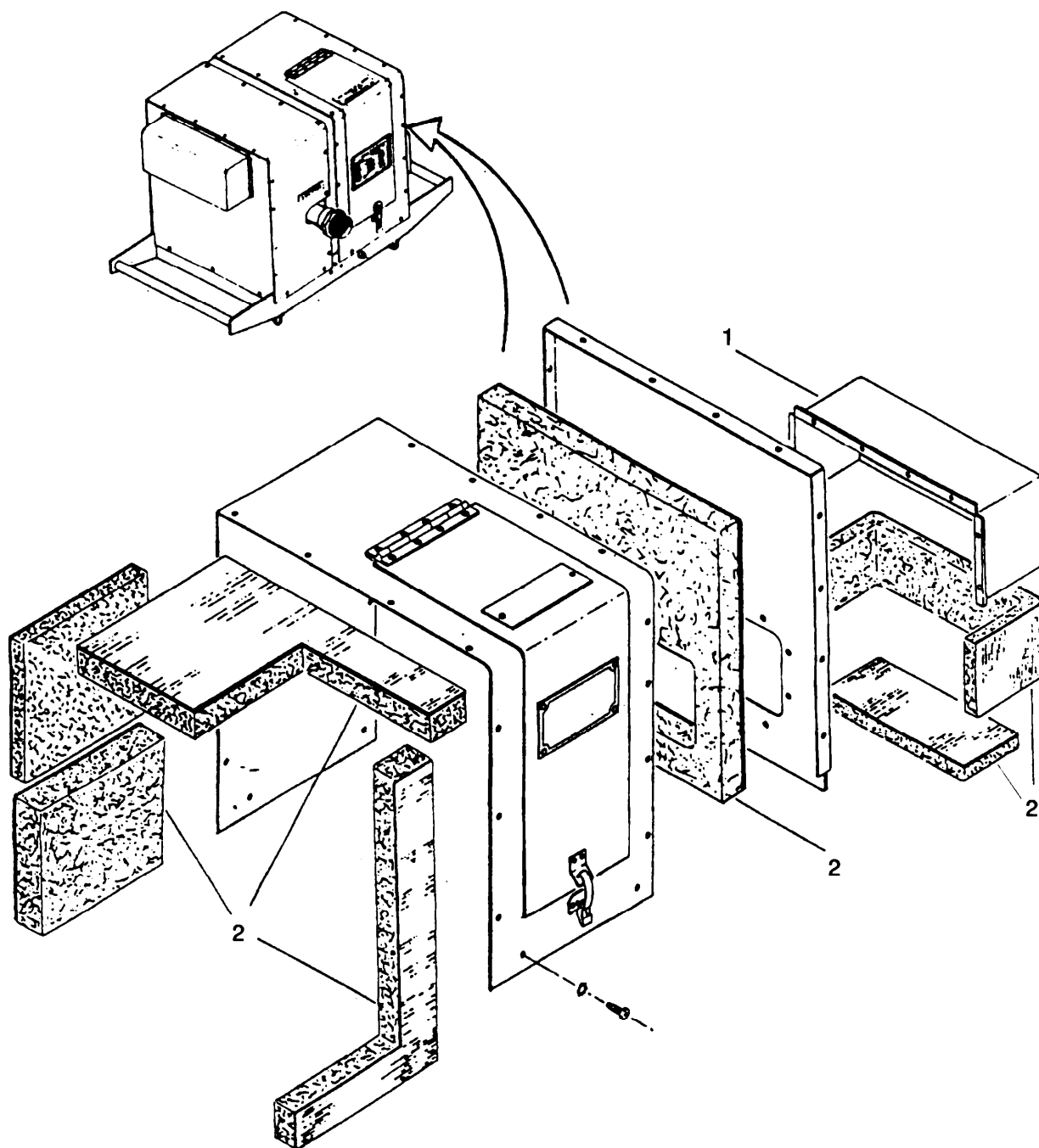


Figure 4-1. Inlet Air Sound Enclosure Assembly



- j. Use hand blind riveter and proper rivets to reattach damaged component.



Toluol solvent Is potentially dangerous Avoid repeated and prolonged breathing of vapors and skin contact. Do not use near open flame, arcing equipment, or other Ignition sources Always wear safety goggles for eye protection from splashing. Gloves should be worn during use of solvent.

- k. To remove damaged acoustical foam (2), pull the acoustical foam firmly away from inlet air sound enclosure assembly. Approximately 1/8 inch of acoustical foam and adhesive backing will remain.
- l. Apply Toluol solvent to acoustical foam and backing to thoroughly wet surface area.
- m. Let set for 2 to 3 minutes.
- n. Using putty knife, peel adhesive backing from surface of inlet air sound enclosure assembly. Apply additional Toluol as needed.
- o. To replace acoustical foam (2), wipe surface area of inlet air sound enclosure assembly with a dean cloth dampened in Toluol solvent, and immediately wipe solvent from surface with a cl ean, dru cloth
- p. select appropriate accoustical foam (2) component for replacement.
- q. Peel off protective backing.
- r. Place acoustical foam over prepared areas, in correct position, and press firmly in place.

---

#### 4-7. REPLACE/INSPECT/REPAIR DOOR, LATCH, AND HINGE

---

This task covers:      a) Inspection      c) Repair  
                                 b) Removal      d) Installation

---

##### INITIAL SETUP

###### Tools

Riveter, Blind Hand (Item 1,  
Appendix B, Section III)

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

Shop Equipment Automotive Maintenance  
and Repair: Unit Maintenance,  
Common No. 1 (Item 3, Appendix B,  
Section III)

###### Materials/Parts

Toluol Solvent (Item 10, Appendix E,  
Section II)

Cloth, Lint-free (Item 11, Appendix E,  
Section II)

##### INSPECTION:



**Do not inspect until engine has shutdown and cooled completely.**

- a. Inspect rivets (7) holding latch (5), strike plate (6), hinge (3), and hinge spacer (4). If half the rivets of a surface are missing, the components must be repaired.
- b. Inspect latch (5) and strike plate (6). Replace if inoperable or damaged.
- c. Inspect acoustical foam (8) within door (9). If acoustical foam blocks airflow or is torn, scarred, or shows signs of contacting a hot engine surface, it must be replaced.

##### REMOVAL:

##### NOTE

**Do not remove the door and hinge unless it is required to repair or replace the door, hinge, strike plate, or latch. Remove only those parts that need to be repaired or replaced. Omit the other steps.**

- a. Remove four blind rivets (7) and remove door (9).
- b. Remove four blind rivets (7) and remove hinge (3).
- c. Remove two blind rivets (12) and remove strike plate (6).
- d. Remove two blind rivets (7) and remove latch (5).

- e. Remove four drive screws (2) securing the identification plate (1) and remove it.
- f. Remove two drive screws (2) securing the oil usage information plate (11) and remove it.

REPAIR:

- a. To remove damaged acoustical foam (8), pull the acoustical foam firmly from metal. Approximately 1/8 inch of acoustical foam and adhesive backing will remain.
- b. Apply Toluol solvent to acoustical foam (8) and backing to thoroughly wet the surface area.

- c. Let set for 2 to 3 minutes.
- d. Using a putty knife, peel adhesive backing from surface of enclosure. Apply additional Toluol as needed.

INSTALLATION:

**NOTE**

**If all parts have been removed, install according to the following sequence. If only certain components have been removed, assemble in sequence as applicable after repair. Components are assembled using blind rivets.**

- a. Rivet hinge (3) to door (9) using four blind rivets (7).
- b. Position hinge spacer (4) on enclosure (10). Position hinge (3) and door (9) on hinge spacer (4) and rivet it to the enclosure with four blind rivets (7). Check that the door operates evenly and easily.
- c. Rivet latch (5) to enclosure (10) using two blind rivets (7).
- d. Close the door. Position strike plate (6) on door (9) and engage the latch. Hold the strike plate in place while disengaging the latch.
- e. Rivet strike plate (6) to door (9) using rivets (12).
- f. Check the operation of latch (5).

## 4-8. INSPECT/REPAIR OUTLET AIR SOUND ENCLOSURE ASSEMBLY

This task covers: a) Inspection c) Repair

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Riveter, Blind, Hand (Item 1, Appendix B, Section III)

Shop Equipment Automotive Maintenance and Repair: Unit Maintenance, Common No. 1 (Item 3, Appendix B, Section III)

#### Materials/Parts

Toluol Solvent (Item 10, Appendix E, Section II)

Cloth, Lint-free (Item 11, Appendix E, Section II)

#### Equipment Condition Parts

3-16 Outlet air sound enclosure assembly removed.

### INSPECTION:

- Inspect the riveted components of the outlet air sound enclosure assembly. If half of the rivets on any surface are missing, the components must be repaired.
- Inspect the acoustical foam within the outlet air sound enclosure assembly. If acoustical foam blocks air flow, or is torn, scarred, or shows signs of contacting the hot engine surface, it must be replaced.

### REPAIR:



**Wear safety goggles during blind rivet removal to protect your eyes from flying metal chips**

- Select drill bit the same diameter as installed blind rivet.
- Install selected drill bit in hand drill chuck.
- Hold drill perpendicular to the surface to prevent enlargement or damage to existing hole.
- Drill through center of rivet just deep enough to sever rivet head from shank.
- Remove remainder of rivet with needle nose pliers.
- Remove all rivets until damaged component can be removed.
- Replace damaged component.
- Select proper diameter and length of blind rivet.
- Select appropriate nose piece for hand blind riveter and install nose piece.

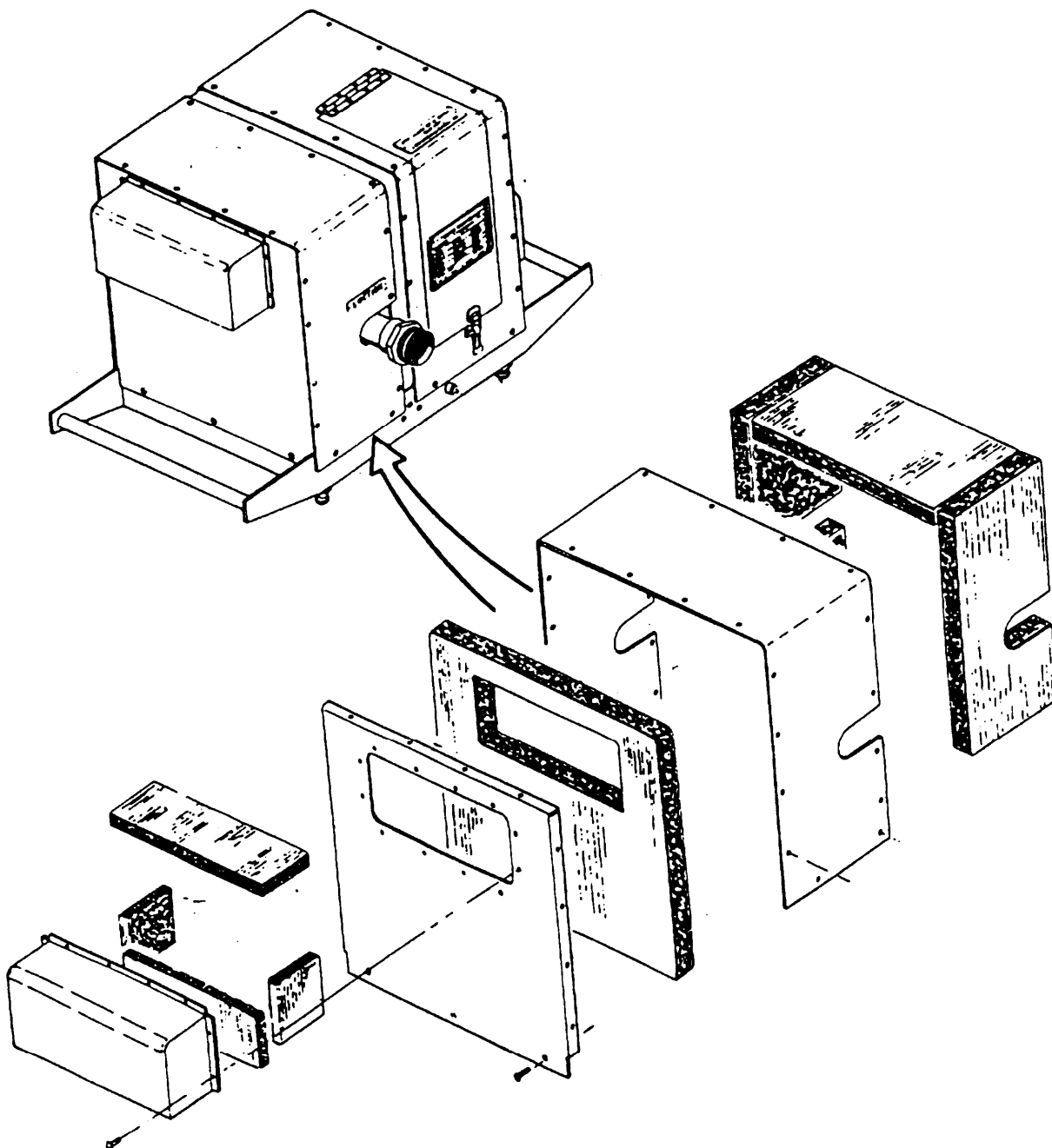


Figure 4-3. Outlet Air Sound Enclosure Assembly

- j. Use hand blind riveter and proper rivets to reattach damaged component.



**Toluol solvent is potentially dangerous. Avoid repeated and prolonged breathing of vapors and skin contact. Do not use near open flame, arcing equipment, or other ignition sources. Always wear safety goggles for eye protection from splashing. Gloves should be worn during use of solvent.**

- k. To remove damaged acoustical foam (2), pull the acoustical foam firmly away from outlet air sound enclosure assembly. Approximately 1/8 inch of acoustical foam and adhesive backing will remain.
- l. Apply Toluol solvent to acoustical foam and backing to thoroughly wet surface area.
- m. Let set for 2 to 3 minutes.
- n. Using putty knife, peel adhesive backing from surface of outlet air sound enclosure assembly. Apply additional Toluol as needed.
- o. To replace acoustical foam (2), wipe surface area of outlet air sound enclosure assembly with a clean cloth dampened in Toluol solvent, and immediately wipe solvent from surface with a clean, dry cloth.
- p. Select appropriate acoustical foam (2) component for replacement.
- q. Peel off protective backing.
- r. Place acoustical foam over prepared areas, in correct position, and press firmly in place.

4-9. REPLACE/INSPECT/REPAIR SOUND ENCLOSURE BRACKET ASSEMBLY

This task covers:     a) Inspection             c) Repair  
                              b) Removal             d) Installation

INITIAL SETUP

Tools

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

Equipment  
Condition  
Para

3-16             Inlet air sound enclosure assembly  
                     removed.

Materials/Parts

Toluol Solvent (Item 10, Appendix E,  
Section II)

3-16             Outlet air sound enclosure assembly  
                     removed.

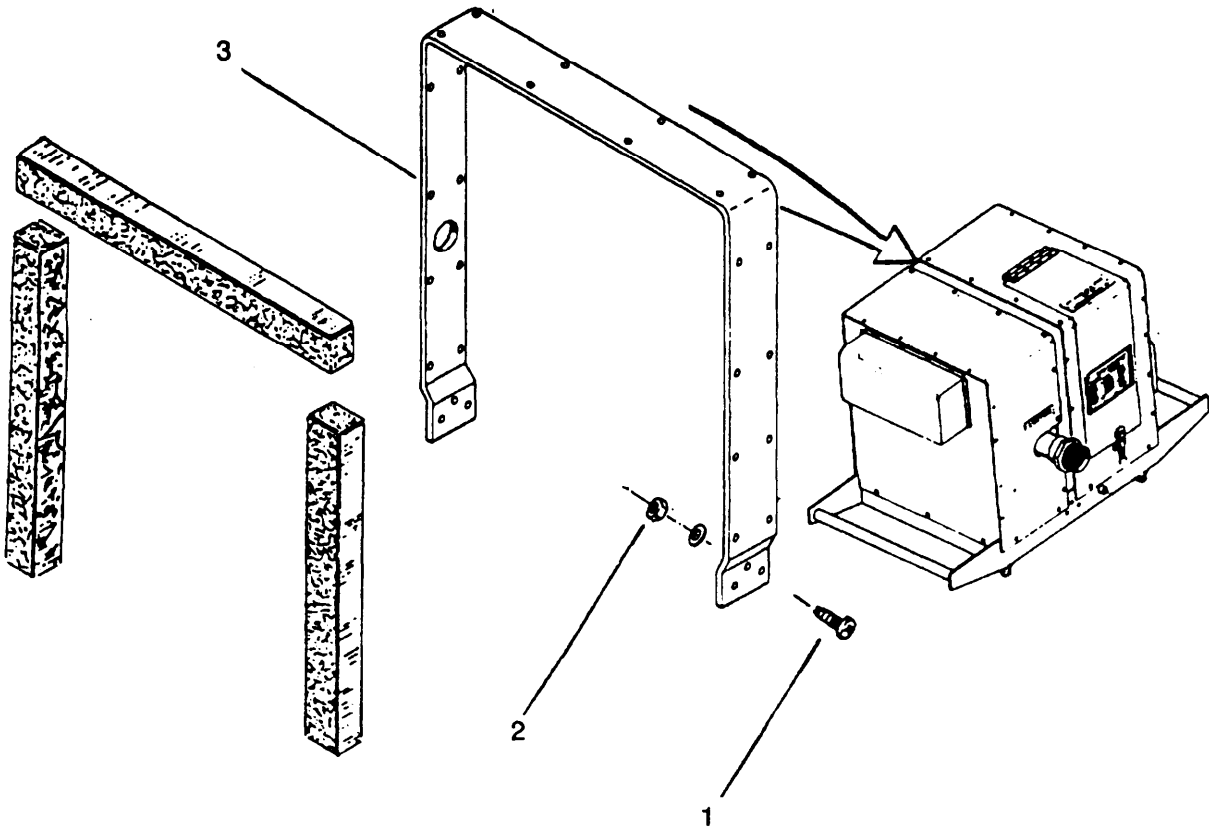


Figure 4-4. Sound Enclosure Bracket



**INSPECTION:**

- a. Check to make sure acoustical foam is not damaged. Replace as required.

**REMOVAL:**

- a. Remove exhaust extension pipe by removing the damp.
- b. Remove six machine screws (1) and six hex nuts (2) securing sound enclosure bracket assembly (3).
- c. Remove sound enclosure bracket assembly (3).

**REPAIR:**

- a. To removed damaged acoustical foam, pull acoustical foam firmly from metal. Approximately 1/8 inch of acoustical foam and adhesive backing will remain.
- b. Apply Toluol solvent to acoustical foam and backing to thoroughly wet the surface area.
- c. Let set for 2 to 3 minutes.
- d. Using a putty knife, peel adhesive backing from surface of bracket. Apply Toluol as needed.

**INSTALLATION:**

- a. Replace acoustical foam as required.
- b. Reinstall sound enclosure bracket assembly (3) using six machine screws (1) and hex nuts (2).
- c. Install exhaust extension pipe with the clamp.

4-10. REPLACE/INSPECT SOUND ENCLOSURE AIR FLOW BAFFLE

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

INITIAL SETUP

Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

Equipment  
Condition  
Para

3-16             Inlet air sound enclosure assembly removed.

4-19             Recoil starter assembly removed from engine.

Materials/Parts  
None

INSPECTION:

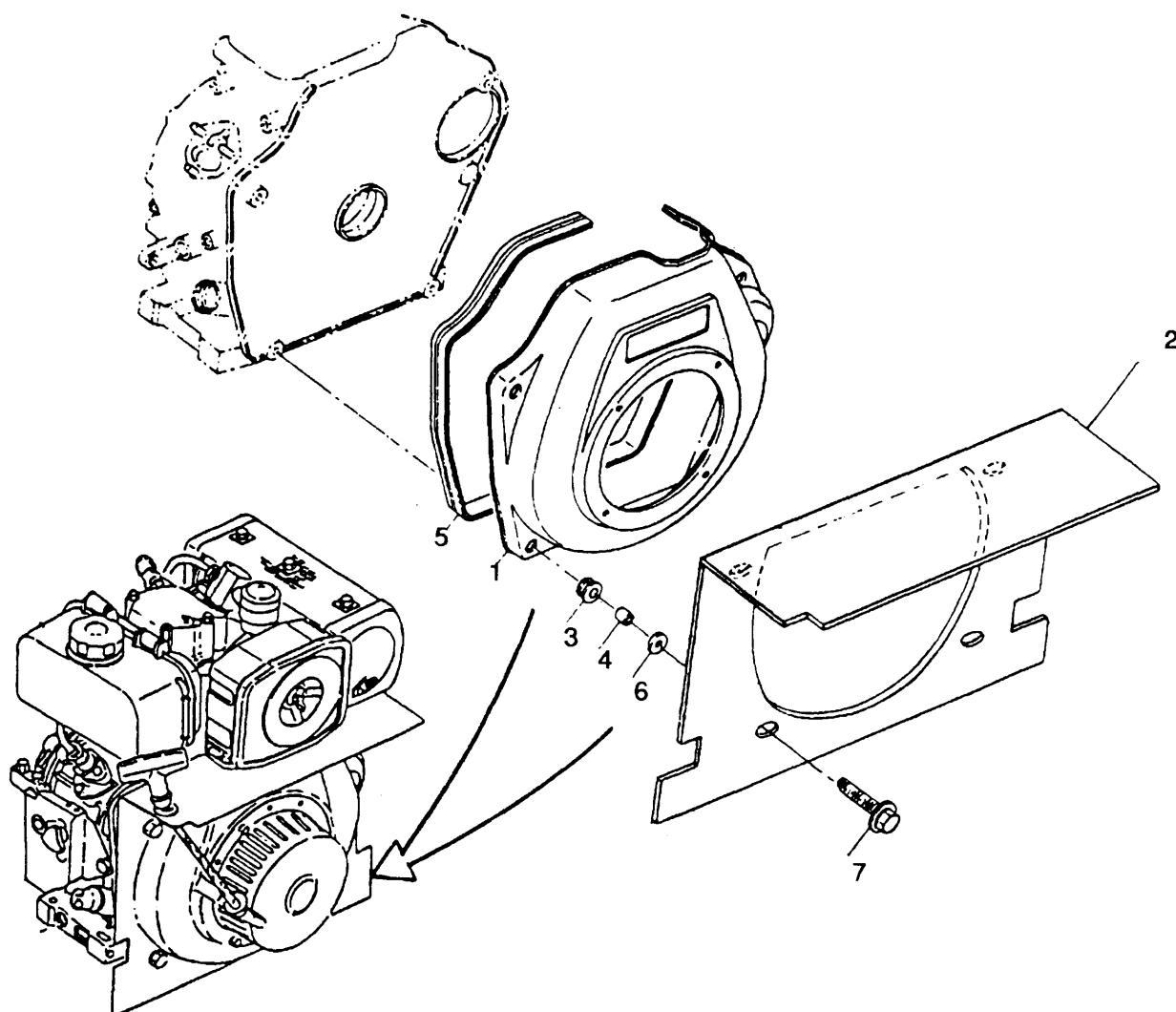
- a.    Inspect sound enclosure air flow baffle to make sure four bolts (7) are tightened and in place. If not, retighten or replace bolts.
- b.    Inspect cooling case cover seal (5) for damage. Replace if damaged.
- c.    Inspect sound enclosure air flow baffle (2) for damage. Replace if damaged.

REMOVAL:

- a.    Remove four bolts (7) attaching cooling case cover (1) to engine.
- b.    Remove air inlet hose from air cleaner assembly by removing damp.
- c.    Remove sound enclosure air flow baffle (2) and cooling case cover (1).

INSTALLATION:

- a.    Place cooling case cover (1) onto engine.
- b.    Install hose and clamp to air cleaner assembly.
- c.    Place sound enclosure air flow baffle (2) onto engine.
- d.    Attach cooling case cover (1) and sound enclosure air flow baffle (2) to engine with four bolts (7).



**Figure 4-5. Air Flow Baffle**

4-11. REPLACE/INSPECT/SERVICE VOLUTE

This task covers:   a) Removal           c) Service  
                          b) Inspection       d) Installation

INITIAL SETUP

Tools	Equipment
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)	Condition Para
	3-16      Inlet air sound enclosure assembly removed.
Materials/Parts None	3-16      Outlet air sound enclosure assembly removed.

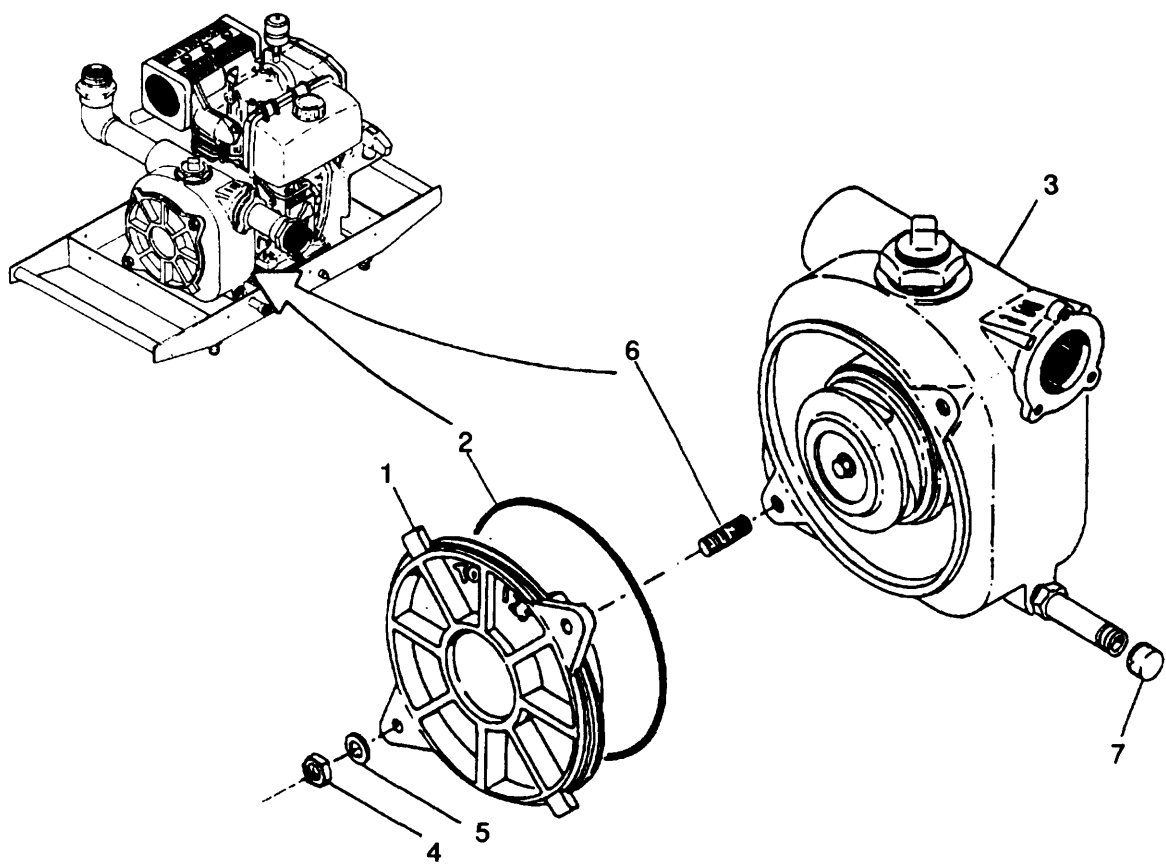


Figure 4-6. Replacing Volute

REMOVAL:

- a. Completely drain the pump by removing pipe cap (7).

- b. Remove volute (1) from pump casing (3) by removing two hex nuts (4) and washers (5) from pump casing studs (6).
- c. Discard O-ring (2).

**INSPECTION:**

- a. Carefully inspect all parts for signs of wear and corrosion.
- b. Inspect volute for foreign matter obstructing flow passages.

**SERVICE:**



**When using compressed air, always use chip guards and wear eye protection.**

- a. Clean all flow passages of volute.
- b. Blow out difficult to reach areas, inside of volute (1) and pump casing (3), with compressed air, if necessary, to remove deposits.

**INSTALLATION:**

- a. Install volute (1) with new O-ring (2) to pump casing (3).
- b. Attach two hex nuts (4) and washers (5) to pump casing studs (6) to secure volute to pump casing.
- c. Fill pump casing with water/fuel and check for leaks.

4-12. REPLACE/INSPECT IMPELLER, SHAFT SEAL, AND SHAFT ADAPTER

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

INITIAL SETUP

Tools	Equipment Condition	
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)	Para	
	3-16	Inlet air sound enclosure assembly removed.
Wrench, Strap (Item 9, Appendix B, Section III)		
	3-16	Outlet air sound enclosure assembly removed.
Mallet, Rubber (Item 17, Appendix B, Section III)		
	4-11	Volute removed.
Materials/Parts	4-19	Recoil starter assembly removed.
None		

REMOVAL:

- a. Fit a strap wrench over the starter pulley cup.
- b. Use 9/16 inch socket to remove impeller locking bolt (1) and teflon washer (2).
- c. Unscrew impeller (3) in a counterclockwise direction using the strap wrench to hold the shaft from turning.

NOTE

it maybe necessary to use a small wood block and the rubber mallet to tap the impeller vanes so impeller breaks loose.

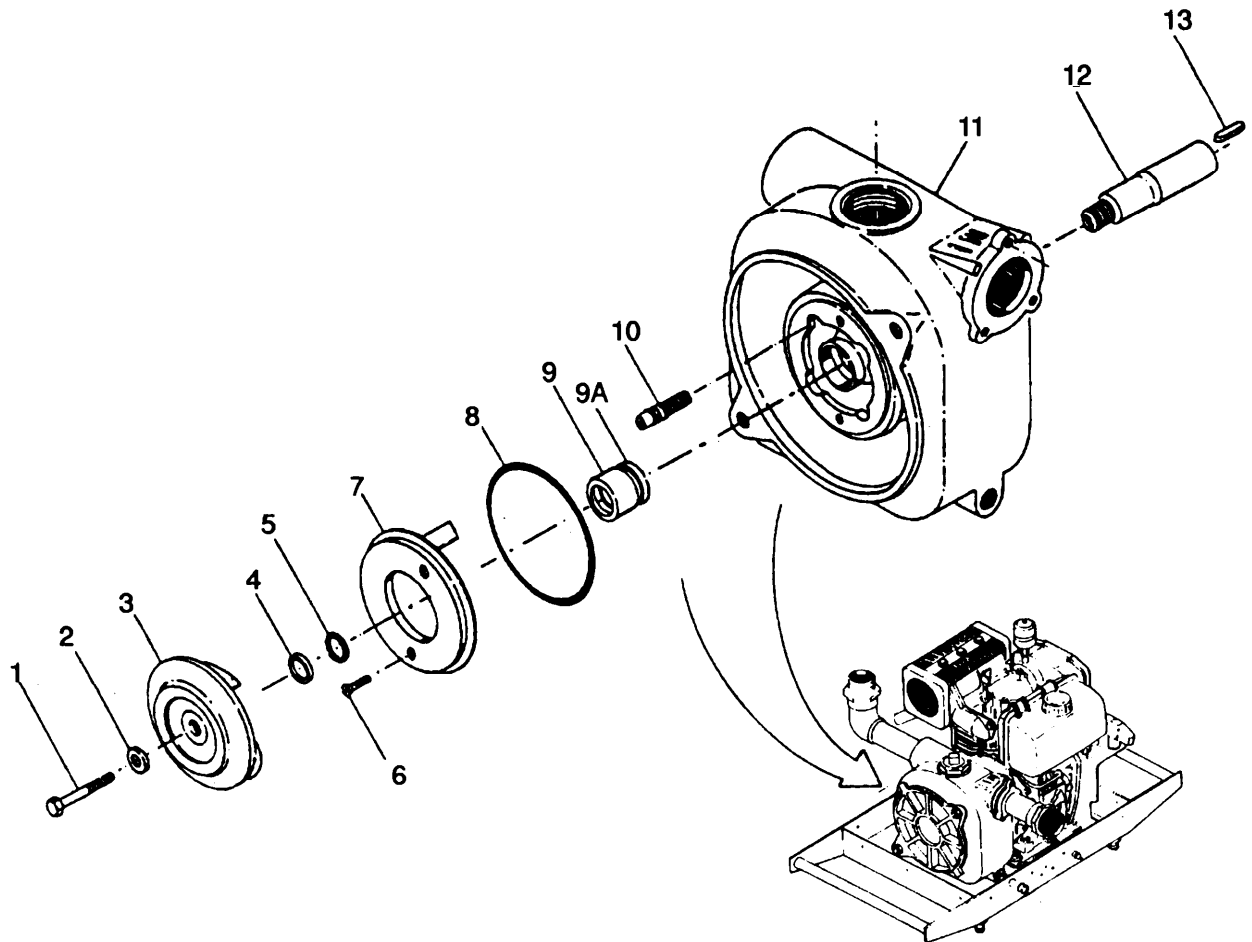
- d. Remove shims (4 and 5).
- e. Remove and discard shaft seal (9) and seat (9A).
- f. Remove shaft adapter (12).

