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WAR DEPARTMENT

TECHNICAL MANUAL

POWER UNITS PE-95-G
AND
PE-95-H

September 3, 1943

WAR DEPARTMENT
WASHINGTON, D. C. September 3, 1943

This Technical Manual, TM 11-904H, published by O'Keefe & Merritt Company on orders 15030-PHILA-43, 20747-PHILA-43, 14889-SCGDL-43, 23408-PHILA-43, 26211-PHILA-43, 33041-PHILA-43, 36900-PHILA-43, and 3605-PHILA-44, covers Power Units PE-95-G and PE-95-H. All parts of these units are interchangeable with those listed in TM 11-904G, Technical Manual for Power Unit PE-95-G, except those specifically noted in the replacement parts list in this manual.

ADDENDA SHEET

SUBJECT: Change in Stator Winding Assembly
Part No. 7515, Ref. No. 583

The present stator winding assembly provides a no-load voltage of approximately 126 when operated at a frequency of 61 cycles. The normal full load voltage with this winding is approximately 118 at a frequency approximately one-half to one cycle below the no-load frequency.

A no-load voltage of 120 has been found desirable and is obtained with the present stator winding assembly by adjusting the engine governor. Final adjustment should be made after the power unit reaches normal operating temperature. At this reduced voltage the frequency meter will be inoperative because the frequency will be below 59 cycles.

A new winding with fewer turns (4-5-6 coil grouping instead of 5-5-6 coil grouping) has been designed and all new generators will have the revised stator winding assembly. This revised winding will provide a no-load voltage of 120 when operated at a frequency of approximately 61 cycles. When the engine governor is properly adjusted to provide a no-load voltage of 120 the corresponding voltage at one-half load (43 amps, 100 percent power factor) will be approximately 116, and the full-load (89 amps, 100 percent power factor) will be 112 volts. At 80 percent power factor half-load (59 amps), the voltage will be approximately 106.

The present and the revised stator winding assemblies are interchangeable, and the same part number will apply to each.

O'KEEFE & MERRITT CO.
Los Angeles, California
November 9, 1943

NOTE

All parts of Power Units PE-95-G and PE-95-H are interchangeable except the following:

Ref. No.	Name and Description	PE-95-G Part No.	PE-95-H Part No.
130	Crankshaft Bearing—Front—Upper	637724	637007
131	Crankshaft Bearing—Front—Lower	637725	637008
132	Crankshaft Bearing—Center—Upper	639237	638730
133	Crankshaft Bearing—Center—Lower	639238	638731
134	Crankshaft Bearing—Rear—Upper	639239	638732
135	Crankshaft Bearing—Rear—Lower	639240	638733
138	Crankshaft	637733	638121
156	Connecting Rod Bearing	116534	639862

Parts listed in column PE-95-G may be used only on Power Unit PE-95-G.
Parts listed in column PE-95-H may be used only on Power Unit PE-95-H.

TECHNICAL MANUAL
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WAR DEPARTMENT
WASHINGTON, SEPTEMBER 3, 1943

POWER UNIT PE-95-G AND PE-95-H

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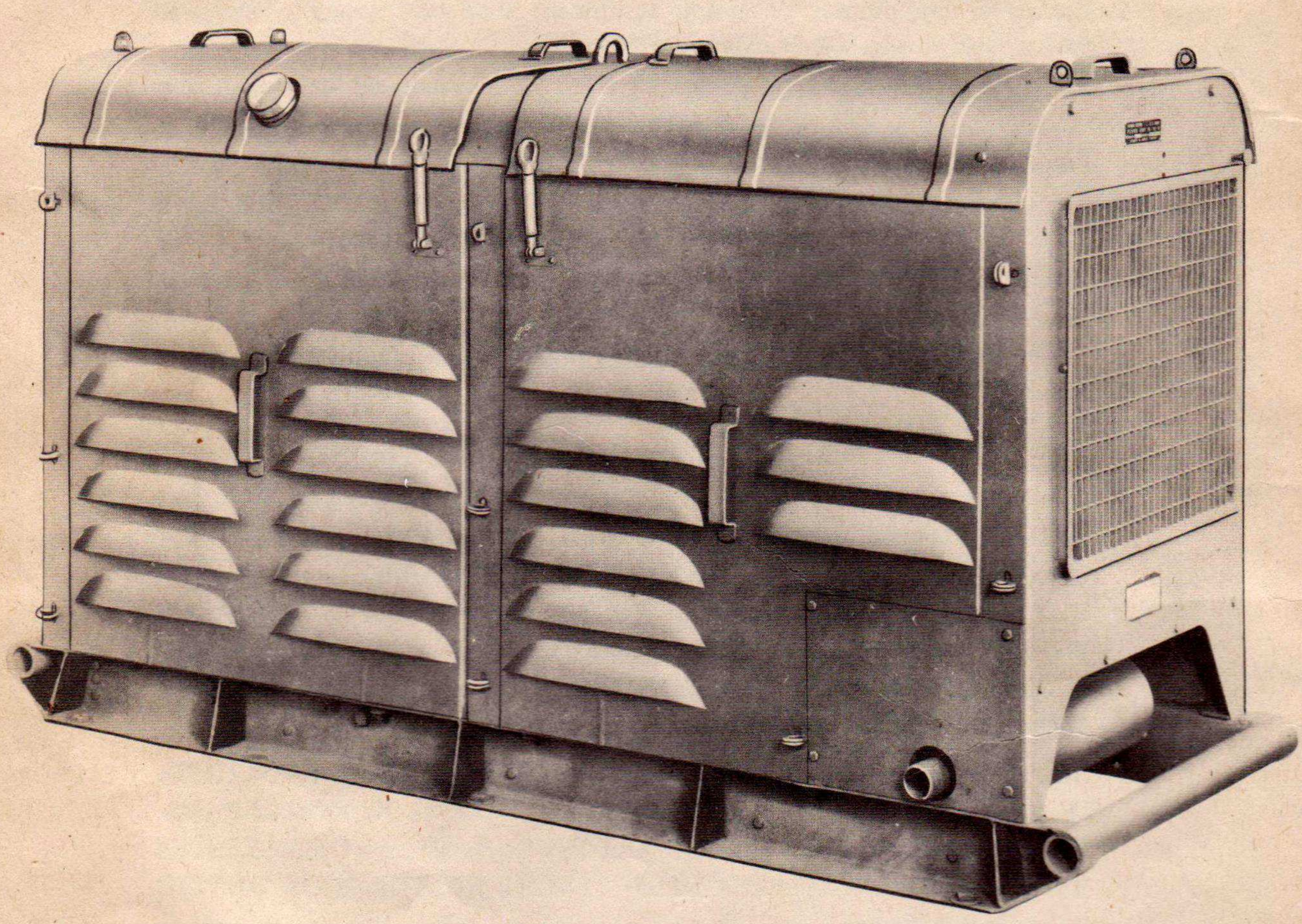
DESTRUCTION NOTICE

If capture of this equipment is imminent, destroy it by any or all of the following means, beyond any possibility of salvage, recognition or duplication:

1. Radio, Telephone and Telegraph equipment shall be thoroughly smashed with a sledge, axe, bar or other heavy object.
2. All wires, cables and internal wiring shall be slashed, cut or ripped out.
3. Castings such as engines and generators and teletypewriter parts shall be smashed with a sledge, axe or other heavy object.
4. All books, documents, wire and smashed equipment containing combustible parts shall be piled up, saturated with gasoline and burned.
5. Hand grenades or TNT may be used provided destruction of all parts of the equipment is thorough and complete.
6. Time permitting, smashed and burned equipment shall be buried or thrown into a stream.

