TECHNICAL MANUAL

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL

FOR

PUMP, CENTRIFUGAL, POL, GED, 6 IN., 1120 GPM

SKID-MOUNTED (BARNES MODEL US67CCG)

FSN 4320-409-8678

H E A D Q U A R T E R S D E P A R T M E N T O F T H E A R M Y
AUGUST 1971

WARNING

Before Operation

Do not operate the pump unit in an inclosed area, unless exhaust gases are piped to the outside. Inhalation of exhaust gases will result in serious illness or death.

Do not smoke or use an open flame in the vicinity when servicing the batteries. Batteries generate hydrogen gas, a highly explosive gas.

When filling the fuel tank always maintain metal to metal contact between the filling apparatus and fuel tank to prevent a spark from being caused by static electricity.

During Operation

Do not fill fuel tank while engine is running.

Do not perform maintenance on pumping unit while it is in operation.

After Operation

Use caution when removing radiator cap while engine is hot. Quick removal will allow coolant to escape and may cause serious injury to personnel.

Use caution when removing cover or cable from batteries, so that batteries do not come in contact with cover. Check for insulation and or space between battery cover and battery terminals.

CHANGE
NO. 5

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

Operator and Organizational Maintenance Manual

PUMP, CENTRIFUGAL; POL; GED; 6IN; 1120 GPM;
SKID MOUNTED (BARNES MODEL US67CCG)
NSN 4320-00-409-8678

Approved for public release; distribution is unlimited

TM 5-4320-258-12, 24 August 1971, is changed as follows:

Page 2-8, paragraph 2-12, add the following subparagraph:

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

Page 4-1, paragraph 4-2c, add the following note:

NOTE

The 6TN and 6TL batteries can be mixed or matched. However, maintenance-free batteries cannot be mixed or matched with military batteries. The 6TN and or the 6TL batteries will perform properly in hot weather as long as electrolyte levels are carefully monitored. If the electrolyte expands and causes the level to rise, some fluid must be removed. If the level becomes too low due to evaporation, distilled water may be used to obtain the proper level. A good grade of drinking water (excluding mineral waters) may be used if distilled water is not available.

By Order of the Secretary of the Army:

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

Official:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

DISTRIBUTION:

To be distributed in accordance with DA Form 12-25E, (qty rqr block no. 1333).

☆ U.S. GOVERNMENT PRINTING OFFICE: 1991 554-123/20121

CHANGE NO. 4.

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D C, *30 October 1977*

Operator and Organizational Maintenance Manual
PUMP, CENTRIFUGAL; POL: GED:6IN: 1120 GPM:
SKID-MOUNTED (BARNES MODEL US67CCG)
NSN 4320-00409-8678

TM 5-4320-258-12, 24 August 1971, is changed as follows:

The title is changed as shown above.
Add under the NSN, Reporting of Errors paragraph as follows:

REPORTING OF ERRORS

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), and/or DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals), may be used. Copies of DA Form 2028-2 are attached to the back of this change for your use. Please mail your recommended changes directly to Commander, US Army Troop Support & Aviation Materiel Readiness Command, ATTN: DRSTS-MTPS, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished directly to you.

Page i. The title of Appendix "C" is changed to read:

APPENDIX C. COMPONENTS OF END ITEM LIST C-1

Page i. Appendix "D" is added as follows:

APPENDIX D. EXPENDABLE SUPPLIES AND MATERIALS LIST D-1

Page i. Move the index under the added Appendix "D".....I-1

Page 1-1. Paragraph 1-4 is rescinded

Page 4.3. Paragraph 4.8d. The title is changed to read:

d. OEA/APG-PD-1

Page 4.3. Paragraph 4-8e. Delete 5W-20, and 10W in the temperature range to read: OEA/APG-PD-1.

Page A-1. Paragraph A-3. TM 9-213 is changed to read: TM 43-0139

APPENDIX C
COMPONENTS OF END ITEM LIST

Section I. INTRODUCTION

C-1. Scope

This appendix lists the integral components of and basic issue items for the pump to help you inventory items required for safe and efficient operation.

C-2. General

The components of end item list is divided into the following sections:

a. Section II. Integral Components of the End Item. These items, when assembled, comprise the pump and must accompany it whenever it is transferred or turned in. These illustrations will help you identify these items.

b. Section III Basic Issue Items. These are minimum essential items required to place the pump in operation, to operate it, and to perform emergency repairs. Although shipped separately packed, they must accompany the Centrifugal

pump during operation and whenever it is transferred between accountable officers. The illustrations will assist you with hard-to-identify items. This manual is your authority to requisition replacement BII, based on Table(s) of Organization and Equipment (TOE)/Modification Table of Organization and Equipment (MTOE) authorization of the end item.

C-3. Explanation of Columns

a. Illustration. This column is divided as follows:

(1) Figure Number. Indicates the figure number of the illustration of which the item is shown (if applicable).

(2) Item Number. The number used to identify item called out in the illustration.

b. National Stock Number (NSN). Indicates the National Stock Number assigned to the item in which will be used for requisitioning.

c. Part Number (P/N). Indicates the primary number used by the manufacturer, which control the design and characteristics of the item by means of its engineering drawings, specifications, standards, and inspection requirements to identify an item or range of items.

d. Description. Indicates the federal Item name and, if required, a minimum description to identify the item.

e. Location. The physical location of each item listed is given in this column. The lists are designed to inventory all items in one area of the major item before moving on to an adjacent area.

f. Usable on Code . "USABLE ON" codes are included to help you identify which component items are used on the different models. Identification of the codes used in this list are: Not Applicable.

g. Quantity Required (Qty Req'd). This column lists the quantity of each item required for a complete major item.

h. Quantity. This column is left blank for use during inventory. Under the RCV'D column, list the quantity you actually receive on your major item. The Date columns are for use when you inventory the major item at a later date; such as for shipment to another site.

Section II. INTEGRAL COMPONENTS OF END ITEM

(1) ILLUSTRATION (a) FIGURE NO.	(1) ILLUSTRATION (b) FIGURE NO.	(2) NATIONAL STOCK NO.	(3) PART NO. & FSCM	(4) DESCRIPTION	(5) LOCATION	(6) USABLE ON CODE	(7) QTY REQD	(8) QUANTITY RCVD	(8) QUANTITY DATE	(8) QUANTITY DATE
4	16	6140-00-057-2554	MS35000-3 (96906)	Battery. Storage		2				
24	1	4330.01.036-9263	F162P03111 (14351)	Crank, Start-ing, Hand		1				

Section III. BASIC ISSUE ITEMS

(1) ILLUSTRATION (a) FIGURE NO.	(b) FIGURE NO.	(2) NATIONAL STOCK NO.	(3) PART NO. & FSCM	(4) DESCRIPTION	(5) LOCATION	(6) USABLE ON CODE	(7) QTY REQD	(8) QUANTITY RCVD	DATE	DATE
		5120-00-900-6103		Hammer, Hand		1				
		5120-00-449-8083		Wrench, Open End Adjustable TM 5-4320-258-12 Operator and Organizational Maintenance Manual pump. Centrifugal; POL; GED; 6-gin; 1120 GPM; skid mounted (Barnes Model US-67CCG) NSN 4320-00-409-86781 LO 5-4320-258-12 Pump. centrifugal POL, GED, 6 In. 1120 GPM; skid mounted (Barnes Model US67CCG) w/Engine Continental Model FS 244-06097P1		1				

APPENDIX D
EXPENDABLE SUPPLIES AND MATERIALS LIST
Section I. INTRODUCTION

D-1. Scope

This appendix lists expendable supplies and materials you will need to maintain and operate the pump. These items are authorized to you by CTA50-970, Expendable Items (except Medical, Clam V, Repair Parts. and Heraldic Items).

D-2. Explanation of Columns

a. Column 1 - Item Number. This number is assigned to the entry of the listing and is referenced in the narrative instructions to identify the material (e.g., "Use cleaning compound, Item 5, App. D").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed item.

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

d. Column 4 - Description. Indicates the federal item name and, if required, a description to identify the item. The last line for each item indicates the part number followed by the Federal Supply Code for Manufacturer (FSCM) in parenthesis, if applicable.

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

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) Item Number	(2) Level	(3) National Stock Number	(4) Description	(5) U/M
1	C	6850-00-281-1983	Solvent, Cleaning	GL
2	C	9150-00-402-4478	Oil, Engine, Subzero	QT
3	C	9150-00-186-6681	Oil, Engine, OE-30	QT
4	C	9150-00-160-1818	Gasoline, Combat	Bulk
5	0	6850-00-664-1403	Anti-freeze	GL

By Order of the Secretary of the Army:

BERNARD W. ROGERS
General, United States Army
Chief of Staff

Official:

J. C. PENNINGTON
Brigadier General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25A, Operator maintenance requirements for Petroleum Distribution.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1984 0-461-202 (11816)

CHANGE
No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON. DC, *20 May 1974*

Operator and Organizational Maintenance Manual
PUMP, CENTRIFUGAL; POL; GED; 6-IN: 1120 GPM; SKIDMOUNTED
(BARNES MODEL US67CCG) FSN 4320-409-8678

TM 5-4320-25812, 24 August 1971, is changed as follows:
Inside cover. Add the following warnings:

WARNING

Operation of this equipment presents a noise hazard to personnel in the area. The noise level exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

Dry cleaning solvent, P-D-680, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100° - 138°F.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25A (qty rqr block No. 153) Operator's Maintenance requirements for Petroleum Distribution.

GPO 806-865

Change
No. 2 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *7 February 1974*

Operator and Organizational Maintenance Manual

PUMP, CENTRIFUGAL; POL; GED; 6-IN; 1120 GPM;

SKID-MOUNTED (BARNES MODEL US67CCG) FSN 4320-409-8678

TM 5-4320-258-12, 24 August 1971, is changed as follows:

Page 4-17. Paragraph 4-25b(2) is superseded as follows:
(2) Remove the governor, items 26 and 32 thru 37, figure 4-11.

Paragraph 4-25d(1) is superseded as follows:
(1) Remove magneto (para 4-34a) before installing governor. Install governor by reversing removal procedure (para 4-250(2). After installing governor, install magneto (para 4-34J).

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25A (qty rqr block no. 153), Operator requirements for Petroleum Distribution.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974-768114/1024

Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, *10 October 1973*

Operator and Organizational Maintenance Manual
PUMP, CENTRIFUGAL; POL; GED; 6-IN; 1120 GPM;
SKID-MOUNTED (BARNES MODEL US67CCG) FSN 4320-409-8678

TM 5-4320-258-12, 24 August 1971, is changed as follows:

Warning Page, add to During Operation: the following:

NOISE HAZARDS exist within twelve (12) feet of pump when operating. Ear protection required when personnel are exposed to noise more than four (4) hours during one (1) day.

Page 1-1. Paragraph 1-4, the mailing address is changed to read:

Commander, US Army Troop Support Command, ATTN: AMSTS-MP, 4300 Goodfellow Blvd, St. Louis, MO 63120.

Page 2-1. Add to paragraph 2-2a the following sentence.

Caution signs that are legible from a distance of twelve (12) feet will be posted in the operating area. Signs will read "CAUTION, NOISE HAZARD AREA - Hearing protection required within twelve (12) feet when pump is operating".

Page 2-6. Add to paragraph 2-7a the following warning.

WARNING

NOISE HAZARDS exist within twelve (12) feet of pump when operating. Ear protection required when personnel are exposed to noise more than four (4) hours during one (1) day. Aural protectors, FSNs 4240-691-5617,4240-762-2582or4240-991-1910 should be worn.

By order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25A (qty rqr block No. 153), Operator requirements for Petroleum Distribution.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1973-768110/528

TECHNICAL
No. 5-4320-258-12

MANUALHEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *24 August 1971*

OPERATOR AND ORGANIZATIONAL MAINTENANCE MANUAL PUMP, CENTRIFUGAL, POL, GED, 6 IN., 1120 GPM, SKID-MOUNTED, (BARNES MODEL US67CCG)

FSN 4320-409-8678

LIST OF ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

These instructions are published for use by personnel to whom the Barnes Manufacturing Company Model US67CCG Centrifugal Pump is issued. They provide information on the operation and organizational maintenance of the equipment as allocated by the Maintenance Allocation Chart.

1-2. Forms and Records

Maintenance forms, records, and reports which are used by maintenance personnel at all maintenance levels are listed in and prescribed by TM 38-750.

1-3. Administrative Storage

Preparation, care, and removal of equipment in administrative storage will be in accordance with the applicable requirements of TM 740-90-1 (Administrative Storage of Equipment).

1-4. Reporting of Errors

Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028, Recommended Changed to Publications, and forwarded directly to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MP, 4300 Goodfellow Boulevard, St. Louis, Mo. 63120.

Section II. DESCRIPTION AND DATA

1-5. Description

a. Centrifugal Pump Model US67CCG (figs. 1-1 and 1-2) consists primarily of a gasoline engine and a centrifugal pump mounted on a welded skid base. The torque from the engine is transferred to the pump through a flexible coupling.

b. The centrifugal pump has a 6-inch suction nipple and a 6-inch discharge elbow. The nipple and elbow are grooved to receive a hose. The pump is capable of pumping 1120 GPM at governed speed of 2450 RPM, with a total dynamic head of 100 feet. It is self priming and has an integral check valve which retains the fluid in the pump body after shut down.

c. The gasoline engine is a 6-cylinder, liquid-cooled, pressure-lubricated, L-head, 4-stroke-cycle unit. It is completely housed in a sheet-metal housing. Engine drains are piped to the outside of the engine housing to provide easy access for servicing.

1-6. Differences in Models

This technical manual covers only Centrifugal Pump Model US67CCG manufactured by Barnes Manufacturing Company, Mansfield, Ohio. No known differences exist on the pumps procured under this model number.

1-7. Identification and Tabulated Data

a. Identification. The centrifugal pump has three identification plates.

(1) US data plate. The US data plate is located on front of the pump above the suction flange. It indicates the pump identification number, serial number, dimensions, weight, and shipping information.

(2) Engine plate. The engine data plate is located on alternator side of the engine block. It indicates engine identification numbers, serial number, valve tappet clearance information, and patent information.

(3) Instruction plate. The pump instruction plate is located in the cover of the control panel. It identifies the controls and provides basic operating instructions.

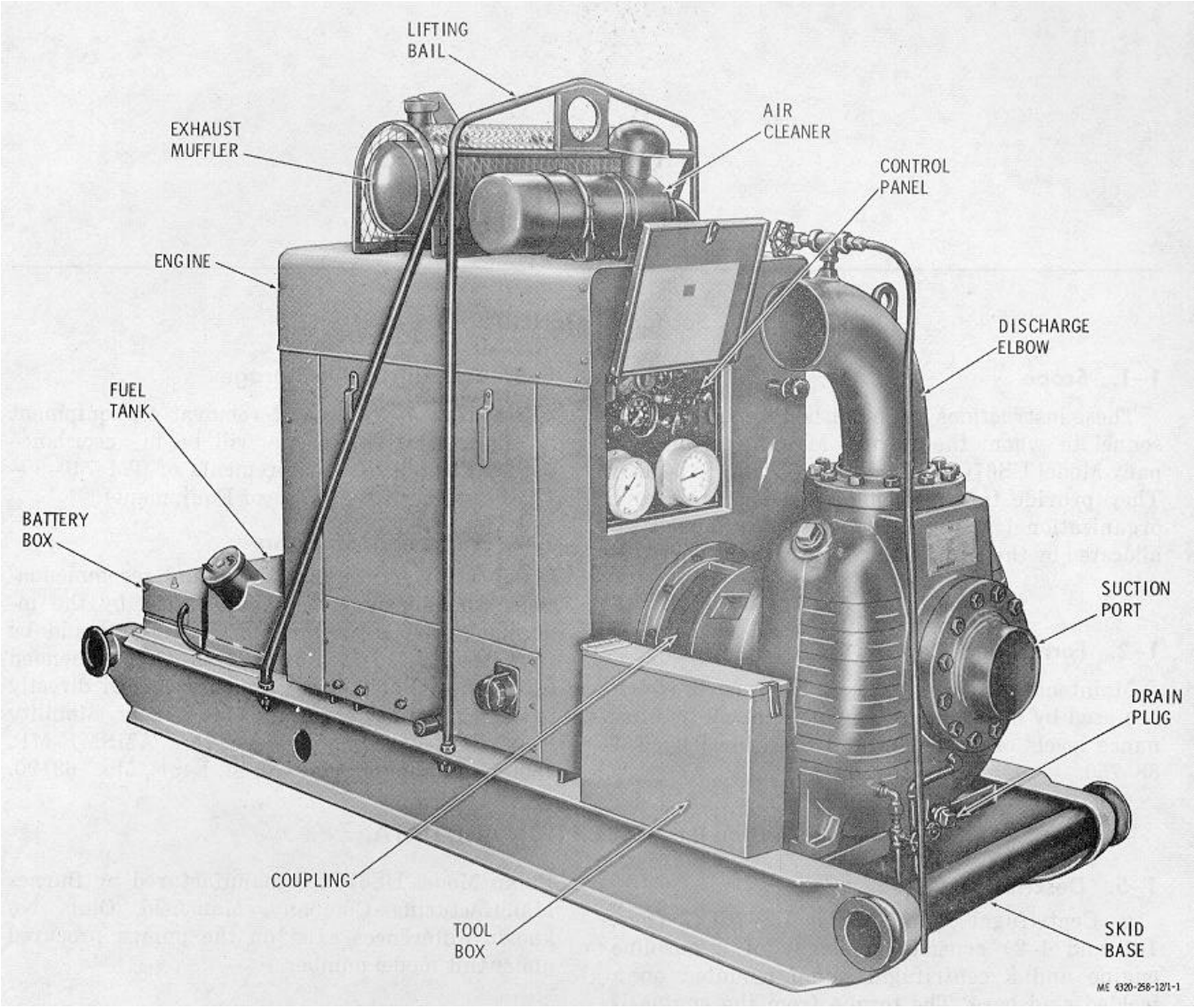


Figure 1-1. Centrifugal pump, left front view.

b. Tabulated Data

(1) Pump.

Manufacturer	Barnes Manufacturing Company
Model	US67CCG
Serial number range	37628-001 thru -047
Type	Centrifugal
Pumping medium	Petroleum products
Output (at maximum rated speed).	245 gpm @200 feet head 1120 gpm @100 feet head
Maximum rated driven speed	2450 rpm
Suction port size	6 in.
Discharge port size	6 in.

(2) Engine.

Manufacturer	Continental Motors Corporation
Model	FS244-06097P
Type	Four stroke cycle
Number of cylinders	6
Displacement	244 cu in.
Compression ratio	6.9:1
Cooling	Liquid
Cooling system capacity	18 qts
Crankcase oil capacity	5% qts
Valve clearance (warm)	
Intake	0.014 in.
Exhaust	0.016 in.
Spark plug gap	0.025 in.
Firing order	1-52-4
Governed speed	2460 rpm
Overspeed cutout	2700 rpm

(3) Alternator.

Manufacturer	Motorola
Part number	MA24-900G
Voltage	24
Amperage output	35

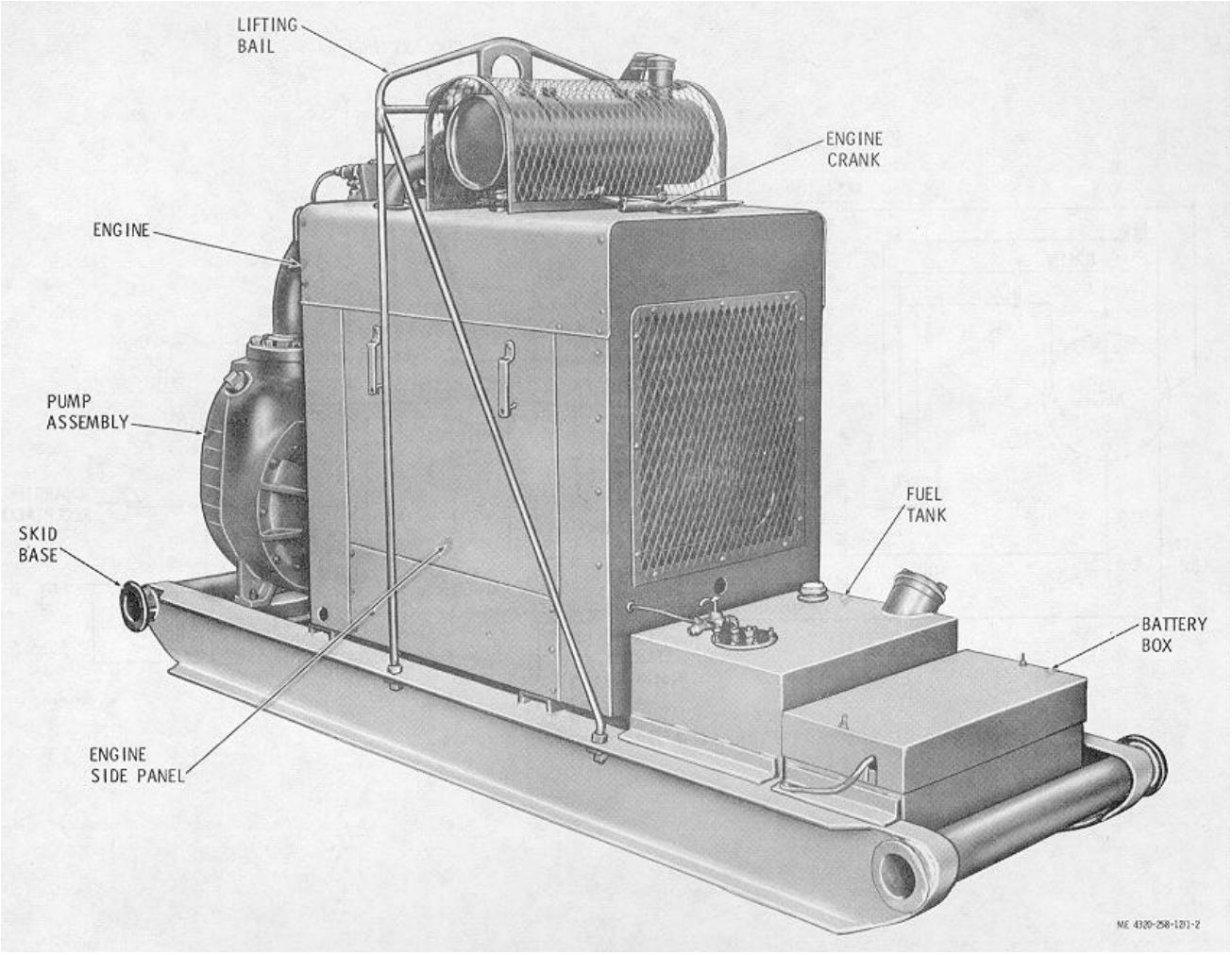


Figure 1-2. Centrifugal pump, right rear view.

(4) Voltage regulator.
Manufacturer.....Motorola
Part number.....70C44707B

(5) Starter.
Manufacturer.....Delco-Remy
Part number.....1108271
Voltage 24

(6) Magneto.
Manufacturer.....Slick
Model.....625
.....

(7) Fuel pump.
Manufacturer.....AC Spark Plug
Part number.....5594228

(8) Carburetor.
Manufacturer.....Zenith
Part number 12334

(9) Air cleaner.
Manufacturer ..... Donaldson
Part number FWG06-5032

(10) Oil filter.
Manufacturer..... Fram
Part number C7407

(11) Overall dimensions and weight.
Overall length ..... 111 in.
Overall width..... 31 in.
Overall height ..... 55 in.
Overall weight..... 4000 lb
Shipping weight..... 4270 lb
Shipping volume ..... 201 cu ft

(12) Wiring diagram. See figure 1-3.

(13) Maintenance and operating supplies.
Refer to appendix C for a complete list of maintenance and operating supplies required for initial operation.

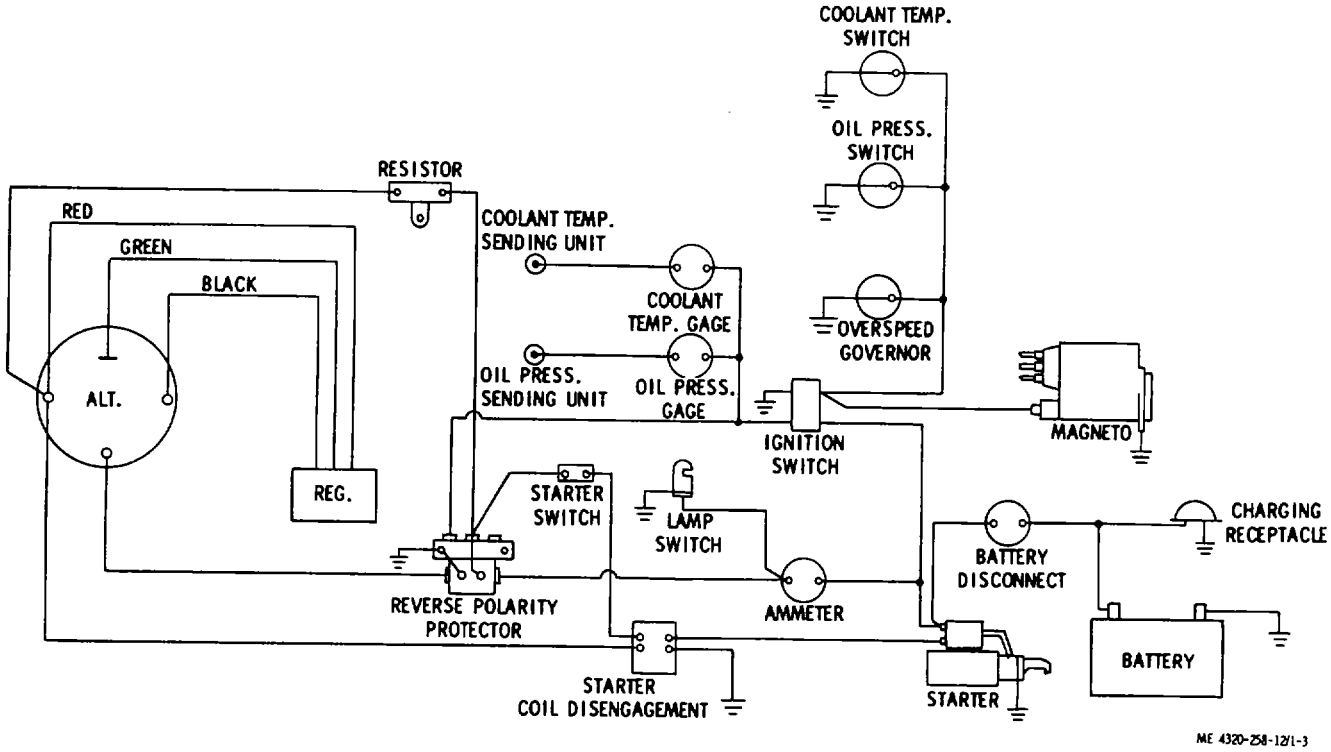


Figure 1-3. Engine wiring diagram.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF MATERIEL

2-1. Inspecting and Servicing the Equipment

a. Inspect the unpacked pump assembly as follows:

(1) Inspect for cracks, dents, and other damage that may have occurred during shipment.

(2) Inspect for loose or missing hardware.

(3) Check the engine for leaking.

(4) Inspect the suction and discharge ports of pump for damaged ends and burred grooves.

(5) Using the engine crank (fig. 1-2), turn over the engine with the battery disconnect switch and ignition switch in the OFF positions. The engine and pump shall turn freely without binding or scraping or other signs of faulty operation. Be careful that the crank does not drop onto the fuel gage on the fuel tank.

(6) Inspect the control panel (fig. 1-1) for damaged controls and instruments.

(7) Remove the engine side panels (fig. 1-2). Inspect all hoses for abrasions, cracks, fraying, and other damage.

(8) Tighten all loose hardware. Report any other damage to the required authority.

b. Servicing.

(1) Refer servicing of the equipment to organizational maintenance.

(2) Perform all daily preventive maintenance services indicated in table 3-1.

2-2. Installation

Install the centrifugal pump as follows:

a. Locate the pump assembly on a solid, flat surface as close as possible to the source of liquid supply. Allow ample room around the pump to support the suction and discharge hoses and to service the pump as required.

Caution: **The tilt of the pump when spotted for operation shall not exceed 15 degrees from horizontal. An angle of more than 15 degrees will result in inefficient operation of the engine lubrication system and may cause severe damage to the engine or automatic shutoff due to low oil pressure.**

b. Connect the suction line to the suction port (fig. 1-1), as follows:

(1) The suction port is provided with a 6-inch grooved nipple. Connect to mating grooved pipe with lock ring.

(2) Keep the suction line as short as possible and the suction lift as low as possible. Reduction in pumping capacity becomes noticeable at suction lifts in excess of 15 feet and is very pronounced at 25 feet. Do not operate the pump with a suction lift in excess of 25 feet.

(3) The suction line should be as large a diameter and as short as practical, and should be installed with as few bends as possible. Use no fittings of less than a 6-inch diameter.

(4) The highest point in the suction line should be at the pump, and the line should be laid in a decline from the pump to the source. Avoid high points which will form air pockets.

(5) Make sure that connections in the suction line are air tight. Even a small leak will greatly reduce pumping efficiency and may cause difficulty in priming, especially when operating with a high suction lift.

(6) Support the suction line at or near the pump to prevent strain.

c. Install the discharge line on the discharge elbow (fig. 1-1), as follows:

(1) The discharge elbow is provided with a 6-inch grooved pipe. Connect to mating grooved pipe with lock ring.

(2) Avoid unnecessary fittings in the discharge line. When necessary to use elbows, use long radius type to reduce friction loss.

(3) Support the discharge line at or near the pump to prevent strain.

Warning: **Do not operate the pump unit in an enclosed area unless exhaust gases are piped to the outside. Inhalation of exhaust fumes will result in serious illness or death.**

d. If the centrifugal pump is operated indoors, provide piping to carry exhaust gases to the outside of the building. Make sure that the diameter of the exhaust piping is large enough to prevent excessive back pressure in the engine.

e. If an auxiliary fuel supply is to be used, connect a fuel line between the source of supply and the 3-way fuel source selector valve (1, fig. 2-4) on the fuel tank. Operate the fuel valve to the AUX position.

Section II. MOVEMENT TO A NEW WORKSITE

2-3. Dismantling for Movement

Dismantle the pump for movement to a new worksite as follows:

a. Disconnect the suction line and discharge line from the pump. If possible, drain the discharge line before disconnecting it from the pump. Drain the lines into a suitable container.

b. Remove the drain plug (fig. 1-1) from the bottom of the pump to drain the pump housing. Catch the fluid in a suitable container.

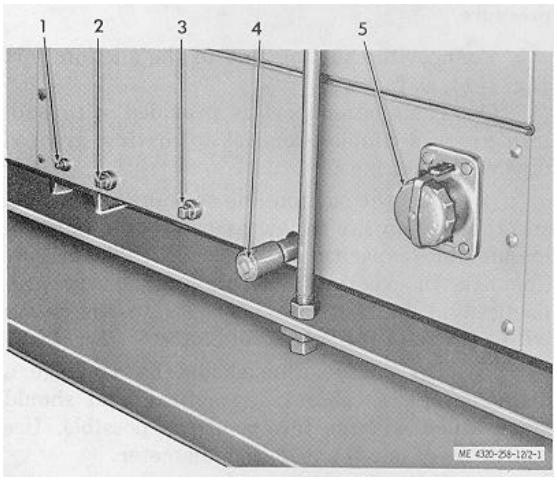
c. If there is any chance of debris entering the pump suction and discharge openings, cover the openingwith tape.

d. If installed, disconnect the fuel line from the 3-way fuel source selector valve (1, fig. 2-4) on the fuel tank.

e. Disconnect any exhaust piping from the pump.

f. Drain the engine as necessary. On the left side of the engine at the bottom of the housing are the oil cooler drain plug (1, fig. 2-1), radiator coolant drain plug (2), block coolant drain plug (3) and oil pan drain plug (4). On the side of the engine is the carburetor bowl drain plug (4, fig. 2-3).

g. When moving the pump assembly, do not attempt to slide pump on its skid base for any long distance. A lifting bail (fig. 1-2) is provided to facilitate hoisting the pump onto a suitable carrier.



1. Oil cooler drain plug
2. Radiator coolant drain plug receptacle
3. Block coolant drain plug
4. Oil pan drain plug
5. Battery charging

Figure 2-1. Left side of engine, showing drain plugs and charging receptacle.

2-4. Reinstallation after Movement

Refer to paragraph 2-2 for installation instructions.

