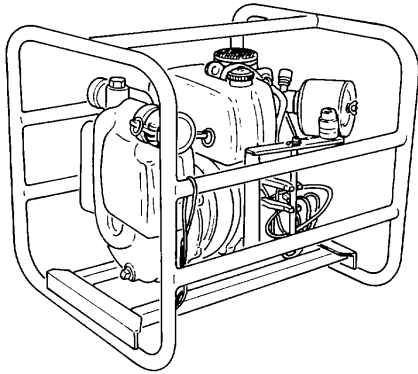


**OPERATOR'S UNIT,
DIRECT SUPPORT AND
GENERAL SUPPORT
MAINTENANCE**



**PUMPING ASSEMBLY,
FLAMMABLE LIQUID,
BULK TRANSFER,
100 GPM, DIESEL
ENGINE DRIVEN (DED)**

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**NSN: 4320-01-306-6892
MODEL NUMBER: LPI-PA--9215**

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100 GPM, DIESEL ENGINE DRIVEN (DED)
NSN: 4320-01-306-6892
MODEL NUMBER: LPI-PA-9215**

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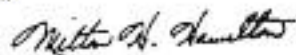
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DIESEL ENGINE DRIVEN (DED)
NSN: 4320-01-30(-6892
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Operator's, Unit, Direct Support and General Support Maintenance

**PUMPING ASSEMBLY, FLAMMABLE LIQUID, BULK TRANSFER, 100 GPM,
DIESEL ENGINE DRIVEN (DED)
NSN: 4320-01-306-6892
MODEL NUMBER: LPI-PA-9215**

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WARNING

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

Do not fill fuel tank while engine is running or hot.

Do not smoke or use an open flame in the vicinity of the pump assembly. Failure to comply may result in personnel injury.

Cleaning solvent, Federal Specification P-D-680, is toxic and flammable. Use only in a well-ventilated area. Avoid prolonged breathing of fumes. Keep away from flames. Do not use in excessive amounts. Avoid skin contact.

Hearing protection must be worn within 18 feet (5.49 m) of the pump assembly.

Wear asbestos gloves to avoid serious burns when handling heated parts.

Weight of the pump assembly is approximately 196 lbs (88.98 kgs). Four persons are required to lift the pump assembly.

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame. Engine must be turned off and cool before refueling. Do not smoke.

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

Death or serious injury to personnel or damage to equipment could occur if improper slings or hoisting equipment is used. Be sure hoisting equipment is suitable for lifting engine assembly.

Serious injury could result from injector fuel spray. Keep hands away from fuel spray.

Before starting the engine and after making repairs or adjustments on the fuel system, a wrench must be available to allow rapid removal of the steel fuel line at the injection pump in case of a runaway condition. Failure to heed this warning can result in injury to personnel and equipment damage.

Extreme care must be taken to prevent injury to fingers or hands when driving the ground rods. Do not place hands between the ram and drive collar. Gloves should be worn.

For artificial respiration, refer to FM 21-11.

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OPERATOR'S, UNIT, DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL
for
PUMPING ASSEMBLY, FLAMMABLE LIQUID, BULK TRANSFER,
100 GPM, DIESEL ENGINE DRIVEN (DED)

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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 Troop Support Command, ATTN: AMSTR-MCTS, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished to you.

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HOW TO USE THIS MANUAL

a. General. This manual contains operation and maintenance procedures for the pumping assembly. At the beginning of each chapter, you will find an index of topics covered in the chapter.

Chapter 1 Introduction

Chapter 2 Operating Instructions

Chapter 3 Operator's Maintenance

Chapter 4 Unit Maintenance

Chapter 5 Direct Support Maintenance

Chapter 6 General Support Maintenance

In using these procedures, you must familiarize yourself with an entire maintenance procedure before beginning a specific task.

Read all **Warnings** before you begin operating your equipment. Read each procedure completely before beginning a task. In locating specific items in this manual. The following sections are included in this manual. References in the manual are to pages, paragraphs and appendixes or other publications.

b. Front Cover Index - Tabbed index of major functions and appendixes are keyed to tabbed pages in the manual. These major items are also enclosed in boxed areas in the Table of Contents.

c. Table of Contents - List of chapters, sections and appendixes.

d. Alphabetical Index - Extensive index for each subject, located at the end of this manual.

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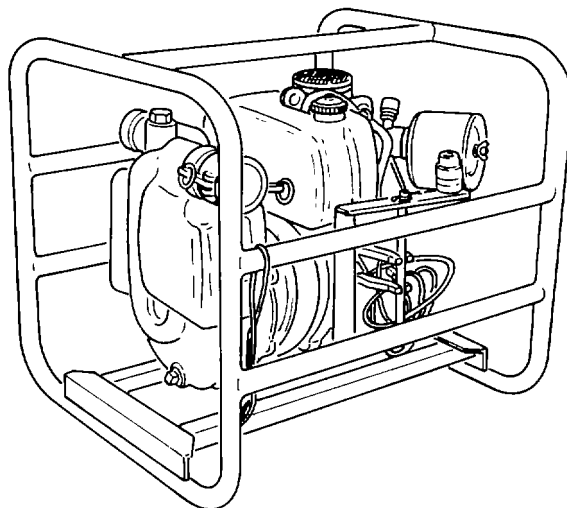


Figure 1-1. Pumping Assembly, 100 GPM.

1-0

CHAPTER 1

INTRODUCTION

| | |
|-------------|-----------------------------------|
| Section I | General Information |
| Section II | Equipment Description and Data |
| Section III | Technical Principles of Operation |

Section I. GENERAL INFORMATION

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1-1. SCOPE.

- a. Type of Manual. This manual is an Operator's, Unit, Direct Support and General Support Maintenance Manual.
- b. Model Number and Equipment Name. The official name is Pumping Assembly, Flammable Liquid, Bulk Transfer, 100 GPM, Diesel Engine Driven (DED), Model Number LPI-PA-9215. Hereafter it will be referred to as the pumping assembly.
- c. Purpose of Equipment. Designed to pump liquid petroleum at the rate of 100 gallons per minute (GPM).

1-2. MAINTENANCE FORMS, RECORDS, AND REPORTS.

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

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

Refer to TM 750-244-3 for instructions covering the destruction of the pumping assembly to prevent enemy use.

1-4. PREPARATION FOR STORAGE OR SHIPMENT.

For other storage requirements or for shipment instructions, refer to Chapter 4, Section VII. Administrative storage requirements will be in accordance with the following:

1-4. PREPARATION FOR STORAGE OR SHIPMENT- Continued.

a. Placement of equipment in administrative storage should be for short periods of time when a shortage of maintenance effort exists. Items should be in mission readiness within 24 hours or within the time factors as determined by the directing authority. During the storage period appropriate maintenance records will be kept.

b. Before placing equipment in administrative storage, current maintenance services and equipment serviceable criteria (ESC) evaluations should be completed, shortcomings and deficiencies should be corrected, and all modification work orders (MWO's) should be applied.

c. Storage site selection. Inside storage is preferred for items selected for administrative storage. If inside storage is not available, trucks, vans, conex containers and other containers may be used.

1-5. QUALITY ASSURANCE/QUALITY CONTROL (QA/OC).

Quality Assurance/Quality Control procedures will be those in force by the local commander.

1-6. NOMENCLATURE CROSS REFERENCE LIST.

| <u>Common Name</u> | <u>Official Nomenclature</u> |
|--------------------|--|
| Pumping Assembly | Pumping Assembly, Flammable Liquid, Bulk Transfer, 100 GPM, Diesel Engine Driven (DED) |
| Engine | Diesel Engine |
| Pump | Centrifugal Pump |

1-7. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR).

If your pumping assembly 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 an SF 368 (Quality Deficiency Report). Mail it to us at: Commander, U.S. Army Troop Support Command, ATTN: AMSTR-QX, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. We'll send you a reply.

1-8. LIST OF ABBREVIATIONS.

| | |
|-----------|----------------------|
| DED | Diesel engine driven |
| GAL..... | Gallon(s) |
| GPM..... | Gallons per minute |
| HP | Horse power |
| Kg..... | Kilogram(s) |

1bs pound(s)
 mm millimeter(s)
 Para Paragraph

Section II. EQUIPMENT DESCRIPTION AND DATA

| Para . | Para. |
|---|---|
| Equipment Characteristics, Capabilities, and Features 1-9 | Location and Description of Major Components 1-10 |
| Equipment Data 1-11 | Safety, Care, and Handling 1-12 |

1-9. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

a. Characteristics.

- (1) Frame mounted.
- (2) Portable.
- (3) Variable speed operation.
- (4) Diesel engine driven.

b. Capabilities and Features.

- (1) Rated at 100 gallons per minute (GPM).
- (2) Hand crank start.
- (3) Throttle controlled.

1-10. LOCATION AND DESCRIPTION OF MAJOR COMPONENTS.

a. Rear and Left Side. (Refer to figure 1-2).

- (1) Pump. The pump is engine driven and pumps fuel from a container to aircraft.
- (2) Frame Assembly. The frame assembly is used to support and transport the pumping assembly.
- (3) Crank Assembly. The crank assembly is used in starting the engine.
- (4) Ground Cable. The ground cable is used to ground the pump assembly during operation.

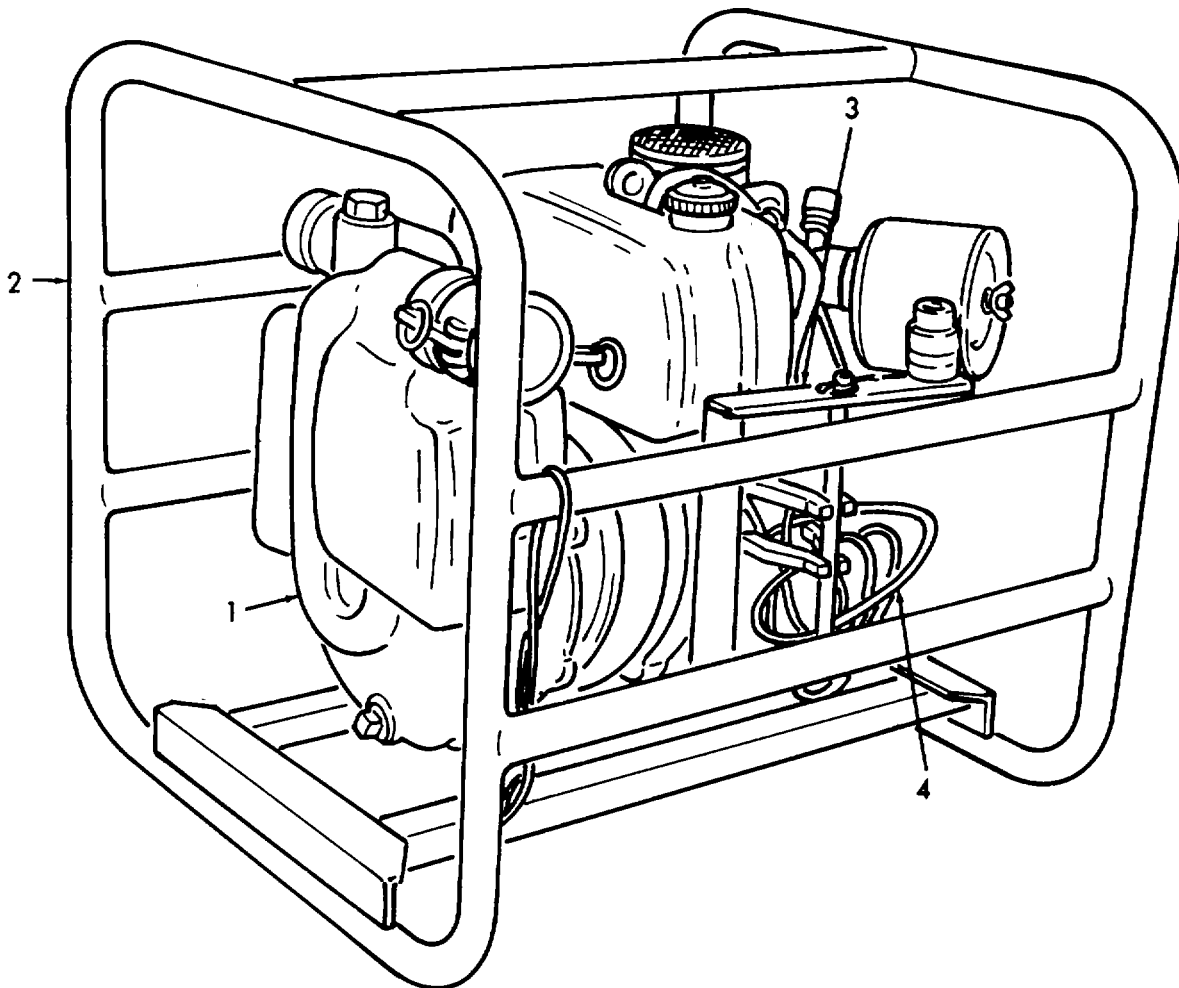


Figure 1-2. Pumping Assembly, Rear and Left Side.

b Front and Right Side (Refer to figure 1-3).

- (1) Air Filter The air filter is used to filter dirt from the air and prevent it from entering the engine.
- (2) Air Filter Indicator The air filter indicator is used to indicate when the air filter element is dirty or clogged. A red band appearing in window of the indicator, indicates filter needs to be changed.
- (3) Engine The engine is used to drive the pump.
- (4) Muffler/Spark Arrestor The muffler/spark arrestor is used to reduce the engine exhaust noise. ■
- (5) Fuel Tank The fuel tank is used to supply fuel to the engine.
- (6) Throttle Lever The throttle lever is used to control engine speed.

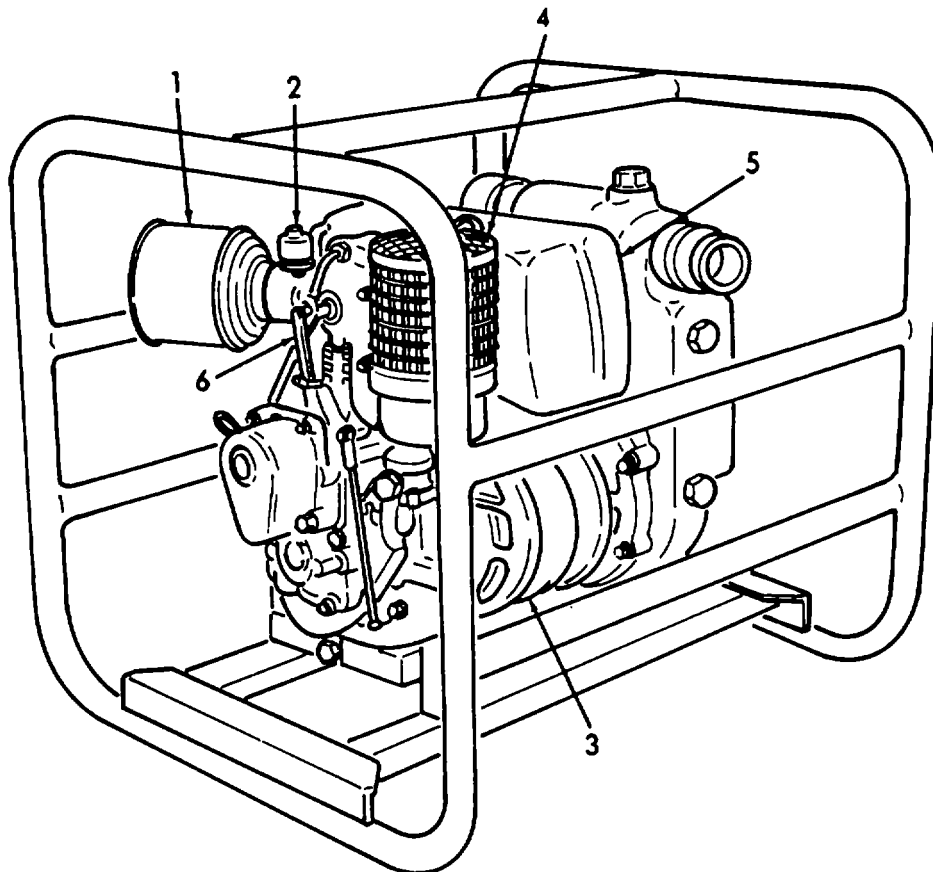


Figure 1-3. Pumping Assembly, Front and Right Side.

1-11. EQUIPMENT DATA. (Refer to table 1-1).*Table 1-1. Equipment Data*

| | | |
|----|-----------------------------|--|
| a | <u>Nomenclature</u> | Pumping Assembly, Flammable Liquid, Bulk Transfer, 100 GPM, Diesel Engine Driven (DED) |
| | Manufacturer's Model Number | LPI-PA-9215 |
| b. | <u>Pump.</u> | |
| | Manufacturer | LaBarge Products Inc. |
| | Part Number | 13219E3949 |
| | Type | Centrifugal |
| | Service | Liquid Petroleum Fuel |
| | Rated Output | 100 GPM at 100 feet total head |
| | Rotation | Counterclockwise (facing pump end) |
| c. | <u>Engine.</u> | |
| | Manufacturer | Hatz Diesel |
| | Model | E673 |
| | Horsepower | 6HP at 3600 RPM |
| | Type | Four stroke air cooled diesel |
| | Number of Cylinders | One |
| | Bore | 2.8740 in. (73.0 mm) |
| | Stroke | 2.6378 in. (67.0 mm) |
| | Compressor Ratio | 19.1 |
| | Direction of Rotation | (Facing hand crank) clockwise |
| d. | <u>Capacities.</u> | |
| | Fuel Tank Engine | 1.04 gal (4.0 liters) |
| | Engine Crankcase | 0.26 gal (1 liter) |

e. Dimensions and Weight.

| | |
|----------------|---------------------------|
| Overall Width | 25 1/4 inches (64.135 mm) |
| Overall Length | 26 3/8 inches (67.990 mm) |
| Overall Height | 25 1/4 inches (64.135 mm) |
| Gross Weight | 196 lbs (88.98 kg) |

1-12. SAFETY, CARE, AND HANDLING.

Observe all WARNINGS, CAUTIONS, and NOTES in this manual. This equipment can be dangerous if these instructions are not followed.

Section III. TECHNICAL PRINCIPLES OF OPERATION

| | Para | | Para. |
|--------------|------|------------|-------|
| Engine | 1-14 | Pump | 1-15 |
| General..... | 1-13 | | |

1-13. GENERAL.

This section provides the theory of operation and a functional description of components comprising the pump assembly. Two systems comprise the pumping assembly. The pump and the engine. These systems are described in the paragraphs below.

1-14. ENGINE.

Refer to figure 1-4. The engine (1) provides the necessary power for the pump. The engine is lubricated by a centrifugal pressure system. The engine is cooled by means of a flywheel fan, which blows cool air through crankcase housing parts onto the cylinder. The engine fuel system includes a fuel tank, fuel lift pump, fuel injection pump, and a fuel filter. The fuel lift pump pumps fuel from the fuel tank, through the fuel filter, to the fuel injection pump to the injector.

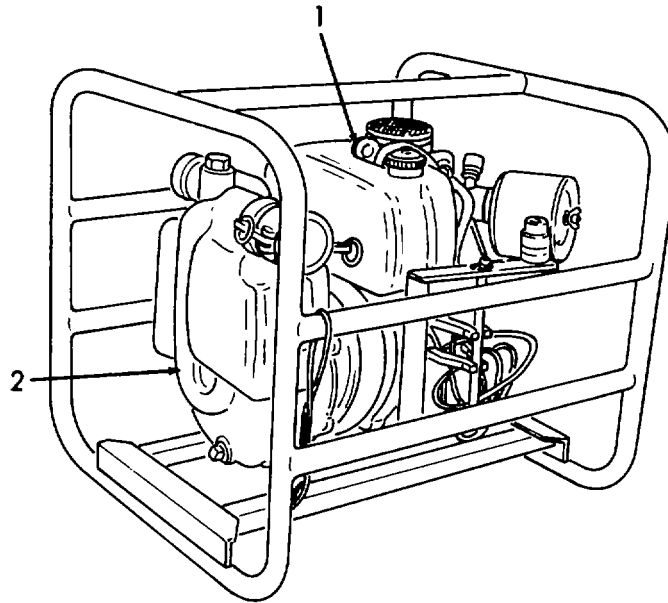


Figure 1-4. Engine and Pump.

1-15. PUMP.

Refer to figure 1-4. The pump (2) uses power from the engine to pump fuel from the suction intake coupling to the discharge coupling. The pump includes a impeller and pump case with suction (intake) and discharge couplings. The pump case houses the impeller which draws fuel in through the suction (intake) coupling and forces it out of the pump through the discharge coupling.

CHAPTER 2

OPERATING INSTRUCTIONS

| | |
|-------------|--|
| Section I | Description and Use of Operator's Controls and Indicators |
| Section II | Operator's Preventive Maintenance Checks and Services (PMCS) |
| Section III | Operation Under Usual Conditions |
| Section IV | Operation Under Unusual Conditions |

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

| | Para | Para. |
|--------------------|------|---|
| Introduction | 2-1 | |
| | | |
| | | Pumping Assembly Controls and Indicators..... |
| | | 2-2 |

2- 1. INTRODUCTION.

This section describes the controls and indicators you, as the operator, will be using. All of your controls and indicators are located on the engine. The following paragraphs will give you a brief description of each control and indicator.

2-2. PUMPING ASSEMBLY CONTROLS AND INDICATORS. (Refer to figure 2-1 and table 2-1).

Table 2-1. Operator's Controls and Indicator

| KEY | CONTROL, INDICATOR OR CONTROL | FUNCTION |
|-----|-------------------------------|---|
| 1 | Air Filter Indicator | Indicates a dirty air filter element. A red band appears in window, which indicates element needs replacing. Air filter indicator must be reset after servicing of the air filter. |
| 2 | Throttle Control Hand Lever | Controls engine speed. With the hand lever in START position, the engine is at its highest operating speed. Place the lever between START and STOP, to obtain the desired engine speed. |
| 3 | Fuel Primer Lever | Mechanically connected to fuel lift pump. Used to prime engine by forcing fuel from fuel tank into fuel system. |
| 4 | Extra Fuel Button | Provides more fuel to engine during starting. Pulling button out allows more fuel to engine. Button returns to normal position when engine reaches operating speed. |
| 5 | Decompression Lever | Controls engine compression. Lever is placed in decompression position during engine starting and returns to compression when engine reaches operating speed. |

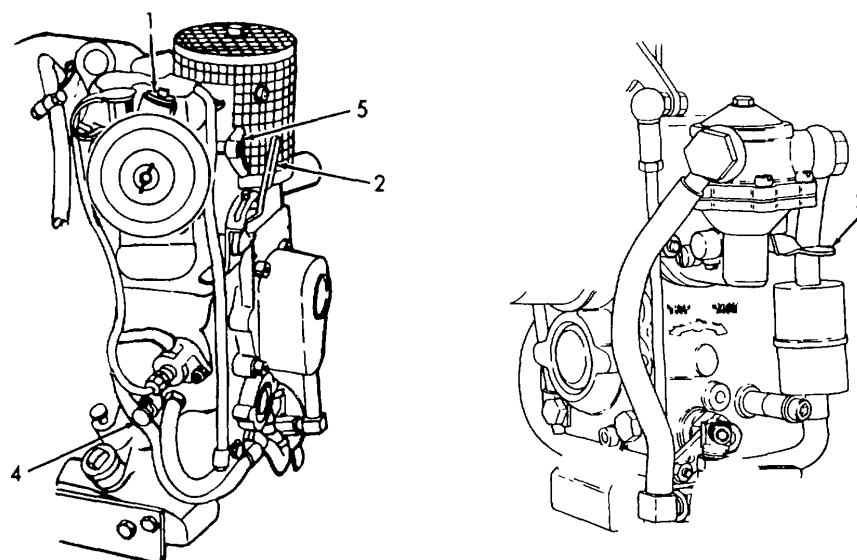


Figure 2-1. Operator's Controls and Indicator.

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

| | | | |
|----------------|-------|---|-------|
| | Para. | | Para. |
| Introduction . | 2-3 | Operator's Preventive Maintenance Checks and Services | 2-4 |

2-3. INTRODUCTION

a. General.

- (1) Before You Operate. Always keep in mind the CAUTIONS and WARNINGS. Perform your (B) PMCS.
- (2) While You Operate. Always keep in mind the CAUTIONS and WARNINGS. Perform your (D) PMCS.
- (3) After You Operate. Be sure to perform your (A) PMCS.
- (4) If Your Equipment Fails to Operate. Report any deficiencies using the proper forms. See DA PAM 738-750.

b. PMCS Procedures.

- (1) Purpose of PMCS. Your Preventive Maintenance Checks and Services list the inspections and care of your equipment required to keep it in good operating condition.
- (2) Item Number Column. Checks and services are numbered in chronological order regardless of interval. This column is used as a source of item numbers for the "Item Number" column on DA Form 2404, Equipment Inspection and Maintenance Worksheet, in recording results of PMCS.
- (3) Interval Column. The interval columns tell you when to do a certain check or service: before, during, or after operation. Sometimes a dot may be placed in more than one interval column which would mean you should do the check or service at each of those intervals.
- (4) Item to Be Inspected Column. This column lists the common name of the item to be inspected such as "Air Filters".
- (5) Procedures Column. This column tells you how to do the required checks and services. Carefully follow these instructions.
- (6) Equipment is Not Ready/Available if Column. This column tells you when and why your equipment cannot be used.

2-3. INTRODUCTION -Continued.b. PMCS Procedures - Continued.**NOTE**

The terms "Ready/Available" and "Mission Capable" refer to the same status: equipment is on hand and is able to perform its combat missions. (See DA PAM 738-750).

(7) Increased Inspections. Perform weekly as well as Before Operations PMCS if:

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

(8) Categories of leakage are classified as follows:

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

CAUTION

Equipment operation is allowable with minor leakage (Class I or II). Of course, you must consider the fluid capacity in the item 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 direct support maintenance.

2-4. OPERATOR'S PREVENTIVE MAINTENANCE CHECKS AND SERVICES.**NOTE**

If the equipment must be kept in 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.

Table 2-2. Operator's Preventive Maintenance Checks and Services

B - Before

D -During

A - After

| ITEM | INTERVAL | | | Item to be inspected/Procedure | Equipment will be reported not ready (red) if: |
|------|----------|----|----|--|--|
| | B | D | A | | |
| 1 . | • | .• | • | Inspect pump for leaks. | Class III leak. |
| 2 . | • | . | • | Check engine oil level. If oil level is below top mark on dipstick, add oil (item 6, appendix E) to bring oil level to top mark on dipstick. | |
| 3 | • | • | • | Check air filter indicator for red band in window. Notify unit maintenance if red band appears in air filter indicator. | |
| 4 | | • | | Inspect muffler/spark arrestor. Notify unit maintenance if muffler is glowing red hot. | |
| 5 | • | • | • | Inspect fuel system hoses and fittings for leaks. | Class III leak. |
| 6 | .• | • | • | Inspect engine for oil leaks. | Class III leak. |
| 7 . | .• | • | .• | Inspect engine and pump for loose and missing mounting hardware. Notify unit maintenance if mounting hardware is loose or missing. | |
| 8 | • | | • | Inspect crank assembly for damage. | |

Section III. OPERATION UNDER USUAL CONDITIONS

Assembly and Preparation for Use

Para. 2-5

Operating Procedures

Para. 2-6

2-5. ASSEMBLY AND PREPARATION FOR USE.

These procedures consist of the following:

a. **General Precautions.**

- (1) Do not operate the pumping assembly in an enclosed area.

2-5. ASSEMBLY AND PREPARATION FOR USE - Continued.

a. General Precautions - Continued.

(2) Do not smoke or use open flame in vicinity of fuel tank.

b. Siting.

WARNING

Weight of pumping assembly is 196 lbs (88.98 kgs). Four persons are required for lifting pumping assembly.

- (1) Select a site that will provide relatively level terrain to locate the pumping assembly. Clear away dry leaves, grass, and brush from the ground where the pumping assembly will be located.
- (2) Position the pumping assembly and filter/separator assemblies for desired fueling operation.
- (3) Refer to figures 2-2 and 2-3 for setting up a refueling operation.

WARNING

Extreme care must be taken to prevent injury to fingers or hands when driving the ground rods. Do not place hands between the ram and drive collar. Gloves should be worn.

- (4) Remove ground rod from filter/separator and drive it into the ground at least 3 ft. Connect ground cables from pumping assembly and filter/separator to the ground rod.
- (5) Perform (B) Before operation PMCS contained in table 2-1.

