DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT, GENERAL SUPPORT, AND DEPOT MAINTENANCE MANUAL

PUMP, CENTRIFUGAL, PETROLEUM PIPELINE, G. E. D., SKID MOUNTED, 500 GPM TO 1400 GPM (JOHN REINER MDL GP 110-5)

FSN 4320-063-7368

This copy is a reprint which includes current pages from Changes 2 and 3.

HEADQUARTERS , DEPARTMENT OF THE ARMY
JULY 1968

SAFETY PRECAUTIONS

BEFORE OPERATION

When filling battery, use rubber gloves and avoid spilling electrolyte on clothing or skin to avoid serious burns. Any spilled acid must be immediately washed away with water.

When handling fuel, always provide a metal-to-metal contact between container and tank to prevent a spark and consequent fire hazard as fuel flows over the metallic surfaces.

Rules prohibiting smoking must be established and strictly enforced. NO SMOKING signs must be prominently posted and obeyed.

The centrifugal pump must be properly grounded before operating. Ungrounded units can product electrical sparks which may ignite gasoline vapor, resulting in fire or explosion.

Do not use a lifting device with a capacity of less than 10,000 pounds. Do not allow the equipment to swing back and forth while suspended. Failure to observe this warning can result in both damage to the unit and severe injury or death to personnel.

DURING OPERATION

Do not operate the centrifugal pump indoors unless gases are properly piped to the outside. Carbon monoxide in the exhaust is odorless and invisible, but a deadly poison if inhaled.

Rules prohibiting smoking must be strictly enforced. NO SMOKING signs must be prominently displayed and obeyed.

AFTER OPERATION

When handling fuel, always provide a metal-to-metal contact between container and tank to prevent a spark and consequent fire hazard as fuel flows over the metallic surfaces.

Rules prohibiting smoking must be strictly enforced. NO SMOKING signs must be prominently displayed and obeyed.

Clean all traces of gasoline from fuel tank before soldering or welding. Make sure tank is completely filled with clean water to eliminate all fumes which might cause explosion.

CHANGES IN FORCE: C 2 AND C 3

TM 5-4320-24S-15
C 3

Change

No. 3

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *29 April 1974*

Operator, Organizational, Direct Support,

General Support, and Depot Maintenance Manual

PUMP, CENTRIFUGAL; PETROLEUM PIPELINE; GED;

SKID MOUNTED; 500 GPM TO 1,400 GPM

(JOHN REINER MDL GP 110-5)

FSN 4320-063-7368

TM 54320-243-15, 8 July 1968, is changed as follows:

Inside Front Cover. Add the following warnings to the list of safety precautions:

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

Page 1-1. Paragraph 1-1*d* is superseded as follows:

d. You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter or DA Form 2028 (Recommended Changes to DA Publications and Blank Forms) should be mailed direct to Commander, US Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Blvd., St. Louis, MO 63120. A reply will be furnished directly to you.

Page 2-10. Immediately after section IV's title, add the following warning:

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.

Page 3-1. Immediately after chapter 8's title, add the following warning:

WARNING
Drycleaning solvent, P-D-80, used to clean parts, is potentially dangerous to personnel and property. Do not Use it near an open flame or excessive beat. The flash point of solvent is 100° F. to 138° F.

Page A-1. In paragraph A-4, appendix A, references, add the following:

TB MED 251, Noise and Conservation of Hearing.

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 12-35A (qty rqr block No. 154), Organizational Maintenance Requirements for Petroleum Distribution.

TM 5-4320-243-15
***C 2**

CHANGE
No. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 14 March 1973

**Operator, Organizational, Direct Support,
General Support and Depot
Maintenance Manual**

**PUMP, CENTRIFUGAL; PETROLEUM PIPELINE; GED;
SKID MOUNTED; 500 GPM TO 1,400 GPM
(JOHN REINER MDL GP 1 1-5)
F5N 4320-063-7368**

TM 5-4320-243-15, 8 July 1968, is changed as follows:

Page B-1. Appendix B is superseded as follows:

**APPENDIX B
BASIC ISSUE ITEMS LIST AND ITEMS
TROOP INSTALLED OR AUTHORIZED
Section 1. INTRODUCTION**

B-1. Scope

This appendix lists items required by the operator for operation of the centrifugal pump.

B-2. General

This list is divided into the following sections:

a. Basic Issue Items List-Section II. Not applicable.

b. Items Troop Installed or Authorized List-Section III. A list of items in alphabetical sequence, which at the discretion of the unit commander may accompany the centrifugal pump. These items are NOT SUBJECT TO TURN-IN with the centrifugal pump when evacuated.

B-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Basic Issue Items List, Section II, and Items Troop Installed or Authorized, Section III.

a. Source, Maintenance, and Recoverability Code (SMR). Not applicable.

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.

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. Quality Furnished with Equipment (BIIL). Not applicable.

f. Quantity Authorized (Items Troop Installed or Authorized). This column indicates the quantity of the item authorized to be used with the equipment.

* This change supersedes C 1, 11 April 1969.

Section III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST				
(1) SMR code	(2) FEDERAL STOCK NUMBER	(3) Description Ref No. & mfr code / Unable on code	(4) Unit of Meas	(5) Qty auth
	7520-59-9618	CASE: Maintenance and Operation Manual	EA	1

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. 242) organizational maintenance requirements for Pumps: Fresh Water.

TECHNICAL MANUAL

No. 5-4320-243-15

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *8 July 1968*

Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual

PUMP, CENTRIFUGAL, PETROLEUM PIPELINE, G.E.D., SKID MOUNTED, 500 GPM TO 1400 GPM (JOHN REINER MODEL GP 110-5) FSN 4320-063-7368

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

a. These instructions are published for use by-personnel to whom the Reiner Centrifugal Pump, Model GP 110-5 is issued. Chapters 1 through 3 provide information on operation, preventive maintenance services, and organizational maintenance of equipment, accessories, components and attachments. Chapters 4 through 7 provide information for direct and general support and depot maintenance and repair. Also included are descriptions of main units and their functions in relationship to other components.

b. Appendix A contains a list of publications applicable to this manual. Appendix B contains a list of basic issue items authorized the operator of this equipment and the list of maintenance and operating supplies required for initial operation. Appendix C contains the maintenance allocation chart. Organizational, direct and general support and depot maintenance repair parts and special tools are listed in TM 5-4320-243-20P and 4320-243-35P.

c. Numbers in parentheses following nomenclature callouts on illustrations indicate quantity; numbers preceding nomenclature callouts indicate preferred maintenance sequence.

d. 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 Changes to DA Publications and forwarded direct to Commanding General, U.S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120.

e. Report all equipment improvement recommendations as prescribed by TM 38-750.

1-2. Record and Report Forms

a. DA Form 2258 (Depreservation Guide for Vehicles and Equipment).

b. For other record and report forms applicable to operator, crew, and organizational maintenance, refer to TM 38-750.

Note

Applicable forms, exclusive of Standard Form 46 (United States Government Motor Vehicles Operator's Identification Card) which is carried by the operator, shall be kept in a canvas bag mounted on the equipment.

Section II. DESCRIPTION AND TABULATED DATA

1-3. Description

a. General. The Reiner Centrifugal Pump, Model GP 110-5 (figs. 1-1, 1-2, 1-3, and 1-4) is a self-contained, skid-mounted, gasoline engine-driven pump unit designed for petroleum pipeline service. The 6-cylinder engine (fig. 1-1) is directly connected to the pumping assembly (fig. 1-2) by the engine and pump couplings (fig. 1-1). All instruments and controls necessary for operation are mounted on the control panel (fig. 1-4).

b. Engine. The Continental Engine Model RS633 is a 6-cylinder, 4-stroke/cycle, liquid cooled, overhead-valve gasoline engine (fig. 1-1) developing 142 rated horsepower at full load speed of 2,200 rpm. When used with the 6-inch flange adapters or the 6-inch Y fittings, the governed engine speed is 2,100 rpm. An

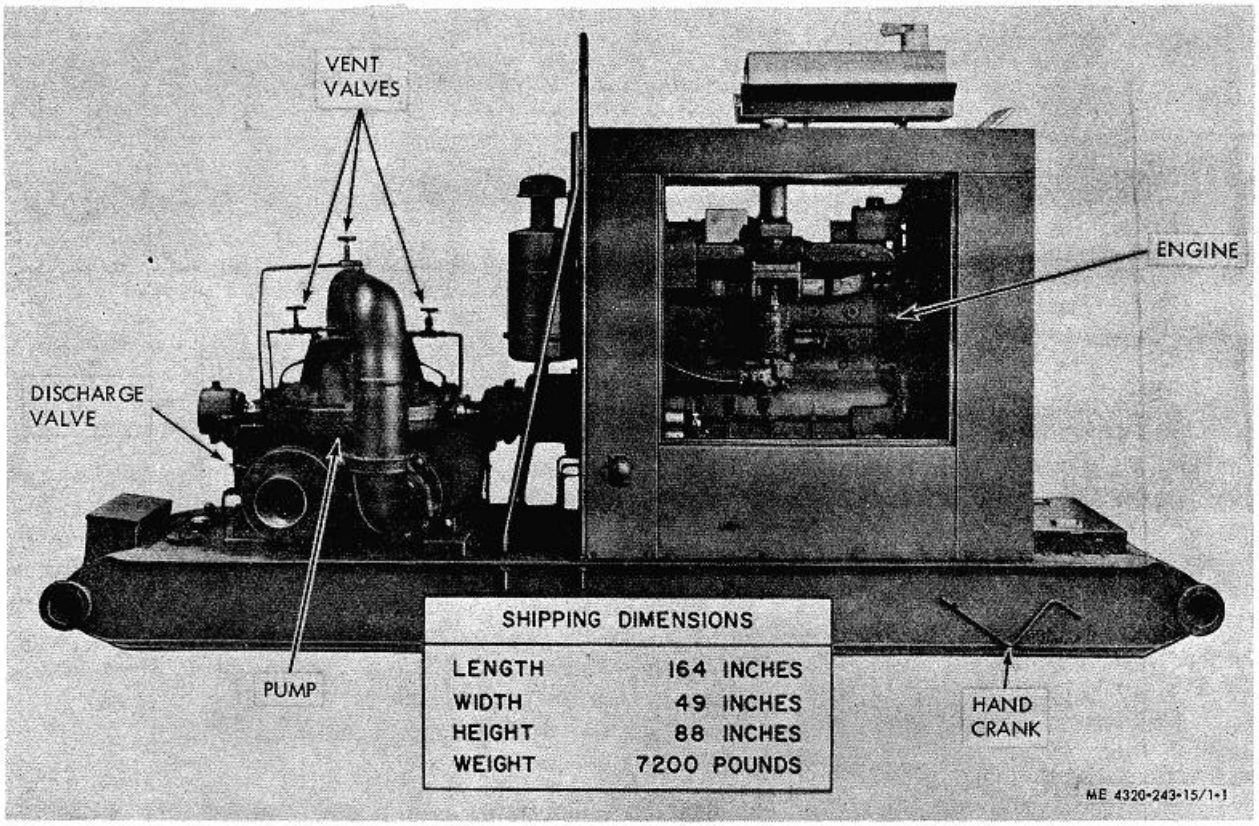


Figure 1-1. Centrifugal pump, right side view.

automatic overflow shutoff in the fuel tank (fig. 1-4) permits continuous operation.

c. Pump. The Patterson Centrifugal Pump Assembly is a 2-stage, 6-inch petroleum pump (fig. 1-2) series rated at 500 8pm at 555-ft. head, or 1,400 8pm at 276-ft. head; parallel rated at 900 8pm at 275-ft. head, or 2,000 8pm at 225-ft. head. An intake valve (fig. 1-2) and discharge valve (fig. 1-1) are mounted on the pump to enable measurement of the intake and discharge pressures.

1 4. Identification and Tabulated Data

a. Identification. The centrifugal pump has two major identification plates. The information on these plates is listed below.

(1) *Unit plate.*

Nomenclature..... Pump, Centrifugal, GED 600 GPM at 655 foot head 2100 RPM 1,400 GPM at 275 foot head 2100 RPM
Model..... GP 110-5
Year of Manufacture..... 1968
Federal Stock Number ... 4320-063-7368
Part No. 13207E9323
Contract Number..... DAAK01-67-C-A669
Shipping Weight..... 7,200 pounds
Length..... 12' 11"
Width ..... 3' 2"
Height ..... 6' 10 % "
Manufactured by ..... John Reiner & Co., Inc.

(2) *Engine plate*.

Eng. Mfr. ..... Continental Motor Corp.
Model..... RS633
Spec 6008
Tappet Clearance..... Exhaust 0.024 Intake 0.018
Rated Horsepower..... 142
At full load speed ..... 2,200 rpm.

b. Tabulated Data.

(1) *General.*

Manufacturer..... John Reiner & Co., Inc.
Model..... GP 110-6
Type..... Portable Gasoline Engine Driven
Serial Number..... 19250 (through 19337), 19660, 19561
Mount..... Skid

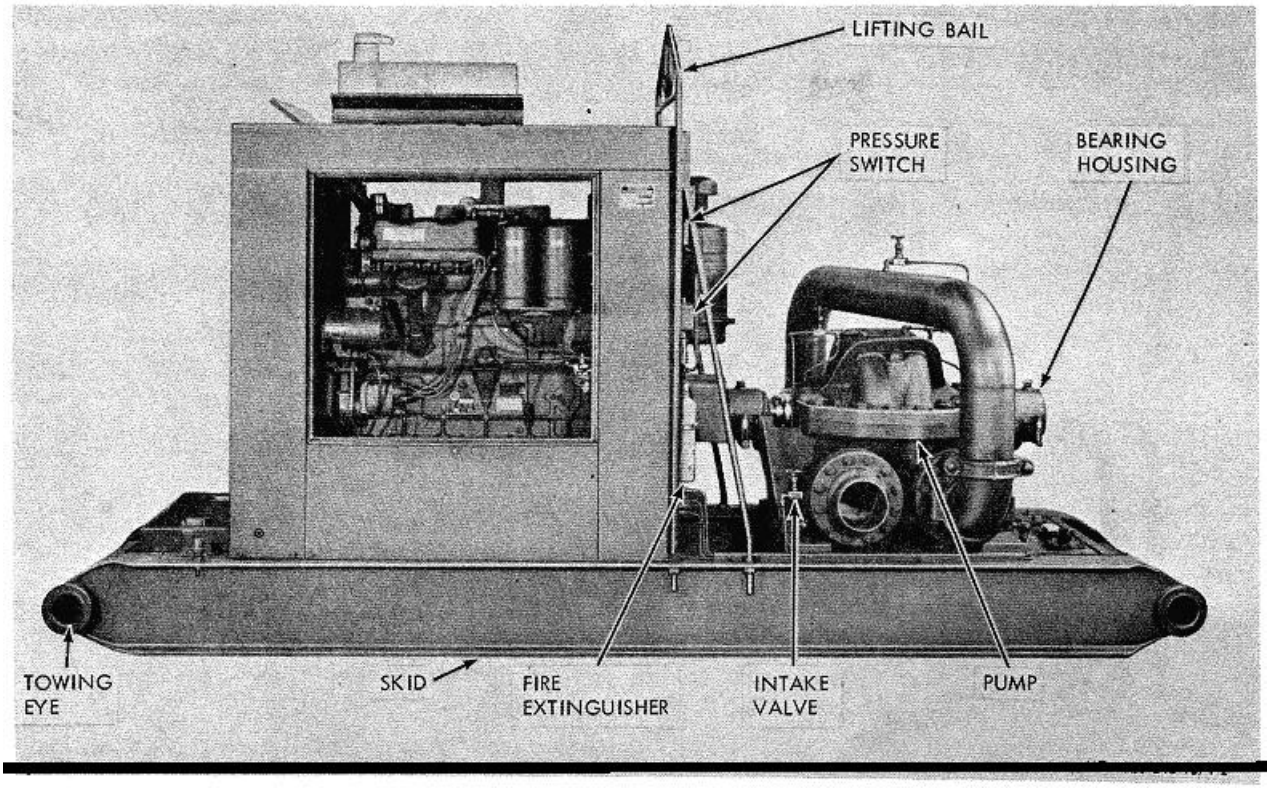


Figure 1-2. Centrifugal pump, left side view.

(2) *Engine.*

Manufacturer	Continental Motors Corp.
Type	Gasoline, valve-in-head
Model	RS 633
Bore	5.000 in. (inch)
Stroke	5.375 in.
Fuel	Gasoline
Piston Displacement	633 cu. (cubic) in.
Specification Number	6008
Compression	6.4 to 1
Cycles	4
Number of Cylinders	6
Cooling	Liquid
Normal Operating Range	160° to 210° F
Rated Horsepower	142 at 2,200 rpm
Firing Order	1-5-3-6-2

(3) *Pumping assembly*.

Manufacturer	Patterson Pump Corp.
Type	Centrifugal
Flange	6 in.
Rotating element	2 stage
Case	Horizontally split
Liquids pumped	Petroleum
Rated 8pm at 555 foot-head	500
Rated 8pm at 275 foot-head	1,400
Drive	Direct

(4) *Engine accessories.*

(a) Magneto.

Manufacturer	Slick Electro Co.
Model	626
Type	Flange Mounted

(b) Carburetor.

Manufacturer	Zenith Carburetor Division of Bendix Aviation Corp.
Model	63AW16 Outline 12653
Type	Updraft

(c) Air cleaner.

Manufacturer	Donaldson
Model	MS35875-5
Type	Oil Bath

(d) Generator.

Manufacturer	Delco-Remy
Model	MS13823
Volts	24

(e) Fuel pump.

Manufacturer	AC Spark Plug Division of General Motors Corp.
Model	ER (5594169)
Type	Hand Printing, cam actuated

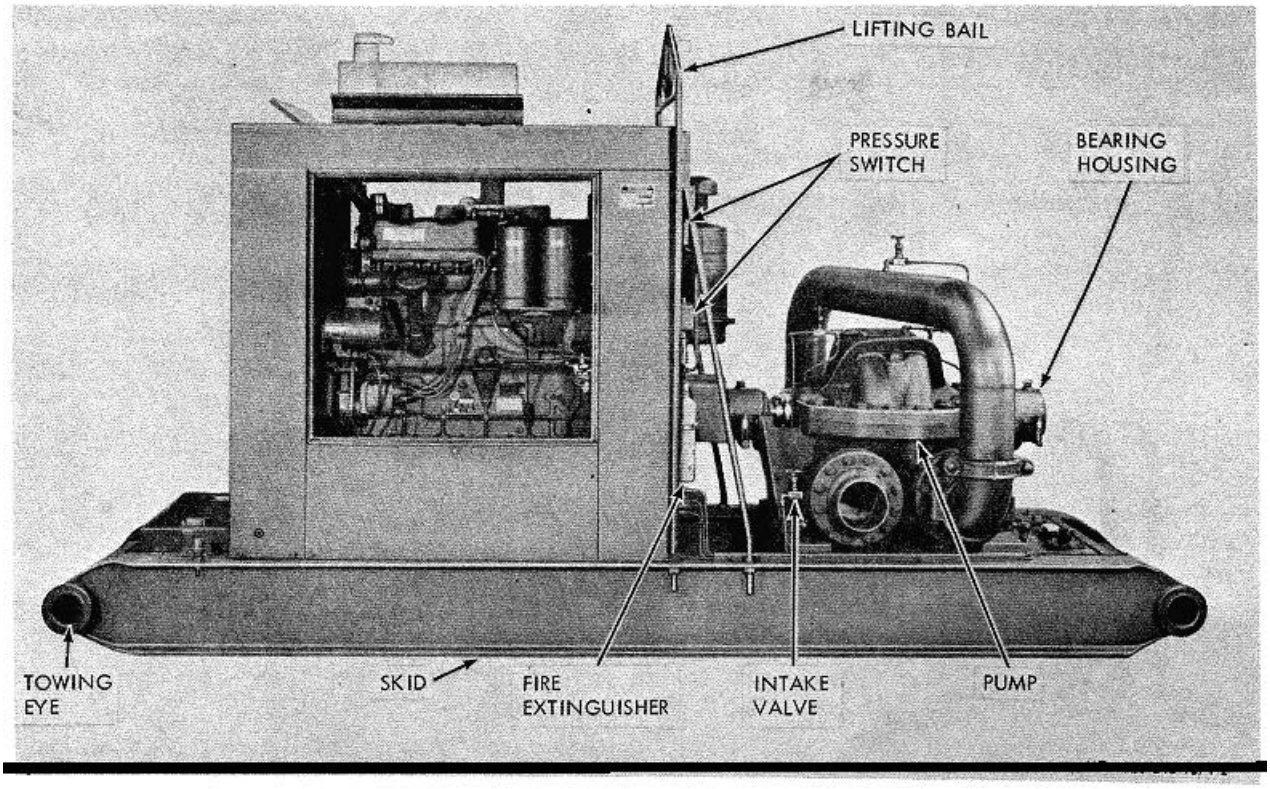


Figure 1-2. Centrifugal pump, right front view.

(f) Spark plugs.

Manufacturer	Ford Motor Co.
Type	BR 9 S (MS-61009-1)
Size	18-mm (millimeter)
Gap	0.030 in.

(g) Starter.

Manufacturer	Delco-Remy Division of General Motors Corp.
Model	1113143
Volts	24

(h) Engine generator regulator.

Manufacturer	Delco-Remy Division of General Motors Corp.
Model	MS13805
Volts	24
Ground Polarity	Negative

(i) Governor.

Manufacturer	Pierce Governor Co.
Model	GC-3379
Type	Centrifugal Flyweight

(j) Batteries (2).

Type	MS36000-3
Volts	12 v
Capacity	100 amp hr. (ampere hours) at 5 ampere discharge rate

(k) Oil filter assemblies.

Manufacturer	Fram Corporation
Model	F 36-PL
Type	Replacement Element
Element	MS35345-1

(5) *Capacities*.

Fuel Tank	25 gal. (gallon)
Radiator	60 qts. (quarts)
Crankcase	15 qts
Air Cleaner	2 qt
Two Oil Filters	1 1/2 qt. ea. (each)
Two Pump Bearings	1/2 qt. ea.

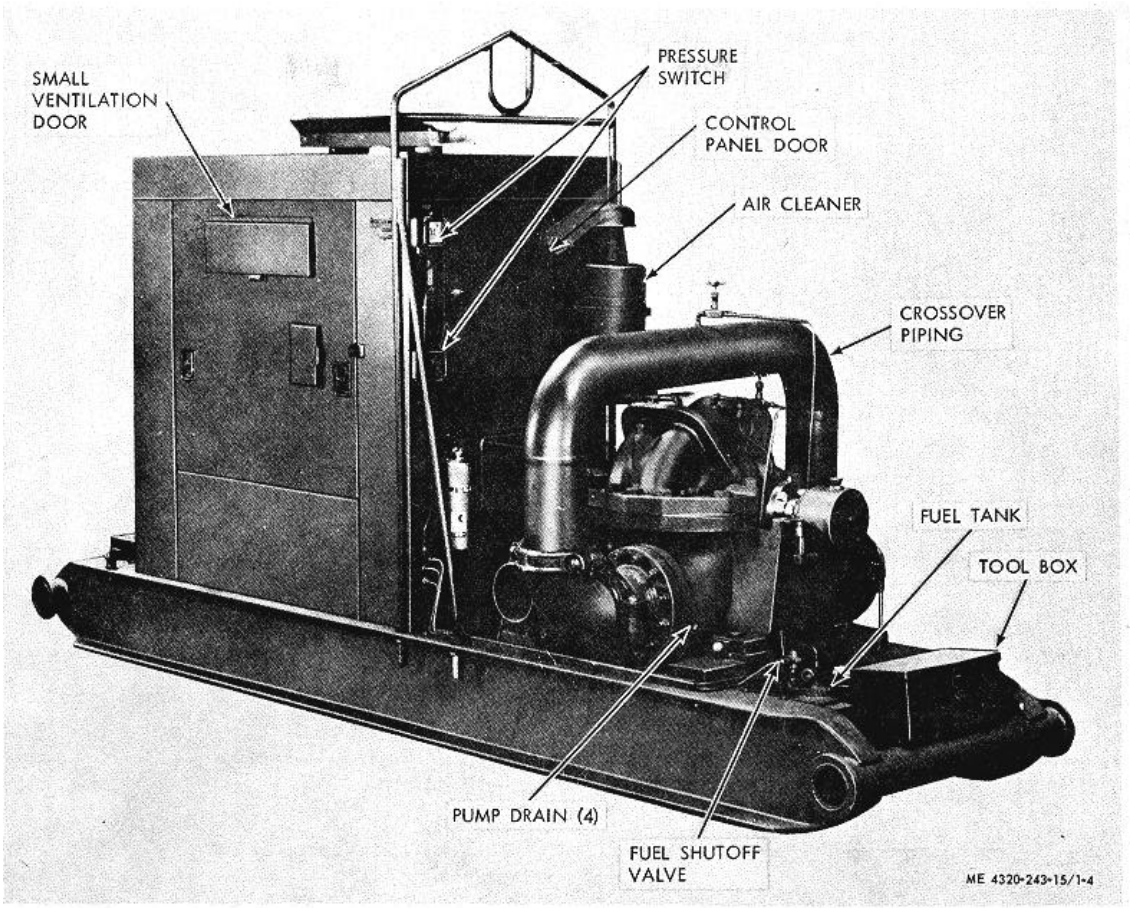


Figure 1-4. Centrifugal pump, left rear view.

(6) *Nut and bolt torque data.*

Size	*Limit in Foot Pounds Torque*
(a) Cylinder Heads	
1/2	100-110
(b) Main Bearing Caps and Connecting Rods.	
1/2	85-95
(c) Flywheels.	
5/8	145-155
(d) Manifolds.	
1/2	50-60
7/16 to 5/8 End Nuts	35
(e) Gear Cover, Water Pumps Front &Rear End Plat , Oil Pans.	
3/8	25-30
7/16	50-55
1/2	80-90

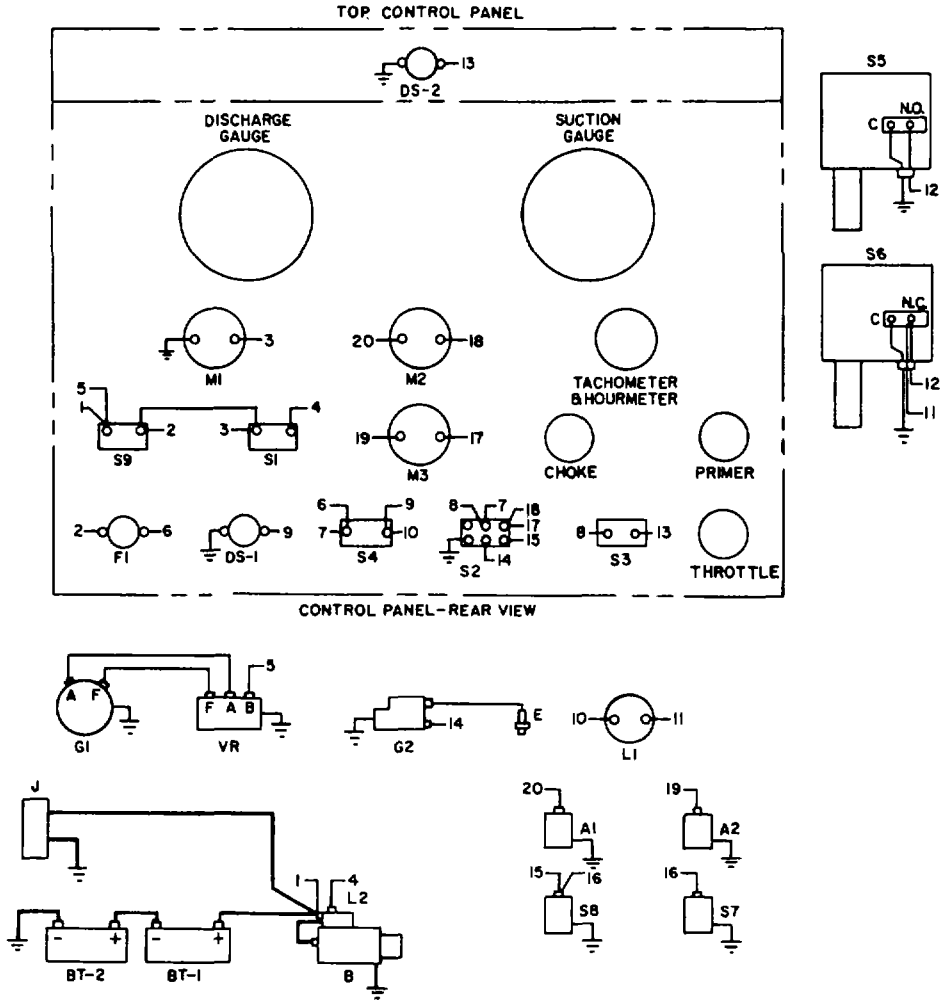
Size	*Limit in Foot Pounds Torque*
(f) Flywheel Housings.	
1/2	80-90
(g) Spark Plugs.	
1/2	30-35

(7) *Adjustment data*.

Rocker arm clearance, intake, cold	0.020
Rocker arm clearance, intake, hot	0.018
Rocker arm clearance, exhaust, cold	0.026
Rocker arm clearance, exhaust, hot	0.024
Magneto breaker points	0.008 to 0.012
Pump high-pressure switch setting	90/1000 psi (pounds per square inch)
Pump low-pressure switch setting	90/1000 psi

(8) *Dimensions and weight*.

Length	153.5 in.
Height	83.75 in.
Width	38 in. (without fittings)
Weight	7,200 pounds (shipping weight)
Volume	450 cu. ft. (boxed)



LEGEND	
SYM	DESCRIPTION
A1	SEND UNIT - OIL PRESS.
A2	SEND UNIT - WATER TEMP.
B	STARTER MOTOR
BT-1&2	BATTERY - 12 VOLT
DS-1	IND. LIGHT - PUMP SAFETY SW.
DS-2	PANEL LIGHT
E	SPARK PLUG
F	FUSE
G1	GENERATOR - BATTERY CHARGING
G2	MAGNETO
J	RECEPTACLE-BATTERY CHARGING
L1	SOLENOID - THROTTLE
L2	SOLENOID - STARTER

LEGEND	
SYM	DESCRIPTION
M1	VOLT METER- BATTERY - GENERATOR
M2	GAUGE - OIL PRESS.
M3	GAUGE - WATER TEMP.
S1	SWITCH - PUSH BUTTON - STARTER
S2	SWITCH - ENGINE SAFETY
S3	SWITCH - PANEL LIGHT
S4	SWITCH - PUMP SAFETY
S5	SWITCH - PUMP PRESS. - HIGH
S6	SWITCH - PUMP PRESS. - LOW
S7	SWITCH - HIGH WATER TEMP.
S8	SWITCH - LOW OIL PRESS.
S9	SWITCH - IGNITION
VR	VOLTAGE REGULATOR

ME 4320-243-15/1-5

Figure 1-5. Wiring diagram.

(9) *Wiring*. The complete wiring diagram will be found in figure 1-5.

(10) *High-pressure switch*.

Manufacturer..... Square D Co.
Type ACW-7S
Class 9012
Range ..... 90-900 psi

(11) *Low-pressure switch.*

Manufacturer..... Square D Co.
Type ACW-7S
Class 9012
Range ..... 90-900 psi

1-5. Difference in Models

This manual covers only the Reiner Centrifugal Pump, Model GP-110-5. No known unit differences exist for the model covered by this manual.

CHAPTER 2

INSTALLATION AND OPERATIN!G INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

2-1. Unloading Equipment

Remove all restricting tie-down strapping and/or blocking securing crate to carrier. Offload crate with sling or fork lift having a minimum lifting capacity of 10,000 lbs.

Warning

: Do not use a lifting device with a capacity of less than 10,000 pounds. Do not allow the equipment to swing back and forth while suspended in the air. Failure to observe this warning can result in damage to the equipment and in severe injury or death to personnel.

a. When off-loading using a sling, attach sling assembly only under skid base.

b. When loading with fork lift from either side lift only under the area marked "center of balance".

2-2. Unpacking Equipment

Unpack the equipment, following the steps below in sequence:

a. Remove crate down to the under skid, taking care not to damage the equipment.

b. Remove lifting bail from its transport position and install in vertical position through holes in steel skid. Use attaching hardware as furnished. Pull up nuts on bail firmly. Remove all nuts securing steel skid to wooden skid.

c. Attach lifting hook of a 10,000-pound minimum capacity crane to the lifting bail, and lift pump vertically off the wooden skid.

d. Remove tiedown strapping securing the elbows, crossover assembly and pipe couplings and remove from the skid.

e. Remove all barrier material, tape and miscellaneous protective packing materials from the unit and accessories.

f. Wipe the preservatives from the following items, using an approved cleaning solvent:

(1) Control wires and linkage.

(2) Other parts coated with preservative material.

g. Drain all preservation from the following items:

(1) Fuel tank

(2) Crankcase

(3) Pump assembly

(4) Air cleaner

h. Inspect all items (para 2-3).

2-3. Inspecting and Servicing Equipment

a. Inspecting the Equipment.

(1) Inspect the pump for loose components or damage that may have occurred during shipment.

(2) Inspect all lines, hoses, fittings, and plugs to see that they are secure and tight.

(3) Inspect and tighten or replace any loose or missing nuts, bolts or screws.

(4) Inspect the controls, instruments, gages and valves for damage, loose mounting, or binding. Replace damaged parts, tighten loose mountings, and free-up and binding of levers and linkage.

(5) Inspect all accessible wiring for loose connections, cuts, burns, frayed insulation and damaged terminals or shielding. Replace damaged wiring or terminals.

(6) Inspect the engine air-cooling system for bent or missing air shrouds.

(7) After servicing as prescribed below, crank the engine several times to make sure engine and magneto are free.

(8) Inspect publications for completeness. Inspect toolbox for damage and loose mounting.

(9) Inspect fire extinguisher. Be sure it is fully charged and in operating condition (para 2-20).

(10) Inspect muffler for holes, corrosion, loose mounting.

b. Servicing the Equipment.

(1) *Lubrication*. Refer to LO 5-4320243-12 for lubrication of engine. Lubricate pump assembly in accordance with Lubrication order (fig. 3-1).

(2) *Preventive maintenance*. Perform the daily preventive maintenance services (para 3-6).

(3) *Battery*. Fill the battery with electrolyte to 3/8 inch above the plates. The specific gravity, checked with hydrometer, must read 1.280 or higher at a temperature of 80° F. Refer to TM 9-6140-200-15 for further information on service and care of batteries.

Warning
Take precautions against spilling electrolyte on clothing, or allowing it to come in contact with skin, to prevent burns. Use rubber gloves when filling battery.

(4) *Cold weather servicing*. Lubricate equipment in accordance with lubrication order (fig. 3-1). Add sufficient anti-freeze to lower the freezing point of the radiator coolant to a safe margin below the anticipated temperature of the surrounding air, as shown in table 2-1.

Note
Fasten a tag near the radiator filler cap indicating the type antifreeze.

2-4. Installation of Separately Packed Components

a. Fill batteries with electrolyte as directed in paragraph 2-3.

b. Install the batteries as shown in figure 2-1.

c. Install the muffler as shown in figure 2-2.

d. Install the fire extinguisher (fig. 2-3).

2-5. Setting-Up Instructions

a. Outdoor Installation. Where conditions permit, avoid a muddy, sandy or dusty site. If unit must be installed on soft ground, arrange a foundation of planking, logs or concrete.

b. Indoor Installation. Make sure the floor will support a total weight of 10,000 pounds. Provide at least four feet of space on all sides

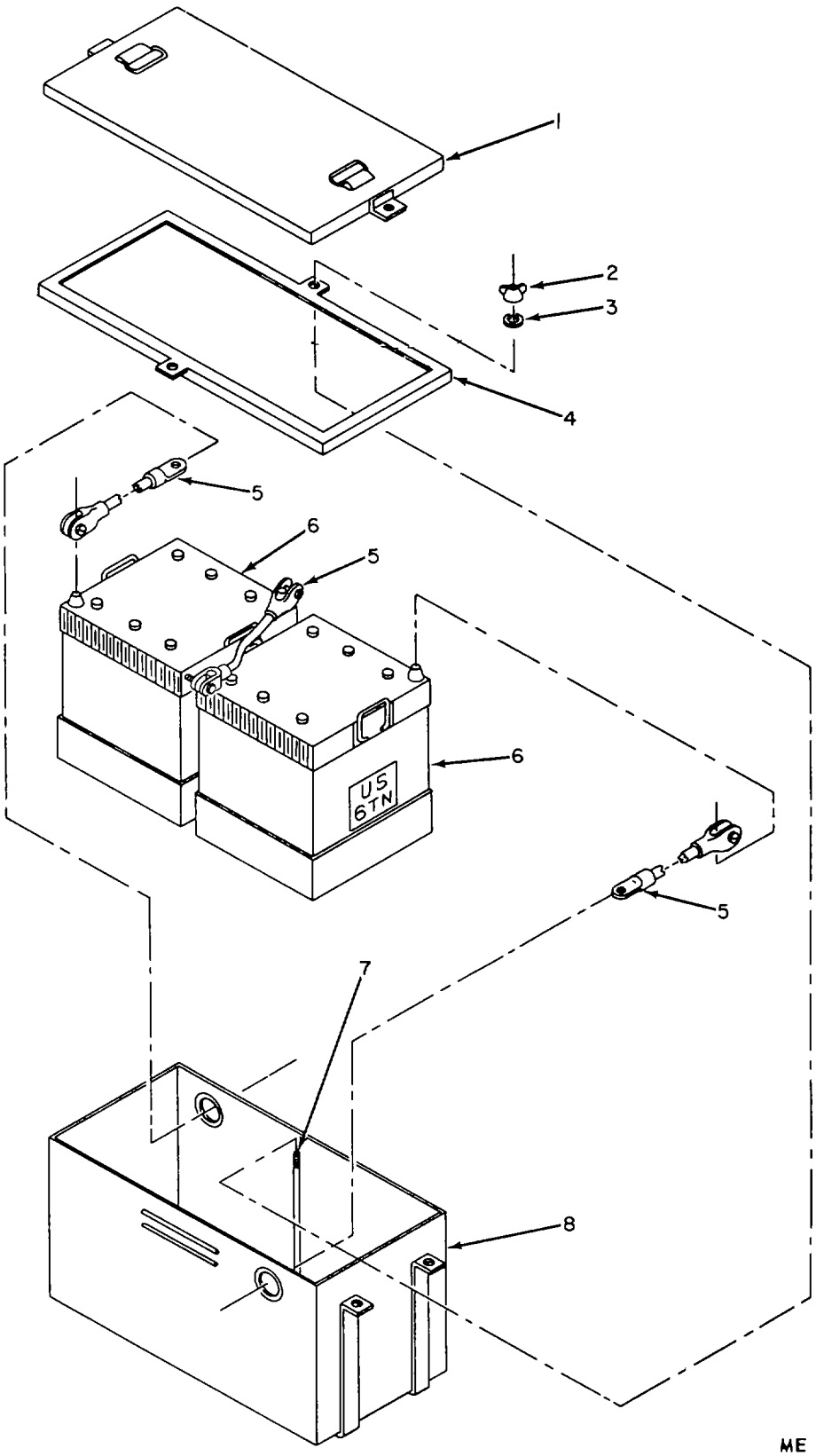
Table 2-1. Freezing Points, Composition, and Specific Gravities of Military Antifreeze Materials

Lowest expected ambient temp. °F	Pints of inhibited glycol per gal. of coolant [1]	Compound, Antifreeze Artic [2]	Ethylene glycol coolant solution specific gravity at 68° F.[3]
+20	112	Issued full strength and ready mixed for 0 to	1.022
+10	2	65° F temperatures for both initial instal-	1.036
0	2a	lation and replenishment of losses	1.047
-10	3 1/4		1.055
-20	3 1/2		1.062
-30	4		1.067
-40	4 1/4		1.073
-50	Arctic Anti-	DO NOT DILUTE WITH WATER OR ANY	
-60	freeze	OTHER SUBSTANCE	
-75	preferred		

[1]Maximum protection is obtained at 60 percent by volume (4.8 pints of ethylene glycol per gallon of solution).

[2]Military Specifications MIL-C-11755 Arctic type, nonvolatile antifreeze compound is intended for use in the cooling system of liquid cooled internal combustion engines. It is used for protection against freezing primarily in Arctic regions where the ambient temperature remains for extended periods close to -40°F or drops below, as to low as -90°F.

[3]Use an accurate hydrometer. To test hydrometer, use 1 part ethylene klycol antifreeze to 2 parts seater. This should produce a hydrometer reading of 0° F.



1 Cover
2 Wingnut (2)
3 Washer (2)
4 Battery Frame Assembly
5 Lead Assembly (3)
6 Battery (2)
7 J Bolt (2)
8 Battery Housing

Figure 2-1. Batteries, removal, and installation

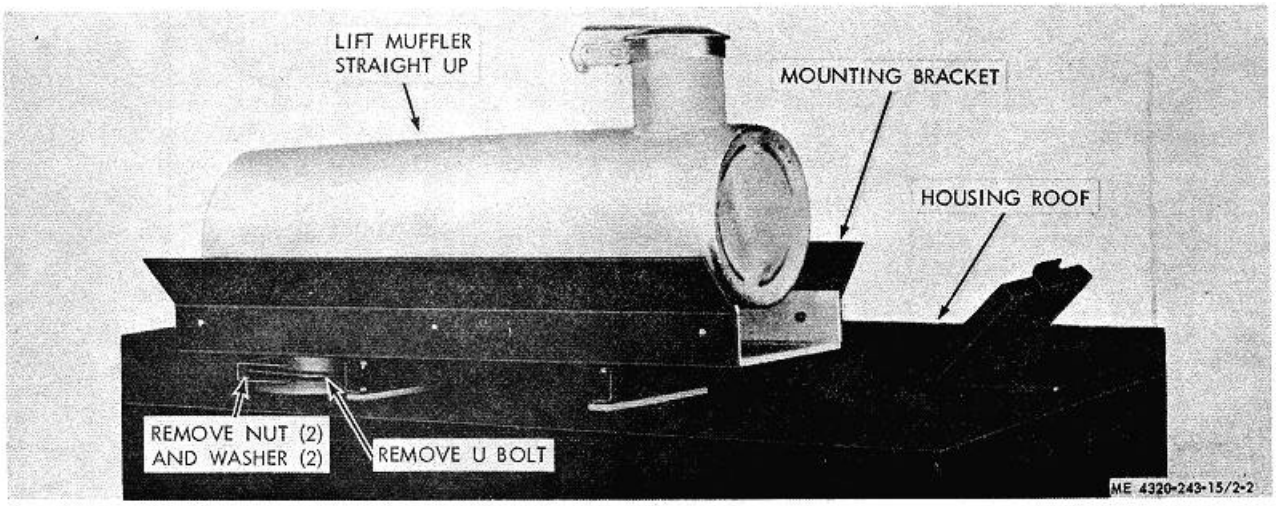


Figure 2-2. Muffler, removal and installation

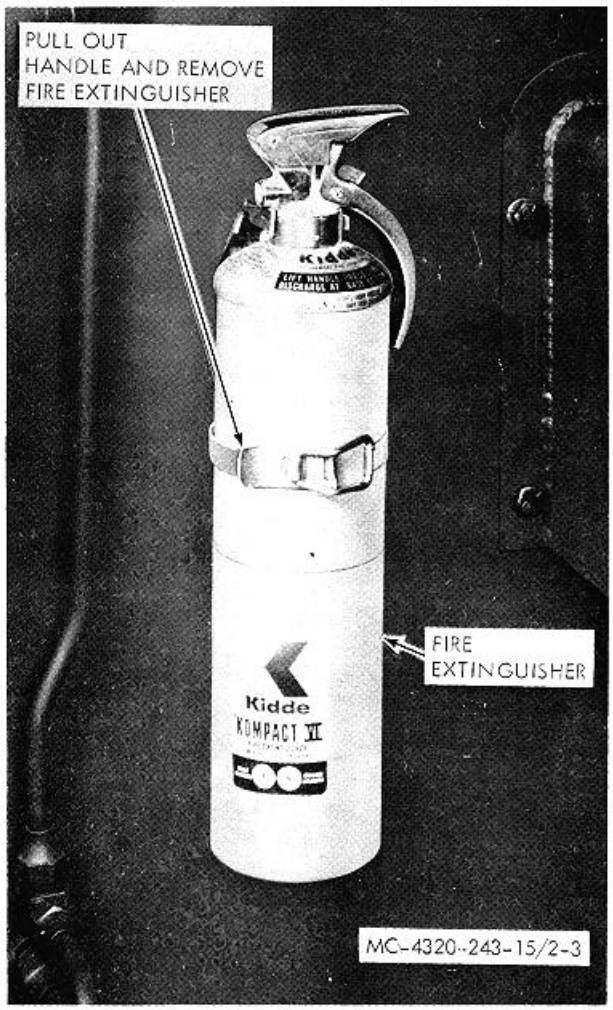


Figure 2-3. Fire extinguisher, removal and installation.

for accessibility. Make sure the area is well ventilated. Pipe the engine exhaust outside the building. Arrange the piping with a minimum of bends, and make sure all connections are tight.

Warning

Do not operate the unit in an enclosed area unless exhaust gases are piped to the outside. Inhaling exhaust fumes will cause serious illness or death.

c. Leveling. Unit must be installed horizontally. Use a carpenter's level along the length of the unit, and across the skid members. Insert spacers, shims, or wedges as needed.

d. Grounding. A proper ground is essential. Drive 1/2 grounding rod into the earth to a depth of at least 2-1/2 feet. Ground lead must be number 12 AWG copper wire, bolted or clamped to a clean, bright rust-free area on the rod. Connect other end of ground lead to the ground stud on left front end of skid f came.

Warning

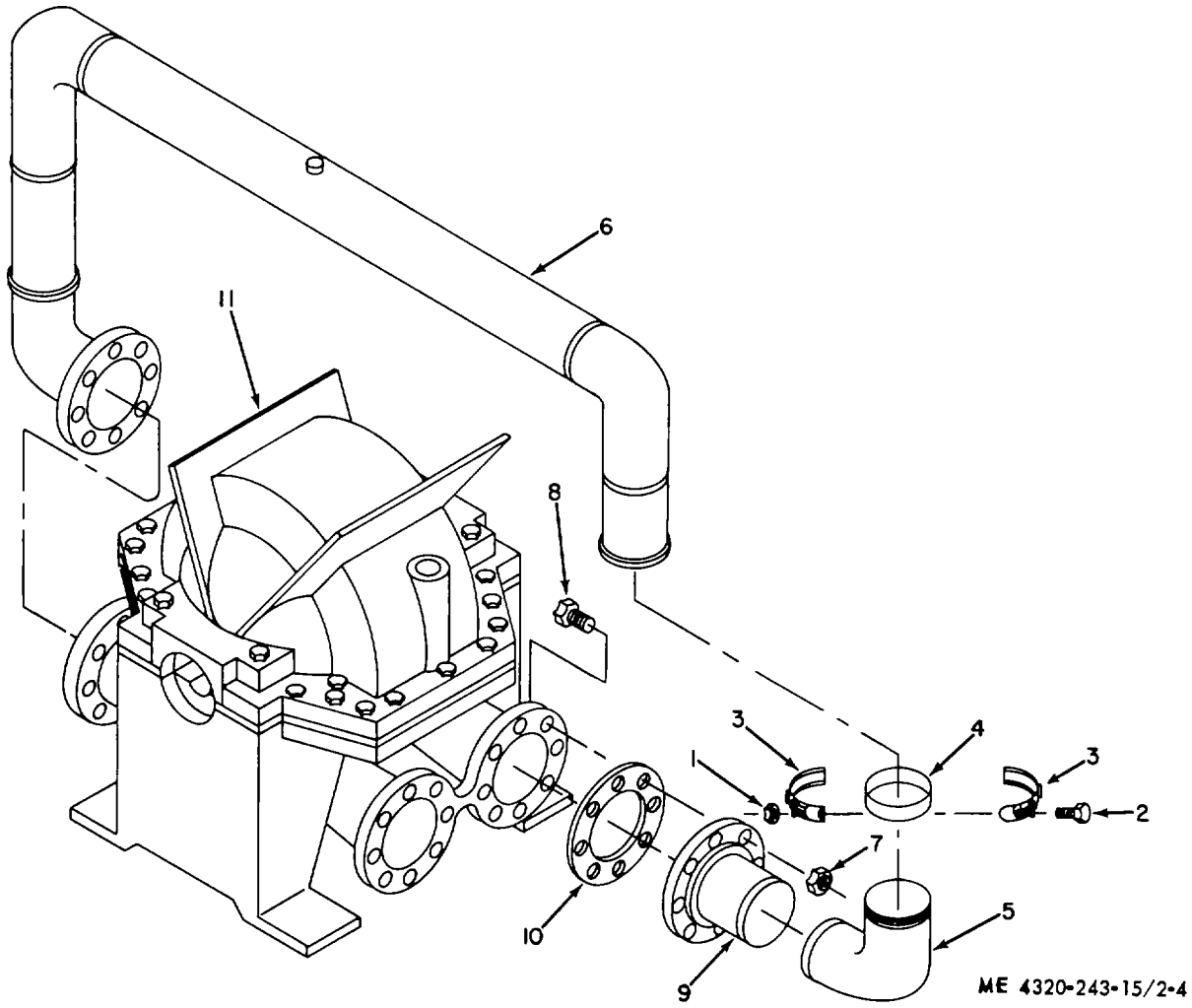
Unit must be properly grounded before operating. An ungrounded system can build up a static charge that can cause fire.

e. Auxiliary Fuel Line. If an auxiliary fuel supply is to be used with the centrifugal pump, connect the auxiliary fuel line to the level control valve on the fuel tank (fig. 1-4).

f. Flange Adapters, Crossover Pipe and Y-Fittings. Determine if the pump is to be

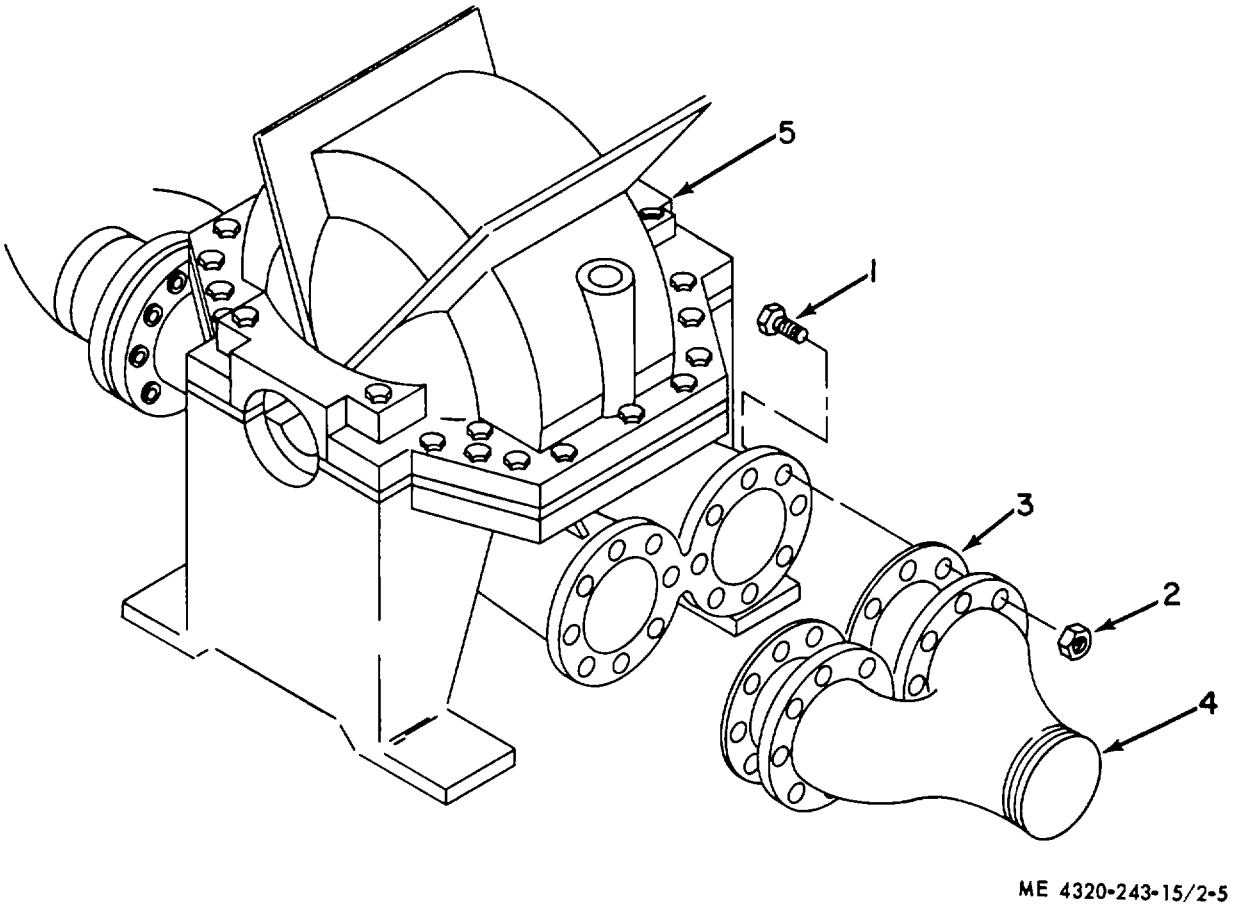
operated in parallel or in series. For series operation, install the flange adapters, crossover pipe, elbows, and assorted hardware in sequence indicated by key numbers in figure 2-4. For parallel operation, install the two Y-fittings and gaskets to the intake and discharge flanges on the pump as shown in figure 2-5.

g. Piping. Intake and discharge pipes must both be independently supported near the pump so that no strain will be transmitted to the pump casting when the connections are made.



1 Nut (4)
2 Bolt (4)
3 Clamp (4)
4 Coupling gasket (4)
5 Elbow (2)
6 Crossover pipe
7 Nut (16)
8 Bolt (16)
9 Flange adapter (2)
10 Gasket (2)
11 Pumping assembly

Figure 2-4. Crossover connections for series operation.



1 Bolt (32)
2 Nut
3 Gasket (4)
4 Y-Fitting
5 Pumping assembly

Figure 2-5. Y-Fitting connection for parallel operation.

Section II. MOVEMENT TO NEW WORKSITE

2-6. Dismantling for Movement

a. Preparation for Movement.

(1) Disconnect suction and discharge lines. Remove auxiliary fuel line if connected. Install dust plugs and caps to suction and discharge fittings.

(2) Disconnect ground cable.

(3) Make sure items on basic issue items list are provided.

(4) Disconnect exhaust pipe extension, if any.

(5) Drain fuel tank and pump casing if unit is to be moved by common carrier.

(6) Remove the crossover pipe or Y-fitting, as applicable.

(7) Disconnect the battery terminal connectors, and apply protective tape to the connectors after removal.

(8) Close and secure all doors and panels.

b. Short Move. The pump can be moved short distances on its skid, after the above steps are performed, by using the towing eye on either end of the skid.

c. Long Move. After performing the steps in a. above, the unit should be lifted onto a carrier by means of the lifting bail (fig. 1-2). Block and tie unit securely to the bed of the carrier to prevent shifting during transport.

2-7. Reinstallation After Movement

a. Refer to paragraph 2-5, and install the pumping assembly.

b. Perform the inspection and service prescribed by paragraph 2-3.

Section III. CONTROLS AND INSTRUMENTS

2-8. General

This section describes, locates, illustrates and furnishes operator, crew, or organizational maintenance personnel sufficient information about various controls and instruments for proper operation of the pump.

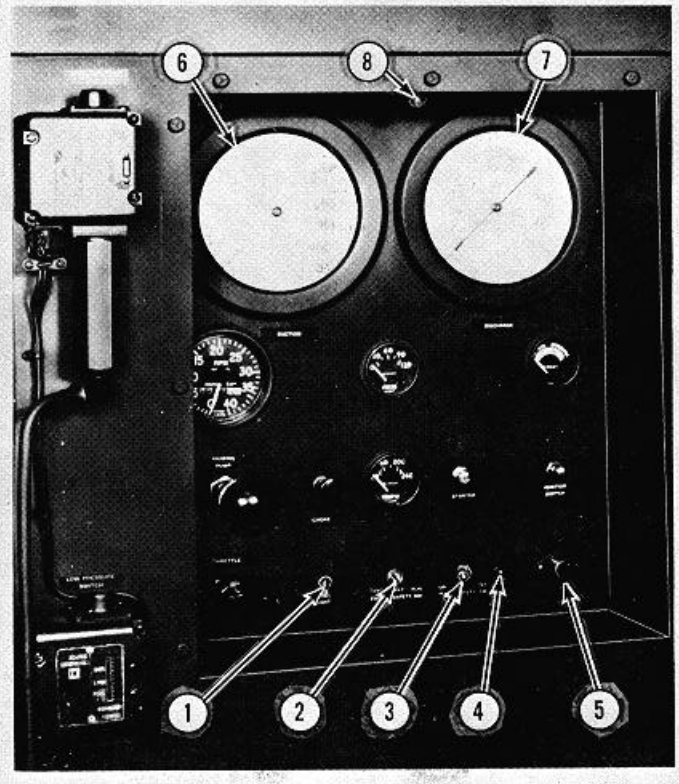
2-9. Controls and Instruments

The purpose of controls and instruments and their normal and maximum readings are illustrated in figure 2-6.

1 PANEL LIGHT SWITCH: USED TO TURN PANEL LIGHT ON OR OFF. NORMALLY OFF.

2 ENGINE SAFETY SWITCH: WHEN IN "START POSITION IT DISCONNECTS ENGINE LOW OIL PRESSURE FAULT CIRCUIT AND UNGROUNDS THE MAGNETO FOR STARTING. NORMALLY IN "RUN" POSITION. TO STOP THE ENGINE IT IS PLACED IN "OFF" POSITION.

3 PUMP SAFETY SWITCH: USED TO OPEN THE SAFETY SWITCH CURCUIT DURING STARTING AND SHUTDOWN PERIODS. NORMALLY ON.



4 PILOT LIGHT: INDICATES THAT PUMP SAFETY SWITCH IS READY FOR OPERATION. NORMALLY ON.

5 FUSE: USED TO PROTECT THE CONTROL CIRCUIT FROM DAMAGE DUE TO EXCESSIVE CURRENT FLOW.

6 SUCTION GAGE: INDICATES PRESSURE ON THE SUCTION SIDE OF THE PUMP. NORMAL OPERATING PRESSURE IS BETWEEN 0 AND 600 PSI. OPERATION ABOVE 600 PSI WILL CAUSE DAMAGE TO THE PUMP.

7 DISCHARGE GAGE: INDICATES PRESSURE ON THE DISCHARGE SIDE OF THE PUMP. NORMAL OPERATING PRESSURE IS BETWEEN 0 AND 600 PSI. OPERATION ABOVE 600 PSI WILL CAUSE DAMAGE TO THE PUMP.

8 PANEL LIGHT: USED TO ILLUMINATE THE CONTROL PANEL DURING NIGHT OPERATION. IT IS TURNED ON OR OFF BY THE PANEL LIGHT SWITCH.

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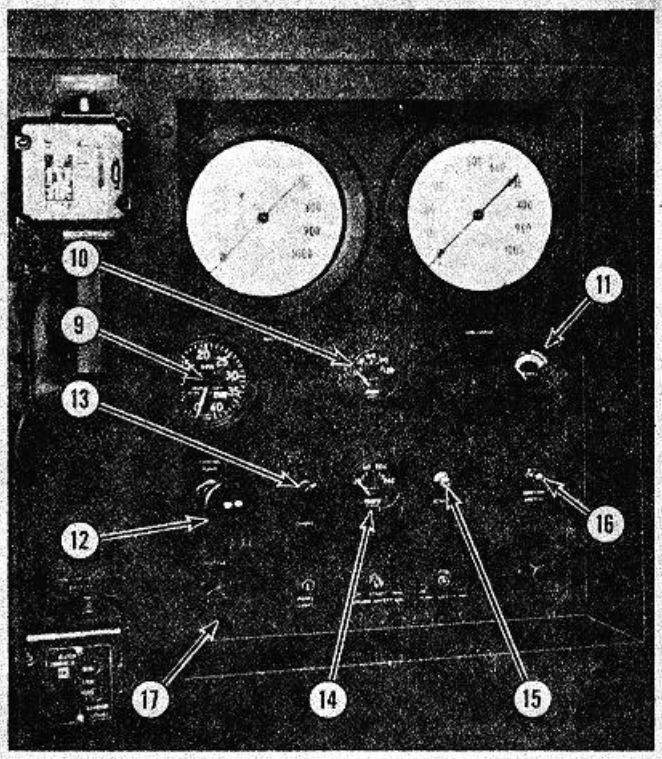
Figure 2-6. Controls and Instruments

9 TACHOURMETER: INDICATES THE SPEED OF THE ENGINE IN RPM AND ALSO THE TOTAL ELAPSED TIME OF ENGINE OPERATION. NORMAL OPERATING RPM IS 2100.

10 OIL PRESSURE GAGE: THE NORMAL READING IS BETWEEN 55 AND 68 PSI.

11 BATTERY - GENERATOR INDICATOR: REGISTERS TO THE FAR LEFT IF BATTERY IS DISCONNECTED OR IS DEAD. WHEN BATTERY IS FULLY CHARGED, INDICATOR IS BETWEEN YELLOW AND GREEN AREAS. WHEN GENERATOR IS CHARGING, INDICATOR APPEARS IN GREEN AREA. WHEN BATTERY IS DISCHARGING, INDICATOR APPEARS IN YELLOW AREA.



12 PRIMING PUMP: USED TO PRIME THE ENGINE IN COLD WEATHER. NORMALLY IN.

13 CHOKE: USED TO AID IN STARTING THE ENGINE. NORMALLY IN.

14 ENGINE TEMPERATURE GAGE: INDICATES THE TEMPERATURE OF THE ENGINE COOLANT IN DEGREES F. NORMAL READING IS BETWEEN 160° AND 200° F.

15 STARTER SWITCH: USED TO ACTUATE THE ENGINE STARTER MOTOR. NORMALLY OPEN.

16 IGNITION SWITCH: ACTIVATES ELECTRICAL SYSTEM. NORMALLY IN.

17 THROTTLE: USED TO VARY THE SPEED OF THE ENGINE. NORMALLY PULLED OUT AND LOCKED AT 2100 RPM.

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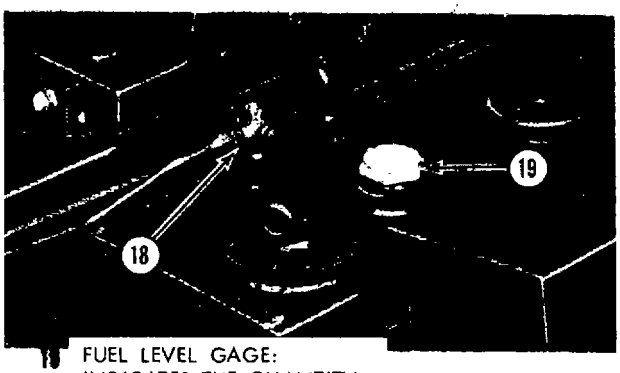
Figure 2-6 - Continued

18 FUEL SHUTOFF VALVE: WHEN OPERATING FROM AN AUXILIARY FUEL SUPPLY, THE ARROW ON THE VALVE HANDLE POINTS UP. WHEN OPERATING FROM THE FUEL TANK, THE ARROW ON THE HANDLE POINTS TO THE LEFT WHEN VIEWED FROM THE REAR OF THE TANK. THE VALVE IS CLOSED WHEN THE ARROW POINTS TO THE RIGHT.



19 FUEL LEVEL GAGE: INDICATES THE QUANTITY OF FUEL IN THE FUEL TANK

ME 4320-243-15/2-6 (3)

Figure 2-6-Continued.

Section IV. OPERATION OF EQUIPMENT

2-10. General

a. Instructions in this section are published for information and guidance of personnel responsible for operation of the pumping assembly.

b. The operator must know how to perform every operation of which the pumping assembly is capable. This section gives instructions on starting and stopping the pumping assembly, basic motions of the pumping assembly, and on coordinating basic motions to perform 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.

2-11. Starting

a. Before attempting to start the engine, the operator shall note the following precautions:

(1) Never operate the pump unless liquid is Rowing through it. An empty pump will rapidly overheat and cause serious damage.

(2) Do not crank the engine for a period of more than 30 seconds continuously. A period longer than 30 seconds can damage the starter. If the engine does not start after a few tries, stop cranking and determine the cause.

(3) Perform necessary daily preventive maintenance services. (pare 3-6).

(4) Check load requirements.

Caution

The small doors on the larger side doors (fig. 1-3) must remain open during engine operation or engine will overheat.

b. Refer to figure 2-7 and start the pump assembly.

Caution

The oil pressure gage (fig. 2-6) must read above 30 psi. If no oil pressure is indicated, stop the engine immediately and check the cause (para 3-15).

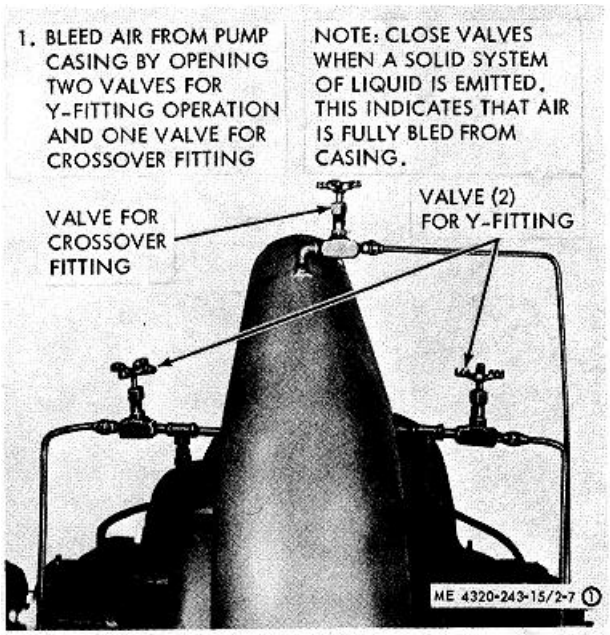


Figure 2-7. Starting the pump assembly.

2-12. Stopping

a. Refer to figure 2-8 and stop the pump assembly.

b. Perform the necessary daily preventive maintenance services (para 3-6).

2-13. Operation Under Usual Conditions

a. Start the pump assembly (para 2-11).

b. To operate the pump assembly open the main discharge line valve (fig. 1-1) to obtain desired pressure.

c. Performance characteristics under usual operating conditions are shown in the pump performance curve (fig. 2-9).

2-14. Operation in Extreme Cold (Below o0 F)

a. Fuel System. Keep the fuel tank full to prevent condensation of moisture which will freeze and can clog the fuel lines.

b. Electrical System. Clean the batteries and cables, and inspect for cracked or damaged cases. Be sure the battery terminals are tight, clean, and lightly greased. Inspect wiring for brittle or broken insulation. The electrolyte level must be three-eighths inch above the plates. To prevent the batteries from freezing, see that they are kept fully charged.

Caution

Water added to a battery may freeze unless it is immediately mixed with the electrolyte by operating the engine at 1,000 rpm for 30 minutes.

c. Lubrication. Lubricate the centrifugal pump for cold weather conditions in accordance with the current lubrication order (fig. 3-1).

d. Cooling System. Test the coolant with a hydrometer to insure adequate protection for the lowest temperature expected. Inspect for leaks and cracks in hoses and fittings. Frequently inspect the coolant level in the radiator and add water if it is necessary.

2-15. Operation in Extreme Heat

a. General. Efficient cooling, adequate ventilation and adequate lubrication are of vital importance for the operation of the centrifugal pump in extreme heat.

b. *Cooling System*. Check the coolant level frequently and add clean water when necessary. Clean and flush the radiator at regular intervals (para 3-56). Keep the V-belts properly adjusted (para 3-58).

c. *Lubrication*. Lubricate the centrifugal pump in accordance with the current lubrication order (fig. 3-1) for hot weather operation.

d. Batteries. Inspect the electrolyte frequently for proper level.

e. *Indoor Ventilation*. Provide adequate ventilation for the radiator. Allow sufficient space around the centrifugal pump for good air circulation.

2-16. Operation in Dusty or Sandy Areas

a. General. If the installation is permanent, erect a protective shield for the centrifugal pump. Dust and sand shorten the life of equipment and cause mechanical failure. If the installation

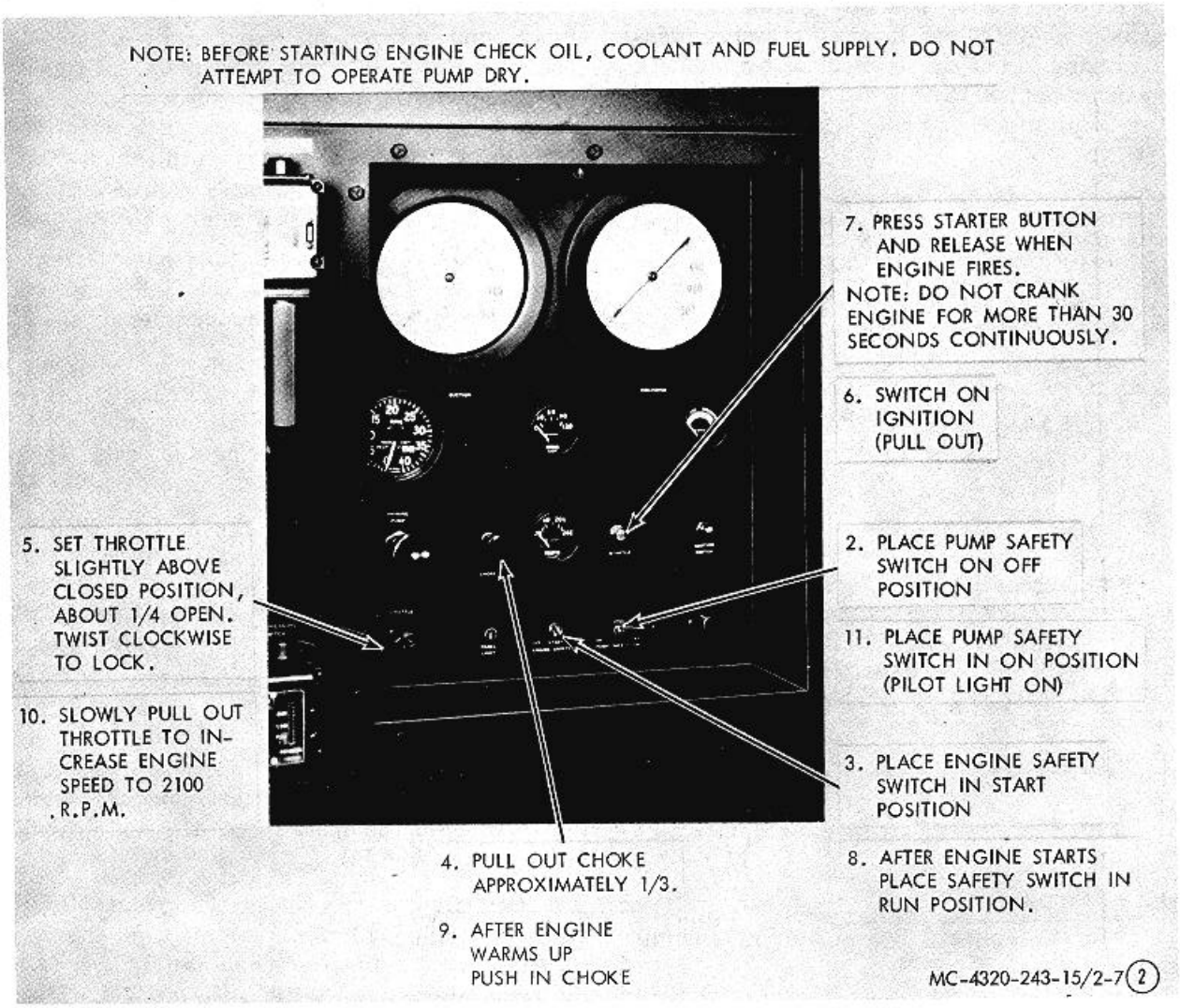


Figure 2-7-Continued.

is temporary, utilize natural barriers. Wipe down the unit at frequent intervals using an approved cleaning solvent. If water is plentiful, wet down the surrounding terrain beyond the immediate operating area.

b. Cooling System. Inspect the cooling system frequently for leaks. Keep the radiator cap tight and see that the V-belts are properly adjusted (para 3-58). Drain and flush the cooling system as often as necessary (para 3-56).

c. Lubrication. Lubricate the centrifugal pump in accordance with the current lubrication order (fig. 3-1). Clean the air cleaner and breather caps more frequently to prevent dust and dirt from entering the engine. Clean all lubrication points before applying lubricants.

d. Fuel System. Keep the fuel filler cap tightly closed to prevent sand and dust from entering the fuel tank. Clean the area around the cap before removing it to add fuel.

2-17. Operation under Rainy or Humid Conditions

During humid periods dry the unit before operating. Keep the fuel tank full to avoid condensation.

2-18. Operation in Salt Water Areas

a. General. Salt water has a corrosive action on metal. Extreme care must be taken to prevent rust from forming on the unit. The electrical insulation should be inspected frequently for deterioration.

b. Cooling System. Use fresh water only for the cooling system. Salt water may damage the equipment. Use an approved rust inhibitor to prevent the formation of rust and scale in the cooling system.

c. Lubrication. Keep the centrifugal pump well lubricated to prevent salt and moisture from entering the engine. Refer to the current lubrication order (fig. 3-1).

d. Rust Prevention. Wash down the unit regularly with fresh water. Inspect all painted surfaces for cracked, peeled, or blistered paint. Coat all exposed surfaces with rustproofing paint. Report the condition to organizational maintenance.

2-19. Operation at High Altitude

The centrifugal pump is designed to operate at altitudes up to 5,000 feet above sea level without any special attention or adjustments. At higher altitudes, provide adequate ventilation as the engine is more likely to overheat. Adjust the carburetor (para 3-40) before operation.