INSPECTION:

- a. Inspect impeller for damage or wear.

INSTALLATION:

- a. Ensure key (13) is installed in keyway of engine shaft.
- b. Position slot of shaft adapter (12) onto shaft key and push shaft adapter onto engine shaft.



**Figure 4-7. Replacing Impeller, Shaft Seal, and Shaft Adapter**

**NOTE**

**When replacing seal, also replace volute O-ring (refer to item 2, Figure 4-6), wear plate O-ring (8, Figure 4-7), and four self-sealing screws (10).**

- c. Install stationary rubber seat (9A) into pump casing cavity.
- d. Install new shaft seal (9) onto shaft adapter (12).
- e. If a new impeller and/or wear plate is installed or if the impeller clearance is to be changed, determine the shim thickness required to obtain a clearance of 0.010 to 0.015 inch (0.254 to 0.381 mm) by the following procedure:
  - (1) Screw impeller (3) dockwise onto shaft adapter (12) without shims (4 and 5). Be sure that the impeller is seated firmly against the shaft shoulder. Secure the impeller with teflon washer (2) and hex bolt (1).

- (2) Measure from the face of the impeller to the face of the wear plate with feeler gauge. Clearance should be 0.010 to 0.015 inch (0.254 to 0.381 mm).
- (3) Shim (4) is 0.010 inch (0.254mm) thick and shim (5) is 0.005 inch (0.127 mm) thick. Add any combination of shims to obtain proper clearance.
- f. After proper clearance is obtained, use strap wrench to hold shaft and tighten impeller locking bolt (1).



---

### 4-13. REPLACE WEAR PLATE

---

This task covers:      a) Removal              c) Installation

---

**INITIAL SETUP**

**Tools**

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

**Equipment  
Condition  
Para**

**Materials/Parts**

None

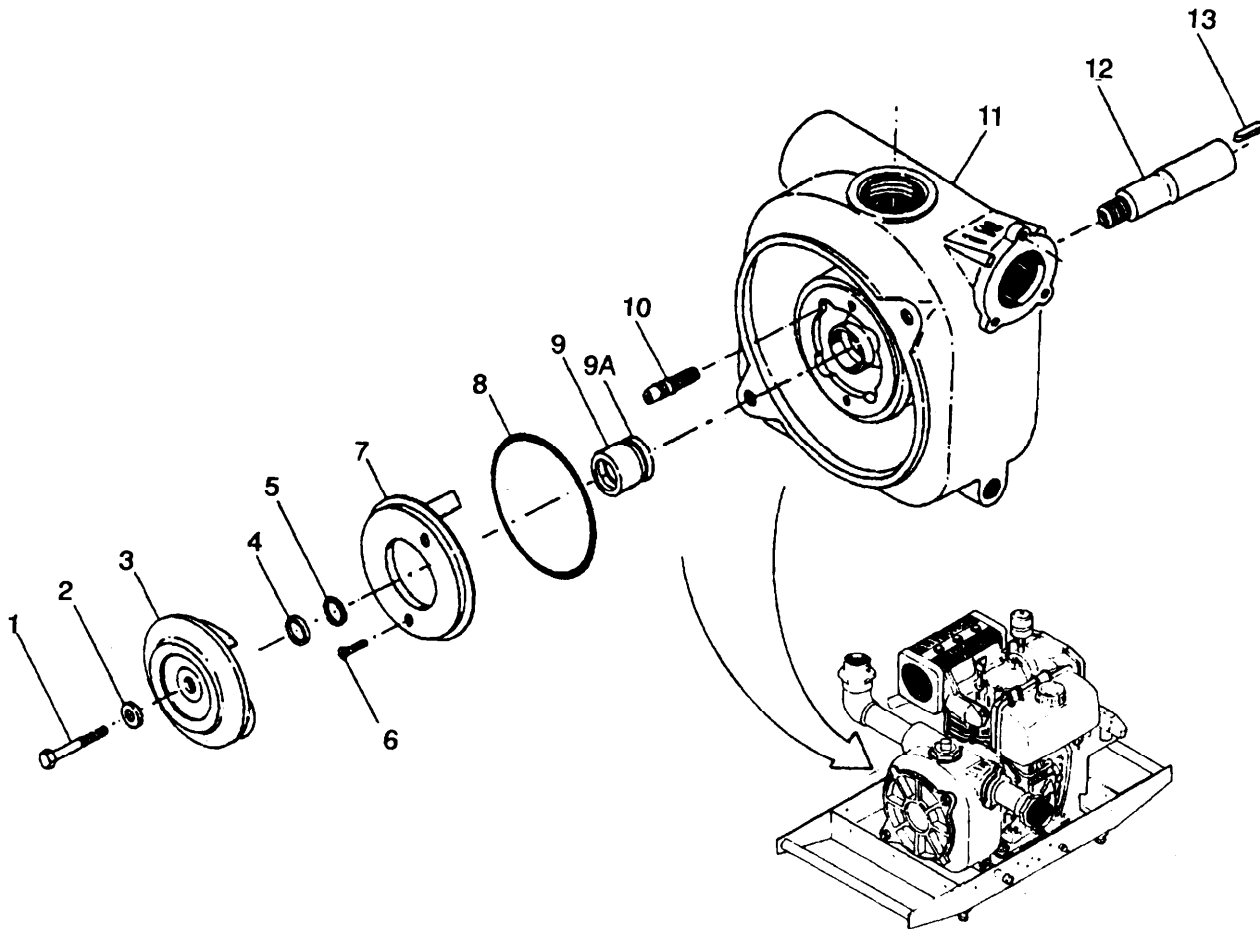
3-16	Outlet air sound enclosure assembly removed.
4-11	Volute removed.
4-12	Impeller removed.
4-19	Recoil starter assembly removed.

**REMOVAL:**

- a. Remove two machine screws (6) holding the wear plate to pump casing.
- b. Remove wear plate (7).
- c. Remove and discard O-ring (8).

**INSTALLATION:**

- a. Install O-ring (8) onto pump casing.
- b. Install wear plate (7) onto pump casing.
- c. Install and tighten two machine screws (6) holding wear plate to pump casing.



**Figure 4-8. Replace Wear Plate**

## 4-14. REPLACE/INSPECT/REPAIR PUMP CASING

This task covers:      a) Removal              c) Repair  
                                    b) Inspection          d) Installation

### INITIAL SETUP

#### Tools

#### Equipment Condition Para

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

3-16

Outlet air sound enclosure assembly  
removed.

Shop Equipment Automotive Maintenance  
and Repair: Field Maintenance,  
Common No. 2 (Item 4, Appendix B,  
Section III)

3-17

Check valve assembly and suction  
discharge pipes removed.

Hook Pick (Item 16, Appendix B,  
Section III)

4-11

Volute assembly removed.

Hex Key Drive (Item 11, Appendix B,  
Section III)

4-12

Impeller, shaft seal, shaft adapter  
removed.

4-13

Wear plate removed.

#### Materials/Parts

Cloth, Lint-free (Item 11, Appendix E  
Section II)

4-19

Recoil starter assembly removed.

#### REMOVAL:

- a. Completely drain the pump by removing pipe cap (1), pipe nipple (2), and bushing adapter (3).
- b. Remove pipe plug (8) and bushing adapter (9).
- c. Remove four self-sealing screws (6).
- d. Separate pump casing (4) from engine.

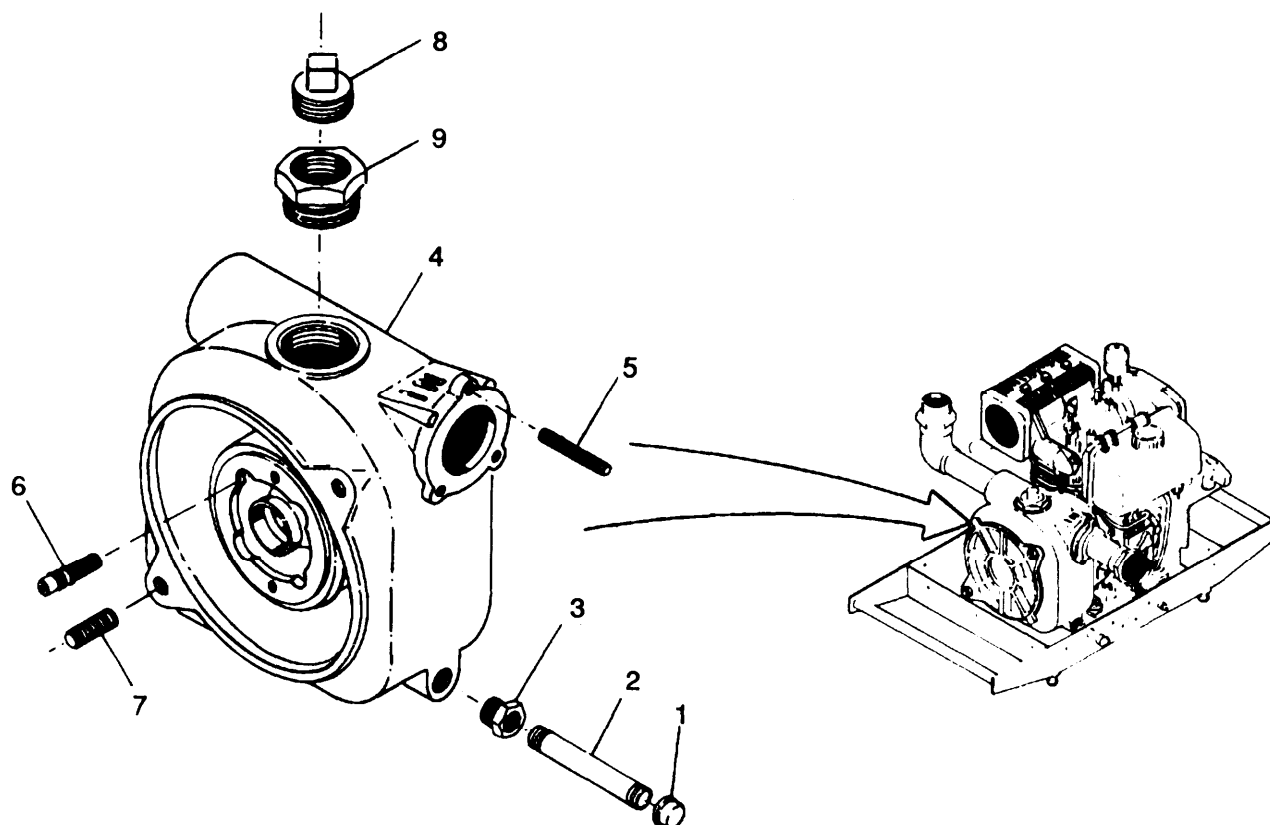
#### INSPECTION:

- a. Wipe surface areas with dean, dry cloth.



**When using compressed air, always use chip guards and wear eye protection.**

- b. Inspect all surfaces and edges for cracks.
- c. Blow out suspicious looting and difficult to reach areas with compressed air to remove deposits and reveal flaws.
- d. Inspect threaded inserts for damaged threads.



**Figure 4-9. Pump Casing Assembly**

**REPAIR:**

- a. Remove and replace stud (5 or 7) from bolt hole if damaged.
- b. Pry the last thread of insert into center of hole with hook pick.
- c. Grasp thread with needle nose pliers and unscrew damaged insert in counterclockwise direction.
- d. Insert new insert to a depth of 0.25 to 0.5 pitch below the top surface of the tapped hole in pump casing.
- e. Remove drive tang with flat punch.

**INSTALLATION:**

- a. Position pump casing to engine and install four self-sealing screws (6). Tighten in an alternating pattern. Torque to 32-35 ft-lb (4.43-4.84 m-kp).
- b. Install bushing (9) and pipe plug (8).
- c. Install bushing adapter (3), pipe nipple (2), and pipe cap (1).

## 4-15. REPLACE DIESEL ENGINE

This task covers: a) Removal b) Installation

### INITIAL SETUP

Tools	Equipment Condition Para	
Tool Kit General Mechanics (Item 2, Appendix B, Section III)		
Drain Pan (Item 7, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
	3-16	Outlet air sound enclosure assembly removed.
<b>Materials/Parts</b>	4-11	Volute removed.
None	4-12	Impeller, shaft seal, and shaft adapter removed.
	4-13	Wear plate removed.
	4-14	Pump casing removed.

### REMOVAL:

- Remove oil drain plug (1) and drain engine oil port.
- Remove oil drain hose (16) from oil drain on engine.
- Remove four nuts (6) and four washers (5) attaching engine to engine base plate (7).
- Remove engine from engine base plate.

### INSTALLATION:

- Mount engine to engine base plate (7) and secure with four washers (5) and four nuts (6).
- Install oil drain hose (16) to engine oil drain port.
- Install oil drain plug (1).
- Fill with engine oil and check for leaks.

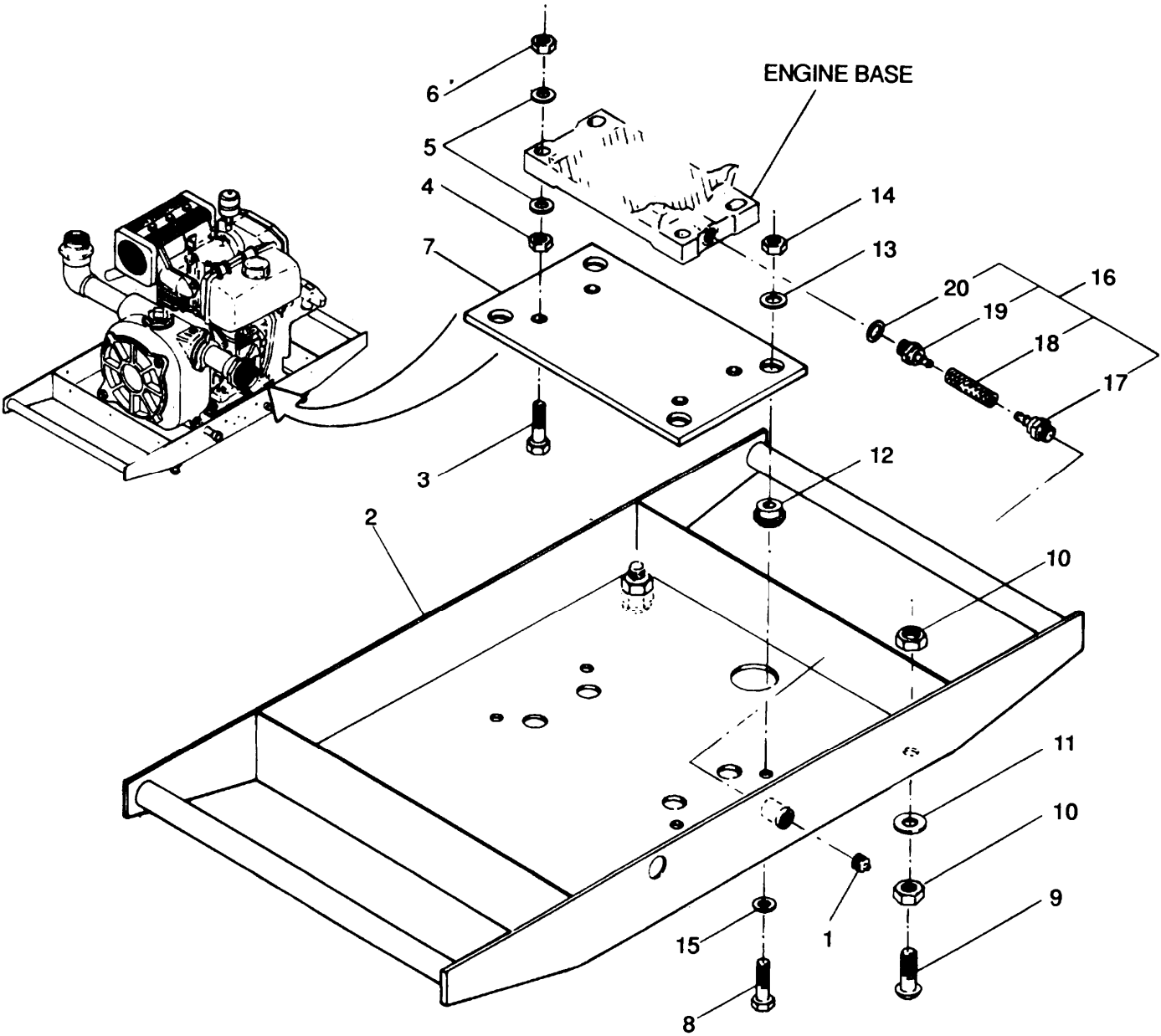


Figure 4-10. Engine Mounting Assembly

## 4-16. REPLACE FUEL INJECTION NOZZLE

This task covers: a) Removal b) Installation

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2  
Appendix B, Section III)

Shop Equipment Automotive Maintenance  
and Repair: Field Maintenance,  
Common No. 2 (Item 4, Appendix B,  
Section III)

Socket Set, 8 to 19 mm (Item 6,  
Appendix B, Section III)

Wrench, 17 mm (Item 14, Appendix B,  
Section III)

Nozzle Tester (Item 27, Appendix B,  
Section III)

#### Materials/Parts

Cloth, Lint-free (Item 11, Appendix E,  
Section II)

#### Equipment Condition Para

3-16 Inlet air sound enclosure assembly  
removed.

3-16 Outlet air sound enclosure assembly  
removed.

3-20 Fuel injection pipe removed from  
engine.

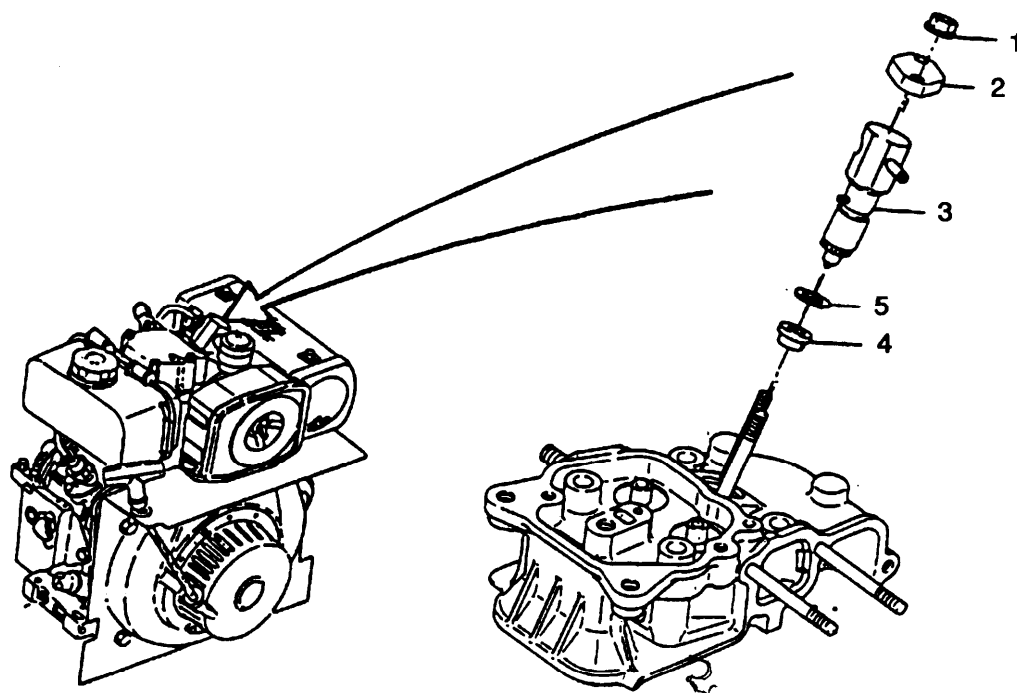


Figure 4-11. Replace Fuel Injection Nozzle

REMOVAL:

**CAUTION**

Do not touch tip of fuel injection nozzle as damage to equipment can occur.

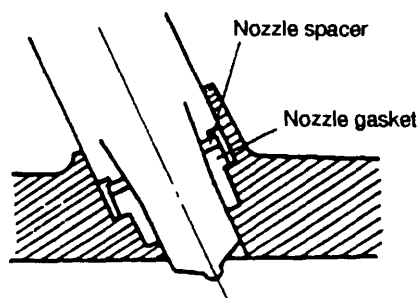
- a. Remove two hex head nuts (1) and retaining plate (2).

**NOTE**

**If the nozzle is tight, gently pry nozzle using a small pry bar. Be careful not to pry on the fuel return hose hub.**

- b. Carefully remove fuel injection nozzle (3). Wrap it in clean cloth to protect the nozzle tip. Do not place nozzle tip directly on any dirty surface without protection.
- c. If nozzle gasket (4) and spacer (5) are not attached to nozzle at removal, screw M8 or M9 stud bolt (more than 4 inches [100 mm] long) into nozzle gasket, then remove stud bolt. The gasket and spacer should come out.

INSTALLATION:



**Figure 4-12. Fuel Injection Nozzle Gasket**

- a. Install new fuel injection nozzle gasket onto fuel injection nozzle before installing nozzle into cylinder block.

**NOTE**

**Make sure nozzle and sleeve surface is clean. Carbon deposits will build upon nozzle in the form of flowers. Flowering lowers combustion performance significantly.**

- b. Carefully insert the fuel injection nozzle into the cylinder block. Care must be taken in order to avoid damage to nozzle gasket.
- c. Make sure fuel injection nozzle (3) positioning pin guides into positioning slot.
- d. Secure nozzle (3) to engine with two hex head nuts (1) and retaining plate (2). Torque to 6.0-7.0 ft-lb (80- 100 cm-kg).



## 4-17. REPLACE/TEST/ADJUST FUEL INJECTION PUMP

This task covers:      a) Removal                      c) Adjustment  
                                    b) Test                                      d) Installation

### INITIAL SETUP

Tools	Materials/Parts	Equipment Condition
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)	None	
Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)	3-16	Outlet air sound enclosure assembly removed.
Wrench, 17 mm (Item 14, Appendix B, Section III)		

### REMOVAL:

- Remove fuel tank (refer to para 3-1 8).
- Remove fuel injection pipe (refer to para 3-20).
- Remove the lower fuel tank mounting bracket.
- Remove fuel line hose (1) by opening securing damp.
- Loosen hex nut (2) securing pump viewing access plate (3) and gasket (4).
- Loosen two hex nuts (5) securing fuel injection pump (6), and remove pump together with base mounting plate.

### NOTE

**If flat tappet is not removed with fuel injection pump, then remove flat tappet with finger.**

### INSTALLATION:

### NOTE

**When replacing or installing a new fuel injection pump, it is usually not necessary to test or adjust the injection timing. Run the engine and observe performance and exhaust color (refer to Table 3-3) before adjusting timing.**

- Insert bottom of tappet down into engine block.

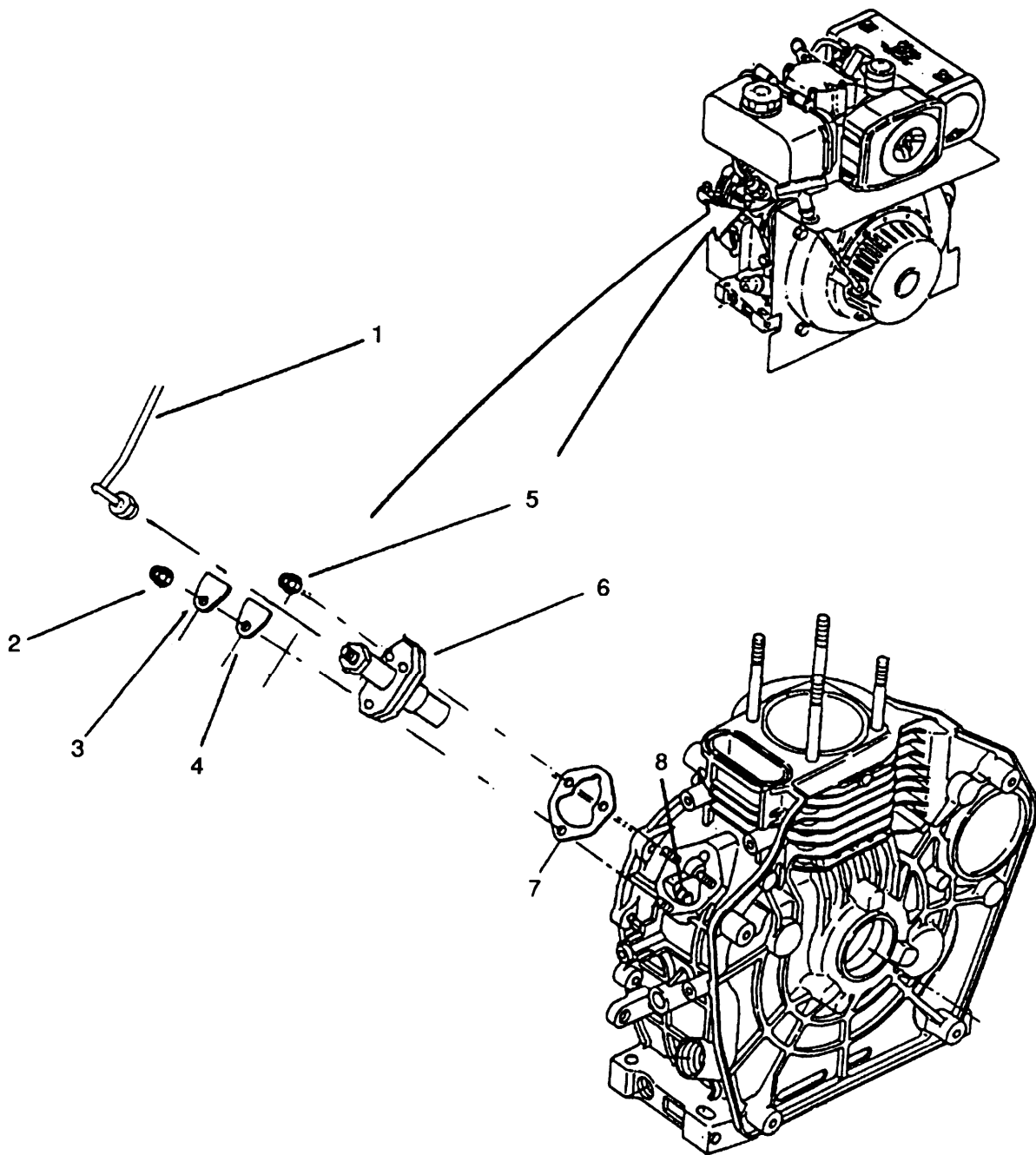


Figure 4-13. Replace Fuel Injection Pump

- b. Adjust speed control lever knob until governor yoke (8) is centered in engine block opening.

**NOTE**

**The access hole on fuel injection pump has an access hole pointer match mark. Make sure the pointer of the control lever lines up with the match mark. (Refer to Figure 4-15)**

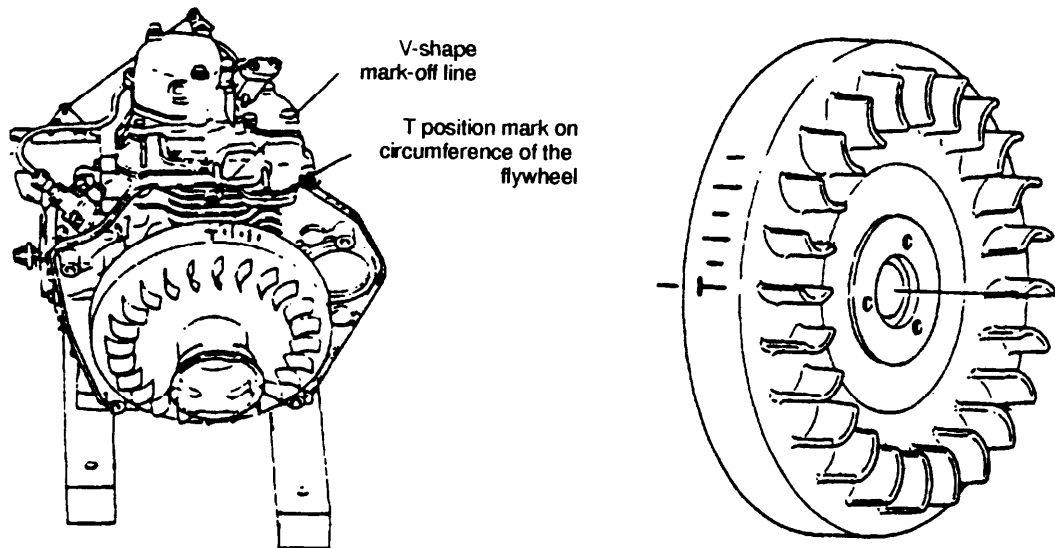
- c. Carefully insert fuel injection pump (6) onto the studs making sure the speed control lever engages into governor yoke (8).
- d. Secure fuel injection pump onto studs using two nuts (5).
- e. Attach pump viewing access plate (3) and gasket (4) with one hex nut (2).
- f. Torque the hex head securing nuts to 7-9 ft-lb (100-120 cm-kg).
- g. Replace fuel line with hose clamp.
- h. Replace lower fuel tank mounting bracket.
- i. Install fuel tank (refer to para 3-18).
- j. Install fuel injection pipe and bleed air from fuel system (refer to para 3-20).

TEST:

**NOTE**

- **Fuel injection timing must be precise. if it is too early or too late, the engine will start hard, provide lowered output, knock and show poor exhaust color. The injection pressure must be adjusted first. (Refer to para 5-3)**
- **The fuel injection pump is a nonrepairable item and must be replaced as a complete unit. However, it must be remembered that the fuel timing is adjustable.**

- a. Remove sound enclosure air flow baffle (refer to para 4-10).
- b. Remove fuel injection pipe (refer to para 3-20).
- c. Set speed control lever knob to run position.
- d. Match the T position mark on the flywheel with the V-shaped mark-off line on the cylinder body fin.
- e. Set the decompression lever to start (downward) position.
- f. Turn the flywheel first clockwise, then counterclockwise about 30 degrees from the T mark to make sure fuel is discharged from the fuel injection pump outlet. Repeat Steps c and d if necessary to inject fuel.
- g. Turn the flywheel slowly until fuel just begins to flow from the pump outlet. Note the timing position on the flywheel when fuel starts to flow.
- h. Repeat 3 or 4 times to make sure the reading is correct.



**EACH LINE REPRESENTS 5 DEGREES**

**Figure 4-14. Top Dead Center Position**

- i. The correct reading should beat 14 degrees, plus or minus 1 degree.
- j. If the injection timing is incorrect, refer to ADJUSTMENT procedure to correct.
- k. Install fuel injection pipe (refer to para 3-20).
- l. Install sound enclosure air flow baffle (refer to para 4-10).

