TM 5-6115-575-14

TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DS, AND GS MAINTENANCE MANUAL

GENERATOR SET

DIESEL ENGINE DRIVEN; LIQUID COOLED

AC, 100 KW, 120 208, 240 416 VOLT 3 PHASE, 4 WIRE, 50 60 HZ; SKID MTD

(JETA POWER MODEL D8001M)

FSN 6115-156-4342

HEADQUARTERS, DEPARTMENT OF THE ARMY

JULY 1970

This reprint includes all changes in effect at the time of publication; change 1 and 2.

WARNING

HIGH VOLTAGE HAZARD

is present when generator set is in operation

DEATH

or severe injury may result

if personnel fail to observe safety precautions.

WARNING

HIGH PRESSURE HAZARD

is present when fuel injection nozzle is tested and adjusted

DEATH

or severe illness may result

if personnel fail to observe safety precautions.

Change No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *27 September 197*

Operator's, Organizational, Direct Support, and General Support Maintenance Manual
GENERATOR SET, DIESEL ENGINE DRIVEN, LIQUID COOLED, AC, 100 KW, 120/208, 240/416 VOLT, 3 PHASE, 4 WIRE, 50/60 HZ, SKID MTD (JETA POWER MODEL D8001M)
FSN 6115-156-4342

TM 5-6115-575-14, 22 July 1970, is changed as follows:

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 Appendix C is superseded as follows:

APPENDIX C
BASIC ISSUE ITEMS LIST AND ITEMS TROOP INSTALLED OR AUTHORIZED LIST

Section I. INTRODUCTION

C-1. Scope

This appendix lists items required by the operator for operation of the generator set.

C-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, in alphabetical sequence, of items which, at the discretion of the unit commander, may accompany the generator set. These items are not subject to turn-in with the generator set when it is evacuated.

C-3. Explanation of Columns

The following provides an explanation of columns in the tabular list of Items Troop installed or Authorized List, Section III.

a. Source, Maintenance, and Recoverability Code(s) (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. Quantity Authorized (Items Troop Installed or Authorized). This column indicates the quantity of the item authorized to be used with the equipment.

Section III. ITEMS TROOP INSTALLED OR AUTHORIZED LIST

(1) SMR code	(2) Federal stock number	(3) Description	(4) Unit of meas	(5) Qty auth
	7520-559-9618	CASE, MAINTENANCE AND OPERATIONAL MANUALS	ea	1
	4210-555-8837	EXTINGUISHER, FIRE	ea	1
	5975-878-3791	ROD, GROUND	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 12-25D (qty rqr block No. 1073), Operator Requirements for Generator Sets, 100 KW, 60 HZ, Utility.

Changes in force: C 1 and C 2

TM 5-6115-575-14
C 2

CHANGE NO. 2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *31 January 1975*

Operator's, Organizational, Direct Support, and General Support Maintenance Manual GENERATOR SET, DIESEL ENGINE DRIVEN, LIQUID COOLED, AC, 100 KW, 120/208, 240/416 VOLT, 3 PHASE, 4 WIRE, 50/60 HZ, SKID MTD (JETA POWER MODEL D8001M) NSN 6115-00-156-4342

TM 5-6115-575-14, 22 July 1970, is changed as follows:

Title is changed as shown above.

Page 2 of Cover. "Warnings" are superseded as follows:

WARNING

Take particular heed to specific warnings throughout this manual.

WARNING

High voltage is used in the operation of this equipment. Death or injury or severe burns may result if personnel fail to observe safety precautions. Do not operate the generator set until the ground terminal stud has been connected to a suitable ground. Disconnect the battery ground cable before removing and installing components on engine or in electrical control panel.

WARNING

Before making load connections for parallel operation, be sure the generator sets are not operating and main circuit breakers are in the off position.

WARNING

Before servicing any part of the generator set, make sure the unit is completely deenergized.

WARNING

Dangerous gases are generated as a result of operating this equipment.

WARNING

Utilize extreme caution, do not smoke, or use open flame in the vicinity when servicing batteries. Batteries generate explosive gas during charging.

WARNING

Do not operate generator sets in inclosed areas unless exhaust gases are properly vented to the outside. Exhaust discharge contains noxious and deadly fumes.

WARNING

Liquids under pressure are generated as a result of operation of this equipment. Injury or severe burns may result if personnel fail to observe safety precautions.

WARNING

Keep hands and other exposed areas of the body away from any malfunction of high pressure fuel lines.

WARNING

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

WARNING

Dry cleaning solvent, FED SPEC P-D-680, used to clean parts is potentially dangerous to personnel and property. Do not use near open flame or excessive heat. Flash point of solvent is 100 F. (38 C.) - 138 F. (59 C.).

Page 1. Paragraph 1.*c* is superseded as follows:

c. Recommendation for Maintenance Publications Improvements. You can improve this manual by recommending improvements using DA Form 2028 (Recommended Changes to Publications and Blank Forms) and mailing the form to Commander, US Army Troop Support Command ATTN: AMSTS-MPP, 4300 Goodfellow Boulevard, St. Louis, MO 63120. A reply will be furnished direct to you.

Page 18. Paragraph 21.*d* is superseded as follows:

d. Grounding Procedure. Generator sets shall be grounded in order to prevent shock due to defective insulation, or external electrical faults. Poor grounding can endanger personnel, may damage equipment, and can create interference in communication or electronic circuits.

(1) Install one of the following items as grounding device.

(a) Drive a ground rod to a depth of at least 8 feet. This is the preferred device which is available in the Army Supply System.

(b) Drive a ground pipe, ¾ inch, copper or steel, to a depth of at least 8 feet. An existing underground pipe may be used in an emergency.

(c) Bury a ¼ inch thick iron or steel plate, approximately 18 inches × 18 inches, with ground cable attached, to a depth of at least 4 feet.

(d) Bury a 1/16 inch thick aluminum or copper plate approximately 18 inches × 18 inches, with ground cable attached, to a depth of at least 4 feet.

(e) Position a ¼ inch thick iron or steel plate, or 1/16 inch thick aluminum or copper plate, approximately 18 inches × 18 inches, on the hard ground or bedrock beneath the trailer stand or roll the wheel of a trailer or truck until it comes to rest on top of the grounding plate.

(f) Saturate the area around the grounding device with water to increase conductivity.

(2) Ground cables should be copper. Braided cable is the best, but no. 6 AWG gauge (or larger) copper wire will suffice.

(3) Connect the ground cable from the grounding device to the generator set frame ground stud and tighten the nut securely.

Page A-1. Appendix A, References is superseded as follows:

APPENDIX A
REFERENCES

A-1. Fire Protection and Safety

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users.
TB MED 251	Noise and Conservation of Hearing

A-2. Lubrication

C9100IL	Fuels, Lubricants, Oils and Waxes
LO 5-6115-575-12	Generator Set, Diesel Engine driven: liquid cooled, ac 100 KW, 120/208, 240/416 volt, 3 Phase, 50/60 Hertz, skid mounted (Jeta Power Model D8001M) w/engine Allis-Chambers model 11000. NSN 6115-00-156-4342
TB 703-1	Specification List of Standard Liquid Fuels, Lubricants, Preservatives, and Related Products Authorized for Use by US Army
TB 55-6650-300-15	Spectrometric Oil Analysis

A-3. Painting

AR 746-1	Color, Marking, and Preparation of Equipment for Shipment
TM 9-213	Painting Instructions for Field Use

A-4. Cleaning

C6800IL	Chemicals and Chemical Products

SB 725-7930-1	Issue of Supplies and Equipment Engineering Practices Study of Conus and Overseas Installation Requirements for Hard and Soft Water Cleaning Compounds
TM 38-230-1	Preservation, Packaging, and Packing of Military Supplies and Equipment (Cleaning)

A-5. Maintenance

FM 29-2	Organizational Maintenance Management
TB ORD-1031	Purging, Cleaning, Inspecting, and Coating Interior of Steel Tanks and Equipment of Tectical and Commercial Type Fuel Tank, Trucks, and Trailers.
TB 5-2800-236-50/1	Reclamation of Crankshafts by Grinding Undersize
TB 750-97-61	Maintenance Expenditure Limits for FSC Group 61, FSC Classes 6115, 6120, and 6125
TB 43-180	Calibration Requirements for Maintenance of Army Materiel
TB 750-255	Uniform Policy for Hour meters and Odometers on Overhauled or Repaired USAMECOM End Items of Equipment.
TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 9-6140-200-12	Operator's and Organizational Maintenance Manual for Lead-Acid Storage Batteries
TM 11-483	Radio Interference Suppression
TM 38-750	The Army Management System (TAMMS)
TM 5-6115-313-20P	Organizational Maintenance Repair Parts and Special Tools Lists, Generator Set: Diesel Driven, Liquid Cooled, 100 KW, 120/208 Volt, 240/416 Volt, 3 Phase, 4 Wire, 50/60 Hz: Skid Mounted (Jeta Power Model D8001M) NSN 6115-00-156-4342
TM 5-6115-313-35P	Direct Support, General Support and Depot Maintenance Repair Parts and Special Tools Lists; Generator Set, Diesel Driven, Liquid Cooled, 100 KW, 120/208 Volt, 240/416 Volt, 3 Phase, 4 Wire, 50/60 Hz; Skid Mounted (Jeta Power Model D8001M) NSN 6115-00-156-4342

A-6. Testing

AMSTE-R-702-108	TECOM Test Operations Procedure, Construction, Support, and Service Equipment

A-7. Shipment and Storage

SB 38-100	Preservation, Packaging, Packing and Marking Materials, Supplies and Equipment Used by the Army
SB 740-1	Storage and Supply Activities, Covered and Open Storage
TM 740-90-1	Administrative Storage of Equipment

A-8. Demolition

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

A-9. Operation

TM 5-766	Electric Power Generation in the Field

By Order of the Secretary of the Army:

FRED C. WEYAND
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 12-25D, (qty rqr block No. 1073) Operator maintenance requirements for Generator Set, 100 KW, 60 HZ, Utility.

TM 5-6115-575-14

TECHNICAL MANUAL

HEADQUARTERS

DEPARTMENT OF THE ARMY

NO. 5-6115-575-14

WASHINGTON, D. C., 22 July 1970

OPERATOR, ORGANIZATIONAL, DS, AND GS MAINTENANCE MANUAL

GENERATOR SET, DIESEL ENGINE DRIVEN; LIQUID COOLED; AC, 100 KW, 120/208, 240/416 VOLT, 3 PHASE, 4 WIRE, 50/60 HZ; SKID MTD (JETA POWER MODEL D8001M)

FSN 6115-156-4342

THE FORMAT OF THIS MANUAL IS NOT IN ACCORDANCE WITH ESTABLISHED DEPARTMENT OF ARMY SPECIFICATIONS BECAUSE OF THE SHORT LEADTIME INVOLVED. THE TECHNICAL CONTENT HAS BEEN AUGMENTED WITH A MAINTENANCE ALLOCATION CHART (MAC) AND A BASIC ISSUE ITEMS LIST (BIIL) TO ASSURE THAT IT PROVIDES THE ESSENTIAL DATA NEEDED TO OPERATE AND MAINTAIN THE EQUIPMENT.

TABLE OF CONTENTS

ILLUSTRATIONS

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. General. This manual contains instructions for use by personnel to whom the Jeta Power Diesel Engine Driven Generator Set, Model D8001M is issued. It contains information required for operation, maintenance and repair of equipment, components, and accessories.

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

c. Reporting of Errors. Report of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commanding General, U. S. Army Mobility Equipment Command, ATTN: AMSME-MPP, 4300 Goodfellow Boulevard, St. Louis, Missouri 63120.

d. Administrative Storage, and Demolition Instructions. Instructions for administrative storage and destruction of materiel to prevent enemy use are contained in the following technical manuals:

TM 740-90-1	Administrative Storage of Equipment.
TM 750-244-3	Destruction of Materiel to Prevent Enemy Use.

Section II. DESCRIPTION, COMPONENTS AND FEATURES

2. Description

The Model D8001M Generator Set (fig. 1-1) is a 100 KW, 120/208 volt convertible to 240/416 volt, 3 phase, 0.8 pf, 50/60 hz, completely self-contained, skid mounted, totally enclosed, heavy duty, continuous duty operation, diesel engine driven drive (1500/1800 RPM), prime power unit. The generator set is provided with all the instruments, controls, and accessories necessary for operation. The control box and engine instrument panel contain the various controls and instruments. The AC generator is directly connected to a 6 cylinder, 4 cycle, full diesel engine. The generator exciter is a direct connect, brushless, alternator type. Engine speed is regulated by a Roosa Master direct drive governor, which maintains the alternator frequency (to 1½ cycles) from no load to full load.

3. Components

All parts of the generator set are readily accessible for operation, servicing, and maintenance by personnel using conventional tools and test equipment normally used with this type equipment.

4. Features

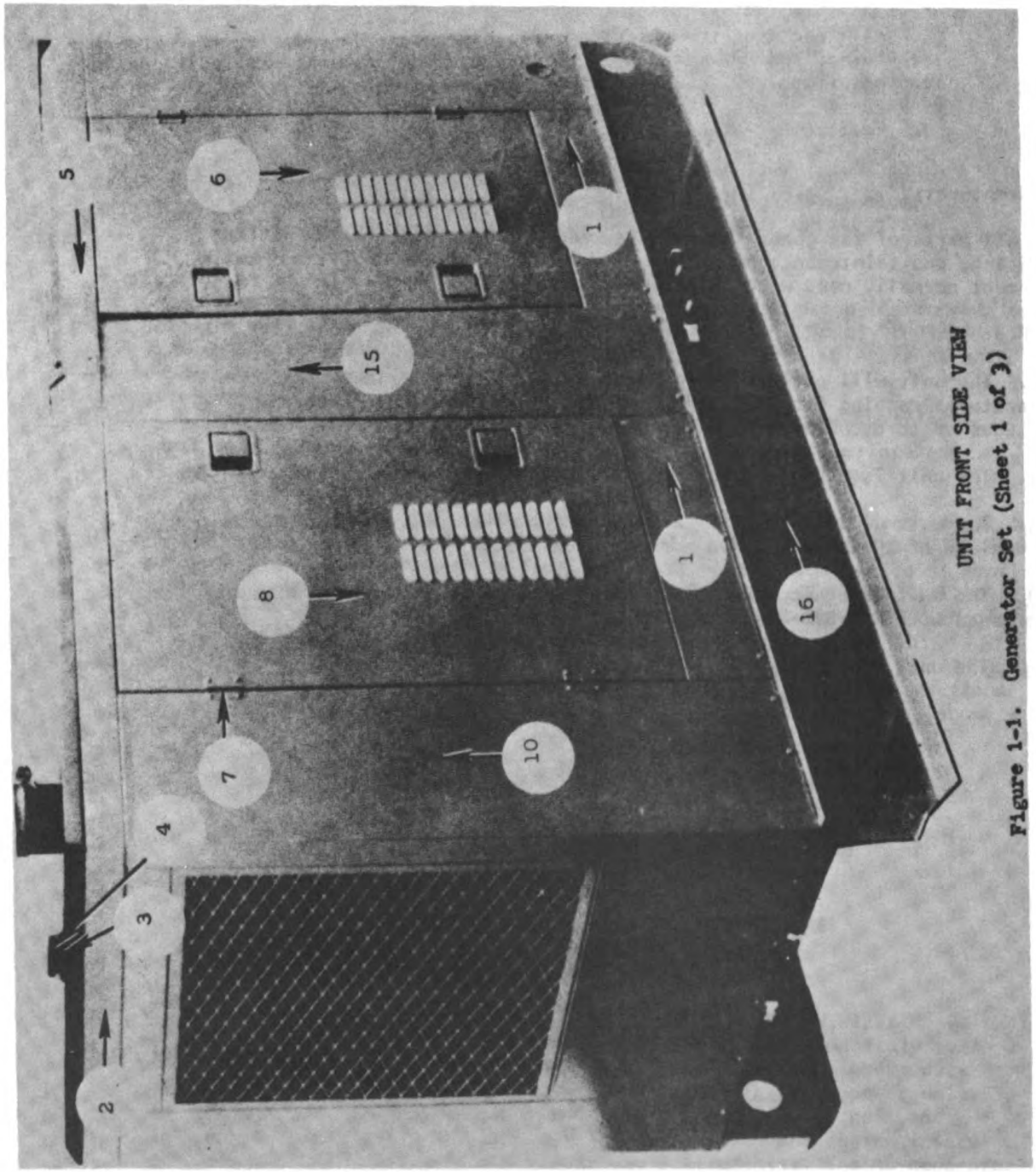
a. The unit will perform at any load up to full rated load at ambient temperatures ranging from 125 degrees F to minus 25 degrees F and at altitudes up to 8,000 at an ambient temperature of 86 degrees F.

b. The unit is capable of parallel operation with identical units.

c. The unit will operate for a period of at least five minutes under an overload of 25 percent above normal rated load.

d. The unit is equipped for the suppression of radio interference in accordance with MIL-STD-461A.

e. The unit is equipped with a fault safety shutdown system.



UNIT FRONT SIDE VIEW

Figure 1-1. Generator Set (Sheet 1 of 3)

UNIT FRONT SIDE VIEW
FIGURE 1-1

Key to figure 1-1

1 Panels, lower side
2 Roof, front
3 Grommet
4 Grommet
5 Roof, rear
6 Door, left rear
7 Hinge
8 Door, right front
9 Door, rear
10 Front shroud
11 Corner post, rear, L/H
12 Rear door, lower
13 Corner post, rear, R/H
14 Cross member, rear
15 Center post
16 Base (weld assembly)

Figure 1-1. Generator set.

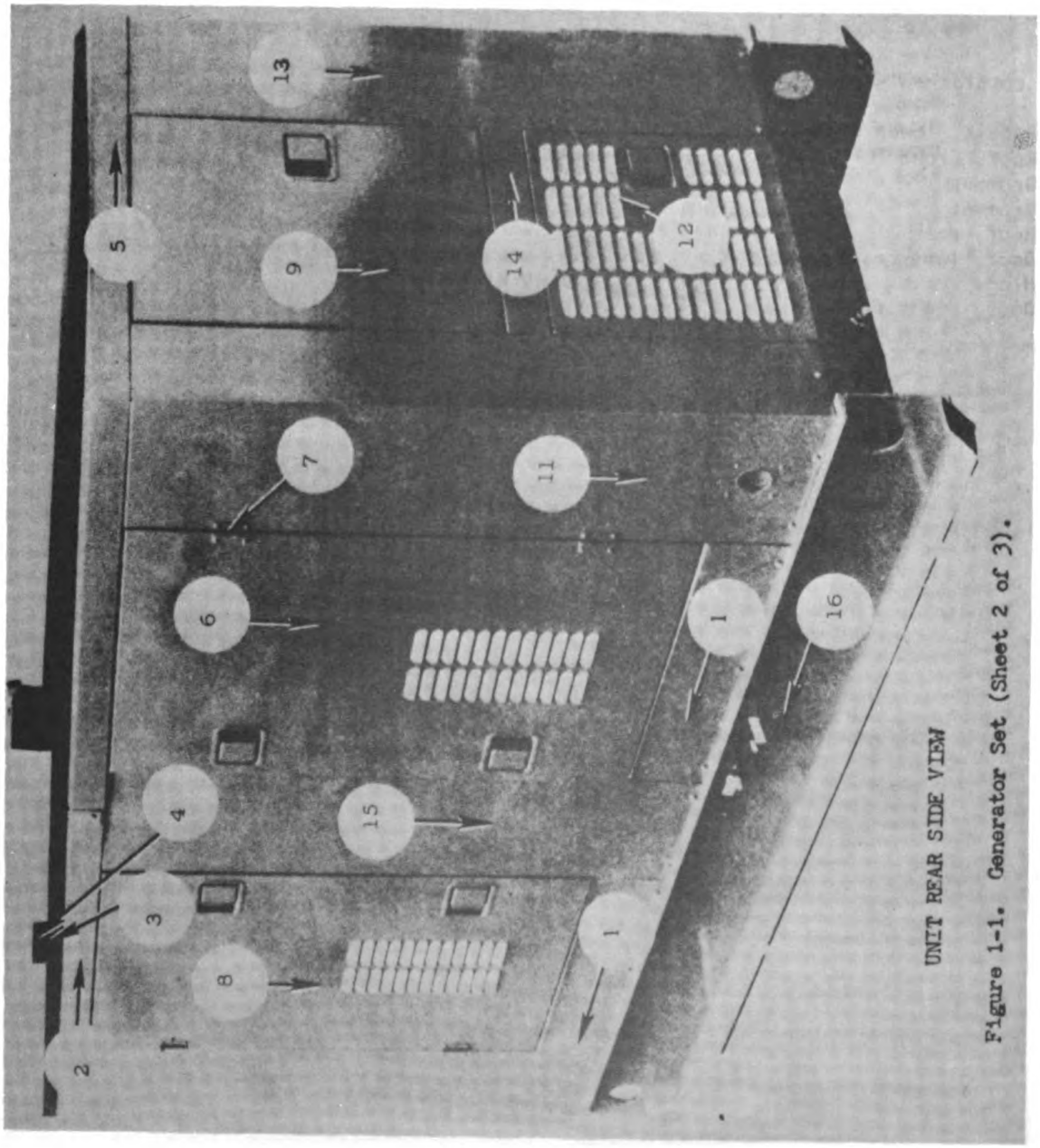


Figure 1-1. Generator Set (Sheet 2 of 3).

UNIT REAR SIDE VIEW
FIGURE 1-2

5. LEADING PARTICULARS

a. The leading particulars for the Generator Set are listed in Table 1-1. The information in the table is of a general nature.

TABLE 1 - 1

LEADING PARTICULARS

CHARACTERISTICS	SPECIFICATIONS
1. Diesel Generator Set	
a. Government nomenclature	Heavy duty, High Speed Diesel Engine Generator Set, General Purpose, Commercial Type
b. Federal Stock Number	FSN 6115-156-4342
c. Manufacturer	JETA POWER, INC.
d. Manufacturer part number	D8001M
e. Rating	100KW, 120/208 volt or 240/416 volt, 3 phase, 4 wire, 0.8PF, 50/60 HZ 1500/1800 R. P. M.
f. Overload Rating	
(1) Maximum	125 percent for 5 minutes
(2) Nominal	110 percent for 2 hours
g. Elevation of Installation	Sea level to 8,000 feet
h. Maximum ambient temperature	125 degrees F
i. Minimum ambient temperature	Minus 25 degrees F
j. Full load running time	Eight hours
k. Set fuel tank capacity	78 Gallons
2. Diesel Engine Manufacturer	ALLIS CHALMERS 11000 SERIES See Paragraph 6, 7, 8, 9, and 10 for Engine Specifications

TABLE 1 - 1

LEADING PARTICULARS

CHARACTERISTICS	SPECIFICATIONS
3. A. C. Generator	
a. Manufacturer	GENERAL ELECTRIC
b. Model	5SJ4405P23Y57
c. Type	SJ
d. Rating	4 pole, (100KW, 125KVA, 60HZ, 83KW, 104 KVA, 50 HZ) 3 phase, 120/208 volts convertible to 240/416 volts, 0.8 power factor
e. R. P. M.	1500/1800
f. Excitation	Direct connected, rotating, brushless
(1) Rating	Full Load Amps 2.75
(2) R. P. M.	1500/1800
4. Voltage Regulator	A. C.
a. Manufacturer	JETA POWER, INC.
b. Model	VR02C
c. Part Number	568610
d. Regulation	2 percent
e. Steady state voltage	Plus or minus 1%
f. Recovery voltage	3%
g. Recovery time	2 Seconds
h. Rating	3 phase, 4 wire sensing Maximum output 8A-50V
5. Automatic Safety System	
a. Shutdown devices	
(1) Overspeed	1920 RPM (66 cycles)
(2) High coolant temperature	217 degrees F

TABLE 1 - 1

LEADING PARTICULARS

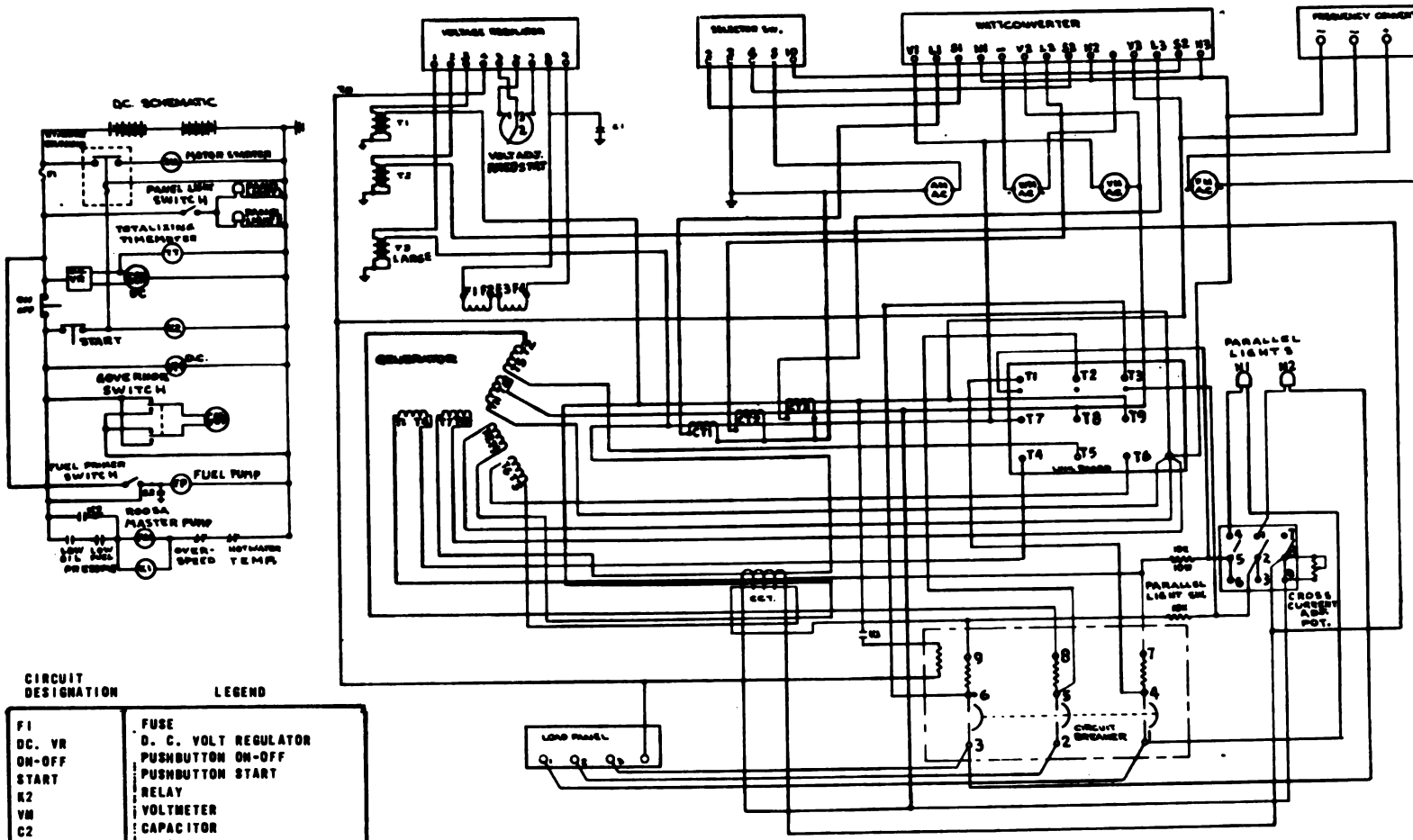
CHARACTERISTICS	SPECIFICATIONS
(3) Low oil pressure	10 PSI
b. Load Disconnect Devices	
(1) Undervoltage	72 or 144 volts
(2) Generator Overload	125 percent of rated load 125KW
6. Control Box	
a. Manufacturer	JETA POWER, INC.
b. AC Voltmeter	Dual Scale 0-300/0-600 VAC
c. Frequency	45 - 65 HERTZ
d. AC Ammeter	Dual Scale 0-250/0-500 Amps
e. Kilowatt meter	0 - 125 Kilowatts
f. DC Voltmeter	0-32 Volts Scale
7. Engine Instruments	
a. Engine hour meter	0 - 9999.9 scale
b. Gage, fuel level	E, ¼, ½, 3/4, F Scale
c. Gage, oil pressure	0 - 80 PSI Scale
d. Gage, coolant temperature	100 - 220 Scale
8. Circuit Breakers	
a. Main Load (CB1)	3 Pole, 600 VAC, 434 Amp, Trip Under-voltage shunt trip
9. Weight	
a. Generator Set (dry)	5200 Lbs.
b. Crated	6000 Lbs.

TABLE 1 - 1

LEADING PARTICULARS

CHARACTERISTICS	SPECIFICATIONS
10. Dimensions, Over-All	
a. Height	60 inches
b. Length	100 inches
c. Width	41 inches
11. Batteries	
a. Manufacturer	PRESTOLITE
b. Type	8T

b. Wiring Diagram. Refer to figure 1-2 for generator set wiring diagram.



CIRCUIT DESIGNATION	LEGEND
FI	FUSE
DC. VR	D. C. VOLT REGULATOR
ON-OFF	PUSHBUTTON ON-OFF
START	PUSHBUTTON START
K2	RELAY
VM	VOLTMETER
C2	CAPACITOR
K1	RELAY
T1, T2, T3	TRANSFORMER
C1	CAPACITOR
AM	AMMETER, A. C.
WM	WATTMETER, A. C.
VM	VOLTMETER, A. C.
FM	FREQUENCY METER
CT1, CT2, CT3	CURRENT TRANSFORMER
CCT	CROSS CURRENT TRANSFORMER
K1	CIRCUIT BREAKER RELAY

Figure 1-2. Schematic Diagram For 100KW Generator Set

Section IV - Engine Specifications

6. ENGINE (BASIC)

Model 11000	Turbocharged
Type	4 Cycle
Number of Cylinders	6
Firing Order	1-5-3-6-2-4
Bore	4-7/16"
Stroke	5-9/16"
Cubic Inch Displacement	516
Crankshaft Rotation (view from fan end)	clockwise
Number of main bearings	7
Compression Ratio (nominal)	16.2:1
Compression Pressure at Sea Level 600 rpm (hot)	445 psi (±15 psi)

7. COOLING SYSTEM

Stabilized Coolant Temperature	220° F max. 180° F min.
Water Pump	Centrifugal Type, Belt Driven from Crankshaft Pulley
Radiator Cap Pressurized	1 psi
Nominal Capacities:	
Engine (only)	22 qt.
Radiator (only)	18 qt.

8. LUBRICATING SYSTEM

Type	Full flow Circulating Pressure
Oil Pump	Gear Type, Positive Displacement
Oil Pressure Range, hot, full throttle	Full flow
Pressure Regulation	30-55 psi
Oil Capacities - Nominal:	Governed by Regulation Valve
Standard 20° Angle of Operation Filter and Oil Change	23 qts.
Optional 45° Angle of Operation Filter Oil Change	21 qts.
Optional 15° Angle of Operation Filter and Oil Change	22 qts.

9. FUEL INJECTION SYSTEM

Fuel Injection Pump Self-lubricated, Roosa Master	
Pump Speed Ratio to Crankshaft	.5:1

Fuel Injection Nozzle
Type . . . . . .Spring Loaded, Four Hole Orifice
Opening Pressure . . . . . .2750 psi

Fuel Injection Pump Timing (Static)

Roosa Master	11000
1200 rpm	36° BTDC
1400 rpm	36° BTDC
1500 rpm	36° BTDC
1600 rpm	36° BTDC
1800 rpm	36° BTDC
2000 rpm	36° BTDC
2200 rpm	36° BTDC

Governor

Regulation (Electric) 3-1/2%
Type . . . . . Variable Speed - Flyball
Speed (Standard Setting)
Full Load . . . . . 1800 rpm
High Idle (No Load) . . . . . .1925 - 1980 rpm
Low Idle . . . . . .500 - 600 rpm

Hand Primer Pump (Roosa Master)
Maximum Lift . . . . . 6ft.

10. VALVE DATA

a. Valve Lash Adjustment
Intake Valve Clearance (Hot) . . . . . .018"
Exhaust Valve Clearance (Hot) . . . . . .018"

b. Valve Timing
Camshaft (4337723)

*(Tappets set at .024")
Exhaust Valve Opens . . . . . 53° BBDC
Exhaust Valve Closes. . . . . 23° ATDC
Intake Valve Opens. . . . . 21° BTDC
Intake Valve Closes . . . . . 55° ABDC
Intake and Exhaust Duration . . . . . 256°
Intake and Exhaust Overlap. . . . . .44°

NOTE: Tappets must be set at this clearance to obtain degrees of valve opening and closing listed for the camshaft. Do not confuse this checking figure with the hot valve lash adjustment, (Running Clearance) of .018".

11. U. S. TO METRIC MEASURE CONVERSION FACTORS

Pints x .4732 = Liters
Quarts x .9463 = Liters
Gallon x 3.7853 = Liters
Pounds x .4536 = Kilograms

Section V - Engine Electrical System

12. GENERAL

The electrical system includes the starter, generator, voltage regulator, and batteries. Current is supplied by the wet cell type storage batteries.

The basic units of the charging circuit are the batteries, generator, and regulator. The batteries are the storage plant for electrical energy and must be kept fully charged while using a minimum amount of water. Electrical energy, drained from the batteries, is replaced by the generator. Too much power output will usually burn out the generator or damage the batteries. To prevent this a voltage regulator is connected into the circuit.

The charging system includes a D. C. generator. The battery ground is negative. A negative type of voltage regulator is used in the charging system. The charging system is a 24 volt D. C. generator; 10 amperes; negative ground. Includes regulator, voltmeter and a DC generator. (Figures 4-1, 2-1, and 4-2.

13. BATTERY

a. If liquid level is low, add distilled water to bring each cell level up to bottom of filler hole.

b. Be sure filler plugs are tight and plug vents are open.

CAUTION: Never fill battery after operation in below freezing weather; water will not mix with acid and may freeze. Always fill batteries before putting engine into service.

c. Periodically check external condition of batteries and cables. Keep batteries clean and secured. If batteries are dirty, clean with a soda solution and brush; filler plugs must be tight to prevent solution from entering cells. After foaming stops, flush with clean water.

d. After cleaning, apply a thin coat of grease to posts and cable terminals.

e. In below freezing temperatures, keep batteries in a fully charged condition.

CAUTION: When charging battery, it is very important that the polarities of the battery and charger agree; connect positive to positive and negative to negative. When using booster batteries, observe the same polarity rule.

f. Check charge condition or specific gravity with a hydrometer with electrolyte temperature at 80°F.

1.110 to 1.135	Completely discharged
1.170 to 1.200	¼ charged
1.205 to 1.230	½ charged
1.235 to 1.260	3/4 charged
1.265 to 1.290	Fully charged

14. ELECTRIC STARTING MOTOR

a. General

The engine electrical starting motor is of the heavy duty, 24 volt, overrunning clutch type. The solenoid switch for closing the starting circuit is a spring type push button switch located on control panel.

These type engines are equipped with a Bendix or overrunning clutch type starting motor which requires a Bendix type ring gear on the flywheel. If the starter drive pinion does not match the flywheel ring gear, difficulty will be encountered during the engagement of the starter drive pinion into the flywheel ring gear. Refer to figure1-3.

CAUTION: The starting motor must never be used continuously for more than 30 seconds at any one time without a pause of two minutes to allow the motor to cool.

b. Starter Removal and Installation (Figure 4-3)

(1) Disconnect the cables and lead wires from the starter.

(2) Remove the capscrews and lockwashers attaching the starter to the flywheel housing and remove starter and starter adapter.

(3) Install starter by a direct reversal of removal procedure. Connect cables and wires to starter.

c. Service

(1) If the starting motor cranks the engine slowly or not at all, the equipment should be checked. Failure to crank normally can be due to a low battery, defective battery cables, poor connections in the starting motor-to-battery circuit, defective starting motor, low temperatures, or various conditions in the engine.

(2) Inspection checks include a periodic investigation of battery condition, battery cables and connections, starting motor, solenoid switch, commutator, brushes, lead connections, and mounting.

(3) Starter motor bearings are lubricated only when unit is disassembled for inspection or repair.

(4) The brushes must be making good contact with the commutator (80 ounces of spring tension) and must not be worn shorter than 5/16" long. Their original length is ½".

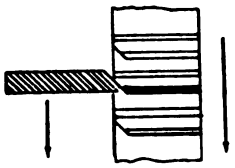
(5) A dirty commutator should be cleaned with #00 sandpaper.

CAUTION: Never clean commutator with emery paper.

d. Disassembly of Engine Starter

To disassemble and reassemble the engine starter refer to Figure 8-29, Figure 8-30.

RING GEAR

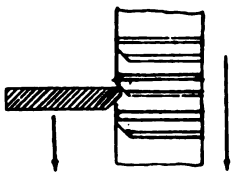


BENDIX OR OVERRUNNING CLUTCH

PINION WITH CORRECT RING GEAR

CORRECT ENGAGEMENT

RING GEAR



RING GEAR FOR BENDIX OR

OVERRUNING CLUTCH PINION

INCORRECT ENGAGEMENT

FIGURE 1-3

15. DC GENERATORS AND REGULATORS

a. General

The engine generating system restores to the battery the current withdrawn during cranking. The system also carries the connected electrical load up to the capacity of the generator when the generator is operating at a speed to produce maximum output.

The voltage regulator is an electromagnetic relay of the vibrating type. Its purpose is to automatically control and limit the generator output in order to properly charge the battery.

b. DC Generator and Regulator Removal (Figures 4-2, 4-1)

(1) Remove the capscrew and lockwasher attaching the generator to the generator adjusting brace. Remove the drive belt. Disconnect generator lead wires.

(2) Remove the capscrews and lockwashers attaching the generator to the generator mounting bracket and remove the generator.

CAUTION: Whenever a DC generator has been removed or disconnected, it must be polarized.

(3) Disconnect generator regulator wires; identify the wires to facilitate installation. (Figure 4-1)

(4) Remove generator regulator attaching capscrews, nuts, and lockwashers.

(5) Remove the generator regulator.

c. Service

(1) Periodically the commutator should be inspected and cleaned, if necessary. Clean only with #00 sandpaper, never use emery cloth. Also inspect the brushes.

(2) If commutator is rough or out-of-round or has high mica, it must be turned down in a lathe and the mica undercut. If necessary to turn down commutator, make cut no deeper than necessary. The mica should be undercut 1/32".

(3) Clean the contacts of the voltage regulator by drawing crocus cloth between them while being held together under slight pressure. Do not use emery paper or any other coarse abrasive. Blow away any dust. Do not use a file except to remove projections or extreme roughness - then use only a fine mill file. A clean piece of hard or bond paper drawn between contacts will dislodge particles.

(4) Polarize the generator as follows (Figure 1-4):

(a) Insulate generator brushes from the armature by placing cardboard between brushes and armature.

(b) Using a short jumper lead, momentarily touch the jumper from the "BAT" to the "GEN" terminals of the regulator.

(c) Remove the cardboard from under the brushes.

CAUTION: Do not operate or test the generator on an open circuit. If it should become necessary to operate the generator without it being connected to the batteries, it should be short circuited; disconnect the lead connected to the "GEN" terminal of the regulator and connect to any convenient ground to accomplish the short-circuit.

d. DC Generator and Regulator Installation

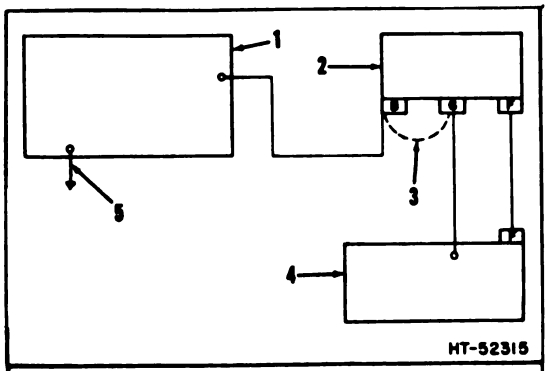
Installation procedure is the reverse of removal.

e. Generator Drive Belt Adjustment (Figure 1-5)

(1) Belt is properly adjusted when it can be pressed inward ½" at a point half-way between the generator pulley and crankshaft pulley.

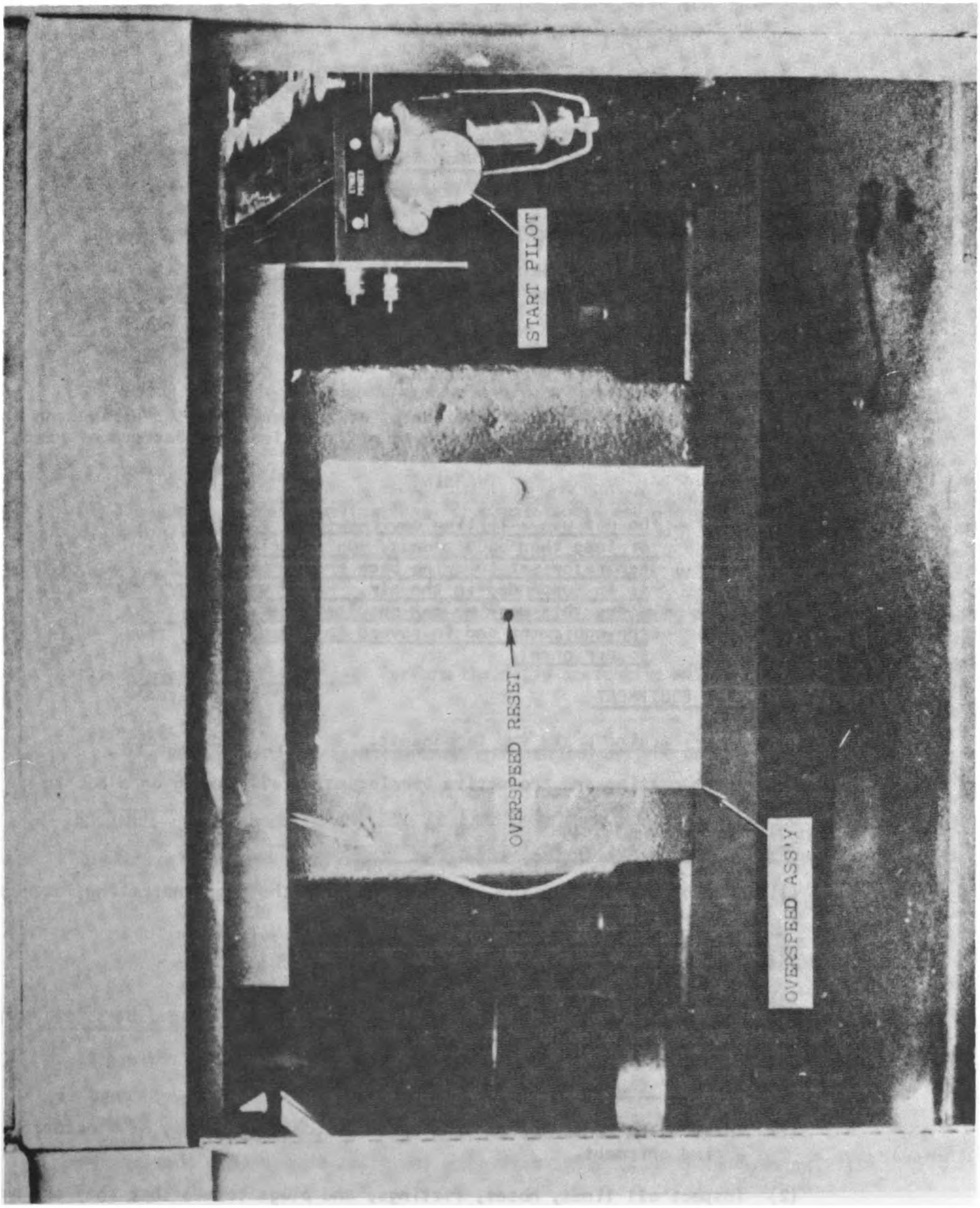
(2) Loosen generator adjusting brace capscrew and move the generator inward or outward to obtain proper tension.

(3) Tighten brace capscrew.



1. Battery
2. Generator Regulator
3. Jumper Lead
4. Generator
5. Battery Ground

FIGURE 1 - 4 POLARIZING CIRCUIT DIAGRAM



OVERSPEED START PILOT
FIGURE 1-5

CHAPTER 2

INSTALLATION AND OPERATING

INSTRUCTIONS

Section I. Service Upon Receipt of Equipment

16. UNLOADING THE EQUIPMENT

a. Remove any tiedowns and blocking that secure the generator set to the bed of the carrier.

b. An overhead hoist, crane, or fork lift truck can be used to remove the generator set from the carrier. The crane or fork lift truck can be used to transport set to desired location.

c. When a lifting device is not available, or the generator set arrives on an enclosed carrier, the set may be towed off to a loading platform or ramp.

WARNING

Do not use a lifting device with a capacity of less than 8000 pounds. Do not allow the generator set to swing back and forth when it is suspended in the air. Failure to observe this warning can result in damage to the equipment and in severe injury or death to personnel.

17. UNPACKING THE EQUIPMENT

a. Removal of Packing Crate and Components.

Remove the crating and protective barrier material, taking care not to damage the equipment.

b. Removal of Protective Material and Devices

(1) Inspect and service the unit according to the tags indicating instructions.

(2) Remove the pressure sensitive tape where applied.

(3) Remove the paper wrapping where applied.

18. INSPECTING AND SERVICING EQUIPMENT

a. Inspection of Equipment

(1) Inspect the generator set for loss or damage which 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, and screws.

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

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

(6) Inspect all doors, hinges, and latches for proper operation.

(7) After servicing, crank the engine several times to make sure the engine and generator is free.

(8) Inspect the accessory drive V-belt tension for correct adjustment. See paragraph 136.

(9) Inspect tools and publications for completeness and serviceable condition.

b. Servicing the Equipment

(1) Lubrication. Lubricate the generator set in accordance with the current lubrication order.

(2) Preventive Maintenance. Perform the daily preventive maintenance services.

(3) Batteries. The battery is shipped fully charged and dry. Do not fill the battery with electrolyte unless the engine will be operated within 12 hours.

WARNING: Do not smoke or use an open flame near the battery when servicing. Batteries generate an explosive gas. Fill each cell with electrolyte, covering the plates approximately three-eighths of an inch.

WARNING

Electrolyte contains sulfuric acid and can cause severe burns. Handle it with care. If the solution comes in contact with the body or clothing, rinse immediately with clean water.

19. ENGINE FUEL SYSTEM

a. Close the fuel tank drain valve (Figure 4-4).

b. Remove the fuel tank cap (Figure 4-5), fill fuel tank with diesel fuel, and replace cap.

(c) Inspect fuel tank gauge (fig. 4-5)for proper operation.

20. INSTALLATION OF SEPARATELY PACKAGED COMPONENTS

The generator set is shipped fully assembled except for electrolyte, manual, and muffler which are separately packed but contained in the main crate.

21. INSTALLATION OR SETTING-UP INSTRUCTIONS

a. Location. Avoid a muddy, sandy, or dusty installation site if possible. If it is necessary to install the unit on soft ground, arrange a foundation of planking, logs, or concrete. See figure 2-2, Base Plan.

b. Indoor Installation. Make sure the floor is sufficiently strong to support the unit. Provide at least 4 feet of space on all sides of the unit to allow accessibility. Make sure the area is well ventilated. Pipe the exhaust of the engine outside the building. Arrange the piping with a minimum of bends, and make sure all connections are tight.

WARNING

Do not operate the generator set in an enclosed area unless the exhaust gases are piped to the outside. Inhalation of exhaust fumes will result in serious illness or death.

c. Leveling. Construct the base so that the generator set will remain level at all times.

NOTE: Do not support exhaust piping on unit exhaust pipe.

CAUTION

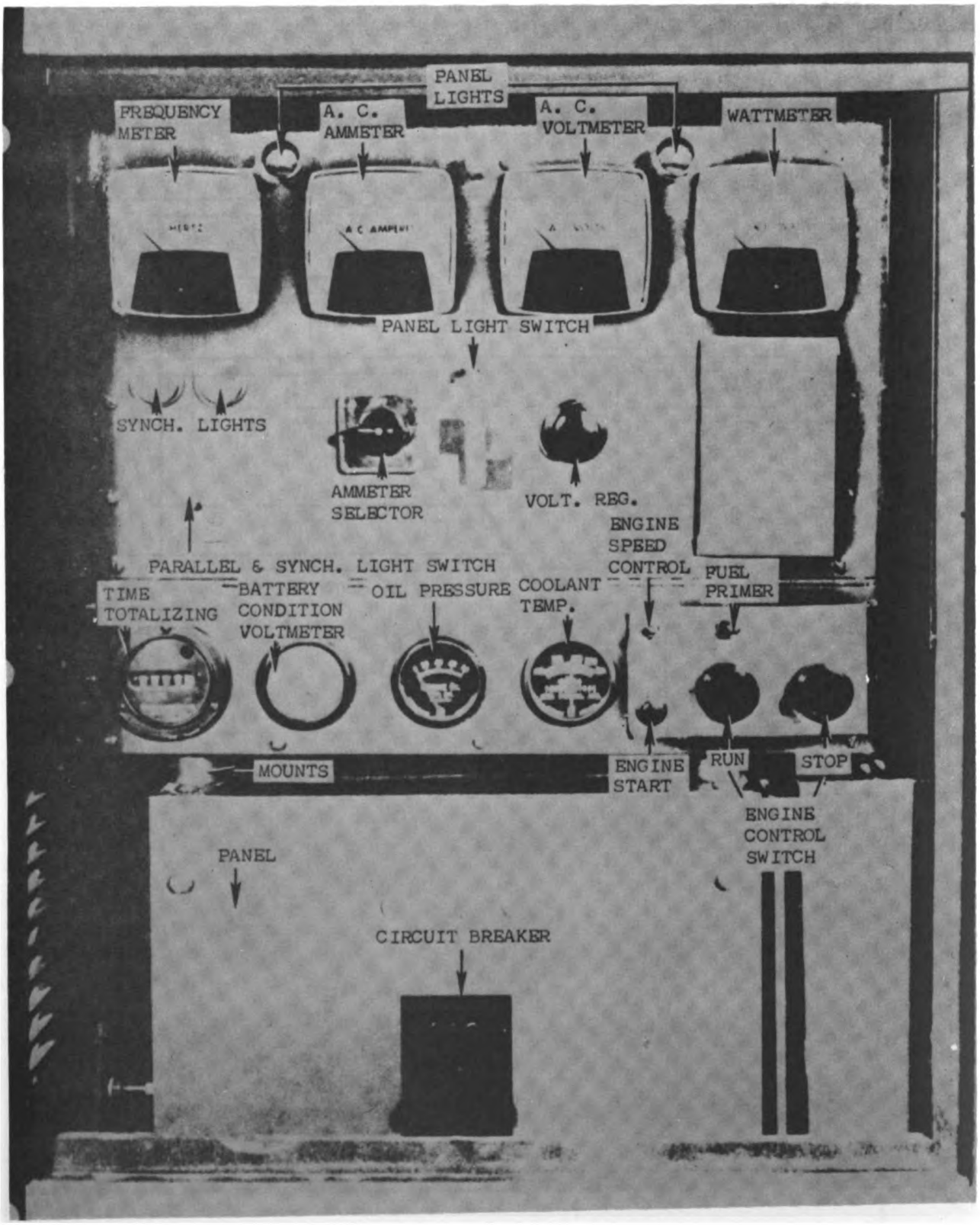
Never operate the generator set at an angle more than 15° from the level position.

d. Grounding. The generator set must be grounded prior to operation. The ground can be, in order of preference, an underground metallic water piping system, a driven metal rod, or a buried metal plate. A ground rod must have a minimum diameter of 5/8 inch if solid or 3/4 inch if pipe, and must be driven to a minimum depth of 8 feet. A ground plate must have minimum area of 9 square feet and be buried at a minimum depth of 4 feet. The ground lead must have No. 6 AWG (American Wire Gauge) copper wire and be bolted or clamped to the rod, plate or piping system. Connect the other end of the ground lead to the generator set ground terminal stud.

e. Attaching Load Lines. Connect the load cables to the generator set load board (Figure 2-3).

WARNING

Stop the generator set and see that it is not connected to an energized line before making or changing connections on the load terminals. Make sure the load lines are not energized by an external power source.



INSTRUMENT CONTROL PANEL
FIGURE 2-1

Base Plan.

The base plan, shown in figure2-2, provides minimum dimensions for a base for the generator set.

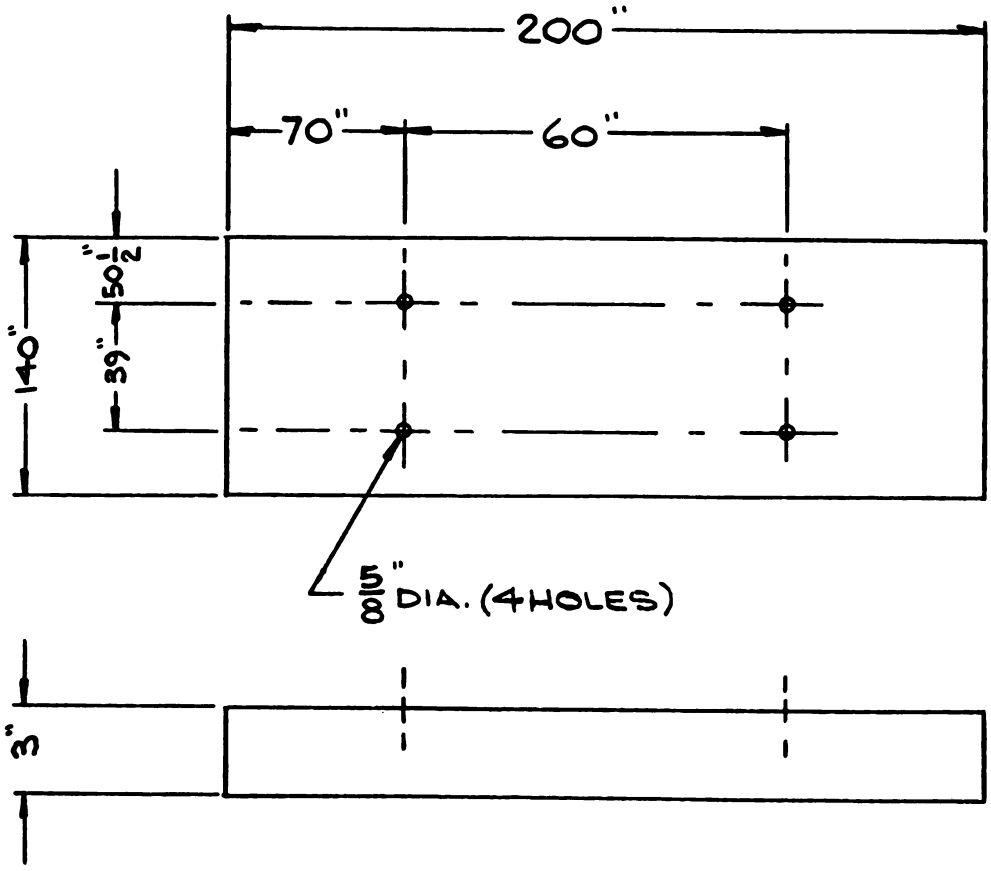
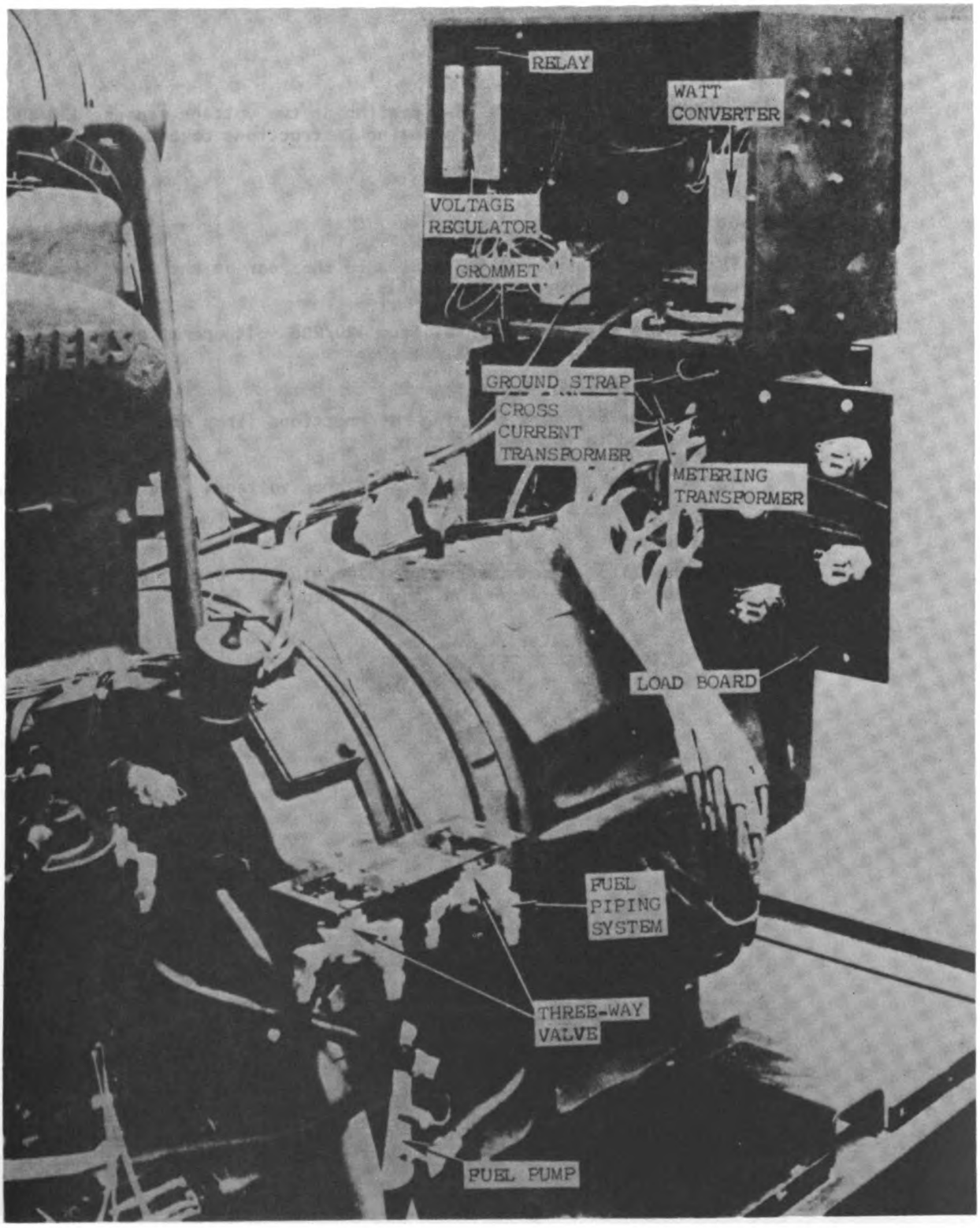


FIGURE 2-2 Base Plan



PONENT PARTS
GURE 2-3

22. EQUIPMENT CONVERSION

a. The generator set is capable of operating on two voltage ranges, 120/208 volts and 240/416 volts. The following instructions covers voltage conversion.

b. Voltage Conversion

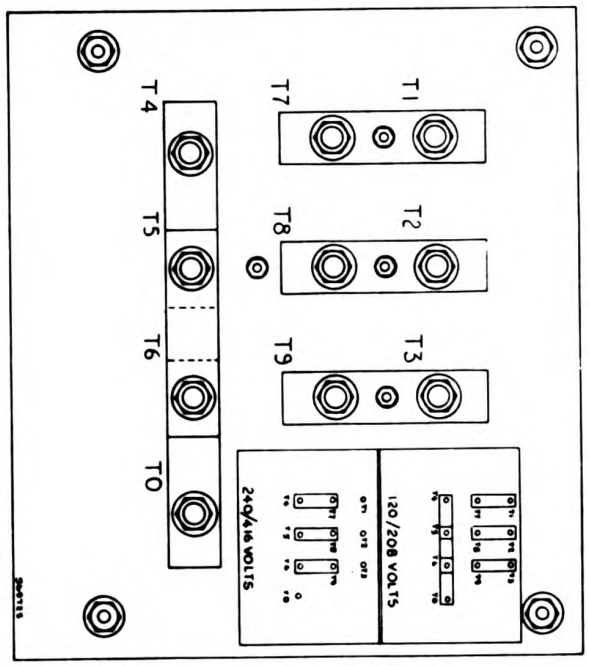
(1) The reconnection panel is located in the rear on the right side of control box support. (Fig. 4-6).