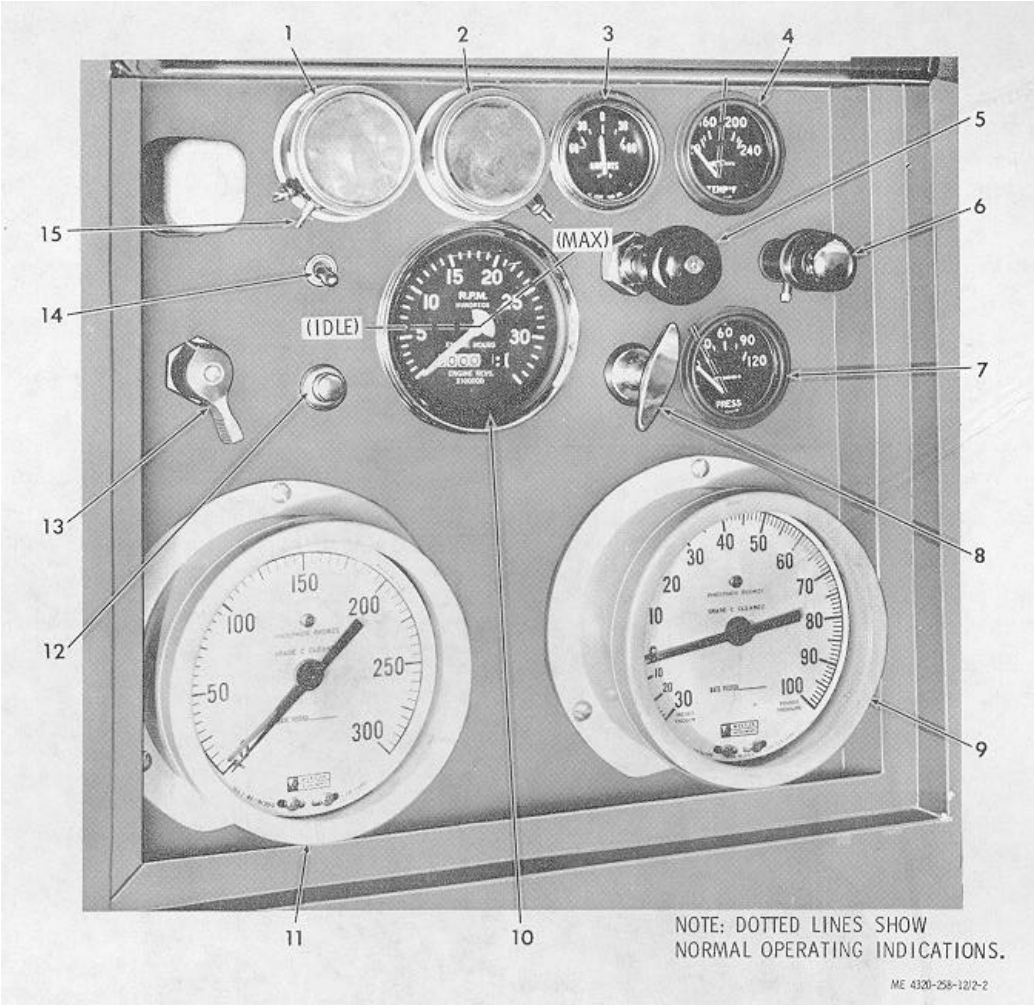
Section III. CONTROLS AND INSTRUMENTS

2-5. General

This section describes the various controls and instruments and provides the operator/crew with sufficient information to assure proper operation of the centrifugal pump assembly.

2-6. Controls and Instruments

The controls necessary for operation of the centrifugal pump are illustrated in figures 2-2 through 2-4 and are described in table 2-1.

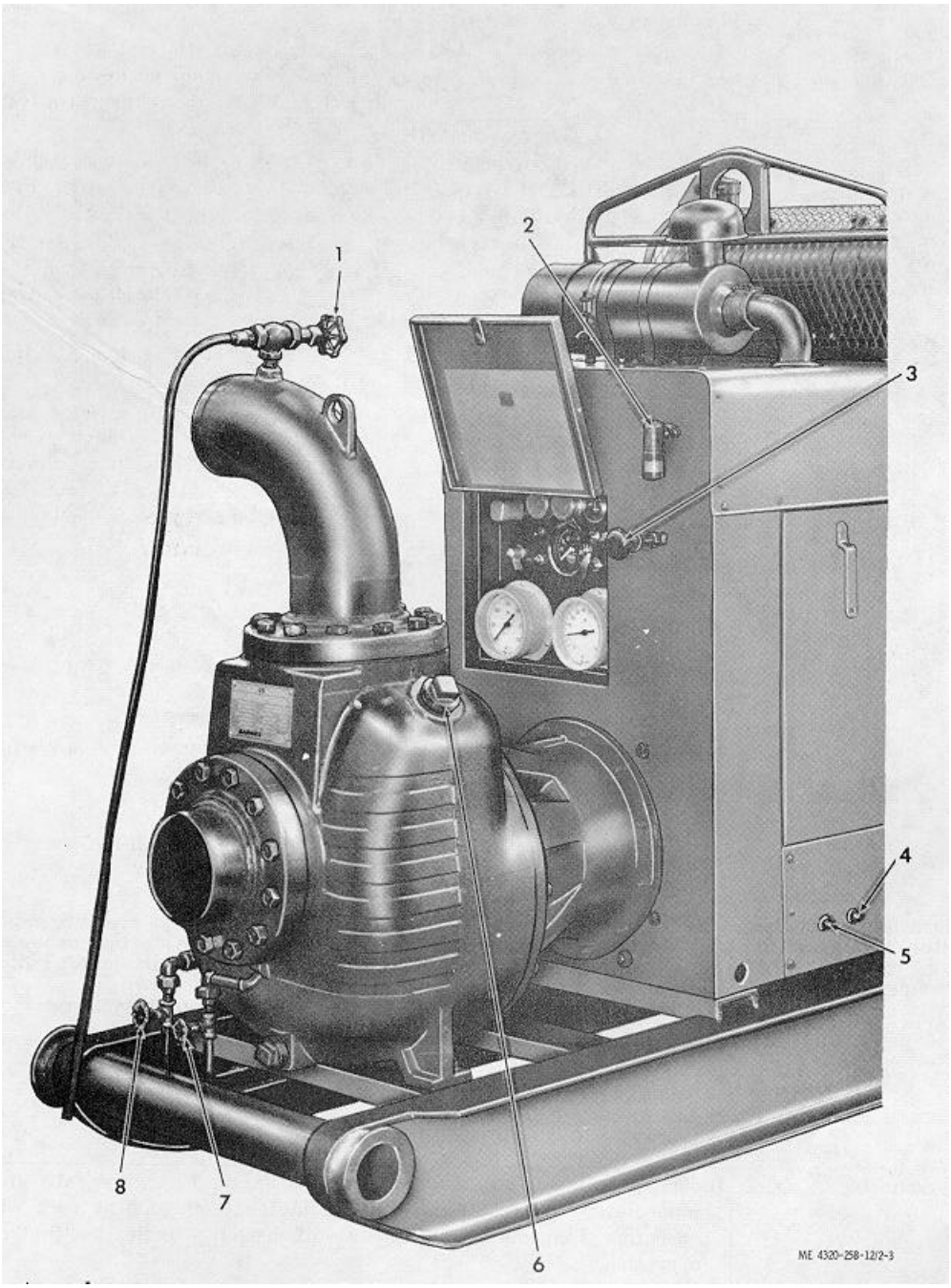


1. Engine oil pressure safety switch
2. Coolant temperature safety switch
3. Ammeter
4. Engine coolant temperature gage
5. Throttle knob
6. Control panel lamp
7. Engine oil pressure gage
8. Choke control
9. Suction gage
10. Tachometer-hourmeter
11. Discharge pressure gage
12. Engine starter pushbutton
13. Battery disconnect switch
14. Ignition switch
15. Low oil pressure reset

Figure 2-2. Control panel controls and instruments.

Table 2-1. Controls and Instruments

Fig. & index No.		Name	Operation and use
2-2	3	Ammeter	Indicates battery rate of charge or discharge. Charging rate may be higher immediately after starting but should taper off to near zero with continued operation. Immediately check cause of discharge indication that occurs during operation.
2-2	4	Coolant temperature gage	Indicates the temperature of engine coolant during operation. Normal warmed-up reading is 180° to 200° F.
2-2	5	Throttle knob	Controls engine speed between idle and governed speed. When pushed in, it causes the engine to operate at idle speed. When pulled out fully, it causes engine to run at full governed speed. Intermediate settings provide intermediate engine speeds.
2-2	6	Control panel lamp	Provides illumination for control panel when operating during hours of darkness.
2-2	7	Engine oil pressure gage	Indicates engine oil pressure. At idle, oil pressure must exceed 7 psi. At governed speed, oil pressure must be 20 to 30 psi.
2-2	8	Choke control	When pulled out, the choke control supplies an extra-rich fuel mixture to the engine to facilitate engine starting and warmup. When pushed in fully, it restores normal fuel mixture for running the engine.

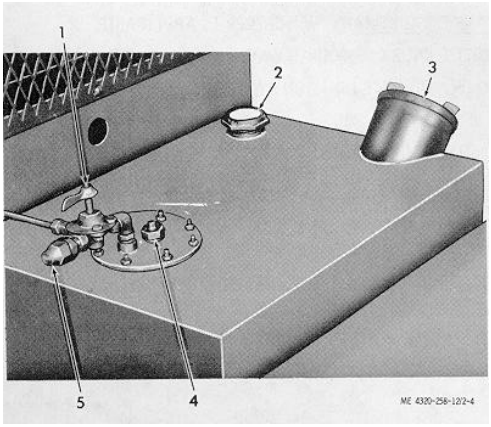


1. Air eliminator valve
2. Air cleaner restriction indicator
8. Engine primer pump
4. Carburetor drain plug
5. Dummy plug
6. Fill plug
7. Suction gage valve
8. Discharge pressure gage valve

Figure 2-3. Miscellaneous controls, indicators, and plugs.

Table 2-1-Continued

Fig. & index No.		Name	Operation and use
2-2	9	Suction gage	Compound gage indicates either vacuum or pressure condition at suction port when suction gage valve is open. Indication depends upon specific operating conditions.
2-2	10	Tachometer-hourmeter	Indicates the engine speed in hundreds of rpms. Normal governed speed rating is 2450 rpm. Engine speed at full load should not go beyond this level. Hour-meter indicates engine running time based on operating speed (engine revolutions x 100, 000).
2-2	11	Discharge pressure gage	Indicates pump discharge pressure when discharge pressure gage valve is open. High pressure indicates high discharge head or discharge line restriction. Normal discharge pressure varies with operating conditions.
2-2	12	Starter push-	When the battery disconnect switch and ignition switch are ON, the starter button pushbutton, when pressed, energizes the engine starter to turn over the engine for starting. Safety bypass switch (15) must be held closed during starting to bypass oil pressure safety switch.
2-2	13	Battery disconnect switch	In the ON position, it closes circuits to the starting system and ignition switch. In the OFF position, it interrupts these circuits.
2-2	14	Ignition switch	In the ON position, it energizes the oil pressure and water temperature gage circuits and removes the ground from the ignition circuit to permit engine ignition. Battery disconnect switch must be in ON position to make this switch operative. When moved to OFF, ignition switch stops the engine by grounding the magneto, regardless of the position of battery disconnect switch.
2-2	15	Low oil pressure reset	When pressed, it resets the low oil pressure safety circuit to allow engine starting.
2-3	1	Air eliminator valve	When open, the air eliminator valve releases air in the discharge piping. Normally closed during operation after starting.
2-3	2	Air cleaner restriction indicator	Indicates red when air cleaner is clogged, preventing free air passage. Requires reset after air cleaner service.
2-3	3	Engine primer pump	When operated, it pumps raw fuel into the intake manifold to facilitate starting.
2-3	7	Suction gage valve	When open, the suction gage valve applies suction port pressure to suction gage.
2-3	8	Discharge pressure gage valve	When open, the discharge pressure gage valve applies discharge pressure to discharge pressure gage.
2-4	1	3-way fuel source selector valve	This valve has three positions as follows: OFF position shuts off fuel supply to engine. TANK position opens tank-to-engine fuel supply line. AUX position opens the line between the auxiliary fuel supply and engine.
2-4	2	Fuel tank gage	Indicates level of fuel in fuel tank



1. Fuel source selector valve
2. Fuel tank level gage
3. Fuel tank filler cap
4. Autofill connector
5. Auxiliary fuel line connector

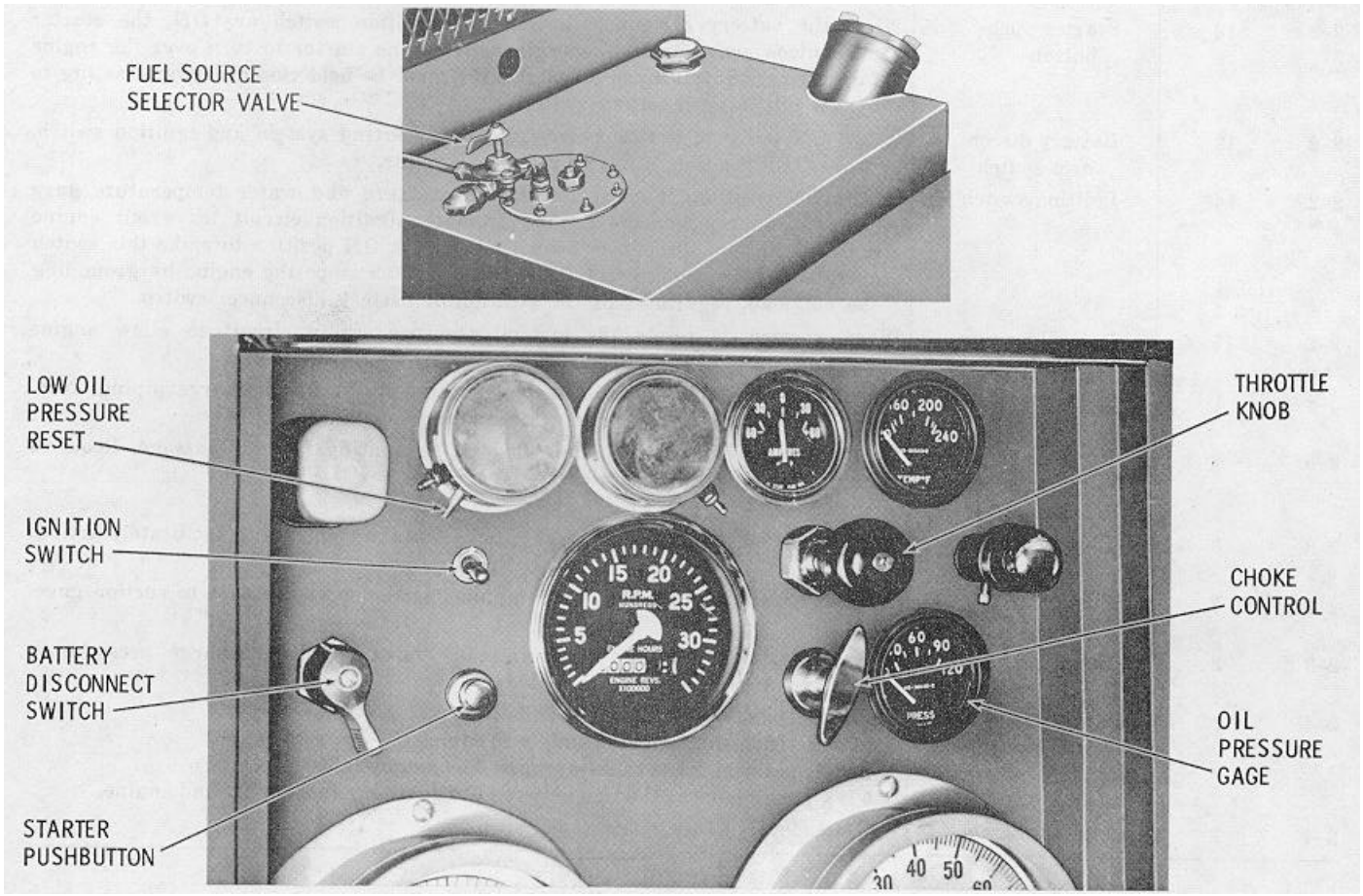
Figure 2-4. Fuel tank and related parts.

Section IV. OPERATION UNDER USUAL CONDITIONS

2-7. General

a. The instructions in this section are for the information and guidance of personnel responsible for operation of the centrifugal pump.

b. The operator must know how to perform every operation of which the centrifugal pump is capable. This section contains instructions on starting and stopping the centrifugal pump, on operation of the centrifugal pump, and on coordinating the basic motions to perform the specific tasks for which the equipment is designed. Since nearly every job presents a different problem, the operator may have to vary given procedures to fit the individual job.



STEP 1. PLACE FUEL SOURCE SELECTOR VALVE TO TANK OR AUXILIARY, WHICHEVER IS APPLICABLE.
STEP 2. PULL OUT CHOKE CONTROL. PULL OUT THROTTLE KNOB ONE-FOURTH WAY.
STEP 3. OPERATE BATTERY DISCONNECT SWITCH TO ON. OPERATE IGNITION SWITCH TO RUN.
STEP 4. MOMENTARILY PRESS LOW OIL PRESSURE RESET.
STEP 5. PRESS AND HOLD STARTER PUSHBUTTON UNTIL ENGINE STARTS.
CAUTION: IF ENGINE FAILS TO START AFTER 30 SECONDS OF CRANKING, RELEASE PUSHBUTTON AND WAIT 2 MINUTES BEFORE ATTEMPTING AGAIN TO ALLOW STARTER TO COOL. IF ENG INE FAILS TO START AFTER SEVERAL ATTEMPTS, REPORT COND ITION TO ORGAN IZATIONAL MAINTENANCE.
STEP 6. AFTER ENGINE STARTS, RELEASE STARTER PUSHBUTTON AND CHECK THAT OIL PRESSURE GAGE INDICATES NORMAL RANGE.
STEP 7. RUN ENGINE AT ONE-FOURTH THROTTLE UNTIL ENGINE REACHES OPERATING TEMPERATURE. PUSH IN CHOKE IN INCREMENTS TO MAINTAIN SMOOTH ENGINE OPERATION UNTIL CHOKE CONTROL IS FULLY IN.

Figure 2-5. Engine starting instructions.

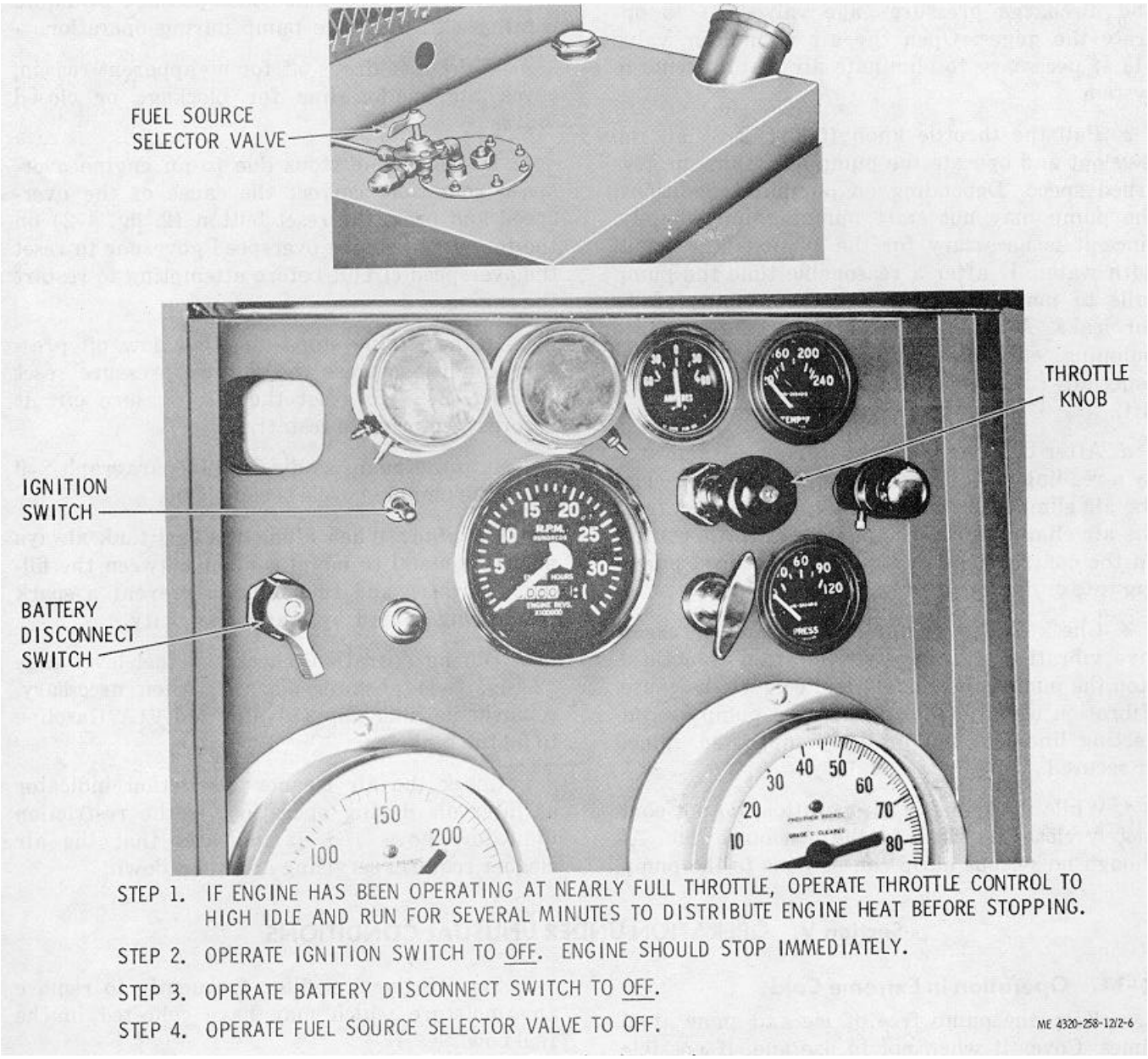


Figure 2-6. Stopping Instructions.

2-8. Starting

a. Preparation for Starting.

(1) Perform the necessary daily preventive maintenance procedures (para 3-4).

(2) If the pump is being started at a new installation for the first time or if it has been drained after the last period of operation, remove the fill plug (6, fig. 2-3) and fill the body with the liquid to be pumped.

Caution

Always prime the pump before starting engine. Operating the pump dry may damage the seal.

(3) Remove the engine cover panels (fig. 1-2).

b. Starting. Refer to figure 2-5 and start the centrifugal pump.

2-9. Stopping

Caution

Do not stop the pump by pulling out the choke. This floods the cylinders with raw gasoline, which washes away the lubricants and makes the engine susceptible to wear.

a. Stop the pump as shown in figure 2-6.

b. Perform all after-operation preventive maintenance services.

2-10. Operation Under Usual Conditions

Caution

Prime the pump before starting. (para 2-8a)

a. Start the centrifugal pump (para 2-8).

b. Open the suction gage valve (7, fig. 2-3) and discharge pressure gage valve (8) to operate the gages. Open the air eliminator valve (1) if necessary to eliminate air from discharge system.

c. Pull the throttle knob (5, fig. 2-2) all the way out and operate the pump at maximum governed speed. Depending on pumping conditions, the pump may not start pumping immediately, since it is necessary for the suction hose to fill with water. If after a reasonable time the pump fails to pump, check the suction line carefully for leaks. A small air leak will greatly reduce pumping efficiency under any conditions and especially when operating under a high suction lift.

d. After the pump starts pumping, as indicated by a reading on the discharge pressure gage, close the air eliminator valve and adjust the flow from the air eliminator valve and/or a throttle control on the control panel to obtain the desired pumping rate or discharge pressure.

e. Check the pump for any unusual or excessive vibration. If excessive vibration is noticed, stop the pump immediately and correct the cause. Vibration usually results when the pump or connecting lines are not properly supported, alined or secured.

f. While the pump is in operation, do not completely close the valve in the discharge line. Although no serious harm can be done to the pump, the rotating impeller churning the water can generate enough heat to cause the liquid in the volute to boil. Make sure that some passage of liquid continues through the pump during operation.

g. If the rate drops off for no apparent reason, check the suction line for blockage or closed valves.

h. If the engine stops due to an engine overspeed condition, correct the cause of the overspeed and press the reset button (2, fig. 4-2) on the top of the engine overspeed governor to reset the overspeed circuit before attempting to restart the engine.

i. If the engine stops due to a low oil pressure condition, press the low oil pressure reset (15, fig. 2-2) to reset the oil pressure circuit before attempting to restart.

j. Stop the pump as directed in paragraph 2-9 when the pumping cycle is completed.

Warning

When filling the fuel tank always maintain metal to metal contact between the filling apparatus and fuel tank to prevent a spark from being caused by static electricity.

k. During operation, check the fuel level gage (2, fig. 2-4) at intervals and, when necessary, remove the filler cap (3) and add 91A Gasoline to fill the tank.

l. Check the air cleaner restriction indicator at intervals during operation. If the restriction indicator shows red, it indicates that the air cleaner requires servicing after shutdown.

Section V. OPERATION UNDER UNUSUAL CONDITIONS

2-11. Operation in Extreme Cold

a. Keep the pump free of ice and snow at all times. Cover it when not in use and, if possible, provide some shelter from the weather.

b. Use a hydrometer to assure that the engine coolant has sufficient antifreeze to prevent freezing at the lowest temperature to which the pump will be subjected.

c. Refer to the current lubrication order to assure that the engine lubricant is the proper grade for the coldest conditions likely to be encountered.

d. Keep the fuel tank filled when the pump is not in use. This will prevent moisture from condensing in the fuel system. Moisture in the fuel system can freeze and clog lines, filters, and carburetor jets, preventing fuel from reaching the engine.

e. Service the fuel filter frequently to remove any moisture which may have collected in the fuel bowl.

2-12. Operation in Extreme Heat

a. Protect the pump assembly from direct rays of the sun if possible.

b. Allow adequate space for ventilation. Use a fan to circulate the air if the pump is operated in an enclosure.

c. Keep the engine and radiator clean to provide proper heat transfer to the air.

d. Check that the lubricants used in the engine comply with the recommendations of the current lubrication order.

2-13. Operation in High Altitudes

The operating efficiency of both engines and pumps diminishes at higher altitudes. Make sure

that the engine is operating at peak efficiency to provide the highest possible pump output.

2-14. Operation in Sandy or Dusty Areas

a. Maintain a careful check of the air cleaner restriction indicator. Immediately report to organizational maintenance when it indicates a restricted condition of the air cleaner. The service frequency of air cleaner service must be increased when operating under conditions of extreme sand or dust.

b. Take care to prevent sand and dust from entering the fuel system while filling the fuel tank. Watch the fuel strainer bowl for accumulations of dirt. Report any dirt accumulations in the bowl.

2-15. Operation Under Rainy or Humid Conditions

a. Take care to prevent moisture from entering the fuel system. Fill the fuel tank immediately after every operating period to prevent moisture in the air from condensing and entering the fuel system. Maintain a careful check of the fuel strainer bowl for collections of moisture. Report it to organizational maintenance when moisture is noted in the fuel bowl.

b. Take special care to prevent rust and corrosion of exposed metal surfaces. Coat exposed metal surfaces with light grease to prevent rusting. Report damaged paint immediately to organizational maintenance.

2-16. Operation in Salt Water Areas

a. Because of the corrosive action of salt water, use fresh water to wash off any salt water that comes in contact with the equipment. This will help prevent the formation of rust and corrosion.

b. Coat all unpainted metal surfaces with grease to prevent formation of rust and corrosion.

2-17. Operation in Snow

a. Before operation, brush away any snow which has seeped into the engine compartment to assure free rotation of the fan and belts and to prevent water from the melted snow from entering engine components.

b. Check that the exhaust muffler weathercap has not frozen shut as the result of freezing of melting snow.

c. Brush all snow away from the instrument panel to assure clear observation of the instruments.

2-18. Operation in Mud

a. Make sure that the pump skid is mounted on a firm base so that it will not become mired in soft earth. Use planking or blocking, if necessary, to prevent the pump from sinking into muddy earth.

b. Keep the radiator free from mud. Mud caked in the radiator cooling fins will decrease the cooling capacity of the radiator.

c. Wipe all mud from the instrument panel to provide clear observation of the instruments.

CHAPTER 3
OPERATOR'S MAINTENANCE INSTRUCTIONS

Section I. BASIC ISSUE ITEMS

3-1. Tools, Equipment, and Repair Parts

Tools, equipment, and repair parts authorized for the centrifugal pump are listed in the Basic Issue Items List, Appendix C.

Section II. LUBRICATION INSTRUCTIONS

3-2. Lubrication Instructions

No lubrication is authorized at the operator/crew maintenance level for this equipment. Refer any troubles to organizational maintenance.

Section III. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

3-3. General

To insure that the centrifugal pump is ready for operation at all times, it must be inspected systematically so that defects may be discovered and corrected before they result in serious damage or failure. The necessary preventive maintenance checks and services to be performed are listed as described in paragraph 3-4. The item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit will be noted for future correction to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noted during operation which would damage the equipment if operation were continued. All deficiencies and shortcomings will be recorded together with the corrective action taken on DA Form 2404 (Equipment Inspection and Maintenance Worksheet) at the earliest possible opportunity.

3-4. Preventive Maintenance Checks and Services

Refer to table 3-1 for a listing of operator's preventive maintenance checks and services.

Table 3-1. Preventive Maintenance Checks and Services

Operator Maintenance Category			Daily Schedule (or weekly)		
Interval and sequence No.					
Before operation	During operation	After operation	Item to be inspection	Procedure	Paragraph reference
1		11	Fuel tank	Fill tank if necessary. Check for secure mounting.	Paragraph 2-10k
2			Engine and pump mounting	Tighten loose hardware.	
3			Battery	Check fluid level. If low, report to organizational maintenance.	Paragraph 4-2c
4			Radiator	Check fluid level. If low, report to organizational maintenance.	Paragraph 4-2a
5			Engine oil	Check level with dipstick. If low, report to organizational maintenance.	Paragraph 4-2b

Operator Maintenance Category			Daily Schedule (or weekly)		
Interval and sequence No.					
Before operation	During operation	After operation	Item to be inspection	Procedure	Paragraph reference
6			Fan drive belt	Belt must deflect ¾ to 1 inch with thumb pressure at midpoint of longest belt span. If loose, report to organizational maintenance.	Paragraph 4-30a
7			Exhaust system	Check weather cap for free operation. Check muffler and pipes for damage and leaks. Free sticking weather cap. Report other damage to organizational maintenance.	Paragraph 4-19
8			Air cleaner	If restriction indicator shows restriction, report it to organizational maintenance.	Paragraph 4-18
9			Unusual noises or vibration	Shut down pump and report trouble to organizational maintenance.	
10			Fuel, lubricant, and coolant leaks.	Report troubles to organizational maintenance.	

Section IV. TROUBLESHOOTING

3-5. General

This section describes troubles which might occur during operation of the centrifugal pump, along with the probable causes and corrective actions relating to the troubles. Only those malfunctions which are within the maintenance scope of the operator/crew are included in this chart. If the corrective actions given in this chart do not correct the malfunction, report the trouble to organizational maintenance.

3-6. Operator/Crew Troubleshooting Chart

Refer to table 3-2 for troubleshooting which is allocated to the operator/crew level of maintenance.

Table 3-2. Troubleshooting Chart

Malfunction	Probable cause	Corrective action
1. Engine fails to turn over.	*a.* Battery dead.	*a.* Jumper battery or recharge weak battery. Report to organizational maintenance if battery fails to retain charge.
	b. Battery disconnect in OFF position.	*b.* Operate battery disconnect to ON (18, fig. 2-2).
	c. Starter defective.	*c.* Report to organizational maintenance.
2. Engine turns over but fails to start.	*a.* Fuel tank empty.	*a.* Fill fuel tank (para 2-10j).
	b. Choke not pulled out.	*b.* Pull out choke (8, fig. 2-2).
	c. Water in fuel.	*c.* Drain fuel tank and lines. Refill with fresh fuel.
	d. Overspeed governor not reset after overspeed shutdown.	*d.* Reset overspeed governor (para 2-10h).
3. Engine starts but then stops.	*a.* Insufficient fuel supply.	*a.* Fill fuel tank (para 2-10j).
	b. Contaminated fuel.	*b.* Drain fuel system and refill with fresh fuel.
	c. Choke pulled out.	*c.* Push in choke control (8, fig. 2-2).
	d. Water temperature safety switch trips.	*d.* Check cause of engine overheating. Report to organizational maintenance.

Malfunction	Probable cause	Corrective action
	e. Oil pressure safety switch trips.	*e.* Check oil level. Report to organizational maintenance if low.
	f. Engine overspeed governor trips.	*f.* Reset governor (para 2-10h). Start engine and watch tachometer to check for overspeed. Report to organizational maintenance if engine speed exceeds 2600 rpm.
4. Engine runs but unit fails to pump.	*a.* Suction leak.	*a.* Correct leak in auction line.
	b. Suction lift too high.	*b.* Reduce suction lift to less than 25 feet (para 2-2).
	c. Pump not primed.	*c.* Prime pump (para 2-8a(2)).
	d. Discharge head too high.	*d.* Reduce discharge head.
	e. Throttle lever not in full-speed position.	*e.* Operate throttle lever so that engine runs at full governed speed.
5. Engine lacks power.	*a.* Throttle control not in full-speed position.	*a.* Operate throttle control to provide full speed operation.
	b. Air cleaner restricted.	*b.* Check for air cleaner restriction.
	c. Exhaust weather cap causing excessive back pressure.	*c.* Free weather cap.