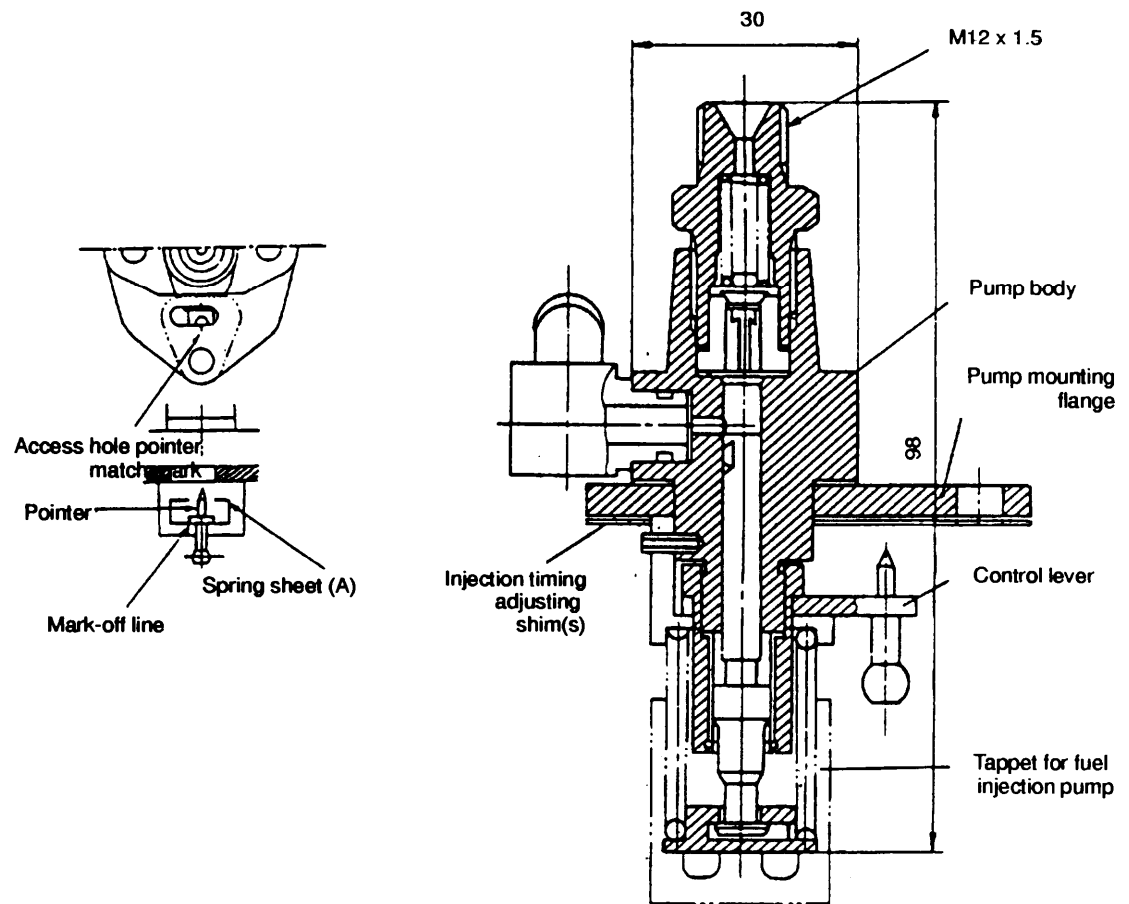
**ADJUSTMENT:**

- a. **Fuel Injection Timing Adjustment**

**NOTE**

**Perform the following steps to adjust fuel injection timing after the timing has been checked several times and incorrect timing is indicated.**

- (1) The fuel injection timing is adjusted by adding or removing shims (7) (refer to Figure 4-13) to speed up or slow down the actual fuel injection.



**Figure 4-15. Configuration of Fuel Injection Pump**

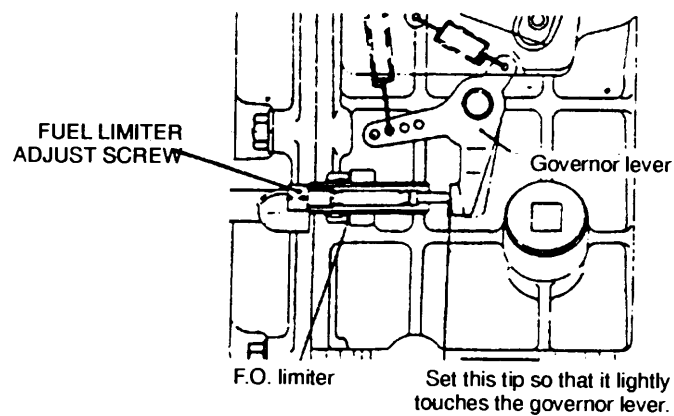
**NOTE**

Each 0.0039 inch (0.01 mm) added slows timing by one degree. Each 0.0039 inch (0.01 mm) removed speeds up timing by one degree. Shims are available in 0.0078 inch (0.2 mm) or 0.0117 inch (0.3 mm) sizes. Changes in 0.0039 inch (1 mm) units can be affected by using combinations of 0.0078 inch (2 mm) and 0.0117 inch (0.3 mm) shims.

- (2) Remove fuel injection pump.
- (3) Add or remove shims (7) to achieve a timing of 14 degrees, plus or minus 1 degree before top dead center.
- (4) Install fuel injection pump and repeat test.

**b. Fuel Injection Volume Limitation Adjustment**

- (1) Loosen hex nut (2) and remove pump viewing access plate (3) and gasket (4). (Refer to Figure 4-13)
- (2) Adjust speed control lever knob until the control lever pointer lines up with access hole match marks. (Refer to Figure 4-15)



**Figure 4-16. Fuel Injection Volume Limitation Adjustment**

- (3) Adjust the fuel limiter adjust screw until the tip lightly touches the governor lever.
- (4) Install pump viewing access plate (3) and gasket (4), and tighten hex nut (2). (Refer to Figure 4-13)

## 4-18. REPLACE/INSPECT AIR INTAKE BEND

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

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

#### Equipment Condition Para

3-14 Air cleaner cover, air cleaner element.  
3-16 Inlet air sound enclosure assembly removed.

#### Materials/Parts

None

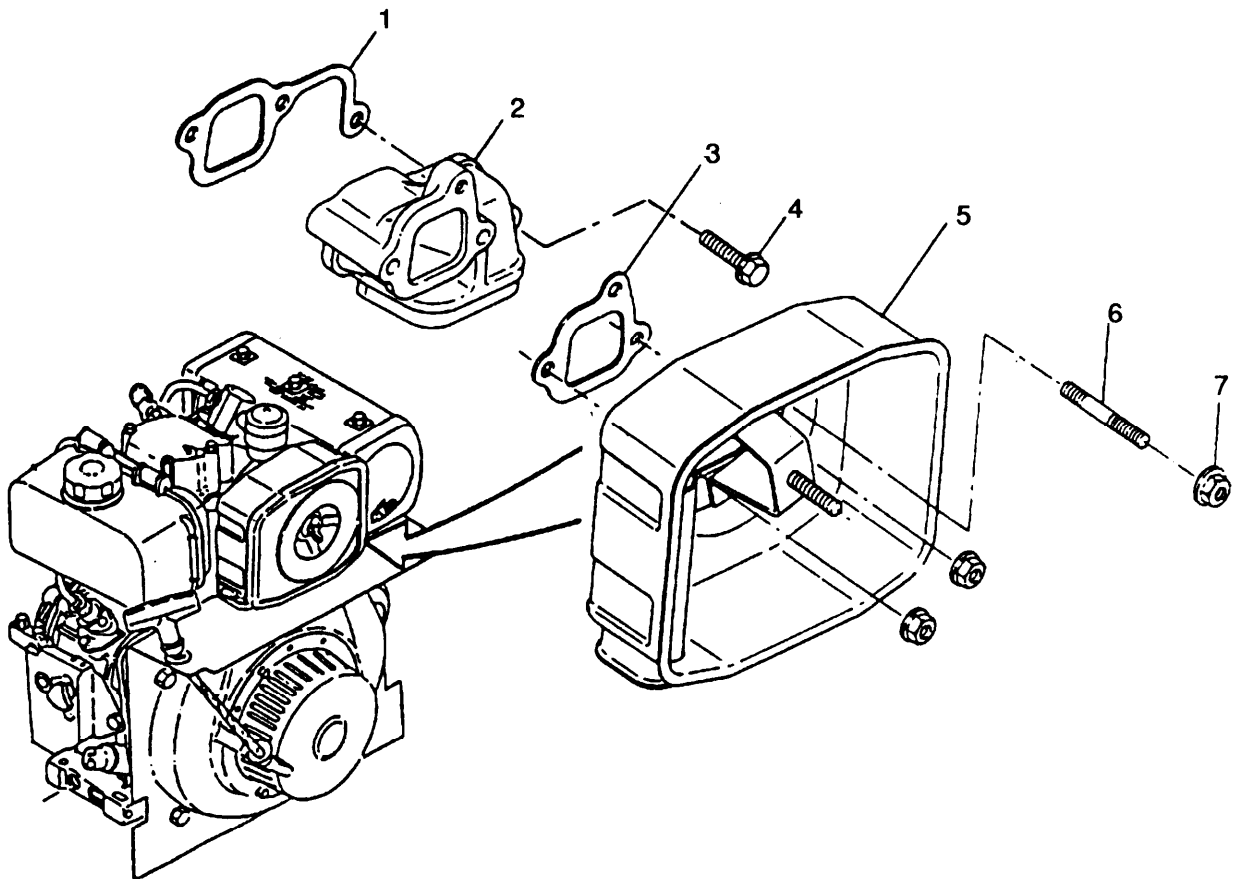


Figure 4-17. Air Intake Bend

#### REMOVAL:

- a. Remove three nuts (7) holding air cleaner housing (5) to air intake bend (2).

- b. Remove air cleaner housing (5) from air intake bend (2).
- c. Remove gasket (3).
- d. Remove one bolt (4) holding air intake bend (2) to engine block.
- e. Remove air intake bend (2).
- f. Remove gasket (1).

**INSPECTION:**

- a. Check that gaskets (1 and 3) are clean and undamaged.
- b. Check that intake bend housing (2) is free from dirt.

**INSTALLATION:**

- a. Position gasket (1) carefully in place over two studs on the cylinder block.
- b. Position air intake bend (2) onto studs and install hex head bolt (4).
- c. Carefully place gasket (3) in position on face of bend, lining up bolt holes.
- d. Attach air cleaner housing (5) over three studs (6). Make sure gasket is still in position and install three nuts (7) onto studs.
- e. Tighten three nuts (7) securely and air intake bend securing bolt (4).



## 4-19. REPLACE/INSPECT/REPAIR RECOIL STARTER ASSEMBLY

This task covers:      a) Removal              c) Repair  
                                 b) Inspection          d) Installation

### INITIAL SETUP

Tools	Materials/Parts
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)	Automotive grease (Item 5, Appendix E, Section II)
Shop Equipment, Automotive Maintenance and Repair: Unit Maintenance, Common No. 1 (Item 3, Appendix B, Section III)	<b>Equipment Condition Para</b>
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)	3-16      Inlet air sound enclosure assembly removed.

### REMOVAL:

- a. Push the decompression lever down to the start position.
- b. Pull the rope T-handle slowly, turning the crankshaft until approximately two feet of pull rope is exposed.
- c. Grasp the rope firmly and pull the knot approximately six inches out of the T-handle.

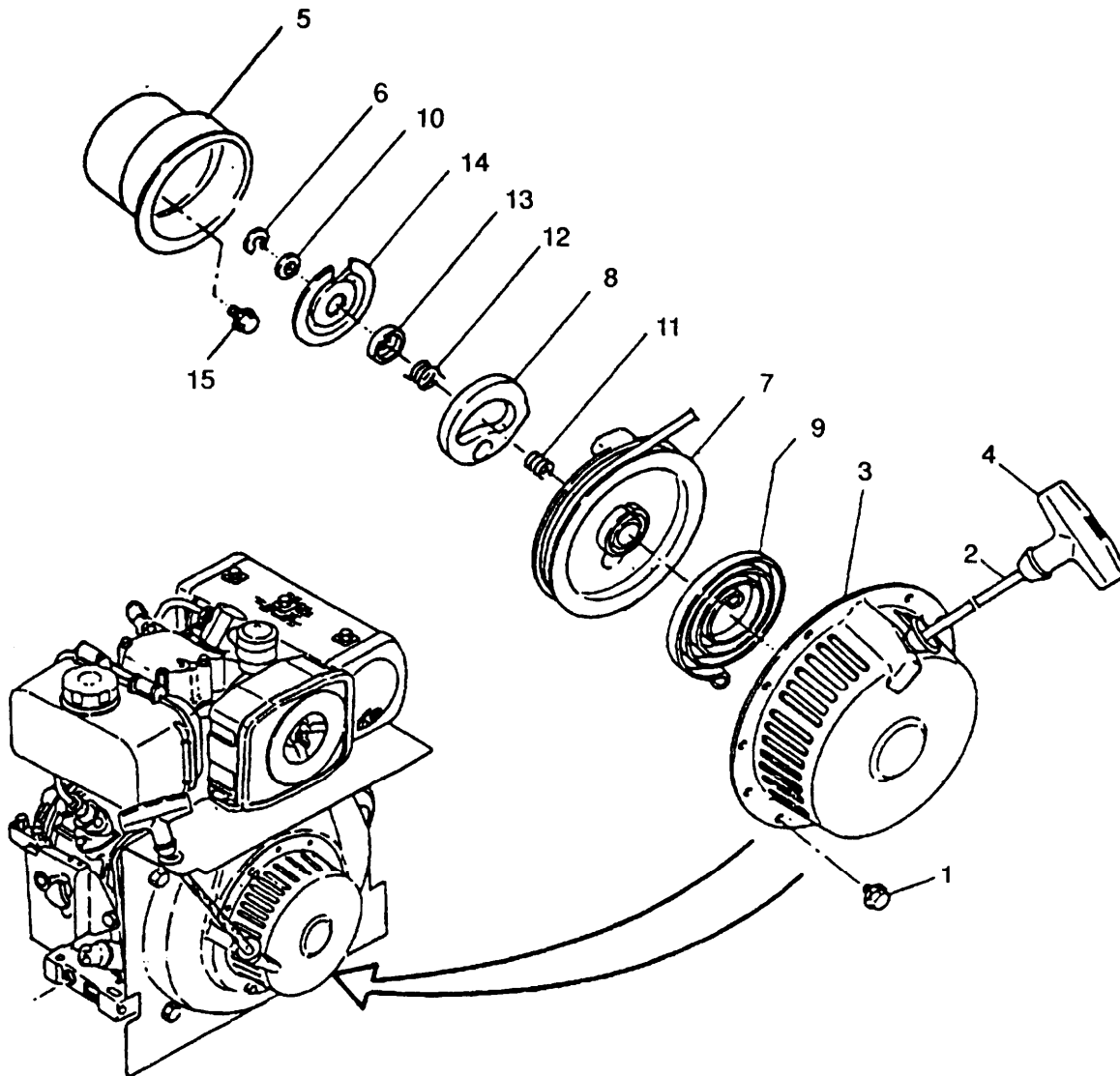
### NOTE

**With knot untied do not allow rope to rewind Into the starter assembly.**

- d. Untie the knot.
- e. Pass the rope through the baffle grommet. Slip the T-handle onto the rope and retie the knot.
- f. Allow the rope to rewind until the T-handle seats on the starter case.
- g. Remove four bolts (1).
- h. Remove the recoil starter assembly as a self-contained unit.

### INSPECTION:

- a. Pull the rope. It should pull easily with no binding.
- b. Observe the drive mechanism. The cam that engages the flywheel cap should extend freely.
- c. Allow the rope to retract. The engaging mechanism should retract.



**Figure 4-18. Recoil Starter Removal**

**REPAIR:**

**a. Disassembly**

- (1) Remove retaining dip (6). Apply slight pressure to keep springs from popping up.
- (2) Remove flat washer (10). Mark face of friction plate (14) to indicate spring position. Remove friction plate (14).
- (3) Remove return spring (12), spring cover (13), and friction spring (11).
- (4) Mark ratchet cam (8) to indicate front face. Remove ratchet cam (8).
- (5) Pull the rope T-handle until approximately one foot of pull rope is exposed.
- (6) Grasp the rope firmly and push the knot approximately six inches out of the T-handle.
- (7) Untie the knot.

- (8) Remove T-handle (4), but keep the end of the rope (2) in hand.
- (9) Release spring tension beholding the raised plastic cup of reel (7), and carefully letting the rope feed into the reel for about 2-1/2 turns.
- (10) Remove plastic reel (7).



**When spring is removed it will expand suddenly. Do not remove recoil spring unless replacement is necessary.**

- (11) Carefully remove recoil spring (9) if necessary.

**b. Assembly**

- (1) Install plastic reel (7) onto the cover spindle. Make sure that the spring end will catch in the reel hub slot.



**If the ratchet cam is assembled backwards, the drive mechanism will not operate.**

**NOTE**

**Follow the matings and layout sequence made during disassembly. The tang of the ratchet cam should be positioned so it points to the 3 o'clock position from the knot on the reel.**

- (2) Install ratchet cam (8) onto spindle and reel (7).
- (3) Install spring cover (13) and friction spring (11).
- (4) Position return spring (12) in the marked hole of friction plate (1 4). Install return spring and friction plate on the spindle. Verify that the spring end goes into the hole on ratchet cam (8).
- (5) Apply pressure to friction plate (14) and install flat washer (10) and retaining dip (6) on spindle.
- (6) Feed the end of rope (2) up through the square slot in plastic reel (7). Make one complete revolution of the reel to tension recoiling spring, and feed rope through cover (3).
- (7) Make a temporary knot in the rope.
- (8) Check the recoil starter operation before installing it on the engine.

**c. Replace Recall Spring**

- (1) Coil new spring (9) before installation so it will fit inside four raised lips of cover (3).
- (2) Form a 1/2 to 3/4 circle in the outside end of the new spring and pushdown into the slotted cover lip. Continue feeding the spring into smaller circles until the entire spring is lodged between the four cover lips. It will take some care and effort to prevent spring from uncoiling.
- (3) Position plastic reel (7) on the cover spindle. Remove the reel and bend inside spring end approximately the same distance as the hub slot.

(4) Position plastic reel (7) again on the cover spindle and verify spring end will catch in the reel hub slot.

(5) Lubricate spring sparingly with silicon grease.

**d. Replace Recall Starter Rope**

**NOTE**

- **It is not necessary to disassemble the mechanism to replace the rope.**
- **It is a good Idea to replace the starter rope whenever another component of recoil starter Is replaced. If the starter rope is frayed or worn, replace it.**

- (1) Use the appropriate replacement nylon-braided rope.
- (2) To replace the rope, pull the rope out all the way with a slow firm pull.
- (3) Prevent plastic reel (7) from rewinding by bracing the raised plastic cup on the reel with a screwdriver.
- (4) Untie or cut the knot in the raised plastic cup on the reel and slide the old rope out.
- (5) If the old rope has broken, wind the plastic reel completely, then release one complete turn before installing new rope. This protects the spring from being overwound when the rope is pulled.
- (6) Select new rope. Singe both ends of the nylon rope with a match flame to prevent fraying.
- (7) Tie a knot in the rope and feed through plastic reel (7). Use a paper clip or a small piece of wire hooked in the end of rope to thread through the holes.
- (8) Attach T-handle (2). Pull enough rope through the handle and make a knot.
- (9) Remove bracing screwdriver and let reel rewind rope slowly.
- (10) Check the starter for proper operation before installing the starter on the engine.

**INSTALLATION:**

- a. Check the recoil starter for operation before installing it on the engine.
- b. Position the recoil starter assembly on the cooling case cover. Push the cam back into the assembly if it is extended.
- c. Install four bolts (1).
- d. Untie the temporary knot in the rope and feed the rope through the baffle grommet.
- e. If a new rope was installed, singe the end of the rope with a match flame to prevent fraying.
- f. Install T-handle on the rope. Thread enough rope through the T-handle to make a knot.
- g. Tie a knot in the rope and pull it against the hole in the T-handle. Stuff excess rope into the T-handle slot.
- h. Check recoil starter for operation on the engine.

## 4-20. REPLACE/INSPECT FLYWHEEL COOLING CASE COVER

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

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (item 6, Appendix B, Section III)

#### Equipment Condition

3-16 Inlet air sound enclosure assembly removed.

3-16 Outlet air sound enclosure assembly removed.

#### Materials/Parts

None

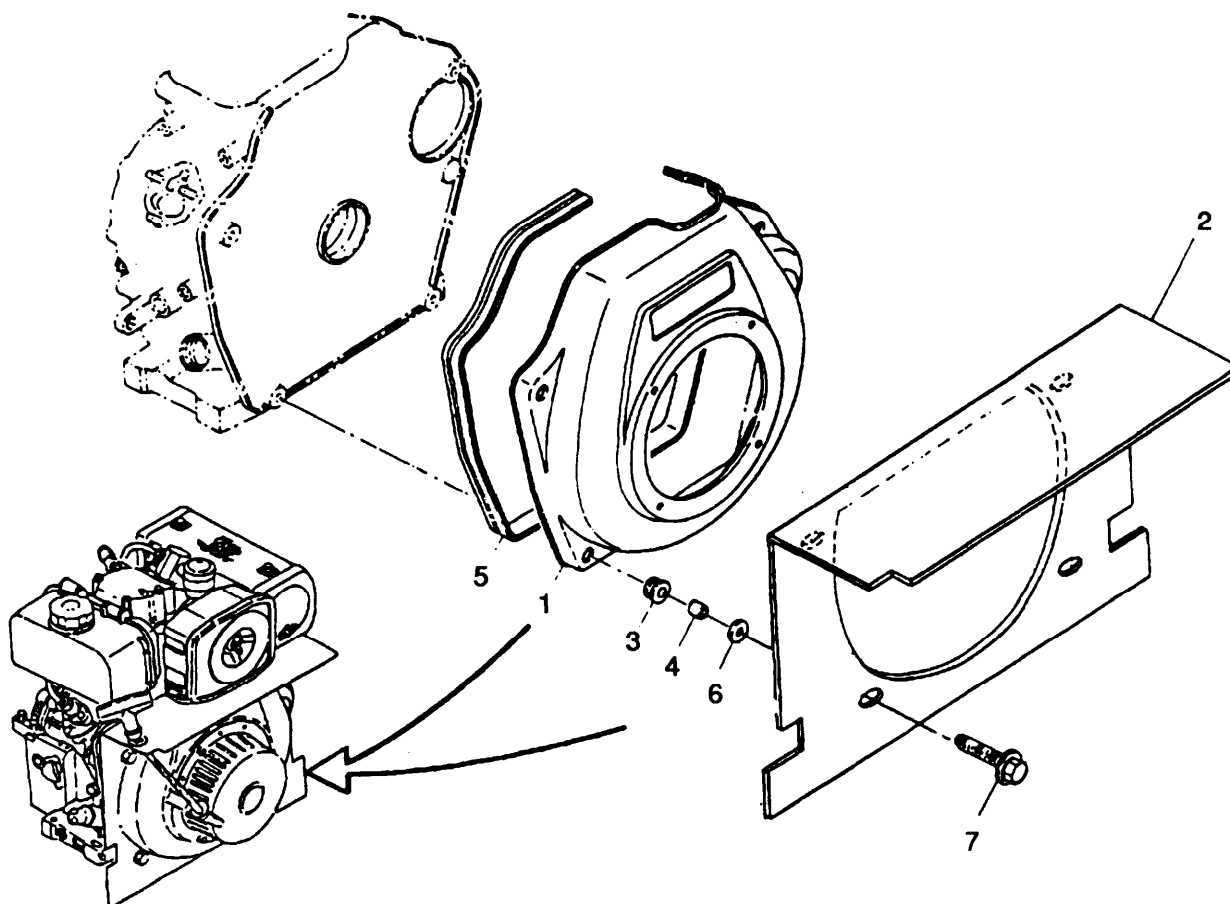


Figure 4-19. Replacing Cooling Case Cover

**REMOVAL:**

- a. Remove four bolts (7) attaching cooling case cover (1) to engine.
- b. Remove air flow baffle (2) and cooling base cover (1).

**INSPECTION:**

- a. Inspect cooling case cover seal (5) for damage. Replace if damaged.
- b. Inspect air flow baffle (2) for damage. Replace if damaged.

**INSTALLATION:**

- a. Place cooling case cover (1) onto engine with seal (5).
- b. Place air flow baffle (2) onto engine.
- c. Attach cooling case cover and air flow baffle onto engine with four bolts (7).

## 4-21. REPLACE/INSPECT/SERVICE LUBE OIL STRAINER

This task covers:      a) Removal                      c) Inspection  
                                     b) Service                      d) Installation

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)  
Socket Set, 8 to 19 mm (Item 6,  
Appendix B, Section III)

#### Equipment Condition Para

3-16      Outlet air sound enclosure assembly  
            removed.

4-11      Volute removed.

#### Materials/Parts

Diesel fuel (Item 4, Appendix E,  
Section II)

4-12      Impeller, shaft seal, and shaft  
            adapter removed.

4-13      Wear plate removed.

4-14      Pump casing removed from engine.

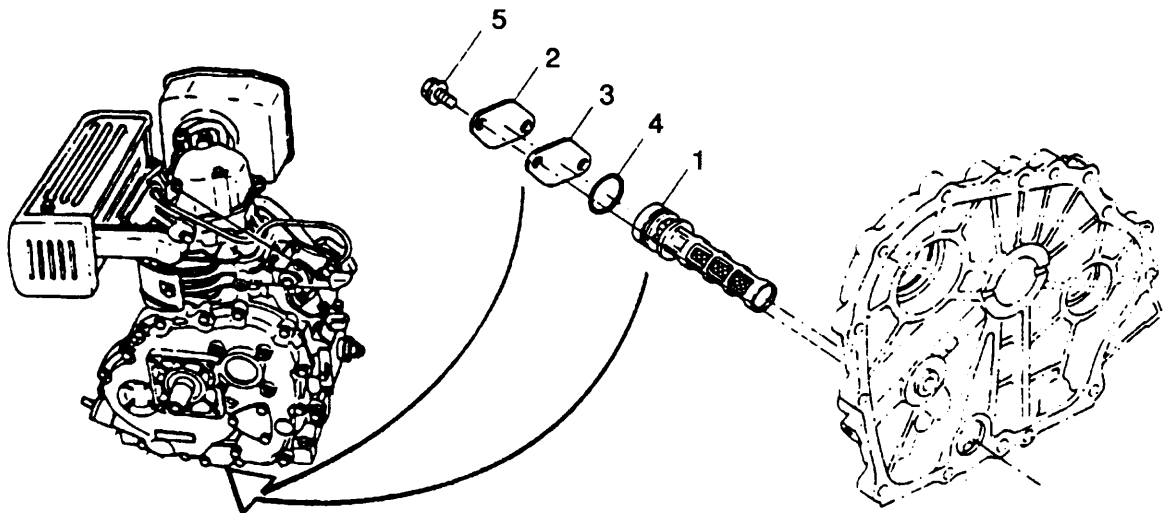


Figure 4-20. Replacing Lube Oil Strainer

#### REMOVAL:

- a. Remove two hex head bolts (5) from crankcase cover.
- b. Remove lube oil strainer cover (2) and gasket (3).
- c. Remove strainer (1) and O-ring (4) from groove in end of strainer.

#### SERVICE:

- a. Thoroughly dean strainer in fuel.

- b. Shake dry and rinse thoroughly again in clean fuel.
- c. Continue until all dirt has been removed from the strainer.
- d. Dry thoroughly to remove fuel.
- e. If strainer cannot be completely cleaned, then it should be replaced.

**INSPECTION:**

- a. Check for splitting or cracking of O-ring (4).
- b. Check gasket (3) for damage.
- c. Examine strainer for damaged mesh, hardened deposits, or other damage.

**INSTALLATION:**

- a. Grease O-ring (4) and insert into groove on end of lube oil strainer(l).
- b. Insert lube oil strainer (1) into hole in crankcase cover.
- c. Install lube oil strainer gasket (3) after coating with oil and position with cover (2) so that holes lineup with holes on crankcase cover.
- d. Secure cover with two hex head bolts (5). Tighten securely.



---

## 4-22. REPLACE FRAME ASSEMBLY, BASE PLATE, AND SHOCK MOUNTS

---

This task covers:      a) Removal              b) Installation

---

### INITIAL SETUP

Tools	Equipment Condition	Para
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)		
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
	3-16	Outlet air sound enclosure assembly removed.
Materials/Parts		
None		

### REMOVAL:

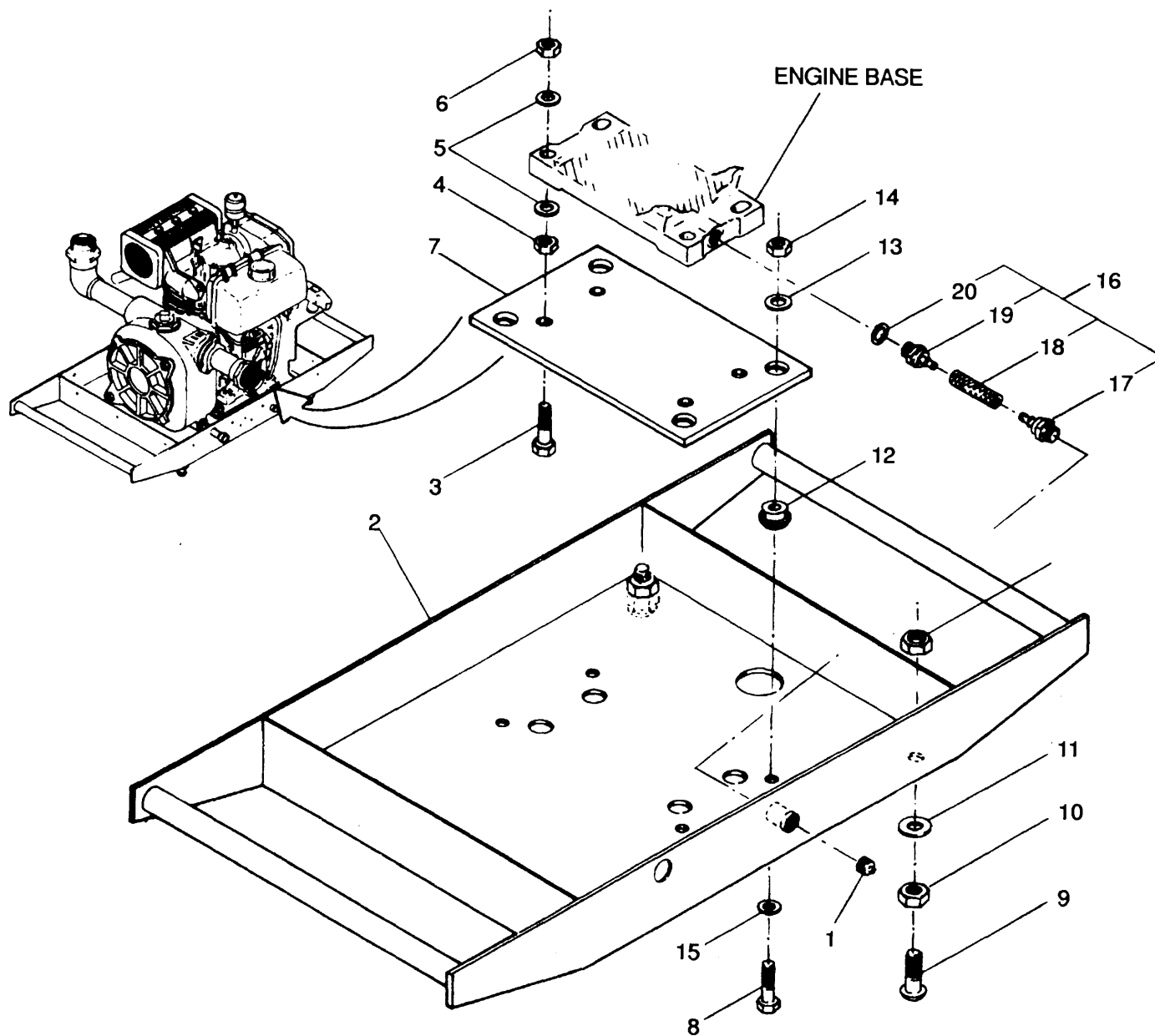
- a. Remove oil drain plug (1) and drain engine oil.
- b. Remove oil drain hose assembly (16) from coupling on frame.
- c. Remove four nuts (14) and washers (13).
- d. Remove engine mounting base plate (7) and engine from frame (2).
- e. Remove four nuts (6) and four washers (5) attaching engine to engine base plate (7).
- f. Remove engine from engine base plate.
- g. Inspect and replace damaged shock mounts (12).
- h. Remove four hex head bolts (8) and flat washers (15) from frame (2).
- i. Remove four spacer nuts (4), four hex head bolts (3), and four washers (5) from engine base plate (7).
- j. Remove four mounting feet bolts (9), spacer nuts (10), washers (11) and nuts (10) from frame (2).