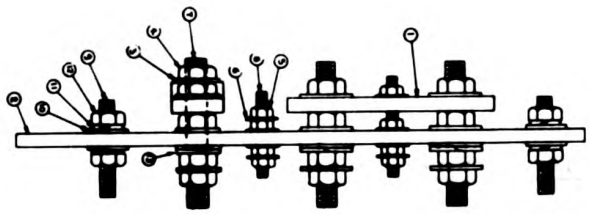
(2) To convert the generator set from 120/208 volt operation to 240/416 volt operation, proceed as follows:

(a) Loosen all nuts securing reconnections links and those nuts involved in the new position.

(b) Reposition link assembly for higher voltage. Tighten all nuts. (See figure 2-4)

(3) To convert the generator set from 240/416 volt operation to 120/208 volt operation, reverse the above procedure.





QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO.	SPECIFICATION	MATERIAL OR NOTE	UNIT WT	ZONE	ITEM NO.
10	13	LOCKWASHER		MS 35338-46		BRASS			13
8	12	NUT, HEX		MS 35649-8252		STEEL			12
8	11	LOCKWASHER		MS 35338-44		STEEL			11
8	10	FLATWASHER		MS 27183-9		STEEL			10
4	9	STUD, CAD PLATE		A-569727		STEEL			9
4	8	STUD		569791-4		BRASS			8
10	7	STUD		569791-3		BRASS			7
16	6	FLATWASHER		MS-15795-908		BRASS			6
16	5	NUT, HEX		MS-35650-305		BRASS			5
40	4	JAM NUT		MS-35691-20		BRASS			4
40	3	FLATWASHER		MS-15795-814		BRASS			3
1	2	LINK PANEL		D-569725		BAKELITE			2
6	1	INTERCONNECTING LINK		4208-272		COPPER			1

LIST OF MATERIALS OR PARTS LIST

Figure 2-4. Link Panel Assembly.

Section II. Movement to a New Worksite

23. DISMANTLING FOR MOVEMENT

a. Preparation for Movement.

WARNING

Make sure all voltage has been removed from the load cables and the generator set is not running.

(1) Disconnect the load cables.

(2) Remove engine exhaust pipe extensions if used.

(3) Remove any extension cords and utility lines attached to unit.

(4) Disconnect ground cables from ground terminal stud (Fig. 4-7).

(5) If the generator set is to be moved a considerable distance or by common carrier, drain the fuel tank.

(6) Close and secure the housing doors.

(7) Remove any lines securing the unit to a floor or base.

b. Movement.

For longer distances, lift the generator set with a suitable hoist onto a carrier, and securely block the unit on the carrier. Use tiedowns or other suitable means to prevent shifting during transport.

24. REINSTALLATION AFTER MOVEMENT.

a. Refer to paragraph 21 to install the generator set.

b. Perform the inspection and services prescribed by paragraph 18.

Section III. Controls and Instruments

25. GENERAL

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

26. CONTROLS AND INSTRUMENTS.

The location of the instruments and controls are shown in Figure 2-1.

27. Engine Speed Control Assembly

It is a spring loaded toggle switch used to operate a motor that is couple to the governor. When switch is in the UP position, the speed of the engine increases. Down position, speed decreases. When desired speed is reached, switch is in neutral position. (Figure 2-1)

28. Circuit Breaker

The circuit breaker (Fig. 2-1), is an enclosed, flush-mounted, manually operated load contactor. It is located in the rear of the unit below the control panel and is used to connect the generator output to the load.

29. Synchronizing Lights

The synchronizing lights (Fig. 2-1) are located on the instrument panel. When two generators are being connected for parallel operation, the lights will flash on and off and will indicate the correct instant to close the circuit breaker of the incoming unit. (Paragraph 52)

30. Unit Parallel and Synchronizing Light Switch

This parallel switch (Fig. 2-1), located on the instrument panel is a two position toggle switch. It is used to connect the cross-current compensation components into the automatic voltage-regulator circuit when the generator set is used in parallel operation and puts the synchronizing lights into operation.

31. Voltage Regulating Rheostat

The voltage rheostat (Fig. 2-1) located on the instrument panel has a knurled-type manually operated knob. It is used to set the generator output voltage. Turning the knob clockwise increases the voltage output and turning it counter-clockwise decreases the voltage output.

32. Ammeter-Selector Switch

The ammeter-selector switch (Fig. 2-1), located on the instrument panel is a 4-positioned, manually operated, rotary-selector switch. It is used to place the ammeter in each of the 3-phase circuits to indicate the output current.

33. Wattmeter

The wattmeter (Fig. 2-1) located on the instrument panel is a dial type indicating instrument with a scale calibrated from 0-to 125-K. W.. It indicates the power being consumed by the electrical load in terms of kilowatts.

34. Panel Light Switch

The panel light switch (Fig. 2-1), located in center of the instrument panel is a two-position toggle switch. It is used to turn the panel lights on and off.

35. AC Ammeter

The AC Ammeter (Fig. 2-1), located on the instrument panel is a dial type indicating instrument with two scale 0-to 250-amperes and 0-to 500-amperes. It indicates current draw from set.

36. Frequency Meter

The frequency meter (Fig. 2-1), located on the instrument panel is a dial indicating type instrument with one scale, 45-to 65-HERTZ (cycle per second) for 50/60- HERTZ operation. It indicates the frequency of the generated current.

37. AC Voltmeter

The AC voltmeter (Fig. 2-1), located on the instrument panel is a dial type indicating instrument with scale from 0-to 300-volts, 0-to 600-volts. It indicates the output voltage of the main generator.

38. Battery-Condition Voltmeter

The battery-condition voltmeter (Fig. 2-1), located on the engine control panel is a needle-type indicating meter, calibrated in a 0-to 30-volts scale. It indicates the state of the batteries. When the engine is operating normally, the battery voltage should read approximately 28 volts.

39. TIME TOTALIZING METER

The time totalizing meter (Figure 2-1), located on the engine control panel is a circular instrument with a 5-digit set of movable figures. It records the total hours of engine operation up to 9,999.9 hours. The meter reading is used as a guide for operational and periodic inspections.

40. COOLANT TEMPERATURE THERMOMETER

The coolant temperature thermometer (Figure 2-1), located on the engine control panel is a needle type indicating gauge, calibrated in a 100 to 200°F scale. It indicates the coolant temperature when the engine is running. Normal temperature is 180°F. The unit should be shut down when the needle is in the red area. (Danger Zone)

41. LUBRICATING OIL PRESSURE GAUGE

The lubricating oil pressure gauge (Figure 2-1), located on the engine control panel is a needle-type indicator, calibrated in a 0-to 80-PSI (pounds per square inch) scale. It indicates the lubricating oil pressure is 30 PSI. The unit should be shut down when the needle is in the red area. (Danger Zone)

42. ENGINE CONTROL SWITCH

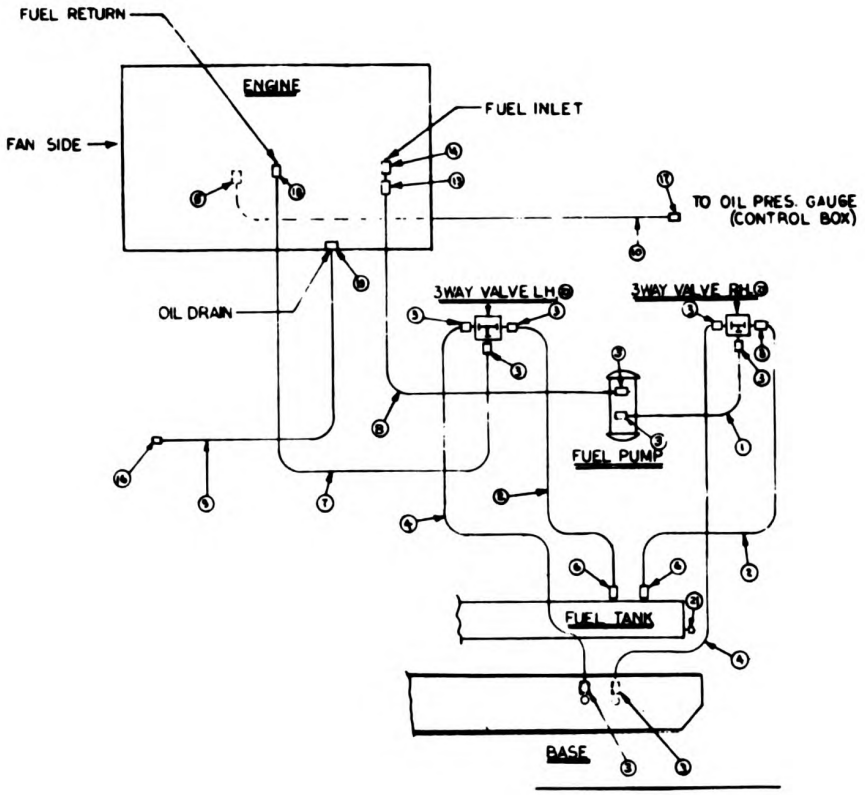
The engine control switch (Figure 2-1), located on the instrument panel is a two position, push button (run and stop) switch. It controls the opening and closing of the fuel solenoid valve. It is also incorporated in the circuit with the engine safety devices.

43. ENGINE START SWITCH

The engine start switch (Figure 2-1) located on the instrument panel is a pushbutton type, spring loaded switch and maintains contact as long as it is depressed. It is depressed to start the engine.

44. FUEL PRIMER SWITCH

The fuel primer switch (Figure 2-1) located on the instrument panel is an ON-OFF toggle switch. It is used to prime the fuel system, when held in the ON position. The engine is equipped with a hand priming pump which can be used if desired.



QTY REQD	SYM	NOMENCLATURE OR DESCRIPTION	CODE IDENT	PART OR IDENTIFYING NO.	SPECIFICATION	MATERIAL OR NOTE	UNIT WT	ZONE	ITEM NO.
2	23	3 WAY VALVE		569764					23
									22
1	21	SQUARE HEAD PLUG		700216					21
									20
1	19	BUSHING		589749					19
1	18	FEMALE CONNECTOR		700205-7					18
1	17	FEMALE CONNECTOR		700205-2					17
1	16	PLUG		700204-7					16
2	15								15
1	14	ELBOW		700202-3					14
1	13	MALE ELBOW		700200-10					13
									12
									11
1	10	LINE #10		C-569740-10					10
1	9	LINE #9		C-569740-9					9
1	8	LINE #8		C-569740-8					8
1	7	LINE #7		C-569740-7					7
2	6	MALE CONNECTOR		700201-7					6
1	5	MALE ELBOW		700200-3					5
2	4	LINE #4		C-569740-4					4
10	3	MALE ELBOW		700200-8					3
2	2	LINE #2		C-569740-2					2
1	1	LINE #1		C-569740-1					1

LIST OF MATERIALS OR PARTS LIST

Figure 2-5. Piping Diagram.

Section IV. Operation of Equipment

45. GENERAL

a. The instructions in this section are published for the use of the personnel responsible for the operation of the generator set.

b. It is essential that the operator know how to perform every operation of which the generator set is capable. This section gives instructions on starting and stopping the generator set, on the operation of the generator set, and on how to coordinate the operation to perform the specific tasks for which the generator set is designed.

46. STARTING

a. Preparation for starting.

(1) Perform the before-operation services. See paragraph 16, 17, 18, 19, 20, 21, and 22.

(2) Attach the load lines to the terminals on load board, Figure 2-3.

(3) Connect the conversion links for the desired voltage position: Reference: Paragraph 22

(4) Turn knob of the voltage-regulating rheostat counterclockwise as far as it will go, Figure 2-1

(5) Place the handle of the fuel selector valve in the proper position to supply fuel to the engine from the set fuel tank or an auxiliary source. Be sure the pointer indexes with the line mark on the plate (Figure 2-3).

(6) Place the start switch in the RUN position (Figure 2-1)

b. Air Venting the Fuel System (Figure 4-8)

Remove the pipe plugs from the top of the filters. Each of the two filters contain primary and secondary filtration stages. Place fuel primer switch (Figure 2-1) in ON position; this will start electric fuel pumps and supply fuel to filters. When no more air bubbles emerge from the fitting, replace pipe plug. Loosen 3/8" flare nut at fuel injection pump and bleed the air from fuel line connecting filter and injection pump. Tighten flare nut. The diesel fuel system is now primed. Put primer switch in OFF position.

47. STARTING THE ENGINE

a. Perform the procedures described in the above (Paragraph 46).

b. Depress engine start switch until the engine starts (Figure 2-1). Adjust the engine speed by raising or lowering the engine control speed switch to achieve the desired speed (frequency), Figure 2-1.

c. Check the engine gauge readings. Proper engine operation is indicated when the gauges indicate the following reading:

(1) Lubricating oil pressure range . . . . . 30-55 PSI

(2) Battery-Condition . . . . . Indicating UP scale

(3) Coolant temperature thermometer . . . . . 165°F - 180°F (normal load conditions)

(4) Time totalizing meter . . . . . The tenth-of-hour wheel should revolve slowly.

(5) Adjust the engine speed to obtain the correct operating frequency. NOTE: The generator set will operate at a frequency of 60 HERTZ at an engine speed of 1800 RPM and 50 HERTZ at 1500 RPM. Reference paragraph 27.

(6) Adjust voltage regulating rheostat to obtain correct operating voltage. Reference: paragraph 31.

d. To apply load, reset circuit breaker by pushing handle down hard to OFF position and then up to ON position.

48. COLD WEATHER STARTING (40° F to -25° F)

a. Prepare engine with low temperature coolant (GLYCOL BASE) or equivalent.

b. Prepare engine with low temperature lubricating oil.

(1) Use winter grade oil

At ambient temperatures
above +10° C (50° F) . . . HD-SAE 20 W 20
below +10° C (50° F) . . . HD-SAE 10 W

NOTE: The viscosity grades selected should be based on the temperature when starting and not on the maximum temperature recorded during the day. The oil change intervals should be 20 to 40 running hours less than normal period.

(2) Use winter grade fuel. This type of fuel will reduce the danger of paraffin clouding.

Ambient temperature	Summer grade diesel fuel %	Admixture	Winter grade diesel fuel %	Admixture %
to 10°C (14°F)	90	10	100	--
to 14°C (7°F)	70	30	100	--
to 14°C (-4°F)	50	50	80	20
to 30°C (-22°F)	--	--	50	50

NOTE: Before using any fuel, expose a sample (small bottle) to the ambient temperature; should there be paraffin clouding, the fuel will be suitable for operation only during summer or in heated rooms.

c. Start Pilot Operation

(1) Operate start pilot (located at lower right hand support, under the unit control panel) by pulling out and holding for one or two seconds (Figure 4-6)

(2) Push in releasing measured shot (below zero, repeat 1 and 2).

(3) Wait three seconds, then engage starter by depressing start button.

(4) Repeat 1 and 2 if necessary until engine runs smoothly.

d. Before applying load, see paragraph 47.

49. STOPPING

a. Normal Stopping

(1) Disconnect the load by pushing the circuit breaker to the OFF position. (Figure 2-1)

(2) After running the engine with load removed for three to five minutes, depress stop button switch to stop the engine (Figure 2-1)

b. Stopping by Safety Devices

Safety devices stop the engine in the event of overspeed, high coolant temperature, or lubricating oil pressure failure. If the engine is stopped by the overspeed switch, push the overspeed reset button and restart the engine, Figure 4-6. If the engine starts but does not continue to run when start switch is released, one of the other safeties has functioned due to abnormal conditions. Report the trouble to organizational maintenance.

c. Removing Load by Overload Devices

If the generator is overloaded, the circuit breaker will open, removing the load from the main generator. Push down on the switch handle of the circuit breaker (Figure 2-1) to reset the breaker, then push up to apply the load. The engine will continue to run during this time. If the circuit breaker opens again, report the condition to organizational maintenance.

Section V. Operation Details

50. GENERAL

This generator set may be operated as a single unit, or in parallel with one or more sets having the same voltage, phase, and frequency rating. Care must be taken to prevent cross-currents between sets and to prevent one generator set from being driven as a motor by the other set or sets.

51. ATTACHING LOAD LINES

Open the draw string on the sock (Fig.4-9) from the side of the housing. Slide the load lines through the openings in the housing and attach the neutral line to the LO terminal (Fig. 2-3) and the 3-phase lines to terminals L1, L2, and L3.

52. PARALLELING SIMILAR UNITS

a. Connect the load lines to one set only, which will hereafter be referred to as the operating unit. The other unit will hereafter be known as the incoming unit.

b. Connect the two generator sets in parallel by attaching jumper leads to like load terminals on both units.

c. Turn the unit parallel and synchronizing light switch (Fig.2-1) on both sets to the ON position and observe the two synchronizing lights of the incoming unit. If they go on and off alternately, rather than simultaneously, the two generator sets are connected in opposing phase sequence. Stop both generator sets.

d. Reverse any two of the three interconnecting leads at the terminals of the incoming set.

e. Start the two generator sets and observe the synchronizing lights. The lights will now go on and off simultaneously.

f. Adjust the frequency of the incoming set with the engine speed control assembly (Fig.2-1) until the synchronizing lights go on and off at approximately 2-second intervals or slower.

g. At the instant the synchronizing lights are out, move the circuit breaker to the ON position.

53. PARALLELING DISSIMILAR UNITS.

Paralleling generator sets that have dissimilar characteristics is beyond the capabilities of the operator. If such paralleling is necessary, report the condition to organizational maintenance.

54. DIVIDING THE KILOWATT LOAD

a. To provide for service load fluctuations, generator sets operated in parallel should be adjusted so the load on each set is in proportion to its rated capacity in kilowatts.

b. To divide the kilowatt load between two sets of equal capacity, take a reading on the kilowatt meter of both sets. Retard the engine speed control assembly of the set having the higher kilowatt reading and advance the throttle control of the other set until both kilowatt meters read the same.

c. Check the frequency meter of each set. If the frequency has changed, adjust the frequency (speed) controls of both generator sets to obtain the desired frequency.

d. To divide the kilowatt load properly across two sets of unequal capacity, determine the ratio of their respective capacities. If one unit has twice the rating of the other, make the adjustments as described in the above, until the kilowatt meter reading of the larger set is twice that of the small set.

55. DIVIDING THE REACTIVE LOAD.

a. When the generator sets are paralleled, it is necessary that they share the reactive load equally. This requires an equal drop in the generator voltages as the reactive load increases.

b. Changing the voltage controls on either of the generator sets affects the currents of the individual generator sets by causing a circulating current to flow between them. This current does not supply any power to the load and is known as a reactive load. Any change in the voltage control adjustment of one of the units will cause the currents in the other unit to go either up or down. The adjustment is correct when the load current is divided between the units in the ratio of their ratings. Observe A. C. ammeter on control box (Figure 2-1) to measure reactive current. The current readings for proper division must read the same on all phases and between generator sets.

c. When the proper reactive load division is achieved, adjust the voltage controls of both units for the correct line voltage.

56. REMOVING UNIT FROM PARALLEL OPERATION

To remove a unit from parallel operation, first determine that the line load is not in excess of the rating of the set that is to assume the total load, then adjust the speed on the unit to be removed until the wattmeter reading drops to zero. Place the circuit breaker (Figure 2-1) in the OFF position to disconnect the generator set from the line.

57. AUXILIARY FUEL CONNECTIONS

NOTE: The generator set is equipped with external connections to permit the use of an outside fuel source for the engine.

a. Remove the capnut (Figure 4-6) and attach the auxiliary fuel hose to the fuel inlet adapter.

b. Install the free end of the auxiliary fuel hose in the external source of fuel.

c. To operate the generator set from the external source place the fuel selector valve in the auxiliary position.

Section VI. Operation Under Unusual Conditions

58. OPERATION IN EXTREME COLD (below 0° F.)

a. General. The generator set is designed to operate at temperatures down to -25° F. without an externally supplied source of heat.

b. Fuel System. Keep the fuel tank full to prevent condensation of moisture. Accumulated moisture will freeze and clog fuel lines, filters, and strainers. Drain the fuel filters and strainers more frequently than usual. Remove snow, ice, and moisture from filler caps, fillernecks, and the dispensing equipment before filling the tank. Before filling the fuel tank, remove the metal strainer and remove foreign matter and dirt from it. Keep the fuel sources clean. Allow the contents of a fuel container to settle after moving before filling the fuel tank.

c. 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. See that the battery cap vent holes are open. The electrolyte level must be three-eights of an inch above the plates. To prevent the batteries from freezing, see that they are kept fully charged. Inspect all electrical wiring for cracks, breaks, or fraying. Tighten loose connections and report defective wiring to organizational maintenance.

d. Lubrication. Lubricate the generator set in accordance with instructions in the current lubrication order.

e. Cooling System. Inspect the level of the coolant in the radiator. Report a low coolant level to organizational maintenance. Inspect the cooling system frequently for leaks, paying particular attention to gaskets and hose connections. Keep all housing door assemblies closed except those covering the control panel.

59. OPERATION IN EXTREME HEAT

Cooling System. Check the coolant level frequently and add clean water when necessary. Use an approved rust inhibitor to prevent formation of rust and scale. Clean and flush the cooling system at regular intervals. Keep all housing doors closed except rear doors and see that there are no obstructions in the core fins of the radiator.

60. OPERATION IN DUSTY OR SANDY AREAS

a. General. If the installation is permanent, erect a protective shield for the generator set. Dust and sand shorten the life of equipment parts and cause mechanical failure. If the installation is temporary, utilize natural barriers. Wipe down the set at frequent intervals using 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 fan belt is properly adjusted. Adjust a loose fan drive belt. Drain and flush the cooling system as often as necessary.

c. Lubrication. Lubricate the generator set in accordance with the current lubrication instruction. Clean the air cleaner and engine breather caps more frequently than in areas of normal operation. Clean all lubrication points before applying lubricants. See paragraph 66.

d. Fuel System. Use all precautions to keep sand or dust out of the fuel system. Clean the fuel filters and replace the filter elements more frequently than in areas of normal operation.

61. OPERATION UNDER RAINY OR HUMID CONDITIONS

a. General. Locate the generator set in a protected place if possible. Erect a suitable shelter or cover the unit with a tarpaulin when not in use. Open all access doors frequently to allow the generator set to air.

b. Fuel System. Keep the fuel tank filled to prevent condensation of moisture.

c. Lubrication. Keep the generator set well lubricated in order to prevent moisture from entering the engine assembly. Refer to the current lubrication instruction. Service the air cleaner and engine breather caps more frequently than usual. See paragraph 67.

d. Electrical System. Keep all electrical equipment dry. Be sure the battery cables are tight and clean and terminals are lightly greased. Inspect all electrical wiring for cracks, breaks, or fraying. Tighten loose connections and report defective wiring to organizational maintenance.

e. Cooling System. Use an approved rust inhibitor to prevent the formation of rust and scale in the cooling system.

62. OPERATION IN SALT-WATER AREAS

a. General. Salt water causes corrosive action on metal. Care must be taken to avoid contact of equipment with salt water. If contact is made with salt, wipe the unit with a clean cloth dampened with fresh water. Be careful not to wet the electrical equipment.

b. Cooling System. Be sure the water used in the cooling system is free of salt, alkali, etc. Use an approved rust inhibitor to prevent the formation of rust and scale in the cooling system.

c. Painting. Paint all exposed nonpolished surfaces. Coat exposed parts of polished steel or other ferrous material with standard issue rustproofing material or cover parts with a light coat of grease. Refer to TM 9-213.

d. Lubrication. Keep the generator set well lubricated. Refer to the current lubrication instruction. Service the air cleaner and engine breather caps more frequently than usual. See paragraph 67.

e. Fuel System. Keep the fuel tank filled to prevent condensation of moisture. Service the fuel filters frequently to prevent accumulation of moisture.

f. Protection. Locate the generator set in a protected place if possible. Erect a suitable shelter or cover the unit with a tarpaulin when not in use. Open all access doors frequently to allow the generator set to air.

63. OPERATION AT HIGH ALTITUDES

The generator set is designed to operate at altitudes up to 8,000 feet above sea level without any special attention or adjustment. Provide adequate ventilaton as the engine is more likely to overheat at high altitudes.

CHAPTER 3

OPERATOR AND ORGANIZATIONAL

MAINTENANCE INSTRUCTIONS

Section I. Operator and Organizational Maintenance Tools and Equipment

64. TOOLS AND EQUIPMENT

Tools are listed, but not issued for servicing the set. See paragraph 79.

Section II. Lubrication

65. DETAILED LUBRICATION INFORMATION

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

b. Lubrication for Engine. Before new engine is put into operation a number of preparations have to be made. But not all of them are confined to the initial starting of the new engine; some of the operations have to be carried out subsequently, at regular intervals, as part of the routine maintenance. First fill up with fuel and oil, as follows:

(1) Fuel. Always use a reputable standard grade of fuel and pay attention to cleanliness when filling up. Use winter grade diesel fuel only at low ambient temperatures. Replenish the fuel supply in good time, so the the tank never runs dry, otherwise the fuel filters and injection lines will have to be air-vented. Refer to paragraph 127 for proper fuel.

NOTE: As there is no fuel in the engine when it leaves the works, air-venting must in any case be carried out before starting up for the first time.

(2) Motor Oil. MD oils must be used for the lubrication of engine. They are lubricating oils containing special chemical additives to meet the requirements of diesel engine duty.

When operation conditions are out of the ordinary, e. g. continuous operation under full load, long idling periods, or poor maintenance, or should fuels be used having a sulphur content exceeding 1%, then select an HD oil with a higher proportion of additives, such as the Supplement 1 grade. (HD oils used should conform to specifications MIL-L-2104A or DEF-2101A). In addition to good lubricating properties, HD oils are able to hold in suspension fine particles of combustion residues and to prevent carbon deposits. This

characteristic causes HD oils to darken after a comparatively short time, but their lubricating capacity is not reduced as a result thereof. You will experience no troubles if you change oil at the intervals prescribed (HD oils of different brands should not be mixed).

(3) Use only HD motoroil having the following viscosity:

At ambient temperatures

above +10°C (50°F) . . . . . SAE 20 W/20
below +10°C (50°F) . . . . . SAE 10 W

For selecting viscosity, the determining factor is the temperature prevailing at time of starting, not the maximum temperature recorded during the day.

NOTE: When the engine duty involves starting at low ambient temperatures, reference should be made to the "Hints for Winter Operation".

c. Lubrication for A. C. Generator. The A. C. generator has bearings that are permanently packed and require no lubrication.

d. Cleaning. Keep all external parts not requiring lubrication clean of lubricants. Before lubricating the equipment, wipe all lubrication points clean to prevent accumulation of foreign matter.

e. Operation after Lubrication. Operate unit for five minutes after lubrication. Inspect filter element, lines, and fittings for leaks. Stop unit and wait five minutes, then check crankcase oil level. Add oil to bring oil level up to FULL mark if necessary.

f. OES Oil

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

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

g. Oil Filter Service. Service the oil filter (para 145).

h. Air Cleaner Service. Service the oil cleaner (para 153).

Section III - Preventive Maintenance Services

66. GENERAL

a. To insure that the generator set 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 Preventive Maintenance Services to be performed are listed and described in subsequent paragraphs. Defects discovered during operation of the unit shall be noted for future corrections, to be made as soon as operation has ceased. Stop operation immediately if a deficiency is noticed during operation which would damage the equipment if operation were continued.

b. Thoroughly clean all lubrication fittings, caps, filler and level plugs and surrounding surfaces before servicing. Prevent dirt from entering with lubricants and coolants. The intervals given in the schedule are based on normal operation; perform these services, inspection, etc. more often (as needed) for operation under abnormal or severe conditions.

67. DAILY PREVENTIVE MAINTENANCE SERVICES

This paragraph contains a tabulated listing of preventive maintenance services which must be performed by the operator. The item letters are listed consecutively and indicate the sequence of minimum requirements.

ITEM

a. AIR CLEANER. Inspect for insecure mounting and condition.

b. OIL LEVEL GAUGE. Check crankcase oil level. Service as required.

c. FUEL FILTERS. Inspect for loose mounting and leaks. Drain water and dirt from filters weekly.

d. V-BELT. Inspect V-belt for excessive wear, cracked or frayed condition and improper adjustment.

e. BATTERIES. Inspect for cracks, leaks, corrosion and insecure mounting. Fill to 3/8" above plates. Clean vent holes in filler caps.

f. FUEL TANK. Check fuel level. Inspect for leaks. Inspect strainer filler neck for cleanliness and damage.

g. GROUND TERMINAL. Inspect to see that the generator set is properly grounded and that all grounding connections are secure.

h. CONTROL PANELS. Inspect for dirt, worn or frayed wiring, and insecure mounting. Inspect interior for loose or missing components, loose electrical connections, damage. Inspect for defective fuses.

i. CONTROLS AND INSTRUMENTS. Inspect the controls and instruments for damage and insecure mounting. With unit operating, inspect controls and instruments for improper operation.

j. RADIATOR HOSES. Inspect to see that the hoses are not cracked or leaking.

k. VISUAL INSPECTION. Check engine and accessories for loose connections, nuts, bolts, and capscrews, leaking seals, gaskets, fuel lines.

l. ENGINE COOLANT. Check level. Fill to within 1½" of filler neck, if required.

m. FUEL FILTERS. Drain water, if applicable.

n. FUEL TANK. Drain water from tank.

o. OIL LEVEL. Check oil level in oil pan. Bring oil level up to proper level on oil level gauge (dipstick), if required.

p. FUEL SUPPLY. Check at end of days operation.

68. EACH 100 HOURS.

a. Make certain the radiator core is free of obstructions.

b. Check condition and tension of generator drive belt, paragraph 15.

c. Drain and renew engine lubricating oil, figure 7-20A.

d. Renew engine lubricating oil filter element(s), figure 7-20.

e. Check condition and tension of fan drive belts, paragraph 136.

f. Inspect turbocharger, paragraph 156 and 157.

g. Check liquid level of battery cells.

69. EACH 200 HOURS

a. Grease the water pump, Paragraph 131.

b. Check intake and exhaust manifold mounting nuts.

70. EACH 500 HOURS

a. Inspect generator and voltage regulator, paragraph 93 and 94.

b. Check timing of fuel injection pump to engine.

c. Engine breather tube - remove, wash in solvent and dry with compressed air.

d. Renew fuel filter elements, figure 7-6.

e. Check valve lash adjustment, paragraph 10 and 93.

f. Grease fan hub, paragraph 136.

g. Inspect turbocharger, paragraph 156 and 157.

h. Inspect electric starting motor, paragraph 95.

i. Check specific gravity of each battery cell. Inspect and clean battery cables.

j. Drain and/or clean exhaust muffler.

71. EACH 2000 HOURS

a. Clean exterior of engine.

b. Inspect and clean screen and nozzle hole in starting aid.

c. Check spray pattern and opening pressure of fuel injection nozzles.

d. Inspect turbocharger, paragraph 156 and 157.

e. Remove and inspect the fuel transfer pump, paragraph 142.

72. EACH 3000 HOURS

a. Remove and clean oil pan. Clean oil pump suction screen.

b. Remove, clean and inspect lubricating filter by pass valve.

c. Remove, clean and inspect oil pump pressure relief valve.

d. Remove, clean and inspect oil pressure regulating valve.

73. MAINTENANCE TOOLS

The following tool listing has been prepared to assist service and maintenance personnel in the selection of tools (other than standard hand or shop tools) to accomplish the various maintenance operations described and illustrated in this manual. These tools listed below must be ordered directly from tool manufacturer.

TOOL MANUFACTURERS

(KM) Kent-Moore Organization, Inc.
Service Tool Division Order Dept.
1501 South Jackson Street
Jackson, Michigan

(AC) Allis-Chalmers Manufacturing Co.
154 and Commercial Avenue
Harvey, Illinois 60426

MANUFACTURER'S TOOL NUMBER AND DESCRIPTION

(KM)	J-6692	Compression Gauge Assembly
(KM)	J-22472	Compression Gauge Adapter (Less Tip)
(KM)	J-21616	Compression Gauge Adapter Tip
(AC)	4389773	Rocker Pin Tool Kit
(AC)	4389772	Spare Parts Kit
(KM)	J-8689	Nozzle Remover Adapter
(KM)	J-6471-1	Slide Hammer
(KM)	J-6765	Fuel Injection Line Nut Wrench (Nozzle End)
(KM)	J-8625	Nozzle Tester Set
(KM)	J-6446-50	Spray Collector
(KM	J-6445-34	Carrying Case for J-8625
(KM)	J-6999	Injection Nozzle Holding Fixture
(KM)	J-4298-1	Pin Vise
(KM)	J-7854-1	Nozzle Hole Cleaning Wire
(KM)	J-7871-01	Injection Nozzle Sleeve Cleaner
(KM)	J-3172	Feeler Gauge Set

Section IV. OPERATORS MAINTENANCE

74. GENERAL

The instructions in this section are published for the information and guidance of the operator to maintain the generator set.

75. FUEL FILTER SERVICE

Remove and discard filter elements and install new ones every 500 hours of operation or when filters become clogged. Clogged filters are usually indicated by irregular engine performance.

76. FUEL LINES

a. Inspect the fuel system lines and fittings for leaks, kinks in the lines, and other damage.

b. Clean fuel lines and fittings externally with an approved cleaning solvent.

c. Report a defective fuel line or fitting.

77. BATTERY SERVICE

a. Remove vent cap and fill with distilled water to a level 3/8 of an inch above the plates.

b. Check vent cap breather holes to see that the holes are free of any obstruction.

c. See that battery hold down brackets secure the batteries firmly in position.

d. Coat battery and cable terminals with a light film of grease to prevent corrosion and see that cable terminals are secure on the battery cables.

78. LUBRICATING OIL FILTER SERVICE

a. To replace oil filter, remove retaining screw. Lift off cap and remove element. Clean out excess oil and replace new element and gasket. Reinstall cover and retaining screw.

b. If it is to function correctly, the filter must be regularly attended to.

79. PANEL LAMP REPLACEMENT

Remove and install the panel lamps as needed. Figure 2-1.

80. FUSE REPLACEMENT

Remove and install the fuse as needed. Figure 4-3.

Section V. TROUBLESHOOTING

81. GENERAL

This section provides information useful in diagnosing and correcting unsatisfactory operation or failure of the generator set and its components. Each trouble symtom stated is followed by a list of probable causes of the trouble. 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.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSES	REMEDY
Engine will not turn	1. Batteries weak.	1. Recharge or replace batteries.
	2. Starter or starter switch inoperative	2. Repair or replace affected parts. (Paragraph 109 and Figure 2-1)
	3. Engine is locked or seized	3. This can be due to extended idle or storage periods, or to improper preparation of the engine for storage, in which case the parts may be rusted or corroded and seized. Broken piston rings, gears, etc., may cause locking. The engine should be disassembled to determine the cause, and the necessary parts replaced. (Figure 8-1 thru 8-28)
	4. Hydro-static lock	4. This can be due to rain water entering uncovered exhaust pipe, leaking cylinder head gasket, cracked block or cylinder head. The engine should be disassembled to determine the cause and the necessary parts replaced. (Figure 8-1 thru 8-28)

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine will not start	1. Slow cranking speed.	1. The specific gravity of the batteries may be too low or the starter may not be delivering its maximum torque to provide adequate cranking speed. Cold weather starting requires the use of a cold weather starting aid. (Paragraph 13 - 48)
	2. Engine controls out of adjustment	2. Check all engine control linkages for proper adjustment. (Paragraph 104)
	3. Insufficient supply of fuel to fuel injection nozzles.	3. Check fuel system. (paragraph 98 - Paragraph 136)
	4. Fuel injection nozzles not properly operating	4. Test and repair or replace nozzles. (Paragraph 140)
	5. Fuel injection pump improperly timed.	5. Time fuel injection pump. (paragraph 142)
Engine hard to start	1. Batteries weak.	1. Recharge or replace batteries.
	2. Insufficient fuel in fuel tank.	2. Check fuel level in tank. Fill with specified fuel if necessary.
	3. Incorrect grade of fuel	3. Drain fuel system. Fill the tank with the specified fuel. (paragraph 136)
	4. Fuel injection nozzles not operating properly	4. Test and repair or replace nozzles. (paragraph 140)
	5. Fuel transfer pump not operating properly	5. Test and repair or replace fuel transfer pump. (page 143) (3)
	6. Air in fuel system	6. Correct air leaks in suction side of fuel system. Vent fuel system.
	7. Insufficient air supply to cylinders	7. Clean air system. (par. 102)

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine stops frequently	1. Idling speed too low.	1. Adjust low idling speed. Page 141 (e)
	2. Restricted fuel supply.	2. Check fuel system.
Engine stops suddenly	1. Out of fuel	1. Fill fuel tank with specified fuel and vent the fuel system. (Fig 7-5)
	2. Restricted fuel supply	2. Check fuel system(Fig 7-5)
	3. Broken or loose fuel lines.	3. Correct or replace affected parts.
	4. Fuel transfer pump or fuel injection pump inoperative.	4. Replace inoperative parts. Page 143 (3) Para 142
	5. Fuel injection pump assembly defective	5. Repair a defective fuel injection pump assembly. (Fig. 8-33 thru 8-38)
	6. Crankshaft gear broken	6. Replace a defective crankshaft gear. Para. 113 -(Fig. 8-4)
	7. Camshaft or camshaft gear broken	7. Replace a defective camshaft or camshaft gear.
	8. Air cleaner clogged	8. Service air cleaner. Para. 102
	9. Safety device functions.	9. Check lubricant level overspeed switch.
Engine overheats	1. Leak in cooling system	1. Correct all leaks and fill cooling system.
	2. Radiator core clogged.	2. Clean and flush radiator.
	3. Radiator air passages clogged	3. Remove debris from radiator core.
	4. Fan drive belts too loose.	4. Adjust fan drive belts to proper tension. Para. 111
	5. Thermostats inoperative	5. Test the thermostats for proper operation. Para. 135.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine overheats (con't)	6. Engine oil cooler clogged	6. Clean or replace the oil cooled core. Fig. 8-37
	7. Improper engine lubrication	7. Check for proper operation of engine lubrication oil pump. Fig. 8-11
	8. Water pump malfunctioning	8. Repair or replace the water pump. Fig. 8-35
	9. Fuel injection pump improperly timed.	9. Time fuel injection pump. Para. 142.
	10. Crankcase oil level low	10. Add oil to proper level. Refer to lubricant instructions.
	11. Ventilation insufficient	11. Provide adequate ventilation.
	12. Air cleaner clogged	12. Service air cleaner. Para. 102
	13. V-belt slipping or broken	13. Adjust or replace V-belt to fan Para. 111
	14. Muffler has back pressure	14. Replace muffler.
	15. Coolant level low	15. Add water to proper level.
Engine lacks power	1. Air cleaner	1. Service Air cleaner Para. 102
	2. Air in fuel lines	2. Bleed fuel lines Para 46 (b)
	3. Fuel filters clogged	3. Service filters. Para. 75

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine has low or no oil pressure	1. Crankcase oil level low	1. Add oil to proper level. Refer to lubrication instructions.
	2. Lubricating oil pressure switch defective	2. Replace lubricating oil pressure switch. (Figure 4-11)
	3. Oil pressure gauge defective	3. Replace oil pressure gauge. (Figure 2-1)
	4. Oil filter clogged	4. Turn thumb screw. (Figure 7-20)
	5. Check pressure relief valve	5. Adjust pressure or replace spring (Figure 7-21)
	6. Oil pump screen clogged	6. Clean oil pump screen.
	7. Connecting rod bearings defective	7. Replace connecting rod bearings. (Paragraph 113)
	8. Oil pump defective	8. Repair or replace a defective oil pump. (Figure 8-11)
	9. Main bearings defective	9. Replace main bearings. (Paragraph 113)
	10. Leaks in lubrication system.	10. Check all piping, joints, gauge for tightness.
Engine exhaust smoke excessive	1. Level of motor oil too high	1. Check and drain off to proper level on dip stick.
	2. Piston or piston rings worn or broken	2. Replace defective piston rings or pistons. (Figure 8-5)
	3. Fuel injection pump assembly improperly timed	3. Time fuel injection pump assembly. (paragraph 142)
	4. Nozzle holder assembly dirty or defective	4. Clean or repair nozzle holder assemblies. (Paragraph 140)
	5. Engine cold causing poor combustion	5. Allow sufficient engine warm up before applying load.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine knocks or develops excessive noise	1. Connecting rod bearings defective	1. Replace connecting rod bearings. Para 113
	2. Main bearing defective	2. Replace defective main bearings. Para 113
	3. Piston cracked or broken	3. Replace a defective piston. Fig. 8-5
	4. Camshaft gear worn.	4. Replace defective camshaft gear.
	5. Crankshaft gear worn	5. Replace defective crankshaft gear. Fig. 8-4
	6. Piston pins loose in piston, or sleeve bearing in connecting rod defective	6. Replace piston and pin, or sleeve, bearing in connecting rod. Fig. 8-5
	7. Nozzle holder assembly sticking	7. Replace nozzle holder assembly Para 140
	8. Fuel injection pump out of time	8. Re-time fuel injection pump. Para 142
	9. Manifold gaskets defective	9. Replace manifold gaskets.
	10. Valve clearance incorrect	10. Adjust valve clearance. Para. 149

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine hard to start or fails to start	1. Starting and operating procedure incorrect.	1. Follow correct procedures. Para. 46, 47.
	2. Fuel tank empty	2. Fill fuel tank and reprime. Para. 46 (b)
	3. Fuel valve closed	3. Open fuel valve. Para. !
	4. Fuel filter or strainer clogged	4. Service fuel filter and strainer. Para 75
	5. Foreign matter in fuel	5. Drain tank, blow out lines, fill with clean fuel.
	6. Starter fails to crank engine	6. Refer to Para 109
	7. Air cleaner clogged	7. Service air cleaner. Para 102
	8. Overspeed switch tripped	8. Reset switch. Fig 4-6
	9. Fuel injection pump defective or out of time	9. Time or replace fuel injection pump. Para 142
	10. Nozzle holder defective	10. Replace nozzle holder. Para 140
	11. Intake manifold leaks air	11. Replace manifold gaskets, or intake manifold.
	12. Valve clearance incorrect	12. Adjust valve clearance. Para 149
	13. Fuel lines leaky	13. Check all fuel lines for tightness and tighten unions.
	14. Fuel injection pump assembly defective	14. Repair fuel injection pump assembly. Para 142
	15. Nozzle holder assemblies defective	15. Repair defective nozzle holder assemblies. Para 140
	16. Engine starter fails to crank engine	16. Check battery connections.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine misses or runs erratically	1. Nozzle holder assemblies dirty or defective	1. Clean or repair nozzle holder assemblies. Para. 140
	2. Fuel injection pump assembly defective	2. Repair the fuel injection pump assembly. Para. 142
	3. Piston rings worn or broken	3. Replace piston rings. Fig. 8-3
	4. Valve seats in cylinder head cracked or burned.	4. Reface valve seats or replace cylinder head assembly. Fig. 8-2
	5. Poppet valves warped or pitted	5. Replace or repair defective poppet valve. Page 132 (5)
	6. Inadequate fuel supply	6. Clean fuel filter and evacuate air. Tighten fuel line connections.
	7. Valve clearance out of adjustment	7. Readjust valve clearances. Para. 149
	8. Valve spring broken	8. Have valve spring renewed.
	9. Nozzle needles stick	9. Remove, clean or replace. Para. 140
	10. Fuel filters clogged	10. Service or repair fuel filters. Para. 75
	11. Valve clearance incorrect	11. Adjust valve clearance. Para. 149
	12. Nozzle holder defective	12. Replace a defective nozzle holder. Para 140
	13. Fuel injection pump defective or out of time	13. Re-time or replace fuel injection pumps. Para. 142

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine runs unevenly and excessive vibration	2. Fuel supply erratic or insufficient.	2. Check fuel system (Fig. 7-5)
	3. Engine operating temperature too low	3. Check thermostats. (Para. 135)
	4. Fuel injection pump malfunctions.	4. Check fuel injection pump. (Paragraph 142)
	5. Valves in bad condition	5. Recondition valves. (para. 149)
	6. Cylinder "cutting-out"	6. Correct cause (para. 140).
	7. Fuel injection nozzle malfunctions.	7. Repair nozzle. (para. 140).
	8. Inoperative fuel injection nozzles.	8. Repair or replace affected parts. (Paragraph 140)
	9. Loss of compression	9. This may be due to leaking valves or worn piston rings or cylinder sleeves. Use a suitable compression tester and check each cylinder as per paragraph 158.
	10. Cylinder cutting out.	10. Locate a "missing" cylinder as follows: Run the engine at low idle speed and "cut-out" each fuel injection nozzle in turn by loosening the fuel injection line nut attaching the fuel injection line to the fuel injection pump. A decrease in engine speed with the injection line nut loosened indicates that the nozzle for that cylinder is functioning properly. If the engine speed does not decrease, the nozzle is malfunctioning and should be replaced. (Paragraph 140)
Engine runs unevenly and excessive vibration	1. Governor not operating properly.	1. Adjust governor and linkage. Page 141 (e)

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine runs unevenly and excessive vibration	2. Fuel supply erratic or insufficient.	2. Check fuel system (Figure 7-5)
	3. Engine operatind temperature too low	3. Check thermostats. (Paragraph 135)
	4. Fuel injection pump malfunctions.	4. Check fuel injection pump. (paragraph 142)
	5. Valves in bad condition.	5. Recondition valves. (Paragraph 149)
	6. Cylinder "cutting-out".	6. Correct cause (paragraph 140)
	7. Fuel injection nozzle malfunctions.	7. Repair nozzle. (paragraph 140)
Engine detonates	1. Air that has been delivered to the cylinder during the compression stroke. (See paragraph 159)	
Engine emits black smoke from exhaust	1. Air system clogged.	1. Check engine air intake system.
	2. Governor torque cam or stop plate incorrectly adjusted.	2. Correct the adjustment. (Paragraph 141 (e)
	3. Improper fuel.	3. Drain fuel system and refill with fuel of proper specifications.
Engine emits blue smoke from exhaust	1. Engine operating temperature too low.	1. Check thermostats. (paragraph 135)
	2. Fuel injection nozzle valve stuck in the open position	2. Clean and adjust (Paragraph 140)

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Starter will not crank engine	1. Batteries weak	1. Check batteries.
	2. Cables and/or connections loose or corroded	2. Tighten all loose connections and clean corrosion from all terminals.
	3. Starter switch inoperative	3. Replace switch. Fig. 2-1
	4. Starter brushes worn or not contacting properly	4. Install new brushes or fit brushes to conform to contour of commutator.
	5. Starter brush springs weak	5. Check brush spring tension, replace springs if necessary. Para. 14
	6. Starter commutator dirty or worn	6. Polish commutator, machine commutator and under-cut mica if necessary. Para 14
	7. Starter armature shaft bushings worn (armature drags on fields)	7. Replace worn bushings and related items. Fig 8-29, Fig 8-30
	8. Starter armature burned out	8. Replace armature. Fig 8-29, Fig. 8-30
	9. Engine starter armature defective	9. Replace starter armature. Fig. 8-29, Fig. 8-30
	10. Field coil assembly defective	10. Replace field coil assembly. Fig 8-29, Fig 8-30
	11. Brush holders defective	11. Replace brush holders. Fig 8-29, Fig 8-30
	12. Sleeve bearing defective	12. Replace sleeve bearing. Fig 8-29, Fig 8-30
	13. Engine starter drive mechanism defective	13. Repair or replace starter drive mechanism. Fig 8-29, Fig 8-30
	14. Engine flywheel spur gear defective	14. Replace engine flywheel spur gear. Fig 8-29, Fig 8-30-

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Starter pinion will not engage with flywheel ring gear.	1. Grease and/or dirt in starter drive mechanism	1. Disassemble and clean the drive assembly.
	2. Broken or excessively worn parts.	2. Replace broken or worn parts. Page 12
Insufficient fuel supply to fuel injection nozzles	1. No fuel in tank	1. Fill fuel tank with specified fuel, vent fuel system.
	2. Inoperative fuel transfer pump	2. Repair or replace transfer pump. Page 143 (3)
	3. Fuel injection nozzle	3. Replace valve assembly in nozzle holder body. Para 140
	4. Fuel lines and/or fuel filters clogged.	4. Clean fuel lines, replace fuel filter elements. Para 75
	5. Fuel injection pump malfunctioning	5. Replace fuel injection pump. Para. 142
	6. Fuel injection nozzles improperly adjusted	6. Adjust fuel injection nozzles. Para. 140
Air in fuel system	1. Loose fuel line fitting or leak in fuel line on suction side of fuel transfer pump	1. Tighten loose fitting or replace damaged line.
	2. Damaged gasket on first and/or second stage fuel filter (Roosa Master)	2. Replace gasket(s).

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Insufficient air supply to cylinders	1. Air cleaner clogged	1. Replace or clean air filter element. Para. 102
	2. Foreign material lodged in turbocharger impeller or turbine	2. Disassemble and clean. Para. 154
	3. Excessive dirt buildup in compressor or turbocharger.	3. Thoroughly clean compressor assembly. Para. 154
	4. Excessive dirt buildup in compressor in short period of time	4. Clean compressor assembly, and service air intake system for leaks.
	5. Leaks in engine intake and/or exhaust manifolds reducing turbocharger efficiency.	5. Tighten loose manifold retaining nuts or capscrews..Replace manifold gaskets.
	6. Turbocharger rotating assembly bearing seized	6. Overhaul turbocharger. Fig 8-16, Fig 8-17
Rapid wear on engine parts	1. Dirt admitted with intake air	1. Inspect air cleaner body, pipe, connecting hoses, gaskets, etc., thoroughly for cracks or openings which would allow air to enter engine without passing through air cleaner. Make necessary repairs.
	2. Dirty lubricating oil	2. Change engine oil and the lubricating oil filter elements at the intervals recommended. Keep oil clean when filling engine.
	3. Improper fuel	3. Use the proper fuel. It is important that the fuel be within the specified limits for ash carbon, sulphur, etc.,

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Engine operating temperature too high with ample coolant in system	1. Temperature gauge inoperative	1. Check gauge. Replace if necessary. Fig 2-1
	2. Radiator air passages restricted.	2. Clean exterior of radiator.
	3. Thermostats inoperative	3. Replace thermostats. Para 135
	4. Loose or broken fan drive belts	4. Adjust or replace fan drive belts. Para 111
	5. Lime deposits in water passages of radiator, cylinder heads and/or cylinder block	5. Thoroughly clean affected parts.
	6. Water passages in oil cooler restricted.	6. Remove and clean oil cooler core. Fig 8-27
	7. Water pump inoperative	7. Remove or replace water pump. Fig 8-25
	8. Excessive load	8. Reduce load.
	9. Engine speed set too high	9. Adjust speed to within specified rpm limits.
Engine operating temperature too high due to loss of coolant	1. External leaks	1. Repair affected parts.
	2. Ruptured oil cooler core (oil in coolant)	2. Replace oil cooler core. Fig 8-27
	3. Engine cylinder head gaskets leaking	3. Replace gaskets and torque cylinder head nuts as specified.
	4. Engine cylinder heads cracked	4. Replace cylinder head. Fig 8-2
	5. Engine cylinder block cracked	5. Replace cylinder block. Fig 8-2
Engine operating temperature too low	1. Thermostats stuck in open position	1. Replace thermostats. Para 135
	2. Operating in extremely cold weather	2. Provide covers for radiator and engine side openings.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
No lubricating oil pressure	1. Insufficient oil in crankcase	1. Fill crankcase to proper level.
	2. Oil pressure gauge inoperative	2. Replace gauge. Fig 2-1
	3. Lubricating oil pump screen clogged	3. Remove and clean the screen. Fig 8-11
	4. Lubricating oil pump inoperative	4. Repair or replace oil pump. Fig 8-11
	5. Oil lines loose or broken inside crankcase	5. Repair or replace affected parts.
Low lubricating oil pressure with proper oil level in crankcase	1. Oil pressure gauge inaccurate	1. Check gauge. Replace if necessary. Fig 2-1
	2. Oil pressure relief valve stuck in open position	2. Clean, repair, or replace affected parts.
	3. Oil lines in crankcase loose or broken	3. Repair or replace affected items. Fig 7-21
	4. Improper lubricant	4. Fill crankcase with specified lubricant.
	5. Main and/or connecting rod bearings worn	5. Replace bearings. Para 113
	6. Camshaft bearings worn	6. Replace bearings. Para 113
	7. Lubricating oil pump worn	7. Repair or replace oil pump Fig 8-11
Excessive lubricating oil pressure	1. Oil pressure gauge inaccurate	1. Check gauge. Replace if necessary. Fig 2-1
	2. Oil pressure regulating valve improperly adjusted	2. Adjust valve to obtain proper pressure Fig 7-21
	3. Improper lubricant	3. Fill crankcase with specified lubricant.

TABLE 3-1 TROUBLESHOOTING		
Overheating of lubricating oil	1. Insufficient oil in crankcase.	1. Fill crankcase to proper level.
	2. Improper lubricant	2. Fill crankcase with specified lubricant
	3. Engine oil cooler clogged	3. Clean or replace the oil cooler. Fig 8-27
Excessive oil consumption	1. External oil leakage, gaskets, etc.	1. Correct all external leaks.
	2. Engine oil seals worn or damaged.	2. Replace oil seals.
	3. Lubricating oil too light	3. Fill crankcase with specified lubricant.
	4. Pistons, rings, and/or cylinder sleeves worn	4. Replace affected parts. Fig 8-5
	5. Oil control rings stuck in piston ring grooves	5. Clean ring grooves and replace rings. Fig 8-5
	6. Valve guides worn	6. Replace valve guides. Check related parts. Para 149
Rapid wear on engine parts	1. Lubricating oil contaminated	1. Fill system with clean engine oil. Replace engine oil filters.
	2. Improper engine lubricating oil being used	2. Fill system with engine lubricating oil of proper specifications.

Generator not charging	1. Drive belt loose or broken	1. Adjust or replace drive belt. Para 15
	2. Regulator inoperative	2. Remove regulator for repair or replacement. Para 15
	3. Generator inoperative	3. Remove unit for repairs or replacement. Para 120
Generator output low and/or unsteady	1. Drive belt improperly adjusted	1. Adjust drive belt. Para. 15
	2. Regulator operating improperly.	2. Remove regulator for repair or replacement. Para. 15
	3. Brushes sticking in holders	3. Free brushes. Para 15

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Generator output low and/or unsteady	5. Generator commutator dirty or worn	5. Clean commutator or remove generator for repair or replacement.
Batteries will not hold charge	1. Loose terminals or connections	1. Tighten affected parts.
	2. Short in electrical system	2. Correct short.
	3. Short circuit in battery	3. Remove and repair or replace battery.
	4. Electrolyte level low (regulator output excessive or battery case cracked)	4. Reduce charging rate. Remove regulator for repair or replacement. Para. 15
Engine generator overheats	1. Engine generator defective	1. Replace generator Para. 108
	2. Engine generator voltage regulator defective	2. Adjust or replace regulator Para. 94
	3. Battery charging circuit wiring defective	3. Repair defective wiring.
Main generator fails to maintain kilowatt load division during parallel operation	1. Main generator frequency fluctuates or drifts	1. Refer to Page 63. Frequency Fluctuates
	2. Main generator frequency drops under load	2. Refer to Page 63
Main generator fails to supply power to load	1. Load terminal loose.	1. Shut down unit; clean and tighten terminals.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Generator fails to build up rated voltage	1. Voltage regulator assembly defective	1. Adjust or replace voltage regulator Para 31.
	2. Exciter stator assembly defective	2. Replace defective exciter stator Fig 5-1
	3. Exciter armature or stator frame rectifier defective	3. Replace defective exciter armature or stator frame rectifier. Fig 5-1
	4. Surge protector defective	4. Replace a defective surge protector. Fig 5-1
	5. Rotor assembly defective	5. Replace rotor assembly Fig. 5-1
	6. Stator assembly defective	6. Replace a defective stator assembly and generator frame. Fig 5-1
	7. Voltage adjusting rheostat defective	7. Replace a defective voltage adjusting rheostat. Para. 31
	8. Residual voltage extremely low (below 5 volts)	8. Flash field from external source (12 volt battery) while set is not running.
	9. Controls improperly adjusted	9. Adjust controls. Fig 2-1
	10. Load excessive	10. Reduce load. Load on each phase should be evenly balanced as possible and should not exceed rated current on any phase.
	11. Engine speed low	11. Increase engine speed until correct frequency is indicated.
	12. Voltage adjusting rheostat defective	12. Replace voltage adjusting rheostat Para 31

TABLE 3-1 TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
Generator voltage drops upon increase of load.	1. Voltage regulator assembly defective	1. Adjust or replace voltage regulator assembly. Para. 31
	2. Exciter stator assembly defective	2. Replace defective exciter stator assembly. Fig. 5-1
	3. Voltage regulator assembly defective	3. Adjust or replace voltage regulator assembly. Para 31
	4. Rotor assembly defective	4. Replace defective rotor assembly. Fig 5-1
	5. Exciter armature or stator frame rectifier defective	5. Replace defective exciter armature or stator frame rectifier Fig. 5-1
	6. Engine lacks power	6. Refer to Page 46.
Generator overheats	1. Operating area not properly ventilated	1. Provide peoper ventilation.
	2. Generator screen or louvers obstructed	2. Clean screen and louver.
	3. Generator load not balanced	3. Balance load.
	4. Load excessive	4. Reduce load
	5. Stator assembly defective	5. Replace stator assembly Fig. 5-1
	6. Rotor assembly defective	6. Replace rotor assembly Fig. 5-1
	7. Rotor end bearing defective	7. Replace rotor end bearing Fig. 5-1
	8. Fan assembly defective	8. Replace fan assembly. Fig. 5-1.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
Low Voltage	1. Line loss	1. Increase size of line wire.
	2. High resistance connections	2. Make better connections.
	3. Shorted field	3. Test field coils for possible short by checking resistance with an ohmeter or resistance bridge. Return rotor assembly to factory for repair if alternator field coils are shorted. Reduce inductive (motor) load. Some AC motors draw approximately the same current regardless of load. Do not use motors of larger horsepower rating than is necessary to carry the mechanical load.
	4. Weak field due to operating in warm temperature	4. Improve the ventilation of generator. Field current can be increased providing the generator temperature rating stamped on the nameplate is not exceeded.
	5. Excessive load	5. Reduce load to rated value.
	6. Defective bearing	6. Replace if worn excessively. Fig 5-1
	7. Defective voltage regulator	7. Check regulator, adjust or repair or replace if defective. Para. 31
	8. Defective diodes in station ary rectifier assembly. Improper adjustment of voltage adjust rheostat	8. Check rectifier assembly. Replace defective diode. Adjust rheostat. Fig 5-1

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
No Voltage	1. Open circuit breaker (if voltage is samples on load side of circuit breaker)	1. Check. Reset circuit breaker if open.
	2. Undervoltage, or overload devices tripped, protective devices incorporated in circuit	2. Check for cause of abnormal condition. Correct deficiences. Reset devices. Check generator data plate for normal operating.
	3. Open circuit in exciter field	3. Check out continuity valve of shunt field and leads to voltage control. (Use ohmeter or wheatstone bridge) Approximate reading 9.6 ohms. If open in field coils, remove exciter field assembly and return assembly to factory for repair.
Fluctuating voltage	1. Voltage regulator not operating properly	1. Check regulator. Repair or replace if defective. (para. 31)
	2. Loose terminal or load connections.	2. Make better connections.
	3. Generator overloaded	3. Reduce load to rated value.
	4. DC excitation voltage fluctuating	4. Trace DC excitation circuit.
Frequency fluctuates, drifts, or drops under load	1. Engine speed fluctuating	1. Operate properly
	2. Fuel injection pump defective	2. Replace fuel injection pump. (Paragraph 142)
	3. Nozzle holder assembly defective	3. Replace nozzle holder. (paragraph 140)
	4. Valve clearance incorrect	4. Adjust valve clearance. (paragraph 149)
	5. Fuel injection line leaking	5. Tighten or replace a defective fuel injection line. (Paragragh 149)
	6. Engine misses or runs erratically	6. Refer to paragraph for causes and remedies.