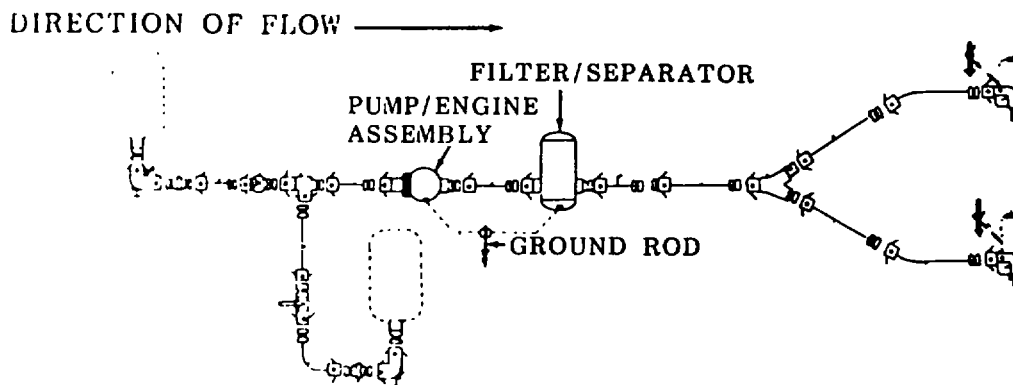


Figure 2-2. Setting Up Refueling Operation.

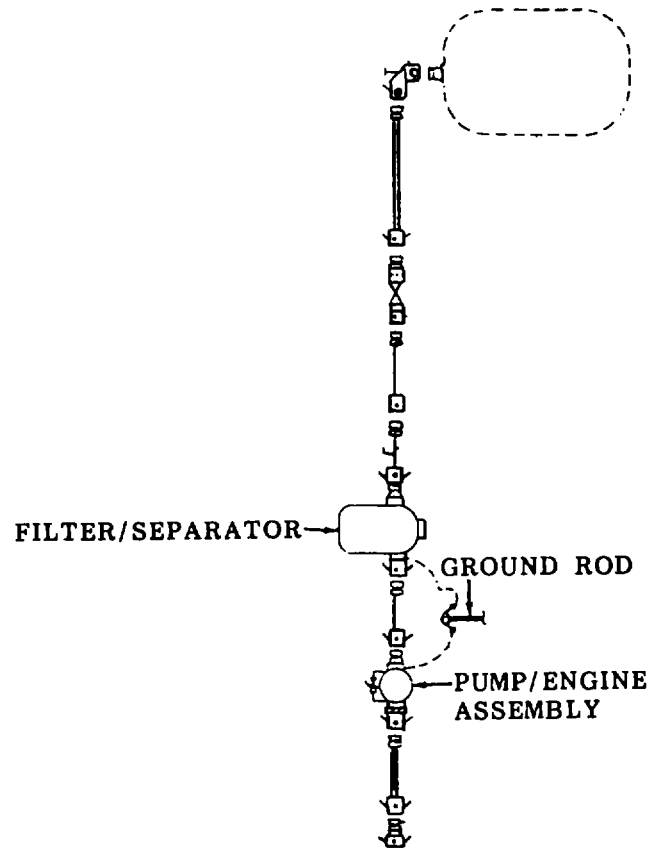


Figure 2-3. Setting Up Refueling Operation.

2-6. OPERATING PROCEDURES. (Refer to figure 2-4).**CAUTION**

Do not operate pumping assembly without priming the pump.

a. Priming Pumping Assembly.

- (1) Remove pipe plug (1) from housing (2).
- (2) Pour fuel into housing (2) until housing is full. Install pipe plug (1) into housing (2).

b. Starting Pumping Assembly.

- (1) Move throttle control lever (3) left to the start position.
- (2) Pull out on extra fuel device button (4) until fully extended, or a click is heard.
- (3) Turn decompression lever (5) to position "B".

CAUTION

If engine does not start on initial attempt, allow engine rotation to stop completely before engaging crank handle.

- (4) Engage crank handle (6) in gear housing (7).
- (5) Using both hands, turn crank handle (6) clockwise with increasing speed.
- (6) When decompression lever (5) reaches position "C", the highest possible speed has to be obtained. Engine will start and goes to highest operating speed. Extra fuel button (4) will return to normal position by itself.
- (7) Remove crank handle (6) and install in holder on frame.

c. Stopping.**CAUTION**

Never stop engine with a full load. Always continue operation with no load for 3 minutes. Never stop engine with the decompression lever.

- (1) Pull out and slowly move throttle control lever (3) right to the idle position. Allow engine to run for 3 minutes.
- (2) Move throttle control lever (3) right to the stop position.

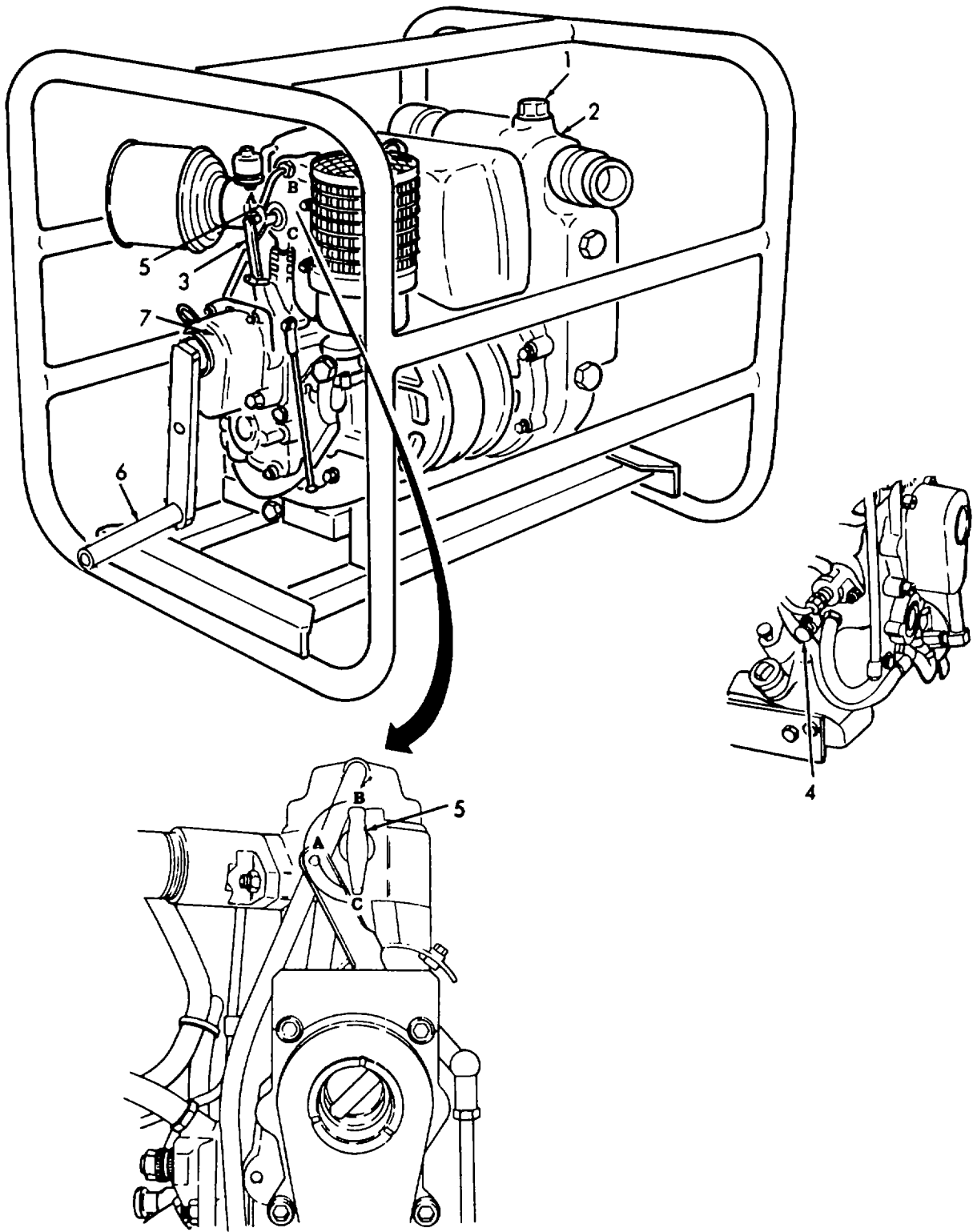


Figure 2-4. Priming, Starting, and Stopping Pumping Assembly.

Section IV. OPERATION UNDER UNUSUAL CONDITIONS

| | | | |
|---------------------------|----------|---|------------|
| Operation in Cold Weather | Para 2-7 | Operation in Rain, Salt Air, or High Humidity | Para. 2-10 |
| Operation in Extreme Heat | 2-8 | Operation in Sandy or Dusty Areas | 2-9 |

2-7. OPERATION IN COLD WEATHER.

- a. Use proper engine oil for cold weather. See lubrication instructions in Chapter 4.

CAUTION

Condensation can freeze and/or damage filters, pump, and injector and clog fuel lines.

- b. Keep fuel tank full to prevent condensation.

- c. Cold weather starting can be improved by the addition of engine oil to the cold start assist. (Refer to figure 2-5).

(1) With engine stopped, remove closing plug (1) from cold start assist (2).

CAUTION

Take care to fill cold start assist cup from the side. Engine lockup could occur if oil is poured into center of cold start assist.

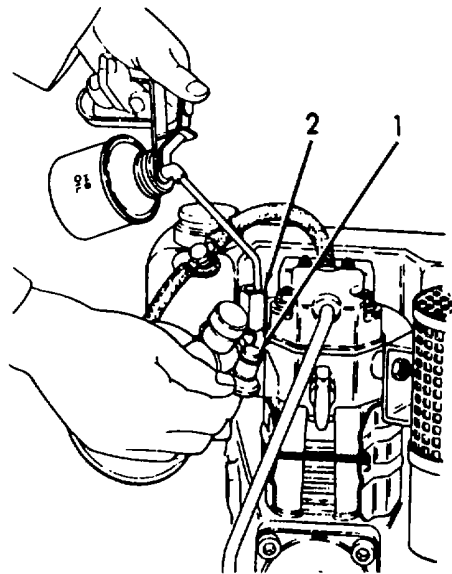


Figure 2-5. Filling Cold Start Assist Cup.

- (2) Fill cold start assist cup with clean engine oil. To prevent engine lockup, carefully pour oil in the side of the cup.
- (3) Replace closing plug (1) into cold start assist (2) and press it in firmly.
- (4) Start engine immediately using instructions in paragraph 2-6.

2-8. OPERATION IN EXTREME HEAT.

- a. With engine stopped, frequently inspect cooling fins and blower ring to insure they are free of dirt. Clean as necessary.
- b. With engine stopped, frequently check engine oil level. Refer to paragraph 3-1 and add oil.
- c. Check the air filter indicator. If red band appears in window of air filter indicator, notify unit maintenance.

2-9. OPERATION IN DUSTY OR SANDY AREAS.

- a. Check the air filter indicator. If red band appears in window of air filter indicator, notify unit maintenance.
- b. With the engine stopped, frequently inspect engine covers and blower ring to insure they are free of dirt. Clean as necessary.
- c. With engine stopped, frequently check engine oil level. Refer to paragraph 3-1 and add oil.

2-10. OPERATION IN RAIN, SALT AIR, OR HIGH HUMIDITY.

- a. Shelter pumping assembly as much as possible from rain or sea spray.
- b. Frequently wipe all components of the pumping assembly to dry moisture on unit.
- c. Frequently wash and dry the pumping assembly' when you are operating in salt air or sea spray conditions.

2-11/(2-12 Blank)

CHAPTER 3

OPERATOR MAINTENANCE INSTRUCTIONS

Section I Lubrication Instructions
Section II Troubleshooting

Section I. LUBRICATION INSTRUCTIONS

Check oil level daily to maintain to "Top Mark" on dipstick. Use Oil, Engine, MIL-L-2104D.

Section II. TROUBLESHOOTING

No operator's troubleshooting procedures are required for the pumping assembly.

3-1/(3-2 Blank)

CHAPTER 4

UNIT MAINTENANCE INSTRUCTIONS

| | | |
|-------------------------|-------------|--|
| Equipment (PMCS) | Section I | Lubrication Instructions |
| | Section II | Repair Parts, Special Tools, TMDE, and Support |
| | Section III | Service Upon Receipt of Equipment |
| | Section IV | Preventive Maintenance Checks and Services |
| | Section V | Troubleshooting |
| | Section VI | Maintenance Procedures |
| | Section VII | Preparation for Storage or Shipment |

Section I. LUBRICATION INSTRUCTIONS

4-1. LUBRICATION INSTRUCTIONS.

a. Engine. (Refer to figure 4-1).

- (1) Every 150 hours of operation change engine oil. Use Oil, Engine, MIL-L-2104D (item 6, appendix E).
 - (a) Remove engine oil drain plug (2) and allow oil to drain into a suitable container. Install oil drain plug (2) and new washer (3).
 - (b) Remove engine oil cap (4) and fill engine sump with MIL-L-2104D to "Top Mark" on dipstick (1). Crankcase capacity is 0.26 gallon (1 liter).

b. Engine (Lubrication in Sandy Areas). During operation in sandy areas, engine oil should be changed every 100 hours. Refer to paragraph 4-1a. And change engine oil.

c. Pump. The pump does not require lubrication.

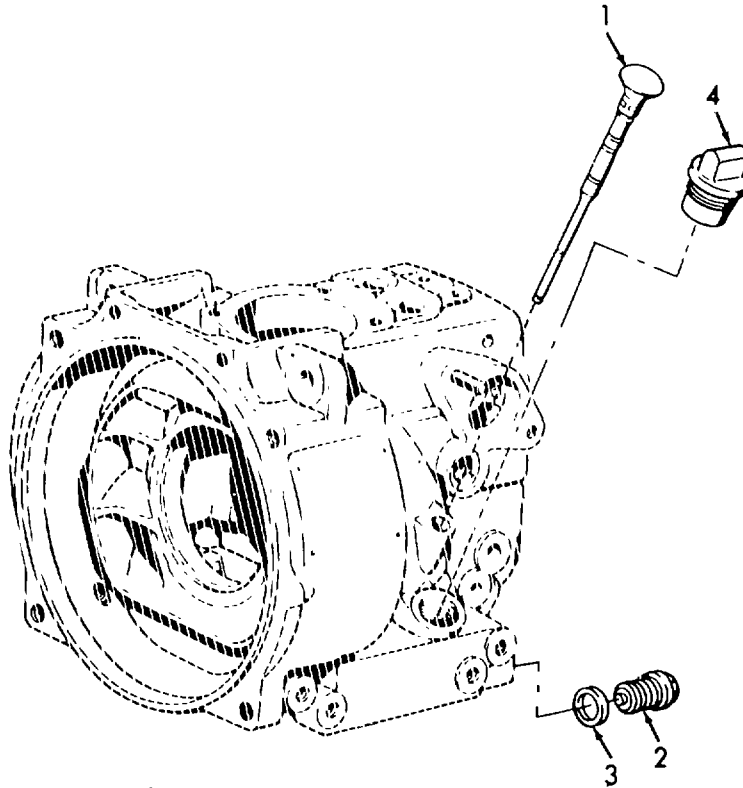


Figure 4-1. Engine Lubrication.

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

4-2. COMMON TOOLS AND EQUIPMENT.

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

4-3. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT.

Special tools required for unit maintenance are listed and illustrated in the Repair Parts and Special Tools List TM 5-4320-313-24P covering unit maintenance. TMDE and support equipment are listed in the Maintenance Allocation Chart (MAC).

4-4. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools List TM 5-4320-313-24P covering unit maintenance for this equipment.

Section III. SERVICE UPON RECEIPT OF EQUIPMENT

4-5. SERVICE UPON RECEIPT OF MATERIEL.

- a. Inspection. Inspect the equipment for damage and loose or missing components. Report all discrepancies in accordance with the instructions of DA PAM 738-750.
- b. Servicing. Refer to table 2-2 and table 4-1 and perform both the operator and unit preventive maintenance checks and services.

Section IV. PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

4-6. UNIT PMCS. (Refer to table 4-1).

Table 4-1. Unit Monthly Preventive Maintenance Checks and Services

| ITEM NO. | ITEM TO BE INSPECTED | PROCEDURE |
|----------|--------------------------------|---|
| 1 | Pumping Assembly | <p>Check that pump housing mounting screws are not loose or missing. Tighten loose screws, report missing screws to direct support maintenance.</p> <p>Check that pump housing fill and drain plugs are securely installed in housing.</p> <p>Inspect pump housing for cracks. Notify direct support maintenance if housing is cracked.</p> |
| 2 | Engine Oil Level | <p>Check engine oil level. If oil level is below top mark on dipstick, add oil (item 6, appendix E) to bring oil level to top mark on dipstick.</p> |
| 3 | Engine Fuel Hoses and Fittings | <p>Inspect fuel system hoses and fittings for leaks.</p> |
| 4 | Fuel Tank | <p>Inspect fuel tank for secure mounting, cracks, or missing cap.</p> |
| 5 | Muffler | <p>Inspect muffler for holes and missing or damaged heat shield or carbon buildup.</p> <p style="text-align: center;">NOTE</p> <p style="text-align: center;">Service muffler/spark arrestor every 250 hours of use.</p> |
| 6 | Air Filter | <p>Inspect air filter for damage to rain hood.</p> |

Change 1 4-3

Table 4-1. Unit Monthly Preventive Maintenance Checks and Services - Continued

| ITEM NO. | ITEM TO BE INSPECTED | PROCEDURE |
|----------|----------------------|--|
| 7 | Air Filter Indicator | Inspect air filter indicator for damage. |

Section V. TROUBLESHOOTING

| | Para. | Para. |
|--------------------------------|-------|-------------------------|
| Introductory Information | 4-7 | Troubleshooting.....4-9 |
| Symptom Index..... | 4-8 | |

4-7. INTRODUCTORY INFORMATION.

a. Table 4-2 lists the common malfunctions which you may find during the operation or maintenance of the pumping assembly or its components. You should perform the tests/inspections and corrective actions in the order listed.

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

4-8. SYMPTOM INDEX.

| MALFUNCTION NO. | MALFUNCTION | PAGE |
|-----------------|--|------|
| 3 | Black smoke from exhaust after warmup | 4-6 |
| 1 | Engine cranks but fails to start | 4-5 |
| 4 | Engine overheats..... | 4-7 |
| 2 | Engine power output is slow and runs unsteadily..... | 4-6 |
| 5 | Engine stops running..... | 4-7 |

4-9. TROUBLESHOOTING. (Refer to table 4-2).*Table 4-2. Unit Maintenance Troubleshooting*

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

1. ENGINE CRANKS BUT FAILS TO START.

Step 1. Check that extra fuel button has been pulled out prior to starting.

Pull out extra fuel button and attempt to start engine (paragraph 2-6).

Step 2. Check window of air filter indicator for red band indicating blocked air filter.

If red band appears in window of air filter indicator, replace air filter element (paragraph 4-10).

Step 3. Check for empty fuel tank.

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Engines must be turned off and cool before refueling. Do not smoke.

If fuel tank is empty, fill with fuel (item 3, appendix E).

Step 4. Check vent valve for proper function.

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Engines must be turned off and cool before refueling. Do not smoke.

- a. Disconnect hose from double ring piece at fuel tank. Turn engine with starting handle.
- b. If fuel does not flow from hose, remove vent valve. Check valve by shaking for free movement of internal valve ball.

4-9. TROUBLESHOOTING - Continued.

Table 4-2. Unit Maintenance Troubleshooting - Continued

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

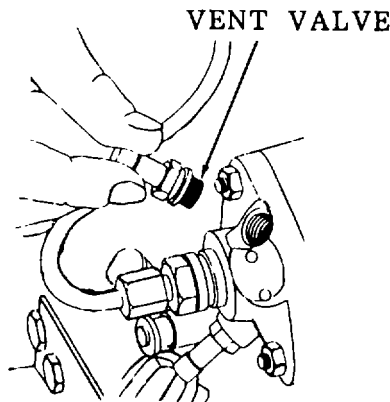
1. ENGINE CRANKS BUT FAILS TO START - Continued.

WARNING

Cleaning solvent, Federal Specification P-D-680, is toxic and flammable. Use only in a well-ventilated area. Avoid prolonged breathing of fumes. Keep solvent away from flames. Do not use in excessive amounts. Avoid skin contact. Do not smoke.

Step 5. If engine does not start, remove vent valve. Check vent valve by shaking for free movement of internal valve ball.

If necessary, clean with cleaning solvent and allow to dry. If unserviceable, notify direct support maintenance.



Step 6. Check starting procedures under prevailing conditions.

If starting procedures have been performed correctly but engine still fails to start, notify direct support maintenance.

2. ENGINE POWER OUTPUT IS SLOW AND RUNS UNSTEADILY.

Step 1. Check window of air filter indicator for red band indicating blocked air filter.

If red band appears in window of air filter indicator, replace air filter element (paragraph 4-10).

MALFUNCTION
TEST OR INSPECTION
CORRECTIVE ACTION

Step 2. See Malfunction 1, step 4.

If vent valve is unserviceable, notify direct support maintenance

3. BLACK SMOKE FROM EXHAUST AFTER WARMUP.

Check window of air filter indicator for red band indicating blocked air filter.

If red band appears in window of air filter indicator, replace air filter element (paragraph 4-10).

4. ENGINE OVERHEATS.

CAUTION

A high temperature condition may cause abnormal engine operation.

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

Remove accumulated dust and dirt with a wire brush (item 1, appendix E).

Step 2. Check cylinder cooling fins for damage or dirt.

Remove accumulated dust and dirt with a wire brush (item 1, appendix E).

Step 3. Check blower ring blades for damage or dirt.

Remove accumulated dust and dirt with a wire brush (item 1, appendix E).

Notify direct support maintenance of a damaged blower ring.

Step 4. Check crankcase oil levels.

Drain excessive oil from crankcase; notify direct support maintenance.

Step 5. Check muffler/spark arrestor for carbon buildup.

Service muffler/spark arrestor (paragraph 4-16).

Change 1 4-7

4-9. TROUBLESHOOTING - Continued.

Table 4-2. Unit Maintenance Troubleshooting - Continued

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

5. ENGINE STOPS RUNNING.

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Engine must be turned off and cool before refueling. Do not smoke.

Step 1. Check for insufficient fuel supply.

Fill fuel tank (item 3, appendix E).

Replace fuel filter (paragraph 4-12).

Step 2. Check air filter indicator for indication of restrictions or excessive dirt in air filter.

If red band appears in window of air filter indicator, replace air filter element (paragraph 4-10).

Step 3. See Malfunction 1, step 4.

If vent valve is unserviceable, notify direct support maintenance.

Step 4. Check that throttle control lever stop has not slipped.

Refer to paragraph 4-17 and adjust stop.

Section VI. MAINTENANCE PROCEDURES

| | Para. | | Para. |
|--------------------------------------|-------|------------------------------|-------|
| Air Filter Assembly | 4-10 | Fuel Pump | 4-13 |
| Air Filter Indicator | 4-11 | Fuel Tank | 4-15 |
| Crank Assembly | 4-18 | Muffler/Spark Arrestor | 4-16 |
| Fuel Filter | 4-12 | Throttle | 4-17 |
| Fuel Lines, Hoses, and Fittings..... | 4-14 | | |

*Change 1 4-8

4-10. AIR FILTER ASSEMBLY.

This task consists of:

- | | | | |
|----------------------------|----------------|------------|---------------|
| a. Removal | b. Disassembly | c. Service | d. Reassembly |
| e. Installation | | | |

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Rags (item 8, appendix E)
 Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Engine cooled down to prevent burns.
 Well-ventilated area required.

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

a. Removal. (Refer to figure 4-2).

- (1) Remove air filter assembly (1) by unscrewing by hand from air intake.

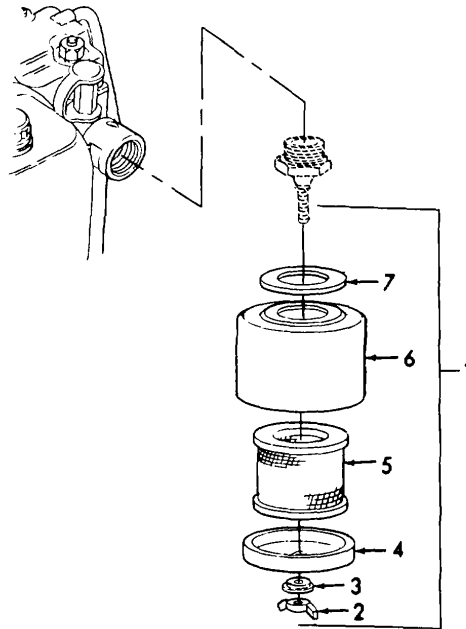


Figure 4-2. Air Filter Assembly.

4-10. AIR FILTER ASSEMBLY - Continued.b. Disassembly.

- (1) Remove wing nut (2), washer (3), and top (4).
- (2) Remove element (5), hood (6), and gasket (7).

c. Service.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean top (4) and hood (6) with cleaning solvent.
- (2) Replace element (5).
- (3) Allow to dry.

d. Reassembly.

- (1) Install gasket (7), hood (6), and element (5).
- (2) Install top (4), washer (3), and wing nut (2).

CAUTION

Do not over tighten air filter assembly when installing, damage to plastic connector will occur.

e. Installation. Install air filter assembly (1) into air intake and hand tighten. Reset air filter indicator by pushing button located on top of air filter indicator.

4-11. AIR FILTER INDICATOR.

This task consists of:

a. Removal

b. Installation

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Gasket, P/N 03477200

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

a. Removal. (Refer to figure 4-3).

- (1) Unscrew air filter indicator (1) from nipple (2).
- (2) Remove nipple (2).
- (3) Remove two nuts (3), adapter (4), and gasket (5). Discard gasket (5).

b. Installation.

- (1) Install new gasket (5), adapter (4), and secure with two nuts (3).
- (2) Install nipple (2).
- (3) Position air filter indicator (1) on nipple (2) and hand tighten.

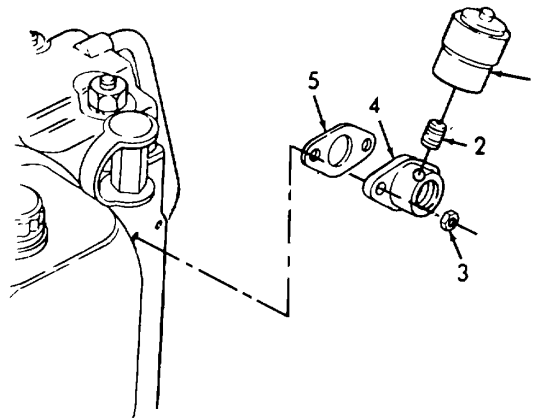


Figure 4-3. Air Filter Indicator Removal/Installation.

4-12. FUEL FILTER.

This task consists of:

~~a. Removal~~

~~b. Installation~~

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Rags, Wiping (item 8, appendix E)

Solvent, Cleaning (item 10, appendix E)

Equipment Conditions:

~~Pumping assembly shut down in accordance with paragraph 2-6.~~

a. Removal. (Refer to figure 4-4).

(1) Remove screw (1), flat washer (2), clamp (3), and two spacers (4).

NOTE

Drain hoses and fuel filter in a suitable container.

(2) Remove hose (5) and hose (6) from fuel filter (7).

(3) Remove fuel filter (7).

b. Installation.

(1) Position fuel filter (7) on engine with arrow pointing down and connect fuel hoses (6 and 5).

(2) Position clamp (3) on fuel hose (6).

(3) Install two spacers (4) between engine and clamp (3) and secure with flat washer (2) and screw (1).

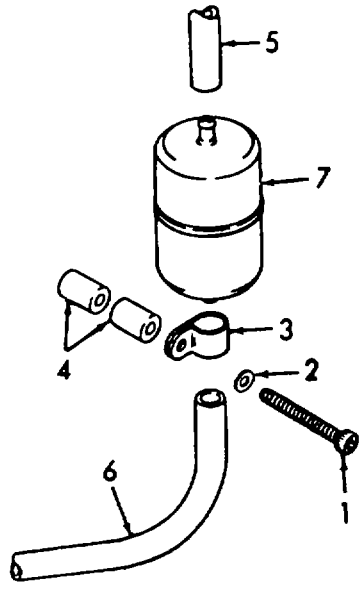


Figure 4-4. Fuel Filter Removal/Installation.

4-12. FUEL FILTER - Continued.b. Installation - Continued.

- (4) After fuel filter is replaced, bleed fuel injection system (refer to figure 4-5).
- (5) Move throttle control lever to stop position.

NOTE

It may be necessary to rotate engine with crank assembly, before fuel primer lever can be activated.

- (6) Pump fuel primer lever (1) on fuel pump 15 to 20 times.
- (7) Refer to paragraph 2-6b and start engine.

WARNING

Cleaning solvent, Federal Specification P-D-680, is toxic and flammable. Use only in a well-ventilated area. Avoid prolonged breathing of fumes. Keep solvent away from flames. Do not use in excessive amounts. Avoid skin contact. Do not smoke.

- (8) If engine does not start, remove venting valve (2). Check venting valve by shaking for free movement of internal valve ball. If necessary, clean venting valve with cleaning solvent. Allow to dry. If after cleaning venting valve ball does not rattle, replace venting valve (2). Repeat step (6) above.