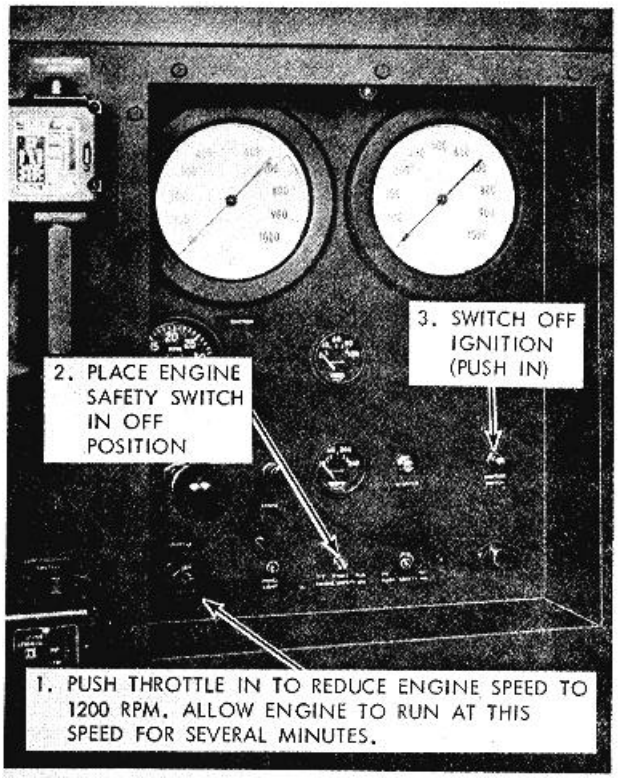


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Figure 2-8. Stopping the pump assembly.

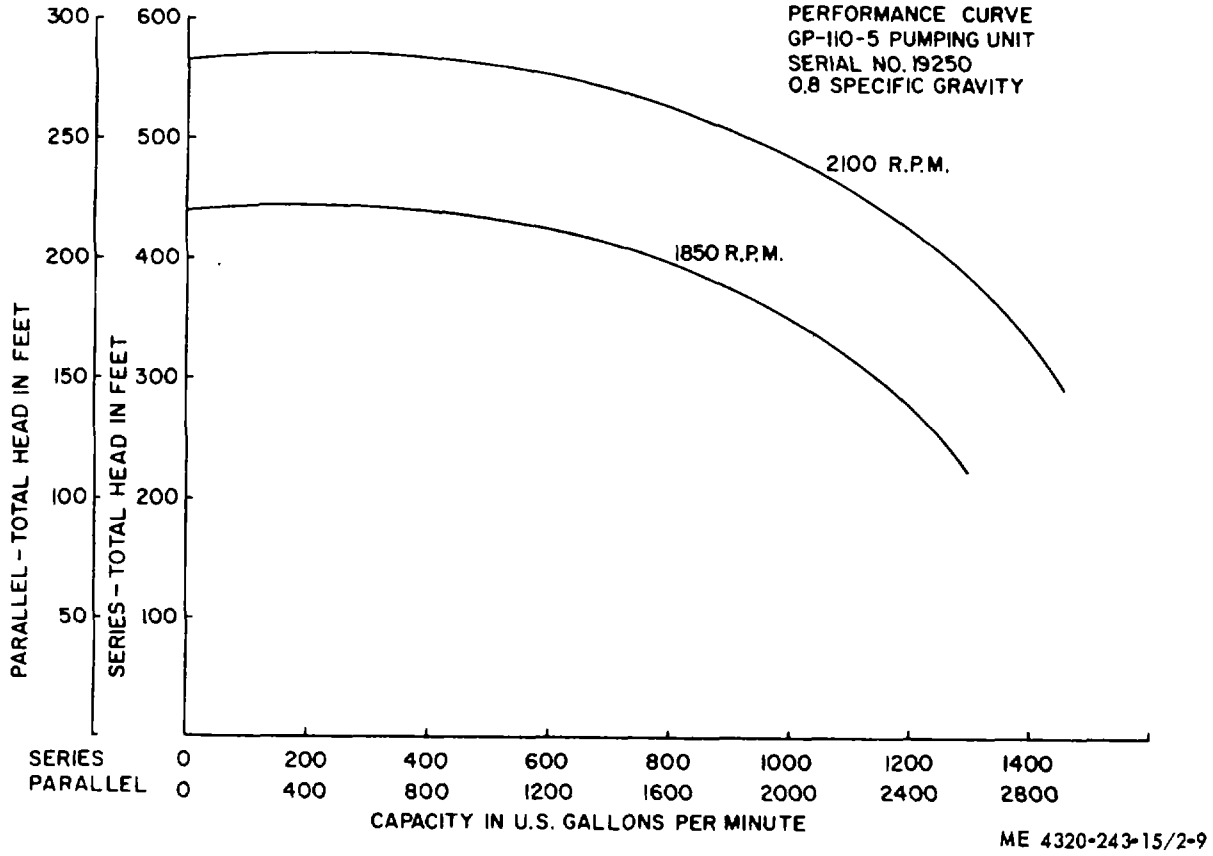

Figure 2-9. Performance curve.

Section V. OPERATION OF MATERIAL USED IN CONJUNCTION WITH CENTRIFUGAL PUMP ASSEMBLY

2-20. Fire Extinguisher (Dry Chemical Type)

a. Description. The dry chemical type fire extinguisher (fig. 2-3) is suitable for use on all types of fire, and is effective in areas where ambient temperature is -25° F. And above. If winterized (pressurized with nitrogen), the fire extinguisher may be used in temperatures below -25° F. The fire extinguisher is a 2 1/2 pound, stored-pressure, lever operated extinguisher.

b. Operation. Remove the fire extinguisher from its location, lift the handle, press lever, and direct the powder at base of flame, using a side-to-side sweeping motion.

c. Maintenance. Weigh the fire extinguisher every 6 months and replace if weight is less than 4 1/2 pounds, or if pressure is below 125 pounds. The dry chemical fire extinguishers will be serviced at installation level through Repair and Utilities facilities with the filling agent supplied by local procurement through Troop Supply Channels. Refer to TB 5-4200-200-10.

CHAPTER 3
OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS
Section I. OPERATOR AND ORGANIZATIONAL MAINTENANCE TOOLS AND EQUIPMENT

3-1. Special Tools and Equipment
No special tools or equipment are required by operator or organizational maintenance personnel for maintenance of the pump.

3-2. Basic Issue Tools and Equipment
Tools and repair parts issued with or authorized for use with the pump assembly are listed in the Basic Issue Items List, Appendix B of this manual.

Section II. LUBRICATION

3-3. General Lubrication Information
a. This section contains a reproduction of the lubrication order and lubrication instructions which are supplemental to, and not specifically covered in, the lubrication order.

b. The lubrication order shown in figure 3-1 is an exact reproduction of the approved lubrication order for the centrifugal pump assembly. For the current lubrication order, refer to DA PAM 310-4.

3-4. Detailed Lubrication
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 for 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 figure 3-1.

d. OES Oil.

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

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

e. Oil Filter Service. Refer to figure 3-2 and service the oil filter.

f. Air Cleaner Service. Refer to figure 3-3 and service the air cleaner.

LUBRICATION ORDER

LO5-4320-243-12

PUMP, CENTRIFUGAL: PETROLEUM; GASOLINE DRIVEN SKID MOUNTED; 6 INCH, 500 GPM 555 FT HEAD TO 1400 GPM 275 FT HEAD (JOHN REINER & CO., MODEL GP 110-5) W/CONTINENTAL ENGINE MODEL RS633

REFERENCE: C9100-IL

Intervals are based upon normal operations. Reduce to compensate for abnormal operation and severe conditions. During inactive periods sufficient lubrication must be performed for adequate preservation. Clean fittings before lubricating. Relubricate after washing.

Clean parts with SOLVENT, drycleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Dotted circle indicates drain below.

Drain crankcase and pump bearings only when hot after operation; replenish and check level when cool.

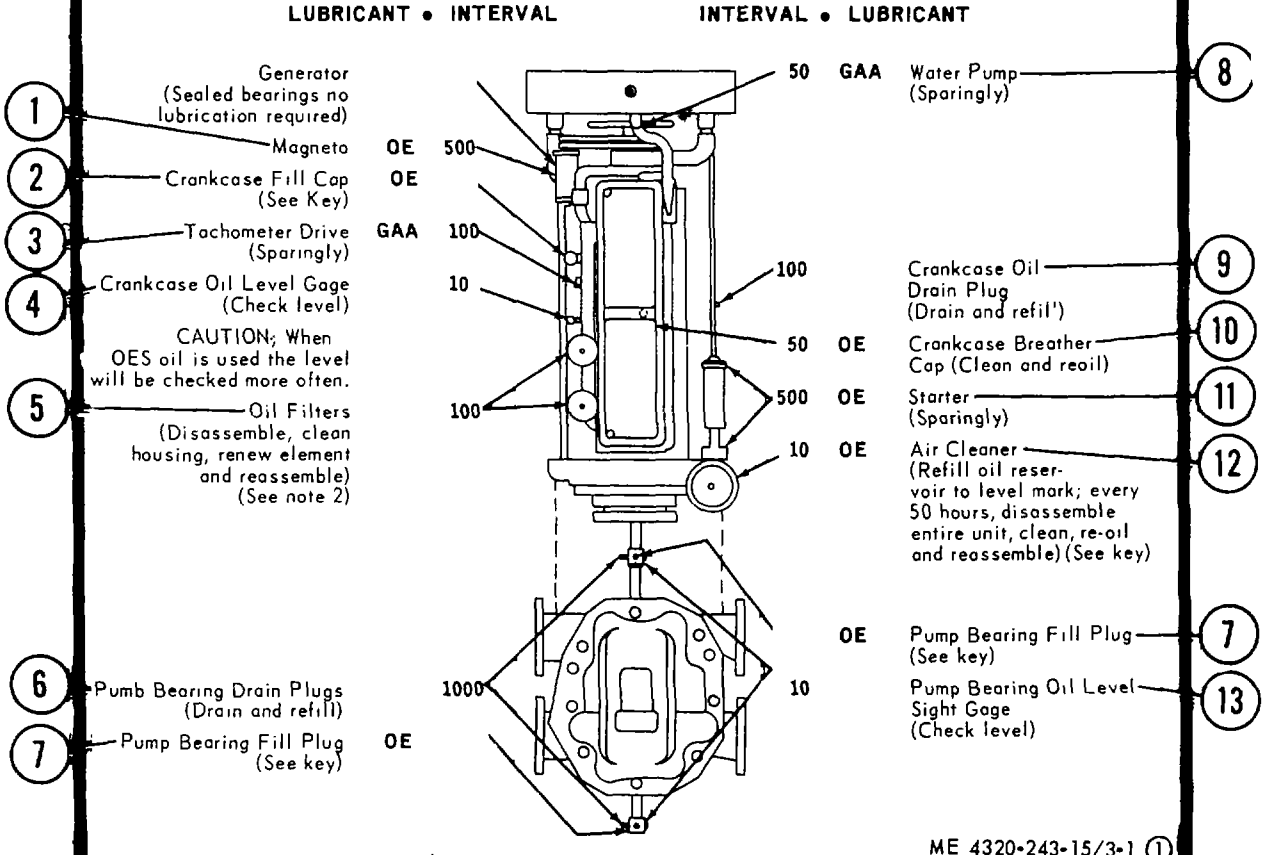

Figure 3-1. Lubrication chart.

–KEY–

LUBRICANTS	CAPACITY	EXPECTED TEMPERATURES			INTERVALS
		Above+32°F	+40°F to –10°F	0°F to –65°F	
OE –OIL, Engine, Heavy Duty					
Crankcase	20 qt	**OE** 30	**OE** 10	**OES**	Intervals given are in hours of normal operation.
Air Cleaner	2 qt				
Pump Bearings	1/8 qt EA				
Oil Can Points		**OE** 10	**OE** 10	**OE** 10	
OES –OIL, Engine, Subzero					
GAA –GREASE, Auto. and Artillery		All Temperatures			

NOTES:

1. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW –10°F. Remove lubricants prescribed in the key for temperatures above –10°F. Relubricate with lubricants specified in the key for temperatures below –10°F.

2. ENGINE OIL FILTER. Every 100 hours, remove filter element, clean housing. Install new element. Fill crankcase, operate engine 5 minutes, check for leaks, check level and bring to full mark.

3. OIL CAN POINTS. Every 50 hours lubricate all hinges and control linkages with OE.

4. LUBRICANTS. The following is a list of lubricants with the Military Symbols and the applicable specification numbers.

OE-MIL-L-2104 OES-MIL-L-10295
GAA-MIL-G-10924

Copy of this Lubrication Order will remain with equipment at all times; instructions contained herein are mandatory.

FOLD FOLD

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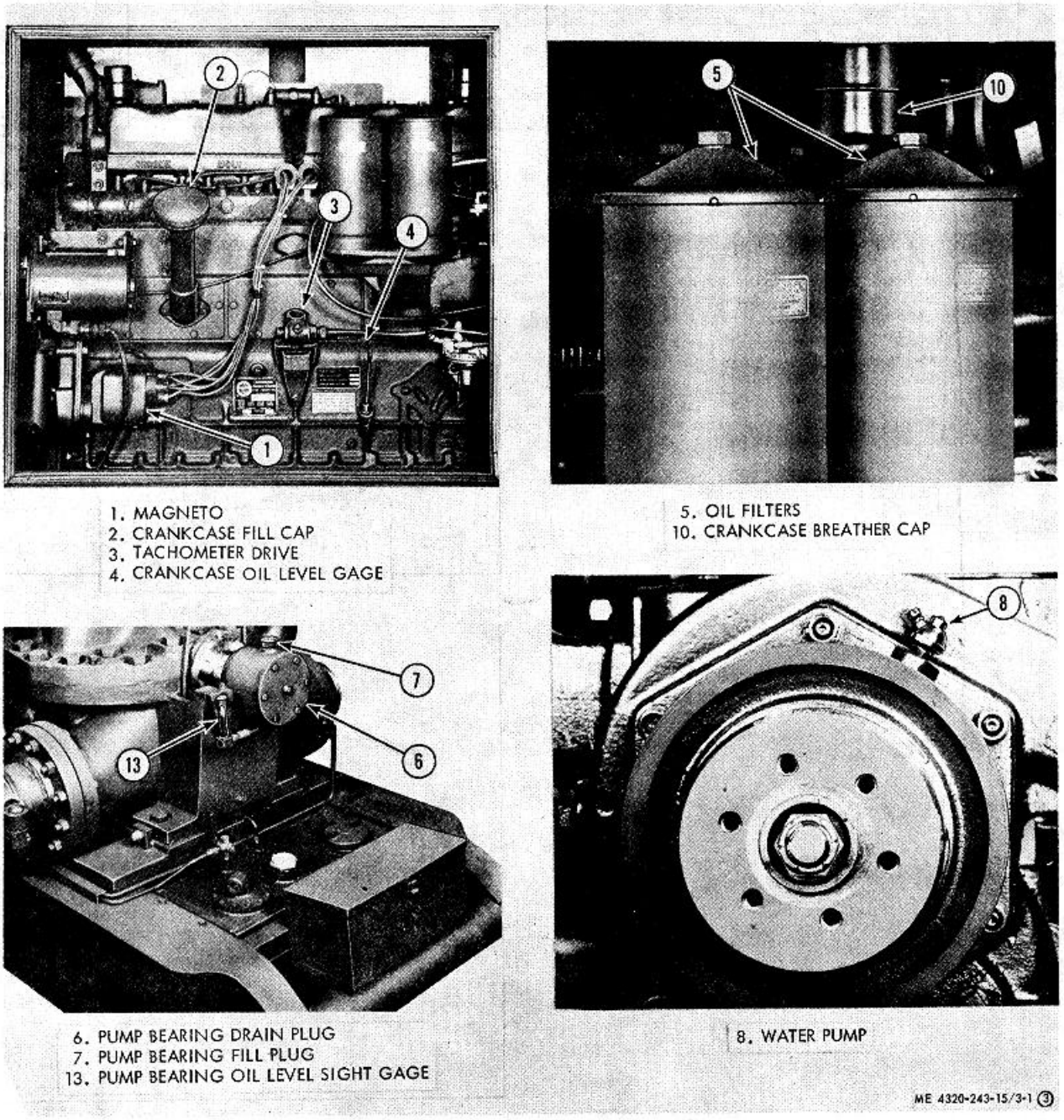
Figure 3-1. -Continued.



1. MAGNETO
2. CRANKCASE FILL CAP
3. TACHOMETER DRIVE
4. CRANKCASE OIL LEVEL GAGE

5. OIL FILTERS
10. CRANKCASE BREATHER CAP

6. PUMP BEARING DRAIN PLUG
7. PUMP BEARING FILL PLUG
13. PUMP BEARING OIL LEVEL SIGHT GAGE

8. WATER PUMP

Figure 3-1. -Continued.

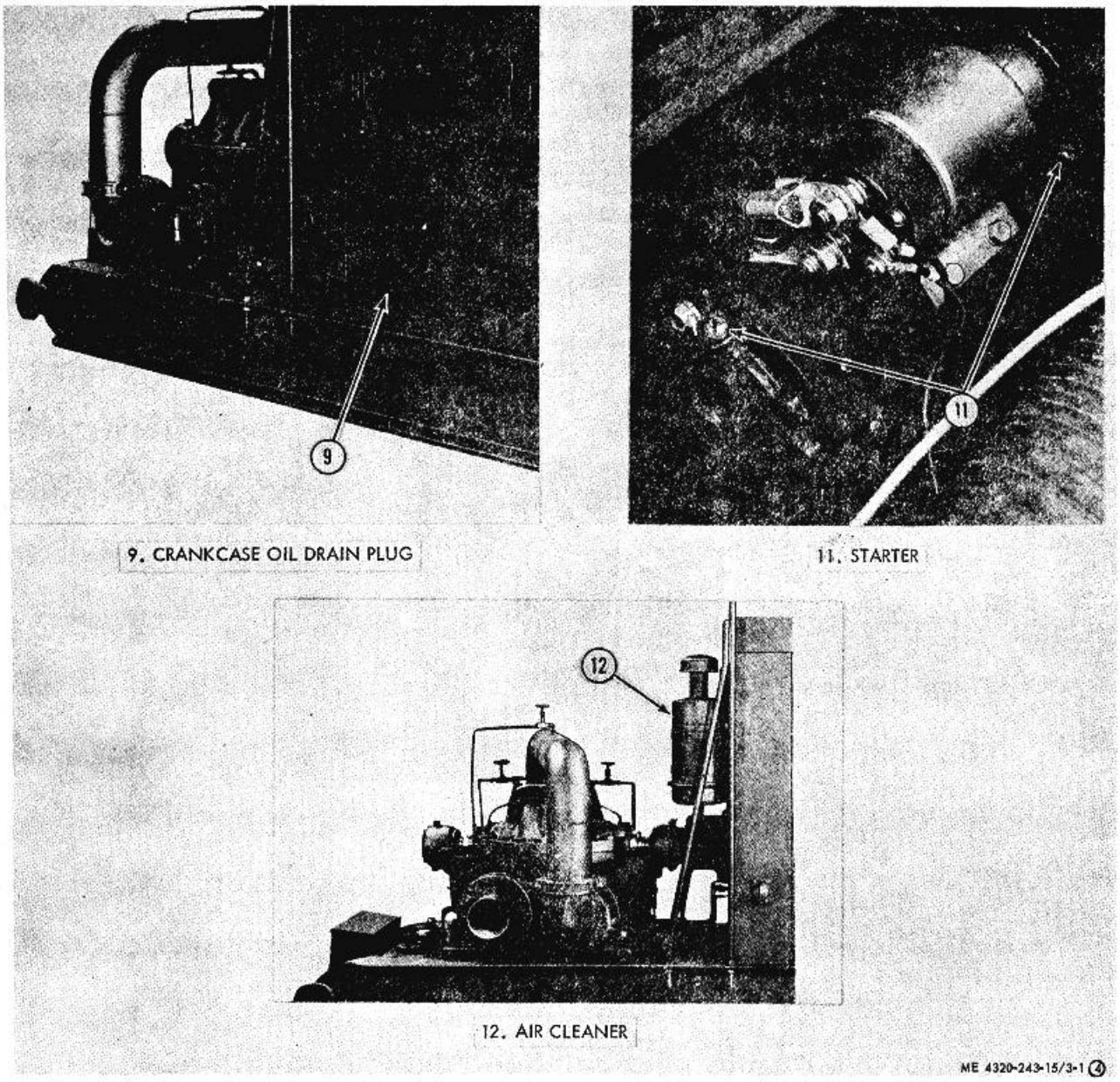


Figure 3-1. -Continued.

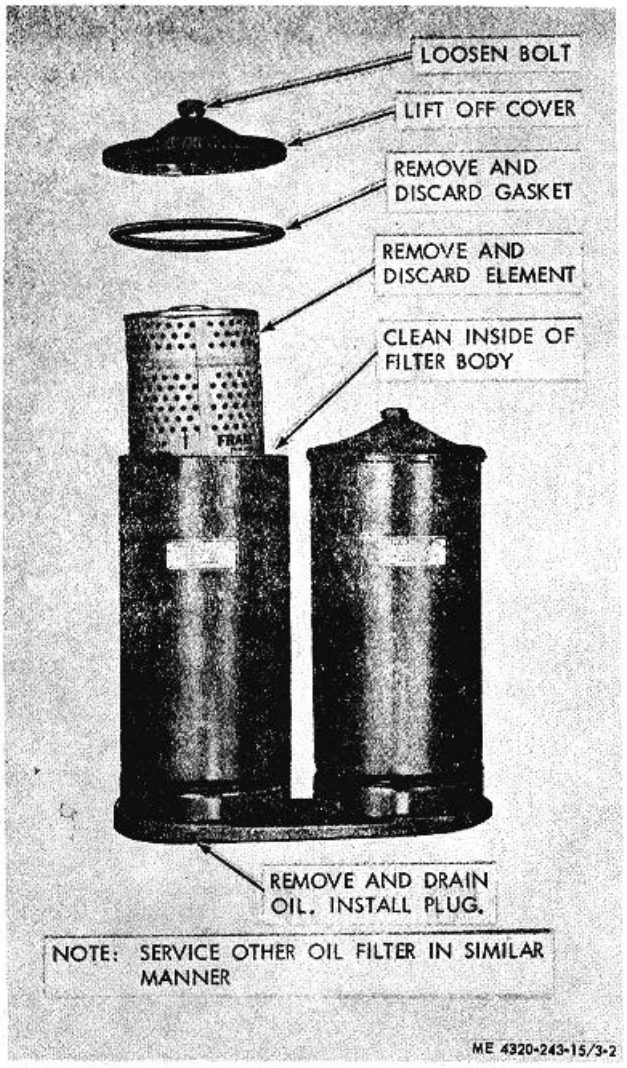
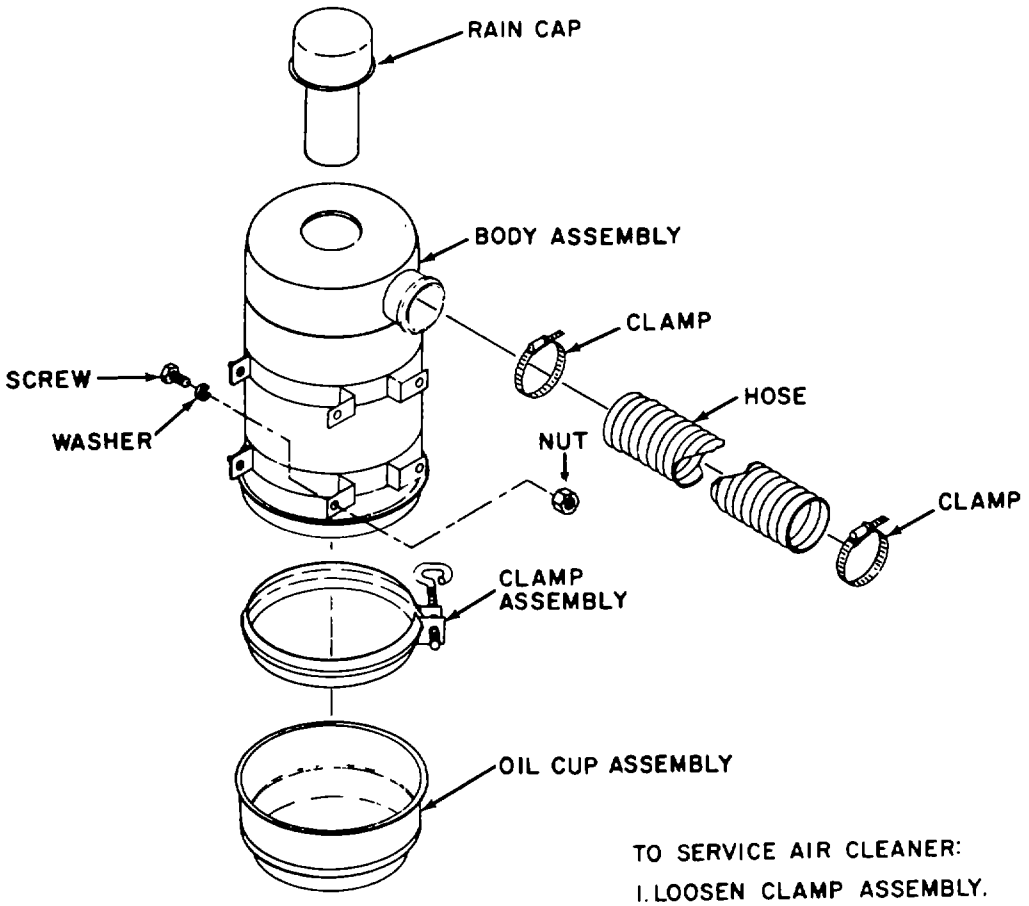


Figure 3-2. Oil filter service.



TO SERVICE AIR CLEANER:

1. LOOSEN CLAMP ASSEMBLY.
2. DROP OIL CUP ASSEMBLY AND DISCARD OIL.
3. CLEAN OIL CUP ASSEMBLY WITH APPROVED SOLVENT.
4. REFILL OIL CUP ASSEMBLY TO LEVEL MARK.
5. REINSTALL OIL CUP ASSEMBLY.

NOTE:
SERVICE AIR CLEANER EVERY 50 HOURS.

ME 4320-243-15/3-3

Figure 3-3. Air cleaner service, assembly and disassembly.

Section III. PREVENTIVE MAINTENANCE SERVICES

3-5. General

To insure that the equipment 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 services to be performed are listed and described in paragraphs 3-6 and 3-7. Item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit shall be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noticed 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.

3-6. Daily Preventive Maintenance Services

This paragraph contains 'an illustrated tabulated listing of preventive maintenance services which must be performed by the operator.

The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-4 for the daily preventive maintenance services.

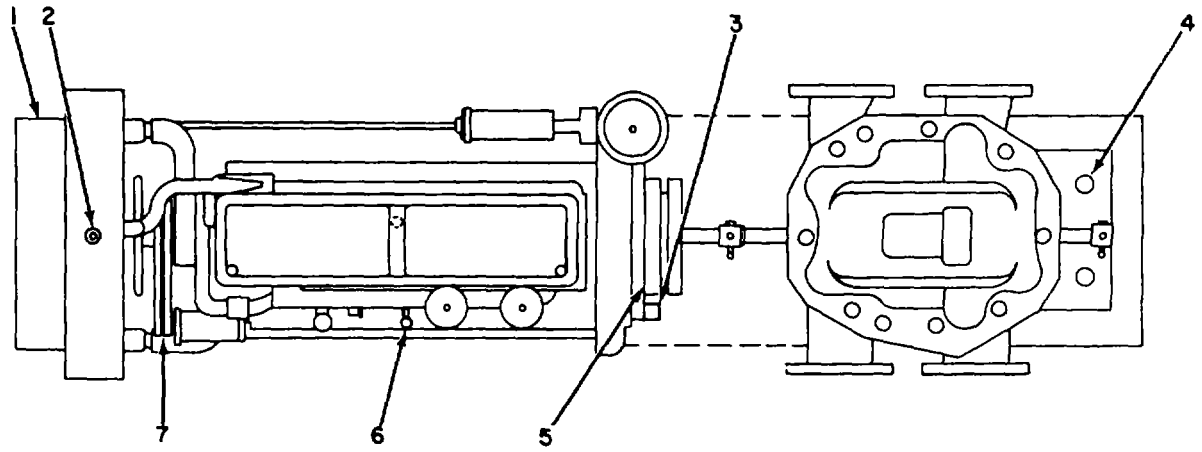
3-7. Quarterly Preventive Maintenance Services

a. This paragraph contains an illustrated, tabulated listing of preventive maintenance services which must be performed by organizational maintenance personnel at quarterly intervals. A quarterly interval is equal to 3 calendar months, or to 250 hours of operation, whichever occurs first.

b. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-5 for the quarterly preventive maintenance requirements.

PREVENTIVE MAINTENANCE SERVICES

DAILY



ITEM	LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER	PAR REF
1.	BATTERIES. Tighten loose cables and mountings. Remove corrosion. Inspect for cracks and leaks. Fill to 3/8 inch above the plates. Clean vent hole in filler cap before replacing. In freezing weather, run engine a minimum of 1 hour after adding water.	2-3
2.	RADIATOR. Inspect for leaks. Inspect radiator core and fan guards for dirt. Fill radiator with coolant to 2 inches below filler neck.	3-56
3.	FIRE EXTINGUISHER. Inspect the extinguisher for insufficient charge by the gage indication and weight. Inspect for broken seal. Do not discharge any of the contents. Inspect for corrosion and insecure mounting. Replace the extinguisher if it is defective or has an insufficient charge..	2-20
4.	FUEL TANK. Add fuel as required. Inspect for leaks in tank and lines.	3-43
5.	CONTROLS AND INSTRUMENTS. Inspect for damage and loose mounting. With the unit operating, check for proper operation. Normal operating readings are as follows: Oil pressure gage 55 to 65 psi. Water temp. gage 160 to 200 F. Pilot light ON-while operating. Suction gage 0 to 600 psi. Discharge gage 0 to 600 psi.	2-8

ME 4320-243-15/3-4 ①

Figure 3-4. Daily preventive maintenance services.

ITEM		PAR REF
6.	OIL-LEVEL GAGE. Add oil as indicated by level gage. Reference current L.O. 5-4320-243-12	
7.	V-BELTS. Proper adjustment is a deflection of 1/2 inch midway between pulleys (weekly.)	3-58

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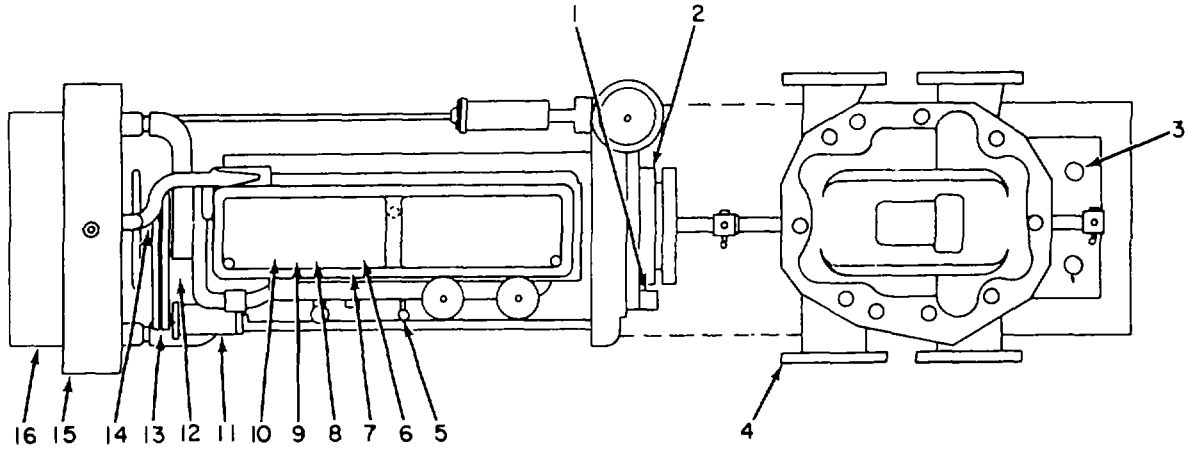
Figure 3-4-CoIntinued.

PREVENTIVE MAINTENANCE SERVICES

QUARTERLY



LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER

ITEM		PAR REF
1.	FIRE EXTINGUISHER. Inspect extinguisher every six months and replace if pressure is below the white field on the gage. The dry chemical fire extinguishers will be serviced at installation level through Repair and Utilities facilities, with the filling agent supplied by local procurement through Troop Supply Chanels. Replace damaged extinguisher.	2-20
2.	CONTROLS AND INSTRUMENTS. Inspect for damage and loose mounting. With the unit operating, check for proper performance. Normal operating readings are as follows: Oil pressure gage 55 to 65 psi. Water temperature gage 160 to 200 F. Suction gage 0 to 600 psi. Pilot light ON while operating. Discharge gage 0 to 600 psi.	2-8
3.	FUEL TANK. Add fuel as required. Tighten loose mounting. Replace leaking tank. Replace defective cap gasket. Clean cap vent.	3-43
4.	GROUND. Check for proper ground. A proper ground will consist of 3/4 inch dia. solid rod, 9 ft. long. The cable will be No. 6 AWG copper wire bolted or clamped to the rod and attached to the ground terminal of the equipment.	

ME 4320-243-15/3-5 ①

Figure 3-5. Quarterly preventive maintenance services.

ITEM		PAR REF
5.	OIL LEVEL GAGE. Add oil as indicated by level gage. Reference current L.O.	
6.	SPARK PLUGS. Replace spark plugs that have cracked insulators or burnt electrodes. Clean and set spark gap for 0.030 inch. Torque plugs to 35 ft-lbs. Replace frayed or broken leads. Clean and tighten lead connections.	3-50
7.	FUEL PUMP. Inspect for insecure mounting and leaks. Service as required.	3-39
8.	FUEL LINES AND VALVES. Inspect for leaks, loose connections, and damage.	3-39
9.	OVERSPEED GOVERNOR, Inspect for loose mounting. Inspect for loose electrical connections.	3-41
10.	FUEL FILTERS. Inspect for loose mounting and leaks. Drain water and dirt from filter.	3-39
11.	GENERATOR. Clean slip ring. Replace brushes worn to less than 1/2 their original length. Proper brush spring tension is 18 to 28 ounces.	3-46
12.	MAGNETO. Replace pitted or burnt magneto points. Proper point gap adjustment is 0.008 to 0.012 inch. (Check adjustment every 500 hours)	3-49
13.	V-BELTS. Proper adjustment is a deflection of 1/2 inch midway between pulleys. Replace a worn, frayed, or cracked belt.	3-58
14.	WATER PUMP. Inspect for leaks and loose mounting.	3-57
15.	RADIATOR. Proper coolant level is 2 inches below filler neck. Replace cracked or frayed hose. Replace defective radiator. Remove obstructions in the air passages. Tighten all mountings and leaking connections. Correct pressure for cap is 7 pounds.	3-56
		ME 4320-243-15/3-5 ②

Figure 3-5-Continued.

ITEM		PAR REF
16.	BATTERIES. Tighten loose cables and mountings. Remove corrosion. Fill to 3/8 inch above plates. Clean vent hole in filler caps before replacing. In freezing weather, run engine at least 1 hour after adding water. Replace a cracked or leaking battery.	2-3

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Figure 3-5-Continued.

Section IV. OPERATOR'S MAINTENANCE

3-8. General

Maintenance to be performed by the operator is limited to the replenishment of fuel, oil, coolant, and battery water at proper intervals. Refer to the MAC (maintenance allocation chart) Appendix C.

Section V. TROUBLESHOOTING

3-9. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the pumping assembly and its components. Each trouble symptom state is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause. Any trouble beyond the scope of organizational maintenance shall be reported to direct support maintenance.

In troubleshooting, never make more than one adjustment at a time; then locate the trouble by a process of elimination. Usually the cause will be Simple rather than complex.

If the engine cranks over but fails to start, for example, the trouble is almost certainly either in the ignition or the fuel system, and a quick check should determine which system to examine further.

3-10. Engine Fails to Start or Is Hard to Start

Probable cause	Possible remedy
Fuel tank empty	---- Fill fuel tank.
Air cleaner clogged	---- Service air cleaner (para 3-4).
Spark plugs defective	---- Adjust or replace spark plugs (para 3-50).
Carburetor defective	---- Replace carburetor (para 3-40).
Magneto defective	---- Replace magneto (para 3-49).
Magneto contacts not closing.	---- Adjust magneto contacts para 3-49).
Fuel pump defective	---- Replace fuel pump (para 3-39).
Cranking motor fails to crank engine.	---- Refer to paragraph 3-48.

3-11. Engine Misses or Runs Erratically

Probable cause	Possible remedy
Air cleaner clogged	---- Service air cleaner (para 3-4).
Spark plugs defective	---- Adjust or replace spark plugs (para 3-50).
Spark plug leads defective.	---- Replace leads (para 3-50).
Probable cause	Possible remedy
Governor defective	---- Replace governor (para 3-41).
Valve adjustment incorrect.	------ Adjust valves (para 3-36).

3-12. Engine Knocks or Develops Unusual Noise

Probable cause	---- Possible remedy
Crankcase oil supply too low.	---- Aid oil to proper level. ---- Refer to figure 3-1.

Caution

If the engine knocks or is noisy when the crankcase is filled with oil to its proper level, stop the engine immediately and report the condition to field maintenance. Continued operation of the unit under these conditions can cause serious damage to the engine.

Accessory mountings loose.	---- Tighten all loose connec- ---- tions.
Valve adjustment incorrect.	---- Adjust valves (para 3-36).
Timing incorrect	---- Adjust engine timing (para 3-49).

3-13. Engine Stops Suddenly

Probable cause	Possible remedy
Fuel tank empty	---- Fill fuel tank.
Air cleaner clogged	---- Service air cleaner (para 3-4).
Oil pressure too low	---- Add oil to the proper level. Refer to figure 3-1.
Fuel pump defective	---- Replace fuel pump (para 3-39).
Coolant too hot	---- Fill cooling system (para 3-55). Replace defective thermostat (para 3-59). Replace defective V-belts para 3-58).

Caution

Never add coolant to an excessively hot engine block. Failure to observe this caution may result in damage to the engine block.

3-14. Engine Overheats

Probable cause	Possible remedy
Crankcase oil too low	---- Add oil to proper level. Refer to current lubrication order.
Coolant low in radiator	---- Fill cooling system.

Probable cause	Possible remedy
V-belt of water pump loose or slipping.	- Adjust or replace V-belts (para 3-58).
Thermostat sticking in closed position.	---- Replace thermostat (para 3-59).

3-15. Engine Oil Pressure Low

Probable cause	Possible remedy
Crankcase oil too low	--- Add oil to proper level. Refer to lubrication order.
Oil pressure gage defective.	--- Replace oil pressure gage (para 3-30).

3-16. Engine Exhaust Smoky

Probable cause	Possible remedy
Crankcase oil level too high.	---- Drain oil to proper level. Refer to figure 3-1.
Poor combustion caused by cold engine.	--- Allow enough time for engine to warm up before adjusting throttle to operating speed. Open choke (fig. 2-7).
Carburetor out of adjustment.	---- Adjust carburetor (para 3-40).

3-17. Engine Backfires

Probable cause	Possible remedy
Timing incorrect	--- Adjust ignition timing (para 3-49).
Intake valves holding open.	---- Adjust intake valves (para 3-36).

3-18. Engine Lacks Power

Probable cause	Possible remedy
Timing incorrect	--- Adjust ignition timing (para 3-49).
Fuel pump defective	--- Replace fuel pump (para 3-39).
Engine speed too low	--- Adjust governor setting to proper rpm (para 3-41).
Spark plugs defective	--- Replace spark plugs (para 3-50).
Carburetor out of adjustment or defective.	--- Adjust or replace carburetor (para 3-40).

3-19. Engine Consumes too Much Oil

Probable cause	Possible remedy
Too light a grade oil used.	--- Drain. Refill with proper --- grade shown in lubrication order (fig. 3-1).
Oil level too high	--- Drain to proper level.
Piston rings not run in	--- Run engine normally, replacing oil as needed. Condition should gradually clear itself up.
Oil filter body loose	---- Tighten oil filter body.
Oil drain plug loose	---- Tighten plug.

3-20. Noisy Engine Generator

Probable cause	Possible remedy
Generator mounting loose.	---- Tighten generator mounting.
Generator drive pulley loose.	---- Tighten generator drive pulley.
Generator defective	---- Replace defective generator (para :3-46).

3-21. Generator Overheats

Probable cause	Possible Remedy
Generator defective	--- Replace generator (para 3-46).
Engine generator regulator out of adjustment or defective.	-- Adjust or replace engine generator regulator (para 2-47).

3-22. Battery-Generator Indicator Reads in Left-Hand Red Part of Dial

Probable cause	Possible Remedy
Battery dead	--- Recharge or replace battery (para 2-4).
Indicator connections loose or broken.	--- Tighten or replace leads (para 3-52).
Indicator defective	--- Replace indicator (para 3-52).
Generator defective	--- Replace generator (para 3-46).
Engine generator regulator out of adjustment or defective.	--- Adjust or replace engine generator regulator (para 3-47).

3-23. Battery Generated Reads in Right-Hand Red Part of Dial

Probable cause	Possible remedy)
Engine generator-regulator out of adjustment or defective.	-- Adjust or replace engine generator regulator (para 3-47).
Indicator defective	--- Replace indicator (para 3-52).

3-24. Starter Fails to Turn Engine

Probable cause	Possible Remedy
Starter push switch defective.	--- Replace cranking motor push switch (para 3-52).
Cranking motor solenoid relay defective.	--- Replace cranking motor solenoid relay (para 3-48).
Cranking motor defective.	--- Replace cranking motor (para 3-48).
Cranking motor leads defective.	--- Replace cranking motor leads (para 3-48).

3-25. Not Enough Pressure

Probable cause	Possible remedy
Engine not running at rated speed.	---- Increase engine speed (para 3-41).
Valves not fully opened	--- Open valves (para 2-11).

Section VI. RADIO INTERFERENCE SUPPRESSION

3-26. General Methods

Essentially, interference is suppressed by providing a low-resistance path to ground stray currents. Methods include shielding the ignition and high-frequency wires, grounding the frame with bonding straps, and using capacitors and resistors where necessary. For general information on radio interference sup-

3-27. Interference Suppression Components

a. Primary Suppression Components. The primary suppression components are those whose primary function is to suppress radio interference. These components are as follows:

(1) Engine generator regulator capacitor.

(2) Generator enclosure. The generator is completely shielded by its housing, which is grounded to the engine.

(3) Magneto bond strap.

(4) Shielded ignition wire.

b. Secondary Suppression Components. The secondary components have radio interference suppression functions that are incidental and/ or secondary to their primary function. In the centrifugal pump unit, these are mainly fastenings or fastening accessories designed to ensure good electrical contact between various parts of the equipment, such as toothed lockwashers.

3-28. Testing and Replacement of Suppression Components

a. Correct faulty suppression by substituting new suppression components until the defective ones are found. Test engine generator regulator capacitor for leaks and shorts on a capacitor tester; replace defective capacitor. If test equipment is not available and interference is indicated, test by substitution.

Note In testing components by substitution, do not pull on cable or twist braided shielding in removing or replacing shielded ignition cables. Gently work cable from side to side and free the rubber seal. Do not use sharp metal tools to install rubber seals.

b. As many of the minor interference suppression components consist of IT (internal tooth), IET (internal-external tooth) and ET (external tooth) lockwashers, always replace with the same type.

c. Be sure all bond straps are securely fastened.

d. Tighten all fastening accessories.

Section VII. GAGES AND INSTRUMENTS

3-29. General

Gages and instruments are located on the instrument panel box, and the fuel tank. They must be replaced when they become inoperative or give incorrect readings during normal operation. Inspect all wiring removed during the replacement; inspect for cracked or frayed insulation, and replace any defective leads. Also check oil-pressure and water-temperature sending units (para 3-53). Tag and remove the necessary lines, leads and cable before removing any gage or instrument.

3-30. Cleaning, Inspection, and Replacement

a. Remove and install the level, pressure, and temperature gages as shown by figure 3-6.

b. Remove and install the tachometer drive assembly as shown by figure 3-7.

c. Refer to figure 3-6 and remove and install the tachometer-hourmeter.

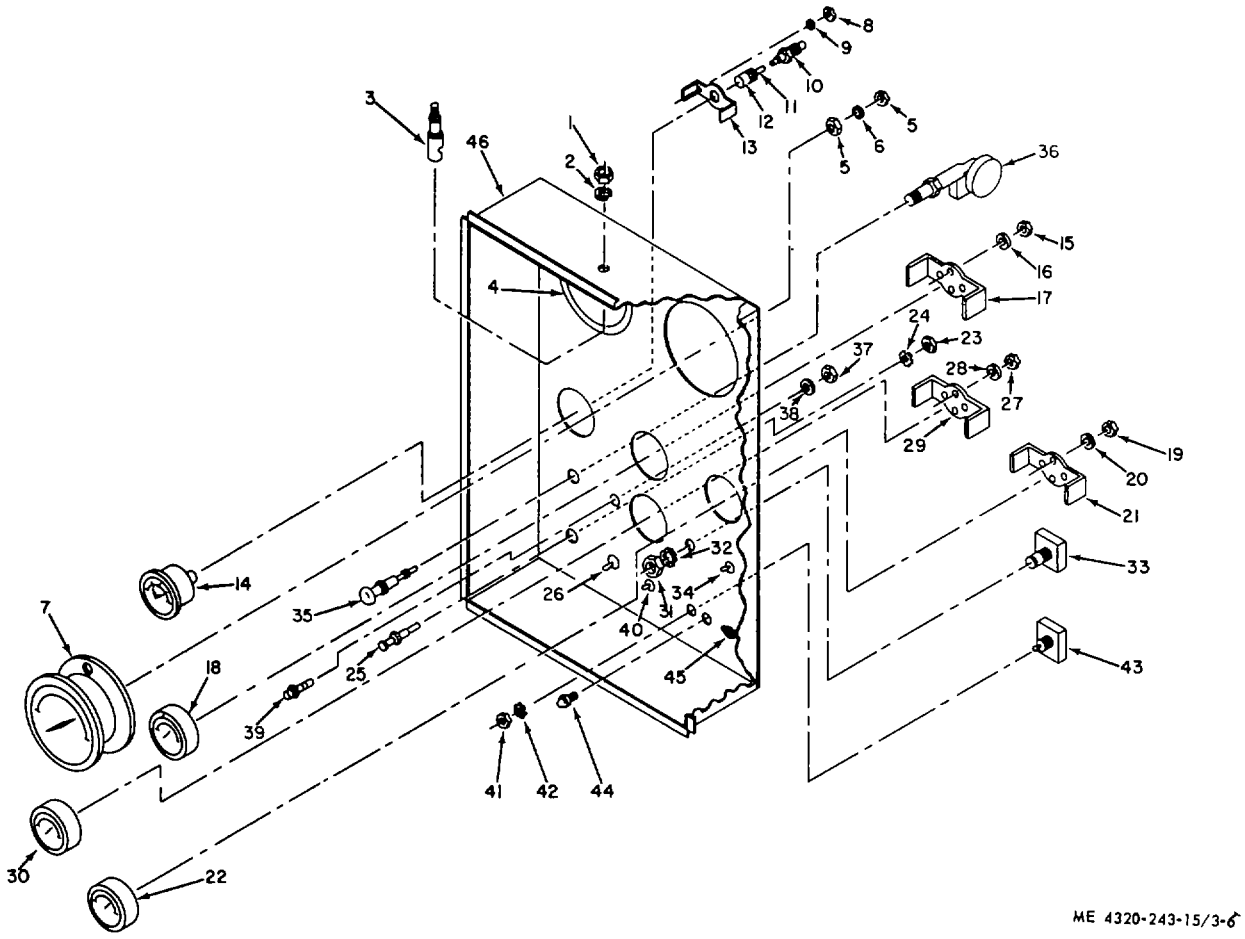
d. Refer to figure 3-6 and remove and install the starting switches.

e. Clean and inspect for corrosion, breaks or other defects.

Section VIII. PUMPING ASSEMBLY AND COUPLING

3-31. Inspection

Make a general visual examination of the pumping assembly and coupling for such deficiencies as loose or missing bolts or nuts, and bent, cracked, or broken parts.



1 Nut
2 Washer
3 Pilot light assembly
4 Suction pressure gage
5 Nut (6)
6 Washer (3)
7 Discharge pressure gage
8 Nut (2)
9 Washer (2)
10 Tachometer shaft housing
11 Flexible shaft
12 Housing
13 Mounting bracket
14 Tachometer
15 Nut
16 Washer
17 Mounting bracket
18 Engine oil gage
19 Nut
20 Washer
21 Mounting bracket
22 Battery charging voltmeter
23 Nut
24 Washer
25 Throttle
26 Panel light switch
27 Nut
28 Washer
29 Mounting bracket
30 Water temperature gage
31 Nut
32 Washer
33 Starting switch
34 Ignition switch
35 Primer pump control
36 Primer pump assembly
37 Nut
38 Washer
39 Choke
40 Engine safety switch
41 Nut
42 Washer
43 Pump safety switch
44 Pilot light
45 Fuse
46 Instrument and control housing

Figure 3-6. Controls and instruments, exploded view.

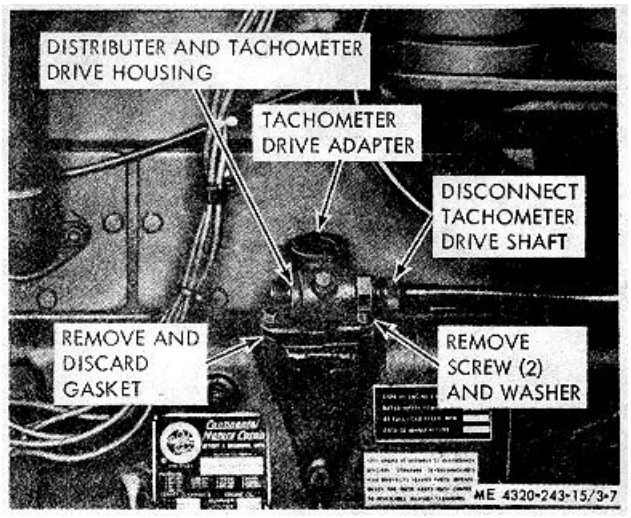


Figure 3-7. Tachometer drive housing, removal and installation.

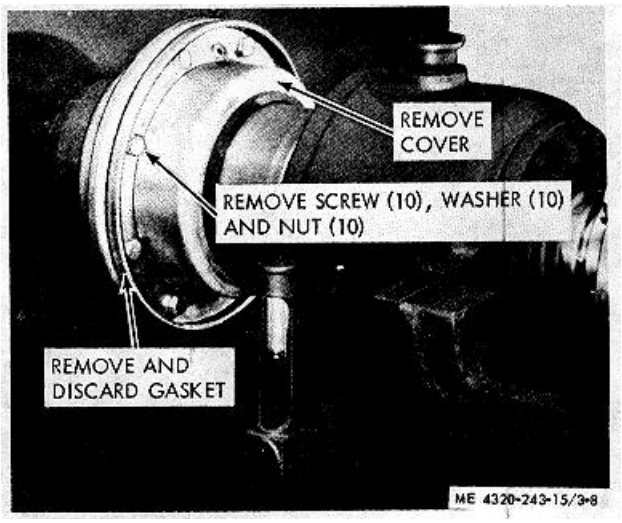


Figure 3-8. Flexible drive coupling, removal and installation.

3-32. Coupling

a. Remove and install the flexible drive coupling as shown in figure 3-8.

b. Clean and inspect.

3-33. Service

Lubricate as prescribed by the current lubrication order, figure 3-1.

Section IX. ENGINE

3-34. General

Continental Engine Model RS 633 is a 6-cylinder, 4-stroke/cycle, liquid cooled, over head-valve, gasoline engine developing 142 rated horsepower at full load speed of 2,200 rpm. Major components located on the engine are the governor, carburetor, starting-motor, oil filters, magneto, generator, and fuel pump.

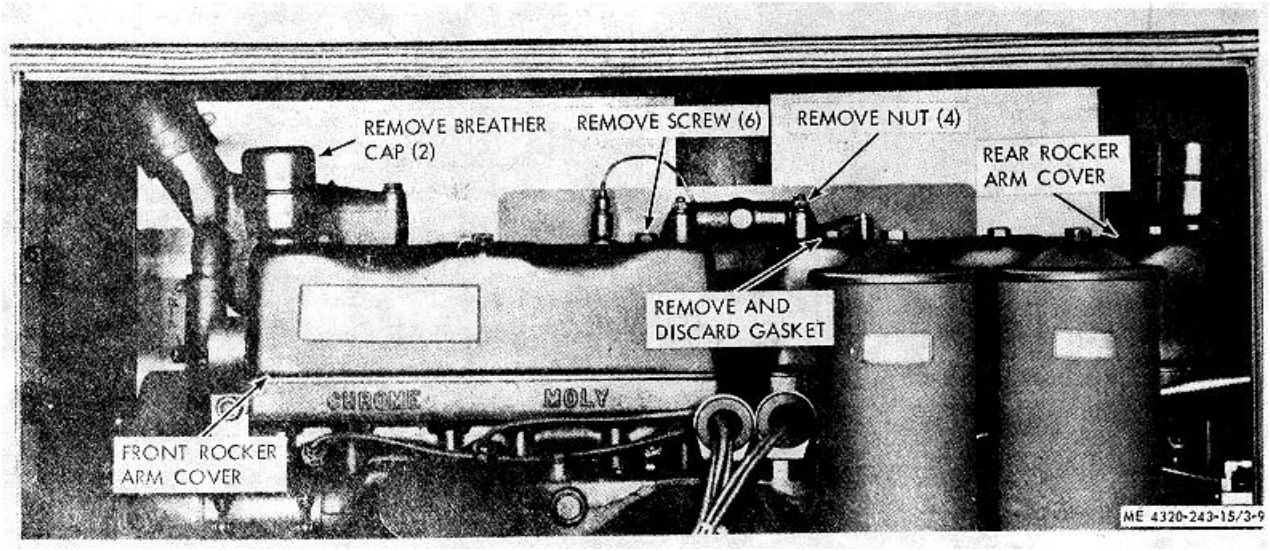


Figure 3-9. Breather connection and rocker arm cover, removal and installation.

3-35. Breather Connection and Rocker Arm Covers

a. Remove and install the breather connection and rocker arm covers as shown in figure 3-9.

b. Clean and inspect.

3-36. Valve Adjustment

a. Remove breather connection and rocker arm covers (para 3-35).

b. Refer to figure 3-10 and adjust valve tappets to clearances shown.

c. Install breather connection and rocker arm covers (para 3-35).

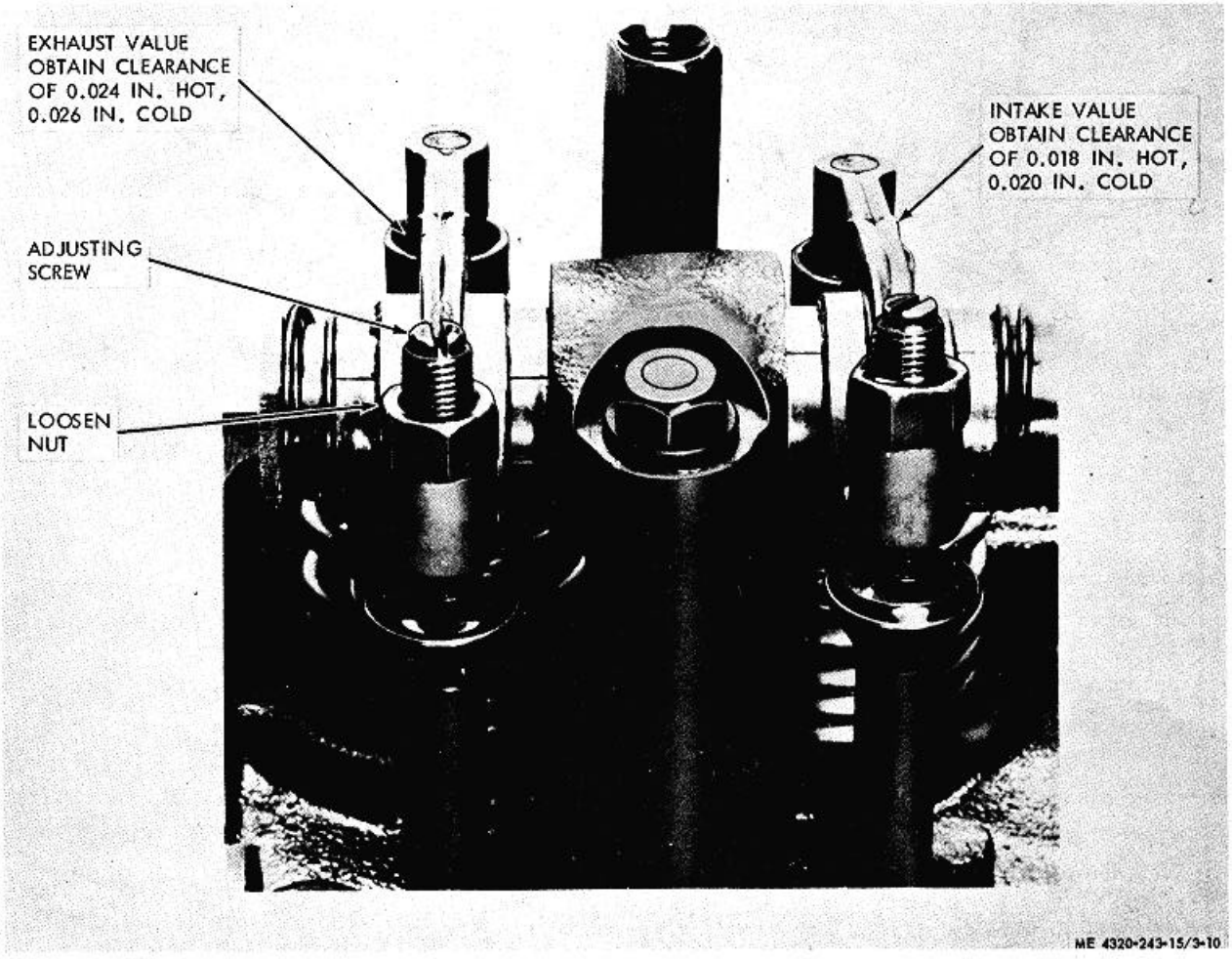
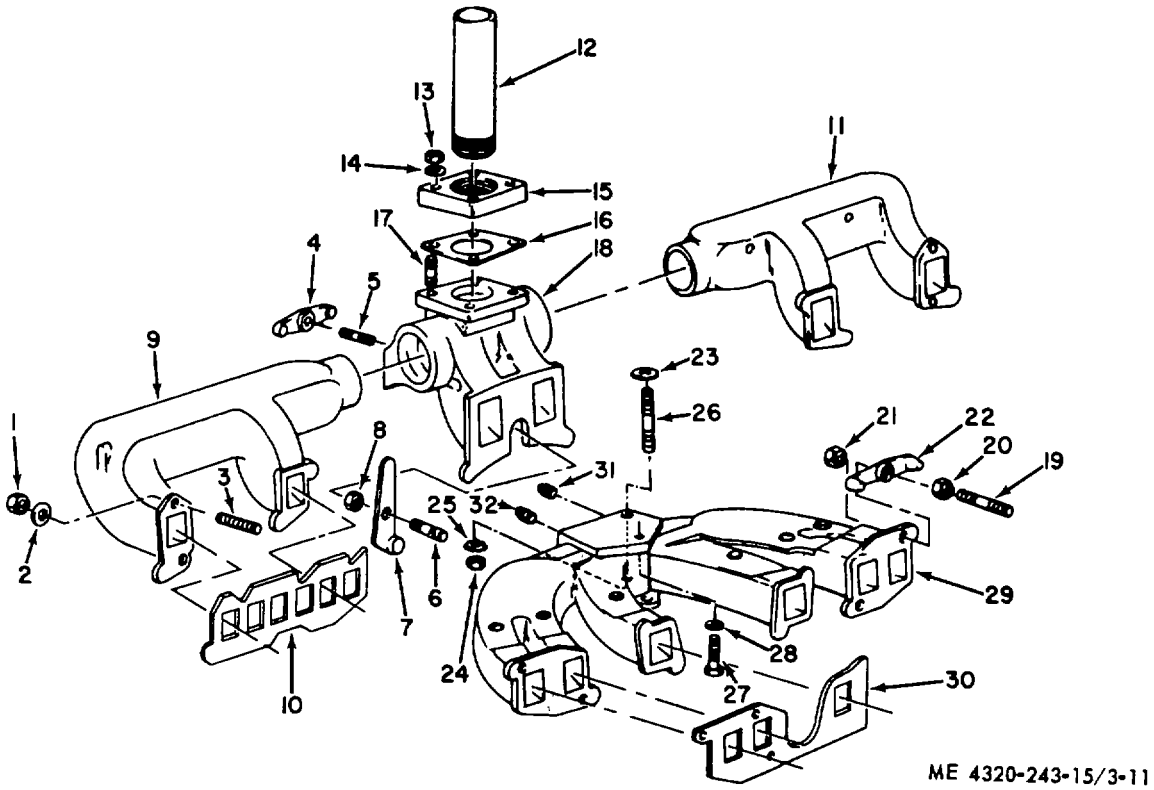


Figure 3-10. Valve Adjustment.

3-37. Intake and Exhaust Manifolds

a. Remove and install intake and exhaust manifolds as shown in figure 3-11.

b. Clean and inspect.



1	Nut	12	Exhaust pipe nipple	23	Washer
2	Washer	13	Nut (4)	24	Nut
3	Stud	14	Washer (4)	25	Washer
4	Manifold crab	15	Exhaust flange	26	Stud
5	Stud	16	Gasket	27	Screw
6	Stud	17	Stud (4)	28	Washer
7	Manifold crab	18	Manifold	29	Intake manifold
8	Nut	19	Stud	30	Gasket
9	Front exhaust manifold	20	Nut	31	Plug
10	Gasket	21	Nut	32	Plug
11	Rear exhaust manifold	22	Manifold crab		

Figure 3-11. Intake and exhaust manifolds.

Section X. FUEL SYSTEM

3-38. General

The fuel system consists of the fuel tank, fuel pump, carburetor, air cleaner assembly, governor, primer, choke, throttle, and the necessary connecting lines, tubing, and linkage. The fuel pump draws the fuel from the tank through the fuel filter to the carburetor; then forces it through the carburetor where it is mixed with filtered air drawn through the air cleaner. This fuel-air mixture is then drawn into the cylinders and ignited by the spark plugs.

3-39. Fuel Pump, Fuel Filter, and Fuel Lines

a. Service the fuel pump and fuel filter as shown by figure 3-12.

b. Remove and install the fuel pump, fuel filter and fuel line as shown by figure 3-12.

c. Clean and inspect.

3-40. Carburetor, Throttle Solenoid and Support and Throttle Body

a. Adjust the carburetor as shown by figure 3-13.

b. Remove and install the carburetor, throttle solenoid and support, and throttle body as shown by figure 3-14.

3-41. Governor

a. Adjust the governor as shown by figure 3-15.

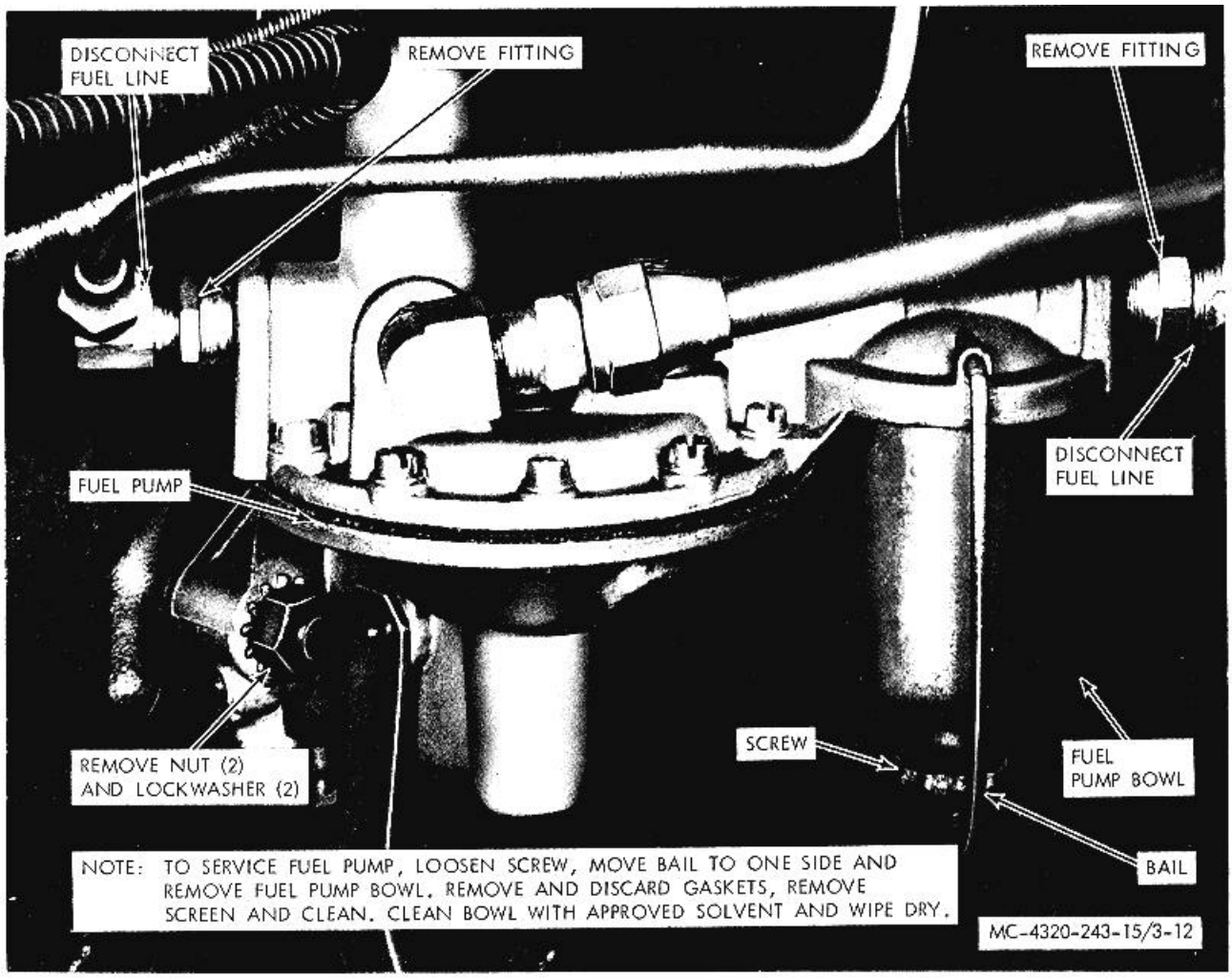


Figure 3-12. Fuel pump and filter service, removal and installation.

b. Remove and install the governor and linkage as shown by figure 3-16.

c. Clean and inspect.

3-42. Air Cleaner

a. Remove and install the air cleaner as shown by figure 3-3.

b. Clean and inspect.

c. If the engine fails to start or stalls because of a stoppage in the air cleaner assembly, when a new assembly is not available, remove the old assembly and securely fasten a section of clean, fine-meshed screen over the open end of the carburetor. In an emergency, this will filter the air adequately in most environments.

***Caution*: Operating the unit in sandy or dusty areas without an air cleaner can damage the engine.**

3-43. Fuel Tank and Associated Parts

a. Remove and install the toolbox, by removing and installing the two screws, and lockwashers attaching the toolbox to the skid.

b. Remove and install the fuel line assembly, fuel shutoff valve, fuel tank level gage, level control valve, fuel filler tank cap, and fuel tank strainer (fig. 3-17).

c. Remove and install the fuel tank shield and fuel tank in sequence as shown by figure 3-18.

d. Clean and inspect.

e. Remove all rust and loose paint from the

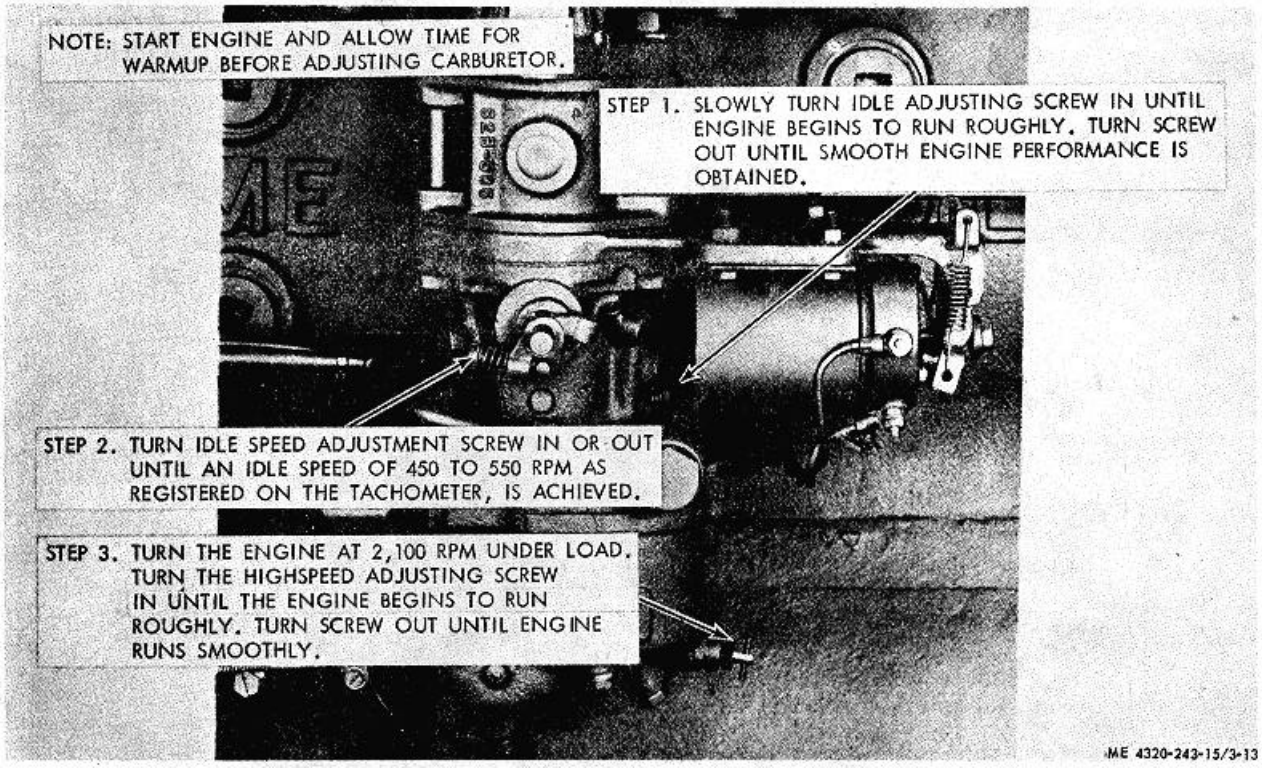


Figure 3-13. Carburetor adjustment

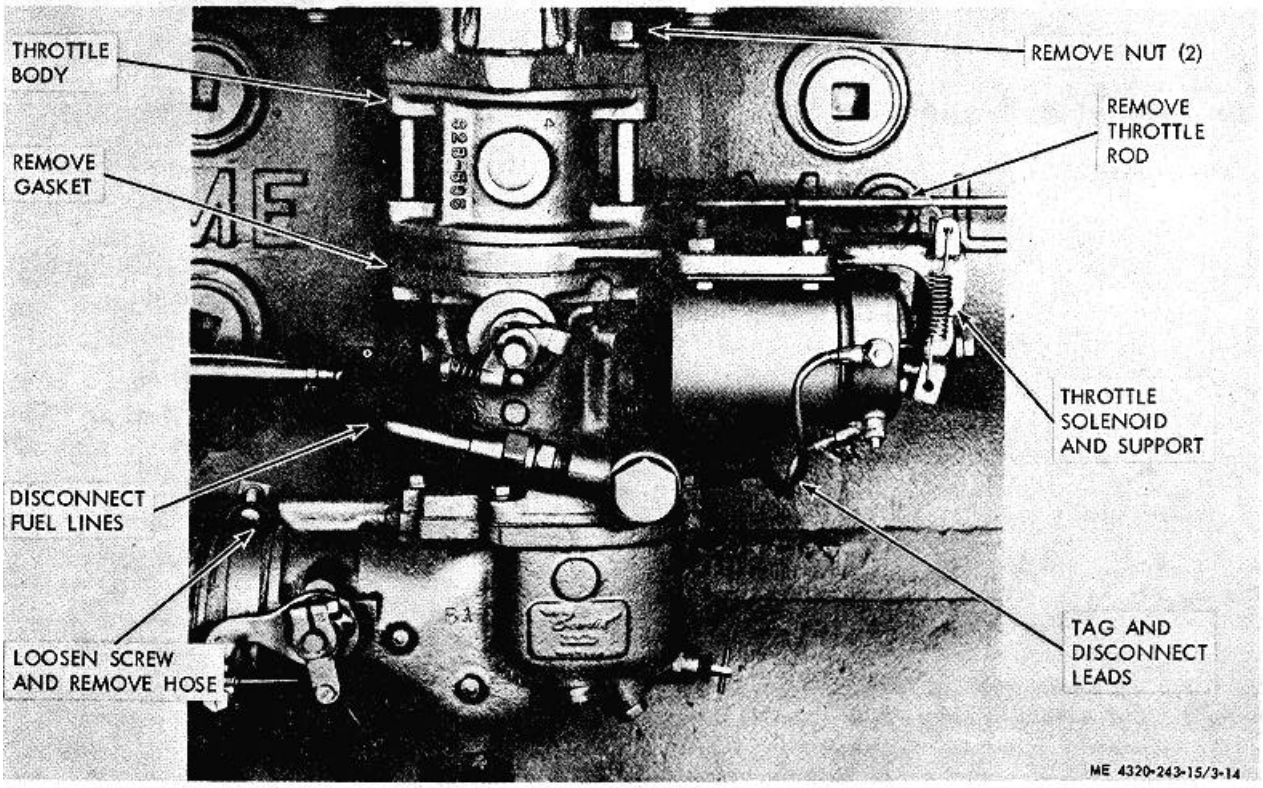


Figure 3-14. Carburetor, throttle solenoid and support and throttle body, removal and installation.

fuel tank shield and fuel tank with a wire brush and repaint as directed in TM 9-213.

f. Replace an unserviceable fuel tank shield or fuel tank.

3-44. Primer Pump, Lines and Fittings

a. Refer to figure 3-6 and remove and install primer pump, lines and fittings.

b. Clean and inspect.