TABLE 3-1 TROUBLESHOOTING

TROUBLE	POSSIBLE CAUSE	REMEDY
Circuit breaker continues to trip	1. Generator overloaded	1. Reduce load.
	2. Generator voltage too low	2. Adjust voltage.
	3. Short circuit in system	3. Check for short circuit.
Circuit breaker trips or fails to close	1. Circuit breaker defective	1. Replace defective circuit breaker.
	2. Generator voltage too low	2. Refer to Page 58 for causes and remedies.
AC voltmeter fails to register	1. Generator controls improperly adjusted	1. Adjust controls. (paragraph 31)
	2. AC voltmeter defective	2. Replace AC voltmeter (figure 2-1)
	3. Voltmeter circuit wiring defective	3. Replace defective wiring.
High voltage	1. Overspeed	1. Correct speed of prime mover.
	2. Improper adjustment of voltage regulator	2. Adjust rheostat and/or voltage regulator. (paragraph 31)
Generator noisy	1. Rotor end bearing defective	1. Replace rotor end bearing. (Figure 5-1)
	2. Fan assembly or rotor assembly loose or defective	2. Replace fan assembly or rotor assembly. (Figure 5-1)
AC Ammeter fails to register	1. Check connections	1. Replace defective ammeter (Figure 2-1)
Main generator voltage erratic	1. Cable connections loose	1. Shut down unit and tighten connections.

Section VI. Radio Interference Suppression

82. DEFINITIONS

a. Interference. The term "interference" as used herein, applies to electrical disturbances in the radio frequency range which are generated by the generator set and which may interfere with the proper operation of radio receivers or other electronic equipment.

b. Interference Suppression. The term "interference suppression" as used herein, applies to the methods used to eliminate or effectively reduce radio interference generated by the generator set.

83. GENERATOR METHODS USED TO ATTAIN PROPER SUPPRESSION

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

84. INTERFERENCE SUPPRESSION COMPONENTS

The primary suppression components are those whose primary function is to supress radio interference.

85. TESTING OF RADIO INTERFERENCE SUPPRESSION

Test the capacitors for leaks and shorts on a capacitor tester; replace defective capacitors. If test equipment is not available and interference is indicated, isolate the cause of the interference by the trial-and error method of replacing each capacitor in turn until the cause of interference is located and eliminated.

CHAPTER 4

MAINTENANCE INSTRUCTIONS

Section I. Housing Assembly

86. GENERAL

The engine and generator are enclosed in a sheet metal housing. Doors, panels at both sides, and at rear of the unit provide access to the generator set components. Sheet metal panels and the housing roof complete the enclosure.

87. HOUSING REMOVAL

a. Removal

(1) Remove the exhaust rain cap and muffler assembly.

(2) Remove radiator filler neck.

(3) To remove housing, unscrew 32 bolts along bottom of housing and 11 bolts across center of roof. When all bolts are removed, lift housing off as a unit.

b. Cleaning and Inspection

(1) Clean all parts with cleaning solvent, and dry thoroughly.

(2) Inspect for cracks, breaks, or other damage.

(3) Straighten all dents. Weld all cracks and broken welds.

(4) Replace all defective parts.

c. Installation

(1) To install housing, reverse the removal procedure.

(2) Install the exhaust rain cap and muffler assembly.

Section II. Exhaust System

88. GENERAL

Exhaust gases from the engine are discharged from the cylinders through exhaust ports into the exhaust manifold. The exhaust pipe and flange, attached to the exhaust manifold, conduct the exhaust gases to the muffler. A self-closing raincap assembly covers the discharge opening from the muffler and prevents entrance of water and dirt.

89. MUFFLER, RAIN CAP ASSEMBLY, AND EXHAUST PIPE

a. Removal

(1) Remove the clamp, and exhaust pipe.

(2) Remove the rain cap assembly and muffler.

b. Cleaning, Inspection and Repair.

(1) Clean all parts with cleaning solvent and dry thoroughly.

(2) Inspect all parts for cracks, or breaks, and other damage.

(3) Replace all damaged or defective parts.

c. Installation

(1) Install the muffler and rain cap assembly.

(2) Install the exhaust pipe and clamp.

Section III. Engine Electrical System

90. GENERAL

The engine is equipped with a 24 volt, negatively grounded electrical system. The engine starter is energized by an engine starter switch. The battery is located on the right side of the unit, near the starter. The battery is normally kept fully charged by a belt-driven engine accessory generator. An engine generator voltage regulator controls the output of the generator. The engine is protected against damage by three safety shut down devices. The shut off switches are for low oil pressure, overspeed high coolant temperature.

91. WIRING

The wiring consists of individual wire lead assemblies, terminals, lugs, and wire lead assemblies laced into harnesses. Replace worn, frayed or damaged individual wire lead assemblies. Tag for proper identification all wire lead assemblies that are to be replaced. Remove the terminals by removing the screws, nuts, lockwashers and clamps, or by melting the solder at soldered connections. Install new wire lead assemblies after proper identification and secure with screws, nuts, lockwashers, and clamps, or by re-soldering as applicable. Be sure all connections are clean and secure.

92. BATTERY CABLE ASSEMBLIES

a. Removal

(1) Disconnect the battery cable from the battery.

(2) Disconnect the cable from the relay on the starter.

(3) Remove bolt, lockwasher, and nut that secures the battery ground cable to the frame.

(4) Remove the battery-charging electrical connector.

b. Cleaning and Inspection

(1) Clean the battery and battery cable terminals with cleaning solvent.

(2) Inspect for cracks, breaks, burned contacts, and defective insulation.

(3) Polish burned contacts with sandpaper.

(4) Replace all defective parts.

c. Installation

(1) Install the battery-charging electrical connector.

(2) Connect the battery ground cable to the frame with bolt, lockwasher, and unit.

(3) Connect the cable to the relay on the starter.

(4) Connect the battery cables to the battery.

93. ENGINE ACCESSORY GENERATOR AND STARTER

CAUTION

When working on the electrical parts of the fitted generator or starter motor, there is the risk of short-circuits occurring. Before beginning such work, the ground cable should be disconnected at the battery.

a. Removal.

(1) The carbon brushes of the generator and starter motor are to be examined after about 250 operating hours. In most cases, it will be necessary to remove the generator and starter motor.

(2) After removal of the cover, the spring which presses the carbon brushes against the commutator can be lifted with a piece of hooked wire. In doing so, take care not to bend the spring sideways and not to stress it more than necessary. At the same time, check whether the carbon brushes move easily in their guides.

b. Cleaning, Inspection, and Repair.

(1) Brushes and brush holders must be free from dust, oil, and grease. Clean contaminated parts with a clean cloth wetted with motor-spirit, and dry well. Scored and unround commutators are to be turned. On no account may commutators and carbon brushes be treated with emery paper or a file. Worn-out or broken brushes must be renewed. Only genuine carbon brushes may be used. It is advisable to renew the brushes at every basic engine overhaul.

(2) The ball bearing of the generator do not as a rule require to be lubricated although they should be provided with special grease at every basic overhaul of the engine.

(3) The starter motor is equipped with self-lubricating bearings. These bearings may not be cleaned with a solution containing grease-solvent.

(4) Starter pinion and ring gear should be cleaned from time to time and smeared with graphitized grease after removal of any bur.

(5) Every generator, following repairs or a change in the sense of rotation, needs to be polarized while installed. (Paragraph 15)

(6) The electrical connection between generator and separately mounted regulator/cut-out is marked on the latter. The regulator/cut-out should be fixed to a side which is free from vibrations, if possible, with the terminals facing downwards.

(7) The regulator/cut-out requires no maintenance. In the case of damage or defect, it should be renewed.

(8) Clean all parts with cleaning solvent and dry thoroughly.

(9) Rotate the generator armature shaft and inspect for signs of rough or worn bearings. Inspect the pulley and V-belt.

(10) Replace a defective generator, bracket, pulley or V-belt.

c. Installation

Install the generator bracket and generator. Adjust the V-belt.

94. VOLTAGE REGULATOR

General. The voltage regulator automatically controls the out-put of the engine generator to keep the battery fully charged. The circuit breaker unit closes the circuit between the battery and the generator when the condition is reversed. The current regulator unit limits the current to the maximum rated value of the generator. The voltage regulator unit maintains the voltage of the system at the full-charge level. The regulator requires no maintenance. In case of damage or defect, replace with a new regulator.

95. ENGINE STARTER AND SOLENOID

a. On-Engine Testing. Test the starter and solenoid. (Figure 4-12)

b. Removal. Remove the starter and solenoid. (Paragraph 14) and Figure 4-3.

c. Cleaning and Inspection.

(1) Clean all parts with cleaning solvent and dry thoroughly.

(2) Inspect for cracks, breaks, corroded terminals, or other damage. Inspect for loose or missing mounting hardware.

(3) Tighten or replace loose or missing mounting hardware. Replace a defective starter or solenoid.

d. Installation. Install the solenoid and starter.

96. LOW OIL PRESSURE SWITCH

a. Removal. Remove the low oil pressure switch. See figure 4-11.

b. Cleaning and Inspection

(1) Clean with cleaning solvent and dry thoroughly.

(2) Inspect for breaks, cracks, corroded terminals, or other damage.

(3) Replace a defective switch.

c. Installation. Install the low oil pressure switch, reverse of removal.

97. OVERSPEED SWITCH

a. Removal. Remove the overspeed switch. See figure 4-6.

b. Cleaning and Inspection.

(1) Wipe all dust and dirt from the overspeed switch with a clean dry cloth.

(2) Clean the bracket with cleaning solvent and dry thoroughly.

(3) Inspect the switch for cracks, breaks, and improper operation.

(4) Inspect the bracket for dents and other damage. Straighten all dents.

(5) Replace all defective parts.

c. Installation. Install the overspeed switch, reverse of removal.

Section IV. Fuel System

98. GENERAL

Diesel fuel is received from the fuel tank to the engine by the built-in transfer pump.

99. FUEL LINE AND TUBE ASSEMBLIES, AND FITTINGS

Fuel and oil line assemblies used on the generator set consist of hoses and necessary fittings. Inspect line and tube assemblies for cracks and breaks. Replace defective line and tube assemblies with those of the same size, length shape,and material. Loosen the fittings at the ends of line assemblies and replace a defective part. Replace all damaged fittings. Make sure all fittings and support clamps are secure.

100. FUEL LEVEL GAUGE (FIGURES 4-5 and 4-10)

a. Removal

(1) Turn the fuel gauge cap (1) counterclockwise and remove the cap from the fuel tank (5).

(2) Remove the cork gaskets (2) and the glass (3) from the fuel gauge cap.

(3) Remove the gauge and float assembly (4) from the fuel tank (5).

b. Cleaning and Inspection

(1) Clean the glass and cap with cleaning solvent and dry thoroughly.

(2) Inspect all parts for breaks, cracks, and other damage. Replace all defective parts.

c. Installation

(1) Install the gauge and float assembly (4) in the fuel tank.

(2) Position the glass (3) and cork gaskets (2) in the fuel gauge cap (1). Place the fuel gauge cap on the fuel tank (5) and secure by turning the cap clockwise.

101. FUEL TANK

a. Removal

(1) Drain fuel tank. (Figure 4-4)

(2) Remove the fuel level gauge. (Figure 4-5)

(3) Remove the fuel line and fittings (fig. 2-5).

(4) Remove four bolts that secure fuel tank to skid base, (Figure 4-4), and slide tank out from rear.

b. Cleaning and Inspection

(1) Clean fuel tank externally with cleaning solvent and dry thoroughly. Use steam or hot water, if available, to remove scale and other foreign matter from the interior of the fuel tank.

(2) Replace a defective fuel tank.

c. Installation

(1) Install fuel tank.

(2) Install fuel lines and fittings.

(3) Install fuel level gauge.

102. AIR CLEANER ASSEMBLY (RE-USABLE TYPE)

a. Removal. Remove the air cleaner, (Figure 4-6).

b. Disassembly. Refer to Figure 7-25. Disassemble the air cleaner.

c. Cleaning and Inspection.

(1) Clean all parts except the gaskets with cleaning solvent and dry thoroughly.

(2) Inspect all parts for breaks, bends, or other damage.

(3) Replace all defective parts.

d. Re-assembly. Re-assemble the air cleaner.

e. Installation. Install the air cleaner.

Section V. Instruments, Controls, Control Box Drop Cover and Engine Instrument Panel

103. CONTROL BOX AND PANELS (See Figure 4-7 , figure 2-1, and figure 2-3)

The control ensemble, control box drop panel, control box tray, and engine instrument panel are mounted at the upper rear of the generator set. They contain the switches, rheostats, gauges, meters, lights fuses and fuse holders, and receptacles necessary for the successful operation of the unit. Before replacing any switches, gauges, meters, or other electrical components, inspect the wiring of the component to be sure it is not damaged or defective. Meters, switches, and gauges must be replaced when they become inoperative or show signs of incorrect reading under normal operation. It is important to handle meters

and gauges with care since they are sensitive and require accurate adjustment. Any misuse or mishandling may cause damage. Switches should be replaced when they become inoperative. Damage to switches is caused by wear and arcing at the contact points. Damage to gauges, switches, and other electrical components may also be caused by overloading, and breakage. Clean components carefully with a dry cloth before installation. Replace all defective components.

WARNING

Do not perform the maintenance services when the generator set is in operation.

Section VI. Removal and Installation of Major Components

104. ROOSA MASTER INJECTION PUMP (FIGURE 4-13)

STEPS	DESCRIPTION
1.	Disconnect battery.
2.	Remove timing cover plate on flywheel and injector pump.
3.	Crank engine around to timing mark on flywheel for 1800 RPM and turbocharged operation. (36°).
4.	Check timing marks on injection pump to insure alignment.
5.	Mark and remove all wires.
6.	Remove dead man spring and throttle control linkage.
7.	Remove fuel input line to pump from filters and fuel return line from pump.
8.	Remove injection line from pump being careful not to damage the lines or sealing washers and their surfaces.
9.	Loosen injection line supports and vibration mounts.
10.	Remove the two mounting nuts on base of pump flange.
11.	Slowly move pump away from its mounting, being careful not to damage the pump drive shaft or fuel lines as pump is removed.
12.	Installation, reverse of removal.
13.	For disassembly and assembly of injection pump, refer to figures 8-33 through 8-37.

105. REMOVAL OF GENERATOR LEADS. (FIGURE 4-7)

STEPS	DESCRIPTION
1.	Remove four nuts and washers on link panel.
2.	Remove link panel shield.
3.	Tilt link panel forward.
4.	All connections made on back side of link panel.
5.	Remove four bolts on circuit breaker panel.
6.	Remove four bolts mounting circuit breaker.

105. REMOVAL OF GENERATOR LEADS (CON'T)

STEPS	DESCRIPTION
7.	Pull out circuit breaker.
8.	Disconnect wires U0-10, U0-11, and U0-12 from T0 on link panel.
9.	Disconnect wire U0-6, from T6 on link panel.
10.	Disconnect wire U0-5 from T5 on link panel.
11.	Disconnect wire U4-4 from T4 on link panel.
12.	Disconnect wire P8-2 from circuit breaker bottom terminal position (1).
13.	When removing the remaining wires, reference wiring diagram (fig.1-2) for threading wires through transformer.
14.	Disconnect wire U7-7 from T7 on link panel and thread through transformer.
15.	Disconnect wire U9-9 from T9 on link panel and thread through transformer.
16.	Disconnect wire P9-3 from circuit breaker bottom terminal (2) and thread through transformer.
17.	Disconnect wire P7-1 from circuit breaker bottom terminal (3) and thread through transformer.
18.	Disconnect wire U8-8 from T8 on link panel then thread through transformer.
19.	Disconnect wire R8FC1 from feed thru capacitor, figure 2-3.
20.	Disconnect wire R9FC4 from voltage regulator terminal 9.

106. TURBOCHARGER (FIGURE 4-14)

STEPS	DESCRIPTION
1.	Allow the turbocharger to cool if engine has been running.
2.	Remove muffler and rain cap assembly, figure 4-9.
3.	Remove exhaust nipple, figure 4-9.
4.	See figure 4-14 for removal of turbocharger.
5.	For disassembly and reassembly, refer to figures 8-16 and 8-17.
6.	Installation, reverse of removal.

107. STARTER (FIGURE 4-3)

STEPS	DESCRIPTION
1.	Remove cables to starter and tag.
2.	Disconnect fuse.
3.	Remove lead wires and tag.
4.	Remove three bolts and three lockwashers.
5.	Remove starter from bell housing.
6.	Installation, reverse of removal.
7.	For disassembly and assembly of starter motor, refer to figures 8-29, 8-30.

108. BATTERY CHARGING GENERATOR (FIGURE 4-2)

STEPS	DESCRIPTION
1.	Remove ground lead.
2.	Remove leads and tag.
3.	Remove adjusting bolt and nut.
4.	Remove drive belt.
5.	Remove two mounting bolts and nuts.
6.	Lift off generator.
7.	Installation, reverse of removal.
8.	For disassembly and assembly of battery charging generator, refer to figure 8-32.

109. FUEL FILTER (FIGURE 4-8)

STEPS	DESCRIPTION
1.	Disconnect hose from fuel pump to hand primer.
2.	Disconnect hose from outlet of filter to injection pump.
3.	Remove four bolts and lockwashers.
4.	Fuel filter assembly and hand primer pump will remove as a unit.
5.	Installation, reverse of removal.
6.	For disassembly and assembly of fuel filter refer to figure 8-20.

110. RADIATOR (FIGURES 4-15, and 4-16)

STEPS	DESCRIPTION
1.	Remove housing assembly, paragraph 112.
2.	Remove clamps and hoses.
3.	Remove fan guard.
4.	Remove radiator brackets support, figure 4-15.
5.	Remove bolts securing radiator to radiator support, figure 4-15.
6.	Installation, reverse of removal.

111. FAN, FAN HUB, AND FAN BELTS (FIGURE 4-17 AND PARAGRAPH 136)

STEPS	DESCRIPTION
1.	Perform steps in paragraph 110, RADIATOR REMOVAL.
2.	Remove six bolts and washers to remove fan, figure 4-17.
3.	Loosen lock nut at rear of the fan hub spindle, figure 8-28, item 6 and figure 4-18.
4.	Turn adjusting screw counterclockwise to low hub to remove belts Figure 8-28, item and figure 4-18.
5.	Remove four bolts and washers to remove fan hub assembly.
6.	Installation, reverse of removal.

112. HOUSING REMOVAL (FIGURE 4-9)

STEPS	DESCRIPTION
1.	Lift off four doors.
2.	Remove 30 bolts at base of housing.
3.	Remove four bolts at top of roof.
4.	Lift off with sling. Place under roof thru doors.

113. CRANKSHAFT REMOVAL

STEPS	DESCRIPTION
1.	Remove flywheel and flywheel housing. (Refer to figures 4-19 and 4-20)
2.	Remove the timing gear housing cover. (Refer to figure 4-21)

113. CRANKSHAFT REMOVAL (CON'T)

STEP	DESCRIPTION
3.	Remove oil pan, pump(s), and associated tubing. (Refer to figures 4-22 and 4-23)
4.	Remove connecting rod bearing caps and shells. (Refer to figure 4-24)
5.	Remove main bearing caps and lower main bearing shells. (Refer to figure 4-24)
6.	Remove the crankshaft.
7.	Remove upper main bearing shells from the cylinder block. NOTE: Identify the bearing shells as to their location in the connecting rods and in the block and main bearing caps in the event inspection proves they can be used again.
8.	Clean crankshaft thoroughly and inspect the journals for scoring, chipping, cracking, or signs of overheating. If crankshaft has been overheated (usually indicated by discolored or blue bearing journal surfaces), or is scored or excessively worn, reconditioning or replacement will be required. Examine bearing journals for cracks if overheating has occured.

NOTES: The specified end play of the crankshaft is .006" - .014" and must not exceed .022". Thrust flanges are available in standard size and .005", .010" and .015" oversize.

The crankshaft gear is keyed and pressed onto the front end of the crankshaft with a .0005" - .0025" interference fit.

114. CONTROL BOX ASSEMBLY (FIGURE 4-7)

STEPS	DESCRIPTION
1.	Cut ty-raps and remove clamps securing harness to generator.
2.	Disconnect generator leads. Procedure paragraph 105.
3.	Remove start pilot, figure 4-6.
4.	Remove coolant temperature sensor, figure 4-25.
5.	Remove high coolant temperature switch, figure 4-25
6.	Remove two wires from overspeed switch, figure 4-6.
7.	Remove four bolts and washers.
8.	Lift off generator and set on floor.
9.	Installation, reverse of removal.

115. CYLINDER HEAD

STEPS	DESCRIPTION
1.	Refer to paragraph 150.
2.	See figure 4-26.
3.	Installation, reverse of removal.
4.	For disassembly and assembly, see figure 8-2.

116. MAIN GENERATOR

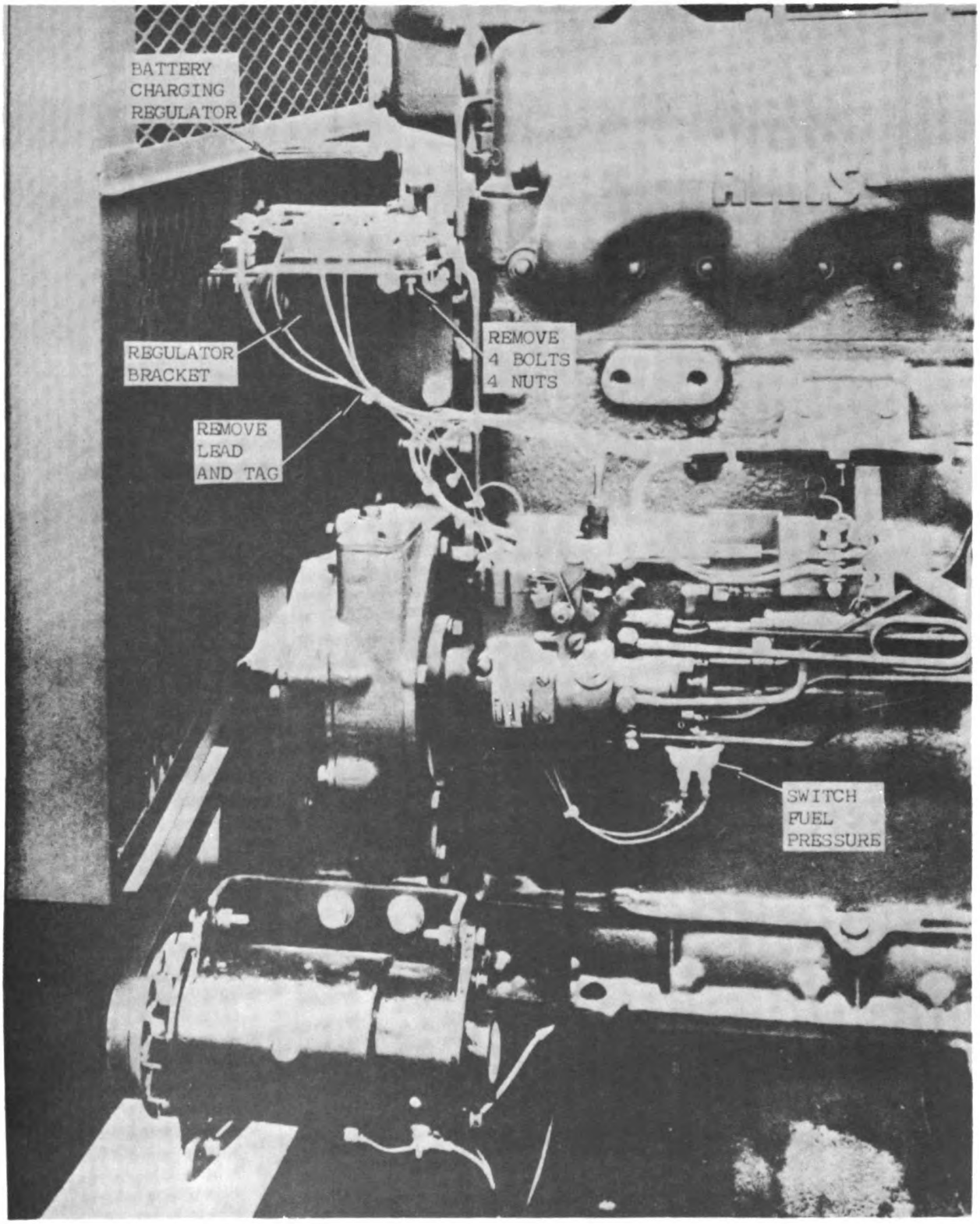
STEPS	DESCRIPTION
1.	Perform steps in housing removal, paragraph 112.
2.	Perform steps in generator leads removal, paragraph 105.
3.	Perform steps in control box assembly removal, paragraph 114.
4.	Remove protective covering and screen from generator. Remove cover by removing four screws.
5.	Remove eight bolts and washers and four locking plates, figure 4-27.
6.	Remove twelve bolts and twelve washers from generator housing.
7.	Remove four generator base mounting bolts, figure 4-7.
8.	Pry between generator housing and engine bell housing to separate.
9.	Attach hoist to hooking eye of generator.

117. ENGINE

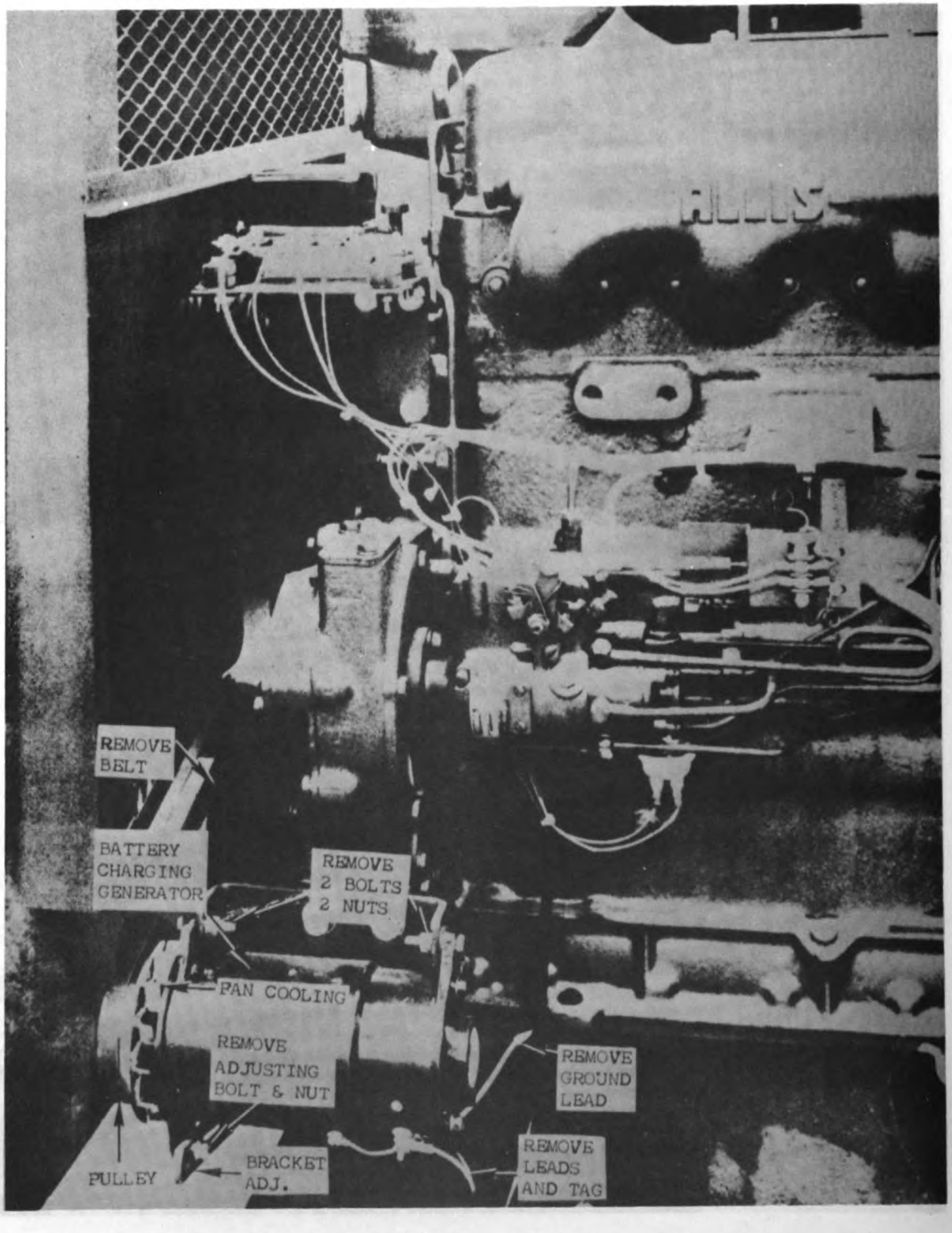
STEPS	DESCRIPTION
1.	Perform steps in paragraph 112, Housing Removal.
2.	Perform steps in paragraph 110, Radiator Removal.
3.	Put 2 X 4 timber under flywheel housing.
4.	Perform steps 4, 5, 6, 7, and 8 outlined in paragraph 116, Main Generator Removal.
5.	Attach hoist to lifting eyes on engines.
6.	Remove two bolts, two washers, and two nuts from trunnion to free engine.

117. ENGINE _____ (CON'T)

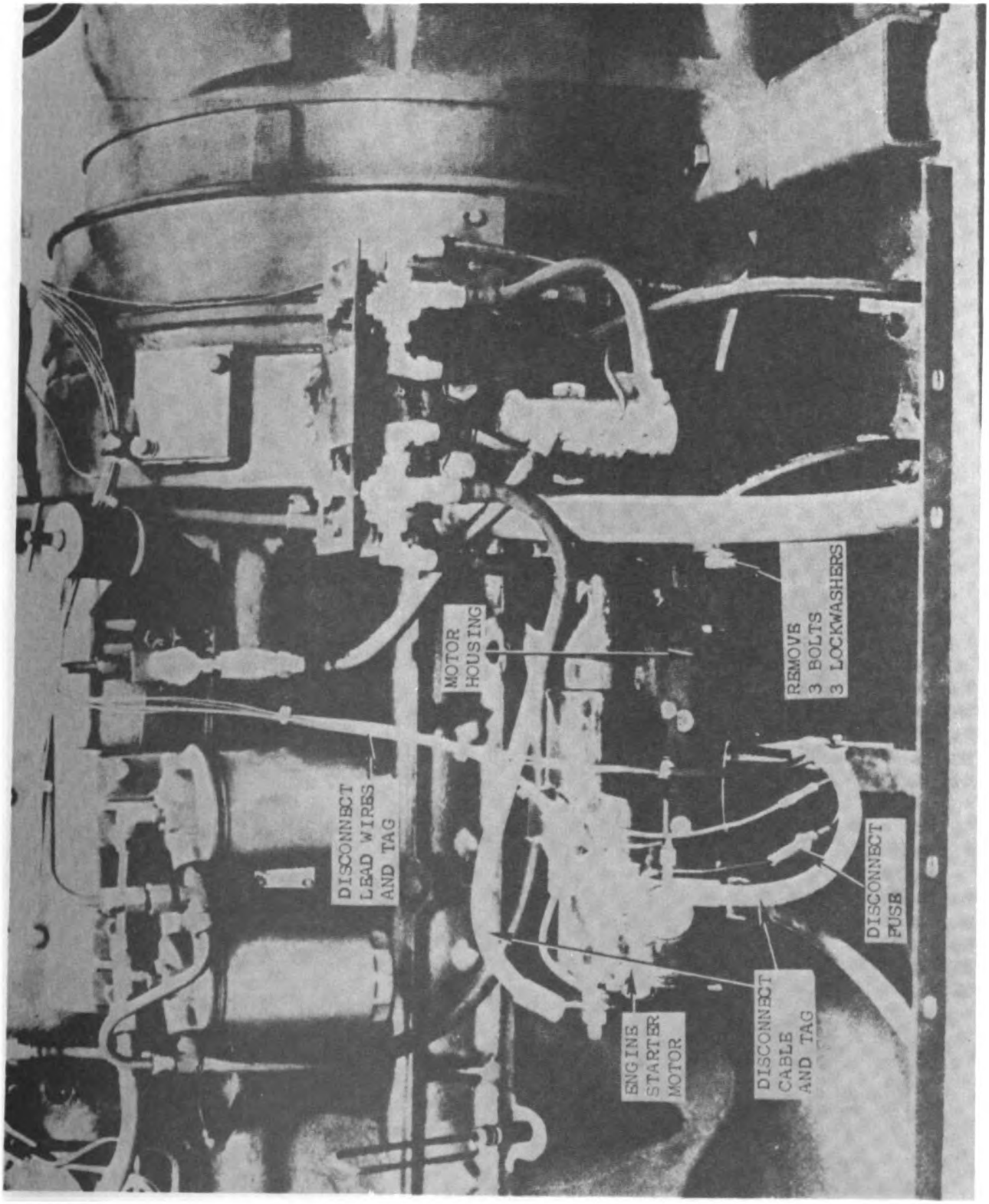
STEPS	DESCRIPTION
7.	Remove from three-way fuel valve inlet and outlet hose from tank and auxiliary inlet and auxiliary outlet hose from skid.
8.	Lift engine off.
9.	Installation, reverse of removal.



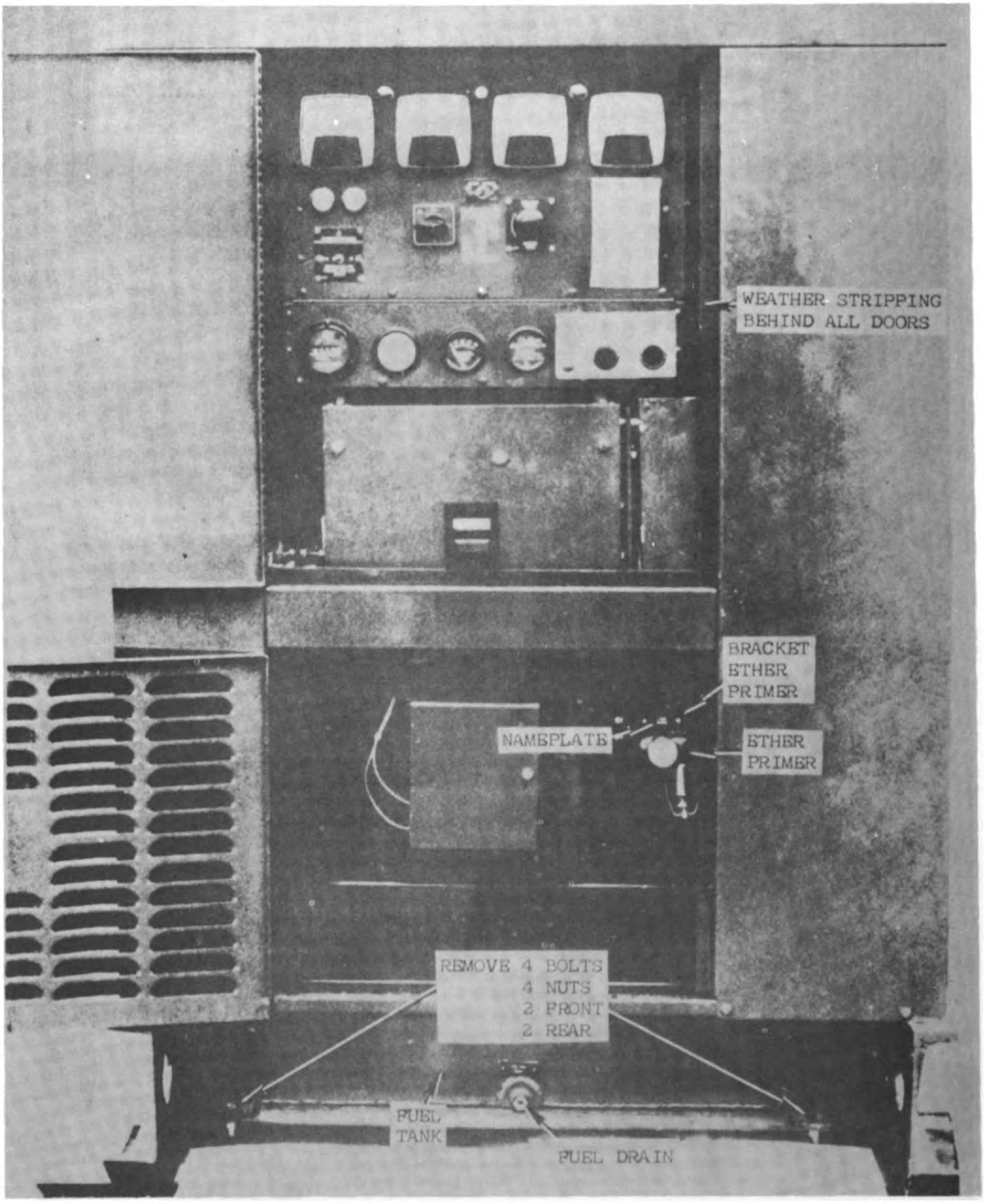
REGULATOR REMOVAL
FIGURE 4-1



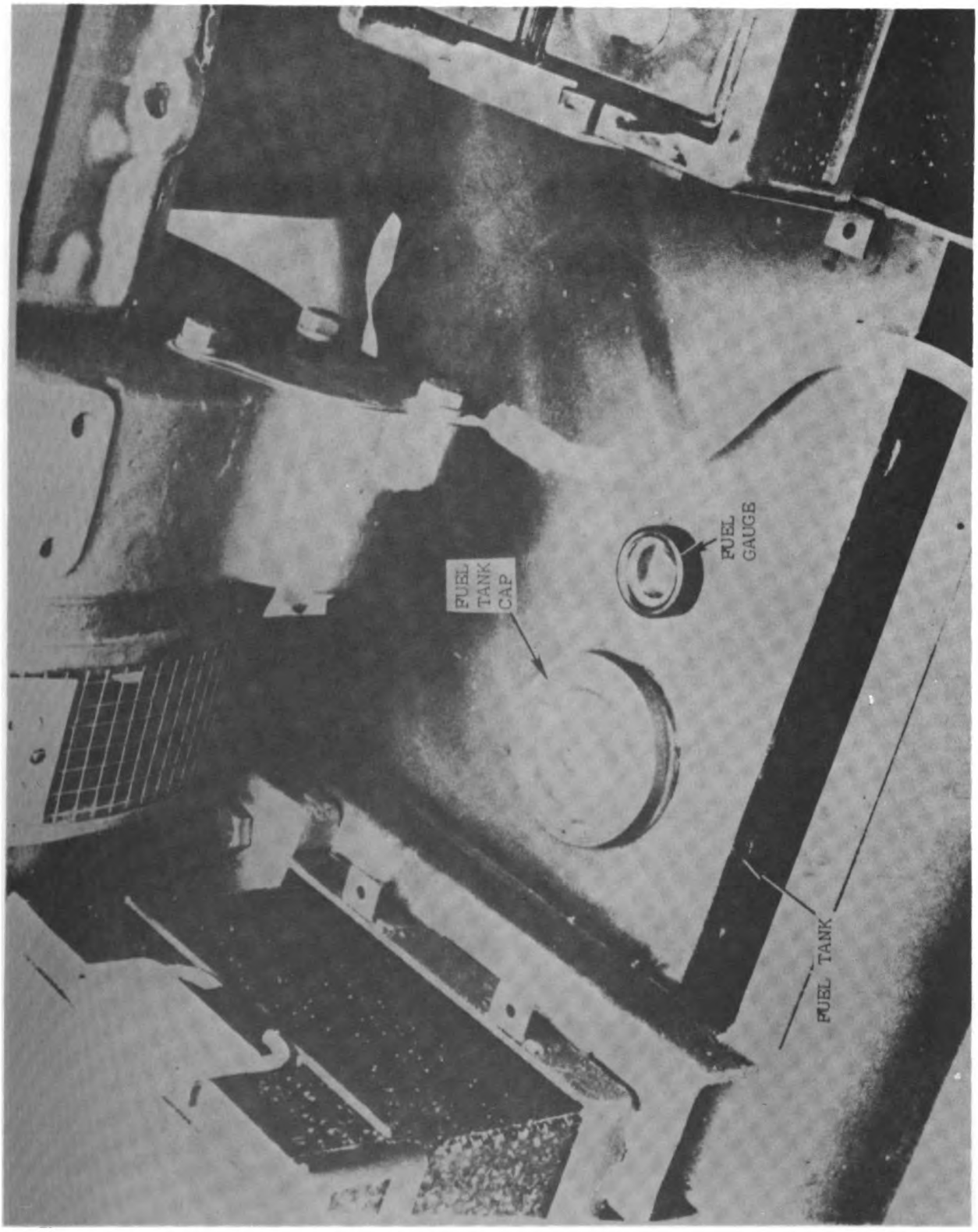
ENGINE GENERATOR REMOVAL
FIGURE 4-2



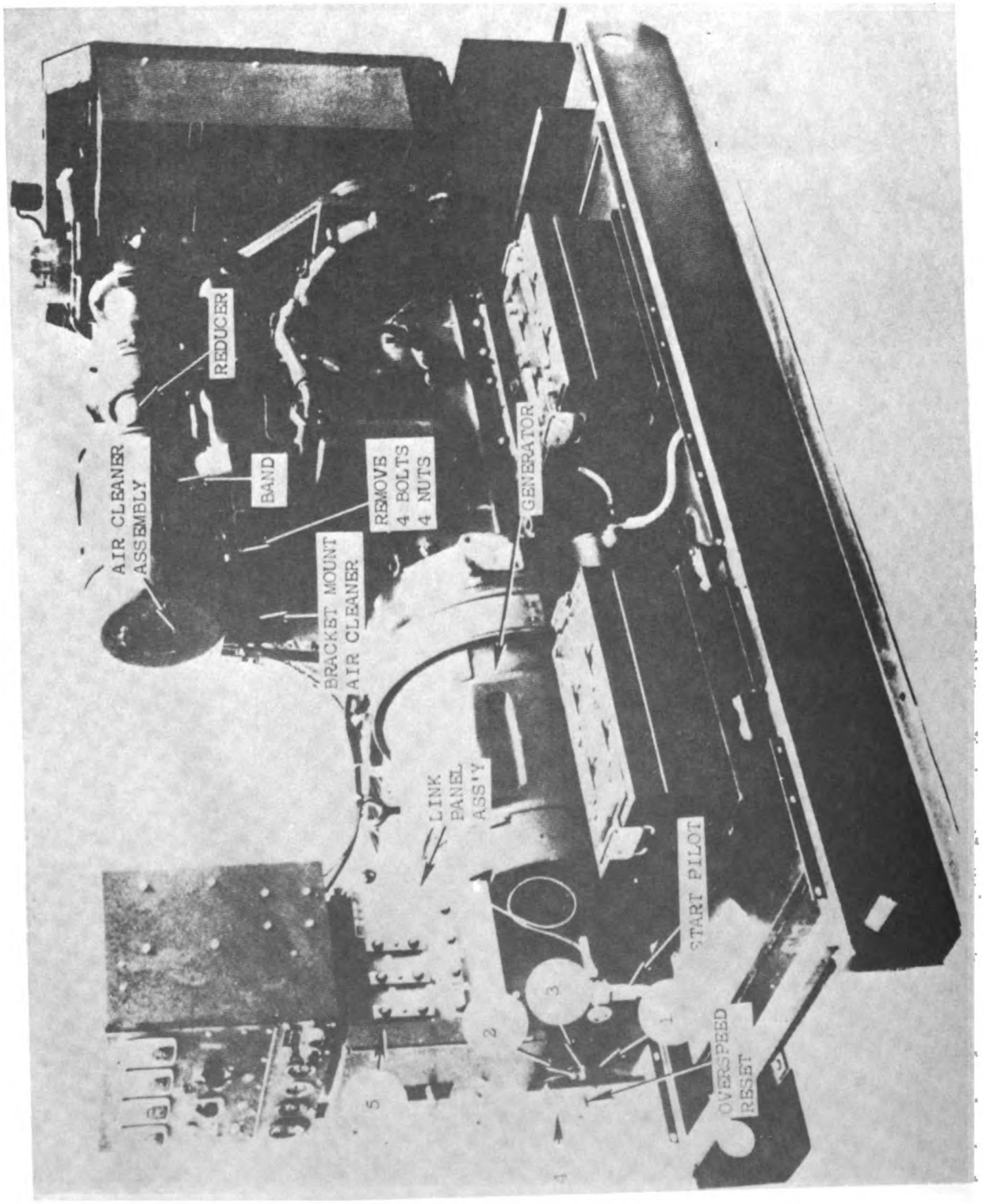
ENGINE STARTER MOTOR REMOVAL
FIGURE 4-3



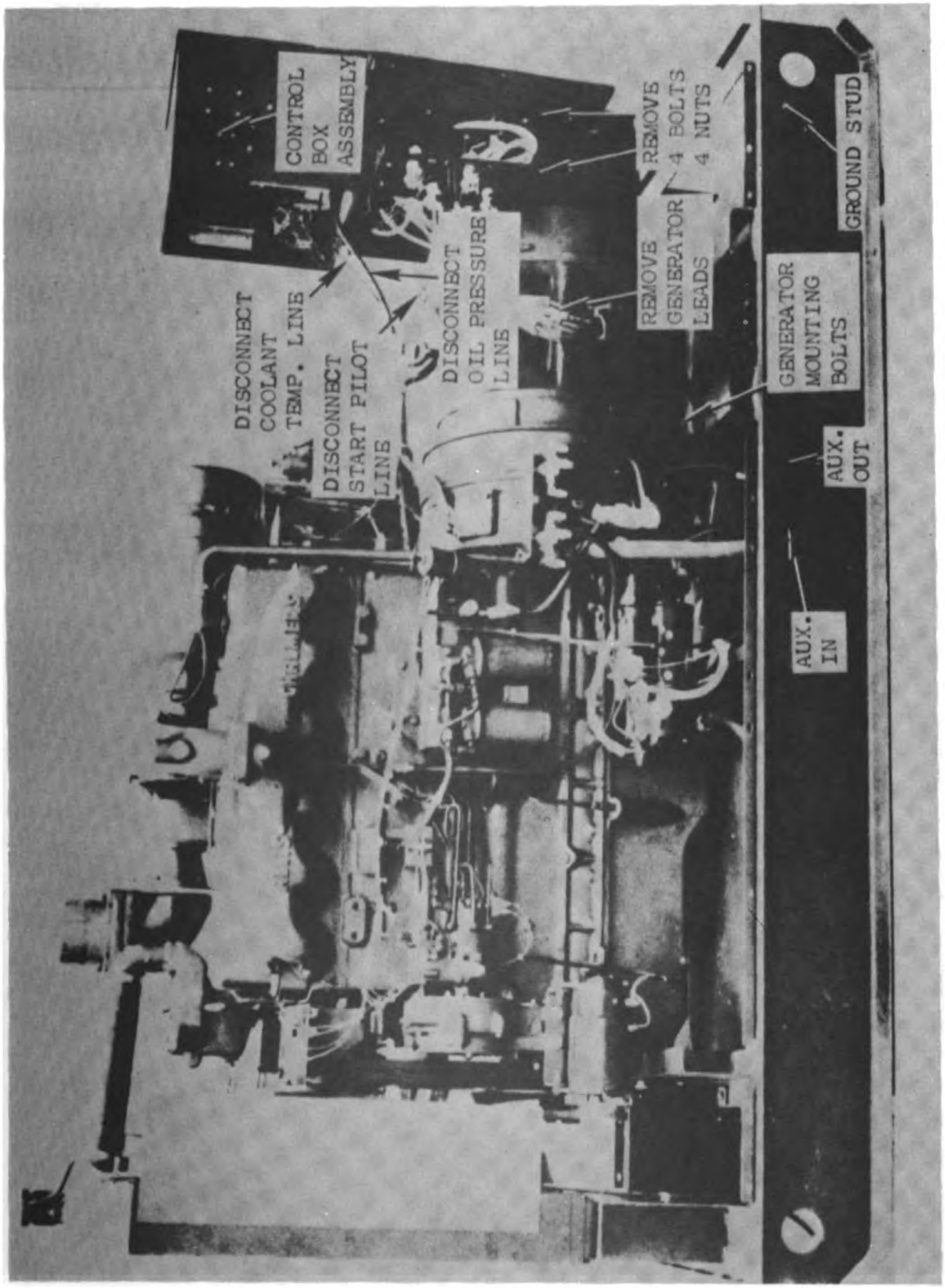
FUEL TANK REMOVAL
FIGURE 4-4



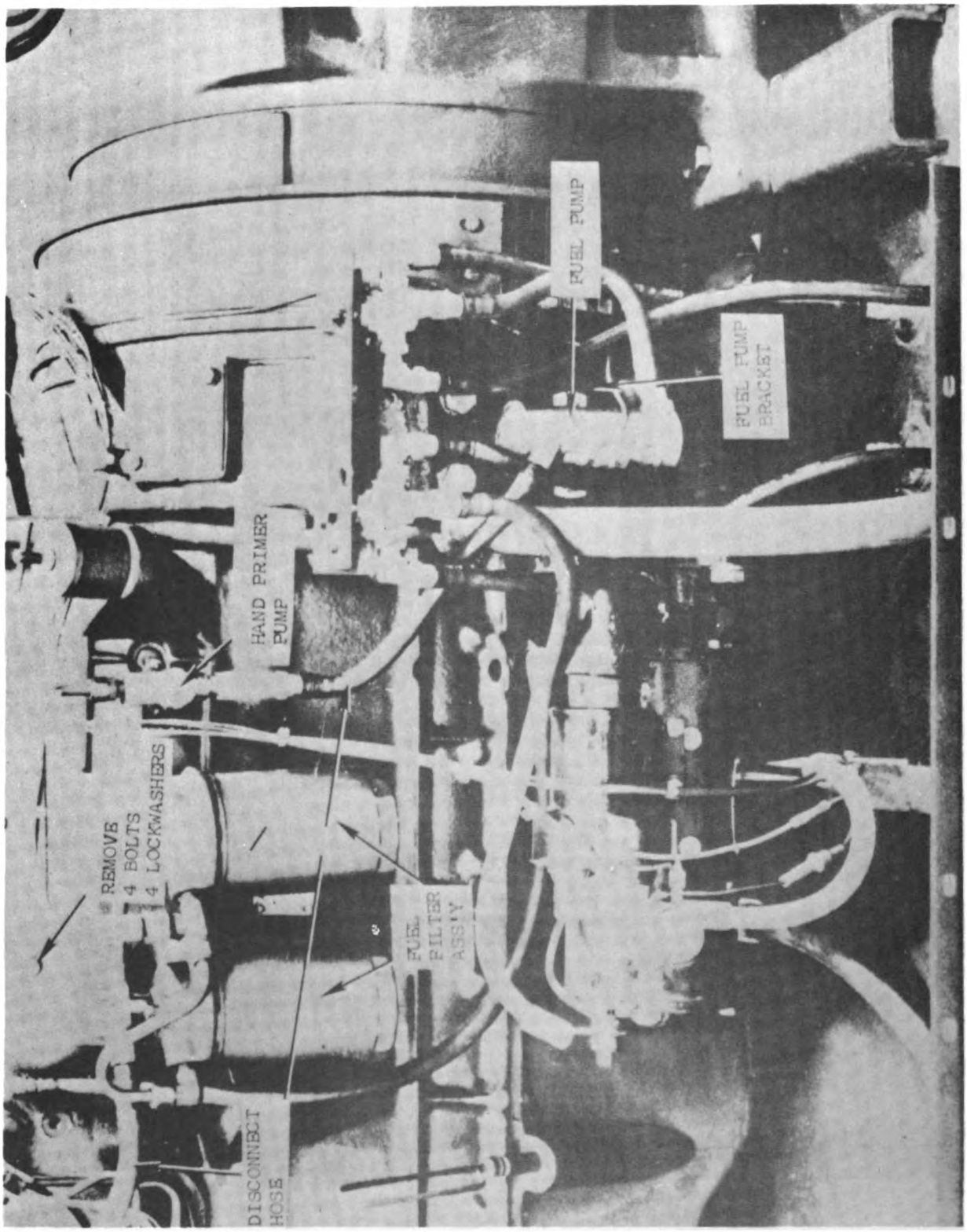
FUEL TANK REMOVAL
FIGURE 4-5



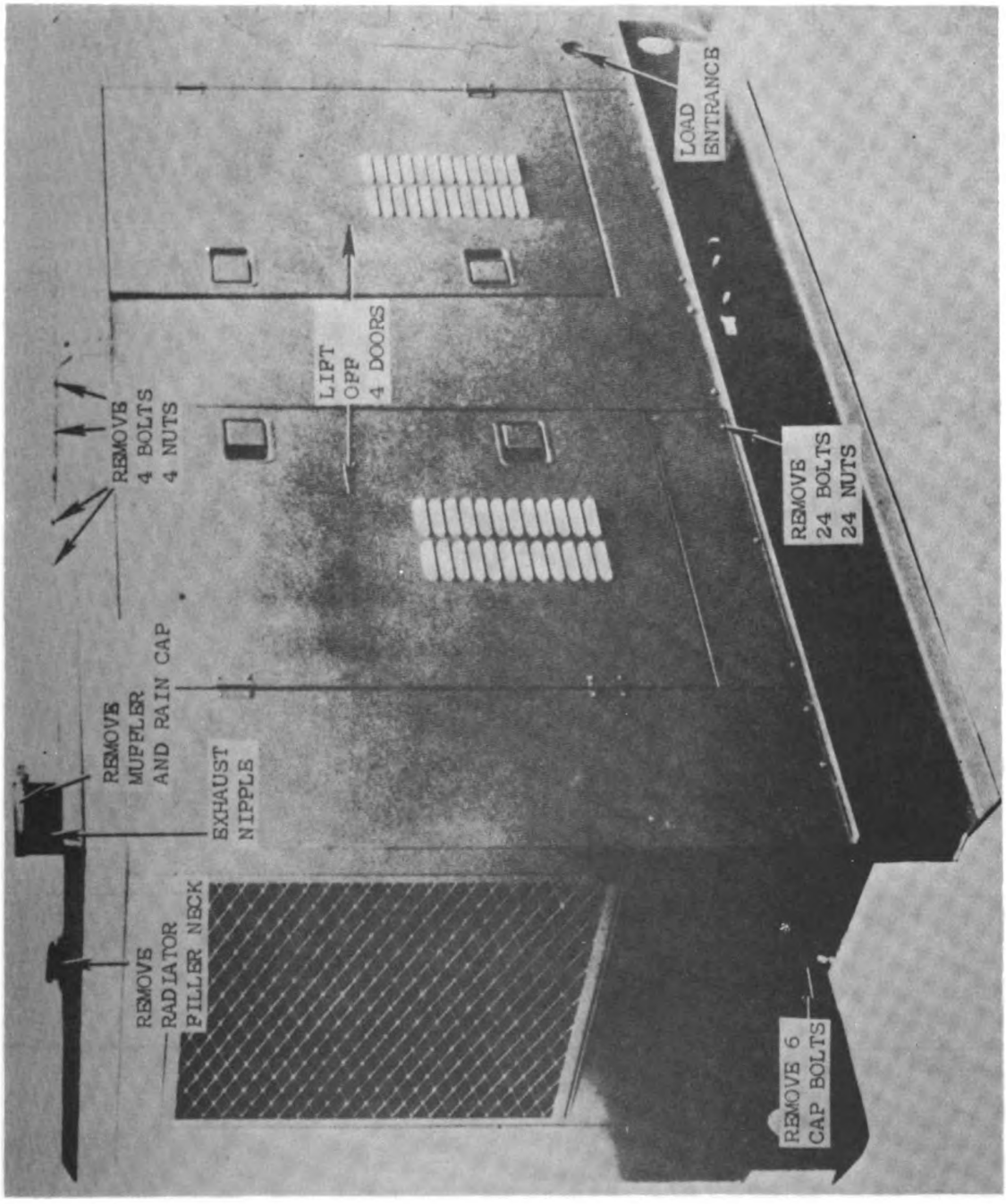
AIR CLEANER REMOVAL
FIGURE 4-6



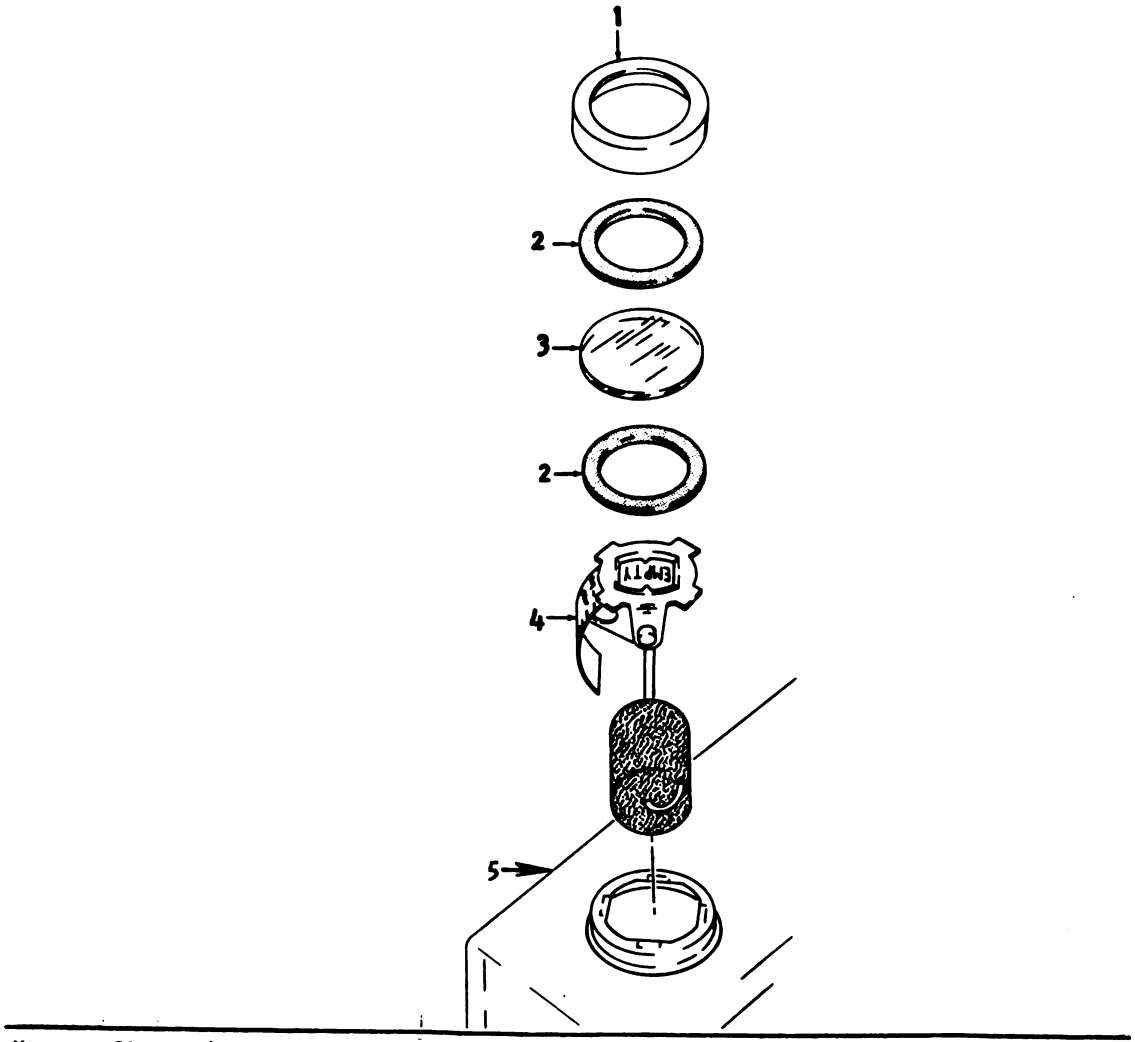
CONTROL BOX REMOVAL
FIGURE 4-7



FUEL FILTER REMOVAL
FIGURE 4-8



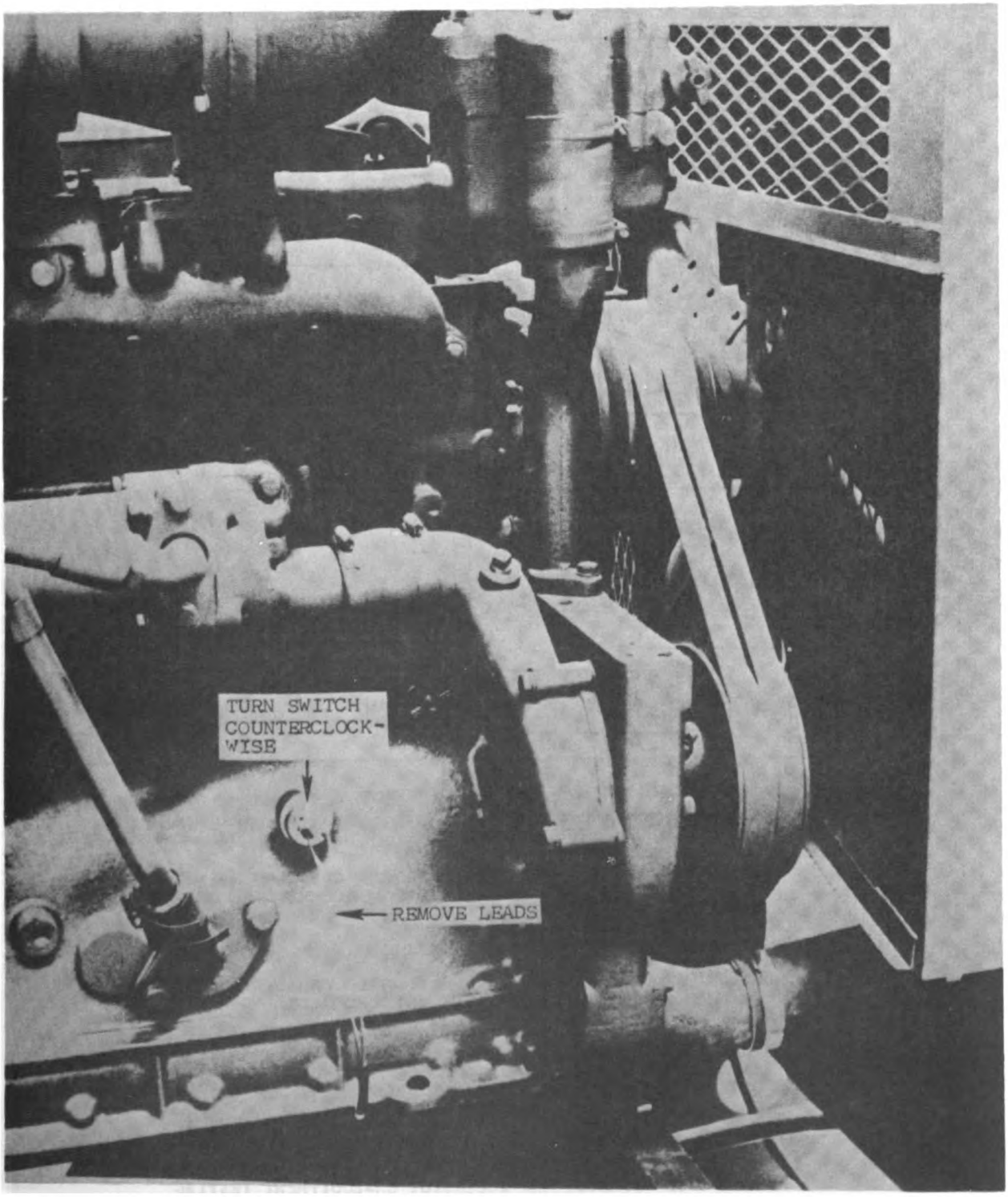
HOUSING REMOVAL
FIGURE 4-9



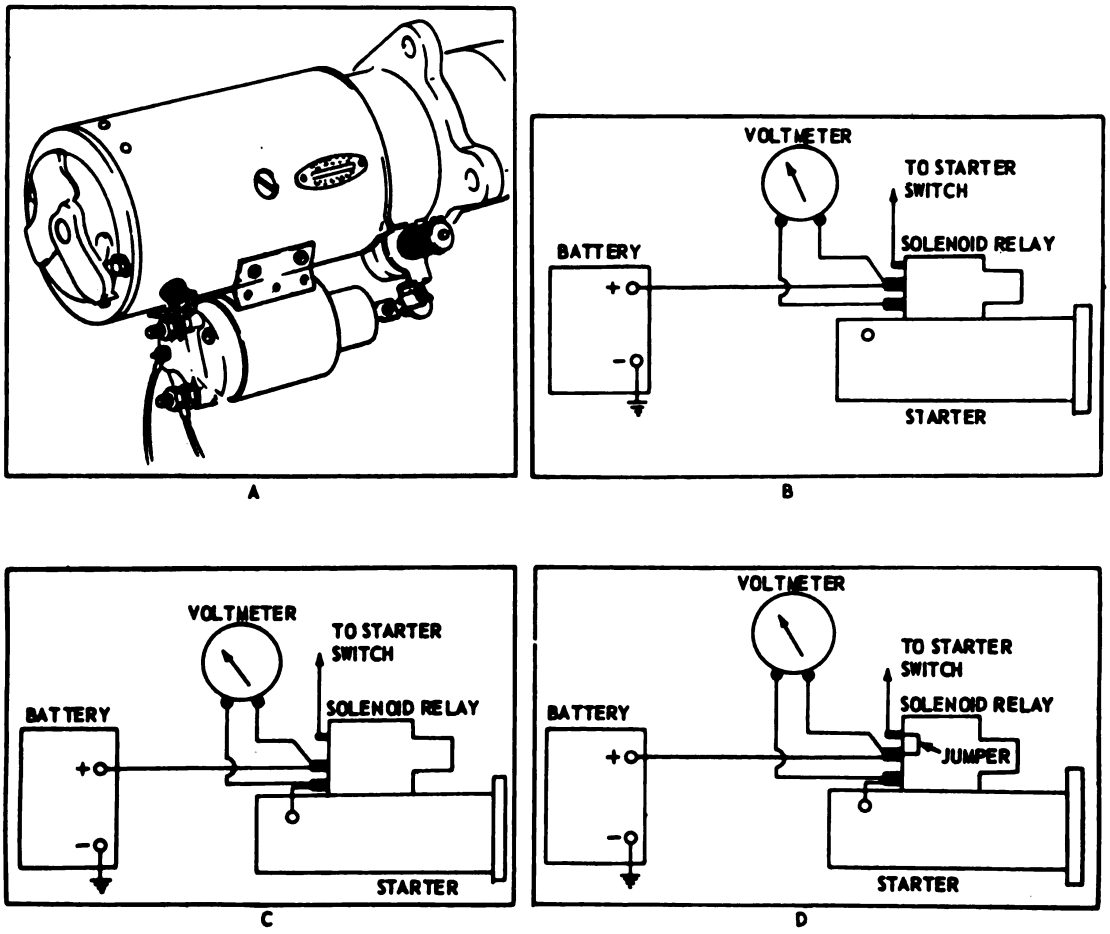
Key to figure 4-10

1 Cap, fuel gage
2 Gasket, cork
3 Glass
4 Float assembly
5 Fuel tank

Figure 4-10. Fuel gage



LOW OIL PRESSURE SWITCH
FIGURE 4-11



(1) DETERMINE THAT BATTERY IS FULLY CHARGED AND THAT ALL BATTERY AND STARTER CABLES ARE SERVICEABLE AND PROPERLY INSTALLED.