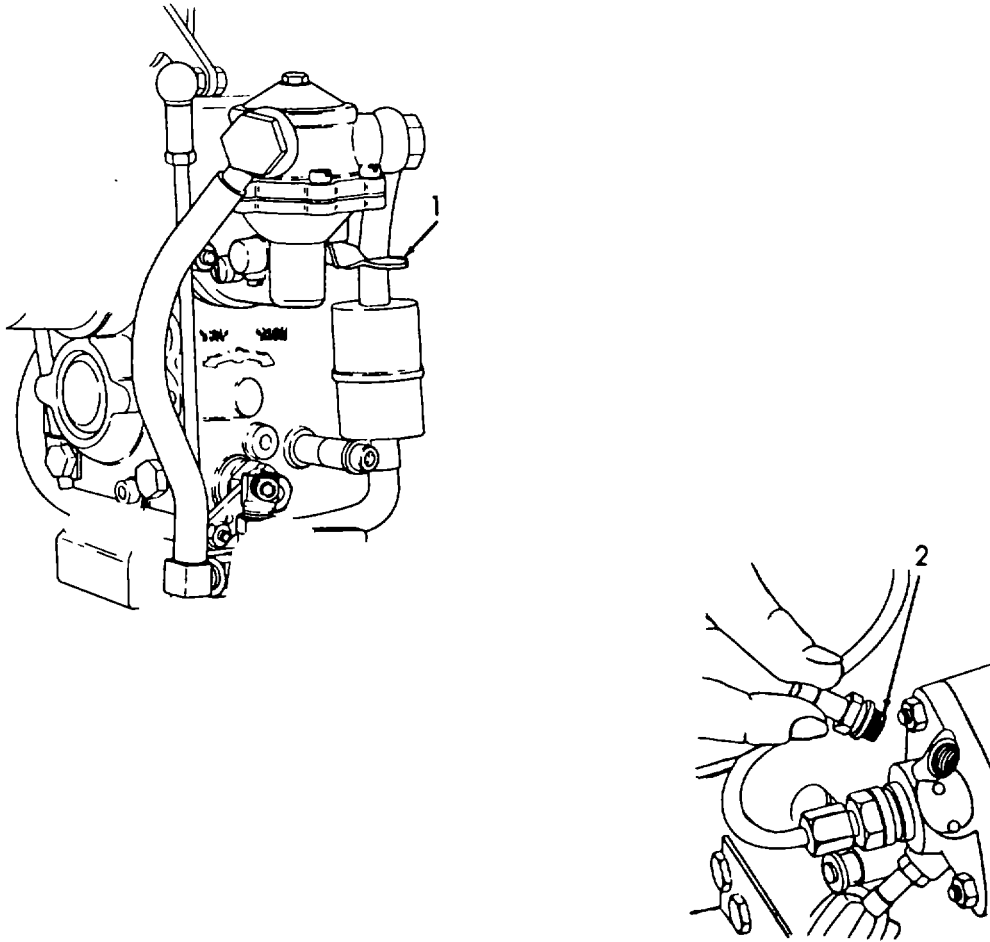


Figure 4-5. Bleeding Fuel System.

4-13. FUEL PUMP.

This task consists of:

~~a. Removal~~

~~b. Installation~~

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Packing, P/N 50129900

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

a. Removal. (Refer to figure 4-6).

- (1) Remove two screws (1), four flat washers (2), and two banjo fittings (3).
- (2) Remove two nuts (4) and two flat washers (5).
- (3) Remove fuel pump (6) and packing (7). Discard packing (7).

b. Installation.

NOTE

Ensure fuel pump cam follower is on top of cam when installing the fuel pump.

- (1) Install new packing (7) and fuel pump (6) on engine and secure with two flat washers (5) and two nuts (4).
- (2) Install two banjo fittings (3), four flat washers (2), and two screws (1).

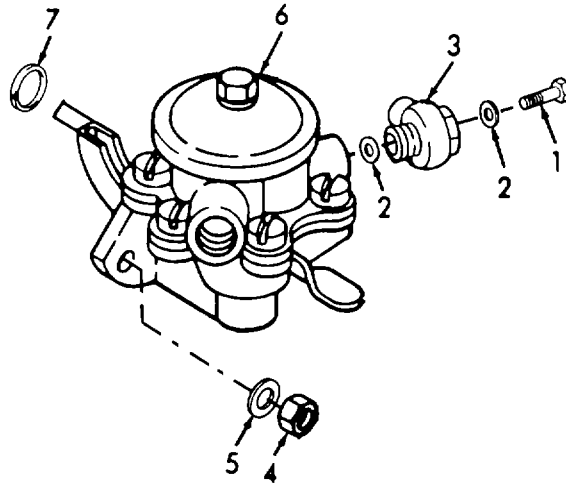


Figure 4-6. Fuel Pump Removal/Installation.

4-14. FUEL LINES, HOSES, AND FITTINGS.

This task consists of:

- ~~a. Removal~~ ~~b. Inspection~~ ~~c. Installation~~
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Allen Socket (item 24, appendix B)

Equipment Conditions:

- Pumping assembly shut down in accordance with paragraph 2-6.
-

a. Removal. (Refer to figure 4-7).

- (1) Remove hose (1), clamp (2), and hose (3).
- (2) Remove bolt (4), flat washer (5), banjo fitting (6), and two flat washers (7).
- (3) Remove screw (8), two screws (10), two flat washers (9), four clamps (11), and spacer (12).
- (4) Remove screw (13), flat washer (14), clamp (15), and two spacers (16).

NOTE

Place a suitable container under engine and drain fuel from fuel tank.

- (5) Remove hoses (17, 18, and 19).
- (6) Remove two bolts (20), four flat washers (21), and two banjo fittings (22).

b. Inspection.

- (1) Inspect all hoses for cracks or signs of fraying.
- (2) Inspect all hardware for damaged threads.

c. Installation.

- (1) Install two banjo fittings (22) and four flat washers (21) and secure with two bolts (20).
- (2) Install hoses (19, 18, and 17).

- (3) Install two spacers (16) and clamp (15) and secure with flat washer (14) and screw (13).
- (4) Install spacer (12) and four clamps (11) and secure with two flat washers (8), two screws (10), and screw (8).
- (5) Install two washers (7), banjo fitting (6), and washer (5) and secure with bolt (4).
- (6) Install hose (3), clamp (2), and hose (1).

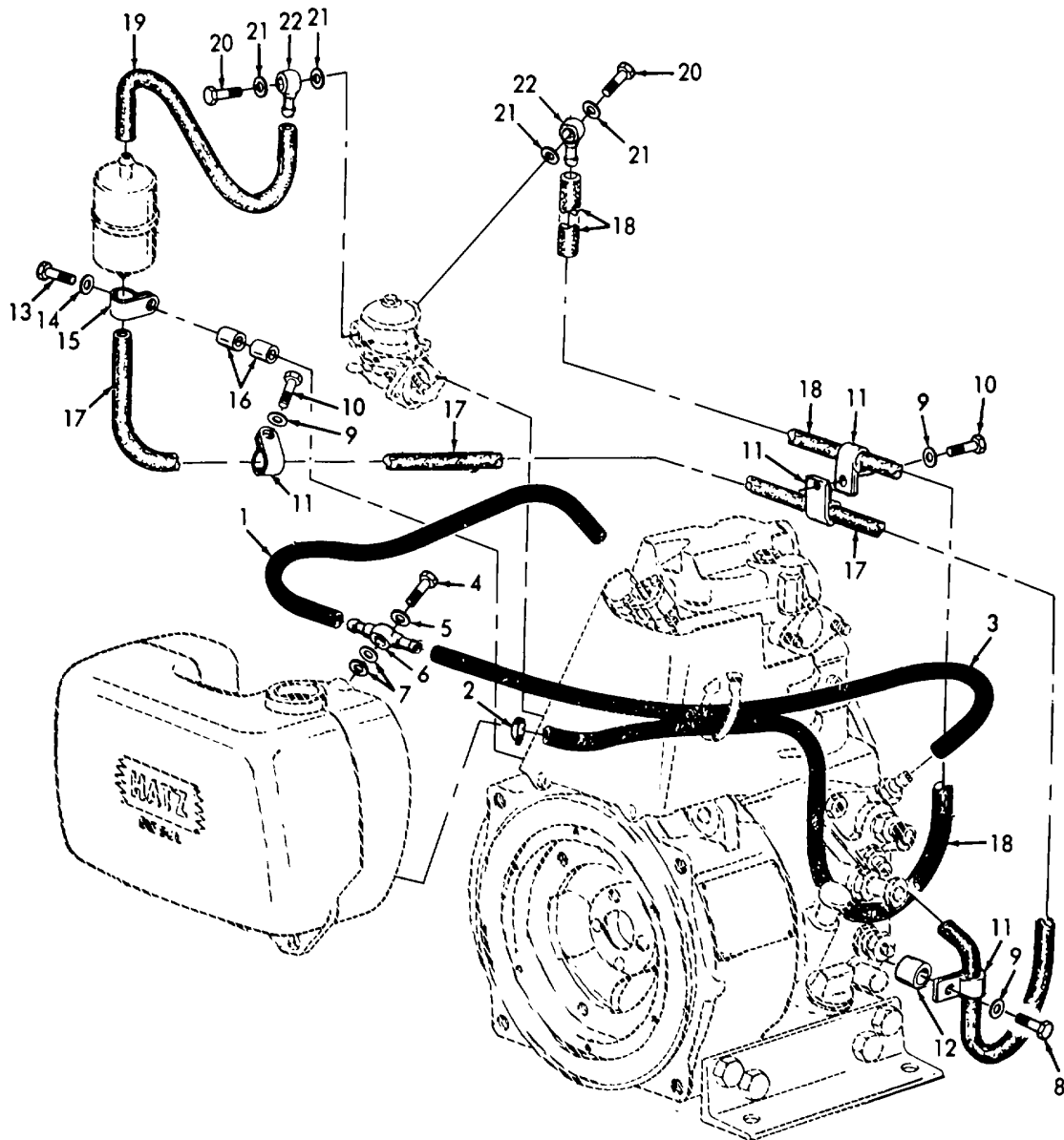


Figure 4-7. Fuel Lines, Hoses, and Fittings Removal/Installation.

4-15. FUEL TANK.

This task consists of:

- ~~a. Removal~~ ~~b. Inspection~~ ~~c. Installation~~
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Allen Socket (item 24, appendix B)

Materials Required:

- Solvent, Cleaning (item 10, appendix E)

Equipment Conditions:

- Pumping assembly shut down in accordance with paragraph 2-6.
 - Fuel lines removed in accordance with paragraph 4-14.
-

a. Removal. (Refer to figure 4-8).

- (1) Remove two screws (1), two nuts (2), four spacers (3), two spacers (4), and two screws (5).
- (2) Lift up on fuel tank (6) and remove. Replace fuel cap (7) if damaged.

b. Inspection.

- (1) Inspect fuel tank for cracks or missing cap.
- (2) Inspect all hardware for damaged threads.

c. Installation.

- (1) Install fuel cap (7).
- (2) Position fuel tank (6) on support.
- (3) Install two spacers (4) and four spacers (3) and secure with two screws (5 and 1) and two nuts (2).

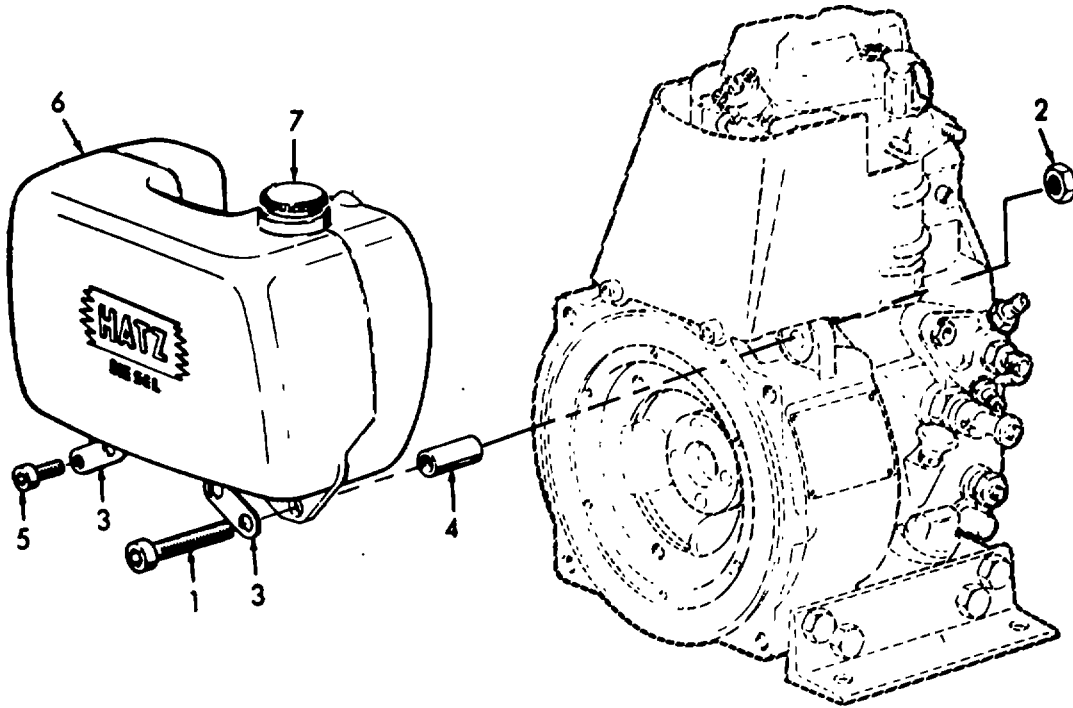


Figure 4-8. Fuel Tank Removal/Installation.

4-16. MUFFLER/SPARK ARRESTOR

This task consists of:

- ~~a. Removal~~ ~~b. Service~~ ~~c. Installation~~
-

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Gasket, P/N 50122400

General Safety Instructions:

Unit must be cool.

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

- a. Removal. (Refer to figure 4-9).

WARNING

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

- (1) Remove two screws (1) and two washers (2).
- (2) Remove heat shield (3).
- (3) Remove three screws (4) and three washers (5).
- (4) Remove protective screen (6).
- (5) Remove two nuts (7).
- (6) Remove muffler (8) and gasket (9). Discard gasket (9).
- (7) Remove cleanout port plug (10).

- b. Service.

(1) Clean the muffler/spark arrestor by lightly tapping the muffler body to loosen carbon soot and flush out with water.

(2) Inspect screws, nuts, washers, heat shield, protective screen and muffler/spark arrestor for corrosion or other damage. Replace damaged parts.

c. Installation.

- (1) Install cleanout port plug (10).
- (2) Install new gasket (9) and muffler (8).
- (3) Install two nuts (7). Tighten nuts (7) securely.
- (4) Install protective screen (6).
- (5) Install three washers (5) and three screws (4).
- (6) Install heat shield (3).
- (7) Install two washers (2) and two screws (1).

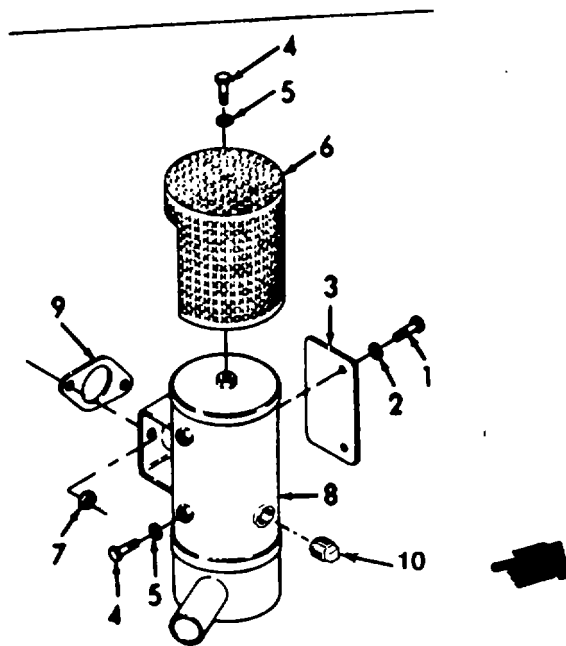


Figure 4-9. Muffler Removal/Installation.

Change 1 4-23

4-17. THROTTLE.

This task consists of:

- ~~a. Removal~~ ~~b. Installation~~ ~~c. Adjustment~~
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Allen Socket (item 24, appendix B)

Equipment Conditions:

- Pumping assembly shut down in accordance with paragraph 2-6.
-

a. Removal. (Refer to figure 4-10).

- (1) Remove nut (1), disc (2), and nut (3). Remove lever (4).
- (2) Loosen nuts (5 and 6). Unscrew angular joint (7) from adjusting screw (10).
- (3) Remove nut (8). Unscrew angular joint (9) from adjusting screw (10).
- (4) Remove two screws (11). Remove console (12) and four discs (13).
- (5) Remove two nuts (14), disc (15), and spring washer (16).
- (6) Remove hand lever (17), lever (18), and screw (19).
- (7) Remove two screws (20), two discs (21), two nuts (22), and two fixing flaps (23).

b. Installation.

- (1) Install two screws (20), two discs (21), two nuts (22), and two fixing flaps (23).
- (2) Install screw (19) into console (12).
- (3) Install hand lever (17) on screw (19) and engage tang on hand lever (17) with notch on lever (18).
- (4) Install flat washer (16), disc (15), and nut (14). Tighten two nuts (14) until lever has a slight drag.
- (5) Install two discs (13) and console (12).
- (6) Install two screws (11). Tighten securely.

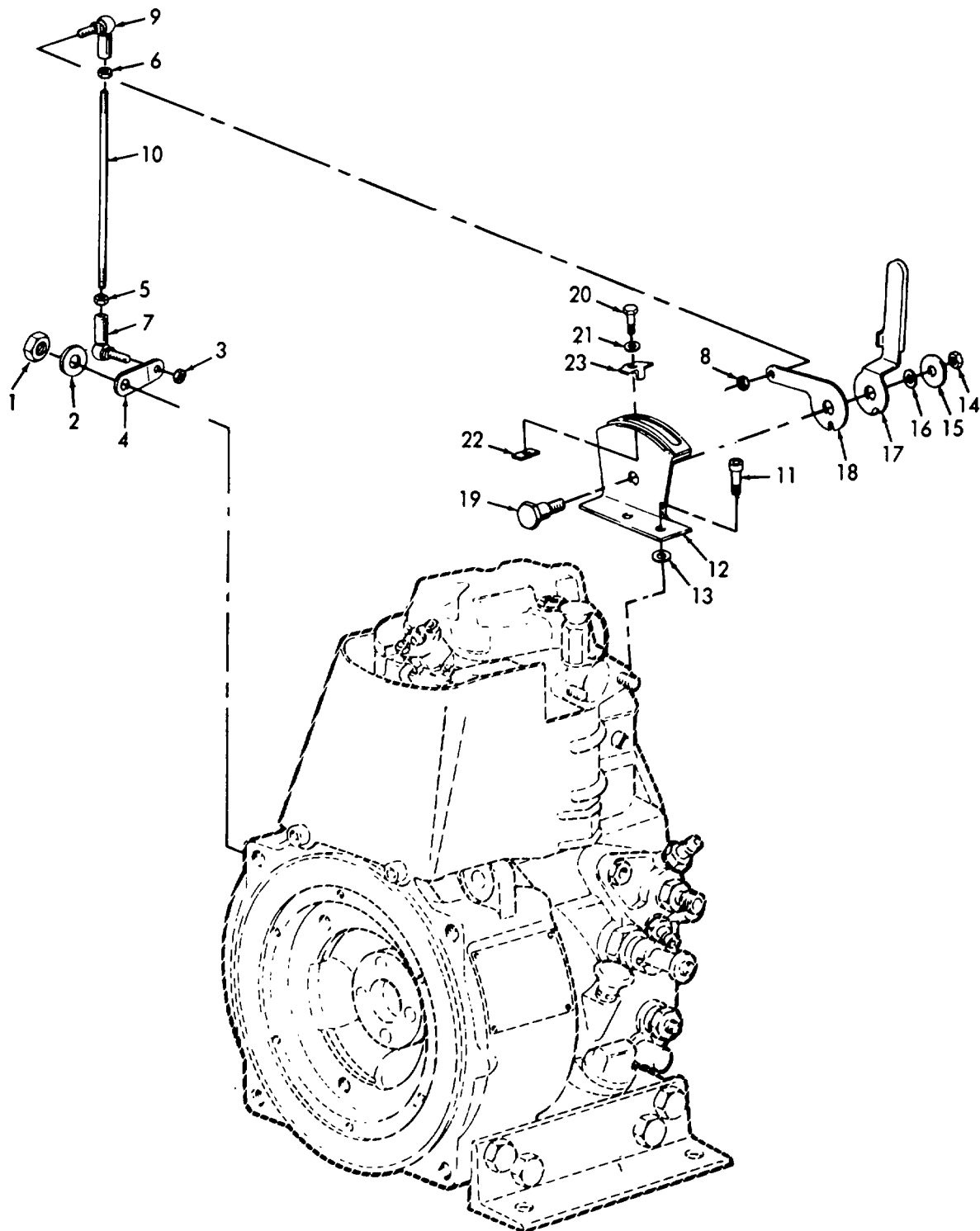


Figure 4-10. Throttle Removal/ Installation/ Adjustment.

4-17. THROTTLE - Continued.**b. Installation - Continued.**

- (7) Install nuts (5 and 6), if they were removed from adjusting screw (10).
- (8) Install angular joints (7 and 9) on adjusting screw (10).
- (9) Install angular joint (9) on lever (18). Secure with nut (8).
- (10) Install angular joint (7) on lever (4). Secure with nut (3).
- (11) Tighten nuts (5 and 6).
- (12) Install lever (4) on engine. Secure with disc (2) and nut (1).

c. Adjustment. (Refer to figure 4-10).

- (1) Idle Adjustment. With engine running, loosen screw (20) and slide fixing flap (23) toward fuel lift pump side of engine. Move hand lever (17) to desired idle speed. Slide fixing flap (23) against hand lever (17) and tighten screw (20).
- (2) Top Speed Adjustment. With engine running, loosen second screw (20) located closest to injection pump. Slide second fixing flap (23) toward injection pump side of engine. Move hand lever (17) to engine top speed. Slide fixing flap (23) against hand lever (17) and tighten screw (20).
- (3) If idle or top speed of engine cannot be obtained, loosen nuts (5 and 6) and turn adjusting screw (10) to increase or decrease travel of hand lever (17). Tighten nuts (5 and 6) after adjusting.

4-18. CRANK ASSEMBLY.

This task consists of:

- ~~a. Removal~~ ~~b. Installation~~
-

INITIAL SETUP:

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

- a. Removal. (Refer to figure 4-11).

Remove crank (1) from holder on frame.

- b. Installation. Install crank (1) into holder on frame.

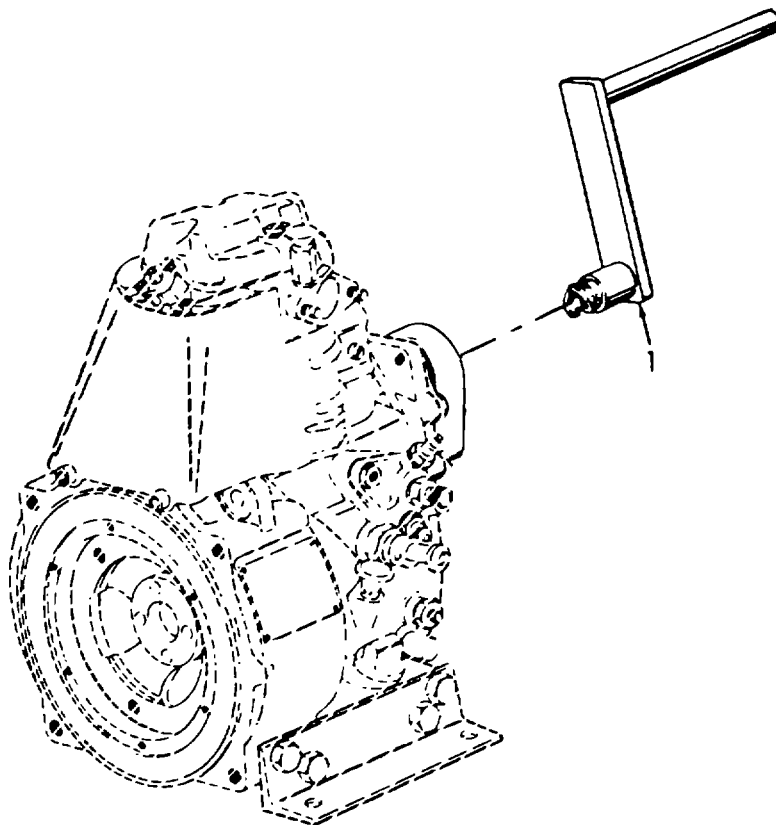


Figure 4-11. Crank Assembly Removal/Installation.

Section VII. PREPARATION FOR STORAGE OR SHIPMENT

4-19. PREPARATION FOR STORAGE OR SHIPMENT.

- a. Shut down the pumping assembly by moving throttle control lever to the stop position.
- b. Disconnect suction and intake assemblies.
- c. Remove pump housing lower drain plug and drain fuel into a suitable container. Replace the drain plug.
- d. Install pump intake and outlet fittings, dust cover and dust plug.
- e. Remove fuel tank lower hose and drain fuel into a suitable container. Install fuel tank lower hose.
- f. If pumping assembly is to be stored for more than 12 months in normal conditions or 6 months in tropical conditions, do the following:
 - (1) Drain engine crankcase oil into a suitable container.
 - (2) Fill crankcase to proper level using preservative lubricating oil (item 7, appendix E).
 - (3) Prepare a mixture of the following: 1 quart of preservative lubricating oil to 4 quarts diesel fuel.
 - (4) Pour fuel mixture into engine fuel tank.
 - (5) Refer to paragraph 2-6 and start the engine. Allow engine to run approximately 10 to 15 minutes. Refer to paragraph 2-6 and stop the engine.
 - (6) Remove fuel tank lower hose and drain fuel mixture into a suitable container. Install fuel tank lower hose.

CHAPTER 5

DIRECT SUPPORT MAINTENANCE INSTRUCTIONS

Section I Troubleshooting
 Section II Maintenance Procedures

Section I. TROUBLESHOOTING

| | Para. | | Para. |
|--------------------------------|-------|----------------------|-------|
| Introductory Information | 5-1 | Troubleshooting..... | 5-3 |
| Symptom Index..... | 5-2 | | |

5-1. INTRODUCTORY INFORMATION.

a. Table 5-1 lists the common malfunctions which you may find during the maintenance of the pump assembly or its components. You should perform the tests/inspections and corrective actions in the order listed.

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

5-2. SYMPTOM INDEX

| MALFUNCTION NO. | MALFUNCTION | PAGE |
|--------------------|--|------|
| 5 | Engine cranks but fails to start | 5-3 |
| 7 | Engine produces black smoke from exhaust | 5-4 |
| 6 | Engine starts but stalls or surges..... | 5-3 |
| 4 | Low pump discharge pressure..... | 5-3 |
| 3 | Pump fails to prime..... | 5-2 |
| 1 | Pump makes excessive noise..... | 5-1 |
| 2 | Pump output low | 5-2 |

5-3. TROUBLESHOOTING. (Refer to table 5-1).

Table 5-1. Direct Support Troubleshooting

**MALFUNCTION
 TEST OR INSPECTION
 CORRECTIVE ACTION**

1. PUMP MAKES EXCESSIVE NOISE.

Step 1. With engine stopped, check pump housing suction intake for foreign material.

5-3. TROUBLESHOOTING - Continued.

Table 5-1. Direct Support Troubleshooting - Continued

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

1. PUMP MAKES EXCESSIVE NOISE - Continued.

Remove foreign material from suction intake.



Running pump dry can cause excessive noise and damage to pump.

Step 2. Check that suction hose is connected to a container with fuel.

Replace empty fuel container.

Step 3. Check that pump has been primed.

Remove pump housing top pipe plug and fill housing with fuel. Install pipe plug in housing.

2. PUMP OUTPUT LOW.

Step 1. Check that engine throttle is properly adjusted.

Adjust throttle lever (paragraph 4-17).

Step 2. Refer to Malfunction 1, steps 1 thru 3.

3. PUMP FAILS TO PRIME.

Step 1. Check for low engine speed.

Adjust throttle lever (paragraph 4-17).

Step 2. Check suction intake for leaks.

Tighten suction intake.

Step 3. Check suction hose for leaks.

Replace a bad suction hose.

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

4. LOW PUMP DISCHARGE PRESSURE.

Step 1. Check for low engine speed.

Adjust throttle lever (paragraph 4-17).

Step 2. Check suction intake for leaks.

Tighten suction intake.

Step 3. Check suction hose for leaks.

Replace a bad suction hose.

Step 4. Check for a damaged impeller.

