INSTRUCTION BOOK

FOR

GASOLINE ENGINE GENERATOR SET PU-107A/U

PREPARED FOR
THE SIGNAL CORPS
ON ORDER No. 29E-7955-29
25 FEBRUARY 1955

FORWARD COMMENTS ON THIS PUBLICATION DIRECTLY TO:

Commanding Officer
The Signal Corps Publications Agency
Fort Monmouth, New Jersey
ATTN: Standards Division

WARNING

Dangerous voltages are generated by this equipment. Do not attempt to change output connections or the setting of the Wye-Delta change board while the equipment is in operation.

Provide proper and adequate ventilation if the equipment is operated in a confined space. Exhaust gases, produced by a gasoline engine, are poisonous. Excessive inhalation may cause serious sickness or death.

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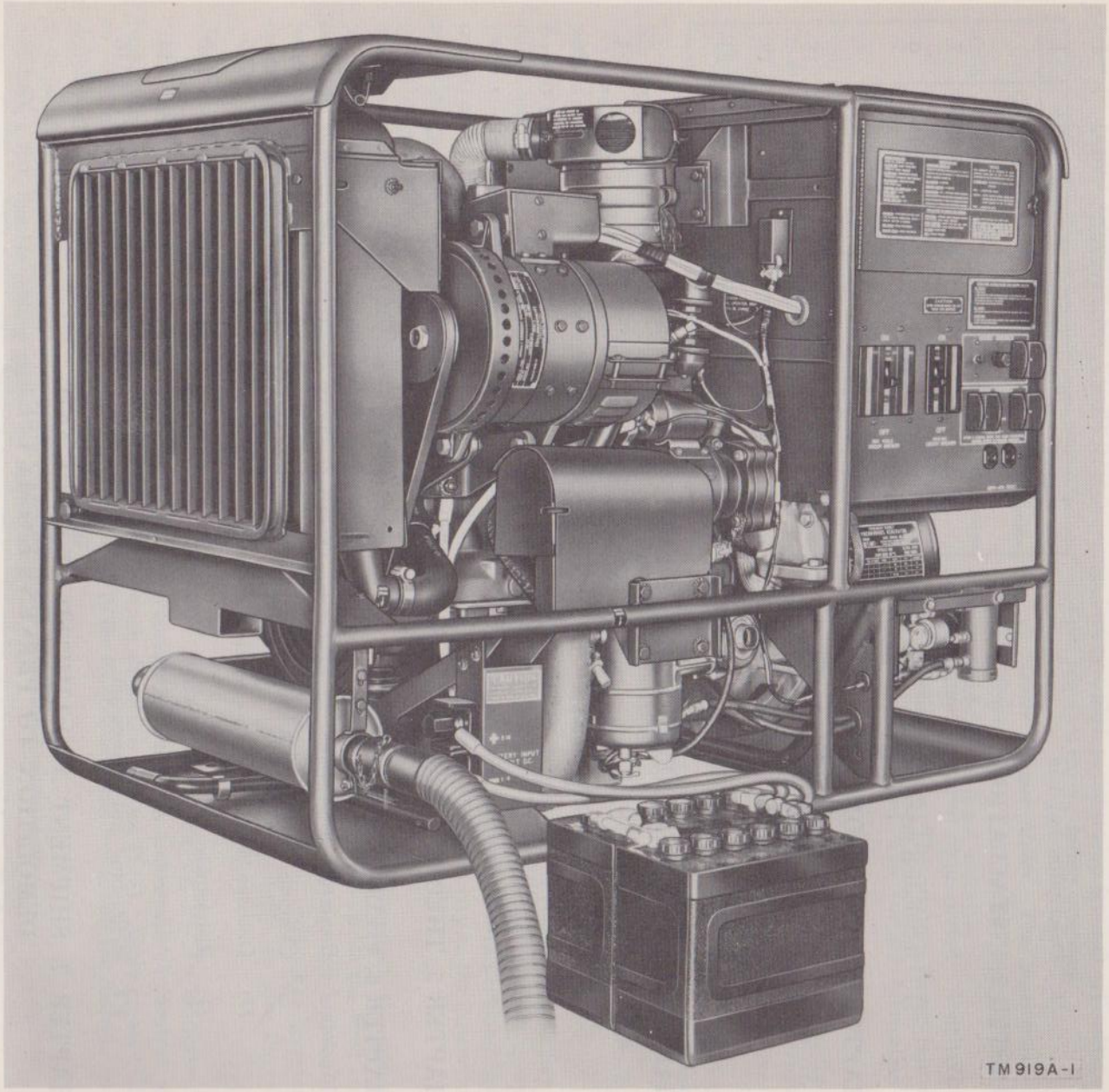


Figure 1. Gasoline Engine Generator Set PU-107A/U.

Note. This instruction book will be replaced by TM11-919A which when published, will be listed Department of the Army Pamphlet No. 310-4.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

These instructions are published for the information of all concerned. They include complete information for operating, servicing, maintaining, and overhauling Gasoline Engine Generator Set PU-107A/U. Also included are a detailed description of all major parts and a discussion of the theory of operation.

2. Forms and Records

a. The following forms will be used for reporting unsatisfactory conditions of Army materiel and equipment and in performing preventive maintenance.

(1) DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745-45-5 (Army); Navy Shipping Guide, Article 1850-4 (Navy); and AFR 71-4 (Air Force).

(2) DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer, as prescribed in SR 700-45-5.

(3) DD Form 535 Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, as prescribed in SR 700-45-5 and AF TO 00-35D-54.

(4) DA Form 11-260, Operator First Echelon Maintenance Check List for Signal Corps Equipment (Power Units, Reel Units (Engine-Driven)), will be used in accordance with instructions appearing on the form.

(5) DA Form 11-261, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Power Units, Reel Units (Engine-Driven)), will be used in accordance with instructions appearing on the form.

(6) WD Form 460 (Preventive Maintenance Roster) will be used in accordance with current practices.

b. Use other forms and records as authorized.

3. Purpose and Use

a. Gasoline Engine Generator Set PU-107A/U is intended as a source of power for Electronic Search Central AN/GSS-1. It also may be used as a source of power for transportable or mobile radar and similar Signal Corps equipment.

b. The 28-volt direct-current (dc) generator can be used to charge groups of wet cell storage batteries in either series or parallel circuits. Using a 20-ampere charging rate with a series circuit, it is possible to charge four 6-volt batteries, or one 24-volt battery. Using a 20-ampere charging rate with a parallel circuit, it is possible to charge five groups of four 6-volt batteries, five groups of two 12-volt batteries, or five 24-volt batteries.

Section II. DESCRIPTION AND DATA

Note. All left and right designations are assumed as viewed from the rear, or generator end, facing the set.

4. Description

Gasoline Engine Generator Set PU-107A/U is a portable electric generating set that consists of the

following major assemblies: a single bearing, permanent magnet, 400-cycle alternator; a 28-volt dc generator; a four-cylinder, four-stroke cycle, liquid cooled, gasoline engine; a winterization system to aid starting in low temperatures; and necessary controls and instruments for the operation and regulation of the equipment. The 400-cycle alternator is directly coupled to the engine flywheel and the 28-volt dc generator is belt driven from the engine crankshaft. All necessary controls and instruments are mounted on panels on the left-hand side at the generator end of the unit. Power output and remote control connections are provided on the right-hand side of the unit. The entire equipment is mounted within a tubular steel frame and a canvas cover is provided to protect the equipment when it is not in operation.

5. Major Systems and Assemblies

a. Engine. The generator is driven by a conventional, L-head, four-stroke cycle, four-cylinder, liquid cooled, gasoline engine. Ignition is provided by a high-tension magneto (11, fig. 3) and self shielded spark plugs (3, fig. 3). A 15-quart, tubular-cell radiator (27, fig. 2), belt driven fan and water pump comprise the major elements of the cooling system. The engine is lubricated by a gear-type oil pump that delivers oil under pressure to the main bearings and connecting rod bearings. The fuel system consists of an up-draft carburetor (14, fig. 3), a diaphragm-type fuel pump (16, fig. 3), and a remote fuel line and fuel drum adapter. There is no fuel tank on the unit. The engine may be started by means of a hand crank or by a 24-volt electric starting system. Two 12-volt storage batteries, connected in series, are provided to supply power for the electric starting motor. A belt-driven, 24-volt dc generator (5, fig. 3) maintains the batteries in a charged condition.

b. Winterization system. A winterization system is provided to aid in starting the engine in low temperatures. The winterization unit consists of a fuel pump (15, fig. 2), fuel control valve (16, fig. 2), blower (17, fig. 2), heat exchanger pan (18, fig. 2), and shield (21, fig. 2). A switch, circuit breaker, and indicator lamp for control of the winterization system are mounted on the unit control panel.

c. Alternator. (9, fig. 4). The alternator is of the permanent magnet-type with 28 poles. It is directly coupled to the engine and, when operated at 1,714 revolutions per minute (rpm), develops 12.5 kilowatts (kw), 120 or 208 volt, three-phase, four-wire output at .8 power factor. A compensator assembly, consisting of a transformer (1, fig. 4) and a capacitor assembly (4, fig. 4), is provided to maintain voltage stability.

d. Dc power generator. A separate, 28-volt dc generator (1, fig. 2) is mounted to one side of the engine and driven by a V-belt from the engine crankshaft. This generator, when operated at 4,500 rpm, will deliver 2.5 kw, 28 volts dc.

e. Radio-frequency Suppression Equipment. Radio frequencies produced by the operation of the set are suppressed by shielding, ground straps, grounded capacitors, resistor-suppressors, and bonds formed by external-internal-toothed lock washers. A complete description of suppression equipment is contained in paragraph 67.

f. Frame. The frame structure (12, fig. 3) supports the entire generator set assembly and is comprised of two parts. The lower frame acts as a skid and also shock-mounts the engine and alternator. The upper frame mounts the instrument and control panels, the wye-delta change board, and terminal panel.

6. Performance Characteristics

a. Output combinations. The generator set is rated at the following output combinations:

(1) Ten kilowatts (kw) at .8 power factor, 120 volts alternating-current (ac), single-phase, 400 cycles, 2.5 kw at 28 volts dc.

(2) Ten kw at .8 power factor, 120/208 volts ac, three-phase, four-wire, 400 cycles, 2.5 kw at 28 volts dc.

(3) Twelve and one-half kw at .8 power factor, 120/208 volts ac, three-phase, four-wire, 400 cycles.

b. Alternating Current.

(1) *Single-phase, 120-volt, .8 power factor.*

Approx. load	Amperes	Volts	Kilowatts	Cycles
0	0	124	0	400-415
¼	25.5	122-124	2.5	400-415
½	52.0	120-122	5.0	400-415
¾	78.0	120-122	7.5	400-415
Full	104.0	118-120	10.0	400-415

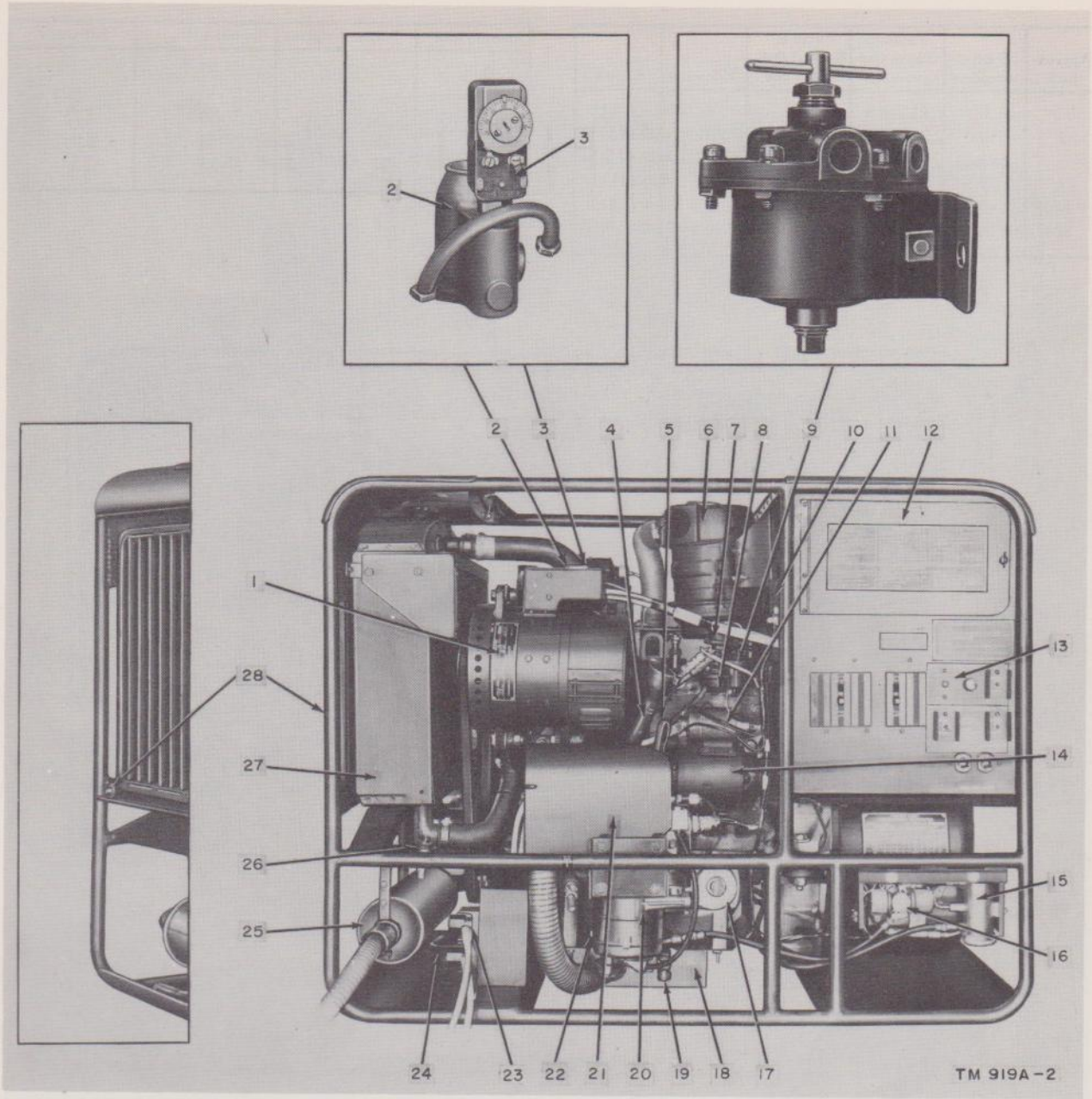


Figure 2. Gasoline Engine Generator Set PU-107A/U, left side.

1. 28-v, 2.5-kw generator (G3).
2. Coolant outlet neck (A 1).
3. Coolant temperature cutoff switch (S3)
4. Oil filler tube (MP3).
5. Bayonet gage (M21).
6. Air cleaner.
7. Low-oil-pressure cutoff switch (S2).
8. Oil-pressure transmitter (E8).
9. Oil filter (FL1).
10. Ten-conductor socket (P1 and J2).
11. Starting motor solenoid (L2).
12. Instrument panel door (A 136).
13. Control panel (MP530).
14. Starting motor (B1).
15. Heater fuel pump (L5).
16. Heater fuel control valve (L4).
17. Heater blower (B2).
18. Heater heat exchanger pan (HR1).
19. Crankcase drain (H535).
20. Heater (HR2).
21. Heater shield (MP550).
22. Crankcase.
23. Battery input terminals (H1953 and H1954).
24. Hand crank (MP557).
25. Muffler (MP201).
26. Radiator drain (MP207).
27. Radiator (A 41).
28. Manual choke (MP534).

(2) *Three-phase, 208-volt, .8 power factor.*

Approx. load	Output Amperes	Phase-to-Phase Output Volts	Phase-to-Neutral Output Volts	Kilowatts	Cycles
0	0	215-218	124	0	400-415
¼	10.0	213-215	123	3.0	400-415
½	21.5	210-212	121	6.25	400-415
¾	32.5	210-212	121	9.5	400-415
Full	43.5	208-211	120	12.5	400-415
5/4	54.0	206-208	119	15.5	400-415

c. Direct current.

Approx. load	Output Amperes	Output Volts	Kilowatts
0	0	27-30	0
¼	22	27-30	.625
½	45	27-30	1.25
¾	71	27-30	2.0
Full	90	27-30	2.5

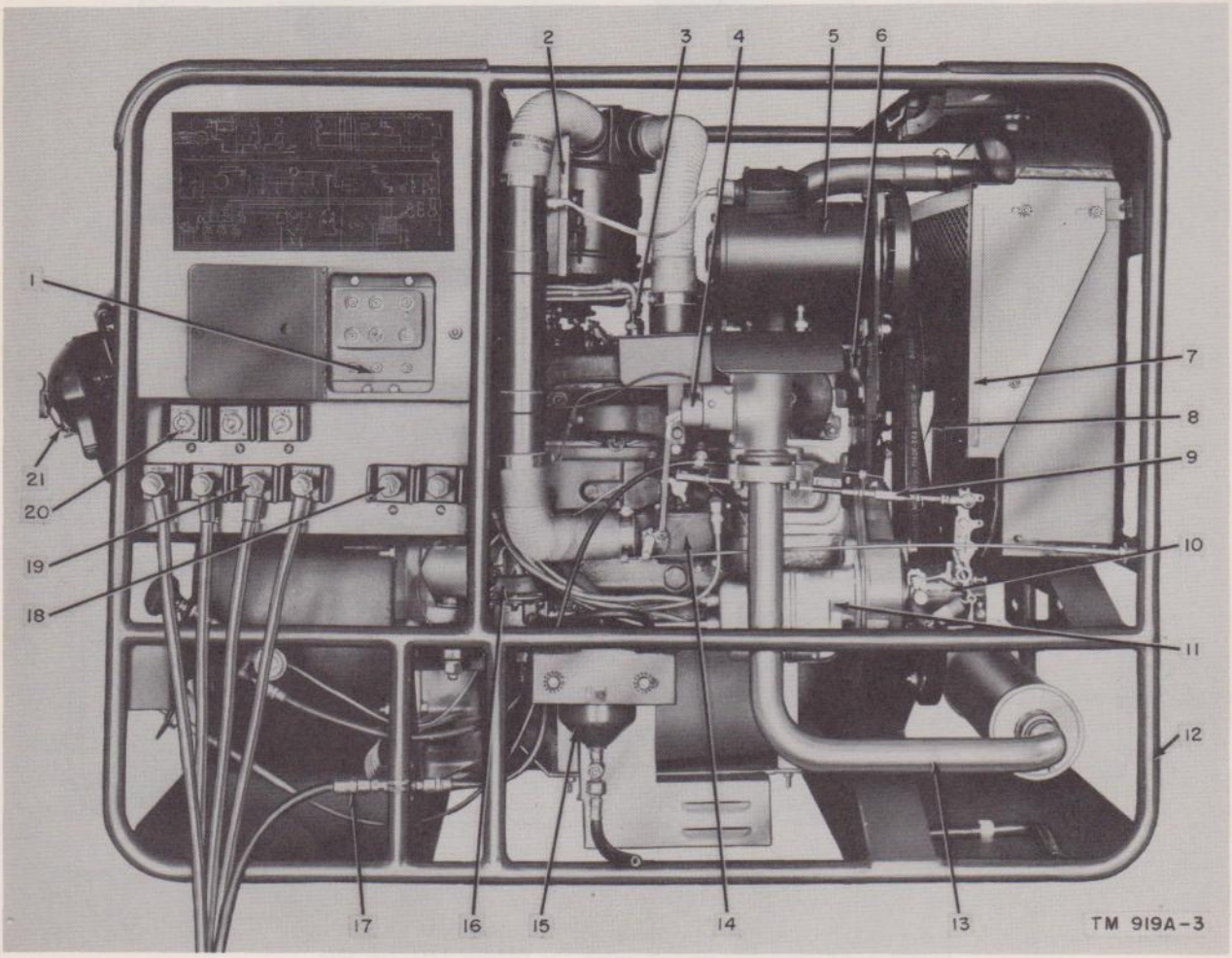


Figure 3. Gasoline Engine Generator Set, PU-107A/U, right view.

1. Wye-delta change board.
2. Suppression box (VR5).
3. Spark plugs (E195 and E198).
4. Electric choke (L3).
5. 24-volt battery-charging generator (G3).
6. Water pump.
7. Fan guards (A 44 and A 45).
8. Fan (B26).
9. Carburetor-to-governor linkage.
10. Governor (MP535).
11. Magneto (E13).
12. Frames (A 178 and A 179).
13. Exhaust system.
14. Carburetor (MP292).
15. Fuel filter (FL12).
16. Fuel pump (MP272).
17. Auxiliary fuel line adapter (MP558).
18. Dc voltage output terminals (E18 and E19).
19. Ac voltage output terminal.
20. Remote control terminal.
21. Fire extinguisher (MP556).

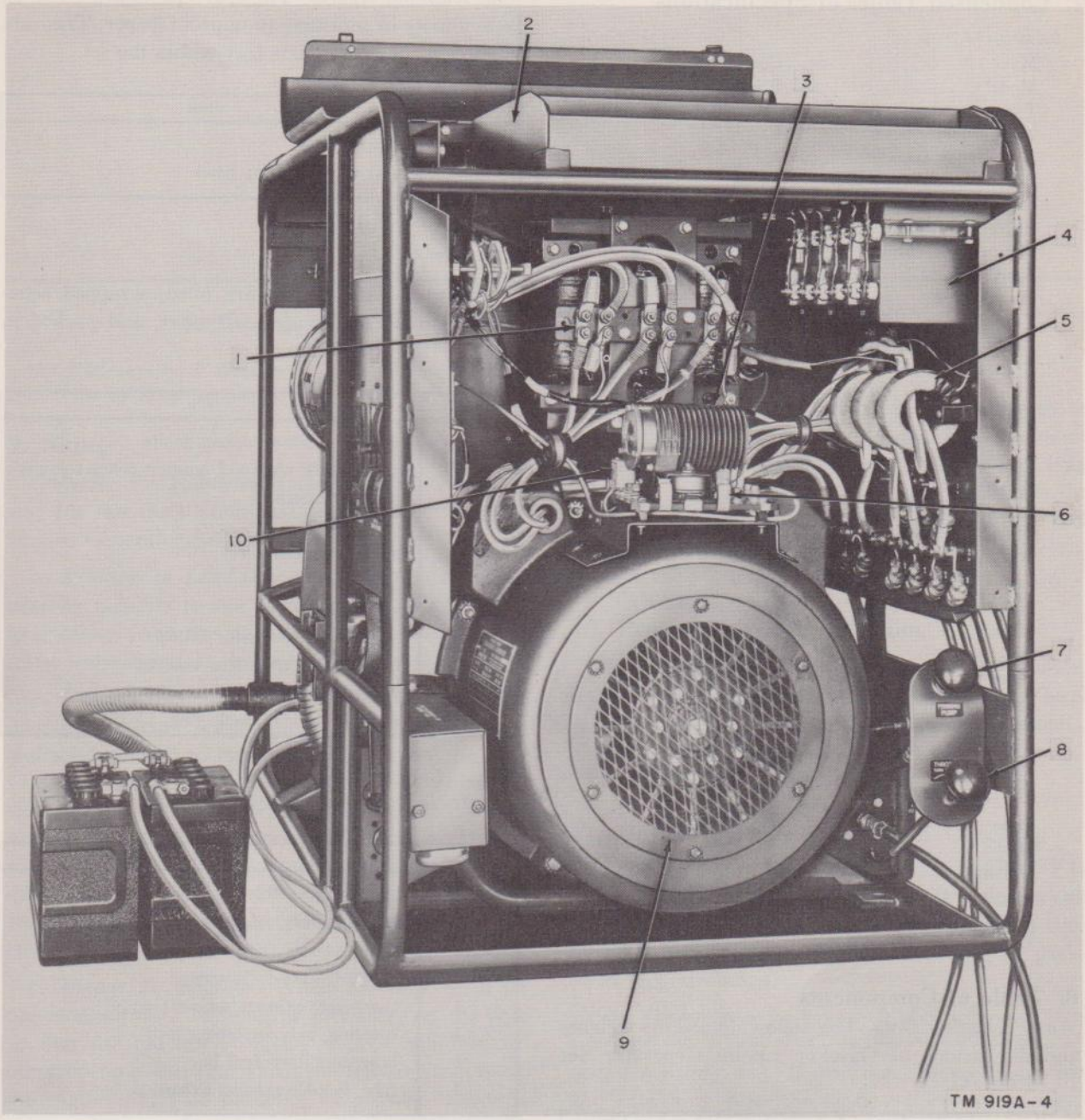


Figure 4. Gasoline Engine Generator Set PU-107A/U, rear view.

1. Compensator transformer (T2).
2. Tool tray (MP546)
3. Dc voltage regulator (E14)
4. Compensator capacitor assembly (C26)
5. Ammeter current transformers (T4 and T6).
6. Stop relay (K3).
7. Primer pump (MP431).
8. Manual throttle (MP531).
9. Alternator (G2).
10. Start relay (K1).

7. Condensed Tables of Specifications

a. Engine.

Make ..... Continental.
Model ..... FS-162-6011.
Type ..... 4-stroke cycle.
Type cylinder head ..... L.
Number of cylinders..... 4.
Bore ..... $3\text{-}^{7}/_{16}$.
Stroke ..... $4\text{-}^{3}/_{8}$.
Piston displacement ..... 162 cu in.
Compression ratio ..... 6.3 to 1.
Speed ..... 1,714 rpm.
Horsepower ..... 41.
Type cooling ..... Liquid.
Cooling system capacity .... 15 qt.
Type lubrication ..... Pressure and splash system
Lube oil capacity ..... 4½ qt.
Fuel consumption (gal per hr). ..... 2.5.
Air cleaner ..... Oil bath.
Spark plugs ..... XE-8 Coml (Champion).
Ignition system ..... Magneto.
Batteries (2) ..... 12-v each.

b. Alternator.

Make ..... Hollingsworth.
Model ..... APG-H-11636.
Voltage ..... 120/208.
Phase ..... Single or three.
Cycle ..... 400.
Power factor 0.8
Speed ..... 1,714 rpm.
Drive ..... Direct.

c. Dc Generator.

Make ..... Hollingsworth.
Model ..... DG.
Voltage ..... 28.
Ampere rating ..... 90.
Speed ..... 4,500 rpm.
Drive ..... Pulley and belt.

8. Table of Components

a. Packaging Data. The following are the weights and dimensions of Gasoline Engine Generator Set PU-107A/U.