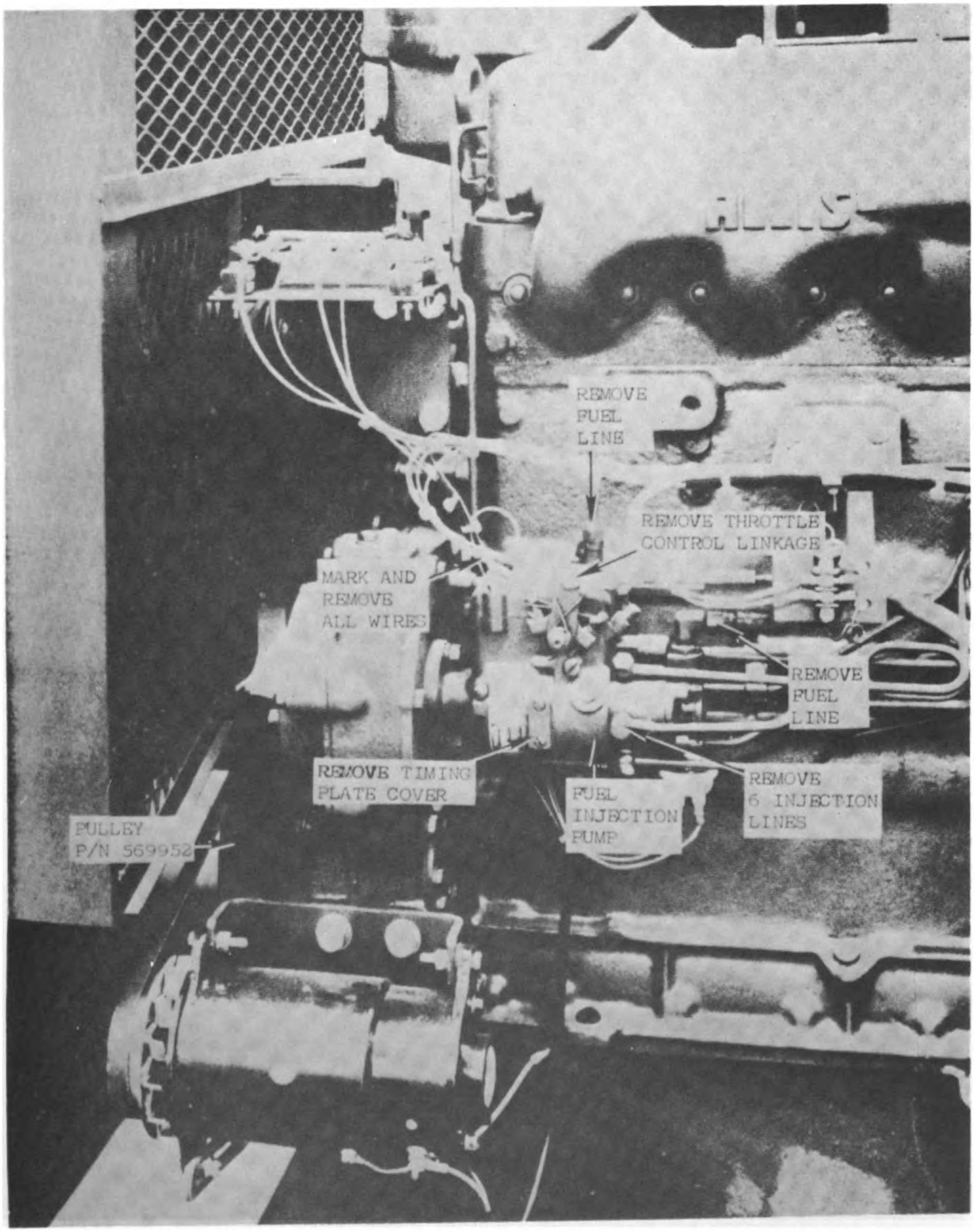
(2) REMOVE SOLENOID-TO-STARTER CONNECTOR AND CONNECT VOLTMETER AS SHOWN IN B ABOVE. IF VOLTAGE IS INDICATED, SOLENOID RELAY IS DEFECTIVE AND MUST BE REPLACED.

(3) INSTALL THE SOLENOID-TO-STARTER CONNECTOR.

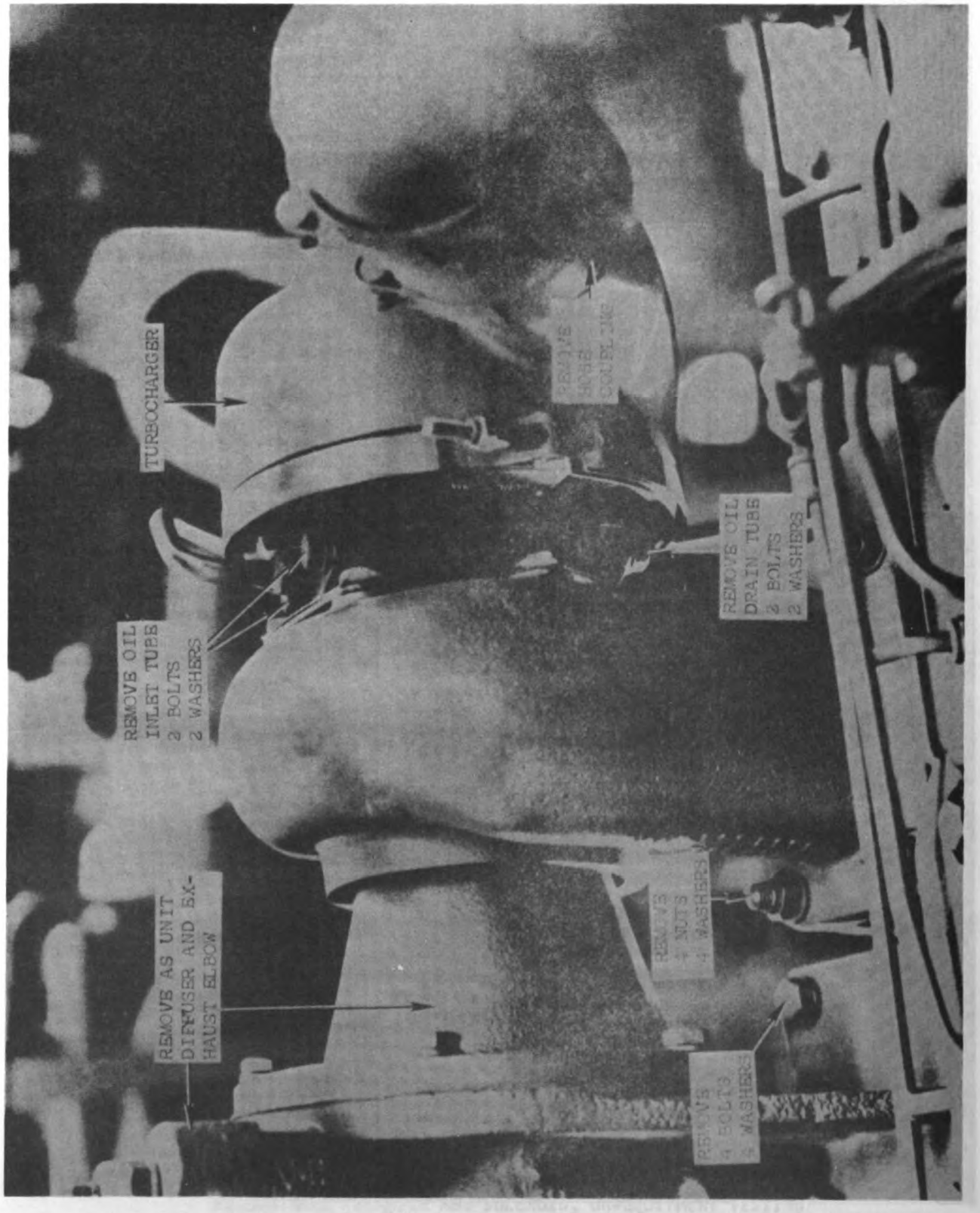
(4) CONNECT VOLTMETER AS SHOWN IN C ABOVE. IF BATTERY VOLTAGE (24 VOLTS) IS NOT INDICATED, THE STARTER IS DEFECTIVE AND MUST BE REPLACED.

(5) MOMENTARILY CONNECT A JUMPER AS SHOWN IN D ABOVE. THE VOLTMETER READING SHOULD DROP TO ZERO AND STARTER SHOULD CRANK ENGINE. IF VOLTMETER READING DOES NOT DROP TO ZERO, SOLENOID RELAY IS DEFECTIVE AND MUST BE REPLACED. IF VOLTMETER READING DROPS TO ZERO BUT STARTER FAILS TO CRANK ENGINE, STARTER IS DEFECTIVE AND MUST BE REPLACED.

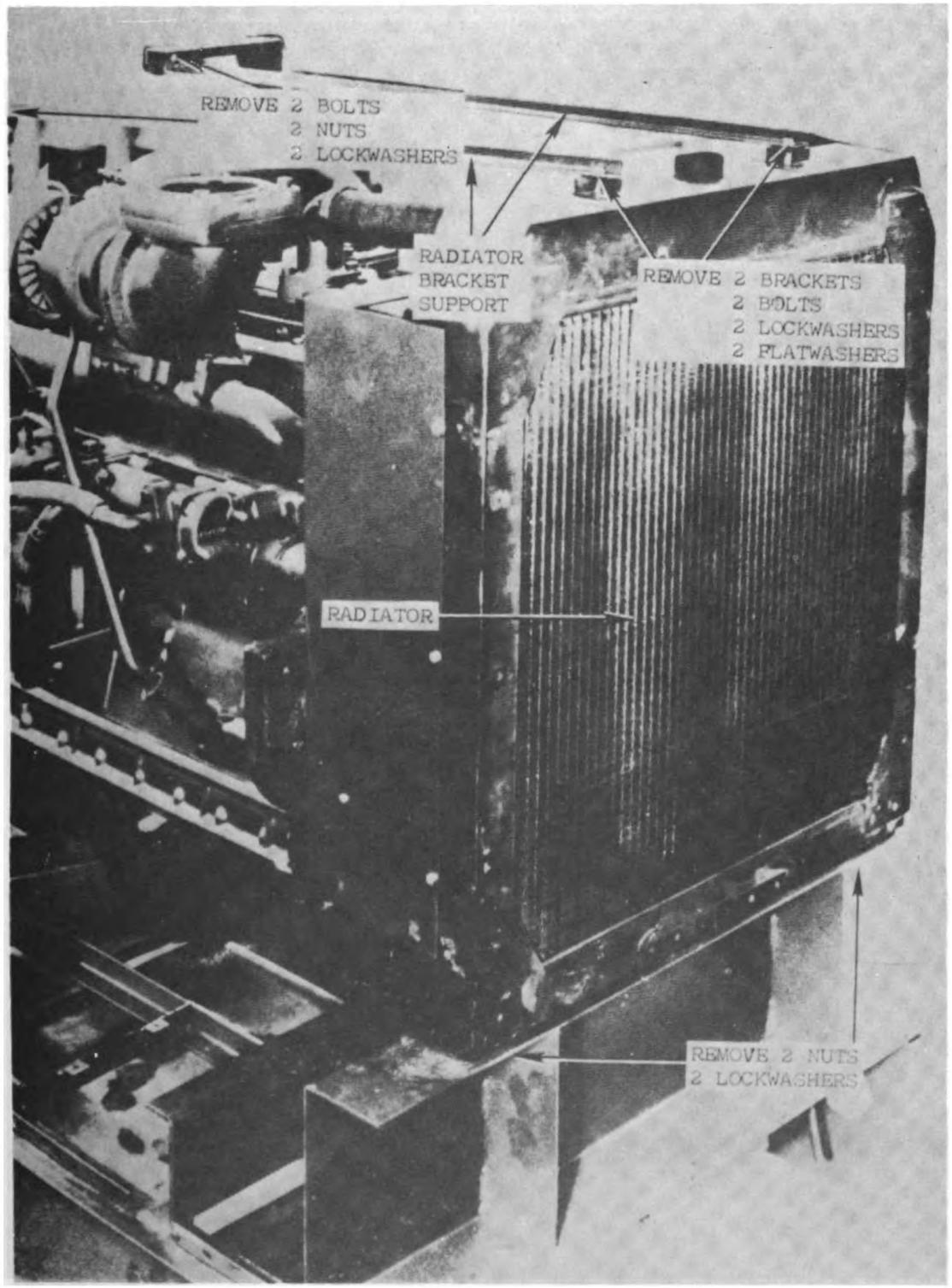
FIGURE 4-12 STARTER AND SOLENOID, ON-EQUIPMENT TESTING



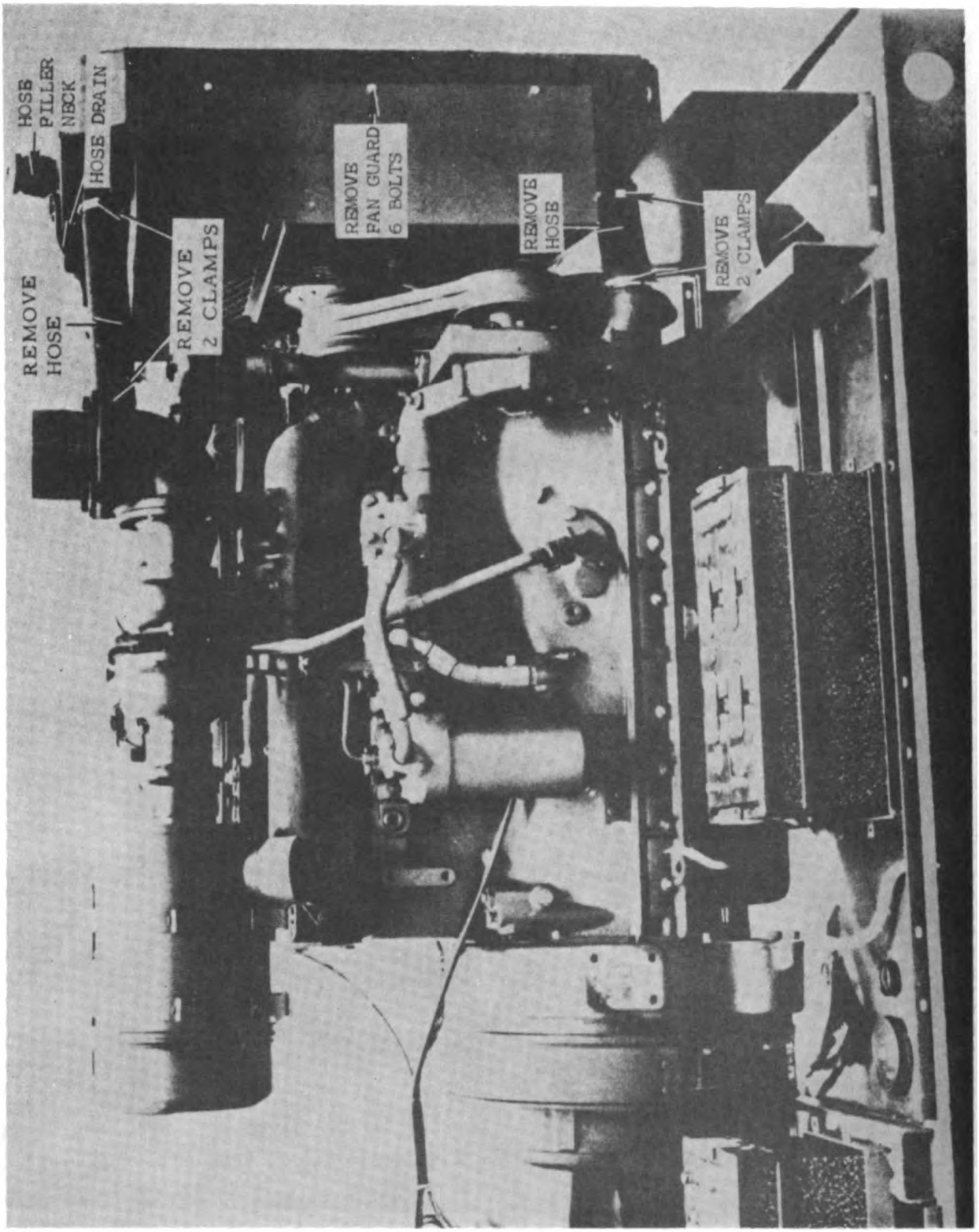
FUEL INJECTION PUMP REMOVAL
FIGURE 4-13



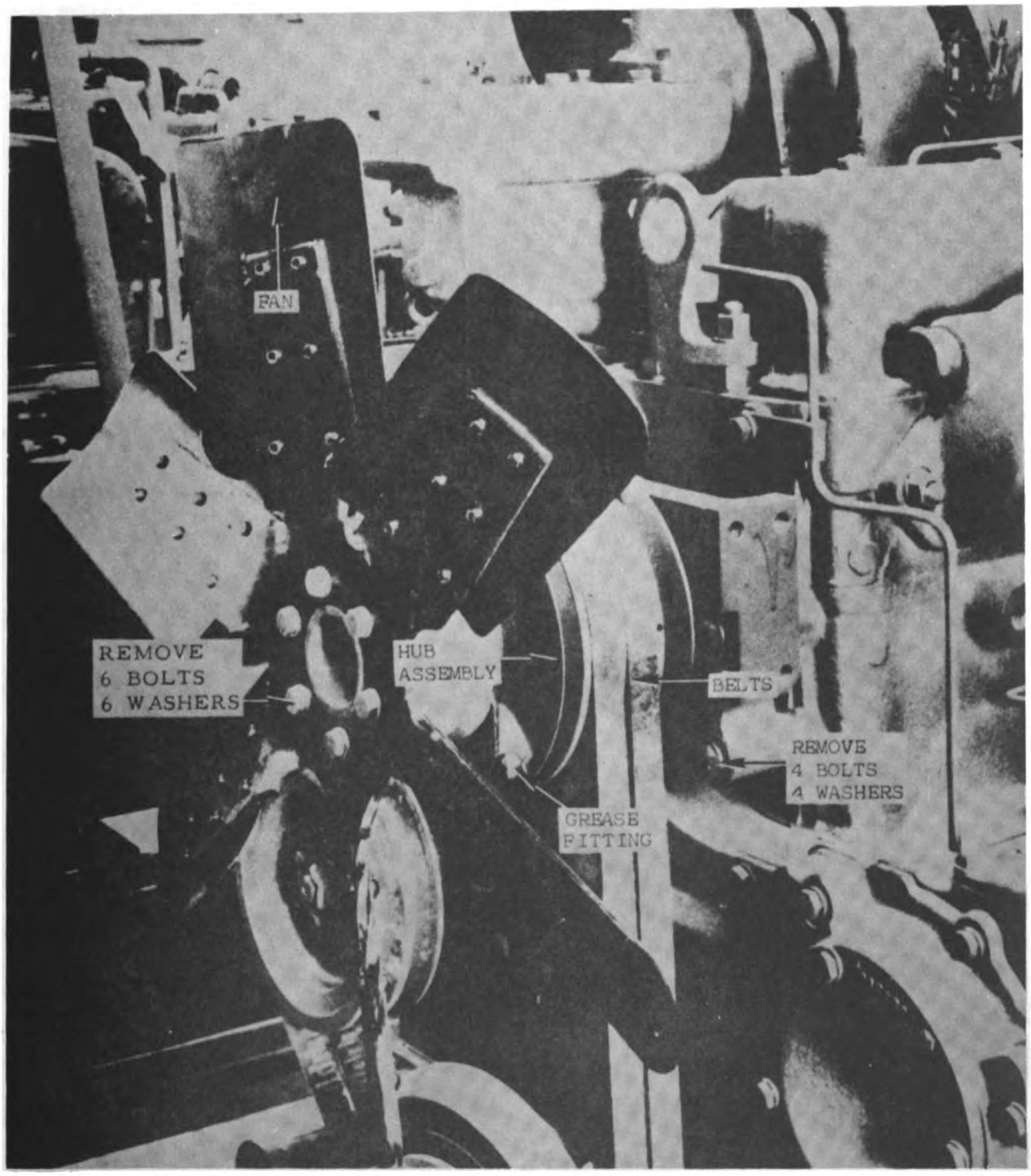
TURBOCHARGER REMOVAL
FIGURE 4-14



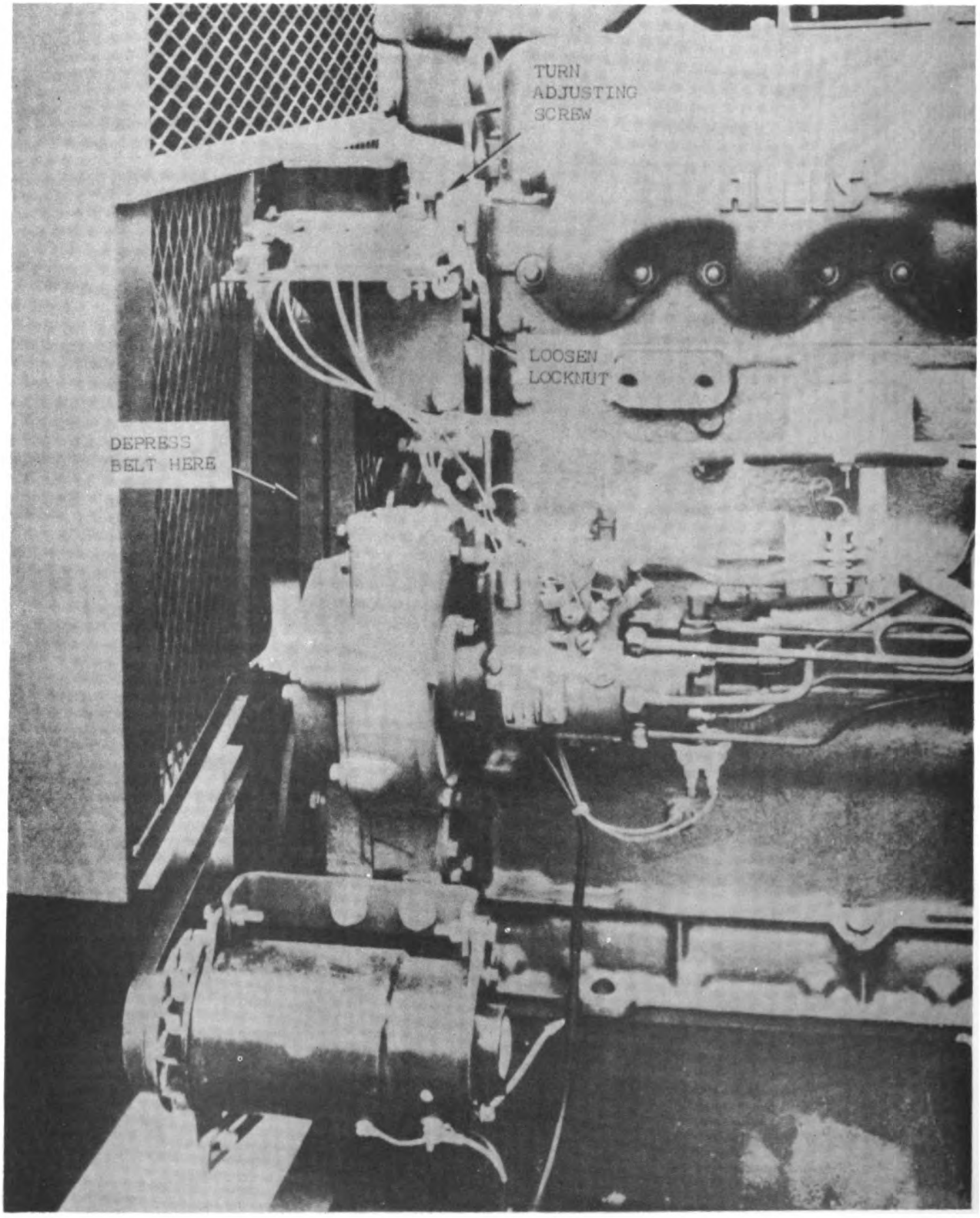
RADIATOR REMOVAL
FIGURE 4-15



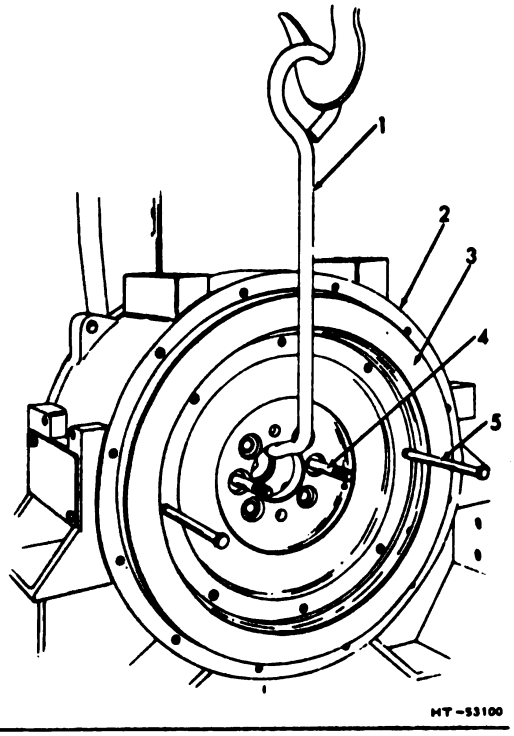
RADIATOR REMOVAL
FIGURE 4-16



FAN, FAN HUB, AND FAN BELT REMOVAL
FIGURE 4-17

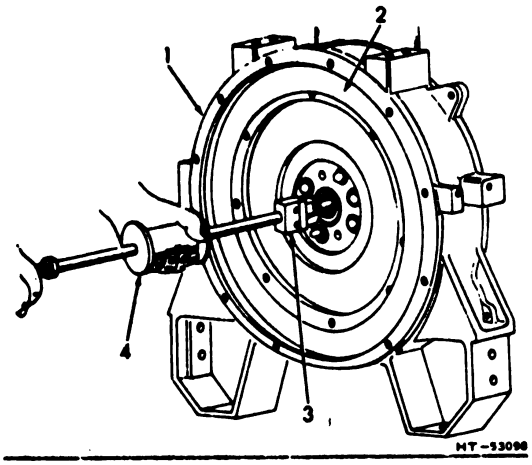


MAIN BELT ADJUSTMENT
FIGURE 4-18



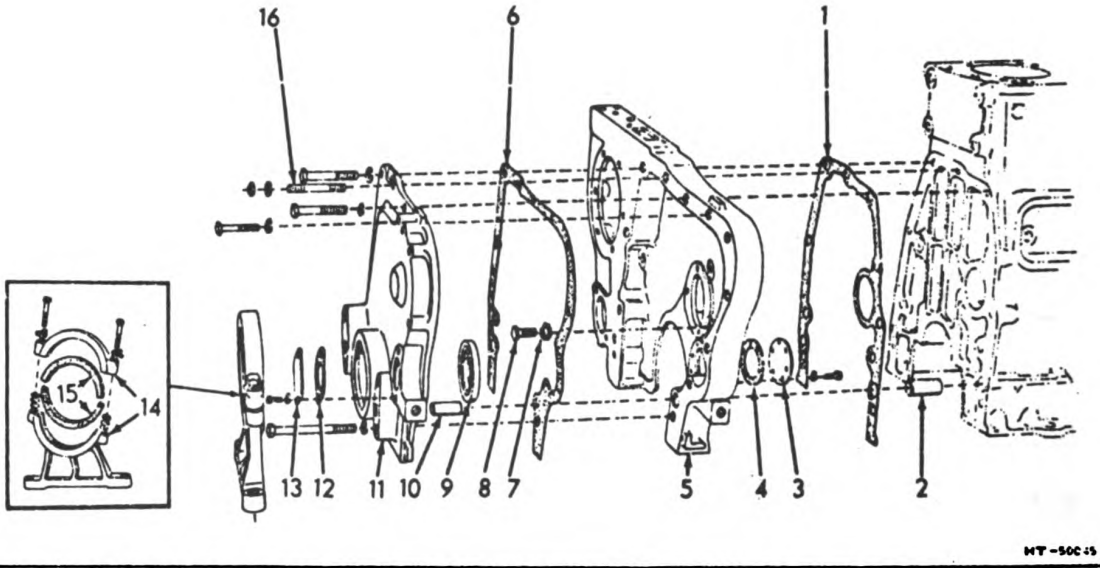
1. Lifting hook
2. Flywheel housing
3. Flywheel
4. Guide pin
5. Capscrew (handle)

TYPICAL FLYWHEEL REMOVAL
FIGURE 4-19



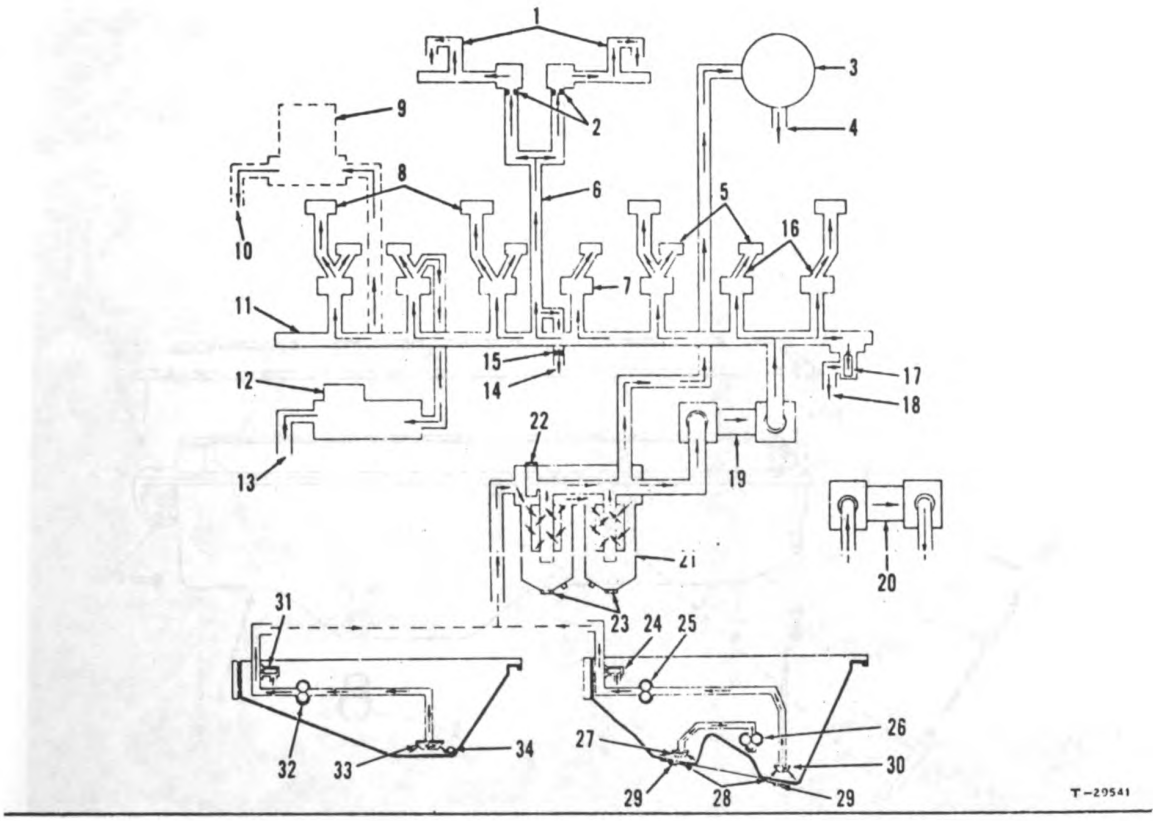
1. Flywheel housing
2. Flywheel
3. Pilot bearing removal tool
4. Slide hammer

FIGURE 4-20 REMOVING CLUTCH SHAFT PILOT BEARING FROM FLYWHEEL



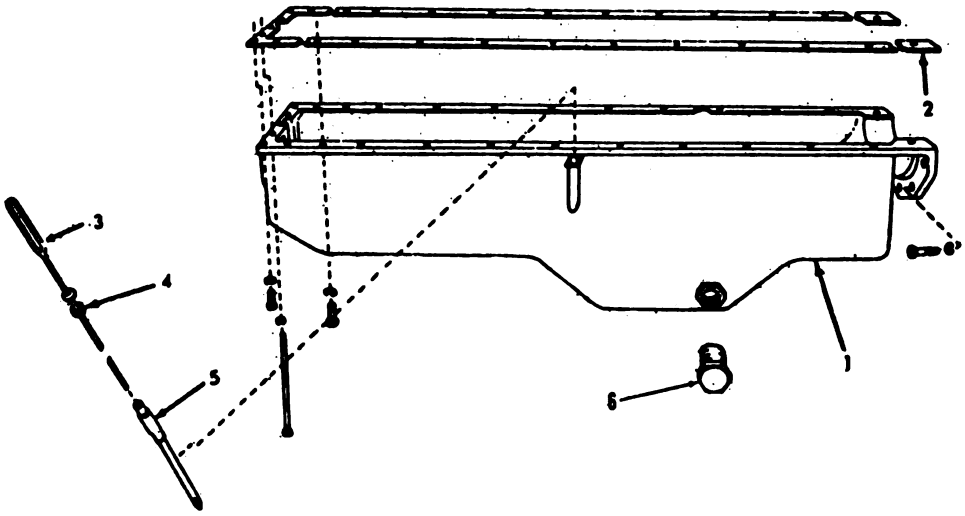
1. Housing gasket
2. Housing dowel pin
3. Housing cover
4. Gasket
5. Timing gear housing
6. Cover gasket
7. Lockwasher
8. Capscrew
9. Front oil seal
10. Cover dowel pin
11. Timing gear housing cover
12. Gasket
13. Cover plate
14. Front support bracket
15. Liner
16. Stud

FIGURE 4- 21 TIMING GEAR HOUSING AND COVER DETAILS



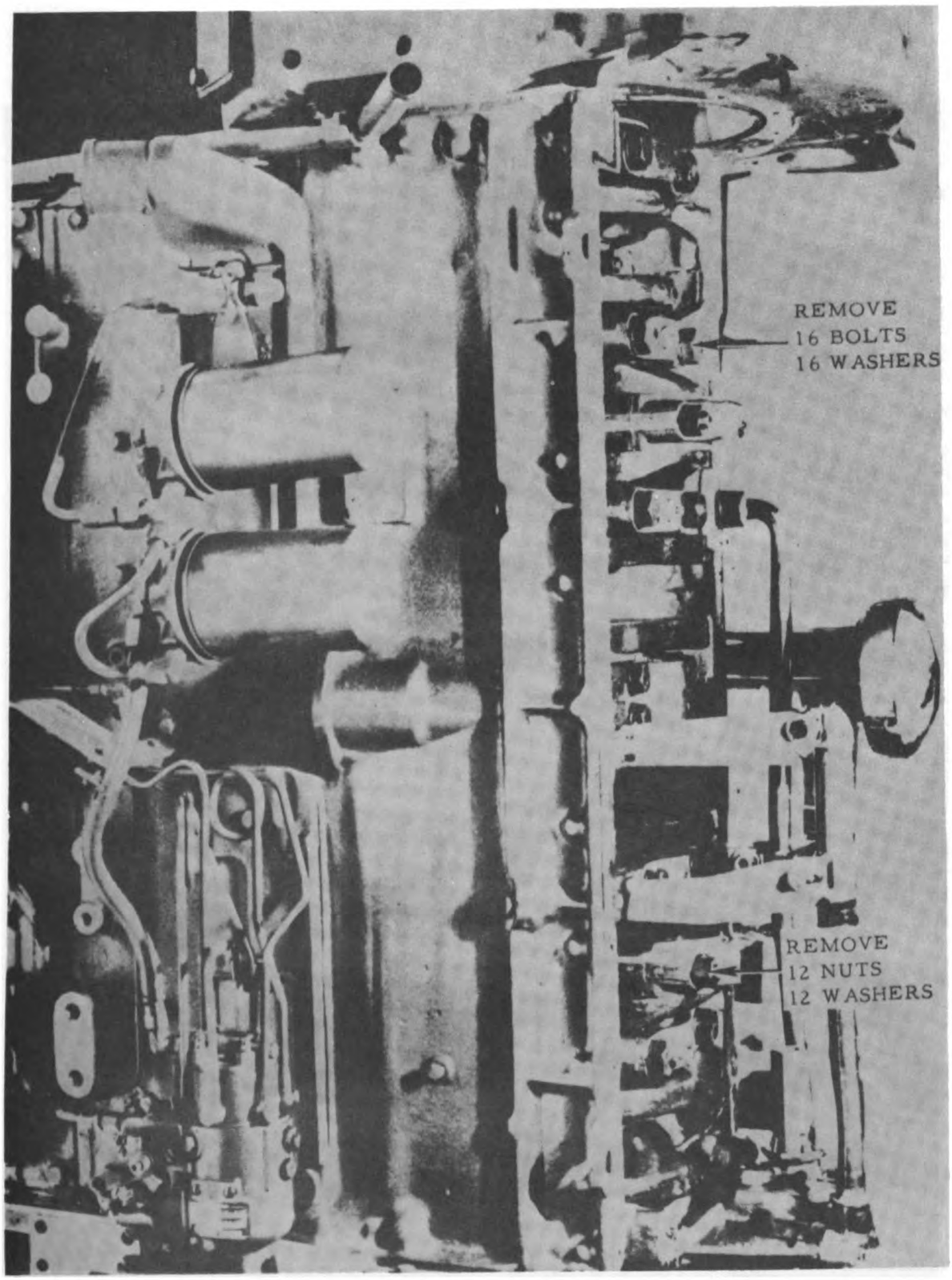
1. Rocker arm shaft drain tubes (drains back to oil pan)
2. Restricted rocker arm brackets (No. 3 and No. 4 cylinders)
3. Turbocharger (12000 engine)
4. Return to oil pan
5. Connecting rod bearings and to piston pins
6. To valve rocker arm shafts
7. Main bearings
8. Camshaft bearings
9. Air compressor (optional)
10. Return to oil pan
11. Main oil gallery
12. Fuel injection pump (American Bosch)
13. Return to oil pan
14. Return to oil pan
15. Restrictor
16. Crankshaft oil passages
17. Oil pressure regulating valve
18. Return to oil pan
19. Engine oil cooler
20. Torque converter oil cooler
21. Lubricating oil filter
22. Oil filter bypass valve
23. Filter drain plugs
24. Lubricating oil pump pressure relief valve
25. Lubricating oil pressure pump
26. Scavenging oil pump
27. Scavenging oil pump suction screen
28. Hand hole covers
29. Oil drain plugs
30. Lubricating oil pressure pump suction screen
31. Lubricating oil pump pressure relief valve
32. Lubricating oil pressure pump
33. Suction screen
34. Oil drain plug

FIGURE 4-22 LUBRICATION SYSTEM SCHEMATIC DIAGRAM

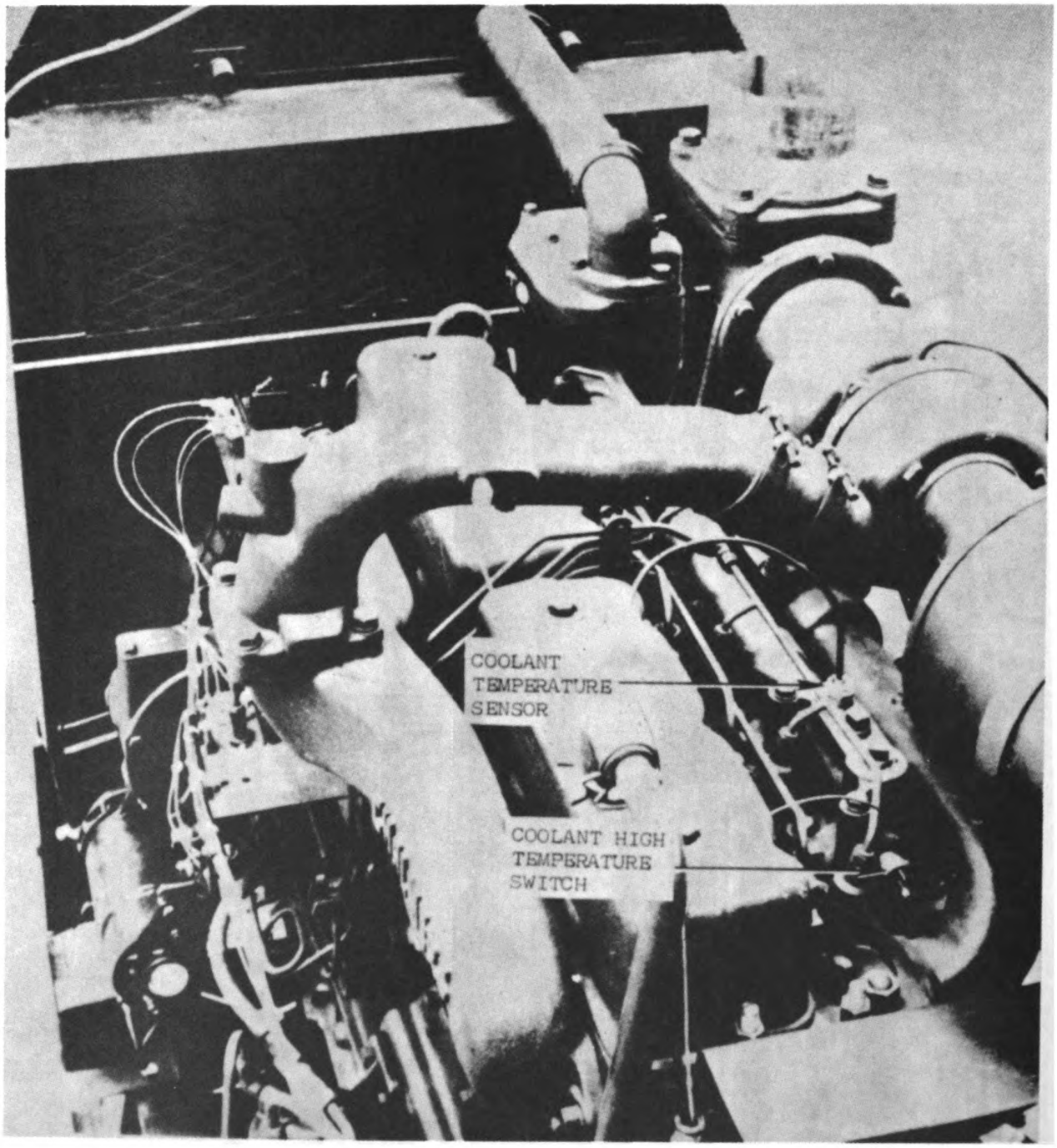


1. Oil pan
2. Gasket set
3. Oil level gauge
4. Seal
5. Adapter
6. Drain plug

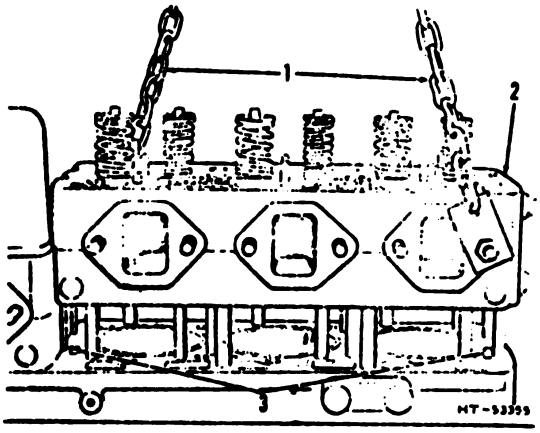
FIGURE 4- 23 ENGINE OIL PAN



CRANKSHAFT REMOVAL
FIGURE 4-24

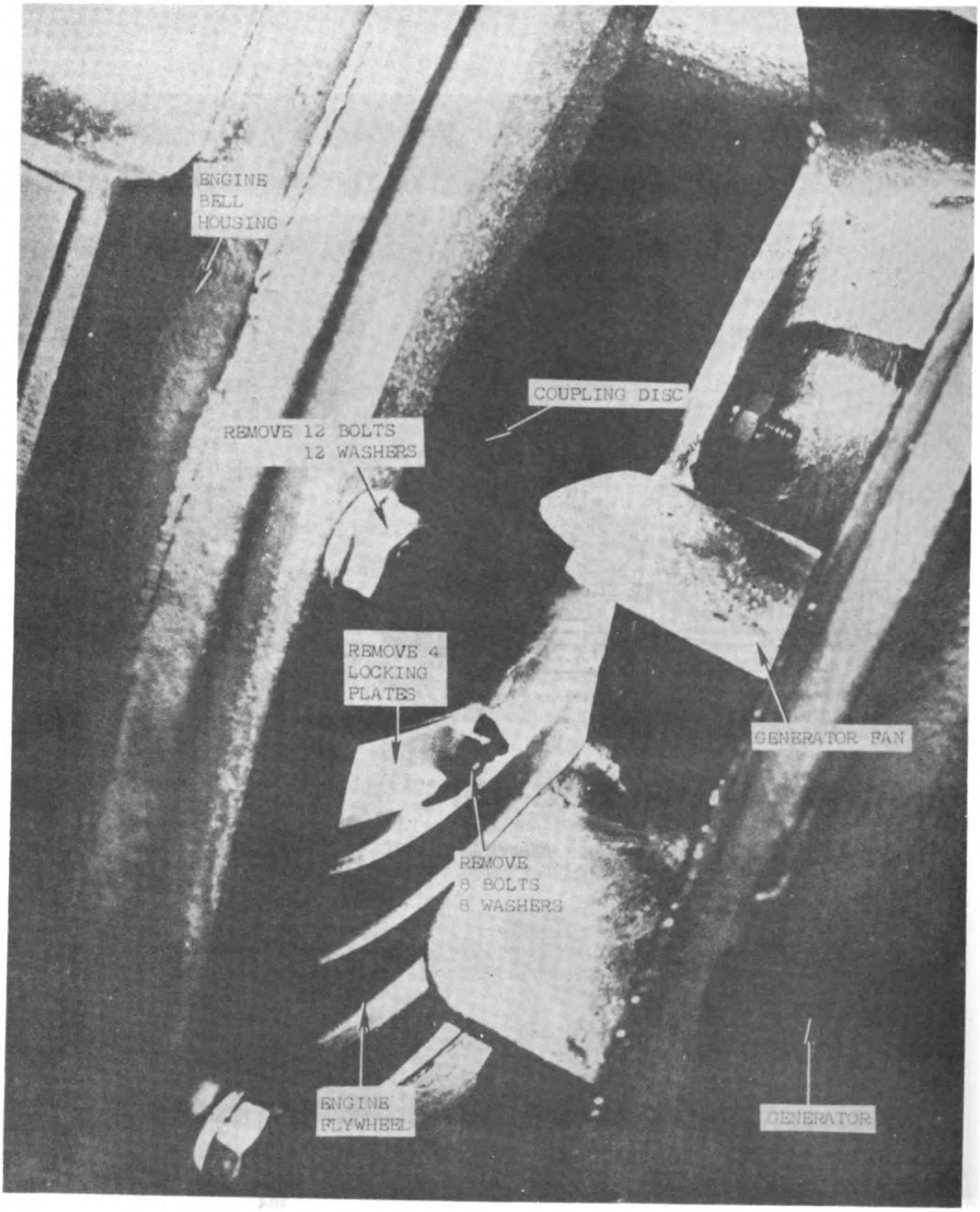


COOLANT TEMPERATURE COMPONENTS
FIGURE 4-25



1. Sling
2. Cylinder head
3. Cylinder head locating dowels

FIGURE 4-26 REMOVING CYLINDER HEAD FROM ENGINE



MAIN GENERATOR REMOVAL
FIGURE 4-27

CHAPTER 5

MAIN GENERATOR REPAIR

118. GENERAL

The main generator assembly is a 4-pole, revolving-field alternator excited by a direct-connected, 3-phase, revolving armature alternator whose output is rectified to provide direct current. The unit is classed as a brushless generator because the armature rectifier assembly revolves the rotor and replaces the conventional commutator and slip rings.

119. ON-EQUIPMENT TESTING

a. Stator Assembly and Generator Frame

(1) Disconnect the 12 stator leads. (FIGURE 4-7)

(2) With a test lamp, test for continuity between stator leads 1 and 4, 2 and 5, 3 and 6, 8 and 11, 7 and 10, and 9 and 12. If the lamp fails to light on any of these tests, an open circuit is indicated and the stator must be replaced.

(3) Using a megohmmeter, test between the stator frame and stator leads, 1, 2, 3, and 10, 11, 12, in turn. A reading of less than 0.4 megohm indicates faulty insulation and the stator must be replaced.

(4) Using a megohmmeter, test between leads 4 and 10, 5 and 11, and 6 and 12. A reading of less than 0.4 megohm indicates faulty insulation and the stator must be replaced.

b. Exciter Field Winding

(1) Disconnect the two stator leads marked F1 and F2. (FIGURE 4-7)

(2) Using a multimeter, test for resistance between the 2 leads. A reading of more than 20 percent above or below 9.6 ohm indicates a faulty field coil and the exciter frame and stator assembly must be replaced.

(3) Using a megohmmeter, test between the field frame and one of the leads. A reading of less than 0.5 megohm indicates faulty insulation and the exciter stator assembly must be replaced.

120. GENERATOR ASSEMBLY

a. Removal and Disassembly

(1) Remove the generator assembly (Para. 116).
a) Disassembly and reassembly of Generator (Fig 5-1).

(2) Remove the two screws (14) and copper gaskets (15) that secure the bearing cap (1) to the exciter frame and stator assembly (10).

(3) Remove the four screws (19), plate (25), gasket (26), and grommet (27) from the stator assembly and generator frame. Remove the lifting eyebolt (21) from the stator assembly and generator frame.

(4) Remove the four screws (12) and lockwashers (11) that secure the exciter frame and stator assembly (10)to the generator frame (22).

(5) Pull the exciter frame and stator assembly (10) from the generator frame (22) pulling the two exciter field leads through grommet opening. Remove the exciter frame and stator assembly.

(6) Remove the two screws (6), lockwashers (7), cover (8), and gasket (9), from the exciter frame and stator assembly (10).

(7) Remove the four screws (6), lockwashers (7), and screen (16) from the exciter frame and stator assembly (10).

(8) Remove the three screws (20) and air deflector (5) from the exciter frame and stator assembly (10). Remove the grommet (3) from the air deflector.

(9) Remove the two screws (19), lockwashers (18), washers (17), and end plug (13) from the exciter frame and stator assembly (10).

(10) Remove 8 screws (44), 4 lock plates (43), and coupling disk (42) from the coupling hub (29). Remove the rotor assembly (31) from the stator assembly and generator frame (22).

(11) Remove the four screws (46), lockwashers (47), and adapter (45) from the adapter (40) and stator assembly and generator frame (22).

(12) Remove the screws (41), lockwashers (11), and adapter (40) from the stator assembly and generator frame (22).

(13) Remove the 8 screws (20), lockwashers (7), and 2 screens (28) from the stator assembly and generator frame (22).

(14) Remove the screw (24) and rectifier assembly (23) from the stator assembly and frame.

(15) Remove the lockring (4A and pull the bearing (4) and remove the gasket (2) and bearing cap (1) from the shaft of the rotor assembly (31).

(16) Remove the coupling hub (29), fan assembly (30), and key (48) from the shaft of the rotor assembly (31).

(17) Tag, unsolder, and remove the electrical leads from the three rectifier assemblies (32). Loosen the locknuts and remove the rectifier assemblies from the rotor assembly (31). Remove the screw (49) and tag the ground wire.

(18) Remove the two nuts (33), screw (39), washer (34), insulating washer (35), surge protector (36), insulating sleeve (37), and washer (38) from the rotor assembly (31).

b. Cleaning, Inspection, and Repair.

(1) Clean all parts with a cloth dampened in cleaning solvent.

(2) Examine the key, fan assembly, and coupling hub for cracks or breaks. Replace a damaged key, fan assembly, or coupling hub.

(3) Inspect the bearing for cracked braces and ball shields and for freedom of movement. Replace a damaged or defective bearing.

(4) Examine the cap, lifting eye, plates, screens, adapters, and end plug for cracks or breaks. Inspect the lifting eye for damaged threads. Replace a damaged part.