SAFETY NOTICE

1. **DO NOT ATTEMPT ADJUSTMENTS OR CHANGES ON WIRING WHILE POWER UNIT PE-95-G IS IN OPERATION. THIS UNIT GENERATES HIGH VOLTAGE, SO THAT SEVERE AND POSSIBLY FATAL SHOCKS MAY BE ENCOUNTERED ESPECIALLY WHEN POWER UNIT IS OPERATING ON WET OR DAMP GROUND. ALWAYS DISCONNECT THE BATTERY BEFORE WORKING ON THE UNIT.**
2. **SUFFICIENT AND PROPER VENTILATION MUST BE PROVIDED, IF THE POWER UNIT IS OPERATED IN A CONFINED SPACE. EXHAUST GASES PRODUCED ARE POISONOUS, AND EXCESSIVE INHALATIONS MAY RESULT IN SEVERE SICKNESS OR DEATH.**
3. **DO NOT SERVICE WITH GASOLINE WHILE POWER UNIT IS RUNNING OR IF A RADIO TRANSMITTER IS OPERATING IN CLOSE PROXIMITY TO POWER UNIT. AVOID SPILLING GASOLINE ON A HOT ENGINE.**
4. **OPERATOR SHOULD OBSERVE EVERY STANDARD SAFETY REGULATION WHILE OPERATING THIS POWER UNIT.**



POWER UNIT PE-95-G AND PE-95-H

SECTION I
DESCRIPTION

1. General.—

a. Description.—Power Unit PE-95-G, (Figs. 1 and 2), is a complete electric generating plant. It consists of an engine and a generator with the necessary accessories and controls, all mounted in a metal housing with a skid base.

b. Output Rating.—Power Unit PE-95-G supplies single-phase, 60-cycle, alternating-current at either 120 volts or 240 volts. The rated capacity is 10 K.W. at unity power factor and 12.5 K.V.A. at 80% power factor.

c. Purpose.—Power Unit PE-95-G is used to furnish electricity to operate radios, signal systems, lights, motors, heating units and other appliances where power line service from a large power station is not available, or upon failure of such power line service.

2. List of Components.—

Quantity	Signal Corps Stock Number	Article	Width	Length	Height	Weight in Lbs.
1		Power Unit PE-95-G	28¼″	67½″	38½″	1556
1		Engine with accessories	22½″	27″	30½″	380
1		Generator with adapter ring.	19″	29¾″	19½″	640
1		Radiator assembly	8½″	20″	23½″	35
2		Battery	7″	10⅜″	8″	50
1		Fuel tank	12″	25¾″	19¾″	20
1		Control panel assembly	5½″	20″	16½″	25
1		Housing and skid base	28¼″	67½″	38½″	307

3. Engine.—

a. Design.—The engine (Fig. 5) is of the 4-cylinder, 4-cycle, L-head, water cooled, automotive type. It furnishes the power which drives the main generator to which it is direct-connected. It also drives certain necessary accessory equipment. It is designed to operate on regular gasoline of 70 to 80 octane.

b. Rating.—The engine is rated 35 horsepower at normal operating speed of 1800 r.p.m. The speed is controlled by a fly-weight mechanical governor which is driven by a V-belt from a pulley on the crankshaft.

c. Cooling system.—The water cooling system includes an automotive type radiator, fan and pump. The fan is mounted on the extended pump shaft and both fan and pump are driven by a V-belt from a pulley on the engine crankshaft. Cooling air is discharged forward through the radiator. A thermostat in the water outlet elbow at the top of the cylinder head controls water circulation.

d. Oiling System.—Main, connecting rod and camshaft bearings are lubricated by oil pressure supplied by a gear type oil pump. Other internal parts are spray lubricated. An oil filter is mounted on the left side of the engine. A bayonet type oil level gauge is mounted in the oil filler tube.

e. Fuel System.—The fuel supply system includes a 10½ gallon fuel tank mounted over the generator, a diaphragm type fuel pump, a downdraft type carburetor fitted with a combination oil-type air cleaner and silencer, and an automatic electric choke. A fuel filter screen, glass sediment bowl and shut-off valve are mounted under the fuel tank. A valve permits connecting an auxiliary fuel tank, if desired.

f. Ignition System.—A battery ignition system is used. An ignition unit is mounted on the left side of the engine, driven by a gear on the camshaft. This unit includes the breaker mechanism, condenser and high-tension distributor. A governor in the lower part of the distributor case advances the timing of the spark as the engine speed increases. The ignition coil is mounted near the distributor. Suppressors on the spark plug cables and on the center cable of the distributor reduce radio interference.

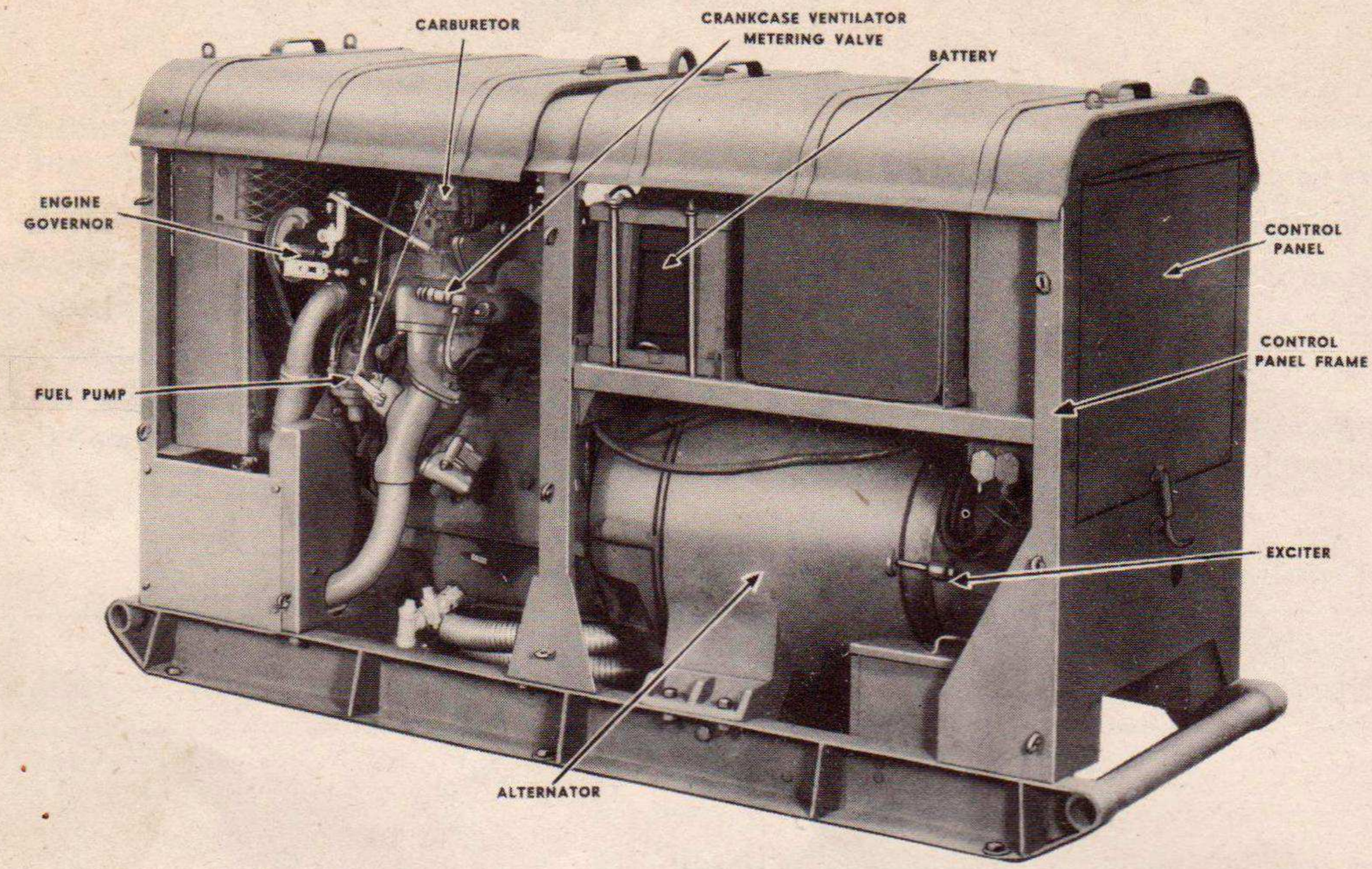


FIG. 1 POWER UNIT PE-95-G (RIGHT SIDE)