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

4-1. General

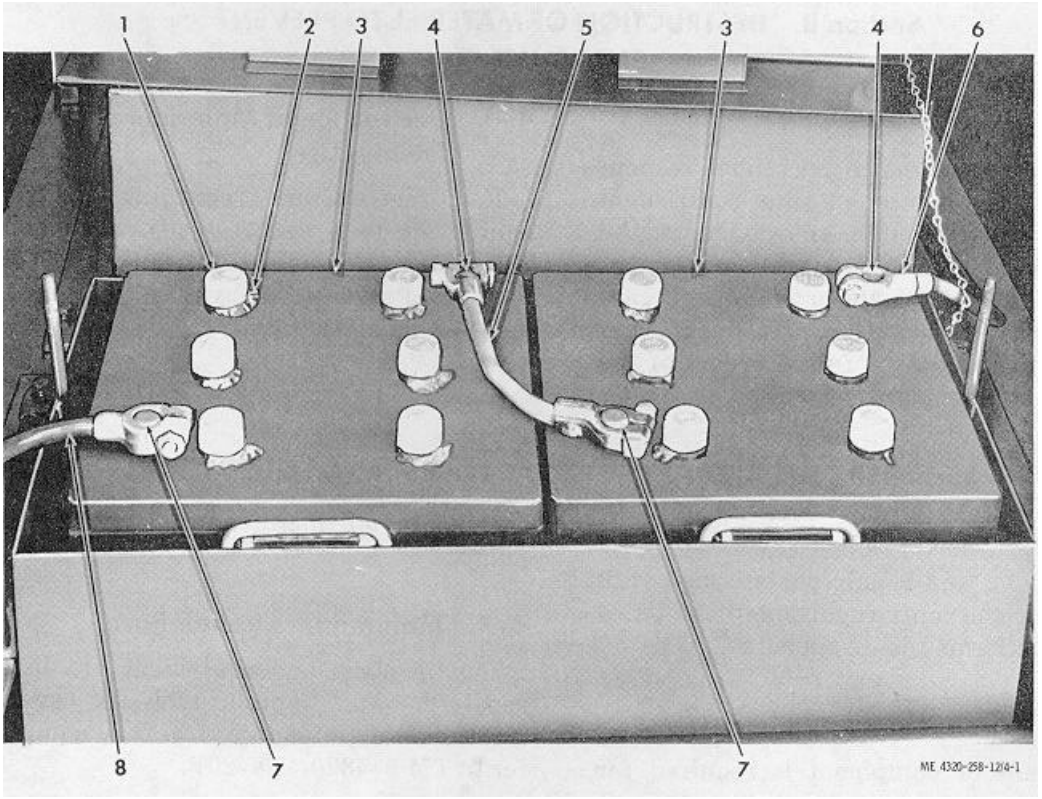
Inspection of the received equipment is described in paragraph 2-1. Service the received equipment as directed in paragraph 4-2 before putting it into operation.

4-2. Servicing

a. Check the engine coolant. Make sure the radiator is filled to the required level and that there is sufficient antifreeze for the required operating conditions. Normally, water that is suitable for drinking is suitable for use in the radiator.

b. Check the oil level in the engine crankcase, using the dipstick (8, fig. 4-26). Add oil if the level is near the low mark on the dipstick.

c. Remove the cover from the battery box (fig. 1-2). Check that the batteries are properly connected as shown in figure 4-1. Install the electrolyte in the batteries as follows:



1. Cap
2. Seal
3. 12-volt storage battery
4. Positive battery terminal
5. Interconnecting cable
6. Battery cable
7. Negative battery terminal
8. Ground cable

Figure 4-1. Battery box with batteries installed.

(1) Remove the caps and remove and destroy plastic film used to seal the battery caps.

(2) Fill the batteries to the level indicated with the separately packed electrolyte. If possible, the battery and electrolyte should be at 77° F during filling. The battery must be at more than 60° F but not more than 100° F at filling. Allow the filled batteries to stand for 30 minutes, then check the specific gravity of the electrolyte. The specific gravity, when temperature corrected to 77° F, must be above 1.250.

(3) If the specific gravity of the electrolyte is less than 1.250, or if the battery is not going to be used within 12 hours, or if the battery is going into service at a temperature of less than 0° F, the battery must be charged before use.

Warning

Do not smoke or use an open flame in the vicinity when servicing the batteries. Batteries generate hydrogen gas, a highly explosive gas.

(4) If battery charging is necessary, use a constant current charger and charge the battery. Check the specific gravity of the electrolyte every 30 minutes. The battery is fully charged when the specific gravity remains constant for three 30-minute intervals.

Caution

Constant current battery charging is always preferred. If a constant potential charger must be used, battery temperature must be maintained at less than 130° F by interrupting the charging procedure as this temperature is approached.

(5) During charging, check the electrolyte level frequently. Add distilled water when necessary to maintain the battery electrolyte level. Continue charging after adding water to assure proper mixing of the solution.

(6) After charging, the specific gravity of the electrolyte must be adjusted to 1.280 +0.010. The specific gravity can be lowered, if necessary, by removing electrolyte and replacing it with distilled water.

(7) After adding electrolyte, charge the batteries a minimum of once each month when the batteries are not in service.

(8) Batteries can be charged without removing the batteries from the equipment. Use the battery charging receptacle (5, fig. 2-1).

Section II. DESTRUCTION OF MATERIEL TO PREVENT ENEMY USE

4-3. General

Organizational maintenance personnel responsible for the maintenance of the centrifugal pump must have a thorough knowledge of the procedures necessary to destroy this equipment in the event of abandonment or imminent capture by the enemy. Destruction procedures shall be carried out only on the expressed orders of the responsible unit commander.

4-4. Destruction of Materiel to Prevent Enemy Use

For instructions regarding destruction of equipment to prevent enemy use, refer to TM 750-244-3 (Procedures for Destruction of Equipment to Prevent Enemy Use) (Mobility Equipment Command).

Section III. REPAIR PARTS, SPECIAL TOOLS, AND EQUIPMENT

4-5. Tools and Equipment

Tools, equipment, and repair parts issued with or authorized for the centrifugal pump are listed in the Basic Issue Items List, Appendix C.

4-6. Special Tools and Equipment

No special tools or equipment is required for organizational maintenance of the centrifugal pump.

4-7. Maintenance Repair Parts

Repair parts and equipment are listed in the repair parts and special tools list covering organizational maintenance for this equipment. Refer to TM 5-4320-258-20P.

Section IV. LUBRICATION INSTRUCTIONS

4-8. Detailed Lubrication Information

a. General. Keep all lubricants in closed containers and store in a clean, dry place away from external heat. Allow no dust, dirt, or other foreign material to mix with the lubricants. Keep all lubrication equipment clean and ready to use.

b. Cleaning. Keep all external parts not requiring lubrication clean of lubricants. Before lubricating the equipment, wipe all lubrication points free of dirt and grease. Clean all lubrication points after lubricating to prevent accumulation of foreign matter.

c. Points of Lubrication. Service the lubrication points at proper intervals as illustrated in the current Lubrication Order: Refer to DA Pam, 310-4 for the current Lubrication Order.

d. OES Oil.

(1) The crankcase oil level must be checked frequently, as oil consumption may increase.

(2) The oil may require changing more frequently than usual because contamination by fuel dilution and sludge formation will increase under cold weather operation conditions.

e. Oil Filter Service. Service the oil filter as described in paragraph 4-9a(3).

4-9. Engine Lubrication

a. Engine crankcase lubrication consists primarily of changing the oil in the crankcase and servicing the oil filter. Change oil every 50 operating hours and change the oil filter every 150 operating hours. Proceed as follows:

(1) Run the engine long enough to heat it to operating temperature. This is important since warm oil will drain from the internal engine parts much more rapidly than cold oil. The warm oil will carry more dirt and sludge with it as it drains.

(2) Place suitable containers under the engine drain ports and remove the oil pan drain plug (4, fig. 2-1) and oil cooler drain plug (1). Allow the oil to drain fully.

(3) Every third oil change (150 operating hours maximum), service the engine oil filter as follows:

(a) Use a wrench on the hex head of the screw on the top of the oil filter (3, fig. 4-26) and remove the filter cover and gasket.

(b) Grasp the filter element by its handle and lift it from the filter housing. Discard the filter element.

(c) Wipe the interior of the filter housing with a clean, dry cloth.

(d) Position a new filter element in the filter housing.

(e) Install the cover and gasket on the filter and tighten the hex screw at the top of the filter to secure the cover.

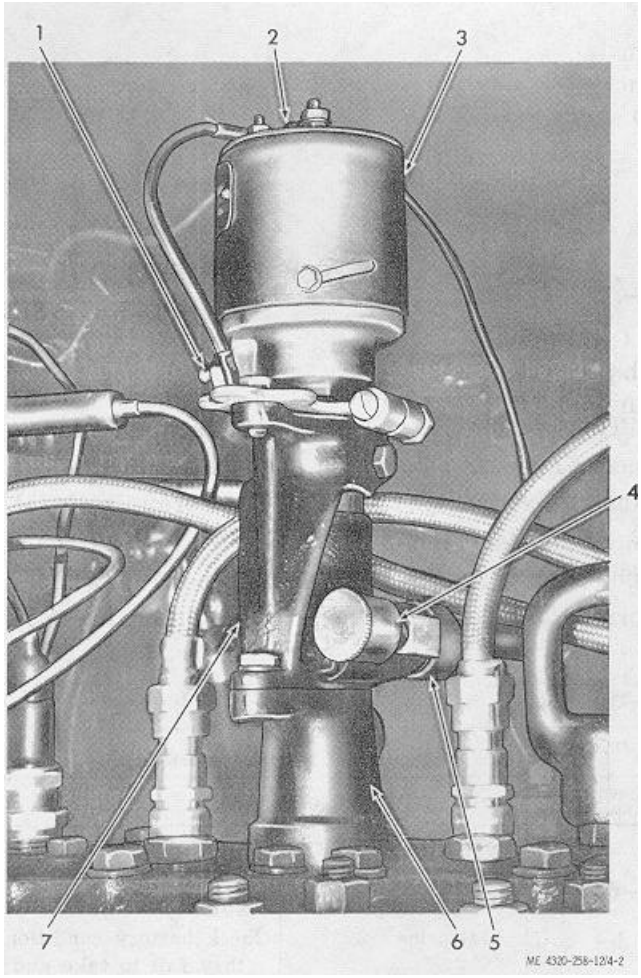
(4) Install the plugs in the drain ports.

(5) Remove the filler cap (11, fig. 4-26) from the engine oil filler pipe and pour 5 1/2 quarts of engine oil into the engine. Use the engine oil required for the particular temperature range which will be encountered. Required grades of engine oils are as follows:

Below 0°F	0-32°F	32-75°F	Above 75°F
5W-20	10w	SAE20W	SAE30

(6) Check the oil level on the oil level dipstick (8, fig. 4-26). It must be up to the full mark. Add oil if necessary, but do not overfill.

b. The tachometer drive has a grease cup (4, fig. 4-2) on the governor arm (7) to lubricate the tachometer adapter and its mating gear teeth on the overspeed governor drive shaft. Weekly, turn the grease cup clockwise two full turns to provide grease to the gear teeth. When the grease cup is turned down all the way, refill it with automotive grease and reinstall it.



1. Lubrication fitting
2. Reset button
3. Overspeed governor
4. Tachometer drive grease cup
5. Tachometer shaft connection
6. Drive adapter
7. Governor arm

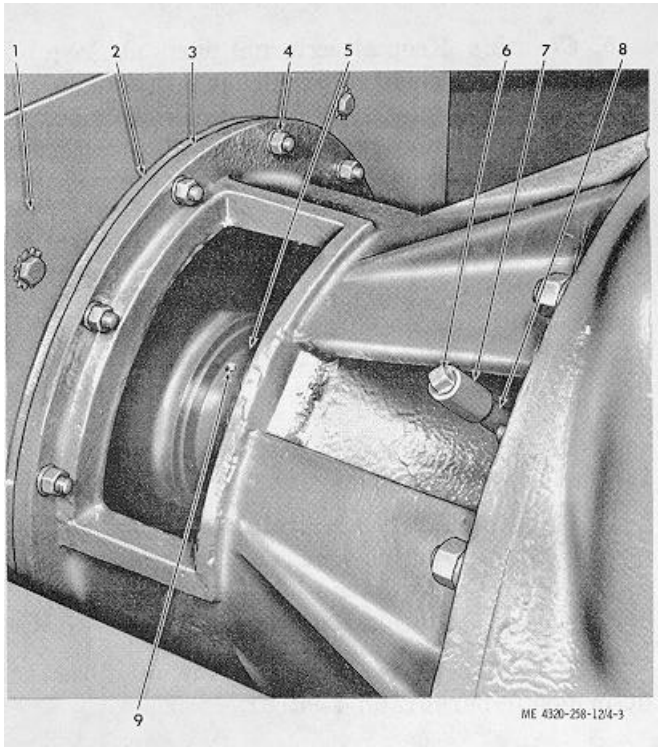
Figure 4-2. Tachometer drive and engine overspeed governor, showing lubrication points.

c. The bearings of the engine overspeed governor (3, fig. 4-2) have a lubrication fitting (1) which must be serviced every 1000 operating hours. Use a hand grease gun and apply grease until overflow appears through the port holes of the fitting. Use automotive grease for this purpose.

4-10. Pump Lubrication

a. The pump shaft bearings were packed with grease by the manufacturer at assembly and require no subsequent lubrication except at overhaul periods. No other pump lubrication is required, except for seal lubrication prior to storage.

b. Prior to storage of 30 days or more, remove the pipe plug (6, fig. 4-3) from the pipe coupling (7) and pour 1/2 pint of preservative oil into the seal lubricant pipe (8) to oil the seal. Install the pipe plug.



1. Engine housing
2. Flywheel housing
3. Pump bearing housing
4. Pump-to-engine mounting nut
5. Pump coupling
6. Plug
7. Pipe coupling
8. Seal lubricant pipe
9. Coupling setscrew hole

Figure 4-3. Engine-to-pump connections.

Section V. PREVENTIVE MAINTENANCE CHECKS AND SERVICES

4-11. General

This section lists the preventive maintenance checks and services which shall be performed on a monthly or quarterly basis by organizational maintenance personnel. It includes and expands upon the preventive maintenance services performed daily by operator/crew maintenance and includes additional services which are allocated to organizational maintenance.

4-12. Preventive Maintenance Checks and Services

Refer to table 4-1 for a listing of the preventive maintenance checks and services which are allocated to organizational maintenance.

Table 4-1. Preventive Maintenance Checks and Services

Organizational Maintenance Category — **Monthly Schedule (or Quarterly)**

Sequence number	Item to be inspected	Procedures	Paragraph reference
1	Fuel tank	Drain tank if fuel is dirty or contaminated. Refill with proper grade of gasoline.	Paragraph 2-10*j*.
2	Pump mounting	Tighten loose hardware. Replace missing hardware.	Figure 4-39.
3	Batteries	Check battery condition with hydrometer. Replace batteries if they fail to take and maintain a charge.	Paragraph 4-2*c*.
4	Radiator	Fill to required level with proper antifreeze solution. Replace radiator if damaged or leaking.	Paragraph 4-2*a* or 4-31.
5	Engine oil	Change engine oil at required interval. Service filter if necessary.	Paragraph 4-2*b*.
6	Fan drive belt	Belt must deflect ¾ to 1 inch with thumb pressure at midpoint of longest belt span. Adjust if loose. Replace defective belt.	Paragraph 4-30.

Organizational Maintenance Category — **Monthly Schedule (or Quarterly)**

Sequence number	Item to be inspected	Procedures	Paragraph reference
7	Exhaust system	Replace muffler or any other parts of exhaust system if damage or leaks are noted.	Paragraph 4-19.
8	Air cleaner	Check condition of air cleaner element. Replace element or any other damaged parts.	Paragraph 4-18.
9	Control panel	Replace inoperative or illegible gages, defective switches, or damaged controls.	Paragraph 4-43.
10	Engine housing	Repair or replace damaged housing panels or parts.	Paragraph 4-20.
11	Fuel lines, fittings, and strainer	Correct any leaks and replace defective parts. Service fuel strainer.	Paragraph 4-22.
12	Intake and exhaust manifolds	Check for cracks and damage. Report to direct support if exhaust leakage is suspected.	
13	Spark plugs	Check for cleanliness and proper gap. Clean and regap if necessary. Replace defective plugs.	Paragraph 4-33.
14	Skid base	Inspect for cracks and distortion. Report damage to direct support maintenance.	
15	Engine starter	Check that starter cranks engine properly. Replace defective starter.	Paragraph 4-41.
16	Battery charging system	Check ammeter with engine running. Test components if alternator fails to provide proper charge rate. Replace defective alternator or regulator.	Paragraph 4-36.
17	Magneto	Check breaker point opening. Replace burned points and adjust point gap.	Paragraph 4-34.
18	Water pump	Check flow of coolant during engine operation. Replace water pump if coolant flow is insufficient or if water pump leaks.	Paragraph 4-30.
19	Engine governor	Adjust engine governor if full-throttle operation is not between 2400 and 2500 rpm.	Paragraph 4-25.
20	Engine compression	If compression is erratic from cylinder to cylinder, report to direct support maintenance.	Paragraph 4-51.

Section VI. TROUBLESHOOTING

4-13. General

This section describes troubles which might occur during operation of the centrifugal pump, along with probable causes and corrective actions relating to the troubles. Only those malfunctions which are within the scope of organizational maintenance are included in this chart. If corrective actions given in this chart do not correct the malfunction, report the trouble to direct support maintenance.

4-14. Organizational Maintenance Troubleshooting Chart

Refer to table 42 for troubleshooting which is allocated to the organizational level of maintenance.

Table 4-2. Organizational Maintenance Troubleshooting Chart

Malfunction	Probable cause	Corrective action
1. Starting motor fails to crank engine.	*a.* Weak or dead battery.	*a*. Charge or replace battery (para 4-2c).
	b. Poor ground connection. cable.	*b*. Replace or tighten battery ground
	c. Faulty starter pushbutton.	*c*. Replace pushbutton (para 4-43).
	d. Defective starting motor.	*d*. Replace starting motor (para 4-41).
	e. Internal engine seizure.	*e*. Report to direct support maintenance.
2. Engine cranks but fails to start (no spark).	*a.* Magneto points not closing.	*a*. Adjust magneto point gap (para 4-34).

Malfunction	Probable cause	Corrective action
	b. Ignition switch defective.	b. Replace ignition switch (para 4-43).
	c. Overspeed stop.	c. Correct cause of overspeed. Reset overspeed stop governor and restart.
	d. Shorted or grounded magneto.	d. Replace magneto (para 4-34).
	e. Magneto points sticking shut.	e. Replace or adjust magneto points (para 4-34).
	f. Defective capacitor.	f. Replace capacitor (para 4-34).
3. Engine cranks but fails to start (good spark).	a. No fuel in tank.	a. Fill tank (para 2-10j).
	b. Clogged fuel lines or filter.	b. Clean lines and replace filter (para 4-22).
	c. Defective fuel pump.	c. Replace fuel pump (para 4-23).
	d. Plugged vent in fuel tank cap.	d. Open fuel tank cap vent.
	e. Water in fuel.	e. Drain and clean fuel tank, and replenish fuel supply.
4. Engine runs but continuously misfires.	a. Uneven compression (para 4-51).	a. Report to direct support maintenance.
	b. Spark plug wire defective.	b. Replace wire (para 4-33).
	c. Magneto defective.	c. Replace magneto (para 4-34).
	d. Defective spark plug.	d. Replace spark plug (para 4-33).
5. Engine runs unevenly at idle.	a. Wide spark plug gap.	a. Regap plugs (para 4-33).
	b. Improper carburetor idle adjustment.	b. Adjust carburetor (para 4-24).
	c. Intake air leaks.	c. Correct air leaks.
6. Engine starts, then stops.	a. Water temperature safety switch trips.	a. Refer to section X and determine and correct the cause of engine overheating.
	b. Oil pressure safety switch trips.	b. Add oil if necessary (para 4-9). If oil level is not low, report the trouble to direct support maintenance.
	c. Engine overspeed governor trips.	c. Reset governor (para 2-10*h*) and restart engine. If engine speed approaches 2700 rpm, adjust engine speed governor (para 4-26a). If overspeed governor trips before 2650 rpm, report to direct support maintenance.
7. Engine lacks power.	a. Timing incorrect.	a. Correct engine timing (para 4-34).
	b. Throttle fails to open fully.	b. Adjust throttle control (para 4-25).
	c. Air leaks in fuel system.	c. Correct air leaks.
	d. Air cleaner restricted.	d. Service air cleaner (para 4-18).
	e. Poor fuel.	e. Drain fuel tank and replenish with proper fuel.
8. Engine overheats.	a. Low coolant level.	a. Fill radiator with correct solution.
	b. Fan belt slipping.	b. Tighten fan belt (para 4-30).
	c. Defective thermostat.	c. Replace thermostat (para 4-29).
	d. Clogged radiator.	d. Replace radiator (para 4-31).
	e. Defective water pump.	e. Replace water pump (para 4-30).
	f. Late ignition timing.	f. Correct engine timing (para 4-34).
9. High engine oil consumption.	a. Oil leaks.	a. Correct oil leaks,
	b. Incorrect grade of oil used.	b. Use oil recommended in lubrication order.
	c. Engine worn.	c. Report to direct support maintenance.
10. Excessive pump vibration.	a. Engine and pump improperly alined.	a. Aline engine and pump (para 4-47).
	b. Coupling defective.	b. Replace coupling (para 4-48).
	c. Pump bearings defective.	c. Replace pump (para 4-47).
11. Pump seized or binding.	Internal pump damage.	Replace pump (para 4-47).

Section VII. RADIO INTERFERENCE SUPPRESSION

4-15. General Methods Used To Attain Proper Suppression

Essentially, suppression is attained by providing a low resistance path to ground for stray currents. The methods used include shielding the ignition and high frequency wires and grounding the frame with bonding straps.

4-16. Replacement of Suppression Components

This equipment uses no primary radio suppression components. Replace the secondary radio suppression components as follows:

a. Replace the shielded spark plug cables as directed in paragraph 4-33.

b. Replace the magneto ground strap as directed in paragraph 4-34.

Section VIII. MAINTENANCE OF AIR CLEANER, EXHAUST SYSTEM, AND ENGINE HOUSING

4-17. Description

a. Air Cleaner. The air cleaner (fig. 1-1) is mounted on the end of the engine housing opposite the radiator. It is a dry-type unit which uses a porous paper element to screen the particles of dust and dirt from the air before the air enters the carburetor. A flexible hose connects the air cleaner and carburetor. Proper maintenance requires cleaning or replacement of the air cleaner element when the restriction indicator shows a restricted condition. This occurs when the engine is running and the clogged condition of the air cleaner prevents sufficient air from entering the engine. The partial vacuum in the air lines trips the restriction indicator, indicating the need for servicing or replacement of the air cleaner element.

b. Muffler. The muffler (fig. 1-1) is a hollow cylinder containing internal baffles which break up the flow pattern of the exhaust gases expelled by the engine to provide quiet engine operation. It is mounted on the top of the engine to provide quiet engine operation. It is mounted on the top of the engine housing and is connected to the exhaust manifold of the engine by a pipe nipple. A heat shield is mounted between the muffler and housing to minimize heat transfer to the housing.

c. Engine Housing. The engine housing protects the engine from the weather, aids cooling by directing the air flow around the engine, and provides a mounting for the air cleaner and muffler.

4-18. Air Cleaner and Piping

Note

The air cleaner element must be replaced after one year of service or after it has been cleaned six times, whichever comes first.

a. Service.

(1) Stop the engine (para 2-9).

(2) Loosen the wing bolt on the clamp assembly (1, fig. 4-4) and remove the assembled dust cup (3) and flexible baffle (2). Remove the baffle from the dust cup and empty the dust from the dust cup.

(3) Remove the wing nut (4) with its assembled washer 'gasket (5) and remove the element (6) from the air cleaner body(7).

Caution

Do not use gasoline or other solvents for cleaning the air cleaner element.

(4) To clean the air cleaner element, use a 1/8-inch air nozzle with 100 psi maximum compressed air, blowing from the inside toward the outside until all dust is removed.

Caution

Mechanical drying methods can be used providing that the heated air does not exceed a temperature of 180°F with the air under constant circulation. Do not attempt to use light bulbs for element drying.

(5) An alternate method of cleaning the element is to wash it with a nonsudsing detergent in a container large enough to immerse the element. Allow it to soak for 10 minutes minimum and agitate it for 2 minutes to dislodge all dirt. Rinse with clean water, using a pressure hose from a tap with pressure of less than 40 psi. Air dry thoroughly before reinstallation.

(6) Insert a light bulb in the cleaned element and carefully check for holes, cracks, or ruptures. A hole in the element will necessitate element replacement. Any hole, no matter how small, will cause unnecessary engine wear.

(7) Install the element in the air cleaner body (7). Check that the washer gasket (5) on the wing nut is in good condition; secure the element to the body with the wing nut.

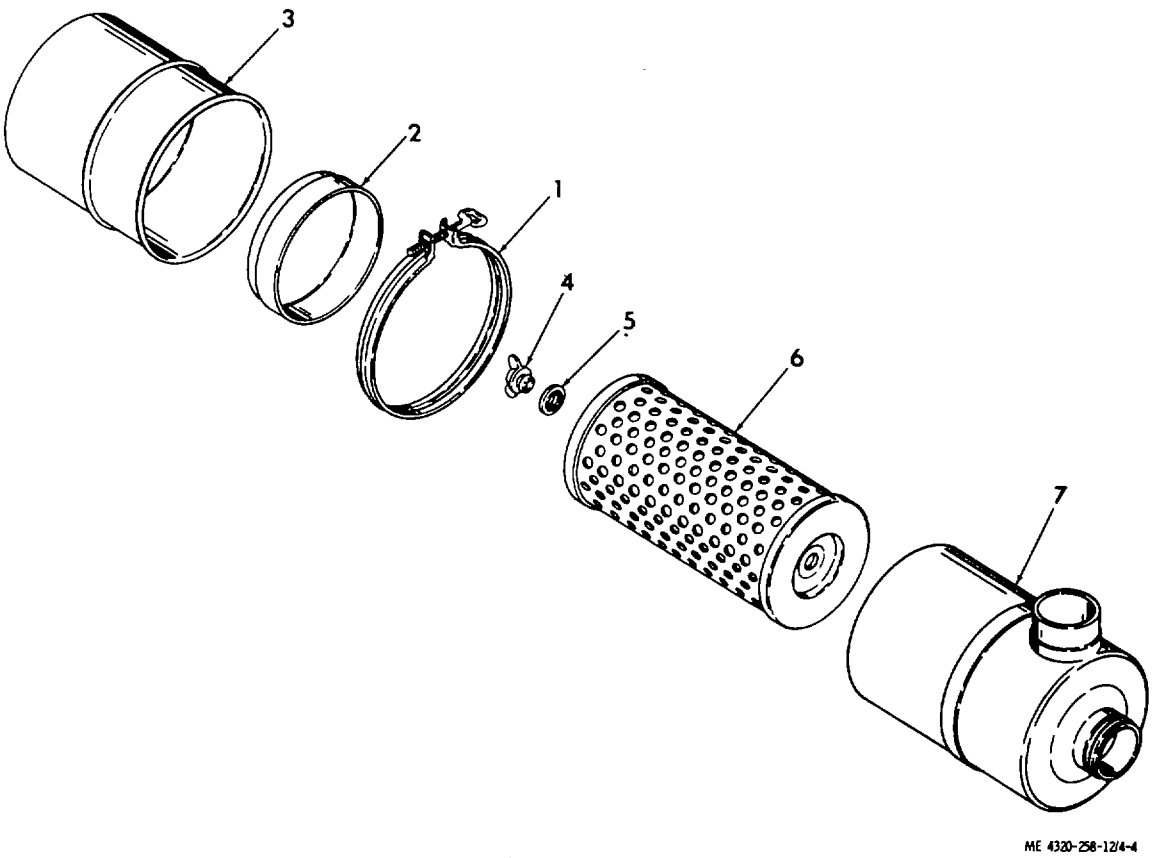


Figure 4-4. Air cleaner, exploded view.

(8) Install the flexible -baffle (2) in the cleaned dust cup (3), and install the parts on the body. Secure by tightening the wing screw on the clamp assembly (1).

b. Removal and Disassembly.

(1) Remove the air cleaner and related piping, following the sequence shown in figure 4-5.

(2) Service the air cleaner as directed in sub paragraph *a* above.

c. Cleaning and Inspection.

(1) Clean the exterior of the air cleaner and the air cleaning piping by wiping with a cloth dampened lightly with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(2) Inspect the air cleaner piping for cracks or holes which could allow unfiltered air to enter the engine; replace any damaged parts.

(3) Inspect the air cleaner for dents, cracks, and leaking; replace the air cleaner if the housing is damaged.

(4) Inspect the air cleaner mounting parts for cracks, distortion, and other damage; replace damaged parts.

d. Installation. Installation of the air cleaner and piping is the reverse of removal and disassembly. Refer to figure 4-5.

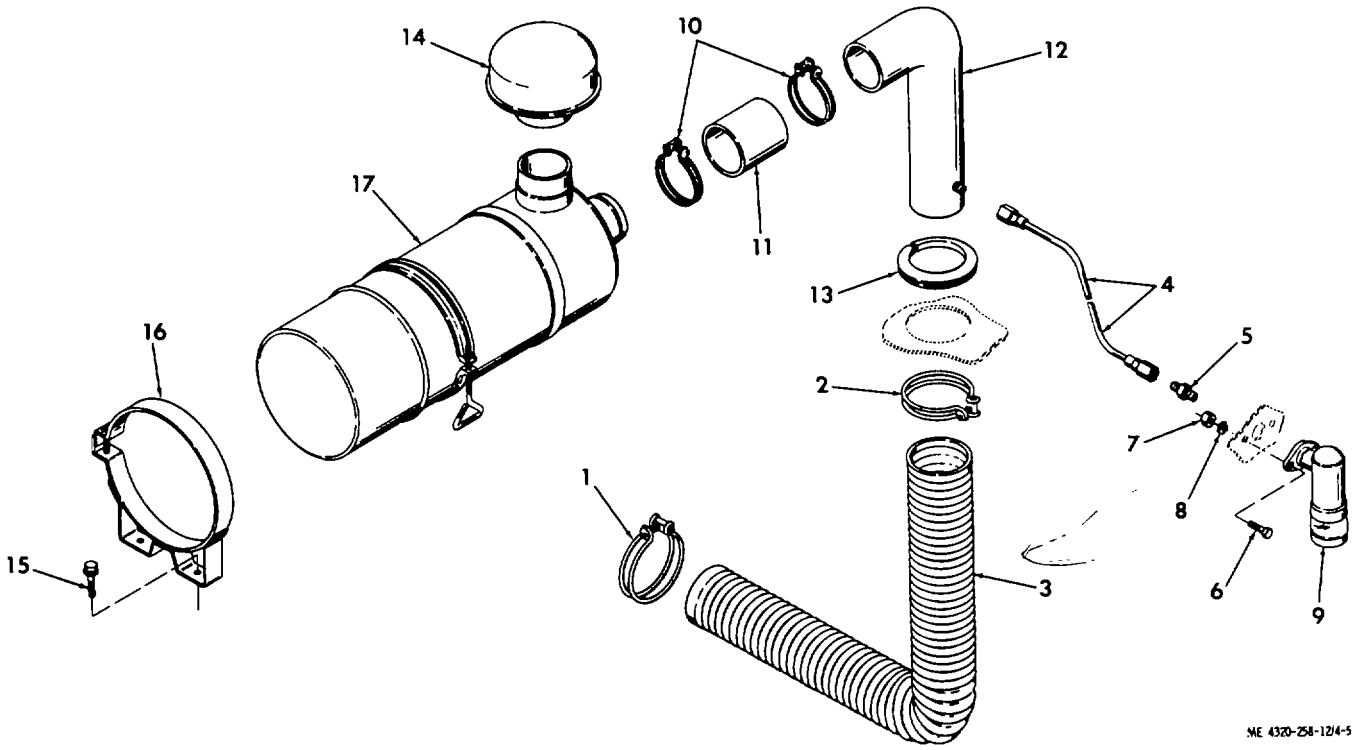
4-19. Muffler and Piping

a. Disassembly. Disassembly the muffler and related parts from the engine by following the sequence indicated in figure 4-6.

b. Cleaning and Inspection.

(1) Clean the muffler and exhaust piping with a wire brush. Wipe with a cloth dampened with cleaning solvent (fed. spec. P-D-680).

(2) Clean all remaining parts with cleaning solvent (fed. spec. P-D-680).



1. Hose clamp
2. Hose clamp
3. Hose
4. Tube assembly
5. Adapter
6. Cap screw
7. Nut
8. Lock washer
9. Restriction in
10. Hose- clamp
11. Hose
12. Elbow
12. Grommet
14. Precleaner
15. Assembled washer screw
16. Air cleaner clamp
17. Air cleaner assembly

Figure 4-5. Air cleaner and piping, exploded view.