Replace a damaged impeller (paragraph 5-4).

5. ENGINE CRANKS BUT FAILS TO START.

Step 1. Check for faulty fuel pump.

Replace a bad fuel pump (paragraph 4-13).

Step 2. Test for a faulty fuel injector (paragraph 5-6).

Replace a bad fuel injector (paragraph 5-6).

6. ENGINE STARTS BUT STALLS OR SURGES.

Step 1. Test for a faulty injector (paragraph 5-6).

Replace a bad fuel injector (paragraph 5-6).

Step 2. Check vent valve for proper operation.

Remove vent valve and check vent valve by shaking for free movement of internal ball.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

If necessary, clean with cleaning solvent. If unserviceable, replace vent valve (paragraph 5-7).

5-3. TROUBLESHOOTING - Continued.

Table 5-1. Direct Support Troubleshooting - Continued

| MALFUNCTION | TEST OR INSPECTION | CORRECTIVE ACTION |
|--|--|--|
| 7. ENGINE PRODUCES BLACK SMOKE FROM EXHAUST. | Step 1. Check air filter indicator for red band. | Replace air filter element (paragraph 4-10). |
| | Step 2. Check tappet clearance. | Adjust tappet clearance (paragraph 5-9). |
| | Step 3. Test for a faulty fuel injector (paragraph 5-6). | Replace a bad fuel injector (paragraph 5-6). |

Section II. MAINTENANCE PROCEDURES

| | Para. | | Para. |
|--|-------|---------------------------|-------|
| Cranking Gears | 5-8 | Frame Assembly | 5-13 |
| Cylinder | 5-10 | Fuel Injection Pump | 5-7 |
| Cylinder Head and Valve Assembly | 5-9 | Injector | 5-6 |
| Engine Assembly | 5-5 | Piston | 5-11 |
| Flywheel..... | 5-12 | Pump Assembly | 5-4 |

5-4. PUMP ASSEMBLY.

This task consists of:

- a. Disassembly
 - b. Cleaning
 - c. Inspection
 - d. Repair
 - e. Reassembly
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Puller (item 2, appendix B)

Materials Required:

- Rags, Wiping (item 8, appendix E)
- Packing, P/N MS29513-270
- Sealing Compound (item 9, appendix E)
- Solvent, Cleaning (item 10, appendix E)

Equipment Conditions:

- Pumping assembly shut down and drained in accordance with paragraph 2-6.
-

5-4. PUMP ASSEMBLY - Continued.

Pump assembly cannot be removed as a assembly. Pump assembly must be disassembled for removal. Failure to observe this caution can result in damage to the pump assembly.

a. Disassembly. (Refer to figure 5-1).

- (1) Place a suitable container under pump assembly. Remove plug (1) and drain pump housing.
- (2) Remove two nuts (2), two lockwashers (3), and two screws (4).
- (3) Remove eight screws (5) and housing (6). Remove plug (7) and connectors (8 and 9) from housing (6).
- (4) Remove diffuser assembly (10) from impeller assembly.



Do not pry on impeller assembly during removal, otherwise damage to impeller assembly may result.

- (5) Remove screw (11), washer (12), and impeller assembly (13) from shaft (20).
- (6) Remove shim (14), seal (15), and keys (16).
- (7) Remove four screws (17), packing (18), and backhead (19).
- (8) Use a puller and remove shaft (20) and key (21).
- (9) Remove inserts (22) from housing if damaged.

b. Cleaning.

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts using a rag and cleaning solvent.
- (2) Allow to dry.

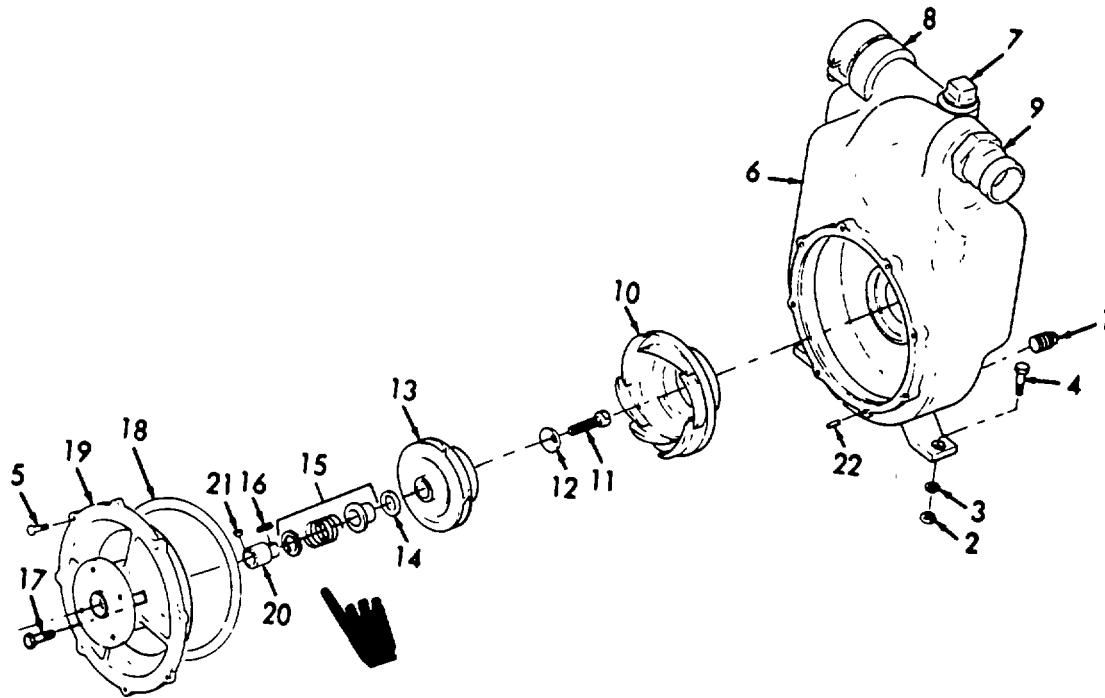


Figure 5-1. Pump Assembly Disassembly.

c. Inspection.

- (1) Inspect impeller for cracks or broken vanes. Inspect impeller wear ring for signs of wear.
- (2) Inspect diffuser assembly for cracks or wear ring for signs of wear.
- (3) Inspect housing assembly for cracks and damaged inserts (item 22, figure 5-1). Replace housing if it is cracked.

d. Repair.

- (1) If housing inserts (22) are damaged, they can be replaced by drilling out and installing new inserts (22).
- (2) All other repairs to the pump assembly consist of replacing damaged parts.

Change 3 5-7

5-4. PUMP ASSEMBLY - Continued.

e. Reassembly. (Refer to figure 5-2).

- (1) Install key (1) and shaft (2).
- (2) Install backhead (3) and secure with four screws (4). Install new packing (5).



Install rubber seat and stationary ring (polished side out) into recess. Install the rest of the seal assembly so carbon face runs against polished side of stationary ring.

- (3) Install seal (6), key (7), shim (8), and impeller assembly (9). Secure impeller (9) to shaft (2) with flat washer (10) and screw (11).
- (4) Use a feeler gauge, measure between the impeller face and backhead. A distance of .03 to .09 inch (7.62 to 22.86 cm) must be maintained. Use shims (8) as required.
- (5) Install diffuser assembly (12) on impeller assembly (9).
- (6) Install housing (13) on backhead (3) and secure with eight screws (14).
- (7) Apply sealing compound to threads of items (15) thru (19). Install connectors (15 and 16) and plugs (17 and 18).
- (8) Install two screws (19), two lockwashers (20), and two nuts (21). Tighten nuts (21).

Change 3 5-8

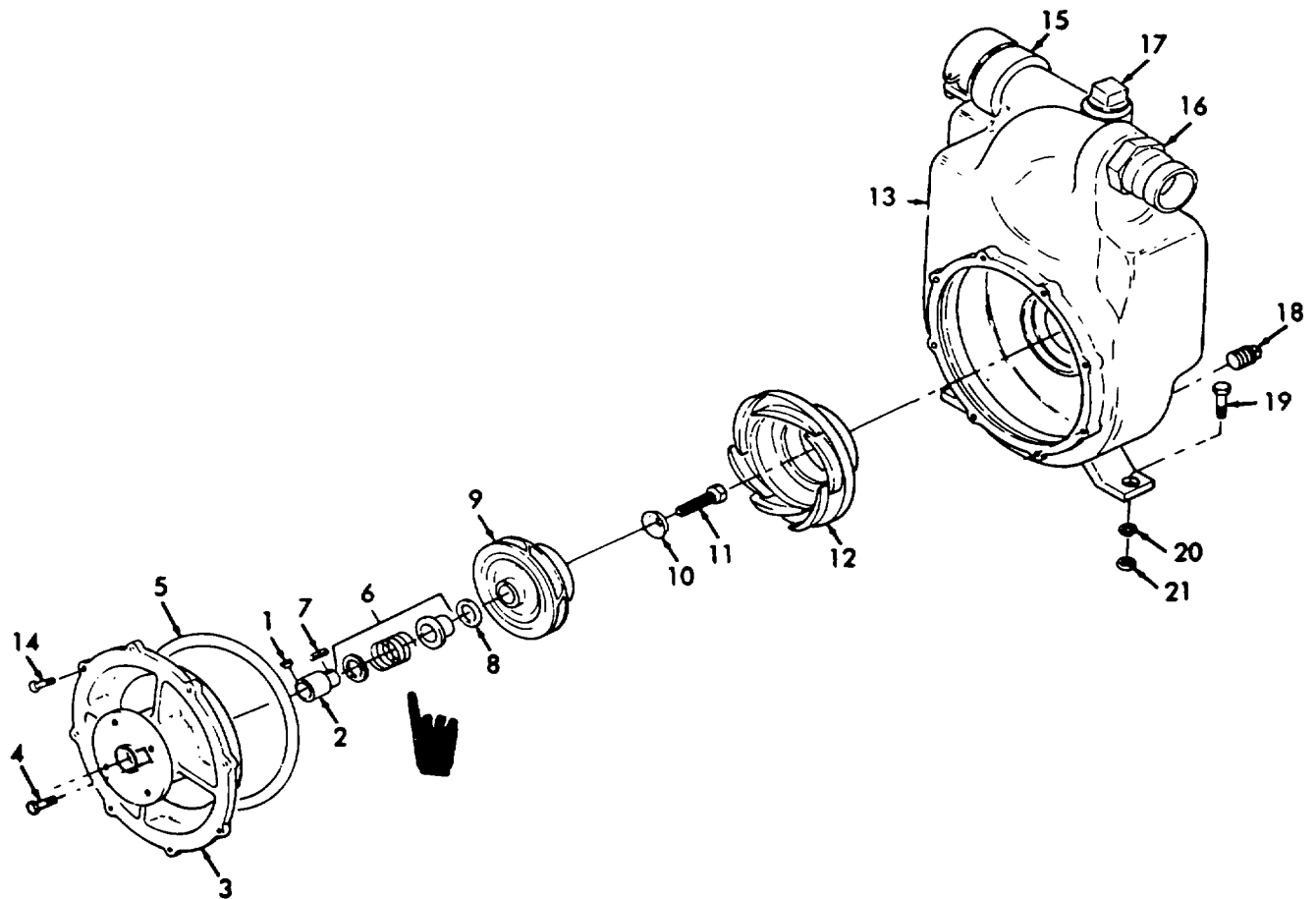


Figure 5-2. Pump Assembly Reassembly.

5-5. ENGINE ASSEMBLY.

This task consists of:

a. Removal

b. Installation

INITIAL SETUP:

Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Shop Set, Automotive Repair, Field Maintenance Basic (item 3, appendix B)

Equipment Conditions:

Pump assembly removed in accordance with paragraph 5-4.

Personnel Required:

2 persons

5-5. ENGINE ASSEMBLY- Continued.a. Removal. (Refer to figure 5-3).

- (1) Remove four nuts (1), four lockwashers (2), and four screws (3).

WARNING

Engine weighs 75 lbs (34 kgs). Two persons are required to lift engine. Failure to observe this warning can result in injury to personnel.

- (2) Slowly raise engine and remove engine assembly (4). Set engine assembly on wooden blocks to prevent damage to bottom of engine.
- (3) Remove eight screws (5), eight lockwashers (6), and two brackets (7).

b. Installation.

- (1) Install two brackets (7) and secure with eight lockwashers (6) and eight screws (5).
- (2) Slowly raise engine assembly (4) and place in base. Carefully lower engine assembly (4) and align mounting holes.
- (3) Install four screws (3), four lockwashers (2), and four nuts (1).
Tighten nuts securely.

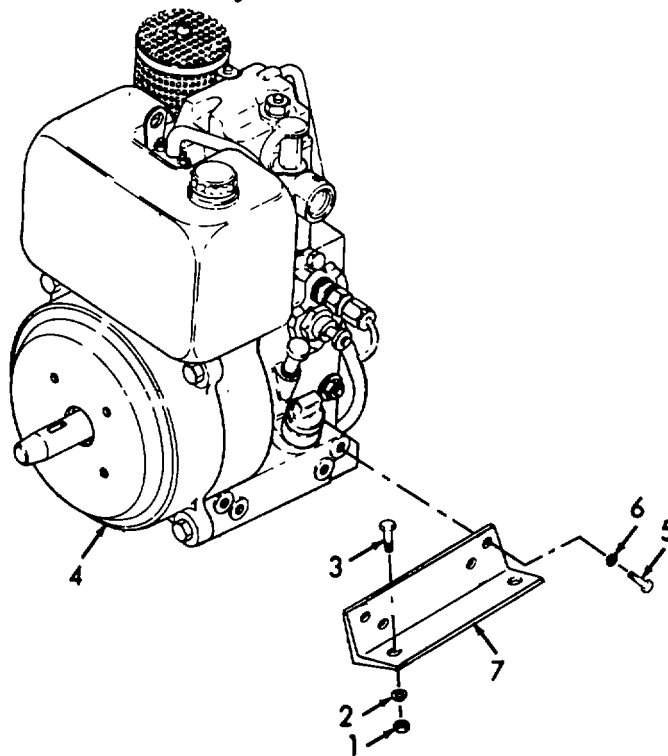


Figure 5-3. Engine Assembly Removal/Installation.

5-6. INJECTOR.

This task consists of:

- a. Removal b. Test c. Installation
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Torque Wrench (item 2, appendix B)
- Testing Device (item 19, appendix B)

Materials Required:

- Grease (item 4, appendix E)
- Washer, P/N 40003100

Equipment Conditions:

- Pumping assembly shut down in accordance with paragraph 2-6.
-

5-6. INJECTOR - Continued.

- a. Removal. (Refer to figure 5-4).



The fuel injection system is extremely intricate and complex. All possible care should be taken in the removal, test, and installation of these components. While handling the fuel injector, be extremely careful not to touch the nozzle or the pin assembly on the nozzle end.

- (1) Loosen fuel pressure line (1) at injection pump and remove from injector (5).
- (2) Remove fuel return hose (2).
- (3) Remove two nuts (3) and clamp (4).
- (4) Remove injector (5) and washer (6). Discard washer (6).

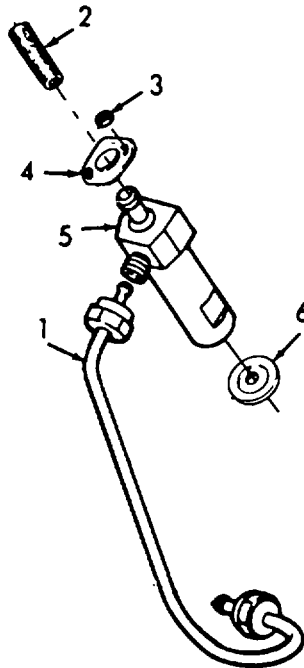


Figure 5-4. Fuel Injector Removal.

b. Test. (Refer to figure 5-5).

- (1) Visually inspect injector (1) for scoring or burning. Inspect to see if injector is bent, cracked, or damaged. If injector is damaged, replace it.
- (2) Connect testing device (3) to injector pump (4) and injector (1). Make sure side connection (5) is tightly locked.

WARNING

- Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame. Do not smoke.
- Serious injury could result from injector fuel spray. Keep hands away from fuel spray.

NOTE

Prior to testing injector, make sure throttle control hand lever is in the HIGH position.

- (3) Crank engine by hand. As the engine is cranked, read fuel injection pressure on the gauge and check fuel spray pattern from injector. Injection pressure should be 1920 to 1928 psi (135 to 143 bar). Fuel should spray out in an even spray pattern. If spray pattern does not conform to above, replace injector. If injector nozzle drips fuel before or after it has reached recommended injection pressure, replace injector.

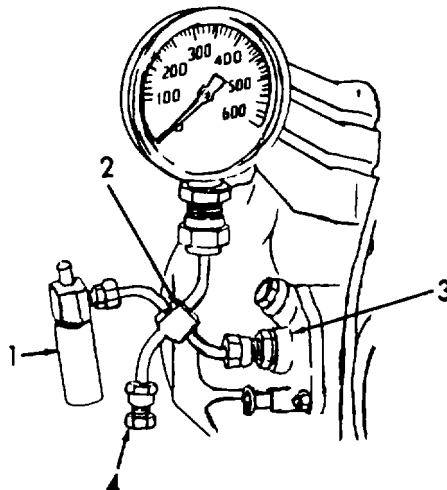


Figure 5-5. Fuel Injector Test Set-Up.

5-6. INJECTOR - Continued.

- c. Installation. (Refer to figure 5-6).

CAUTION

The fuel injection system is extremely intricate and complex. All possible care should be taken in the removal, inspection, testing, and reassembly of these components. While handling the fuel injector, be extremely careful not to touch the nozzle or the pin assembly on the nozzle end.

- (1) Be certain injector seat in cylinder head is clean. Lightly coat washer (1) with grease and install on nozzle end of injector (2). Make sure recess of washer (1) points to the nozzle.
- (2) Carefully install injector (2) into injector bore in cylinder head. Make sure not to damage nozzle needle.
- (3) Install clamp (3), two nuts (4), and torque nuts to 7 ft-lbs (10 Nm).
- (4) Install fuel pressure line (5) and return hose (6). Tighten fuel pressure line (1) at injection pump.

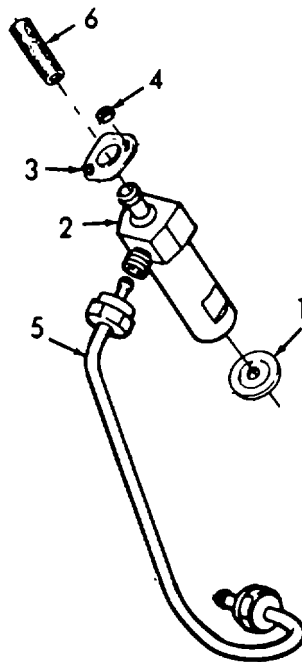


Figure 5-6. Fuel Injector Installation.

5-7. FUEL INJECTION PUMP.

This task consists of:

- a. Test b. Removal c. Installation d. Adjustment
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)
Socket Wrench, 30 mm 668 335 00 (item 6, appendix B)
Special Wrench 606 000 00 (item 5, appendix B)
Spill Device 665 030 01 (item 4, appendix B)
Clamp, Fuel Shutoff 668 38300 (item 17, appendix B)
Testing Device 604 62800 (item 19, appendix B)
Dial Gauge 612 08700 (item 18, appendix B)

Materials Required:

Packing, P/N 50001100
Rags, Wiping (item 8, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.

5-7. FUEL INJECTION PUMP - Continued.

- a. Test. (Refer to figure 5-7).

NOTE

Perform this test before removal of injection pump and after installation.

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame and arcing equipment. Do not smoke.

- (1) Remove fuel pressure line injection pump (1) from injector. Install fuel shutoff clamp.
- (2) Make sure the extra fuel device button is not pulled to the extended position. If the button is extended, move the throttle control hand lever to the stop position and then return the lever to the START position to reset the extra fuel button.
- (3) Connect testing device (2) to injection pump (1). Make sure side connections (3) are tightly locked.
- (4) Install dial gauge (4) to testing device (2).
- (5) Loosen the pressure gauge connection, and crank the engine until trapped air is removed from the system.
- (6) Tighten pressure gauge connections.

CAUTION

The pressure gauge can be damaged if the engine is cranked beyond the gauge limits. Failure to heed this caution can damage equipment.

- (7) Slowly crank engine by hand. As the engine is cranked, read fuel injection pressure on the gauge. Injection pressure should be 4351 to 5076 psi (300 to 350 bar). Stop cranking engine and observe whether pressure is maintain. If pressure drops below 3650 psi (250 bar) within 10 to 15 seconds, then injection pump is not in working order. Replace injection pump.
- (8) Remove testing device (2) and dial gauge (4). Connect fuel pressure line to injector.

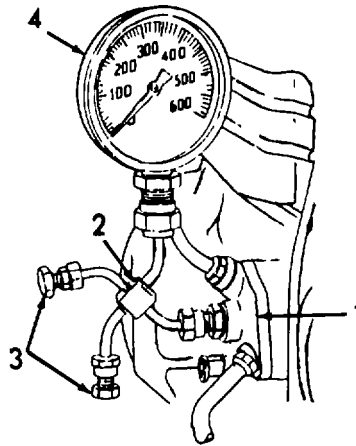


Figure 5-7. Fuel Injection Pump Testing.

b. Removal. (Refer to figure 5-8).

- (1) Disconnect fuel pressure line (1).
- (2) Remove hose (2) and hose (3). Install fuel shutoff clamp on hose (3).
- (3) Remove hose connection (4) and packing (5). Discard packing (5).
- (4) Remove vent valve (6) and packing (7). Discard packing (7).
- (5) Move throttle control lever to the START position.
- (6) Remove two nuts (8) and injection pump (9).
- (7) Remove shim (10), spacer (11), and tappet (12).

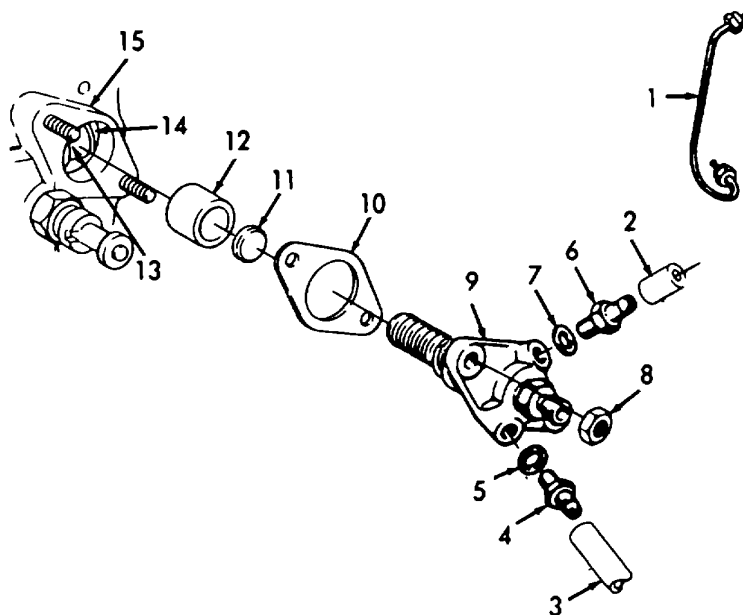


Figure 5-8. Fuel Injection Pump Removal/Installation.

5-7. FUEL INJECTION PUMP - Continued.c. Installation.

- (1) Refer to figure 5-8 and install tappet (12) into crankcase (15).
- (2) Turn engine by hand until tappet (12) reaches the lowest point on the camshaft (14).
- (3) Position throttle control hand lever so that governor lever slot (13) lies exactly in the center of the tappet bore.
- (4) Install spacer (11), with the flat surface toward the injection pump (9).
- (5) Place shim (10) on crankcase (15) studs.
- (6) Position control sleeve on injection pump (8) so that control sleeve pin enters slot in governor lever.
- (7) Insert injection pump (9) carefully without moving the control sleeve out of its proper position.

NOTE

No resistance should be felt until the pump is within 0.160 inch (4 mm) of the crankcase, then a resistance due to initial load of plunger spring can be felt.



Do not tighten pump if not seated properly. Damage to pump governor lever, or engine could result if improperly installed.

- (8) Using hand pressure, insert injection pump (9) fully into crankcase (15) and install two hexagon nuts (8). If the pump does not seat properly, governor sleeve pin of injection pump has not entered slot (13) in governor lever.

NOTE

Before tightening nuts (8), move throttle lever a few times from START to STOP position if correctly installed at each position a noise caused by the governor lever and eccentric pin will be heard.

- (9) Install new packing (7) and vent valve (6), packing (5), and hose connection (4).
- (10) Remove fuel shutoff clamp and install hose (3) and hose (2).
- (11) Connect fuel pressure line (1).

- d. Adjustment. (Refer to figure 5-9).

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame, arcing equipment, ignition sources, heaters, or excessive heat. Do not smoke.

CAUTION

When adjusting timing, pay special attention to rotation of engine. Timing can be accomplished only when engine is rotated correctly. Correct rotation is clockwise when facing throttle control hand lever.

- (1) Remove engine adapter housing to expose engine flywheel.
- (2) Disconnect fuel hose (fuel tank to fuel pump) and install fuel shutoff clamp.
- (3) Remove delivery valve holder (1), spring (2), washer (3), valve (4), and valve body (5).

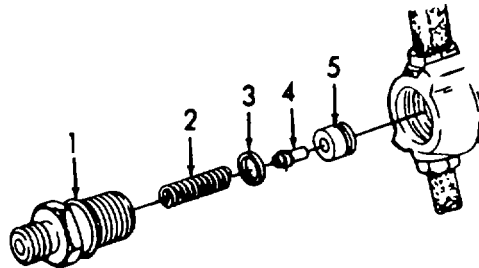


Figure 5-9. Delivery Valve Removal.

5-7. FUEL INJECTION PUMP - Continued.d. Adjustment - Continued.

- (4) Refer to figure 5-9 and insert washer (3) and valve body (5) into spill device (1, figure 5-10).
- (5) Thread spill device into injection pump and adjust with spill pipe in up position, and then secure in place.
- (6) Install dial gauge (2, figure 5-10) with adapter pin 2.68-inch (68 mm) long attached, into spill device, and pre-tension approximately 1 mm (one rotation of dial indicator hand).
- (7) Remove fuel shutoff clamp from fuel hose.

NOTE

Fuel emerging from the spill pipe on spill device must be bubble free.

- (8) Move the throttle hand lever to the HIGH position.

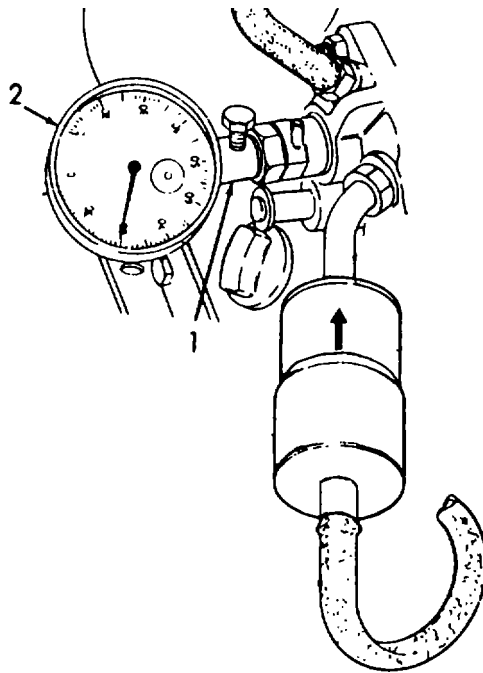


Figure 5-10. Spill Device and Dial Gauge Installation.

- (9) Adjustment of Delivery End. (Refer to figure 5-11).

NOTE

The position of Top Dead Center (TDC) (2) and end of delivery (3) are marked on the flywheel. The corresponding (alignment) mark (4) is on the right upper side of the crankcase.

- (a) Slowly rotate flywheel counterclockwise (when facing flywheel) until no fuel emerges from spill pipe on spill device.
- (b) Continue to very slowly rotate flywheel, while frequently blotting spill pipe with rag to absorb fuel, until fuel just begins to weep from spill pipe.

NOTE

The position achieved above is the end of delivery. If the shim pack is of the correct thickness, the timing marks on flywheel (1) (11.5 to 12.5 degrees) should align with reference mark (2).