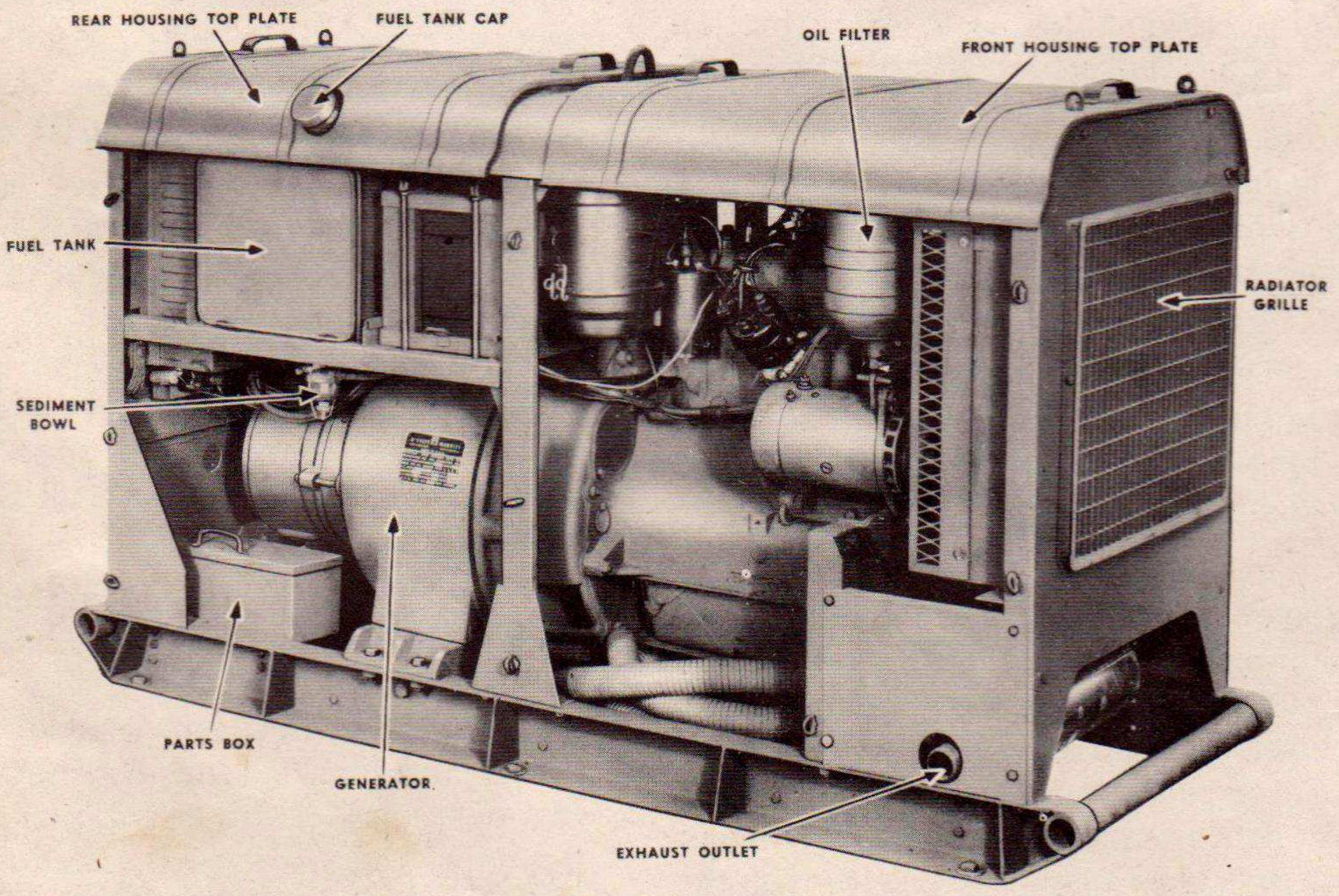


FIG. 2 POWER UNIT PE-95-G (LEFT SIDE)

g. 12-volt Battery System.—The 12-volt storage battery, consisting of two 6-volt automotive type batteries connected in series, is mounted in front of the fuel tank. The storage battery supplies power for electric cranking, automatic choking and for ignition during the starting period. It is recharged by current supplied by the exciting generator. The charging is controlled by the battery charging relay and the battery charging regulator and resistor group mounted on the rear of the control panel. The exciting generator has a special series field winding and operates as a motor for cranking the engine electrically.

4. Generator.—

a. Purpose.—The generator supplies the alternating-current power output of the power unit. This generator assembly really consists of two individual generators, the alternator and the exciter, (Fig. 2).

b. Alternator.—The alternator consists of two major parts, the revolving field and the stationary armature. It is in the two windings of the stationary armature that the alternating current is generated. These windings are connected directly to the terminal block on the control panel.

c. Exciter.—The exciter is attached to the outer end of the alternator and supplies the direct-current used to excite the revolving field. The exciter also supplies current for recharging the battery, for ignition and for operating certain controls while the engine is running. It operates as a motor for the purpose of cranking the engine electrically when starting the power unit.

d. Design.—The alternator frame is attached to, and supports, the rear end of the engine. The revolving field of the alternator and the revolving armature of the exciter are mounted on the same shaft. This shaft is driven by a steel disc connected to the shaft and to the engine flywheel. The rear end of the shaft is carried by a grease-sealed ball bearing. A flywheel blower circulates cooling air.

e. Rating.—The generator supplies single-phase alternating current at 60 cycles per second frequency. The voltage may be either 120 or 240, the change from one standard voltage to the other being made by changing jumper connections at the control panel terminal block. The generator is designed to operate with a full load temperature rise of less than 40° C. Rated capacity is 10 kw at unity power factor and 12.5 kva at 80% power factor.

f. Regulation.—

(1) *Voltage Regulation.*—The output voltage regulation of the generator after reaching normal operating temperature is within the limits of 126 volts at no load to 118 volts at full load at unity power factor, when a-c terminal jumpers are connected for 120 volts. When connected for 240 volts, the regulation is within the limits of 252 volts at no load to 236 volts at full load at unity power factor. Regulation is due to inherent characteristics obtained by strongly saturating certain parts of the magnetic circuit.

(2) *Frequency Regulation.*— Frequency regulation depends on the regulation of the engine speed, and is within the limits of 1 to 1¼ cycles per second, plus or minus, when adjusted for a no-load frequency below 63 cycles per second and a full-load frequency above 59 cycles per second.

5. Controls.—

a. Purpose.—Certain controls are used to start and stop the power unit. Others regulate it automatically under normal operating conditions and protect it against heavy overload, high water- temperature and low oil-pressure. Much of the control equipment is mounted on the control panel for convenient use. Other controls are necessarily located at different places on the power unit.

b. Control Panel Equipment.—The following pieces of equipment are mounted on the control panel. (See Figs. 3 and 4).

(1) *A.C. Voltmeter.*—0-300 volts scale, indicates the output voltage.

(2) *A.C. Ammeter.*—0-150 amperes scale, indicates the load amperes.

(3) *Fuel Gauge.*—Indicates the supply of fuel in the tank.

(4) *Battery Charge Rate Ammeter.* — Indicates the rate of battery charge and discharge.

(5) *Engine Oil Pressure Gauge.*—Indicates the operating pressure of the engine lubricating system.

(6) *Engine Water Temperature Gauge.* — Indicates the temperature within the engine water jacket.

(7) *Running-Time Meter.*—Shows the total operating hours.

(8) *Frequency Meter.*—Indicates the output frequency.

(9) *Circuit Breaker.* — Serves as the load switch, trips automatically when the power unit is heavily overloaded.