(3) Inspect the muffler for cracks, holes, severe rust, and other damage; replace a damaged muffler.

(4) Inspect the remaining parts for cracks, distortion, and other damage; replace damaged parts.

c. Reassembly. Reassembly of the muffler and piping is the reverse of disassembly. Refer to figure 46.

4-20. Engine Housing

a. Removal.

(1) Remove the air cleaner (para 4-18).

(2) Remove the muffler and exhaust system (para 4-19).

(3) To remove the lower left and lower right side panels (15 and 24, fig. 4-7), disconnect the drain lines from the connections on the panels.

(4) Before the dash panel (27) can be removed, it will be necessary to remove the pump from the engine (para 4 47).

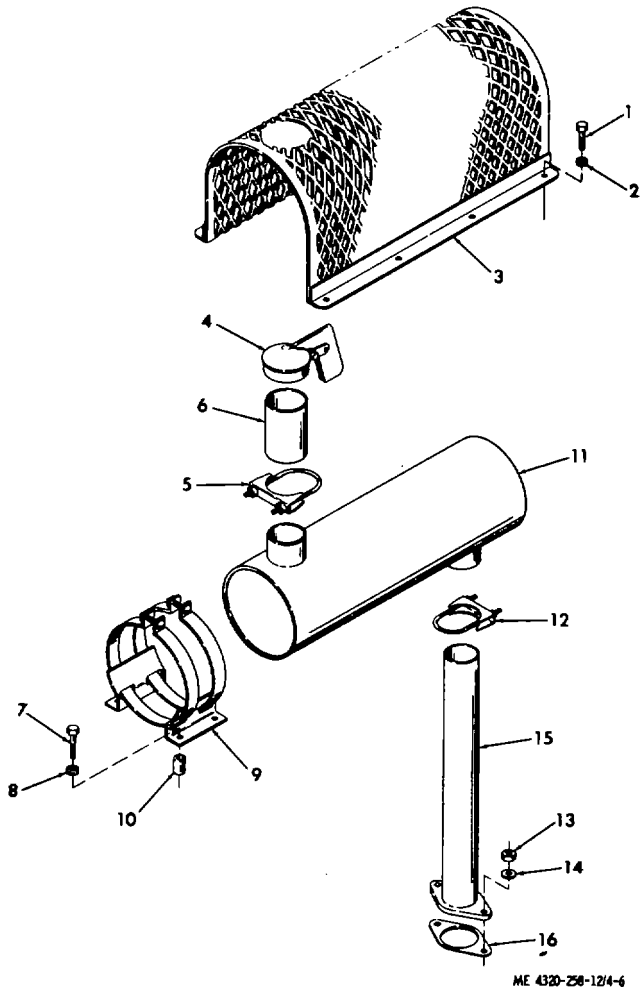
(5) Disassemble the engine housing following sequence of index numbers in figure 4-7.

b. Cleaning and Inspection.

(1) Clean the parts of the engine housing with a cloth dampened with cleaning solvent (fed. spec. P-D-680); dry thoroughly.

(2) Inspect all parts for rust, corrosion, cracks, chipped paint, dents, and distortion. Straighten dented and distorted panels. Remove rust and corrosion with sandpaper, rubbing until the surface is clean and bright. Prime and paint the bare surfaces.

c. Installation. Installation is the reverse of removal. Refer to figure 4-7.



1. Cap screw
2. Lock washer
3. Muffler guard
4. Weather cap
5. Clamp
6. Pipe
7. Cap screw
8. Lock washer
9. Muffler
10. Spacer
11. Muffler
12. Clamp
13. Nut
14. Flat washer
15. Exhaust pipe
16. Gasket

Figure 4-6. Muffler and piping, exploded view.

1. Engine side panel
2. Screw
3. Nut
4. Lock washer
5. Crank clip
6. Screw
7. Lock washer
8. Screw
9. Flat washer
10. Top hood
11. Screw
12. Flat washer
13. Screw
14. Flat washer
15. Lower left panel
16. Cap screw
17. Nut
18. Lock washer
19. Battery charging receptacle
20. Screw
21. Flat washer
22. Screw
23. Flat washer
24. Lower right panel
25. Cap screw
26. Lock washer
27. Dash panel
28. Engine crank
29. Screw
30. Lock washer
31. Radiator grille
32. Baffle
33. Baffle
84. Baffle
35. Baffle
36. Radiator shell

Figure 4-7-Continued

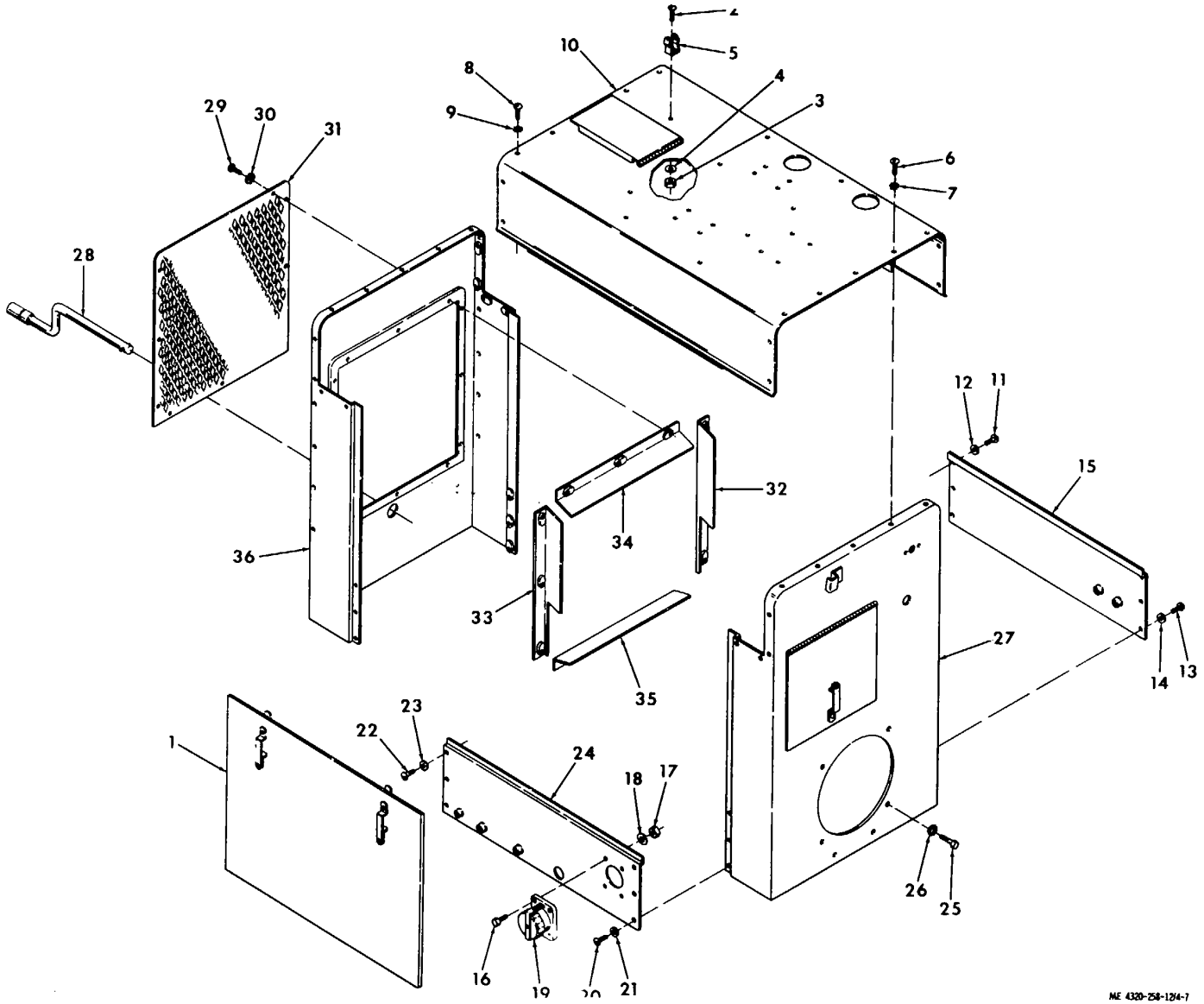


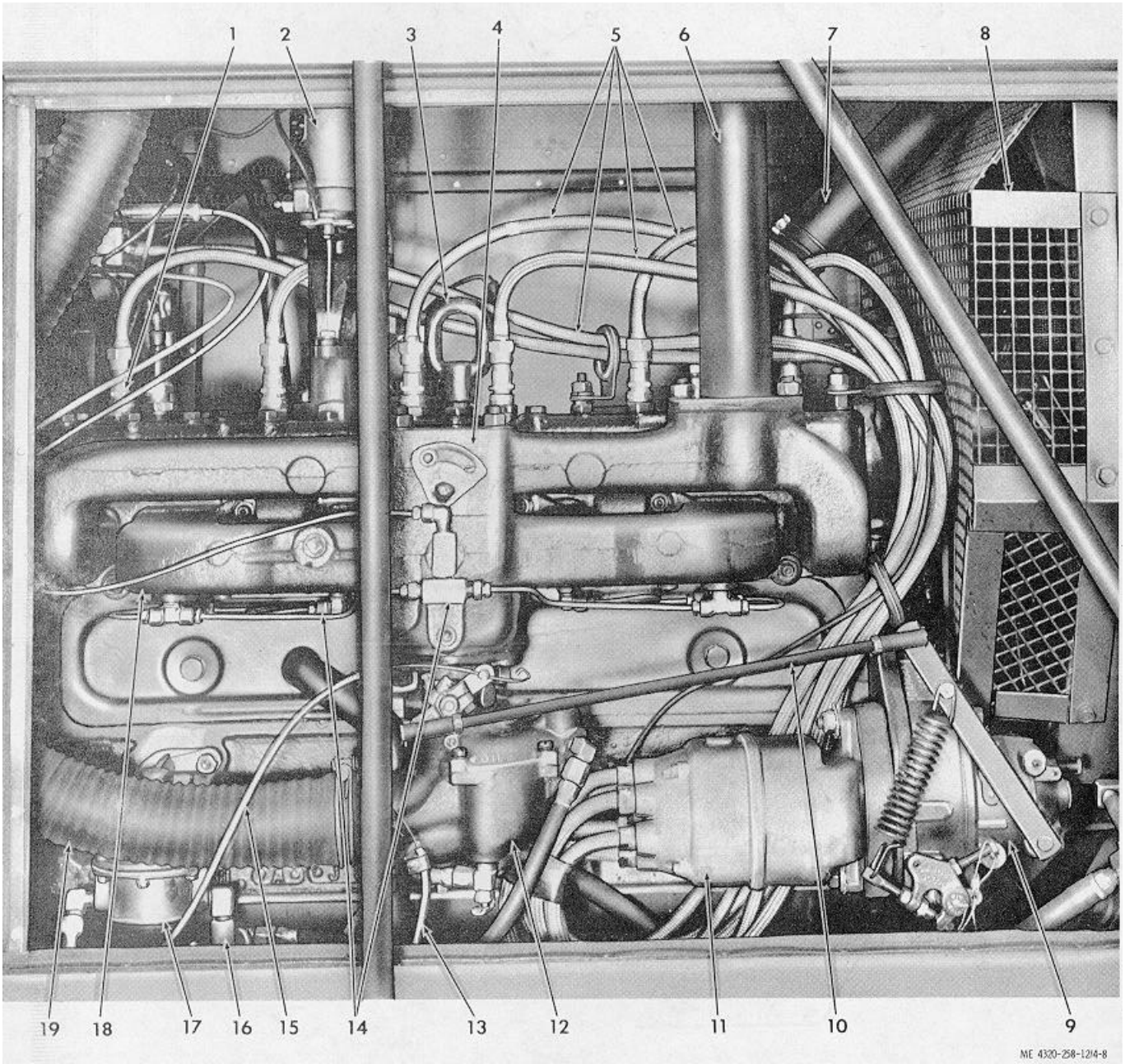
Figure 4-7. Engine housing, exploded view

Section IX. MAINTENANCE OF FUEL SYSTEM

4-21. Description

a. The fuel tank (fig. 1-2) is mounted between the longitudinal members of the skid base at the fan end of the engine. It incorporates a 3-way fuel source selector valve (1, fig. 2-4) to permit the engine to use the fuel from the fuel tank or from an auxiliary source, whichever way the valve is operated. A fuel line connects the 3-way valve with the fuel pump.

b. The diaphragm-type, engine-driven fuel pump (17, fig. 4-8) is operated by a lobe on the camshaft.. It is mounted on the side of the



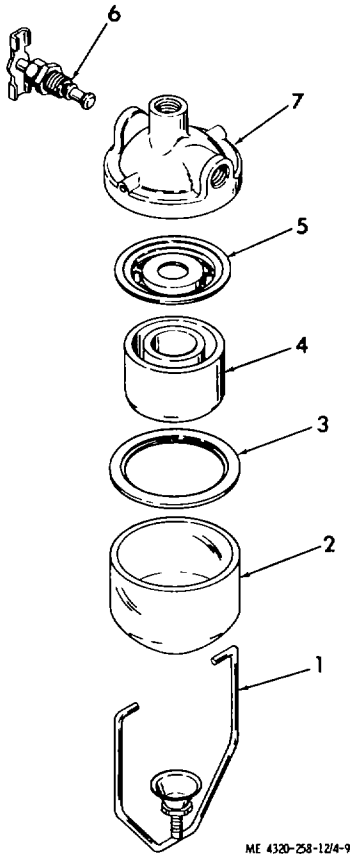
1. Spark plug
2. Overspeed governor
3. Engine lifting eye
4. Exhaust manifold
5. Shielded spark plug cables
6. Exhaust pipe
7. Radiator hose
8. Fan guard
9. Engine speed governor
10. Governor-to-throttle rod
11. Magneto
12. Carburetor
13. Choke control cable
14. Primer lines
15. Throttle control cable
16. Fuel strainer
17. Fuel pump
18. Intake manifold
19. Air intake hose

Figure 4-8. Left side of engine, identifying components.

engine. Fuel is pumped through a strainer (16) to the carburetor (12), which is mounted on the intake manifold. The carburetor provides a fuel-air mixture to the engine, and has several adjustments for smooth engine operation.

c. The governor (9, fig. 4-8) controls the throttle control of the carburetor (12) to provide the required engine speed, depending upon the setting of the manual throttle. The engine will maintain the set speed regardless of load, provided the load applied does not exceed the horsepower rating of the engine. Several adjustment points are provided to assure proper engine governor control.

d. The fuel system uses a primer pump and lines which aid starting in cold weather or after the engine has been idle for a considerable length of time. The primer pump pumps raw fuel into the intake manifold to provide fast starting.



1. Bail
2. Fuel bowl
3. Bowl gasket
4. Filter element
5. Filter gasket
6. Fuel shutoff valve
7. Fuel strainer housing

Figure 4-9. Fuel strainer, exploded view.

4-22. Fuel Strainer, Fuel Lines, and Fittings

a. Fuel Strainer Service. If moisture or other contaminants are visible through the glass bowl of the fuel strainer, service the fuel strainer as follows:

(1) Close the shutoff valve (6, fig. 4-9) on the fuel strainer.

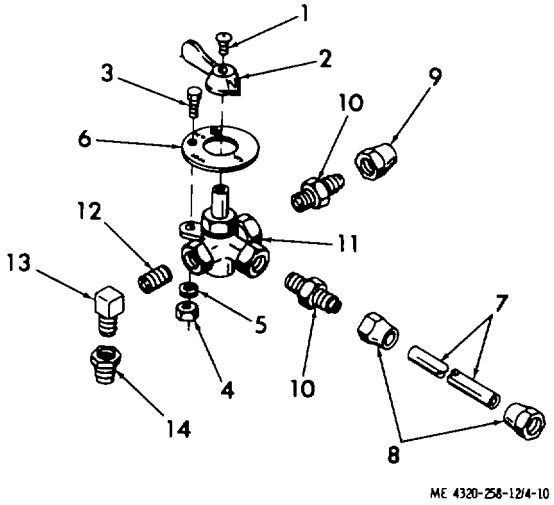
(2) Loosen the nut on the bail (1) and swing the bail aside to release the glass fuel bowl (2). Remove the bowl and gasket (3). Empty the contents of the bowl and wipe it dry with a clean cloth.

(3) If engine operation indicates that the filter element (4) is contaminated, replace it with a new one.

(4) Position the gasket (3) and fuel bowl (2) on the fuel strainer housing (7). Swing the bail (1) into position and tighten the bail nut to hold the bowl in place.

(5) Open the fuel shutoff valve (6) and check for leaks. Correct any leaks.

b. Removal. Remove the fuel strainer and the fuel lines and fittings as shown in figure 4-10 and items 1 through 7 of figure 4-11.



1. Screw
2. Pointer
3 Screw
4. Nut
5. Lockwasher
6. Position plate
7. Tube
8. Tube nut
9. Tube nut
10. Adapter
11. Fuel source selector 3-way valve
12. Nipple
13. Elbow
14. Bushing

Figure 4-10. Fuel lines and fittings, exploded view.

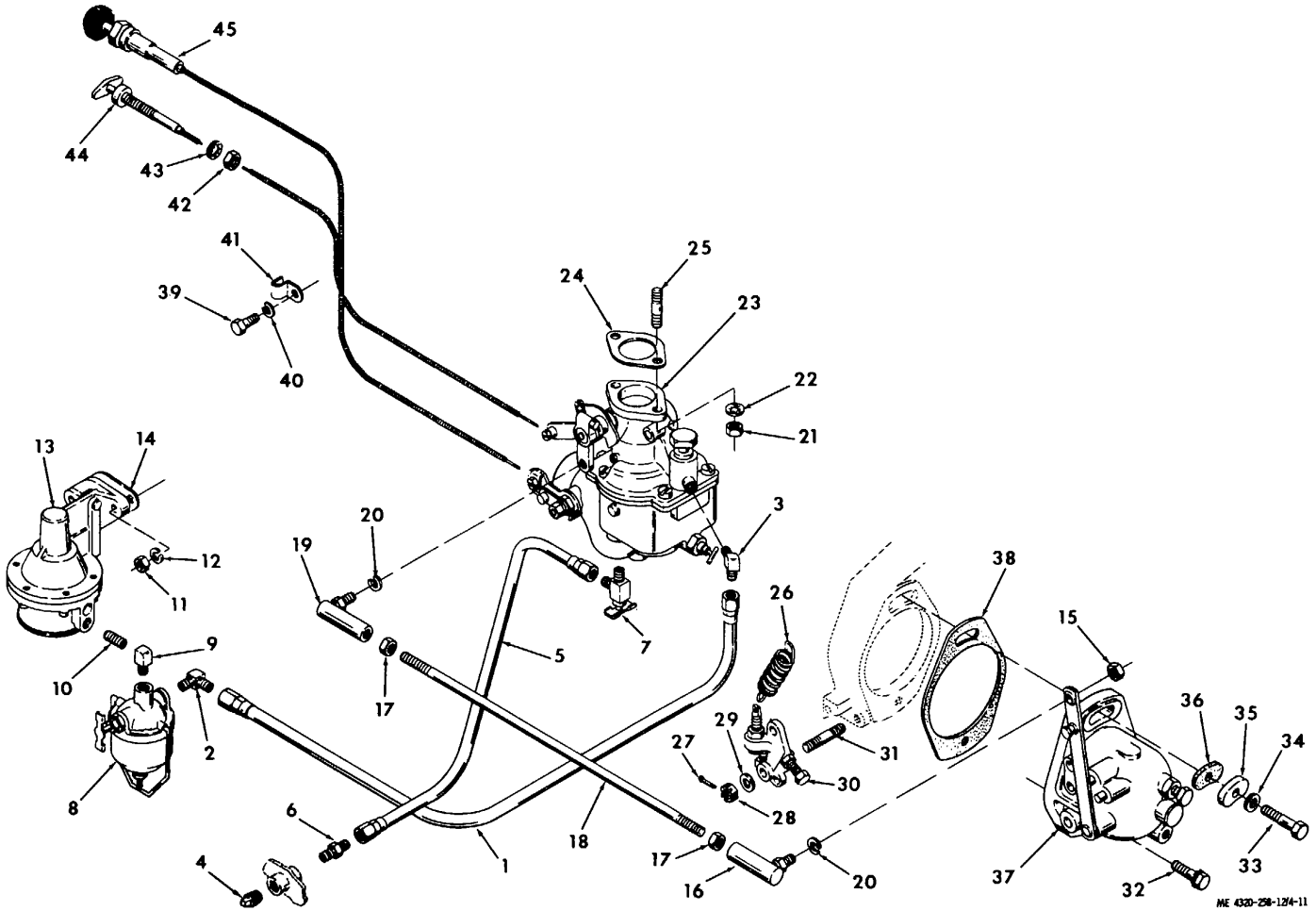


Figure 4-11. Fuel system components, exploded view.

1. Fuel supply hose
2. Elbow
3. Elbow
4. Pipe plug
5. Carburetor bowl drain hose
6. Adapter
7. Carburetor drain cock
8. Fuel strainer
9. Elbow
10. Nipple
11. Nut
12. Lock washer
13. Fuel pump
14. Gasket
15. Nut
16. Ball joint
17. Lock nut
18. Governor-to-carburetor control rod
19. Ball joint
20. Lock washer
21. Nut
22. Lock washer
23. Carburetor
24. Gasket
25. Stud
26. Governor spring
27. Cotter pin
28. Nut
29. Flat washer
30. Governor adjusting assembly
31. Stud
32. Assembled washer screw
33. Bolt
34. Flat washer
35. Gasket plate
36. Gasket
37. Governor
38. Gasket
39. Cap screw
40. Lock washer
41. Clamp
42. Nut
43. Lock washer
44. Choke control wire
45. Throttle control wire

Figure 4-11-Continued

c. Cleaning and Inspection.

(1) Service the fuel strainer as directed in subparagraph *a* above.

(2) Clean all fuel lines and fittings with cleaning solvent (fed. spec. P-D-680). Blow through them with compressed air to assure all are clear.

(3) Inspect the hoses for cracks, fraying, and damaged threads; replace damaged hoses.

(4) Inspect the 3-way valve for difficult operation and for cracked or damaged threads; replace a damaged valve.

(5) Inspect all other parts for cracks, distortion, and damaged threads; replace damaged parts.

d. Reassembly. Reassemble the fuel lines and fittings as shown in figure 4-10 and items 1 through 7 of figure 4-11. After assembly, check for leaks. Correct any leaks noted.

4-23. Fuel Pump

a. Removal. Remove the fuel lines to the fuel pump (para 4-22). Remove the two nuts (11, fig. 4-11) and lock washers (12) that secure the fuel pump (13) to the cylinder block; remove the fuel pump.

b. Cleaning and Inspection.

(1) Clean the fuel pump with a cloth dampened with cleaning solvent (fed. spec. P-D-680); wipe dry.

(2) Inspect the fuel pump for cracks, damaged threads, and other obvious damage. Operate the cam follower lever of the fuel pump to check for faulty movement. Replace the fuel pump if defective.

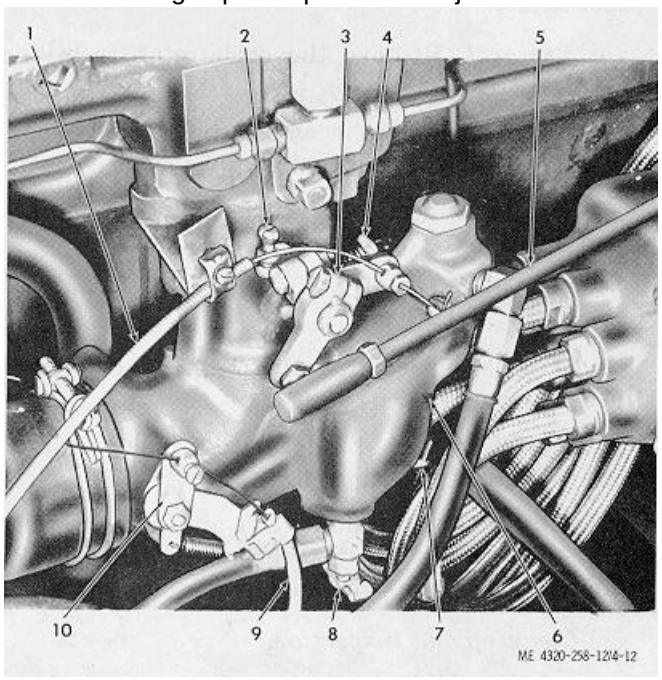
c. Installation. Position the fuel pump (13, fig. 4-11) on the engine and secure with two nuts (11) and lock washers (12). Connect the fuel lines to the fuel pump (para 4-22).

4-24. Carburetor

a. Adjustment. If troubleshooting indicates that the carburetor is responsible for faulty engine operation, adjust the carburetor as follows:

(1) Start the engine and allow it to warm up to operating temperature.

(2) Adjust the main adjusting screw (7, fig. 4-12). This adjustment determines the amount of fuel available for high-speed operation. Adjust as follows:



1. Throttle wire
2. Idle speed adjustment screw
3. Throttle lever
4. Idle mixture adjustment needle
5. Throttle rod
6. Carburetor
7. Main adjusting screw
8. Carburetor bowl drain cock
9. Choke wire
10. Choke lever

Figure 4-12. Carburetor and related parts.

(a) Adjust the throttle control of the pump to open the carburetor throttle to about one-fourth open.

(b) Turn the main adjusting screw clockwise to reduce the fuel to the engine until the engine begins to miss due to a lean fuel mixture.

(c) Turn the adjusting screw counterclockwise until the engine runs smoothly without missing.

(3) Adjust the idle mixture adjustment needle (4, fig. 4-12). This adjustment controls the amount of air admitted to the idling system which functions only at low speeds. Adjust as follows:

(a) With the engine at idle, turn the idle mixture adjustment screw clockwise to cut off air, making the fuel mixture richer until the engine starts to run roughly due to excessively rich mixture.

(b) Turn the adjustment needle counterclockwise to obtain the smoothest idle operation possible.

(c) If a vacuum gage is available, use a vacuum gage attached to the intake manifold and adjust the needle for highest engine vacuum.

(4) Adjust the idle speed adjustment screw (2, fig. 4-12). Turn the screw clockwise or counterclockwise as necessary to provide 400 to 600 rpm idle speed when the pump throttle control is set to idle.

b. Removal. Remove the carburetor from the engine as follows:

(1) Disconnect the choke control wire (44, fig. 4-11) from the carburetor choke lever.

(2) Disconnect the throttle control wire (45) from the carburetor throttle lever.

(3) Disconnect the fuel lines from the carburetor (para 4-22b).

(4) Disconnect the air cleaner hose from the carburetor (para 4-18b).

(5) Disconnect the carburetor bowl drain hose (5) from the carburetor.

(6) Remove the nuts (21) and lock washers (22) that secure the carburetor to the intake manifold; remove the carburetor and gasket.

c. Cleaning and Inspection.

(1) Clean the exterior of the carburetor with a cloth dampened with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(2) Inspect the carburetor for cracks and other obvious damage. Check the operation of the throttle lever and choke lever. They must operate freely, without binding. Refer a damaged carburetor to direct support maintenance.

d. Installation. Install the carburetor by reversing the removal procedure. Note the following:

(1) Make sure there are no air leaks between the carburetor and air cleaner. Air leaks will allow dust and dirt to enter the engine, causing rapid engine wear.

(2) Adjust the choke wire connection to the carburetor so that the choke lever can move through its full operating range as the choke control on the instrument panel is operated.

(3) Adjust the throttle linkage from the governor as directed in paragraph 4-25.

4-25. Engine Speed Governor

a. Adjustment. Adjust the engine speed governor as follows:

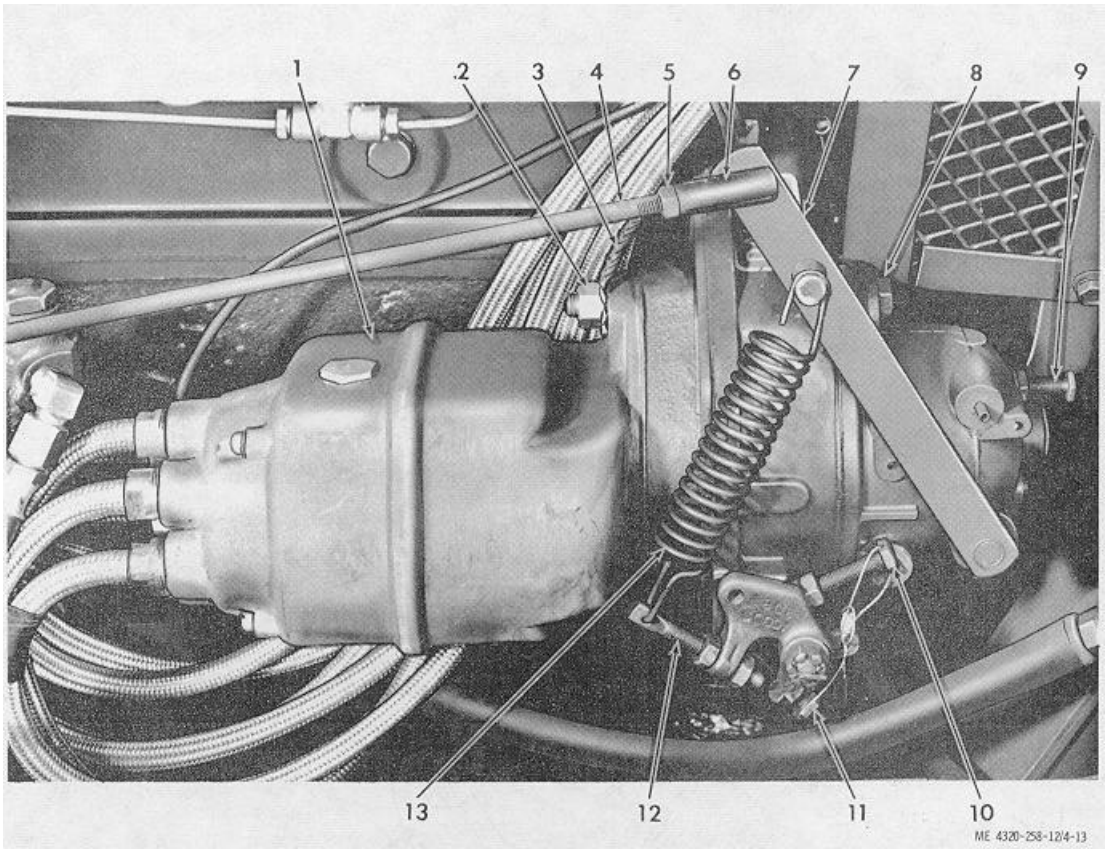
(1) Start the engine and allow it to warm up to operating temperature. While it is warming up, back out the surge adjusting screw (9, fig. 4-13) so that it will not influence the governor setting.

(2) With the engine warmed up and with the pump not under load, adjust the engine idle speed to approximately 150 rpm higher than the required idle speed under load. Make this adjustment by turning the speed adjusting screw (11). Back out speed adjusting lock screw (10) so that it will not influence the adjustment.

(3) The governor's range of action is the differential between the engine speed under load and the engine speed without load. To broaden the range of action, use the sensitivity adjusting screw (12). Lengthen the sensitivity adjusting screw to broaden the range of action of the engine. Compensate for speed changes by readjusting the speed adjusting screw (11). To narrow the range of action, shorten the sensitivity adjusting screw (12) and compensate for speed change with the speed adjusting screw (11).

(4) When the governor range of action is properly adjusted, allow the engine to run at governed speed, no load, and check for surging. If surging is noted, turn in the surge adjusting screw (9) just far enough to eliminate the surging.

(5) The surge adjustment can also be adjusted by using the tachometer. With the engine running at governed speed, no load, turn the surge adjusting screw (9) in until the engine speed increases 10 to 20 rpm and tighten the



1. Magneto
2. Nut
3. Magneto ground strap
4. Governor-to-carburetor control rod
5. Nut
6. Throttle rod ball joint
7. Throttle operating lever
8. Mounting screw
9. Surge adjusting screw
10. Speed adjusting lock screw
11. Speed adjusting screw
12. Sensitivity adjusting screw
13. Governor spring

Figure 4-13. Magneto and governor installation.

locking nut. If the carburetor and linkage are properly adjusted, surge will disappear.

(6) When the governor adjustment is completed, tighten the speed adjusting lock screw (10) to lock the cam in position. Make sure all locking nuts are tightened.

b. Removal.

(1) Disconnect the ball joint (16, fig. 4-11) on governor-to-carburetor control rod (18) from the lever on the governor.

(2) Remove the governor and related parts as shown in items 27 through 37, figure 4-11.

c. Cleaning and Inspection.

(1) Clean the exterior of the governor with a cloth dampened with cleaning solvent (fed. spec. P-D-680). Wipe dry.

(2) Clean all remaining parts with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(3) Inspect the governor for cracks, and missing parts, wear, and other obvious damage. Check the rotation of the governor drive shaft. It must turn freely without catching or binding. Check the movement of the governing shaft in its needle bearings. It must pivot freely without catching or binding and without excessive play. Refer a damaged governor to direct support maintenance.

d. Installation.