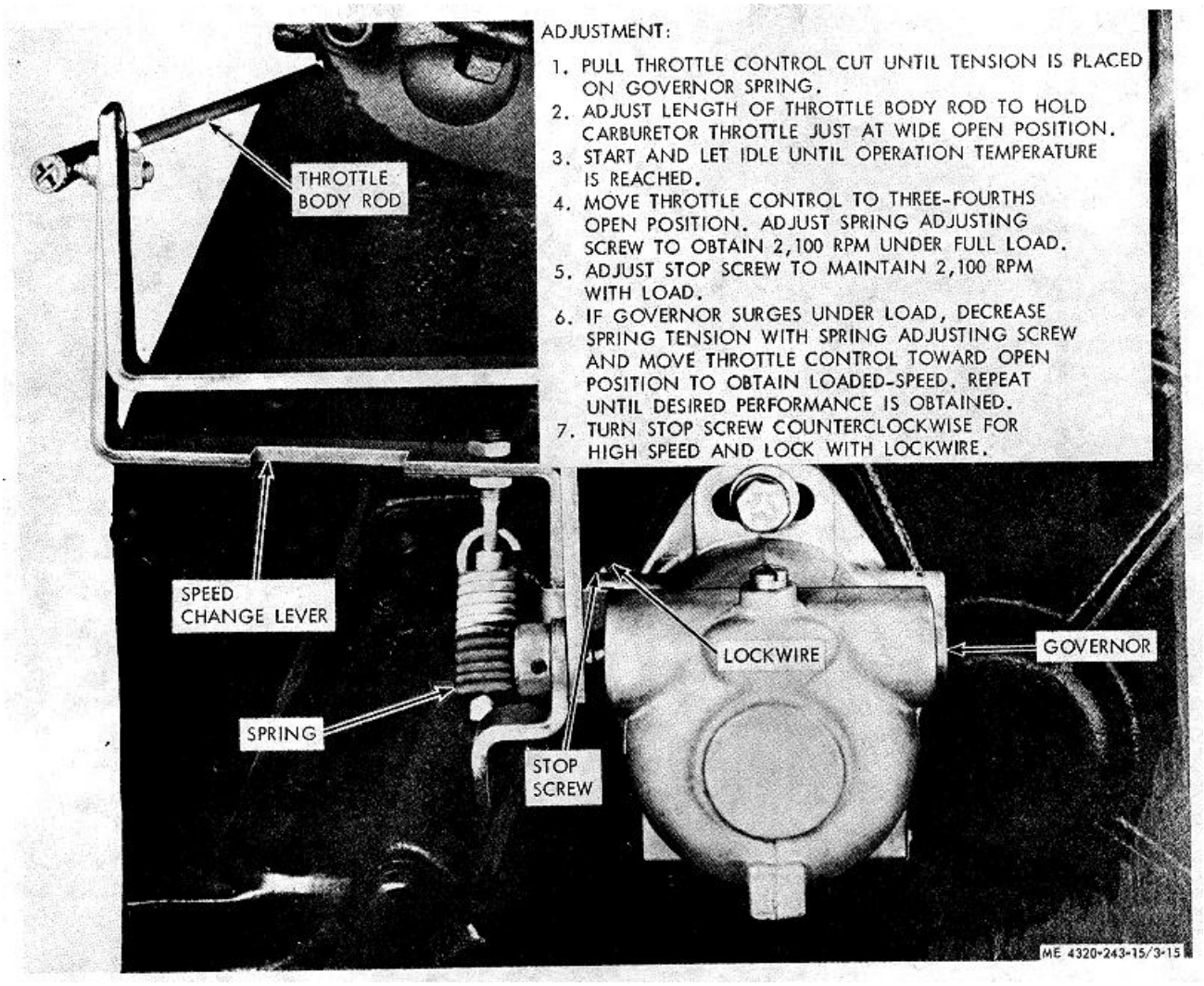


Figure 3-15. Governor adjustment

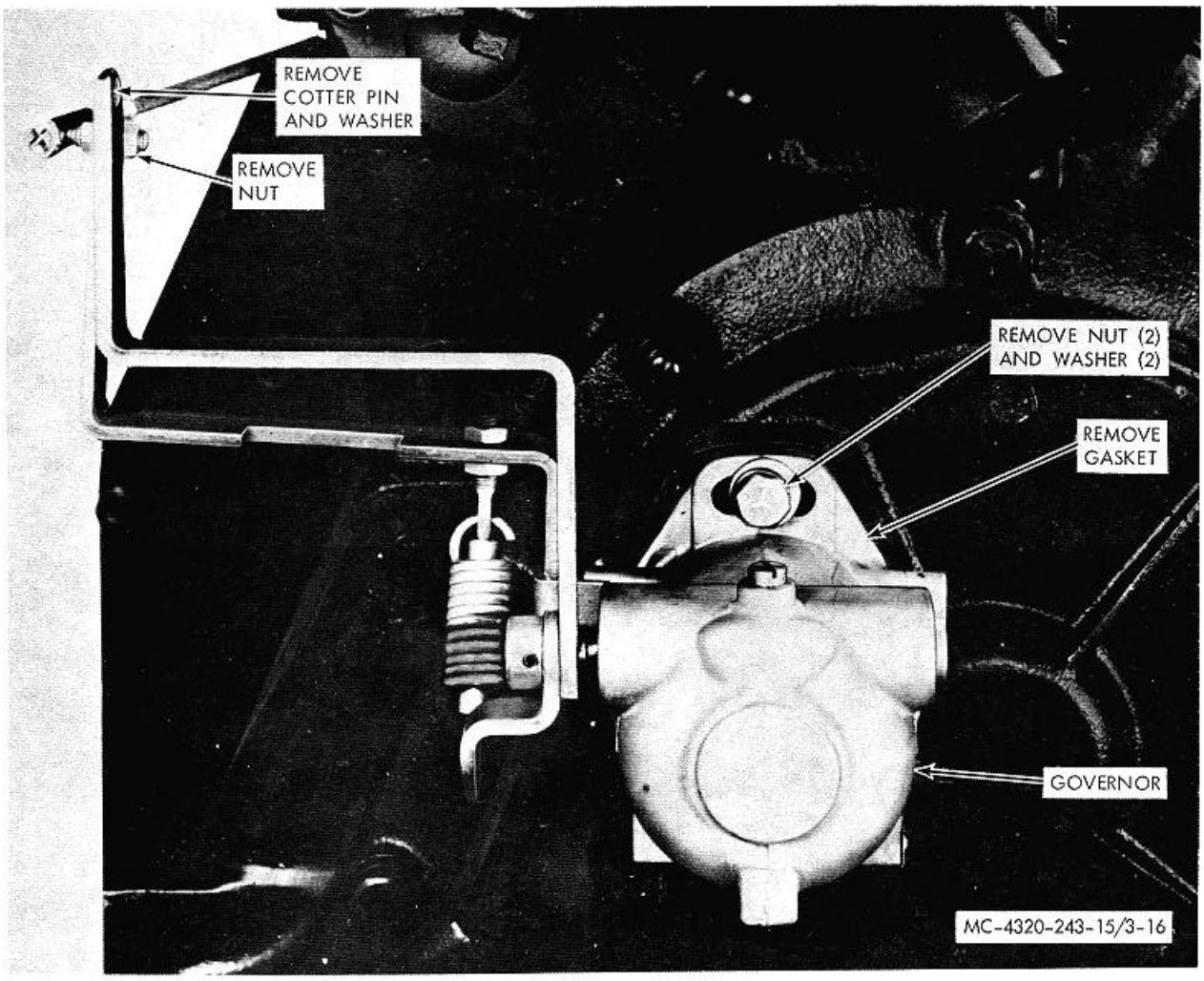
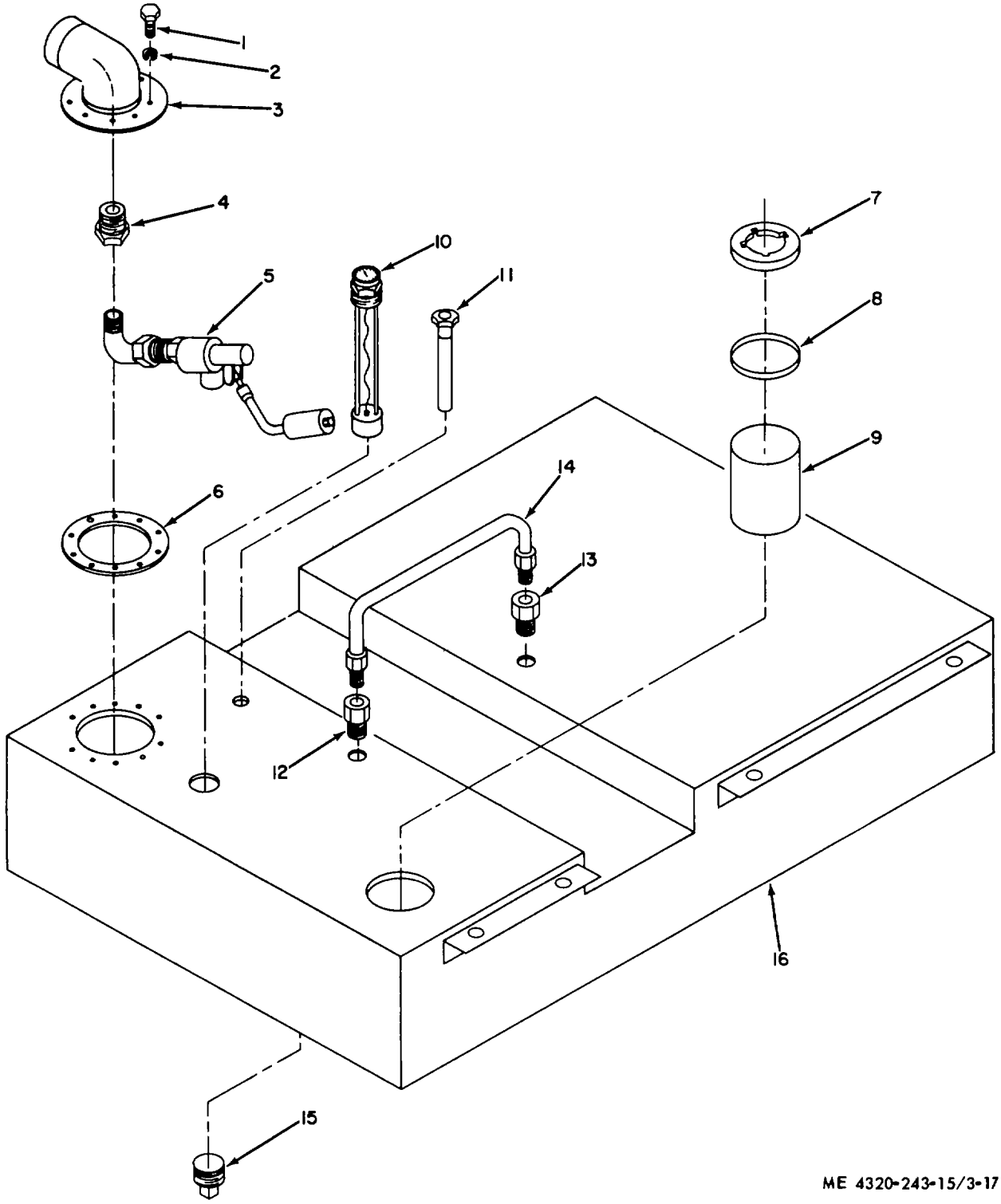


Figure 3-16. Governor and linkage, removal and installation.



1	Screw (12)	5	Float assembly	9	Inner sleeve strainer	13	Male connector
2	Washer (12)	6	Gasket	10	Fuel gage	14	Air vent assembly
3	Flange	7	Cap	11	Riser assembly	15	Plug
4	Bushing	8	Gasket	12	Male connector	16	Fuel tank assembly

Figure 3-17. Fuel tank assembly, disassembly and reassembly.

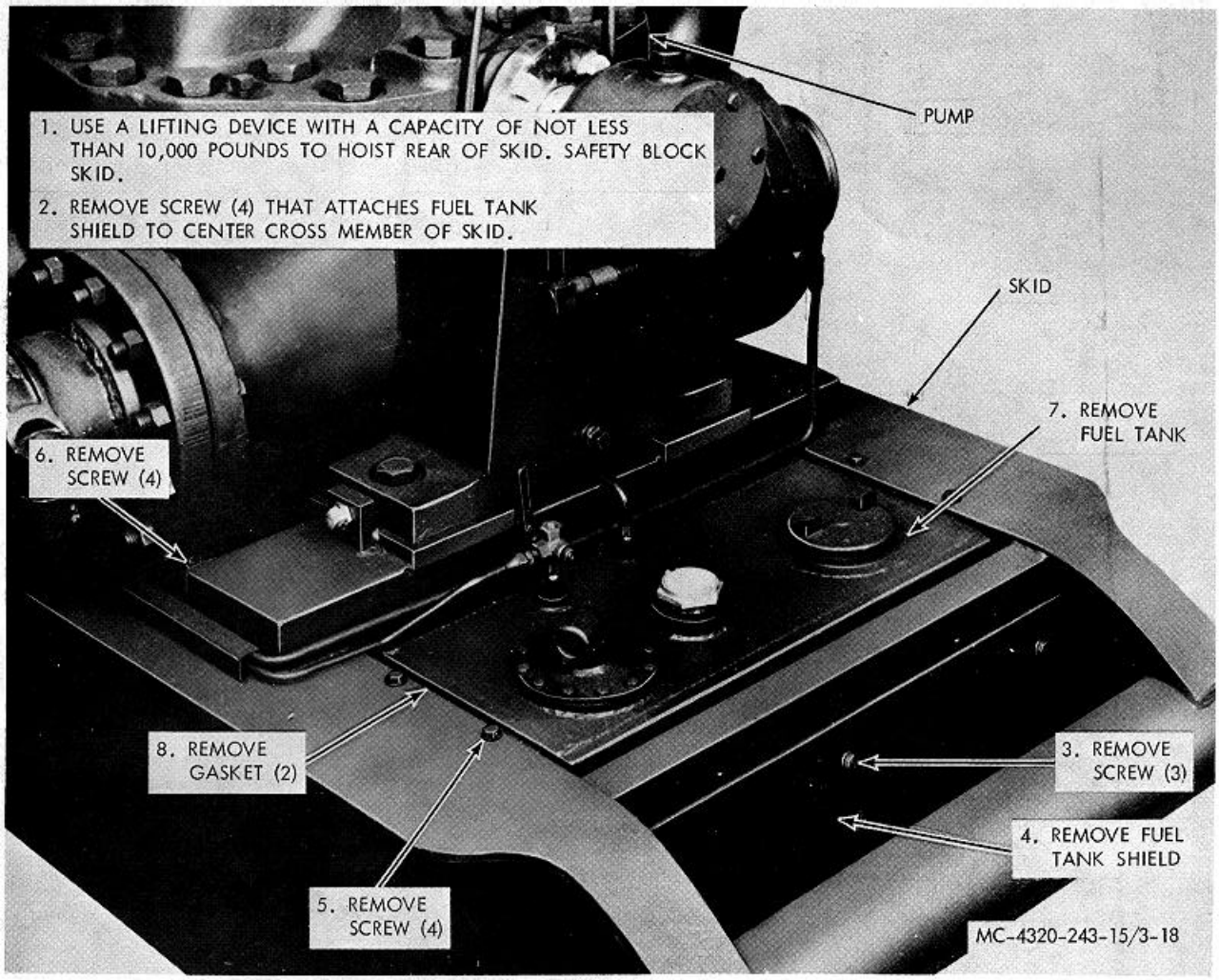


Figure 3-18. Fuel tank shield and fuel tank, removal and installation.

Section XI. ELECTRICAL SYSTEM

3-45. General

The 24-volt electrical system consists of two 12-volt batteries in series, the battery box, generator, magneto, starting motor, generator regulator, spark plugs, and the wiring and switches required to connect and operate these components. The starter motor is a 24-volt, series-wound dc motor powered by the 24-volt generator driven by two V-belts. The generator charging rate is controlled by the generator regulator which is mounted on the front engine support. The magneto furnishes the high-voltage ignition current via the ignition wires to the spark plugs.

***Caution*: Always remove the battery ground cable before working on the engine electrical system.**

3-46. Generator

Remove and install the generator, following the sequence shown by figure 3-19.

3-47. Generator Regulator

Remove and install the generator-regulator as shown by figure 3-20.

3-48. Starting Motor and Solenoid

a. Remove and install the starting motor, solenoid and lead assembly in sequence shown by key numbers in figure 3-21.

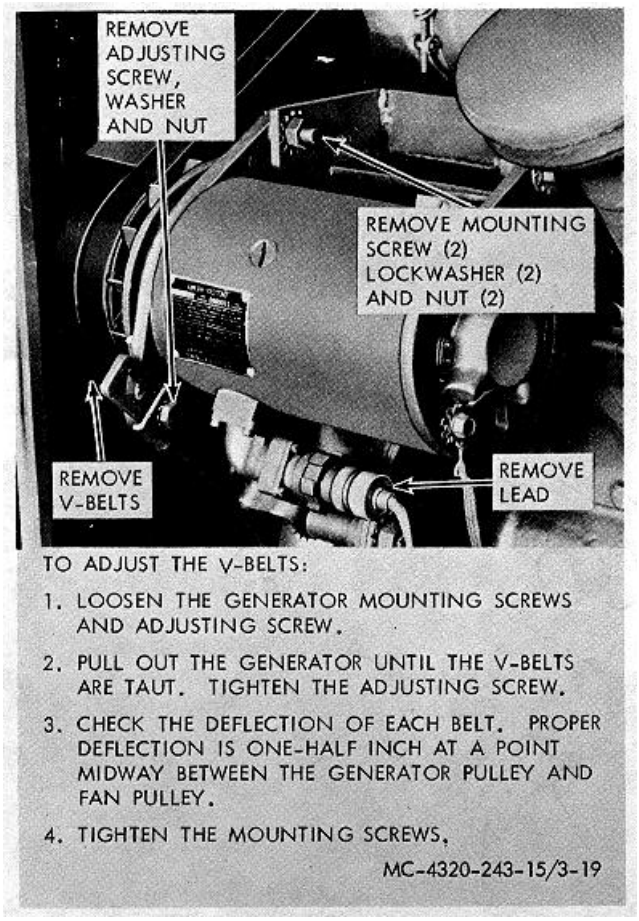


Figure 3-19. Generator, bracket and adjustment strap,

b. Refer to figure 3-22, and perform the on-equipment test.

3-49. Magneto

a. *Adjustment*. Adjust the magneto contacts as shown by figure 3-23.

b. Removal. Remove the magneto and magneto gear as shown by figure 3-24. Clean and inspect.

c. Installation.

(1) Remove the spark plug from the number 6 cylinder (para 3-50).

(2) Make the timing marks accessible as shown by figure 3-25.

(3) Place the thumb over the spark plug hole. Rotate the engine until air pressure is felt, indicating the compression stroke.

(4) Continue to rotate the engine until the flywheel timing mark is aligned as shown in figure 3-25.

(5) Install the magneto and gear as shown by figure 3-24 with the magneto timing gear mark aligned as shown by figure 3-25.

(6) Install the spark plug in the number 6 cylinder and install the timing cover plug(fig. 3-25).

(7) Follow the instructions in *d* below and time the engine.

d. Ignition Timing

(1) Connect the ignition timing light to the number 6 sparkplug lead and to the 24-volt power source.

(2) Start the engine and let it idle

(3) Point the timing light through the timing hole in the flywheel housing. If the timing is correct, the flywheel timing mark (fig. 3-25) will be in line with the pointer inside the flywheel housing each time the light flashes.

(4) To correct faulty timing, loosen the magneto clockwise and counterclockwise until timing is correct. Tighten the magneto mounting screws.

3-50. Spark Plug Leads and Spark Plugs

a. Remove and install the spark plug leads and spark plugs as shown in figure3-26.

***Caution*: Do not pull on the cable or twist the braided shielding.**

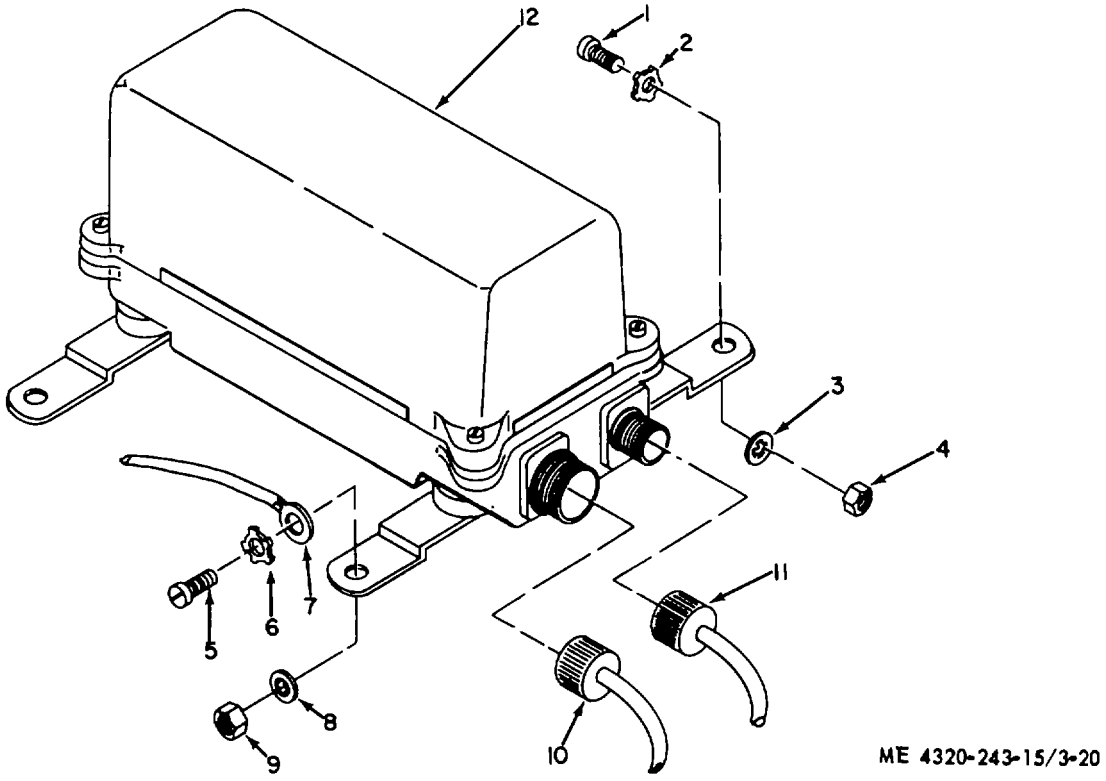
b. Clean and check the gap between the spark plug electrodes with a wire feeler gage. The correct gap is 0.030 inch. If necessary, regap the electrodes, carefully bending the ground electrodes until the proper gap is established.

3-51. Batteries, Cable and Box

a. Remove and install the battery cover, batteries, and battery cable as shown in figure 2-1, in sequence indicated by key numbers.

b. Remove and install the battery box by removing four screws and lockwashers holding the battery box to the skid.

c. Test and service battery as directed in daily preventive maintenance services chart, figure 3-4.



1 Screw (3)
2 Washer (3)
3 Washer (3)
4 Nut (3)
5 Screw
6 Washer
7 Bond strip terminal
8 Washer
9 Nut
10 Lead assembly
11 Lead assembly
12 Generator regulator

Figure 3-20. Generator regulator, removal and installation.

3-52. Electrical Instruments

Remove and install ammeter and switch, in sequence indicated by key numbers in figure 3-6. Replace defective wiring in accordance with wiring diagram, figure 1-5.

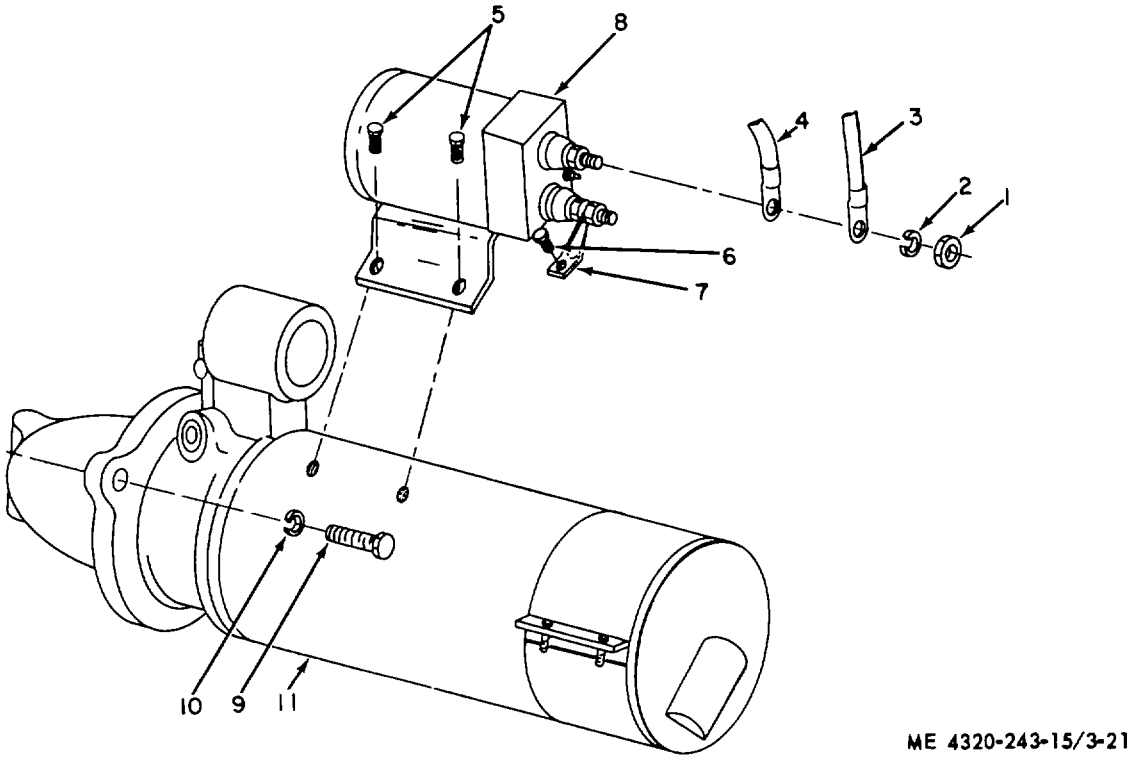
3-53. Sending Units

Remove and install oil-pressure sending unit as shown in figure 3-27. Remove and install temperature sending unit (10, fig. 3-28).

3-54. Engine Safety Switch

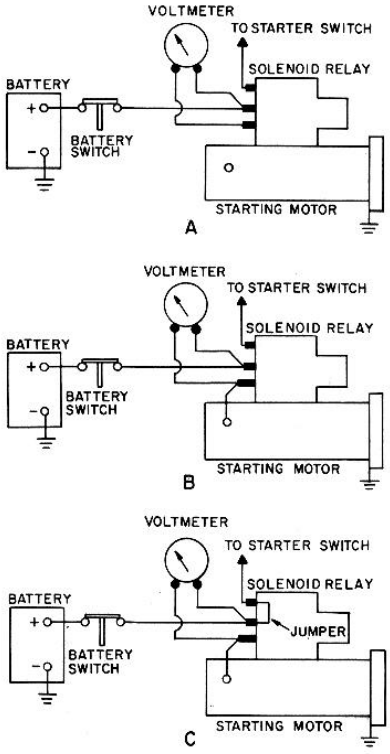
a. Refer to figure 3-6 and remove and install the engine safety switch.

b. Clean and inspect.



1 Nut
2 Washer
3 Lead assembly (to battery)
4 Lead assembly (to B.C. receptacle)
5 Bolt (4)
6 Bolt
7 Solenoid grounding bracket
8 Solenoid assembly
9 Bolt (2)
10 Washer (2)
11 Starter motor

Figure 3-21. Starter motor assembly, removal and installation.



1. Determine that battery is fully charged and that all battery and starting motor cables are serviceable and properly installed.
2. Remove solenoid-to-staring motor connector and connect voltmeter as shown in A above. If voltage is indicated, solenoid relay is defective and must be replaced.
3. Install the solenoid-t00-starting motor connector.
4. Connect voltmeter as shown in B above. If battery voltage (24 volts) is not indicated, the starting motor is defective.
5. Momentarily connect a jumper as shown in C above. The voltmeter reading should drop to zero and starting motor should start engine. If voltmeter reading does not drop to zero, solenoid relay is defective and must be replaced. If voltmeter reading drops to zero but starting motor fails to start engine, starting motor is defective.

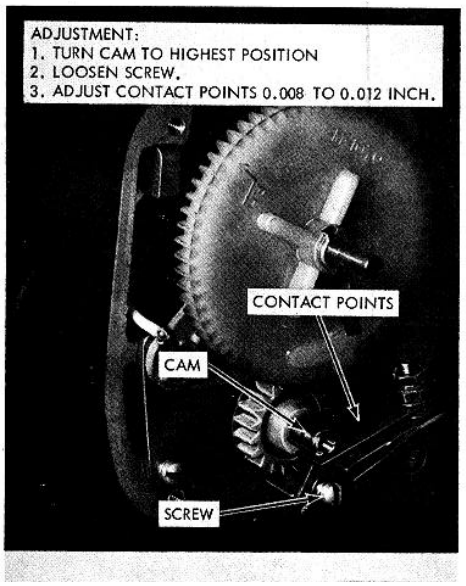


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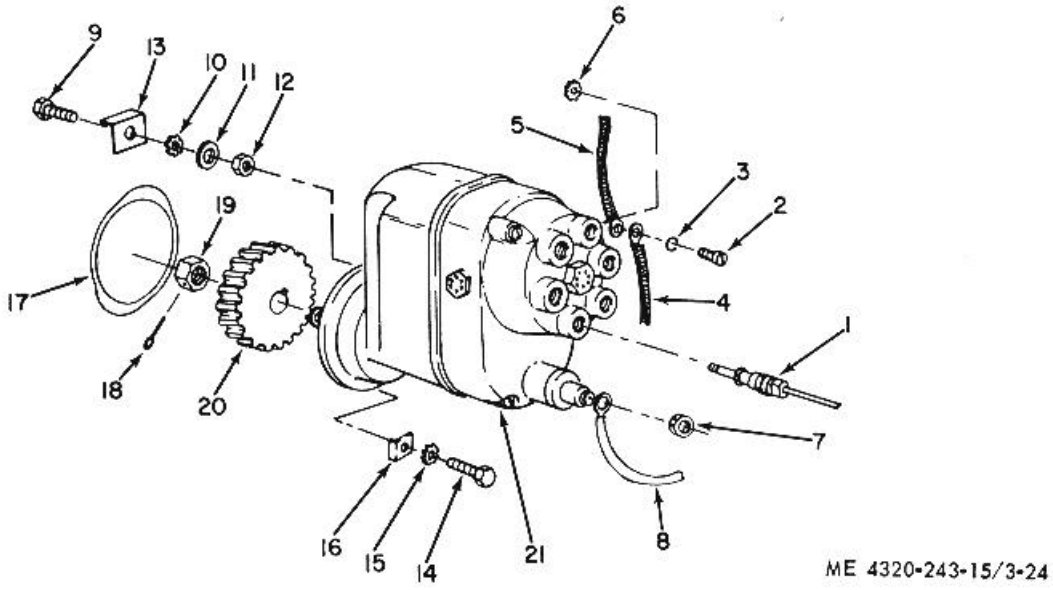
Figure 3-23. Magneto adjustment.



1	Leads (6)	8	Terminal	15	Washer
2	Screw	9	Screw	16	Clamp
3	Washer	10	Washer	17	Gasket
4	Terminal	11	Washer	18	Pin
5	Terminal	12	Nut	19	Nut
6	Washer	13	Clamp	20	Gear
7	Nut	14	Screw	21	Magneto

Figure 3-24. Magneto, removal and installation.

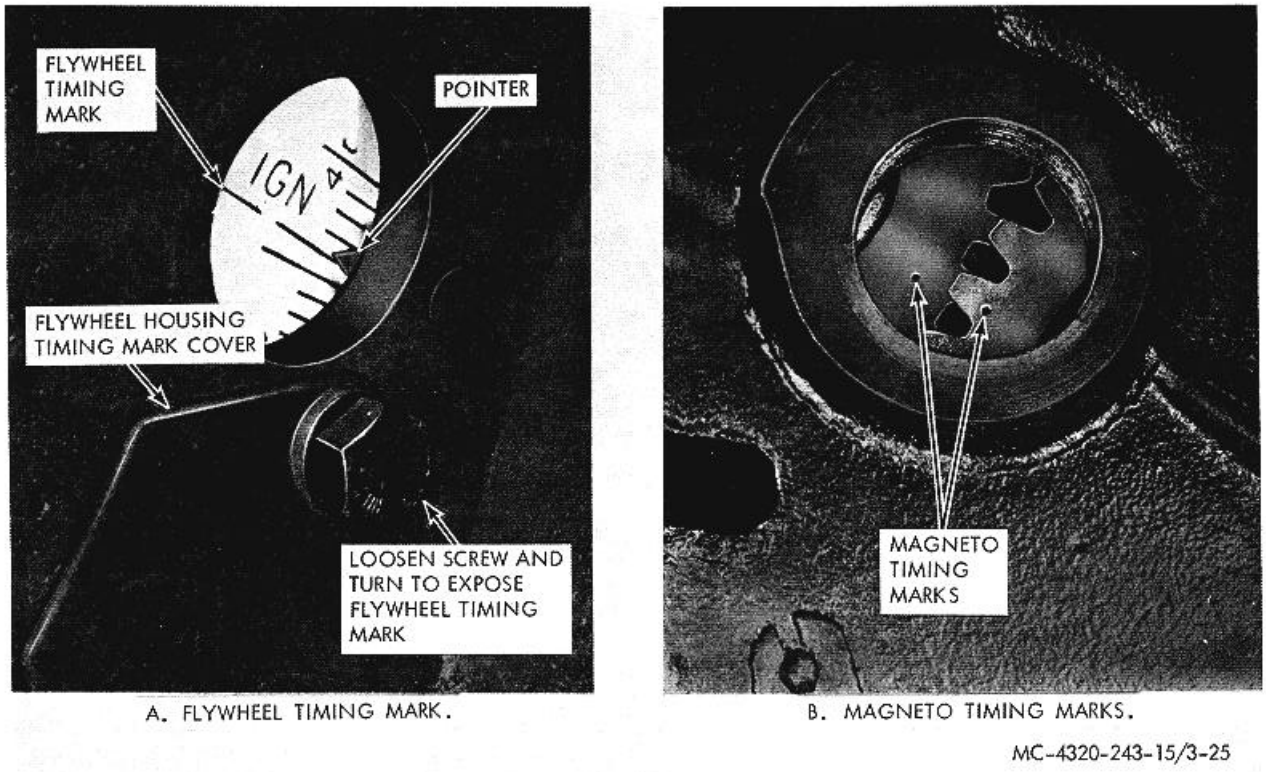


Figure 3-25. Timing marks.

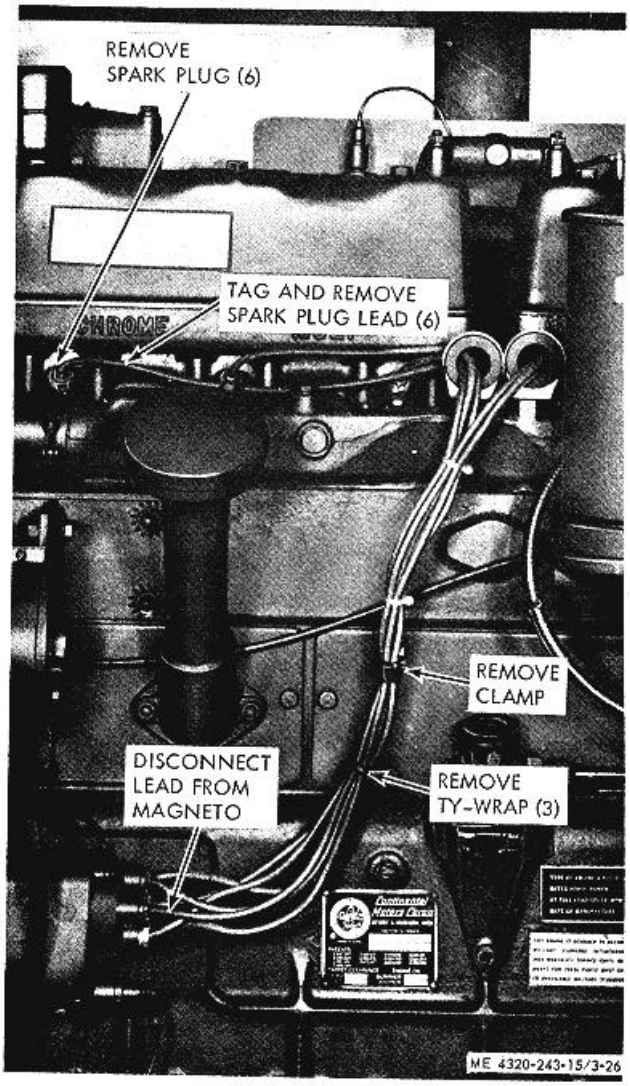


Figure 3-36. Spark plug leads and spark plugs, removal and installation.

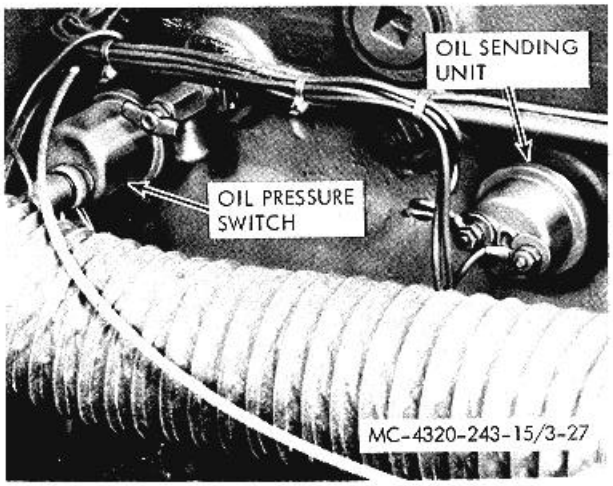
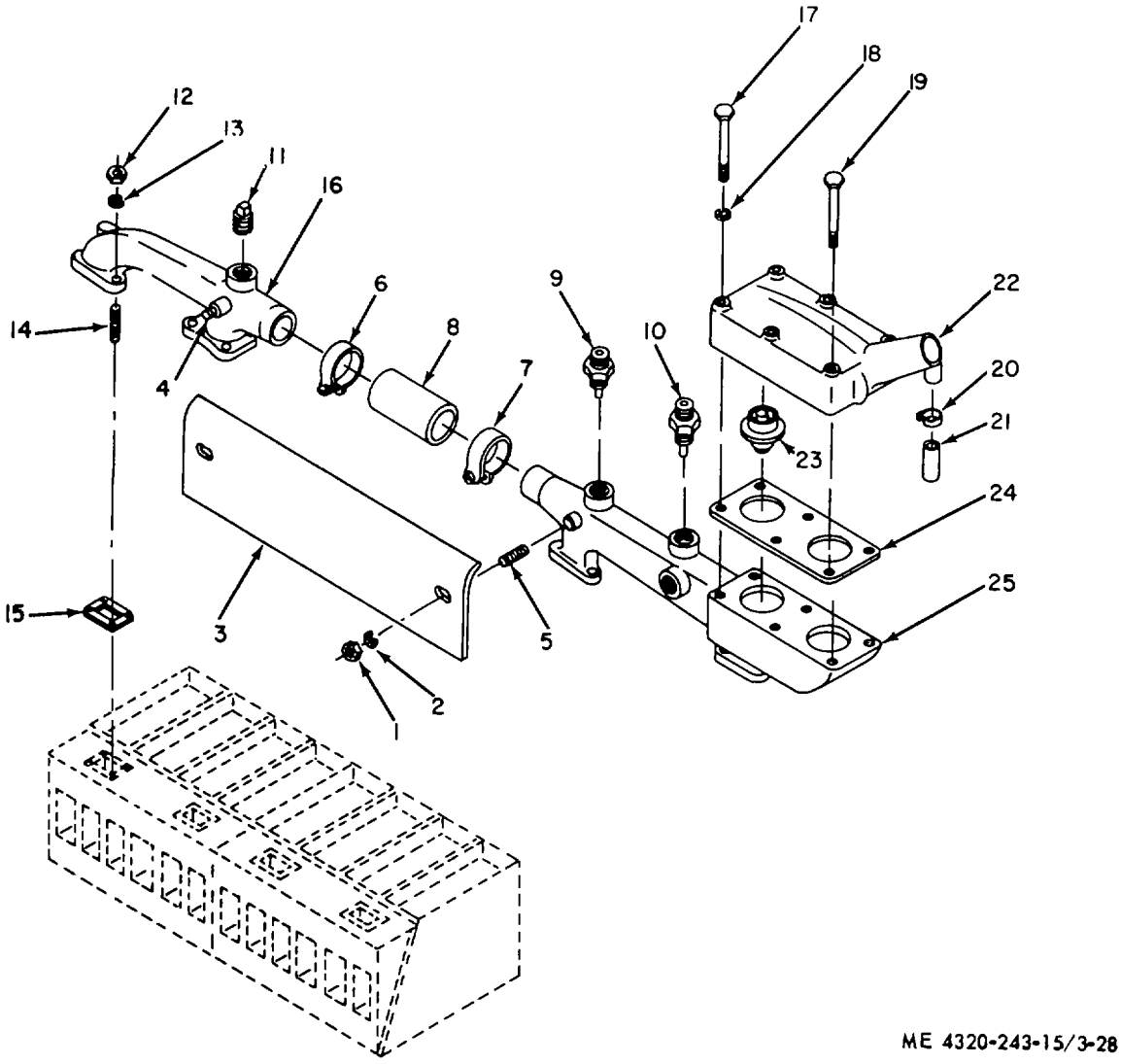


Figure 3-27. Oil pressure switch and oil sending unit, removal and installation.



1	Nut (2)	10	Temperature Sending Unit	18	Washer (6)
2	Washer (2)	11	Plug	19	Screw (2)
3	Heat shield	12	Nut (8)	20	Clamp
4	Stud	13	Washer (8)	21	Hose
5	Stud	14	Stud (8)	22	Outlet connection
6	Clamp	15	Gasket (4)	23	Thermostat
7	Clamp	16	Rear outlet header	24	Gasket
8	Hose	17	Screw (4)	25	Front outlet header
9	Thermoswitch				

Figure 3-28. Water outlet header and related parts.

Section XII. COOLING SYSTEM

3-55. General

The engine cooling system consists of the radiator, fan, water pump inlet and outline headers, outlet elbow, thermostats, shutter thermostat, and shutter assembly. The V-belts from the crankshaft pulley drive the water pump which circulates coolant to the engine block cylinder heads. The radiator is connected to the engine block and cylinder heads by the top and bottom radiator hoses, rigid tube, inlet

and outlet headers, and the outlet elbow. Correct engine operating temperature is maintained by the two thermostats and by the fan which circulates air through the radiator. The thermostats control the flow of coolant through the radiator. The shutter assembly, when closed, blocks the flow of air through the radiator. When the coolant temperature reaches 160° F the shutter begins to open, and is fully open at 185° F. A manual arm is provided on the shutter thermostat housing to open the shutter at temperatures below the shutter thermostat setting.

3-56. Radiator

Service the radiator assembly (fig. 3-29) as follows:

a. lush the radiator as indicated below:

(1) Start the engine and run at slightly faster than idling speed until the water temperature gage registers 180° F. Stop the engine.

(2) Remove the radiator cap, and the radiator drainplug, open the crankcase draincock and drain the coolant into suitable containers. Close the radiator drainplug and crankcase draincock.

(3) Allow the engine to cool. Refill cooling system with clean, fresh water and the -recommended quantity of an approved cooling system cleaning compound. Install radiator cap.

(4) Start the engine and run it slightly faster than idling speed for at least 30 minutes after operating temperature is reached.

(5) Stop the engine. Repeat step (2) above and drain the cooling system.

Note

Always neutralize the cooling system with an approved neutralizing compound after a cleaning compound has been used.

(6) Allow the engine to cool. Fill the cooling system with the clean, fresh water and an approved neutralizing compound. Install the radiator cap.

(7) Start the engine and run it for at least 10 minutes at slightly faster than idling speed after the coolant has reached a temperature of 180° F.

(8) Stop the engine and repeat step (2) above and drain the cooling system.

(9) Allow the engine to cool. Fill the cooling system with clean, fresh water.

(10) Start the engine and run it until the coolant reaches 180° F.

(11) Stop the engine, repeat step (2) above and drain the cooling system.

(12) Repeat steps (9), (10), and (11) above until the water runs clear.

(14) Fill the cooling system to the proper operating level with the proper coolant (pare 2-3). Start the engine and run it until the coolant reaches 180° F. Observe the coolant level and add water if required.

b. Inspect the radiator core, hoses and connections for leaks and air blockage.

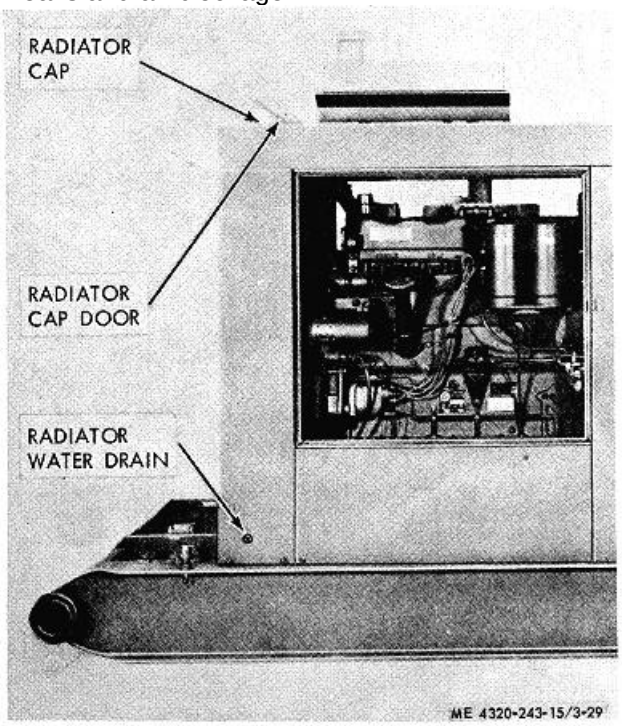


Figure 3-29. Radiator service.

3-57. Water Pump

a. Service the water pump (fig. 3-30) by adding lubricant as directed in the current lubrication order (fig. 3-1).

b. Remove and install as shown by figure 3-30.

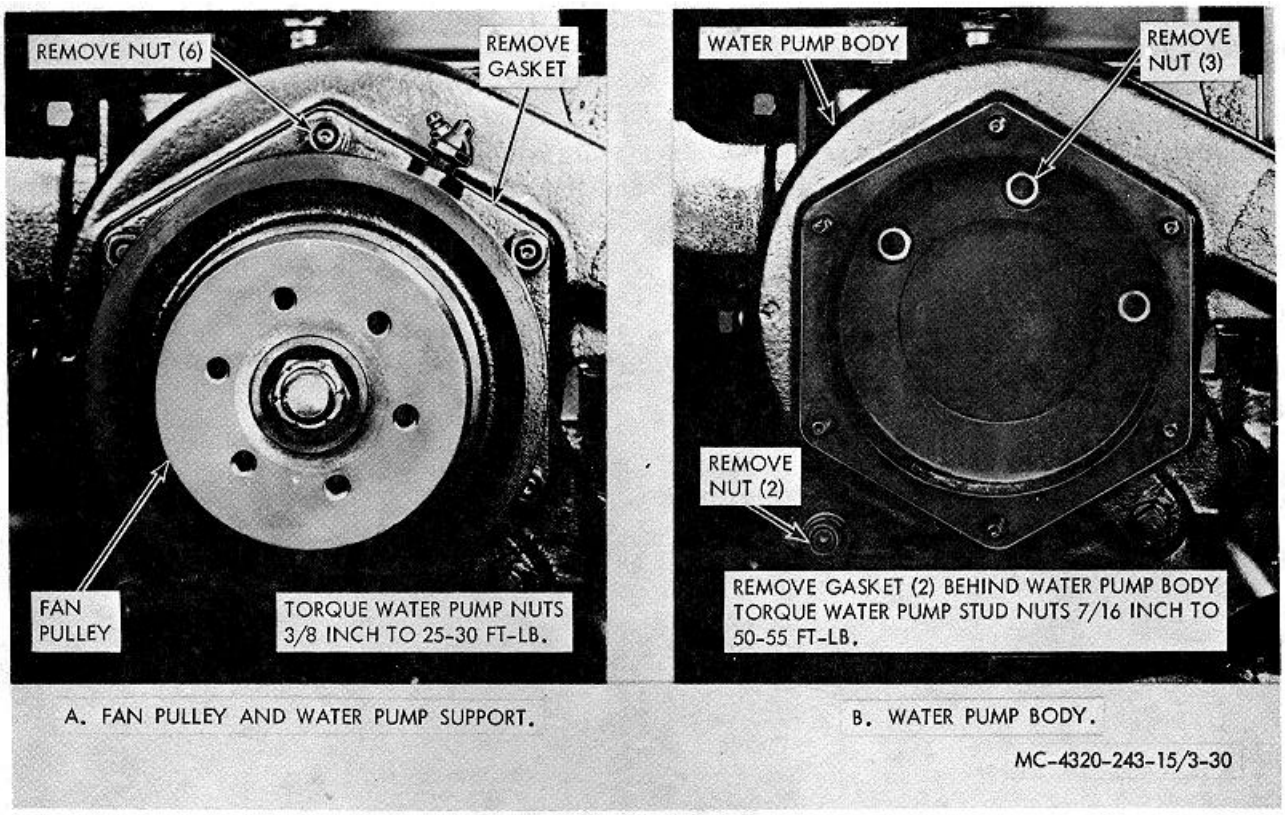


Figure 3-30. Water pump, removal and installation.

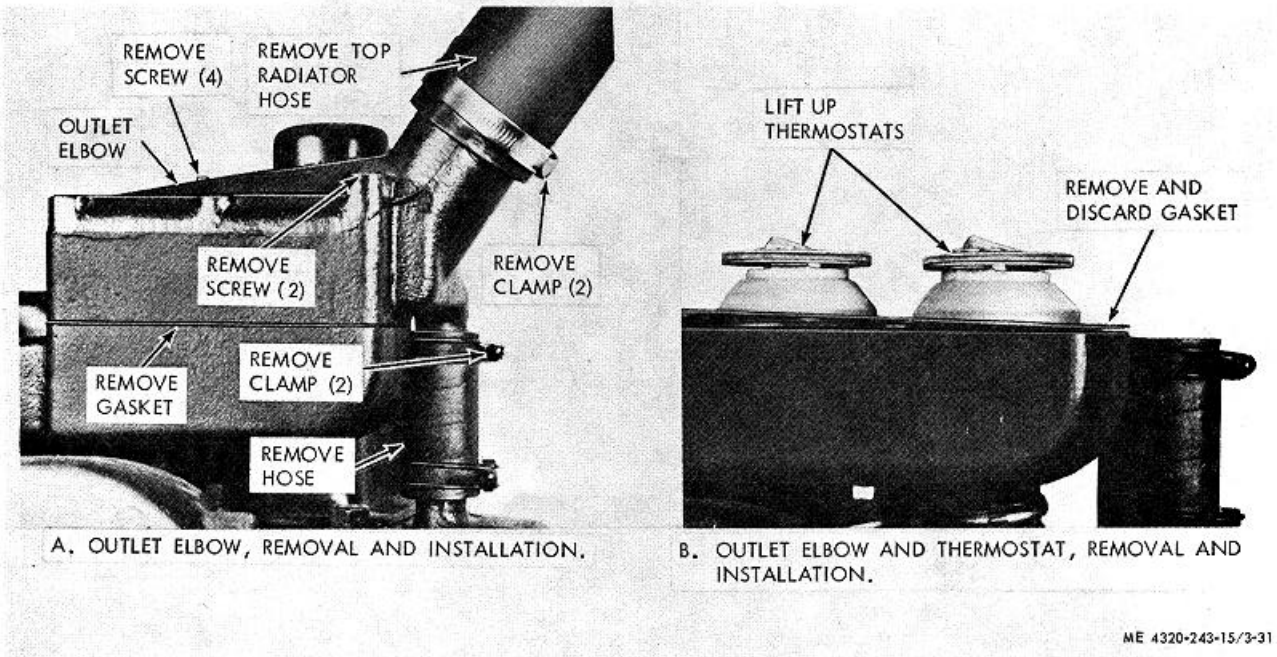


Figure 3-31. Thermostat, removal and installation.

3-58. V-Drive, Belt Assembly

a. Adjust the V-belts as directed in figure 3-19.

b. Remove the V-belts as follows:

(1) Remove radiator fan guard by removing the screws (18) attaching the guard to the radiator.

(2) Loosen the generator mounting screws (fig. 3-19).

(3) Push the generator toward the engine and slip the V-belts off the generator, fan and drive shaft pulleys.

(4) Install in reverse order.

3-59. Water Manifold, Headers, Thermostat and Housing Gasket

a. Test and replace the coolant thermostat as follows:

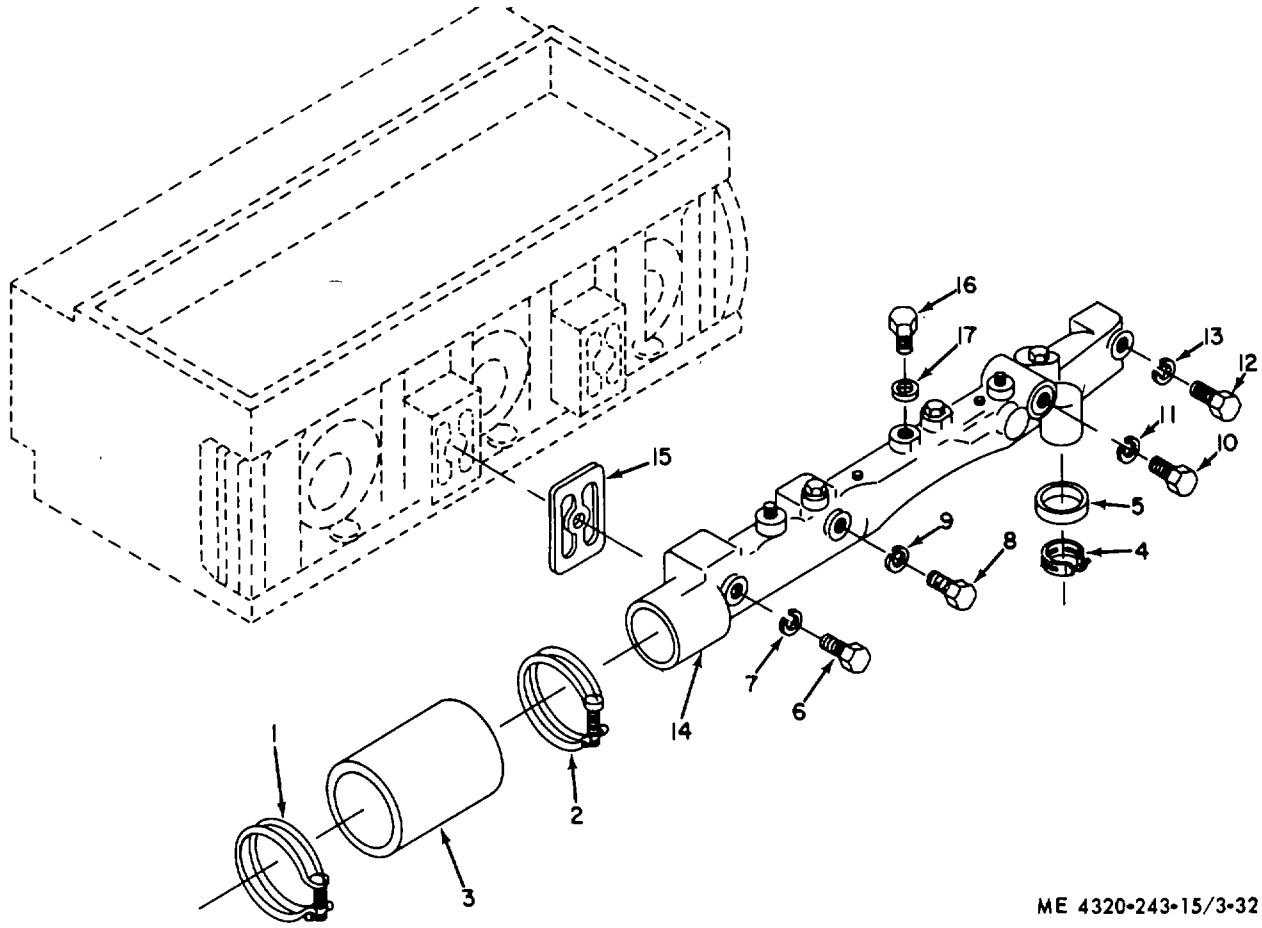
(1) Drain the cooling system (para 3- 56).

(2) Remove and install the outlet elbow and thermostat as shown by figure 3-31.

(3) Test thermostat by suspending in a container of water, into which a thermometer is immersed. Heat water slowly. Thermostat should begin to open at 165° F. and be fully opened at 1750 F. Replace thermostat if defective.

b. Remove and install water inlet header as shown in figure 3-32.

c. Remove and install water outlet header as shown in figure 3-28.



1	Hose clamp	6	Bolt	10	Bolt	14	Header
2	Hose clamp	7	Washer	11	Washer	15	Gasket (2)
3	Hose	8	Bolt	12	Bolt	16	Bolt
4	Hose clamp	9	Washer	13	Washer	17	Washer
5	Seal						

Figure 3-32. Water inlet header and related parts.

Section XIII. LUBRICATION SYSTEM

3-60. General

The lubrication system consists of the two oil filters, oil cooler, oil filler, oil pressure relief valve, oil pressure switch, and oil pressure gage sending unit. The built-in cooler is secured to the left side of the engine at the rear and serves as base for the oil filters. The oil pressure relief valve is located behind the carburetor in the right side of the engine block. The oil filters are located on the left side of the engine.

3-61. Oil Filters

a. Service the oil filters as shown by figure 3-2.

b. Remove and disassemble the front and rear oil filters in sequence shown by figure 3-33. Reassemble and install in opposite order.

c. Clean and inspect.

d. Add oil to the proper level as shown by the current lubrication chart.

3-62. Oil Cooler and Oil Cooler Base

a. Remove hose between the inlet header and oil cooler base.

b. Remove and install the oil filters (para 3-61 above).

c. Remove and install the oil cooler and base as shown by figure 3-34.

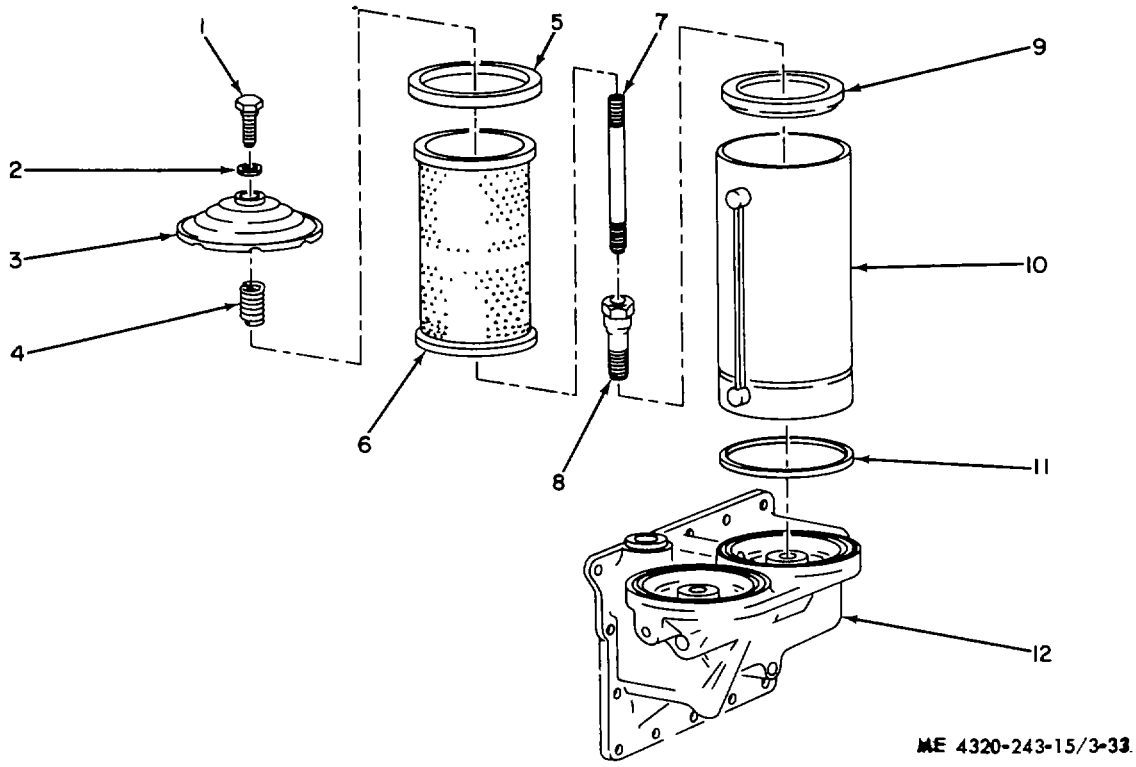
d. Clean and inspect.

3-63. Oil Pressure Relief Valve

a. Remove and install oil pressure relief valve as shown by figure 3-35.

b. Clean and inspect.

c. Adjust, if necessary, by changing springs as shown by figure 3-35.



1	Bolt	5	Gasket	9	Plate
2	Washer	6	Filter element	10	Body
3	Cover	7	Tube	11	Gasket
4	Spring	8	Bolt	12	Base

Figure 3-83. Oil filter, assembly and disassembly.

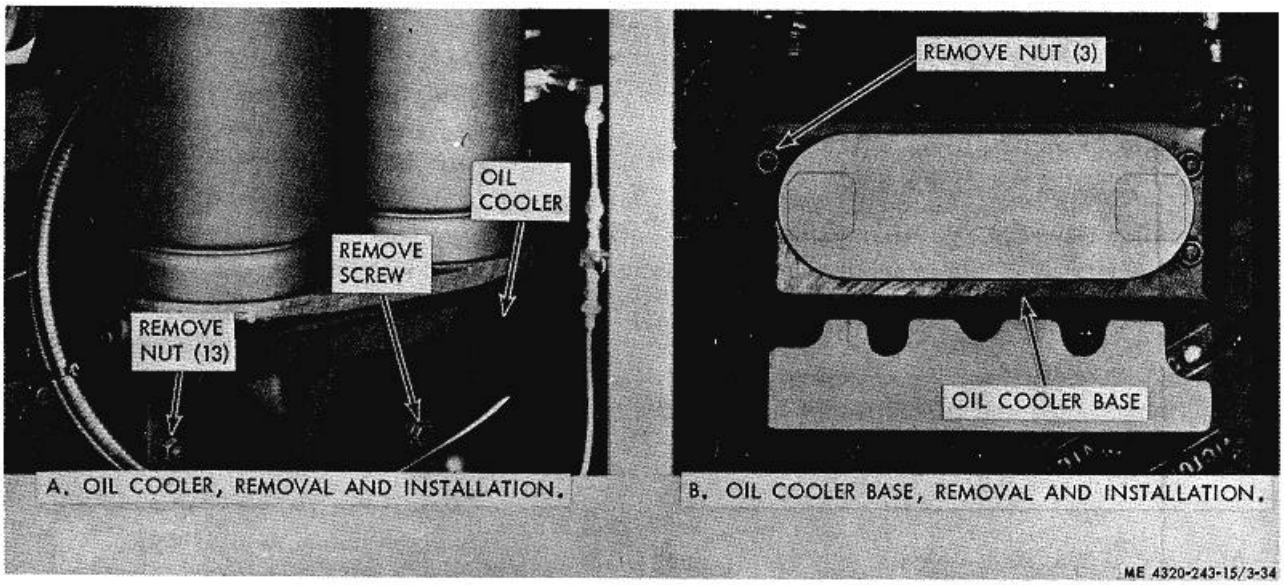


Figure 3-34. Oil cooler and oil cooler base, removal and installation.

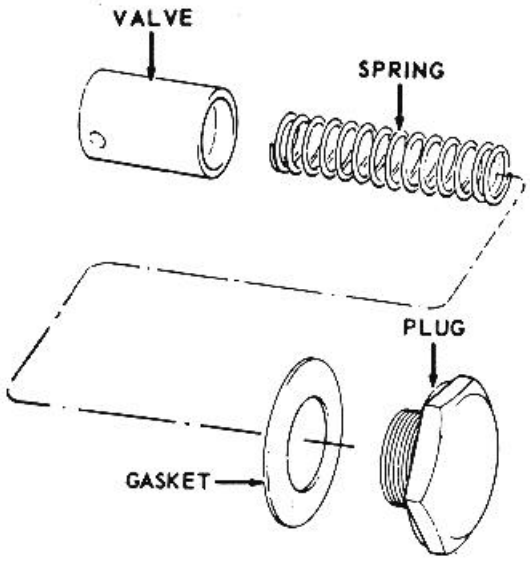


Figure 3-35. Oil pressure relief valve.

Section XIV. HOUSING ASSEMBLY AND FRAME

3-64. General

The engine is enclosed in a sheet metal assembly, with doors at both sides to provide access. The pumping unit is exposed.

3-65. Housing Assembly

Remove and install the housing assembly as shown in figure 3-36.

3-66. Lifting Bail and Toolbox

a. Remove the lifting bail (fig. 1-2) by removing the four nuts attaching it to the skid.

b. Clean and inspect.

c. Install in reverse order.

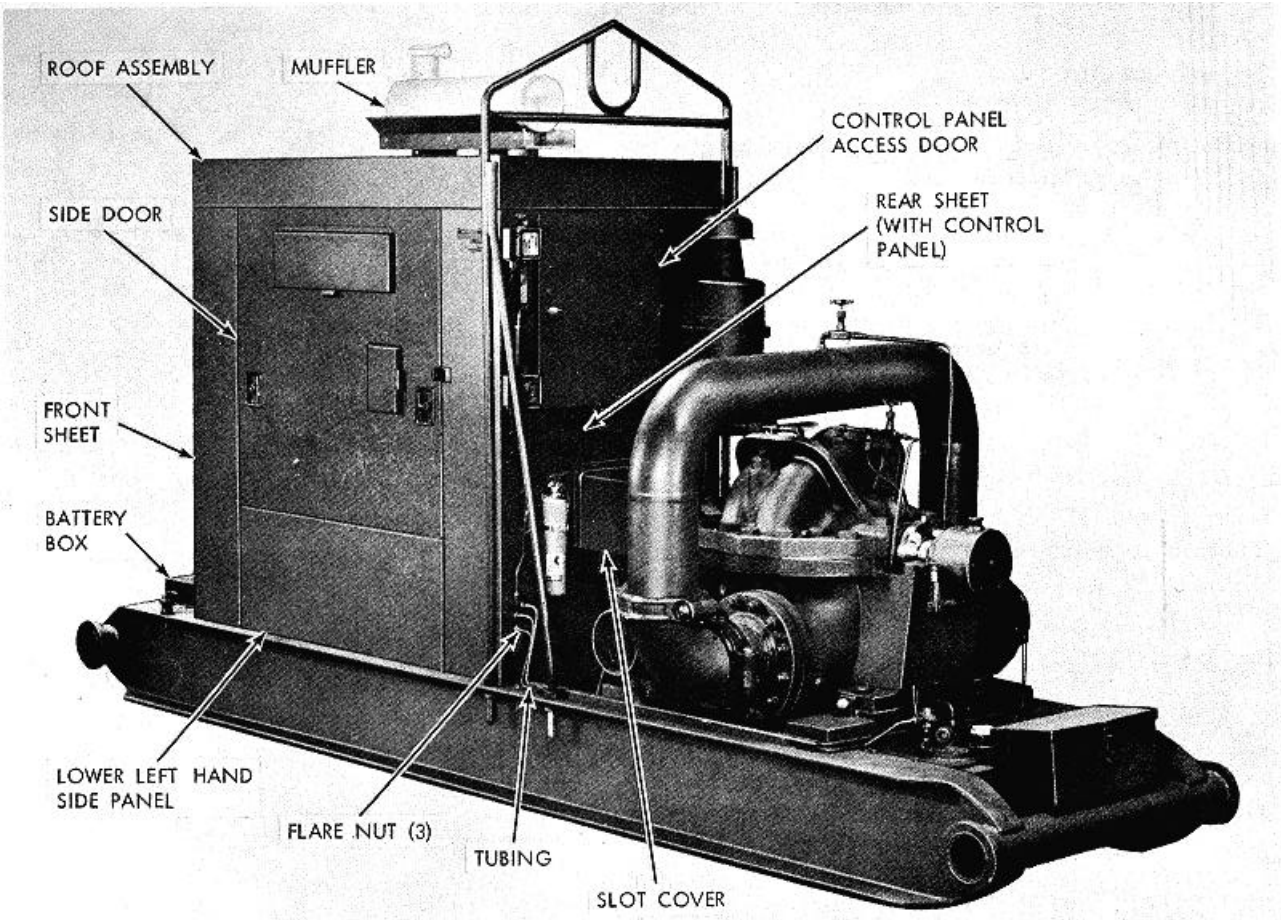
d. Remove the toolbox (fig. 1-4) by removing the two bolts, and washers attaching it to the rear cross beam on the skid.

e. Clean and inspect.

f. Install in reverse order.

Section XV. FIRE FIGHTING EQUIPMENT

Refer to paragraph 2-20 and service the dry chemical type fire extinguisher.



1. UNLATCH AND REMOVE SIDE DOORS (2).
2. REMOVE MUFFLER (PAR. 2-4).
3. REMOVE SCREW (16) AND LOCKWASHER (16) AND REMOVE ROOF ASSEMBLY.
4. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE LOWER LEFT HAND SIDE PANEL.
5. REMOVE OIL DRAIN BY LOOSENING HOSE CLAMP SCREW.
6. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE LOWER RIGHT HAND SIDE PANEL.
7. LOOSEN FLARE NUT (3) AND REMOVE TUBING.

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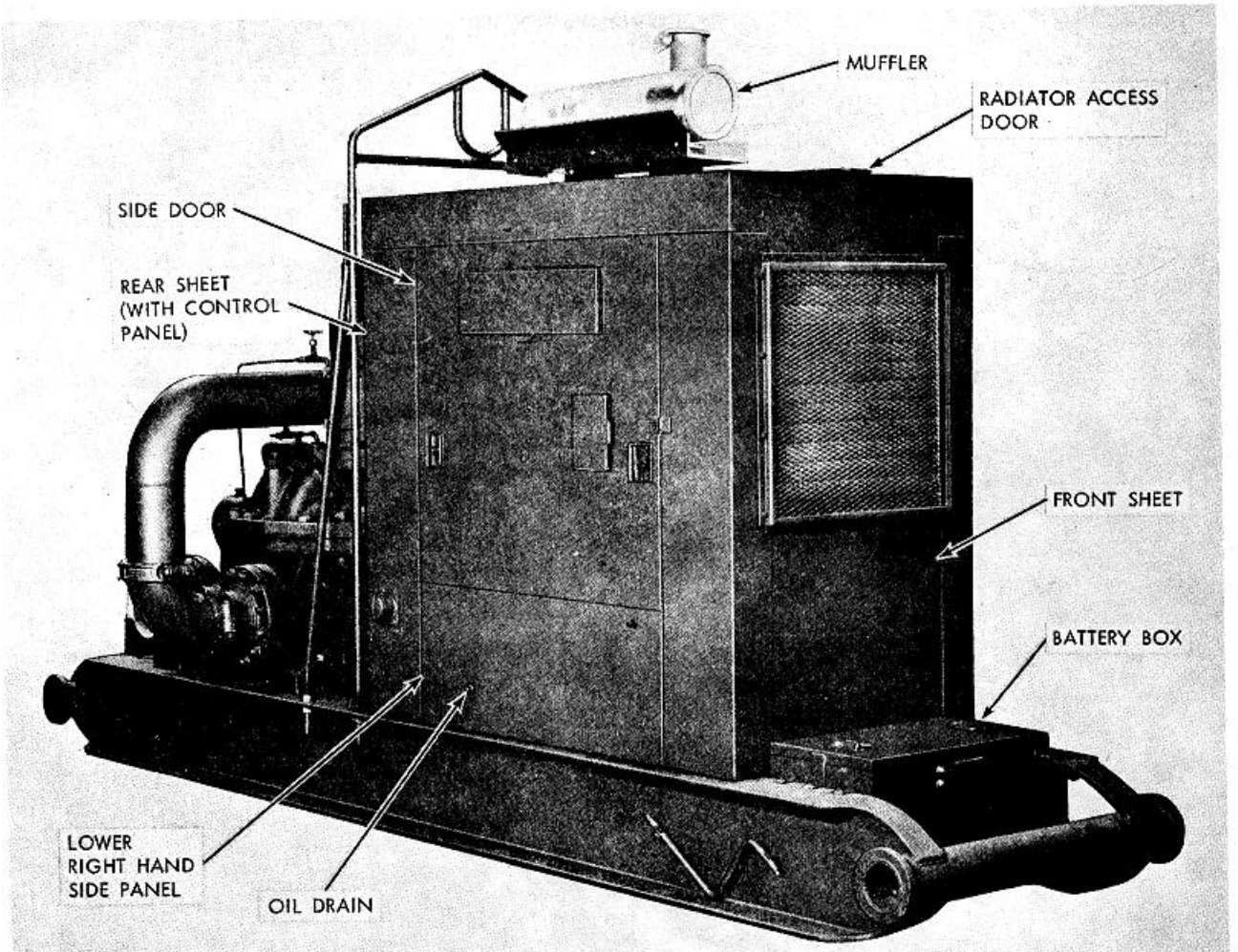
Figure 3-36. Housing, removal and installation.



8. REMOVE SCREW (6) AND LOCKWASHER (6) AND REMOVE SLOT COVER.
9. DISCONNECT PIPING AND WIRING LEADS FROM CONTROL PANEL AND CONTROLS (FIG. 3-6).
10. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE REAR SHEET (INCLUDES CONTROL PANEL).
11. REMOVE BATTERY BOX (PAR. 3-51)
12. DISCONNECT HOSE CONNECTIONS TO RADIATOR (PAR. 3-56).
13. REMOVE SCREW (9) AND LOCKWASHER (9) AND REMOVE FRONT SHEET (INCLUDES RADIATOR ASSEMBLY).
14. REMOVE SCREW (6) AND LOCKWASHER (6) AND REMOVE BOTTOM CENTER PANEL.

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Figure 3-36 --- Continued.

CHAPTER 4

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Scope

These instructions are published for the use of direct and general support and depot maintenance personnel maintaining the Reiner Model GP 110-5 Centrifugal Pump. They provide information on the maintenance of the equipment which is beyond the scope of tools, equipment, personnel or supplies normally available to using organizations.

4-2. Record and Report Forms

For record and report forms applicable to direct and general support and depot maintenance, refer to TM 38750.

Note

Applicable forms, excluding Standard Form 46 which is carried by the operator, shall be kept in a canvas bag mounted on equipment.

Section II. DESCRIPTION AND TABULATED DATA

4-3. Description

For a complete description of the John Reiner Model GP 110-5 Centrifugal Pump refer to paragraph 1-3.