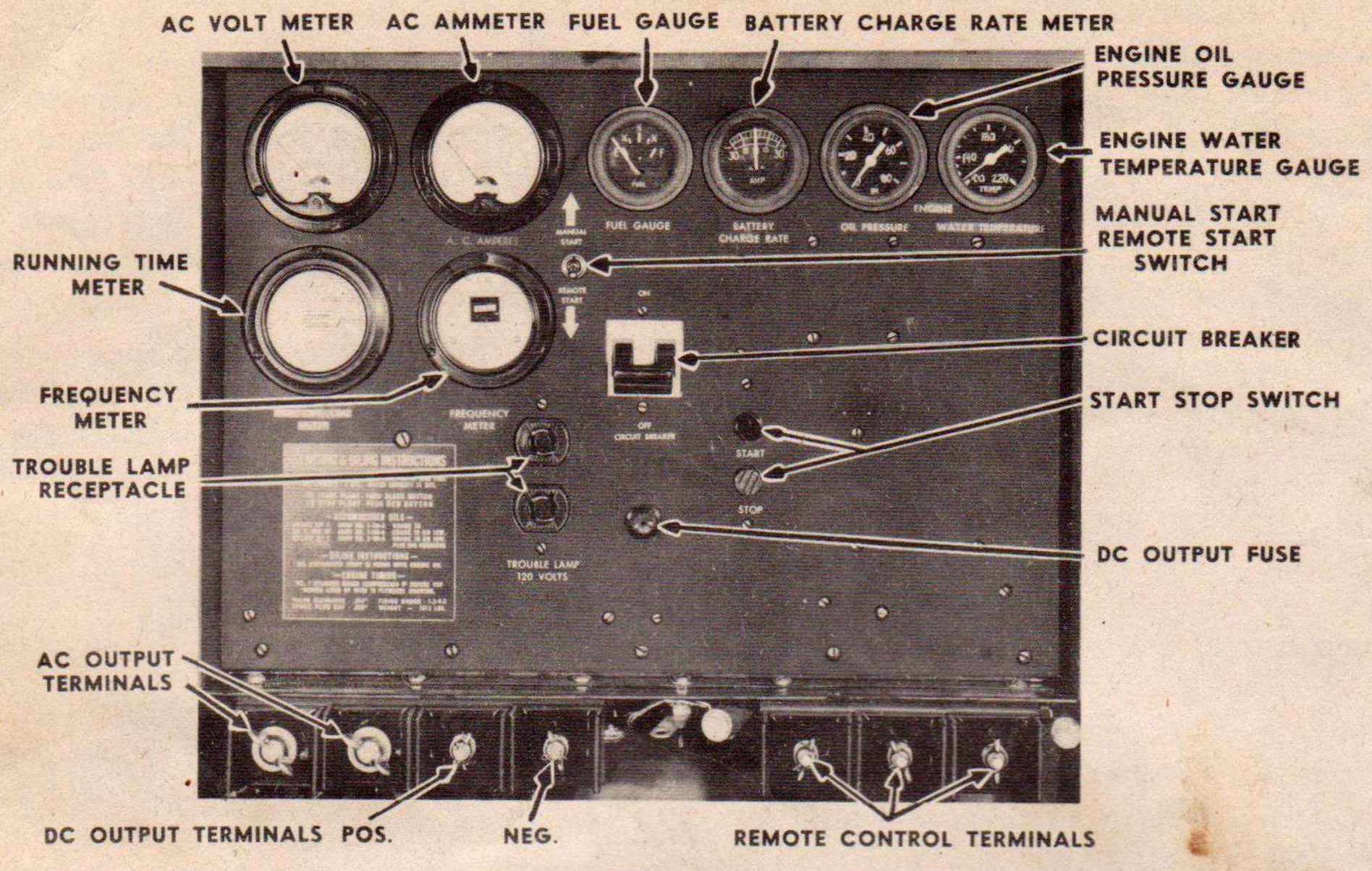


FIG. 3 CONTROL PANEL

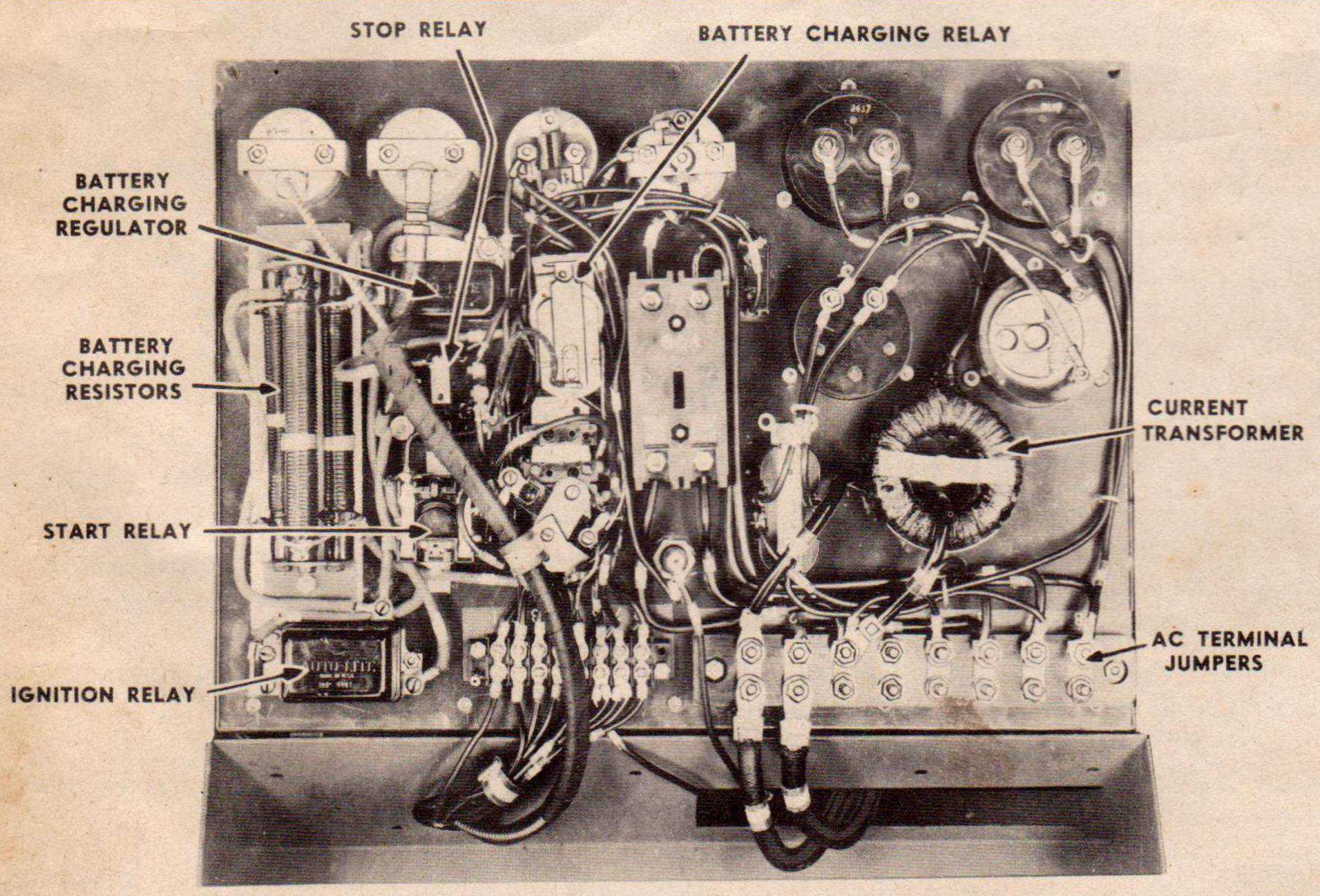


FIG. 4 CONTROL PANEL (REVERSE SIDE)