(1) Install the governor by reversing the removal procedure. Refer to items 27 through 37 in figure 4-11.

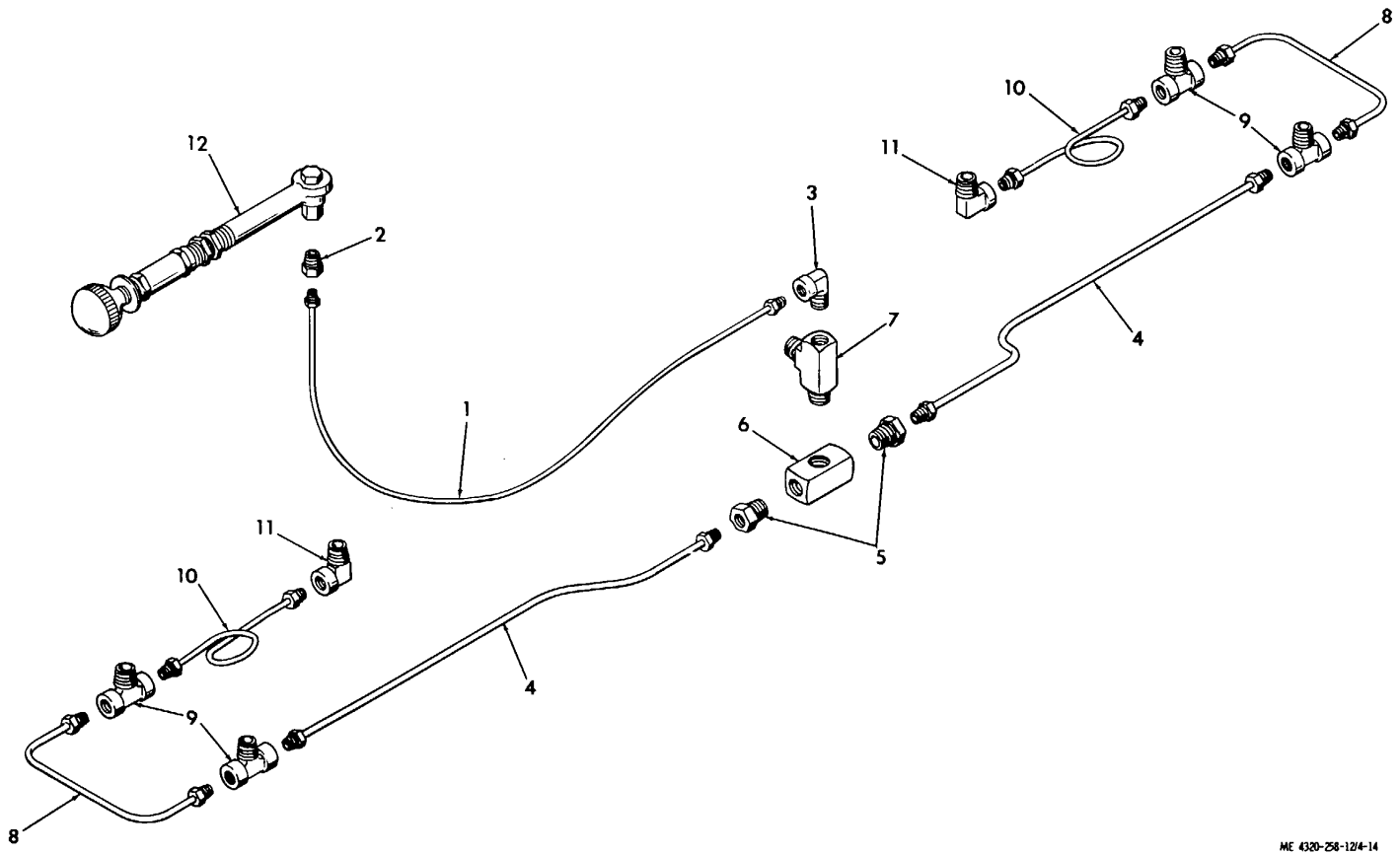
(2) Adjust the governor as directed in sub-paragraph *a* above.

4-26. Primer Pump, Lines, and Fittings

a. Removal. Remove the primer pump, lines, and fittings as shown in figure 4-14.

b. Cleaning and Inspection.

(1) Clean the exterior of the primer pump with a cloth dampened with cleaning solvent



1. Tube
2. Bushing
3. Elbow
4. Tube
5. Bushing
6. Tee
7. Tee
8. Tube
9. Tee
10. Tube
11. Elbow
12. Primer pump

Figure 4-14. Primer pump, lines, and fittings, exploded view.

(fed. spec. P-D-680). Pump clean solvent through the pump to thoroughly flush the interior.

(2) Clean all lines and fittings with cleaning solvent (fed. spec. P-D-680). Blow out all lines with compressed air to make sure they are not clogged.

(3) Check the exterior of the primer pump for cracks or obvious damage. Operate the pump handle. Make sure it operates freely without binding. Replace a damaged priming pump.

(4) Inspect the primer tubes for damaged threads on tube nuts, kinked tubing, cracked tubing ends, or other damage. Replace damaged tubes.

(5) Inspect all fittings for cracks, damaged threads, and other damage; replace damaged parts.

c. Installation. Install the primer pump, lines, and fittings as shown in figure 4-14. After installation, operate the primer pump and check all connections for leaks. Correct any leaks.

Section X. MAINTENANCE OF COOLING SYSTEM

4-27. Description

a. The engine cooling system is a conventional automotive type in which coolant is circulated through the cylinder block to remove the heat of combustion from the operating parts of the engine. The coolant is then passed through the radiator, which acts as a large heat exchanger to dissipate the heat to the atmosphere. The water pump maintains the flow of coolant through the engine.

b. A thermostat is installed in the engine to prevent the flow of coolant into the radiator when the engine is cold. Instead, the coolant is bypassed directly to the water pump and recirculated into the block without being cooled in the radiator. In this way, the engine heats more rapidly, providing efficient operation more quickly. When the coolant in the cylinder block reaches operating temperature, the thermostat opens and the coolant is forced to flow through the radiator.

c. To assure efficient operation of the cooling system, it is important to keep the exterior of the radiator clean and free from bugs, dirt, and debris. It is also necessary to keep the interior of the radiator and the engine block flushed out to prevent accumulations of rust and scale which can prevent proper heat transfer.

4-28. Cleaning and Flushing the Cooling System

a. Clean the exterior of the radiator by flushing a stream of water through it in a direction opposite that of the cooling fan flow. Since this engine uses a pusher type fan, it is necessary to squirt the water from the outside of the radiator inward toward the engine. Cover the engine with a piece of plastic film to prevent saturating the components before attempting to flush out the exterior of the radiator.

b. Disconnect the hoses connecting the engine and radiator. With the radiator cap closed tightly, use a flushing gun as shown in figure 4-15 to reverse-flush the radiator. Fill the radiator with water, then blow it out with compressed air, applying pressure slowly to prevent radiator damage. Repeat several times until the expelled flushing stream is clear.

c. Remove the thermostat (para 4-29) from the engine and use a flushing gun as shown in figure 4-16. Fill the cylinder block with water before applying air pressure. When the block is filled, expel the water with an 80 psi air stream. Repeat until the expelled flushing stream is clear.

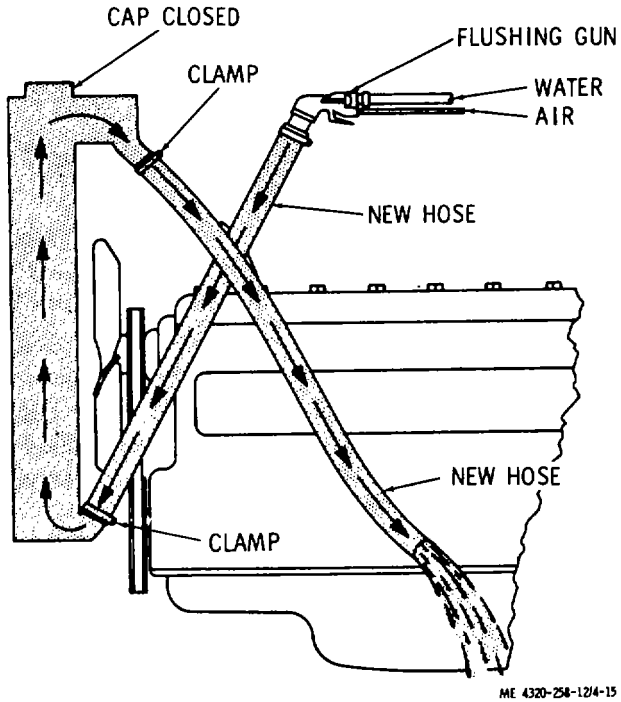


Figure 4-15. Reverse-flushing the radiator.

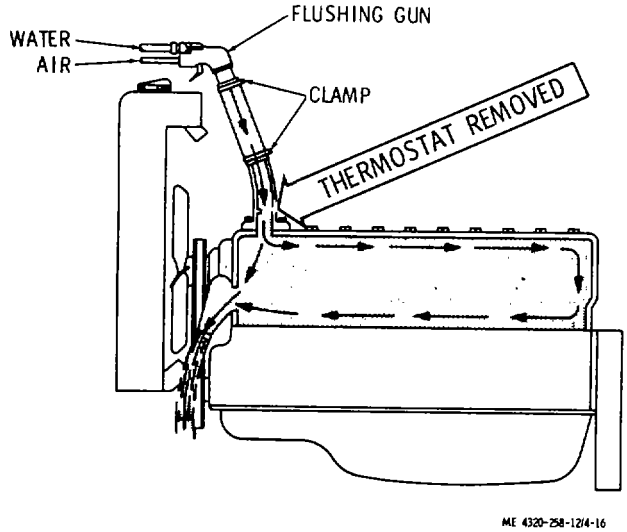


Figure 4-16. Reverse-flushing tee engine block.

d. Install the thermostat and connect the hoses between the engine and radiator (para 4-29). Start the engine and allow to run until the coolant reaches operating temperature. Check for coolant leaks and correct if any are noted.

4-29. Thermostat, Outlet Elbow, Lines, and Fittings

a. Removal.

(1) Drain the radiator and block (para 2-3f).

(2) Remove and disassemble the thermostat, outlet elbow, lines, and fittings as shown in figure 4-17.

b. Cleaning, Inspection, and Thermostat Testing.

(1) Clean all parts by washing in warm, soapy water. Remove any greasy or gummy deposits with a cloth dampened with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(2) Inspect the thermostat for obvious defects, including ruptured bellows and distortion. If the valve, when cold, can be pushed off its seat with only slight effort, the thermostat is defective and must be replaced.

(3) Check the thermostat operation as follows:

(a) Hang the thermostat by its frame in a container of water so that it does not touch the container. Hang a thermometer in the container to maintain a check of water temperature.

(b) Heat the water slowly while watching the thermometer and thermostat. The thermostat must start to open before the thermometer indicates 180° F. Replace the thermostat if it fails to open at 180° F or if it opens at too low a temperature.

(4) Inspect the water outlet elbow for cracks, damaged threads, and distortion; replace a damaged elbow.

(5) Inspect the hoses for cracks, cuts, deterioration, brittleness, and other damage; replace damaged hoses.

(6) Inspect all other parts for cracks, distortion, and other damage; replace damaged parts.

c. Installation. Installation of the thermostat, outlet elbow, hoses, and fittings is the reverse of removal. Refer to figure 4-14. Service the coolant and engine lubrication systems. After installation, run the engine until it reaches operating temperature, and check for leaks. Correct any leaks noted.

4-30. Water Pump, Cooling Fan and Fan Belt

a. Fan Belt Adjustment. The fan belt should be tensioned so that it can be deflected approximately 3/4 inch with thumb pressure at a point midway between pulleys at the longest belt span. Adjust belt tension as follows:

(1) Loosen the alternator strap mounting screw (5, fig. 4-18).

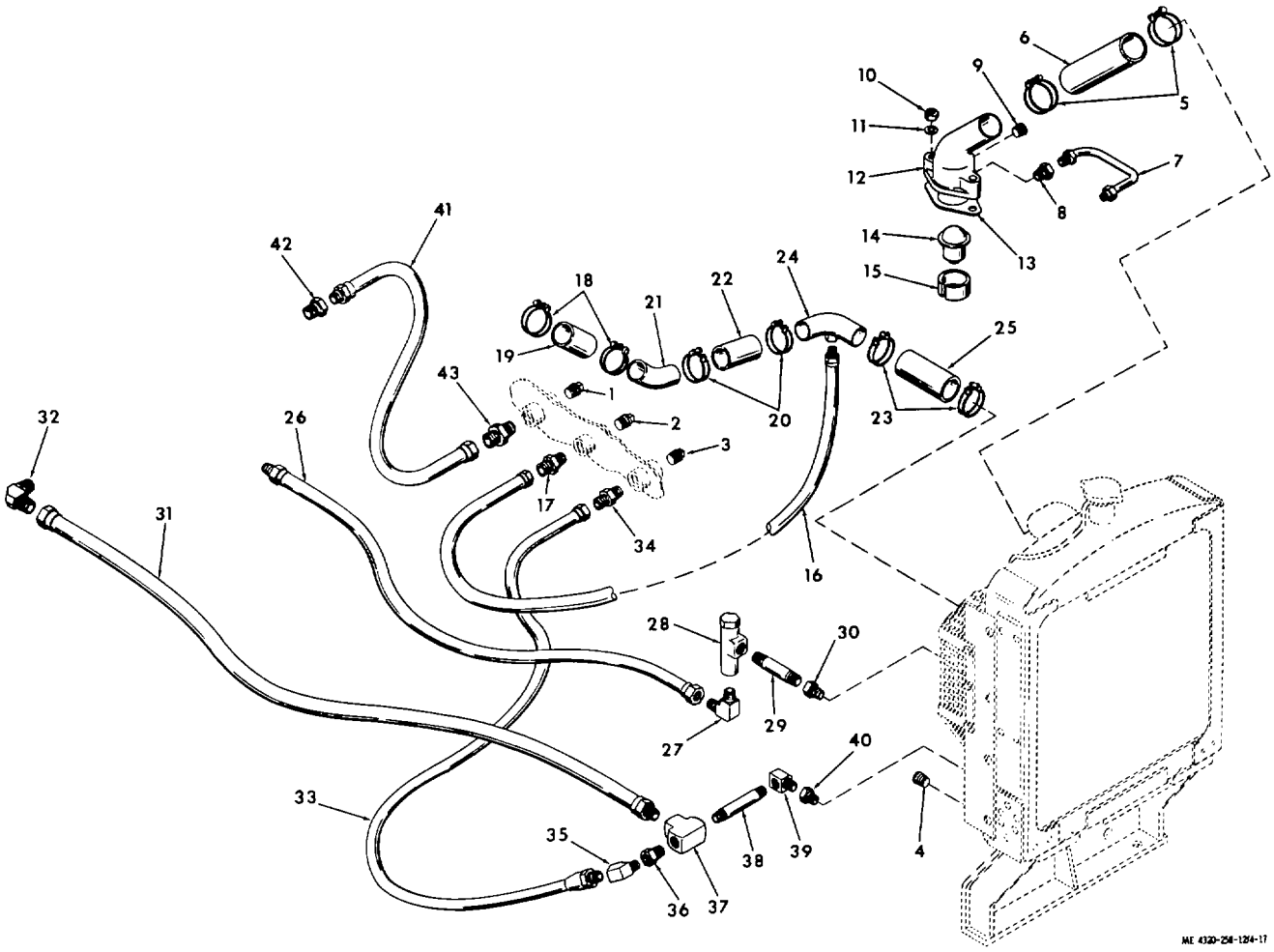
(2) Loosen the adjusting screw (3) on the adjusting strap (2) and pull the alternator (1) away from the engine with hand pressure to tighten the fan belt (4).

(3) Hold the alternator away from the engine and tighten the adjusting screw (3). Recheck fan belt tension and readjust if necessary. Tighten the strap mounting screw (5) after proper adjustment is made.

b. Removal.

(1) Loosen the adjusting screw (3, fig. 4-18) on the alternator adjusting strap and push the alternator toward the engine to loosen fan belt tension. Slip the fan belt (4) off the alternator drive pulley and disengage it from the fan and pulley.

(2) Remove the four cap screws (1, fig. 4-19) and lock washers (2) that secure the cooling fan (3) to the pulley on the water pump; remove the cooling fan.



1. Drain plug
2. Drain plug
3. Drain plug
4. Drain plug
5. Hose clamp
6. Hose
7. Bypass tube
8. Connector
9. Plug
10. Nut
11. Lock washer
12. Water outlet elbow
13. Gasket
14. Thermostat
15. Thermostat ring
16. Radiator drain tube
17. Connector
18. Hose clamp
19. Hose
20. Hose clamp
21. Elbow
22. Hose
23. Hose clamp
24. Drain elbow
25. Hose
26. Crankcase-to-cooler hose
27. Elbow
28. Bypass valve
29. Nipple
30. Bushing
31. Cooler-to-crankcase hose
32. Elbow
33. Oil cooler drain hose
34. Bushing
35. Elbow
36. Bushing
37. Tee
38. Nipple
39. Elbow
40. Bushing
41. Crankcase coolant drain hose
42. Bushing
43. Bushing

Figure 4-17. Thermostat, outlet elbow, coolant and oil cooler lines and fittings, exploded view.

(3) Drain the coolant from the radiator and cylinder block. Disconnect coolant hoses and by-pass tube from the water pump (para 4-29). Remove the three cap screws (4, 6, and 8) and lock washers (5, 7, and 9) that secure the water pump (10) to the cylinder block; remove the water pump and gasket (11).

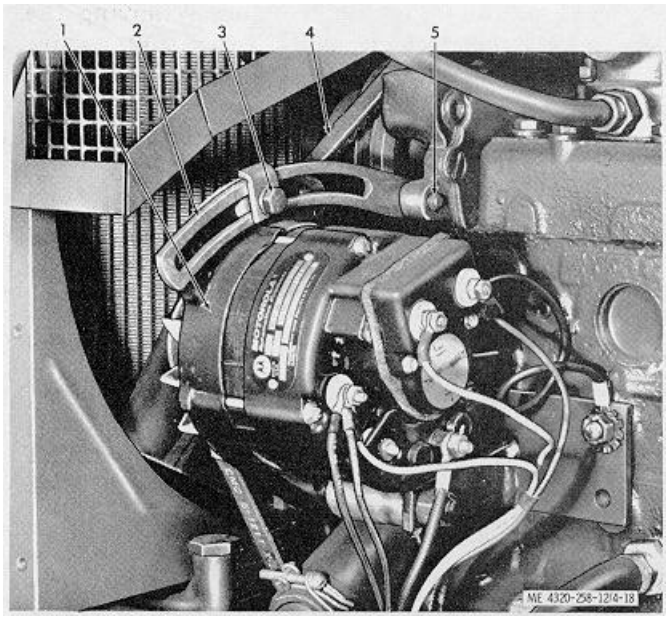
c. Cleaning and Inspection.

(1) Clean the fan belt with a clean, dry cloth.

(2) Clean the cooling fan and water pump with a cloth dampened with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(3) Inspect the fan belt for cracks, brittleness, severe glazing, and other damage; replace a damaged fan belt.

(4) Inspect the cooling fan for cracked, bent, loose, or severely nicked fan blades, damaged or elongated mounting holes, or other damage; replace a damaged cooling fan.



1. Alternator
2. Adjusting strap
3. Adjusting screw
4. Fan belt
5. Strap mounting screw

Figure 4-18. Alternator mounting.

(5) Inspect the water pump for a cracked or distorted housing, damaged mounting flanges, and other damage. Check the rotation of the water pump shaft. It must rotate easily without catching or binding. Refer a damaged water pump to direct support maintenance.

d. Installation.

(1) Installation of the water pump and cooling fan is the reverse of removal. Refer to figure 4-19.

(2) Install the fan belt on the pulleys and tighten to the required tension (subparagraph a above).

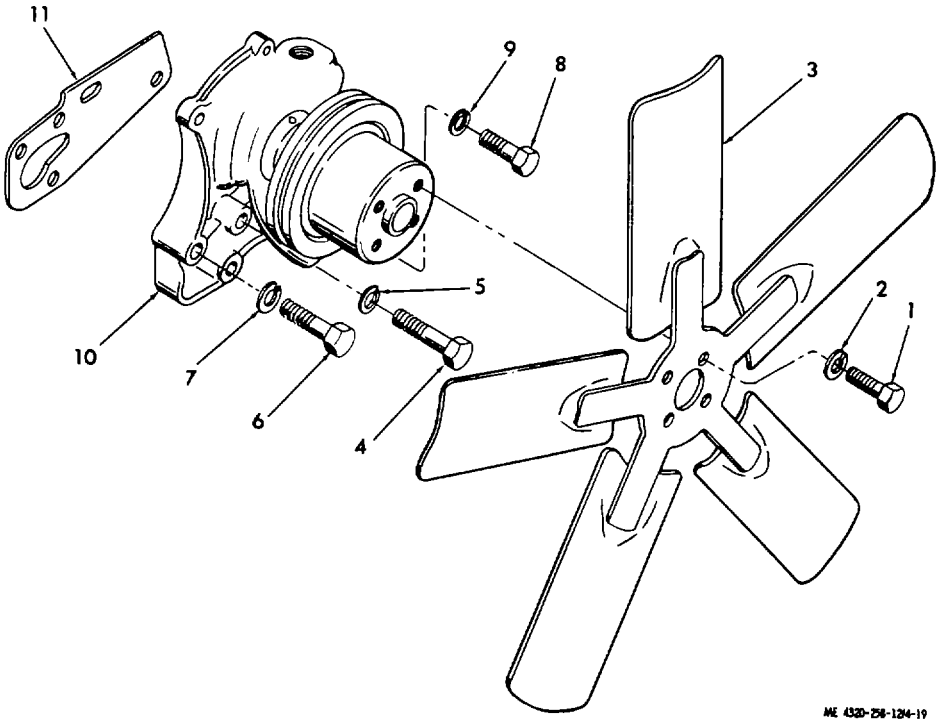
4-31. Radiator

a. Removal.

(1) Drain the radiator and oil cooler, and remove the coolant and oil cooler lines from the radiator (para 4-29).

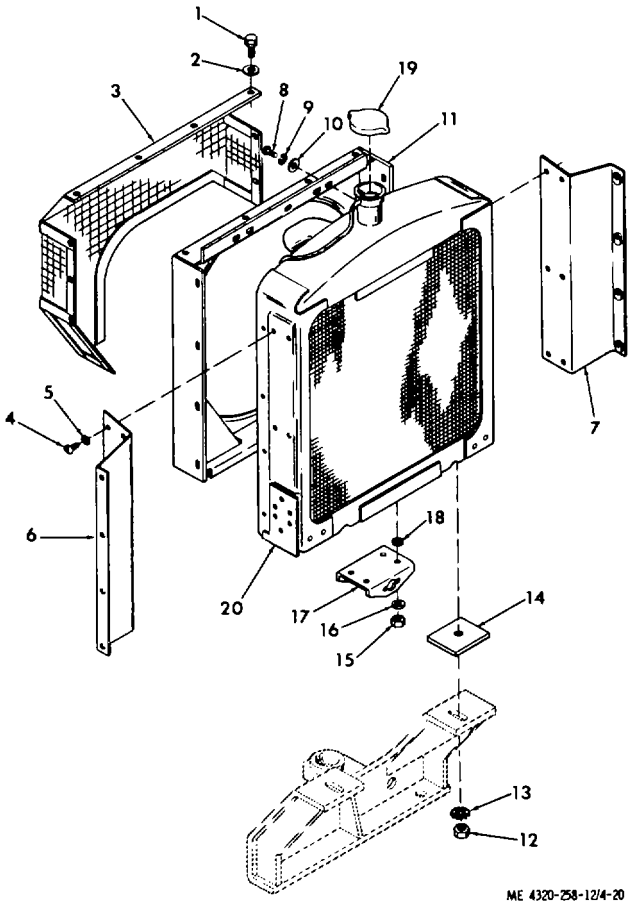
(2) Remove the engine housing as necessary to provide access to the radiator for removal. Refer to paragraph 4-20*a*.

(3) Remove the fan guard (3, fig. 220), supports (6 and 7), and fan shroud (11).



1. Cap screw
2. Lock washer
3. Cooling fan
4. Cap screw
5. Lock washer
6. Cap screw
7. Lock washer
8. Cap screw
9. Lock washer
10. Water pump
11. Gasket

Figure 4-19. Water pump and cooling fan, exploded view.



1. Cap screw
2. Flat washer
3. Fan guard
4. Machine screw
5. Lock washer
6. Radiator support
7. Radiator support
8. Machine screw
9. Lock washer
10. Flat washer
11. Fan shroud
12. Nut
13. Lock washer
14. Liner
15. Nut
16. Lock washer
17. Crank support
18. Spacer
19. Radiator cap
20. Radiator

Figure 4-20. Radiator and related parts, exploded view.

(4) Use a rope sling and support the weight of the radiator with a hoist before removing the nuts (12) and lock washers (13) that secure the radiator (20) to the engine support; remove the radiator.

b. Cleaning and Inspection.

(1) Thoroughly flush the radiator with water, both inside and out. Make sure all bugs and debris are removed from the cooling fins.

(2) Inspect the radiator for cracks, damaged cooling fins, leaking tubes, leaks around the top bonnet, and other damage. Refer a damaged radiator to direct support maintenance for repair.

(3) Inspect the fan guard and fan shroud for cracks, broken weldments, distortion, and other damage. Replace damaged parts.

c. Installation.

(1) Installation is the reverse of the removal procedure. Refer to figure 4-20.

(2) Install the coolant and oil cooler lines and fittings (para 4-29).

(3) Install the engine housing panels that were removed to provide access to the radiator (para 4-20*c*).

(4) Service the engine coolant system end the engine oil system. Start the engine and check for leaks. Correct any deficiencies.

Section XI. MAINTENANCE OF IGNITION SYSTEM

4-32. Description

a. The ignition system includes the magneto (11, fig. 4-8) and radio-surpressed spark plugs (1) which have shielded cables (5). The system is completely independent of the battery- and alternator-powered electrical system.

b. The magneto is timed t) the engine and is driven by the camshaft gear through the governor drive gear which is engaged by the drive lugs on the magneto drive coupling. There is a critical timing relationship between these driving parts since it determines the instant at which the spark from the magneto will be delivered to each spark plug. An improperly timed magneto will make engine operation impossible.

c. The magneto consists of a magneto rotor which is rotated in a laminated frame to set up magnetic flux in the laminated frame. This induces a current in the primary winding each time the magnetic flux rises and falls. The primary winding acts as the primary winding of a step-up transformer, surrounded by the secondary coil. Breaker point opening occurs at the instant of maximum primary current, causing an immediate collapse of the magnetic field. This collapsing magnetic field induces an extremely high voltage surge through the secondary circuit. The capaci-

tor in the primary circuit speeds the collapse of the circuit, increasing the secondary voltage and also reducing contact point burning.

d. The voltage induced in the secondary coil is applied to the spark plug of the required cylinder at the exact correct instant by the distributor rotor in the magneto. The breaker points open at the required instant to assure a hot spark to the spark plug at this time. The spark at the spark plug causes the ignition of the fuel-air mixture in the cylinder.

e. At starting, an impulse coupling on the magneto causes a snapping action of the magneto rotor to produce the rapid rotation necessary to energize the electrical windings. This retards the rotation of the magneto rotor at slow speeds until top-dead-center is reached. Spring action then snaps the rotor forward to produce the required snap.

f. The magneto also contains automatic spark advance provisions so that the spark will occur sooner during high speed operation. This is necessary for smooth engine performance. The automatic spark advance rotor has pawls which are thrown outward as engine speed increases to change the relationship of the distributor rotor in the magneto.

4-33. Spark Plugs

a. Removal.

(1) Use compressed air to blow dirt away from the spark plugs before removing them. This will prevent the dirt from entering the cylinder as the spark plug is removed.

(2) Disconnect the shielded spark plug cables from the spark plugs (13, fig. 4-21) and remove the spark plugs, using a socket wrench.

b. Cleaning and Inspection.

Note

It is normally more economical to replace the spark plugs than to clean and regap them. It also provides greater assurance that there are no hidden cracks in the ceramic insulators which could cause engine misfiring at high engine speeds. Cleaning and inspection instructions are given here in case it is necessary to reuse the removed plugs.

(1) Wipe the exterior of the spark plugs with a cloth dampened with cleaning solvent (fed. spec. P-D-680); dry thoroughly.

(2) Check the ceramic insulator for cracks, porosity, and other damage.

(3) If the electrodes of the spark plugs are not too badly burned, remove the scale and other deposits from them. This can be done by a sandblast-type cleaner or with a contact file.

(4) Inspect the electrodes for severe burning, cracks, and other damage. If it is necessary to reuse the plugs, correct the contact gap to 0.025 inch.

(5) Replace any spark plugs whose condition is doubtful.

c. Installation.

(1) Make sure all spark plugs are gapped to 0.025 inch before installation.

(2) Install the spark plugs, using a socket and torque wrench. Tighten the spark plugs to 35 foot-pounds torque.

(3) Install the shielded spark plug cables on the spark plugs. Make sure the leads are not interchanged. Refer to figure 4-22 to assure proper magneto-to-spark plug wiring if spark plug connection is doubtful.

4-34. Magneto

a. Removal.

(1) Disconnect the shielded spark plug cables from the magneto. Disconnect the primary lead to the magneto.

(2) Remove the lower cap screw (19, fig. 4-21) and lock washers (20 and 22), and flat washer (21) that secure the bottom of the magneto to the engine front plate. Remove the nut (16) and lock washer (17) from the bolt (33, fig. 4-11) that secures the ground strap (18, fig. 4-21), the top of the magneto, and the top of the engine speed governor to the gear cover; remove the magneto (23), gasket (24), and spacer (25).

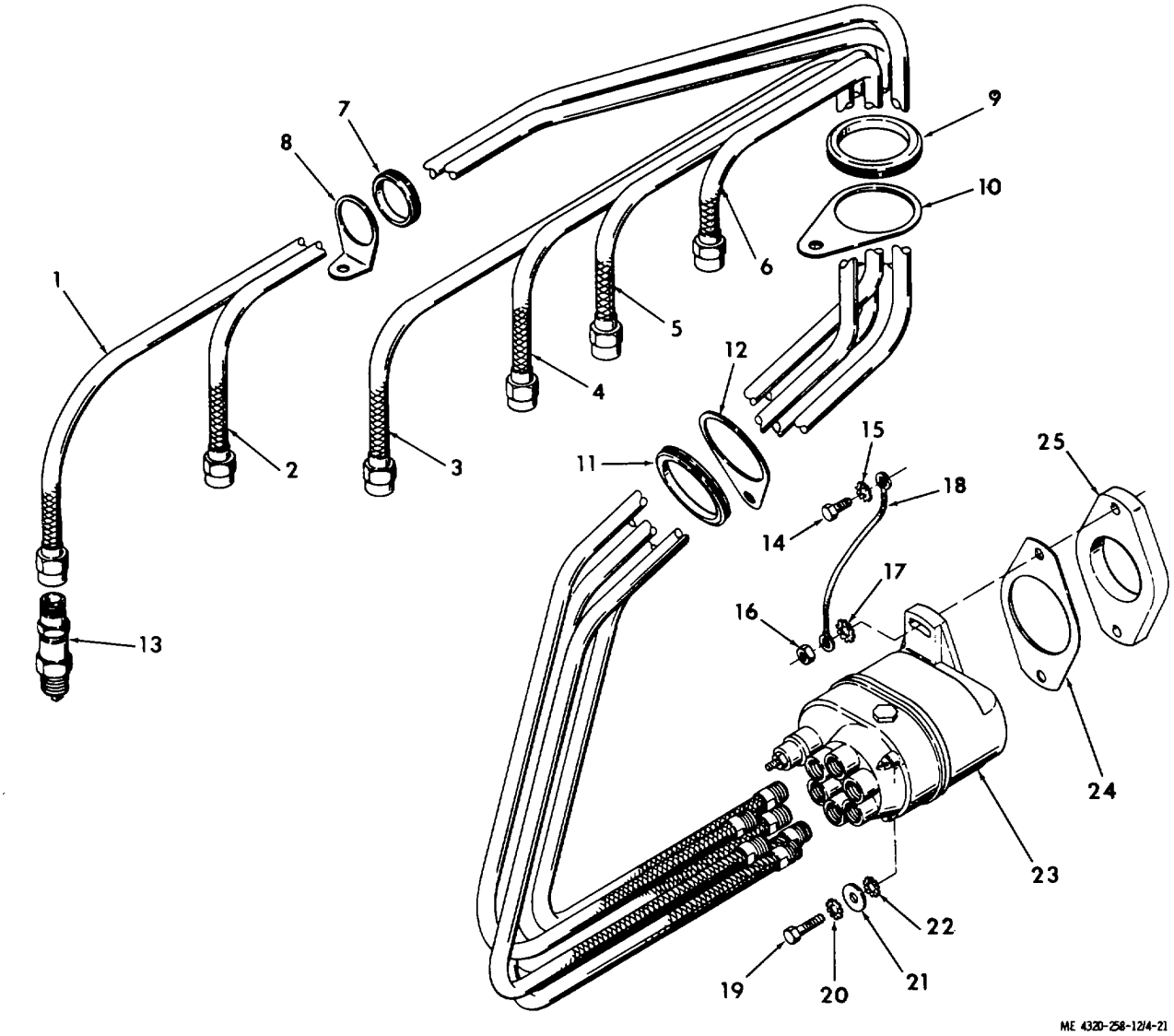
b. Replacing and Adjusting Breaker Point Assembly.