Quantity	Item	Width (in.)	Length (in.)	Height (in.)	Volume (cu ft)	Weight (lb)
1	Gasoline Engine Generator Set PU-107A/U	28	48	37	28.8	1,150
	1 Engine	22	24	22	7.77	335
	1 Alternator	18.5	11.06	18.88	1.79	245
	2 Battery (crated)	9	14	12	0.087	35

b. Running Spares. The spare parts are wrapped individually in moisture-fungiproof paper. They are packed in the spare parts tray within the set.

Quantity	Item
4	spark plugs
4	gaskets, fuel pump bowl

c. Tools.

The tools listed below are oiled, wrapped separately in moisture-fungiproof paper, and packed in the tool tray within the set.

Quantity	Item
1	dresser, ignition contact points
1	gage, spark plug and ignition contact points
1	handle, wrench
1	oiler, hand
1	pliers, combination
2	sandpaper, flint
1	screw driver
1	screw, eye, alternator lifting
1	bolt, puller, alternator bearing
1	wrench, adjustable
1	wrench, socket, spark plug, 13/16 in.

d. Installation Equipment.

Quantity	Item
1	adapter, fuel drum
1	cable, battery, negative
1	cable, battery, positive
1	cable, battery-to-battery
1	connector, exhaust tubing pipe
1	coupling, exhaust tubing lock
1	hose, auxiliary fuel line
1	tube, flexible exhaust extension

e. Miscellaneous Equipment.

Quantity	Item
2	battery, 12-volt storage (separately packaged)
1	cover, canvas
1	crank, hand
1	fire extinguisher

CHAPTER 2

INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

Note. Paragraphs 9 through 17 cover service for new, old, or reconditioned equipment.

9. Siting

Consider the following factors when selecting a site for the installation and operation of Gasoline Engine Generator Set PU-107A/U.

a. Relation to Load. Locate the generator set as near as possible to the electrical load. Excessively long cables from the unit to the load increase line resistance and cause a definite voltage drop.

b. Outdoor Installation. When the unit is to be operated outdoors, select a site that is reasonably dry and solid enough to support the weight of the unit (1,250 pounds). No special foundation is necessary; however, the unit should be operated in as near a level position as possible. If the terrain is soft or muddy, make a foundation out of planks or other similar material. If possible, provide some form of shelter to protect the equipment from the elements.

c. Indoor Installation. When the unit is to be operated within a building or inclosure, set the unit so that the radiator is facing a door, window, or other opening through which the hot-air blast from the engine may pass outdoors. If possible, attach a canvas duct to the radiator grill and attach the other end of the duct to the building opening. Connect the flexible exhaust tubing to the muffler outlet and extend the free end of the exhaust tubing to the outside of the building or shelter. Be sure that all exhaust connections are gastight. *Carbon monoxide fumes from a gasoline engine are extremely dangerous and, when inhaled, may cause serious illness or death.* Provide not less than 2 feet of space on all sides of the unit to facilitate working on and operating the equipment.

d. Location of Fuel Supply. If the unit is to be operated indoors, locate the fuel supply tank outside the inclosure within easy range of the 20-foot long fuel line furnished with the equipment. Locate the fuel supply drum so that the bottom of the fuel drum adapter is not more than 6 feet below the level of the engine fuel pump.

10. Preparation of Foundation

No special foundation is necessary; however, the generator set should be placed on a firm, level surface capable of supporting at least 1,250 pounds. The base of the packing crate will serve as a temporary foundation in mud or snow.

11. Uncrating, Unpacking, and Checking

Gasoline Engine Generator Set PU-107A/U is shipped in three packages. The set, including all spare parts, tools, and installation equipment, is contained in one large crate. The two batteries are packed in separate boxes.

Note. The bottom of the large crate is constructed to form a skid and can be used for sliding the set short distances.

a. Uncrating and Unpacking. Before uncrating and unpacking, place the set near the location where it will be operated. Uncrate the set carefully to avoid damage. Use a nail puller and other appropriate tools. Be sure to remove all packages and parts within the crate or they may be accidentally discarded with the packing material. The set is inclosed in waterproof paper and a vaporproof barrier only when prepared for overseas shipment. When prepared for domestic shipment, the vaporproof barrier is not used. Refer to figure 5 and uncrate and unpack the equipment as follows:

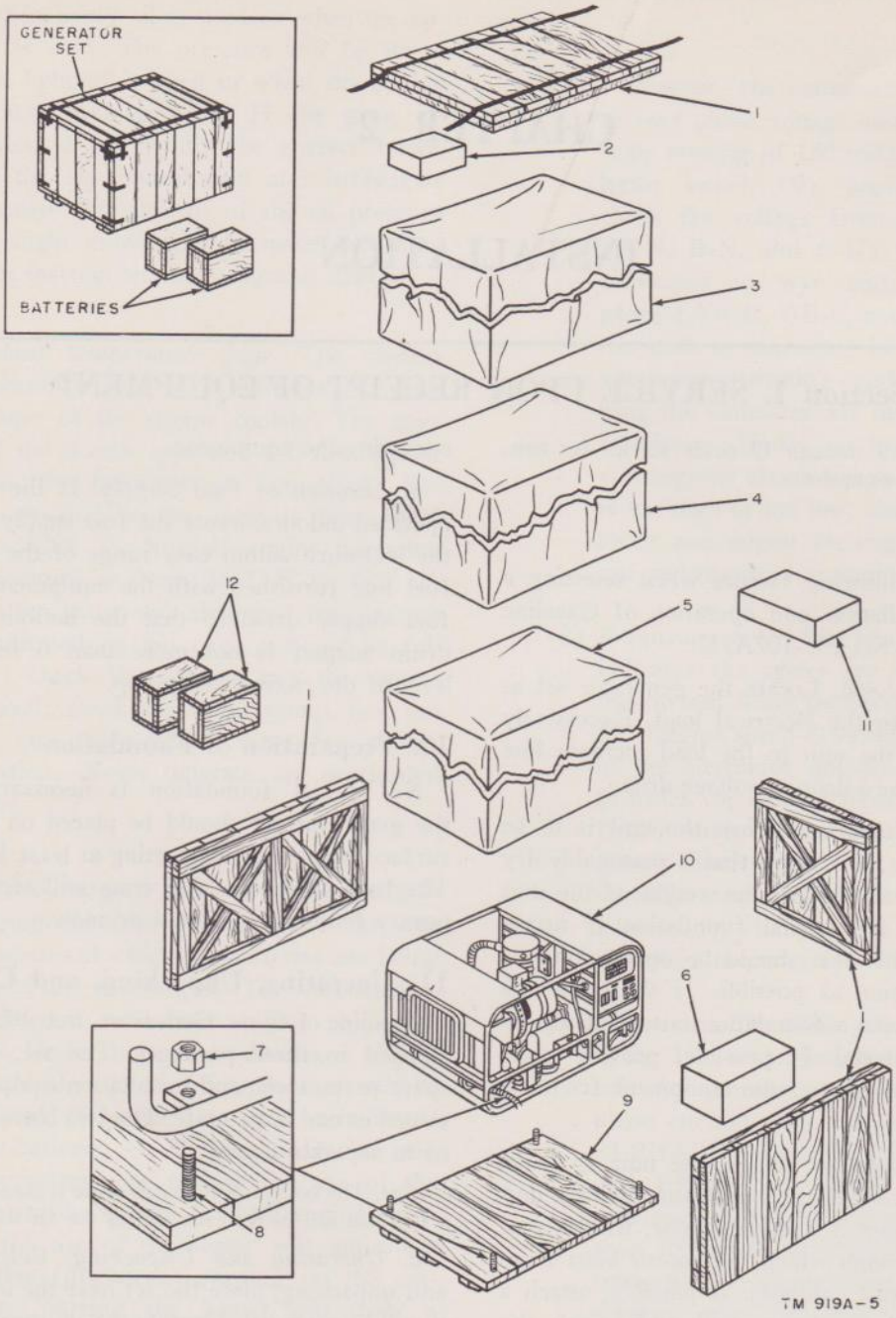


Figure 5. Generator set, packaging.

1. Top and sides.
2. Manuals.
3. Waterproof paper.
4. Vaporproof barrier.
5. Canvas cover (H2368).
6. Installation equipment.
7. Nuts.
8. Bolts.
9. Base.
10. Generator set.
11. Spare parts.
12. Batteries (BT1 and BT2).

(1) Remove the top and sides (1) of the large crate.
(2) Remove the manuals (2), located on top of the set.
(3) Remove the waterproof paper (3) and the vaporproof barrier (4).
(4) Remove the canvas cover (5), inclosing the entire set.
(5) Remove all the packaged installation equipment (6) located in the bottom of the lower frame.
(6) Remove the nuts (7) from the four bolts (8) fastening the set to the crate base (9). The generator set (10) can now be removed.
(7) Unpack the spare parts (11). The tools are wrapped individually in the tool tray in the top rear of the unit. Unwrap these only as required.
(8) Do not uncrate the batteries (12) until the equipment has been set up for operation.

b. Checking. A list of all spare parts and tools packed with the equipment is mounted on the underside of the tool tray cover. Check to be sure the equipment is complete and has not been damaged in shipment and handling.

(1) Check the tools, spare parts, installation equipment, and all major components with the packing lists.
(2) Inspect the over-all unit carefully for damage. Give particular attention to the following: Examine the carburetor, magneto, air cleaner, and fuel pump for dents and breakage. Check the fuel line from the fuel pump to the carburetor for loose connections and kinks. Examine the instruments and controls or damage. Check all wiring for torn insulation and broken wires. If any damage is noted or if the equipment does not check with the packing lists, fill out and forward DD Form 6 in accordance with the instructions in paragraph 2.

Section II. INSTALLATION PROCEDURE

12. Setting Up Equipment

After a suitable location has been chosen (par. 9) and the equipment has been checked (par. 11*b*), set up the equipment as follows:

a. Mounting on Foundation. Determine whether the equipment is to be installed indoors or outdoors, and follow the instructions in subparagraphs (1) or (2) below, as applicable.

(1) For permanent indoor installation, fasten the set to the floor or foundation. Four holes are located in the mounting pads on the bottom four corners of the lower frame. Fasten the set to the floor with ½-inch bolts or lag screws of proper length.
(2) For outdoor installation, locate the set on level ground. If this is impossible, the alternator end of the set must be the lower end.

Warning: Never operate the generator set in a position more than 10° off level, longitudinally or laterally.

b. Connecting Exhaust Tube. For indoor operation, connect the exhaust extension tube to the muffler (fig. 6). Extend the tube to an exterior wall by the most direct route with as few turns as possible. Pitch the tube downward so all condensate will drain out. If the tubing passes through an inflammable wall, install appropriate fireproof insulation.

Warning: Be sure that all connections are gastight. Carbon monoxide is deadly poisonous. Inhaling exhaust gases may be fatal.

c. Installing Fuel Hose. Connect the 20-foot

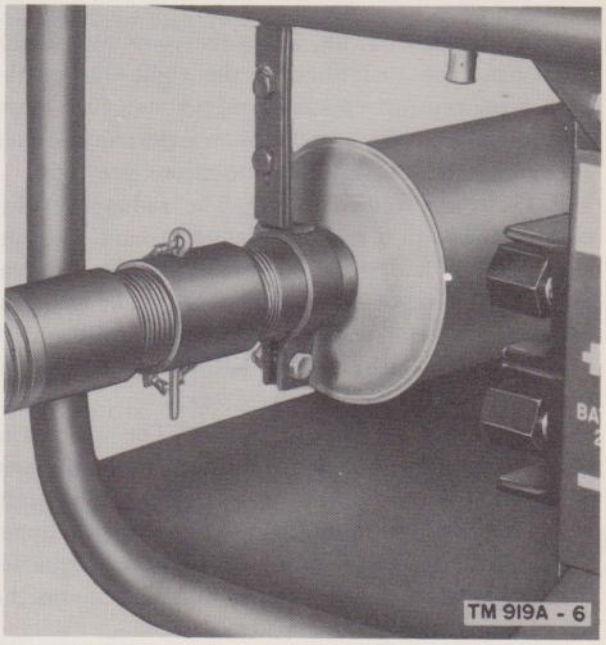


Figure 6. Exhaust tube connection to muffler.

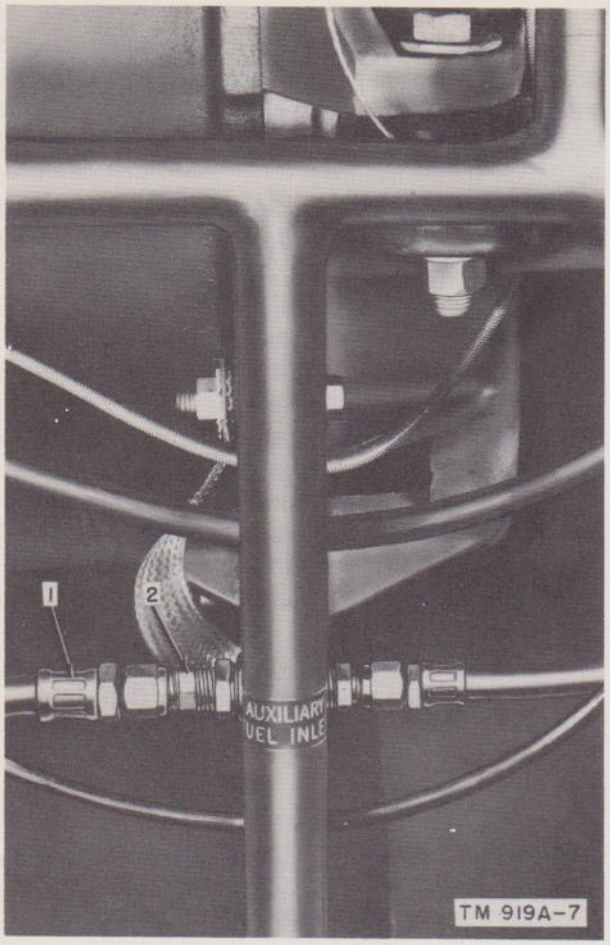


Figure 7. Fuel supply hose connection.
1. Remote fuel line. 2. Remote fuel line adapter.

remote fuel line (1, fig. 7) to the coupling (2) located near the fuel filter on the right side of the unit. Connect the opposite end to the fuel drum adapter. Mount the adapter in an externally located fuel container. Be sure all connections are tight.

d. Installing Radiator Duct. The radiator grill is constructed with a channel flange around the outside edge. For indoor operation, attach a canvas duct to the flange. Use a window or make an opening in an exterior wall and attach the outlet end of the duct. This opening must be at least as large as the radiator grill flange.

e. Installing Fire Extinguisher. The fire extinguisher, mounting bracket, and hardware are shipped with the equipment but detached from the unit. Mounting holes have been drilled in the rear upper frame panel for mounting the fire-extinguisher bracket. Bolt the bracket to the unit and mount the fire extinguisher in the bracket.

13. Removal of Corrosion Preventives

Corrosion preventives are for permanent protection and must not be removed. There are no protective seals installed on the unit.

14. Connections and Interconnections

All internal connections for the operation of the generator set are made at the factory and no additional connections within the unit are needed. Make ac output connections, dc output connections, remote start connections, and battery connections as follows:

a. Ac Output Connections. The wye-delta change board and the output terminals are located on the right side of the unit. Open the change board door to check the ac output rating in which the generator set is connected. The symbol of the rated load will be either Y (wye) or Δ (delta). To change the voltage connections, remove the six nuts and washers that secure the jumper board to the terminal board. For 120-volt, single-phase, 10-kw operation, connect the jumper board in the delta position (fig. 8). Connect cables from the load to output terminals marked PHASE A (1, fig. 8) and PHASE C (2). Use #O AWG (American Wire Gauge) cable. For 120/208-volt, three-phase, 12.5-kw operation, connect the jumper board in the wye position (fig. 9). Connect cables from the load to output terminals marked PHASE A (1, fig. 9), PHASE B (2), PHASE C (3), and NEUTRAL (if required). Use #4 AWG cable. Figures 8 and 9 show the proper delta and wye connections.

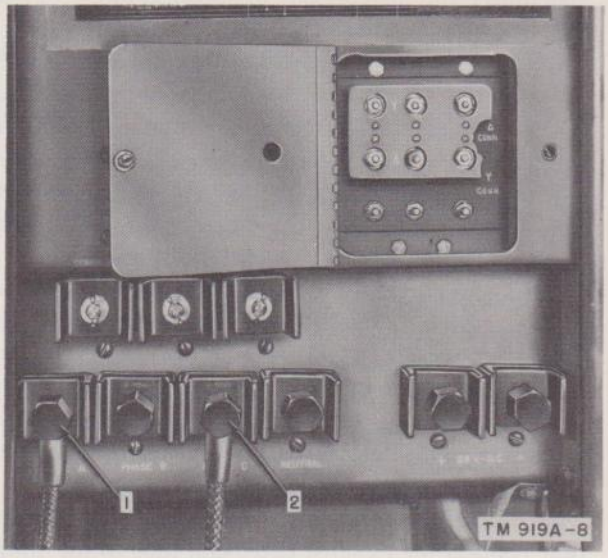


Figure 8. Single phase, 120 volt connections (Delta).
1. PHASE A terminal. 2. PHASE B terminal.

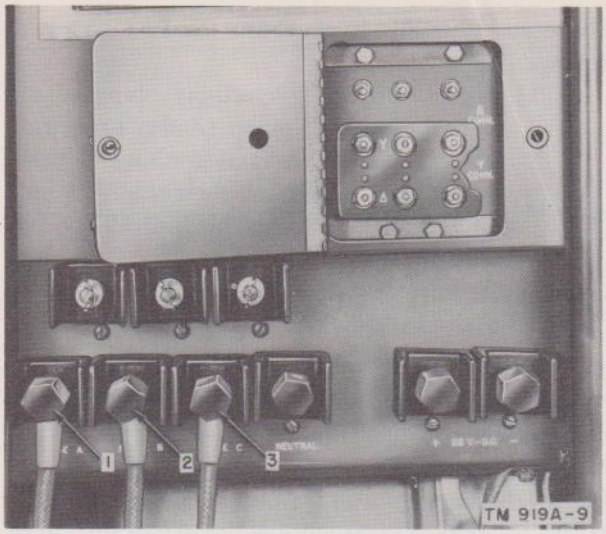


Figure 9. Three-phase, 120/208-volt connections (Wye).

1. PHASE A terminal. 2. PHASE B terminal. 3. PHASE C terminal.

Warning: Never change the output voltage with the unit in operation.

b. Dc Output Connections. A dc load of 2.5 kw at 28 volts may be connected to the unit at any time that the total ac load is not in excess of 10 kw, three-phase, or single-phase. Connect the dc load to the positive (+) and negative (—) output terminals located adjacent to the ac output terminals on the left side of the unit. Use #O AWG cable.

c. Remote Control Connections (fig. 10). Three remote control terminals are located on the right side of the unit, above the ac output terminals. The terminals are marked STOP, COMMON, and START. By using a three-conductor cable, #14 AWG or larger, the remote location may be extended up to 150 feet. To operate the unit from a remote location, it will be necessary to install a start-stop switch at the remote point. With a single-pole, double-throw, center-off toggle switch, make the following connections:

(1) Connect one wire of the cable from the stop terminal on the switch to the remote stop terminal on the unit.

(2) Connect one wire of the cable from the start terminal on the switch to the remote start terminal on the unit.

(3) Connect the remaining wire from the common terminal on the unit to the center (common) terminal of the switch.

d. Battery Connections. Two terminals for connecting the battery cables are located on the left side of the unit. After preparing the batteries for use as instructed in paragraph 17, position the batteries near the unit and connect them as follows: Attach the battery jumper cable from the negative post of one battery to the positive post of the other battery. Connect a cable from the positive (+) terminal (1, fig. 11) on the unit to the battery with the *open* positive post. Connect a cable from the negative (—) terminal (2) on the unit to the battery with the *open* negative post. Figure 11 shows the proper battery connections.

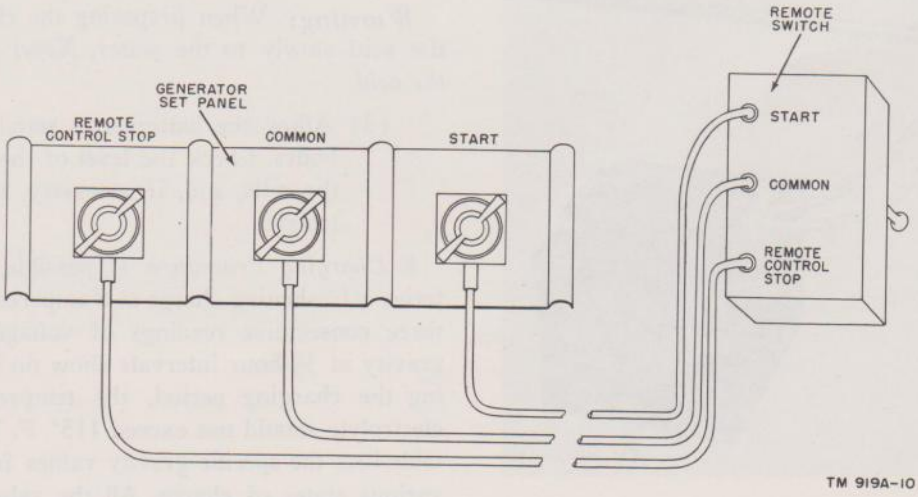


Figure 10. Remote control connections.

15. Initial Lubrication

Inspect the crankcase oil drain valve to be sure it is closed. Remove the cap from the oil filler tube and fill the crankcase with oil as specified in the lubrication chart (fig. 17). The capacity of the lubrication system is 4½ quarts. Replace the oil-filler tube cap. Unfasten the two clamps on the air cleaner and remove the bowl. Clean the bowl with Solvent, Dry Cleaning (SD) and fill to the normal oil level mark with oil as specified in the lubrication chart. The remainder of the set is factory-lubricated and does not require initial preparation.

16. Preparation of Fuel System and Cooling System

a. Install the flexible fuel line and the fuel drum adapter as instructed in paragraph 12*c*. If possible, the container from which fuel is drawn should be located so that the bottom of the fuel drum adapter is about on the same level as the carburetor on the engine. Avoid placing the fuel container too much above or below this level. Prime the fuel system as follows:

(1) With all the fuel connections completed, operate the priming pump (7, fig. 4) by pulling the handle up and pushing it down again, until considerable resistance is built up within the pump. This will fill the fuel filter and fuel lines.

(2) Be sure that the priming pump handle is pushed all the way in before attempting to start the engine.

b. Be sure the coolant drain cocks on the radiator and the winterization heater are closed. Fill the cooling system with clear water for temperatures above 32° F. In temperatures 32° F or lower, add antifreeze solution in accordance with current directives. The liquid capacity of the cooling system is 15 quarts.

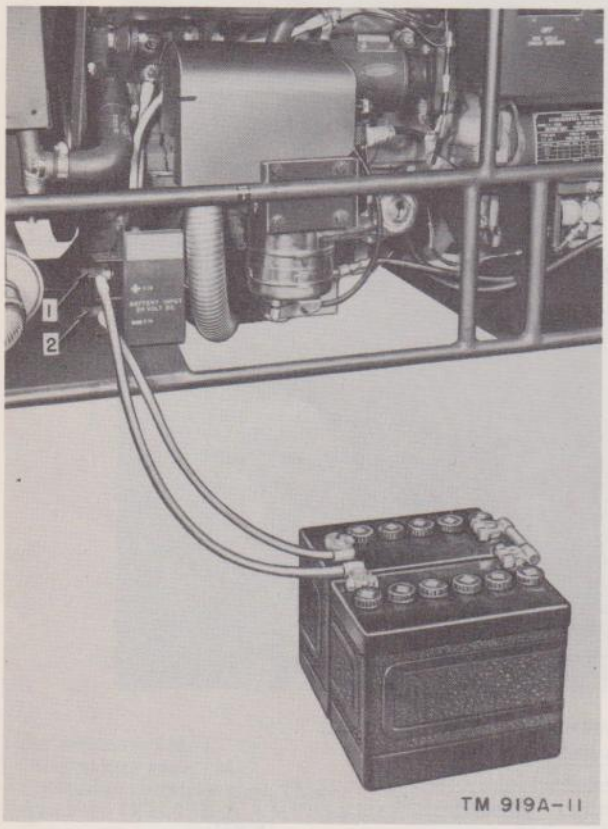


Figure 11. Battery connections.
1. Positive (+) terminal. 2. Negative (—) terminal.

17. Preparation of Storage Batteries

a. Initial Preparation. The two 12-volt lead-acid storage batteries are shipped in a dry-charged condition. The manufacturer's instructions for preparing the batteries are lettered on each battery. Additional instructions follow:

(1) Remove or destroy any sealing device that may have been used to close or restrict the vent openings.

(2) Fill the cells to ½ inch above the separators with electrolyte (sulphuric acid diluted with distilled water). The electrolyte should have a specific gravity of 1.280 at a temperature of 80° F.

Warning: When preparing the electrolyte, add the acid slowly to the water. *Never add water to the acid.*

(3) Allow the batteries to stand from 1 to 4 hours. Check the level of the electrolyte in the cells, and, if necessary, add more electrolyte.

b. Charging Procedure. If possible, give the batteries a freshening charge at 8 amperes. Charge until three consecutive readings of voltage and specific gravity at ½-hour intervals show no increase. During the charging period, the temperature of the electrolyte should not exceed 115° F. The following table lists the specific gravity values for batteries in various states of charge. All the values shown are for electrolyte at the correct filling height and at 80° F.

State of Charge	Standard specific gravity in temperate climates
Fully charged	1.280
75% charged.	1.230
50% charged.	1.180
25% charged.	1.130
Discharged.	1.080

c. Temperature Changes of Specific Gravity.

(1) The hydrometer readings will be correct only when the electrolyte in the battery is at a temperature of 80° F. If the temperature is higher or lower than 80° F, an allowance must be made to correct the reading obtained.

(2) Draw electrolyte in and out of the hydrometer barrel several times to bring the temperature of the hydrometer float to that of the acid in the cell and then measure the electrloyte temperature in the cell. Some hydrometers have a small thermometer and a correction scale built into them so that the temperature corrections can be made readily. The temperature correction is approximately .004 specific gravity, sometimes referred to as four points of gravity for each 10° F change in temperature.

(3) The following table lists the correction for hydrometer readings with the amount to be added or subtracted when the electrolyte temperature (not the air temperature) is above or below 80° F.