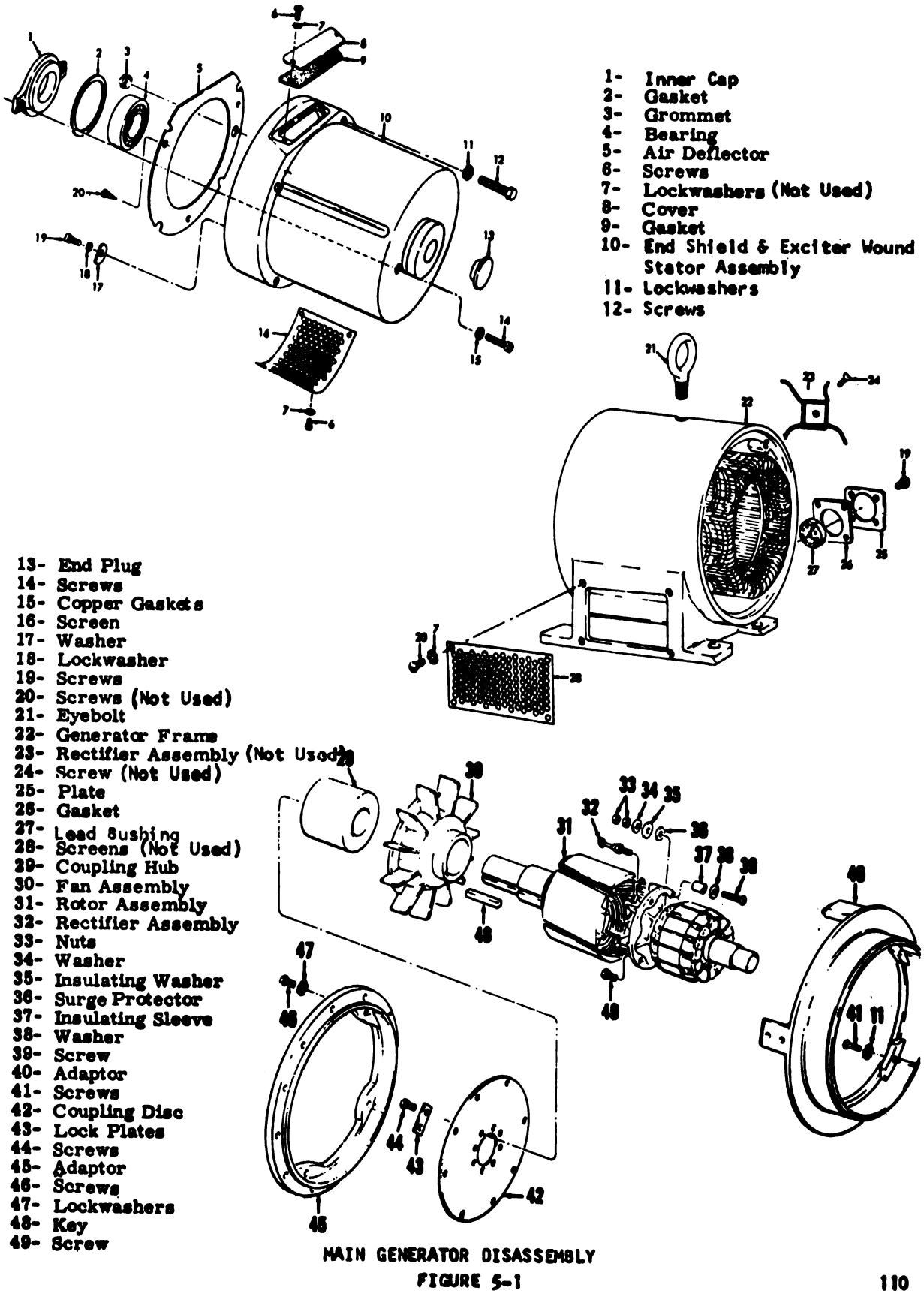
(5) Inspect the grommets or gaskets for cracks, breaks, or signs of deterioration. Replace a damaged gasket or grommet.

(6) Examine the exciter frame and stator assembly and generator frame for cracks or breaks. Replace a damaged part.

(7) Examine the screws and nuts for damaged threads. Inspect the screws, nuts, washers, and insulating sleeves for cracks or breaks. Replace a damaged or missing screw, nut washer, or sleeve.

c. Reassembly and Installation

For reassembly and installation, reverse the removal and disassembly instructions.



1- Inner Cap
2- Gasket
3- Grommet
4- Bearing
5- Air Deflector
6- Screws
7- Lockwashers (Not Used)
8- Cover
9- Gasket
10- End Shield & Exciter Wound Stator Assembly
11- Lockwashers
12- Screws
13- End Plug
14- Screws
15- Copper Gaskets
16- Screen
17- Washer
18- Lockwasher
19- Screws
20- Screws (Not Used)
21- Eyebolt
22- Generator Frame
23- Rectifier Assembly (Not Used)
24- Screw (Not Used)
25- Plate
26- Gasket
27- Lead Bushing
28- Screens (Not Used)
29- Coupling Hub
30- Fan Assembly
31- Rotor Assembly
32- Rectifier Assembly
33- Nuts
34- Washer
35- Insulating Washer
36- Surge Protector
37- Insulating Sleeve
38- Washer
39- Screw
40- Adaptor
41- Screws
42- Coupling Disc
43- Lock Plates
44- Screws
45- Adaptor
46- Screws
47- Lockwashers
48- Key
49- Screw

MAIN GENERATOR DISASSEMBLY
FIGURE 5-1

CHAPTER 6

GENERATOR CONTROL BOX

121. GENERAL

The controls and instruments needed for normal operation of the generator are mounted on the generator control box drop cover. Purpose and normal readings of these components can be found in Chapter 2. A transducer, AC voltage regulator, and AC relay are located behind the panel. Refer to figure 2-1 for the instruments and switches on the control panel.

122. ELECTRICAL LEADS AND WIRING HARNESS

a. General. All wiring of the generator set carries code numbers for ease of testing, repairing, or replacing electrical leads and wiring harness.

b. Inspection. Inspect the insulation for cracks and fraying. Pay particular attention to the wires passing through holes in the frame and over rough edges. If inspection reveals a broken or cut wire, and the break is exposed, repair the wire (c Below). If the break in a wire is in the wiring harness or in an inaccessible area, replace the wire (e Below).

c. Repair. Shave the insulation on the wire to expose one-half inch of bare wire at both ends of the break. Twist the bare wire together and solder the connection. Cover the repaired break with electrical tape. Do not leave any bare wire exposed. If a terminal lug breaks off a wire, replace the lug.

d. Testing. Test a wire for continuity by disconnecting each end from the components to which it is connected. Touch the test probes of a multimeter to each end of the wire. If the multimeter fails to show continuity, the wire is defective and must be repaired or replaced. (core)

e. Replacement. Replace a wire by disconnecting it from it's attachments and installing a new wire. If a broken wire is part of a wiring harness, disconnect the wire at each end and tape the ends with electrical tape. Install a new wire and attach it to the wiring harness. Tag the new electrical lead with correct code.

123. AC VOLTAGE REGULATOR

a. General. The AC voltage regulator acts as an automatic field rheostat to maintain constant output voltage of the main generator by controlling the voltage through it's field. The voltage regulator is a static control device using a transformer, silicon transistors, silicon controlled rectifiers, silicon diodes, capacitors and resistors, The regulator is not subject to wear from any moving parts and is relatively unaffected by temperature, humidity, vibration, and shock.

b. On-Unit Testing. Test the voltage regulator for operation as follows:

(1) Connect an alternating current voltmeter to the load terminal of the generator set.

(2) Connect a load (that can be varied between no load and full load) to the generator set, start the generator set, and adjust the output voltage to 120 volts.

(3) Apply any constant load, from no load to full load. Adjust the voltage output to 120 volts with the voltage adjusting rheostat. The voltage of the generator must not vary more than 1.2 volts above or below 120 volts at any constant load.

(4) Slowly vary the load from no load to full load and from full load to no load. The voltage must not vary more than 4.8 volts above or below 120 volts in either case.

(5) Apply the full load suddenly and disconnect it suddenly. The generator should re-establish stable voltage within 4 seconds in either case.

(6) If the voltage regulator fails to meet the above requirements and the generator set is otherwise in good operating condition, replace the voltage regulator unit.

c. Cleaning and Inspection.

(1) Clean the voltage regulator and mounting hardware with cleaning solvent and dry thoroughly. Use low pressure compressed air to blow dust and dirt from the voltage regulator.

(2) Inspect for dents, cracks, breaks and other damage.

(3) Replace a damaged or defective part.

CHAPTER 7

ENGINE SERVICE AND REPAIR

Section I - Lubrication

124. ENGINE LUBRICATING OIL

Service DS, Series 3, lubricating oil applies to all turbocharged engines in any application. It will also apply to naturally aspirated engines in severe operation applications, or when fuel sulphur content exceeds 0.5%.

SAE weight of oils to be used in engines are:

Ambient Temperature	SAE
0°F and below	10W
0°F to 32°F	20
Above 32°F	30

Specification of 100 hours for filter and oil change periods is based on the use of high quality oils, fuels with less than 0.5% sulphur, and average engine load not exceeding the continuous rating with engines in good adjustment and operating with coolant and lubricating oil temperatures between 170° and 200°F. Variations from these considered normal operating conditions must be compensated for by more frequent oil change and/or filter change periods. Oil change periods are further based on what experience has shown to be conservative and safe hours of operation between oil changes.

Optimum oil life and also optimum engine life can be realized if the following items are given proper consideration.

a. Use of quality fuels.

b. Adequate turbocharger and combustion chamber cooling by running engine at a fast idle for 5 minutes before shutdown.

c. Proper attention to air cleaner service and prevention of leaks in the air intake system.

d. Engine adjustment:

   (1) Correct fuel settings.

   (2) Fuel injection pump timing.

   (3) Injection nozzle function and opening pressure.

   (4) Valve clearance settings.

e. Cleanliness with lubricating oil, oil containers, oil storage facilities, and oil fill caps and pipes on engines.

f. Proper attention to entire cooling system including removal of antifreeze and flushing system for summer operation, maintaining specified operating temperature, maintaining fan belts and water pump drive belts in correct adjustment, and keeping radiator surfaces free of debris.

125. GREASE

Use a ball and roller bearing lubricant that has a minimum melting point of 300°F. It must be waterproof and have a viscosity that assures easy handling in the pressure gun at prevailing ambient temperatures.

Section II. Fuel Oil

126. GENERAL

The American Society for Testing Materials (ASTM) has established fuel oil specifications and testing methods to which the petroleum industry conforms very closely. Diesel engine manufacturers have, over the years, come to rely on the ASTM specifications as a standard of the industry. The classification system established by the ASTM covers the grades of fuel oil that are suitable for various types of diesel engines, along with the permissible limits of properties within each grade. In general, an ASTM Number 2-D fuel purchased from a reputable oil company will meet the specifications recommended in Paragraph 167.

127. FUEL OIL CHARACTERISTICS

a. API Gravity

The API gravity rating is an index of the fuel's density or weight per unit volume. In addition, it affords an indication of the viscosity, distillation characteristics, and heating value of a fuel. Since fuel is purchased on a volume basis, gravity is used when setting up purchasing specs and in delivery inspections. Low API (heavier) fuels are desirable because they contain more BTU's per gallon but if they are too heavy, combustion may be incomplete.

Data extracted from a typical table based on degrees API at 60° F reveals the following:

Degrees API At 60°F	Specific Gravity At 60°F	Pounds Per Gallon At 60°F	Gallons Per Pound At 60°F	BTU Per Pound	BTU Per Gallon
30	.8762	7.296	.1371	19,420	141,800
35	.8498	7.076	.1413	19,590	138,800
40	.8251	6.870	.1456	19,750	135,800

b. Cetane Number

The cetane number indicates the ignition quality of fuel oil, a critical factor in both ease of starting and smooth operation of a diesel engine. The higher the cetane number, the higher the ignition quality of the fuel.

c. Viscosity

The viscosity rating of fuel oil is a measure of its resistance to flow due to the friction that exists within the oil itself. It must have the proper body or viscosity, i. e. a "heavy" fuel oil, may cause extremely high pres-

sures in the fuel injection system and reduce the atomization and vaporization of the fuel spray, whereas a fuel of extremely low viscosity may not provide sufficient lubrication for the close fitting pump and injector plungers, a condition which may cause abnormal wear and permit excessive leakage past the plungers.

d. Flash Point

The flash point of a fuel is the temperature at which vapors in a standard testing apparatus are ignited by a small flame. Although the flash point rating has no quality signifigance, it is important with respect to safety in storing, shipping, and handling.

e. Pour Point

The pour point of fuel is the lowest temperature at which it will flow or can be pumped through the fuel injection system. In equipment operating in cold ambient temperatures, the pour point must be at least 10°F below the lowest temperature expected in order to ensure satisfactory transfer and flow of fuel throughout the system.

f. Distillation Temperature, 90°F Point

The distillation temperature of fuel is a direct indication of its volatility and vaporization characteristics. Fuel can be completely burned in an engine only in vaporize form. Fuel that cannot be completely vaporized and burned will form sludge and other harmful deposits in the engine. Low distillation fuels will give more satisfactory performance and better economy when used in engines that operate periodically in cold ambient temperatures or at reduced speeds and loads, and in engines that normally operate under varying conditions of speed and load.

g. Ash

Fuel oil contains measurable amounts of non-burnable, ash-forming materials in the form of abrasive solids and soluble metallic soaps. These materials tend to form harmful deposits in the engine and accelerate wear of fuel injection equipment, pistons, rings, liners, etc.

h. Water and Sediment

Water and sediment in fuel oil promotes wear of fuel injection equipment and other engine parts. In addition, these contaminants contribute to sludge formation and shorter fuel filter life.

i. Sulphur

Sulphur in fuel oil has a marked effect on wear of engine parts and causes an increase of harmful engine deposits. Under conditions of low ambient temperatures and intermittent engine operation, condensation occurs within the engine and combines with the sulphur to form sulphurous acid (H_2SP_3), which is highly corrosive to engine parts. The sulphur content should be kept to a minimum in order to increase the intervals between oil changes and engine overhauls.

j. Carbon Residue

This specification indicates the amount of carbon deposit formed by petroleum oil under coking conditions. Carbon residue is throught to be related to engine deposits and thoroughness of combustion.

k. Copper Strip Corrosion

The corrosive tendency of a particular fuel oil is determined by immersing a copper test strip in the oil and, after following a prescribed procedure, comparing the resultant corrosion with a standard color chart.

128. FUEL OIL SPECIFICATIONS

Gravity, API Degrees	30-40
Cetane Number	40-65
Viscosity, SUS at 100°F	32.6-40
Flash Point	100°F or Legal
Pour Point	10°F Below Ambient Temperature
Distillation Temperature - 90% Point	640°F Max
Ash % by Weight	0.02 Max
Water and Sediment % by Volume	0.10 Max
Sulphur Content % by Weight	0.5 Max
Carbon Residue on 10% Ramsbottom	0.35 Max
Copper Strip Corrosion	No. 3 Max

These specifications are offered as a guide to help make a satisfactory selection from available stocks of fuel oil. Such factors as climate, economy, and availability of fuel may at times necessitate the use of fuel with certain specifications which are outside those listed in the table.

129. HANDLING AND STORAGE OF FUEL OIL

Improper handling and storage practices cause a major portion of all fuel system troubles. The interval between receipt of the fuel and its final use in the engine is critical to proper functioning of the engine. The following information should be kept in mind and used as a check list from time to time in order to maintain a trouble-free fuel system.

a. Take all precautions necessary to prevent the entrance of dirt and moisture into the fuel system. Contamination by these materials accelerates sludge formation, clogs filters, lines, and nozzles, and causes abnormal wear of close fitting parts in the fuel injection pump.

b. Moisture does not accumulate as rapidly in underground storage tanks as it does in above-ground tanks because temperature is more stable.

c. Alternately cooling and heating of above ground tanks causes condensate to accumulate rapidly. Such tanks should be placed at an angle to horizontal and be equipped with a drain-cock valve at the lowest point. Condensate and sediment should be drained at regular intervals.

d. Large storage tanks should be equipped with covered manholes, and small tanks should be provided with ports and removable covers in order to facilitate tank cleaning.

e. Fuel fill pipe should extend above ground level and be equipped with a watertight, dustproof cap or cover.

f. Tanks should be vented to a safe area to allow normal "breathing" caused by expansion and contraction of the fuel and air.

g. The fuel outlet line should be connected to the tank either at the end opposite the sediment collection point or at a point that is well above the area of maximum accumulation.

h. Fuel lines should be of aluminum or steel wherever possible. Copper accelerates deterioration of fuel and induces sludge and gel formation.

i. All fuel handling equipment, such as funnels, hand pumps, and dipsticks, should be kept clean at all times and covered when not in use.

j. Do not open fuel containers or transfer fuel from drums to tanks in areas exposed to blowing dust and dirt. Also, do not use cotton waste material or linty rags to wipe containers, funnels, hand pumps, dipsticks, etc.

k. All fuel oils deteriorate at different rates depending upon such factors as the original source of the crude oil, the extent of refining and blending it has undergone, the degree of contamination introduced during storage, and age of the fuel oil.

(1) Do not use tanks of larger capacity than necessary. The maximum recommended storage period for current type diesel fuels composed of blends of straight run distillates and catalytically cracked stocks is 6 months to 1 year. The user is inviting clogged filters and fuel injection difficulties if fuel is used that has been stored for longer periods. When longer storage periods are anticipated, a stabilizing additive should be specified when the fuel is ordered. Regardless of storage time, a full tank is preferable to one that is only partially filled.

(2) Fuel instability is related in some degree to its sulphur content. Sulphur promotes the formation of corrosive compounds that are very destructive to metals in the fuel storage and fuel injection systems.

(3) Do not continually add new fuel to old fuel in storage with occasionally draining and disposing of all fuel remaining in the tank. The chemical change already started in the old fuel accelerates deterioration of the new fuel.

(4) Straight run distillate fuels are less subject to chemical change in aging than are the more refined, catalytically cracked fuels. In this respect, the lighter Number 1 fuel oil rates higher than Number 2 fuel oil.

Section III. Cooling System

130. GENERAL

Depending upon the optional cooling system components selected for a particular engine application, proper temperature of engine coolant is maintained by a radiator and fan combination. The most commonly used system is the radiator and fan combination (Fig. 7-1).

In addition to the major components mentioned above, the engine cooling system also includes a water pump, water outlet manifold, thermostats, engine oil cooler, coolant passages in cylinder block and heads.

The cooling system is pressurized by a 7 psi pressure cap. By pressurizing the cooling system, the normal boiling point (212°F) of clean water at sea level is raised approximately 3°F per pound (psi). Consequently, coolant in the system at sea level will not boil until a temperature of 212°F, plus 21°F, or a total of 233°F is reached. Temperatures exceeding this figure will cause loss of coolant and will result in engine overheating. Altitude affects the coolant boiling point, that is, the higher the altitude, the sooner (lower temperature) the coolant will boil. To estimate the boiling point of coolant for various altitudes above sea level deduct 1-1/2°F per 1000 feet of altitude from 233°F, the boiling point established with a pressure cap at sea level.

A double-acting valve in the pressure cap relieves pressure caused by expansion of the heated coolant and allows atmospheric pressure to enter when contraction occurs due to cooling of the coolant. Because this is a pressure type cooling system, it is necessary to keep the radiator cap screwed on tightly at all times to prevent loss of pressure.

WARNING

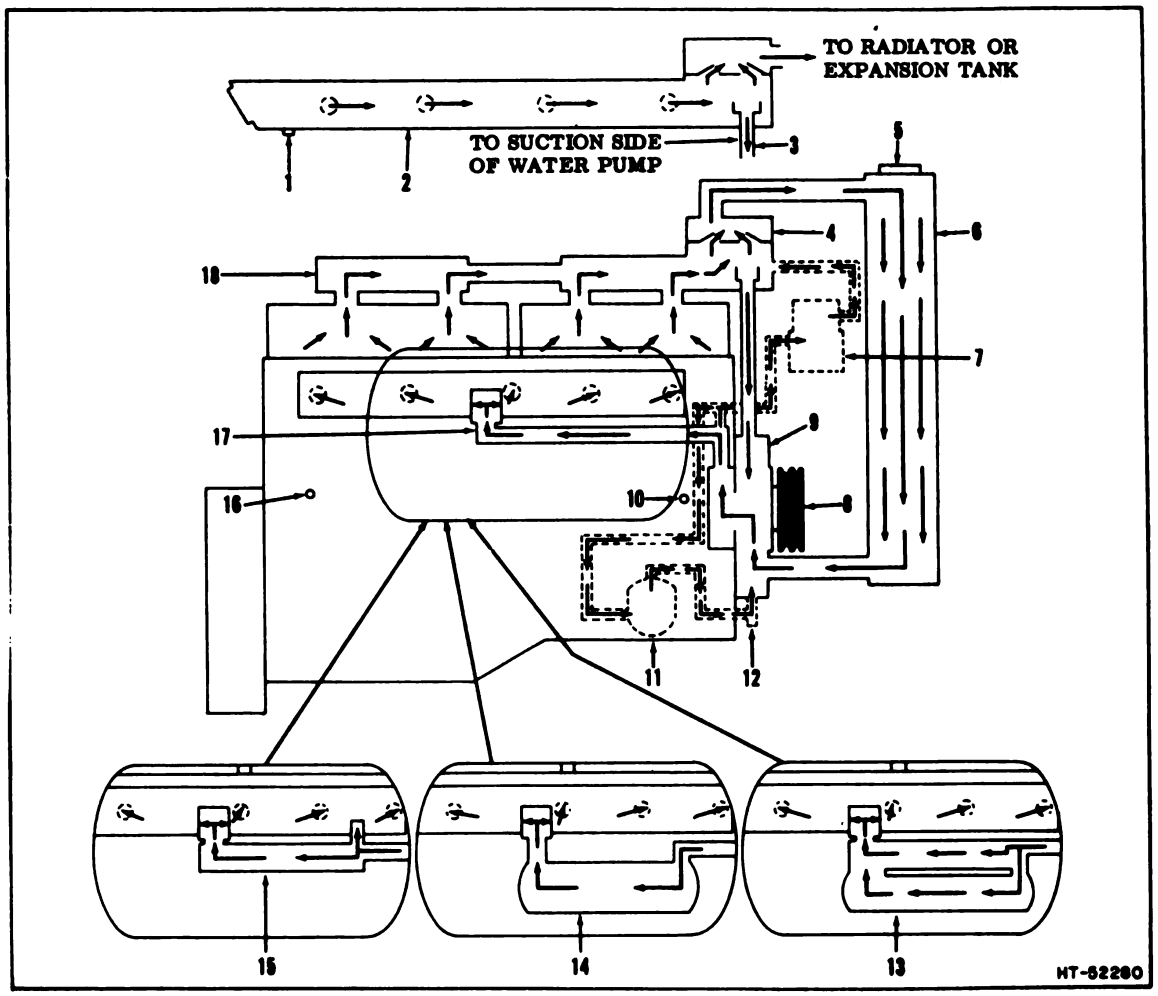
Do not remove pressure cap while coolant is above 212°F because coolant will break into a boil and may splash onto the person removing the cap.

IMPORTANT: The current engine thermostats begin to open at 180° F and are fully open at 200° F. Operating the engine in this temperature range is not harmful. However, some temperature gauges are not always exactly accurate and may indicate a higher than actual temperature. This can lead the operator to believe the engine is overheating when actually it is operating normally.

Overheating is always associated with loss of coolant. In the event of any doubt, the coolant level in the radiator should be checked.

131. GENERAL MAINTENANCE

In warm weather keep the cooling system filled with clean, soft water or rain water. If soft water is not available and hard water must be used, it must first be treated with a water softener. A rust inhibitor should be added to the water for warm weather operation. As optional equipment, a coolant filter is available to maintain a clean cooling system and thereby extend engine life.



1. Drain Cock
2. Water Cooled Exhaust Manifold
3. Bypass Pipe
4. Thermostat Housing Cover
5. Pressure Cap (7 psi)
6. Radiator
7. Air Compressor (optional)
8. Water Pump Pulley
9. Water Pump
10. Drain Cock
11. Perry Water Filter (optional-cannot be used with air compressor)
12. Drain Cock
13. Model 11000 Lube Oil And Torque Converter Coolers
14. Model 10000 Torque Converter Oil Cooler
15. Model 11000 Engine Oil Cooler
16. Drain Cock
17. Water Inlet Manifold (Model 10000)
18. Water Outlet Manifold

FIGURE 7-1 COOLING SYSTEM

In winter weather, use a glycol base antifreeze solution in the system to protect against damage from freezing. After any addition of water or antifreeze compound, test the solution after the added quantity has become thoroughly mixed to make sure it will withstand the prevailing or anticipated temperature. Refer to instruction or protection charts (TB 750-651) of the antifreeze for information on quantity of antifreeze required for the lowest anticipated temperature.

CAUTION: Keep cylinder head nuts, water pump mounting capscrews, hose clamps, and fitting connections tight. All leaks must be corrected as soon as they become evident. Inspect hoses carefully and replace them if they have deteriorated.

After each 200 hour interval of operation, apply one or two shots of grease in fitting in water pump housing.

CAUTION: Do not overgrease water pump bearings.

132. DRAINING OF COOLING SYSTEM

a. If engine is installed in portable type equipment, make certain it is in a level position to assure complete draining.

b. Remove radiator cap.

c. Open vent cocks located in thermostat housing cover (Fig.7 -2).

d. Open drain cocks located on the right-hand side of cylinder block (Fig 7-3).

e. Open drain cock at bottom of timing gear housing below the water inlet to the pump (Fig.7 -3).

f. Open drain cock located in bottom of radiator.

NOTE: Be sure to tighten cover screws before starting engine.

CAUTION: When draining the cooling system in freezing weather, make certain that coolant flows freely from all drain cocks and that the system drains completely.

133. FILLING OF COOLING SYSTEM

a. Install coolant filter drain plug, and close all drain cocks that were opened to drain paragraph 132.

b. Check to assure vent cocks in thermostat housing are open.

c. Pour coolant into radiator until it flows from vent cocks.

d. Close vent cocks and continue filling until coolant level is approximately 1-1/2" below bottom of filler cap.

NOTE: Operate the engine for a period of time at normal operating temperature to vent all air from the system. Check the level of the coolant in the radiator and if necessary, add coolant to bring it up to the proper level.

134. CLEANING OF COOLING SYSTEM

a. Clean cooling system at beginning of cold weather before antifreeze is added, and again after antifreeze is drained for warm weather operation. Also, drain, flush, and refill the system whenever inspection reveals an accumulation of rust and scale.

b. If engine is provided with a coolant filter that has been properly maintained cleaning of system should not be necessary. However, coolant filter's effectiveness is only as good as the maintenance it receives. If inspection reveals coolant to be a brown and rusty color, drain, flush, and refill cooling system and replace coolant filter element.

CAUTION: Never mix antifreeze compound or inhibitors with any cleaning, neutralizing, or flushing compounds.

c. If radiator tubes become clogged, reverse flush radiator as follows:

(1) Disconnect upper and lower radiator hoses.

(2) Connect a pressure water hose to lower connections with a suitable adaptor.

(3) Plug upper connection and remove radiator cap.

(4) Force water through radiator. Foreign material will flow out through top of radiator with the water.

CAUTION: Do not use more than 5-or 6-psi pressure when flushing. Excessive pressure may rupture radiator.

d. Keep radiator air passages free of debris and other obstructions. Clean exterior by means of an air blast carrying a grease solvent of oleum spirits or tetrachloride. For engines having a blower-type fan, direct spray at front of radiator. Cover engine before performing cleaning operation.

CAUTION: Provide adequate ventilation to avoid possible toxic effects of the cleaning spray. Never use gasoline, fuel oil, or kerosene.

135. THERMOSTATS

This engine is equipped with two "by-pass" type thermostats (Figure 7-4) that begin to open at 180°F.

Operation of the engine when coolant temperature is below operating temperature will result in incomplete fuel combustion, higher fuel consumption with less power, and cause harmful deposits to form within the engine. Maintenance of normal coolant operating temperature depends on properly functioning thermostats. Replacement of thermostats is necessary when the thermostats become corroded, sticking in the open or closed position. If the engine overheats or does

not reach and maintain minimum operating temperature, the thermostats should be removed and tested as a possible cause of trouble.

a. Thermostat Removal

(1) Drain cooling system (refer to paragraph 132).

(2) Loosen water by-pass pipe upper hose clamp to facilitate removal of thermostat housing cover (Figure 7-4).

(3) Remove the capscrews from the water outlet elbow and remove the elbow and gasket.

(4) Remove the thermostat housing cover from the water outlet manifold. Remove the thermostats and gasket from their positions on the water outlet manifold.

(5) Clean and inspect the thermostat housing cover and examine the gasket and seals; replace the gasket or seals if necessary.

NOTE: To remove the seals, pry them from their seats in the thermostat housing cover. Install new seals using a suitable driver. The open side of the seal must be positioned toward the top of the thermostat housing cover.

b. Thermostat Testing

(1) Suspend the thermostat to be tested in a pan of clean water so it is completely immersed.

(2) Gradually heat the water and use a reliable thermometer to check water temperature.

NOTE: Stir water during heating so heat is evenly distributed in the volume of water.

(3) Observe the thermometer and note temperature at which the thermostat starts to open and at which it is fully open. The amount of travel between open and closed positions is from 5/16" to 11/32".

NOTE: The 170°F thermostat is designed to start opening at 170°F and be fully open at 185°F. The 180°F thermostat is designed to start opening at 180°F and be fully open at 200°F.

(4) Thermostats are not adjustable. If they do not operate within the above limits, they must be replaced.

c. Thermostat Installation

(1) Place a gasket in position on the water outlet manifold and install the thermostats.

(2) Position thermostat housing cover on water outlet manifold and secure with capscrews and lockwasher. If applicable, connect bypass pipe to thermostat housing cover with hose and clamps. Tighten hose clamps securely.

(3) Install water outlet elbow and gasket on top of thermostat housing cover with capscrews and lockwashers.

(4) Fill the cooling system (refer to preceding paragraph(4).

136. FAN, FAN HUB, FAN BELTS AND BELT ADJUSTMENT

a. General

The fan pushes air through the radiator and the engine coolant is cooled as it circulates from the top to the bottom of the radiator core. The fan hub assembly is mounted on a bracket which is bolted to the front of the engine cylinder block. The fan is bolted to the fan hub assembly, which rotates on two ball bearings, and is driven by two matched drive belts from the crankshaft pulley. Figure 4-17.

The original fan driving belts supplied on the engine are a matched pair of identical length. If only one belt replacement is required, it is imperative that both belts are replaced with a matched pair, otherwise satisfactory belt life will not be obtained.

b. Belt Replacement and Adjustment (Figure 4-17)

It is important that the fan drive belts, which also drive the water pump, are inspected frequently to make certain no oil or grease has accumulated on them, and that proper belt tension is maintained. Replace badly worn, burned, oil/grease soaked belts.

The fan drive belts are properly adjusted when the belts can be pressed inward by hand approximately ½-to 3/4-inch at a point half-way between the crankshaft pulley and the fan hub pulley.

To replace and adjust the drive belts (Figure 7-2, Figure 4-18)

(1) Loosen lock nut at rear of the fan hub spindle (shaft) so spindle can be moved in slot of the fan hub mounting bracket, (figure 8-28, Item 6).

(2) An adjustment screw passes through the bracket top and a tapped hole in the hub spindle, and bottoms in the lower part of the bracket slot. Lower the hub by turning the adjustment screw counterclockwise, (figure 8-28, Item 5).

(3) Remove both old belts. Inspect belts for slickness, oil soak, wear, tears, cracks, and overstretching. Replace belts if necessary.

(4) Position belts on pulley grooves.

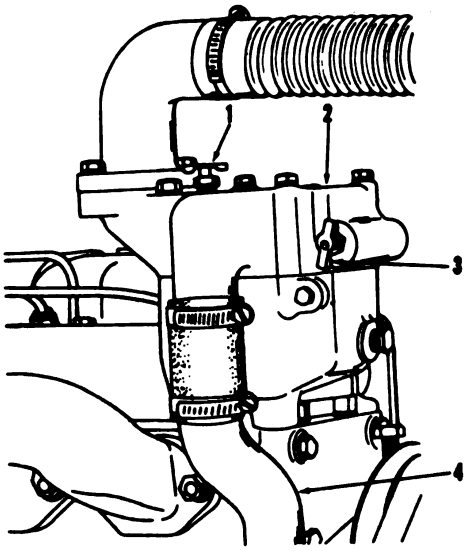
(5) Raise the hub and adjust proper tension of belts by turning the adjustment screw clockwise.

(6) After proper adjustment is obtained, tighten the spindle lock nut securely.

c. Fan Hub Lubrication

Bearings in the fan hub must be lubricated at prescribed intervals with a pressure type lubricant. For ease of accessibility and balance, the fan hub is provided with two grease fittings. After each 500 hour interval of operation, apply one or two shots of grease with a low pressure, hand operated grease gun in either of the two fittings.

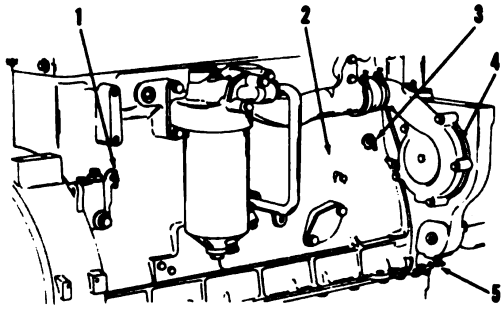
CAUTION: Do not overgrease fan hub bearings.



HT-52295

1. Vent Cock
2. Thermostat Housing Cover
3. Vent Cock
4. Bypass Pipe

FIGURE 7-2
VENT COCK LOCATION SYSTEM



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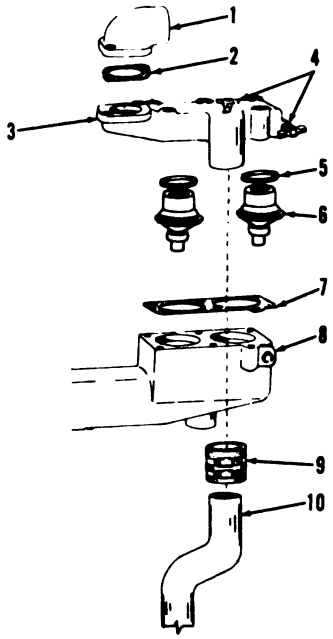
1. Drain Cock
2. Cylinder Block
3. Drain Cock
4. Water Pump
5. Drain Cock

FIGURE 7-3 DRAIN COCKS



E-1031

1. Water Outlet Elbow
2. Gasket
3. Thermostat Housing Cover
4. Vent Cocks
5. Thermostat Seal
6. Thermostat
7. Gasket
8. Front Water Outlet Manifold
9. Hose With Clamps
10. Bypass Pipe

FIGURE 7-4
THERMOSTAT REMOVAL

Section IV - Fuel System

137. GENERAL

The fuel system consists of a fuel tank, hand primer pump, fuel filters, transfer pump, fuel injection pump, fuel injection nozzles, and fuel lines. There are two fuel pressure systems, low pressure and high pressure. (Figure 7-5)

The low pressure system is comprised of the fuel tank, hand primer pump, fuel filters, transfer pump, fuel lines between the fuel tank and the fuel pump, and fuel return lines.

In the high pressure system, the fuel injection pump meters and forces the fuel, under extremely high pressure, to the fuel injection nozzles. The nozzles spray the fuel into the engine combustion chambers. The fuel injection lines are seamless steel tubing and each line is the same length. These lines being of equal length assures proper timing and the proper amount of fuel to each injection nozzle.

The fuel transfer pump delivers more fuel to the fuel injection pump than is required for engine operation. A fuel return line extending from the fuel injection pump to the fuel tank conveys the surplus fuel back to the fuel tank.

There is a certain amount of fuel seepage between the lapped surfaces of each fuel injection nozzle valve and its body, which is necessary for lubrication. This leakage of fuel accumulates around the spindle and in the spring compartment of each fuel injection nozzle holder and is returned through the fuel drip manifold and return line to the fuel tank.

If necessary precautions are not taken in the storage of fuel, in the transfer of fuel to the fuel tank, and in keeping the fuel tank full to prevent condensation, foreign matter and water will enter the fuel system and damage the fuel injection pump and fuel injection nozzles. The fuel filters are installed in the fuel system to clean the fuel before it enters the fuel injection pump.

It is essential that personnel responsible for the care and operation of the engine adhere to the following maintenance recommendations:

a. Use only fuel meeting the specifications as outlined in paragraph 128.

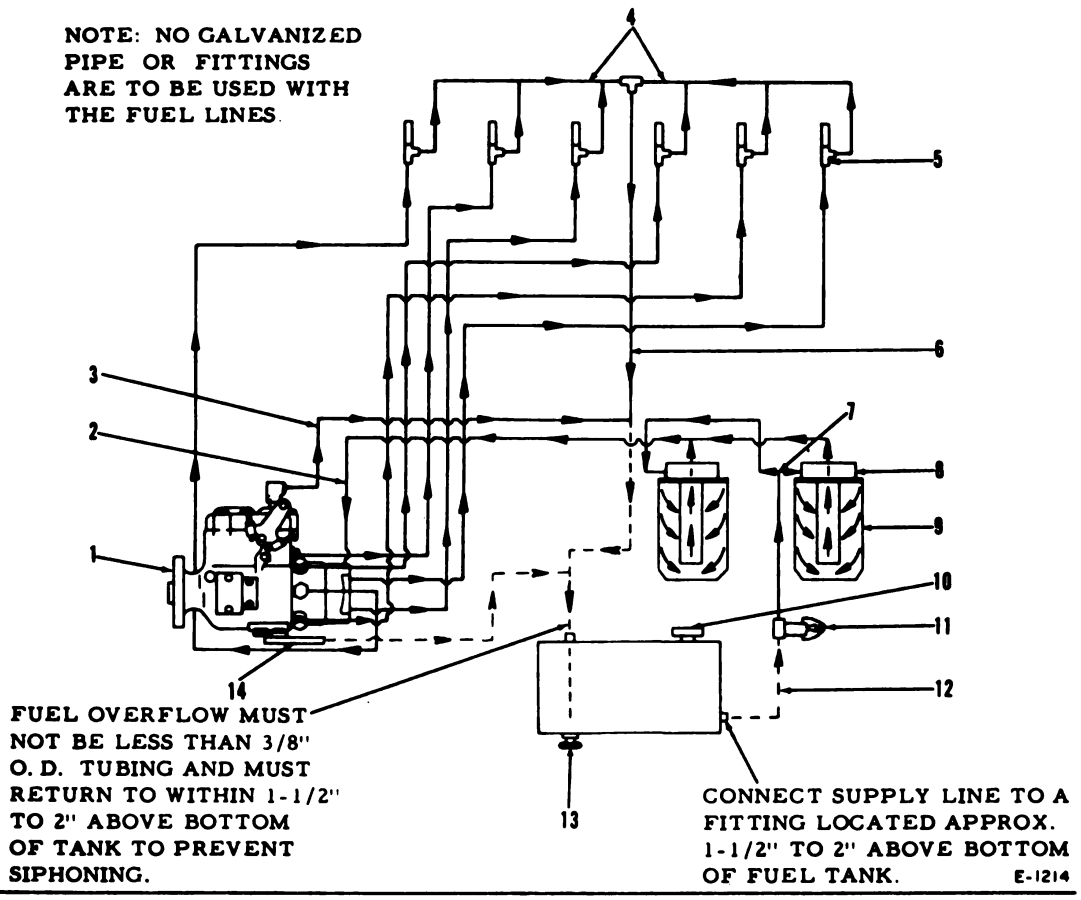
b. Store and handle fuel with utmost care to prevent water and foreign matter from entering the fuel system.

c. Properly maintain fuel oil filters.

d. Remove injection nozzle holder assemblies at the prescribed intervals; adjust the opening pressure and check the spray pattern.

e. Daily, drain water and sediment from fuel tank and, if applicable, from fuel filters.

f. Periodically check injection pump timing.



1. Fuel Injection Pump
2. Fuel Supply Hose
3. Fuel Return Line
4. Drip Manifold
5. Nozzle Holder Assembly
6. Drip Manifold Return Line
7. Fuel Inlet Tee
8. Fuel Filter Head
9. Fuel Filter
10. Fuel Tank Must Have Air Vent
11. Hand Primer Pump
12. Fuel Supply Line
13. Drain Cock
14. Accumulator (Optional Hydraulic Governor)

FIGURE 7-5

FUEL SYSTEM

g. Keep all fuel line connections, filters, injection pump and injection nozzle assemblies tightened securely (specified torque) to the engine.

h. Before removing any part of the fuel injection system from the engine be sure to wash the part with cleaning solvent, also the surrounding area to prevent the entrance of abrasives into the system. Cover all openings immediately.

138. FUEL FILTER ASSEMBLY REMOVAL (Figure 4-8)

The two identical combination fuel filters used are the disposable, throw-away type. Any dirt or sediment that passes through the primary portion of each filter is collected by the secondary portion and prevented from entering the fuel injection pump.

The fuel filter head is a manifold used to collect and distribute fuel; the head also serves as a holder for the filter elements. Inspect filter head for cleanliness at time of changing filter elements.

a. Filter Service

Drain the water from bottom of fuel tank daily and, if applicable, from fuel filters before start of operation during warm weather, and shortly after end of day's operation during freezing weather. Remove and discard filter elements and install new ones every 500 hours of operation or when filters become clogged. Clogged filters are usually indicated by irregular engine performance.

b. Fuel Filter Element Replacement

(1) Remove dirt from around filters, and clean filter heads and surrounding area.

NOTE: Close fuel tank shutoff valve if fuel level in tank is above level of fuel filters.

(2) Remove filter elements and O-rings from filter heads. Discard filters and O-rings.

(3) Clean dirt and sediment from inside of filter heads.

CAUTION: Keep parts clean when replacing fuel filters.

(4) Position new O-ring from filter replacement kit on threaded insert in each filter head. Screw each new filter by hand into position until gasket contacts base of filter head. Using hand pressure, tighten filters ½ to 3/4 of a turn more.

CAUTION: Do not use any tools to tighten filters. Do not use sealing compound or lubricant. Always use Allis-Chalmers replacement filters (P/N 4025230).

(5) Open fuel supply shutoff valve and prime the low pressure system. Refer to following Paragraph 139.

139. PRIMING FUEL SYSTEM BY HAND PRIMER PUMP

a. Priming Low Pressure Fuel System (ROOSA MASTER INJECTION PUMP, ALLIS CHALMERS P/N 4357897)

(1) Loosen filter vent plug on both filter heads (Fig.7 -6)

(2) Open fuel supply shutoff valve.

(3) Loosen locking screw on top of hand primer pump plunger and move clamp to one side. (Figure 4-7.)

CAUTION: Operate the hand primer only until resistance is felt at the pump plunger. Continued pumping could rupture filter element and does no further good in priming the fuel system.

(4) Move primer plunger back and forth in a pumping motion to fill the filters with fuel and expel the air.

(5) When flow of fuel around each vent plug is free of air bubbles, tighten each vent plug securely.

(6) Position primer pump plunger clamp and retighten locking screw.

b. Priming High Pressure System

The high pressure fuel system is usually self-priming due to the fact that any air trapped by the fuel injection pump is forced out through the fuel injection nozzles and into the engine combustion chambers. However, in the event the fuel lines have been removed, the engine has run out of fuel, or the engine has not been operated for some time, priming of the high pressure system may be necessary to facilitate engine starting.

Prime the high pressure fuel system as follows:

(1) Loosen the fuel line connection nut attaching each fuel injection line to its corresponding fuel nozzle holder.

(2) Place the speed control in the high speed position and the engine stop control in the run position.

(3) Crank engine with the starting motor until fuel flows from the ends of all high pressure fuel lines. Connect the fuel injection lines to the fuel nozzle holders and tighten the fuel line connection nuts.

CAUTION: The starting motor must never be used continuously for more than 30 seconds at any one time without a pause of two minutes to allow the motor to cool.

140. FUEL INJECTION NOZZLE HOLDER ASSEMBLY

a. Description

Each engine cylinder is provided with a multi-hole, differential needle, hydraulically lifted, fuel injection nozzle holder assembly. The function of each nozzle holder assembly is to direct a metered quantity of fuel received from the fuel injection pump into the corresponding engine com-

bustion chamber in a highly atomized, predetermined spray pattern, and in such a manner as to produce the most efficient performance (Fig. 7-12).

Each fuel injection nozzle holder assembly, (Fig. 7-7) consists of two assemblies; an injection nozzle holder assembly and an injection nozzle assembly. The holder assembly positions the nozzle in the cylinder head and provides a means of conducting fuel received from the fuel injection pump to the nozzle. The holder consists of a steel holder body, two locating dowels, spindle, spindle spring, pressure adjusting screw, adjusting screw locknut, gaskets, cap nut, and a nozzle retaining nut. The nozzle assembly consists of a nozzle valve and a nozzle body in which are located four spray orifices, equally spaced 90° apart. The nozzle valve is operated hydraulically within the valve body by fuel delivered under pressure by the fuel injection pump. The nozzle is positioned on the holder by two dowels whereby the four spray orifices are fixed on a plane parallel to the piston top, and the nozzle fuel duct is registered with the holder fuel duct.

Fuel enters the nozzle holder fuel inlet passage, passes through the holder fuel duct into the nozzle fuel duct via an annular groove in the nozzle body, and then into the pressure chamber above the nozzle valve seat. At instant the pressure of fuel in the pressure chamber exceeds pressure exerted on the spindle and nozzle valve by the spindle spring, the nozzle valve is lifted off its seat and fuel is forced through orifices in the valve body end and into the corresponding engine combustion chamber. The nozzle valve is returned to its seat by pressure exerted by the spindle spring when the fuel injection pump has ceased to deliver fuel to the nozzle holder.

A certain amount of fuel seepage between the lapped surfaces of each nozzle valve and valve body is normal and necessary for lubrication. This fuel accumulates around the spindle and in the spring compartment of the fuel nozzle, and is returned through the fuel drip manifold and fuel return lines to the fuel tank.

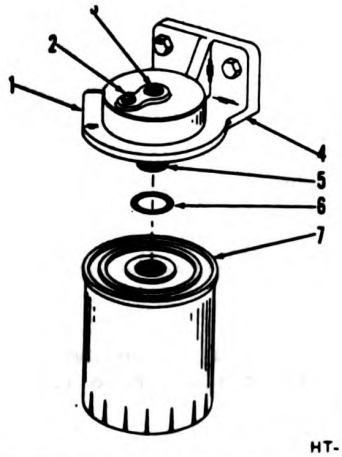
b. Service

After each operating interval of approximately 2,000 hours, the fuel injection nozzles should be removed, cleaned, tested, and adjusted if necessary. The specified opening ("popping") pressure is 2750 psi. New production nozzles and rebuilt nozzles with new springs are set at 2800 to 2850-psi to compensate for initial set of new spindle springs. Popping pressure can be adjusted with the pressure adjusting screw. Turn the adjusting screw counterclockwise to increase opening pressure. A nozzle tester with an accurate pressure gauge must be used to observe the opening pressure spray pattern and general function of the nozzle.

c. Fuel Injection Nozzle Holder Removal

(1) Thoroughly clean fuel injection nozzles, lines, connectors, and surrounding area.

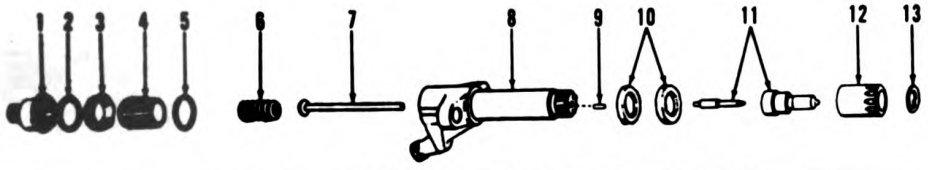
(2) Remove fuel drip manifold and disconnect lines from nozzle holder assemblies as illustrated in Figure 7-8.



HT-54803

1. Fuel Inlet
2. Vent Plug
3. Fuel Outlet
4. Filter Head
5. Threaded Insert
6. O-Ring
7. Fuel Filter

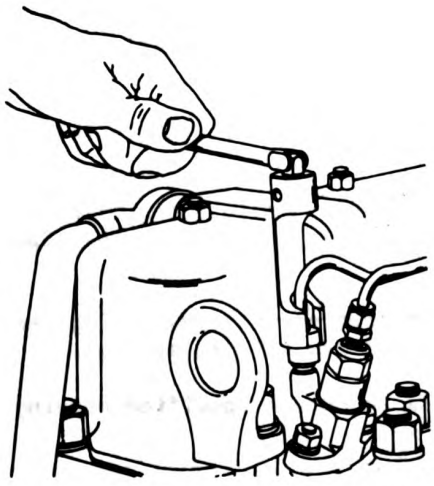
FIGURE 7-6 FUEL FILTER



E-1230

1. Cap Nut
2. Gasket
3. Locking Nut
4. Adjusting Screw
5. Gasket
6. Spindle Spring
7. Spindle
8. Holder Body
9. Dowel Pins
10. Dust Shields
11. Nozzle Assembly
12. Retaining Nut
13. Gasket

FIGURE 7-7 FUEL INJECTION NOZZLE



HT-52527

FIGURE 7-8 NOZZLE HOLDER ASSEMBLY

CAUTION: Do not bend lines when disconnecting. Cover all openings immediately to prevent entrance of dirt.

(3) Remove capscrews or nuts and lockwasher securing nozzles to cylinder head.

(4) Remove nozzles from cylinder head by using two small pry bars, or by using a slide hammer with adaptor similar to that illustrated in Fig. 7-9.

NOTE: Be sure to use the correct slide hammer adaptor. The Allis-Chalmers nozzle holder assembly locking nut (Fig. 7 -9) has SAE threads.

CAUTION: Use care when removing an injection nozzle to prevent striking nozzle tip against a hard object which could result in damage to the tip.

(5) Remove dust shields from nozzle holder body.

d. Testing and Adjusting Fuel Injection Nozzle Holder

A nozzle tester similar to that illustrated in Figure 7-10 is required to properly test and adjust fuel injection nozzles.

WARNING

KEEP HANDS AWAY FROM NOZZLE TIP WHEN POPPING A NOZZLE. THE FINELY ATOMIZED FUEL IS EJECTED WITH SUFFICIENT FORCE TO PENETRATE THE SKIN AND CAUSE BLOOD POISONING.

Test and adjust each fuel injection nozzle as follows:

(1) Bolt or clamp base of nozzle tester to a work bench.

(2) Turn nozzle tester valve handle to the open position. Loosen filler cap to prevent air lock in the tester. Operate handle until fuel flows from end of tester fuel line, then close valve.

(3) Remove cap nut or protecting cap from nozzle holder assembly as illustrated in Figure 7-11.

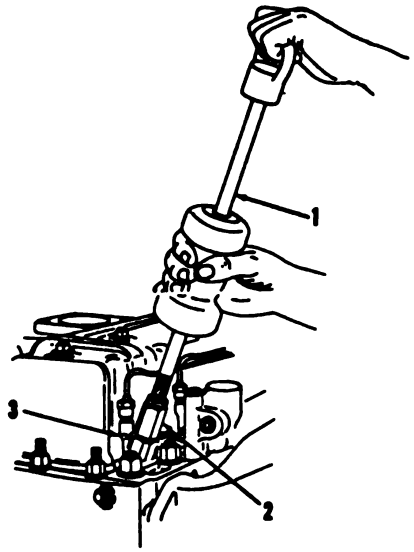
(4) Install nozzle in tester and connect line. Place spray collector under valve end of nozzle.

(5) Open nozzle tester valve. Operate handle a few quick strokes and observe popping pressure indicated on pressure gauge. Specified popping pressure is 2750 psi.

NOTE: New production nozzles and rebuilt nozzles with new springs are set at 2800- to 2850-psi to compensate for initial set of new spindle springs.

(6) Adjust fuel injection nozzle to obtain specified popping pressure as follows:

(a) Loosen adjusting screw locknut.

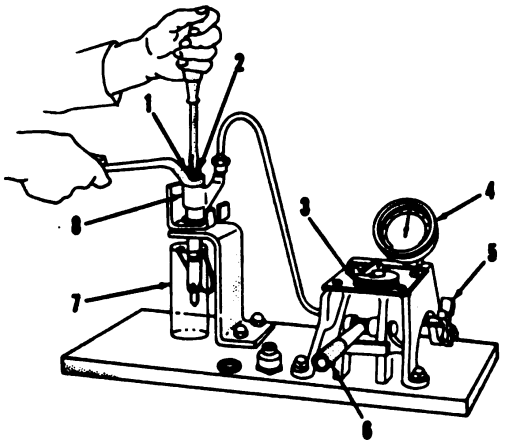


HT-50580

1. Slide Hammer
2. Nozzle Holder Remover Adaptor
3. Nozzle Holder

FIGURE 7-9

REMOVING FUEL INJECTION NOZZLE ASSEMBLY

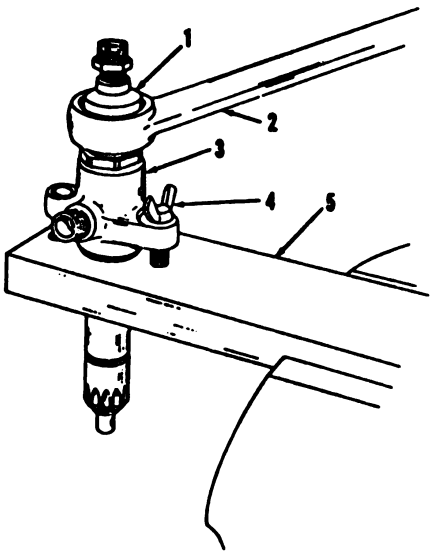


HT-50066

1. Pressure Adjusting Screw
2. Adjusting Screw Locknut
3. Filler Cap
4. Pressure Gauge
5. Valve Handle
6. Tester Handle
7. Spray Collector
8. Nozzle Holder Assembly

FIGURE 7-10

FUEL INJECTION NOZZLE TESTER



HT-52115

1. Cap Nut
2. Wrench
3. Nozzle Holder Assembly
4. Retaining Screw
5. Injection Nozzle Holding Fixture

FIGURE 7-11
REMOVING NOZZLE CAPNUT

(b) While operating handle, turn pressure adjusting screw IN to increase or OUT to decrease popping pressure. When specified pressure is obtained, hold adjusting screw and tighten locknut to 60-to 75-lb-ft.

(7) Dry the nozzle tip. Operate handle slowly until pressure is approximately 200 psi below popping pressure. Observe nozzle tip for fuel leakage. If nozzle does not leak, the nozzle valve is seating properly in the valve body. If drops of fuel collect at a pressure of approximately 200 psi, or less, below popping pressure, the nozzle valve is not seating properly. In this case, the valve body and valve must be removed for cleaning and inspection.

(8) If the nozzle proved satisfactory when subjected to the leakage test above, operate handle at a speed of approximately 100 strokes per minute and observe nozzle spray pattern.

(9) The nozzle tip has 4 equally spaced holes, 90° apart. Size and spacing of these holes determines the spray pattern (Fig. 7-12). If fuel is discharged evenly through all 4 holes at specified popping pressure, the spray pattern is considered satisfactory. However, if fuel is not discharged evenly from all 4 holes, a plugged hole(s) is indicated, in which case, the nozzle must be removed and cleaned (Fig. 7-13) using a proper size cleaning wire.

(10) Install cap nut or protecting cap. Tighten cap nut to 60-to 75-lb-ft.

e. Installation of Fuel Injection Nozzle Holder Assembly

(1) Thoroughly clean nozzle holder sleeves in cylinder head. When cleaning sleeves, make certain old nozzle holder gaskets are removed because new gaskets must be used when installing the nozzle holders. Make sure no small particles of carbon are in nozzle holder sleeves that could prevent nozzle holder gaskets from seating properly, thereby permitting "blow-by" from the cylinders.

NOTE: When cylinder head has been removed from the engine, it is advisable to use a carbon removing tool (Fig. 7-14) to clean carbon deposits from sleeves before reinstalling the cylinder head.

(2) Install dust shields on nozzle holder and replace new holder gasket, concave face down, in position on nozzle holder. Carefully position nozzle holder in nozzle sleeve of cylinder head.

(3) Install nozzle holder lockwashers and capscrews or nuts for each nozzle but do not tighten at this time. Place fuel injection tubes in position in nozzle holders. Start injection tube nuts but do not tighten at this time. Install fuel drip manifold.

(4) Tighten nozzle holder capscrews or nuts alternately. Tighten capscrew or nut on one side to 4-to 7-lb-ft torque. Tighten capscrew or nut on opposite side to full specified torque of 12-to 15-lb-ft. Then tighten first capscrew or nut to full specified torque. Tighten injection tube and fuel return manifold nuts securely.

(5) Start engine and observe fuel injection tubes and fuel return manifold connections for fuel leakage. Correct any leaks found.

141. REMOVING CARBON FROM FUEL INJECTION NOZZLE SLEEVES

If the cylinder head has been removed from the engine, it is advisable to remove carbon deposits from nozzle sleeves with a tool similar to the one illustrated in Figure 7-14. Use a wire brush to remove carbon from nozzle tip holes in the cylinder head before reinstalling it on the engine.

CAUTION: Under no circumstances should an engine be operated with a leaking or "blow -by" nozzle holder because localization of heat will occur that will distort the nozzle holder and result in serious damage.

142. ROOSA MASTER FUEL INJECTION PUMP - P/N 4357897

a. General

The Roosa Master fuel injection pump is a distributor type pump incorporating inlet metering and opposed plungers that are operated by an internal cam ring. It is designed for self-lubrication by the fuel oil supply. Purpose of the pump is to accurately meter and deliver quantities of fuel under high pressure to injection nozzles through which the fuel is introduced into the engine combustion chambers at a definite timing in relation to the engine firing cycle and within the required injection period.

An integral governor of the mechanical-centrifugal type controls fuel delivery and, therefore, engine speed. The governor is driven directly off of the pump drive shaft without gearing. The direction of rotation of the drive shaft is clockwise.

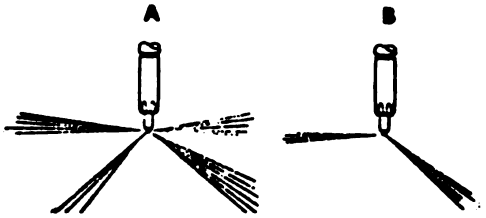
The integral transfer or supply pump, in the opposite end of the rotor from the pumping cylinder, is of the positive displacement, vane type and is covered by the end-plate.

Fuel shutoff is accomplished by the injection pump fuel shutoff lever which closes the metering valve to stop the flow of fuel to the pump plungers.

An electric fuel solenoid is available in addition to the manual shutdown. The electric solenoid mechanism within the fuel pump opens or closes the metering valve to permit or stop the flow of fuel to the engine. The electric solenoid mechanism is of the energized to run type.

b. Service

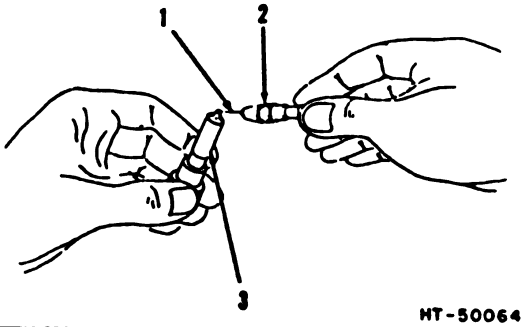
In most cases, malfunctioning of the fuel injection equipment is the direct result of dirty fuel. Dirt in the fuel causes rapid wear on the precision parts, particularly the plungers, distributor rotor, metering valve, fuel transfer pump, delivery valve and seat, and the fuel injection nozzle valves and valve bodies. Therefore, extreme care should be used in the storage and handling of fuel to prevent the entrance of dirt, water, and abrasive particles. Any water or sediment should be drained from the fuel tank daily



MT-50063

A. Acceptable Spray Pattern
B. Non-Acceptable Spray Pattern

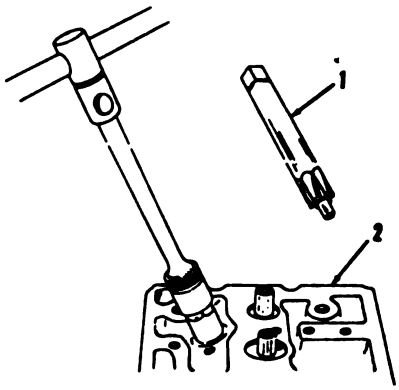
FIGURE 7-12
NOZZLE SPRAY PATTERNS



MT-50064

1. Cleaning Wire
2. Pin Vise
3. Valve Body

FIGURE 7-13
CLEANING WIRING NOZZLE



MT-50581

1. Fuel Injection Nozzle Sleeve Carbon Removing Tool
2. Cylinder Head

FIGURE 7-14
CARBON REMOVING

and, if applicable, from the fuel filters. The fuel filter elements must be changed after every 500 hours of operation (more often if conditions warrant).