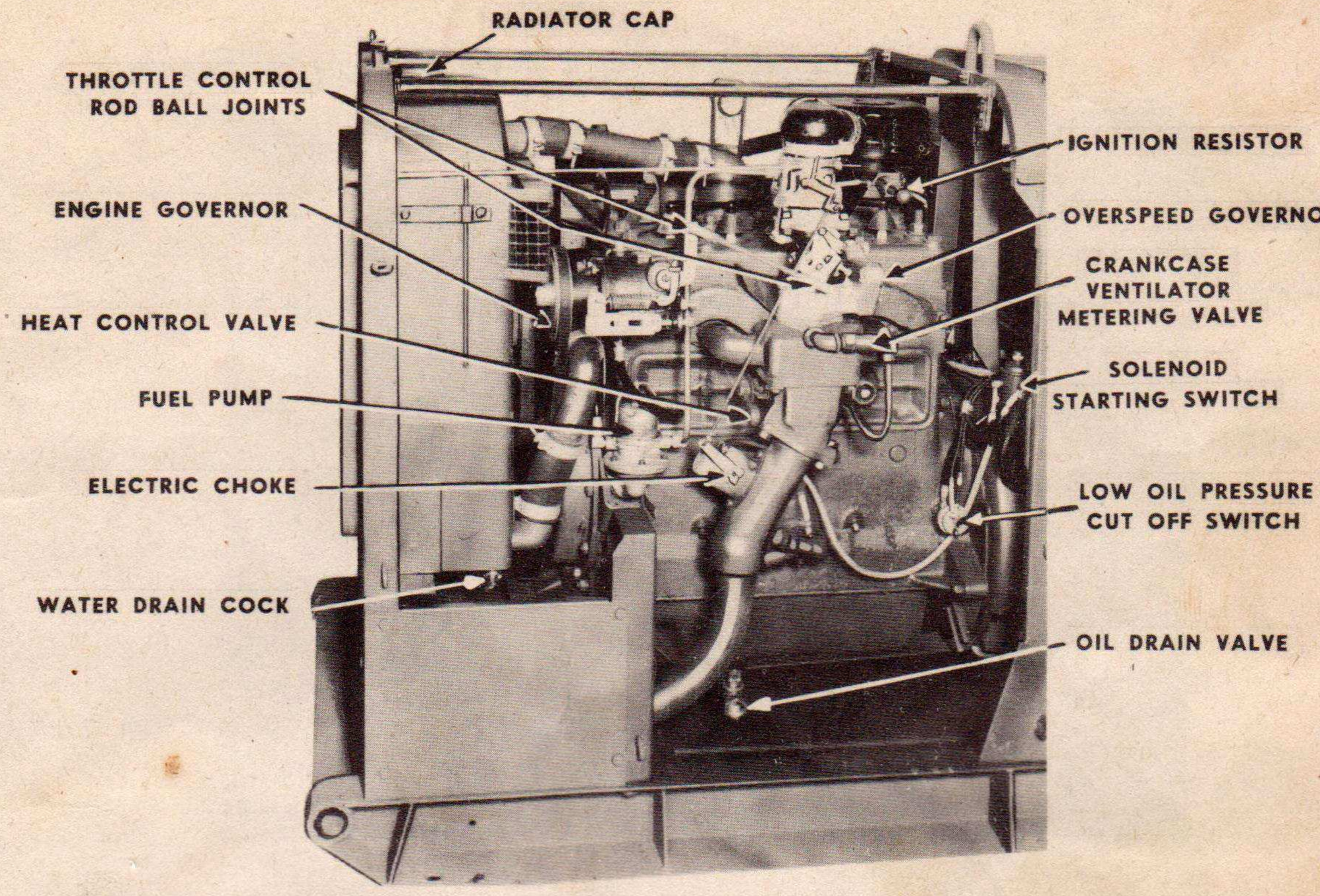


FIG. 5 RIGHT SIDE OF ENGINE

(10) *Trouble-Lamp Receptacles.*—Serve for connecting 120 Volt trouble lamps.

(11) *Start-Stop Switch.*—Serves to start and stop the power unit.

(12) *Manual Start-Remote Start Switch.*—Serves to switch the ignition circuit to Manual Start position as required for hand starting.

(13) *Relays.*—Control various circuits.

(14) *Battery Charging Regulator and Resistor Group.*—Regulates the battery charging rate.

(15) *A.C. Terminal Block and Jumpers.*—Serve to change the output voltage from 120 to 240 volts, or the reverse.

(16) *D.C. Output Fuse.*— Protects against short-circuit or severe overload on the D. C. OUTPUT circuit.

c. *Miscellaneous Control Equipment.*—The following control devices are located at different places on the power unit. (See Figs. 5 and 6).

(1) *Low Oil Pressure Cut-Off Switch.*—Stops the power unit if the oil pressure drops below 8 lbs. per sq. in. while the power unit is in operation.

(2) *High Water Temperature Cut-Off Switch.*—Stops the power unit if the water temperature rises above the value it is set at.

(3) *Electric Choke.*—Chokes the carburetor automatically when the engine is cranked electrically.

(4) *Engine Governor.*—Regulates the engine speed and the frequency of the a-c output.

(5) *Overspeed Governor.* — Limits the top speed of the engine if the main governor fails.

(6) *Heat Control Valve.*—Diverts hot exhaust gas to heat the intake manifold during the warm-up period.

(7) *Crankcase Ventilator Metering Valve.*—Controls the flow of ventilating air from valve spring chamber to the intake manifold.

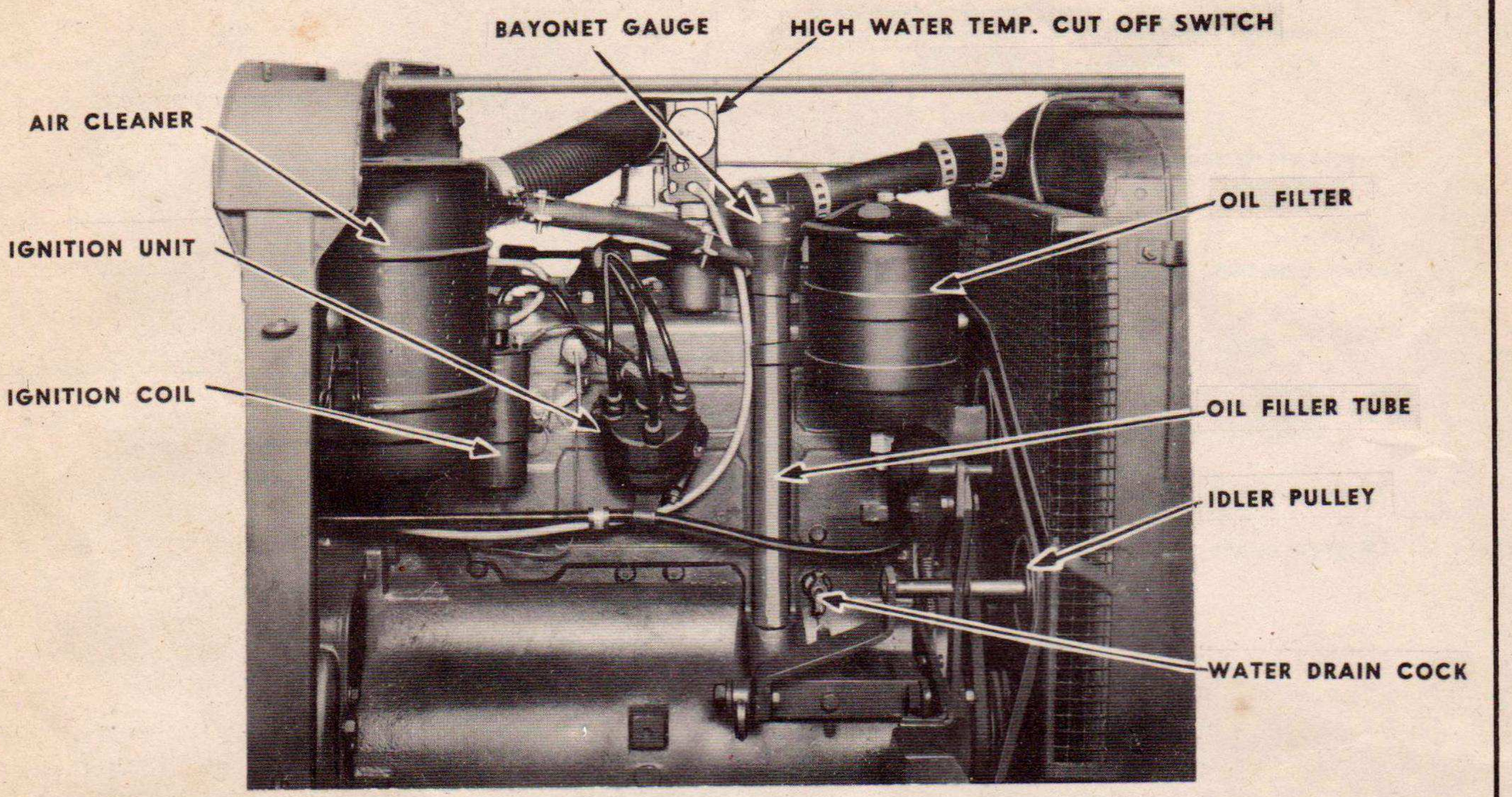


FIG. 6 LEFT SIDE OF ENGINE

6. Housing.—

The complete engine-generator unit with controls is mounted in a steel housing with steel skid base. The housing serves as radio shielding, helps direct cooling air currents and provides some protection against mechanical and other damage. Top and side panels are removable to permit inspecting and servicing the power unit. The fuel tank cap projects through the top of the housing. A grille at the front end protects the radiator and is provided with a grooved frame to which a canvas duct may be tied to convey heated air outside the room. The control panel is inset at the rear end of the housing and protected by a sliding door. Provision is made for inserting a starting crank and for manually operating the choke from the front end of the housing. Metal compartments for tools and parts are built into the housing. The inverted U-bolt of the lifting yoke extends through the top of the housing for accessibility in lifting the completely housed power unit.