Temperature of electrolyte (° F)	Specific gravity correction factor
160	Add .032
155	Add .030
150	Add .028
145	Add .026
140	Add .024
135	Add .022
130	Add .020
125	Add .018
120	Add .016
115	Add .014
110	Add .012
105	Add .010
100	Add .008
95	Add .006
90	Add .004
85	Add .002
80	.000
75	Subtract .002
70	Subtract .004
65	Subtract .006
60	Subtract .008
55	Subtract .010
50	Subtract .012
45	Subtract .014
40	Subtract .016
35	Subtract .018
30	Subtract .020
25	Subtract .022
20	Subtract .024
15	Subtract .026
10	Subtract .028

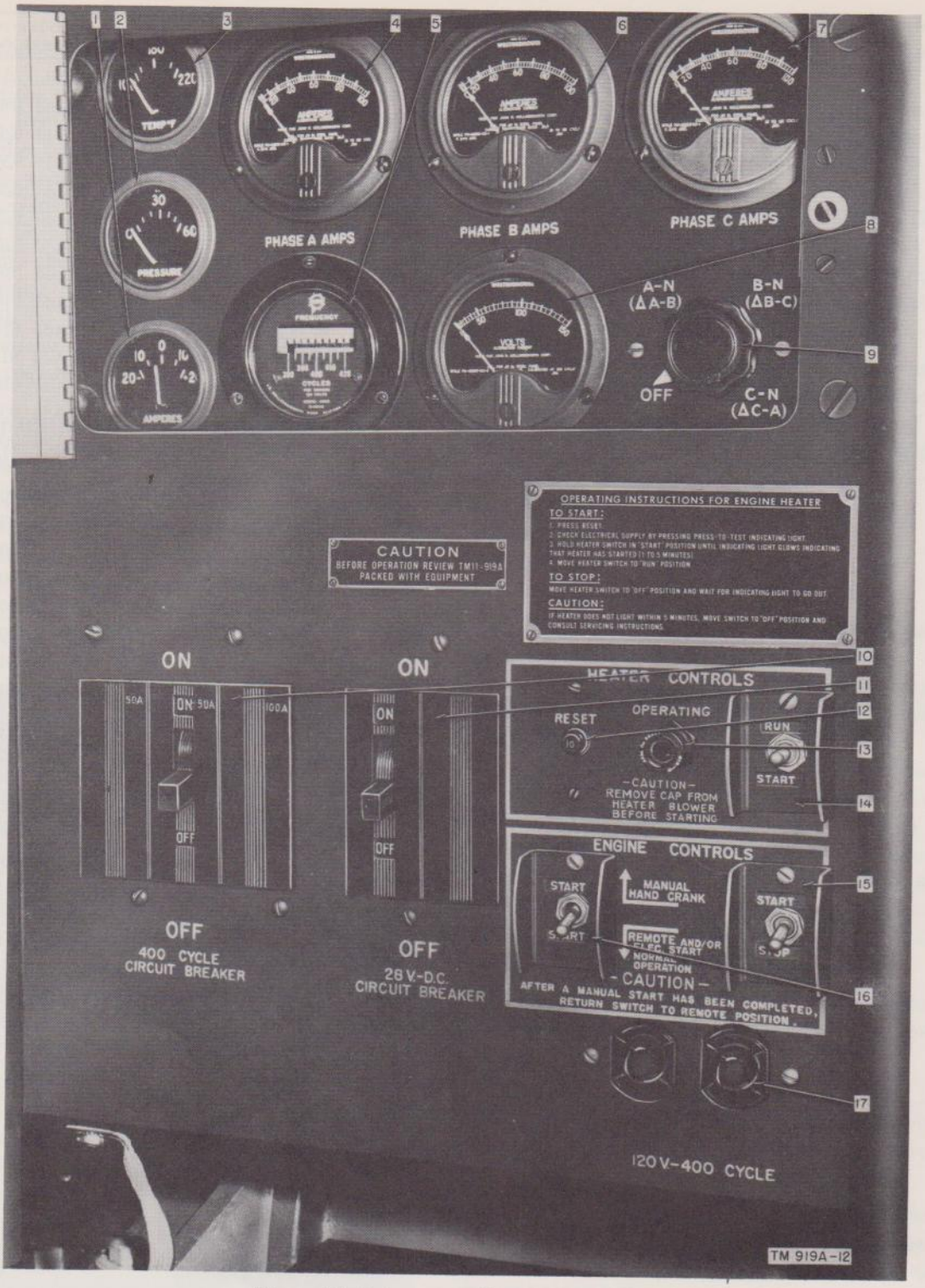


Figure 12. Instrument and control panel.

1. Dc ammeter (M3).
2. Oil pressure gage (M1).
3. Coolant temperature gage (M2).
4. Ammeter (PHASE A AMPS) (M6).
5. Frequency meter (M4).
6. Ammeter (PHASE B AMPS) (M7).
7. Ammeter (PHASE C AMPS) (M8).
8. Voltmeter (M4).
9. Voltmeter selector switch (S8).
10. 400 CYCLE CIRCUIT BREAKER (CD3).
11. 28-V.-D.C. CIRCUIT BREAKER (CD1).
12. Heater circuit breaker (RESET) (CD2).
13. Heater OPERATING indicator lamp (XDS1).
14. Heater RUN-START switch (S7).
15. START-STOP switch (S4).
16. Ignition switch (S1).
17. 120 V.-400 CYCLE duplex receptacle (J1).

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

Note. This section describes, locates, illustrates, and furnishes the operating personnel with information pertaining to the various controls and instruments provided for the proper operation of the equipment.

18. Manual Controls

a. Engine.

(1) *Ignition switch* (16, fig. 12). A toggle-type switch, located on the control panel, selects the ignition circuit for MANUAL HAND CRANK or REMOTE AND/OR ELEC. START NORMAL OPERATION. If the unit is to be started by hand cranking, place the switch in the MANUAL HAND CRANK position; if the set is to be started remotely or by the START-STOP switch (subpar. (2) below), place the switch in the REMOTE AND/OR ELEC. START NORMAL OPERATION position.

(2) *START-STOP switch* (15, fig. 12). The three-position, START-STOP toggle switch is located on the control panel. To start the set, hold the switch in the START position; to stop the set, place the switch in the STOP position. The switch is designed so that the actuating handle returns to the center position when released from the START position.

(3) *CHOKE* (28, fig. 2). To assist in starting the set while hand cranking, a flexible wire-and-sleeve type manual choke is mounted on the right side of the radiator. Pull the CHOKE out when cranking a cold engine. After the set has started, push the CHOKE in all the way.

Note. Function of the automatic choke (par. 19*a*(4)) is sufficient after the engine has started, and manual choking is no longer necessary.

(4) *THROTTLE* (8, fig. 4). The manual THROTTLE is a wire-and-sleeve-type control mounted on the rear of the set on the lower frame. Use the manual THROTTLE to run the engine for prolonged periods of no load operation or when the unit is to be started in a cold temperature and it is necessary to warm the engine at idling speed. Lock the THROTTLE in the desired position by turning the knob clockwise.

Caution: Do not apply load to the set while the manual THROTTLE is in control.

(5) PRIMING PUMP (fig. 4). The set is provided with a PRIMING PUMP (7) located just above the manual THROTTLE. Use the pump when starting the set in low temperatures. To operate the pump, pull the knob out all the way and push it back to its original position. Operate the pump only while the engine is being cranked. One or two strokes are usually enough to start the engine. Be careful not to overprime.

b. Dc Generator. Two manual controls are used with the dc generator (1, fig. 2); a circuit breaker

and a variable voltage resistor. The 28-V. D. C. CIRCUIT BREAKER (11, fig. 12), mounted on the control panel, serves as the main load switch and the overload trip in the dc circuit. To connect the load, push the trip lever to ON; to disconnect the load, push the trip lever to OFF. The circuit breaker trips off automatically (par. 19*b*(1)) whenever the circuit becomes overloaded. To reset the circuit breaker after it has tripped, push the lever all the way down to the OFF position and then up to the ON position. The variable resistor on the dc voltage regulator (3, fig. 4) has a range of from 25 to 30 volts. Turn the slotted shaft of the variable resistor until the desired voltage is reached.

c. Winterization System (fig. 12). All the winterization controls are located on the control panel.

(1) *Circuit breaker* (RESET). The circuit breaker (RESET) (12) is used as the main switch to connect and disconnect the winterization system circuit. Push in the RESET button all the way to connect the system; pull out the button to disconnect the system. The circuit breaker trips off automatically (par. 19*c*(1)) whenever the circuit becomes heavily overloaded. To reset the circuit breaker after it has tripped, push in the RESET button.

(2) *Heater RUN-START switch.* The heater RUN-START switch (14) is used to start and run the winterization heater. To start the heater, after the RESET button has been pushed in (subpar. (1) above), hold the switch in the START position 2 to 4 minutes. After the heater OPERATing indicator lamp (subpar. (3) below) flashes on, place the switch in the RUN position. To shut off the heater, place the switch in the off (center) position.

(3) *Heater OPERATING indicator lamp.* The heater OPERATING indicator lamp (13) shows when the heater is in operation (par. 19*c*(2)). The lamp also may be used as a check on the power supply to the heater. To check the power supply, be sure the circuit breaker (RESET) button (subpar. (1) above) is in all the way. Then press the lamp. If power is available, the lamp will glow.

d. Alternator.

(1) *Circuit breaker* (fig. 12). The 400 CYCLE CIRCUIT BREAKER (10) mounted on the control panel, serves as the main load ON-OFF switch and the overload trip in the ac circuit. To connect the load, push the trip lever to ON; to disconnect the load, push the trip lever to OFF. The circuit breaker trips off automatically (par. 19*d*(1)) whenever the circuit becomes heavily overloaded. To reset the circuit breaker after it has tripped, push the lever all the way down to the OFF position and then up to the ON position.

(2) *Wye-delta change board* (fig. 3). The wye-delta change board (1), mounted on the right side of the set, is used to select the output voltage of the alternator, depending on the load requirements. Refer to paragraph 14*a* for instructions on changing the voltage connections by means of the wye-delta change board. The connection can be checked and/or changed after opening the change board door.

e. Miscellaneous. The 120V-400 CYCLE duplex receptacle (17, fig. 12) mounted on the control panel, is a means of connecting external power for trouble-shooting lamps, fans, or similar equipment requiring 120-volt, 400-cycle power. The receptacle is the Twistlock type and contains two connectors.

19. Automatic Controls

a. Engine.

(1) *Engine speed governor* (10, fig. 3). An engine speed governor, mounted on the right side of the engine, regulates the speed of the engine that governs the output frequency of the set. The governor is gear-driven from the camshaft timing gear and is connected to the carburetor throttle through adjustable linkage. The governor is set at the factory and should not require adjustment. However, if adjustment is necessary, follow the instructions in paragraph 25*b*.

(2) *High coolant temperature cutoff switch* (3, fig. 2). The engine is equipped with a thermostatically operated high coolant

temperature cutoff switch, mounted on the cylinder-head coolant outlet neck. If the coolant temperature exceeds a predetermined value, the switch grounds the magneto primary and thereby stops the engine. The switch is adjustable to permit selection of any desired temperature between 160° F and 220° F. It is set at 200° F at the factory.

(3) *Low-oil-pressure cutoff switch* (7, fig. 2). A low-oil-pressure cutoff switch, mounted on the left side of the engine, grounds the magneto circuit if the engine oil pressure drops below a safe minimum of approximately 5 psi for engine operation.

(4) *Automatic choke* (4, fig. 3). An automatic thermal-type choke is installed on the exhaust manifold adapter elbow. When the engine is cranked electrically, the carburetor is choked automatically to the extent required by the temperature of the engine.

b. Dc Generator.

(1) *Circuit breaker* (11, fig. 12). The 28-V. D.C. CIRCUIT BREAKER, mounted on the control panel, trips automatically if the circuit becomes heavily overloaded. The thermal trip release is factory-set for time-delay operation and the circuit breaker is sealed. To reset or manually operate the circuit breaker as a load switch, refer to paragraph 18*b*.

(2) *Dc voltage regulator* (3, fig. 4). A dc voltage regulator is mounted on a base secured to the top of the alternator stator housing. The carbon pile voltage regulator controls the 28-volt dc generator voltage output by automatically controlling the generator field current.

c. Winterization System.

(1) *Heater circuit breaker* (12, fig. 12). The heater circuit breaker (RESET) trips automatically when the heater circuit becomes heavily overloaded. For use as a master switch and for the method of resetting, refer to paragraph 18*c*(1).

(2) *Heater OPERATING indicator lamp.* The heater OPERATING indicator lamp (13), mounted on the control panel indicates when the heater is operating. The lamp will glow when the heater is burning on either high or low fire, or after the heater has been turned off and is purging itself of fuel. To operate the lamp as a check on the winterization system power supply, refer to paragraph 18*c*(3).

d. Alternator.

(1) 400 CYCLE CIRCUIT BREAKER. The 400 CYCLE CIRCUIT BREAKER (10), mounted on the control panel, trips automatically if the circuit becomes heavily overloaded. The thermal trip release is factory-set for time-delay operation and the circuit breaker is sealed. To reset or manually operate the circuit breaker as a load switch, refer to paragraph 18*d*(1).

(2) *Compensator assembly* (1, fig. 4). A compensator assembly, consisting of a three-phase transformer and a network of six capacitors (4), serves as a static voltage regulator by correcting the alternator internal power factor. The compensating transformer is mounted on the firewall above the alternator stator housing. The capacitors are mounted above and to the right of the transformer.

e. Battery Charging (5, fig. 3). The 24-volt dc automotive-type battery-charging generator is mounted on the right side of the engine, and is used to keep the engine starting batteries charged for regular use. The charging rate to the batteries is controlled by the automotive-type battery-charging voltage regulator mounted on the forward side of the firewall, inside of the suppression box (2).

20. Instruments

a. Engine Instruments (fig. 12). All the engine instruments are located on the instrument panel.

(1) *Oil-pressure gage.* The oil-pressure gage (2) indicates the pounds per square inch of oil pressure being delivered to the engine bearings. The gage is of the electric type and will not operate unless the batteries are connected. The gage has a 0 to 60-pound

scale, and normal operating oil pressure is 20 to 30 psi. The pressure will be higher when heavy oil is used or when the engine is cold. The pressure will be lower when light oil is used or when the engine bearings become worn. If the gage indication is not within the correct range, stop the set immediately and investigate the cause. Adjustment of the oil pressure to a slight extent can be made according to the instructions in paragraph 25*b*(6).

(2) *Coolant temperature gage.* The coolant temperature gage (3) indicates the temperature of the engine coolant. The gage is of the electric type and will not operate unless the batteries are connected. The scale reading on the gage is from 100° F to 220° F. Normal engine operating temperature is from 165° F to 185° F. If, after warm-up, abnormal temperature is indicated on the gage, proceed as follows: check the coolant and the engine oil level; check the water pump, fan, fan belt, and thermostatic valve for proper operation. Never operate an overheated engine.

(3) *Battery-charging ammeter.* The battery-charging ammeter (1) indicates the rate in amperes at which the batteries are being charged or discharged. The ammeter is calibrated to read from —20 to +20 amperes. Under normal conditions, a charging rate of +½ to +5 amperes should be indicated. A higher rate may be indicated if the batteries are discharged. During cold temperatures that require the use of the winterization system for cold engine starting, the use of the heater will indicate a negative (discharge) reading on the ammeter. Starting the heater will show a —12-ampere reading from 1 to 5 minutes; and running the heater will show approximately —¾ ampere. Negative readings, while the unit is operating, may also indicate that the battery leads are reversed or that there is a short circuit in the charging system. No reading indicates a faulty charging system or a loose or broken connection.

b. Alternator Instruments (fig. 12). All the alternator instruments are located on the instrument panel.

(1) *Voltmeter.* The voltmeter (8) is connected to read phase voltage and has a maximum scale reading of 150 volts. A voltmeter selector switch (9), provides facilities to check the voltage from phase to neutral (A-N, B-N, and C-N) when the unit is connected in wye and from phase to phase (△A-B, △B-C, and △C-A) when the unit is connected in delta. With the alternator operating under full balanced load, the voltmeter will indicate 120 volts in all phases. Under no load, the voltmeter will register about 124 volts. If the voltage is too high or too low, check the frequency meter and adjust the engine speed governor as instructed in paragraph 25*b*.

(2) *Frequency meter.* The frequency meter (5) indicates the cycles per second (cps) of the current being produced by the alternator. Engine speed determines the frequency of the alternator output. The meter scale provides for indications of 380 to 420 cps. Under stable operation at full load, the frequency meter must indicate 400 cps. Any deviation from the desired reading can be adjusted by changing the engine speed as described in paragraph 25*b*.

(3) *Ammeters.* The three ammeters (4, 6, and 7, fig. 12), connected to the alternator circuit by current transformers, register phase current. The ammeters are designated PHASE A AMPS, PHASE B AMPS, and PHASE C AMPS and provide a maximum scale reading of slightly more than 100 amperes. When the alternator is connected for single-phase, 120-volt output (delta), the PHASE A AMPS and PHASE C AMPS ammeters will register 104 amperes under full load. The PHASE B AMPS ammeter will indicate zero. When the alternator is connected for three-phase, 208-volt output (wye), all the ammeters will register 43.5 amperes under full load, Abnormal ammeter readings indicate an unbalanced load, defective ammeters, or defective lines to the load.

Section II. OPERATION UNDER USUAL CONDITIONS

Note. Personnel charged with the operation of the equipment covered in this manual will secure DA Form 11-260, and make appropriate entries thereon.

21. Preliminary Procedures

Before starting, check the set as follows:

a. Fuel System. Check the available supply for the correct grade of fuel. In temperatures above 0° F, use Gasoline, Automotive Combat (86A). Check the auxiliary fuel hose for proper connections (par. 12*c*). Examine all fuel fittings for loose connections.

b. Cooling System. Be sure the cooling system is filled to capacity (15 quarts) with clean water. Inspect all hose fittings and drains for evidence of looseness or leakage. Check the high coolant temperature cutoff switch for proper setting (par. 19*a*(2)).

c. Exhaust System. Check all exhaust connections for proper installation. Be sure the exhaust extension tube is assembled properly (par. 12*b*). All connections must be gastight.

d. Lubrication. The lubrication system must be prepared as instructed in paragraph 15. Recheck to be sure the crankcase oil level is correct.

e. Batteries. Check to be sure that the batteries have been prepared adequately for use (par. 17) and that all cable connections are correct and secure (par. 14*d*).

f. Instrument and Control Panel. Check all the instruments and controls located on the panel and within the unit for damage and insecure mounting. See that all electrical connections are tight and correct. The circuit breakers must be in the OFF position unless the unit is to be started remotely.

g. Remote Starting. If the unit is to be operated from a remote location, be sure the connections are correct as instructed in paragraph 14*c*. They must be clean and secure. The circuit breakers must be in the ON positions for remote operation.

h. Output Connections. Check the wye-delta change board for proper setting for desired output. If incorrect, change as instructed in paragraph 14*a*. The output terminals must be connected to the load correctly, and the connections must be secure and clean.

i. General Inspection. Inspect the fan belt, dc generator belt, and battery-charging generator belt for proper tension (par. 48). Check the entire unit for loose nuts, bolts, electrical connections, and fittings. Remove all tools and waste material from around the unit. Be sure the operating location is ventilated properly.

22. Starting

Caution: Do not attempt to start the set with the circuit breakers in the ON position, except when starting from a remote location.

a. Electrically. To start the set electrically, proceed as follows:

(1) Be sure both circuit breakers (10 and 11) are in the OFF position.

(2) Move the ignition switch (16) into the REMOTE AND/OR ELEC. START NORMAL OPERATION position.

(3) Move the START-STOP switch (15) to the START position and hold it there until the engine starts. As soon as the engine starts, release the switch. If the engine fails to start, release the switch for at least 10 seconds and then repeat the starting procedure. If the engine still fails to start, refer to the trouble-shooting chart (par. 50) for the possible cause and the remedy.

Caution: Do not operate the hand CHOKE when starting electrically.

(4) To start the set at idling speed, operate the manual THROTTLE as instructed in paragraph 18*a*(4).

b. Manually. The engine may be started by hand cranking in the event that the batteries do not supply sufficient power. To start the engine manually, proceed as follows:

(1) Be sure both circuit breakers (10 and 11) are in the OFF positions.

(2) Be sure the START-STOP switch (15) is in the run (center) position.

(3) Place the ignition switch (16) in the MANUAL HAND CRANK position.

(4) Insert the hand crank (24, fig. 2) and rotate it until it engages with the crankshaft.

(5) Pull out the manual CHOKE (28, fig. 2) in the front of the set if starting in cold temperatures.

(6) Crank the engine by using a strong, quick, upward pull. Repeat as necessary; be careful not to overchoke.

(7) After the engine starts, return the ignition switch to the REMOTE AND/OR ELEC. START NORMAL OPERATION position, and push in the manual CHOKE all the way.

c. Remotely. To start the engine from a remote location, connect the remote cables as instructed in paragraph 14*c* and proceed as follows:

(1) Place the ignition switch (16) into the REMOTE AND/OR ELEC. START NORMAL OPERATION position.

(2) Place the circuit breakers (10 and 11) into the ON positions.

(3) Continue remote starting procedure in accordance with subparagraph *a*(3) above. The ignition switch in the REMOTE AND/OR ELEC. START NORMAL OPERATION position serves the same function as the electric START-STOP switch on the control panel.

23. Precaution after Starting

Warning: Do not touch the wye-delta change board or the output terminals while the set is in operation. Perform the following immediately after starting the equipment.

a. Check the coolant, fuel, and oil lines for leakage. If leaks have developed, correct them immediately. Stop the set if necessary.

b. Check the reading of the engine oil-pressure gage. It may read high during the first minutes of operation. After the warm-up period, the gage should read between 20 and 30 psi. If a high- or low-oil pressure reading is observed, shut off the unit and refer to the trouble-shooting chart (par. 50) for the possible cause.

c. The battery-charging ammeter should indicate a charging rate of +½ to +5 amperes with the batteries fully charged. If no charge or a discharge is indicated, refer to the trouble-shooting chart (par. 50) for the possible cause.

d. Observe the readings of the voltmeter and the frequency meter. The voltmeter should register between 120 and 126 volts; the frequency meter should indicate between 400 and 407 cps. The frequency is factory-set and should be correct. However, if necessary to correct the frequency, refer to paragraph 25*b* and adjust the engine speed governor as instructed.

e. The coolant temperature indicated should be between 165° F and 185° F after the warm-up period. If the temperature is above normal, remove the radiator cap and check the coolant level. Add coolant if necessary. Be careful when removing the radiator cap to avoid scalding.

f. Observe the manual CHOKE to be sure it is all the way in.

24. Applying Load

Warning: Do not apply load to the set until the engine has warmed. Be sure the load is within the range of the unit.

To apply the ac or dc load to the set, place the appropriate circuit breaker in the ON position. If the ac load has been applied, check the ammeter, voltmeter, and frequency meter readings. Compare them with the correct readings listed in paragraph 20*b*. Any deviation must be investigated and corrected immediately. If the circuit breaker automatically trips off after applying the load, recheck for overload conditions and incorrect connections. To reset, switch the circuit breaker lever to the OFF position and then to ON. *Never manually hold the circuit breaker in the ON position.*

25. Operating Procedure

a. Instrument Readings. At frequent intervals during load operation, check the reading of the instruments located on the instrument panel. Refer to paragraph 23 for normal instrument indications and the corrections necessary to adjust abnormal readings.

b. Adjustments. Adjustments necessary to correct abnormal operation of the set are explained below:

(1) *Governor adjustment to correct frequency*

(fig. 13). If the indicated frequency is abnormal and thereby causes improper voltage output, correct the frequency by making the governor adjustments as instructed in subparagraph (1)(*a*) through (*d*) below.

(*a*) To adjust the governor to correct abnormal frequency, the engine must be stopped. Loosen the lock nuts (4) and rotate the adjusting sleeve (5) until the dimension A is approximately 11¼ inches. Check the eyebolt dimension B to see that it is ⅞ inch. To increase this dimension, loosen the upper adjusting nut (9) and tighten the lower adjusting nut (10). To decrease this dimension, loosen the lower adjusting nut (10) and tighten the upper adjusting nut (9).

(*b*) Start the engine and bring the unit up to operating speed and temperature. With the generator operating at approximately 400 cycles at no load, loosen the lock nuts (4) and rotate the adjusting sleeve (5) until an increase in engine speed is effected. Turn the sleeve back until the governor just begins to take control and the generator frequency is restored to 400 cycles. Tighten the lock nuts (4) when the adjustment has been completed.

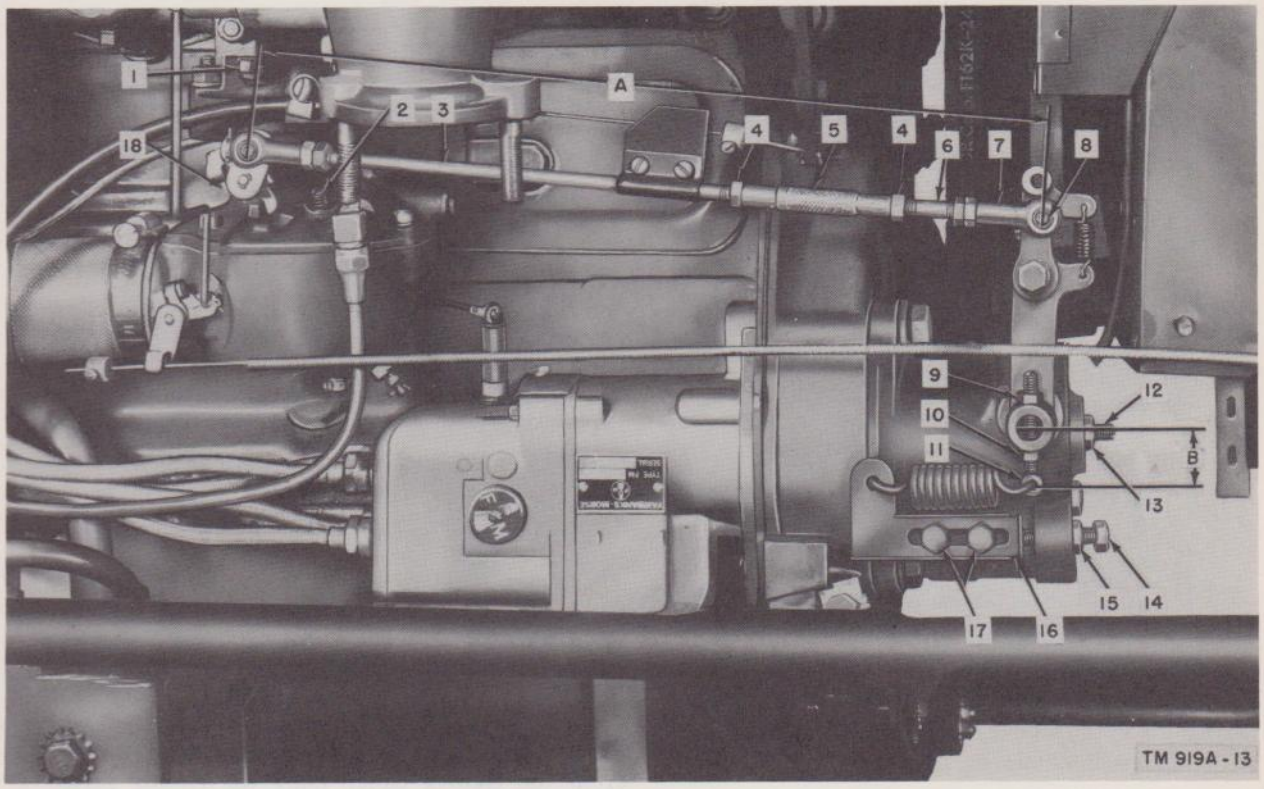


Figure 13. Engine speed governor adjustments.