(1) Remove the screws (1 and 2, fig. 4-23) and lock washers (3) that secure the distributor housing (7) to the magneto frame. Pull the distributor housing away from the frame far enough to disconnect the capacitor lead from the terminal on the breaker point assembly. Remove the distributor housing. Remove and discard the distributor housing gasket (6).

(2) Use a spanner wrench to remove the capacitor (4) from the distributor housing and remove the preformed packing (5). Discard both parts.

(3) Remove the nut that secures the coil lead to the breaker point assembly (14) and disconnect the lead.

(4) Remove the two screws (10 and 11), lock washers (12), and flat washer (13) that secure the breaker point assembly to the rotor bearing plate (28); remove the breaker point assembly.



1. No. 6 spark plug cable
2. No. 5 spark plug cable
3. No. 4 spark plug cable
4. No. 3 spark plug cable
5. No. 2 spark plug cable
6. No. 1 spark plug cable
7. Grommet
8. Bracket
9. Grommet
10. Bracket
11. Grommet
12. Bracket
13. Spark plug
14. Cap screw
15. Lock washer
16. Nut
17. Lock washer
18. Ground strap
19. Cap screw
20. Lock washer
21. Flat washer
22. Lock washer
23. Magneto
24. Gasket
25. Magneto spacer

Figure 4-21. Ignition system, exploded view.

(5) Remove the distributor gear (8). Remove the retaining ring (15) and use two screwdrivers inserted under opposite sides of the rotor shaft gear (17) to pry the assembled gear and breaker cam assembly (16) from the rotor shaft (33). The cam also acts as a key for the gear.

(6) Make sure the gear mounting surface of the rotor shaft is clean. Install the rotor shaft gear (17) and cam assembly (16) on the shaft.
Secure with the retaining ring (15). Apply a light coat of grease on the cam lobes. The grease is provided in the breaker point kit.

(7) Apply one drop of SAE 20 lubricating oil on the shaft bushings for the distributor gear.

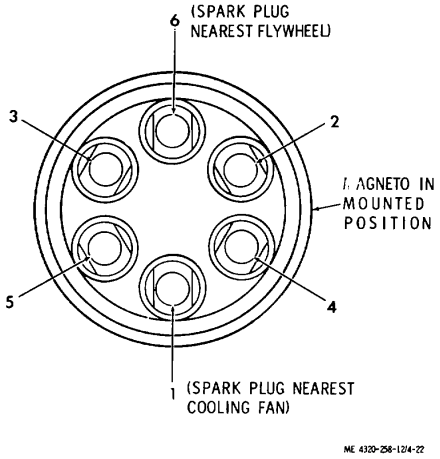


Figure 4-22. Magneto-to-spark plug connections.

One bushing is in the bearing plate (27) and the other is in the distributor housing (7).

(8) Install the distributor gear (8), making sure the timing marks are a lined as shown in figure 4-24.

(9) Install the breaker point assembly (14) loosely on the rotor bearing plate (28), using the screws (10 and 11), lock washers (12), and flat washer (13).

(10) Slowly rotate the magneto rotor shaft while attempting to insert a 6 penny nail in the timing hole of the magneto frame. With the nail inserted and with the rotor held in this position, adjust the position of the contact points so that the points are just starting to open. This provides the required point gap for the magneto. Tighten the breaker point screws (10 and 11) to maintain this setting.

(11) Install a new capacitor (4) with a new preformed packing (5) in the distributor housing (7). Tighten the capacitor with a spanner wrench.

(12) Position the distributor housing (7) on the magneto frame, using new housing gaskets (6). Be sure to connect the capacitor lead to the terminal of the breaker point assembly. Secure the housing with four screws (1 and 2) and lock washers (3).

(13) Install the magneto as directed in subparagraph f below.

c. Disassembly. Disassemble the magneto far enough to install the parts included in the major repair kit, following the sequence indicated in figure 4-23. Note the following:

(1) After removing the screws (1 and 2) and lock washers (3), pull the distributor housing far enough away from the magneto frame (38) to disconnect the lead of the capacitor (4) from the breaker point assembly (14).

Caution: Do not attempt to remove the capacitor (4) from the distributor housing (7) before disconnecting the capacitor lead.

(2) Use a spanner wrench to unscrew the capacitor from the distributor housing. Remove the preformed packing (5).

(3) Remove the distributor housing gaskets (6) from the distributor housing.

(4) Pull the distributor gear (8) from the bearing plate (27). Do not remove the brush (9) from the distributor gear unless inspection indicates that it is excessively worn.

(5) Remove the screws (10 and 11) lock washers (12), and washer (13) that retain the breaker point assembly (14) to the rotor bearing plate (28); remove and discard the breaker point assembly.

(6) Remove the retaining ring (15) and use two screwdrivers inserted under opposite sides of the rotor shaft gear (17). Pry the gear and break cam assembly from the rotor shaft.

(7) Remove the pal nut (18) and impulse coupling nut (19) from the drive end of the rotor shaft (33). Remove the shell (20) and spring (21) as an assembly.

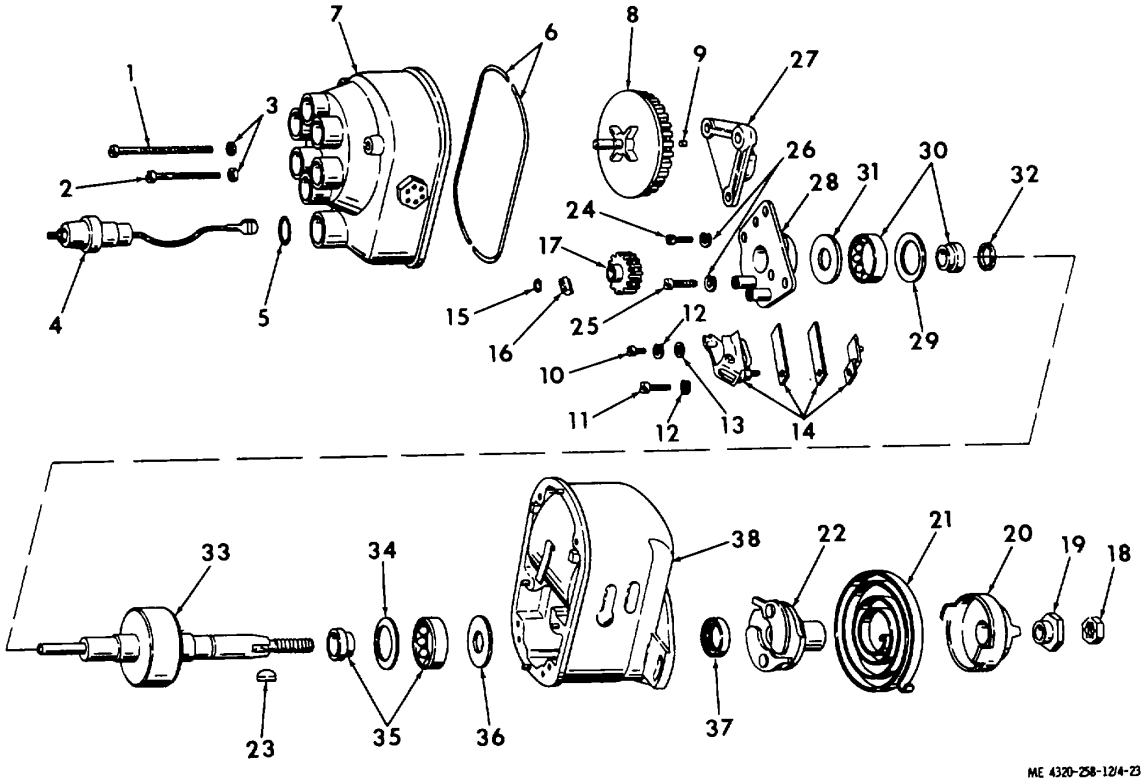
(8) Use a puller to remove the hub (22) from the rotor shaft (33).

(9) To remove the bearing (30) from the rotor bearing plate (28), pry out the expanding washer (29) and remove the bearing and bearing washer (31). Similarly, remove the bearing (35) from the magneto frame (38).

(10) Press the seal (37) from the magneto frame.

d. Cleaning and Inspection.

(1) If a repair kit is available and is being installed, discard all removed parts which have replacements in the kit. Clean the remaining metallic parts with cleaning solvent (fed. spec. P-D680); dry thoroughly. Clean nonmetallic parts with a cloth dampened lightly with solvent. Take care to prevent saturating the coil in the magneto frame.



1. Screw
2. Screw
3. Lock washer
4. Capacitor
5. Preformed packing
6. Housing gasket
7. Distributor housing
8. Distributor gear
9. Distributor gear brush
10. Screw
11. Screw
12. Lock washer
13. Washer
14. Breaker point assembly
15. Retaining ring
16. Breaker cam assembly
17. Rotor shaft gear
18. Pal nut
19. Impulse coupling nut
20. Shell
21. Impulse coupling spring
22. Impulse coupling hub
23. Key
24. Screw
25. Screw
26. Lock washer
27. Bearing plate
28. Rotor bearing plate
29. Expanding washer
30. Rotor bearing
31. Bearing washer
32. Shim
33. Rotor shaft
34. Expanding washer
35. Rotor bearing
36. Bearing washer
37. Shaft seal
38. Magneto frame

Figure 4-23. Magneto, exploded view.

(2) Inspect the distributor housing for cracks, burned terminals, signs of arcing, and other damage.

(3) Inspect the bearing plate for cracks, distortion, and wear. There shall be no perceptible play between the shaft of the distributor gear and the bearing plate bushing.

(4) Inspect the rotor shaft for damaged seal and bearing seats, loss of magnetism, and damaged threads.

(5) Inspect all coupling parts for obvious damage.

(6) Inspect the magneto frame for cracks, distortion, and damaged threads. Check that the coil is firmly wedged in the frame. Drive the wedges in if necessary to tighten the coil. Check the coil for damaged insulation, gouges, and other damage.

(7) If any non-kitted parts other than hardware are damaged, replace the magneto as an assembly.

e. Reassembly. During reassembly, install all of the new parts that are contained in the repair kit, to replace the parts which were removed from

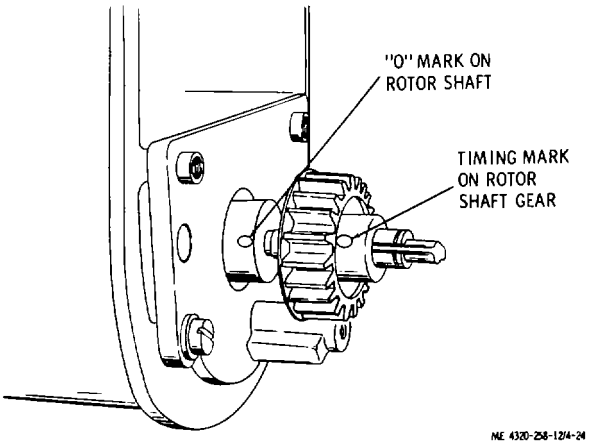


Figure 4-24. Timing marks on distributor gear and rotor shaft.

the magneto. Reassembly is the reverse of disassembly. Refer to figure 4-23. Note the following:

(1) When installing the rotor bearing (35) in the magneto frame, position the flat bearing washer in the bore and position the bearing in the bore against the washer. Install the expanding washer (34) with the concave side toward the bearing. Press against the washer to expand it into the groove in the magneto frame, locking the bearing in place. Install the bearing (30) in the rotor bearing plate (28) in a similar manner.

(2) Before installing the bearing plate (27), make sure the flat contact spring on the coil in the magneto frame (38) extends outward from the coil at an angle of approximately 20 degrees from vertical. This is necessary to provide spring pressure to hold the distributor gear against the bearing in the distributor block. Make sure the contact spring is exactly alined with the bushing in the bearing plate (27).

(3) When installing the bearing plate (27), secure the ground lead from the coil in the magneto frame under one of the mounting screws (24) that secures the bearing plate to the frame.

(4) During reassembly, apply one drop of SAE 20 lubricating oil to the porous distributor gear bushings in the bearing plate (27) and in the distributor housing (7).

(5) Install and adjust the breaker point assembly (14) as directed in subparagraph b above.

(6) This is a "right-hand" magneto-that is, rotation when viewing the impulse coupling end is clockwise. When installing the distributor gear (8), aline the tooth of the gear marked "RH" with the timing mark on the rotor shaft gear (17). See figure 4-25.

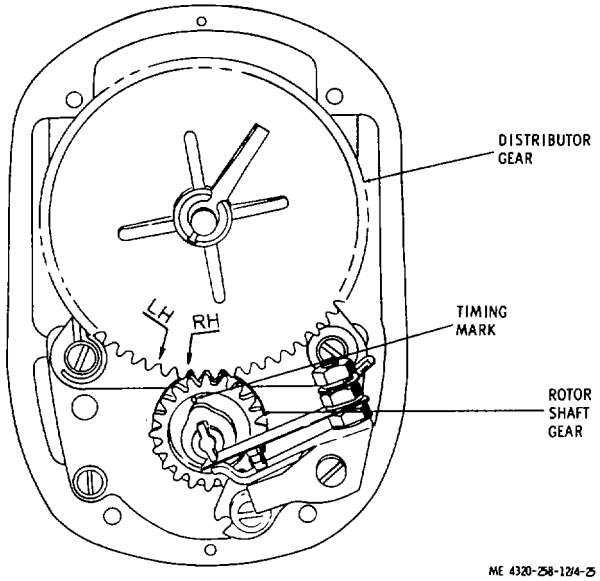


Figure 4-25. Distributor gear properly alined with rotor shaft gear.

(7) Install the capacitor (4) and preformed packing (5) in the distributor housing. Tighten with a spanner wrench. Before installing the distributor housing on the magneto frame, connect the pigtail from the capacitor to the terminal on the breaker point assembly.

f. Installation. Timing the magneto to the engine is a critical procedure. Install the magneto as follows:

(1) Remove the rear spark plug from the engine. Put a thumb over the spark plug hole and crank the engine until No. 6 cylinder starts on the compression stroke. This is indicated by air being compressed against the thumb as the piston rises in the cylinder.

(2) Set the piston on top-dead-center by slowly cranking until the DC mark on the flywheel, visible through the timing hole in the housing, is alined with the timing mark pointer. Hold the engine at this setting.

(3) With the magneto still removed from the engine and mounted in a vise thoroughly lined with soft cloths, turn the drive lugs clockwise while holding the high tension lead for No. 6 cylinder (fig. 4-22) close to the magneto frame so that a spark will arc when the No. 6 lead is energized. When No. 6 lead arcs, the magneto is

at the No. 6 firing position. Hold the magneto drive shaft at this position.

(4) Check the governor drive gear to make sure that the punch-marked tooth in the cam gear is engaged between the two punch-marked teeth on the governor drive gear.

(5) Remove the magneto from the vise. Turn the magneto drive lugs of the impulse coupling counterclockwise about one-quarter turn so that the lugs will mesh with the drive members of the governor drive gear. Position the magneto (23, fig. 4-21), spacer (25), and gasket (24) on the engine with the magneto lugs engaged and tighten the mounting bolts moderately. Connect the spark plug cables.

(6) Start the engine and idle it at 600 rpm.

If the engine fails to start, it is probably due to faulty ignition timing. Recheck as directed above.

(7) With the engine running at 600 rpm, use a timing light connected to the rear spark plug and check that the IGN-M indication on the flywheel is alined with the timing pointer. If it is not exactly alined, rotate the magneto slightly until the correct indication is attained. Tighten the mounting bolts firmly.

Section XII. MAINTENANCE OF ELECTRICAL SYSTEM

4-35. Description

a. The electrical system includes the battery box which houses two 12-volt, lead-acid-type storage batteries (3, fig. 4-1) connected in series to power the 24-volt electrical system. Battery output is used to energize the electrical starter (7, fig. 4-26) to start the engine. The battery charge is partially depleted as the engine is started and is restored by the battery charging system consisting of the alternator (1) and voltage regulator (10).

b. The alternator and regulator are typical automotive type in which the alternator output is controlled through the voltage regulator, depending upon the state of charge of the battery.

When the battery charge is low, the voltage regulator increases the strength of the alternator field to increase the output of the alternator. When the battery charge is normal, the output of the alternator decreases to near zero.

c. Reverse polarity connections to an alternator can severely damage the alternator. To prevent this damage, the system is protected by a reverse polarity protector (9) which is mounted on the panel next to the voltage regulator.

Caution: Though this engine is equipped with a reverse polarity protector to protect the alternator against damage due to reverse polarity connections, it is good practice to take special precautions when connecting and disconnecting electrical leads and cables. Do not ground the field terminal between the alternator and regulator. Do not operate the alternator in an open circuit with the rotor winding energized. Do not ground the alternator output circuit. Take care to prevent reversing polarity of the electrical system. When using a battery booster or fast charger, make sure the leads are connected with proper polarity. Failure to follow these instructions may damage the alternator rectifiers, voltage regulator, and wiring.

d. The engine starter (7, fig. 4-26) is a solenoid-operated type in which the soleonid switch (6) is mounted on the top of the starter. The solenoid switch uses electrical energy to pull the starter drive into engagement with the flywheel ring gear and to make the electrical circuit which energizes the starter after the drive is engaged. When the engine starts, the starter drive is disengaged, preventing the engine from driving the starter since engine operating speeds could severely damage the starter. Reengagement of the starter while the engine is running is prohibited by the starter disengage relay (para 4-42e).

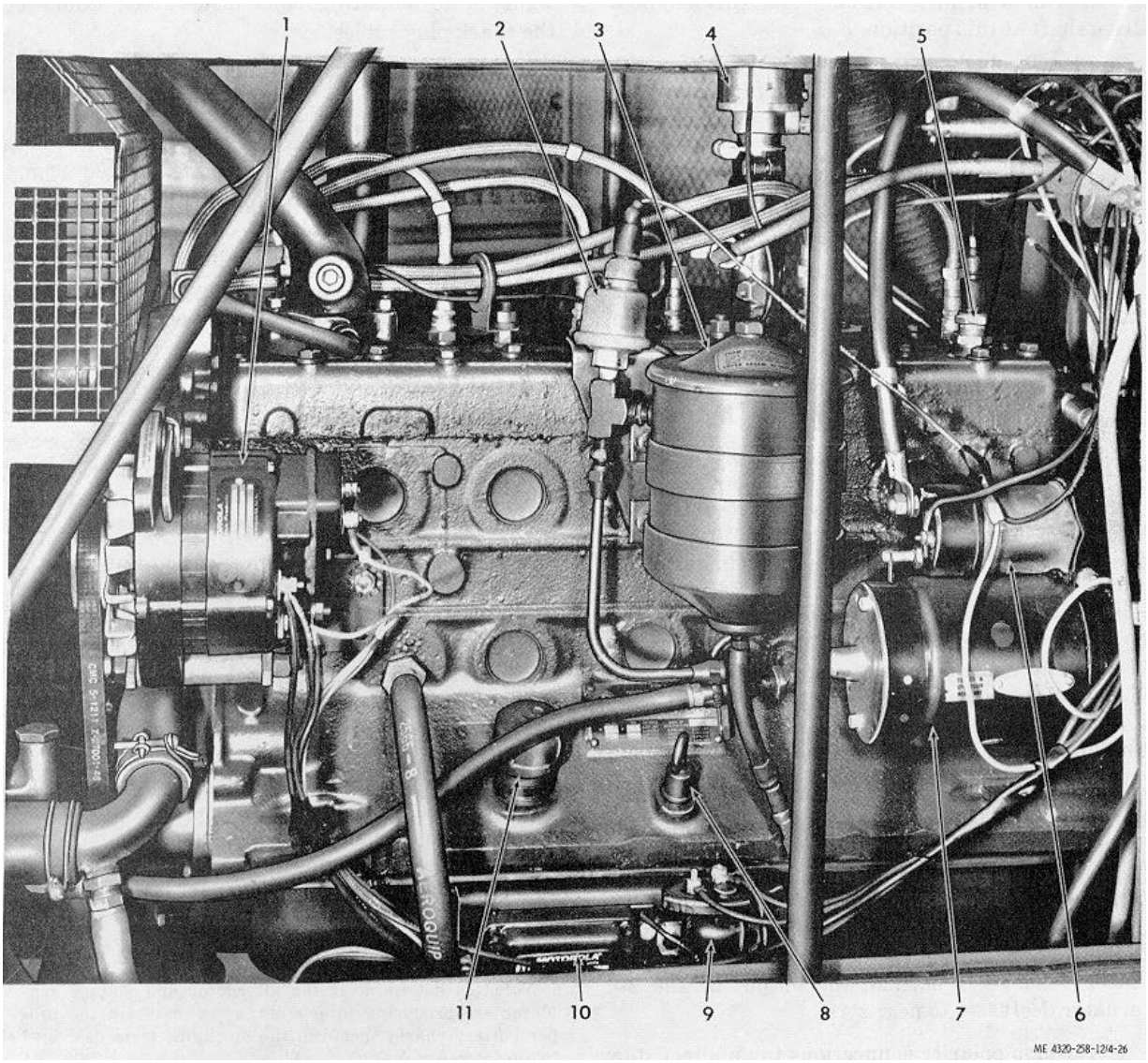
4-36. Battery Charging Circuit Testing

Note. To determine if the alternator and voltage regulator are producing proper output to maintain the proper battery charge, perform the on-engine tests described in this paragraph.

a. Battery Voltage and Shorted Isolation Diode Tests. These tests determine if the batteries are properly connected to the alternator and if the isolation diode is shorted. A shorted isolation diode will discharge the battery through the voltage regulator to ground.

(1) With the engine stopped, the battery disconnect switch positioned to ON, and the ignition switch positioned to OFF, the electrical circuit will be as shown in figure 4-27.

(2) With a voltmeter, check the voltage across the negative output terminal of the alternator and the positive terminal of the one battery which does not have its negative terminal grounded. Note the voltage. It should be 24.0 to 25.2 volts.



1. Alternator
2. Oil pressure sender
3. Oil filter
4. Engine overspeed governor
5. Water temperature sender
6. Starter solenoid switch
7. Engine starter
8. Oil level dipstick
9. Reverse polarity protector
10. Voltage regulator
11. Engine oil filler cap

Figure 4-26. Right side of engine, showing components.

(3) Move the voltmeter probe from the positive battery terminal to the positive output terminal of the alternator. It must be the same as the voltage to the positive battery terminal. If it is not, check for loose cable connections or damaged cables.

(4) Move the voltmeter probe from the positive terminal to the regulator terminal of the alternator. The voltmeter must register zero voltage. If it registers a voltage higher than zero, it indicates a shorted isolation diode in the alternator, or possibly an output cable terminal touching the heat sink. If more than zero is still registered after the output cable is repositioned, replace the alternator.

b. Open Isolation Diode Test. This test deter

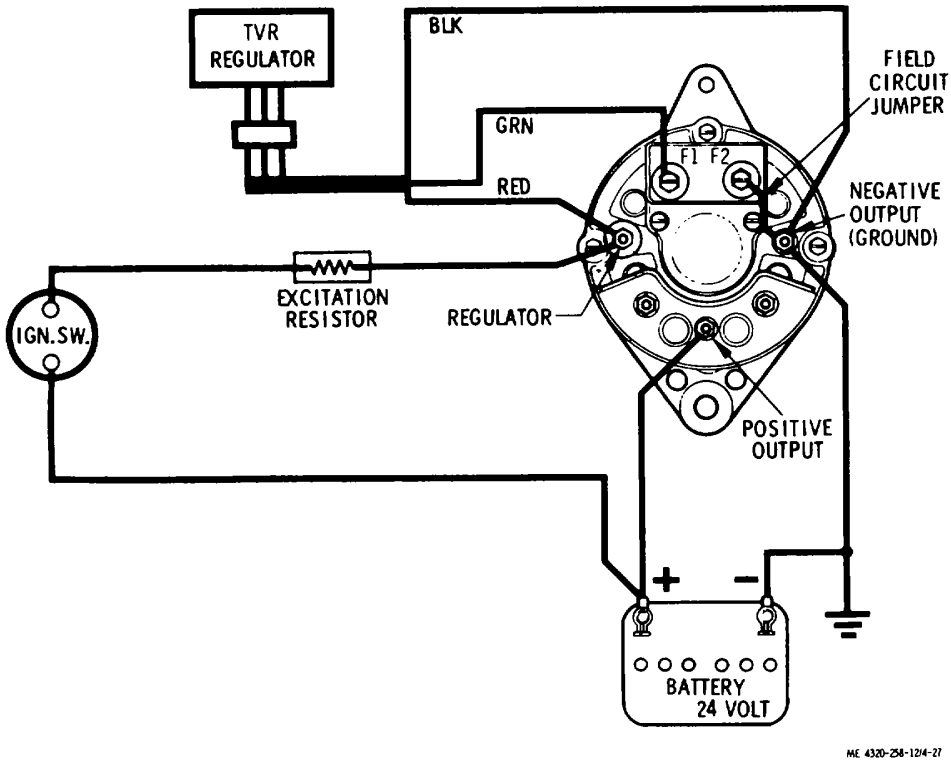


Figure 4-27. Electrical system setup for battery voltage and isolation diode test.

mines if the isolation diode is conducting alternator energy. If the isolation diode is open, battery charge cannot be provided and may result in damage to the rectifier diodes and to the voltage regulator.

(1) Refer to figure 427 for the electrical circuit setup for this test. With the battery disconnect switch and the ignition switch both in the ON positions and the engine running at fast idle, check the voltage across the negative output terminal and the regulator terminal of the alternator, then check the voltage from the negative output terminal to the positive output terminal of the alternator.

(2) The positive output of the alternator must be 28.6 +0.4 volts. The negative to regulator terminal output must be between 0.8 and 1.2 volts higher than the positive output voltage.

(3) If only battery voltage is indicated at the positive output terminal, the isolation diode is open and the alternator should be replaced.

c. Field Current Test. This test is designed to measure the alternator field current draw in amperes. The brushes and sliprings are part of the field circuit in this test. Excessive field current may produce high alternator output and may result in damage to the voltage regulator. Low field current will result in low alternator output.

(1) With the engine stopped, the ignition switch at OFF, and the battery disconnect switch positioned to ON, set up the field test as shown in figure 4-28. Note that the regulator field lead is disconnected from the Fl terminal of the alternator.

(2) With the field rheostat set to the maximum resistance position, set the ammeter to read in the 0 to 10 ampere range.

(3) Reduce rheostat resistance carefully, watching the ammeter. If the ammeter indicates more than 3.5 amperes, the field circuit is faulty. Stop the test immediately. Remove the rear cover and check the brushes and sliprings for faults. Correct any shorted or grounded conditions of the sliprings or brushes.

(4) The normal field current is 2.0 to 3.0 amperes when field rheostat resistance is reduced to zero.

(5) With the ammeter registering the field

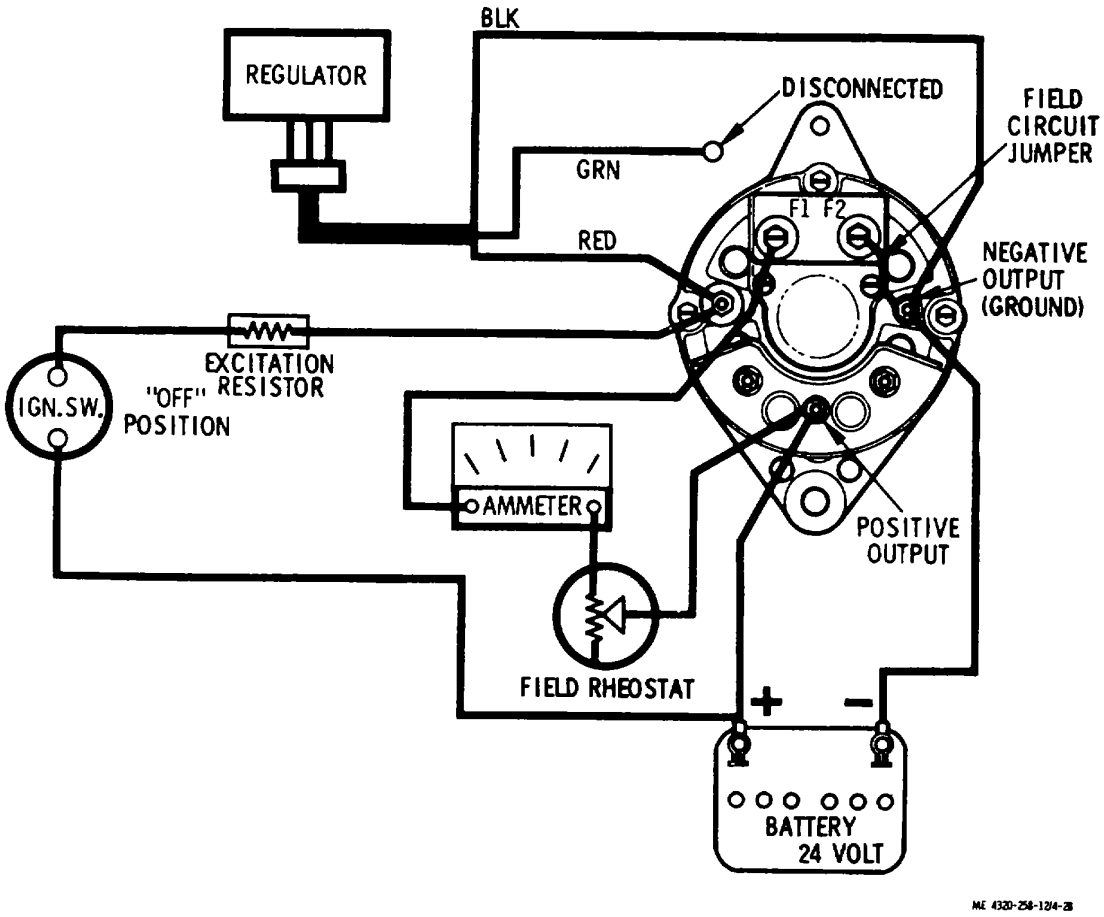


Figure 4-28. Field current draw test setup.

resistance, rotate the alternator rotor slightly, while watching the ammeter. If the ammeter reading varies when the rotor is turned, the brushes and/or sliprings require cleaning.

(6) When the field current test is completed, disconnect the ammeter and reconnect the lead to the F1 terminal of the alternator.

d. Voltage Regulator Operating Voltage. This test determines the operating level of the voltage regulator. Voltage tests are most accurate when operating with a fully charged battery, since current output is then at the minimum. Under this condition, charging voltage will rise to the regulator limiting level.

(1) Conduct this test with the battery disconnect switch in ON position, the ignition switch in ON position and the engine running at high idle, and the test circuit as shown in figure 4-29.

The 4-ohmresistor must have a 25-watt rating.

(2) Connect the voltmeter to read the output across the negative output terminal and the positive output terminal of the alternator. Allow the engine to run for several minute to stabilize component temperature, then read the voltage. The voltage must read 28.4 + 0.4 volts.

(3) A high voltage indication may be due to the following causes: (a) Excessive resistance in the regulator ground lead.

(b) Poor alternator ground circuit.
(c) High voltage regulator setting (para 4-38a).
(d) Defective voltage regulator.

(4) A low voltage indication may be due to the following causes:
(a) Excessive resistance in the field circuit.
(b) Alternator drive belt slipping, causing low rotor speed.