4-4. Tabulated Data

a. General. This paragraph contains all the overhaul data pertinent to direct and general support and depot maintenance personnel. A wiring diagram (fig. 1-5) will be found in chapter 1.

b. Tabulated Data.

(1) *General.* Refer to paragraph 1-4.

(2) *Engine.* Refer to paragraph 1-4.

(3) *Pump assembly*. Refer to paragraph 1-4.

(4) *Engine accessories*. Refer to paragraph 1-4.

c. Engine Repair and Replacement Standards. Table 4-1 lists manufacturer's sizes, tolerances, clearances, and the maximum allowable wear and clearance.

d. Pump Repair and Replacement Standards. The following data lists specifications and adjustments of rotating element assembly components.

(1) Concentricity between bore of bottom of the stuffing box and pump shaft, total indicated runout _0.010 in. max. (maximum)

(2) Face of stuffing box bottom squared to pump shaft, total indicated runout ..... 0.005 in. max.

(3) Bearing end cover to splash collar clearance at rear end with rotating element assembly moved maximum distance toward rear of pump ..... 0.0312 in.

(4) Bearing end cover to splash collar clearance at front end, with rotating element assembly moved maximum distance towards front of pump ..... 0.0312 in.

(5) Nominal clearance between bearing end covers and splash collars, with rotating element at center position in pump -0.0625 in.

(6) Mechanical seal, drive collar-to-gland clearance, front of pump ..... 0.125 in.

(7) Mechanical seal, drive collar-to-gland clearance, rear of pump ..... 0.125 in.

Table 4-1. Engine Repair and Replacement Standards

	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Maximum	Minimum	Maximum	Minimum	
VALVES					
Valve seat angle:					
Intake-45 °					
Exhaust-45					
Stem diameter:					
Intake	0.4335	0.4345	-----	-----	0.4315
Exhaust	0.4325	0.4335	-----	-----	0.4305
Stem-to-guide clearance:		-----			
Intake	-----		0.0008	0.0028	0.0048
			(0.002 desired)		
Exhaust	-----		0.0045	0.0065	0.0085
VALVE GUIDES			(0.005 desired)		
Length		3.000			
Outside diameter	0.745	0.755			
Stem hole diameter:					
Intake	0.4353	0.4363	-----	-----	0.4373
Exhaust	0.4380	0.4390	-----		0.4400
Distance from face of valve seat to valve guide:					
Intake	-----	1.625			
Exhaust	-----	1.8125			
VALVE SPRINGS					
Outside diameter:					
Outer spring	-----	1.820			
Inner spring	-----	1.655			
Length-valve closed:					
Outer spring	-----	2.117			
Inner spring	-----	1.867			
Load-valve closed:					
Outer spring	63 lb	71 lb	-----	-----	60 lb
Inner spring	35 lb	41 lb	-----	-----	34 lb
Length-valve open:					
Outer spring	-----	1.427			
Inner spring	-----	1.367			
Load-valve open:					
Outer spring	153 lb	167 lb	-----	-----	1601b
Inner spring	83 lb	94 lb	-----	-----	81 lb
TIMING GEARS					
Crankshaft gear-to-camshaft gear clearance	-----	-----	0.0015	0.002	0.003
CAMSHAFT					
Journal diameter (all)	2.122	2.1225	-----	-----	2.121
Bushing inside diameter (all)	2.1240	2.1245			
Bushing-to-journal clearance	-----	-----	0.0015	0.0025	
Camshaft end play	-----	-----	0.005	0.009	
PISTON RINGS					
Ring width:					
No. 1 compression	0.0925	0.0935	-----	-----	0.0905
No. 2 and No. 3 compression	0.1250	0.1240	-----	-----	0.1210
No. 4 oil	0.2480	0.2490	-----	-----	0.2460
Ring side clearance:					
No. 1 compression	0.0035	0.0055			
No. 2 and No. 3 compression	0.0025	0.0045			
No. 4 oil	0.002	0.004			
Ring gap clearance (all)	0.017	0.032			

Table 4-1. Engine Repair and Replacement Standards-Continued.

	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Maximum	Minimum	Maximum	Minimum	
PISTONS					
Ring groove width:					
Top groove	0.097	0.098	-----	-----	0.100
Second and third	0.1265	0.1275	-----	-----	0.1295
Fourth groove	0.2510	0.2520	-----	-----	0.2540
Piston fit in cylinder bore on high side of piston:					
Clearance	-----	-----	-----	0.006	
Pounds pull	5 lb	10 lb			
Pinhole diameter	1.4995	1.4998			
PISTON PINS					
Piston pin length	4.433	4.438			
Piston pin diameter	1.4994	1.4996	-----	-----	1.4991
Pin-to-bushing clearance	-----	-----	0.0003	0.0008	
			(0 0005 desired)		
CONNECTING RODS					
Bushing hole diameter	1.6870	1.6880			
Finished inside diameter of bushing	1.4999	1.5002	-----	-----	1.5012
Bearing hole diameter	3.1505	3.1510			
CONNECTING ROD BEARINGS					
Thickness	0.0748	0.0753	-----	-----	0.0743
Bearing-to-journal clearance	-----	-----	0 002	0 004	0 0055
			(0 003 desired)		
Side play	----	-----	0 005	0 010	
			(0 006 desired)		
MAIN BEARINGS					
Thickness	0.1248	0.1253	-----	-----	0.1243
Diameter	3.2514	3.2534			
Bearing-to-journal clearance	-----	-----	0.0014	0.0044	
			(0.003 desired)		
CRANKSHAFT					
Main bearing journal diameter	3.249	3.250	-----	-----	3.247
Connecting rod bearing journal diameter	2.9974	2.9983			2.9964
End play	-----	-----	0.006	0.010	
CYLINDER ASSEMBLY					
Cylinder bore diameter	5.0000	5.0005			
Cylinder stroke	5.375				
Cylinder out-of-round:					
Top	-----	-----	-----	-----	0.001
Bottom	-----	-----	-----	-----	0.005
Cylinder taper:					
Top	-----	-----	-----	-----	0.001
Bottom	0.010				
Main bearing bore diameter	3.5020	3.5030			

CHAPTER 5

GENERAL MAINTENANCE INSTRUCTIONS

Section I. SPECIAL TOOLS AND EQUIPMENT

5-1. Special Tools and Equipment

No special tools or equipment are required by direct and general support and depot maintenance personnel for performing maintenance or major overhaul work on the centrifugal pump.

5-2. Specially Designed Tools and Equipment

No specially designed tools or equipment are required by direct and general support and depot maintenance personnel performing major overhaul work on the centrifugal pump.

Section II. TROUBLESHOOTING

5-3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the pumping assembly or any of its components. Each trouble symptom stated is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause.

5-4. Poor Engine Compression

Probable cause	Possible remedy
Valves holding open-no tappet clearance.	Adjust valves (para 3-36).
Leaky cylinder head gasket.	Replace gasket (fig. 7-13).
Broken or weak valve springs.	Replace springs (fig.7-13).
Badly worn, broken or stuck piston rings.	Replace rings (fig. 7-26).

5-5. Low Engine Oil Pressure

Probable cause	Possible remedy
Dirt in relief valve or broken spring.	Clean valve or replace spring (fig. 7-13).
Worn bearings	Replace bearings (fig. 7-55).
Worn or damaged oil pump gears	Repair or replace oil pump (para 7-38).
Worn cam bushings	Replace bushings (para 7-56).

5-6. High Engine Oil Consumption

Probable cause	Possible remedy
Worn or broken piston rings.	Replace rings (fig. 7-76).
Worn pistons and sleeves	Replace pistons and sleeves (fig. 7-26).
Worn bearings	Replace bearings (para 7-55).

5-7. Engine Knocks or Develops Excessive Noise

Probable Cause	Possible remedy
Worn or burned-out main bearings.	Replace bearings (para 7-55).
Worn or burned-out connecting rod bearings.	Replace bearings (para 7-53).
Loose piston	Replace piston (para 7-54).
Broken piston ring or pin.	Replace piston or pin para 7-54).
Burned valves and seats	Replace valves or seats (fig. 7-13).
Weak or broken valve springs.	Replace springs (fig.7-13).
Tappet noise	Adjust valves (para 3-36).
Worn camshaft	Replace camshaft (para (7-46).
Misalinement of engine	Aline engine (fig. 6-3).
Faulty vibration damper	Replace vibration damper (para 7-42).

5-8. Pump Fails to Discharge, Capacity Decreases or Pressure Drops

Probable Cause	Possible remedy
Impeller damaged d or broke"	Replace impeller (fig 6-7)
Seal assembly defective.....	Replace seal assembly (fig 6-7)
Housing cracked or de-fective	Replace housing (fig. 6-3).

5-9. Pump Vibrates or Develops Excessive Noise

Probable Cause	Possible remedy
Impeller damaged or broken	Replace impeller (fig. 6-7
Defective impeller shaft bearing	Replace bearing (fig 6-7

Section III. RADIO INTERFERENCE SUPPRESSION

5-10 General

Information on radio interference suppression methods and components will be found in Chapter 3, Section VI, of this manual.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

5-11. General

The gasoline engine and the centrifugal pomp are mounted d on a welded-steel skid. The front of the engine is supported by a trunnion bracket which is bolted to an engine support mounted on the skid. The rear of the engine is supported d by flywheel housing b bolted directly to the skid. The pump is secured to the skid at the four corners of the pump bottom ease. The engine is e connected to the pump by a flexible steel grid that joins the engine coupling half to the pump coupling half. The engine and pump have b en aligned at the factory and no further alignment is necessary unless the engine or the pump is replaced.

5-12. Housing Assembly Remove and l install as directed in paragraph 3-65

Remove and install as directed in paragraph 3-65.

5-13. Engine a Remove the engine as follows:

a. Remove the engine as follows:
(1) Remove battery box (para b 511.
(2) Remove muffler (fig 2-2).
(3) Disconnect gages and instruments fig. 3 6).
(4) Remove housing assembly (para b 65)
(5) Drain the radiator (para a-A i)
(6) Disconnect radiator hoses (fig 7-7).

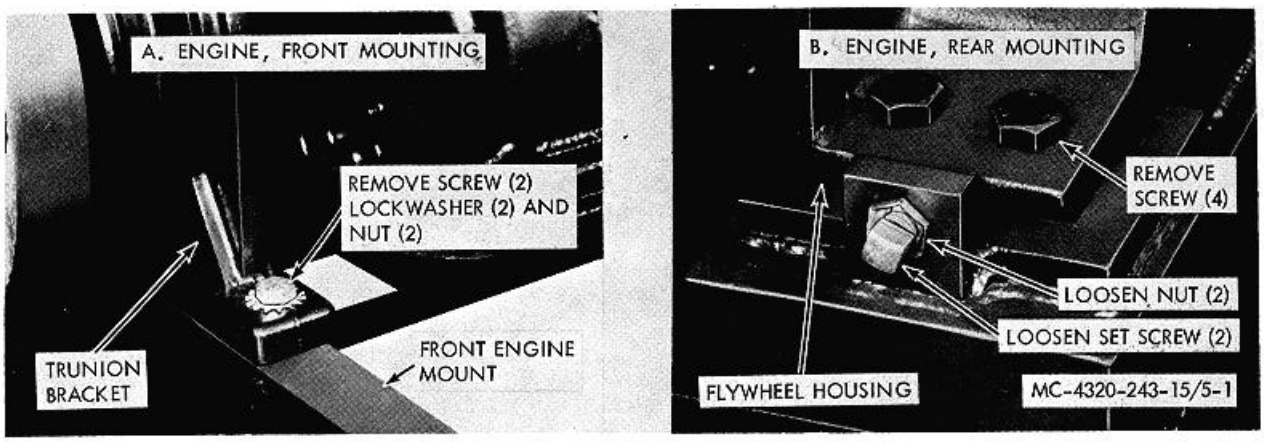

Figure 5-1. Engine, removal and installation.

Caution

The oil pressure gage (fig. 2-6) must read above 30 psi. If no oil pressure is indicated, stop the engine immediately and check the cause (para 3-15).

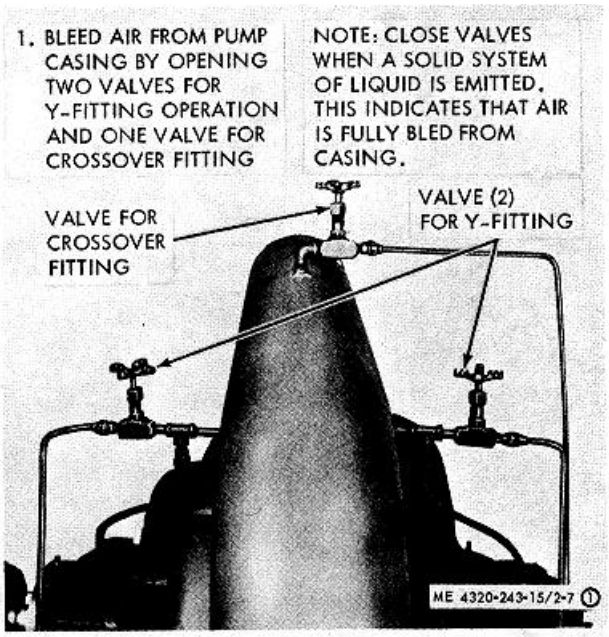

Figure 2-7. Starting the pump assembly.

2-12. Stopping

a. Refer to figure 2-8 and stop the pump assembly.

b. Perform the necessary daily preventive maintenance services (para 3-6).

2-13. Operation Under Usual Conditions

a. Start the pump assembly (para 2-11).

b. To operate the pump assembly open the main discharge line valve (fig. 1-1) to obtain desired pressure.

c. Performance characteristics under usual operating conditions are shown in the pump performance curve (fig. 2-9).

2-14. Operation in Extreme Cold (Below o0 F)

a. Fuel System. Keep the fuel tank full to prevent condensation of moisture which will freeze and can clog the fuel lines.

b. Electrical System. Clean the batteries and cables, and inspect for cracked or damaged cases. Be sure the battery terminals are tight, clean, and lightly greased. Inspect wiring for brittle or broken insulation. The electrolyte level must be three-eighths inch above the plates. To prevent the batteries from freezing, see that they are kept fully charged.

Caution

Water added to a battery may freeze unless it is immediately mixed with the electrolyte by operating the engine at 1,000 rpm for 30 minutes.

c. Lubrication. Lubricate the centrifugal pump for cold weather conditions in accordance with the current lubrication order (fig. 3-1).

d. Cooling System. Test the coolant with a hydrometer to insure adequate protection for the lowest temperature expected. Inspect for leaks and cracks in hoses and fittings. Frequently inspect the coolant level in the radiator and add water if it is necessary.

2-15. Operation in Extreme Heat

a. General. Efficient cooling, adequate ventilation and adequate lubrication are of vital importance for the operation of the centrifugal pump in extreme heat.

b. *Cooling System*. Check the coolant level frequently and add clean water when necessary. Clean and flush the radiator at regular intervals (para 3-56). Keep the V-belts properly adjusted (para 3-58).

c. *Lubrication*. Lubricate the centrifugal pump in accordance with the current lubrication order (fig. 3-1) for hot weather operation.

d. Batteries. Inspect the electrolyte frequently for proper level.

e. *Indoor Ventilation*. Provide adequate ventilation for the radiator. Allow sufficient space around the centrifugal pump for good air circulation.

2-16. Operation in Dusty or Sandy Areas

a. General. If the installation is permanent, erect a protective shield for the centrifugal pump. Dust and sand shorten the life of equipment and cause mechanical failure. If the installation

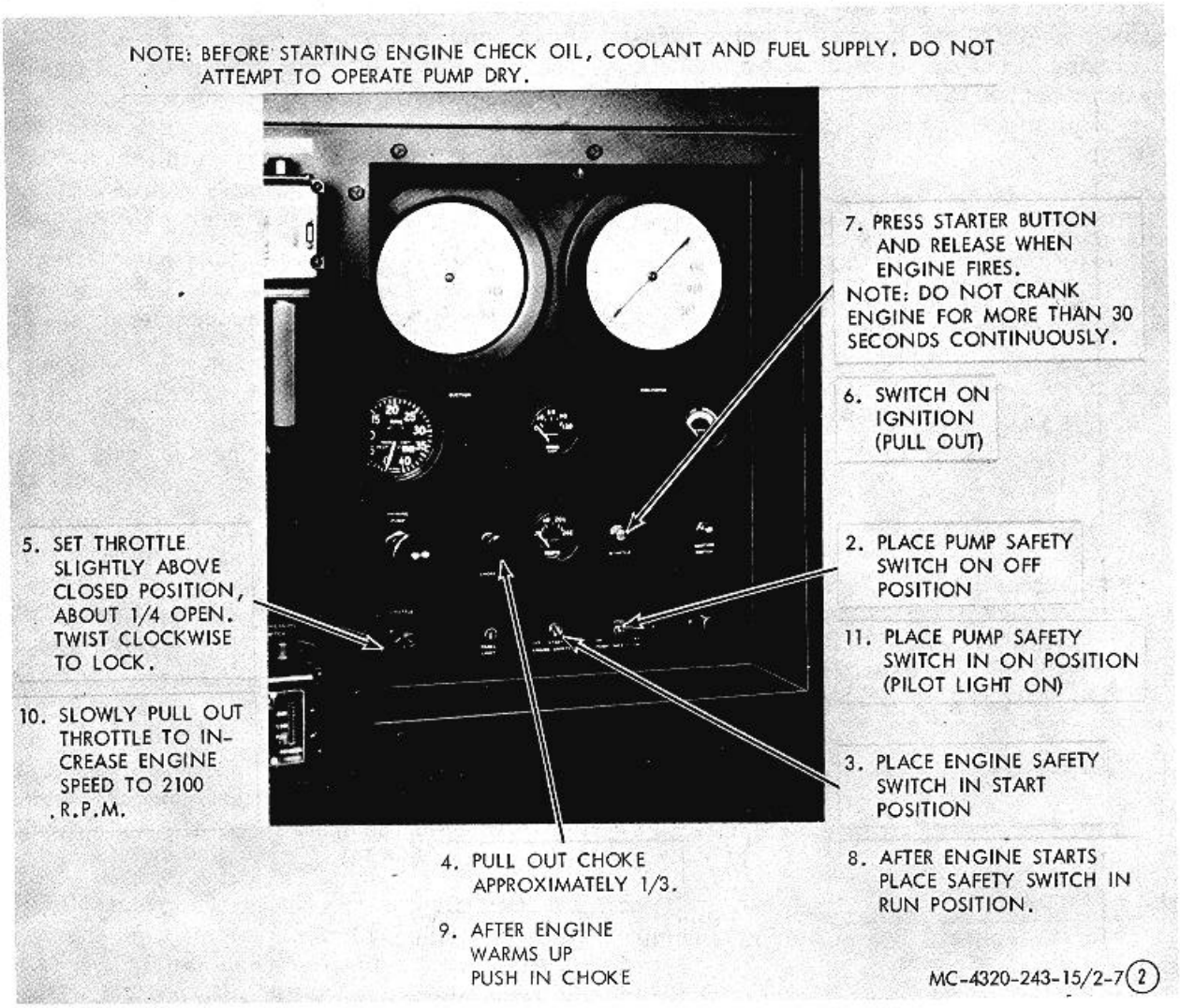

Figure 2-7-Continued.

is temporary, utilize natural barriers. Wipe down the unit at frequent intervals using an approved cleaning solvent. If water is plentiful, wet down the surrounding terrain beyond the immediate operating area.

b. Cooling System. Inspect the cooling system frequently for leaks. Keep the radiator cap tight and see that the V-belts are properly adjusted (para 3-58). Drain and flush the cooling system as often as necessary (para 3-56).

c. Lubrication. Lubricate the centrifugal pump in accordance with the current lubrication order (fig. 3-1). Clean the air cleaner and breather caps more frequently to prevent dust and dirt from entering the engine. Clean all lubrication points before applying lubricants.

d. Fuel System. Keep the fuel filler cap tightly closed to prevent sand and dust from entering the fuel tank. Clean the area around the cap before removing it to add fuel.

2-17. Operation under Rainy or Humid Conditions

During humid periods dry the unit before operating. Keep the fuel tank full to avoid condensation.

2-18. Operation in Salt Water Areas

a. General. Salt water has a corrosive action on metal. Extreme care must be taken to prevent rust from forming on the unit. The electrical insulation should be inspected frequently for deterioration.

b. Cooling System. Use fresh water only for the cooling system. Salt water may damage the equipment. Use an approved rust inhibitor to prevent the formation of rust and scale in the cooling system.

c. Lubrication. Keep the centrifugal pump well lubricated to prevent salt and moisture from entering the engine. Refer to the current lubrication order (fig. 3-1).

d. Rust Prevention. Wash down the unit regularly with fresh water. Inspect all painted surfaces for cracked, peeled, or blistered paint. Coat all exposed surfaces with rustproofing paint. Report the condition to organizational maintenance.

2-19. Operation at High Altitude

The centrifugal pump is designed to operate at altitudes up to 5,000 feet above sea level without any special attention or adjustments. At higher altitudes, provide adequate ventilation as the engine is more likely to overheat. Adjust the carburetor (para 3-40) before operation.

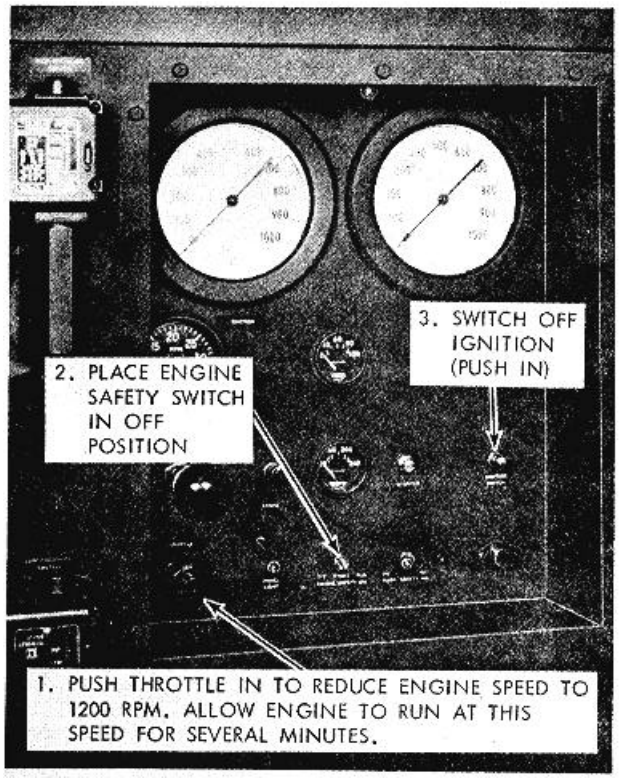

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Figure 2-8. Stopping the pump assembly.

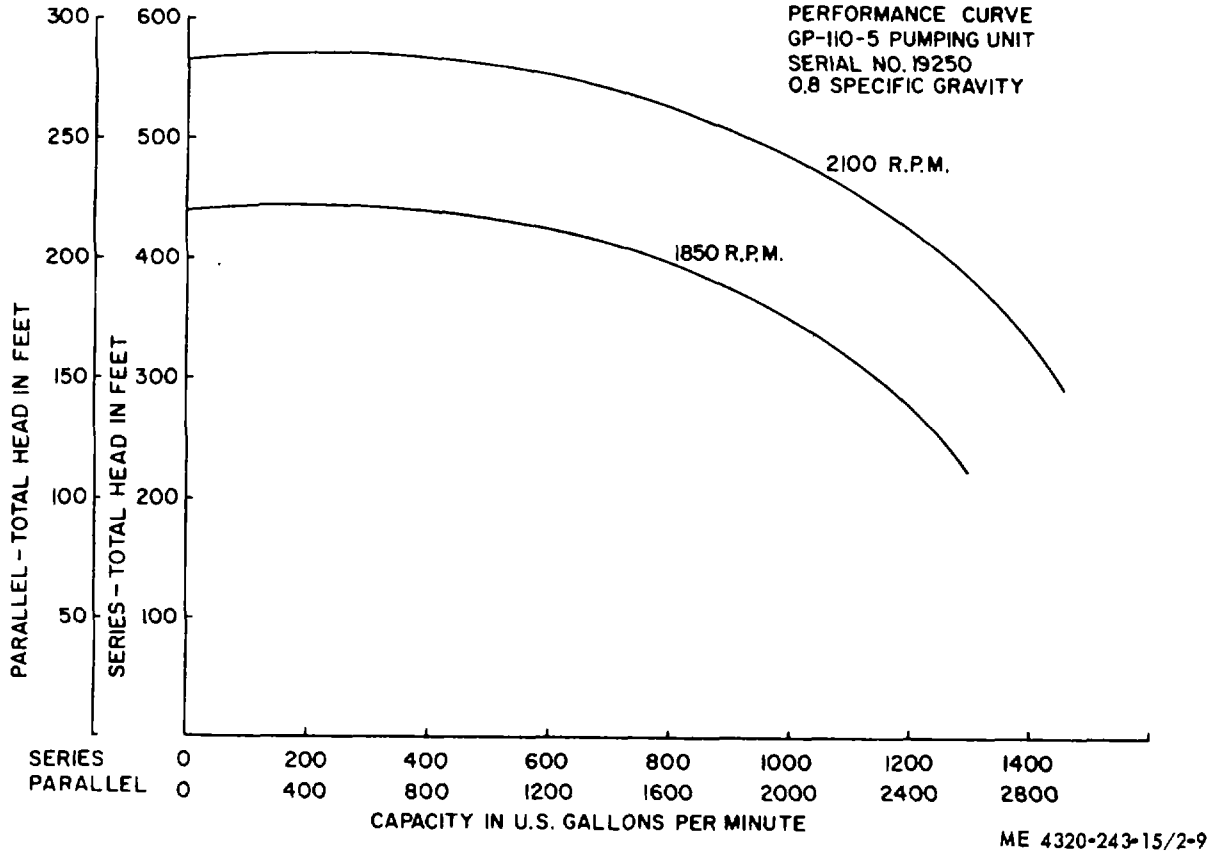

Figure 2-9. Performance curve.

Section V. OPERATION OF MATERIAL USED IN CONJUNCTION WITH CENTRIFUGAL PUMP ASSEMBLY

2-20. Fire Extinguisher (Dry Chemical Type)

a. Description. The dry chemical type fire extinguisher (fig. 2-3) is suitable for use on all types of fire, and is effective in areas where ambient temperature is -25° F. And above. If winterized (pressurized with nitrogen), the fire extinguisher may be used in temperatures below -25° F. The fire extinguisher is a 2 1/2 pound, stored-pressure, lever operated extinguisher.

b. Operation. Remove the fire extinguisher from its location, lift the handle, press lever, and direct the powder at base of flame, using a side-to-side sweeping motion.

c. Maintenance. Weigh the fire extinguisher every 6 months and replace if weight is less than 4 1/2 pounds, or if pressure is below 125 pounds. The dry chemical fire extinguishers will be serviced at installation level through Repair and Utilities facilities with the filling agent supplied by local procurement through Troop Supply Channels. Refer to TB 5-4200-200-10.

CHAPTER 3
OPERATOR AND ORGANIZATIONAL MAINTENANCE INSTRUCTIONS
Section I. OPERATOR AND ORGANIZATIONAL MAINTENANCE TOOLS AND EQUIPMENT

3-1. Special Tools and Equipment
No special tools or equipment are required by operator or organizational maintenance personnel for maintenance of the pump.

3-2. Basic Issue Tools and Equipment
Tools and repair parts issued with or authorized for use with the pump assembly are listed in the Basic Issue Items List, Appendix B of this manual.

Section II. LUBRICATION

3-3. General Lubrication Information
a. This section contains a reproduction of the lubrication order and lubrication instructions which are supplemental to, and not specifically covered in, the lubrication order.
b. The lubrication order shown in figure 3-1 is an exact reproduction of the approved lubrication order for the centrifugal pump assembly. For the current lubrication order, refer to DA PAM 310-4.

3-4. Detailed Lubrication
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 for 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 figure 3-1.
d. OES Oil.
(1) Crankcase oil level must be checked frequently, as oil consumption may increase.
(2) Oil may require changing more frequently than usual because contamination by dilution and sludge formation will increase under cold weather operating conditions.
e. Oil Filter Service. Refer to figure 3-2 and service the oil filter.
f. Air Cleaner Service. Refer to figure 3-3 and service the air cleaner.

LUBRICATION ORDER

LO5-4320-243-12

PUMP, CENTRIFUGAL: PETROLEUM; GASOLINE DRIVEN SKID MOUNTED; 6 INCH, 500 GPM 555 FT HEAD TO 1400 GPM 275 FT HEAD (JOHN REINER & CO., MODEL GP 110-5) W/CONTINENTAL ENGINE MODEL RS633

REFERENCE: C9100-IL

Intervals are based upon normal operations. Reduce to compensate for abnormal operation and severe conditions. During inactive periods sufficient lubrication must be performed for adequate preservation. Clean fittings before lubricating. Relubricate after washing.

Clean parts with SOLVENT, drycleaning, or with OIL, fuel, Diesel. Dry before lubricating.

Dotted circle indicates drain below.

Drain crankcase and pump bearings only when hot after operation; replenish and check level when cool.

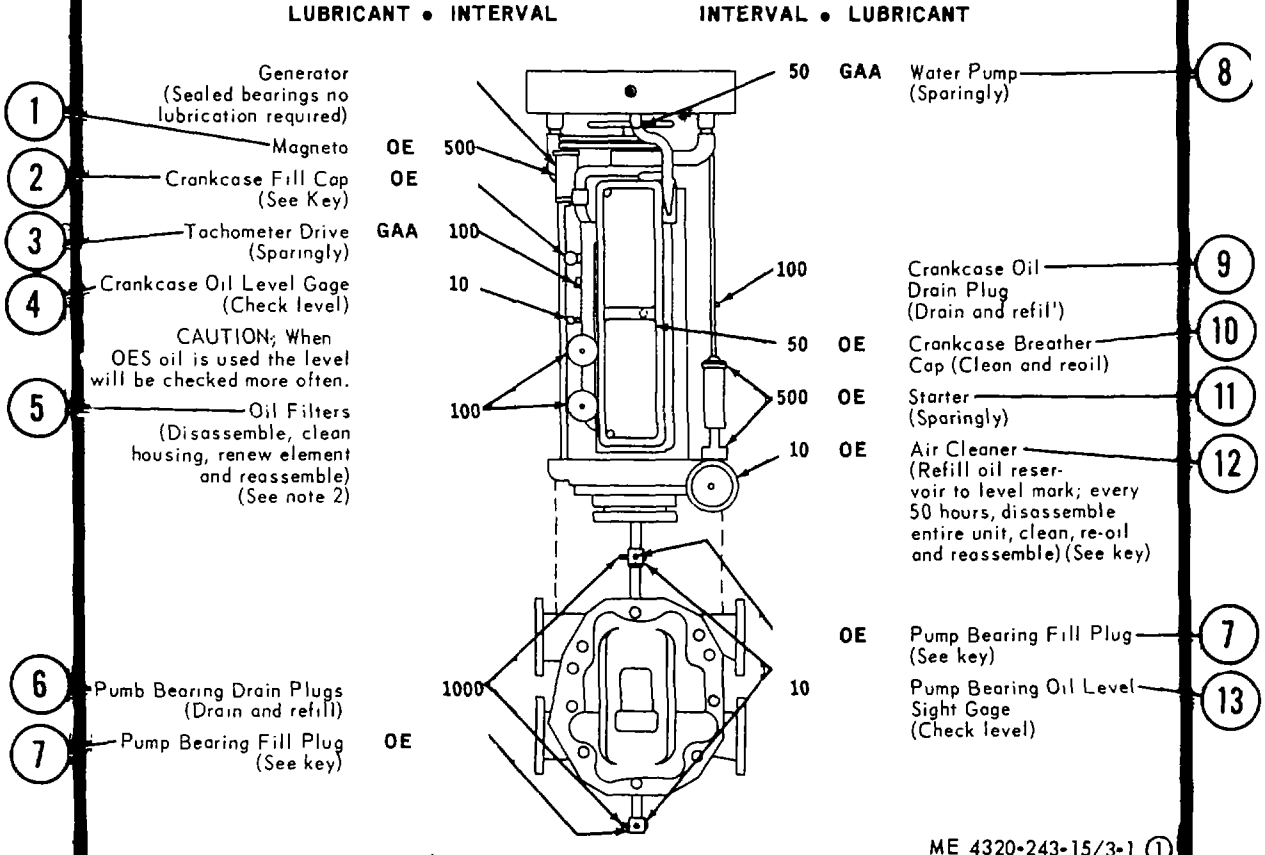

Figure 3-1. Lubrication chart.

–KEY–

LUBRICANTS	CAPACITY	EXPECTED TEMPERATURES			INTERVALS
		Above+32°F	+40°F to –10°F	0°F to –65°F	
OE –OIL, Engine, Heavy Duty					
Crankcase	20 qt	**OE** 30	**OE** 10	**OES**	Intervals given are in hours of normal operation.
Air Cleaner	2 qt				
Pump Bearings	1/8 qt EA				
Oil Can Points		**OE** 10	**OE** 10	**OE** 10	
OES –OIL, Engine, Subzero					
GAA –GREASE, Auto. and Artillery		All Temperatures			

NOTES:

1. FOR OPERATION OF EQUIPMENT IN PROTRACTED COLD TEMPERATURES BELOW –10°F. Remove lubricants prescribed in the key for temperatures above –10°F. Relubricate with lubricants specified in the key for temperatures below –10°F.

2. ENGINE OIL FILTER. Every 100 hours, remove filter element, clean housing. Install new element. Fill crankcase, operate engine 5 minutes, check for leaks, check level and bring to full mark.

3. OIL CAN POINTS. Every 50 hours lubricate all hinges and control linkages with OE.

4. LUBRICANTS. The following is a list of lubricants with the Military Symbols and the applicable specification numbers.

OE-MIL-L-2104 OES-MIL-L-10295
GAA-MIL-G-10924

Copy of this Lubrication Order will remain with equipment at all times; instructions contained herein are mandatory.

FOLD FOLD

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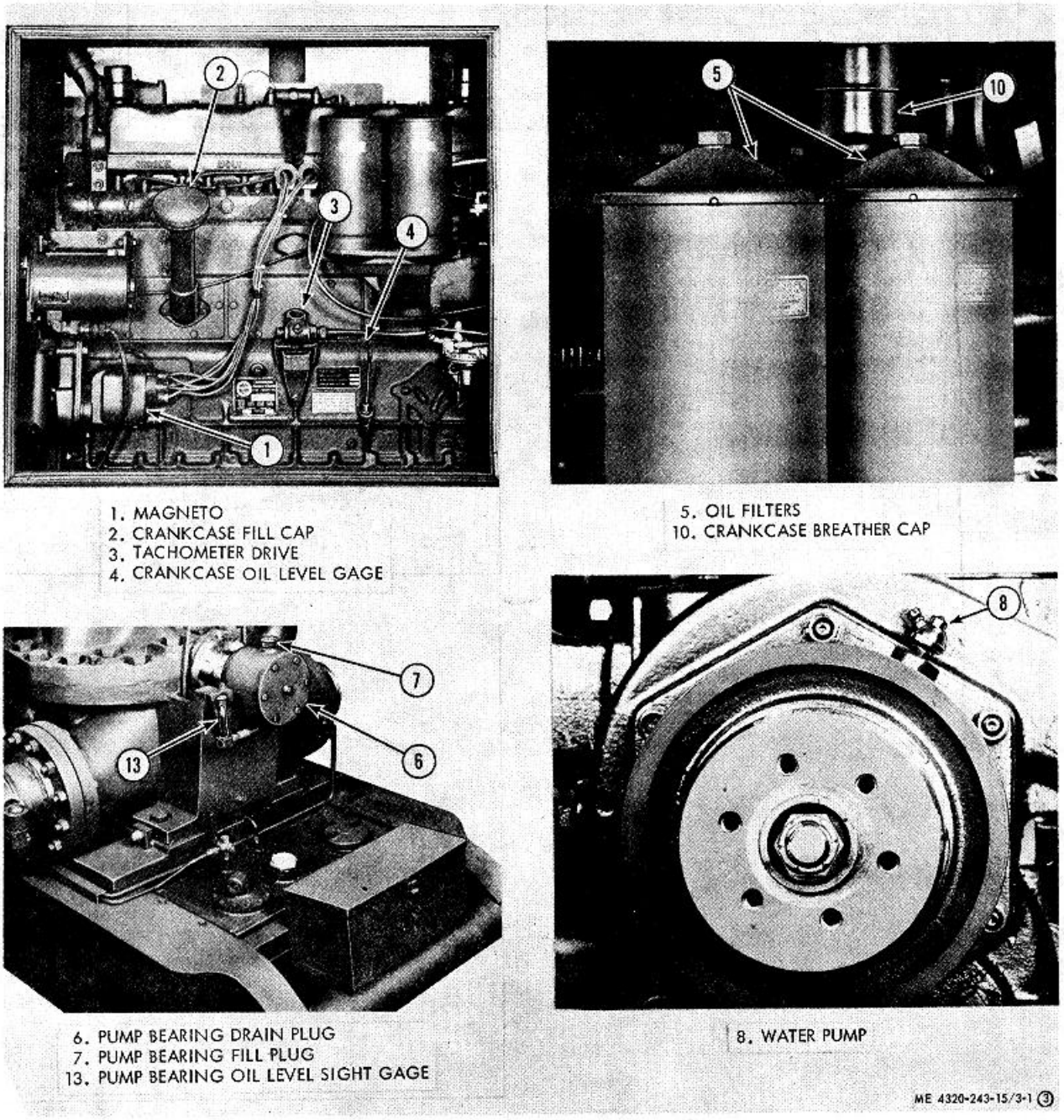
Figure 3-1. -Continued.



1. MAGNETO
2. CRANKCASE FILL CAP
3. TACHOMETER DRIVE
4. CRANKCASE OIL LEVEL GAGE

5. OIL FILTERS
10. CRANKCASE BREATHER CAP

6. PUMP BEARING DRAIN PLUG
7. PUMP BEARING FILL PLUG
13. PUMP BEARING OIL LEVEL SIGHT GAGE

8. WATER PUMP

Figure 3-1. -Continued.

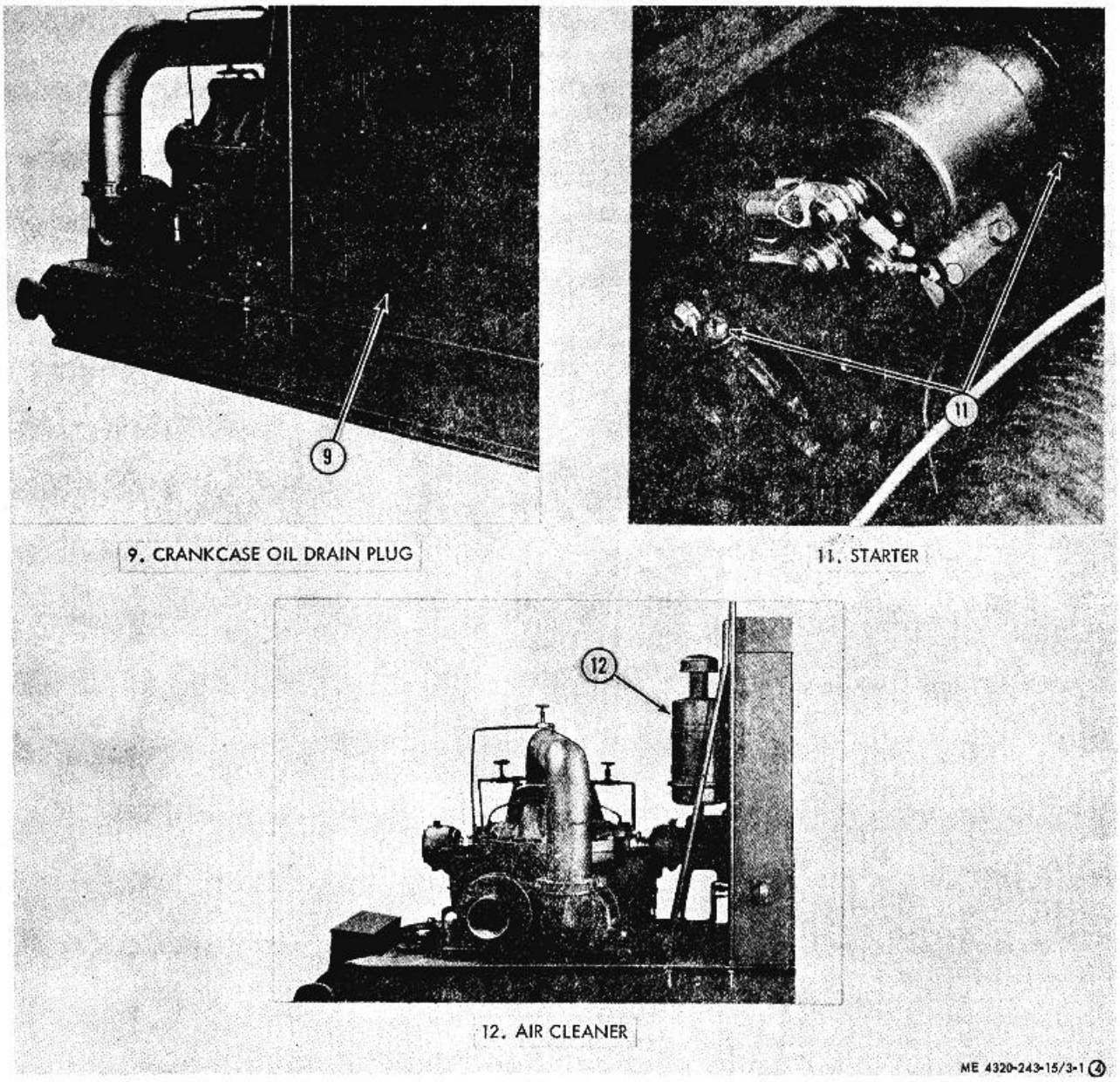


Figure 3-1. -Continued.

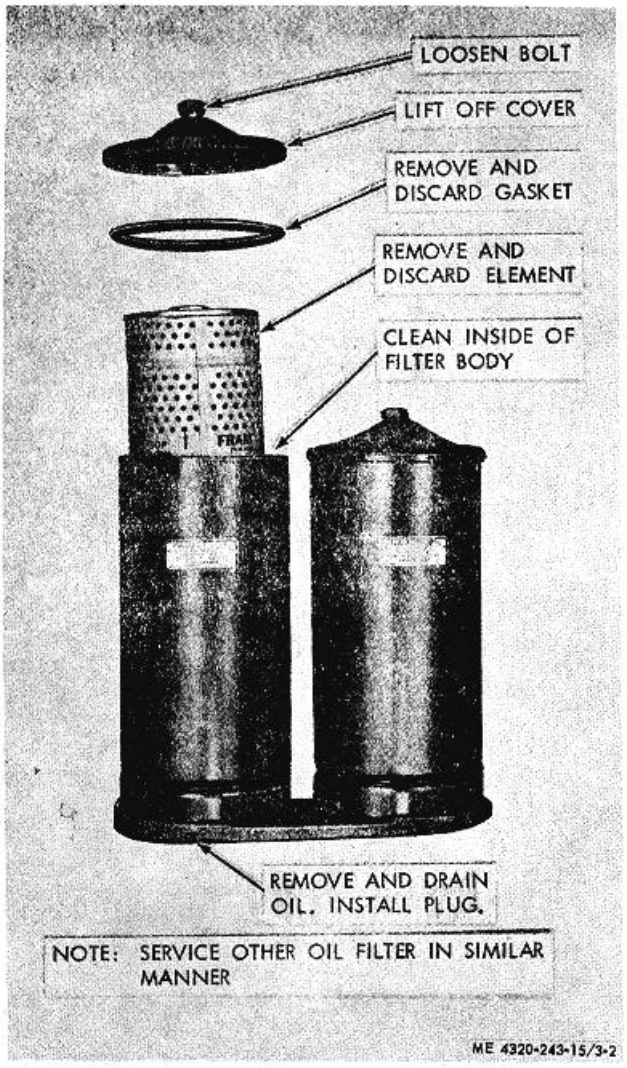
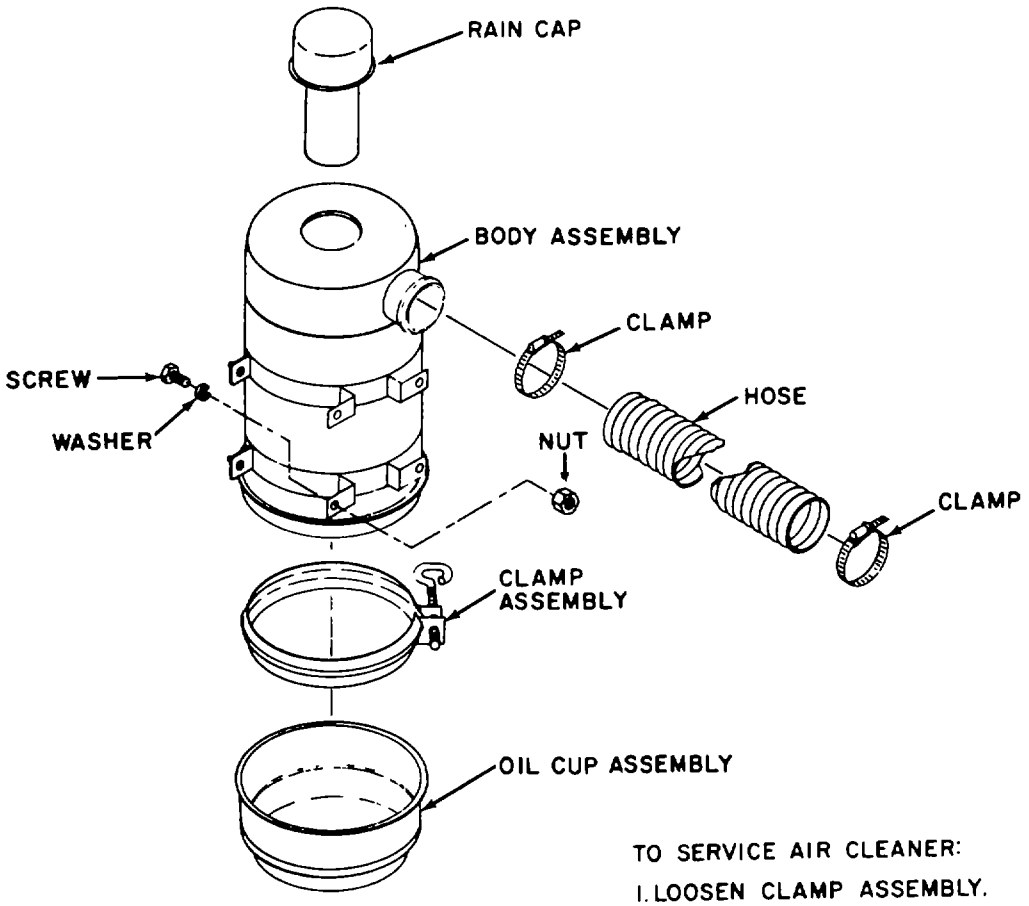


Figure 3-2. Oil filter service.



TO SERVICE AIR CLEANER:

1. LOOSEN CLAMP ASSEMBLY.
2. DROP OIL CUP ASSEMBLY AND DISCARD OIL.
3. CLEAN OIL CUP ASSEMBLY WITH APPROVED SOLVENT.
4. REFILL OIL CUP ASSEMBLY TO LEVEL MARK.
5. REINSTALL OIL CUP ASSEMBLY.

NOTE:
SERVICE AIR CLEANER EVERY 50 HOURS.

ME 4320-243-15/3-3

Figure 3-3. Air cleaner service, assembly and disassembly.

Section III. PREVENTIVE MAINTENANCE SERVICES

3-5. General

To insure that the equipment 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 services to be performed are listed and described in paragraphs 3-6 and 3-7. Item numbers indicate the sequence of minimum inspection requirements. Defects discovered during operation of the unit shall be noted for future correction, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noticed 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.

3-6. Daily Preventive Maintenance Services

This paragraph contains 'an illustrated tabulated listing of preventive maintenance services which must be performed by the operator.

The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-4 for the daily preventive maintenance services.

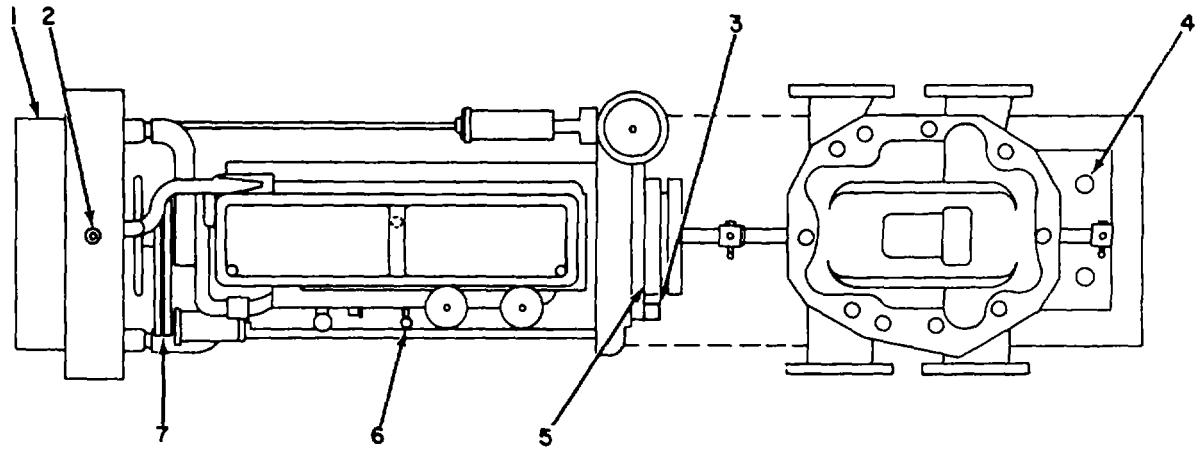
3-7. Quarterly Preventive Maintenance Services

a. This paragraph contains an illustrated, tabulated listing of preventive maintenance services which must be performed by organizational maintenance personnel at quarterly intervals. A quarterly interval is equal to 3 calendar months, or to 250 hours of operation, whichever occurs first.

b. The item numbers are listed consecutively and indicate the sequence of minimum requirements. Refer to figure 3-5 for the quarterly preventive maintenance requirements.

PREVENTIVE MAINTENANCE SERVICES

DAILY



ITEM	LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER	PAR REF
1.	BATTERIES. Tighten loose cables and mountings. Remove corrosion. Inspect for cracks and leaks. Fill to 3/8 inch above the plates. Clean vent hole in filler cap before replacing. In freezing weather, run engine a minimum of 1 hour after adding water.	2-3
2.	RADIATOR. Inspect for leaks. Inspect radiator core and fan guards for dirt. Fill radiator with coolant to 2 inches below filler neck.	3-56
3.	FIRE EXTINGUISHER. Inspect the extinguisher for insufficient charge by the gage indication and weight. Inspect for broken seal. Do not discharge any of the contents. Inspect for corrosion and insecure mounting. Replace the extinguisher if it is defective or has an insufficient charge..	2-20
4.	FUEL TANK. Add fuel as required. Inspect for leaks in tank and lines.	3-43
5.	CONTROLS AND INSTRUMENTS. Inspect for damage and loose mounting. With the unit operating, check for proper operation. Normal operating readings are as follows: Oil pressure gage 55 to 65 psi. Water temp. gage 160 to 200 F. Pilot light ON-while operating. Suction gage 0 to 600 psi. Discharge gage 0 to 600 psi.	2-8

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Figure 3-4. Daily preventive maintenance services.

ITEM		PAR REF
6.	OIL-LEVEL GAGE. Add oil as indicated by level gage. Reference current L.O. 5-4320-243-12	
7.	V-BELTS. Proper adjustment is a deflection of 1/2 inch midway between pulleys (weekly.)	3-58

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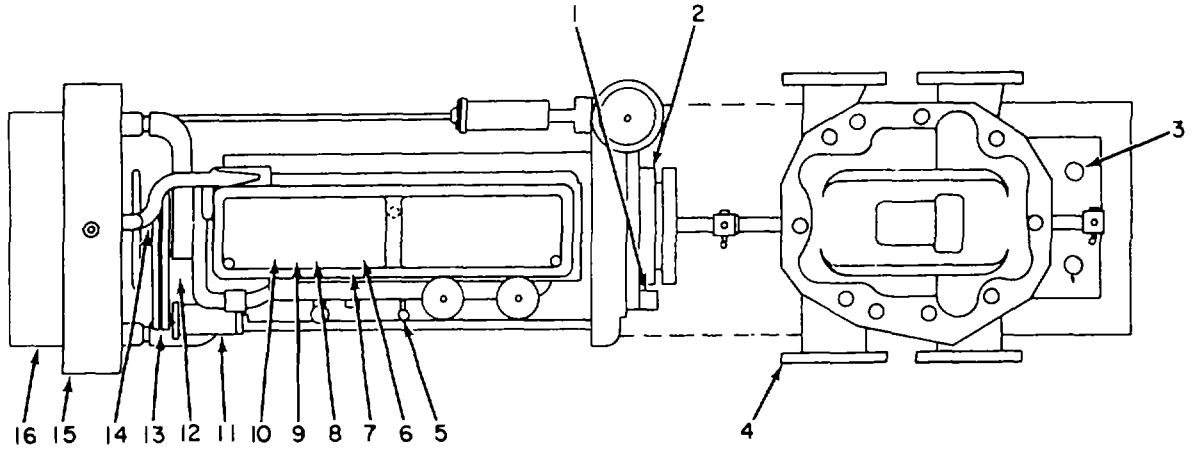
Figure 3-4-CoIntinued.

PREVENTIVE MAINTENANCE SERVICES

QUARTERLY



LUBRICATE IN ACCORDANCE WITH CURRENT LUBRICATION ORDER

ITEM		PAR REF
1.	FIRE EXTINGUISHER. Inspect extinguisher every six months and replace if pressure is below the white field on the gage. The dry chemical fire extinguishers will be serviced at installation level through Repair and Utilities facilities, with the filling agent supplied by local procurement through Troop Supply Chanels. Replace damaged extinguisher.	2-20
2.	CONTROLS AND INSTRUMENTS. Inspect for damage and loose mounting. With the unit operating, check for proper performance. Normal operating readings are as follows: Oil pressure gage 55 to 65 psi. Water temperature gage 160 to 200 F. Suction gage 0 to 600 psi. Pilot light ON while operating. Discharge gage 0 to 600 psi.	2-8
3.	FUEL TANK. Add fuel as required. Tighten loose mounting. Replace leaking tank. Replace defective cap gasket. Clean cap vent.	3-43
4.	GROUND. Check for proper ground. A proper ground will consist of 3/4 inch dia. solid rod, 9 ft. long. The cable will be No. 6 AWG copper wire bolted or clamped to the rod and attached to the ground terminal of the equipment.	

ME 4320-243-15/3-5 ①

Figure 3-5. Quarterly preventive maintenance services.

ITEM		PAR REF
5.	OIL LEVEL GAGE. Add oil as indicated by level gage. Reference current L.O.	
6.	SPARK PLUGS. Replace spark plugs that have cracked insulators or burnt electrodes. Clean and set spark gap for 0.030 inch. Torque plugs to 35 ft-lbs. Replace frayed or broken leads. Clean and tighten lead connections.	3-50
7.	FUEL PUMP. Inspect for insecure mounting and leaks. Service as required.	3-39
8.	FUEL LINES AND VALVES. Inspect for leaks, loose connections, and damage.	3-39
9.	OVERSPEED GOVERNOR, Inspect for loose mounting. Inspect for loose electrical connections.	3-41
10.	FUEL FILTERS. Inspect for loose mounting and leaks. Drain water and dirt from filter.	3-39
11.	GENERATOR. Clean slip ring. Replace brushes worn to less than 1/2 their original length. Proper brush spring tension is 18 to 28 ounces.	3-46
12.	MAGNETO. Replace pitted or burnt magneto points. Proper point gap adjustment is 0.008 to 0.012 inch. (Check adjustment every 500 hours)	3-49
13.	V-BELTS. Proper adjustment is a deflection of 1/2 inch midway between pulleys. Replace a worn, frayed, or cracked belt.	3-58
14.	WATER PUMP. Inspect for leaks and loose mounting.	3-57
15.	RADIATOR. Proper coolant level is 2 inches below filler neck. Replace cracked or frayed hose. Replace defective radiator. Remove obstructions in the air passages. Tighten all mountings and leaking connections. Correct pressure for cap is 7 pounds.	3-56
		ME 4320-243-15/3-5 ②

Figure 3-5-Continued.

ITEM		PAR REF
16.	BATTERIES. Tighten loose cables and mountings. Remove corrosion. Fill to 3/8 inch above plates. Clean vent hole in filler caps before replacing. In freezing weather, run engine at least 1 hour after adding water. Replace a cracked or leaking battery.	2-3

ME 4320-243-15/3-5 (3)

Figure 3-5-Continued.

Section IV. OPERATOR'S MAINTENANCE

3-8. General

Maintenance to be performed by the operator is limited to the replenishment of fuel, oil, coolant, and battery water at proper intervals. Refer to the MAC (maintenance allocation chart) Appendix C.

Section V. TROUBLESHOOTING

3-9. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the pumping assembly and its components. Each trouble symptom state is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause. Any trouble beyond the scope of organizational maintenance shall be reported to direct support maintenance.

In troubleshooting, never make more than one adjustment at a time; then locate the trouble by a process of elimination. Usually the cause will be Simple rather than complex.

If the engine cranks over but fails to start, for example, the trouble is almost certainly either in the ignition or the fuel system, and a quick check should determine which system to examine further.

3-10. Engine Fails to Start or Is Hard to Start

Probable cause	Possible remedy
Fuel tank empty	---- Fill fuel tank.
Air cleaner clogged	---- Service air cleaner (para 3-4).
Spark plugs defective	---- Adjust or replace spark plugs (para 3-50).
Carburetor defective	---- Replace carburetor (para 3-40).
Magneto defective	---- Replace magneto (para 3-49).
Magneto contacts not closing.	---- Adjust magneto contacts para 3-49).
Fuel pump defective	---- Replace fuel pump (para 3-39).
Cranking motor fails to crank engine.	---- Refer to paragraph 3-48.

3-11. Engine Misses or Runs Erratically

Probable cause	Possible remedy
Air cleaner clogged	---- Service air cleaner (para 3-4).
Spark plugs defective	---- Adjust or replace spark plugs (para 3-50).
Spark plug leads defective.	---- Replace leads (para 3-50).
Probable cause	Possible remedy
Governor defective	---- Replace governor (para 3-41).
Valve adjustment incorrect.	------ Adjust valves (para 3-36).

3-12. Engine Knocks or Develops Unusual Noise

Probable cause	---- Possible remedy
Crankcase oil supply too low.	---- Aid oil to proper level. ---- Refer to figure 3-1.

Caution

If the engine knocks or is noisy when the crankcase is filled with oil to its proper level, stop the engine immediately and report the condition to field maintenance. Continued operation of the unit under these conditions can cause serious damage to the engine.

Accessory mountings loose.	---- Tighten all loose connec- ---- tions.
Valve adjustment incorrect.	---- Adjust valves (para 3-36).
Timing incorrect	---- Adjust engine timing (para 3-49).

3-13. Engine Stops Suddenly

Probable cause	Possible remedy
Fuel tank empty	---- Fill fuel tank.
Air cleaner clogged	---- Service air cleaner (para 3-4).
Oil pressure too low	---- Add oil to the proper level. Refer to figure 3-1.
Fuel pump defective	---- Replace fuel pump (para 3-39).
Coolant too hot	---- Fill cooling system (para 3-55). Replace defective thermostat (para 3-59). Replace defective V-belts para 3-58).

Caution

Never add coolant to an excessively hot engine block. Failure to observe this caution may result in damage to the engine block.

3-14. Engine Overheats

Probable cause	Possible remedy
Crankcase oil too low	---- Add oil to proper level. Refer to current lubrication order.
Coolant low in radiator	---- Fill cooling system.

Probable cause	Possible remedy
V-belt of water pump loose or slipping.	- Adjust or replace V-belts (para 3-58).
Thermostat sticking in closed position.	---- Replace thermostat (para 3-59).

3-15. Engine Oil Pressure Low

Probable cause	Possible remedy
Crankcase oil too low	--- Add oil to proper level. Refer to lubrication order.
Oil pressure gage defective.	--- Replace oil pressure gage (para 3-30).

3-16. Engine Exhaust Smoky

Probable cause	Possible remedy
Crankcase oil level too high.	---- Drain oil to proper level. Refer to figure 3-1.
Poor combustion caused by cold engine.	--- Allow enough time for engine to warm up before adjusting throttle to operating speed. Open choke (fig. 2-7).
Carburetor out of adjustment.	---- Adjust carburetor (para 3-40).

3-17. Engine Backfires

Probable cause	Possible remedy
Timing incorrect	--- Adjust ignition timing (para 3-49).
Intake valves holding open.	---- Adjust intake valves (para 3-36).

3-18. Engine Lacks Power

Probable cause	Possible remedy
Timing incorrect	--- Adjust ignition timing (para 3-49).
Fuel pump defective	--- Replace fuel pump (para 3-39).
Engine speed too low	--- Adjust governor setting to proper rpm (para 3-41).
Spark plugs defective	--- Replace spark plugs (para 3-50).
Carburetor out of adjustment or defective.	--- Adjust or replace carburetor (para 3-40).

3-19. Engine Consumes too Much Oil

Probable cause	Possible remedy
Too light a grade oil used.	--- Drain. Refill with proper --- grade shown in lubrication order (fig. 3-1).
Oil level too high	--- Drain to proper level.
Piston rings not run in	--- Run engine normally, replacing oil as needed. Condition should gradually clear itself up.
Oil filter body loose	---- Tighten oil filter body.
Oil drain plug loose	---- Tighten plug.

3-20. Noisy Engine Generator

Probable cause	Possible remedy
Generator mounting loose.	---- Tighten generator mounting.
Generator drive pulley loose.	---- Tighten generator drive pulley.
Generator defective	---- Replace defective generator (para :3-46).

3-21. Generator Overheats

Probable cause	Possible Remedy
Generator defective	--- Replace generator (para 3-46).
Engine generator regulator out of adjustment or defective.	-- Adjust or replace engine generator regulator (para 2-47).

3-22. Battery-Generator Indicator Reads in Left-Hand Red Part of Dial

Probable cause	Possible Remedy
Battery dead	--- Recharge or replace battery (para 2-4).
Indicator connections loose or broken.	--- Tighten or replace leads (para 3-52).
Indicator defective	--- Replace indicator (para 3-52).
Generator defective	--- Replace generator (para 3-46).
Engine generator regulator out of adjustment or defective.	--- Adjust or replace engine generator regulator (para 3-47).

3-23. Battery Generated Reads in Right-Hand Red Part of Dial

Probable cause	Possible remedy)
Engine generator-regulator out of adjustment or defective.	-- Adjust or replace engine generator regulator (para 3-47).
Indicator defective	--- Replace indicator (para 3-52).

3-24. Starter Fails to Turn Engine

Probable cause	Possible Remedy
Starter push switch defective.	--- Replace cranking motor push switch (para 3-52).
Cranking motor solenoid relay defective.	--- Replace cranking motor solenoid relay (para 3-48).
Cranking motor defective.	--- Replace cranking motor (para 3-48).
Cranking motor leads defective.	--- Replace cranking motor leads (para 3-48).

3-25. Not Enough Pressure

Probable cause	Possible remedy
Engine not running at rated speed.	---- Increase engine speed (para 3-41).
Valves not fully opened	--- Open valves (para 2-11).

Section VI. RADIO INTERFERENCE SUPPRESSION

3-26. General Methods

Essentially, interference is suppressed by providing a low-resistance path to ground stray currents. Methods include shielding the ignition and high-frequency wires, grounding the frame with bonding straps, and using capacitors and resistors where necessary. For general information on radio interference sup-

3-27. Interference Suppression Components

a. Primary Suppression Components. The primary suppression components are those whose primary function is to suppress radio interference. These components are as follows:

(1) Engine generator regulator capacitor.

(2) Generator enclosure. The generator is completely shielded by its housing, which is grounded to the engine.

(3) Magneto bond strap.

(4) Shielded ignition wire.

b. Secondary Suppression Components. The secondary components have radio interference suppression functions that are incidental and/ or secondary to their primary function. In the centrifugal pump unit, these are mainly fastenings or fastening accessories designed to ensure good electrical contact between various parts of the equipment, such as toothed lockwashers.

3-28. Testing and Replacement of Suppression Components

a. Correct faulty suppression by substituting new suppression components until the defective ones are found. Test engine generator regulator capacitor for leaks and shorts on a capacitor tester; replace defective capacitor. If test equipment is not available and interference is indicated, test by substitution.

Note In testing components by substitution, do not pull on cable or twist braided shielding in removing or replacing shielded ignition cables. Gently work cable from side to side and free the rubber seal. Do not use sharp metal tools to install rubber seals.

b. As many of the minor interference suppression components consist of IT (internal tooth), IET (internal-external tooth) and ET (external tooth) lockwashers, always replace with the same type.

c. Be sure all bond straps are securely fastened.

d. Tighten all fastening accessories.

Section VII. GAGES AND INSTRUMENTS

3-29. General

Gages and instruments are located on the instrument panel box, and the fuel tank. They must be replaced when they become inoperative or give incorrect readings during normal operation. Inspect all wiring removed during the replacement; inspect for cracked or frayed insulation, and replace any defective leads. Also check oil-pressure and water-temperature sending units (para 3-53). Tag and remove the necessary lines, leads and cable before removing any gage or instrument.

3-30. Cleaning, Inspection, and Replacement

a. Remove and install the level, pressure, and temperature gages as shown by figure 3-6.

b. Remove and install the tachometer drive assembly as shown by figure 3-7.

c. Refer to figure 3-6 and remove and install the tachometer-hourmeter.

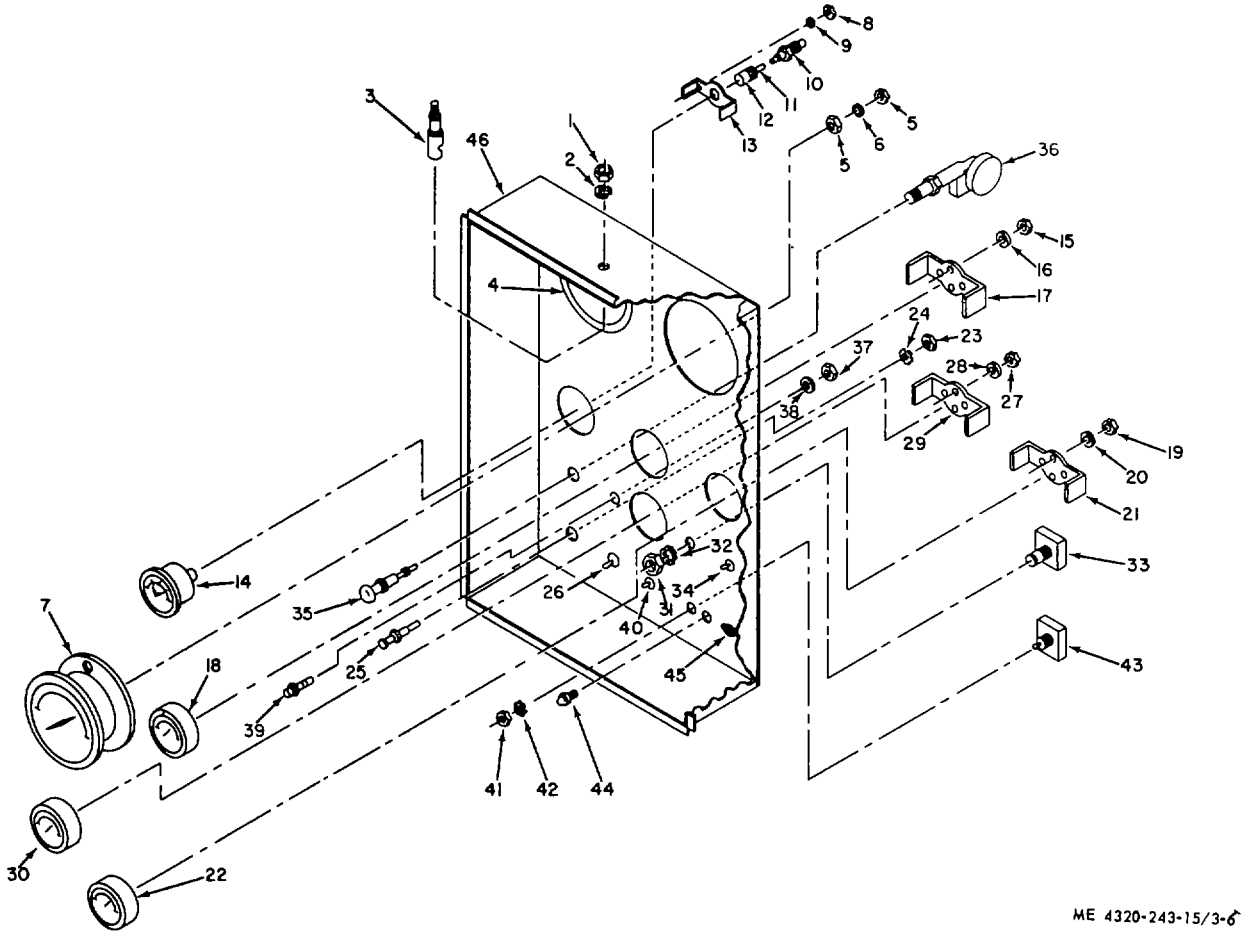
d. Refer to figure 3-6 and remove and install the starting switches.

e. Clean and inspect for corrosion, breaks or other defects.

Section VIII. PUMPING ASSEMBLY AND COUPLING

3-31. Inspection

Make a general visual examination of the pumping assembly and coupling for such deficiencies as loose or missing bolts or nuts, and bent, cracked, or broken parts.



1 Nut
2 Washer
3 Pilot light assembly
4 Suction pressure gage
5 Nut (6)
6 Washer (3)
7 Discharge pressure gage
8 Nut (2)
9 Washer (2)
10 Tachometer shaft housing
11 Flexible shaft
12 Housing
13 Mounting bracket
14 Tachometer
15 Nut
16 Washer
17 Mounting bracket
18 Engine oil gage
19 Nut
20 Washer
21 Mounting bracket
22 Battery charging voltmeter
23 Nut
24 Washer
25 Throttle
26 Panel light switch
27 Nut
28 Washer
29 Mounting bracket
30 Water temperature gage
31 Nut
32 Washer
33 Starting switch
34 Ignition switch
35 Primer pump control
36 Primer pump assembly
37 Nut
38 Washer
39 Choke
40 Engine safety switch
41 Nut
42 Washer
43 Pump safety switch
44 Pilot light
45 Fuse
46 Instrument and control housing

Figure 3-6. Controls and instruments, exploded view.

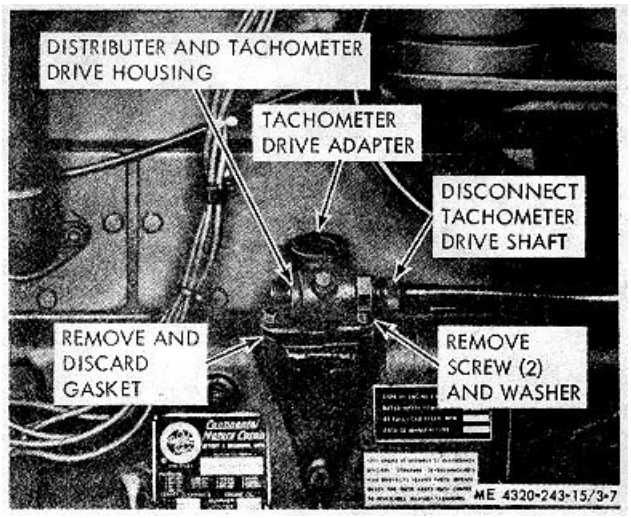


Figure 3-7. Tachometer drive housing, removal and installation.

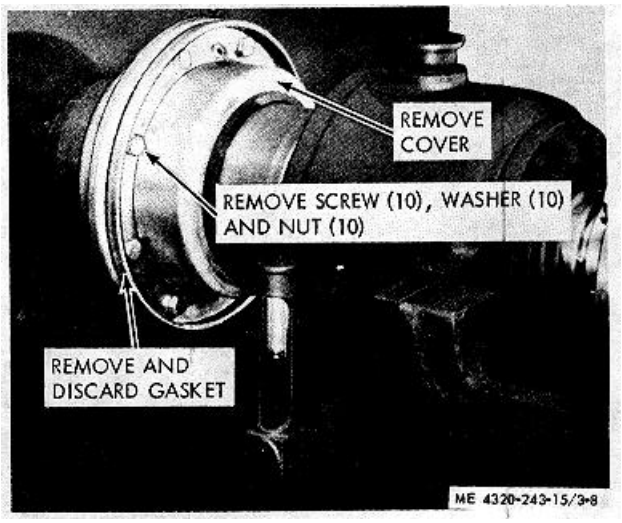


Figure 3-8. Flexible drive coupling, removal and installation.

3-32. Coupling

a. Remove and install the flexible drive coupling as shown in figure 3-8.

b. Clean and inspect.

3-33. Service

Lubricate as prescribed by the current lubrication order, figure 3-1.

Section IX. ENGINE

3-34. General

Continental Engine Model RS 633 is a 6-cylinder, 4-stroke/cycle, liquid cooled, over head-valve, gasoline engine developing 142 rated horsepower at full load speed of 2,200 rpm. Major components located on the engine are the governor, carburetor, starting-motor, oil filters, magneto, generator, and fuel pump.