1. Pipe plug.
2. Idle-adjusting needle.
3. Governor-to-throttle rod, long.
4. Lock nut.
5. Adjusting sleeve.
6. Governor-to-throttle rod, short.
7. Rod end.
8. Hexagonal nut.
9. Upper adjusting nut.
10. Lower adjusting nut.
11. Control arm eyebolt.
12. Bumper screw.
13. Lock nut.
14. Adjusting screw.
15. Lock nut.
16. Adjustment slide.
17. Shoulder bolt.
18. Throttle stop screw.

(*c*) Loosen the two shoulder bolts (17) that hold the adjustment slide (16). Loosen the lock nut (15) and change the engine speed by turning the adjustment screw (14). Turn the screw clockwise to increase the engine speed and counterclockwise to decrease the engine speed.

(*d*) When the frequency meter indicates 400 cps under load or about 405 cps under no load, secure the adjustment by tightening the lock nut (15) and shoulder bolts (17). If necessary, readjust the linkage between the governor and carburetor (subpar. (*a*) and (*b*) above).

(2) *Governor adjustment to correct engine surge under no load.* If the engine is hunting or surging under no load, correct the condition by adjusting the engine speed governor as follows:

(*a*) Loosen the lock nut (13) and turn the bumper screw (12) in, until the engine stops surging. Do not turn the bumper screw in too far or the engine speed will increase and the governor will not function properly.

(*b*) When the bumper screw has been adjusted properly, secure the setting by tightening the lock nut (13).

(*c*) If the frequency drop from no load to rated load is greater than the specified 407 to 400 cycles, decrease dimension B (fig. 13) by loosening the lower adjusting nut (10) and tightening the upper adjusting nut (9). Then readjust the no-load speed of the engine (subpar. (1)(*c*) above) until a frequency of 405 cps is obtained.

(3) *Governor adjustment to correct engine surge under load.* If the engine is hunting or surging under load, correct the condition by increasing dimension B. To do this, loosen the upper nut (9) and tighten the lower nut (10). Readjust the engine no-load speed in accordance with the instructions in subparagraph (1)(*c*) above.

(4) *Dc voltage regulator adjustment.* If necessary, refer to paragraph 18*b* and adjust the regulator to the desired output as instructed.

(5) *Carburetor adjustments.* The carburetor is provided with two external adjustments, the throttle stop screw (18, fig. 13) and the idle-adjusting needle (2). If the carburetor idling adjustment is required after the engine has warmed to operating temperature, proceed as follows: Set the hand throttle to an idling speed of approximately 500 to 700 rpm with the engine under *no load*, or to a point where the carburetor throttle stop screw (18) will touch or nearly touch the throttle stop pin (21, fig. 24). Turn the idle-adjusting needle (2, fig. 13) in (clockwise) until the engine begins to run roughly or falters, then slowly turn the screw out (counterclockwise) until the engine runs smoothly. Recheck the adjustment after the engine has been operating under load for about ½ hour.

(6) *Oil-pressure adjustment.* The engine oil-pressure adjustment should never need altering under normal conditions. However, the pressure can be slightly raised or lowered by adding or removing shims in the relief valve assembly (fig. 45) located on the right side of the cylinder block. Adding .030-inch shims between the plug (23) and the spring (26) will increase the oil pressure. Removing shims will decrease the pressure. This adjustment will change the pressure at load speed but not at idle speed.

26. Stopping

a. If the engine generator set is being controlled from the control panel, place the circuit breakers in OFF position. If the engine generator is being controlled from a remote point, leave the circuit breakers in ON position but, if possible, remove or disconnect the load at the using equipment.

b. Allow the unit to operate for a few minutes at no load and then place the START-STOP switch in STOP position.

c. Service the unit with fuel, coolant, and lubricants and, if it is not to be restarted immediately, cover it with the canvas cover provided.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

27. Operation in Arctic Climates

To operate the set in subzero temperature, special precautions must be taken to prevent poor performance or total operational failure. The equipment can operate effectively under extreme cold conditions (to —65° F) only if the procedures listed below are followed carefully. If possible, install the unit in a properly ventilated, heated shelter.

a. Service and Maintenance.

(1) *Fuel system.* When freezing temperatures are expected, drain the fuel filters and fuel lines to remove any water that may have accumulated in the fuel system. Moisture, resulting from condensation, will accumulate in tanks, drums, and containers. At low temperatures, this condensation will form into ice crystals that will clog fuel lines and carburetor jets, unless the following precautions are taken:

(*a*) Be sure that all containers are thoroughly clean and free from rust before storing fuel in them.

(*b*) Keep all containers tightly closed to prevent snow, ice, dirt, and other foreign matter from entering.

(*c*) Add 2 to 3 ounces of denatured alcohol to each gallon of fuel.

(*d*) Inspect the fuel system for leaks and correct any that are found.

(*e*) Drain any water-alcohol precipitate from the fuel filter weekly or more frequently if necessary.

(2) *Lubrication.* For protracted low temperature operation (below —10° F), drain the oil filter, engine crankcase, and air cleaner and refill with Oil, Engine, Subzero (OES). Check the crankcase oil level every 4 hours. Drain the lubricating oil filter after every shut-down to prevent accumulated sludge from freezing. Drain the engine crankcase every third day of operation.

(3) *Cooling system.* If temperatures below freezing are anticipated, protect the cooling system with antifreeze. Drain the system and refill with a mixture of 50 per cent ethylene glycol noncorrosive antifreeze and 50 per cent clean water. If the temperature is expected to reach —30° F or lower, drain the system and refill with Compound Antifreeze, Arctic, (MIL-C-11755). Do not dilute the arctic-type antifreeze.

(4) *Batteries.* In arctic climates it is essential to keep the battery electrolyte at the proper level and the batteries fully charged. The danger of the electrolyte freezing depends on the full-charge specific gravity. The electrolyte will become mushy with ice crystals at —63° F with the specific gravity at 1.250 and at —18° with the specific gravity at 1.200. When the batteries are not in use, store them in a warm place.

b. Starting. To facilitate starting in subzero temperatures, the set is equipped with a winterization system which heats the coolant, engine oil, and intake manifold. To start the unit with the aid of the winterization system, remove the cap from the blower intake, and proceed as follows:

(1) Check the fuel supply and prime the fuel system as instructed in paragraph 16*a*.

(2) Disconnect the automatic choke rod. The automatic choke must be inoperative when starting in subzero temperature.

(3) Press in the heater circuit breaker (RESET) button.

(4) Check the electrical supply by pushing the heater OPERATING indicator lamp. If power is available, the lamp will glow.

(5) Hold the heater RUN-START switch in START position until the indicator lamp flashes on (approximately 2 to 4 minutes). This indicates that the heater has started.

(6) Move the RUN-START switch to RUN position.

Note. The sound of combustion may be heard before the indicator lamp flashes on; however, do not move the switch to the RUN position until the indicator lamp lights. If the lamp does not light within 5 minutes, move the RUN-START switch to off (center) position and consult the trouble-shooting chart (par. 50).

(7) Keep the heater on for approximately 20

to 30 minutes until the engine is sufficiently warm to start and operate smoothly.

(8) Start the set in accordance with instructions in paragraph 22. Pull out the manual CHOKE about ½ to ¾ of the way from its closed position. Prime the engine slowly with one stroke of the primer pump while the engine is being cranked. If the engine does not start within 15 to 20 seconds, stop cranking and wait for at least 5 minutes before repeating the starting procedure.

Caution: Fuel does not vaporize readily in subzero temperatures. Be careful not to overprime.

(9) To stop the heater, move the heater RUN-START switch to off (center) position. The indicator lamp will remain lighted until the heater has purged itself of fuel and will then go out automatically. Pull out the heater circuit breaker (RESET) button.

(10) Replace the cap on the blower intake.

c. Stopping. Refer to paragraph 26 and stop the set as instructed. Recheck the arctic service and maintenance instructions; use adequate precautions to protect the unit when not in use.

28. Operation in Desert Areas

Locate the equipment in an area protected from sand and dust. Inspect and clean the equipment more frequently than under normal operating conditions. Keep the unit covered when not in operation.

a. Fuel System. Be sure all fuel line connections are tight. Keep the fuel supply tank tightly closed to prevent the entrance of dirt and sand.

b. Lubrication. Keep all moving parts well cleaned and lubricated when the unit is being operated in desert areas. Always remove sand, dirt, and old lubricant from parts before relubrication. Check and change the engine oil often, depending on the severity of the climate, presence of excessive dust conditions, and frequency of operation.

c. Cooling System. Proper ventilation of the cooling system is of prime importance. Keep the system full of clean water, and keep the radiator cap tight.

d. Batteries. Check the level of the electrolyte in the batteries more frequently than under normal operating conditions. Keep the vent caps tightly in place.

e. Air Cleaner. Keep clean oil in the air cleaner to prevent dust from entering the engine. Clean the air cleaner and change the oil at frequent intervals, depending on the severity of the climate. Under these conditions, never operate the unit with the air cleaner dry.

29. Operation in Tropical Climates

When operating in hot, humid climates, the equipment must be provided with unobstructed ventilation. Locate the set so that it is protected from direct rays of the sun. Shorten the time between normal lubrication periods. Keep the cooling system full of clean water. If the set is to remain idle for long periods in humid areas, run it every few days for at least 1 hour to prevent the accumulation of moisture in the stator housing. In tropical climates, prepare the batteries as instructed in paragraph 17, with the following modifications: Batteries operating in tropical climates should use electrolyte of about 1.225 specific gravity when fully charged. This milder strength of acid is less deteriorating to separators and plates which results in longer battery life. The following chart lists the specific gravity values to be used in tropical climates for batteries in various states of charge. The values shown in the table are for electrolyte at the correct filling height and at 80° F.

State of charge	Specific gravity used in tropical climates
Fully charged.	1.225
75% charged.	1.180
50% charged.	1.135
25% charged.	1.090
Discharged.	1.045

30. Operation in High Altitudes

The set will operate at rated performance at elevations from sea level to 5,000 feet above with no major adjustments. At high altitudes, however, the engine is more apt to overheat than at sea level. It is important to keep the cooling system full and to provide adequate ventilation.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS

31. Tools

All tools required for organizational maintenance are supplied with Gasoline Engine Generator Set PU-107A/U. The tools are listed in paragraph 8*c* and are normally stored in the tool tray within the set.

32. Use of Tools

a. General. The proper use of tools is very important. Tools used improperly will result in damage to the tools or the equipment and may cause personal injury.

b. Wrenches. When tightening a nut, bolt, or cap screw, be sure to use the proper size wrench. A wrench that is worn or slightly oversize will round the nut, bolt, or cap screw, and may cause damage to the equipment or personal injury if it should slip. Never use pliers for tightening or loosening nuts or bolts. Use the correct size open-end, box, or socket wrench. When tightening cylinder-head nuts or bolts, use a tension wrench if one is available. Never use a piece of pipe or other means to increase the leverage of a wrench, as this will probably result in bending the wrench or stripping the threads of the fastening.

c. Screw Drivers. When tightening or loosening a fastening with a slotted head, use a screw driver with a blade that fits the head of the fastening. Do not use a wrench or pliers on the shaft of the screw driver to increase leverage. Be sure to keep the blade of the screw driver square in the slot of the fastening. Never use a screw driver as a pry bar or chisel.

33. Care of Tools

The condition in which a mechanic keeps his tools and equipment is a good indication of his ability. Do not abuse tools by using them for work for which they were not designed. Keep tools and equipment properly stored and protected at all times when not in use. After using a tool, clean it and replace it in its proper place in the tool box. Keep all tools free from rust and protected from moisture. Keep the tool box clean and free from rust and dampness.

Section II. LUBRICATION AND PRESERVATION

34. Lubricants

The following table lists the lubricants, solvents, and preservative materials approved for use with Gasoline Engine Generator Set PU-107A/U.

Symbol	Nomenclature	Specification	Application
OE	Oil, Engine, Heavy Duty	MIL-O-2104 (ORD)	Engine crankcase, air cleaner.
OES	Oil, Engine, Subzero	MIL-O-10295 (ORD)	Engine crankcase.
GL	Grease, Aircraft and Instruments (for low and high temperatures.)	MIL-G-3278	Carburetor-to-governor linkage bearings, primer pump, throttle, manual choke.
SD	Solvent, Dry Cleaning	Federal P-S-661a	Cleaning
D-40 or D-35	Fuel Oil, Diesel	MIL-F-896	Cleaning.
GAA	Grease, Automotive and Artillery	MIL-G-10924 (ORD)	Battery cables and terminals.

35. Lubrication Periods

Lubrication instructions frequently are given in periods of days, weeks, months, half-years, and years. A daily period of operation consists of any continuous 8-hour period or any number of consecutive periods of operation that total 8 hours. A weekly period of operation is any number of consecutive operating periods that total 50 hours. A monthly period of operation is any number of consecutive operating periods that total 250 hours. A half-yearly period of operation is any number of consecutive operating periods that total 1,000 hours. A yearly period of operation is any number of consecutive operating periods that total 2,000 hours.

36. Factory-lubricated Parts

a. Alternator Bearing. The alternator bearing is packed, at the factory, with grease conforming to specification MIL-G-3278. The bearing is a double-seal Fafnir Plya-Seal type. The Plya-Seal is a diaphragm-type contact seal, composed of two members, a flat, flexible sealing washer of synthetic rubber-impregnated fabric and a split retaining ring of thin spring steel. The two members of the seal can readily be removed for inspection, cleaning, and lubrication. At the time of disassembly and overhaul of the alternator, remove the bearing seals and, if necessary, add new grease (GL). If there is evidence of dirt or grit in the bearing, remove both seals and thoroughly flush the old grease from the bearing with hot oil.

b. Water Pump Bearing. The water pump has a factory-sealed, prelubricated bearing, and lubrication is not required except during overhaul.

c. Heater Blower Motor. The bearings of the heater blower motor are factory-lubricated and additional lubrication is not necessary.

d. Starting Motor. The starting motor bearings are factory-lubricated. No further lubrication is necessary.

e. Dc 28-volt Generator. All bearings in the dc generator are of the same type used in the alternator. Follow the instructions in subparagraph *a* above.

f. 24-volt Battery-charging Generator. The 24-volt battery-charging generator bearings are factory lubricated. No further lubrication is necessary.

37. Lubrication Requiring Disassembly

Lubrication operations that require disassembly of parts or assemblies are explained in subparagraphs *a* and *b* below and the detailed lubrication and cleaning information is supplementary to the instructions in the lubrication chart (fig. 17).

a. Air cleaner (fig. 14). To check the quantity of oil in the air cleaner, disassemble the bowl from the body by loosening the spring clips, and see that oil is up to the caution level. Add oil as necessary. Reassemble the bowl to the body; be sure the clips are secure.

b. Manuel Choke (28, fig. 2). To lubricate the manual choke control, disassemble the control, and wash all parts in solvent (SD). Apply grease (GL) to the control wire and reassemble the control.

38. Routine Lubrication

a. Lubrication Orders. Each power unit is provided with an official lubrication order or a lubrication chart. Official lubrication orders are illustrated, numbered or dated cards, or decalcomania labels that prescribe approved lubrication instructions for mechanical equipment which requires lubrication by using organizations. Current lubrication orders

should be requisitioned in conformance with instructions and lists in Dept. of the Army Pamphlet No. 310-4 Index of Technical Manuals, Technical Regulations, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders. Instructions contained in lubrication orders are mandatory and supersede all conflicting lubrication instructions of an earlier date.

b. Lubrication Instructions. Subparagraphs (1) through (10) below contain detailed lubrication and cleaning information and are supplementary to the instructions in the lubrication chart (fig. 17).

(1) *Engine crankcase.* Check the crankcase oil level daily (after 8 operating hours) and add oil (OE) if necessary. Change the engine oil weekly (after 50 operating hours). Drain the oil by opening the drain cock located on the left side of the engine oil pan. (Drain oil while engine is warm.) Refill the crankcase with 4½ quarts of oil (OE), in accordance with the lubrication chart (fig. 17).

(2) *Air Cleaner* (fig. 14). Check the quantity of oil in the air cleaner bowl weekly (after 50 operating hours). If the oil is below the caution level, add oil (OE) up to the normal level of the bowl. At monthly intervals (after 250 operating hours), remove the air cleaner element and wash it in solvent (SD). At the same time, clean the air cleaner bowl and refill with engine oil (OE). To remove the element, remove the bowl and unscrew the wing screw located on the bottom of the element housing. Then pull the element out of the housing. (The wing screw does not come out of the element.)

(3) *Oil filter* (fig. 15). Clean the oil filter element at least once every day (after 8 operating hours) by rotating the external handle 1 complete turn in either direction. Remove the plug in the filter bowl and drain the sludge from the filter with each crankcase oil change (after 50 operating hours). If the handle becomes difficult to rotate, remove the element from the housing and wash it in solvent (SD). Clean the bowl and replace the bowl gasket. If the element disks or blades are damaged, replace the body and element assembly.

(4) *Fuel filter* (fig. 16). After each day of operation (8 operating hours), open the fuel filter drain to remove any accumulated dirt and water. This is particularly important when operating in damp or cold climates. At least once each month, after 250 operating hours, remove the filter element and wash it in fuel oil (D-40 or D-35) or solvent (SD). Be careful not to damage the element disks. Worn gaskets must be replaced.

(5) *Fuel pump* (fig. 25). To avoid difficulties created by water and other foreign matter, refer to paragraph 56*d*(1)(*a*) and remove the cover cap plate (6), gasket (5), and screen (4). Clean parts thoroughly with solvent (SD) at least twice a year (after

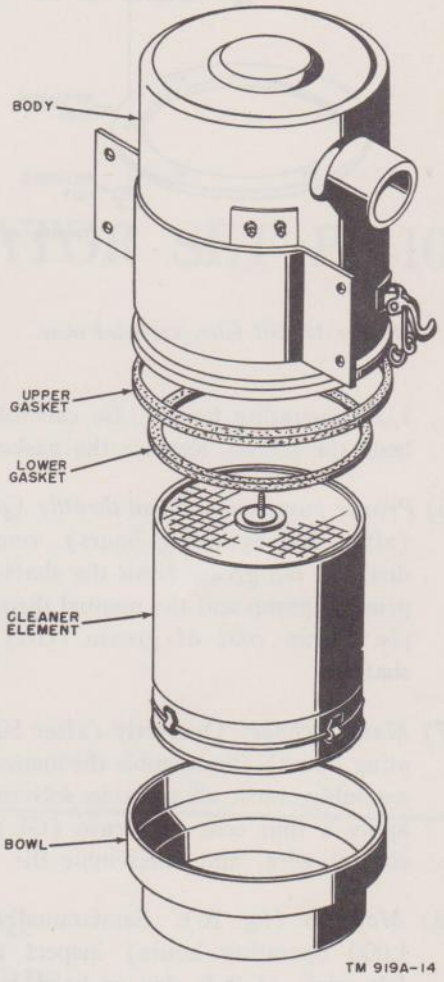


Figure 14. Air cleaner, exploded view.

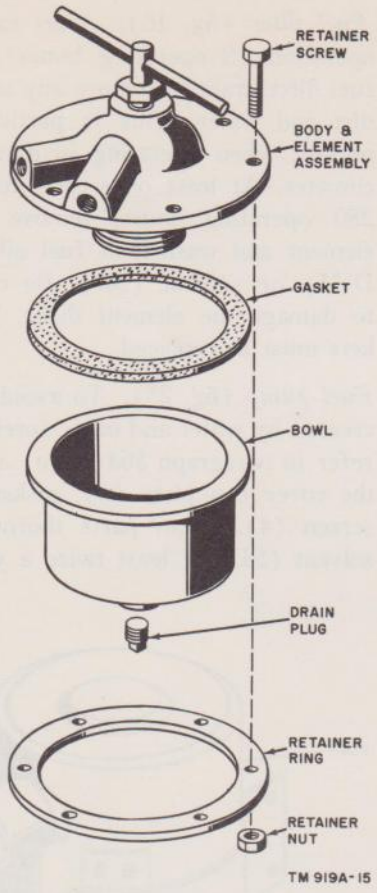


Figure 15. Oil filter, exploded view.

1,000 operating hours). Be careful not to bend the screen. Replace the gasket (5).

(6) *Primer pump and manual throttle.* Quarterly (after 500 operating hours), remove all dirt and old grease from the shafts of the priming pump and the manual throttle. Apply a thin coat of grease (GL) to the shafts.

(7) *Manual choke.* Quarterly (after 500 operating hours), disassemble the manual choke assembly, wash all parts in solvent (SD), apply a thin coat of grease (GL) to the control wire, and reassemble the control.

(8) *Magneto* (fig. 26). Semiannually (after 1,000 operating hours) inspect the cam felt wick. If it is dry or hard, replace it with a new factory-impregnated wick. The magneto is factory-lubricated and will require no further lubrication except during overhaul.

(9) *Heater fuel pump* (fig. 35). When operating the heater every day, remove and clean the heater fuel pump strainer and cover daily (after 8 equipment operating hours) with solvent (SD) or fuel oil (D-40 or D-35). Apply air pressure to remove any foreign particles that may have accumulated in the small magnetic separator chamber in the center of the fuel pump cover. If the heater is in frequent operation, clean the fuel pump subassembly twice a year (after 1,000 equipment operating hours) with solvent (SD) or fuel oil (D-40 or D-35). To remove the strainer and subassembly follow the instructions in paragraph 56*l*.

(10) *Engine speed governor.* The engine speed governor is factory-lubricated and the drive gear is lubricated by engine oil during operation. No lubrication is necessary at overhaul.

39. Weatherproofing

a. General. Signal Corps equipment, when operated under severe climatic conditions, requires special treatment and maintenance. Fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperatures are harmful to most materials.

b. Tropical Maintenance. A special moisture-proofing and fungiproofing treatment has been devised, which, if properly applied, provides a reasonable degree of protection. This treatment is fully explained in TB SIG 13 and TB SIG 72, Moisture-proofing and Fungiproofing Signal Corps Equipment, and Tropical Maintenance of Ground Signal Equipment, respectively.

c. Lubrication. The effects of extreme cold and heat on materials and lubricants are explained in TB SIG 69, Lubrication of Ground Signal Equipment. Observe all precautions outlined in TB SIG 69 and pay strict attention to all lubrication orders when operating equipment under conditions of extreme cold or heat.

40. Rustproofing

Whenever the equipment is to be placed in storage or is to be out of service for a period of 30 days or more, precautions must be taken to guard against

ADDITIONAL INFORMATION TO INSTRUCTION BOOK
FOR
GASOLINE ENGINE GENERATOR SET PU-107A-U

REFERENCE: Engine Speed Governor - Page 28 Item (10)

A restricted adapter has been added to the hose assembly from filter to governor at the filter end so that appropriate oil pressure registers on oil gage and sufficient flow of oil to governor is maintained.

rust and against the formation of gum in the fuel system. Process the equipment as follows:

a. Materials Required. Requisition the materials below through regular channels and proceed with the rustproofing and gumproofing treatment immediately after shutting down the unit. Rustproofing must be done while the engine is still warm.

(1) Fuel Oil, Diesel (D-40 or D-35), Specification MIL-F-896.

(2) Oil, Engine, Heavy Duty (OE), Specification MIL-O-2104 (ORD).

(3) Oil, Lubricating, Preservative, Special (PL Special), Specification MIL-L-644A.

(4) Compound, Insulation, Ignition, Ordnance Specification 3-182.

(5) Compound, Gum Preventive, Federal stock No. 51-C1586-225.