No lubrication service on the governor assembly is required and it seldom needs adjustment. If engine speed is irregular, check the fuel system and all other applicable engine adjustments before removing the fuel injection pump assembly for repair.

The fuel injection pump and governor are factory sealed to discourage any disassembly or tampering with adjustment in the field. Any major service must be performed in a qualified fuel pump repair station equipped with the know-how and tools necessary to work on this precision unit with its close fits and tolerances.

c. Fuel Injection Pump Removal See Paragraph 104.

(1) Clean external surfaces of the injection pump, including all line connections and fittings that are to be disconnected to prevent dirt from entering system.

(2) Rotate engine flywheel until Number 1 piston is near top of its compression stroke and the timing pointer (Fig. 7-15) in the flywheel housing is aligned with proper number of timing degrees stamped on the flywheel. Refer to paragraph 9 for timing degrees per engine rpm.

(3) Disconnect speed control cable from injection pump speed control lever.

(4) If injection pump is equipped with an electric fuel shutoff solenoid, disconnect electrical lead from terminal on pump cover.

(5) Close fuel supply shutoff valve.

(6) Remove fuel supply hose from rear of fuel injection pump.

(7) Remove fuel return line from top of fuel injection pump.

(8) Remove connector screws and gaskets that secure fuel injection lines to fuel injection pump.

CAUTION: Tape or cover all openings immediately to prevent entrance of dirt.

(9) Remove capscrews and lockwashers securing injection pump adaptor cover to rear of timing gear housing.

(10) Carefully withdraw fuel injection pump, adaptor cover, o-ring, and fuel pump driven gear as an assembly from timing gear housing (Fig. 7-16)

CAUTION: Be careful that thrust button and spring in end of fuel injection pump drive shaft does not drop down inside of timing gear housing when removing fuel injection pump.

(11) Remove thrust button and spring from end of fuel injection pump drive shaft.

(12) Remove stud nuts and serrated washers securing fuel injection pump to adaptor cover and slide fuel injection pump from injection pump drive shaft being careful not to damage drive shaft seals.

(13) If so desired, remove adaptor cover from fuel pump drive shaft being careful not to damage drive shaft seals.

(14) If necessary, remove fuel pump driven gear from pump drive shaft as follows:

(a) Remove fuel pump driven gear retaining nut and lockwasher from end of drive shaft.

(b) Using a shaft protector on end of pump drive shaft, press drive shaft from fuel pump driven gear.

d. Fuel Injection Pump Installation and Timing

When the fuel injection pump has been serviced and is ready to be installed, or if a new pump is to be installed on the engine, follow the procedure outlined below:

(1) If the engine was not rotated from its position since the injection pump was removed as indicated in preceding Subparagraph c, the engine is properly positioned for installation of the injection pump. If the engine was rotated or has been overhauled, make certain the #1 piston is on its compression stroke. This may be determined as follows:

(a) Remove the rocker arm rear cover so valve action can be observed.

(b) Bar the engine over by hand until #6 cylinder exhaust valve is nearly closed and #6 cylinder intake valve is just beginning to open. This will position #1 piston near the top on its compression stroke.

(c) Continue rotating the flywheel until the timing pointer (Fig. 7-19) indicates the specified number of degrees BTDC on the flywheel. Refer to paragraph 9 for the proper number of timing degrees per engine rpm.

NOTE: To be sure that all slack is out of the timing gears, back up the engine a few degrees and again come up to the timing mark in the direction of normal engine rotation (clockwise when viewed from the front). The engine is now in correct position for beginning of fuel injection into number one cylinder and for installing the fuel injection pump or for checking its timing.

(2) Inspect pump drive shaft seals, drive shaft end seal, and pilot seal (Fig. 1-17). Replace if necessary.

(3) If fuel pump driven gear was removed from drive shaft, install gear on drive shaft. Secure with retaining nut and lockwasher. Tighten nut to a torque of 35-to 40-lb-ft.

(4) Insert fuel pump drive shaft into adaptor cover being careful not to damage drive shaft seals.

(5) Lubricate seals with engine oil. Slide injection pump over drive shaft and on to pump mounting studs in adaptor cover using care to prevent damage to shaft seals. Install serrated washers and pump stud nuts; tighten stud nuts finger tight after positioning fuel injection pump so that the center line of the lines scribed on top of the injection pump housing flange is in line with the mark stamped on the adaptor cover.

CAUTION: In order to prevent installation of fuel pump 180° out of time, an internal groove is provided in the splined end of the pump drive shaft. The splined end must be engaged by an internal tang of the fuel pump distributor rotor before drive shaft will engage distributor rotor splines. (See Fig. 7-17)

(6) Insert spring and thrust button in end of fuel injection pump drive shaft.

(7) Remove timing window cover from fuel injection pump. Two fuel pump timing marks (Fig. 7-18) are used for timing injection of fuel into #1 cylinder. One mark is located on governor weight retainer hub and one is located on the cam ring. Turn gear until timing marks are aligned as viewed through the timing window.

(8) Holding fuel injection pump in a horizontal position and top straight up, install fuel injection pump, adaptor cover, o-ring, and fuel pump driven gear as an assembly into timing gear housing making certain fuel pump driven gear is in mesh with fuel pump drive gear which is integral with the camshaft gear. Secure adaptor cover with capscrews and lockwashers.

(9) Turn injection pump on mounting studs until timing marks are aligned. Tighten attaching stud nuts securely to a torque of 19-to 22-lb-ft.

NOTE: Mounting holes in pump housing are elongated so pump can be turned to align timing marks withing the timing window. However, if timing marks cannot be aligned, remove fuel injection pump, adaptor cover, o-ring, and driven gear as an assembly from timing gear housing. Turn driven gear so that position of gear is at least on tooth over and in direction to facilitate alignment of fuel pump timing marks. Again install fuel injection pump, adaptor cover, o-ring, and fuel pump driven gear as an assembly as mentioned in preceding Step(8). If necessary, repeat operation until timing marks are aligned.

(10) Install timing window cover and gasket.

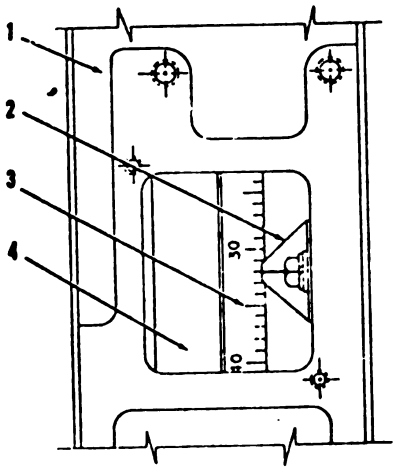
(11) Install fuel injection lines.

NOTE: Use a new fuel line connector copper gasket on both sides of each injection line fitting at the fuel injection pump.

(12) Install fuel return line to top of fuel injection pump.

(13) Install fuel supply hose to rear of fuel injection pump.

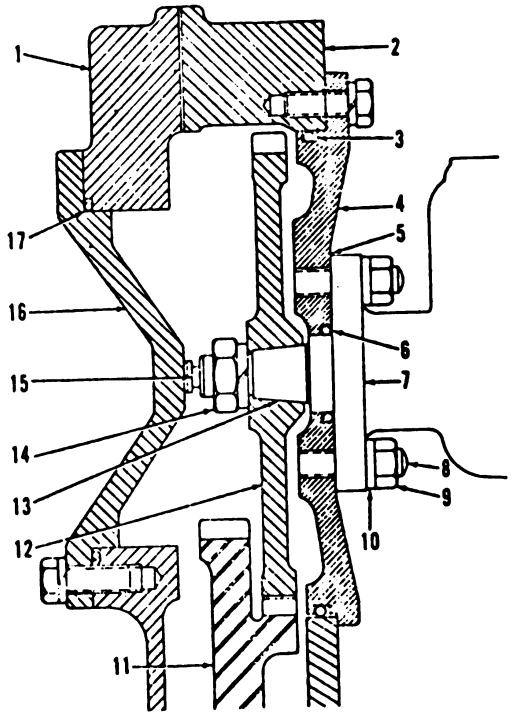
(14) Open fuel supply tank shutoff valve and prime the fuel system, (refer to preceding Paragraph 139)



HT

1. Flywheel Housing
2. Timing Pointer
3. Timing Degrees
4. Flywheel

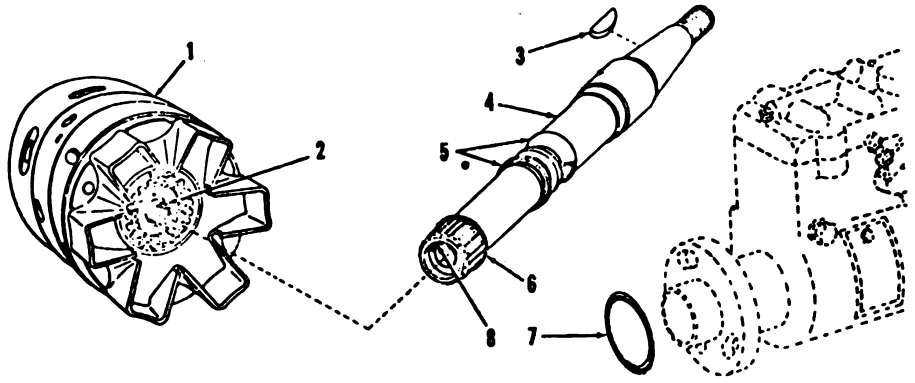
FIGURE 7-15 TIMING POINT



HT-53931

1. Timing Gear Housing Cover
2. Timing Gear Housing
3. O-ring
4. Adaptor Cover
5. Mark on Adaptor Cover
6. Pilot Seal
7. Fuel Injection Pump Flange
8. Injection Pump Mounting Stud
9. Stud Nut
10. Serrated Washer
11. Camshaft Gear
12. Injection Pump Driven Gear
13. Injection Pump Drive Shaft
14. Driven Gear Retaining Nut
15. Thrust Button
16. Auxiliary Drive Cover Plate
17. O-ring

FIGURE 7-16 FUEL PUMP DRIVE



1. Hydraulic Head and Rotor Assembly
2. Internal Tang
3. Key
4. Pump Drive Shaft
5. Drive Shaft Seals
6. Drive Shaft End Seal
7. Pilot Seal
8. Internal Groove

FIGURE 7-17 PUMP MOTOR SPLINES

(15) Connect stop control cable to pump shutoff lever.

(16) If applicable, connect electrical lead to terminal on pump cover.

(17) Connect speed control cable to speed control lever.

e. Governor

The fuel injection pump contains its own mechanical or flyweight-type governor which controls the amount of fuel delivered to the engine. The movement of the flyweights against the governor thrust sleeve rotates the metering valve. The rotation varies the position of the metering valve slot with the passage to the rotor, controlling the flow of fuel. The governor is adjusted at the factory to provide for the proper horsepower at full-load governed speeds. The specified idle speed is from 500-to 600-rpm.

All engines leaving the factory are equipped with fuel injection pumps and governors that have been carefully calibrated, adjusted, and sealed. No lubrication service on the governor assembly is required and it seldom needs adjustment. If engine speed is irregular, check the fuel system and applicable engine adjustments before changing the governor setting. Refer to Paragraph 9 for standard speed settings.

(1) Checking Engine Speed

(a) Run engine until minimum operating temperature is obtained.

(b) Move speed control to low and high speed positions and make sure the control moves governor speed control lever through its full arc of travel.

(c) Move speed control to LOW IDLE position. Check engine speed to make certain rpm is within specified range.

(d) Move speed control to HIGH IDLE position. Check engine speed to see if rpm is within specified range.

(e) If engine speed is not within ranges specified, governor must be adjusted.

(2) Governor Adjustments

An external speed droop adjustment screw at rear of the pump housing (Fig. 7 -19) provides precision control of governor sensitivity by decreasing effective length of the governor control spring. Turning the adjusting screw IN shortens effective length of the control spring, making it less sensitive and increasing the speed droop. Turning the screw OUT has opposite effect. Adjust governor as detailed below:

(a) Make low idle and high idle speed adjustments following procedure outlined above for the standard governor.

(b) To adjust speed droop:

1. Operate engine until normal operating temperature is reached.

2. Apply full load. With engine operating at rated speed, droop is determined by removing load and noting the no-load speed, or in the case of a diesel electric set, by noting its frequency.

3. Turn adjusting screw clockwise to increase, or counterclockwise to decrease speed droop. A minor correction of the speed control position is also necessary.

f. Checking Fuel System

"Missing" or uneven running of the engine, excessive vibration, stalling when idling, and loss of power are indications of insufficient fuel supply to the engine. Before making any of the following checks, make certain there is an ample supply of clean fuel in the fuel tank and that the fuel tank shutoff valve is open.

(1) Check for Admission of Air Into System

Remove fuel return line from fitting in the injection pump cover. Insert length of hose on the fitting. Place other end of hose in a container partially filled with fuel oil. Run engine at approximately 800- to 1000-rpm and observe end of hose in container for bubbles. Occasional bubbles are permissible, however, excessive bubbling or foaming indicates air is being drawn into the system. Correct this condition by tightening any loose low pressure fuel line connections.

(2) Check for Clogged Fuel Filters and Clogged or Collapsed Fuel Lines

A clogged filter or restriction(s) in fuel lines will cause loss of power, engine stalling, or erratic operation. A simple method of eliminating these troubles is to remove the fuel filter elements, blow out all low pressure fuel lines with filtered compressed air, and install new filter elements. Another method is to install a vacuum gauge at the inlet and also one at the outlet of the fuel filters. Pressure drop across clean filters should not exceed 1½" to 2½" of mercury at full load speed. A pressure drop 10" of mercury indicates filter elements are loaded and should be replaced. If a 10" mercury pressure drop is still obtained when new filter elements are used, inspect all low pres-pressure lines for clogging, crimping, etc., and clean or replace as required.

To check high pressure lines between fuel pump and fuel injection nozzles start engine and loosen each line nut, one at a time, at the injectors. If no fuel is observed at the loosened line nut, line may be clogged, crimped, or cracked. In any case, it must be replaced.

Check fuel strainer in end plate of the injection pump. Remove foreign material if screen is clogged.

(3) Check for Inoperative Fuel Transfer Pump

If engine is still erratic after making checks detailed in steps 1 and 2 above, check operation of the fuel transfer pump and end plate pressure regulating valve. Run engine until normal operating temperature is reached, then shut it down. Remove plug marked OUT in bottom of end plate opposite fuel inlet, and install a pressure gauge. With the stop control in the STOP position and speed control lever in the IDLE position, crank engine with the starter. Minimum pressure should be 6 psi at 150 rpm cranking speed. If pressure is less than 6 psi, check for malfunction in end plate and transfer pump parts.

(4) Check for Inoperative Fuel Injection Nozzles

"Missing" or uneven running of engine and loss of power are also indicative of an inoperative fuel injection nozzle(s). To locate a faulty fuel nozzle, use following procedure:

(a) Run engine at low idle speed and "cut out" each fuel nozzle in turn by loosening line nut attaching high pressure line to its corresponding fuel nozzle.

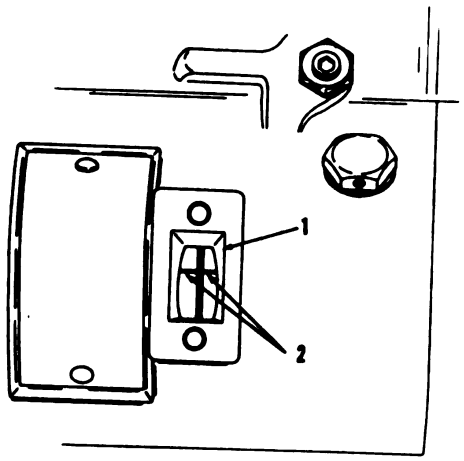
(b) A decrease in engine speed with line nut lossened indicates fuel nozzle for that cylinder is functioning properly. If engine speed does not decrease, the fuel nozzle is inoperative and should be repaired or replaced.

(5) Check for Inoperative Fuel Injection Pump

Do not replace the fuel injection pump before making a compression test. The compression test is used to detect burned or stuck valves, worn or scored pistons, sleeves, worn or stuck rings, etc., that cause faulty engine operation.

If all possible causes for insufficient fuel supply have been eliminated and the engine still runs unevenly, and normal engine performance is not obtained, the fuel injection pump may be at fault and should be checked, repaired or replaced.

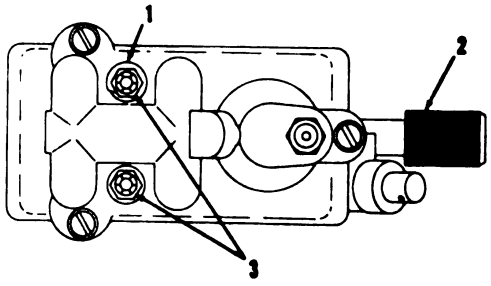
IMPORTANT: Do not replace the fuel injection pump until making certain that all other possible causes for improper engine operation have been eliminated.



HT-50586

1. Timing Window
2. Timing Marks

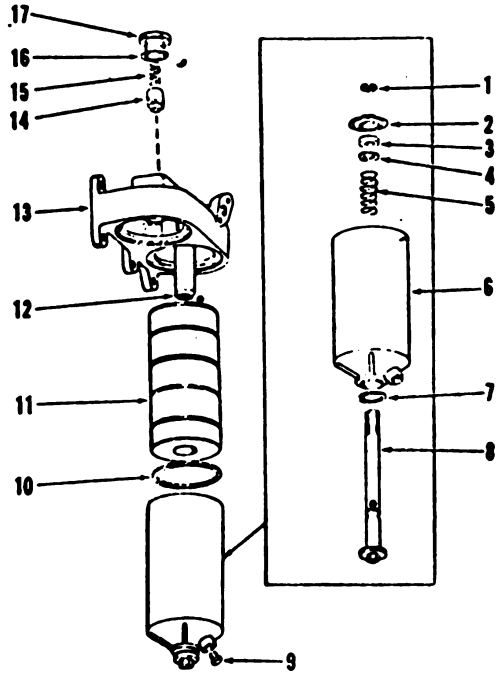
FIGURE 7-18 TIMING WINDOW



T-33582

1. Ground Washer
2. Speed Droop Adjustment Screw
3. Electric Fuel Solenoid Terminals

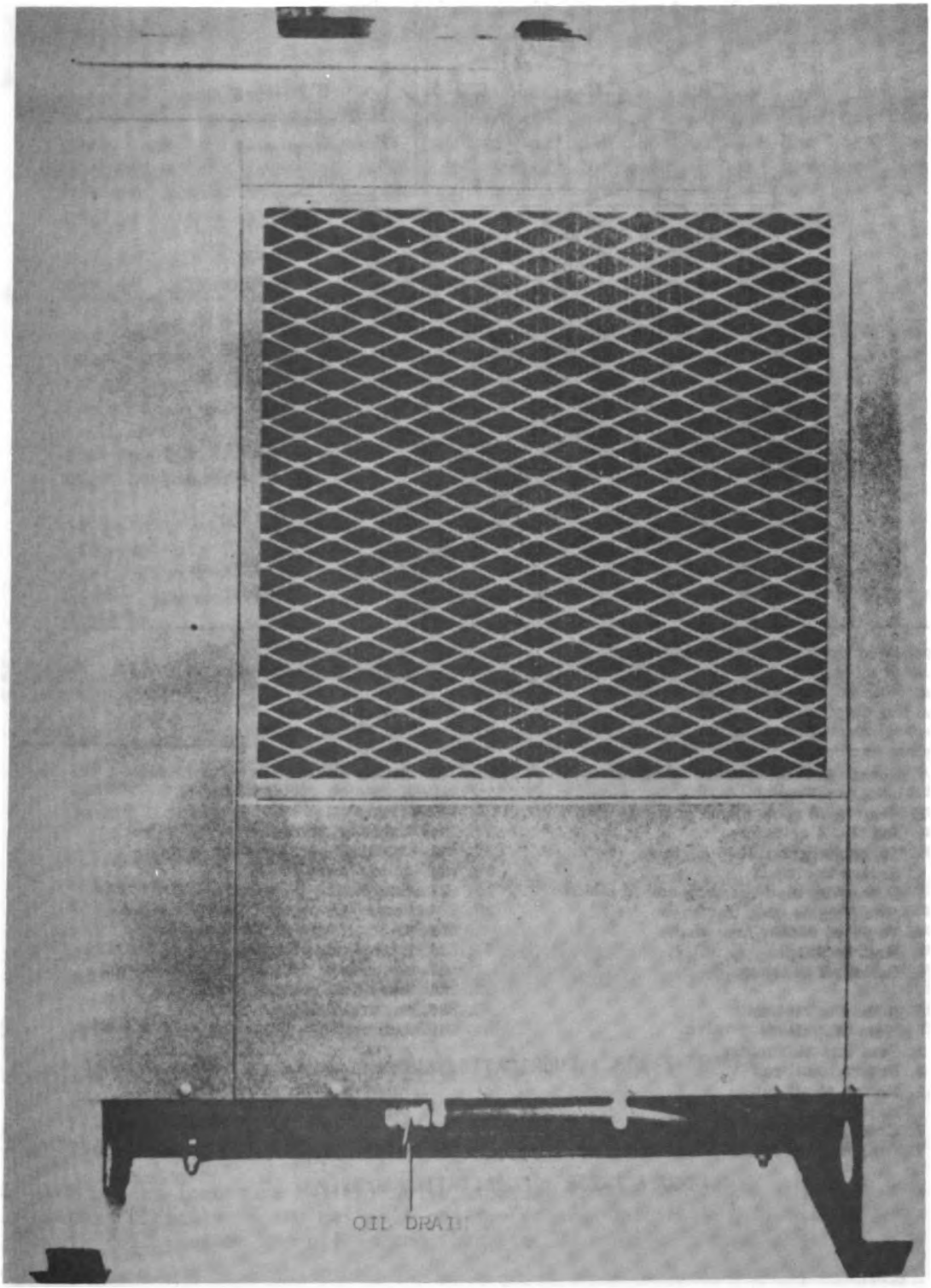
FIGURE 7-19 FUEL PUMP SOLENOID



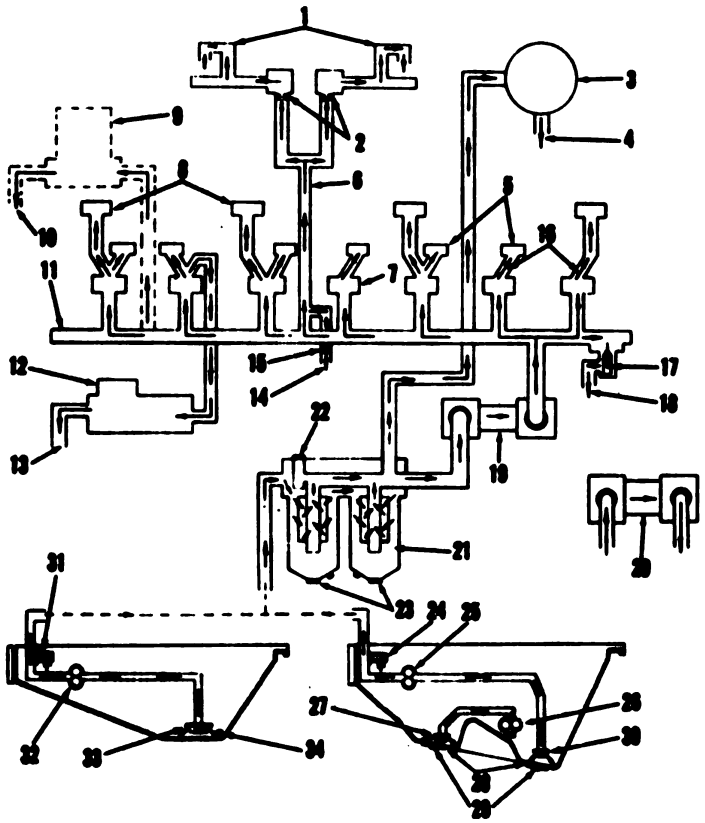
MT-52311

1. Snap Ring
2. Element Adaptor
3. Seal
4. Element Seal Washer
5. Spring
6. Oil Filter Body
7. Gasket
8. Center Bolt
9. Drain Plug
10. Body Gasket
11. Filter Element
12. Center Bolt Adaptor
13. Filter Head Assembly
14. Piston
15. Piston Spring
16. Cap Gasket
17. Bypass (Pressure Relief) Valve Cap

FIGURE 7-20 OIL FILTER



OIL DRAIN
FIGURE 7-20A



1. Rocker arm shaft drain tubes (drains back to oil pan)
2. Restricted rocker arm brackets (No. 3 and No. 4 cylinders)
3. Turbocharger (11000 engine)
4. Return to oil pan
5. Connecting Rod bearings and to piston pins (Drains back to oil pan)
6. To valve rocker arm shafts
7. Main bearings
8. Camshaft bearings
10. Return to oil pan
11. Main oil gallery
12. Fuel injection pump
13. Return to oil pan
14. Return to oil pan
15. Restrictor
16. Crankshaft oil passages
17. Oil pressure regulating valve
18. Return to oil pan
19. Engine oil cooler
20.
21. Lubricating oil filter
22. Oil filter bypass valve
23. Filter drain plugs
24. Lubricating oil pump pressure relief valve
25. Lubricating oil pressure pump
26. Scavenging oil pump
27. Scavenging oil pump suction screen
28. Hand hole covers
29. Oil drain plugs
30. Lubricating oil pressure pump suction screen
31. Lubricating oil pump pressure relief valve
32. Lubricating oil pressure pump
33. Suction screen
34. Oil drain plug

FIGURE 7-20B : LUBRICATION SYSTEM

Section V - Lubrication System

143. DESCRIPTION

The engine is pressure-lubricated throughout by a gear-type lubricating oil pressure pump, driven by the oil pump driving gear in mesh with the crankshaft gear located on the front end of the crankshaft. The engine oil pressure should be between 30-and 55-psi when the engine is operating at full throttle and with the engine coolant at normal operating temperature. (See figure 7-208)

144. GENERAL MAINTENANCE

The level of lubricating oil in the oil pan should be checked at the start of each period of engine operation. Add the specified lubricant as necessary to raise the oil level to the full mark on the oil level gauge (dipstick). Once the engine has started, observe the engine oil pressure gauge. If the engine is cold, no pressure may be indicated on the gauge for a few seconds after engine starts, but if the pressure does not then rise to normal or above, the engine must be stopped immediately and the cause determined and corrected.

It is extremely important after starting a turbocharged engine to allow the engine to idle for 3-to 5-minutes without racing. This permits oil to warm and circulate freely through the bearings before the turbocharger is operated at higher speeds. This procedure should be stressed especially for cold weather starting.

CAUTION: Allowing a turbocharger to operate at high speed without sufficient lubrication can result in failure of the turbocharger bearings in 30 seconds or less.

Before stopping the engine always allow it to operate at a fast idle for at least 5 minutes so that the engine may cool gradually and uniformly and the turbocharger impeller speed (on applications equipped with a turbocharger) may be substantially reduced before its supply of oil is cut off.

Maintenance personnel should familarize themselves with the recommended lubrication intervals and grades of lubricating oil specified for use in the engine. See Paragraph 124.

Lubricating oil filter elements and the oil in the oil pan must be replaced each 100 hours of operation or more often if adverse operating conditions warrant.

145. LUBRICATING OIL FILTERS (Figure 7-20)

The engine lubricating oil filters are of the full-flow type and contain replaceable elements. A drain plug in each filter shell permits draining of the filters when replacing the filter elements. New elements must be installed each time the oil pan lubricant is changed, or more often if conditions warrant.

A bypass (pressure relief) valve, located in the oil filter head permits oil to pass directly to the main oil gallery if the oil filters become clogged or when in cold weather the oil is too thick to flow freely through the filters.

Engines with an engine rated speed over 1800 rpm are provided with dual lubricating oil filters.

To change engine oil and replace oil filter element, proceed as follows:

a. Drain the engine oil pan and reinstall drain plug(s) in oil pan. (Figure 7-20A)

NOTE: The engine should be brought up to operating temperature and shut down before draining the lubricant.

b. Thoroughly clean filter head, filter body, and surrounding area. Remove oil drain plug from the oil filter body and allow to drain.

c. Loosen body center bolt and remove center bolt, filter body, and filter element as an assembly from the oil filter head.

d. Remove the filter element from the filter body and discard the element. Remove and discard body gasket.

e. Thoroughly wash and dry interior of filter body. Install the new element in position in the filter body.

f. Install filter body assembly in position on the filter head using a new body gasket. Tighten body center bolt to a torque of 45 to 50 lb-ft. Install the filter drain plug and tighten securely.

146. DRAINING AND FILLING OIL SYSTEM

a. Before draining the oil system, operate the engine until a minimum coolant temperature of 180°F is obtained. Remove the drain plug from the oil pan and allow the oil to drain.

b. Install the drain plug and fill the oil pan with the specified grade of lubricant to the top mark of the oil level gauge (dipstick).

c. Crank the engine for 15 seconds but do not start. This will assure filling of the filters and that lubricant has been pumped to engine components before engine is started. Operate the engine for approximately 5 minutes.

d. Stop the engine and allow several minutes for the oil to drain back to the oil pan before checking the oil level.

e. Using the oil level gauge, check the oil level and add oil as necessary to raise the level even with the uppermost mark on the gauge.

f. Observe the engine lubricating oil filter for oil leakage and be certain that the body and body gasket is properly installed.

147. LUBRICATION SYSTEM MAINTENANCE

Lubrication system maintenance requires the observance of the following checks and services:

a. Lubricating Oil

The lubricating oil must be of the best quality, proper SAE weight for the prevailing ambient temperature, and kept free of water and abrasives by proper handling and storage. Refer to paragraph 125.

b. Daily Check

Before each period of operation, check the oil level in the oil pan. If it is necessary, add oil to bring the level to the high mark on the oil level gauge. Inspect the engine for evidence of leaks and make necessary repairs.

c. Cooling System Temperature

It is important to maintain the cooling system temperature at a minimum of 180°F so that the lubricating oil will be hot enough for proper filtering. A low cooling system temperature will cause low oil temperature and poor filtering of the lubricating oil, which will result in rapid wear of all moving parts.

d. Oil Level Gauge (Dipstick)

The oil level gauge is the shielded type which allows the operator to check oil level while the engine is either stopped or running. The gauge is stamped on both sides to indicate two different oil level locations. The engine RUNNING side is stamped ADD, FULL, and RUNNING. The engine STOPPED side is stamped ADD, FULL and STOPPED.

CAUTION: Use appropriate ADD and FULL marks depending upon whether the engine is stopped or running.

When oil level is at the high mark the proper amount of oil is in the pan. Never fill pan above high mark. The engine cannot be operated safely after level reaches the low level mark on the dipstick and oil must be added to raise level to the high mark.

A seal in the oil level gauge cap prevents oil from leaking to the outside of the engine and foreign material from entering. For these reasons, the gauge must be kept tight on the level gauge adaptor. Each time oil is changed, inspect the seal to make certain it is in good condition.

e. Engine Breather Tube

The purpose of the breather tube is to vent the inside of the engine to the atmosphere, thus preventing pressure buildup and removing harmful vapors from the crankcase, gear train, and valve compartments. If the tube becomes clogged, vapors are trapped within the engine, and pressure buildup will force oil past crankcase seals, dipstick, cover gasket, etc.

After each operating interval of 500 hours, remove breather tube from the rocker covers. Clean inside of tube with cleaning solvent, blow out with compressed air, and replace in engine.

f. Oil Pan and Oil Suction Screen

After every 3,000 hours of operation, the oil pan should be removed from the engine for cleaning. The sludge should be washed from the bottom of the pan using a cleaning solvent. The oil pump suction screen should also be removed and cleaned thoroughly in a cleaning solvent.

g. Lubricating Filter Bypass Valve (Figure 7-20)

Each 3,000 hours of operation, remove, clean, and inspect the parts of the bypass valve. The piston must slide smoothly in the I. D. of the sleeve pressed into the filter head.

When piston, or I. D. of sleeve shows excessive wear, the parts must be replaced.

Reinstall the parts in the filter head and tighten the cap securely.

h. Oil Pump Pressure Relief Valve

At the time the oil pan is removed for cleaning, remove the oil pump pressure relief valve from the oil pump.

Disassemble, clean and inspect the parts. The piston must slide smoothly in the bore of the valve body. When piston or bore of the valve body shows excessive wear, a new valve assembly must be installed.

Reinstall the pressure relief valve into the rear of the oil pump and secure it with the pressure relief valve body lock.

i. Oil Pressure Regulating Valve (Figure 7-21)

The oil pressure regulating valve is located in the main oil gallery at the right-rear corner of the cylinder block. The pressure regulating valve maintains stabilized oil pressure within the lubrication system. When the oil pressure at the regulating valve exceeds approximately 55 psi, the valve piston is raised off the valve piston seat, and the oil is bypassed directly from the cylinder block to the oil pan.

If the lubrication system is allowed to sludge, the valve may not work properly. If the valve sticks in the open position, a sharp drop in the engine oil pressure will occur; if the valve sticks in the closed position, a sharp rise in the engine oil pressure will occur.

Every 3,000 hours of operation, remove and inspect the oil pressure regulating valve.

NOTE: The valve assembly consists of a regulating screw with a nylon belt, jam nut spring, and piston.

Remove pressure regulating valve screw, noting the number of turns required for removal. Withdraw the valve spring and piston. Wash all parts thoroughly and inspect carefully. Replace any parts that are worn.

Thoroughly clean the area in the cylinder block, lubricate the valve piston with clean oil (the valve piston must slide smoothly in the bore of the cylinder block), and install the regulating valve components.

NOTE: Turn the valve screw into the cylinder block the same number of turns that was required for removal.

Start engine and allow it to reach normal operating temperature. Adjust the oil pressure regulating valve screw to obtain oil pressure of 45-to 50-psi at high idle engine speed.

Section VI - Valve Adjustment and Cylinder Head

148. GENERAL

The correct clearance (valve lash) between the rocker arms and the intake and exhaust valves is very important in a diesel engine due to the high compression developed within the cylinders. Insufficient valve clearance can cause loss of compression, misfiring, and will eventually cause burning of the valves and valve seats. Excessive valve clearance will result in faulty engine operation, valve lifter noise, and rapid wear of the valve operating mechanism.

With the engine coolant temperature at a minimum of 160°F, the specified valve clearance is 0.018" for both the intake and the exhaust valves. After any mechanical work has been done which would disturb the valve clearance, the valves may be set cold at 0.020" so the engine may be run and allowed to warm up. After engine has reached a minimum of 160°F coolant temperature, the valve clearance should again be checked.

CAUTION: After any mechanical work has been done which would disturb the valve adjustment, make certain that the adjusting screws in the rocker arms are turned upward (counterclockwise) high enough so that the rocker arms and push rods will not open the valves too far and thus allow the pistons to strike the valves when the engine is cranked.

149. VALVE LASH ADJUSTMENT (Figure 7-22)

Valve lash must be adjusted when the piston is near top dead center on its compression stroke and intake and exhaust valves are closed. Number 1 and Number 6 pistons move up and down in their respective cylinders simultaneously. When one piston is on its compression stroke, the other is on its exhaust stroke, and vice versa. Observe valves for Number 6 cylinder; when the exhaust valve is almost closed and the intake valve starts to open, Number 6 piston is near top dead center on its exhaust stroke and Number 1 piston is in the same position on its compression stroke. At this point, both valves for Number 1 cylinder are closed and valve lash can be adjusted. Engine firing order is 1-5-3-6-2-4, and if this sequency is followed, the lash for all valves can be checked and adjusted in 2 complete revolutions of the crankshaft. Check valve clearance periodically. When adjustment is necessary, proceed as follows to obtain specified clearance:

a. Operate the engine until it reaches 160°F minimum. Stop the engine.

b. Thoroughly clean the valve rocker covers and surrounding area.

c. Remove upper section of breather tube, valve rocker cover nuts, sealing washers, and rocker covers.

d. Crank engine until exhaust valve for Number 6 cylinder is almost closed and intake valve starts to open then check and adjust intake and exhaust valve lash for Number 1 cylinder.

e. Use a 0.018" feeler gauge and check clearance between valve stems and rocker arms. Gauge should pass between rocker arm and corresponding valve stem with a slight drag when valve lash is properly adjusted.

f. Adjust each valve by loosening the locknut on the adjusting screw and turning the screw clockwise to decrease the clearance or counterclockwise to increase the clearance as necessary. When the proper clearance is obtained, hold the rocker arm adjusting screw stationary and tighten the locknut. Recheck the lash to make certain the clearance did not change when the locknut was tightened.

g. Crank engine until Number 2 cylinder exhaust valve is almost closed and intake valve starts to open, then adjust lash for intake and exhaust valves for Number 5 cylinder, following procedure in preceding Steps e and f.

h. Crank engine until Number 4 cylinder exhaust valve is almost closed and intake valve starts to open, then adjust lash for intake and exhaust valves for Number 3 cylinder, following procedure in preceding Steps e and f.

i. Crank engine until Number 1 cylinder exhaust valve is almost closed and intake valve starts to open, then adjust lash for intake and exhaust valves for Number 6 cylinder, following procedure in preceding Steps e and f.

j. Crank engine until Number 5 cylinder exhaust valve is almost closed and intake valve starts to open, then adjust lash for intake and exhaust valves for Number 2 cylinder, following procedure in preceding Steps e and f.

k. Crank engine until Number 3 cylinder exhaust valve is almost closed and intake valve starts to open, then adjust lash for intake and exhaust valves for Number 4 cylinder, following procedure in preceding Steps e and f.

150. TORQUING CYLINDER HEADS (Figure 4-26)

If the cylinder heads are removed for any reason, the cylinder head stud nuts must be tightened evenly following the numerical sequence illustrated in Figure 7-23. The specified torque for the 5/8" nuts is 180-to 185-lb-ft and 95-to 195-lb-ft for the ½" nuts with lubricated threads. To prevent oil leakage Nylok inserted nuts are used in positions 9, 12, 25 and 27 illustrated in Figure 7-23. Adjust valve lash after each retorquing. New cylinder head gaskets must be used when installing the cylinder heads. Make certain the gaskets are installed with the indicated side down as stamped on the gaskets. Follow instructions packaged with service cylinder head gaskets. Do not use any sealer or gasket dope.

151. INSTALLING CYLINDER HEADS

Install the cylinder heads and tighten the stud nuts as follows:

a. Align cylinder head afr intake manifold surfaces.

b. Tighten stud nuts in numerical sequence to ½ specified torque.

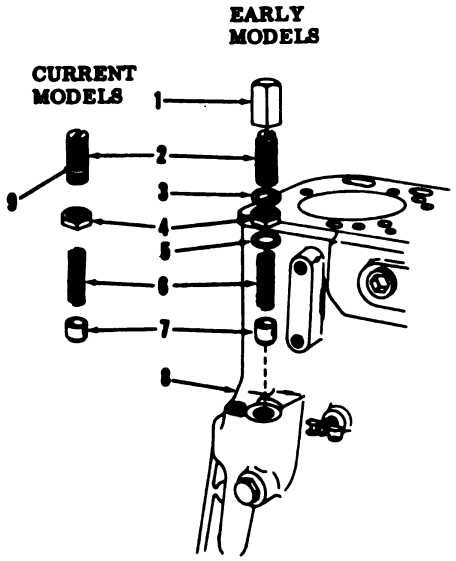
c. Tighten stud nuts in numerical sequence to full specified torque.

d. Again tighten stud nuts in numerical sequence to full specified torque.

e. Run engine until coolant temperature reaches minimum of 160°F and again tighten the stud nuts to full specified torque.

f. Adjust valve lash (refer to Paragraph 149.)

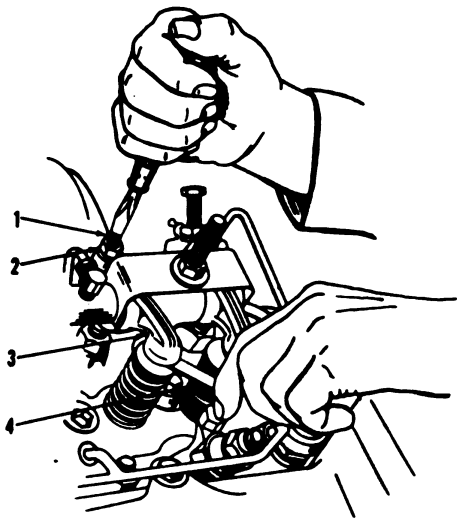
NOTE: The valve rocker cover nuts are Nylok inserted nuts and must be tightened to 20-25 lb-ft torque when the rocker covers are installed.



HT-52309

1. Cap Nut
2. Screw
3. Cap Nut Gasket
4. Jam Nut
5. Jam Nut Gasket
6. Spring
7. Piston
8. Cylinder Block
9. Nylon Pellet

FIGURE 7-21 OIL PRESSURE VALVE



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1. Adjusting Screw
2. Locknut
3. Rocker Arm
4. Feeler Gauge

FIGURE 7-22 VALVE LASH ADJUSTMENT

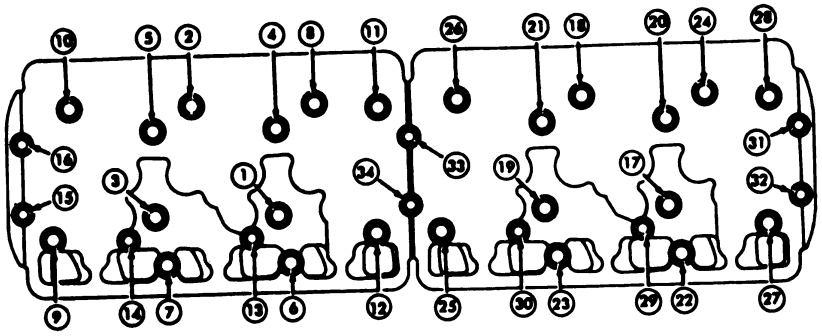

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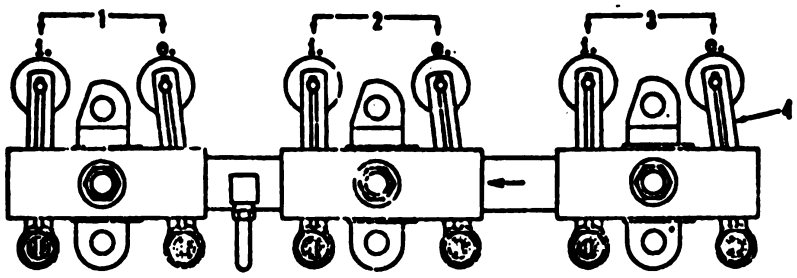
FIGURE 7-23 TORQUING SEQUENCE



MT-50338

1. No. 1 Cylinder
   i. Intake Valve
   e. Exhaust Valve
2. No. 2 Cylinder
   i. Intake Valve
   e. Exhaust Valve
3. No. 3 Cylinder
   i. Intake Valve
   e. Exhaust Valve
4. Rocker Arm

FIGURE 7-24 ROCKER AND VALVE LOCATION

Section VII - Air Cleaner

152. GENERAL

The purpose of the air cleaner is to remove dust and other foreign matter from the air used by the engine. The amount of servicing required and frequency of element change is completely dependent upon the abrasives (dirt in the air surrounding the engine).

A cartridge renewal period should be determined by daily inspection of the air cleaner under actual operating conditions, until the period can be established.

Periodic inspection of air cleaner body for dents, cracks, etc., should be made. Also check for damaged hoses, loose hose clamps, damaged gaskets, or any kind of leak that allows air to enter engine without first passing through the air cleaner. If any of the above conditions exist, immediate corrective action must be taken.

NOTE: Always refer to instructions on the air cleaner.

153. SERVICE

a. DONALDSON Dry Type Air Cleaner (Figure 7-25)

(1) Loosen wing nuts and clamps on air cleaner housing (Fig. 7-25), Illustration E to remove dust cup.

(2) Inspect inside of housing and remove all foreign material.

CAUTION: Inspect new cartridge for shipping damage before installation.

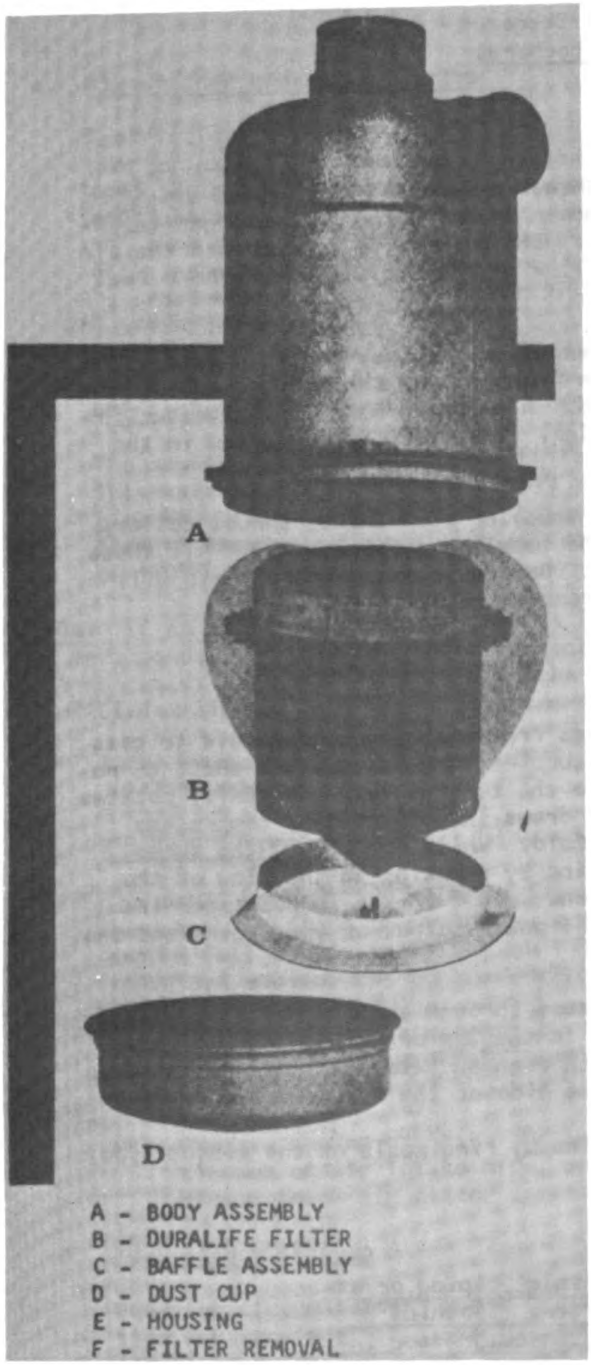
(3) Empty dust cup daily or more often if required. Dust level should not be allowed to build up to less than one-half inch from slot in dust cup baffle.

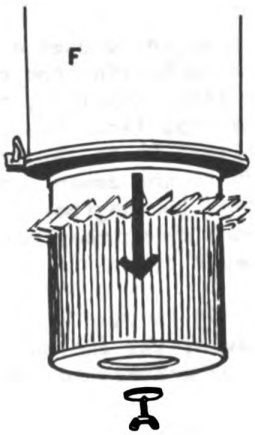
(4) Remove wing bolt and gasket washer and take out filter, as shown in Figure 7-25 , Illustration E.

(5) For minimum downtime, replace filter with a new or cleaned Dura-life element. If filter is to be cleaned for immediate re-use, follow direction on filter.

(6) Inspect filter gasket for damage and replace filter if necessary.

(7) For horizontal mounting, rotate cup to proper position as shown by arrows on bottom of cup.





AIR CLEANER

FIGURE 7-25

Section VIII - Turbocharger

154. GENERAL

The turbocharger used is an oil cooled exhaust driven blower (Figure 7-26). The power to drive the turbocharger is extracted from energy in the exhaust system. Its purpose is to increase the air supply to the engine cylinders, thereby allowing the engine to burn more fuel and produce more power.

The turbocharger consists of a radial inward flow turbine, center housing, and compressor. The turbine is located at the front end of the center housing assembly and the compressor at the rear end. A shaft integral with the turbine impeller also drives the compressor inpeller. The shaft is supported in the bearing housing by sleeve type bearings.

The rotating parts consist of the turbine impeller with shaft, thrust collar, thrust spacer, compressor impeller, and the impeller retaining nut. All these parts are individually precision balanced. Damage to one or more parts will not cause the replacement of any other undamaged rotating parts.

155. OPERATION

Operation of the engine causes exhaust gases from the exhaust manifold to pass through the turbine housing and cause the turbine impeller and the shaft to rotate. The compressor impeller, attached to the turbine impeller shaft, rotates with the turbine impeller. The compressor draws in ambient air, compresses the air and delivers it to the intake manifold. While operating, the turbocharger responds to the demands of the engine by reacting to the flow of the exhaust gases from the engine. The speed and output of the turbocharger increases in proportion to the increase of the power output of the engine and the flow of the exhaust gases.

Filtered engine oil is supplied under pressure through an external line extending from the head of the engine oil filter to the top of the center housing. The oil returns by gravity to the oil pan through an external line that extends from the bottom of the center housing to the side of the cylinder block.

Oil is sealed from the compressor and turbine by ring seals of the piston type, located at each end of the center housing.

WARNING:

Never operate the engine with air inlet piping or exhaust elbow removed from turbocharger. Clothing or foreign objects can be drawn into the compressor inlet. Discharged carbon particles and hot gases from the turbine outlet can cause injury to personnel.

156. MAINTENANCE

Each time the engine lubricating oil and filter elements are replaced, or any routine service operation is performed, inspect the turbocharger as follows:

a. Air Cleaner and Intake System

Restriction in the air intake system will cause malfunction of the turbocharger as well as the engine. The restriction (vacuum) should never exceed 30 inches of water at the turbocharger air inlet at engine full speed and full load.

(1) Inspect the hose connections, air cleaner-to-turbocharger inlet tubing, gaskets or loose clamps for air leaks.

(2) Inspect for restrictions due to dented tubing or collapsed hoses.

b. Lubrication System

The engine lubricating oil and filter elements must be replaced at specified intervals to assure a clean supply of oil to the turbocharger. Loss of engine oil pressure can quickly damage or destroy a turbocharger. Minimum oil flow to the turbocharger with engine running is 10 psi with oil temperature of 180°F.

CAUTION: If an engine has been in storage for several months without being operated, it is recommended that the oil inlet connection at the turbocharger be removed and 3 to 4 ounces of lubricant be placed in the oil inlet of the center housing. Also, fill oil inlet line with oil. Perform the above BEFORE operating engine.

(1) Inspect oil inlet lines, drain lines, and fittings for leakage, clogging, or other damage.

c. Exhaust System

The total restriction of the exhaust system must not exceed one inch of mercury back pressure at the turbocharger turbine housing exhaust outlet at engine full speed and full load. Excessive back pressure will reduce turbine speed and subject the turbine to excessive temperatures.

(1) Inspect for exhaust leaks due to damaged gaskets, cracks in exhaust manifold, loose manifold mounting, or loose turbocharger-to-manifold mounting.

(2) Observe engine exhaust. Excessive smoke may indicate a restricted air cleaner or air intake pipe, over-fueling, or faulty turbocharger operation. Check air filter service indicator.

d. Fuel Injection Pump

Under no circumstances should the maximum fuel delivery specification for the injection pump be exceeded in order to increase power. The resulting turbocharger and engine damage will be costly and off-set any benefits that might have been derived from increasing engine power.

e. Engine Breather System

A clogged engine breather will cause a pressure build-up in the engine. This pressure will prevent the oil from draining down the oil return line and will force oil out the low pressure side of the turbocharger and into the engine air intake system.

(1) Check the engine crankcase breather to assure air-flow is not restricted.

f. Operating Checks

(1) Operate the engine at approximately rated output and listen for unusual turbocharger noises. (Do not confuse the whine heard during run-down with one which indicates an impeller shaft bearing failure during operation). Other unusual noises can result from improper clearance between the turbine impeller and the turbine housing. If such noises are heard, the turbocharger assembly must be removed, disassembled, and inspected.

157. SERVICE

After each 500 hours of service or less, depending on operating conditions, visually inspect for an accumulation of dirt on the compressor impeller vanes and in the compressor housing.

If the coating of dirt is light and even, cleaning the compressor impeller is not necessary. An uneven build-up of dirt will disturb the balance of the rotating parts and lead to failure of the turbocharger. If the coating of dirt is uneven, excessive or approaching the appearance of a layer which might flake-off, cleaning is necessary. An excessive build-up of dirt in the diffuser will result in loss of turbocharger efficiency and is recognized by excessive exhaust smoke.

The 500 hour inspection and cleaning operation can be performed without removing the turbocharger from the engine.

CAUTION: DO NOT BEND THE BLADES OF THE IMPELLER. The delicate construction and precision balance may be upset during this cleaning and inspection operation unless extreme care is exercised.

a. 500 Hours

To perform the inspection and cleaning operation, proceed as follows:

(1) Clean the turbocharger and surrounding area with a non-caustic cleaner.

(2) Remove the air cleaner-to-turbocharger compressor housing air inlet piping.

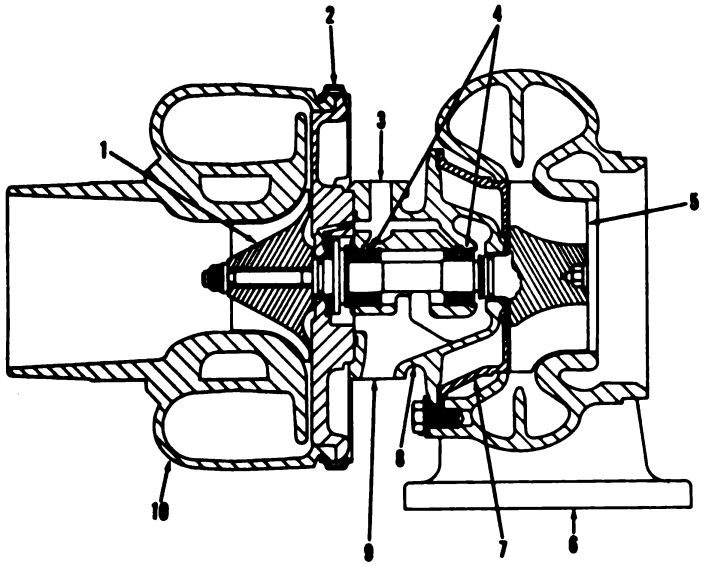
(3) Remove the hose connection between the compressor housing air outlet and intake manifold elbow.

(4) Remove the V-clamp securing the compressor housing to the turbocharger center housing. If necessary, tap compressor housing with a soft hammer to jar it loose from the center housing.

(5) Use a non-caustic cleaning solution, soft bristle brush, a plastic or wood blade scraper to remove dirt from the compressor impeller and the compressor housing.

CAUTION: A poor cleaning job which leaves deposits on the compressor impeller is as destructive as an uneven layer of dirt. If the layer of dirt on the compressor impeller or in the compressor housing is hard and has to be softened for removal by soaking in a cleaning solution, the turbocharger must be removed from the engine.

f. Install the compressor housing to the center housing and complete the rest of the installation by a direct reversal of the removal procedure.



MT-80348

1. Compressor Impeller
2. V-Clamp
3. Oil Inlet
4. Impeller Shaft Bearings
5. Turbine Impeller
6. Turbine Housing
7. Turbine Impeller Shroud
8. Center Housing
9. Oil Outlet
10. Compressor Housing

TURBOCHARGER
FIGURE 7-26

158. ENGINE SHOWS LOSS OF POWER

Compression pressure for a normal engine at normal operating temperature firing on five cylinders at 600 rpm and at sea level conditions is 445 psi.

When checking compression pressure, altitude at which engine is located must be taken into consideration for an accurate evaluation of test, because the density of air decreases as altitude increases. For each 1,000 feet of altitude above sea level the specified sea level figure of 445 psi must be derated 3%.

It is common practice to consider a differential of 25 psi between one or more cylinders as an indication of possible trouble. This is not always true. Pressure readings taken at 600 rpm are not always representative of what is happening within the engine at 1800 or 2000 rpm, under load. If a spread between cylinders of 25 psi or more at 600 rpm is noted and there is no evidence of excessive oil consumption, intake or exhaust valve blow-by into the manifolds, or loss of engine power, it is safe to continue to operate the engine. However, if any of the above conditions exist, or a difference of 50 psi or more is noted between cylinders, the cylinder head should be removed and a detailed inspection made of cylinder head, valves, pistons, rings, and cylinder sleeves and necessary repairs should be made to eliminate cause of the low compression pressure.

NOTE: When using a compression tester, make certain gauge has been properly tested so an accurate pressure reading can be obtained. In no case should an engine be rebuilt because of low compression readings unless gauge is known to be accurate.

To check compression pressure, proceed as follows:

a. Start engine and allow to warm up to a minimum temperature of 160°F.

b. Shut off engine.

c. Start with No. 1 cylinder when checking the compression. Remove the fuel injection nozzle and install the compression tester adapter in the same manner as the fuel injection nozzle was installed. Install the compression tester hose and gauge assembly.

NOTE: To prevent spillage of fuel over the engine while making a compression test, it is recommended to remove the drip manifold. Also disconnect manifold to filter head return line from filter head and replace elbow on filter head with a ¼" pipe plug. Then install one end of a rubber hose over the disconnected fuel injection line of the cylinder being tested and run the other end of the hose into a container to receive the fuel that pumped through the injection line.

d. Start engine, run at approximately 600 rpm and take several readings on gauge.

NOTE: Do not check compression by cranking engine with starter.

e. Remove tester assembly, install nozzle holder, connect fuel injection line and fuel return line.

f. Repeat operation on each of remaining cylinders.

159. ENGINE DETONATES

If a hard metallic knock indicates detonation in one or more cylinders, the engine must be stopped immediately to prevent serious damage due to the excessive pressures accompanying the detonation. Detonation is caused by the presence of fuel or lubricating oil in the charge of air that has been delivered to the cylinder during the compression stroke.

Check for leaky fuel injection nozzles or improper timing of the fuel injection pump.