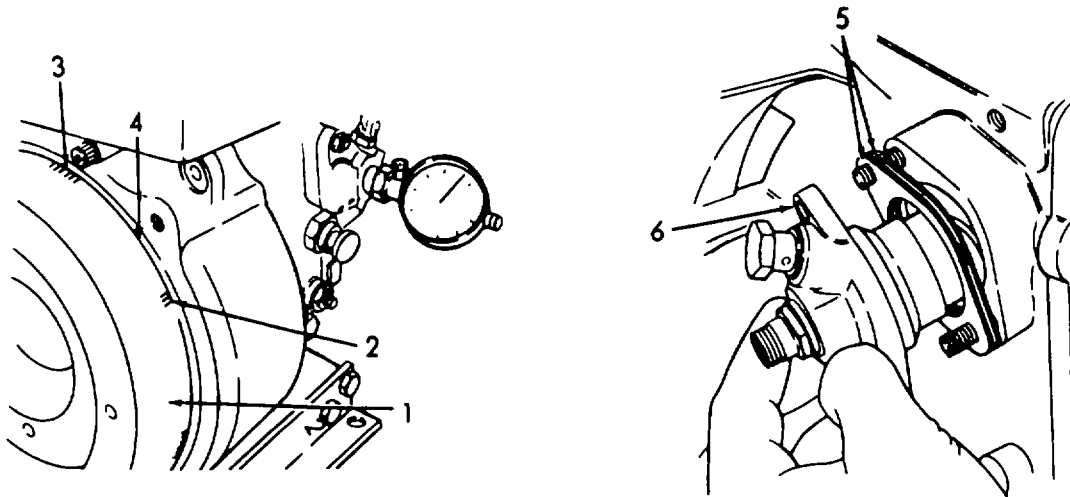


Figure 5-11. Fuel Injection Pump Delivery and Adjustment.

- (c) Block fuel hose (from fuel tank) using fuel shutoff clamp.
- (d) If timing marks do not align with reference mark (2), rotate outer face of dial gauge until "O" mark aligns with needle.
- (e) Slowly rotate flywheel (1) in either direction to align timing marks of 11.5 to 12.5 degrees with reference mark (2). Gauge reading will indicate amount of reshimming (as necessary).

5-7. FUEL INJECTION PUMP - Continued.d. Adjustment - Continued.**NOTE**

The end of delivery is delayed or advanced by adding or removing shims (5) to injection pump (6). The general rule for shimming is as follows:

More shims = end of delivery later (lower number of degrees)

Less shims = end of delivery earlier (higher number of degrees)

(f) Remove fuel shutoff clamp from fuel hose.

(g) After correction of shimming, repeat steps (a) and (b) for checking purposes.

(10) Adjustment of Delivery Lift. (Refer to figures 5-12 and 5-13).

NOTE

Delivery lift controls the quantity of fuel which is injected at full throttle (full load).

(a) Refer to figure 5-12 and with flywheel timing marks (2) (11.5 to 12.5 degrees) aligned with reference mark (3), rotate dial gauge face to zero.

(b) Slowly rotate flywheel (1) in a clockwise direction when facing flywheel until dial gauge indicates 0.052 inch (1.34 mm).

(c) Stop flywheel at position indicated in step (b).

WARNING

Death or serious injury could occur if fuel is not handled carefully. Use in a well-ventilated area away from open flame. Do not smoke.

(d) At this point, fuel should emerge again from spill pipe (4) of spill device (5)

NOTE

If fuel does not emerge, turn the extra fuel device. If results are not obtained, turn the extra fuel device in the opposite direction.

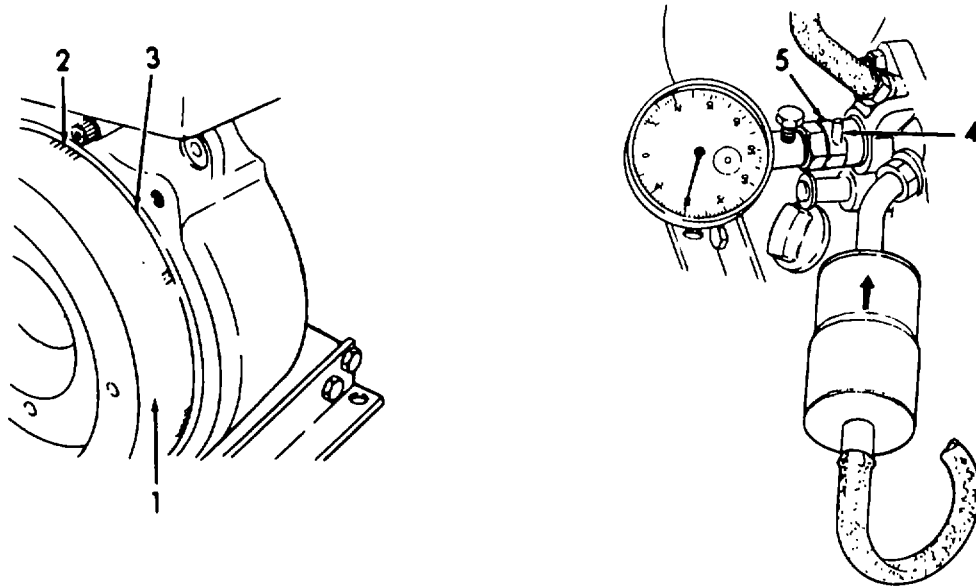


Figure 5-12. Fuel Injection Pump Delivery Lift Adjustment.

- (e) Refer to figure 5-13 and loosen extra fuel button jam nut (2) with socket wrench, 30 mm.
- (f) Using special wrench (3), slightly rotate eccentric (1) until fuel drips at desired rate.
- (g) Tighten extra fuel fuel button jam nut (2).

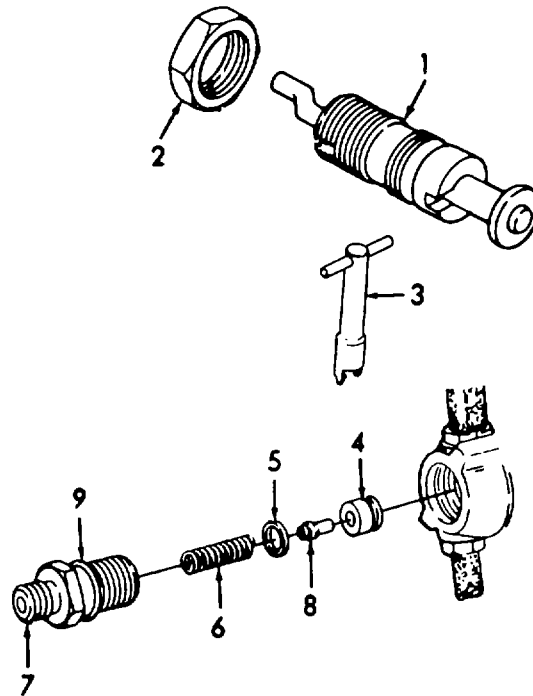


Figure 5-13. Extra Fuel Button Adjustment.

5-7. FUEL INJECTION PUMP - Continued.d. Adjustment - Continued.(10) Adjustment of Delivery Lift - Continued.

- (h) Block fuel hose (from fuel tank) using fuel shutoff clamp (3).
- (i) Remove dial gauge and spill device.
- (j) Remove valve (4) and washer (5).
- (k) Insert spring (6) in delivery valve holder (7).
- (l) Insert copper washer (5) in delivery valve holder (7).
- (m) Insert delivery valve (8) in valve body (4).
- (n) Insert delivery valve (8) and valve body (4) into delivery valve holder (7).

NOTE

Verify that grooved end in the valve body enters the injection pump opening first.

- (o) Install new preformed packing (9), and then tighten delivery valve holder assembly into injection pump.

WARNING

Before starting the engine and after making repairs or adjustments on the fuel system, a wrench must be available to allow rapid removal of the steel fuel line at the injection pump in case of a runaway condition. Failure to heed this warning can result in injury to personnel and equipment damage.

- (p) Remove fuel shutoff clamp from fuel hose and install hose.
- (q) Install engine adapter housing.

5-8. CRANKING GEARS.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Installation**
-

INITIAL SETUP:

Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Puller (item 2, appendix B)

Materials Required:

- Gasket, P/N 03210000
- Grease (item 4, appendix E)
- Grease (item 5, appendix E)
- Oil Seal, P/N 50252400
- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

- Well-ventilated area required.

Equipment Conditions:

- Pumping assembly shut down in accordance with paragraph 2-6.
-

5-8. CRANKING GEARS - Continued.a. Removal. (Refer to figure 5-14).

- (1) Remove four screws (1) and remove housing (2).
- (2) Remove and discard gasket (3).
- (3) Remove needle bearing (4), oil seal (5), gear wheel (6), and pin (7) as an assembly.
- (4) Remove needle bearing (4), oil seal (5), and pin (7) from gear wheel (6) Discard oil seal (5).
- (5) Remove bushing (8) and disc (9).
- (6) Remove nut (10) and washer (11).
- (7) Remove pinion (12) with puller.

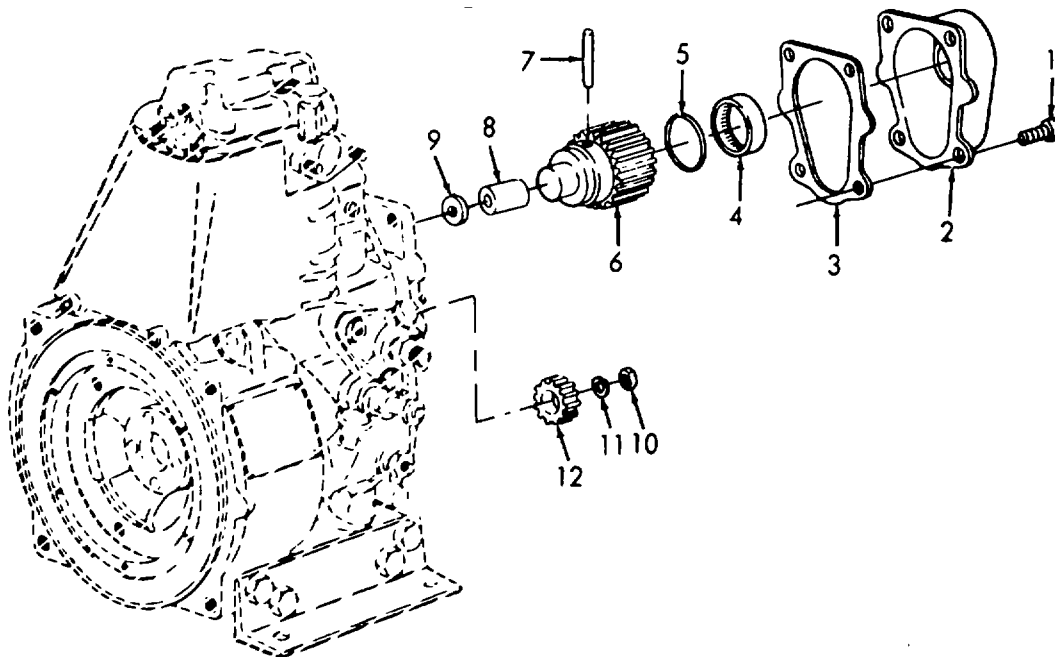


Figure 5-14. Cranking Cover and Gears Removal.

b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean housing, gear, and pinion with cleaning solvent and rags.
- (2) Allow parts to dry.

c. Inspection.

- (1) Inspect gear and pinion for damaged or chipped teeth.
- (2) Inspect bushing for excessive wear.
- (3) Inspect housing for cracks.
- (4) Replace any damaged component.

d. Installation.

- (1) Install pinion (12) onto camshaft. Secure with washer (11) and nut (10). Tighten nut (10) securely.

NOTE

Make sure timing marks on pinion (12) and gear wheel (6) are matched.

- (2) Install disc (9) into timing cover housing with the graphite side of disc facing outward.
- (3) Install bushing (8) into timing cover housing.
- (4) Install pin (7) onto gear wheel (6).
- (5) Lubricate housing (2) dry bushing with a small amount grease MIL-G10924.
- (6) Install needle bearing (4), new oil seal (5), and gear wheel (6) into housing (2).
- (6) Fill housing (2) with 3 1/2 ounces (100 g) of warm grease MIL-G- 10789.
- (7) Install new gasket (3) and housing (2) onto timing cover and secure with four screws (1). Tighten all screws securely.

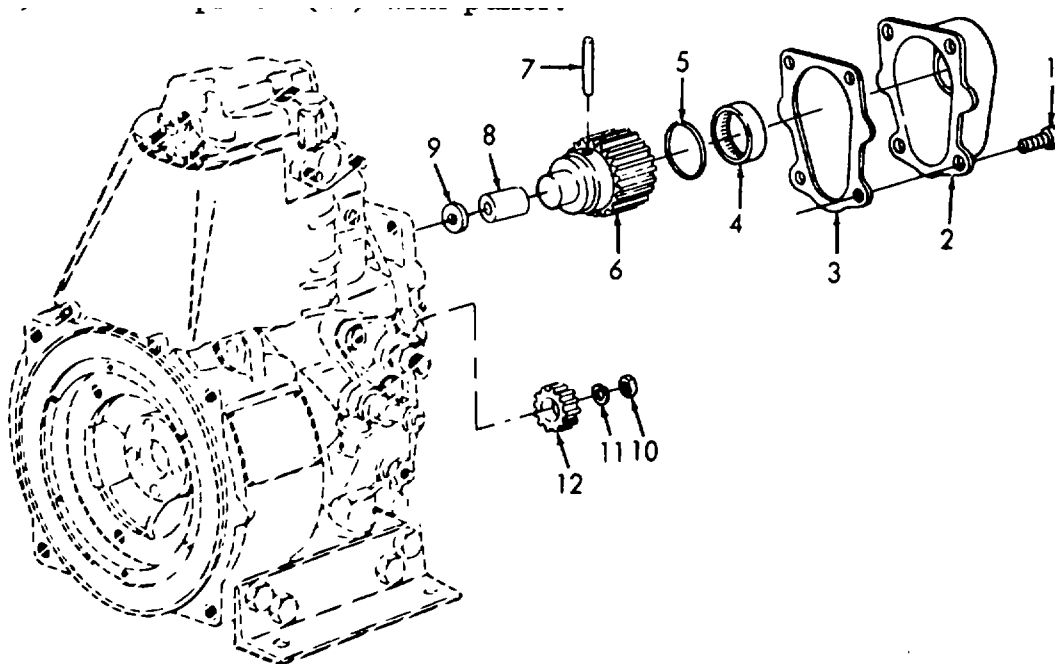


Figure 5-15. Cranking Cover and Gears Installation.

5-9. CYLINDER HEAD AND VALVE ASSEMBLY.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Installation**
e. Adjustment
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)
Retaining Bracket (item 21, appendix B)
Depth Gauge (item 20, appendix B)
Torque Wrench (item 2, appendix B)

Materials Required:

Gasket, P/N 03208902
Gasket, P/N 03770300
Gasket, P/N 5025806
Rags, Wiping (item 8, appendix E)
Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Pumping assembly shut down in accordance with paragraph 2-6.
Fuel tank removed in accordance with paragraph 4-15.
Muffler removed in accordance with paragraph 4-16.
Injector removed from cylinder head in accordance with paragraph 5-6.
Air cleaner removed in accordance with paragraph 4-10.

a. Removal. (Refer to figure 5-16).

- (1) Remove screw (1) and nut (2) from cowling (3).
- (2) Remove cowling (3) from engine.

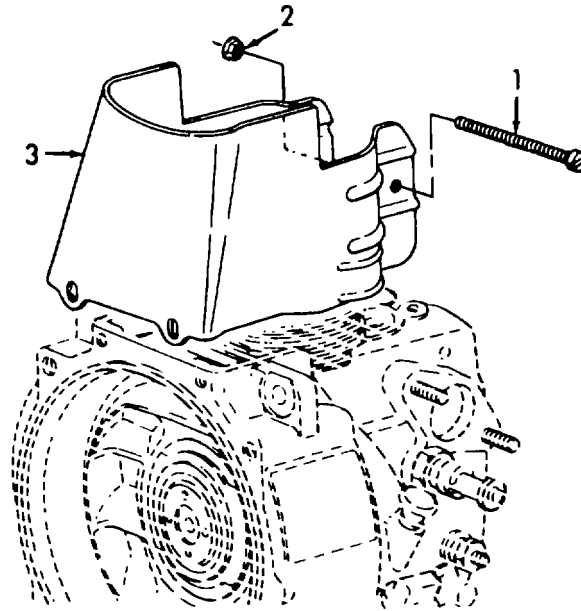


Figure 5-16. Cylinder Head Cowling Removal.

- (3) Refer to figure 5-17 and remove screw (1), two flat washers (2), and clip (3).
- (4) Remove two nuts (4) and two flat washers (5).
- (5) Lift cylinder head cover (6) off cylinder head.
- (6) Remove and discard gasket (7).

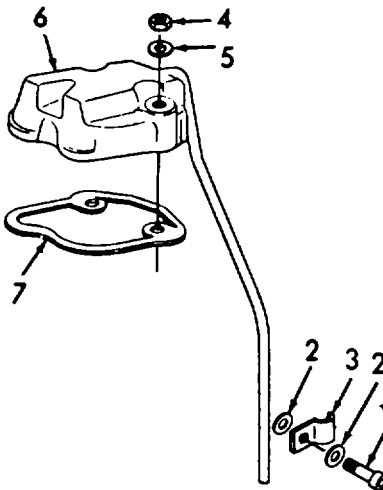


Figure 5-17. Cylinder Head Cover Removal.

5-9. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.**a. Removal - Continued.**

- (7) Refer to figure 5-18 and remove four nuts (1), four flat washers (2), and rocker shaft (3) with rockers. Lifting eye (5), fuel tank bracket (6), and two air shields (7 and 8). Remove deflector (4).

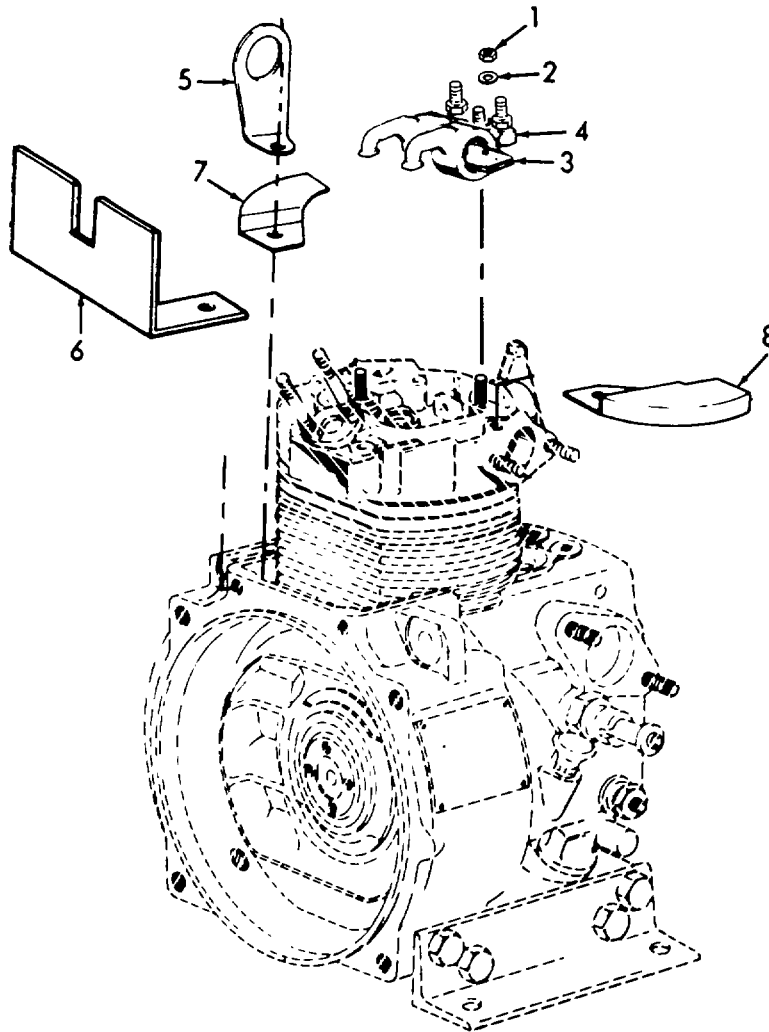


Figure 5-18. Rocker Arm Removal.

CAUTION

Do not scratch the cylinder head sealing face. Scratches could cause poor sealing of cylinder head and cylinder.

- (8) Refer to figure 5-19 and remove cylinder head (1) and gasket (2). Discard gasket.

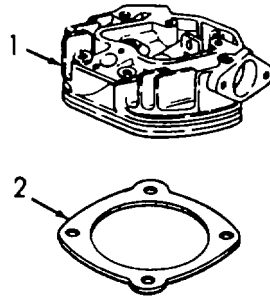


Figure 5-19. Cylinder Head Removal.

- (9) Refer to figure 5-20 and remove pushrod (1) and pushrod (2) from protection tubes (3).
 (10) Remove protection tubes (3), packings (4), shims (5), and springs (6). Discard packings (4).

NOTE

Complete pushrod (2) belongs to injection pump side of engine.

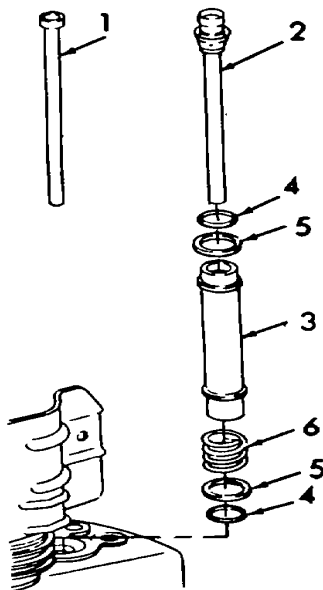


Figure 5-20. Pushrods and Protection Tube Removal.

5-9. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean cylinder head with a clean rags dampened with cleaning solvent.
- (2) Allow cylinder head to dry.

c. Inspection.

- (1) Inspect cylinder head for cracks or signs of excessive heat.
- (2) Using a straight edge, check cylinder for warpage.
- (3) Inspect cylinder head contact surface for damage.
- (4) Replace a damaged cylinder head.

d. Installation. (Refer to figure 5-21).**CAUTION**

Too small a clearance will damage piston, cylinder head, and valves. Too large a clearance will result in difficult starting.

NOTE

Prior to installing cylinder head, check the clearance between cylinder head and piston top to obtain cylinder head gasket thickness requirements.

- (1) Bring piston to Top Dead Center (TDC) position. Install retaining bracket and secure with two cylinder head mounting nuts. Tighten nuts securely.
- (2) Insert depth gauge (1) and measure distance between top of the cylinder and top of piston.
- (3) Subtract reading on depth gauge from the required clearance of 0.0216/ 0.0255 inch (0.55/0.65 mm). The difference is the thickness of the gasket required for proper cylinder head clearance.

NOTE

If you have a choice between using either one of two thickness of gaskets, use the thicker of the two.

- (4) Remove depth gauge (1).
- (5) Install new (4, figure 5-20), shims (5), spring (6), and protection tubes (3).

NOTE

Complete pushrod (2) belongs to injection pump side of engine.

- (6) Install pushrods (2 and 1).
- (7) Install new gasket (2, figure 5-19) and cylinder head (1) onto cylinder.
- (8) Install two air shields (8 and 7, figure 5-18), fuel tank bracket (6), and lifting eye (5).

NOTE

Install rocker shaft with high side up.

- (9) Install deflector (4) and rocker shaft (3) with rockers, two air shields, fuel tank bracket, and lifting eye.
- (10) Install four flat washers (2) and four nuts (1) on studs and tighten nuts equally and crosswise to a torque of 25.80 ft-lbs (35 Nm).

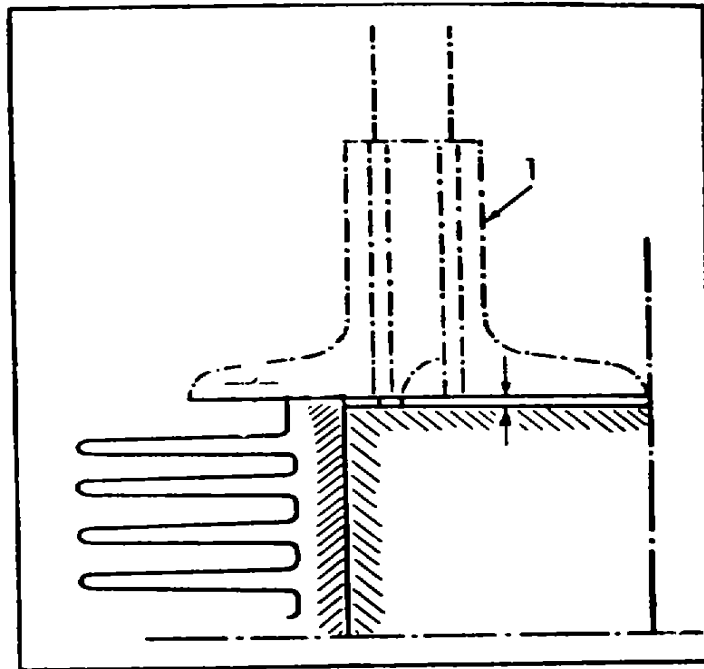


Figure 5-21. Cylinder Head and Piston Bumping Clearance Measurement.

5-9. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.

e. Adjustment. (Refer to figure 5-22).

- (1) Move decompression lever (1) clockwise to position "C".
- (2) Turn engine clockwise until compression resistance can be felt.
- (3) Check clearance between rockers and valve stem with a feeler gauge. Tappet clearance cold should be 0.004 inch (0.10 mm). To correct clearance loosen nuts (2) using box wrench (4).
- (4) Adjust screw (3) with screwdriver until feeler gauge can be pulled between rocker and valve stem with very slight resistance after nuts (2) have been tightened.

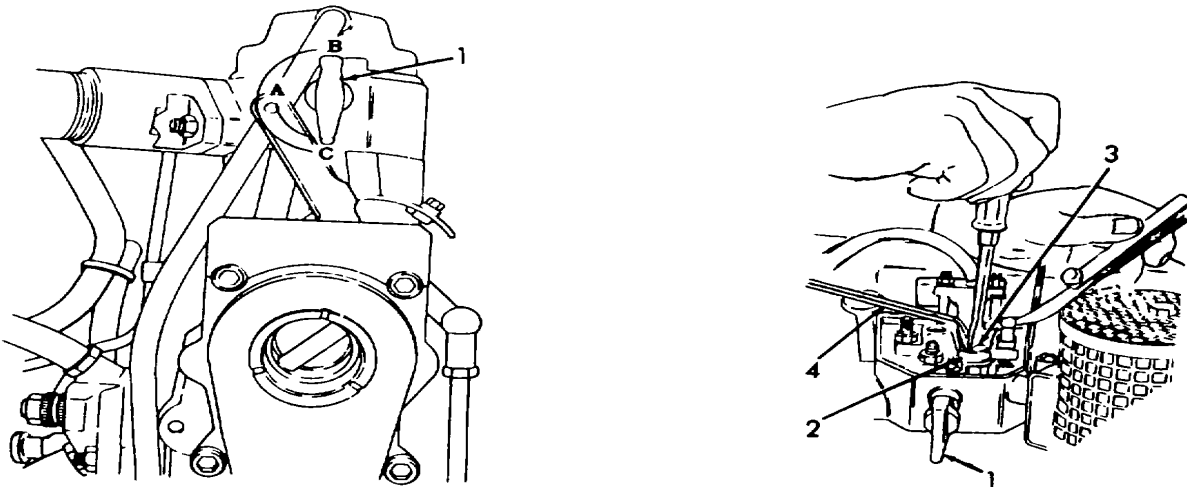


Figure 5-22. Tappet Clearance Adjustment.

- (5) Refer to figure 5-23. The adjustment of decompression adjustment screw (1) is required if the engine does not decompress when the decompression lever is in position "A".
- (6) Turn engine clockwise and put decompression lever in position "A".
- (7) Loosen nut (2) using box wrench (3) and turn adjustment screw (1) clockwise until rocker touches valve stem.
- (8) Turn adjustment screw (1) another half turn and secure by tightening nut (2).
- (9) Check clearance of complete pushrod (4) and pinion (5).

- (a) Use a feeler gauge to check that clearance (6) between socket of complete pushrod (4) and pinion (5) is 0.039 inch (1.0 mm).
- (b) Check that clearance (7) is 0.039 inch (1.0 mm).
- (c) Clearance can be adjusted by adjusting complete pushrod (4) for clearance (6) and adjusting rocker shaft for clearance (7).

NOTE

During engine operation decompression shaft must not move. Assured clearances will prevent movement.