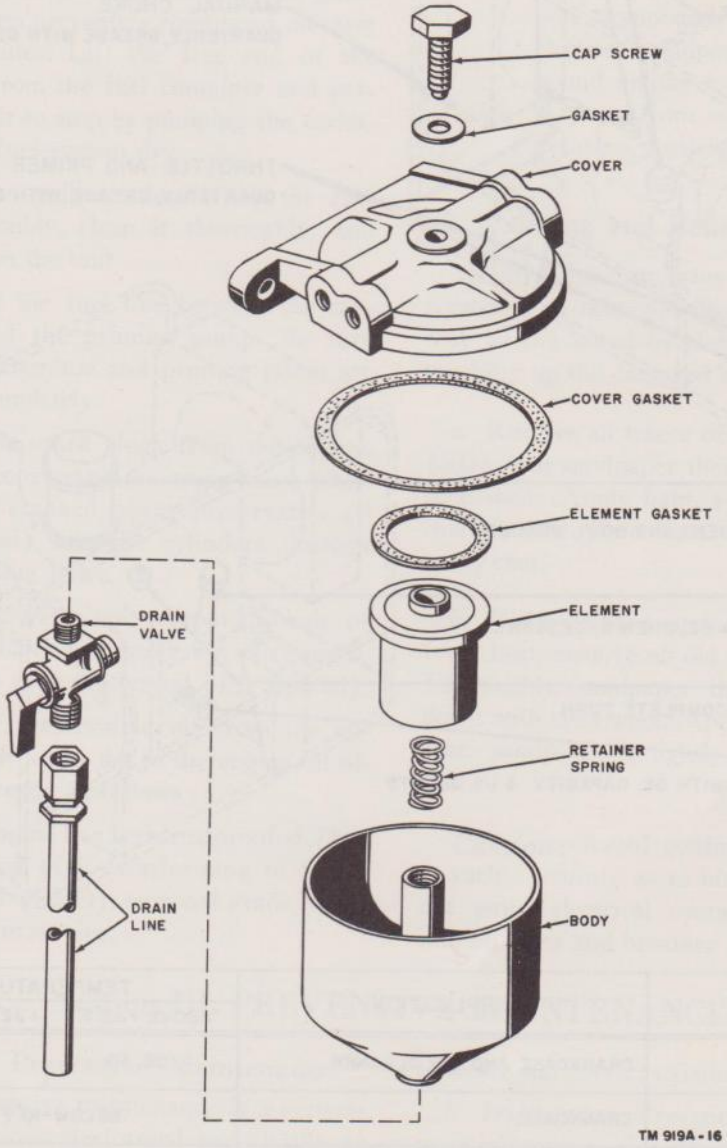
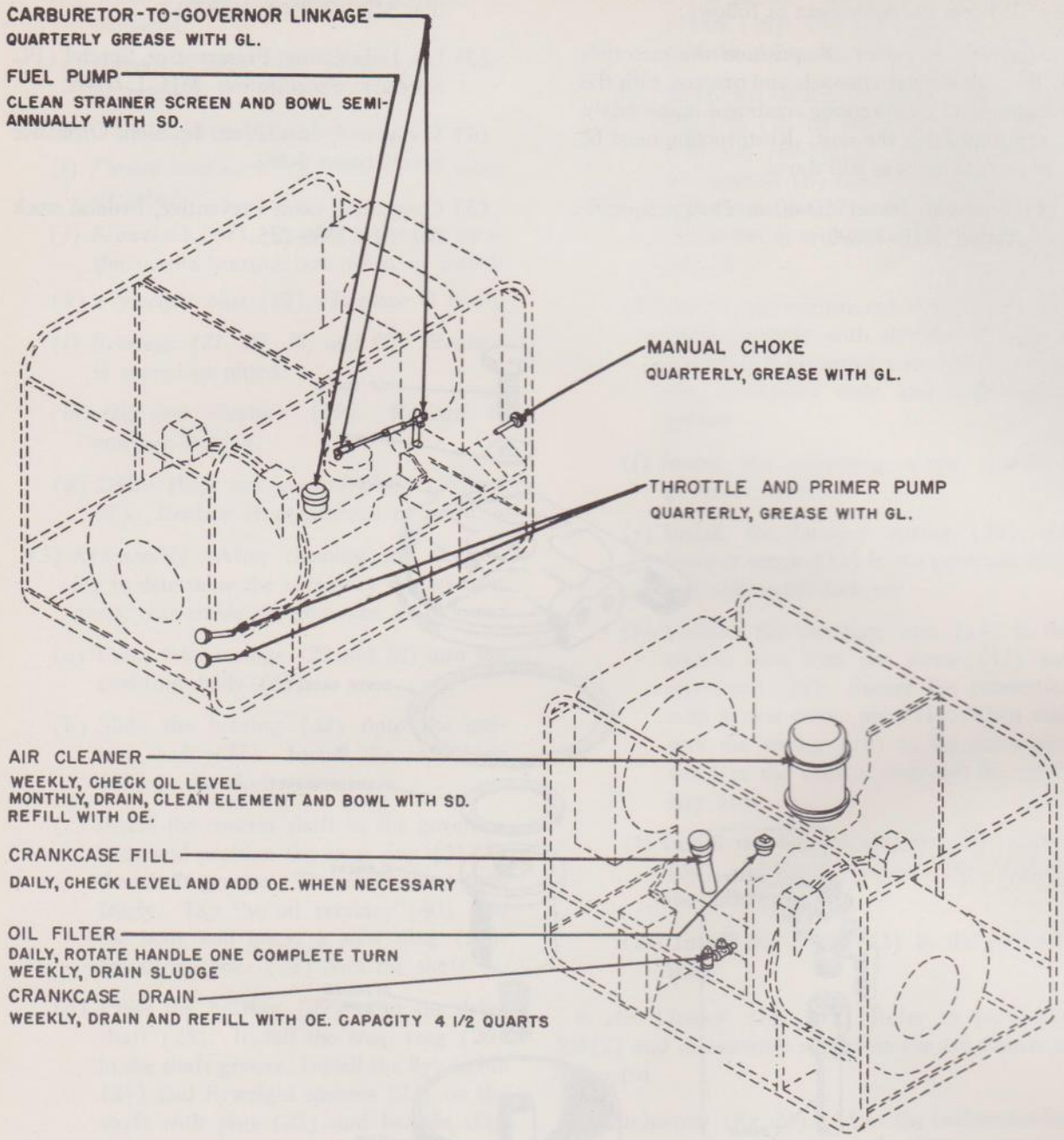


Figure 16. Fuel filter, exploded view.



LUBRICANT	APPLICATION	TEMPERATURE	
		ABOVE +32°F	+32°F TO -10°F
OE - OIL, ENGINE	CRANKCASE AND AIR CLEANER	OE 30	OE 10
OES - OIL ENGINE, SUB ZERO	CRANKCASE	BELOW -10°F	
GL - GREASE, AIRCRAFT AND INSTRUMENTS	MANUAL CHOKE, THROTTLE, PRIMER AND CARBURETOR-TO-GOVERNOR LINKAGE	ALL TEMPERATURES	

TM 919A-17

Figure 17. Lubrication chart.

(6) Tape, nonhygroscopic, adhesive, Ordnance Specification AXS-871.

b. Procedure.

(1) Drain the lubricating system and fill the engine oil reservoir with preservative oil (PL Special).

(2) Connect the fuel line to a container of 5 gallons of gasoline to which one-quarter of a container of gum preventive compound has been added.

(3) Start the unit and operate it on the gasoline and gum preventive compound mixture for 5 minutes. Lift the free end of the fuel line from the fuel container and permit the unit to stop by pumping the carburetor and fuel system dry.

(4) Remove the sediment bowl from the fuel pump assembly, clean it thoroughly, and replace it on the unit.

(5) Disconnect the fuel line between the carburetor and the priming pump. Be sure that the carburetor and priming pump are drained completely.

(6) Remove the spark plugs from the engine. Have someone crank the engine and, while it is being cranked, spray preservative oil (PL Special) into the cylinders through the spark plug holes.

(7) Remove the valve cover from the side of the engine block and spray the valve mechanism with preservative oil (PL Special).

(8) Drain the preservative oil from the engine. Attach a red tag to the engine oil filler which reads as follows:

Caution: This engine has been rustproofed. Date . . . . Use engine oil (OE) conforming to Specification MIL-O-2104 (ORD), seasonal grade, when placing the unit back in service.

(9) After the engine has cooled, remove all grease, oil, and dirt from the exterior of the unit. Use solvent (SD) for this purpose. Remove all traces of rust and touch up all painted surfaces which have become damaged.

(10) Seal all breathers and breather holes, air intakes, and the exhaust outlet with nonhygroscopic tape.

(11) Be sure that all surfaces are dry, and spray all unpainted surfaces with insulation compound. Include all wiring and electrical equipment. Do not get this compound on the interior of generators; keep it away from such components as circuit breakers, switches, etc.

41. Painting and Refinishing

When painted surfaces of the equipment become scratched or otherwise damaged, rust and corrosion may be prevented by cleaning thoroughly and then touching up the damaged surfaces.

a. Remove all traces of oil or grease with solvent (SD), and sandpaper thoroughly the portions to be refinished. Apply light, even coats of paint with a small brush. Two light coats are better than one heavy coat.

b. If the painted surfaces have become blistered from heat, remove all old paint with paint remover. Thoroughly sandpaper the surfaces or rub them down with steel wool. Apply a smooth, even priming coat, sandpaper it lightly, and then apply a finish coat.

Caution: Avoid getting paint into moving parts in such a manner as to hinder their movement. Do not paint electrical contacts; avoid getting paint into oil holes and breather holes.

Section III. PREVENTIVE MAINTENANCE

42. Definition of Preventive Maintenance

a. Purpose. Preventive maintenance is a systematic series of operations performed periodically to keep equipment operating at top efficiency. The primary purpose of preventive maintenance is to prevent major break-downs and the consequent need for repair. The primary function of troubleshooting is to locate and correct existing defects.

b. Importance. Preventive maintenance is of utmost importance since the failure or inefficient operation of one piece of equipment may cause the failure of an entire system. It is necessary to inspect the equipment systematically each day that it is operated and at weekly intervals, so that defects may be

discovered and corrected before they result in serious damage or failure.

c. Responsibility. Preventive maintenance services are the responsibility of operating organizations. They comprise the scheduled maintenance services performed by the equipment operator and maintenance personnel, respectively. Ordinarily, the operator will replenish fuel and lubricants. He will perform necessary cleaning operations, tighten loose nuts, bolts, screws, and other fastenings, care for tools and accessories, and make such emergency repairs as are within the scope of his ability, tool equipment, and parts available. He will perform all daily lubrication operations, before operation, at halt (during shut-down periods), and after operation. Maintenance personnel will perform the weekly and monthly maintenance operations with the assistance of the unit operator. Any maintenance operations beyond the scope of maintenance personnel will be reported to the officer in charge.

43. Daily Maintenance Services

For purposes of the following instructions, a daily maintenance period is defined as being 8 hours of operation. Daily services will be performed in accordance with DA Form 11-260 (fig. 68) and in the specified sequence.

a. Before Operation. Before operating the set, perform the following services:

(1) See that the auxiliary fuel hose is connected properly (par. 12*c*) and that the available fuel supply is adequate.

(2) Check the exhaust extension tube for correct installation (par. 12*b*).

(3) Be sure the cooling system and lubrication system are full. Check the oil level in the air cleaner.

(4) Examine all instruments and controls on the panel for damage and loose electrical connections.

(5) Check the fan belt, battery-charging generator belt, and dc generator belt for proper tension.

(6) If the set is to be started other than remotely, be sure the circuit breakers are in the OFF position. If the set is to be started remotely, the circuit breakers should be in the ON position. The load switch on the using equipment should be off until the engine generator has reached operating temperature.

(7) Check the wye-delta change board for proper setting for the desired output (par. 14*a*). See that all output connections are correct and well secured.

(8) Check all fuel, coolant, lubrication, and exhaust connections for evidence of leakage.

(9) Examine the surrounding area for foreign matter and obstructions that may damage the equipment.

(10) If the equipment is to be operated in an inclosure, be sure it is properly ventilated.

b. During Operation. After the engine has been started (par. 22) and warmed, perform the following services:

(1) Check the engine instruments for any abnormal indications (par. 20) before applying any load.

(2) After the load has been applied, check all the instruments (par. 20) to be sure the indicated values are within the rated range of the equipment. Check the instrument readings frequently during operation.

(3) Check the fuel supply periodically to prevent running out of fuel.

(4) Always be alert for any evidence of abnormal operation and for unusual noises or conditions.

c. At-halt. Disconnect the load by placing the circuit breakers in the OFF position; then stop the set (par. 26), and proceed as follows:

(1) Check the fuel supply, coolant level, and oil level. Replenish as required.

Caution: If it is necessary to add coolant to a hot engine, first, restart the engine and set the manual throttle at slow or near idling speed (under no load). *Add the coolant slowly.* After the coolant has been added and the engine has run for about 1 or 2 minutes and is somewhat cooler, stop the engine.

(2) Inspect all fuel, oil, and coolant fittings, gaskets, and connections for evidence of leakage.

(3) Inspect the condition of the wiring and check all electrical connections.

(4) Check the entire equipment to be sure it is in proper operational order.

d. After Operation. Perform the services as instructed in subparagraph *c* above. Then proceed as follows:

(1) Wipe the set clean as required.

(2) Perform the daily lubrication services as instructed in paragraph 38*b* and as indicated on the lubrication chart (fig. 17).

(3) Add water to the batteries, if necessary.

(4) Correct or report any troubles developed during the operation.

(5) Clean all tools and stow them properly.

(6) Perform any function necessary to prepare the set for the next operation.

44. Weekly Maintenance Services

For purposes of the following instructions, a weekly maintenance period is defined as being 50 operating hours. Perform all daily maintenance and lubrication services as instructed in pargaraph 43 and in the lubrication chart (fig. 17). Perform all other weekly services as specified in the W (weekly) column in paragraph 48. Make a record of the services actually performed and repairs or additional services required.

45. Monthly Maintenance Services

For purposes of the following instructions, a monthly maintenance period is defined as being 250 operating hours. Perform all daily and weekly maintenance and lubrication services as instructed in paragraphs 43 and 44 and in the lubrication chart (fig. 17). Perform all the other monthly services as specified in the M (monthly) column in paragraph 48. Make a record of the services actually performed and repairs or additional services required.

46. Semiannual Maintenance Services

For the purposes of the following instructions, a semiannual maintenance period is defined as being 1,000 operating hours. Perform all daily, weekly, and monthly maintenance and lubrication services as instructed in paragraphs 43, 44, and 45 and in the lubrication chart (fig. 17). Perform all other semiannual services specified in paragraph 48. Make a record of the services actually performed and repairs or additional services required.

47. Annual Maintenance Services

For purposes of the following instructions, an annual maintenance period is defined as being 2,000 operating hours. Perform all daily, weekly, monthly and semiannual maintenance and lubrication services as instructed in paragraphs 43, 44, 45, and 46 and in the lubrication chart (fig. 17). Perform all other annual services as specified in paragraph 48. Make a record of the services actually performed and repairs or additional services required.

48. Preventive Maintenance Procedures

Perform the following maintenance services at the intervals indicated in the frequency columns of the following subparagraphs. Report all unsatisfactory conditions to the officer in charge.

a. General.

Item No.	Item	Frequency		Action
		M	W	
1	Before-operation services.	*	*	Perform all before-operation services as instructed in paragraph 43*a*.
2	Lubrication.	*	*	Lubricate the set as instructed in paragraph 38*b* and in accordance with the lubrication chart (fig. 17).
3	Tools and equipment.	*	*	See that all tools, spare parts, and equipment are present by checking with the packing list on the set or the tables in paragraph 8. Examine the condition of the tools and clean them and the tool trays thoroughly. Stow the tools properly.
4	Fire extinguishers.	*	*	Inspect the condition of the fire extinguisher. See that it is fully charged.

a. General (cont).

Item No.	Item	Frequency M	Frequency W	Action
5	Publications.	*	*	An adequate supply of DA Forms 11-260 and 11-261 should be available. The manual for the equipment and other required publications should be present and in legible condition.
6	Appearance.	*	*	Examine the entire set for damage to the finish. Remove all traces of rust and dirt. If necessary, refer to paragraph 41 and refinish as instructed.
7	Modifications.	*	*	See that all modification work orders and other directives have been completed.
8	Noise and vibration.	*	*	While operating the set, with or without load, be alert for any unusual noises which may indicate trouble. Also, be aware of any excessive vibrations which may indicate loose or damaged parts or inadequate lubrication.
9	Housing.	*	*	Inspect the canvas cover supplied with the generator set for general condition and cleanliness. Install the canvas cover whenever the set is not operated for any appreciable period of time.

b. Engine and Accessories.

Item No.	Item	Frequency M	Frequency W	Action
10	Cylinder head, manifold, and gaskets.	*	*	Check the cylinder head and exhaust manifold for cracks. Examine for coolant, oil, and compression leaks around the cylinder head gasket and stud nuts. See that the manifold nuts are secure. Check the cylinder-head stud nuts for tightness. Use a torque wrench and tighten each nut to a tension of 70-75 foot-pounds in sequence shown in figure 60.
11	Valve mechanism.	*		Remove the valve cover and examine the valve mechanism as follows: Remove the two hexagonal-head valve cover retaining bolts and remove the valve cover by moving it away from the cylinder block and then downward behind the carburetor. Have some clean rags ready to catch or wipe up the small amount of oil that will come out of the valve spring chamber. See that the valve tappets and springs are in good condition and that they are well lubricated. Check all valve clearances. Both intake and exhaust clearances should be .014 inch (engine hot). If the valve check shows the clearances to be too close or too wide, adjust the valves in accordance with instructions in paragraph 64*c*. When replacing the valve cover, replace the gasket also, and be sure the fit is oil tight.
12	Compression test.	*		Before testing the engine for compression, allow the set to run until normal operating temperature is reached. Remove all the spark plugs and hold a compression gage firmly in the spark plug hole of No. 1 cylinder. Push in the manual choke and throttle all the way. Crank the engine with the starting motor until the maximum compression reading is shown on the compression gage. Perform the test on the remaining three cylinders. The standard compression for each cylinder is 105 psi. Satisfactory engine performance cannot be expected if the compression is below 95 psi, or if the reading varies more than 10 pounds between the cylinders. Refer to the trouble chart (par. 50) to determine the cause and remedy for low or variant engine compression.
13	Crankcase, Breathers.	*	*	With the engine running at idle speed, check the oil pan, gear cover, and valve spring cover for oil leaks. Change oil as instructed in paragraph 38*b*(1) and in the lubrication chart (fig. 17). Semiannually, clean the crankcase breather tube, which is attached to the valve cover, in solvent (SD). Also clean all carbon and sludge from the valve chamber.

g. Miscellaneous Items.

Item No.	Item	Frequency M	Frequency W	Action
44	Gages.	*	*	Observe the oil pressure gage and coolant temperature gage for correct readings. Refer to paragraph 20*a* fo normal gage indications. Investigate any abnormal reading.
45	Meters.	*	*	Observe the dc ammeter, ac ammeters, voltmeter, and frequency meter for correct readings. Refer to paragraph 20 for normal meter indications. Investigate any abnormal reading.
46	Frame and mountings.	*		Examine the upper and lower frame for warpage and for cracks around the welds. See that the engine and alternator mounting bolts are tight. Examine the condition of the shock mounts.
47	Suppression equipment.	*		Inspect the condition of all the radio-frequency suppression equipment. Be sure that all bonding straps, capacitors, and external-internal-toothed lock washers are well secured. Refer to paragraph 67 for suppression equipment details.

Section IV. TROUBLE SHOOTING

49. Meaning of Trouble Shooting

The primary function of trouble shooting is to locate and correct causes of faulty operation and equipment failure. All mechanical and electrical equipment is subject to occasional failure. Whenever difficulty with the equipment is experienced, the operator or repair man must be able to locate and correct the cause as quickly as possible. The trouble-shooting charts (par. 50) indicate various difficulties that may be experienced, symptoms which indicate that trouble exists, the possible causes, and suggested remedies. Reference to various illustrations and diagrams in this manual will aid in localizing the trouble.

50. Trouble-shooting Chart

a. Engine.

Symptom	Possible Cause	Remedy
1. Starting motor will not crank engine; cranks engine too slowly.	Discharged battery or shorted cell.	Recharge or replace battery.
	Corroded battery terminals.	Clean terminals.
	Loose or dirty battery cable connections.	Clean and tighten connections.
	Engine seized.	Try with hand crank.
	Defective start relay.	Replace relay.
	Too heavy oil in crankcase.	Refer to lubrication chart (fig. 17). Drain and refill with lighter oil.
	Engine ground strap connections loose.	Clean and tighten connections.
	Wire connections loose at starting motor.	Tighten connections.
	Worn starting motor brushes.	Replace brushes.
	Dirty starting motor commutator.	Clean with #0000 sandpaper
	Worn starting motor bearings.	Replace bearings.
	Burned start solenoid contacts.	Replace solenoid.

a. Engine (cont).

Symptom	Possible Cause	Remedy
2. Engine is cranked electrically, but will not start.	Defective spark plugs.	Clean, adjust, or replace (par. 48).
	Magneto breaker contacts pitted or out of adjustment.	Resurface or replace contacts and adjust gap (par. 56).
	Empty fuel supply tank.	Refill.
	Clogged or frozen fuel line.	Disconnect and clean (par. 27*a*(1)).
	Dirty fuel filter.	Clean (par. 38*b*(4)).
	Clogged fuel pump screen.	Clean (par. 38*b*(5)).
	Defective electric choke.	Use manual choke. Replace.
	Poor fuel.	Drain, refill with correct grade of fuel.
	Dirt in carburetor.	Clean.
	Low compression.	Refer to symptom 21 below.
	Incorrect magneto timing.	Retime (par. 63*i*).
	No ignition current or weak ignition current.	Replace defective ignition capacitor or coil.
	Distributor block or rotor cracked, burned, or carbonized.	Replace defective part.
	Leaking fuel line connection.	Tighten.
	Fuel pump cover plate loose.	Tighten cap screw.
	Carburetor inlet valve stuck.	Replace needle valve assembly.
3. Low oil pressure.	Oil too light or badly diluted.	Drain and refill with oil of correct grade and weight. Refer to lubrication chart (fig. 17).
	Oil too low.	Add oil. Refer to lubrication chart (fig. 17).
	Oil-pressure relief valve not seating.	Remove and clean.
	Worn crankshaft bearings.	Deadline for repair.
	Restricted oil pump intake.	Remove intake screen and clean.
	Worn oil pump.	Replace.
	Defective oil gage.	Replace.
4. High oil pressure.	Oil too heavy.	Drain and refill with oil of correct grade and weight. Refer to lubrication chart (fig. 17).
	Oil-pressure relief valve stuck.	Remove and clean.
	Clogged oil passage.	Drain oil and clean passage .
	Defective oil gage.	Replace.
5. Excessive oil consumption, light blue smoky exhaust.	Poor compression.	Refer to sympton 21 below.
	Oil leaking from pan or connections.	Replace gaskets and leaking hoses. Tighten screws and connections.
	Oil too light or diluted.	Drain and refill with oil of correct grade and weight. Refer to lubrication chart (fig. 17).
	Bearing clearance too great.	Deadline for repair.
	Too much oil in crankcase.	Drain excess oil.

a. Engine (cont).

Symptom	Possible Cause	Remedy
	Excessive clearance between valve stems and guides.	Deadline for repair.
	Piston rings stuck in grooves, worn, or broken.	Deadline for repair.
	Piston rings improperly fitted or weak.	Deadline for repair.
	Oil leaks at gaskets or seals.	Replace.
	Too much clearance between piston and cylinder bore.	Deadline for repair.
	Misaligned connecting rods.	Deadline for repair.
6. Engine stops unexpectedly.	Fuel tank empty.	Refill.
	Broken or clogged fuel line.	Repair or clean fuel line.
	Coolant temperature too high.	Refer to symptom 24 below.
	Coolant high temperature switch set too low.	Adjust setting (par. 19*a*(2)).
	Low oil pressure.	Refer to symptom 3 above.
	Grounded ignition wire.	Check ignition circuit.
7. Engine will not idle satisfactorily.	Carburetor out of adjustment.	Adjust (par. 25*b*(5)).
8. Engine misses.	Fouled spark plugs.	Clean, adjust, or replace (par. 48).
	Uneven compression.	Refer to symptom 21 below.
	Intake manifold air leak.	Tighten or replace gaskets.
	Pitted or improperly adjusted ignition contacts.	Resurface, adjust, or replace contacts (par. 56*g*(2)).
	Defective ignition capacitor.	Replace capacitor.
	Faulty ignition coil.	Replace.
	Tappet adjustment too close.	Adjust (par. 64*c*).
	Defective ignition cable.	Replace.
	Sticking valves.	Clean valve guides and valve stems.
	Weak or broken valve spring.	Replace spring.
	Faulty wiring.	Check ignition circuit.
	Water or dirt in fuel.	Drain and refill with clean fuel.
	Clogged carburetor jets.	Remove and clean.
	Engine overheated.	Refer to symptom 24 below.
9. Engine will not take full load.	Caburetor-to-governor linkage too short.	Adjust (par. 25*b*).
	Incorrect valve timing.	Retime (par. 64*b*).
	Magneto timing late.	Adjust timing (par. 63*i*).
10. Engine hunting under load.	Carburetor-to-governor linkage too short.	Adjust (par. 25*b*).
	Governor spring eyebolt out of adjustment.	Adjust (par. 25*b*).

a. Engine (cont).

Symptom	Possible Cause	Remedy
11. Engine hunting under no-load.	Carburetor-to-governor linkage too short.	Adjust (par. 25*b*).
	Governor bumper screw out of adjustment.	Adjust (par. 25*b*).
	Governor spring eyebolt out of adjustment.	Adjust (par. 25*b*).
12. Engine backfires through carburetor.	Lean fuel mixture.	Adjust and clean carburetor. Clean fuel filter. Tighten or replace intake manifold gasket.
	Poor grade fuel.	Drain and refill with correct grade fuel.
	Incorrect ignition timing.	Retime ignition (par. 63*i*).
	Distributor wires crossed.	Install wires correctly.
	Intake valves leaking.	Grind and reseat valves.
	Incorrect valve timing.	Retime (par. 64*b*).
	Air leak in intake manifold.	Locate and correct leak; replace gasket.
13. Light pounding knock.	Loose connecting rod bearing.	Deadline for repair.
	Low oil supply.	Add oil. Refer to lubrication chart (fig. 17).
	Low oil pressure.	Refer to symptom 3 above.
	Oil badly diluted.	Change oil. Refer to lubricaton chart (fig. 17).
14. Dull metallic thud, increases with load.	Loose crankshaft bearings.	Deadline for repair.
15. Sharp metallic thud in cold starting.	Low oil supply.	Add oil. Refer to lubrication chart (fig. 17).
	Low oil pressure.	Refer to symptom 3 above.
	Oil badly diluted.	Change oil. Refer to lubrication chart (fig. 17).
16. Pinging sound during rapid acceleration or overload.	Carbon in cylinders.	Remove carbon.
	Spark too early.	Retime ignition (par. 63*i*).
	Wrong spark plugs.	Replace with new plugs of correct heat range.
	Spark plugs burned or carboned.	Clean or install new plugs (par. 48).
	Fuel stale or low octane.	Use fresh fuel of the correct grade.
17. Clicking Sound.	Tappet clearance too great.	Adjust tappets (par. 64*c*).
	Broken valve spring.	Install new spring.
18. Hollow clicking sound.	Loose pistons.	If noise is slight, and disappears after warm up, no immediate attention is needed.
		If noise increases, deadline for repair.
19. Popping, spitting, or detonation.	Incorrect ignition timing.	Retime (par. 64*b*).
	Improper carburetion.	Adjust and clean carburetor.
	Poor valve seating.	Grind valves and reseat.
	Sticking valves.	Refer to symptom 23 below.
	Broken valve spring.	Replace spring.

a. Engine (cont).

Symptom	Possible Cause	Remedy
	Tappets adjusted too close.	Adjust tappets (par. 64*c*).
	Spark plug electrodes burned.	Replace spark plugs.
	Water or dirt in fuel.	Drain fuel.
	Clogged fuel lines.	Blow out lines.
20. Engine lacks power.	Low compression.	Refer to symptom 21 below.
	Dirt in carburetor or fuel pump.	Clean.
	Dirty air cleaner.	Clean, refill to proper level. Refer to lubrication chart (fig. 17).
	Choke inoperative.	Use manual choke. Replace electric choke.
	Carbon in cylinders.	Remove carbon.
	Restricted exhaust line.	Clean.
	Incorrect ignition timing.	Retime (par. 63*i*).
	Carburetor flooded or dirty.	Clean carburetor.
	Engine overheated.	Refer to symptom 24 below.
	Fuel lines clogged.	Drain and clean.
	Improper tappet clearance.	Adjust (par. 64*c*).
	Sticking valves.	Grind and reseat valves.
	Piston rings broken or worn.	Deadline for repair.
21. Low or fluctuating engine compression.	Faulty cylinder head gasket.	Replace.
	Insufficient tappet clearance.	Adjust tappets (par. 64*c*).
	Improperly fitted pistons or piston rings.	Deadline for repair.
	Valves not seating properly.	Grind and reseat valves.
	Valve spring weak or broken.	Replace spring.
	Burned valves.	Grind or replace valves.
22. Lack of vacuum.	Incorrect ignition timing.	Retime (par. 63*i*).
	Weak valve springs.	Replace springs.
	Worn valve guides.	Deadline for repairs.
	Leakage of carburetor gasket, manifold gasket.	Replace gaskets.
	Exhaust line clogged.	Clean.
	Burned valves.	Grind or replace valves.
23. Valves sticking.	Warped valve.	Replace.
	Improper tappet clearance.	Adjust (par. 64*c*).
	Carbonized or scored valve stems.	Buff or replace valve.
	Valve stem-to-guide clearance insufficient.	Deadline for repair.
	Weak or broken valve spring.	Replace spring.
	Valve spring cocked.	Replace spring.

a. Engine (cont).