SECTION II
INSTALLATION AND OPERATION

7. Installation.—

a. Handling the Uncrated Power Unit.—The skid base permits towing the power unit short distances over firm ground with truck or tractor. In very sandy or soft, muddy soil it may be necessary to lay down planks over which to skid it. Attach the tow rope or chain at one end of the skid base. Use a long hitch and go slowly. To hoist the power unit, attach a hoisting chain to the inverted U-bolt which extends above the top of the housing. Rollers may be used under the metal skid base.

b. Importance of Proper Installation.—Although Power Unit PE-95-G is built to rigid specifications and carefully tested and inspected before leaving the factory, it cannot function properly and give the best service unless the operating conditions are reasonably favorable. Many of these conditions depend entirely on the installation. The instructions which follow apply under usual conditions. When they cannot be followed exactly, use them as a guide and make the best installation that circumstances permit.

c. Choice of Location.—

(1) *Relation to Load.*—Locate the plant as near the center of the load as practicable. This assures lower line loss with a given size of wire and improves the control of voltage at the remote end of the lines. The size of line wires required depends largely upon the distance from the power unit to the load, the amount and kind of load and the permissible voltage drop between power unit and load. Be sure to use wire that is large enough for the purpose. If you do not know the proper size of wire, refer to the wiring tables in Section V of this manual.

(2) *Surrounding Conditions.*—The circumstances under which power units are used vary greatly, but for best results you must provide the most favorable operating conditions that circumstances permit. The housing on Power Unit PE-95-G protects it so that it can be operated out-of-doors, if necessary, but rain, snow, dust and grit and extremely cold weather are very unfavorable to satisfactory operation and long life. If circumstances permit, install the power unit inside a building or inside a mobile vehicle.

d. Indoor Installation.—

(1) *Space Required.*—If the power unit is to be permanently installed, provide an indoor location. This is particularly important in cold climates. Provide a floor space 9′ x 12′, or larger, in size. Install the power unit lengthwise in the space and at least 2½′ from the nearest wall or partition, to provide easy access for servicing. Usually the left side of the power unit, as viewed from the engine end, should be toward an outside wall so that the exhaust line can be extended outdoors conveniently. Provide ventilation, at least a door and a window on different sides of the room, so that the room temperature may be controlled. If necessary, in order to prevent too great a rise in room temperature, attach a canvas duct to the radiator grille and to a wall opening at least as large, so that the heated air will be conducted outside the room.

(2) *Foundation.*—Attach the power unit to a firm level base. The base must be strong enough to permanently support the weight of approximately 1800 pounds. It may be made of concrete or heavy timbers and should extend about 10 inches above the floor level for convenience. Shock absorbing material may be used between the plant and the base, if desired.

(3) *Exhaust.*—Exhaust gases are deadly poisonous. Pipe them outside the building. A 10′ length of flexible exhaust line is furnished with the power unit. Connect one end of this to the exhaust outlet located near the lower left front corner of the power unit. The exhaust pipe must extend outside the building by the most direct route practicable. If additional pipe is necessary, increase the size by one pipe size for each additional 10′ length. The additional pipe may be any suitable pipe of proper size. **Be sure that all connections are mechanically secure and gas tight.** Avoid unnecessary turns. Pitch the pipe downward from its connection at the power unit, if possible. If necessary to pitch the pipe upward, install a condensation trap in the line at the point where the upward pitch starts. This trap may be assembled of suitable pipe fittings. Its purpose is to catch water that condenses in the exhaust line and prevent its running into the muffler of the power unit. The trap must be drained periodically to perform this function. An exhaust line gets hot. If it passes through

an inflammable wall, partition or floor, install it in metal collars so as to separate it at least several inches from the inflammable material. Support the pipe securely at necessary points. If necessary, shield the pipe so nobody will get burned by contact with it.

(4) *Auxiliary Fuel Tank.*—Provision is made for connecting an auxiliary fuel tank, if desired. Use the 20′ length of flexible fuel line furnished. Install the fuel tank out-of-doors, if possible, but not farther from the power unit than the 20′ fuel line will permit. If a longer fuel line is used, the pump may fail to keep the carburetor supplied with fuel. The bottom of the fuel tank should not be more than 6′ below the fuel shut-off valve at the power unit. Be sure that the fuel line has a continuous downward pitch from power unit to tank. If the fuel line attaches to a fitting at the top of the auxiliary tank, there must be a suction tube inside the tank extending from the fitting to within an inch or two of the bottom of the tank so that the fuel may be drawn from the tank by the pump. Do not install the tank near the exhaust line. The tank must be vented.

(5) *Electrical Connections.*—Make sure that all electric wires entering the room and within the room are properly supported and insulated. Connect the load wires to the two A.C. OUTPUT terminals, (Fig. 3), beneath the control panel, one to each terminal. The size of insulated wire to use within the room for connecting the load to the power unit depends on the load amperes and the type of insulation on the wire. The following sizes are recommended as the smallest safe sizes for use within the room to carry the full load of the power unit; use No. 0 for 120-volt service, if the insulation contains rubber, or No. 2 if the insulation does not contain rubber; use No. 6 for 240-volt service if the insulation contains rubber, or No. 8 if the insulation does not contain rubber. Make sure that all connections are mechanically and electrically secure.

(6) *Remote Control.*—If it is desired to start and stop the power unit from one or more remote points, it will be necessary to install remote start and stop switches at each of the remote points and to connect them with the REMOTE CONTROL terminals, (Fig. 3), below the control panel of the power unit. Use 2-pole push button type switches, one for starting and one for stopping. Connect the insulated terminal of the starting switch to the REMOTE CONTROL terminal "Start". Connect the insulated terminal of the stopping switch to the REMOTE CONTROL terminal "Stop". Connect the REMOTE CONTROL terminal "Ground Return" through one wire to both remaining terminals of the two switches. No. 16 wires will serve for these connections up to 150 feet. Support them properly. These wires are connected with the 12-volt battery circuit.

e. Mobile Installation.—

(1) *Mounting.*—Attach the power unit securely to the floor or other supporting member of the vehicle in which it is installed. It should be so installed that it will set approximately level when in normal operation. Take full advantage of the available space in locating the power unit so as to provide proper ventilation and space for servicing. Use as much of the 10′ length of flexible exhaust tube as needed and pipe the exhaust gases outside the vehicle. Keep this pipe at least several inches from inflammable material and support it securely so that it will remain permanently in place. **This is important because exhaust gases are deadly poisonous.**

(2) *Caution.*—**Do not run the vehicle into a closed building and operate the power unit without carefully attaching an extension exhaust line that will carry all the exhaust gases outside the building.** The size of this extra piping should be increased one pipe size for each 10′ of length.

(3) *Ventilation.*—If the vehicle is a closed one, proper ventilation must be provided. This will require at least two openings, an inlet and an outlet, near opposite ends of the power unit. Several smaller openings will serve, if necessary, but there must be a total of at least 3½ square feet of opening for the inlet and a similar amount for the outlet. If necessary, connect a canvas duct to the radiator grille and the outlet opening in such manner that the heated air is forced outside the vehicle and thus prevented from recirculating.