### NOTE

**Never replace one shock mount. If one shock mount requires changing, then all four shock mounts must be changed.**

### INSTALLATION:

- a. Attach four mounting feet bolts (9), nuts (10), and washers (11) to frame assembly (2).
- b. Replace damaged shock mounts (12).
- c. Install four hex head bolts (3), four spacer nuts (4), and four washers (5) to engine mounting plate (7).
- d. Mount engine to engine base plate and secure with four washers (5) and four nuts (6).
- e. Install four hex head bolts (8) and washers (15) from the bottom into frame (2).



**Figure 4-21. Engine Mounting Assembly**

- f. If oil drain hose (18) is bad, remove hose from fittings (17 and 19) and place new hose onto fittings.
- g. Install oil drain hose assembly (16) to engine oil drain.
- h. Mount engine base plate and engine to the frame using four washers (13) and nuts (14).
- i. Attach oil drain hose assembly (16) to coupling in frame.
- j. Install oil drain plug (1). Fill with engine oil and check for leaks.

## CHAPTER 5

### GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

#### 5-1. INTRODUCTION

This chapter of the technical manual provides intermediate maintenance instructions for general support maintenance personnel. It provides the maintenance procedures to service, repair, remove, disassemble, inspect, reassemble, install, or adjust the faulty component of the Diesel-Driven Centrifugal Pump Assembly Model PAD - 125A. Chapter 5 is divided into two sections, Section I Troubleshooting, and Section II Maintenance Procedures.

---

#### Section I. TROUBLESHOOTING

No troubleshooting procedures are required.

#### Section II. MAINTENANCE PROCEDURES

##### INDEX

Para	Para
General Instructions . . . . . 5-2	Replace/Inspect Balancer Shaft . . . . . 5-8
Adjust/Repair Fuel Injection Nozzle . . . . . 5-3	Replace/Inspect Governor and Speed Control Device . . . . . 5-9
Replace/Inspect/Repair Cylinder Head and Valve Assembly . . . . . 5-4	Replace/Inspect Connecting Rod . . . . . 5-10
Replace/Inspect/Repair Crankcase Cover . . . . . 5-5	Replace/Inspect Piston . . . . . 5-11
Replace/Inspect/Repair Lube Oil Pump . . . . 5-6	Replace flywheel . . . . . 5-12
Replace/Inspect Camshaft. . . . . 5-7	Replace/Inspect/Repair Crankshaft . . . . . 5-13
	Replace/Inspect/Repair Crankcase . . . . . 5-14

#### 5-2. GENERAL INSTRUCTIONS

- a. Unless otherwise stated, one person can perform the task listed.
- b. The normal standard equipment condition to start a maintenance task is engine stopped.
- c. Refer to Appendix F to determine torque requirements when tightening threaded fasteners, unless a specific torque value is given in the procedure. Torque values in Appendix F are determined by thread size.

---

### 5-3. ADJUST/REPAIR FUEL INJECTION NOZZLE

---

This task covers:      a) Adjust                      b) Repair

---

#### INITIAL SETUP

<b>Tools</b>		<b>Materials/Parts</b>	
Nozzle Tester and Injection Timing Measurement Pipe (Item 27, Appendix B, Section III)		None	
		<b>Equipment Condition</b>	
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)		<b>Para</b>	
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)		3-16	Inlet air sound enclosure assembly removed.
Wrench, 17 mm (Item 14, Appendix B, Section III)		3-16	Outlet air sound enclosure assembly removed.
Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)		3-20	Fuel injection pipe removed from engine.
		4-16	Fuel injection nozzle removed from engine.

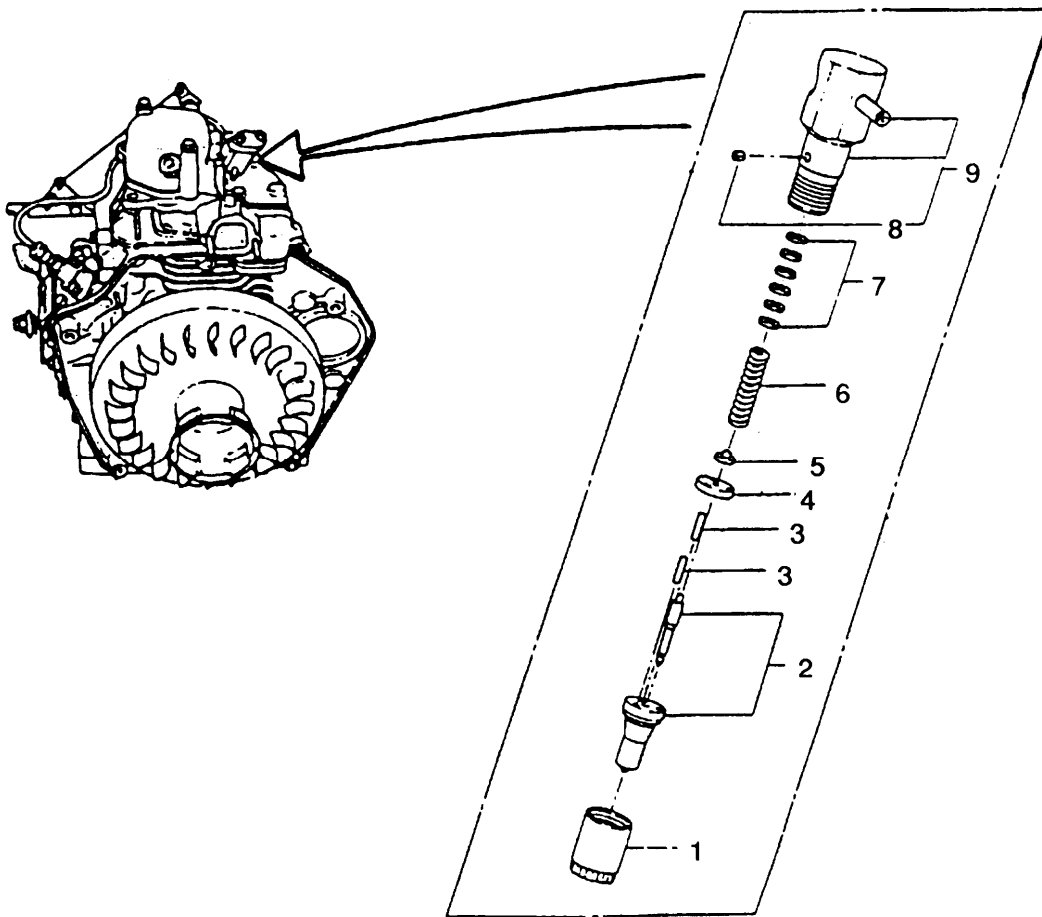
#### ADJUST:

- a. Use nozzle tester to check injection starting pressure.
- b. The injection starting pressure should be 2844 psig (200 kg/sq cm).
- c. Nozzle injection starting pressure adjustment is accomplished by increasing or decreasing the number of adjusting shims (7).
- d. Adjustment by 0.039 inch (1.0 mm) results in a change in the injection starting pressure of about 284 psig.
- e. Adjusting shims can be obtained in the following sizes.
 

0.004 inch (0.10 mm)	0.005 inch (0.15 mm)
0.015 inch (0.40 mm)	0.019 inch (0.50 mm)
0.024 inch (0.60 mm)	0.027 inch (0.70 mm)
0.031 inch (0.80 mm)	
- f. Standard adjusting shim thickness should be approximately 0.023-0.025 inch (0.60-0.65 mm).

#### REPAIR:

- a. **Disassembly of Fuel Injection Nozzle**
  - (1) Remove case nut (1).
  - (2) Remove fuel injection nozzle body and valve (2).
  - (3) Remove stop plate (4).
  - (4) Remove nozzle positioning pins (3) from nozzle body (2).



**Figure 5-1. Fuel Injection Nozzle Repair**

- |                         |                          |
|-------------------------|--------------------------|
| 1 Case Nut              | 6 Nozzle Spring          |
| 2 Fuel Injection Nozzle | 7 Shim Pack              |
| 3 Pin                   | 8 Spring Pin             |
| 4 Stop Plate            | 9 Nozzle Holder Assembly |
| 5 Spring Retainer       |                          |

(5) Remove spring retainer (5).

(6) Remove nozzle spring (6).

**NOTE**

**Take care to note the number of shims used in the fuel injection nozzle. The number of shims determines the fuel injection pressure. Refer to Adjustment section if nozzle pressure is incorrect.**

(7) Remove shim pack (7).

**NOTE**

**The fuel injection valve positioning pin (8) does not need to be removed in most cases.**

(8) Remove fuel injection valve positioning pin (8) from nozzle holder (9).

**b. Reassembly of Fuel Injection Nozzle**

(1) Insert fuel injection valve positioning pin (8) into nozzle holder (9) if pin was removed.

(2) Insert adjusting shims (7) into fuel injection nozzle holder (9).

(3) Install nozzle spring (6) into nozzle holder (9).

(4) Install spring retainer (5) onto nozzle spring (6).

(5) Insert nozzle positioning pins (3) into fuel injection nozzle body and valve (2).

(6) Install stop plate (4) onto nozzle body and valve (2).

(7) Install nozzle body and valve (2) into nozzle holder (9) using case nut. Tighten case nut to 29-32 ft-lb (400-450 kg-cm).

## 5-4. REPLACE/INSPECT/REPAIR CYLINDER HEAD AND VALVE ASSEMBLY

This task covers:      a) Removal              c) Repair  
                                 b) Inspection          d) Installation

### INITIAL SETUP

#### Tools

Square, 6" Machinist (Item 5, Appendix B, Section III)

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)

Calipers, Vernier, 0" to 6" (Item 20, Appendix B, Section III)  
moved from

Fitting Tool, Valve Stem Seal (Item 26, Appendix B, Section III)

#### Materials/Parts

Crocus cloth (Item 1, Appendix E, Section II)

Diesel fuel (Item 4, Appendix E, Section II)

#### Equipment Condition Pars

3-14	Air cleaner removed.
3-18	Fuel tank removed from valve rocker arm cover.
3-21	Exhaust silencer/spark arrestor removed from cylinder head.
3-22	Valve rocker arm removed.
4-16	Fuel injection nozzle removed from cylinder head.
4-18	Air intake bend removed.

### REMOVAL:

- a. Remove rocker arm support bolt (15, Figure 5-2)
- b. Remove rocker arm support (7) with intake and exhaust valve rocker arms (10 and 13) attached.
- c. Remove retainer (5) and retainer keeper (6) from top of valve spring (4).
- d. Remove valve spring (4).
- e. Remove valve spring washer (9).
- f. Remove two nuts (1, Figure 5-3) and washers (2) from cylinder head studs.
- g. Remove two cylinder head nuts (3) and cylinder head washers (2) from cylinder head studs.
- h. Remove cylinder head assembly (4) by lifting straight up off the four cylinder head studs.
- i. Remove and discard push rod O-ring (6) and cylinder head gasket (5).

REF NO.	DESCRIPTION	QTY
1	Head Cylinder	1
2	Valve, Intake	1
3	Valve, Exhaust	1
4	Spring, Valve	2
5	Retainer	2
6	Retainer Keeper	2
7	Support, Rocker Arm	1
8	Seal, Valve Stem	2
9	Washer, Valve Spring	2
10	Arm Valve Rocker (Intake)	1
11	Screw, Valve Adjusting	2
12	Lock Nut	2
13	Arm, Valve Rocker (Exhaust)	1
14	Spring Pin, Valve	1
15	Bolt, M8 X 40	1
16	Stud, M8 X 18	2
17	Stud, M6 X 50	2
18	Stud, M6 X 55	2

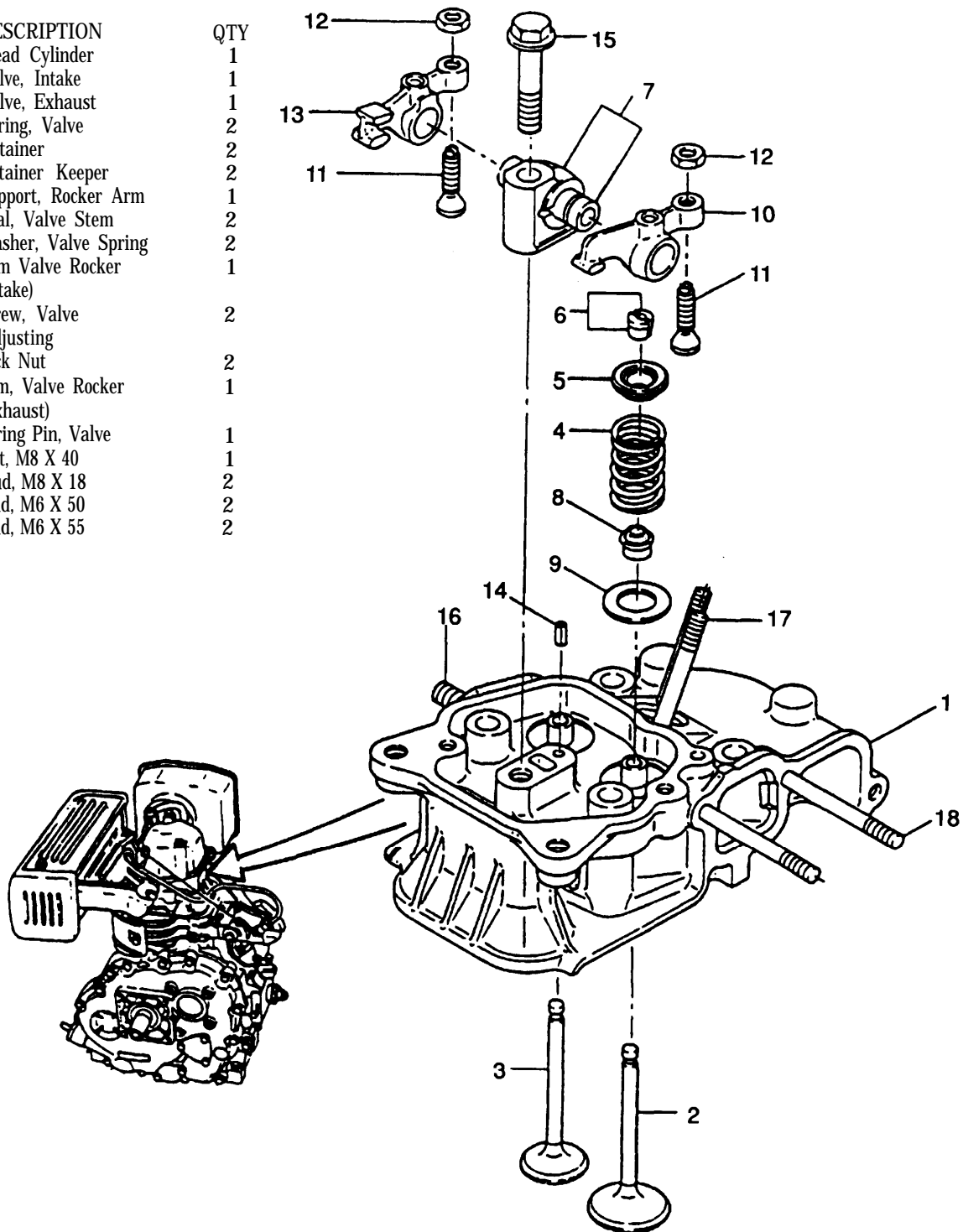
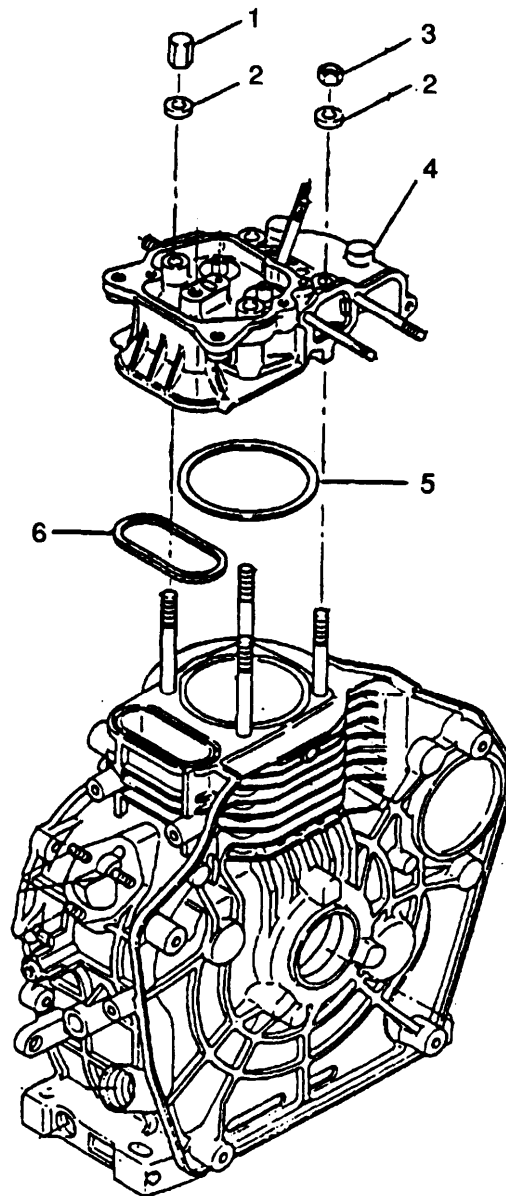


Figure 5-2. Cylinder Head Assembly





**Figure 5-3. Removing Cylinder Head**

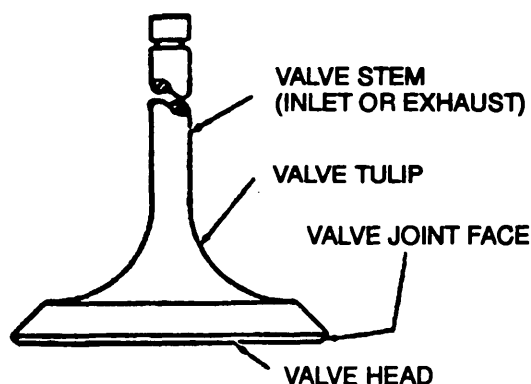
INSPECTION:



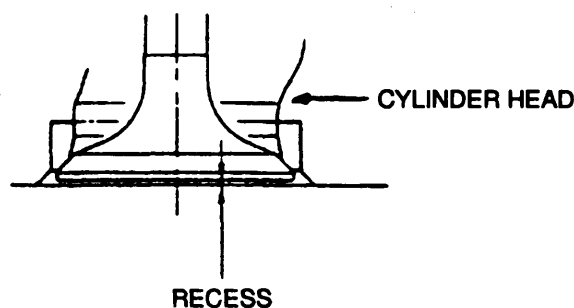
Death or serious injury could occur if compressed air is directed against skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 PSI or less. When working with compressed air always use eye protection and any other protective equipment.

**CAUTION**

- Do not confuse the Intake and exhaust valve stems.
  - The Intake/exhaust valve guides are provided with a valve stem seal. Valve stem seals cannot be reused and must be replaced with new ones.
  - When Inserting the Intake and exhaust valve stems, apply lube oil to the valve stems.
- a. Clean cylinder head and valves with a clean cloth dampened with diesel fuel. Use wire brush where necessary and dry with compressed air.
  - b. Inspect cylinder head for cracks, rust, corrosion, or excessive heat damage.
  - c. Inspect valve heads and valve stems for cracks, pitting, scratches, warpage, or any other damage.



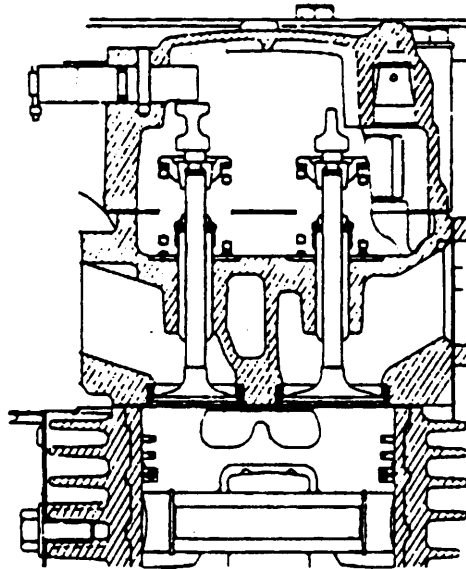
**Figure 5-4 Typical Valve**



**Figure 5-5 Valve Recess**

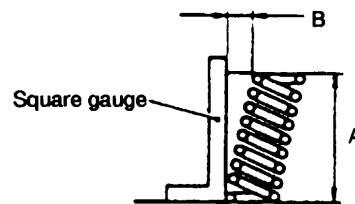
- d. Check that each valve stem diameter is greater than 0.2126 inch (5.40 mm).
- e. Check that each valve recess is less than 0.043 inch (1.1 mm).

- f. Check that the inside diameter of each valve guide does not exceed 0.2197 inch (5.58 mm).



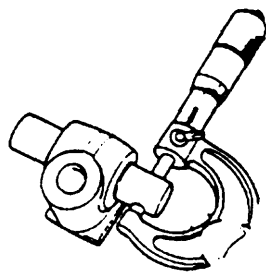
**Figure 5-6. Intake Exhaust Valve Assembly**

- g. Clean off carbon deposits on the valve seats since carbon buildup, excessive wear, and corrosion can cause compression leaks.
- h. Replace cylinder head if any of the following conditions exist:  
If cylinder block contact surface is roughened or not level; if the valve seats are worn; if the valve rocker arm cover contact surface is rough or damaged; or if there are cracks between the valve seats.
- i. Check the valve spring for flaw or corrosion.
- j. Check that the valve spring free length (dimension A) is less than 1.043 inches (26.5 mm).



**Figure 5-7. Spring Inclination**

- k. Check that the spring inclination (how far spring inclines to the left or right, dimension B) is less than 0.039 inch (1.0 mm).



**Figure 5-8. Measuring Valve Rocker Arm Support**

- l. Check that the OD of the valve rocker arm support shaft is at least 0.4685 inch (11.90 mm).
- m. Check that the ID of the valve rocker arm does not exceed 0.4764 inch (12.1 mm).
- n. Check for bending of the push rods. Maximum push rod distortion is 0.0118 inch (0.3 mm).
- o. Inspect and thoroughly clean the gasket and O-ring areas of cylinder head and crankcase.

**REPAIR:**

- a. Replace any valves (refer to 2 and 3, Figure 5-2) that show warpage, burning, or other damage.
- b. Replace any valves that are seriously scratched, scuffed, pitted, or cracked.
- c. Replace any valves that allow a valve recess greater than 0.043 inch (1.1 mm).
- d. Replace any valve with a stem diameter less than 0.2126 inch (5.40 mm).
- e. Remove slight scratches or scuff marks with crocus cloth.
- f. Press out valve guide using valve stem seal fitting tool.
- g. Insert new valve stem seal into cylinder head by pressing in with valve stem seal fitting tool.
- h. Replace valve spring (refer to 4, Figure 5-2) if any of the following are true.
  - (1) Valve spring is damaged.
  - (2) Valve spring free length is greater than 1.043 inches (26.5 mm).
  - (3) Valve spring inclination is greater than 0.039 inch (1.0 mm).
- i. Replace valve rocker arm support shaft (refer to 7, Figure 5-2) if shaft diameter is less than 0.4685 inch (11.90mm).
- j. Replace rocker arm (refer to 13, Figure 5-2) if ID exceeds 0.4764 inch (12.1 mm).
- k. Replace push rods if distortion exceeds 0.0118 inch (0.3 mm).

**INSTALLATION:**

- a. Place new cylinder head gasket (refer to 5, Figure 5-3) and push rod O-ring (refer to 6, Figure 5-3) onto cylinder block.
- b. Install cylinder head (refer to 4, Figure 5-3) onto four studs protruding from cylinder block.
- c. Secure cylinder head (refer to 4, Figure 5-3) to cylinder block using four nuts (refer to 1 and 3, Figure 5-3) with four washers (refer to 2, Figure 5-3)
- d. Tighten nuts using torque wrench to 20-23 ft-lb (280-320 kg-cm).
- e. Install valve spring washer (refer to 9, Figure 5-2)

- f. Install valve spring (refer to 4, Figure 5-2)
- g. Install retainer (refer to 5, Figure 5-2) and retainer keeper (refer to 6, Figure 5-2)

**NOTE**

**Ensure push rods have cup on top end to hold lubrication for valve adjusting screw engagement. (Some early engines have straight rods.)  
Replace both push rods and adjusting screws with new, if cups are not on the push rods.**

- h. Install push rods (with cup on top) into tappets.
- i. Install rocker arm support (refer to 7, Figure 5-2) with intake and exhaust valve rocker arms (refer to 10 and 13, Figure 5-2) attached.
- j. Tighten rocker arm support bolt (refer to 15, Figure 5-2) with torque wrench to 14-16 ft-lb (200-220 kg-cm).
- k. Adjust valve clearance as per ADJUSTMENT procedure in paragraph 3-22.

**5-5. REPLACE/INSPECT/REPAIR CRANKCASE COVER**

This task covers:      a) Removal              c) Repair  
                                  b) Inspection          d) Installation

**INITIAL SETUP**

**Tools**

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)  
  
 Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)  
  
 Hammer, Rubber Mallet (Item 17, Appendix B, Section III)  
  
 Fitting Tool, Oil Seal (item 21, Appendix B, Section III)  
  
 Guide, Oil Seal Fitting (item 22, Appendix B, Section III)  
  
 Square, 6" Machinist (item 5, Appendix B, Section III)  
  
 Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (item 4, Appendix B, Section III)

**Materials/Parts**

Lubricating oil (item 8, Appendix E, Section II)  
  
 Grease (Item 6, Appendix E, Section II)  
  
 Diesel fuel (Item 4, Appendix E, Section II)

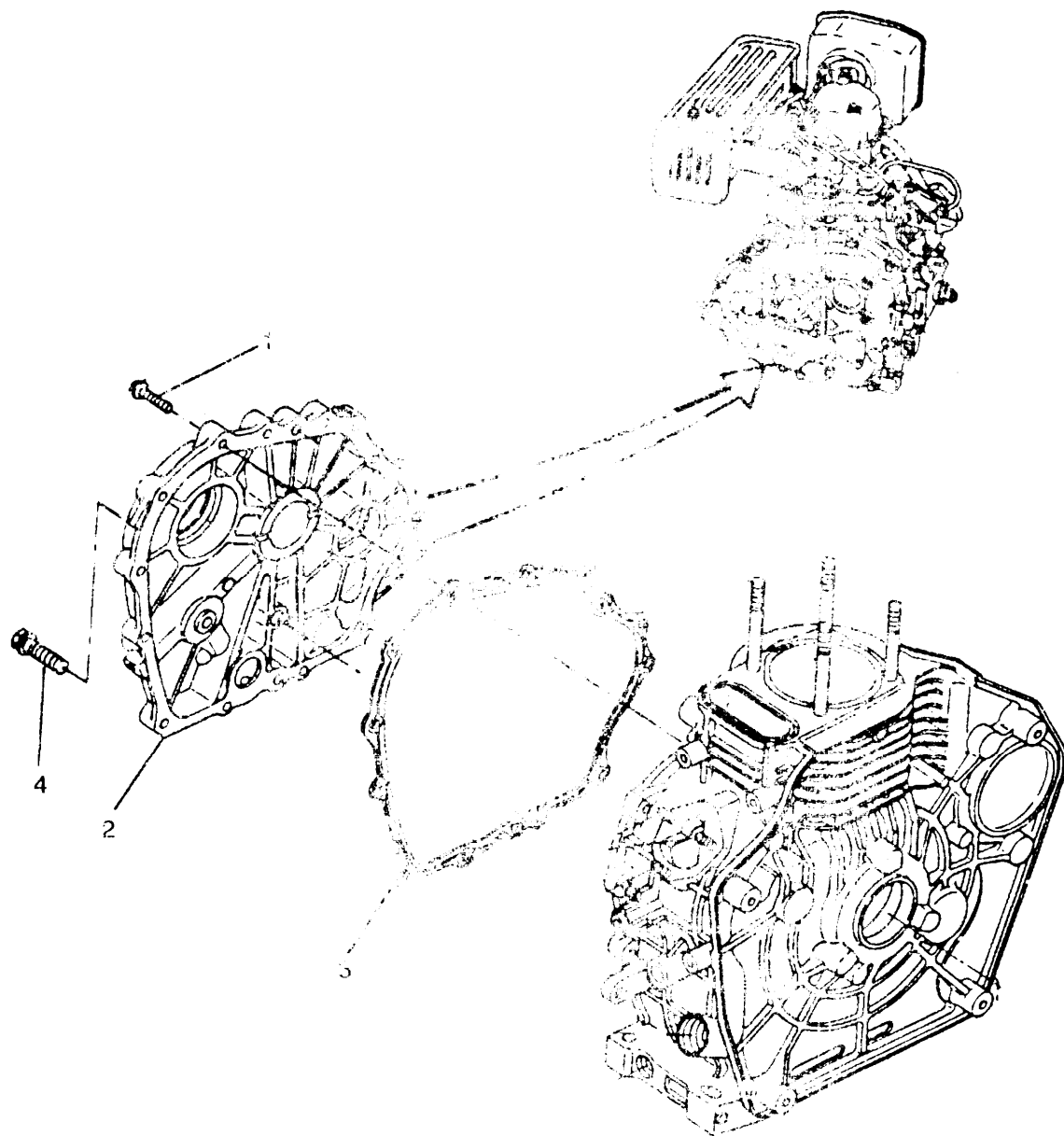
**Equipment  
Condition  
Para**

3-16	Inlet air sound enclosure assembly removed.
3-16	Outlet air sound enclosure assembly removed.
4-11	Volute removed.
4-12	Impeller, shaft seal, and shaft adapter removed.
4-13	Wear plate removed.
4-14	Pump casing removed from engine.

REMOVAL:

**CAUTION**

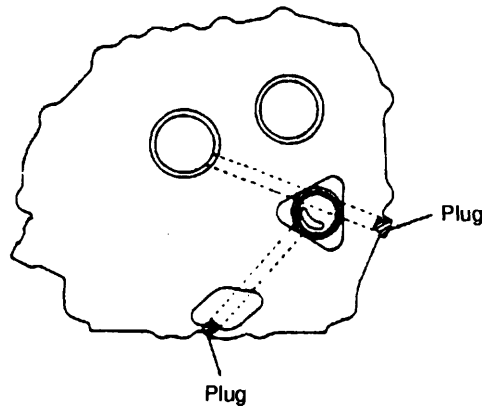
- Be careful not to damage oil seal.
  - Oil pump cover and oil filter cover do not have to be disassembled to remove crankcase cover and should only be disassembled when necessary.
- a. Remove 14 crankcase cover bolts (1).



**Figure 5-9. Replacing Crankcase Cover**

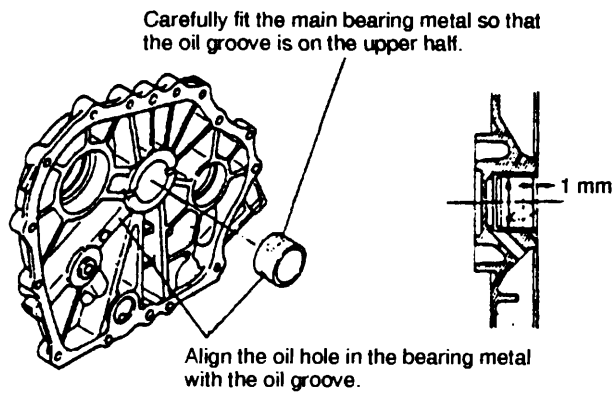
- b. Remove one additional crankcase cover bolt (4) located inside of the bolt pattern and above the lube oil strainer.
- c. Remove crankcase cover (2) and discard gasket (3).