Symptom	Possible Cause	Remedy
	Contaminated oil.	Drain and refill. Refer to lubrication chart (fig. 17).
24. Engine overheating.	Lack of proper lubrication.	Refer to lubrication chart (fig. 17).
	Stoppage of coolant circulation.	Check for sludge in radiator.
	Faulty thermostat.	Replace.
	Lack of coolant.	Refill. Refer to symptom 26 below.
	Slipping fan belt.	Tighten (par. 48).
	Incorrect ignition timing.	Retime (par. 63*i*).
	Clogged muffler.	Clean.
	Water pump inoperative.	Overhaul or replace.
	Lack of ventilation.	Provide better ventilation.
25. Engine overcooling.	Thermostatic valve sticking open.	Replace.
	Climatic conditions.	Cover radiator to bring temperature to proper range.
26. Loss of coolant.	Loose hose connections.	Tighten.
	Damaged hose.	Replace.
	Leaking water pump.	Overhaul or replace.
	Leaking radiator.	Remove and repair.
	Leaking cylinder-head gasket.	Replace.
	Crack in cylinder-head or block.	Deadline for repair.
27. Poor fuel economy.	Ignition timing late.	Retime (par. 63*i*).
	Carburetor float too high.	Adjust float by bending float lip.
	Fuel leakage.	Check lines. Tighten connections.
	Leaking fuel pump diaphragm.	Replace diaphragm or fuel pump.
	Low compression.	Refer to symptom 21 above.
	Valves sticking.	Grind and reseat.
	Fouled spark plugs.	Replace.
	Weak ignition coil or capacitor.	Replace.
	Improper valve tappet clearance.	Adjust tappets (par. 64*c*).
	Dirty air cleaner.	Clean and refill. Refer to lubrication chart (fig. 17).
	Clogged muffler.	Clean.
28. Bearing failure.	Crankshaft bearing journal out-of-round.	Deadline for repair.
	Lack of oil.	Fill crankcase.
	Oil leakage.	Replace leaking oil seals and gaskets.
	Dirty oil.	Refer to lubrication chart (fig. 17).
	Low oil pressure.	Refer to symptom 3 above.
	Connecting rod bent.	Deadline for repair.
29. Rear main bearing leak.	Excessively worn bearing and/or packing.	Deadline for repair.

b. Engine and Accessories (cont).

Item No.	Item	Frequency M	Frequency W	Action
14	Oil filters.	*	*	Examine the oil filter, oil lines, and connections for evidence of leakage. Drain the filter whenever the crankcase oil is changed (par. 38*b*(3)).
15	Radiator.	*		Inspect the radiator core and hoses for evidence of leakage. See that the hoses are in good condition and are tight. Be sure the radiator is mounted securely. Check the air passages in the core for such obstructions as dirt, insects, and any other foreign matter. Remove the obstructions in the core with a stream of compressed air. Examine the coolant for rust or other foreign matter. Test the antifreeze and note the lowest temperature to which the set is protected. If the coolant is badly contaminated, clean the system in accordance with current directives.
16	Water pump, fan, shroud.	*	*	Inspect the water pump for evidence of leakage. Tighten the pump mounting bolts. Check the fan blades for nicks and for other signs of damage. Tighten the bolts securing the fan to the pulley.
17	Belts and pulleys.	*	*	See that the drive pulleys are in good condition and are mounted securely. Examine the three drive belts for evidence of deterioration, wear, or fraying. Adjust the 2.5-kw generator belt for about ¾-inch deflection. Adjust the fan belt for about ½-inch deflection. Adjust the 24-volt battery-charging generator drive belt for about ¾-inch deflection.
18	Oil pump, pressure-relief valve.	*		The oil pump will usually require no attention except during major overhaul of the engine (ch 4). During normal operation the oil pressure should be 20 to 30 psi. The oil-pressure relief valve, mounted on the right side of the cylinder block, requires little or no attention. However, if it becomes necessary to adjust the pressure by means of the relief valve, follow the instructions in paragraph 25*b*(6).
19	Governor and linkage.	*		Examine the engine speed governor-to-throttle linkage for any evidence of binding and for wear. See that the linkage is secured properly and operating freely. Once a year (after 2,000 operating hours), disassemble, clean, and inspect the governor as instructed in paragraph 56*a*.
20	Vacuum test.	*		Remove the ⅜-inch pipe plug (1, fig. 13) located directly above the carburetor on the intake manifold, install a ⅜-inch to ⅛-inch pipe reducing bushing, and connect a vacuum gage to the manifold. Be sure the connection is tight. Start the engine and allow it to run until normal operating temperature is reached. With the set running at load speed at an altitude between sea level and 2,000 feet, the vacuum gage should indicate not less than 16 inches of mercury at no load. At higher altitudes, deduct 1 inch of vacuum for each 1,000 feet of increase in altitude. Refer to the trouble-shooting chart (par. 50) to determine the cause and remedy for abnormal vacuum indications.

c. Fuel System.

Item No.	Item	Frequency M	Frequency W	Action
21	Fuel pump.	*		See that all connections on the engine fuel pump are tight. Note any evidence of leakage. Clean the filter bowl and screen as instructed in paragraph 38*b*(5) and in the lubrication chart (fig. 17).
22	Carburetor and linkage.	*	*	Examine the carburetor throttle housing gasket, bowl cover gasket, fuel inlet line and all jets for evidence of leakage. See that the carburetor is mounted securely. Check all the linkage for free operation.

c. Fuel System (cont).

Item No.	Item	Frequency M	Frequency W	Action
23	Filters.	*	*	Check the fuel filter and fittings for evidence of leakage. Clean the filter element as instructed in paragraph 38*b*(4) and in the lubrication chart (fig. 17).
24	Air cleaner.	*	*	See that the air cleaner hoses are well-secured and in good condition. Clean and service the air cleaner as instructed in paragraph 38*b*(2) and in the lubrication chart (fig. 17).
25	Fuel lines.	*	*	Carefully examine all fuel lines and fittings for evidence of leakage and damage. See that all connections are tight.

d. Electric System.

Item No.	Item	Frequency M	Frequency W	Action
26	Spark plugs.	*		Check for leakage around the spark plug gaskets. Remove the spark plugs and examine for cracked insulation, excessive carbon deposits, and electrode erosion. If necessary, clean off carbon deposits by applying an abrasive to the plugs for not more than 3 seconds. (Prolonged use of abrasive will wear away the insulator and electrodes.) Use an air blast to remove loose particles of abrasive. Examine the spark plug again for cracked insulator. If no spark plug cleaner is available, install new or reconditioned plugs. Measure the spark plug gap and adjust to .025 inch.
27	Batteries.	*	*	Examine the batteries for cracks and for evidence of leakage. Clean corrosion off the battery terminal posts and cable terminals and lubricate with a light coat of grease (GAR). Make sure the cable terminals are well secured and are making a good contact with the battery posts. Check the level of the electrolyte. The level should be ½-inch above the separators. If the electrolyte is below this level, add distilled water. Test the voltage of each cell. Each cell should measure 2 volts. Refer to paragraph 17 and test the specific gravity of each cell as instructed.
28	Starter.	*		See that the starting motor is mounted securely and that all cable connections are clean and tight. Check the brushes for free movement in the holders. Examine the brushes for wear and replace them if they are worn to ½ inch in length. To replace the brushes, first remove the starter and the commutator end plate. Remove the old brushes by disconnecting the brush screws on the brush wire terminals and pulling them out of the brush holders. Connect the new brushes and slip them into the holders. Replace the end plate. Refer to paragraph 56*j*(2)(*a*) and seat-in the brushes as instructed. Check the brush spring tension with a spring scale as instructed in paragraph 56*j*(2)(*a*). If the brushes have been arcing, as evidenced by a dirty commutator, clean the commutator with fine sandpaper (#0000). Blow out the sand with compressed air and seat-in the brushes. If the commutator is dirty or worn to the extent that sandpaper will not clean it, refer to paragraph 56*j* (2)(*b*) and turn it down in a lathe as instructed.

d. Electric System (cont).

Item No.	Item	Frequency M	Frequency W	Action
29	Magneto.	*		Remove the magneto end cap; be careful not to damage the lead gasket. Remove the distributor rotor and clean the distributor compartment thoroughly, observing whether the air vents are open or clogged. *Air vents must be free of all dirt and foreign matter.* Examine the high-tension lead brush and replace it if it is noticeably worn or damaged. This brush should move freely in its holder and should be under light spring pressure. Inspect the breaker points for pitting or pyramiding. If pitted or pointed, resurface the points with a small tungsten file or fine stone. If the points are badly pitted, replace them. Refer to paragraph 56*g* when resurfacing or replacing breaker points and proceed as instructed. Inspect the cam felt wick and replace it if it is hard or dry.
30	Wiring, switches.	*		See that all wiring and cables are in good condition and are mounted properly. Examine for poor connections and worn insulation. Check all switches for correct connections and mountings and for proper operation.
31	High temperature cutoff switch.			Check the accuracy of the cutoff switch as follows: Insert a thermometer in the upper tank of the radiator. Set the dial of the cutoff switch at 220° F. Cover the radiator and start the engine. When the temperature exceeds 180° F, slowly move the dial counterclockwise until the engine shuts off. The reading on the dial should coincide with the thermometer reading. If the readings differ, adjustment is necessary. Adjust the cutoff switch as follows: Loosen the two screws in the dial; be careful not to disturb the dial setting. With the screws loose, break the seal on the dial scale and set the scale to correspond with the thermometer reading just taken. Tighten the screws and reset. *Caution.* The factory setting of the dial scale is sealed with compound on both the scale and the central disk of the dial. Do not break this seal except during adjustment. After adjustment has been made, set the dial at 200° F.
32	Low-oil-pressure cutoff switch.			Test the accuracy of the cutoff switch as follows: Remove the switch from the engine. With a pressure regulating valve, pressure gage, and a continuity tester, check the pressure at which the switch opens. If the pressure is above or below 5 psi (± 1 pound), replace the switch.

e. Generators.

Item No.	Item	Frequency M	Frequency W	Action
33	Dc generator.	*		See that the dc generator is mounted securely and that all cable connections are clean and tight. To examine the brush rigging, loosen the mounting bolts and adjusting bolts and remove the drive belt. Then swing the generator outboard for easy access. Remove the commutator end cover. Check the brushes for free movement in the holders. Test the brush spring pressure. It must be between ½ and ¾ pound when deflected ½ inch. Examine the brushes for wear and replace them if they are worn to ⅜ inch in length. Refer to paragraph 56*h* and seat-in the brushes as instructed. Blow out the brush dust from the brush rigging, armature assembly, and field ring assembly with dry, compressed air. If the brushes have been arcing, as evidenced by a dirty commutator, clean with fine sandpaper (#0000). Blow out the sand with compressed air and seat-in the brushes. If the commutator is dirty or worn to the extent that the sandpaper will not clean it, refer to paragraph 56*h* and turn it down on a lathe as instructed.

e. Generators (cont).

Item No.	Item	Frequency M	Frequency W	Action
34	Alternator.	*		The alternator is of the permanent-magnet type and has no commutator, brushes, etc. Examine the bearing and bearing liner of the alternator for evidence of overheating. Blow dirt and dust out of the alternator with dry, compressed air.
35	Battery-charging generator.	*		See that the 24-volt battery-charging generator is mounted securely and that all cable connections are clean and tight. To examine the brush rigging, remove the cover band on the commutator end of the generator. Examine the brushes for wear and replace if worn to 5/8 inch in length. Refer to paragraph 56*h* and seat-in the brushes as instructed. If the brushes have been arcing, as evidenced by a dirty commutator, clean with fine sandpaper (#0000). Blow out the sand with dry, compressed air. If the commutator is dirty or worn to the extent that sandpaper will not clean clean it, refer to paragraph 56*h* and turn it down in a lathe as instructed.
36	Circuit breakers.	*		See that the dc and ac circuit breakers are secured tightly to the instrument panel. Examine the condition of all connections.
37	Voltage regulator.	*		See that the dc voltage regulator is mounted securely and that all cable connections are clean and tight. Remove dust and dirt particles from the regulator with dry, compressed air. Wipe off any accumulation of grease.
38	Compensator assembly.	*		Examine the condition of the transformers. Check for damaged insulation and bare wires. See that the transformer is mounted securely. Check all transformer connections; be sure they are clean and tight. Remove dust and dirt from the transformer-to-capacitor network with dry, compressed air.
39	Wye-delta change board.	*		See that all the cable connections on the change board are clean and tight. Check for short circuits.
40	Drive couplings.	*		Inspect area of alternator housing and flywheel housing and be sure there are no loose particles or foreign matter in the ventilation openings.

f. Winterization System.

Item No.	Item	Frequency M	Frequency W	Action
41	Tubes and hoses.	*		Examine the condition of all metal tubes and hoses. See that all connections are tight. Check the condition of all the wiring for worn insulation and loose connections. Examine the heater controls for proper mounting. Operate the winterization system at least once a month.
42	Heater.			Examine the combustion area and exhaust passages by removing the burner assembly (par. 56*k*). Inspect the primary air holes in the top section of the burner. If the holes are plugged, clean them with a piece of wire. Examine the heat exchanger and exhaust outlet with a flashlight and an inspection mirror. If uniform carbon deposits on surfaces visible with the mirror exceed 1/8 inch in thickness, clean all tubing and heat exchanger parts. Check the exchanger for cracks. Inspect the burner wick for wear and deterioration. Replace the wick if it is charred or burned to a point 1/4 inch below the top edge of the igniter tube. See that the insulation on the electrode is not cracked or damaged.
43	Heater fuel pump.	*		Refer to paragraph 56*l*(2) and clean the pump subassembly as instructed.

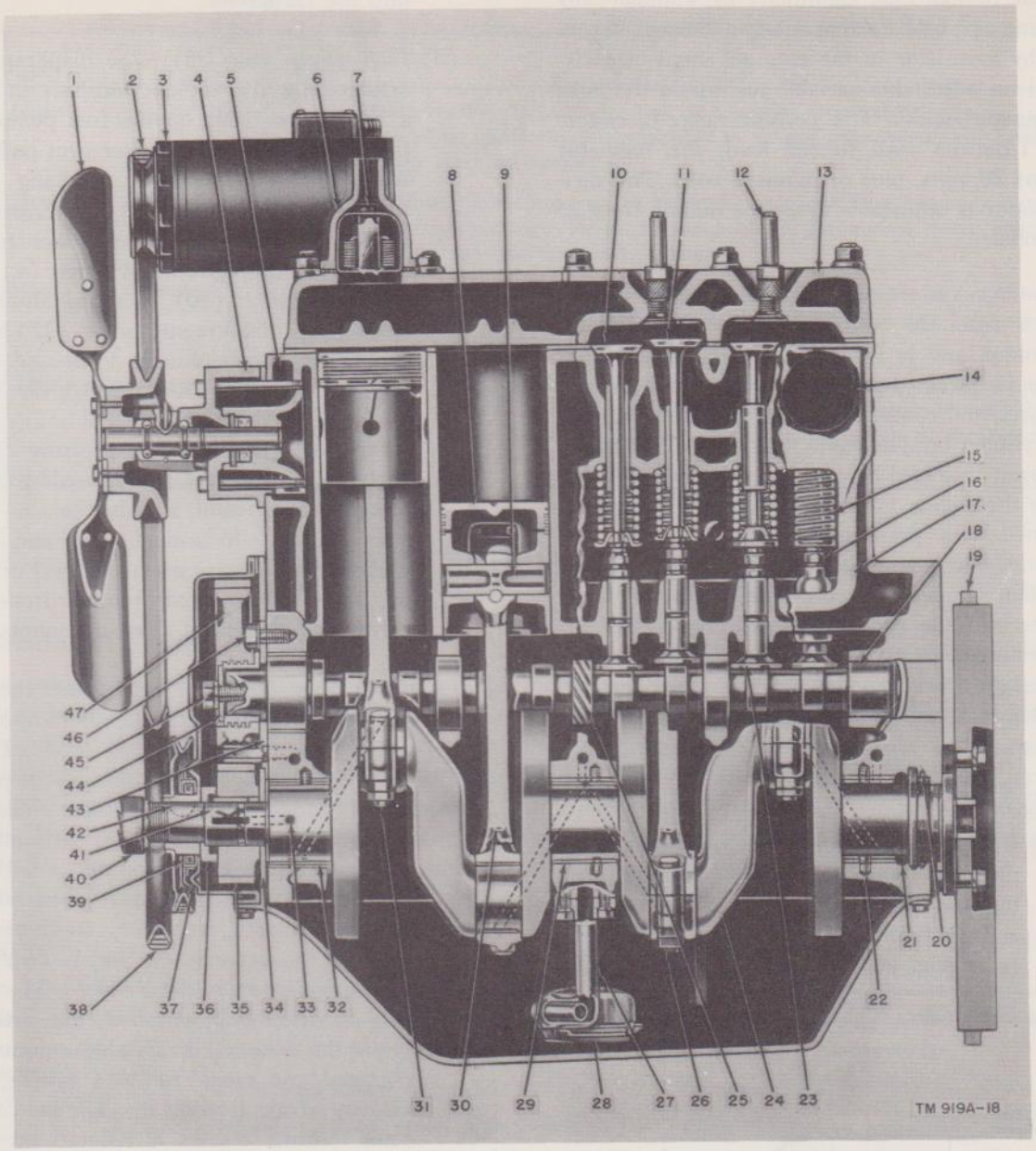


Figure 18. Engine, cross section, side view.

1. Fan (B26).
2. Fan belt (MP208).
3. 24-volt generator (C3).
4. Water pump.
5. Water pump impeller (MP186).
6. Coolant outlet neck (A 1).
7. Coolant thermostat (S 15).
8. Pistons (MP17 to MP20).
9. Wrist pins (MP21 to MP24).
10. Exhaust valves (MP76 to MP to MP79).
11. Intake valves (MP80 to MP83).
12. Spark plugs (E195 to E198).
13. Cylinder head (A 2).
14. Manifold group (A 12).
15. Valve springs (MP96 to MP103).
16. Valve tappet adjusting screw (H251).
17. Cylinder block (A 4).
18. Camshaft (MP128).
19. Flywheel ring gear (MP156).
20. Rear bearing oil guard felt (H333).
21. Rear bearing packings (H334 and H335).
22. Rear main bearings (MP39 and MP40).
23. Valve tappets (MP120 to H127).
24. Crankshaft (MP54).
25. Oil pump drive gear.
26. Connecting rod cap bolts (H201 to H208).
27. Oil pump drive shaft (MP174).
28. Oil pump.
29. Center main bearings (MP41 and MP42).
30. Connecting rod assemblies (MP15 and MP16).
31. Connecting rod lock nuts (H233 to H240).
32. Front main bearings (MP51 and MP52).
33. Crankshaft oil passages.
34. Crankshaft thrust plate (MP55).
35. Crankshaft gear (MP56).
36. Crankshaft oil thrower (MP58).
37. Timing gear cover (MP142).
38. Crankshaft pulley (MP153).
39. Crankshaft pulley seal (H241).
40. Starting jaw bolt (MP154).
41. Crankshaft gear key (MP56).
42. Crankshaft pulley key (H308).
43. Camshaft thrust plate (MP129).
44. Camshaft gear lockwasher (H267).
45. Camshaft gear retaining nut (H262).
46. Camshaft gear thrust plate retaining screws (H259 and H260).
47. Camshaft gear (MP133).

for maintaining an almost constant output voltage under all normal load conditions by automatically controlling the field current. Output voltage is controlled by a resistor in the external shunt-field circuit and an adjustable variable resistor in the voltage regulator, within a 4 percent range in engine speed; from no load to full load, the regulator maintains 28 volts, plus or minus 2 volts. The variable resistor is adjustable to set the output from 25 to 30 volts.

e. Cooling System (fig. 19). The engine coolant is drawn from the bottom of the radiator by the water pump, and is forced into the cylinder block through the jacketed passages around the cylinders, valve ports, and combustion chambers, and then out of the cylinder head and into the top of the radiator. The coolant is cooled by air blown through the radiator by the engine fan. The engine temperature is maintained at a pre-established minimum by the thermostat. The engine is automatically stopped by the coolant temperature cutoff switch in the water outlet neck if the coolant temperature reaches the predetermined setting of the cutoff switch. The pressure-type filler cap will release vapor through the radiator overflow if the pressure in system exceeds 4 psi.

f. Fuel System.

(1) *General.* The generator set operates on fuel pumped from an external supply tank through the auxiliary fuel line (fig. 7) and fuel filter (15, fig. 3) to the carburetor (fig. 20) by fuel pump (fig. 25).

(2) *Fuel filter.* The fuel passes through the disk-type fuel filter before being pumped into the carburetor.

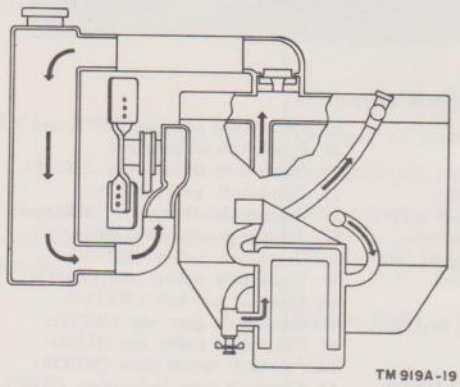


Figure 19. Cooling system flow diagram.

(3) *Fuel pump* (fig. 25). The diaphragm is actuated by the engine camshaft through a rocker arm (23) on the fuel pump. On the intake stroke, the rocker arm pulls the diaphragm (15) upward, reducing pressure within the cover (2) and creating a suction on the inlet. Fuel flows to the cover (2) through the strainer (4) and the inlet valve (10). On the discharge stroke, the diaphragm spring (17) pressure pushes the diaphragm downward, forcing fuel from the cover through the outlet valve (9) and into the fuel line to carburetor float chamber. The pressure of the fuel, within the fuel pump, holds the diaphragm down until a reduction in pressure permits it to resume its up and down motion. This occurs when the level of fuel in the carburetor float chamber drops and permits fuel to flow from the pump.

(4) *Carburetor* (fig. 20). Fuel enters the carburetor bowl through the float-operated needle valve assembly; the level of fuel being governed by the float position. At idling speeds and light-load operation, fuel flows through the idle well jet and the low speed jet where it combines with air entering through the bypass. The fuel is broken up into a vapor, continues on through the economizer, and is combined with more air from the air bleed. The mixture is richer than required, but with air from the venturi, a suitable mixture is obtained. At rated full-load speeds, the velocity of air flowing through the carburetor venturi creates a reduced pressure at the tip of the main nozzle. The low pressure causes fuel to flow from the float chamber through the metering jet and out of the main nozzle into the carburetor venturi.

g. Starting System (fig. 21).

(1) *Automatic starting.* With the ignition switch (S1) in the REMOTE AND/OR ELEC. START NORMAL OPERATION position and the START-STOP

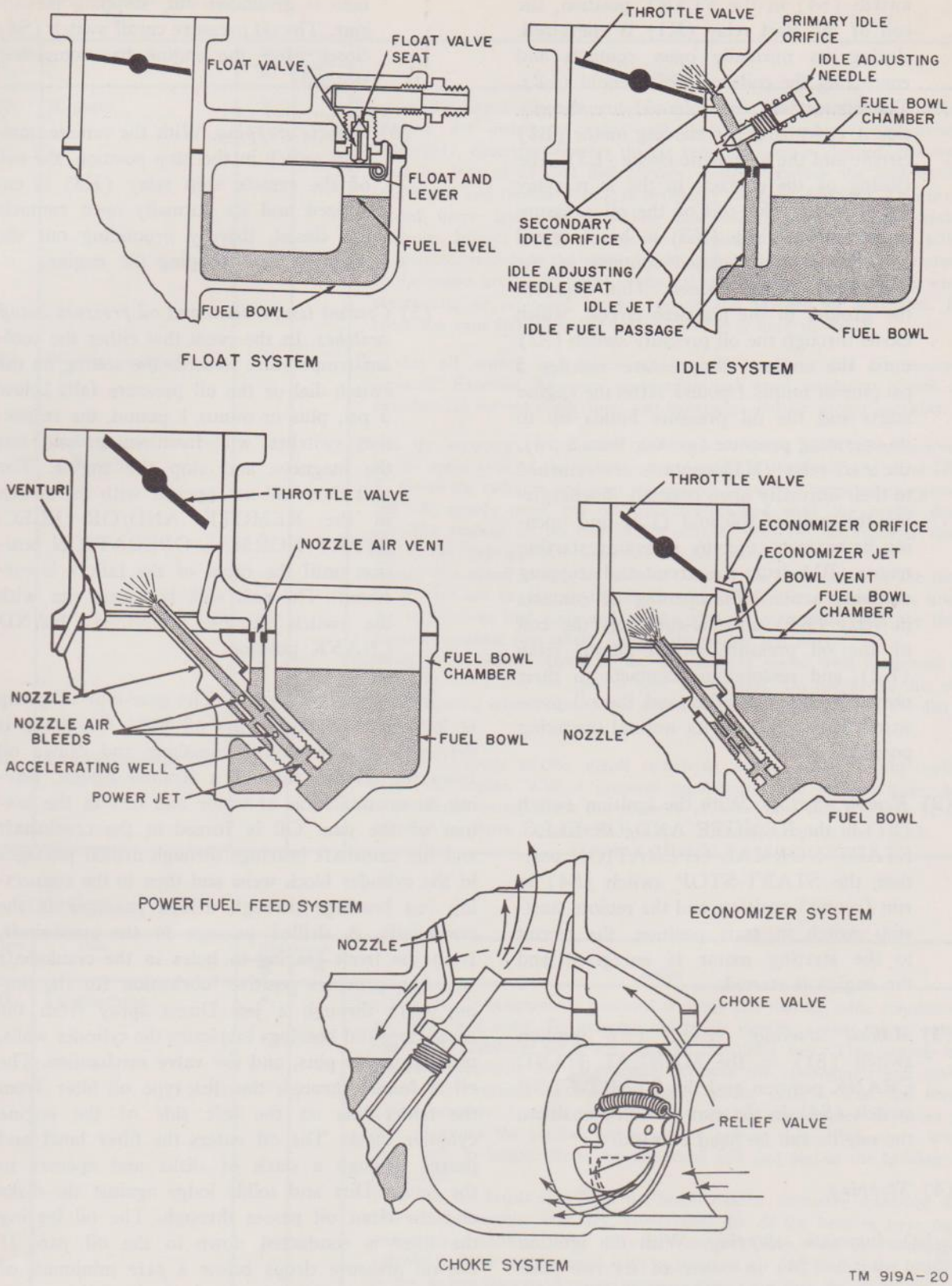


Figure 20. Carburetor flow diagram.

switch (S4) in the START position, the coil of the start relay (K1) is energized, closing its normally open contacts and energizing the coils of the solenoid (L2). The contacts in the solenoid are thereby closed, energizing the starting motor (B1) circuit and the automatic choke (L3). The closing of the contacts in the start relay (K1) causes the coil of the oil pressure switch cutout relay (K2) to be energized and the normally closed contacts in the coil (K2) to be opened. This removes the ground in the magneto circuit, which exists through the oil pressure switch (S2) until the engine oil pressure reaches 5 psi plus or minus 1 pound. After the engine starts and the oil pressure builds up to its operating pressure (greater than 5 psi), the start relay (K1) contacts are returned to their normally open position, de-energizing the coils of solenoid (L2) and opening its contacts, thereby removing starting motor (B1) from the circuit and stopping cranking action. The opening of contacts in relay (K1) also de-energizes the coil of the oil pressure switch cutout relay (K2), and restores its contacts to their normally closed position and the oil pressure switch (S2) to its normal operating position.