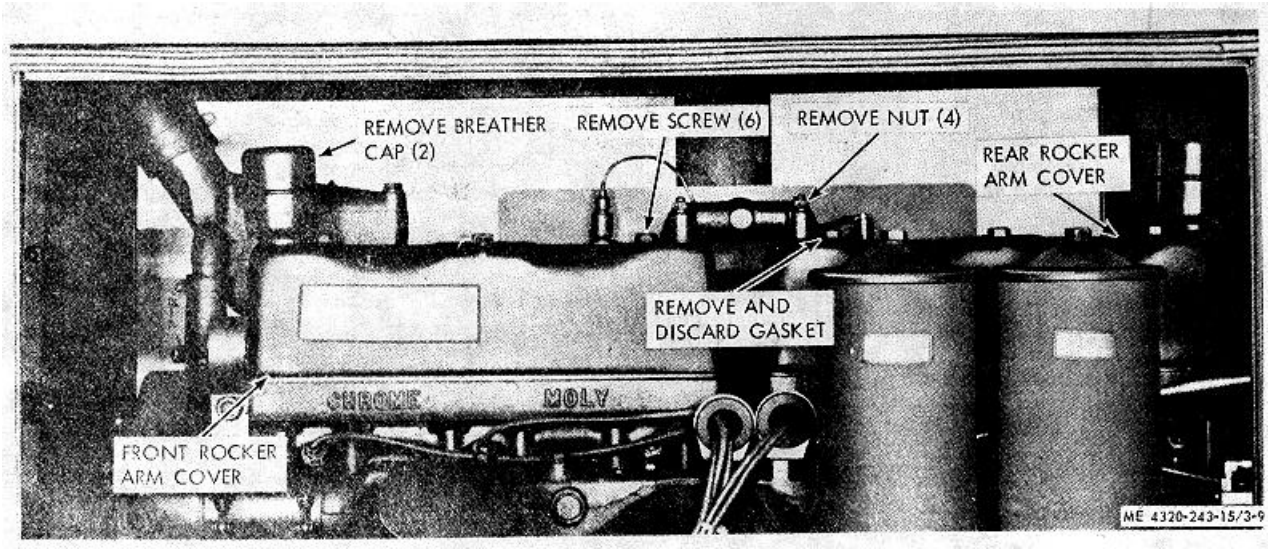


Figure 3-9. Breather connection and rocker arm cover, removal and installation.

3-35. Breather Connection and Rocker Arm Covers

a. Remove and install the breather connection and rocker arm covers as shown in figure 3-9.

b. Clean and inspect.

3-36. Valve Adjustment

a. Remove breather connection and rocker arm covers (para 3-35).

b. Refer to figure 3-10 and adjust valve tappets to clearances shown.

c. Install breather connection and rocker arm covers (para 3-35).

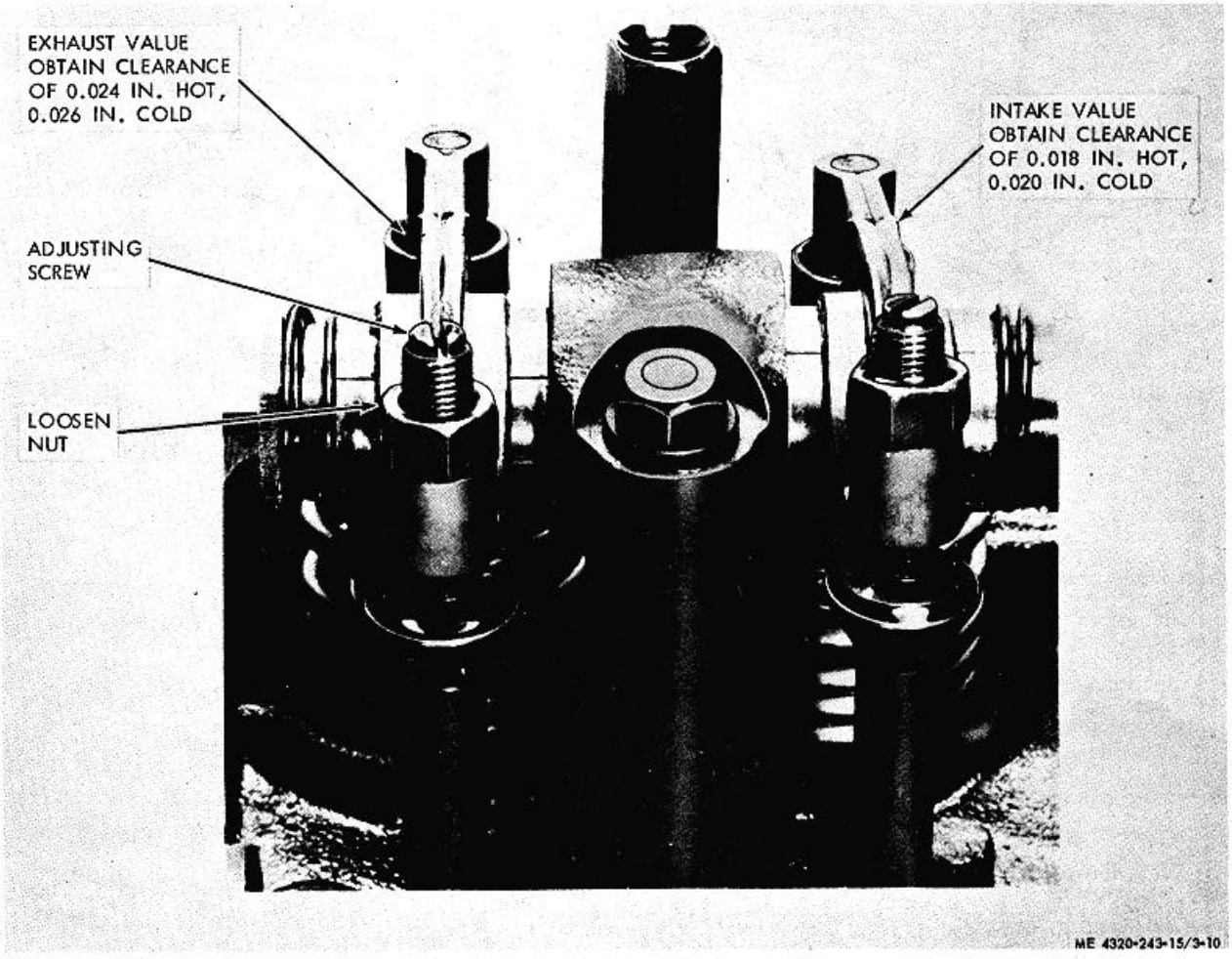
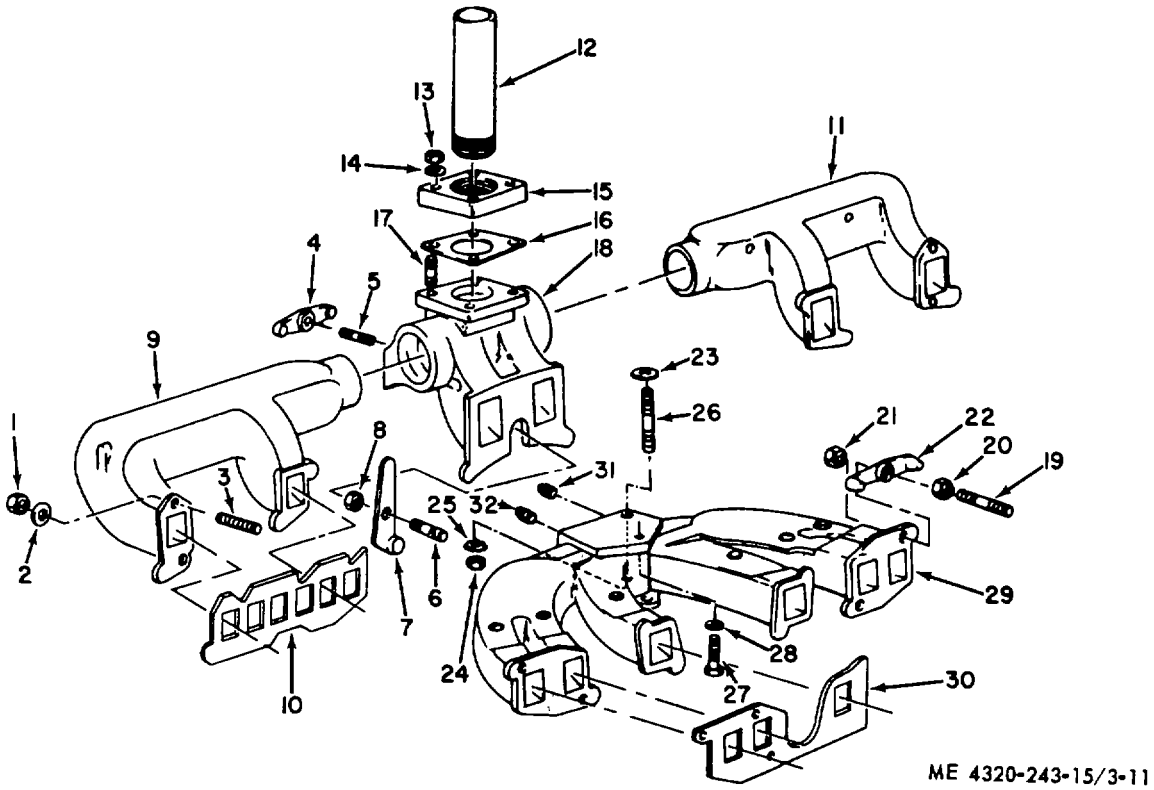


Figure 3-10. Valve Adjustment.

3-37. Intake and Exhaust Manifolds

a. Remove and install intake and exhaust manifolds as shown in figure 3-11.

b. Clean and inspect.



1	Nut	12	Exhaust pipe nipple	23	Washer
2	Washer	13	Nut (4)	24	Nut
3	Stud	14	Washer (4)	25	Washer
4	Manifold crab	15	Exhaust flange	26	Stud
5	Stud	16	Gasket	27	Screw
6	Stud	17	Stud (4)	28	Washer
7	Manifold crab	18	Manifold	29	Intake manifold
8	Nut	19	Stud	30	Gasket
9	Front exhaust manifold	20	Nut	31	Plug
10	Gasket	21	Nut	32	Plug
11	Rear exhaust manifold	22	Manifold crab		

Figure 3-11. Intake and exhaust manifolds.

Section X. FUEL SYSTEM

3-38. General

The fuel system consists of the fuel tank, fuel pump, carburetor, air cleaner assembly, governor, primer, choke, throttle, and the necessary connecting lines, tubing, and linkage. The fuel pump draws the fuel from the tank through the fuel filter to the carburetor; then forces it through the carburetor where it is mixed with filtered air drawn through the air cleaner. This fuel-air mixture is then drawn into the cylinders and ignited by the spark plugs.

3-39. Fuel Pump, Fuel Filter, and Fuel Lines

a. Service the fuel pump and fuel filter as shown by figure 3-12.

b. Remove and install the fuel pump, fuel filter and fuel line as shown by figure 3-12.

c. Clean and inspect.

3-40. Carburetor, Throttle Solenoid and Support and Throttle Body

a. Adjust the carburetor as shown by figure 3-13.

b. Remove and install the carburetor, throttle solenoid and support, and throttle body as shown by figure 3-14.

3-41. Governor

a. Adjust the governor as shown by figure 3-15.

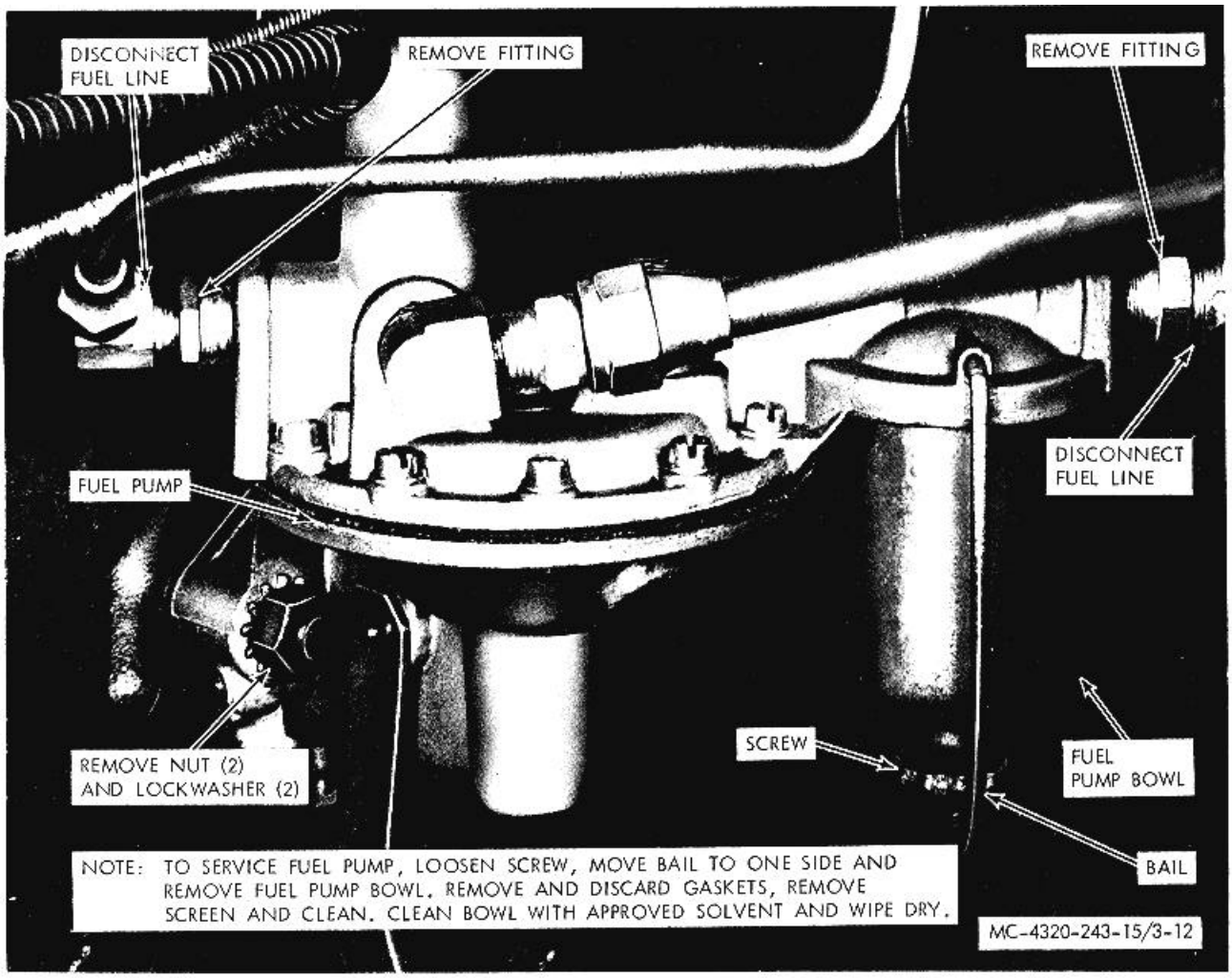


Figure 3-12. Fuel pump and filter service, removal and installation.

b. Remove and install the governor and linkage as shown by figure 3-16.

c. Clean and inspect.

3-42. Air Cleaner

a. Remove and install the air cleaner as shown by figure 3-3.

b. Clean and inspect.

c. If the engine fails to start or stalls because of a stoppage in the air cleaner assembly, when a new assembly is not available, remove the old assembly and securely fasten a section of clean, fine-meshed screen over the open end of the carburetor. In an emergency, this will filter the air adequately in most environments.

***Caution*: Operating the unit in sandy or dusty areas without an air cleaner can damage the engine.**

3-43. Fuel Tank and Associated Parts

a. Remove and install the toolbox, by removing and installing the two screws, and lockwashers attaching the toolbox to the skid.

b. Remove and install the fuel line assembly, fuel shutoff valve, fuel tank level gage, level control valve, fuel filler tank cap, and fuel tank strainer (fig. 3-17).

c. Remove and install the fuel tank shield and fuel tank in sequence as shown by figure 3-18.

d. Clean and inspect.

e. Remove all rust and loose paint from the

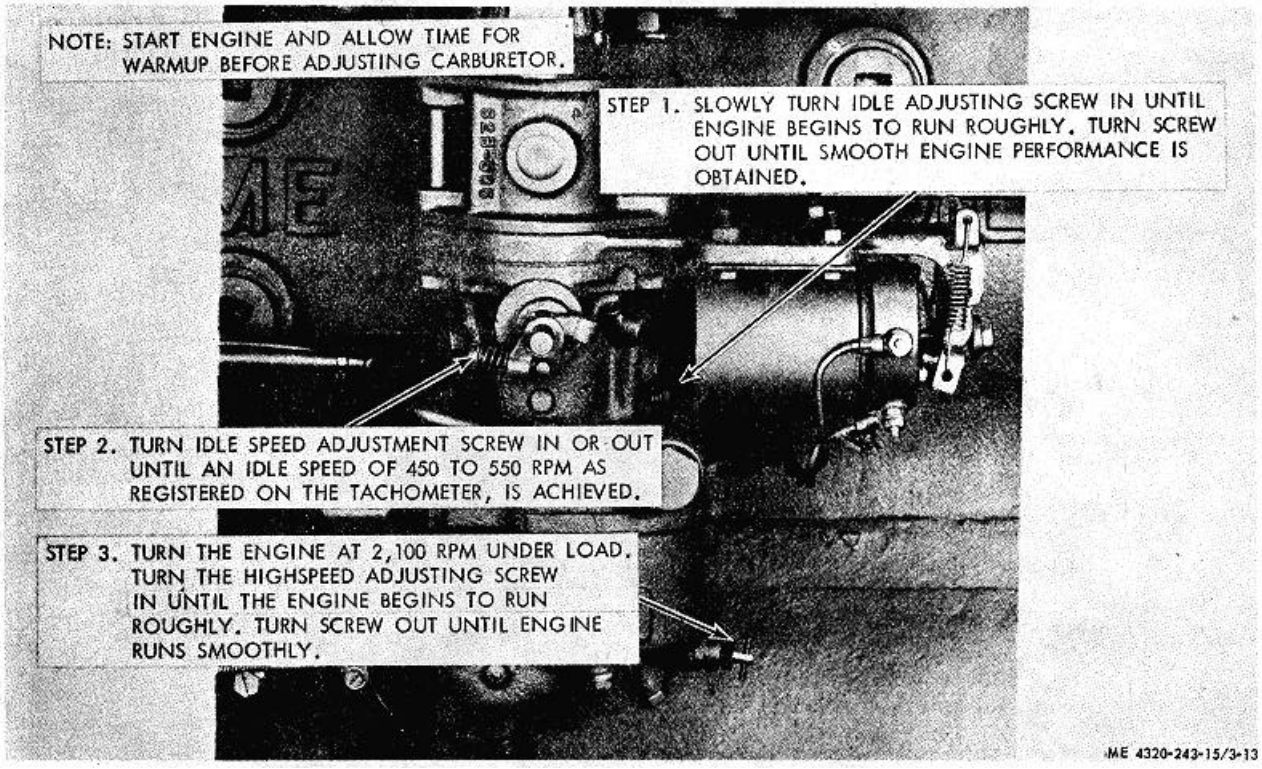


Figure 3-13. Carburetor adjustment

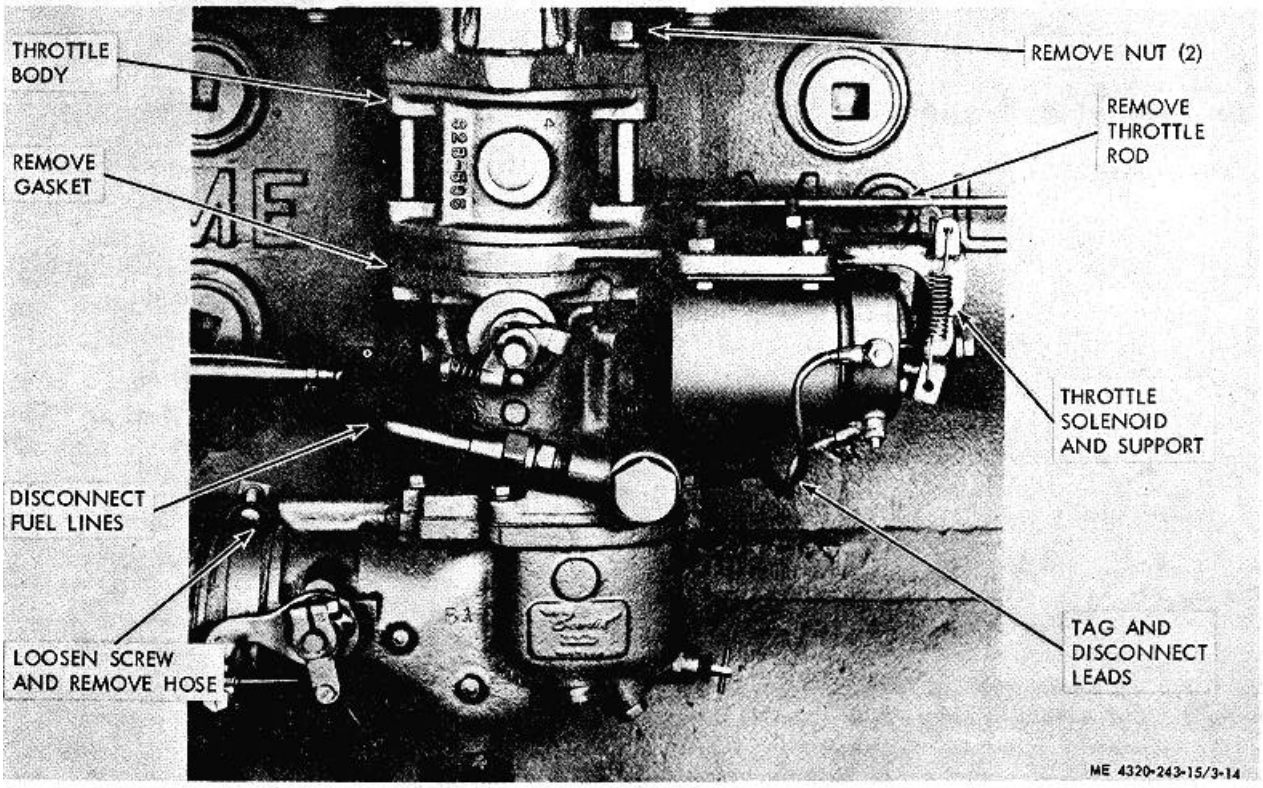


Figure 3-14. Carburetor, throttle solenoid and support and throttle body, removal and installation.

fuel tank shield and fuel tank with a wire brush and repaint as directed in TM 9-213.

f. Replace an unserviceable fuel tank shield or fuel tank.

3-44. Primer Pump, Lines and Fittings

a. Refer to figure 3-6 and remove and install primer pump, lines and fittings.

b. Clean and inspect.

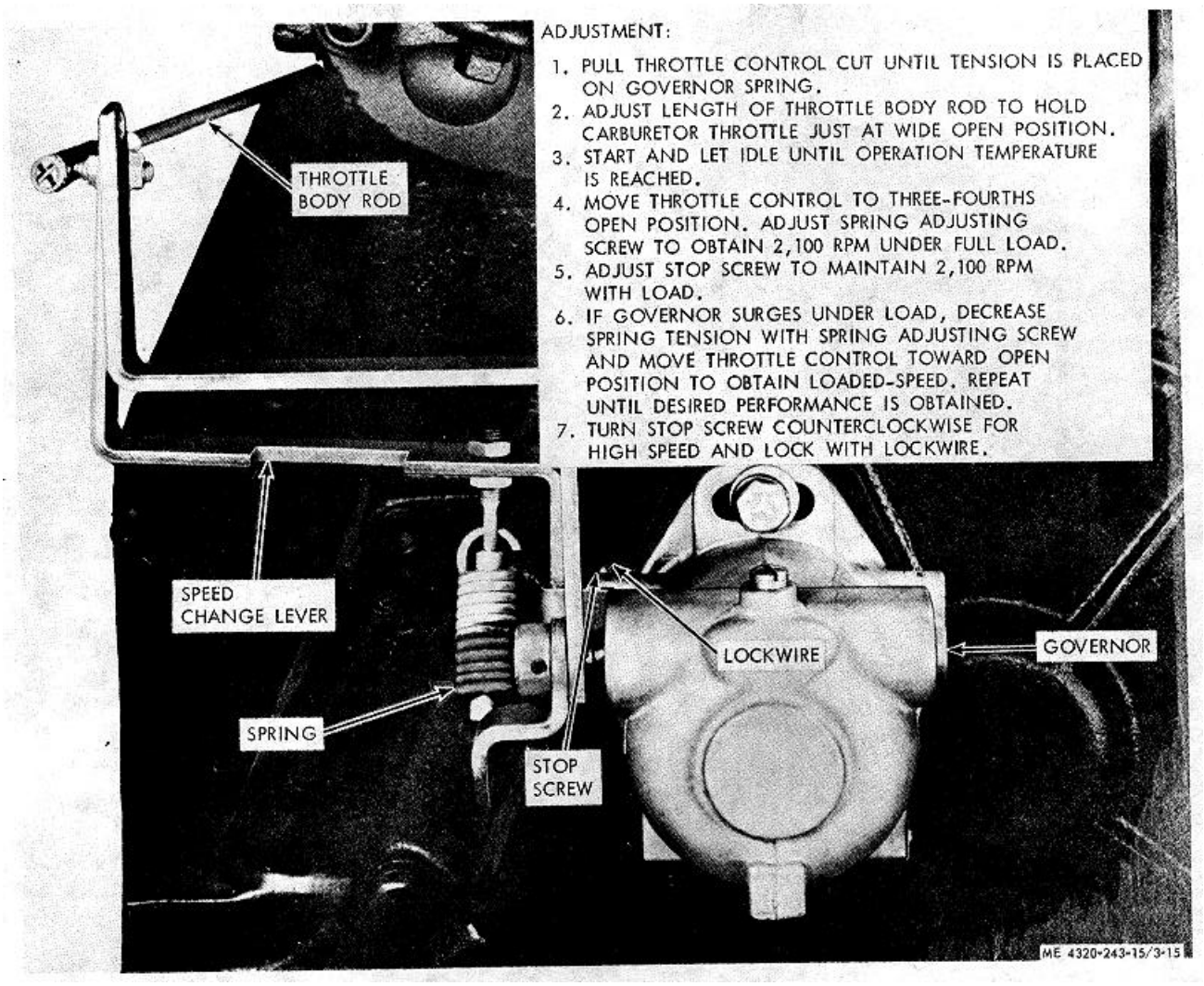


Figure 3-15. Governor adjustment

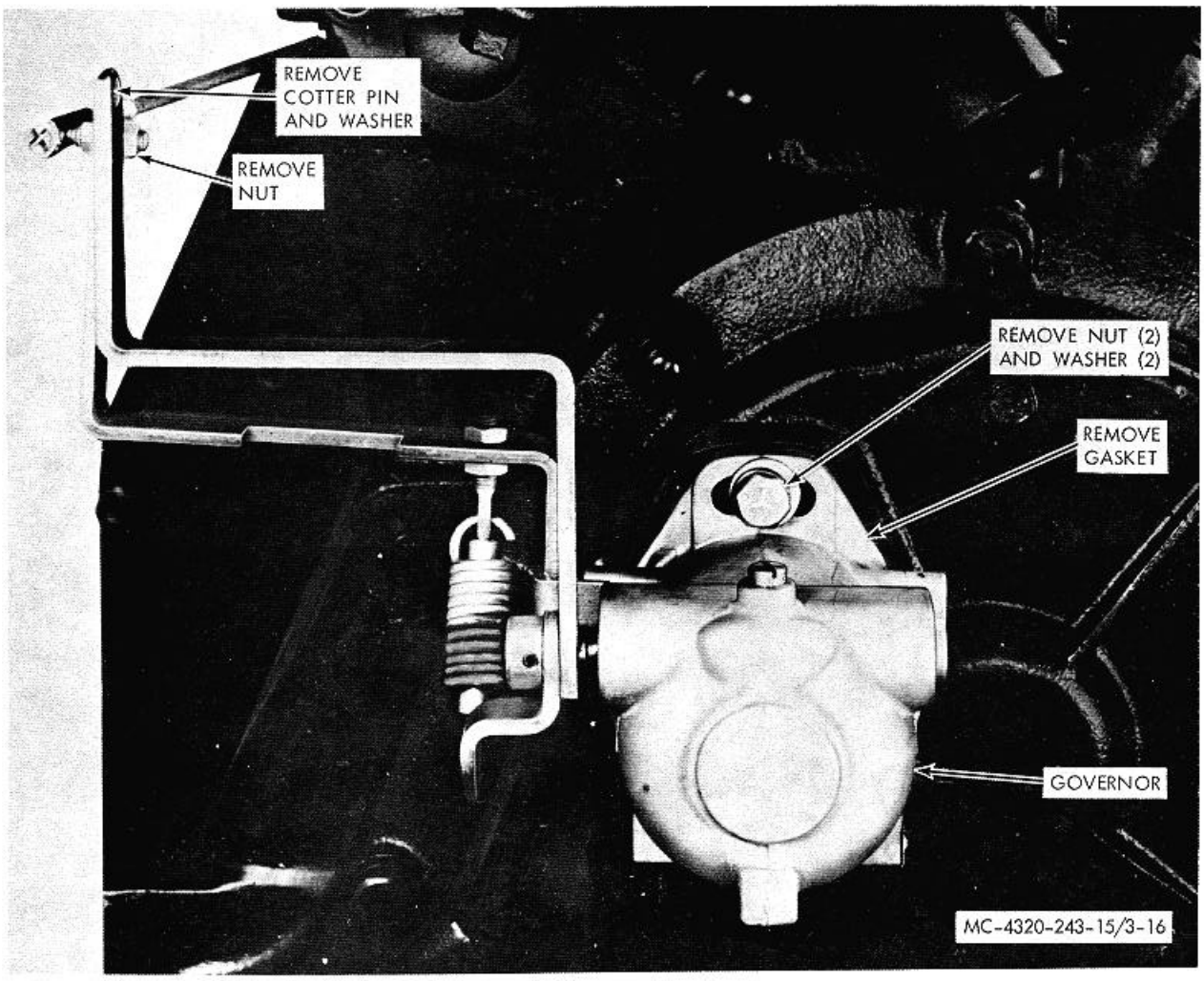
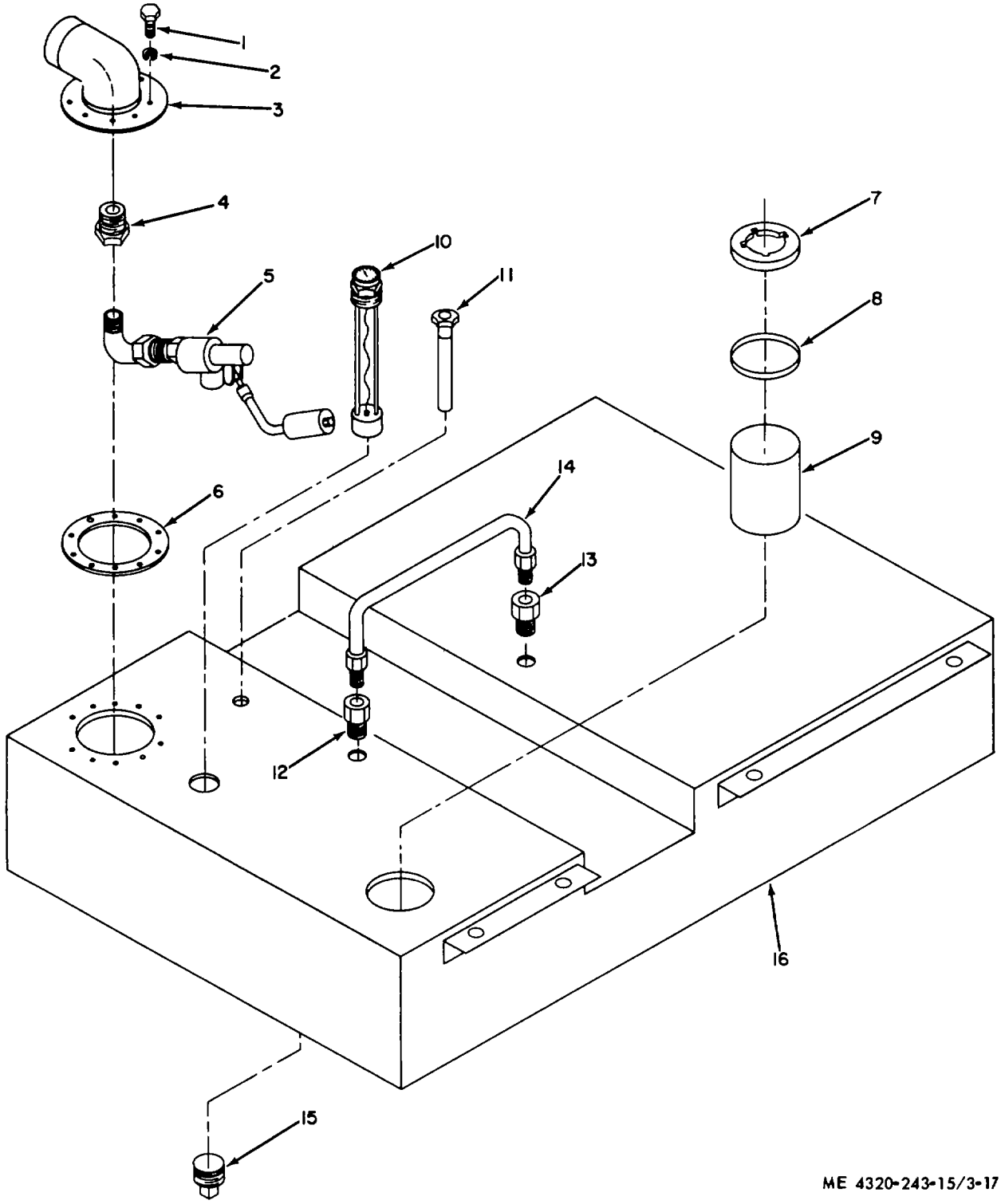


Figure 3-16. Governor and linkage, removal and installation.



1	Screw (12)	5	Float assembly	9	Inner sleeve strainer	13	Male connector
2	Washer (12)	6	Gasket	10	Fuel gage	14	Air vent assembly
3	Flange	7	Cap	11	Riser assembly	15	Plug
4	Bushing	8	Gasket	12	Male connector	16	Fuel tank assembly

Figure 3-17. Fuel tank assembly, disassembly and reassembly.

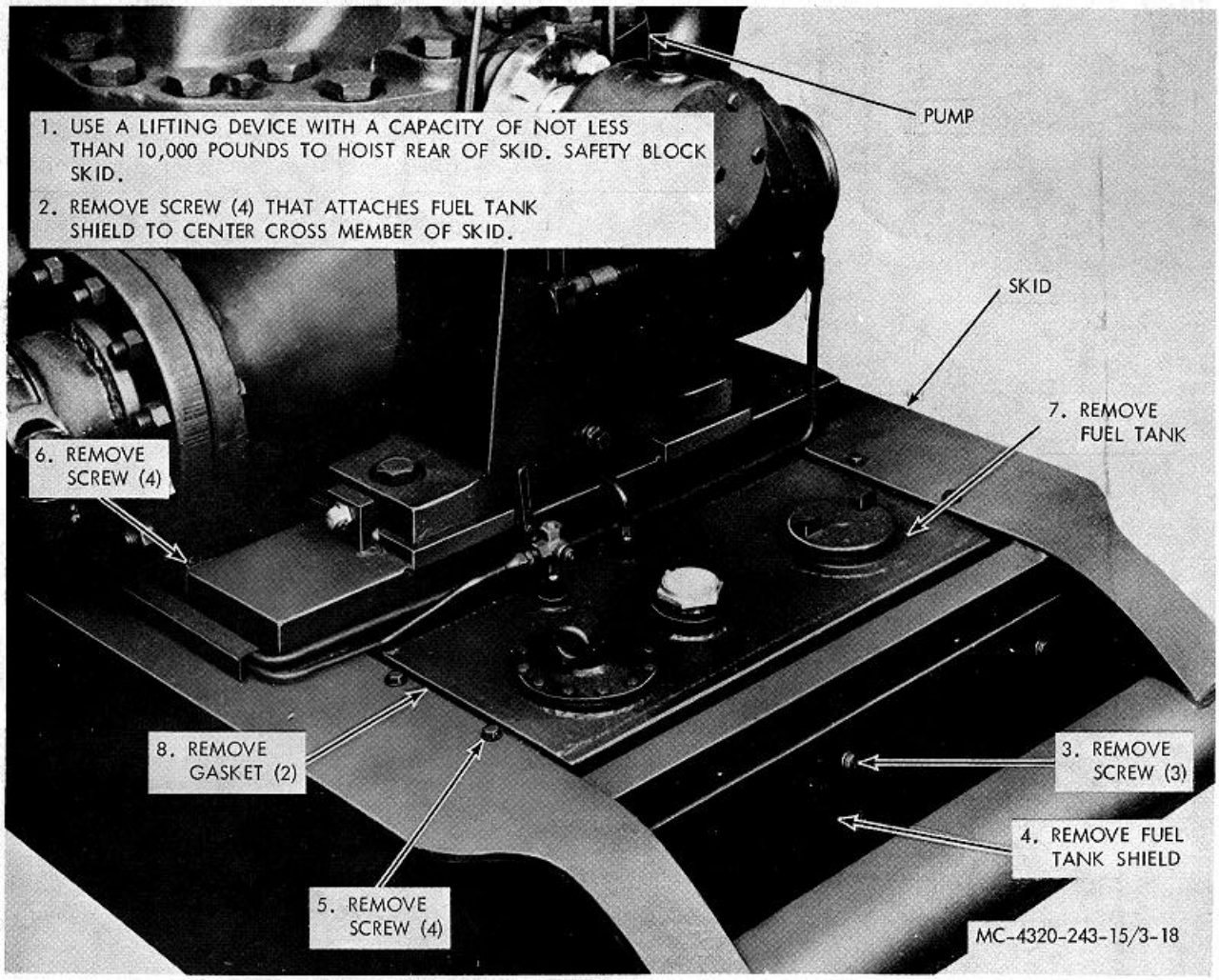


Figure 3-18. Fuel tank shield and fuel tank, removal and installation.

Section XI. ELECTRICAL SYSTEM

3-45. General

The 24-volt electrical system consists of two 12-volt batteries in series, the battery box, generator, magneto, starting motor, generator regulator, spark plugs, and the wiring and switches required to connect and operate these components. The starter motor is a 24-volt, series-wound dc motor powered by the 24-volt generator driven by two V-belts. The generator charging rate is controlled by the generator regulator which is mounted on the front engine support. The magneto furnishes the high-voltage ignition current via the ignition wires to the spark plugs.

***Caution*: Always remove the battery ground cable before working on the engine electrical system.**

3-46. Generator

Remove and install the generator, following the sequence shown by figure 3-19.

3-47. Generator Regulator

Remove and install the generator-regulator as shown by figure 3-20.

3-48. Starting Motor and Solenoid

a. Remove and install the starting motor, solenoid and lead assembly in sequence shown by key numbers in figure 3-21.

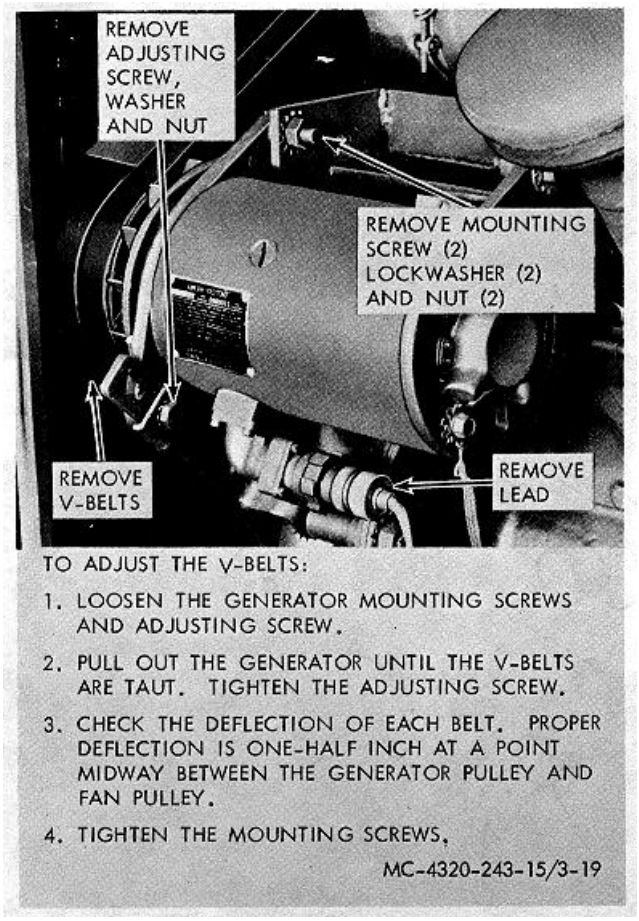


Figure 3-19. Generator, bracket and adjustment strap,

b. Refer to figure 3-22, and perform the on-equipment test.

3-49. Magneto

a. *Adjustment*. Adjust the magneto contacts as shown by figure 3-23.

b. Removal. Remove the magneto and magneto gear as shown by figure 3-24. Clean and inspect.

c. Installation.

(1) Remove the spark plug from the number 6 cylinder (para 3-50).

(2) Make the timing marks accessible as shown by figure 3-25.

(3) Place the thumb over the spark plug hole. Rotate the engine until air pressure is felt, indicating the compression stroke.

(4) Continue to rotate the engine until the flywheel timing mark is aligned as shown in figure 3-25.

(5) Install the magneto and gear as shown by figure 3-24 with the magneto timing gear mark aligned as shown by figure 3-25.

(6) Install the spark plug in the number 6 cylinder and install the timing cover plug(fig. 3-25).

(7) Follow the instructions in *d* below and time the engine.

d. Ignition Timing

(1) Connect the ignition timing light to the number 6 sparkplug lead and to the 24-volt power source.

(2) Start the engine and let it idle

(3) Point the timing light through the timing hole in the flywheel housing. If the timing is correct, the flywheel timing mark (fig. 3-25) will be in line with the pointer inside the flywheel housing each time the light flashes.

(4) To correct faulty timing, loosen the magneto clockwise and counterclockwise until timing is correct. Tighten the magneto mounting screws.

3-50. Spark Plug Leads and Spark Plugs

a. Remove and install the spark plug leads and spark plugs as shown in figure3-26.

***Caution*: Do not pull on the cable or twist the braided shielding.**

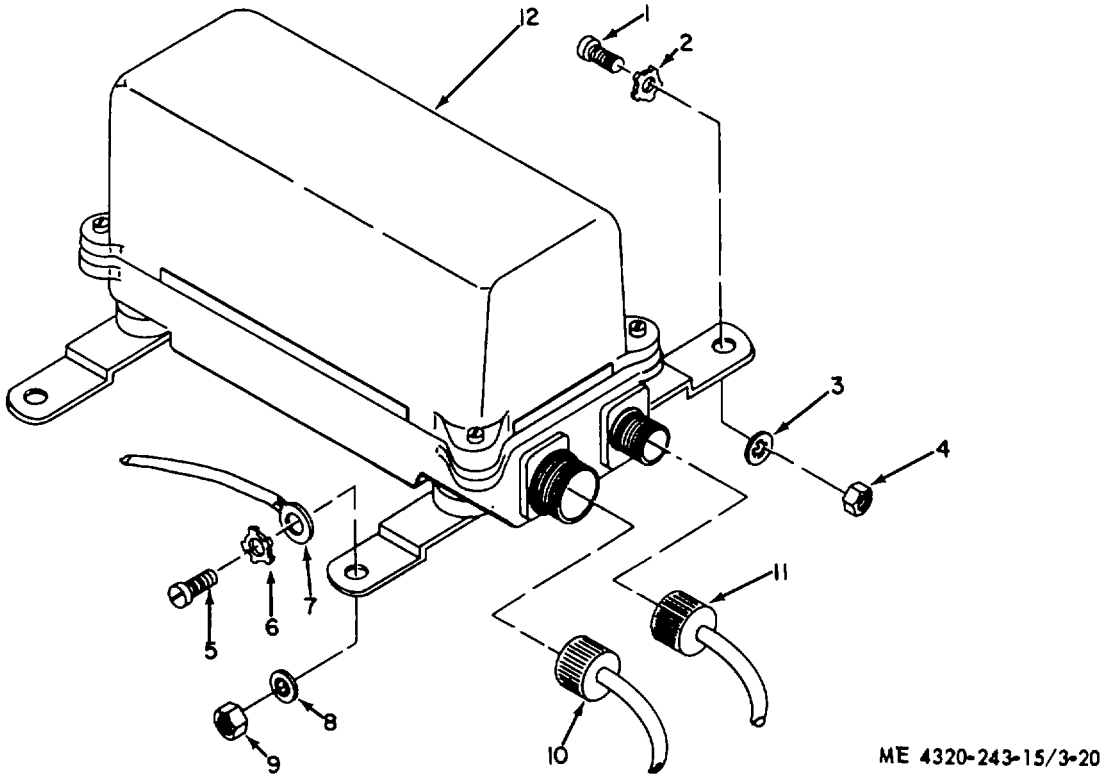
b. Clean and check the gap between the spark plug electrodes with a wire feeler gage. The correct gap is 0.030 inch. If necessary, regap the electrodes, carefully bending the ground electrodes until the proper gap is established.

3-51. Batteries, Cable and Box

a. Remove and install the battery cover, batteries, and battery cable as shown in figure 2-1, in sequence indicated by key numbers.

b. Remove and install the battery box by removing four screws and lockwashers holding the battery box to the skid.

c. Test and service battery as directed in daily preventive maintenance services chart, figure 3-4.



1 Screw (3)
2 Washer (3)
3 Washer (3)
4 Nut (3)
5 Screw
6 Washer
7 Bond strip terminal
8 Washer
9 Nut
10 Lead assembly
11 Lead assembly
12 Generator regulator

Figure 3-20. Generator regulator, removal and installation.

3-52. Electrical Instruments

Remove and install ammeter and switch, in sequence indicated by key numbers in figure 3-6. Replace defective wiring in accordance with wiring diagram, figure 1-5.

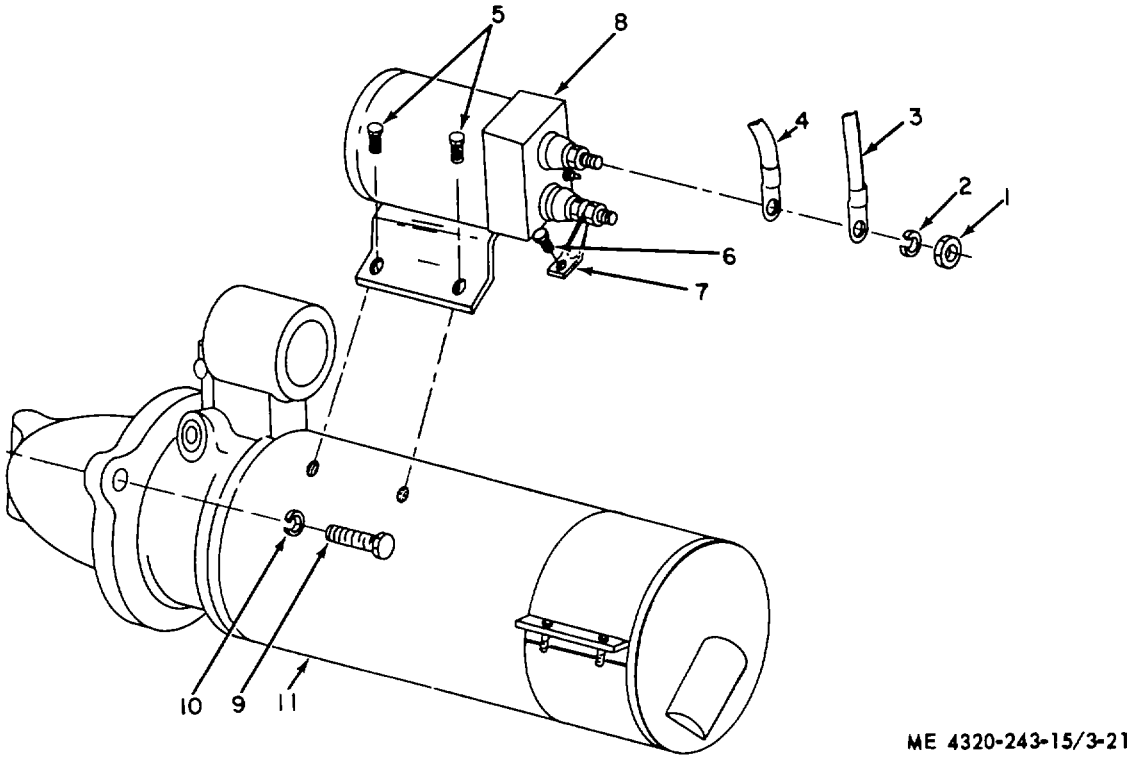
3-53. Sending Units

Remove and install oil-pressure sending unit as shown in figure 3-27. Remove and install temperature sending unit (10, fig. 3-28).

3-54. Engine Safety Switch

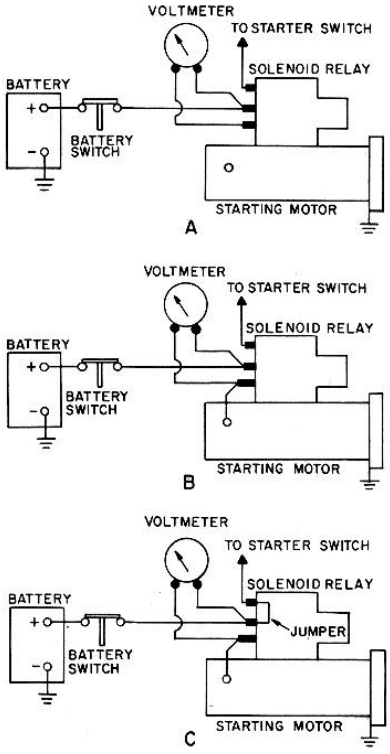
a. Refer to figure 3-6 and remove and install the engine safety switch.

b. Clean and inspect.

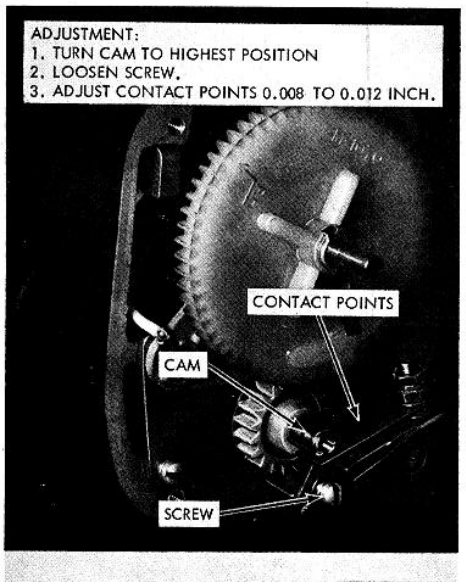


1 Nut
2 Washer
3 Lead assembly (to battery)
4 Lead assembly (to B.C. receptacle)
5 Bolt (4)
6 Bolt
7 Solenoid grounding bracket
8 Solenoid assembly
9 Bolt (2)
10 Washer (2)
11 Starter motor

Figure 3-21. Starter motor assembly, removal and installation.

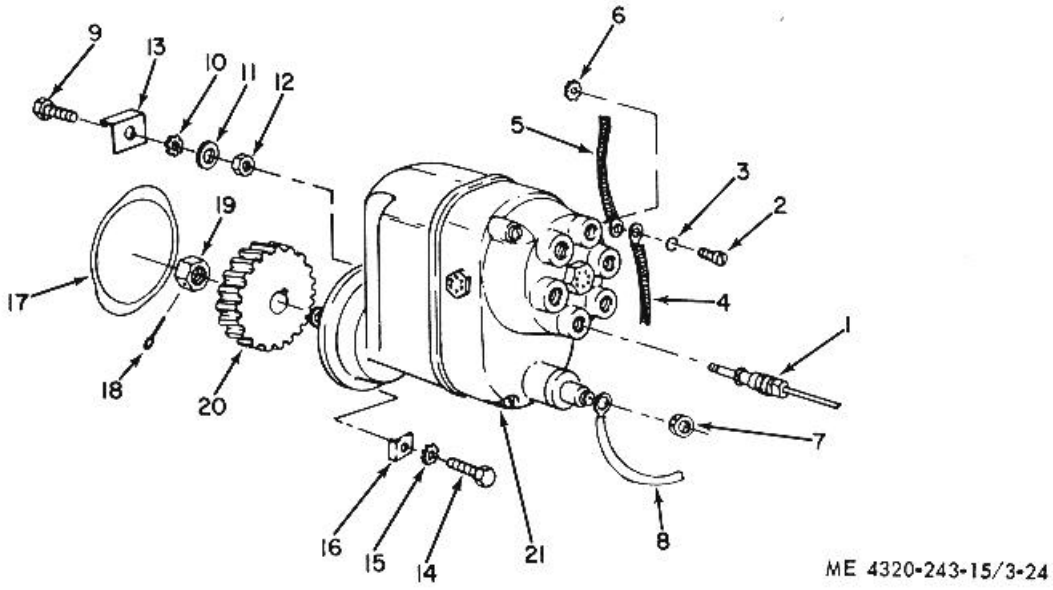


1. Determine that battery is fully charged and that all battery and starting motor cables are serviceable and properly installed.
2. Remove solenoid-to-staring motor connector and connect voltmeter as shown in A above. If voltage is indicated, solenoid relay is defective and must be replaced.
3. Install the solenoid-t00-starting motor connector.
4. Connect voltmeter as shown in B above. If battery voltage (24 volts) is not indicated, the starting motor is defective.
5. Momentarily connect a jumper as shown in C above. The voltmeter reading should drop to zero and starting motor should start engine. If voltmeter reading does not drop to zero, solenoid relay is defective and must be replaced. If voltmeter reading drops to zero but starting motor fails to start engine, starting motor is defective.



ME 4320-243-15/3-22

Figure 3-23. Magneto adjustment.



1	Leads (6)	8	Terminal	15	Washer
2	Screw	9	Screw	16	Clamp
3	Washer	10	Washer	17	Gasket
4	Terminal	11	Washer	18	Pin
5	Terminal	12	Nut	19	Nut
6	Washer	13	Clamp	20	Gear
7	Nut	14	Screw	21	Magneto

Figure 3-24. Magneto, removal and installation.

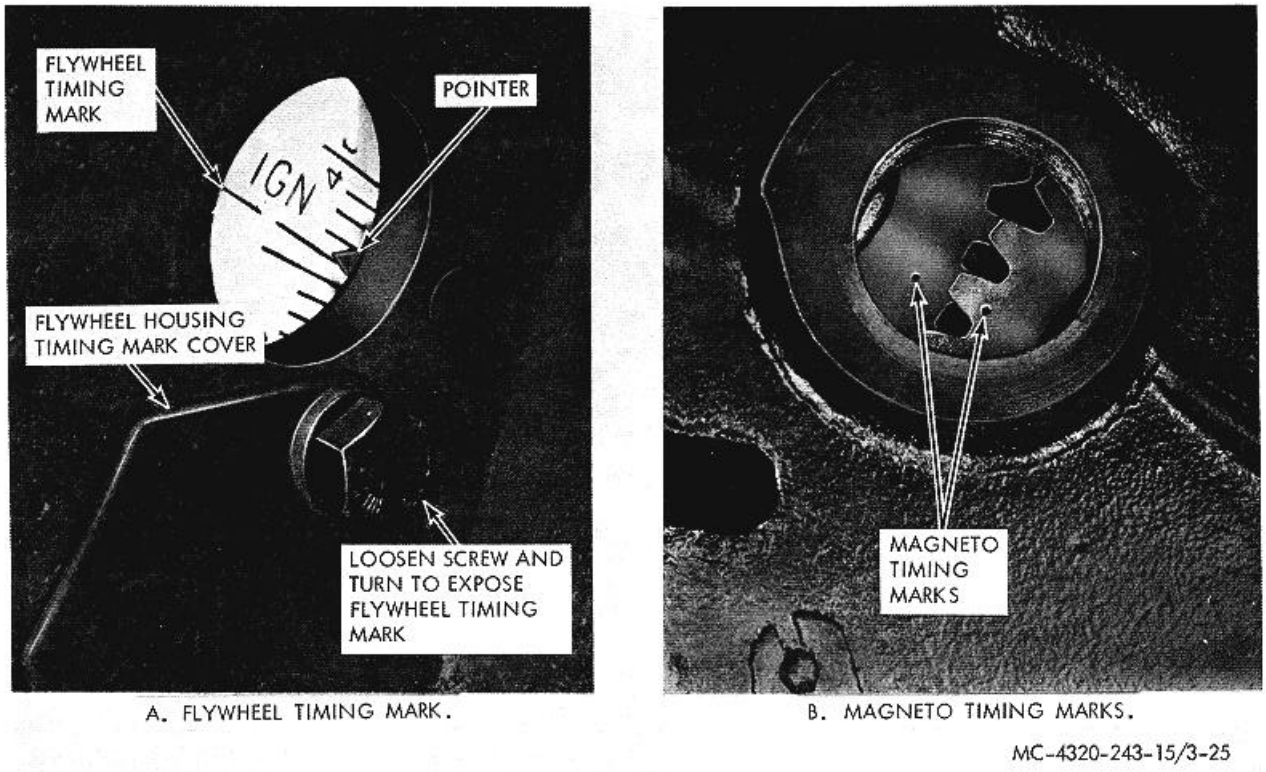


Figure 3-25. Timing marks.

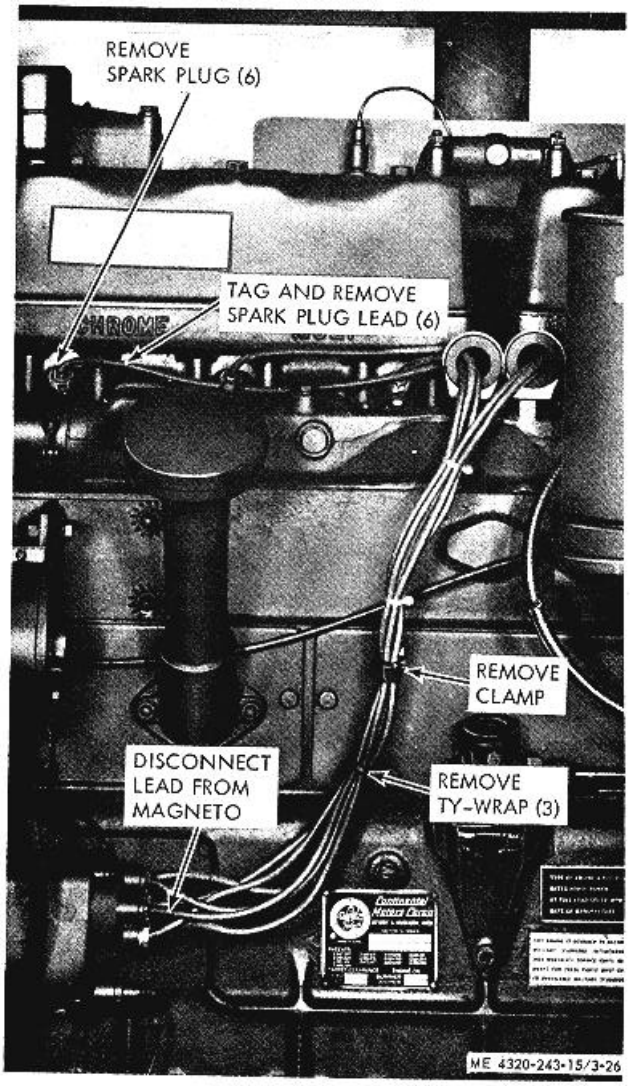


Figure 3-36. Spark plug leads and spark plugs, removal and installation.

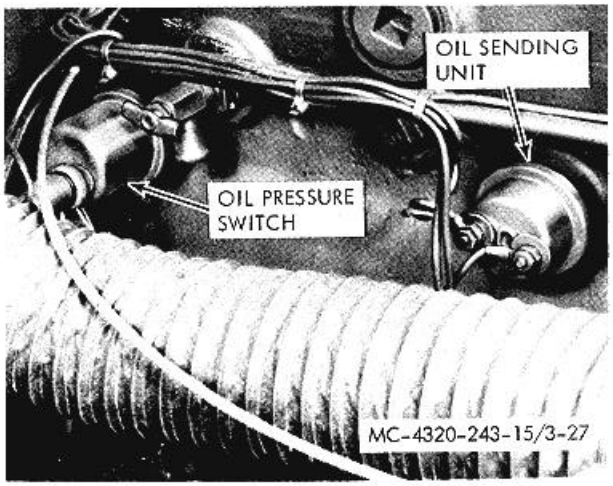
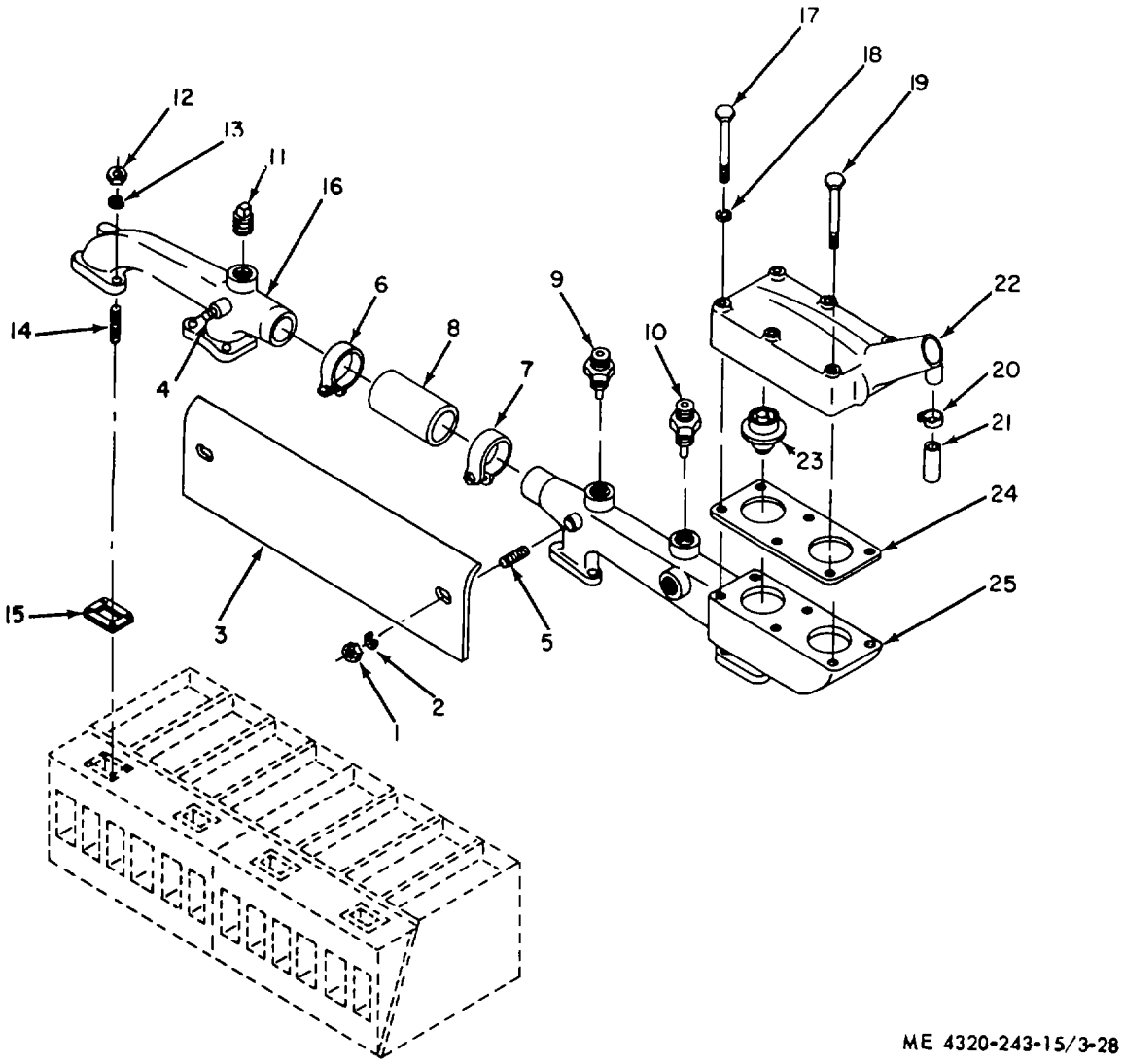


Figure 3-27. Oil pressure switch and oil sending unit, removal and installation.



1	Nut (2)	10	Temperature Sending Unit	18	Washer (6)
2	Washer (2)	11	Plug	19	Screw (2)
3	Heat shield	12	Nut (8)	20	Clamp
4	Stud	13	Washer (8)	21	Hose
5	Stud	14	Stud (8)	22	Outlet connection
6	Clamp	15	Gasket (4)	23	Thermostat
7	Clamp	16	Rear outlet header	24	Gasket
8	Hose	17	Screw (4)	25	Front outlet header
9	Thermoswitch				

Figure 3-28. Water outlet header and related parts.

Section XII. COOLING SYSTEM

3-55. General

The engine cooling system consists of the radiator, fan, water pump inlet and outline headers, outlet elbow, thermostats, shutter thermostat, and shutter assembly. The V-belts from the crankshaft pulley drive the water pump which circulates coolant to the engine block cylinder heads. The radiator is connected to the engine block and cylinder heads by the top and bottom radiator hoses, rigid tube, inlet

and outlet headers, and the outlet elbow. Correct engine operating temperature is maintained by the two thermostats and by the fan which circulates air through the radiator. The thermostats control the flow of coolant through the radiator. The shutter assembly, when closed, blocks the flow of air through the radiator. When the coolant temperature reaches 160° F the shutter begins to open, and is fully open at 185° F. A manual arm is provided on the shutter thermostat housing to open the shutter at temperatures below the shutter thermostat setting.

3-56. Radiator

Service the radiator assembly (fig. 3-29) as follows:

a. lush the radiator as indicated below:

(1) Start the engine and run at slightly faster than idling speed until the water temperature gage registers 180° F. Stop the engine.

(2) Remove the radiator cap, and the radiator drainplug, open the crankcase draincock and drain the coolant into suitable containers. Close the radiator drainplug and crankcase draincock.

(3) Allow the engine to cool. Refill cooling system with clean, fresh water and the -recommended quantity of an approved cooling system cleaning compound. Install radiator cap.

(4) Start the engine and run it slightly faster than idling speed for at least 30 minutes after operating temperature is reached.

(5) Stop the engine. Repeat step (2) above and drain the cooling system.

Note

Always neutralize the cooling system with an approved neutralizing compound after a cleaning compound has been used.

(6) Allow the engine to cool. Fill the cooling system with the clean, fresh water and an approved neutralizing compound. Install the radiator cap.

(7) Start the engine and run it for at least 10 minutes at slightly faster than idling speed after the coolant has reached a temperature of 180° F.

(8) Stop the engine and repeat step (2) above and drain the cooling system.

(9) Allow the engine to cool. Fill the cooling system with clean, fresh water.

(10) Start the engine and run it until the coolant reaches 180° F.

(11) Stop the engine, repeat step (2) above and drain the cooling system.

(12) Repeat steps (9), (10), and (11) above until the water runs clear.

(14) Fill the cooling system to the proper operating level with the proper coolant (pare 2-3). Start the engine and run it until the coolant reaches 180° F. Observe the coolant level and add water if required.

b. Inspect the radiator core, hoses and connections for leaks and air blockage.

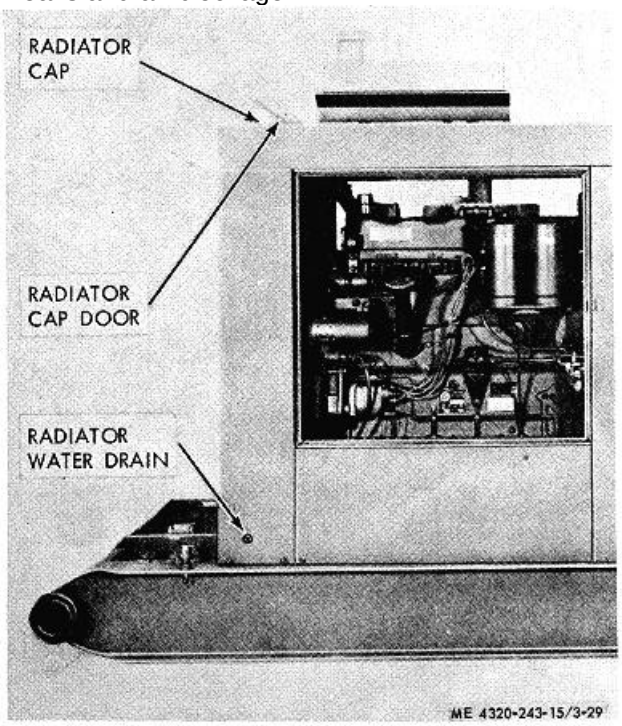


Figure 3-29. Radiator service.

3-57. Water Pump

a. Service the water pump (fig. 3-30) by adding lubricant as directed in the current lubrication order (fig. 3-1).

b. Remove and install as shown by figure 3-30.

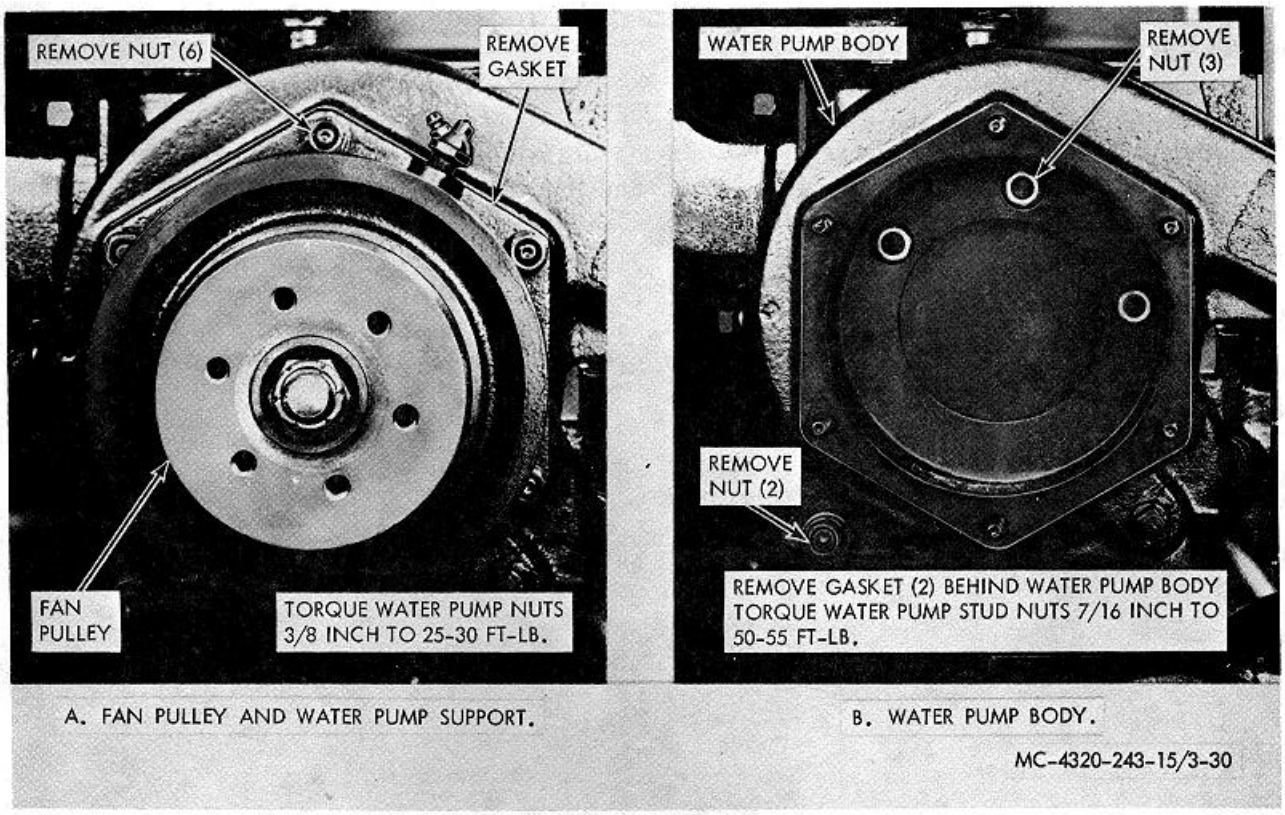


Figure 3-30. Water pump, removal and installation.

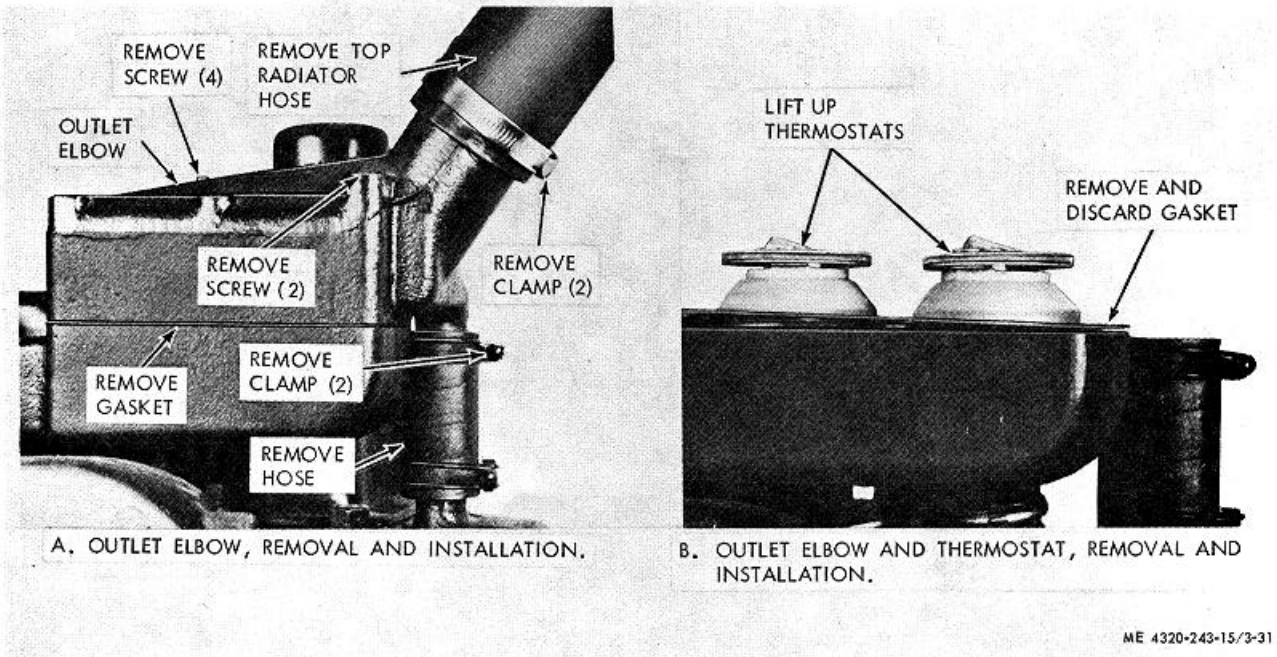


Figure 3-31. Thermostat, removal and installation.

3-58. V-Drive, Belt Assembly

a. Adjust the V-belts as directed in figure 3-19.

b. Remove the V-belts as follows:

(1) Remove radiator fan guard by removing the screws (18) attaching the guard to the radiator.

(2) Loosen the generator mounting screws (fig. 3-19).

(3) Push the generator toward the engine and slip the V-belts off the generator, fan and drive shaft pulleys.