**INSPECTION:**



**Figure 5-10. Crankcase Cover Oil Passages**

- a. Clean out each oil hole on the crankcase cover with diesel fuel. Make sure no oil passage is dogged. Leave plugs in place if they don't need to be replaced.



**Figure 5-11. Main Bearing Metal Insert**

- b. Check the main bearing metal insert on the crankcase side for discoloration or damage.

**REPAIR:**

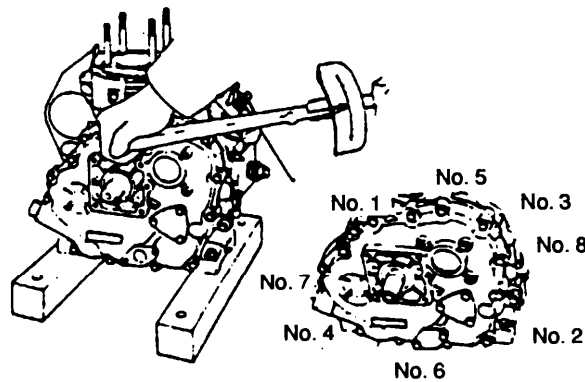
- a. Replace crankcase cover gasket (3).
- b. Replace crankshaft oil seal.
  - (1) Insert new crankshaft oil seal into crankcase cover using the oil seal fitting tool.
  - (2) Insert crankshaft seal into crankcase cover until it is 0.1575 inch (4 mm) deep from the end of crankcase.
- c. Replace the main bearing metal insert if it is discolored or damaged.
  - (1) Remove bad main bearing metal insert.
  - (2) Insert main bearing into crankcase cover. Carefully fit the main bearing so that the oil groove is in the upper half and the oil hole in the bearing is aligned with the oil groove.



- (3) Press fit the main bearing until recess is 0.0039 inch (1 mm) past the cover edge.
- d. Replace the camshaft ball bearing or the balance shaft ball bearing.
  - (1) Remove bad bearing using the mechanical bearing puller.
  - (2) Press fit the new ball bearing into the crankcase cover.

INSTALLATION:

- a. Place a crankcase cover gasket (3) between the surface of the crankcase and the crankcase cover.
- b. Apply grease to the lips of oil seal.
- c. Apply lubricating oil to crankshaft and camshaft.
- d. Make sure that the oil pump drive gears are properly engaged.
- e. To protect the oil seal, attach the oil seal fitting guide for inserting the oil seal to the shaft prior to insertion.
- f. Attach crankcase cover (2) to the cylinder block using 14 bolts (1) plus additional bolts (4) located above the lube oil strainer.



**Figure 5-12. lightening Sequence for Crankcase Cover Sorts**

- g. Tighten all bolts in sequence shown above and torque to 6-8 ft-lb (83-110 kg-cm).

5-6. REPLACE/INSPECT/REPAIR LUBE OIL PUMP

This task covers:     a) Removal           c) Repair  
                          b) Inspection       d) Installation

INITIAL SETUP

Tools	Equipment Condition Para	
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)		
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
	3-16	Outlet air sound enclosure assembly removed.
Calipers, Vernier, 0" to 6" (Item 20, Appendix B, Section III)	4-11	Volute removed.
Materials/Parts	4-12	Impeller, shaft seal, and shaft adapter removed.
	4-13	Wear plate removed.
	4-14	Pump casing removed from engine.

NOTE

This engine adopts a forced oil lubrication system driven by a trochoid pump. Lubricating oil is circuited as follows: Lubricating oil filter to trochoid pump to crankshaft bearing insert to crankpinn bearing insert. The rocker arm chamber is lubricated by lube oil vapors. Figure 5-13 shows the lubricating oil route.

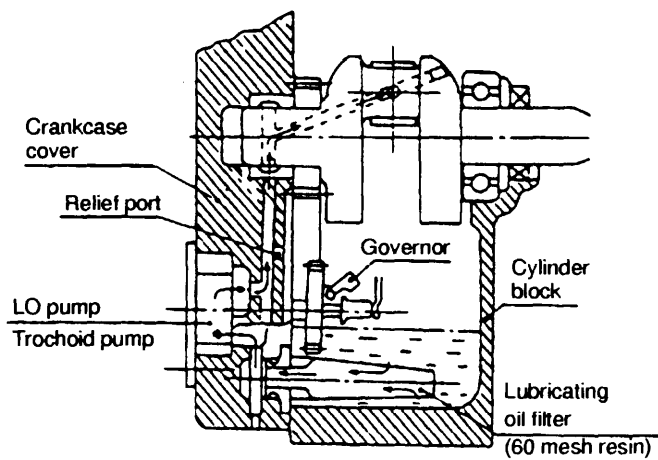
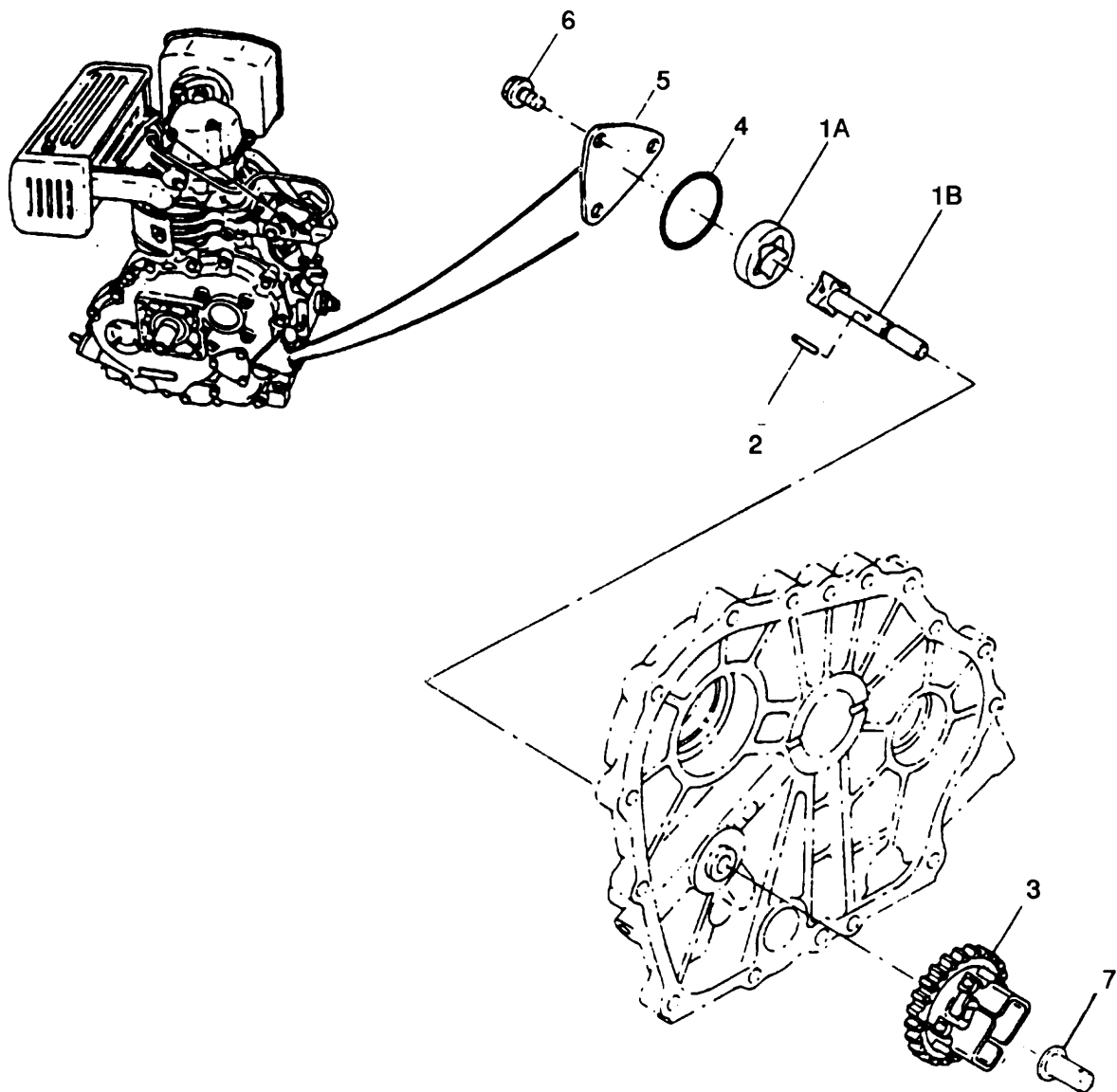


Figure 5-13. Lubricating Oil Route



**Figure 5-14. Lube Oil Pump Assembly**

**REMOVAL:**

- Remove three lube oil pump cover bolts (6) holding lube oil pump cover (5).
- Remove lube oil pump cover (5).
- Remove O-ring (4).
- Lay crankcase cover on dean, flat surface.
- Grasp hold of the plastic gear and carefully pull spindle (7) and governor gear (3) from lube oil pump shaft (1 B) and outer rotor (1A).

- f. Remove parallel pin (2).
- g. Remove lube oil pump shaft (1B) and outer rotor (1A) from crankcase cover.

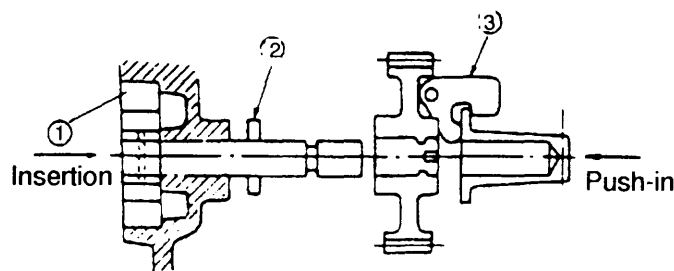
**INSPECTION:**

- a. Clean lube oil pump parts with diesel fuel.
- b. Check that the outside diameter of the outer rotor (1A) is at least 1.138 inches (28.90 mm).
- c. Check that the crankcase cover housing inside diameter is less than 1.149 inches (29.18 mm).
- d. Check that the clearance between housing ID and outer rotor OD is between 0.005-0.011 inch (0.120-0.280 mm).
- e. Check that outer rotor and inner rotor width is at least 0.311 inch (7.90 mm).
- f. Check that the crankcase cover housing depth is less than 0.319 inch (8.10 mm).
- g. Check that the clearance between the inner and outer rotor is less than 0.010 inch (0.25 mm).

**REPAIR:**

- a. Replace lube oil pump if the OD of the outer rotor is less than 1.138 inches (28.9 mm).
- b. Replace crankcase cover if the housing ID is greater than 1.149 inches (29.18 mm).
- c. Replace the lube oil pump if the clearance between housing ID and outer rotor OD is greater than 0.011 inch (0.280 mm).
- d. Replace lube oil pump if the outer and inner rotor width is less than 0.311 inch (7.9 mm).
- e. Replace crankcase cover if the housing depth is greater than 0.319 inch (8.1 mm).
- f. Replace lube oil pump if the clearance between the inner and outer rotor is less than 0.010 inch (0.25 mm).

**INSTALLATION:**



**Figure 5-15. Installation of Lubricating Oil Pump**

- a. Insert lubricating oil pump assembly (1) from the outside of the crankcase cover. Coat the rotor with oil before installing the cover.
- b. Insert parallel pin (2) into the lubricating oil pump shaft (1B). (Refer to Figure 5-14)
- c. Insert spindle (7) (refer to Figure 5-14) into the weight on governor gear (3), then push the spindle onto the shaft. Ensure that gear is firmly inserted onto pin (2).

## 5-7. REPLACE/INSPECT CAMSHAFT

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

### INITIAL SETUP

#### Tools

Calipers, Vernier, 0" to 6" (Item 20, Appendix B, Section III).

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)

#### Materials/Parts

Diesel fuel (Item 4, Appendix E, Section II)

#### Equipment Condition Para

3-16	Inlet air sound enclosure assembly removed.
3-16	Outlet air sound enclosure assembly removed.
4-11	Volute removed.
4-12	Impeller, shaft seal, and shaft adapter removed.
4-13	Wear plate removed.
4-14	Pump casing removed.
4-17	Fuel injection pump removed.
5-4	Cylinder head and valve assembly removed.
5-5	Crankcase cover removed.

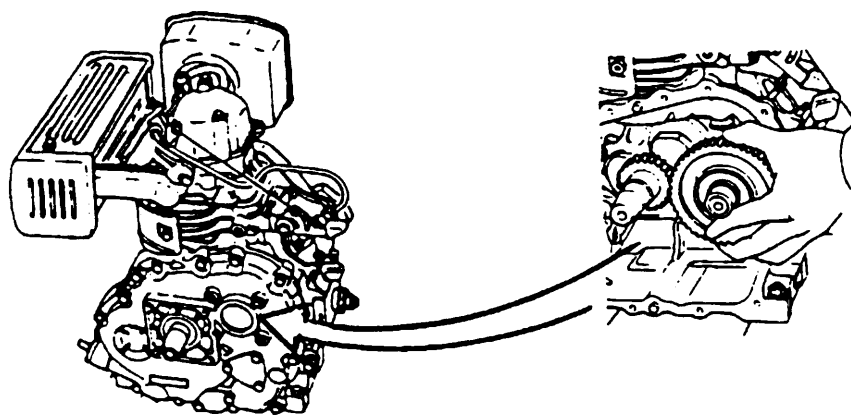


Figure 5-16. Removing the Camshaft

REMOVAL:

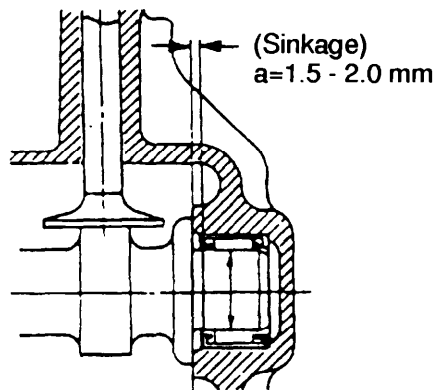
**CAUTION**

**Keep exhaust and intake tappets separate. They may fall down when pulling out the camshaft and may be confused.**

- a. Check the location of the timing marks on all gears.
- b. Lay engine down on the flywheel side to prevent tappets from falling out.
- c. Pull out the camshaft.

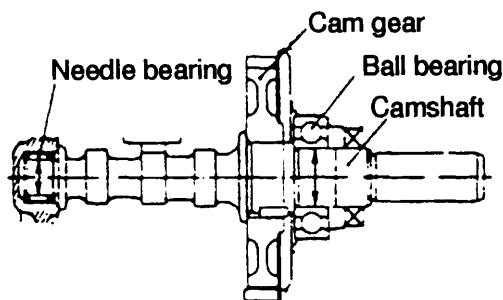
INSPECTION/REPLACEMENT

- a. Clean camshaft with diesel fuel.
- b. Inspect all components for damage or excessive wear. Replace any components severely damaged or worn.



**Figure 5-17. Recess of Needle Bearing**

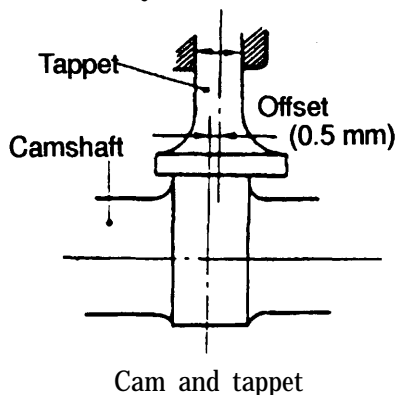
- c. Check the clearance at the thrust of the camshaft (cylinder block side). The camshaft bearing has been press-fitted into the cylinder block. Maintain the recess between the press-fitted bearing face and the thrust surface of cylinder block at 0.059-0.079 inch (1.5-2.0 mm).
- d. Check the OD of the camshaft on the needle bearing/cylinder block side. OD of camshaft must be at least 0.587 inches (14.92 mm). Replace camshaft if OD is under the wear limit.
- e. Check the OD of the camshaft on the ball bearing/crankcase cover side. OD of camshaft must be at least 0.981 inch (24.90 mm). Replace camshaft if OD is under the wear limit.
- f. Check that the ID of the ball bearing on the crankcase cover side is greater than 0.984 inch (24.98 mm). Replace ball bearing if it exceeds the wear limit or is damaged.
- g. Check the condition of the tappet contact point. The tappet is offset with regard to the cam center and rotated during operation to prevent excess wear. Replace the tappet if it is badly worn or contacts the cam improperly.



**Figure 5-18. Camshaft Bearings**

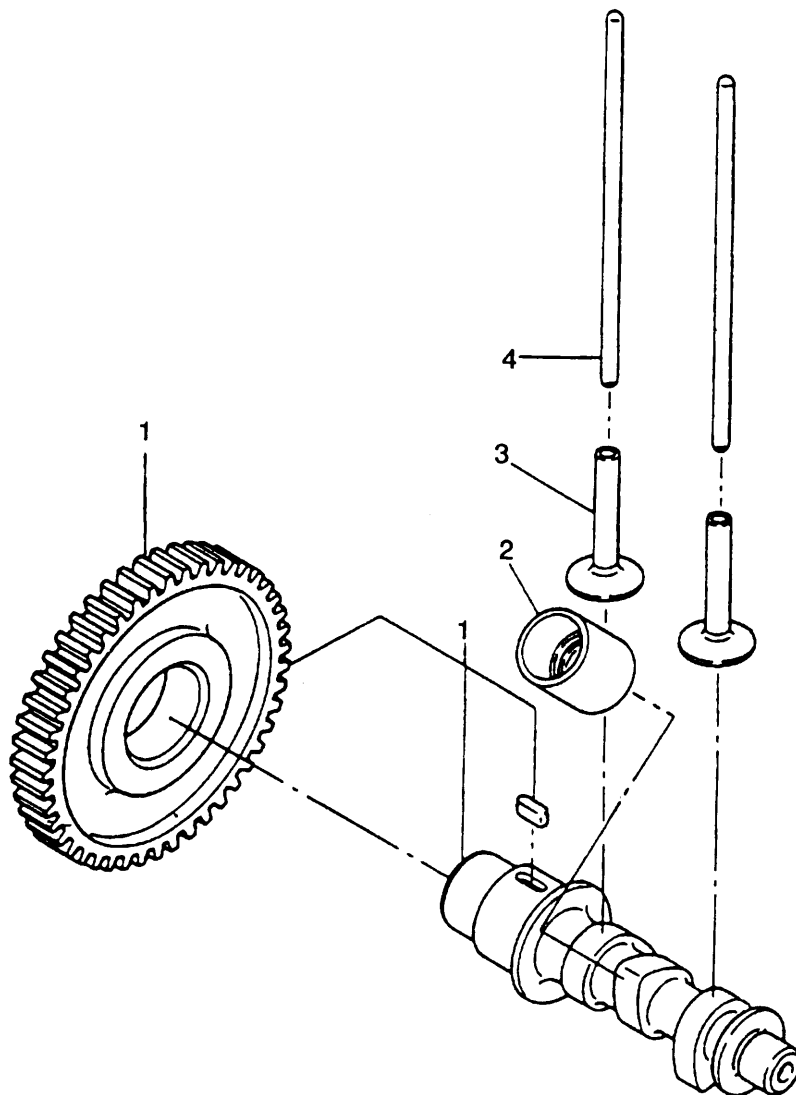
**CAUTION**

Keep the intake and exhaust tappets separate and return into same location at reassembly.



**Figure 5-19. Cam and Tappet**

- h. Check the outer surface of the tappet for wear and damage. Replace if defective.
- i. Check that the tappet stem OD for the intake and exhaust valves is greater than 0.271 inch (6.87 mm). Replace tappet if the stem is under wear limit.
- j. Check that the hole diameter in the cylinder block for the intake and exhaust valve tappets is less than 0.278 inches (7.06 mm). Replace cylinder block if hole diameter exceeds wear limit.
- k. Check that the OD of the tappet for the fuel injection pump is greater than 0.941 inches (23.89 mm). Replace tappet if OD is under the wear limit.
- l. Check that the hole diameter in the cylinder block for the fuel injection pump tappet is less than 0.947 inch (24.06 mm). Replace cylinder block if hole diameter exceeds wear limits.
- m. Check for damage or worn camshaft gear. Replace if required.



**Figure 5-20. Camshaft and Tappet Assembly**

- 1 Camshaft and Gear Assembly
- 2 Tappet, Fuel Oil
- 3 Exhaust and Inlet Valve Tappets
- 4 Push Rods

INSTALLATION:

**CAUTION**

**Keep the intake and exhaust tappets separate and return into same location at reassembly.**

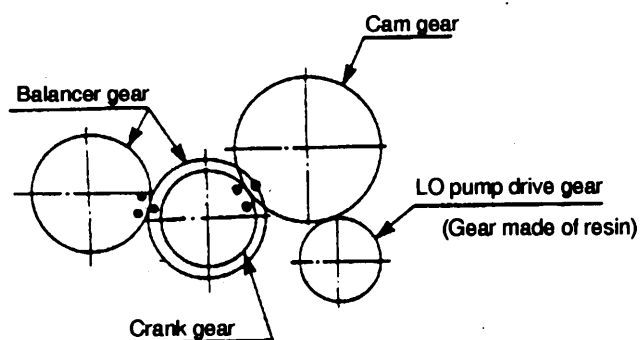
- a. Insert the intake and exhaust valve tappets and the fuel injection pump tappet into the cylinder block.





**Figure 5-21. Inserting Camshaft**

- b. Insert the camshaft assembly into the cylinder block.



**Figure 5-22. Timing Marks**

- c. Make sure the timing marks on each gear are aligned.

5-8. REPLACE/INSPECT BALANCER SHAFT

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

INITIAL SETUP

**Tools**  
None

**Materials/Parts**

Diesel fuel (Item 4, Appendix E,  
Section II)

**Equipment  
Condition  
Para**

- 3-16      Inlet air sound enclosure assembly removed.
- 3-16      Outlet air sound enclosure assembly removed.
- 4-11      Volute removed
- 4-12      Impeller, shaft seal, and shaft adapter removed.
- 4-13      Wear plate removed.
- 4-14      Pump casing removed.
- 4-17      Fuel injection pump removed.
- 5-4      Cylinder head and valve assembly removed.
- 5-5      Crankcase cover removed.

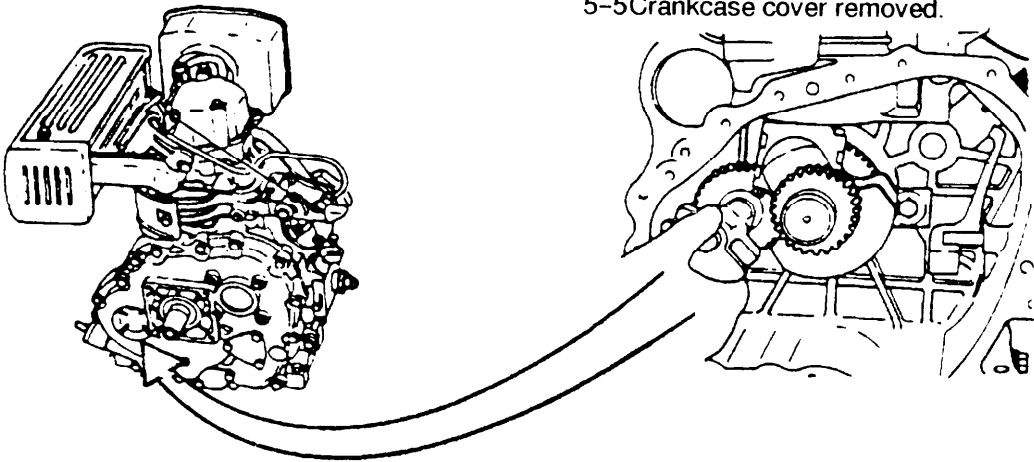


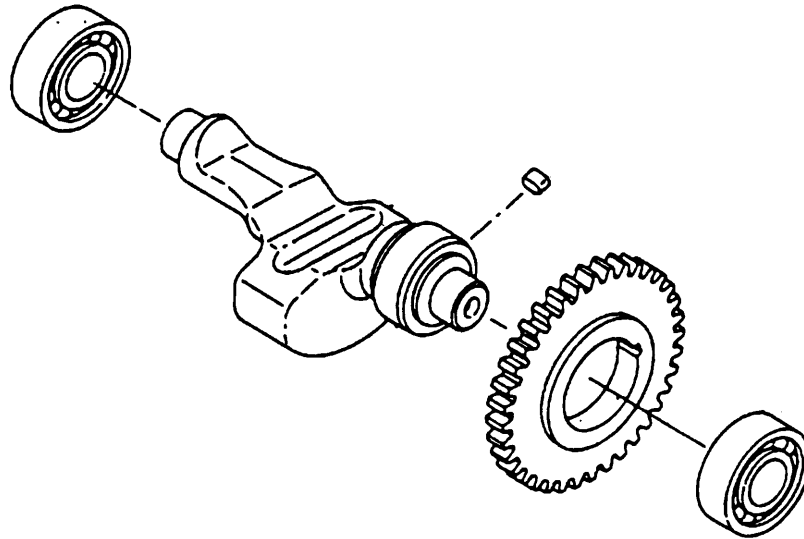
Figure 5-23. Removing the Balancer Shaft

REMOVAL:

- a. Check the location of the timing marks on all gears.
- b. Remove the balancer shaft.

**INSPECTION:**

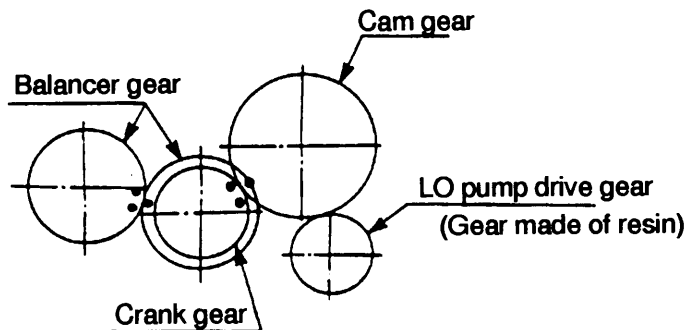
- a. Clean balancer shaft with diesel fuel.
- b. Inspect the balancer shaft for damage or excessive wear. Replace if damaged or worn.
- c. Check for damaged or worn balancer gear. Replace if required.



**Figure 5-24. Balancer Shaft Assembly**

**INSTALLATION:**

- a. Insert the balancer shaft assembly into the cylinder block.



**Figure 5-25. Timing Marks**

- b. Make sure the timing marks on each gear are aligned.

---

## 5-9. REPLACE/INSPECT GOVERNOR AND SPEED CONTROL DEVICE

---

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

---

### INITIAL SETUP

#### Tools

Tool Kit, General Mechanics (Item 2, Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)

#### Equipment Condition Para

3-16	Inlet air sound enclosure assembly removed.
3-16	outlet air sound enclosure assembly removed.

#### Materials/Parts

Diesel fuel (Item 4, Appendix E, Section II)

Lubricating oil (Item 8, Appendix E, Section II)

Grease (Item 5, Appendix E, Section II)

4-11	Volute removed.
4-12	Impeller, shaft seal, and shaft adapter removed.
4-13	Wear plate removed.
4-14	Pump casing removed.
4-17	Fuel injection pump removed.
5-4	Cylinder head and valve assembly removed.
5-5	Crankcase cover removed.
5-7	Camshaft removed.
5-13	Crankshaft removed.

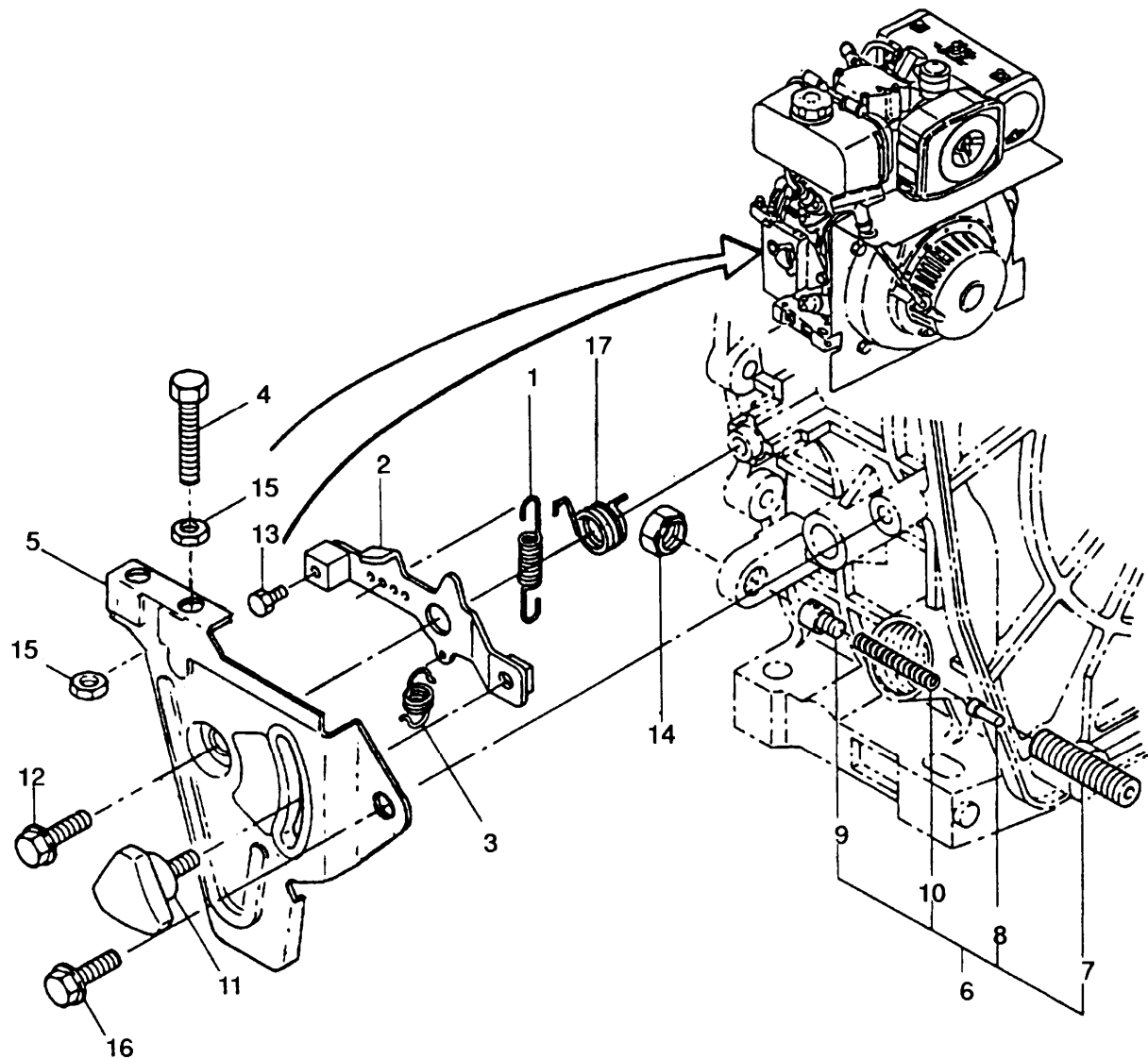
#### REMOVAL:

##### a. **Speed Control Device**

#### NOTE

**The crankcase cover does not have to be removed to repair the speed control device.**

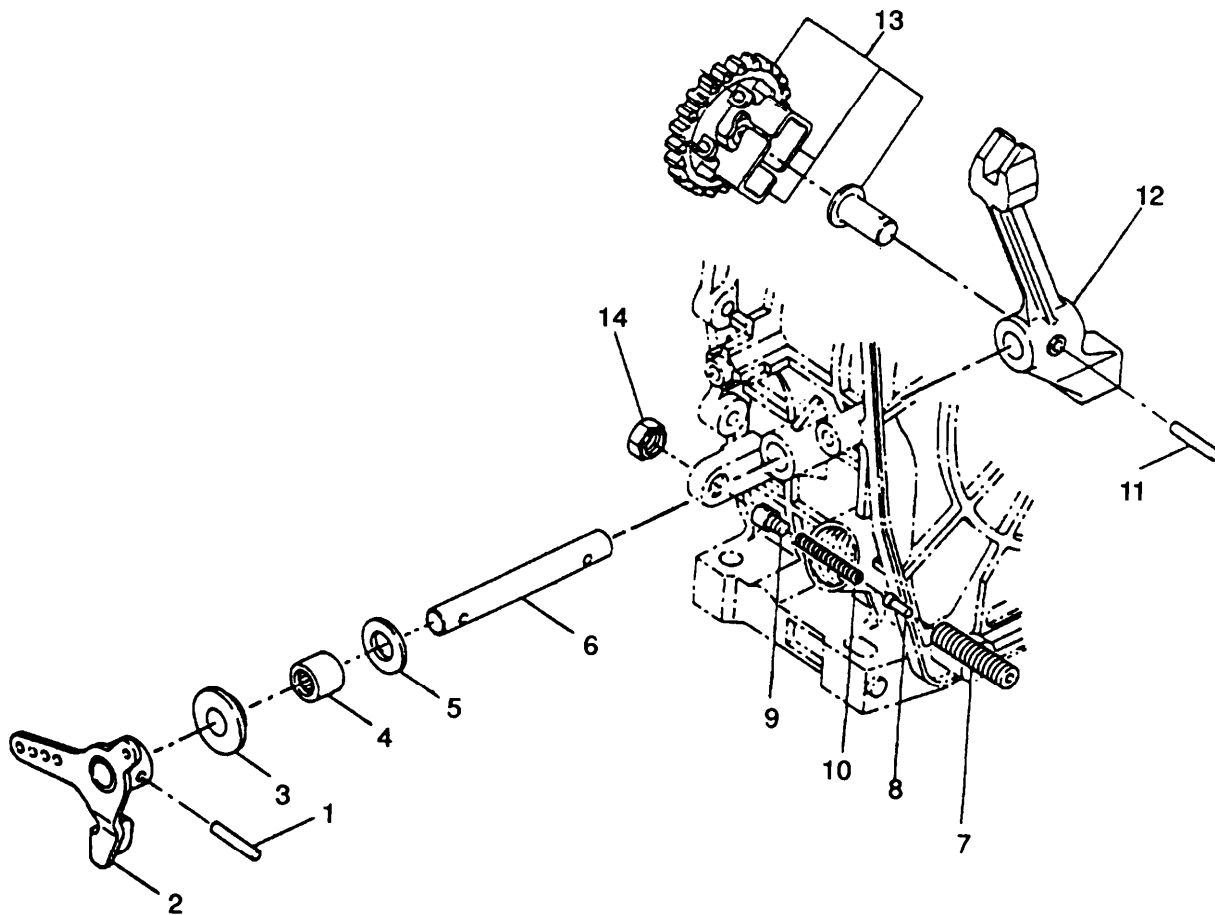
- (1) Remove regulator spring (1) from the governor lever and regulator lever (2).
- (2) Remove return spring (3) from the governor lever and regulator lever(2).
- (3) Remove mounting bolts (12 and 16).
- (4) Remove regulator bracket (5) with regulator lever (2) attached.
- (5) Remove regulator coil spring (17).
- (6) Remove regulator lever (2) from regulator bracket (5) by unscrewing lever locking knob (11).