(2) *Remote starting.* With the ignition switch (S1) in the REMOTE AND/OR ELEC. START NORMAL OPERATION position, the START-STOP switch (S4) in run (center) position, and the remote start-stop switch in start position, the circuit to the starting motor is energized and the engine is started.

(3) *Manual starting.* With the ignition switch (S1) in the MANUAL HAND CRANK position and the START-STOP switch (S4) in the run (center) position, the engine can be hand cranked.

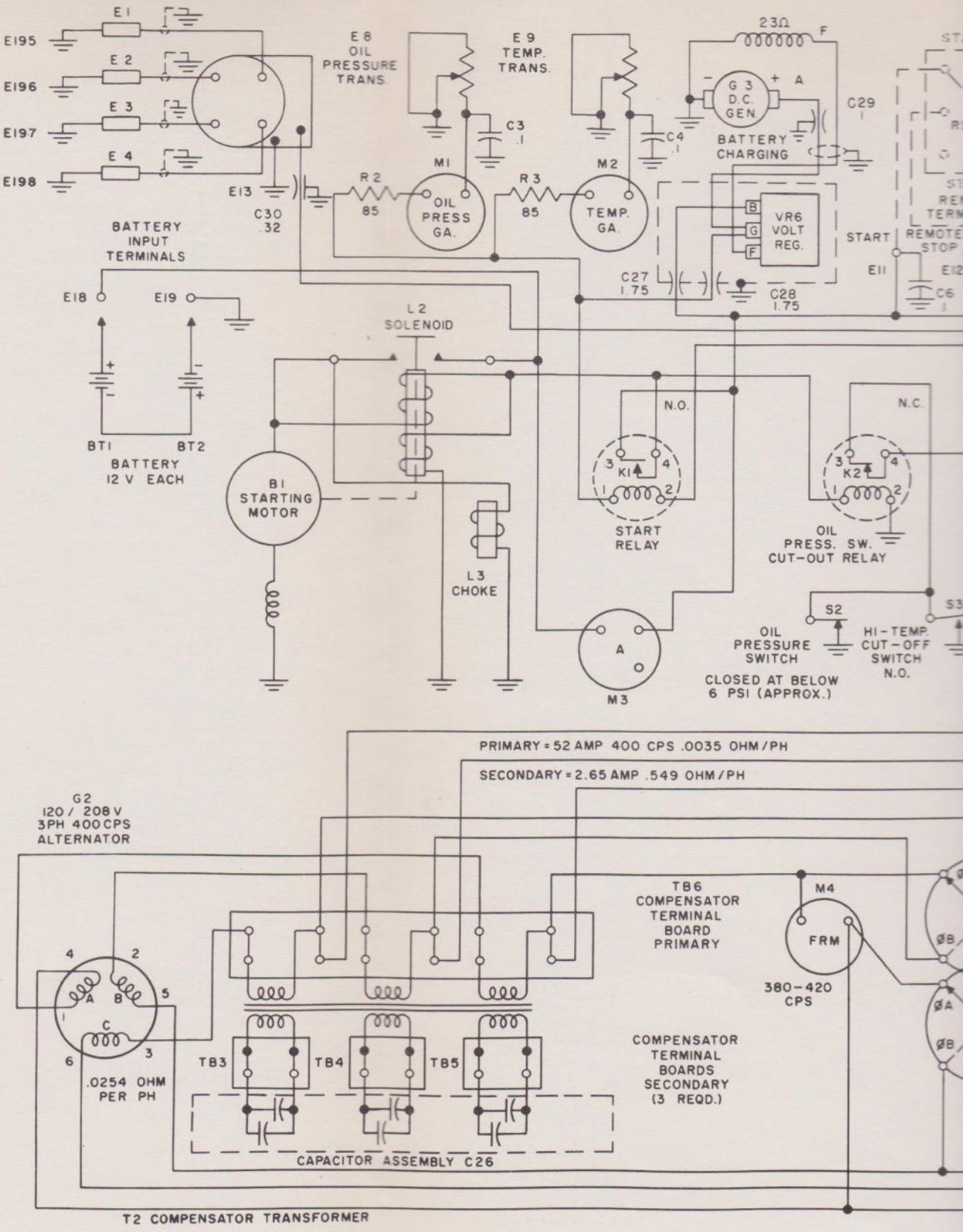
(4) *Stopping.*

(*a*) *Automatic stopping.* With the ignition switch (S1) in either of its two positions, and the START-STOP switch (S4) in the STOP position, the magneto is grounded out, stopping the engine. The oil pressure cutoff switch (S2) closes after the engine has completely stopped.

(*b*) *Remote stopping.* With the remote start-stop switch in the stop position, the coil of the remote stop relay (K3) is energized and its normally open contacts are closed, thereby grounding out the magneto and stopping the engine.

(5) *Coolant temperature and oil pressure cutoff switches.* In the event that either the coolant temperature exceeds the setting on the switch dial or the oil pressure falls below 5 psi, plus or minus 1 pound, the respective switches will function, ground out the magneto, and stop the engine. The unit then will not operate with the switch in the REMOTE AND/OR ELEC. START NORMAL OPERATION position until the cause of the failure is corrected. The unit will, however, run with the switch in the MANUAL HAND CRANK position.

h. Lubrication System. The gear-type oil pump is located internally in the oil pan. The pump is driven from the engine camshaft and draws oil from the oil pan through a strainer screen, leaving an accumulation of water and dirt in the bottom of the pan. Oil is forced to the crankshaft and the camshaft bearings through drilled passages in the cylinder block webs and then to the connecting rod bearings through drilled passages in the crankshaft. A drilled passage in the crankshaft, from the front bearing to holes in the crankshaft sprocket, provides positive lubrication for the timing gears through a jet. Direct spray from the connecting rod bearings lubricates the cylinder walls, pistons, piston pins, and the valve mechanism. The oil is forced through the disk-type oil filter from the outlet line on the left side of the engine cylinder block. The oil enters the filter bowl and passes through a stack of disks and spacers to the outlet. Dirt and solids lodge against the disks and the clean oil passes through. The oil leaving the filter is conducted down to the oil pan. If the oil pressure drops below a safe minimum of 5 psi, plus or minus 1 pound, the low-oil-pressure cutoff switch stops the engine.


E1
E195
E2
E196
E3
E197
E4
E198
E13
C30
.32
E8
OIL
PRESSURE
TRANS.
E9
TEMP.
TRANS.
C3
.1
C4
.1
M1
M2
R2
85
R3
85
OIL
PRESS
GA.
TEMP.
GA.
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F
G 3
D.C.
GEN.
+ A
−
BATTERY
CHARGING
C29
.1
B
G
F
VR6
VOLT
REG.
START
REMOTE
STOP
E11
C27
1.75
C28
1.75
C6
BATTERY
INPUT
TERMINALS
E18
E19
BT1
BT2
BATTERY
12 V EACH
L2
SOLENOID
B1
STARTING
MOTOR
L3
CHOKE
N.O.
K1
START
RELAY
N.C.
K2
OIL
PRESS. SW.
CUT-OUT RELAY
A
M3
S2
OIL
PRESSURE
SWITCH
CLOSED AT BELOW
6 PSI (APPROX.)
HI-TEMP.
CUT-OFF
SWITCH
N.O.
PRIMARY = 52 AMP 400 CPS .0035 OHM/PH
SECONDARY = 2.65 AMP .549 OHM/PH
G2
120 / 208 V
3PH 400 CPS
ALTERNATOR
TB6
COMPENSATOR
TERMINAL
BOARD
PRIMARY
M4
FRM
380-420
CPS
ØB
ØA
ØB
A
B
C
.0254 OHM
PER PH
TB3
TB4
TB5
COMPENSATOR
TERMINAL
BOARDS
SECONDARY
(3 REQD.)
CAPACITOR ASSEMBLY C26
T2 COMPENSATOR TRANSFORMER

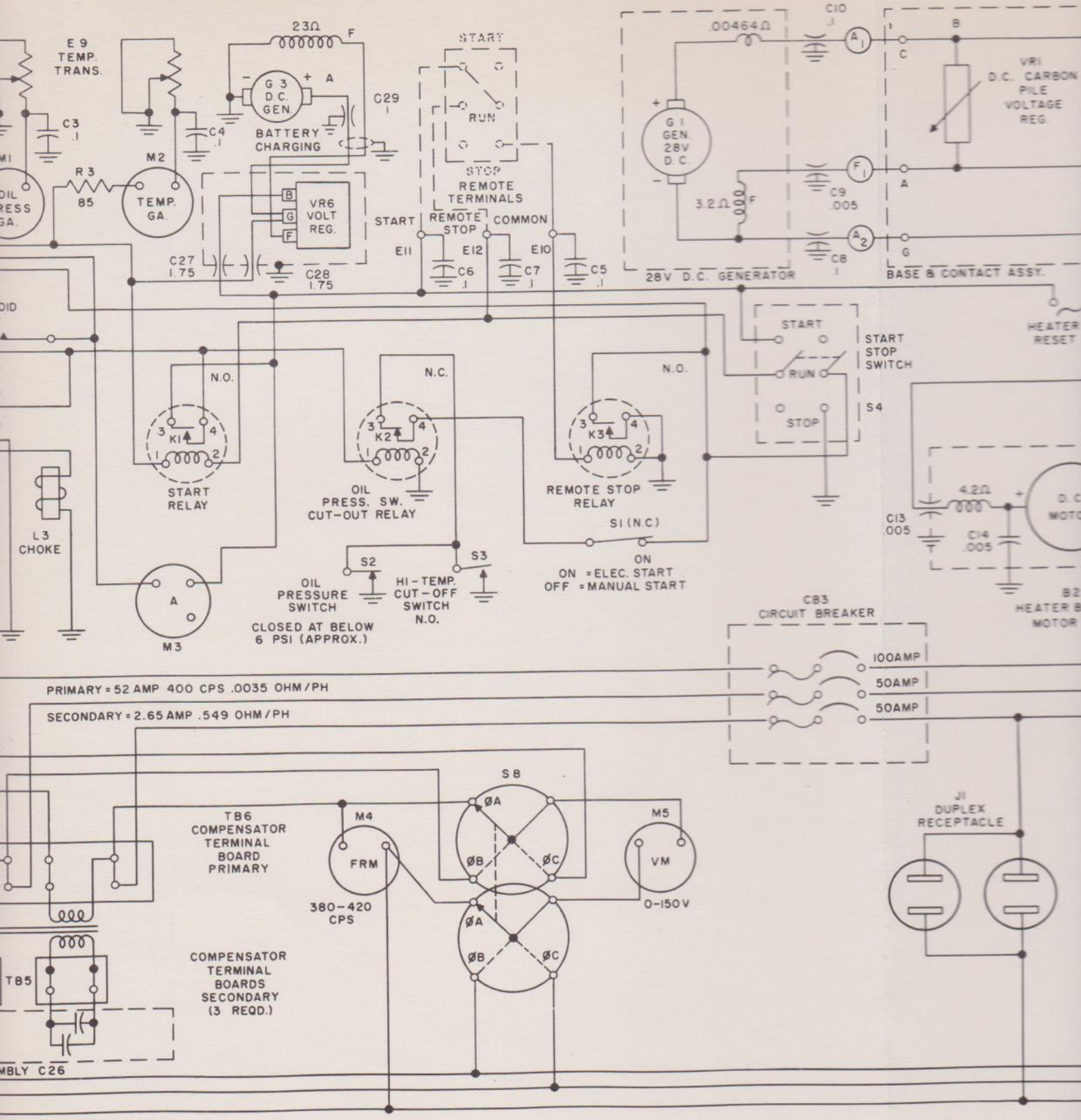


Figure 21. Schematic wiring diagram.

b. Alternator.

Symptom	Possible Cause	Remedy
1. Abnormal frequency regulation.	Carburetor-to-governor linkage out of adjustment.	Adjust (par. 25*b*).
	Governor spring eyebolt out of adjustment.	Adjust (par. 25*b*).
2. Voltage too high.	Governor out of adjustment.	Adjust (par. 25*b*).
3. Voltage too low.	Governor out of adjustment.	Adjust (par. 25*b*).
	Rotor has lost magnetism because of severe jolt, coming in contact with another rotor, or being allowed to roll on a steel bench. *Note.* Loss of magnetism can occur only while rotor is out of unit.	Deadline for repair.
4. Low or no voltage on one phase with other phase abnormally high.	Short circuit across the particular phase.	Check stator with internal growler. Repair short circuit or replace stator.
5. No voltage reading in any one or all phases under no load.	Voltmeter circuit open.	Repair open circuit.
6. Unbalanced phase voltage under balanced load conditions.	Failure of one or more capacitors in the compensator capacitor assembly (C26). (Maximum upper limit of the capacitors, per phase, is 5.60 uf. Minimum lower limit, per phase, is 5.40 uf. Maximum allowable deviation, between phases, is ±.015 uf).	Replace entire capacitor assembly (C26). Do not change individual capacitors. Always use a factory-matched set.

c. 28-volt, 2.5-kw, Dc Generator.

Symptom	Possible Cause	Remedy
1. Generator operating at rated rpm, but has low or no voltage.	Connections loose, dirty, or have high resistance.	Clean and tighten connections.
	Brushes binding in holders.	Remove brushes and clean with lint-free dry cloth.
	Brush spring tension too low.	Replace brush springs.
	Brushes worn.	Replace.
	Commutator rough, pitted, or eccentric.	Clean or resurface (par. 56*i* (2)).
	Armature winding short-circuited or grounded.	Replace armature.
	Generator field polarity reversed (magnetized in wrong direction).	Flash shunt field in proper direction as follows: Connect two #8 AWG or larger cables to a 24-volt battery. With engine operating at 1,714 rpm, connect the negative lead of the battery to the negative terminal on the generator and momentarily touch the hot or positive lead to the positive terminal on the generator.
	Generator drive belt loose or slipping.	Tighten belt.

c. 28-volt, 2.5-kw, Dc Generator (cont).

Symptom	Possible Cause	Remedy
	Regulator armature spring weak or broken.	Replace armature assembly.
	Armature lead in regulator broken.	Repair lead or replace armature assembly.
	Regulator-pile adjusting screw contact lead broken.	Repair adjusting screw lead assembly.
	Regulator adjusting screw not making contact with carbon stack.	Readjust regulator (par. 64*g*).
	Regulator carbons pitted or burned.	Replace carbon stack and readjust regulator (par. 64*g*).
	Regulator core screwed in too far.	Readjust regulator (par. 64*g*).
	Regulator operating coil is shorted.	Repair or replace operating coil.
2. Voltage flutters.	Regulator stabilizing resistors open.	Replace resistor.
	Regulator not properly adjusted.	Readjust regulator (par. 64*g*).
3. Generator operating at rated rpm, but voltage is too high.	Short circuit between the two cables to the regulator terminals A and B.	Restore to correct condition.
	Regulator cannot be adjusted.	Replace voltage regulator.
	Voltage regulator operating coil lead broken or unsoldered.	Resolder.
	Voltage regulator operating coil burned out.	Replace operating coil.
	Fixed resistor on regulator (18 ohms) burned out or open.	Replace resistor.
	Regulator armature contact sticking in pile tube.	Disassemble and free armature.
	Regulator core screwed out too far.	Readjust core (par. 64*g*).
	A and B leads reversed at regulator base.	Check wiring.
	Regulator voltage variable resistor is open or shorted.	Replace resistor.
	Dirty contact buttons and contact blades in regulator base.	Clean contact buttons and blades.
4. Excessive arcing present at generator brushes.	Brushes worn too short to be held against commutator.	Replace brushes.
	Brushes binding in their holders.	Remove brushes and clean with lint-free dry cloth.
	Brush spring tension too low.	Replace the brush springs.
	Rough or burned commutator.	Clean and polish with #0000 sandpaper.
	Rough, burned, pitted, or eccentric commutator.	Resurface.
	High voltage.	Check voltage regulator adjustments.
	Wrong connections between generator and switch relay.	Check and correct according to wiring diagram (fig. 61).
5. Generator commutator throwing solder.	Excessive arcing at generator brushes.	Refer to symptom 4 above.

c. 28-volt, 2.5 kw, Dc Generator (cont).

Symptom	Possible Cause	Remedy
6. Field current cannot be adjusted within the specified limits.	Faulty wiring connections.	Clean and tighten all connections, replace defective wires or connections.
	Field circuit is either open-circuited, short-circuited, or field resistance incorrect.	Replace the field frame assembly.
	Brushes not seating properly.	Check and apply remedies given.
7. Generator overheats.	Brushes improperly seated.	Reseat.
	Armature is short-circuited.	Replace armature.
	Bearings tight.	Replace bearings.
	Commutator bars high or out of alignment.	Replace the armature assembly if the commutator bars are out of alignment; turn down the bars on a lathe if they are too high.

d. 24-volt Battery-charging Generator.

Symptom	Possible Cause	Remedy
1. Generator output low or none at all.	Battery electrolyte low.	Fill batteries.
	Electrical charging circuit connections loose and/or dirty.	Clean and tighten connections.
	Dirty commutator.	Clean commutator.
	Worn commutator.	Turn down on lathe and undercut mica strips.
	Dirty or worn brushes.	Clean, free up, or replace brushes.
	Broken circuit in field or armature.	Overhaul generator.
	Voltage regulator not functioning properly.	Clean, test, and adjust regulator. Replace regulator if results are unsatisfactory.
2. Generator output too high.	Voltage regulator not functioning properly.	Clean, test, and adjust regulator. Replace regulator if results are unsatisfactory.

CHAPTER 5

THEORY

51. Engine and Dc Generators

a. Engine (fig. 18). The internal combustion, four-stroke cycle engine is of the conventional automotive type. Four-stroke cycle means that there are four strokes of the piston, two up and two down, to each operating cycle. Only every fourth stroke of the piston is a power stroke. A complete cycle of one piston, with the individual operation of each stroke, is described in the following subparagraphs.

(1) *Intake stroke.* With the exhaust valve closed and the intake valve open, a correctly metered, highly combustible mixture of air and gasoline is drawn from the carburetor through the intake manifold and intake valve port into the combustion chamber. The mixture is drawn into the cylinder as the piston travels downward, and the intake valve for that cylinder is open.

(2) *Compression stroke.* As the piston travels past bottom dead center, the intake valve closes and with the exhaust valve closed, the fuel-air mixture then is compressed between the piston and the cylinder head. As the piston reaches the top of the stroke, the spark plug emits a spark and ignites the highly compressed fuel-air mixture.

(3) *Power stroke.* With both valves closed, the rapidly expanding gases that result from the burning fuel mixture force the piston downward. This movement is transmitted through the connecting rod to the crankshaft which converts the reciprocating motion to rotary motion.

(4) *Exhaust stroke.* The exhaust valve, as is the intake valve, is operated by a tappet in contact with the camshaft. The exhaust valve opens 45° before bottom dead center and permits the upward travel of the piston to expel the exhaust gases through the exhaust port. As the piston approaches top dead center, the intake valve again starts to open, the exhaust valve starts to close, and a new cycle is under way.

b. Engine Speed Governor (fig. 23). The engine speed governor is of the flyweight type, gear-driven from the camshaft gear in the engine. The centrifugal force of the revolving flyweights (24) is transmitted by a pivoted yoke (32) to lateral motion which acts against the tension of the control arm spring (2). This action also moves the carburetor throttle towards the closed position. When the predetermined speed setting is reached, the governor maintains the engine speed at 1,714 rpm which is the synchronous speed for 400-cycle operation. Governor adjustments are described in paragraph 25*b*.

c. 24-volt Battery-charging System. The two 12-volt storage batteries are maintained in a full state of charge by the 24-volt battery-charging generator (fig. 28) which is belt-driven from the engine fan pulley. The rate of charge is controlled automatically by the automotive-type voltage regulator (fig. 29) which is mounted in the suppression box on the firewall.

d. 28-volt, 2.5-kw Dc System. The 28-volt, dc system consists of two main components, a self-excited belt-driven generator (fig. 27) and an aircraft-type, carbon-pile voltage regulator (fig. 36). The generator develops 2.5 kw at 28 volts, operating at a shaft speed of 4,500 rpm (engine speed of 1,714 rpm). The voltage regulator provides a means

(8) Disconnect the two ground straps from the right and left sides of the upper frame.

(9) Remove the bolts and nuts securing the upper radiator brackets to the radiator.

(10) Remove the four bolts and nuts that secure the upper frame to the lower frame.

(11) Lift the upper frame off the lower frame, being careful not to damage any parts on the unit.

b. Radiator. Before removing the radiator (*27*, fig. 2), open the radiator cap to prevent a vacuum. Drain the coolant through the rediator drain cock (*26*, fig. 2).

(1) Remove the fan guard (*7*, fig. 3).

(2) Loosen the radiator hose clamps and remove all necessary hose.

(3) Remove the fan assembly and leave it resting in the fan shroud on the radiator.

(4) Remove the nuts that secure the radiator to the lower frame. Slide the radiator forward in the slots and lift it off the frame. Remove the fan assembly.

c. Muffler (fig. 2).

(1) Remove the two nuts that secure the exhaust pipe adapter to the exhaust manifold.

(2) Loosen the clamp that secures the muffler (*25*) to the lower frame.

(3) Slowly remove the muffler assembly. Be careful not to damage any parts of the engine.

d. Engine Speed Governor (fig. 3).

(1) Disconnect the carburetor-to-governor linkage (*9*) from the governor control arm.

(2) Remove the two mounting bolts and take the governor from the engine.

e. Air Cleaner (fig. 2).

(1) Disconnect all hoses (subpar. *a*(3) above).

(2) Unscrew the four bolts that hold the air cleaner (*6*) to the mounting brackets and remove the air cleaner.

f. Carburetor.

(1) Disconnect the cable for the manual choke (*28*, fig. 2) and disconnect the automatic choke rod from the carburetor choke control.

(2) Disconnect the cable for the manual throttle (*8*, fig. 4) and disconnect the carburetor-to-governor linkage (*9*, fig. 3) from the carburetor throttle lever.

(3) Remove the fuel line from the carburetor.

(4) Unscrew the two nuts that secure the carburetor to the intake manifold.

(5) Lower the carburetor from the manifold.

g. Fuel Pump (fig. 3).

(1) Disconnect the fuel lines from the fuel pump (*16*).

(2) Remove the two bolts that secure the fuel pump to the engine.

(3) Remove the fuel pump from the engine.

h. Oil-pressure Cut-off Switch and Oil-pressure Transmitter (fig. 2).

(1) Disconnect the electrical leads from the oil-pressure cut-off switch (*7*) and the oil-pressure transmitter (*8*).

(2) Screw the switch and transmitter out of the cross fitting.

i. Fuel Filter (fig. 3).

(1) Open the drain cock and drain the fuel from the fuel filter (*15*).

(2) Disconnect all hose fittings and remove the fuel lines from the filter.

(3) Remove the two bolts that secure the filter to the mounting bracket and remove the filter.

j. Coolant High Temperature Cutoff Switch (fig. 2).

(1) Disconnect the electrical lead from the coolant high temperature cutoff switch (*3*).

(2) Carefully screw the cutoff switch out of the coolant outlet neck. Do not damage the thermal element.

k. Oil Filter (fig. 2).

(1) Disconnect the hose fittings and remove the oil lines from the oil filter (*9*).

(2) Remove the two bolts that secure the oil filter to the bracket on the engine. Remove the filter.

l. Magneto (fig. 3).

(1) Disconnect the shielded ignition cables from the rear of the magneto assembly (11).

(2) Remove the capacitor from the top of the magneto.

(3) Remove the bolt that secures the governor and magneto to the engine timing gear cover at top, and remove the nut that secures the magneto to engine timing gear cover at the bottom.

(4) Slowly pull the assembly from the engine timing gear cover.

m. 24-volt Battery-charging Generator.

(1) Remove the terminal insulator cap from the terminal board on the capacitor cover. Disconnect the electrical leads from the terminals on top of the generator (5).

(2) Loosen the adjusting bolt in the generator adjusting arm and remove the drive belt from the generator pulley.

(3) Unscrew the bolt that secures the generator adjusting arm to the generator.

(4) Remove the two bolts that secure the generator to the mounting bracket on the engine.

(5) Lift the generator from the unit.

n. 28-volt, 2.5-kw Dc Generator (fig. 2).

(1) Remove the cover from the capacitor suppression shield assembly and disconnect all electrical leads from the top of the generator.

(2) Remove the adjusting bolt in the generator adjusting arm and remove the belt from the generator pulley.

(3) Remove the two bolts that attach the generator to the mounting bracket on the engine.

(4) Lift the generator from the unit.

o. Starting Motor (fig. 2).

(1) Remove the heater shield (21).

(2) Disconnect the electrical leads from the starting motor (14) and the solenoid switch (11).

(3) Unscrew the three mounting bolts that secure the starting motor to the flywheel housing.