(4) Install in reverse order.

3-59. Water Manifold, Headers, Thermostat and Housing Gasket

a. Test and replace the coolant thermostat as follows:

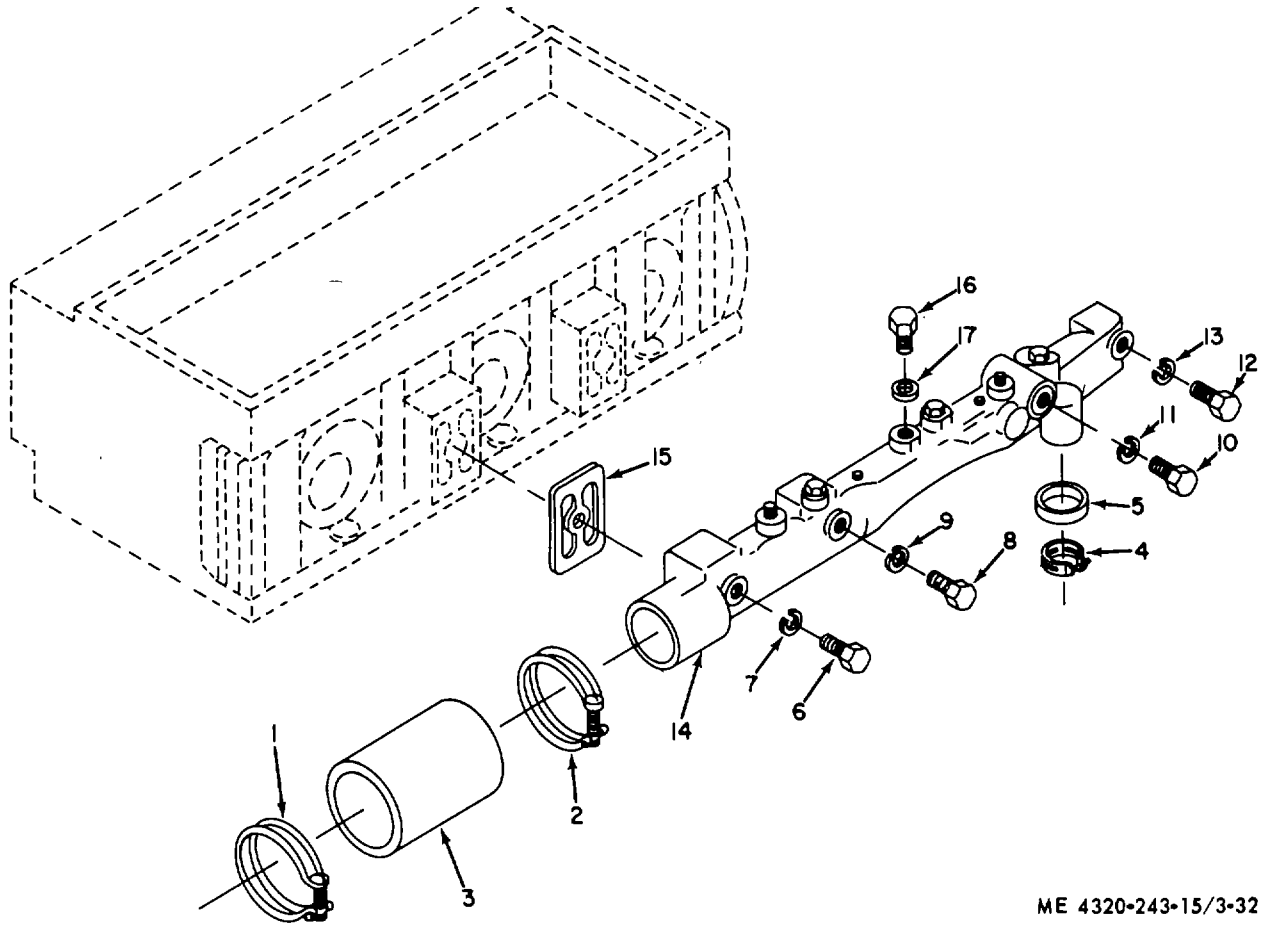
(1) Drain the cooling system (para 3- 56).

(2) Remove and install the outlet elbow and thermostat as shown by figure 3-31.

(3) Test thermostat by suspending in a container of water, into which a thermometer is immersed. Heat water slowly. Thermostat should begin to open at 165° F. and be fully opened at 1750 F. Replace thermostat if defective.

b. Remove and install water inlet header as shown in figure 3-32.

c. Remove and install water outlet header as shown in figure 3-28.



1	Hose clamp	6	Bolt	10	Bolt	14	Header
2	Hose clamp	7	Washer	11	Washer	15	Gasket (2)
3	Hose	8	Bolt	12	Bolt	16	Bolt
4	Hose clamp	9	Washer	13	Washer	17	Washer
5	Seal						

Figure 3-32. Water inlet header and related parts.

Section XIII. LUBRICATION SYSTEM

3-60. General

The lubrication system consists of the two oil filters, oil cooler, oil filler, oil pressure relief valve, oil pressure switch, and oil pressure gage sending unit. The built-in cooler is secured to the left side of the engine at the rear and serves as base for the oil filters. The oil pressure relief valve is located behind the carburetor in the right side of the engine block. The oil filters are located on the left side of the engine.

3-61. Oil Filters

a. Service the oil filters as shown by figure 3-2.

b. Remove and disassemble the front and rear oil filters in sequence shown by figure 3-33. Reassemble and install in opposite order.

c. Clean and inspect.

d. Add oil to the proper level as shown by the current lubrication chart.

3-62. Oil Cooler and Oil Cooler Base

a. Remove hose between the inlet header and oil cooler base.

b. Remove and install the oil filters (para 3-61 above).

c. Remove and install the oil cooler and base as shown by figure 3-34.

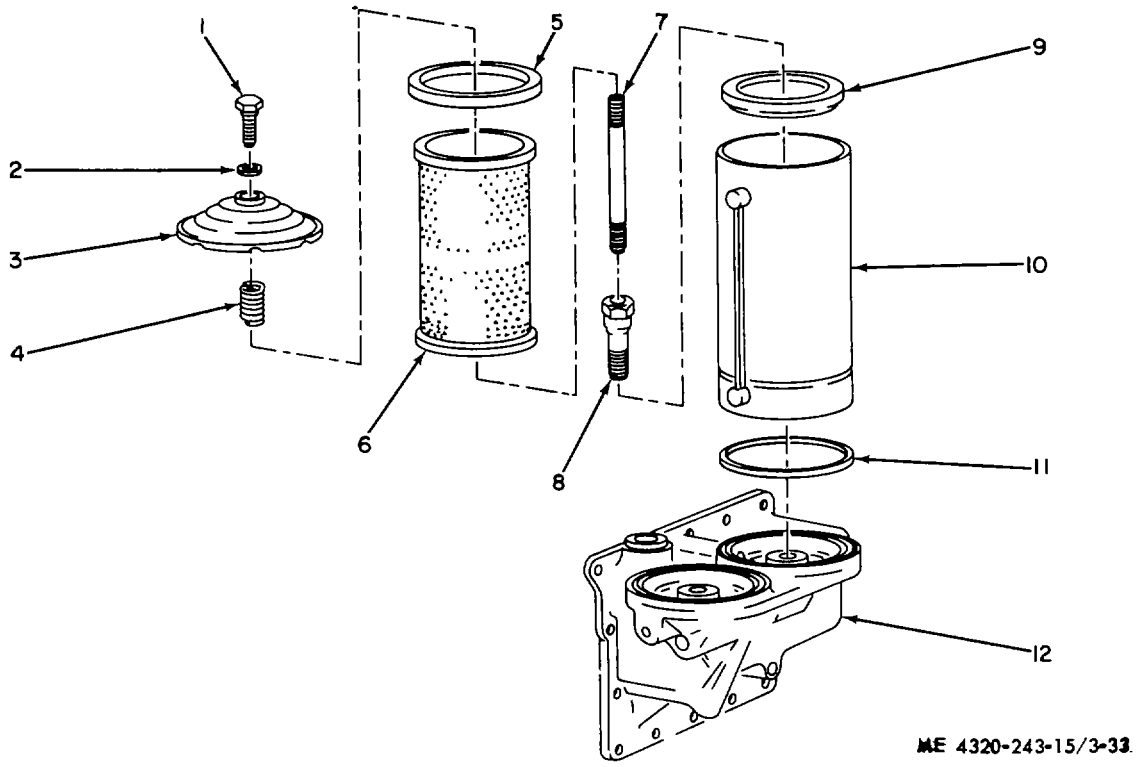
d. Clean and inspect.

3-63. Oil Pressure Relief Valve

a. Remove and install oil pressure relief valve as shown by figure 3-35.

b. Clean and inspect.

c. Adjust, if necessary, by changing springs as shown by figure 3-35.



1	Bolt	5	Gasket	9	Plate
2	Washer	6	Filter element	10	Body
3	Cover	7	Tube	11	Gasket
4	Spring	8	Bolt	12	Base

Figure 3-83. Oil filter, assembly and disassembly.

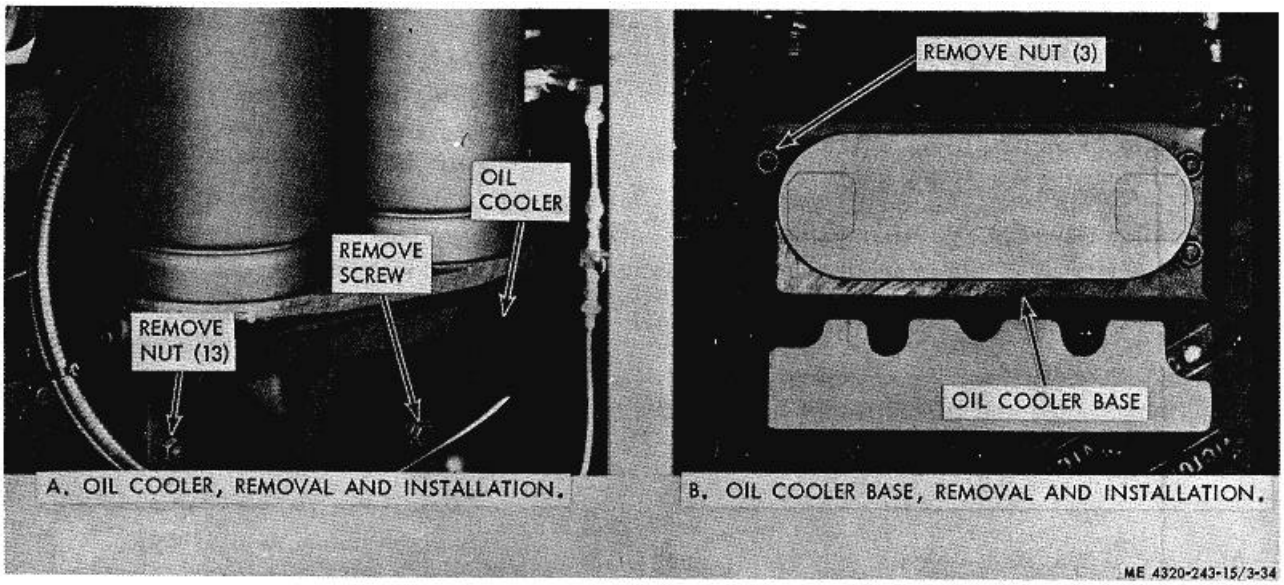


Figure 3-34. Oil cooler and oil cooler base, removal and installation.

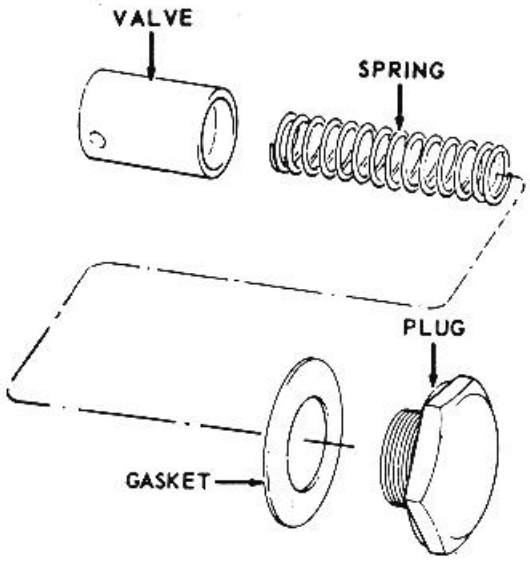


Figure 3-35. Oil pressure relief valve.

Section XIV. HOUSING ASSEMBLY AND FRAME

3-64. General

The engine is enclosed in a sheet metal assembly, with doors at both sides to provide access. The pumping unit is exposed.

3-65. Housing Assembly

Remove and install the housing assembly as shown in figure 3-36.

3-66. Lifting Bail and Toolbox

a. Remove the lifting bail (fig. 1-2) by removing the four nuts attaching it to the skid.

b. Clean and inspect.

c. Install in reverse order.

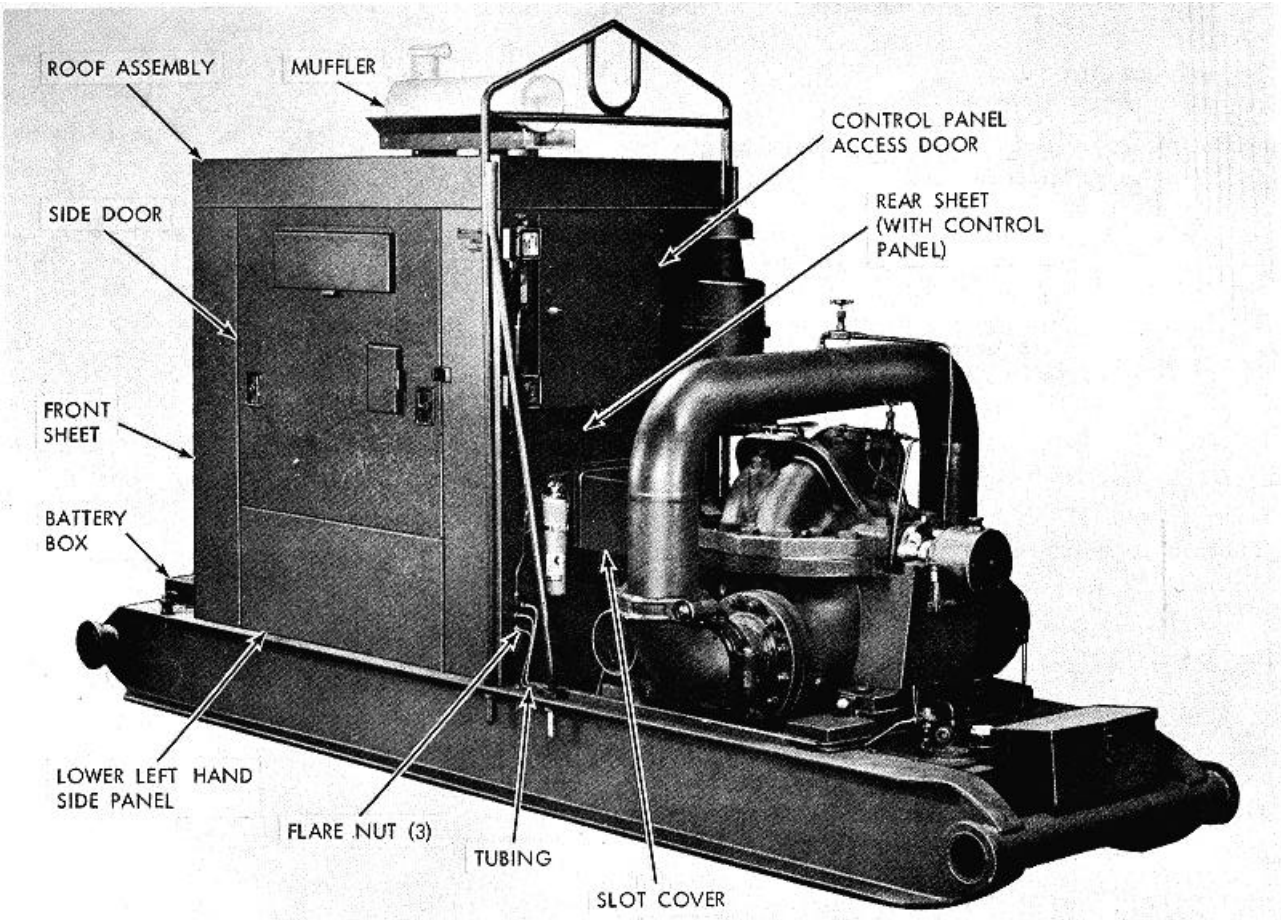
d. Remove the toolbox (fig. 1-4) by removing the two bolts, and washers attaching it to the rear cross beam on the skid.

e. Clean and inspect.

f. Install in reverse order.

Section XV. FIRE FIGHTING EQUIPMENT

Refer to paragraph 2-20 and service the dry chemical type fire extinguisher.



1. UNLATCH AND REMOVE SIDE DOORS (2).
2. REMOVE MUFFLER (PAR. 2-4).
3. REMOVE SCREW (16) AND LOCKWASHER (16) AND REMOVE ROOF ASSEMBLY.
4. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE LOWER LEFT HAND SIDE PANEL.
5. REMOVE OIL DRAIN BY LOOSENING HOSE CLAMP SCREW.
6. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE LOWER RIGHT HAND SIDE PANEL.
7. LOOSEN FLARE NUT (3) AND REMOVE TUBING.

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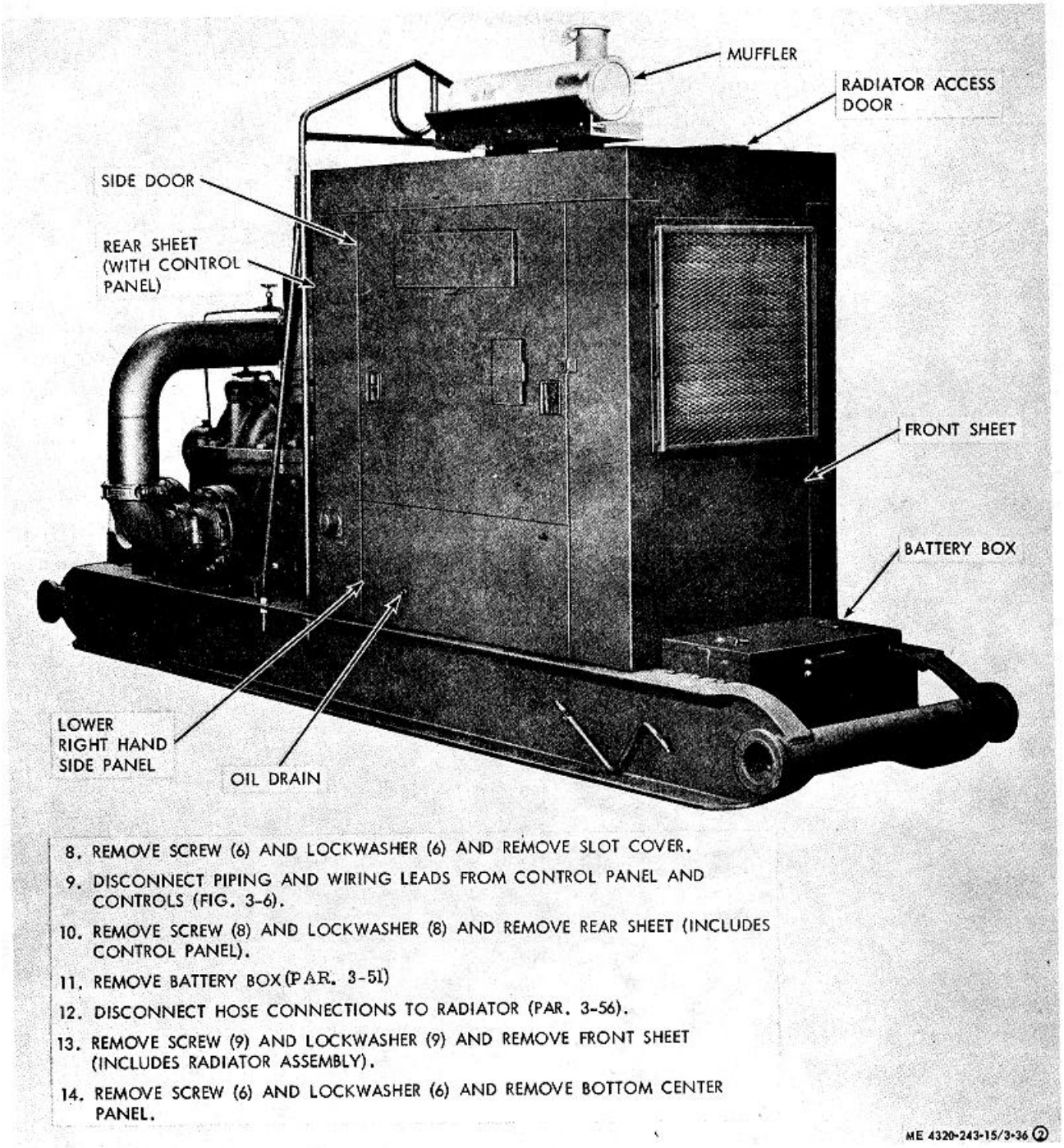
Figure 3-36. Housing, removal and installation.



8. REMOVE SCREW (6) AND LOCKWASHER (6) AND REMOVE SLOT COVER.
9. DISCONNECT PIPING AND WIRING LEADS FROM CONTROL PANEL AND CONTROLS (FIG. 3-6).
10. REMOVE SCREW (8) AND LOCKWASHER (8) AND REMOVE REAR SHEET (INCLUDES CONTROL PANEL).
11. REMOVE BATTERY BOX (PAR. 3-51)
12. DISCONNECT HOSE CONNECTIONS TO RADIATOR (PAR. 3-56).
13. REMOVE SCREW (9) AND LOCKWASHER (9) AND REMOVE FRONT SHEET (INCLUDES RADIATOR ASSEMBLY).
14. REMOVE SCREW (6) AND LOCKWASHER (6) AND REMOVE BOTTOM CENTER PANEL.

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Figure 3-36 --- Continued.

CHAPTER 4

DIRECT AND GENERAL SUPPORT AND DEPOT MAINTENANCE INSTRUCTIONS

Section I. GENERAL

4-1. Scope

These instructions are published for the use of direct and general support and depot maintenance personnel maintaining the Reiner Model GP 110-5 Centrifugal Pump. They provide information on the maintenance of the equipment which is beyond the scope of tools, equipment, personnel or supplies normally available to using organizations.

4-2. Record and Report Forms

For record and report forms applicable to direct and general support and depot maintenance, refer to TM 38750.

Note

Applicable forms, excluding Standard Form 46 which is carried by the operator, shall be kept in a canvas bag mounted on equipment.

Section II. DESCRIPTION AND TABULATED DATA

4-3. Description

For a complete description of the John Reiner Model GP 110-5 Centrifugal Pump refer to paragraph 1-3.

4-4. Tabulated Data

a. General. This paragraph contains all the overhaul data pertinent to direct and general support and depot maintenance personnel. A wiring diagram (fig. 1-5) will be found in chapter 1.

b. Tabulated Data.

(1) *General.* Refer to paragraph 1-4.

(2) *Engine.* Refer to paragraph 1-4.

(3) *Pump assembly*. Refer to paragraph 1-4.

(4) *Engine accessories*. Refer to paragraph 1-4.

c. Engine Repair and Replacement Standards. Table 4-1 lists manufacturer's sizes, tolerances, clearances, and the maximum allowable wear and clearance.

d. Pump Repair and Replacement Standards. The following data lists specifications and adjustments of rotating element assembly components.

(1) Concentricity between bore of bottom of the stuffing box and pump shaft, total indicated runout _0.010 in. max. (maximum)

(2) Face of stuffing box bottom squared to pump shaft, total indicated runout ..... 0.005 in. max.

(3) Bearing end cover to splash collar clearance at rear end with rotating element assembly moved maximum distance toward rear of pump ..... 0.0312 in.

(4) Bearing end cover to splash collar clearance at front end, with rotating element assembly moved maximum distance towards front of pump ..... 0.0312 in.

(5) Nominal clearance between bearing end covers and splash collars, with rotating element at center position in pump -0.0625 in.

(6) Mechanical seal, drive collar-to-gland clearance, front of pump ..... 0.125 in.

(7) Mechanical seal, drive collar-to-gland clearance, rear of pump ..... 0.125 in.

Table 4-1. Engine Repair and Replacement Standards

	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Maximum	Minimum	Maximum	Minimum	
VALVES					
Valve seat angle:					
Intake-45 °					
Exhaust-45					
Stem diameter:					
Intake	0.4335	0.4345	-----	-----	0.4315
Exhaust	0.4325	0.4335	-----	-----	0.4305
Stem-to-guide clearance:		-----			
Intake	-----		0.0008	0.0028	0.0048
			(0.002 desired)		
Exhaust	-----		0.0045	0.0065	0.0085
VALVE GUIDES			(0.005 desired)		
Length		3.000			
Outside diameter	0.745	0.755			
Stem hole diameter:					
Intake	0.4353	0.4363	-----	-----	0.4373
Exhaust	0.4380	0.4390	-----		0.4400
Distance from face of valve seat to valve guide:					
Intake	-----	1.625			
Exhaust	-----	1.8125			
VALVE SPRINGS					
Outside diameter:					
Outer spring	-----	1.820			
Inner spring	-----	1.655			
Length-valve closed:					
Outer spring	-----	2.117			
Inner spring	-----	1.867			
Load-valve closed:					
Outer spring	63 lb	71 lb	-----	-----	60 lb
Inner spring	35 lb	41 lb	-----	-----	34 lb
Length-valve open:					
Outer spring	-----	1.427			
Inner spring	-----	1.367			
Load-valve open:					
Outer spring	153 lb	167 lb	-----	-----	1601b
Inner spring	83 lb	94 lb	-----	-----	81 lb
TIMING GEARS					
Crankshaft gear-to-camshaft gear clearance	-----	-----	0.0015	0.002	0.003
CAMSHAFT					
Journal diameter (all)	2.122	2.1225	-----	-----	2.121
Bushing inside diameter (all)	2.1240	2.1245			
Bushing-to-journal clearance	-----	-----	0.0015	0.0025	
Camshaft end play	-----	-----	0.005	0.009	
PISTON RINGS					
Ring width:					
No. 1 compression	0.0925	0.0935	-----	-----	0.0905
No. 2 and No. 3 compression	0.1250	0.1240	-----	-----	0.1210
No. 4 oil	0.2480	0.2490	-----	-----	0.2460
Ring side clearance:					
No. 1 compression	0.0035	0.0055			
No. 2 and No. 3 compression	0.0025	0.0045			
No. 4 oil	0.002	0.004			
Ring gap clearance (all)	0.017	0.032			

Table 4-1. Engine Repair and Replacement Standards-Continued.

	Manufacturer's dimensions and tolerances in inches		Desired clearance		Maximum allowable wear and clearance
	Maximum	Minimum	Maximum	Minimum	
PISTONS					
Ring groove width:					
Top groove	0.097	0.098	-----	-----	0.100
Second and third	0.1265	0.1275	-----	-----	0.1295
Fourth groove	0.2510	0.2520	-----	-----	0.2540
Piston fit in cylinder bore on high side of piston:					
Clearance	-----	-----	-----	0.006	
Pounds pull	5 lb	10 lb			
Pinhole diameter	1.4995	1.4998			
PISTON PINS					
Piston pin length	4.433	4.438			
Piston pin diameter	1.4994	1.4996	-----	-----	1.4991
Pin-to-bushing clearance	-----	-----	0.0003	0.0008	
			(0 0005 desired)		
CONNECTING RODS					
Bushing hole diameter	1.6870	1.6880			
Finished inside diameter of bushing	1.4999	1.5002	-----	-----	1.5012
Bearing hole diameter	3.1505	3.1510			
CONNECTING ROD BEARINGS					
Thickness	0.0748	0.0753	-----	-----	0.0743
Bearing-to-journal clearance	-----	-----	0 002	0 004	0 0055
			(0 003 desired)		
Side play	----	-----	0 005	0 010	
			(0 006 desired)		
MAIN BEARINGS					
Thickness	0.1248	0.1253	-----	-----	0.1243
Diameter	3.2514	3.2534			
Bearing-to-journal clearance	-----	-----	0.0014	0.0044	
			(0.003 desired)		
CRANKSHAFT					
Main bearing journal diameter	3.249	3.250	-----	-----	3.247
Connecting rod bearing journal diameter	2.9974	2.9983			2.9964
End play	-----	-----	0.006	0.010	
CYLINDER ASSEMBLY					
Cylinder bore diameter	5.0000	5.0005			
Cylinder stroke	5.375				
Cylinder out-of-round:					
Top	-----	-----	-----	-----	0.001
Bottom	-----	-----	-----	-----	0.005
Cylinder taper:					
Top	-----	-----	-----	-----	0.001
Bottom	0.010				
Main bearing bore diameter	3.5020	3.5030			

CHAPTER 5

GENERAL MAINTENANCE INSTRUCTIONS

Section I. SPECIAL TOOLS AND EQUIPMENT

5-1. Special Tools and Equipment

No special tools or equipment are required by direct and general support and depot maintenance personnel for performing maintenance or major overhaul work on the centrifugal pump.

5-2. Specially Designed Tools and Equipment

No specially designed tools or equipment are required by direct and general support and depot maintenance personnel performing major overhaul work on the centrifugal pump.

Section II. TROUBLESHOOTING

5-3. General

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the pumping assembly or any of its components. Each trouble symptom stated is followed by a list of probable causes. The possible remedy recommended is described opposite the probable cause.

5-4. Poor Engine Compression

Probable cause	Possible remedy
Valves holding open-no tappet clearance.	Adjust valves (para 3-36).
Leaky cylinder head gasket.	Replace gasket (fig. 7-13).
Broken or weak valve springs.	Replace springs (fig.7-13).
Badly worn, broken or stuck piston rings.	Replace rings (fig. 7-26).

5-5. Low Engine Oil Pressure

Probable cause	Possible remedy
Dirt in relief valve or broken spring.	Clean valve or replace spring (fig. 7-13).
Worn bearings	Replace bearings (fig. 7-55).
Worn or damaged oil pump gears	Repair or replace oil pump (para 7-38).
Worn cam bushings	Replace bushings (para 7-56).

5-6. High Engine Oil Consumption

Probable cause	Possible remedy
Worn or broken piston rings.	Replace rings (fig. 7-76).
Worn pistons and sleeves	Replace pistons and sleeves (fig. 7-26).
Worn bearings	Replace bearings (para 7-55).

5-7. Engine Knocks or Develops Excessive Noise

Probable Cause	Possible remedy
Worn or burned-out main bearings.	Replace bearings (para 7-55).
Worn or burned-out connecting rod bearings.	Replace bearings (para 7-53).
Loose piston	Replace piston (para 7-54).
Broken piston ring or pin.	Replace piston or pin para 7-54).
Burned valves and seats	Replace valves or seats (fig. 7-13).
Weak or broken valve springs.	Replace springs (fig.7-13).
Tappet noise	Adjust valves (para 3-36).
Worn camshaft	Replace camshaft (para (7-46).
Misalinement of engine	Aline engine (fig. 6-3).
Faulty vibration damper	Replace vibration damper (para 7-42).

5-8. Pump Fails to Discharge, Capacity Decreases or Pressure Drops

Probable Cause	Possible remedy
Impeller damaged d or broke"	Replace impeller (fig 6-7)
Seal assembly defective.....	Replace seal assembly (fig 6-7)
Housing cracked or defective	Replace housing (fig. 6-3).

5-9. Pump Vibrates or Develops Excessive Noise

Probable Cause	Possible remedy
Impeller damaged or broken	Replace impeller (fig. 6-7
Defective impeller shaft bearing	Replace bearing (fig 6-7

Section III. RADIO INTERFERENCE SUPPRESSION

5-10 General

Information on radio interference suppression methods and components will be found in Chapter 3, Section VI, of this manual.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS

5-11. General

The gasoline engine and the centrifugal pomp are mounted d on a welded-steel skid. The front of the engine is supported by a trunnion bracket which is bolted to an engine support mounted on the skid. The rear of the engine is supported d by flywheel housing b bolted directly to the skid. The pump is secured to the skid at the four corners of the pump bottom ease. The engine is e connected to the pump by a flexible steel grid that joins the engine coupling half to the pump coupling half. The engine and pump have b en aligned at the factory and no further alignment is necessary unless the engine or the pump is replaced.

5-12. Housing Assembly Remove and I install as directed in paragraph 3-65

Remove and install as directed in paragraph 3-65.

5-13. Engine a Remove the engine as follows:

a. Remove the engine as follows:
(1) Remove battery box (para b 511.
(2) Remove muffler (fig 2-2).
(3) Disconnect gages and instruments fig. 3 6).
(4) Remove housing assembly (para b 65)
(5) Drain the radiator (para a-A i)
(6) Disconnect radiator hoses (fig 7-7).

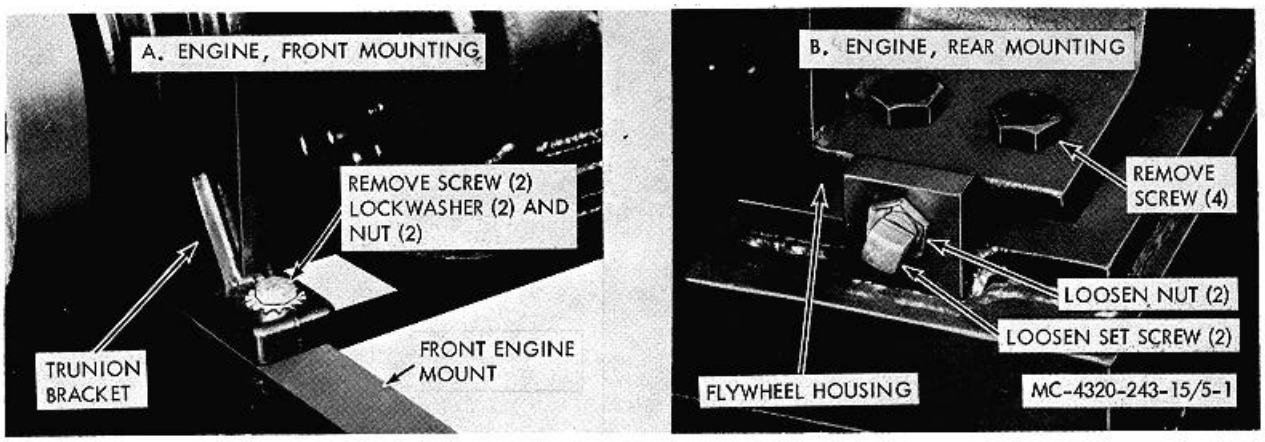


Figure 5-1. Engine, removal and installation.

(7) Drain the oil from the crankcase.

(8) Close the fuel shutoff ,valve on the fuel tank (fig. 3-17) and disconnect the fuel line at the fuel filter (fig. 3-17).

(9) Detach the engine coupling from the pump coupling as shown by figure 6-5.

(10) Remove the engine (fig. 5-1).

b. Install the engine following above steps in reverse.

5-14. Pump

a. Remove the pump as follows:

(1) Detach the pump coupling from the engine coupling (fig. 6-5).

(2) Remove all tubing and valves on the pump.

(3) Remove pump (fig. 5-2).

b. To install pump, follow above steps in, reverse.

5-15. Pump Alinement

a. Check gap, angular and offset misalignment (para 6-5).

b. If misalinement exists it can be corrected by shimming or adjusting the aligning screws on either the pump side, the engine side or both (fig. 5-3).

Note

When replacing the engine or the pump ensure that existing shims are left in place or replaced exactly as they were before. This will expedite pump alinement.

c. After alinement has been ascertained tighten screws (fig. 5-3) and check alinement and gap once again (para 6-5).

d. Install coupling hubs as shown in figure 6-5.

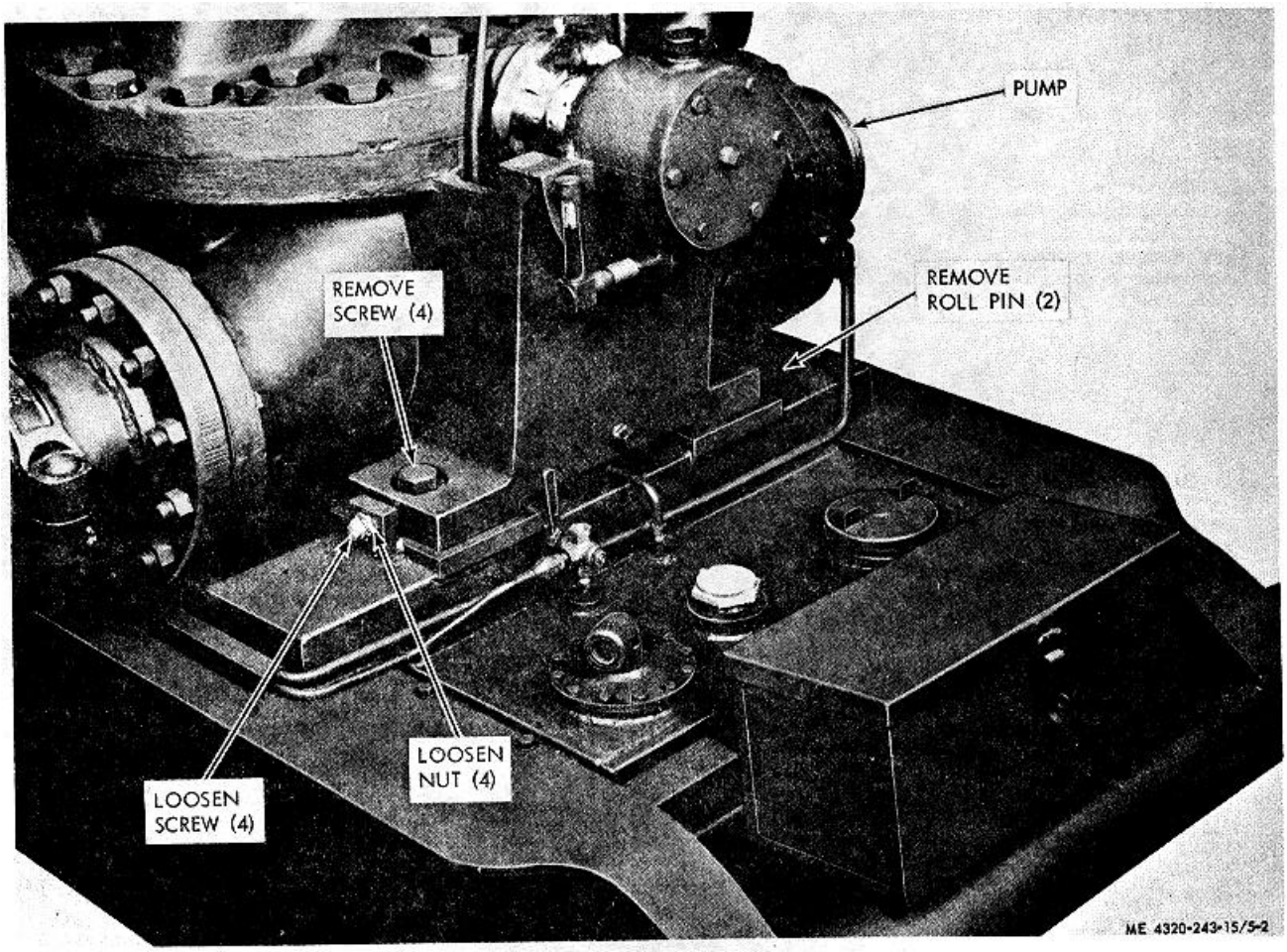


Figure 5-2. Pump, removal and installation.

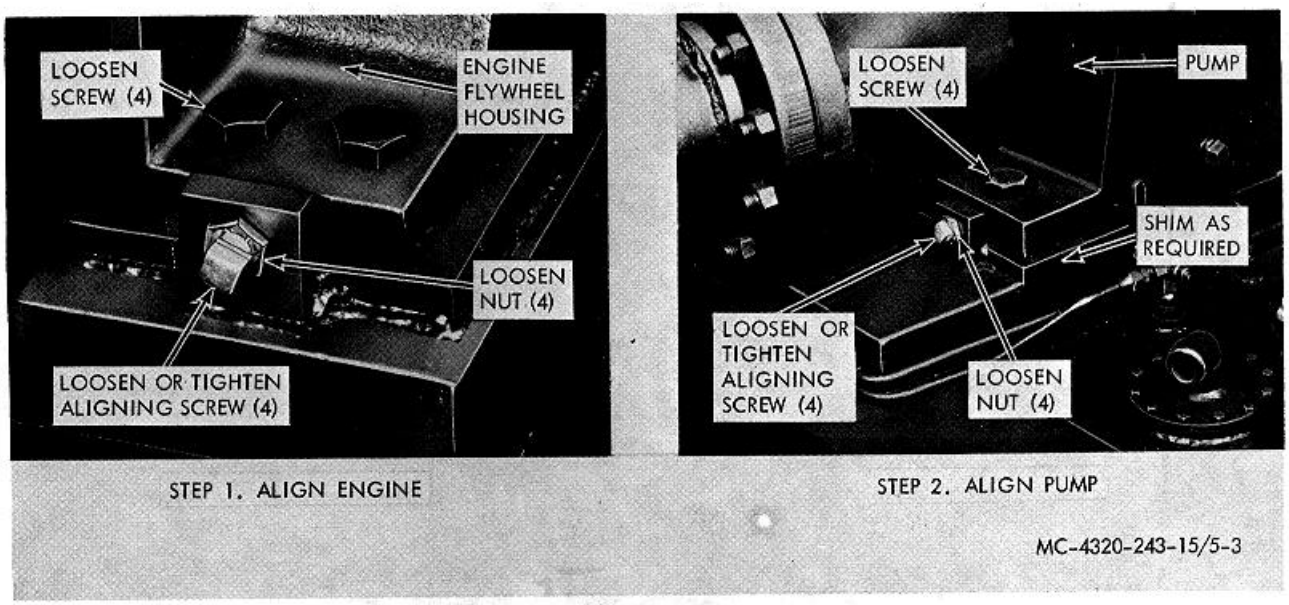


Figure 5-3. Engine and pump alinement.

CHAPTER 6

PUMPING ASSEMBLY REPAIR INSTRUCTIONS

Section I. GENERAL

6-1. Description

This section covers the components of the pump assembly. Refer to Chapter 7 for engine repair instructions. The two-stage centrifugal pump has an upper case and bottom case of cast iron that serves as a cover and mounting for the rotating element assembly. The bottom case is mounted on the skid assembly and has 2 suction flanges on the left side and 2 discharge flanges on the right side. Within the upper and bottom cases are chambers to direct the flow and maintain the pressure of petroleum through the pump. The engine drives the rotating element assembly by a coupling. The engine coupling is keyed to the accessory drive shaft. The pump coupling is keyed to the pump shaft. Two flexible tapered grids, set in grooves in each coupling half, connect the engine and pump. The two outer cover halves are connected by eight bolts and nuts. The first and second stage impellers of the rotating element assembly increase the pressure and maintain the flow of petroleum through the pump.

The low-and high-pressure switches are mounted on the instrument panel box. Both switches automatically protect the pump from possible damage of abnormal operating pressures. If the pump discharge pressure falls below, or rises above the preset ranges of the pressure switches, an electrical circuit is closed in the affected pressure switch. This activates the carburetor solenoid which reduces engine rpm to idling speed.

Section II. PUMP ASSEMBLY COMPONENTS

62. High and Low Pressure Switches

a. Remove and install the high and lowpressure switches (fig. 6-1) located on the side of the instrument control panel as follows:

(1) Place the safety switch located on the instrument panel in the "off" position. This will disconnect voltage from the pressure switches.

(2) Remove the pressure switch cover and disconnect the two leads from the switch.

(3) Disconnect the copper tubing from the switch bellows housing and remove the nut from the nipple containing the switch leads.

(4) Remove the screws, nuts, and washers holding the switch housing to the control panel and remove the switch.

(5) Install in reverse order.

b. Clean and inspect.

c. Adjust the low pressure switch as follows.

(1) Tag and remove the leads from the switch terminals.

(2) Disconnect the tubing from the switch pressure connection and connect the switch to a source of pressure that can be varied between zero (0) and 150 psi.

(3) Connect a test lamp circuit between the common and normally closed terminals on the switch. The lamp should light.

(4) To adjust the switch for series operation of the pump, slowly raise the pressure on the switch to 110-120 psi. The lamp should go out. If the lamp goes out before reaching 110 psi, turn the adjustment nut (fig. 6-1)

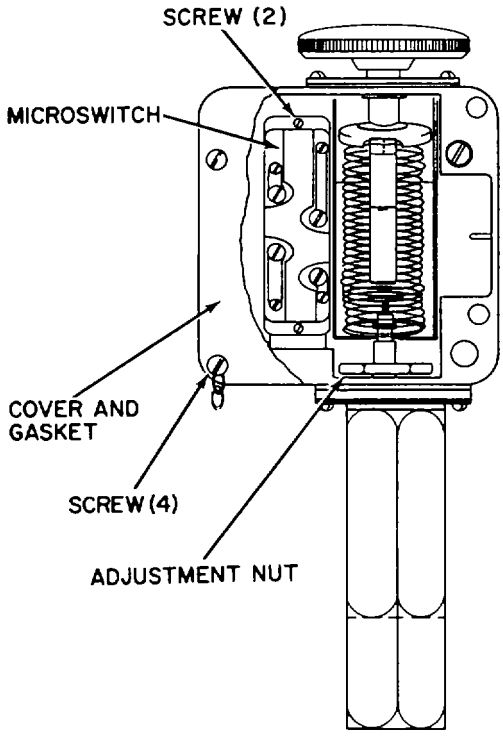


Figure 6-1. Pressure switch.

clockwise to increase the setting of the switch. If the lamp does not light between 110-120 psi, turn the adjustment nut counterclockwise to decrease the setting.

(5) Slowly decrease the pressure on the switch until the lamp lights. The lamp should light at 100 + 3 psi, on a decreasing pressure. If the lamp does not light at 100 + 3 psi, turn the adjustment nut clockwise to increase or counterclockwise to decrease the setting.

(6) Repeat steps (4) and (5) until the lamp will light at 100 + 3 psi, on a decreasing pressure.

(7) To adjust the switch for parallel operation of the pump follow steps (1) through (6) except adjust the switch to light the lamp at 55 + 3 psi on a decreasing pressure.

d. Adjust the high pressure switch (fig. 61) as follows:

(1) Tag and remove the leads from the switch terminals.

(2) Disconnect the line from the switch pressure connection and connect the switch to a source of pressure that can be varied between zero (0) and 300 psi.

(3) Connect a test lamp circuit between the common and normally open terminals on the switch, The lamp should not light.

(4) To adjust the switch for series operation of the pump, slowly raise the pressure on the switch to 250 + 3 psi. The lamp should light. If the lamp does not light, slowly turn the adjusting nut (fig. 6-1) counterclockwise to decrease the setting, and cause the lamp to light. Turning the adjustment nut clockwise will increase the setting.

(5) After making an adjustment, slowly decrease the pressure until the lamp goes out, and then repeat step (4).

(6) Repeat steps (4) and (5) until the lamp will light at 250 + 3 psi on an increasing pressure.

(7) To adjust the switch for parallel operation of the pump, follow steps (1) through (6) except adjust the switch to light the lamp at 125 + 3 psi on an increasing pressure.

6-3. Throttle Solenoid.

a. The throttle solenoid is wired in series to the high and low-pressure switches and is also connected to the carburetor throttle valve. Excessively high or low discharge pressure will activate the pressure switches, thus tripping the throttle solenoid to idle the engine.

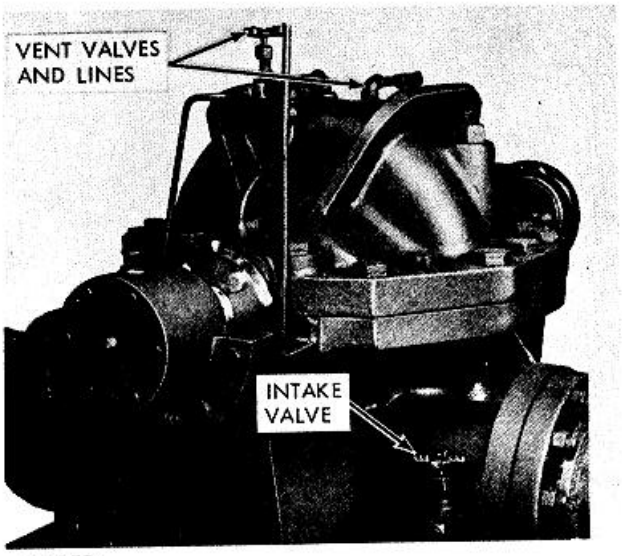
b. Remove and install the throttle solenoid as shown by figure 3-14.

6-4. Upper Case.

a. Remove and install the vent line, valves, and fluid lines from the upper case as shown by figure 6-2.

b. Remove and install the upper case and casing studs in sequence shown by key numbers in figure 6-3.

c. During installation of the upper case, tighten fastening bolts in sequence shown by key numbers in figure 6-4.



ME 4320-243-15/6-2

Figure 6-2. Vent, discharge and intake valves, and lines, removal and installation.

d. Clean, inspect, and repair.

6-5. Pump Coupling

a. General. The tapered-grid flexible coupling connecting the engine shaft and pump shaft (fig. 6-5) utilizes a spring-steel grid coupling member to absorb engine vibrations. The performance and life of this coupling depend on proper installation and servicing.

b. Disassembly. Unbolt and slide the covers away from the coupling hubs as shown in figure 6-5. To remove the grid, use a found rod or pry-bar that will fit conveniently into the open loop ends, and pry grid out radially in gradual stages. Proceed alternately from side to side, lifting each loop about halfway out of its slot until the end of the grid is reached. Follow the same procedure once again and the grid will clear the teeth.

c. Reassembly.

(1) Place hub covers and seals on shaft before mounting hubs. Press or shrink each hub on its respective shaft so that the hub face is flush with the shaft end (fig. 6-5).

(2) Check gap and angular alignment with a spacer bar. Gap should be exactly 1/8 inch between the hubs as measured at 90° intervals.

(3) Check offset alinement. Aline shafts so that a straightedge will rest squarely on both hubs at the top and also at 900 on either side.

(4) After coupling hubs are alined (para 5-15) insert gasket through gap and hang it on either shaft. Pack gap and grooves with lubricant before inserting grid.

(5) Insert grid. It is necessary to spread the grid slightly to pass over the coupling teeth at the outside diameter: to minimize this spreading, start grid at either end and tap into place rung by rung. Do not attempt to force grid to the bottom of the groove; it will seat readily after all rungs are positioned. Pack spaces around grid with as much lubricant as possible in accordance with current lubrication order. Wipe off excess flush with top of grid.

(6) Place seals on cover halves and slide onto hubs. Installation will be easier if lube plugs are not in place, so as to allow trapped air to escape. Position covers with lube holes 180° apart and bolt gasket and cover halves together, as shown in figure 6-5.

(7) With both lube plugs removed, insert fitting and fill with grease in accordance with current lubrication order until an excess appears at the other opening, then install the lube plugs.

6-6. Rotating Element Assembly and Mechanical Seal

a. Remove and install the upper case (para 6-4, above).

b. Remove and install the pump coupling as directed in paragraph 332.

c. Remove and install the rotating element assembly as shown by figure 6-6.

d. Disassemble the rotating element assembly in sequence shown by key numbers in figure 67. Reassemble in reverse sequence.

e. Disassemble the mechanical seal in sequence shown by key numbers in figure 6-8. Reassemble in reverse sequence.

f. Clean, inspect, and repair.

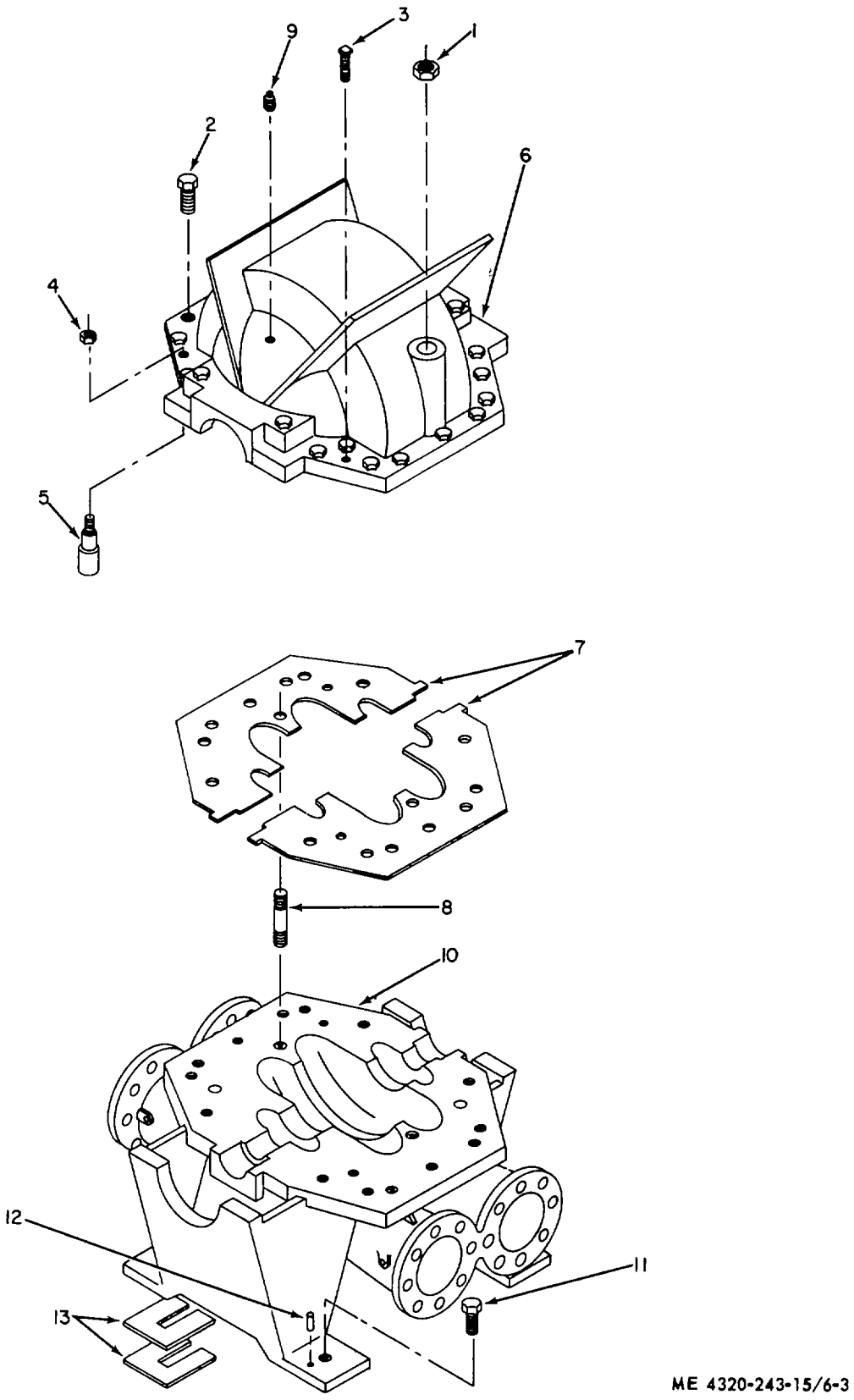


Figure 6-3. Upper and lower case studs, removal and installation.

1. Nut (2)
2. Bolt (19)
3. Setscrew (2)
4. Nut
5. Pin
6. Upper case
7. Gasket
8. Stud (2)
9. Plug
10. Bottom case
11. Bolt (4)
12. Roll pin
13. Shims (as required)

Figure 6-3-Continued.

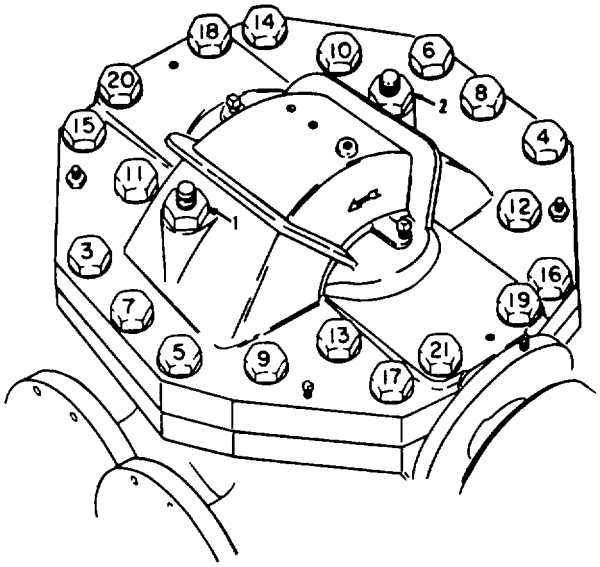


Figure 6-4. Upper case, nut and screw tightening sequence.

g. Adjust the splash collar and mechanical seal during the installation of the rotating element assembly in sequence shown by key numbers in figure 6-9.

6-7. Bottom Case

a. Remove and install the pump coupling and rotating element assemblies as directed in paragraphs 6-5 and 6-6, above.

b. Remove and install the bottom case and shims as shown in figure -3.

c. Clean, inspect, and repair.

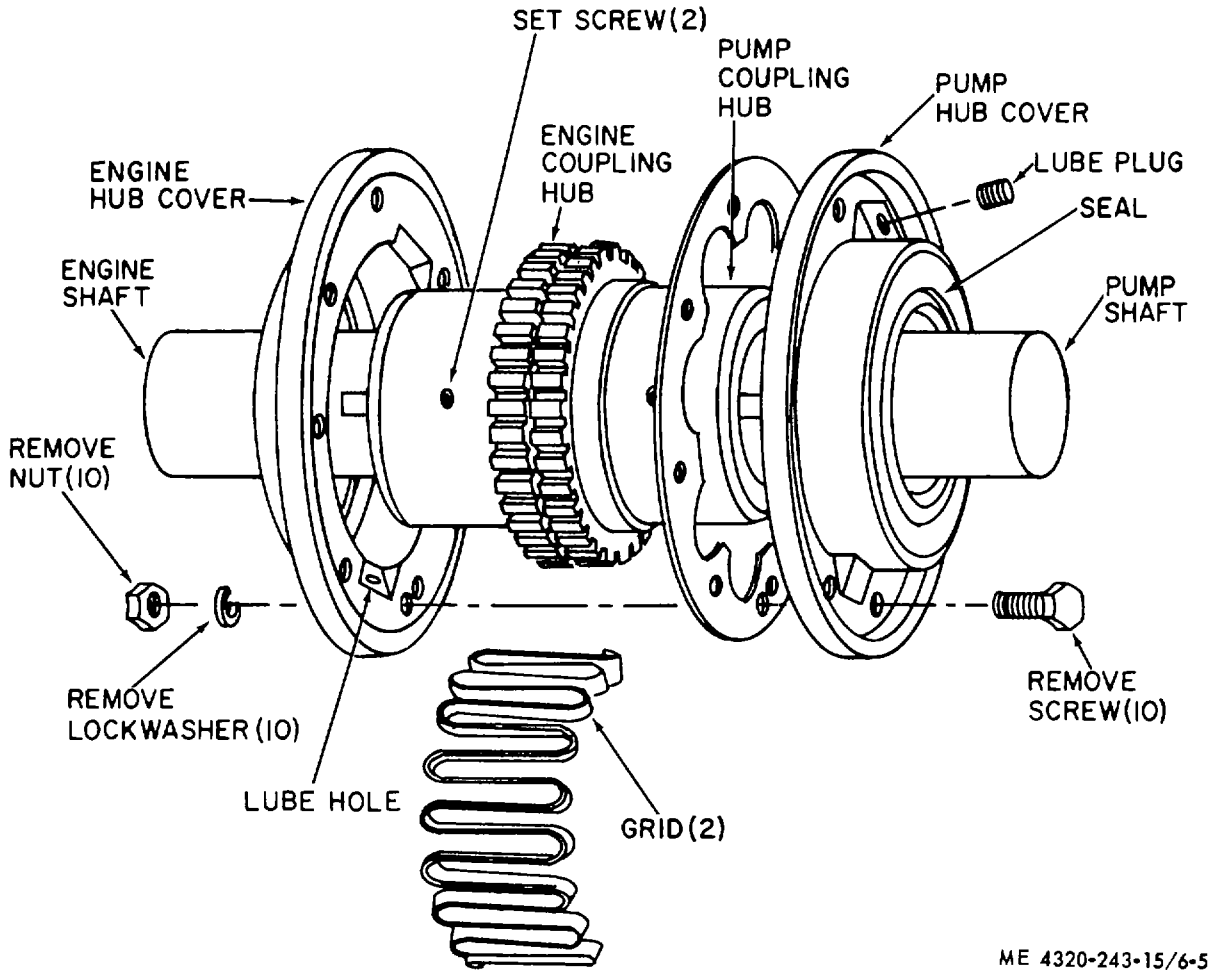


Figure 6-5. Flexible drive coupling, alinement, assembly and disassembly.

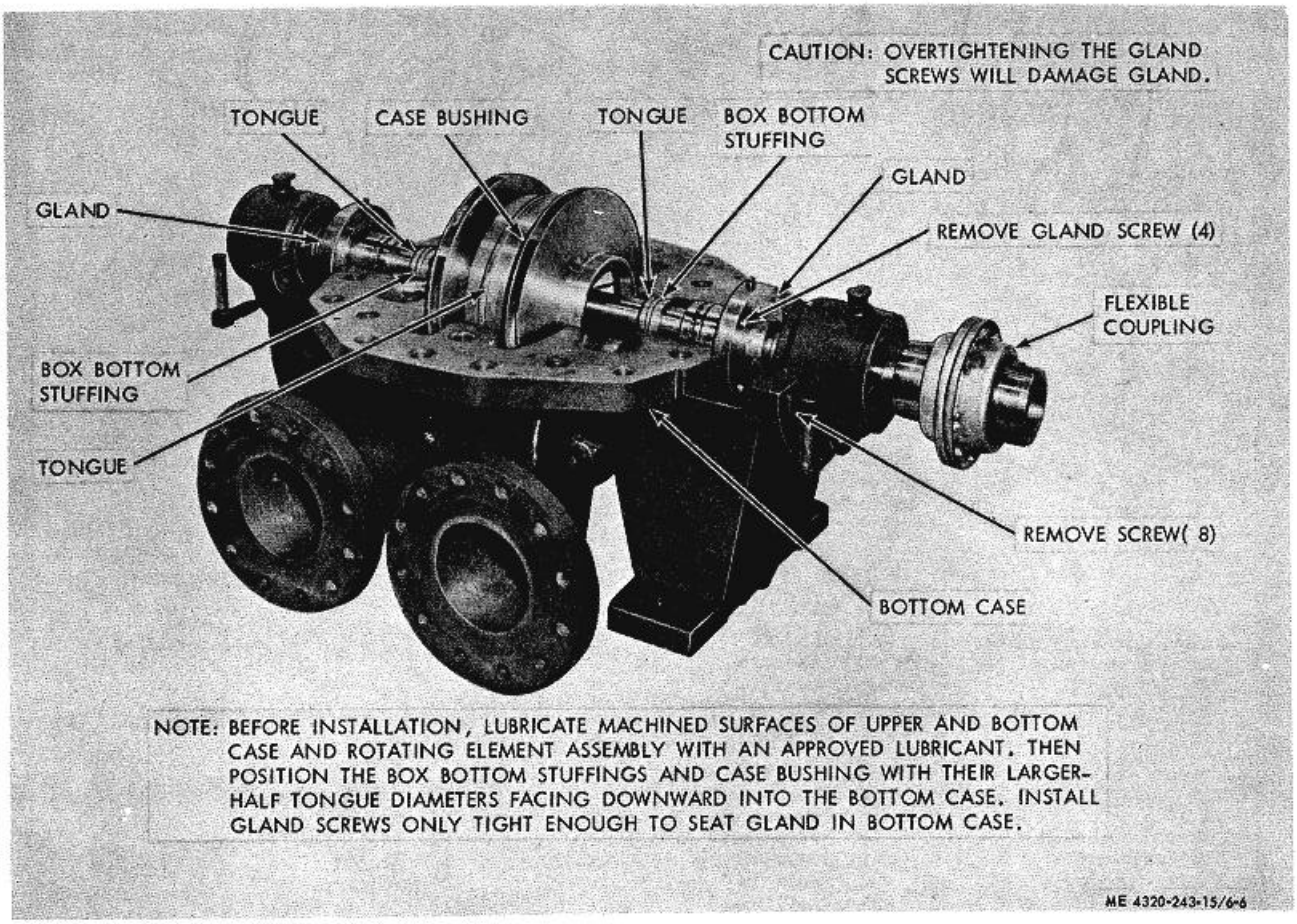
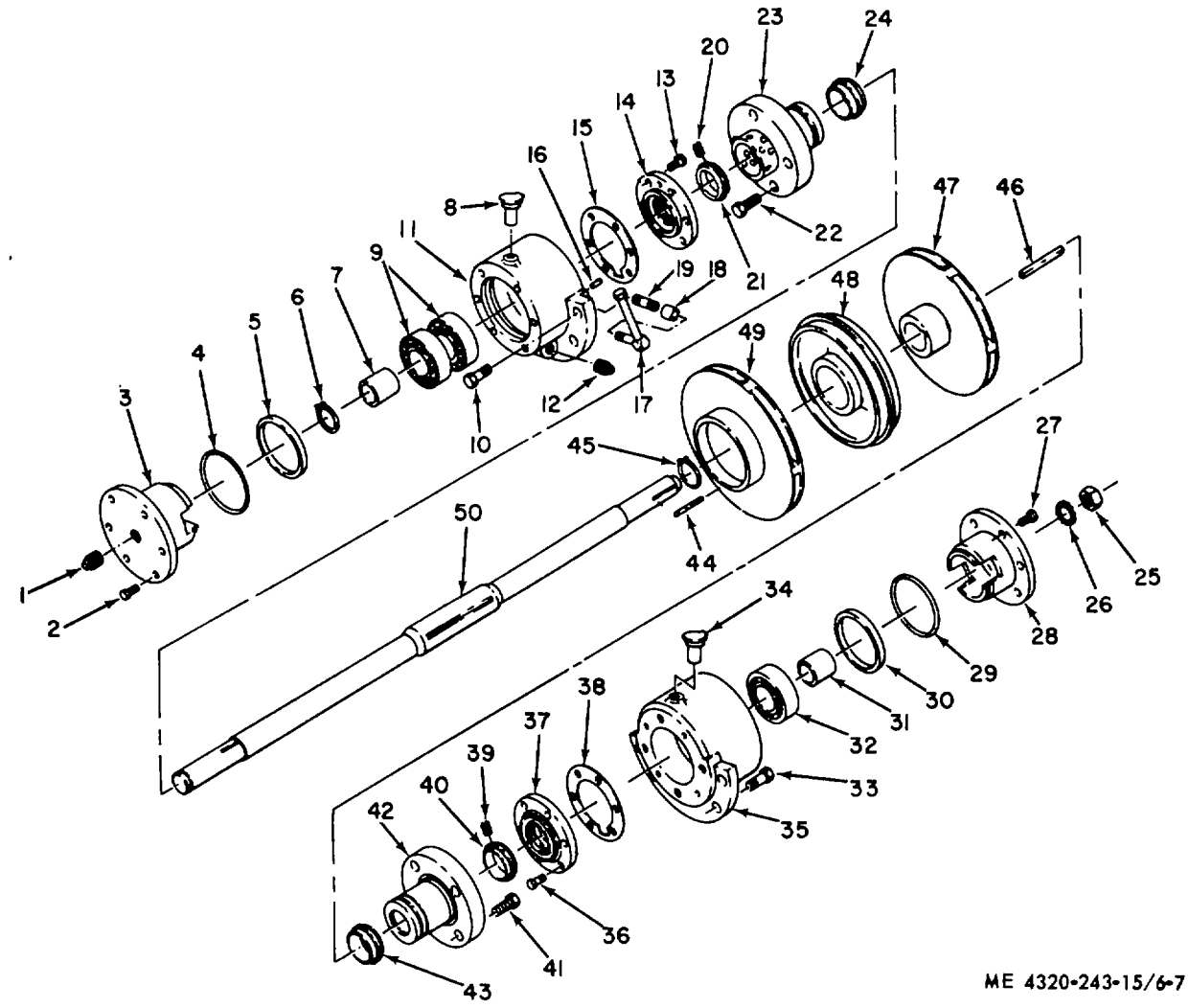
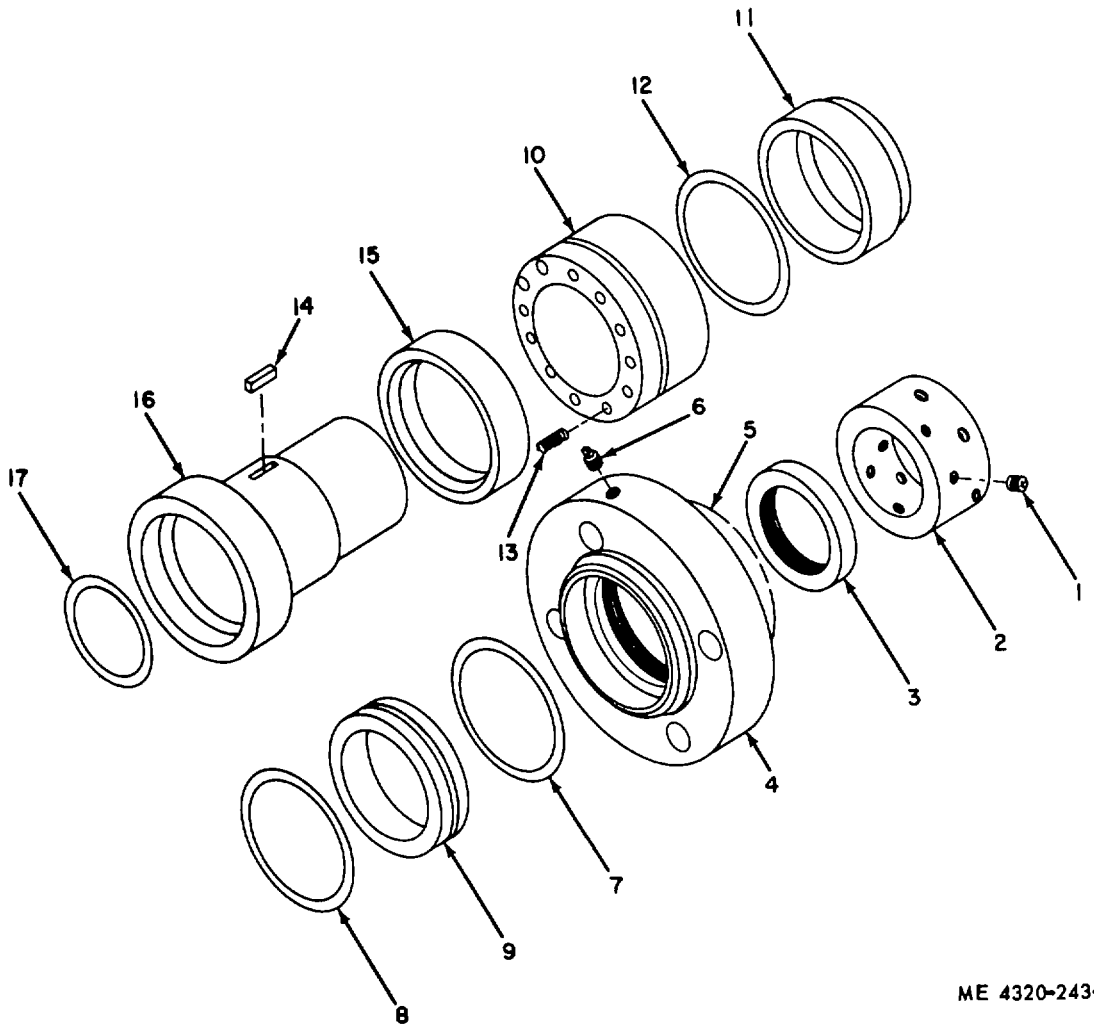


Figure 6-6. Rotating element, removal and installation.



1	Plug	18	Pipe covering	35	Bearing housing
2	Screw (6)	19	Pipe nipple	36	Screw (6)
3	End cover, outboard	20	Setscrew	37	End cover (coupling)
4	O-Ring (outboard)	21	Splash collar	38	Gasket
5	Oil ring	22	Screw (4)	39	Setscrew
6	Retaining ring	23	Shaft seal	40	Splash collar
7	Oil ring carrier	24	Stuffing box	41	Screw
8	Oil hole cover	25	Nut	42	Shaft seal
9	Ball bearings	26	Washer	43	Stuffing box
10	Screw (4)	27	Screw	44	Key
11	Bearing housing	28	End cover (coupling)	45	Retainer ring
12	Plug	29	O-Ring (coupling)	46	Impeller shaft key
13	Screw (6)	30	Oil ring	47	First stage impeller
14	End cover (inboard)	31	Oil ring carrier	48	Case bushing
15	Gasket	32	Ball bearing	49	Second stage impeller
16	Roll pin	33	Screw (4)	50	Shaft
17	Oil gage	34	Oil hole cover		

Figure 6-7. Rotating element assembly, disassembly and reassembly.



1 Setscrew (21)
2 Drive collar
3 Gland bushing
4 Gland
5 Rubber spacer
6 Plug
7 O-Ring
8 O-Ring
9 Floating seat
10 Retainer
11 Washer
12 O-Ring
13 Spring (12)
14 Drive key
15 Spring holder
16 Sleeve
17 O-Ring

Figure 6-8. Mechanical seal, disassembly and reassembly.