**Figure 5-26. Speed Control Device Assembly**

- |                               |                           |
|-------------------------------|---------------------------|
| 1 Spring, Regulator           | 10 Spring, Controller     |
| 2 Lever, Regulator            | 11 Regulator Locking Knob |
| 3 Spring, Return              | 12 Bolt M6 x 20           |
| 4 Bolt                        | 13 Bolt M4 X 8            |
| 5 Bracket Assembly, Regulator | 14 Nut M10                |
| 6 Controller Assembly         | 15 Lock Nut M6            |
| 7 Body, Controller            | 16 Bolt M6 X 20           |
| 8 Pin, Controller             | 17 Regulator Coil Spring  |
| 9 Screw                       |                           |

b. Governor Assembly



**Figure 5-27. Governor Assembly**

- (1) Remove governor lever taper pin (1).
- (2) Remove governor lever (2).
- (3) Remove governor control arm (12) and governor shaft (6) from inside the engine.
- (4) Remove governor control arm lever taper pin (11).
- (5) Remove governor control arm (8) from the governor shaft (6).
- (6) Remove thrust brush (3).
- (7) Remove needle bearing (4) and washer (5).

INSPECTION:

- a. Clean all parts with diesel fuel.
- b. Inspect all components for damage or excessive wear. Replace any components damaged or worn.

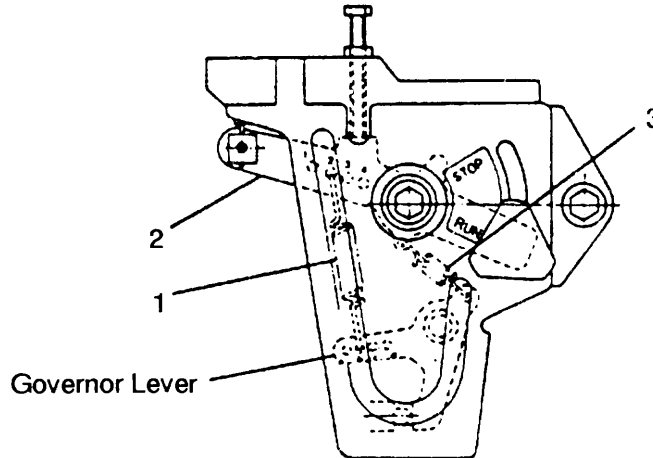
INSTALLATION:

a. **Governor Assembly (Refer to Figure 5-27)**

- (1) Install needle bearing (4) into cylinder block.
- (2) Insert shaft (6) into governor control arm (12) and lock into position with taper pin (11).
- (3) Install governor control arm (12), shaft (6), and washer (5) into needle bearing in engine from the inside.
- (4) Insert thrust bushing (3) onto shaft (6) in cylinder block.
- (5) Install control arm lever (2) onto shaft (6) and insert taper pin (1) into shaft.

b. **Speed Control Device (Refer to Figure 5-26)**

- (1) Install regulator coil spring (17).
- (2) Mount regulator handle (2) to regulator bracket (5) using the handle locking nut (11).
- (3) Mount regulator bracket assembly (5) with regulator handle (2) attached by installing two (2) mounting bolts (12 and 16).



**Figure 5-28. Speed Control Device Springs**

- (4) Attach return spring (3) to the governor lever and to regulator handle (2).
- (5) Attach regulator spring (1) to the second hole from the left (marked "b") on the governor lever and connect spring to second hole from the left (marked "2") on regulator handle (2).
- (6) Lubricate all moving parts with lubricating oil.

**5-10. REPLACE/INSPECT CONNECTING ROD**

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

**INITIAL SETUP**

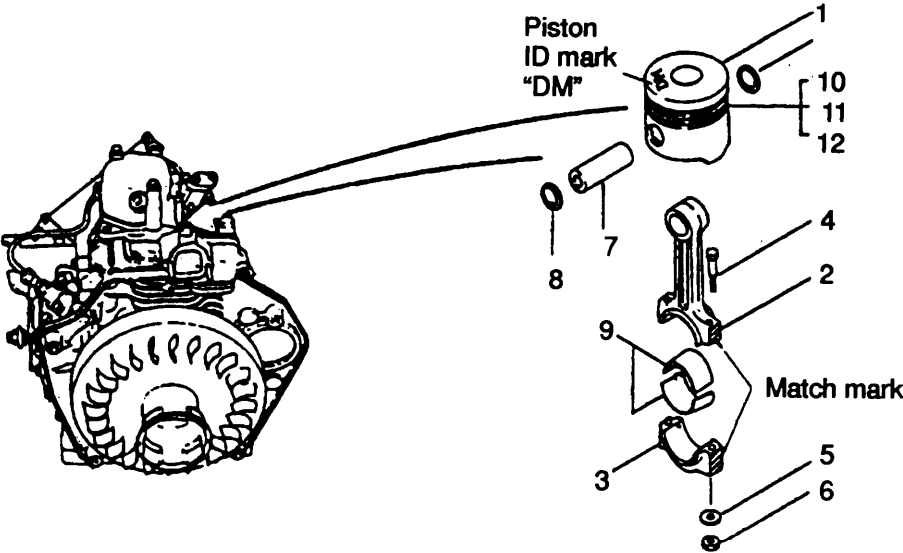
**Tools**

	Equipment Condition	Para
Pick Hook Set (Item 16, Appendix B, Section III)		
Hammer, Rubber Mallet (Item 17, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
Calipers, Vernier, 0" to 6" (Item 20, Appendix B, Section III)	3-16	Outlet air sound enclosure assembly removed.
Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 3, Appendix B, Section III)	4-11	Volute removed.
	4-12	Impeller, shaft seal, and shaft adapter removed.
	4-13	Wear plate removed.
	4-14	Pump casing removed.
Lubricating oil (Item 8, Appendix E, Section II)	5-5	Crankcase cover removed.
	5-11	Piston removed.

**Materials/Parts**

Diesel fuel (Item 4, Appendix E, Section II)

Lubricating oil (Item 8, Appendix E, Section II)



**Figure 5-29. Piston and Connecting Rod Assembly**



**REMOVAL:**

- a. Remove both snap lock rings (8).

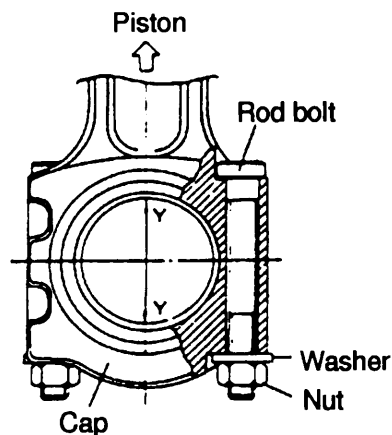
**NOTE**

Heating of piston should be done In an oil bath. Avoid heating directly.

- b. Heat piston (1) and piston pin (7) to 160-180°F.
- c. Remove piston pin (7) from piston (1).
- d. Connecting rod (2) can now be separated from piston.

**INSPECTION:**

- a. Clean connecting rod components with diesel fuel.
- b. Inspect all connecting rod components for bending, warping, cracking, excessive wear, or any other damage. Replace any components damaged or worn.
- c. Check that piston pin hole ID (small end hole) of connecting rod is less than 0.752 inch (19.1 mm). Replace connecting rod if piston pin hole diameter exceeds wear limit.
- d. Check that crank pin hole ID (large end hole) of connecting rod is less than 1.184 inches (30.08 mm). Replace connecting rod if crank pin hole diameter exceeds wear limit.
- e. Check the thrust surfaces on both ends of the connecting rod for damage. Replace connecting rod if necessary.
- f. Check the contact surface of the crank pin bearing insert for separation, melting, seizure, etc. Replace crank pin bearing insert if it is separated or damaged.



**Figure 5-30. Check of Crankpin Bearing Insert**

- g. Check that clearance between crank pin and crank pin bearing insert is less than 0.004 inch (0.12 mm). Replace crankpin bearing insert if clearance exceeds wear limit.

INSTALLATION:

**CAUTION**

**Connecting rod is made of a special aluminum alloy. Avoid damage while handling. Do not drop or clash against a hard object.**

**NOTE**

**Heating of piston should be done in an oil bath. Avoid direct heating.**

- a. Heat piston (1) to 160-180°F.
- b. Line up the piston top identification mark "DM" and the ID number on the connecting rod as shown in Figure 5-29
- c. Align the small end hole of connecting rod (2) with the piston pin hole.
- d. Insert piston pin (7) into the piston pin hole.
- e. Insert two snap lock rings (8) into piston pin hole.

---

## 5-11 . REPLACE/INSPECT PISTON

---

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

---

### INITIAL SETUP

#### Tools

#### Equipment Condition Para

Calipers, Vernier, 0" to 6" (Item 20,  
Appendix B, Section III)

Tool Kit, General Mechanics (Item 2,  
Appendix B, Section III)

Socket Set, 8 to 19 mm (Item 6,  
Appendix B, Section III)

Piston Ring Compressor (Item 12,  
Appendix B, Section III)

Groove Cleaner, Piston (Item 13,  
Appendix B, Section III)

Shop Equipment Automotive Maintenance  
and Repair: Field Maintenance,  
Common No. 2 (Item 4, Appendix B,  
Section III)

#### Materials/Parts

Diesel fuel (Item 4, Appendix E,  
Section II)

Lubricating oil (Item 9, Appendix E,  
Section II)

Crocus cloth (Item 1, Appendix E,  
Section II)

3-16	Inlet air sound enclosure assembly removed.
3-16	Outlet air sound enclosure assembly removed.
4-11	Volute removed.
4-12	Impeller, shaft seal, and shaft adapter removed.
4-13	Wear plate removed.
4-14	Pump casing removed.
5-5	Crankcase cover removed.
5-7	Camshaft removed.
5-8	Balancer shaft removed.

#### REMOVAL:

- a. Remove carbon deposited on the upper inside surface of the cylinder sleeve before extracting the piston.
- b. Remove two connecting rod mounting bolts (4), nuts (6), and washers (5).
- c. Remove connecting rod cap (3).
- d. Make sure the main bearing is in the proper position before removing piston.
- e. Move crankshaft to the top of the piston stroke and pull out piston.
- f. Remove connecting rod assembly from piston (refer to para 5-10).

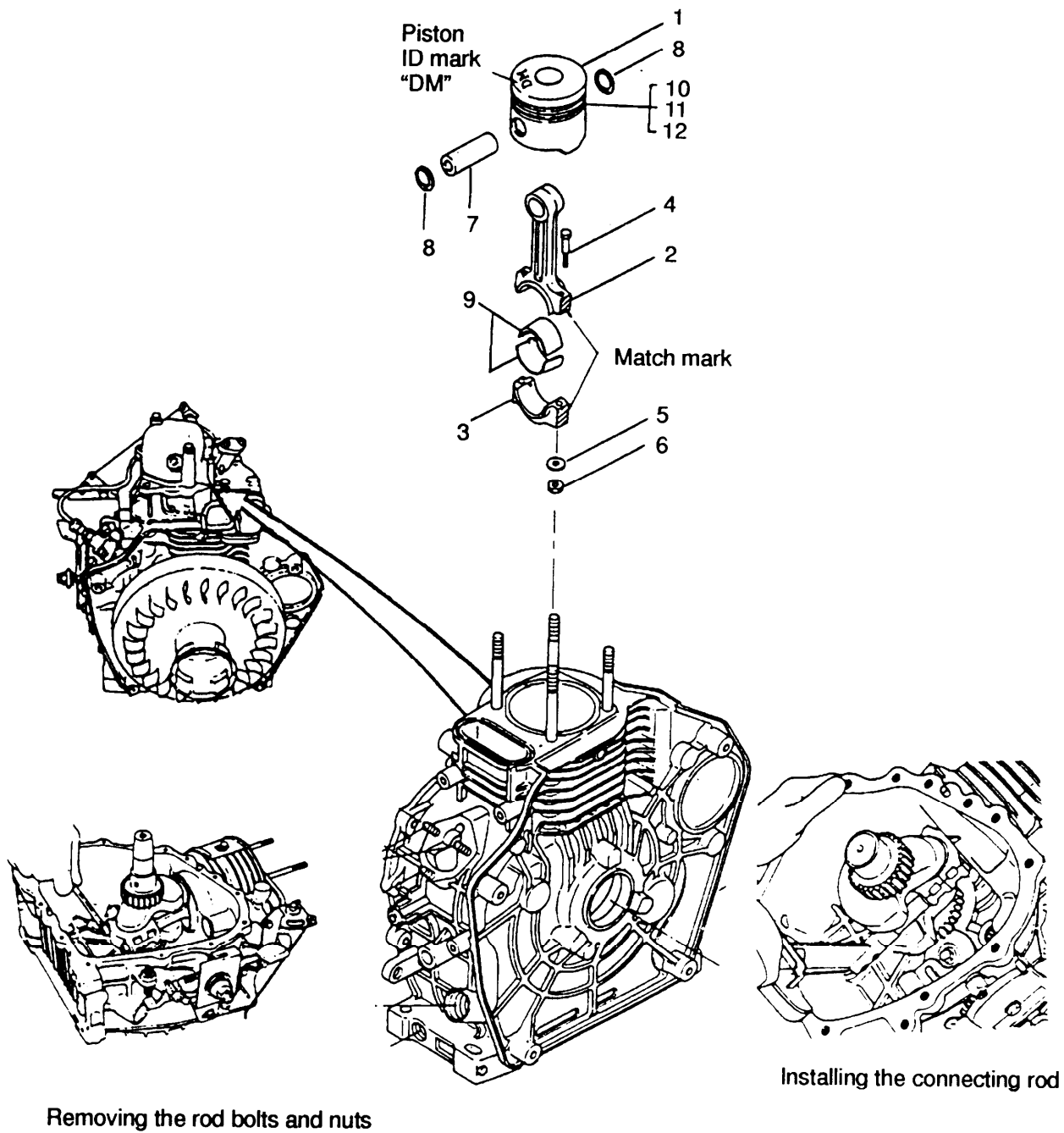
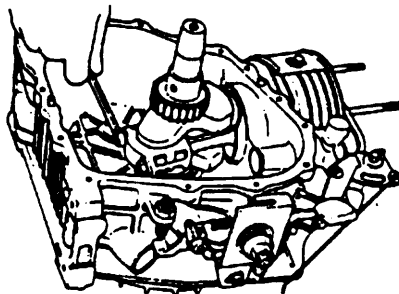


Figure 5-31. Removing and Installing Piston



**Figure 5-32. Removing the Rod Bolts and Nuts**

**CAUTION**

**Piston ring breakage may occur if rings are opened more than necessary when removing. Never stretch piston rings more than necessary.**

- g. Use the piston ring remover tool to remove piston rings.

**INSPECTION:**

- a. Clean piston (1), piston pin (7), and piston rings (10, 11, and 12).
- b. Remove carbon from piston and piston components.
- c. Carefully dean the piston ring groove after the piston rings have been removed.
- d. Inspect piston, piston skirt, piston grooves, and piston pin for excessive wear, discoloration, and damage. Replace damaged piston.

**NOTE**

**Before reading any measurements all carbon buildup must be removed. Carbon buildup will cause unreliable measurement.**

- e. Check that OD of piston is greater than 2.665 inches (67.68 mm). Measure piston OD 90 degrees from the piston pin hole and about 0.50 inch (12 mm) from the bottom of piston. Replace piston if worn beyond the wear limit.
- f. Check that the ID of the piston pin hole is less than 0.751 inch (19.07 mm). Replace piston if ID exceeds wear limit.

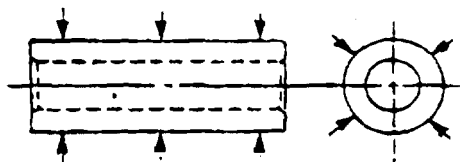


Figure 5-33. Measuring Point of Piston Pin

- g. Check that the OD of the piston pin is greater than 0.745 inch (18.92 mm). Replace piston pin if OD is worn beyond the wear limit.

Table 5-1 Piston Ring Wear Limits

Item	Dimension	Wear Limit
1st Ring	T	0.099 inch (2.52 mm)
	B	0.054 inch (1.36 mm)
2nd Ring	T	0.101 inch (2.57 mm)
	B	0.054 inch (1.36 mm)
Oil Ring	T	Not applicable
	B	0.132 inch (3.36 mm)

\*Refer to Figure 5-34 for definition of dimensions T and B.

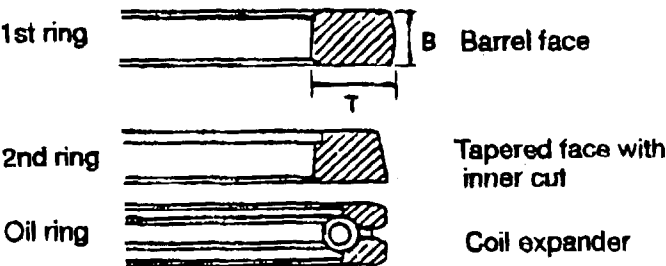


Figure 5-34. Piston Ring Dimensions

- h. Measure the thickness (dimension B) and the width (dimension T) of each piston ring. Replace piston ring if it is worn beyond the wear limits shown in Table 5-1

Table 5-2 Maximum Side Clearance

Item	Clearance
1st Ring	0.006 inch (0.15 mm)
2nd Ring	0.006 inch (0.15 mm)
Oil Ring	0.066 inch (0.15 mm)

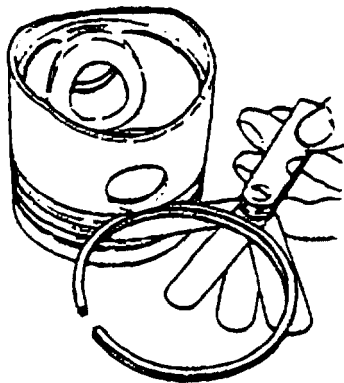
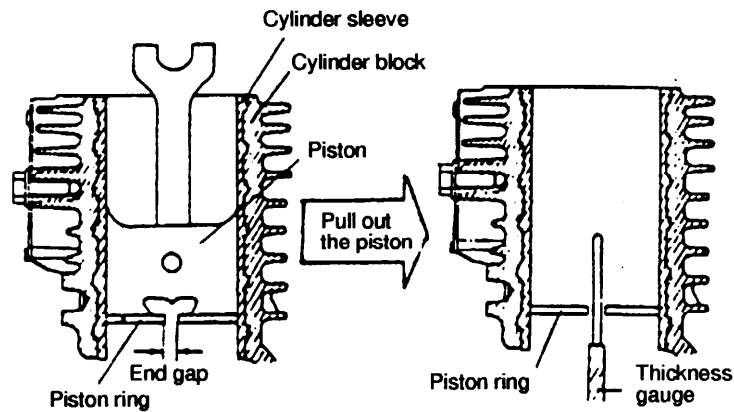


Figure 5-35. Piston Ring Side Clearance

- i. Insert each piston ring into the corresponding piston ring groove and measure the side clearance (distance between piston groove side wall and piston ring). Replace piston ring if side clearance exceeds the wear limit shown in Table 5-2



**Figure 5-36. Measuring of Ring End Gap**

- j. Measure piston ring end gap of each piston ring. Measure the ring end gap by using a new cylinder which is free from wear. If a new cylinder is not available, then measure the end gap at the bottom of the cylinder as this will be most free from wear. Push the piston ring only into the cylinder using the piston top. Replace any piston ring if end gap exceeds 0.039 inch (1.0 mm).

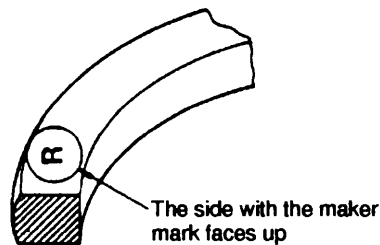
**INSTALLATION:**

**NOTE**

**Any time piston is removed from engine, new piston rings should be installed.**

- a. Attach connecting rod assembly to piston by inserting piston pin (7). (Refer to para 5-10.)

**Table 5-3 Piston Ring Top Identification Mark**



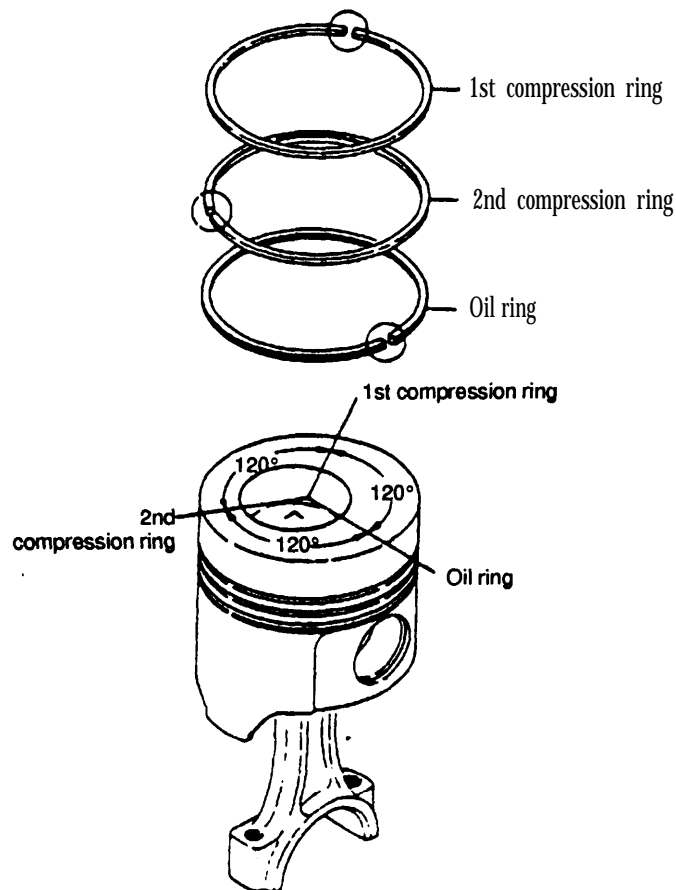
item	identification Mark (on top)
1st Ring	T
2nd Ring	2T
Oil Ring	#1

**Figure 5-37. Piston Ring Identification Mark**

- b. When inserting the rings, the identification mark should face up.

**CAUTION**

Piston ring breakage may occur if rings are opened more than necessary when installing. Never stretch piston rings more than necessary.



**Figure 5-38. Piston Ring Installation**

- c. Use the piston ring remover tool to install piston rings. Install oil ring, 2nd compression ring, and 1st compression ring in order.
- d. Make sure each piston ring gap is 120 degrees.
- e. Make sure the piston rings move smoothly.
- f. Apply liberal amount of lubricating oil to the outer surface of the piston and inner surface of the cylinder sleeve.
- g. Align the identification mark DM in the piston head with the matching mark on the connecting rod.
- h. Make sure the main bearing is in the proper position.
- i. Install crank pin bearing insert (refer to 9, Figure 5-31) into connecting rod (refer to 2, Figure 5-31).

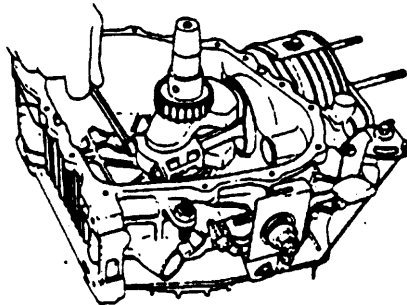


- j. Apply oil to the crank pin on the crankshaft.

**CAUTION**

**Connecting rod is made of a special aluminum alloy. Avoid damage while handling. Do not drop or clash against a hard object.**

- k. Insert the piston and connecting rod assembly, and move the crankshaft to top dead center. The identification mark DM on the piston head should align with the mark on the cylinder block. Use piston ring compressor to install piston.
- l. Insert crank pin bearing insert (refer to 9, Figure 5-31) into connecting rod cap (refer to 3, Figure 5-31).



**Figure 5-39. installing the Connecting Rod End Cap**

- m. Refer to Figure 5-31 and install the connecting rod cap (3) using bolts (4), washers (5), and nuts (6). Rotate flywheel so piston is at bottom dead center. Always use a washer for the tightening nuts. Tightening torque for connecting rod bolts is 13.0-14.5 ft-lb (190-200 cm-kg).

5-12. REPLACE FLYWHEEL

This task covers:     a) Removal             b) Installation

INITIAL SETUP

Tools

- Flywheel Tightening Handle (Item 24, Appendix B, Section III)
- Flywheel Extractor (Item 25, Appendix B, Section III)
- Tool Kit, General Mechanics (Item 2, Appendix B, Section III)
- Socket Set, 24 mm (Item 10, Appendix B, Section III)
- Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)
- Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)

Materials/Parts

Diesel fuel (Item 4, Appendix E, Section II)

Equipment  
Condition  
Para

- 3-16     Inlet air sound enclosure assembly removed.
- 4-20     Cooling case cover removed.

REMOVAL:

- a. Remove starter pulley (1) by removing three bolts (2).
- b. Install flywheel tightening handle (refer to Figure 5-41) by using starter pulley bolts (2). Use this handle to prevent flywheel (5) from turning while loosening flywheel nut (3).
- c. Remove flywheel end nut (3) and washer (4) from crankshaft (6).

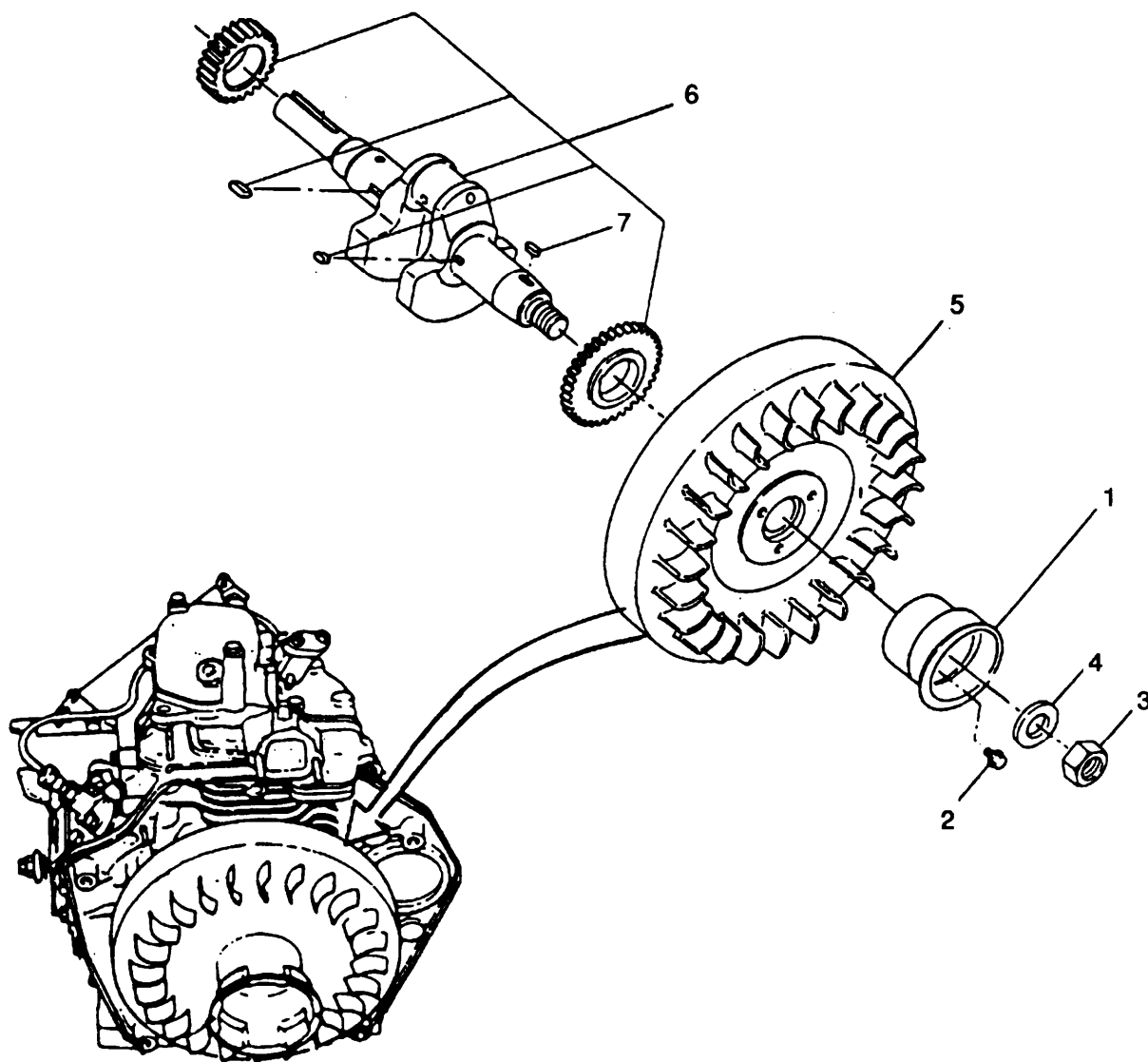


Figure 5-40. Crankshaft and Flywheel Assembly



Figure 5-41 Flywheel Tightening Handle

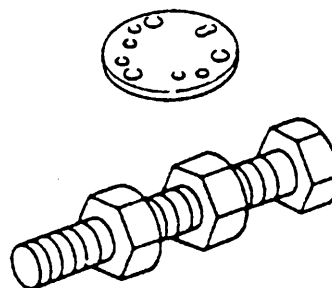


Figure 5-42 flywheel Extractor

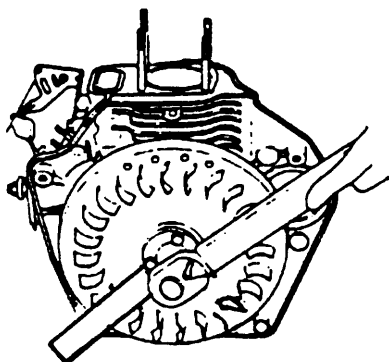


Figure 5-43 Loosening the Flywheel Nut

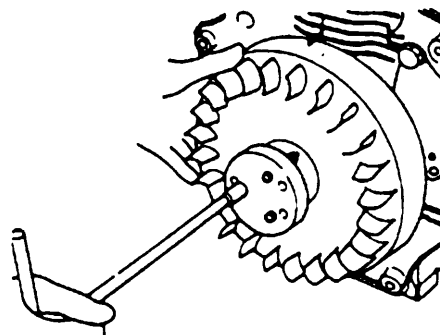


Figure 5-44 Removing the Flywheel

- d. Remove flywheel tightening handle.