CHAPTER 8

MAINTENANCE ILLUSTRATIONS

DESCRIPTION	QTY.	ILLUSTRATION INDEX FIGURE	ITEM
Diesel Engine	1	8-1	1
Block-Cylinder Ass'y	1	8-2	1
Plug Expansion	1	8-2	1A
Plug Expansion	1	8-2	1B
Cock Drain	2	8-2	1C
Bearing, Camshaft	1	8-2	2
Bearing, Camshaft	2	8-2	3
Plate, Lower	1	8-2	7
O-Ring	2	8-2	8
Plate, Upper	1	8-2	9
Bearing	1	8-2	15
Cap, Rear, Main	1	8-2	25
Sleeve, Cylinder	6	8-2	10
Ring, Packing	12	8-2	12
O-Ring	1	8-2	16
Piston Oil Pressure Valve	1	8-2	19
Spring Oil Pressure	1	8-2	20
Gasket	2	8-2	21
Cover Valve Lifter Rear	1	8-3	10
Strainer Oil Filler	1	8-3	2
Cover Valve Lifter Front	1	8-3	8
Gasket Valve Lifter Cover	2	8-3	9
Filler Oil Right Hand Side	1	8-3	13
Gasket Oil Filler	1	8-3	14
Crankshaft Ass'y	1	8-4	1
Gear Crankshaft	1	8-4	3
Pulley	1	8-4	6
Bearing, Front & Intermed Main	10	8-4	14
Bearing, Center	2	8-4	15
Flange Thrust Ctr., Main Upper	2	8-4	16
Flange Thrust Ctr. Main Lower	2	8-4	17
Bearing, Rear Main	2	8-4	19
Pulley	1	4-13	Picture
Piston	6	8-5	1
Pin Piston	6	8-5	2
Retainer Piston Pin	12	8-5	3
Ring Set Compression	12	8-5	5
Rod Assembly, Connection	6	8-5	7
Bushing Connecting Rod	6	8-5	8
Bearing Connecting Rod	12	8-5	11
Flywheel Ass'y	1	8-6	1
Gear Ring	1	8-6	2
Seal Oil, Rear Crankshaft	1	8-6	4
Cover Timing Hose	1	8-6	8
O-Ring Seal	1	8-6	10
Housing, Flywheel	1	8-6	19
Cover Starter Pad	1	8-6	24

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Cover Ass'y Timing Gear	1	8-7	1
Gasket Timing Cover	1	8-7	2
Housing Timing Gear	1	8-7	3
Gasket Cover	1	8-7	4
Cover Plate Oil Filler	1	8-7	5
Gasket Timing Gear Housing	1	8-7	6
Cover Hydraulic Pump Hose	1	8-7	8
Gasket Cover	1	8-7	9
Seal Oil Crankshaft	1	8-7	12
Gasket Cover	1	8-7	14
Cover Tach, Hole	1	8-7	15
Bracket Support Engine Front	1	8-7	17
Liner Bracket	2	8-7	18
Cover Sux. Drive Hole	1	8-7	21
O-Ring Cover	1	8-7	22
Cylinder Head Assembly	2	8-8	1
Sleeve Inject Nozzle	6	8-8	2
Guide Valve Stem	12	8-8	3
Spring Exhaust Valve	6	8-8	4
Retainer Exhaust Valve Spring	6	8-8	5
Lock Valve Spring Retainer	24	8-8	6
Tube Train Breather	1	8-8	7
Tube Breather Engine	1	8-8	10
Elbow Breather	1	8-8	11
Washer Sealing Cover Nut	6	8-8	13
Cover Rocker	2	8-8	14
Gasket Rocker Cover	2	8-8	15
Retainer Intake Valve Spring	6	8-8	16
Spring Intake Valve (Outer)	6	8-8	17
Spring Intake Valve (Inner)	6	8-8	18
Plate End	2	8-8	26
Stud Cylinder Head	2	8-8	27
Stud Cylinder Head	4	8-8	28
Stud Cylinder Head	24	8-8	29
Gasket Ass'y Cyl. Head (Front)	1	8-8	30
Gasket Ass'y Cyl. Head (Rear)	1	8-8	30
Valve Intake	6	8-8	31
Insert	6	8-8	32
Insert	6	8-8	33
Valve Exhaust	6	8-8	34
Gasket Fire Ring	6	8-8	36
Rocker Cover	1	8-8	37
Closure Ass'y	1	8-8	39
Camshaft	1	8-9	1
Collar Camshaft Thrust	1	8-9	2
Gear Camshaft	1	8-9	4
Lifter Valve	12	8-9	6
Bracket Valve Lifter	2	8-9	7
Rod Push	12	8-9	10
Bracket	4	8-9	12
Arm Assembly	6	8-9	13

DESCRIPTION	QTY.	ILLUSTRATION INDEX FIGURE	ITEM
Arm Assembly	6	8-9	14
Bushing Rocker Arm	12	8-9	17
Tube Assembly	2	8-9	24
Elbow	2	8-9	24
Nut	1	8-9	24
Shaft Assembly	2	8-9	25
Ring	4	8-9	26
Oil Pan	1	8-10	1
Gasket Set	1	8-10	2
Gauge	1	8-10	3
Seal	1	8-10	4
Adaptor	1	8-10	5
Pump Ass'y Oil Pump	1	8-11	1
Gear	1	8-11	4
Shaft	1	8-11	5
Bushing Pump Cover	1	8-11	6
Cover Assembly	1	8-11	7
Gear, Upper	1	8-11	10
Shaft, Lower	1	8-11	11
Gear Ass'y Lower	1	8-11	12
Bushing	1	8-11	13
Housing Ass'y	1	8-11	14
Bushing	1	8-11	15
Retainer Lower Shaft	1	8-11	16
Valve Ass'y	1	8-11	17
Spring	1	8-11	20
Oil Filter Ass'y	1	8-12	1
Cap	1	8-13	1
Gasket	1	8-13	2
Spring	1	8-13	3
Piston	1	8-13	4
Sleeve	1	8-13	5
Seat	1	8-13	6
Head Assembly	1	8-13	7
Adaptor	1	8-13	8
Element Kit	1	8-13	9
Gasket	1	8-13	10
Bolt	1	8-13	11
Gasket	1	8-13	12
Body	1	8-13	13
Spring	1	8-13	15
Seal	1	8-13	17
Adaptor	1	8-13	18
Can Ass'y	1	8-13	20
O-Ring	1	8-12	2
Hose Assembly	1	8-12	3
Gasket	3	8-12	4
Hose Ass'y	1	8-12	5
Gasket	1	8-12	6
Intake Manifold	1	8-14	1
Gasket	6	8-14	3
Manifold Exhaust, Front	1	8-15	1
Manifold	1	8-15	2
Gasket	6	8-15	6

DESCRIPTION	QTY.	ILLUSTRATION INDEX FIGURE	ITEM
Turbocharger Assembly	1	8-16	6
Housing Assembly	1	8-17	1
Coupling	1	8-17	2
Impeller	1	8-17	3
Ring	1	8-17	5
Spacer	1	8-17	6
Plate Assembly	1	8-17	7
Ring	1	8-17	8
Collar	1	8-17	9
Bearing	1	8-17	10
Bearing	2	8-17	11
Ring	3	8-17	12
Housing Ass'y	1	8-17	13
Shroud	1	8-17	14
Wheel	1	8-17	20
Housing Turbine	1	8-17	21
Elbow	1	8-16	1
Lockplate	4	8-17	15
Plate	3	8-17	19
Hose	1	8-16	3
Gasket	1	8-16	5
Tube Assembly	1	8-16	7
Elbow	1	8-16	7
Sleeve	1	8-16	7
Support	1	8-16	8
Gasket	1	8-16	10
Tube Assembly	1	8-16	11
Adaptor	1	8-16	14
Flange	1	8-16	16
Gasket	1	8-16	17
Gasket	1	8-16	19
Adaptor	1	8-16	20
Gasket	1	8-16	21
Gasket	2	8-16	22
Spacer	1	8-16	23
Diffuser	1	8-18	1
Ring	1	8-18	2
Gasket	1	8-18	3
Elbow	1	8-18	5
Gasket	1	8-18	6
Flange	1	8-18	7
Pump Assembly	1	8-19	1
Seal	1	8-19	4
Cover	1	8-19	5
O-Ring	1	8-19	6
Gear	1	8-19	7
Element Fuel Filter	2	8-20	1
O-Ring	2	8-20	2
Base Assembly	2	8-20	3
Tube Assembly	1	8-20	4
Sleeve	2	8-20	4

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Elbow	1	8-20	4
Tube Assembly	1	8-20	5
Sleeve	2	8-20	5
Elbow	1	8-20	5
Bracket	1	8-21	4
Tube Assembly Drip Manifold Front	1	8-22	1
Sleeve	4	8-22	1
Connector	3	8-22	1
Tube Assembly Drip Manifold Rear	1	8-22	2
Sleeve	4	8-22	2
Connector	3	8-22	2
Tube Assembly	1	8-22	3
Sleeve	2	8-22	3
Tube Assembly	1	8-22	4
Sleeve	2	8-22	4
Connector	1	8-22	4
Tee	1	8-22	4
Hose Assembly	1	8-22	5
Connector	1	8-22	5
Elbow	1	8-22	5
Tube Ass'y Fuel Inj. #1 Cylinder	1	8-23	1
Tube Ass'y Fuel Inj. #2 Cylinder	1	8-23	3
Tube Ass'y Fuel Inj. #3 Cylinder	1	8-23	4
Tube Ass'y Fuel Inj. #4 Cylinder	1	8-23	5
Tube Ass'y Fuel Inj. #5 Cylinder	1	8-23	6
Tube Ass'y Fuel Inj. #6 Cylinder	1	8-23	7
Holder Ass'y Inj. Nozzle	6	8-23	8
Shield Dust	12	8-23	10
Gasket	2	8-24	2
Screw Adjusting	1	8-24	4
Spring	1	8-24	5
Rod Spindle	1	8-24	6
Pin	2	8-24	8
Nozzle Assembly	1	8-24	9
Nut Retaining	1	8-24	10
Gasket	1	8-24	11
Pump Assembly Hand Primer	1	8-21	1
Connector	1	8-21	1
Tube Assembly	1	8-21	2
Sleeve	2	8-21	2
Connector	1	8-21	2
Adaptor Pipe	1	8-21	2
Bracket	1	8-21	3
Pump Assembly Water Pump	1	8-25	1
Shaft Assembly	1	8-25	2
Flinger	1	8-25	3
Seal Assembly	1	8-25	4
Impeller Assembly	1	8-25	5
Body	1	8-25	8
Bearing, Ball	1	8-25	9
Spacer	1	8-25	10
Bearing, Ball	1	8-25	11

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Retainer	1	8-25	14
Flange	1	8-25	16
Pulley	1	8-25	20
Gasket	1	8-25	21
Gasket	1	8-25	22
Hose	1	8-25	23
Volute	1	8-25	25
Gasket	1	8-25	26
Manifold Water Outlet Rear	1	8-26	1
Gasket	4	8-26	2
Tube	1	8-26	3
O-Ring	4	8-26	4
Manifold	1	8-26	5
Housing Ass'y	1	8-26	6
Gasket	1	8-26	8
Seal	2	8-26	9
Thrmostat 180°	2	8-26	10
Hose	1	8-26	11
Pipe	1	8-26	12
Gasket	1	8-26	13
Gasket	1	8-26	14
Elbow	1	8-26	15
Cooler Lubricating Oil	1	8-27	1
Gasket	2	8-27	2
Connection	1	8-27	3
Gasket	1	8-27	4
Connection	1	8-27	5
Gasket	1	8-27	6
Radiator Assembly	1	4-16	Picture
Hose Top	1	4-16	Picture
Hose -Fillerneck	1	4-16	Picture
Hose -Bottom	1	4-16	Picture
Hose - Drain	1	4-16	Picture
Fan Guard	1	4-16	Picture
Hub Assembly	1	8-28	3
Belt	2	8-28	8
Spindle	1	8-28	11
Retainer	1	8-28	13
Gasket	1	8-28	16
Bearing, Ball	1	8-28	17
Spacer	1	8-28	18
Washer	1	8-28	19
Bearing, Ball	1	8-28	20
Hub	1	8-28	22
Fan	1	4-17	Picture
Bracket	1	8-28	7
Spacer	1	8-28	2
Bracket Mount Air Cleaner	1	4-6	Picture
Spacer	1	8-28	4
Cleaner Assembly	1	4-6	Picture
Band	2	4-6	Picture
Reducer	1	4-6	Picture
Element, Air Cleaner	1	7-25	8

DESCRIPTION	QTY.	ILLUSTRATION INDEX FIGURE	ITEM
Generator	1	4-2	Picture
Frame	1	8-32	1
Pin Dowel C. E.	1	8-32	44
Brush	2	8-32	2
Brush Arm	2	8-32	3
Brush Spring	1	8-32	4
Brush Holder	1	8-32	5
Brush Holder	1	8-32	6
Armature	1	8-32	7
Coil Field Assembly	2	8-32	8
Seal Oil Level Housing	1	8-29	5
Gasket Lever Housing Plug	1	8-29	68
Shift Lever	1	8-29	9
O-Ring Shift Lever	1	8-29	78
Clip Terminal	1	8-32	20
Shoe Pole	2	8-32	9
Insulator Field	1	8-32	21
Plate Retainer	1	8-32	19
Bushing, Insulated	1	8-32	17
Ball Bearing	1	8-32	10
Frame DE	1	8-32	11
Thrubolt	2	8-32	22
Collar Space	1	8-32	12
Terminal Stud	1	8-32	15
Bushing	1	8-32	17
Stud Terminal	1	8-32	16
Washer Insulated	1	8-32	35
Fan Cooling	1	4-2	Picture
Pulley	1	4-2	Picture
Link Generator Adjust	1	4-2	Picture
Bracket Adj.	1	4-2	Picture
Belt	1	4-2	Picture
Pulley Gen.	1	4-2	Picture
Bracket Regulator	1	4-1	Picture
Regulator	1	4-1	Picture
Starter Cranking Motor	1	4-3	Picture
Frame CE	1	8-29	1
Bushing CE	1	8-30	59
Housing	1	4-3	Picture
Gasket Brush Cover Plate	2	8-29	65
Plate Brush	2	8-29	22
Shoe Pole	4	8-29	85
O-Ring Field Frame Seal CE	1	8-29	75
Plate Assembly	1	8-29	12
Plate and Stud	1	8-30	15
Insulator Brush Plate	1	8-30	14
Plate Support	1	8-30	13
Insulator Brush Holder	2	8-30	16
Plate Space Ins. Holder	2	8-30	17
Plate Space Grd. Holder	2	8-30	18
Brush Holder	4	8-30	21
Spring Brush	2	8-30	20
Brush	8	8-30	19

DESCRIPTION	QTY.	ILLUSTRATION INDEX FIGURE	ITEM
Bushing Ins. Terminal Stud	1	8-30	62
Insulator Terminal Stud	1	8-30	72
Lead CE Terminal to Stud	1	8-29	73
Armature	1	8-29	2
Field Coil	4	8-29	3
Stud Terminal	1	8-29	4
Bushing	1	8-29	63
Washer Field	2	8-29	51
Connector	1	8-29	64
Insulator Field Coil CE	1	8-29	70
Insulator Field Coil DE	1	8-29	71
O-Ring Field Frame Seal	1	8-29	75
Housing Lever	1	8-29	5
Bushing Lever Housing	1	8-29	61
Lever Shaft	1	8-29	10
O-Ring Shaft Lever	1	8-29	78
Snap Ring Lever Shaft Retaining	1	8-29	90
Gasket	1	8-29	67
Drive	1	8-29	6
Drive Housing	1	8-29	7
Bushing Drive Housing	1	8-29	60
Switch	1	8-29	8
Plunger	1	8-29	11
Boot Plunger	1	8-29	58
Retainer	1	8-29	87
Spring	1	8-29	91
Retainer	1	8-29	86
Snap	1	8-29	89
Adaptor Starter	1	8-31	2
Switch Fuel Pressure	1	4-1	Picture
Switch Oil Pressure	1	4-11	Picture
Switch High Temperature	1	4-25	Picture
Generator Assembly	1	4-6	Picture
Generator Frame	1	5-1	22
Lead Bushing	1	5-1	27
Cover Plate	1	5-1	25
End Shield & Ex. Wound Stator Assy	1	5-1	10
Cover	1	5-1	8
Gasket	1	5-1	9
Rotor Generator & Exciter Field	1	5-1	31
Bearing, Ball	1	5-1	4
Inner Cap	1	5-1	1
Gasket	1	5-1	2
Rectifier Surge & Load Assembly	1	5-1	32
Rectifier	3	5-1	32
Surge Protector	1	5-1	36
Adapter	1	5-1	40
Screen	1	5-1	16
Cover	1	5-1	8
Adapter SAE	1	5-1	45
Coupling	2	5-1	42
Coupling Hub	1	5-1	29

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Locking Plate	4	5-1	43
Control Cabinet Assembly	1	4-7	Picture
Panel Circuit Breaker	1	2-1	Picture
Circuit Breaker Assembly	1	2-1	Picture
Circuit Breaker	1	2-1	Picture
Link Panel Assembly	1	4-6	Picture
Interconnecting Link	6	2-4	1
Link Panel (Reconnection)	1	2-4	2
Stud	10	2-4	7
Stud	4	2-4	8
Stud Cadium Plate	4	2-4	9
Protective Bracket	1	4-6	5
Grommet	2	2-3	Picture
Load Panel	1	2-3	Picture
Load Lugs	4	2-3	Picture
Cross Current Transformer	3	2-3	Picture
Bracket Ct.	1	2-3	Picture
Transformer	1	2-3	Picture
Bracket Transformer	1	2-3	Picture
Ground Strap	1	2-3	Picture
Voltage Regulator	1	2-3	Picture
Watt Converter	1	2-3	Picture
Transducer, Frequency	1	2-3	Picture
Relay	2	2-3	Picture
Lower Panel Control Cabinet	1	2-1	Picture
Meter Time	1	2-1	Picture
Meter Oil Pressure	1	2-1	Picture
Meter Water Temperature	1	2-1	Picture
Nameplate	1	2-1	Picture
Voltmeter, D.C.	1	2-1	Picture
Switch, Start	1	2-1	Picture
Switch, Toggle (Fuel Primer)	1	2-1	Picture
Switch, Toggle	1	2-1	Picture
Switch Button	1	2-1	Picture
Drop Panel	1	2-1	Picture
Panel Light	1	2-1	Picture
Bulb	2	2-1	Picture
Shields	2	2-1	Picture
Switch Panel Lights	1	2-1	Picture
Nameplate	1	2-1	Picture

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Volmeter, A.C.	1	2-1	Picture
Wattmeter	1	2-1	Picture
Frequency Meter	1	2-1	Picture
Ammeter, A.C.	1	2-1	Picture
Selector Switch, Ammeter	1	2-1	Picture
Rheostat Volt Adjust	1	2-1	Picture
Knob Rheostat	1	2-1	Picture
Nameplate	1	2-1	Picture
Synchronizing Lights	2	2-1	Picture
Bulb	2	2-1	Picture
Nameplate	1	2-1	Picture
Parallel Switch	1	2-1	Picture
Nameplate	1	2-1	Picture
Base Weld Assembly	1	1-1	Picture
Ground Stud	1	4-7	Picture
Fuel Tank Assembly	1	4-4	Picture
Gauge Liquid Level	1	4-5	Picture
Roof Support Angle	2	4-15	Picture
Lower Side, Panels	4	1-1	1
Roof, Front	1	1-1	2
Grommet	1	1-1	3
Grommet	1	1-1	4
Radiator Filler Neck	1	4-9	Picture
Roof, Rear	1	1-2	5
Door, Left Rear	1	1-1	6
Hinge	2	1-1	7
Door, Right Front	1	1-1	8
Hinge	2	1-1	7
Door, Left Front Right Rear	2	1-1	8
Hinge	2	1-1	7
Door, Rear	1	1-1	9
Front Shroud	1	1-1	10
Rear Corner Post, L.H.	1	1-1	11
Lower Rear Door	1	1-1	12
Weather Stripping	8	4-4	Picture
Weather Stripping	8	4-4	Picture
Weather Stripping	3	4-4	Picture
Weather Stripping	1	4-4	Picture
Weather Stripping	1	4-4	Picture
Rear Corner Post, R.H.	1	1-1	13
Cross Member, Rear	1	1-1	14
Center Post	2	1-1	15
Frequency Control Motor Assy.	1	8-39	1
Drive Arm	1	8-39	2
D.C. Motor Governor Drive	1	8-39	3
Upper Bracket Throttle Control	1	8-39	4
Bracket	1	8-39	5
Yoke End	1	8-39	6
Terminal Block	1	8-39	7

DESCRIPTION	QTY.	ILLUSTRATION FIGURE	INDEX ITEM
Bracket Ether Primer	1	4-4	Picture
Ether Primer (Start Pilot)	1	4-4	Picture
Nameplate	1	4-4	Picture
Bracket 3-Way Vlave	2	2-3	Picture
3-Way Valve	2	2-3	Picture
Nameplate	1	2-3	Picture
Nameplate	1	2-3	Picture
Exhaust Pipe	1	1-1	Picture
Rain Cap	1	1-1	Picture
Fuel Pump Bracket	1	4-8	Picture
Fuel Pump	1	4-8	Picture
Radiator Brace, R.H.	1	4-15	Picture
Radiator Brace, L.H.	1	4-15	Picture
Line 1 Hose Assembly	1	2-5	1
Line 2 Hose Assembly	3	2-5	2
Line 7 Hose Assembly	1	2-5	7
Line 8 Hose Assembly	1	2-5	8
Line 9 Hose Assembly	1	2-5	9
Line 10 Hose Assembly	1	2-5	10
Overspeed Switch Assembly	1	4-6	Picture
Overspeed Switch	1	4-6	1
Microswitch Assembly	1	4-6	2
Overspeed Bracket	1	4-6	3
Cover	1	4-6	4

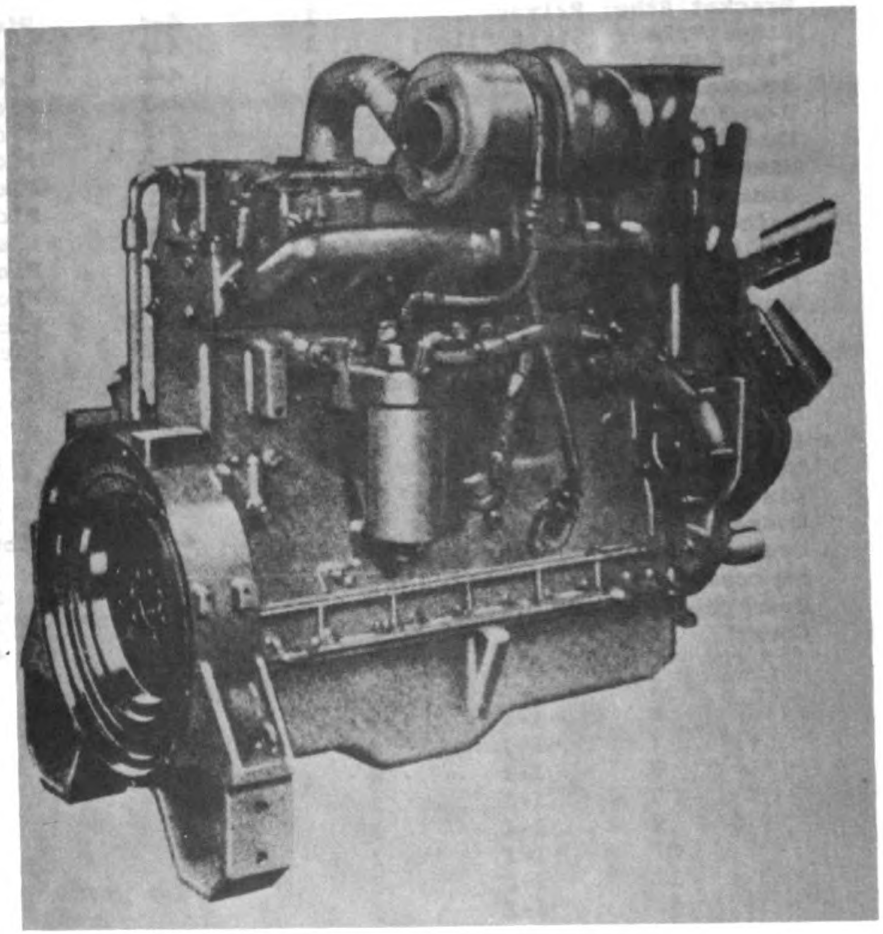


FIGURE 4-1 DIESEL ENGINE

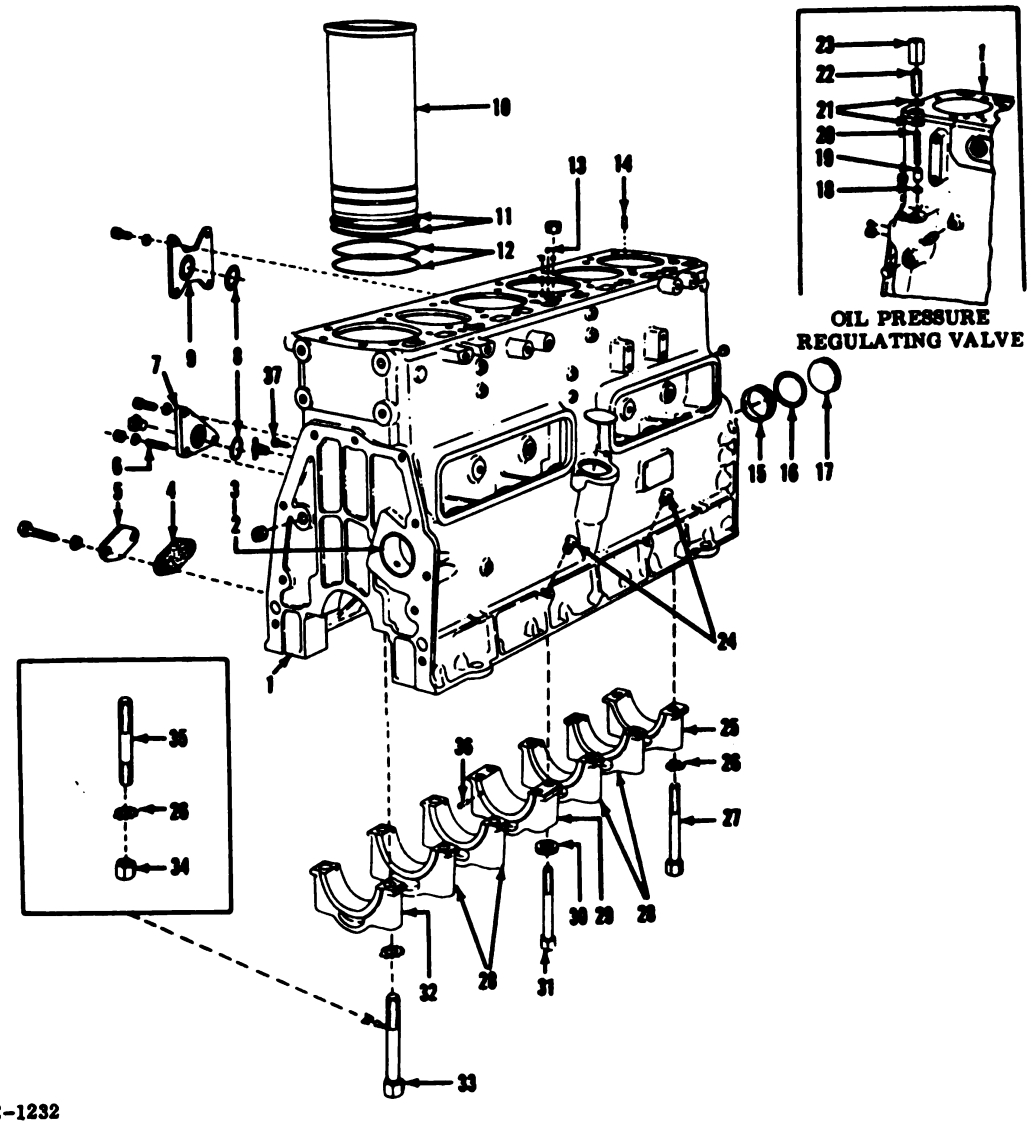
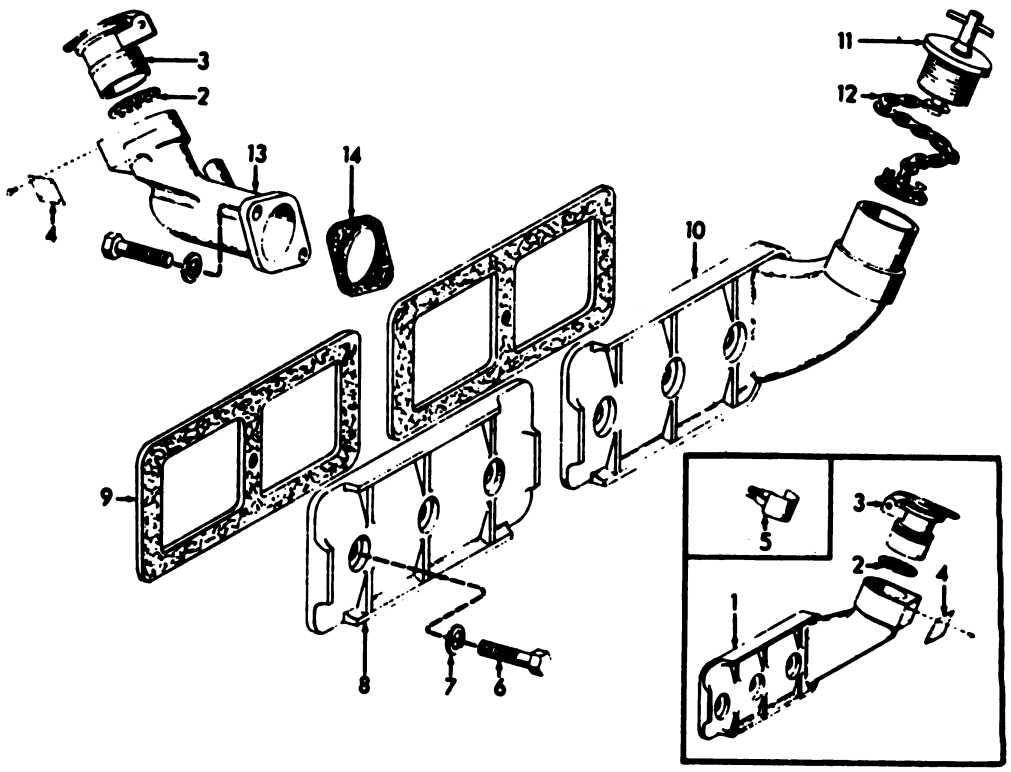


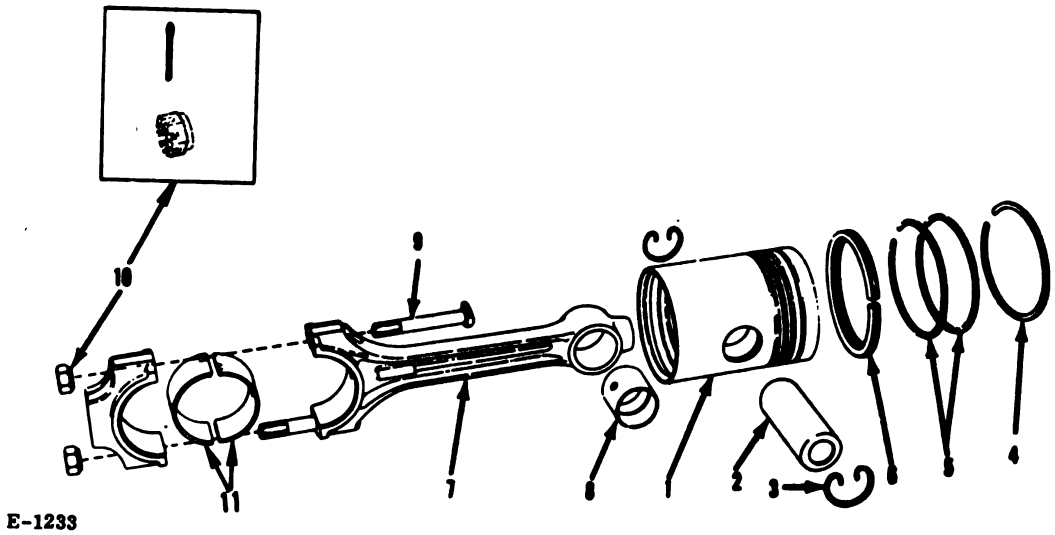
FIGURE 8-2 CYLINDER BLOCK



T-50739

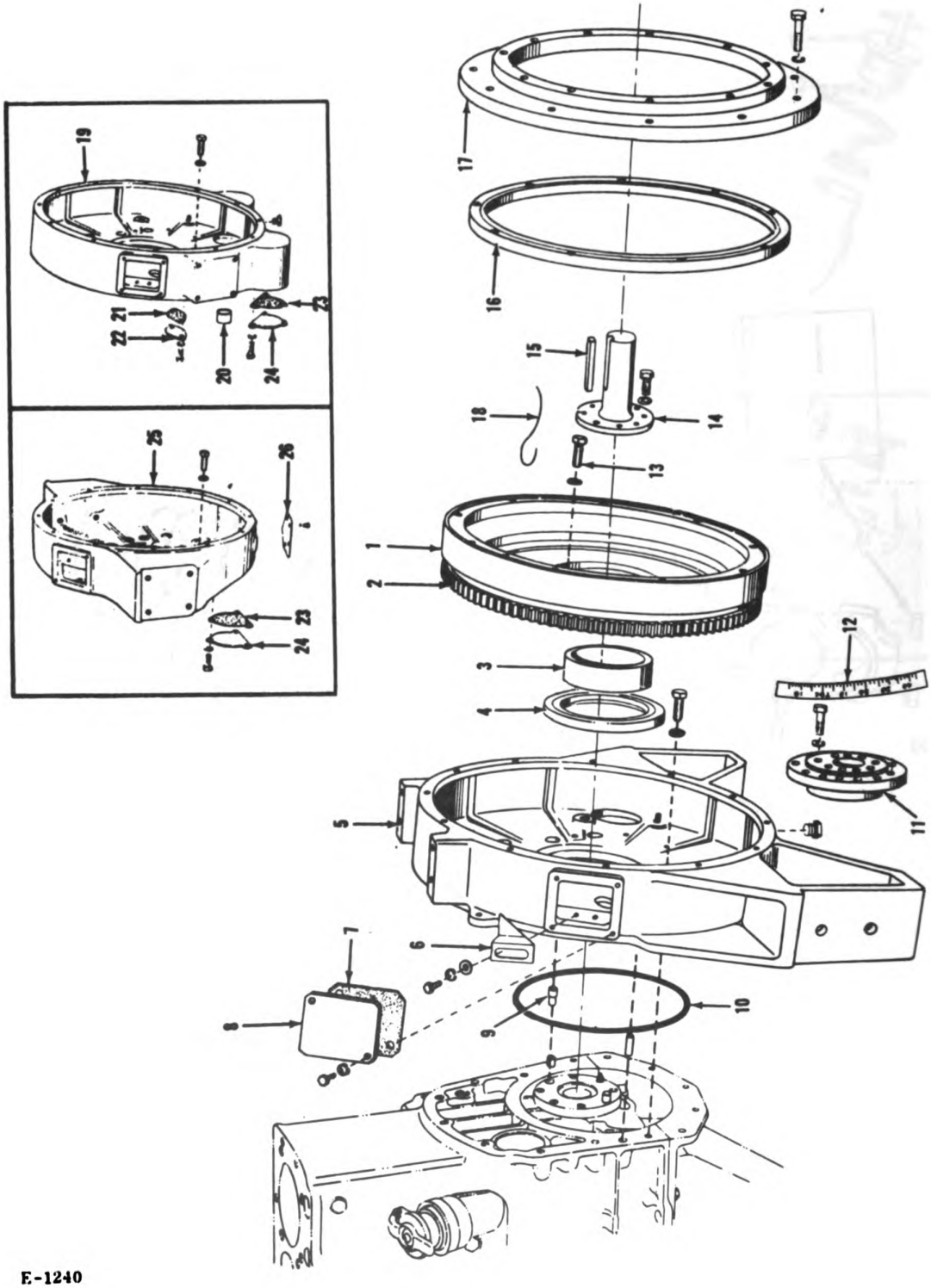
FIGURE 8-3 VALVE LIFTER COVER

FIGURE 8-4 CRANKSHAFT



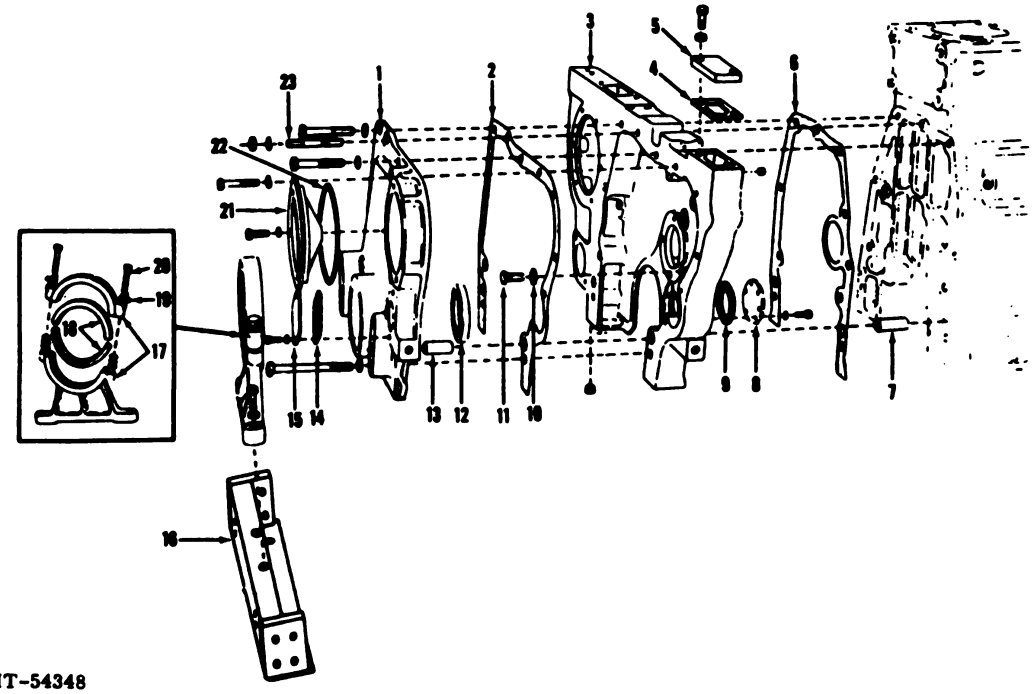
E-1233

FIGURE 8-5 PISTON AND CONNECTING ROD



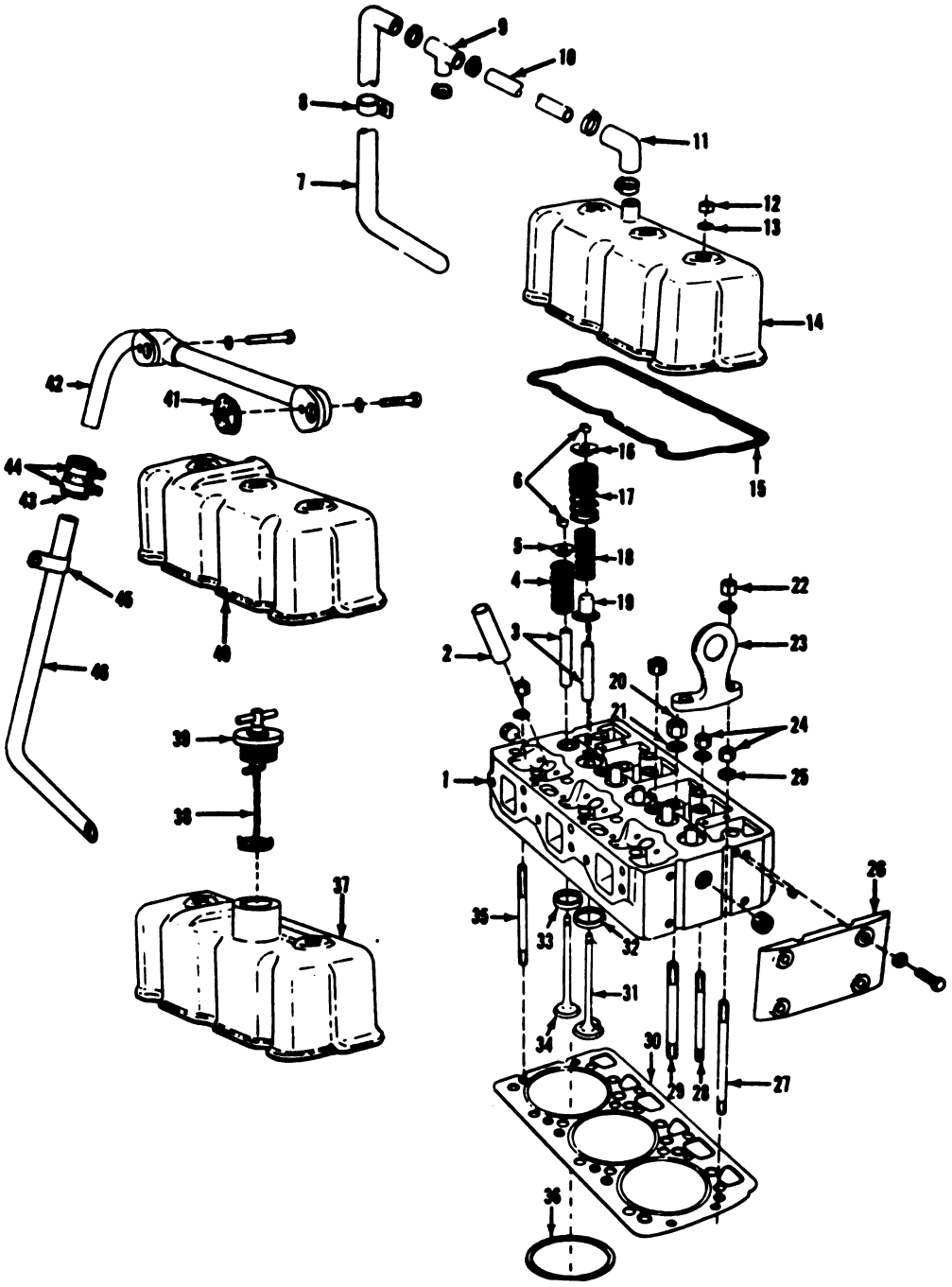
E-1240

FIGURE 8-6 FLYWHEEL AND HOUSING



HT-54348

FIGURE 8-7 TIMING GEAR HOUSING AND COVER



E-1355

FIGURE 8-8 CYLINDER HEAD

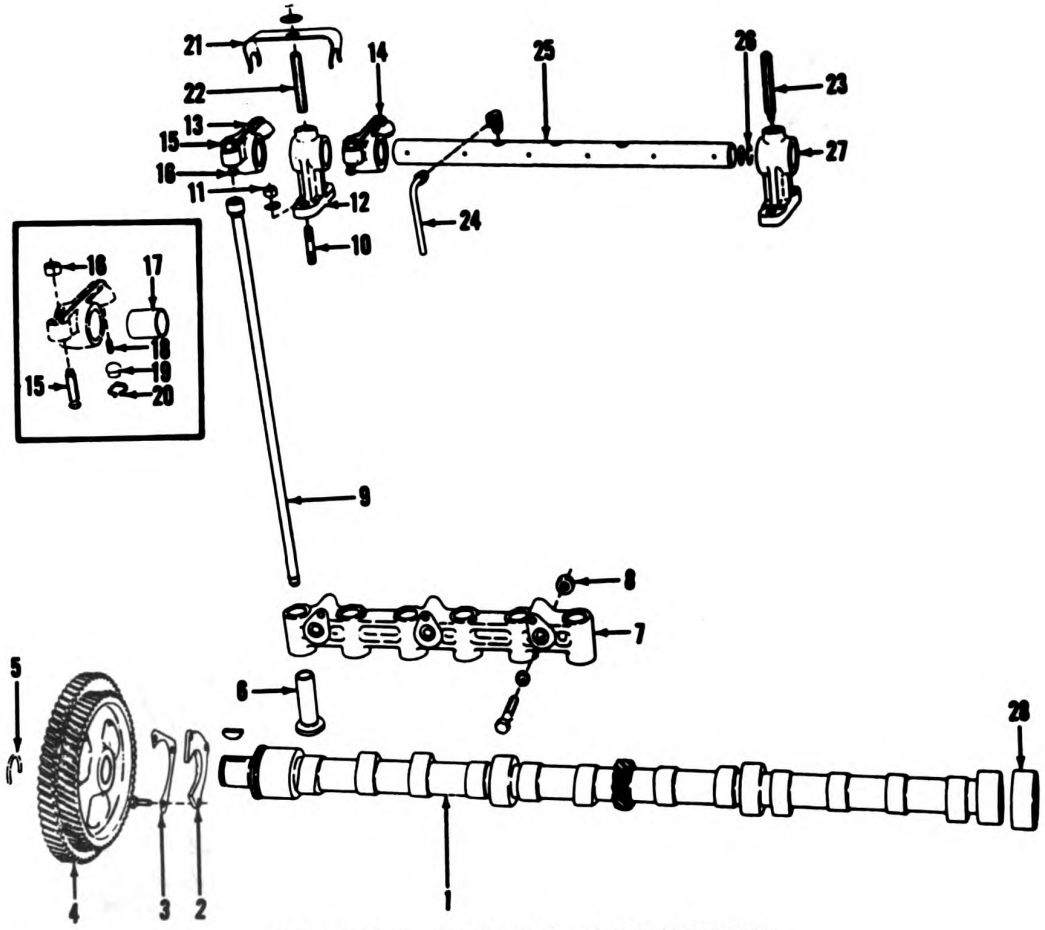


FIGURE 8-9 VALVE OPERATING MECHANISM

E-1359

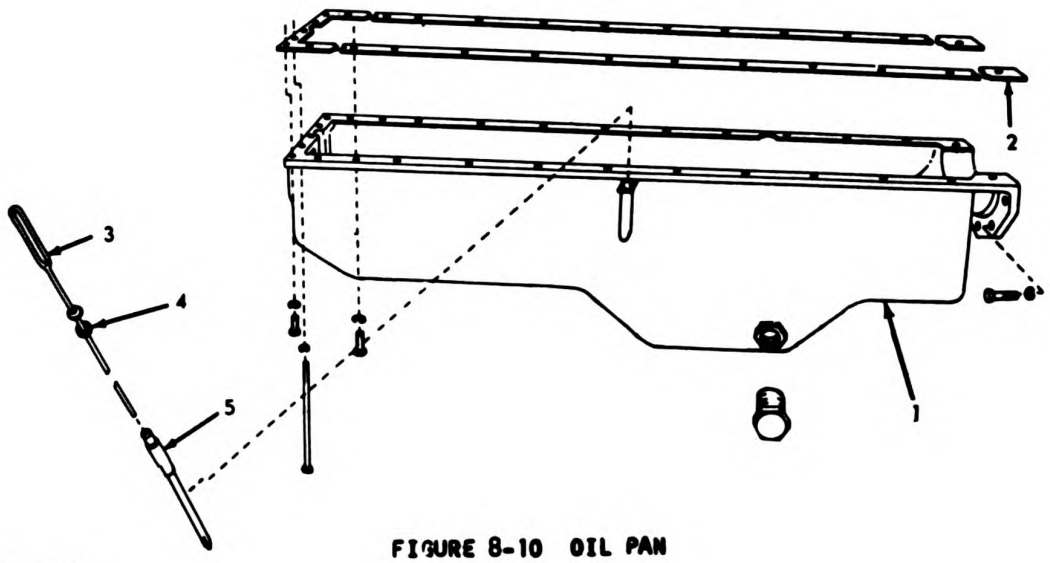
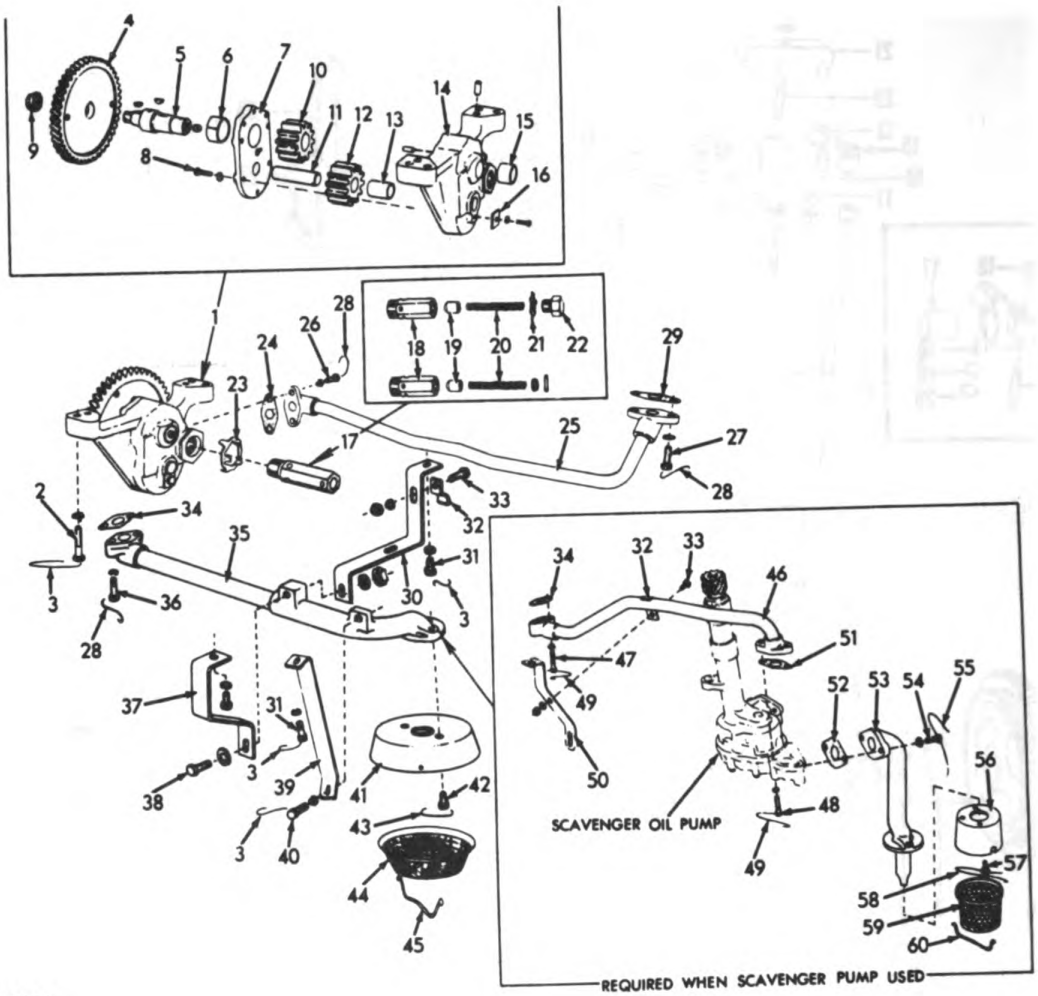


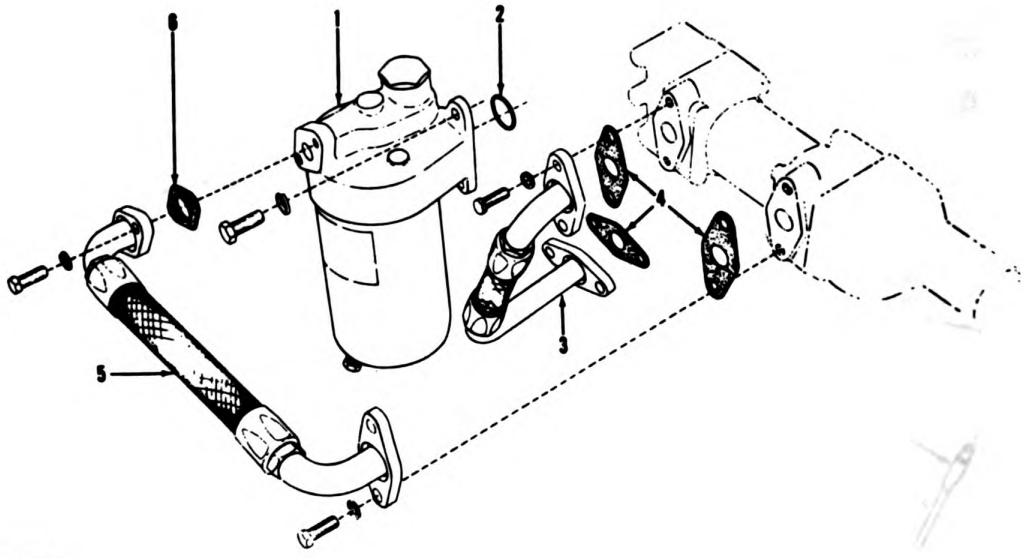
FIGURE 8-10 OIL PAN

T-29862



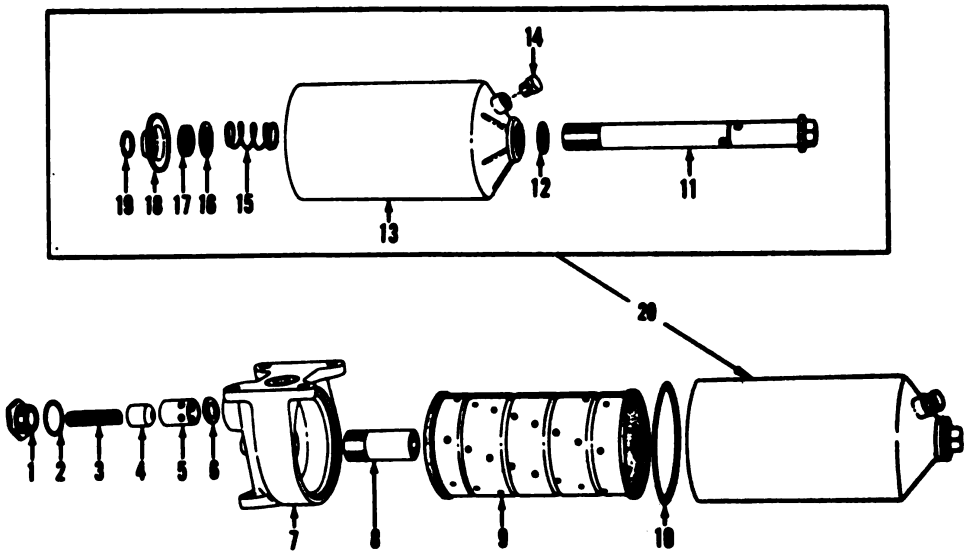
E-1353

FIGURE 8-11 OIL PUMP



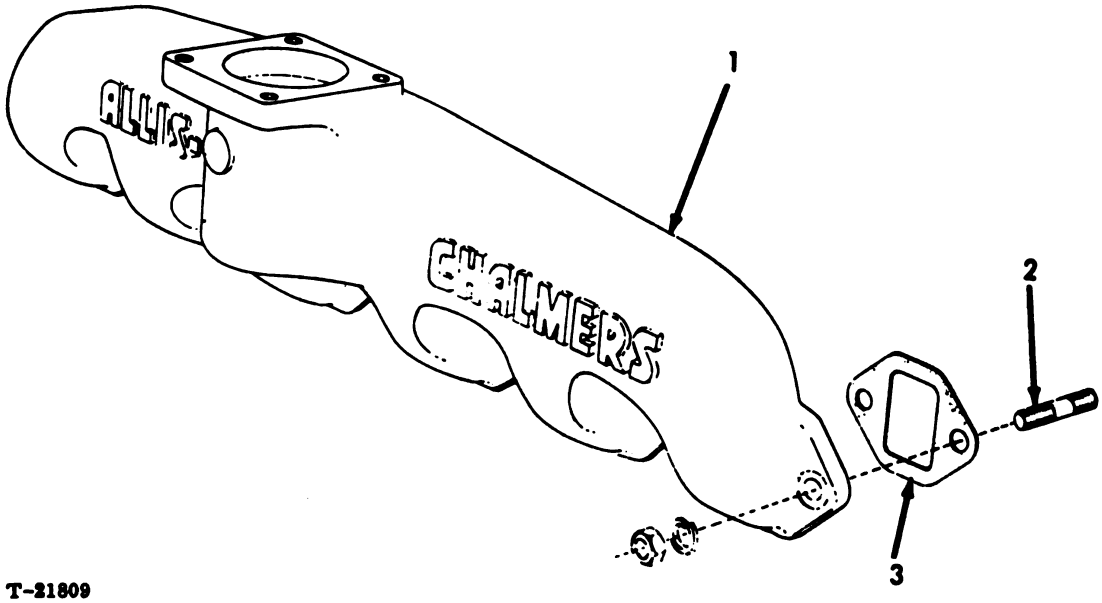
T-29883

FIGURE 8-12 OIL FILTER



T-29882

FIGURE 8-13 OIL FILTER ASSEMBLIES



T-21809

FIGURE 8014 INTAKE MANIFOLD

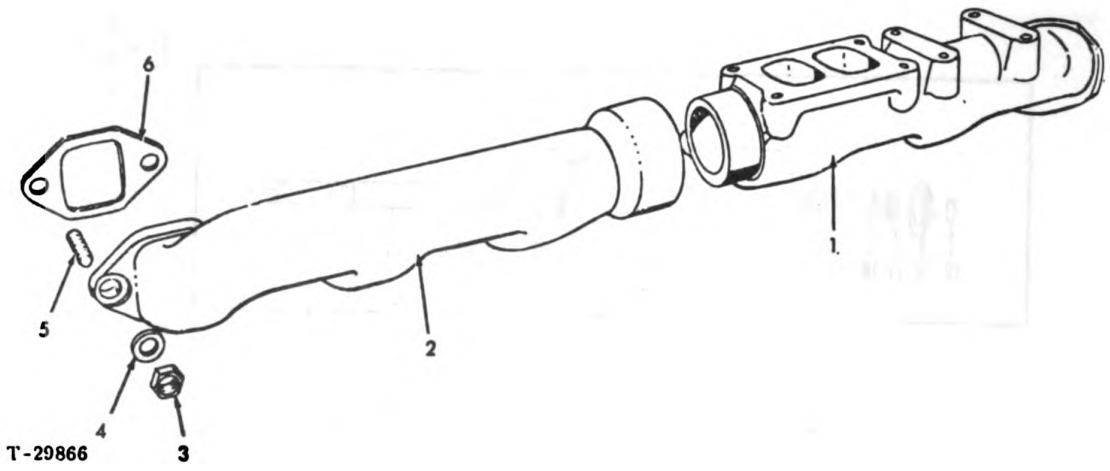
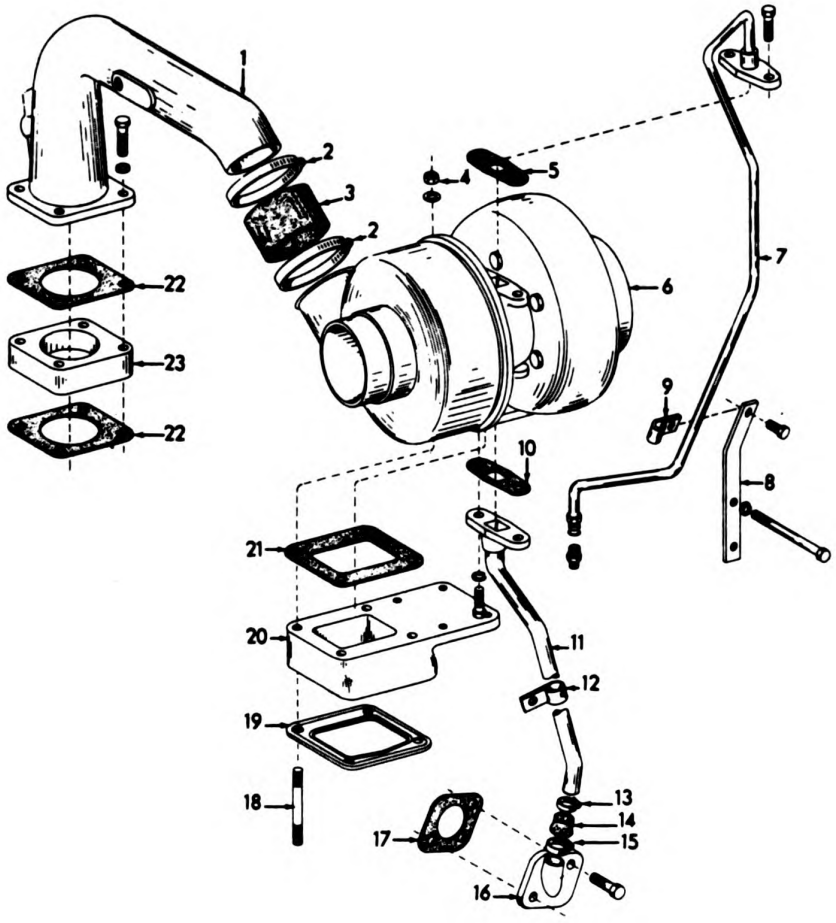
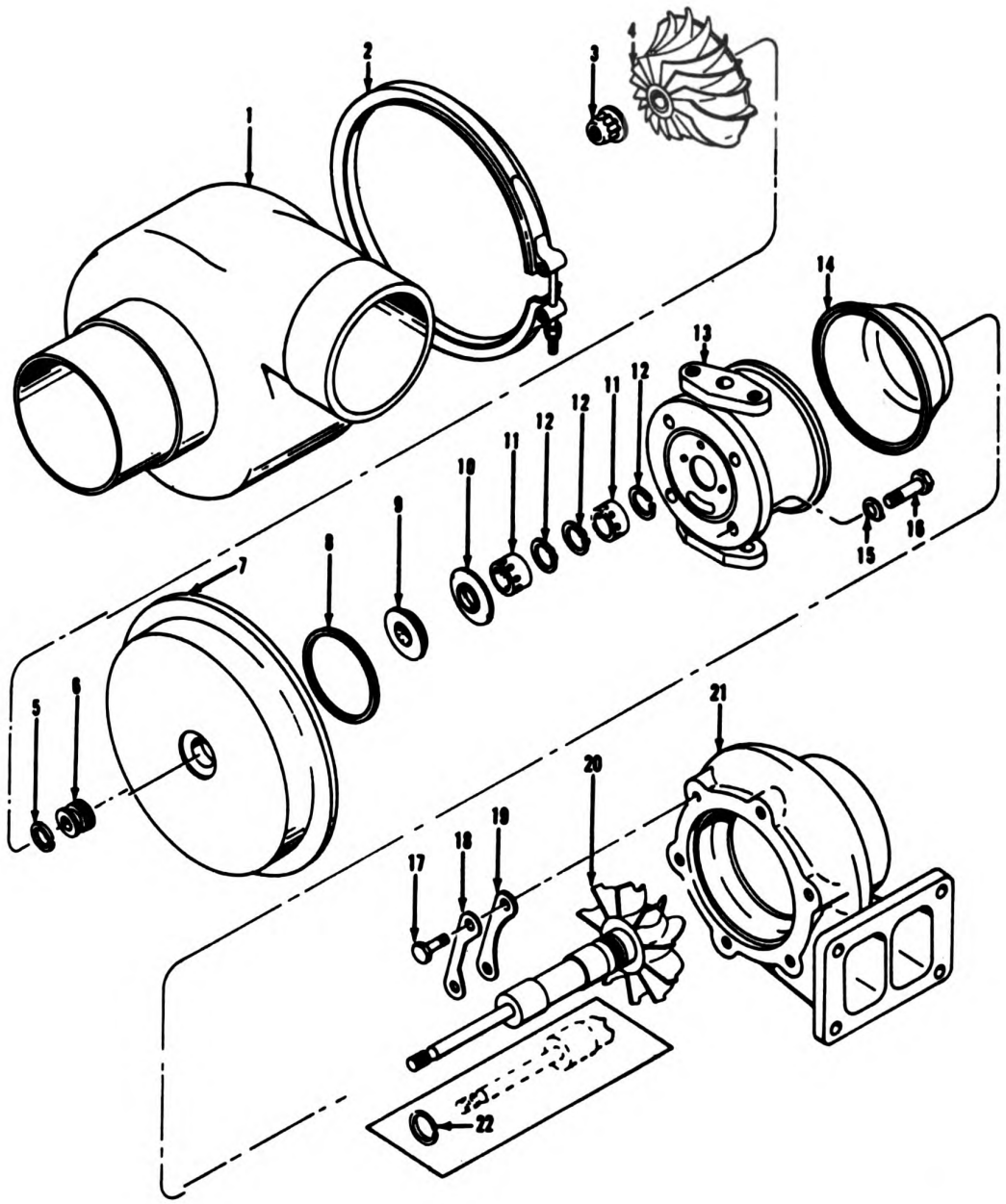