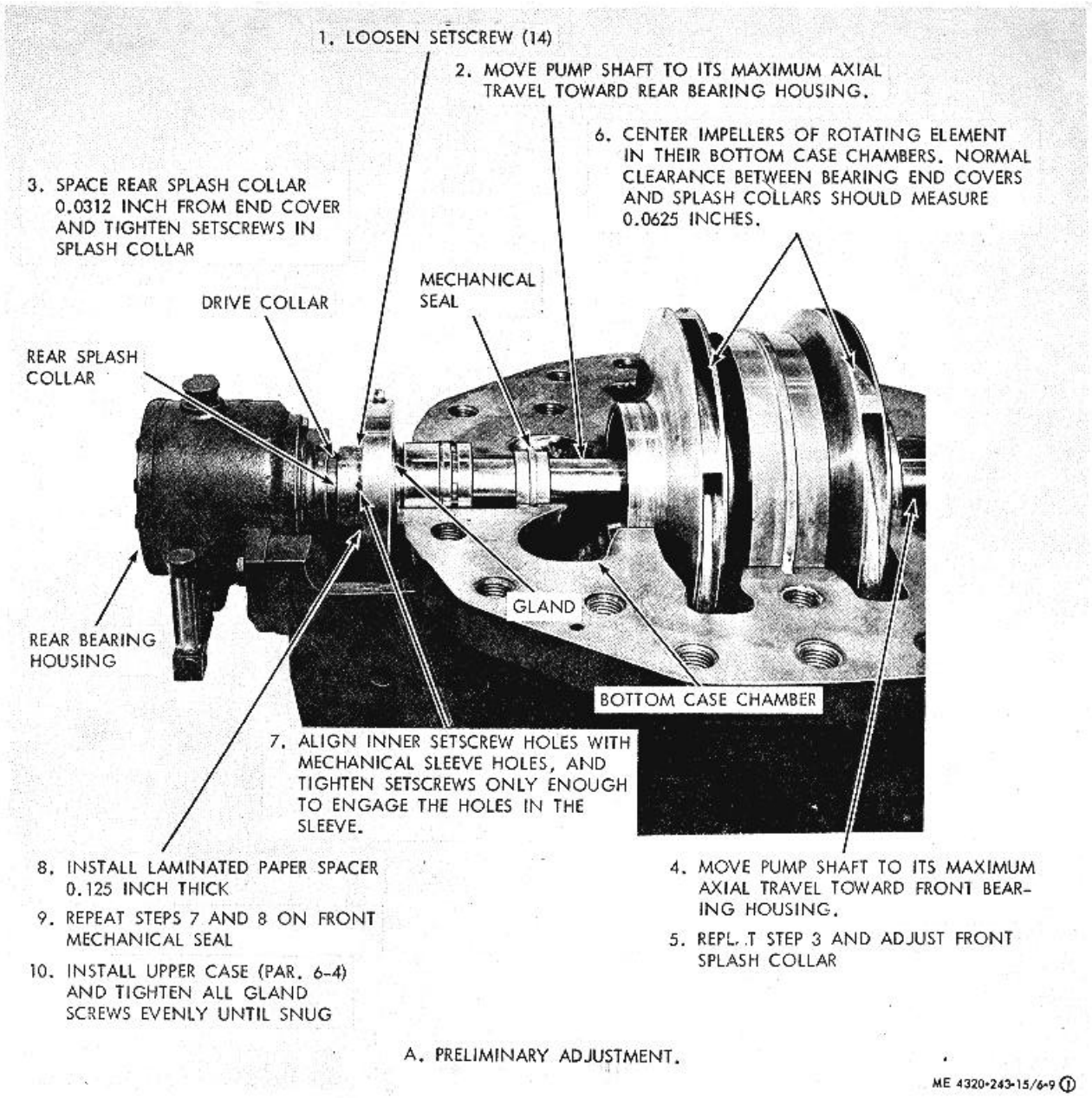


Figure 6-9. Splash collar and mechanical seal adjustment sequence.

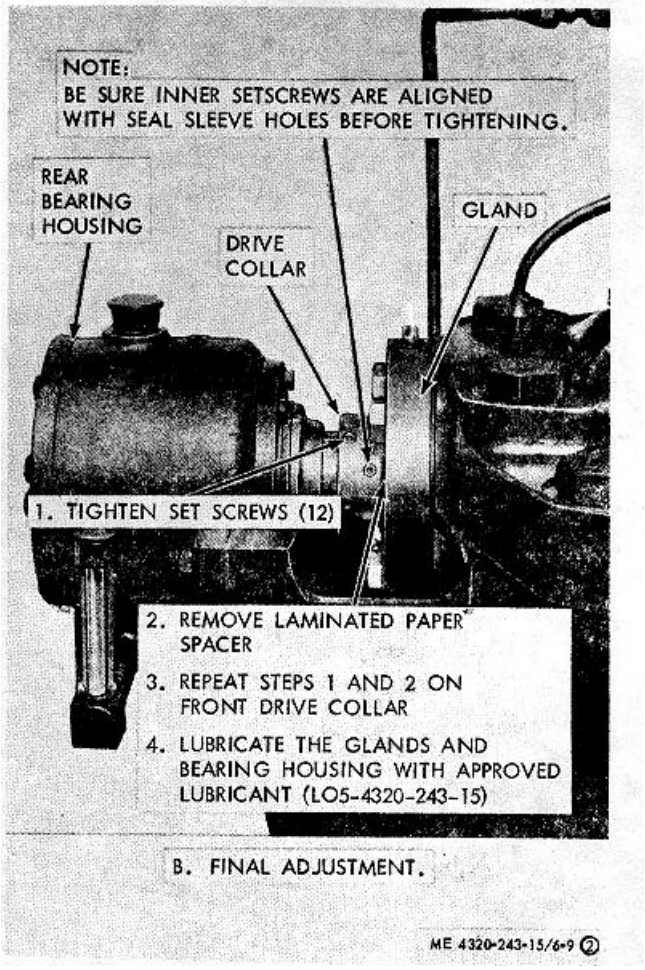


Figure 6-9-Continued.

CHAPTER 7
ENGINE REPAIR INSTRUCTIONS

Section I. GENERAL

7-1. Description

The Continental Engine Model RS 633 is a 6-cylinder, 4-stroke/cycle, overhead-valve, liquid-cooled gasoline engine, developing 142 rated horsepower at 2,200 rpm. Major components located on the engine are the governor, carburetor, starter, oil filters, magneto, generator, and fuel pump.

Manufacturer's tabulated data on the engine will be found in chapter I, section II.

Section II. CARBURETOR

7-2. General

The updraft-type carburetor, with duplex float, is of the double-venturi design to aid in complete vaporization of fuel. The power jet and accelerating pump systems are operated by the engine vacuum.

7-3. Disassembly and Reassembly

Disassemble the carburetor as shown in figures 7-1 and 7-2, in sequence indicated by the key numbers. Reassemble in the reverse sequence.

Note. Do not remove the throttle shaft bushings from the throttle body unless they are worn. See paragraph 7-4h.

Caution

Do not pull, twist, or apply pressure on the float bodies. To adjust the distance between the float bodies and the machined surface, apply pressure with long nosed pliers on the float lever close to the float body.

Note

Adjust the float 2 1/64 inches + 1/32 inch from the bottom of the float to the machined surface of the cover.

7-4. Cleaning, Inspection, Repair

a. Clean all parts in an approved solvent; then blow dry with compressed air.

b. Blow out all passages in the throttle body and fuel bowl with compressed air.

Note

Remove all deposits from the throttle bore and idle port.

c. Inspect the float for a badly worn shaft bearing or wear on the top side of the float lever, where it contacts the fuel valve. Shake the floats to determine if gasoline has leaked inside.

d. Inspect the throttle plate for burrs or damaged edges.

e. Inspect the choke plate for bends, burrs, or damaged edges.

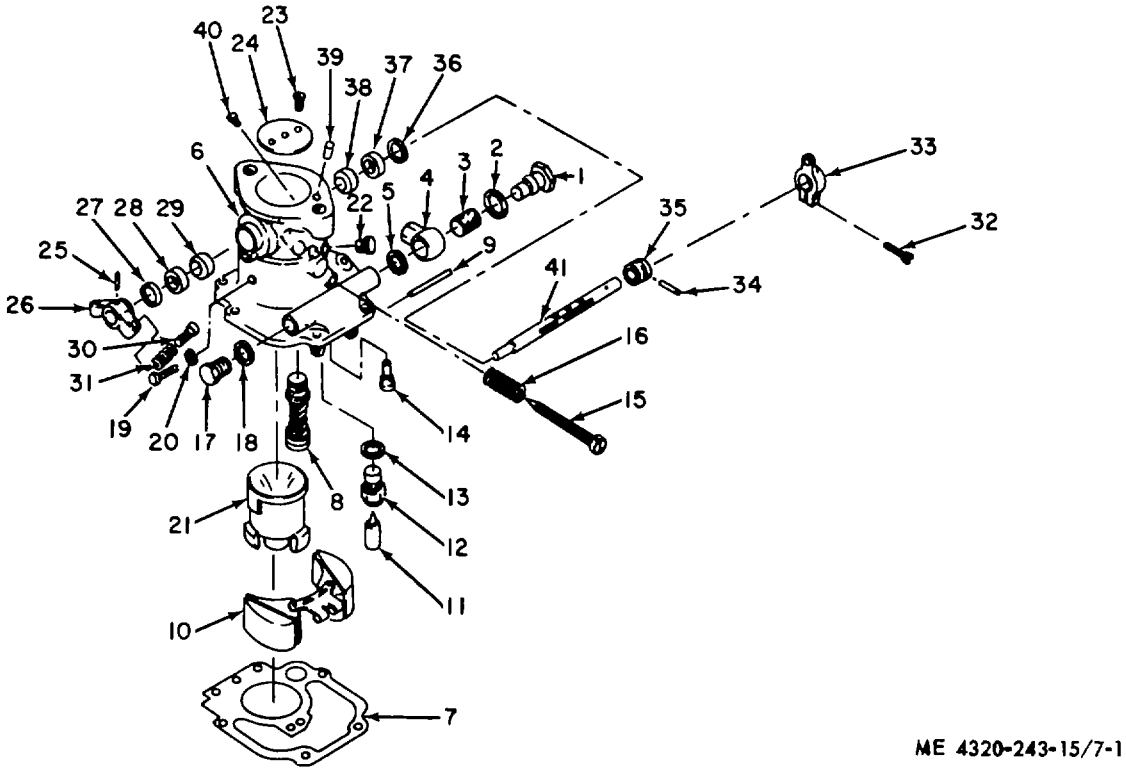
f. Inspect the choke shaft for straightness and the bearing surfaces for wear.

g. Inspect the vacuum pump cylinder in the throttle body for excessive wear, deep scratches, ridges, or scoring of the vacuum pump cylinder head. Reassemble the vacuum pump into the vacuum pump cylinder. Inspect the clearance at the upper operating end. Desirable clearance is 0.001 inch. Maximum allowable clearance is 0.003 inch. Clearance in excess of 0.003 inch will allow air or fuel to be discharged into the manifold through the vacuum package, and result in poor performance of the idling jet, power jet, and vacuum pump.

h. Inspect the throttle shaft for excessive wear on the bearing surfaces.

Caution

Side play of the throttle shaft in excess of 0.005 inch, due to worn throttle



1	Filter plug	15	Idle adjust needle	29	Bushing
2	Washer	16	Idle needle spring	30	Screw
3	Filter plug screen	17	Plug	31	Spring
4	Fuel union body	18	Washer	32	Screw
5	Washer	19	Venturi screw	33	Carburetor lever
6	Throttle body	20	Washer	34	Spacer pin
7	Gasket	21	Venturi	35	Throttle lever spacer
8	Pump	22	Pipe plug (3)	36	Shaft seal retainer
9	Float axle	23	Throttle plate screw (3)	37	Throttle plate seal
10	Float	24	Throttle plate	38	Shaft-throttle bushing
11	Fuel valve	25	Pin	39	Vacuum channel screw
12	Fuel valve seat	26	Stop-throttle lever	40	Screw
13	Washer	27	Retainer	41	Throttle shaft
14	Idle jet	28	Throttle plate seal		

Figure 7-I. Carburetor, assembly and disassembly.

shaft buildings will allow dirt or grit to pass into the engine and result in excessive wear of the rings, pistons, and cylinders.

i. Inspect the vacuum pump cylinder, located in the fuel bowl, for excessive wear or deep scratches. Reassemble the vacuum pump into the vacuum pump cylinder. Inspect the clearance at the lower operating end. Desirable clearance is 0.001 inch. Maximum allowable clearance is 0.003 inch. Clearance in excess of 0.003 inch will reduce accelerating pump discharge and result in poor acceleration.

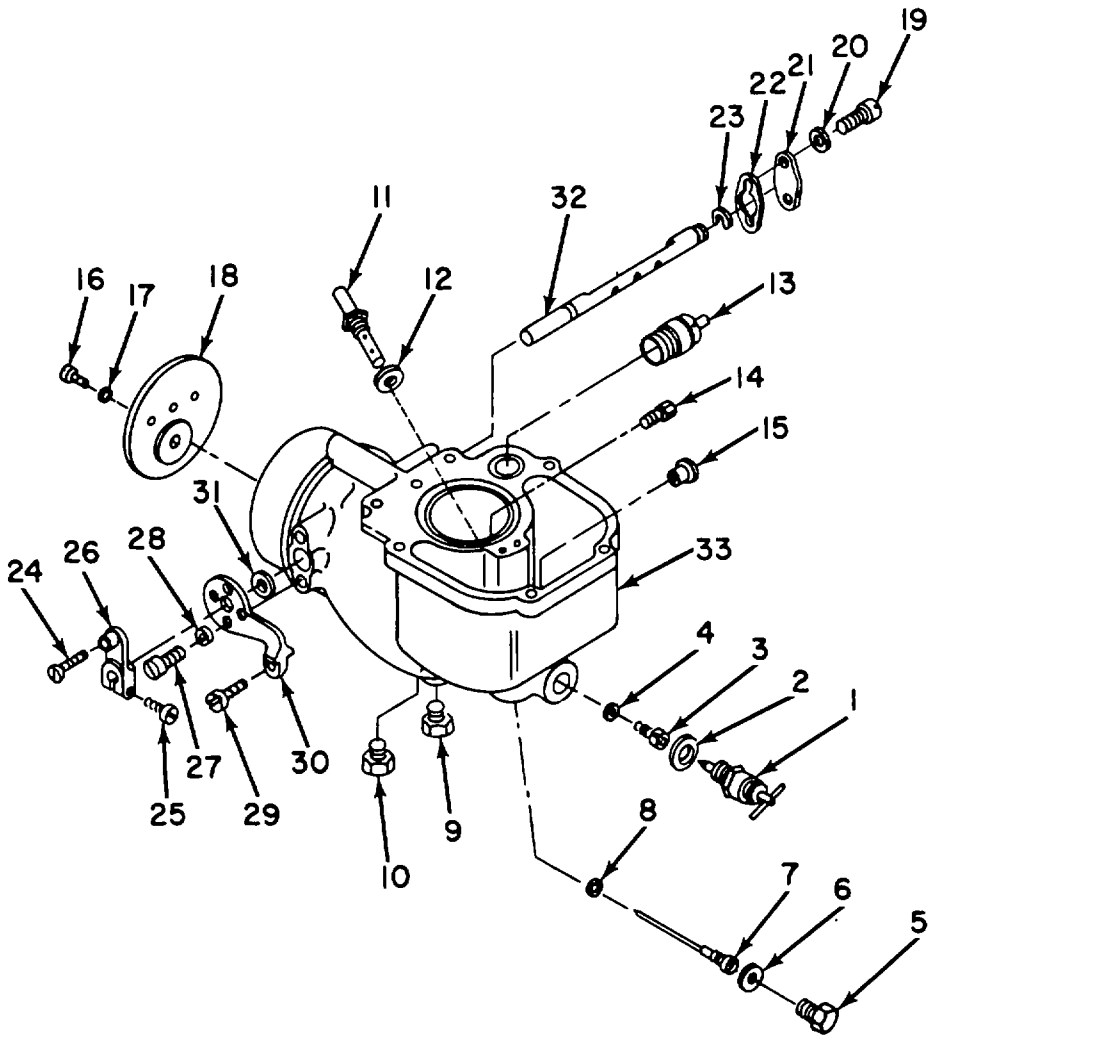
j. Inspect all parts for pitts, burrs, and excessive wear.

k. Replace all defective parts.

l. Replace all gaskets and fiber washers.

m. Replace an unserviceable carburetor.

n. Adjust the carburetor after installation (para 3-40).



1	Adjustment	12	Washer	23	Washer
2	Washer	13	Vent wall jet	24	Screw
3	Jet	14	Power jet valve	25	Screw
4	Washer	15	Pump check valve	26	Lever
5	Plug	16	Screw (3)	27	Screw
6	Washer	17	Washer (3)	28	Washer
7	Jet	18	Choke plate	29	Screw
8	Washer	19	Screw (2)	30	Bracket
9	Pipe plug	20	Washer (2)	31	Washer
10	Pipe plug	21	Choke shaft cover plate	32	Shaft
11	Main discharge jet	22	Choke cover plate gasket	33	Fuel bowl

Figure 7-2. Carburetor, assembly and disassembly.

Section III. GOVERNOR

7-5. General

The governor is mounted to the front of the timing gear cover and driven by the camshaft. The centrifugal-type governor mechanically controls preset engine speeds selected from a range of 1,200 to 2,100 rpm. Centrifugal force developed by the governor moves the speed change lever towards the closed throttle position. This movement is opposed by the governor spring until the centrifugal force and spring

tension are in balance. The throttle is then in position to maintain the desired engine rpm.

7-6. Disassembly, Reassembly, and Repair

a. Remove and install the governor as directed in paragraph 3-41.

b. Refer to figure 7-3, and disassemble governor in the sequence shown by the key numbers. Reassemble in reverse sequence.

c. Clean, inspect, and repair if required.

d. Adjust the governor after installation as directed in paragraph 3-41.

Section IV. GENERATOR

7-7. General

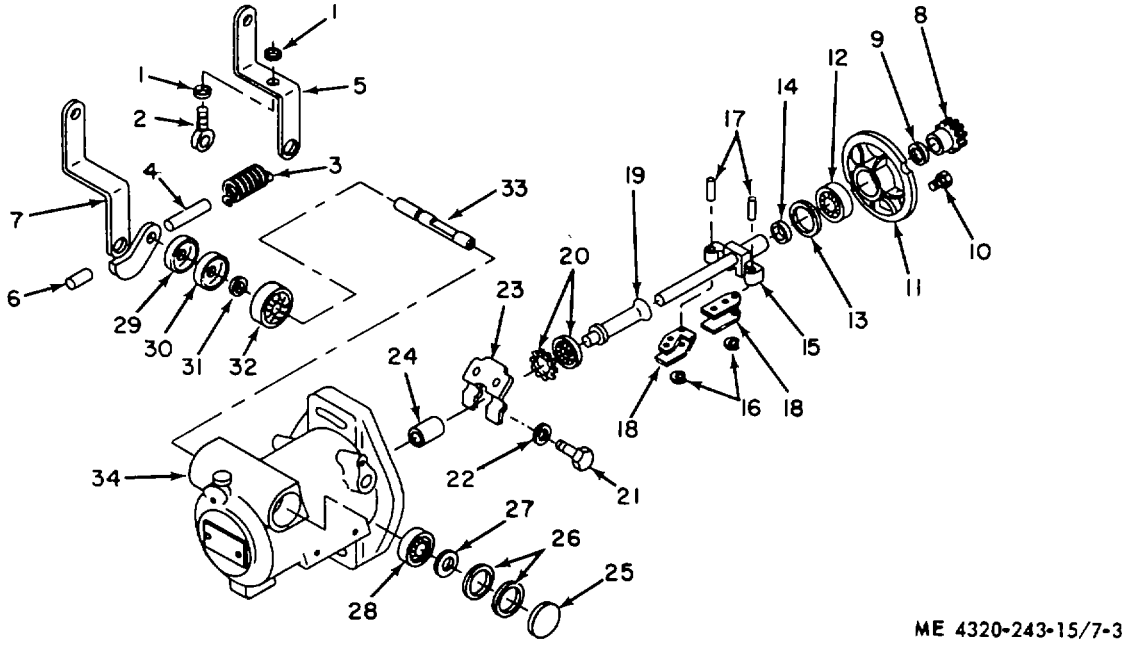
The generator is a belt-driven, air cooled, self-excited, externally controlled unit of the two-brush type. One brush is grounded, with the generator field frame serving as the return ground conductor in the electrical circuit. The other brush, mounted in an insulated brush holder, is connected in the armature terminal of the generator. One field lead connects to the insulated brush holder and the other field lead connects to the field terminal of the generator.

7-8. Removal and Installation

Remove and install the generator, fan, and pulley as directed in paragraph 3-46.

7-9. Disassembly and Reassembly

Disassemble the generator as shown in figure



1	Nut (2)	13	Ring	24	Bushing
2	Screw	14	Washer	25	Plug
3	Spring	15	Shaft assembly	26	Washer (2)
4	Plunger	17	Pin (2)	27	Ring
5	Lever assembly	16	Ring (2)	28	Bearing
6	Pin	18	Weight assembly (2)	29	Retainer
7	Lever assembly	19	Sleeve	30	Packing
8	Gear	20	Bearing	31	Ring
9	Washer	21	Screw (2)	32	Bearing
10	Screw	22	Washer (2)	33	Shaft
11	Diaphram	23	Yoke	34	Body
12	Bearing				

Figure 7-3. Governor, disassembly and reassembly.

7-4, following the sequence indicated by the key numbers. Reassembly in reverse sequence.

7-10. Cleaning, Inspection and Repair

a. Clean all metal parts in an approved cleaning solvent and blow dry with compressed air.

b. Clean the generator field frame with a soft cloth dampened in an approved cleaning solvent and wipe dry.

c. Blow all dust and dirt from the armature.

d. Inspect the field frame, commutator end frame, and drive end frame for cracks and breaks.

e. Inspect the armature for separated commutator bars and burning.

f. Inspect the ball bearings for roughness and wear.

g. Turn a burned or scored commutator on a lathe until the surface is clean and on cneter, and undercut the mica.

h. Replace all defective parts in the generator.

7-1 1. Testing

a. Brush Holder Testing.

(1) Using a circuit test lamp, test between the insulated brush holder and the commutator end frame. If the lamp lights on this test, the brush holder is grounded and the commutator end frame must be replaced.

(2) Test between the grounded brush holder and the commutator end frame. If the lamp fails to light on this test, the brush holder is not grounded and the commutator end frame must be replaced.

b BenchTesting.

(1) *Field current draw*. Connect a dc voltmeter between the field terminal and armature terminal of the generator. Connect an ammeter, field rheostat, battery switch, and fully charged, 24-volt battery in series with each other and connect the group between the field and armature terminals of the generator. Close the battery switch and adjust the field rheostat for a reading of 28.5 volts on the volt meter. The ammeter should indicate between 1.07 and 1.27 amperes. If the current does not fall within this range, inspect the generator field frame for defective terminals, terminal insulation, internal connections, or field windings.

(2) *Motoring test*. Connect a jumper from the field terminal to the generator field frame. Connect a fully-charged, 24-volt battery and a battery switch in series with each other and connect the group between the armature terminal and the generator field frame of the generator. Close the battery switch. The generator armature should revolve in a clockwise direction as viewed from the drive end. If the armature does not turn freely in the correct direction, inspect the generator for incorrect assembly, defective bearings, poor brush contact, or a defective armature.

(3) Output test. Mount the generator on a test bench and couple it to a drive motor. Connect a field rheostat between the field terminal and the generator field frame. Connect the negative terminal of a fully-charged battery to the generator and connect the positive terminal to one terminal of a reverse current relay. Connect the other terminal of the relay to the armature terminal of the generator. Connect a carbon pile rheostat across the battery. Momentarily connect a jumper across the terminals of the reverse current relay to polarize the generator. Start the drive motor and adjust its speed to 1,900 rpm. Adjust the field rheostat for a reading of 28.5 volts on the voltmeter and adjust the carbon pile rheostat until the ammeter shows a load of 18 amperes. Adjust the field rheostat as necessary to maintain the voltage. Operate the generator for 15 minutes to attain operating temperature. Adjust the voltage and amperage to the above mentioned values. If the rated voltage and amperage cannot be maintained, disassemble and overhaul the generator.

c. Armature and field wiring testing. Test the armature and field windings of the generator as described in TM 5-764.

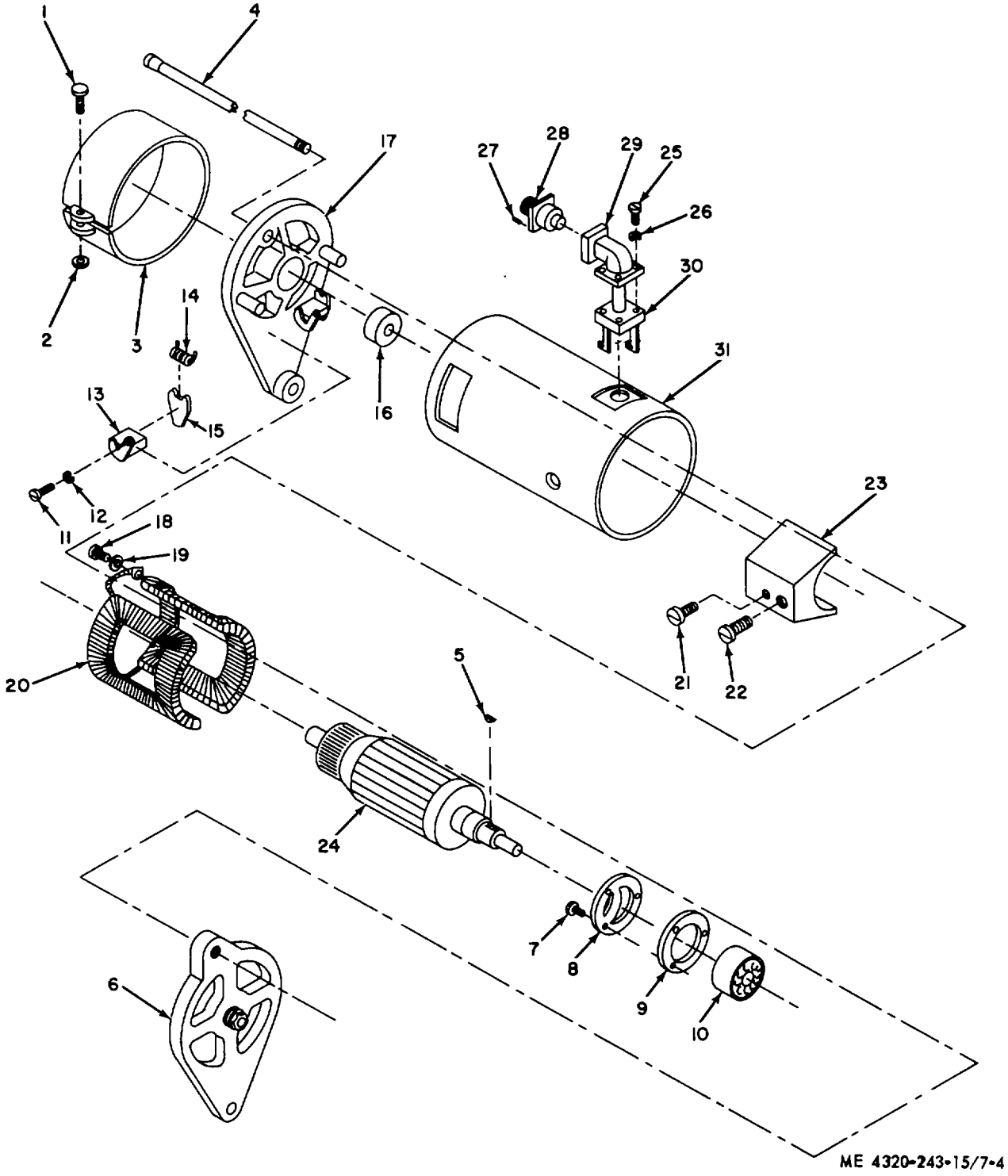


Figure 7-4. Generator, disassembly and reassembly.

1 Screw
2 Washer
3 Cover band
4 Thru bolt (2)
5 Key
6 Drive end head assembly
7 Screw (3)
8 Spring plate
9 Bearing retainer
10 Ball bearing
11 Screw (2)
12 Washer (2)
13 Brush (2)
14 Spring (2)
15 Arm (2)
16 Ball Bearing
17 Head assembly
18 Screw
19 Washer
20 Field assembly
21 Screw (2)
22 Screw (2)
23 Shoe (2)
24 Armature assembly
25 Screw (4)
26 Washer (4)
27 Screw (4)
28 Receptacle
29 Elbow
30 Spacer
31 Frame

Figure 7-4-Continued.

Section V. GENERATOR REGULATOR

7-12. General

The three-unit, battery-charging generator regulator (fig. 3-20) automatically controls the output of the generator to keep the batteries fully charged. The circuit-breaker unit closes the circuit between the batteries and the generator when the generator voltage is higher than the battery voltage, and opens the circuit when the battery voltage equals that of the generator. The current-regulator unit limits the current to the maximum rated value of the generator. The voltage regulator limits the voltage to the maximum rated value of the system at full charge.

7-13. Removal and Installation

Remove and install the Generator Regulator as directed in paragraph 3-47.

7-14. On-Engine Testing

Defects in the battery-charging generator system are indicated by a high charging rate when the batteries are fully charged. Perform the on-engine testing as follows:

a. When a high-charging rate with fully charged batteries is indicated, disconnect the lead assembly connector from the regulator (fig. 320) and connect a jumper between pin "A" of the lead assembly connector and pin "A" of the voltage regulator connector. Operate the unit at half throttle. If the output remains high, the fault is in the generator or wiring. If the output drops off, the trouble is in the regulator and it must be adjusted or replaced.

b. When a low, or no-charging rate with partially or fully discharged batteries is indicated, inspect for loose connections or damaged wiring. If no faults are found, disconnect the connector as in (1) above. Connect two jumpers between the pins of the lead assembly connector and the regulator connector. Connect another jumper between pin "B" of the regulator connector and ground. Start the engine and slowly increase the speed. No increase in the charging rates indicates the generator is at fault. An increase indicates that the regulator is at fault and must be adjusted or replaced.

Caution

Never remove the cover from the voltage regulator while the engine is operating or the battery is connected.

7-15. Cleaning

Do not disassemble the regulator under any circumstances. Remove cover and wipe assemblies, insulation, capacitors, and resistors with a clean rag, slightly dampened in gasoline, paint thinner, or drycleaning solvent.

7-16. Testing

a. With test probes, touch "Arm" Terminal and circuit breaker stationary contact. (Touch end of series winding and circuit breaker stationary contact on regulators which do not have the terminals directly on the sub-base.) If lamp does not light, it indicates an open circuit in one of the series coils or connections. Inspect to find cause of open and repair or replace parts affected.

b. Touch test probes to "Arm" and "Bat" terminals. (Touch end of series winding end circuit breaker yoke on regulators which do not have the terminals directly on the subbase.) If lamp lights, install new circuit breaker contacts or complete circuit breaker. unit.

c. Touch test probes to "Field" and "Arm"

terminals. (Series winding and voltage regulator yoke if terminals are not on sub-base.) If lamp does not light, it indicates a faulty resistor, frequency winding or faulty contacts on either current or voltage regulator units. If lamp lights, open current regulator contacts. Release current regulator contacts and open voltage regulator contacts. If lamp does not go out in each case, replace armature affected.

d. Inspect contacts on all three units. In normal use, contacts will become grayed. If contacts are burned, dirty or rough, file with contact point dresser parallel and length wise to armature. File just enough so contacts pre- sent smooth surfaces towards each other. It is not necessary to remove every trace of burning. After filing, dampen a piece of linen tape in carbon tetrachloride and draw between contacts. Repeat with a dry tape. Use clean tape for each set of contacts.

e. Adjust Armature Air Gap.

(1) *Circuit breaker unit*. Use pin gage of correct limits and insert between armature and core on contact side and next to brass pin in core. Adjust gap by bending armature stop. Be sure stop does not interfere with armature movement.

(2) *Voltage-regulator unit*. Connect battery and lamp in series with "Arm" and "Field" terminals to indicate when contacts are opened and closed. Insert pin gage of correct dimension between armature and core on contact side and next to brass pin in core. Hold armature down with two fingers so contact spring is not touched. Adjust gap so lamp will burn brightly when high limit gage is in place, and will go out or dim when low limit gage is in place. Adjust gap by slightly loosening screw holding armature stop and raising or lowering stop. Tighten screws and check gap.

(3) *Current-regulator unit*. Check and ad- just as described above for voltage-regulator, using correct gage.

f. Check Gap Between Contact Spring and Stop.

(1) *Voltage-regulator unit*. Hold armature down against core stop with feeler gage measure gap between contact spring and armature stop. If gap is not between 0.010 and 0.016 inch inspect bumper block for damage or improper assembly, and inspect armature stop for distortion or incorrect adjustment.

(2) *Current- regulator unit*. The same limits and procedures as described for voltage- regulator applies to current regulator unit.

g. Measure Contact Point Gap on Circuit Breaker Unit. Measure gap between both sets of contacts. Do not set this gap less than 0.025 inch, but it may be set larger than this after adjusting contact opening amperage. Bend stationary contact brackets to adjust gap, and align contacts so contact is made and broken on both sets of contacts.

h. Circuit Breaker Adjustment.

(1) Mount regulator on test stand in same position as it is mounted on vehicle, or if this is unknown, mount with base vertical and terminal hanging down. Use generator of type specified for regulator and mount on test stand. Connect battery of correct voltage and polarity.

(2) Connect test stand battery ground lead to generator frame and connect other battery lead to regulator terminal marked "Bat". Connect generator "Arm" terminal to regulator "Arm" terminal and connect variable resistance in series with generator "Field" and regulator "Field" terminals. Run a ground lead from generator frame to regulator ground frame. Connect voltmeter from regulator ground frame to regulator "Arm" terminal.

(3) Polarize the generator to prevent burning regulator contacts; remove generator field lead from variable resistance, close test stand battery switch and momentarily touch field lead to regulator "Bat" terminal, then connect field lead to variable resistance as above.

(4) Insert all the resistance in field circuit. Start generator and operate at 1,000 to 2,000 rpm. Decrease field resistance slowly, and noting voltmeter reading just before change caused by closing of the circuit breaker. Decrease resistance until ammeter shows a charge of one half current value stamped on regulator name- plate,, then increase resistance slowly. Note amperage discharge just before contacts open and ammeter reading drops to zero.

(5) Adjust closing voltage to specified figure by turning thumb nut on lower end of armature spring.

(6) Adjust opening discharge current to specified figure by raising or lowering stationary contacts. Open test stand battery switch to prevent shorting. Bend stationary contact brackets to increase or decrease contact gap. Increasing contact gap increases opening discharge amperes. Keep contacts aligned for full face contact and adjust both sets of contacts so they operate simultaneously. Do not adjust gap between contacts when open to less than 0.025 inch.

(7) Open test-stand battery switch.

i . Voltage and Current Regulator Adjustment.

(1) Remove variable resistance from field circuit. Change voltmeter connections so that it is connected to regulator base and "Bat" terminal. Connect variable load across battery. This load may consist of a carbon pile or lamp bank.

(2) On units that have been completely overhauled, close test stand battery switch and operate generator at 2,500 to 3,000 rpm. Hold voltage regulator contact closed by pressing lightly on back of voltage regulator armature and read ammeter. If this is within two amperes of correct setting, do not adjust. If current setting is not within two amperes, turn adjusting nut on lower end of armature spring. Release voltage regulator armature. Stop generator, then start and bring speed up to 2,500 to 3,000 rpm. Adjust current to one half the value stamped on regulator nameplate by changing load rheostat or lamp bank. Read voltmeter. If this reading is within 0.8 volts units of correct operating voltage, do not adjust. If voltage is not within these approximate settings, turn adjusting nut on lower end of armature spring. Stop generator and open test-stand battery switch.

(3) Install cover gasket and cover regulator.

(4) Close test stand battery switch and operate generator at 2,500 to 3,000 rpm. Adjust load rheostat or lamp bank so ammeter reads one half current regulator operating amperage.

Operate at this current for 30 minutes to bring regulator up to operating temperature.

(5) Place thermometer near regulator to ascertain temperature of 70°F. Adjust current to one-half current regulator setting and read voltmeter and thermometer. This voltage must be within the limits specified for voltage regulator for temperature specified. If voltage is not within limits, stop generator, open tests and battery switch, and remove regulator cover. Turn adjusting nut on lower end of voltage regulator armature spring until voltmeter reading is within limits. Check this setting by stopping generator, then operate generator at 2,500 to 3,000 rpm at one-half maximum current. Read voltmeter and readjust and recheck voltage regulator if not within operating limits.

(7) Adjust load rheostat or lamp bank so voltmeter reading drops 0.5 to 0.7 volts and read ammeter. This reading must be within, limits specified for current regulator. If current is not within limits, stop generator and remove regulator cover. Start generator and adjust current setting by turning thumb nut on lower end of armature spring.

(8) Stop generator and open battery switch. Install regulator cover.

(9) Close test stand battery and operate generator at one-half current regulator setting for 5 minutes, then check voltage and current settings. Make any readjustments that are necessary and finish with a final 5) minute run and check.

Section VI. STARTING MOTOR

7-17. General

The starting motor is a heavy-duty, 24-volt, 4pole, 4-brush, series wound dc motor located at the lower right side of the engine. When energized by the starting motor solenoid, the pinion gear of the motor drive engages the flywheel ring gear on the engine, and the engine is cranked electrically. An intermediate duty clutch absorbs high engine torque to prevent damage to the starting motor and the flywheel ring gear during the starting period.

7-18. Removal and Installation

Remove and install starting motor as directed in paragraph 3-48.

7-19. Disassembly and Reassembly

Disassemble the starting motor in the sequence indicated by the key numbers in figure 7-5. Reassemble in reverse sequence.

7-20. Cleaning, Inspection, and Repair

a. Clean all metal parts in an approved solvent and blow dry with compressed air.

b. Clean the field frame with a cloth dampened with an approved solvent and wipe dry.

c. Blow all dust and dirt from the armature.

d. Inspect the field frame for cracks and breaks.

e. Inspect the brush holders and brush springs for rust, corrosion and breaks.

f. Inspect the commutator for burning and pitting. Turn a burned or pitted commutator and undercut the mica.

g. Inspect the motor drive for worn or broken teeth and other damages.

h. Inspect all bushings and bearings for excessive wear.

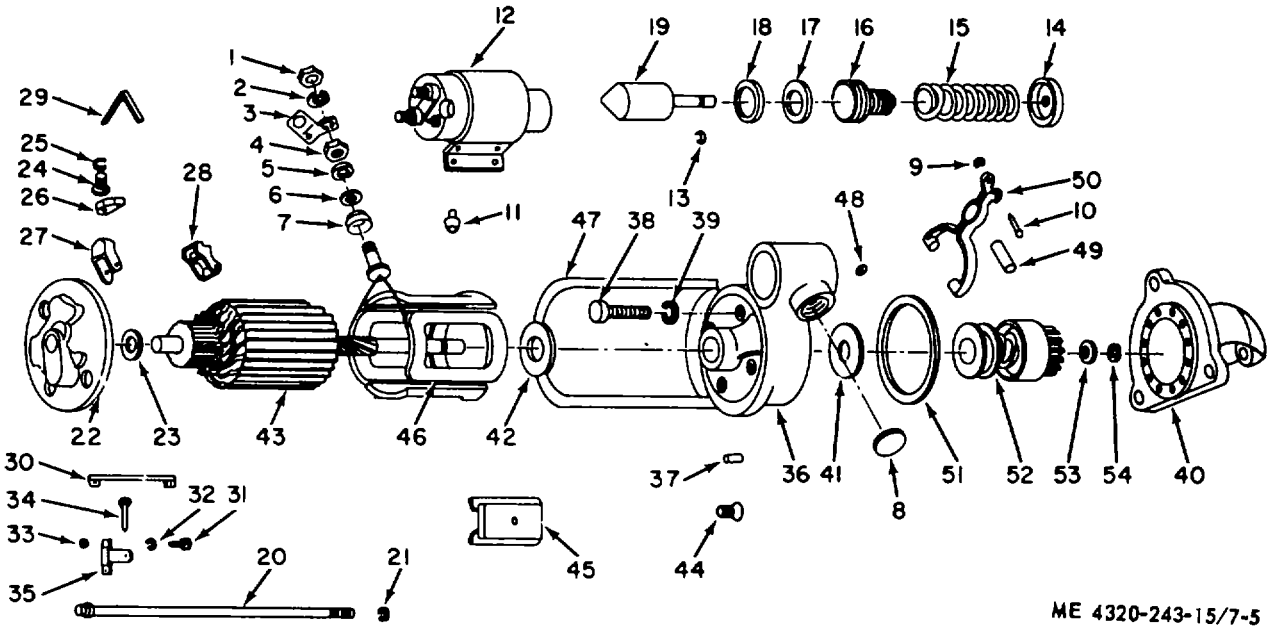
i. Replace all defective parts.

7-21. Testing

a. Brush Holder Testing.

Note

Perform the following tests before removing the brush holders from the commutator end frame.



1	Terminal stud nut	19	Plunger assembly	37	Dowel pin
2	Washer	20	Thru bolt (2)	38	Bolt (4)
3	Connector	21	Washer (2)	39	Washer (4)
4	Nut	22	Commutator end frame	40	Drive housing
5	Washer	23	Thrust washer	41	Washer
6	Washer	24	Brush-attaching screw (4)	42	Brake washer
7	Bushing	25	Washer (4)	43	Armature
8	Extension plug	26	Brush (4)	44	Screw (4)
9	Lever snap ring	27	Grounded brush holder (2)	45	Pole shoe
10	Pin	28	Insulated brush holder (2)	46	Field coil assembly
11	Screw (4)	29	Brush spring (2)	47	Field frame
12	Solenoid switch	30	Ground lead (2)	48	Plug (2)
13	Spring retainer snap ring	31	Screw (4)	49	Lever shaft
14	Pole shoe	32	Washer (4)	50	Shaft lever assembly
15	Spring lever assembly	33	Nut (4)	51	Bushing
16	Boot	34	Brush pin (2)	52	Motor drive clutch
17	Spring retainer	35	Support spring (2)	53	Pinion stop collar
18	Spring retainer	36	Lever housing	54	Pinion stop retainer ring

Figure 7-5. Starter, assembly and disassembly.

(1) Using a circuit test lamp, test between each brush holder and the commutator end frame. If the lamp lights on one of these tests, the brush holder is grounded.

(2) Test between adjacent brush holders. If the lamp lights, the two brush holder groups are shorted to each other.

(3) Test between opposite brush holders. If the lamp fails to light on one of these tests, remove the brush holders and clean the mounting surfaces and hardware.

b. Armature and Field Frame Testing. Test the armature and field frame of the starting motor as described in TM 5-764.

c. Bench Testing.

(1) *No-load test.* Connect a 24-volt battery in series with a load rheostat and an ammeter shunt of a capacity greater than 200 amperes, connect this group to the starting motor terminal and starting motor field frame. Connect an ammeter to the shunt and connect a dc voltmeter between the starting motor terminal and starting motor field frame. With the voltage adjust to 23.4 volts, the average current should be 36 amperes at 6,300 rpm. The direction of rotation should be clockwise as viewed from the drive end. If the current is high and the speed is low, inspect the bearing and armature for binding and incorrect alinement.

(2) *Stall Torque Test*. With the starter connected as in (1) above, fasten a torque arm and a spring scale to the armature at the drive end. Adjust the rheostat to give 6.6 volts. The correct readings are 225 amperes maximum and a stall torque of 15 foot-pounds minimum. The stall torque is the product of the spring scale reading in pounds, multiplied by the length of the torque arm in feet. If the current and torque are both low, inspect for high resistance in internal connections and for improper brush contact. High current and low torque may be caused by a defective armature or field coil winding.

Section VII. MAGNETO

7-22. General

The magneto is a heavy-duty, radio-shielded unit, located on the left side of the engine and driven by the camshaft gear. The entire magneto is enclosed in a grounded metal frame. The magneto revolves clockwise. When the magneto breaker points are forced apart, the primary electrical circuit is interrupted, building up high voltage in the secondary electrical circuit. This causes the high-tension electrical current to jump the air-gap of the spark plug electrodes, completing the secondary electrical circuit. The impulse coupling retards the timing of the ignition during the starting operation and at the same time produces an extremely high voltage which would otherwise be impossible at low engine cranking speeds. The impulse coupling disengages when the engine reaches operating speed.

7-23. Removal and Installation

a. Time the ignition as directed in paragraph 3-49.

b. Remove and install magneto and drive gear as shown in figure 3-24.

7-24. Disassembly and Reassembly

Disassemble the magneto as shown in figure 7-6, in the sequence indicated by the key numbers. Reassemble in opposite sequence.

7-25. Cleaning, Inspection and Repair

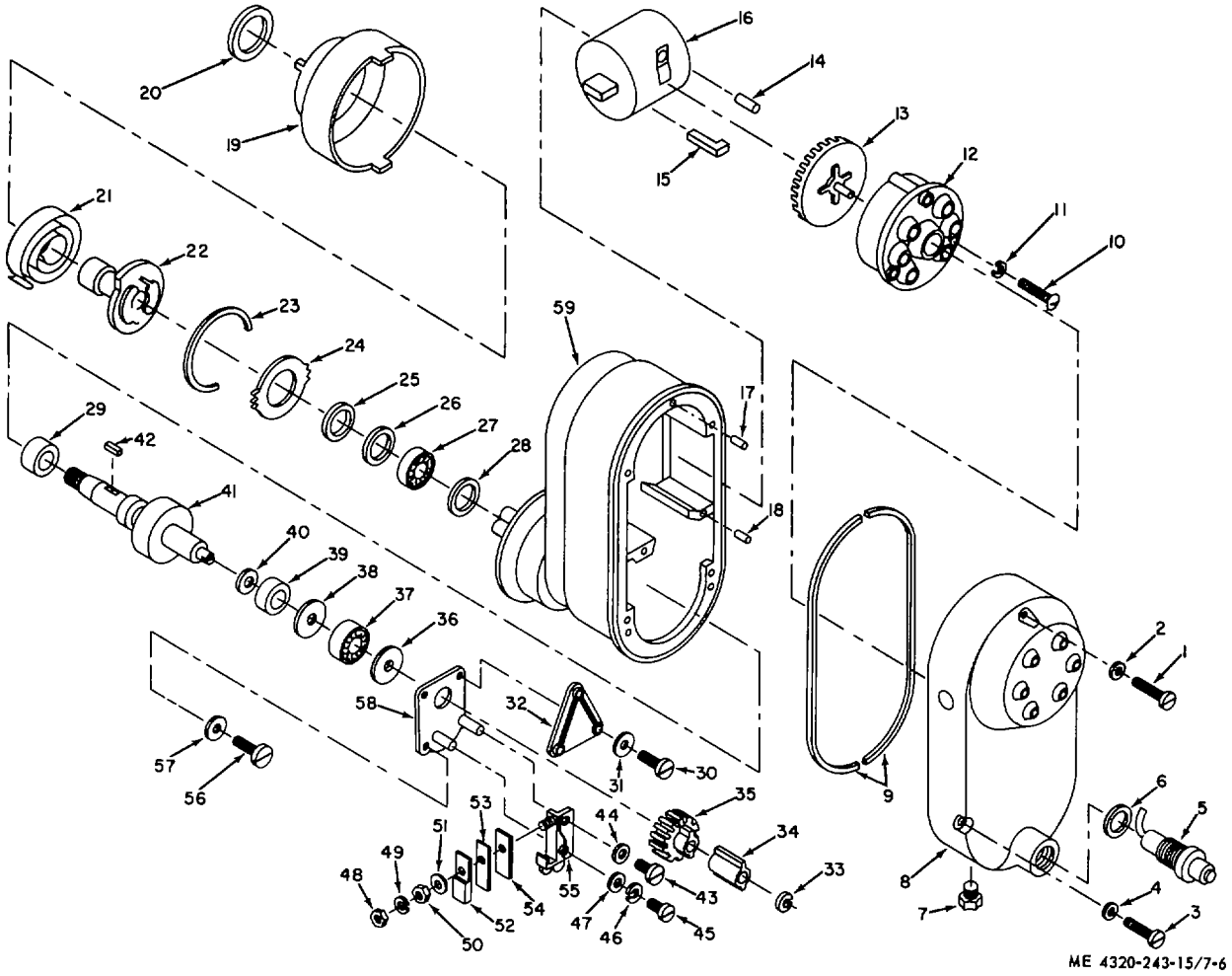
a. Clean all metal parts in an approved solvent and blow dry with compressed air.

b. Inspect the distributor gear brush for wear. Replace a brush worn to less than 0.031 inch from the end of the distributor gear shaft. The rounded end of the new brush should extend 0.062 inch beyond the end of the distributor gear shaft. Adjust the clearance between the distributor gear electrode and the distributor block terminals to 0.010 inch.

c. Adjust the contact points from 0.008 inch to 0.012 inch.

d. The stop pin plate is adjustable from 5° to 35° depending on the lag angle of the engine. Set the stop pin plate at 35° by alining the arrow on the stop pin plate with the "0" in the magneto frame.

e. Replace all defective parts.



1 Screw
2 Washer
3 Screw
4 Washer
5 Capacitor
6 Seal
7 Air Vent
8 Housing
9 Gasket
10 Screw
11 Washer
12 Block
13 Gear
14 Brush
15 Coil wedge
16 Coil
17 Bushing
18 Roll pin
19 Shell
20 Retaining hub
21 Spring
22 Hub
23 Retaining ring
24 Stop pin plate
25 Oil seal
26 Washer
27 Ball bearing
28 Washer
29 Inner race
30 Screw (2)
31 Washer (2)
32 Bearing plate
33 Retaining ring
34 Breaker cam
35 Rotor gear
36 Washer
37 Ball bearing
38 Washer
39 Inner race
40 Shim
41 Rotor
42 Key
43 Screw
44 Washer
45 Screw
46 Washer
47 Washer
48 Nut
49 Washer
50 Nut
51 Washer
52 Cam oiler
53 Cam follower
54 Insulator
55 Point set
56 Screw
57 Washer
58 Bearing plate
59 Frame

Figure 7-6. Magneto, assembly and disassembly.

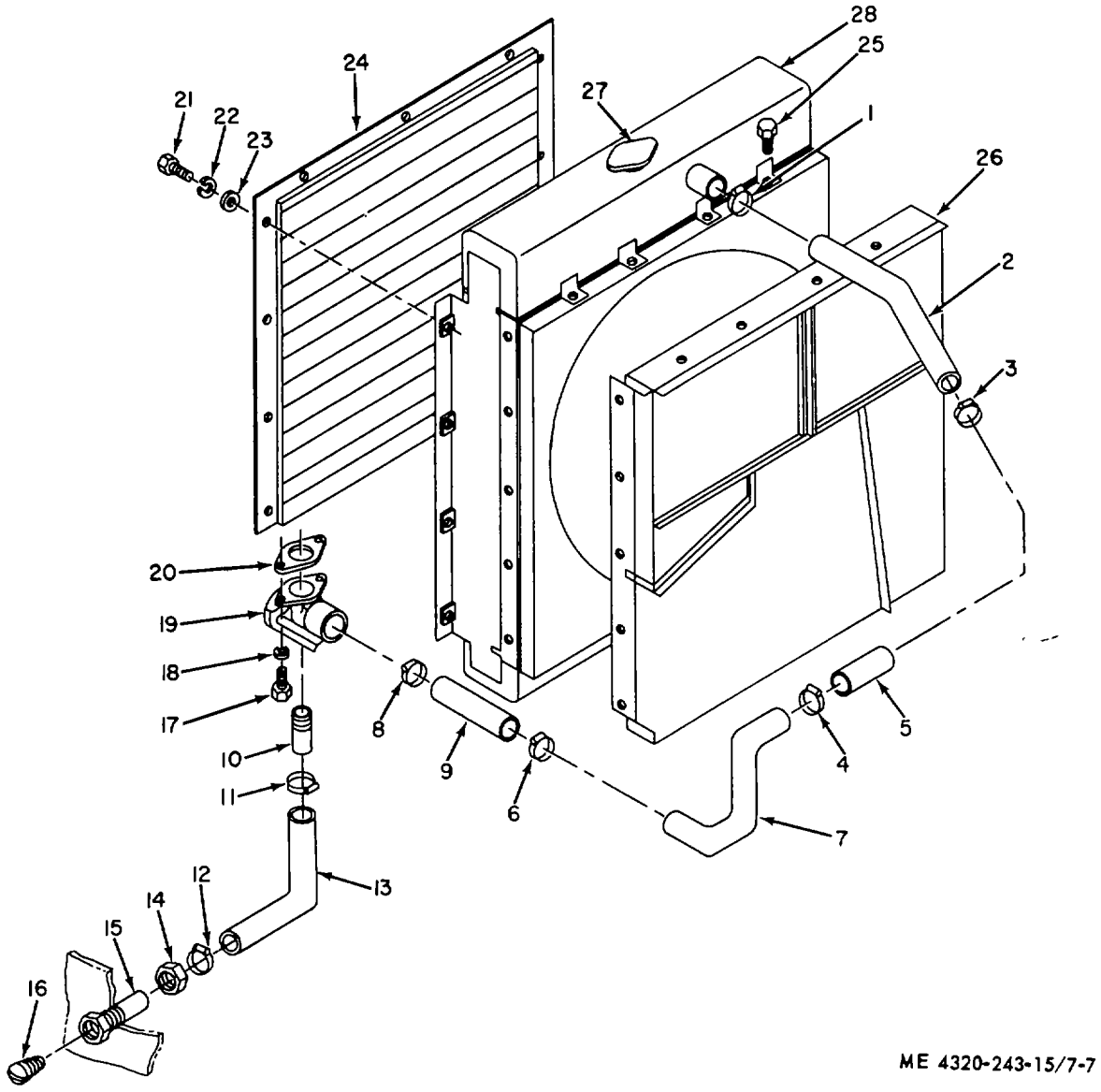
Section VIII. RADIATOR ASSEMBLY

7-26. General

The radiator assembly (fig. 7-7) is mounted to the housing front sheet and consists of a shutter assembly, radiator core, and tank, fan guard, and the hoses and tubing required to connect the radiator to the engine.

7-27. Shutter Assembly

a. Remove and install the muffler (fig. 2-2).



1	Hose clamp	8	Hose clamp	15	Fitting	22	Washer (14)
2	Preformed hose	9	Flexible hose	16	Plug	23	Washer (14)
3	Hose clamp	10	Nipple	17	Screw (2)	24	Shutter assembly
4	Hose clamp	11	Hose clamp	18	Washer (2)	25	Bolt (18)
5	Flexible hose	12	Hose clamp	19	Hose coupling assembly	26	Fan guard assembly
6	Hose clamp	13	Hose	20	Gasket	27	Radiator cap
7	Rigid tube	14	Lock nut	21	Bolt (14)	28	Radiator

Figure 7-7. Radiator assembly and related parts.

b. Remove and install the roof assembly (fig. 3-35).

c. Remove and install the radiator assembly (fig. 7-8).

d. Remove and install the shutter assembly (fig. 7-7).

e. Inspect the shutter louvers for worn or damaged weather stripping and operate by manually opening and closing the louvers.

f. Replace a damaged shutter assembly.

7-28. Radiator Core and Tank

a. Remove and install the shutter assembly (pare 7-27, above).

b. Remove and install the radiator core and tank (fig. 7-7) .

c. Clean the outside of the radiator core with compressed air. ~ d. Clean the radiator with an approved solvent.

e. Flush the interior and exterior surfaces of the radiator thoroughly with clean water.

f. Inspect the radiator, particularly at the corners, for signs of leaks and damage. If a leak exists that cannot be located, plug all outlets except the filler opening. Submerge the radiator in water and connect the filler opening to a low-pressure air source. Air bubbles will indicate the location of leaks.

Caution

Do not apply air pressure in excess of 15 psi. Higher pressure will damage the radiator.

g. Solder all leaks.

h. Remove all loose paint and rust spots from the radiator with a wire brush and repaint.

i. Replace an unserviceable radiator.

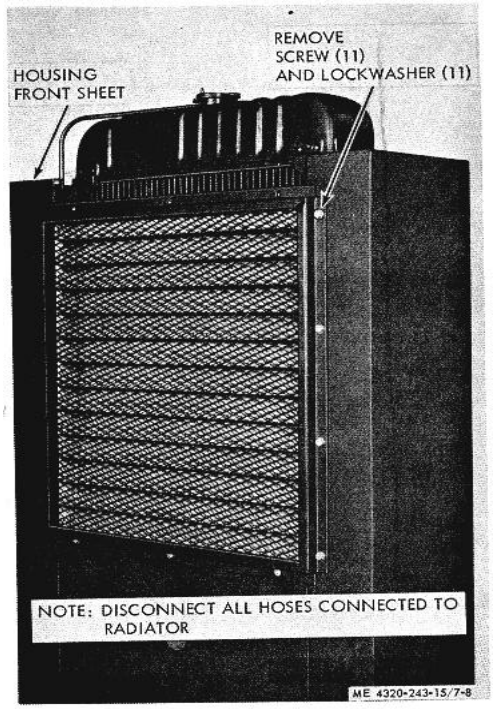


Figure 7-8. Radiator, removal and installation.

Section IX. WATER PUMP

7-29. General

The centrifugal-impeller warer pump is flange mounted to the front of the engine, and belt driven. It circulates the coolant through the pipes, tubing, and manifolds to the cylinder assembly, cylinder heads, and radiator.

7-30. Assembly, Disassembly, and Repair

a. Drain the cooling system.

b. Remove and install the muffler (fig. 2-2).

c. Remove and install the roof assembly (fig. 8-36).

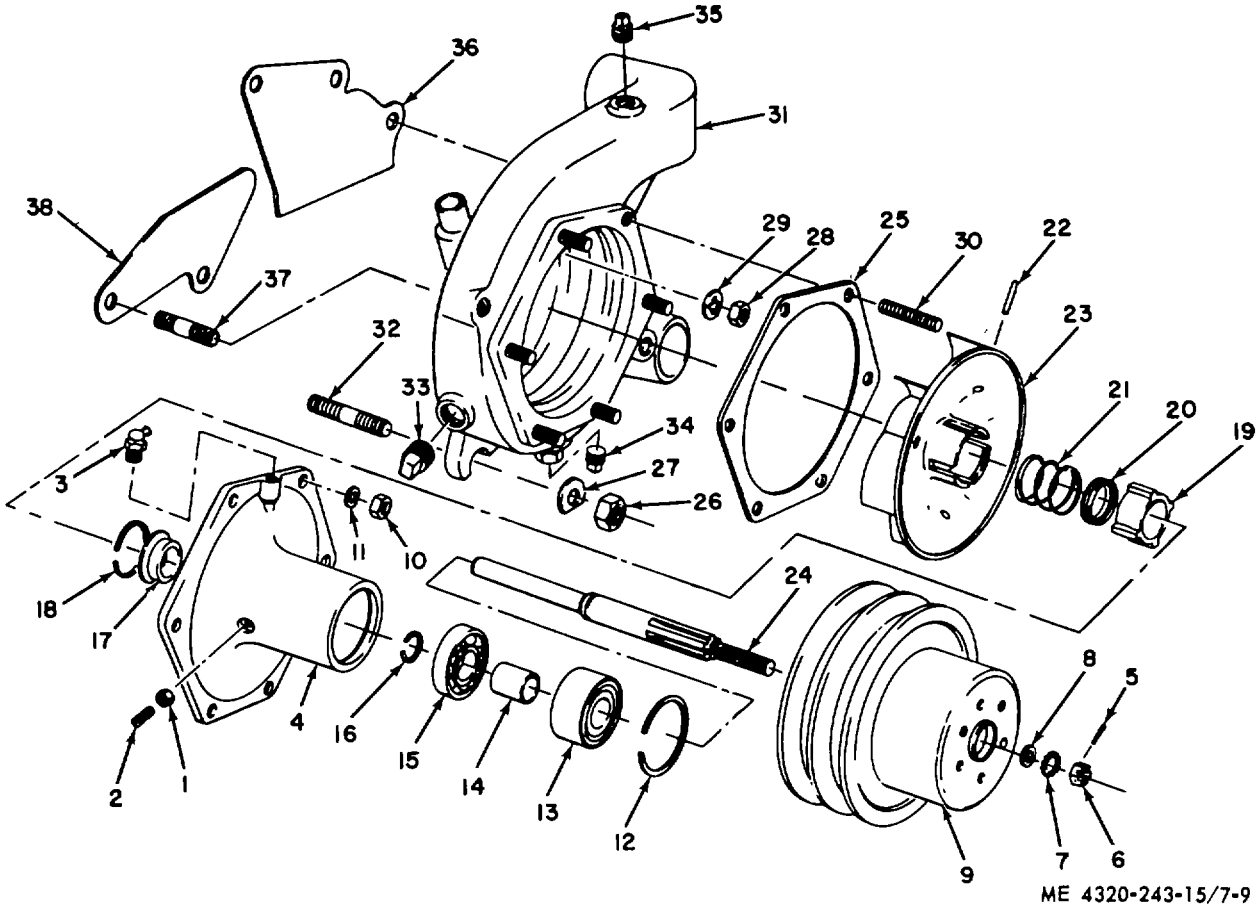
d. Remove and install the radiator assembly (fig. 7-8)

e. Remove and install the fan and V-belts (fig. 3-19).

f. Disconnect water pump hoses.

g. Remove and install the water pump as directed in paragraph 3-57.

h. Disassemble the water pump as shown on figure 7-9, in the sequence indicated by key numbers. Reassemble in opposite sequence.



1	Nut	14	Spacer	27	Washer (2)
2	Setscrew	15	Bearing	28	Nut
3	Fitting	16	Retainer	29	Washer
4	Support	17	Bushing	30	Stud (6)
5	Pin	18	Ring	31	Body
6	Nut	19	Retainer	32	Stud (2)
7	Washer	20	Gland	33	Plug
8	Washer	21	Spring	34	Plug
9	Pulley	22	Pin	35	Plug
10	Nut (6)	23	Impeller	36	Gasket
11	Washer (6)	24	Shaft	37	Stud
12	Ring	25	Gasket	38	Gasket
13	Bearing	26	Nut (2)		

Figure 7-9. Water pump, assembly and disassemlbly.

Section X. TACHOMETER DRIVE HOUSING

7-31. General

The tachometer drive housing is mounted on the left side of the engine, and serves as a mounting for the tachometer adapter. The housing encases the camshaft-driven tachometer drive which mechanically drives the tachometer adapter.

7-32. Disassembly and Reassembly

a. Remove and install the tachometer drive housing as shown in figure 3-7.

b. Disassemble the tachometer drive housing as shown in figure 7-10, in sequence indicated by key numbers. Reassemble in reverse sequence.

Section XI. ROCKER ARM ASSEMBLIES AND PUSH RODS

7-33. General

The rocker arm assemblies are mounted on top of the cylinder heads, shielded under the rocker arm covers. The push rods are vertically positioned in openings on the left side of the engine. When engine is operating, the push rods are moved up and down by the revolving cams on the camshaft. This movement is transmitted by the rocker arms to the intake and exhaust valves, causing them to open and close in correct timing with the positions of the pistons. The rocker arm shafts are made of steel tubing, drilled to carry oil under pressure to each rocker arm.

7-34. Disassembly and Reassembly

a. Remove and install the rocker arm covers as shown in figure 3-9.

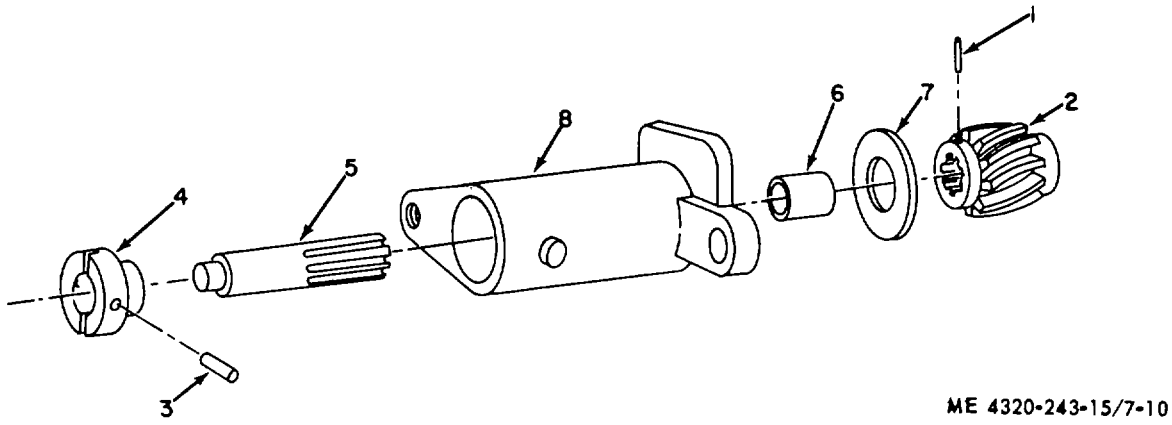
b. Remove and install the rocker arm assemblies and push rods as shown in figure 7-11.

c. Disassemble the rocker arm assembly, as shown in figure 7-12, in the sequence indicated by the key numbers. Reassemble in reverse sequence.

7-35. Cleaning, Inspection, and Repair

a. Refer to paragraph 1-4 for valve clearance.

b. Adjust the valves after installation of the rocker arm assemblies (para 3-36).



1 Pin
2 Drive gear
3 Pin
4 Coupling
5 Adapter
6 Bushing
7 Thrust washer
8 Housing

Figure 7-10. Tachometer drive housing, disassembly and reassembly.

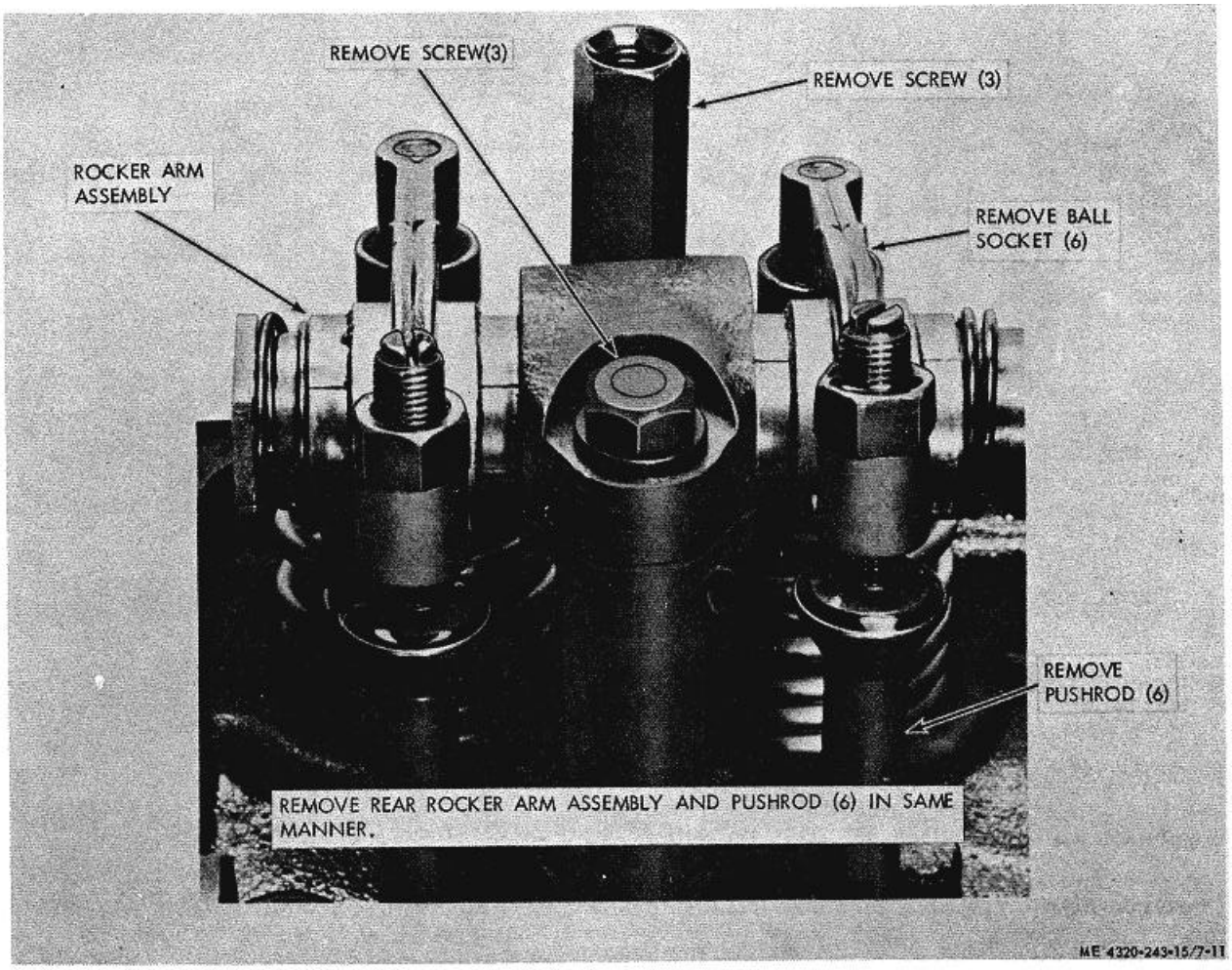
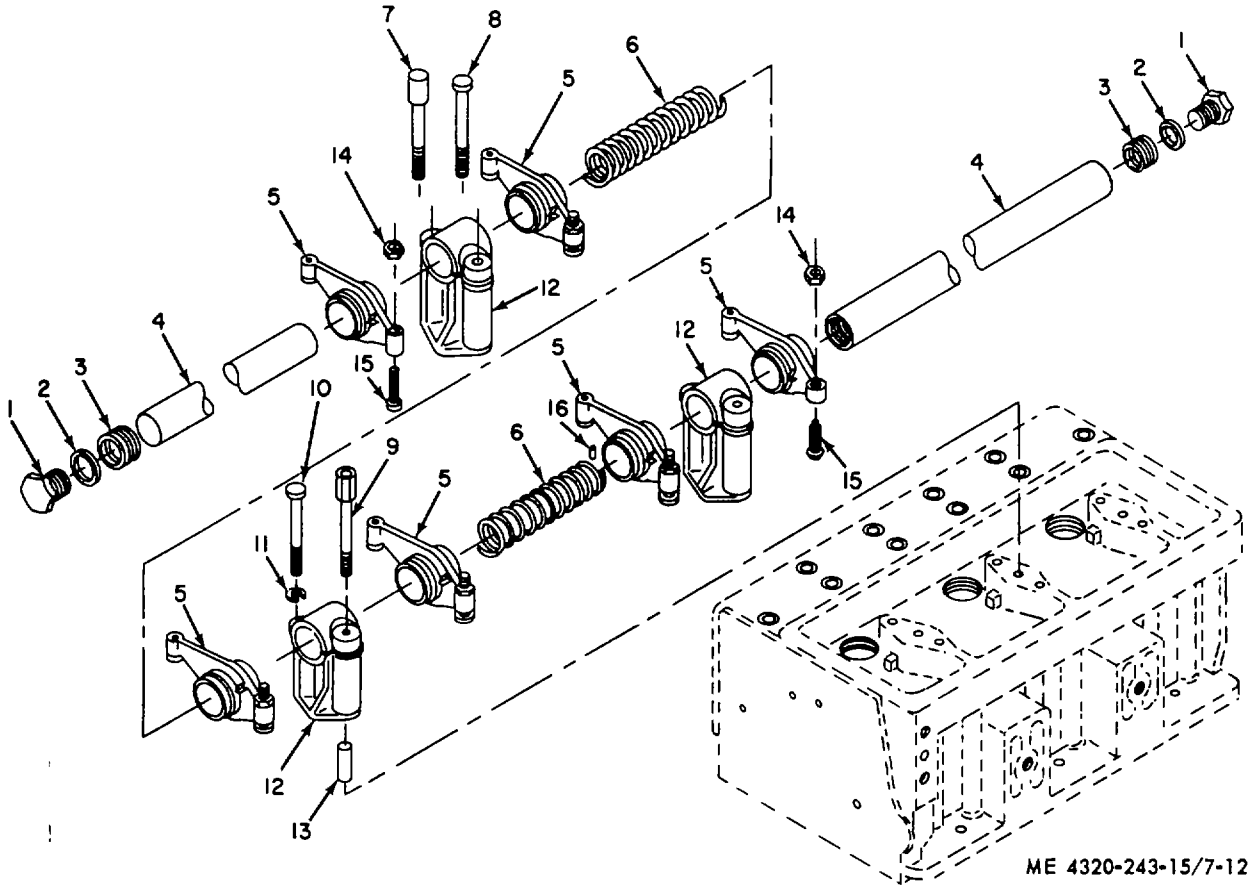


Figure 7-11. Rocker arm assembly and push rods, removal and installation



1 Plug (2)
2 Gasket (2)
3 Spring (2)
4 Shaft (2)
5 Arm (6)
6 Spring (4)
7 Screw (2)
8 Screw (4)
9 Screw (4)
10 Screw (2)
11 Washer (12)
12 Support (5)
13 Pin (2)
14 Nut (12)
15 Screw (12)
16 Socket (12)

Figure 7-12. Rocker arm assembly, disassembly and reassembly.

Section XII. CYLINDER HEADS, INTAKE AND EXHAUST VALVES AND VALVE TAPPETS

7-36. General

The two cylinder heads are mounted on top of the cylinder assembly. The rocker arm assemblies, exhaust valves, and intake valves are positioned in the cylinder heads. The bottoms of the cylinder heads form the top portions of the combustion chambers. These chambers are surrounded by passages through which coolant is circulated. The intake and exhaust valves, activated by the valve tappets and push rods, open and close during engine operation, allowing the fuel mixture to enter and the exhaust gases to escape the combustion chambers.

7-37. Cylinder Heads, Intake and Exhaust Valves, and Valve Tappets

a. Remove and install the housing assembly (para 3-65).

b. Remove and install the inlet and outlet headers (fig. 3-28 and 3-32).

c. Remove and install the carburetor (para 340), intake and exhaust manifolds (para 337), V-belt (para 3-58), oil filters (para 3-60), oil cooler (para 3-62), oil filter (para 3-4), and rocker arm covers (para 3-35).

d. Remove and install the water pump (para 3-57).

e. Remove and install the rocker arm assemblies (para 7-34).

f. Refer to figure 7-13 and remove and install the cylinder heads in the following sequence.

(1) Remove and install bolts (28) (30) (31) and lockwashers (29).

(2) Remove and discard gasket (32).

(3) Remove and install rear cylinder head (34) in same manner.

g. Refer to figure 7-13 and remove and install the valve tappets in the following manner.

(1) Remove and install bolts (35) attaching the valve tappet guide crab to engine block.