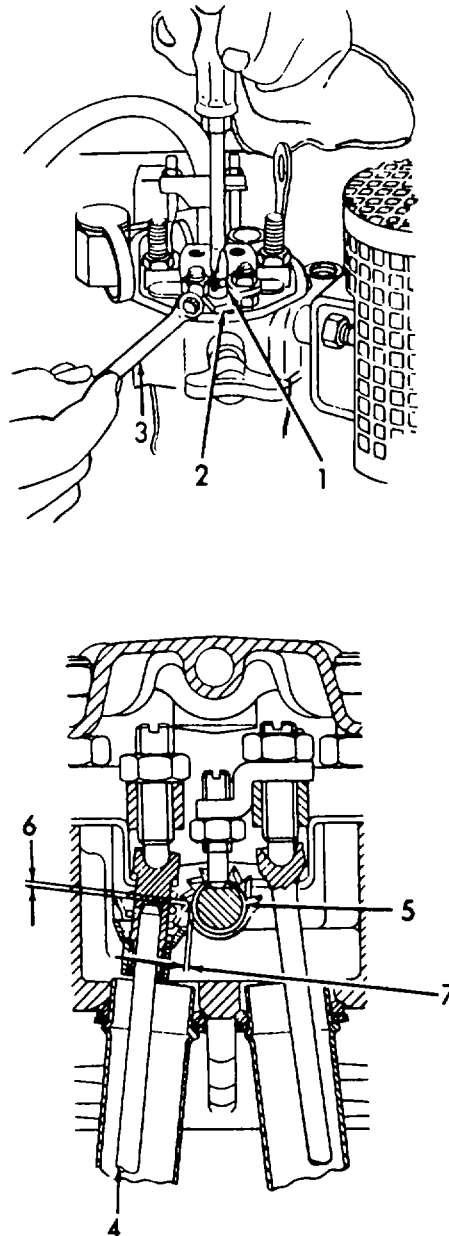


Figure 5-23. Decompression Screw and Pinion Adjustment.

5-9. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.e. Adjustment - Continued.

- (10) Install gasket (6, figure 5-17) and cover (5) on cylinder head and secure with two lockwashers (4) and two nuts (3).
- (11) Install clip (2) and secure with screw (1).
- (12) Install cowling (3) (figure 5-16) and secure with nut (2) and screw (1).
- (13) Refer to paragraph 5-6 and install injector.
- (14) Refer to paragraph 4-16 and install muffler.
- (15) Refer to paragraph 4-15 and install fuel tank.

5-10. CYLINDER.

This task consists of:

- | | | | |
|------------|-------------|---------------|-----------------|
| a. Removal | b. Cleaning | c. Inspection | d. Installation |
|------------|-------------|---------------|-----------------|
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Piston Ring Clamp (item 22, appendix B)
- Caliber Set (item 3, appendix B)

Materials Required:

- Oil, Lubricating (item 6, appendix E)
- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Cylinder head removed in accordance with paragraph 5-9.

- a. Removal. (Refer to figure 5-24).

CAUTION

When removing cylinder, make sure piston or connecting rod does not knock against crankcase. This could result in serious damage to piston or connecting rod.

- (1) Matchmark cylinder (1) and crankcase (2) to make sure of proper installation during assembly.
- (2) Pull cylinder (1) from crankcase (2).

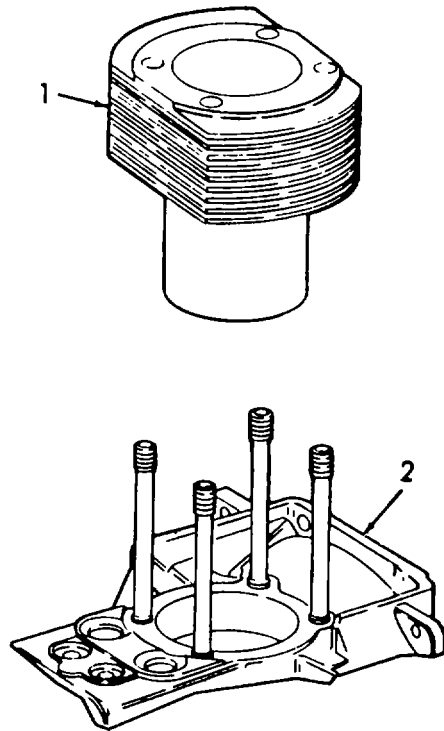


Figure 5-24. Cylinder Removal.

b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean cylinder with a rag and cleaning solvent.
- (2) Allow to dry.

5-10. CYLINDER- Continued.c. Inspection. (Refer to figure 5-25).

- (1) Measure cylinder bore at levels 1 to 4 of engine centerline axis A and crossline axis B. A normal or new bore diameter should be 2.8740 to 2.8774 inches (73.00 to 73.09 mm). If wear limits for a normal bore cylinder have been reached or exceeded, replace cylinder and piston. If measurements on axis A and axis B are different, cylinder is out of-round or has high spots. Replace cylinder.
- (2) Check that the top and bottom joint faces are smooth and flat. If damaged, replace cylinder.

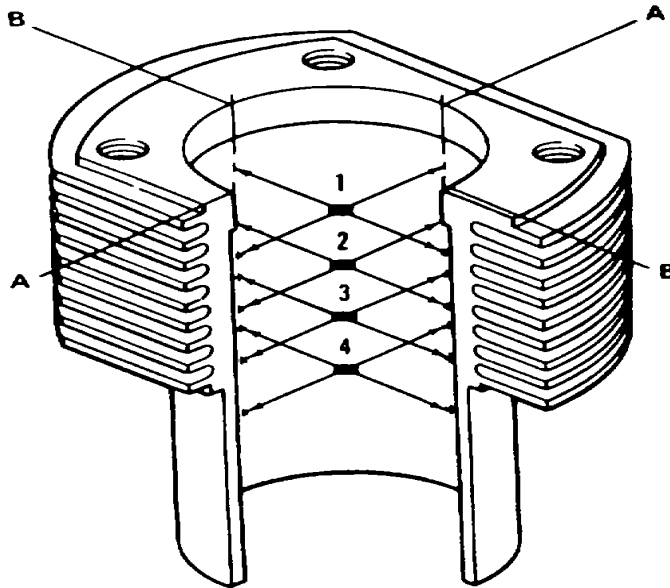


Figure 5-25. Cylinder Measuring Points.

d. Installation. (Refer to figure 5-26).

- (1) Check that piston rings are offset by 120 degrees.
- (2) Compress piston rings with piston ring clamp (1).

| |
|----------------|
| CAUTION |
|----------------|

Use care when installing cylinder to prevent damage to piston rings.

NOTE

Recessed part of cylinder must be to front of engine.

- (3) Apply lubricating oil to inside of cylinder (2) and slowly mount cylinder on studs (3).
- (4) Remove piston ring clamp (1).

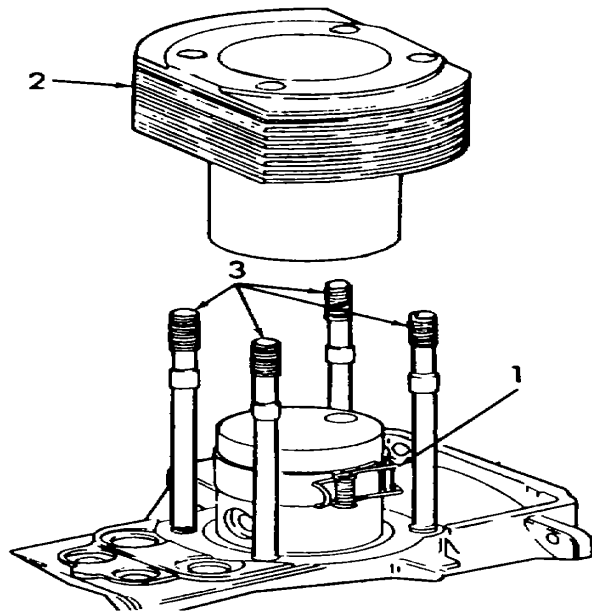


Figure 5-26. Cylinder Installation.

- (5) Refer to paragraph 5-9 and install cylinder head.

5-11. PISTON.

This task consists of:

- | | | | |
|------------|-----------------|-------------|---------------|
| a. Removal | b. Disassembly | c. Cleaning | d. Inspection |
| e. Repair | f. Installation | | |
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Pliers, Retaining Ring (item 2, appendix B)
- Piston Ring Clamp (item 22, appendix B)
- Micrometer (item 3, appendix B)

Materials Required:

- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Cylinder removed in accordance with paragraph 5-10.

a. Removal. (Refer to figure 5-27).

- (1) Using retaining ring pliers remove circlip (1).

| |
|----------------|
| CAUTION |
|----------------|

When removing piston, make sure piston or connecting rod does not knock against crankcase. This could result in serious damage to piston or connecting rod.

- (2) Press gudgeon pin (2) from piston (3). Remove piston (3) from connecting rod (4). Remove other circlip (1).

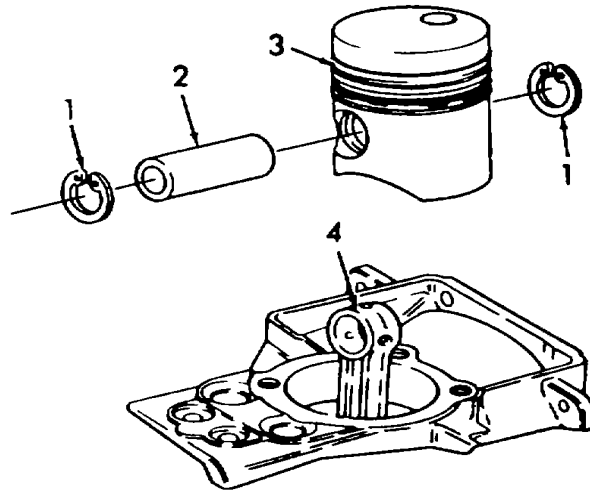


Figure 5-27. Piston Removal.

- b. Disassembly. Remove piston rings from piston.
- c. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean gudgeon pin and piston with a rag and cleaning solvent and allow to dry.
- (2) Remove carbon from piston ring grooves.

- d. Inspection.

- (1) Inspect piston for cracks between ring grooves.
- (2) Inspect piston for indications of overheating.

5-11. PISTON- Continued.d. Inspection - Continued.

- (3) Refer to figure 5-28 and measure piston diameter (1) along axis A and B. A normal or new piston diameter should be 2.8724 inches (72.96 mm). If piston is worn, replace piston.

NOTE

Install piston rings into the cylinder one at a time and measure the gap.

- (4) Measure top ring gap. Measurement must not exceed .030 inch (0.80 mm).
 (5) Measure middle ring gap. Measurement must not exceed .060 inch (1.50 mm).
 (6) Measure bottom ring gap. Measurement must not exceed .060 inch (1.50 mm).
 (7) If ring gap exceeds the dimensions listed above, install a new ringset.
 (8) Replace a damaged piston.

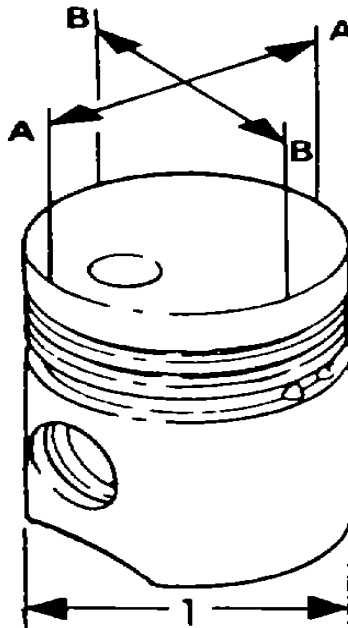


Figure 5-28. Measuring Piston Circumference.

e. Repair Refer to figure 5-29).

- (1) Install oil control ring (1), compression ring (2), and compression ring (3) on piston (4).
 (2) Make sure the piston ring gaps are equally spaced around the piston 120 degrees from each other.

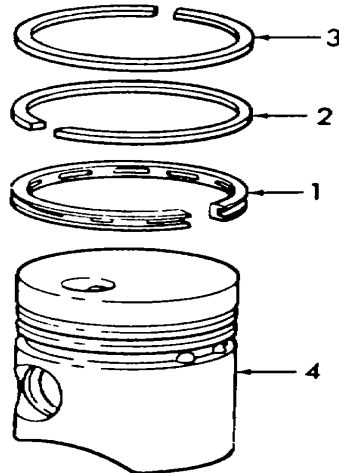


Figure 5-29. Piston Rings Installation.

f. Installation. (Refer to figure 5-30).

- (1) Install one circlip (1) in lip groove of piston (3) gudgeon bore.

CAUTION

When installing piston, make sure piston or connecting rod does not knock against crankcase. This could result in serious damage to piston or connecting rod.

- (2) Insert connecting rod (4) into bottom of piston (3). Make sure that opening of combustion chamber is on the flywheel side.
- (3) Insert gudgeon pin (2) into piston (3) gudgeon bore and through rod bushing of connecting rod (4). Push in gudgeon pin until it contacts installed circlip (1) and stops.
- (4) Install other circlip (1).

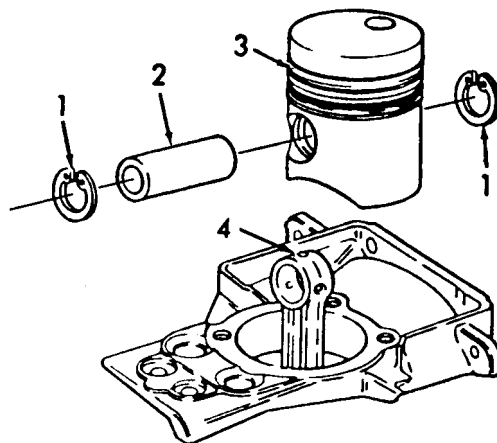


Figure 5-30. Piston Installation.

- (5) Refer to paragraph 5-10 and install cylinder.

5-12. FLYWHEEL.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Installation
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Torque Wrench (item 2, appendix B)
- Socket (item 25, appendix B)

Materials Required:

- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Pump assembly removed in accordance with paragraph 5-4.

a. Removal. (Refer to figure 5-31).

- (1) Remove four screws (1), four lockwashers (2), and housing (3).
- (2) Remove three screws (4), three lockwashers (5), and stub shaft (6).
- (3) Remove four screws (7), four lockwashers (8), and flywheel (9).
- (4) Remove six screws (10), six lockwashers (11), and blower ring (12).

b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with a rag and cleaning solvent.
- (2) Allow to dry.

c. Inspection.

- (1) Inspect blower ring for cracked, chipped, or missing blades.

- (2) Inspect flywheel for corrosion or cracks.
- (3) Replace all parts that are damaged.

d. Installation.

- (1) Install blower ring (12) on flywheel (9) and secure with six lockwashers (11) and six screws (10).
- (2) Position flywheel (9) on the engine, align all bolt holes on flywheel and crankshaft and secure with four lockwashers (8) and four screws (7). Torque screws to 51.60 ft-lbs (70 Nm).
- (3) Install stub shaft (6) on flywheel (9) and secure with three lockwashers (5) and three screws (4).
- (4) Install housing (3) on engine and secure with four lockwashers (2) and four screws (1).
- (5) Refer to paragraph 5-4 and install pump assembly.

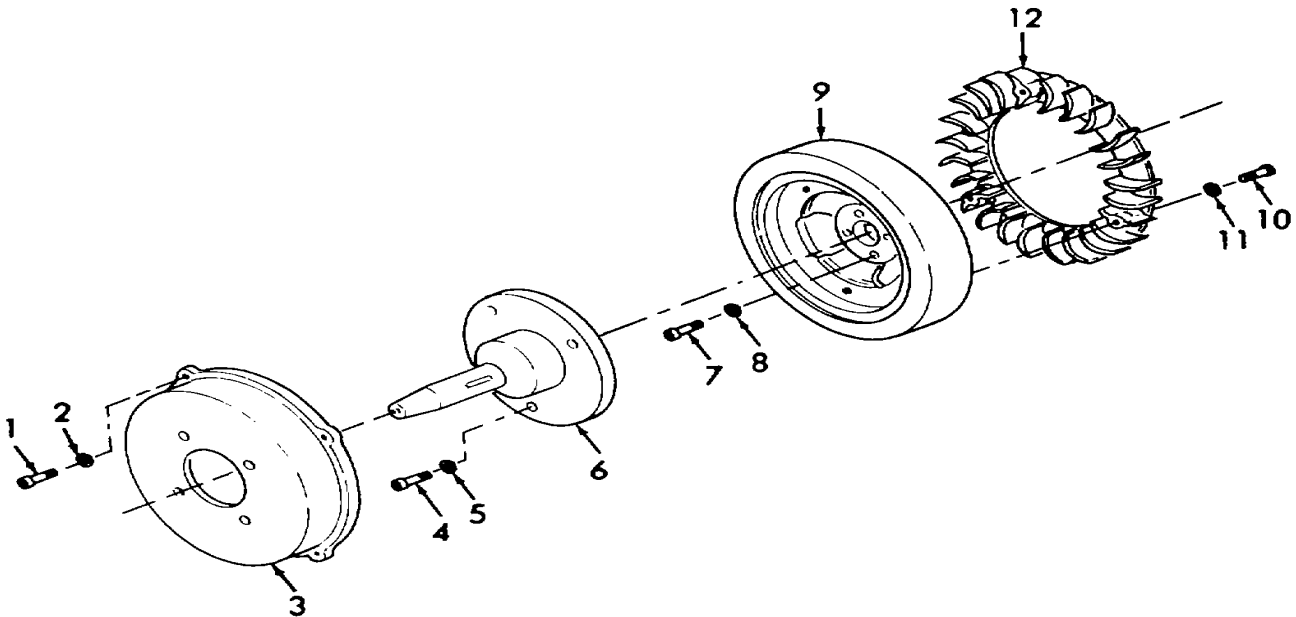


Figure 5-31. Flywheel Removal/Installation.

5-13. FRAME ASSEMBLY.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Repair
e. Installation
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)

Materials Required:

Rags, Wiping (item 8, appendix E)
Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Pump assembly removed in accordance with paragraph 5-4.
Engine assembly removed in accordance with paragraph 5-5.

- a. Removal. Refer to figure 5-32 and remove frame assembly (1).
b. Cleaning.

| |
|----------------|
| WARNING |
|----------------|

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean frame assembly with a rag and cleaning solvent.
(2) Allow to dry.

c. Inspection.

- (1) Inspect frame assembly for broken welds.
(2) Inspect frame assembly for rust or corrosion.

d. Repair. Repair to frame assembly is limited to repairing broken welds and painting. Refer to TM 43-0139 for painting instructions.

e. Installation.

- (1) Place frame assembly (1) into position.

- (2) Refer to paragraph 5-5 and install the engine assembly.
- (3) Refer to paragraph 5-4 and install the pump assembly.

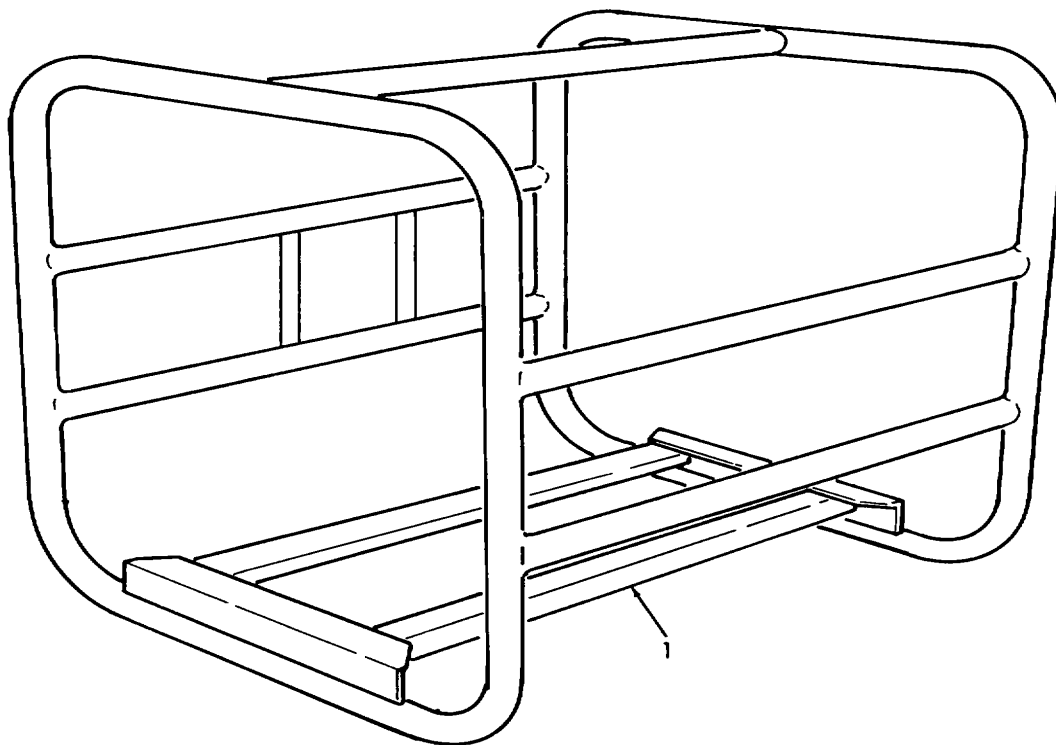


Figure 5-32. Frame Assembly Removal/Installation.

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CHAPTER 6

GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

- Section I Troubleshooting
- Section II Maintenance Procedures

Section I. TROUBLESHOOTING

No troubleshooting procedures are required of general support for the pumping assembly.

Section II. MAINTENANCE PROCEDURES

| | Para. | | Para. |
|--|-------|---------------------------------|-------|
| Crankcase | 6-7 | Governor | 6-4 |
| Crankshaft | 6-6 | Oil Seal (Flywheel Side) | 6-5 |
| Connecting Rod | 6-2 | Timing Cover and Camshaft | 6-3 |
| Cylinder Head and Valve Assembly | 6-1 | | |

6-1. CYLINDER HEAD AND VALVE ASSEMBLY.

This task consists of:

- a. Disassembly b. Cleaning c. Inspection d. Repair
e. Reassembly
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Shop Equipment, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)
- Reamer, Valve Guide (item 23, appendix B)

Materials Required:

- Brush, Wire (item 1, appendix E)
- Packing, P/N 50001100
- Packing, P/N 50154100
- Packing, P/N 50154200
- Packing, P/N 50154300
- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

- Well-ventilated area required.

Equipment Conditions:

- Cylinder head removed in accordance with paragraph 5-9.
 - Air filter adapter removed in accordance with paragraph 4-11.
-

a. Disassembly. (Refer to figure 6-1).

- (1) Using a valve spring compressor, depress valve spring and remove collet (1).
- (2) Remove cup (2), spring (3), washer (4), cap (5), and valve (6). Remove other valve in the same manner.
- (3) Remove nut (7), threaded pin (8), ten plates (9), pin (10), and packing (11). Discard packing (11).
- (4) Remove pin (12), pin (13), lever (14), shaft (15), packing (16) and pinion (17). Discard packing (16).
- (5) Remove oil fill device (18), packing (19), and packing (20). Discard packings (19 and 20).
- (6) Remove two pins (21) and two spacer rings (22) and press out two valve guides (23).
- (7) Remove closing screw (24).

- (8) Remove two studs (25) from cylinder head (27).
- (9) Remove two studs (26) from cylinder head (27).

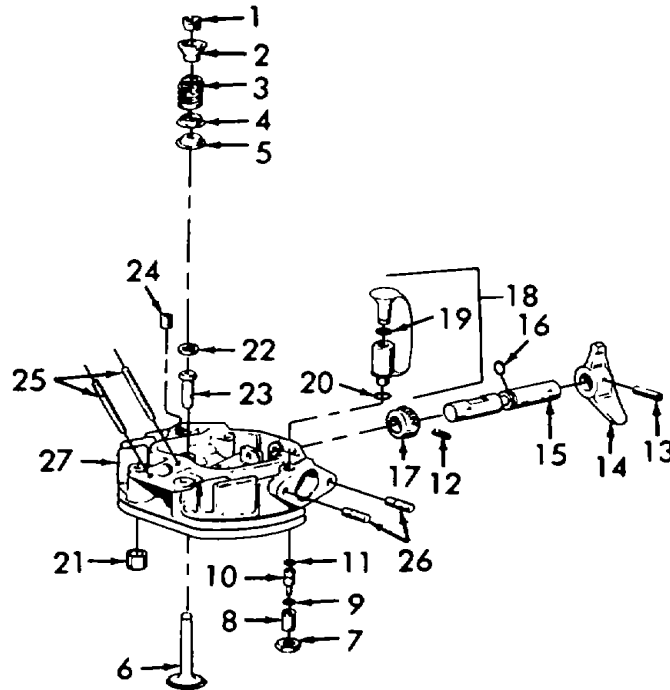


Figure 6-1. Cylinder Head Disassembly.

b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean cylinder head with cleaning solvent. Use a wire brush to remove carbon deposits.
- (2) Allow to dry.

c. Inspection.

- (1) Using a straight edge, check cylinder head for warpage. Replace a cylinder if it is warped.
- (2) Inspect valves for warpage and check that valve stem diameter is not less than 0.2736 inch (6.75 mm).
- (3) Check that each valve head diameter is not less than 1.200 inch (30.5 mm).

6-1. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.c. Inspection - Continued.

- (4) Check that inside diameter of each valve guide does not exceed 0.2779 inch (7.059 mm).
- (5) Check that valve seat angle does not exceed 45 degrees.

d. Repair. (Refer to figure 6-2).

- (1) If the inside diameter of a cylinder head valve guide exceeds 0.2779 inch (7.059 mm), replace valve guide. Press out valve guide.
- (2) From cylinder head bottom, push valve guide out of cylinder head. Insert new valve guide into cylinder head. Install new valve guide by pressing in. Minimum inserting pressure is 220 inch-pounds (245 cm-kg).

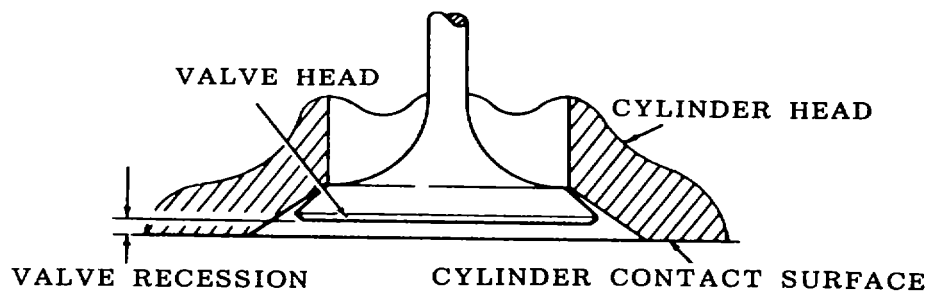


Figure 6-2. Checking Valve Recession.

- (3) Ream the inside diameter of the valve guide to 0.2755/0.2760 inch (7.000/7.009 mm) using hand reamer.
- (4) Repair defective cylinder head valve seats by grinding with a 45 degree valve seat cutter.
- (5) The cylinder contact surface of the cylinder head can be repaired by machining. Remove up to a maximum of 0.0196 inch (0.5 mm) of metal provided the minimum valve recession is maintained.
- (6) Replace any valves that show head warping, burning, or other damage.
- (7) Replace valves that have seriously scratched or scuffed stems, or pitted, ridged, or cracked faces, or heads.
- (8) Replace valves that have a valve head diameter of less than 1.197 inch (30.4 mm).

CAUTION

The valve recession must not be less than 0.018 inch (0.45 mm), otherwise valve head may touch piston.

(9) The valve recession shall be a maximum of 0.0275 inch (0.70 mm) and a minimum of 0.0180 inch (0.45 mm).

e. Reassembly. (Refer to figure 6-3).

- (1) Install two studs (26 and 25) into cylinder head (27).
- (2) Install closing screw (24).
- (3) Press in two valve guides (23) and install two spacer rings (22), if removed.
- (4) Install two pins (21). Install new packing (20), new packing (19), and oil fill device (18).
- (5) Install pinion (17), new packing (16), shaft (15), lever (14), and pins (13 and 12).

NOTE

- Plates (9) have a bevel side and a smooth side. Install plates (9) in pairs, bevel side to bevel side.
- Lever (14) must be in the run position before installing threaded pin (8).

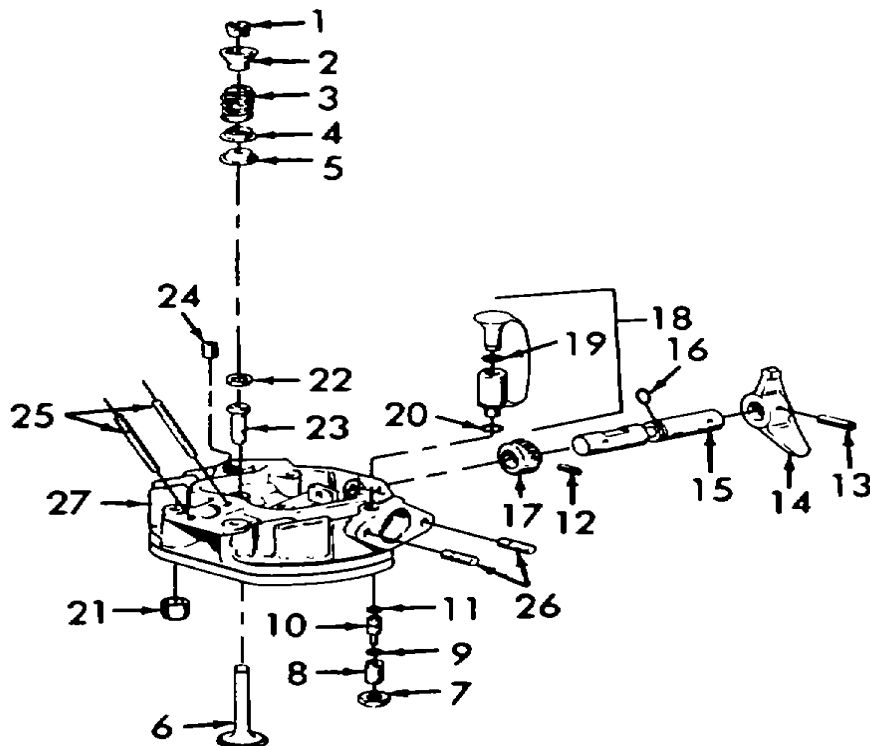


Figure 6-3. Cylinder Head Reassembly.