**NOTE**

**Make sure bolts holding flywheel extractor are screwed in deep enough to prevent stripping of the tapped holes**

- e. Remove flywheel (5) by using the special flywheel extractor (refer to Figure 5-42). Be sure to tighten nuts on flywheel extractor evenly.
- f. When flywheel (5) loosens on tapered crankshaft (6), remove the tool.
- g. Remove flywheel (5).

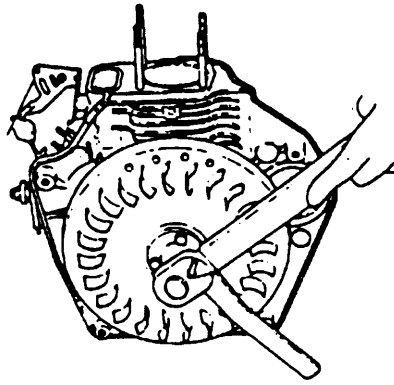
**CAUTION**

**Be careful not to damage the taper part of the crankshaft**

- h. Remove flywheel key (7) from crankshaft (6).

**INSTALLATION:**

- a. Install flywheel key (7) onto crankshaft (6).



**Figure 5-45. Tightening the Flywheel**

- b. Install flywheel (5) onto crankshaft (6).
- c. Install flywheel end nut (3) and washer (4).
- d. Tighten flywheel end nut (3) by using flywheel tightening handle to prevent flywheel from turning. Use torque wrench to tighten flywheel end nut to 73-80 ft-lb (1000-1100 cm-kg).
- e. Remove flywheel tightening handle.
- f. Install starter pulley (1) using three starter pulley bolts (2).

5-13. REPLACE/INSPECT/REPAIR CRANKSHAFT

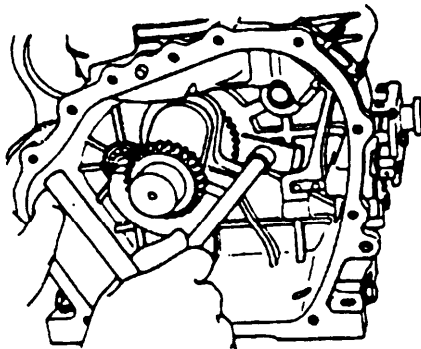
This task covers:      a) Removal              c) Repair  
                                 b) Inspection          d) Installation

INITIAL SETUP

TOOL	Equipment Condition Para	
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)		
Socket Set, 8 to 19 mm (Item 6, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
Calipers, Vernier, 0" to 6" (Item 20, Appendix B, Section III)	3-16	Outlet air sound enclosure assembly removed.
Hammer, Rubber Mallet (Item 17, Appendix B, Section III)	4-11	Volute removed.
Oil Seal Fitting Tool (Item 22, Appendix B, Section III)	4-12	Impeller, shaft seal, and shaft adapter removed.
Shop Equipment Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)	4-13	Wear plate removed.
	4-14	Pump casing removed.
	5-5	Crankcase cover removed.
	5-7	Camshaft removed.
	5-8	Balancer shaft removed.
<b>Materials/Parts</b>		
Diesel fuel (Item 4, Appendix E, Section II)	5-12	Flywheel removed.
Lubricating oil (Item 8, Appendix E, Section II)		

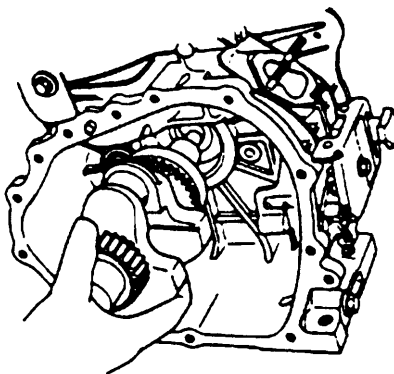
REMOVAL:

- 5-45**



**Figure 5-47. Removing the Bearing Holder**

- b. Remove bearing holder (1) and bearing holder nut (2).



**Figure 5-48. Removing Crankshaft**

- c. Pull out the crankshaft. It may be necessary to carefully tap crankshaft with a rubber mallet.

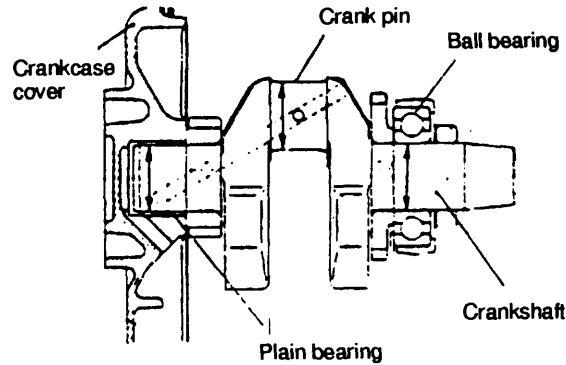
**CAUTION**

**Be careful not to damage the oil seal.**

**INSPECTION:**

- a. Clean crankshaft components with diesel fuel.
- b. Inspect crankshaft components for damage or excessive wear. Replace crankshaft or crankshaft components if any cracks or damage is found.
- c. Check that the crank pin OD is greater than 1.177 inches (29.90 mm). Replace crankshaft if crank pin is worn below wear limit.
- d. Check that the plain bearing side (crankcase cover side) shaft OD is greater than 1.777 inches (29.91 mm). Replace shaft if worn below wear limit.





**Figure 5-49. Crankcase Cross-Section**

**REPAIR:**

- a. Ball bearing (5) on the flywheel side has been press fitted onto the crankshaft.
- b. If ball bearing (5) is bad, then remove bearing with a mechanical puller.
- c. Check crankshaft for wearing or scoring surface. Replace crankshaft if excessive wear is evident.
- d. Install new ball bearings (5) by press fitting onto crankshaft.

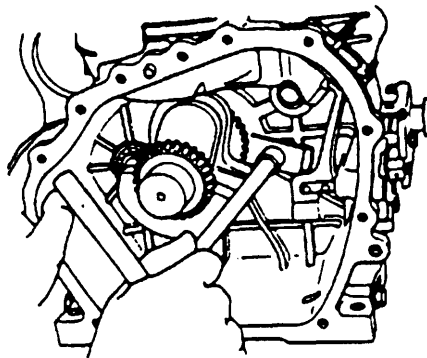
**INSTALLATION:**

- a. Grease the oil seal lips.
- b. Apply lubricating oil to the crankshaft bearing insert and crankpin.

**CAUTION**

**Crankshaft must be carefully Installed Into crankcase to avoid damaging the crankcase oil seal.**

- c. Insert the crankshaft using the crankshaft to crankcase oil seat fitting guide.
- d. Make sure crankshaft has been inserted as far as it will go by tapping on crankshaft with rubber mallet.



**Figure 5-50. Installing the Bearing Holder**

- e. Install the bearing holder.

---

## 5-14. REPLACE/INSPECT/REPAIR CRANKCASE

---

This task covers:      a) Removal              c) Repair  
                                  b) Inspection          d) Installation

---

### INITIAL SETUP

#### Tools

	Equipment Condition Para	
Wrench, 17 mm (Item 14, Appendix B, Section III)		
Tool Kit, General Mechanics (Item 2, Appendix B, Section III)	3-16	Inlet air sound enclosure assembly removed.
Fitting Tool, Oil Seal (Item 18, Appendix B, Section III)	3-16	Outlet air sound enclosure assembly removed.
Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Common No. 2 (Item 4, Appendix B, Section III)	4-11	Volute removed.
	4-12	Impeller, shaft seal, and shaft adapter removed.
	4-13	Wear plate removed.

#### Materials/Parts

Diesel fuel (Item 4, Appendix E, Section II)	4-14	Pump casing removed.
	5-5	Crankcase cover removed.
Lubricating oil (Item 8, Appendix E, Section II)	5-7	Camshaft removed.
	5-8	Balancer shaft removed.
	5-9	Governor and speed control device removed.
	5-12	flywheel removed.
	5-13	Crankshaft removed.

REMOVAL/INSTALLATION:

**NOTE**

Once the equipment has been prepared to the equipment condition requirements, there is no further removal/installation procedure required.

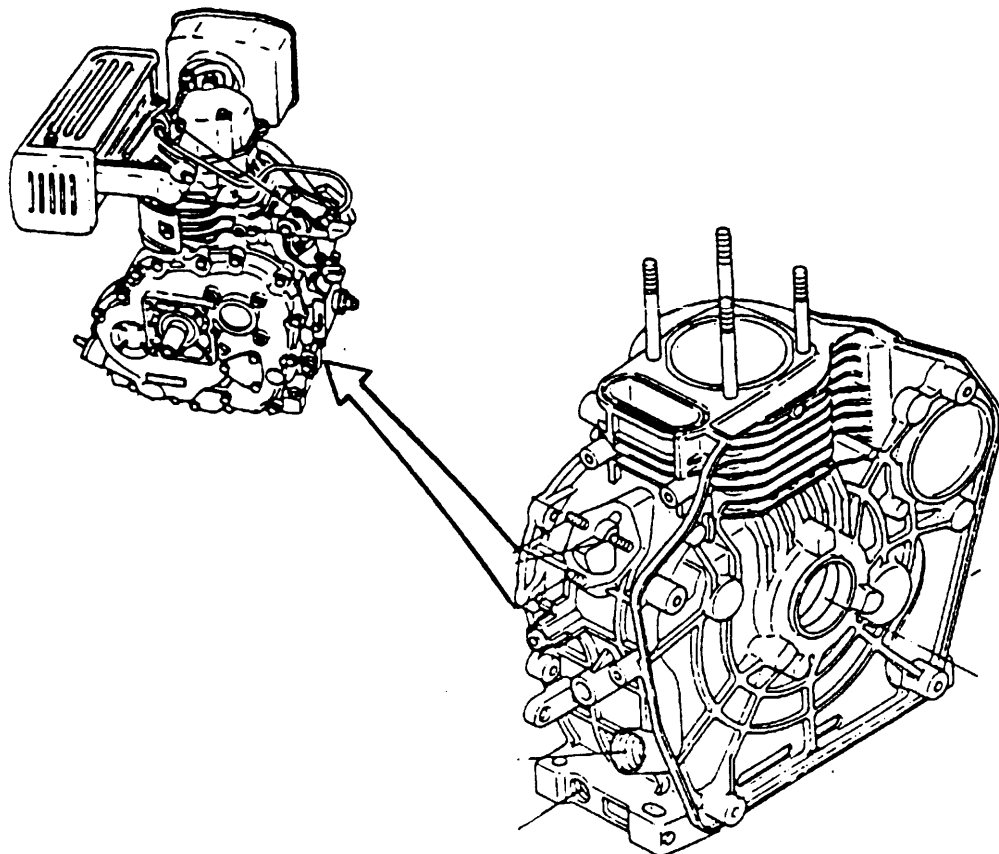
INSPECTION:



Live steam used for cleaning shall not exceed 100 psi. Use goggles or face shield for eye protection. DO NOT direct live steam against skin.

Death or serious injury could occur if compressed air is directed against skin. Do not use compressed air for cleaning or drying unless the pressure is/has been reduced to 30 psi or less. When working with compressed air, always use chip guards, eye protection, and other personal protective equipment.

- a. Clean crankcase with diesel fuel and a wire brush to remove carbon or oil deposits. Wash thoroughly with live steam and dry with compressed air.
- b. inspect cylinder sleeve for cracks, warpage, corrosion, scoring, or any other damage. Replace crankcase and piston if damage is found.



**NOTE**

**For piston replacement Instructions, refer to para 5-11.**

- c. Inspect studs (1 and 2). Replace the studs if damaged.
- d. Inspect push rod O-ring (3). Replace the O-ring if damaged.
- e. Inspect cylinder head gasket (4). Replace gasket if damaged.
- f. Inspect oil drain plug (5) and drain plug washer seal (6).
- g. Inspect oil drain hose (7), fittings (8 and 9), and fitting seal (10).
- h. Inspect crankshaft seal for damage.
- i. Check that cylinder sleeve ID is greater than 2.684 inches (68.16 mm). Re-bore the cylinder sleeve if it exceeds the wear limit and use with an oversized piston [0.0098 inch (0.25 mm)].

**REPAIR:**

- a. Unscrew any damaged studs (1 or 2) and insert new studs.
- b. Discard push rod O-ring (3) and replace with new O-ring.
- c. Discard cylinder head gasket (4) and replace with new gasket.
- d. Replace damaged oil drain plug (5) or drain plug seal (6).
- e. Replace oil drain hose (7), fittings (8 and 9), or fitting seal (10) if damaged.
- f. Remove crankshaft oil seal if damaged and insert new seal using crank shaft crankcase oil seal fitting tool.
- g. Replace governor shaft needle bearing (11) by removing bearing with mechanical bearing puller. Insert new needle bearing into hole in crankcase.
- h. Remove bad camshaft needle bearing (13) or bad balancer shaft ball bearing using mechanical bearing puller. Insert new camshaft needle bearing or balancer shaft ball bearing into crankcase.

## **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 Publications . . . . . DA PAM310-1

#### **A-2. FORMS AND RECORDS**

Recommended Changes to Publications and Blank Forms. . . . .	DA 2028-2
Equipment Inspection and Maintenance Worksheet . . . . .	DA Form 2404
Equipment Control Record . . . . .	DA Form 2408-9
Packaging Improvement Report . . . . .	DD Form 6
Quality Deficiency Report . . . . .	SF 368

#### **A-3. FIELD MANUALS**

Operation and Maintenance of Ordnance Material in Cold Weather (0°F to 65°F) . . . . .	FM9-207
Artificial Respiration . . . . .	FM21-11

#### **A-4. TECHNICAL MANUALS**

The Army Maintenance Management System (TAMMS) . . . . .	DA PAM 738-750
Stock List 4 . . . . .	SLA-08922A
Equipment Records and Procedures . . . . .	TM 4700
Hand Portable Fire Extinguishers for Army Users . . . . .	TM 5-4320-200-10
Unit, Direct Support, and General Support Maintenance Repair Parts and Special Tool List, Centrifugal Pump Unit, Self-Priming, Class 3, Diesel-Driven, Model PAD125A . . . . .	TM 10-4320-309-24P
Destruction of Army Materiel to Prevent Enemy Use . . . . .	TM 750-244-3

## 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 authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance categories.
- c. Section III lists the tools and test equipment (both special tools and common tool sets) 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 verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.
- b. **Test.** To verify serviceability by measuring the mechanical, pneumatic, hydraulic, 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 pain, or to replenish fuel, lubricants, chemical fluids, or gases.
- d. **Adjust.** To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.
- e. **Align.** 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 equipments 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. **Remove/Install.** To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

- h. **Replace.** To remove an unserviceable item and install a serviceable counterpart in its place. "Replace" is authorized by the MAC and is shown as the third position code of the SMR code.
- i. **Repair.** The application of maintenance services, including fault location/troubleshootings removal/installation, and disassembly/assembly procedures, and maintenance actions, to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item, or system.
- j. **Overhaul.** That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required 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 materiel 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 equipment/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 maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be "00"
- b. **Column 2. Component/Assembly.** Column 2 contains the names of components, assemblies, sub-assemblies, 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 a detailed explanation of these functions, see paragraph B-2)
- d. **Column 4. Maintenance Category.** Column 4 specifies, by the listing of a worktime 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, sub-assembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time),

troubleshooting/fault location 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 categories are as follows:

C.....	Operator or crew
O.....	Unit 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 alphabetic order, which shall be keyed to the remarks contained in section IV.

**B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST 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. Column1. 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	(4) Maintenance Level*					(5) Tools & Equip- ment	(6) Remarks
			C	O	F	H	D		
00	Centrifugal Pump, Diesel- Driven, Model PAD125A	Replace Inspect Service		1.0 0.5 0.5				2 2 2,7	
01	Sound Enclosure Assembly	Replace Inspect Install	.01	0.5 0.2 0.1				2 2 2	A
0101	Inlet Air Sound Enclosure Assembly	Inspect Repair			0.1 0.5			1,2,3,4,5	A
0102	Door, Latch, and Hinge	Replace Inspect Repair	.01		0.5 0.1 0.5			1,3,4,5 1,3,4,5	A
0103	Outlet Air Sound Enclosure Assembly	Inspect Repair			0.1 0.5			1,3,4,5	A
0104	Sound Enclosure Bracket Assembly	Replace Inspect Repair			0.3 0.1 0.5			2,5 2	A, B
0105	Sound Enclosure AirFlow Baffle	Replace Inspect			0.5 0.1			2,10,11 2	A
02	Centrifugal Pump Assembly	Remove		0.5				2,6,7,9, 10,11,15, 16,17	
		Inspect Service		0.5 0.3				7 2,7	
0201	Check Valve Assembly	Inspect Replace	0.1	1.0				2,7,14, 16	B
		Repair		0.5				3,7,8,14, 16	
0202	Volute	Install Replace		0.5	0.3			2,7,1 4,16 2,7,1 4,16 17	B
		Inspect Service			0.1 0.1			7,14,17 7,14,17	

**Section II. MAINTENANCE ALLOCATION CHART (Cont)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level*					(5) Tools & Equip- ment	(6) Remarks
			C	O	F	H	D		
0203	Impeller, Shaft Seal, Adapter Shaft	Replace			1.0			6,7,9,10, 11,17	C
		Inspect			0.5			5,7,8,9 10,11,16, 17	
0204	Wear Plate	Replace			1.0			6,7,9,10, 11,16,17	C
0205	Pump Casing	Replace			2.5			2,6,7,9, 10,11,15, 16,17,20	
		Inspect			0.1			2,6,7,9	
03	Engine, Diesel Air-Cooled	Inspect Replace	0.1	0.1	2.0			2,7,10,11, 14,16,17	
04	Fuel System								
0401	Fuel Tank	Inspect Replace	0.1	0.5				---- 2,7,9,10, 14,15	
		Service			0.1			----	
0402	Fuel Filter	Inspect Replace Service		0.1 0.5 0.1				---- 2,7 2,7	
0403		Inspect Replace	0.1	0.5				---- 2,7,10,15 16	
		Service		0.1				2,7,16	
0404	Fuel Injection Pipe	Replace Service		0.3 0.1				2,7,14 ----	
0405	Fuel Injection Nozzle	Replace Adjust			2.0	2.0		2,7, 2,6,7,14 23,27	
		Repair				2.0		2,6,7,14, 23,27	

Section II. MAINTENANCE ALLOCATION CHART (Cont)

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level*					(5) Tools & Equip- ment	(6) Remarks
			C	O	F	H	D		
0406	Fuel Injection Pump	Replace			2.0			2,7,10, 11,14,16, 20	
		Test			2.0			2,7,10, 11,14,16, 20	
		Adjust			1.5			2,7,10, 11,14,16 20	
05	Exhaust Silencer/Spark Arrestor	Replace		0.3				2,6,8,16	
		Inspect		0.1	2.0			2,16	
0600	Air Cleaner Element	Replace		0.3				2	
0601	Air Intake Bend	Replace			0.5			2,6,8	
		Inspect			0.1			----	
07	Recoil Starter Assembly	Replace			0.5			2,6,8	
		Inspect			0.1			----	
		Repair			0.5			2,6,8,10	
08	Flywheel Coding Case Cover	Replace			0.3			2,6,8, 10,17	
		Inspect		0.1	0.1			2,16	
09	Cylinder Head Assembly								
0901	Valve Rocker Arm Assembly	Replace		2.0				2,6,7,8, 17	
		Inspect		0.3				2,6,7	
		Adjust		0.5				2,6,7	
0902	Cylinder Head and Valve Assembly	Replace				2.0		2,6,8,16, 26	
		Inspect				0.3		2,6,8,16, 26	
		Repair				2.0		2,6,8,16, 26	
10	Crankcase Assembly								
1001	Lube Oil Strainer	Replace			1.0			2,6,7,8, 16	
		Inspect			1.0			2,6,7,8, 16	

Section II. MAINTENANCE ALLOCATION CHART (Cont)

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level*					(5) Tools & Equip- ment	(6) Remarks
			C	O	F	H	D		
1002	Crankcase Cover	Replace				2.0		2,6,7,8, 16,17, 21,22	
		Inspect				0.1		----	
		Repair				1.5		2,21,22	
1003	Lube Oil Pump	Replace				2.0		2,6,7,8 16,17	
		Inspect				1.5		----	
		Repair				2.0		2,6,7,8, 16,17	
1004	Camshaft	Replace				2.0		2,6,7,8, 16	
		Inspect				1.5		2,7,19	
1005	Balancer Shaft	Replace				1.0		2,6,7,8, 16	
		Inspect				1.0		2,7,19	
11	Governor and Speed Control Device	Replace				1.0		2,7,8,18,	
		Inspect				0.5		2,7,20	
12	Piston and Connecting Rod Assembly								
1201	Connecting Rod	Replace				1.0		2,6,7,19,	
		Inspect				1.0		2	
1202	Piston	Replace				1.0		2,6,7,19, 20	
		Inspect				1.0		2	
1203	Flywheel	Replace				0.5		2,6,7,24, 25	
1204	Crankshaft	Replace				0.1		2,6,7	
		Inspect				0.5		2,6,7,16, 19	
		Repair				1.5		----	

Section II. MAINTENANCE ALLOCATION CHART (Cont)

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level*					(5) Tools & Equip- ment	(6) REMARKS
			C	O	F	H	D		
1205	Crankcase	Replace				5.0		2,6,7, 21,22	
		Inspect Repair				1.0 1.5		2,16,17 ----	
13	Frame Assembly								
1301	Frame Assembly	Replace			2.5			2,6,8	B
1302	Base Plate	Replace			1.0			2,6,8, 17	B
1303	Shock Mounts	Replace		0.1	1.0			2,6,8,17	

### Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

(1) Tool or Test Equipment Ref. Code	(2) Maintenance Category	(3) Nomenclature	(4) National/ NATO Stock Number	(5) Tool Number
1	F	Riverter, Blind, Hand	5120-00-017-2849	
2	O, F, H	Tool Kit, General Mechanics	5180-00-699-5273	
3	O, F, H	Shop Equipment, Automotive Maintenance and Repair: Unit Maintenance, Common No. 1	4910-00-754-0654	
4	F,H	Shop Equipment, Automotive Maintenance and Repair: Field Maintenance, Common No. 2	4910-00-754-0705	
5	F,H	Square, 6" Machinist	5210-00-132-5695	
6	O, F, H	Socket Set, 8 to 19 mm 3/8" Drive, chrome	5120-00-103-9785	
7	O, F, H	Pan, Drain	4910-00-387-9592	
8	O, F, H	Breaker Bar, 3/8" Sq Drive, 9-1/2" lg	5120-01-131-4461	
9	F,H	Strap Wrench, 1" to 5" diameter capacity	5120-01-192-9406	
10	H	Socket, 24 mm x 3/8" Drive, Flank Drive, chrome	5120-01-102-4471	
11	F,H	Hex Key Drive, Long 7/32" x 3/8"	5120-01-075-1200	
12	H	Compressor, Piston Ring, 2-band, 2-1/8" to 5" capacity	5120-01-191-9542	
13	H	Groove Cleaner, Piston Ring, small diameter	5110-00-554-7286	
14	O, F, H	Wrench, Combination, 17 mm 12-point, Std Handle, Indst finish	5120-01-045-4909	
15	O, F, H	Wrench, Combination, 10 mm, 12-point, Std Handle, Indst finish	5120-01-045-4904	
16	O, F, H	Pick, Hook, Set	5180-01-186-2842	
17	F,H	Hammer, Rubber Mallet	5120-01-116-6996	

**Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS**

(1) Tool or Test Equipment Ref. Code	(2) Maintenance Category	(3) Nomenclature	(5) National/ NATO Stock Number	(6) Tool Number
18	H	Fitting Tool, Oil Seal, Crankshaft/Crankcase		CAGEC-OAK42, P/N-114350- 92311
19	H	Micrometer, 2" to 3" capacity	5210-00-253-9880	
20	H	Vernier Calipers, 0" to 6", out- side or depth measurement	5210-01-113-1548	
21	F, H	Fitting Tool, Oil Seal, Crankcase Cover		CAGEC-OAK42, P/N-114250- 92311
22	F, H	Guide, Oil Seal Fitting, Crankcase Cover and Crankshaft/Crankcase		CAGEC-OAK42, P/N-114268- 92300
23	F, H	Cleaning Tool, Fuel Injection, Valve Jet Hole		CAGEC-OAK42, P/N-28210- 000010
24	H	Flywheel Tightening Handle		CAGEC-OAK42, P/N-114250- 92101
25	H	Extractor, Flywheel		CAGEC-OAK42, P/N-114250- 92121
26	H	Fitting Tool, Valve Stem Seal		CAGEC-OAK42, P/N-114250- 92350
27	F, H	Nozzle Tester 0-7, 112 psi, with high pressure measurement pipe		CAGEC-OAK42, P/N-737600- 93502
28	F, H	Tachometer		CAGEC-OAK42, P/N-95500- 001043
29	F, H	Tape, Reflecting		CAGEC-OAK42, P/N-9550- 001041

**Section IV. REMARKS**

(1) Reference Code	(2) Remarks
A	Replace failed rivets/replace acoustic foam.
B	Clean with solvent to remove rust or corrosion.
C	On replacing impeller or wear plate, impeller clearance must be checked.
D	Repair by replacing inserts.
E	Replace piston rings.
F	Weld.



## APPENDIX C

### COMPONENTS OF END ITEM (COEI) AND BASIC ISSUE ITEMS LISTS (BIIL)

---

#### Section I. INTRODUCTION

##### C-1. SCOPE

This appendix lists the components of end items and basic issue items for the Diesel-Driven 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 Lists are divided into the following sections:

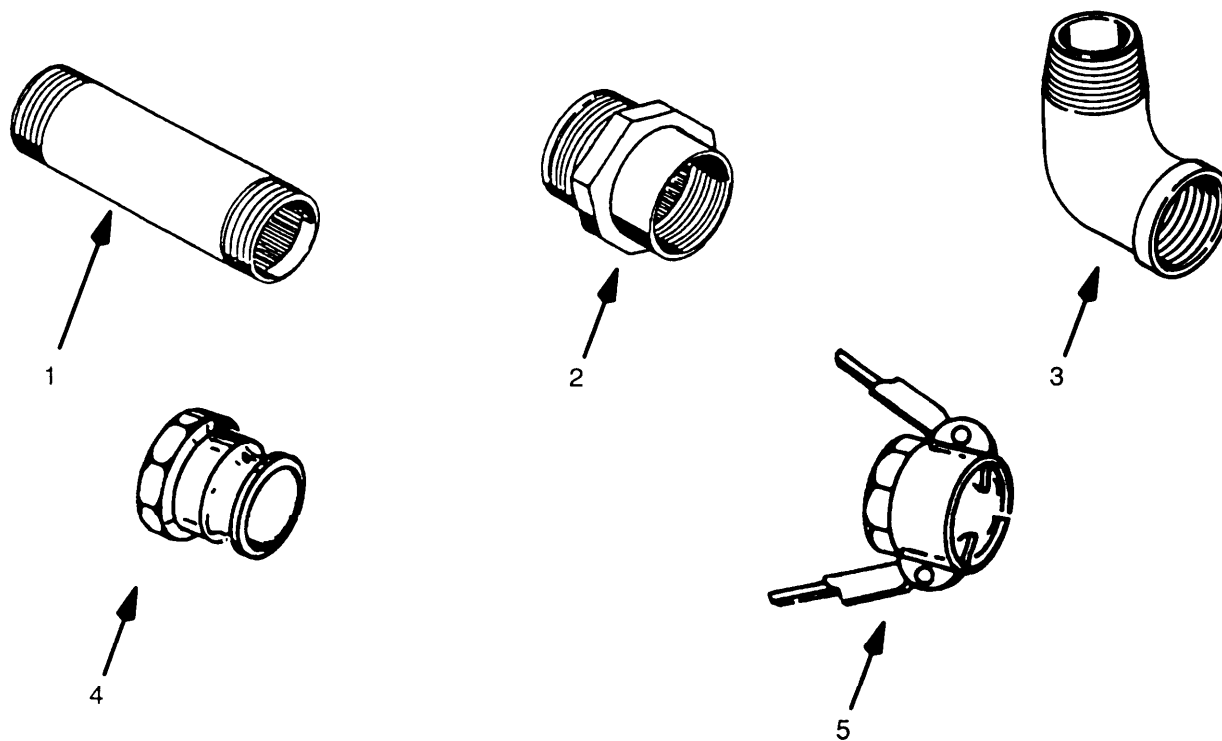
- a. **Section II. Components of End Item.** This listing is not authority to requisition replacements. These items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Illustrations are furnished to assist you in identifying the items.
- b. **Section III. Basic Issue Items.** These are the minimum essential items required to place the Diesel-Driven Centrifugal Pump Unit in operation, operate it, and perform emergency repairs. Although shipped separately packaged, BII must be with the Diesel-Driven 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/MTOE authorization of the end item.