(4) *Wiring.* — Support all permanent wiring within the vehicle so that vibration will not destroy the insulation or break the wires. Wiring is easily run in any direction. Do not let its location interfere with convenient servicing of the power unit. If power is taken off the power unit by flexible cable, provide a reel for the cable and store it in such location while in transit that it will not become damaged. Do not store other items on, or against, the power unit, or loosely within the compartment in such manner as to risk damaging the unit while in transit.

(5) *Leveling.*—If the power unit is to be operated for hours at a temporary location, locate the vehicle so that the power unit is reasonably level.

8. Preparation for Use.—

a. Procedure.—Comply with the following instructions in the order given:

(1) *Installation.*—Recheck to make sure that all instructions for installing the plant as given in paragraph 7 have been complied with.

(2) *Side Panels.*—Remove the side panels of the housing.

(3) *Manual Start-Remote Start Switch.*—Open the control panel door and make sure the MANUAL START - REMOTE START ignition switch is on the REMOTE START position. This switch must be on the REMOTE START position at all times except while starting the power unit by hand cranking and for emergency operation as explained in paragraph *9*.

(4) *Crank Manually.*—Crank the engine over a few times with the hand crank to make sure that the pistons are free and that the generator turns freely. You will find the hand crank attached in front of the engine oil pan inside the housing. Keep it there when not in use.

(5) *Battery.*—Prepare the battery for use.

(*a*) The battery is of the dry-charged type, shipped with plates in a partially charged condition. A card attached to the battery gives the manufacturer's instructions for preparing the battery for service.

(*b*) The electrolyte to be used is diluted sulphuric acid having a specific gravity of 1.265 at 80° F. It is packed in a separate container. In tropical climates, use electrolyte having a specific gravity of 1.200, produced by mixing 10 parts of the 1.265 electrolyte with 3 parts of water. Be sure to use distilled water, or other water known to be suitable for use in a lead-acid storage battery. Add the acid very slowly to the water. Never add the water to the acid.

(c) Remove the vent caps. Remove and destroy the Scotch tape or seals which covers the vent holes. Fill each cell with the correct electrolyte to a level 3/8 inch above the tops of the separators. Replace the vent caps and tighten securely. Be sure the seals have been removed.

(*d*) If the battery is filled with 1.200 electrolyte, for tropical use, stamp the numeral one (1) on the lead top connector at the positive cell for the information of anyone servicing the battery in the future. This number may be stamped with the end of a screwdriver or small chisel.

(*e*) If possible, allow the battery to stand from 4 to 12 hours after filling before placing in service. In an emergency, the battery may be placed in service 1 hour after it has been filled with proper electrolyte, however, this is not good practice.

(*f*) If possible, give the battery a freshening charge of from 16 to 20 hours at 6.0 amperes before placing in service. It will give satisfactory results without this charge if the battery temperature is above 50° F. If the battery temperature is below 50° F. it must be given a freshening charge in order to give satisfactory service. If temperatures are below 50° F. and no outside source for charging the battery is available, warm both the battery and the electrolyte to at least 50° F. before filling. Caution: Do not put cold electrolyte into a warm battery, or warm electrolyte into a cold battery, as severe damage will result.

(*g*) If the battery has been filled with 1.265 electrolyte, it may be considered fully charged when the specific gravity, corrected to 70° F., is between 1.270 and 1.285. If it has been filled with 1.200 electrolyte, it may be considered fully charged when the specific gravity, corrected to 70°. F, is between 1.210 and 1.225. At this point the terminal voltage of each cell should read not less than 2.5 volts while the battery is on charge at a 6.0 ampere rate.

(*h*) Whenever charging the battery from an outside source, keep the temperature of the electrolyte below 120° F. If this temperature exceeds 120° F., reduce the charging rate until the temperature drops below that figure.

(*i*) Wash the top of the battery with water and tighten the vent plugs before placing in service.

(*j*) The negative battery cable is grounded to a rear cylinder-head stud. Connect this cable to the negative (—) post of the left-hand battery unit. Place this cable in such position that it will not interfere with removing a vent cap. Connect the positive (+) battery cable, which is attached to the left terminal of the solenoid starting switch, to the positive (+) post of the right-hand battery. The short connecting cable connects the positive (+) post of the left-hand battery unit to the negative (—) post of the right-hand battery unit. If it has been disconnected while servicing the battery, replace it. Place all the cable connectors well down around the battery posts and tighten the bolts securely.

(6) *Electrical Connections.*—Check all electrical connections to make sure they are tight and clean, including those of distributor and spark plugs.

(7) *Crankcase Lubrication.*—Fill the crankcase with oil to the FULL level, as indicated by the bayonet gauge. Use Army No. 2-104-A oil of proper S.A.E. number according to the lowest temperature to which the power unit will be exposed, as indicated in the following table:

Temperature	S.A.E. Number
Above 32° F.	S.A.E. No. 30
Between 0° F. and 32° F.	S.A.E. No. 10 or 10W
Below 0° F.	S.A.E. No. 10 or 10W diluted with 10% kerosene as instructed in paragraph 9 *i* (1) (c).

Caution: Do not put diluted oil into the engine until ready to start it, as it may separate if allowed to stand too long before use. Mix well just before pouring into the engine. Special instructions for preparing and using this mixture are given in paragraph 9*i* (1) (*a*) through (*g*). Refer to (Fig. 64) Lubrication Chart and Assembly Outline in connection with crankcase and other lubrication.

(8) *Air Cleaner.*—Remove the oil cup from the intake-air-cleaner and fill to the proper level as marked on the cup, with oil of the same grade as used in the crankcase. Replace the cup, making sure that the snaps hold it securely in place.

(9) *Throttle Control Rod Ball Joints.* — Place a drop of light cylinder oil in each ball joint of the throttle control rod and check to make sure the throttle mechanism moves freely.

(10) *Ignition Unit.*—Place 5 drops of light oil in the oil cup on the side of the ignition unit.

(11) *Water Drain Cocks.*—Close the water drain cock at the lower radiator connection and the water drain cock on the left side of the cylinder block.

(12) *Radiator.*—Fill the radiator to one inch below the bottom of the radiator neck with clean, alkali-free water. Distilled or rain water may be used. If there is danger of freezing use a standard anti-freeze solution in proper proportion. Carefully check all connections for water leaks, correcting any found. The capacity of the cooling system is 15½ quarts.

(13) *High Water Temperature Cut-Off Switch.*—Set the dial of the high water temperature cut-off switch to indicate a temperature several degrees Fahrenheit below the boiling point of the liquid used for cooling. For water, at sea level, the setting should be 208. This should be decreased 3 degrees for each 1000 feet above sea level.

(14) *Circuit-Breaker.*—Make sure that the CIRCUIT BREAKER handle is in the OFF position so that the load is not connected to the alternator.

(15) *Load Wires.*—Check the load wires for proper connections.

(16) *AC Terminal Jumpers.* — The terminal jumpers at the a-c terminal block on the rear of the control panel are connected properly for an output of 120 volts and will need no attention if that is the desired voltage. If an output of 240 volts is desired it will be necessary to change the jumper connections. Remove the three round-headed screws from the top edge of the control panel and tip the panel outward to an approximately horizontal position. Refer to the panel wiring diagram (Fig. 14). Remove the jumpers from terminals 3 and 4 and terminals 5 and 6. Connect both jumpers across terminals 4 and 5. Tighten all nuts securely. Tip the panel up into proper position, replace the screws and tighten securely.

(17) *Close Fuel Shut-Off Valve.*—Close the 2-way fuel shut-off valve located under the main fuel tank. The lever handle extends rearward when the valve is closed.

(18) *Fuel Tank.*—Fill the main or the auxiliary fuel tank, or both, with a good grade of gasoline, **observing the usual safety precautions in the handling of this fuel.**

(19) *Open Fuel Shut-Off Valves.*—Open the 2-way fuel shut-off valve to the position corresponding with the fuel tank which is to be used. The lever handle must extend down if the main tank is to be used; forward if the auxiliary tank is to be used. Make sure that the fuel shut-off valve at the top of the sediment bulb is open.