6-1. CYLINDER HEAD AND VALVE ASSEMBLY - Continued.e. Reassembly - Continued.

- (6) Install new packing (11), pin (10), ten plates (9), threaded pin (8), and nut (7). Install threaded pin (8) until pressure is felt, then turn it one more turn and tighten nut (7).
- (7) Install valve (6) into cylinder head.
- (8) Install cap (5), washer (4)', spring (3), and cap (2).
- (9) Using a valve spring compressor, depress valve spring and install collet (1). Remove valve spring compressor. Refer to steps (7) thru (9) and install other valve.
- (10) Proper fit of valves can be checked, by pouring fuel into intake and exhaust ports. Valves fit properly if no fuel trickles through.
- (11) Refer to paragraph 5-9 and install cylinder head.

6-2. CONNECTING ROD.

This task consists of:

- a. Removal
 - b. Cleaning
 - c. Inspection
 - d. Repair
 - e. Installation
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)
 Shop Equipment, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)

Materials Required:

Brush, Wire (item 1, appendix E)
 Oil, Lubricating (item 6, appendix E)
 Rags, Wiping (item 8, appendix E)
 Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Piston removed in accordance with paragraph 5-11.
 Engine oil drained in accordance with paragraph 4-1.

- a. Removal. (Refer to figure 6-4).

NOTE

Remove oil fill plug. Insert a screwdriver through oil fill hole and push out cover (3).

- (1) Remove four screws (1), four caps (2), cover (3), and packing (4). Discard packing (4).

CAUTION

When removing connecting rod, make sure it does not knock against crankcase. This could result in serious damage to connecting rod.

- (2) Using allen socket, remove two allen screws (5) and remove bottom half of connecting rod (6).
- (3) Remove top half of connecting rod (6) from top of crankcase.
- (4) Remove two bearing halves (7) from both halves of connecting rod (6).
- (5) Refer to figure 6-5 and measure the inside diameter of connecting rod bushing. Measure at points 1 and 2 along axes A and B. Measurements should be .9858 to .9877 inch (25.040 to 25.073 mm). If measurement is over .9877 inch (25.088 mm) limit, replace rod bushing.
- (6) Using a arbor press, Dress bushing (8) from connecting rod (7).

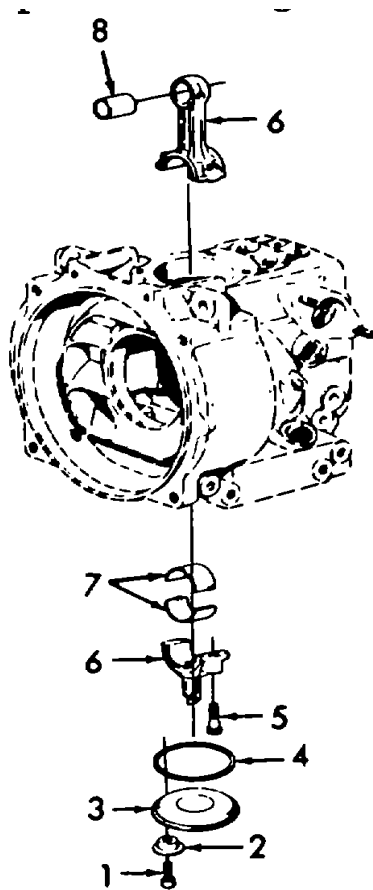


Figure 6-4. Connecting Rod Removal.

6-2. CONNECTING ROD - Continued.b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean connecting rod with a rag and cleaning solvent.
- (2) Remove any carbon deposits with a wire brush.

c. Inspection.

- (1) Visually inspect connecting rod for bending, warping, or other damage. Replace a damaged connecting rod.
- (2) Inspect upper and lower bearing halves for excessive wear, scoring, pitting, flaking, etching, and signs of overheating. Inspect bearing backs for bright spots (bearing moving in supports).
- (3) Temporarily assemble connecting rod with two new allen screws and without bearings. Using torque wrench, tighten screws to 29.50 ft-lbs (40 Nm). Apply some oil to threads and contact surfaces.
- (4) Measure inside diameter of connecting rod bearing bore. Measurement should be 1.8114 to 1.8107 inches (46.010 to 45.994 mm). If measurement is outside specified limits, replace connecting rod.
- (5) Disassemble connecting rod and carefully insert bearing halves. The bottom half has a hole which fits into connecting rod cup. Reassemble connecting rod with two allen screws. Tighten screws following procedures described in step (3).

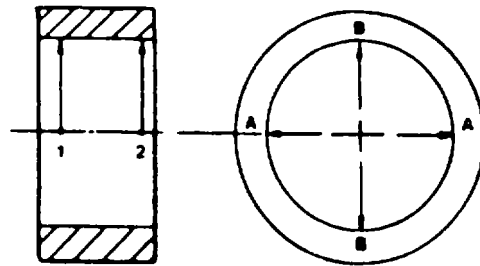


Figure 6-5. Measuring Connecting Rod Bushing Inside Diameter.

- d. Repair. Repair to the connecting rod is limited to replacing the bearing halves and bushing.

e. Installation. (Refer to figure 6-6).

- (1) Using an arbor press, press bushing (8) into connecting rod (6).

CAUTION

Be certain that bearing halves are installed correctly. The bottom bearing half (7) has a hole which fits into lower connecting rod half (6).

- (2) Carefully insert bearing halves (7) into connecting rod.

CAUTION

- Be certain that the numbers on both halves of the connecting rod match.
- When installing connecting rod, make sure it does not knock against crankcase. This could result in serious damage to connecting rod.

- (3) Apply a light coat of lubricating oil to both bearing halves.
- (4) Install top and bottom of connecting rod (6) on crankshaft with dipping opening on bottom half to dipstick side.
- (5) Install two screws (5). Using a torque wrench and allen socket, tighten screws to 29.50 ft-lbs (40 Nm).
- (6) Position packing (4) on cover (3). Install cover (3) and secure with four caps (2) and four screws (1).
- (7) Refer to paragraph 5-11 and install piston.

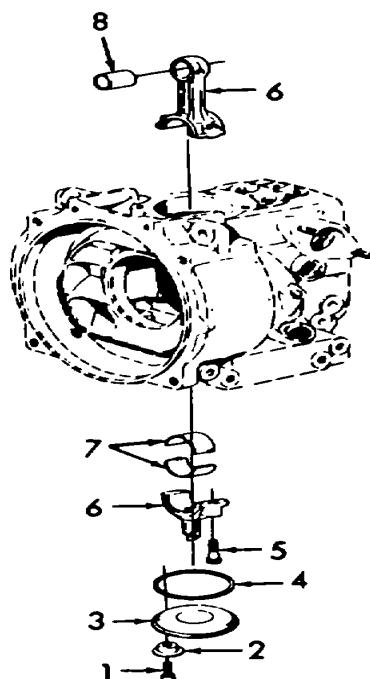


Figure 6-6. Connecting Rod Installation.

6-3. TIMING COVER AND CAMSHAFT.

This task consists of:

- | | | | |
|------------|----------------|-------------|---------------|
| a. Removal | b. Disassembly | c. Cleaning | d. Inspection |
| e. Repair | f. Reassembly | | |
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Shop Set, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)
- Auxiliary Bush, Timing Cover Oil Seal (30 x 47 mm) 666 075 00 (item 7, appendix B)
- Extractor, Cam Follower Spindle 666 324 00 (item 8, appendix B)
- Mounting Device, Camshaft Needle Bearing 666 418 00 (item 9, appendix B)

Materials Required:

- Gasket, P/N 03209202
- Oil Seal, P/N 40033700
- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

- Well-ventilated area required.

Equipment Conditions:

- Cylinder head removed in accordance with paragraph 5-9.
 - Cranking gears removed in accordance with paragraph 5-8.
-

- a. Removal. (Refer to figure 6-7).

CAUTION

Lift both cam followers from camshaft when removing timing cover to prevent bending by cam points.

- (1) Remove four screws (1), two screws (2), five washers (3), timing cover (4), and camshaft (14) as a unit.

NOTE

Insertion of allen screws (8 mm dia., 1-1/2 inches long) in timing cover holes will aid in removal of timing cover.

- (2) Remove and discard gasket (5).
- (3) Remove plastic plug (6) above fuel injection pump, and remove setscrew (7) from crankcase.
- (4) Remove spindle (8), cam followers (9 and 10), and shim (11) from crankcase using extractor.

b. Disassembly. (Refer to figure 6-7).

- (1) Remove oil seal (12) from timing cover (4). Discard oil seal (12).
- (2) Collapse dry bushing (13) and remove.

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (3) Using an oven, heat timing cover to 1200 to 1600F (500 to 700C). Pull out ball bearing (14) and remove intermediate ring (15).
- (4) While timing cover is still hot, drive out camshaft (16).
- (5) Remove nut (17), spring washer (18), circlip (19), flanged wheel (20), roller bearing (21), and spacer (22).
- (6) Remove bearing (23) from crankcase.

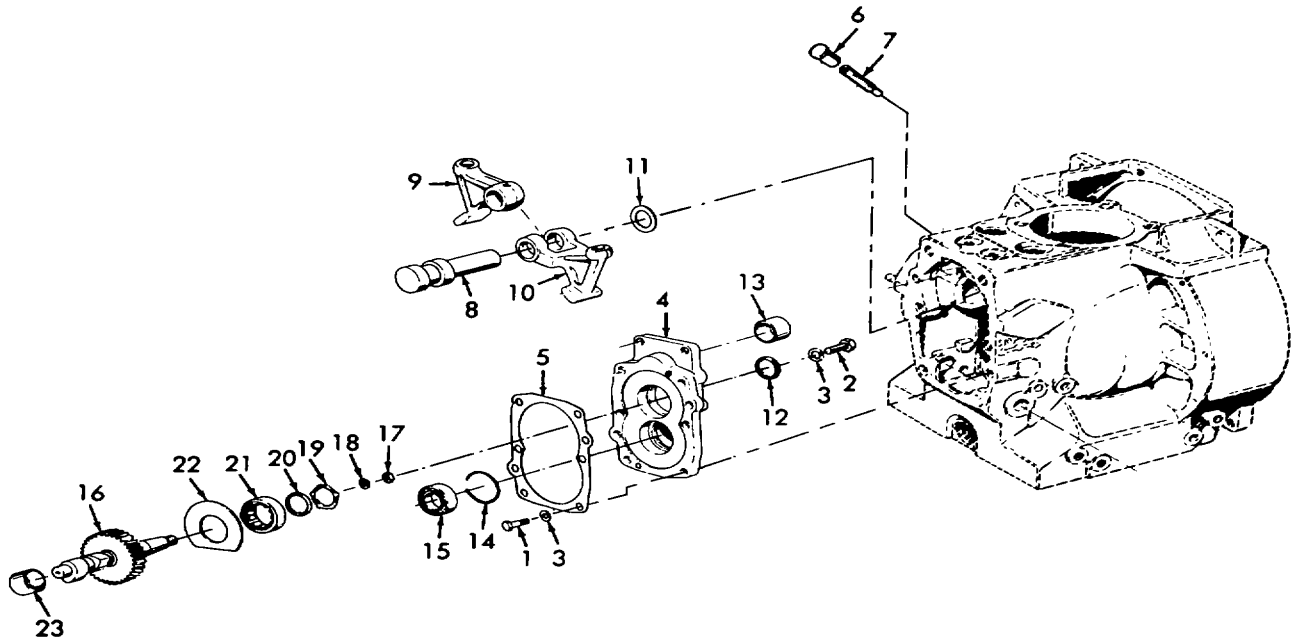


Figure 6-7. Timing Cover and Camshaft Removal/Disassembly.

6-3. TIMING COVER AND CAMSHAFT - Continued.c. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with a rag and cleaning solvent.
- (2) Allow to dry.

d. Inspection.

- (1) Inspect timing cover for cracks or signs of wear. Replace a damaged timing cover.
- (2) Inspect camshaft for missing teeth on gear or scoring of camshaft lobes. Replace a damaged camshaft.
- (3) Inspect all bearings for scoring or pitting. Replace a damaged bearing.
- (4) Inspect camshaft bearing (22) for damage. If bearing (22) is damaged, remove by using a punch.

e. Repair. Repair is limited to replacing damaged parts.f. Reassembly. (Refer to figure 6-8).

- (1) Install a new bearing (23) using camshaft needle bearing mounting device.
- (2) Install spacer (22), roller bearing (21), flanged wheel (20), circlip (19), spring washer (18), and nut (17) on camshaft (16).

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (3) Using an oven, heat timing cover (4) to 1200 to 1600F (500 to 700C). Install new intermediate ring (14) and drive in new ball bearing (15).
- (4) While timing cover is still hot, drive in camshaft (16).
- (5) Drive in new dry bushing (13).

- (6) Using timing cover oil seal auxiliary bushing, install new oil seal (12).
- (7) Install shim (11), cam followers (10 and 9), and spindle (8).
- (8) Install setscrew (7) and plastic plug (6).
- (9) Position a new gasket (5) on crankcase.

NOTE

Make sure matchmarks on camshaft gear and crankshaft gears are aligned when installing timing cover.

- (10) Install timing cover (4) on crankcase and secure with five washers (3), two screws (2), and four screws (1).
- (11) Refer to paragraph 5-9 and install cylinder head.
- (12) Refer to paragraph 5-8 and install cranking gears.

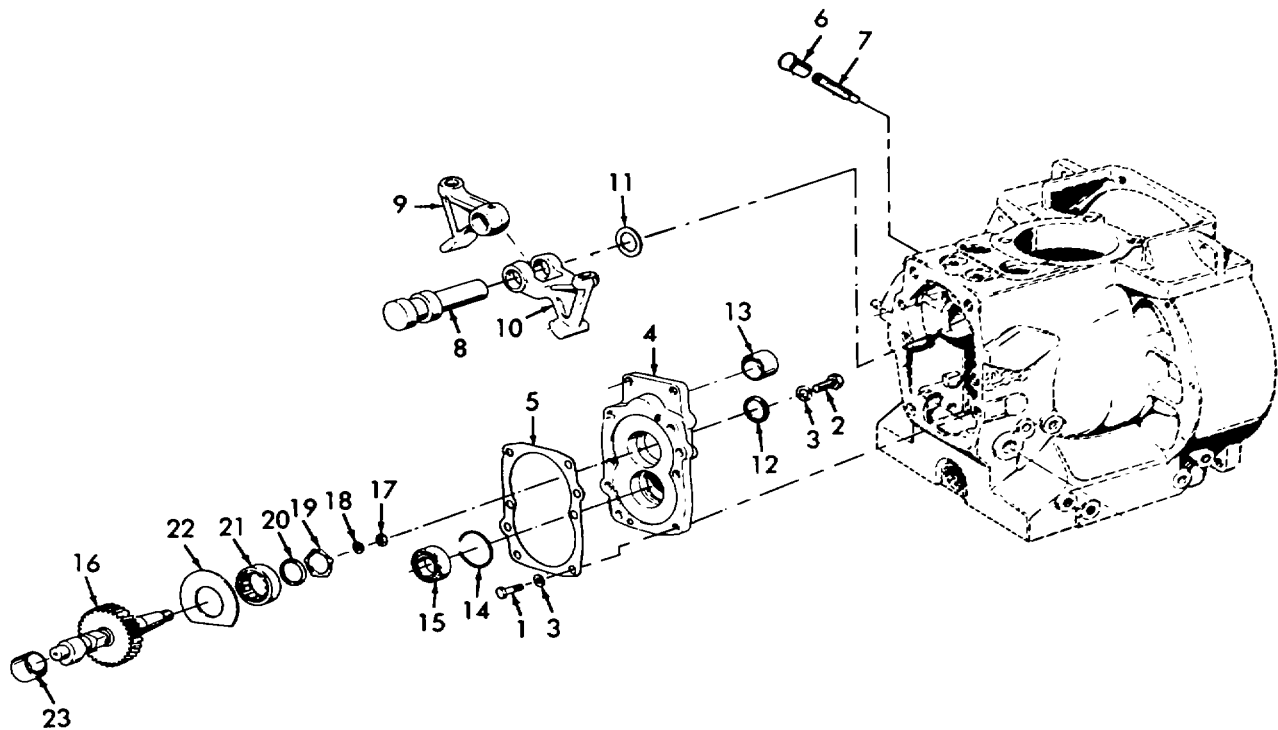


Figure 6-8. Timing Cover and Camshaft Reassembly.

6-4. GOVERNOR.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Repair
e. Installation
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)
Shop Set, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)
Extractor for Gear, Crankshaft 618 168 00 (item 12, appendix B)
Impact Mandrel, Gear on Crankshaft 666 069 00 (item 14, appendix B)
Special Tool for Governor Spring 618 305 00 (item 15, appendix B)

Materials Required:

Oil, Lubricating (item 6, appendix E)
Packing, P/N 40021700
Rags, Wiping (item 8, appendix E)
Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Timing cover and camshaft removed in accordance with paragraph 6-3.
Cranking gears removed in accordance with paragraph 5-8.

a. Removal. (Refer to figure 6-9).

- (1) Remove two nuts (1), lever (2), nut (3), and disc (4).
- (2) Remove gear (5) using extractor. Remove disc (6) and shell (7) from crankshaft.
- (3) Remove threaded pin (10) and nut (11) from lever (20).
- (4) Remove four pins (8 and 9) from shaft (17).
- (5) Remove cap (12), nut (13), plate (14), packing (15), and eccentric pin (16). Discard packing (15).
- (6) Lightly push shaft (17) from crankcase.
- (7) Remove washer (18) and two packings (19). Discard packing (19).
- (8) Remove lever (20) and spring (21) from crankcase.

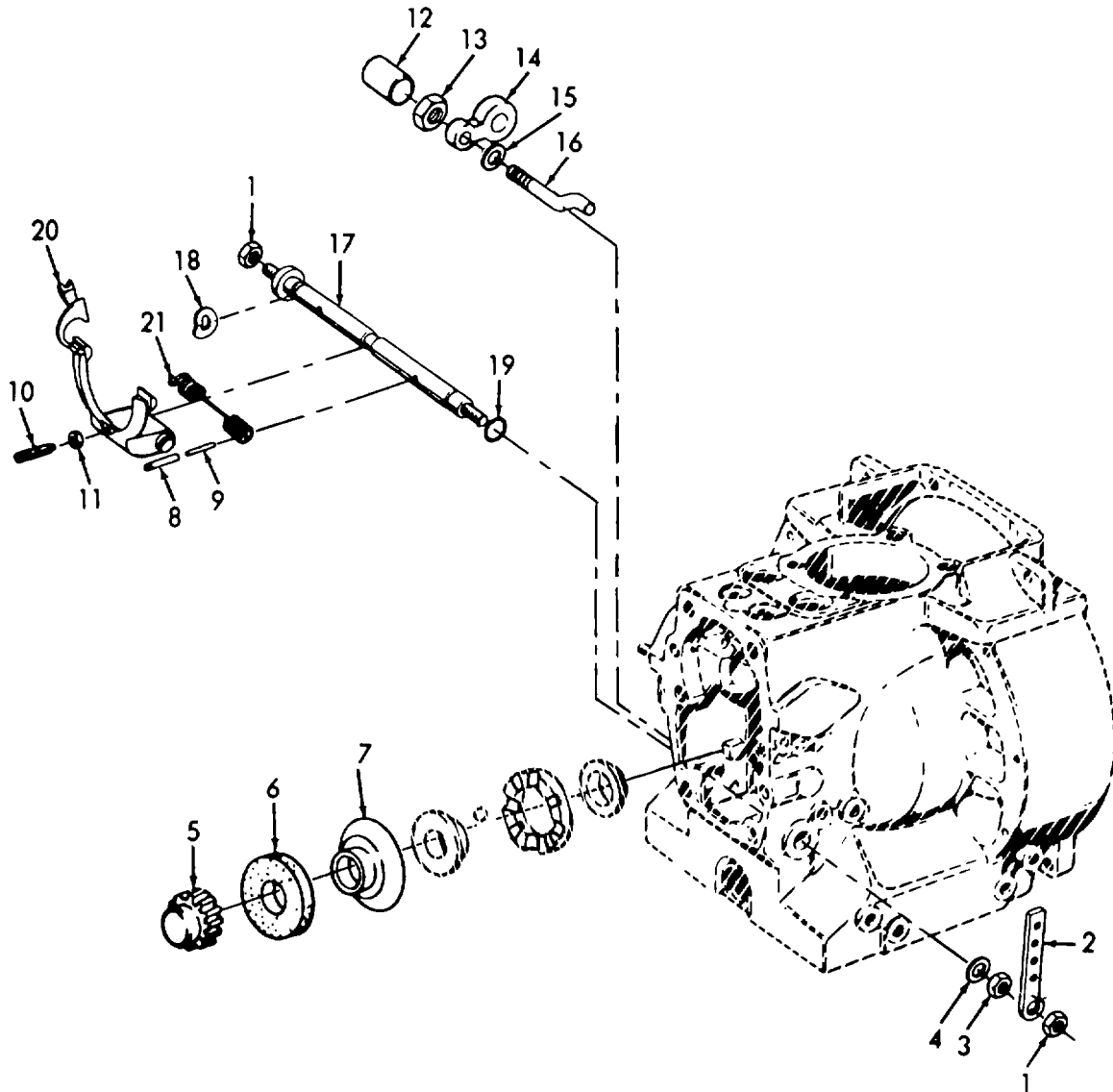


Figure 6-9. Governor Removal.

b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with a rag and cleaning solvent.
- (2) Allow to dry.

6-4. GOVERNOR - Continued.c. Inspection.

- (1) Inspect shaft for burrs, cracks, or signs of wear.
- (2) Inspect lever for cracks or signs of wear.
- (3) Replace all damaged parts.

d. Repair. Repair is limited to replacing damaged parts.e. Installation. (Refer to figure 6-10).

- (1) Mount spring (21) on lever (20) and install both parts in crankcase.

NOTE

The loop hole of the governor spring should point upward.

- (2) Apply lubricating oil to two packings (19). Install packings (19) in grooves on shaft (17).
- (3) Install washer (18) on shaft (17) and install shaft (17) into crankcase.
- (4) Install eccentric pin (16), packing (15), plate (14), nut (13), and cap (12).



Governor lever and shaft should move freely. Do not overtighten threaded pin and lock lever on shaft. (Snug pin to bottom and unscrew 1/2 turn).

- (5) Install threaded pin (10) and nut (11).
- (6) Install disc (4), nut (3), lever (2), and two nuts (1) on shaft (17).
- (7) Drive pins (8) through shaft until approximately 0.125 inch (3.21 mm) of roll pins protrude through reverse side of shaft (17). Using special tool loop ends of governor spring over drive pins (8).
- (8) Install pins (9) into center of pins (8).
- (9) Drive pins (8 and 9) in, until they are flush with outer surface of shaft (17).
- (10) Install shell (7) and disc (6) on crankshaft.
- (11) Using an oven, heat gear (5) to 1600 to 1750F (700 to 800°C). Install gear (5) onto crankshaft using impact mandrel 666 069 00.
- (12) Refer to paragraph 6-3 and install camshaft and timing cover.

NOTE

Items (1) thru (6) of figure 6-12 are part of the governor, however, they must be removed with the crankshaft.

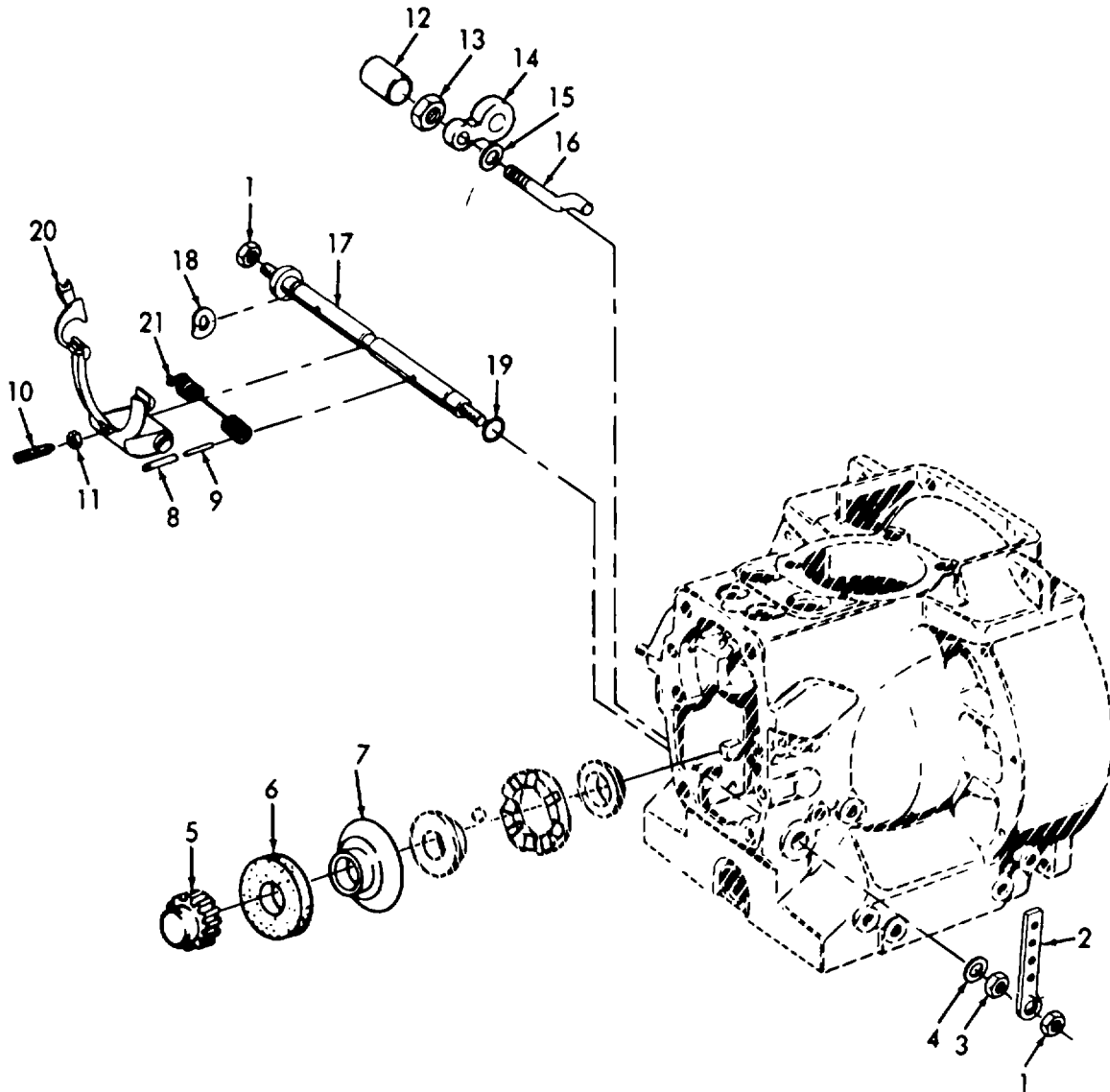


Figure 6-10. Governor Installation.

6-5. OIL SEAL (FLYWHEEL SIDE).

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Installation**
-

INITIAL SETUP:Tools Required:

Tool Kit, General Mechanics (item 1, appendix B)
 Shop Set, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)
 Auxiliary Bushing, Oil Seal (60 x 75 mm dia) Support Flywheel Side 666 068 00
 (item 13, appendix B)

Materials Required:

Grease (item 4, appendix E)
 Oil Seal, P/N 40034200
 Packing, P/N 50154000
 Rags, Wiping (item 8, appendix E)
 Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

Flywheel removed in accordance with paragraph 5-12.
 Cranking gears removed in accordance with paragraph 5-8.

a. Removal. (Refer to figure 6-11).

- (1) Bend tabs of plates (2) away from screws (1).
- (2) Remove four screws (1) and two plates (2).
- (3) Remove cover (3) and packing (4). Discard packing (4).
- (4) Remove seal (5) from cover (3). Discard seal (5).

b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean cover with a rag and cleaning solvent.
- (2) Allow to dry.

c. Inspection.

- (1) Inspect cover for cracks or signs of wear.
- (2) Replace a damaged cover.

d. Installation.