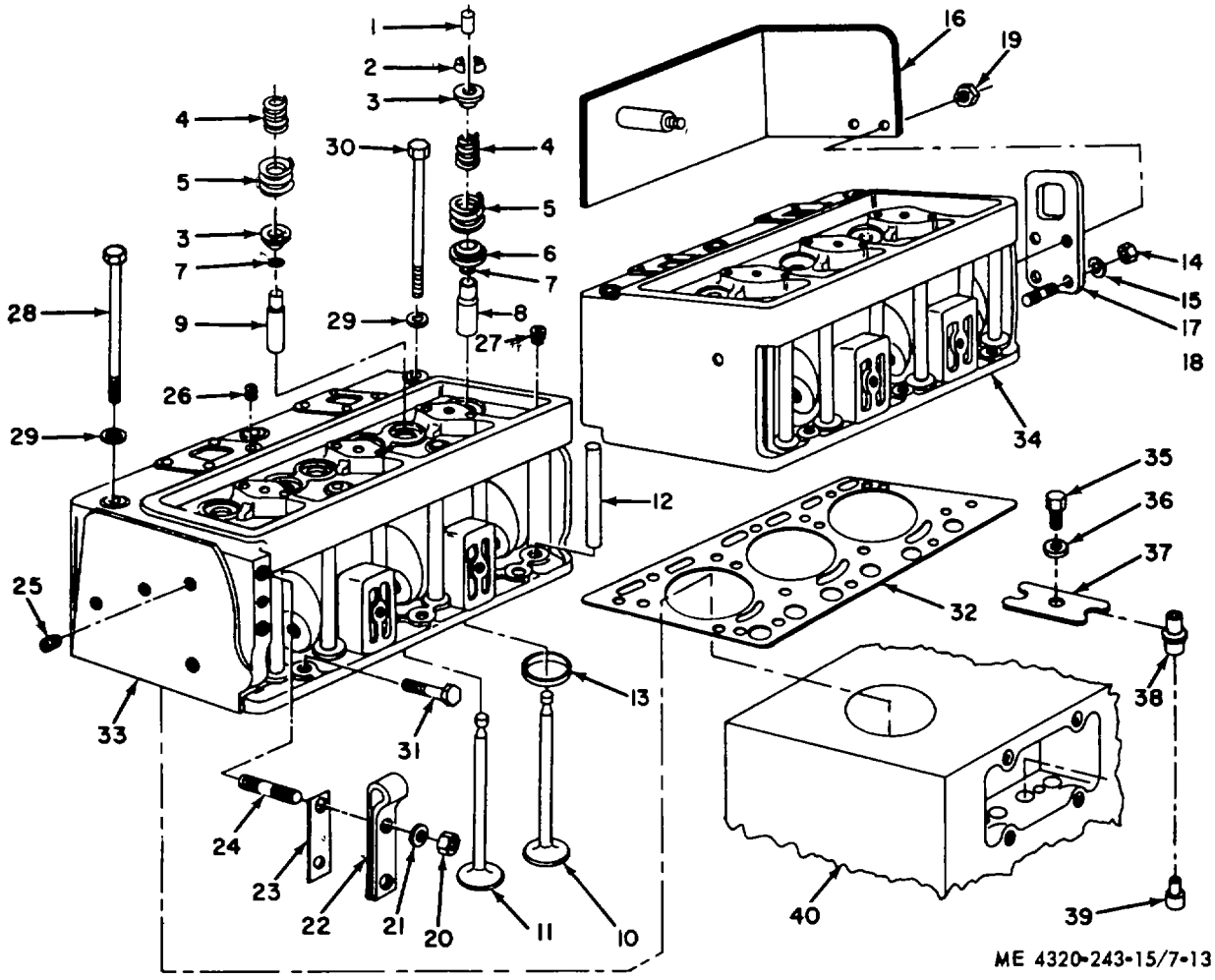
(2) Remove and install the valve tappet guides (38).

(3) Remove and install the valve tappets (39).

h. Disassemble the cylinder heads as shown by figure 7-13 and in the sequence indicated by key numbers. Reassemble in opposite sequence.

i. Clean, inspect, and repair.

j. Adjust the valves after installation (para 3-36).



1	Cap (12)	15	Washer (2)	28	Bolt (2)
2	Lock (24)	16	Heat shield	29	Washer (4)
3	Retainer (12)	17	Eye	30	Bolt (2)
4	Spring (12)	18	Stud (4)	31	Bolt (3)
5	Spring (12)	19	Locknut (2)	32	Gasket
6	Roto assembly (6)	20	Nut (2)	33	Front head
7	Snap ring (12)	21	Washer (2)	34	Rear head
8	Exhaust valve stem guide (6)	22	Eye	35	Screw (6)
9	Intake valve stem guide (6)	23	Spacer	36	Washer (6)
10	Exhaust valve (6)	24	Stud (2)	37	Crab (6)
11	Intake valve (6)	25	Plug (4)	38	Tappet guide (12)
12	Tube (12)	26	Plug	39	Tappet (12)
13	Valve seat insert	27	Plug	40	Engine block
14	Nut (2)				

Figure 7-13. Cylinder head and valve tappets, removal and installation, assembly and disassembly.

Section XIII. OIL PAN AND OIL PUMP

7-38. General

The oil pan is mounted underneath the cylinder assembly and serves as a protective cover and a reservoir for engine oil. The oil pump is mounted to the bottom of the cylinder assembly and is driven by the tachometer drive gear. Maximum oil pressure is limited to approximately 65 psi by a recirculating regulator

built into the oil pump body. Oil pressure in excess of 65 psi is bypassed from the pressure side of the oil pump through the regulator and consists of a calibrated coil spring to provide correct oil pressure and a relief valve. If the coil spring loses tension, it should be replaced. A handhole cover is provided in the bottom of the oil pan for inspection of the oil screen.

7-39. Oil Pan

a. Open the right side door of housing (fig. 3-36).

b. Drain oil.

c. Remove and install oil drain (fig. 3-36).

d. Remove and install bottom right hand panel (fig. 3-36).

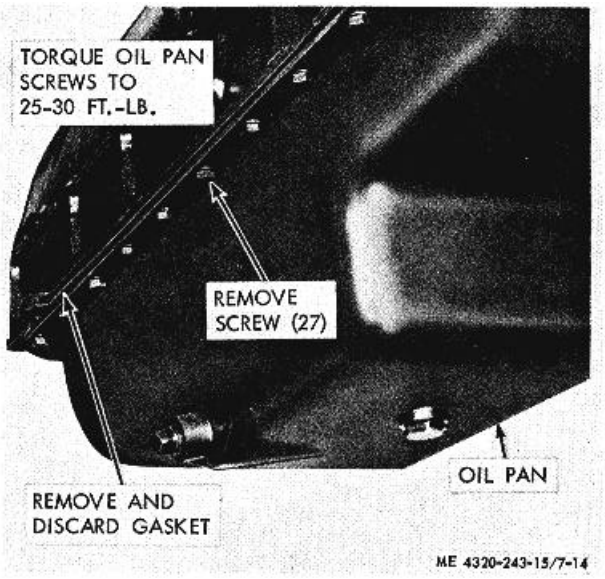


Figure 7-14. Oil pan, removal and installation

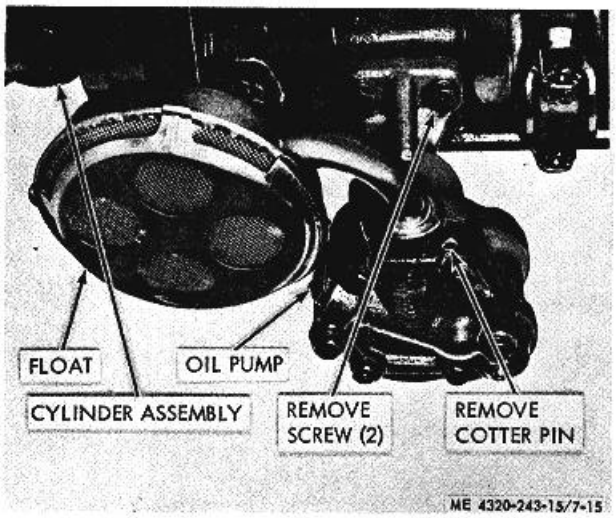


Figure 7-15. Oil pump, removal and installation.

e. Remove and install center bottom sheet.

f. Remove and install the oil pan as shown by figure 7-14. Remove and discard oil pan gasket; replace with a new one.

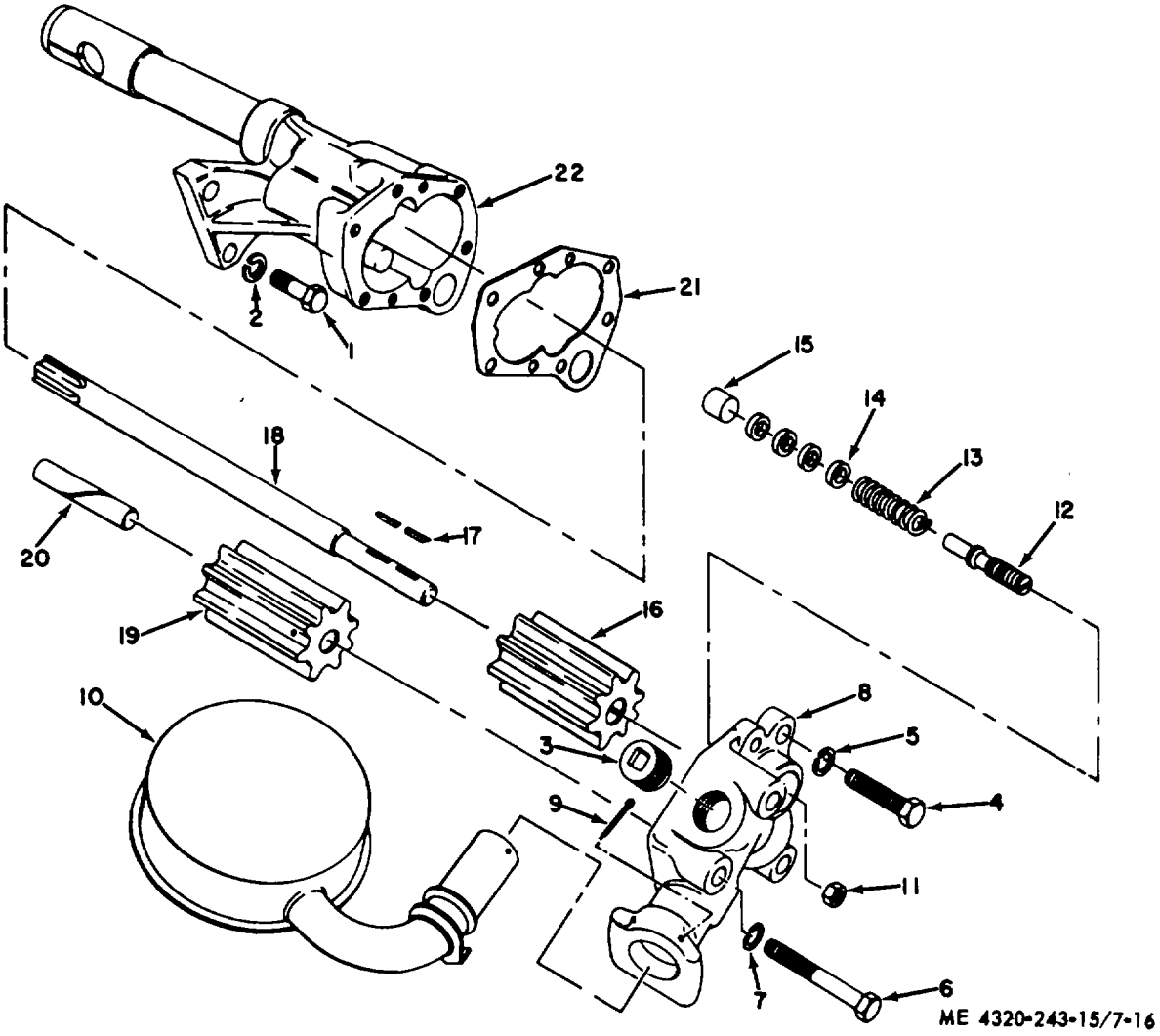
7-40. Oil Pump Assembly, Disassembly, and Repair

a. Remove and install the oil pan (para 7-39).

b. Remove and install the oil pump (fig. 7-15).

c. Disassemble the oil pump and float as shown in figure 7-16, in sequence indicated by key numbers. Reassemble in opposite sequences.

d. Inspect float-o-assembly oil screen for dirt. Clean screen with approved solvent.



1 Bolt (2)
2 Washer (2)
3 Plug
4 Bolt (4)
5 Washer (4)
6 Bolt (4)
7 Washer (4)
8 Cover
9 Pin
10 Float assembly
11 Nut
12 Screw
13 Spring
14 Washer (up to 4)
15 Valve
16 Gear
17 Key (2)
18 Shaft
19 Gear
20 Shaft
21 Gasket
22 Body

Figure 7-16. Oil pump and float, disassembly and assembly.

Section XIV. STARTING JAW, VIBRATION DAMPER AND DRIVE PULLEY

7-41. General

The starting jaw, vibration damper, and drive pulley, are mounted on the crankshaft in front of the engine. The vibration damper and drive pulley are balanced to reduce vibration.

7-42. Starting Jaw and Vibration Damper

a. Remove and install the starting jaw and vibration damper as shown by figure 7-17.

b. Clean, inspect, and repair.

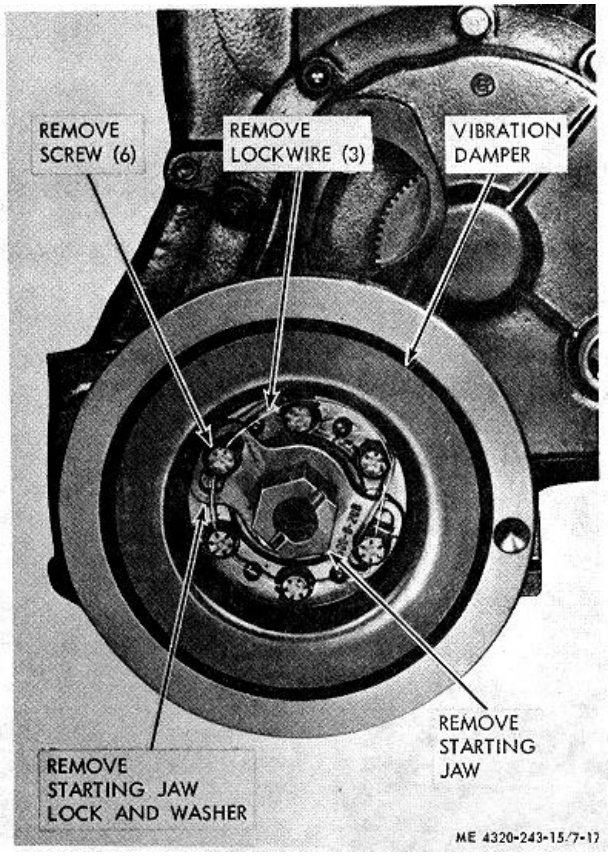


Figure 7-17. Starting jaw and vibration damper, removal and installation

7-43. Drive Pulley

a. Remove and install the starting jaw and vibration damper (para 7-42).

b. Remove and install the drive pulley as shown by figure 7-18.

c. Clean, inspect, and repair.

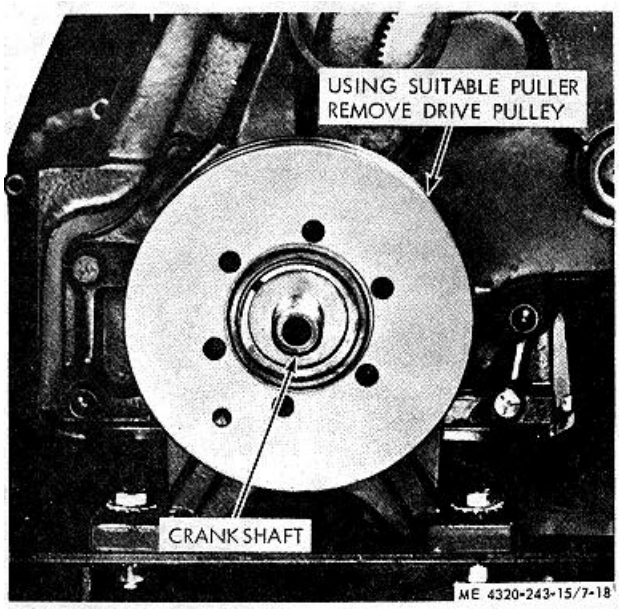


Figure 7-18. Drive pulley, removal and installation.

Section XV. TRUNNION BRACKET, TIMING GEAR COVER AND FRONT OIL SEAL

7-44. General

The trunnion bracket is base-mounted on the front engine support and supports the front of the engine. The timing gear and serves as a mounting for the magneto and governor. The timing gear cover also encases the front oil seal.

7-45. Removal, Installation, and Repair

a. Remove and install the magneto timing hole cover and governor (para 3-41).

b. Remove and install the drive pulley (para 7-43).

c. Remove and install the three capscrews and lockwashers that secure the oil pan to the timing gear cover.

d. Remove and install the trunnion bracket, timing gear cover, and front oil seal as shown by figure 7-19.

e. Clean, inspect, and repair.

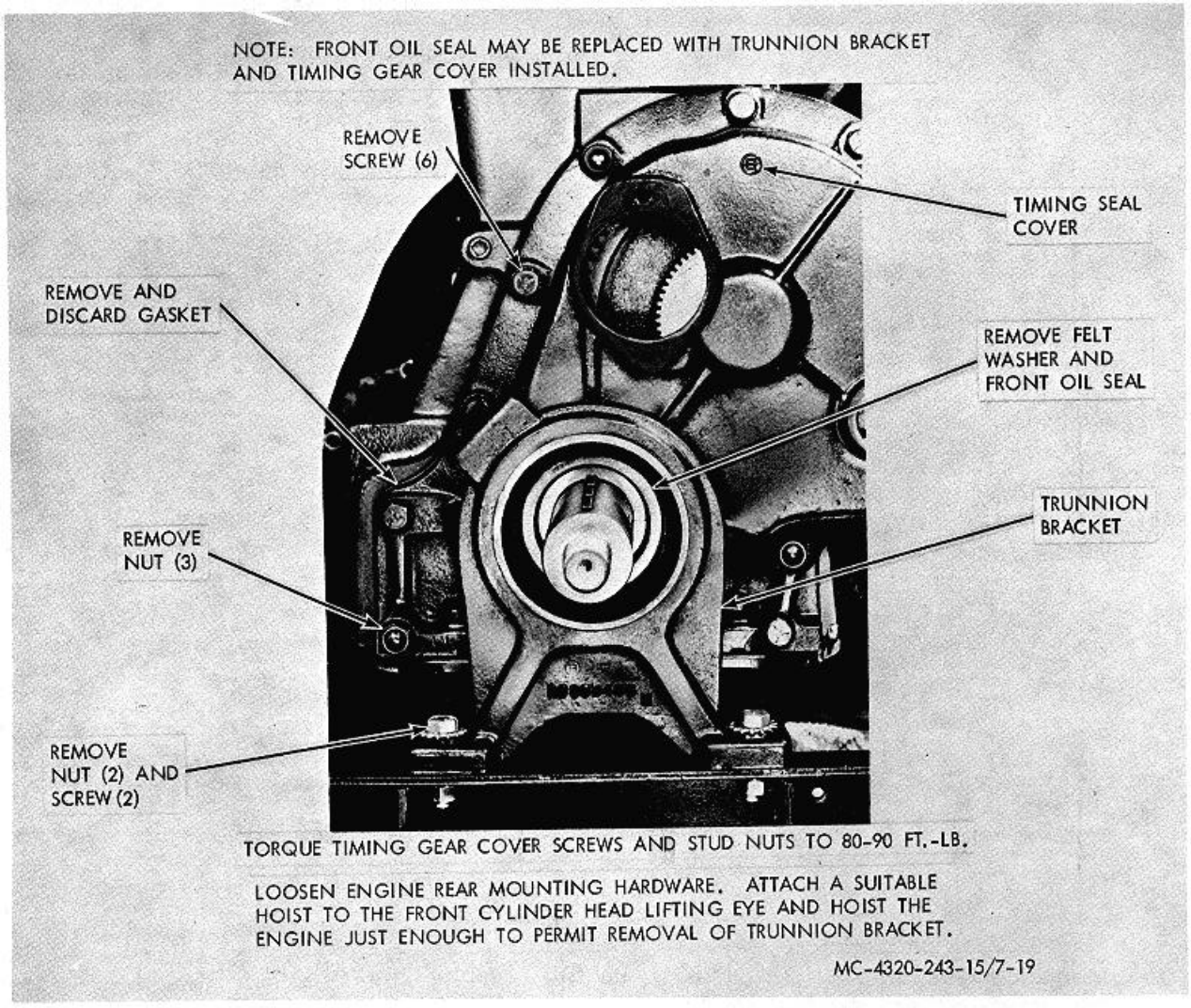


Figure 7-19. Trunnion bracket, timing gear cover and front oil seal, removal and installation.

Section XVI. GOVERNOR DRIVE GEAR, OIL DEFLECTOR CAMSHAFT GEAR, FRONT END PLATE, CAMSHAFT THRUST PLATE, AND CAMSHAFT

7-46. General

All components covered in this section are located on the front of the cylinder assembly behind the timing gear cover. The governor drive gear and camshaft gear are mounted on the camshaft. The governor drive gear drives the governor. The crankshaft gear drives the camshaft gear, which revolves the camshaft in proper time. The front end plate serves as a mounting base for the timing gear cover. The camshaft thrust plate retains and supports the camshaft in the cylinder assembly. The camshaft rides in bushings pressed into the cylinder assembly.

7-47. Governor Drive Gear, Oil Deflector, and Camshaft Gear

a. Remove and install the engine (para 5-13).

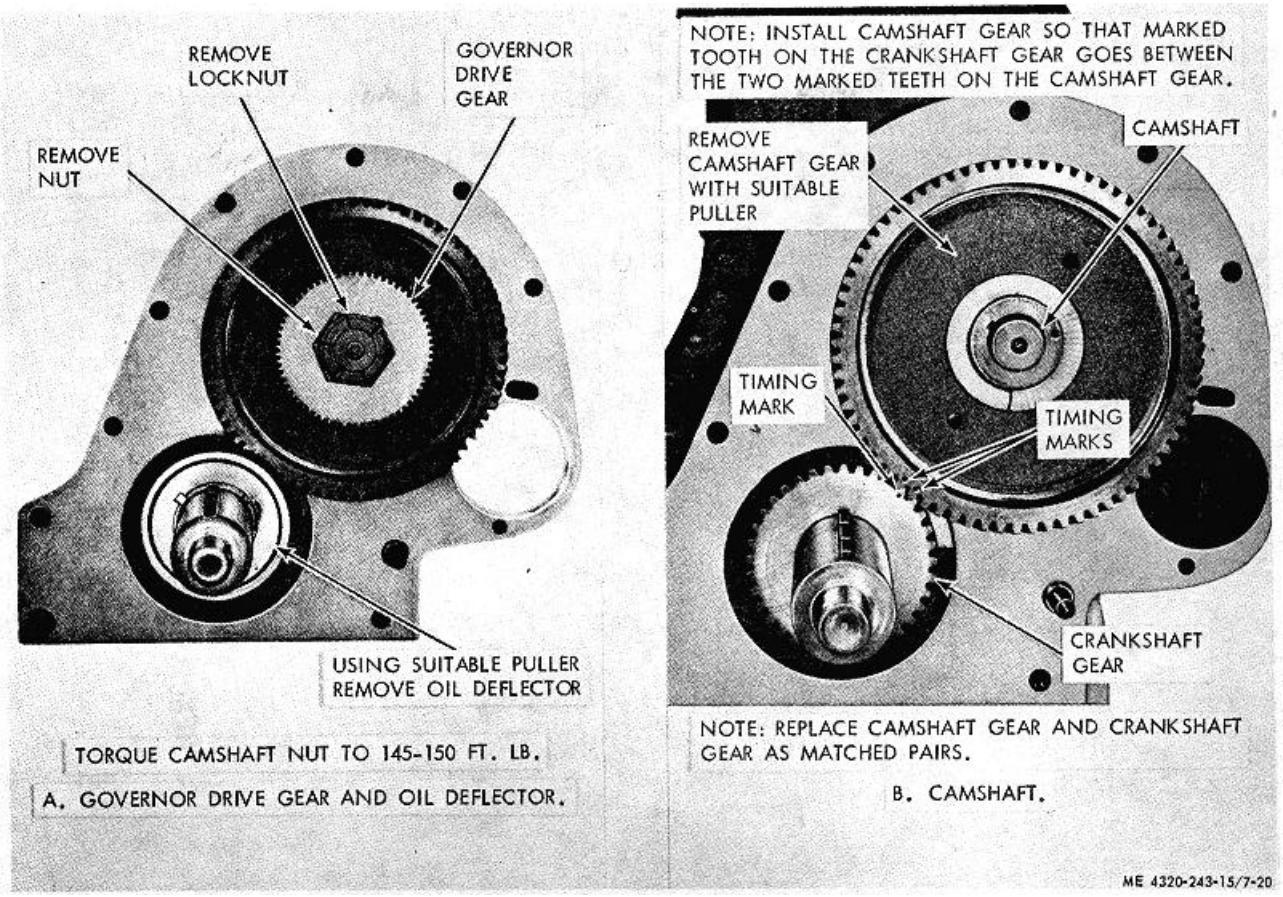


Figure 7-20. Governor drive gear, oil deflector and camshaft gear, removal and installation.

b. Remove and install the rocker arms and push rods (para 7-34).

c. Remove and install the valve tappets (para 7-37).

d. Remove and install the timing hole cover.

e. Remove and install the governor drive gear, oil deflector, and camshaft gear as shown by figure 7-20.

f. Clean, inspect and repair.

7-48. Front End Plate, Camshaft Thrust Plate and Camshaft

a. Remove and install the governor drive gear, oil deflector, and camshaft gear (fig. 7-20).

b. Remove and install the front end plate, camshaft thrust plate and camshaft as shown by figure 7-21.

c. Clean, inspect and repair.

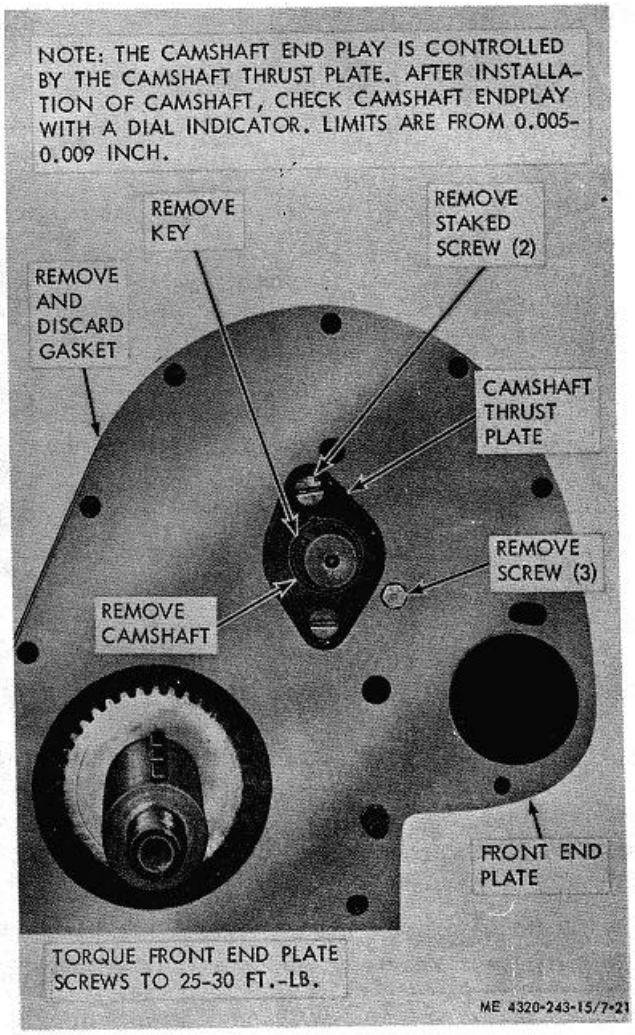


Figure 7-21. Front end plate, camshaft thrust plate and camshaft, removal and installation

Section XVII. ACCESSORY DRIVE SHAFT, FLYWHEEL HOUSING AND REAR OIL SEAL

7-49. General

The flywheel housing is mounted at the rear of the cylinder assembly. It provides a protective cover for the flywheel and is used as a mounting base for the starting motor and rear engine support. The accessory drive shaft is mounted to the center of the flywheel. The engine coupling mounts on the rear end of accessory drive shaft, and is connected to the pump coupling. The accessory drive shaft transfers the motive power of the engine to the engine coupling.

7-50. Accessory Drive Shaft

a. Remove and install the engine (para 5-13).

b. Remove and install the accessory driveshaft in sequence as shown by figure 7-22.

c. Clean, inspect, and repair.

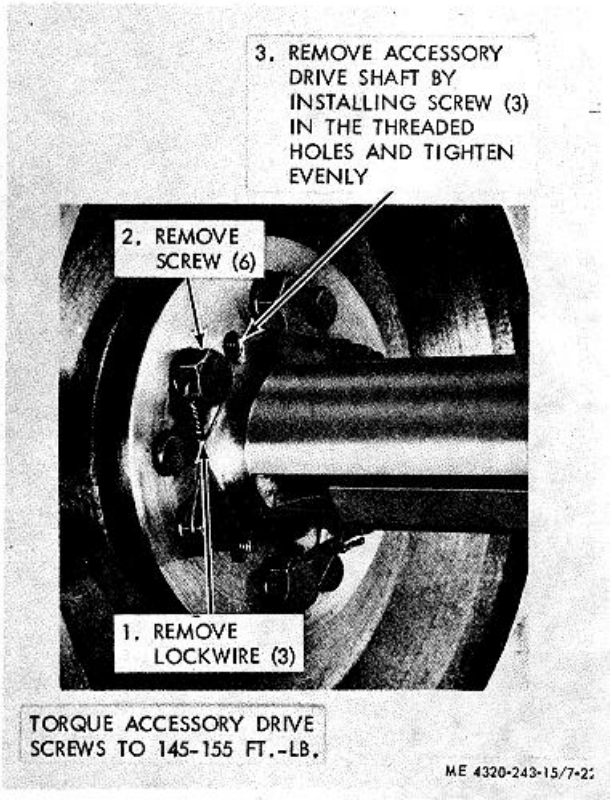


Figure 7-22. Accessory drive shaft, removal and installation

7-51. Flywheel and Flywheel Housing

a. Remove and install the timing hole cover, and starting motor (para 3-48).

b. Remove and install the accessory drive shaft (par. 7-50) and engine coupling (fig. 6-5).

c. Remove and install the flywheel and flywheel housing as shown by figure 7-23.

d. Clean, inspect, and repair.

7-52. Rear Oil Seal

a. Remove and install the flywheel and flywheel housing (para 7-51, above).

b. Remove and install the rear oil seal as shown by figure 7-24.

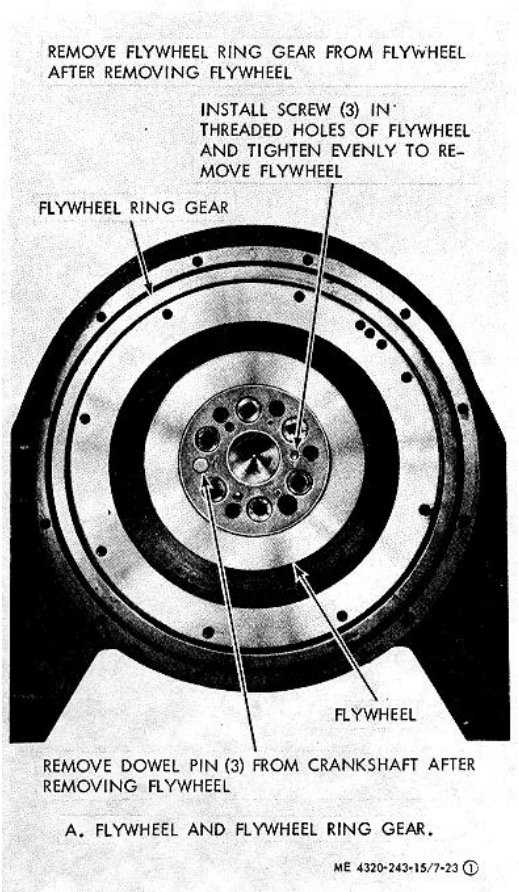


Figure 7-23. Flywheel and flywheel housing, removal and installation.

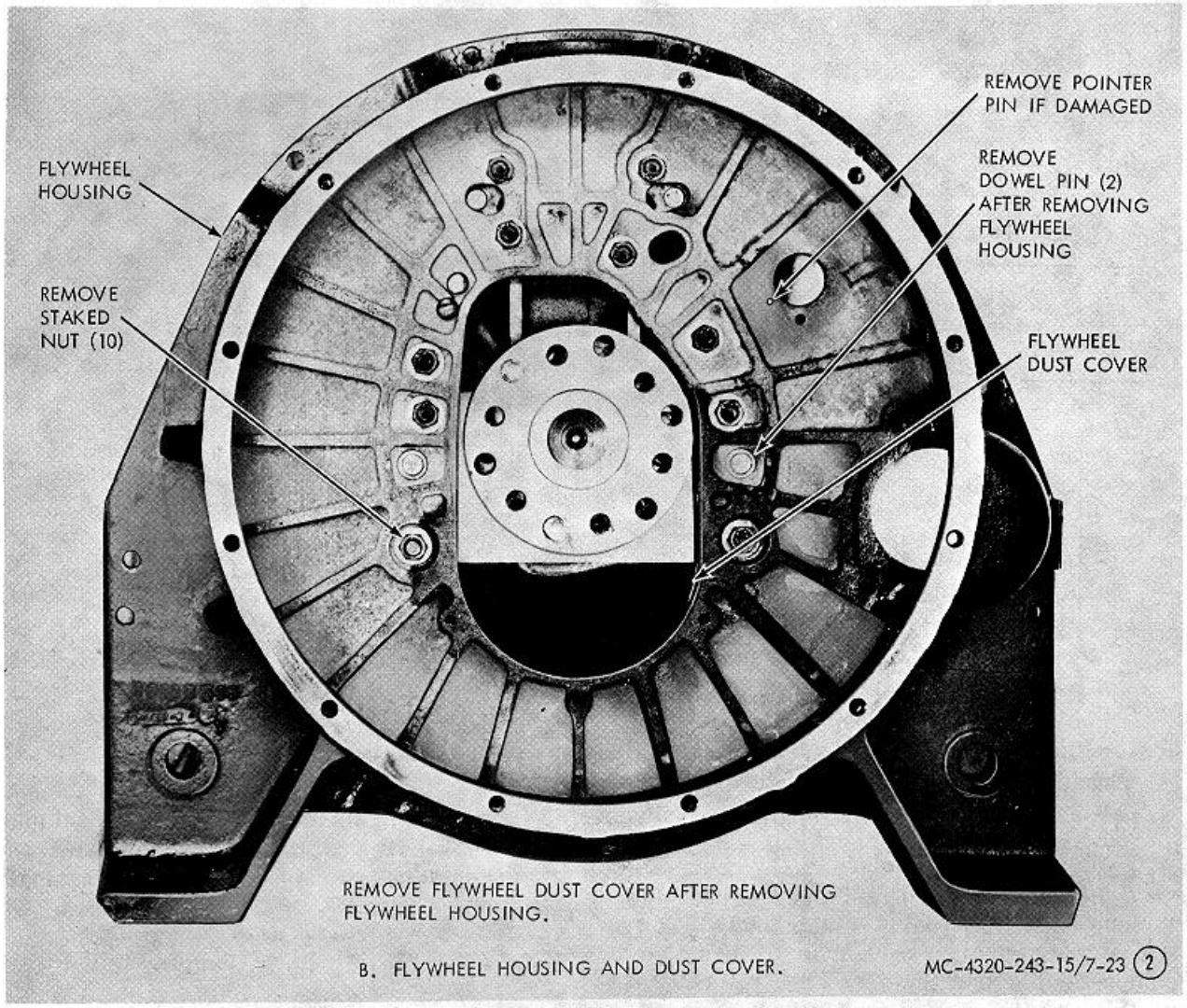


Figure 7-23-Continued.

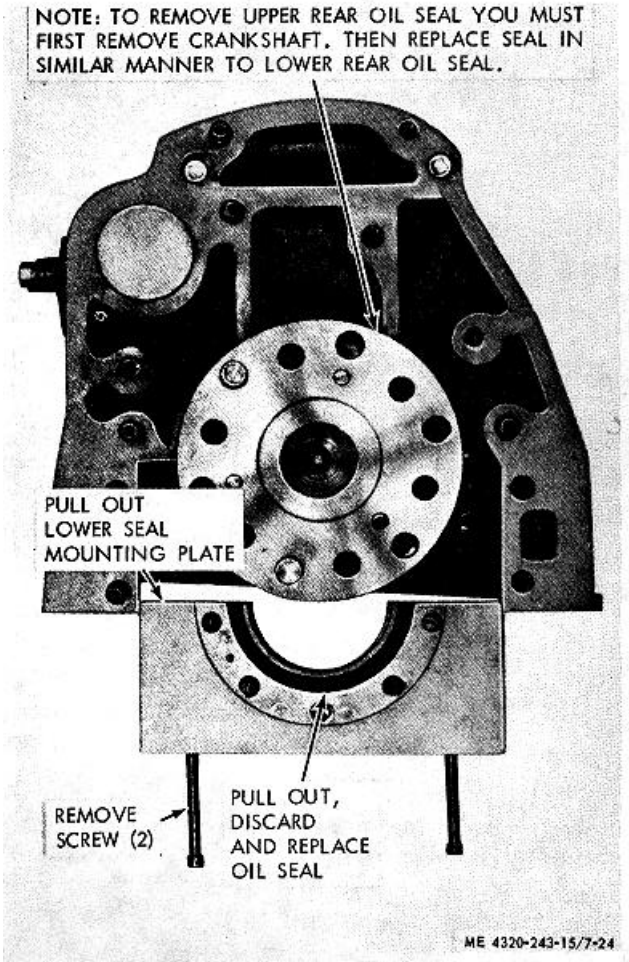


Figure 7-24. Rear oil seal, removal and installation.

Section XVIII. CONNECTING RODS, CONNECTING ROD BEARINGS, PISTONS, FILLER BLOCK, MAIN BEARING CAPS, MAIN BEARINGS, CRANKSHAFT, CRANKSHAFT GEAR, AND CAMSHAFT BUSHINGS

7-53. General

The connecting rods, made of drop-forged steel, are precision machined at each end. The pistons are made of aluminum alloy and are both tapered and oval ground. Grooves for 3 compression rings and 1 oil-control ring are machined into each piston above the piston pin bore. The filler block is located at the lower rear of the cylinder assembly and must be removed for crankshaft removal. The crankshaft is a 1-piece steel, case hardened forging, counter balance with 12 integral counterweights. Seven main bearings caps support the crankshaft in the cylinder assembly. The crankshaft rides in 7 upper-half and 7 lower-half main bearings. Both halves of the center main bearing are flanged to control crankshaft endplay. The crankshaft gear is mounted on the front of the crankshaft and drives the camshaft gear.

7-54. Connecting Rods, Pistons, and Piston Pins

a. Remove and install the cylinder heads (para 7-37).

b. Remove and install the oil pump (para 7-40).

c. Remove and install the engine (para 5-13).

d. Remove and install the connecting rods and pistons as shown by figure 7-25.

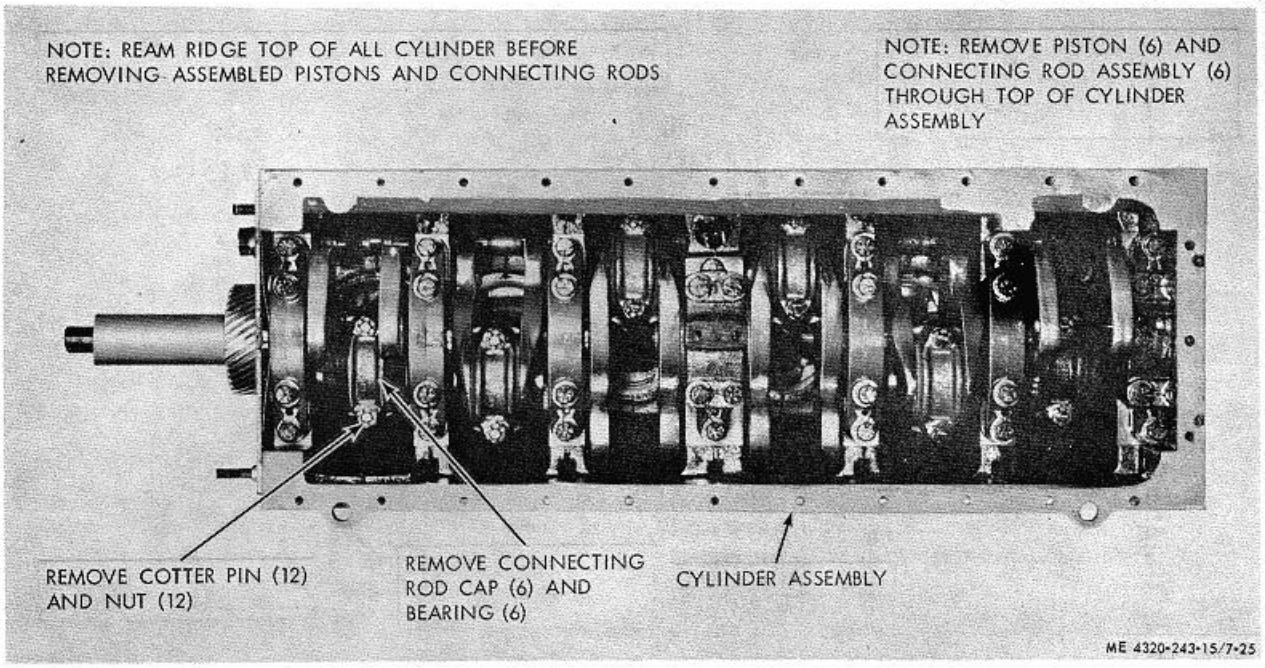


Figure 7-25. Connecting rods and pistons, removal and installation.

e. Disassemble the connecting rods and pistons as shown by figure 7-26, in sequence indicated by key numbers. Reassemble in opposite sequence.

f. Clean, inspect, and repair.

7-55. Filler Block, Main Bearing Caps, Crankshaft Gear, and Main Bearings

a. Remove and install the fuel pump and filter (para 3-39), fuel line (para 3-39), cylinder assembly draincock (fig. 7-27), and the oil level dipstick.

b. Remove and install the generator (para 3-46) and tachometer drive housing (para 3-30) and adapter.

c. Remove and install the engine (para 5-13).

d. Remove and install the cylinder heads (para 7-37).

e. Remove and install the cylinder heads (para 7-48).

f. Remove and install the rear oil seal (para 7-52).

g. Remove and install the connecting rods and pistons (para 7-54).

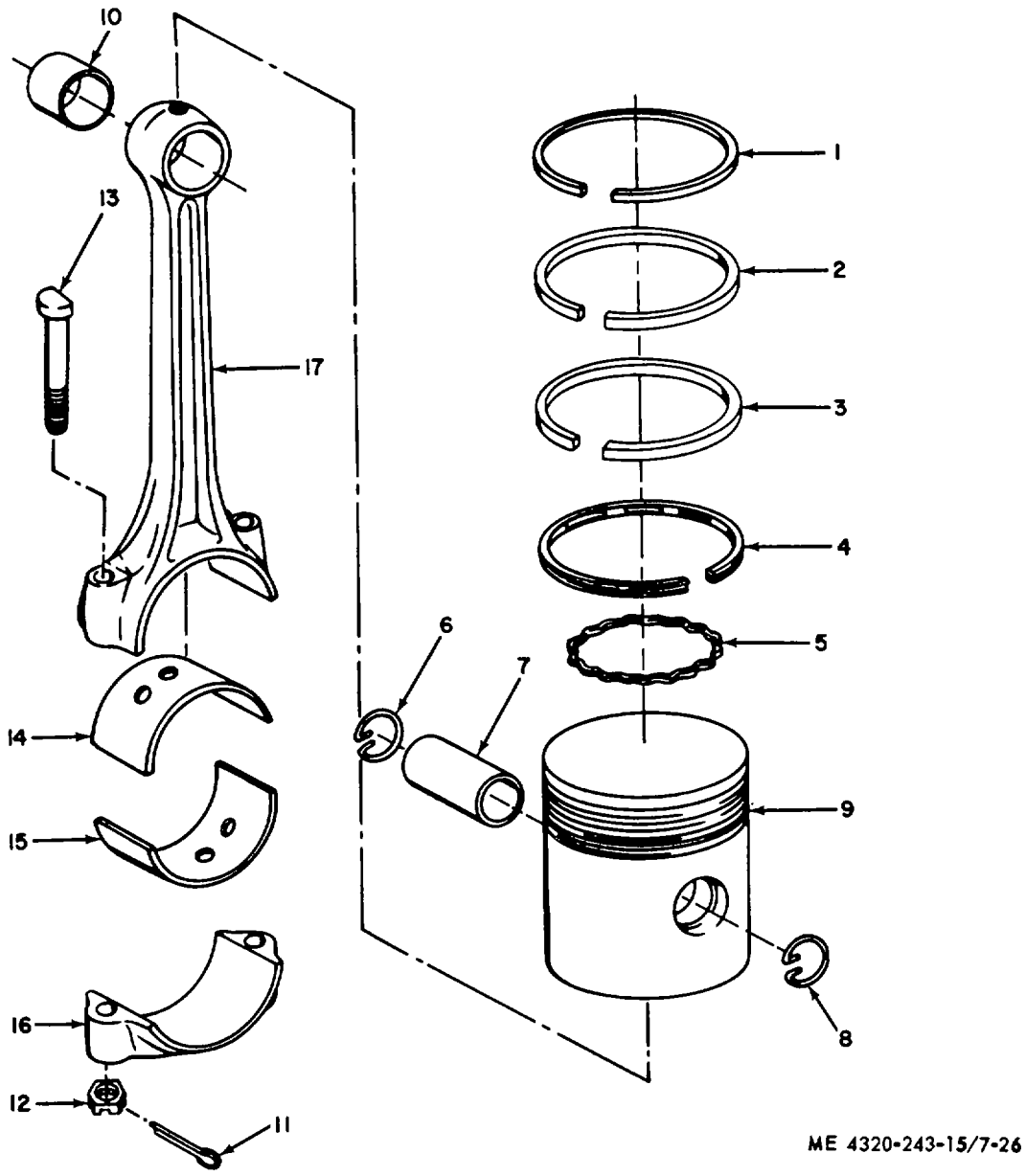
h. Remove and install the filler block, main bearing caps, crankshaft gear, and main bearings as shown by figure 7-28.

7-56. Camshaft Bushings

a. Remove and install the filler block, main-bearing caps, crankshaft, crankshaft gear, and main bearings (para 7-55).

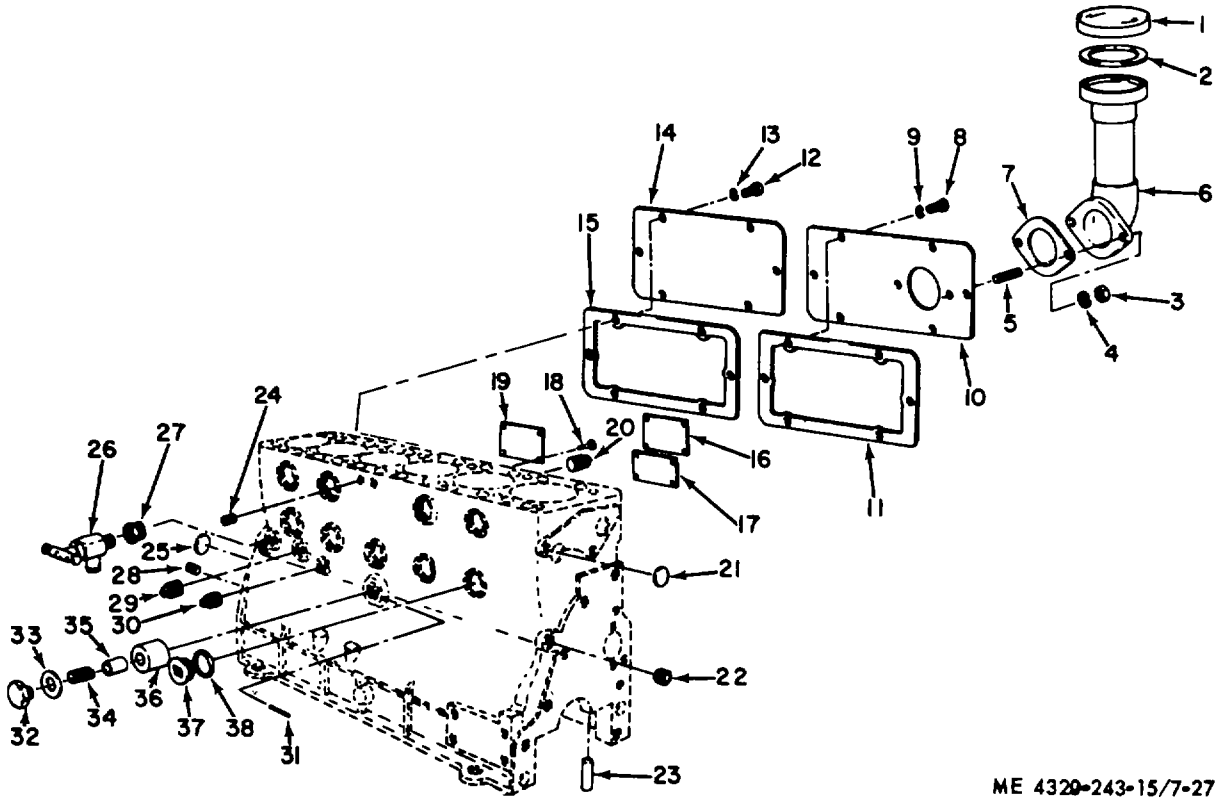
b. Remove and install the camshaft bushings as shown in fig. 7-28.

c. Clean, inspect and repair.



1 Ring
2 Ring
3 Ring
4 Ring
5 Expander
6 Retaining ring
7 Pin
8 Retaining ring
9 Piston
10 Bushing
11 Cotter pin
12 Nut
13 Bolt
14 Bearing
15 Bearing
16 Cap
17 Rod

Figure 7-26. Piston, rings and connecting rod assembly, assembly and disassembly.



1	Cap	14	Cover	27	Bushing
2	Gasket	15	Gasket	28	Plug
3	Nut	16	Plate	29	Plug
4	Washer	17	Plate	30	Plug
5	Stud	18	Screw	31	Pin
6	Filler	19	Plate	32	Plug
7	Gasket	20	Plug	33	Gasket
8	Screw	21	Plug	34	Spring
9	Washer	22	Plug	35	Valve
10	Cover	23	Pin	36	Sleeve
11	Gasket	24	Plug	37	Plug
12	Screw	25	Plug	38	Gasket
13	Washer	26	Cock		

Figure 7-27. Cylinder assembly, assembly and disassembly.

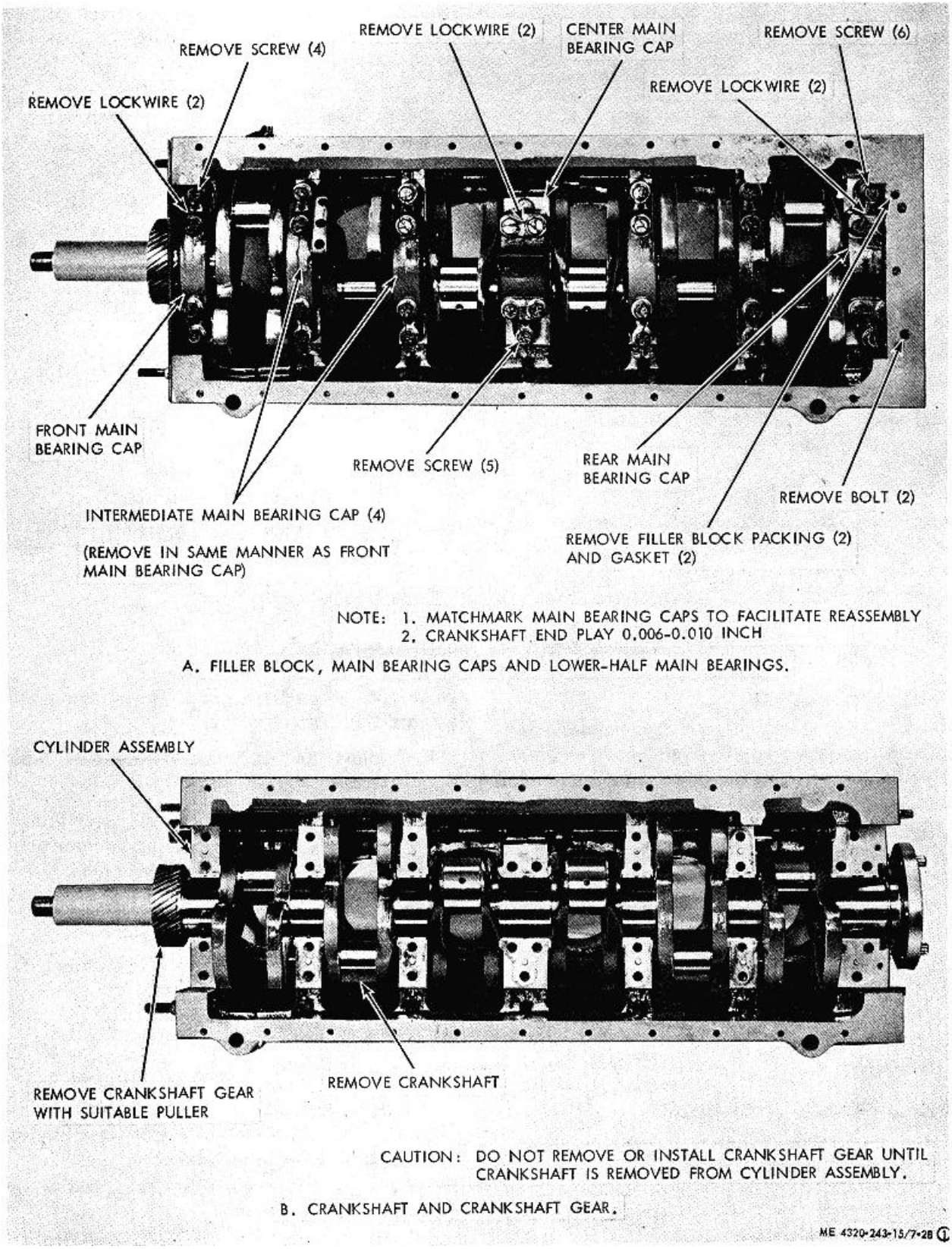


Figure 7-28. Filler block, main bearing caps, crankshaft gear, main bearings and camshaft bushings removal and installation.

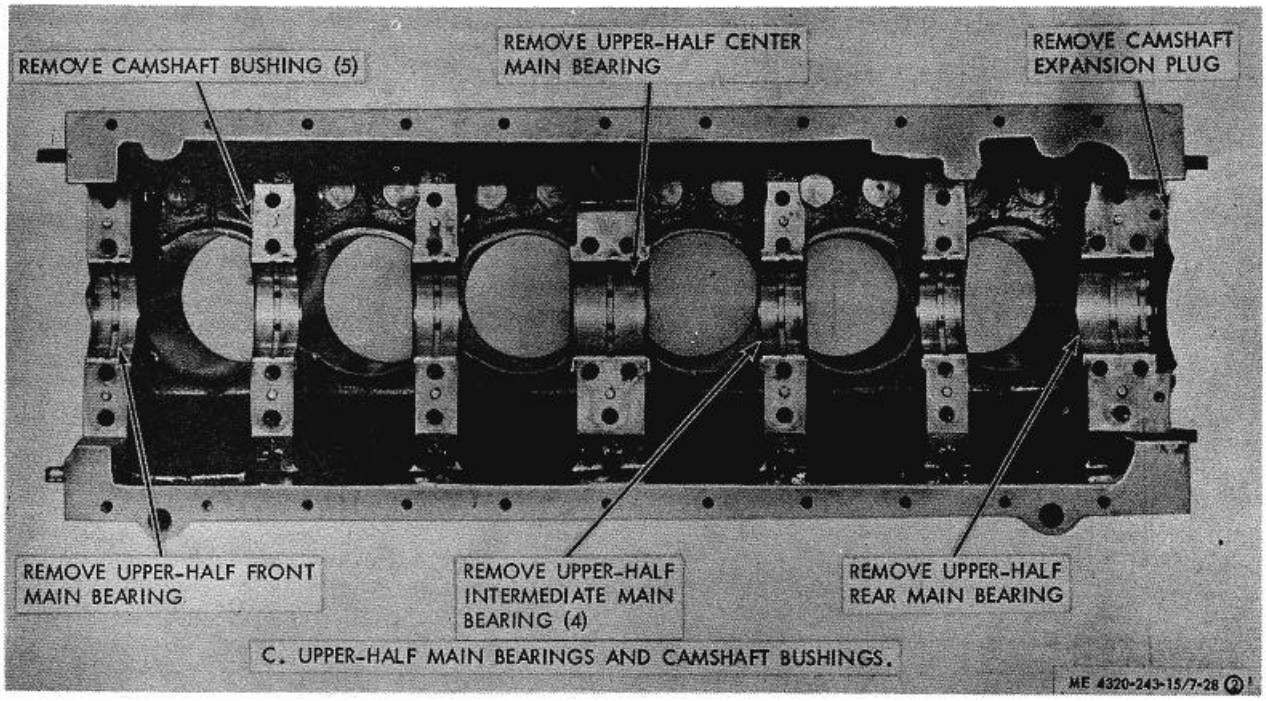


Figure 7-28-Continued

Section XIX. CYLINDER ASSEMBLY

7-57. General

The cylinder assembly is a chrome-alloy casting with unused opening plugged. The cylinder assembly serves as a main housing for engine components. Oil and water passages in the cylinder assembly provide cooling and lubrication for engine components. The cylinder assembly is machined to accomodate engine components and to maintain their proper relationship.

7-58. Removal, Installation, and Repair

a. Remove and install the oil pressure relief valve located on the right side of the cylinder assembly (para 3-63).

b. Remove and install the camshaft bushings (para 7-56).

c. Disassemble the cylinder assembly as shown by figure 7-27, in the sequence indicated by key numbers. Reassemble in the reverse sequence.

d. Clean all parts and oil passages.

e. Refer to table 4-1 for wear limits.

f. Inspect, clean and repair.

Section XX. FUEL TANK ASSEMBLY

7-59. Repair of Fuel Tank

a. Remove and install the fuel tank as directed in paragraph 3-43.

b. Be sure all fuel has been drained from the tank.

c. Flush the fuel tank with clean water.

d. Install plugs in all openings of the tank, except the filler, and fill tank with clean water.

***Warning*: Make sure the tank is completely filled with water to eliminate all fumes which might cause an explosion.**

e. Check for location of leaks and weld as necessary.

f. Remove plugs from tank and drain out the water. Dry thoroughly with compressed air before reinstalling.

APPENDIX A

REFERENCES

A-1. Fire Protection

TB 5-4200-200-10	Hand Portable Fire Extinguisher for Army use.

A-2. Lubrication

C9100-IL	Fuels, Lubricants, Oils, and Waxes.
LO 5-4320-243-12	Department of The Army Lubrication Order.

A-3. Painting

TM 9-213	Painting Instructions for Field Use.

A-4. Maintenance

TM 9-6140-200-15	Storage Batteries, Lead-Acid Type.
TM 38750	Army Equipment Record Procedures.
TM 5-764	Electric Motor and Generator Repair.
TB ORD 651	Use of Antifreeze Solutions and Cleaning Compounds in EngineCooling Systems.
TM 5.4320-243-20P	Organizational Maintenance Repair Parts and Special Tools List.
TM 54320-243-35P	Direct Support, General Support and Depot Maintenance Repair Parts and Special Tools List.
TM 5-4320-243-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual.

A-5. Radio Suppression

TM 11483	Radio Interference Suppression.

A-6. Shipment and Storage

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage.
TB 740-93-3	Administrative Storage of USAMEC Mechanical Equipment.

APPENDIX B

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

B-1. Scope

This appendix lists items which accompany the John Reiner Centrifugal Pump-Model GP 110-5, or are required for installation, operation, or operator's maintenance.

B-2. General

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

a. Basic Issue Items-Section II. This section is a listing of accessories, repair parts, tools, and publications required for operator's maintenance and operation, initially issued with, or authorized for the Centrifugal Pump Unit.

b. Maintenance and Operating Supplies Section III. This section is a listing of maintenance and operating supplies required for initial operation.

B-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), Column (1):

(1) Source Code indicates the selection status and source for the listed item. Source codes are:

Code	*Explanation*
P	Applied to repair parts which are stocked in or supplied from GSA/DSA Army supply system, and authorized for use at indicated maintenance categories.
M	Applied to repair parts which are not procured or stocked, but are to be manufactured at indicated maintenance categories.
A	Applied to assemblies which are not procured, or stocked as such, but made up of two or more units, each of which carry individual stock numbers and descriptions and are procured and stocked and can be assembled by units at indicated maintenance categories.
X	Applied to parts and assemblies which are not procured or stocked, the mortality of which is normally below that of the applicable end item, and the failure of which should result in retirement of the end item from the supply system.
X1	Applied to repair parts which are not procured or stocked, the requirement for which will be supplied by use of the next higher assembly or components.
X2	Applied to repair parts which are not stocked. The indicated maintenance category requiring such repair parts will attempt to obtain them through cannibalization; if not obtainable through cannibalization, such repair parts will be requisitioned with supporting justification through normal supply channels.
C	Applied to repair parts authorized for local procurements. If not obtainable from local procurement, such repair parts will be requisitioned through normal supply channels with a supporting statement of non-availability from local procurement.
G	Applied to Major assemblies that are procured with PEMA (Procurement Equipment Missile Army) funds for initial issue only to be used as exchange assemblies at DSU and GSU lever or returned to depot supply level.

Note

Source code is not shown on common hardware items known to be readily available in Army supply channels and through local procurement.

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

Code	*Explanation*
C	Operator/crew
O	Organizational maintenance

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

Code	*Explanation*
R	Applied to repair parts and assemblies which are economically reparable at DSU and GSU activities and are normally furnished by supply on an exchange basis.
T	Applied to high dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts are normally repaired or overhauled at depot maintenance activities.
U	Applied to repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, high dollar value reusable castings, and castings.

b. Federal Stock Number, Column (2). This column indicates the Federal Stock Number for the item.

c. Description, Column (3). This column indicates the Federal item name and any additional description required. A five-digit manufacturer's or other service code is shown in parentheses followed by the manufacturer's part number. Repair parts quantities included in kits, sets, and assemblies that differ from the actual quantity used in the specific item, are listed in parentheses following the repair part name.

d. Unit of Issue, Column (4). This column indicates the unit used as a basic of issue, e.g., ea, pr, ft, yd, etc.

e. Quantity Incorporated in Unit Pack, Column (5). This column indicates the actual quantity contained in the unit pack.

f. Quantity Incorporated in Unit, Column (6). This column indicates the quantity of the item used in the equipment.

g. Quantity Furnished with Equipment, Column (7). This column indicates the quantity of an item furnished with the equipment in excess of the quantity incorporated in the unit.

h. Quantity Authorized, Column (8). This column indicates the quantity of an item authorized the operator/crew to have on hand or to obtain as required. As required items are indicated with an asterisk.

i. Illustration, Column (9). This column is divided as follows:

(1) Figure Number, column (9)(a), indicates the figure number of the illustration in which the item is shown.

(2) Item Number, column (9)(b), indicates the callout number used to reference the item in the illustration.

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

a. Item, Column (1). This column contains numerical sequence item numbers assigned to each component application to facilitate reference.

b. Component Application, Column (2). This column identifies the component application of each maintenance or operating supply item.

c. Federal Stock Number, Column (3). This column indicates the Federal Stock Number for the item and will be used for requisitioning purposes.

d. Description, Column (4). This column indicates the item and a brief description.

e. Quantity Required for Initial Operation, Column (5). This column indicates the quantity of each maintenance or operating supply item required for initial operation of the shipment.

f. Quantity Required for 8 Hours Operation, Column (6). This column indicates the estimated quantities required for an average eight hours of operation.

g. Notes, Column (7). This column indicates informative notes keyed to data appearing in a preceding column.

Section II. BASIC ISSUE ITEMS LIST

(1) Source, maint. & recov. code (A) S	(B) M	(C) R	(2) Federal stock No.	(3) Description	(4) Unit of issue	(5) Qty. inc in unit pack	(6) Qty. inc in unit	(7) Qty. furn with equip	(8) Qty. auth	(9) Illustrat. (A) Fig. No.	(B) Item No.
				Group 31-Basic Issue Items, manufacturer installed.							
				3100-Basic Issue Items, manufacturer or depot installed.							
P	O		7510-889-3494	Binder Log Book: Note with applicable forms required	Ea			1	1		
P	O		7520-559-9618	Case: Maintenance and operational Manuals, cotton duck Water repellent, mildew resistant-MIL-B-11743B.	Ea			1	1		
				Department of the Army, Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual. TM 5-4320-243-15.	Ea			1	1		

Section III. MAINTENANCE AND OPERATING SUPPLIES

(1) Item	(2) Component Application	(3) Federal Stock Number	(4) Description	(5) Quantity required f/initial operation	(6) Quantity required f/8 hrs operation	(7) Notes
1	0101 CRANKCASE		OIL, LUBRICATING: as follows:	5 gal drum		(1) Includes quantity of oil to fill engine oil system as follows:
		9150-265-9435 (2)	OE-30	20 qt (1)	(3)	16 qt-crankcase 4 qt-oil filters
		9150-265-9428 (2)	OE-10	20 qt (1)	(3)	(2) See C9100-IL for additional
		9150-242-7603 (2)	OES	20 qt (1)		(3) data and requisitioning procedure.
2	0304 AIR CLEANER		OIL LUBRICATING (4)			(3) See current L.O. for grade application and replenishment intervals.
			OE-30	2 qt	(3)	
			OE-10	2 qt	(3)	
			OES	2 qt	(3)	
3	0306 TANK FUEL		FUEL, GASOLINE: bulk as follows:			(4) Use oil as prescribed in item 1. (5) Tank capacity.
		9130-160-1818 (2)	Automotive combat 91A	25 gal (5)	56 (6)	(6) Average fuel consumption is 7 gal per hour of continuous operation.
		9130-160-1830 (2)	Automotive combat 91C	25 gal (5)	56 (6)	
4	RADIATOR		WATER ANTIFREEZE	55 gal	38 qt	
		6850-664-1409	drum as follows: Ethylene Glycol	23 qt		
		6850-174-1806	ANTIFREEZE: compound Artic	38 qt		
5	5501 PUMP BEARING		OIL LUBRICATING(4) OE-10	1/8 qt ea	(3)	
6	GREASE POINTS		GREASE, AUTOMOTIVE AND ARTILLERY: 1 lb can as follows:	1 lb	(3)	
		9150-190-0904	GAA			

APPENDIX C

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

C-1. General

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

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

c. Section III lists the special tools and test equipment required for each maintenance operation as referenced from Section II.

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

C-2. Explanation of Columns in Section II

a. Functional Group Number. The functional group is a numerical group set up on a functional basis. The applicable functional grouping indexes (obtained from TB 750-931, Functional Grouping Codes) are listed on the MAC in the appropriate numerical sequence. These indexes are normally set up in accordance with their function and proximity to each other.

b. Component Assembly Nomenclature. This column contains a brief description of the components of each functional group.

c. Maintenance Functions and Maintenance Categories. This column lists the various maintenance functions (A through K) and indicates the lowest maintenance category authorized to perform these operations. 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: Verify serviceability and detect incipient electrical or mechanical failure by close visual examination.

B--Test: Verify serviceability and detect incipient electrical or mechanical failure by measuring the mechanical or electrical characteristics of the item and comparing those characteristics with authorized standards. Tests will be made to commensurate with test procedures and with calibrated tools and/or test equipment referenced in the MAC.

C--Service: Operations required periodically to keep the item in proper operating conditions, i.e., to clean, preserve, drain, paint, and replenish fuel, lubricants, hydraulic, and de-icing fluids, or compressed air supplies.

D--Adjust: Regulate periodically to prevent malfunction. Adjustments will be made to commensurate with adjustment procedures and associated equipment adjustment specifications.

E--Aline: Adjust two or more components of an electrical or mechanical system so that their functions are properly synchronized or adjusted.

F--Calibrate: Determine, check, or rectify the graduation of an instrument, weapon, or weapons system or components of a weapons system.

G--Install: Remove and install the same item for service or when required for the performance of other maintenance operations.

H--Replace: Substitute serviceable components, assemblies, and subassemblies for unserviceable counter-parts.

I--Repair: Restore to a serviceable condition by replacing unserviceable parts or by any other action required using available tools, equipment, and skills, including welding, grinding, riveting, straightening, adjusting, and facing.

J--Overhaul: Restore an item to a completely serviceable condition (as prescribed by serviceability standards developed and published by the commodity commands) by employing techniques of "Inspect and Repair Only As Necessary" (IROAN). Maximum use of diagnostic and test equipment is combined with minimum disassembly during overhaul. "Overhaul" may be assigned to any level of maintenance except organizational, provided the time, tools, equipment, repair parts authorization, and technical skills are available at that level. Normally, overhaul as applied to end items is limited to depot maintenance level.

K--Rebuild: Restore to a condition comparable to new by disassembling to determine the condition of each component part and reassembling using serviceable, rebuilt, or new assemblies, sub-assemblies, and parts.

d. Note Reference. This column, subdivided into columns L and M, is provided for referencing the Special Tool and Test Equipment Requirements (sec. III) and Remarks (sec. IV) that may be associated with maintenance functions (sec. II).

C-3. Explanations of Columns in Section III

a. Reference Code. This column consists of a number and a letter separated by a dash. The number references the T & TE requirements column on the MAC. The letter represents the specific maintenance function the item is to be used with. The letter is representative of columns A through K on the MAC.

b. Maintenance Level. This column shows the lowest level of maintenance authorized to use the special tool or test equipment.

c. Nomenclature. This column lists the name or identification of the tool or test equipment.

d. Tool Number. This column lists the manufacturer's code and part number, or Federal Stock Number of tools and test equipment.

C-4. Explanation of Columns in Section IV

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 M and the second references a maintenance operation, columns A through K.

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

Section II. MAINTENANCE ALLOCATION CHART

GROUP NUMBER	Component assembly nomenclature	Maintenance functions											Note reference	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	LIBRATE	INSTALL	REPLACE	REPAIR	VERHAUL	REBUILD	Tools and equipment	Remarks
01	ENGINE													
0100	Engine Assembly	O	O	O					F	F	H	D		A
0101	Crankcase; Block Cylinder Head													
	Cylinder assembly	H							H	H		D		
	Head, cylinder	F							F	F	D			B
0102	Crankshaft	H							H	D				C
0103	Flywheel assembly	F							F	H				D
0104	Pistons, connecting rods	H							H	H				E, F

GROUP NUMBER	Component assembly nomenclature	Maintenance functions											Note reference	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	LIBRATE	INSTALL	REPLACE	REPAIR	VERHAUL	REBUILD	Tools and equipment	Remarks
0106	Valves, camshafts and timing system													
	Rocker arm				O				F					
	Camshafts	H							H					
	Valves & seats	F			O				F	F				G
0106	Engine lubrication system													
	Pump, oil	F							F	F				H
0106	Engine Lubrication System													
	Oil filter & breather			O					O					
	Valve, relief				O				O					
0108	Manifold (Intake & Exhaust)	O							O	O				
03	**FUEL SYSTEM**													
0301	Carburetor			O	O				O	F				I
0302	Fuel Pump			O					O					
0304	Air cleaner			O					O					
0306	Tank, Fuel	O		O					O	F				
0308	Governor Assembly				O				O	F				
0311	Engine Starting Aids													
	Primer pump	O							O					
	Lines & fittings	O							O					
0312	Throttle or Choke Controls	O							O					
05	**COOLING SYSTEM**													
0501	Radiator			O					F	F				
0503	Water Manifold, Headers Thermostats & Housing Gasket								O					
0504	Water Pump			O					O	F				K
0605	Fan Assembly, Belt, V-Drive					O			O					
06	**ELECTRICAL SYSTEM**													
0601	Generator		F						O	F	H			L
0602	Regulator		O		O				O					
0603	Starting Motor													
	Lead assembly	O							O					
	Relay solenoid	O							O					
	Starter engine		O	O					O	F	H			M
0605	Ignition Components													
	Condenser, point set	O							O					
	Leads, plug set	O							O					
	Magneto				O				O	H				
	Spark plug			O	O				O					
0606	Engine Safety Switch				O				O					
0607	Engine Control Panel													
	Ammeter	O							O					
	Switch (for lights, etc.)	O							O					
	Wiring	O							O					
0610	Sending Units													
	Oil sending unit	O							O					
	Oil pressure	O							O					
	Temperature & liquid transmitter.	O							O					
0612	Batteries, Storage		O	O					O					

GROUP NUMBER	Component assembly nomenclature	Maintenance functions											Note reference	
		A	B	C	D	E	F	G	H	I	J	K	L	M
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	LIBRATE	INSTALL	REPLACE	REPAIR	VERHAUL	REBUILD	Tools and equipment	Remarks
15	**FRAME**													
1501	Frame Assembly													
	Lifting bail	O												
	Skid assembly	H												
22	**ACCESSORY ITEMS**													
2210	Instruction Plates	O							O					
47	**GAGES**													
4701	Tachometer Drive Assembly	O							O					
4702	Gages, Mounting Lines & Fittings	O							O					
	Gages, level													
	Pressure of temperature													
55	**PUMPING ASSEMBLY**													
5500	Pump assembly	O	O						F	F	H			
5501	Shafts, Rotors, Impellers													
	Impeller shaft	F							F					
	Rotor assembly	F							F					
5505	Suction and/or Discharge assembly													
	Line assembly	O							O					
5510	**INLET & OUTLET COMPONENTS**													
	Coupling, flanges, adapters	O							O					
	crossover	O							O					
5511	Coupling Assembly								O	F				
7603	Fire Extinguisher	O							O					

Section III. SPECIAL TOOL AND SPECIAL TEST EQUIPMENT REQUIREMENTS

Reference code	Maintenance level	Nomenclature	Tool number
		No special tools or test equipment required	

Section IV. REMARKS

Reference code	Remarks
A-B	Test includes engine operation and compression.
B-K	Rebuild of cylinder head includes resurfacing.
C-K	Rebuild of crankshaft includes metalizing, aligning and regrinding.
D-I	Repair of flywheel assembly includes replacing ring gear.
E-I	Repair of pistons includes replacing rings.
F-I	Repair of rods includes replacing bearings.
G-I	Repair of valve includes refacing valve and seat.
H-I	Repair of oil pump includes installing repair kit.
I-C	Servicing carburetor includes cleaning screen.
I-I	Repair of carburetor includes installing repair kit.
K-I	Repair of water pump includes installing repair kit.
L-I	Repair of generator includes installing repair kit.
M-J	Repair of starter includes installing repair kit.
N-I	Repair of magneto includes installing repair kit.

By Order of the Secretary of the Army:

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

Official:

KENNETH G. WICKHAM
Major General, United States Army,
The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-25 (qty rqr block no. 246) Section I, Organizational Maintenance requirements for Pumps, Centrifugal, Petroleum.

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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

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