FIGURE 8-15 EHAUST MANIFOLD



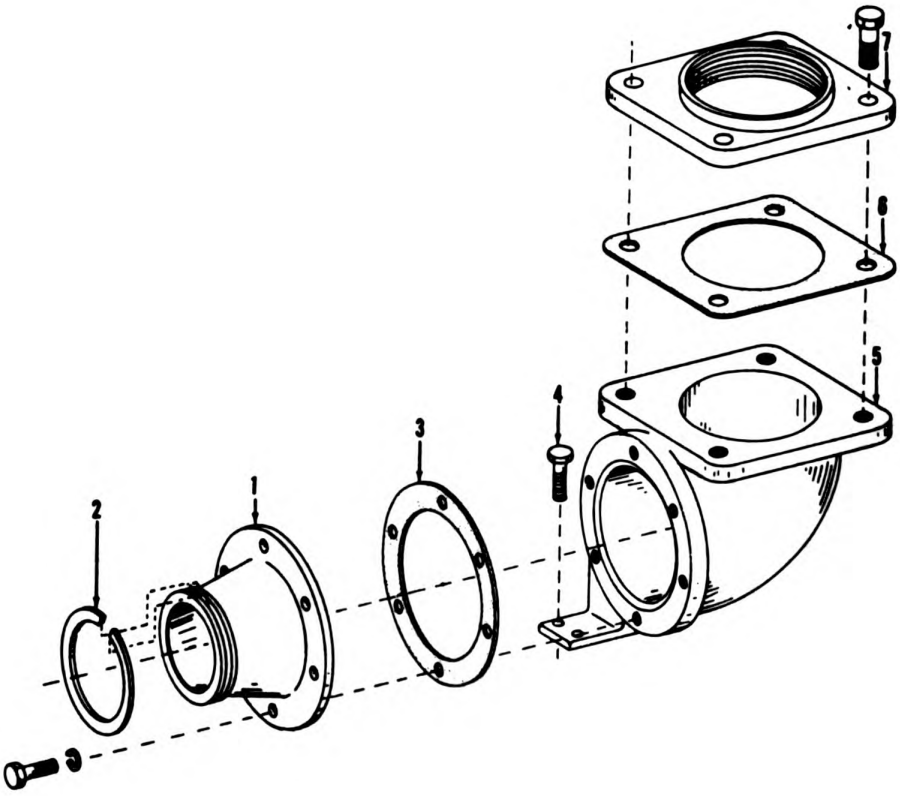
HT-51068

FIGURE 8-16 TURBOCHARGER



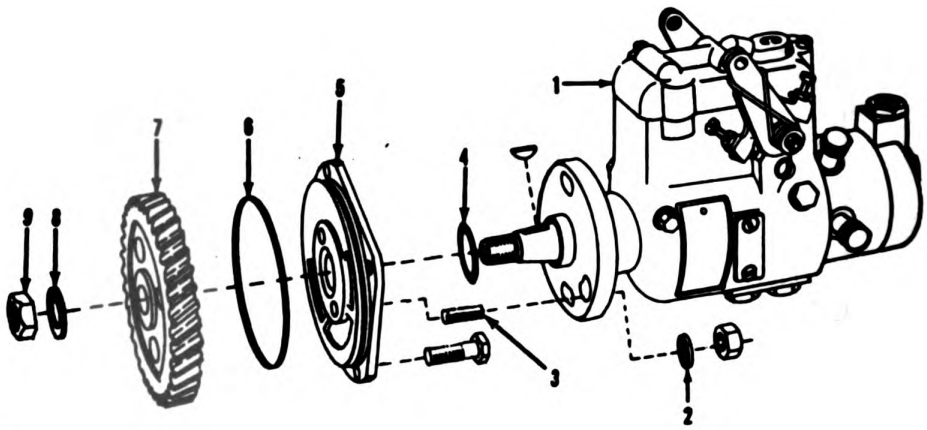
E-1327

FIGURE 8-17 TURBOCHARGER PARTS



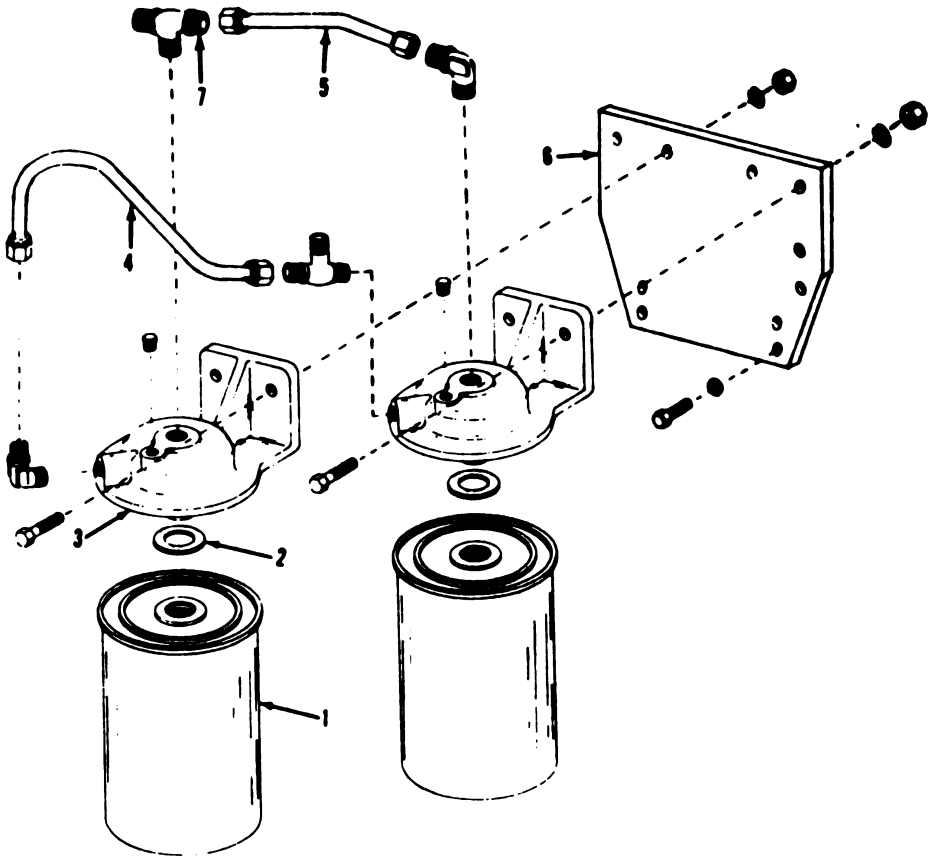
HT-51032

FIGURE 8-18 EXHAUST DIFFUSER



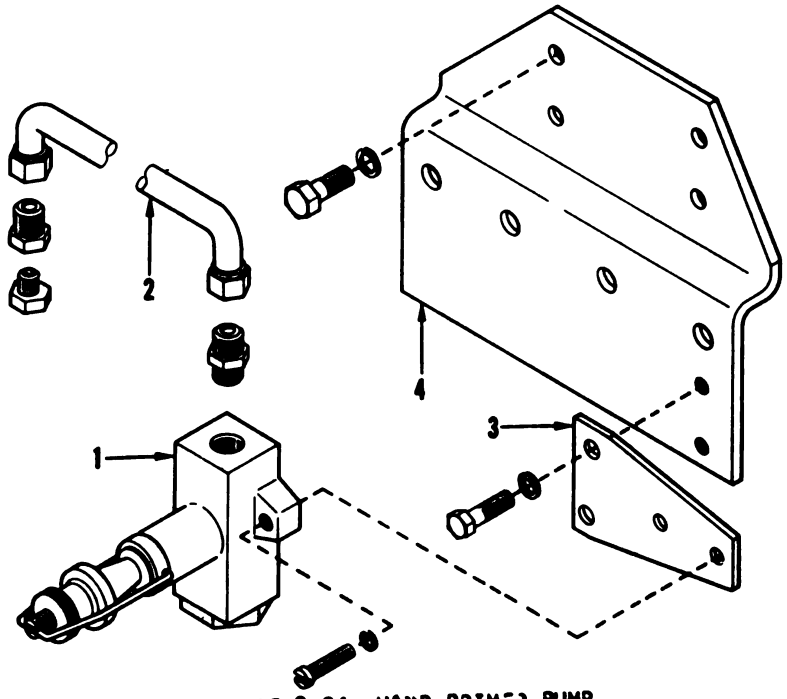
E-1349

FIGURE 8-19 FUEL INJECTION PUMP



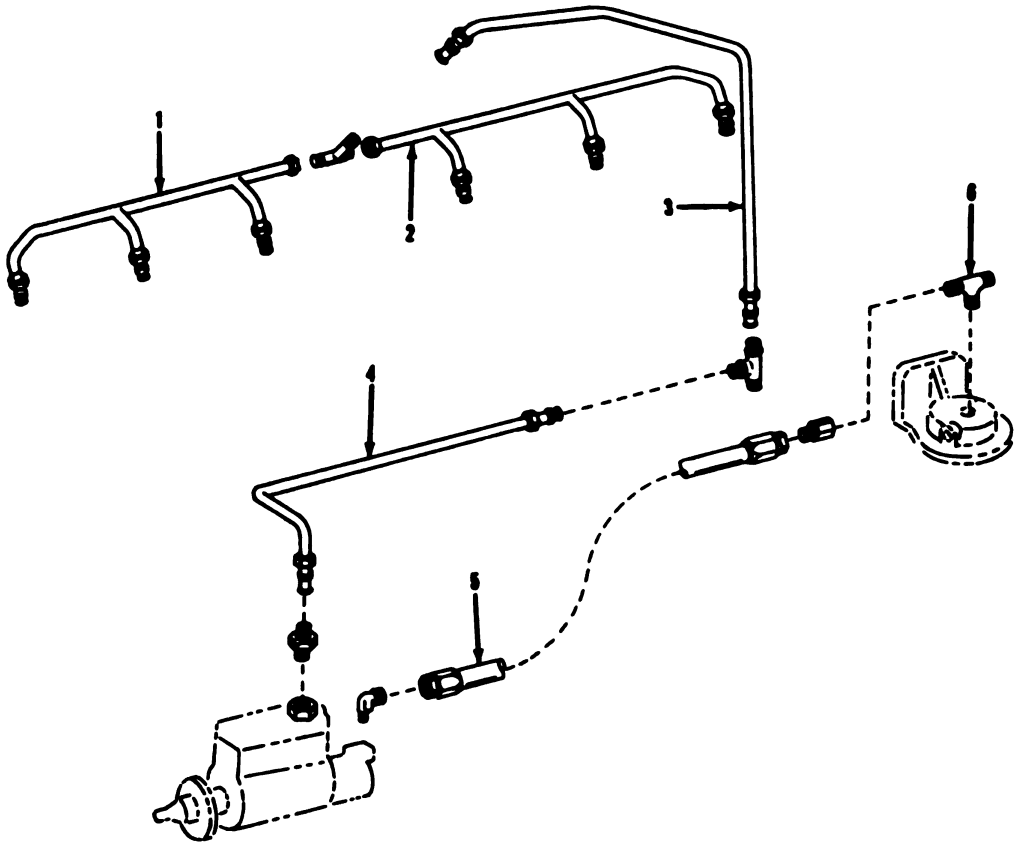
E-1350

FIGURE 8-20 FUEL FILTER



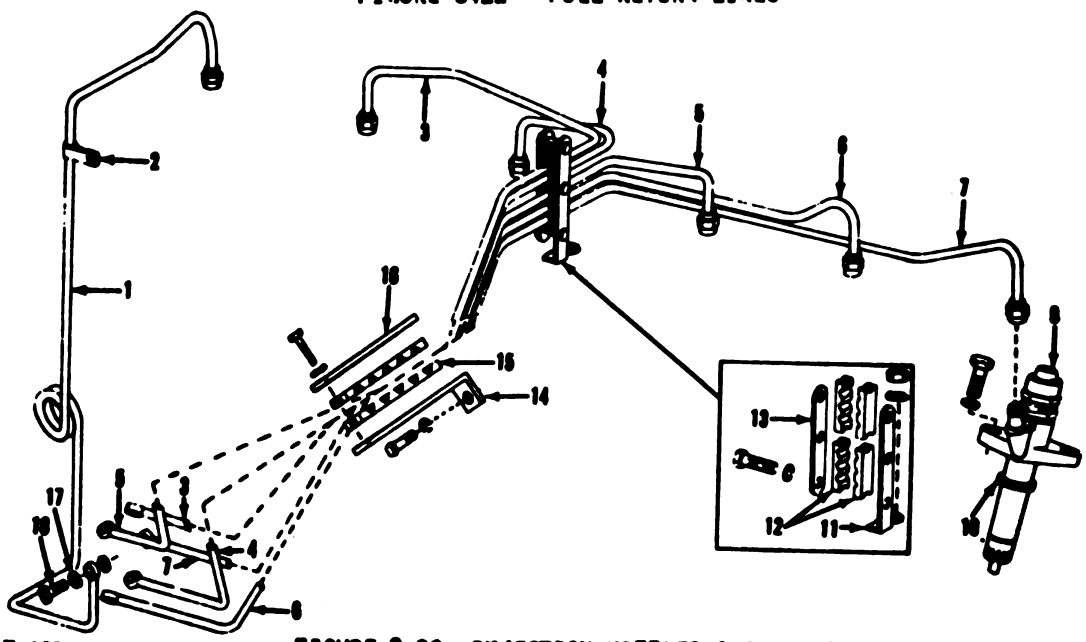
E-1344

FIGURE 8-21 HAND PRIMER PUMP



E-1352

FIGURE 8-22 FUEL RETURN LINES



E-1351

FIGURE 8-23 INJECTION NOZZLES AND LINES

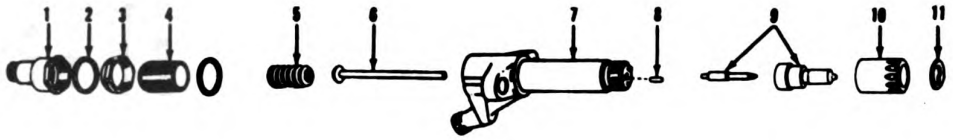
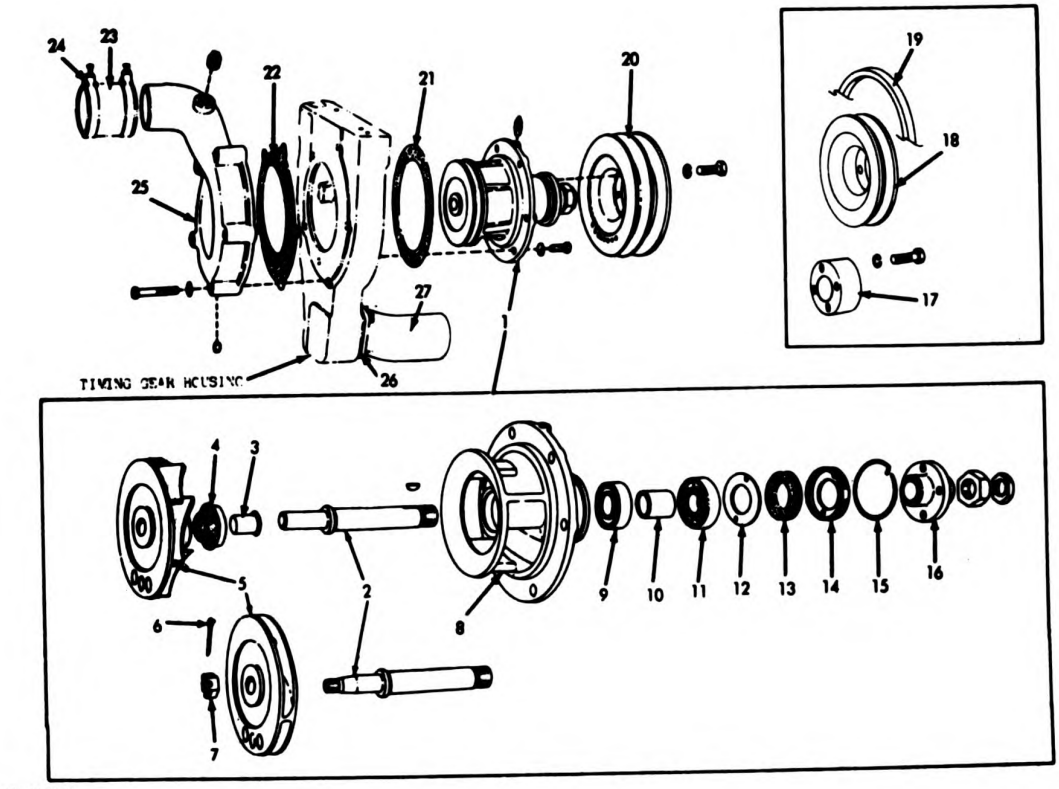
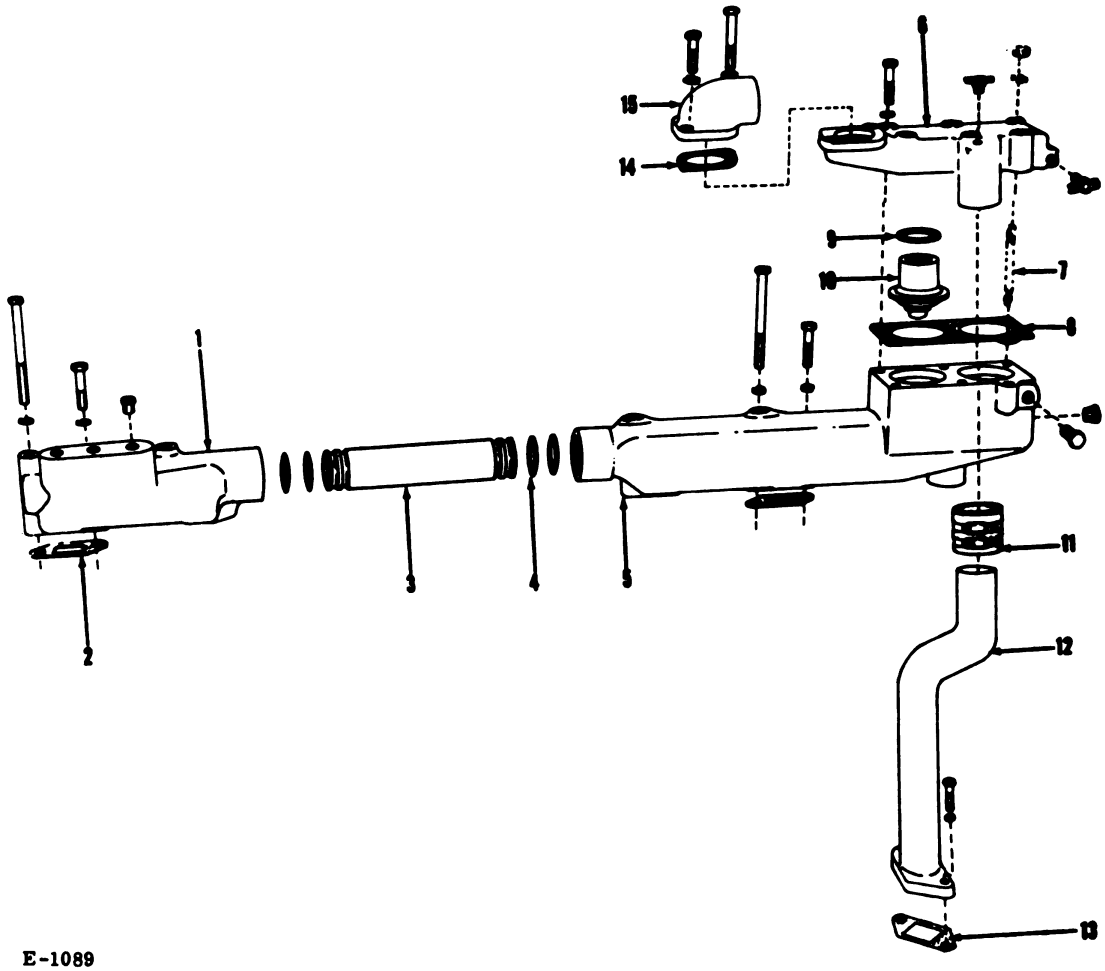


FIGURE 8-24 INJECTION NOZZLE HOLDER ASSEMBLY



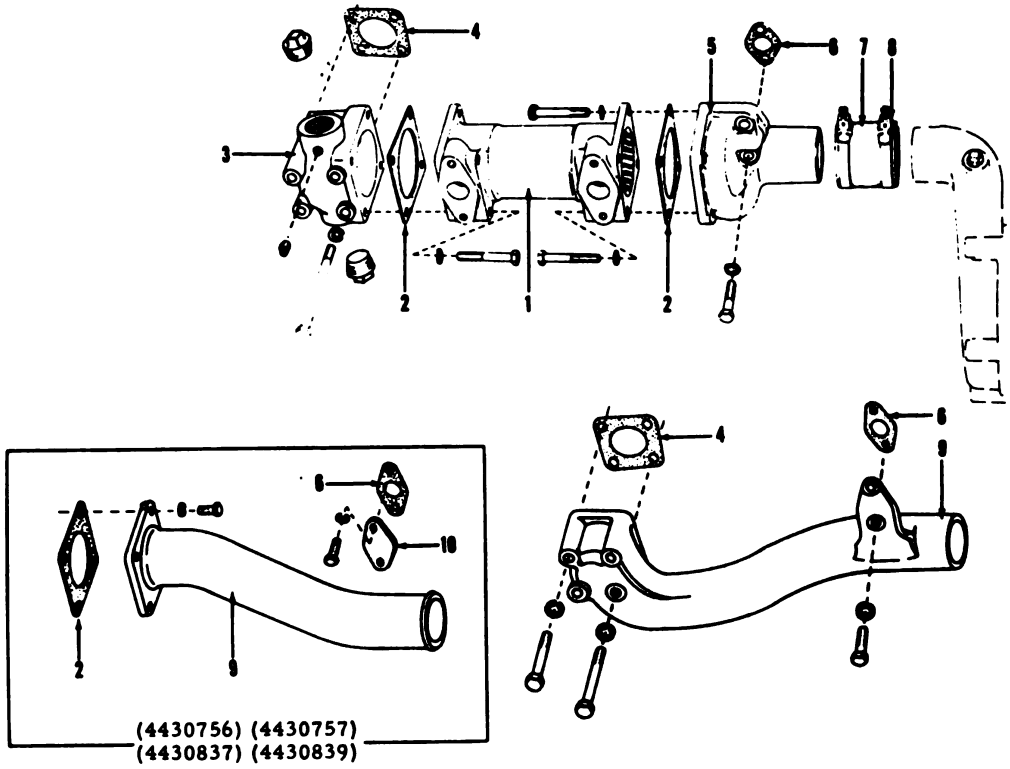
E-1361

FIGURE 8-25 WATER PUMP



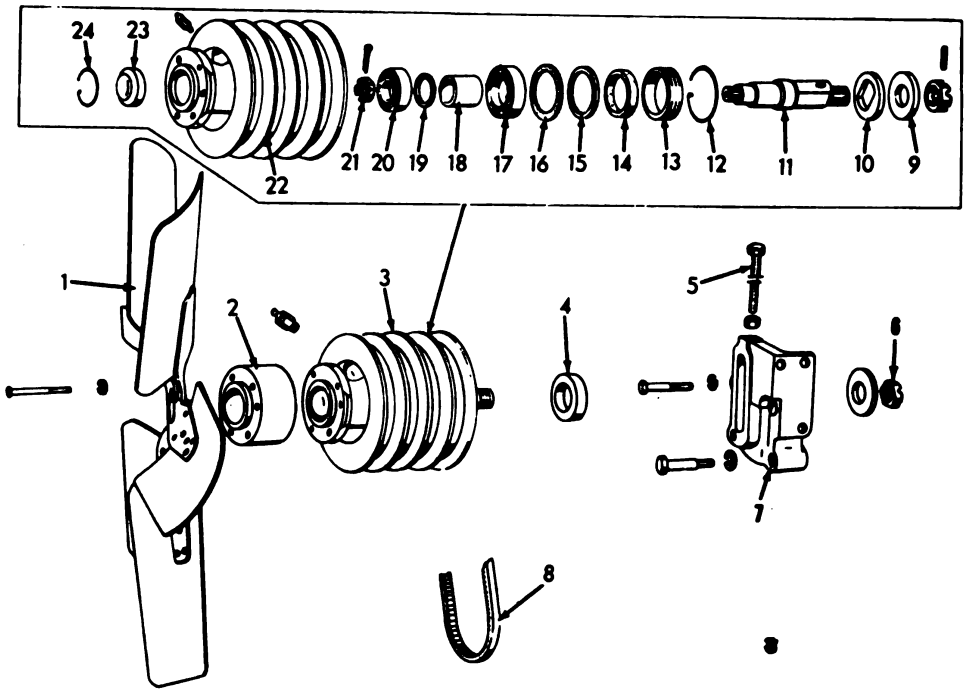
E-1089

FIGURE 8-26 WATER OUTLET MANIFOLD AND THERMOSTAT



HT-50266

FIGURE 8-27 OIL COOLER AND WATER INLET MANIFOLD



HT-51918

FIGURE 8-28 FAN AND HUB

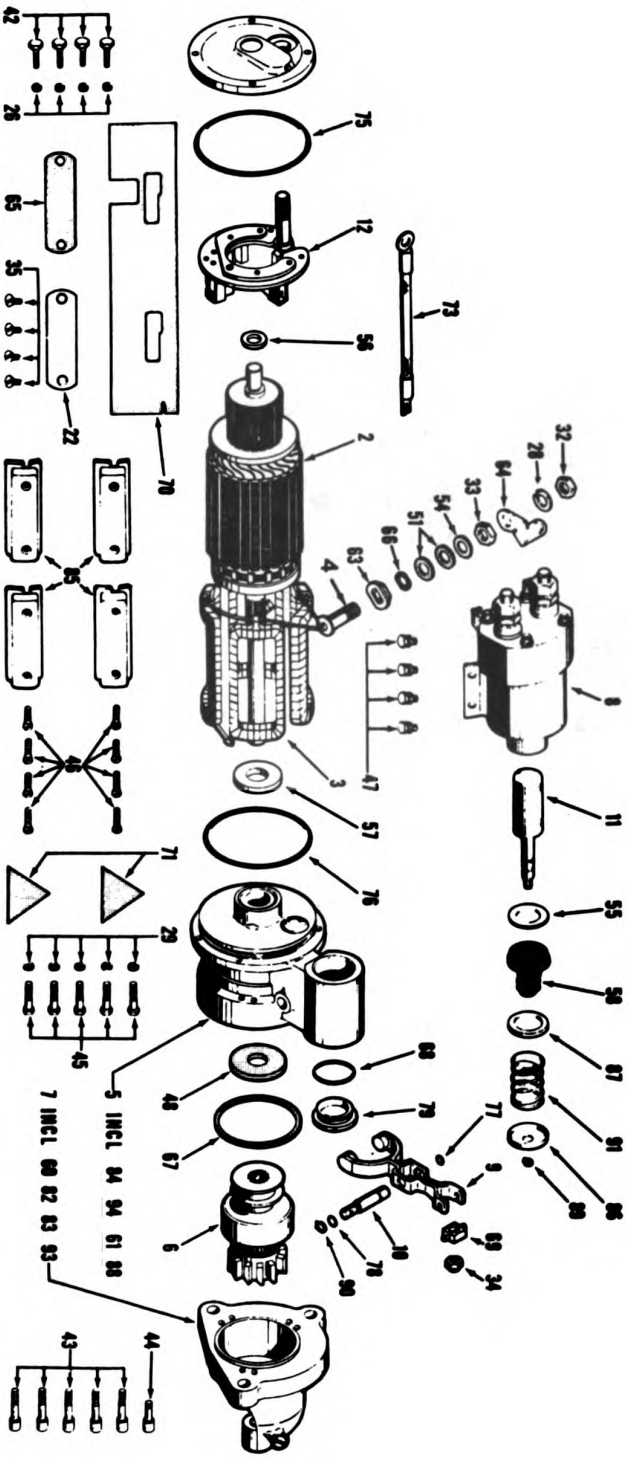


FIGURE 8-29 STARTER CRANKING MOTOR

PLATE 5007

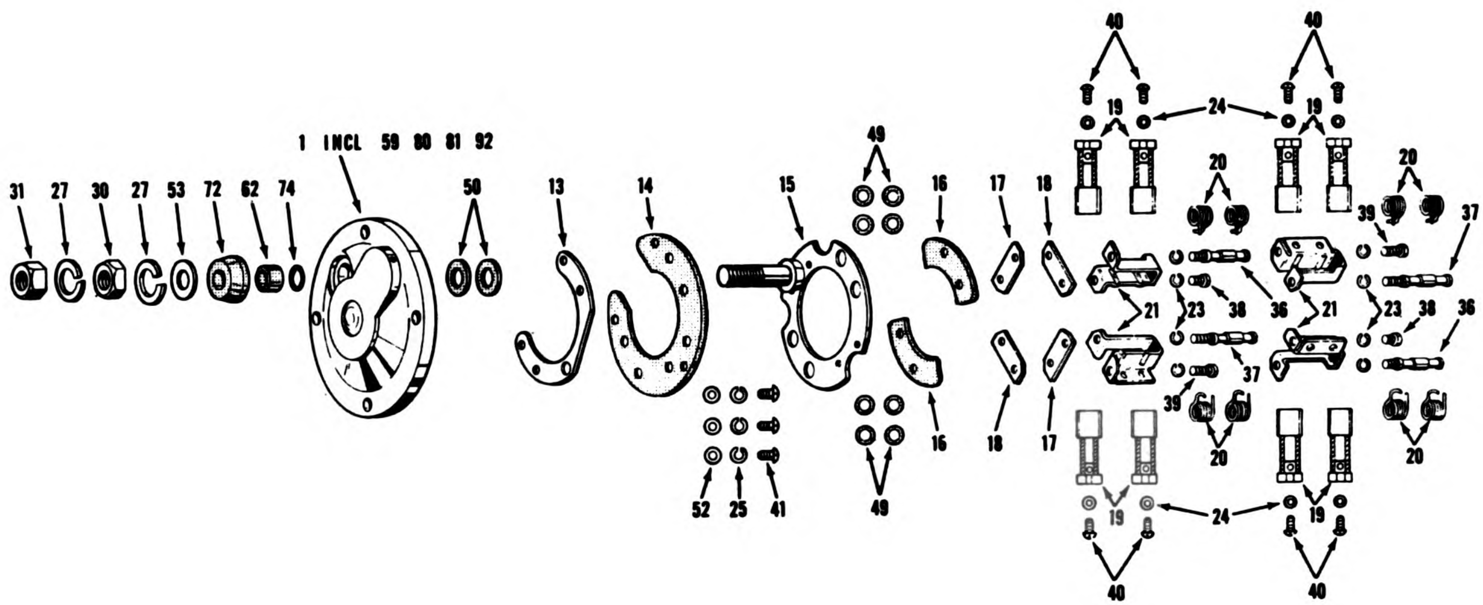
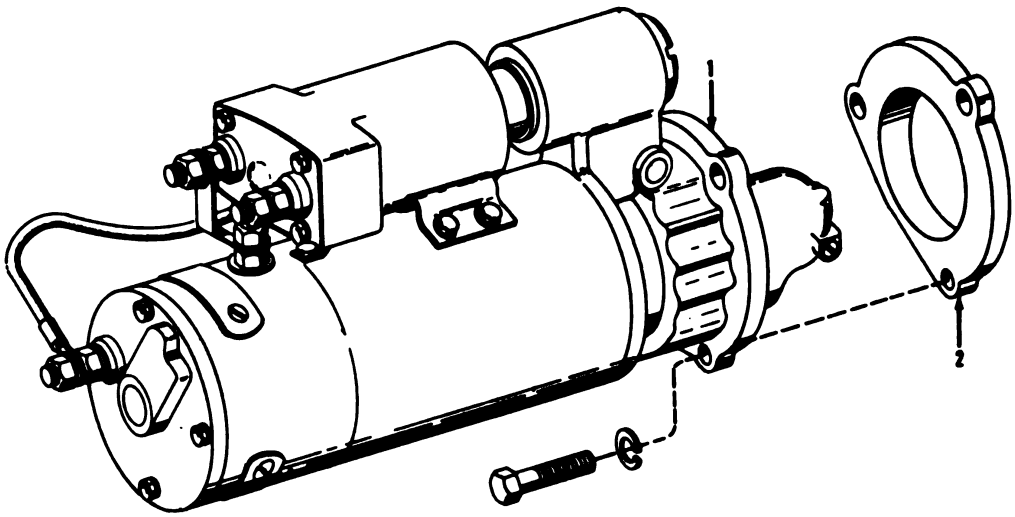


PLATE 5088

FIGURE 8-30 STARTER CRANKING MOTOR



HT-50888

FIGURE 8-31 STARTER

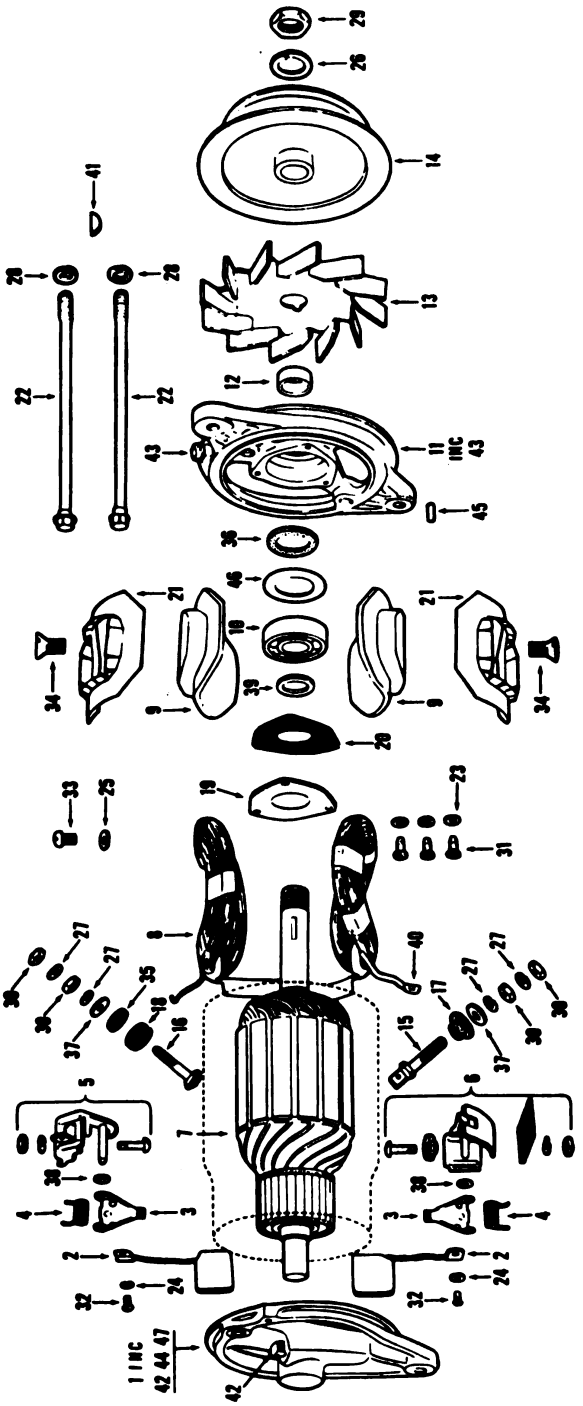
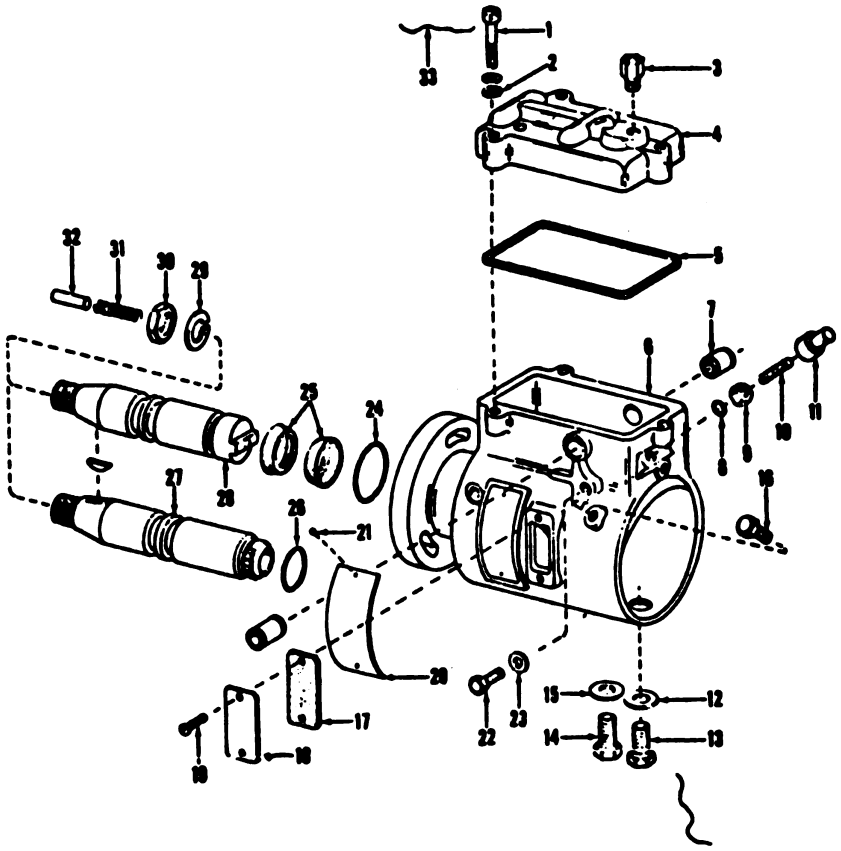


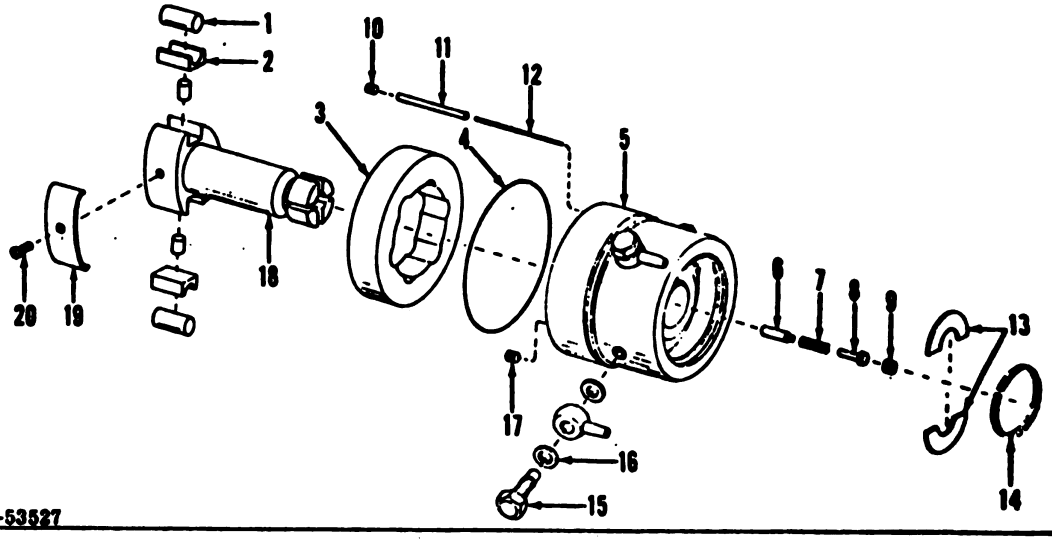
FIGURE 8-32 CHARGING GENERATOR



HT-53523

TYPICAL HOUSING & DRIVE

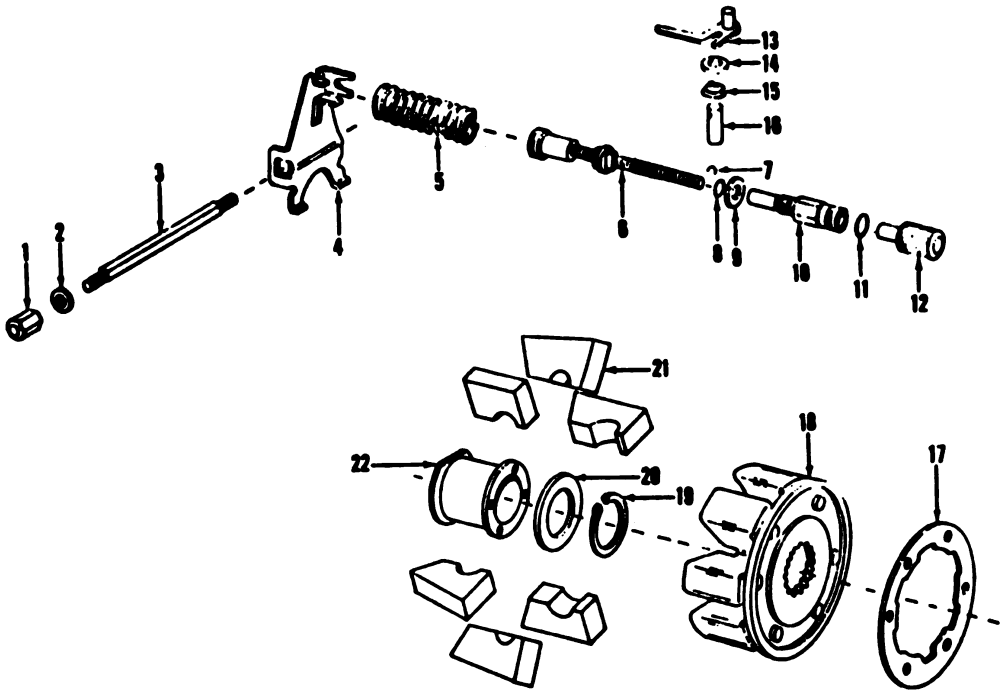
Figure 8-33



HT-53527

TYPICAL HEAD & ROTOR

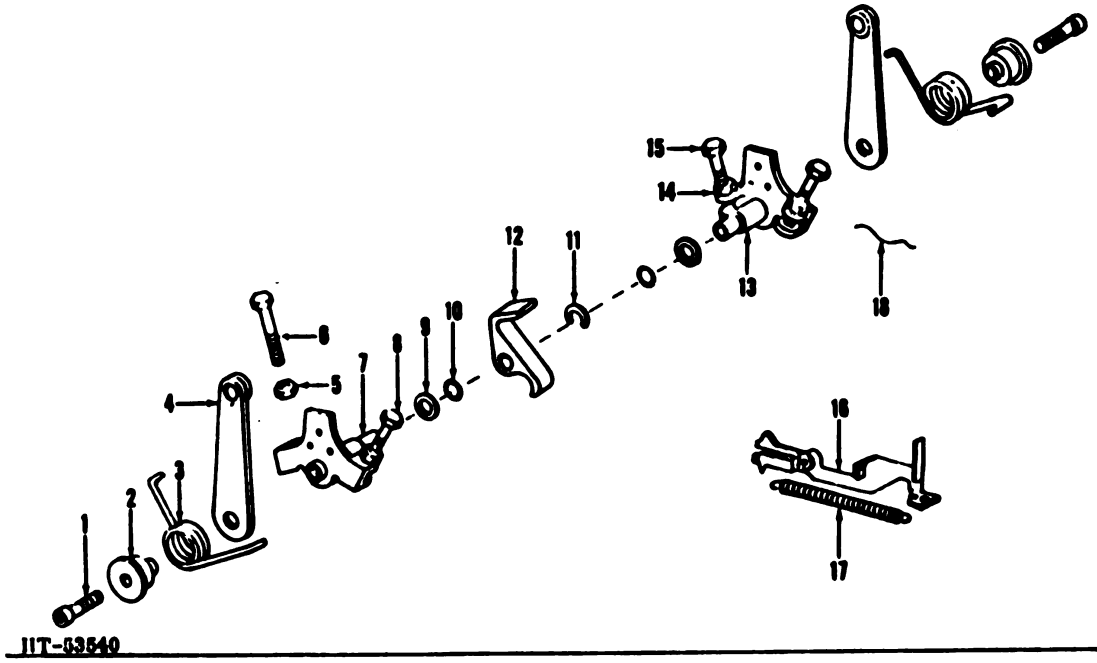
Figure 8-34



IIT-53531

TYPICAL GOVERNOR

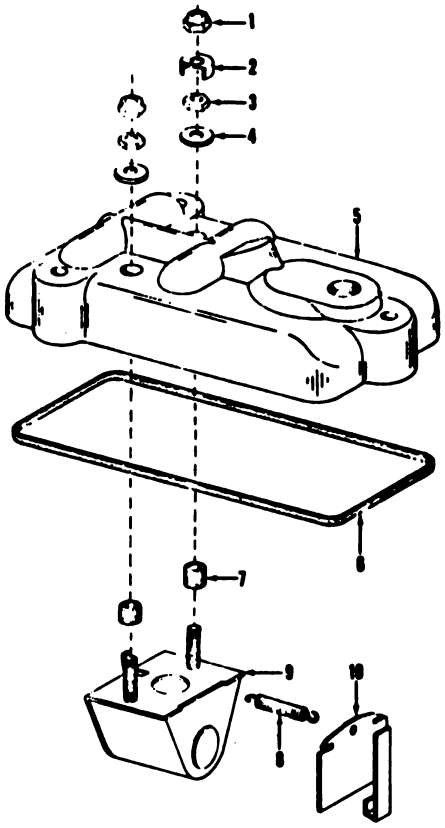
Figure 8-35



IIT-53540

TYPICAL LINKAGE

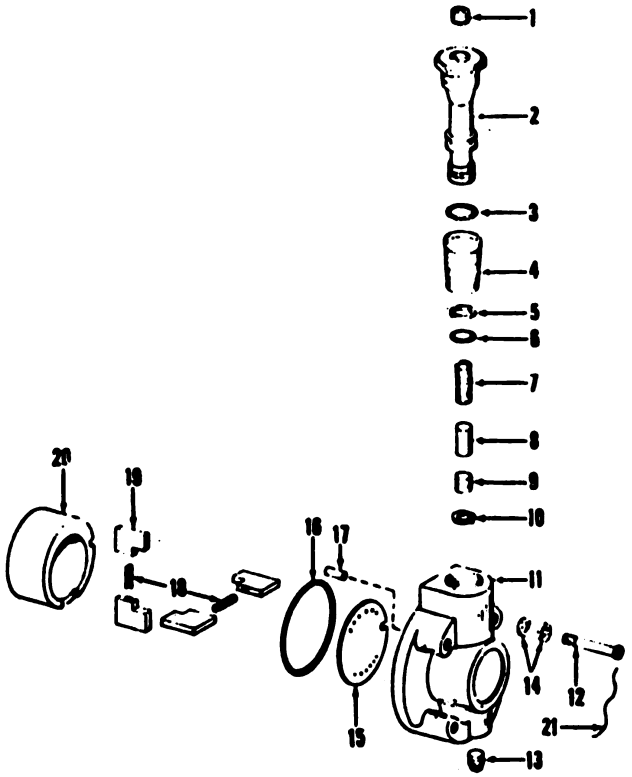
Figure 8-36



HT-53546

TYPICAL ELECTRIC SHUT-OFF

Figure 8-37



IIT-53530

TYPICAL TRANSFER PUMP

Figure 8-38

APPENDIX A

REFERENCES

A-1. CLEANING

C68001L	Chemicals and Chemical Products.
SB725-7930-1	Hard and Soft Water Cleaning Compounds.
TB SIG-327	Substitutes for Carbon-Tetrachloride

A-2. DEMOLITION

TM 750-244-3	Destruction of Materiel to Prevent Enemy Use.

A-3. FIRE PROTECTION

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

A-4. LUBRICATION

C91001L	Fuels, Lubricants, Oils, and Waxes.
LO 5-6115-575-12	Lubrication Order

A-5. MAINTENANCE

TB 750-651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems.
TB 5-6100-200-15	Basic Component Operation and Parallel Power Generating Equipment.
TB 5-6100-223-15/1	Ground Power Generating Equipment
TM 5-766	Electric Power Generators in the Field.
TM 11-483	Radio Interference Suppression.
TM 38-750	The Army Maintenance Management System

A-6. SHIPMENT AND STORAGE

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

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. General

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

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

c. Section III not applicable.

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

B-2. Explanation of Columns in Section II

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

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

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

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

The maintenance functions are defined as follows:

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

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

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

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

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

F - CALIBRATE. To determine the corrections to be made in the readings of instruments or test equipment used in precise measurement. Consists of the comparison of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared with the certified standard.

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

H - REPLACE. To replace unserviceable items with serviceable like items.

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

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

K - REBUILD. The highest degree of materiel maintenance. It consists of restoring equipment as nearly as possible to new condition in accordance with original manufacturing standards. Rebuild is performed only when required by operational considerations or other paramount factors and then only at the depot maintenance level. Rebuild reduces to zero the hours or miles the equipment, or component thereof, has been in use.

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

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

B-3. 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 5 and the second letter references a maintenance function, column 3, A through K.

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

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
01	BATTERIES	C	C	C					O					
02	MUFFLER & PIPES	C							O					
03	HOUSING ASSEMBLY	O							O					
	Doors & Covers	O							O	O				
	Panels								O	O				
	Associated Hardware	O							F					
04	WIRING HARNESS		O						O					
05	AIR CLEANER ASSEMBLY			C					O					
06	RADIATOR ASSEMBLY	O	F	C					O	F				
	Cap Radiator		O						C					
	Core Radiator								F	F				
07	TANKS LINES FITTINGS													
	Links Fuel								O	O				

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
07	TANKS LINES FITTINGS (CONT)													
	Tank Fuel	O		C					F	F				
08	ENGINE ASSEMBLY	F		C					F	O	H	D		
09	ELECTRIC SYSTEM													
	Governor Overspeed		O						O	O				
	Regulated Voltage (DC)		F		F				O					
	Belt V Generator Drive	C			O				O					
	Generator Batt Charge	O							O	F				
	Starter Electric	O							O	F				
	Sending Units & Transmitters		O						O					A-H
	Solenoid Shut Down		O		O				O					
10	FUEL SYSTEM, ENGINE LINES, FUEL INJECTION	O							O					

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
10	FUEL SYSTEM, ENGINE LINES, FUEL INJECTION (CONT)													
	Fuel Injection Pump & Governor		F						O	F	F			
	Injectors Fuel		F						O	F		F		
	Filters Fuel			O					O					B-H
11	COOLING SYSTEM, ENGINE FAN ASSEMBLY				O				O	O				
	Water Pump Assembly								F	F		F		
	Thermostats		O						O					
12	ENGINE LUBRICATING SYSTEM COMPONENTS													
	Lines Oil	O							O					
	Cooler Oil	O							F					
	Filters Oil			O					O					C-H

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
12	ENGINE LUBRICATING SYSTEM COMPONENTS (CONT)													
	Valve, Oil Pressure Regulating				F				F					
	Oil Pump Assembly (See Group #18)													
13	TURBOCHARGER ASSEMBLY	F							F	H	H			
	Manifolds													
14	MANIFOLDS ENGINE													
	Manifold Intake	F							F					
	Manifold Exhaust	F							F					
	Manifold Water	F							F					
15	HEAD ASSEMBLY CYL								F	F	F			
	Rocker Arms				O				F	F				
	Rods Push					F			F					

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
15	HEAD ASSEMBLY CYL (CONT)													
	Valves Int & Exh	F	F											D-B
	Valves Inserts (Seats)								F	F				E-I
	Springs Valve		F						F					
16	FLYWHEEL ASSEMBLY								H	H				F-I
17	TIMING GEARS	H							H					
18	BLOCK ASSEMBLY & COMPONENTS													
	Pump Oil								H	H				
	Bearings Rod	H							H					
	Pistons & Rings	H	H						H					G-B
	Sleeves Cylinder	H							H					
	Rods Connecting	H				H			H	H				H-H
	Bearings Main	H							H					

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
18	BLOCK ASSEMBLY & COMPONENTS (CONT)													
	Crankshaft Assembly	H							H			D		I-K
	Tappets & Cam Followers	F							F					
	Cam Shaft & Bearings	H							H					
	Block Engine Basic	H							H					
19	GENERATOR CONTROL ASSEMBLY													
	Harness Wiring		F						F	O				J-H
	Voltage Regulator													
	Alternating Current		H						F					
	Transformers		F						F					
	Relays		O						O					
	Potentiometers		O						O					
	Switches		O						O					

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
19	GENERATOR CONTROL ASSEMBLY (CONT)													
	Lights		O						O					
20	METERS & GAUGES ENGINE CONTROL													
	Gauge Pressure Oil & Fuel		O						O					
	Meter Time Totaling		O		H				O					K-D
	Ammeter, Battery Charging Generator		O						O					
	Temperature Gauge Engine		O						O					
21	METERS GENERATOR CONTROL													
	Voltmeter (AC)		O						O					
	Wattmeter		F				H		F					L-F
	Ammeter (AC)		O						F					
	Frequency Meter		F				H		O					M-F

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD	(4) TOOLS AND EQUIPMENT	(5) REMARKS
22	GENERATOR CONTROL BASE ASSEMBLY													
	Transformers Current		F						F					
	Breaker Circuit		F						F					
23	GENERATOR ALTERNATOR ASSEMBLY		F						H	H		D		
24	STATORS ASSEMBLY													
	Stator Exciter											D		
	Stator Main Generator											D		
25	ROTORS ASSEMBLY													
	Rotor Exciter		H						H			D		
	Diodes Rectifier		F						F					
	Rotor Main Generator		H						H			D		
26	SKID BASE ASSEMBLY	O							H	H				

SECTION II - MAINTENANCE ALLOCATION CHART

(1) GROUP NO.	(2) FUNCTIONAL GROUP	(3) MAINTENANCE FUNCTIONS											(4) TOOLS AND EQUIPMENT	(5) REMARKS
		A INSPECT	B TEST	C SERVICE	D ADJUST	E ALIGN	F CALIBRATE	G INSTALL	H REPLACE	I REPAIR	J OVERHAUL	K REBUILD		
27	ITEMS ACCESSORY													
	Extinguisher Fire	O	O						O					
	Hose Fuel Auxiliary	O						C	C					

REFERENCE CODE	REMARKS
A-H	Replacement of Microswitches
B-H	Replacement of Filter Elements
C-H	Replacement of Filter Elements
D-B	Refacing
E-I	Reseating
F-I	Replacement of Ring Gear
G-B	Compression Test Before Disassembly
H-H	Replacement of Wrist Pin Bushing
I-K	Undercutting, Metallizing & Resurfacing
J-H	Replacement of Connectors
K-D	Turning Back to Zero
L-F	Performed in Conjunction with Transducer
M-F	Performed in Conjunction with Transducer

APPENDIX C

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

C-1. Scope

This appendix lists items which accompany the generator set or are required for installation, operation, or operator's maintenance.

C-2. General

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

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

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

C-3. Explanation of Columns

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

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

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

Code	Explanation
P	Repair parts which are stocked in or supplied from the GSA/DSA, or Army supply system and authorized for use at indicated maintenance level.

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

Code	Explanation
C	Operator/crew

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

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 2 character alphabetic abbreviation indicating the amount or quantity of the item upon which the allowances are based, e.g., ft, ea, pr, etc.

e. Quantity Incorporated in Unit. This column not applicable.

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

g. Illustration. This column is not applicable.

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

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

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

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

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

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

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

SECTION II. BASIC ISSUE ITEMS

(1) SMR CODE	(2) FEDERAL STOCK NUMBER	(3) DESCRIPTION	(4) UNIT OF MEAS	(5) QTY INC IN UNIT	(6) QTY FURN WITH EQUIP	(7) ILLUSTRATION (A) FIG NO.	(7) ILLUSTRATION (B) ITEM NO.
		ARMY LUBRICATION ORDER TM 5-6115-575-12	EA		1		
		ARMY TECHNICAL MANUAL TM 5-6115-575-14	EA		1		
PC	7510-889-3494	BINDER, Looseleaf	EA		1		
PC	7520-559-9618	CASE, Maintenance and Operation Manuals	EA		1		

SECTION III. MAINTENANCE AND OPERATING SUPPLIES

(1) COMPONENT APPLICATION	(2) FEDERAL STOCK NUMBER	(3) DESCRIPTION	(4) QUANTITY REQUIRED F/ INITIAL OPERATION	(5) QUANTITY REQUIRED F/8 HRS OPERATION	(6) NOTES
CRANKCASE (1)		OIL LUBRICATING:			1. Includes qty of oil to fill engine oil system as follows:
		55 gal drum as follows:			
	9150-680-1103	HDO-10	23 qt	(2)	40 Qt System
	9150-680-1106	HDO-30	23 qt	(2)	
	9150-242-7684	OES	23 qt	(2)	2. See current LO for grade application and replenishment
OIL BATH AIR CLEANER	9150-680-7684	HDO-10	4 qt	(2)	3. Tank capacity.
TANK, DIESEL FUEL		FUEL OIL, DIESEL:			4. Cooling system capacity.
		bulk as follows:			
	9140-286-5294	DF-2	78 gal (3)	78 gal	
	9140-286-5286	DF-1	78 gal (3)	78 gal	
	9140-286-5283	DF-A	78 gal (3)	78 gal	
RADIATOR		ANTIFREEZE:			
		55 gal drum as follows:			
	6850-243-1990	ANTIFREEZE:			
		Perm Type	40 qt (4)		
	6850-174-1806	ANTIFREEZE:			
		Perm Type, Arctic	40 qt (4)		
FAN PULLEY WATER PUMP		GREASE: Automotive and Artillery			
		5 Pound Can	(2)		

By Order of the Secretary of the Army:

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

Official:
KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

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*U.S. GOVERNMENT PRINTING OFFICE:1989-242-466:08388