- (1) Install auxiliary bushing on crankshaft.
- (2) Install new seal (5) into cover (3). Fill groove of oil seal (5) with grease.
- (3) Lubricate new packing (4) with grease and install packing (4) in groove of cover (3).
- (4) Install cover (3) on crankshaft and secure with two plates (2) and four screws (1). Remove auxiliary bushing and bend tabs of plates (2) over screws (1).
- (5) Torque screws (1) to 7.3 ft-lbs (10 Nm).
- (6) Refer to paragraph 5-12 and install flywheel.

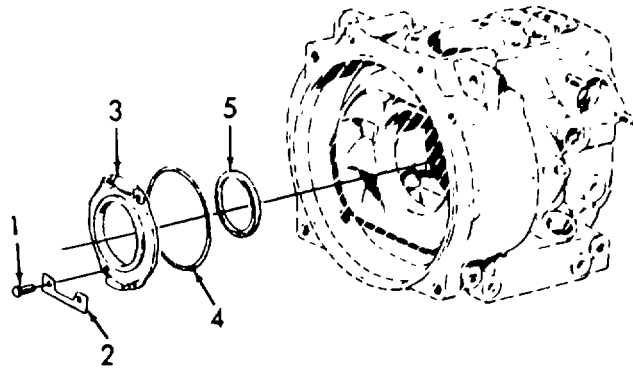


Figure 6-11. Oil Seal (Flywheel Side) Removal/Installation.

6-6. CRANKSHAFT.

This task consists of:

- a. Removal b. Cleaning c. Inspection d. Installation
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Shop Set, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)
- Crankshaft Removing Device 666 327 01 (item 11, appendix B)
- Impact Mandrel, Ball Hub 666 067 00 (item 10, appendix B)
- Mounting Device, Crankshaft End Play 666 074 00 (item 16, appendix B)

Materials Required:

- Grease (item 5, appendix E)
- Rags, Wiping (item 8, appendix E)
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

Well-ventilated area required.

Equipment Conditions:

- Connecting rod removed in accordance with paragraph 6-2.
- Timing cover removed in accordance with paragraph 6-3.
- Oil seal (flywheel side) removed in accordance with paragraph 6-5.
- Governor removed in accordance with paragraph 6-4.

a. Removal. (Refer to figure 6-12).

- (1) Remove disc (1), shell (2), disc (3), four balls (4), hub (5), and spacer (6) from crankshaft.

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (2) Using an oven, heat crankcase to 1750 to 2100F (800 to 1000C).
- (3) Using crankshaft removing device, push crankshaft (7) and bearing outer race (8) from crankcase. Remove key (9).
- (4) Remove circlip (10). Use a arbor press, press bearing outer race (11) from crankcase.
- (5) Using an oven heat crankshaft to 1600 to 1750F (700 to 800C), remove bearing inner races (12 and 13) from crankshaft, tapping lightly with a brass drift.

(6) Remove two screws (14) and counterweight (15) from crankshaft. Remove plug (16) from crankshaft.

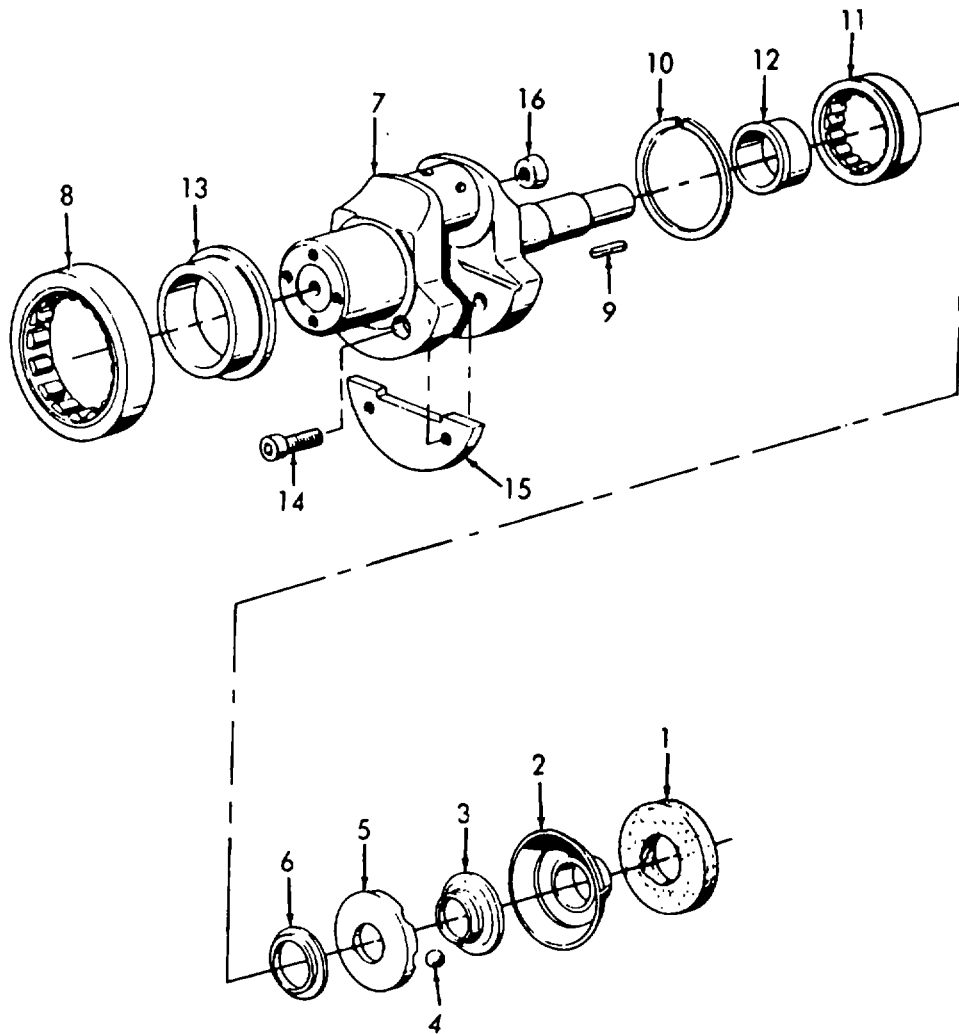


Figure 6-12. Crankshaft Removal.

6-6. CRANKSHAFT - Continued.b. Cleaning.**WARNING**

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean all parts with a rag and cleaning solvent.
- (2) Clean all oil passages on crankshaft.
- (3) Allow to dry.

c. Inspection.

- (1) Inspect crankshaft for nicks or scratches on bearing journals.
- (2) Inspect all bearings inner and outer races for pitting or signs of wear.

d. Installation. (Refer to figure 6-13).

- (1) Install plug (16) into crankshaft (7).
- (2) Position counterweight (15) on crankshaft and secure with two screws (14). Torque screws to 16.23 ft-lbs (22 Nm).

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (3) Using an oven, heat the inner races of roller bearings (13 and 12) to 1600 to 1750F (700 to 800C) and press them onto crankshaft (7).
- (4) Install circlip (10) into crankcase. Insert bearing outer race (11) in crankcase from the flywheel side and press it into crankcase until it comes to a stop against circlip (10).
- (5) Press bearing outer race (8) onto crankshaft.
- (6) Install mounting device to control crankshaft end play, on crankshaft (7).

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

- (7) Using an oven, heat crankcase to 175° to 210°F (80° to 100°C).
- (8) Install crankshaft (7) into crankcase until mounting device stops. Allow crankcase to cool and remove mounting device. Install key (9)

WARNING

Wear asbestos gloves to avoid serious burns when handling heated parts.

NOTE

Do not disturb position of crankshaft end play when installing the following.

- (9) Using an oven heat ball hub disc (3), ball hub (5), and spacer (6) to 160° to 175°F (70° to 80°C).
- (10) Install spacer (6), ball hub (5), and ball hub disc (3) onto crankshaft using ball hub impact mandrel.
- (11) Apply grease to four balls (4) and install in hub (5) one in every other notch.
- (12) Install shell (2) and disc (1) on crankshaft.
- (13) Refer to paragraph 6-5 and install oil seal (flywheel side).
- (14) Refer to paragraph 6-3 and install timing cover and camshaft.
- (15) Refer to paragraph 6-2 and install connecting rod.
- (16) Refer to paragraph 6-4 and install governor.

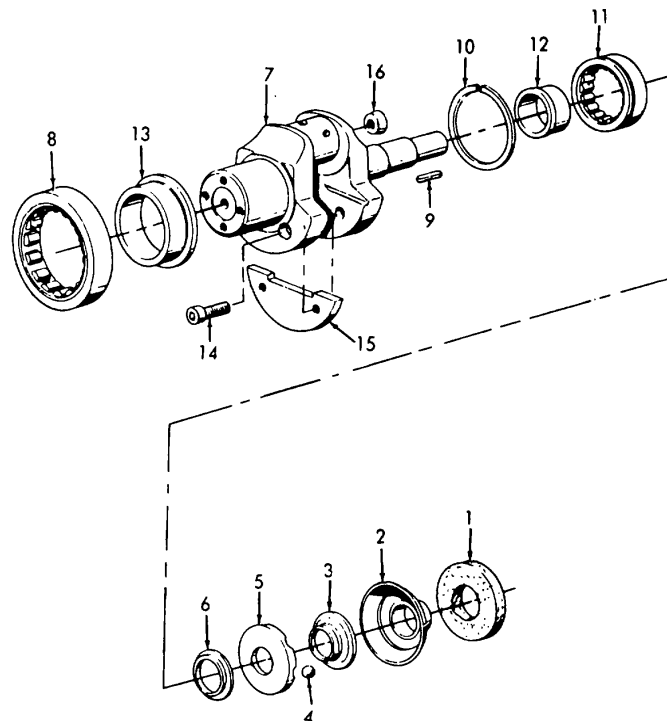


Figure 6-13. Crankshaft Installation.

6-7. CRANKCASE.

This task consists of:

- | | | | |
|-----------------------|--------------------|----------------------|------------------|
| a. Disassembly | b. Cleaning | c. Inspection | d. Repair |
| e. Reassembly | | | |
-

INITIAL SETUP:Tools Required:

- Tool Kit, General Mechanics (item 1, appendix B)
- Shop Set, Automotive Repair, Field Maintenance, Basic (item 3, appendix B)

Materials Required:

- Packing, P/N 40022000
- Packing, P/N 50001500
- Packing, P/N 50153800
- Solvent, Cleaning (item 10, appendix E)

General Safety Instructions:

- Well-ventilated area required.

Equipment Conditions:

- Crankshaft removed in accordance with paragraph 6-6.
-

- a. Disassembly. (Refer to figure 6-14).
 - (1) Remove oil dipstick (1) and packing (2). Discard packing (2).
 - (2) Remove oil fill cap (3) and packing (4). Discard packing (4).
 - (3) Remove two pins (5), oil drain plug (6), and packing (7). Discard packing (7).
 - (4) Remove two studs (8).
 - (5) Remove two studs (9) and two studs (10) from crankcase (11).
- b. Cleaning.

WARNING

Do not breathe cleaning solvent P-D-680 vapors for long periods of time or use solvent near open flames. To avoid illness, explosion, or fire, only use solvent in well-ventilated areas away from open flames.

- (1) Clean sludge and dirt deposits with cleaning solvent. If necessary, crankcase should be steam cleaned.

- (2) Clean all oil passages.
 - (3) Allow to dry.
- c. Inspection.
- (1) Use a straight edge and check the crankcase lengthwise and across cylinder for warpage. Replace crankcase if warped.
 - (2) Inspect all internal threads for stripping or peening.
 - (3) Inspect for broken or damaged studs.
- d. Repair. Repair is limited to replacement of damaged components.
- e. Reassembly.
- (1) Install two studs (10 and 9) into crankcase (11).
 - (2) Install two studs (8) into crankcase (11).
 - (3) Position new packing (7) on oil drain plug (6). Install oil drain plug (6). (4) Install two pins (5).
 - (5) Position new packing (4) on oil fill cap (3). Install oil fill cap (3).
 - (6) Position new packing (2) on oil dipstick (1). Install oil dipstick (1).
 - (7) Refer to paragraph 6-6 and install the crankshaft.

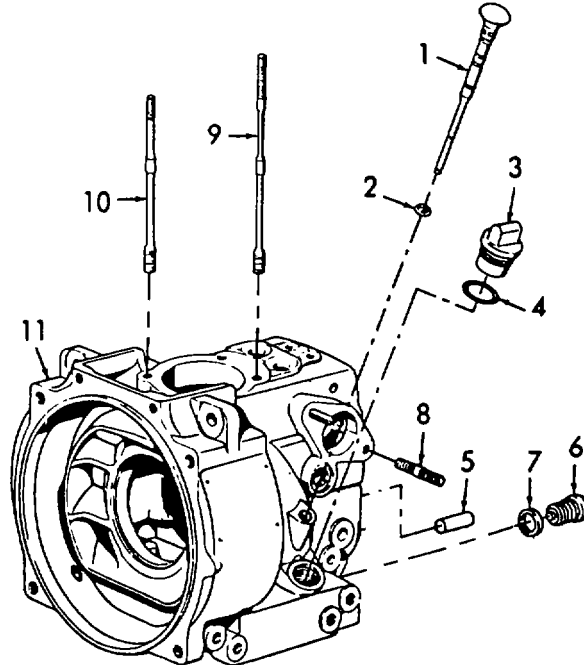


Figure 6-14. Crankcase Disassembly/Reassembly.

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 PAM 25-30

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. TECHNICAL MANUALS.

The Army Maintenance Management System (TAMMS) DA PAM 738-750

Painting Instructions for Field Use TM 43-0139

Unit, Direct Support, and General Support Maintenance Repair

Parts and Special Tools List, Pump Assembly, 100 GPM TM 5-4320-313-24P

A-1/(A-2 Blank)

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. INTRODUCTION.

a. This section provides a general explanation of all maintenance and repair functions authorized at the various maintenance levels.

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 components 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.

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (e.g., by sight, sound, or feel).

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 decontamination, when required), to preserve, to drain, to paint, 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. Aline. To adjust specified variable elements of an item to bring about optimum performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted to instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

B-2. MAINTENANCE FUNCTIONS - Continued.

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 3rd position code of the SMR code.

i. Repair. The application of maintenance services (1), including fault location/troubleshooting (2), removal/installation, and disassembly/assembly (3) procedures, and maintenance actions (4) 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.

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 numbers shall be "00".

b. Column 2, Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3, Maintenance Function. Column 3 lists the functions to be performed on the item listed in Column 2. (For a detailed explanation of these functions, see paragraph B-2).

(1) Services Inspect, test, service, adjust, aline, calibrate, and/or replace.

(2) Fault locate/troubleshoot The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

(3) Disassemble/Assemble Encompasses the step-by-step taking apart (or breakdown) of a spare/functional group coded item to the level of its least componentry identified as maintenance significant (i.e., assigned an SMR code) for the category of maintenance under consideration.

(4) Action Welding, grinding, riveting, straightening, facing, remachineing, and/or resurfacing.

d. Column 4, Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function that maintenance function at the indicated category of maintenance. If the number or complexity of task within a listed maintenance function vary at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (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 allocation chart. The symbol designations for the various maintenance categories are as follows:

- C Operator or crew
- O Unit Maintenance
- F Direct Support Maintenance
- H General Support Maintenance (5)
- L Specified Repair Activity (SRA)

e. Column 5, Tools and Equipment. Column 5 specifies, by code, those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. Column 6, Remarks. This column shall, when applicable, contain a letter code, in alphabetical order, which shall be keyed to the remarks contained in Section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. Column 1, Reference Code. The tool and test equipment reference code correlates with a code used in the MAC, Section II, Column 5.

b. Column 2, Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3, Nomenclature. Name or identification of the tool or test equipment.

(5) This maintenance category is not included in Section II, column (4) of the Maintenance Allocation Chart. To identify functions to this category of maintenance, enter a work time figure in the "H" column of Section II, column (4), and use an associated reference code in the Remarks column (6). Key the code to Section IV, Remarks, and explain the SRA complete repair application there. The explanatory remark(s) shall reference the specific Repair Parts and Special Tools List (RPSTL) TM which contains additional SRA criteria and the additional spare/ repair parts.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

- d. Column 4, National Stock Number. The national stock number of the tool or test equipment.
- e. Column 5, Tool Number. The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

- a. Column 1, Reference Code. The code recorded in column 6, Section II.
- b. Column 2, Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section III.

Section II. MAINTENANCE ALLOCATION CHART

| (1) GROUP NUMBER | (2) COMPONENT ASSEMBLY | (3) MAINTENANCE FUNCTION | (4) MAINTENANCE LEVEL | | | | | (5) TOOLS AND EQUIPMENT | (6) REMARKS |
|------------------------|-----------------------------|--------------------------------|--------------------------|---|-------------------|--------------------|-------|----------------------------------|----------------|
| | | | UNIT | | DIRECT SUPPORT | GENERAL SUPPORT | DEPOT | | |
| | | | C | O | F | H | D | | |
| 00 | ENGINE AND PUMP ASSEMBLY | | | | | | | | |
| 01 | PUMP ASSEMBLY | Inspect Repair | 0.2 | | 6.0 | | | 1, 2 A | |
| | Housing | Inspect Replace | | | 0.1 1.0 | | | 1 | |
| | Diffuser Assembly | Inspect Replace | | | 0.2 1.1 | | | 1 | |
| | Impeller | Inspect Replace | | | 0.2 1.2 | | | 1 | |
| | Seal | Inspect Replace | | | 0.1 1.3 | | | 1 | |
| | Backhead | Inspect Replace | | | 0.2 1.4 | | | 1 | |
| | Shaft | Inspect Replace | | | 0.1 1.5 | | | 2 | |
| 02 | ENGINE ASSEMBLY | Inspect Service Replace | 0.2 0.2 | | 2.0 | | | 1, 3 | |

| (1) GROUP NUMBER | (2) COMPONENT ASSEMBLY | (3) MAINTENANCE FUNCTION | (4) MAINTENANCE LEVEL | | | | | (5) TOOLS AND EQUIPMENT | (6) REMARKS |
|------------------------|-------------------------------------|--|--------------------------|------------|-------------------|--------------------|-------|----------------------------------|----------------|
| | | | UNIT | | DIRECT SUPPORT | GENERAL SUPPORT | DEPOT | | |
| | | | C | O | F | H | D | | |
| | Air Filter Assembly | Inspect Replace Service | 0.1 | 0.2 0.1 | | | | 1 | |
| | Air Filter Indicator | Inspect Replace | 0.1 | 0.2 | | | | 1 | |
| | Fuel Filter | Inspect Replace | 0.1 | | 0.5 | | | 1 | |
| | Fuel Pump | Replace | | | 0.5 | | | 1 | |
| | Fuel Lines, Hoses and Fittings | Inspec Replace | 0.1 | | 0.5 | | | 1,24 | |
| | Fuel Tank | Inspect Replace | 0.1 | 1.0 | | | | 1,24 | |
| | Injector | Test Replace | | | 1.0 1.0 | | | 1,19 2 | |
| | Injection Pump | Adjust Test Replace | | | 1.5 2.0 1.0 | | | 1,6 4, 5, 17, 18,19 1 | |
| | Muffler/Spark Arrestor | Inspect Replace Service | 0.1 | | 0.3 0.5 | | | 1 | |
| | Throttle | Inspect Adjust Replace | 0.1 | | 0.5 1.3 | | | 1 1,24 | |
| | Crank Assembly | Inspect Replace | 0.1 | 0.1 | | | | | |
| | Gears, Cranking | Inspect Replace | | | | 1.5 1.0 | | 1,2 | |
| | Cylinder Head and Valve Assembly | Inspect Adjust Replace Repair | | | 4.1 1.0 3.0 | | 6.0 | 1 2, 20, 21 1,3, 23 | B |
| | Cylinder | Inspect Replace | | | 3.3 3.0 | | | 1,3, 22 | |

Section II. MAINTENANCE ALLOCATION CHART - Continued

| (1) GROUP NUMBER | (2) COMPONENT ASSEMBLY | (3) MAINTENANCE FUNCTION | (4) MAINTENANCE LEVEL | | | | | (5) TOOLS AND EQUIPMENT | (6) REMARKS |
|-------------------------------|--------------------------------|--------------------------------|--------------------------|-----|-------------------|--------------------|---------------------|----------------------------------|----------------|
| | | | UNIT | | DIRECT SUPPORT | GENERAL SUPPORT | DEPOT | | |
| | | | C | O | F | H | D | | |
| 02 | ENGINE ASSEMBLY - Continued | | | | | | | | |
| | Piston | Inspect | | | 3.5 | | | | |
| | | Replace | | | 3.0 | | | 1, 2, 3, 22 | |
| | | Repair | | | 4.5 | | | | |
| | Connecting Rod | Inspect | | | | 4.5 | | | |
| | | Replace | | | | 3.5 | | 1, 2 | |
| | | Repair | | | | 5.0 | | | C |
| | Timing Cover | Inspect | | | | 3.2 | | | |
| | | Replace | | | | 3.0 | | 1, 3, 8 | |
| | | Repair | | | | | | 3, 7, 9 | |
| | Camshaft | Inspect | | | | 5.0 | | | |
| | | Replace | | | | 4.0 | | 3 | |
| | Governor | Inspect | | | | 5.5 | | | |
| | | Replace | | | | 4.5 | | 1, 3, 12 | |
| Repair | | | | | 6.5 | | 3, 14, 15 | | |
| Flywheel | Inspect | | | 1.0 | | | | | |
| | Replace | | | 2.0 | | | 1, 2, 25 | | |
| Oil Seal (Fly- wheel Side) | Inspect | | | | 3.0 | | | | |
| | Replace | | | | 2.0 | | 1, 3, 13 | | |
| Crankshaft | Inspect | | | | 6.0 | | | | |
| | Replace | | | | 5.0 | | 1, 3, 10, 11, 16 | | |
| Crankcase | Inspect | | | | 6.0 | | | | |
| | Replace | | | | 5.0 | | 1, 3 | | |
| | Repair | | | | 7.0 | | 3 | | |
| 03 FRAME ASSEMBLY Frame | Inspect | | | 2.6 | | | | | |
| | Replace | | | 2.5 | | | 1 | | |
| | Repair | | | 3.5 | | | | D | |

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS

| (1) REF. CODE | (2) MAINT. LEVEL | (3) NOMENCLATURE | (4) NATIONAL/NATO STOCK NUMBER | (5) TOOL NUMBER |
|---------------------|------------------------|---|--------------------------------------|-----------------------|
| 1 | 0 | Tool Kit, General Mechanics Automotive | 5180-00-177-7033 | |
| 2 | F | Shop Equipment, Automotive Maintenance and Repair, Common No. 1 | 4910-00-754-0654 | |
| 3 | F, H | Shop Set, Automotive Repair, Field Maintenance, Basic | 4910-00-754-0705 | |
| 4 | F | Spill Device | | 665 030 01 |
| 5 | F | Special Wrench | | 606 000 00 |
| 6 | F | Socket Wrench, 30 mm | | 668 335 00 |
| 7 | H | Auxiliary Bushing - Oil Seal (30 x 47 mm dia) Timing Cover | | 666 075 00 |
| 8 | H | Extractor - Cam Follower Spindle | | 666 324 00 |
| 9 | H | Mounting Device - Needle Bearing Camshaft | | 666 418 00 |
| 10 | H | Impact Mandrel, Ball Hub | | 666 067 00 |
| 11 | H | Crankshaft Removing Device | | 666 327 01 |
| 12 | H | Extractor for Crankshaft Gear | | 618 168 00 |
| 13 | H | Auxiliary Bushing - Oil Seal (60 x 75 mm dia) Support Flywheel | | 666 068 00 |
| 14 | H | Impact Mandrel, Gear on Crankshaft | | 666 069 00 |
| 15 | H | Special Tool for Governor Spring | | 618 305 00 |
| 16 | H | Mounting Device, Crankshaft End Play | | 666 074 00 |

| (1) REFERENCE CODE | (2) MAINTENANCE CATEGORY | (3) NOMENCLATURE | (4) NATIONAL STOCK NUMBER (NSN) | (5) TOOL NUMBER |
|--------------------------|--------------------------------|--------------------------|---------------------------------------|-----------------------|
| 17 | F | &amp, Fuel Line | | 66838300 |
| 1a | F | Dial Gauge, Millimeter . | | 61208700 |
| 19 | F | Testing Device | | 60462800 |
| 20 | F | Depth Gauge | | 61311401 |
| 21 | F | Retaining Bracket | | 61275200 |
| 22 | H | Piston Ring Clamp | | 66634600 |
| 23 | H | Reamer, Valve Guide | | 61210700 |
| 24 | O | Allen Socket, 6 mm | | 61209100 |
| 25 | F | Socket | | 61209900 |

Section IV. REMARKS

| REFERENCE CODE, | REMARKS |
|--------------------|---|
| A | Pump assembly cannot be replaced as an assembly. Disassembly is required. |
| B | Repair includes replacing valves, valve seats, and guides. |
| C | Repair includes replacing rod bearings. |
| D | Repair by welding or painting. |

APPENDIX C

COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

C-1. SCOPE.

This appendix lists components of end item and basic issue items for the pumping assembly to help you 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 for informational purposes only, and 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 centrifugal pump assembly in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged, BII must be with the pump assembly 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.

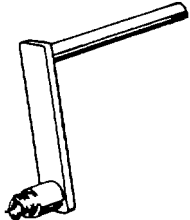
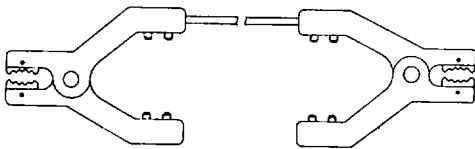
b. Column (2) - National Stock Number. Indicates the National stock number assigned to the item and will be used for requisitioning purposes.

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 FSCM (in parentheses) followed by the part number.

d. Column (4) - Unit of Measure (U/M). Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr).

e. Column (5) - Quantity required (Qty rqr). Indicates the quantity of the item authorized to be used with/on the equipment.

Section II. COMPONENTS OF END ITEM

| (1) ILLUS NUMBER | (2) NATIONAL STOCK NUMBER | (3) DESCRIPTION, CAGEC and Part Number | (4) Usable On Code U/M | (5) QTY RQR |
|------------------------|------------------------------------|--|---------------------------------|-------------------|
| 1 | | Crank, Starting (60180) 00315000  | EA | 1 |
| 2 | | Cable, Ground (96906) 13220E1127  | EA | 1 |

Section III. BASIC ISSUE ITEMS

| (1) ILLUS NUMBER | (2) NATIONAL STOCK NUMBER | (3) DESCRIPTION, CAGEC and Part Number | (4) Usable On Code U/M | (5) QTY RQR |
|------------------------|------------------------------------|---|---------------------------------|-------------------|
| | | TM 5-4320-313-14 OPERATOR'S, UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL TM 5-4320-313-24P UNIT, DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE REPAIR PARTS AND SPECIAL TOOLS LIST | EA | 1 |

APPENDIX D

ADDITIONAL AUTHORIZATION LIST

NOT APPLICABLE

APPENDIX E

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

E-1. SCOPE.

This appendix lists expendable/durable supplies and materials you will need to operate and maintain the pump assembly. These items are authorized to you by CTA 50-970, Expendable/Durable Items (except Medical, Class V, Repair Parts and Heraldic Items), or CTA 8-100, Army Medical Department.

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., "Use sealing compound, item 6, appendix E").

b. Column 2 - Category. This column identified the lowest category of maintenance that required the listed item:

C - Operator/Crew
0 - Unit
F - Direct Support
H - General Support

c. Column 3 - National Stock Number. This is the National stock number assigned to the item; use it to request/requisition the item.

d. Column 4 - Description. Indicate the federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Commercial and Government Entity Code (CAGE) in parentheses, if applicable.

e. Column 5 - Unit of Measure (U/M). Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the lowest unit of measure differs from the rest of the issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

| (1) ITEM NUMBER | (2) LEVEL | (3) NATIONAL STOCK NUMBER | (4) DESCRIPTION | (5) U/M |
|-----------------------|--------------|------------------------------------|---|------------|
| 1 | F | | Brush, Wire | ea |
| 2 | F | | Crocus Cloth | sh |
| 3 | C | | Fuel Oil, Diesel, VV-F-800 | gal |
| 4 | F | 9150-00-190-0907 | Grease, Automotive and Artillery, MIL-G-10924 | 5 gal can |
| 5 | O | 9150-00-754-2595 | Grease, Ball and Roller Bearing, MIL-G-10789 | 1 lb can |
| 6 | O | 9150-00-186-6681 | Oil, Lubricating, Internal Com- bustion Engine, MIL-L-2104 | qt |
| 7 | O | | Oil, Lubricating, Preservative, MIL-L-21260 | qt |
| 8 | F | 7920-00-205-1711 | Rags, Wiping | lb |
| 9 | F | | Sealing Compound MIL-S-7916 | tb |
| 10 | O | 6850-00-274-5421 | Solvent, Dry Cleaning, P-D-680 | gal |

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By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

Official:

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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 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 |
|----|---------------------------|-------------------------------|------------------------|----|

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