##### C-3. EXPLANATION OF COLUMNS

The following provides an explanation of columns found in the tabular listings:

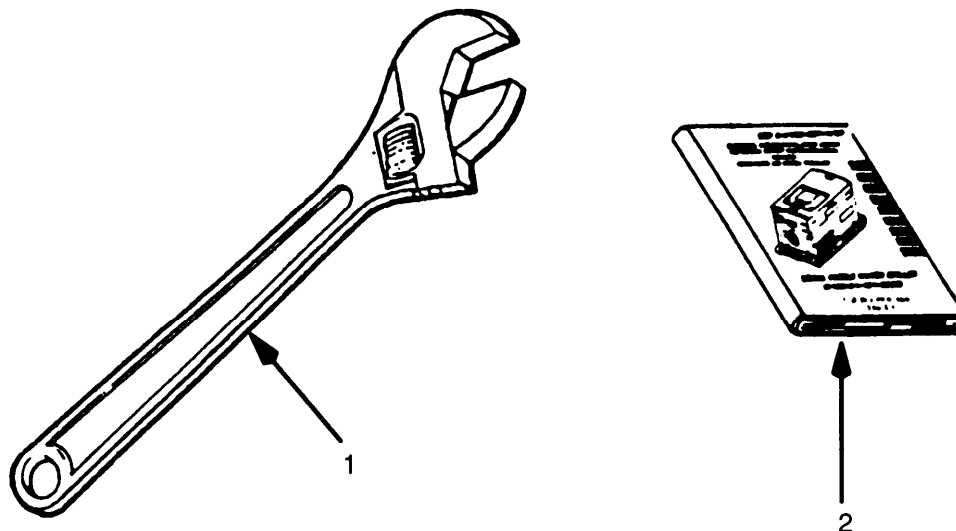
- a. **Column (1) — Illustration Number (Illus Number).** This column indicates the number of the illustration in which the item is shown.
- b. **Column (2) — National Stock Number.** Indicates the stock number assigned to the item and will be used for requisitioning purposes.
- c. **Column (3) — Description.** Indicates the Federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the CAGEC (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 II. COMPONENTS OF END ITEM



(1) Illus Num- ber	(2) National Stock Number	(3) Description CAGEC and Part Number	(4) U/M	(5) Qty
1		Nipple, 2" T.B.E. x 6" LG.	EA	2 Brass
2		Adapter, Hose, 2" FPT x 2"	EA NPSH	2 Brass
3		Elbow, 2" FPT X 2" MPT 90 degree	EA	1 Brass
4		Coupling Half Quick Disconnect Male 2" (Fuel Only)	EA	1
5		Coupling Half Quick Disconnect Female 2" (Fuel Only)	EA	1

### Section III. BASIC ISSUE ITEMS



(1) Illus Num- ber	(2) National Stock Number	(3) Description CAGEC and Part Number	(4) U/M	(5) Qty
1	5120-00-449-8083	Wrench, Adjustable	EA	2
2		Manmual, Operator's, Unit, Direct Support, and General Support Maintenance TM 10-4320-309-14, TM 4320-14/1		

**APPENDIX D**  
**ADDITIONAL AUTHORIZATION LIST**

---

**(Not Applicable)**

## APPENDIX E

### EXPANDABLE AND DURABLE SUPPLIES LIST

---

#### Section I. INTRODUCTION

##### E-1. SCOPE

This appendix lists expendable and durable supplies you will need to operate and maintain the Diesel-Driven Centrifugal Pump Unit. These items are authorized to you by CTA 50-970, Expendable/Durable 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 3, Appendix E).
- b. **Column (2) - Level.** This column identifies the lowest level of maintenance that requires the listed item.
  - C - Operator/Crew
  - O - Unit Maintenance
  - F - Direct Support Maintenance
  - H - General Support Maintenance
- c. **Column (3) — National Stock Number.** This is the 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 of 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 measures used in performing the actual maintenance function. 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 AND DURABLE SUPPLIES LIST**

(1) Item Number	(2) Level	(3) National stock Number	(4) Description	(5) U/M
1	F,H	6850-00-664-5685	Abrasive Cloth, Crocus, P-C-458	ea
2	F,H		Abrasive Cloth, Emery, P-C-1673	ea
3	O, F, H		Solvent, Dry Cleaning, AA 711, Type II (58536)	5 gal
4	C,O, F,H		Fuel, Diesel, V V-F-800	gal
5	H	9150-00-190-0907	Grease, Automotive and Artillery, MIL-G-10924	5 gal can
6	O	9150-00-754-2595	Grease, Ball and Roller Bearing, MILG-18709	1 lb can
7	F,H	9150-00-186-6681	Chemical Agent Resistant Coating, MIL-T-704T Type G, PUP Sand/Camouflage Green	gal
8	O, F, H		Oil, Lubricating, Internal Combustion Engine, MIL-L-2104	qt
9	O		Oil, Lubricating, Preservative, MIL-L-21260	qt
10	O, F, H		Solvent, Toluol	gal
11	C,O, F,H	5330-01-083-0081	Cloth, Lint-free	ea
12	O, F, H	5330-01-083-0081	Air Cleaner Element	ea
13	O		Detergent, Mild, A-A 1376, Class II	lb

## APPENDIX F

### ILLUSTRATED LIST OF MANUFACTURED ITEMS

---

#### Section I. INTRODUCTION

##### F-1. SCOPE

This appendix includes complete instructions for making items authorized to be manufactured or fabricate at the unit maintenance level.

#### Section II. ILLUSTRATED LIST OF MANUFACTURED ITEMS

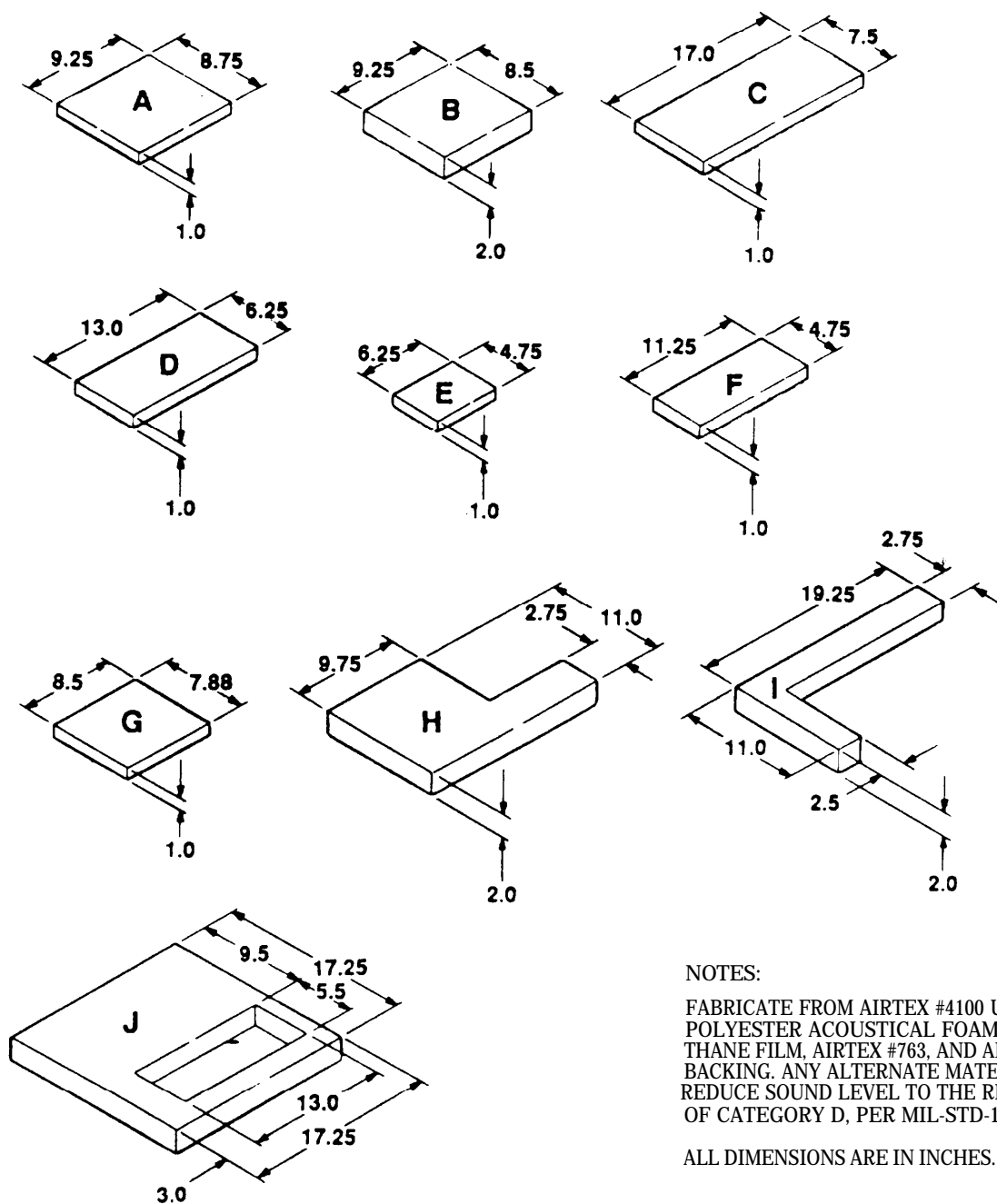
**F-2.** The following manufactured items are required for this centrifugal pump unit. They are cut from bulk material (3R939) P/N 4100-763-1" or P/N 4100-763-2. See Figures F-1 and F-2.

Figure F-1

A	Acoustical Foam, Inlet Air Enclosure, Exhaust Side
B	Acoustical Foam, Inlet Air Enclosure, Exhaust Side
C	Acoustical Foam, Inlet Air Enclosure, Access Door Side
D	Acoustical Foam, Inlet Air Enclosure, Vent Hood Top
E	Acoustical Foam, Inlet Air Enclosure, Vent Hood Side
F	Acoustical Foam, Inlet Air Enclosure, Vent Hood Back
G	Acoustical Foam, Inlet Air Enclosure, Access Door Top
H	Acoustical Foam, Inlet Air Enclosure, Top
I	Acoustical Foam, Inlet Air Enclosure, Fuel Tank Side
J	Acoustical Foam, Inlet Air Enclosure, Back

Figure F-2

A	Acoustical Foam, Outlet Air Sound Enclosure, Side
B	Acoustical Foam, Outlet Air Sound Enclosure, Top
C	Acoustical Foam, Outlet Air Sound Enclosure, Back
D	Acoustical Foam, Outlet Air Sound Enclosure, Vent Hood Side
E	Acoustical Foam, Outlet Air Sound Enclosure, Vent Hood Back
F	Acoustical Foam, Outlet Air Sound Enclosure, Vent Hood Top



NOTES:

FABRICATE FROM AIRTEX #4100 URETHANE POLYESTER ACOUSTICAL FOAM WITH URETHANE FILM, AIRTEX #763, AND ADHESIVE BACKING. ANY ALTERNATE MATERIAL MUST REDUCE SOUND LEVEL TO THE REQUIREMENT OF CATEGORY D, PER MIL-STD-1474

ALL DIMENSIONS ARE IN INCHES.

Figure F-1



NOTES:

FABRICATE FROM AIRTEX #4100 URETHANE  
POLYESTER ACOUSTICAL FOAM WITH URE-  
THANE FILM, AIRTEX #763, AND ADHESIVE  
BACKING. ANY ALTERNATE MATERIAL MUST  
REDUCE SOUND LEVEL TO THE REQUIREMENT  
OF CATEGORY D, PER MIL-STD-1474

ALL DIMENSIONS ARE IN INCHES.

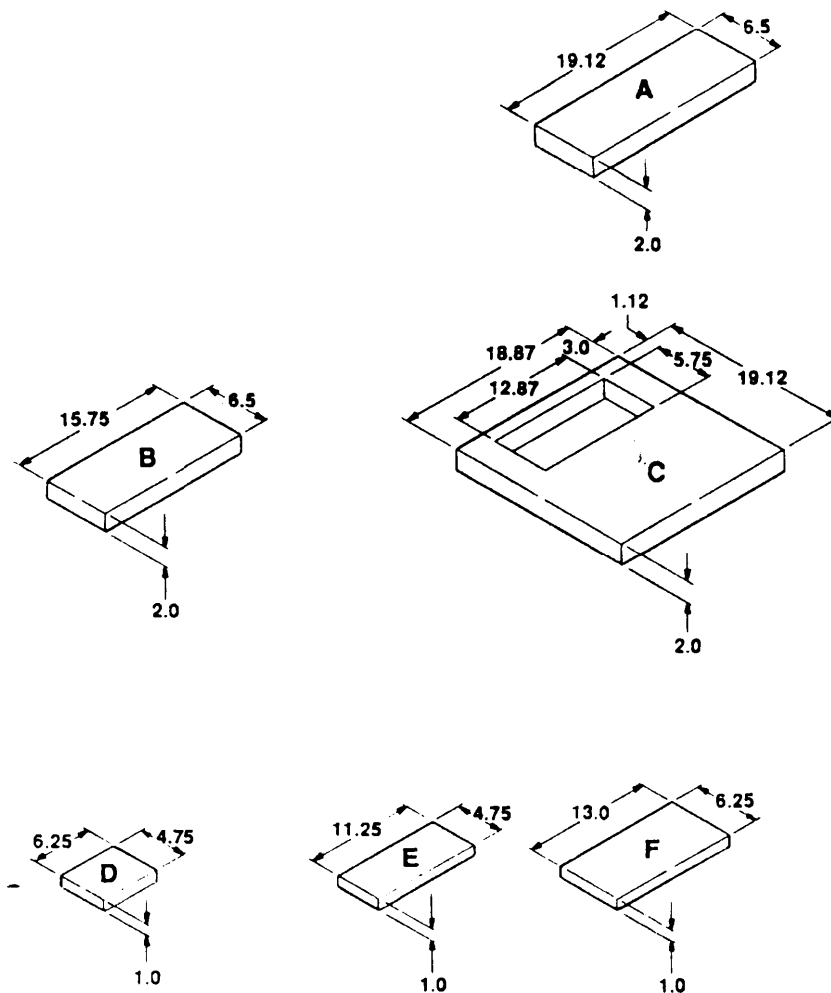
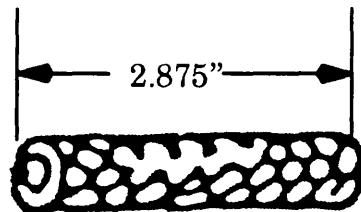


Figure F-2

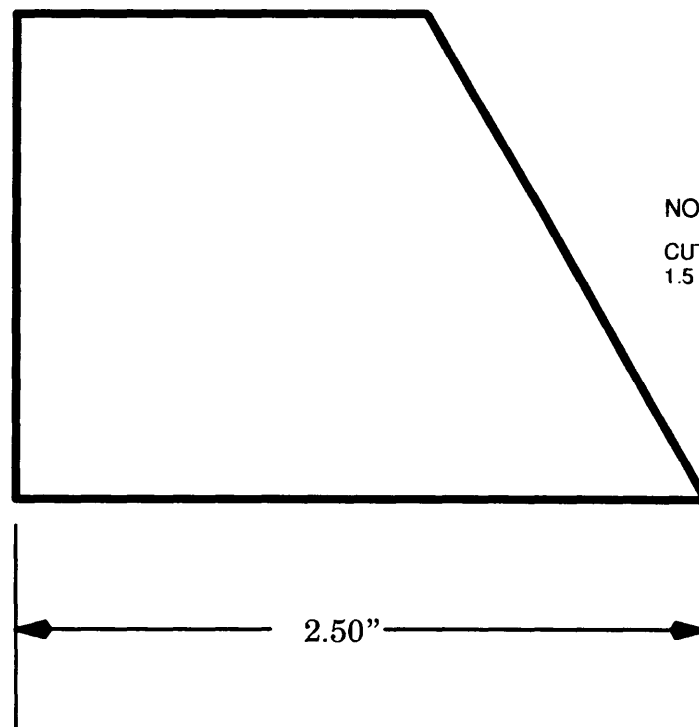
**F-3.** The following manufactured item is required for this centrifugal pump unit. It is cut from bulk material P/N 1525-6. See Figure F-3.



NOTE;  
CUT 2.875 INCHES LONG

Figure F-3

**F-4.** The following manufactured item is required for this centrifugal pump unit. It is cut from bulk material P/N 70-125 (97403) 13228E9862. See Figure F-4.



NOTE;  
CUT ON DIAGONAL  
1.5 INCHES

Figure F-4

## APPENDIX G

### TORQUE LIMITS

#### NOTE

To determine breakaway torque, thread nut onto screw or bolt until at least two threads stick out. Nut shall not make contact with a mating part. Stop the nut. Torque necessary to begin turning nut again is the breakaway torque. Do not reuse self-locking nuts that do not meet minimum break-away torque.

#### SELF-LOCKING NUT BREAKAWAY TORQUE VALUES

Thread Size	Minimum Breakaway Torque (In.-Lb)	Thread Size	Minimum Breakaway Torque (In.-Lb)
10-32	2.0	5/8-18	32.0
1/4-28	3.5	3/4-16	50.0
5/16-24	6.5	7/8-14	70.0
3/8-24	9.5	1-12	90.0
7/16-20	14.0	1-1/8-12	117.0
1/2-20	18.0	1-1/4-12	143.0
9/16-18	24.0		

Standard tightening torque for metric bolts and nuts

M6 - 5.0 - 7.0 lb-ft ( 70-100 kg-cm)

M8 -13.0 - 14.5 lb-ft (180-200 kg-cm)

Specific Torque Requirements - use table from next page.

## **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.

**ALIGN** - 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.

**ASSEMBLY** - A combination of parts that maybe 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.

### **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.

**CAVITATION** - Condition caused when engine speed is increased beyond point of maximum suction vacuum. Cavitation is indicated by loud cracking noise in pump housing and is harmful to the pump unit.

**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.

**DISPLACEMENT** - The volume displaced by a piston in a single stroke.

**DISTORTION** - The bending, twisting, or any other dynamic change of a surface.

## GLOSSARY

### Section I. ABBREVIATIONS

cm	Centimeter
cm-kg	Centimeter-kilogram
cu	cubic
cu cm	Cubic Centimeters
cu in	Cubic inches
°F	Degree Fahrenheit
ea	Each
EIR	Equipment Improvement Recommendation
Fig.	Figure
ft	Foot
ft-lb.	Foot pound
FPT	Female pipe thread
gal	Gallon
gpm	Gallons per minute
hp	Horsepower
ID	Inside diameter
in.	Inch
kg	Kilogram
l	Liters
lb.	Pound
mm	Millimeter
MAC	Maintenance Allocation Chart
No.	Number
NPSH	National Pipe Size Hose Thread
NPT	National pipe thread
OD	Outside diameter
para	Paragraph
pg.	Page
PMCS	Preventive maintenance checks and services
psi	pounds per square inch
ref	Reference
rpm	Revolutions per minute
sq.	Square
TBE	Threaded both ends
TDC	Top dead center
TMDE	Test, measurement, and diagnostic equipment

### TIGHTENING TORQUES

Where specified torque be applied	Tightening torue ft-lb (kg-cm)
Valve rocker arm support bolt	14.5-15.9 (200-220)
Flywheel end nut	72.3-79.6 (1000-1100)
Crankcase cover bolts	5.8-8.7 (80-120)
Head stud bolts (stud side)	9.4-10.8 (130-150)
Cylinder bead nuts	20.3-23.1 (280-320)
Fuel nozzle case nut	28.9-32.5 (400-450)
Fuel pump stud bolts (stud side)	21.7-25.3 (300-350)
Fuel pump bolts	5.1-7.2 (70-100)
Fuel pump nuts	5.8-8.7 (80-120)
Fuel nozzle bolts (stud side)	5.1-7.2 (70-100)
Fuel inject km nozzle nuts	5.8-7.2 (80-100)
Connecting rod bolts and nuts	13.0-14.5 (180-200)
Pump casing self-sealing screw	32-35 (440-480)

**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.

**FLUID** - A substance that can flow; that is, either a gas or a liquid.

**FRAYED** - Something which has been worn away or unraveled, usually by rubbing.

**G**

**GASKET** - A seal or packing used between matched marine 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.

**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.

**P**

**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 maybe 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**

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

SCRIBE - Sharp pointed tool.

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 meter-kilograms (m-kg).

**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.

VOLUTE - Housing into which impeller discharges water.



## ALPHABETICAL INDEX

### Subject, Page

#### A

Adapter Shaft, 4-20  
 Adjust,  
     (See Specific Items)  
 Adjusting Pump Speed, 2-29  
 Administrative Storage, 3-36  
 Air Cleaner Equipment, 3-17  
 Air Intake Bend, 4-37  
 Air Sound Enclosure Assembly, 4-5

#### B

Baffle, Sound Enclosure Air Flow, 4-16  
 Balancer Shaft, 5-24  
 Base Plate, 4-47  
 Bracket Assembly, Sound Enclosure, 4-14

#### C

Camshaft, 5-19  
 Capabilities, Equipment, 1-4  
 Casing, Pump, 4-25  
 Centrifugal Pump, Diesel-Driven, 3-19  
 Characteristics, Equipment, 1-4  
 Check Valve Assembly, 3-23  
 Checking Unpacked Equipment, 3-5  
 Cold, Operation in Extreme, 2-33  
 Common Tools and Equipment, 3-4  
 Components  
     Description of, 1-5  
     Location of, 1-5  
 Connecting Rod, 5-30  
 Controls, Operator's, 2-1, 2-2  
 Cover  
     Crankcase, 5-12  
     Flywheel Cooling Case, 4-43  
 Crankcase, 5-48  
 Crankcase Cover, 5-12  
 Crankshaft, 5-44  
 Cylinder Head and Valve Assembly, 5-5

#### D

Data, Equipment, 1-6  
 Definitions, Leakage, 2-5

### Subject, Page

#### Description

    Functional, 1-8  
     of Major Components, 1-5  
     of Operator's Controls and Indicators, 2-1  
 Destruction of Army Materiel to Prevent Enemy Use,  
     1-1  
 Diesel Engine, 4-27  
 Diesel-Driven Centrifugal Pump, 1-2, 1-5, 1-6,  
     1-8, 1-9, 1-10, 3-19  
 Direct Support  
     Maintenance Instructions, 4-1  
     Troubleshooting Chart, 4-2  
 Door, Latch, and Hinge, 4-8  
 Dusty Areas, Operation in, 2-35

#### E

Engine, Diesel, 4-27  
 Equipment  
     Characteristics, Capabilities, and Features, 1-4  
     Checking Unpacked, 3-5  
     Common, 3-4  
     Data, 1-6  
     Improvement Recommendations, Reporting, 1-1  
     Preliminary Adjusting of, 3-7  
     Preliminary Servicing of, 3-7  
     Service Upon Receipt of, 3-4  
     support, 3-4  
     Unpacking, 3-4  
 Exhaust Silencer/Spark arrestor, 3-31

#### F

Features, Equipment, 1-4  
 Flywheel, 5-40  
 Flywheel Cooling Case Cover, 4-43  
 Forms, Maintenance, 1-1  
 Frame Assembly, 4-47  
 Fuel Cock, 3-27  
 Fuel Filter, 3-27  
 Fuel Injection Nozzle, 4-29, 5-2  
 Fuel Injection Pipe, 3-29  
 Fuel Injection Pump, 4-31  
 Fuel Tank, 3-25  
 Functional Description, 1-8

**Subject, Page**

**G**

General Support Maintenance Instructions, 5-1  
Governor, 5-26

**H**

Heat, Operation in Extreme, 2-34  
High Altitudes, Operation in, 2-35  
Humid Conditions, Operation Under, 2-35

**I**

Identification Nameplates, 2-31  
Impeller, 4-20  
Indicators, Operator's, 2-1, 2-2  
Informational Nameplates, 2-31  
Inspect,  
    (See Specific Items)  
Installation, 2-25  
    Instructions, 3-5  
    Items, 2-25, 2-26  
Instructions  
    Direct Support Maintenance, 4-1  
    General Support Maintenance, 5-1  
    Installation, 3-5  
    Operating, 2-1  
    Set-Up, 3-6  
    Unit Maintenance, 3-1

**L**

Leakage Definitions, 2-5  
Location of Major Components, 1-5  
Lube Oil  
    Capacity, 3-2  
    Oil Pump, 5-16  
    Oil Strainer, 4-45  
Lubrication, 3-1  
Lubrication Points, 3-3

**M**

Maintenance  
    Forms and Records, 1-1  
    Procedures, 3-16, 4-4, 5-1  
Mounts, Shock, 4-47  
Movement, Preparation for, 2-31

**Index 2**

**Subject, Page**

**N**

Nameplates  
    Identification, 2-31  
    Informational, 2-31  
Nozzle, Fuel Injection, 4-29, 5-2

**O**

Operating  
    Instructions, 2-1  
    Procedures, 2-27  
Operation  
    in Dusty Areas, 2-35  
    in Extreme Cold, 2-33  
    in Extreme Heat, 2-34  
    in High Altitudes, 2-35  
    in Salt Water Areas, 2-36  
    in Sandy Areas, 2-35  
    Technical Principles of, 1-8  
    Under Humid Conditions, 2-35  
    Under Rainy Conditions, 2-35  
    Under Unusual Conditions, 2-32  
    Under Usual Conditions, 2-25  
Operator's Preventive Maintenance Checks and  
    Services (PMCS), 2-4, 2-6  
Outlet Air Sound Enclosure Assembly, 4-11

**P**

Piston, 5-33  
Plate  
    Base, 4-47  
    Wear, 4-23  
Preliminary  
    Adjusting of Equipment, 3-7  
    Servicing of Equipment, 3-7  
Preparation  
    for Movement, 2-31  
    for Storage or Shipment, 1-1, 3-36  
    for Use, 2-26  
Preventive Maintenance Checks and Services  
    Operator's, 2-4, 2-6  
    Procedures, 2-5  
    Unit, 3-7, 3-8  
Priming Pump, 2-27, 3-6

## **Subject, Page**

Procedures  
 Maintenance, 3-16, 4-4, 5-1  
 operating, 2-27  
 Preventive Maintenance Checks  
 and Services, 2-5  
 Unit Troubleshooting, 3-13  
 Pump  
 Adjusting Speed, 2-29  
 Casting, 4-25  
 Diesel-Driven Centrifugal, 1-2  
 Fuel Injection, 4-31  
 Lube Oil, 5-16  
 Priming, 2-27, 3-6  
 Setup, 3-5  
 Starting, 2-27, 2-28  
 Stopping, 2-30

## **R**

Rainy Conditions, Operation Under, 2-35  
 Receipt of Equipment, Service Upon, 3-4  
 Recoil Starter Assembly, 4-39  
 Records, Maintenance, 1-1  
 Repair,  
 (See Specific Items)  
 Repair Parts, 3-4  
 Replace,  
 (See Specific Items)  
 Reporting Equipment Improvement  
 Recommendations, 1-1  
 Rod, Connecting, 5-30

## **S**

Salt Water Areas, Operation in, 2-36  
 Sandy Areas, Operation in, 2-35  
 Scope, 1-1, 2-1, 2-25, 4-1  
 Seal, Shaft, 4-20  
 Service  
 (See Specific Items)  
 Upon Receipt of Equipment, 3-4  
 Setup  
 Instructions, 3-6  
 Pump, 3-5  
 Shaft  
 Adapter, 4-20  
 Balancer, 5-24  
 Seal, 4-20  
 Shipment, Preparation for, 1-1, 3-36

## **Subject, Page**

Shock Mounts, 4-47  
 Sound Enclosure  
 Air Flow Baffle, 4-16  
 Assembly, 3-21  
 Bracket Assembly, 4-14  
 Special Tools List, 3-4  
 Speed Control Device, 5-26  
 Starter Assembly, Recoil, 4-39  
 Starting Pump, 2-27, 2-28  
 Stopping Pump, 2-30  
 Storage  
 Administrative, 3-36  
 Preparation for, 1-1, 3-36  
 Strainer, Lube Oil, 4-45  
 Support Equipment, 3-4

## **T**

Technical Principles of Operation, 1-8  
 Test, Measurement, and Diagnostic Equipment  
 (TMDE), 3-4  
 Tools  
 Common, 3-4  
 Special, 3-4  
 Troubleshooting, 4-1, 5-1  
 Chart, Direct Support, 4-2  
 Procedures, Unit, 3-13

## **U**

Unit Maintenance Instructions, 3-1  
 Unit Preventative Maintenance Checks and Ser-  
 vices, 3-7, 3-8  
 Unit Troubleshooting Procedures, 3-13  
 Unpacking Equipment, 3-4  
 Unusual Conditions, Operation Under, 2-32  
 Use of Operator's Controls and Indicators, 2-1  
 Use, Preparation for, 2-26  
 Usual Conditions, Operation Under, 2-25

## **V**

Valve  
 and Cylinder Head Assembly, 5-5  
 Clearance, 3-35  
 Rocker Arm Assembly, 3-33  
 Volute, 4-18

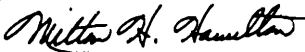
## **W**

Warranty, 1-1  
 Wear Plate, 4-23

**By Order of the Secretaries of the Army and Navy (Including the Marine Corps):**

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

Official:

  
MILTON H. HAMILTON  
*Administrative Assistant to the*  
*Secretary of the Army*  
04650

**DAVID E. BOTTORFF**  
*Rear Admiral, CEC, US Navy*  
*Commander*  
*Navy Facilities Engineering*  
*Command*

**RONALD D. ELLIOT**  
*Executive Director*  
*Marine Corps Systems Command*

**DISTRIBUTION:**

To be distributed in accordance with DA Form 12-25-E, block no. 6075, requirements for  
TM 10-4320-309-14.

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



THEN... JOT DOWN THE  
DOPE ABOUT IT ON THIS  
FORM, CAREFULLY TEAR IT  
OUT, FOLD IT AND DROP IT  
IN THE MAIL!

SOMETHING WRONG WITH THIS PUBLICATION?

FROM (PRINT YOUR UNIT'S COMPLETE ADDRESS)

PFC JOHN DOE  
COA, 3d ENGINEER BN  
FT. LEANARDWOOD, MD 63108

DATE SENT

PUBLICATION NUMBER

TM 10-4320-309-14

PUBLICATION DATE

30 June 1993

PUBLICATION TITLE

PUMP UNIT, CENTRIFUGAL, SELF-PRIMING

BE EXACT... PIN-POINT WHERE IT IS

PAGE NO	PARA-GRAPH	FIGURE NO	TABLE NO
6	2-1 a		
B1		4-3	
125	line 20		

IN THIS SPACE TELL WHAT IS WRONG  
AND WHAT SHOULD BE DONE ABOUT IT:

In line 6 of paragraph 2-1a the manual states the engine has 6 Cylinders. The engine on my set only has 4 Cylinders. Change the manual to show 4 Cylinders.

Callout 16 on figure 4-3 is pointing at a bolt. In key to figure 4-3, item 16 is called a shim - Please correct one or the other.

I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got what I ordered, so the NSN is wrong. Please give me a good NSN

PRINTED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER

JOHN DOE, PFC (268) 317.7111

SIGN HERE

JOHN DOE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

DRSTS-M Overprint 1, 1 Nov 80

PS--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS

TEAR ALONG PERFORATED LINE

1 Nov 80

FILL IN YOUR  
UNITS ADDRESS



FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

COMMANDER  
U.S. ARMY AVIATION AND TROOP COMMAND  
ATTN: AMSAT-I-MP  
4300 GOODFELLOW BOULEVARD  
ST. LOUIS, MO 63120-1798

TEAR ALONG PERFORATED LINE

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS



THEN... JOT DOWN THE  
DOPE ABOUT IT ON THIS  
FORM. CAREFULLY TEAR IT  
OUT. FOLD IT AND DROP IT  
IN THE MAIL.

# SOMETHING WRONG WITH THIS PUBLICATION?

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER  
TM 10-4320-309-14

PUBLICATION DATE  
30 June 1993

PUBLICATION TITLE  
PUMP UNIT, CENTRIFUGAL, SELF-  
PRIMING

BE EXACT PIN-POINT WHERE IT IS

PAGE  
NO

PARA-  
GRAPH

FIGURE  
NO

TABLE  
NO

IN THIS SPACE TELL WHAT IS WRONG  
AND WHAT SHOULD BE DONE ABOUT IT:

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER

SIGN HERE

DA FORM 2028-2  
1 JUL 79

PREVIOUS EDITIONS  
ARE OBSOLETE

P.S. - IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR  
RECOMMENDATION MAKE A CARBON COPY OF THIS  
AND GIVE IT TO YOUR HEADQUARTERS

1 Nov 80

FILL IN YOUR  
UNITS ADDRESS



FOLD BACK

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS

COMMANDER  
U.S. ARMY AVIATION AND TROOP COMMAND  
ATTN: AMSAT-I-MP  
4300 GOODFELLOW BOULEVARD  
ST. LOUIS, MO 63120-1798

TEAR ALONG PERFORATED LINE



# 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 decigrams = .035 ounce  
 1 dekagram = 10 grams = .35 ounce  
 1 hectogram = 10 dekagrams = 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 acres  
 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 temperature	5/9 (after subtracting 32)	Celsius temperature	°C
----	------------------------	----------------------------	---------------------	----



This fine document...

Was brought to you by me:



### [Liberated Manuals -- free army and government manuals](#)

Why do I do it? I am tired of sleazy CD-ROM sellers, who take publicly available information, slap “watermarks” and other junk on it, and sell it. Those masters of search engine manipulation make sure that their sites that sell free information, come up first in search engines. They did not create it... They did not even scan it... Why should they get your money? Why are not letting you give those free manuals to your friends?

I am setting this document FREE. This document was made by the US Government and is NOT protected by Copyright. Feel free to share, republish, sell and so on.

I am not asking you for donations, fees or handouts. If you can, please provide a link to [liberatedmanuals.com](http://liberatedmanuals.com), so that free manuals come up first in search engines:

<A HREF=<http://www.liberatedmanuals.com/>>Free Military and Government Manuals</A>

- Sincerely  
Igor Chudov  
<http://igor.chudov.com/>
- [Chicago Machinery Movers](#)