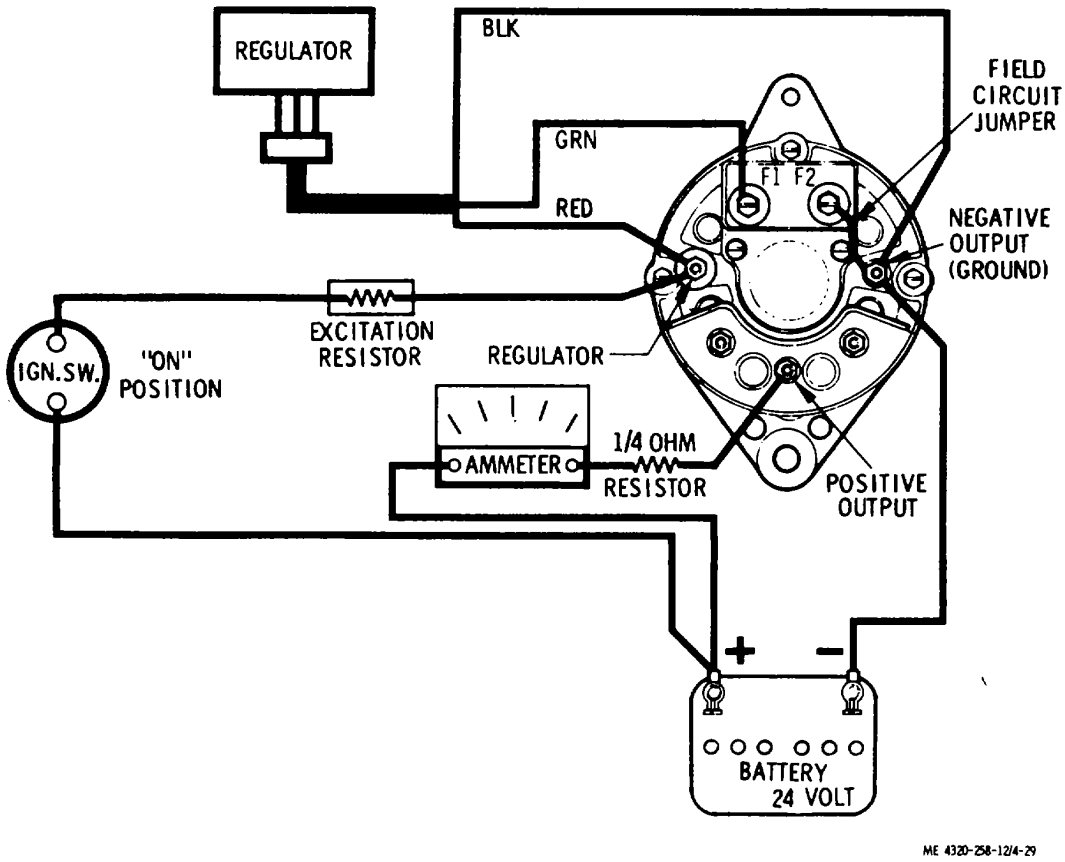


Figure 4-29. Voltage regulator operating voltage test setup.

(c) Low voltage regulator setting (para 4-38a).
(d) Defective regulator.

(5) Correct the cause of the overvoltage or undervoltage condition and recheck the voltage regulator operating voltage. When tests are completed, disconnect the 1/4-ohm resistor from the circuit.

e. Alternator Output and System Test.

(1) Conduct this test with the battery disconnect switch in ON position, the ignition switch in ON position, the engine running, and the equipment set up as shown in figure 4-30. At the start, set the carbon pile resistor to minimum current drain. The ammeter must be adjusted to read in the 0 to 100 ampere scale.

(2) With the engine running at fast idle, adjust the carbon pile to provide a 20-ampere charge rate. Maintain this for a few minutes to warm up the components.

(3) Use a tachometer to check the alternator speed. Adjust engine speed to maintain an alternator speed of 3000 to 5000 rpm.

(4) Adjust the carbon pile rheostat to attain a maximum current reading on the ammeter. Maximum current output must be 30 amperes minimum, at 25 to 28 volts.

Caution: Unload the carbon pile rheostat immediately after completion of the test to prevent discharge of the battery.

(5) Readjust the carbon pile rheostat for a 10-ampere output of the alternator. Check the voltage drop between the alternator and battery at this output. If the voltage drop exceeds 0.3 volt, check battery cable connections for high resistance connections.

4-37. Alternator

Caution: Disconnect the battery cable (6, fig.4-1) from the positive battery terminal (4) before disconnecting any other leads from the engine components. This will prevent shorts which

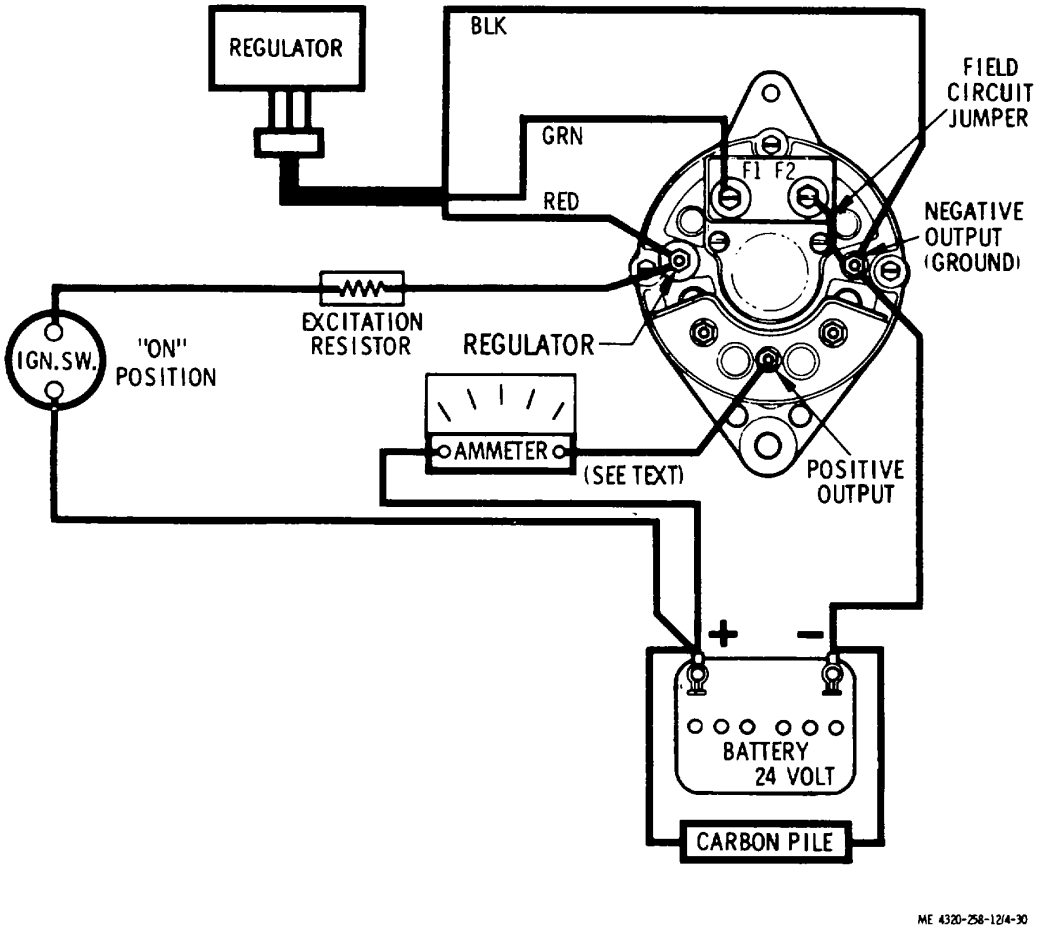


Figure 4-30. Alternator output and system test setup.

could damage the alternator, voltage regulator, or other parts.

a. Removal.

(1) Loosen the adjusting screw (1, fig. 4-31) and push the alternator toward the engine to loosen the fan belt. Disengage the fan belt from the alternator drive pulley.

(2) Disconnect the electrical leads from the alternator. Tag leads to facilitate reassembly.

(3) Remove the alternator from the engine, following the sequence of index numbers 1 through 15 in figure 4-31.

b. Alternator Brush Replacement.

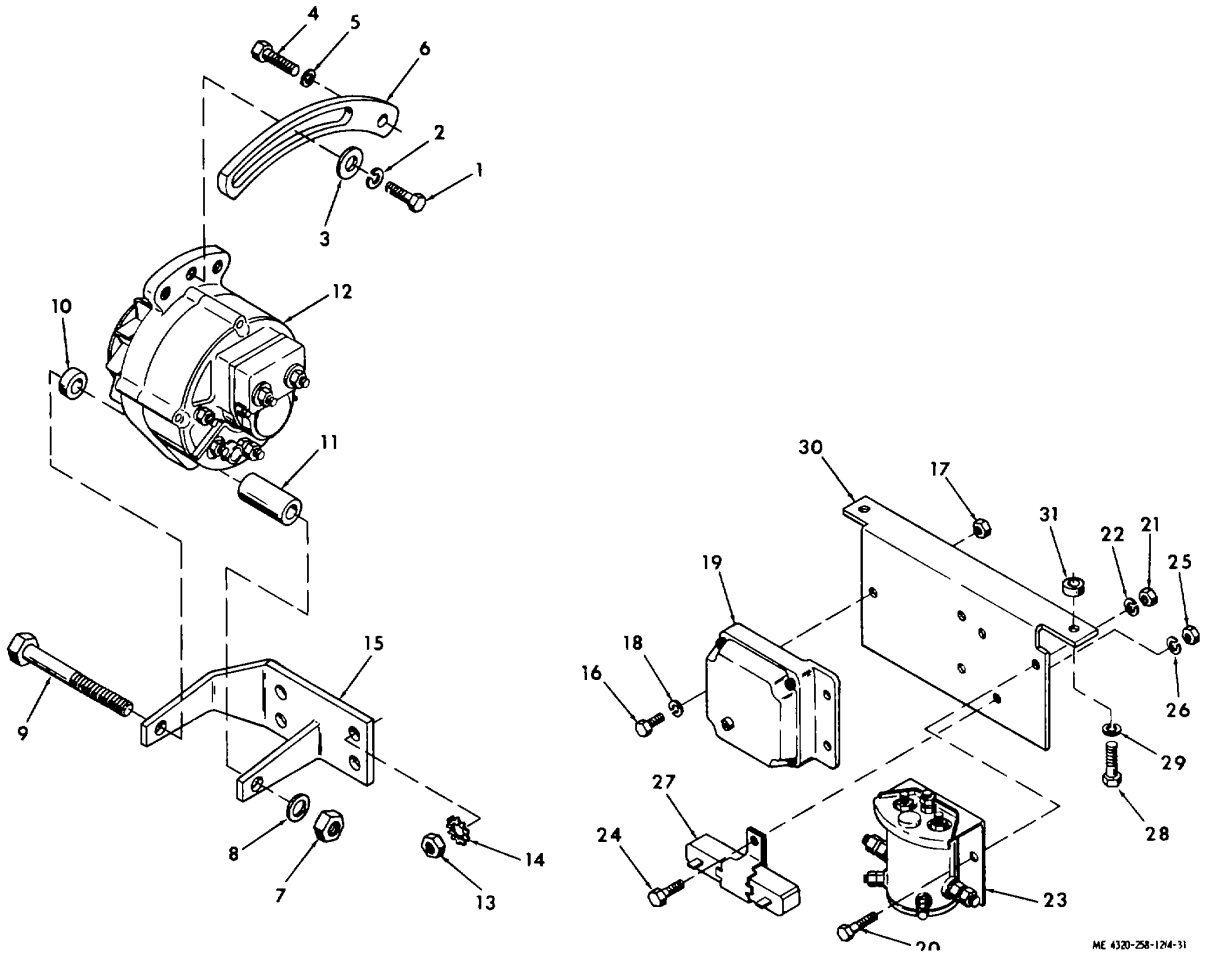
(1) Remove the two assembled washer screws '(1, fig. 4-32) that secure the brush cover (2) to the alternator; carefully pull the cover away from the alternator.
put and system test setup.

(2) Remove the two terminal screws (4), nuts (5), insulating washers (6), leads (7), washers (8), and bushings (9) from the brush cover.

(3) Remove the two screws (10) that secure the insulator (11) and brush assembly (12) to the alternator; remove the brush assembly with the attached electrical leads (7).

(4) Inspect the brush assembly for cracks, signs of overheating, and distortion. Check that the brushes slide freely in the brushholders and that the brush springs provide sufficient brush tension. Inspect the brushes for cracks, oil saturation, and wear. If brushes are worn to less than 3/16 inch, oil soaked, or cracked, replace the brush assembly.

(5) If the brush assembly passes the visual inspection, check the electrical condition of the assembly. Refer to figure 4-33. Check that continuity exists between points A and B and between points C and D, but that no continuity exist



1. Adjusting screw
2. Lock washer
3. Flatwasher
4. Strap mounting screw
5. Lock washer
6. Adjusting strap
7. Nut
8. Flat washer
9. Bolt
10. Spacer
11. Spacer
12. Alternator
13. Nut
14. Lock washer
15. Alternator mounting bracket
16. Cap screw
17. Nut
18. Lock washer
19. Voltage regulator
20. Cap screw
21. Nut
22. Lock washer
23. Reverse polarity protector
24. Cap screw
26. Nut
26. Lock washer
27. Excitation resistor
28. Cap screw
29. Lock washer
30. Mounting bracket
31. Spacer

Figure 4-31. Battery charging system, exploded view.

between point E and points A or C.

(6) Use a new brush assembly if the inspection indicates faults.

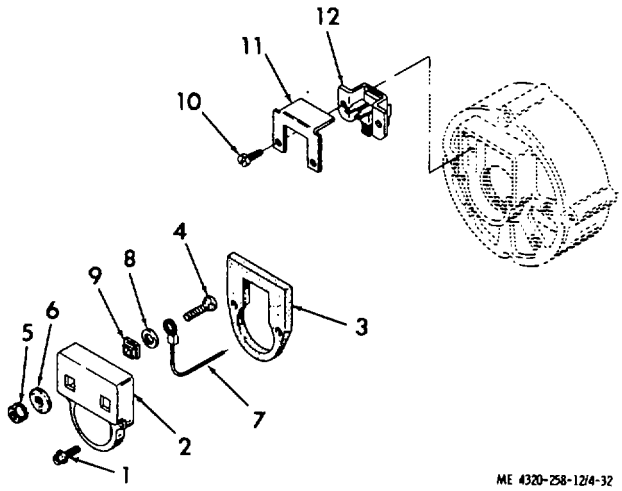
(7) Position the brush assembly (12, fig 4-32) and insulator (11) on the alternator; se cure with two machine screws (10).

(8) Connect the electrical leads (7) from the brush assembly to the brush cover (2) with the terminal screws (4), nuts (5), insulating washers (6), and washers (8). Make sure the bushings (9) are in place.

(9) Position the brush cover (2) on the alternator; secure with two assembled washer screws (1).

c. Cleaning and Inspection.

(1) Clean the exterior of the alternator with a cloth dampened with cleaning solvent (fed. spec.P-D-680). Take care to prevent the solvent from



1. Assembled washer screw
2. Brush cover
3. Gasket
4. Terminal screw
5. Nut
6. Insulating washer
7. Electrical lead
8. Flat washer
9. Bushing
10. Machine screw
11. Insulator
12. Brush assembly

Figure 4-32. Alternator brush assembly, exploded view.

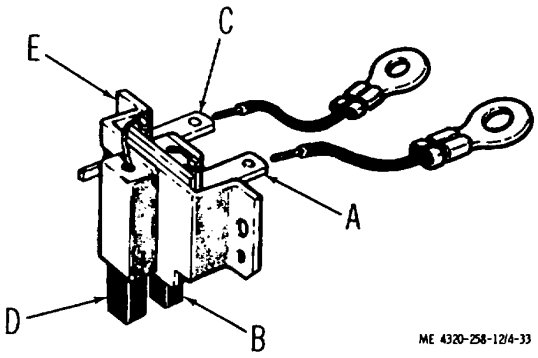


Figure 4-33. Alternator brush assembly, showing continuity paths.

entering the interior of the alternator. Wipe the alternator dry.

(2) Inspect the alternator for cracks, signs of overheating, damaged terminals, and damaged internal wiring.

(3) Check the alternator rotor shaft for free rotation. The shaft must turn freely and smoothly without catching or binding. Replace the alternator if it is damaged.

d. Installation.

(1) Installation is the reverse of removal. Refer to items 1 through 15 in figure 4-31.

(2) Connect the electrical leads to the alternator. If necessary, refer to the wiring diagram in figure 1-3.

(3) Engage the fan belt on the alternator pulley and tighten the belt (para 4-30a).\par

4-38. Voltage Regulator

Caution: Disconnect the battery cable (6, fig.4-1) from the positive battery terminal (4) before disconnecting any other leads from the engine components. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

a. Adjustment. If adjustment of the voltage regulator is indicated when making the voltage regulator operating voltage test (para 4-36d), adjust the voltage regulator as follows:

(1) Remove the seal screw from the voltage regulator cover to provide access to the adjusting screw of the variable resistor in the voltage regulator.

(2) With the battery charging system set up as shown in figure 4-29, adjust the setting of the variable resistor with a No. 0 Phillips screwdriver to provide a voltage of 28.4 + 0.4 volts when the battery is at full charge and the alternator output current is 8 to 10 amperes.

(3) After adjustment, install the seal screw in the voltage regulator cover.

b. Removal.

(1) Disconnect the electrical leads from the voltage regulator. Tag leads to facilitate reassembly.

(2) Remove the three cap screws (16, fig. 431), nuts (17), and lock washers (18) that secure the voltage regulator to the mounting bracket; remove the voltage regulator.

c. Cleaning and Inspection.

(1) Clean the voltage regulator with a cloth dampened with cleaning solvent (fed. spec. P-D680); dry thoroughly.

(2) Inspect the voltage regulator for cracks, signs of overheating, loose or damaged terminals, and other damage; replace a damaged voltage regulator.

d. Installation. Installation of the voltage regulator is the reverse of removal. Refer to items 16 through 19 of figure 4-31. If necessary, refer to the wiring diagram in figure 1-3 for connection requirements.

4-39. Reverse Polarity Protector

a. Removal.

Caution: Disconnect the battery cable (6, fig. 4-1) from the positive battery terminal (4) before disconnecting any other leads from the engine components. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

(1) Disconnect the electrical leads from the reverse polarity protector. Tag leads to facilitate reassembly.

(2) Remove the two cap screws (20, fig. 431), nuts (21), and lock washers (22) that secure the reverse polarity protector (23) to the mounting bracket; remove the reverse polarity protector.

b. Cleaning and Inspection.

(1) Wipe the exterior of the reverse polarity protector with a cloth dampened with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(2) Inspect the reverse polarity protector for cracks, signs of overheating, loose or damaged terminals, and other damage; replace a damaged polarity protector.

c. Installation. Installation of the reverse polarity protector is the reverse of removal. Refer to items 20 through 23 in figure 4-31. If necessary, refer to figure 1-3 for connection requirements.

4-40. Excitation Resistor

a. Removal.

Caution: Disconnect the battery cable (6, fig. 4-1) from the positive battery terminal (4) before disconnecting any other leads from the engine components. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

(1) Disconnect the electrical leads from the excitation resistor. Tag leads to facilitate reassembly.

(2) Remove the cap screw (24, fig. 4-31), nut (25), and lock washer (26) that secure the excitation resistor (27) to the mounting bracket.

b. Cleaning and Inspection.

(1) Clean the excitation resistor with a cloth dampened with cleaning solvent (fed. spec. P-D680); dry thoroughly.

(2) Inspect the excitation resistor for cracks, signs of overheating, loose or damaged terminals, and other damage. Use a multimeter to check the resistance of the unit. Resistance must be 33
ohms. Replace the resistor if it is damaged or if resistance is in correct.

c. Installation. Installation of the excitation resistor is the reverse of removal. Refer to items 24 through 27 in figure 4-31. If necessary, refer to figure 1-3 for connection requirements.

4-41. Engine Starter a. Removal.

Caution: Disconnect the battery cable (6, fig. 4-1) from the positive battery terminal (4) before disconnecting any other electrical leads from the engine components. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

(1) Disconnect the electrical leads to the starter solenoid switch (6, fig. 4-26).

(2) Remove the three cap screws and lock washers that secure the engine starter (7) to the engine side of the flywheel housing; pull straight forward on the starter to remove the assembled starter solenoid switch and starter from the engine.

b. Cleaning and Inspection.

(1) Clean the exterior of the engine starter with a cloth dampened with cleaning solvent (fed.
spec. - -680). Take care to prevent solvent from entering the starter.

(2) Inspect the starter for cracks, signs of overheating, loose solenoid switch mounting, damaged pinion teeth on the drive, and other damage.

(3) Check the armature for free rotation. There must be no catching, binding, or scraping as the armature is rotated.

(4) Check the starter brushes and replace if necessary (subparagraph c below).

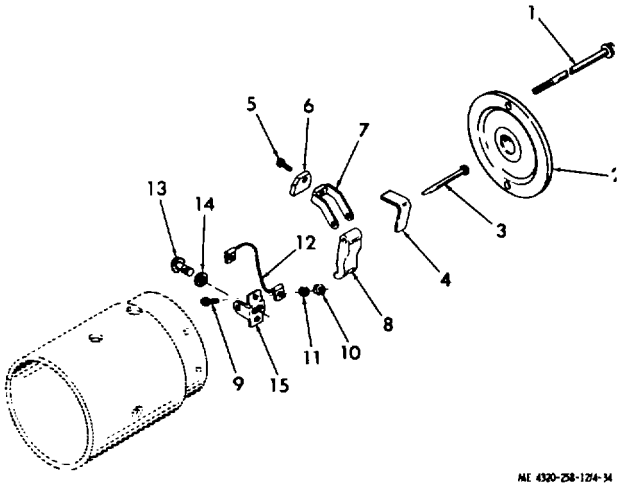
(5) Bench test the starter as directed in subparagraph d below.

(6) Replace the starter if it fails to meet the inspection or testing requirements.

c. Starter Brush Replacement.

(1) Remove the thru bolts (1, fig. 4-34) that secure the commutator end frame (2) to the engine starter; pull straight out on the end frame to disengage the end of the rotor shaft from the bushing in the end frame.

(2) Remove the support pins (3) to release the grounded brush holders (7), insulated brush holders (8), and brush springs (4) from the brush supports (15). Remove the brush screws (5) that secure the brushes (6) to the brush holders; remove the brushes.



1. Thru bolt
2. Commutator end frame
3. Support pin
4. Brush spring
5. Brush screw
6. Brush
7. Grounded brush holder
8. Insulated brush holder
9. Brush lead screw
10. Nut
11. Lock washer
12. Grounded brush lead
13. Brush support screw
14. Washer
15. Brush support

Figure 4-34. Engine starter brushes, exploded view.

(3) Remove the screws (13) and washers (14) that secure the brush leads (12) to the brush support (15); remove the brush leads.

(4) Replace brushes if they are chipped, oil soaked, or worn to less than 5/16 inch. Replace any other parts that are cracked, worn, or distorted.

(5) Install the brushes and related parts as shown in figure 4-34. Before. installing the commutator end frame (2), seat the brushes on the commutator, using 00 sandpaper.

Note. The commutator on the armature shaft must be smooth and concentric, free from burrs, scoring, high segments, or other damage. Replace the engine starter if the commutator is damaged (6) Install the commutator end frame (2) with the thru bolts (1).

d. Starter Bench Testing. Check the operation of the starter on a bench as follows:

(1) Set up the starter for testing as shown in figure 4-35. Make sure the batteries are fully charged prior to the test.

Caution: Take care not to exceed a 20-volt input to the starter during this test. Higher voltages may cause the starter to throw its windings.

(2) Make all test setups with the switch

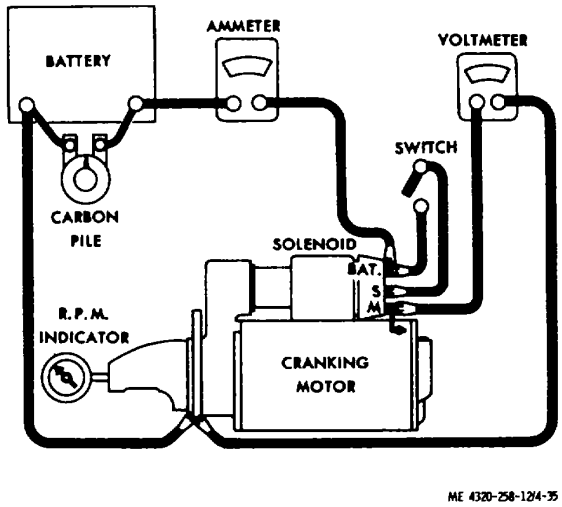


Figure 4-35. Engine starter test setup.

open and the carbon pile rheostat at a non-load condition. Just prior to closing the switch, operate the carbon pile rheostat to load the battery.

(3) Close the switch and adjust the carbon pile rheostat to provide a 20-volt indication on the voltmeter. The starter must operate at a high rate of speed. Allow the starter to gain full speed rotation and check the indication of the tachometer. It must read 3300 and 5600 rpm.

(4) With the starter operating in the required speed range, check the indication on the ammeter. Current draw shall not exceed 40 to 75 amperes. This includes the draw of the solenoid.

(5) Open the switch and disconnect the starter. Disconnect the carbon pile rheostat to prevent it from draining the battery.

(6) If the starter fails to operate within the required range of speeds and amperages at 20 volts, replace the starter.

e. Installation.

(1) Position the engine starter (7, fig. 426) with its assembled solenoid switch (6) on the flywheel housing of the engine; secure with three cap screws and lock washers.

(2) If necessary, refer to figure 1-3 for connection information.

(3) Attempt to start the engine as directed in paragraph 2-8. The starter must crank the engine freely and easily.

Section XIII. MAINTENANCE OF CONTROLS AND INSTRUMNETS

4-42. Description

a. The engine controls and instruments are mounted on the control panel which is part of the dash assembly of the engine. Refer to figure 1-3 for the wiring diagram showing the electrical connections between the engine and controls. The function of the controls and instruments is described in table 2-1.

b. The engine has three protective devices which will shut down the engine under certain conditions which could damage the engine. These conditions are high coolant temperature, low oil pressure, and engine overspeed. In each of these emergency conditions, the engine shutdown is accomplished by grounding the primary of the magneto to prevent the engine ignition system from operating. The adjustment and replacement of these devices are the responsibility of direct support maintenance.

c. Two large gages on the engine control panel indicate the suction and discharge pressures of their related systems. They are connected to the pump by hoses and fittings, and each system incorporates a valve to disconnect the gage from the system if desired. A dampener in the system at each gage prevents momentary pressure surges from damaging the related gage.

d. The tachometer-hourmeter mounted on the control panel is driven by a flexible drive shaft which connects to a drive adapter on the overspeed governor arm. The drive adapter meshes with a threaded portion of the overspeed governor drive shaft, providing the rotational force necessary to operate the tachometer and hourmeter.

e. The starter disengage relay, mounted on the control panel, opens the circuit to the starter solenoid switch to deenergize the start circuit immediately when the engine starts, and prevents the operation of the starter at any time while the engine is running. This protects the engine starter from damage which could be caused by accidental operating of the starter pushbutton while the engine is running. The operating coil of the relay is connected to alternator output so that the start circuit is held open whenever there is alternator output.

4-43. Control Panel Engine Controls and Instruments

a. Removal and Disassembly.

Caution: Disconnect the battery cable (6, fig. 4-1) from the positive battery terminal (4) before disconnecting any leads to the engine controls and instruments. This will prevent shorts which could damage the alternator, voltage regulator, and other parts.

(1) Disconnect the electrical leads from the engine controls and instruments on the control panel. Tag leads to facilitate reassembly.

(2) Remove and disassemble the engine controls and instruments from the control panel as shown in figure 4-36.

b. Cleaning and Inspection.

(1) Clean all parts by wiping them with a cloth dampened lightly with cleaning solvent (fed.
spec. - -680); take care to prevent the solvent from entering the interior of the components.

(2) Inspect all meters and gages for cracked dial glass, defaced or illegible dial marking, sticking or binding dial pointers, damaged terminals, evidence of entry of moisture, and other damage. Replace damaged gages and meters.

(3) Check all switches for cracked cases, difficult operation, lack of positive switch action, and other damage. Check the switches for continuity, using a multimeter or test lamp. Replace defective switches.

(4) Inspect the starter disengage relay for cracks, dented housing, loose or damaged terminals, and other damage. Apply 24 volts across the coil terminals and check for continuity across the contact terminals. No continuity should exist. Disconnect the 24-volt input to the coil terminals.
There should not be continuity across the contact terminals. Replace a damaged or inoperative relay.

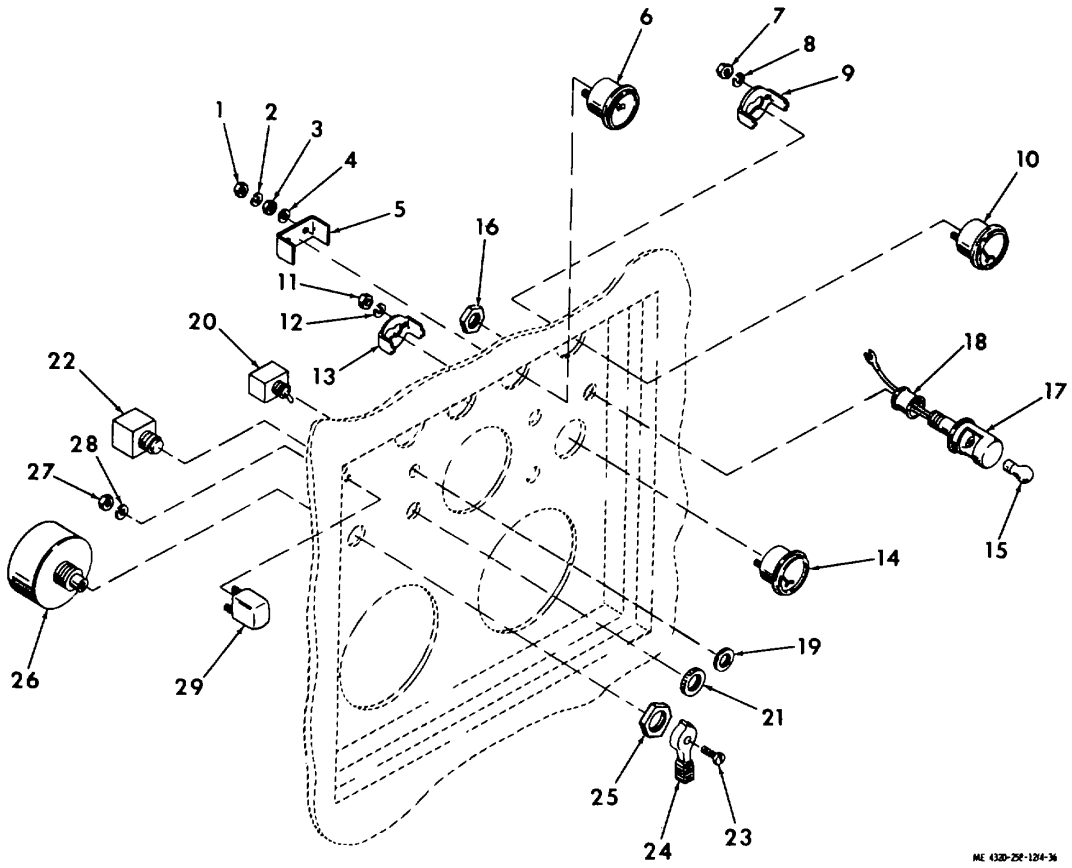
c. Reassembly and Installation.

(1) Reassemble and install the controls and indicators on the control panel as shown in figure 4-36.
(2) Connect the electrical leads to the components as shown in figure 1-3.

4-44. Tachometer and Tachometer Drive a. Removal.

(1) Disconnect the tachometer shaft (1, fig.4-37) from both the tachometer-hourmeter (2) and from the tachometer drive (3) on the overspeed governor drive mechanism.

(2) Remove the tachometer form the control panel.



1. Nut
2. Lock washer
3. Nut
4. Lock washer
5. Clamp
6. Ammeter
7. Nut
8. Lock washer
9. Clamp
10. Water temperature gage
11. Nut
12. Lock washer
13. Clamp
14. Oil pressure gage
15. Panel lamp
16. Nut
17. Lamp holder
18. Panel lamp spacer
19. Knurled nut
20. Ignition switch
21. Knurled nut
22. Starter pushbutton switch
23. Screw
24. Switch handle
25. Thin nut
26. Battery disconnect switch
27. Nut
28. Lock washer
29. Starter disengage relay

Figure 4-36. Control panel engine controls and instruments, exploded view.

(3) Use an open-end wrench to remove the tachometer drive from the overspeed governor drive mechanism.

b. Cleaning and Inspection.

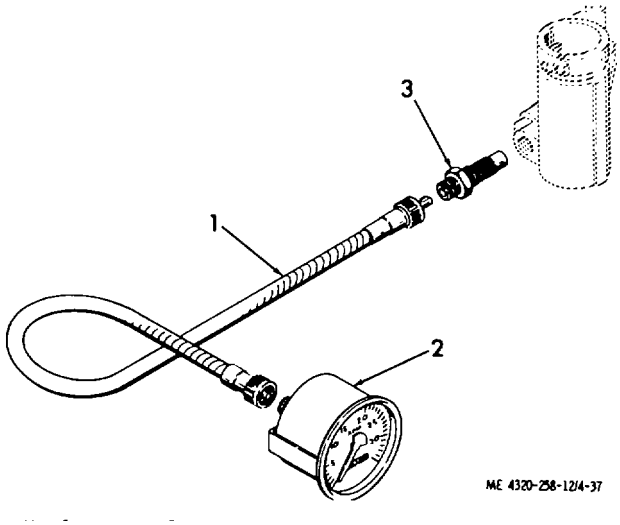
(1) Wipe the exterior of the tachometer hourmeter and the tachometer shaft with a cloth dampened with cleaning solvent (fed. spec. PD-680).

(2) Wash the tachometer drive with cleaning solvent (fed. spec. P-D-680). Dislodge all hardened and caked grease from the drive.