(4) Remove the starting motor; be careful not to damage the drive gear or flywheel ring gear.

p. Winterization System. To remove individual components of the winterization system, follow the applicable instructions below:

(1) *Heater.*

(*a*) Drain the coolant by using the drain located on the side of the heater (20, fig. 2). This also will drain the coolant from the engine block.

(*b*) Remove the heater shield (21).

(*c*) Unplug the socket that contains the electrical leads.

(*d*) Disconnect the fuel line at the heater.

(*e*) Loosen the clamp that secures the heat exchanger tube to the combustion outlet on the heater.

(*f*) Remove the coolant hoses from the fittings on the heater.

(*g*) Remove the four bolts that secure the heater to the mounting bracket. Carefully remove the heater.

(2) *Heat exchanger pan.* Remove the tubes from the heat exchanger pan. Then remove the bolts that secure the exchanger to the engine oil pan. Carefully slide the exchanger from the oil pan.

(3) *Fuel pump and fuel control valve.*

(*a*) Carefully disconnect the fuel lines and electrical leads from the heater fuel pump (15) and fuel control valve (16).

(*b*) Remove the bolts and screws that secure the pump and valve to the heater control box and take the pump and valve from the unit.

q. 24-volt Battery-charging Voltage Regulator.

(1) Remove the cover from the suppression box (2, fig. 3).

(2) Disconnect the electrical leads from the voltage regulator (fig. 29).

(3) Remove the three nuts that secure the voltage regulator to the suppression box.

(4) Remove the voltage regulator from the unit.

r. 28-volt, 2.5-kw, Dc Voltage Regulator (fig. 4).

(1) Disconnect all electrical leads attached to the regulator base.

(2) Grip the bottom of the rubber vibration mounts with an open-end wrench to prevent tearing the rubber. Remove the attaching nuts.

(3) Lift the voltage regulator (3) and base from the bracket.

Note. To remove the voltage regulator without removing the base, press the spring clips of the regulator base outward, thereby releasing the voltage regulator. Remove the regulator by slipping the tabs from the slotted brackets in the base.

56. Detailed Inspection

This paragraph contains instructions for the disassembly, cleaning, inspection, and reassembly of all subassemblies and accessories removed from the unit in paragraph 55.

a. Engine Speed Governor (fig. 23). After the engine speed governor has been removed (par. 55*d*), proceed as follows:

(1) *Disassembly.*

(*a*) Remove the gasket (1).

(*b*) Remove the control arm spring (2).

(*c*) Remove the shoulder bolts (3) and adjustment slide (4).

(*d*) Unscrew the upper adjustment nut (5), remove the control arm eyebolt (6) with its lower adjustment nut (7).

(*e*) Remove the roll-pin (8) with a drift and hammer and slide the control arm (9) off the control shaft.

(*f*) Remove the spring (10) from the auxiliary arm. Remove the cotter pin (11), castle nut (12), auxiliary arm screw (13), and auxiliary arm (14) from the control arm.

(*g*) Carefully pull the drive shaft gear (15) from the drive shaft.

(*h*) Remove the four screws (16) that hold the diaphragm plate (17) to the governor body and pull the plate off with the governor drive shaft and weight assembly attached. Remove the gasket (18).

(*i*) Slide the thrust sleeve (19) and thrust bearing (20) off the drive shaft. Press the bearings off the sleeve.

(*j*) Remove the flyweights (24) from the drive shaft by removing hairpin clips (21), flyweight pins (22), and spacers (23).

(*k*) Remove the screw (25) that holds the bearing (27) in the diaphragm plate (17) with pliers or a screw driver, and drive the shaft with bearing (27) from the diaphragm plate. Remove the snap ring (26) and pull the bearing (27) off the drive shaft (28).

(*l*) Using a bearing puller, remove the bearing (29) from the governor body.

(*m*) Pry the plug (30) from the body with a screw driver or punch. Then remove the snap ring (31).

(*n*) Remove the yoke (32). Then remove the bumper screw (33), washer (34), and bumper spring (35) by loosening the lock nut (36).

(*o*) Drive the control shaft (37) out of the body. Remove the bearing (38) from the body with a bearing puller.

(*p*) Slide the oil retainer (39) and oil seal (40) off the shaft.

(*q*) Remove the snap ring (41) and pull the bearing (42) off the shaft.

(*r*) Remove the screw (43) and adjusting screw (44).

(2) *Cleaning and inspection.* Clean all parts of the governor with Diesel oil (D-40 or D-35) or solvent (SD). Inspect the governor parts for conditions indicated below.

(*a*) *Drive shaft gear* (*15*). Replace if gear teeth or shaft bore are damaged or excessively worn.

(*b*) *Mounting gasket* (*1*). Replace whenever removing or replacing governor.

(*c*) *Diaphragm plate* (*17*). Replace if worn or damaged.

(*d*) *Adjustment slide* (*4*). Replace if bent, worn, or dented.

(*e*) *Control arm spring* (*2*). Check the spring for free length and for tension. The free length should be 2⅝ inches. The pressure should be between 38 and 46 pounds at ¼ inch deflection, and 70 pounds at ½ inch deflection. Replace if out of tolerance.

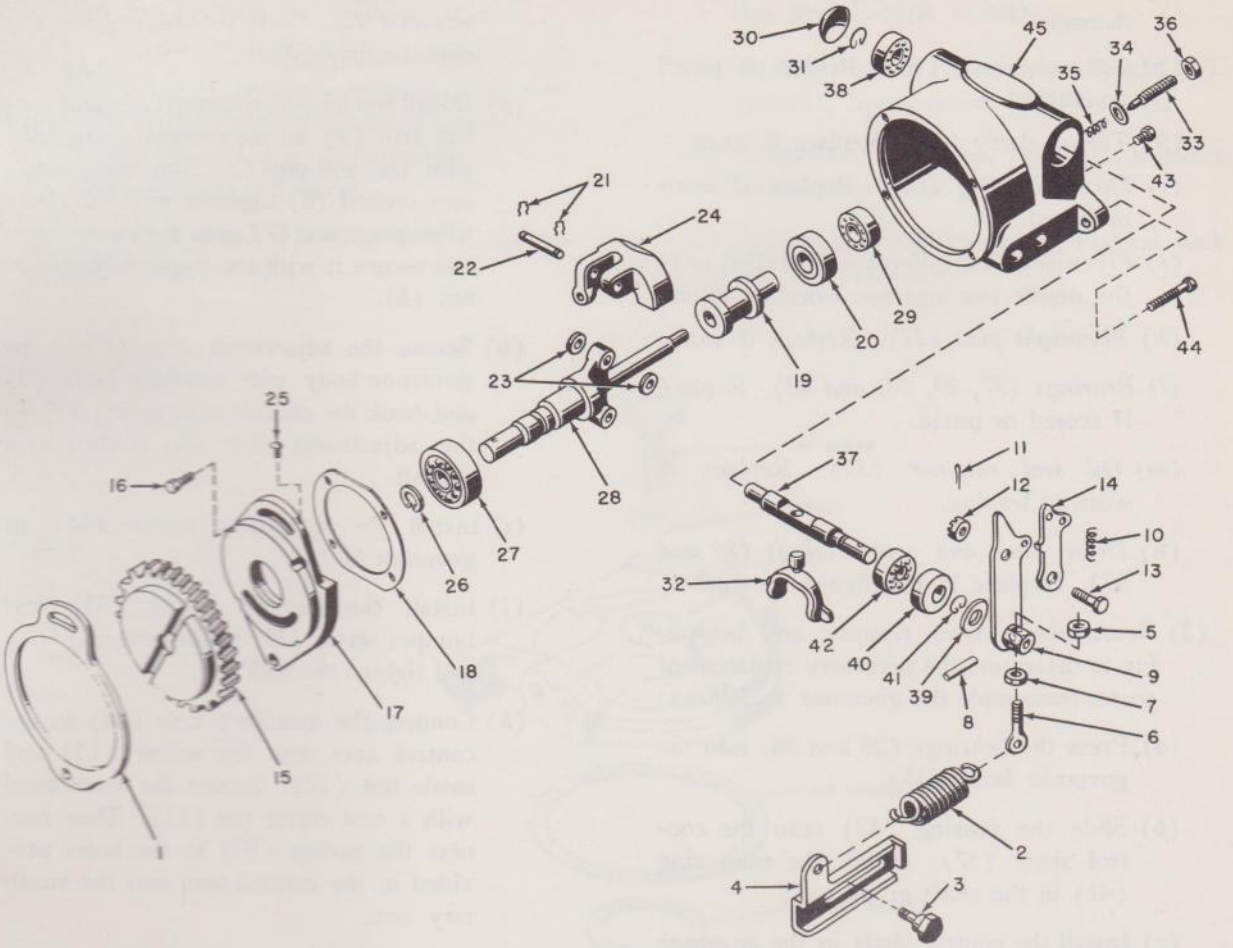


Figure 23. Engine speed governor, exploded view.

1. Gasket.
2. Control arm spring.
3. Shoulder bolt.
4. Adjustment slide.
5. Upper adjustment nut.
6. Control arm eyebolt.
7. Lower adjustment nut.
8. Roll-pin.
9. Control arm.
10. Auxiliary arm spring.
11. Cotter pin.
12. Castle nut.
13. Auxiliary arm screw.
14. Auxiliary arm.
15. Drive shaft gear.
16. Screw.
17. Diaphragm plate.
18. Body gasket.
19. Thrust sleeve.
20. Thrust bearing.
21. Hairpin clip.
22. Flyweight pin.
23. Pin spacers.
24. Flyweight.
25. Screw.
26. Snap ring.
27. Bearing.
28. Drive shaft.
29. Bearing.
30. Plug.
31. Snap ring.
32. Yoke.
33. Bumper screw.
34. Washer.
35. Bumper spring.
36. Lock nut.
37. Control shaft.
38. Bearing.
39. Oil seal retainer.
40. Oil seal.
41. Snap ring.
42. Bearing.
43. Screw.
44. Adjusting screw.
45. Governor body.

(*f*) *Control arm* (*9*). Replace if bent or damaged.

(*g*) *Governor body* (*45*). Replace if pitted or cracked.

(*h*) *Thrust sleeve* (*19*). Replace if worn.

(*i*) *Thrust bearing* (*02*). Replace if worn or pitted.

(*j*) *Flyweight* (*24*). Replace if scuffed or if the needle bearings are worn or pitted.

(*k*) *Flyweight pins* (*22*). Replace if worn.

(*l*) *Bearings* (*27, 29, 38, and 42*). Replace if scored or pitted.

(*m*) *Oil seal retainer* (*39*). Replace if worn or leaking.

(*n*) *Drive shaft and control shaft* (*28 and 37*). Replace if misaligned or worn.

(3) *Reassembly.* After cleaning and inspecting to determine the necessary replacement parts, reassemble the governor as follows:

(*a*) Press the bearings (29 and 38) into the governor body (45).

(*b*) Slide the bearing (42) onto the control shaft (37). Install the snap ring (41) in the shaft groove.

(*c*) Install the control shaft in the governor body and position the snap ring (31) in the shaft groove. The shaft must turn freely. Tap the oil retainer (40) into the body and insert a new plug (30). Install the yoke (32) onto the shaft.

(*d*) Press the bearing (27) onto the drive shaft (28). Install the snap ring (26) in the shaft groove. Install the flyweights (24) and flyweight spacers (23) on the shaft with pins (22) and hairpin clips (21).

(*e*) Press the thrust bearing (20) onto the thrust sleeve (19). Make certain that the bearing fits snugly against the shoulder on the sleeve. Then slide the sleeve and bearing onto the drive shaft.

(*f*) Install the drive shaft into the diaphragm plate (17) and install the screw (25) in the diaphragm plate. Position the diaphragm plate to the governor body using a new gasket (18), and fasten with the screws (16). Press the drive gear (15) onto the drive shaft.

(*g*) Install the oil seal retainer (39) and control arm (9) on the control shaft (37) with the roll-pin(8). Slip the control arm eyebolt (6) together with the lower adjustment nut (7) onto the control arm and secure it with the upper adjustment nut (5).

(*h*) Secure the adjustment slide (4) to the governor body with shoulder bolts (3) and hook the control arm spring (2) to the adjustment slide and control arm eyebolt.

(*i*) Install the adjusting screw (44) in governor body.

(*j*) Install the bumper spring (35) and bumper screw (33) in the governor body and tighten the lock nut.

(*k*) Connect the auxiliary arm (14) to the control arm with the screw (13) and castle nut (12). Secure the connection with a new cotter pin (11). Then connect the spring (10) to the holes provided in the control arm and the auxiliary arm.

(*l*) Install the bumper spring (35), washer (34), and bumper screw (33). Tighten the lock nut (36).

(*m*) Install the screw (43) in the governor body.

b. Air Cleaner (fig. 14). Refer to paragraph 38*b*(2) and disassemble and clean the air cleaner as instructed.

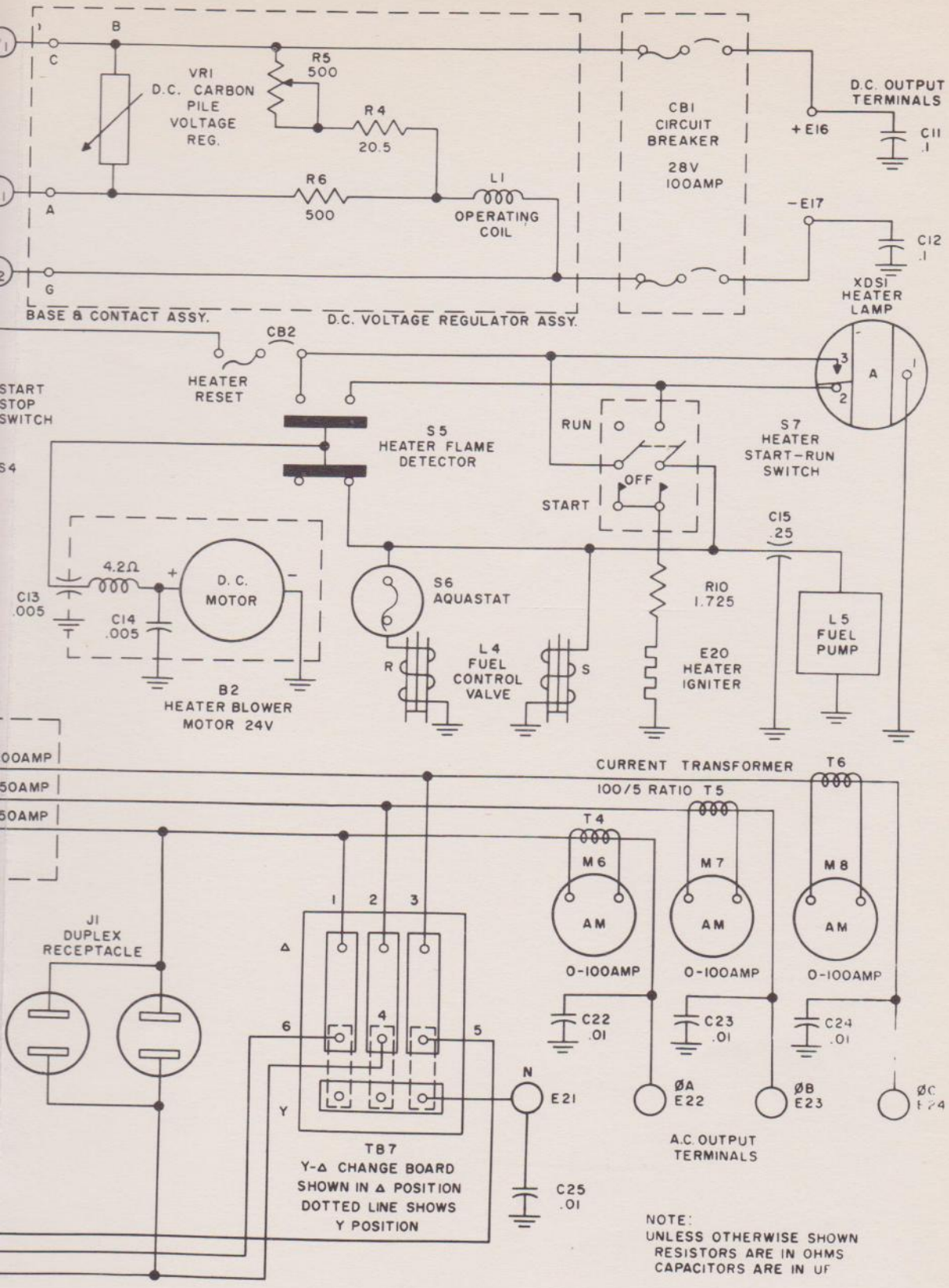
c. Carburetor (fig. 24). After the carburetor has been removed from the unit (par. 55*f*), proceed as follows:

(1) *Disassembly.*

(*a*) Remove the screws and lock washers (6). Separate the throttle body assembly (7) from the fuel bowl assembly (47).

(*b*) Remove the gasket (8).

(*c*) Remove the venturi (9).


B
C
VR1
D.C. CARBON PILE VOLTAGE REG.
R5
500
R4
20.5
R6
500
L1
OPERATING COIL
A
G
BASE & CONTACT ASSY.
D.C. VOLTAGE REGULATOR ASSY.
CB1
CIRCUIT BREAKER
28V
100AMP
D.C. OUTPUT TERMINALS
+E16
C11
.1
-E17
C12
.1
XDS1
HEATER LAMP
CB2
HEATER RESET
START STOP SWITCH
S4
S5
HEATER FLAME DETECTOR
RUN
OFF
START
S7
HEATER START-RUN SWITCH
C15
.25
4.2Ω
C13
.005
C14
.005
D.C. MOTOR
B2
HEATER BLOWER MOTOR 24V
S6
AQUASTAT
R
L4
FUEL CONTROL VALVE
S
R10
1.725
E20
HEATER IGNITER
L5
FUEL PUMP
100AMP
50AMP
50AMP
CURRENT TRANSFORMER
100/5 RATIO T5
T6
T4
M6
M7
M8
AM
0-100AMP
J1
DUPLEX RECEPTACLE
Δ
Y
1
2
3
4
5
6
TB7
Y-Δ CHANGE BOARD
SHOWN IN Δ POSITION
DOTTED LINE SHOWS
Y POSITION
N
E21
C22
.01
C23
.01
C24
.01
ØA
E22
ØB
E23
ØC
E24
A.C OUTPUT TERMINALS
C25
.01
NOTE:
UNLESS OTHERWISE SHOWN
RESISTORS ARE IN OHMS
CAPACITORS ARE IN UF

TM 919A-21

52. Alternator and Winterization System

a. Alternator. Gasoline Engine Generator Set PU-107A/U is equipped with an alternator directly coupled to the engine flywheel and supported at the outboard end by a ball bearing. The alternator is of the rotating permanent magnet field type with 28 poles, resulting in a frequency of 400 cps with an engine speed of 1,714 rpm. The alternator is rated at 12.5 kw and generates 120 or 208 volts, depending on the connection used. The specific feature of the permanent magnet alternator is that it has no field windings; therefore, it requires no external excitation. The rotor is magnetized with the poles that have alternate north and south polarity around the circumference. The magnetic flux (fig. 22) leaves each north pole of the rotating field, passes through the iron core of the stator, and then returns to the adjacent south poles of the rotating field. The rotor with its magnetic field sweeps across the stator windings. There are three separate coils wound on the stator, 120 electrical degrees apart. As the lines of flux cut the stator conductors, voltages are induced in each separate stator winding, producing three-phase alternating voltage. The inherent voltage regulation varies from very close regulation for unity power factor loads to very poor regulation for highly lagging power factor loads. Leading power factor loads increase the voltage so that close voltage regulation can be obtained on single- or three-phase loading when each load is power factor corrected with parallel capacitance. The compensator assembly will increase the voltage of low power factor loads but cannot completely correct it for unity power factor voltage drop. The compensator assembly consists of a series current transformer and a network of six capacitors connected two in parallel across each transformer secondary. The primary windings of the transformer are connected in series with the respective stator windings. This assembly provides a static means of voltage regulation.

b. Winterization System. Incorporated within the unit is a winterization system designed to preheat the engine crankcase oil, coolant, and intake manifold for ease in starting under arctic conditions. The gasoline-burning, semiautomatic heater has an input capacity of 32,000 Btu (British thermal unit) per hour on high fire and 14,000 Btu per hour on low fire. The heater will start quickly under all temperature conditions to —65° F.

(1) *Air system.*

(*a*) *Blower and motor.* A paddle-wheel type blower mounted to a 24-volt motor supplies air for combustion and for diluting the burned gases. The blower motor must turn at least 4,000 rpm to provide satisfactory combustion.

(*b*) *Burner and throat.* The air delivered by the blower is conducted to the heater

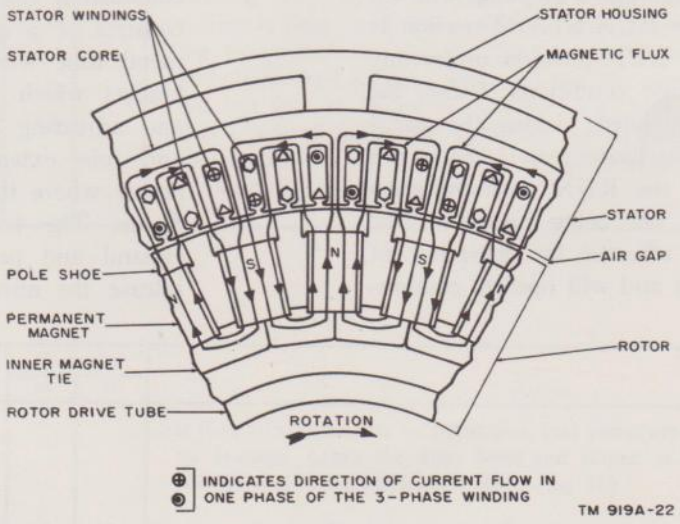


Figure 22. Alternator theory.

burner bowl and combustion chamber through an air box and gallery. It enters the burner bowl through the primary air holes. From the primary air holes in the burner bowl, the air mixes with fuel vapor, but the mixture remains too rich to burn until sufficient secondary air is introduced through the throat opening, where combustion takes place. Air is added to the exhaust gases through the relief holes in the throat. This additional air aids combustion, but its primary purpose is to lower the exhaust gas temperatures and to provide a larger volume of warm air for external heating of the oil pan and intake manifold.

(2) *Fuel system.*

(*a*) *Pump.* The heater fuel pump supplies fuel under pressure to a two-stage fuel control valve. This is accomplished by a solenoid which, when energized, activates a hollow plunger. The stroke of the plunger is controlled by a set of interrupter points (sealed in helium) in the electrical circuit and a calibrated plunger spring. The pump is self-priming and requires no bleeding or adjustment. The pump provides fuel when the heater RUN-START switch is held in the START position and also when it is thrown to the RUN position after the heater is ignited. The pump will not operate if the RUN-START switch is moved to the RUN position under any of the following conditions: before the ignition is completed; during the purging cycle of the heater; or if the switch is moved to the RUN position when the heater is not being operated. The pump is not affected by operation of the thermostat and will operate continuously whenever the heater is in use.

(*b*) *Fuel control valve.* The electrically operated fuel control valve consists essentially of a pressure regulator and two independent, solenoid-operated valves which control the flow of fuel to the heater through orifices. Both solenoid valves are normally closed (when the coils are not energized). The shut-off valve allows fuel to flow only when the coil is energized; the high-low valve is connected into the circuit with the heater thermostat. When the coil is not energized, fuel is forced to flow through a restricted orifice calibrated for low fire operation. When the high-low valve is energized, the valve is opened and fuel passes through a bypass calibrated for high fire operation.

(3) *Electrical system.*

(*a*) *Control panel.* Heater components of the control panel include a RUN-START switch, a heater OPERATING indicator lamp, and the circuit breaker (RESET). These components are discussed and the instructions for their operation are covered in paragraph 18.

(*b*) *Flame switch.* The flame switch controls the electrical supply to the pump, control valve, indicator lamp, and blower motor. This switch is actuated by the presence of flame in the heater combustion chamber. The flame switch consists of a quartz rod encased in a metal tube with an integral mounting bracket which supports a microswitch and adjusting spring. The quartz rod and tube extend into the top of the heater where they are subjected to the flame. The heat causes the tube to expand and permit the quartz rod to release the microswitch button.

CHAPTER 6

FIELD MAINTENANCE

Section I. PRE-REPAIR PROCEDURES

53. General

This chapter covers complete repair and overhaul instructions for Gasoline Engine Generator Set PU-107A/U and is written specifically for personnel in charge of field and depot maintenance and repair. The instructions include detailed steps to be followed in the stripping, disassembly, cleaning, inspection, and reassembly of the unit. Exploded view illustrations are provided to facilitate overhaul. A table of fits and tolerances and a paragraph covering adjustments after reassembly are included in the chapter. Requirements and methods for testing the unit after overhaul are furnished, together with instructions on refinishing. Installation details for radio-frequency suppression equipment are also included.

54. Preliminary Inspection

Before repairing any part of the equipment, check the unit for the extent of repair necessary as noted by the operating personnel. Inspect the unit as instructed in paragraph 48.

Section II. CLEANING, STRIPPING, AND INSPECTING

55. Cleaning and Stripping

Before stripping the unit, thoroughly clean all grease, oil, and dirt from the entire exterior of the unit. Use solvent (SD) for washing when necessary. Do not let the solvent come in contact with any electrical equipment. Blow dirt from not easily accessible places with dry, compressed air. The following paragraphs contain instructions for stripping the unit of all subassemblies and accessories. When performing a major overhaul, all components and accessories must be removed from the unit for accessibility to the engine and alternator.

Warning: If the unit has been operated for inspection purposes before stripping, disconnect the batteries before attempting to repair or overhaul any part of the equipment.

a. Upper Frame. The tubular frame is composed of two sections and is constructed to permit removal of the top half. For complete overhaul of the unit, remove the upper frame first. Proceed as follows:

(1) Remove the rear panel and disconnect the alternator leads connected to the compensator transformer (1, fig. 4) and to the wye-delta change board (1, fig. 3).

(2) Disconnect the electrical leads from the 28-volt, 2.5 kw dc generator (1, fig. 2). Pull the leads through the insulator bushings in the firewall. Disconnect the electrical leads from the 24-volt battery-charging generator (5, fig. 3).

(3) Remove the inlet and outlet air duct hose from the air cleaner.

(4) Unplug the 10-conductor socket (10, fig. 2) mounted on the firewall.

(5) Remove the clip securing the electrical lead for the automatic choke (4, fig. 3). This clip is located on the firewall.

(6) Remove two clips securing the ignition cables to the firewall.

(7) Disconnect the capacitor from the oil pressure transmitter (8, fig. 2).