(20) *Fuel Pump.*—By means of the lever on the side of the fuel pump, (Fig. 5), pump the carburetor bowl full of fuel. If the engine camshaft sets so that the pump diaphragm is in its lowest position, the lever will not operate the pump. In that case insert the hand crank and crank the engine one complete revolution. Then the pump can be operated by the lever. Always push the lever down after pumping. If left up, the pump will not be operated by the engine. Examine the entire fuel system for leaks and correct any found.

9. Operation.—

a. Preliminary.—When the instructions for Installation and Preparation for Use, paragraphs 7 and 8, have been complied with, the power unit is ready for use and may be started. If the power unit was prepared for cold weather operation, the initial filling with diluted oil may have been left to be done immediately before starting the power unit. Check the oil level by means of the bayonet gauge. Make sure that the crankcase is filled with proper oil to the FULL mark on the gauge before attempting to start the power unit.

b. Starting the Power Unit Electrically.—

(1) *Circuit-Breaker.*—Make sure that the CIRCUIT BREAKER (Fig. 3) is in the OFF position.

(2) *Manual Start-Remote Start Switch.*—Make sure that the MANUAL START-REMOTE START switch is in the REMOTE START position.

(3) *Start Button.*—Press the START button firmly until the engine starts and builds up oil pressure, but not more than 10 or 15 seconds. Choking is automatic and the plant should start at once. If it fails to start, wait 10 seconds and then repeat the procedure. If the START button is released too soon the ignition will be cut off and the engine will stop. If the plant does not start after a few attempts, check the fuel supply and the ignition wires and then repeat the starting procedure. NOTE: **Oil was placed in the cylinders before shipping and in some cases it may be necessary to remove and clean the spark plugs before the engine will start the first time. This may be done by washing thoroughly in gasoline.**

c. Starting the Power Unit Manually. — In case the starting battery does not furnish sufficient cranking power, the plant may be started by hand cranking. However, the battery must furnish enough power for ignition. If it does not, it must be recharged from a separate source or replaced with a charged battery. To start the plant manually, proceed as follows:

(1) *Circuit-Breaker.* — Make sure that the CIRCUIT BREAKER is in the OFF position.

(2) *Manual Start-Remote Start Switch.*—Throw the MANUAL START-REMOTE START ignition switch to the MANUAL START position.

(3) *Cranking.*—Insert the hand crank and crank the engine. Do not spin or push down on the crank. Use a strong, quick, upward pull. Repeat as necessary.

(4) *Choking.*—Choke as necessary by means of the choke control at the front of the housing. Open the choke gradually as soon as the engine starts.

(5) *Manual Start-Remote Start Switch—Running Position.*—After the engine has been started, throw the MANUAL START-REMOTE START switch to the REMOTE START position.

d. Operation After the Engine Starts.—Check the oil pressure gauge immediately after starting the engine. Pressure will be high until the engine warms up. Observe the readings of gauges and meters on the control panel as a check on the normal operation of the power unit. Normal readings for the various instruments after the plant reaches normal operating temperature are given here.

(1) ENGINE WATER TEMPERATURE, about 175° F.

(2) ENGINE OIL PRESSURE, about 22 pounds.

(3) BATTERY CHARGE RATE, 2 to 10 amperes, depends on the state of charge of the battery and the amount of load connected to the D.C. OUTPUT terminals.

(4) FUEL GAUGE, indicates the supply of fuel in the fuel tank on the plant. Does not indicate the supply in the auxiliary fuel tank.

(5) A.C. VOLTMETER, indicates the voltage at the A.C. OUTPUT terminals which should be approximately 120 volts or approximately 240 volts, depending on the jumper connections on the back of the control panel. With a constant, unity power factor load, and after reaching normal operating temperature, the voltage should be between the limits of 118 to 126 or 236 to 252 volts.

(6) A.C. AMMETER, indicates the a-c output in amperes. The actual reading depends on the amount of load, the power factor of the load and the operating voltage. At 120 volts and a unity power factor load, the full load amperage is 83. At 120 volts and an 80% power factor load, the full load amperage is 104. At 240 volts, the corresponding full load amperages are just half the above values.

(7) RUNNING TIME METER, shows the total hours the power unit has been operated.

(8) FREQUENCY METER, indicates the output frequency.

e. Connecting the Load. — Throw the CIRCUIT-BREAKER control handle to the ON position to connect the load. The CIRCUIT-BREAKER will open and disconnect the load automatically if the power unit is heavily overloaded. Throw the control handle to the OFF position to disconnect the load when desired. A 12-volt D.C. load, not exceeding 10 amperes, may be connected to the D.C. OUTPUT terminals. Connect the positive load wire to POS. terminal. Connect the negative load wire to NEG. terminal. This load may consist of radio, battery-charging or a 12-volt trouble lamp. Caution: This load must not be so heavy and long continued that the storage battery on the power unit will not have enough charge to supply ignition current to permit starting the power unit manually.

f. Housing Side Panels and Top Plates.— Keep the side panels and top plates on the housing except while servicing. They help to direct the cooling air properly and to reduce radio interference.

g. Stopping the Power Unit.—To stop the power unit, press the STOP button on the control panel. The MANUAL START-REMOTE START switch must be in the REMOTE START position before the power unit can be stopped by means of the STOP button. It is good practice to disconnect the load by throwing the CIRCUIT-BREAKER control handle to the OFF position before stopping the power unit unless the power unit is to be controlled from a remote point.

h. Remote Control.—The remote-control push button switches which may have been installed at remote points perform the same functions as the START and STOP buttons on the control panel and are used in the same manner. The CIRCUIT-BREAKER must be left in the ON position if the plant is to be operated by remote control.

i. Abnormal Operating Conditions.—Temperatures below 0° F. require special attention in regard to lubrication and cooling liquids. Unusually dirty and dusty operating conditions, which sometimes cannot be avoided, require extra attention.

(1) *Lubrication.*—

(*a*) For temperatures below 0° F. use diluted oil in the crankcase to aid in starting and to assure proper lubrication.

(*b*) If the crankcase is filled with undiluted oil, run the engine until warm. Then drain the oil and close the drain valve.

(*c*) Thoroughly mix 1 pint of kerosene with 5 quarts of Army No. 2-104-A oil, SAE No. 10 or 10W. If kerosene is not available, use 1 pint of a good grade of distillate instead. Do not use heavier than S.A.E. No. 20 oil as it may separate when the engine is stopped, thus defeating the purpose and possibly causing damage.

(*d*) Fill the crankcase with the diluted oil to the FULL mark on the bayonet gauge.

(*e*) Run the engine 10 minutes to circulate the mixture throughout the lubricating system.

(*f*) Never add kerosene alone. Mix the kerosene with the oil before pouring into the crankcase. This applies also to the addition of diluted oil between changes.

(*g*) When using diluted oil, change the oil every 50 operating hours and check the level each night and morning, or more frequently if experience shows it to be necessary.

(2) *Cooling System.*—The liquid in the cooling system must be protected if there is any possibility of its freezing. Use any good anti-freeze prepared as directed by the manufacturer. Common ones are alcohol, glycerin, Prestone and Zerone. Never use kerosene or distillate in the cooling system.

(*a*) If the power unit has been used, drain and flush the cooling system with running water or a special flushing agent. Run the plant until warm before draining. Never flush a very cold plant with water or any solution which may freeze upon contact with the cold metal and cause damage.

(*b*) Close the drain cocks and fill the cooling system to a point one inch below the bottom of the radiator neck with water and anti-freeze in proper proportions, depending on the kind of anti-freeze and the degree of protection needed. **Do not fill to overflowing.**

(*c*) Check the cooling mixture often, both as to the amount and the degree of protection. Provide protection enough to take care of any unexpected drop in temperature.

(3) *Dust and Dirt.*—When the power unit is operated under dusty conditions it is necessary to check and service it more often.

(*a*) Keep the plant as clean as possible.

(*b*) Keep supplies of fuel and oil in air tight containers.

(*c*) Clean the air cleaner and refill the oil cup as often as is necessary. Check daily.