(3) Inspect the tachometer for broken dial glass, defaced or illegible dial markings, binding or sticking pointer, jammed digital hour counter, or evidence of entry of moisture. Replace a damaged tachometer-hourmeter.

(4) Inspect the tachometer drive for cracks, chipped, or broken gear teeth, rough or catching operation, and damaged threads; replace a damaged tachometer drive.

(5) Inspect the tachometer shaft for kinks, broken sheathing, binding or catching rotation of the internal shaft, and damaged threads on the



1. Tachometer shaft
2. Tachometer-hourmeter
3. Tachometer drive

Figure 4-37. Tachometer and drive, exploded view.

coupling nuts. Replace a damaged tachometer shaft.

c. Installation. Installation is the reverse of removal; refer to figure 4-37. After installation, start the engine and check the tachometer for proper operation.

4-45. Suction and Discharge Gages, Lines, and Fittings

a. Removal and Disassembly.

(1) Remove and disassemble the lines and fittings from the suction and discharge gages and from the pump as shown in figure 4-38.

(2) Remove the cap screws (20 and 24, fig.4-38), nuts (21 and 25), and lock washers (22 and 26) that secure the suction and discharge gages (23 and 27) to the control panel; remove the gages.

b. Cleaning and Inspection.

(1) Clean the suction and discharge gages with a cloth dampened with cleaning solvent (fed. spec. P-D-680); dry thoroughly.

(2) Clean all lines and fittings by washing in cleaning solvent (fed. spec. P-D-680). Shake off excessive solvent.

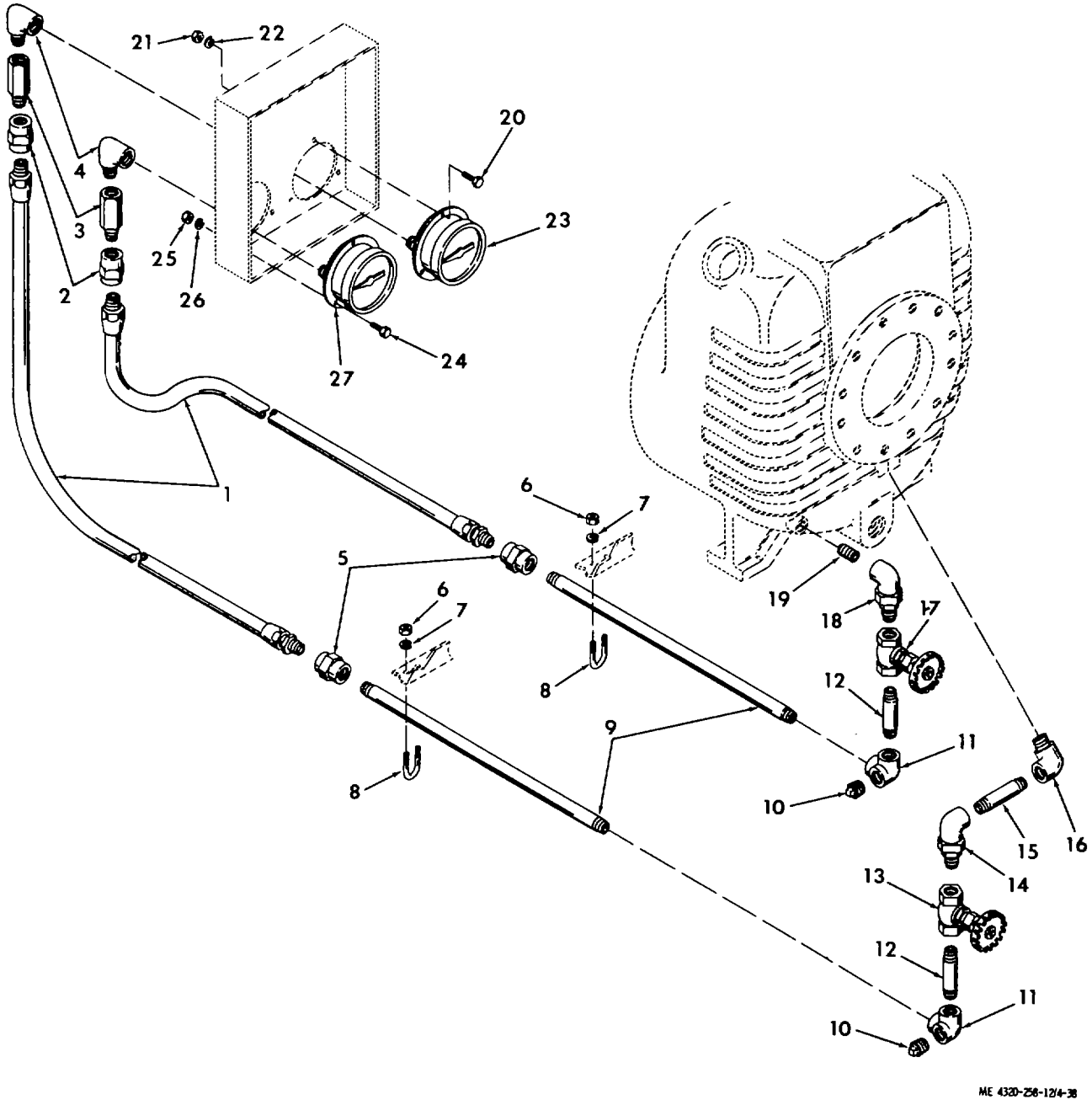
(3) Inspect the suction and pressure gages for cracked dial glass, binding or sticking needle movement, illegible dial faces, evidence of water entry, and other damage. If possible, check the operation against master gages to assure the accuracy of the indication. Replace damaged gages.

(4) Inspect the hoses for cuts, abrasions, leaks, damaged threads, and other damage; replace damaged hoses.

(5) Inspect .the valves for cracks, damaged threads, and for catching or binding of the valve stem. Replace damaged valves.

(6) Inspect all other parts for cracks, distortion, damaged threads, and other damage; replace damaged parts.

c. Reassembly and Installation. Install the suction and discharge gages, lines, and fittings as shown in figure 4-38. After assembly, start the pump and check for leaks. Correct any leaks noted.



1. Hose
2. Coupling
3. Dampener
4. Elbow
5. Coupling
6. Nut
7. Lock washer
8. U-bolt
9. Pipe nipple
10. Plug
11. Slide outlet elbow
12. Pipe nipple
13. Suction gage valve
14. Elbow
15. Pipe nipple
16. Elbow
17. Discharge gage valve
18. Elbow
19. Close nipple
20. Cap screw
21. Nut
22. Lock washer
23. Suction gage
24. Cap screw
25. Nut
26. Lock washer
27. Discharge gage

Figure 4-38. Suction and discharge gages, lines, and fittings, exploded view.

Section XIV. MAINTENANCE OF PUMP AND COUPLING

4-46. Description

a. The pump is secured to the flywheel housing of the engine and to the skid which mounts both the engine and pump. The pump shaft is secured to the engine flywheel through a flexible coupling, one member of which is keyed to the pump shaft and the other half of which is bolted to a drive plate that is bolted to the flywheel.

b. Pump alignment is attained by the installation of horseshoe-type shims which are placed between the mounting feet of the pump body and the skid. Adding or removing shims raises or lowers the pump as required to aline it with the engine flywheel and flywheel housing. The engine and pump must be closely alined to assure a smooth transfer of power from the engine to the pump, even though the flexible coupling will tolerate a small amount of misalignment of the drive system.

4-47. Centrifugal Pump

a. Removal.

(1) Remove the drain plug (fig. 1-1) from the centrifugal pump.

(2) Disconnect all suction and discharge piping from the pump.

(3) Remove the air eliminator valve (items 1 through 5, fig. 4-39).

(4) Support the weight of the pump with a hoist or crane hooked into the lifting eye welded onto the discharge elbow.

(5) Remove the nuts (11) and lock washers (12) that secure the bearing housing of the pump (13) to the flywheel housing of the engine.

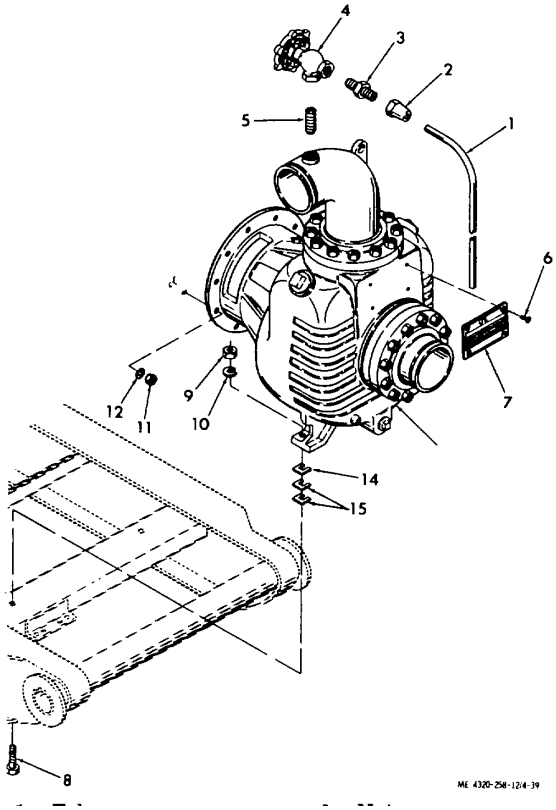
(6) Remove the cap screws (8), nuts (9), and lock washers (10) that secure the pump to the skid. Operate the hoist or crane so that the pump feet just clear the skid. Pull straight out on the pump to disengage the pump half of the flexible coupling from the engine half of the coupling. Take care to prevent losing the cushions that are installed between the coupling halves. Remove the pump and shims (14 and 15).

(7) Remove the coupling (para 4-48a).

b. Cleaning and Inspection.

(1) Clean the exterior of the pump with a cloth dampened with cleaning solvent (fed. spec.P-D-680); dry thoroughly.

(2) Wash the air eliminator valve and related parts with cleaning solvent (fed. spec. PD-680) ; dry thoroughly.



1.	Tube	9.	Nut
2.	Tube nut	10.	Lock washer
3.	Connector	11.	Nut
4.	Air eliminator valve	12.	Lock washer
6.	Pipe nipple	13.	Centrifugal pump
6.	Screw	14.	Shim
7.	Identification plate	15.	Shim
8.	Cap screw	16.	Stud

Figure 4-39. Centrifugal pump, removal and installation.

(3) Inspect the pump for a cracked or dented housing, suction flange, or discharge elbow. Attempt to turn the pump shaft. It must turn freely and smoothly, without catching or binding. Reach into the pump through the suction flange and check the operation of the check valve. It must operate freely and must make a good seal against its seat. Report any pump deficiencies to direct support maintenance.

(4) Inspect the air eliminator valve for rough or catching operation and for cracked or damaged threads. Replace a damaged valve.

(5) Inspect all other parts for cracks, distortion, and other damage; replace damaged parts.

c. Installation.

(1) Install the coupling (para 4-48c).

(2) If the same pump is being installed as was removed, use shims (14 and 15) having thicknesses the same as were removed. If a different pump is being installed, provide shim thicknesses which will aline the bearing housing with the flywheel housing of the engine. Slide the pump into engagement with the engine so that the coupling halves are properly alined.

(3) Secure the bearing housing of the pump to the flywheel housing of the engine with nuts (11, fig. P39). Secure the pump feet to the skid with cap screws (8), nuts (9), and lock washers (10), making sure the shims (14 and 15) are in place.

(4) Install the air eliminator valve and related parts (items 1 through 5, fig. 4-39).

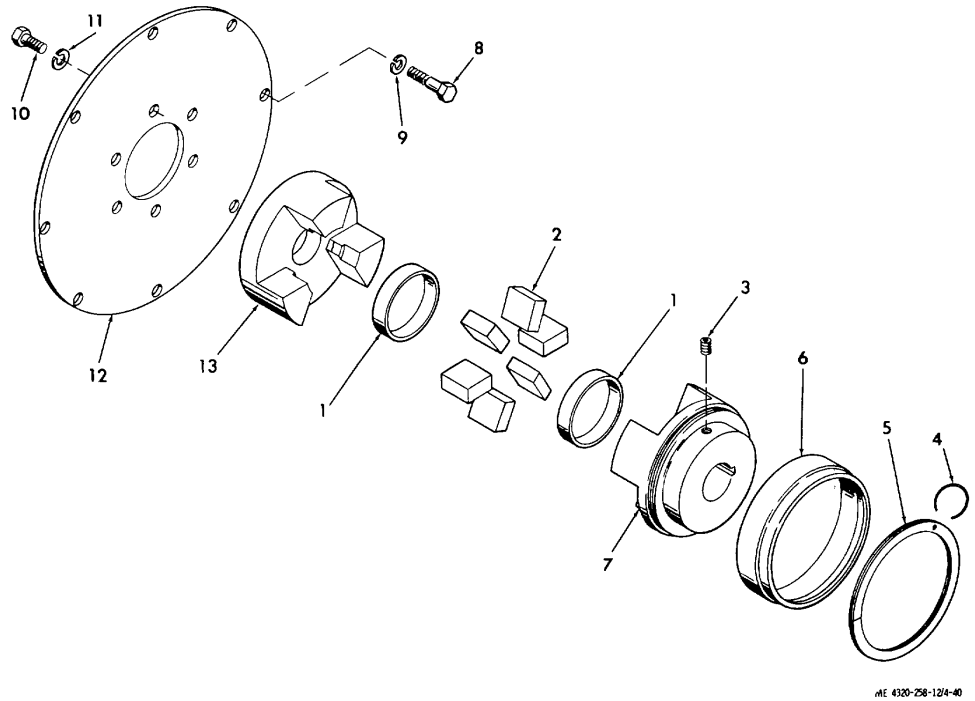
(5) Turn over the engine and pump with the engine crank to make sure there is no binding ' between the pump and engine before restoring the pump assembly to service.

4-48. Flexible Coupling

a. Removal and Disassembly.

(1) Remove the pump from the engine and skid as directed in paragraph 4-47a. The one half of the coupling assembly will remain with the engine; the other half will remain with the pump.

(2) Remove the sleeves (1, fig. 4-40) to release the cushions (2) from the coupling halves (7 and 13).



1. Sleeve
2. Cushion
3. Setscrew
4. Lock wire
5. Retaining ring
6. Collar
7. Pump coupling half
8. Cap screw
9. Lock washer
10. Cap screw
11. Lock washer
12. Drive plate
13. Engine coupling half

Figure 4-40. Pump coupling, exploded view.

(3) Remove the setscrew (3) that secures the coupling half (7) to the pump shaft; remove the coupling half and key.

(4) Remove the lock wire (4) and the retaining ring (5) that secure the collar (6) to the coupling half; remove the collar.

(5) Remove the cap screws (8) and lock washers (9) that secure the drive plate (12) to the engine flywheel; remove the assembled coupling half (13) and drive plate.

(6) Remove the cap screws (10) and lock washers (11) that secure the coupling half (13) to the drive plate (12); remove the coupling half.

b. Cleaning and Inspection.

(1) Clean the six cushions by wiping them with a clean, dry cloth.

(2) Wash all remaining parts with cleaning solvent (fed. spec. P-D-680) ; dry thoroughly.

(3) Inspect the cushions for cracks, wear, brittleness, and deterioration; replace damaged cushions.

(4) Inspect the coupling halves for cracks, worn teeth, worn bores, damaged threads, and other damage; replace damaged coupling halves.

(5) Inspect the drive plate for cracks, distortion, and worn mounting holes; replace a damaged drive plate.

(6) Inspect all other parts for cracks, distortion, and other damage; replace damaged parts.

c. Reassembly and Installation.

(1) Position the coupling half (13, fig. 440) on the drive plate (12); secure with six cap screws (10) and lock washers (11).

(2) Position the assembled drive plate and coupling half on the engine flywheel; secure with eight cap screws (8) and lock washers (9).

(3) Position the collar (6) on the coupling half (7); secure with the retaining ring (5). Make sure the retaining ring is fully seated in the ring groove and install the lock wire (4) in the retaining ring.

(4) Position the assembled coupling half (7) and collar (6) on the end of the pump shaft so that the keyway engages the key on the shaft. Secure with the setscrew (3).

(5) Install three cushions (2) on each coupling half; secure each with a sleeve (1).

(6) Install the pump on the engine and skid (para 4-47c).

Section XV. ENGINE TESTING

4-49. General

Engine testing at organizational maintenance level includes an operational test and a cylinder compression check. Close observation of the engine while operating under load plus a compression check which indicates the condition of the valves, piston rings, and pistons, will provide fairly comprehensive information regarding the condition of the engine. This can be accomplished without the use of any specialized tools other than a compression gage. Perform all daily preventive maintenance services before testing the engine.

4-50. Engine Operational Test

Caution: Make sure pump is primed before starting engine. Running pump dry may damage shaft seal. Refer to paragraph 2-8a(2).

a. Start the engine. The engine starter should turn over the engine freely and easily. The engine must start without excessive cranking. Run the engine long enough to warm it to operating temperature.

b. Check the operating temperature on the engine coolant temperature gage. It must stabilize between 180° and 200° F. Failure to reach this temperature indicates that the thermostat is faulty. Temperatures above this range indicate either a faulty thermostat, clogged or dirty radiator, scale buildup in the block or head, damaged water pump, improper ignition timing, or a faulty lubrication system which is allowing excessive friction in the interior of the engine.

c. Check the oil pressure on the oil pressure gage. At governed speed, the oil pressure must be between 20 and 30 psi. Low oil pressure indicates low engine oil level, clogged screen on the engine lube oil pressure pump, faulty lube oil pump, or improper setting of the oil pressure relief valve. High oil pressure indicates a clogged oil passage or an improperly adjusted oil pressure relief valve.

d. Check the indication of the ammeter. After an initial high charge rate, the ammeter must remain close to the midposition, just slightly to the charge side. A high charge rate indicates a faulty battery, shorted or grounded connection, high resistance connection, or a faulty regulator setting.

A discharge indication of the ammeter may be caused by a faulty alternator, faulty regulator setting, or a shorted or grounded lead.

e. With the engine at full throttle, partially close the valve in the discharge line (if one is provided) so that the indication on the discharge pressure gage is approximately 90 psi. With the engine operating at this loaded condition, check for visible and audible signs of improper operation. Check for excessive smoke from the exhaust system or from the engine breather system. Check for knocks, misfiring, excessive valve tappet noise, backfiring or other signs of faulty operation. Check that the engine maintains governed speed at full load.

f. If the engine fails to operate properly, and correction of the trouble is not within the scope of organizational maintenance, report it to direct support maintenance. A compression test, as described in paragraph 4-51, may help to isolate and identify engine problems.

4-51. Engine Compression Test

a. Ground the primary of the magneto to prevent the engine from starting.

b. Remove the spark plug from the cylinder at which compression is to be tested.

c. Insert the end of the compression testing gage into the spark plug hole and hold it there.

d. With the battery disconnect switch and the ignition switch in the ON positions, press and hold the starter pushbutton long enough to provide about five compression strokes at the cylinder being tested. Note the indicated compression.

e. Repeat the procedure at the remaining five cylinders.

f. Check the noted compression readings. The readings should be fairly consistent for the six cylinders. If one or more cylinders indicate obviously lower compression, check further to isolate the trouble.

g. Pour one teaspoonful of engine oil into the low compression cylinder and recheck compression. A continued low reading indicates a sticking or improperly seating valve. If the reading now approaches normal, it indicates faulty piston rings, scored cylinder walls, or worn pistons.

h. A sticking valve can sometimes be freed by adding a valve lubricant to the engine oil and running the engine. Report erratic engine compression to direct support maintenance.

APPENDIX A

REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users

A-2. Lubrication

C9100-IL	Identification List for Fuels, Lubricants, Oils and Waxes
LO 5-4320-258-12	Lubrication Order for Pump, Centrifugal, Barnes Model US67CCG

A-3. Painting

TM 9-213	Painting Instructions for Field Use

A-4. Radio Suppression

TM 11-483	Radio Interference Suppression

A-5. Maintenance

TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38750	The Army Maintenance Management System.
TM 5-4320-258-12	Operator and Organizational Maintenance Manual for Pump Centrifugal, Barnes Model US67CCG
TM 5-4320-258-20P	Organizational Maintenance Repair Parts Manual for Pump, Centrifugal, Barnes Model US67CCG.
TM 9-6140-200-15	Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type

A-6. Shipment and Storage

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for shipment and storage
TM 740-90-1	Administrative Storage of Equipment

A-7. Destruction of Army Materiel to Prevent Enemy Use

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General

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

b. Section II designates overall responsibility for the performance of maintenance functions on the identified end item or component. The implementation of the maintenance functions upon the end item or component will be consistent with the assigned maintenance functions.

c. Section III contains supplemental instructions, explanatory notes and/or illustrations required for a particular maintenance function.

B-2. Explanation of Columns in Section II

a. Group Number, Column (1). The assembly group is a numerical group assigned to each assembly in a top down breakdown sequence. The applicable assembly groups are listed on the MAC in disassembly sequence beginning with the first assembly removed in a top down disassembly sequence.

b. Assembly Group, Column (2). This column contains a brief description of the components of each assembly group.

c. Maintenance Functions, Column. (3). This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these functions. The symbol designations for the various maintenance categories are as follows:

C-Operator or crew
O-Organizational maintenance
F-Direct support maintenance
H-General support maintenance
D-Depot maintenance

The maintenance functions are defined as follows:

A-Inspect: To determine serviceability of an item by comparing its physical, mechanical, and electrical characteristics with established standards.

B-Test: To verify serviceability and to detect electrical or mechanical failure by use of test equipment.

C-Service: To clean, to preserve, to charge, and to add fuel, lubricants, cooling agents, and air. If it is desired that elements, such as painting and lubricating, be defined separately, they may be so listed.

D-Adjust: To rectify to the extent necessary to bring into proper operating range.

E-Aline: To adjust specified variable elements of an item to bring to optimum performance.

F-Calibrate: To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison 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 with the certified standard.

G-Install: To set up for use in an operational environment such as an emplacement, site, or vehicle.

H-Replace: To replace unserviceable items with serviceable like items.

I-Repair: Those maintenance operations necessary to restore an item to serviceable condition through correction of material damage or a specific failure. Repair may be accomplished at each category of maintenance.

J-Overhaul: Normally, the highest degree of maintenance performed by the Army in order to minimize time work in process is consistent with quality and economy of operation. It consists of that maintenance necessary to restore an item to completely serviceable condition as prescribed by maintenance standards in technical publications for each item of equipment. Overhaul normally does not return an item to like new, zero mileage, or zero hour condition.

K-Rebuild: The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accord-

ance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance category. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.

d. Tools and Equipment, Column (4). This column is provided for referencing by code the special tools and test equipment, (see III) required to perform the maintenance functions (sec II).

e. Remarks, Column (5). This column is provided for referencing by code the remarks (sec IV) pertinent to the maintenance functions.

B-4. Explanation of Columns in Section III,

a. Reference Code. This column consists of two letters separated by a dash, both of which are references to Section II. The first letter references column (5) and the second letter references a maintenance function, column (3), A through K.

b. Remarks. This column lists information pertinent to the maintenance function being performed, as indicated on the MAC, Section II.

Section II. MAINTENANCE ALLOCATION CHART

(1) Group No.	(2) Functional group	(3) Maintenance functions A Inspect	B Test	C Service	D Adjust	E Aline	F Calibrate	G Install	H Replace	I Repair	J Overhaul	K Rebuild	(4) Tools and equipment	(5) Remarks
01	MUFFLER, EXHAUST SYSTEM	C							O					
02	BATTERY AND CARRIER	C		O					O					
03	AIR CLEANER	C		O					O					
04	SWITCHES, HIGH AND LOW PRESSURE	O	F		F				O					
05	CONTROL PANEL Gages and Switches	O							O					
06	ENGINE HOUSING	O							O	O				
07	RADIATOR ASSEMBLY	C	F	O					O	F				
08	WATER PUMP	O		O					O	F				A–I
09	FAN ASSEMBLY & DRIVE BELT	C			O				O					
10	CARBURETOR ASSEMBLY	O			O				O	F				
11	FUEL PUMP	O	O						O					
12	GOVERNOR ASSEMBLY	O			O				O	F				
13	FUEL LINES & FITTINGS	O		O					O					B–C
14	MANIFOLDS, Intake and Exhaust	O							F					
15	OIL FILTERING SYSTEM			O					F					C–C
16	GENERATOR	O	O						O	O				D–I
17	VOLTAGE REGULATOR	O	O		F				O					
18	STARTER ASSEMBLY	O	O						O	O				E–I
19	MAGNETO ASSEMBLY		O		O				O	O				F–I
20	SPARK PLUGS		O	O	O				O					
21	ENGINE ASSEMBLY	O	O	O					F	F	H	D		G–B
22	PUMP ASSEMBLY	O	D	O		O			O	F	H			H–I
23	FUEL TANK	C		C					F					
24	SKID AND RELATED PARTS	O							F					

Section III. REMARKS

Reference code	Remarks
A-I	Repair of water pump is limited to installation of a repair kit.
B-C	Includes servicing fuel filter in lines.
C-C	Service is limited to pressure valve and filter.
D-I	Repair is limited to installation of a repair kit.
E-I	Repair is limited to installation of a repair kit.
F-I	Repair is limited to installation of a repair kit.
G-B	Test includes engine operation and compression check.
H-I	Repair includes use of repair kit for seal assembly.

APPENDIX C

BASIC ISSUE ITEMS LIST

SECTION I. INTRODCUTION

C-1. Scope

This appendix lists items which accompany the pump or are required for installation, operation, or operator's maintenance. Repair Parts and Special Tools assigned maintenance code "C" in the organizational portion of the Maintenance Repair Parts and Special Tools List Manuals, may be stocked at the operator level of maintenance when authorized by the Unit Commander.

C-2. General

This Basic Issue Items List is divided into the following sections:

a. Basic Issue Items-Section II. A list of items which accompany the pump and are required by the crew/operator for installation, operation, or maintenance.

b. Maintenance and Operating Supplies-Section III. A listing of maintenance and operating supplies required for initial operation.

C-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items, Section II.

a. Source, Maintenance, and Recoverability Codes (SMR):

(1) Source code indicates the source for the listed item. Source codes are:

Code	*Explanation*
P	Repair parts, Special Tools and Test Equipment supplied from the GSA/DSA, or Army supply system and authorized for use at indicated maintenance categories.
P2	Repair parts, Special Tools and Test Equipment which are procured and stocked for insurance purposes because the combat or military essentially of the end item dictates that a minimum quantity be available in the supply system.
M	Repair parts, Special Tools and Test Equipment which are not procured or stocked, as such, in the supply system but are to be manufactured at indicated maintenance levels.
A	Assemblies which are not procured or stocked as such, but are made up of two or more units. Such component units carry individual stock numbers and descriptions, are procured and stocked separately and can be assembled to form the required assembly at indicated maintenance categories.
X	Parts and assemblies that are not procured or stocked because the failure rate is normally below that of the applicable end item or component. The failure of such part of assembly should result in retirement of the end item from the supply system.
X1	Repair parts which are not procured or stocked. The requirement for such items will be filled by use of the next higher assembly or component.
X2	Repair parts, Special Tools and Test Equipment which are not stocked and have no foreseen mortality. The indicated maintenance category requiring such repair parts will attempt to obtain the parts through cannibalization or salvage, if not obtainable through cannibalization or salvage, the item may be requisitioned with exception data, from the end item manager, for immediate use.
G	Major assemblies that are procured with PEMA funds for initial issue only as exchange assemblies at DSU and GSU level. These assemblies will not be stocked above DS and GS level or returned to depot supply level.

Note. Cannibalization or salvage may be used as a source of supply for any items source coded above except those coded X1 and aircraft support items as restricted by AR 700-42.

(2) Maintenance code indicates the lowest category of maintenance authorized to install the listed item. The maintenance level code is:

Code	*Explanation*
C	----------Crew/Operator

(3) Recoverability code indicates whether unserviceable items should be returned for recovery or salvage. Items not coded are nonrecoverable. Recoverability codes are:

Code	*Explanation*
R	Applied to repair parts, (assemblies and components) special tools and test equipment which are considered economically reparable at direct and general support maintenance levels. When the item is no longer economically reparable, it is normally disposed of at the GS level. When supply considerations dictate, some of these repair parts may be listed for automatic return to supply for depot level repair as set forth in AR 71040. When so listed, they will be replaced by supply on an exchange basis.
S	Repair parts, special tools, test equipment and assemblies which are economically reparable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically reparable, they will be evacuated to a depot for evaluation and analysis before final disposition.
T	High dollar value recoverable repair parts, special tools and test equipment which are subject to special handling and are issued on an exchange basis. Such items will be evacuated to the depot for overhaul or final disposition. Communication-Electronics and Missile Support items will be repaired/overhauled only at depots.
U	Repair parts, special tools and test equipment specifically selected for salvage by reclamation units because of precious metal content, critical materials, high dollar value or reusable casings or castings.

b. Federal Stock Number. This column indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the Federal item name and any additional description of the item required. The abbreviation "w/e", when used as a part of the nomenclature, indicates the Federal stock number, includes all armament, equipment, accessories, and repair parts issued with the item. A part number or other reference number is followed by the applicable five-digit Federal supply code for manufacturers in parenthesis. The usable on codes indicate different model and serial number application. Repair parts quantities included in kits, sets, and assemblies are shown in front of the repair part name.

d. Unit of Measure (U/M). A two-character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Incorporated in Unit. This column f indicates the quantity of the item used in the \parassembly group. A "V" appearing in this column in lieu of a quantity indicates that a definite quantity cannot be indicated (e.g. shims, spacers, etc.).

f. Quantity Furnished With Equipment. This column indicates the quantity of an item furnished with the equipment.

g. Illustration. This column is divided as follows:

(1) Figure number. Indicates the figure number of the illustration in which the item is shown.

(2) Item number. Indicates the callout number used to reference the item in the illustration.

C-4. Explanation of Columns in the Tabular List of Maintenance and Operating Supplies-Section III

a. Component Application. This column identifies the component application of each maintenance or operating supply item.

b. Federal Stock Number. This column indi\parcates the Federal stock number assigned to the item and will be used for requisitioning purposes.

c. Description. This column indicates the item name and brief description.

d. Quantity Required for Initial Operation. This column indicates the quantity of each maintenance or operating supply item required for initial Operation of the equipment.

e. Quantity Required for Eight Hours Operation. This column indicates the estimated quantities required for an average 8 hours of operation.

f. Notes. This column indicates informative notes keyed to data appearing in a preceding column.

Section II. BASIC ISSUE ITEMS

(1) SMR Code	(2) Federal stock number	(3) Description Ref No. & mfr code Usable on code	(4) Unit of meas unit	(5) Qty inc in equip	(6) Qty furn with No.	(7) Illustration (A) Fig No.	(7) Illustration (B) Item
PC	7510-889-3494	BINDER, Looseleaf	ea		1		
PC	7520-559-9618	CABLE, Operator and maintenance publications	ea		1		
		ARMY TECHNICAL MANUAL TM 5-4320-258-12			1		
		ARMY LUBRICATION ORDER LO 6-4320-258-12			1		

Section III. MAINTENANCE AND OPERATING SUPPLIES

(1) Component application	(2) Federal stock number	(3) Description	(4) Quantity required F/initial operation	(5) Quantity required F/8 hours operation	(6) Notes
CRANKCASEOIL,	9150-246-7923(1) 9150-242-7603(1)	ENGINE OE 30, 5 gal pail OES, 5 gal pail (3)	5½ qts (2)		(1) See C9100-IL for additional requisitioning data
GREASE CUPS	9150-190-0904(1)	GREASE, AUTO & ARTY GAA 1 lb can			(2) Crakcase capacity
ENGINE	9130-160-1818(1)	GASOLINE, BULK			(3) Use OES in temperatures below O0F

By Order of the Secretary of the Army:

W. C. WESTMORELAND,
General, United States Army,
Chief of Staff.

Official:

VERNE L. BOWERS,
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 1225, (qty rqr block No. 153) operator maintenance requirements for Petroleum Distribution.

* U.S. GOVERNMENT PRINTING OFFICE: 1971-769-157/56021

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

THEN...JOT DOWN THE DOPE ABOUT IT ON THIS FORM. CAREFULLY TEAR IT OUT, FOLD IT AND DROP IT IN THE MAIL.

SOMETHING WRONG WITH PUBLICATION

FROM: (PRINT YOUR UNIT'S COMPLETE ADDRESS)

DATE SENT

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE

BE EXACT PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.

IN THIS SPACE, TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT.

PRINTED NAME, GRADE OR TITLE AND TELEPHONE NUMBER	SIGN HERE

DA FORM 1 JUL 79 2028-2

PREVIOUS EDITIONS ARE OBSOLETE.

P.S.--IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR RECOMMENDATION MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

The Metric System and Equivalents

Linear Measure

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

Weights

1 centigram = 10 milligrams = .15 grain
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 decagram = 10 grams = .35 ounce
1 hectogram = 10 decagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliters = .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

To change	*To*	*Multiply by*	*To change*	*To*	*Multiply by*
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

PIN: 008487-000